

Jon Fauer, ASC

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ALEXA 35 Camera Report



FILM AND DIGITAL TIMES

Art, Technique and Technology

Film and Digital Times is the guide to technique and technology, tools and how-tos for Cinematographers, Photographers, Directors, Producers, Studio Executives, Camera Assistants, Camera Operators, Grips, Gaffers, Crews, Rental Houses, and Manufacturers.

It's written, edited, and published by Jon Fauer, ASC, an award-winning Cinematographer and Director. He is the author of 14 bestselling books—over 120,000 in print—famous for their user-friendly way of explaining things. With inside-the-industry “secrets-of-the-pros” information, *Film and Digital Times* is delivered to you by subscription or invitation, online or on paper. We don't take ads and are supported by readers and sponsors.

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Contents: June 2022 Issue 115 ALEXA 35 Camera Report

Introduction: ALEXA 35.....	4-5
ALEXA 35 Details.....	6-9
ALEXA 35 Camera Body.....	10
"Accessories oft Proclaim the Camera".....	11
Camera Prep: Lens Mounts and Front.....	12
Prep: Camera Left Side.....	13
Prep: Camera Right Side.....	14
Prep: Camera Right Rear with PDM-1.....	15
Prep: Camera Left Rear.....	16
Prep: Camera Top.....	17
Camera Bottom.....	17
Cool Running.....	18
This BUD's for Air and Balance.....	19
Outfitting ALEXA 35.....	20
Studio Mode.....	21-22
Almost Unlimited Viewfinder Positions.....	23
Multi Viewfinder MVF-2 In-Out, Front-Back Positions.....	24
Multi Viewfinder MVF-2.....	25
ALEXA 35 Textures.....	26
ALEXA 35 Lens Mounts.....	26
Batteries.....	27
ARRI Camera Companion on iPad (or M1 Macs).....	28
ARRI Camera Companion on iPhone.....	29
ALEXA 35 and DaVinci Resolve Introduction.....	30-31
Sensor Modes, Resolutions, Formats, Dimensions, Frame Rates.....	32
Recording Formats, Data Rates, Recording Time.....	33
Recording Formats and Pre-Record.....	33
ALEXA 35 Specifications.....	34-35
Some ALEXA 35 Sensor Modes (Recording Formats).....	36
Some ALEXA 35 Framelines.....	36
ALEXA History.....	37
Christoph Stahl, ARRI Shareholder Representative.....	38-39

Dr. Matthias Erb & Dr. Michael Neuhaeuser, ARRI Executive Board.....	40-41
Stephan Schenk, ARRI General Manager Global Sales and Solutions.....	42-43
Walter Trauninger, Head of Business Unit Camera Systems.....	44
Marc Shipman-Mueller, Senior Product Manager at ARRI.....	45-49
Dr. Achim Oehler, Head of Sensor Design and Imaging Front-End.....	50-51
Harald Brendel on Image Science.....	52-55
Dr. Tamara Seybold on Textures.....	56-57
Christian (Geoffrey) Grafwallner, Workflow Product Manager.....	58-60
ARRI Reference Tool (ART).....	61
Christian Hartl, Director of Global Production.....	62-63
Sandra Yap, Head of Assembly and Testing.....	64-65
Jeanfre Fachon, Product Manager for Camera Support Systems.....	66-67
"Jeanfre Wants to See Daylight through the Accessories".....	68
Dr. Michael Frank, Head of Business Unit Camera Systems and R&D.....	69-71
Elisa Weiss, Head of Center of Competence R&D Excellence.....	72-73
Clean Room.....	74
Michael Stadler, Head of Testing.....	75-76
Jan Heugel, Global Field Test Coordinator.....	77
Field Tests.....	78
Henning Raedlein on ALEXA 35 <i>Encounters</i>	79-80
Eleven ALEXA 35 <i>Encounters</i>	81
Argentina: <i>An Ancestral Path</i>	82
Argentina: <i>An Ancestral Path</i>	83
Australia: <i>Sweetheart</i>	84
China: <i>Tigerine</i>	85
France: <i>Avoid Boredom</i>	86
Germany: <i>Nice</i>	87
India: <i>Through the Colors</i>	88
Japan: <i>Found It</i>	89
Korea: <i>Treasure Hunter</i>	90
Nigeria: <i>The Painting</i>	91
UK: <i>The Siren</i>	92
USA: <i>The Swing</i>	93



Introduction: ALEXA 35



You may ask, why was FDTimes serially missing from BSC Expo and AFC Micro Salon and NAB? Some of you mischievously bestowed virtual awards for the most minimalistic, unoccupied booth at NAB. The new ARRI ALEXA 35 is the good reason why.

Missing BSC Expo, AFC Micro Salon and NAB were necessary just to wade through massive amounts of information and equipment that kept landing here—requiring, like *Hamilton*, to “write day and night like it’s going out of style.”

An ALEXA 35 pre-production test camera was delivered to the FDT office by ARRI’s Guenter Noessner on March 18. The result, 74 days later at camera launch, is this camera report of 96 pages. Initially, the June edition was planned with some pages of ALEXA 35 along with many other products that missed the April deadline. The page count kept growing, a massive Dickensian doorstop. And then, real world supply chain challenges arrived, and not only limited to semiconductors, copper, cars and aluminum. Paper deliveries, and ink for the paper this is printed on, dried up.

But, that is not the only reason all 96 pages are monopolized by ALEXA 35. If you send a camera here three months before deadline, you know that it will be tried, taken out, taken apart, scrutinized and tested like a ship’s open water sea trial. Every angle and surface will be photographed with as much obsession as Col. Henry Charles Baskerville Tanner, the Victorian surveyor-artist who mapped the Himalayas.

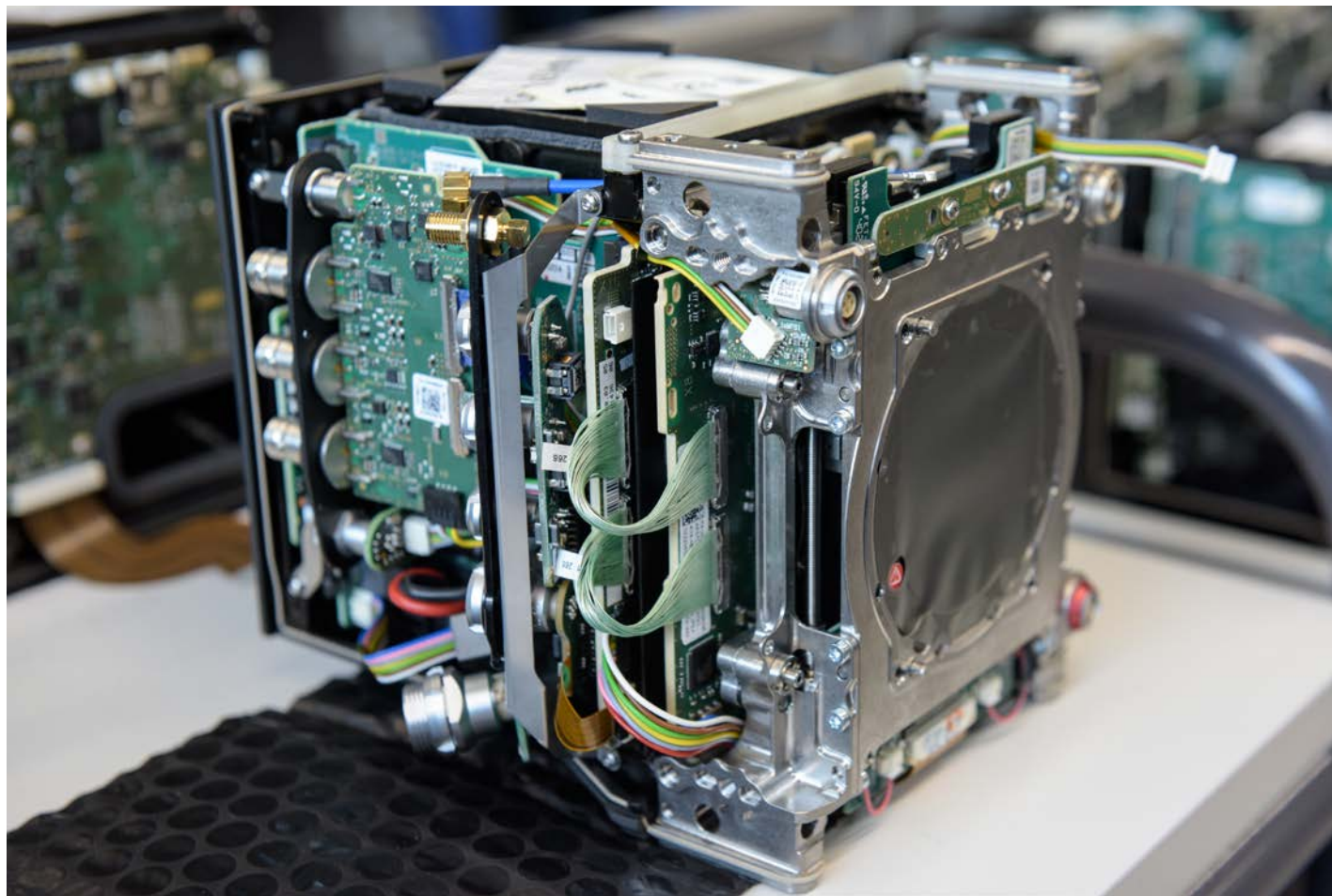
Moreover, this was the first time a company has made available so many scientists, engineers, executives, product managers,

designers, testers and planners to talk about their work in lengthy discussions. Usually a factory visit is a sweaty tour lasting a couple of days, punctuated by a few meetings of short duration. (By the way, “Sweaty Tours” was what film director Mel London called location scouting trips.) This time, it was Zoom that enabled so many fascinating, in-depth interviews.

The new ALEXA 35 is like a film lab inside a digital camera. A film lab is an alchemy of permutations: chemicals, water, temperature, light and human temperament. Let’s forget the dreaded 3 a.m. call, “Oh sorry, the developing machine jammed with all your footage ruined inside.” ALEXA 35 is digital and fortunately doesn’t jam.

And yet, ALEXA 35 offers many hitherto unobtainable digital possibilities that are reminiscent of an analog film process: textures, contrast, grain, sharpness. The digital camera is no longer “just a box” onto which you put all kinds of different lenses to achieve unique looks. Now the camera itself returns as an instigator of looks, along with your good looks created by lighting, lenses, composition, art, planning and happy accidents.

I never suspected that something Super35 was afoot at ARRI, not even several years ago when they kept asking why FDTimes was writing so fervently about Full Frame: “But don’t you think there’s room for a new generation Super35 camera?” I must have caused Franz Kraus great agita at Yamazato in Amsterdam one evening after IBC. It wasn’t the sushi, but rather my unknowing (about plans of a new camera) speculation and repetition of Jeff Allen’s observation that “old” 35mm would be relegated to productions



that formerly were done in 16mm, while Full Frame would be the “new” replacement for high-end productions that previously shot on 35mm. Little did I know that ALEXA 35, or at least its sensor, had been in development for a decade or more.

It turns out that a camera this interesting and good certainly provides ample room for both formats to continue to coexist salubriously. The 35mm format has been a universal standard ever since the Lumière Brothers projected *Workers Leaving the Factory* on December 28, 1895 at the Grand Café in Paris. Along the way, cinematographers have enjoyed a vast inventory of 35mm lenses, many of them still cherished and used today. As for ARRI, there has always been a historical affinity of separate cameras for different formats: 16BL and 35BL; 16SR and 535; 416 and 435 and 765. And now: ALEXA 35 for Super35—together with ALEXA Mini LF for Large Format, a.k.a. Full Frame.

If someone told you, “The new ALEXA 35 has 17 stops of dynamic range, prettier images and better color, your inner DP instinct would most likely reply, “Great, but show me.” This healthy skepticism of verbal description—how ironic—is assuaged by viewing real and really good images. They’re here. ARRI’s series of *Encounters* films shot around the world by eleven talented cinematographers are online (arri.com) with frames and production stills beginning page 81.

ALEXA 35 represents a new chapter in the hundred and five years of ARRI. I hope you enjoy the ALEXA 35 camera system as much as I did trying it and writing all about it.

Credits

Thanks to all the people who graciously spent so much time on this project. The list is as long as an Oscar thank-you speech without the “take-them-away” music. The envelope please: Marc Shipman-Mueller at ARRI has edited every book and camera report I’ve done since the 535 and maybe before. Marc is a brilliant product manager, writer, friend and fellow windsurfer.

Thanks to all interviewees who endured long hours being interviewed by Zoom and reviewed the text. To Johannes Polta of *Renderings by polta.co* company for the best renderings in the business. For editing, logistics, help and patience: Henning Raedlein, Reagan Koester, Heiko Meyer, Marina Aytakov, Ute Asel, Celia Donnoli; Simon Duschl for guidance on DaVinci Resolve with ARRI, to Guenter Noesner of ARRI New York who started all this when he arrived with one of the first test cameras, and to anyone I inadvertently omitted.

Dr. Michael Frank acknowledged the following, in addition to those interviewed: Dr. Nicolas Dedek and Michael Cieslinski for the sensor. Project Lead: Thomas Kling (Camera System) and Stefan Purr (Camera Body). Software: Jens Peter Wittenburg. Hardware: Bernhard Raß (mechanics) and Stefan Blindhammer (electronics). Integration: Victor Gómez-Hernández. For work on the ARRI Camera Companion App: Michael Jonas, Tilman Schlenker, Bernhard Hering and Fred Merten.

Photos in this report are by Jon Fauer and ARRI. Diagrams and specifications, courtesy of ARRI, are subject to change.

ALEXA 35 Details

The anxiously-awaited ARRI ALEXA 35 is here.

Fifty test cameras, code named PIA or ARRI S35 4K, appeared around the world in past months. ARRI hadn't done this before—a massive program of “trying to break the camera,” as Product Manager Marc Shipman-Mueller put it. Test crews did not take his words literally. The cameras did not break.

ALEXA 35 launched on May 31, 2022.

A few bullet points should suffice:

- Super35 4.6K (4608 x 3164) 4:3 sensor
27.99 x 19.22 mm (33.96 mm Ø), 6.075 µm photosite pitch.
- Yes, standard 35mm format (pre-Super35 era) lenses with 28 mm Ø image circles cover a 4K image area on the sensor and fulfill 4K mandates.

- 17 stops of dynamic range.
1.5 more stops in highlights and 1 stop more in shadows than ALEXA Mini.
- 0.75 - 120 fps.
- EI 160 to 6400, with Enhanced Sensitivity 2560 - 6400.
- Lower noise.
- New Image Science.
- Textures are like different film stocks, offering choices of grain and contrast that are baked into the image. You cannot “unbake” it at this time. But isn't that permanence the point? Didn't Gordon Willis, ASC expose film negative so close to the edge of disaster that it would be almost impossible for a producer to try to pull it back later in post?



ALEXA 35 Details

- Textures are not like LUTs that travel in the metadata and are loaded, added or removed in post. We'll get to LUTs later.
- Improved color, reduced lens cavity flare.
- View SDR and HDR simultaneously on two monitors, or in the EVF at the push of a button— with the same look.
- Light weight, compact Mini size.
- New system of thoughtful accessories with rounded, smooth edges and lots of cut-outs to make them super lightweight. Probably more aluminum was CNC'd and recycled than the remaining accessory itself. As Jeanfre Fachon said, "you can see the sky through them."

- 24 Volt power input—cabled or with on-board battery.
- Enough 24 V and 12 V accessory outputs and amperage to power at least 7 on-board electronic accessories.
- Remote camera control via iPhone, iPad or M1 Mac apps.

But this is FDTimes, and a few bullet points are never enough when 96 pages beckon.

Let's prep the camera, add its ergonomic accessories, talk about the menu, 19 recording formats, post production, Compact Drive media, go into painful detail about REVEAL color science, talk to many of the engineers, scientists, product managers and executives who created ALEXA 35.





Camera right side.

ALEXA 35 in Studio Mode for full-on production is still compact and lightweight.

Shown with OConnor Ultimate 1040 fluid head on Sachtler Flowtech 100 Tripod.



Camera left side.

ALEXA 35 in Studio Mode.

Shown with Anton/Bauer
Dionic 26V
Gold Mount Plus Battery.

ALEXA 35 Camera Body

Left



It begins with a compact body about 10 mm larger than ALEXA Mini but with a lot more processing power.

ALEXA 35 measures 5.8" x 6" x 8" / 147 x 152.5 x 203 mm (without antennas). It weighs about 6.4 lb / 2.9 kg, which is 300 grams more than Mini LE, despite being machined from aluminum. It's not carbon fiber. We'll get to the advantages later.

Front



Right



Rear



“Accessories oft Proclaim the Camera”



Shakespeare wrote, “The apparel oft proclaims the man.” (*Hamlet*, c. 1600.)

A hundred years earlier, Erasmus wrote, “Vestis virum facit.” (*Adagia*, c 1500.)

Just as clothes make the man or woman, accessories make the camera.

As ALEXA 35 was being developed, its companion accessories were being designed at the same time.

The result is an integrated, versatile, quick and ergonomic system for almost any camera setup you might encounter.

So, let's continue and build the camera from the bare body on the opposite page to various configurations from handheld to fully-festooned studio mode, and all kinds of other scenarios in between.

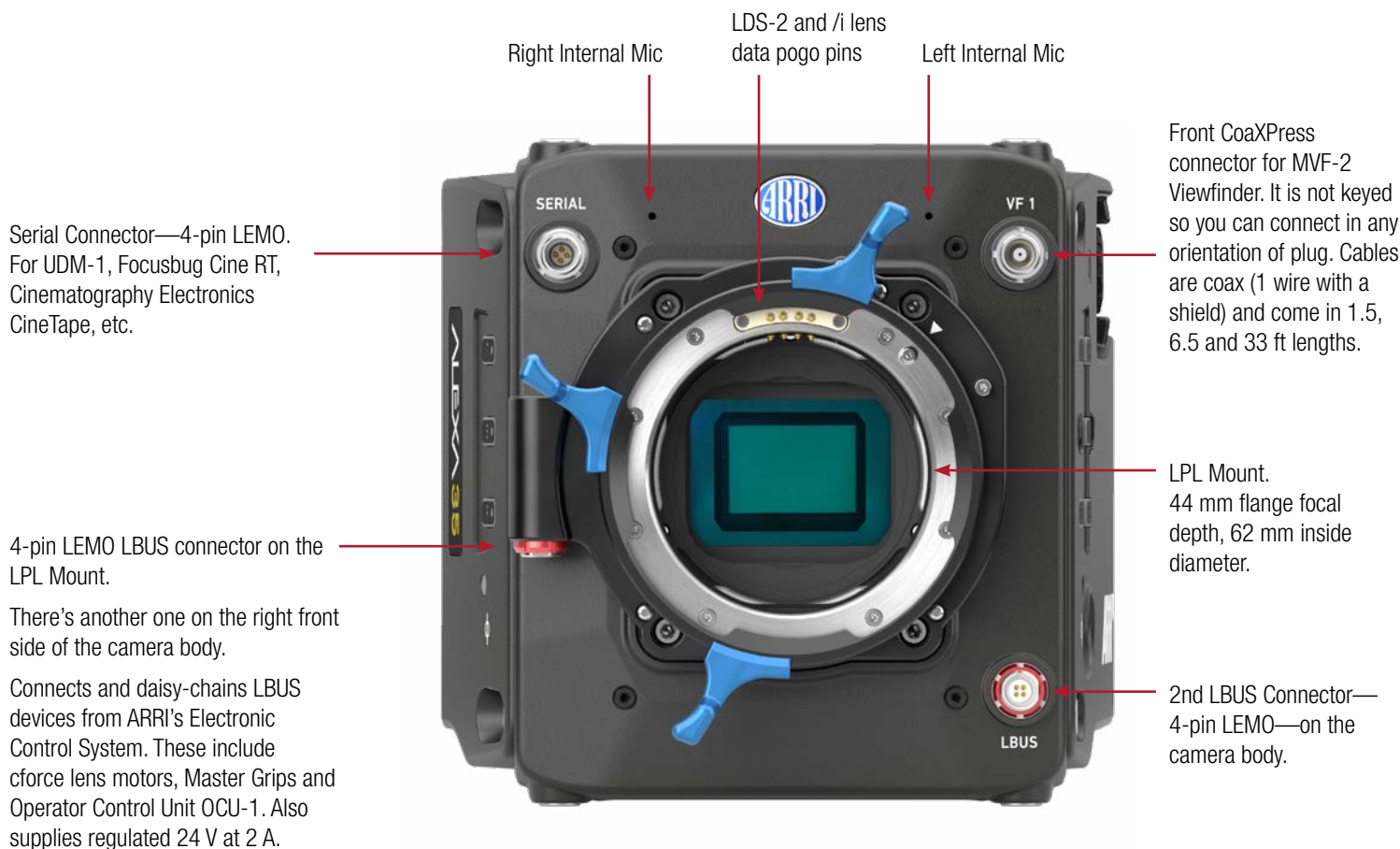
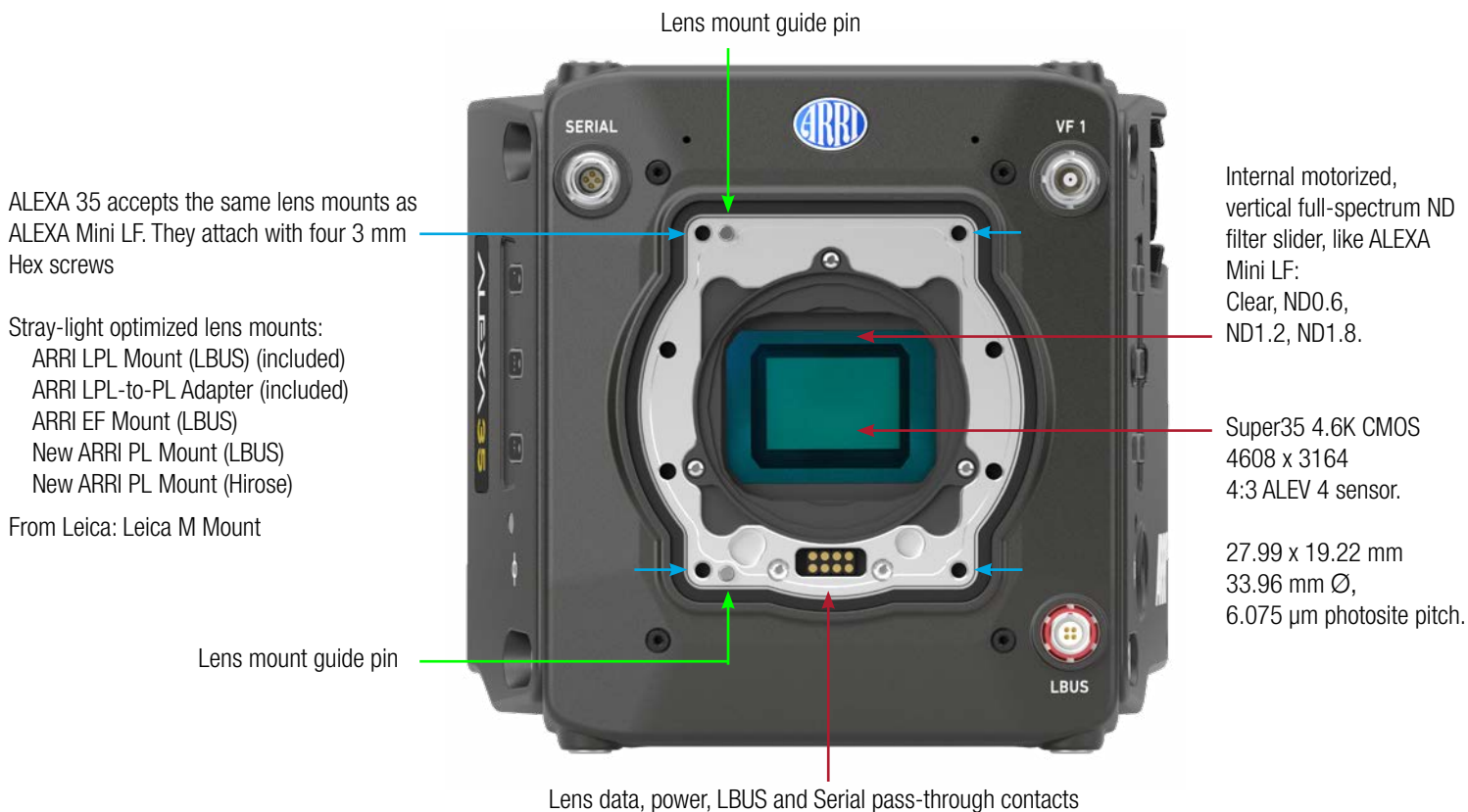


Studio Full-On Production Mode



Lightweight and Handheld Mode

Camera Prep: Lens Mounts and Front



Prep: Camera Left Side

Camera Left Display:

Home, Page 1

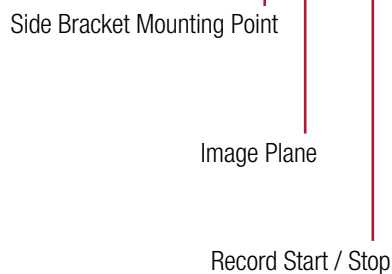
FPS frames per second
Shutter angle in degrees
EI exposure index (ISO)
ND internal ND setting
WB white balance

Info, Page 2

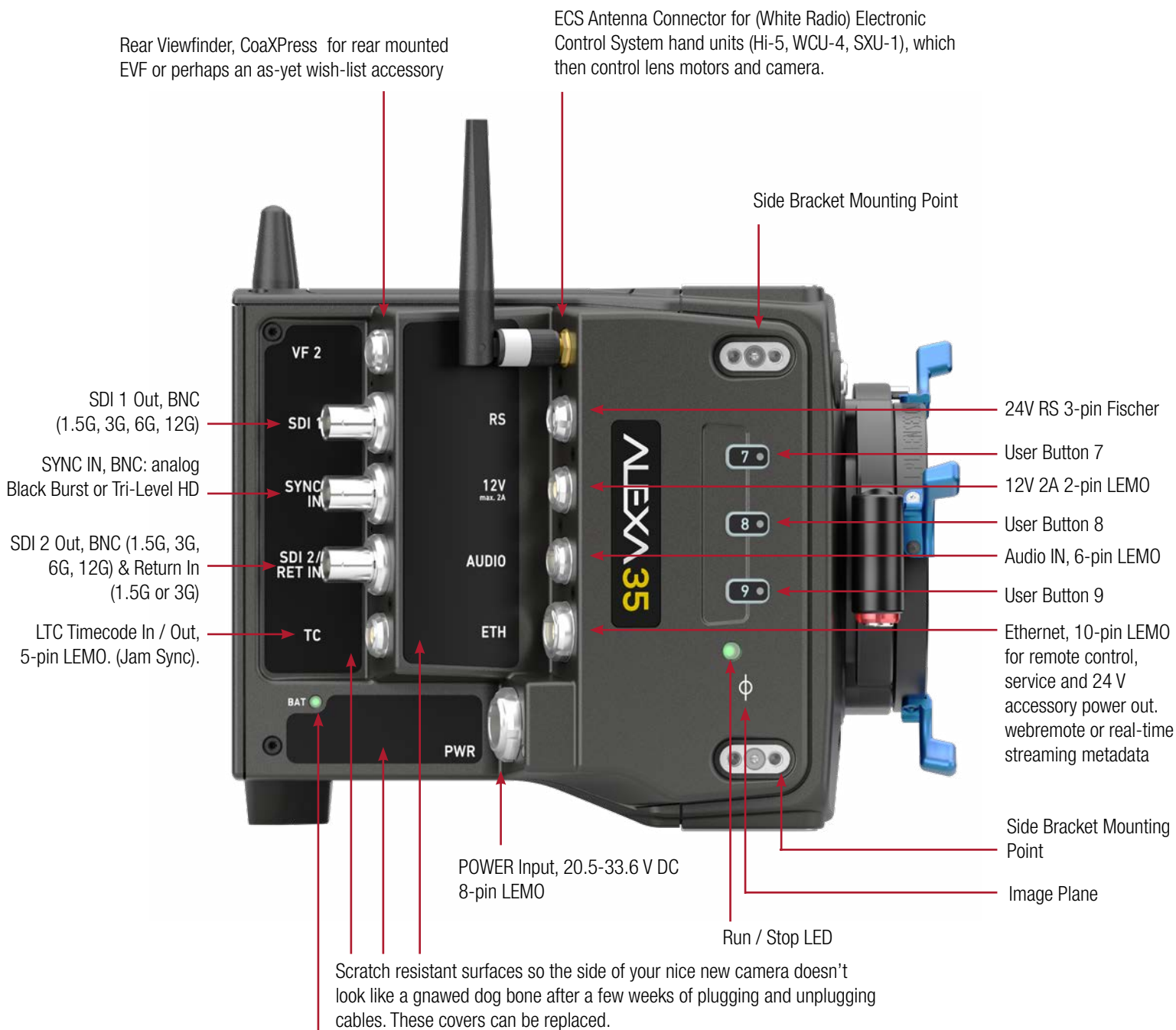
Sensor Mode & Recording Resolution
Media remaining
BAT: On-board battery status
PWR: block battery status
Look
Texture
ETH: IP address

Settings, Page 3

WiFi
Display Mode
Display Brightness
User Button Brightness
Erase Media



Prep: Camera Right Side



Onboard Battery Status LED with the color codes shown at right. There is another battery status LED to the right of the PWR connector with the same color codes.

Green: Active Input	Solid	Sufficient power
	Blinking	Warning, power low
Blue: Standby Input	Solid	Sufficient power
	Blinking	Warning, power low
White: Camera off	Solid	Sufficient Power
	Blinking	Warning, power low
Red	Blinking	Insufficient Power

Prep: Camera Right Rear with PDM-1

You can never have enough accessory power outlets, right?

A bare-body ALEXA 35 has one 24V and one 12V socket.

Add an ARRI Power Distribution Module PDM-1 and you get a total of five 24V 4A RS 3-pin, and three 12V 2A 2-pin LEMO connectors.



ALEXA 35 Rear Modules



24V B-Mount battery plate, camera side.

SONOSAX Audio Extension Module AEM-1

Power Distribution Module PDM-1

Prep: Camera Left Rear



Rear Modules, Either / Or:

+ And Rear Battery Plate:



Power Distribution Module PDM-1



SONOSAX Audio Extension Module AEM-1
(You cannot stack the PDM-1 and AEM-1 module together at the same time.)



24V B-Mount Battery Plate

Prep: Camera Top



Viewed from the top and bottom, ALEXA 35 looks like a wind tunnel.

That's essentially what it is: air is inhaled from the bottom and exhaled out of the top.

The fan is whisper-quiet. Your sound-mixer will not complain, even on the quietest set and most intimate close-up. As

David Ogilvy wrote 63 years ago in one of the most famous ads of all time, "At 60 miles an hour the loudest noise in this new Rolls-Royce comes from the electric clock."

Today, you could write, "At 60 frame per second the loudest noise in this ALEXA 35 comes from the director sipping coffee in video village 35 feet away."

It's clear that much of the space inside ALEXA 35 is devoted to cooling the sensor and processing circuits.

Camera Bottom



And what about spray at sea or rain in Vancouver? The cooling system is like the chimney in your Mac Pro. The sensitive sensor and essential electronics are sealed in separate chambers. As with any camera, you want to use a rain or spray cover and not pour buckets of water directly down the chimney.

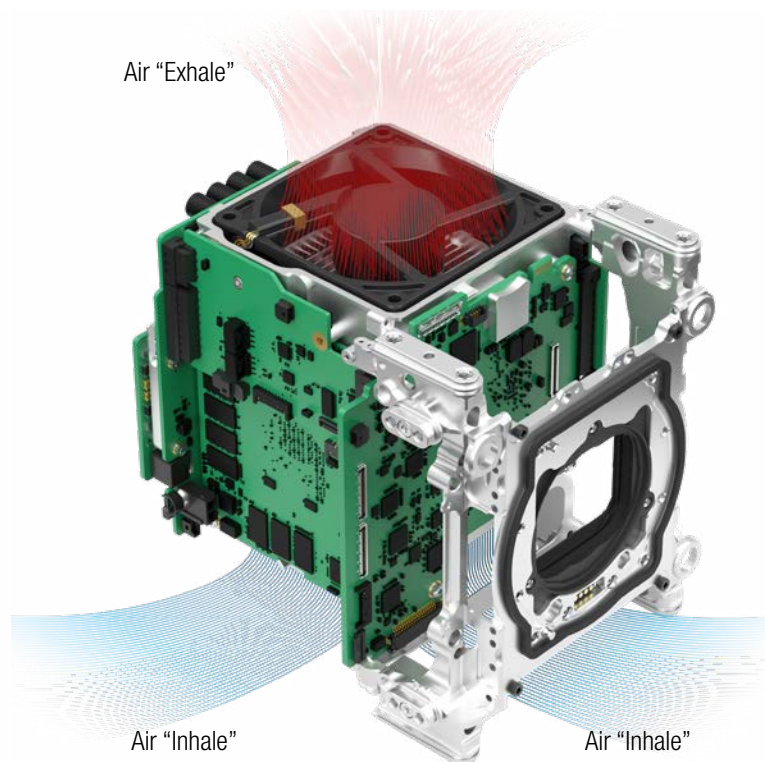
But the camera is sealed tighter than previous ARRI cameras, so it takes a sprinkling. Be sure not to block the intake or exhaust.

The fan is easily replaceable (remove four screws on top for access).

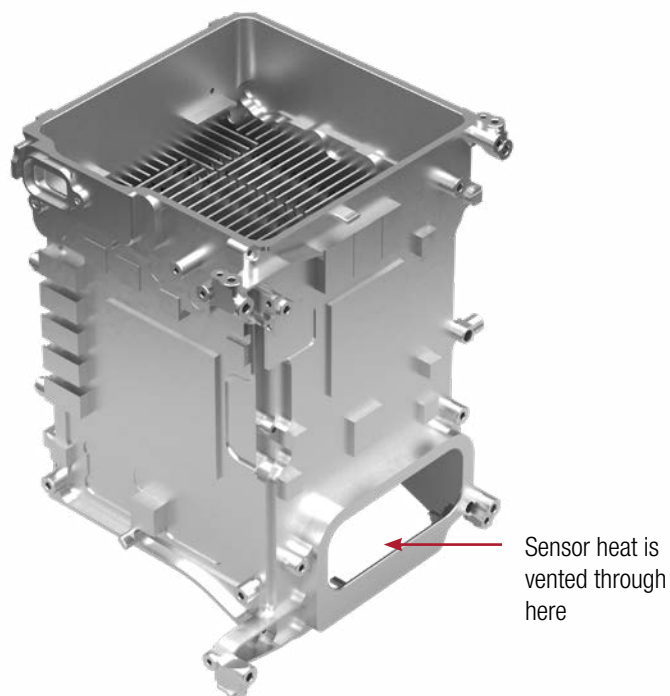
As with ALEXA Mini LF, note that there are no $\frac{3}{8}$ -16 tripod threads or $\frac{1}{4}$ -20 mounting points on the camera body itself. Instead, you attach an entirely new generation of lightweight top, bottom and side mounts — providing enough permutations of camera operating flexibility to anticipate almost any setup, real or dreamed of.

Note: Photos of the ALEXA 35 on this page are of a pre-production test model. The code-name "ARRI S35 4K" has changed but almost everything else is the same.

Cool Running



ALEXA 35 deconstructed from exterior to exploded interior views



This BUD's for Air and Balance



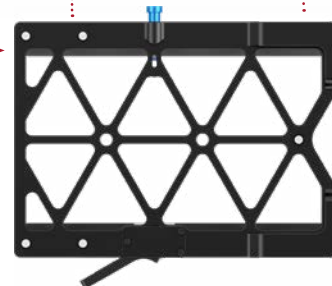
1. Because the camera cooling air intake is located at the cutout bottom rear portion of the camera, you cannot simply rest it on your shoulder. Thanks to a mesh screen, your fine cashmere sweater will not be inhaled by the cooling fan blades, but your shoulder blockage could heat things up.



Balance Utility Dovetail BUD-1
(top view)



BUD-1 — front view



2. That is the reason for the Balance Utility Dovetail BUD-1 bottom plate. It's the intermediary between camera body and everything else that attaches below: lightweight supports, shoulder pads, quick release baseplates, bridge plates.



3. BUD-1 maintains a gap between the air intake at the bottom of the camera and everything else. BUD attaches with two M4 (3mm hex head) screws on each side, and one in the back. See the black locking lever on the camera right side? BUD slides forward and aft for balance. There's a blue safety lock on the camera left side.



4. The Compact Shoulder Pad CSP-2 slides onto BUD-1 for 16SR-style shoulder-resting.

Outfitting ALEXA 35

Remember Rusty Gates, infamous first camera assistant? It's 6 am and he's setting up an ALEXA 35 for the first time. He missed his camera checkout, having been away on holiday on a beach in Tahiti. Rusty didn't see FDTimes at the news stand in Papeete's Faa'a International Airport, and so his long-suffering second is guiding him from bare camera to handheld mode to studio setup. It goes like this:



ALEXA 35 Minimal Mode. Add a lens, plug in a power cable and you're ready to go on a gimbal, stabilizer or rig.



Lightweight Camera Handle LCH-1



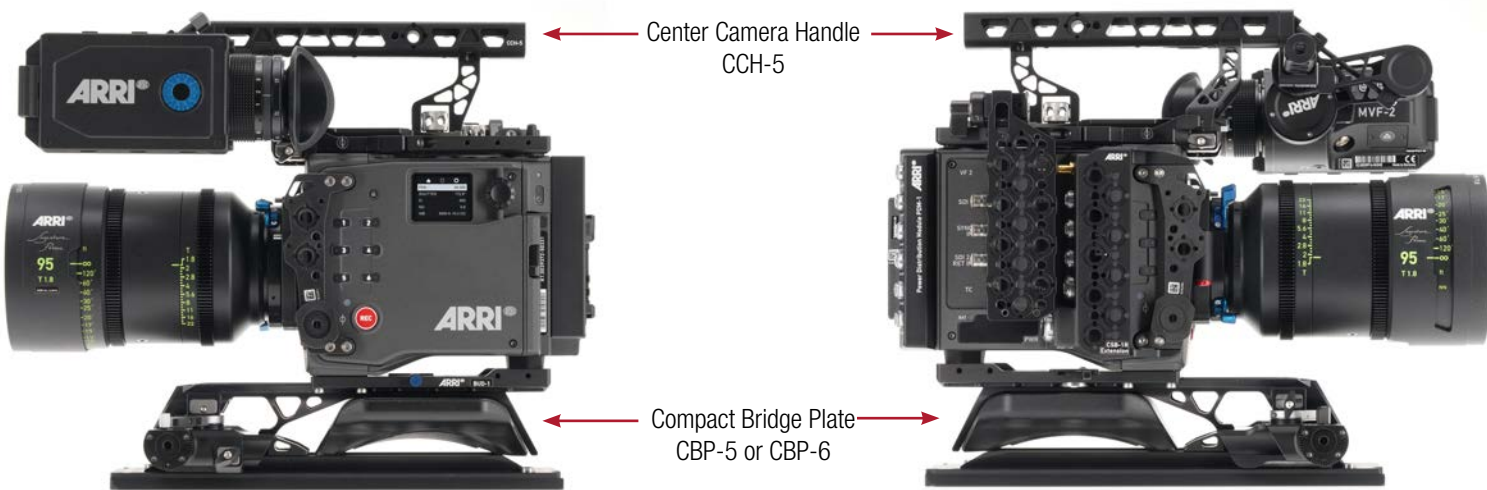
Compact Shoulder Pad CSP-2

ALEXA 35 Lightweight Handheld Mode—16SR style CSP-2 flat base (with center-contoured shoulder rest) and carbon fiber top handle.

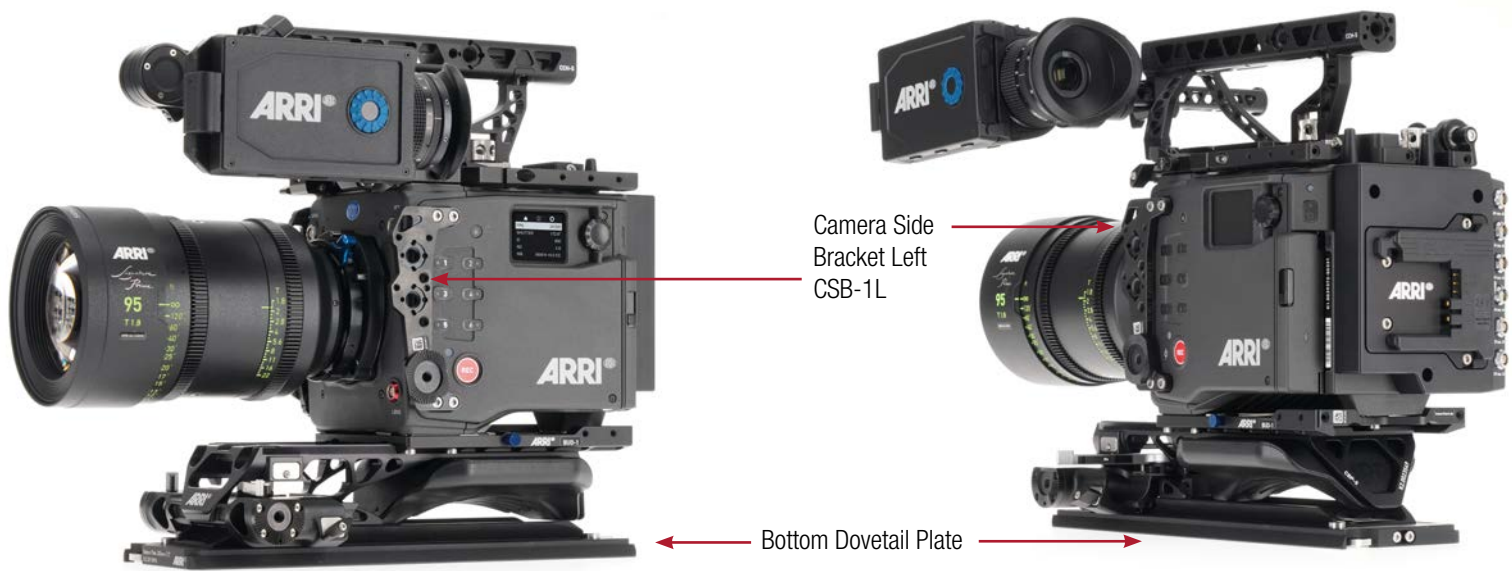


When shoulder-resting, do not assume this is like an Arriflex 235. The curved base is there for cooling. Use a shoulder pad that allows air to enter the camera from the bottom.

Studio Mode



ALEXA 35 Studio (Full-On Production) Mode—Enables quick-change from studio bridge plate to integrated handheld shoulder pad



Articulating Mounting Plate AMP-1 can slide up and down and flip up



Studio Mode, cont'd



Rear



Front



Right



Top



Bottom

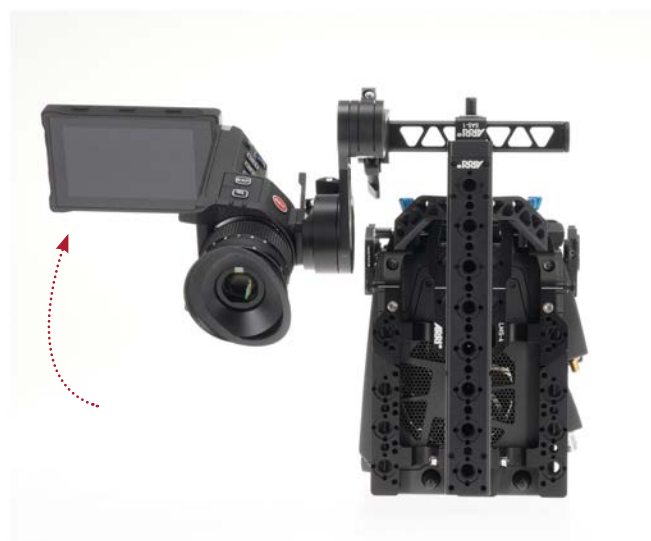
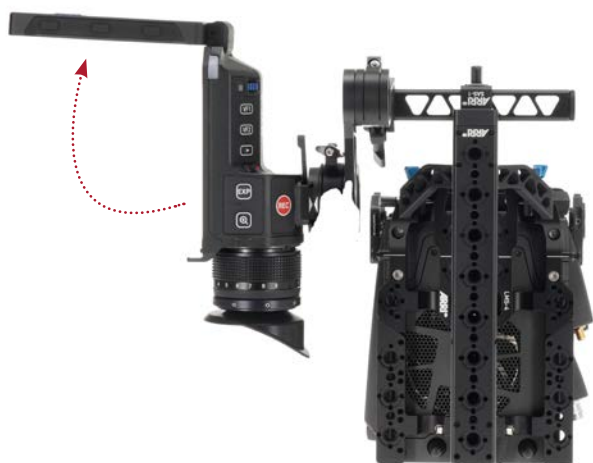
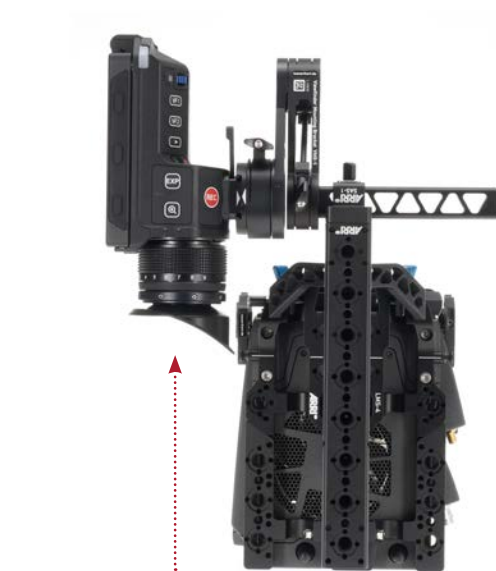
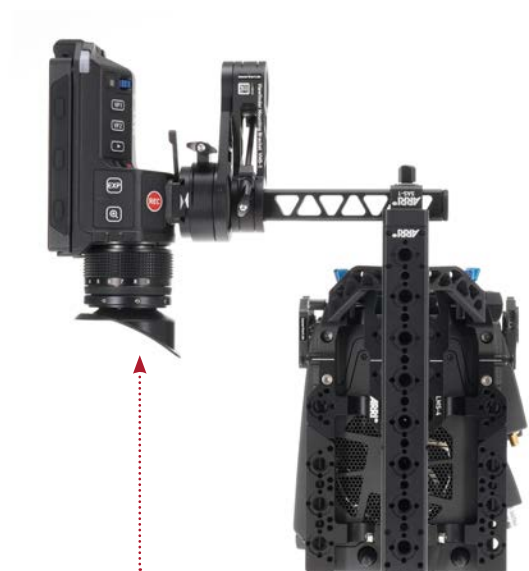
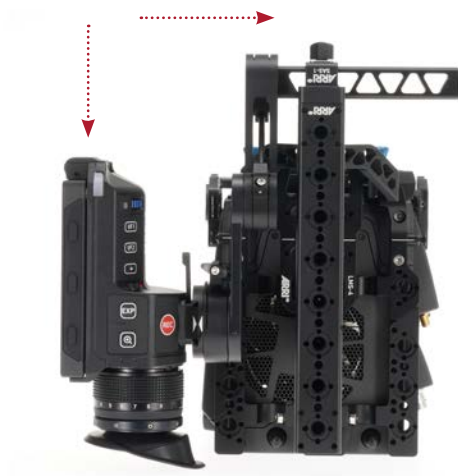
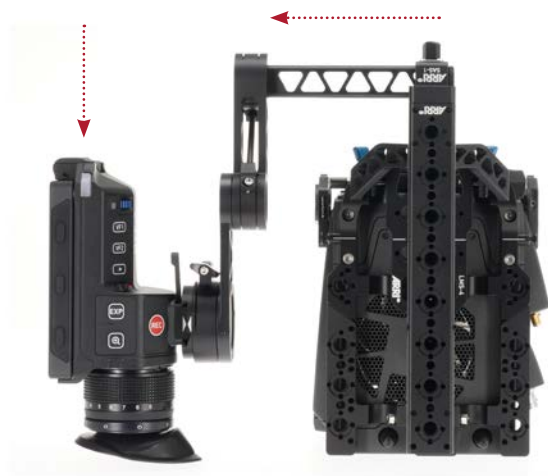


Bottom

Almost Unlimited Viewfinder Positions



Multi Viewfinder MVF-2 In-Out, Front-Back Positions



Multi Viewfinder MVF-2



Multifunctional OLED EVF with swing-out 4" LCD Monitor/Menu connects with a keyless CoaXpress cable available in lengths up to 33'. As with ALEXA Mini LF, the MVF-2 provides live viewing or full menu control.



ALEXA 35 Textures

ALEXA 35 Textures are like a film lab in a box, the box being the camera. Textures are designated as characters with names. For example, let's decipher P425 Cosmetic. From left to right:

1. The first letter indicates the type of grain. There are different letters for different types, but the letters are arbitrary.
2. The first number (2nd character) is the amount of grain. The higher the number (0-9), the greater amount of grain.
3. Next is the amount of contrast of fine details (e.g. edges, skin tones). The higher the number (0-9), the greater the contrast.
4. The 4th character is the amount of contrast of coarse detail (e.g. overall shapes).

ALEXA 35 Textures at camera launch may include the following:

- K445 Default Go-to for most situations. Smooth skin tones, excellent clarity and detail.
- P425 Cosmetic Softer texture, close to the default, more forgiving on skin tones. Low to moderate grain.
- P325 Soft Cosmetic Softer texture than Cosmetic.
- G733 Nostalgic More grain (higher first number), vintage, softer, less saturation.
- G522 Soft Nostalgic Softer texture than Nostalgic
- F567 Clarity Greater sharpness and detail compared to the Default. Good for landscapes, trees, product shots.
- F578 High Clarity Even more detail than Clarity.
- L345 Shadow As the name says, works well for dark scenes, with grain reminiscent of the toe of color negative film.
- H457 Deep Shadow For very dark scenes, less saturated grain with more shadow detail than Shadow Texture.

ALEXA 35 Lens Mounts

These lens mounts fit ALEXA Mini LF and Mini. Two new PL Mounts with LBUS and Hirose connectors have greater light baffling.



ARRI LPL Mount with LBUS connector



ARRI LPL to PL Mount Adapter



Leica M mount made by Leitz for ARRI ALEXA 35



ARRI PL Mount with LBUS connector



ARRI PL Mount with Hirose connector



EF Mount with LBUS connector, made by ARRI

26V Batteries



B-Mount 26V battery adapter on the back of ALEXA 35.

26V alternative to B-Mount: Anton/Bauer 26V Gold Mount Plus battery adapter for the ALEXA 35.



In addition to 26V Gold Mount Plus batteries, Anton/Bauer now makes 26V B-Mount batteries in 98 Wh and 240 Wh, shown above.



Bebob 14.4 / 28.8 Dual-Voltage B-Mount Batteries. There are currently four different Bebob B-Mount batteries available now – from the B90cine with 86Wh capacity to the B155cine (156Wh) and the B290cine (285Wh). Bebob, based in Munich, developed the B-Mount system three years ago. It has a new, multi-voltage-capable interface that has been shared as an open, manufacturer-independent industry standard.



Hawk-Woods currently have 3 different capacities / sizes of B-Lok (B-Mount) batteries. Hazar Kinali of Hawk-Woods said, “We want to make these new batteries available everywhere, so productions traveling with the new camera can source B-lock batteries anywhere they go. ARRI brilliantly shared the design and the technical specs of B-lock with every 3rd party manufacturer. Its all for the benefit of the end-user.”

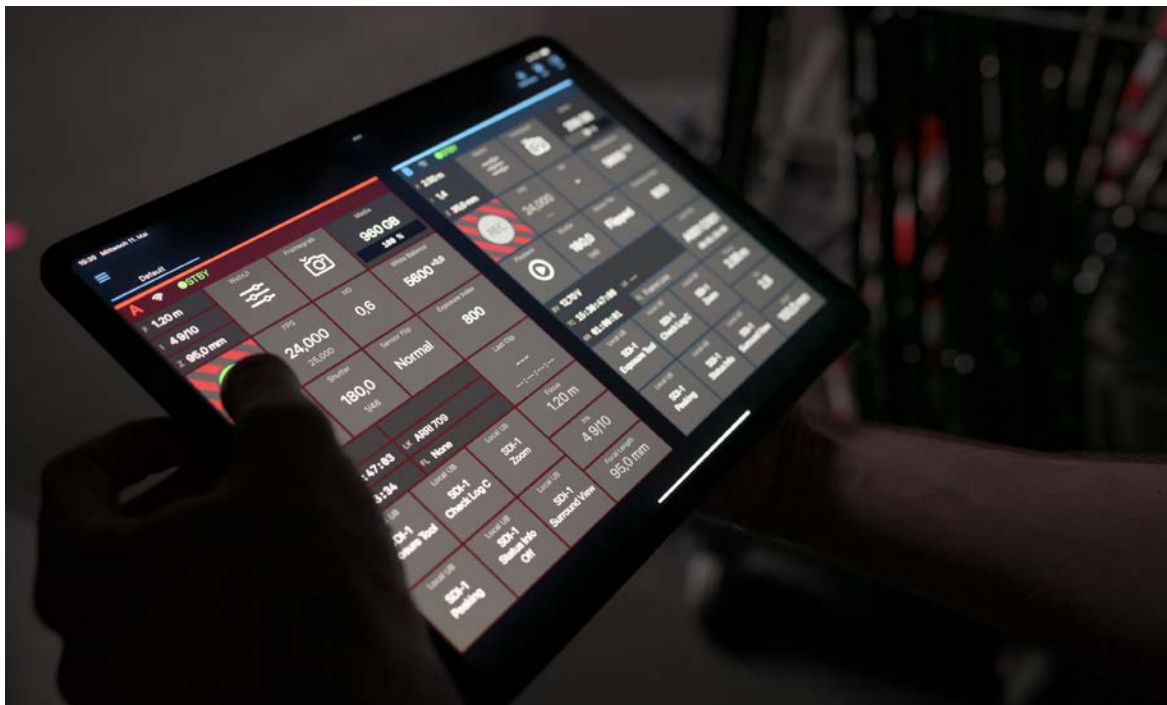


SWIT embraced the B-mount from the beginning. Their B-mount power system includes B-mount batteries, B-mount fast chargers, B-mount hot-swap plates for ARRI ALEXA SXT, LF, 65, Mini, Mini LF, and now the new ALEXA 35. The HB-A290B 290Wh 28.8V B-mount Battery Pack provides a maximum of 250W / 10A. It has two 16V D-taps, USB-C 60W in (for charging) and out (for accessories), and an OLED power information display.



Core SWX Helix Dual Voltage 14 / 28 B-mount batteries are available as 98Wh and 147Wh models. “The battery is the least interesting part of the kit but the most important,” said Ross Kanarek, CEO of CoreSWX. This should prove to be even truer as the new ALEXA 35 goes on location to remote locations around the world, shipping batteries becomes more difficult, and supplying batteries locally becomes more important to rental houses everywhere. Core SWX is based in Long Island, NY.

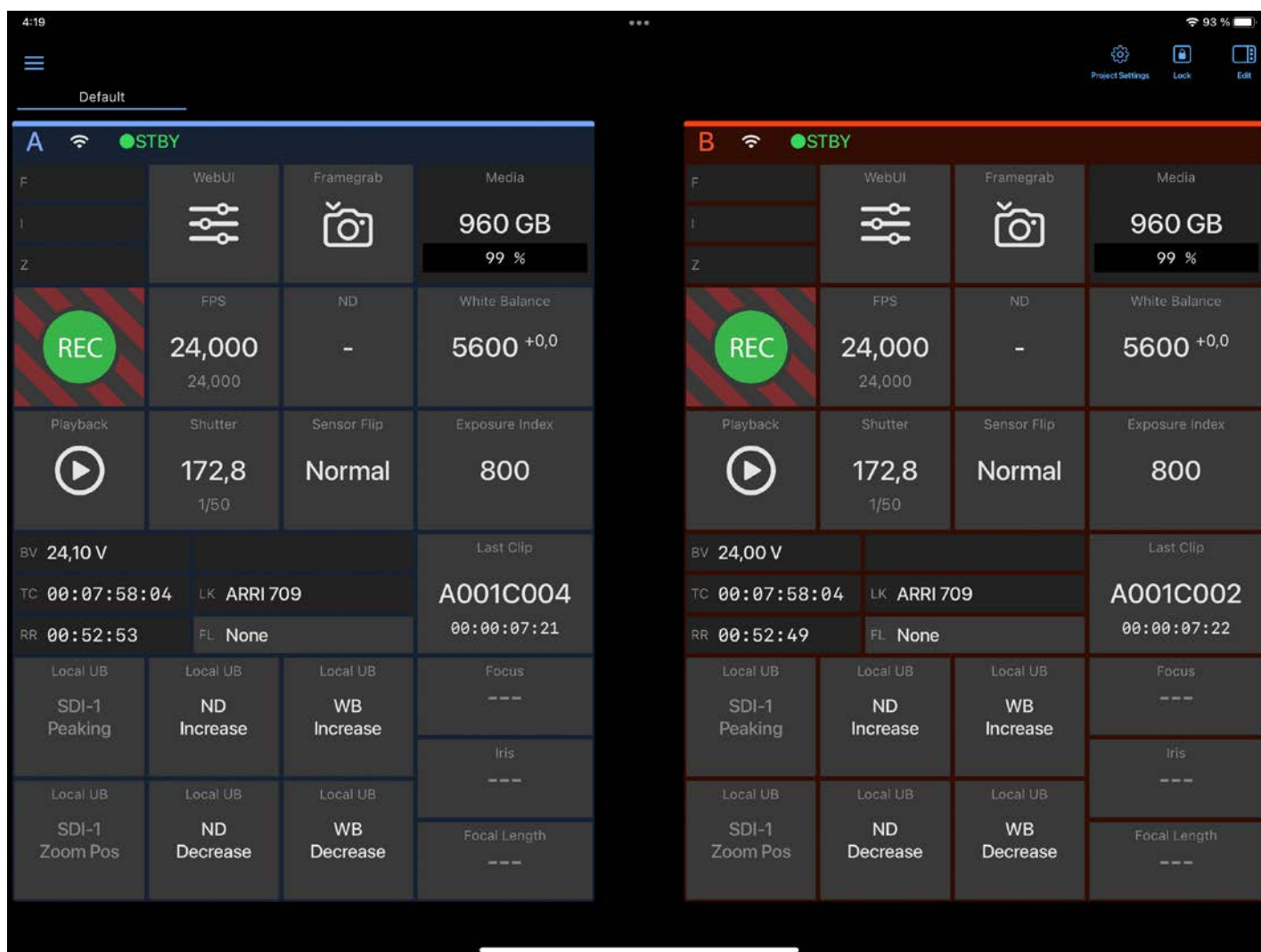
ARRI Camera Companion on iPad (or M1 Macs)



The ARRI Companion app runs on iPhone, iPad, and M1 Mac. You connect to the camera via WiFi.

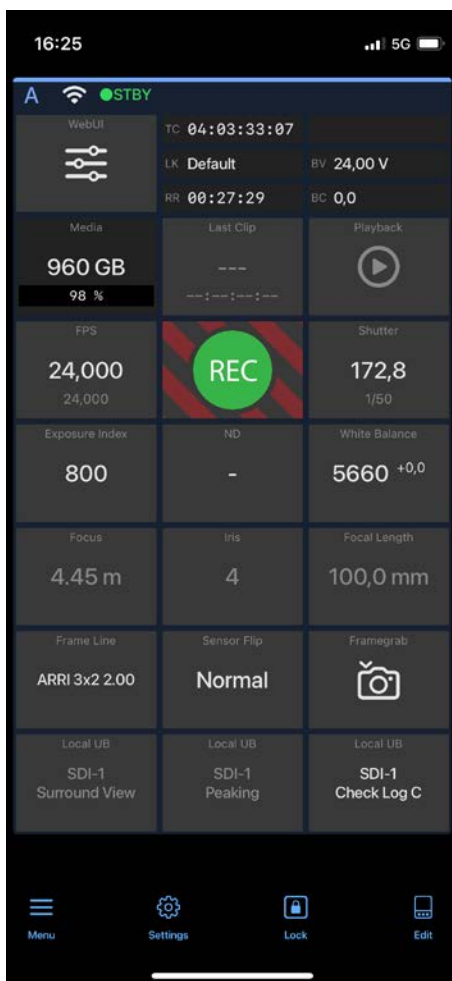
Its layout is highly customizable. In addition to the ALEXA 35, it will also control ALEXA Mini LF, ALEXA Mini and AMIRA.

The screenshots shown here were taken with a beta version.

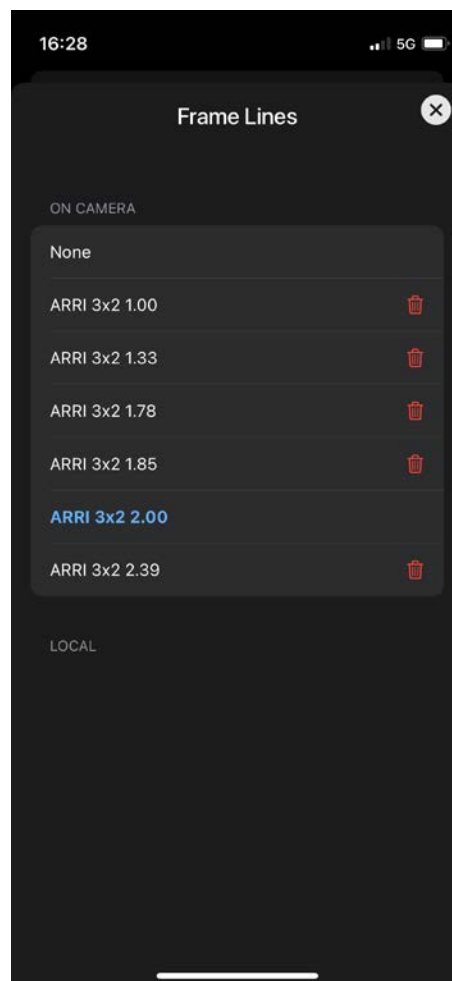


Predefined iPad user interface. The whole interface can be modified by the user.

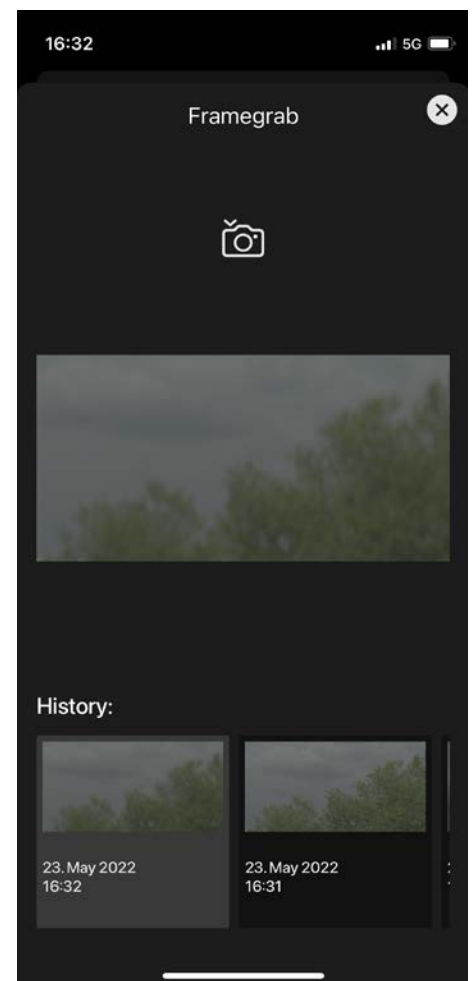
ARRI Camera Companion on iPhone



Predefined iPhone user interface. The whole interface can be modified by the user.



iPhone Frameline menu.



iPhone Framegrab menu.

ALEXA 35 and DaVinci Resolve Introduction

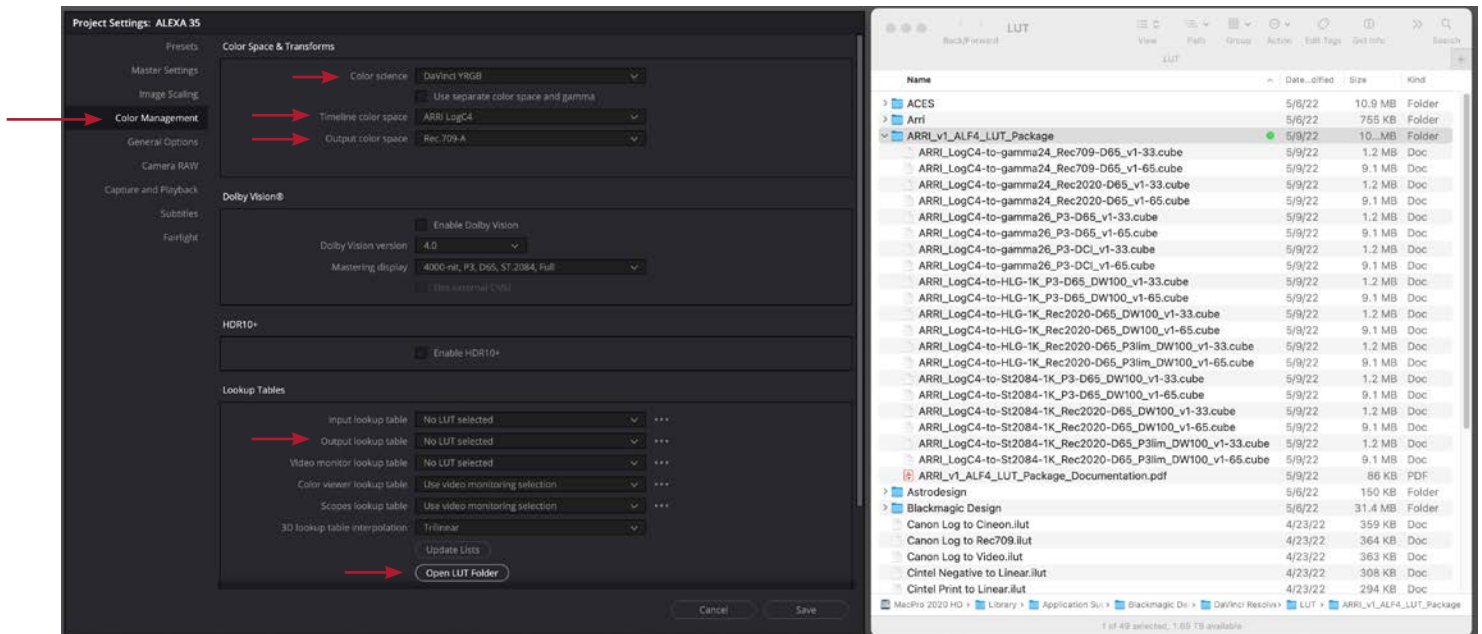
Name	Date Modified	Size	Kind
A001C003_220202_R097.mxf	2/2/22, 10:35 AM	1.71 GB	ARRIRAW MXF
A001C004_220202_R097.mxf	2/2/22, 10:35 AM	1.57 GB	ARRIRAW MXF
A001C005_220202_R097.mxf	2/2/22, 10:35 AM	526.1 MB	ARRIRAW MXF
A001C006_220202_R097.mxf	2/2/22, 10:36 AM	1.31 GB	ARRIRAW MXF
A001C007_220202_R097.mxf	2/2/22, 10:36 AM	710.3 MB	ARRIRAW MXF
A001C008_220202_R097.mxf	2/2/22, 10:36 AM	1.75 GB	ARRIRAW MXF
A001C009_220202_R097.mxf	2/2/22, 10:37 AM	771.7 MB	ARRIRAW MXF
A001C010_220202_R097.mxf	2/2/22, 10:37 AM	1.11 GB	ARRIRAW MXF
A001C011_220202_R097.mxf	2/2/22, 10:38 AM	2.35 GB	ARRIRAW MXF
A001C012_220202_R097.mxf	2/2/22, 10:38 AM	1.95 GB	ARRIRAW MXF
A001C013_220202_R097.mxf	2/2/22, 10:39 AM	1.28 GB	ARRIRAW MXF
A001C014_220202_R097.mxf	2/2/22, 10:39 AM	3.06 GB	ARRIRAW MXF
A001C015_220202_R097.mxf	2/2/22, 10:40 AM	2.25 GB	ARRIRAW MXF
A001C016_220202_R097.mxf	2/2/22, 10:40 AM	1.59 GB	ARRIRAW MXF
A001C017_220202_R097.mxf	2/2/22, 10:40 AM	1.52 GB	ARRIRAW MXF

1. Early ARRIRAW test cameras' media looked like this in Mac Finder. New file-naming would be as follows:

A_001C003_220202_103025_a12RJ.mxt
A=Camera_Reel +Clip_Date_Times_a=ARRIRAW, (p=ProRes), followed by camera serial number.mxf

Name	Date Modified	Size	Kind
ARRI_LogC4-to-gamma24_Rec709-D65_v1-33.cube	5/9/22, 4:20 AM	1.2 MB	Document
ARRI_LogC4-to-gamma24_Rec709-D65_v1-65.cube	5/9/22, 4:20 AM	9.1 MB	Document
ARRI_LogC4-to-gamma24_Rec2020-D65_v1-33.cube	5/9/22, 4:22 AM	1.2 MB	Document
ARRI_LogC4-to-gamma24_Rec2020-D65_v1-65.cube	5/9/22, 4:22 AM	9.1 MB	Document
ARRI_LogC4-to-gamma26_P3-D65_v1-33.cube	5/9/22, 4:23 AM	1.2 MB	Document
ARRI_LogC4-to-gamma26_P3-D65_v1-65.cube	5/9/22, 4:23 AM	9.1 MB	Document
ARRI_LogC4-to-gamma26_P3-DCI_v1-33.cube	5/9/22, 4:25 AM	1.2 MB	Document
ARRI_LogC4-to-gamma26_P3-DCI_v1-65.cube	5/9/22, 4:25 AM	9.1 MB	Document
ARRI_LogC4-to-HLG-1K_P3-D65_DW100_v1-33.cube	5/9/22, 4:26 AM	1.2 MB	Document
ARRI_LogC4-to-HLG-1K_P3-D65_DW100_v1-65.cube	5/9/22, 4:26 AM	9.1 MB	Document
ARRI_LogC4-to-HLG-1K_Rec2020-D65_DW100_v1-33.cube	5/9/22, 4:28 AM	1.2 MB	Document
ARRI_LogC4-to-HLG-1K_Rec2020-D65_DW100_v1-65.cube	5/9/22, 4:28 AM	9.1 MB	Document
ARRI_LogC4-to-HLG-1K_Rec2020-D65_P3lim_DW100_v1-33.cube	5/9/22, 4:28 AM	1.2 MB	Document
ARRI_LogC4-to-HLG-1K_Rec2020-D65_P3lim_DW100_v1-65.cube	5/9/22, 4:29 AM	9.1 MB	Document
ARRI_LogC4-to-St2084-1K_P3-D65_DW100_v1-33.cube	5/9/22, 4:31 AM	1.2 MB	Document
ARRI_LogC4-to-St2084-1K_P3-D65_DW100_v1-65.cube	5/9/22, 4:31 AM	9.1 MB	Document
ARRI_LogC4-to-St2084-1K_Rec2020-D65_DW100_v1-33.cube	5/9/22, 4:32 AM	1.2 MB	Document
ARRI_LogC4-to-St2084-1K_Rec2020-D65_DW100_v1-65.cube	5/9/22, 4:32 AM	9.1 MB	Document
ARRI_LogC4-to-St2084-1K_Rec2020-D65_P3lim_DW100_v1-33.cube	5/9/22, 4:34 AM	1.2 MB	Document
ARRI_LogC4-to-St2084-1K_Rec2020-D65_P3lim_DW100_v1-65.cube	5/9/22, 4:34 AM	9.1 MB	Document
ARRI_v1_ALF4_LUT_Package_Documentation.pdf	5/9/22, 5:01 AM	86 KB	PDF Document

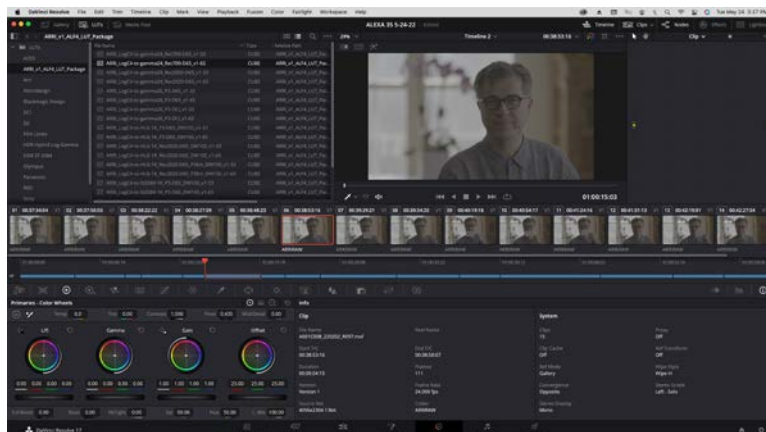
2. Here is a folder of beta ARRI LogC4 LUTs in the Mac Finder. A quick, straightforward starter LUT could be: ARRI_LogC4-to-gamma24_Rec709-D65_v1-65.cube



3. Open DaVinci Resolve. Click PROJECT SETTINGS gear at lower right.

- Go to the COLOR MANAGEMENT. The following are just suggestions.
- Click OPEN LUT FOLDER and drag the entire ARRI ALF4 LUT Package from your desktop into DaVinci Resolve's LUT Folder.

- While you're here, set your TIMELINE COLOR SPACE to ARRI LogC4.
- Set the OUTPUT COLOR SPACE to Rec.709-A.
- COLOR SCIENCE = DaVinci YRGB.
- You can set OUTPUT LOOKUP TABLE later.



4. The ARRIRAW LogC4 image ungraded is darker than what we've been used to.



5. Hover over a LUT thumbnail to preview its effect.

ALEXA 35 and DaVinci Resolve



6. (Above right.) Add a node. Note: this is still a beta version of DaVinci Resolve; things may change.

7. (Below, right.) Add another node to the left of the one you just created. Now we have two nodes. The one on the right is the "official" LUT file to do the current transformation to Rec. 709 from LogC4. The node on the left is for your creative grading to define your look in this node.

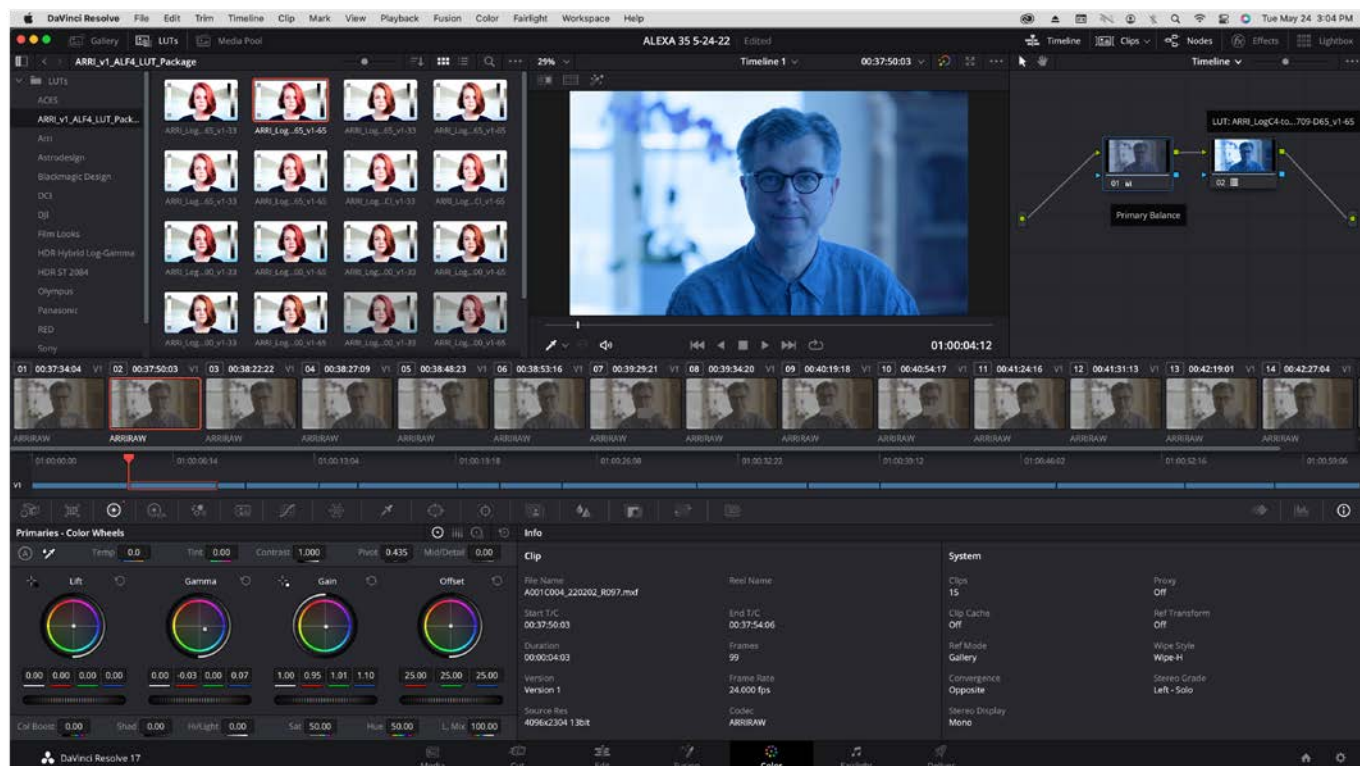
Of course, you have to use basic color correction functions like lift-gamma-gain and do your tweaking in this node.

The example below is a moonlight look on ARRI's Guenter Noesner.

And at the very end, you have to deactivate the color transform and only export the first node as a 3D LUT to import it back to the ARRI Reference Tool to create your ARRI Log file.

Note: these examples of project settings and 3D-LUT files are for Rec.709. For an HDR look, you need an HDR-capable monitor, the HDR 3D-LUT (Color Transform), and different DaVinci Resolve settings. We'll get into those in the next episodes of FDTimes.

Thanks to Simon Duschl, Digital Workflow wizard at ARRI Munich.



Sensor Modes, Resolutions, Formats, Dimensions, Frame Rates

Recording Format				Sensor Photosites					Recorded Pixels		Compact Drive Max FPS	
Codec	Sensor Mode	Recording Resolution	Recording File Setting	H	V	H mm	V mm	Diag. mm	H	V	1TB	2TB
ARRIRAW	4.6K 3:2 Open Gate	4.6K (4608 x 3164)	ARRIRAW	4608	3164	27.99	19.22	33.96	4608	3164	35	75
	4.6K 16:9	4.6K (4608 x 2592)	ARRIRAW	4608	2592	27.99	15.75	32.12	4608	2592	45	75
	4K 16:9	4K (4096 x 2304)	ARRIRAW	4096	2304	24.88	14	28.55	4096	2304	55	120
	4K 2:1	4K (4096 x 2048)	ARRIRAW	4096	2048	24.88	12.44	27.82	4096	2048	65	120
	3.3K 6:5	3.3K (3328 x 2790)	ARRIRAW	3328	2790	20.22	16.95	26.38	3328	2790	55	100
	3K 1:1	3K (3072 x 3072)	ARRIRAW	3072	3072	18.66	18.66	26.39	3072	3072	55	100
Apple ProRes	4.6K 3:2 Open Gate	4.6K (4608 x 3164)	422 HQ, 4444, 4444 XQ	4608	3164	27.99	19.22	33.96	4608	3164	60	60
	4.6K 16:9	4K (4096 x 2304)	422 H, 4444, 4444 XQ	4608	2592	27.99	15.75	32.12	4096	2304	75	75
	4K 16:9	4K (4096 x 2304)	422 HQ, 4444, 4444 XQ	4096	2304	24.88	14	28.55	4096	2304	100	100
		UHD (3840 x 2160)	422 HQ, 4444, 4444 XQ	4096	2304	24.88	14	28.55	3840	2160	120	120
		2K (2048 x 1152)	422 HQ, 4444, 4444 XQ	4096	2304	24.88	14	28.55	2048	1152	120	120
		HD (1920 x 1080)	422 HQ, 4444, 4444 XQ	4096	2304	24.88	14	28.55	1920	1080	120	120
	4K 2:1	4K (4096 x 2048)	422 HQ, 4444, 4444 XQ	4096	2048	24.88	12.44	27.82	4096	2048	120	120
	3.3K 6:5	3.3K (3328 x 2790)	422 HQ, 4444, 4444 XQ	3328	2790	20.22	16.95	26.38	3328	2790	75	75
		4K 2.39:1 Ana 2x	422 HQ, 4444, 4444 XQ	3328	2790	20.22	16.95	26.38	4096	1716	90	90
	3K 1:1	3K (3072 x 3072)	422 HQ, 4444, 4444 XQ	3072	3072	18.66	18.66	26.39	3072	3072	90	90
		3.8K 2:1 Ana 2x	422 HQ, 4444, 4444 XQ	3072	3072	18.66	18.66	26.39	3840	1920	100	100
	2.7K 8:9	UHD 16:9 Ana 2x	422 HQ, 4444, 4444 XQ	2743	3086	16.66	18.75	25.08	3840	2160	100	100
	2K 16:9 S16	2K (2048 x 1152)	422 HQ, 4444, 4444 XQ	2048	1152	12.44	7	14.27	2048	1152	120	120

Recording Formats, Data Rates, Recording Time

Recording Format			Date Rate *	Capture Card Recording Time at 24 fps **	
Codec	Sensor Mode	Recording Resolution	GB/h	1TB	2TB
ARRIRAW	4.6K 3:2 Open Gate	4.6K (4608 x 3164)	2,055	0:28	0:56
	4.6K 16:9	4.6K (4608 x 2592)	1,685	0:34	1:08
	4K 16:9	4K (4096 x 2304)	1,333	0:43	1:26
	4K 2:1	4K (4096 x 2048)	1,186	0:48	1:37
	3.3K 6:5	3.3K (3328 x 2790)	1,312	0:43	1:27
	3K 1:1	3K (3072 x 3072)	1,333	0:43	1:26
Apple ProRes	4.6K 3:2 Open Gate	4.6K (4608 x 3164)	945	1:00	2:01
	4.6K 16:9	4K (4096 x 2304)	615	1:33	3:07
	4K 16:9	4K (4096 x 2304)	615	1:33	3:07
		UHD (3840 x 2160)	541	1:46	3:32
		2K (2048 x 1152)	160	6:00	12:01
		HD (1920 x 1080)	141	6:47	13:34
	4K 2:1	4K (4096 x 2048)	547	1:45	3:30
	3.3K 6:5	3.3K (3328 x 2790)	605	1:35	3:10
		4K 2.39:1 Ana 2x	460	2:05	4:10
	3K 1:1	3K (3072 x 3072)	615	1:33	3:07
		3.8K 2:1 Ana 2x	482	1:59	3:59
	2.7K 8:9	UHD 16:9 Ana 2x	541	1:46	3:32
	2K 16:9 S16	2K (2048 x 1152)	160	6:00	12:01

* Data Rate is for 24 fps — image, audio and metadata.

Apple ProRes values are for ProRes 4444

** Recording time is in Hours:Minutes

Apple ProRes values are for ProRes 4444

Recording Formats and Pre-Record

Perhaps you're a wildlife cinematographer. Your ALEXA 35 is trained on an ornery hippo at the other end of a 600mm telephoto. You've been waiting for hours; the beast hasn't moved. You're dozing off in the heat of an African afternoon. Suddenly the hippo stirs. If ALEXA 35 didn't have a Pre-Record function, you would have missed half the shot. And so, when you pushed RECORD, the camera actually captured several seconds, stored in buffer, before you pushed the button.

The Pre-Record function is also useful on set when an over-eager actor jumps the director's call for "Action."

Recording Format			Pre-Record at 24 fps
Codec	Sensor Mode	Recording Resolution	Seconds
ARRIRAW	4.6K 3:2 Open Gate	4.6K (4608 x 3164)	2.8
	4K 16:9	4K (4096 x 2304)	4.6
	3.3K 6:5	3.3K (3328 x 2790)	4.7
Apple ProRes ***	4.6K 3:2 Open Gate	4.6K (4608 x 3164)	8.5, 5.6, 3.6
	4K 16:9	UHD (3840 x 2160)	14.2, 9.9, 6.6
	3.3K 6:5	4K 2.39:1 Ana 2x	16.3, 11.5, 7.8

*** Times for Apple ProRes are for 422 HQ, 4444 and 4444 XQ

ALEXA 35 Specifications

Sensor Type	Super 35 format ARRI ALEV 4 CMOS sensor with Bayer pattern color filter array
Sensor Photosites and Size	4608 x 3164 resolution 27.99 x 19.22 mm / 1.102 x 0.757" 33.96 mm Ø Image diagonal
Sensor Frame Rates	0.75 - 120 fps
Project Frame Rates	23.976, 24, 25, 29.97, 30, 47.952, 48, 50, 59.94, 60 fps
Weight	2.9 kg / 6.4 lbs (camera body with three antennas and LPL Mount with LBUS connector)
Photosite Pitch	6.075 µm
Dynamic Range	17 stops (2.5 stops more than with previous ALEXA cameras)
Exposure Index	Adjustable from EI 160 - 6400 in 1/3 stops
	EI 800 base sensitivity
Shutter	Electronic shutter, adjustable from 5.0° - 356° (or 1 - 1/8000 second)
Recording Codecs	MXF/ARRIRAW MXF/Apple ProRes 4444 XQ MXF/Apple ProRes 4444 MXF/Apple ProRes 422 HQ
Recording Media	Codex Compact Drive 1TB (CA08-1024), Codex Compact Drive 2TB (CB16-2048)
Recording Modes	Standard real-time recording, and pre-recording
Viewfinder	Multi Viewfinder MVF-2 with OLED viewfinder display (1920 x 1080) and 4" LCD flip-out monitor (800 x 400)
Viewfinder Diopter	Adjustable from -5 to +5 diopters
Color Output	Rec 709, Rec 2020, Rec 2100 PQ, Rec 2100 HLG, LogC4
Look Control	ARRI Textures Custom color look (through ARRI Look File ALF4 or ARRI Look Library)
White Balance	Manual and auto white balance, adjustable from 2000K to 11000K Color correction adjustable from -16 to +16 CC (1 CC corresponds to 035 Kodak CC values or 1/8 Rosco values)
Filters	Four position built-in motorized ND filter: Clear, 0.6, 1.2, 1.8 Fixed optical low pass, UV, IR filter
Anamorphic Lens Squeeze Factors	1.00, 1.25, 1.30, 1.33, 1.50, 1.65, 1.80, 1.85, 2.00
Exposure and Focus Tools	False Color, Zoom, Aperture Peaking, Color Peaking
Audio Recording	4 channel linear PCM (24 bit, 48 kHz)
Audio Inputs	1x AUDIO (LEMO 6-pin) for balanced stereo line in (line input max. level +24 dBu correlating to 0 dBFS) Two built-in microphones for scratch audio With Audio Extension Module AEM-1: additional 3x TA3 connectors (MIC/Line, +48 V, AES)
Audio Outputs	1x 3.5 mm stereo headphone connector (on MVF-2) 2x SDI (embedded audio)

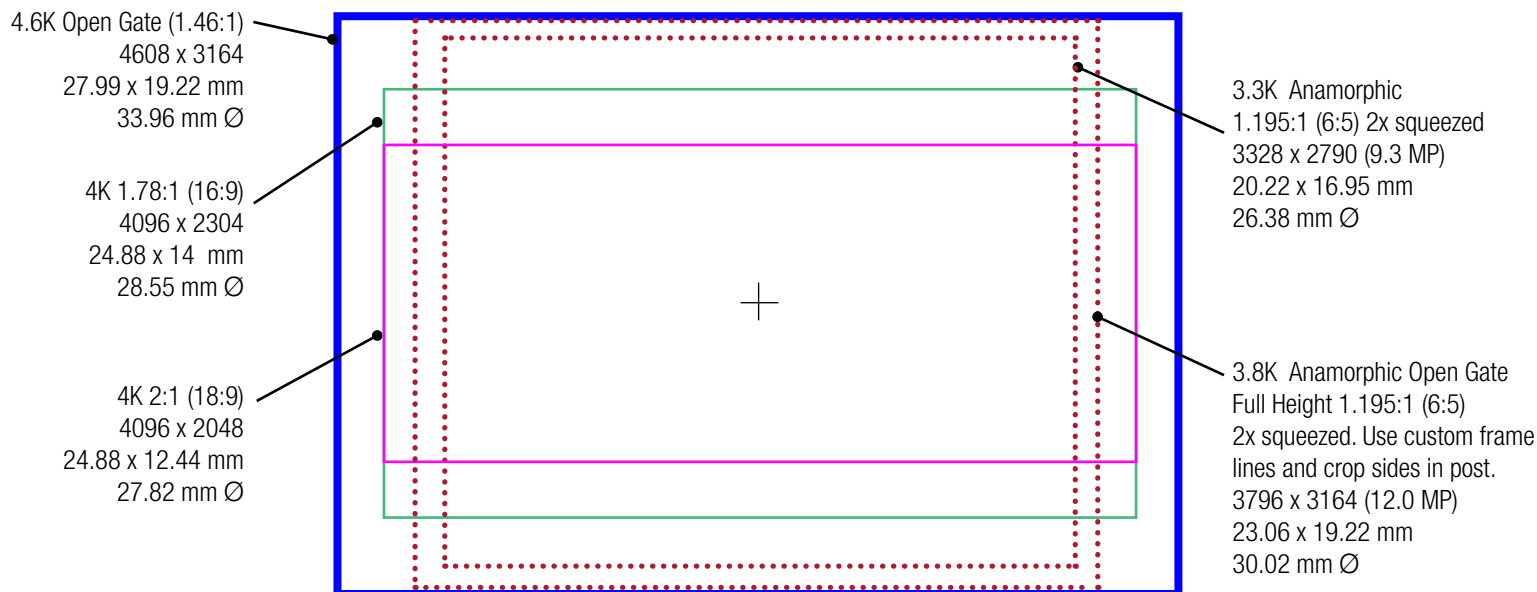
ALEXA 35 Specifications

Image Outputs	2x VF custom CoaXPress connectors for MVF-2 viewfinder 2x 12G SDI (BNC) 422 1.5G HD, 422 3G HD, 444 3G HD, 422 6G UHD, 422 12G UHD, 444 12G UHD
Interfaces (Connections)	1x LBUS (LEMO 4-pin) for lens motors, daisy chainable 1x SERIAL (LEMO 4-pin) for distance measuring accessories 1x TC (LEMO 5-pin) for timecode In/Out 1x ETH (LEMO 10-pin) for remote control and service 1x SYNC IN (BNC) for Genlock synchronization 1x RET IN (BNC, switchable on SDI 2) 1x USB-C for user setups, look files etc 1x Rear Interface (18-pin Pogo) 1x Top Interface (5-pin Pogo)
Power Inputs	1x PWR (LEMO 8-pin) 1x BAT (camera rear interface / battery adapter) 20.5 - 33.6 V DC
Power Outputs	1x RS (Fischer 3-pin) for 24 V accessory power out, start/stop and shutter pulse 1x 12 V (LEMO 2-pin) for 12 V accessory power out 1x LBUS (LEMO 4-pin) for lens motors & 24 V power out, daisy-chainable 1x AUDIO (LEMO 6-pin) for balanced stereo line in and 12 V accessory power out 1x ETH (LEMO 10-pin) for remote control, service and 24 V accessory power out With Power Distribution Module PDM-1: additionally 4x 24 V, 2x 12 V and 1x D-Tap
Remote Control Options	Camera Companion App ARRI Electronic Control System (ECS) Web-based remote control from phones, tablets and laptops via WiFi & Ethernet Camera Access Protocol (CAP) via WiFi & Ethernet GPIO interface for integration with custom control interfaces
Wireless Interfaces	Built-in WiFi module (IEEE 802.11b/g) Built-in White Radio for ARRI ECS lens and camera remote control
Lens Mounts & Adapters	ARRI LPL Mount (LBUS) ARRI PL-to-LPL Adapter ARRI PL Mount (LBUS) ARRI PL Mount (Hirose) ARRI EF Mount (LBUS) Leitz ARRI ALEXA M-Mount (Leitz product)
Lens Metadata Protocols	ARRI LDS-1, ARRI LDS-2, /i, EF mount and ENG (Hirose)
Flange Focal Depth	LPL mount: 44 mm PL mount with LPL to PL adapter: 52 mm
Power Consumption	~ 90 W (Camera body and MVF-2)
Measurements (H x W x L)	147 x 152.5 x 203 mm / 5.8 x 6.0 x 8.0" (camera body with LPL lens mount)
Environmental	Splash and dust proof
Operating Temperature	20° C to +45° C / -4° F to +113° F @ 0-95% Relative Humidity
Storage Temperature	30° C to +70° C / -22° F to +158° F
Sound level	< 20 dB(A) at 30fps, recording 4K 16:9 - UHD, Apple ProRes 4444 XQ, ≤ +30° C ambient temperature
Licenses	ALEXA 35 Cine License (ARRIRAW and Open-Gate-width recording formats)

Some ALEXA 35 Sensor Modes (Recording Formats)

This diagram addresses the question everyone has been asking for the past year or two: will my older, existing 35mm lenses— many with image circles of 27.5 mm diagonal — cover the new ALEXA 35 sensor in at least 4K. This diagram says yes. The 4096 pixel-wide width is indeed 4K. If you want more K, some of your existing S35 lenses will cover if their image circles are at minimum 33.96 mm diagonal.

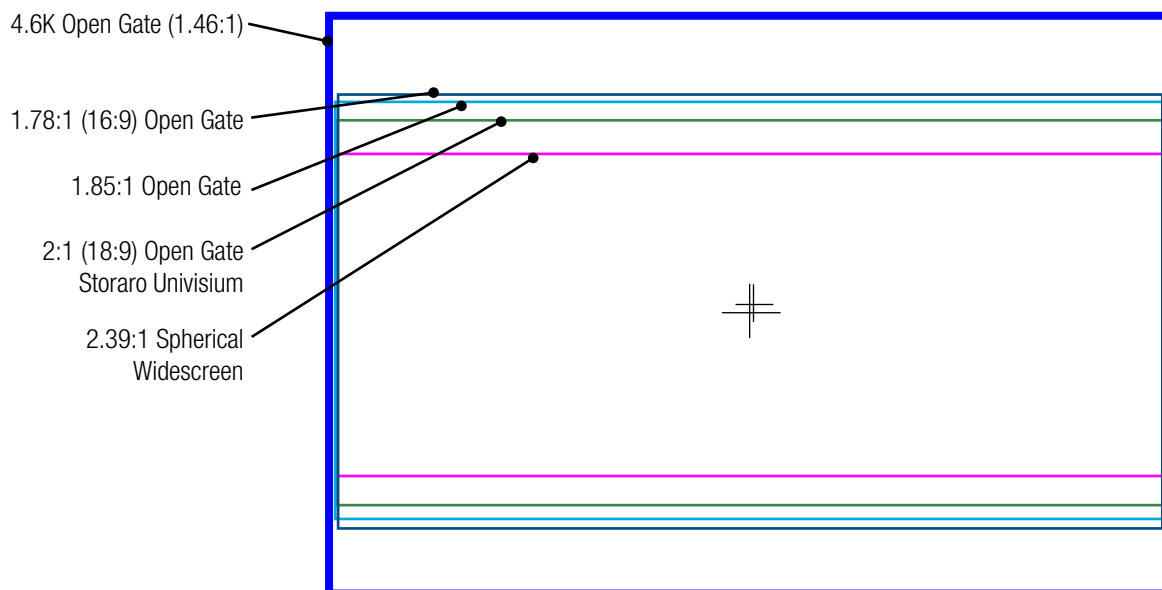
And what about 4K anamorphic? The 4K minimum math anamorphic mandate for 2x squeeze anamorphic lenses requires at least 3840 x 2160, which multiplies to 8.29 Megapixels. Open Gate Anamorphic is 3796 x 3164 = 12.0 MP.



Some ALEXA 35 Framelines

Framelines can be the same as Sensor Modes (Recording Formats).

But they don't have to be. For example, if you prefer 16:9 in highest resolution 4.6K, you can shoot Open Gate Recording Format and make your own viewfinder-viewable aspect ratios or use the online ARRI ALEXA 35 Frame Line & Lens Illumination Tool. The only caveats are lower maximum frame rates (potentially 75 fps vs 120 fps) and the requirement to crop in post.



ALEXA History



ALEXA Classic, April 2010
S35. ALEV 3 Sensor.



ALEXA Studio, April 2011
S35. ALEV 3 Sensor.



ALEXA Plus, March 2012
S35. ALEV 3 Sensor.



ALEXA XT, April 2013
S35. ALEV 3 Sensor.



ALEXA XT Studio, April 2013
S35. ALEV 3 Sensor.



ALEXA XT M, April 2013
S35, tethered. ALEV 3 Sensor.



AMIRA, Sept. 2013
S35. ALEV 3 Sensor.



ALEXA 65, Sept. 2014
65 Format. ALEV 3X Sensor (based on ALEV 3)



ALEXA Mini, April 2015
S35, ALEV 3 Sensor.



ALEXA LF, Feb. 2018
Large Format. ALEV 2X Sensor (based on ALEV 3)



ALEXA Mini LF, April 2019
Large Format. ALEV 2X Sensor (based on ALEV 3)



ALEXA 35, May 31, 2022
S35. New Super35 ALEV 4 Sensor.

Christoph Stahl, ARRI Shareholder Representative



Christoph Stahl is Shareholder Representative at ARRI, a member of ARRI's Supervisory Board and CEO of Stahl Beteiligungs, GmbH, the holding company of ARRI. His grandfather, Robert Richter, in the photo above, is to the right of co-founder August Arnold. An Arriflex 35 is on display behind Christoph's left shoulder.

Jon: It seems that ALEXA 35 carries on a company tradition.

Christoph Stahl: More than 1000 people at ARRI share a common passion. We enjoy designing and building, to the best of our abilities, tools for filmmakers. ARRI has been synonymous with innovation in the cine business since it was founded in 1917 by my grandfather, Robert Richter, and his friend August Arnold.

105 years later it is still a family-owned business that defines itself by a spirit of trust and the shared passion of everyone who works here. It is the same passion that drove our founders: a belief that technology can help enable the creativity and language of cinema.

85 years ago, ARRI released the Arriflex 35, the first movie camera with a spinning mirror shutter. In many ways, it resonates with the new ALEXA 35. Both are small, rugged 35mm cameras incorporating new technologies that enable new techniques and creative control. The difference is that the ALEXA 35 does so in ways that would not have been dreamed of back in 1937.

How was the original Arriflex 35 so unique 85 years ago?

Well, I wasn't around back then. Seriously, when Erich Kästner developed one of the first reflex viewing systems for a cine camera, you could optically see the same image that was being captured on film. You could frame and focus the camera accurately. The camera was small, rugged and easy to use; that's what made it a successful camera back then.

Arriflex 35 and ALEXA 35 suggest a common history, with a shared evolution of 35mm format cameras. What else?

I always like small and simple products. The original ALEXA of 2010 had a simple menu and its functions allowed an easy transition for our users to move from analog film to digital. Over the years, things got more complicated. For example, if you consider an iPhone, in its early iterations, you didn't need a manual, but today there are so many functions you either need a manual or you can watch a YouTube video to learn how it works.

We tried to keep the ALEXA 35 as intuitive as possible, which I think is important. At the same time, I appreciate the way it renders images, colors and skin tones. I find the images it captures are extraordinarily beautiful. I like the idea of Textures: that's absolutely unique. For the first time with a digital cine camera, filmmakers can "process" their images in camera in ways reminiscent of the ways they worked in the photo-chemical analog film days.

It's like a film lab in a camera, essentially.

Yes. Cinematographers want to have their own handwriting on their films, whether it's with lenses or lighting or Textures. I really appreciate Dr. Tamara Seybold's work on Textures. It's a fantastic part of the camera. Also very important is the significantly higher dynamic range that gives filmmakers more creative control and more interesting images. For example, there's a lovely sunset scene over a river in one of the test films. You see gradations, colors and details in the highlights that you probably never saw before and they are absolutely amazing.

The ALEXA 35 project must have been a massive, collaborative effort by many talented people.

On a film set, people collaborate based on trust and reputation. ARRI is a company with more than 1000 people working together, also working on a basis of trust and freedom as much as we can. That's the essence of keeping our agility and enthusiasm.



ARRIAL reception area with ARRI Museum in background.

Sometimes you do need control, for sure, for example in a complicated software R&D process or quality testing. But it should be as limited as possible to keep the right spirit in the company.

Nice analogy. ARRI is somewhat like a film set with a thousand people instead of maybe a hundred.

Coming together and working on the basis of your own reputation is a very nice way to collaborate. You have met them—lots of absolutely great people. It's the overall coordination that's the challenge. Back in 1937, it was different. Many cinematographers worked as their own R&D department and rental house. They owned their cameras; the times may have been more simple. But meanwhile, Arnold & Richter always had a rental company, from the beginning, even when it was founded in 1917.

Now it's called ARRI Rental. In London, it's run by Jannie van Wyk. He and his team share their observations with our product development teams. Because the rental business is very close to the cinematographer, to the set, they can evaluate what's good, what's needed and what can be improved.

And yet, some rental houses worry about ARRI being in the business of both building and renting cameras.

We are not in the rental business to grow and get big and make things difficult for our customers. We are there to get unfiltered, first-hand information from the set and from location. For example, David Bermbach is now in charge of linking the rental business to our R&D departments. He used to be with ARRI R&D and now his task is to enable a more efficient information exchange between the two.

Where do you see our industry heading?

When you look at activity pie charts, there are the 24 hours in each

day for people like you and me. However, our kids have 72 hours in a day because they can watch three screens simultaneously: phone, tablet and laptop. Subtract some time for sleep.

And then, for most of our hours awake, the streaming companies compete for our attention. I think they realize that having high-quality productions, with good content, is necessary and important to gain subscribers. That's a big plus for ARRI because that is where we fit in. We can help them produce high-quality movies. In the post-pandemic boom, it seems that they expanded their production capacity too fast and sometimes the quality couldn't keep up with demand. The realization that quality is important to attract subscribers is something that is encouraging for us.

Where do you see ARRI heading in the next few years?

ARRI should stay small and focused, but there's still a lot of room for better products, better workflow and even better images. There's room for the integration of lenses, lighting, cameras and active backgrounds. With the right decisions, the abilities and knowledge of our entire team can continue to provide equipment and services that benefit filmmakers. At the same time, it's also about keeping the culture that's the heart and soul of the company that is ARRI. And that is something we absolutely need to keep.

ARRI is a company you have to live with heart and soul. You truly have to be dedicated to this company. It's not just about making money as it is to provide tools and services for filmmakers, to enable their creativity with innovative products. And that's where we all derive our satisfaction.

Ultimately, it boils down to listening very carefully to your small base of dedicated users. The original ALEXA platform served users well for many, many years, and I am confident that will continue with the new ALEXA 35.



Michael Neuhaeuser and Matthias Erb in the museum area of ARRIAL, ARRI's headquarters and manufacturing facility in Munich.

Dr. Matthias Erb (l.) was appointed Chairman of the Executive Board of ARRI on January 1, 2022. In addition to his duties as Chairman, he oversees the business units Camera Systems, Lighting, and Rental, as well as the departments Global Sales and Solutions, Finance, Human Resources, Corporate Marketing, Quality Management, and Legal. Dr. Michael Neuhaeuser was appointed to the Executive Board of ARRI in September 2018. In this position, he is responsible for technology and operations.

Jon: I would imagine that your latest camera project, the ALEXA 35, has been rather stressful because it's no small enterprise developing a new sensor. As Achim Oehler, your Head of Sensor Design, said, "It requires unlimited resources."

Michael Neuhaeuser: The new sensor is the heart of the ALEXA 35 camera system, and it delivers outstanding image quality. Our engineers and experts spent years in development. The ALEXA 35 and its sensor combine all the knowledge from a decade's worth of research on the ALEXA camera system and its evolution. We are very excited to see the creative output filmmakers around the world will produce with this new tool and are convinced that the success story of the ALEXA will continue.

Coming back to your question, yes, it was quite an effort. If I look back at our previous interview from August 2021, we were in the middle of the COVID crisis at that time. Luckily, we decided to continue investing heavily in innovation and R&D. This was not

a given since we were really in crisis mode. We were concerned about cash flow, operations and the health of everyone at ARRI. But we never gave up developing the new sensor and the whole ALEXA 35 platform while continuing to work on other projects. Then, we had a very steep ramp-up of production after the lockdown. And so, we are more than happy to introduce the new ALEXA 35 camera to the world. Now, ARRI offers outstanding digital cameras in three sensor formats: Super 35, Large Format, and 65 — providing excellent choices for our customers in terms of options and flexibility.

Before coming to ARRI, you both spent time working with the automotive industry. It's good to be talking to two car guys. Cameras and cars.

Matthias Erb: I cannot imagine a more attractive field of business than the industry in which ARRI is working. If you look at the technology and the next steps for our cinema industry, we can clearly see common challenges. There are huge technological disruptions and demands to be met in terms of structures, footprint, and even how you collaborate. After four months at ARRI, I have a lot to learn about our customers and our industry. There are a lot of similarities, now more than ever, and the speed of change is very rapid.

Interesting. What are some examples of these similarities?

Michael: Let's take the ALEXA 35 and sensor development. If we

talk about autonomous driving, there's a lot of camera technology inside to enable such a car. The development and manufacturing processes are similar, even if the markets and the end customers are different. It means that we need the same toolset to get it running.

There is a lot of computing power in the camera because, after the sensor, it's a sophisticated computer that we have developed. The ARRI team had to design it, create the architecture, get the high-speed data connectivity in the camera, develop the software and the algorithms. This is similar in the automotive industry and also in the mobile phone industry.

Matthias: Similar to the car business, we are talking more and more about system integration, and we also collaborate with other industries. We see this already with virtual production and active backgrounds where ARRI plays a very important role and where we are integrating our products and services. I'm delighted that ARRI delivers cameras, lighting and rental services to these studios and productions.

Michael: There is a motivation that perhaps attracts people to cars because it is an emotional product. It is the same connection that creatives in our industry have with their tools.

I agree. Cameras are emotional, aspirational products.

Michael: The ability to fulfill the needs of the user is increasing. I'm not talking about just the camera. I'm talking about how people are creating movies today. Yesterday I was in the UK and visited the ARRI Stage London, a mixed reality and virtual production studio in Uxbridge. Many ARRI products were there: cameras, lenses and lighting systems such as Orbiters and SkyPanels. Then I saw the brain bar where Unreal Engine was working to create pictures on the LED walls.

It was clear that there was much more ARRI technology than just the hardware. ARRI is on its way to becoming an important system designer and engineer for state-of-the-art studios.

Despite the acceleration of technology, it's interesting that the original ALEXA sensor was first developed beginning in 2006.

Michael: For sure, there were adjustments and optimizations here and there, but it was fundamentally the same architecture. I was impressed to see that with this sensor architecture, ALEXA cameras have been successful for more than a decade. That shows how the development of the ALEXA was really an outstanding achievement. It has proven itself to be a trusted tool for creatives and a safe investment for our customers.

Matthias: ARRI would never speed up so fast that our customers' business models would be harmed. We understand and support the fact that our customers need a certain amount of time to generate a good return on their investment with our products. For sure, we will not come out with a new camera and a new sensor platform every year or so. Don't worry about that.

Michael: We are introducing the ALEXA 35 three years after the ALEXA Mini LF. In between, we also brought out the Orbiter LED lighting fixture and several other exciting products and solutions. We continuously strive to improve our lineup to provide our customers with equipment and services to support their creativity. Of course, we have an eye on what is happening

in the industry. There is competition. But even if the competition is much bigger than we are, we accept the challenge.

May I ask a challenging question then? If other companies manufacture their own sensors and circuits, how do you address that? Does it rest on aspiration, brand, service, quality, and customer loyalty to a smaller, nimble company?

Matthias: That is the strength of a smaller company like ARRI. Building relationships with our customers and the users of our products, listening to their needs, and producing the equipment and solutions they want is vital to our business. If our colleagues visit a cinematographer on set somewhere, they can call Michael or me. We can decide something in five minutes, while other bigger corporations usually cannot do that.

Our predecessors did a great job bringing ARRI where it is today. Our focus is on creating tools for professional productions of all kinds. Not only high-end, but we also supply the more affordable segment. ARRI's Certified Pre-Owned program offers filmmakers with smaller budgets the chance to work with our equipment. ARRI quality remains the same across the board, and our customers do not have to make compromises.

Michael: Innovation often comes from small companies. ARRI is in a very good position. For sure, our competitors enjoy some advantages because they have their own semiconductor fabs. They can put 1,000 people on one project easily. However, we are agile.

You mentioned systems and disruption. Do you see disruptive forces as private equity is taking over rentals and studios?

Matthias: These things do influence ARRI's business because it results in our customer base contracting a little bit. But, as larger entities acquire smaller companies, they are still our customers, and we do our very best to serve them with the things they need.

We are very well aware that the focus or requirements within the industry might shift slightly. Working in a very open environment that is also creating art is challenging. Making movies is making art and, of course, you cannot industrialize creating art.

If you look at streaming and motion picture theatrical distribution, you can very well imagine that there is room for productivity gains. We shouldn't forget that investors in those companies want to see a good return on their investment. And so, they might look into a more profit-driven business overall. However, I've learned over the years that good art also brings good profit, so this can be a very positive motivation.

In preparing this ALEXA 35 camera report, I spoke to many people at ARRI in the past couple of weeks. It seemed that everyone was really happy and positive. Team spirit was palpable. I did not expect that so close to a major camera launch.

Michael: You could not have made me happier than by saying that. It is wonderful to see the entire company come together to create the ALEXA 35 and bring it to market. An innovative product that will hopefully be used and enjoyed by many. At ARRI, we have a passion for building great cameras and seeing this passion come to life is thrilling.



Stephan Schenk is General Manager Global Sales and Solutions at ARRI. He has endured FDTimes interviews for every major camera launch since the original ALEXA and needs no further introduction.

Jon Fauer: Please tell us about ARRI's strategy behind the new ALEXA 35.

Stephan Schenk: At ARRI, it has always been about offering the best overall image quality. This has been the mantra for all our digital cameras over the past 12 years, since the first ALEXA was launched. The new ALEXA 35 camera, we feel, raises the bar for shooting in Super35. Super35 was and remains a very valid market segment—the majority of feature films, episodic TV shows, commercials, many high-end documentaries, and more and more live events continue to work in this format.

What about Large Format?

Large Format is also very important. Demand for the ALEXA Mini LF continues to grow. ALEXA Mini LF and ALEXA 35 serve two different formats, providing choices for the cinematographer, the style of shooting, and the requirements of the production. And ARRI Rental continues to offer the ALEXA 65.

There is a vast inventory of Super35 lenses in the fleets of rental houses around the world.

Yes, we expect that rental houses will embrace the new camera also because it really helps their inventory of S35 lenses to stay relevant with the latest, state-of-the-art Super35 camera technology. It's all about offering choices.

When and how was this camera developed originally?

The concept of a successor to the ALEXA began even before the ALEXA Mini was introduced in 2015. The idea of a camera having a next-generation sensor was actually raised a couple of years after the original ALEXA was launched in 2010.

But when we looked at what was possible in terms of better image quality, we always realized how good the current ALEXA sensor was. Of course, we were asked more than once to come up with a higher resolution S35 camera because several studios were demanding native 4K. And it was a pain for us not to offer such a camera. However, we resisted coming up with inferior overall image quality just to fulfill one specification.

Now we have a 4:3 aspect ratio Super35 4.6K sensor and a software pipeline that truly raises the bar in image quality, actually in many ways, as our team will explain in detail. Physically, it comes in a body that is Mini in size. That is relevant to our customers because they did not want something bigger anymore. And so, that is how it all evolved.

Developing a new sensor is not a trivial matter and comes at an astonishingly high price. That must have been quite a commitment.

Absolutely. Developing a sensor is always an expensive endeavor. It was even tougher to come up with a sensor even better than the one we had. But it is not only the sensor: we devoted a lot of time to develop the software which is important not only for the image but also for the workflow. On top of that, we selected quality

Stephan Schenk, ARRI General Manager Global Sales and Solutions

components and enabled a rugged design. And then, there is the goal of ease of use which also means attention to the right balance of size and weight and connectivity options. All these qualities are just as valid today as they were seven years ago when the ALEXA Mini was launched.

Speaking of the Mini, will it be discontinued?

The ALEXA Mini will be discontinued in terms of production, because the ALEXA 35 is the successor. But our CPO (Certified Pre-Owned) program, that we established some years ago, shows continued demand for the original Mini. The Mini is still one of if not the most used cameras in our market segment. Considering that many of the early ALEXAs, even the original 2010 models, are still out in the field 12 years later, I'm pretty sure the Mini will also be around for many years to come.

Will the ALEXA Mini continue to be supported with service and parts?

Yes, of course. We have superb service all around the world and they will make sure that those cameras stay running. To provide an example, we also continue to service analog cameras, e.g. ARRICAMS, 235s and 416s—and they've been out of production for far more than 10 years.

Who will be the main customers for the new ALEXA 35 camera: rental houses or owner-operators?

Both. We design and manufacture cameras that are a long-term investment. And as such we have rentals, and the business they service, in mind. But over the years we have also seen a growing number of owner-ops; I think this will continue. However, whether rental house or owner-op, it should be a good investment, as with the Minis that are still used on top-notch productions today.

You're also in charge of selling lenses. Do you see ARRI or other companies selling or even making new Super35 lenses for the new Super35 camera?

That's an interesting question. We truly believe that the ALEXA 35 will find great additional acceptance because there are already so many beloved Super35 lenses out there. In terms of new sales, we currently see a huge demand for our Signature Primes and Signature Zooms that you can use on an ALEXA 35 as well as on a Mini LF—and you get fantastic images with both. To come up with a new Super35 lens range will not be easy, it would have to be something really unique, that does not already exist.

In our discussion of April 2019 at the launch of ALEXA Mini LF, you said, "We at ARRI still believe in Super35. A large number of productions will remain in Super35 for the foreseeable future. I say this very openly here, we are also working on a dedicated Super 35 4K camera that is planned to be introduced in the first half of 2020. So, the choices for cinematographers will increase again." To paraphrase Orson Welles in the famous Paul Masson commercials, "We will sell no Super35 camera before its time."

Everything in the statement is still correct with the exception of the last digit in 2020. COVID certainly delayed us and it took a bit longer to raise the bar. But now the ALEXA 35 is a true and amazing successor to the ALEXA Mini and I am sure the camera will resonate with cinematographers. I'm referring especially to

the increased dynamic range, the increased color fidelity, and the ARRI Textures of the ALEXA 35.

For many years, we have heard from cinematographers that there were two reasons why they loved shooting analog film. One was the roll-off in the highlights and the other was a certain texture that film brings to the table. But when cinematographers say, "I want more texture," it is not necessarily the same. It really depends on their taste and on the project they are working on.

ALEXA 35 was defined by our Product Managers and developed by our engineers with these challenging requests in mind. Both did a great job and we can't wait to see the images that will be captured by the creatives from all around the world, including the use of the various textures the camera offers. We believe all those reasons were worth the wait.

What else would you say to a customer, head of a rental house or an owner-operator, to encourage them to buy this camera?

It is a camera with ergonomics that are desirable for the DP and camera operator. It is well-balanced—the result of all we learned from our previous cameras. It has all the accessory connectors that camera assistants were asking for. It has been optimized in terms of size and weight and connectivity. That answers how easily you can put the camera on your shoulder, put it on a rig, on a TRINITY, or on a crane. All these setups have been anticipated. It's an extremely versatile, yet very small, camera.

I always ask you at the end of each interview, what's next?

What's next? I can assure you, it won't be boring. First, we will do a lot of hands-on events around the world, of course respecting the local pandemic rules. We want to support users and ensure that everyone understands the advantages of using the ALEXA 35, with all the bells and whistles that our engineers have achieved to integrate in the camera.

We will be on top of education and workshops about new workflows, new textures, LUTs, grading and so on. Let's not forget the ALEXA image has been here for 12 years now. I've heard colorists say they can grade ALEXA footage with eyes wide shut because they know exactly how it reacts and what it does. Now we have a new sensor, with new image dynamics. We plan to train everybody—cinematographers, DITs, post houses—about what is in this camera, how it works, how it is similar and yet different.

And as always we will listen and learn from what everybody will tell us. We have been listening quite a bit in the past months to comments from many field testers. I'm pretty sure that as the global industry embraces the camera, we will get a lot more feedback that we will then incorporate into the camera in the future.

Will there be a large-format version of the sensor?

We believe that with ALEXA 35 and the ALEXA Mini LF we offer the best overall image quality for the two formats and there will not be a camera that substitutes them in the next at least 2 to 3 years.

But there will be SUPs (Software Update Packages) for the ALEXA 35 coming in the next months and years. We have planned for some already, as with all our cameras. We support them over a long time, make them stay relevant and up to date by software update packages. I believe that the ALEXA 35 will be a great investment.

Walter Trauninger, Head of Business Unit Camera Systems



Walter Trauninger, above with ARRI TRINITY, is Managing Director and Head of Business Unit Camera Systems together with Michael Frank at ARRI. He joined ARRI in 1986 as a mechanical design engineer for the Arriflex 765 film camera. He was named Head of Development in 1993 and supervisor of the 435 camera. In 1997, he was Project Manager and co-designer (with Fritz Gabriel Bauer) of the ARRICAM. Walter Trauninger, who had supervised the manufacturing of most ARRI cameras in recent memory, was in charge of production of the original ALEXA and many more ALEXAs that followed.

Jon: We have this discussion every time you come out with a new camera. How did the ALEXA 35 project begin for you?

Walter Trauninger: We started to develop a Super35 4K camera after the introduction of the AMIRA and Mini, but we always said that we would not compromise image quality for anything else. Therefore, the development of the new camera took a bit longer, but the result speaks for itself. We received great, positive feedback

from our field tests. Cinematographers appreciated having much more headroom than they had ever seen with any other ARRI camera that came before. The new ALEXA 35 camera is more efficient. It can support your creativity in almost any situation, providing many possibilities. As always, our main focus at ARRI is supporting cinematographers and crews on set and on location so they can create the best images with the tools we deliver.

How has the process of camera development changed since the last camera that you and I talked about, the ALEXA LF?

In the meantime, I took over the responsibility of Product Management and Product Marketing for the Business Unit Camera Systems and improved the cooperation between Product Management and R&D together with Michael Frank.

It used to be a development process called Waterfall where you do one thing after the other in a linear way. Now, the process is called Agile Development, and a lot of things are done in parallel. The tasks are divided into smaller chunks. And we have Testing right next to Development.

The other good thing about Agile Development is that self-reflection and self-improvement is built in. You work in two-week sprints. And after each sprint, you have a review where all the people in the sprint show everybody else and anybody who wants to join, what they've done. It's a very good and positive thing.

You probably remember from your earlier visits with my team, we had daily morning meetings with color-coded charts on the wall and red post-its showing if something was behind schedule or not working as we'd like. Now, after the bi-weekly meetings, the sprint people stay on longer and do what's called a retrospective where they talk about the previous two weeks, what worked, what didn't work, what can be changed in the next sprint. Then you implement those changes in the next sprint. And then you have another retrospective.

Part of the process is continual optimization. In the past, somebody said, "This is our development method." And then for two years, we developed the camera with "the development method." Now, with Agile Development, each individual team can optimize it themselves. Oh, and by the way, during a sprint, we in management are not allowed to disturb the engineers.

If you don't disturb the engineers, something you know firsthand from your days as an engineer, what do you personally do between sprints?

I make sure our camera business unit remains profitable. Any major decision that has to be made, I discuss with the Product Managers, Michael Frank and Stephan Schenk and come to a decision.

So, things are busy. Compare how far we've come since the original ALEXA. That camera in 2010 had one SDI output and only 16:9 format. Development took years until we had a 4:3 format and anamorphic desqueeze. The ALEXA 35 is a lot more complex because people expect a lot more from it. R&D grew, testing grew. We have a whole new department to manage the transition from research and development into manufacturing. And we've learned a few things along the way, over the years.

Now we have the new ALEXA 35 and it does all the things we wanted. I hope you like it.



Jon: When did you personally start working on the new ALEXA 35 camera?

Marc Shipman-Mueller: About two years ago. Camera development never stands still. So, some years after the first ALEXAs were introduced, we started looking into building the next generation Super 35 4K camera. But we've always said we're not going to come out with a new camera unless it had better image quality than the current one. We would develop concepts of cameras around new sensor designs, but it turns out that the original ALEXA sensor was a brilliant design, and it was difficult for us to beat that. So, we continued to build several cameras around the original ALEXA sensor: the XT, SXT, AMIRA, Mini, LF and Mini LF, all great cameras. But at some point the new, better sensor was ready and then we said, "Okay, let's go." My colleague Michael Jonas wrote the specs for the ALEXA 35 and shepherded most of the development. He then moved onto another project, and since I was done with the ALEXA Mini LF, which had kept me busy, I took over.

What would you say has been the biggest challenge in camera design?

One of the biggest problems in digital camera design is cooling the camera. They are little super computers with a sensor attached. They create a tremendous amount of heat. The ALEXA 35 essentially has more processing power than an ALEXA LF but with a new cooling concept that is more than twice as efficient as the ALEXA Mini.

What is the difference?

The Mini takes air in on the side. The air goes in, around a corner and then comes out the back. This was dictated by the shape of the sensor boards and the electronics and the tiny package of the camera. But it also means that if you want to hang a battery on the back of the Mini, you need an extra bracket, which makes the camera package a little longer.

So, with the ALEXA 35, there's one large central chimney, which pulls air in from the bottom and blows it out the top with one single, large, silent, very powerful fan. All the electronic boards huddle around this chimney like cowboys around a campfire, except the cowboys warm themselves and here the boards cool themselves. The semiconductors transfer heat to the metal of the chimney. Inside the chimney extended these very special cooling fins. Air blows over the fins, and the whole thing gets cooled.

Didn't previous cameras have chimneys as well?

Yes, but in the Mini it goes around a corner, which is less efficient. And this camera now has a larger chimney and a larger fan. As a result, we can move a much larger volume of air across the cooling fins inside the chimney.

How was the original ALEXA cooled?

The original ALEXA has its electronics in a separate compartment that is completely sealed and there are heat pipes going to the chimney. This works well, except you have the extra weight of the heat pipes. By clustering the boards around the chimney, we're

Marc Shipman-Mueller, Senior Product Manager

saving all that extra weight and can actually make the camera much smaller and more efficient.

The cool thing, pardon the pun, is that once you have all this processing power in the ALEXA 35, you can do things like process 17 stops of dynamic range and record 4K at 120 frames a second. You can have two totally independent SDI outputs, which the Mini never had. You have many more connectors than you had on the Mini. And we have things like Enhanced Sensitivity Mode and ARRI Textures that require more processing power. But all that processing power and all those features sit in a body that is about the size of the Mini body.

Take us through a day in your life as product manager, or a year in the life. The first time I saw a hint of a new camera was a 3D-printed block in your office in September 2019. You were designing accessories around that shape at that time.

My colleague Jeanfre Fachon was and is in charge of accessories for ARRI cameras, and he has designed all the lovely accessories for the ALEXA 35. I am a big fan of his, as the obsessive attention to detail that went into these new accessories speak directly to my camera assistant's heart. So, let's detour to the accessories. The Mini camera, we foolishly thought, would be a second-unit, C or D camera, just for drones, gimbals, and action setups.

We thought people would just put it on a drone, so they wouldn't need a lot of accessories. Wow, were we wrong! As the Mini became really successful, people used it for everything, and then we built accessories for it. And when the Mini LF came out, it also made sense to use the same accessories.

When the ALEXA 35 development began, we said, "Let's just start from the ground up. We're going to design a complete camera system." Equal importance was placed on the accessories and on the camera body and the design of both was started at the same time. A lot of thought went into how the camera and accessories could work better together.

We learned a lot from the Mini and the Mini LF. For example, on the ALEXA 35, you can attach the side accessories separate from the accessories that go on the top or the bottom. This makes changes on set much easier and faster. We made things smaller and lighter, there are more options and many, many more attachment points, 3/8-16, 1/4-20 and two M4 threaded holes 20 mm apart, which is the new standard we are slowly transitioning to.

So, back to a day in the life. Let's start in the very beginning of the timeline.

Life is complicated and things happen. But in an idealized product development cycle, you would have just introduced your previous product. Then you go to trade shows, travel the world, visit sets, and talk to users because they generally know much better what they need and how we can make their lives on location better.

At the same time, you try to keep an eye open for new technology trends and trends in the industry. So, you take all those things into consideration when you are thinking about the next camera. Then you present a proposal to management. You tell them how great it will be and how many millions of cameras we're going to sell.

Once you get the green light from management, then R&D will start to do feasibility studies and product management will write specifications. R&D will look at individual bits of the

camera: cooling, how many pixels, bit depth, frames per second and processing. Out of that, they generate a power budget, and determine how to cool it and what the housing could look like.

I used to write the specifications all on my own, in the early ALEXA days. Now, part of our product management team is a new department called product design with two very smart guys: Lars Hartmann and Georg Lanz. The product manager roughly outlines what the camera should be like and then the product designers work out the technical details. For example, I might suggest the camera should have an SDI output with 1.5G to 12G. And they look up the SMPTE specifications and write it in a way that an engineer can use to build it.

That goes on for a while, and at some point, engineering says, "Yes, we think we can build it with these specifications." Again, management has to give a green light before we proceed, and if they do, R&D starts to develop the camera. A lot of refinement takes place. Someone says, "Hey, it can be done this way, but it could also be done another way. Which do you prefer?" Or, "The specifications are not complete; we need more information." This is where, in my opinion, the product gets refined to match very closely what the customer can best use on set.

It's a continuous feedback loop between R&D, the product designers and the product managers. What helps tremendously is that a lot of us have worked in the industry. Which is not to say that we always agree on everything, but we have a very healthy discussion culture at ARRI, where everyone can say what they think, and in the end the product manager makes a decision based on what is best for the customer, and that is accepted.

Is approval done when the sensor is ready, or do you specify the camera and then work on the sensor?

No, the sensor is the part that takes the longest, so whenever it is ready, we build a camera around it. When it was clear that this new sensor was viable and we saw it could deliver 17 stops of dynamic range, we knew it was time to start building the camera.

Developing a sensor is not a trivial matter.

It's not for the faint of heart.

Those are the same words that Achim Oehler used.

It's voodoo. You have ideas and try things. Some work, some don't. None are cheap. You need these super brainy people who understand what happens at the pixel level, you need people who can speak photons, electrons, and quantum efficiency. ARRI is fortunate to have a team with these smart scientists, and they have delivered each time. This sensor has 17 stops of dynamic range and amazing image quality, which makes it much easier to build a good camera around.

And what happens when you have the first prototypes?

Once we have prototypes, the life of the product manager changes. This was a first for ARRI: we sent 50 pre-production cameras around the world for field tests. Organizing and managing that was a massive undertaking, and we could not have done it without our field test coordinator, Jan Heugel, and Stephan Schwellenbach, who was dealing with the logistics, and all the local teams that handled the cameras and field tests at the ARRI subsidiaries. We learned a lot. When you give your camera to a bunch of DPs, they



In the “whisper room” at IBC, September 2009. ARRI presented non-working models of three new digital motion picture cameras code-named ALEXA. By the end of the show the catchy name had caught on, and it seemed difficult to imagine calling these cameras anything else when they went into production in mid 2010. Right to left: Marc Shipman-Mueller (ARRI Product Manager Cameras & Lenses in 2009, now Senior Product Manager) with ALEXA EV-Plus; Jon Fauer with ALEXA OV-Plus; Glenn Kennel (ARRI Inc. CTO in 2009, now President), with ALEXA EV.

will see more things in the images than most of us see. Because that’s what they do all day. They look at images all day. Their eyes and their brains are really trained for that. So then, in the second phase of the development, it becomes more about testing and deciding what to do with the results of those tests.

At the same time, we also have a huge testing department at ARRI in Munich now. These cameras are “driven” by software. And with software, you essentially need as many testers as developers. There’s mechanical and electronic testing, automated and manual. There’s a team that shoots test scenes all the time. All this testing, internal and external, has really improved the camera to a great deal, and I am very thankful to all the customers who have participated in the field test and provided a ton of good feedback.

As product manager, what were some of the challenges with the ALEXA 35 along the way and what were some of the thrills and triumphs and rewarding moments?

There are a lot of new things in this camera. It’s a new sensor,

there’s a completely new color science, there’s a new LogC4 curve. One of the biggest challenges for me was to wrap my mind around all this, and then be able to explain it to our customers. Color science is not an easy subject.

And quite frankly, with every new camera, you’re scared. You wake up in the middle of the night and you think, “Oh, my God, is anybody ever going to buy this?” With every camera, it’s always the same thing.

It’s just like being a DP, “Did I remember to add that filter?” Or the assistant, “Was I in focus?” And with you, “Is the camera going to work?”

I think it’s almost a type of stage fright. And then the most rewarding times are when I sit together with DPs and talk about the new camera and they say, “I don’t want to hear any more details. When can I shoot with it?” And then they produce these great images and are happy with the camera. That’s really rewarding. These are things we’ve been working on for years and

Marc Shipman-Mueller, Senior Product Manager

then to get the affirmation of the DP saying, “It’s great that you built this. I can really use it. This is going to be helpful to our work.” That is very satisfying.

What are some examples of these rewarding things?

The additional stops of dynamic range. In sensor development, we could have made the decision to go for more photosites or higher frame rates or, or, or. But we decided that more dynamic range was one of the most important things. Having shown the camera to many DPs already, nobody said, “Oh, I don’t need 17 stops, but I really want 500 fps.” They’ve been very happy with the increase in dynamic range.

And then there is the new color science. Technically, it produces more accurate colors, but the great thing is, you can totally see it on the screen. My colleague Henning Rädlein has been orchestrating the “Encounters” project, which is a series of short films shot with ALEXA 35 pre-production cameras all over the world. The results are not only very interesting, as you get to see very different works from very different DPs, but the images all look phenomenal. There is a lot of high-tech and a lot of complicated science in the camera, but in the end, we are looking at images. And if they look better than anything we have seen before (and they do), then we have done a good job.

I don’t want to make it sound like the product manager thought all these things up. We have a lot of very smart people within ARRI and a lot of them have given input to this camera. The product manager, in a way, is the person who wrangles all this information, filters it, creates specifications, and then guides development. But, often the ideas come from the engineers, from the color scientists and from the users.

In some ways, your job is like the assistant director, the AD, on set.

Yes. Except you also help write the script.

We should do a parenthesis here because it’s relevant to your story. Tell us about your career leading to your work now.

I started as a film student in LA and then taught film at a university. I ran the camera department of a special effects company, worked as a camera assistant, shot documentaries, helped building a motion-control boom, assembled editing bays, worked as a DP, and then at a rental house in Chicago as a service manager. After that I joined ARRI. So, I’ve actually been in the shoes of most of our customers, which really helps.

Yes, you’re like the DP whisperer. The translator between the DP and the engineer.

It requires an understanding of what DPs, rental houses and production companies need, what’s important, what’s not important. And this is a very specialized, strange industry. You can’t build a camera the size of a refrigerator that makes beautiful images, but no one can move it.

In DP-speak, please explain the new Log-to-Log ALF4 look file in the ALEXA 35?

First, you have to remember that the Log images from our cameras so far have been called “Log C”, but that really is the third generation of the ARRI Log file format, so I will call it “LogC3” from now on.

Let me try to break this down by first talking about the previous look files we had. They’re called the ALF-2 look files.

- Let’s say you have a LogC3 image from an ALEXA Mini LF, without a look.
- And you want to have a Rec 709 image with a look.
- So, you would get an ALF-2 look file that does two things. First, it has the creative intent of the DP and director in it. Let’s say the director says, “This is an acrimonious meeting. I want it greenish, evil looking.”
- And then you need to have the conversion to the display color space. You need to convert the LogC3 coming out of the camera into the Rec 709 color space, because that is what your display can show. Those are two separate things, the creative intent, and the conversion to the display color space, but they’re both in one file.

And Look is the same as LUT in this instance?

Yes, essentially, Look is the same as LUT. Except if you have a LUT, you must feed it into the ARRI Color Tool (for all previous ALEXA and AMIRA cameras) or into the ARRI Reference Tool (for ALEXA 35), and that will package it into an ARRI look file. Because the ARRI look files contain more than just the LUT: there are also CDL values and other versions of the LUT to make creating dailies easier.

So, a Mini LF ALF-2 look file contains the creative intent and the conversion to a display color space together in one file. And this worked great until HDR came along. Because now, DPs want to monitor not only in Standard Dynamic Range (SDR), but also in High Dynamic Range (HDR). With the old system, you had to make two different look files for each look, one for SDR and one for HDR.

While we thought about this, we saw something interesting in some postproduction houses: they started using two separate LUTs: the first one would be a Log-to-Log file containing just the creative intent, for example, the green color that the DP and director wanted. And then they would have another LUT that does the conversion to the display color space. Displays change, and display color spaces will change, but if you have your creative intent in a Log-to-Log files, that makes it future proof, and you just add whatever the latest color space conversion is.

For example, SDR and HDR.

Exactly. So, one of the advantages of the new camera is that you can connect one SDI out to an SDR monitor and another to an HDR color monitor and they will both display the same Look. Our new ALF4 look file contains only the creative intent. It’s a Log-to-Log file. The conversion to any display color space is a second step, and you can choose any display color space in the camera. And thereby, you can monitor SDR and HDR with the same Look, simultaneously.

And in post?

In post, the colorist gets just the ALF4 Log-to-Log file from the metadata and they can put their favorite display color space transform on top of that.

Marc Shipman-Mueller, Senior Product Manager

Can you use your favorite LUTs from ALEXA Mini or Mini LF with the new ALEXA 35?

That is very important to mention: with the new LogC4 of the ALEXA 35, you cannot. To capture the 2.5 stops of increased dynamic range, we had to come up with a new Log format, LogC4. We highly recommend that you create your new LUTs based on one of many LogC4 to display color space LUTs that we publish.

With LogC3, some would do it manually. “I don’t need a LUT,” they might have said. “I can make a Log C-into-Rec 709 on my own.” With LogC3, if you have experience, or you’re a DIT or colorist, you can do this, even though we would recommend using a LUT. But with the new LogC4, you simply cannot.

This is a strong recommendation: Please, we have really wonderful LogC4 LUTs that are designed to get the most out of the new sensor and out of the new color science, and you should use these as a basis for what you do. And then go wild. But start with our LogC4 LUTs. Don’t go LUT-less. Don’t go naked. There are many of them already developed for each existing color space. We’ll distribute them happily for free.

And they’re already loaded into the camera?

They’re loaded into the camera, yes. We also distribute them separately, so you can load them into your monitor, your LUT box, into DaVinci Resolve or whatever you have. And they are also part of the ARRI Imaging Software Developer Kits (SDK) that we distribute to third parties, so they can build that into their products.

The other thing maybe also worth mentioning is that the camera also comes with a new ARRI Look Library—the LogC4 Look library. We updated the ARRI Look Library from the Mini, taking into consideration the greater dynamic range, the LogC4 curve, and the new color science. It comes free with the camera. And both the LogC3 Look Library and the LogC4 Look Library are included for free in the new ARRI Reference Tool. There are at least 87 looks, all updated for LogC4, high dynamic range, 17 stops.

Since you are explaining complex things, do you want to tackle Enhanced Sensitivity Mode?

Enhanced Sensitivity Mode Frame Rates and Shutter Angle Limits

Codec	Sensor Mode	Max. fps	Shutter ≤
ARRIRAW	All	60	180°
Apple ProRes	4.6K 3:2 Open Gate	30	180°
	4.6K 16:9	48	180°
	All others	60	180°

Sure. We know people like to shoot in the dark, so this camera has less noise than previous ARRI cameras and you can set it from EI 160 to EI 6400 in the menu.

But there is more. The ALEXA 35 offers a recording mode called Enhanced Sensitivity Mode (ES), that is available from EI 2560 to

EI 6400. It gives you cleaner images in low light. It is not available below EI 2560, as we saw that the difference between a regular and an ES image below EI 2560 was almost not detectable.

Enhanced Sensitivity is an in-camera process. Here is how it works: let’s say you’re shooting at 24 fps with a 180-degree shutter. Half the time the camera captures an image, and the other half it just sits around and is bored.

When Enhanced Sensitivity Mode is on, in the time that the camera doesn’t do anything, in the dark phase of the image cycle, we also capture an image. So now, we have two images. However, we ignore the image content of the second image, but instead take the noise from the second image, and combine it with the noise of the first image, to reduce the noise of the first image.

In noise reduction, you run into a problem when you try to reduce the noise of just one image: at some point it becomes difficult to distinguish between fine image detail and noise. But once you have the noise from two images, you can make that distinction much more accurately.

However, there’s always a little caveat. This is temporal noise reduction, and you should see if that works for what you do. For instance, if you have a really big change of the image, like a flash, then the next couple of frames can have the regular amount of noise, before it settles back to the lower ES noise level. It takes a couple of frames to adjust after a huge change. That’s the reason it’s optional.

Certainly, everybody should shoot their own tests, but it’s there and it allows you to shoot with a much cleaner image in low light. So far, the feedback has been very positive and we have seen some great looking images from night shoots.

One more thing. Because we’re taking two frames now, we’re limited to half the maximum speed of the camera and half the full shutter. So, in ARRIRAW, that only goes up to 60 frames a second and a 180-degree shutter, and in Apple ProRes a little less.

Once you get this camera out the door, what’s next for Marc Shipman-Mueller?

Well, we first must get the camera out the door. We’re preparing for the launch, then I’m going to be traveling around. I’m showing the camera to customers. And the ALEXA 35 is an ongoing project, there will be future software updates. The camera is designed with hardware and software upgrades in mind, and we have many ideas and things we couldn’t fit into software 1.0.

But the Mini LF is also an important product. It’s a different product from the ALEXA 35. It’s large format and that has a different look, and that has its own place in the market. It is also a hugely successful product. And so, the next thing after this camera, I think, is going to be a next software for the Mini LF, which is being managed by my colleague Fred Merten, who is the product manager for the Mini LF now. While he does that, I will be pondering the next software update for the ALEXA 35.

In conclusion?

It has been fun and a privilege to work on this camera, and now I cannot wait to see it out there and to see what great images and stories our customers are going to create.



Dr. Achim Oehler is Head of Center of Competence Imaging Front-End. His team in the ARRI R&D Department focuses mainly on the design of the sensor, sensor package, camera front-end, sensor calibration, sensor qualification, ADC ASICs, electronics, software, embedded software, and mechanics including thermal issues.

He graduated with a Ph.D. in Geophysics from Ludwig-Maximilians Universität München. From geophysics, he went into planetology, did six years of research including the Giotto comet mission and development of the Mars HRSC camera. He joined ARRI in 1999, worked on the ARRILASER, was head of the ARRISCAN project, project manager for the D-20 and D-21 digital cameras, and managed the ALEXA project through first customer deliveries. He was the project leader of the ALEXA 65 camera. There's a famous photo of Achim in FDTimes February 2018 tossing an ALEXA LF into the air. (He caught it.)

Jon: What is the Imaging Front-End?

Dr. Achim Oehler: The Imaging Front-End is essentially the sensor, the electronics around it, and the calibration. It is the module we deliver to the rest of the ARRI camera development departments. It starts with the first optical interface after the lens and ends with a linearized image. That's what our group does. That's what we deliver. And meanwhile, we are designing our own sensors, completely from scratch.

What do the people on your team do?

It's a mix, a cross-functional team: software, digital design, analog design, sensor architecture, and people just characterizing sensors. It's a lot of work because each sensor has a huge parameter space. We use experimental cameras and have to be very quick in our workflow. And when looking around this planet of ours, it does appear that what we do is outstanding. You would assume that others have done this, but ours seems to be unique.

What makes it unique?

It's full control over everything from getting the chip, loading all the parameters, bias currents, control voltages, timing, everything you need to get the chip running and to optimize it. And you

have all the feedback. You'll get an image instantly, you change the timing and get a new image within five seconds with the new timing, you can feed the image in a processing chain that is completely node based, versatile, where you can do any kind of processing and see what is the result. What is the effect of the change you did on your sensor? So this quick feedback loop is super important. And it's a high data rate chain, where you really get at least four or five frames in real time, on your computer screen. So it's a closed loop. And that's super important that you have these quick feedback cycles.

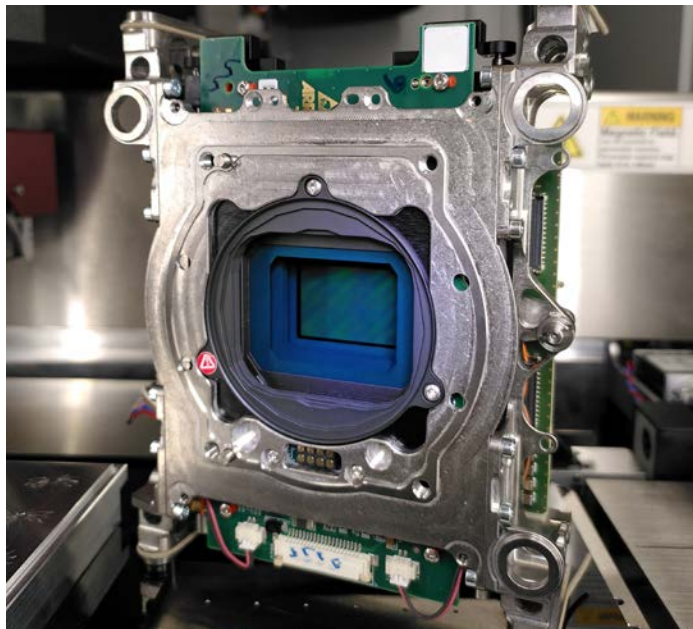
Your team is part of the ARRI R&D group?

Yes. In R&D we are grouped into teams. A very big team is software development that has grown a lot over the years.

How is the new ALEXA 35 sensor different from the original ALEXA sensor that you designed?

The earlier sensor is called ALEV 3. The new one is called ALEV 4. It's different in several ways. First of all, it's a "digital" sensor. The ALEV 3 series of sensors in previous ALEXA cameras have all been "analog"—in other words, they have analog outputs that then go to separate A/D (Analog-to-Digital) converter circuits. This is good because it is just the sensor that has to be temperature stabilized, not the A/D converters. In the new sensor, everything is all on one chip, so cooling is a bit more of a challenge, but of course it's more compact.

It's also dual gain, like the ALEV 3. That's important. Dual gain is our enabler for having a very high dynamic range. It's impossible to transport more than a certain number of stops out of a sensor with just single gain. These two gains have a lot of consequences, not only to the architecture of the sensor's readout and the calibration. The dual gain sensor requires careful temperature stabilization. That's important but it's not different from the ALEXA sensor we had before. We just carried the concept over to this new sensor generation. Dual gain means that two images come out simultaneously from the sensor, one high gain and the other low gain, for each single frame—and then they have to be combined. You can imagine that any single slip of the offset



Imaging Front-End

would jeopardize the combination of these two images. That's an important reason why we cool our sensor actively. You could build a sensor without active cooling, and you would accept a little bit of offset drift and that would be OK for a single image. But if you had drift in multiple images, this scheme would not work anymore.

And then you need to have a special pixel that accommodates a low gain signal and a high gain signal. In the old ALEXA cameras, we had a standard pixel and some tricks around it. Now it's all in the pixel. All the tricks are in the pixel and that pixel accommodates both high gain and low gain, in parallel. And that makes it in total a very high dynamic range sensor.

What other technical advances enabled the new sensor?

We can say that we are using technology similar to the original ALEV 3 because it's better for a large, fast and artifact-free sensor. It's important to know that quite a few of the newer technologies used by all the other players currently are all slower in terms of on chip signal propagation.

From the time the first ALEXA was developed until now, what new changes in technology have enabled this new camera, this new sensor? We got a completely new pixel from the fab, which had not been available at the time when we started the original ALEXA cameras. I wanted to have that pixel, I proposed it, but I didn't get it. And then, 10 years later, I got it. All this sensor business is very much pixel driven. Where do you get the pixel you really need? Is it already there? Is it proven? And so on.

In a chicken and egg analogy, does someone develop the sensor and then you design around it, or do you design the dream sensor and then somebody builds it for you?

There are different models. If you're doing your own complete sensor design, you would just do a schematic layout, put the pixel in, tape it out and get your sensor back from the fab. If you have pixel design in-house, you are also modifying the pixel, and that can go down to a really deep dive into your own recipes for how many

implants to have here and there. It's like a secret sauce for every fab. Some fabs give you parameters that you can change, others give you a reference pixel, others send you to a service provider.

Meanwhile, here at ARRI, we are also working on the pixel-level.

Back to your original question, the pixel finally became available and that was the enabler for the new sensor. Then we had to account for the huge data rates: at 4K 120fps, dual gain. In the end, that's 240 frames per second. And we have to calibrate it with a lot of data. We have huge memory bandwidth requirements, and that only can be accommodated by the latest and biggest FPGAs. Luckily the FPGA technology also evolved concurrently. Since the ALEXA and AMIRA, we have one big FPGA absorbing all the data and doing the image processing. It's not split up in parts anymore.

With the earlier ALEXA cameras, it was split up among several FPGAs. Now we have one big FPGA doing all the work, which saves the interfaces from having to send the data all around, and that's more power efficient. So this technology helped us and enabled us to build the new ALEXA 35 camera.

Another thing happening is that the bandwidths coming from the sensor scale quadratically. So, e.g. from 2K to 4K, it would be four times the amount of data. Obviously, there is a constant increase in data rate over time. Every new camera will have a new, higher data rate. What to do with this data is the big question. Luckily the flash memory technology scaled faster than the increase in data rates. That helps. We can write this data in certain bits per pixel to the 3D flash memory in the Codex Compact Drives; it is a data rate around two gigabytes per second. So the answer is: FPGA technology and 3D flash technology are enablers of higher data rates and compact sizes of these storage devices. And then, yes, certainly, the pixel.

Does your sensor development team do tests and experiments in color science? Or should I say, how the image looks?

In this context, color science is a misleading term. Certainly, it starts with the sensor. One of the ways to get a nice image is to have certain crosstalk characteristics on your sensor. That's what we can control. The filter package also plays a role, that's also something we are controlling. And this, ultimately, is the input for all the color science. Personally, I prefer the words "image" science. Color science is dealing with colors, colorimetry—handling and mapping colors.

What our team does is deliver an artifact-free image in the native color space of the sensor. We have some processing to apply in order to see what the final image will be. But normally, the Front-End department is only interested in the pure images coming from the sensor. It shall be artifact-free and linear and free of unwanted crosstalk. And what else? All these other properties like MTF, signal-to-noise ratio over transfer curve, no image lag, and then all these hundreds of measurements we do. Twice the number of photons amounts to twice the signal. The transfer curve of the sensor is not linear, and we have to map it in a way that it's linear in the output.

So that's it. We are building a scientific instrument, in a way. Not because it's a science, but rather because we are strictly mapping number of photons to a linear space.

Harald Brendel on Image Science



Harald Brendel is Head of the Center of Competence Image Science in the Camera and R&D in Munich. He got involved in color science in the post industry beginning from 1994. He started at ARRI Film & TV on one of the first Kodak Cineon CRT-based film recorders as an in-house developer, system administrator and data wrangler. There were only a few Cinesite service providers in the world and that gave ARRI the idea to build a laser film recorder, which then became a very successful product. Harald left ARRI from 2001-2003 to work on The Lord of the Rings in New Zealand and at Warner Bros in LA. And he's been at ARRI ever since.

Jon: I guess Franz Kraus encouraged you to return to ARRI?

Harald Brendel: When I rejoined ARRI Cine Technik in 2004, they wanted us to develop a complete color management system for the DI (Digital Intermediate) industry. We had a system to measure print film and then build 3D LUTs for converting digital scanned images to emulate the printer light values that were used at the time. I was in the scanner department until 2008.

And then you started working on the original ALEXA?

Yes. When the 2008 financial crisis hit, the analog film camera business just disappeared from literally one month to the next and never really came back. It looked like the film scanner business would also dry up. Well, it lasted longer than we thought, mostly for film archives. So, I moved into camera R&D in 2009, and then I designed the color management system for the ALEXA and then later for the AMIRA and ALEXA Mini.

Fast forward to today. When did you personally start working on the ALEXA 35?

I worked on some preliminary tests back in 2016. We got the first samples of the new sensor, with its incredible dynamic range. There are two images, high-gain and low-gain, coming off the sensor and the A7D (Analog-to-Digital) converter. They are combined into one 18-bit image. If it were not 18-bit data, you could not really quantize the high dynamic range properly. And then we needed to find a way to encode this data, both for ARRIRAW, and also for a new Log function to work with the increased dynamic range of the sensor. The first tests and investigations started around 2016. In 2018, a colleague made tests to come up with the new color space, ALEXA Wide Gamma 4, and also the new LogC4 curve. Things started to ramp up full-time in 2019.

What happened from 2016 to 2019? I guess you were sidetracked with the Mini LF?

For example, yes. There were always things to do with the other cameras. We had to work on HDR transforms as HDR became more prevalent and we introduced 4K output, or UltraHD output, on the AMIRA and Mini.

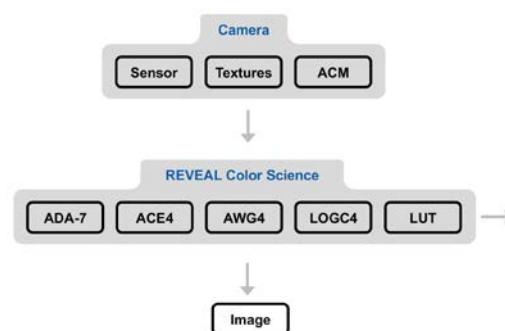
Your team develops the color science or color engineering after the image leaves the sensor?

My department is the image science group at ARRI. The sensor and front-end itself needs to be designed and calibrated, and that is done by Achim Oehler's group. Then as mentioned, we have this dual gain architecture of low gain and the high gain, and the two images are fused into one—and that's the image we take on.

The two images are taken at the same moment in time?

Yes. It's not like some other manufacturers who use a sequence of long and short exposures. It's really the same image from the same sensor converted with two different gains. The high gain image gives you cleaner shadows and the low gain image avoids highlight clipping.

Please take us through the process of what happens with the image after it leaves the sensor and goes into your domain.

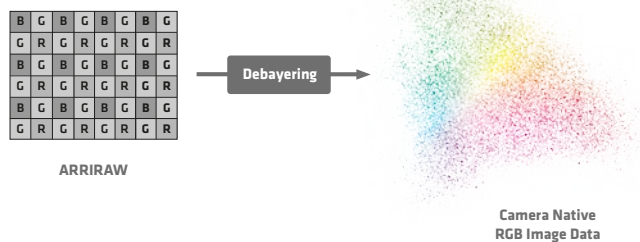


The first thing when the image comes from the sensor is that sometimes there are defective pixels. Luckily, most of these defective pixels have been identified during the sensor calibration and they need to be corrected by us.

So, that's the first step. Then the next step is part of the processing, which we do here—called Textures—that influence the noise in the image and also the look of the noise.

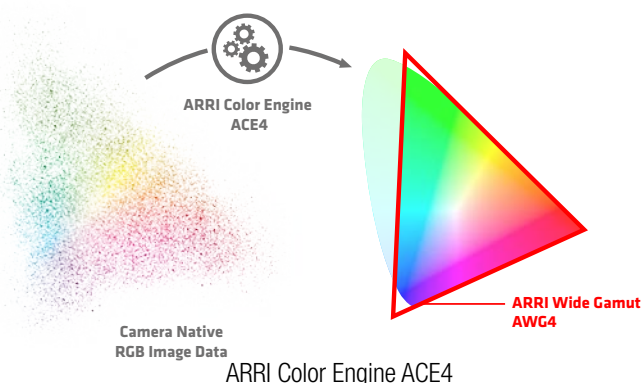
Then comes the ADA-7, the new ARRI Debayer Algorithm. We received feedback about ADA-5, which was used in previous ALEXA cameras, that people liked the image but they did not like

Harald Brendel on Image Science



ARRIRAW Debayer Algorithm ADA-7

the performance of the debayer in green screen and blue screen shots. We had cases with some artifacts at the edges between the foreground subject and the background. So, ADA-7 was specifically designed to give cleaner edges in front of a blue or green skin image. Obviously without sacrificing anything else in the image.



The next part is color correction: the ARRI Color Engine (ACE4). We changed a few things compared to other ALEXAs. We wanted to have a new color space. This is the ARRI Wide Gamut 4 (AWG4), which is fully enclosed in an ACES AP0 color space.

When you do your post-production work, you might want to master in ARRI LogC, but you might also have visual effects shots. Our earlier AWG3 color space was larger than ACES and some colors were outside its color space. When you encoded these images in ACES for visual effects work and took them back, you sometimes saw color clipping in the blue region. We wanted to have a color space that was more contained and fit into ACES AP0, and at the same time, would handle all the LED lighting fixtures that everyone is using these days.

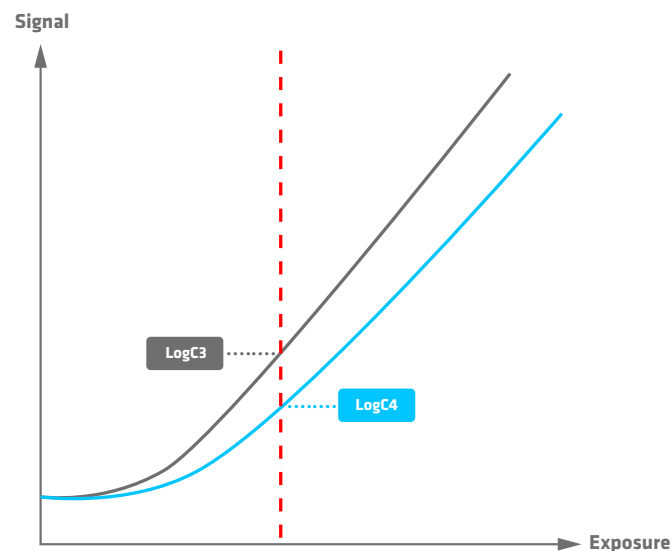
When earlier ALEXAs came out, there was not much LED lighting used on sets, and now you have LEDs everywhere that can create crazy saturated colors. For example, the blue lights on an emergency vehicle or police car are done with LEDs in a very saturated blue color. The blue is so saturated that it can cause clipping in the color channels. Obviously that can be disturbing.

Those LED effects are ubiquitous, and they are a completely different light source than we had 10 years ago.

Therefore, we wanted to have a color scheme that handles those extreme colors better. This color processing turned out to be more complicated than we thought in the beginning, but we are really happy with it now. We have a better rendition of highly saturated colors with the new color engine.

What about skin tones?

For skin tones, we wanted to stay more or less where we were with earlier ALEXAs, so we didn't see much reason to change much. We had done extensive testing with skin tones. When you apply the new render transform to the LogC4 image and you compare it with earlier LogC3 images, you get a tonal curve that looks very similar, with just a bit more saturation of colors, but not much. That was also an intended change. I think the original ALEXA image was rather desaturated to begin with. So now, the default image has a bit more color. But not much. You can get very comparable results when you look at portraits shot with the ALEXA 35 and with the ALEXA LF.



And then we get to LogC4.

We currently say that ALEXA 35 has a dynamic range of 17 stops. This is more than two stops greater than the other ALEXAs, and we needed to have a new encoding function for this—LogC4. Basically the old LogC3 doesn't have enough head room, so we could not simply put the new images into the LogC3 curve. In designing the new LogC4 curve, we also wanted to solve a few issues that people had with LogC3. When we came up with the original ALEXA, you would record ARRIRAW and then you would pre-render it into 10-bit DPX and then take the 10-bit DPX files into your DI color grading. That was a common workflow at that time.

Obviously that 10-bit quantization is a bit of a bottleneck. When we designed the ALEXA, we wanted to maximize the 10-bit number space, and that's why we designed a few things into

Harald Brendel on Image Science

the LogC3 curve which later made life a bit more harder than it needed to be. We fiddled a bit with the camera at different ISO ratings, which made processing LogC3 into linear images or converting it into other color spaces a bit more difficult. So, with the new LogC4 curve, it's much easier. You also have fixed values to which certain scene values are mapped. With LogC3, 18% gray would sit at 39% signal, but then your white values would change as your ISO setting in the camera was adjusted. With the new LogC4 curve, it always stays the same.

And what about recording?

Either you record ARRIRAW or you record LogC4 as a 12-bit ProRes image.

ARRIRAW is the same as before?

Essentially, yes. We do a non-linear recording of the RAW images and 512 digital numbers are allocated per exposure stop. But, because in the new ARRIRAW we have to encode two more stops, we need 1,024 more numbers in our range. That's why we needed to add one bit to the file format, so ARRIRAW is encoded in the ALEXA 35 in 13-bit, whereas ARRIRAW is encoded in 12-bit in the ALEXA LF.

So, the quantization per stop is exactly the same. We didn't want to change it because it has proven to be fine for more than 10 years on many successful productions. We never had complaints where people would said that the quantization of the RAW file wasn't good enough. So we kept the same encoding per stop other than to add one more bit.

So, 18-bit from the sensor results in 13-bit after processing?

Yes. It's 18-bit linear coming into the processing, and then either before the color processing, it gets encoded into 13-bit ARRIRAW, or after the LogC4 curve it gets encoded in 12-bit LogC4 for Apple ProRes.

ARRIRAW is also a Log-like exposure, which also allocates a fixed amount of digital numbers for each stop. We always had 512 numbers in each stop. So when you look at neutral gray and then one stop over, you have 512 intermediate steps, and if you add yet another stop, you have another 512 numbers.

How is the workflow different from the previous ALEXA, other than dynamic range and textures?

When the ALEXA came out, there was only SDR. And then for a few years we have had HDR. When you work for streaming providers, they normally also ask you to generate an HDR and SDR master. I know that some people also want to preview HDR on set because it may influence how you light the scene.

In the ALEXA, you can only load one LUT, and it's either SDR or HDR. So, when we started to think about the ALEXA 35, we thought, well, okay, perhaps we should do a Look file where you can put in an SDR LUT and an HDR LUT at the same time, and then in the camera you can switch which one you want to see.

But then we realized that's not really practical because you always would have to create two LUTS. Also, later in mastering when you want to import all your shots into a timeline in your color corrector, you would need to decide which LUT you wanted to use. Normally in color grading, you'll do an SDR version first, and then you switch to HDR, or you do it the other way around.

You want to go back and forth between the SDR and HDR master.

Now, with the new ALEXA 35 camera system, all the Look files are so-called Log-to-Log transforms. They're a bit like the LMTs (Look Modification Transforms) in ACES. And then comes a render transform that takes you either to SDR or to HDR.

The old look files took you from LogC into your target color space, which was either Rec.709 or one of the HDR color spaces like PQ or HLG. But now we have a Look file that takes you from LogC into LogC, and then on top of that you add the render transform for your intended target color space. In the camera, that could be Rec.709 or Rec.2020 in SDR, or the two flavors of Rec.2100 in HDR. For post, there are more options—like all the different DCI color spaces.

Let's say you have a Look that desaturates the colors. You load this Look file and you will see the same look in both SDR and in HDR. And the camera can also simultaneously output separate SDR and HDR images. There are two SDI ports at the rear of the camera and you can connect two different monitors and send one output to SDR and the other output to HDR.

That is very helpful to be able to simultaneously monitor in SDR and HDR on set.

You can also switch the eyepiece between SDR and HDR at the push of a user button that you have assigned in the menu. And, as mentioned, it will also show the same Look file if you have added one.

Since your background was originally in live images and grading, were you looking at real test images and then adjusting them when you were developing the camera?

Sure. Always. When we make a new camera, one of the first things we build is a very primitive prototype that doesn't really look much like a camera. It looks more like a toaster or a household appliance, and then we take it out, and normally you need to connect a laptop to operate it. Then we start to do the first test shoots. Normally we do a series of portraits. We go to a casting agency and cast as many different skin types and people we can find. We also go out and capture landscapes and night scenes. We use all these tests in developing the image processing.

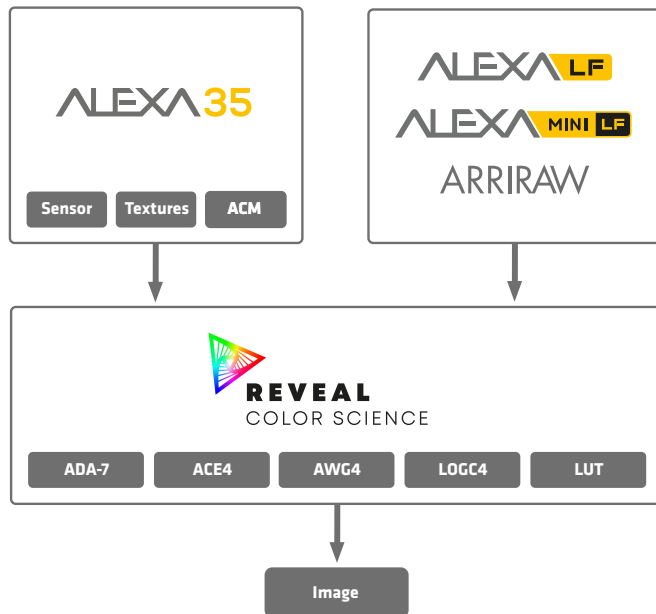
That leads us to post-production. Let's say you're shooting with ALEXA Mini LF and a new ALEXA 35. How would you recommend working on the same timeline?

There will be an option in the SDK to process the Mini LF and LF files into AWG4 LogC4. So, in the future, once the version is out, there will be a switch in the software where you say process it to LogC3 or process it to LogC4. When it's processed to LogC4, then you can apply the same LUTs, or the same Looks that you have for your ALEXA 35 images. It works quite well, and we have seen that we can get quite a good color match between those cameras even while they have different sensors.

In the first version, it'll be for the ALEXA Mini LF and ALEXA LF only, but then we will also have it for the ALEXA Mini and SXT and every other ALEXA camera.

But the SDK that will live in your DaVinci Resolve or Baselight will have a switch where you can say process my ALEXA footage to LogC3 or LogC4. So, yes, it's done in post.

Harald Brendel on Image Science



I have to admit that we don't have this ability yet for matching on set. If you have a Mini LF and an ALEXA 35 side by side, you will see slightly different images in the on-set monitors because with the Mini LF, the on-set Look management will be all based on LogC3, and the ALEXA 35 will be based on LogC4. But once you bring it into post, you can cross-process your Mini LF footage into LogC4, and then you should be able to intercut it with ALEXA 35 footage without much hassle.

What about overall contrast?

You continue to do with the Look file. As said, you can load a Look file, and that you can make the image more contrasty or less contrasty. You can increase saturation or take saturation away. But you cannot create a Look file with just any color corrector. You can create a 3D lookup table that transforms Log-to-Log, and then you take this Look file into the new ARRI Reference Tool, you convert it into a Look file, and then you load it into the camera. So, this is a similar workflow as with the Mini LF.

The new workflow is not all that terrifying. That's reassuring.

The only thing I have experienced so far is that more DPs than I thought view at the LogC image for exposure checking. But, the new LogC4 image looks really quite different than the old LogC3 image. It's darker because it needs to have more headroom, so the whole curve is flatter and your mid-grays come out darker. But once you apply the transform into your target color space, the images are very set, and you need to basically remember a few new numbers if you are someone who uses a waveform monitor.

If you were the DP, I gather that you would rather expose by the live image coming onto a good monitor? Not the LogC image.

Yes, sure. Or, you could use the false color exposure tool as you did with earlier ALEXAs.

Shooting available light in a dimly lit room with full sunlight outside a window makes one grateful for 17 stops of exposure.

I think cinematographers will appreciate this additional headroom, especially in HDR. When you look at an SDR image

from the new ALEXA 35 without modifying it, sometimes it's difficult to appreciate those additional stops of dynamic range. Because the tonal curve is already so flat and you want to have this gentle roll off towards the highlights, if the sensor captures two and a half more stops, you won't see much of it in an SD image unless you start to bring it down, or stop down the lens, increase the contrast in the highlights or make them lower. And clipping in HDR really looks ugly.

In HDR, you expect to see in the highlights but then if it suddenly stops, it looks quite wrong. In SDR, if your camera clips, you don't see it sometimes because you already have this flat part of the curve. So for example, if the sun is shining through a cloud and it's clipping, it doesn't matter because the cloud is already white. The sun is clipped within this cloud. But in HDR, you see all the differences and then you suddenly have a clipped area that is much more of a problem. That is why I think, especially in HDR, people will appreciate this additional headroom.

How do you divide responsibilities in your team?

We have a few color engineers. They specifically take care of colors. Then we have people who are really experienced in digital filtering, and we have a few software engineers on the team. We don't write the camera software, but we contribute parts of the software that controls the image processing in the camera. We develop a module that is then used not only in the camera software, but also in the SDK, and that translates all the user parameters like exposure index and white balance and Look files into all the LUTs and matrices and whatever you need to process the images.

The images are really beautiful. Congratulations.

I think everyone here is also looking forward to the launch; it has been a long project and a big project, and like every really long project, there were things that would not go well, and then you had phases where it was going well. I think the outcome looks amazing. The images look amazing. We are ready to finish it and pack it up and then...

And then?

I'm sure we will have lots of questions and a lot of things to learn and do, especially since Textures are quite a new concept. I think we will get a lot of feedback and we will also listen carefully where it works and where it needs improvement. Also with the new separation between the Log files and the transformation LUT. It brings us a bit in the same situation the Academy is with ACES, that you have this reference rendering transform, which you can't influence as a user anymore. It's a different concept because, for sure, you need to come up with a way those images are rendered, and not everyone may agree on it. So we will have to listen carefully to our customers and users.

I expect this camera to be in the market for many years, and I think we will deliver many software upgrades for it. Remember, with earlier ALEXAs, we did how many software updates? At least 14 or something like that.



Dr. Tamara Seybold and Harald Brendel.

Dr. Tamara Seybold is Technical Lead Image Science. She joined ARRI in 2009.

How did you get into image science?

I studied electrical engineering and information technology at the Technical University of Munich. After other technical jobs, I started working at ARRI while still a student. At that time, 2009, I was lucky to join in the final phase of the ALEXA development. It was really exiting to work with all the great colleagues in that team. The project was fun and exiting and known to be critical for ARRI to really make the step to digital film cameras. I was working on electronics mainly at that time.

Then I worked at Siemens in Japan for half a year, after which I came back to work at ARRI on my Master's thesis about 3D LUT implementation. That is where I started to work on image quality and technical solutions for image processing in a camera. I later found this to be "my thing:" bringing together really good visual image quality with the best technical implementations. My professor then said that I should get a graduate degree, but I didn't want to do that at university. So I was lucky enough to work on my Ph.D. while continuing to work at ARRI on motion picture denoising. I learned a lot about the human visual system and

how we see moving images. I completed the Ph.D. in 2015 and continued in the image science team. Now I'm the Technical Lead of the team. At ARRI, we have a Team Lead and a Technical Lead, so there are two people jointly heading a team. Harald Brendel is the Team Lead, or Center of Competence as it is called now.

What is image science? Please define.

Image Science is the team at ARRI developing the image processing algorithms that render a full resolution and full color image from an image sensor's data. In the beginning, this basically involved a debayering algorithm necessary to obtain the full color RGB image, and basic color processing using a matrix and LUTs. Nowadays, there are more steps and more sophisticated steps. Each of them contributes to rendering a final image that comes as natural and rich as possible out of the sensor data.

It's more than just colors?

Oh yes. For example, the debayering already needed to obtain the full color image doesn't only generate RGB values but also influences the perceived sharpness and grain rendering. And many more steps influence the clarity and grain that are important aspects of the texture of an image. So we, in the image science

Dr. Tamara Seybold on Textures

team, pushed hard to obtain the best results by really optimizing each and every step in the image processing pipeline, not only for the best color rendition but also for the best texture, as we call it. We did that in a holistic way, optimizing steps in the beginning of the pipeline together with later steps so that the overall result would be best. At some point, this came down to having more than 30 parameters that we had to optimize together—a huge amount. We specifically had to build a small “texture grading machine” to be able to optimize all these parameters together.

I actually started working on Textures quite some time ago. I realized that it's not only about having one perfect texture of an image. Some people would be amazed by the wow-effect of an extremely clean and sharp image, while others would prefer a smoother rendering, especially on skin tones. Still other cinematographers like a certain graininess. So, early on, my vision was to make this a creative tool that we give to the DPs—similar to the choice of film stock they had in the past.

It's also an art, not just science?

Yes and no. So yes, compared to classic university image processing, it's also art here, because we influence the look of an image not only to be correct but also to be pleasing. At university, everyone measured PSNR, (Peak Signal to Noise Ratio), how similar the image is to the “true” values. But when you do that, sometimes you get really ugly results because it is a mathematical point of view that doesn't respect the human eye and brain looking at the image.

And no, because what we do, I would never call art. Art is what people create when using our cameras. We want to give you the best tools to create that art. With our image processing, of course we make certain choices. But with Textures, we leave the decision up to the users. With our image processing, we provide a good starting point for creating something, offering a good and reliable selection of looks. So, let's just say that our cameras capture the world in a way that works well for being used by artists.

Please discuss the path to arrive at the new ALEXA 35 image science.

The work on this camera was a long journey. In the beginning, we wanted to solve certain problems, like the blue colors in ACES, or the noise in low light situations. Then we started putting things together and realized how much more we could do. Our team worked on getting the best color processing and the best image processing. As for me, I was mainly working on the processing that we now call Textures.

It also was around that time, 2017, when I was invited to the Imago Cinema Conference in Oslo. I gave a presentation about exposure and some aspects of Texture. I realized the diversity of taste regarding sharpness, grain and cleanliness of an image. Basically, DPs mostly had the choice of the camera itself, lenses, and optical filters to create a certain look. I realized that look is more than color.

We mostly understand the color when we speak of the look of an image, but there is more that contributes to it than pure color processing. Some people liked our cameras for the texture of the grain they offered, but at the same time, there was a need for a more individual look of the image. DPs mostly used old lenses to make the image special. So, I thought, what can I do to give them

some additional possibilities for a more individual image, for a creative decision on the Texture of an image. Now that would be a decision on the look of an image much more than just color.

Those were really exciting times. We also did a lot of research on the perception of noise and grain at that time, and we investigated the perception of grain and sharpness. Bringing together the research and the needs that colorists saw when they worked so intensively on images was also very inspiring.

As I mentioned, we had over 30 parameters that contributed to the texture of an image. It was especially challenging because they all influence each other. You know, when you have greater sharpness in the debayering, you should apply a little less sharpening in the digital filtering step later on for a similar effect in the image. And if you make changes to an algorithm, you also need to change the parameter again. It was not so easy working on the Texture parameters as long as we were still improving the algorithms at the same time, because it all had to fit together. So, it was a long journey, but I think it paid off. The image processing in the ALEXA 35 is greatly improved and with Textures we really have something new.

How would you explain the difference between the new camera and previous ALEXAs?

The sensor has an incredible dynamic range. At 17 stops of exposure latitude, it's really quite something. The image processing is completely renewed and much more powerful. Both color processing and all image processing steps are completely redesigned and extended. All the color and Texture processing maintains the reliable characteristics we have known from the ALEXA, while exceeding the color rendition and dynamic range. With Textures, you have a interesting creative choice that you didn't have before.

Additional thoughts?

About Textures, I'm really excited to see how people will use them. I think it can really have a certain effect in the image that makes it a more individual choice. The effect is subtle. You can have much stronger effects with optical filters or digital filtering in post production. I would suggest determining your intended Texture for a production in the prep phase where you can view different Textures on a large monitor and decide which ones to use. I recommend that you pick a Texture together with the lenses you plan to use on your production. And finally, I'd like to add that you don't need to worry about Textures if you don't want anything other than the camera's default Texture. It's an extremely versatile Texture with a cinematic look and works well on almost any kind of shot.

It's quite exciting.

I'm really excited to see how cinematographers will use Textures. We are really at the beginning; it's something new. I try to avoid recommending which Textures you should choose because I do not want to influence your creative decisions. I want to see how you use them and the context of the effect. But at the same time, I am here to help explain the process. We are looking forward to hearing customers' comments about how they used Textures and the looks they achieved.



Christian (Geoffrey) Grafwallner is the Product Manager for the ARRI Image Software Developer Kit (SDK), the ARRI Reference Tool (ART), Camera Access Protocol (CAP) and the MXF Library. It's essentially about all the tools and workflow after the image comes out of the camera.

Jon: Where does the name Geoffrey come from?

Christian Grafwallner: When I started at ARRI, there were some people who knew me from school and that was my nickname. But when I'm in contact with partners or customers, they always call me Christian.

When did you start at ARRI?

It was April 1, 1991—32 years ago. I started in the ARRI studios, got involved in nonlinear and AVID editing, ARRISCAN (scanning film negative), ARRILASER (printing digital back to film), D-20 and D-21, and then ALEXA.

Tell us about the workflow with the new ALEXA 35 camera.

One thing that is very important about the new camera is that all files are recorded in MXF. Only MXF. No matter whether you record ARRIRAW or Apple ProRes, it's always an MXF wrapper. There will be no single-frame ARRIRAW format anymore. The reason is that gives us a lot more flexibility with metadata for future applications. Also, there is more metadata now, for the processing and all the workflows. We also heard from customers that they prefer the clip to be a single package and not a folder of individual files for each frame of the sequence. The MXF header has been completely reconstructed. It's a public document; everything is open and I think it's a big help for integration.

We also provide the ARRI MXF Library. It helps our partners to read the data from new and legacy footage and also to write the metadata. For example, if you want to export an ARRIRAW clip

in Apple ProRes for dailies or for viewing, you can pack all the metadata into the Apple ProRes, and it won't strip any information out.

Is it backwards and forward compatible with other ALEXAs?

Yes. We supply our debayering engine and our image science to third parties as part of our ARRI Image SDK, so they can incorporate it into their products. We give samples to the partners as to how they should read the legacy material and how they can map it into the new structure. The SDK that we will deliver, version 7.0, will handle all material from the first ALEXA Classic to the SXT, and all models until the new one. So, you will have one SDK.

If you're shooting with an ALEXA Classic, you keep it in its native format—it's not reconfigured to MXF?

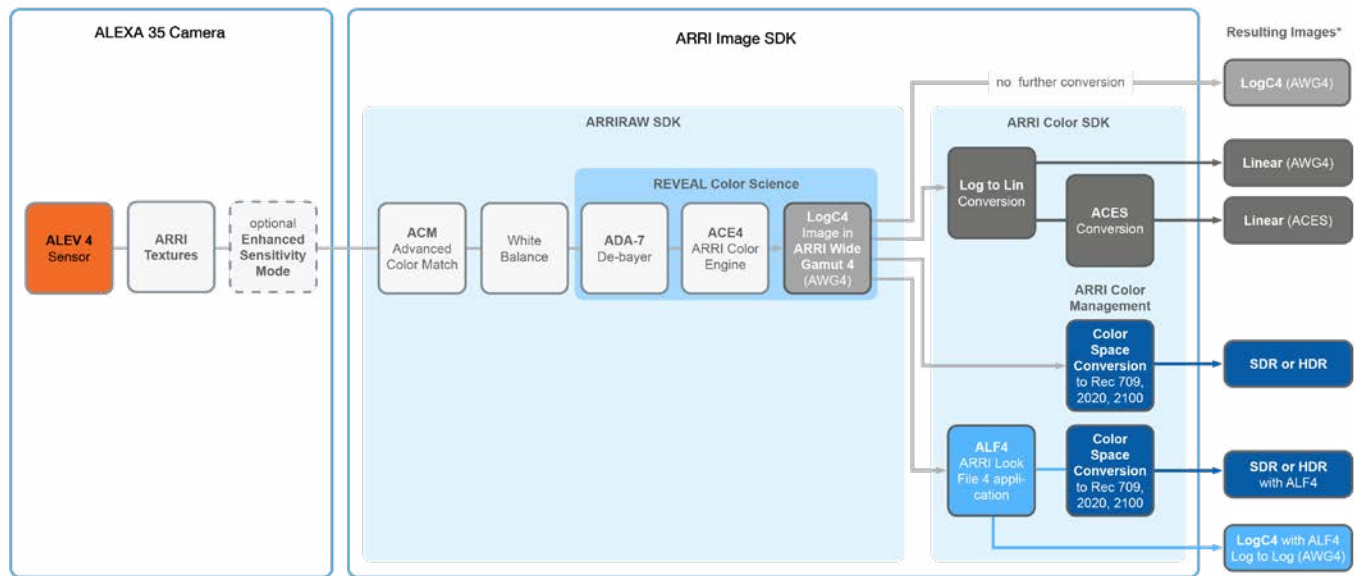
Correct. We will not do an update. Maybe we can do it for the Mini LF, maybe the Mini LF can get the same metadata structure, the same recording format, we are looking into that right now.

Looking at the ARRIRAW image Chain, the SDK begins with Advanced Color Match (ACM)?

Exactly. (See chart.) We have the ARRIRAW part, which is similar to what we have from the previous ARRIRAW SDK, but the second part is the color SDK, which is new, and there you have the option to also do color transforms. In the first part, there is Advanced Color Matching - ACM. This is to get matched cameras. To achieve this, we calibrate every camera with a special calibration lamp, and that calibration is loaded into the camera. When you record something, then there will be a set of data that ensures, for example, that the white balance is really well corrected for that camera's sensor. It's a "unit calibration" done at the factory or in service.

Then there is a new, optimized ARRI Debayer Algorithm (ADA-7). We made some improvements over ADA-5. ADA-7 utilizes the

ARRIRAW Image Chain



* Resulting Images: Except for LogC4 (AWG4), the ARRI Color SDK can either render these images or create 1D LUTs, 3D LUTs and/or matrices for third-party tools to render the images based on the LogC4 (AWG4) image.

greater processing power of the ALEXA 35 to provide cleaner edges, which will be especially helpful in green and bluescreen work.

Then, we have the ARRI Color Engine (ACE4). This is an improvement in terms of color handling. We don't do it with matrices and LUTs anymore. Now, we have a new and novel method that provides more accurate color rendition and that corrects clipping of certain colors like electric blue, especially when you go into ACES or other color spaces.

We don't map any colors into any regions where we can't get them back. For that reason, color handling and reproducing colors correctly is much better.

The last part is the LogC4 image in ARRI Wide Gamut 4 (AWG4) and the new Look Up Tables that allow you to convert LogC4/ AWG4 to any display color space. So, when we talk about the new REVEAL Color Science of ALEXA 35, those are the "building blocks:" the new Debayer, the new Color Engine, the new LogC4 format in ARRI Wide Gamut 4, and the new LogC4 LUTs.

I think many cinematographers will appreciate the fact that the ARRI Textures are baked in so some producer's nephew's son is not going to mess with it later in post.

I think so too. Also, in the beginning of a new product with so many new bells and whistles, if you reduce the information overload a little bit in the beginning and introduce it step by step into the workflows, I think it's more helpful because then they can concentrate on new features that are of interest.

Who are some of these partners?

We have been talking to Blackmagic DaVinci Resolve, Autodesk, FilmLight, Pomfort, and other big players in postproduction for the past two years.

And then, in the chart, we come to Color and Look.

Yes, now we come to the color stuff. That's one of the reasons we thought it is good to include color features in the SDK: because you can also use it for ARRIRAW and Apple ProRes. Now, no matter from which format you come, ARRIRAW or Apple ProRes, you can use the same color SDK to do the same conversions. You can have a mixed timeline and you can use the same color science.

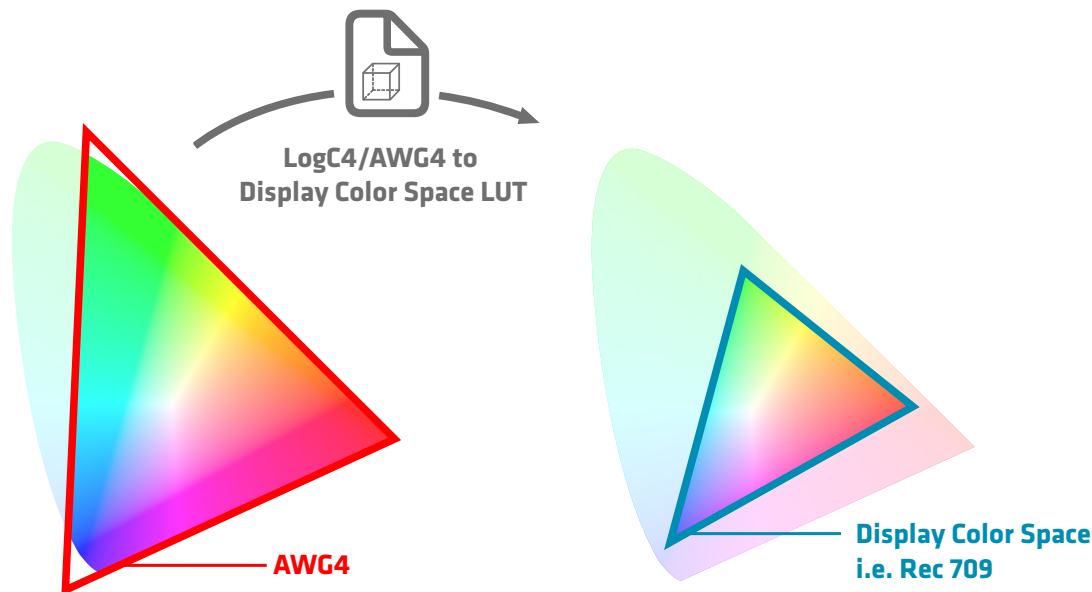
There are four outputs, basically. The first one is clear: you have a normal LogC4 out in ARRI Wide Gamut 4.

It has a different curve than our previous LogC3 from the previous cameras. And this is very important for all customers to know. For the new LogC4, you should use our new LogC4 LUTs.

I think a bit of orientation might be in order in the beginning to avoid using the wrong workflows. If they're working with the tools that they know, that they have been working with ALEXA footage for many years, there maybe some surprises. Please take care: you have a new camera and you have to make sure to use the new LogC4 LUTs.

What do you recommend to a DP who has a favorite LUT that's been created for a previous ALEXA show? Should you go to a postproduction facility and have them convert it? Is there a conversion tool?

The best way would be to create a completely new LUT, because the new ALEXA 35 has 2.5 more stops of dynamic range. We have been thinking about a conversion tool, but the problem is that the handling of highlights will not work because the previous cameras did not retain those highlights in the first place. How should a LUT handle a highlight that did not exist before? So, I think a conversion tool is unrealistic. If you really want to work seriously with the new camera, you have to go to a colorist and create new



show LUTs, using our LogC4 LUTs as a basis.

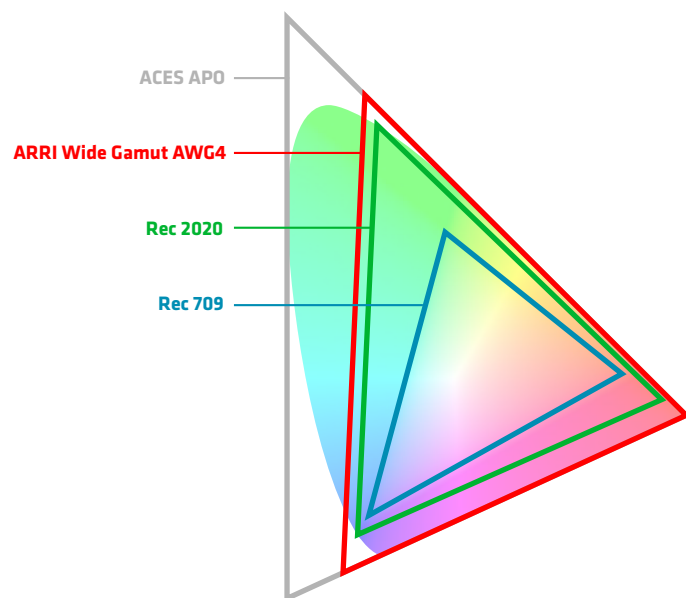
Getting back to the resulting camera images...

We have a technical conversion to linear, for example when you go to visual effects and want to produce OpenXR files, then you can convert it to linear ARRI Wide Gamut. That means the gamma is the same and it's not a Log but a Linear signal, which is what most of the visual effects houses require.

Or you can do an add-on and convert it to ACES. If you want to have an ACES workflow, then you have to add another matrix to get a linear ACES image, for example, when you're mixing different cameras on a show, or you want to do grading in ACES, which is more or less a common way now for high-end productions.

The fourth thing is if you want to do dailies or just preview material, then you can apply color management, which means going to Rec 709, or Rec 2020, or SDR or HDR workflows.

The final output combines that with a specific look file, and that's



now different from what we had in the past. You remember in the old look files; we always had a 3D LUT that was going from either LogC3 with your artistic intention to Rec 709 or some other display color space.

For example, you might have had a black and white look for Rec 709, and that was a LUT. And then you combined it with or without a CDL, depending on whether you were doing CDL grading on set, to get a better match of the scenes. The problem was that the LUT was only for one color space. So, if you then went into post and you wanted to go a different direction, then you needed a different LUT. That was a really cumbersome workflow. You might have gotten in contact with ARRI Media, a rental house or your favorite colorist and asked for a LUT for the different color space, and they wanted to charge you. If you were a colorist sitting with a client and you needed a different LUT, and you needed it now, do you really want to have to ask somebody, "Can you send me a LUT?"

For that reason, the new look file (ALF4) in the ALEXA 35 is Log-to-Log. So, you get LogC4 in and you get LogC4 out—and the application of the display color space is a second, separate step. So, if you want the dailies for Rec 709, you put your Rec 709 LUT on top of the ALF4 look file. If you want your dailies for Rec2020, you put a Rec 2020 LUT on top of the ALF4 look file. Your look in the ALF4 look file is always the same, we just separated it from the final step of converting it into a color display space.

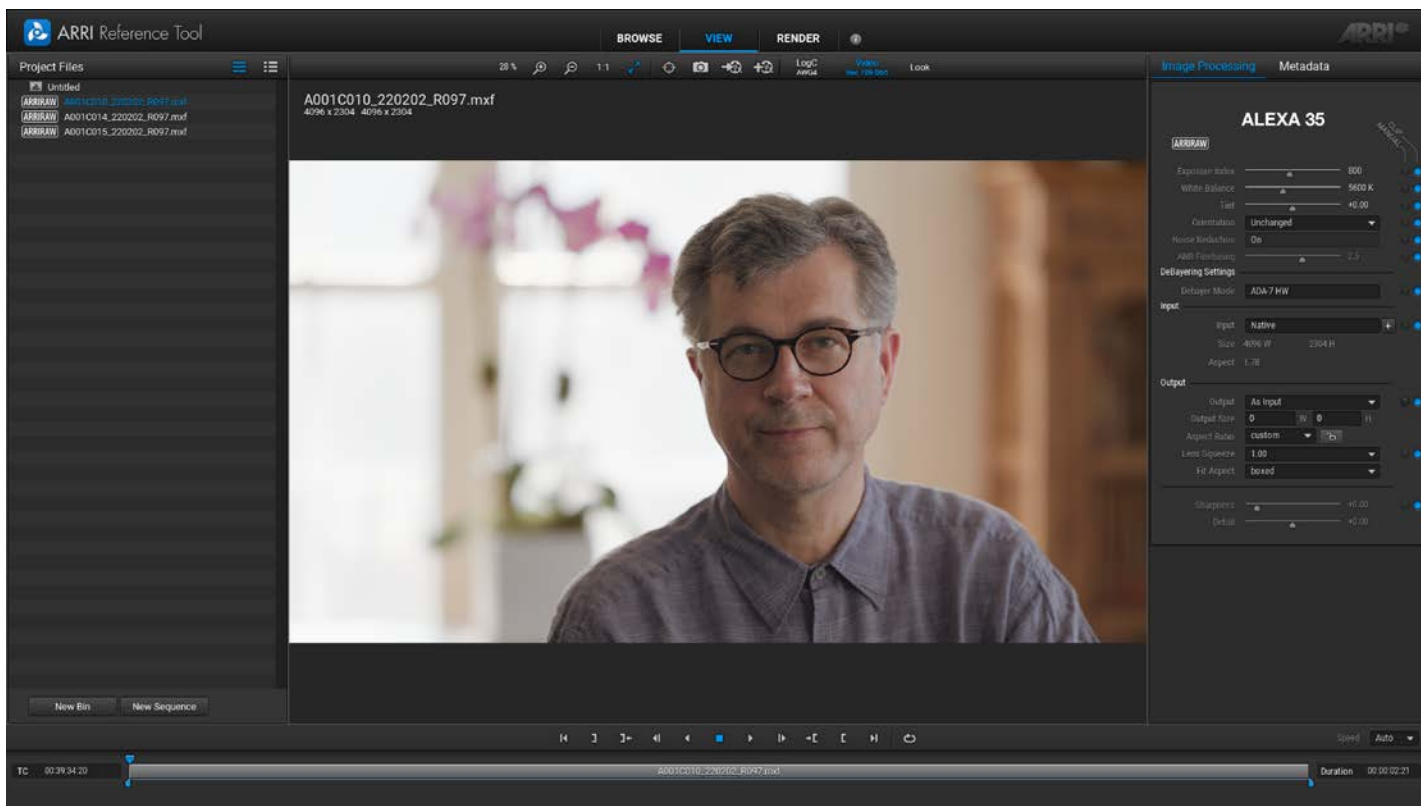
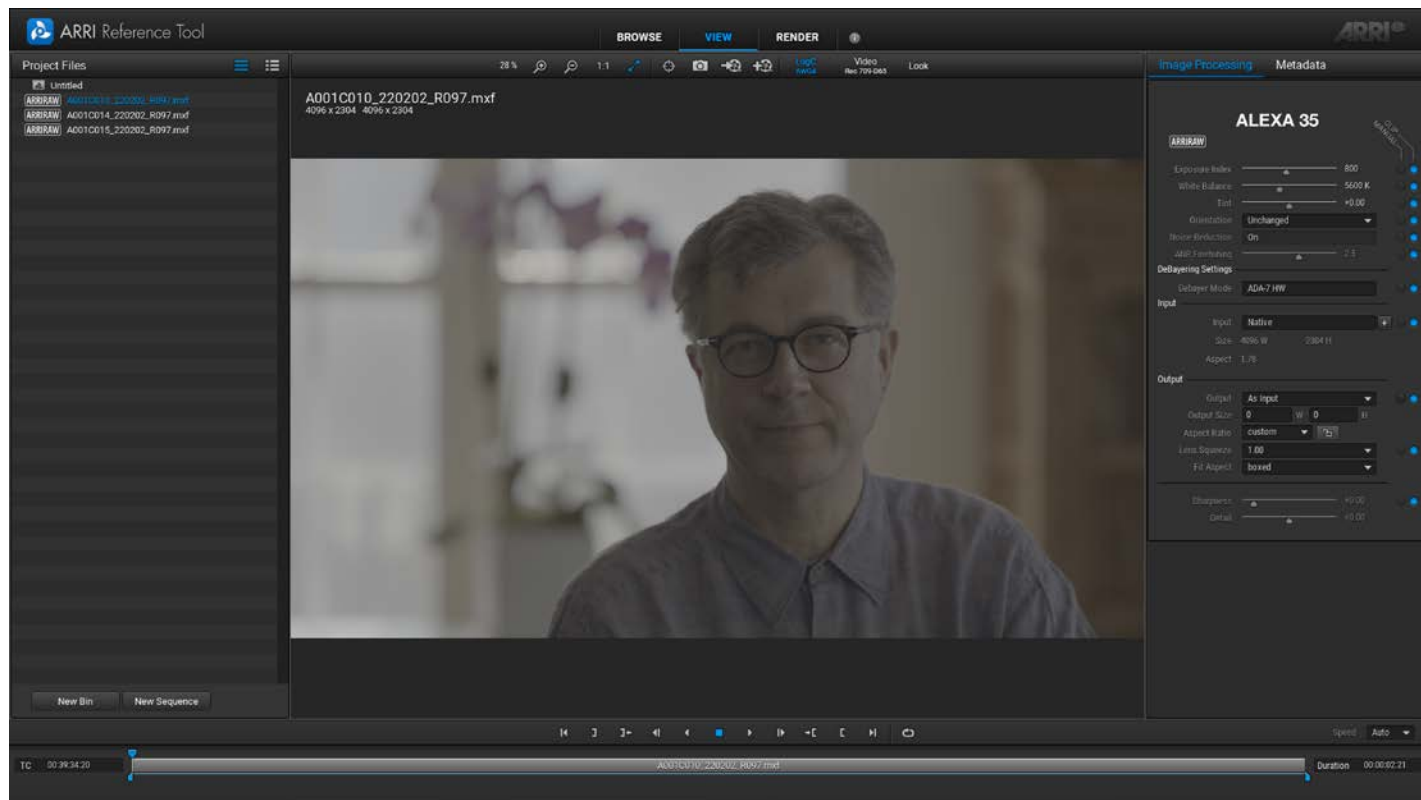
Tell us about the ARRI Reference Tool (ART). [see next page].

The Reference Tool basically combines everything that we had in the past. It combines all the functions of the ARRIRAW Converter, ARRI Color Tool and ARRI Meta Extract. We think that will make it easier for our customers. It will read all the footage of all ARRI digital cameras. And we can read Apple ProRes files. We can read every format that comes out of the camera. We have integrated the ARRI Color Tool so that we can create look files as well and import and export 3D LUTs. And we have the integration of the ARRI Meta Extract to extract metadata.

I can see you have been rather busy for the past two years.

Not just me. It has been intense for the entire company.

ARRI Reference Tool (ART)



Beta version of the ARRI Reference Tool.

Top. LogC4 AWG4 without LUT.

Bottom. LogC4 AWG4 with Rec.709-D65 LUT enabled.



Christian Hartl began at ARRI as an apprentice in 1986. Then, he worked on the Arriflex 535B (1992), 435 (1995), ARRICAM (2001), 235 (2003), 416 (2006), and ALEXA cameras (2009).

Jon: Tell us about the manufacturing area in the new ARRIAL Munich headquarters compared to the old rabbit warren series of buildings on Tuerkenstrasse?

Christian Hartl: It's completely new and really high-tech. The main difference for us now is that production and the R&D department, along with many other departments, are under one roof. Manufacturing and R&D are even on the same floor. This is a big advantage for better communication and better understanding. To have the R&D department and the production department working side by side is very helpful.

How is manufacturing integrated with the R&D department?

We have a newly designed project area, and this is directly linked to the development department. It simplifies everything during the overall product development process. R&D often adds many additional ideas for efficiency with our serial production. Now we see the results in the new ALEXA 35 camera model. I think it's a milestone in our product development and expedited the preparation of our production department for our ramp-up phase.

Are you already ramping up production of the ALEXA 35?

Yes. We started manufacturing and we are working at maximum capacity. Meanwhile, we also have a huge demand for our Mini LF. By the way, I'm also responsible for manufacturing lighting

and our products coming out of Vienna. I'm responsible for all production, not only camera assembly. The lighting department is in Stephanskirchen, close to Rosenheim, and Vienna is a one-hour flight or 5-hour drive from Munich.

Is the manufacturing area at ARRIAL bigger than it was on Tuerkenstrasse?

Much bigger, much bigger. Everyone enjoys working in this ultramodern space. It's really bright and we have a lot of windows.

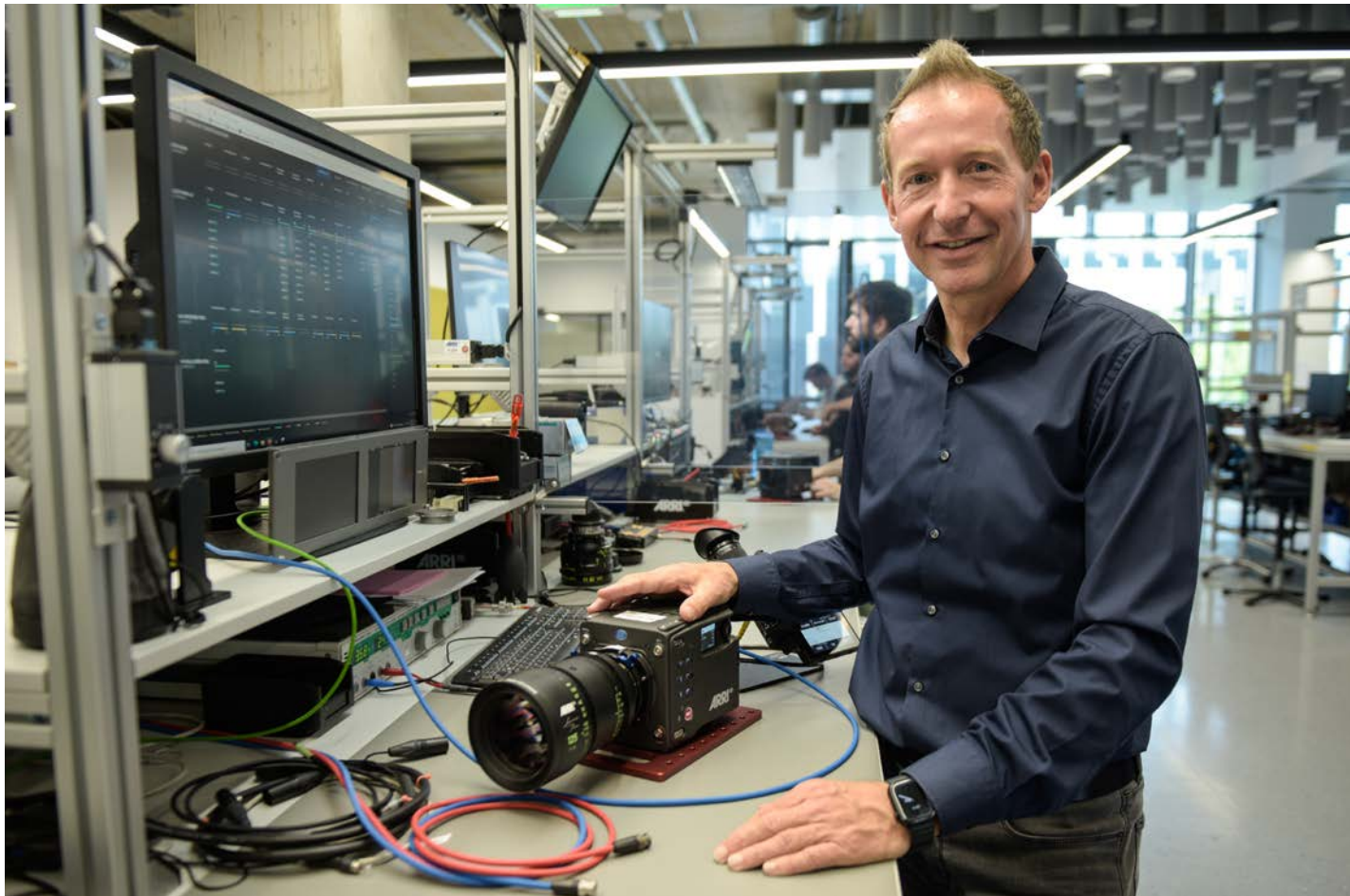
It's one big area, but we have different standardized assembly lines as well. At the moment, we are manufacturing the Mini LF, AMIRA and the new ALEXA 35. We also produce all our accessories in this area: ARRI Camera Accessories, Professional Camera Accessories, the viewfinder, the new TRINITY, etc.

When did you start building the new ALEXA 35 camera?

At the beginning of this year. This is also something new. Marketing and sales would like to launch the camera and ship in volume around the same time. It's completely different than before when we just had a handful of cameras in the beginning. Now we have shelves upon shelves of cameras ready to go.

How is the manufacturing process different?

We're still working in a one-piece flow system. We ordered a lot of material and components in advance, which was a good decision during this period of supply chain issues. We are fortunate to have enough supplies to manufacture the cameras.



Our staff is very versatile and we have very flexible assembly lines. We can switch between models quickly. We spend a lot of time and a couple of months each year qualifying and training our assembly staff. This, from my perspective, is an absolutely crucial thing. Everyone on the team is very well trained on the new camera. Even better, many have a lot of experience on the older ALEXA models, especially the Mini LF. This makes things a lot easier. We have a really great and highly motivated team.

How do you find new team members?

We still have an ARRI apprenticeship program in-house. They learn mechanical manufacturing but what's new is that we started an apprenticeship for electronics.

Are the mechanical parts machined in-house, for example, the camera body and sub-assemblies?

The mechanical manufacturing also is done on the ground floor level of the ARRIAL. You remember it used to be in a separate building near Tuerkenstrasse. All our housings, some cooling assemblies, and the parts necessary to support the sensor front-end are made here on the latest CNC machines.

What about the sensor?

The sensor work is done in a state-of-the-art clean room on the second floor. It's much bigger than before. The internal filter slider is now separate from the sensor and this is better for service.

You made 50 pre-production models for testing around the world. Is that process different from serial production?

A little bit. But the process for our assembly staff was the same.

We learned a lot and it is important to do both versions in the same way. It's equally important for the R&D team to get feedback from the assembly people. We constantly ask ourselves what is good and what is not so good, what is working and what is not so optimal in order to find the best solution together.

That's interesting. With R&D right next to manufacturing, they can see where things might be more streamlined or built in an easier way for the next camera or the next design. An architect designs a house, but if you can't build it, it's not a good idea.

Absolutely. This is why we created our production area with a direct link to the R&D department.

I would like to add something else about what is different from Tuerkenstrasse. We now have a fully automated robotic shuttle system in our new headquarters that spans three floors and connects our warehouse to the logistics area. We have a lot of glass walls so you can see the shuttles arriving with the parts for assembly. The shuttle can move among different levels. Everything is fully automated, from logistics on the ground floor to assembly on the first floor and the clean room on the second floor. The material goes directly from the transport in the warehouse to the different areas. You remember in the old days, there was an employee delivering parts with a small cart.

So, I look forward to showing you around in person very soon.

Sandra Yap, Head of Assembly and Testing



Sandra Yap is the Head of Assembly and Testing for ARRI's camera products being produced at the Munich headquarters. When Christian Hartl was put in charge of global production for both camera and lighting, Sandra stepped up to take over the management of the Munich teams.

Jon: Please describe what your job involves as Head of Assembly and Testing.

Sandra Yap: Since August of last year, I have been responsible for all the assembly teams in Munich—this also includes sensor bonding and clean room assembly, camera testing as well as failure analysis and rework.

I assume that means you put cameras together and test them afterwards?

Not personally, but yes, that's mainly the work we do.

Just a short side note—we also assemble viewfinders, camera accessories and camera stabilization systems in Munich. So our teams fulfill many different jobs, not just camera assembly.

Please take us through the steps of assembling the ALEXA 35.

One of the biggest changes compared to the previous camera products is that we implemented tests as early as possible to check the quality and find potential issues. After assembling the first motherboards, we ran the first installation and a built-in self-test. In total, we go through this testing three times in the assembly process before the cameras reach the first final camera test.

However, the assembly of the camera itself is more or less similar

to what you have seen before. We have various pre-assemblies, such as connector strips, display and side panels. We start by connecting the motherboards to the cooling core, then we connect it to the front-end where the sensor and filter slider are installed. After that, we complete the camera by assembling the side panels, top and bottom plates. When the camera is finished and checked, it goes to the final camera tests.

And testing it.

The final camera testing process also has not changed significantly compared to previous products. However, the tests are more intense and—always important for production—they take longer. The total testing time for each individual camera is almost 22 hours. There are various workstations for stress and environmental tests (shaking and climate), calibration and sensor characterization, image tests and functional tests.

I remember the big shaking machine down in the garage at Tuerkenstrasse. Is it still something like that?

Yes, it is still in use but now it sits next to the test line on the first floor. The shaking machines and environmental test chambers are fully integrated into the testing workflow.

How is your testing different from the testing done by Michael Stadler, whose interview comes next?

Michael Stadler is responsible for the tests parallel to the different development phases. His team checks the camera before the product launch and, above all, has done a variety of automated tests. They test our products to the limits.

Sandra Yap, Head of Assembly and Testing



His team also supports us in production. They define the limits of the final camera tests, they help us to set up and qualify our test equipment and support us in the ramp-up phase with their know-how.

The assembly line is designed as a classic “one-piece flow” assembly line. At one workstation, an employee assembles one component of the camera and then gives it to the next workstation. This way, we can synchronize the various steps and work efficiently.

In addition, we have the necessary flexibility to organize the assembly teams around the required products and quantity. In our new headquarters, we can adapt our assembly lines and workstations very quickly, so that we can switch one line to another product within one day.

Is it still the Toyota system of supply where you order parts “just in time?”

In principle, yes. With the new logistics concept and the shuttle system, we have also implemented a milk-run that continuously supplies the assembly lines with material and therefore ensures that the assembly teams always have enough parts at their disposal.

Christian Hartl mentioned ARRI’s robotic shuttle. He said that this apparatus allows for an efficient and automated supply of parts. Could you expand on this?

Yes, the shuttle has improved the efficiency of our teams. Everything is fully automated and parts can be transported and delivered from logistics on the ground floor to assembly on the

first floor to the clean room on the second floor. The material can now go directly from the warehouse to our different work stations.

During our move from Tuerkenstrasse to ARRIAL in 2020, I was a project manager, responsible for the relocation of logistics and production as well as for the realignment, conception and implementation. When I look around the factory now, I am happy to be a part of this achievement.



Jeanfre Fachon, Product Manager for Camera Support Systems



Jeanfre Fachon is Product Manager for Camera Support Systems, essentially the accessories that fit ARRI cameras. (Philip Vischer is Product Manager of PCA, Professional Camera Accessories such as matteboxes and follow focus units that fit third-party cameras.)

Jon: In September 2019, you showed me accessories for an early prototype model of this camera.

Jeanfre Fachon: It has come a long way. Work on accessories started at the same time as development of the camera body. That's something new for us. In past projects, you would develop the camera, and at some point you would start on a set of accessories. Here, it was important to start at the same time.

Why didn't you reuse the accessories of the ALEXA Mini?

We considered that at first. Everybody's got Mini accessories, and we could simply have used them on the new 35 ALEXA camera. The new camera has many more connectors and a new cooling system. The camera body is metal, not carbon fiber. It is very rigid and can bear a load. You can attach many things to it, and so, we took this opportunity to add other attachment points on the camera. Ultimately, we designed more than 34 new accessories.

The side brackets among them.

On the new ALEXA 35, you can attach the side brackets separately from the top or the bottom plates. Whereas on the Mini, there are attachment points only at the top and bottom of the camera body, so you always need to have the top and the bottom bracket and then attach the side brackets to that. If you want to take the top bracket off, you have to first take the side brackets off and anything attached to those. This is much easier and it's much faster on set to change configurations.

I never saw so many accessories ready for a new camera at launch. Usually they arrive over time.

It was planned as a complete camera system from the start. We learned a lot from our users since ALEXA Mini and Mini LF got into their hands. The amount of trust that we had from all at ARRI involved in the camera project was amazing. So we ended up with a concept of accessories covering three main styles of shooting.

What three styles?

I'd call it minimal, lightweight and production. For example, on a typical big studio production, you're going to attach a lot of things to the camera: battery, video transmitter, onboard monitor, rods, mattebox, lens motors, focus devices, Preston or RIA-1, etc. We knew other users would want to support most of those things with a much lighter weight and not too much compromise. Sometimes it is surprising to have a camera that we have spent so much time making as light as possible, and then adding all that extra heavy aluminum around it.

It was important for us to have three main ways to rig the camera. We just discussed big productions. Another mode is run-and-go style, often handheld, with lightweight accessories. And the third mode is having as little rigging weight on the camera as manageable, like just a top handle and a very light shoulder pad.

The new accessories have so many holes and weight-saving milled out areas, they will make Steadicam operators envious.

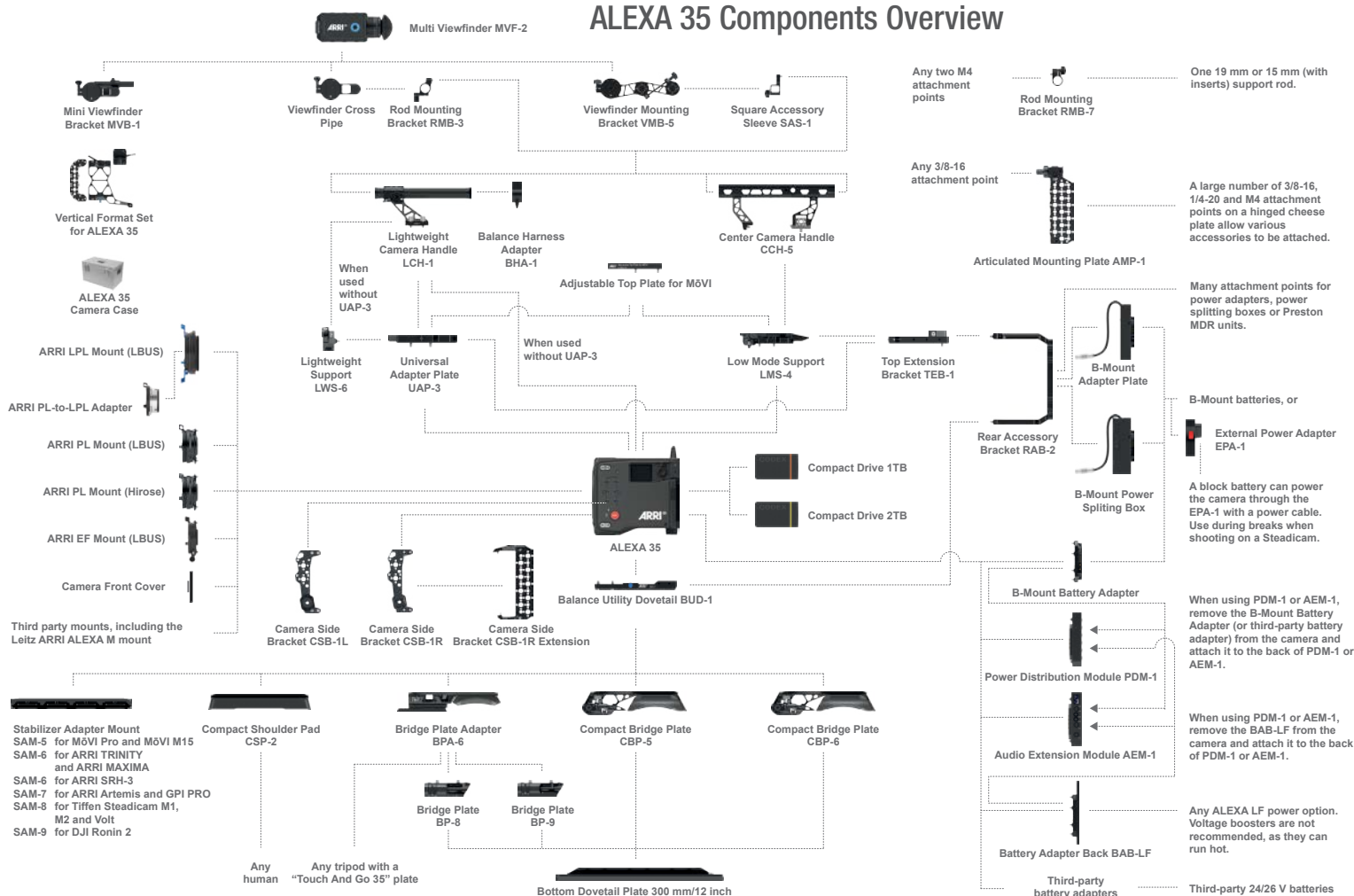
We tried to offer as little mass on the camera as possible while improving the overall rigidity. We used a lot of stress calculation. The machining is interesting, and we have a running joke with our engineers that I would like to see daylight through the accessories, I would like to see through them, as a way to communicate how light and unintrusive the system is.

It was important for us to have three ways to rig the camera. We just discussed big productions. Another mode is run-and-go style, often handheld, with lightweight accessories. And the third mode is having as little on the camera, like just a top handle.

Were there times where you had suggestions about changing the body design to better accommodate accessories?

Oh, yes, often. For example, the side mounting points for the side brackets weren't there on day one, neither were the new rear

ALEXA 35 Components Overview



threaded mounts. We suggested that and I know that it was an absolute pain for the camera designers to add them, but they did.

Did the position of the air cooling intake at the bottom influence how you designed baseplates, handheld and shoulder brackets?

Absolutely. We had to leave a space there for the air intake. Even if you remove everything and are prepping the bare camera on a table or camera cart, you still need air coming up the bottom. And you cannot block the air intakes when you go handheld with the bottom of the camera resting on your shoulder.

The guys who designed the cooling are geniuses. You should see all their simulations. They steered away from trying to have the air enter from the side. They wanted to go from the bottom to the top. So, it was very important for us to take that into consideration. That meant the accessories on the bottom had to leave space for cooling without compromise. We decided on a concept for mounting such that you would use a set of screws to attach a first layer to the top and bottom of the camera. And most main components, such as handles and baseplates, attach or slide in without having to use a tool.

What are all those different accessories called “SAM?”

Stabilizer Adapter Mount. We wanted to make the new camera compatible with as many stabilizers as possible. It's no longer the time where your camera is going to be attached for eight hours

all day on a Steadicam or Ronin. These days, the camera is going to be used in all kinds of different configurations. So we decided to make SAMs—Stabilizer Adapter Mounts—for all them. Each has its own unique mounting method: Tiffen Steadicam, ARRI TRINITY, Artemis Camera Stabilizers and SRH remote heads, DJI Ronin, GPI Pro and MoVi. The ALEXA Mini/Mini LF had one SAM, the ALEXA 35 has a collection 6 SAMs so far.

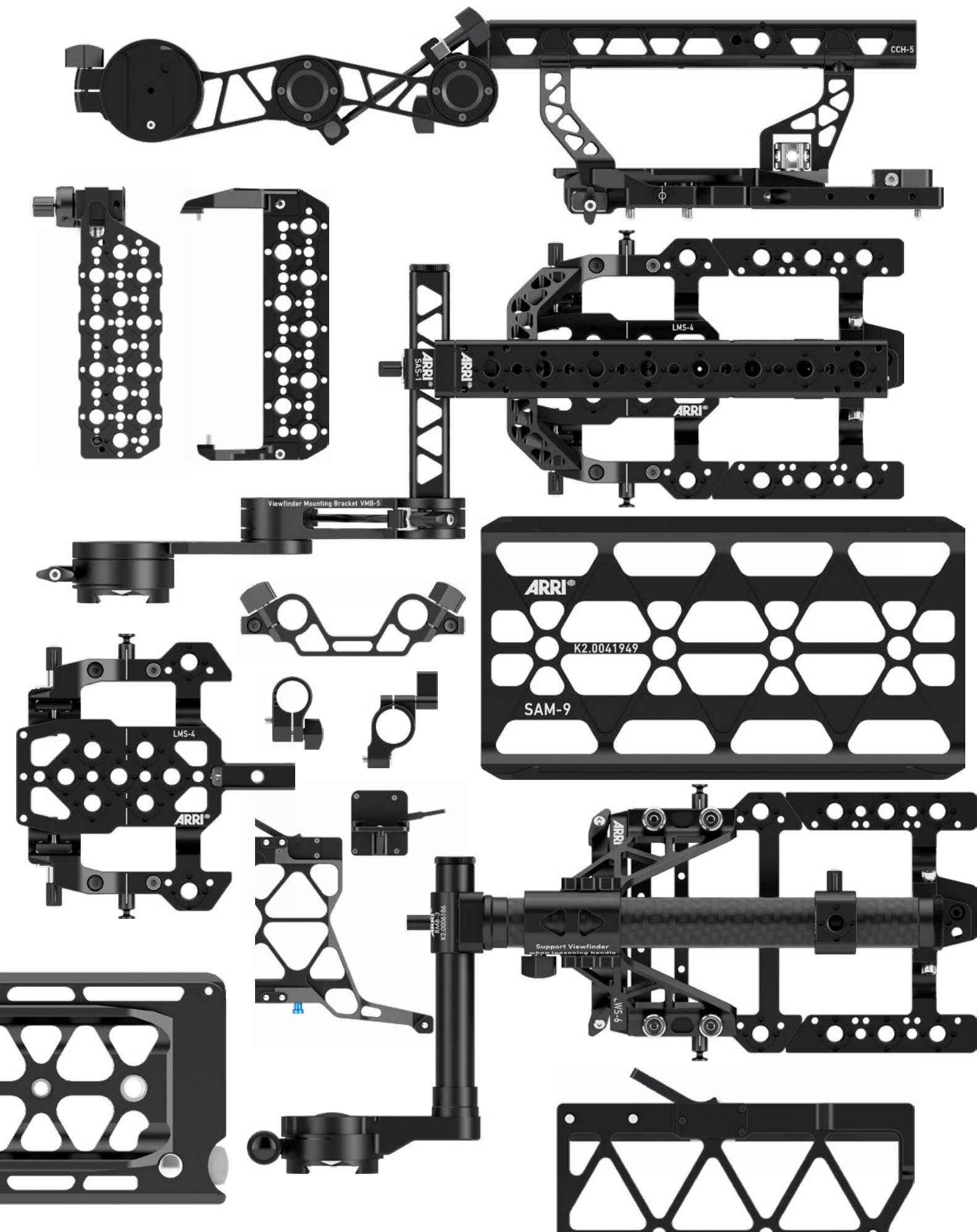
My favorite accessory is your new Viewfinder Mounting Bracket. It looks like a modern sculpture.

It's interesting. Since the original ALEXA came out, and then the XT, Mini and LF, people kept telling us that our EVF brackets were much more limited than our earlier optical viewfinders with their eyepiece extenders, levelers and multiple positions.

There were two principal things that defined the new bracket. One was to be able to have as much reach and comfort while viewing as you had with earlier eyepiece extenders. When I worked in rental, every camera would go out with at least the medium extender.

Also, with earlier systems, there was always a no-go zone where you couldn't put your view finder. So, we addressed that. Now you can position your viewfinder anywhere within a very large radius. And because it's attached to the top handle instead of the top rods, your top rods are now free for lens motors or anything else you want to use. Oh, and we managed to have the new mounting bracket weigh as little as the current one!

“Jeanfre Wants to See Daylight through the Accessories”





Dr. Michael Frank's title doesn't all fit into the headline at the top of this page. He is Head of ARRI Business Unit Camera Systems and Head of R&D Camera Systems.

Michael received his Ph.D. in mathematics in the field of Orthogonal Polynomials. He worked for 13 years in the telecommunication industry at Siemens AG, 10 years Rohde & Schwarz, 4 years at Leica Camera AG heading R&D, Industrial Engineering and as Managing Director of the Max Berek Innovation Lab and was responsible for Agile Transformation of R&D at Leica Camera.

Since 2020, he has been Head of BU Camera Systems together with Walter Trauninger.

Jon: Please tell us how Business Unit Camera is structured these days and what you are doing.

Dr. Michael Frank: Our Business Unit is not only responsible for the camera body, but also for accessories, cine lenses, camera support systems and postproduction tools. That is why we call our Business Unit not only "Camera" but, better, "Camera Systems."

We are located in Munich at ARRIAL, the ARRI headquarters, and Vienna. Munich is focused on the camera body and cine lenses; Vienna works on the accessories like Hi-5 and the TRINITY camera support system. We are responsible for profit & loss, strategy, product and technology roadmaps, product management and R&D of the camera systems.

Who does what?

BU Camera Systems is headed by Walter Trauninger (responsible for Product Management) and me, Michael Frank (responsible for R&D). Profit/loss and strategy decisions are made together by both of us.

How does R&D fit in with manufacturing these days?

R&D is based on so-called Center of Competences (CoC), which are bundled in six core disciplines: Imaging (CoC Optics, Imaging Frontend and Imaging Science), Software (several Scrum teams), Hardware (CoC Mechanical Design, Electronics, Digital Design), Project Managing Office (R&D Controlling, R&D Excellence and Projects Munich), System Engineering (CoC Architecture, System Integration and Testing), and Accessories (CoC Projects Vienna, Mechanics, Software ECS, Electronics, Camera Software).

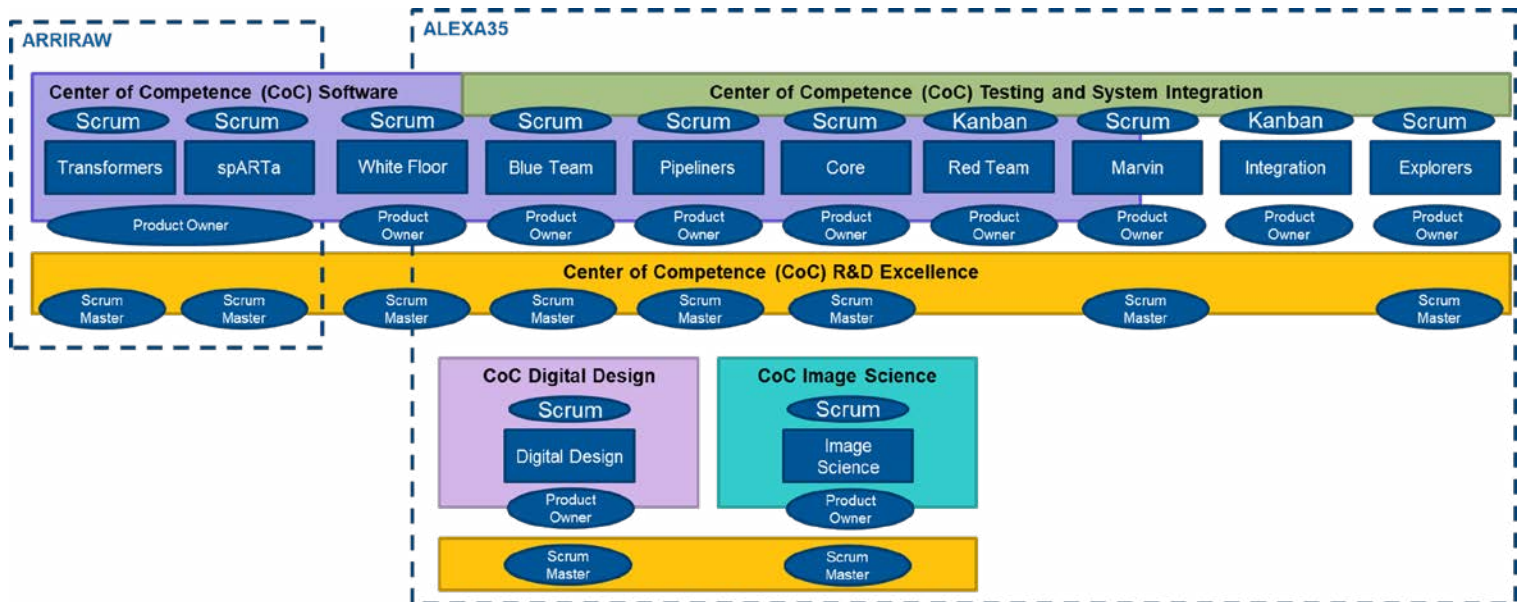
It's funny that CoC in optics is Circle of Confusion. I cannot imagine your CoCs being confusing.

That is ironic. No, our development is done as a series of projects, which are staffed by the CoCs. Depending on the complexity, the projects are realized using Agile Development with Scrum Teams consisting of a Scrum Master, Product Owner and a Development Team. Depending on the size of the project or task, we also do Kanban and classical project planning with a project leader.

What is Agile Development?

Agile lets teams develop projects in measured increments called

Scrum and Kanban Development Teams for ALEXA 35 Camera Software



sprints. It enables efficient collaborations among teams working on complex projects. It is widely used in software development.

In 2021, a reset of software development at ARRI was necessary and we decided to change to Agile. This meant establishing several Scrum teams to develop and test software features on their own. We talked about changing the teams from horizontal to vertical, e.g. each Scrum team had its own user interface experts and its own tester, so the feedback loops from development to testing could be as short as possible. This enabled time-boxed SUP (Software Update Package) releases and MVP (Minimum Viable Product) development, fueled by the results of our field tests.

The field tests comprised 50 cameras worldwide, used by early-adopter productions, in the so-called Agile Product Discovery phase. My job is not only to provide guidance in the restructuring and application of Agile Development, but also to remove impediments that might occur along the way and that get identified in the regular retrospective sessions that are part of Scrum. This is where we reflect on what worked and what did not in the completed sprint and refine our methodology constantly.

How did you manage R&D and development of the new camera during the COVID crisis?

When worldwide productions shut down in March 2020, that was the time when we sent all the ARRI R&D employees in Munich and Vienna, wherever possible, into their home offices. R&D equipment was transferred to these locations.

We got together online every day on Teams in 15-minute meetings. Each day began at 9 am with a “daily” — a meeting of

the CoC heads and myself. At 9:30 am, each CoC head met with their team. These daily discussions were used to communicate any impediments that could not be solved by the individuals themselves.

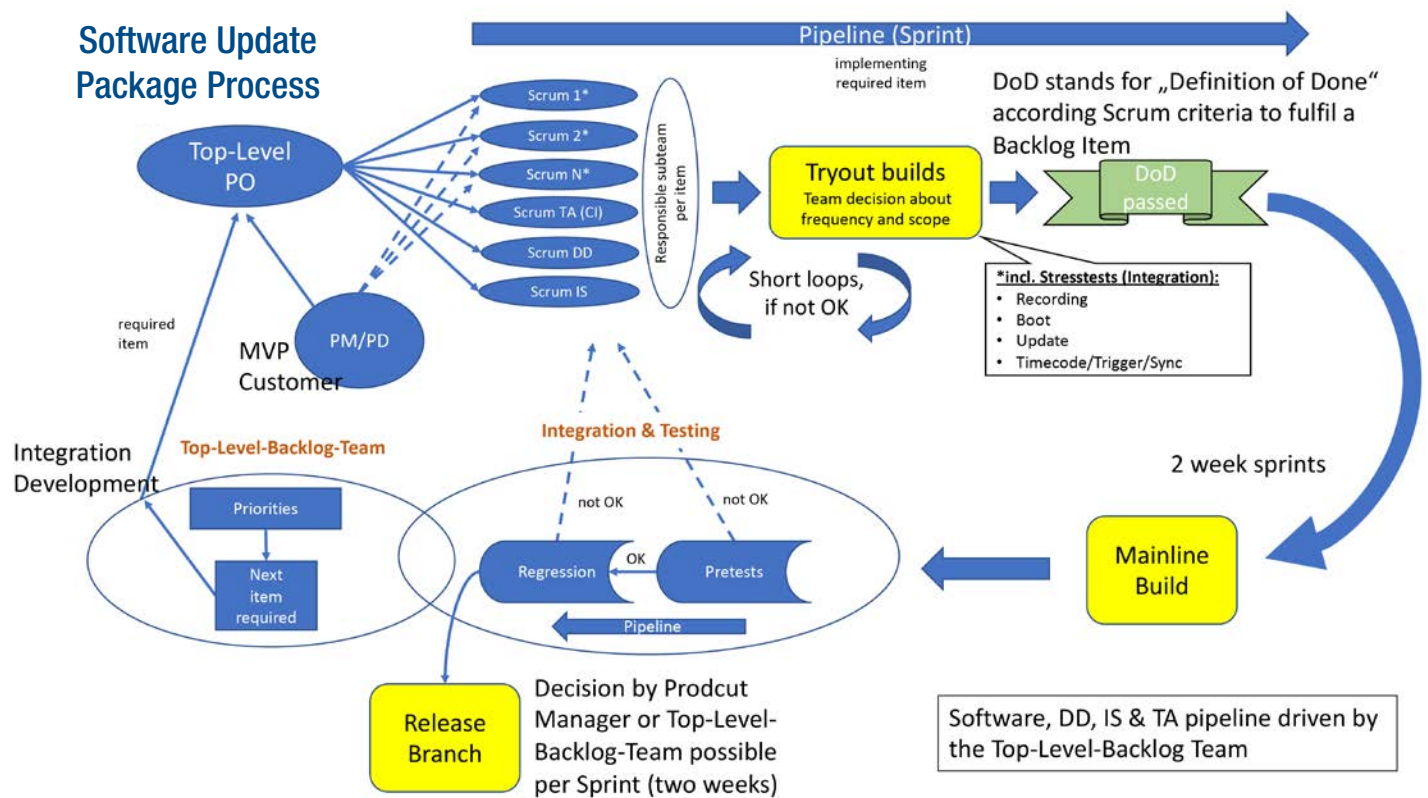
Our daily meetings were timed to a maximum of 15 minutes. We each had an ELMO card (“Enough, Let’s Move On”). Any one of us could hold up the ELMO card (*see photo on opposite page*) if someone talked too long or became boring. Sometimes it was me.

We also had an all-hands-on-deck meeting every two weeks for 25 minutes to make short presentations on topics of interest in our Business Unit. Occasionally, we invited participation of our colleagues in sales, marketing, HR and other departments.

The development projects were also organized in that manner, with regular, short meetings to stay in touch with each other and the product managers. The product managers provided regular reports on feedback from the field about customers and market trends.

Some things don’t work from the home office, for example, team building with new employees. Some of us were asked to come into the company for specific days, weeks or months. We followed strict COVID safety rules. We enjoyed walking together outside in the fresh air and having open discussions. Also, we had a COVID test each day before coming into the office.

Let me add something. I mentioned that we have two development locations: Munich and Vienna. During the pandemic, we had many virtual meetings together. One positive result was that the two locations came much closer together that way. Of course, now we drive back and forth more often.



Please discuss the ALEXA 35 project from inception to now.

Well, there was a lot of new stuff. We have a new sensor, new color science, new electronics, new cooling, new housing, really a completely new camera hardware architecture. We are using the same software architecture as we have in the ALEXA Mini LF, except the ALEXA 35 is seriously tweaked for performance improvements.

The project was delayed due to a stronger focus on Mini LF in the early phase, and then after we started shipping Mini LF in mid 2019 we focused all resources on the ALEXA 35.

In 2021 we had the reset of our software development methodology with Agile Development and Minimum Viable Product (MVP). There were a lot of new ways in how we worked and what we built, but I feel that we are at a point now when most kinks have been ironed out and we are working with greater efficiency.

Did Scrum and Agile Development reduce the time from the beginning of the project to delivery?

Yes. And also, it adapts the customers' requirements into the market changes—in other words, it anticipates how to handle technology risks. Ultimately, that means how to handle all these complex tasks. It's much better to do it by Scrum than with the older processes, one of which was called Waterfall.

R&D is also investing in pre-development of certain features, in methodology improvements and in new tools. This is to enable our CoCs to be ready for the future of Cine and the future of R&D.

Another important concept is "shift left," which means to invest more time in the earlier phases of the project, which helps to minimize development risks. In simple terms, the earlier you can identify an issue, the less expensive it is to fix. Agile becomes more and more important due to changes in customer requirements and new, upcoming technologies, e.g. virtual productions.

For a better understanding of customer needs we also work with the concepts of Customer Journeys and Design Thinking. To implement customer feedback in a rapid way we use Product Discovery combined with Scrum.

The scope of the ALEXA 35 project was very ambitious.

The scope of the ALEXA 35 project was to build a camera with the best picture and user experience ever, starting from each individual component, like the cooling, the electronic boards, the housing, and so on, and then to develop towards a system level where all those components were integrated into a functioning camera body.

This was accompanied by the rigorous work of our continually growing testing department, testing not only the camera body itself, but also testing the camera body as part of a larger camera package—including lenses, electronic accessories, mechanical accessories, Hi-5, TRINITY, batteries, and so on.

A modern digital motion picture camera is a complex system, and we want to make sure that we deliver something that is reliable and easy to use and allows our customers to concentrate on the images, not the technology.



Elisa Weiss studied industrial engineering and management at the Karlsruhe Institute of Technology (KIT). She joined ARRI's R&D department in February 2017. She started working in innovation management and later in process management, designing processes for resource management, absence management and others. Since 2020, she headed the Center of Competence R&D Excellence and has been focused on Agile Development since 2021.

Jon: What does your job involve as head of R&D Excellence?

We introduced R&D Excellence as a department at the end of 2019. I have been a part of the ideation process from the beginning and was asked to lead the Center of Competence—as our departments are called—at the beginning of 2020. As part of my job, I am responsible for the organizational development of the R&D department, as well as R&D wide processes, tools and methodological improvements. Pretty soon after the CoC was formed, Agile Development became part of our software development organization and I started to build up a team of Scrum Masters to accompany our Agile journey.

Each Scrum Master coaches one or two Development Teams—depending on size, complexity and newness of the team. But I must add that all the Scrum Teams consist of developers from other CoCs and are not in R&D Excellence. You have to imagine our R&D organization with two different structures: a hierarchical organization and a project organization. This setup is also called a matrix organization and is quite common in larger companies. But maybe I can talk about our structure later in our interview.

Please give some examples, especially as related to ALEXA 35.

I guess you are more interested in the Scrum Teams and their responsibilities, as in the individual Scrum Masters. First of all, every Scrum Team consists of a Scrum Master, Product Owner and Development Team. Every Scrum Team has a clear responsibility in the development of the camera. Since 2021, every CoC with any sort of software or firmware competencies were organized in Scrum Teams within the ALEXA 35 project. That means CoCs Embedded Software, Digital Design, Image Science and Testing.

There are teams having developers with heterogenous competencies to work on specific features—we call them Feature Teams and then there are teams where everyone has similar technical competencies. The latter are, for example, our test automation and explorative testing teams. I think Mike Stadler will be giving more details on those. ARRI SDK and ARRI Reference Tool are also completely developed using Scrum.

How did you and your teams work during lock-down?

Basically in March 2020, when lockdown started, we made a quite radical move and sent everyone home. For my team, that was easy to do, since they require no equipment. For the developers, it was a more drastic change. We even had developers setting up test equipment in their garages. Everybody was on board and tried to make the best of it, which was really great to see. Of course, since then we have been in and out of the office as the pandemic allowed, with some work environments requiring presence in the office more than others.

In order to adapt to the new situation and to cope with virtual meetings, we started having daily meetings with the leadership team (all the Heads of CoC) and then every leader with their team

Elisa Weiss on CoC R&D Excellence

to keep information flowing. We also organized virtual coffee dates and opportunities to allow for more informal communication. It was important to us that personal relationships still existed and new employees got integrated as well. So overall, we have been working quite well during the pandemic. I think our ARRI values, like trust or passion, really helped. However, everyone, myself included, is very happy to be back at the office more frequently with a lot of team events happening at the moment.

Can you please translate the complicated title “Center of Competence R&D Excellence” into cinematography language that DPs and camera crews will understand?

We coach the teams to be as efficient as they can be— by removing impediments and creating clear interfaces between them, so that everyone can focus on exactly their field of expertise without too many distractions. We work like in-house efficiency consultants that are not so deep in the day-to-day business, and therefore we have a different, broader perspective. This allows us to spot risks or opportunities in the overall workflow that the people on the floor may not be able to see.

So how is R&D structured at ARRI?

Within Camera Systems, we are organized into Center of Competences, abbreviated CoCs. The CoCs are specialist teams that represent different areas of expertise—all needed to develop our cameras, accessories or lenses. Next to Achim's, Harald's and Michael Stadler's CoCs, we have Mechanical Design, Electronics Design, Embedded Software and more. CoCs are responsible to constantly advance in their technical fields, which they do by finding the best talent on the market and developing their skills as needed.

For new product development, we are organized in projects staffed with developers from various CoCs. We need the integration of these heterogeneous competencies to develop a product. That's what I meant earlier by having a hierarchical organization and a project organization. The Scrum Teams are part of the project organization.

Please, take us through a “day in the life” of Scrum meetings, Masters, sprints and Agile — related to ALEXA 35.

Every Scrum Team starts their day with a “daily.” This keeps everyone in the team up to date about work in progress and possible impediments that need solving in order to advance with the work. This is a short 15 minute meeting but provides focus for the day ahead. A typical ALEXA 35 sprint is two weeks long. This is our feedback cycle. At the end of each sprint the teams demonstrate their work done in a Sprint Review, which, by the way, everyone in the company can attend. To conclude, each Sprint every team does a Retrospective. This event serves the purpose to review what worked well or not so well during the Sprint and really helps to ensure the teams can work efficiently.

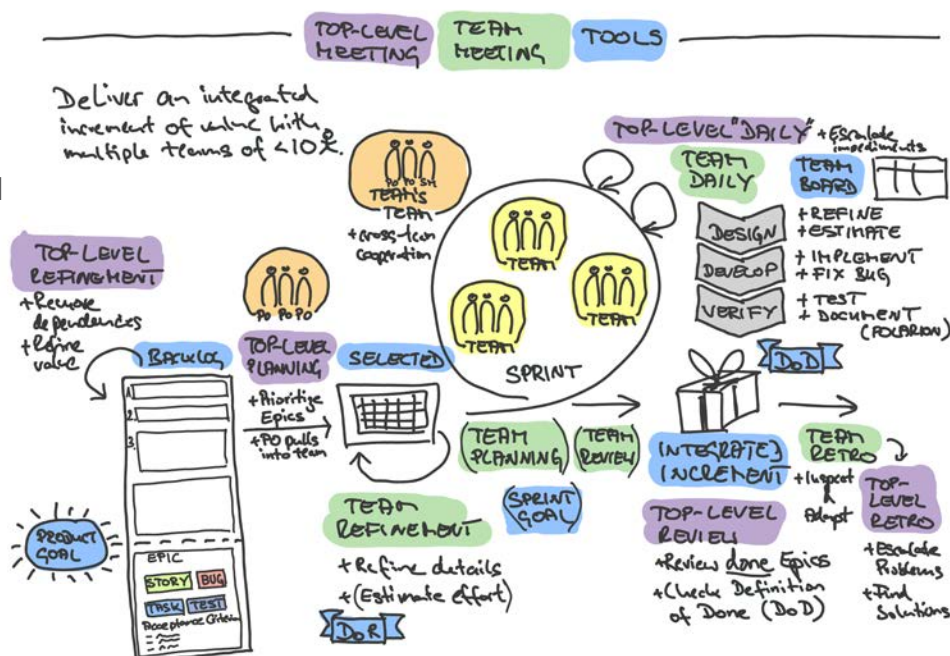
Insights from all the Sprint Reviews are brought into our Top-Level Team, which is one part of our method to scale our Scrum. The Top-Level Team consists of Product Owners (every team has one. They are responsible for the work to be done in the teams and that only work with approved quality is integrated into the product), Product Management and Technical Experts. Together, they plan what features to implement in the next Sprints. The Product Owners use this information in order to plan the work for their team for the next Sprint. And with this, the Planning, every new Sprint starts.

Earlier cameras didn't have this kind of setup for R&D; we used to develop with a waterfall approach. With ALEXA 35 however, we built a completely new hardware architecture and the complexity, especially for software development, has been very high. On top of that, we had and will have to deal with changing market requirements and new technologies emerging over the period of development for every new product in the future. We can better master that with Agile methods.

And in conclusion?

Working with Scrum was possible because we have people who are passionate about what they're doing. We are fortunate that the ARRI culture enables the freedom to explore. Not every company would have dared to let us change the way we worked in the middle of a new camera development, in the middle of a pandemic.

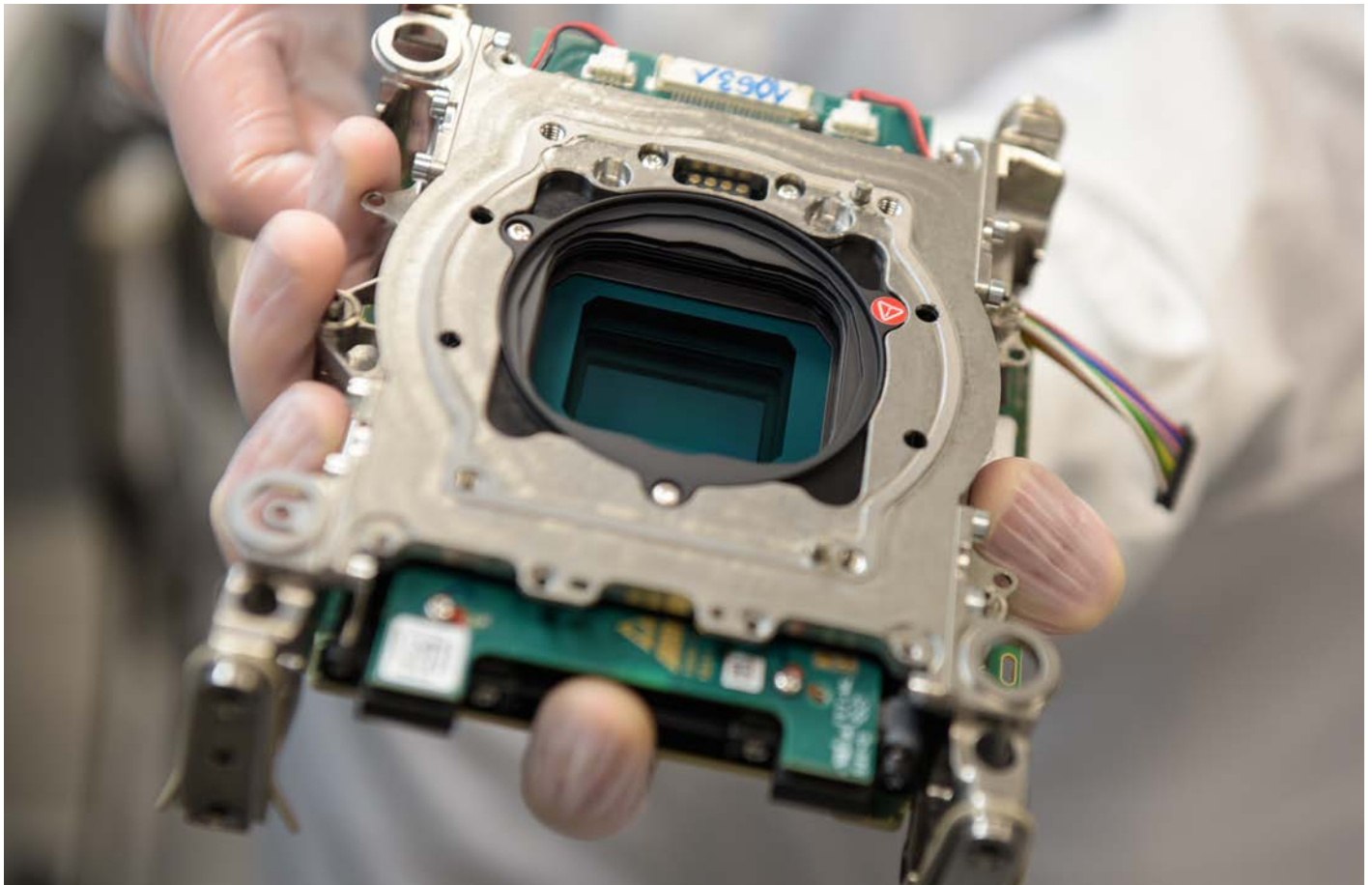
Scaled Scrum at ARRI



Clean Room



Above and below: in the ARRIAL Clean Room.





Michael Stadler joined ARRI five years ago. Now, he is Head of ARRI Center of Competence Testing. It is part of the R&D Department. Michael is the guy who makes sure your new ALEXA 35 can endure the rough ride thousands of miles to location, withstand temperatures from Arctic to Sahara conditions and can run longer hours than camera crew union regulations would every permit without meal breaks and humane turnaround times.

Jon: What does your work on ALEXA 35 involve?

Michael Stadler: Our team does mechanical and electronic testing, but mostly software and firmware. Every camera that leaves ARRI has to go through rigorous tests to ensure that each one meets the same demanding specifications and that the customers will be pleased when they unpack it. The main focus is testing during development of new cameras, accessories and software updates.

What are the things that you might have been testing on the new ALEXA 35?

In our department, there are three different teams. One takes care of the structured part of testing to make sure that all the technical requirements are met. For example, let's say there is a requirement that the camera can record at 120 frames per second. We need to make sure that works under all conditions.

Next, there's a team, mostly freelancers, who are DPs and camera assistants, who work part-time for ARRI to test, from a user's point of view, that the products and their functions are working as they should be. It is a two-level approach. We also have an ex-

plorative testing team that also has the viewpoint of the customer, but this team is internal. They are checking "Okay this feature is supposed to be like this. And to be used like that, does it meet all the customer's requirements? Is it really useful how we implement the testing?"

The third team is all about test automation, to ensure a continuous verification of our software and firmware quality. They also address the durability of the system. For example, we run tests that do about 1000 reboots. On every reboot we check various system parameters to ensure the system is working as expected.

Do you also conduct testing in advance, either on prototypes or simulations before manufacturing begins?

Sure. These are part of the steps in the development phase. When the requirements are created even before the product is created, we have testing to do. Can it be met? Can it be even tested? Is it useful for the customer? In every step of development, we are deeply involved to ensure the product's quality in the end.

Please give us some examples of testing the new ALEXA 35.

We did outdoor test shoots that were interesting. We tried to find the edge cases of image quality. Edge case scenarios involve testing for extreme conditions, possible bugs or even conditions that users may not even encounter—for example, where the sensor maybe is not working as it should. Or if any limitations appear in the image chain. We deliberately try to find those edge cases and prepare them to be shown in a screening, followed by technical discussions on how we can improve or solve those issues, so the



customer gets the best image quality available.

Other tests we do are about reliability, to see if something breaks. We'll see if clip recovery is still working. Environmental tests take the camera from plus 45 degrees Celsius (113° F) and to minus 20° (-4 F). Is the camera booting? Can we record? And all kinds of other things.

What happens if you discover something during testing that needs to be corrected? Do the designers sometimes have to rethink something or the manufacturing process has to be changed, or is it pretty seamless from the beginning?

No, it's not always seamless. We always find things and that's the challenge. I think that's the evolution of a camera. You want to build a camera that's small, light and not loud, but it needs more power. Not too much power, but we have a really processing-hungry computing system in it with real-time data evaluation and calculation. And it needs to be robust. So those are some of the challenges of engineering combined into really small products. Of course, there are limitations you haven't thought of before. Then you need to find them and rethink things and maybe you need to rebuild something. Maybe just algorithms, or just mechanical parts to make it more robust to fulfill the requirements.

How do you ensure general overall quality?

This has changed significantly compared to the past. In the past, we had the R&D department doing internal testing for new products. And then we had our quality department, at the end, looking over all the things that were done in R&D.

That was a two-step approach. It was disconnected sometimes

because of time-frames. It was not really working as fast as we wanted so that customers who needed something could get it as fast as possible and still have the quality we wanted to deliver.

So this changed. The responsibility for all testing was moved into the R&D department. Now we have testers and software engineers working side by side. They're really integrated. So when we are done, the quality is met and we are really done.

As you probably heard from our other colleagues, software and testing changed from a Waterfall to an Agile process. Agile Development, as I'm sure they explained, means that we are able to switch focus without disturbing the whole process. You work in short cycles. And things might change. For example, we are working on five top-priority things. And then some customer feedback comes in. And it's like, "Okay, we are going to change the priority." And that's no problem, because we can start a new cycle of testing or development. And then we complete the new tasks. That's how we can re-prioritize.

Software testing and updating is a continuous process?

Yes, this is a continuous process. We're doing that and we are focusing on improving our test automation process for the repetitive tasks. Most of the parts of the camera, once they are changed, require additional testing. As you know, we want to have a high quality and we want to ensure that the customer gets that quality. But having the complexity of this product, the ALEXA 35, in mind, it can be a challenge to always ensure that everything is working. That's why we focus on test automation. Then we have all those parts coming together in a great camera.



Jan Heugel is an application engineer with ARRI working in the digital workflow department. Currently, he is a global field test coordinator as well. Working out of Munich, Jan distributed 50 pre-production cameras around the world for the field testing, kept track of them, and discussed the goals of the tests with all the users. Jan is also responsible for the ARRI museum at ARRIAL and the archives.

Jon: Tell us about field testing the new ALEXA 35.

It was decided to have a prelaunch testing phase externally as well as internally. We do a lot of testing internally, but nothing beats the real world. We decided to hand out a number of cameras—but how many? “Well, 50 might be a good number,” they said. So we sent cameras to most regions of the world. We had cameras in cold weather, in the desert, in every environment possible from sea to land to air, and from dry to humid conditions. There’s nothing like real world conditions. So we have put 50 incognito (no name) ALEXA 35s to the test for almost five months now.

Why so many cameras?

It’s a lot, but it’s a necessary amount. We were looking for small productions because major movies always want to hang onto the equipment for a longer time. With smaller projects, we could have a greater number of them going on. Of course, we caught some of the really big productions whose DPs wanted to try the camera. So we had A-list DPs, students, owner-operators, wildlife and documentary filmmakers. Each had a different style, point of view and workflow. It was good to cover so many.

50 cameras needed 50 cases, and at least 1,800 accessory parts. The logistics were handled by our colleagues in the loaner department. They checked everything out, handed the equipment to our shipping department where carnets or pro forma invoices were filled out, and then out the door to nearby locations and the far corners of the world. 50 camera packages is the equivalent of a medium-sized rental house.

What feedback did you get back?

Most feedback was about image quality. Most users were totally blown away by the difference between the new sensor and the older cameras. We had some really old school ALEXA users as

well as recent ALEXA Mini users being totally fascinated by what they saw. For me, the most heartwarming description came from Aiden Ulrich. He said, “It’s a sensor that portrays my home as I have it in memory from my childhood.” If you can touch someone’s heart with your product, then you have done your job.

What was their reaction to Textures?

Textures are among the big image science topics that were under investigation along with the LUTs. For us, it was a matter of collecting feedback so the team could refine them. For example, on the more grainy Textures, it was about finding the sweet spot where it worked well in different conditions of light and dark. Textures were added, improved and even the default Texture was reworked over the course of the testing period.

How did the testers handle the workflow of ALEXA 35?

The workflow is pretty simple, as before. You have your ARRIRAW in an MXF wrapper or Apple ProRes in an MXF wrapper. They benefit from the new color science. It’s LogC4 footage, which in the first blink of an eye, is a darker image.

And now, we have to urge people to really work with our Look-Up Tables (LUTs) in the color pipeline because we learned that lots of freestyle shooters, as I would call them, tend not to follow the rule to grade their LogC and then add a color transform to the target color space. In the past they said, “Yeah, LogC, I like it, but I can tune it how I want to deliver it.” But with LogC4, they appreciated the benefits of using the color space transformations afterwards, in post, to get to Rec.709 or Rec.2020 or HDR color spaces.

Because otherwise, the colors might not be as pleasant to look at. For example, skin tones could fall into another color area. Perhaps the skin color could turn magenta because you’re not applying that last step of the color correction correctly. But as long as you grade the LogC4 footage and then apply a color space LUT (which you also should have done with LogC3 and the other versions), then it’s basically the same workflow. So, there are no drastic changes except for some exciting new things to enjoy—more exposure latitude, new LUTs—and Textures, of course. These are new tools for DPs.

Field Tests





Henning Raedlein is head of the marketing department for the Business Unit Camera Systems, and head of the Digital Workflow Solutions department that was founded when the first ALEXA was in development and Franz Kraus said to the team, “Make sure the images look good on monitors and projectors, and that people understand the workflow.”

Henning joined ARRI in 1991 to run the post production department with Franz Kraus. By 1998, he was on the ARRILASER development team and was at the forefront of the transition from film to digital, the digital intermediate process, and then the “Ur-ALEXA,” the first ALEXA.

Jon: How does a workflow guy become the head of marketing?

Henning Raedlein: The workflow guy gets into marketing when the heart beats on his filmmaker side. I studied photography and filmmaking. Cameras were always very interesting to me. So when I moved over to ARRI Cine Technik in 2003, I was doing all the demo reels, camera comparisons and show reels that we made. With that background, I had the idea of doing the massive ARRI hundred years documentary project and book a couple of years ago. This allowed me to get my feet wet in marketing and I never looked back.

Superb! Looking back on the original ALEXA, it seems that your experience in post and workflow helped a lot.

The big question at the time was how do we ensure that users have a secure workflow and learn to cope with check sums, digital workflows and “Hey, what is a Look-Up Table?” But first we had

to understand it ourselves. With the experience of making the ARRILASER and the ARRISCAN, ARRI had a good foundation.

I remember a DP calling long distance from location right after the first ALEXA shipped. He said, “I have to shoot with this new ALEXA camera and I don’t know what to do. I’m embarrassed to ask anyone here because they will think that I don’t know what to do and that I’m not the right DP for the job. What should I do?”

I replied, “Just ask your camera assistant to do a factory reset, located in the menu of ALEXA. After the factory reset, your camera will be at 5,600K, 24 fps, 172.8° shutter, and 800 ISO. Then frame your shot, be sure it’s in focus, and push the red record button on the left side.”

Like the first Kodak cameras: “You push the button. We do the rest.” Fast forward to today. When and how did your marketing strategy evolve? Take us through that process.

We started planning the marketing and launch of the new ALEXA 35 last December. Now, I must admit that, in the past, I was always a bit bothered when I produced or received demo reels, tests actually, that didn’t make any sense and had no story. I found it a bit tedious watching people just walking or driving around.

We wanted something cinematic: something that spoke the language of cinema. I wanted to have a series of films that, taken as a whole, would give a good idea of all the uses of a camera. Over the years, we’ve learned what essentials are actually most important: skin tones, eyes and human beings.

Henning Raedlein on ALEXA 35 *Encounters*

With that in mind, we thought maybe we could do a series of demo films with a consistent concept and theme. The films would be linked by a common theme, but beyond that, they should be as diverse as possible.

In combination, they would demonstrate every aspect of the new camera's exceptional functionality and image quality (dynamic range, sensitivity, color rendition, skin tones) in a range of environments. Since ARRI has offices and customers all over the world, I wanted as many of those countries as possible to be involved.

The common story could be about people who meet, there is an interaction between them, and something happens that might change their lives...or not. It could be day or night, interior or exterior, city or country. The title of the series is *Encounters*.

I think we were lucky because we found very good filmmakers who were interested in helping us make those films with the new camera. And now those films are ready for the launch of the ALEXA 35.

For example, there's a short by an Uruguayan filmmaker. She captured wonderful images in the highlands of Argentina with a lady talking about how life, knowledge, trust and tradition are passed down from generation to generation. She says that you should not become bogged down if something doesn't work—you should persevere, go your own way, and that is how life goes on from generation to generation.

We wanted to show the capabilities of the new camera in use on real films. We did not give instructions to test over-exposure and under-exposure. No gray scales, color charts, fairy lights or bare lightbulbs on a dark stage—that was not the intention.

We wanted to have real films and real setups. We wanted to see what happened if the scene involved an incredible, colorfully-lit French castle or the rocks of the Patagonian desert. I saw incredible colors that I have never seen before, because, first, I have never been to Argentina, but second, it has never been captured with a camera such as this one, with such a color separation and differentiation.

The British filmmakers did an underwater welding sequence in deep, dark water. The contrast was incredible, but the light from the welding remained yellow, not clipped white because the camera was able to capture the true yellow light.

Did you give the DPs instructions on how to use the camera? To push the factory reset button and then the start button?

No, I forgot to tell them that. Seriously, we did request some daylight scenes, night scenes and high contrast situations. People sitting around a campfire is an interesting test of dynamic range, even if the concept may be a bit boring. Ironically, we wound up with three films with three campfires. I did not have the idea of underwater welding or the horse in the desert. That all was the creativity of the DPs and directors who helped us.

What did you learn about the ALEXA 35 in post production?

When we completed post production, everybody was smiling because we saw things on the monitors and screens that we had not seen before. The biggest achievement of the series of *Encounters* shorts, and of the camera, is that we saw great new

colors and extreme exposure latitude. That was the joy of this job.

How did you choose the filmmakers?

We asked our ARRI colleagues around the world to reach out and select the people in each country. We wanted to have a diverse group. There are 11 films, five of them with female DPs. And there were young filmmakers—young but quite experienced.

How long is each film approximately?

Actually, I asked for the films not to be much longer than two minutes. Sometimes it worked out, sometimes not. During the editing process, I saw some longer versions, and I have to apologize for not being able to keep them all in their original length because they are all beautiful. I want to thank all the filmmakers who contributed so much!

Did each country hire the DP first and then the director?

Yes, most found the DP first and then asked whom they would like to work with. For example, in Germany, I talked to Nik Summerer who we know from the Netflix projects like *1899* and *Dark*.

He came back a couple of days later and said, "Well, my director friend in Berlin has an idea for a short road movie." They worked on the story together and showed it to us. They wanted to shoot in snow and ice, but suddenly spring came. So they had to shoot without ice and without snow.

They were the first to use ARRI Textures which turned out to be a great feature. We like the film a lot.

Did you have final approval of the individual scripts and stories in the different countries?

Yes. Most of them. Everybody presented their script and the plan in advance. Everything had been approved by the local ARRI colleagues. It was a very good collaboration. The projects sometimes developed a bit differently than you actually imagined when reading the script, but those things can happen.

I'm sure it was an honor for those working on the films to be the very first with new ALEXA 35s. Who wouldn't want to be invited on a project like this—that you surely could add to your own demo reel?

We invited some famous cinematographers as well: Erik Messerschmidt, ASC in the US and Ari Wegner, ACS in Australia. Jessie Wang in China, James Friend ASC, BSC in the UK, Christoph Grailot in France and many others. This was the cool thing: different people, different settings, different visual approaches, but the same camera.

How did the camera behave in all those situations?

We had a couple of films that were shot in very low light. The German one has a day and a night scene. In Nigeria, we also had very dark night scenes that demonstrated how beautiful skin tones were at 3,200 ISO.

It was similar with Ari Wegner who was shooting a very moody situation in a forest with no highlights. She rated the camera at 3,200 as well with very good success. The cameras were in heat and in the cold, on cranes, on TRINITY, underwater, handheld, with a lot of different lenses, also anamorphic, and everything worked out as expected.

Henning Raedlein and Eleven ALEXA 35 *Encounters*

Eleven *Encounters* films must have been a lot of hard work.

It was actually something that was possible—and you probably have heard this before, but it's true—that ARRI is like a big family. You can ask a colleague on the far side of the world to help produce the film. It's not a favor; it's a lot of hard work for weeks and weeks. But everybody is in high gear and on the same page; everyone wants the project to be a success. There's no opposition, no elbowing and no unhealthy competition. I sincerely thank the ARRI team for their help and contribution. As Volker Bahnemann said in an interview you once conducted: "ARRI is our home."

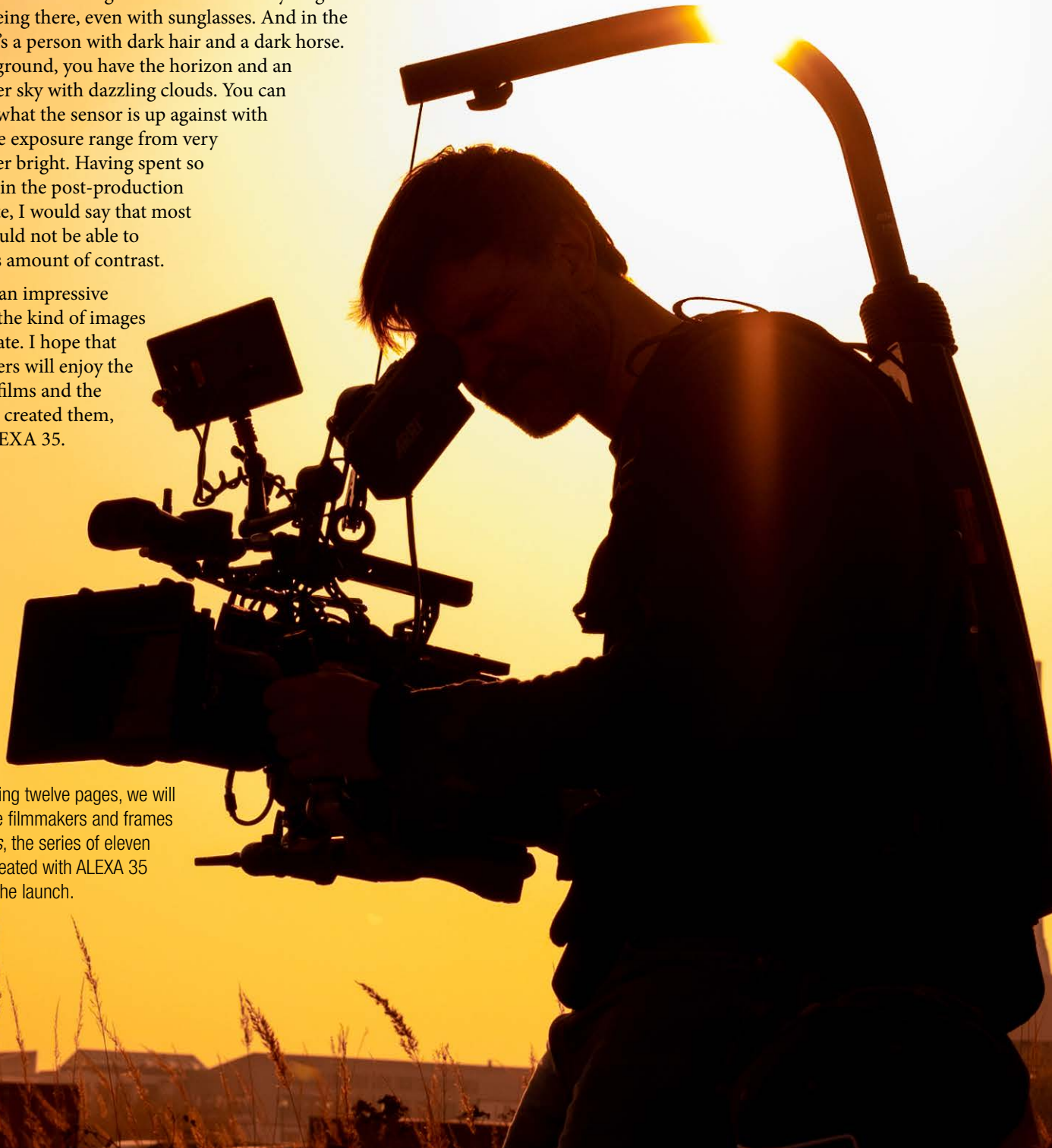
Was there a best film?

The audience can decide. They are all very different and all have their unique qualities. I hope that cinematographers, customers and users will see the beauty of the ALEXA 35's color processing that so many team members at ARRI worked on so diligently.

The films are not about camera size and weight and accessories and technical details. The films are about the image quality. For example, there's a scene on a salt lake in Argentina. It is extremely bright. It hurts your eyes being there, even with sunglasses. And in the scene, there's a person with dark hair and a dark horse. In the background, you have the horizon and an even brighter sky with dazzling clouds. You can almost feel what the sensor is up against with that extreme exposure range from very dark to super bright. Having spent so many years in the post-production grading suite, I would say that most cameras would not be able to manage this amount of contrast.

So this was an impressive example of the kind of images you can create. I hope that our customers will enjoy the *Encounters* films and the camera that created them, the new ALEXA 35.

On the following twelve pages, we will encounter the filmmakers and frames of *Encounters*, the series of eleven short films created with ALEXA 35 cameras for the launch.



Argentina: *An Ancestral Path*



Argentina: *An Ancestral Path*



An Ancestral Path. ALEXA 35, K445 Default ARRI Texture. ARRI Signature Primes. Director: Augusto Tejada.

"The sensor of the ALEXA 35 is something else, both strong and gentle in the perception of color and texture."

— Bárbara Alvarez, Cinematographer, Uruguay.





Sweetheart. ALEXA 35, C733 Nostalgic & L345 Shadow ARRI Textures. ZEISS Super Speed Mk3 and Angénieux 25-250 HR. Director: Leo Woodhead.

"With increased light sensitivity and more detail in the highlights, I can be even more bold with my lighting and exposure choices."

— Ari Wegner ACS, Cinematographer, Australia.





Tigerine. ALEXA 35, K445 Default ARRI Texture. ARRI Master Anamorphic and Kowa Anamorphic lenses. Director: Arden Tse.

"The way the camera captured all the different variations of the color red, in quite extreme environments, was remarkable."

— Jesse Wang, Cinematographer, China



France: *Avoid Boredom*



Avoid Boredom. ALEXA 35, P425 Cosmetic ARRI Texture. Leitz Summicron-C lenses. Director: JF Julian.

"In the ALEXA 35, I have met a new friend, and she is already a valued part of my team." — Christophe Gaillot, Cinematographer, France.





Nice. ALEXA 35, C733 Nostalgic ARRI Texture. Hawk class-X Anamorphic lenses. Director: Jan Rasmus Voss.

“The combination of anamorphic lenses, the ARRI Texture we chose, and the use of available light was very nice.”

— Nikolaus Summerer, Cinematographer, Germany.



India: *Through the Colors*



Through the Colors. ALEXA 35. K445 Default ARRI Texture. ARRI Signature Prime lenses.

"The ALEXA 35 has a vivid, true-to-life color rendition and handles highlights beautifully."

— Neha Parti Matiyani, ISC, Cinematographer, India.



Japan: *Found It*



Found It. ALEXA 35, K445 Default ARRI Texture. ARRI Rental Prime DNA lenses. Takashi Noguchi, Cinematographer.
“It’s a totally new type of camera.” — Director/DIT: Yoshikatsu Date.



Korea: *Treasure Hunter*



Treasure Hunter. ALEXA 35. K445 Default ARRI Texture. ARRI Signature Prime and ARRI Master Prime lenses. Director: Sehyun Park.

"The richness of the images captured by this new camera immediately seized my eyes and my heart."

— Jin-Kyung Ha, Cinematographer, Korea.

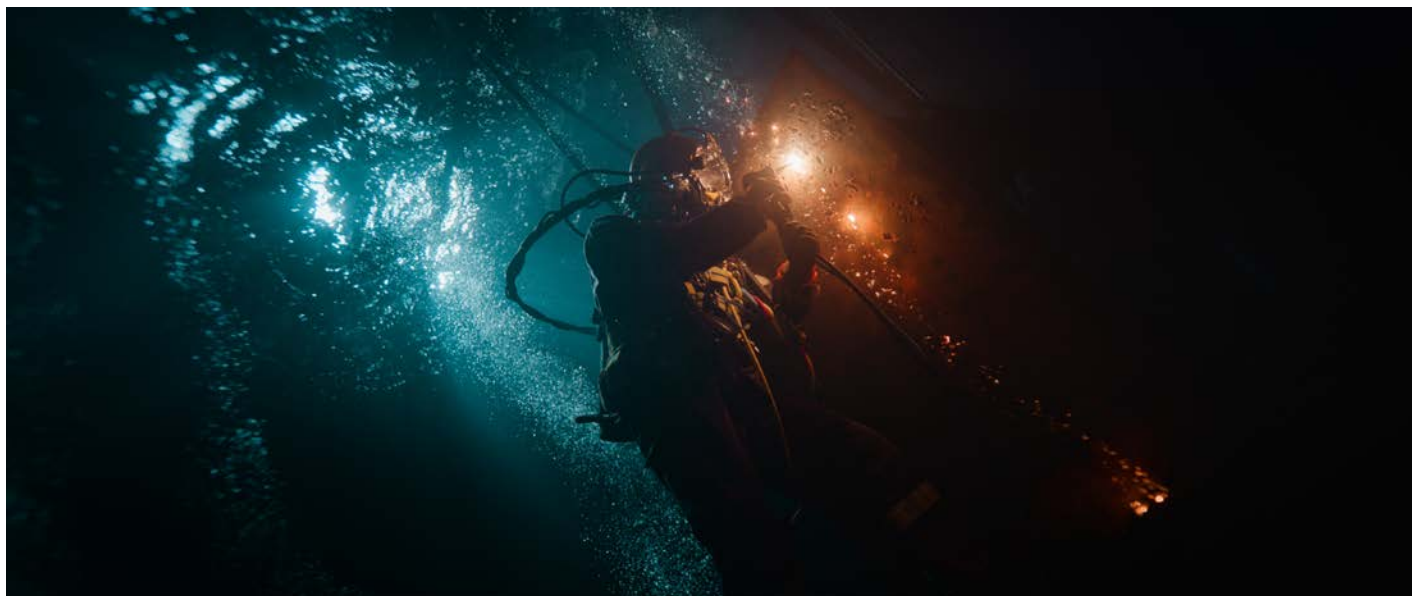


Nigeria: *The Painting*



The Painting. ALEXA 35. K445 Default ARRI Texture. ARRI Signature Primes. Director: Tope Alake.
“The new camera works so well for black skin tones, and the way it sees colors is amazing.”
— Barnabas “Barny” Emordi, Cinematographer based in Lagos, Nigeria (below).





The Siren. ALEXA 35. K445 Default & L345 Shadow ARRI Textures. ARRI Signature Primes and Master Anamorphics. Director: Mike Valentine BSC. "The new sensor retained all the color and information, even in the most brilliant highlights and deepest shadows." — James Friend ASC, BSC; UK.



USA: *The Swing*



The Swing. ALEXA 35. K445 Default ARRI Texture. ARRI Signature Primes, ARRI TRINITY. Director: Rusi Schwab.

"I could not get the camera to clip; the dynamic range is so wide and impressive. This is a completely new generation."

— Erik Messerschmidt, ASC. USA.



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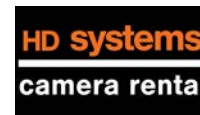
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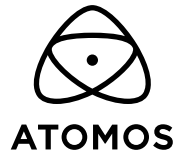
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