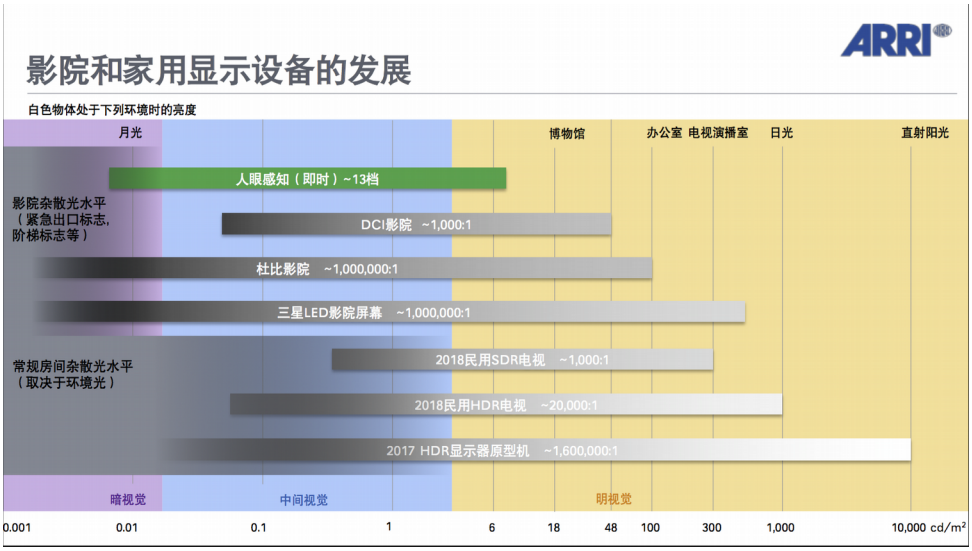
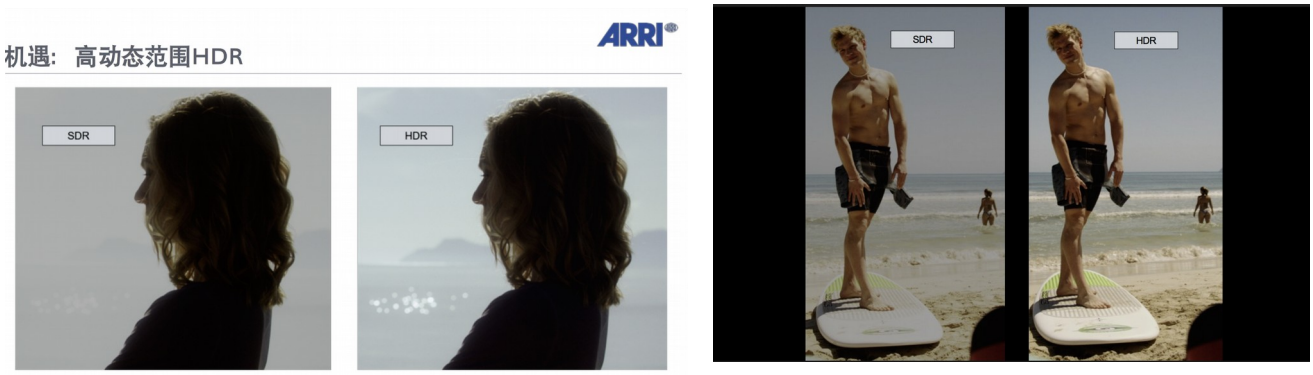
ARRI Group: Reflecting on Analog developments, an Exploration of the Future of Image Development in the Film Industry

The Advanced Innovation Center for Future Visual Entertainment invited Professor Franz Kraus, Managing Director and former member of the executive board of the ARRI Group, to give an exclusive presentation to top level students at the Beijing Film Academy. The presentation was a three hour overview of how film images and quality has improved, standard by standard, through the decades and where we are now. The speech bordered on both introductory and in-depth, with strong technical arguments for ARRI's current cinema standards and approach to research and development. The room was packed, beyond expectation, which shows ARRI's strong reputation in the Chinese film industry and potential dominance in the years to come.

Professor Kraus began with a summary of film and sound projection over the years, how they developed and what that meant to audience's film going experience. This focus on sound quality, might at first, feel out of place coming from an image company, but the point Professor Kraus made, and repeated with reinterpretations throughout his presentation, is that both quality and immersion improve with technological development; and while many things might seem *good enough* to an audience, there is always the potential to be *Greater*!



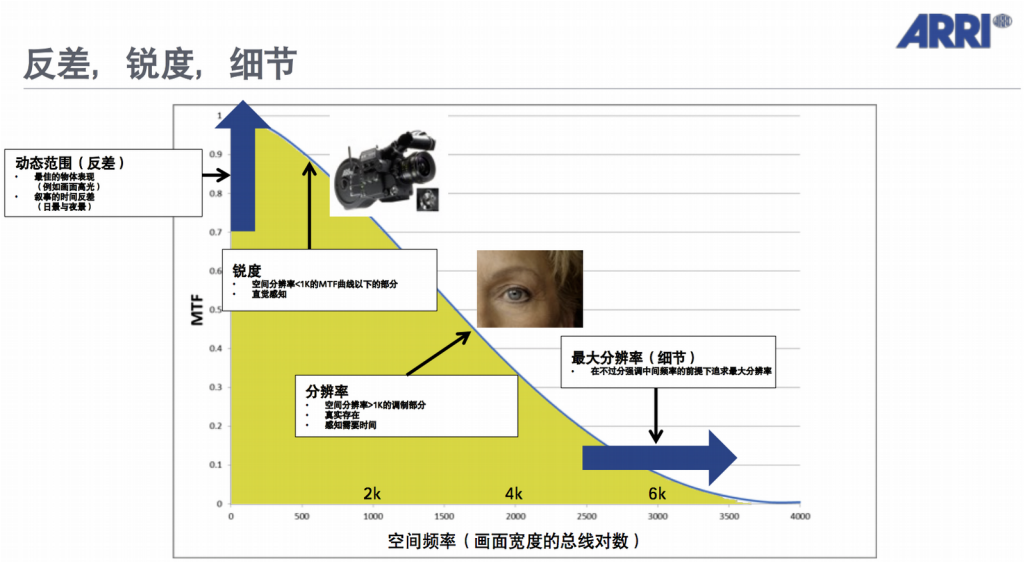
The chart above demonstrates different display types and their respective dynamic range. The purple section on the left represents a white piece of paper in moonlight and how much luminescence would be reflected, the right is representative of broad daylight. The green bar at the top is the human eye's ability to see in an instant, without having to change the iris of the eye to overlay exposures in our mind. After this is the Digital Cinema Projector by Christie, then Dolby's Vision Projection system, and in the 4th position is the new Samsung LED theater system, which boasts the most dynamic range currently possible. The next two entries are television standards for SD and HD ranges. The final bar is a prototype television, that may never exist in reality.



Here we have examples of Standard Dynamic Range vs. High Dynamic Range. The image for High Dynamic range is not as murky, the contrast feels natural, there is more color in the highlights and roll off (exposure changes in bright areas) seems more natural.

In the first example given we can see mountains in the background, which are nearly gone in the standard range photos. This makes it clear that a first big step forward in achieving better imagery is more dynamic range, but what is the best way to capture and show that range?

It is well known that ARRI cameras don't boast the highest resolution or pixel count among cameras. In fact, they've only recently released their 4k camera, the Alexa LF (large format) and a 6.5k Alexa 65 (named for its 65mm sensor). This choice might boggle the minds of many filmmakers who go to rental houses seeing competitive brand posters boasting 8k cinema and tiny DSLRs that shoot 4k images. So why has ARRI held out? The answer is not so simple.



On the X axis we have MTF (modular transfer function), which is a measurement of contrast. On the Y axis we have spatial resolution, or details which is commonly understood as resolution (2k, 4k, 6k)

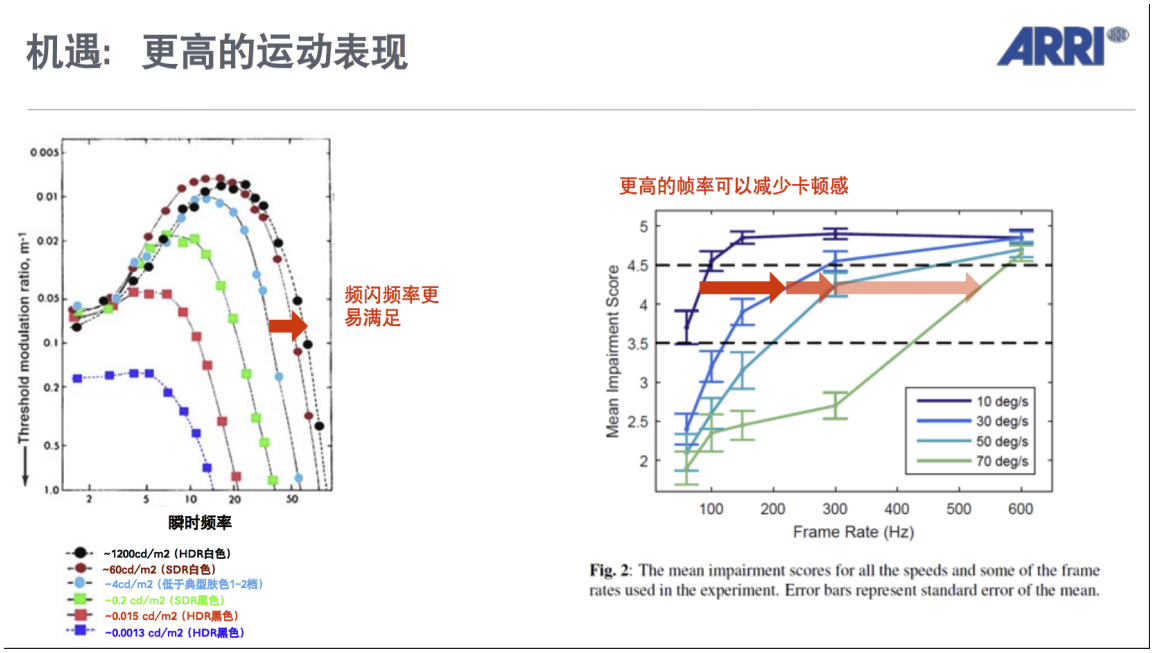
Through a long, and thorough, explanation, Professor Kraus argued that, with digital acquisition, as resolution goes up, contrast goes down (in simple terms). The same cannot be said for traditional film, a topic not spoken about often enough in the digital era. With analog film, the resolution (film is said to have between 15-50k) remains the same and the contrast can be controlled with lighting, print techniques, or the len's resolving power. In digital, the resolution only exists if the detail and contrast are available in the image. The resolving power of lenses, projectors, and the codec (which he didn't get into because he said that would take a further three hours) all limit the viability of higher resolution cameras. There are many issues yet with digital imagery and throwing more resolution at the problems doesn't necessarily improve anything. In fact, many cinematographers prefer lower contrast glass, or legacy lenses, in order to take out some of the sharpness inherent in higher resolution images, which runs contrary to the point of even shooting high resolution. So with all the buzz surrounding 4k and higher resolutions, what is the best way to achieve good quality image?

The first argument would be for larger sensors that allow the room for large photo-sites and higher resolutions to fit naturally. The ARRI 65 allows up to 6.5k (6560x3100) resolution on a larger sensor and the ARRI LF has a sensor slightly bigger than 135mm film and it achieves a resolution up to 4k (4448x3096). It's at these larger sensor sizes that ARRI believes the ideal ratio of resolution and MTF can be met, and, of course, with cinema lenses meant to shoot up to this resolution, the contrast and details can be maintained.

Much like HDR, the effects can be subtle yet help make the overall image look better.

A taboo topic during these camera tech talks and exhibitions is motion artifacts and motion cadence. This is where the image quality becomes worse during movement. The most extreme examples are jello shutter, and ARRI is well known for having cameras that don't jello on their DPs, but Professor Kraus didn't shy away from showing limitation even their cameras have with motion and how it might be the most extreme and unspoken issue of digital cinema.

You can see that even with very slow movement blurring is visible and distracting. This issue can be equated to the use of 24 frames per second and 180 degree shutters, a vestigial aspect from the days of film. There is a certain romantic quality to 24fps, but does it belong in a digital world? ARRI isn't just asking this question, they are challenging it. In the final picture we can see a screen shot taken of the same movement, but recorded at double the fps, and the improvement to clarity is obvious. High frame rates can yield better images, especially when you have high resolutions to support that amount of detail.



This chart directly shows us that as frame rate goes up the impairment, or blurriness of image, goes down. By the time we reach 400+ fps the image degradation from movement is negligible. This only works if you are projecting in a high frame rate as well, or else you we would all be watching slow motion footage. But high frame rate acquisition and projection are a new concept, only Ang Lee, in his directing of *Billy Lynn's Long Halftime Walk*, has accomplished this. Critics had mixed feelings, with reviews ranging from uncannily real, to so real it was mesmerizing, and everyone has been left curiously waiting for what this format is capable of. Luckily, Lee is at it again, this time use ARRI high frame rate (Alexa M, 3D, 120 fps, 360˚, ARRIRAW) cameras to shoot *Gemini Man.* Currently, only 120 fps is possible, and only 4 projectors in the world are capable of showing 3D, 4k, 120 fps, but audiences and critics are very attracted to this new technology, a technology that Professor Kraus is arguing will become the standard of digital cinema. It is left to be seen if *Gemini Man* can be shown in more theaters at it's full frame rate.

Excited to say more, but low on time, Professor Kraus had to end his lecture with a brief talk on how with the improvement of theaters will come new ways of seeing films and images and as we learn

and develop the science of optics we can experiment with an images contrast to achieve currently unimaginable things. Professor Kraus proves that you don’t become the head of one of the world's biggest optics companies without being both a passionate visionary and methodical researcher. Thank you for his time, which couldn’t have come at a better moment, just one day before the announcement of the Alexa Mini LF: a small body with a big 4.5k sensor.