Mscope – anamorphic capture with dual CIF HD

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Mscope facilitates the conversion of generic 4x3 aspect ratio originated pictures into the 16x9 aspect ratio frame format by maintaining optimal resolution and picture quality of the original images.

The innovative Mscope process allows effective and efficient digital High Definition (HD) recording of 4x3 originated pictures, maintaining the same horizontal resolution while utilizing multiple HD frames (with native 16x9 aspect ratio) for storing additional vertical information.

Therefore, Mscope allows straightforward digital HD storage of anamorphic images originated with conventional 35 mm film anamorphic lenses, or full frame images originated with conventional spherical film lenses, via a 4x3 aspect ratio imaging sensor, using readily available HD recorders. Equally, Mscope allows digital HD recording of digitally scanned film frames originated within 4x3 aspect ratio frame formats.

This invention can also be applied for effective mastering, exchange, presentation, distribution, exhibition and archiving of anamorphic (and full frame) content, using industry standard HD-compliant equipment.

The first practical implementation of the Mscope process is on the ARRIFLEX D-21 film style digital camera. Its implementation allows anamorphically captured images to be recorded as a dual HD signal.

This paper details the implementation of Mscope and how it provides an effective alternative to existing acquisition and Digital Intermediate (DI) workflows, allowing the use of available HD recorders and other HD equipment (which comply with industry established standards) for production, postproduction and exchange of content shot with anamorphic 2.40:1 or full frame (open gate) aspect ratio frame formats.

Present situation and shortcomings

Producing content for ultra-wide CinemaScope projection in the 2.40:1 aspect ratio with currently available HD technology does not provide satisfactory results for many movie makers. Almost all presently available HD cameras have 16x9 aspect ratio sensors and with spherical lenses they produce 16x9 aspect ratio images from which CinemaScope pictures can only be derived after substantially cropping off the top and bottom of the picture. Images produced this way, for the 2.40:1 aspect ratio, have a resolution of 1920x800. This substantially reduces the vertical resolution of the projected image when transferred to film for theatrical exhibition.

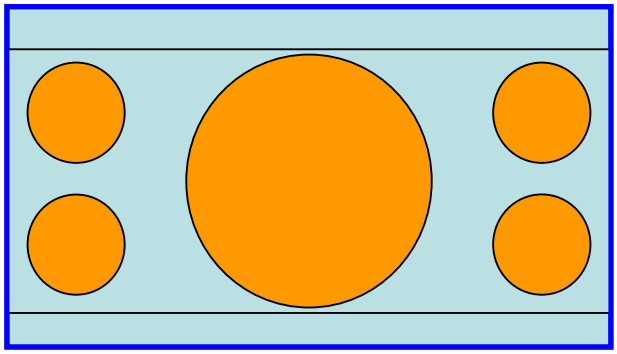

Fig 1 - 2.40:1 picture within 16x9 frame

One possible way to rectify this is to develop “semi-anamorphic” lenses capable of squeezing a 2.40:1 aspect ratio image into the 16x9 frame. However, images captured in this way would have a different look and feel from those shot with conventional anamorphic lenses. As a consequence that would not bring a completely satisfactory result in aesthetic terms and in addition would require costly and time consuming development of an entirely new range of lenses.

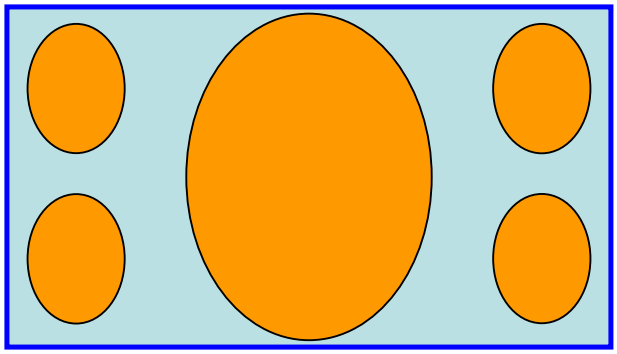

Fig 2 - 2.40:1 picture within 16x9 frame with “half” squeeze

The more promising option is to use a digital camera with a 4x3 aspect ratio sensor which, with conventional anamorphic lenses, produces the same results as if shooting on film. However, this raises a problem of how to record 4x3 aspect ratio images with 16x9 HD recorders without any loss of picture quality.

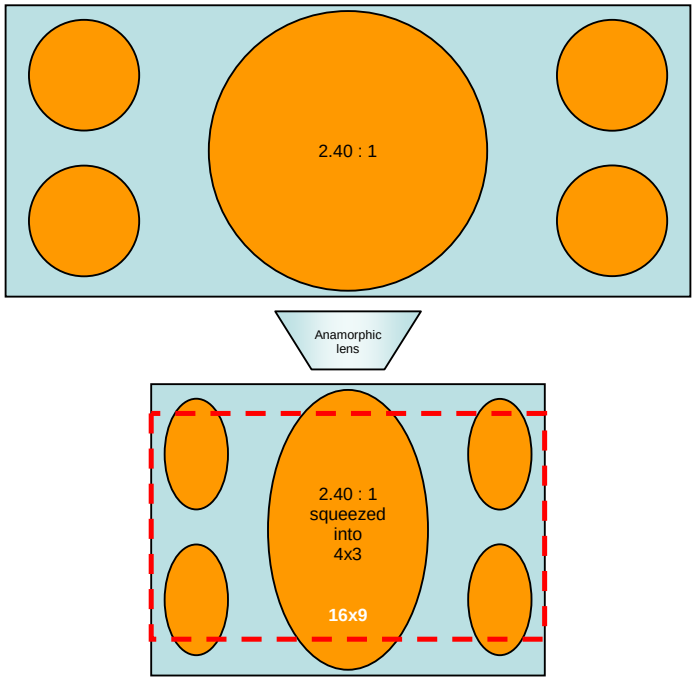

Fig 3 - 2.40:1 picture captured with a conventional (2:1) anamorphic lens on a 4x3 sensor with horizontal resolution equivalent to HD

Equally, when recording digitally scanned film images, which have the generic 4x3 aspect ratio (i.e. anamorphic and full frame), with HD, a similar problem arises - how to record 4x3 aspect ratio pictures with currently available 16x9 HD recorders without any loss of picture quality.

How does Mscope work?

Mscope uses two 16x9 HD frames to record a single 4x3 aspect ratio image. Consequently, any loss of definition and picture quality degradation is avoided.

This can be achieved by applying the following method:

Even/Odd method, whereby all even lines of the 4x3 image are recorded into the first 16x9 HD frame, called the E-frame and then all odd lines into the second HD frame, called the O-frame. This way recorded images can easily be reconstructed into the original frame format at a postproduction workstation.

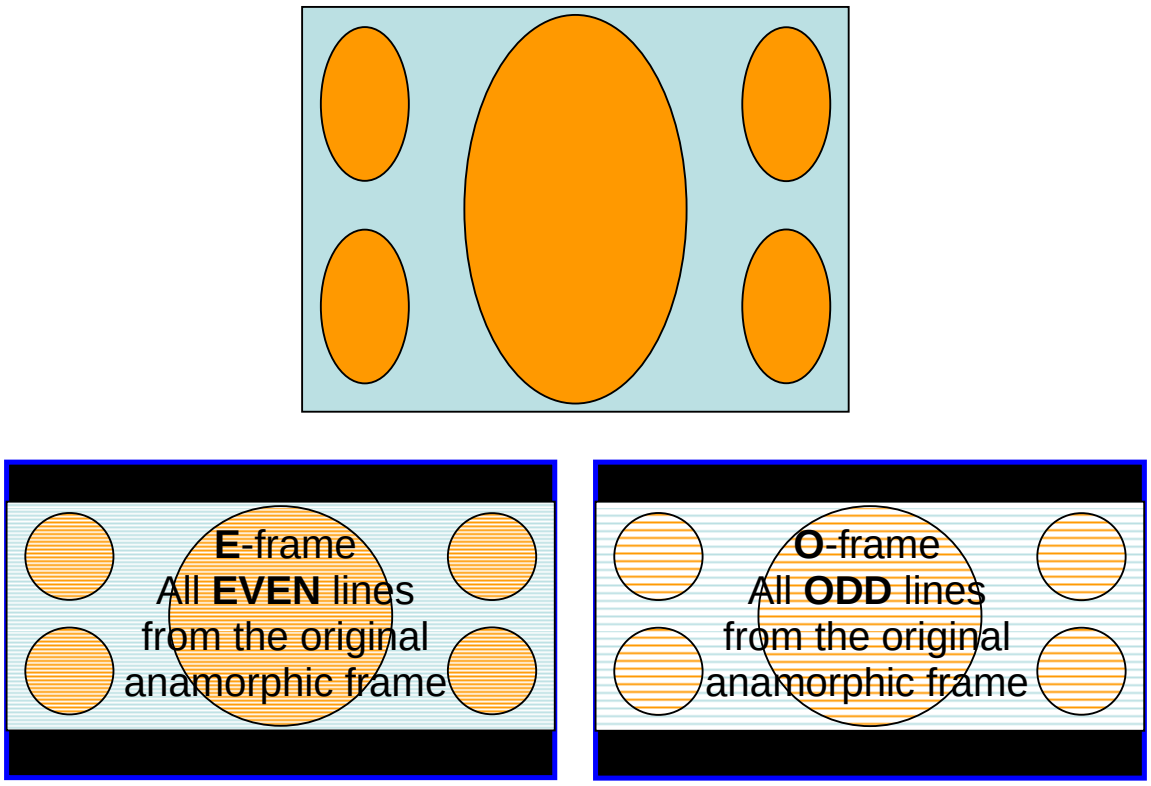

Fig 4 – From the original 2.40:1 picture, captured with a conventional anamorphic lens on a 4x3 sensor, two HD frames are produced: frame E contains all the even lines while frame O contains all the odd lines of the original image

The even/odd method, when monitoring either of the streams, allows for the entire CinemaScope image, with a 2.40:1 aspect ratio, to be viewed on any 16x9 aspect ratio HD display at half the vertical resolution but in full horizontal HD resolution.

This will allow for many creative decisions to be made by just using one of the streams and combining them only at the final postproduction and mastering stage.

In case that 4x3 aspect ratio sensor has a working scanning resolution of 1920x1440 pixels, then the anamorphically squeezed (with the 2:1 factor) picture (with 1.20:1 aspect ratio) will have a resolution of 1728x1440. This, when divided into two streams, provides images with 1728x720 pixels resolution, with the full 2.40:1 aspect ratio. Pictures will have a border of 180 lines top and bottom and 96 pixels left and right for every HD frame of full 1920x1080 pixels resolution.

If, however, the entire width of the 4x3 sensor is used, the resulting aspect ratio will be 2.66:1 (due to the fact that conventional film anamorphic lenses have a squeeze factor of 2:1). In this case both streams will have a raster of 1920x720 pixels, allowing for final framing to be fixed during postproduction.

In the case of a sensor with 1920x1600 pixels of working scanning resolution, the E and O streams will have 1920x800 resolutions, with 140 blanked lines at the top and bottom of the full HD frame.

If, however, the sensor has resolution equivalent to a standard 2K anamorphic film scan of 1828x1556 pixels, then the HD streams will have images with 1828x778 pixels resolution each. They will be bordered with 151 lines top and bottom and 46 pixels left and right.

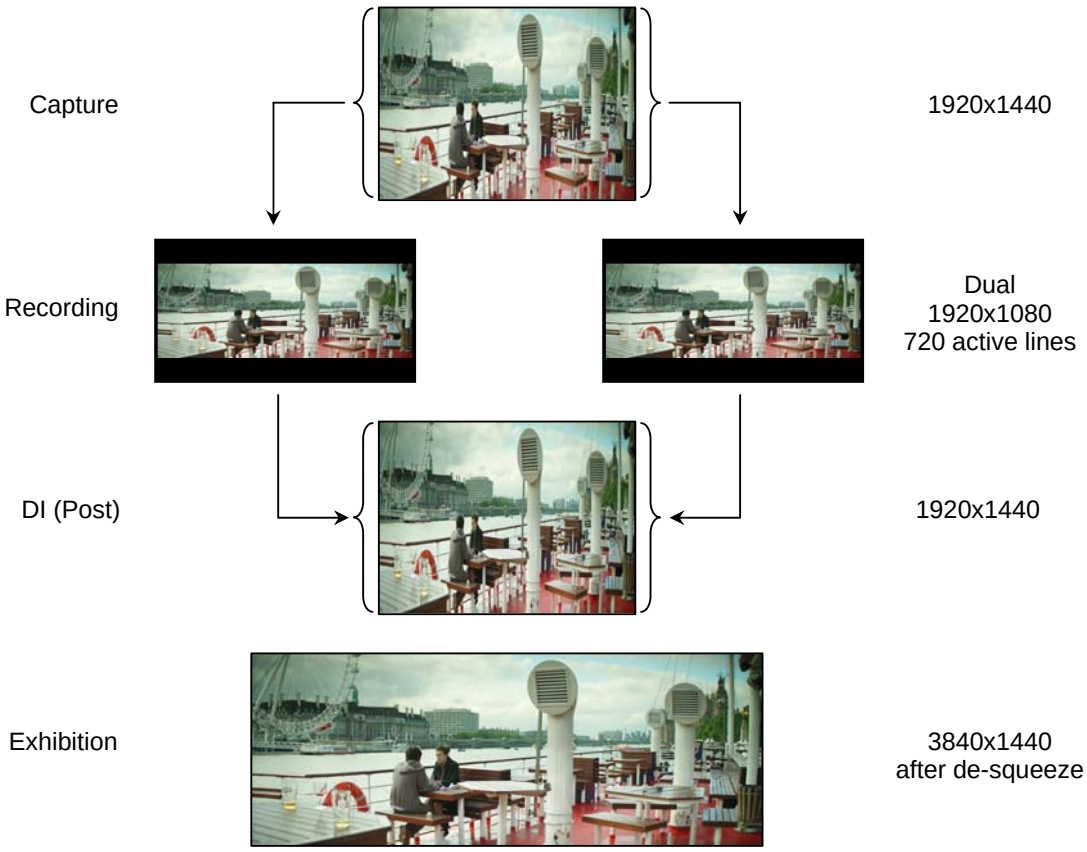

Fig 5 –Mscope – conceptual outline

Mscope image structure

The ARRIFLEX D-21 camera houses a single Super 35-size CMOS sensor with Bayer mask structure. Its dimensions are 23.76 mm x 17.82 mm with 2880x2160 Bayer pixels. In HD mode, the D-21 outputs a 1920x1080 signal utilizing only the central part of the sensor. However, in Mscope mode, the D-21 utilizes the entire height of the sensor, producing an image which consists of 1920x1440 HD pixels. Mscope splits this image into two (4:2:2/PsF) HD-SDI streams which fully comply with SMPTE 274M standard. The A-channel contains all even lines of the original full frame (with line count starting from 0); while the B-channel contains all odd lines. Each stream has resolution of 1920x720 active pixels with an additional 180 blank lines on the top and bottom of the frame.

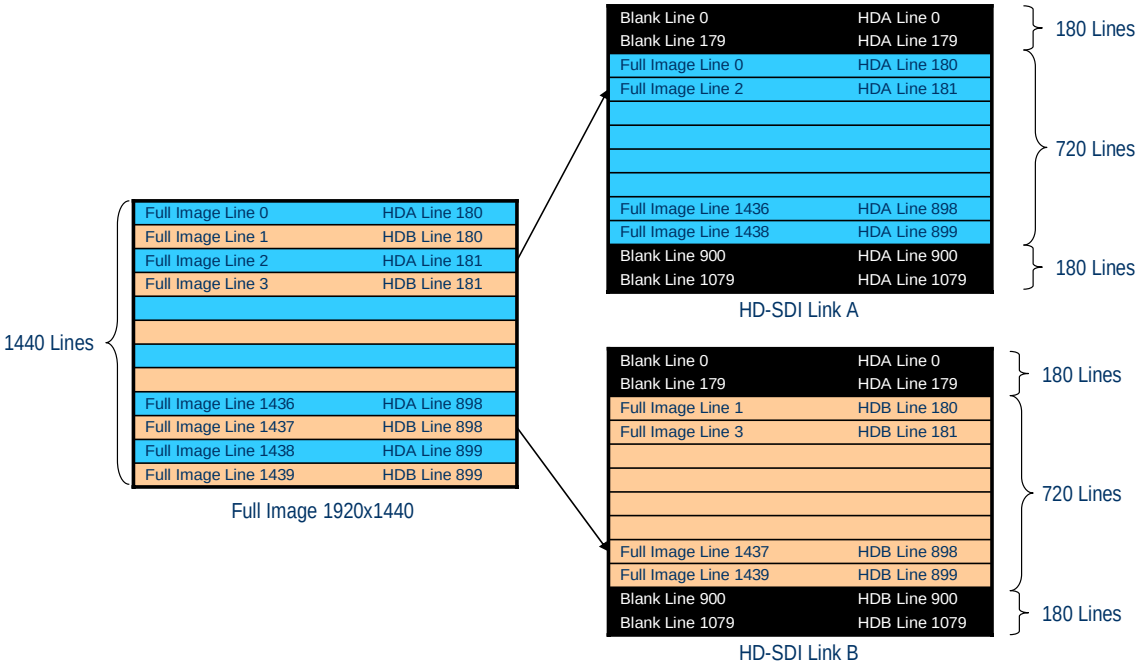

Fig 6 – The original 4x3 image with 1920 x 1440 HD pixel resolution is split into two HD-SDI streams in the manner illustrated here

These HD streams can be recorded synchronously on any HD recorder with dual stream recording capability (such as the SRW-1) or even on two separate HD recorders.

Though each stream has half the vertical resolution of the original frame, the picture quality is perfectly suitable for on-set monitoring, assessing artistic performance and evaluating exposure, focus, etc. An added benefit is that each stream has a normal looking (non-squeezed) image. Picture quality is good enough for offline editing; hence, any of the streams can be down-converted and fed into commonly used offline edit systems.

Mscope Workflow

The Mscope workflow is based on dual HD-SDI (4:2:2) and benefits from the readily available HD infrastructure.

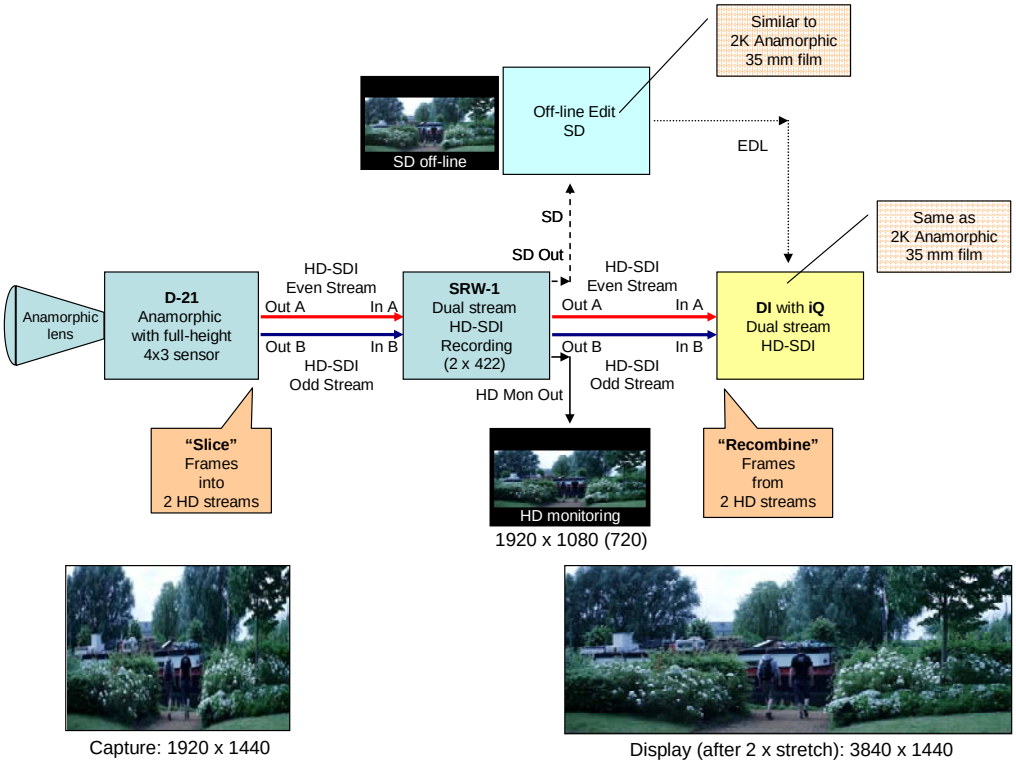

Fig 7 – Typical Mscope workflow is illustrated on this block diagram.
The full 1920x1440 squeezed Mscope image is recombined at the start of DI,
prior to auto-conforming and grading

During the DI, as a first step, the two HD streams are recombined to produce a high resolution, squeezed, Mscope image.

The first company to support Mscope postproduction is Quantel and they make the Mscope workflow straightforward and efficient with all the benefits one would expect from them. From then on the project can be treated as a 35 mm anamorphic feature, right up to laser film-out, distribution and exhibition.

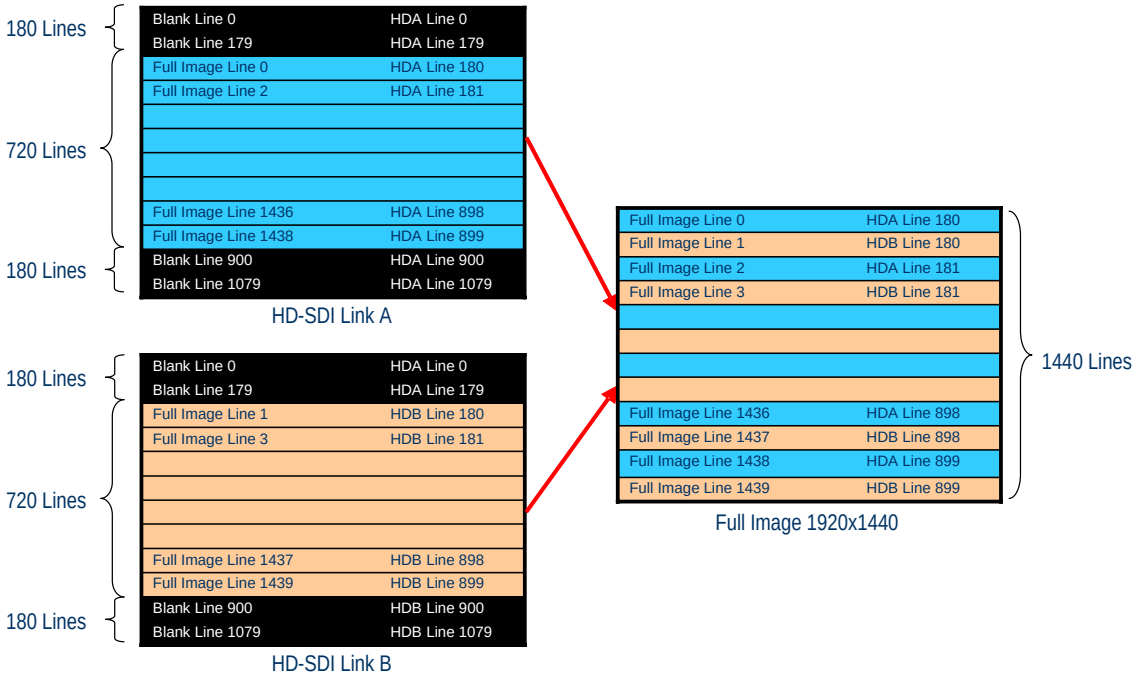

Fig 8 – The original anamorphic 4x3 image with 1920x1440 HD pixel resolution is recombined from two HD-SDI streams in a manner illustrated here.
This looks like an inversion of the process in Fig 5

Mscope also allows for film-originated pictures shot with anamorphic lenses or with full frame open gate to be recorded as dual stream HD recordings without loss of resolution.

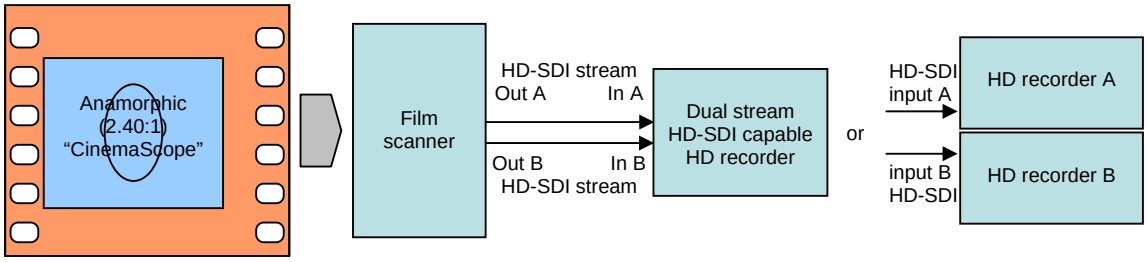

Fig 9 – The film scanner, scanning the full width and height of an anamorphic (or open gate) frame, outputs images via dual HD-SDI link to a single HD recorder capable of recording dual stream HD signals or to two synchronised HD recorders, each recording one of the HD streams

Practical Implementation – *Love Hate*

The first production to benefit from Mscope was a short movie titled *Love Hate*, which was shot over five days at various locations across London in early August 2008. *Love Hate* is a romantic comedy with a difference; it is about a sweet-natured guy who falls in love with a girl who is the embodiment of everything he hates.

Love Hate was commissioned by BBC Films and the UK Film Council via Film London.

The film stars two of Britain's hottest young actors, Ben Whishaw and Hayley Atwell, and was written and directed by the enormously talented Ritson brothers - Blake and Dylan. The producer was Scott Jacobson and the cinematographer was John Lynch. John is a highly successful commercials DP and has great affinity for anamorphic/scope shooting.

The movie was shot using one D-21 with a set of anamorphic Hawk primes. The camera setting was linear, extended range, running at 25 fps. The rushes were recorded using one SRW-1 portable HDCAM SR recorder (set at 2 x 4:2:2) on 23 cassettes, each recording up to 25 minutes (since Mscope records dual stream HD, recording capacity is half of the normal run). For on-set monitoring they used a standard 17" Panasonic HD monitor and for on-board camera monitoring they had a commonly used 6" HD Astro picture/waveform display. Their offline was fed using just one of the Mscope HD streams. The auto-conform and grading is due to be carried out using Quantel's iQ, which will also be used for recombining the full anamorphic Mscope signal. The anamorphic film-out is scheduled to be carried out using an ARRILASER. *Love Hate* is intended for theatrical exhibition in CinemaScope with a 2.40:1 scope aspect ratio.

Conclusion

To get a scope picture with conventional HD cameras that have 16x9 sensors requires cropping the picture top and bottom, which diminishes its quality. Mscope goes the other way: it actually adds quality and resolution to a normal HD picture since Mscope frames contain approximately 80% more lines than equivalent 2.40:1 scope images derived from ordinary 16x9 HD. Plus, with Mscope the production is shooting with anamorphic lenses, which give very different aesthetics, particularly in terms of depth of field, the way out of focus backgrounds look, incidental light flares, etc; while benefiting from HD's cost-effectiveness and flexibility.

Special thanks

To the senior management at ARRI for green-lighting the Mscope project and for allowing me to present this paper, also to Dr. Achim Oehler, head of the D-21 development team in the ARRI R&D department and his colleagues and fellow team-members for the great work they are doing.

To the *Love Hate* production team for being the first to use Mscope in earnest on their short movie.