digital film technology

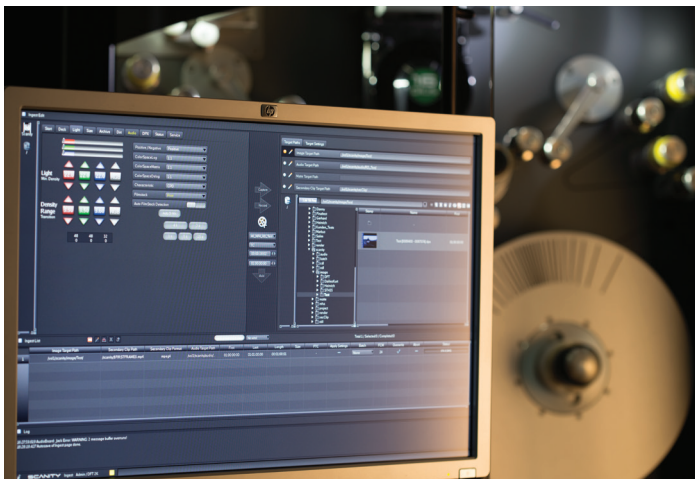
Scanity HDR

high dynamic range film scanner

white paper

dft
standing the test of time


sondor
35
SCANTY HDR

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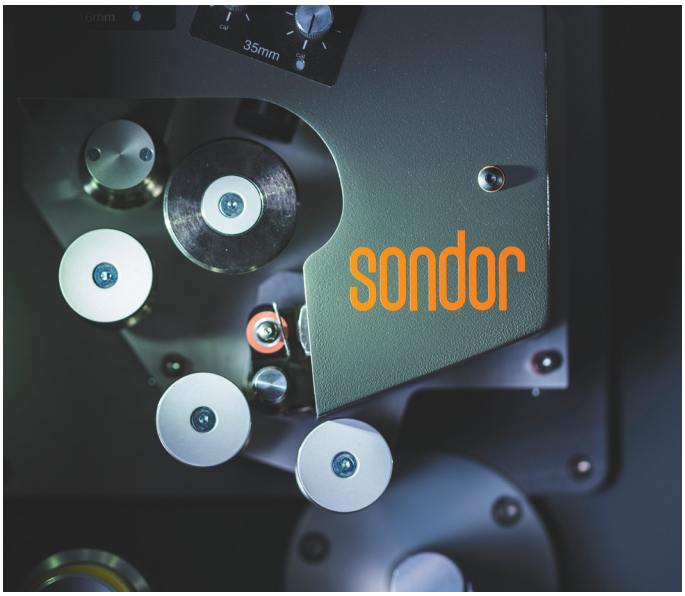
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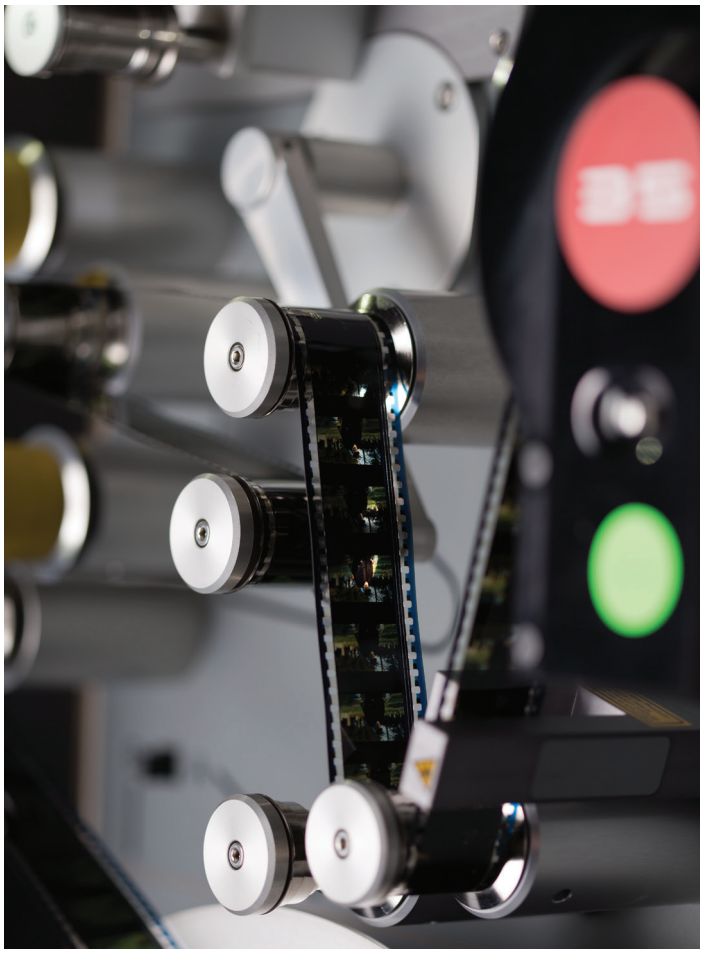
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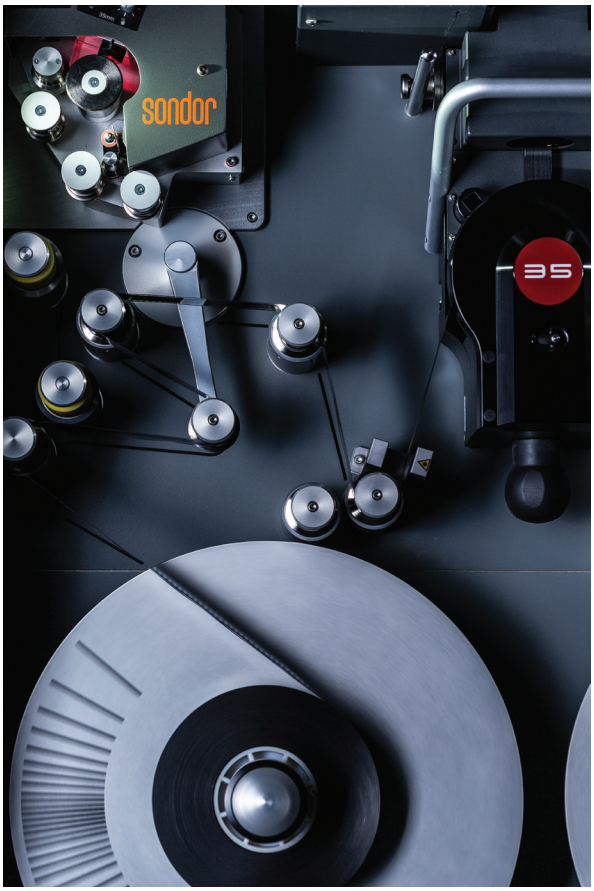
high dynamic range film scanner

Scanity HDR >>>

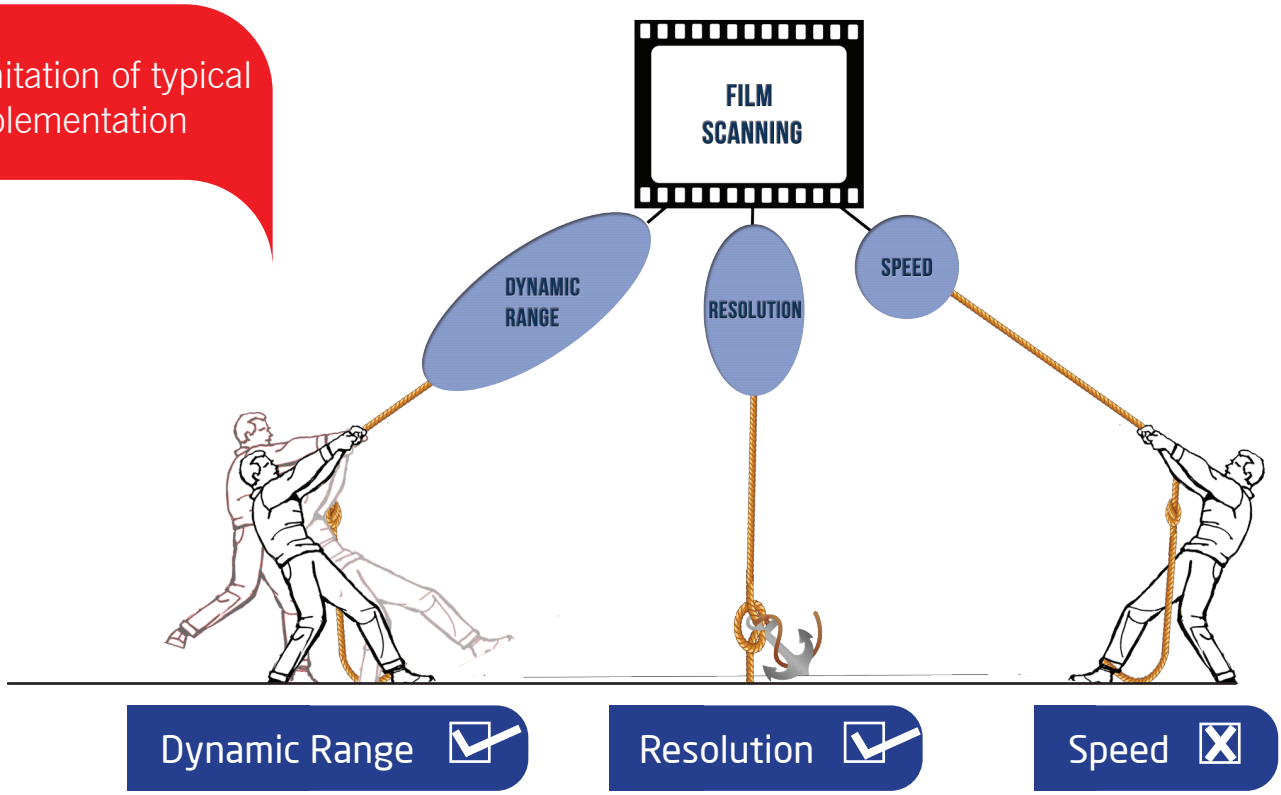
Scanning normal colour negative images for post-production and visual effects using modern high-end technology allows users to capture the dynamic range of the colour negative. Film archives, however, typically manage large volumes of historic images, and require specialist equipment which enables the capture of an even greater dynamic range. This is particularly important when managing black and white (B&W) recorded images on either print or negative stocks which have a high dynamic range (HDR).



Traditionally, HDR scanning is done using a multiple exposure method during which a scanner ‘stops the film’ to capture images at different exposure levels. Images are subsequently recombined into a single HDR image, a process which significantly slows the rate of scanning.

This white paper demonstrates the normal process of HDR imaging and then explains our technique for HDR film scanning of B&W film stock (either print or negative) without affecting the maximum scan-rate of a scanner or its maximum resolution.

Limitation of typical implementation



Dynamic range, resolution and speed

Motion picture scanning is different to normal stills-imaging scanning. The resolution and dynamic range are of equal importance as stills but the speed of scanning is also a critical factor. A 90 minute feature has approximately 130,000 images to scan. With hundreds of thousands of hours of material in the world, image scanning speed is a key consideration.

These three factors (dynamic range, resolution and speed) are usually competing 'forces' in the film scanning world, whereby the increase in one area has an impact on one or both of the other factors.

Typically, most other OEM scanning solutions scan at speeds less than half that of real time 2K and significantly slower when in HDR mode.

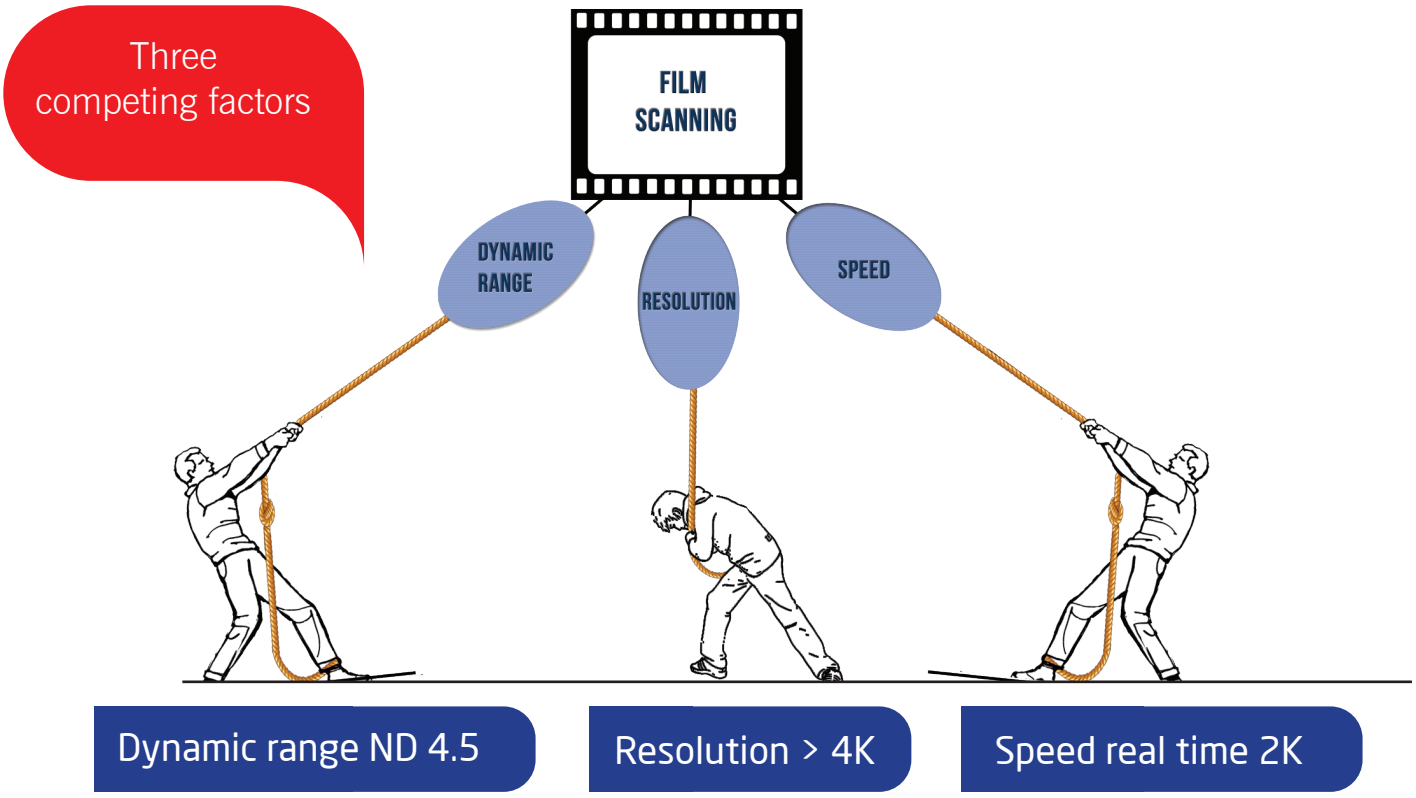
Faster speeds are possible - but only by compromising resolution, or by reducing the effective dynamic range. Better dynamic range or resolution can be offered through slowing the scan speeds – which also allow for multiple exposure and potentially better line resolutions, but at the cost of speed!

However, Scanity HDR provides speed without compromising dynamic range or resolution. It offers a high dynamic range up to an ND of 4.5 for B&W materials whilst maintaining real-time 2K speeds of >25 fps at full bandwidth 2K.

Scanity achieves:

(2K @ 25 fps ; 2040 x 1556 RGB full Bandwidth; 4 perforations)

(4K @ 15 fps ; 4096 x 3112 RGB full Bandwidth; 4 perforations)



Need for increased dynamic range

Typical colour film negatives have a dynamic range (Dmin to Dmax) of around ND 3.0 - 3.5. Most images have a lower dynamic range of around ND 2.2, which fall within the usable dynamic range of the high-end film scanner.

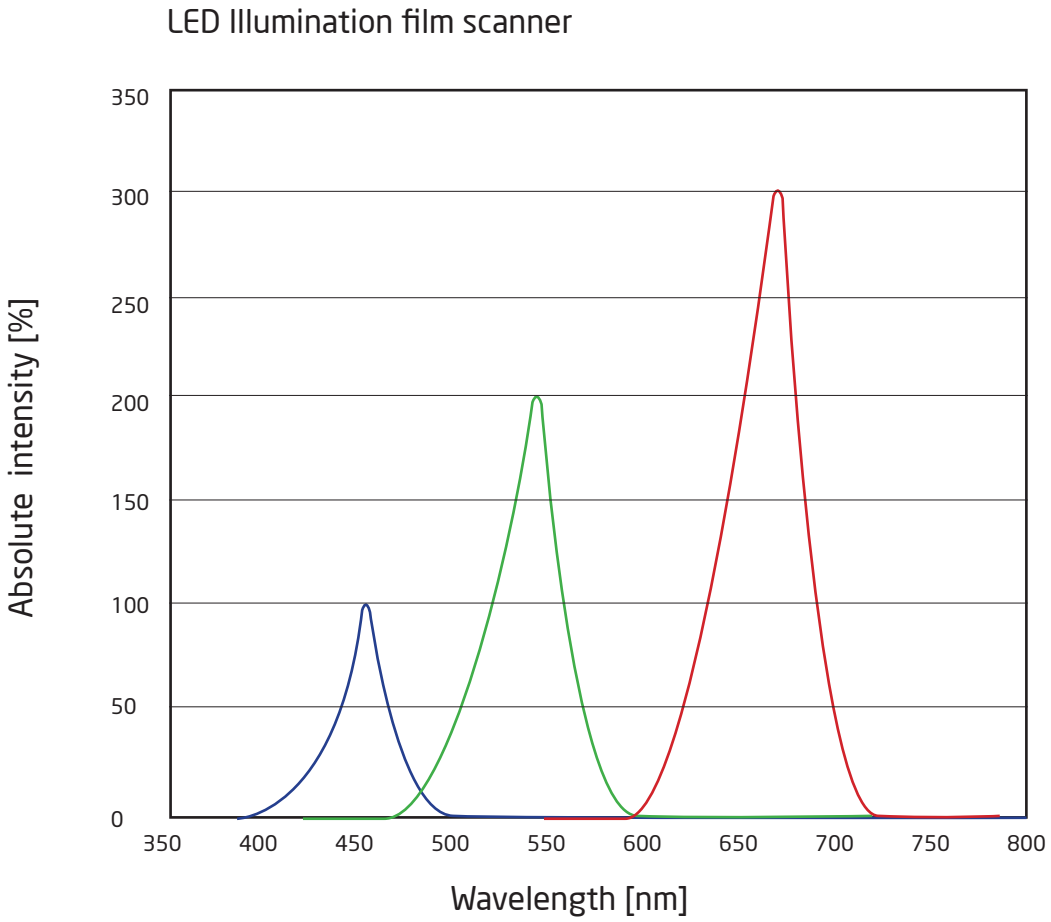
However, with B&W images this is not the case. These film stocks, positive or negative, can have dynamic ranges of 3, 4 or more stops greater that of colour negative film.

With large amounts of archival B&W film now being scanned for either restoration, digital archives or repurposing, it is important that new scanning techniques are developed to minimize or eliminate the competing 3 way compromises involved in normal film scanning.

1. High dynamic range
2. Fast speed
3. High resolution

Scanity HDR

Spectral control



High dynamic range

HDR imaging is by no means a new concept in the field of photography or film scanning. It has been used for many years to increase the dynamic range of a captured image. The basic concept is to capture multiple exposures of a single scene or image then combine these associated or (bracketed) images into a single HDR image.

Images can be bracketed by:

- adjusting the lens aperture differently for each bracketed image or
- changing the exposure time for each bracketed image or
- changing the light level of a scene for each bracketed image or
- any combination of the above

The final combined HDR picture is made by choosing the 'most appropriately' exposed part of the film from each bracketed image and combining them into a single resultant image. This, in digital imagery, is typically done at the pixel level. A typical HDR picture will use a combination of two, three or more bracketed images to produce the final look.

Slow speed – a typical HDR issue

Using the typical approach for HDR can significantly improve the usable dynamic range of any resultant image over any one pass or image capture on its own.

This, however, means that multiple images must be captured, which slows the maximum speed of the scanning process down by at least a factor equal to the number of images taken to produce the HDR image.

For example, if two bracketed images are to be used to make a single HDR image there are at least two images 'taken'. This takes at least twice as long to achieve, plus whatever time is required to change the parameter used for the bracketed exposures be it lens aperture, exposure time or light-level control.

The resulting image will have maintained the scanning resolution and increased dynamic range but compromised the speed of the process. Clearly, a new method is required if time is not to be compromised.

Increasing speed – a new patented approach

Fortunately there is a property of B&W film stocks that can be used to our advantage. B&W stocks rely on retained silver to produce density range B&W films – which means that film density is exactly the same at any given spectral frequency or 'colour' of light that passes through it.

Traditionally, B&W film is scanned using a colour scanning camera, and each colour is given exactly the same exposure. Usually one 'colour' is chosen – but this does not accurately represent the 'exposure balance'. There will be some difference between the captured colours based on the colour temperature of the light source used to illuminate the image.

For example, in a typical three-colour camera system, if the light source is warmer, the red channel will have a slightly higher exposure than green channel and the blue channel will have a slightly lower exposure than the green channel. If the light source is cooler then the opposite is true. The blue will be slightly more exposed and the red will be slightly less exposed. Not a problem for B&W stocks when choosing only one colour to capture the image.

If we take this a step further and exaggerate this colour temperature difference we significantly affect the degree of over or underexposed images on the red and blue channels. Furthermore, if we can accurately control the colour temperature of the light source we can accurately control the exposure levels of each of the colour sensors. The resulting response of each colour sensor is the representation of the density of the bracketed B&W original. This is done at the maximum colour resolution of the sensor.

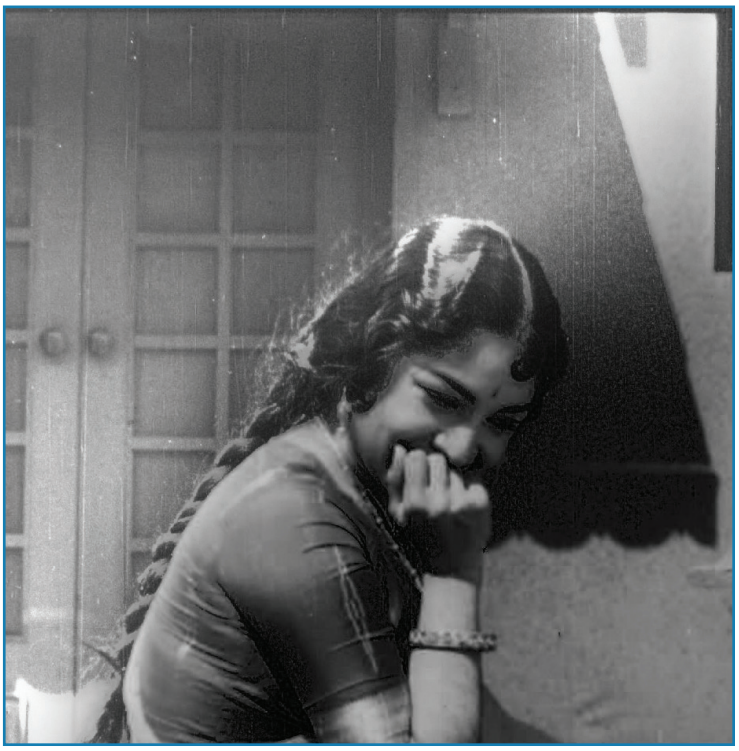
This process creates bracketed exposures of a scanned B&W film image without the need for multiple scan passes, and therefore without affecting scanning speed. Running the scanner to capture in real time means we have created an HDR scanning process at full resolution at maximum capture speed.

Normal Exposure

Medium Exposure

Over Exposure

A typical HDR picture will use a combination of two, three or more bracketed images to produce the final look



Resultant HDR Image

Results

Using this process, the increase in the film's HDR is effectively at maximum scanning speed and maximum resolution. The practical limitation is the amount of control over the illuminating light source and the number of spectral capture cameras.

The research team at DFT has demonstrated that this process can easily produce a ND 1.2 improvement of usable dynamic range at both 4K and 2K horizontal resolution on B&W film at maximum scan speed of the scanning device.

Conclusions

HDR imaging of B&W motion film has been achieved at the maximum scan speeds of DFT's new Scanity HDR product (2K @25fps - 2048 x 1556 RGB full bandwidth, 4 perforations) or (4K@ 15fps – 4096 x 3112 RGB full bandwidth, 4 perforations)"

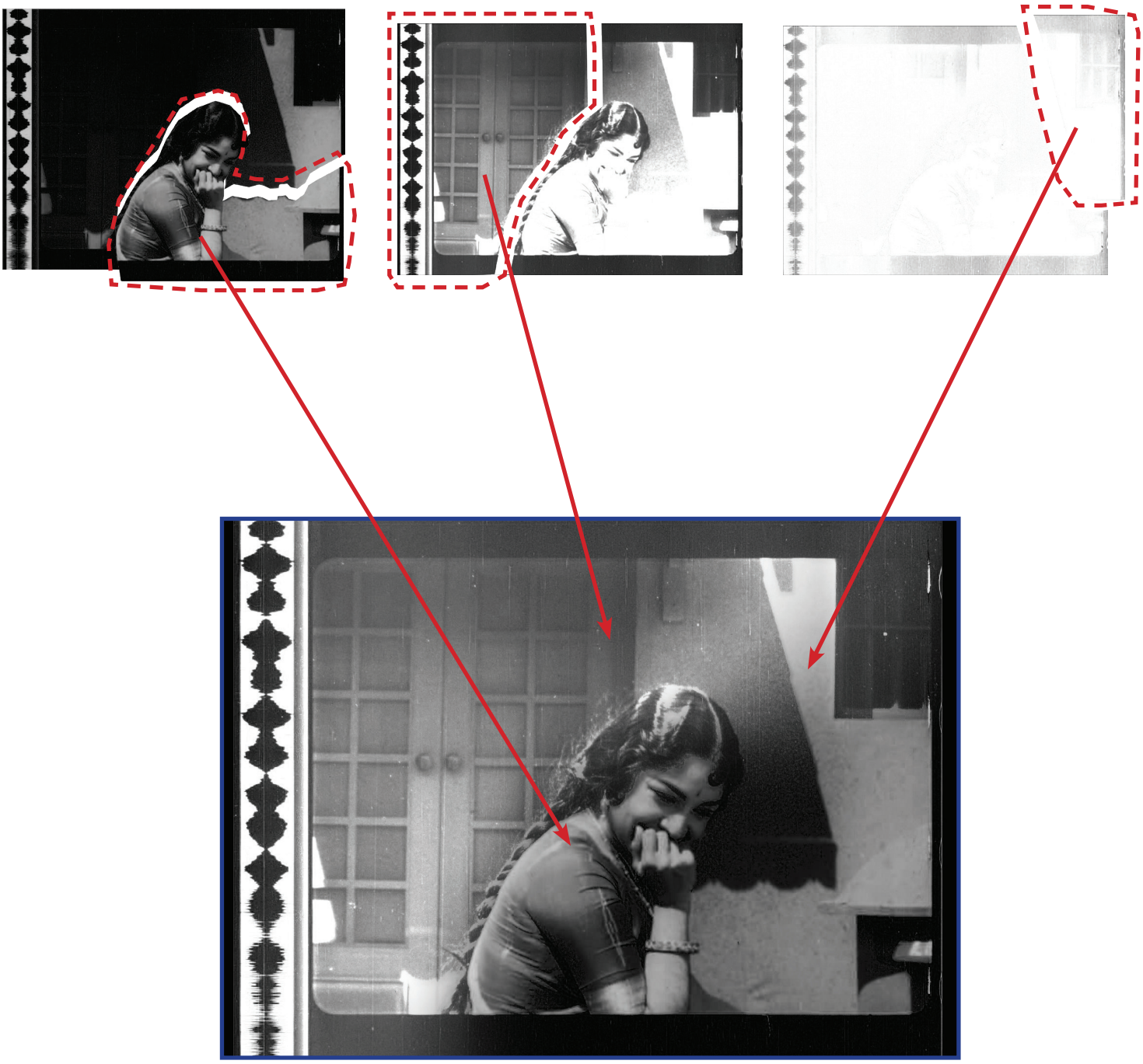
This was accomplished by controlling the spectral composition of the light source passing through a B&W film image. An image sensor at the same spectral frequencies captures the exposed bracketed images at maximum scan speed. These bracketed images are then combined at 'real time scan speeds' to produce HDR images with greater improvement in usable dynamic range without any speed compromise to the scanning or recording process.

Concept of HDR

Normal Expose

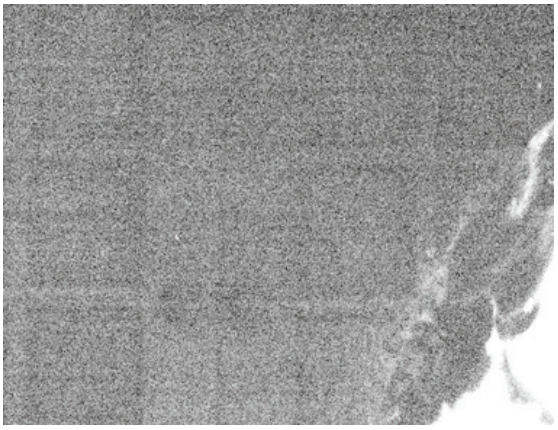
Medium Expose

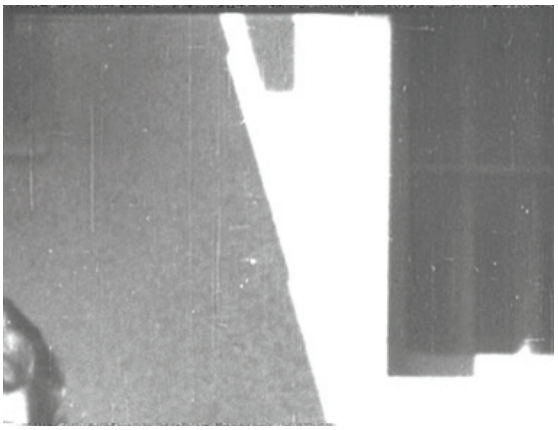
Over Expose



Before

After





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