

# Letter to the Editor

**Re: “The Image Resolution of 35mm Cinema Film in Theatrical Presentation,”**

By V. Baroncini, H. Mahler, and M. Sintas,

Published in the *SMPTE Motion Imaging Journal*, February/March 2004, pp. 60-66.

The results reported in this paper give an inferior measurement of Visual Limiting Resolution of projected motion picture film due to the use of an inappropriate test target. When using the correct test target (an ISO test chart), the results are 30% higher. In addition, technology advances in digital intermediate systems continue to increase the on-screen resolution. At least 4000 pixels per line are required to reproduce the complete information content available on screen, using conventional film systems.

**1. The Baroncini, Mahler, and Sintas paper used the wrong test image to measure Visual Limiting Resolution.**

- a. The test image used in the Baroncini, Mahler, and Sintas paper<sup>1</sup> is valid for the instrumental measurement of Modulation Transfer Function (MTF) by scanning the film with a microdensitometer.
- b. However, it is unsuitable for measuring Visual Limiting Resolution because of psychophysical factors in the way the human eye works, and because the test image violates standards procedures:
  - i. The contrast of the test image is too low.
  - ii. It uses a sine wave, not a square wave profile.
- c. A suitable test image for these measurements of Visual Limiting Resolution is the ISO 12233<sup>2</sup> test target. Like the IEEE and SMPTE standards for Visual Limiting Resolution, the ISO target uses high contrast black to white square waves.
- d. The test image used in the Baroncini, Mahler, and Sintas paper<sup>1</sup> has sine waves of 60% contrast. Compared to a square wave target of 100% contrast at the limiting resolution, this sine wave target has a 53% lower contrast. This will give a result that is well below the results measured with the correct target.

**2. Actual results are 30% higher.**

- a. The use of 5% MTF Limiting Resolution gives a more reproducible measurement. It is derived from on-screen MTF. 5% MTF Limiting Resolution for film printed in a commercial lab using high-speed printers (for release prints) or panel printers (for show prints or answer prints) in both 1.85 (“flat”) aspect ratio and 2.39:1 (Cinemascope) gives a horizontal resolution range from 870 to 1040 LW/PH (line widths per picture height). 5% MTF Limiting Resolution corresponds quite well to Visual Limiting Resolution assessed using the correct target viewed at two picture heights from the screen.
- b. The measurements of 870 to 1040 LW/PH for horizontal resolution using the correct high-contrast test image are 30% higher than the measurements of 600 to 875 LW/PH quoted in the Baroncini, Mahler, and Sintas paper<sup>1</sup>, which used the incorrect low contrast sine wave target procedure.

**3. More importantly, thanks to the increasing use of Digital Intermediate, on-screen resolution of film will increase over the next decade.**

- a. Already, an on-screen Visual Limiting Resolution of 1200 LW/PH has been demonstrated for the film-based digital intermediate system.
- b. This means that losses from scene to screen in film post-production will be reduced by future digital intermediate systems.
- c. Consequently, today’s 35mm origination negative can be considered an archive that will in the future produce even higher on-screen quality than today’s cinema quality.

**4. How many pixels are required to match the on-screen performance of conventional film?**

**Answer: at least 4000 pixels per line.**

- a. A digital imaging system needs at least 4000 pixels per line to prevent aliasing in the image.
- b. Aliasing is the generation of visual image artifacts as a consequence of the digital sampling of the image. Unwanted patterns are produced by interference between the scanning system and fine detail in the image.
- c. Film systems do not introduce aliasing.

<sup>1</sup> “The Image Resolution of 35mm Cinema Film in Theatrical Presentation,” *SMPTE Motion Imaging Journal*, Vol. 113 No. 2 & 3, pp. 60-66, February/March 2004.

<sup>2</sup> See for example Photography—Electronic still-picture cameras—Resolution measurements ISO 12233:2000(E) Para 6.1 page 11.

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