TESTING FLAT-PANEL IMAGING SYSTEMS: What the Medical Physicist Needs to Know

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Topics

- Image Uniformity and Artifacts
- Image Quality - Detail
- Image Quality - Contrast
- Detector Sensitivity

Image Uniformity - Setup

- PMMA – 8” thick x 14”x17”
- Copper – 2-3 mm x 14”x17”
- Typical radiographic technique or AEC

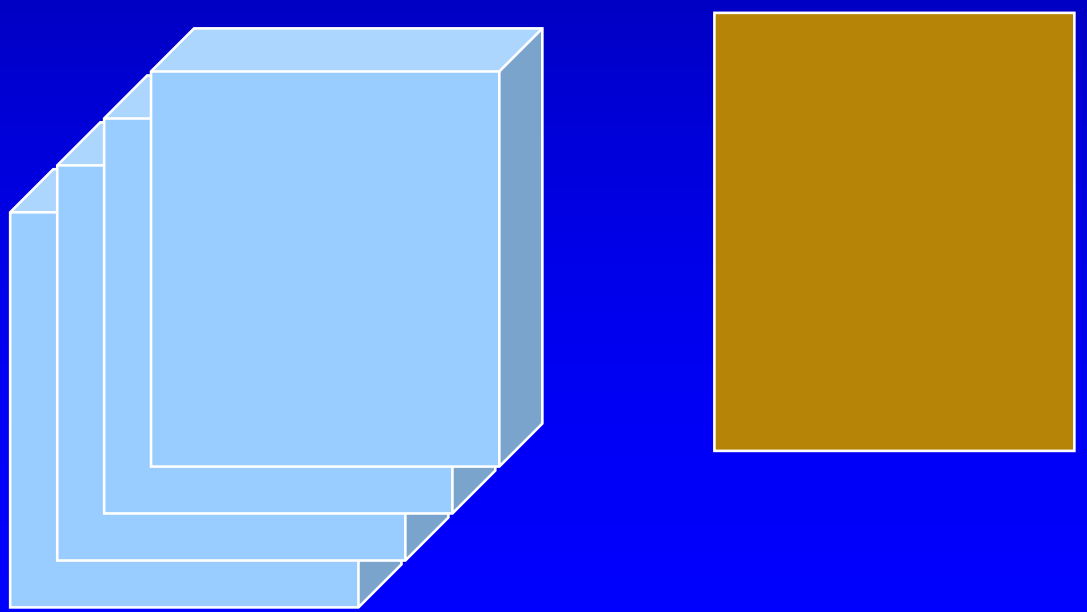


Image Uniformity - Analysis

- Visual inspection of image to look for shading or signal brightness variation
- Use typical display window, then narrow window
- Provides a quick review
- Comprehensive testing requires analytical tools to measure signal variation across image

Image Artifacts

- Inspect uniformity image for:
  - signal voids or defects
  - lines (banding)
  - residual image burn

- CAUTION: Latent images can result from phosphor burn if detector dose is too high !

Image Quality - Detail

- Primarily controlled by sampling pitch (pixel size) and display pitch
- Use PSF, LSF, or ESF to generate MTF curve
- **Line-pair test tool** quickly evaluates cut-off frequency in the field

DF Detail

- Past experience using line-pair test tool with digital fluoro shows increasing detail with decreasing image size, because fluoroscopic image has more detail than converted digital matrix , up to 2048x2048.

FOV (cm)	lp/mm (1k)
20	2.5
16	3.2
13	3.9

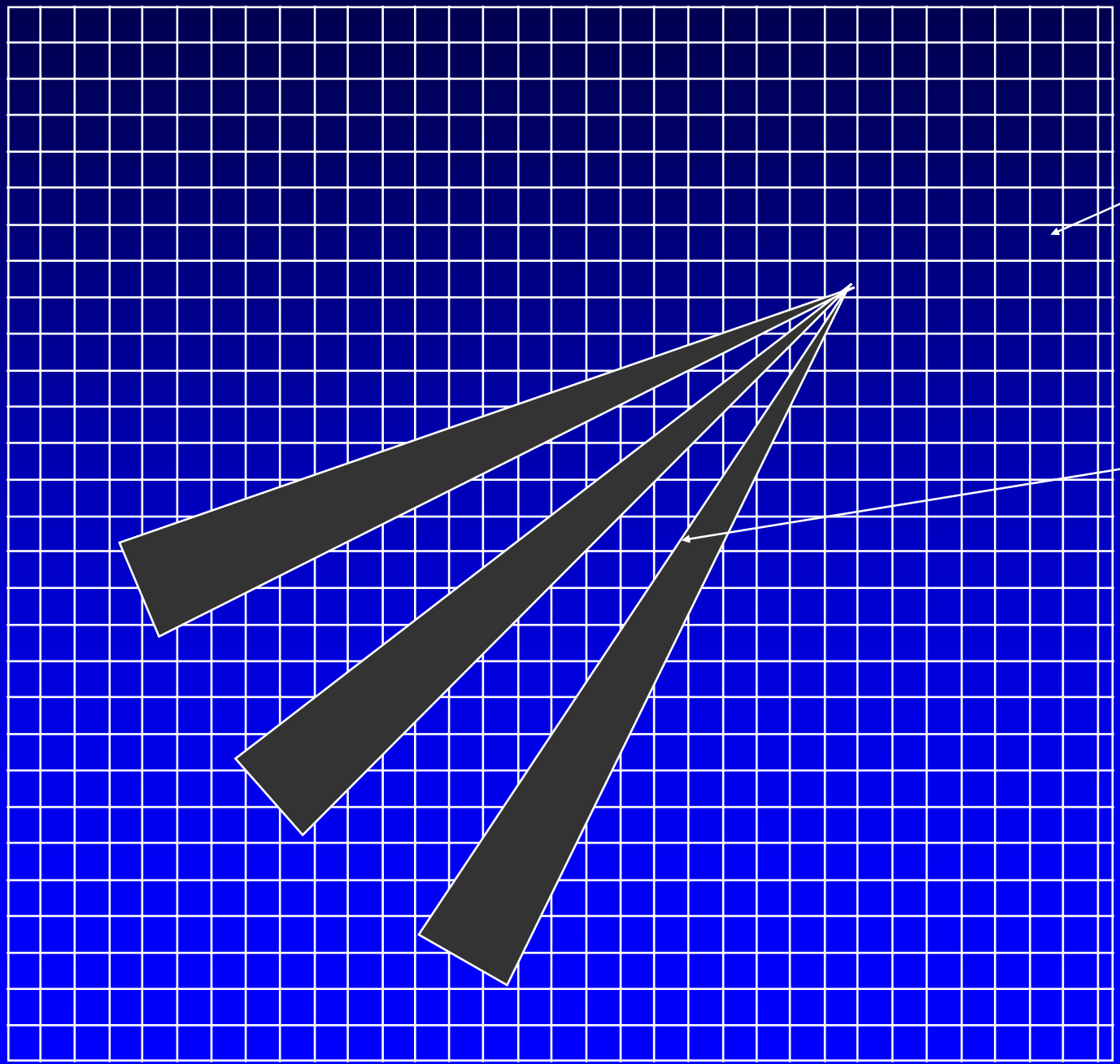
Flat Panel Detail

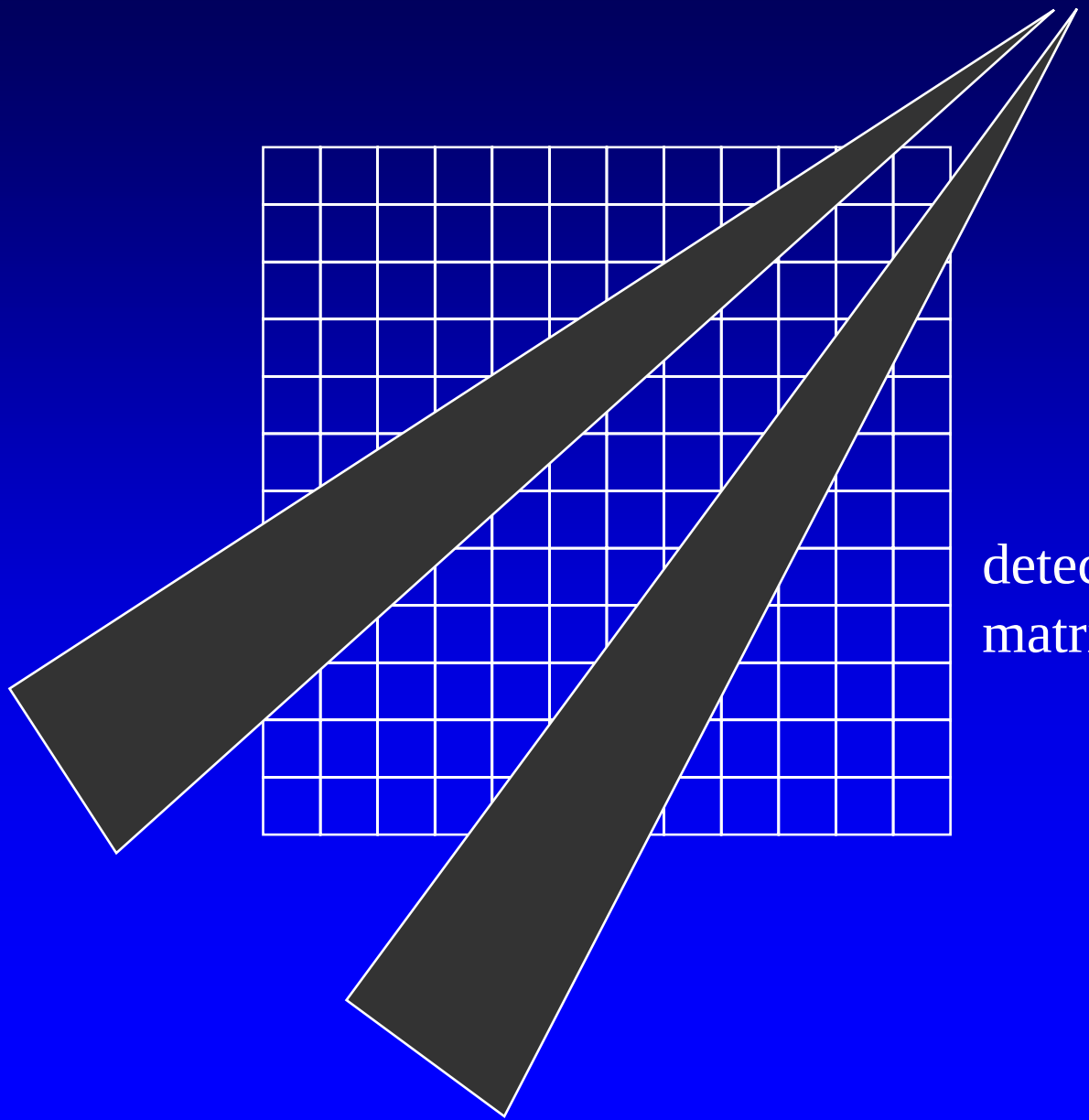
- Flat panel detectors often have the same cut-off frequency regardless of FOV.

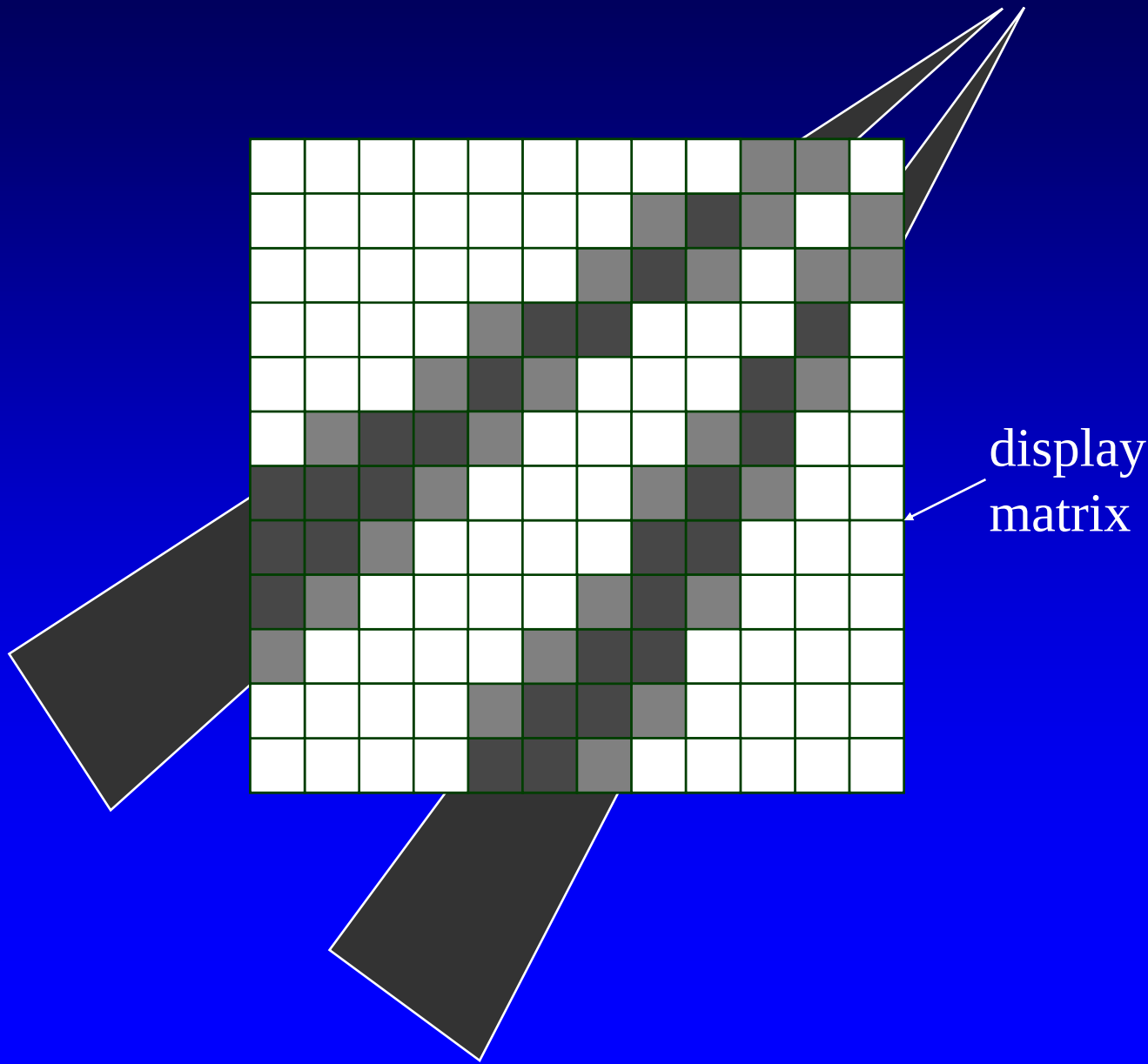
FOV (cm)	lp/mm (1k)
20	3.5
16	3.5
13	3.5

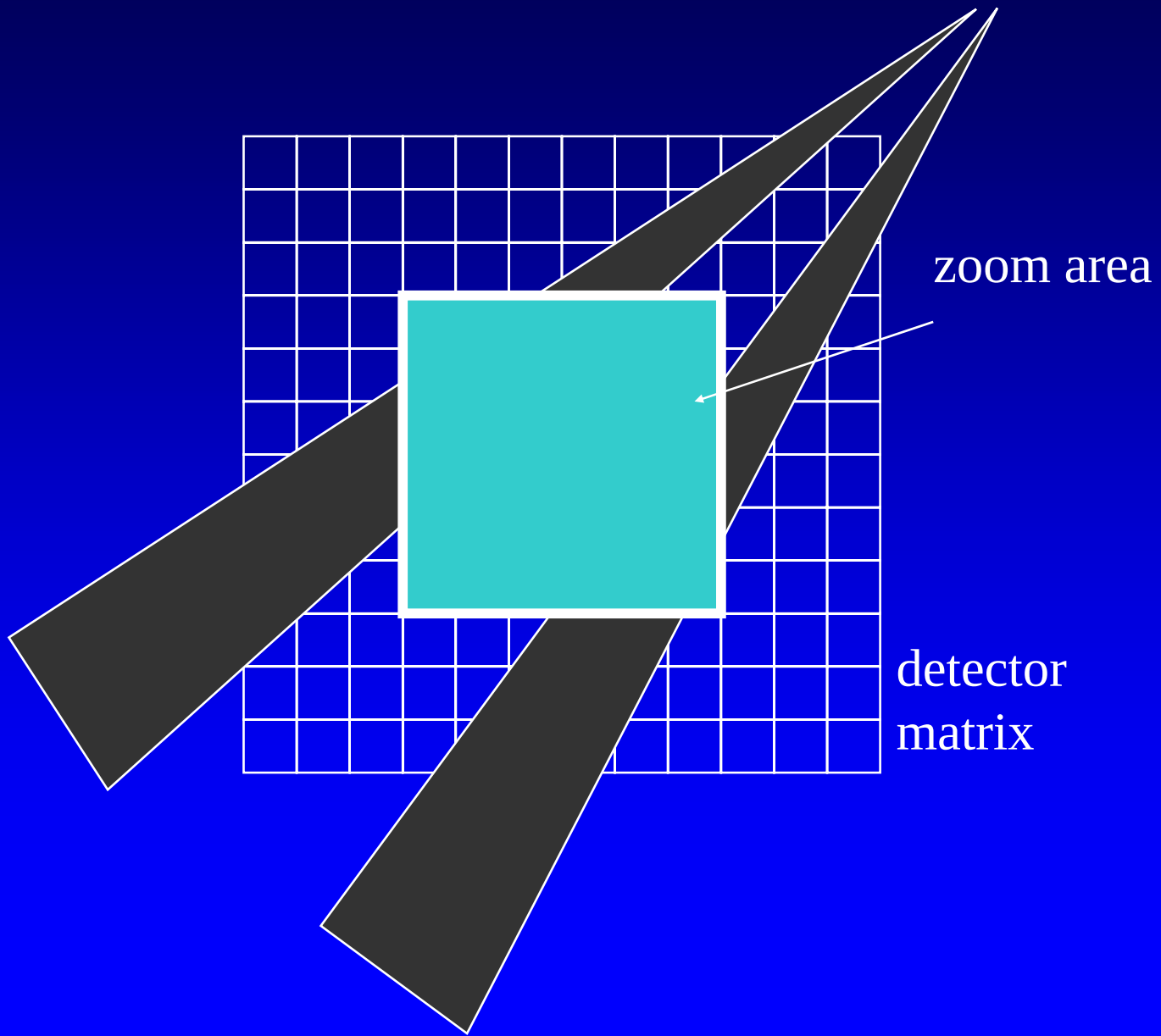
Digital Zoom

- Because native detector element size is constant, it is limiting factor with detail
- When change FOV, the system does “digital zoom”, by overlaying original data pattern over new display matrix (like digital cameras)
- Since original pattern remains constant from sampling frequency, so does cut-off frequency

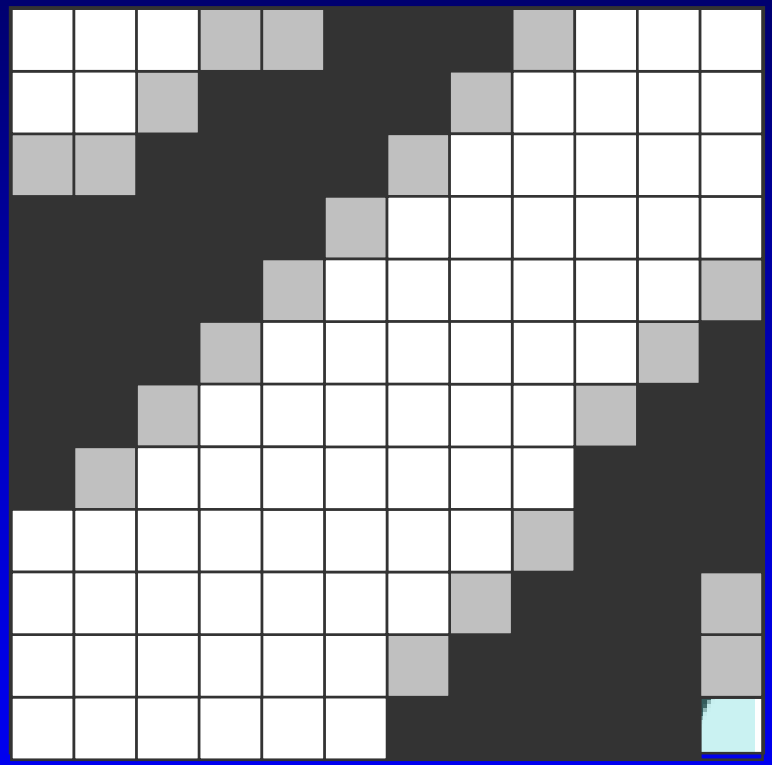

detector
matrix
test
pattern


detector
matrix


display
matrix


zoom area
detector
matrix

zoom



same cut-off frequency

Magnification

- If detector matrix (512-1024) ≤ display matrix (1024), image magnification (zoom) results in spread of data across pixels and no increased detail

- If detector matrix (2048) is > display matrix (1024), image magnification (zoom) results in increased detail displayed

Pixel Binning

- Some systems combine a group of detector element data together to form one pixel for display
- Results in larger than expected blur and low cut-off frequencies
- Used in some applications, such as cardiac cath, where data throughput is restricted at high frame rates

Pixel Binning (1k display)

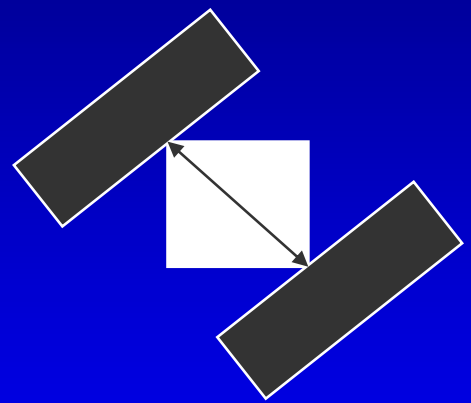
FOV	lp/mm
xlarge	1.7
large	1.7
medium	1.7
small	**3.5**

Sampling Pitch

Size	Matrix	Pixel	Pitch
3 MP	1500x2000	0.24 mm	2 lp/mm
5 MP	2000x2500	0.17 mm	3 lp/mm
9 MP	2700x3300	0.13 mm	3.8 lp/mm

Aliasing

- To reduce aliasing errors with detector and display matrices , place test object at 45^0 to the matrix
- Underestimates cut-off frequency
- Divide observed frequency by sin 45^0 (0.7)



Typical DR Resolution

- 3-5 lp/mm
- Should use magnifying glasses, especially for ~~old~~ senior physicists, due to visual loss with age

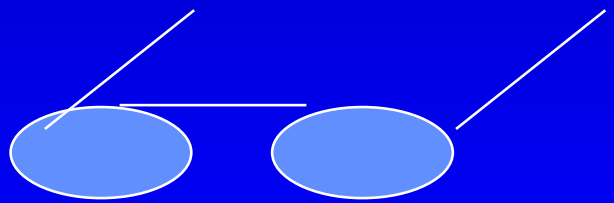
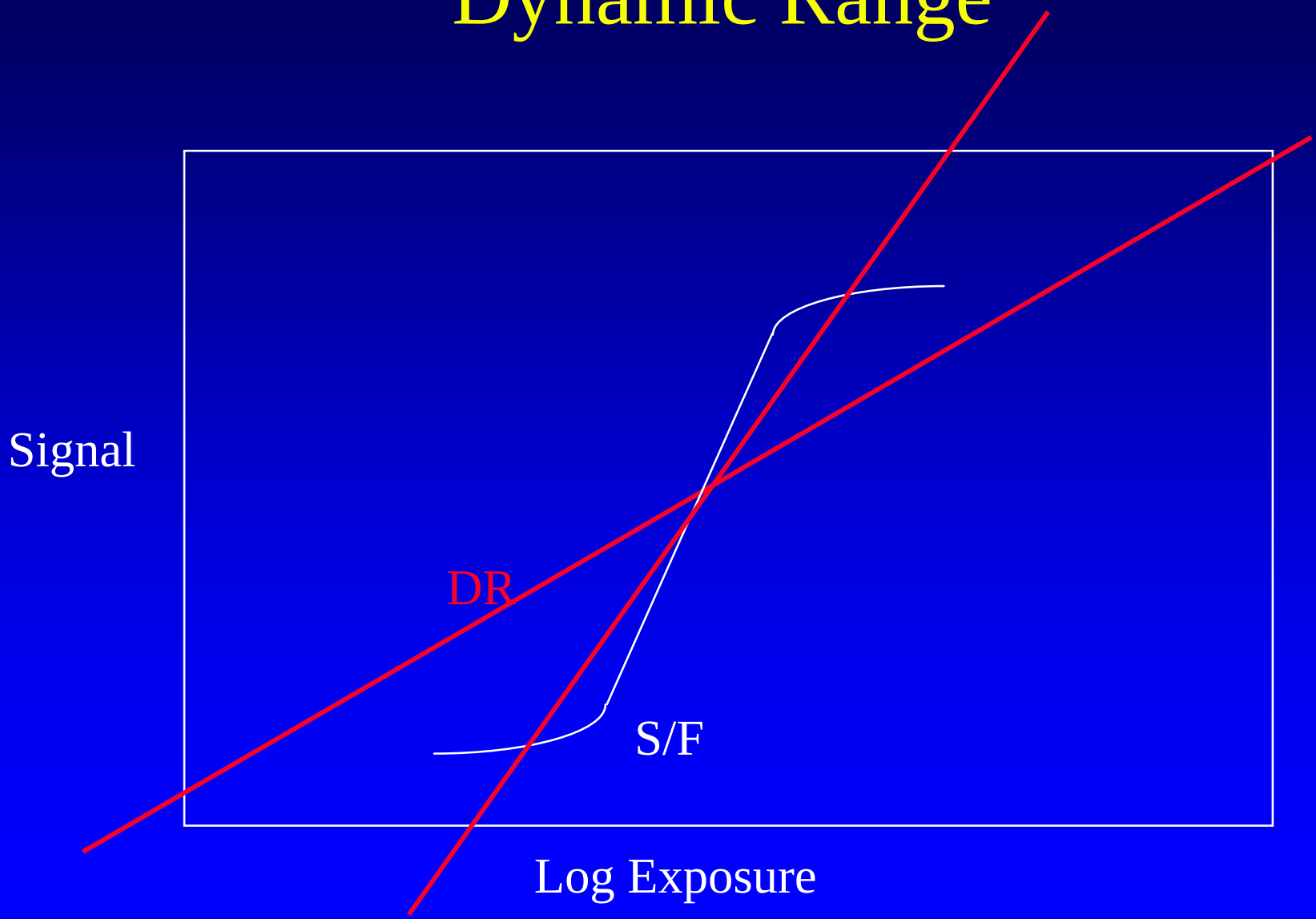


Image Contrast

- Contrast sensitivity and resolution is much better for DR systems than screen/film systems

- Image should be viewed at a greater distance than for detail review.

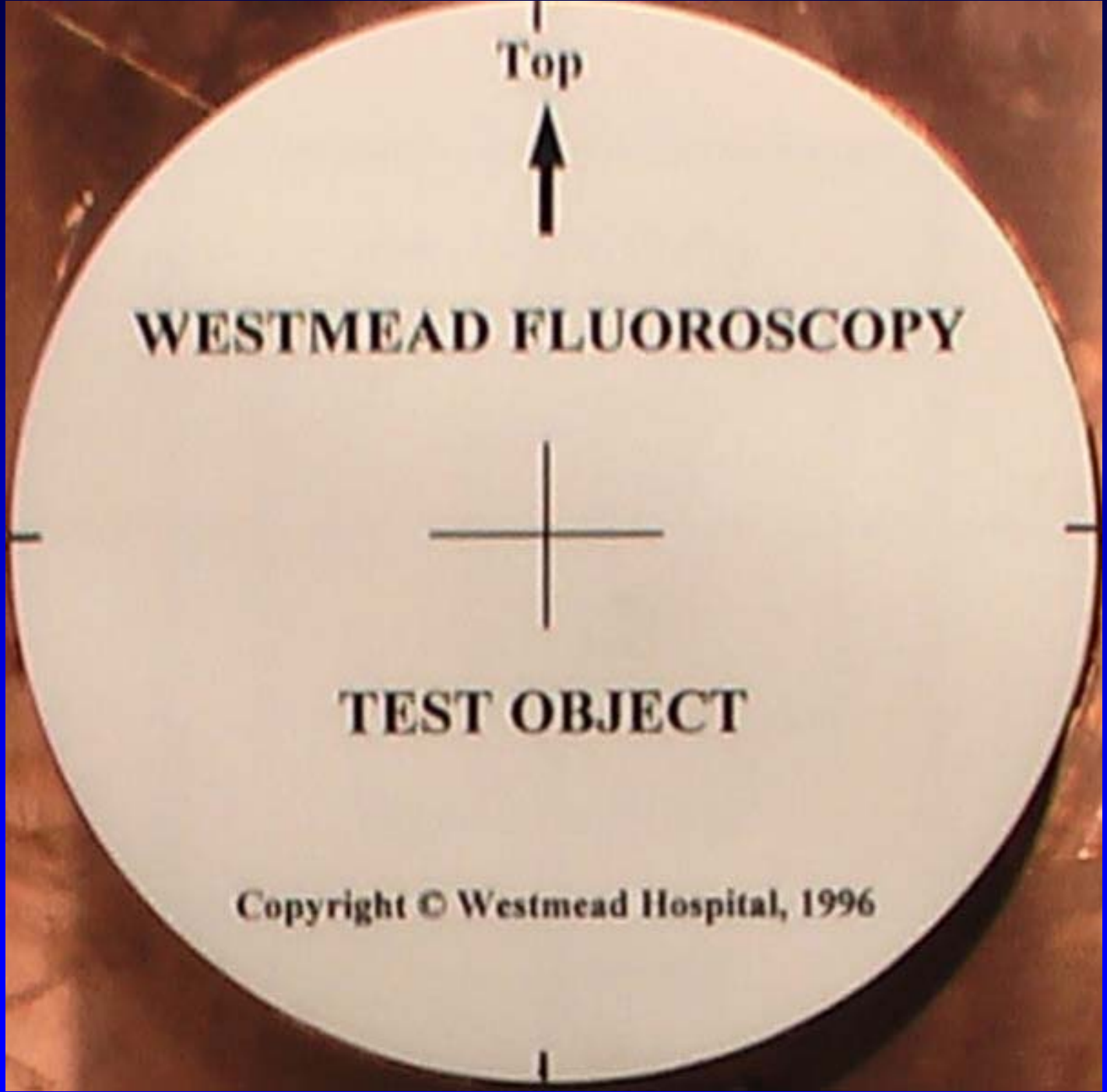
Dynamic Range

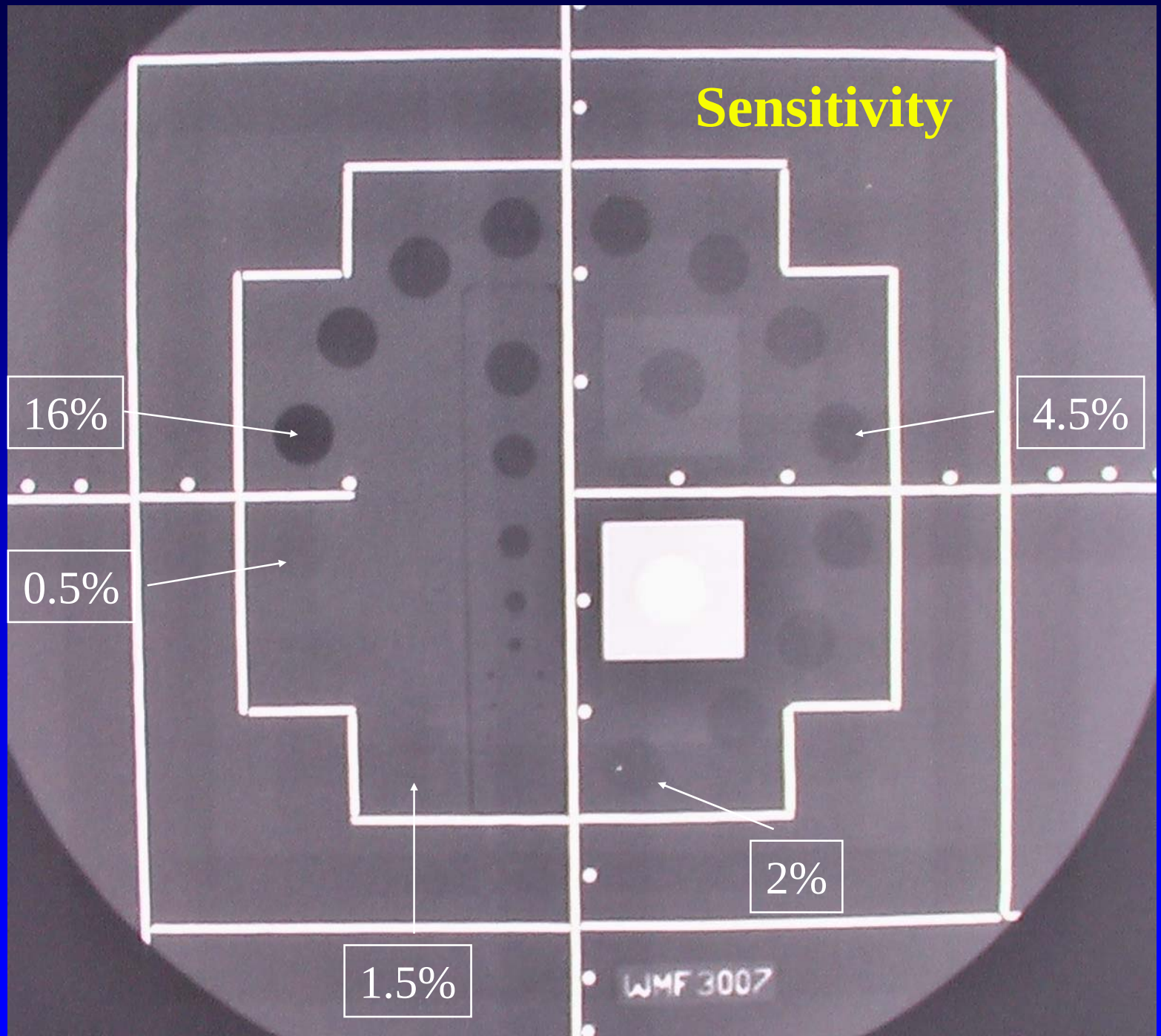


Contrast Sensitivity

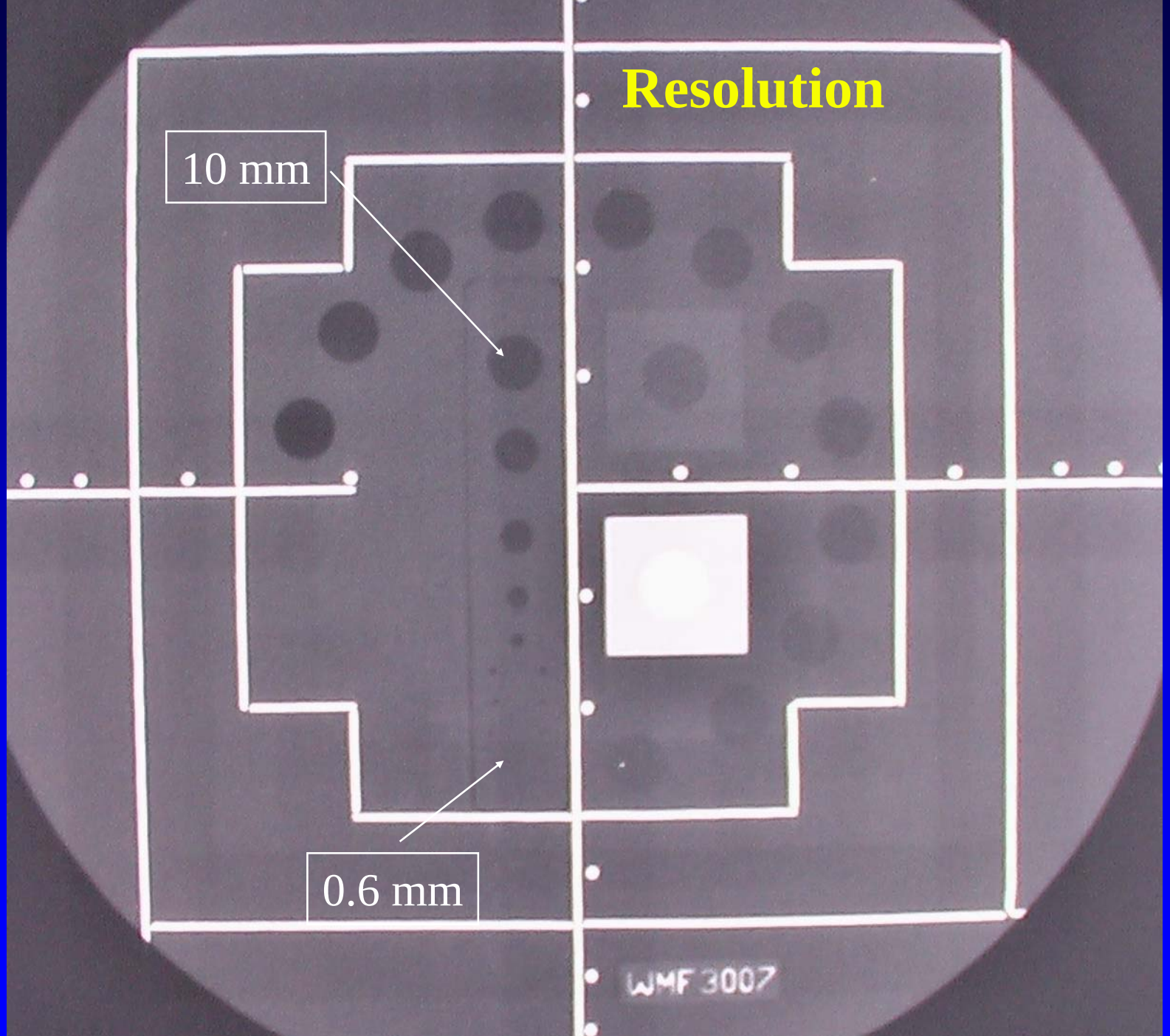
- Test tools commonly available to determine cutoff contrast level (%) and size

- Typical contrast = < 1%


Top
WESTMEAD FLUOROSCOPY
TEST OBJECT
Copyright © Westmead Hospital, 1996


Sensitivity
16%
4.5%
0.5%
2%
1.5%
WMF 3007

Resolution



Detector Radiation Sensitivity

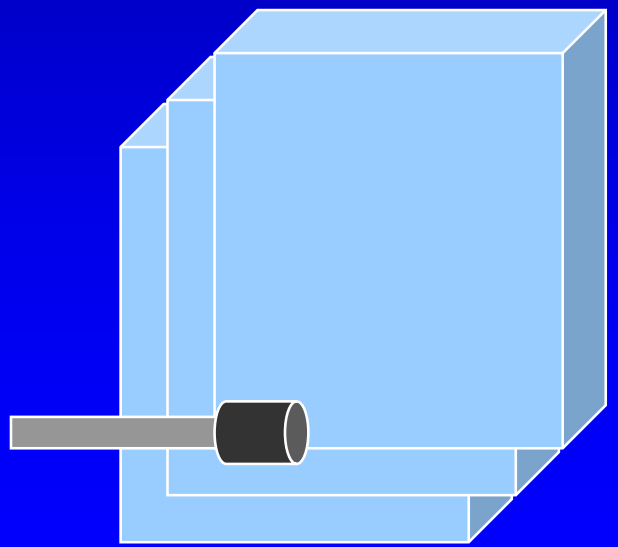
- Measure radiation to the detector, required to produce acceptable image

- Clinical medical physicists need to know what the **patient** entrance radiation exposures are, for exposure control, organ dose calculations and fetal dose estimates

AEC Calibration

- To assess routine patient exposure, the ESE from AEC should be assessed with 4-10 inches of PMMA
- The kVp should be appropriate for the thickness
- We have found that for patient ESE:

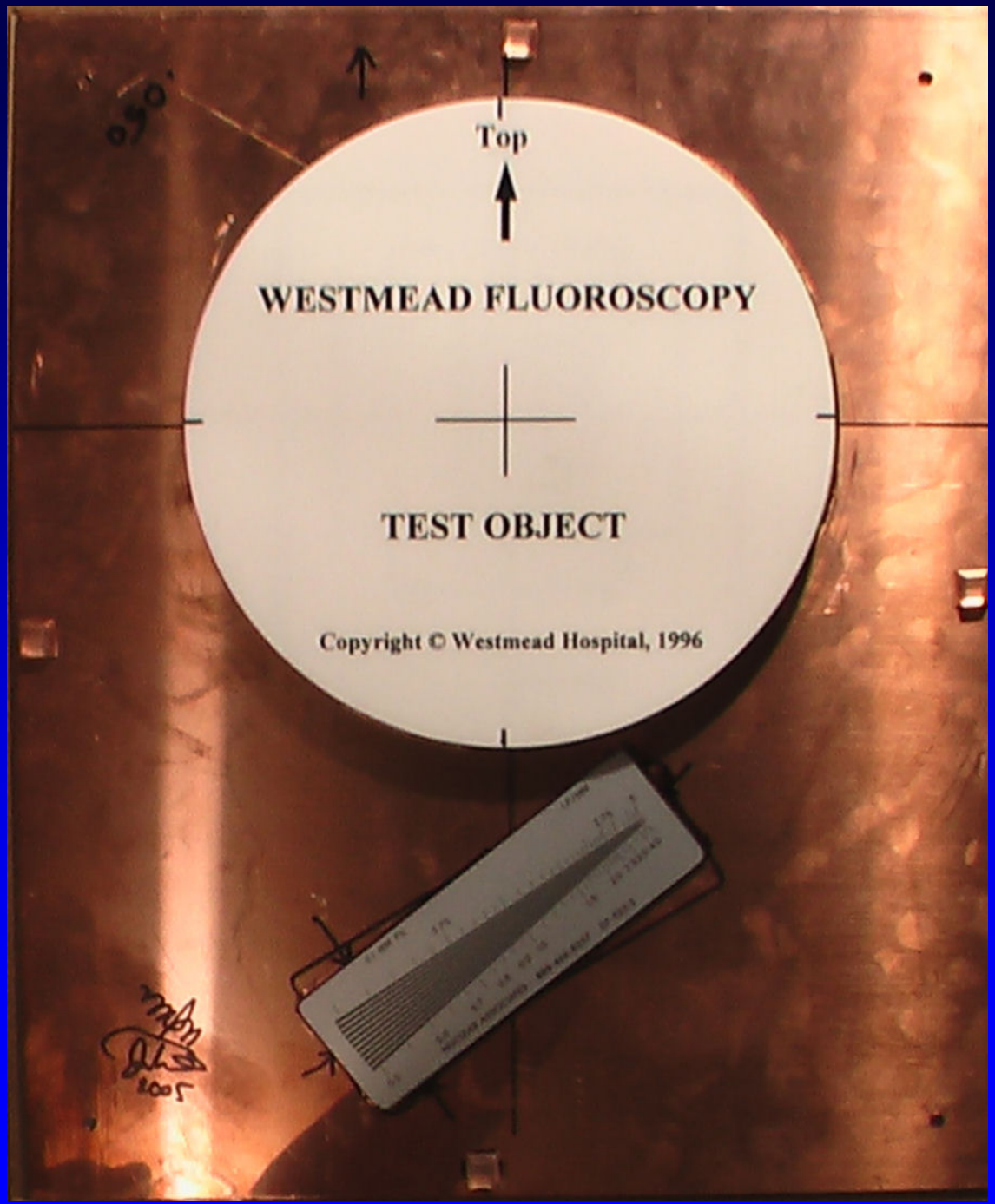
  CR 2x > Screen/film 2x > DR



My Image Quality Phantom

- With readily available test tools, a combo phantom can be built to provide quick evaluation of detail and contrast.

- Considerable cost savings to other phantoms…


Top
WESTMEAD FLUOROSCOPY
TEST OBJECT
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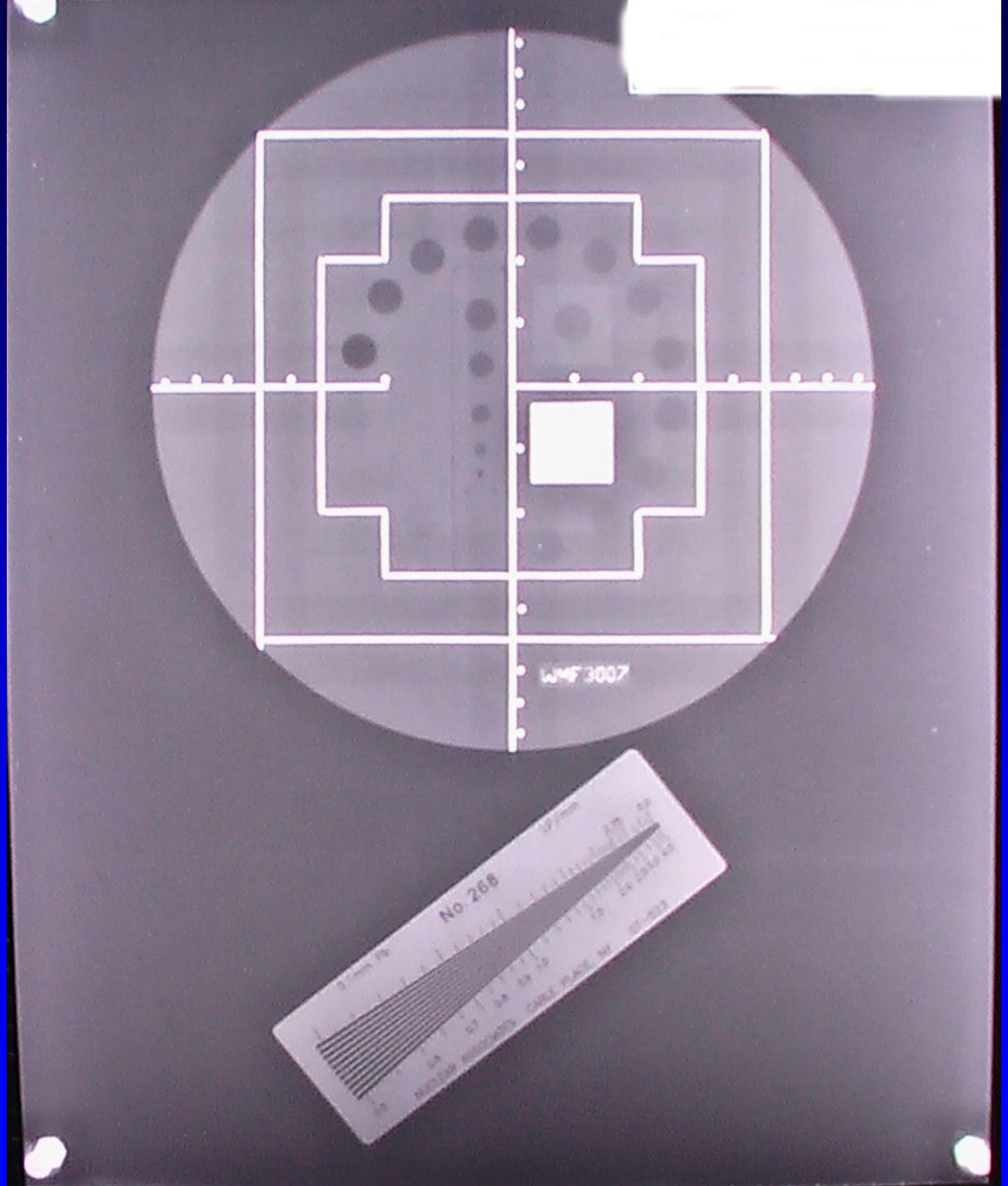
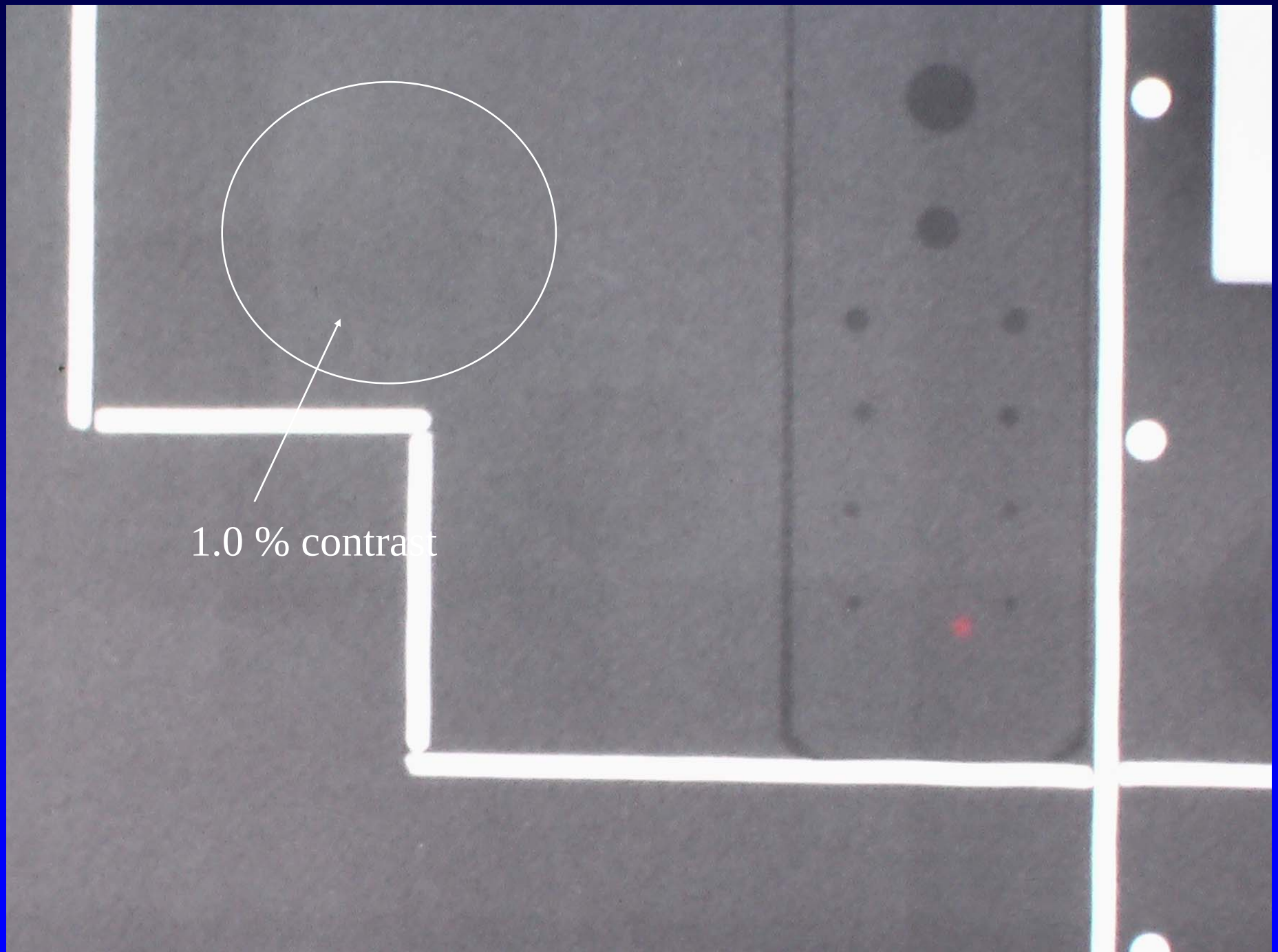
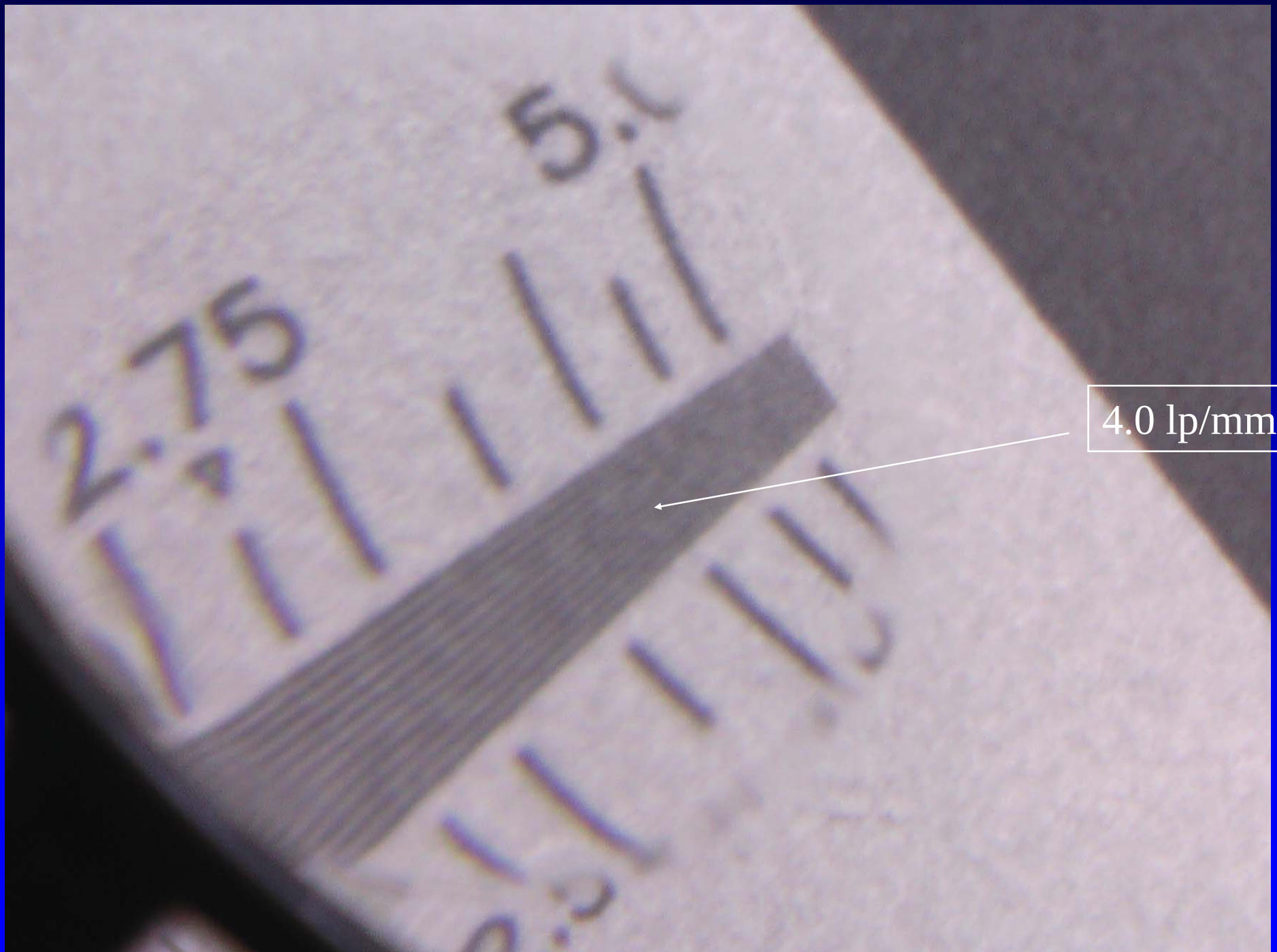

WMF 3007
No. 268


1.0 % contrast


LP/mm
5.0
2.75
4.0
3.0
2.5
2.0
1.5
07-523
NY


2.75
5.1
4.0 lp/mm

“Name That Phantom”

- D.R.I.Q.
- D.R.I.P.
- The TESTOOL
- M.I.Q.P.
- P.E.D.R.O.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