



**The Abdus Salam  
International Centre for Theoretical Physics**



**2166-Handout**

**College on Medical Physics. Digital Imaging Science and Technology to  
Enhance Healthcare in the Developing Countries**

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**Image Quality Assessment in X-ray Fluoroscopic System Practical QC**

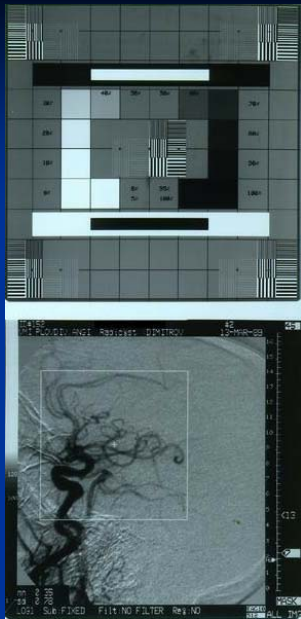
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# IMAGE QUALITY ASSESSMENT IN X-RAY FLUOROSCOPIC SYSTEMS - PRACTICAL QC

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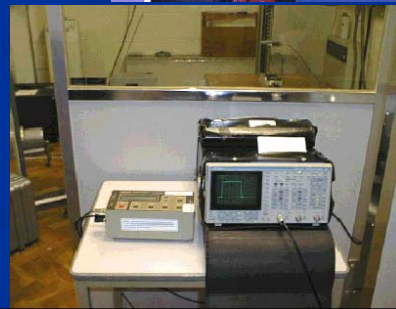


## OBJECTIVES

- Principles of Fluoroscopic Quality Control (QC)
- QC equipment and test objects
- AEC and patient dose assessment
- Scattered radiation assessment
- Assessment of contrast scale and image geometry
- Assessment of image noise and contrast resolution
- Spatial resolution
- Influence of window parameters
- Assessment of homogeneity
- Main problems in image quality

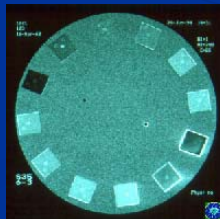
## Main steps for a QC survey in Diagnostic Radiology

- General X-ray tube & generator assessment
- Image quality assessment
- Specific parameters assessment
- Quality Control protocols



## QC equipment for Fluoroscopy

- Dosimeter - dose rate - (flat ion. chamber)
- Image quality test objects (at least for contrast scale, limiting spatial resolution, II field size and contrast delectability)
- Attenuators (at least 1mm Cu)
- Special test objects for Digital Fluoroscopy
- (Oscilloscope)



## Automatic Brightness Control (ABC/ABS)

- Check fluoroscopy timer-guard (2 min.)
- Measure the maximum dose delivered
- Measure Image Intens. entrance dose with standard beam attenuation (1mm Cu) for all II field sizes (inter-equip. comparison)

II field size cm	Read kV	Read mA	Dose rate (1mm Cu)	
			(mR/min)	(mGy/s)
30	75	0.9	10.9	0.0016
23	75	2.4	24.8	0.0036
17	75	4.2	40.2	0.0058

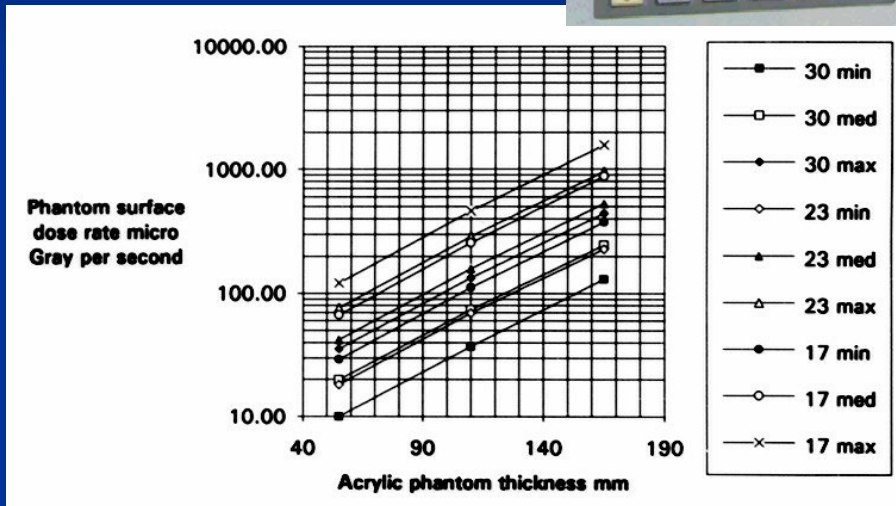


## ABC - skin entrance dose

- Test all II field sizes (cm) and dose settings (patient thick.) with various attenuation (perspex ~ 50-200mm)
- Maximal patient skin entrance dose should not exceed 100 mGy/min
- II entrance dose measured together with the skin entrance dose (separately from 1mm Cu)

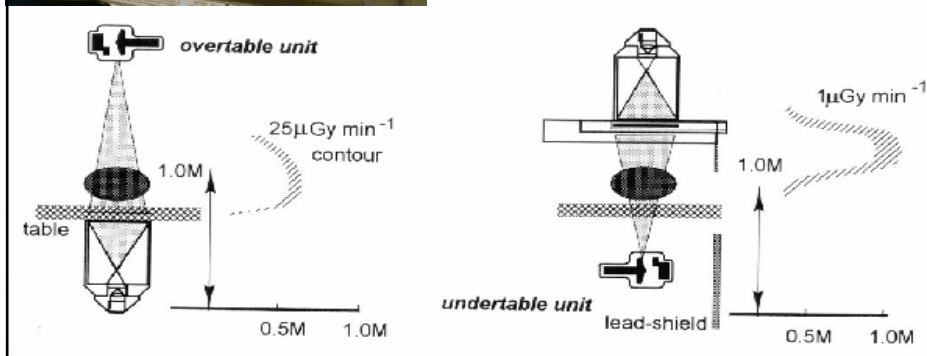
Field size cm	Read kV	Read mA	Phantom thick' mm	I.I. entrance dose		Phantom surf' dose	
				(mR/min)	(mGy/s)	(mR/min)	(mGy/min)
30	75	0.3	55	29.9	0.004	264	2.27
	75	1.4	110	43.3	0.006	1010	8.69
	75	5.6	165	68.5	0.010	3880	33.37

Typical phantom surface (patient entrance) doses -  $\mu\text{Gy}/\text{sec}$  during fluoroscopy with ABC



### Scatter radiation in fluoroscopy

when the II is above the patient table the scatter radiation to staff is lower



## Image quality assessment

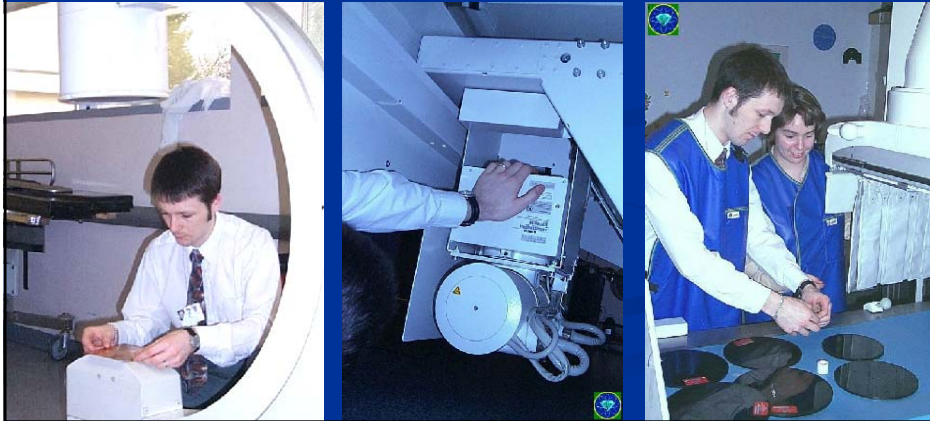
- Contrast scale
- Image uniformity and distortion
- Spatial (high contrast) resolution
- Noise (and Video signal)
- Contrast (low contrast) resolution
- Overall Image Quality (Contrast/Detail Diagr.)
- IQ dependence of “window” and matrix
- IQ dependence of reconstruction/frame rate
- IQ dependence of image processing (F,Sub)
- Artefacts

## Fluoroscopic image quality assessment:

- Subjective assessment (eyes condition)
- Attenuate the X-ray output (1mm Cu)
- Check all II field sizes with all test objects
- Adjust TV monitor (contrast/brightness)
- II visible field  
size/distortions/homogeneity
- II noise, contrast resolution  
(contrast/detail)
- II lim.spatial resolution (*no attenuation*)
- (Video signal)

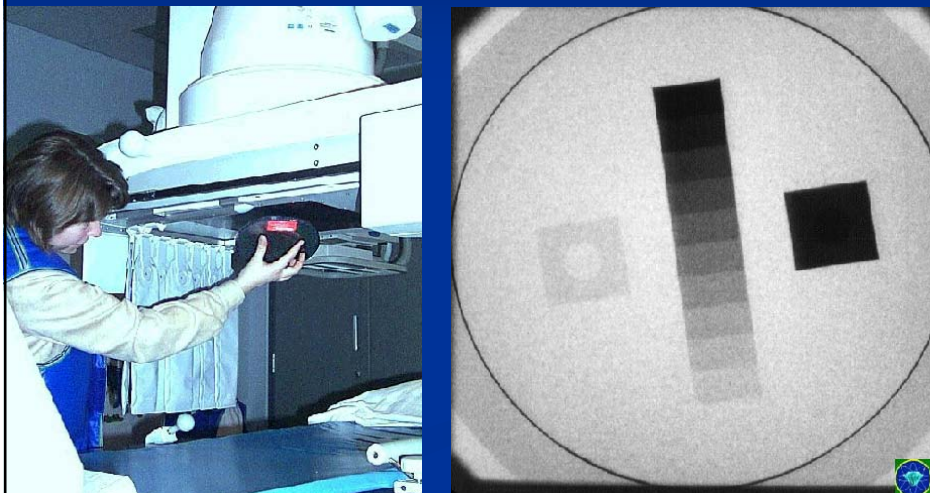


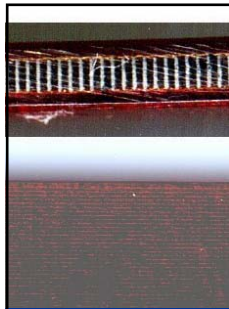
- Attenuating the X-ray tube output with 1mm Cu filter
- Selecting appropriate Test Objects (TO)
- Normally performed by two physicists



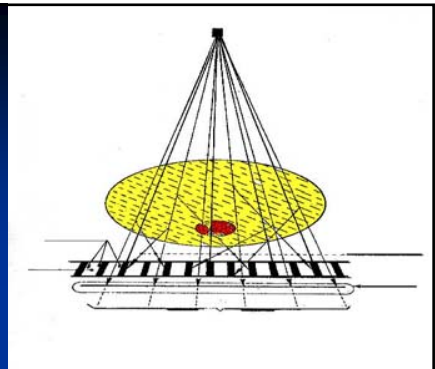
### **Assessment of Contrast Scale (TV monitor adjustment)**

All test objects should be placed at the front of the II  
(the presence/absence of the anti-scatter grid must be noted in the QC protocol)





Scattered radiation and anti-scatter grid



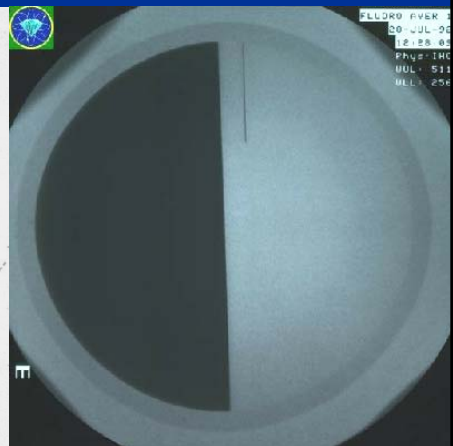
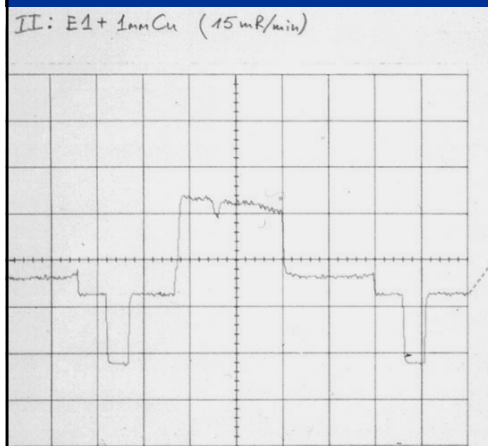
With anti-scatter grid

Without anti-scatter grid



### Assessment of Sensitivity of the Imaging system (video signal assessment)

- use of a TV line selector is recommended
- do not measure the TV monitor input when assessing digital fluoroscopic systems

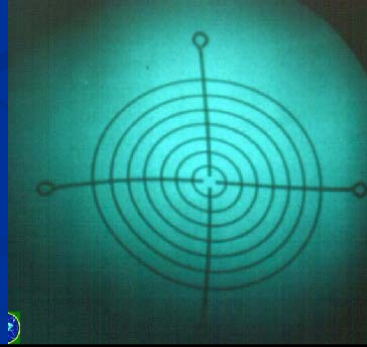
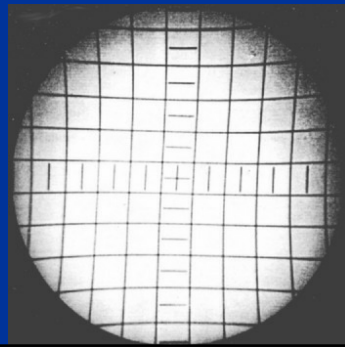


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PRUF: 040  
MUL: 511  
MILL: 250



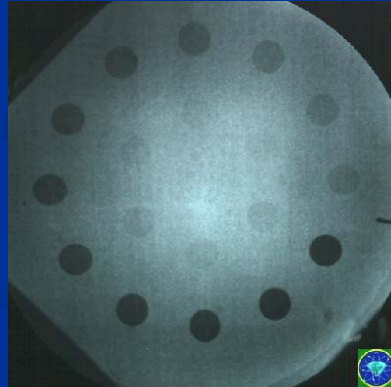
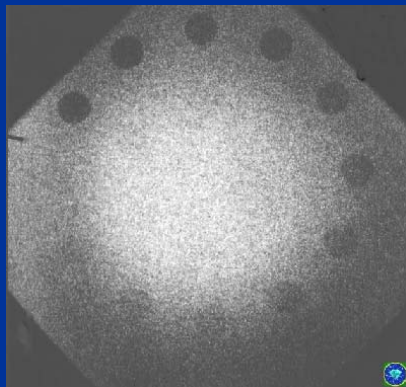
### Assessment of Image Geometry and Sizing

- measuring of all II field sizes (horiz. and vert.)
- assessment of image distortion



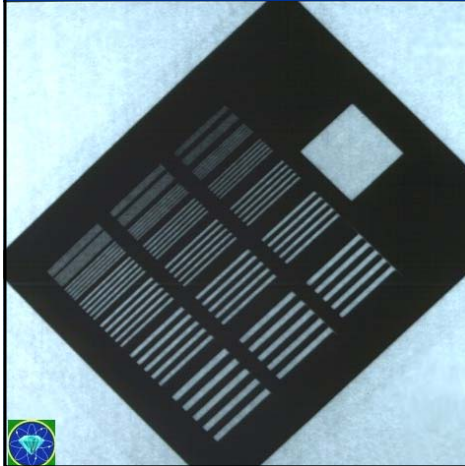
### Assessment of Image Noise

- for all II field sizes
- proper adjustment of “Window” (and record of WW, WC !) is essential in digital fluoroscopy
- record the kV/mA displayed for all image quality tests!



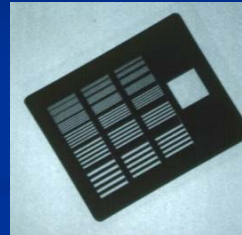
## Assessment of Limiting Spatial Resolution (Unsharpness) **!! REMOVE the 1mm Cu filter !!**

- for all II field sizes
- proper adjustment of "Window" (and record of WW, WL!) is essential in digital fluoroscopy



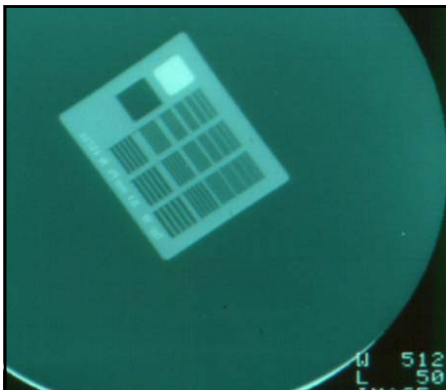
### Analogue:

Place the test object at 45° to TV raster!



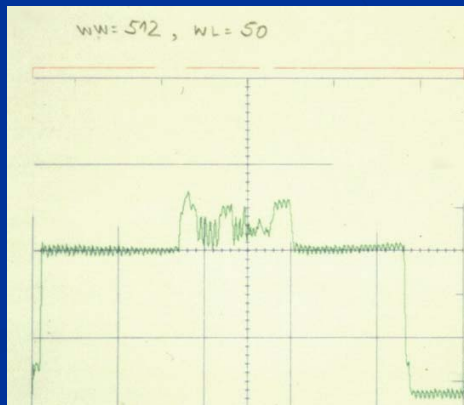
### Digital:

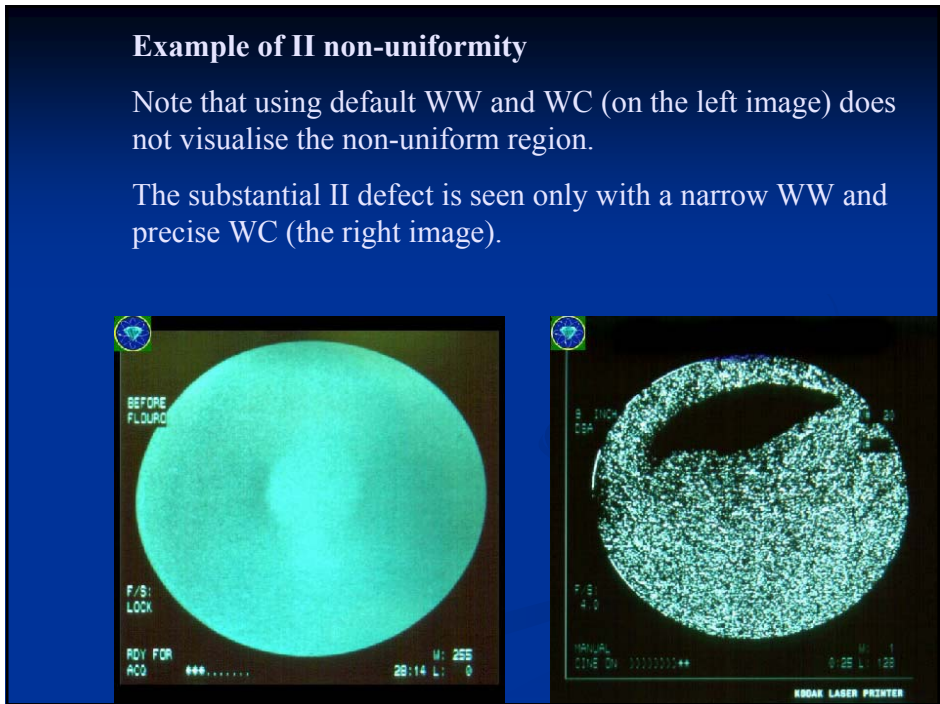
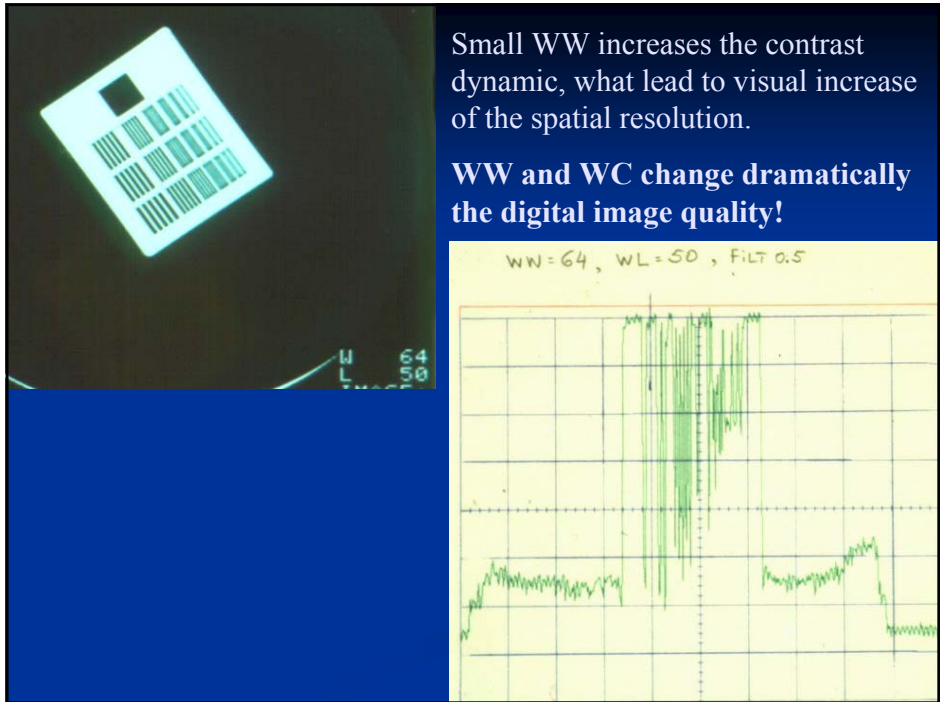
Angle not of importance (usually X, Y)



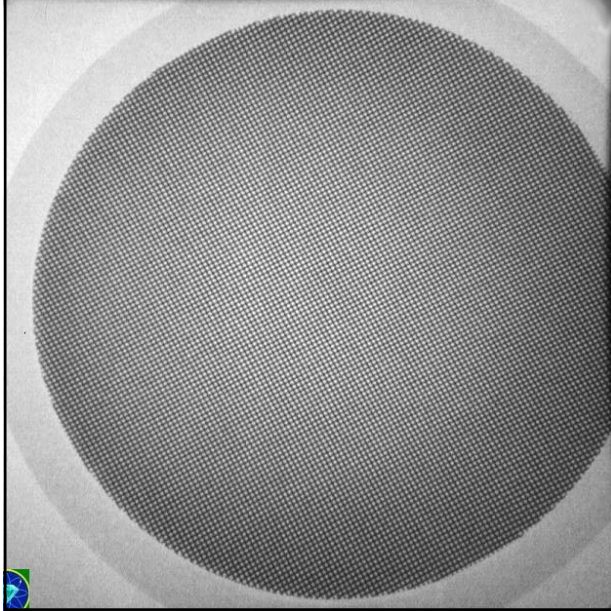
## WINDOW PARAMETERS IN DIGITAL FLUOROSCOPY

WW changes the image contrast - its amplitude is well seen from the video signal of the displayed image.

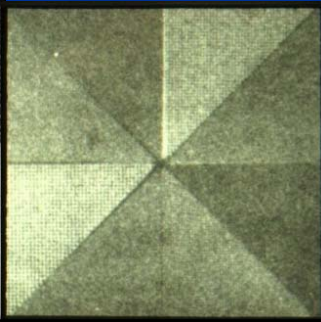




### Assessment of II uniformity (non-uniformity)



The Mesh “uniformity” test objects can also be used for assessment of spatial resolution.

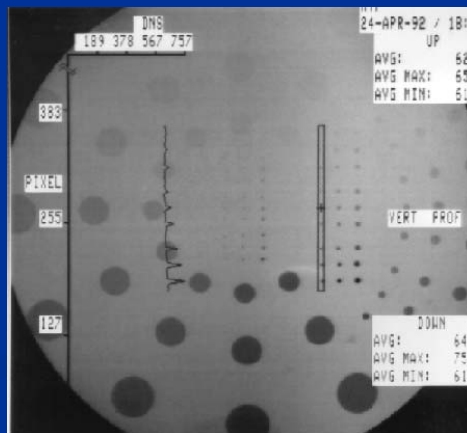
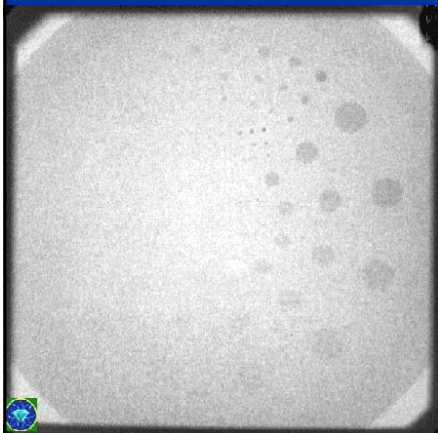


### Overall Image Quality Assessment (Contrast Resolution)

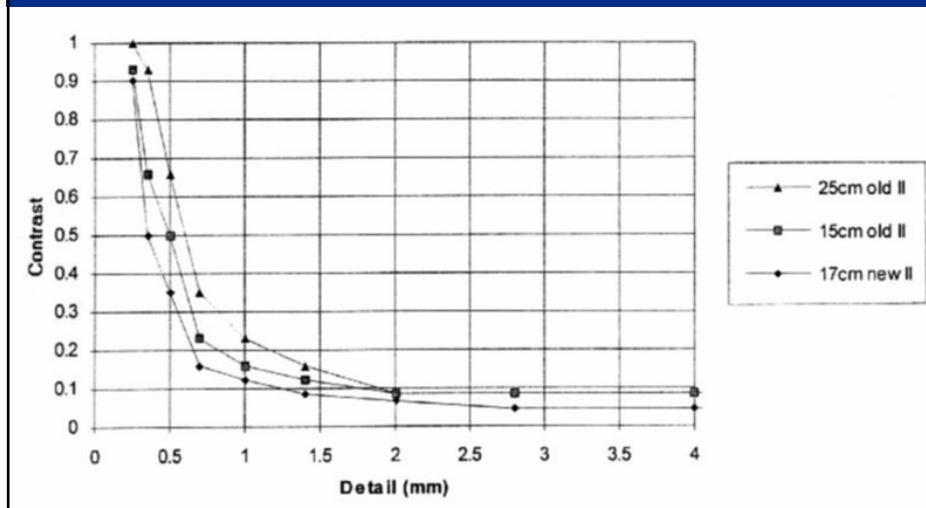
**!! WITH 1mm Cu filter !!**

- for all II field sizes

- proper adjustment of “Window” (and record of WW, WC !) is essential in digital fluoroscopy

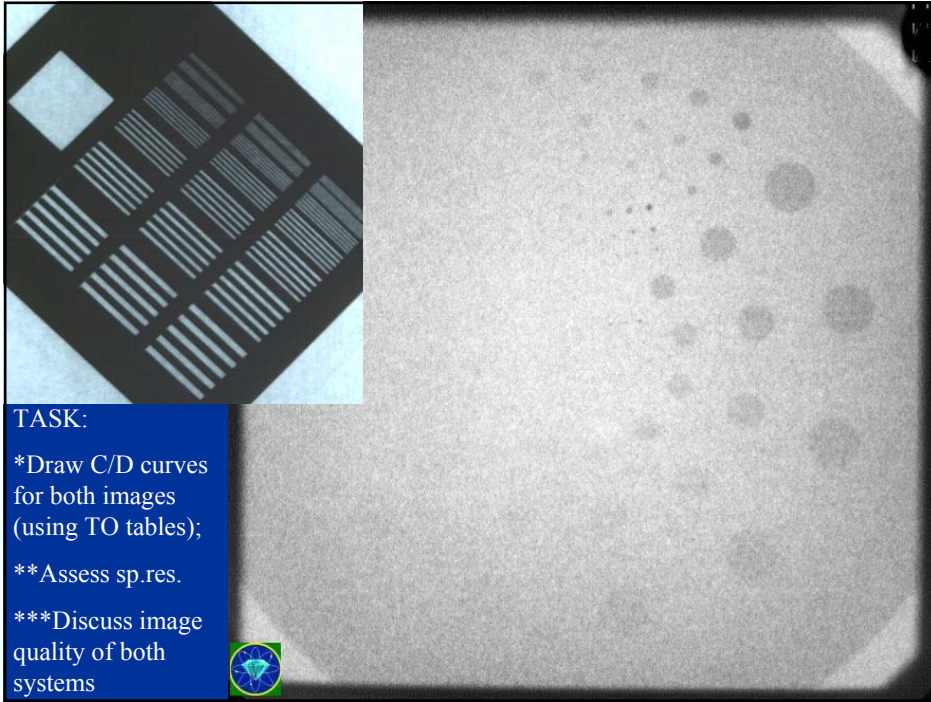


Typical Contrast/Detail diagram for the *Leeds TO 10* phantom for various II filed sizes (old and new II)

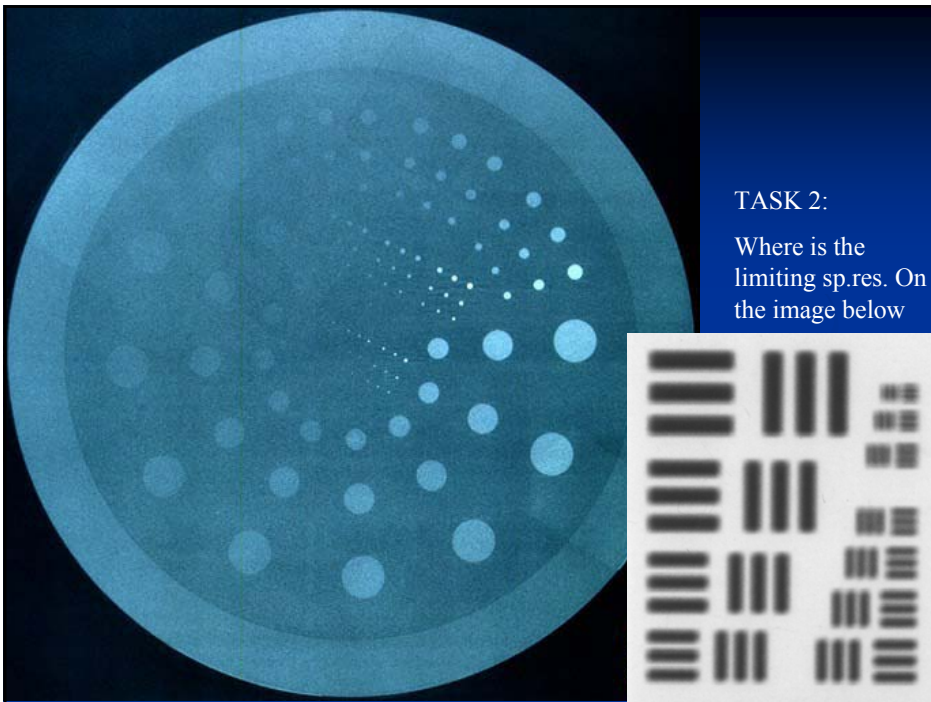


## Fluoro digital image quality assessment

- Objective/subjective assessment
- Perform set-up/calibration of imaging chain
- Record the Window parameters for each measurement (width/centre ; contr/bright)
- Record image processing parameters used (filters, matrix, masks, subtract., frame rate)
- Use the built-in measuring functions and densoprofile
- Special (quantitative) functions
- Other specific parameters (Grey level/Dose, etc)



TASK:  
\*Draw C/D curves for both images (using TO tables);  
\*\* Assess sp.res.  
\*\*\* Discuss image quality of both systems



TASK 2:  
Where is the limiting sp.res. On the image below