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)

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

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)

<table>
<thead>
<tr>
<th>Field size cm</th>
<th>Read kV</th>
<th>Read mA</th>
<th>Phantom thick mm</th>
<th>I.I. entrance dose (mR/min)</th>
<th>Phantom surf dose (mR/min)</th>
<th>Phantom surf dose (mGy/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>75</td>
<td>0.3</td>
<td>55</td>
<td>29.9</td>
<td>0.004</td>
<td>264</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>1.4</td>
<td>110</td>
<td>43.3</td>
<td>0.006</td>
<td>1010</td>
<td>8.69</td>
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<td>75</td>
<td>5.6</td>
<td>166</td>
<td>68.5</td>
<td>0.010</td>
<td>3880</td>
<td>33.37</td>
</tr>
</tbody>
</table>
Typical phantom surface (patient entrance) doses - $\mu$Gy/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)
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
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, WC !) 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.
Small WW increases the contrast dynamic, what lead to visual increase of the spatial resolution.

**WW and WC change dramatically the digital image quality!**

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**Example of II non-uniformity**

Note that using default WW and WC (on the left image) does not visualise the non-uniform region.

The substantial II defect is seen only with a narrow WW and precise WC (the right 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