



SVENSK FÖRENING FÖR RADIOFYSIK
Swedish Society of Radiation Physics
(Member of IUPESM)

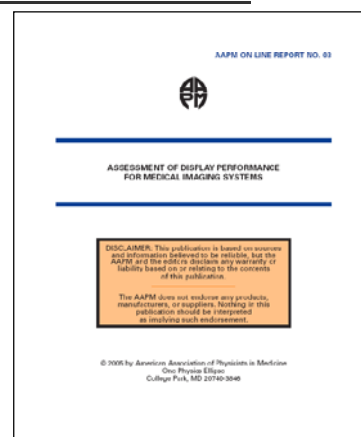
Quality control of displays and image transfer

2007-05-10

Patrik Sund
Markus Håkansson

AAPM TG18

- Extensive guidelines for medical images (154 p)
- Does not cover image transfer, only displays.



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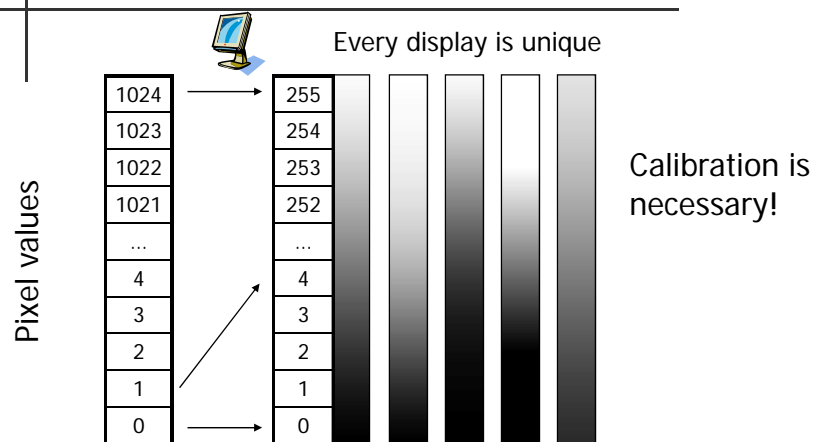
- Displays
 - Display QA
 - Display system QA
 - Ambient lighting
 - Photometers
- Image transfer
 - W/L, VOI LUT
 - Distance measurements



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Patrik Sund
Markus Håkansson

Image display



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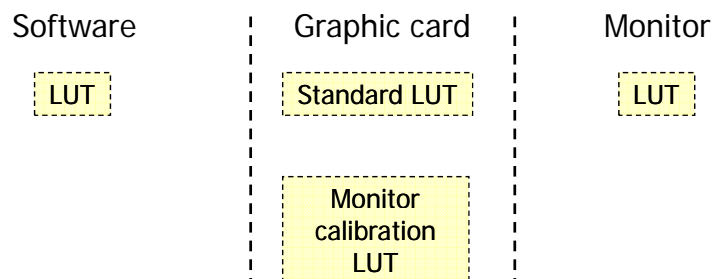
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Display QA

- Display types
 - Primary interpretation
 - Quality control
 - Modality
 - For home use
- Instructions
 - Description
 - Luminance range
 - Control frequency
 - Method

Display system QA

- Clinically used software \neq display calibration software

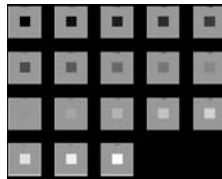


Necessary after software/hardware upgrades.

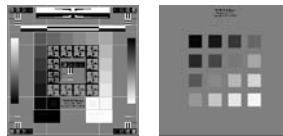
Display system QA

The only way to verify a calibration is by displaying test images using **the same software** as will be used for medical images.

Suitable test images are:
 TG18-LN12-01 to -18
 (requires measurements)



TG18-QC or TG-18-CT
 (visual inspection)



Ambient lighting

- Avoid all specular reflections
- Maximum allowed variation in illuminance
 (for max 10% loss of contrast)

| L_{min} | R_d | | | |
|-----------|-------|-------|-------|-------|
| | 0.005 | 0.010 | 0.020 | 0.040 |
| 0.5 | 23 | 11 | 6 | 3 |
| 1.0 | 38 | 19 | 9 | 5 |
| 2.0 | 62 | 31 | 16 | 8 |
| 3.0 | 91 | 46 | 23 | 11 |
| 4.0 | 126 | 63 | 31 | 16 |
| 5.0 | 163 | 81 | 41 | 20 |
| 10.0 | 354 | 177 | 89 | 44 |
| 20.0 | 632 | 316 | 158 | 79 |

Photometers

Near-range

- Attached to front surface
- Blocks ambient light
- Usually wide aperture angle



Telescopic

- Operates at a distance
- Includes ambient light
- Usually narrow aperture angle ($\sim 1^\circ$)



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Photometers

Internal

- Can be used for QA tasks or full calibrations
- Usually not as accurate as external photometers.
- Photometers inside an LCD have to estimate the ageing of LCD panel.
- Photometers permanently attached to the front surface blocks part of the visible area, usually a corner – not really representative of the rest of the surface.
- How is ambient light level estimated?



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Markus Håkansson

Light measurement geometry

lambertian emission

Non-lambertian emission

A photometer with a wide aperture angle will only give correct values when angular light distribution is the same as when calibrated.

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Markus Håkansson

Light measurement geometry

lambertian emission

Non-lambertian emission

A photometer with a narrow aperture angle will only measure light in a given direction.

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Markus Håkansson

Light measurement geometry

Lambertian emission

Non-lambertian emission


Luminance measured on a lambertian surface is independent of incident angle.
Luminance measured on non-lambertian surfaces will vary with incident angle.

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Patrik Sund
Markus Håkansson

Image gray-scale Image measurements

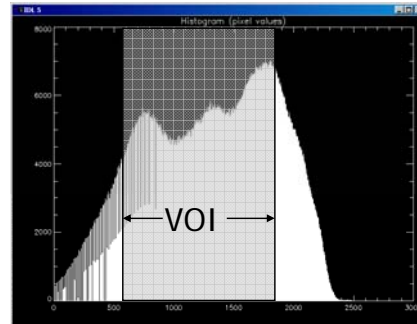
- Gray-scale rendition is determined by window/level or VOI LUT values.
Multiple values?
- Distance and area measurements are based on pixel size.
Which pixel size?
- **How is your PACS configured?**

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Patrik Sund
Markus Håkansson

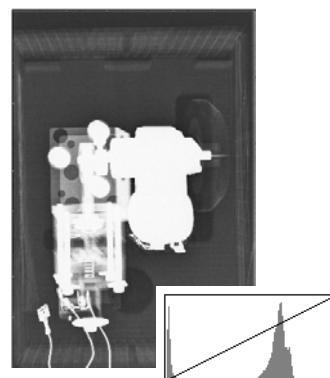
VOI LUT

- VOI = Value of Interest
- WL,
(0028,1050)
- WW,
(0028,1051)
- VOI LUT Sequence
(0028,3010)



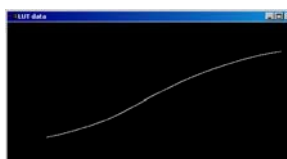
WW/WL

- All image processing and non linear look up tables are burned into image data
- Preferable for soft copy viewing
- DICOM elements for rescale slope and intercept can be sent



VOI LUT Sequence

- LUT Sequence, (0028,3010)
- LUT descriptor, (0028,3002) [570 2500 16]
- LUT explanation, (0028,3003) NK5
- LUT, (0028,3006)

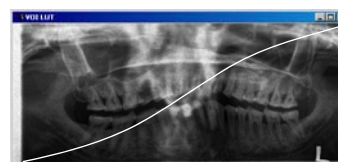
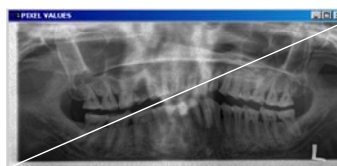


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Patrik Sund
Markus Håkansson

VOI LUT Sequence

- Not ideal for soft copy viewing
- No real time update of LUT data
- WW = number of entries (NOE) in LUT
WL = first value mapped + NOE/2
- Choice of LUT?
- printers



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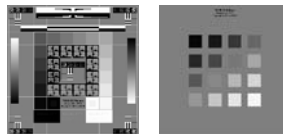
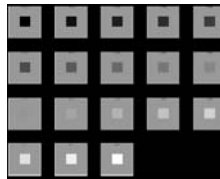
Patrik Sund
Markus Håkansson

From modality to archive

Test images should be available in the modality with the **same DICOM tags** as acquired images.

Suitable test images are:
TG18-LN12-01 to -18
(requires measurements)

TG18-QC or TG-18-CT
(visual inspection)



Pixel spacing I

- (0018,1164): Imager Pixel Spacing

(DICOM, part 3, 2007, Page 378)

Mandatory!

Physical distance measured at the front plane of the Image Receptor housing between the centre of each pixel specified by a numeric pair - row spacing value (delimiter) column spacing value in mm. See 10.7.1.3 for further explanation of the value order. The value of this attribute shall never be adjusted to account for correction for the effect of geometric magnification or calibration against an object of known size; Pixel Spacing (0028,0030) is specified for that purpose.

Pixel Spacing II

- (0018,7020): Detector Element Physical Size

(DICOM, part 3, 2007, Page 650)

Physical dimensions of each detector element that comprises the detector matrix, in mm. Expressed as row dimension followed by column. Note: This may not be the same as Detector Element Spacing (0018,7022) due to the presence of spacing material between detector elements.



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*Patrik Sund
Markus Håkansson*

Pixel Spacing III

- (0018,7022): Detector Element Spacing

(DICOM, part 3, 2007, Page 650)

Physical distance between the centre of each detector element, specified by a numeric pair - row spacing value (delimiter) column spacing value in mm. See 10.7.1.3 for further explanation of the value order. Note: This may not be the same as the Imager Pixel Spacing (0018,1164), and should not be assumed to describe the stored image.



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*Patrik Sund
Markus Håkansson*

Pixel Spacing IV

- (0028,0030): Pixel Spacing

(DICOM, part 3, 2007, Page 301)

Physical distance in the patient between the centre of each pixel, specified by a numeric pair adjacent row spacing (delimiter) adjacent column spacing in mm. See 10.7.1.1 and 10.7.1.3.



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*Patrik Sund
Markus Håkansson*

Summary

- Displays:
 - Control the ambient lighting
 - Calibrate on a regular basis
 - Verify image software (upgrades) with test images
- Image transfer:
 - "Burn-in" will keep you on the safe side
 - Verify image rendition with test images
- Distance measurements
 - If precision is important, place a ruler in the image.



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Markus Håkansson*