SVENSK FÖRENING FÖR RADIOFYSIK
Swedish Society of Radiation Physics
(Member of IUPESM)
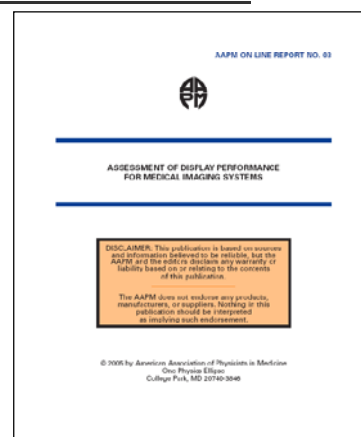
Quality control of displays and image transfer

2007-05-10

Patrik Sund
Markus Håkansson

AAPM TG18

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

AAPM ON LINE REPORT NO. 03

ASSESSMENT OF DISPLAY PERFORMANCE
FOR MEDICAL IMAGING SYSTEMS

DISCLAIMER: This publication is based on sources
and information believed to be reliable, but the
AAPM and the editors disclaim any warranty or
liability based on or relating to the contents
of this publication.

The AAPM does not endorse any products,
manufacturers, or suppliers. Nothing in this
publication should be interpreted
as involving such endorsement.

© 2005 by American Association of Physicists in Medicine
One Physics Ellipse
College Park, MD 20740-3846

SVENSK FÖRENING FÖR RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
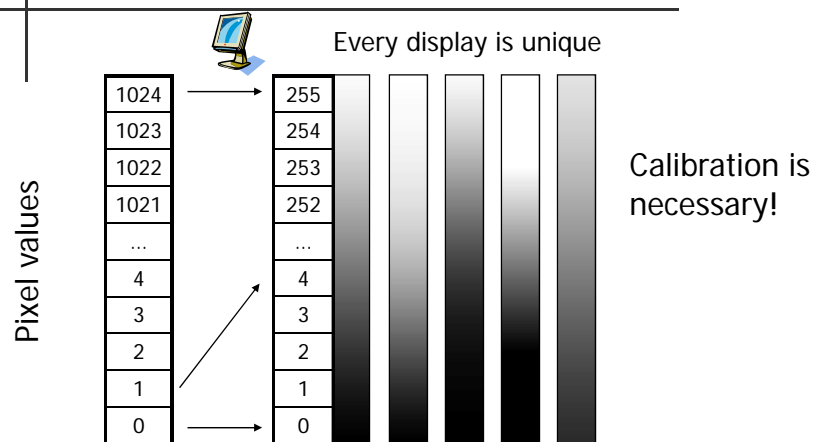*Markus Håkansson*

Contents

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

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson

Image display

Every display is unique

Pixel values

1024	→	255
1023		254
1022		253
1021		252
...		...
4		4
3		3
2		2
1		1
0	→	0

Calibration is necessary!

SVENSK FÖRENING FÖR
RADIOFYSIK
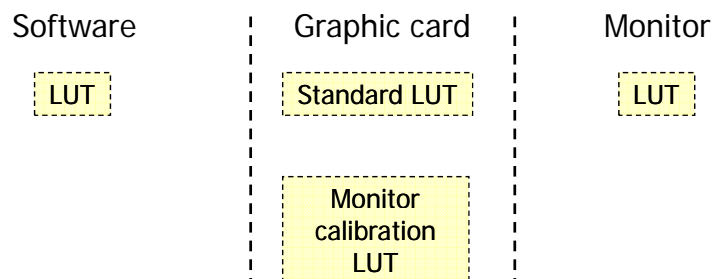Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson

Display QA

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

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson

Display system QA

- Clinically used software ≠ display calibration software

Software	Graphic card	Monitor
LUT	Standard LUT	LUT
	Monitor calibration LUT	

Necessary after software/hardware upgrades.

SVENSK FÖRENING FÖR
RADIOFYSIK
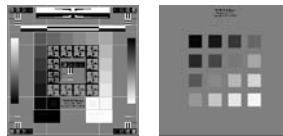Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson

3

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)

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson

Ambient lighting

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

		R_d		
L_{min}	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

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson

Photometers

Near-range	Telescopic
• Attached to front surface	• Operates at a distance
• Blocks ambient light	• Includes ambient light
• Usually wide aperture angle	• Usually narrow aperture angle (~ 1°)

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson

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?

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
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.

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
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.

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
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-labertian surfaces will vary with incident angle.

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson

Image gray-scale
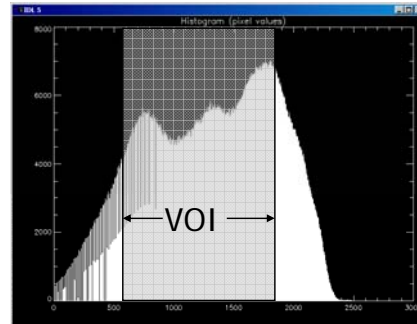# Image measurements

- 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?**

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics
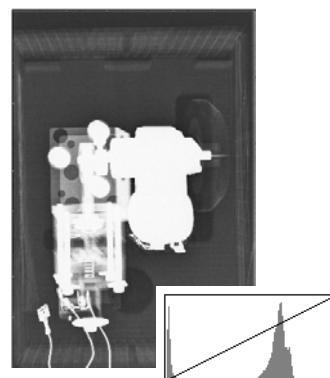
Patrik Sund
Markus Håkansson

VOI LUT

- VOI = Value of Interest

- WL, (0028,1050)
- WW. (0028,1051)

- VOI LUT Sequence (0028,3010)

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics
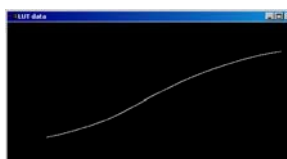
Patrik Sund
Markus Håkansson

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

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson

VOI LUT Sequence

- LUT Sequence,
  (0028,3010)

- LUT descriptor,
  (0028,3002)   [570 2500 16]

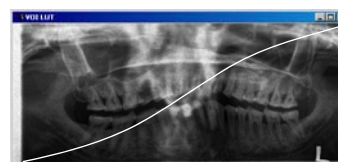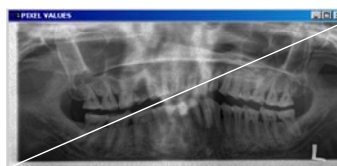- LUT explanation,
  (0028,3003)   NK5

- LUT,
  (0028,3006)

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

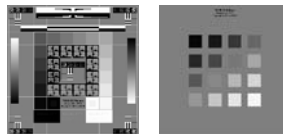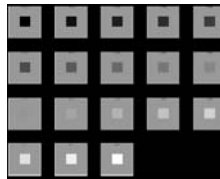- Choice of LUT?

- printers

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)

<div align="right">

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson
</div>

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.

<div align="right">

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson
</div>

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.

SVENSK FÖRENING FÖR RADIOFYSIK
Swedish Society of Radiation Physics

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.

SVENSK FÖRENING FÖR RADIOFYSIK
Swedish Society of Radiation Physics

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.

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

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.

SVENSK FÖRENING FÖR
RADIOFYSIK
Swedish Society of Radiation Physics

Patrik Sund
Markus Håkansson