Goal of this session of MIWG Displays

- Agree upon a visualization architecture that supports

  the different ways that
  color medical images are used

  in clinical practice

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Structure of this session

1. Define the use cases that need to be supported
2. In depth discussion on important architectural choices to be made
3. Coming to conclusion on architecture of the color visualization system

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1. Use cases

1. Use cases - Overview

- Direct representation of greyscale medical images (current practice today)
- Direct representation of medical RGB images without color management (current practice today)
- Representation of medical RGB images with correct color management (*mostly* future practice)

1.1. Use case 1 – Greyscale medical images

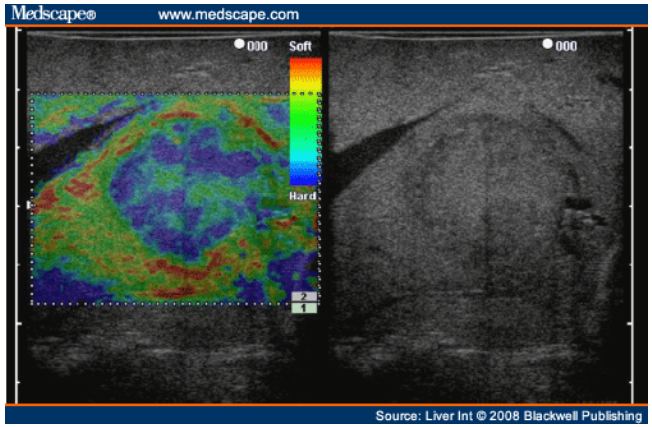
- Eg. Radiological images

- Specifics
  - Applications forward greyscale images to the display and expect the display to be DICOM GSDF compliant with clearly defined tolerance levels
  - Displays have builtin LUTs (12-14 bit) and dynamically change LUTs based on realtime embedded sensor measurements in order to meet DICOM GSDF compliance
  - Frequent use of “window level”
  - Most important for these images: “detection of subtle signals”

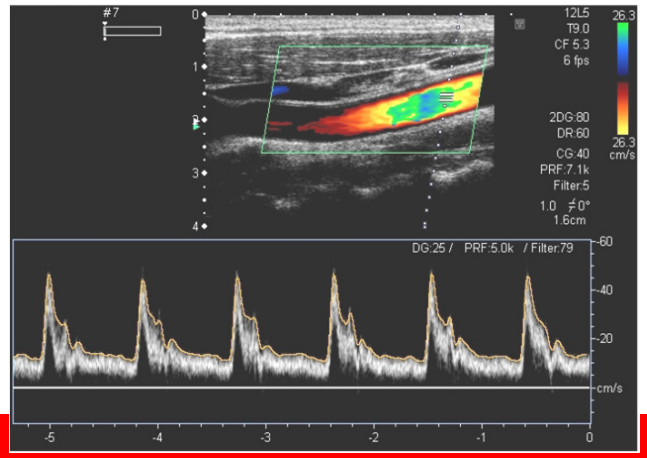
1.2. Use case 2: direct representation of medical RGB images (1)

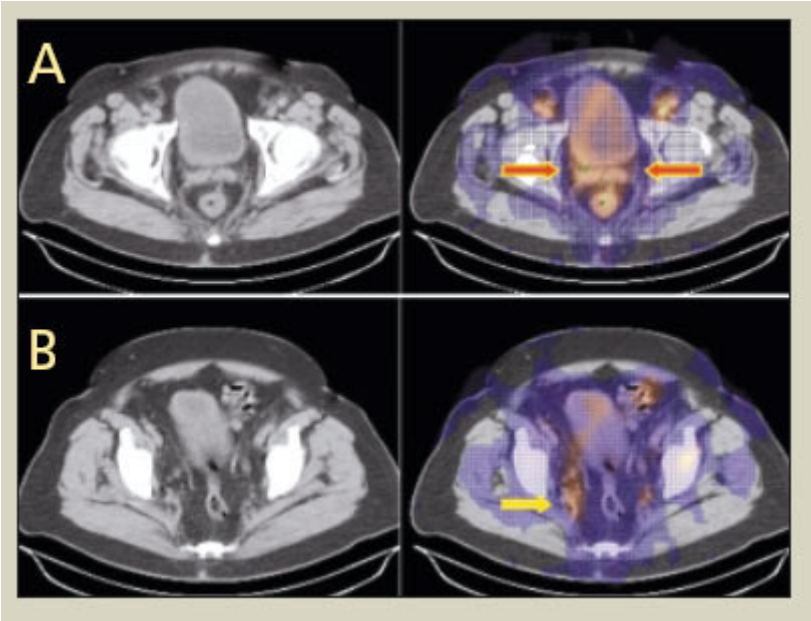
- Eg. Quantitative imaging applications, biomarkers, nuclear medicine, multimodality imaging

Source: www.medscape.com



Source: http://www.intechopen.com/books/design-and-architectures-for-digital-signal-processing/progress-of-doppler-ultrasound-system-design-and-architecture





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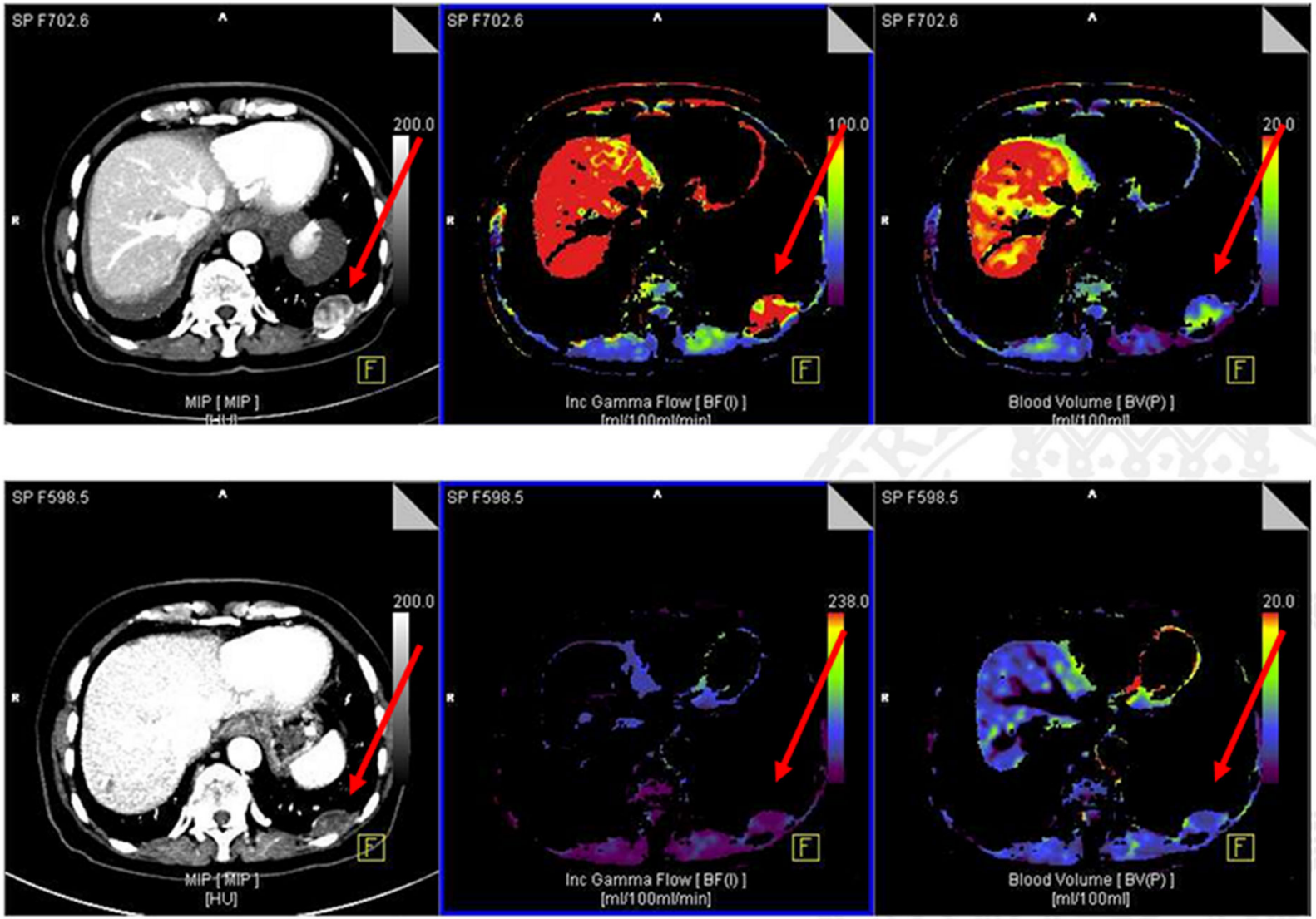

Source: http://health.siemens.com/ct_applications/somatomsessions/index.php/research-clusters-enable-transfer-of-basic-research-to-clinical-routine/

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1.2. Use case 2: direct representation of medical RGB images

- Specifics:
  - The vaste majority of medical viewing applications today do not have color management and just forward color RGB data to the display
  - Some applications implicitly “assume” sRGB behavior
  - Colour typically is artificial and represents either relative or calculated values
  - Tasks to be performed are typically either “detection tasks” or “quantification tasks”, which means that it is important to “detect subtle things” or to “determine from the image what the underlying value is”

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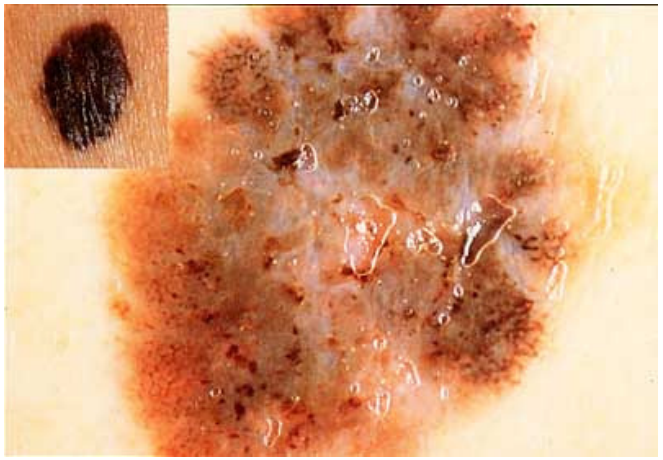
1.3. Use case 3: representation of medical RGB images with color management (1)

- Eg. Medical photography / dermatology



Source: http://www.medilor.be/catalogue/dermatoscope.htm

- Specifics:
  - Absolute correct color is important
  - Applications use typically ICC framework to achieve this

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1.3. Use case 3: representation of medical RGB images with color management (2)

- Very important note:
  - Of course it is possible to build visualization software that correctly uses a Color Management System (use case 3) and that is used for visualization of content that was described in use case 1 and 2. But that is not current practice today and therefore we also need to support use cases 1 and 2.
  - Ideally, over time (but this will take many years), use case 1 & 2 will be replaced by use case 3

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- Do we agree that we need to be compatible with the three use cases discussed before?

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2. Components of a medical color display system

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2.1. Components of a color medical display system

- GPU with driver
- QA/Calibration software application
- Viewing application
- Presentation LUT
- (color management framework)

- Displayport: standard 8 bit per color channel and demo implementations today up to 10 bit

- Several LUTs for calibration
- Luminance & color sensors
- Realtime stabilization circuitry
- Postprocessing for Uniformity correction, response time improvement, ...

2.2 Important architectural choices to be made (1)

- Do we agree that DICOM GSDF compliance is a must-have?
- Do we agree that it should be possible to calibrate the display to sRGB as well as to perceptually linear behavior?
- Is it beneficial to define a new ICC rendering intent for 'perceptually linear color behavior'?
- Should mRGB be used to encode color images for applications that do not support color management (use case 2)

- Choice for specific "standard behavior" of the display
  - Eg. GSDF, sRGB, PLCB?
  - Relevant question to be considered: is it easier to achieve sRGB from GSDF/PLCB, or easier to achieve GSDF/PLCB from sRGB?

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2.2 Important architectural choices to be made (2)

- Position of the LUTs for “calibrating the display”
  - Inside the display or inside the GPU?
  - Minimal required bit depth to achieve accurate calibration (for achieving DICOM GSDF, for achieving PLCB, for achieveing absolute correct color behavior)?

- (Application) LUT for window/leveling & color presentation optimization
  - Needed for color application?
  - Position of this LUT? Before or after CMM?

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2.2 Important architectural choices to be made (3)

- Stabilization of the display
  - Handled internally by the display or by an external process?
  - Difference between luminance/color/GSDF stabilization?
  - Relevant to be considered it the influence that real-time behavioral changes of the display has on the entire color management chain (dynamic ICC profiles)

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What can we learn from greyscale medical displays?

- High bit depth is needed for accurate greyscale DICOM GSDF calibration (12 bits or more)
- Calculating GSDF calibration LUT requires knowledge on absolute (current) luminance behavior of the display
- This calibration LUT needs to be as close as possible to the “LCD panel”

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3. Possible architecture for a color medical display system

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- In this section I would like to interactively with the group challenge/verify that the proposed architecture indeed can support/be compatible with all presented use cases

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Plain grey or color medical image

Use case 1
Use case 2

8 or 10-bit greyscale or color medical images

Display calibrated to be perceptually linear

- using DICOM GSDF for neutral (R=G=B) scale
- and optionally being also perceptually linear in its color behavior

- Calibration LUT of at least 12 bits depth

The tone scale changes when the white point or black point (including ambient illumination) changes

Grey or color medical image with ICC profile

Use case 3

CMM

8 or 10-bit greyscale or color medical images

The standard operating system CMM may not be appropriate for this application

(eg. handling dynamic ICC profiles)

ICC profile

A set of example/default profiles could be developed for different white/black range and could be posted on the ICC web site

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