

DICOM

Supplement 188
Multi-energy CT Imaging

DICOM Working Group 21
Computed Tomography

Short introduction of Multi Energy (ME) Images

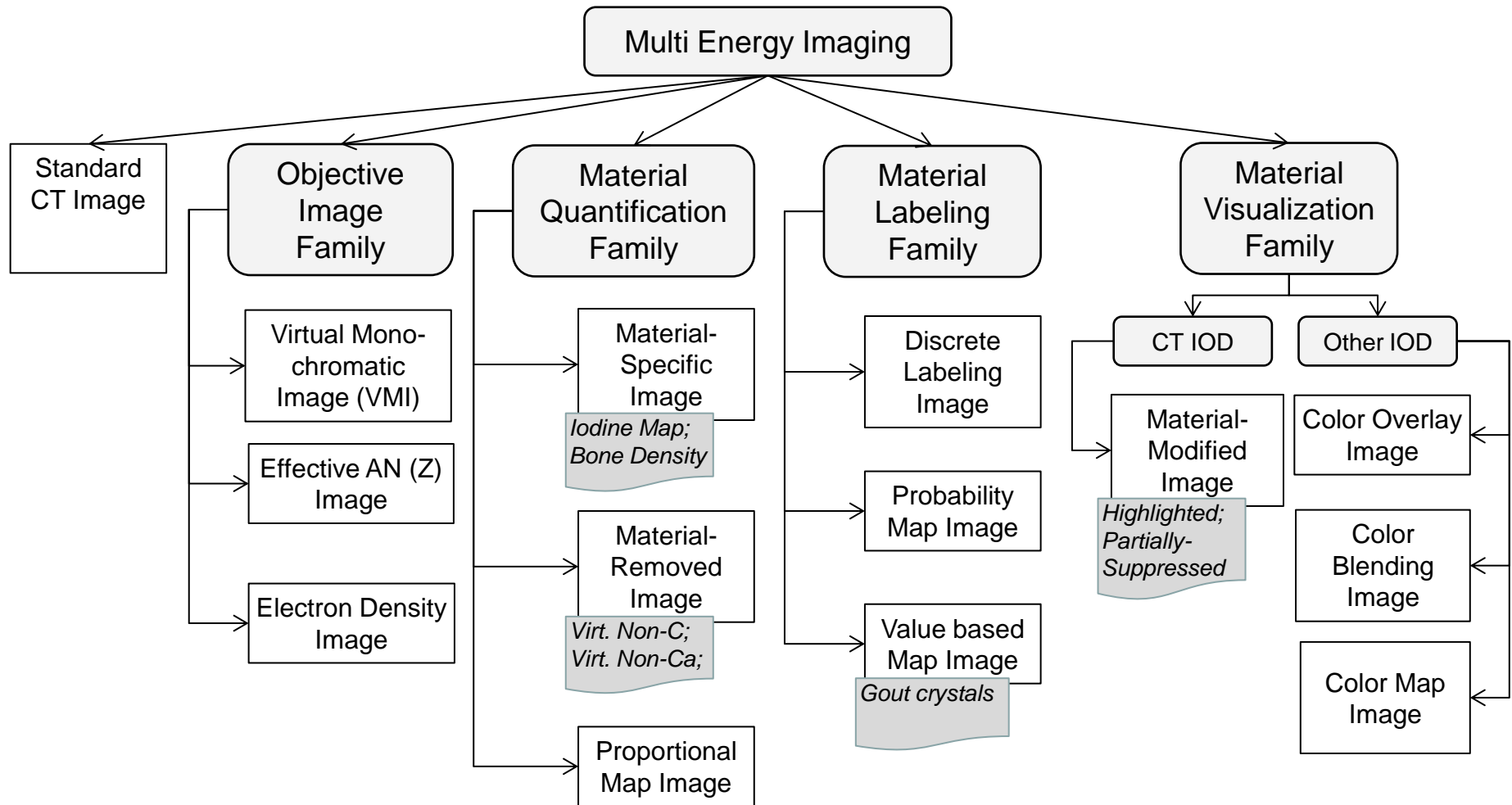
Overview:

- Imaging techniques, including scanning, reconstruction, processing, when the scanner utilizes multiple energies from the X-Ray beam spectrum, as opposed to the conventional CT imaging, when a single (accumulated) X-Ray spectrum is used.
- The existing CT and Enhanced CT (eCT) IODs do not adequately describe the new CT multi-energy imaging. Although different vendors apply different scanning and detection techniques to achieve multi-energy images, there is large commonality in the generated diagnostic images.

Goals for ME Image implementation:

- provide new essential ME information (acquisition, reconstruction and processing attributes) within the IOD.
- facilitate fast and easy adoption of standard based ME imaging across the imaging community, both modalities and PACS/Displays.
- address (or at least to minimize) the risk of mis-interpretation when the ME images are displayed by a display does not support the new attributes of the ME-image, including incorrect measurements
- adapt existing attributes of the CT / Enhanced CT IOD to fit ME techniques.

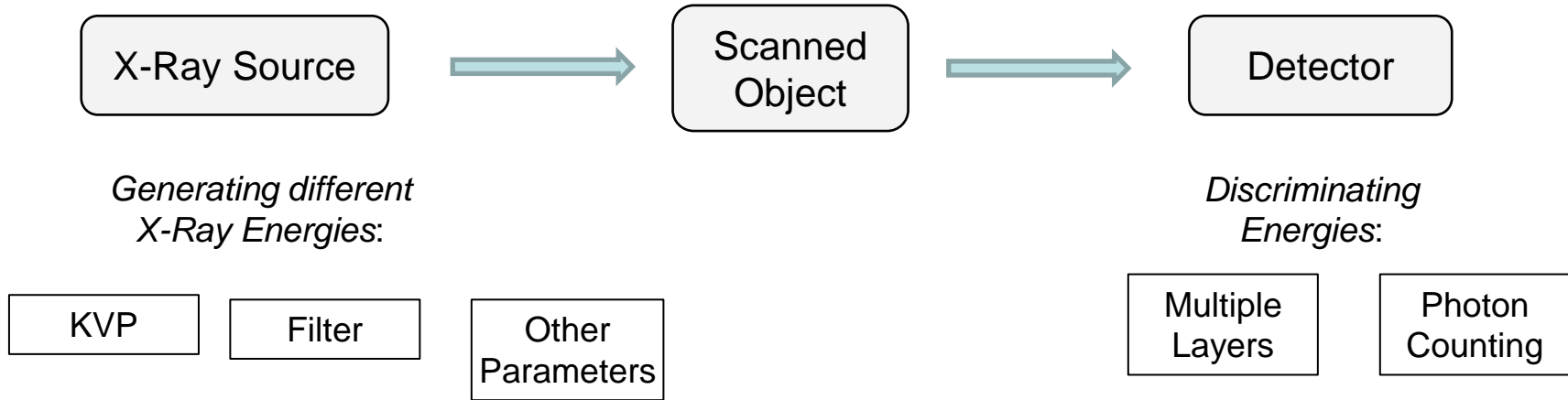
Overview



Multi-energy CT Macro (*new added to CT IODs*)

- **Multi-energy Flag (Y/N)**
- **Multi-energy CT Acquisition Sequence (1C, 1 item)**
 - Multi-energy CT Acquisition Sequence (1-N)
 - Multi-Energy Source Technique
 - Multi-Energy Detection Technique
 - *Other ME-specific attributes*
- **Multi-energy CT Processing Sequence (1C, 1 item)**
 - Decomposition Method
 - Decomposition Sequence (2-N items, one for each basis)
 - *Other decomposition attributes*
- **Multi-energy CT Characteristics Sequence (1C)**
 - Monochromatic Energy Equivalent (*for Virtual Monochromatic Image*)
 - Multi-energy Quantification CT Image Macro
 - Specific Material Code Sequence
 - Material Modification Sequence
 - Multi-energy Labeling CT Image Sequence (1 item)
 - Material Labeling Type
 - Material Labeling Sequence

Multi-Energy CT Acquisition Techniques



Methods to separate at least two energies include

- Multiple Scans of the same area with diff parameters
- Multiple X-Ray Sources and/or Detectors
- Switch KVP during the rotation
- One source with Multi-Layer Detector
- One source with Photon Counting Detector

“Objective” Images

Data Acquisition

A1

A2

...

An

Decomposition to
Base Components

M1

M2

...

Mn

Generation of
Diagnostic images

**Virtual
Monochromatic**

**Effective
Atomic Number**

**Electron
Density**

*Described in ME CT
Acquisition Sequence*

*Described in ME CT
Processing Sequence*

*Described in ME CT
Characteristics Sequence
(currently just keV for VMI)*

“Material” Images

Data
Acquisition

Decomposition to and/or Classification of
two or more Materials

Generation of
Diagnostic images

A1

A2

...

An

M1

M2

...

Mn

Material
Quantification
Family

Material Labeling
Family

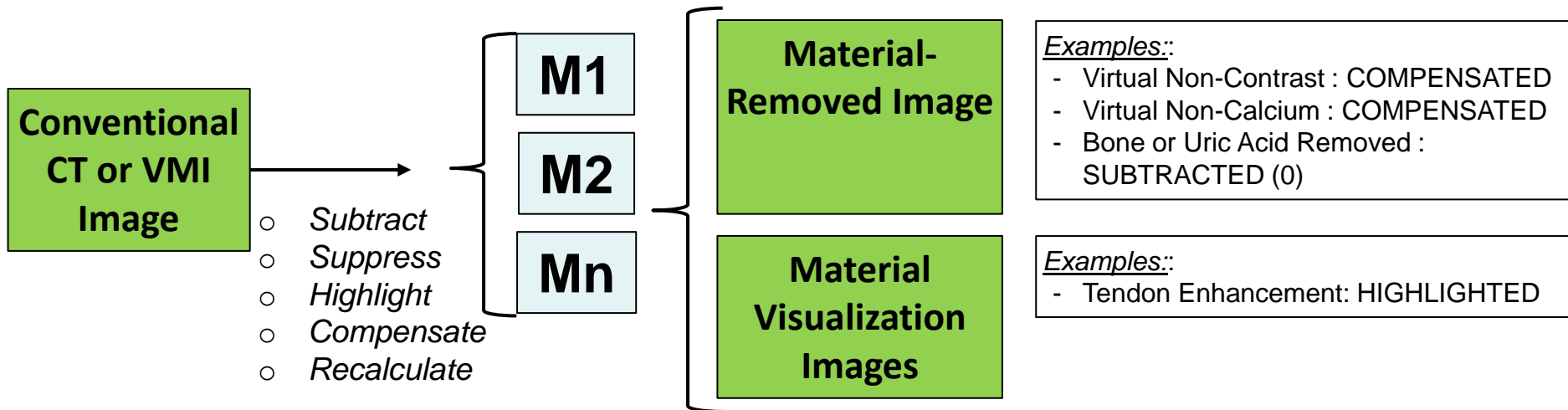
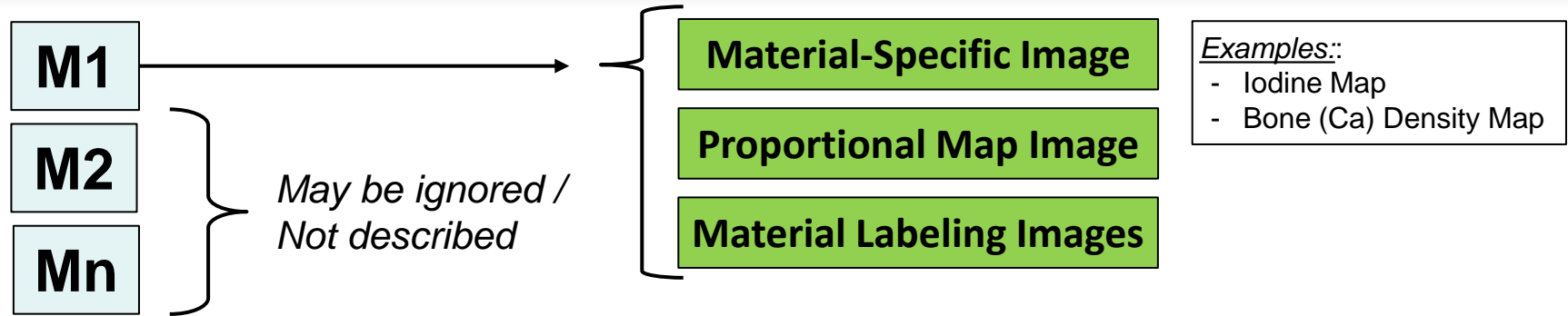
Material
Visualization
Family

*Described in ME CT
Acquisition Sequence*

*Described in ME CT
Processing Sequence*

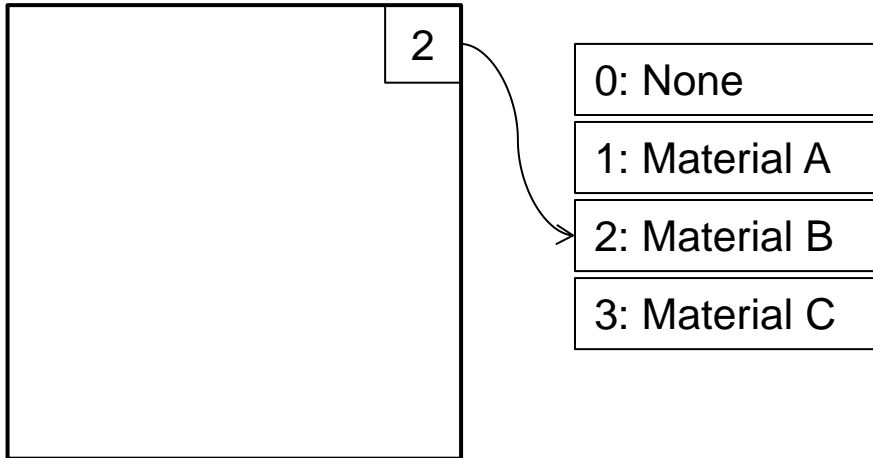
*Described in ME CT
Characteristics Sequence*

Material Images Generation

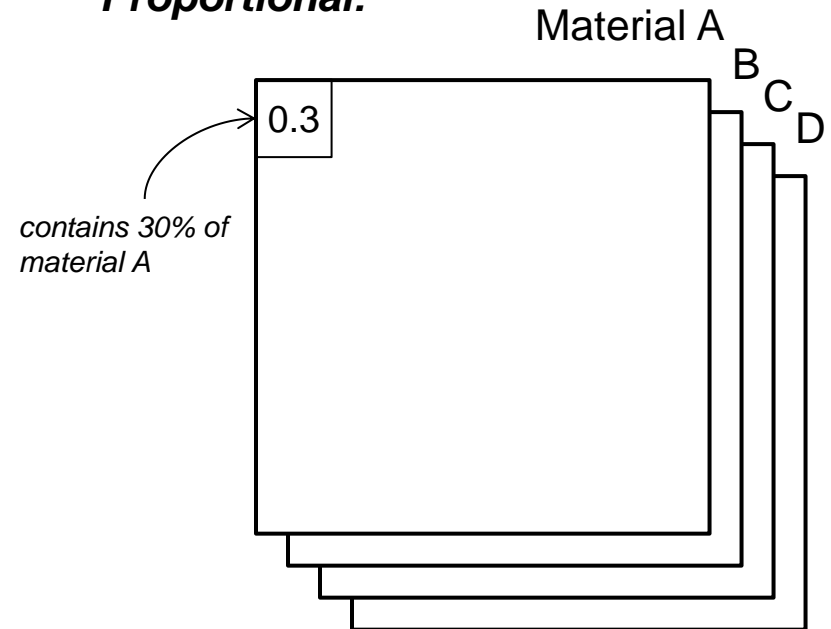


Material Labeling Images

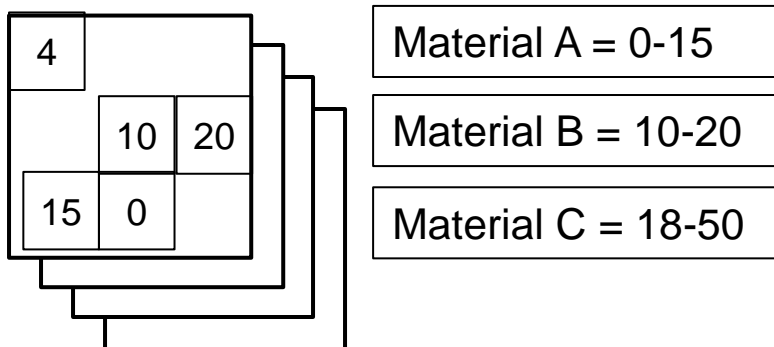
Discrete Labeling (most-probable material):



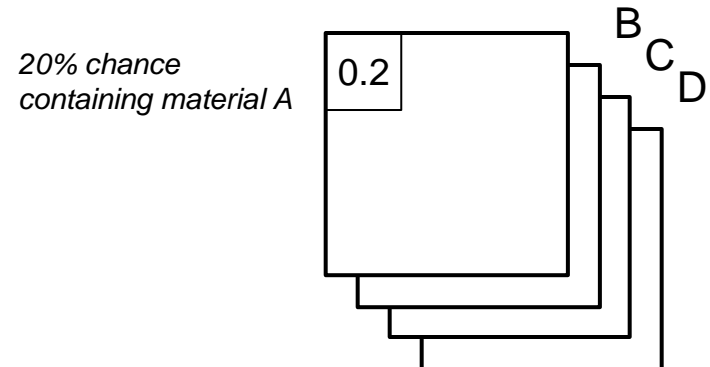
Proportional:



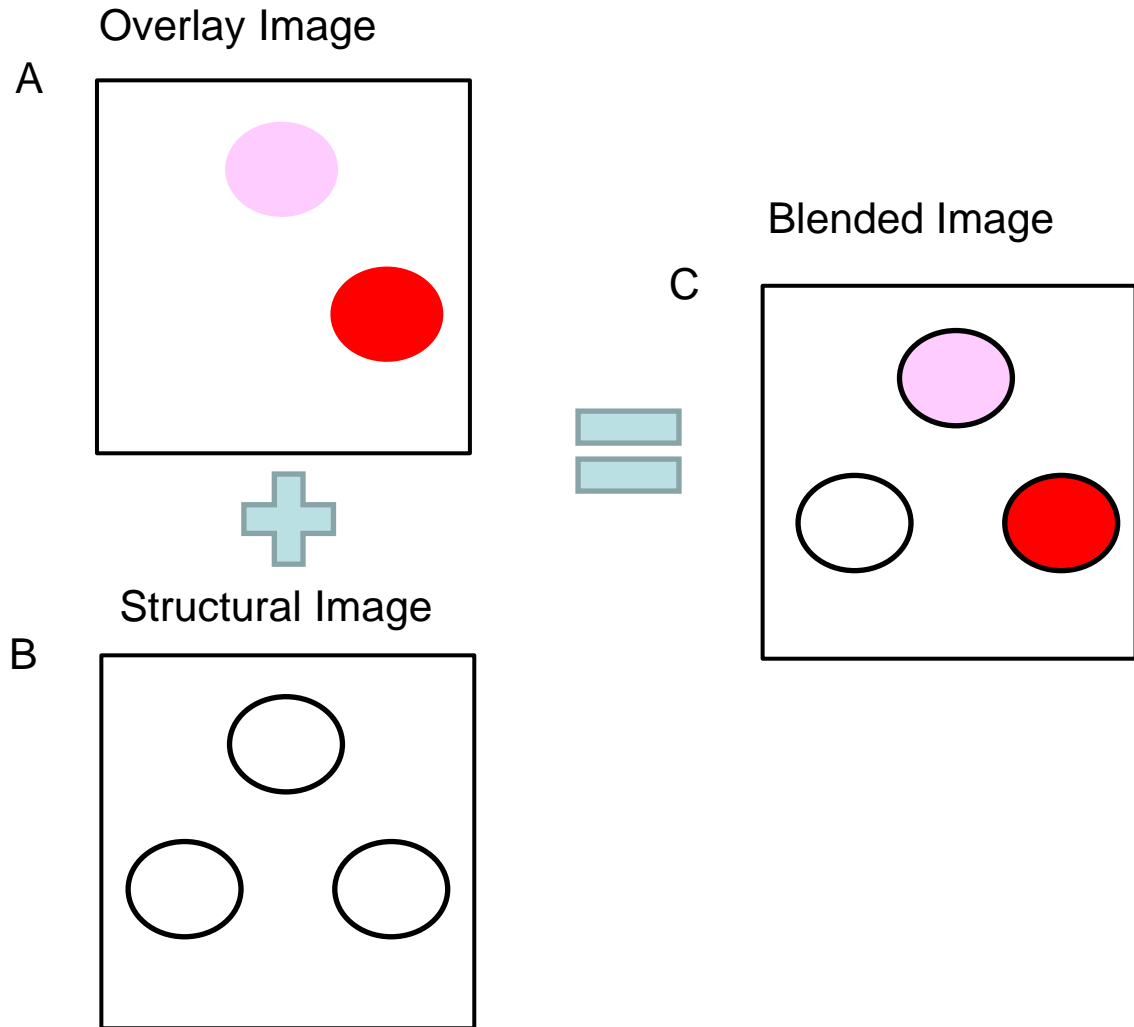
Value based:



Probability: Material A



“Visualization” Images Color Overlay



A) A CT image that is windowed to highlight a particular material with a color map applied. It also may have a translucency applied to be able to see the image underneath. (E.g. Iodine image, Effective Z image)

B) A structural image showing the anatomical structure. (E.g. Monochromatic image)

C) The result image (combined information e.g. Secondary Capture, Blending, ...)