MAYO CLINIC

New and Innovative CZT-based Gamma Cameras

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CZT Detectors

- Dual detector planar imaging
  - Molecular Breast Imaging
- 12- Detector SPECT/CT Imaging
  - Veriton (spectrum Dynamics)
  - Starguide (GE – not FDA approved)

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Imaging the breast with conventional Gamma Camera

- Large detector designed for imaging the whole body
- Only front and side views of the breast can be obtained
- Poor resolution - cannot reliably detect tumors < 15 mm in diameter

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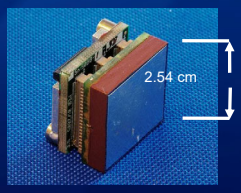
Molecular Breast Imaging (MBI)



- Excellent Intrinsic Resolution = 1.6 mm / 2.5 mm
- No dead space – ideal for breast imaging

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Test	Equipment	Frequency	Acquisition Details	Passing Criteria
Uniformity	Co-57 sheet source or fillable phantom	Daily	7.5 Mcts	≤5% integral uniformity
Spatial Resolution	4-quadrant bar phantom	Semi-annually	7.5 Mcts; phantom angled across FOV	Meets manufacturer's specifications
Sensitivity	Flask	Annually	120 second images	≤10% difference between 2 detectors
Energy Resolution	Point source	Annually	2 keV energy windows; 1 minute images	Meets manufacturer's specifications. FWHM ≤ 6%
Lesion Contrast Test	Contrast detail phantom	Quarterly	1 Mcts; Images at 3 depths	CNR >3; Count number of visible lesions at each depth
Clinical Images required for ACR	Currently we submit MBI images under the heading of hepatobiliary images, as no MBI category exits.			

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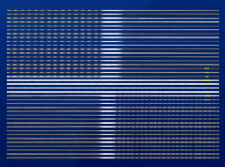
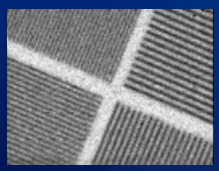
MBI vs Conventional Gamma Camera Differences in testing and QC

Spatial Resolution: Not really required for a pixelated system. If performed, rotate the bar ~45 degrees to reduce aliasing artifacts.





The ACR Subcommittee on Nuclear Medicine Physics recommends the following:

The weekly resolution phantom is not necessary on cameras with pixilated detectors but a resolution image using either the ACR SPECT phantom (preferred) or a 4-quadrant bar phantom must be done at least semi-annually and also submitted with the accreditation testing materials.

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MBI vs Conventional Gamma Camera
Differences in testing and QC

System sensitivity:
The flask should be filled completely with water and Tc-99m to minimize differences between detector geometry. Both images can be acquired simultaneously.

Difference in sensitivity < 10%

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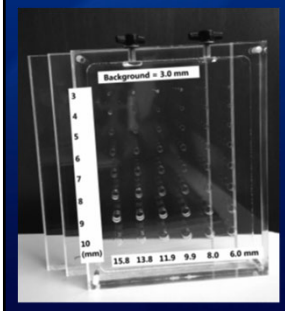
MBI vs Conventional Gamma Camera
Differences in testing and QC



Jaszczak phantom :
Separation between detectors insufficient to allow Jaszczak phantom to be placed in the field of view.

Alternative option - Contrast Detail phantom

D. Dickerscheid, et al,

Contrast-noise-ratio (CNR) analysis and optimization of breast-specific gamma imaging (BSGI) acquisition protocols,

EJNMMI Res 3, 21 (2013).

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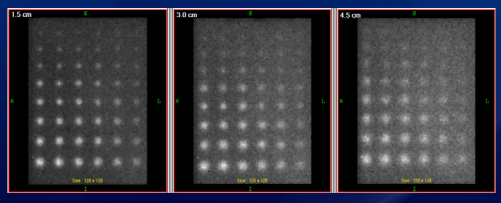

Sample contrast detail phantom images acquired at distances of 1.5 cm, 3.0 cm and 4.5 cm, respectively, from collimator face

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ACR Accreditation of MBI Units
(similar to what was done for BSGI systems)

Nuclear Medicine Accreditation Program Modality Section

You will be required to submit the exams selected below.

Based on the responses from the previous screen, this facility is applying for:
-Planar

Exam Selection
Planar: Clinical images for a total of 2 exams must be submitted.
Choose one of the following
- ○ Whole Body Bone
- ○ Spot Bone
- ◉ This unit does not perform bone scans

Choose two exams from the following (you may select two of the same exam type)

If this unit performs MUGA exams and is not applying for the Nuclear Cardiology module, you MUST select MUGA for at least one of your exams.
- ☑ Hepatobiliary
- ☑ Hepatobiliary
- ☐ Perfusion Lung (including ventilation study)
- ☐ MUGA
- ☐ Thyroid
- ☐ I131 Whole Body
- ☐ I131 Spot
- ☐ Gallium Whole Body
- ☐ Gallium Spot
- ☐ Octreotide Whole Body
- ☐ Octreotide Spot

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Next Generation SPECT/CT Imaging
Veriton (Spectrum Dynamics)
Starguide (GE Healthcare)

Conventional
Dual-detector SPECT/CT

Veriton SPECT/CT

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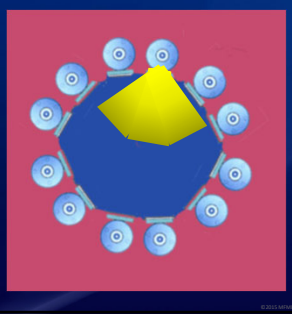
12 independent detectors equipped with tungsten collimators
Each detector = 4 x 32 cm FOV
Detectors move in a radial direction
Each detector can swivel over a 180º arc.
The gantry has a rotational range of 25º
Current detectors capable of imaging up to ~200 keV

Angular scan range of motion of each detector is selectable.

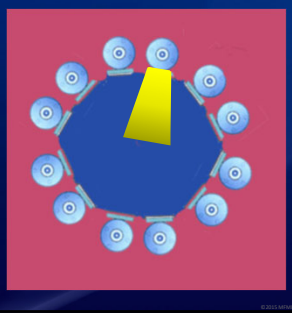


12

12 independent detectors equipped with tungsten collimators
Each detector = 4 x 32 cm FOV
Detectors move in a radial direction
Each detector can swivel over a 180° arc.
The gantry has a rotational range of 25°
Current detectors capable of imaging up to ~200 keV

Angular scan range of motion of each detector is selectable.

Short angular range used for imaging small organs / head



13

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Current detectors capable of imaging up to ~200 keV

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QC / Acceptance Testing on Veriton / Starguide

Key points to note:

In terms of QC and testing ,the Veriton has more in common with a conventional PET/CT system than with a conventional SPECT/CT system.

The Veriton cannot perform planar imaging (although pseudo-planar images can be produced from the tomographic data if needed)

The majority of acceptance testing procedures that are routinely performed on conventional SPECT/CT systems, cannot be performed on the Veriton or Starguide systems

Vendors supply a suite of QC tools specifically designed for these systems.

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QC / Acceptance Testing on Veriton / Starguide

Co-57 rod source (12 mCi) in position

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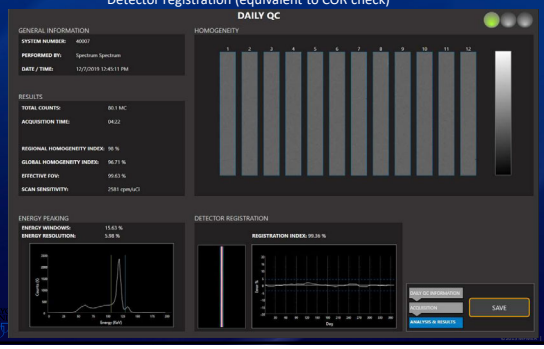
Daily Quality Control – Veriton System:

- Uniformity
- Sensitivity
- Energy peaking / resolution
- Detector registration (equivalent to COR check)



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Daily Quality Control – Veriton System:

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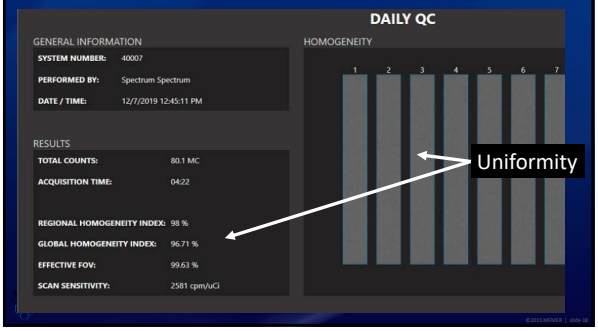

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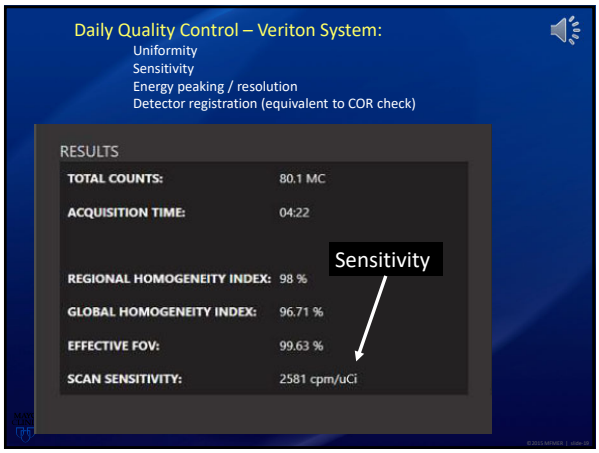
Daily Quality Control – Veriton System:
Uniformity
Sensitivity
Energy peaking / resolution
Detector registration (equivalent to COR check)
RESULTS
TOTAL COUNTS: 80.1 MC
ACQUISITION TIME: 04:22
REGIONAL HOMOGENEITY INDEX: 98 %
GLOBAL HOMOGENEITY INDEX: 96.71 %
EFFECTIVE FOV: 99.63 %
SCAN SENSITIVITY: 2581 cpm/uCi
Sensitivity

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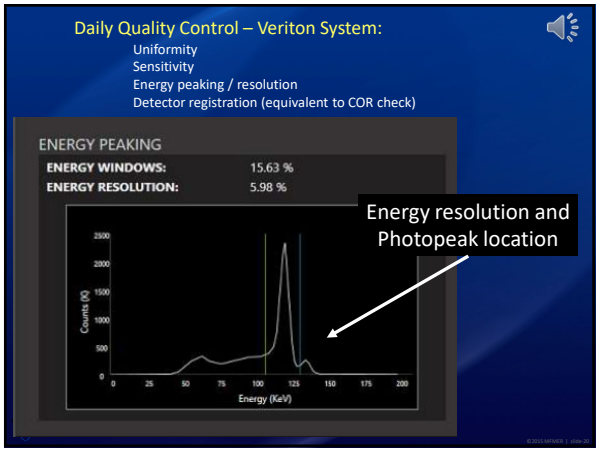
Daily Quality Control – Veriton System:
Uniformity
Sensitivity
Energy peaking / resolution
Detector registration (equivalent to COR check)
ENERGY PEAKING
ENERGY WINDOWS: 15.63 %
ENERGY RESOLUTION: 5.98 %
Energy resolution and Photopeak location
Counts (K)
Energy (KeV)

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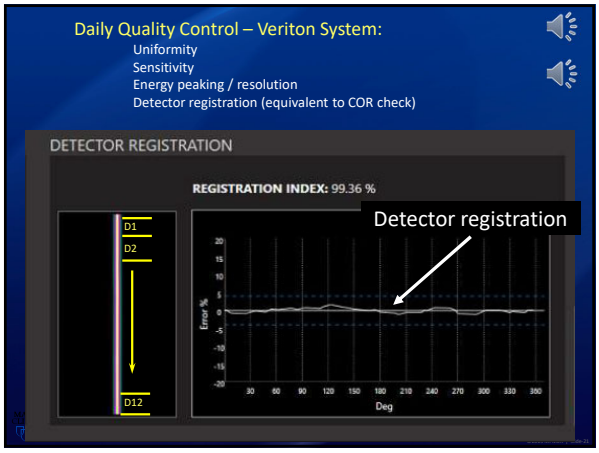
Daily Quality Control – Veriton System:
Uniformity
Sensitivity
Energy peaking / resolution
Detector registration (equivalent to COR check)
DETECTOR REGISTRATION
REGISTRATION INDEX: 99.36 %
Detector registration
D1
D2
D12
Error %
Deg

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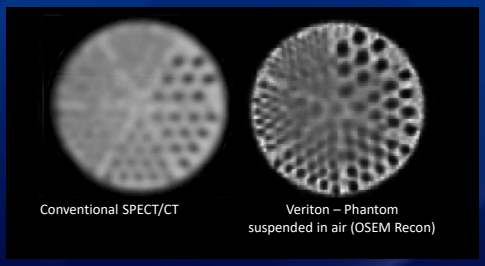
QC / Acceptance Testing on Veriton / Starguide

Jaszczak phantom



Conventional SPECT/CT

Veriton – Phantom suspended in air (OSEM Recon)

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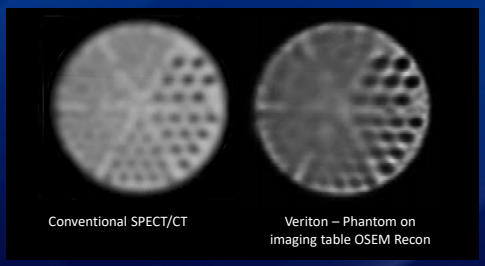
QC / Acceptance Testing on Veriton / Starguide

Jaszczak phantom



Conventional SPECT/CT

Veriton – Phantom on imaging table OSEM Recon

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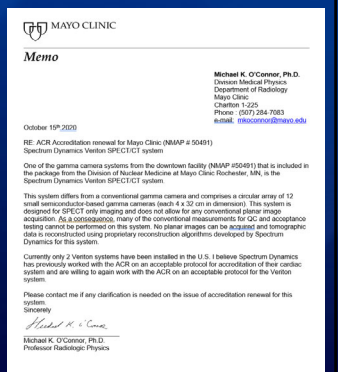
ACR accreditation

Because many of the standard QC measurements cannot be performed, a letter clarifying why these tests were not perfomed was submitted along with the accreditation documentation.

This is similar to what was done when we applied for accreditation of the D-SPECT system



MAYO CLINIC

Memo

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e-mail: mkoconnor@mayo.edu

October 15th 2020

RE: ACR Accreditation renewal for Mayo Clinic (NMAP # 50491)
Spectrum Dynamics Veriton SPECT/CT system

One of the gamma camera systems from the downtown facility (NMAP #50491) that is included in the package from the Division of Nuclear Medicine at Mayo Clinic Rochester, MN, is the Spectrum Dynamics Veriton SPECT/CT system.

This system differs from a conventional gamma camera and comprises a circular array of 12 small semiconductor-based gamma cameras (each 4 x 32 cm in dimension). This system is designed for SPECT only imaging and does not allow for any conventional planar image acquisition. As a consequence, many of the conventional measurements for QC and acceptance testing cannot be performed on this system. No planar images can be acquired and tomographic data is reconstructed using proprietary reconstruction algorithms developed by Spectrum Dynamics for this system.

Currently only 2 Veriton systems have been installed in the U.S. I believe Spectrum Dynamics has previously worked with the ACR on an acceptable protocol for accreditation of their cardiac system and are willing to again work with the ACR on an acceptable protocol for the Veriton system.

Please contact me if any clarification is needed on the issue of accreditation renewal for this system.
Sincerely

Michael K. O'Connor, Ph.D.
Professor Radiologic Physics

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Summary:

- Many of the QC and acceptance test procedures used for conventional sodium iodide based gamma cameras are not longer applicable to the next generation of semi-conductor based gamma camera systems.
- The ACR currently makes an exception for these systems in its accreditation process
- As systems such as the Veriton and Starguide become more widely utilized, new standards and procedures need to be developed for testing and QC of these devices.

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