Optimization of SPECT-CT imaging for Selective Internal Radiation Therapy of liver malignancies with Y-90 microspheres
The present work is focused on the optimisation of SPECT/CT Imaging for Selective Internal Radiation Therapy using Monte Carlo Simind Code
Yttrium 90 is widely used in the SIRT:

- The MC. Simind, is well adapted to the nuclear medicine applications.

- **SPECT imaging Y90** bremsstrahlung photon spectrum; Wide continuous; no distinct peak
Moreover, the image quality is closely linked to the geometry and characteristics of the collimators: such as spatial resolution, sensitivity, contrast,…

Another problem is that the gamma camera detects at most about 500 keV, while the bremsstrahlung radiation due to yttrium-90 may exceed 2000 keV.
* The choice of collimator type should be sensible, because photons belonging to the highest energy region of the Bremsstrahlung spectrum pass through the collimator septa, lowering the image quality.
* In addition, it could produce scattering radiation affecting the image quality.

* Image quality parameters such as resolution, contrast, contrast to noise ratio, .... should be evaluated.
we used Monte Carlo SIMIND simulation.

Different types of collimators, E.CAM SIEMENS MEDICAL SYSTEM (ME, HE, LEAP, LEHR)

cylindrical source of Y90, inside a cylindrical phantom.

distance between the collimator and the phantom is also taken into account.

The effect of the energy windows,

Image Quality parameters: contrast, CNR, …

Jaszack phantom
Results: Bremsstrahlung Spectrum

Y90 Bremsstrahlung Spectra: MC. SIMIND

MC. Gate Simulation Y90 spectrum
Results: FWHM--Sensitivity

FWHM - [50 - 250] keV

SENSITIVITY [50 - 250] keV
Results: Scattering Radiation Effect

- a: without scattering
- b: Scattering order 1
- c: Scattering order 2
- d: Scattering order 3
Bremsstrahlung Photons: Geometric, Scattered and Penetration Components. Siemens Medical System

Low Energy Collimator

Medium Energy Collimator

Low Energy High Resolution

High Energy Collimator
Contrast - Contrast to Noise Ratio

\[ \text{Contrast} = \frac{(C_s - C_b)}{C_b} \]

\[ 1^* \text{CNR} = \frac{|C_s - C_B|}{\sigma_B} \times \sqrt{N \text{pixel}} \]

\[ 2^* \text{CNR} = \frac{C_s - C_B}{\sqrt{\sigma_S^2 + \sigma_B^2}} \times \sqrt{N \text{pixel}} \]

Drawing circular area around center of each sphere
Image Quality Parameters: Contrast

Medium Energy Collimator

High Energy Collimator

Experimental Contrast -- HE. collimator
Medium Energy Collimator

![Graph showing energy levels and emission patterns for different energies: 30 keV, 70 keV, 160 keV, 220 keV, 310 keV, 420 keV. The graph includes multiple curves for different emission patterns denoted as s1, s2, s3, s4, s5, and s6.](image-url)
CNR - Simind Simulation

Low energy: Higher CNR - Collimator X-Ray Characteristics
CNR – SIMIND Simulation
Conclusion

• Experimental results were confirmed by the simulation calculation

• With the new systems, we can choose acquisition windows to privilege the contrast and contrast to noise ratio.

• Now that our results have been confirmed and approved by experience, we plan to continue the work using Monte Carlo Gate code, to give more possibilities and accuracy to our results.

• In addition to the qualification work we done, we also plan to develop the quantification part.
Thank You