# Poster session Applications


Ralf Hendrik Menk

*Sincrotrone Trieste*

# Poster contribution Applications

1. PICASSO: A Single-Photon Counting Detector for *in-vivo* Mammography at Elettra
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3. A Novel High Resolution and High Efficiency Dual Detector System for Molecular Breast Imaging: Results from Clinical Trials Franco Garibaldi
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12. Lead Activation Neutron Yield Measurement System Used in ICF Experiment
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Diagnosis/ imaging (1–5)

in beam imaging (6–8)

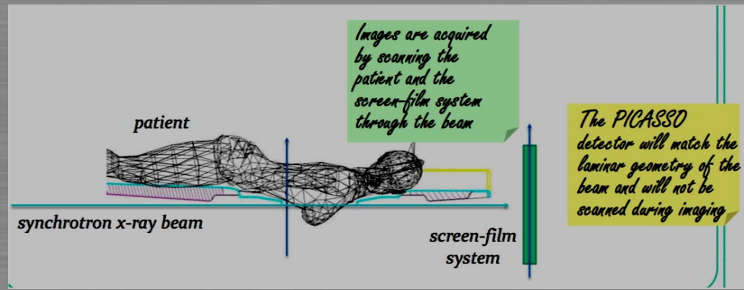
Instrumentation (9–10)

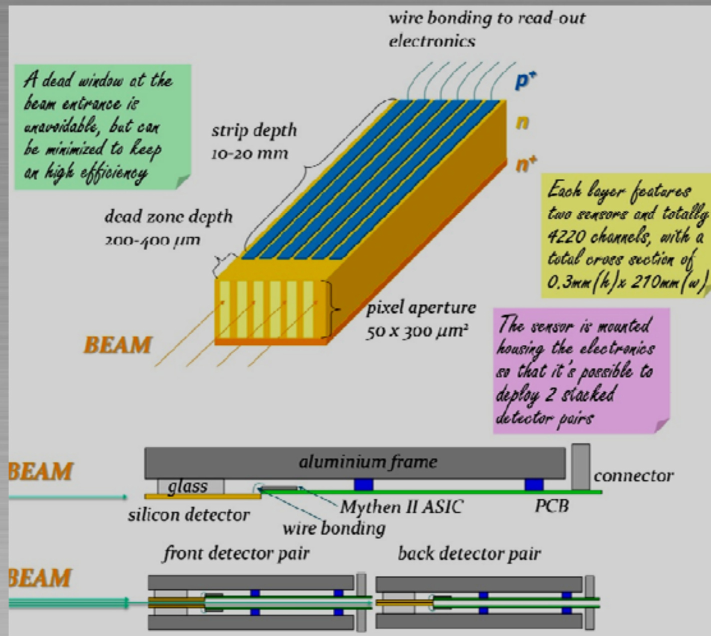
~ 83% medical applications

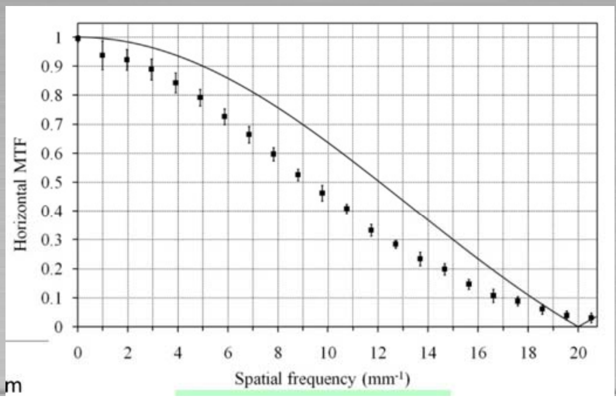
## PICASSO: A Single-Photon Counting Detector for in Vivo Mammography at Elettra

Luigi Rigon

- Motivation
  - Breast cancer is one of the leading cause of female death
  - Mammography is one of the most sensitive screening methods
- Method:
  - Use of synchrotron radiation & single photon counting detector that can significantly increase the visibility of tumor masses
  - edge on Si strip detector & Mythen read out (preamp, shaper, discriminator, counter)
- Results:
  - Count rate 1 MHz / pixel (paralyzed),
  - spatial resolution almost box function
  - little charge sharing



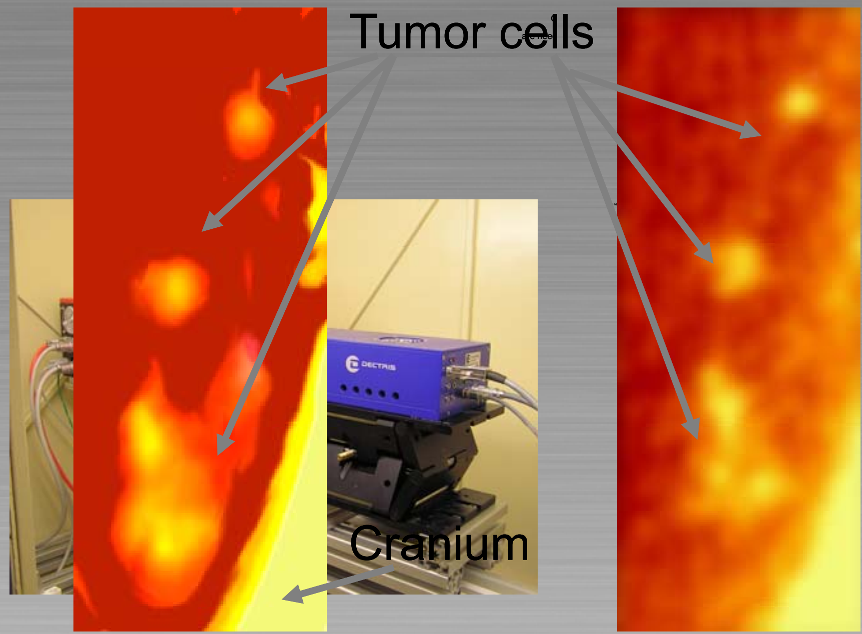



On the Possibility of Tracking Cells in Host Organism Utilizing State of the Art Si Pixel Detectors

Ralf Hendrik Menk

- Motivation:
  - to follow the fate of therapeutically implanted pluripotent cells (stem cells) in a living being (small animal) over long time in 3-d at any anatomical location
- Method:
  - Prior implantation cells are laden with gold nano particles. The labeling remains in the cells like a tattoo. CT (synchrotron & μ focus x-ray tube in combination with CCDs and Pilatus Si pixel detector.
- Results:
  - Small cell clusters of pluripotent or tumor cells (< 10 cells ) can be visualized. Using the Pilatus a six fold decrease in entrance dose and a three fold increase in SNR is observed due to the substantial higher DQE.

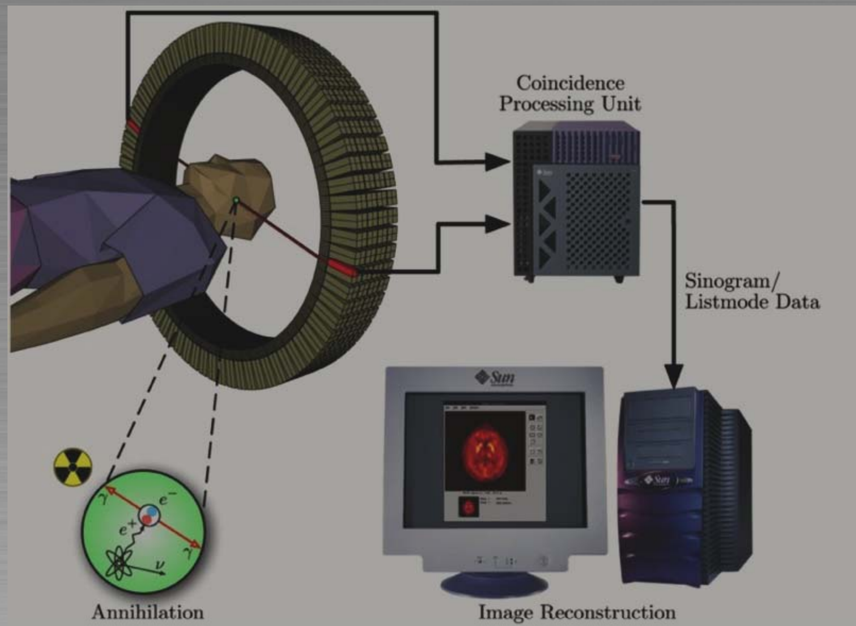


# Functional imaging SPECT & PET

QuickTime™ and a decompressor are needed to see this picture.

## $\gamma$ - emitter SPECT

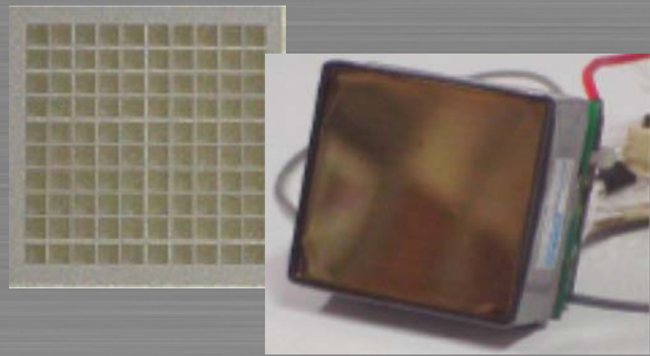
• Method: functionalize $\gamma$ or $\beta^+$ emitter by bounding them to some sort of receptors / proteins/molecules that selectively reveals function or pathology
• use of collimators (mechanically or electronically) to generate a virtuel image of the source on the detector plane which enables to trace back the source in real space (SPECT).
• use of coincidences of annihilation photons to trace back the source point (PET)



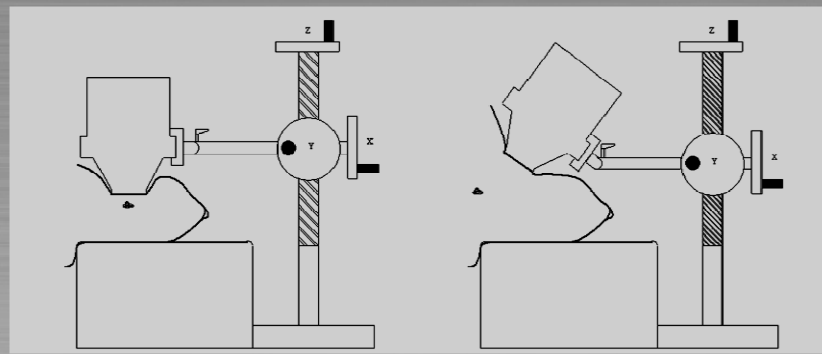

## $\beta^+$ - emitter PET

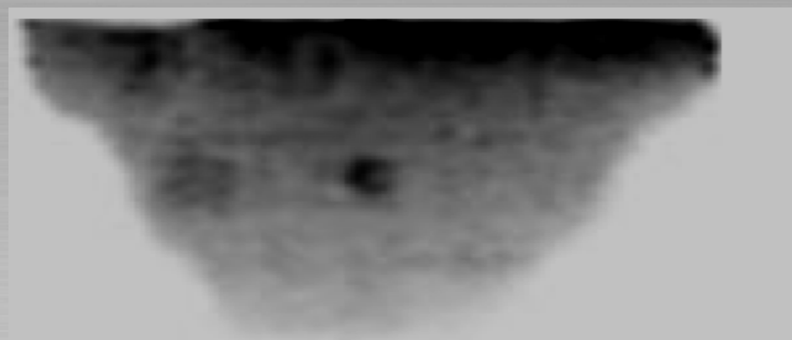
The beauty: Extreme high sensitivity & high SNR already for small detected photon numbers

## A Novel High Resolution and High Efficiency Dual Detector System for Molecular Breast Imaging: Results from Clinical Trials Franco Garibaldi

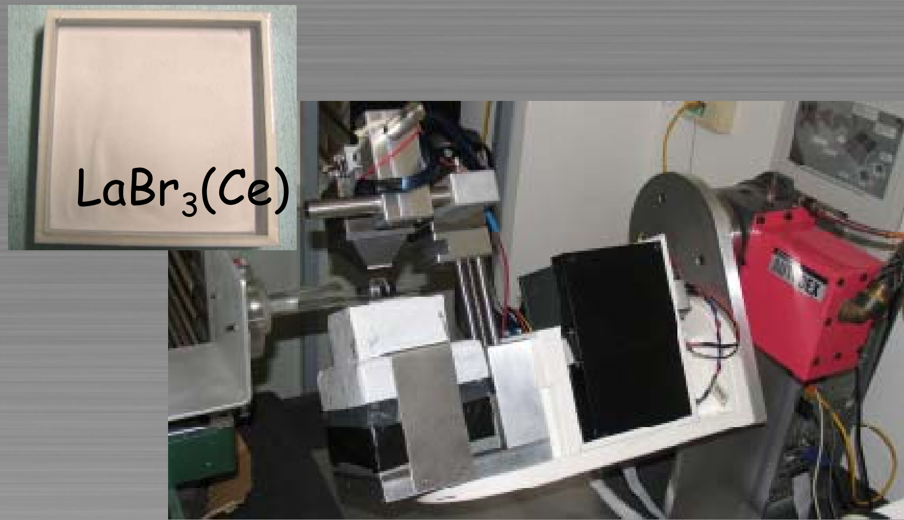


- Motivation
    - to visualize breast tumors at early stage < 5 mm to increase survival rate or to avoid biopsy
- Method:
    - Functionalized radionuclide bounds to breast cancer.
    - Use of pinhole collimator, dual detector system based on NaI Scintillator / CsI scintillators in combination with position sensitive PMT  to trace back the source (SPECT) and thus the tumor
- Result:
    - First clinical trials with special dual detector head.

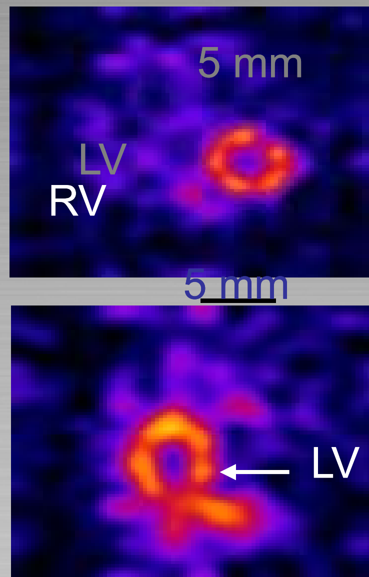




# A Novel High Resolution, High Sensitivity SPECT Detector for Molecular Imaging of Cardiovascular Diseases: Francesco Cusanno



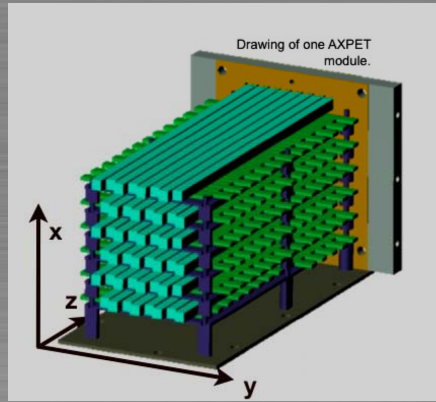

- Motivation
  - to visualize the cardiac perfusion (important after myocardial infarction) and /or therapeutically implanted pluripotent cells for myocardial repair
- Method:
  - $^{99}$Tc is injected for myocardial perfusion measurements (distribution of the radionuclide in the myocardial muscle )
  - Dual head SPECT system based on $LaBr_3(Ce)$ scintillator and position sensitive photon detectors.
- Result:
  - High spatial resolution system (better 800μm) for small animal exams. Can be used for animal trials with translation potential to humans.

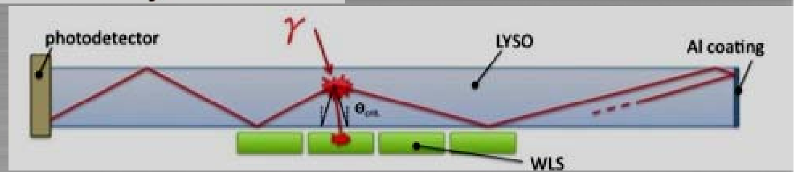


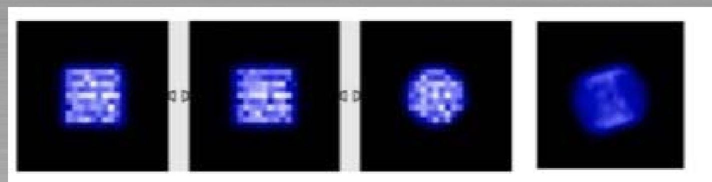
# The AX-PET Project: Demonstration of a High Resolution Axial 3D PET

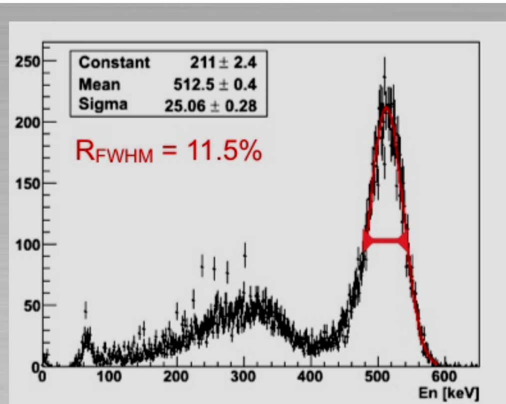
Chiara Casella

- Motivation
  - Novel approach to increase the sensitivity of current PET scanners and obtain a direct 3-d reconstruction (axial 3d PET)
  - Reconstruction of inter crystal Compton scattering events
- Method:
  - Matrix of 6x8 LYSO scintillator crystals are axially oriented in the tomograph.
  - In each layer, hodoscope of 26 wave length shifter strips for detection of axial coordinate
  - Each scintillator and WLS is individually coupled to a photo detector
- Result:
  - First full module of demonstrator assembled.
  - Energy resolution of single element ~11 %
  - first reconstructions and simulations

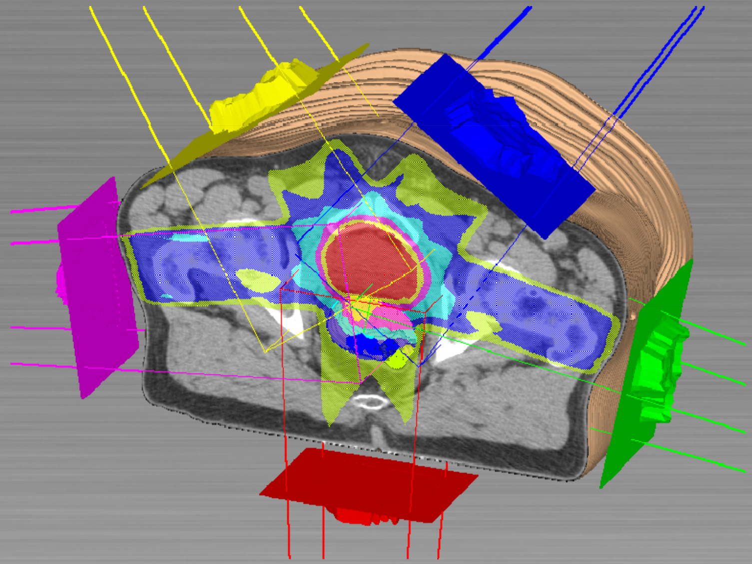




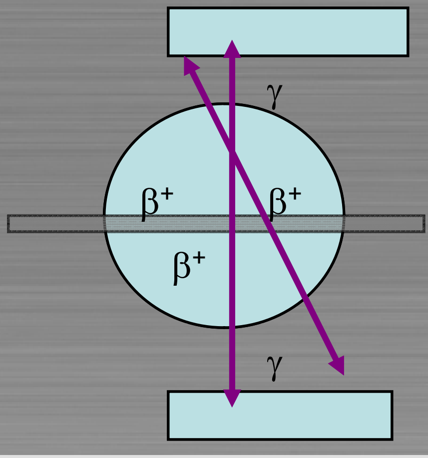
# Radiation Therapy & in-beam imaging (portal imaging)

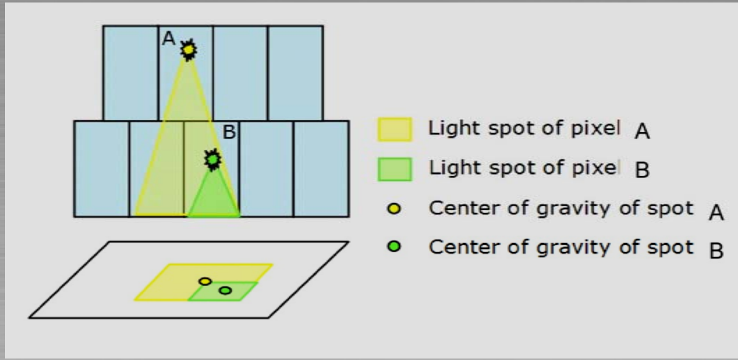


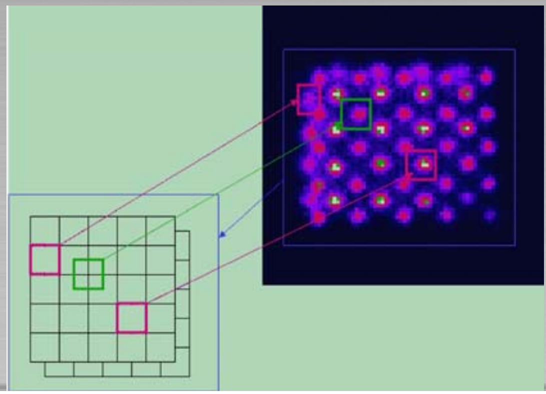
- Motivation
  - Treatment planning relies on the knowledge of the anatomical location of the tumor using different imaging modalities. In-beam imaging allows localizing the tumor during therapy and thus increases the efficiency of radiation therapy.
- Method:
  - Ionizing radiation (α, β,γ, ions) is used to externally irradiate monodirectional or multidirectional the tumor with particle or photon beams.
  - Radioactive sources are placed close or into tumor side (brachytherapy).
  - Using SPECT, PET, nuclear vertex imaging or proton range radiography to locate the source or to monitor the particle beam (in-beam imaging) with respect to the anatomy of the patient.

QuickTime™ and a decompressor are needed to see this picture.

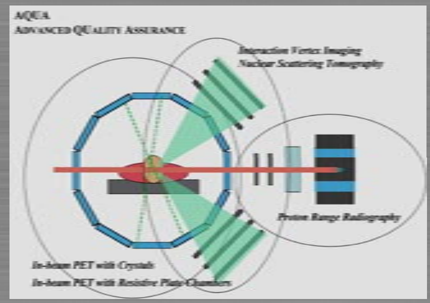
- Motivation
  - To increased efficiency for radiation therapy in tumor treatment by imaging hadrons beam
- Method:
  - Hadron beam generates along its path $\beta^+$ with short lifetime. Annihilation generates two 511 keV photons that can be imaged in a PET scanner.
  - the bigger the crystal the higher the sensitivity in vertical direction but the higher the parallax error
  - Staggered double layer array crystals are used to image the depth of the interaction point in the crystal with less parallax error and thus helps to determine more precisely the vertical beam position
- Results:
  - From 511 keV flat field illumination the difference in the depth of the interaction point could be verified.

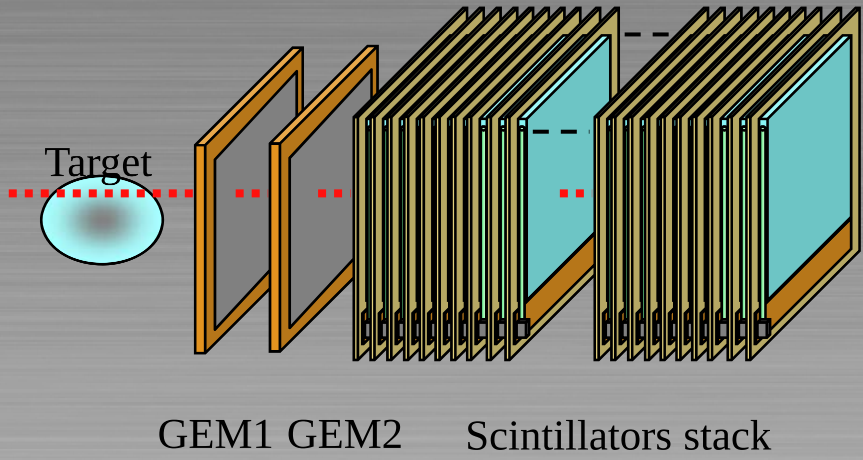


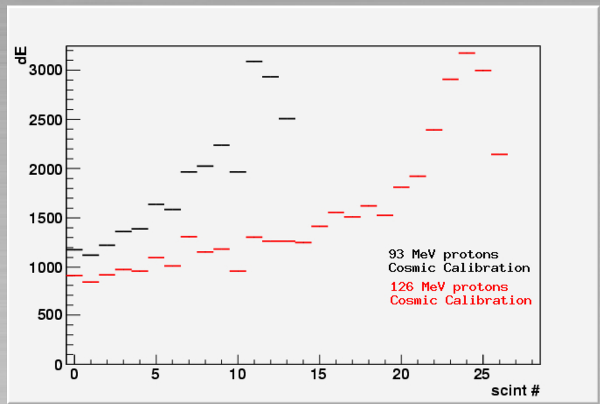



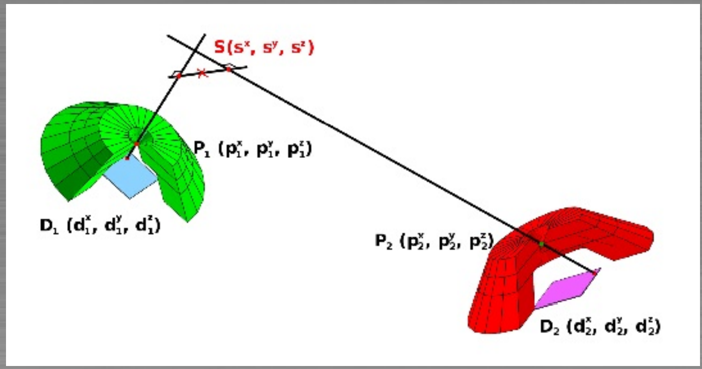
- Motivation
  - To increased efficiency for radiation therapy in tumor treatment by imaging the proton beam
- Method:
  - For imaging the proton beam energy is increased such that the beam exits the patient.
  - The position of the proton can be monitored with GEMs and the residual energy or range can be measured with a scintillator stack.
  - residual range is coupled to the density modulation of the patient through a line integral thus carrying a similar information like the transmission of x-rays through a patient (2d density map).
  - recording the residual energy under different angles allows the backprojection of the density line integrals thus the tomographic reconstruction
- Results:
  - Bragg energy loss has been measured
  - a density resolution of ~ 0.1% is obtained with 100 counts per pixel



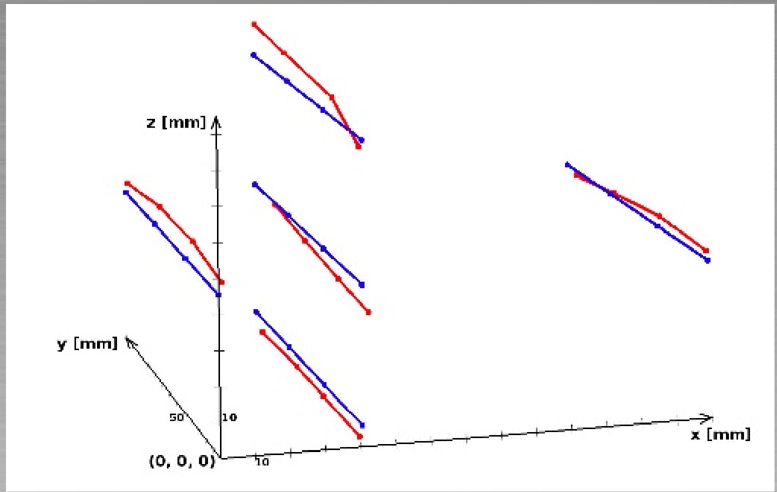



- Motivation
  - Measuring the position of the radiation source in brachytherapy to avoid misplacements
- Method:
  - Dual head SPECT / Compton camera system comprising two pinholes and position sensitive Si pad detectors record the photons emitted by the 1 Ci $^{192}$Ir source
  - Stereo tactic view of the source allows the 3d reconstruction of the source in real space.
  - verification with Geant 4




- Results:
  - Absolute coordinates of source positions could be constructed with a precision of about 10 mm.
  - relative movements of the source could b reconstructed with a precision of 0.6 mm



- Motivation
  - Knowledge of the dose distribution in x-ray radiotherapy is important for the treatment planning. Ionization chambers employed for this task have some limitations since the ballistic equilibrium is not obeyed. Diamond detectors are closer to tissue than air filled ion chambers and thus more suited for this task.
- Method:
  - CVD build as solid state ionization chamber
  - dose response was measured
  - Depth - dose curves were measure using a PMMA phantom
- Results:
  - The CVD shows reasonable linearity
  - nonlinearities due to trapped charges can be corrected.