Enhancing InBeam PET with single Photon (Compton) Detection

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VALENCIA GROUP, **IFIMED**

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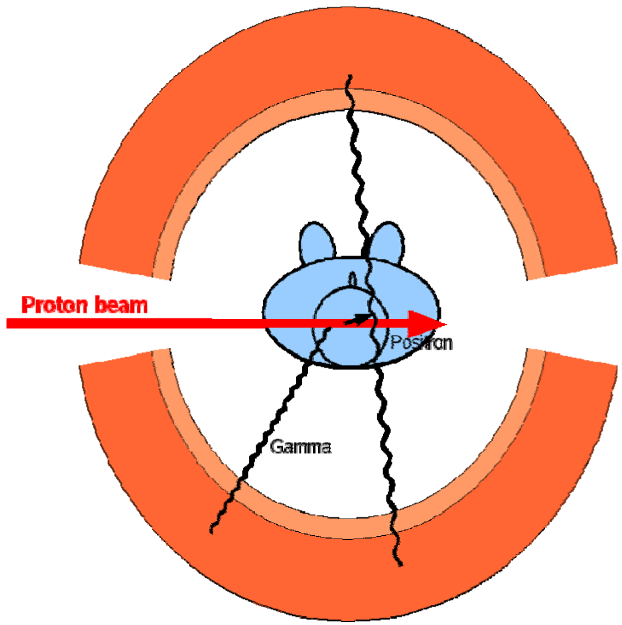
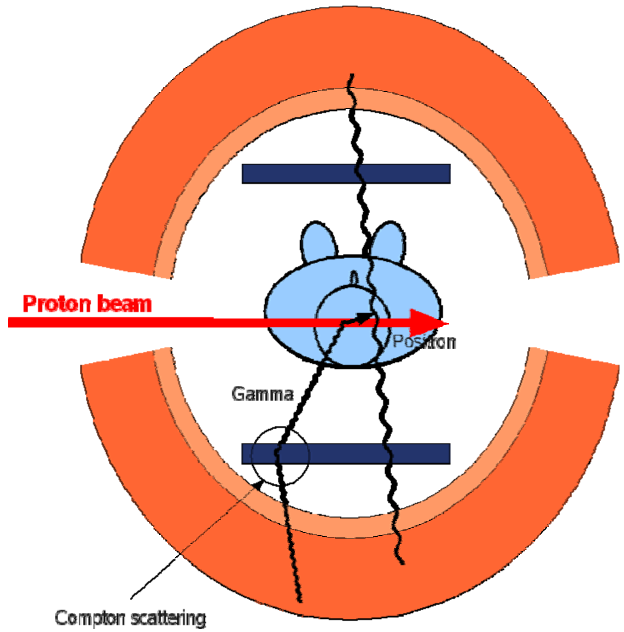
Principle

- Current InBeam devices operate in PET mode
  - Only gammas from positron annihilation
- Being also sensitive to prompt gammas would increase the efficiency.



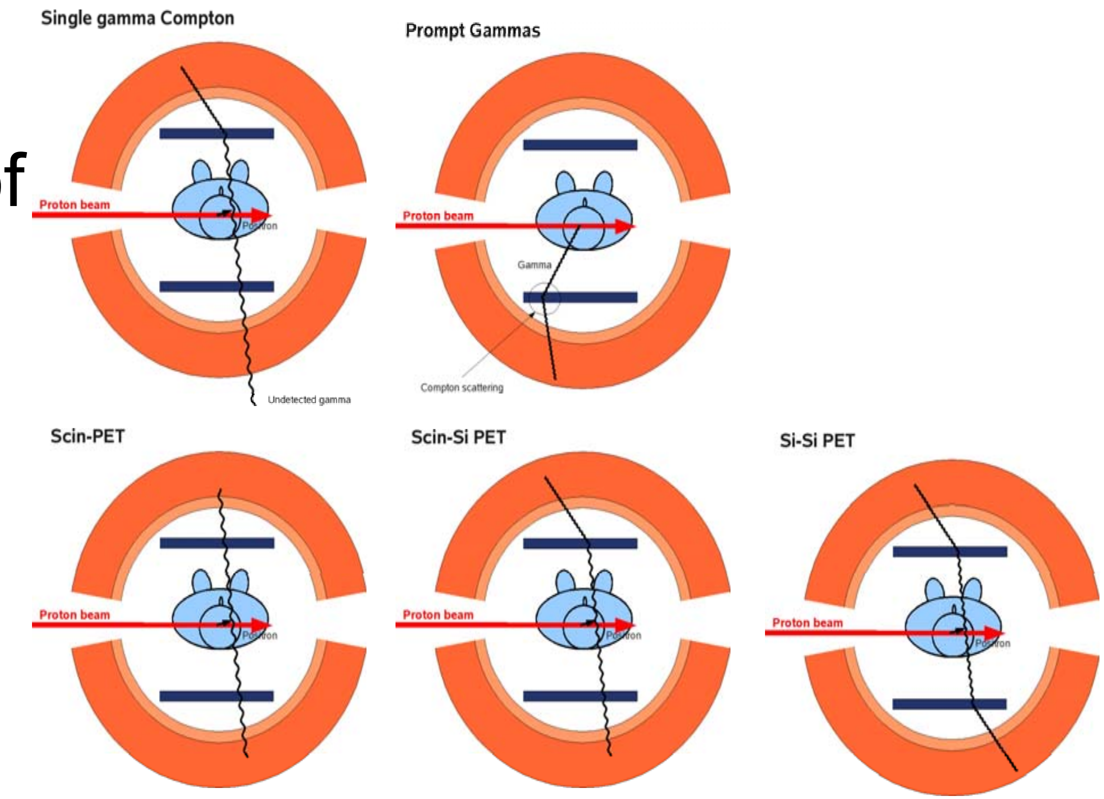
The Compton PET

- We can augment the InBeam PET performance and efficiency by adding a scatterer in front of the PET scintillator.
- Our PET is now also a Compton Camera



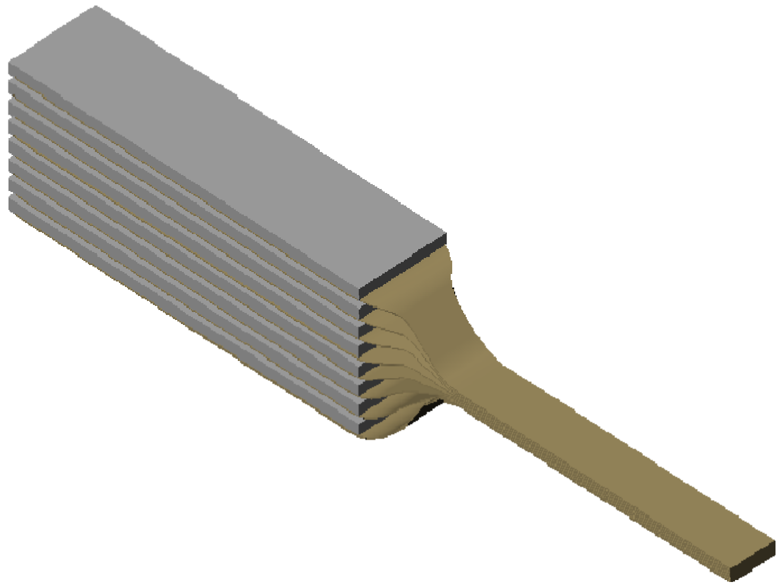
The Compton PET

- Topologies
  - It can operate in PET mode with the combination of scatterer and scintillator
  - And also in single gamma mode.
- We certainly need some simulation to see the real gain



The scatterer

- We propose a stack of silicon pad (big pixels 1x1 mm) sensors as building block for the scatterer.



The scatterer

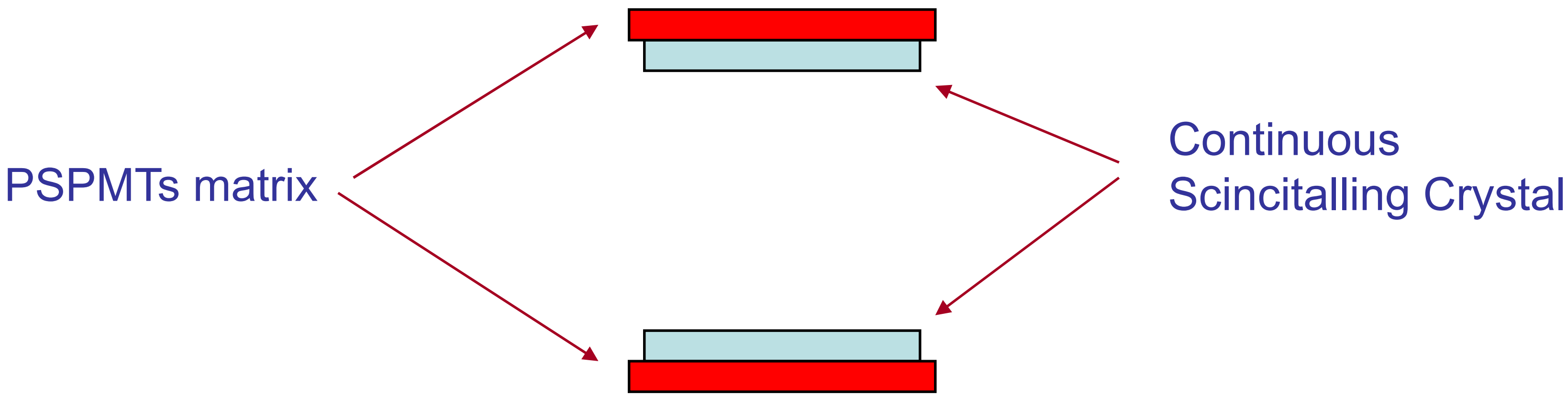
- Silicon is probably one of the best materials
  - Right Compton cross section
    - no absorption
    - Second Compton has low probability
  - Smallest tail produced by Doppler broadening compared to other materials
    - Only relevant for low energy photons (<300 keV)
- Mastered technology (detectors + r/o electronics) in High Energy Physics
- Some prototypes already built in Valencia for other applications

The PET detector

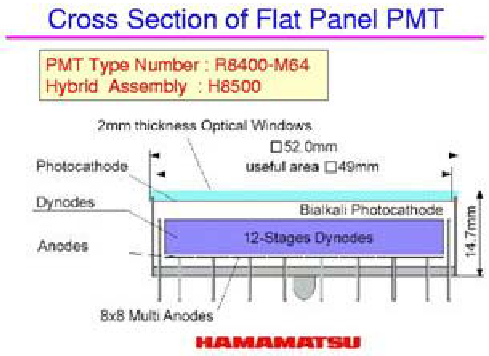
FIRST APPROACH: 2 PANELS.

EACH PANNEL MADE OF:

- FOTODETECTOR: matrix of PSPMTs (HAMMAMATSU H8500).
- CRYSTAL: continuous scintillating crystal.



The PSPMT matrix



Resistor network to reduce the number of channels to be digitized and to join several PSPMTs in a common readout.

9 x 9 PSPMTs will cover an area of about 16 x 16 cm2

The Scintillating Crystal

Two options:

•**LSO.**

Advantage: higher stopping power.

Disadvantage: high intrinsic rate (cannot be used for triggering in single mode).

•**LnBr.**

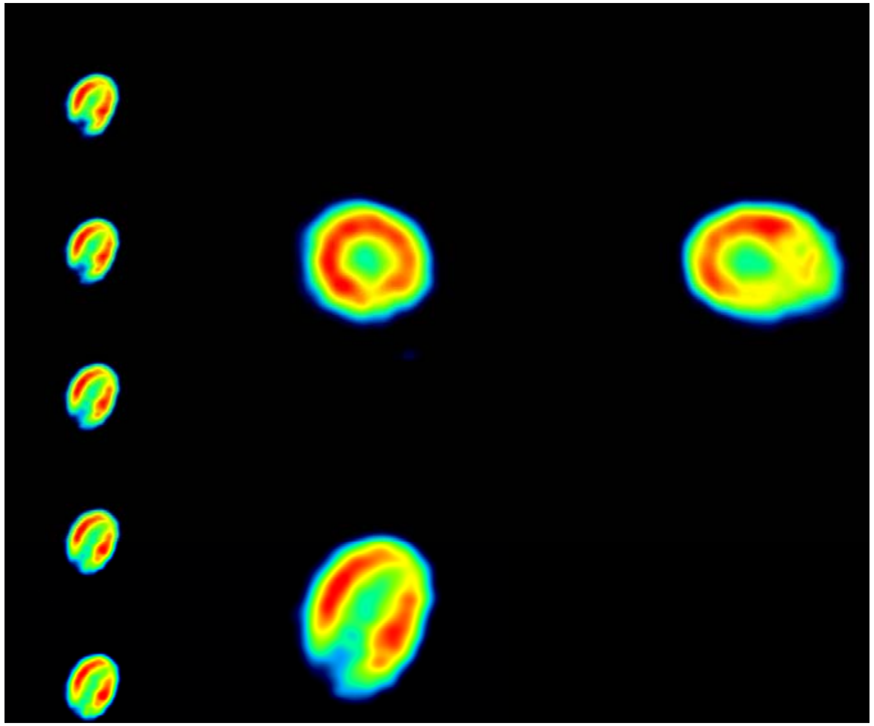
Advantage: fast and higher light yield (ideal for TOF-PET).

Disadvantage: currently still very expensive.

We have also experience in building such PET technology.

Small animal PET

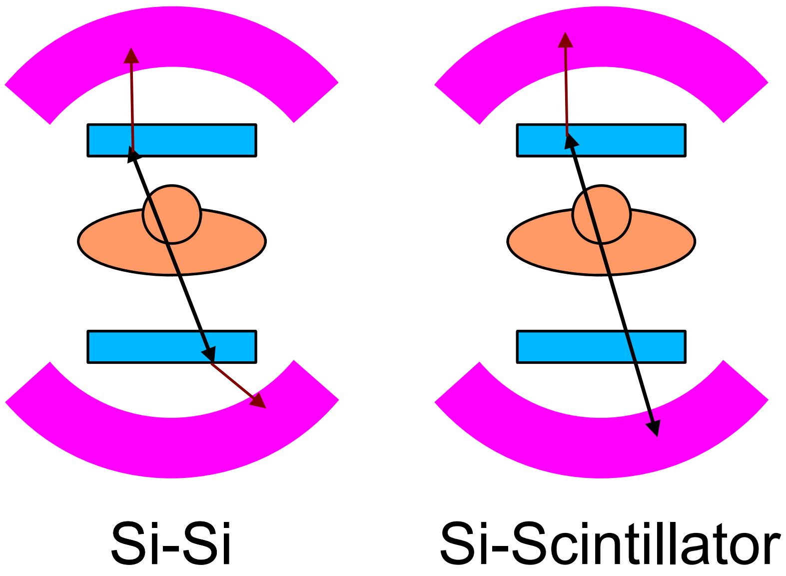
Rat´s Heart



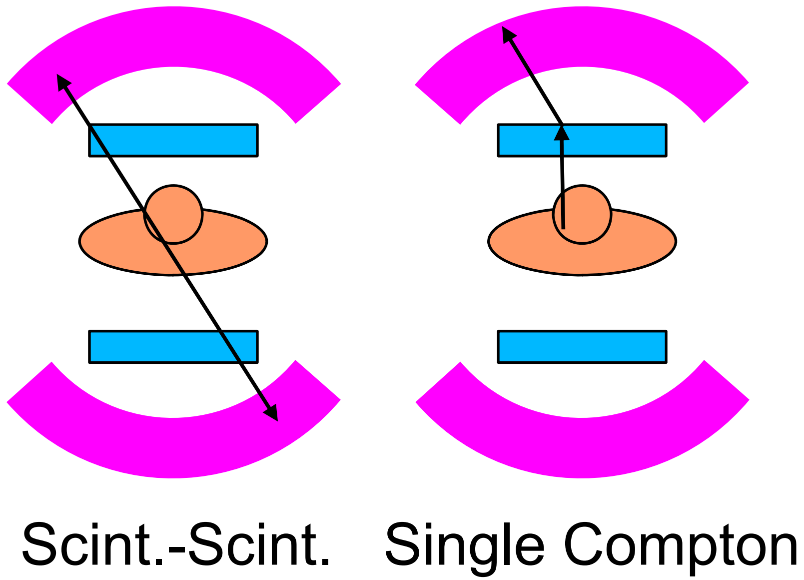
Multichannel reconstruction

Goal: use and reconstruct all types of events

High resolution channels



Low resolution channels



Improve spatial resolution

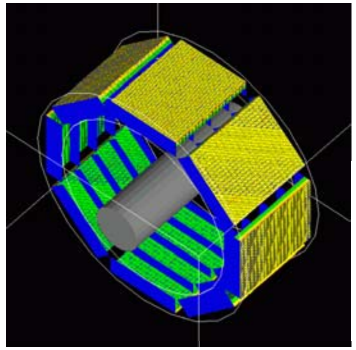
Improve sensitivity

Multichannel reconstruction

Dedicated reconstruction algorithms are needed

- Resolution channels considered in the system response matrix
- Dedicated modeling for each type of event
- Increased computational complexity

Monte-Carlo simulations



Goal:

- Optimization of system design
- Support modeling of physical response
- Evaluation of system performance and reconstruction algorithms

Monte Carlo Simulation packages:

- Geant4
- GATE

Resources:

- Grid infrastructure at IFIC
- PC Clusters

Questions

- How much space do we have for PET and Compton PET?.
- How many prototypes in the project?
  - Only 1: Enhanced TOF-PET with Compton.
  - 2 prototypes: TOF-PET and enhanced PET.