Characterisation of a pixellated CsI detector for the Distinguish Project.

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UNIVERSITY OF LIVERPOOL

PSD8

8TH INTERNATIONAL CONFERENCE ON POSITION SENSITIVE DETECTORS

Overview.

- Introduction to the Distinguish Project.
- Gamma-ray detection and Imaging.
- Compton Imaging.
- The detector.
- Current progress.
- Future Work.

The Distinguish project.

- A collaboration of three UK Universities.

- Working together in developing a highly specific detection and imaging system for the detection and quantification of narcotics and more notably, explosives.

- Current imaging systems are based on methods such as conventional X-ray imaging through to CT scanners.

- They have high-sensitivity density information but not such good specificity which could lead to disaster.

- It is clear there is a need for something specific, sensitive, quick and automated to help prevent future atrocities caused by explosives.

The Distinguish project.

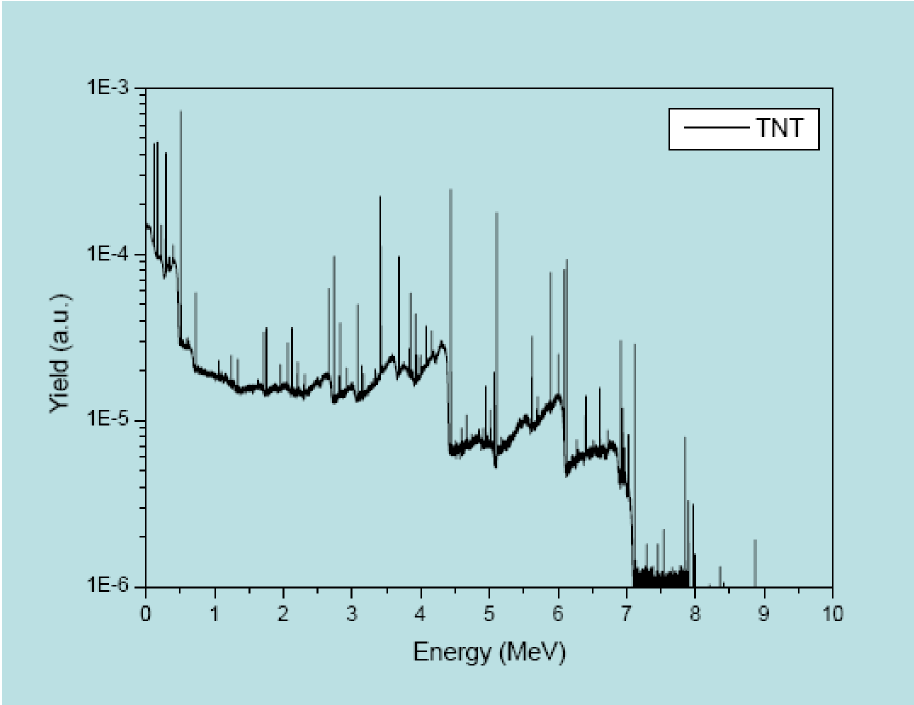
• Explosives/narcotics contain combinations of the lighter elements.

•Elements such as Oxygen, Carbon and Nitrogen which have characteristic gammarays.

• After neutron interrogation these characteristic gamma rays will be emitted.

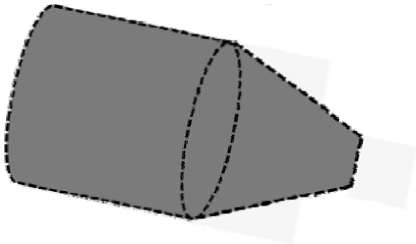
• Characteristic gamma rays:

•Oxygen - 6.13MeV.
Nitrogen - 5.11MeV, 2.31MeV,1.64MeV.
Carbon – 4.43MeV.



The Distinguish project.

Neutron detector

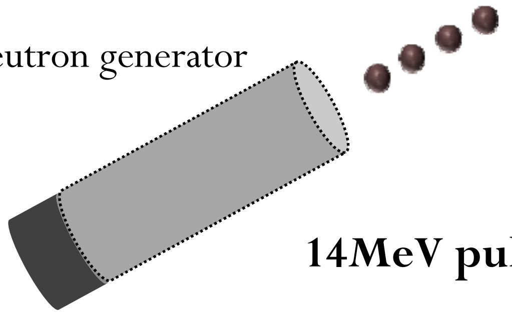


Inelastic scattering.

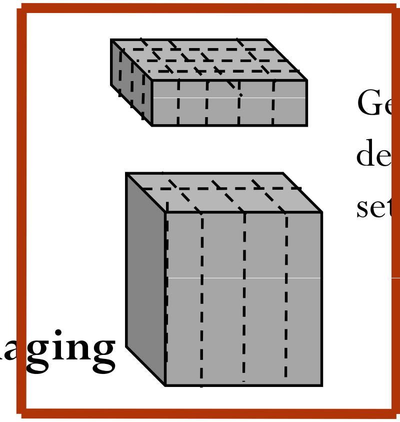
γ

Characteristic gamma rays emitted

Neutron generator



14MeV pulsed neutrons.



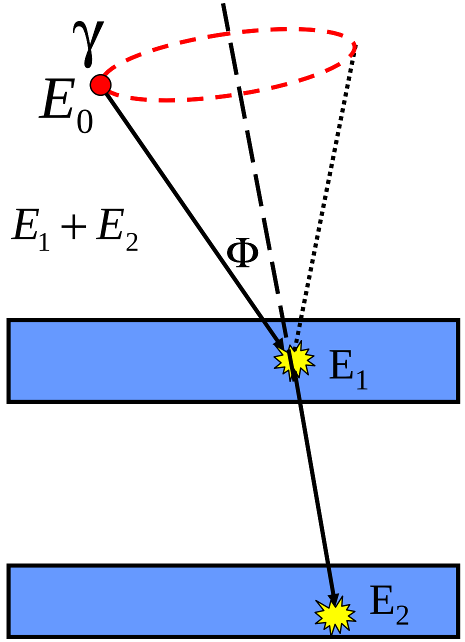
Ge and CsI detector setup

Detection and imaging

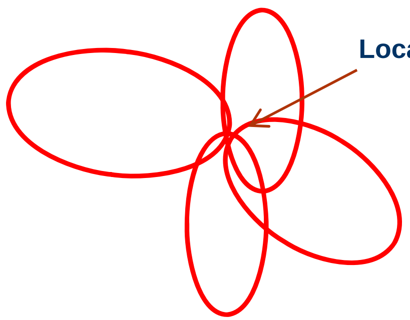
Compton Imaging.

- The Compton imaging technique is to be used to localise the source of gamma rays.
- Cone reconstruction method allows localisation of source.
- Electronic collimation allows high imaging efficiency.
- Scatter detector – good energy resolution, position dependence.
- Absorber detector - high stopping power and position dependence.
- Looking at energies in the range of 4-7MeV.

$$E_0 = E_1 + E_2$$

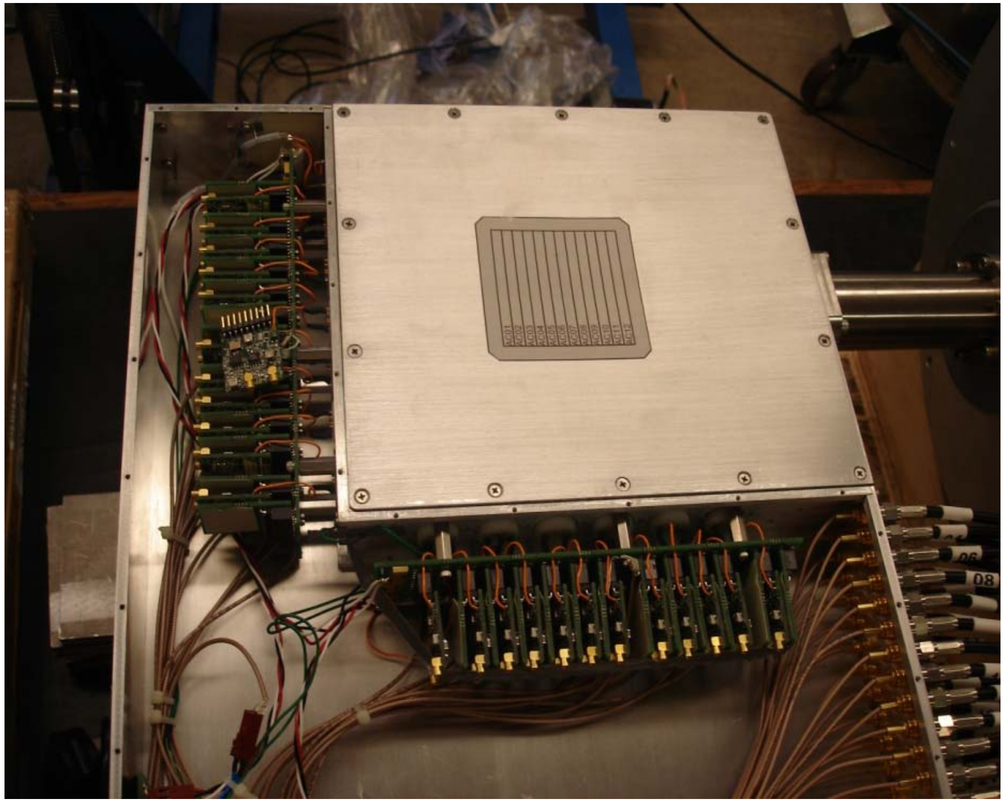


$$Cos\Phi = 1 - m_o c^2 \left(\frac{1}{E_1} - \frac{1}{E_0} \right)$$



Gamma-ray detection and imaging.

<u>The Germanium detector.</u>



- Planar Germanium detector.

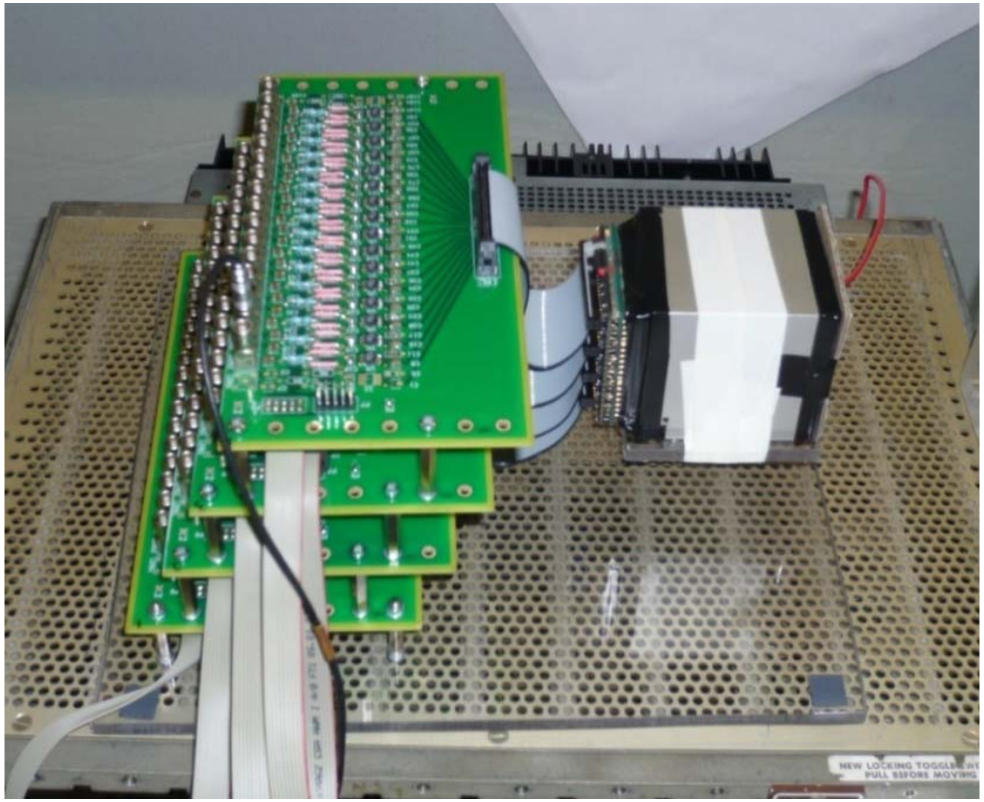
- AC/DC strip configuration.
  12 x 12 orthogonal strips.

- Good energy resolution.

- 60 x 60 x 20mm active area with
  5 x 5 x 20mm pixels.

Gamma-ray detection and imaging.

The Caesium Iodide detector.



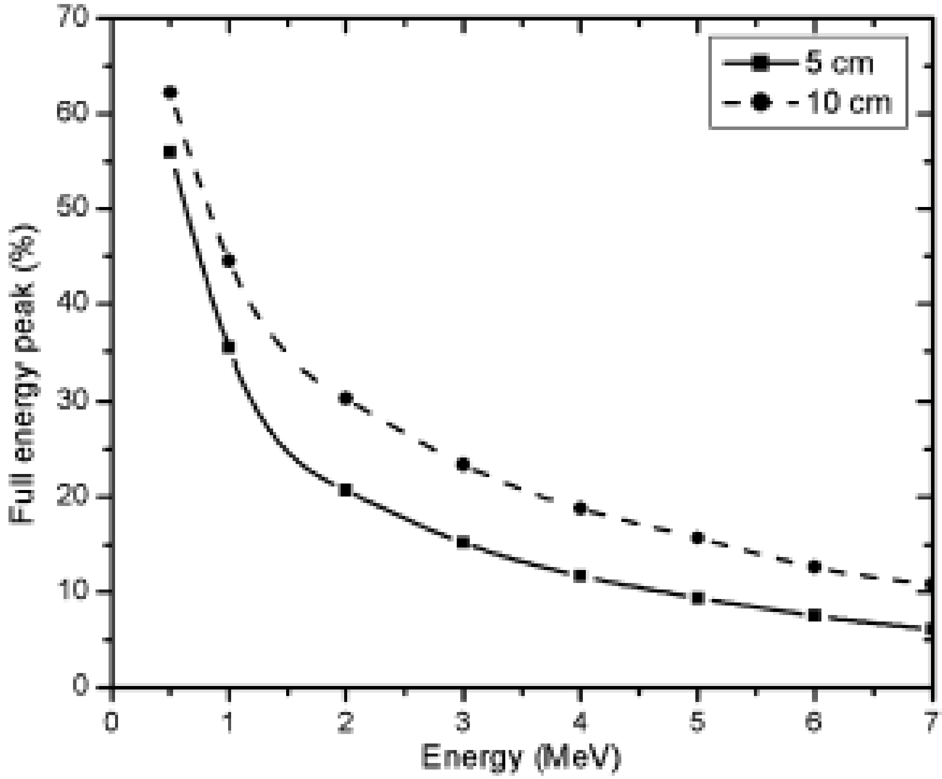
- 64 pixel CsI detector (8 x 8).
- High stopping power.
- 48 x 48 x 50mm active area with 5 x 5 x 50mm pixels.
- Photomultiplier – 64 pixels (8 x 8).
- 64 individual preamps

Current progress.

• Simulations, two thicknesses assessed.

• Full energy peak (%) Vs Energy (MeV).

• Thicker detector gives higher efficiency.



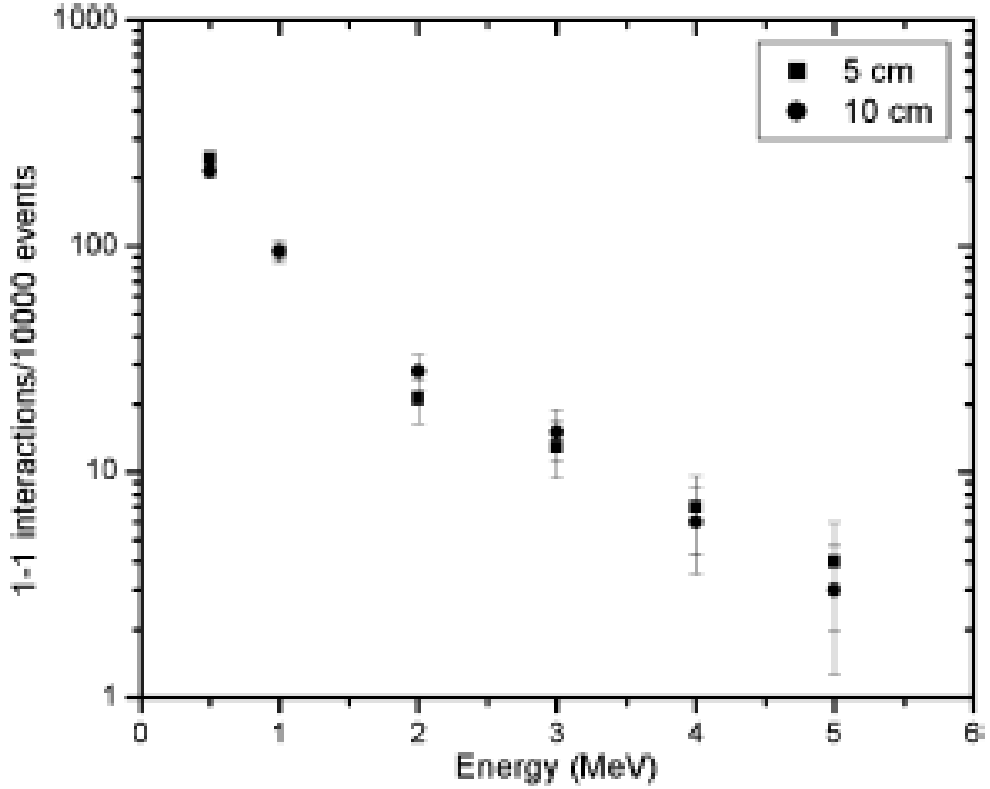
Current progress.

• Further simulations.

• No significant change in the number of 1-1 interactions when comparing 5cm and 10cm thick detector.

• No depth of interaction information possible.

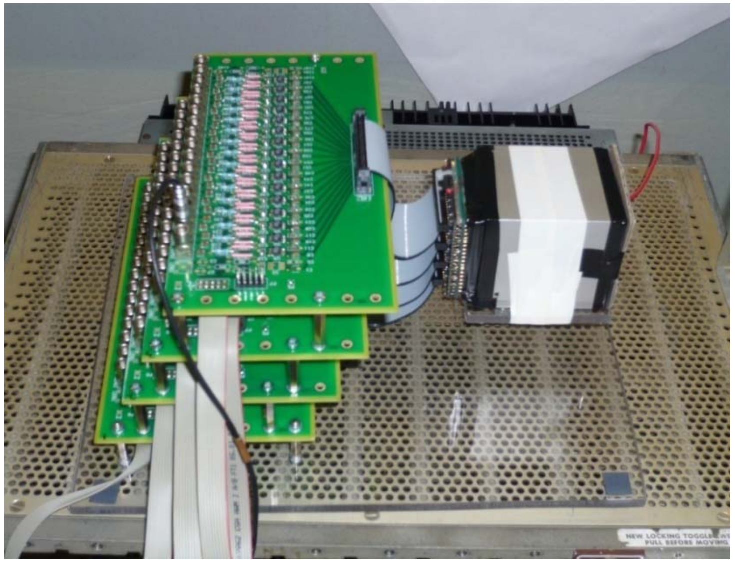
• 5cm thick detector being used to reduce angular uncertainty.



Current progress.

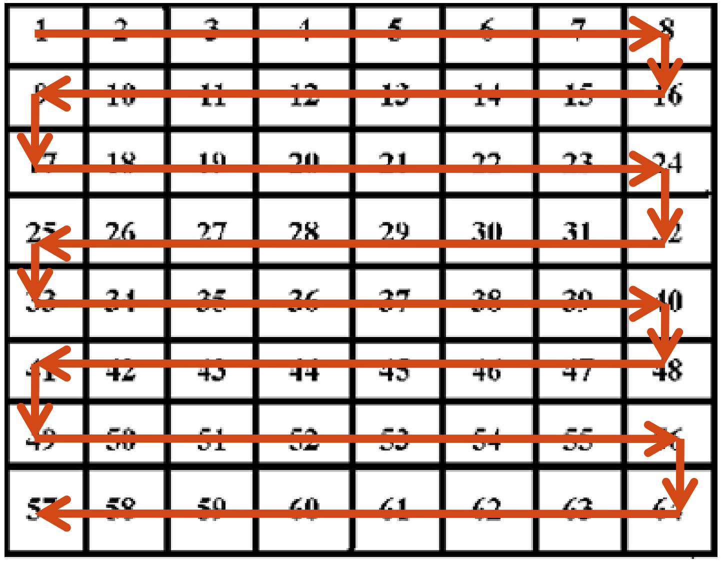
- Preamps constructed and coupled to detector at Liverpool.
- Before tests on detector, preamp tests done to check performance of the detector.
- Results mostly good.
- 61/64 preamps give good output.
- Pixel 64 produced no response.
- Pixels 32 and 48 noise issues.
- Usual preamp output – 1.5μs RT 15μs FT.

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64



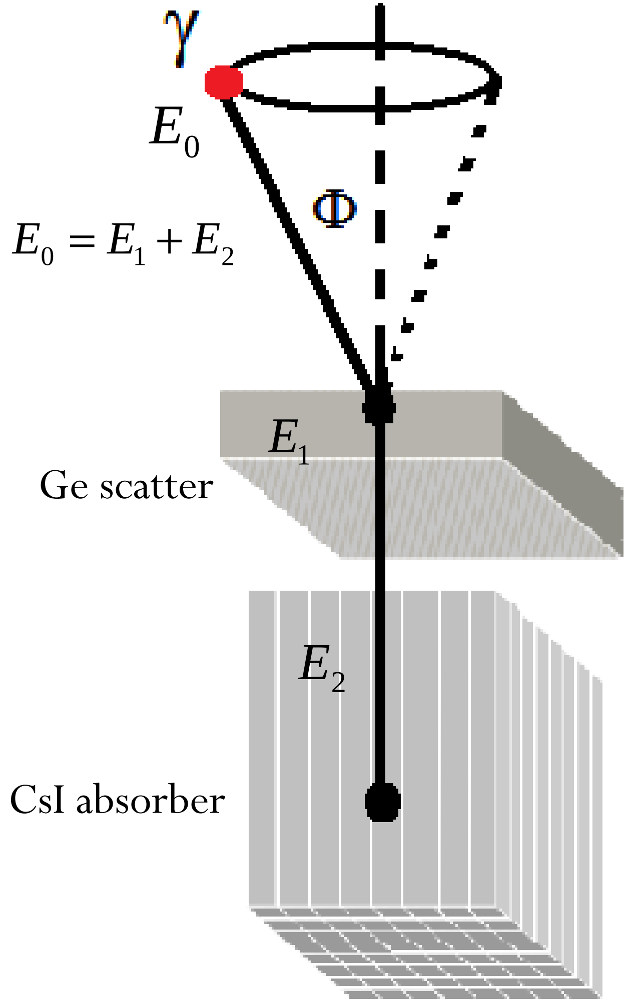
Future work.

- Full detector characterisation to be complete.
- Will be performed using X-Y scanning table.
- Move in increments of 1mm.
- Collimated beam of 60keV gamma-rays. (Am-241).
- Should enable quantification of position dependant response of the detector.
- Full optical crosstalk measurement.



Future work.

- Aim to complete imaging with Ge/CsI in Compton camera mode.
- Looking at energies in the range of 4-7MeV.
- Full simulation of setup to be performed.
    - Optimisation of CC geometry.
    - Neutron interactions.



$$Cos\Phi = 1 - m_o c^2 \left(\frac{1}{E_1} - \frac{1}{E_0} \right)$$

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