



CANBERRA



Recent developments in detection technology for scientific research applications

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Chief Technology Officer

Agenda

Introduction to CANBERRA

History of Nuclear Structure Research

Small Anode Technology

Additional Research / Collaboration

CANBERRA at a Glance



- ▶ **Worldwide leader in nuclear measurement**
- ▶ **50 years in business**
- ▶ **Revenues: around 190M Euros**
- ▶ **1,000 employees**
- ▶ **250 customer-facing sales and service personnel**
- ▶ **40 PhD's**
- ▶ **7 industrial sites**
- ▶ **26 sales and service offices**
- ▶ **35 distributors**
- ▶ **Over 5,000 customers**
- ▶ **Parent company--AREVA**

Applications (other than education and research)

Radiochemistry



Health Physics



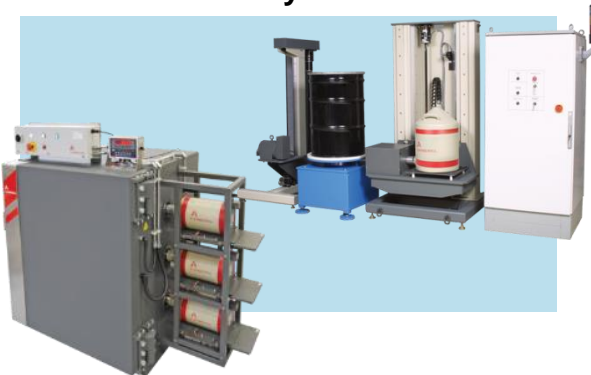
Tactical Military



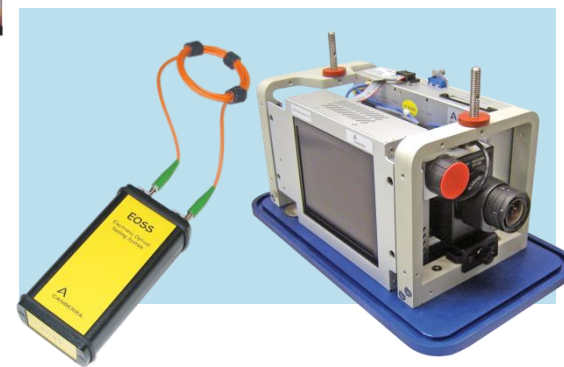
Environmental and Process Monitoring



NDA Systems



Containment and Surveillance



Customers

(in addition to universities / national labs)



NPP



Laboratories



D&D



Fuel Cycle



Military

Long-standing relationships with diverse customer base

A small sampling of major customers



Nuclear power plants

Fuel cycle

Decommissioning and
dismantling

Laboratories

Military, security and
safeguards



Recent Successes



3M Euros Contract to Supply Waste Assay System to the DOUNREAY Shaft and Silo Project in the UK



Japanese Government orders Rice Counters



CANBERRA Equipment in New Teaching Lab at University of Liverpool



Significant Commercial Successes in Near and Middle East Region

Spain, Cofrentes Nuclear Power Plant Orders SafePoint™ skid for continuous noble gas measurement



Horia Hulubei National Institute of Physics and Nuclear Engineering in Romania orders Clover detectors



Westinghouse orders SafePoint™ Process Radiation Monitors and Gas Stripper Effluent Radiation Monitors



CANBERRA Equipment Lands on Mars



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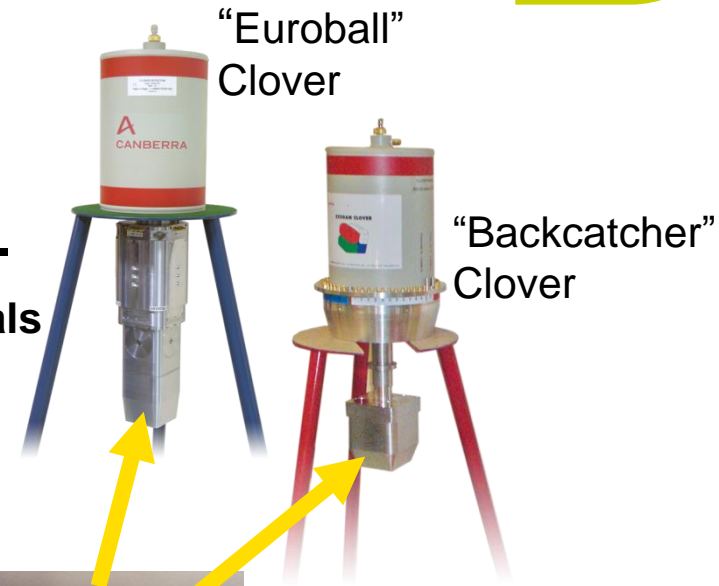
Importance of Nuclear Physics Research for Canberra



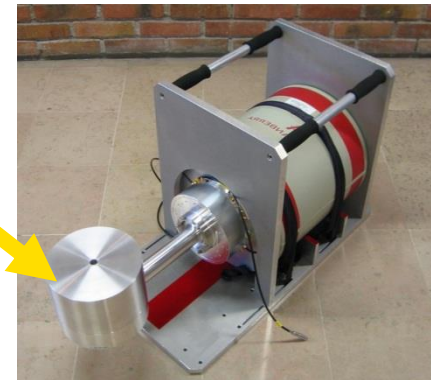
- ▶ **Innovation driven by you, the users**
- ▶ **A frontier for technology development**
- ▶ **Underlines Canberra as a scientific brand**

CANBERRA Clover Detectors

- ▶ First introduced by the Euroball collaboration (Peter Twin, Francis Beck).
- ▶ Recognized worldwide as a reference detector for nuclear physics for 20 years.
 - ▶ Record efficiency with unmatched large crystals (VEGA Clover 140x140x140mm³).
 - ▶ With or without segmentation.
 - ▶ Up to **12kg** HPGe material in 1 cryostat.
- ▶ Under development:
 - ▶ LN2 free cooling.
 - ▶ Broader energy ranges.
 - ▶ Intelligent electronics with new features.
 - ▶ New crystal sizes and shapes.
 - ▶ High customization possible with dedicated crystal shape or special cryostat.



Array of 4 HPGe coaxial N type crystals



"True Well type" Clover

Array detector expertise

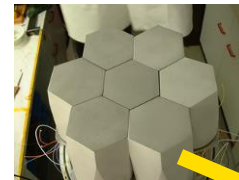
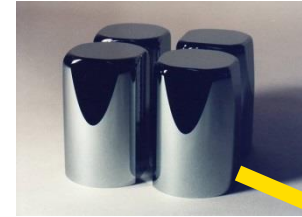
► Increased efficiency and resolving power with array detectors:

- Encapsulated HPGe crystals in a common cryostat for nuclear physics (EuroBall, MiniBall, Agata, Greta).
- Success in space, industrial (CTBTO) or airborne applications.
- From 2kg up to 15kg of HPGe to reach an unprecedented **1300%** relative efficiency with add-back measurement.
- Up to 36 fold segmentation
- High degree of customization possible.

► Under developments:

- LN2 free cooling.
- Intelligent electronics with new features.

Clover detector



Cluster detector (600%)



Greta detector



Integral project

Agenda

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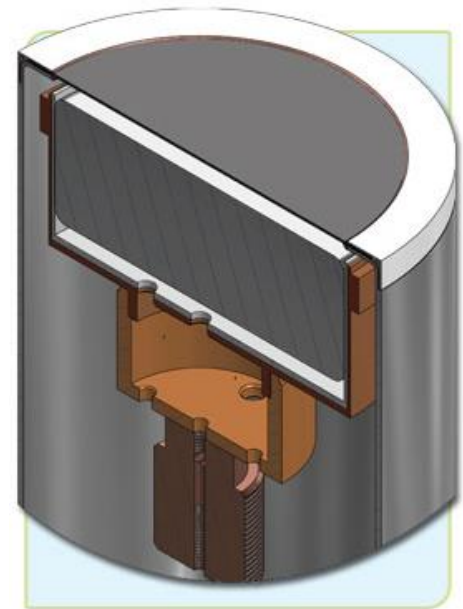
History of Nuclear Structure Research

Small Anode Technology

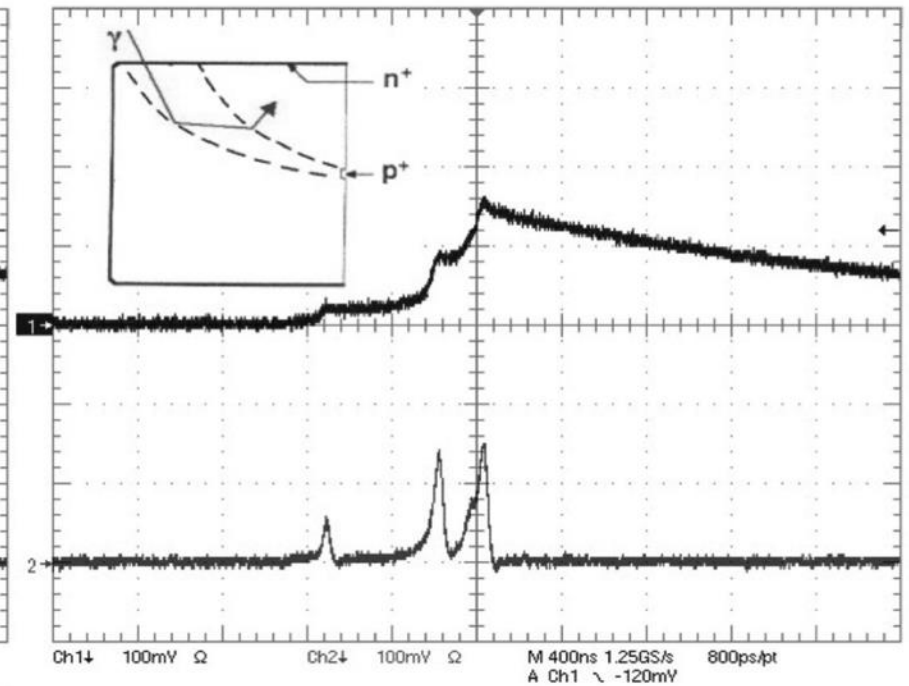
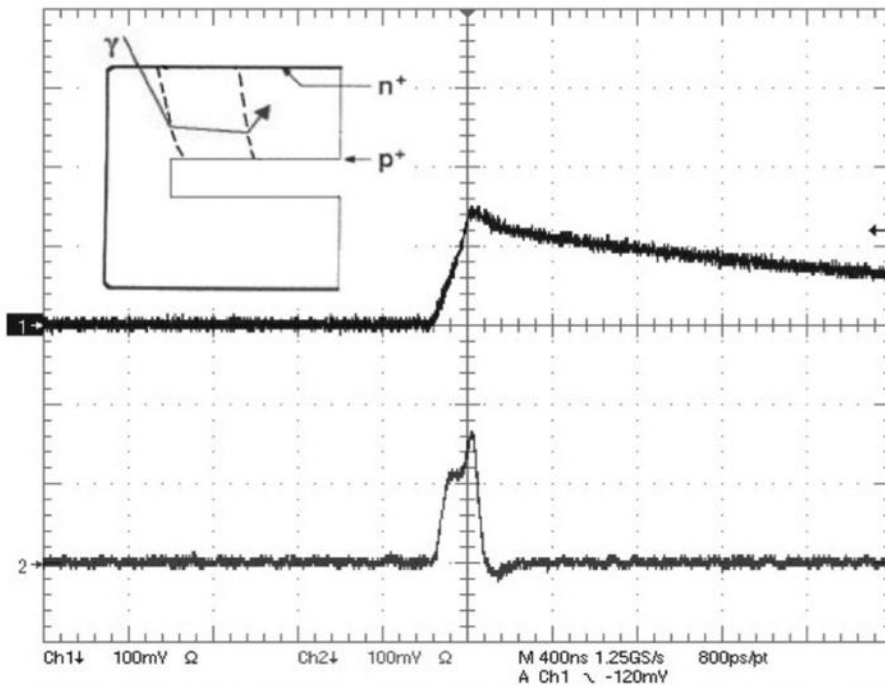
Additional Research / Collaboration

Broad Energy HPGe Detectors

- ▶ Drift of charges is radically different from a normal coaxial detector
- ▶ Long drift times, up to $\sim 2 \mu\text{s}$
- ▶ Small capacitance gives very low noise
- ▶ Can be segmented to give superb position resolution
- ▶ Signal time helps to determine drift distance and therefore position

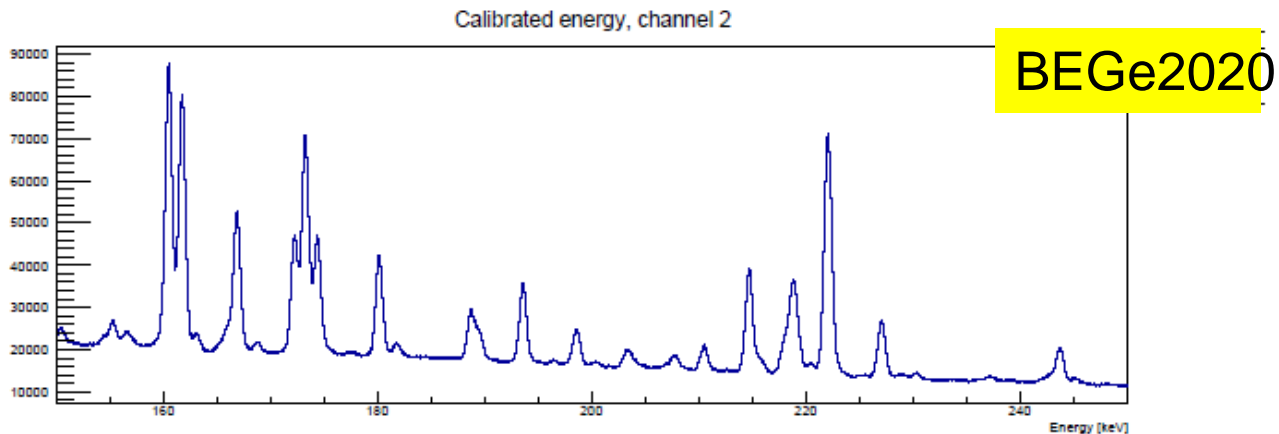
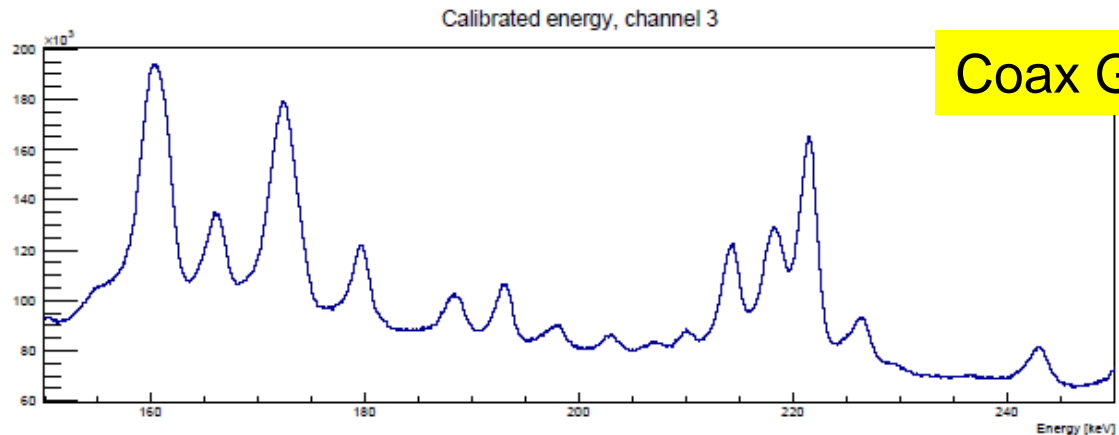


Coax vs BEGe charge pulse shape response



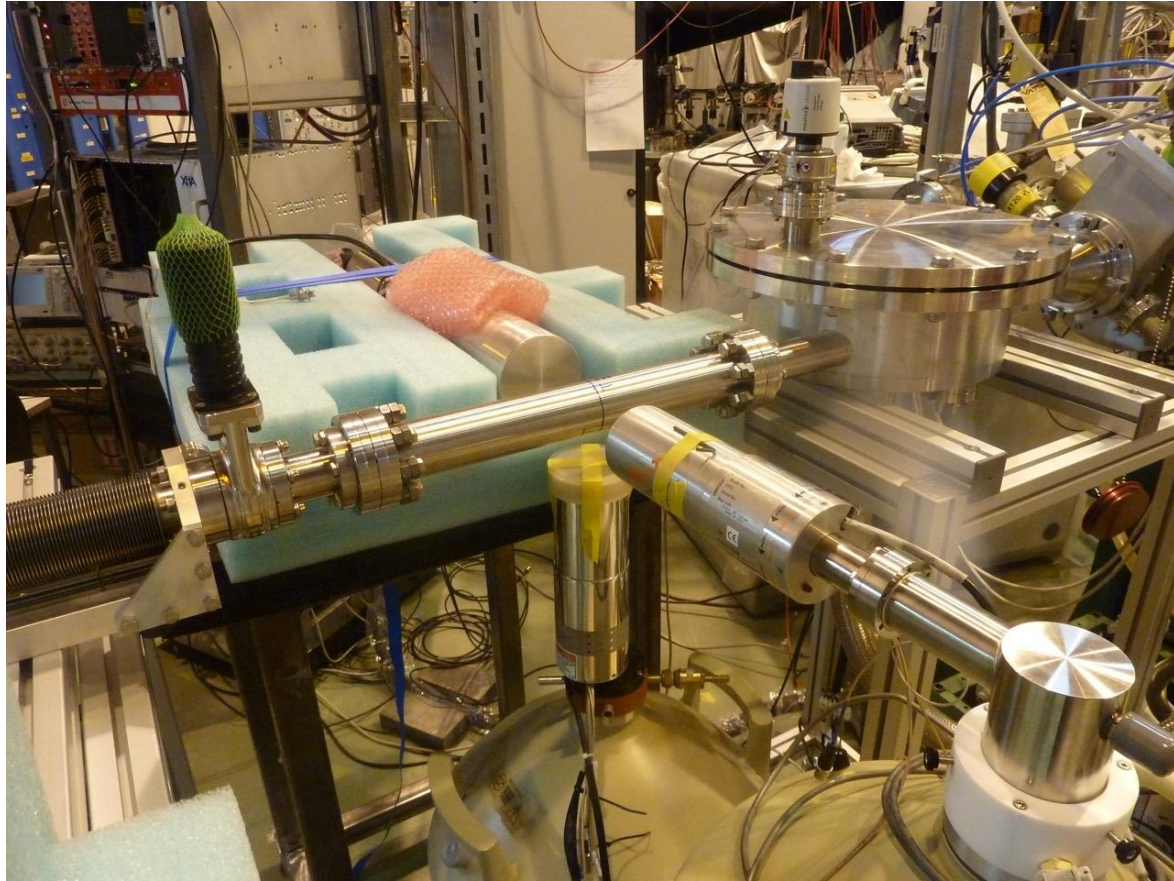
Application of a BEGe detector Nuclear Physics - Isolde

^{183}Hg β decay



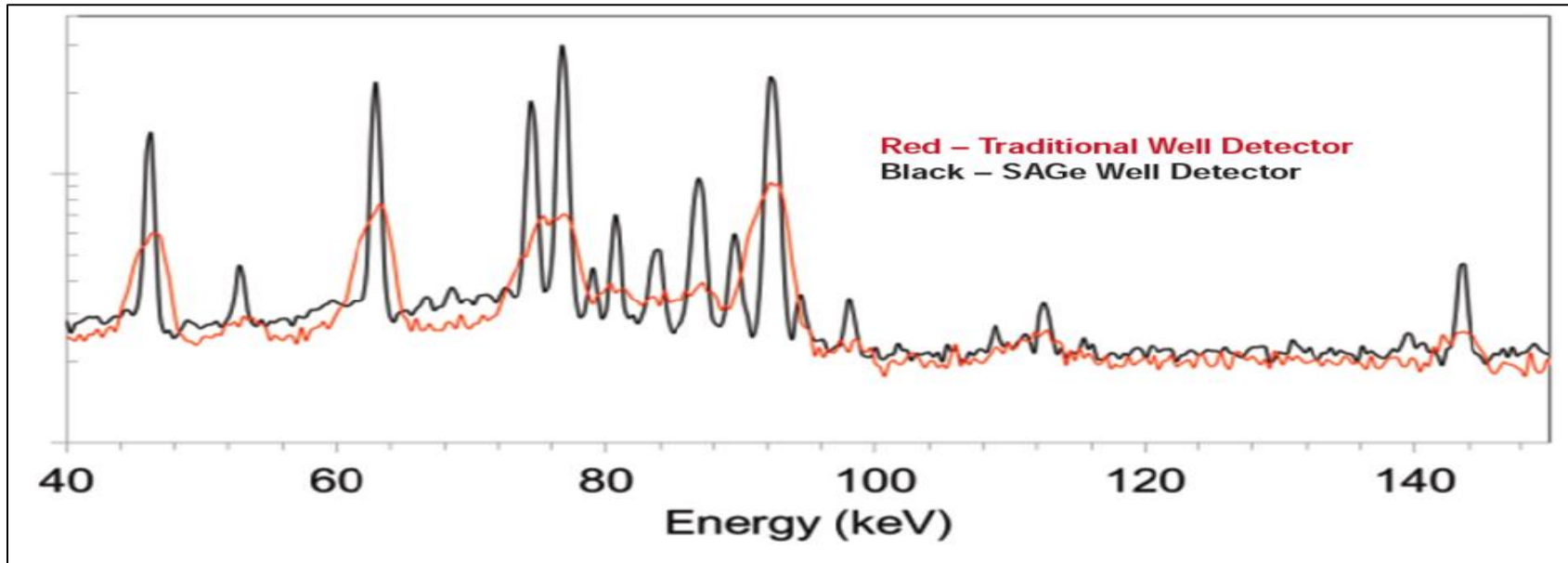
Thanks to Martin Venhart

Ideal for Beta decay studies

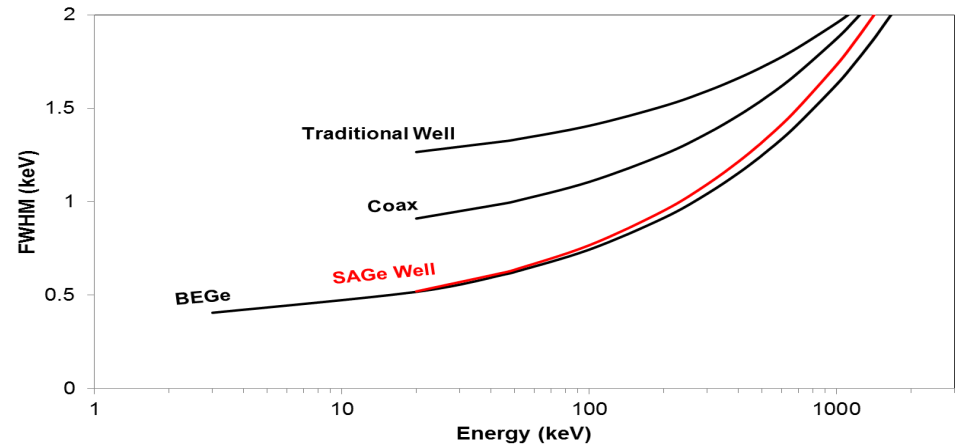


Thanks to Martin Venhart

SAGe Well Detector

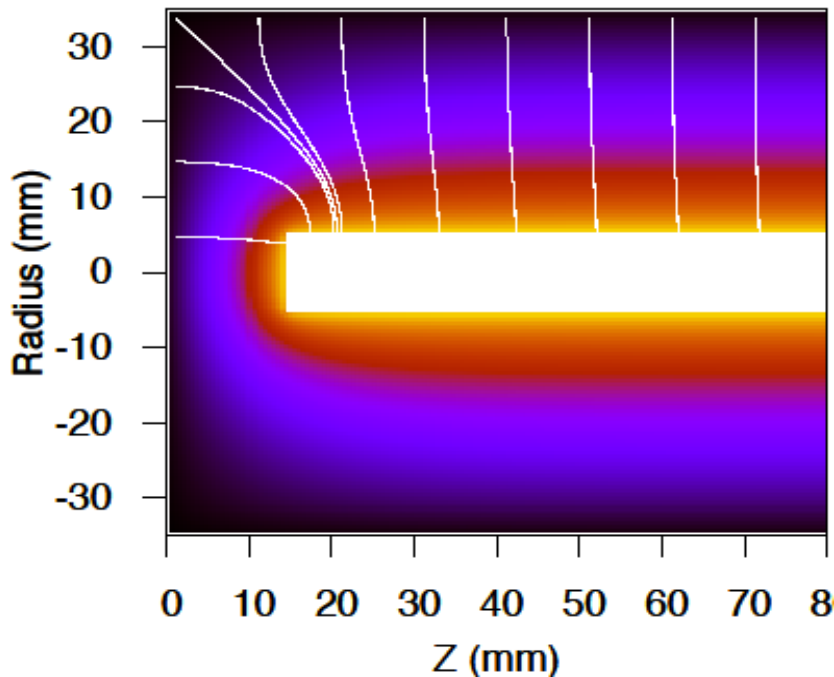


Typical resolution versus energy

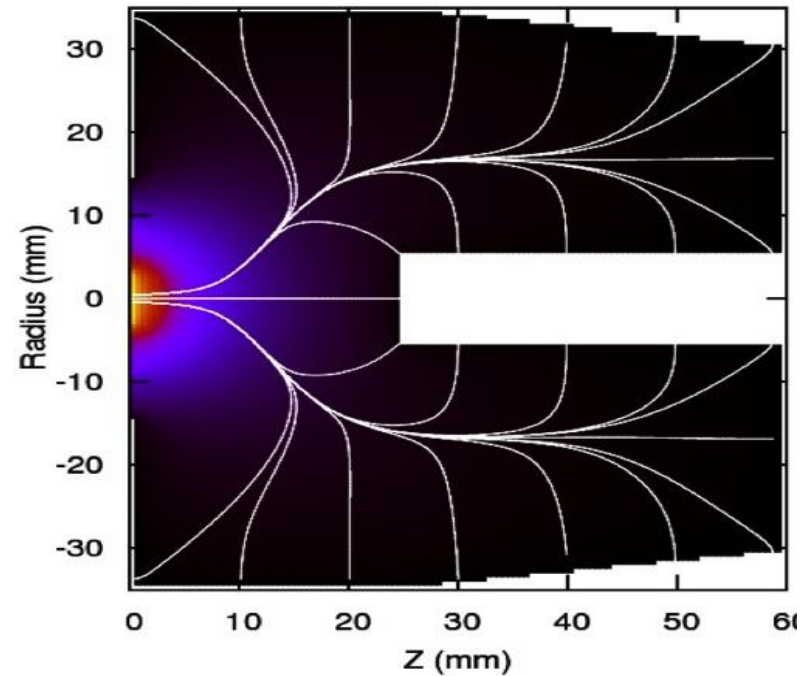


“Inverted Coaxial” Point-Contact

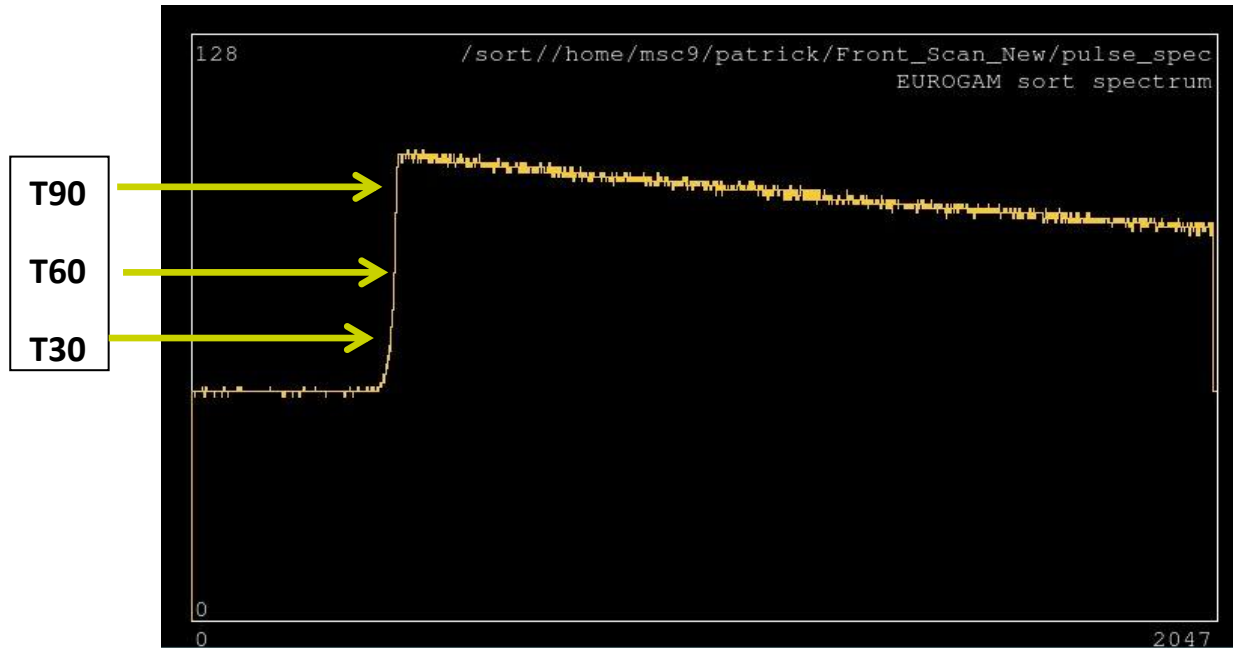
Closed-end Coaxial



Inverted Coaxial



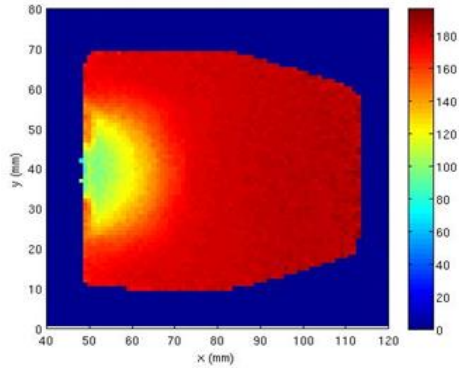
Rise Time Analysis



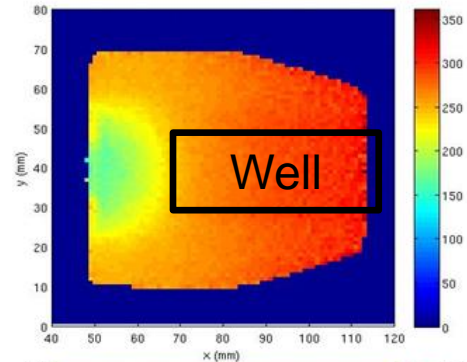
**Use T30 – time to rise to 30% of pulse height
plus T60 and T90**

Rise Time Versus Position

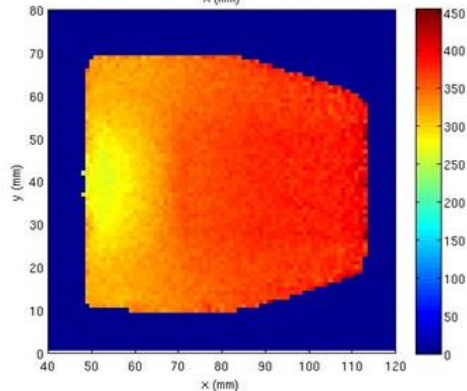
T30



T60



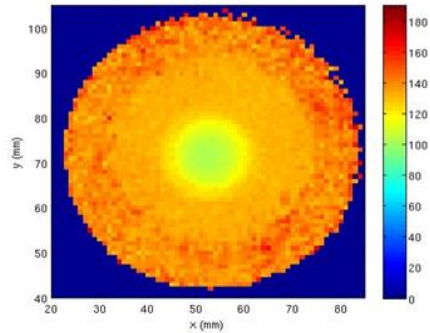
T90



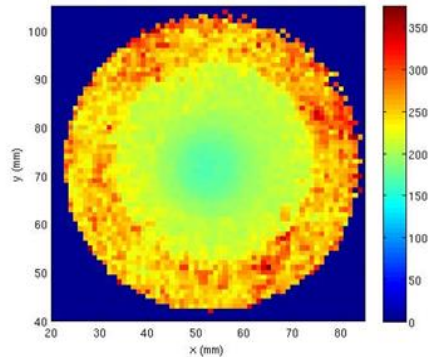
- Cs 137 keV source
- Scan across side
- Rise time map

Rise Time Versus Position

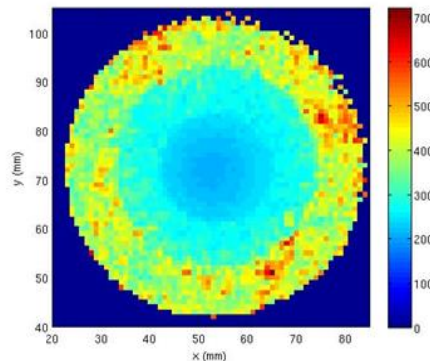
T30



T60



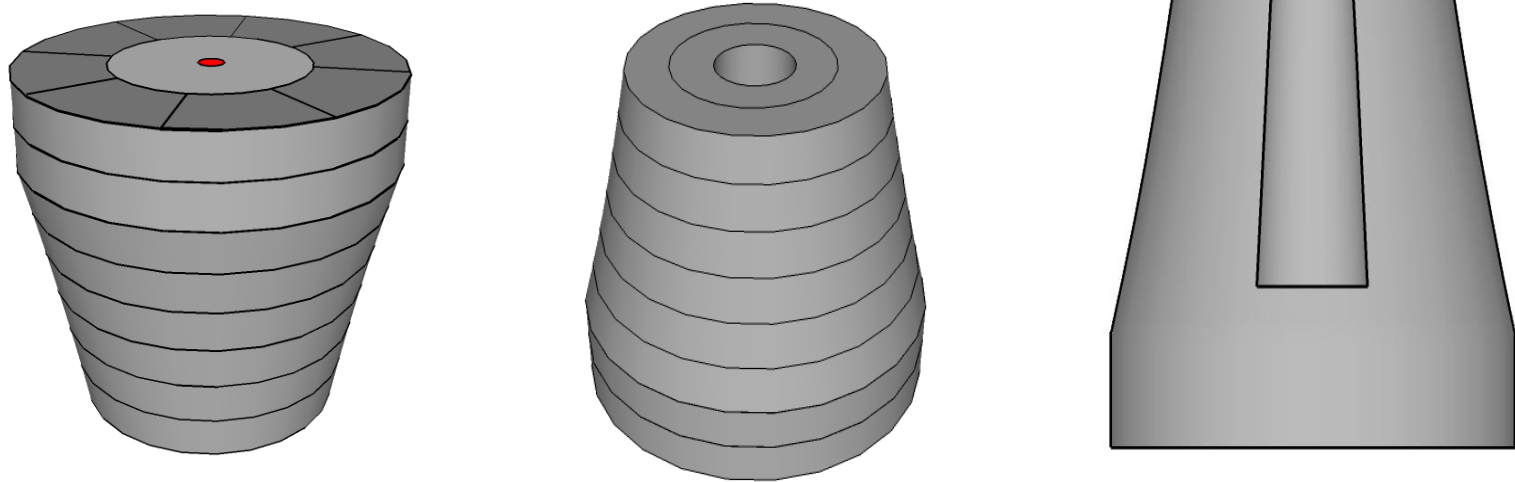
T90



- **Cs 137 keV source**
- **Scan across front**
- **Rise time map**

Segmentation (SIGMA Detector)

Under development



P-type material

- Excellent energy resolution (low capacitance)
- Pulse shape analysis to provide 1mm^3 position resolution

Small Anode Technology – Summary



- ▶ **Low capacitance – unrivaled energy resolution across a broad energy range**
- ▶ **Pulse shape properties support analysis to give position information**

SIGMA

- ▶ **Physical segmentation in conjunction with pulse shape analysis can deliver 1mm³**

Standard BEGe

- ▶ **Investigation of time resolution improvements under way for standard BEGe**
- ▶ **Electronic Compton suppression to reduce cost / improve efficiency**

Agenda

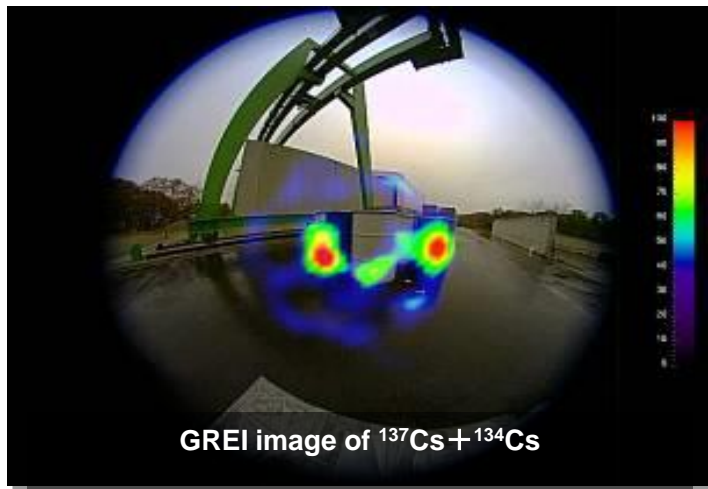
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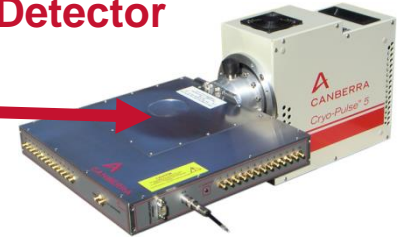
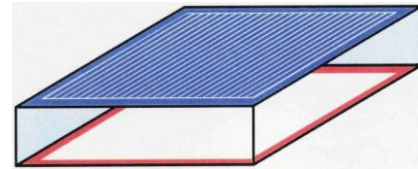
Segmented Detectors



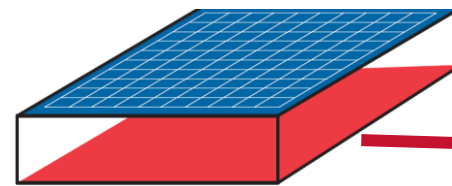
► Highlights:

- Coaxial & planar detectors.
- HPGe & Si(Li) material.
- Telescope (stack) or other assembly
- High level of cryostat customization.
- LN2 free operation possible.
- Versatile application:
 - Compton gamma camera, imaging, homeland security, non destructive control

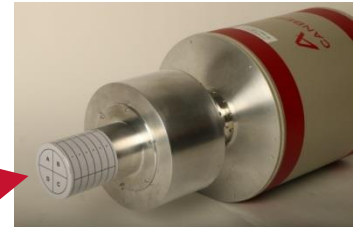
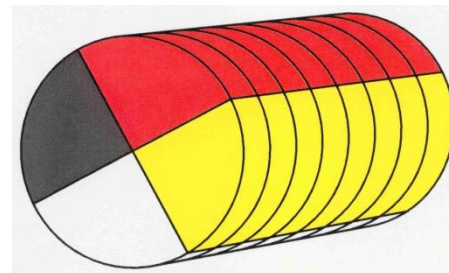
DSSD: Double Sided Strip Detector



Pixel detector

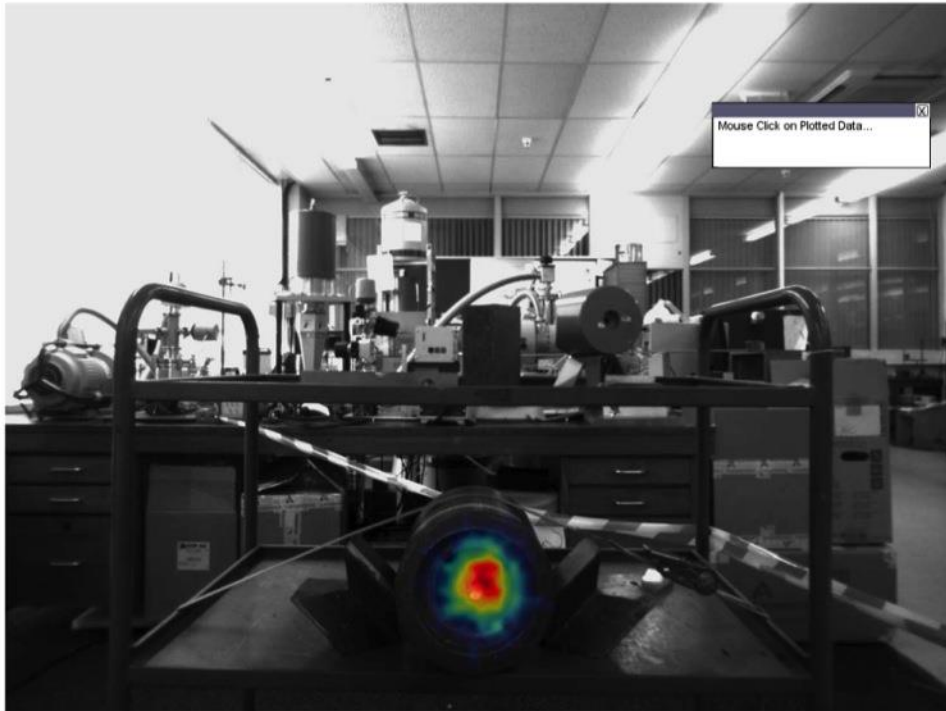


Segmented coaxial detector

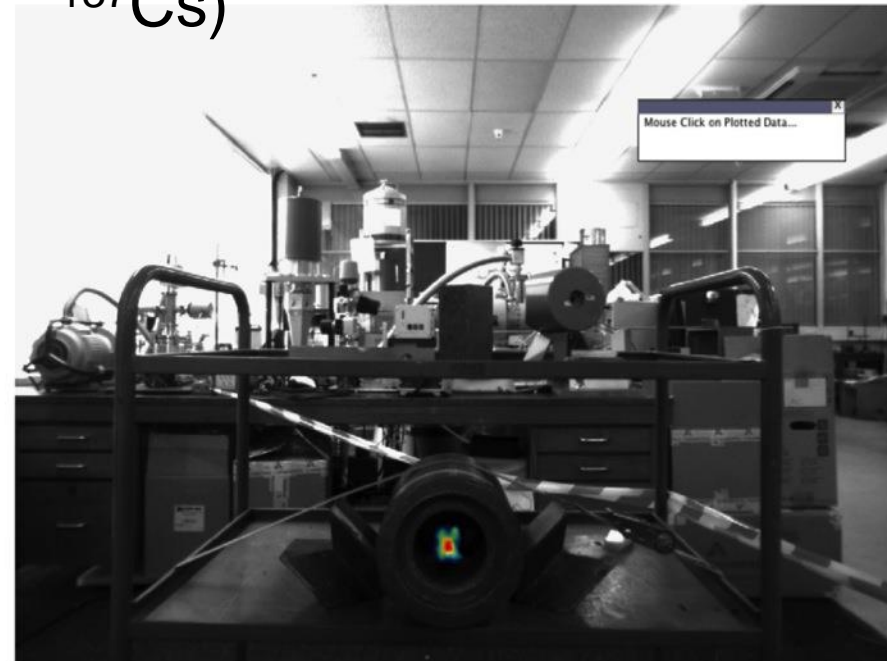


The potential: 3D Gamma & Optical Stereoscopic image fusion

1.5m standoff (20 MBq ^{137}Cs)



Back projection (6 deg)



Iterative (2 deg)

A Compton Camera provides 3D source location

The logo for Canberra, featuring a stylized red 'A' shape above the word 'CANBERRA' in red capital letters.

- 
- ▶ **Thank you for your collaboration which has pushed detector technology frontiers.**



- ▶ **Special thanks to the teams at Liverpool University for their contribution**