Exploiting the 8π spectrometer to probe nuclear matter and drive innovative applications at SFU and TRIUMF

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J.E. Williams, and the 8π collaboration

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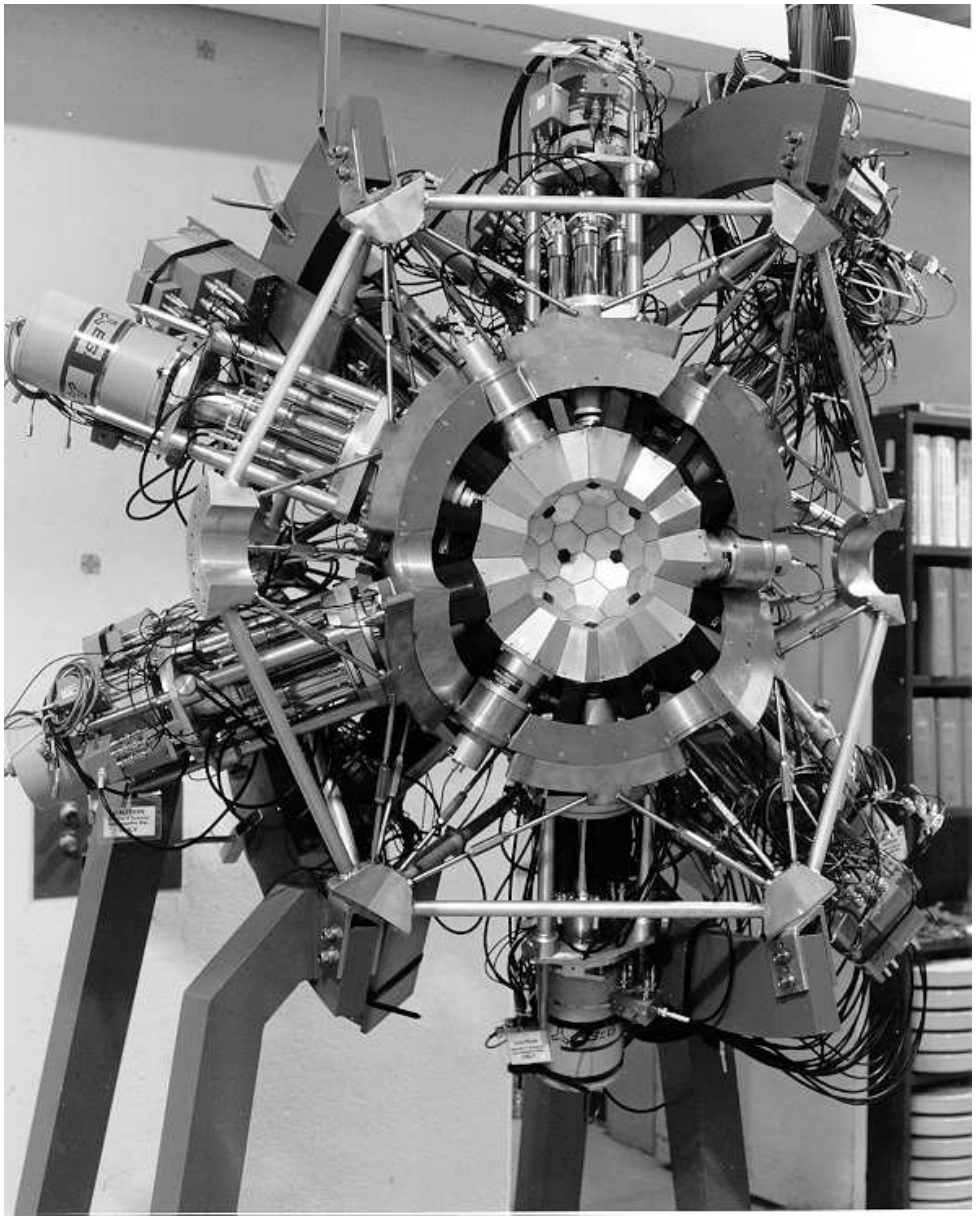
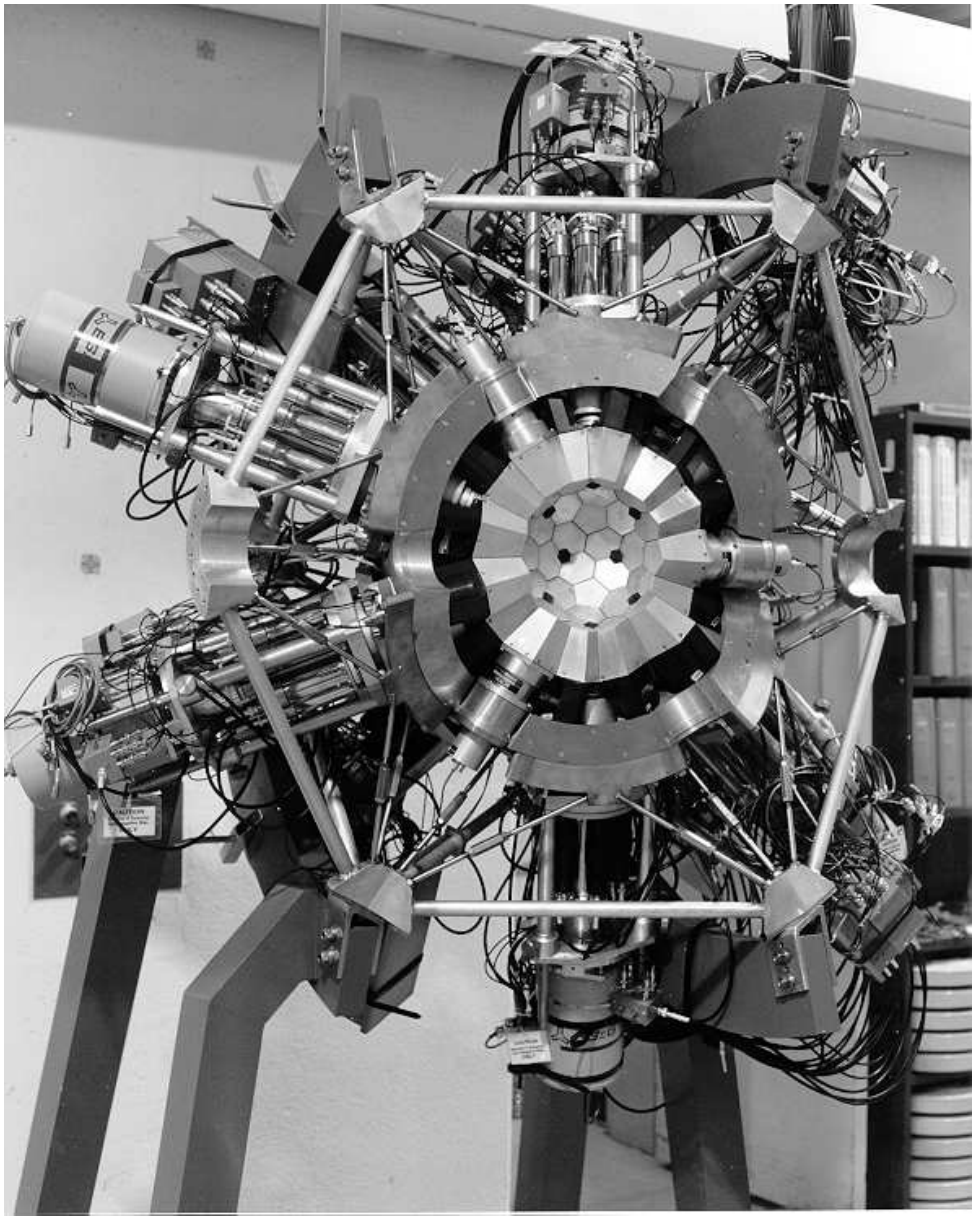
June 17, 2014

The 8π γ-ray spectrometer



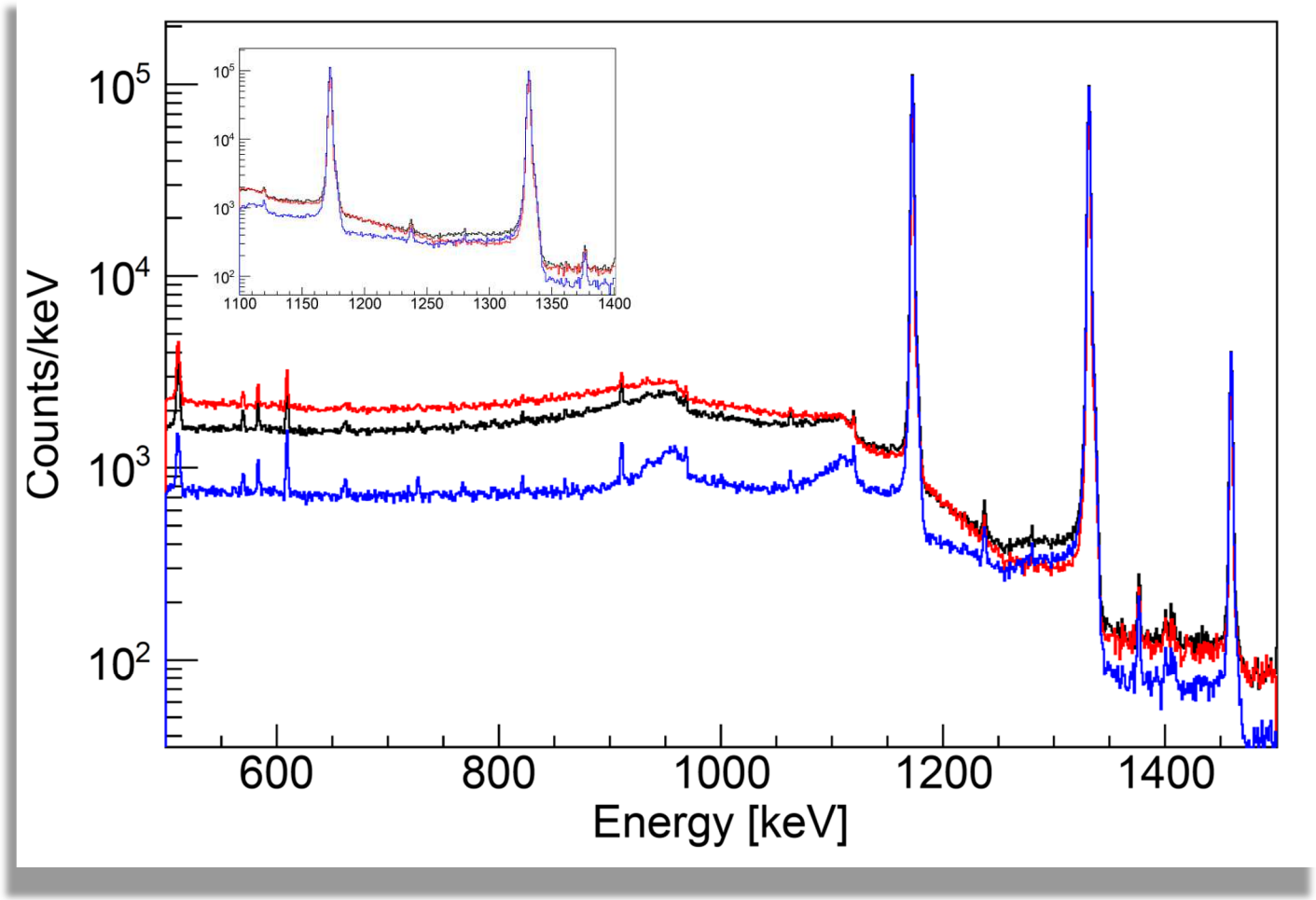
- Collaboration between Chalk River and Canadian Universities.
- Funded in 1984 by a joint AECL and NSERC grant.
- Becomes operational in 1986.
- 1986—1997 at TASCC as a high-spin spectrometer.
- 1997—2000 at the 88" Cyclotron as a high-spin spectrometer.
- 2000—2013 at TRIUMF ISAC I as a decay spectrometer.
- In January 2014 moved to SFU.

The designed 8π configuration



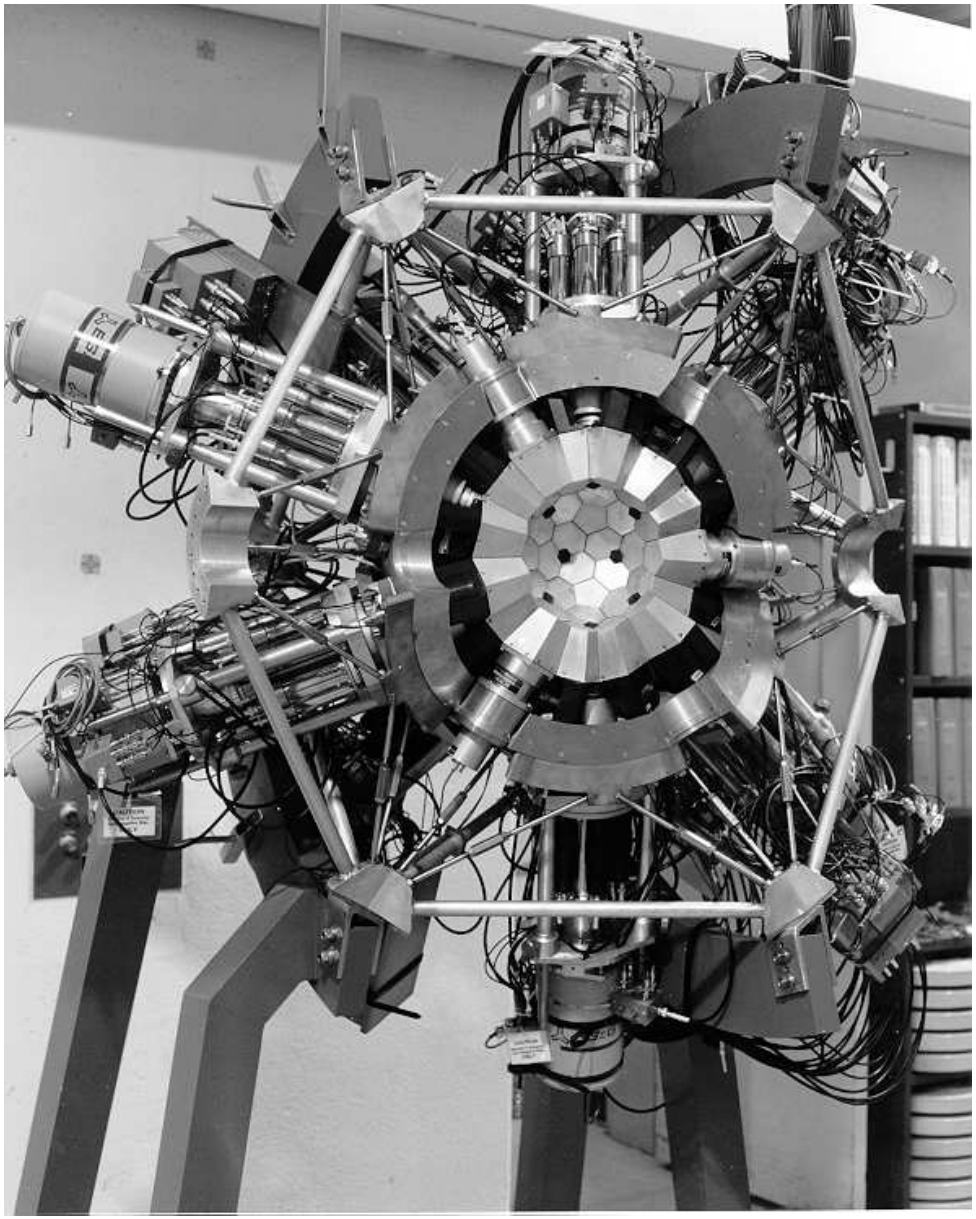
- $8\pi = 4\pi + 4\pi$
- The inside 4π shell:
  - γ-ray sum-energy and multiplicity calorimeter,
  - comprised of 72 high-efficiency, low-resolution, BGO detectors.
- The outside 4π shell:
  - high-resolution, low-Compton background measurement of γ-ray spectra,
  - comprised of 20 Compton-Suppressed Spectrometers (CSS),
  - each CSS is comprised of a high-resolution HpGe, a BGO shield and a BGO back-catcher.

TRIUMF ISAC Gamma-Ray Escape Suppressed Spectrometer



TIGRESS 90° clovers summed: ^{60}Co source spectra illustrating effect of **add back** and **Compton suppression**.

The 8π at SFU detector inventory



- 25 HpGe (20—30% efficiency),
- 21 BGO shields,
- 21 BGO back-catchers,
- 12 BGO filter pentagons,
- 62 BGO filter hexagons,
  20 of them in 6-element clusters.

Use of the 8π for γ-ray detection at SFU and TRIUMF

- Nuclear structure far from stability:
  - trap-assisted decay spectroscopy at TITAN at TRIUMF,
  - spontaneous fission studies at SFU using the Twin Ionisation Chamber for Fission Fragment Investigations (TIFFIN) detector,
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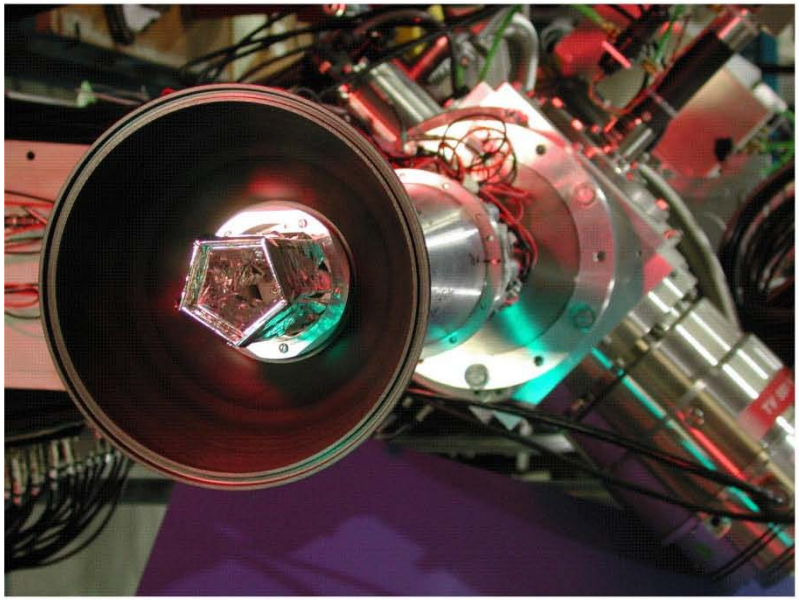
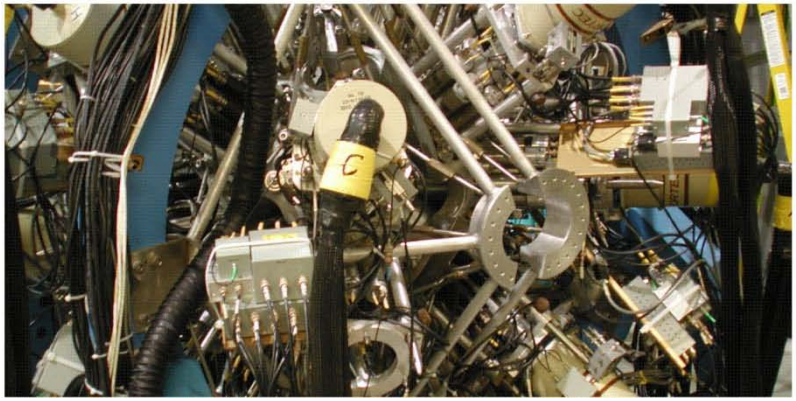
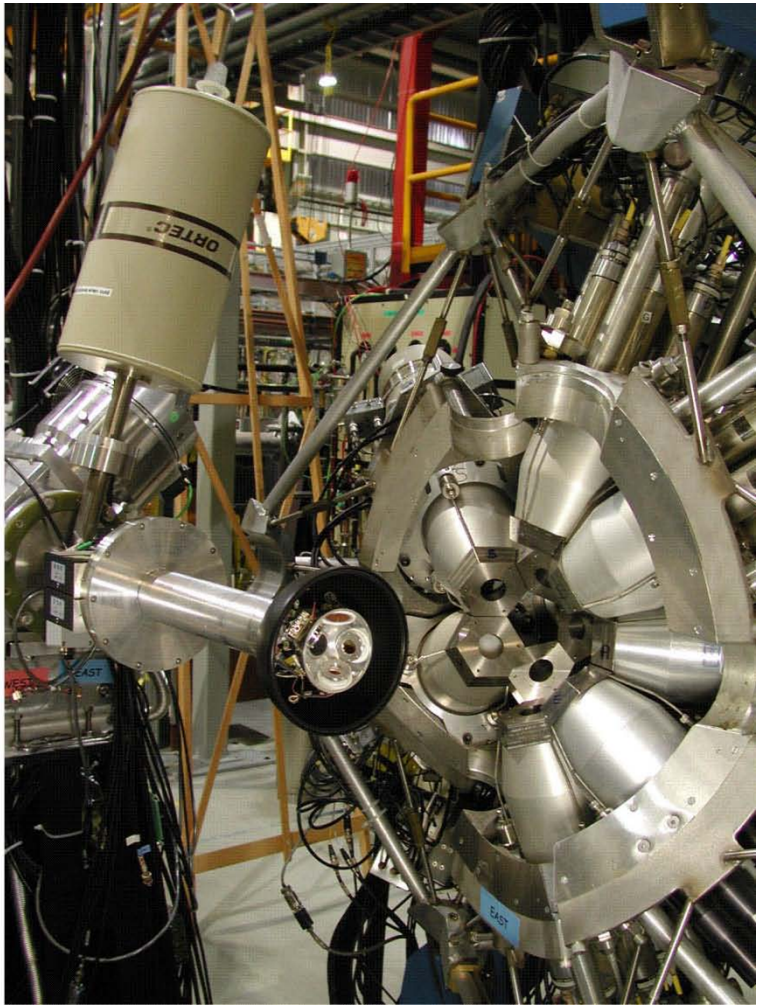
- Neutron activation analysis at SFU:
  - activity concentration of (n,2n) and (n,γ) reaction products following fast and thermal neutron irradiation using the SFU deuterium-tritium neutron generator.
- Environmental monitoring at SFU:
  - activity concentration of ^{134}Cs from the Fukushima accident using a coincidence method for detection of 604-keV/795-keV decay-pair in environmental samples.

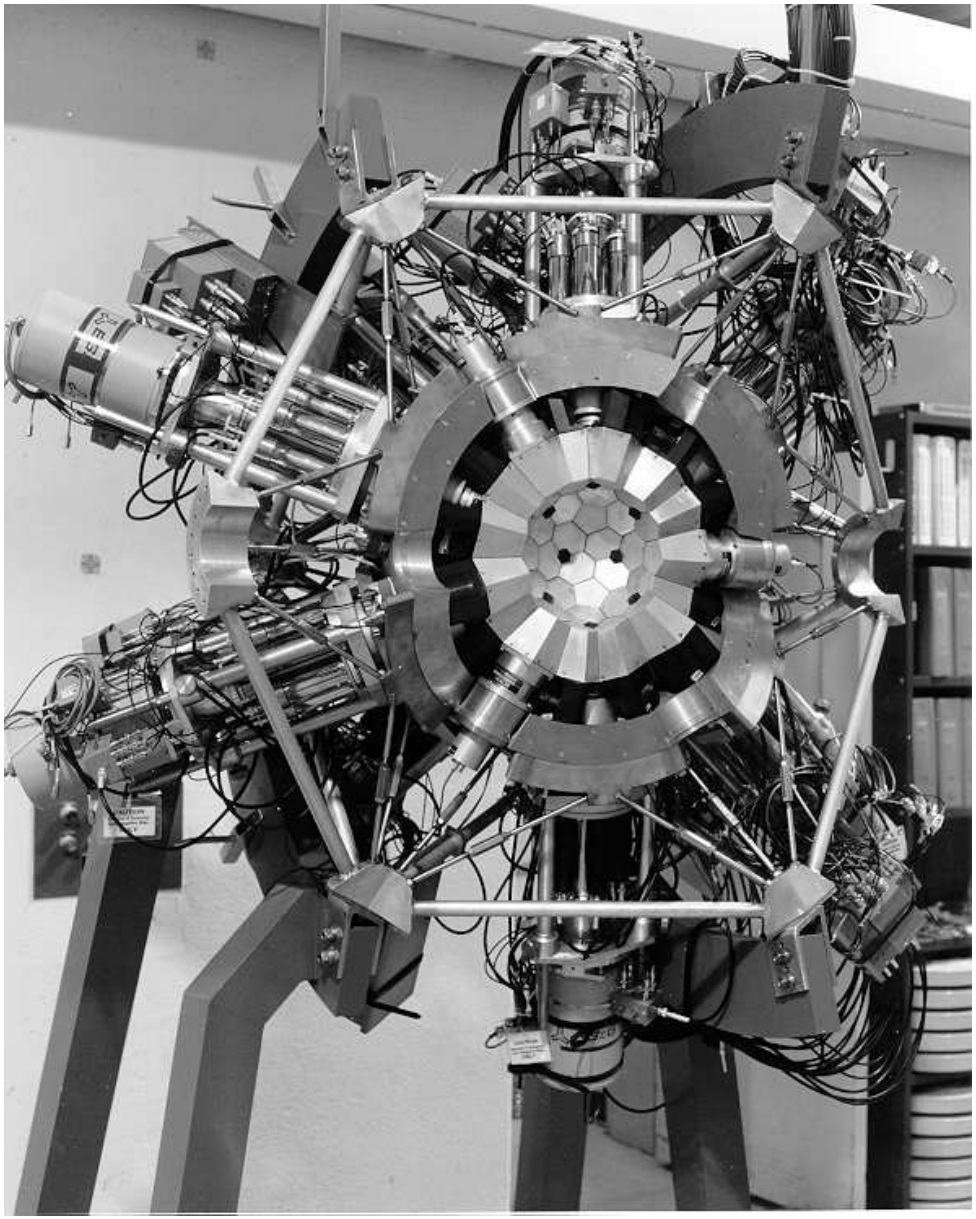
8π Spectrometer at TRIUMF-ISAC





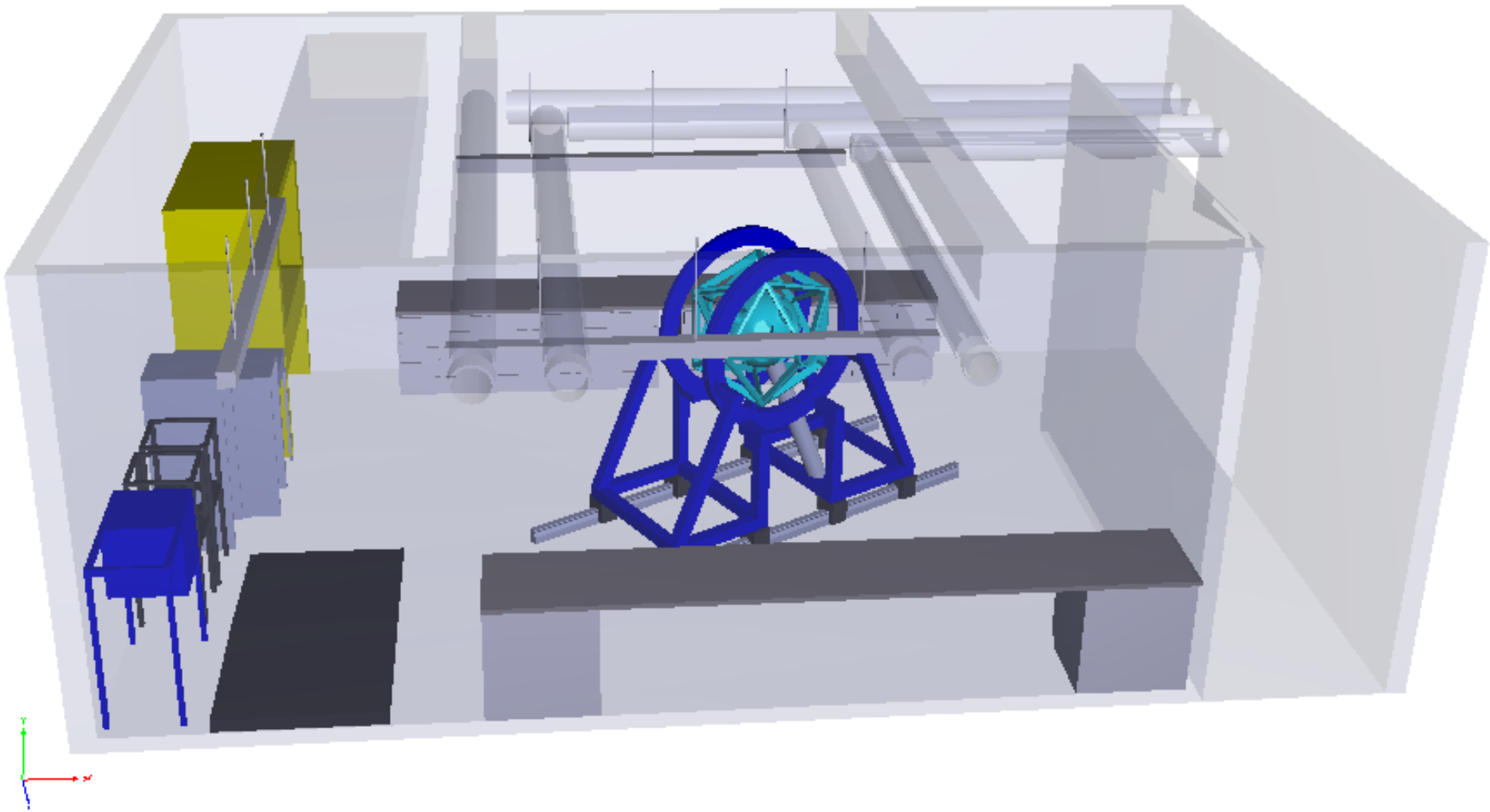


The 8π at SFU installation tasks



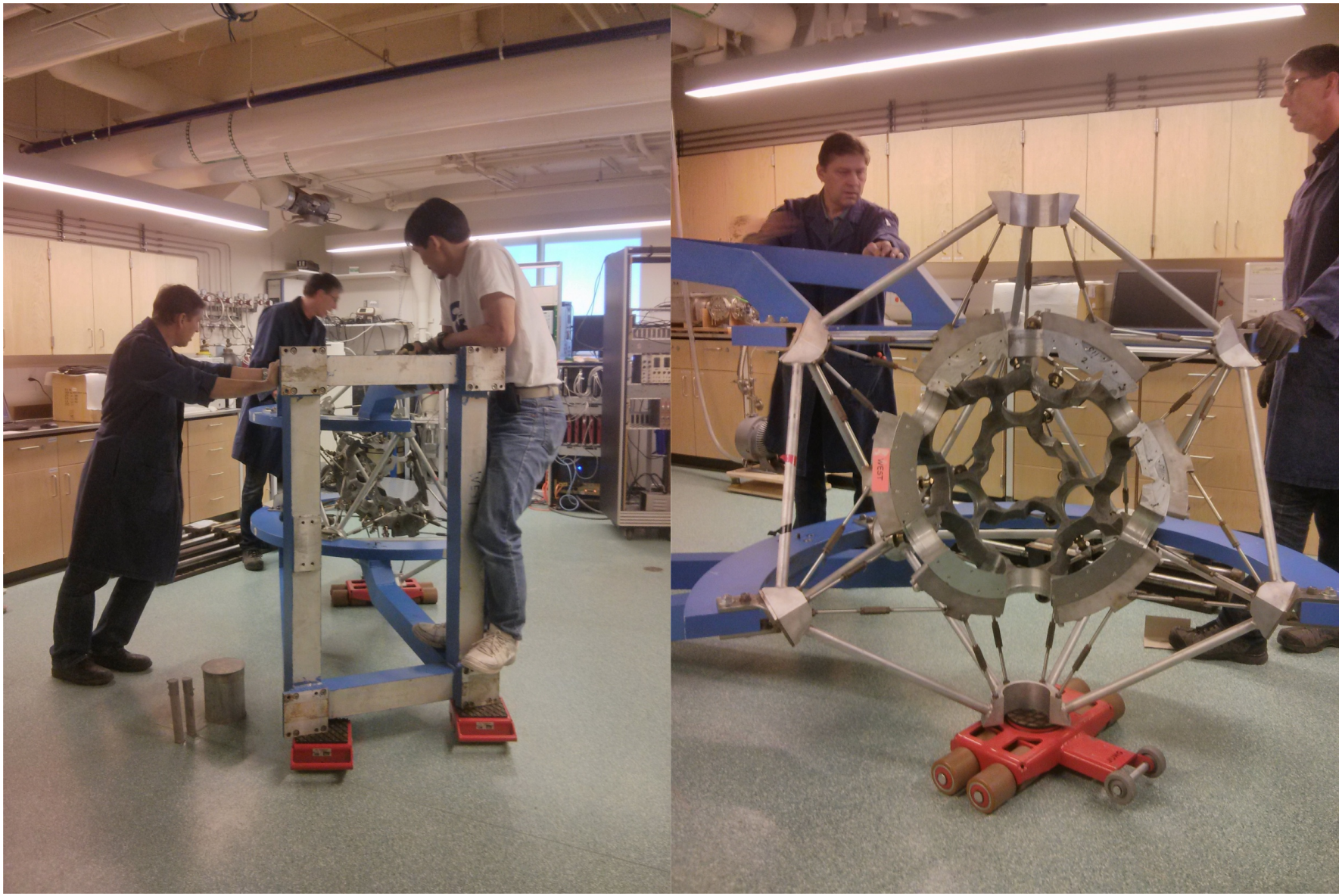
- Installation of the 8π frame for compatibility with the SFU neutron-generator pneumatic transport system.
- Rebuilding of the 8π to its original design for γ-ray calorimetry.
- Operation of the 8π using the SFU digital Data Acquisition System (DAQ).
- Capacity development at SFU for 8π detector maintenance and development.

Fitting in the 8π: the CAD model



The 8π move

The 8π move



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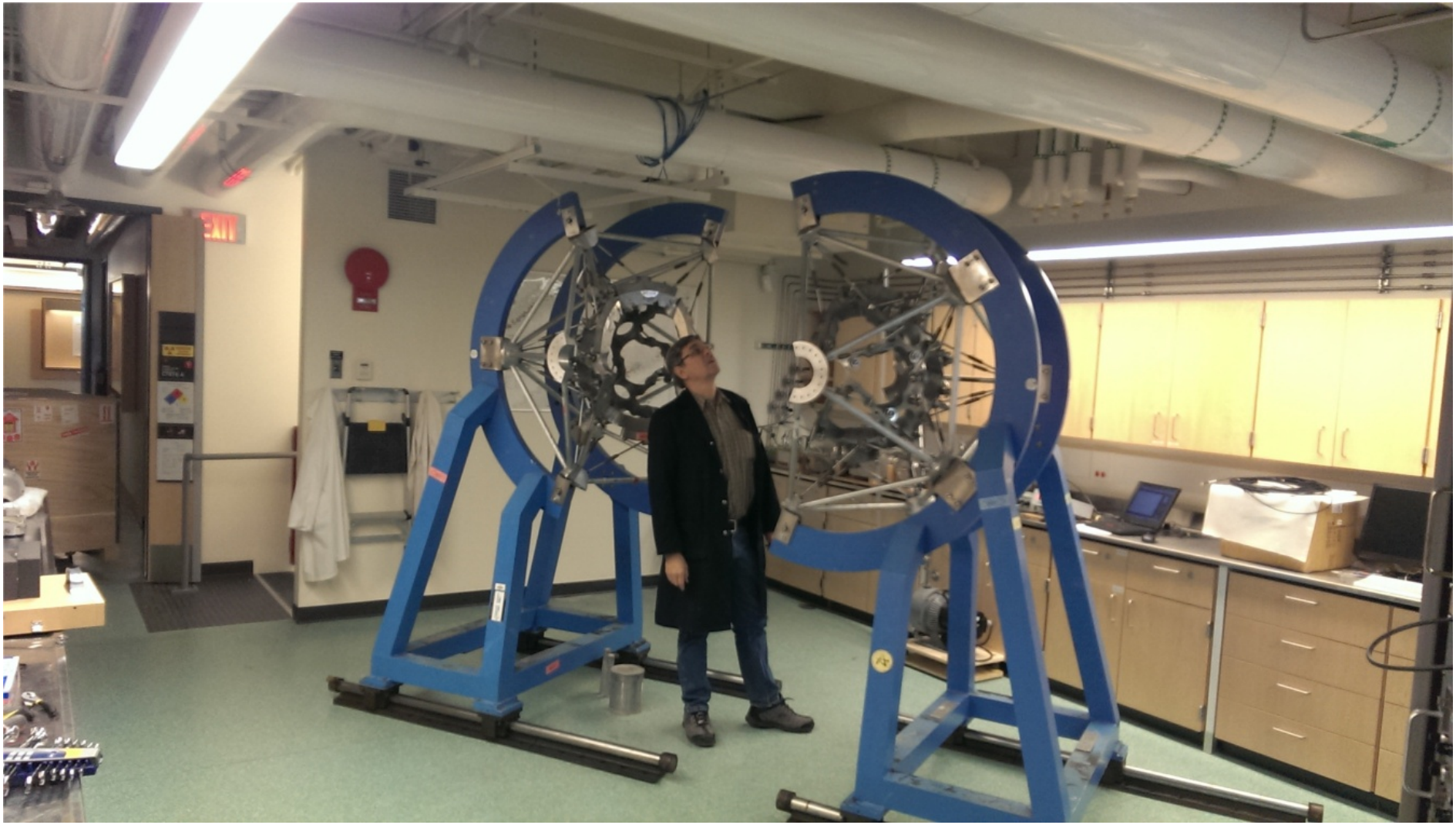
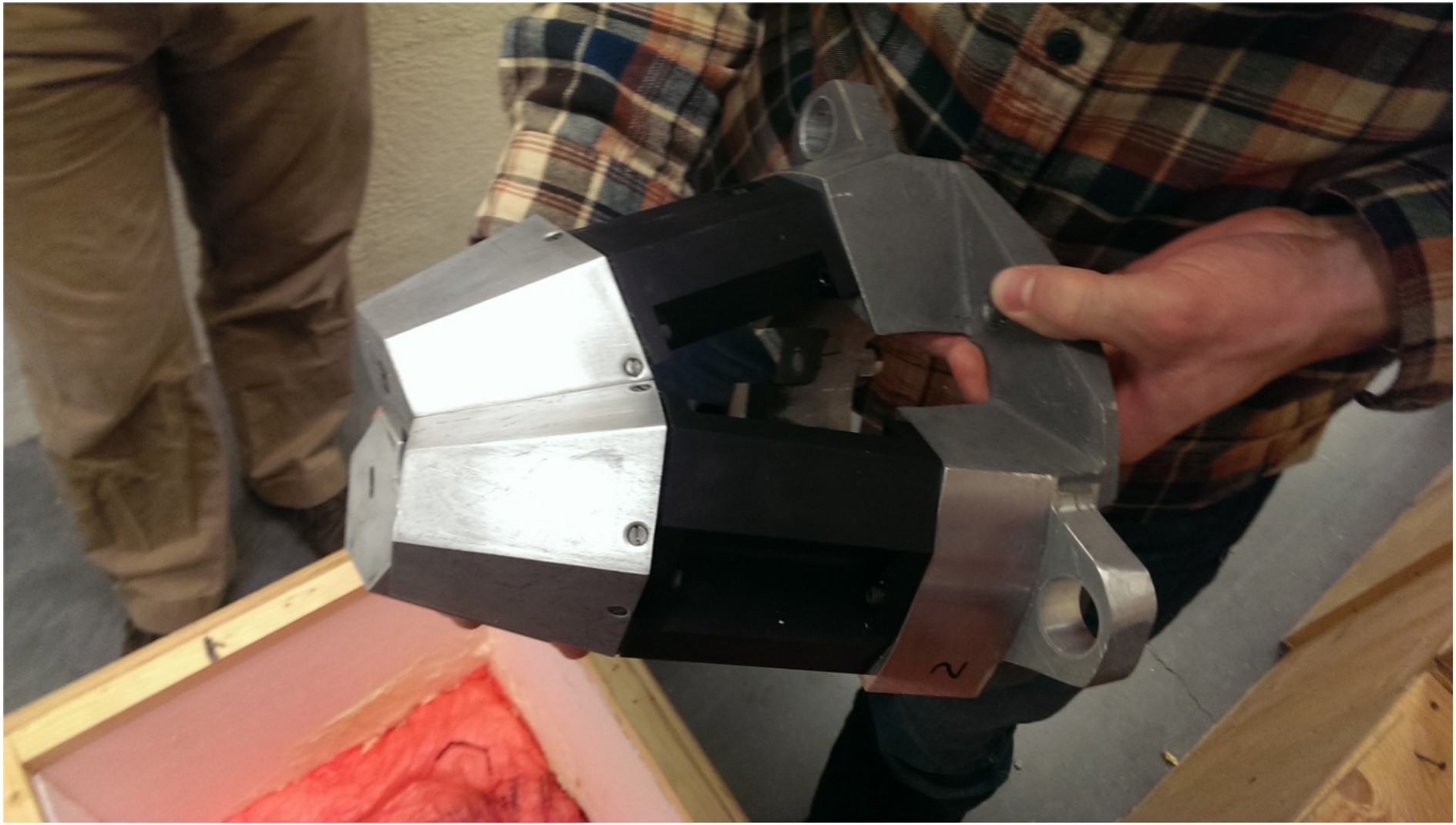


8π BGO hexagons



8π BGO hexagons

8π BGO pentagons

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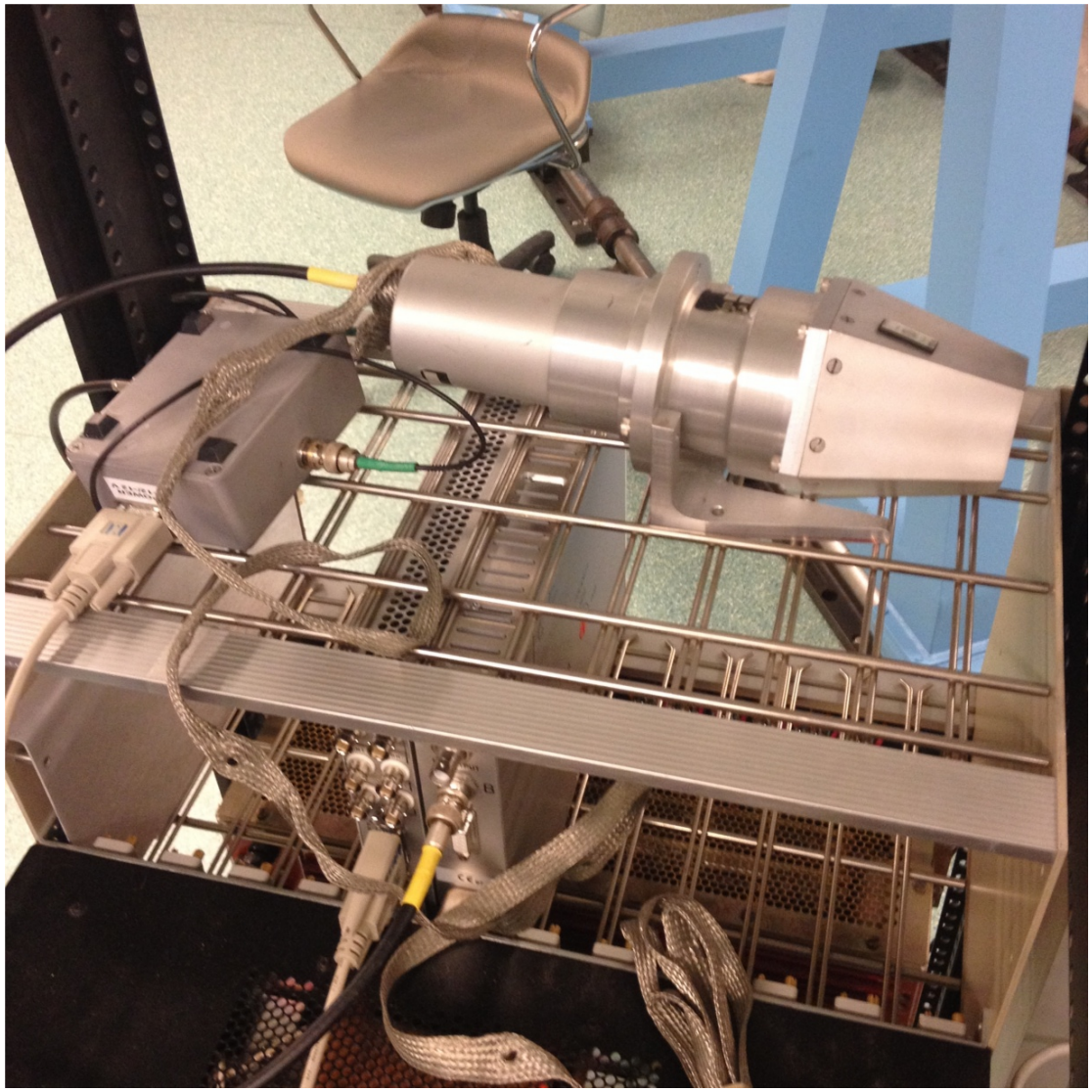
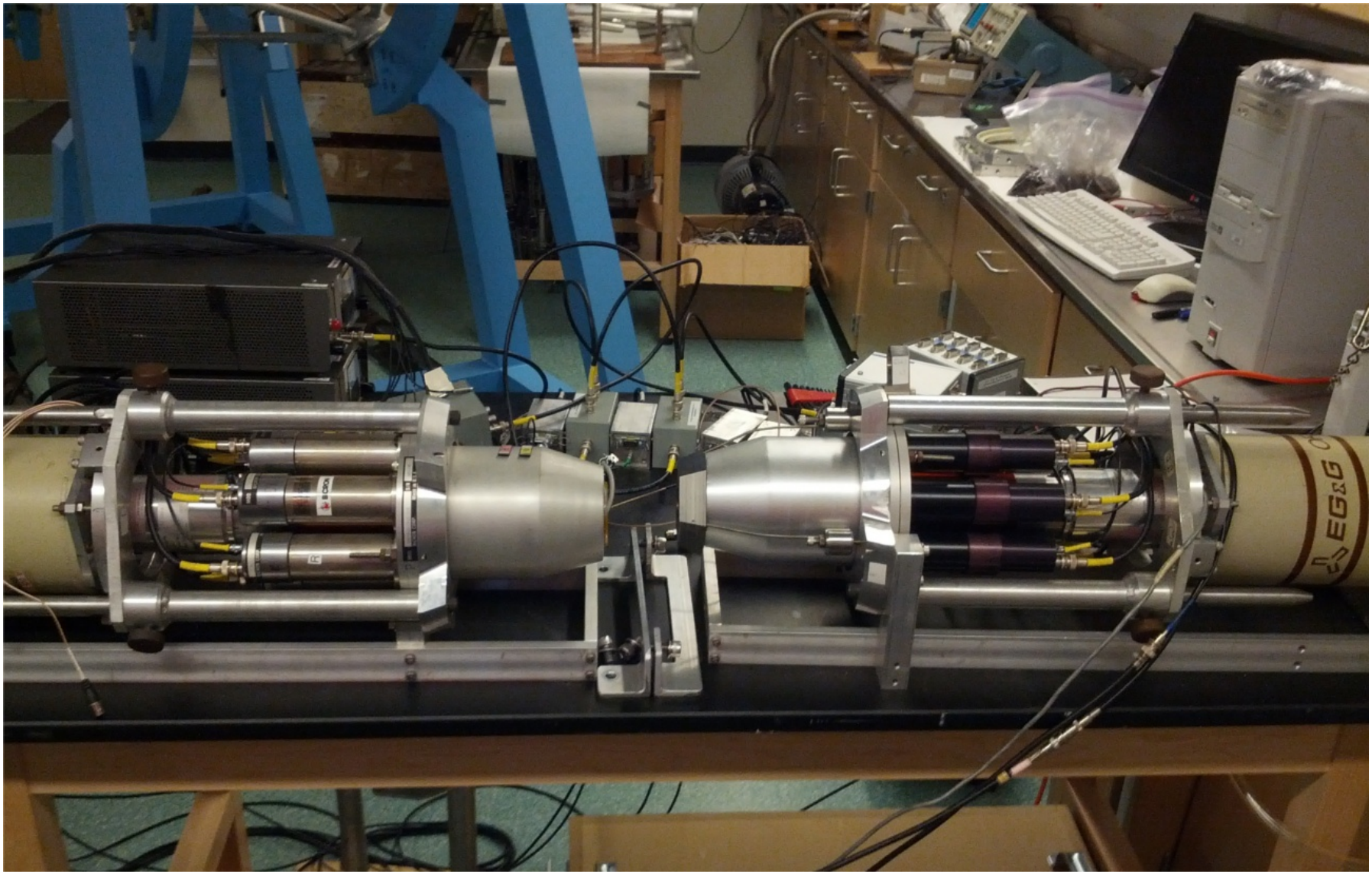
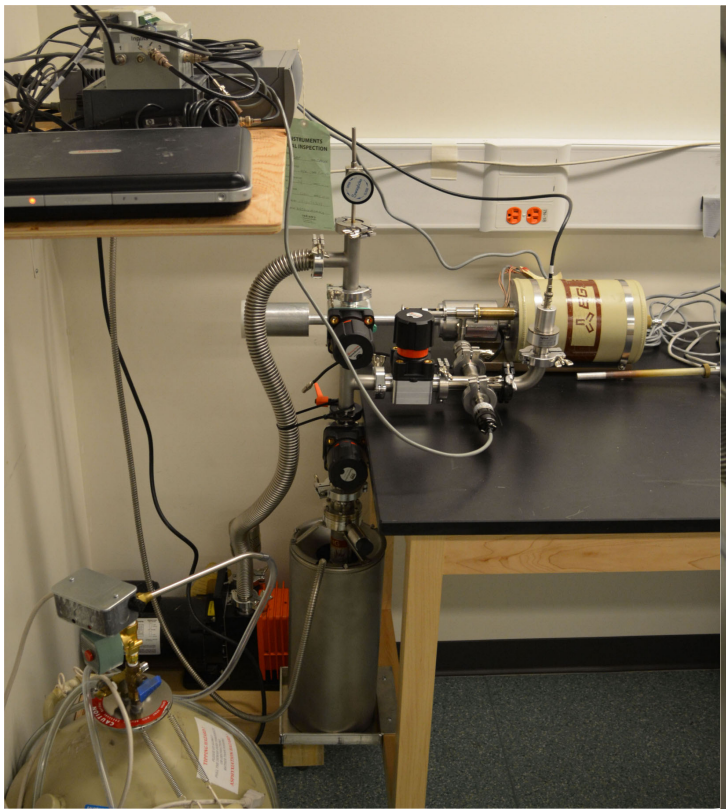
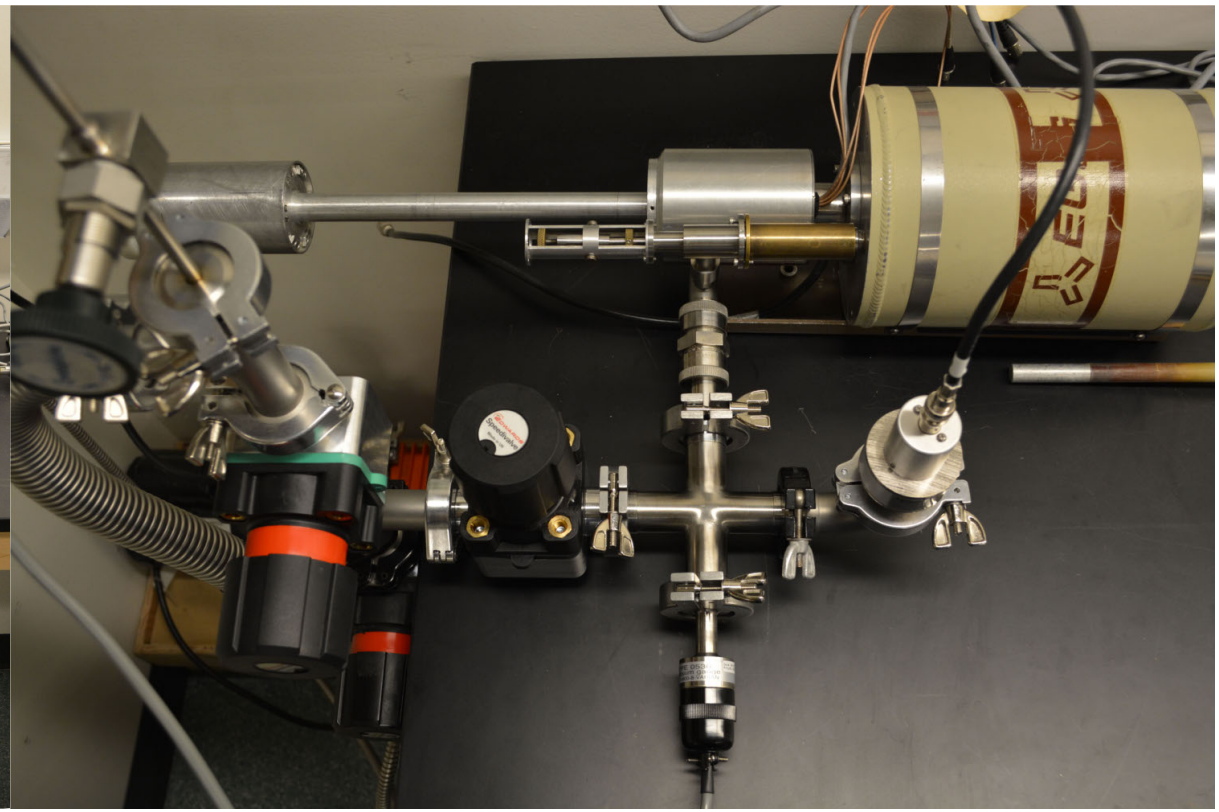


8π Compton Suppressed Spectrometers

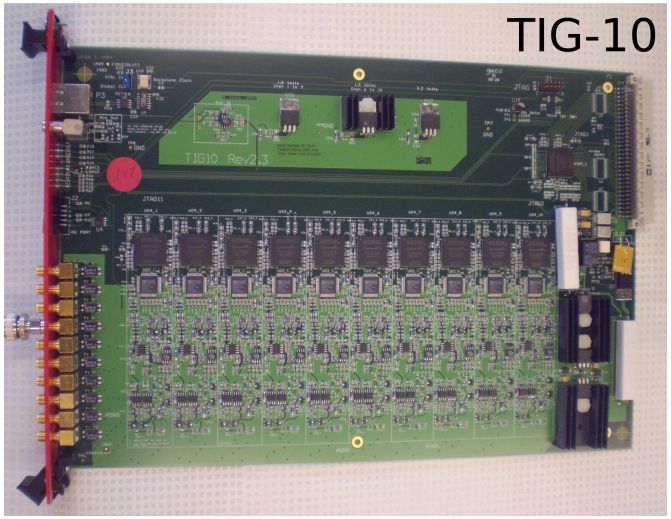


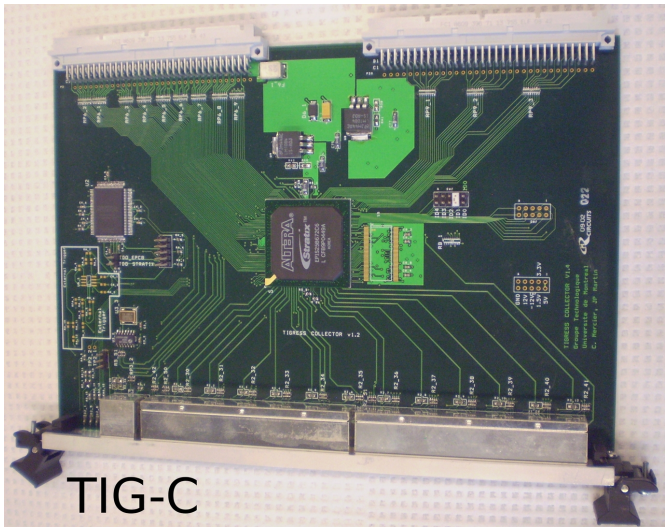
The 8π HpGe annealing station

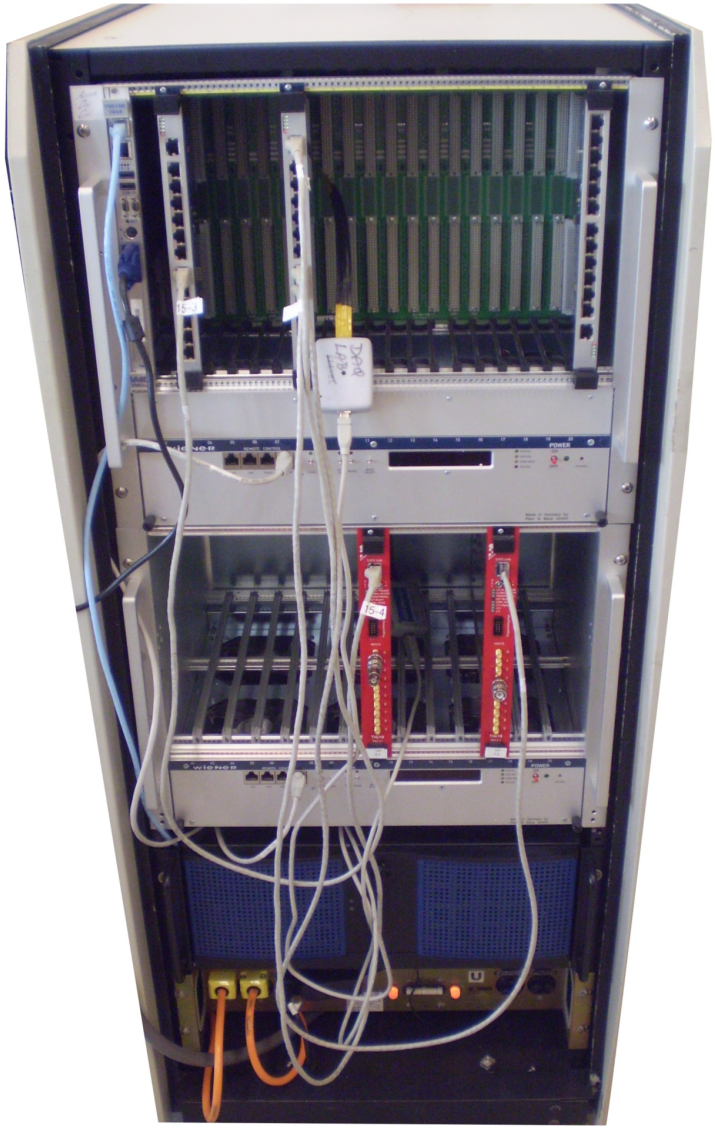




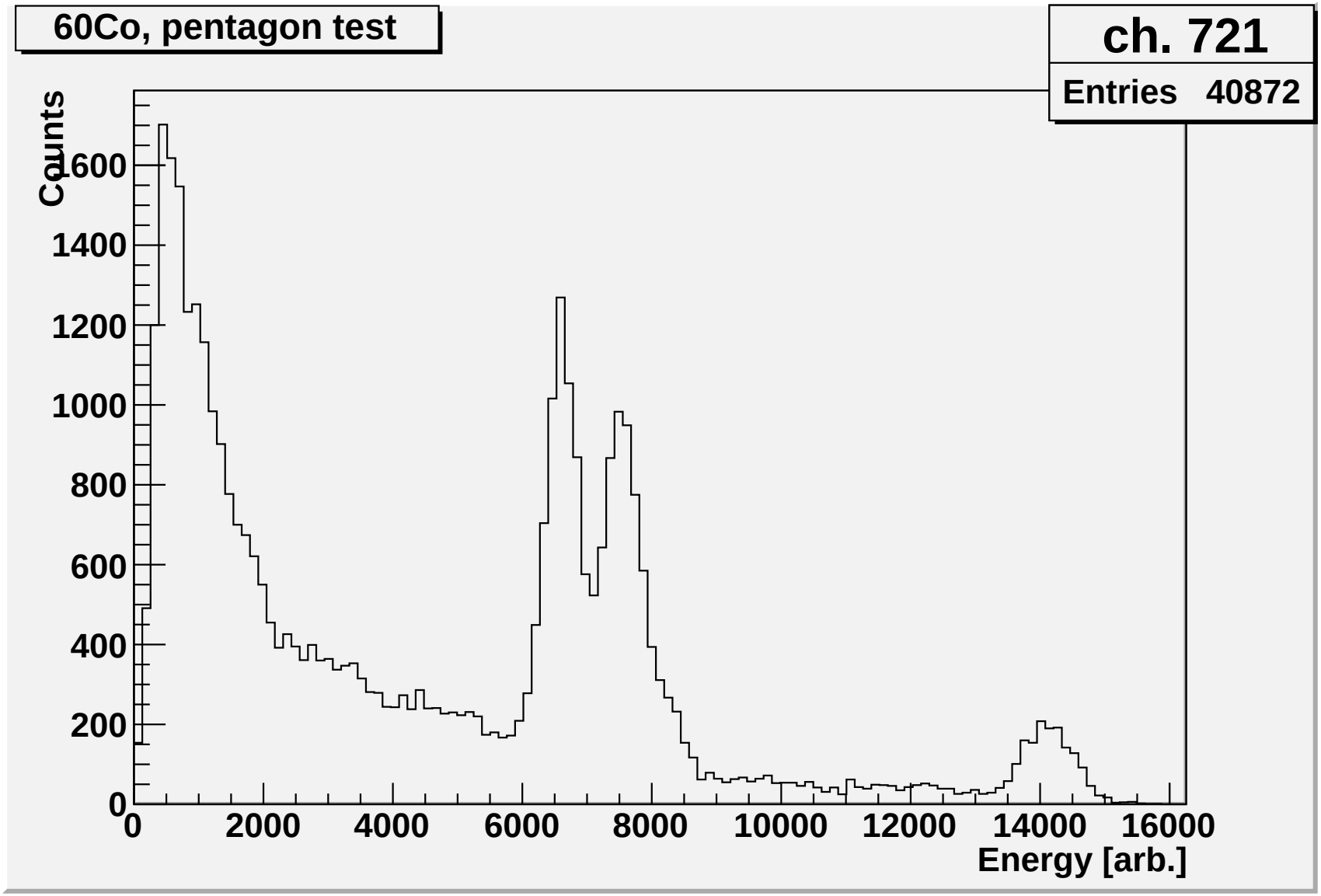
100MHz 14-bit Digital Data Acquisition System



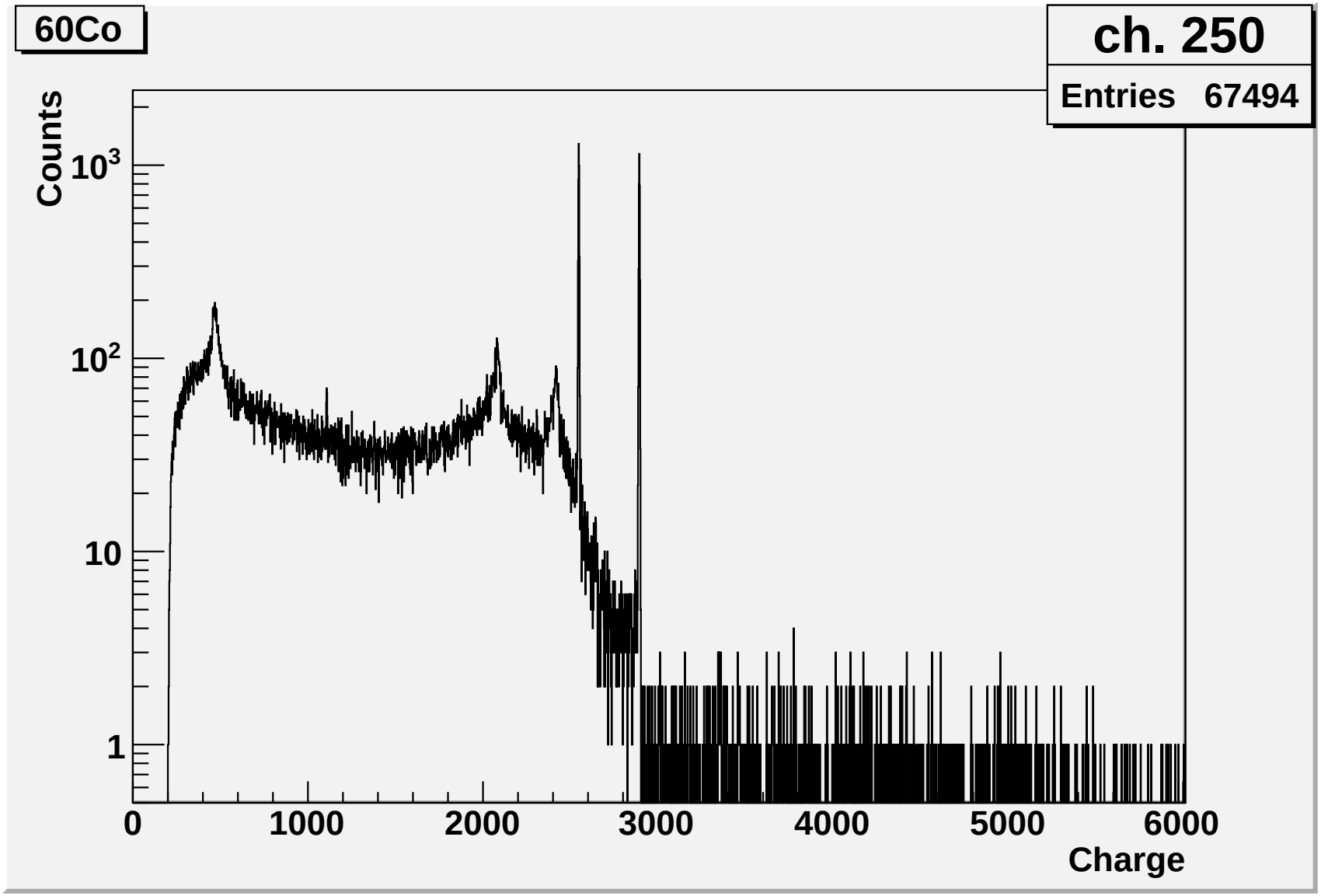




8π BGO pentagon digital DAQ test



8π HpGe digital DAQ test



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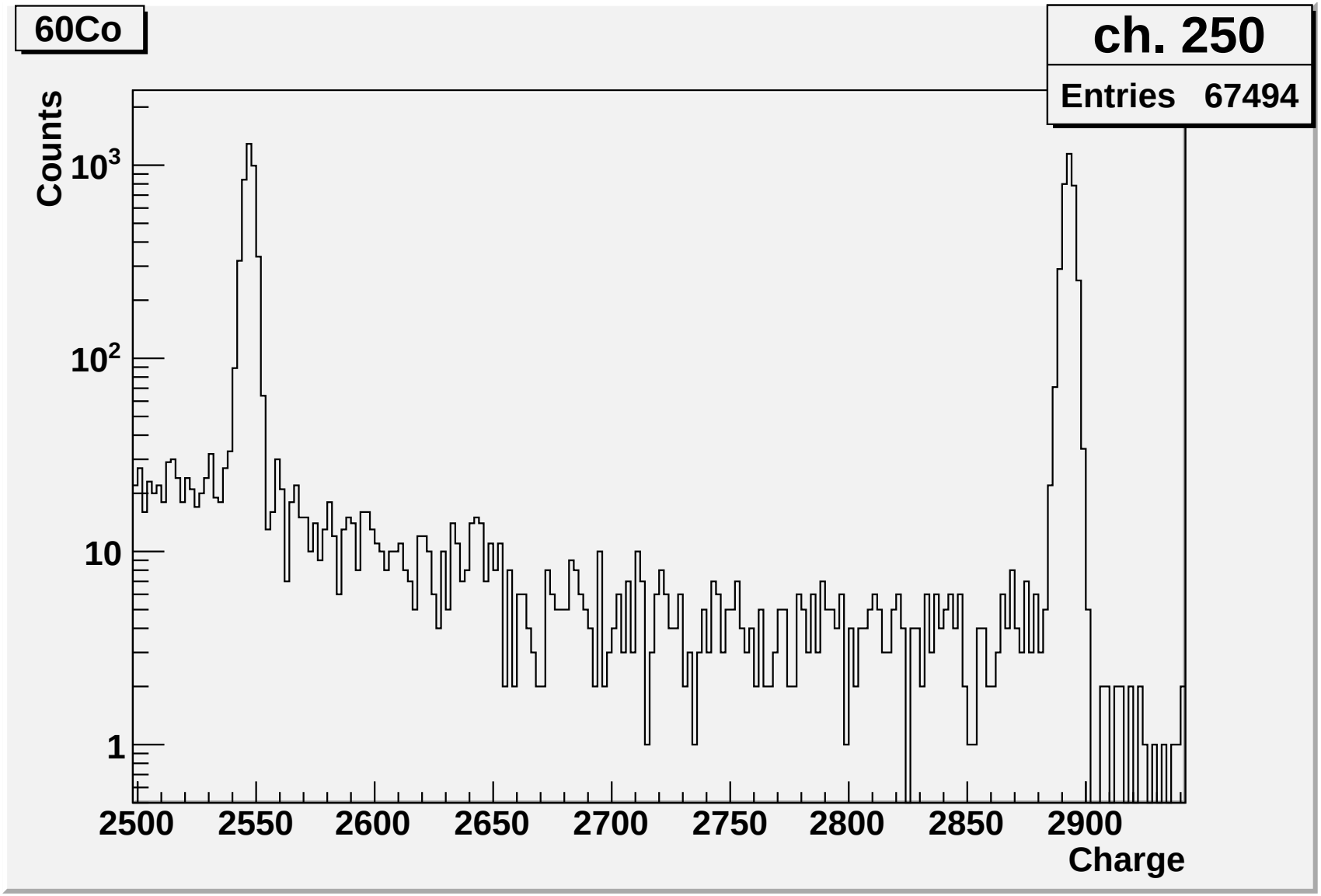
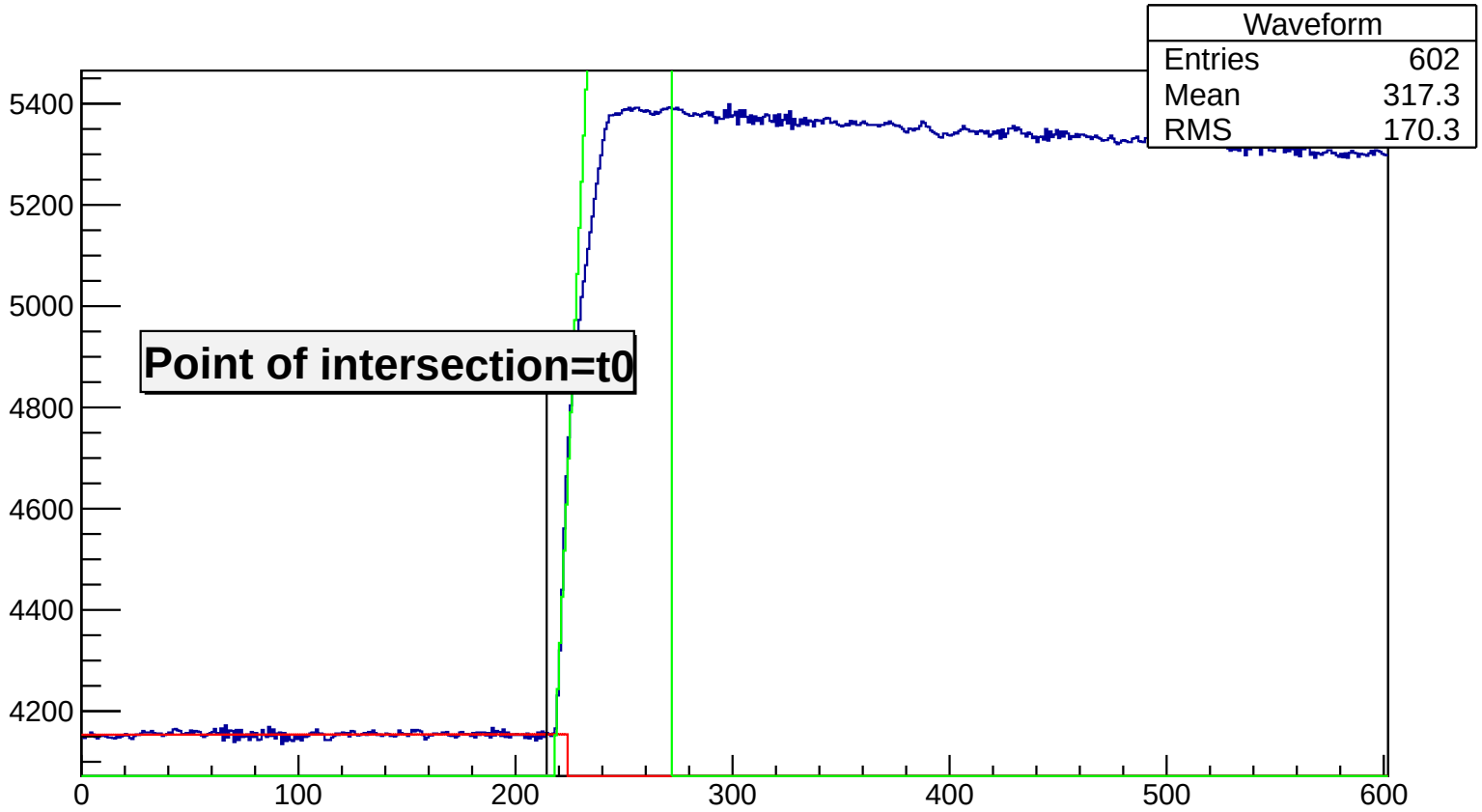
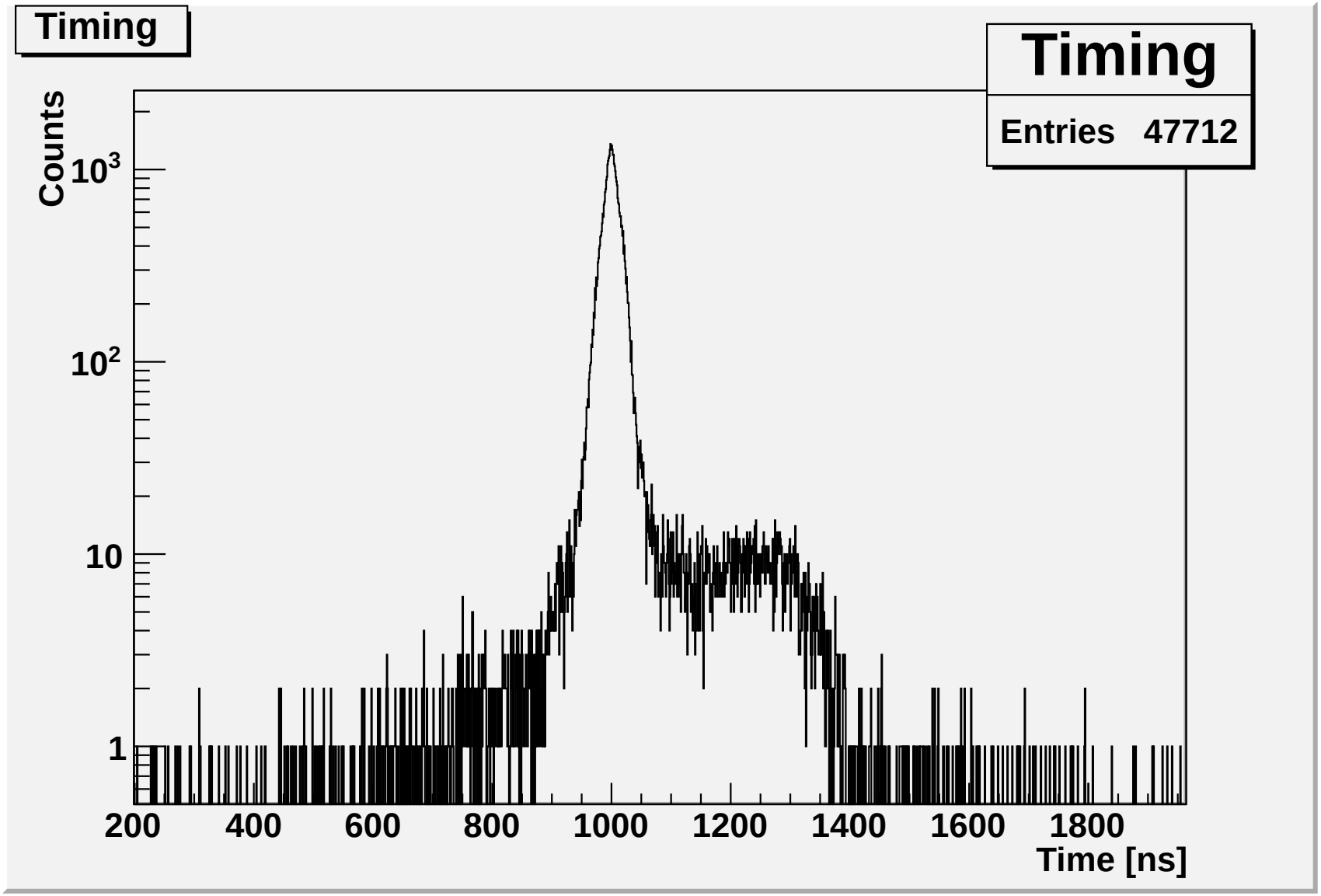


8π HpGe digital DAQ timing



8π HpGe $\gamma - \gamma$ digital DAQ timing test



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