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Title: LANL Countroom Gamma-Gamma Coincidence Capabilities

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Los Alamos
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LANL Countroom Gamma-Gamma Coincidence Capabilities

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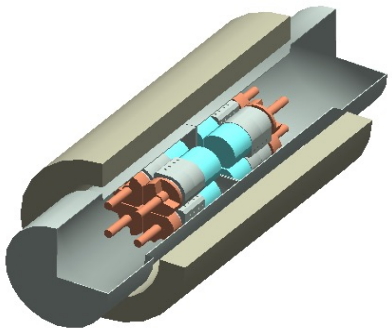
Instruments

- Clover
- Beta-Gamma
- PHDS Fulcrum portables

LANL Compton Suppressed Clover System:

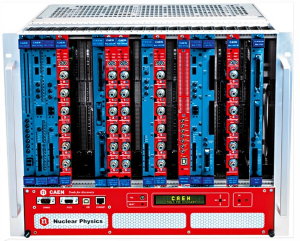


- *Low-background detector system*
  - Dual Ortec HPGe clover detectors
  - Detectors fit inside of a low-background NaI Compton suppression annulus
  - System sits on a stand where 1 Clover moves in/out of the annulus to allow sample loading
  - Inside of a room made from pre-WWII steel and air filtration for radon

- *History*
  - Operating at LANL since ~2010
  - Designed for low-activity samples
    - Forensics applications
    - Inertial Confinement Fusion (ICF) neutron activation experiments*
  - As of 2016, has a LANL-Owned/operated twin at LLNL that is currently dedicated to Radchem experiments for ICF

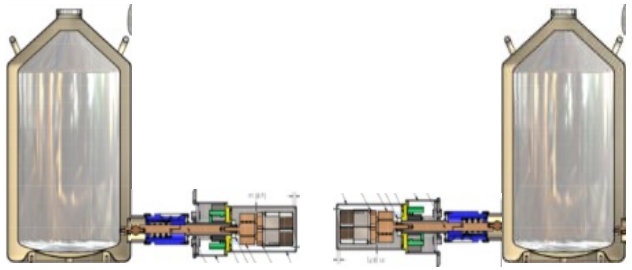
*A.C. Hayes, et.al., "Plasma stopping-power measurements reveal transition from non-degenerate to degenerate plasmas", Nature Physics **16**, 432-437 (2020).

LANL Compton Suppressed Clover System:



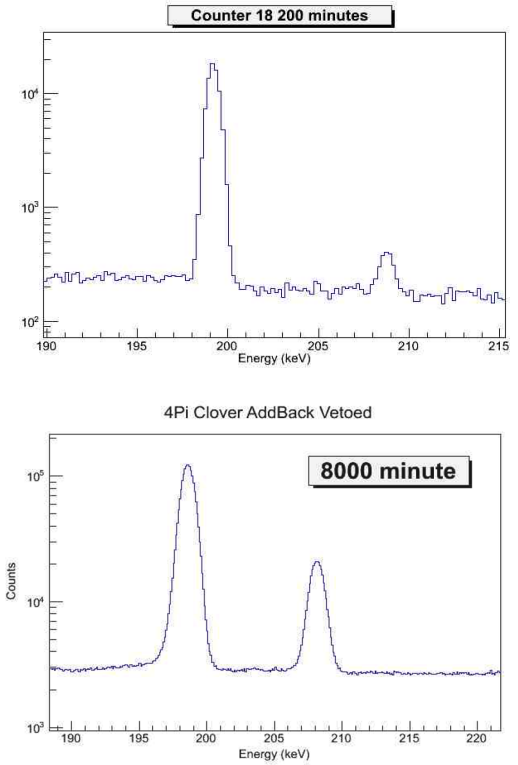
- *Clover Detectors*
  - Each detector is made up of 4 independent ~25% rel. eff. Crystals (55mm x 70mm)
  - Can achieve high efficiency while minimizing summing effects from cascades
  - Utilize segmentation to reconstruct decay schemes and/or perform other coincidence or anti-coincidence measurements
- *NaI Annulus*
  - Custom made NaI(Tl) annulus
  - 2” thick walls, 16” long
  - OFHC Copper outer jacket/thin copper and plastic inner jacket
  - Background reduction of ~10x
  - Acts as both a passive and active veto for Compton scatters events and external background

- *Data Acquisition System*
  - Originally setup with XIA Pixie digital daq
  - Since moved to CAEN digitizers (VME based)
  - The 8 NaI PMT signals are read by a CAEN VX1724 100MS/s digitizer
  - 8 HPGe channels are read by CAEN V1782; 100 MS/s
  - Boards are synchronized together
  - Waveforms are not recorded but list mode Energy/Timestamp information is recorded for each event using CAEN’s PHA firmware.



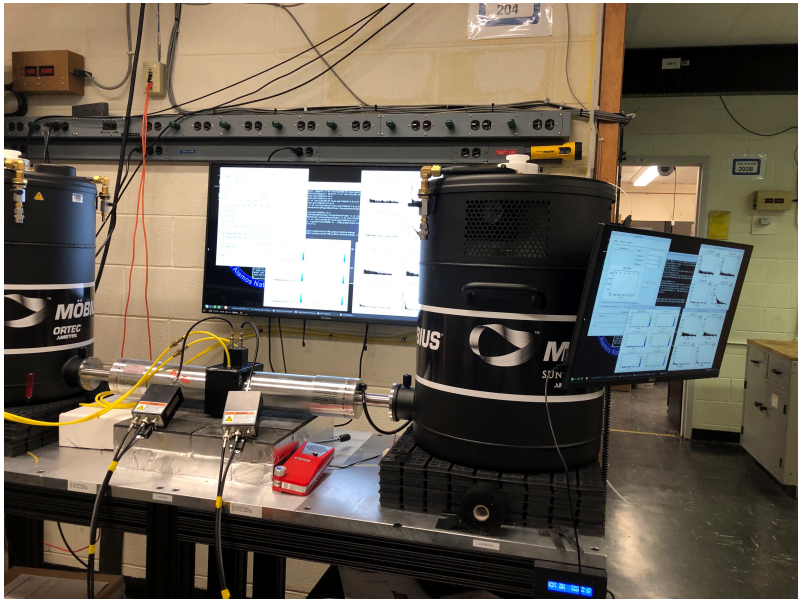
LANL Compton Suppressed Clover System:

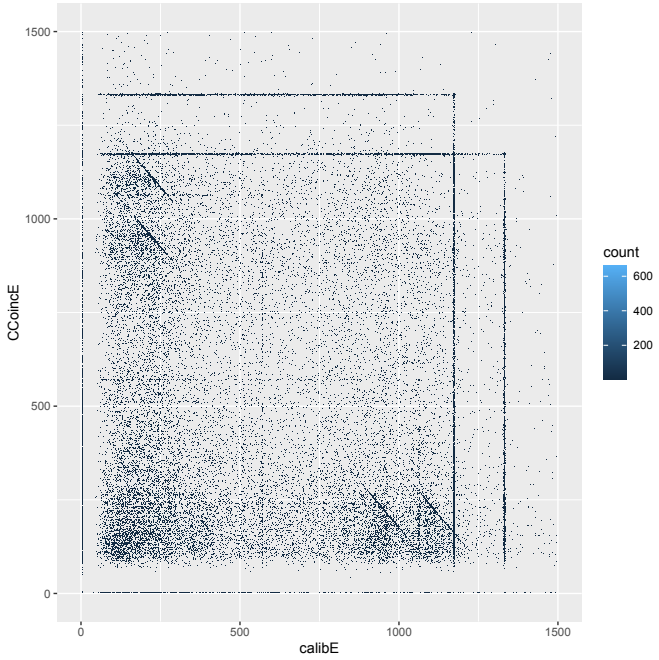
- For small samples the solid angle coverage can be ~4π; Efficiency at 200 keV is ~40%
- **Example**
  - ^{167}Tm coming from the ^{169}Tm(n,3n) reaction
  - Irradiated as part of LANL ICF experiments at the National Ignition Facility
  - 167Tm decays via a 208keV gamma transition; +1000x more of the ^{168}Tm is also produced which decays via a large cascade terminating in a 197keV gamma ray.
  - Challenge: ^{167}Tm is low-activity; Compton and summing events from the ^{168}Tm cascade work together to swamp the 208keV signal of interest
  - Compton events are reduced significantly operating in an anti-coincidence mode with the NaI annulus
  - Operating the clovers in Add-back mode further reduces Compton and summing events in the 208keV region of interest -> Large improvement for signal to noise



Beta-Gamma

- Dual n-type HPGe detectors surrounding two proportional gas-filled beta chambers.
- Under active development through R^3 Venture.



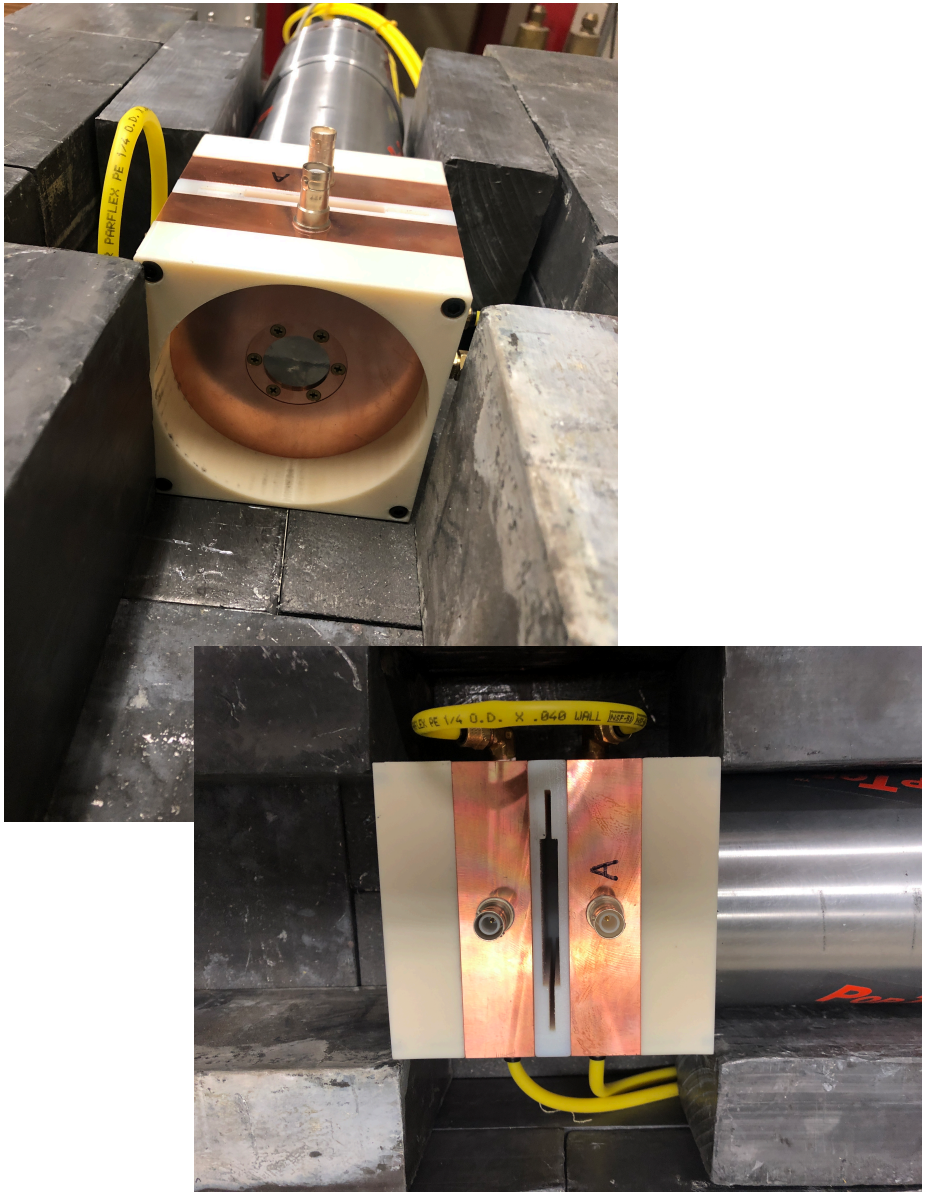


- We have demonstrated gamma-gamma data acquisition.
- Reducing overall noise in the system and reliably working out timing between the beta and gamma signals is underway.
- Poor performance of the beta chamber led to redesign.

Beta-Gamma - Continued

- Recently fabricated a new beta chamber from copper to replace the previous PTFE one.
- The recycling Dewars have also been relocated below the table to enable better shiedling.

- The system is in the process of reassembly…



Fulcrums

- Two PHDS Fulcrum portable HPGe detectors with external timing ports.
- Awaiting delivery
- Development of their use under R^3 Venture.