STARS at GAMMASPHERE

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The case for a Highly Segmented Particle Detector for particle-γ coincidences

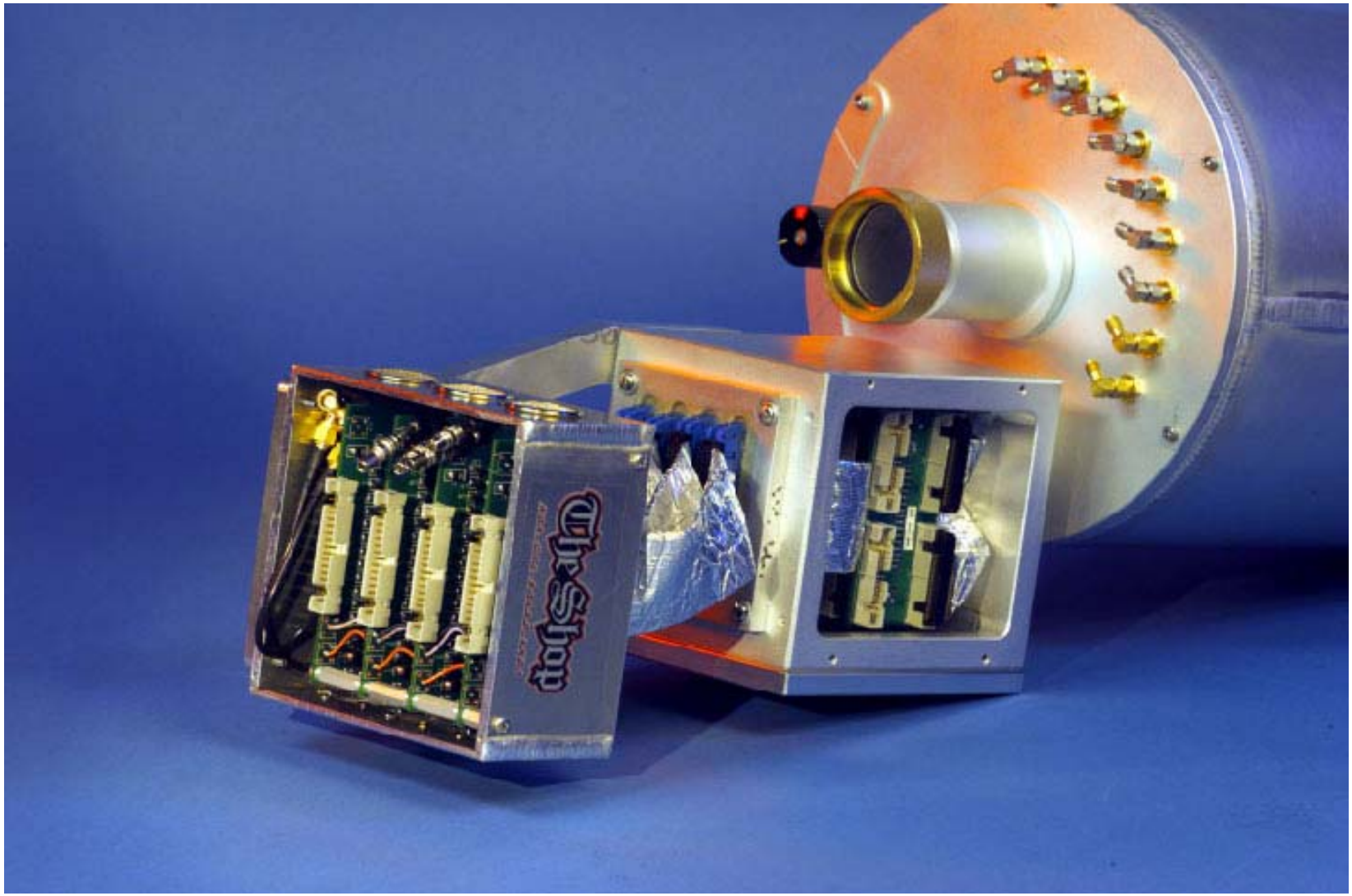
- **Magnetic spectrometers provide the best θ and E resolution at a price - low efficiency (10^{-4}).**
  - **Stable beams overcome this by raising the current.**
  - **This makes coincident γ-ray measurements extremely difficult.**
- **STARS will provide reasonable particle id, θ and E resolution for a wide variety of particles with decent efficiency (0.1-0.2)**
  - **p, d, t, α, τ, Li**
  - **Particle-γ measurements now possible @ 0.1 pnA**

This new array is called **STARS**
(**S**ilicon **T**elescope **A**rray for **R**eaction **S**tudies

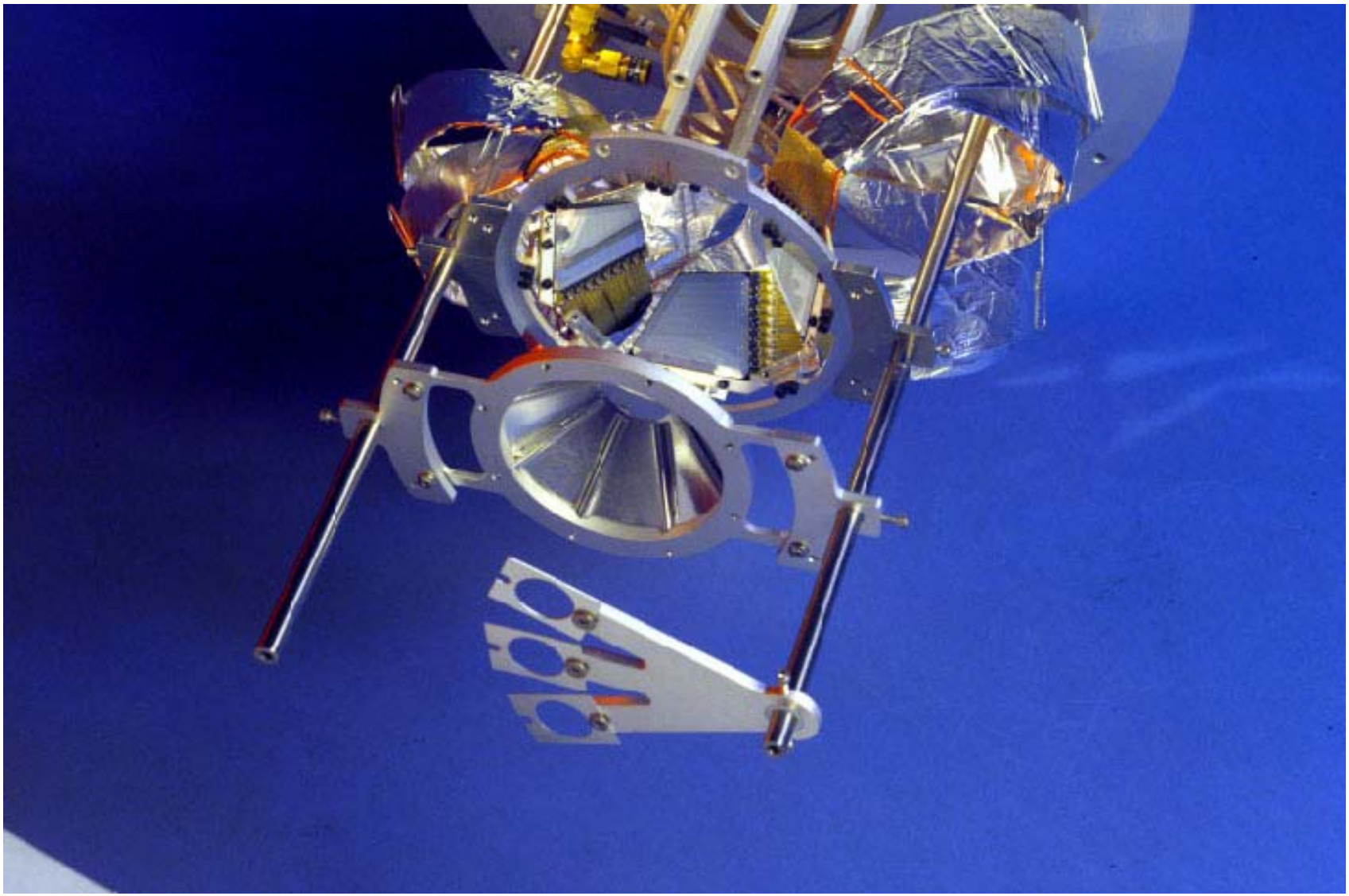
STARS Components

- A target chamber (designed and built at LLNL)
  - Fits inside of GAMMASPHERE
  - Can be used separately for experiments that don't require γ-ray coincidences.
- Two particle detectors
  - S2 model "CD" detector from Micron Semiconductor.
    - Can be used with inverse kinematics experiments
  - SiRi (Silicon Ring) detector from the University of Oslo.
    - Best for "Normal" kinematics
- Electronics
  - CAEN shapers
  - CAMAC ADCs (GAMMASPHERE DAQ)

STARS Target Chamber and Vacuum Feedthroughs

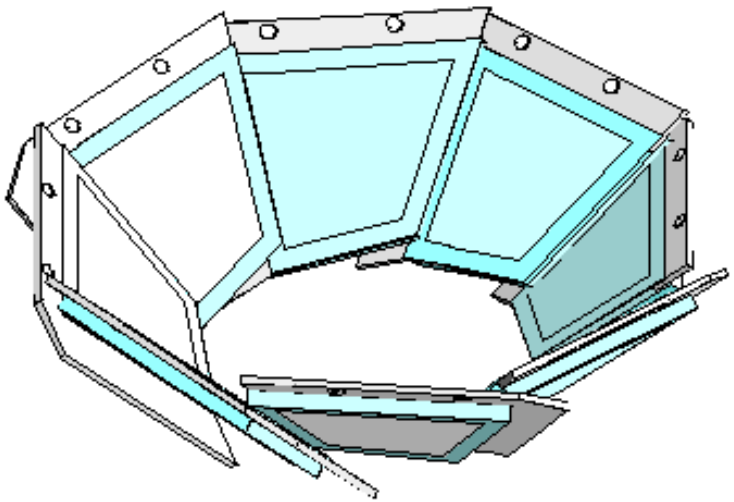


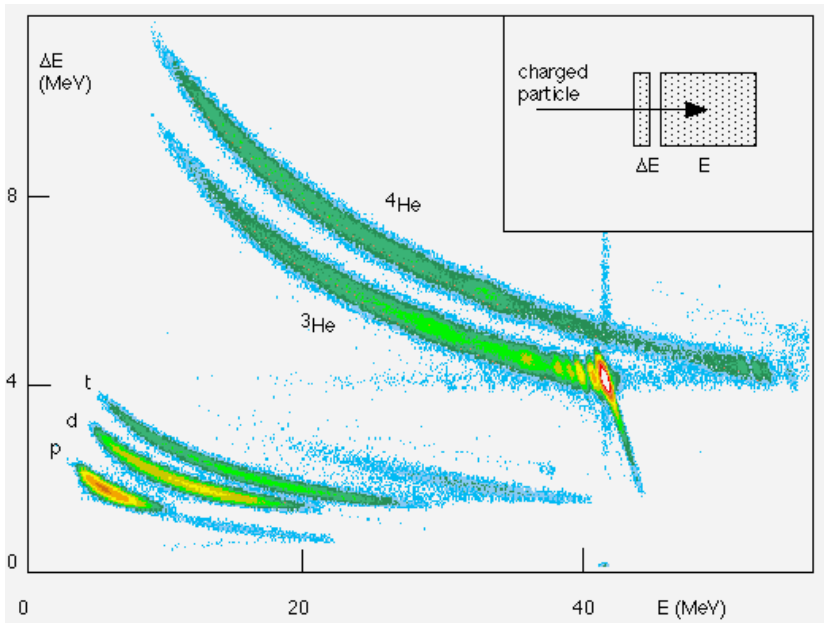
STARS Detector + Target Ladder



The SI(licon) RI(ng) detector from the University of Oslo Nuclear Physics Group

- 8 separate particle telescopes
  - 140 micron ΔE
  - 1500 micron E
- Covers 30° to 60°
- 8 segments/telescope (3 mm pitch, $\Delta\theta = 3.75°$).

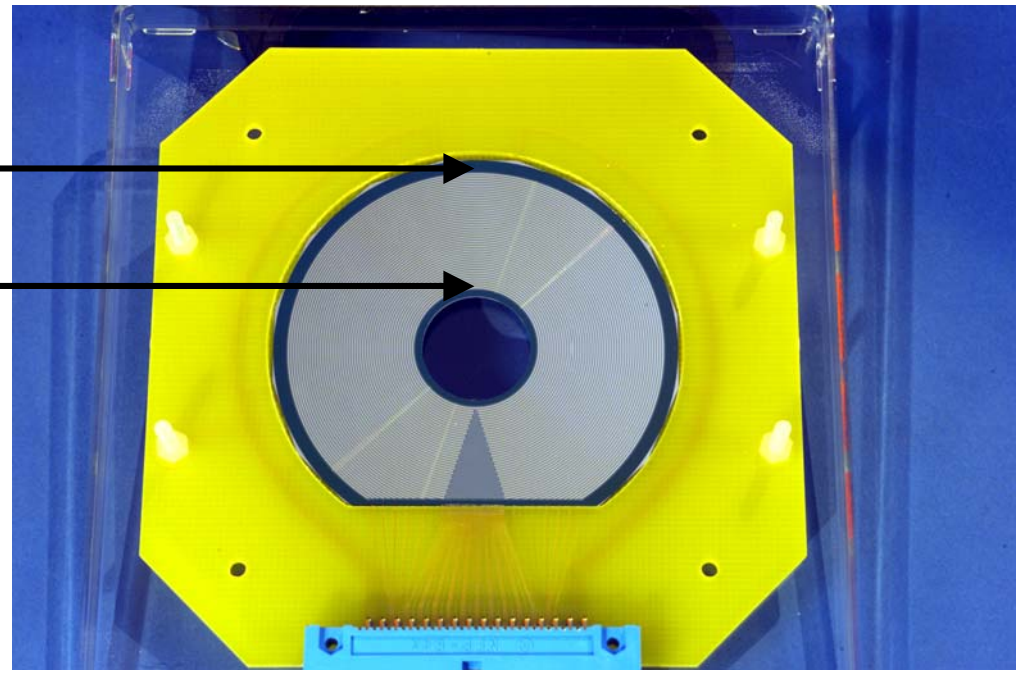




The Micron S2 detector

- **E/ΔE particle telescopes**
  - **140 micron ΔE**
  - **1000 micron E**
- **22 mm ID**
- **70 mm OD**
- **1 mm pitch**
  - **Adjacent rings to be summed**
- **2 ΔE's and 3 E's acquired**

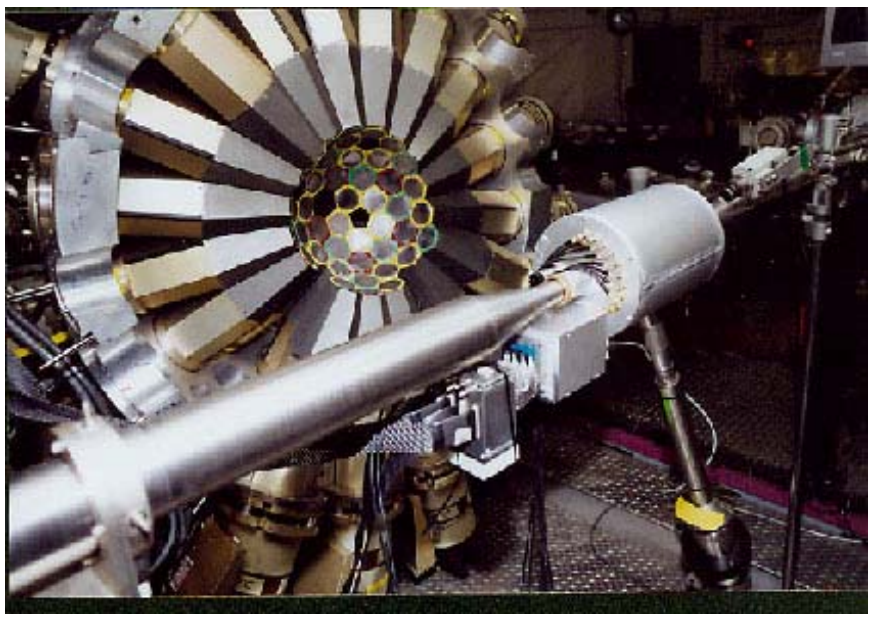
48 rings

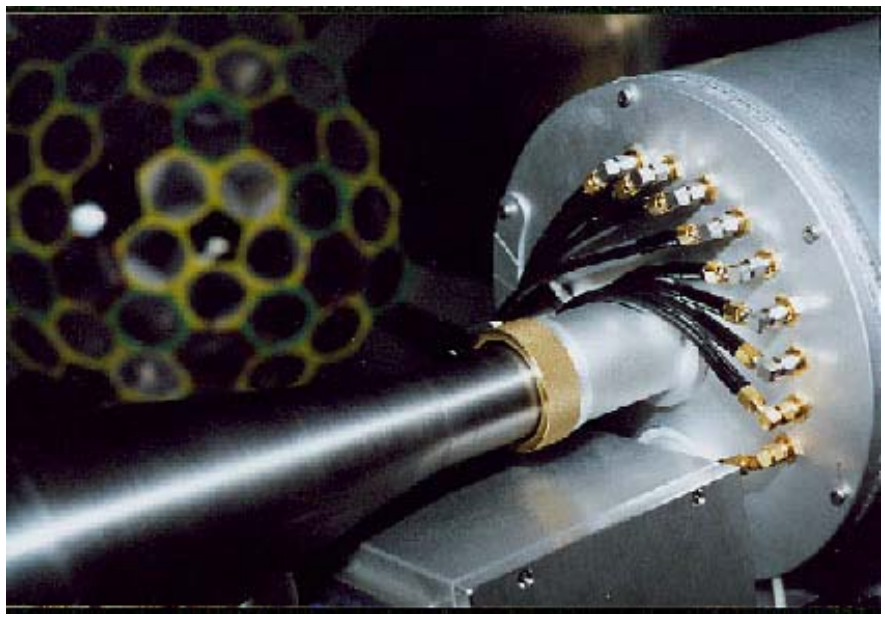


The first run @ GAMMASPHERE: March 2002

$^{157}Gd(^{3}He,^{4}He)^{156}Gd$ @ E_{beam} = 45 MeV

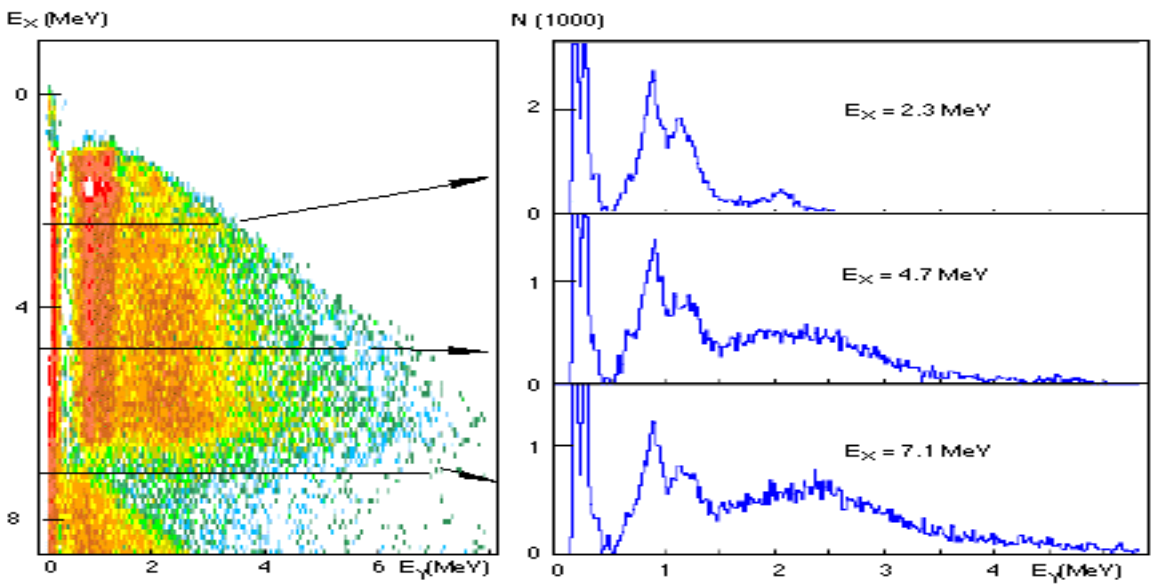
- SiRi detectors used
  - only 1/2 of the detectors mounted
- Low beam current due to neutron damage concerns.
  - Average current = 0.3-0.5 pnA
- Short production run (<3 days of beam on target).



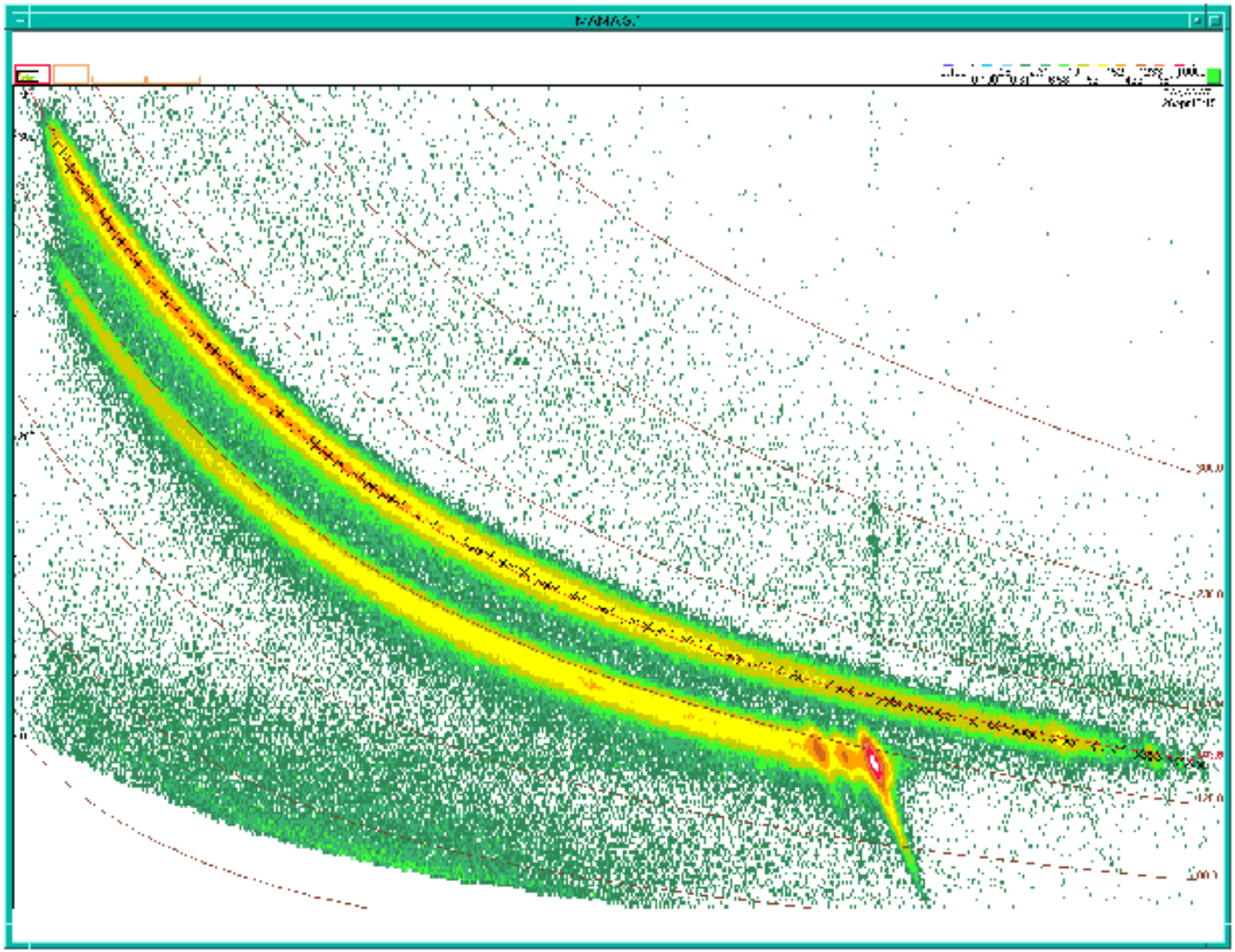


Measuring Level Densities and γ-ray strength functions up to $E_x=S_n$

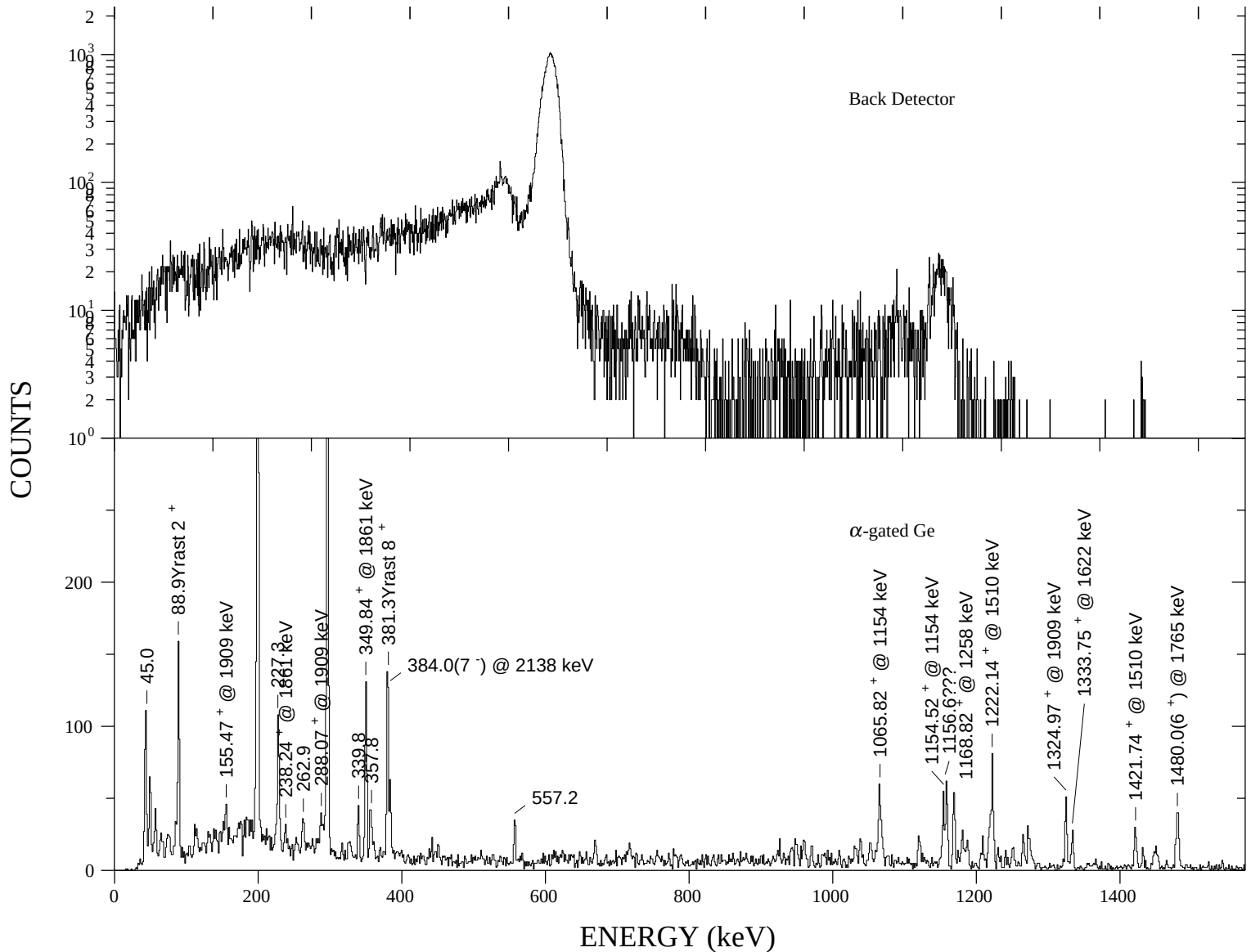
- Subject of numerous PRC/PRL
- GAMMASPHERE set-up will improve on Oslo in two significant ways:
  - 80 times greater α–γ(BGO) coincidence rate
  - Ge detectors allow for discrete state coincidences



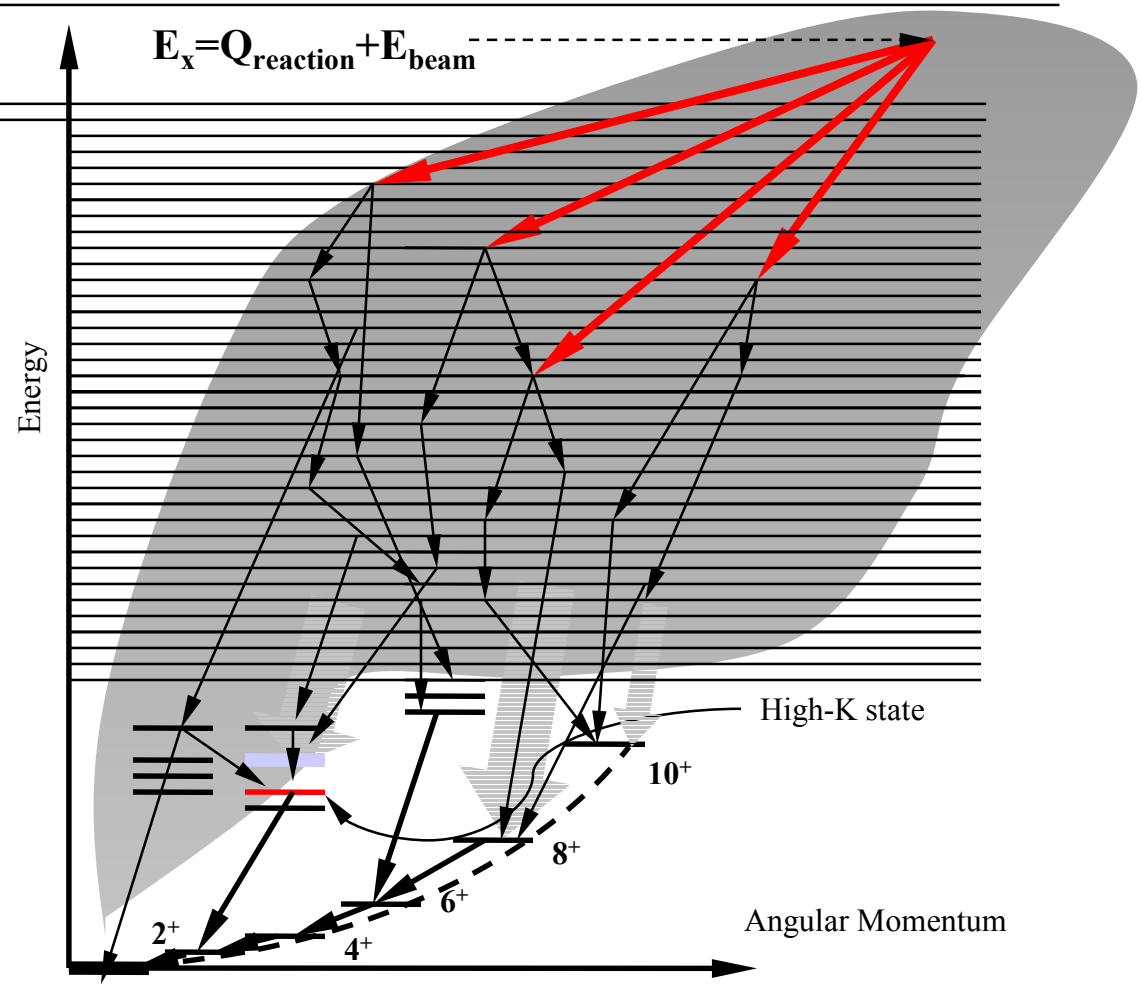
E-AE Matrix for 1 ring in 1 particle telescope



Transfer Peak gated Ge spectra



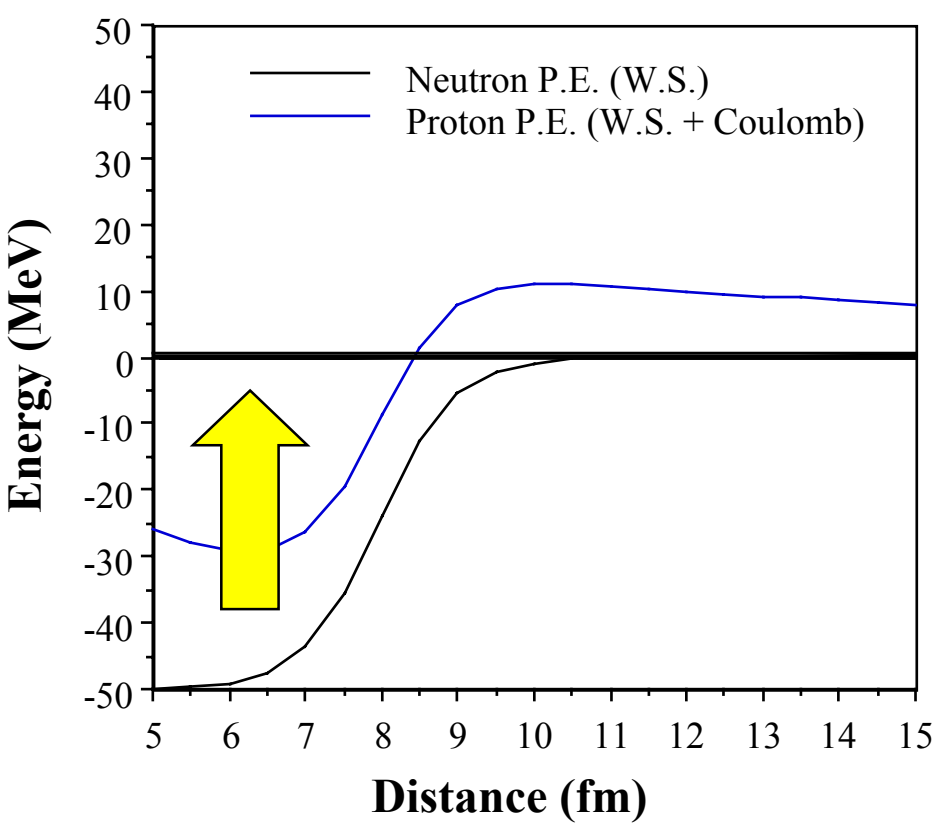
Physics with GS+HSPD: Nuclear structure as a function of E_x

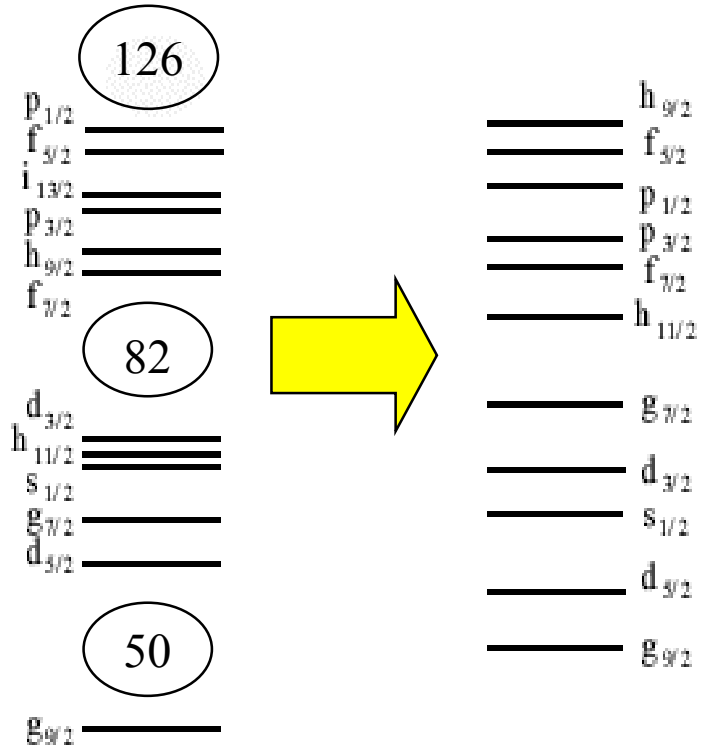


- **How do low energy symmetries break down as energy increases?**
  - **K-conservation**
  - **Vibrations**
  - **Pairing**
- **Spin dependence of level density**

γ(BGO)-α/p(HSPD)-γ(Ge) coincidences will allow for tracing of cascades above the limits of discrete spectroscopy

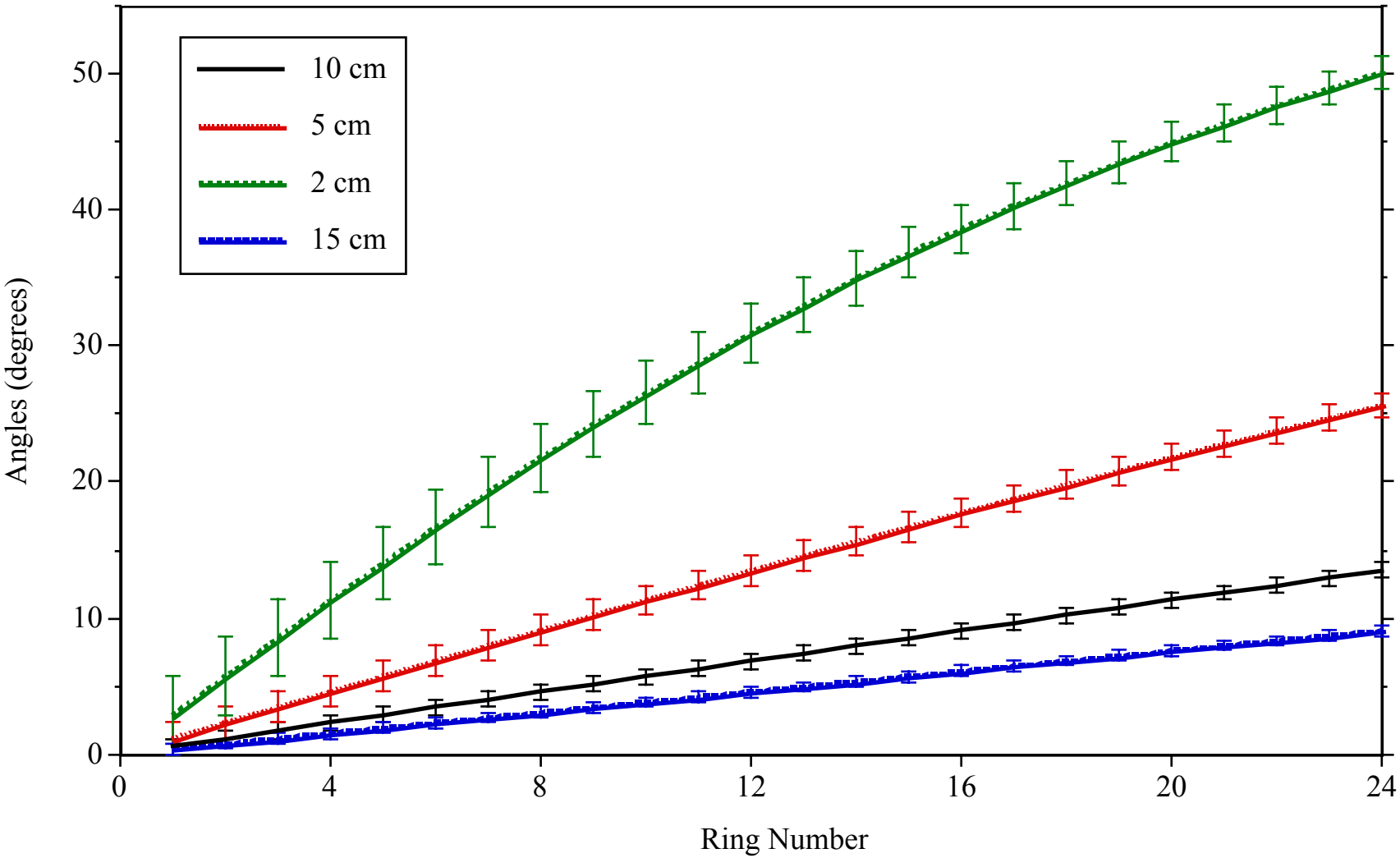
Physics with STARS+Ge detectors: Shell structure near the "lip" of the potential well (L.G. Moretto/L. Phair)





Does the spin-orbit interaction decrease near the edge of the well?

Angles and Angular Resolution for the S2 detector at various distances from the target



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