SAGE Spectrometer : Comparison of First Results and Geant4 Simulation

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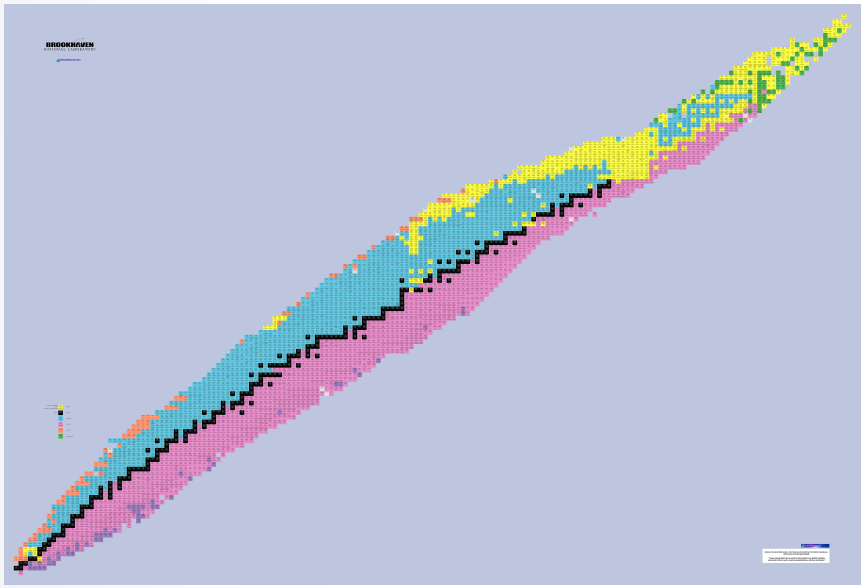
Outline

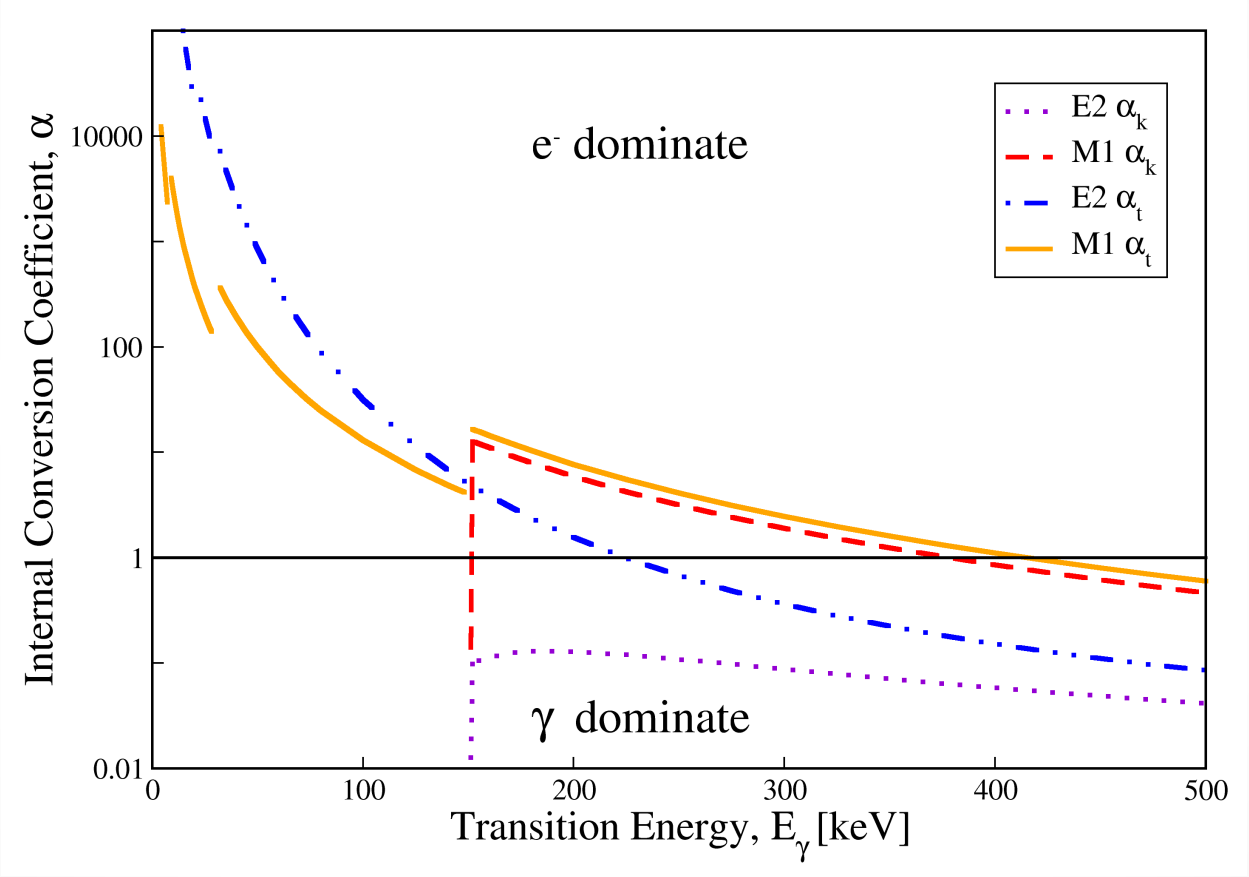
- Scientific Motivation
- Instrumentation
- First Results
- Simulation
- Summary

Scientific Motivation



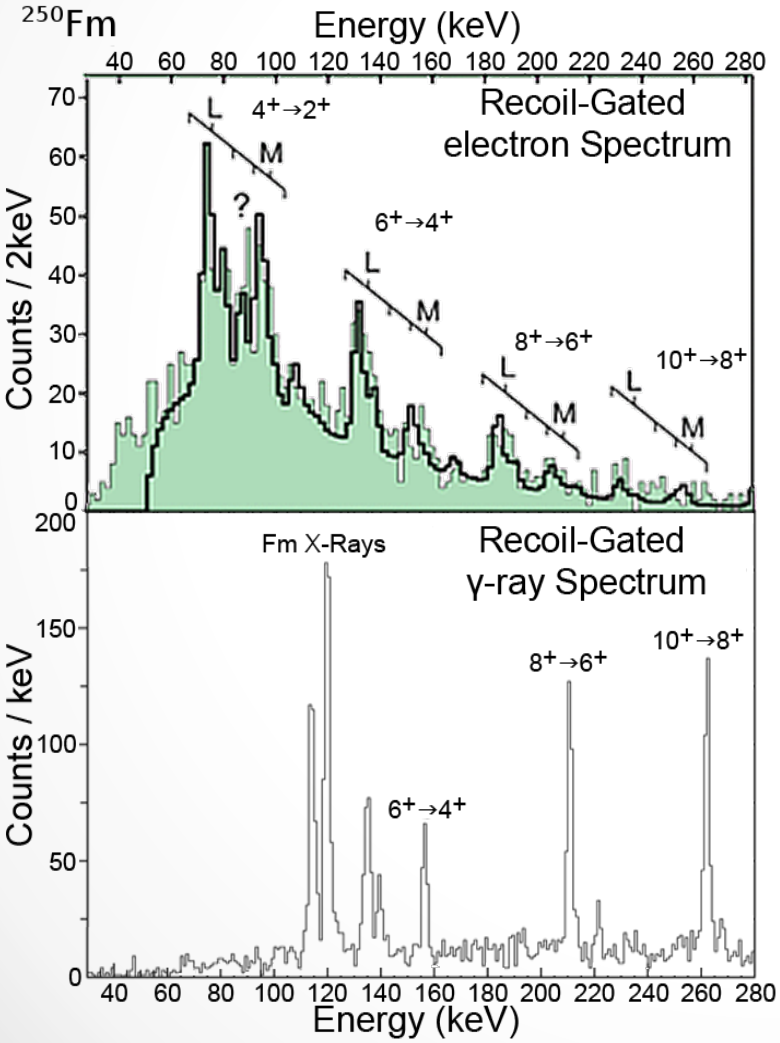
- >3000 known isotopes
- <300 stable isotopes
- Study of unstable nuclei at extremes helps to understand underlying structure
- Studying how nuclei decay can provide insight
- Possible decay routes, α, β, γ, particle emission and spontaneous fission
- SAGE designed to measure γ-rays and conversion electrons simultaneously.

Scientific Motivation



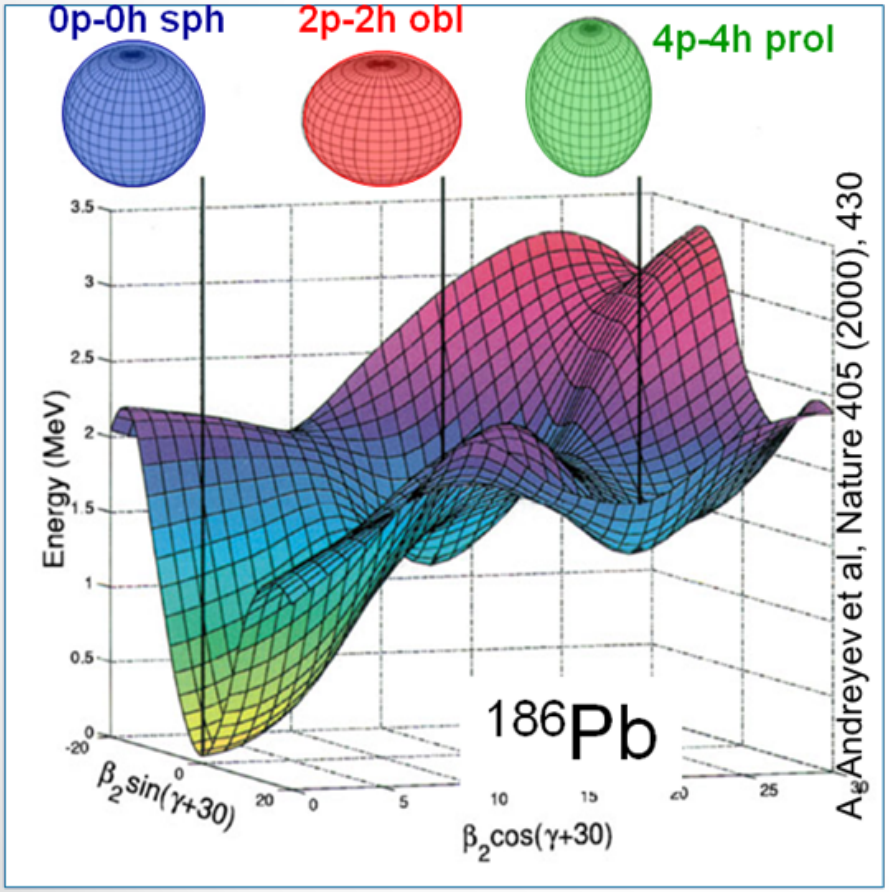
Transition energy versus internal conversion coefficient for Z=100

Scientific Motivation



- Internal conversion dominates at low energies
- Only part of the picture from either γ rays or conversion electrons
- Cross coincidences give a fuller picture

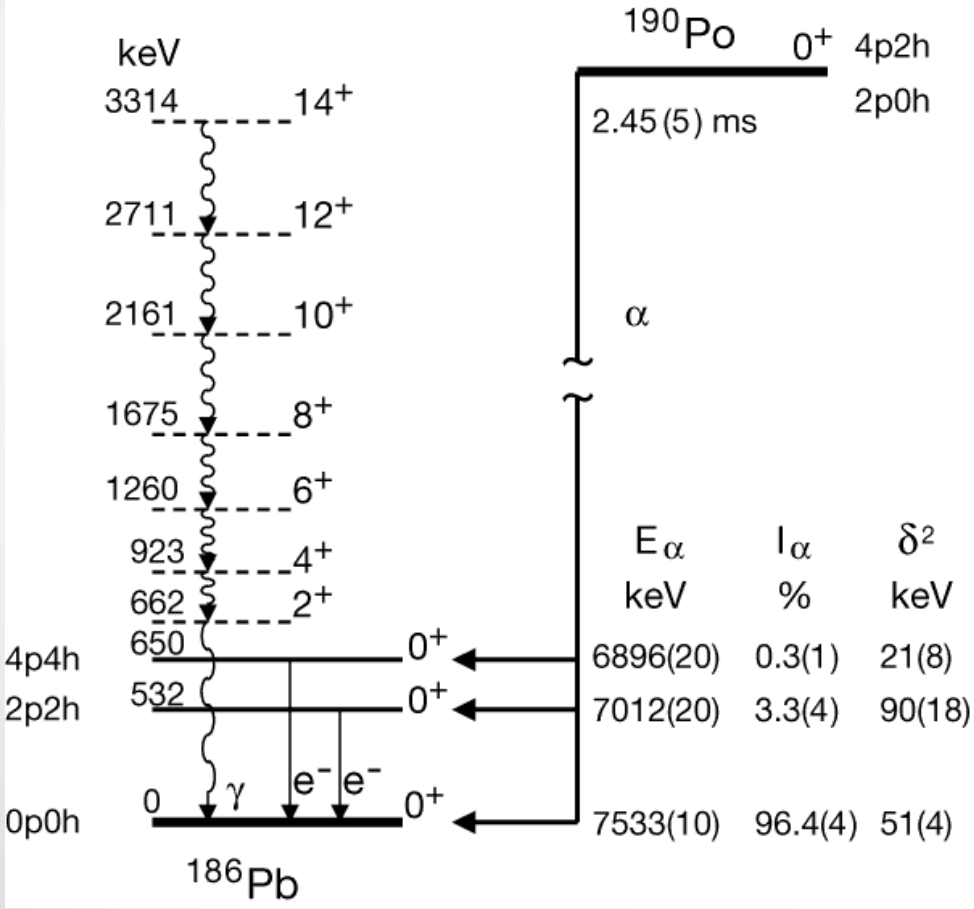
Scientific Motivation



Examples

- Shape coexistence in ^{186}Pb
- Spherical, Oblate, Prolate

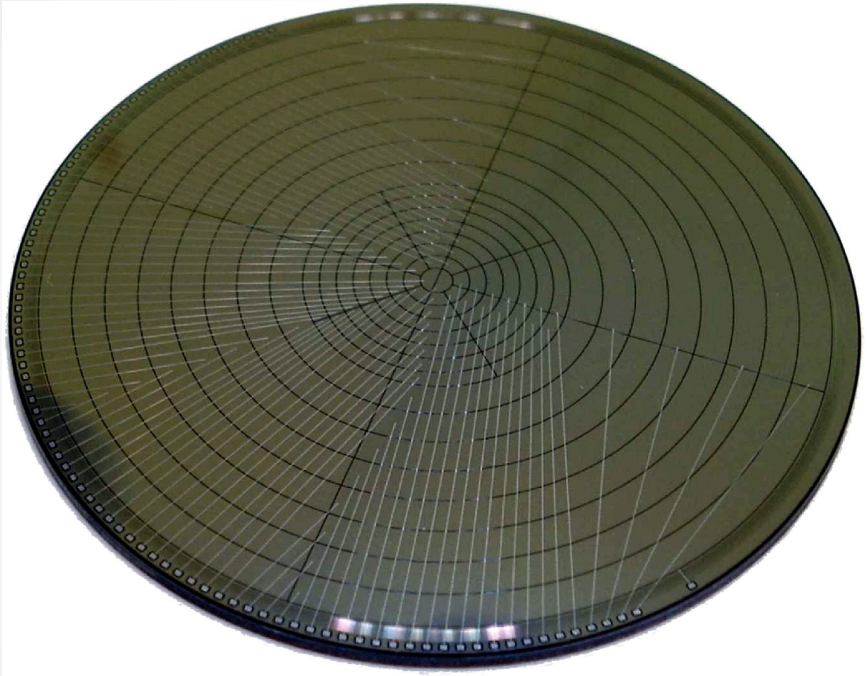
Scientific Motivation



Examples

- Shape coexistence in ^{186}Pb
- Spherical, Oblate, Prolate
- three 0^+ states
- Cannot decay by γ-ray
- E0 transitions can only occur via internal conversion

Instrumentation



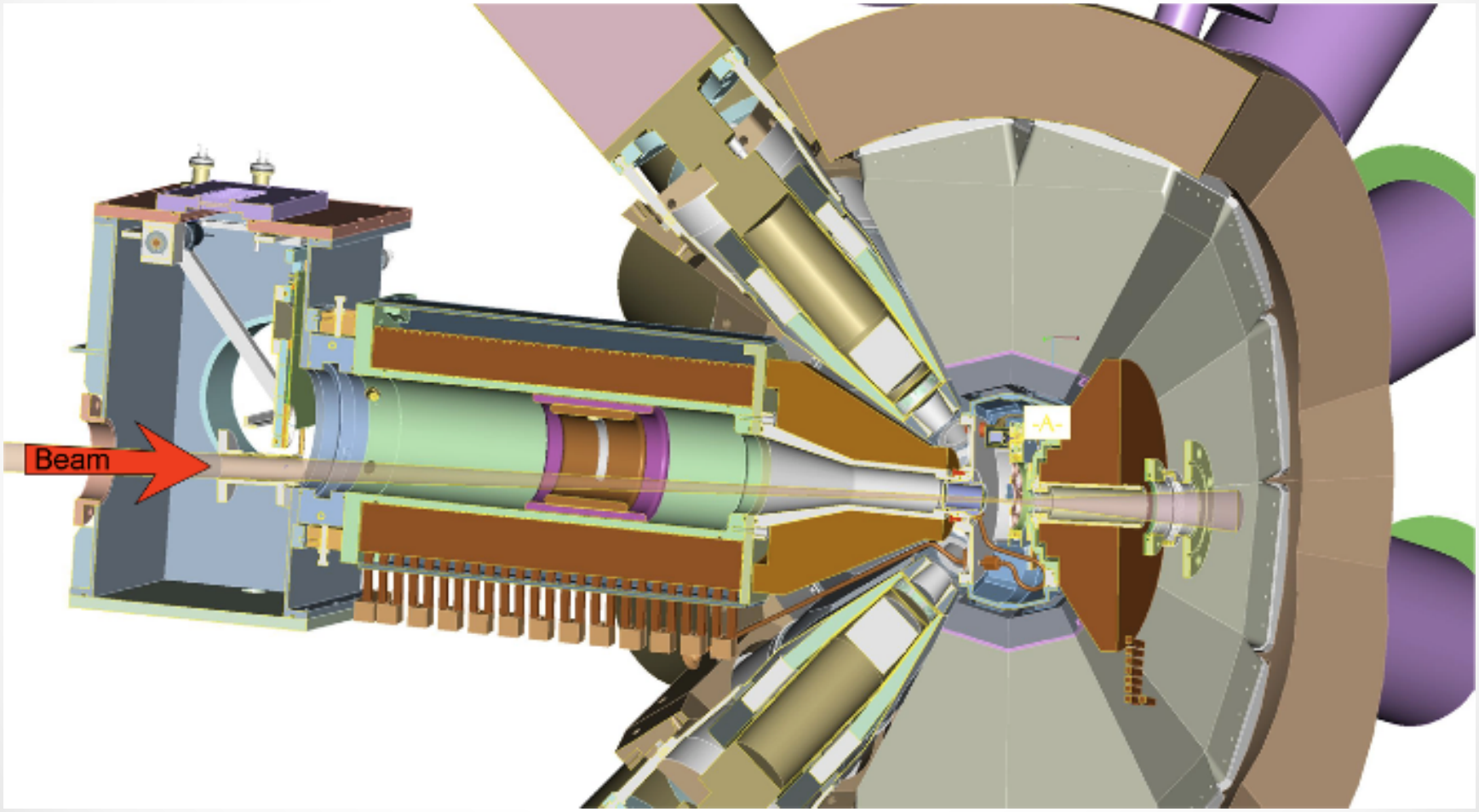
Silicon **A**nd **GE**rmanium spectrometer

- Highly Segmented silicon detector
- Solenoid Transport Magnet
- High Voltage Barrier
- Carbon Foil Unit
- JUROGAM II array

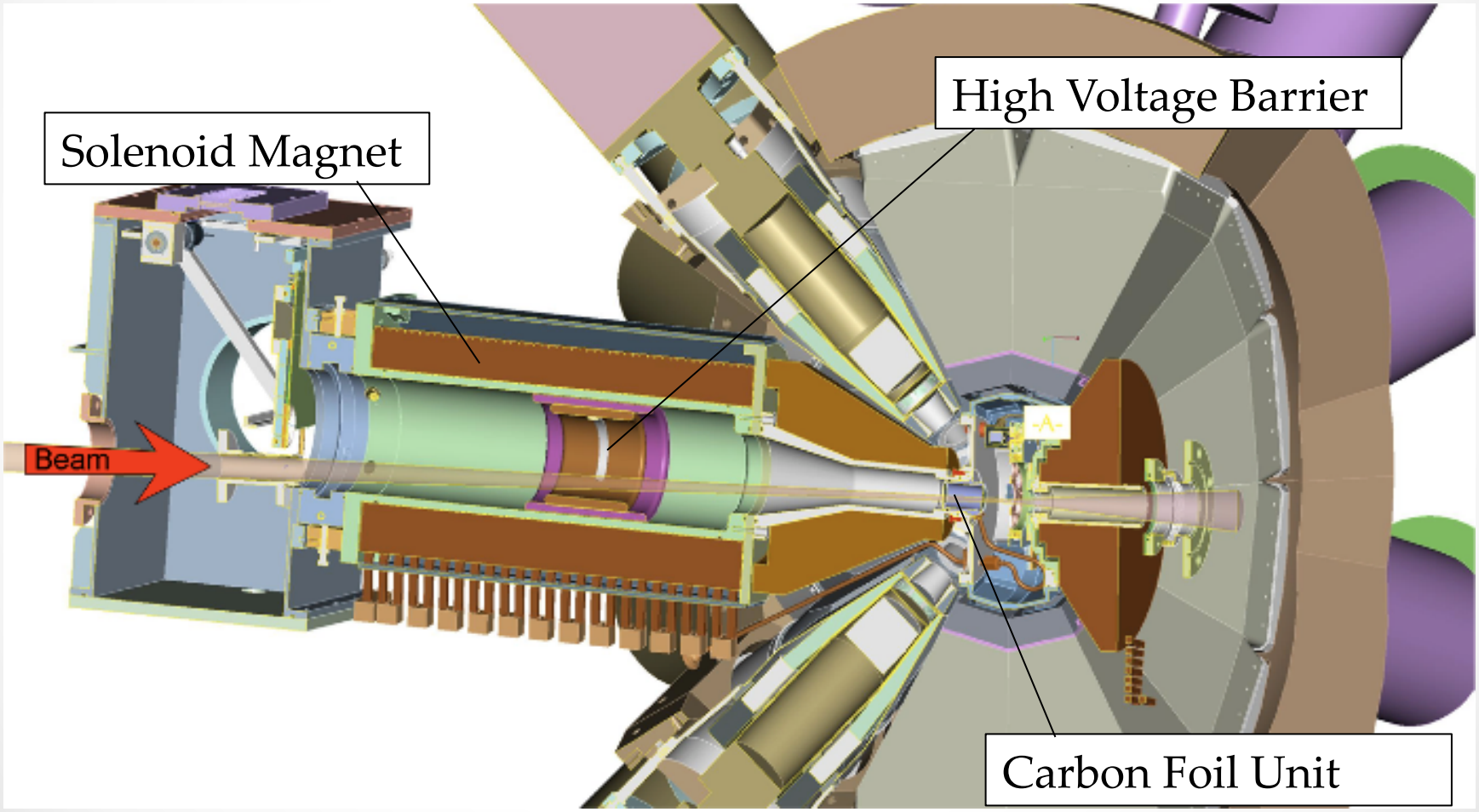
Detector 50mm diameter
1mm thick

Resolution ~3keV for some channels
~4.5keV average over all pixels

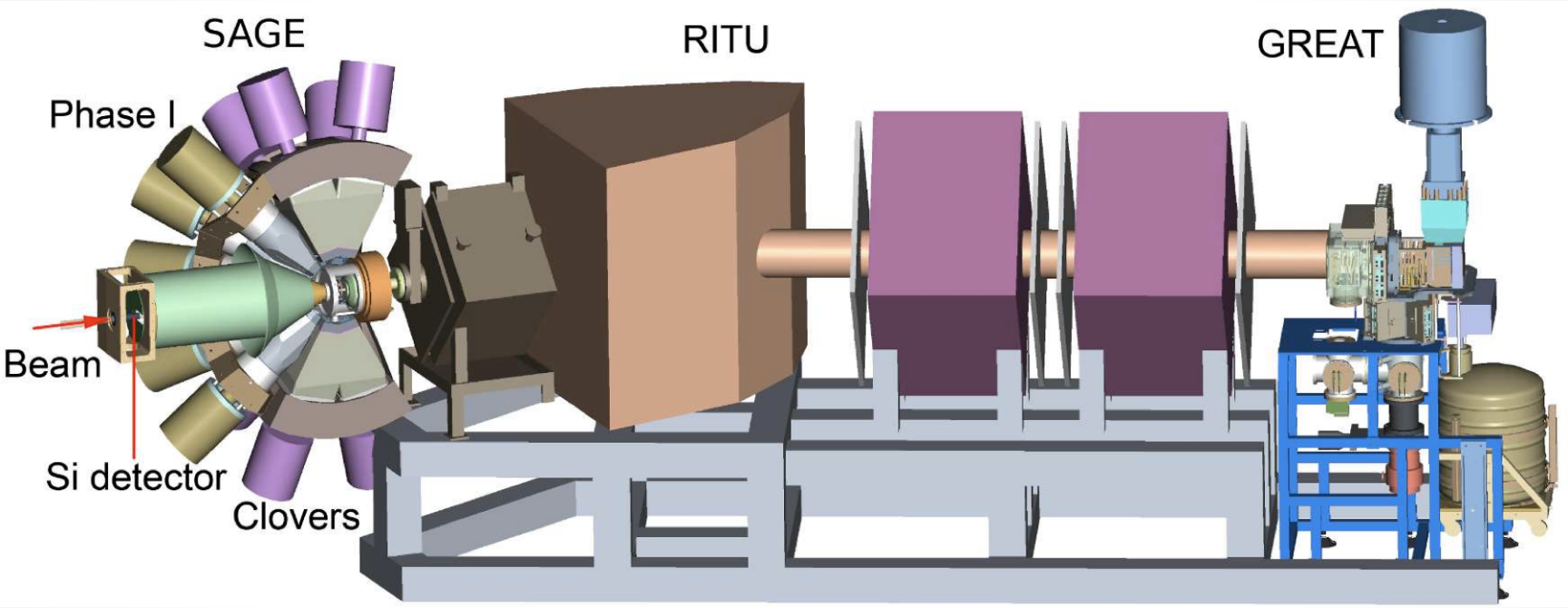
Instrumentation



Instrumentation



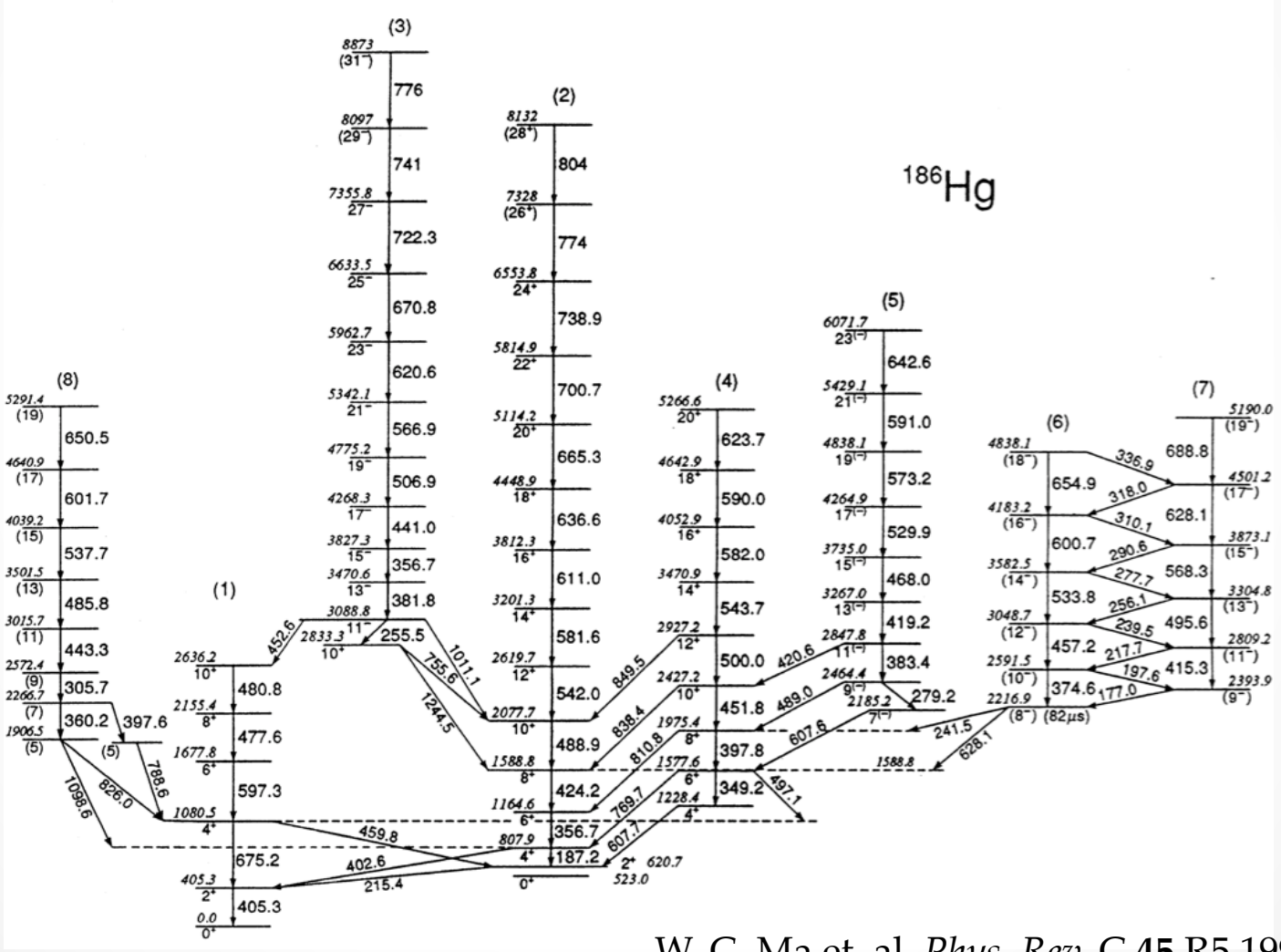
Instrumentation



Upgraded to fully digital frontend electronics

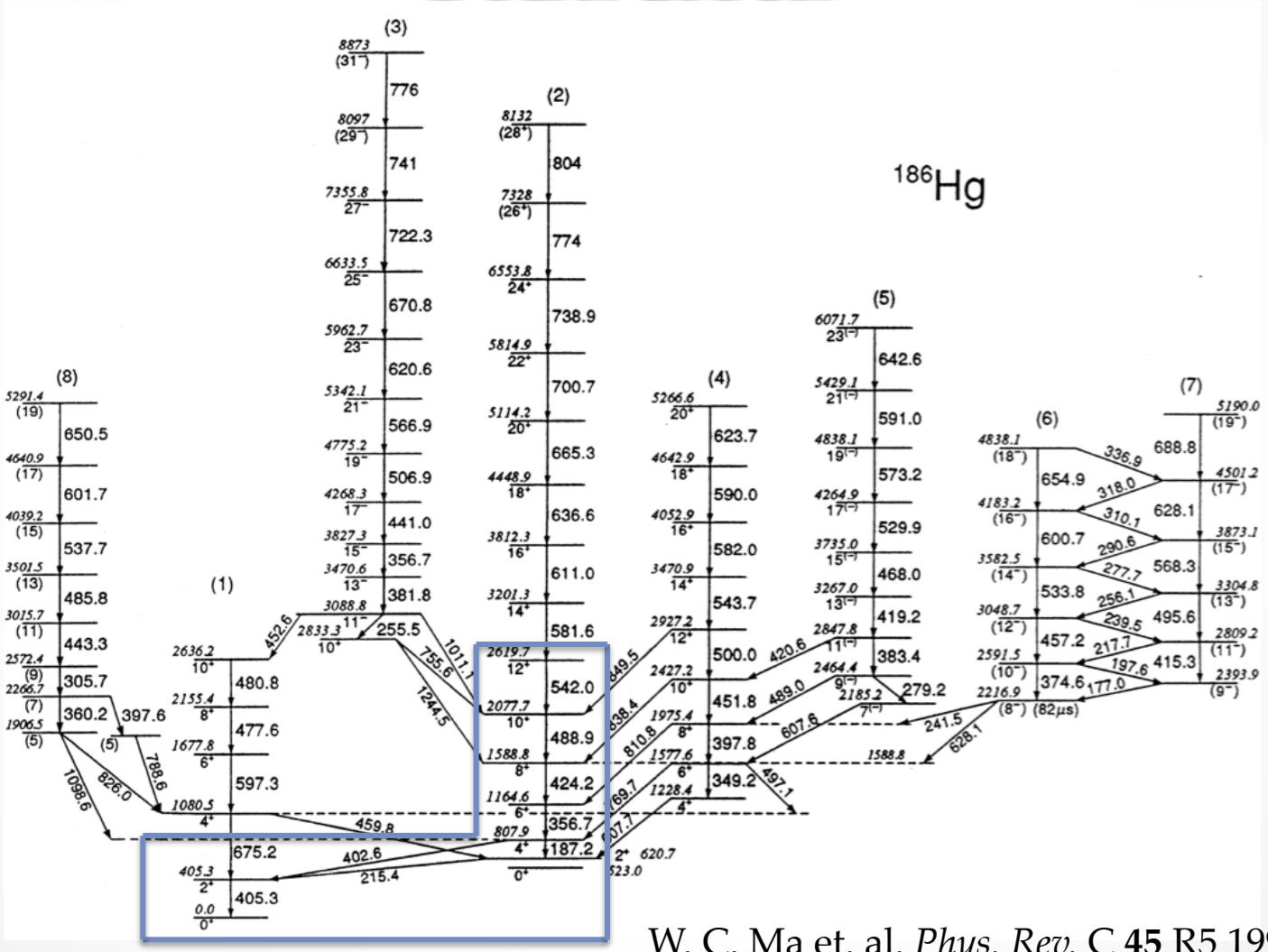
- Run at higher count rates (30kHz/Ge detectors)
- Linear throughout energy range

Results



W. C. Ma et. al. *Phys. Rev.* C **45** R5 1992

Results



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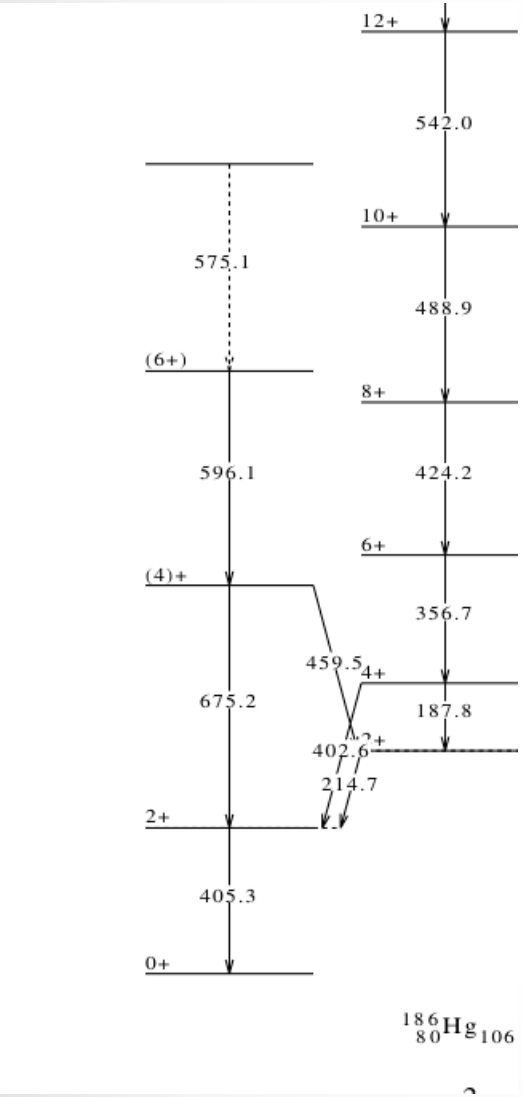
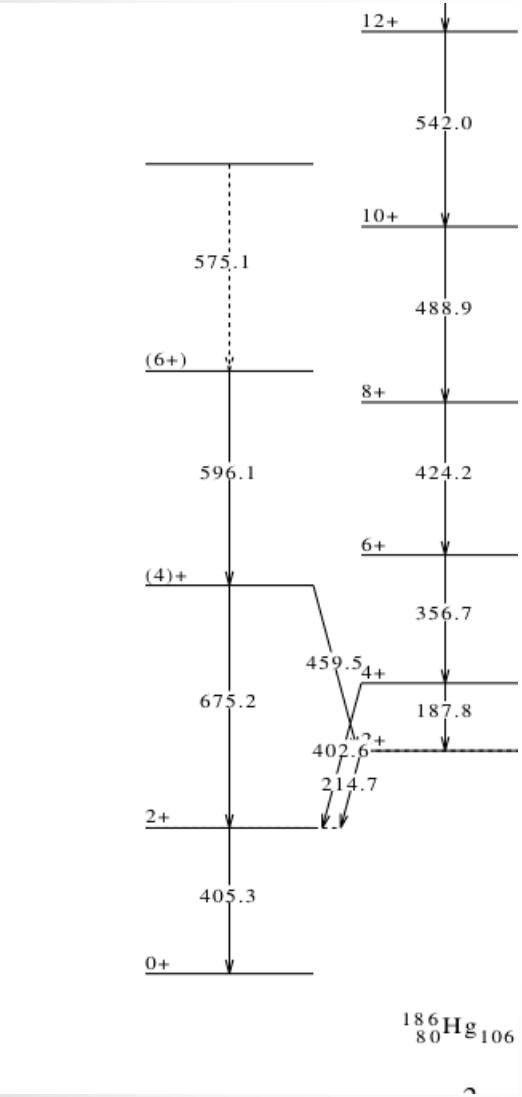
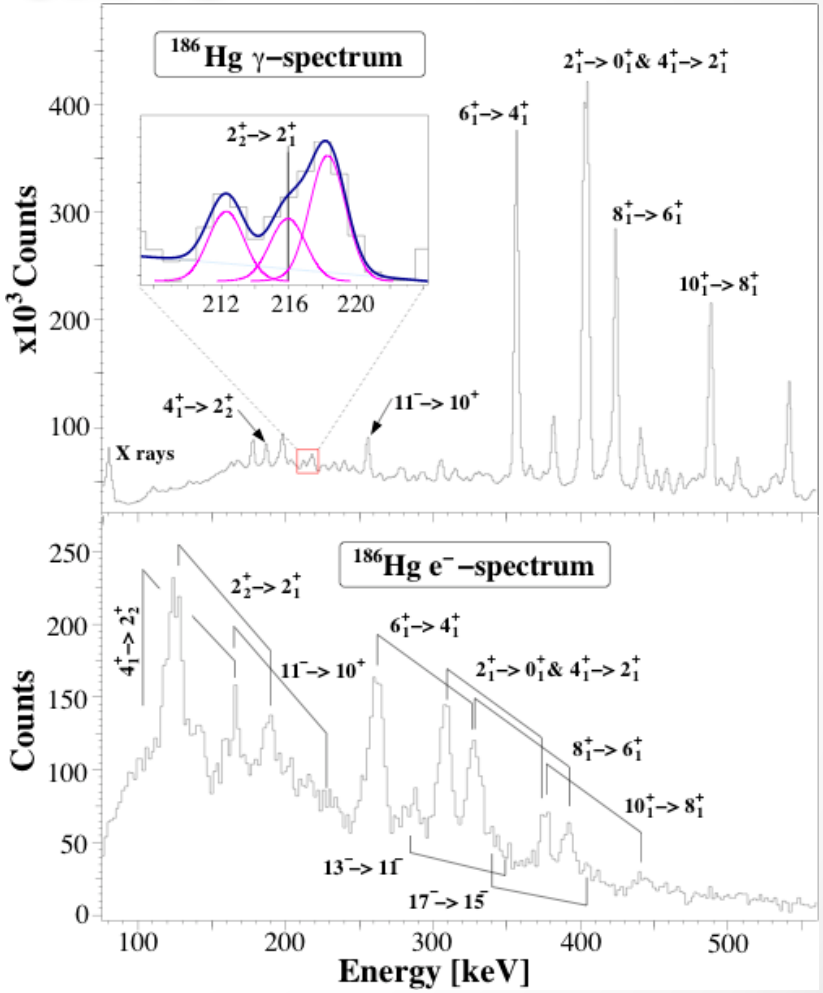
Results


12+
542.0
10+
575.1
488.9
(6+)
8+
596.1
424.2
6+
(4)+
356.7
459.5
4+
675.2
187.8
402.6
214.7
2+
405.3
0+
186 80 Hg 106

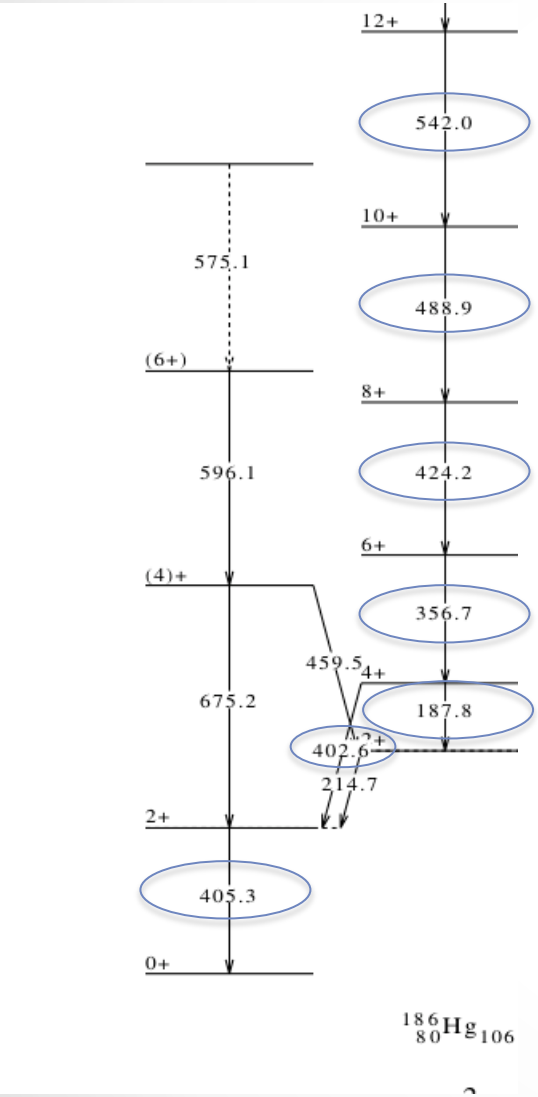
Results

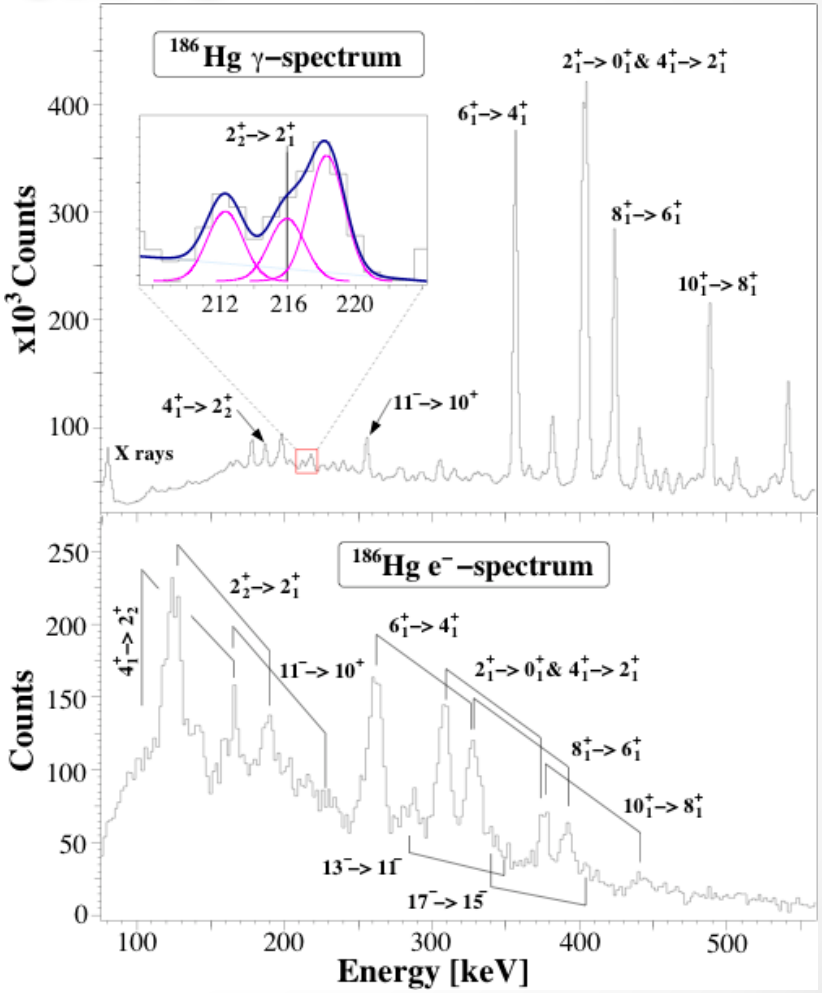




M. Scheck *et. al.* Phys. Rev. C Accepted (2011)

Results





M. Scheck *et. al.* Phys. Rev. C Accepted (2011)

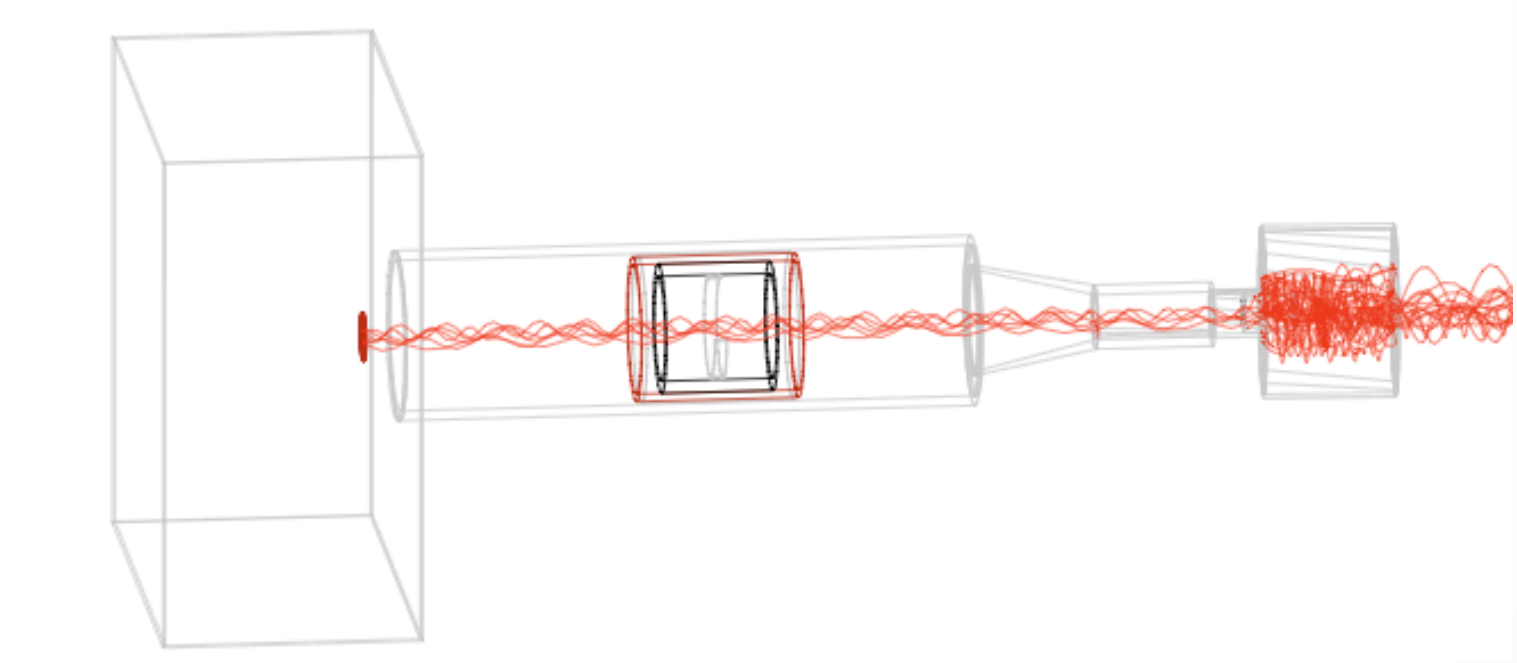
Simulation

Geant4 is a toolkit developed to simulate the passage of particles through matter.

Reasons for Simulation

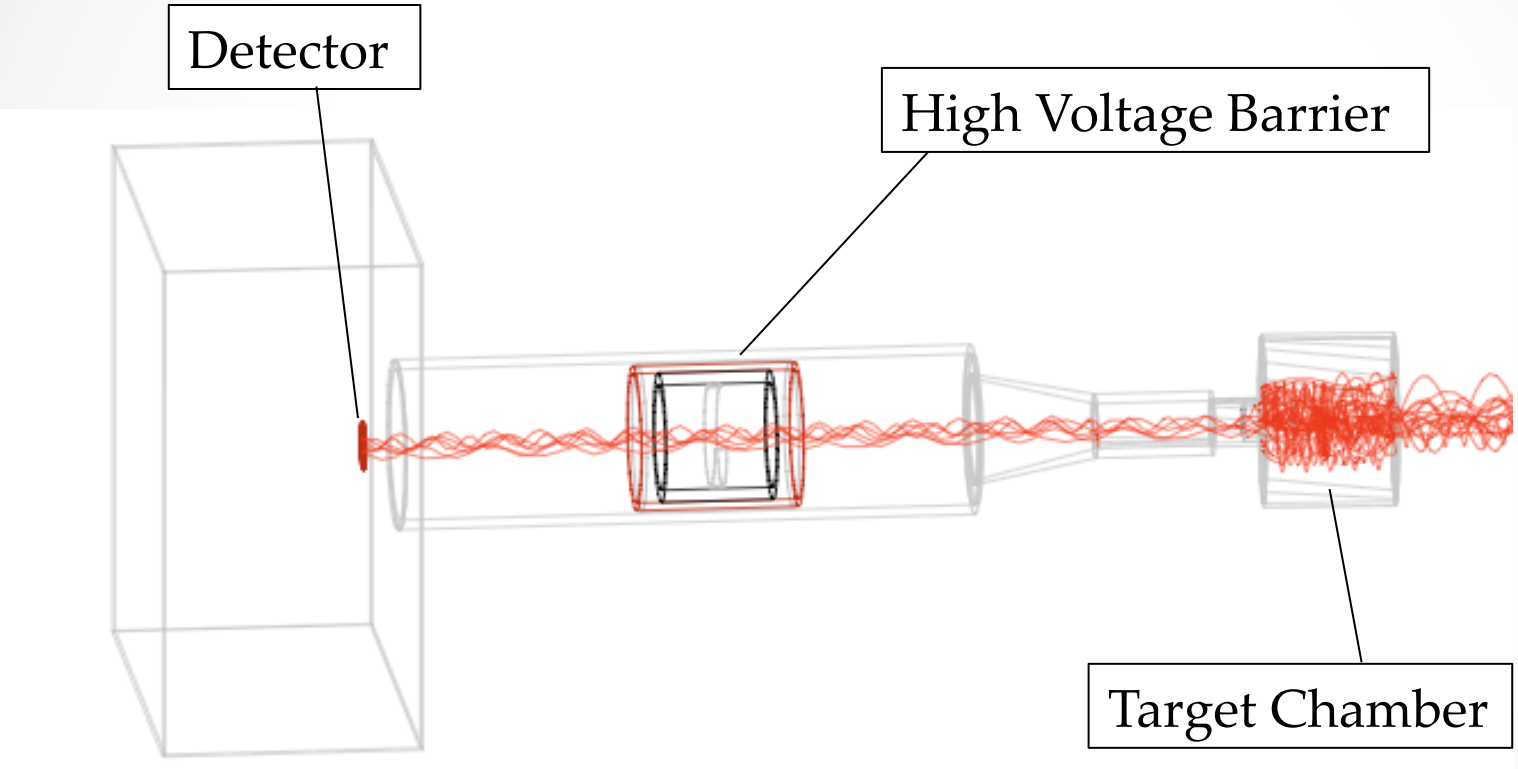
- Deeper understanding of instrument
- Simulation beforehand, aid in setup

Simulation



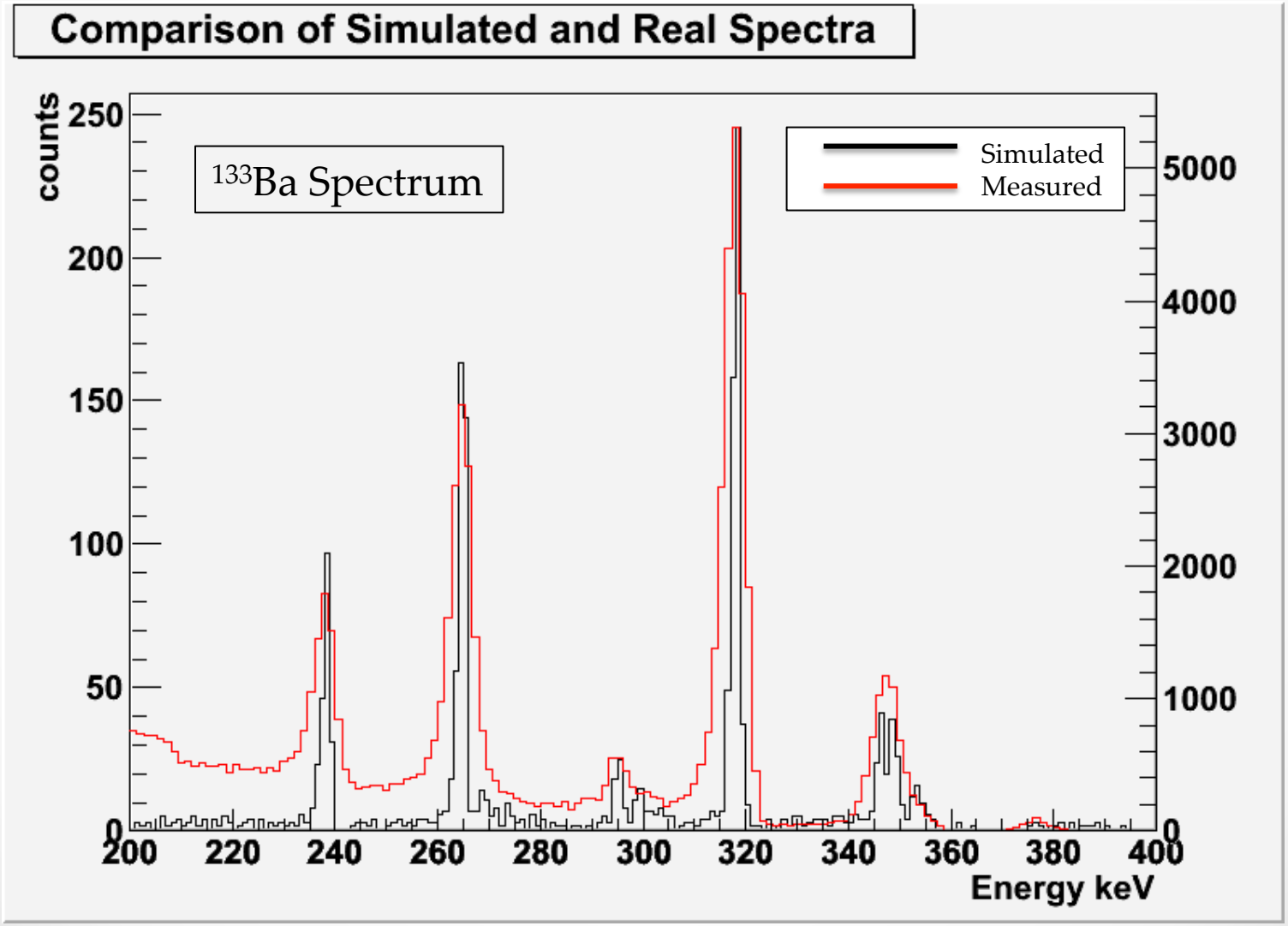
Simulation of SAGE, electrons can be seen travelling in the magnetic field and hitting the detector

Simulation



Simulation of SAGE, electrons can be seen travelling in the magnetic field and hitting the detector

Simulation


Comparison of Simulated and Real Spectra
counts
250
200
150
100
50
0
^{133}Ba Spectrum
Simulated
Measured
5000
4000
3000
2000
1000
0
200
220
240
260
280
300
320
340
360
380
400
Energy keV

Simulation

Current implementation

- Simple inner geometry (what the electron sees)
  - Carbon foil unit
  - Helium in target chamber
- Magnetic field imported from OPERA 3D simulation package
- Full readout to a ROOT file of energy deposited in detector either in a single pixel or in the whole detector

Simulation

Planned future additions

- Import of electric field for high voltage barrier from OPERA 3D simulation package
- Inclusion of JUROGAM II array
- Addition of more complicated geometry (e.g. target wheel)
- Detailed simulation of δ electron production

Summary

SAGE spectrometer allows simultaneous measurement of conversion electrons and γ rays

Coupled with RITU & GREAT

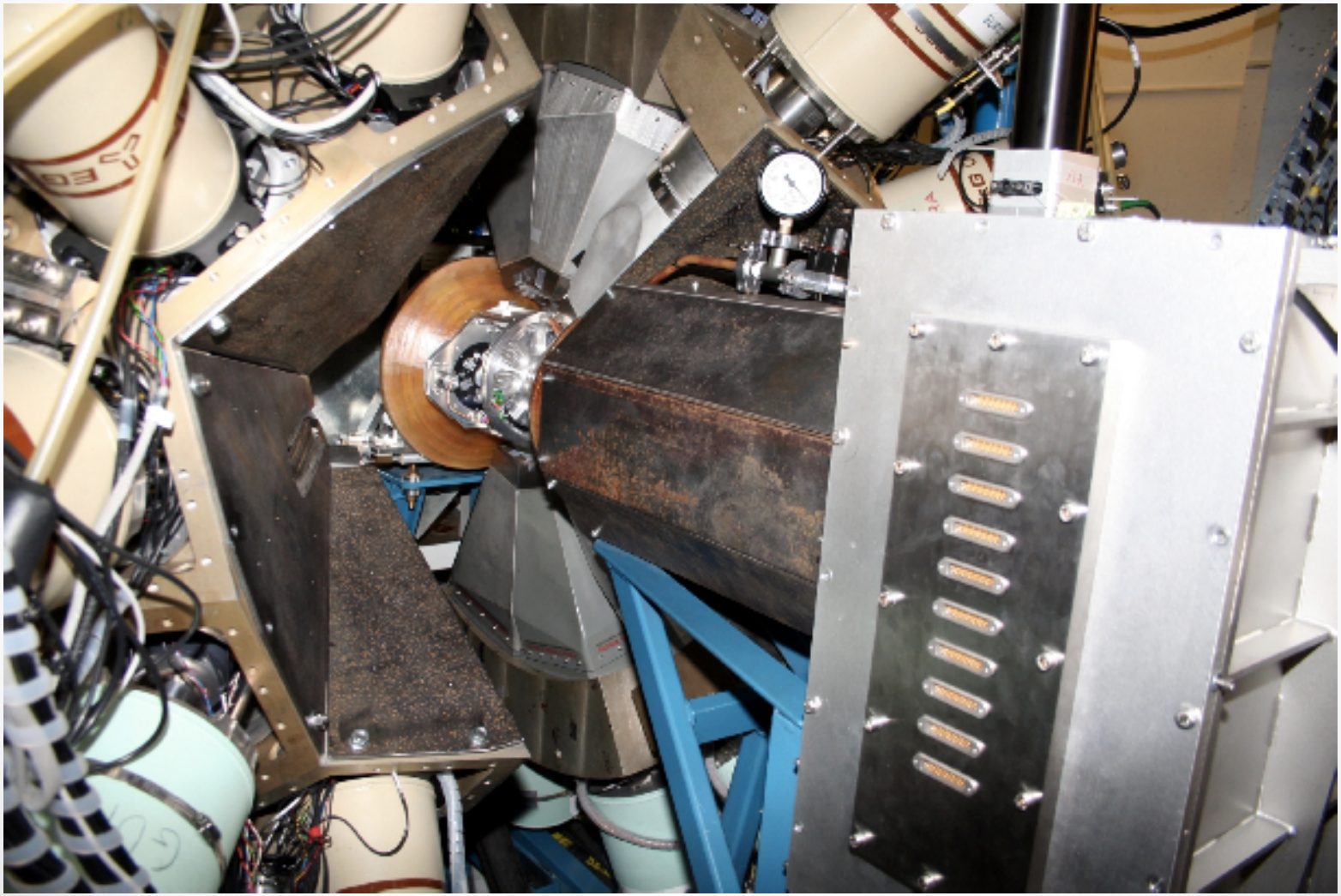
- Both in beam and decay spectroscopy
- Recoil Decay Tagging Technique

First experiments successful

- Mercury isotopes
- Radon isotopes

Experimental campaign scheduled for later this year

Summary



Collaboration

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