Improving Resolution for the KATRIN Detector Prototype

By Tabatha Spencer

Ursinus College, Collegeville PA

CENPA, University of Washington

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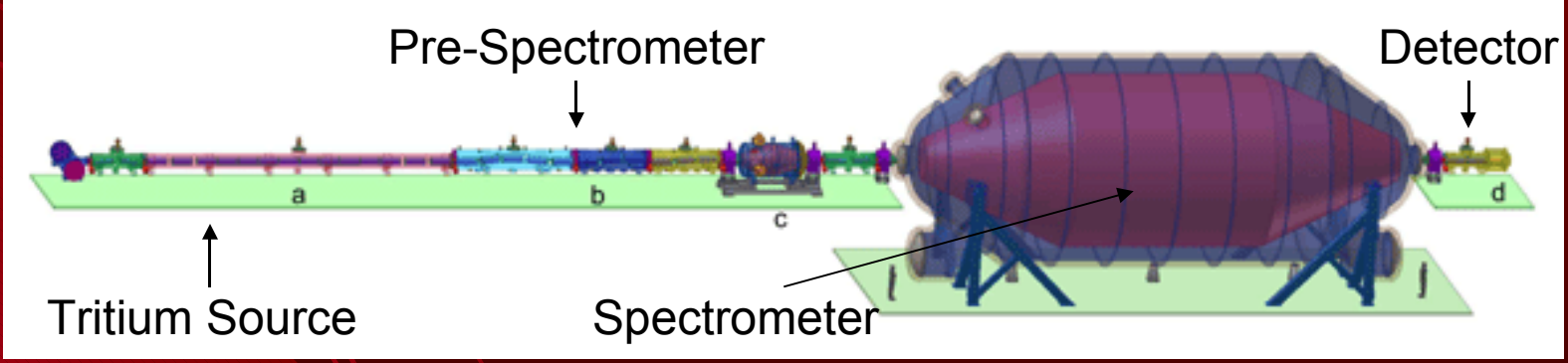
Basic Outline

- KATRIN
  - Purpose
  - Schematic
- Equipment
  - Silicon Detector
  - Electron Gun
  - Vacuum System
- Resolution Techniques
  - Dead Layer Determination
  - Noise reduction
- Cooling Designs
  - Attempts
  - Future plans

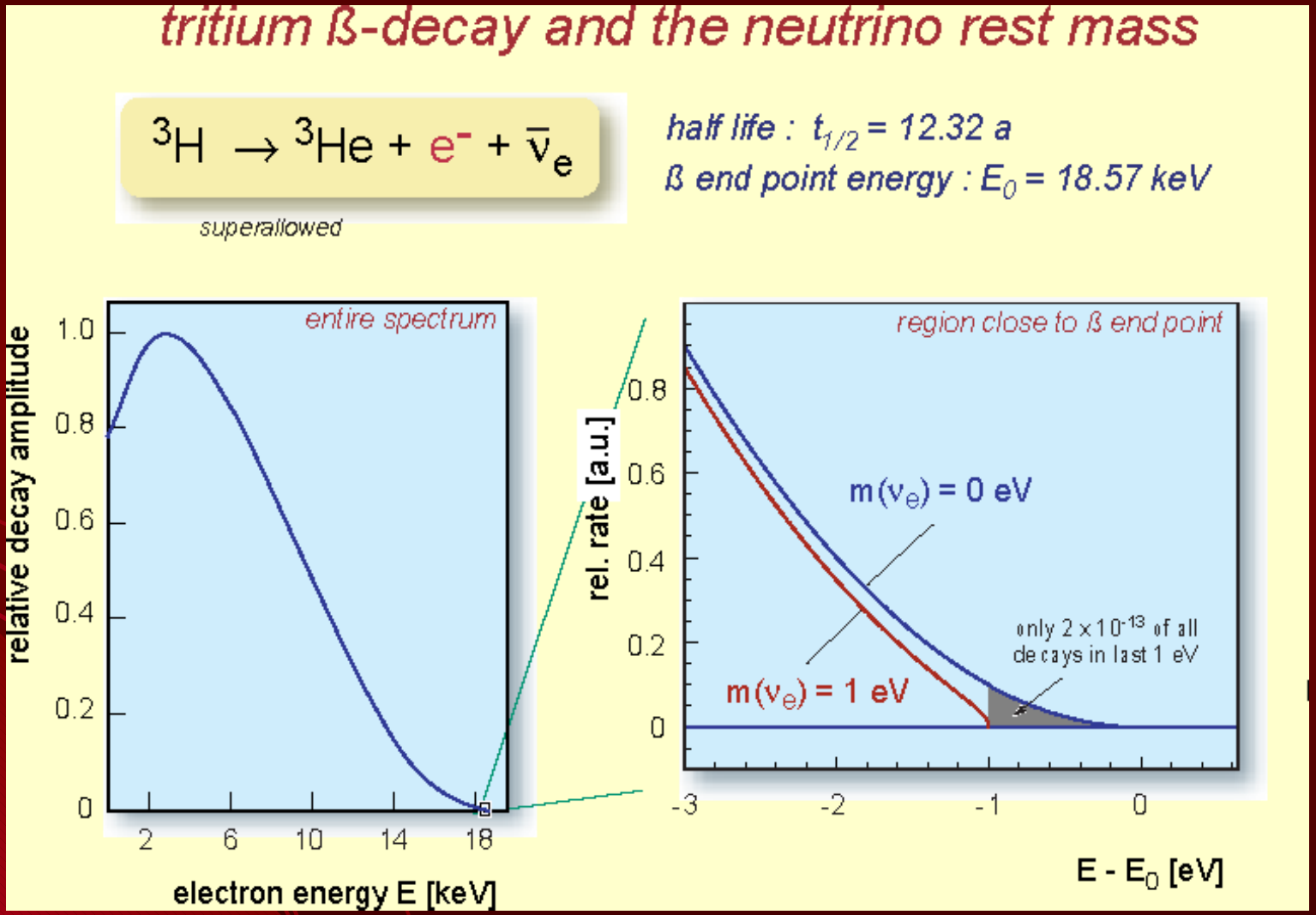
KATRIN
(**Ka**rlsruhe **Tr**itium **N**eutrino Experiment)

- Next generation tritium beta-decay neutrino experiment
- Direct measurement of neutrino mass
- Collaboration in Karlsruhe, Germany
- Projected start date in 2006



http://www-ik1.fzk.de/tritium/

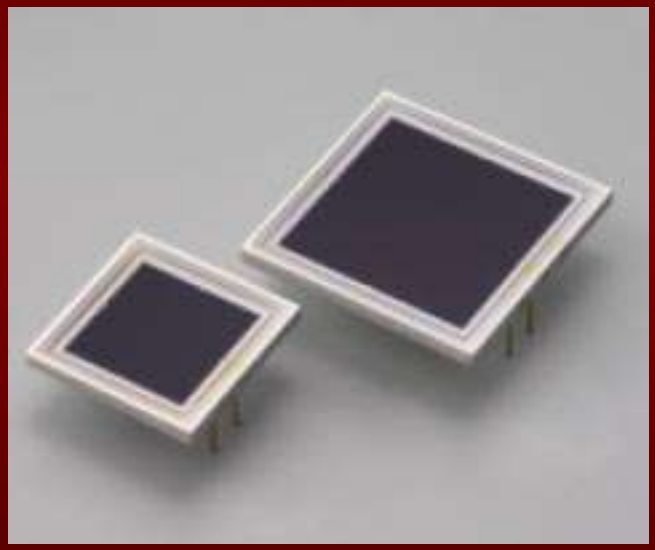
High Resolution



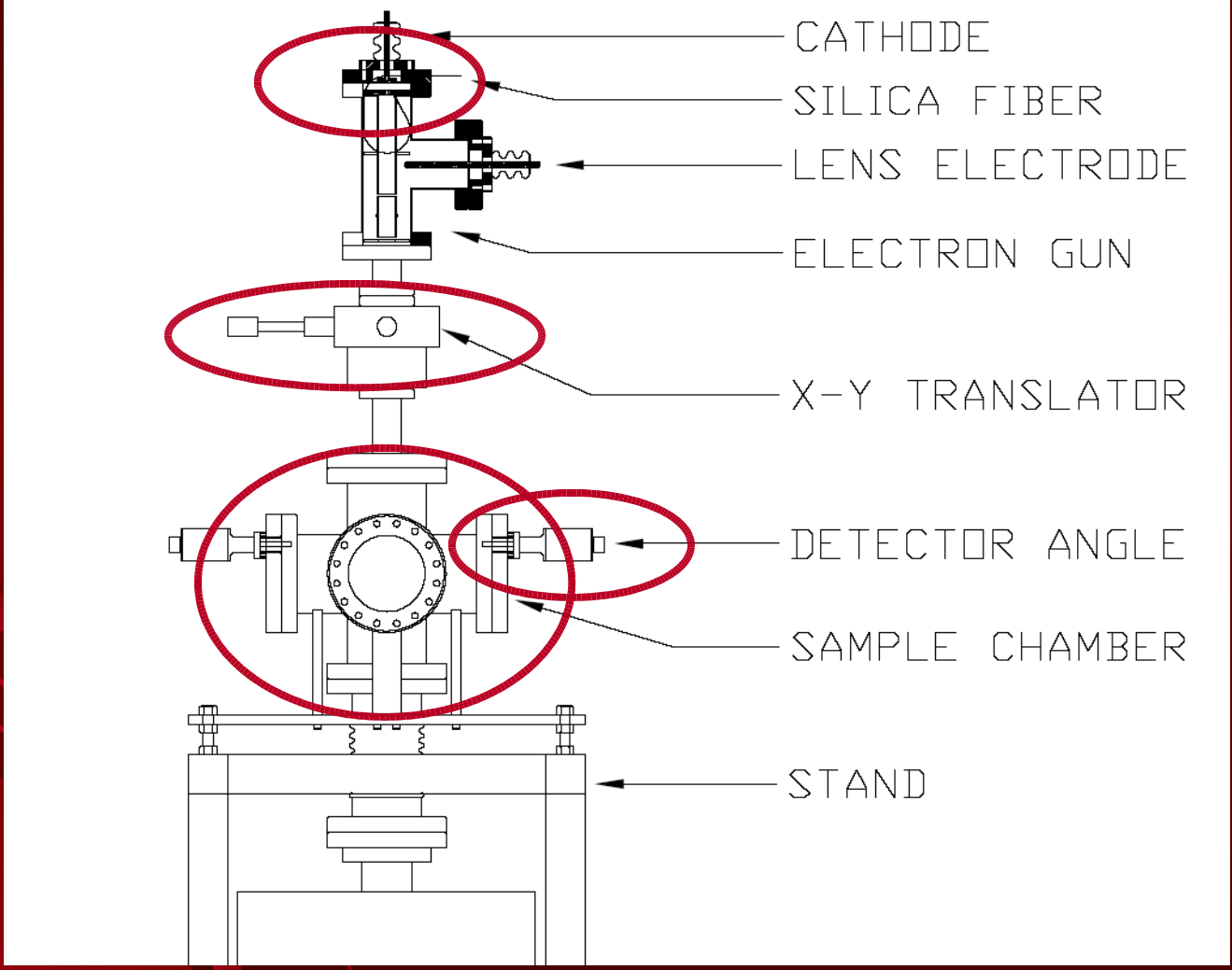
http://www-ik1.fzk.de/tritium/overview/index.html

Silicon Detectors

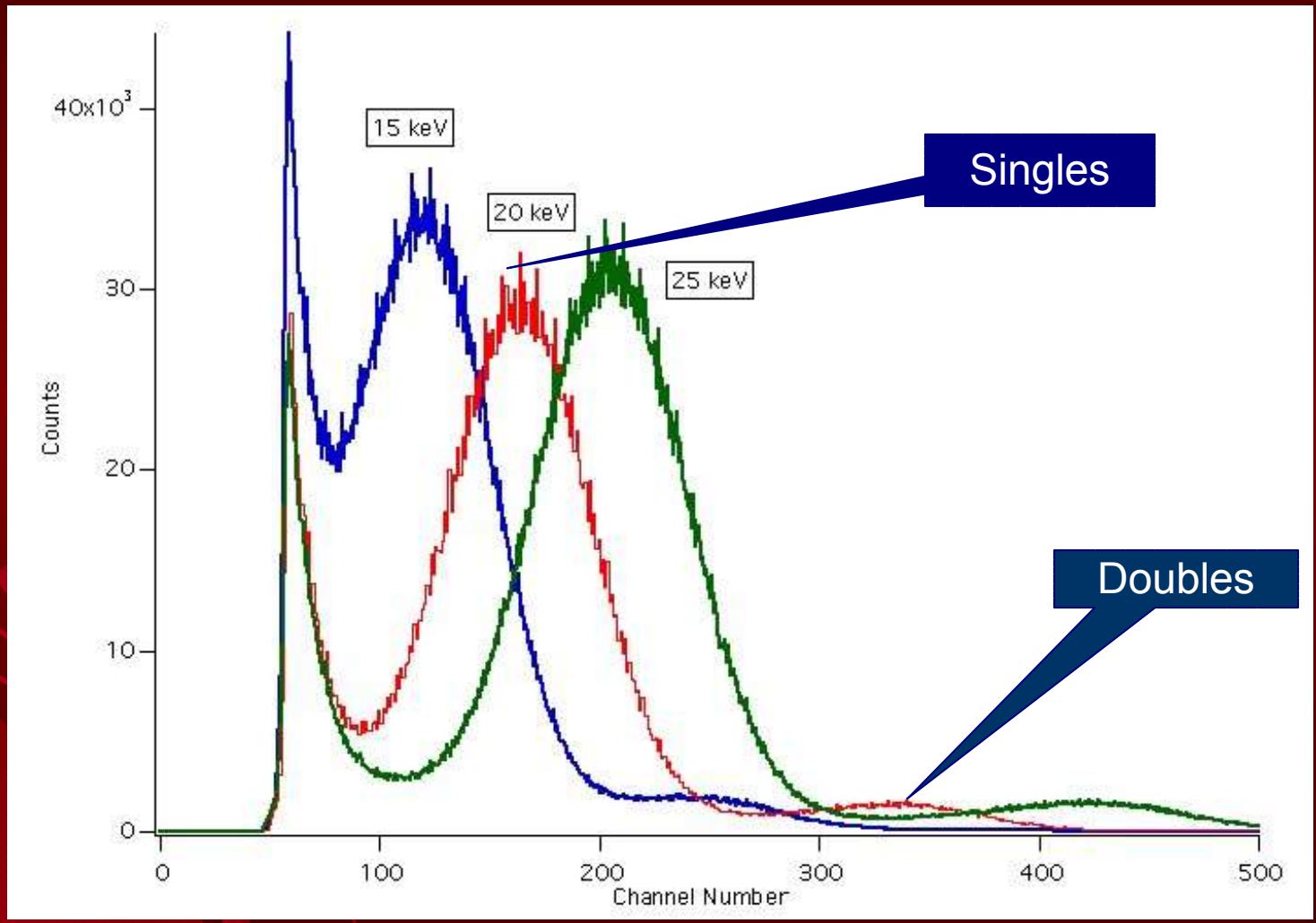
- Testing resolution refining techniques on less sophisticated technology first
- Initial - Silicon Pin Diode
- Intermediate – Silicon Drift Diode
- Final - Segmented Pin Diode



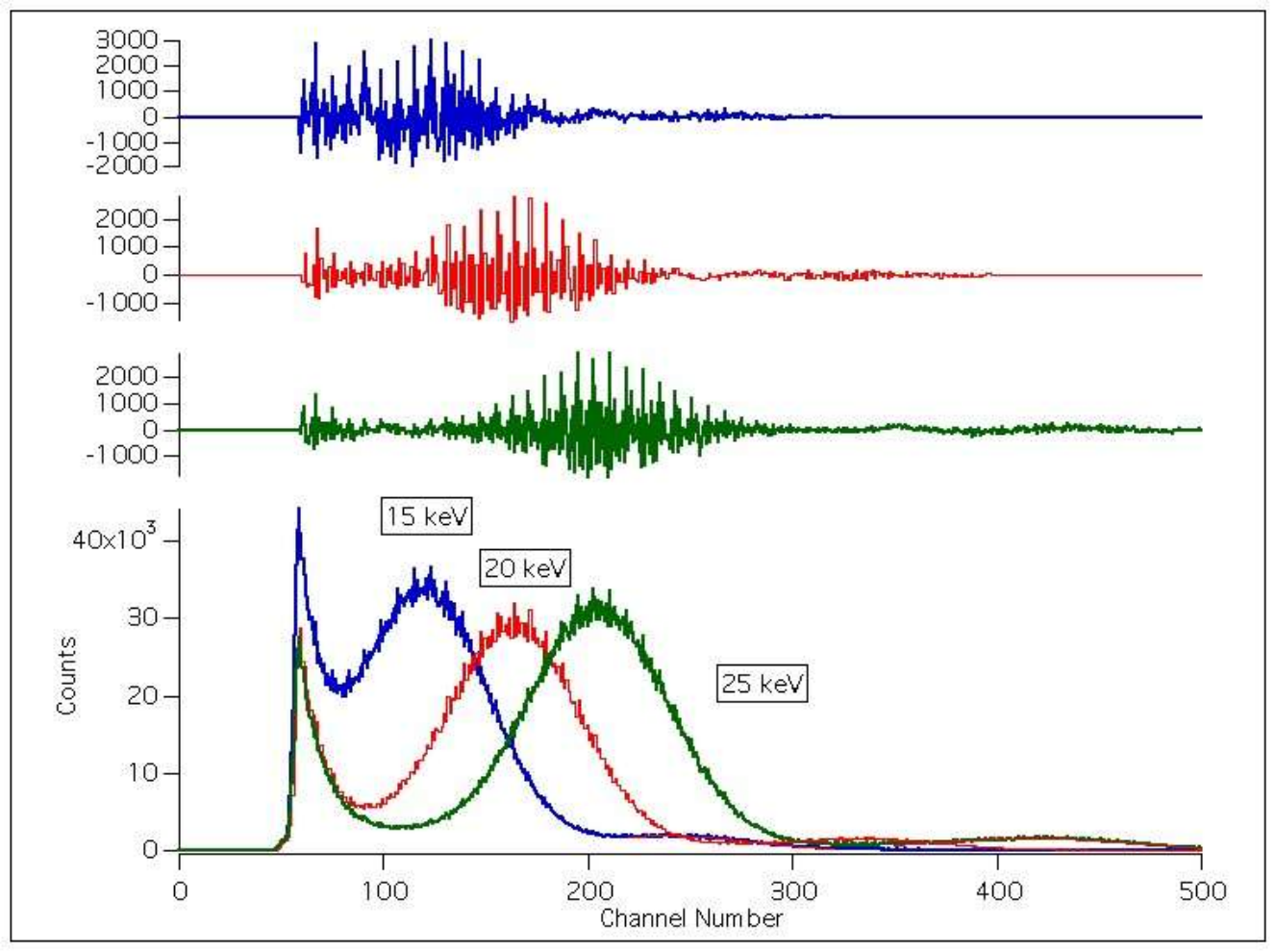
Electron Gun and Vacuum System



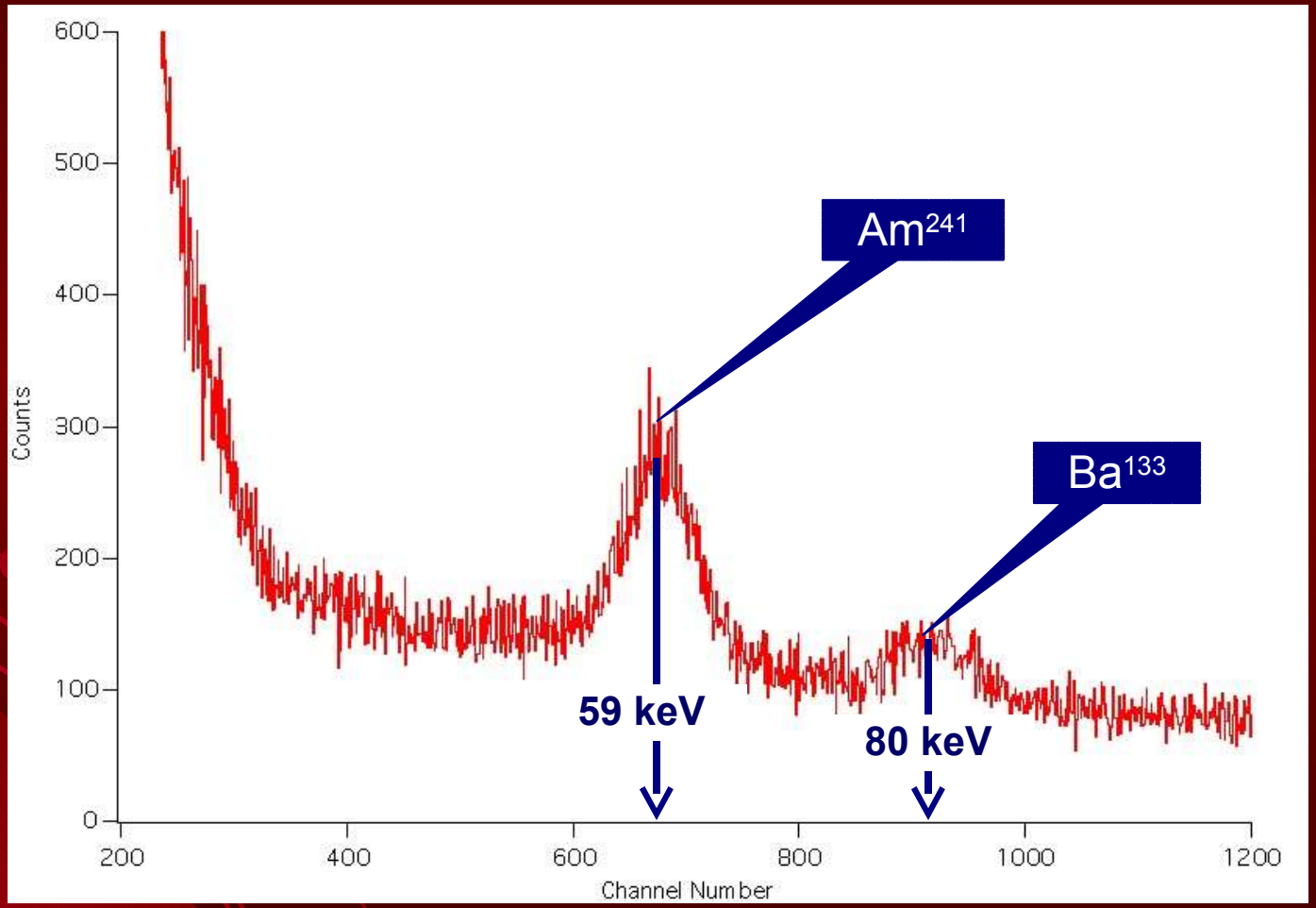
Initial Measurements



8-Bit Bias

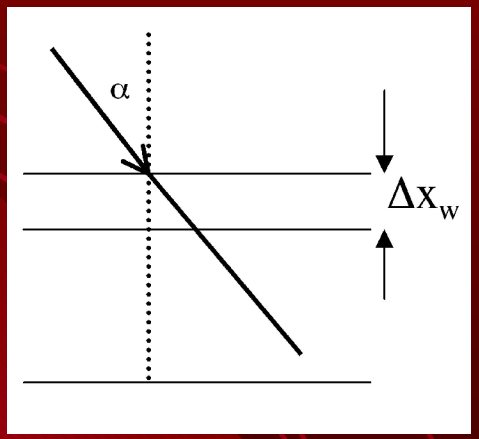

3000
2000
1000
0
-1000
-2000
2000
1000
0
-1000
2000
1000
0
-1000
15 keV
20 keV
25 keV
40x10^3
30
20
10
0
Counts
0
100
200
300
400
500
Channel Number

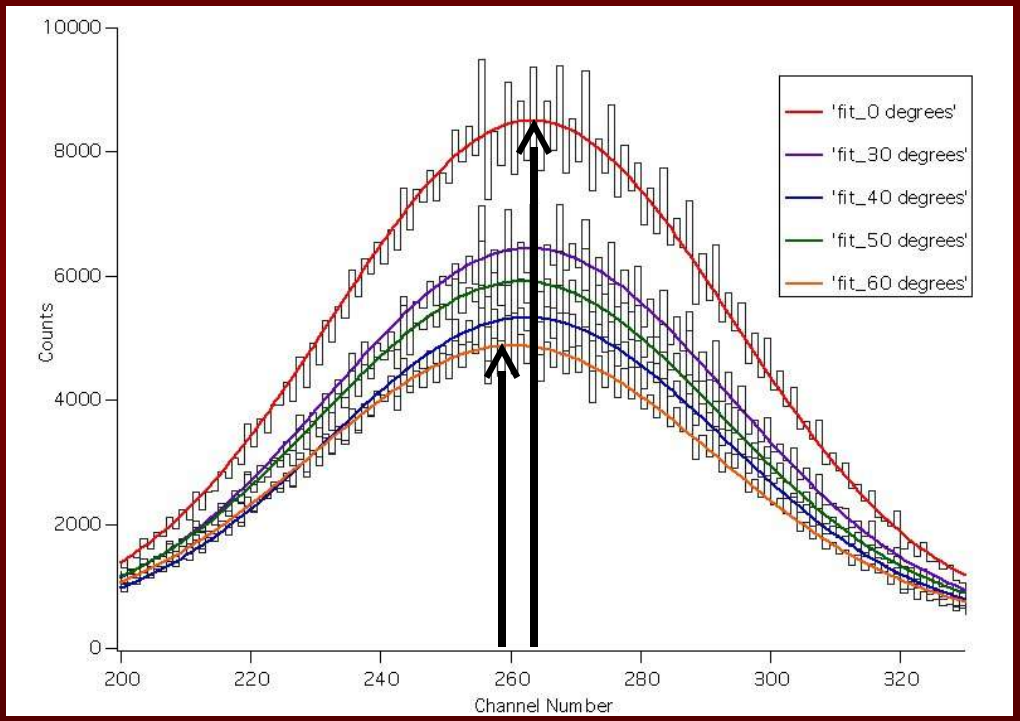
Scale Calibration



Dead Layer Measurement

- Small amount of energy lost on surface of the detector
- Correction needed
- Peak energy compared at multiple angles

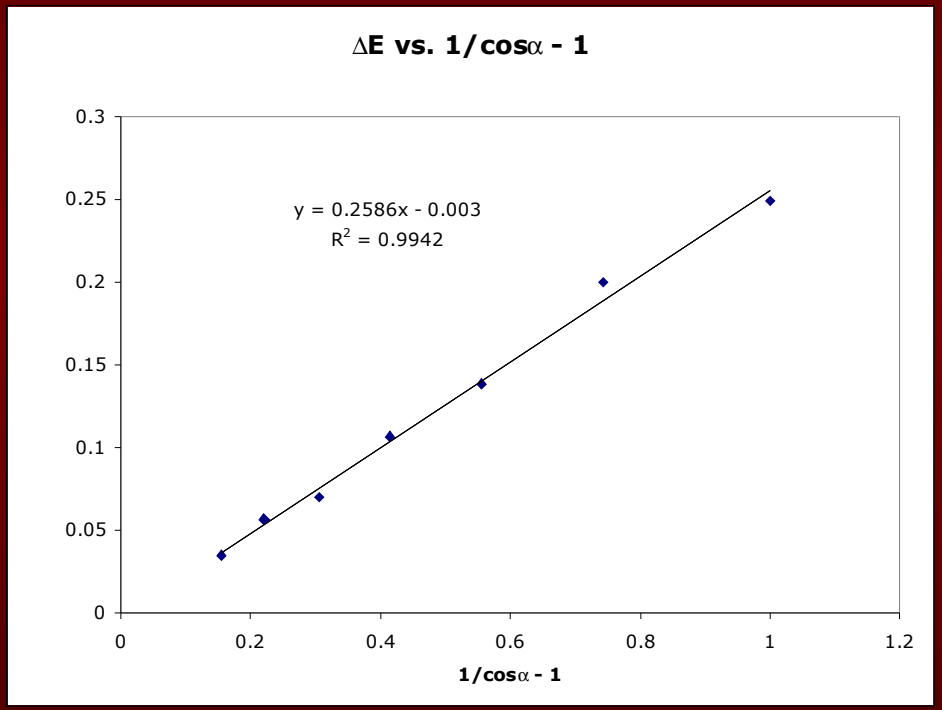




Dead Layer Results

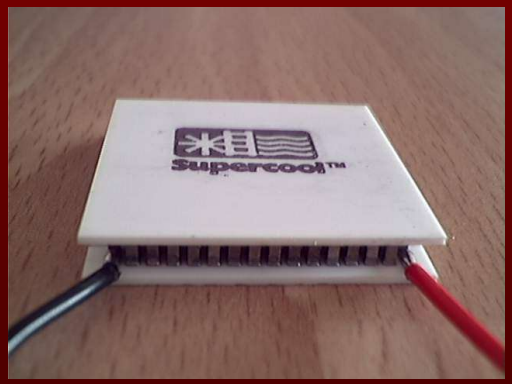
$$\Delta E = dE/dx * \Delta x_w * (1/\cos\alpha - 1)$$

- Can solve for the dead layer thickness
- Δx_W = 123 nm
- Agrees well within error of previous measurement

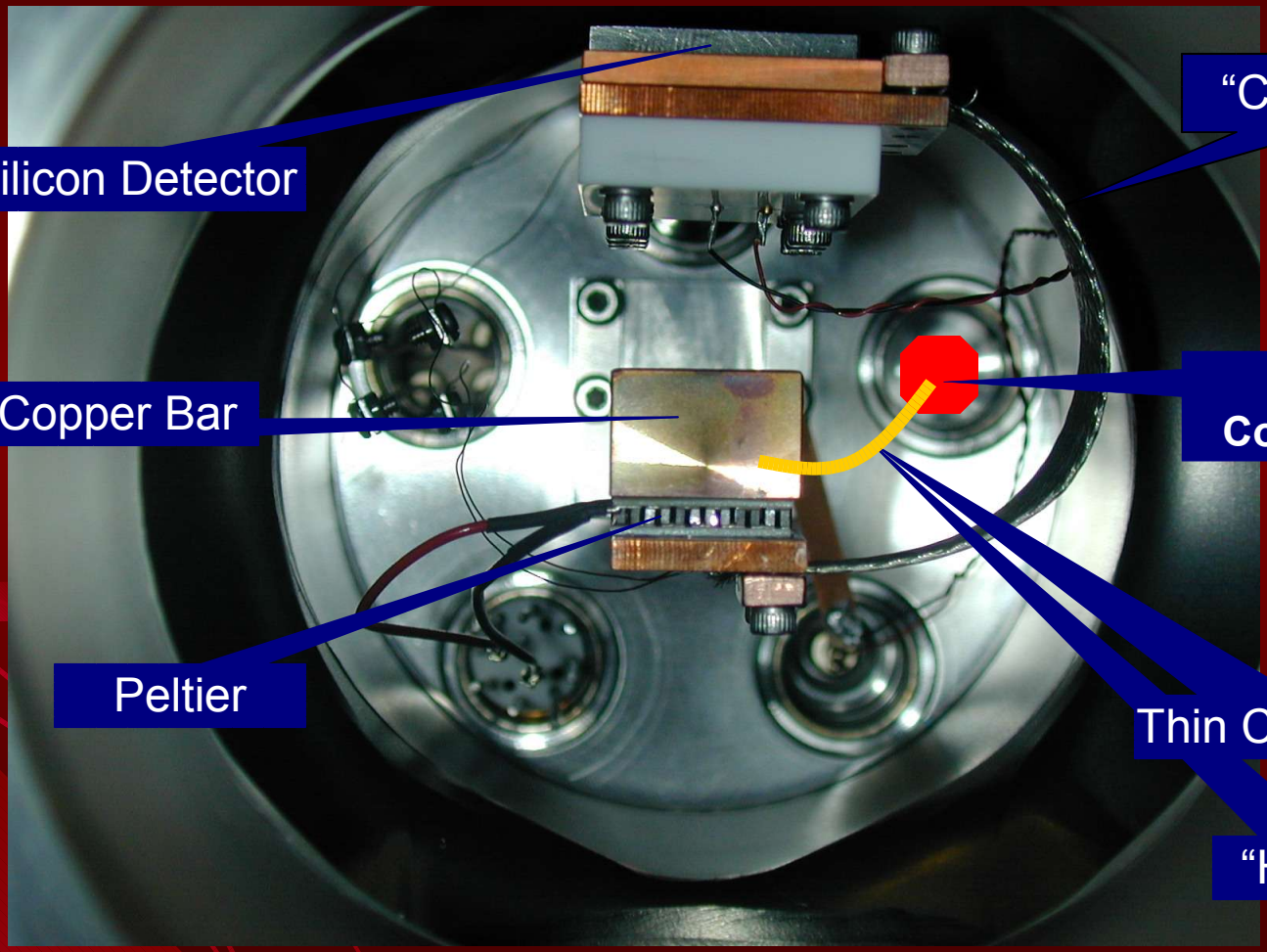


Next Step: Cooling

- Try to significantly reduce amount of noise
- Clear precise peaks required
- Operating at low temperatures is a good way to do this
- Inexpensive and available devices:
  - Chiller
  - Peltier Device



Cooling Plan



Repeated Failure and Death

Current and Future Cooling Plans

- Scrapped Peltier plans till replacements available
- Go straight from cold rod to detector
- Look for better flexible connectors than braid
  - Multiple braids
  - Copper foil
  - Other possibilities?

THE END!!