Solar Cells for Detection of Fission Fragments

Talk for the
Mini-Workshop on Future In-Beam Conversion-Electron Spectroscopy
Bonn, 23-24 January 2003

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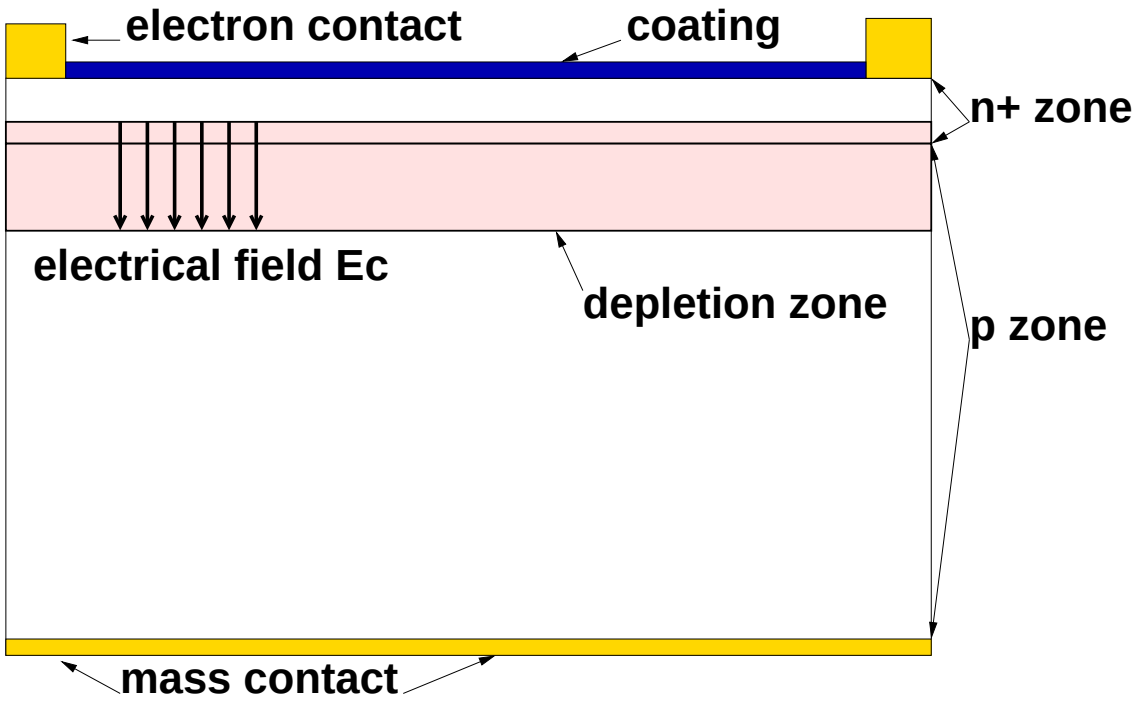
Layers & Function

- A solar cell has different layers:



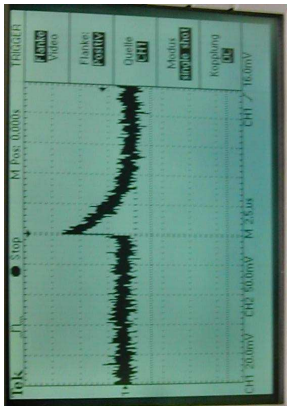
Important properties:

- The junction has a capacity proportional to the area.
- No bias voltage is applied.
- No cooling necessary.
- Different coatings are used (with different colors).
- Signal depends on E with a mass-dependent offset and factor:

$$X_{signal} = \frac{E - (b + b'M)}{a + a'M}$$

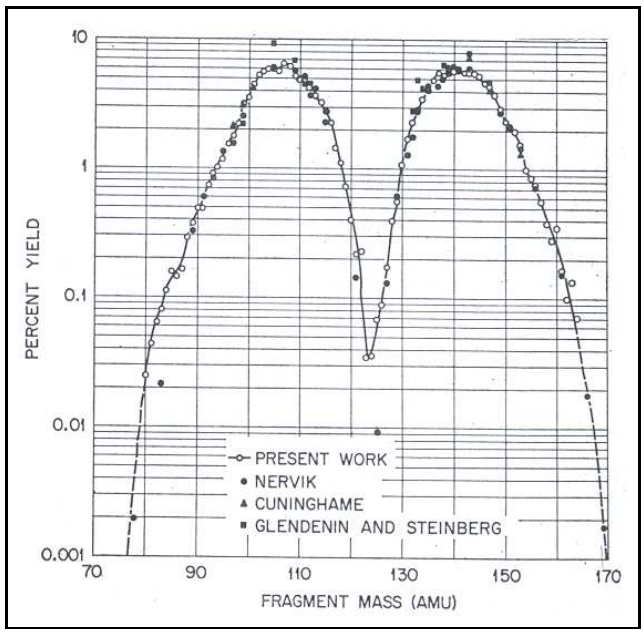
(Schmitt, Kiker, Williams, Phys. Rev. B 137, 837 (1965))

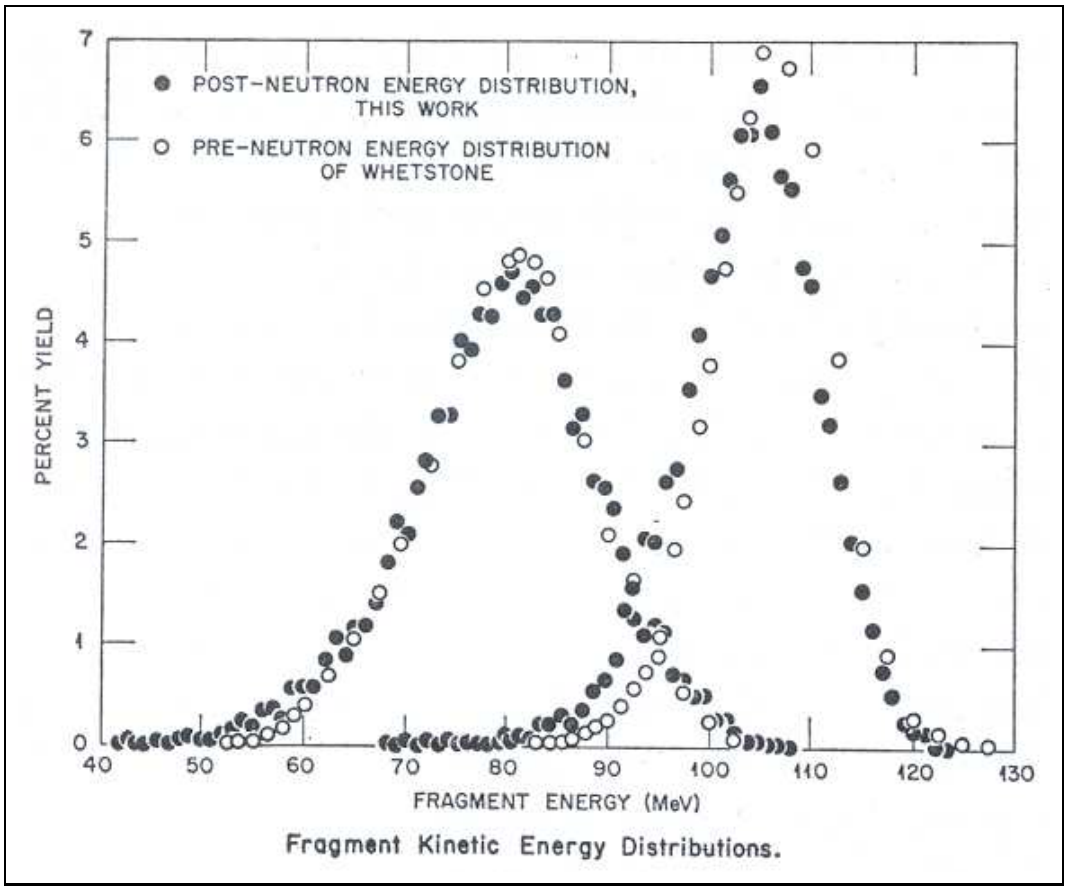
Setup for the source measurements



Californium

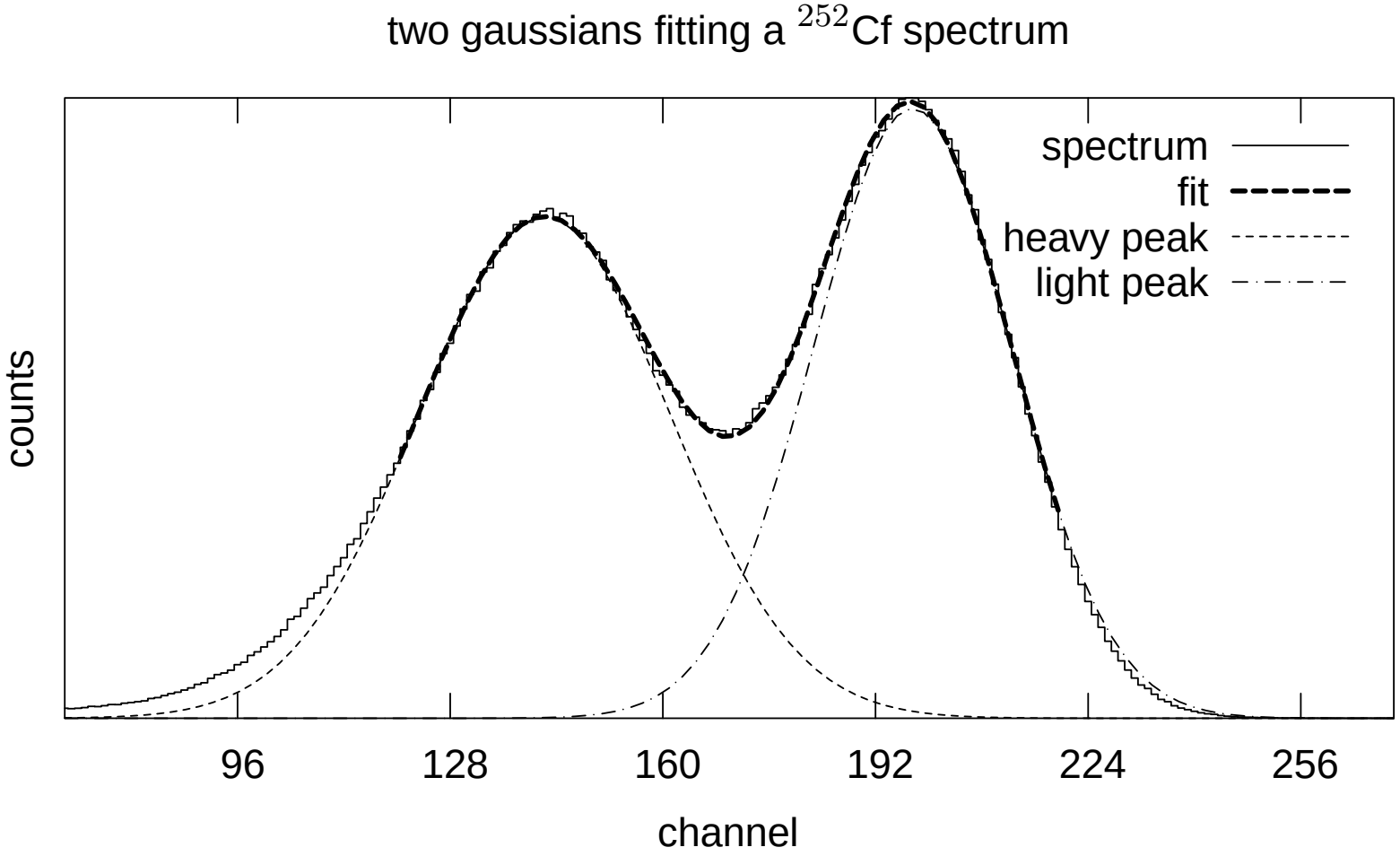
- Halflife: 2.645y.
- ^{252}Cf decays:
  - $\approx 96.9\%$ to α
  - $\approx 3.1\%$ to heavy fission fragments
- Sources are available on thick backings and with or without covering.





(both figures from Schmitt, Kiker, Williams, Phys. Rev. B 137, 837 (1965))

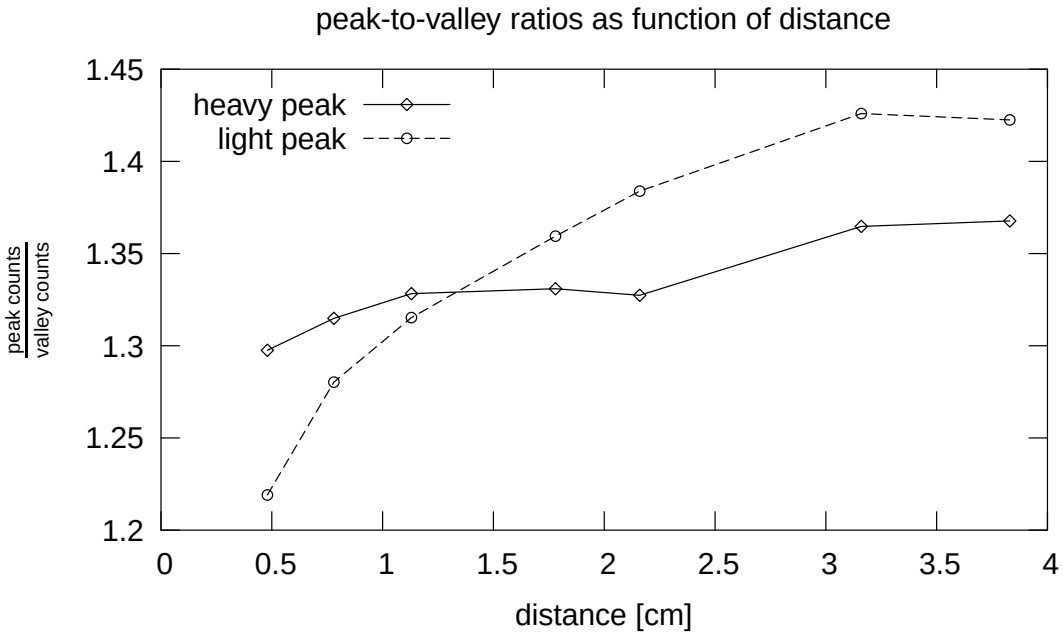
Fitting the ^{252}Cf spectra



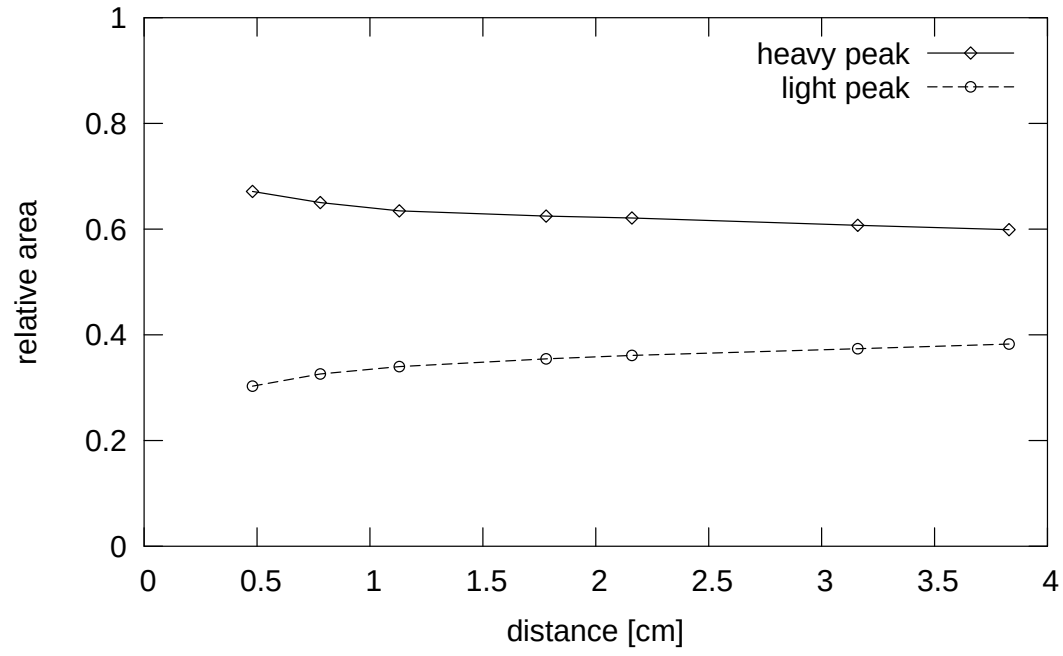
Peak and valley positions are calculated numerically.

Distortion of spectra

With a covered source we observe a distortion of the spectra dependant on the distance between cell and source.



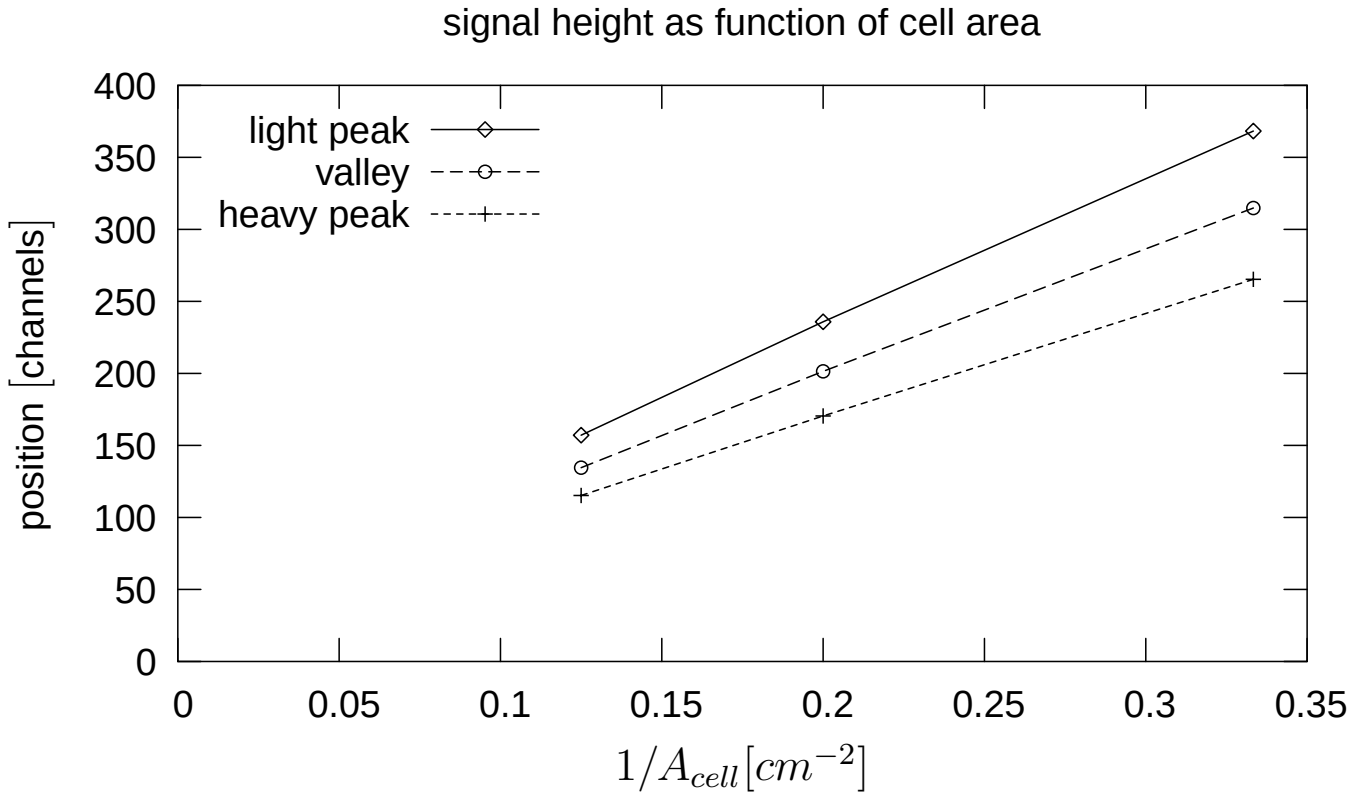
Peak areas:



Cell size and signal height

- Signal height depends on cell area:

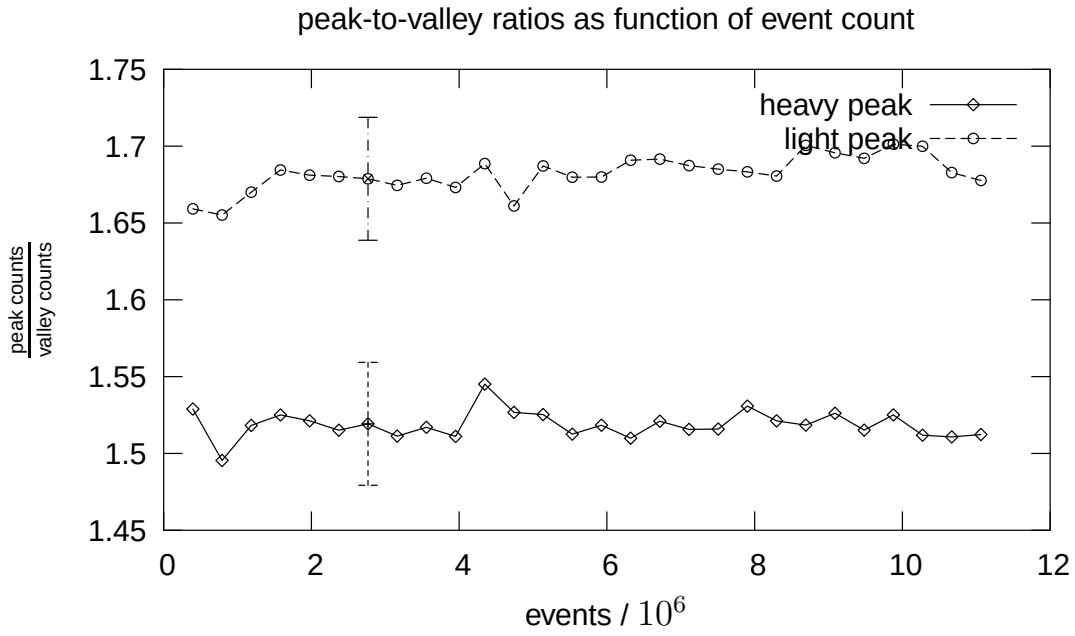
$$X_{signal} \sim \frac{1}{A_{cell}}$$



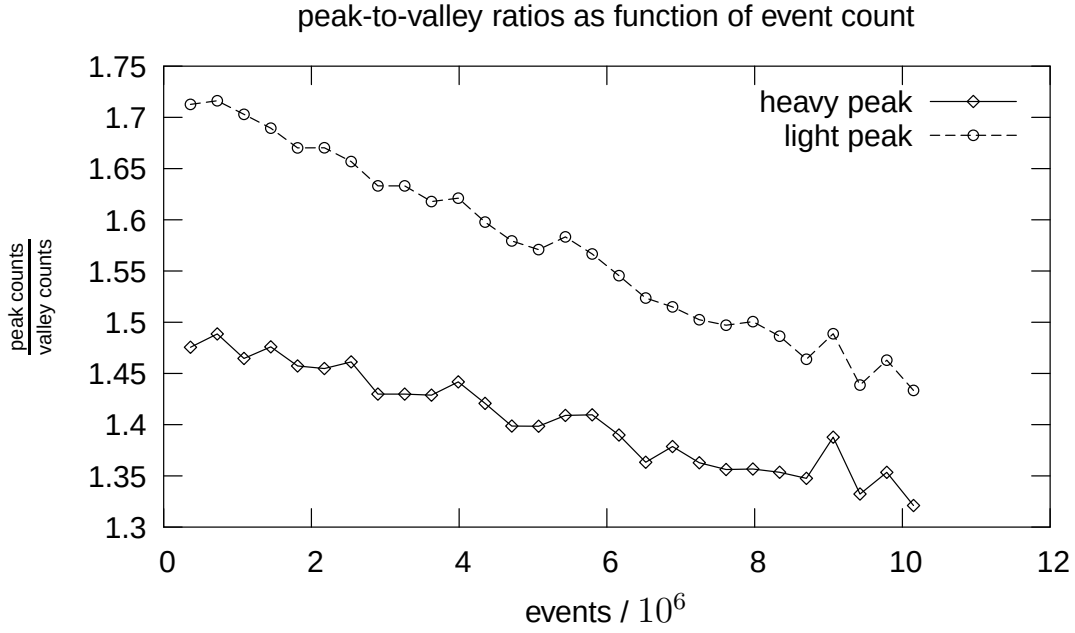
- Interpretation: $Q = CU$

Destruction of cells by long-time exposure

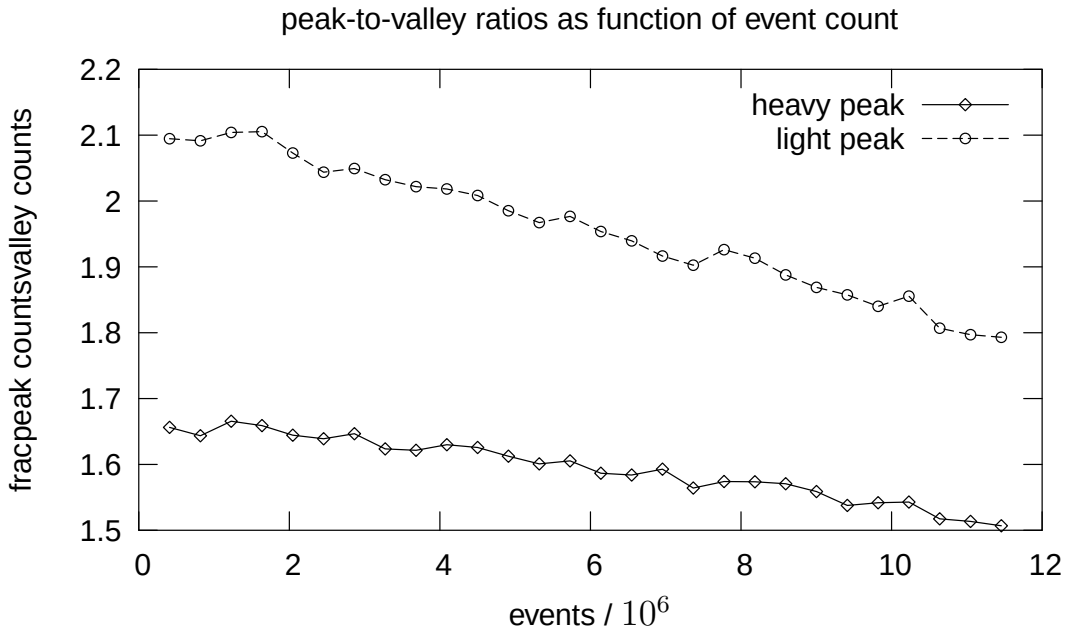
- Black monocrystalline cell:



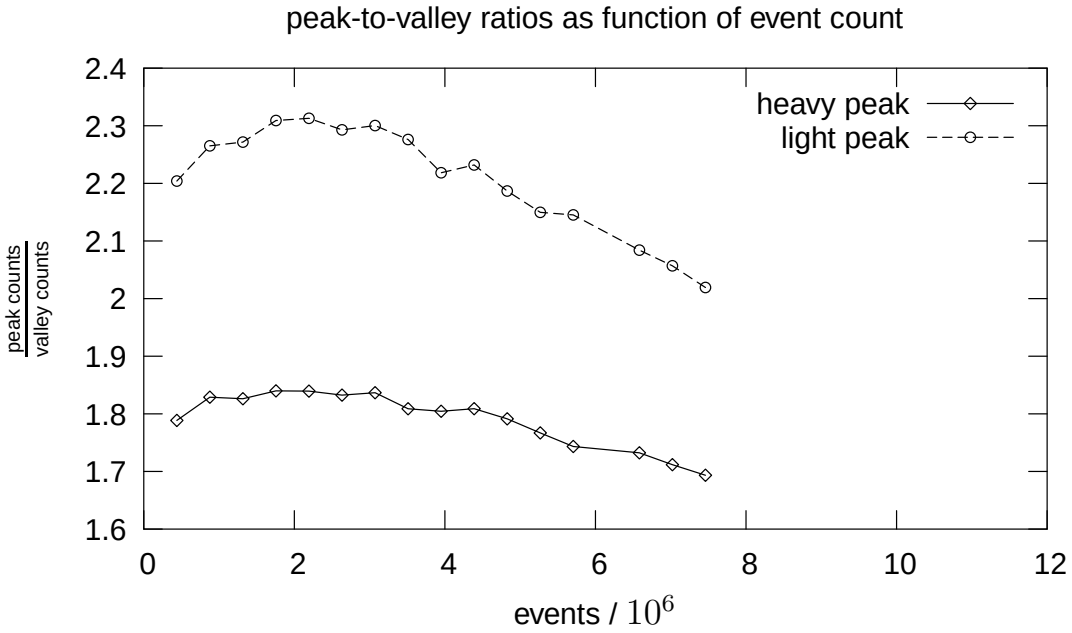
- Blue polycrystalline cell:



- Green monocrystalline cell:

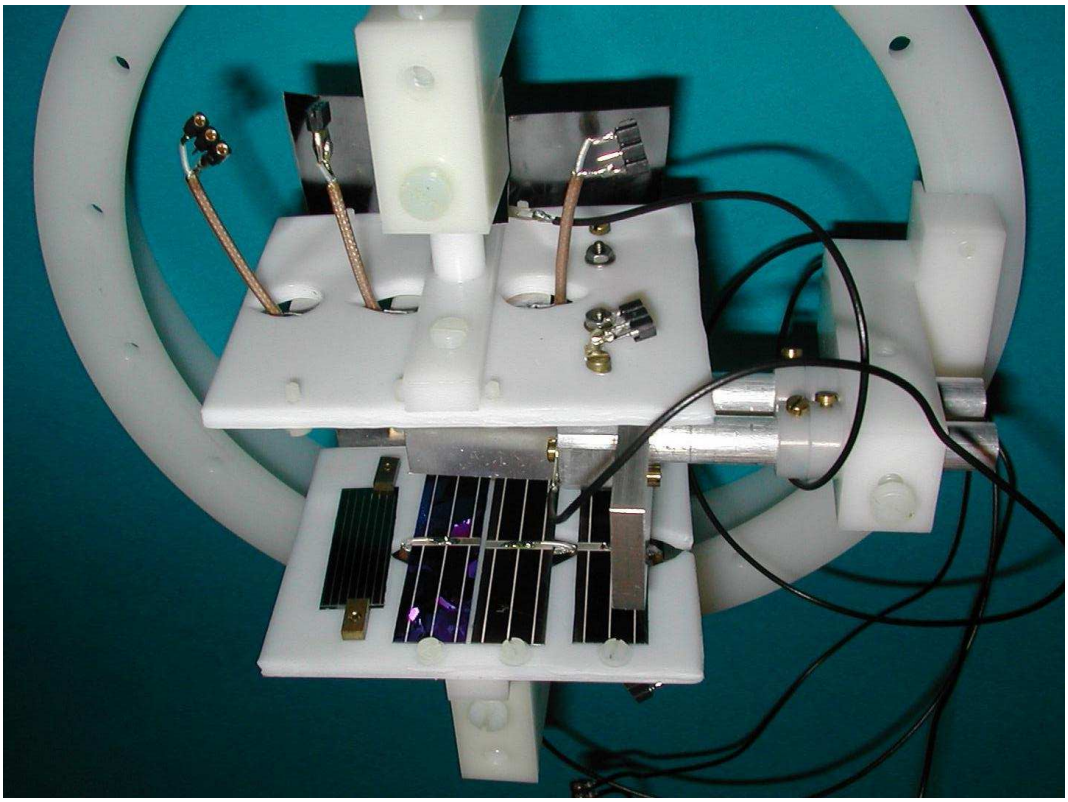


- Blue monocrystalline cell:

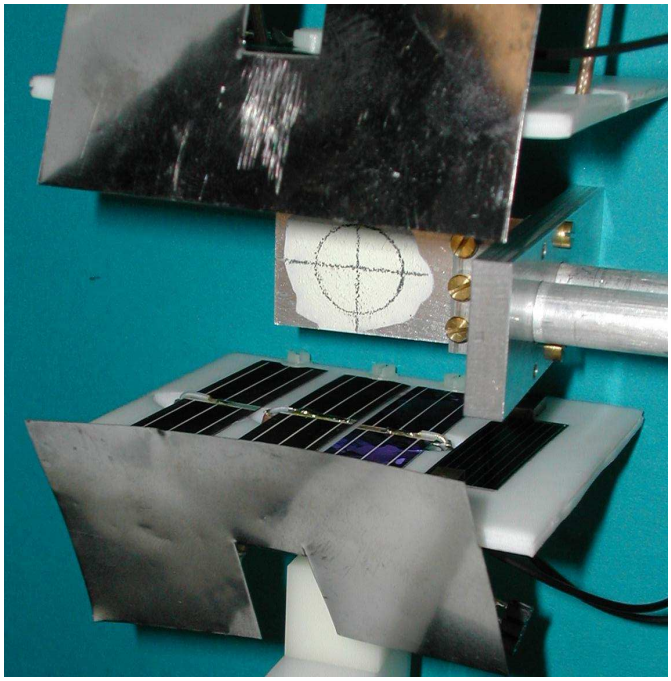


Setup for ^{238}U (p, f) at 10 MeV

Rear view:

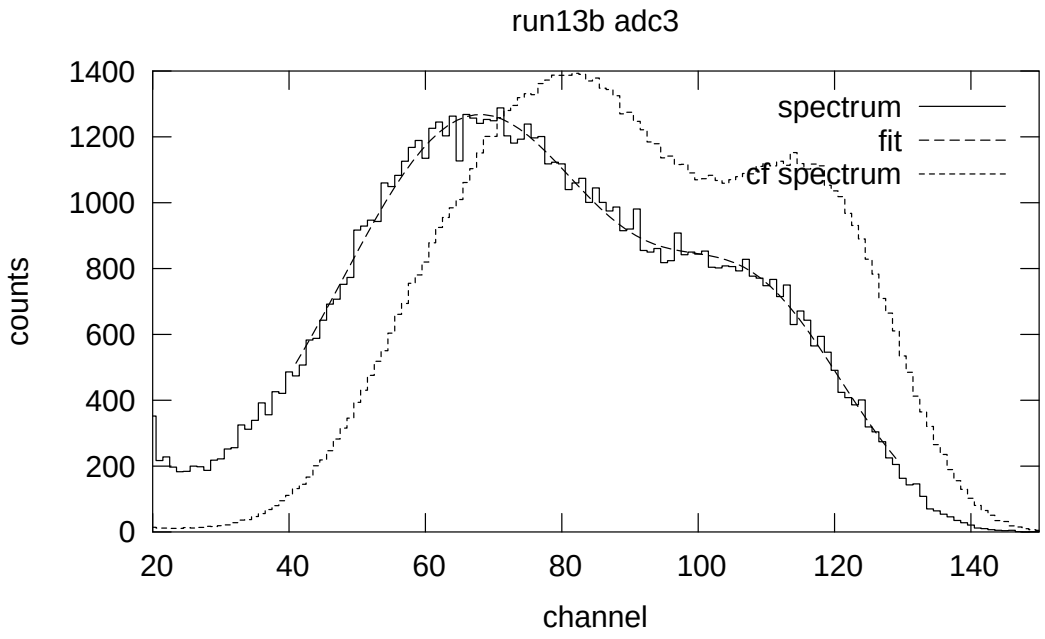


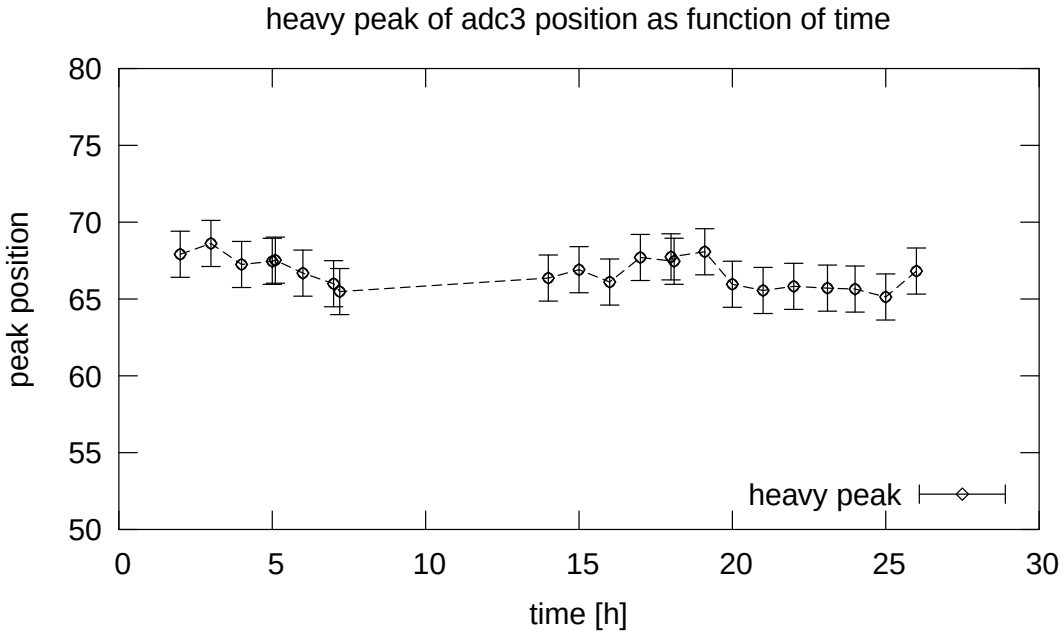
Front view:



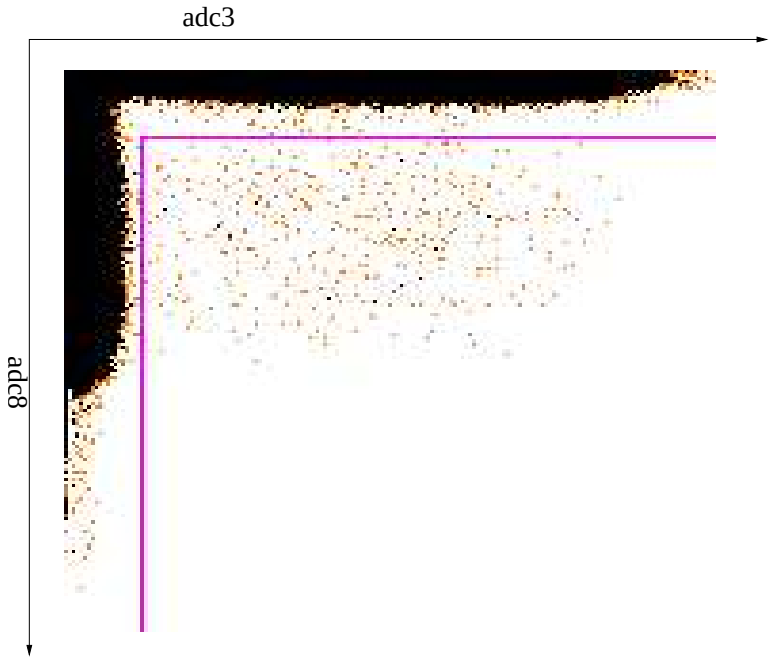
Results of ^{238}U (p, f) experiment

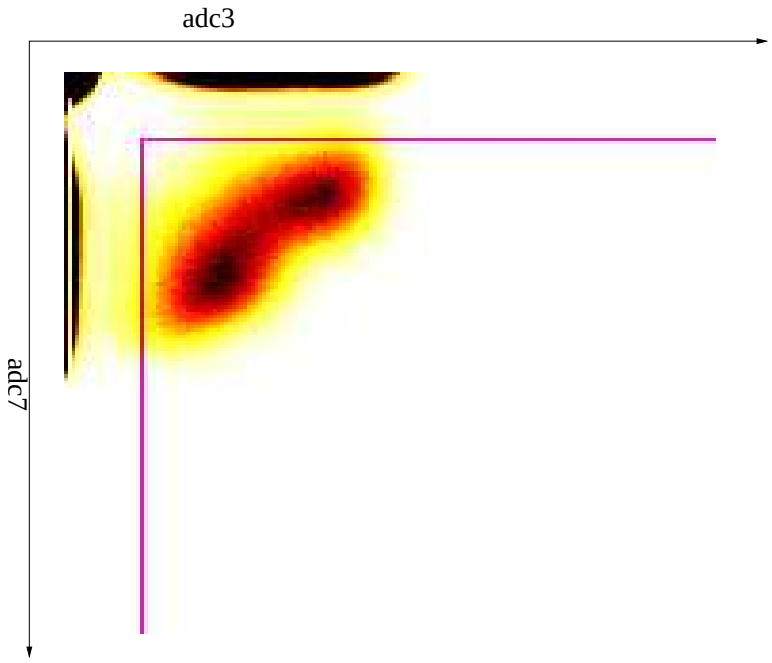
- Spectra alone show bad resolution:





- Noise problems:
  - low gate $=>$ trigger on noise,
  - high gate $=>$ cut off the heavy bump
- Signal-noise $\approx 2:1$.
- Coincidence matrices of facing cells have been made:





Practical considerations

- Electronic noise is a big problem.
  - Good shielding is required.
  - Connectors and cables have to be well attached.
  - Cables should be as short as possible up to the preamplifiers.
- Cells are cheap.
- Cells are easy to handle and to cut into pieces.
- Have a small volume.
- Possible to build large-area, even 4π detectors.