HIRA CSI DETECTOR RESPONSE TO LOW ENERGY PROTONS

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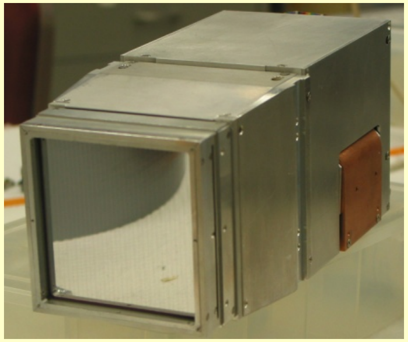
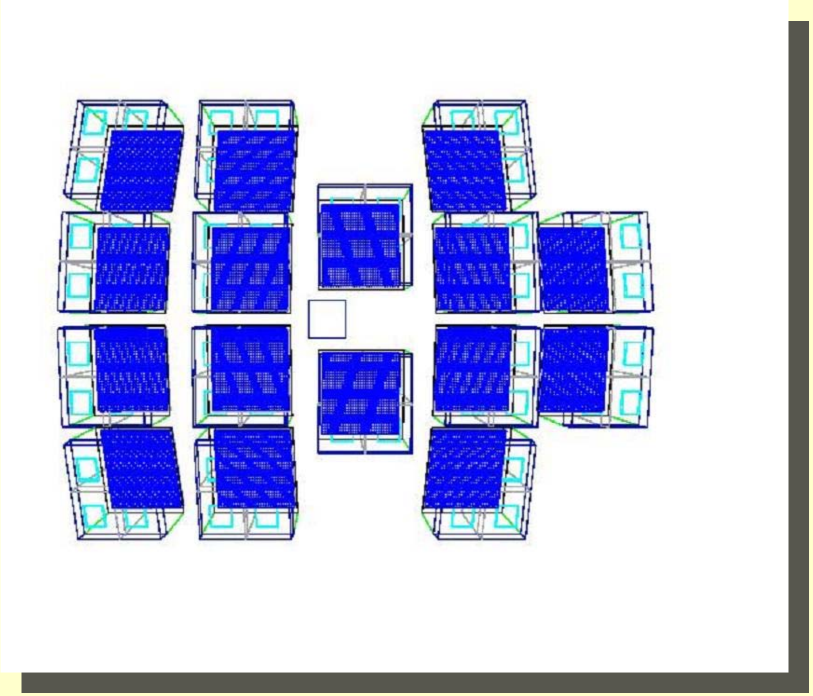
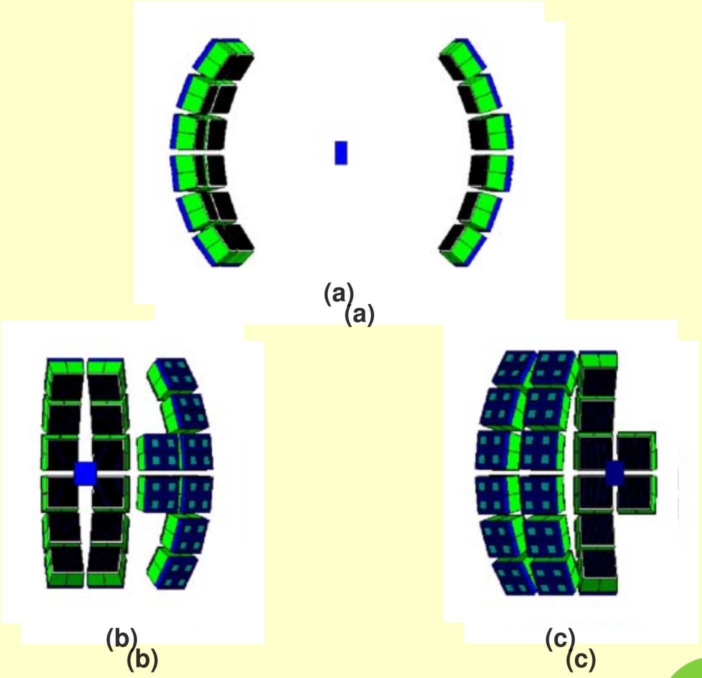


The High Resolution Array

Each of the 20 identical telescopes can be individually placed and aligned, allowing for many different experimental set-ups.



Experiment 05133



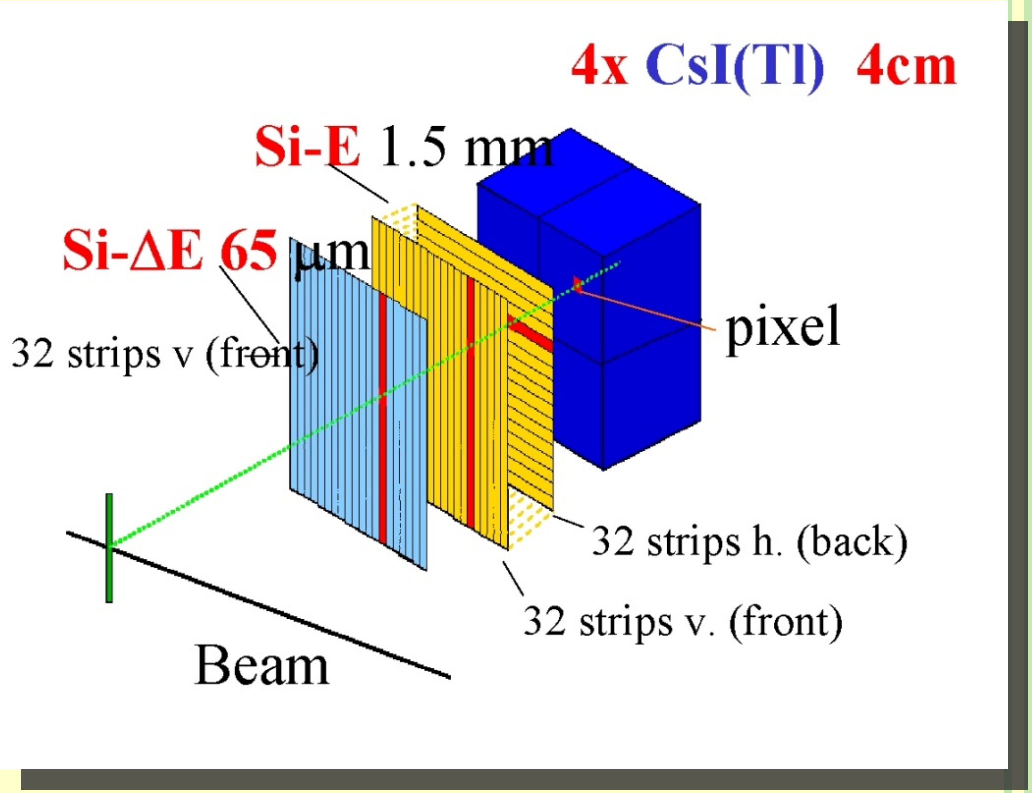
Experiment 07012

Measure direction, velocity, electrical charge, and mass of small charged particles produced by colliding nuclei

The ΔE detects low energy particles. The charge generated is analyzed to determine energy, charge, and mass of the particle

The path of the charged particle is determined by **the E's.** A current is generated and collected by the 2mm wide strips.

The 4 CsI (Tl) crystals stop higher energy particles that penetrate both Si strips. The light generated by a particle is analyzed to determine energy, charge, and mass of the particle



Experiment 01533

Neutron transfer reactions for neutron rich and proton rich Ar isotopes

Compare the neutron spectroscopic factors of neutron rich and proton rich isotopes using 46-Ar (neutron rich) and 34-Ar (proton rich) beams, which will strike a thin CH_2 target.

A detailed proposal is available online through the HiRA website.

- Will be detecting low energy deuterons, around 10 MeV
- Such low energy particles have not been detected before using HiRA
- The response of the CsI crystals is unknown
- Necessary calibrations of CsI's are unknown

Tandem Van de Graaff Accelerator

Western Michigan University

Negative ion source from hydrogen gas

These negative ions are accelerated toward the high positive voltage.

Gas at the terminal strips electrons from the ions, creating positive ions, which are accelerated away from the high positive voltage.

A proton beam between 1 - 12 MeV can be produced.

The Plan:
Testing the Detectors

Place 2 detectors in the Ortec-600 Series Scattering Chamber

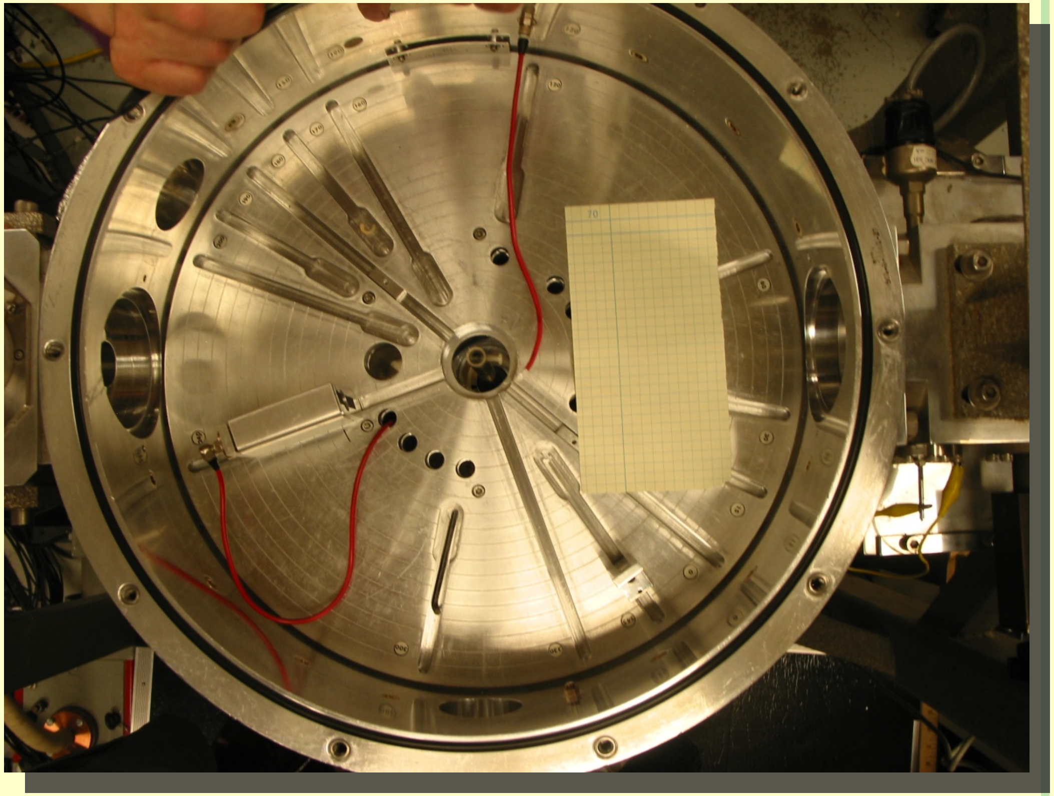
Generate protons beams of energies 2, 4, 6, 8, 10 MeV

The proton beam strikes a thin carbon foil target

Protons are elastically scattered

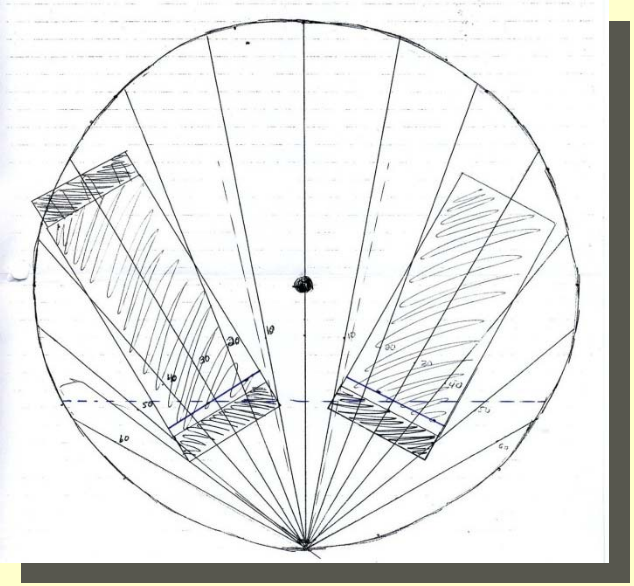
Scattered protons strike detectors

We record output from the detectors



Design Phase

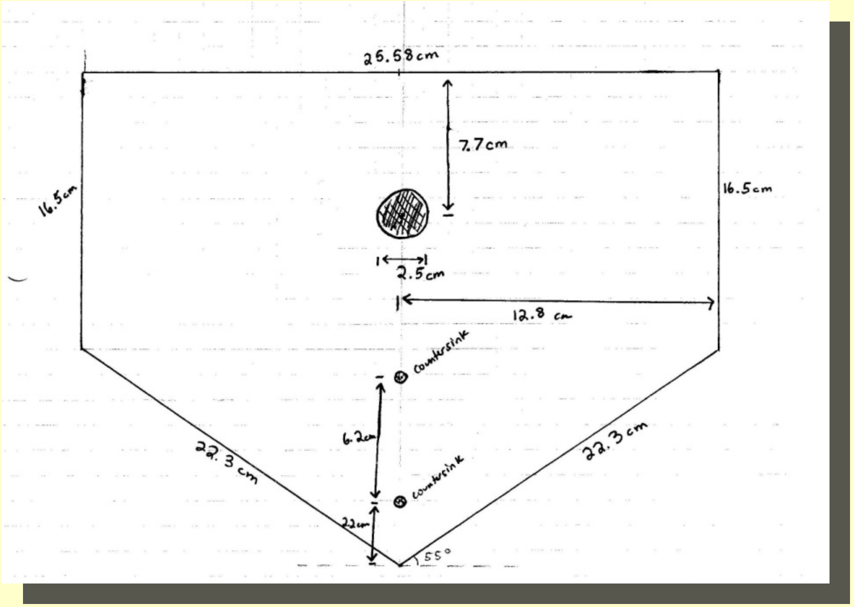
❖Detector Alignment



2 detectors in the chamber

Faces perpendicular to median scattered angle

As far from the target as possible



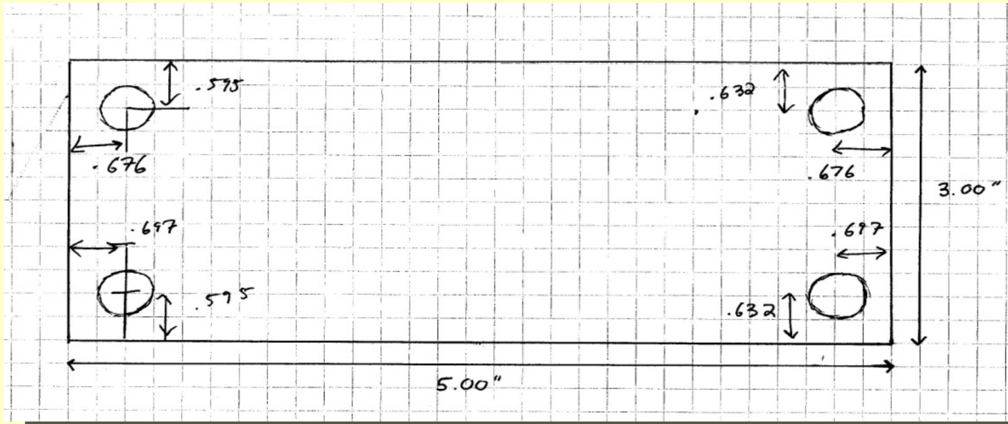
Space behind telescopes for electronics and cooling line

Anchors to floor of chamber

❖Telescope Holder

Prevent movement of telescopes in all directions

Easy removal and replacement of telescopes

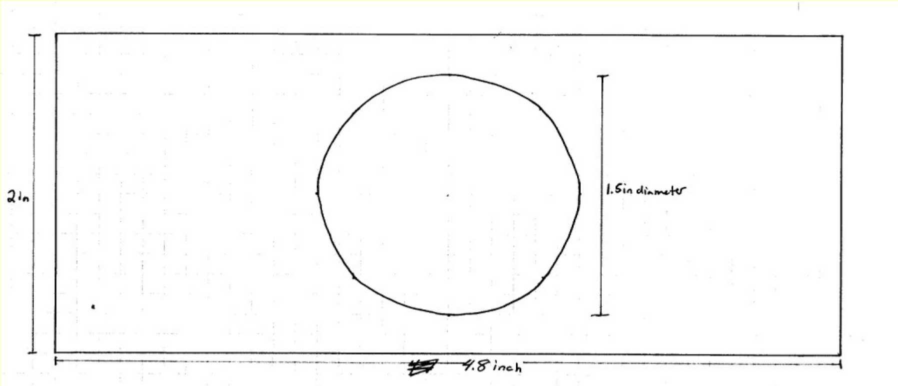


❖Target Holder

Frame to mount plastic target

Attaches to side of chamber

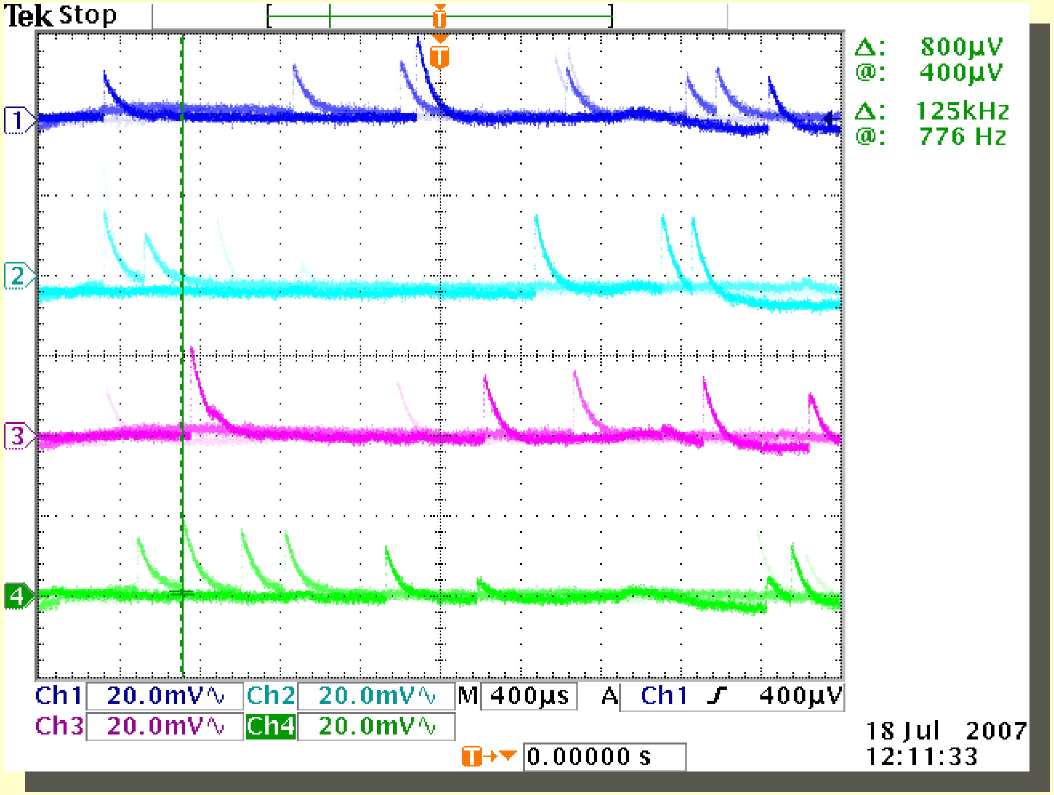
*Accommodates curvature of chamber



Pretesting

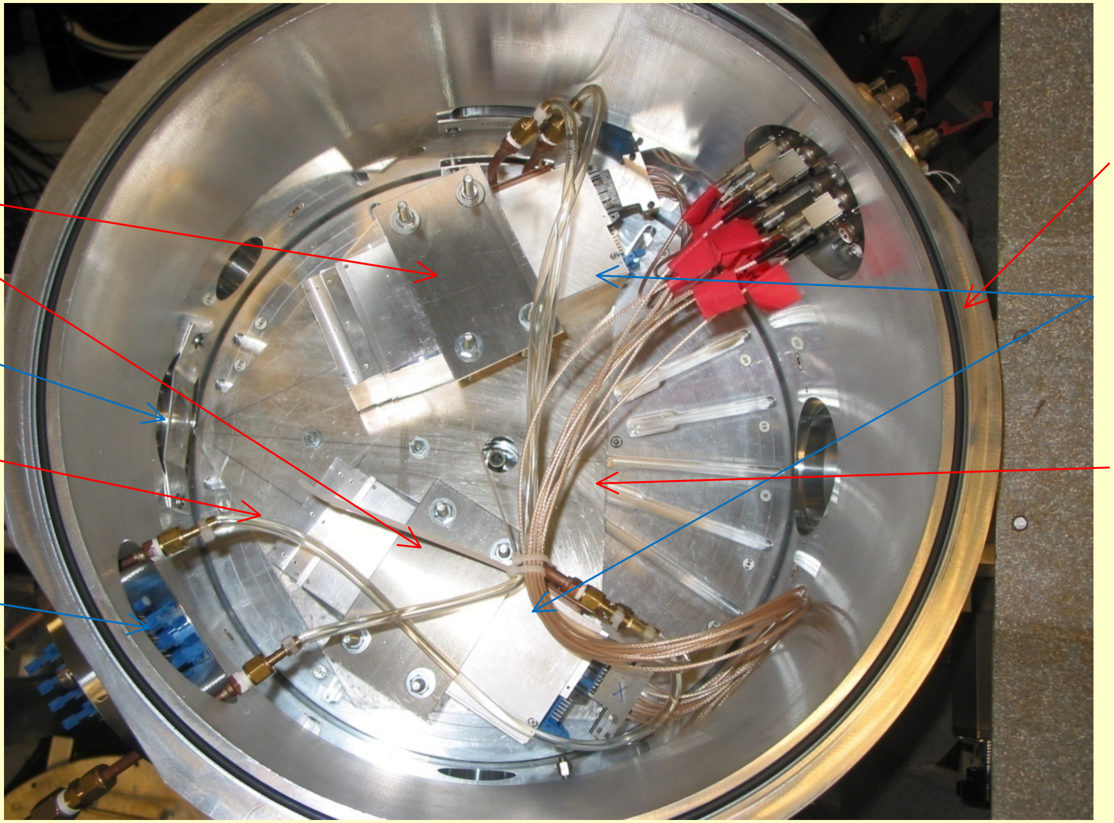
The detectors are extremely sensitive, and they needed to be tested to ensure that all CsI crystals worked before taking them to WMU

- Disassemble telescope and remove Si
- Place telescope in small vacuum chamber
- Test with pulser
- Place 228-Th source
- Pump chamber to vacuum
- Record peaks from oscilloscope



Experimental Set-Up

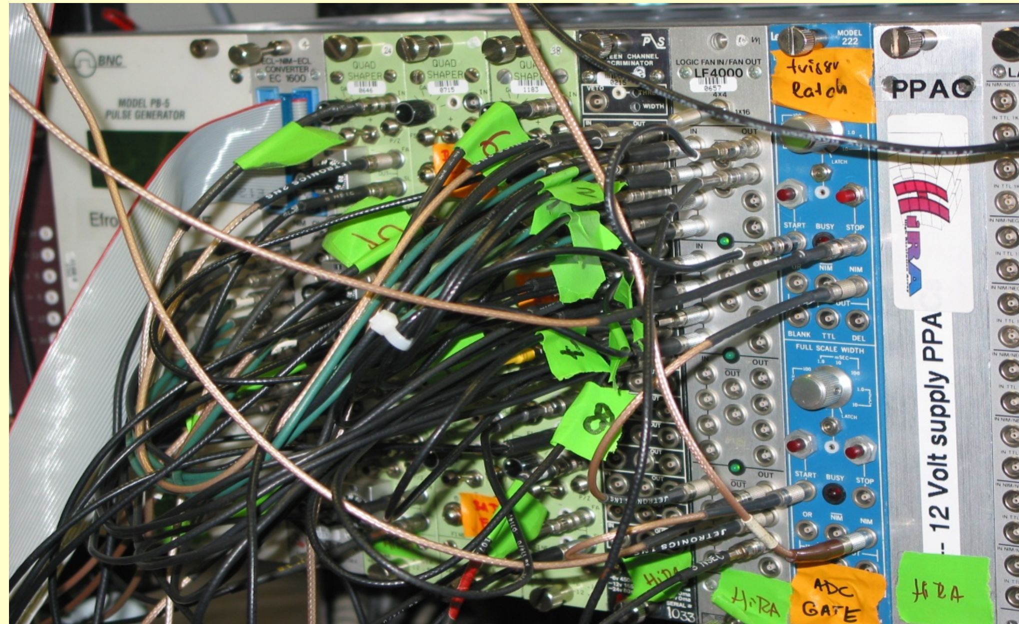
❖Mechanical Set-Up



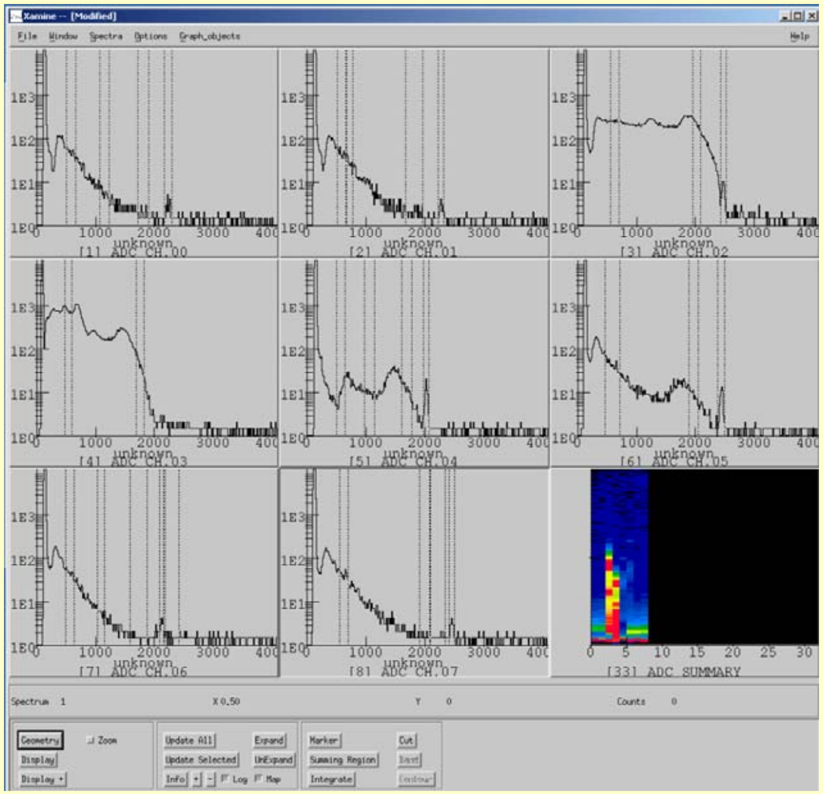
Experimental Set-Up

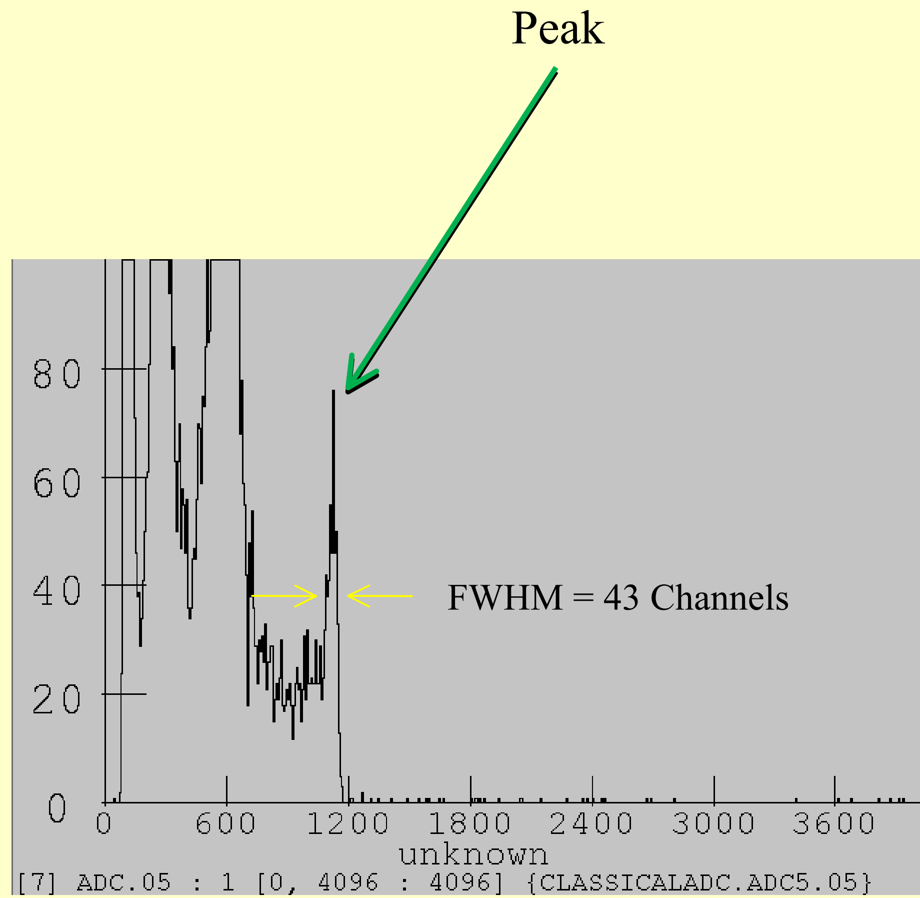
❖Electronic Set-Up

- +/- 12V
- Bias
- Detectors
- Shapers
- Lemo-Ribbon Cable Converter
- V785 ADC ⟶ Computer
- Discriminator
- Fan In/Fan Out
- Trigger/Latch
- V262 ADC ⟶ Computer
- NIM-ECL Converter
- Scaler



Data Acquisition



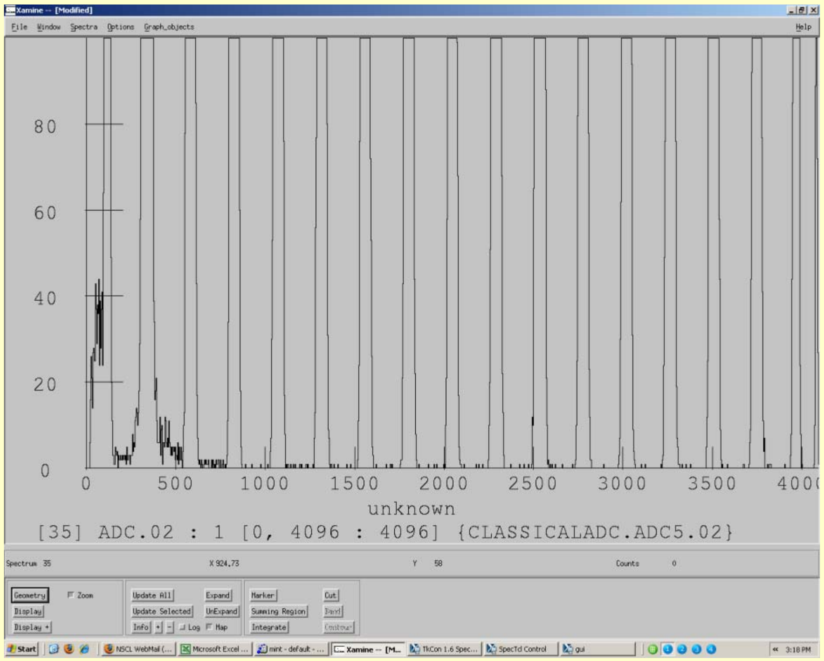


4 MeV
Telescope 16
CsI Crystal 1

Collected data using Gui Builder/SpecTcl
Observed data using Xamine

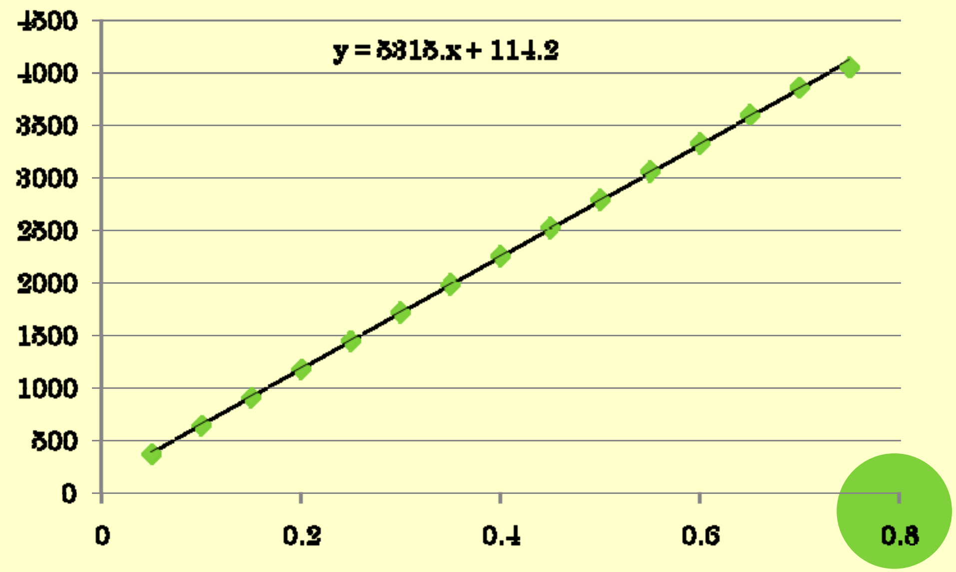
Data Analysis

❖Use Pulser Ramp to determine the 0 channel



•Choose boundary points around a peak

•Integrate and determine centroid

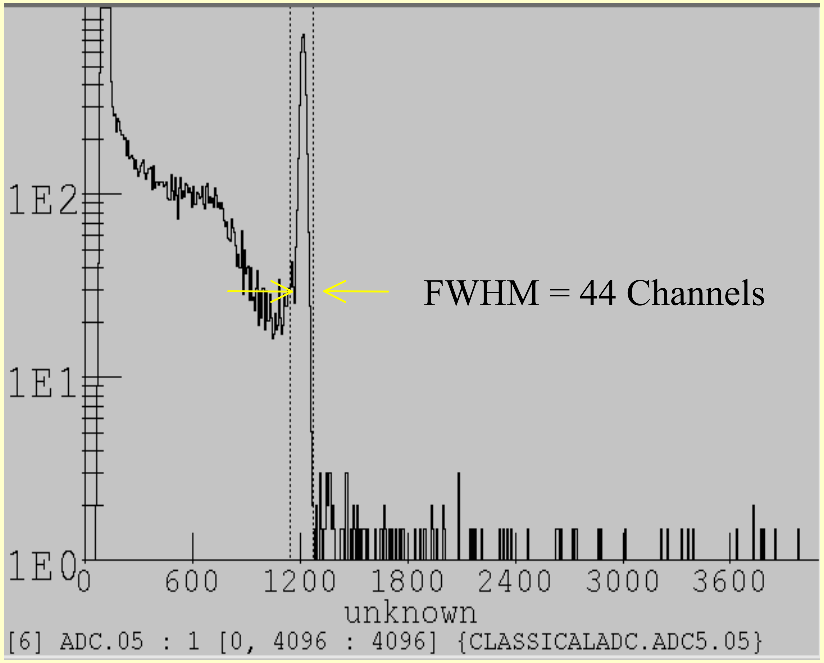


•Plot centriod against voltage

•View linear trendline to find 0 channel

Data Analysis

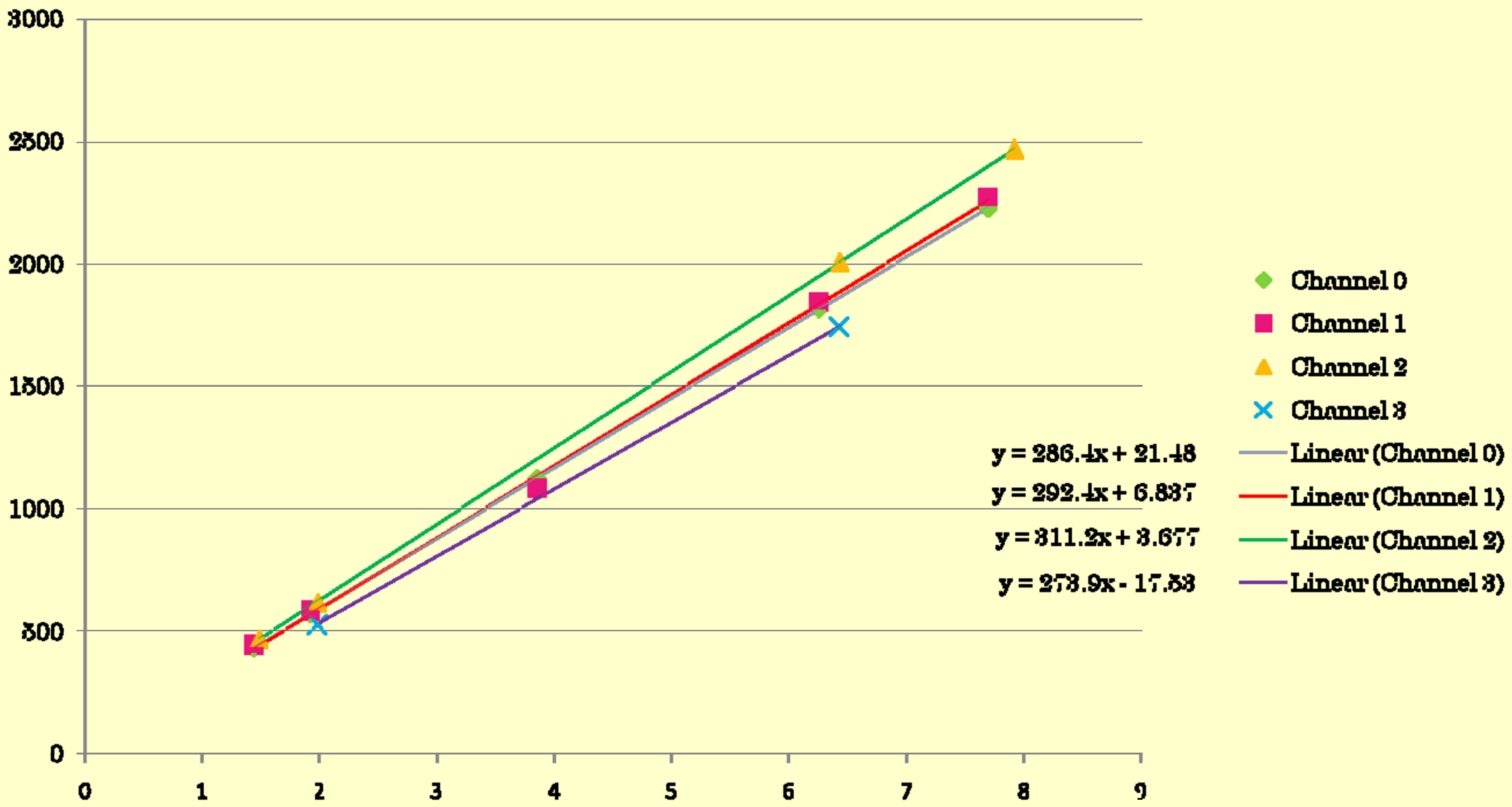
❖Determine channel number and expected energy for peaks



- Choose boundary points around a peak
- Integrate and determine centroid
- Determine expected energy for peaks

4 MeV
Telescope 16
CsI Crystal 2

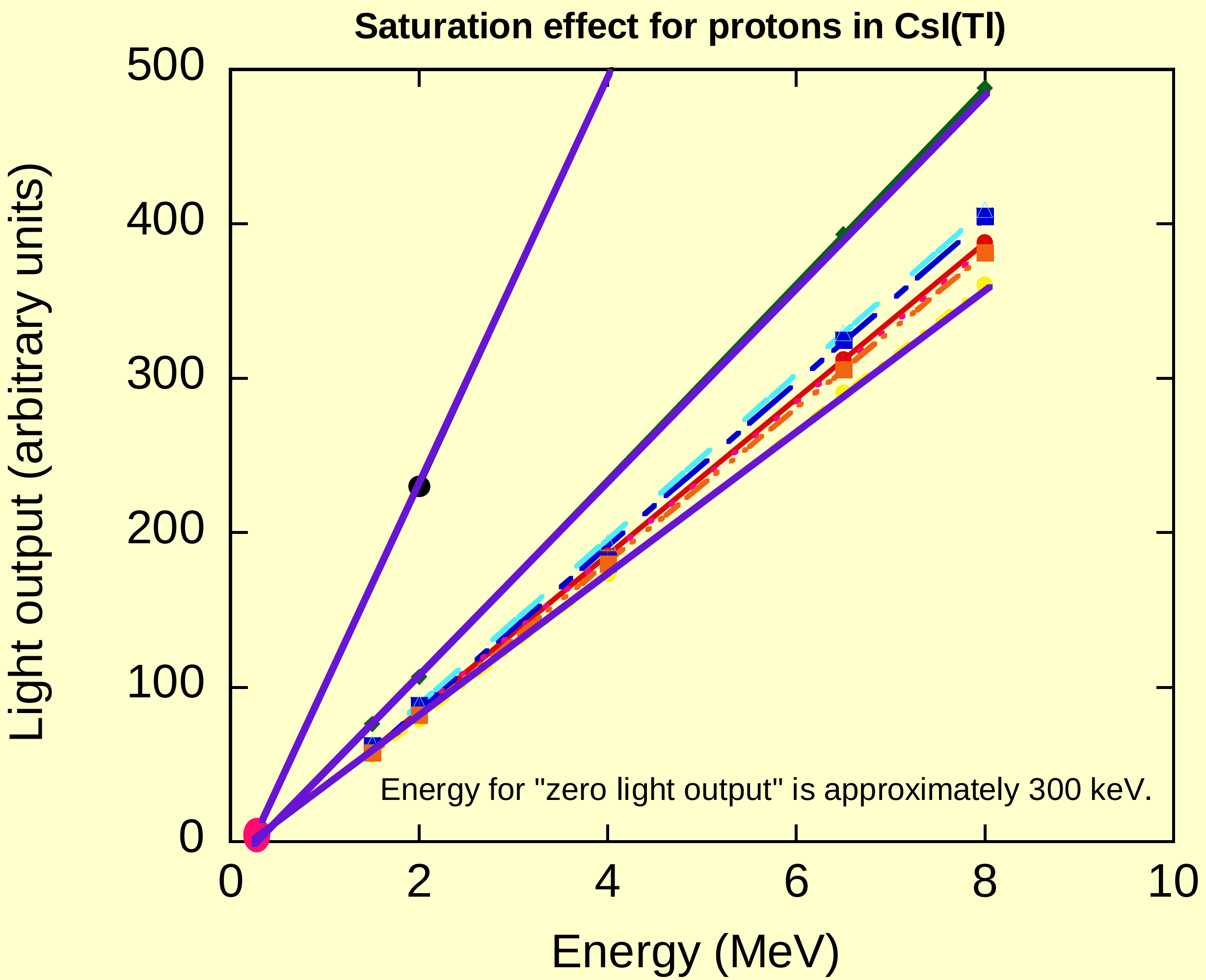
Data Analysis



•Plot channel number vs. expected energy (MeV)

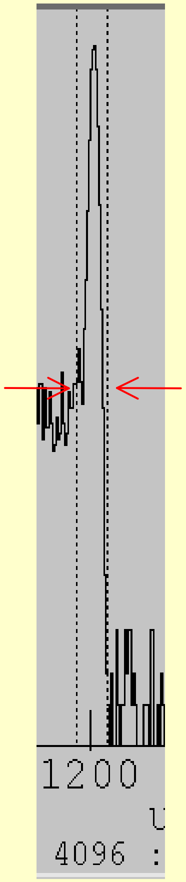
•Fit a linear trendline

Data Analysis

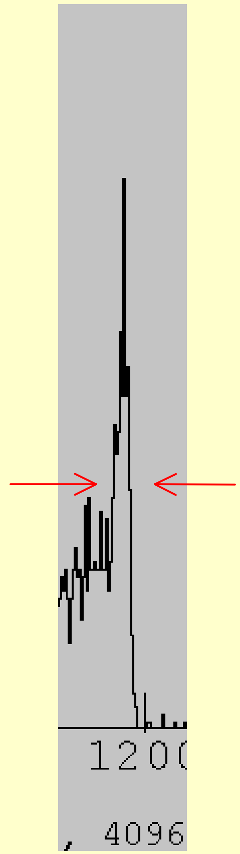


Conclusions

1) The typical resolution



Resolution
= 130 KeV

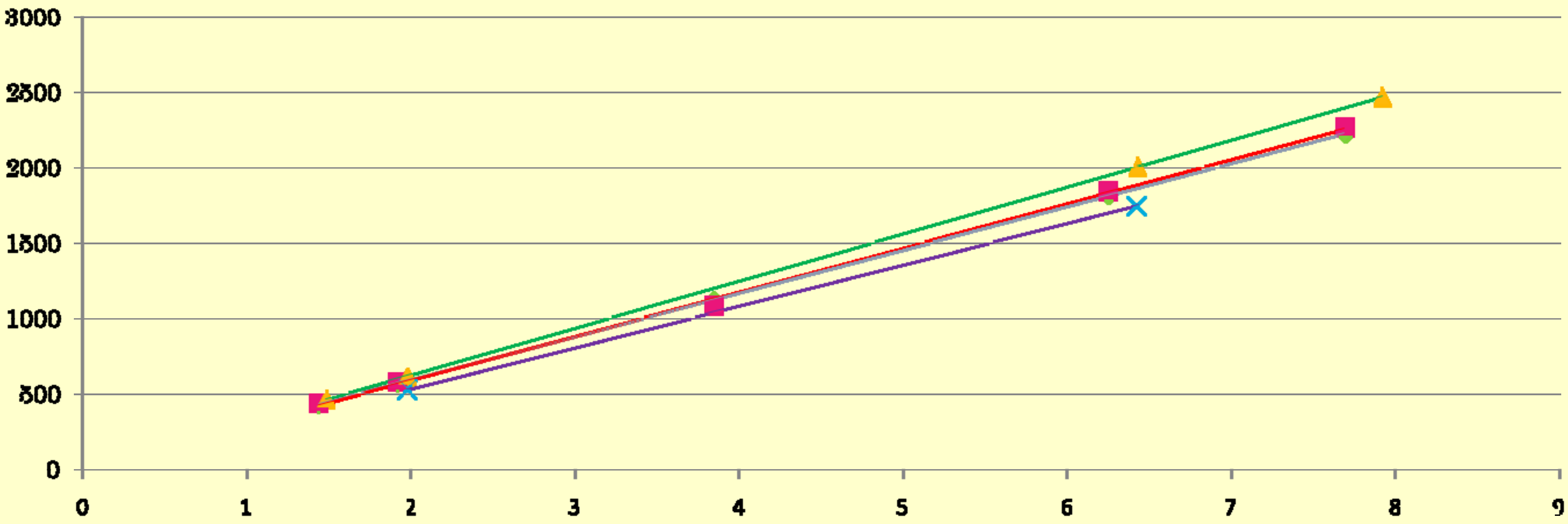


Resolution
= 125 KeV

We can expect resolutions between 150 and 170 KeV

Conclusions

2) The crystals are linear



We have found linearity for 1.5 MeV ≤ E ≤ 8 MeV

Already knew linearity for 8 MeV < E

Can conclude linearity for 1.5 MeV < E

Conclusions

3) The calibration equation

$$E = a(ch - ch_0) + 300\ KeV$$

Based on the electronic gain (for a)

From the pulser calibration (for ch_0)

Takes the non-linearity into account (for $300\ KeV$)

Acknowledgements

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