



The **H**igh **R**esolution **A**rray

The High Resolution Array is a detector designed to detect and identify light charged particles like protons, deuterium, triton, alpha's and the different isotopes of nuclei with $Z < 10$. These are particles that are produced in nuclear reactions, and by obtaining an accurate measurement of their direction and energy we can learn much about the dynamics of nuclear reactions and the structure of nuclei.

This project is a collaboration between the National Superconducting Cyclotron Laboratory, Michigan State University, Chemistry department, Indiana University, Washington University, St. Louis (MO) and INFN, Milan, Italy.

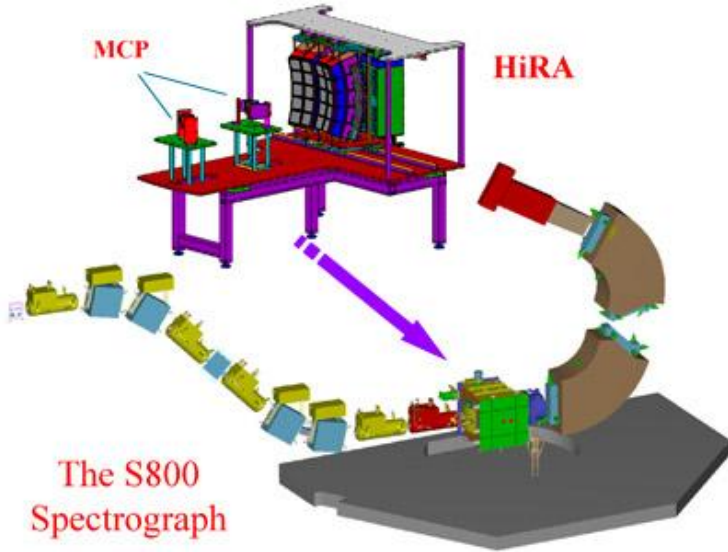
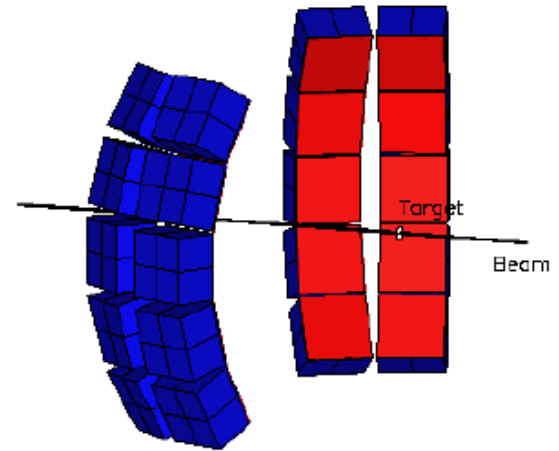
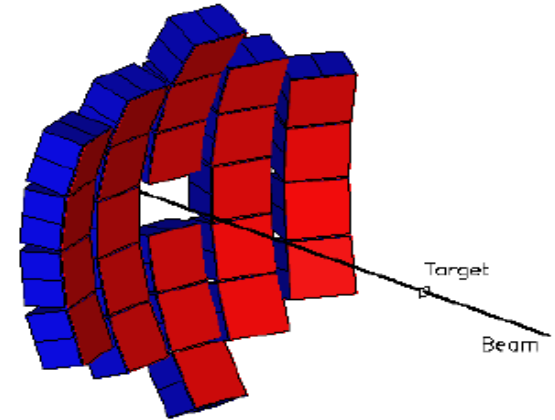
[Click anywhere in the slides to continue the slideshow]

Some of the Physics Addressed with HiRA

HiRA was designed with radioactive beam facilities like the Coupled Cyclotron Facility at NSCL/MSU in mind.

- Multifragmentation
- Transfer reactions (p,d), (d,p), (α ,t), ...
- Resonance spectroscopy
- Inverse Kinematics Measurements
- Radiative Capture via Coulomb dissociation.
- Elastic and Inelastic Scattering in reverse kinematics (p,p'), (α , α), ...

This defines performance goals
 $\rightarrow \delta\theta < 0.3^\circ$, $\delta E < 50$ keV ($E < 20$ MeV)

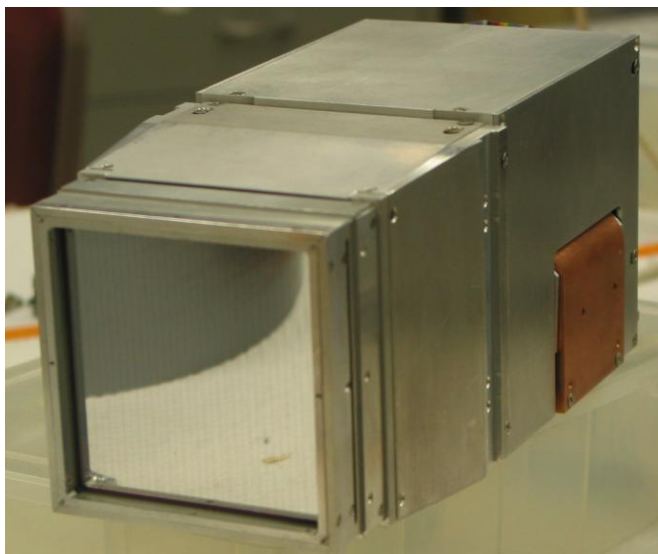
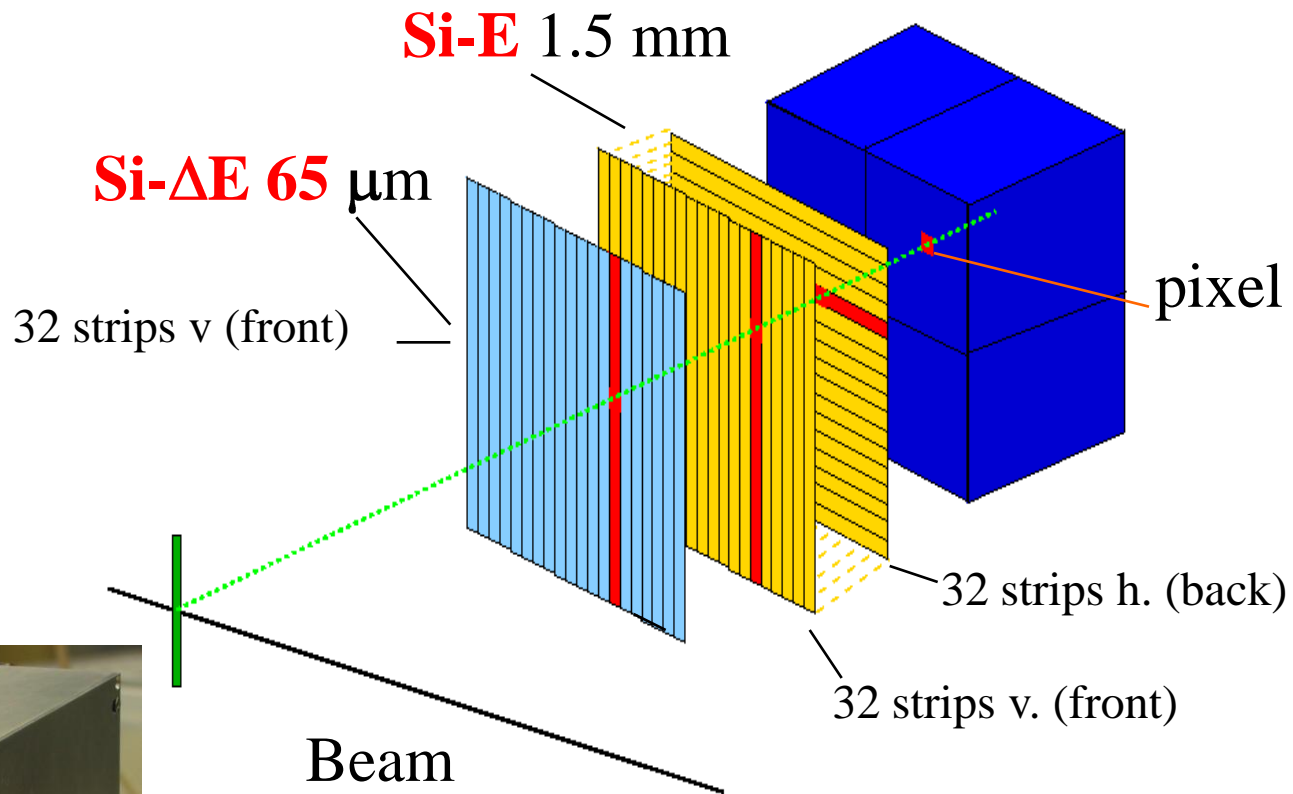


With 20 Identical detectors HiRA is highly configurable for different physics experiments.

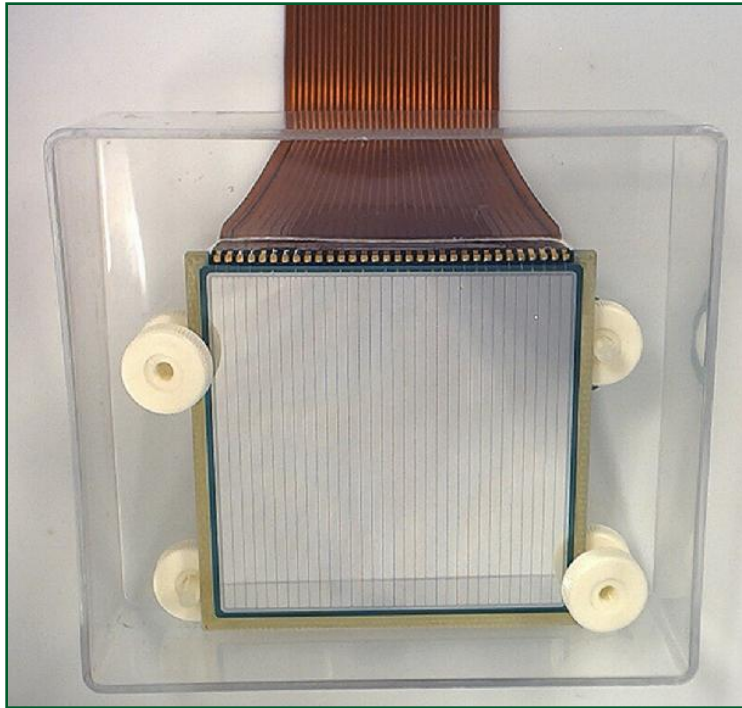
HiRA Telescope Design

4x CsI(Tl) 4cm

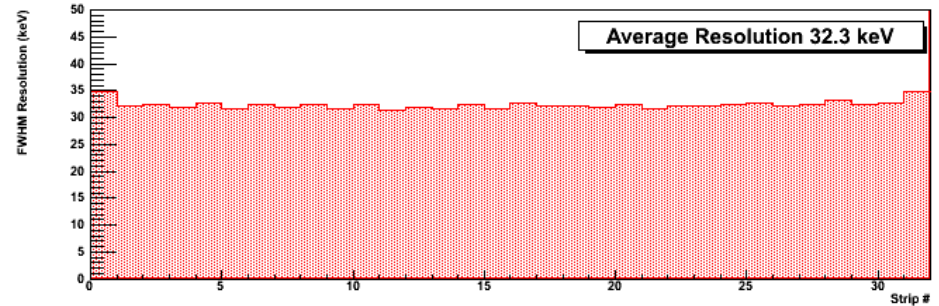
- 20 Telescopes
- 62.3 x 62.3 mm² Active Area
- strip pitch 1.8 mm
- 1024 Pixels per telescope



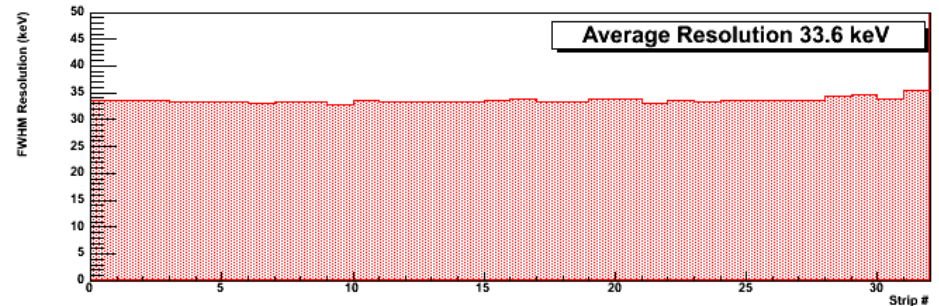
Energy Resolution for 1.5 mm thick double sided silicon strip detectors



Front resolutions corrected



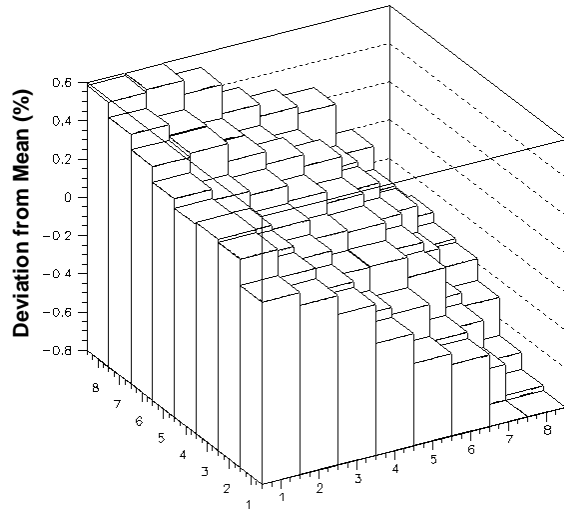
Back resolutions corrected



- Bulk material is n type
- Interstrip on junction side is $25 \mu\text{m}$
- Interstrip on ohmic side is $40 \mu\text{m}$
 - P+ implant for better interstrip isolation
- Depletion voltage for 1.5 mm detector $< 500 \text{ V}$
- 10 guard ring structure on periphery (2mm dead area region)

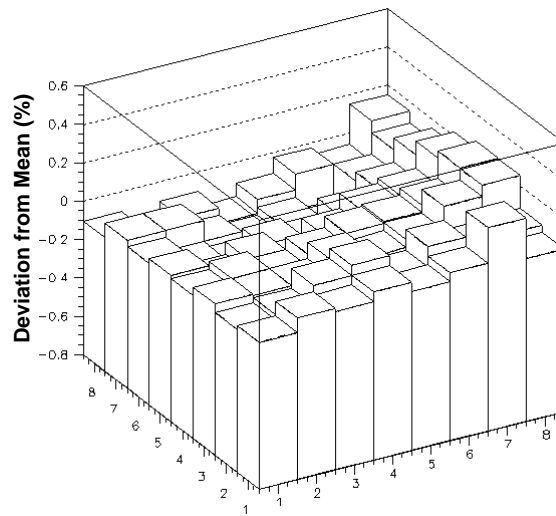


CsI(Tl) Crystals

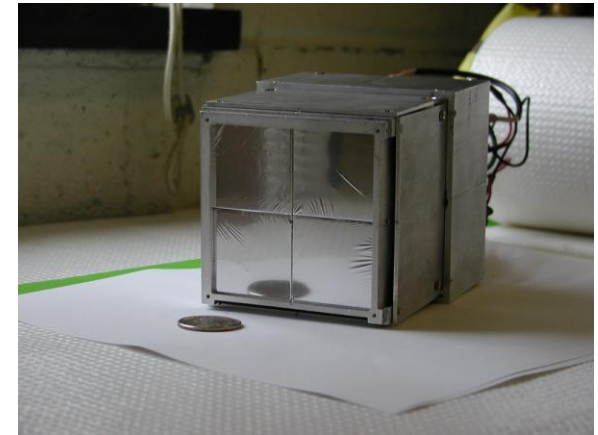


crystal #3

55 AMeV α Beam
Incident on crystal



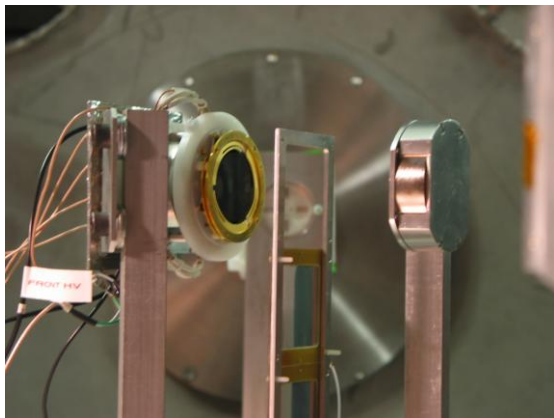
crystal #7



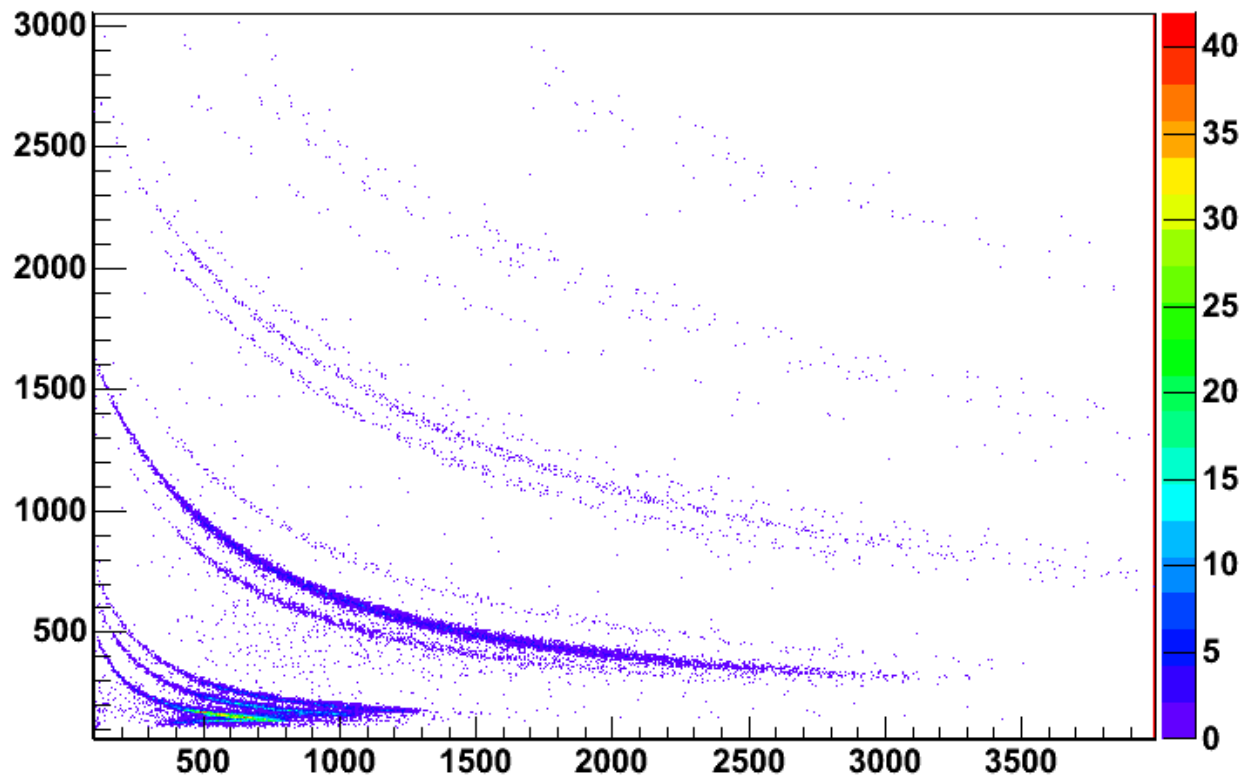
*Each crystal is
scanned for
uniformity of
light output!*



Particle ID



Particle ID by E vs TOF using thick Silicon and target MCP.



*Particle ID by DE vs E using thick Silicon and CsI.
Particle ID by DE vs E using thin and thick Silicon.*



Electronic Readout

*Developed at Washington University (St. Louis) and
Southern Illinois University,*

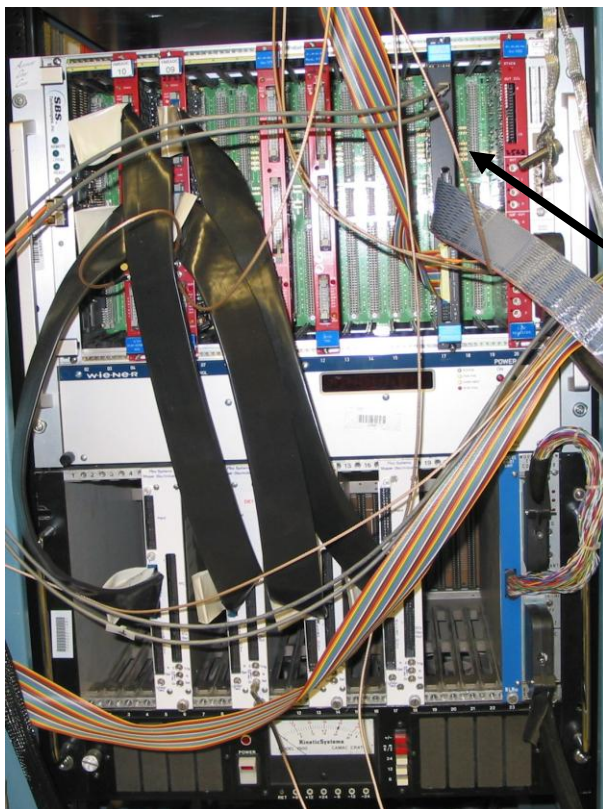
With 2000 channels to readout, cost of
“traditional” readout is prohibitive.



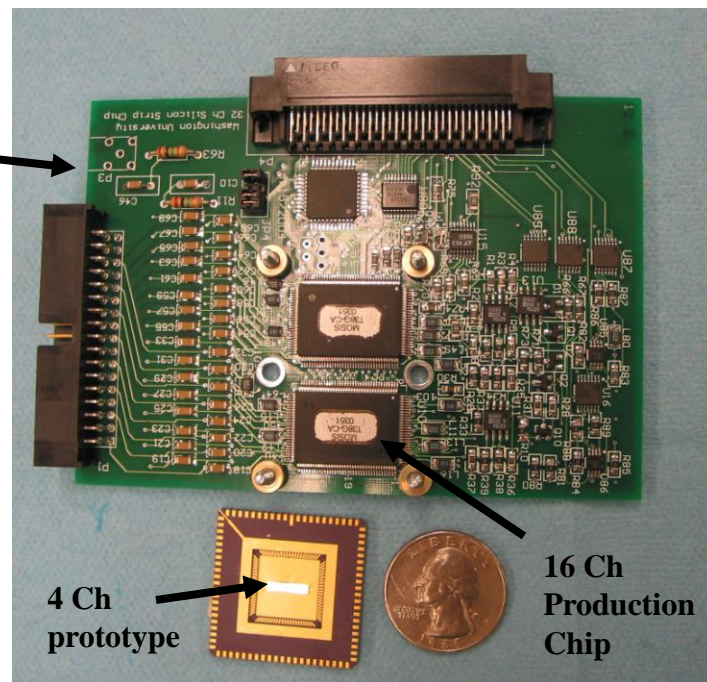
Application **S**pecific **I**ntegrated **C**ircuit

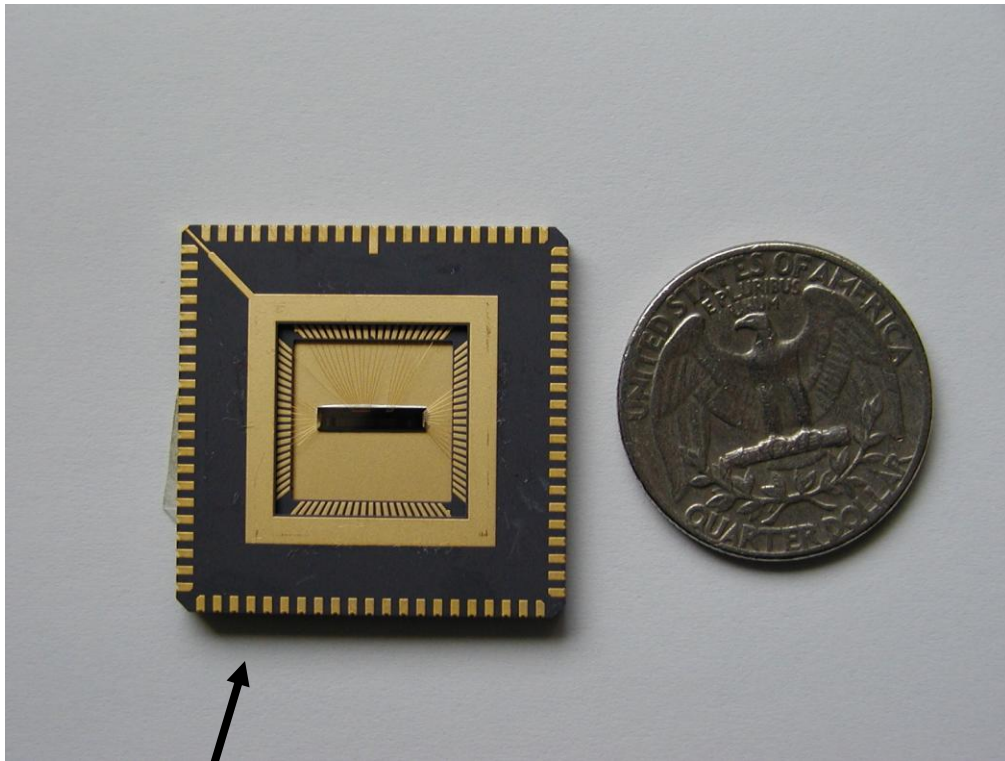
Design Includes:

- Multiple Preamps
- Shapers
- Discriminator
- Time to amplitude converters



This chip board
+ one VME
module replaces
64 pre-amp's, 32
Shapers, 32 TDCs
and 32 ADCs



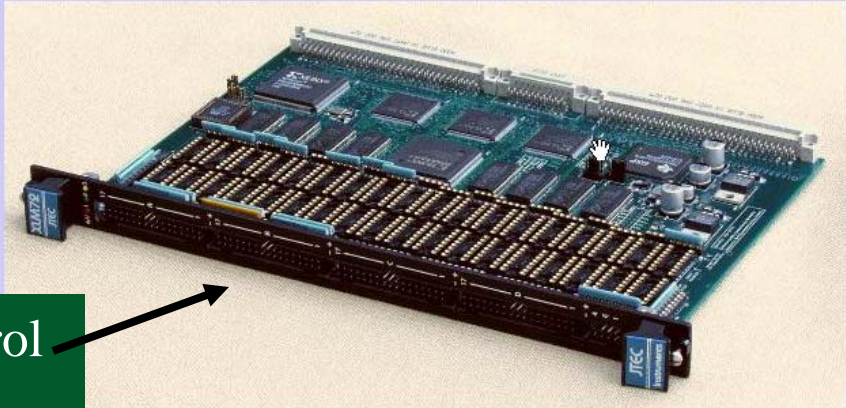


ASIC Chip

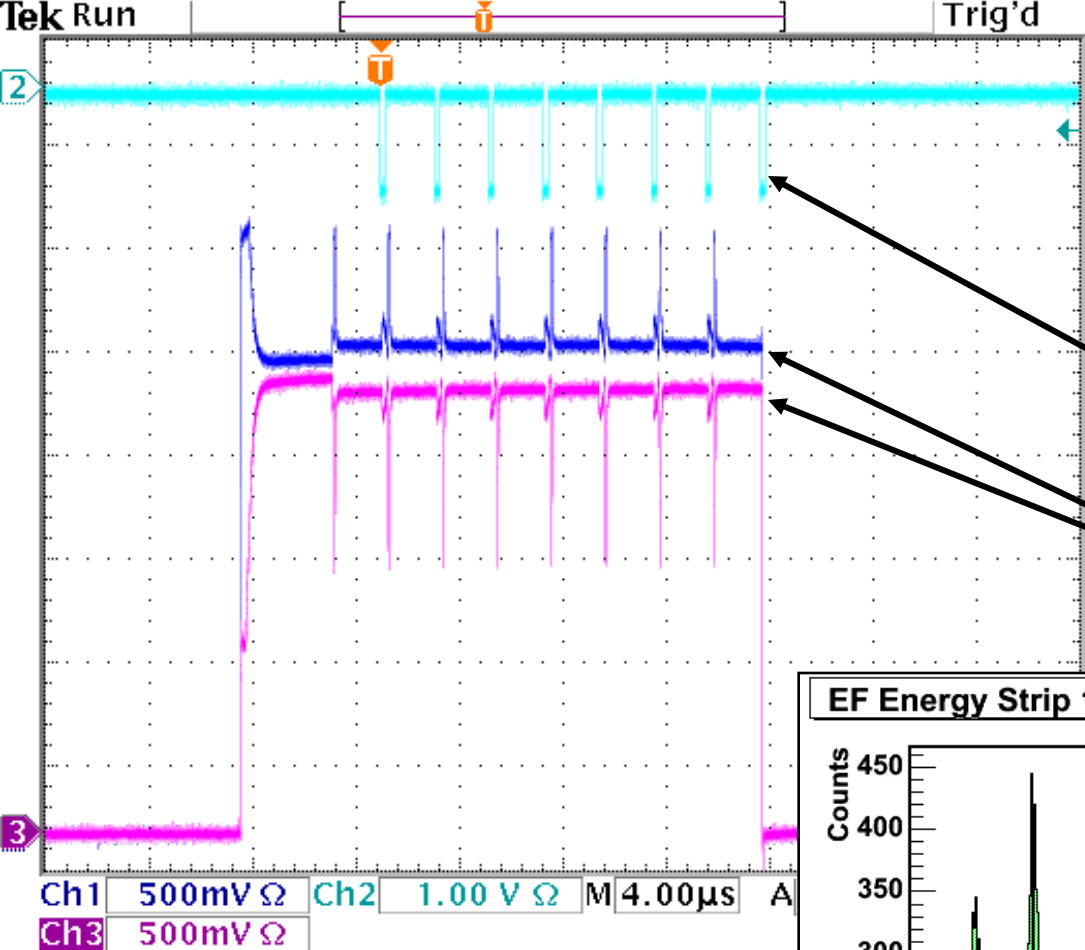
ADC module,
used for ALL
20 telescopes



XLM72 Universal Logic Module



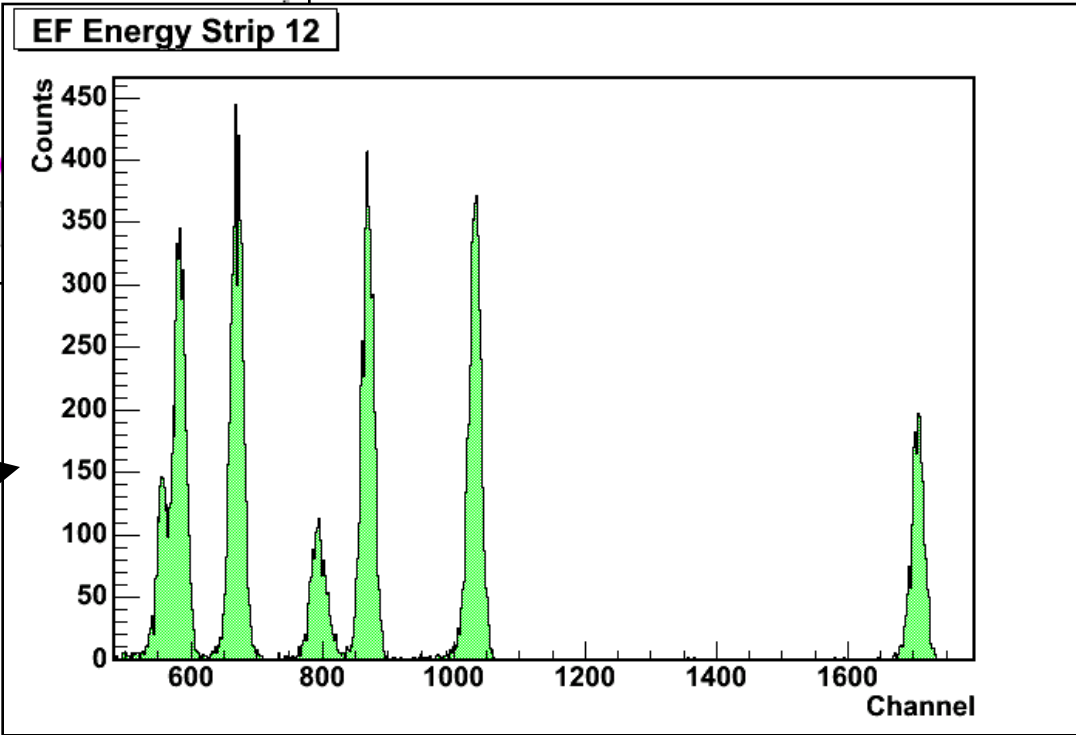
ULM for control
of ASIC



The Signals go from the ASIC chip to a differential amp and then to a sampling ADC.

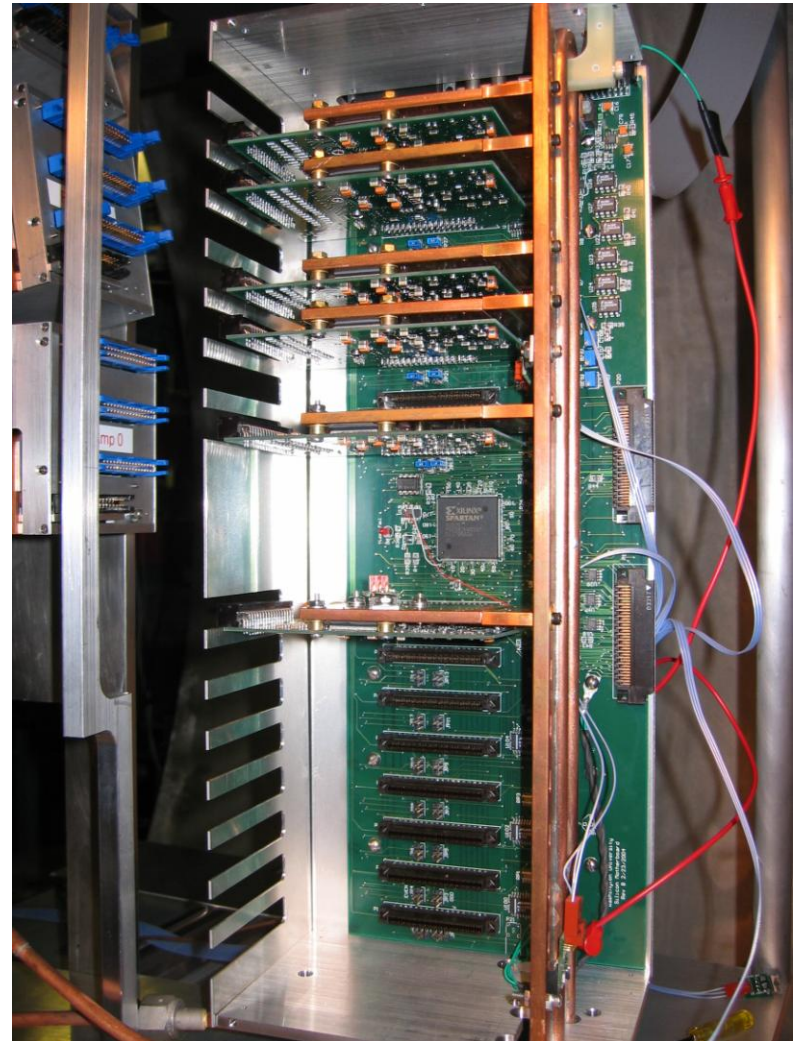
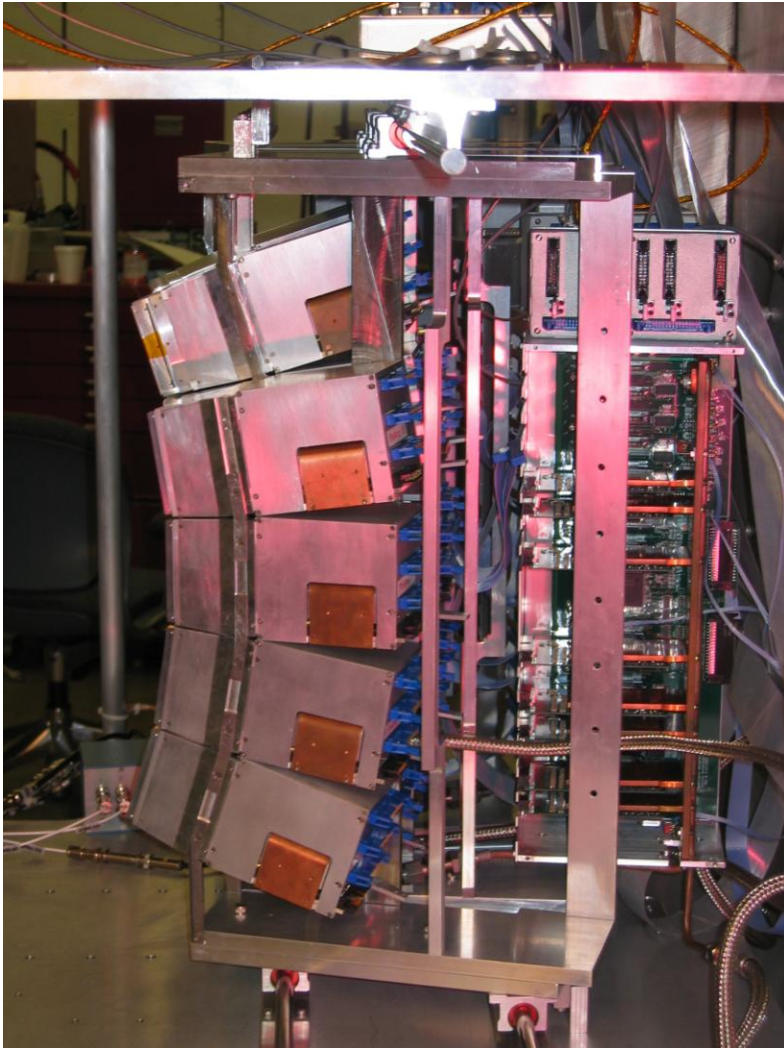
Sample time

Differential Signals



α spectrum ^{228}Th source
 → SIS 14 Bit Sampling
 ADC

HiRA electronics setup behind detectors in tower configuration



The HiRA collaboration (as of 2005)

MSU / NSCL

- Bill Lynch
- Betty Tsang
- Mark Wallace
- M-J. van Goethem
- Mike Famiano
- Franck Delaunay
- Michal Mocko
- Andy Rogers
- B. Nett
- D. Oostdyke
- S. Simpson
- J. K
- J. Veazey
- Shawn Tornga
- Jacob Clifford
- Sergei Lukyanov

IU / IUUCF

- RT.de Souza
- A.L. Caraley
- B.P. Davin
- R. Alfaro-Molina
- S. Hudan
- V. Viola
- Carlos

INFN Milano

- A. Moroni

Washington University, St. Louis

- L. Sobotka
- R. Charity
- J.M. Elson

Southern Illinois University, Edwardsville

- G.L. Engel



Laser Based Alignment System



- *Designed for precision measurement of detector positions relative to target.*
- *Adaptable to various configurations and other devices.*
- *Computer controlled.*

• *Resolution:*

- *0.005 for angular stages.*
- *100 microns for distance.*

