HiRA Array Upgrade to Detect Higher Energy Fragments from Heavy Ion Collisions

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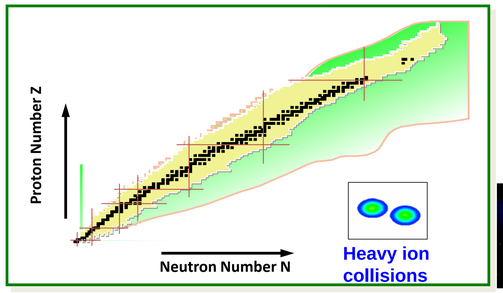
PHYSICS MOTIVATION

- ***Why doesn't neutron star collapse under its own weight (one teaspoon = 5.5 E12 kg)?*** Pressure from symmetry energy from the imbalance of neutrons to protons counters the gravitational force.
- The same physics that governs the properties of neutron stars also governs the ***properties of nuclei***
- At NSCL, the HiRA group measures fragments, n,p,d,t,3He, alpha, Li up to O isotopes emitted in Sn+Sn collisions to study the ***symmetry energy***.

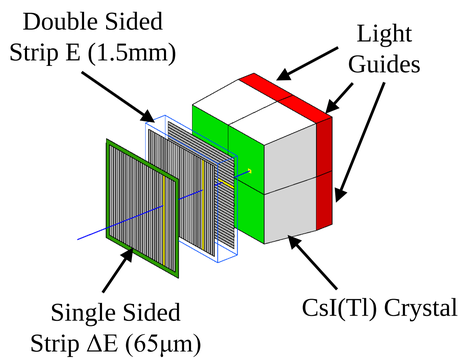


Crab Pulsar

ORIGINAL DEVELOPMENT MOTIVATION

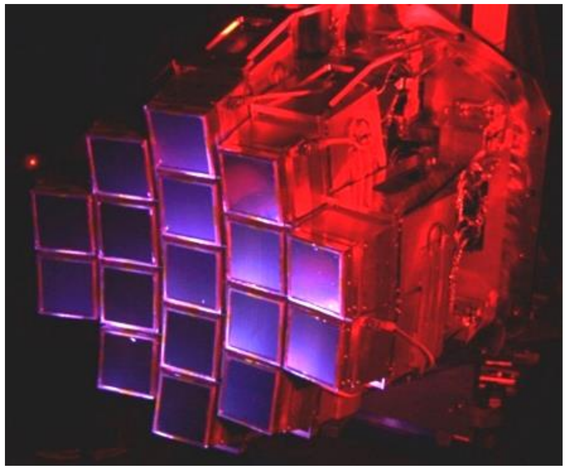
HiRA was an array of ***20 charged particle telescopes*** designed to provide the ***high angular coverage*** and ***high granularity*** required in a variety of experiments.

- Nuclear Structure and Reactions
- Probing the Nuclear EOS & Nuclear Astrophysics
- ~20 papers published



PREVIOUS HIRA TECHNICAL SPECIFICATIONS

- 32 strip, single-sided 65μm "ΔE" layer
- 32 strip, double-sided "E" layer
- Si strip pitch of 2000μm
- ***4 CsI(Tl) crystals 4 cm long*** for particles that go through Si



NEW HIRA TECHNICAL SPECIFICATIONS

- Same Si detectors
- ***9 CsI(Tl) crystals 10 cm long*** for higher energy particles that stop in the CsI crystals after going through Si

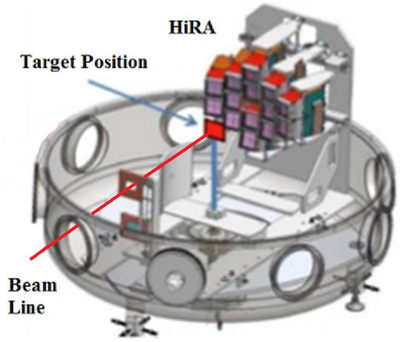
PRINCIPLES OF OPERATION

Particle identification**:** Isotopes are identified using the ΔE-E technique. By comparing the energy loss in one Si detector layer to the energy deposited in another layer, particles are identified based on their mass A and charge Z.

Position sensitivity**:** The perpendicular strips on the front and back of the thick "E" detector define a pixel that characterizes the particle's trajectory. Each E detector contains 1024 pixels.

CURRENT STATUS (Rough Schedule)

Conceptual Design: Nearly Complete
Quotes from Vendor: End of April
Test single CsI crystal: End of June
Finalize Crystal Design: Middle of July
Finalize Preamp Box Design: End of August
Delivery of upgraded crystal array: End of October
Assembly : End of December



OUTLOOK

- Finish date : December, 2015
- Approved experiment proposal #14030, expected to run in 2016 & another proposal submitted.

The new telescope design with more crystals of greater length, should identify particles and their positions with ***greater sensitivity***. The re-designed telescope array is expected to be used in future experiments.

Motivation for the upgrade

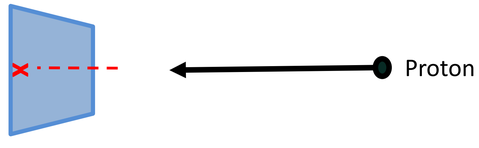
CESIUM IODIDE (CsI) CRYSTALS

CsI crystals are useful for ***measuring the energies of nuclear particles*** in a reaction. The crystals produce light when electrons are ionized within them as particles travel through. By measuring the light produced, a measurement of the energy of the particles is reached. The Si photo-diodes attached to the crystals have a current ∝ to the collected light and to the energy deposited.

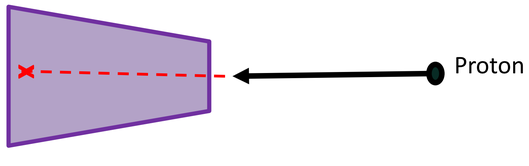
UPDATED DEVELOPMENT MOTIVATION

Detection of ***higher energy particles*** than previously feasible. 4 cm CsI detect up to 116 MeV proton. HiRA upgrade CsI (10 cm) will detect p up to 190 MeV.

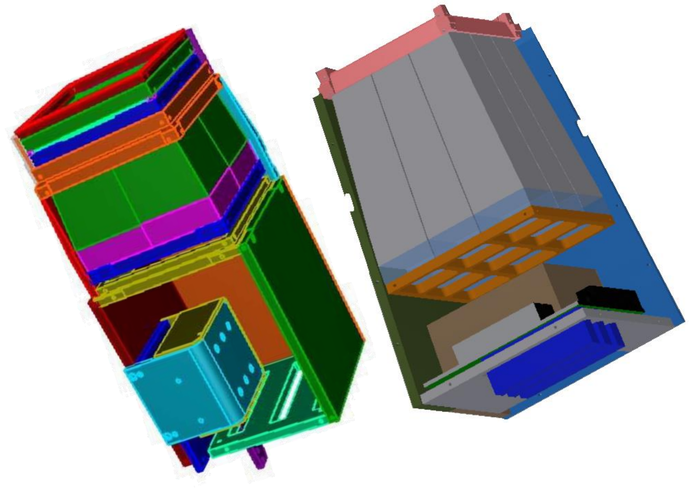
4 cm CsI Stops Proton of 116 MeV



10 cm CsI Stopped Proton of 190 MeV



Old and New Telescope Design



REDESIGNED COMPONENTS

CsI Crystals**:** Longer cesium iodide crystals were used to detect high energy particles.

Telescope Box**:** A new box was designed with fewer parts to reduce machining costs and to accommodate the new crystals.

Back Plate**:** The back plate had to be altered to accommodate the new box design and to allow cooling of the pre-amps from the back.

Pre-Amp Box**:** The new pre-amp box was designed in order to hold 9 pre-amps instead of 4.

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