CsI (Tl) Crystals for Charged Particle Detection in the High Resolution Array (HiRA)

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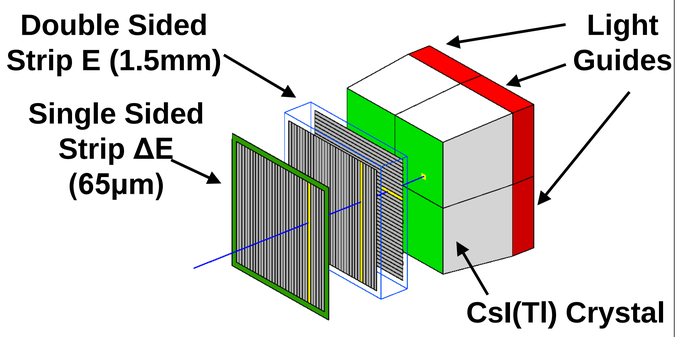
DEVELOPMENT MOTIVATION

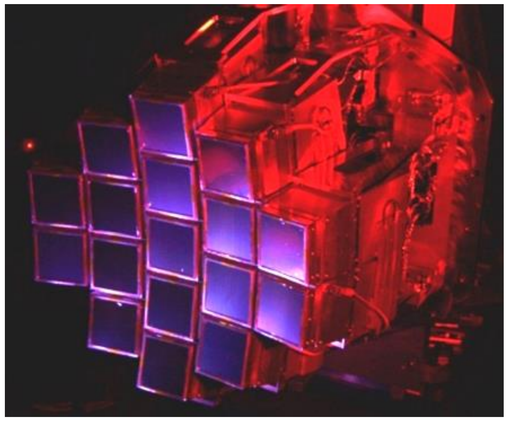
HiRA is an array of ***20 charged particle telescopes*** designed to provide the ***high angular coverage*** and ***high granularity*** required in a variety of experiments :

- Nuclear Structure and Reactions
- Nuclear Astrophysics
- Probing the Nuclear EOS



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 for particles that go through Si (light is collected using guides to Si diodes)
- Si photo-diode’s current is $\propto$ to the collected light and to the energy deposited.



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.

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, an measurement of the energy of the particles is reached.

DAMAGE

The CsI crystals are hydroscopic. In a recent experiment, the crystals in the HiRA telescopes were accidentally exposed to condensation. This caused damage to the surface of the crystals.

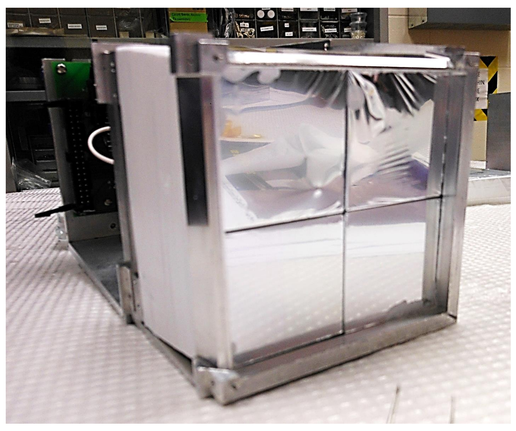
REPAIRS

The telescopes were disassembled, and the crystals taken out. The crystals protective wrappings, were then removed. The damage was assessed and put in a database. A procedure was constructed to repair crystals in an organized and systematic manner. Photo-diodes were detached to prevent damage. Paint was cleaned off. The sides of the crystals were sanded to remove damage and to make the surface uniformly reflective. And the face of the crystal was lapped appropriately to remove damage and improve light collection near the surface. The crystal faces were then polished with silk to clear them even further. Light guides which had become detached in the process were glued back on along with photo-diodes. Surfaces of the light guides were re-painted to diffusely-reflect light and prevent it from escaping from the detector. The crystals are then re-wrapped, and placed back into the telescopes.

OUTLOOK

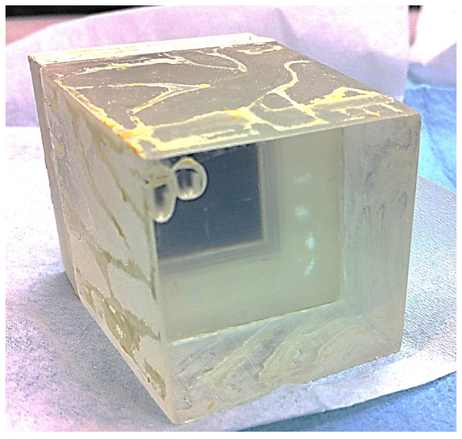
After all proper repairs have been made, we will test the crystals to see that they work as well as they did prior to the damage. There are two experiments planned for the fall using the HiRA telescopes with fully operational CsI crystals.

CsI Crystals in Detector



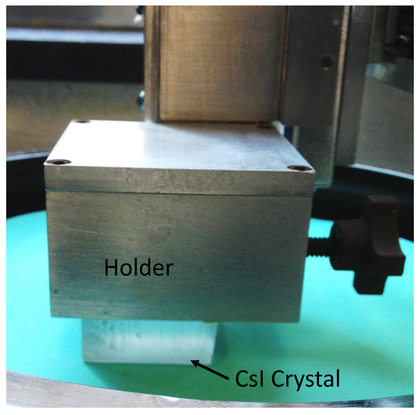
Crystals are arranged in the detectors so that the light created by the particles are passed to the photo-diodes.

Damaged Crystal



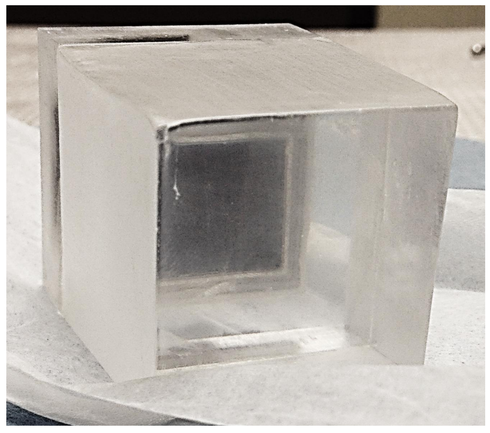
Water had eroded portions on the crystal face and remnants of protective wrappings stuck to the sides.

Lapping Set-Up



The lapping set-up was arranged to remove the damage from the face of the crystals and produce a smooth, level, and clear surface in a controlled manner.

Repaired Crystal



This is a finished crystal with all repairs made before being wrapped and put back into a telescope.

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