Measuring Neutrons and Charged Particles from Nuclear Reactions

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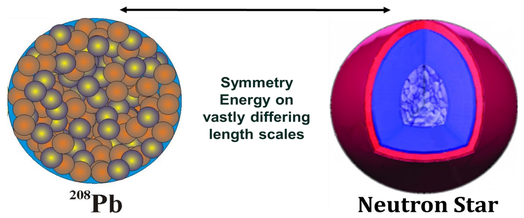
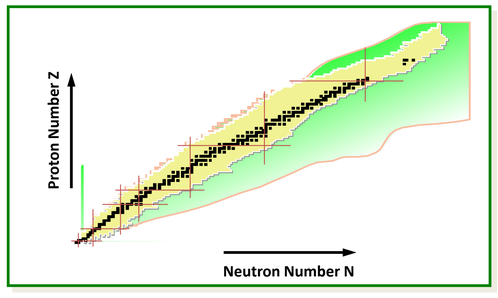
PHYSICS MOTIVATION

- ***Why doesn't a neutron star collapse under its own weight (one teaspoon = 5.5 x 10^{12} 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***



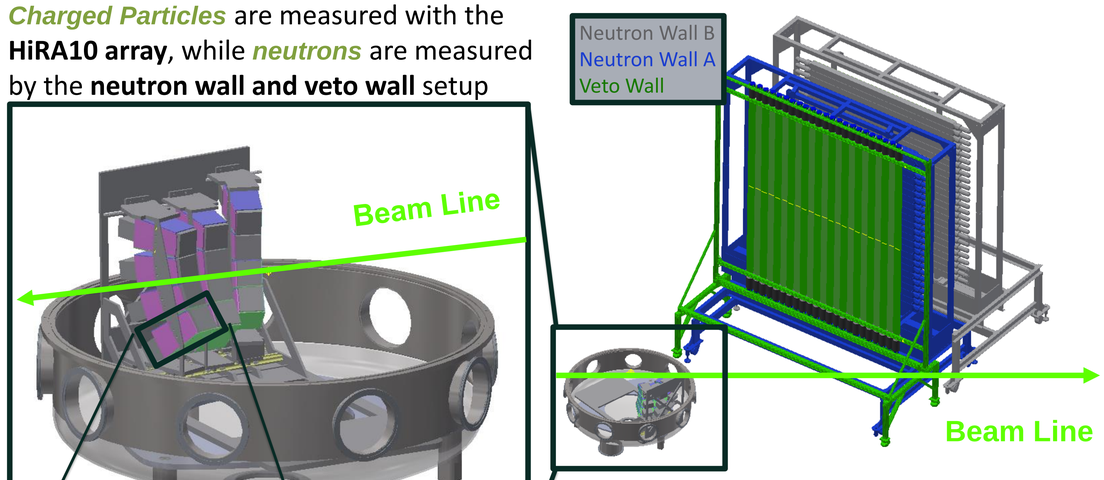
- At NSCL, the HiRA group measures fragments, n,p,d,t,3He, alpha, Li up to O isotopes emitted in Sn+Sn collisions to study the ***symmetry energy***.

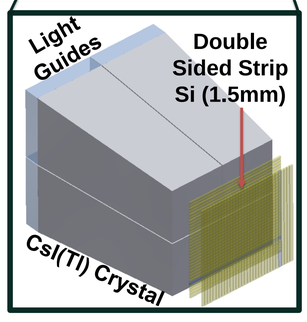


Hubble ST

EXPERIMENT SETUP

Charged Particles are measured with the **HiRA10 array**, while ***neutrons*** are measured by the **neutron wall and veto wall** setup





Double Sided Strip Si: Provides position information as well as energy loss within strips

CsI Crystals: Stops protons up to 190 MeV, providing energy information

Veto Principle

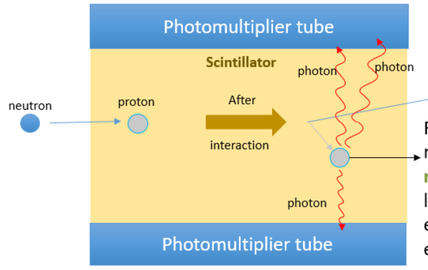
The ***Neutron Walls*** detect both ***Neutrons*** and charged particles.

The ***Veto Wall*** detects mainly charged particles, which can be subtracted from the spectrum measured in the ***Neutron Walls***

Contributions

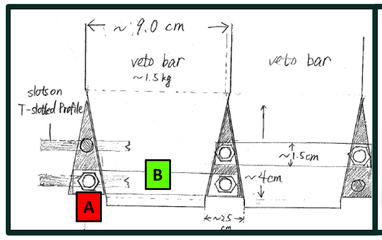
- ***Mobile*** and ***Modular*** design of Veto Wall
- ***Versatile*** and ***Reusable*** design of HiRA 10

Veto Wall Concept



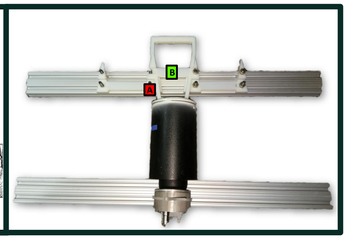
Recoil **proton** will excite molecule in **scintillation material** causing the latter to **absorb** proton's energy and **re-emit** the energy in photon form

Veto Wall Design



Design Concept Draft

A : Mounting Wedge

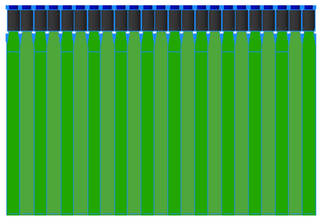


Details of 3D mounting structure

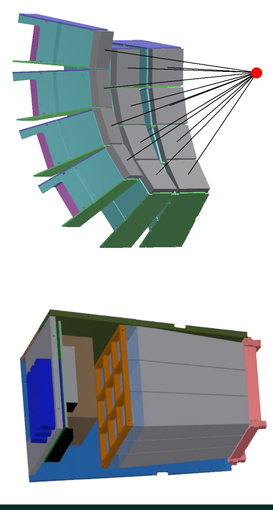
B : Prototype of Scintillator Veto Bar

Close-Packed

Scintillator Bars ***overlap*** as shown in order to obtain ***maximum efficiency*** for charged particle detection



HiRA 10 Array Design

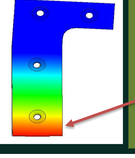


HiRA Design Considerations

- Constant Distance to target
- Cooling bars for electronics
- Cable planning
- Operate inside Vacuum

Unique Problems

- Modular design
  Solution: linear guides
- Close to edge of chamber
  Solution: Tightly toleranced back plate



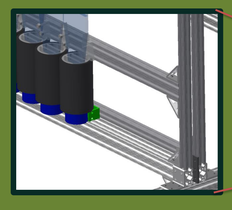
Max elastic deformation of 0.003 mm

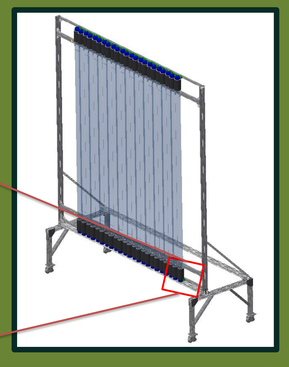
Tower Prototype

Mount Design Considerations

- Hold weight of HiRA10 detectors (~4 kg each)
  Analysis yields Factor of Safety of 15
- Modular design: each tower must be pulled apart for inspection or repairs
- "Key" slot at different angle than rest of telescope

Veto Wall Final Design





80/20 Beam Cross-section is optimized for high ***strength-to-weight*** ratio and ***modularity***

Veto Wall Design Considerations

- Complete coverage of neutron walls
- Mobility (caster wheels)
- Lightweight construction
- Shippable design
- Secured mounting for scintillator bars

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