



Detectors for Ultraheavy Particle Detection: 2018 HNX Test at CERN

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A message from the team...

We apologize we are unable to attend and report at this week user's meeting but had to return to the United States.

We wanted to share preliminary results which are very promising for our goal to measure galactic cosmic rays across the whole periodic table to investigate how matter is synthesized and distributed in the universe.

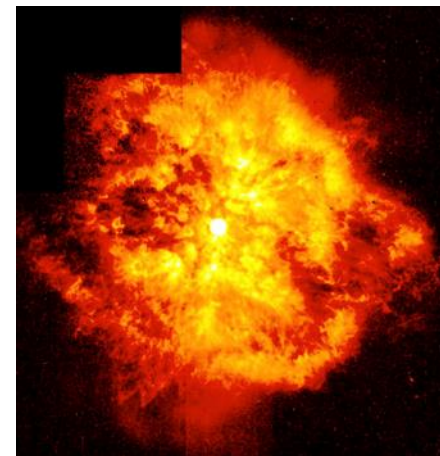


HNX would address key questions in Nuclear Astrophysics

- **What is the age of the Nuclear Material?**
 - “Radioactive clocks” measure **Ultra Heavy Galactic Cosmic Ray (UHGCR)** age - relative abundances probe mixture of old and new material
- **Where/how are UHGCR accelerated?**
 - Element abundances carry the signature of the accelerator mechanism
 - Secondary to primary ratios measure the pathlength
- **What mixture of rapid (r) and slow (s) process nucleosynthesis can explain the measured abundances**
 - Only direct measurements of Ultra Heavy GCR abundances can fully answer this.
 - Photon spectroscopy is highly synergistic.
- **Are there naturally occurring superheavy elements or strange quark matter?(Bonus Science)**
 - Superheavies from postulated “island of stability above actinides.
 - SQM “nuggets” with unusual ratio of mass to charge due to quark composition.



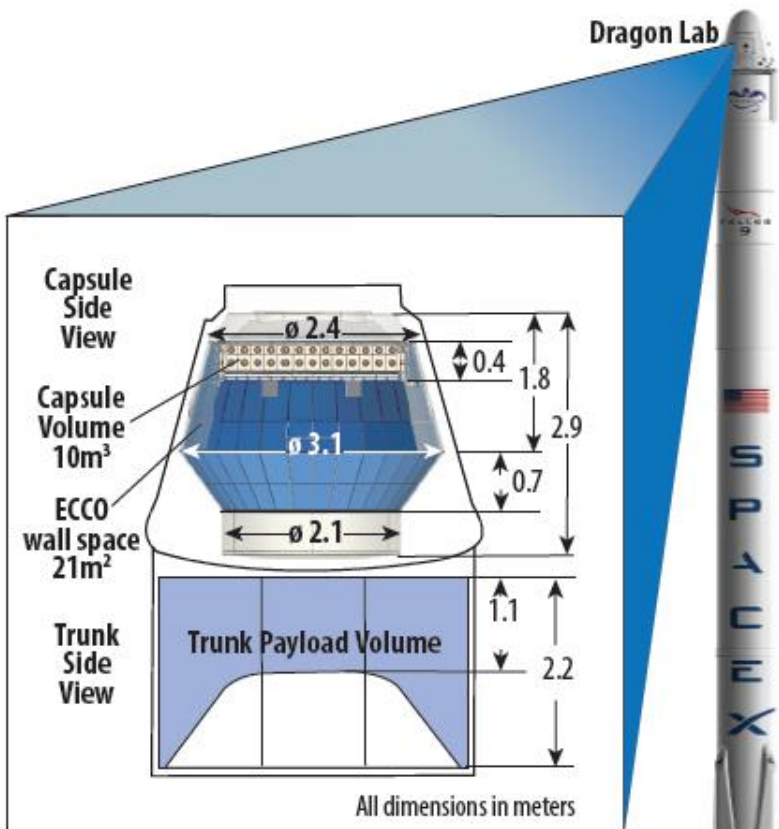
OB Superbubble 30
Doradus in LMC



Wind-nebula around
WR-124 in Sagittarius



HNX Science Implementation



Falcon-9 Launch Vehicle



HNX uses two complementary instruments flown in a Space-X Dragon Lab capsule to span the periodic table $2 \leq Z \leq 96$ ($Z > 96$ if present)

- ECCO (Extremely-heavy Cosmic-ray Composition Observer) – UC SSL
 - Measures ⁷⁰Yb to the actinides
 - ~21m² of special BP-1 glass tiles covering the walls and part of the top of the DragonLab Capsule
 - Recovery is required for post-flight processing of glass
- CosmicTIGER (Cosmic-ray Trans-Iron Galactic Element Recorder) –GSFC, Wash. U., and JPL/Caltech
 - Measures energy to ~10 GeV/nucleon
 - Measures ²He to the actinides, reference ⁷⁸Pt-⁸²Pb for cross cal.
 - 2m² electronic instrument using well-proven instrumental techniques – silicon strip detectors and Cherenkov detectors with acrylic and silica-aerogel radiators

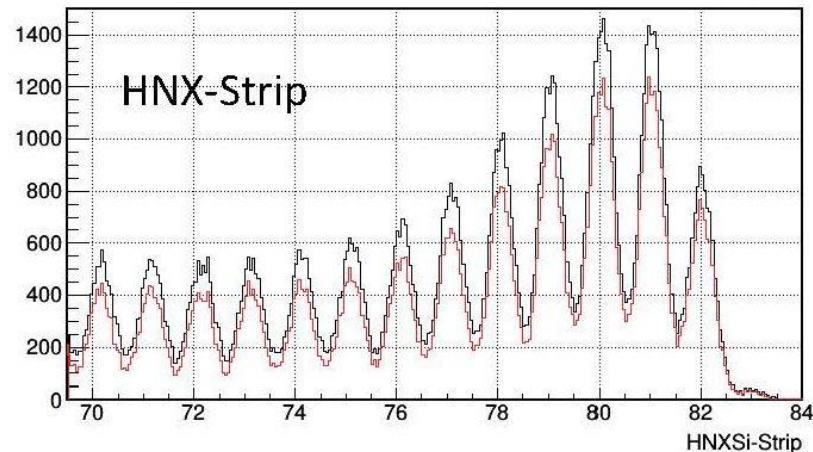
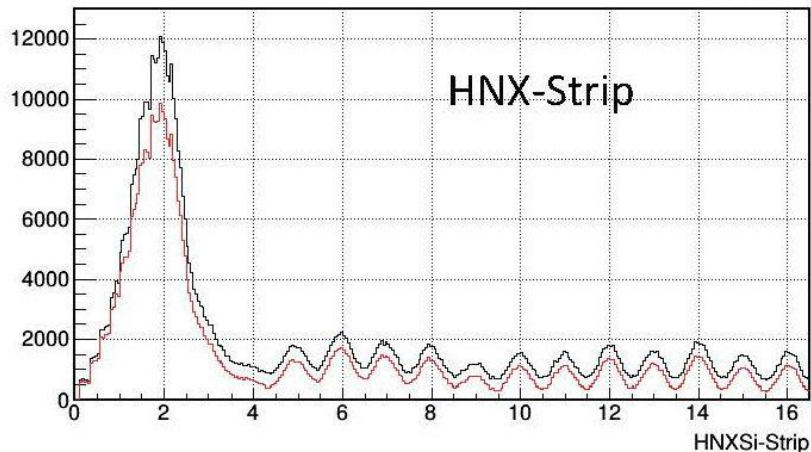
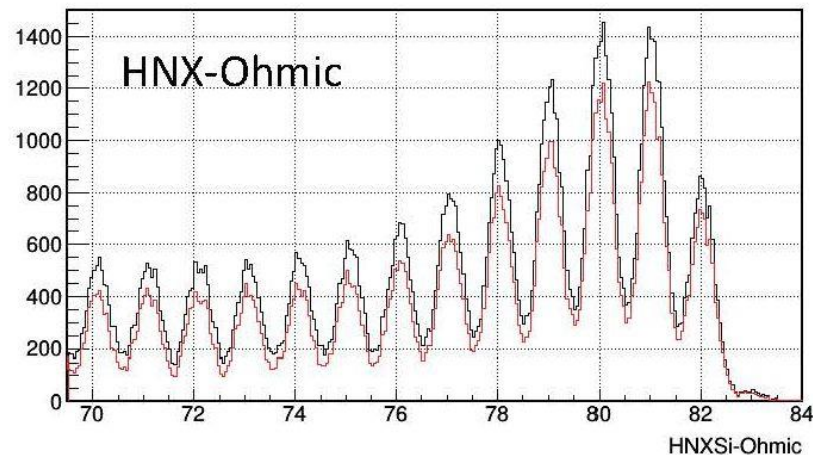
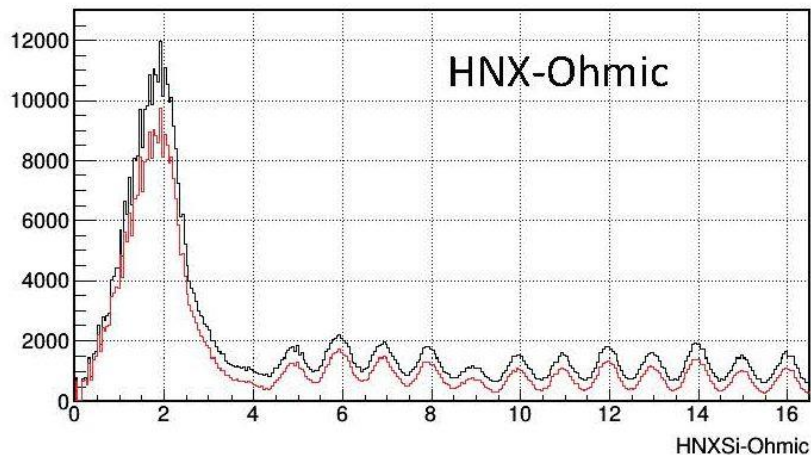


Tests Objectives

- Measure with a fragmented lead beam the charge resolution that can be obtained by large area silicon strip detectors.
- Compare resolution in charge we can get with SiPMs versus PMTs.
- See how low in charge we can resolve with our silicon strip and SiPM detectors using a 16 bit ADC readout system.
- Test prototype gamma-ray detector setup (APT) to see if it can be used for heavy element measurements.



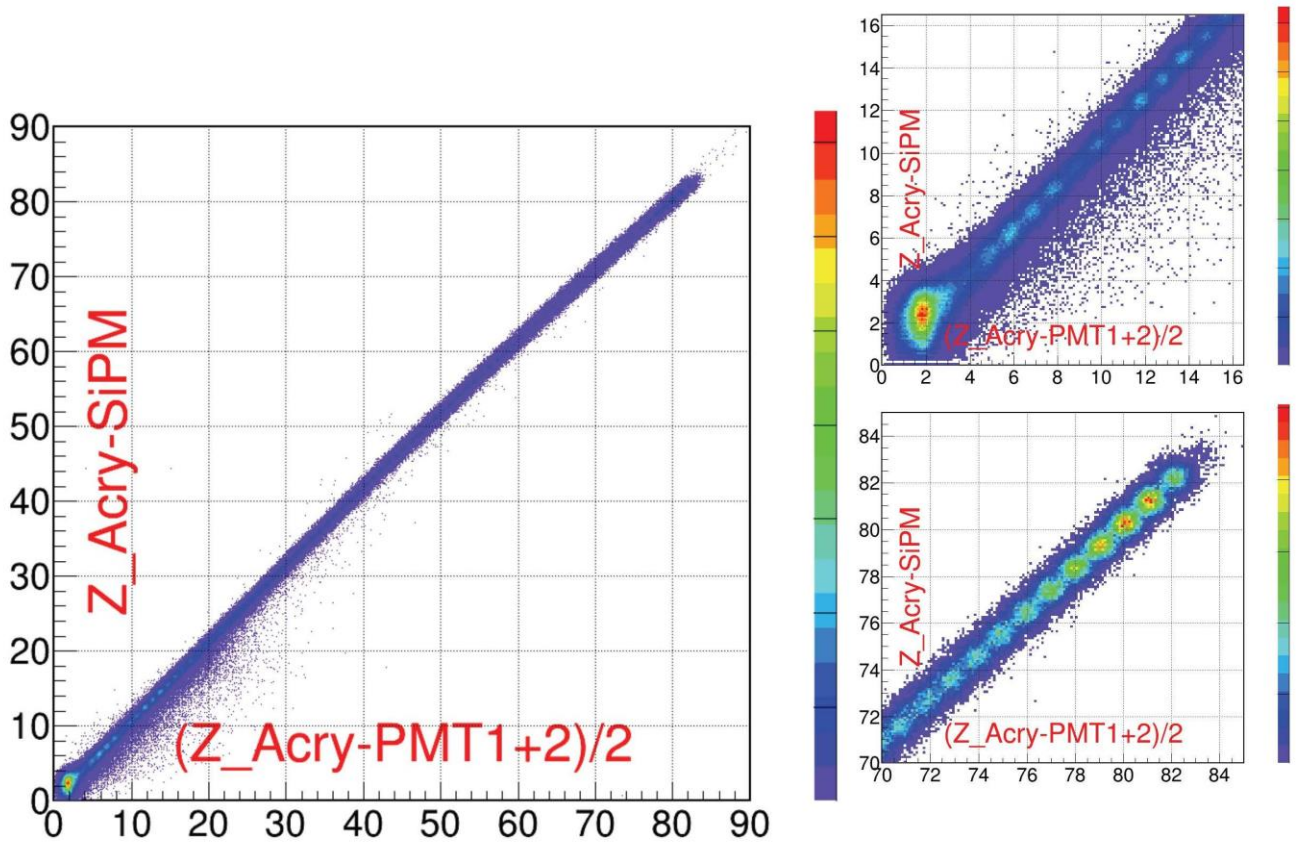
Silicon Strip Detectors



- Excellent charge resolution from Lead ($Z=82$) down to Boron ($Z=5$). A closer look at the data suggests we may in fact be able to see a peak at Helium ($Z=2$) but further analysis will be needed.



SiPM vs PMTs



- Two Hammamatsu R1924 and SiPM with active area to match the photocathode of the PMTs were installed in a Cherenkov lightbox with acrylic radiator.
- Can see charge distributions From Lead ($Z=82$) to Boron ($Z=5$) with SiPMs.
- Looks like resolution of SiPMs is better than PMTs but further analysis is required. 7