TBD

CEPS – A Compact Electron-Proton Spectrometer

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EXECUTIVE SUMMARY

The aim of this project is the development of compact, low power space weather sensors for crew protection based on the combination of AES flight heritage Timepix hardware with novel CdTe (Cadmium Telluride) sensors. CdTe technology has only recently matured to a point where it can be reliably used with Timepix detectors. These detectors will be able to measure electron spectra in an energy range relevant to the RELEASE model, which is used operationally by NASA to provide crew early warning of Solar Energetic Particle Events as well as protons in the energy ranges relevant to human health allowing for event 'nowcasting' and total event crew dose prediction. **Concurrent measurements of electrons and protons are needed to mitigate operational hazards posed by solar storming.**

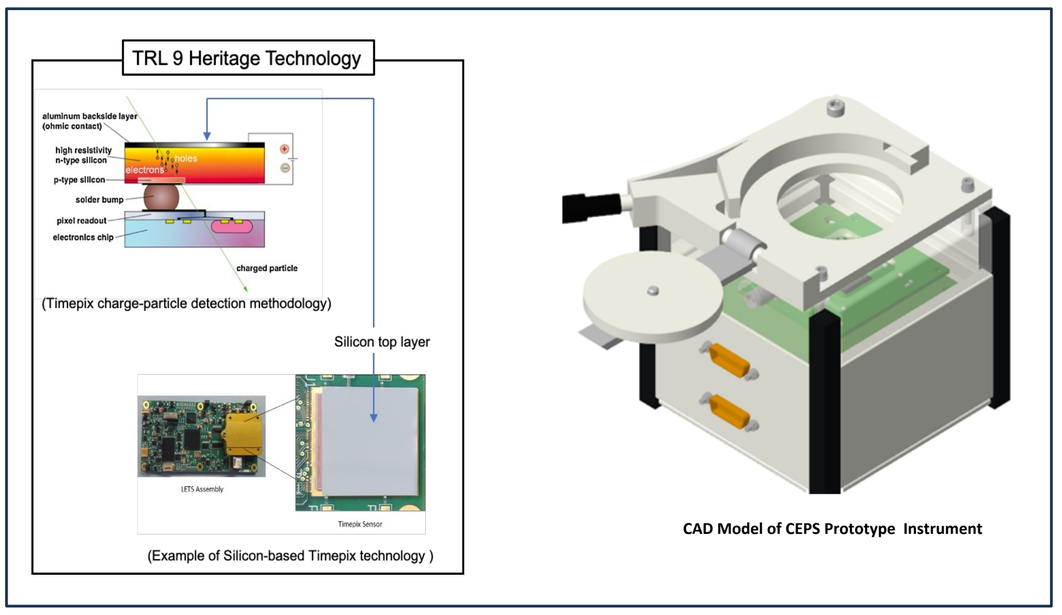
INNOVATION

- **Need small, low mass/power space weather sensors capable of being carried by crew on lunar surface, that can be deployed on habitat and/or rover, or stand-alone orbiting robotic assets.**
- Enabling capability – small space weather sensors at location of crew for space weather alert/warning on lunar surface are not currently available
- Current technology requires roughly twice the mass and three times the volume to measure the same particle type and energy range capable with CdTe Timepix technology.
- This project leverages and advances CdTe technology for charged particle detection.
- **Broadly applicable to supporting robotic mission under SMD as well as HEOMD crewed missions. Small enough in volume / mass / power to be launched on a CubeSat.**

COLLABORATION

This project was conducted in collaboration with subject matter experts at the following two institutes:

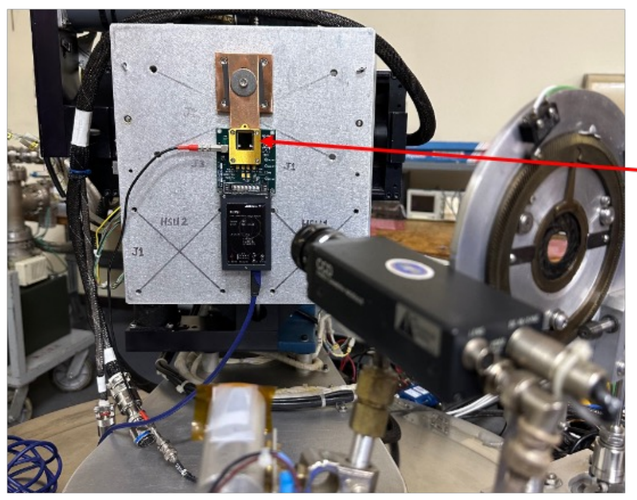
1. Los Alamos National Lab (LANL)
2. University of Houston



(Left) Diagram showing fundamentals of Timepix sensor technology. (Right) Prototype of CEPS assembly.

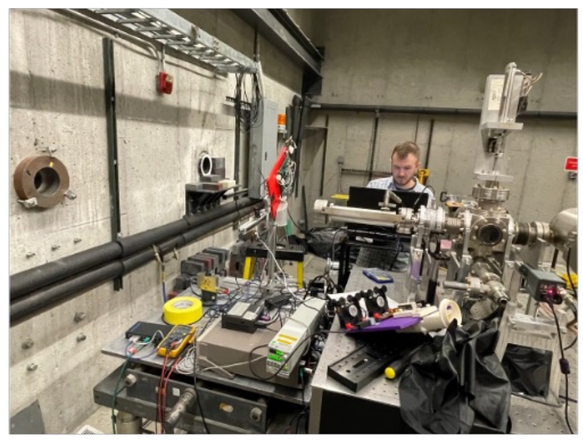
OUTCOMES & INFUSION

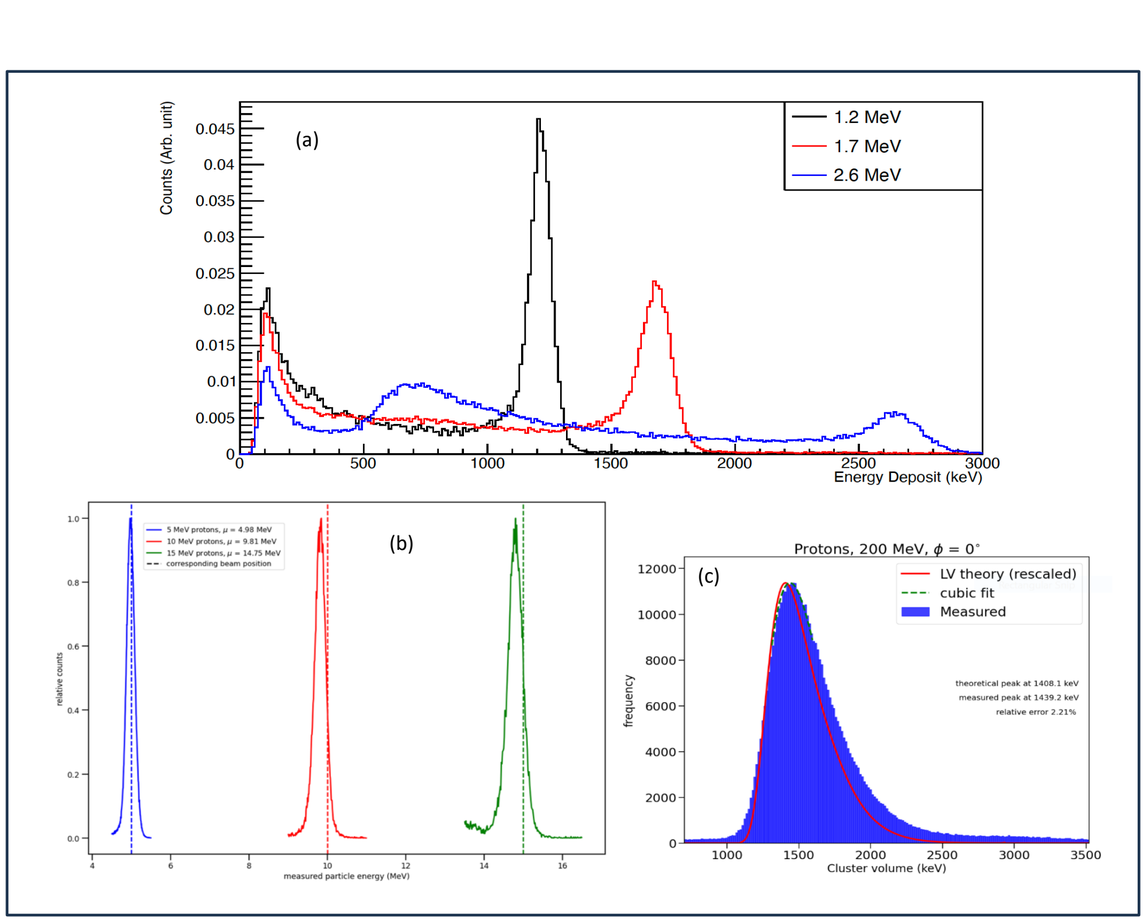
- Advanced technology to TRL 5.
- Successfully demonstrated acceptable performance with electron and protons.
  - Calibration successful
  - Response functions developed and tested
  - Validated detector response with electrons and protons
  - Ready to move to next step in development
- Future work is now infused into Mars Capability Office (MCO) planned work for FY24.



- Proton measurement setup at Brookhaven National Lab.
- Active CdTe Timepix sensor
- Copper plate and bar installed and tested to verify ability to sink thermal load from sensor.

- Electron measurement setup at Idaho Accelerator Center (IAC)





(a) Measurement with energetic electrons at three different energies. (b) Measurement with low-energy protons. Dotted vertical line represents reference beam energy; (c) Measurement with energetic protons. Solid red line is the simulated spectrum.

FUTURE WORK

1. Advance prototype electronics to EDU design
2. Design and test of entrance aperture with protective foil
3. Assemble EDU and test
4. Baseline environmental testing to bring design to TRL 6.

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NTR#(s) N/A