Miniaturized Particle Telescope (MPT)

D. Fry, PhD

December 15, 2016

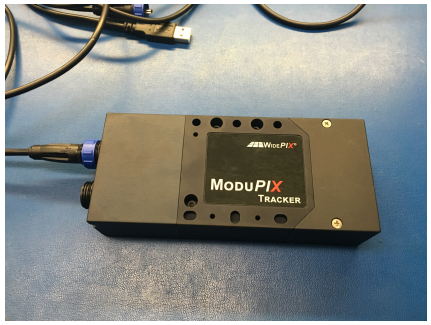
Purpose

- To demo the capability of determining the directional characteristics of charged particle energy spectra in space this project shall:

Build, ground test and deploy (on ISS) a two-sensor TimePix detector capable of: (1) detecting protons and higher Z ions at energies from a few to >100 MeV/n; (2) measuring the angular dependence of detected ions.

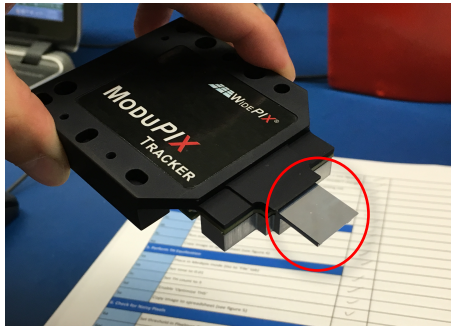
- Detector comprised of 'off-the-shelf' components produced by Advacam (publicly available)
  - Relatively smaller footprint and lower power than traditional particle spectrometers.
- Being tested out to possibly fill Orion / future exploration (habitat) requirements for energetic particle spectroscopy
- May provide higher fidelity information of characteristics of radiation field that will enable better calculation of crew exposure risk
- Being considered as part of a suite of instruments for future exploration habitats.

- MPT Project Team
  - D. Fry
  - T. Campbell-Rickets (Univ. of Houston)
  - M. Ecord
  - J. Keller
  - M. Kroupa
  - C. McLeod
  - R. Rios
  - E. Semones
  - N. Stoffle



Sensor unit as received from vendor

Sensor unit packaged in Nomex case for flight.



Single sensor showing active detection chip (red ellipse)

Overview

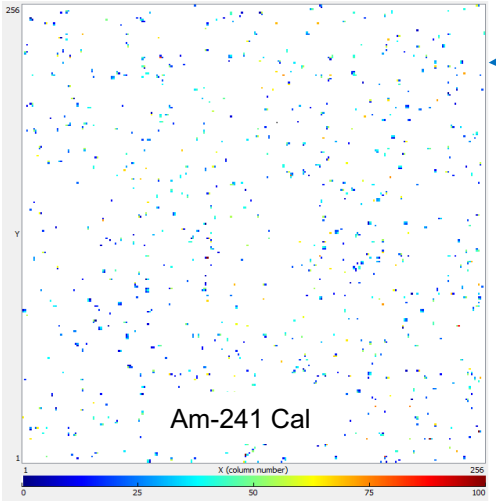
- Power/Data is through two micro-USB connectors (picture on left shows one cable connected). Cables are identical.

- Crew procedure is very simple:
  - Retrieve cables and telescope.
  - Connect cables to laptop.
  - Start software

- Data handling
  - Onboard software is identical to current REM DTO software. Planned REM software update will include new drivers to 'talk' to telescope.
  - All data will be downloaded following the current REM DTO process.

- Science Requirements
  - Detection of electrons, protons and higher-Z ions from a few to >100 MeV/A
  - Resolve particle energy within a minimum of 6 energy bins (ground processing)
  - Determination of particle track through both detectors (ground processing)
  - Determine flux spectrum, $\Phi(E, \delta\theta, \delta\theta)$ within angular resolution determined by acceptance angle of stack.

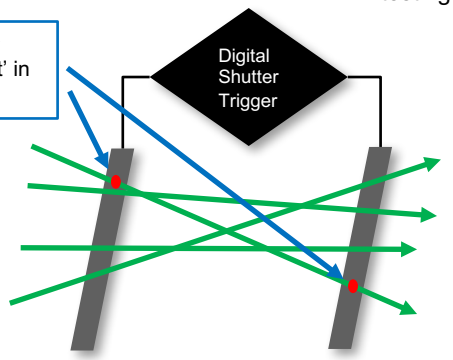
Sample Data Snapshots from Ground Testing



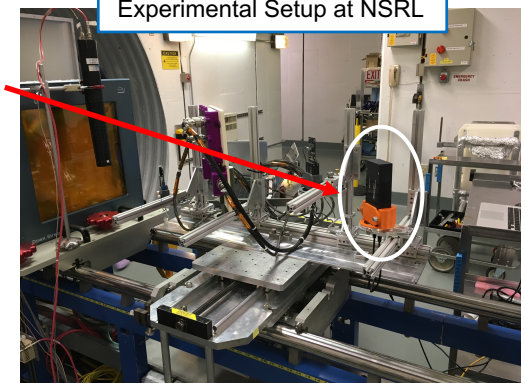
Calibration with photons at JSC. Each ”spec” corresponds to a ‘hit’ of a γ-ray of 59.5 keV.

MPT mounted on beamline at NSRL. Piggybacked off of HERA testing.

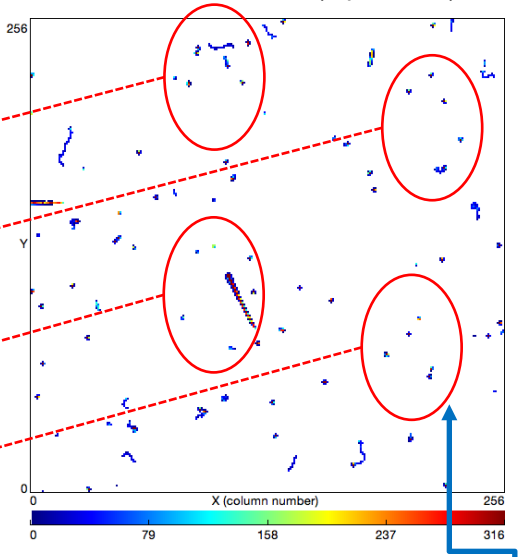
Each sensor records a ‘hit’ in coincidence



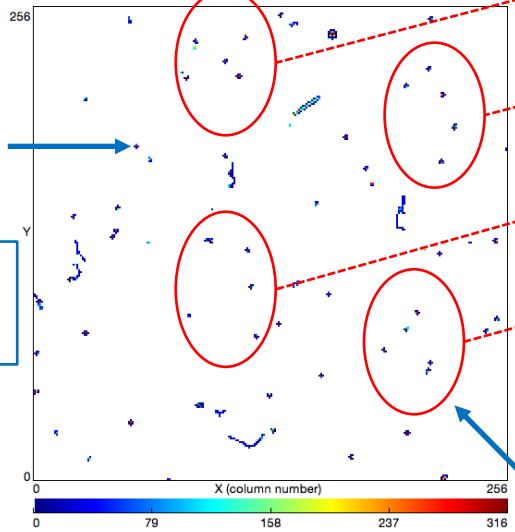
Experimental Setup at NSRL



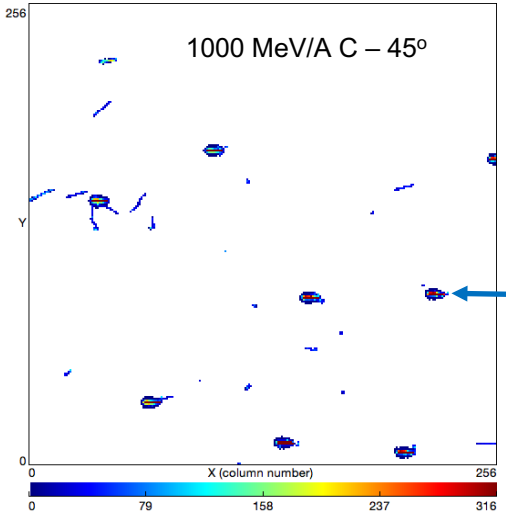
1000 MeV/A He – 0º(top sensor)



1000 MeV/A He – 0º (bottom sensor)



1000 MeV/A C – 45º



Helium – smaller clusters at normal incidence than Carbon at 45º.

Carbon - relatively higher energy deposition and ‘fatter’ clusters

Cluster patterns shown inside of each ellipse found in both top and bottom sensors highlights particle tracks through telescope.

Operational Data Flow

Miniaturized Particle Telescope (MPT) Technology Demonstration

Data Flow – **SSC (zBook)**

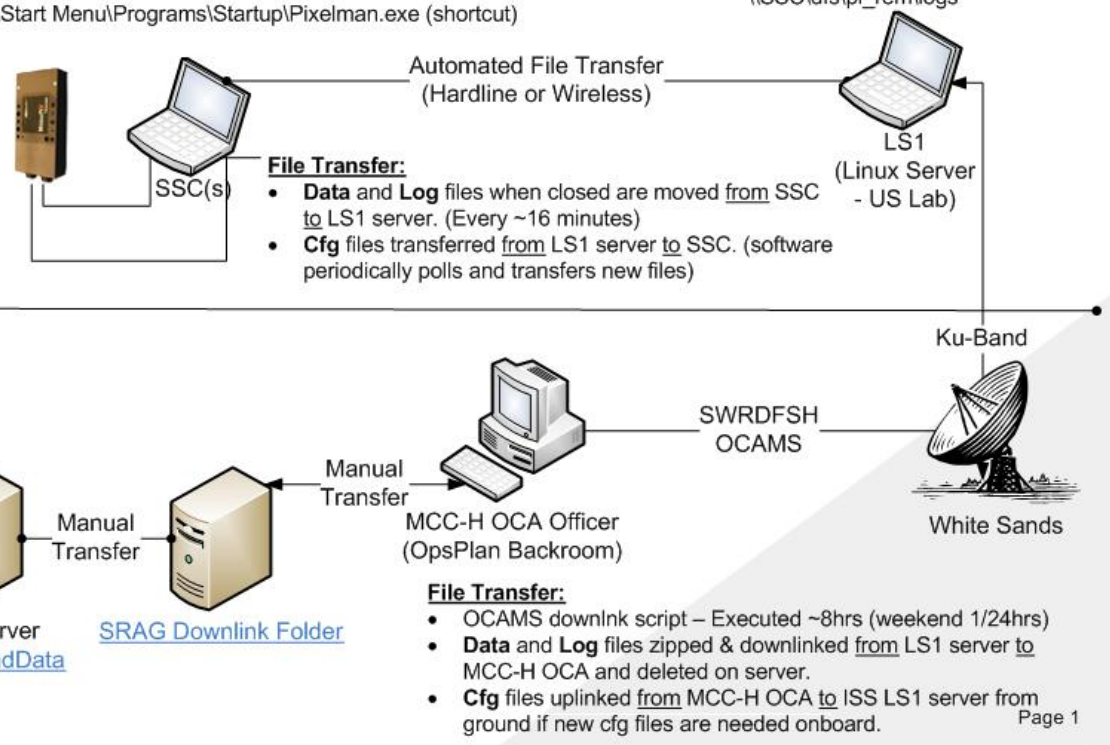
Pixelman Software Location/Folder Configuration (Standard SSC Load)

Pixelman Application (C: Drive):
[C:]\Program Files\PixelmanISS_v1.2.0\Pixelman\Pixelman.exe
(shortcut in \Station Apps\Payloads\Pixelman.exe (shortcut) folder on desktop)
Pixelman Startup after Reboot:
[C:]\Program Data\Microsoft\Windows\Start Menu\Programs\Startup\Pixelman.exe (shortcut)

Data Files on D: Drive:
[D:]\Apps\pl_rem_data\configs
[D:]\Apps\pl_rem_data\data
[D:]\Apps\pl_rem_data\logs

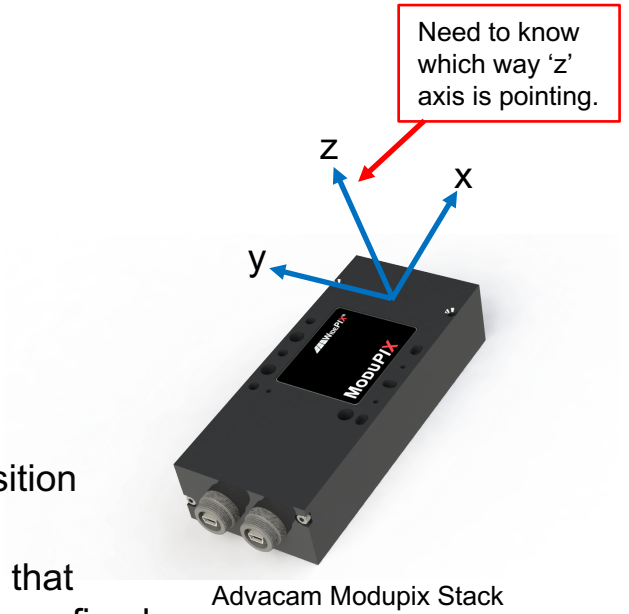
Graph:
[D:]\Apps\pl_rem_data\graph_*.dat

Location on LS1 Server:
\\SSC\dfs\pl_rem\data
\\SSC\dfs\pl_rem\Cfgs
\\SSC\dfs\pl_rem\logs



Ops Concept

- Initial Deploy
  - Anticipate 15 min of crew time
    - Destow (unit will be flown with micro-USB cables attached to unit.
    - Velcro to wall
    - Connect micro-USB cables to laptop
    - Start software
    - Take pictures
- Deploy duration: as long as we can
  - Measuring directional dependence typically requires longer data acquisition times.
    - Nature of telescope inherently limits angular spread in particle tracks that actually pass through both sensors. Result is lower data statistics over a fixed time window and thus requires longer acquisition times.
- Crew Time: No crew time anticipated except during deploy and re-orient
  - **Critical that we know which way the enclosure is oriented.** Would like pictures of deploy and when re-oriented.
  - Have had some discussion regarding potential future deploy inside of the BEAM module.
  - For now expect to stay at a single location for roughly 6 months.
    - Re-orient quarterly
    - Relocate when possible a minimum of three times over life of demo.
- Data Download: all data downloaded daily per REM DTO process (see previous slide)



Advacam Modupix Stack