

Low Energy Electron and Positron Spectra from the 2024 AESOP-Lite Balloon Flight



Paul Evenson

John Clem

Robert Johnson

Brian Lucas

Pierre-Simon

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Scott Martin



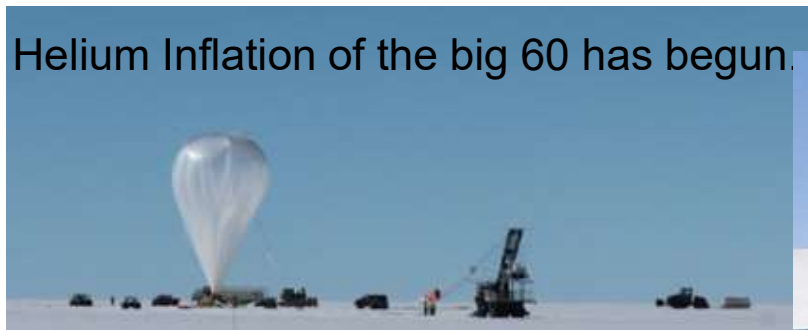
AESOP-lite Anti-Electron Sub-Orbital Payload



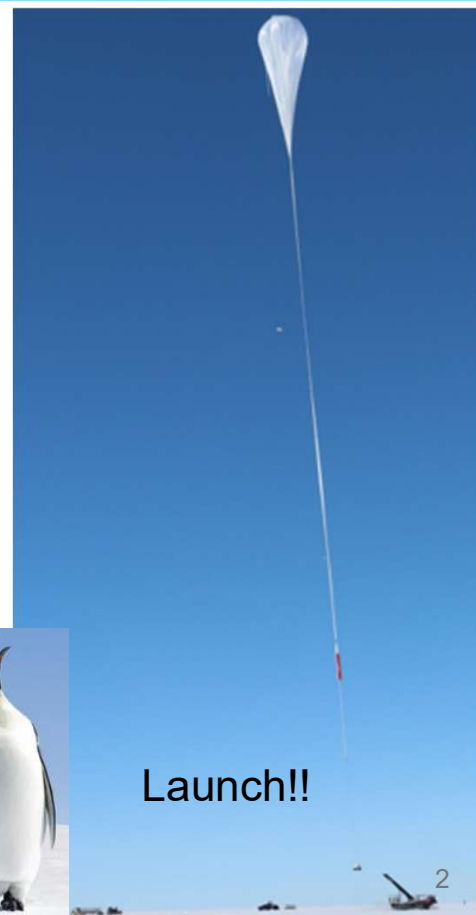
Lucky 7th
launch
attempt.
Weather
looking
very good!



Payload being moved to launch site



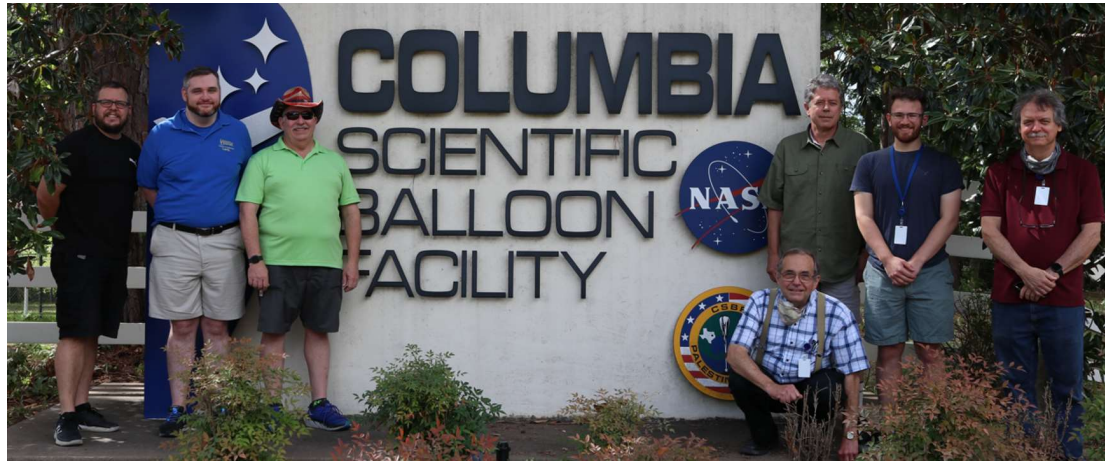
Helium Inflation of the big 60 has begun.



Launch!!



Team AESOP-lite



University of Delaware

John Clem - PI

Paul Evenson – Co I

Brian Lucas - Engineer Graduate Student

James Roth – Senior Technician

Pierre-Simon Mangeard – Research Scientist

Scott Martin – Physics Graduate Student

University of California Santa Cruz

Robert Johnson - Co I

NASA Award 80NSSC19K0746



Primary Science Objectives



Explore the turn-up in the low energy cosmic ray electron spectrum

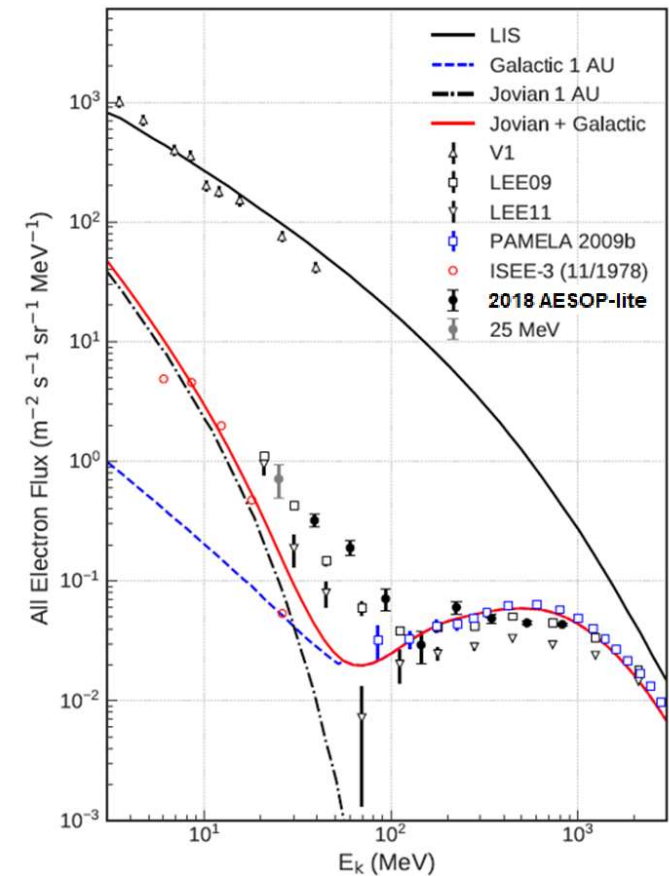
Resolving electrons and positrons is vital to understanding both electron origin and propagation in interplanetary space.

AESOP-lite is capable of charge sign separation at these energies

Voyager Provides the Interstellar Spectrum of Total Electrons

Spacecraft Voyager 1 (08/2012) and Voyager 2 (11/2018) made the historic entry into interstellar space.

AESOP-lite is the only instrument at Earth that provides overlapping electron energies.

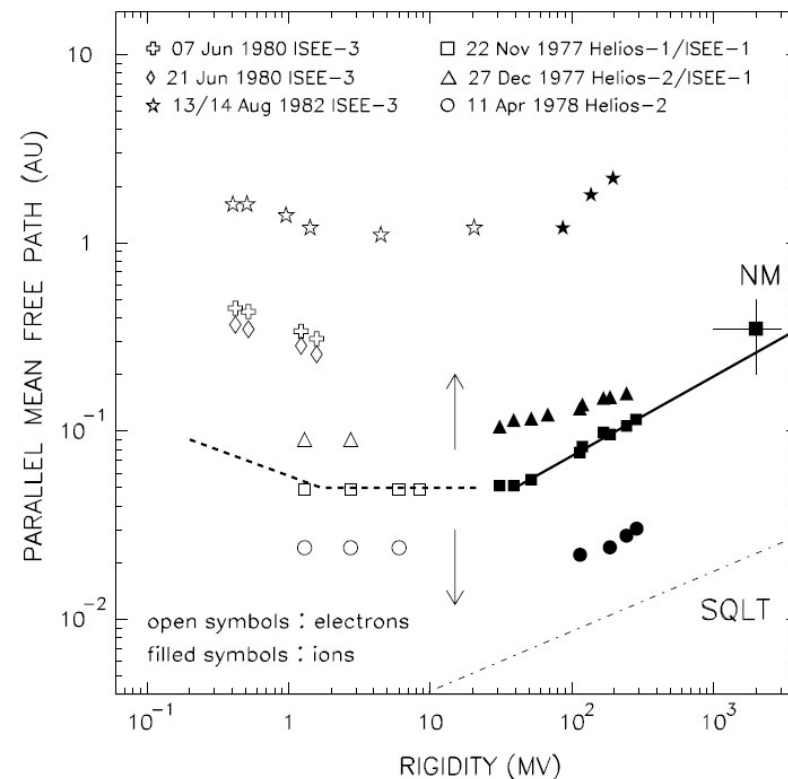




Why Electrons are Unique



- Mean free paths are very long so low energy interstellar particles can be observed at Earth relatively unaffected by adiabatic deceleration
- Positron abundance could be an indicator of injection from radioactive nuclei such as ^{26}Al



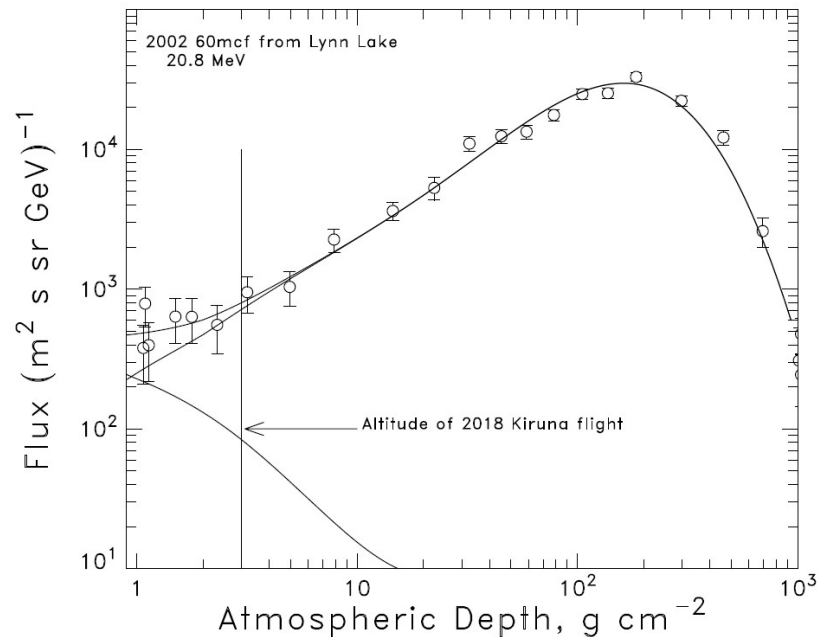
Droege, W., ApJ 537:1073-1079, 2000



Why Altitude Matters



- Cosmic electrons are rare.
- The small flux is rapidly lost in the proton induced background



CNN.com / SPACE

Record-setting balloon skirts edge of space

August 29, 2002 Posted: 9:10 AM EDT (1310 GMT)



NASA research balloon inflated before flight.

Richard Stenger
CNN

(CNN) -- The largest balloon ever successfully launched floated to the fringes of the upper atmosphere this week, loaded with space science equipment to study cosmic rays, NASA said.

The mammoth airship had a volume of 60 million cubic feet (1.7 million cubic meters) and reached a height of 30.5 miles (49 km), according to the space agency.

Made of a thin polyethylene material, about the same thinness as household plastic wrap, it began its flight from Lynn Lake, a small gold mining town in Manitoba, Canada.

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Lynn Lake, a small gold mining town in Manitoba, Canada.



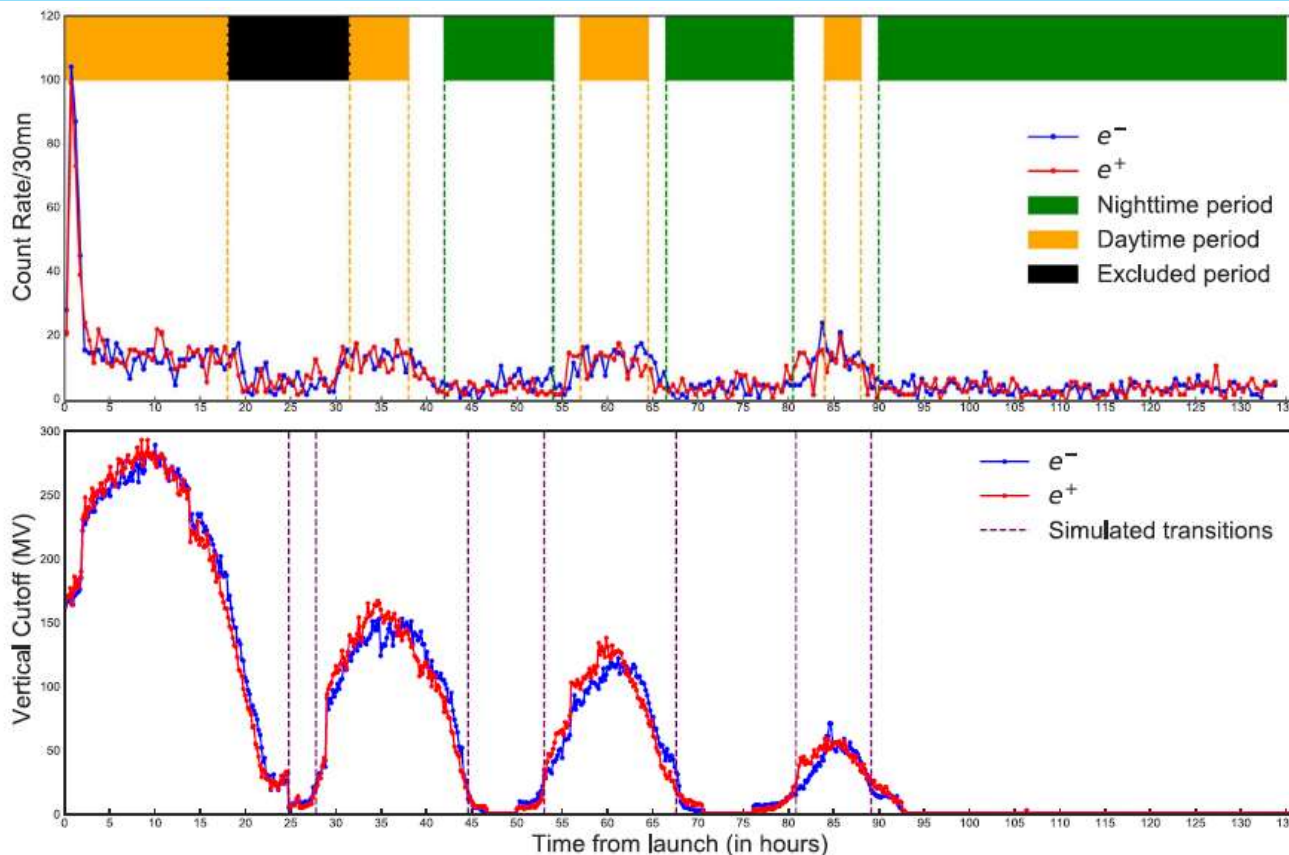
McMurdo Launch Advantage



Geomagnetic cutoff rigidity is zero

The diagram shows the effect of the varying cutoff in the 2018 flight from Sweden

- Top panel: time series of reconstructed electrons and positrons at the lowest momentum bin (20–30 MeV/c).
- Diurnal variations between geomagnetic “day” and “night” are clearly visible.
- Bottom panel: simulated variation of the vertical geomagnetic cutoff.



Mechbal, S. et al., ApJ 903:21 (14pp), 2020



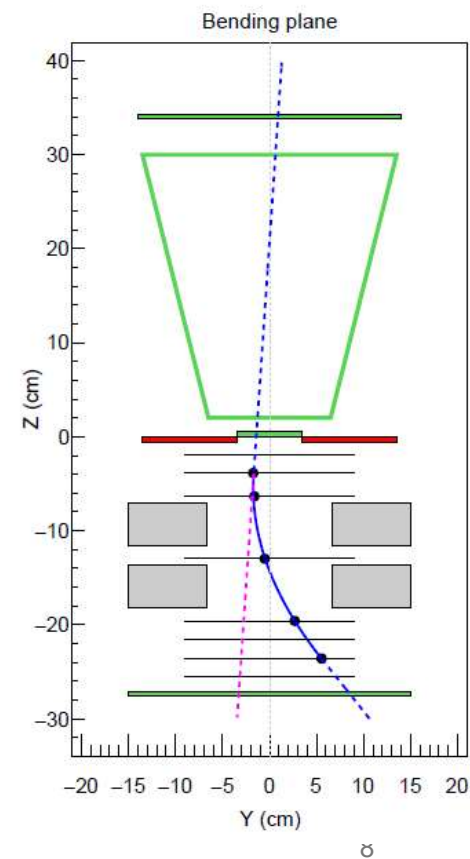
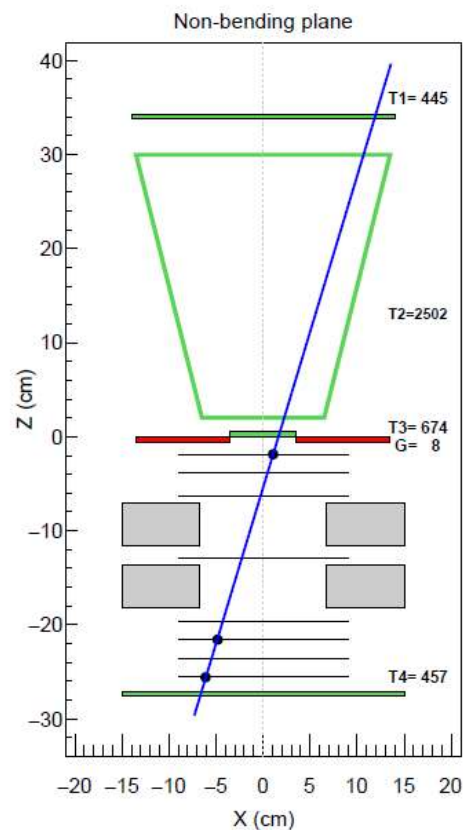
AESOP-lite Magnet Spectrometer



Low-momentum electron candidate recorded during instrument integration at the NASA Long-Duration Balloon site near McMurdo Station, Antarctica:

- Trigger scintillators T1, T3, and T4 fired (green), and no signal was seen in the guard (red). Cerenkov signal was observed in T2 (green).
- Numbers give the amplitude of the signal from photomultipliers.
- Each of the 8 tracker layers has a single hit.

The reconstructed momentum of this event is 23 MeV/c at the entry of the spectrometer.

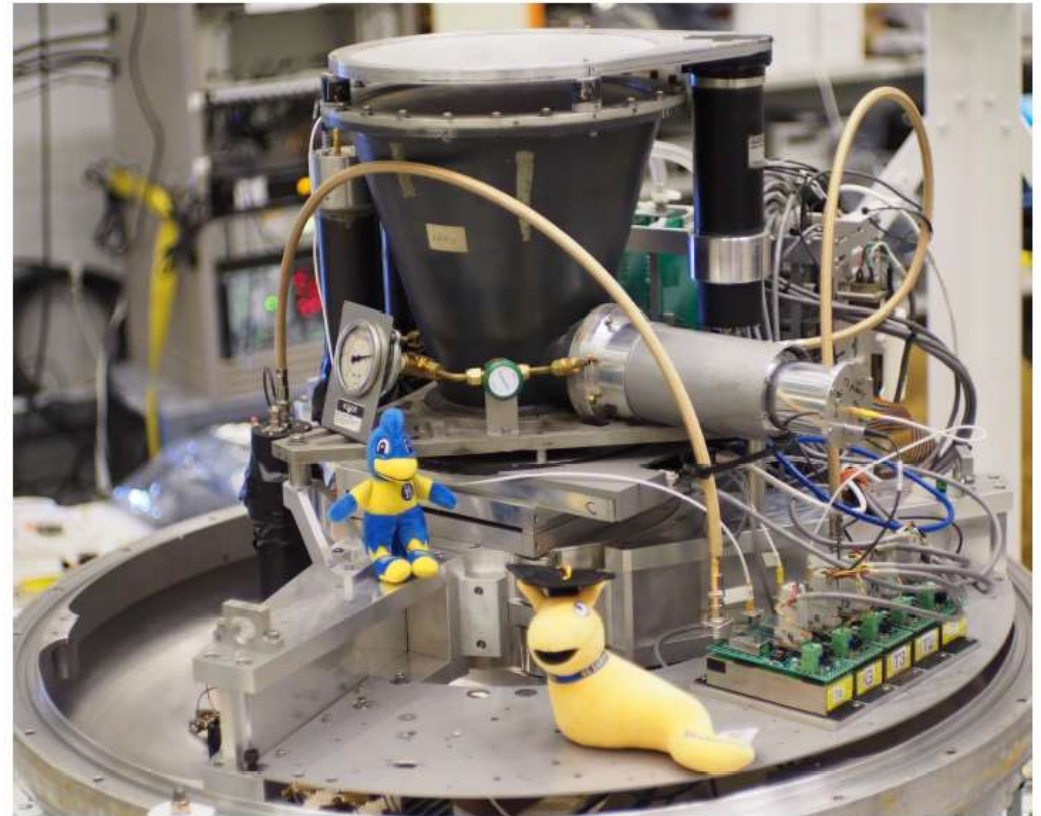




AESOP-lite Construction



Photograph of the AESOP-Lite instrument with the pressure-vessel “shell” removed, taken during payload integration at the NASA Long-Duration Balloon Site near McMurdo Station, Antarctica.

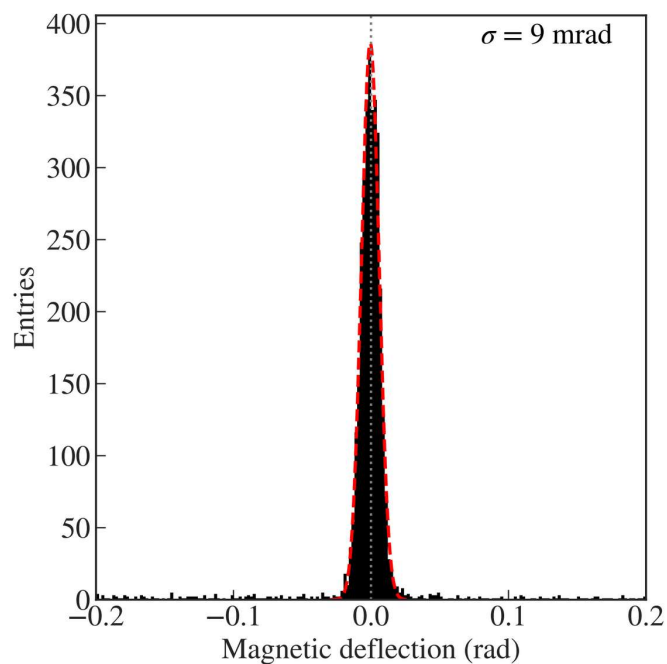




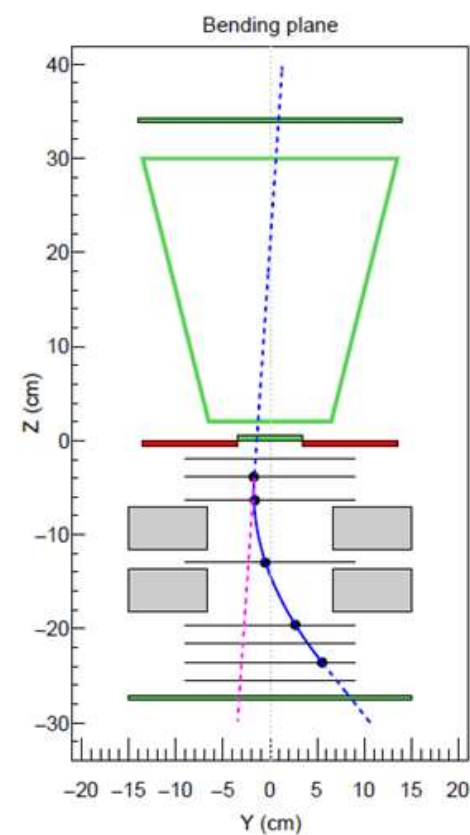
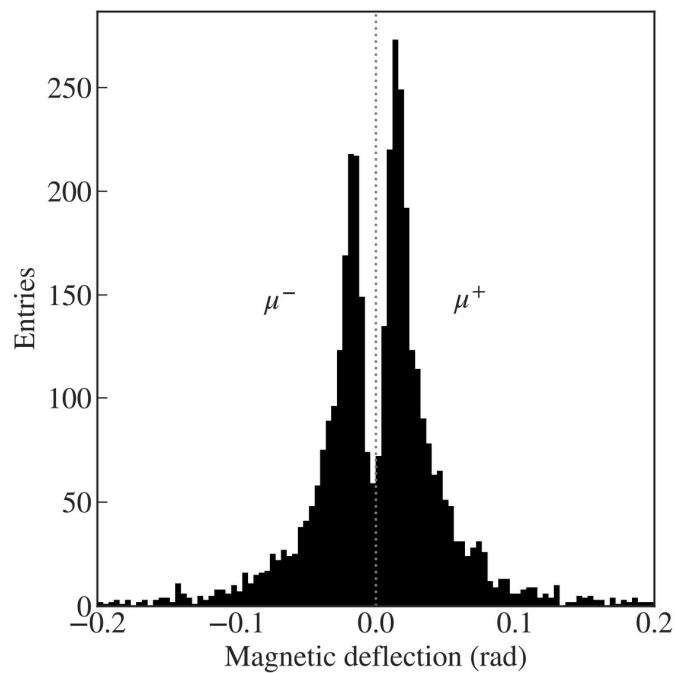
Momentum Resolution



$T_1 + T_2 + T_3 + T_4 - G$
Muons $> 1.5 \text{ GeV}$



$T_1 - T_2 + T_3 + T_4 - G$
Muons $< 1.5 \text{ GeV}$

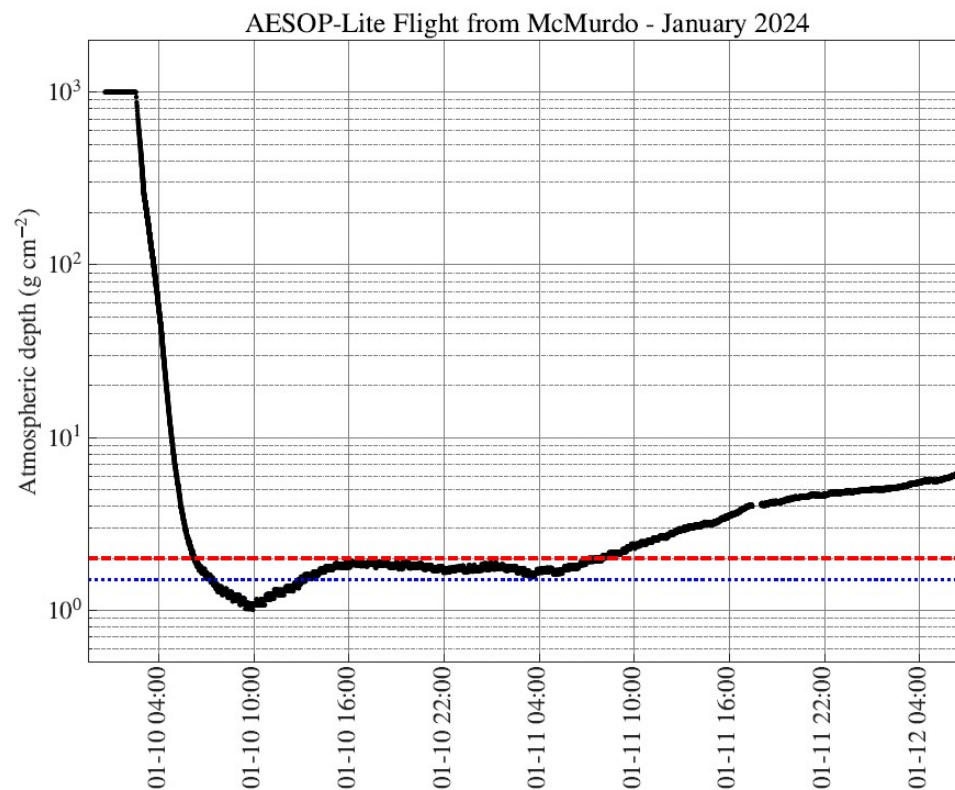




Beautiful Launch – Disappointing Flight

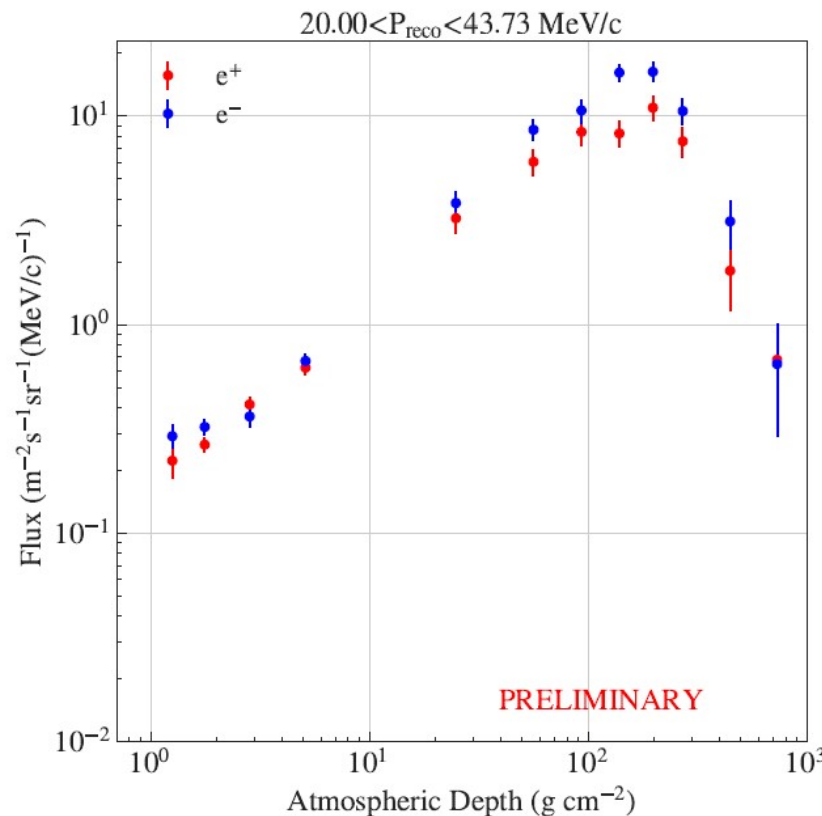
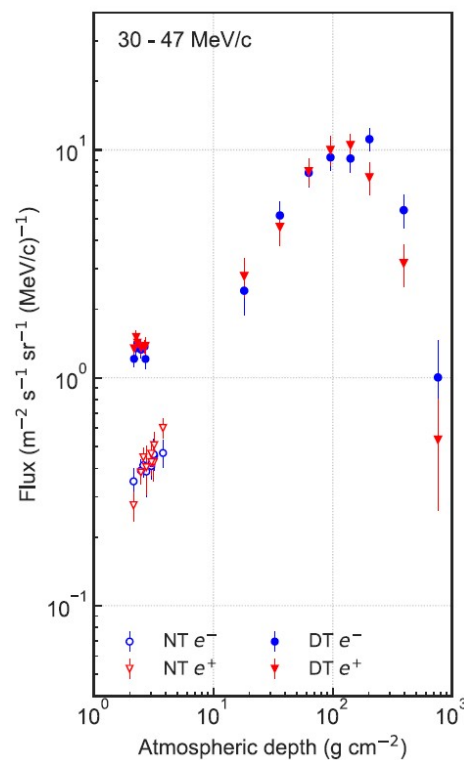


The balloon briefly reached one millibar but did not retain the altitude long enough to get the statistics that we had hoped for.





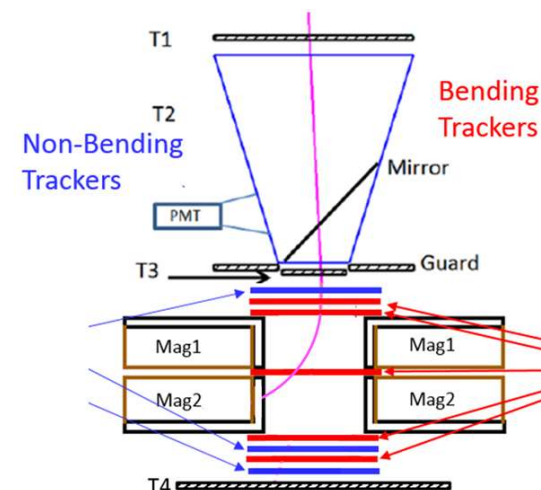
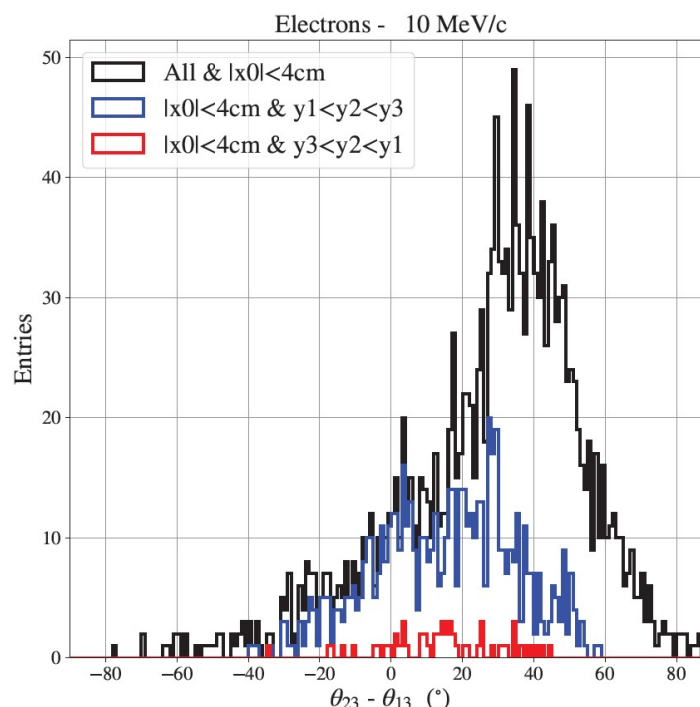
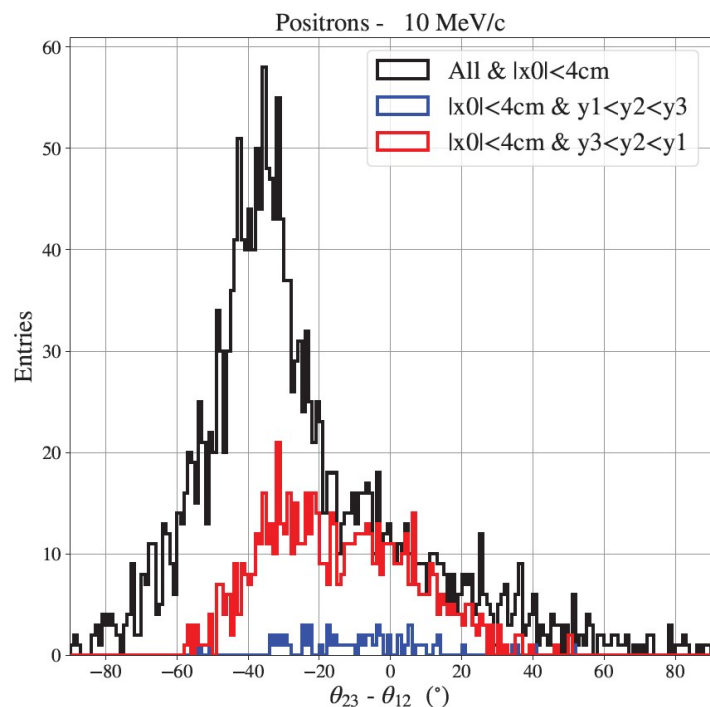
Preliminary Results



- Compared to 2018 there is a hint that we are seeing electrons (but not positrons) in the very low energy regime, in spite of the overall higher level of modulation



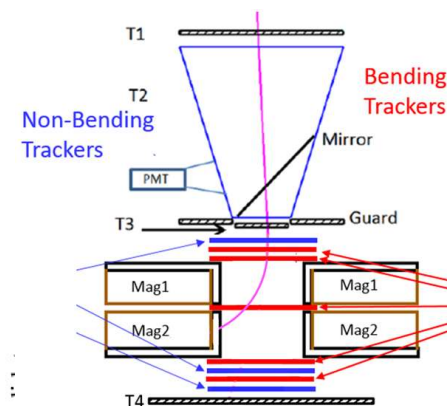
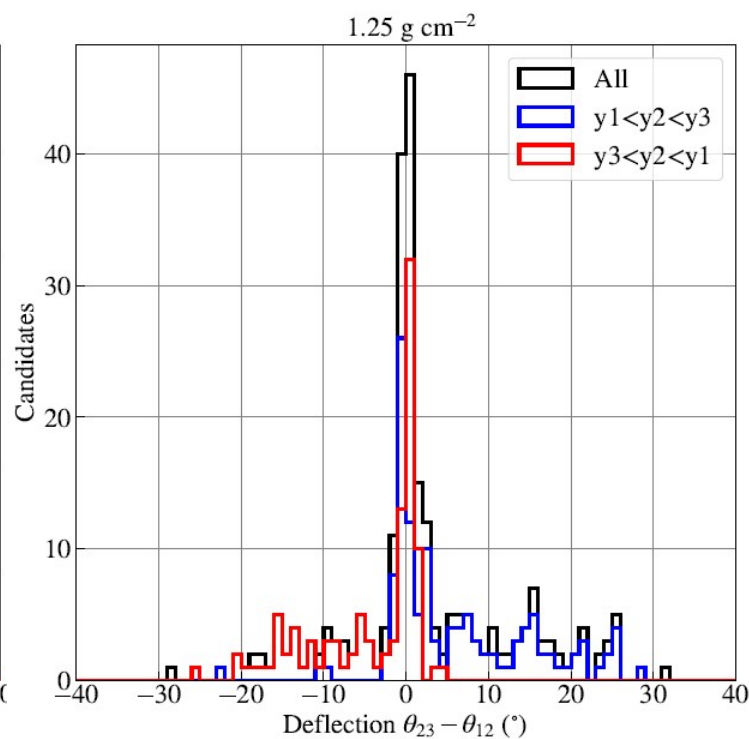
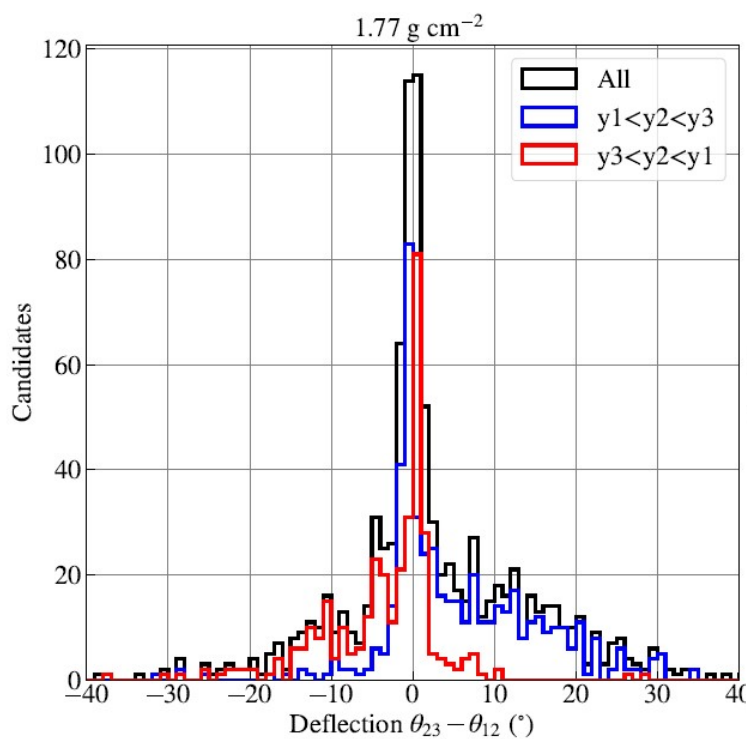
Simulation: Improving Statistics at Low Energy



At 10 MeV, most electrons bend so much that they get only to the middle tracker. We are working on deconvolution approach to estimate the composition and spectrum based on simulations like these.



Preliminary Data for “Stopping” Particles



There appears to be a clear preference for electrons at the higher altitudes.

There is hope....



Thank You

