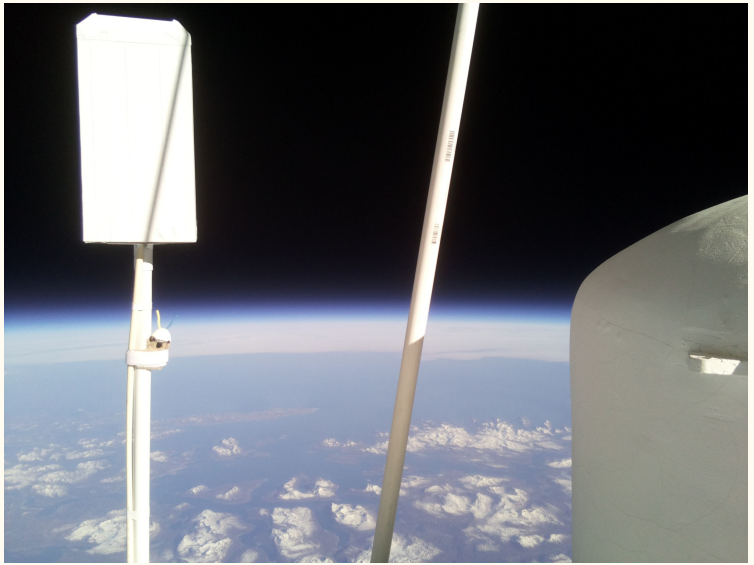
Ground and flight performance of the balloon-borne magnetic spectrometer AESOP-Lite

Pierre-Simon Mangeard
Bartol Research Institute
University of Delaware, Newark, DE, USA
mangeard@udel.edu



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Team AESOP-Lite

Bartol Research Institute
University of Delaware, Newark, DE, USA

John Clem - Principal Investigator
Paul Evenson - Collaborator
Brian Lucas - Engineering Graduate Student
James Roth – Senior Technician
Pierre-Simon Mangeard – Postdoctoral Researcher

Santa Cruz Institute for Particle Physics
University of California, Santa Cruz, CA, USA

Robert Johnson - Collaborator
Sarah Mechbal - Graduate Student

Outline

I- Science Goals

II- The AESOP-Lite Instrument

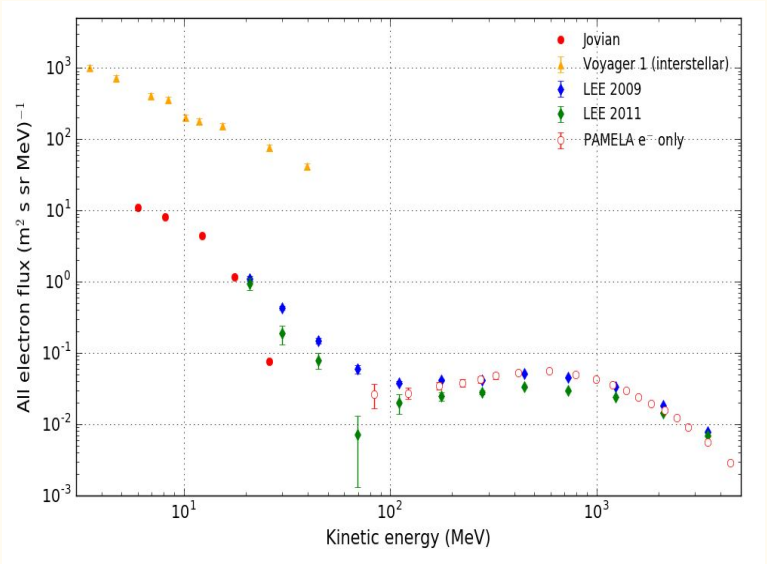
III- Performances

IV- Conclusion

Science Goals (1)

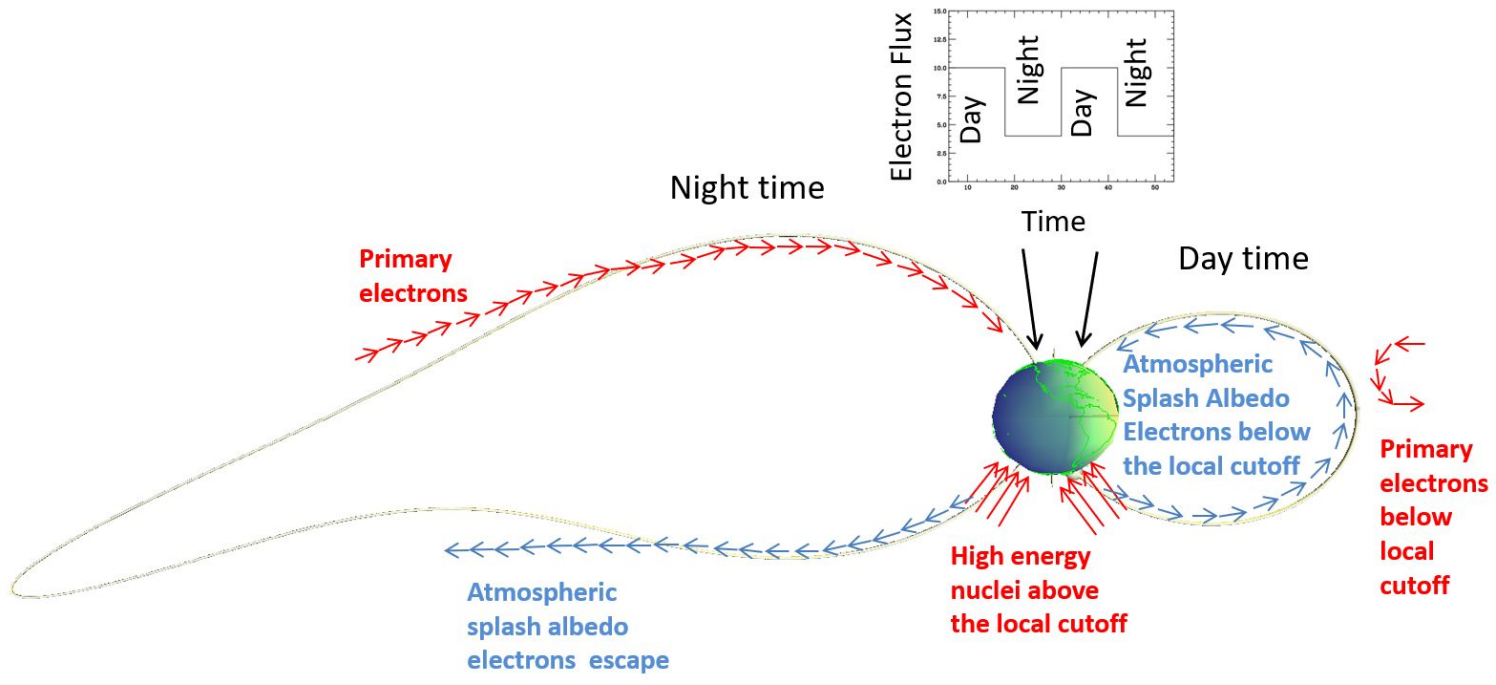
AESOP-Lite: Anti-Electron Sub-Orbital Payload - Low Energy

- Serve as 1AU baseline for Voyager electron measurements
  - Voyager 1 (08/2012) and 2 (11/2018) are now in the interstellar space
  - AESOP-Lite provides measurements in the overlapping electron energies (below 100 MeV)
- Search for the origin of the turn-up in the low energy electron spectrum
  - Resolving the electrons and positrons is vital to understand both electron origin and propagation in the interplanetary space
  - AESOP-Lite is capable of charge sign separation at these energies



Science Goals (2)

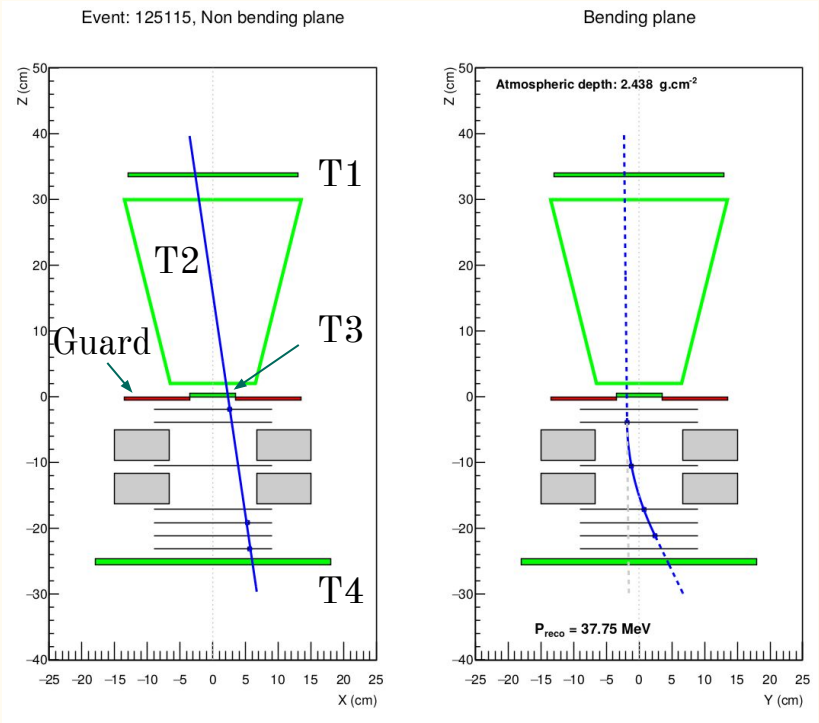
- Measure the time variations of electrons and positrons magnetically trapped in the geomagnetic field



The AESOP-Lite instrument (1)

Main components, some of which are inherited from the LEE telescope:

- 4 scintillators (T1, T3 and T4 + Guard) each connected to a photomultiplier tube (PMT)
- Gas Cherenkov detector for hadron and backwards particle discrimination (C_3F_8)
- Magnetic spectrometer: dual ring dipole magnet (B_{av}=0.3T) + 7 planes of Silicon Strip Detectors (SSD)
- 4 SSD planes in the bending view, 3 in the non-bending view, 20 cm lever arm

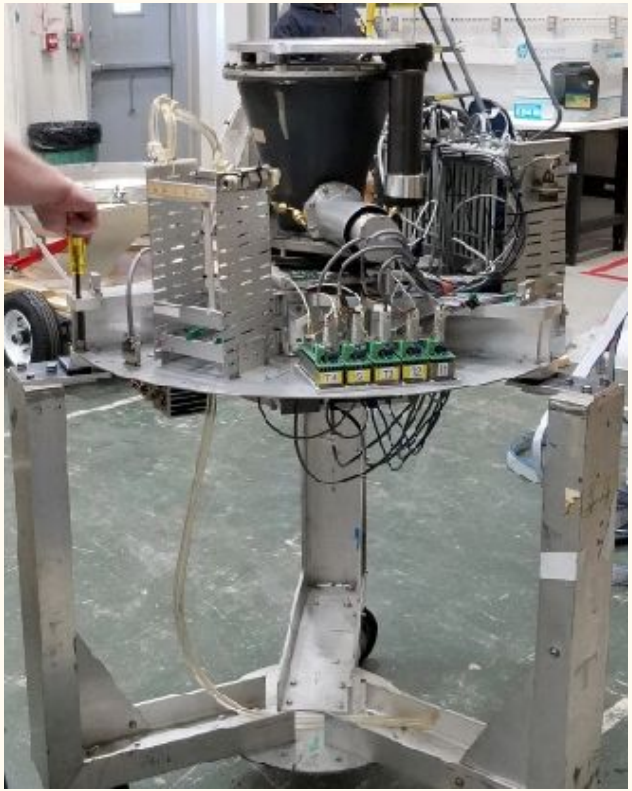


The AESOP-Lite instrument (2)

- Detectors were specially designed for the Fermi/LAT satellite instrument, the “excess ladders” were then used for several particle physics experiments

Thickness	400 μm
Length	18 cm
Strip number	768
Strip pitch	228 μm
$\sigma_{detector}$	66 μm
System Clock	10 MHz

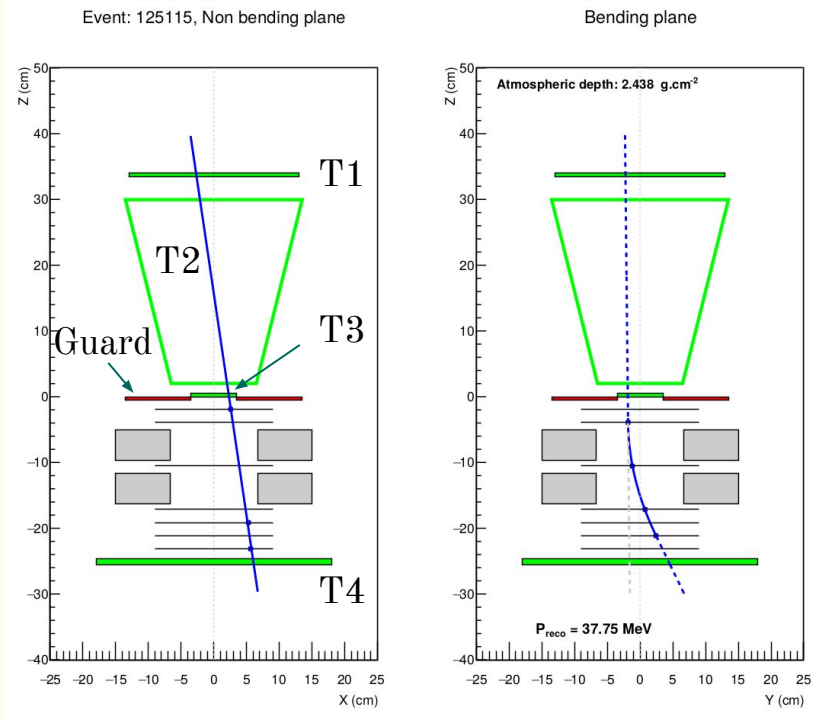
The AESOP-Lite instrument (4)



The payload on the lab stand during the integration phase in Palestine, Texas (Winter 2018)

Performances (1)

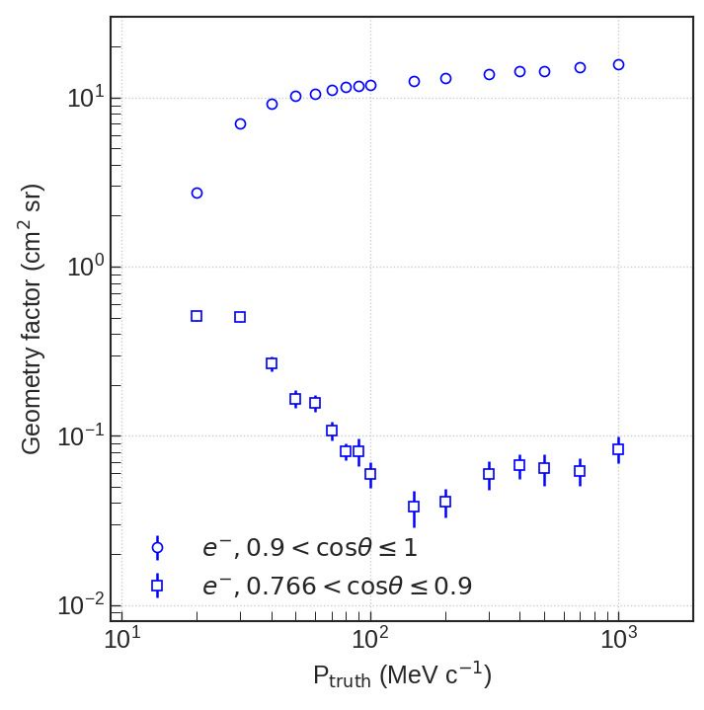
- Monte Carlo simulation (Fluka)
- Trigger requirement:
  - T1&T2&T3
  - The 3 tracker layers hit in the non-bending plane OR the 3 upper tracker layers hit in the bending plane
- Selection:
  - 5 to 12 hits in the tracker
- Preliminary track reconstruction:
  - Straight line in the non-bending plane
  - 2nd order polynomial function in the non-bending plane
  - Hits are selected to minimize the χ^2



Performances (2)

- Monte Carlo simulation (Fluka)
- Trigger requirement:
  - T1&T2&T3
  - The 3 tracker layers hit in the non-bending plane OR the 3 upper tracker layers hit in the bending plane
- Selection:
  - 5 to 12 hits in the tracker
- Preliminary track reconstruction:
  - Straight line in the non-bending plane
  - 2nd order polynomial function in the non-bending plane
  - Hits are selected to minimize the χ^2

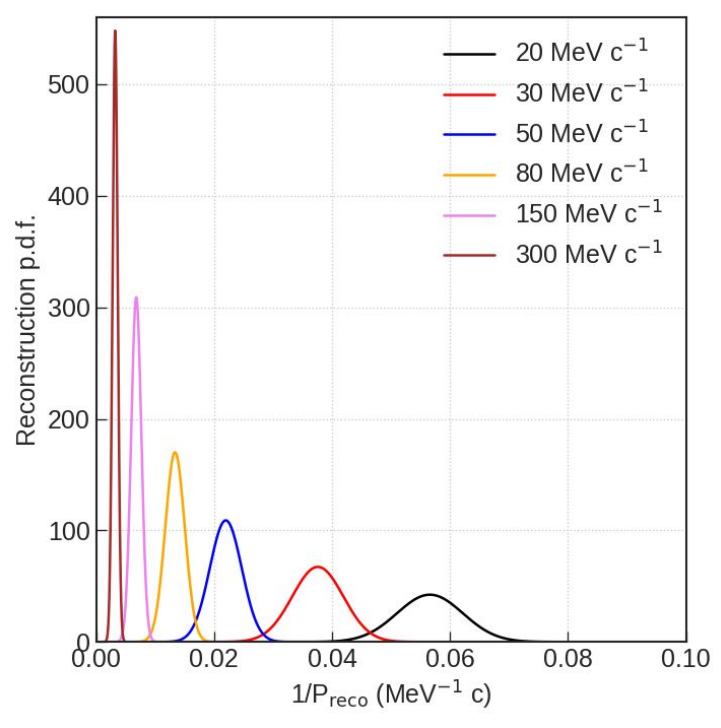
- Incident angle dependence of the geometric factor



Performances (3)

- Monte Carlo simulation (Fluka)
- Trigger requirement:
  - T1&T2&T3
  - The 3 tracker layers hit in the non-bending plane OR the 3 upper tracker layers hit in the bending plane
- Selection:
  - 5 to 12 hits in the tracker
- Preliminary track reconstruction:
  - Straight line in the non-bending plane
  - 2nd order polynomial function in the non-bending plane
  - Hits are selected to minimize the χ^2

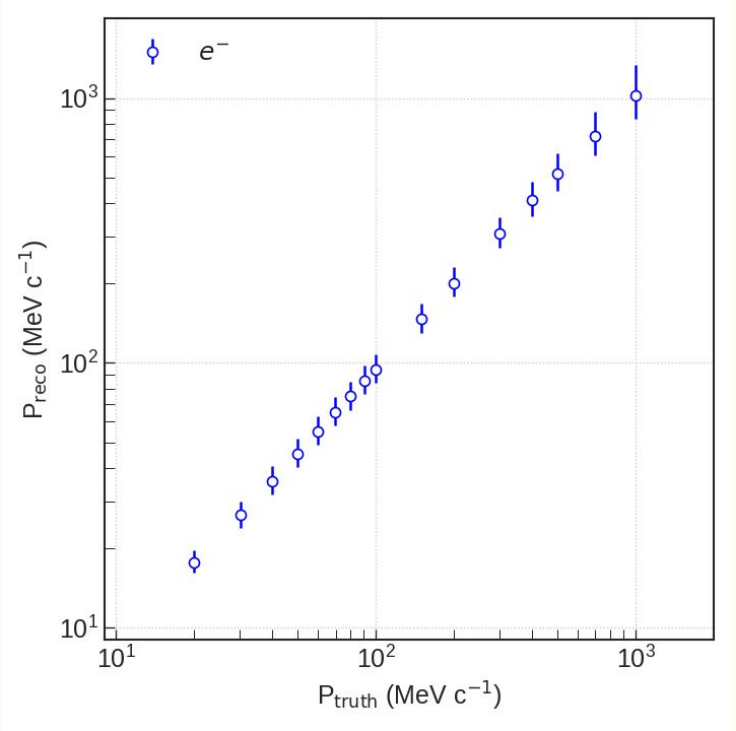
- Resolution of ~11.5% to 13.5% on the inverse momentum



Performances (4)

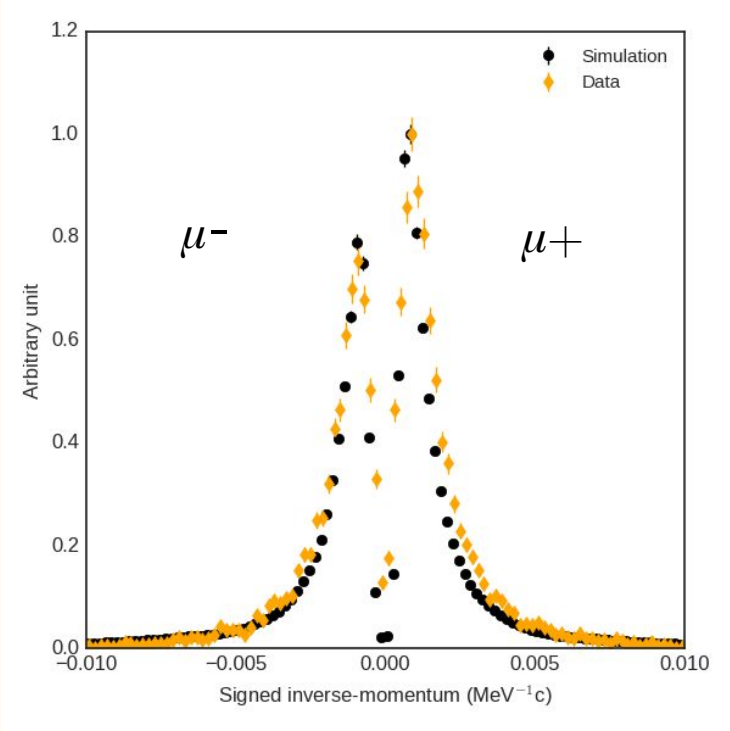
- Monte Carlo simulation (Fluka)
- Trigger requirement:
  - T1&T2&T3
  - The 3 tracker layers hit in the non-bending plane OR the 3 upper tracker layers hit in the bending plane
- Selection:
  - 5 to 12 hits in the tracker
- Preliminary track reconstruction:
  - Straight line in the non-bending plane
  - 2nd order polynomial function in the non-bending plane
  - Hits are selected to minimize the χ^2

- Resolution of ~11.5% to 13.5% on the inverse momentum
- Loss of energy in the detector above the spectrometer is taken into account (~4 MeV)



Performances (5)

- Ground runs at Esrange, Sweden, April-May 2018
- Trigger selection:
  - Online: T1 & T4
  - Offline: T1 & T3 & T4 & NoGuard
  - Offline: Anti-coincidence with T2
- No Cherenkov signal in T2:
  - Select muons below ~1.6 GeV
  - Electron and positron won't pass the spectrometer (<8MeV)
- Good test to check the charge separation of the spectrometer
- Peak-to-Peak ratio: $\mu+/\mu- = 1.33(7)$



Conclusion

- AESOP-Lite is a new instrument designed to measure positrons and electrons between 20 and 300 MeV
- Preliminary energy resolution: ~13%. We still need to improve the track reconstruction
- Charge separation ability was checked at much higher energy with atmospheric muons measured at ground level

- AESOP-Lite had a successful inaugural flight in May 2018 with a live time of 99%

- We working on an upgrade of the data acquisition system

- Preliminary results: Sarah Mechbal PoS(ICRC2019)1119

THANK YOU

The AESOP-Lite instrument (3)

- Use 8 ring dipole permanent magnets
- Average field of 0.3T at the center of the magnet
- One plane of SSD is inserted in the center