Measurement of the low energy electron and positron spectra with the AESOP-Lite balloon mission

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Outline

I- Primary science goals

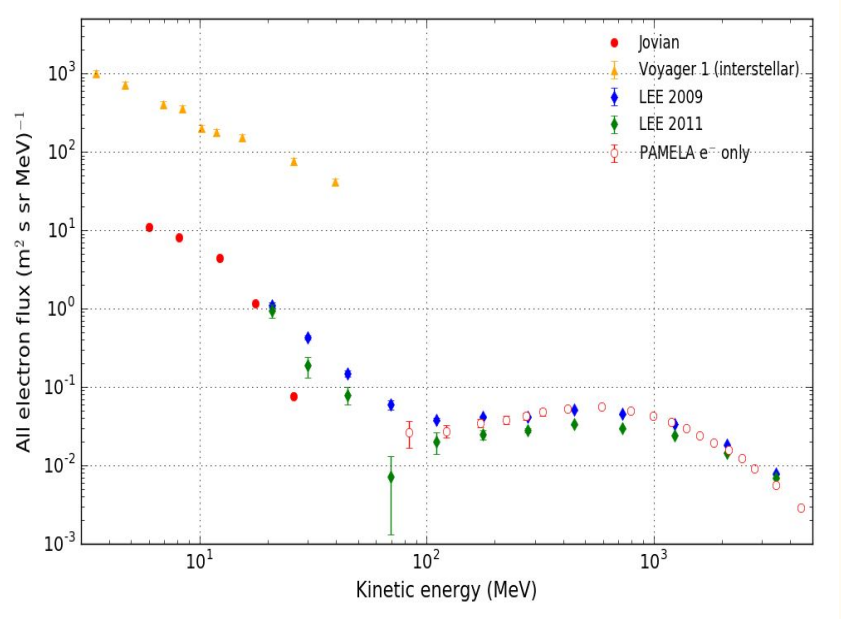
II- The 2018 balloon mission

III- Analysis method

IV- Electron spectrum

Primary Science Goals

- 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

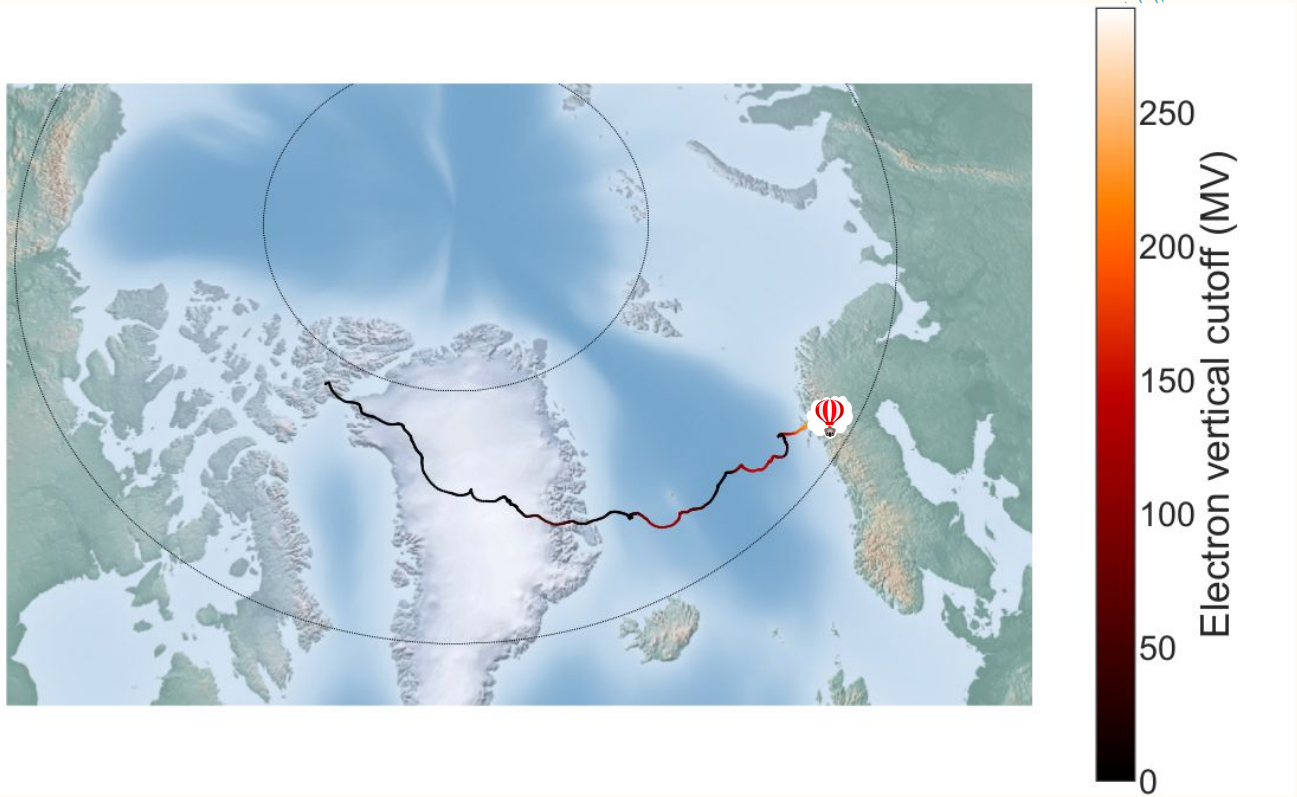


AESOP-Lite payload

- Instrument inside a pressure vessel made of a foam inside an insulated aluminium shell
- Science weight ~629.3 lbs (285 kg), total gondola weight with ballast 938.5 lbs (425 kg)
- Telemetry to monitor instrument during flight and receive data live: line-of-sight, low-rate Iridium, high-rate Iridium
- Two external black box recorders, one internal memory card

Flight Trajectory

May 15th 2018-
Launch from Esrange, Sweden (67°89'N) on 40 MCF, Zero Pressure, Long Duration balloon, for a 133 hours flight, at an altitude of ~135 kft (41 km), landed on Ellesmere Island, Canada (78°40'N)



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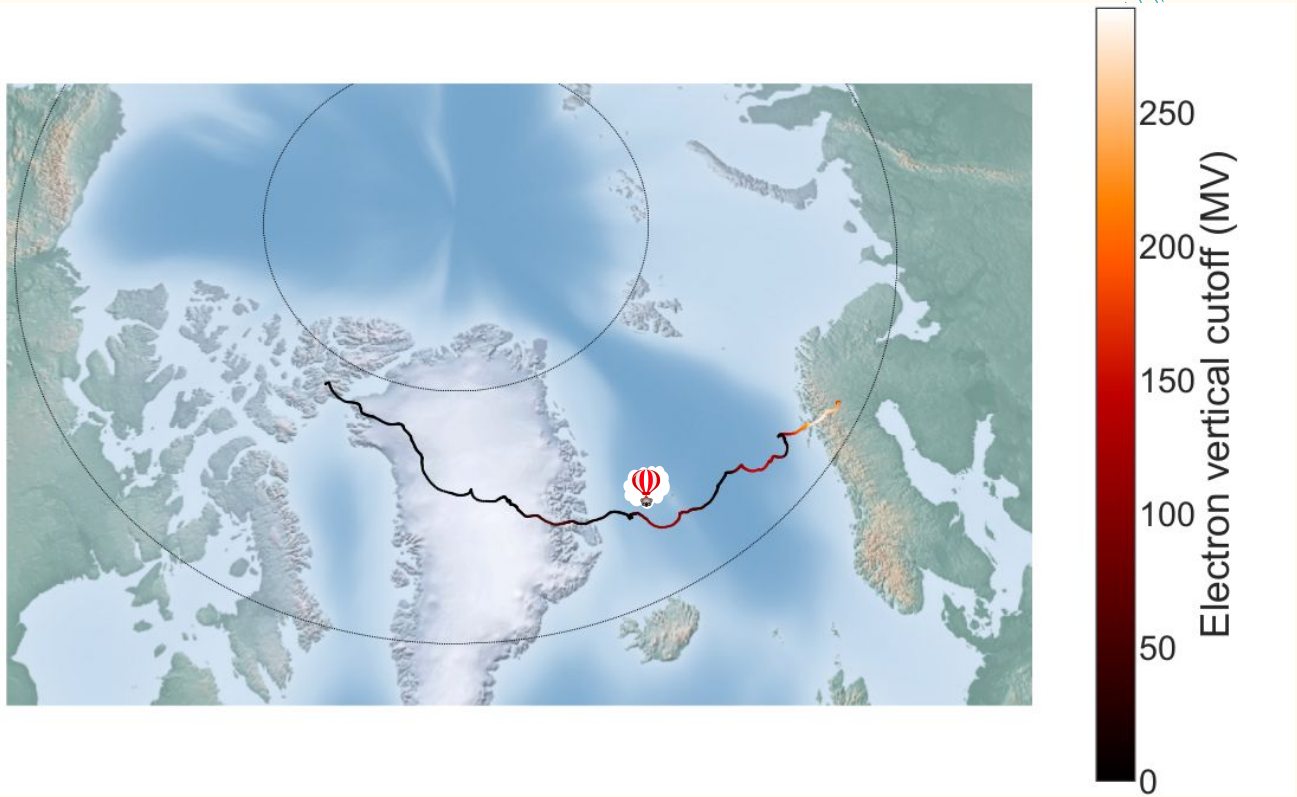

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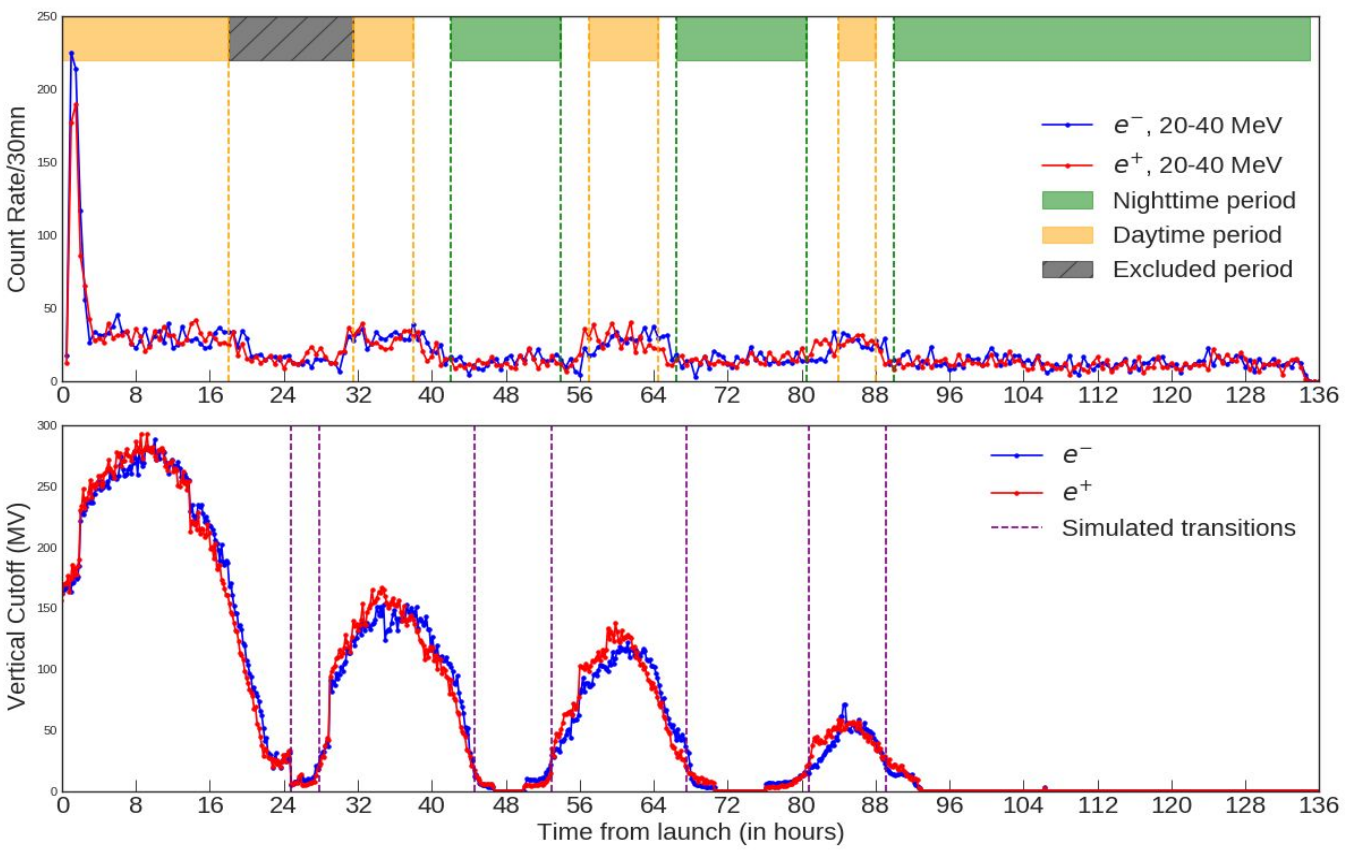
Geomagnetic Variations

Top Panel: The diurnal variations between geomagnetic day and night are clearly visible. The rate of particles rises during geomagnetic day, when secondary albedo particles, produced in the interaction of primary cosmic rays with atmospheric nuclei, are trapped and travel along the geomagnetic field lines.

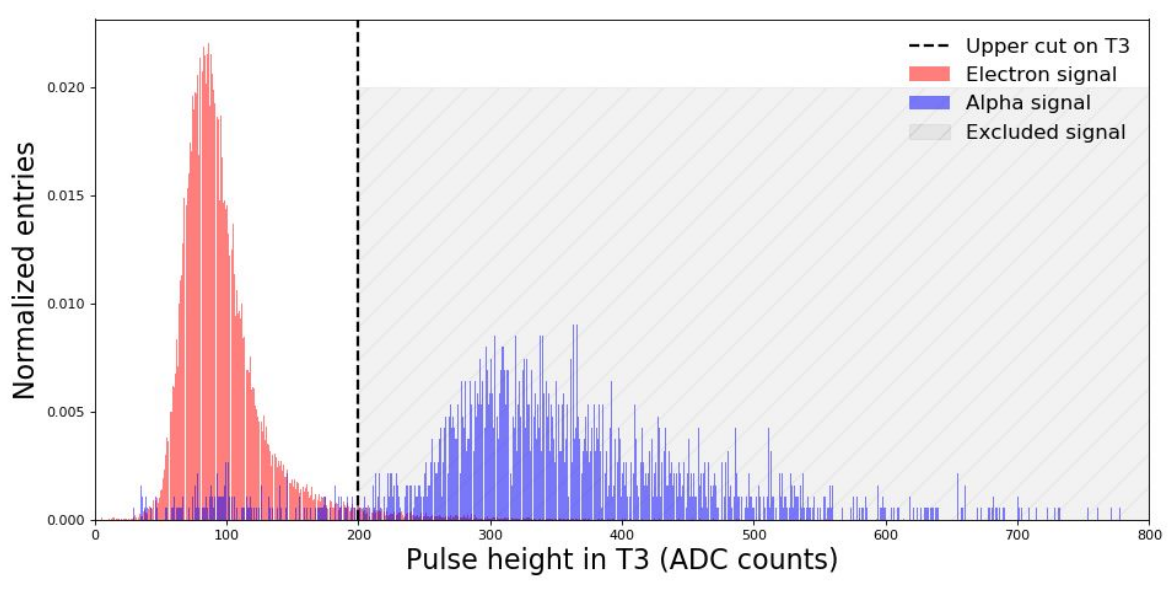
Bottom Panel: Simulated variation of the vertical geomagnetic cutoff



Particle Identification

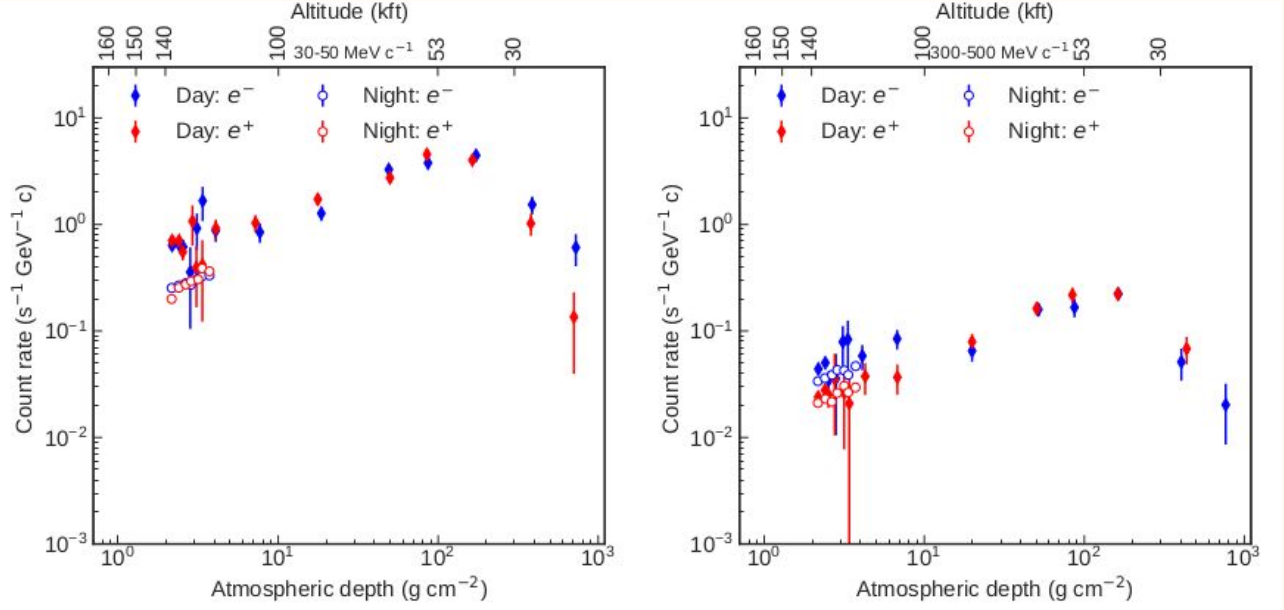
Selection criteria:

- Geomagnetic night only
- T1&T2&T3, no hit in the guard
- Tracker trigger is an OR of bending and non-bending views
- 5 to 12 hits in the trackers
- Cut on Cherenkov detector (T2) eliminate scintillating low energy protons
- Cut on T3 to eliminate Z=2 particles



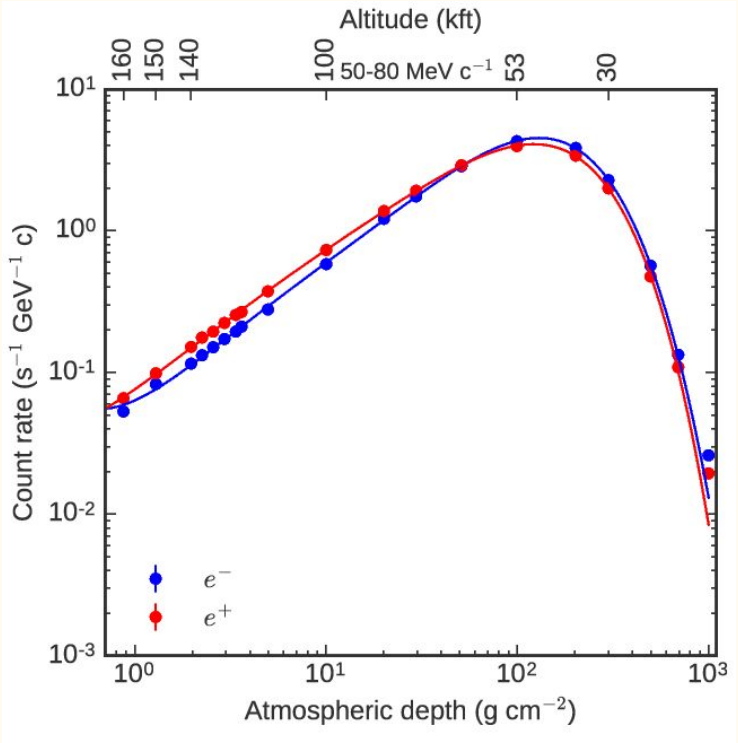
The data

- Separate geomagnetic daytime/nighttime data sets
- For 7 energy bins, produce a profile of the count rate as a function of atmospheric depth: a **growth curve**
- Major challenge of the analysis: extracting the background secondary production of electrons and positrons in the spallation of Galactic Cosmic Rays (GCR) and nuclei in the residual atmosphere



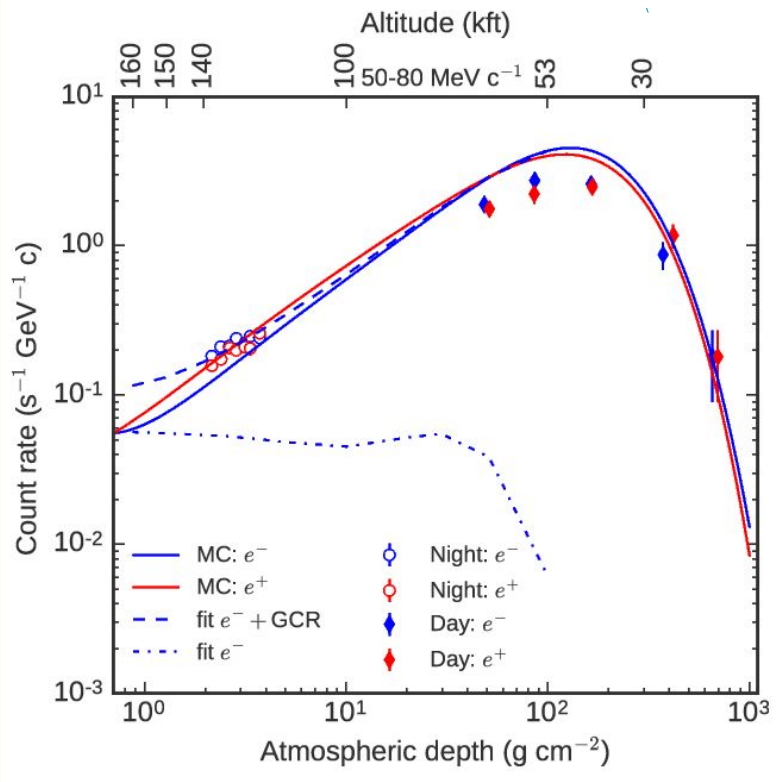
MC simulation

- Run MC simulations of air shower development induced by H and He (with FLUKA)
- Secondary particles fluxes are extracted to make growth curves of the background contribution
- Flux at TOA local IS from Ghelfi et A&A, 2016 + solar modulation parameter (ϕ =300 MV)
- Take into account the instrument's overall response: see talk by Pierre-Simon Mangeard PoS(ICRC2019)1116



How do we get a spectrum?

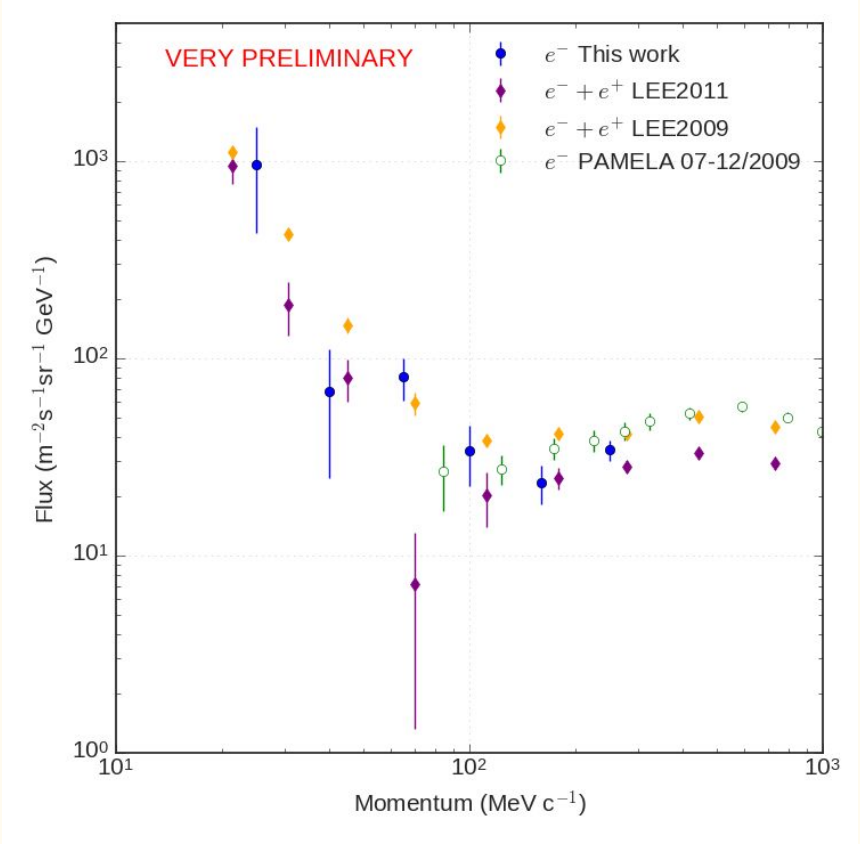
- Agreement between MC and ascent data of the order of ~35%
- Normalize MC growth curve to ascent points (where contribution is all secondary)? Take MC as absolute?
- There are systematic uncertainties arising from using a single MC software package. The disagreement of MC to data at Pfotzer maximum leads to uncertainty at float altitude
- Predicts a positron background on the order of the signal



Preliminary electron spectrum

- Very early results indicate that the negative slope below 100 MeV remains during the period of positive solar polarity

- The spectrum is similar to previous measurements at the same overall modulation level (2009)



Conclusions

- More work is needed on background secondaries to understand systematic and extract positron spectrum
- Our science is very dependent on reaching the highest possible altitude
- AESOP-Lite was accepted for a second balloon flight, hopefully on a 60 mcf from Antarctica in ~2021

Thank you