### AESOP-lite Kickoff Meeting

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00</td>
<td>Fermi, PCT and Strip detectors – Robert</td>
<td>Robert</td>
</tr>
<tr>
<td>12:00</td>
<td>AESOP-lite Electronics – Paul</td>
<td>Paul</td>
</tr>
<tr>
<td>1:00</td>
<td>Working Lunch ?? Delivery from Claymont Steak Shop</td>
<td></td>
</tr>
<tr>
<td>2:00</td>
<td>PMT magnetic shielding - Yang</td>
<td>Yang</td>
</tr>
<tr>
<td>2:30</td>
<td>Magnet Modelling – Heeju - Electron Energy (call in)</td>
<td>Heeju</td>
</tr>
<tr>
<td>3:00</td>
<td>Spectrometer simulations - John</td>
<td>John</td>
</tr>
<tr>
<td>3:30</td>
<td>Instrument Frame and Gondola – James</td>
<td>James</td>
</tr>
<tr>
<td>4:00</td>
<td>Plans – All</td>
<td></td>
</tr>
<tr>
<td>5:00</td>
<td>Tour of the lab</td>
<td></td>
</tr>
<tr>
<td>6:30</td>
<td>Dinner at Iron Hill</td>
<td></td>
</tr>
</tbody>
</table>
Proposal has been selected for funding and
As of yesterday the funds have arrived!

So we now have to build the payload..
In 1960 Peter Meyer and Rochus Vogt discovered electrons in cosmic rays from balloon flights out of Churchill, Manitoba.

A few years later, Meyer and Roger Hildebrand discovered cosmic ray positrons.

Only about 1% of the primary cosmic rays that enter the earth's atmosphere are electrons, while positrons are even less abundance. CR is represented by a nucleonic dominated flux with protons representing ~90% and Helium 9%.

In the early 1970s, modulation theory was established that describes the variation of cosmic ray flux as a function of solar cycle. The time dependence was quantified based on the diffusion process through the turbulent solar wind.
A neutron monitor is a ground-based detector designed to continuously measure the number of high-energy charged particles striking the Earth's atmosphere.

Analysis of long term data from NMs led to a more accurate description explaining these intensity variations.

Figure displays Climax and Haleakala monitor counts and sun spot numbers as a function of time. As solar activity rises (bottom panel), the count rate recorded by a neutron monitor in Climax and Haleakala decreases (top panel).
Balloon and space measurements of proton and He ion spectra
Curves are global fit - all experiments, times, p and He

Thule Monitor count rates with times marked for above observations.
Same color code is used.

Fokker-Plank equation for the spherically symmetric model of the interplanetary medium, including only diffusion, convection and adiabatic acceleration

\[
\frac{1}{r^2} \frac{\partial}{\partial r} \left( r^2 \kappa \frac{\partial U}{\partial r} \right) - \frac{1}{r^2} \frac{\partial}{\partial r} \left( r^2 V U \right) + \frac{1}{3} \left( \frac{1}{r^2} \frac{\partial}{\partial r} \left( r^2 V \right) \right) \left( \frac{\partial}{\partial T} (\alpha TU) \right) = 0
\]

where \( U(r, T, t) \) is the cosmic-ray number density per unit interval with kinetic energy \( T \) per nucleon, \( \alpha = (T + 2 \cdot T_r)/(T + T_r) \), and \( T_r \) is proton’s rest energy.
Being that electrons constituted only 1% of primary cosmic radiation, it was not identified until 1961.

And initially it appeared that modulation of electrons could be described by the same formalism as that for protons but this simple picture failed in the years 1973 and 1974.

Evenson et al. (1983) collected all available data for the years 1965-1979 and attempted to find a set of diffusion coefficients which would simultaneously reproduce modulation of the negative and positive particles.

This study confirmed the conclusion that the observed variation of nuclei and electrons was indeed larger than could readily be explained by a charge-sign independent model. Became known as the “Modulation Reluctance”
This plot illustrates how the response of electrons and nuclei to changing conditions in interplanetary space is qualitatively similar but quantitatively different.

For both species fluxes are low when the sun is active and high when the sun is inactive, however particles with opposite sign to the polarity state reveal a narrower time profile than those with like charge-sign.

The electron profile in the 1990s seems to be broader than the helium spike profile observed in the 1980s possibly due to positron component in the electron observations.
the solar magnetic field changes its polarity which occurs every 11 years during solar maximum.

Although the Sun has a complex magnetic field, the dipole term nearly always dominates the magnetic field of the solar wind. The projection of this dipole on the solar rotation axis (A) can be either positive, which we refer to as the A+ state, or negative, which we refer to as the A- state.

At each sunspot maximum, the dipole reverses direction, leading to alternating magnetic polarity in successive solar cycles.
Revisions understanding of the large scale structure of the interplanetary magnetic field led to an examination of the role played by gradient and curvature drifts in the overall process of modulation (Jokipii and Levy 1977; Lee and Fisk 1981).

These drifts are in opposite directions for positive and negative particles and reverse direction when the solar magnetic field changes its polarity which occurs every 11 years during solar maximum.

The combination of the outward flowing solar wind and the solar rotation produces the spiral geometry of solar magnetic field lines as shown above. A+ symbol represents the case when the dipole axis projection rotation axis is positive and A- the projection is negative.
But there is a problem

Although the addition of drifts in modulation theory has provided charge-sign dependent component yielding unified diffusion coefficients for both nuclei and electrons with energies greater than 300 MeV, yet it can not predict the observed negative slope of low energy electron spectrum 20–200 MeV.

Based on solar electron observation it is expected the electron diffusion at low energies have much longer mean free paths than predicted. However incorporating this effect, the magnitude is still not enough to explain our observations.

![Graph showing electron flux vs energy](image)

Estimate of the interstellar electron spectrum based on recent Voyager data (Potgeiter et al. 2013) compared with Pamela and LEE observations during 2009 (Evenson and Clem 2011) as well as 2011 LEE flight for comparison.
The goal of AESOP-lite is to explore the source of the negative spectral index of low energy cosmic ray electrons (20-100MeV).

1) Measure electrons in the energy range of 20MeV to 300MeV with a new instrument, AESOP-lite. This data will be compared with Voyager electron observations from interstellar space. Voyager I and II are currently returning electron spectra roughly within this energy range (<160MeV).

2) Simultaneously measure the positron fraction in the electron flux within this low energy regime using the same instrument. Positron abundances in this energy range should be highly diagnostic of the particle origin.
AESOPLite will include the actual entry telescope and Gas Cherenkov detector from LEE, seven planes of silicon strip detectors of the design flown in FERMI, and dual-ring permanent magnets of the design flown in the AESOP payload.