# Solar Particle Update

LANL
11 July 2003

1. 6 November 1997 Particle Event paper in print Astrophysical Journal (2003), Falcone et al.
2. Background corrections coming under control.
3. Other work (non-Milagro) being done on 15 April 2001 event. Plenty already done on 14 July 2000 event.
4. Losing undergraduate helper, but getting another (both talented).
5. Need assistance in accessing other data and initiating simulations for Milagro.

# Falcone et al. (2003)

- For those who missed it, the refereeing process went smoothly.
- Reprints in hand.
- Ap.J., **588**, May 1, 2003

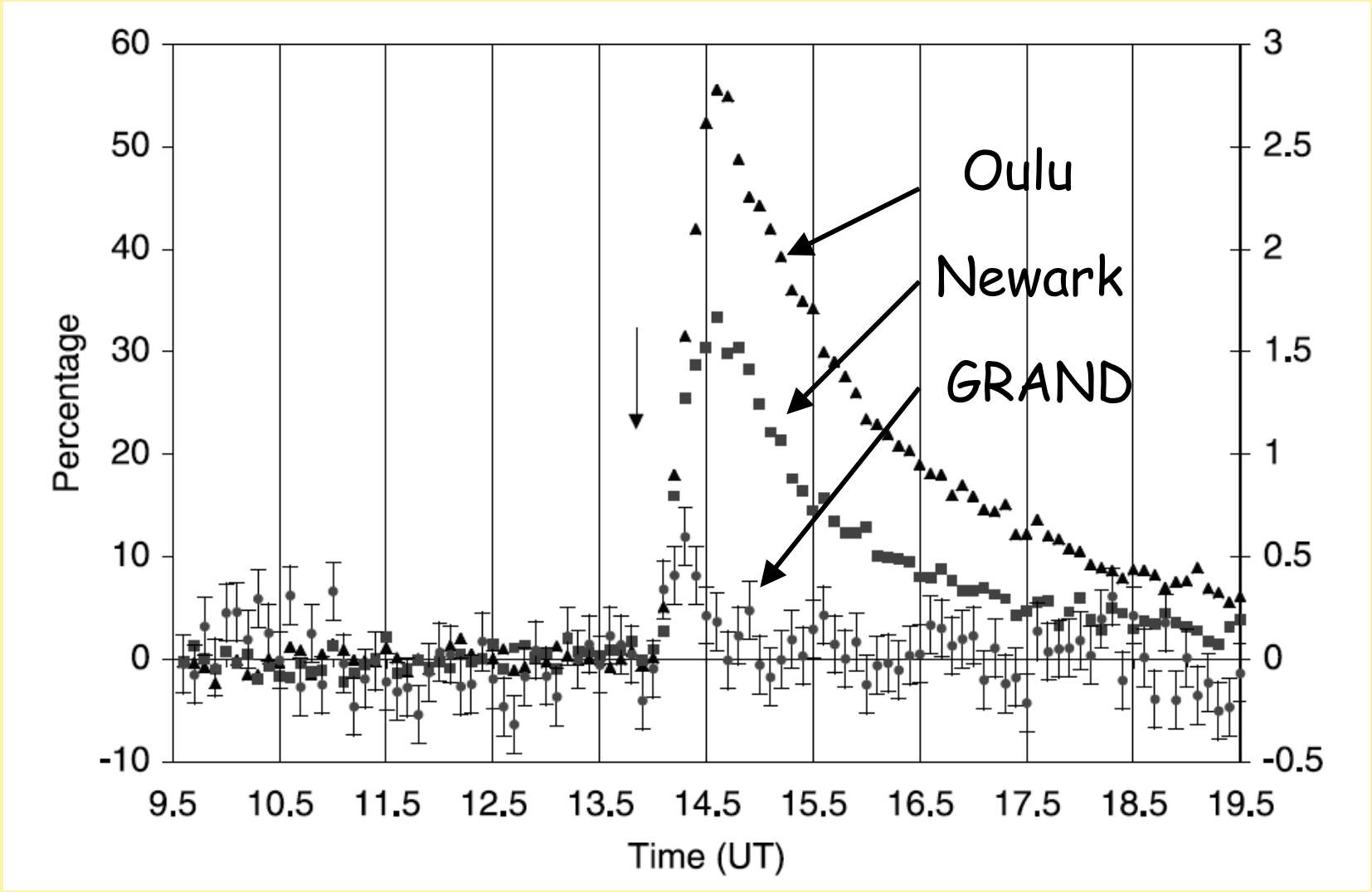
# Background Corrections

- Techniques appear promising to provide more than adequate smoothing of background necessary for small event detection and analysis.

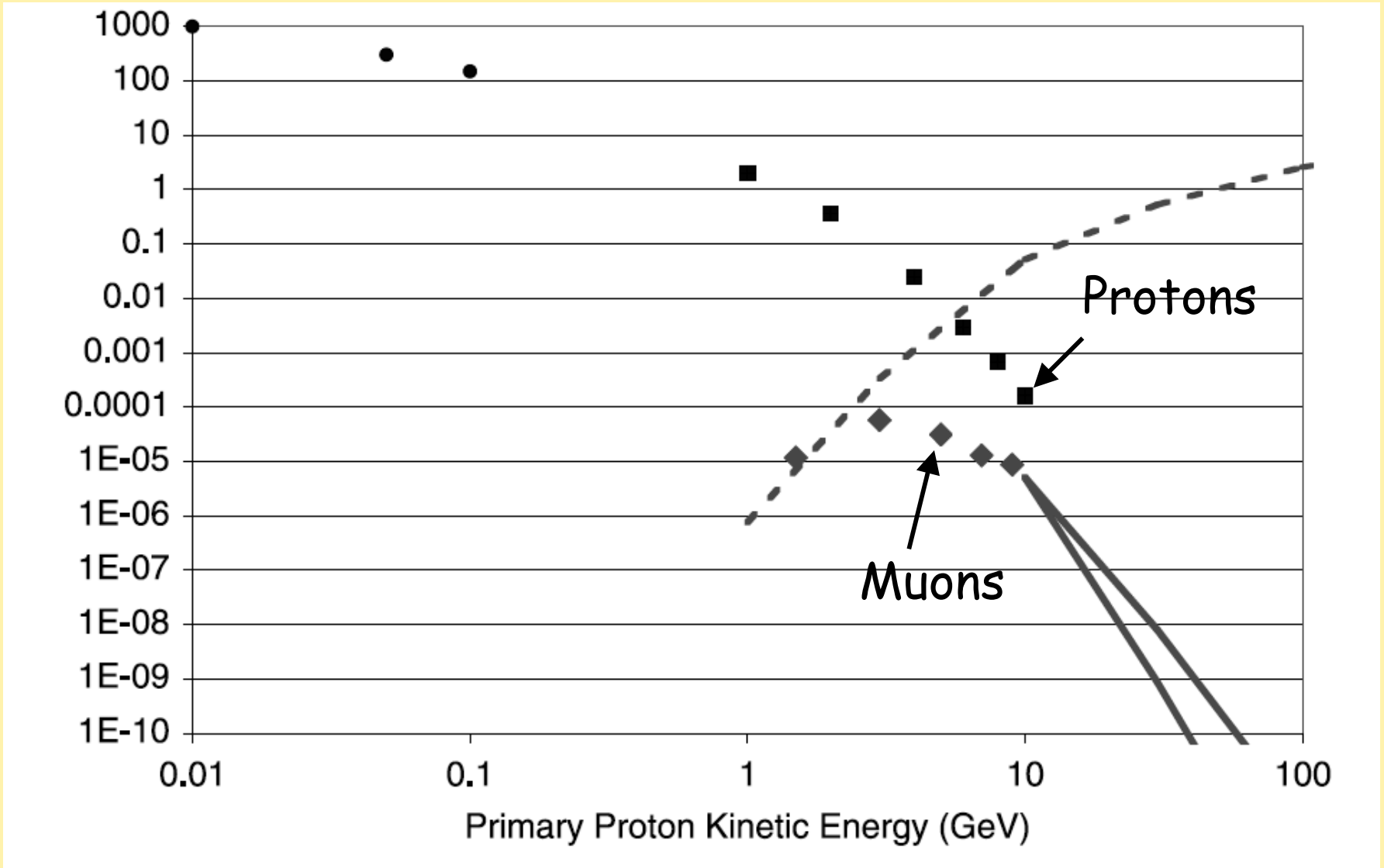
# Other work

- GRAND paper published in JGR on muon detection of 15 April event.
- J. Poirier and C. D'Andrea (Notre Dame)
- Few conclusions other than detection.

# 6 σ increase of shorter duration than NMs

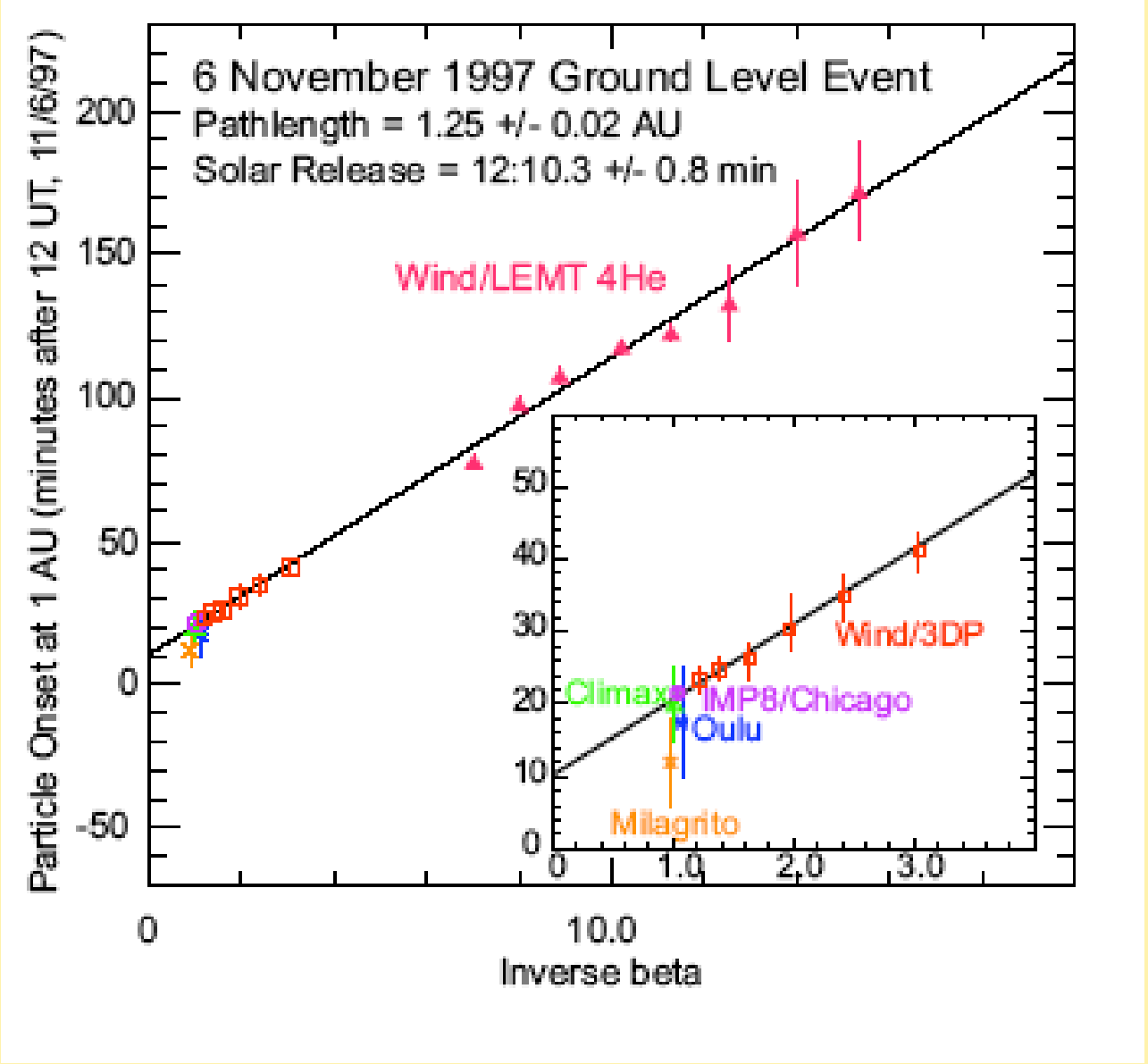


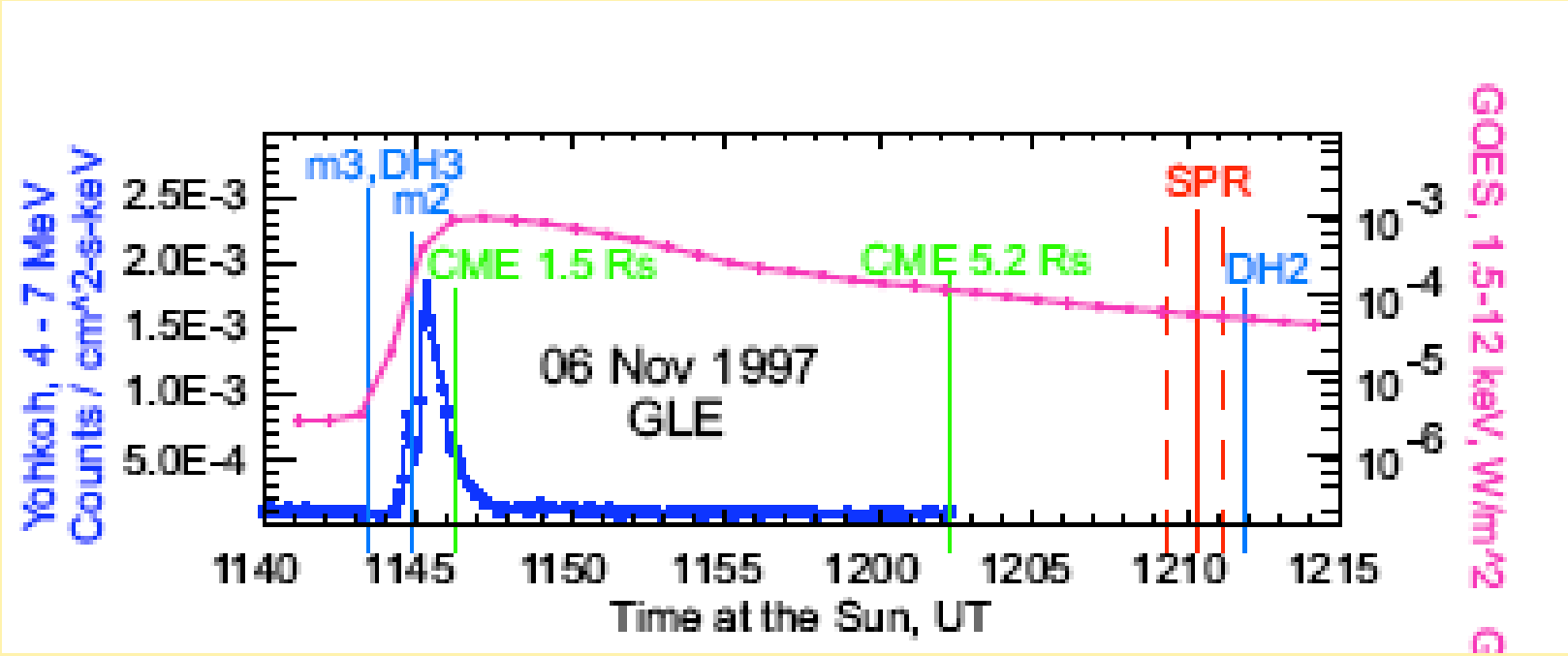
# They did not conclude anything about cutoff.



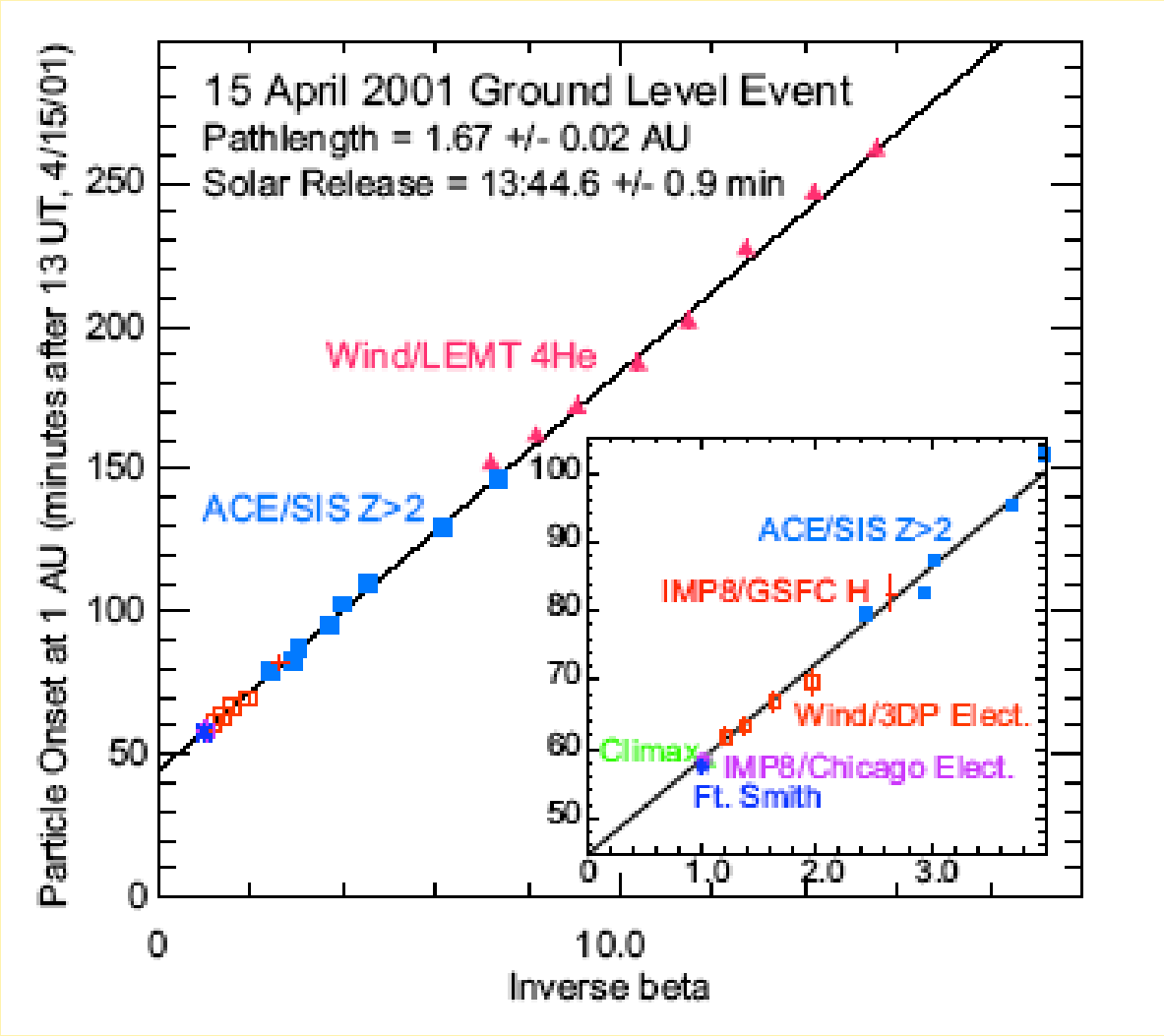
"GRAND's GLE detection occurs slightly earlier than Climax, Newark, or Oulu neutron monitor signals which might be expected from the slightly higher primary energies detected by GRAND (above about 4 GeV) compared to the neutron monitors (the vertical geomagnetic cutoff energies for the Climax, Newark, and Oulu neutron monitor stations are 3, 2, and 0.8 GeV, respectively). Earlier times would be consistent with smaller pitch angles relative to the IMF (and thus a shorter flight path) for the higher energies as well as the increased velocity. **The fact that GRAND's GLE signal is not as pronounced as those from the neutron monitors indicates that there are fewer particles at GRAND's higher energies.** The mean energy of primary protons which produces the detected muons depends somewhat upon the spectral index of this GLE in the 4 GeV region. In the future, combined analyses of world-wide neutron monitor stations and muon telescopes are anticipated to yield more detailed information on this GLE."

Alan Tylka (NRL) uses our stuff and wants to collaborate in future work






We started at 1212 UT, in good agreement with ensemble of measurements.


15 April 2001 Ground Level Event
Pathlength = 1.67 +/- 0.02 AU
Solar Release = 13:44.6 +/- 0.9 min
Wind/LEMT 4He
ACE/SIS Z>2
Particle Onset at 1 AU (minutes after 13 UT, 4/15/01)
Inverse beta
0
50
100
150
200
250
10.0
ACE/SIS Z>2
IMP8/GSFC H
Wind/3DP Elect.
Climax
IMP8/Chicago Elect.
Ft. Smith
50
60
70
80
90
100
1.0
2.0
3.0

Tylka et al.: "Above 30 MeV/nuc, 6 Nov. 1997 and 15 April 2001 have Fe/O approaching unity and Fe with mean charge 20 [6], both of which are characteristic of flare-accelerated ions. However, since Figure 3 argues against a direct flare origin, these results suggest reacceleration of particles from preceding flare(s)."

One of our conclusions in Falcone et al.

# What can we do with 15 April?

- Perform multiple integral measures of protons using different multiplicity channels.
- If the signal appears in the unreconstructable events, then the pitch angle distribution can be measured.
- Both would be new results.

# Forbush Decreases

- Undoubtedly some decreases will be evident in higher multiplicitiy rates, so that we can measure the momentum dependence as a function of recovery phase, as well the angular distribution.
- Again a new result.