

WG 6 Summary of the 2015 ISEST Workshop

Nat Gopalswamy

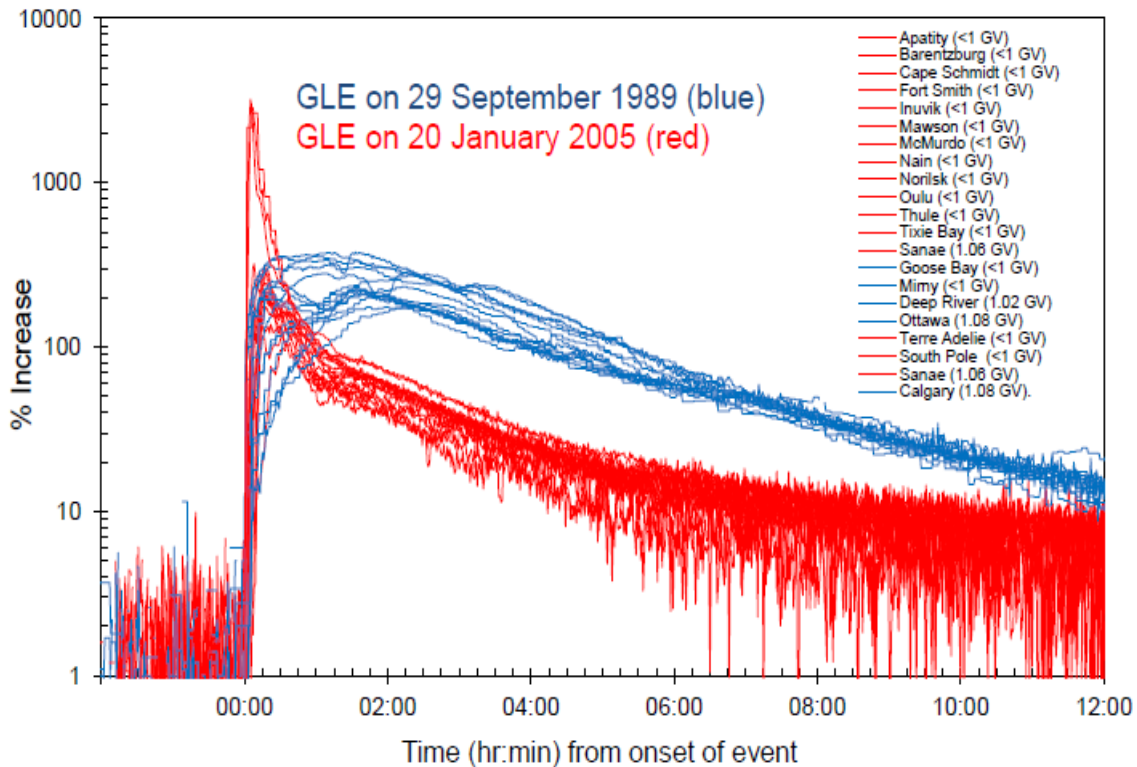
Presentations

- R. Caballero-Lopez: GLEs
- A. Lara-Sanchez: GLEs, flare neutrons, gamma rays from the Sun using the HAWC detector
- N. Gopalswamy: Highlights of current SEP studies
- C.-L. Shen: Energetic Particles in shock-ICME structures
- L. Preisser: Shock shape and ESP variability

GLE Source: Flare & Shock

GLE 42 vs GLE 69

(Moraal and Caballero-Lopez, 2014)

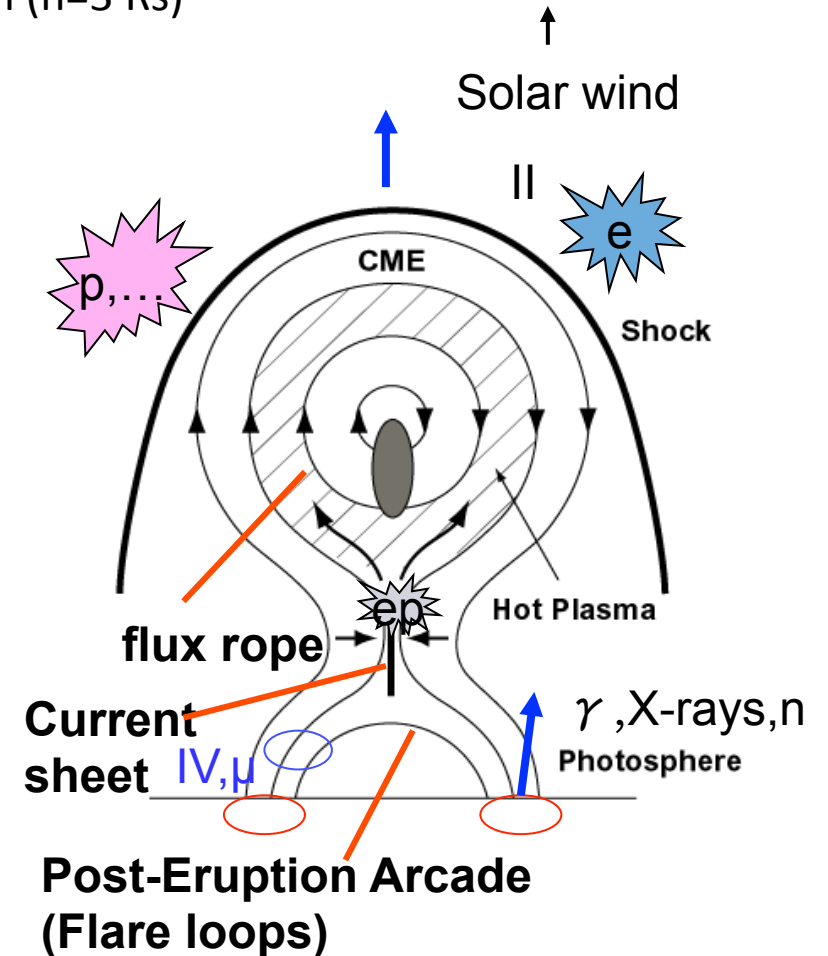


Questions: Could impulsive component also due to shock?
How do flare particles escape?

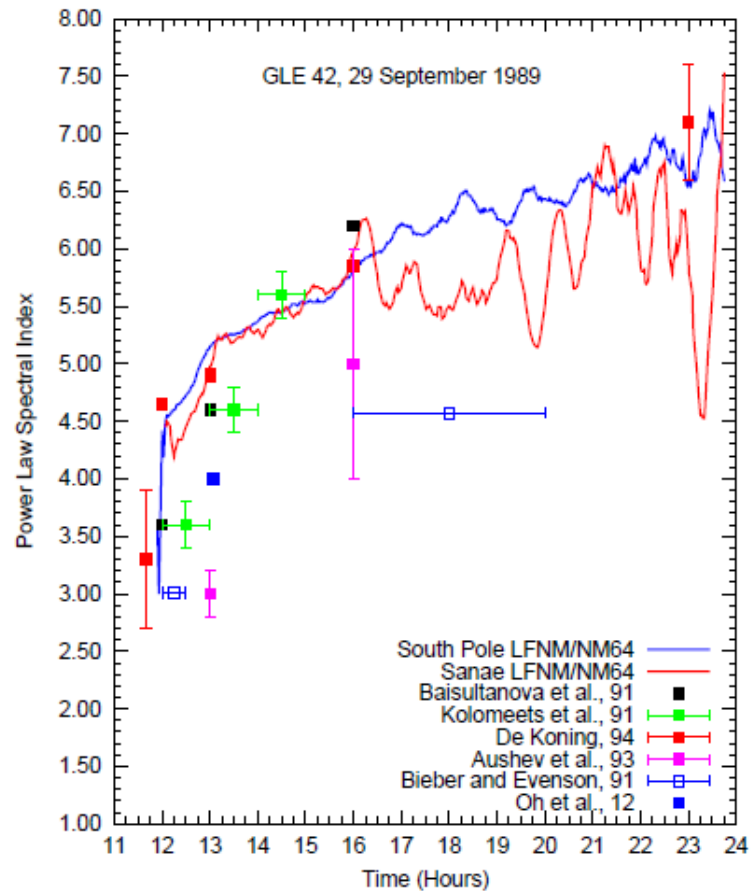
Large GLEs (>100%) originating at >W24 on the solar disk invariably commence with an HEI GLE: pulse duration 20 min. (from rise to 50% fall-off) (McCracken et al., 2012)

Impulsive component: shorter timescales, highly anisotropic
Due to flare reconnection ($h = 1.05 R_s$)

Gradual component: longer timescales, less anisotropic. Due to shock acceleration ($h=3 R_s$)



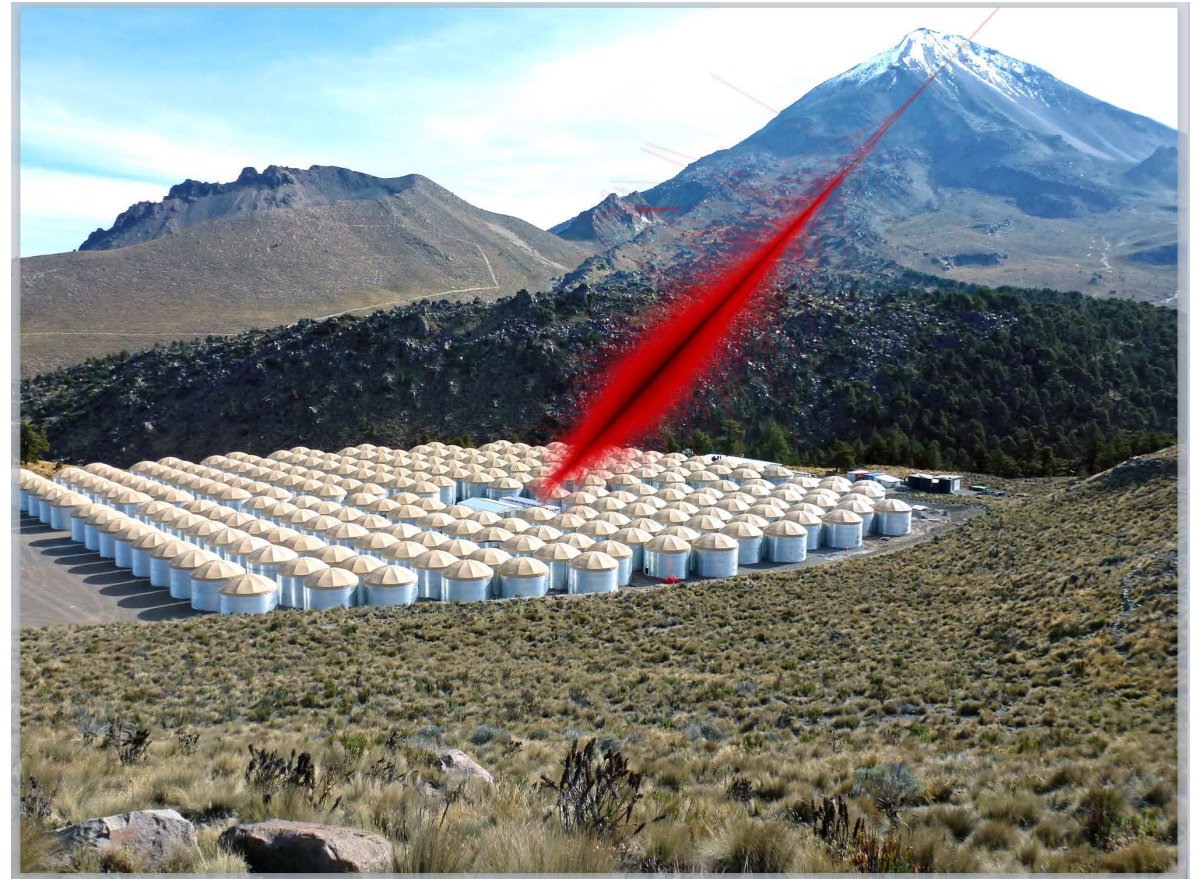
Determining the GLE Spectrum



- Analysis of the LFNM/NM64 ratio allows to precisely determinate the SCR spectrum
- Determination of the spectral index from a pair of narrow-cone monitors like South Pole is the most valid one
- A pair of wide-cone monitors like Sanae is a sensitive indicator of shifts in beam direction

Lara: ISEST Studies Using: High Altitude Water Cherenkov (HAWC) Array

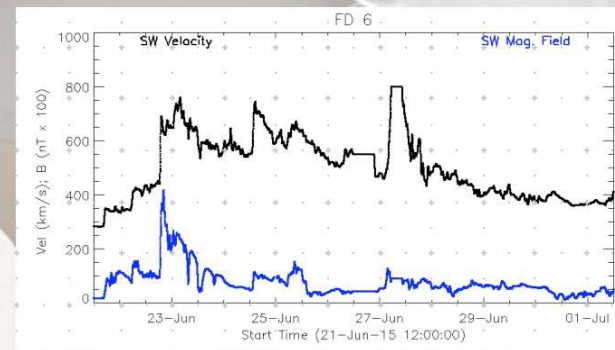
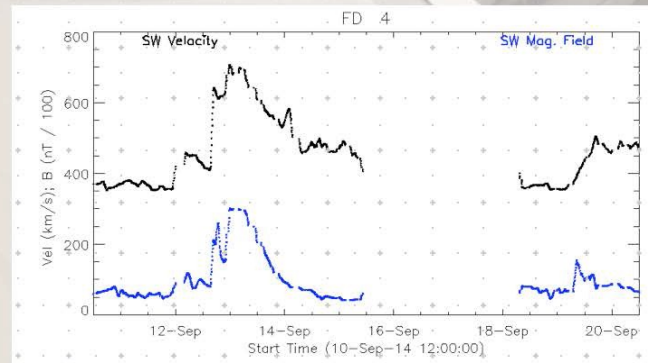
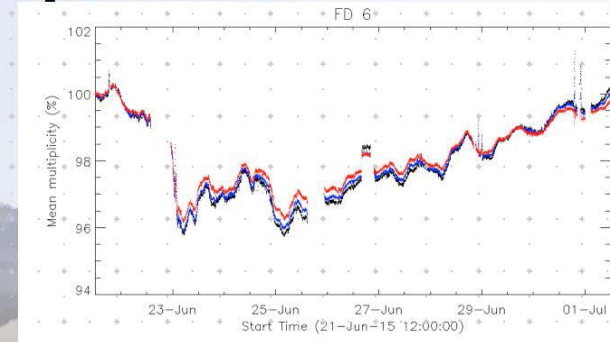
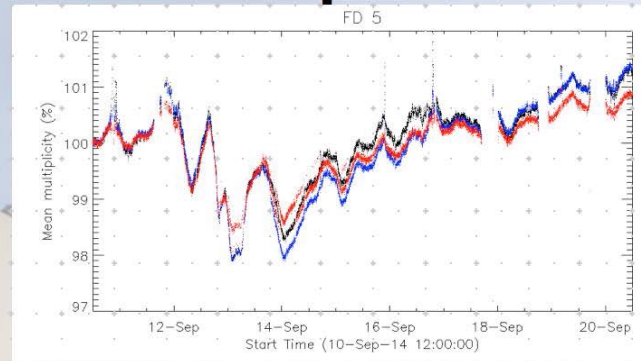
- Forbush decrease
- GLEs
- Neutrons
- gamma rays
- Data from Mid 2013
- Analysis in progress



HAWC Array with a cosmic ray cascade

Campaign Events Detected by HAWC

Sep 2014 & Jun 2015



Gopalswamy: SEP Highlights

- CME speeds are consistently important for SEP occurrence; Flare size is not
- Complex type III bursts are not sufficient for SEP events
- # of high-energy SEP events in SC 24 is small compared to SC 23:
Reduced efficiency of shock acceleration (weak heliospheric B), shock formation height, latitudinal connectivity, ambient conditions (e.g. high Alfvén speed)
- Anomalous expansion of CMEs may be linked to longitudinal spread of SEPs –shock shape

Does the Flux Rope Orientation Matter?

Gopalswamy

STEREO Ahead EUVI 195

S06W102

EW



2014-01-06 08:25:30

STEREO Ahead EUVI 195

N12W115

NS

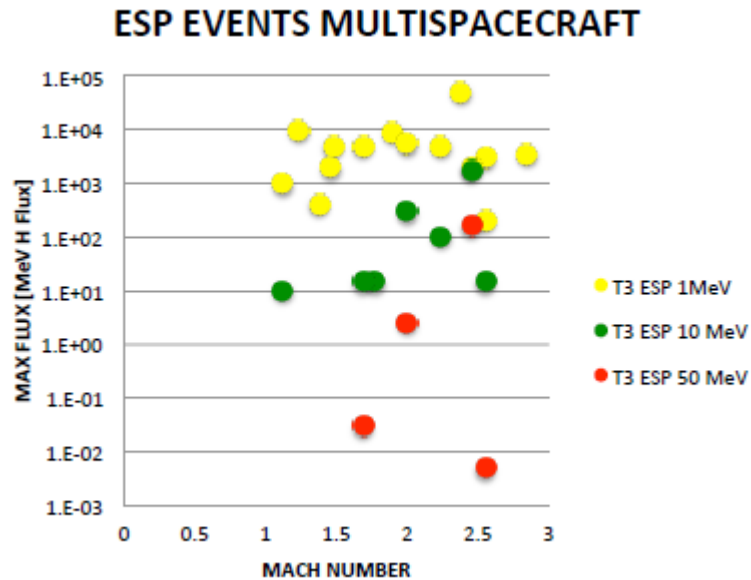


2012-05-26 21:15:30

Shen: Energetic Particles in Shock-ICME Structures

- Energetic particle increase inside ICMEs, contrary to Forbush-like decrease
- Considered Shock-ICME interaction structures during 1996-2014
- Half of these structures had SEP increase

Preisser: ESP Events



- Multi-spacecraft observations of ESP events
- Effect of Shock ripples on the observed SEP flux
- Work in progress

Suggested Science Topics for WG6

- Trace the origin of SEPs - Via 3D reconstructions of shock envelope
- Understand the shock type at SEP injection site - Estimate the shock normal angle to B-field via 3D reconstruction of shock envelope and B-field model
- What is the role of compression on SEP production?
- Measure CME lateral expansion low in the corona
- GLE from shock nose: latitudinal connectivity
- FE vs. GLE spectrum: shock formation heights
- Solar Cycle effect on SEPs
- CME interaction and SEPs