

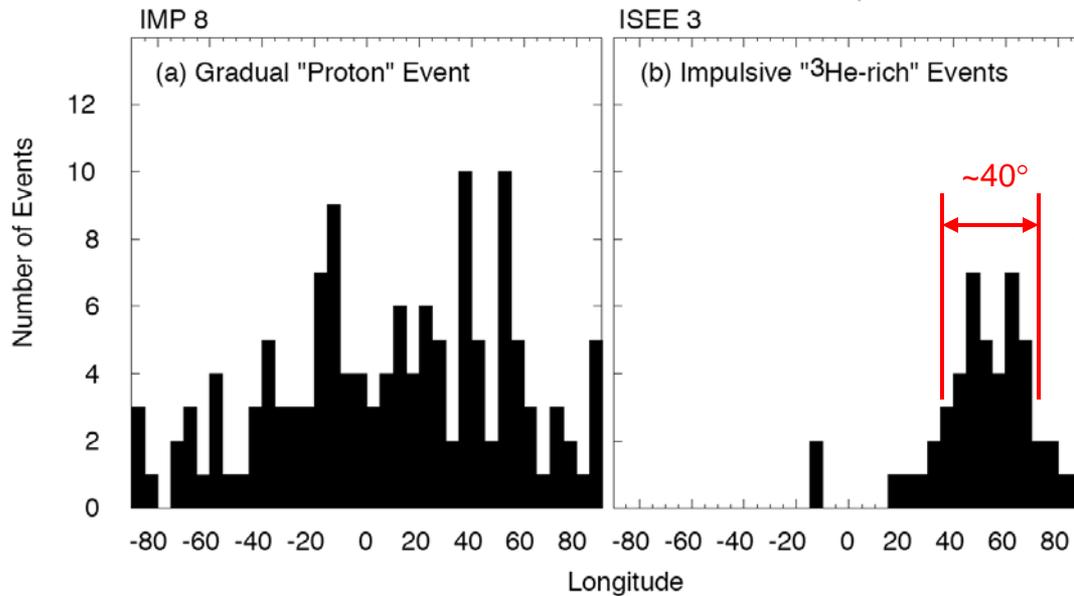
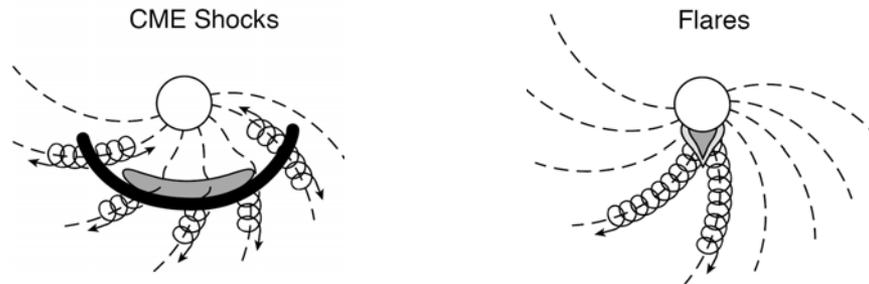
A ^3He -rich SEP Event Observed over $\sim 80^\circ$ in Solar Longitude

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with contributions from:

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Expected Longitudinal Distribution



Reames 1999

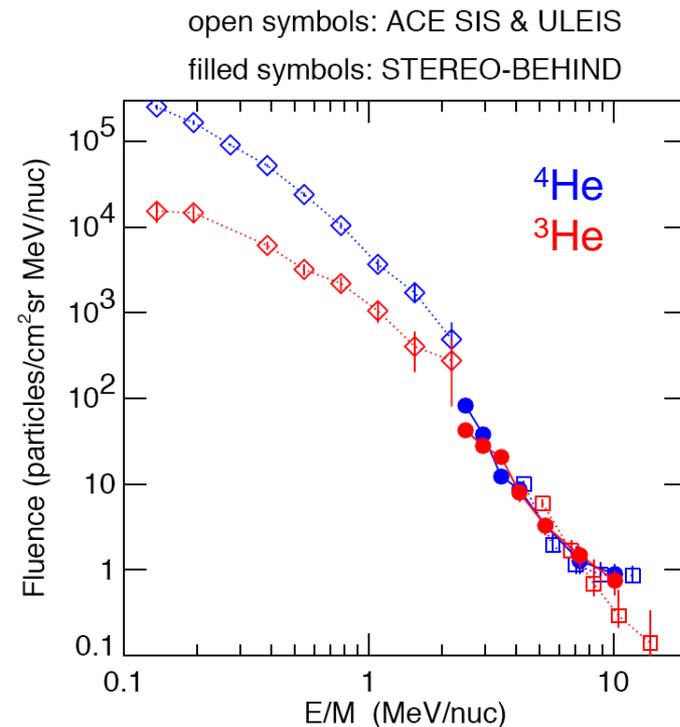
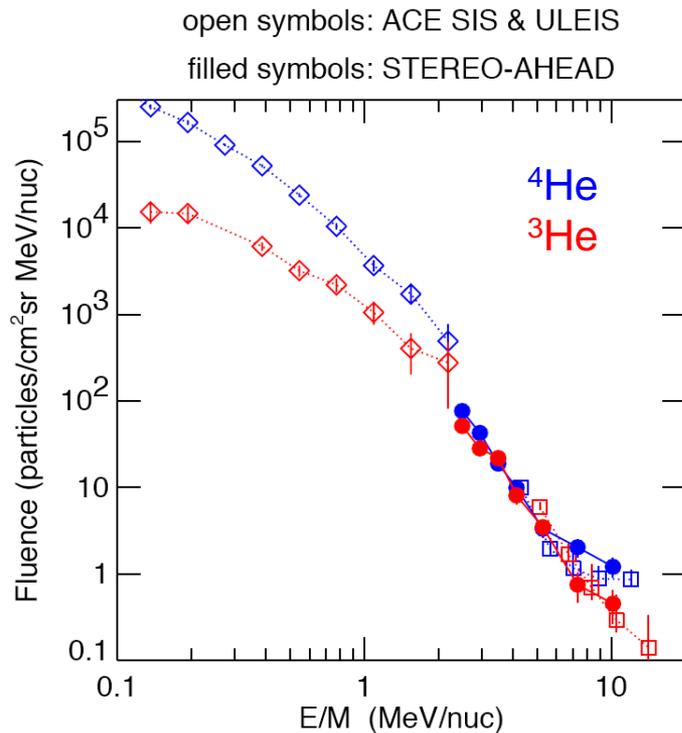
- point-like injection in flare events should lead to relatively narrow range of longitudes over which SEPs can be observed near 1 AU
- previous studies were based on correlating single-spacecraft measurements with flare locations derived from solar imaging
- an important objective of the SEP suite on STEREO is to directly determine the longitudinal width of the SEP distribution in the heliosphere from ³He-rich events
- in addition to the STEREOs these studies can take advantage of the L1 spacecraft (ACE, SOHO, Wind) and of solar imaging

The Energetic Particle Environment During the Prime Mission

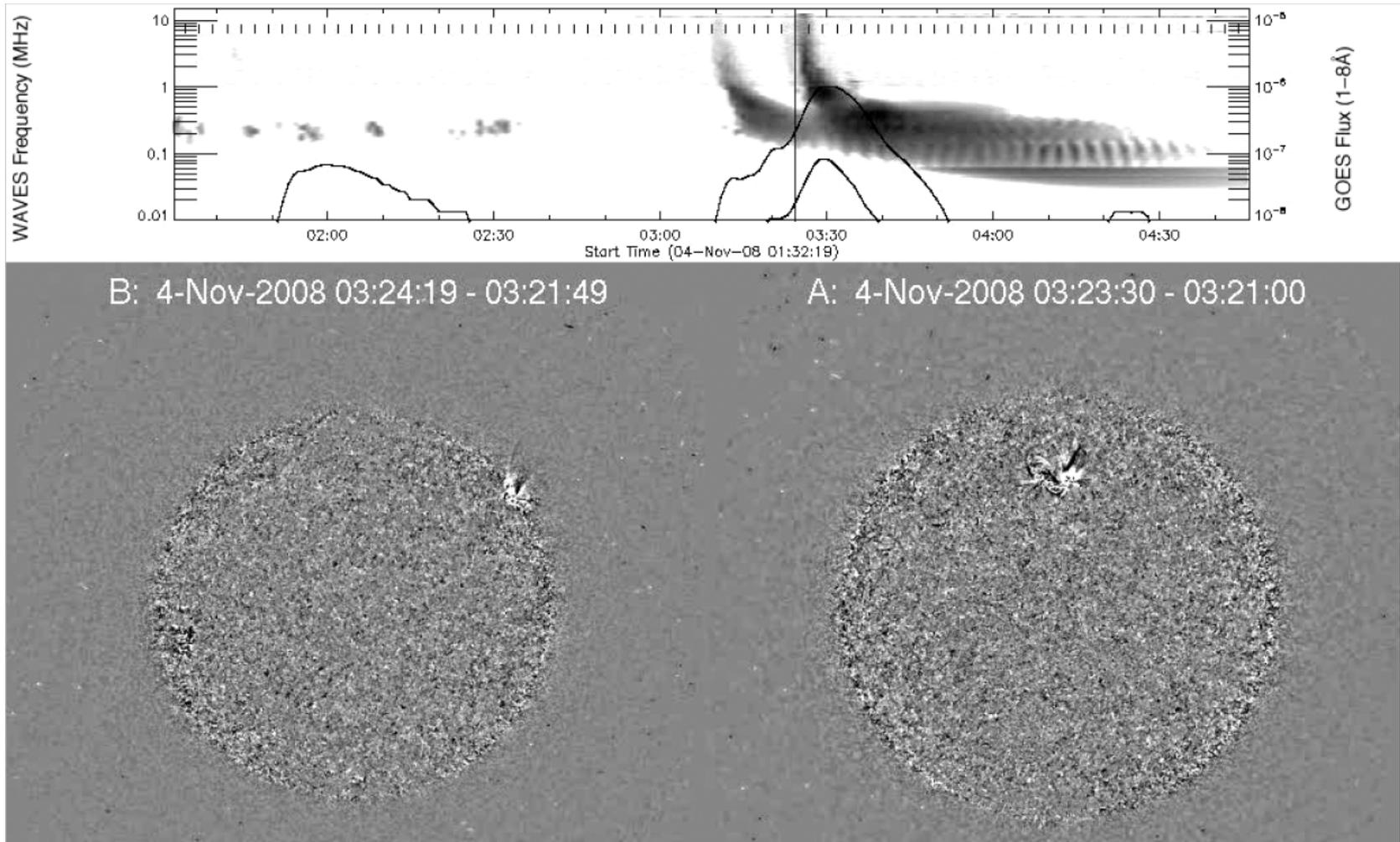
- Since the beginning of 2007 energetic particles measured on STEREO have been dominated by CIRs and ACRs
- No large events have been observed since the December 2006 events
- Impulsive (^3He -rich) events have also been scarce
- The only clearly ^3He -rich periods thus far have been
 - around 24 Jan 2007 when both STEREO spacecraft were near Earth
 - around 4 Nov 2008 when the STEREOs were each about 40° from Earth

Comparison of Intensity Measurements in the 24 January 2007 Event

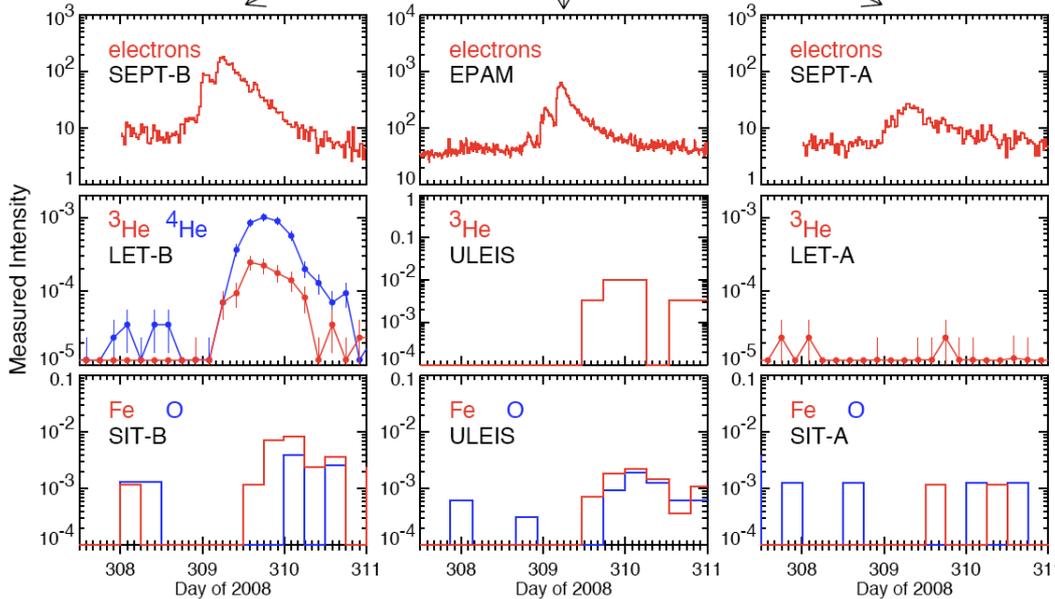
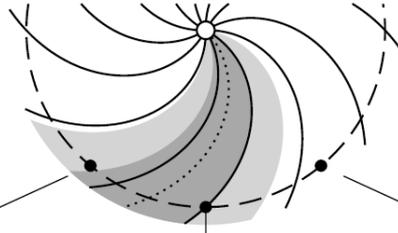
- energy spectra of ^4He and ^3He from both STEREO/LET instruments agree well with ACE composite spectrum from SIS and ULEIS
- $^3\text{He}/^4\text{He}$ ratio varies from <0.1 below 0.2 MeV/nuc to ~ 1 at several MeV/nuc



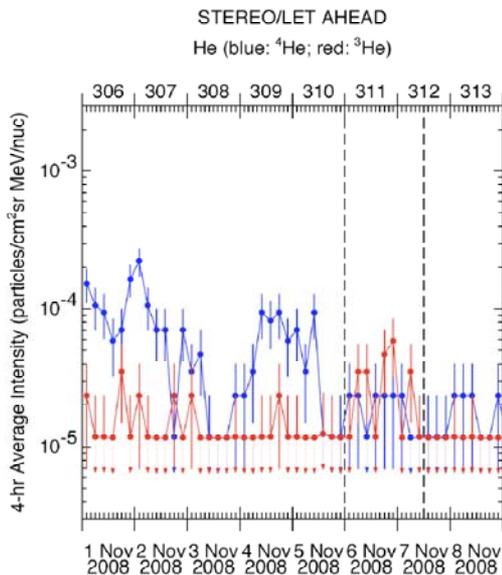
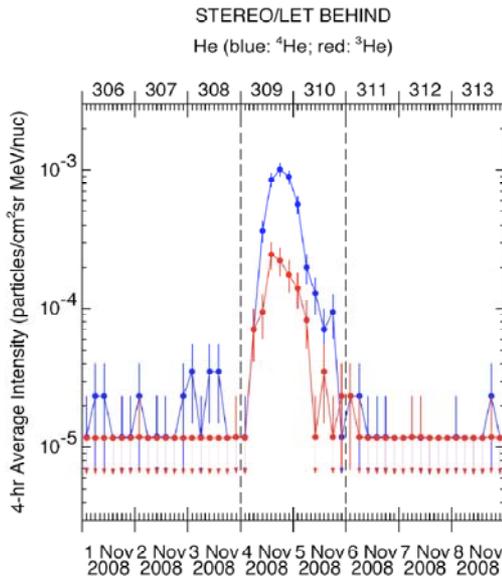
4 November 2008 Event -- Solar Context



Longitude Dependences in the Events of 3-4 November 2008

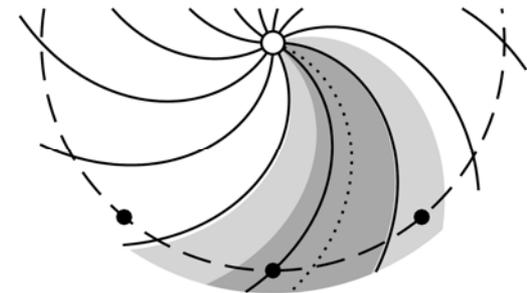


- flare at $\sim 40^\circ\text{W}$ (as seen from Earth) -- Parker spiral for 400 km/s solar wind reaches 1 AU approximately midway between BEHIND and ACE; AHEAD was not well connected
- observed increases of ^3He and of Fe/O at BEHIND and ACE but not at AHEAD
- observed electron increases at all 3 spacecraft, but with slower rise at AHEAD
- ion event also observed in ^4He at BEHIND; at ACE and BEHIND the ^4He was dominated by CIRs at this time

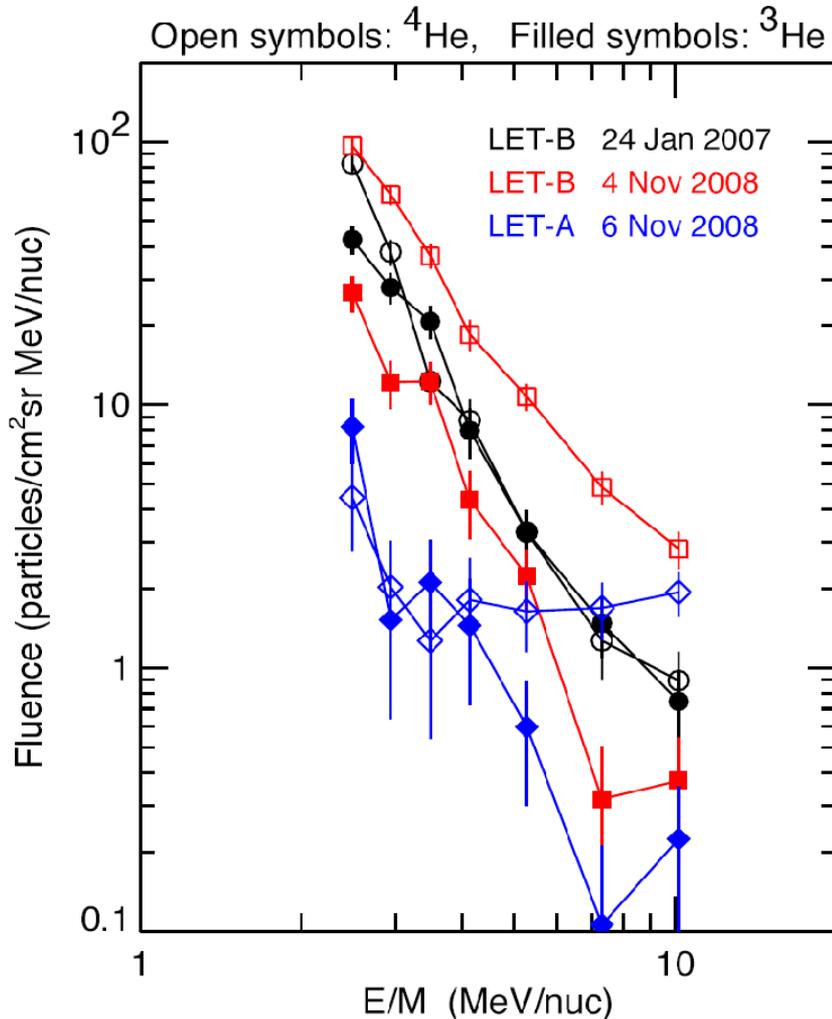


What happened as the active region became better connected at AHEAD?

- ^4He from the CIR was declining at AHEAD
- a tiny ^3He increase seen at AHEAD on 6 Nov (day 311) was probably due to another ^3He -rich event from the same active region
- intensity is very close to the instrument sensitivity level, but unlikely to be to spillover ^4He because the $^3\text{He}/^4\text{He}$ ratio is >1
- significantly different $^3\text{He}/^4\text{He}$ ratios in the 4 Nov and the 6 Nov events argue that they are indeed due to distinct injections
- event not seen at ACE, possibly due to higher energy threshold of SIS and smaller geometrical factor of ULEIS



new connection after rotating $\sim 28^\circ$ (2 days)



Energy Spectra in Three ^3He -rich Events

- spectra from LET-A in 24 Jan event (not shown) are essentially the same as those from LET-B (both spacecraft near Earth)
- ^3He intensity in 6 Nov event $\sim 1/10$ that in 4 Nov event
- ^4He spectra have various amounts of contamination from non-SEP sources
 - mainly from ACRs
 - time periods used avoid CIR periods
 - small contributions to both ^3He and ^4He from secondary GCRs
- spectral indexes (2.5-7.5 MeV/nuc) for ^3He range from -3.1 (24 Jan) to -4.1 (both Nov events)
- the largest ^3He -rich events observed with ACE/SIS during solar cycle 23 had intensities several hundred times higher than seen in these events at comparable energies

Discussion

- to our knowledge this is the first detection of ^3He and Fe, the traditional signatures of a ^3He -rich SEP event, at two widely separated spacecraft from an individual event of this type
- the most surprising features of these data are:
 - the electron event was observed at all three locations, even though BEHIND and AHEAD were separated by 80° in longitude
 - the angular spread seen in ^3He and Fe appears to be different (less) than that seen in electrons
- if observation of additional ^3He -rich events confirms a difference in the electron and ion angular distributions, this might be associated with:
 - the general poor correlation between electron and ^3He intensities these events
 - the apparent contradiction between the need for a high coronal source to obtain the electron spectra sometimes observed below 10 keV but a low coronal source to obtain enough stripping to produce the increase of the Fe ionic charge with energy by Coulomb collisions
- the observation of more and larger ^3He -rich SEP events as solar activity picks up should contribute a new dimension to our understanding of these events as a result of the multipoint observations that are now possible