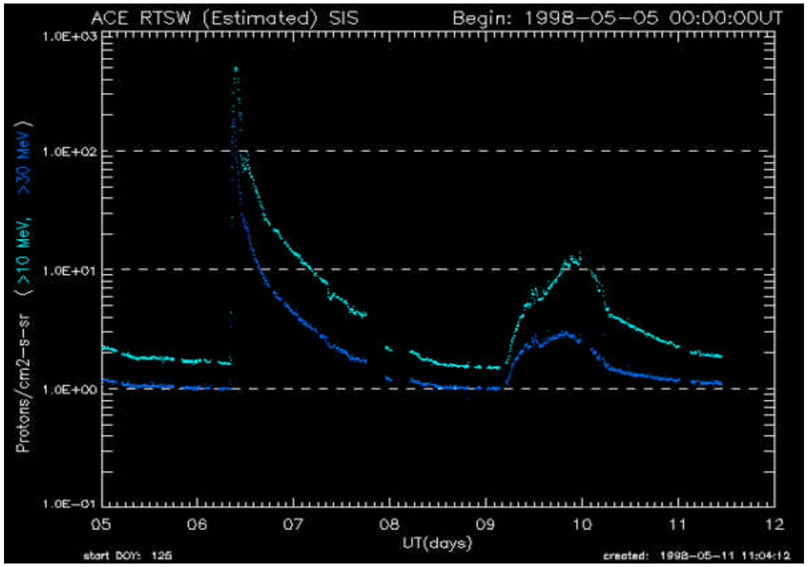
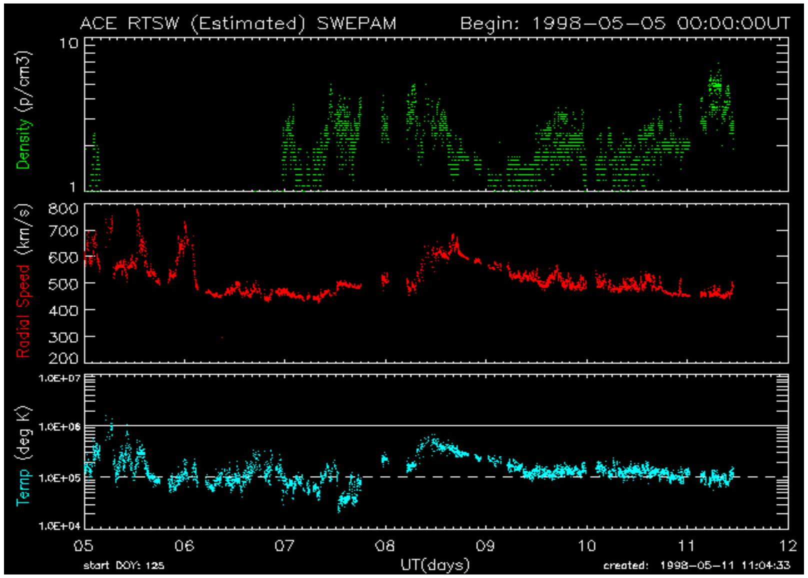
ACE Real Time Solar Wind Data Available on the Web

- Real Time data from four ACE instruments is available from NOAA's Space Environment Center within 5 minutes of acquisition, at http://sec.noaa.gov/ace/ACErtsw_home.html.
- Ground stations operated by the Air Force, Japan, and the United Kingdom provide almost 24-hour coverage.
- Data and plots from MAG, EPAM, SIS and SWEPAM are available. Plots of SIS and SWEPAM data are shown here.
- The location of ACE at the L1 libration point between the Earth and the Sun enable ACE to give about a one hour advance warning of impending geomagnetic activity.
- Recent data indicate an increasing level of solar activity.

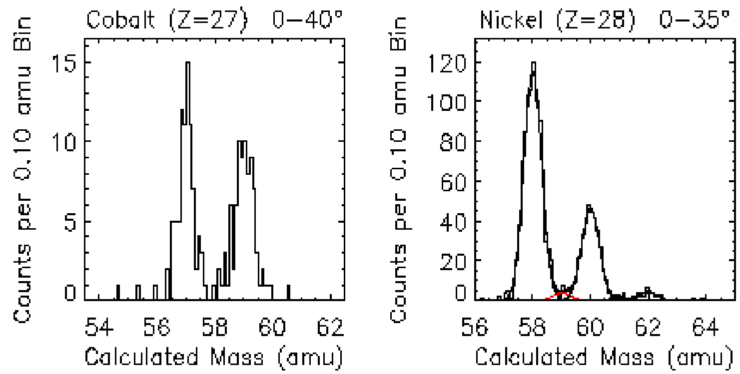


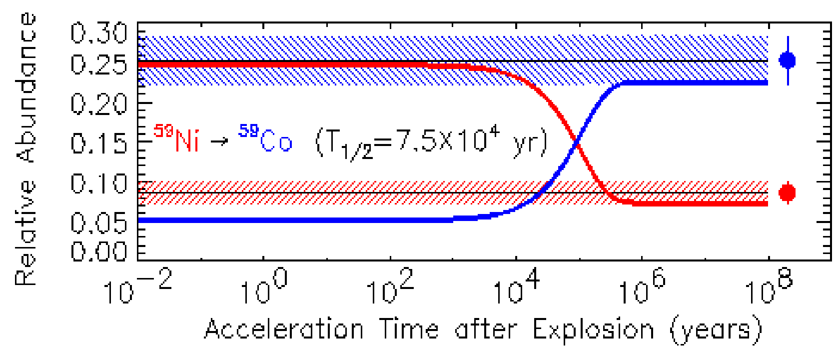


Contributed by: Andrew Davis and Richard Mewaldt

ACE Measurements show that Cosmic Rays are not Accelerated from Fresh Supernova Ejecta

- Although supernovae are believed to supply the energy that accelerates cosmic rays, it is not known whether the accelerated material is from the exploding star itself, or from surrounding interstellar material.
- Among the nucleosynthesis products in supernovae is the radioactive isotope ^{59}Ni (half-life = 75,000 years) which decays to ^{59}Co by capturing one of its orbital electrons.
- However, once accelerated to high energy, all orbital electrons are stripped away and ^{59}Ni cannot decay.
- If cosmic rays are fresh supernova ejecta, we expect much more ^{59}Ni than ^{59}Co; if they are old material then most ^{59}Ni will have decayed to ^{59}Co.
- Measurements from the CRIS instrument on ACE show that ^{59}Ni has decayed, indicating that cosmic rays were accelerated at least 100,000 years after nucleosynthesis.

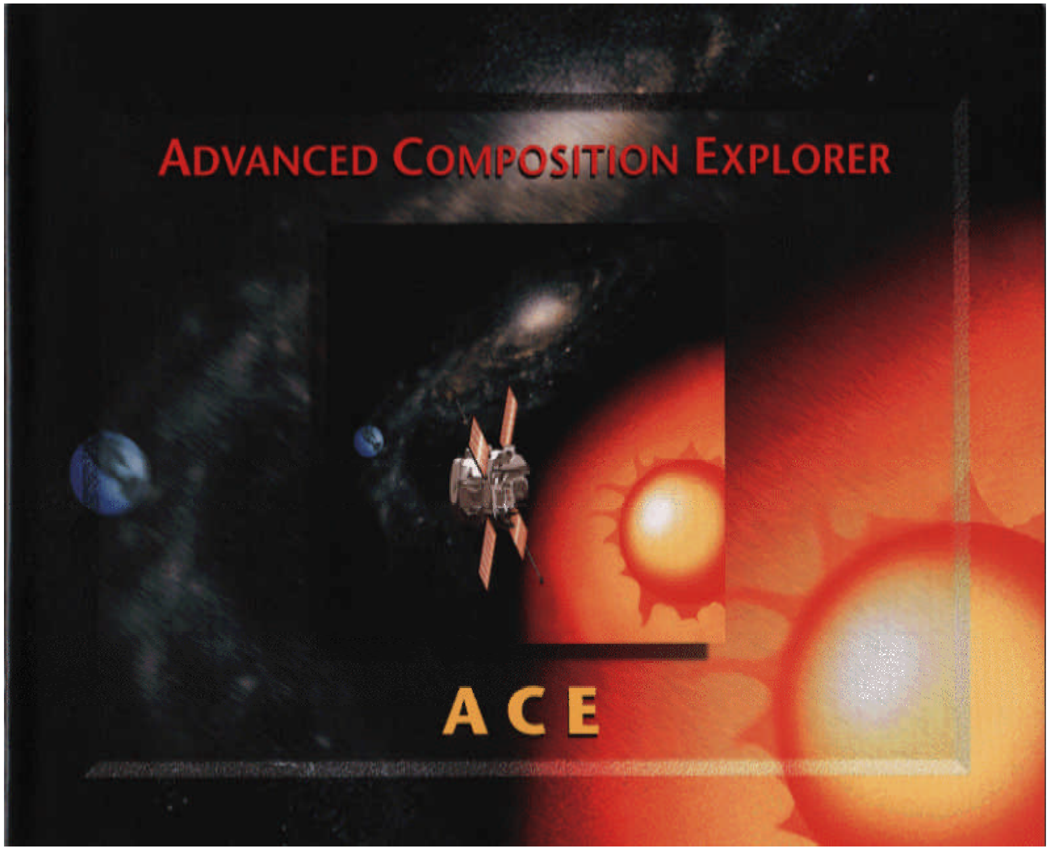




Contributed by: Mark Wiedenbeck and Richard Mewaldt

ACE Brochure Available

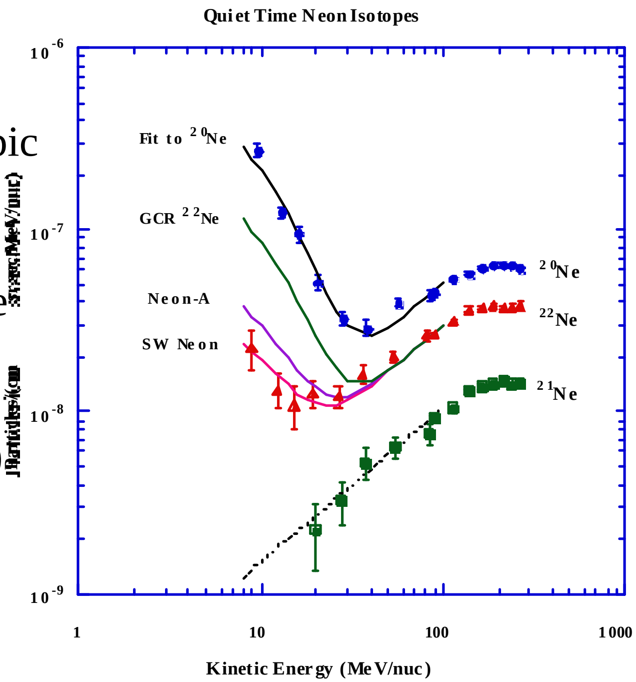
- The ACE mission is described in a new 21-page color brochure.
- Includes Mission overview, spacecraft and instrument descriptions, and science goals, along with solar, heliospheric and galactic cosmic ray science background material.
- Copies available by emailing erc@cosmicra.gsfc.nasa.gov.
- More than 5,000 distributed at the recent National Science Teachers Association meeting.



Contributed by: Eric Christian and Richard Mewaldt

ACE Reveals Isotopic Composition of Interstellar Material

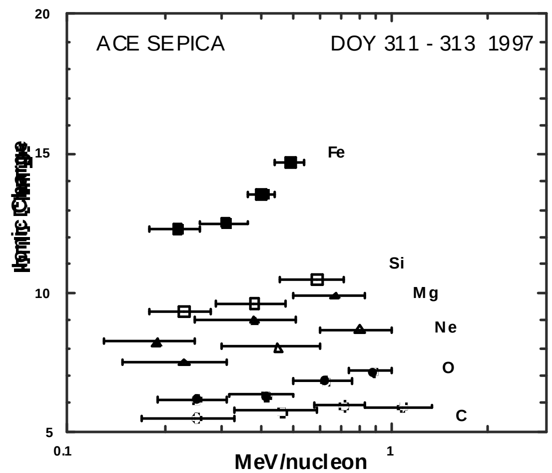
- **Anomalous Cosmic Rays (ACRS) are a sample of the neutral interstellar medium that has been swept into the Heliosphere, ionized, and then accelerated to energies of ~1 to ~50 MeV/nuc at the solar wind termination shock.**
  - To date, the elements H, He C, N, O, Ne and Ar have been identified in ACRs, but relatively little is known about their isotopic composition.
  - Data from the CRIS and SIS instruments have been combined to produce energy spectra for the individual isotopes of N, O, and Ne from ~10 to ~250 MeV/nuc.
  - Low-energy ACR enhancements are observed in the rare isotopes 18O and 22Ne, as well as the abundant isotopes 14N, 16O, and 20 Ne.
  - The observed 22Ne/20Ne ratio is more consistent with solar-wind neon than with the meteoritic component known as Neon-A. The observed 18O/16O ratio is consistent with the terrestrial value.
  - There is ~5 times less 22Ne in ACRs than in Galactic Cosmic Ray (GCR) source material, supporting an earlier conclusion that cosmic rays are not simply an accelerated sample of the local interstellar medium.



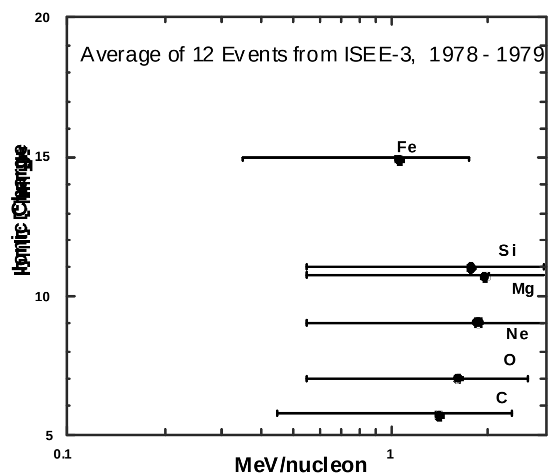
Energy-Dependent Ionic-Charge Composition Observed in Large Solar Particle Event

- The ionic charge states of solar energetic particles (SEPs) contain information about the temperature at their source and about acceleration and transport processes.
- Previous direct measurements by ISEE-3 found average charge states for C, N, O, Si, and Fe compatible with T = 1 to 2 million deg (typical of the corona), while Ne and Mg required T = 4 to 6 million deg. No energy dependence was detectable.
- New measurements of the Nov. 6, 1997 SEP event with the SEPICA sensor, extending lower in energy with increased statistical accuracy, show charge states which increase with energy.
- The new ACE data, reported at the Spring AGU meeting, are consistent with ISEE-3 data where they overlap, but reveal that SEP events are more complex than previously thought. Similar results were reported from SAMPEX at the same meeting.
- The cause of the observed energy dependence is as yet unknown.

Charge State Variation with Energy

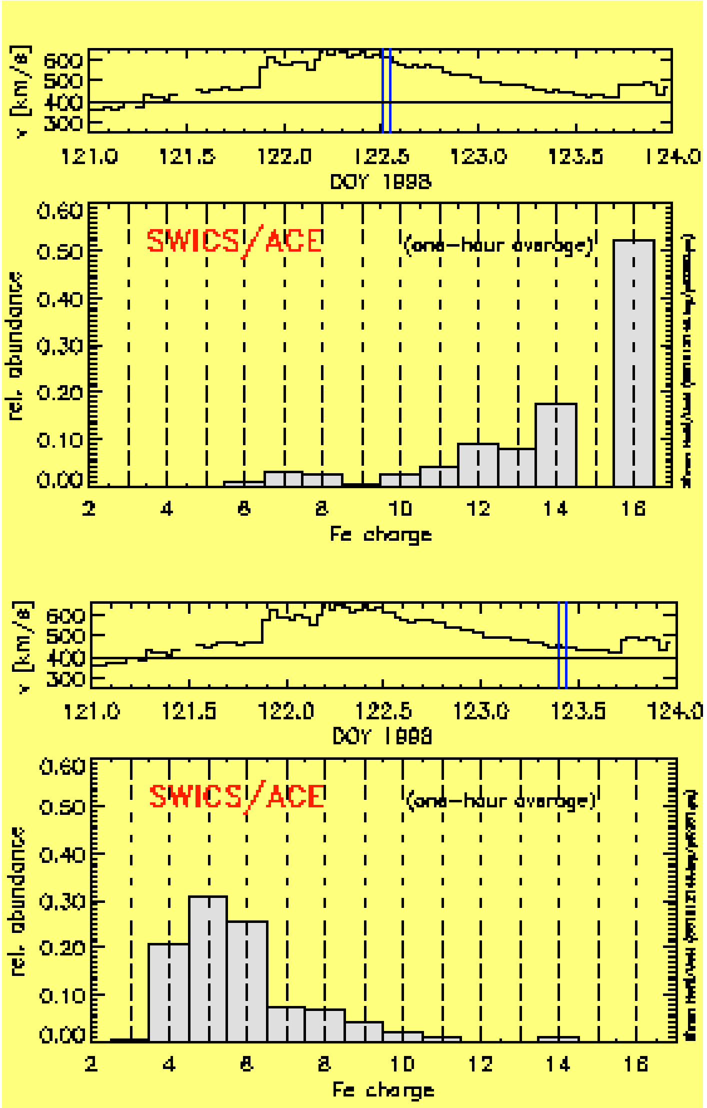


Earlier Measurements



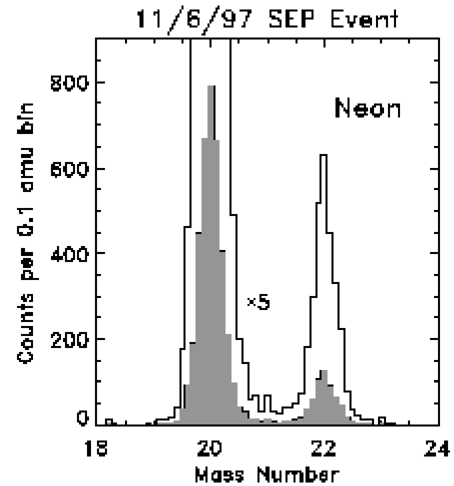
ACE Measurements Reveal Unusual Thermal History of a CME

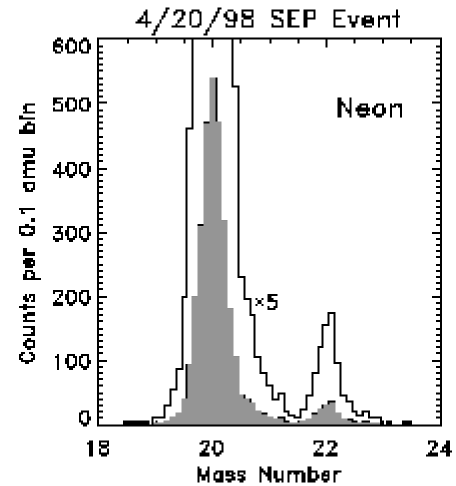
- The ionic charge-states of plasma in a coronal mass ejection (CME) are an imprint of the electron temperature distribution a few solar radii above the solar surface.
- High time-resolution measurements of a CME by the SWICS/ACE sensor in early May, 1998 imply a surprisingly wide range of temperatures.
- The iron charge states midway through day 98:122 are dominated by Fe^{+16}, corresponding to very hot plasma (several million degrees).
- Less than a day later very cold plasma (~10^5 K) is observed, including the first-ever observations of Fe^{+3} in the solar wind. Indeed, Fe^{+3} and Fe^{+16} co-exist at this time.
- A movie showing the entire time history of the CME can be viewed at http://www.srl.caltech.edu/ACE/ACENews16.html.
- Such data can provide the missing link between SOHO images of CMEs and in situ observations of electron & proton temperatures in plasma at 1 AU.



Contributed by S. Hefti and T. H. Zurbuchen

Evidence for Mass Fractionation in the Isotopic Composition of Solar Energetic Particles





- Although it is well known that the abundances of the elements vary from one solar energetic particle (SEP) event to another, little is known about whether the isotopic composition of heavy elements also varies.
- Data from the Solar Isotopic Spectrometer (SIS) on ACE now show that the $^{22}Ne/^{20}Ne$ ratio in SEPs can vary by up to a factor of three from event to event (see above).
- In the 11/6/97 event a ratio of $^{22}Ne/^{20}Ne$ ~ 0.15 was observed, approximately twice that measured in the solar wind, while in the 4/20/98 event the ratio was only ~0.05.
- Although the long-term average of $^{22}Ne/^{20}Ne$ in SEPs is not yet known, this evidence that the isotopic composition of SEPs can differ from that of the solar wind may shed light on the unknown origin of a component of Ne (with $^{22}Ne/^{20}Ne$ ~ 0.09) that is found implanted in Lunar rocks.
- These observations of mass fractionation in SEPs provide a challenge to theoretical models of SEP acceleration and transport.

Mewaldt/Leske, Caltech

ACE Plans for the Leonids Shower

- **Do Stationkeeping Burn (SK-08) week of Nov. 9; corrects orbit before arrival of Leonids.**
  - Delta-V will be quite small.
  - In the event ACE does take a hit from a Leonid and is in recovery mode there will not be an immediate need/pressure for an orbit maneuver.
  - No maneuvers will take place during the storm.
- **Reorient ACE so that spin axis is at least 18 degrees east of the Sun.**
  - Protects Instruments, especially SEPICA and SIS. Calculations predict a significant probability of damage to these instruments if the nominal spacecraft orientation is maintained.
  - Protects Star Tracker.
  - Slightly faces the rear of Solar Arrays into storm.
  - Utilize low rate omni antennas and be prepared for recovery mode if necessary--no need to switch from high to low gain.
- **Science instrument configurations are being planned and submitted to the FOT. Several instruments will ramp down HV.**
- **An extended pass encompassing storm peak activity time is being scheduled.**
- **Contingency procedures for spacecraft as a whole are being prepared.**

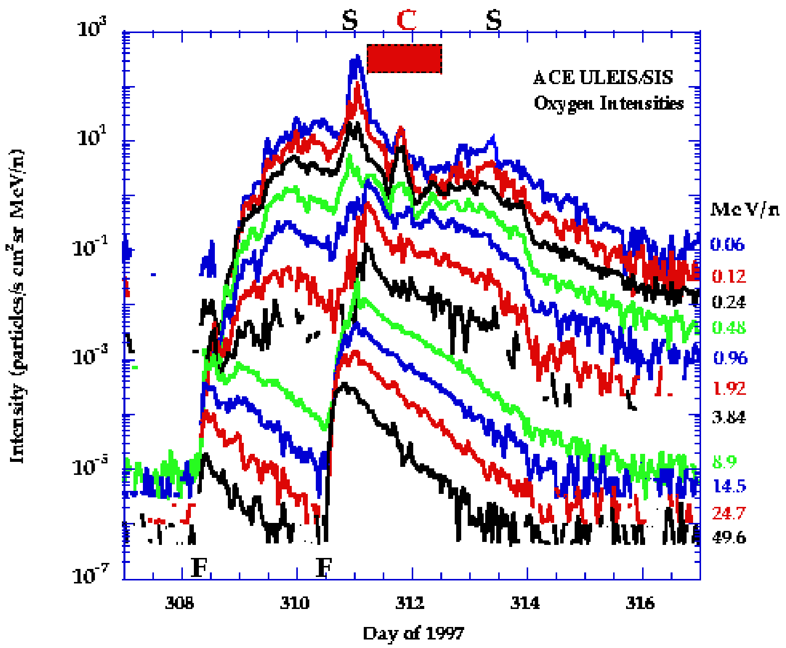
Sodano, GSFC. Mewaldt/Davis, Caltech.

ACE S3DPU Processor Status

- **The S3DPU has experienced 5 warm reboots, or resets, since the start of the mission.**
- **The S3DPU controls and processes data for the SEPICA, SWICS and SWIMS instruments. Each reset puts SWICS and SWIMS into standby mode, and turns SEPICA off. Several days of science are lost for these instruments during the recovery period.**
- **Efforts are under way to diagnose and resolve the problem:**
  - S3DPU HK data items are being trended.
  - The S3DPU engineering model at UNH is being used to simulate the problem. The engineering model has also experienced resets.
  - Correlations with solar activity are being investigated.
  - The S3DPU engineer at TUB, Germany, is involved in these efforts.
  - The resets appear to be caused by memory corruption in the S3DPU, but the cause of the corruption is not yet known.

ACE Guest Investigator Selection Announced

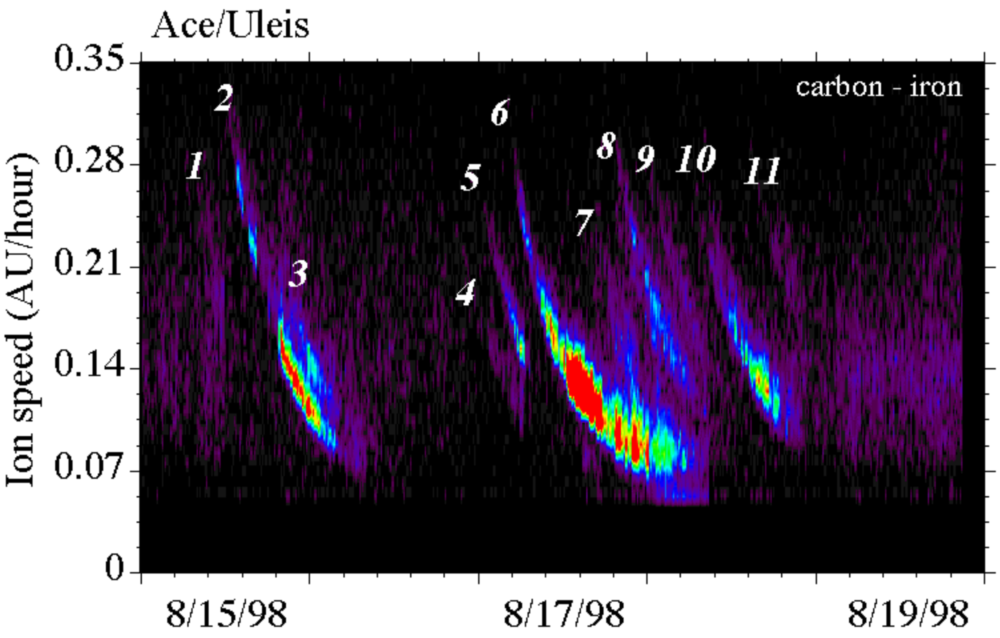
- NASA Headquarters recently announced that eight Guest Investigator proposals for the ACE mission have been selected.
- A total of 21 investigators at 11 institutions are represented.
- The selected investigations include studies of:
  - Solar energetic particle composition and acceleration
  - Solar particle and solar gamma ray correlations
  - Multi-spacecraft solar wind & solar particle studies
  - Anomalous cosmic ray acceleration and transport
  - Cosmic ray acceleration and transport in the Galaxy
  - Solar modulation of anomalous and galactic cosmic rays
- Three GI teams have already met with ACE investigators; other meetings are scheduled for the ACE team meeting in October
- The Figure at right illustrates ACE observations from the 11/6/97 solar particle event that marked the onset of activity leading to the next solar maximum; an event that is receiving a great deal of attention because of its unusual composition and energy spectra.



Mewaldt/Davis, Caltech

Interplanetary Propagation of Ions From Impulsive Solar Flares: ACE/ULEIS Data

- **Impulsive solar particle events have a composition unlike any other sample of accelerated matter in the heliosphere: the isotope 3He is enhanced by a factor of ~100 to 1000 over its abundance in the Sun, and heavy ions are enhanced by factors of ~3 to 10.**
- **Particles from impulsive flares propagate outward from the flare along the spiral interplanetary magnetic field; to observe them the field line through ACE must connect to a flare site at western solar longitudes.**
- **A plot of particle velocity versus arrival time results in distinct velocity-dispersion curves; faster particles arrive before slower particles and form curves of velocity = distance/time. The ULEIS data above include at least 11 separate events.**
- **These profiles also illustrate varying amounts of scattering (event 2 has smaller width than event 6) and dramatic effects of the meandering interplanetary magnetic field (events 4 and 5 are cutoff, while 6 is unaffected).**
- **ULEIS data demonstrate that impulsive solar particle events occur much more frequently than was previously realized.**

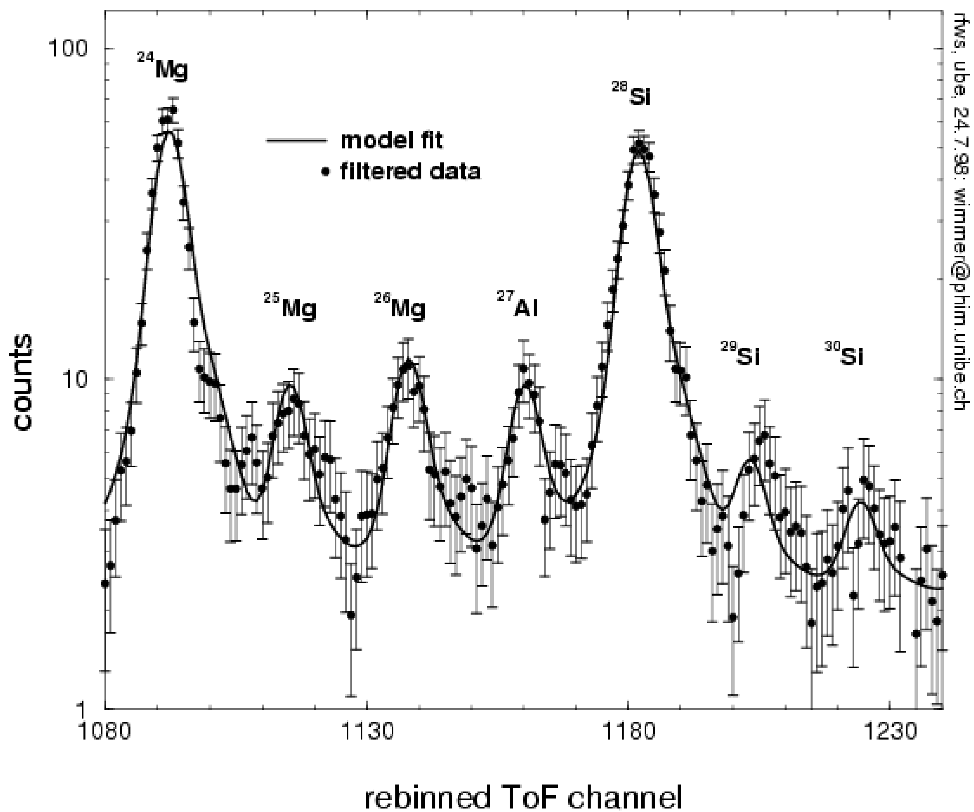


Joe Mazur (Aerospace Corp.), Glenn Mason and Joe Dwyer (UMD)

N

Solar Wind Isotopes in the May 3, 1998 CME: ACE/SWIMS Data

- Solar energetic particles (SEPs) in “gradual” events are accelerated at a shock driven by a coronal mass ejection (CME) moving through the corona into the interplanetary medium.
- The actual source of the accelerated material is a subject of controversy; possibilities include ambient coronal material, CME material, and solar wind. SEPs are sometimes enriched in heavy isotopes such as 22Ne and 26Mg; to date there are no reports of whether CME material is enriched in heavy isotopes.
- The figure shows SWIMS/ACE isotope data from the May, 3, 1998 CME - preliminary analysis of the Mg isotopes reveals very little or no enhancement of the heavier isotopes, 25Mg and 26Mg, with respect to the main isotope, 24Mg.
- As solar maximum approaches it should be possible to relate the isotopic composition of SEPs to that of additional possible seed populations observed at solar wind energies.



R.F. Wimmer-Schweingruber, U. of Bern, Switzerland

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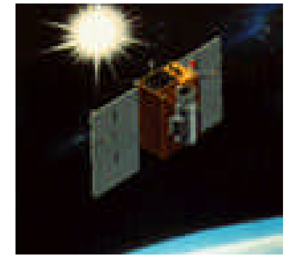
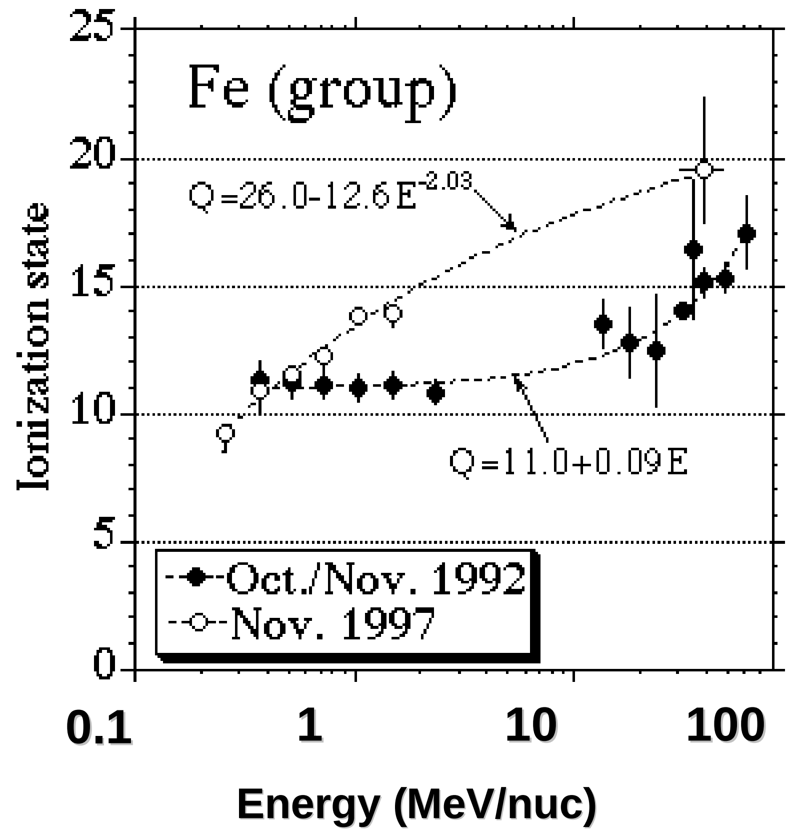
SAMPEX Data
Complement ACE data



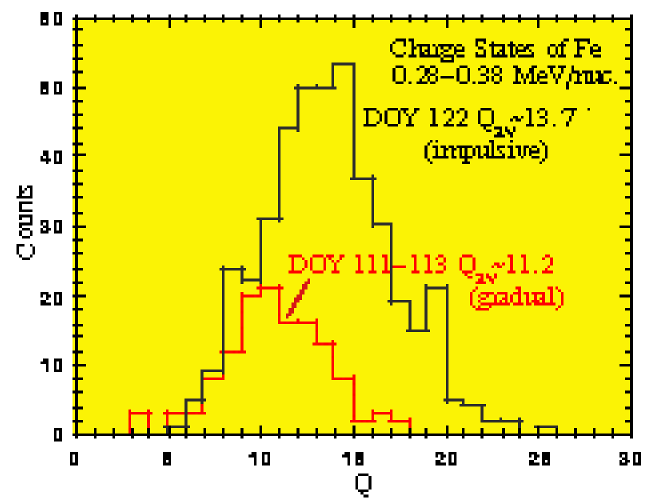
- SAMPEX instruments have measured the ionization states of solar flare accelerated iron nuclei by using the geomagnetic field as a magnetic spectrometer
  - The ionization states are important for understanding the origin and acceleration of the particles.
  - Usually the ionization state is interpreted as indicative of the temperature of the original plasma;
  - Charge states of +18 indicate temperatures of 7,000,000 K, while the lower charge states indicate temperatures of <2,000,000 K (see figure)
- In the Nov. 1997 event, large element and isotope abundance anomalies (fractionation) were observed on ACE; the ionization states are critically important for interpreting these data
  - This event showed an increase in ionization state from low to high energies-- this has not been seen before
  - These data give information about the source plasma temperatures and the acceleration processes, and are critical for understanding abundances observed on ACE

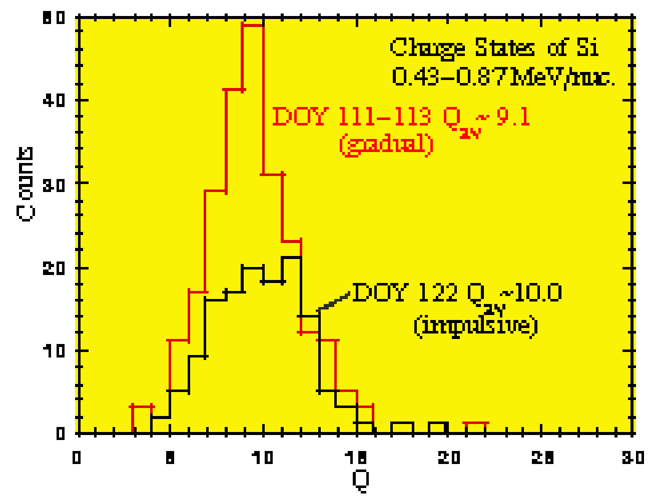


from Mazur, Mason, Looper, Leske & Mewaldt, Geophys. Res. Letters, 1998, in press

First Ionic Charge State Measurements in an Individual Impulsive Solar Particle Event

- There are two general classes of solar energetic particle (SEP) events: *gradual* events accelerated by shocks associated with coronal mass ejections, and *impulsive* events associated with solar flares. Impulsive events are enriched in the rare isotope 3He, and are generally much smaller in size.
- Ionic charge-state measurements provide insight into the source regions of the particles, and the mechanisms that accelerate them. The only previous measurements for impulsive events were summed over 22 3He-rich solar events (from ISEE-3).
- Data from ACE/SEPICA show that the Fe charge state is substantially greater in the impulsive event (Qav = 13.7 on Day 122/98) than for the gradual event (Qav = 11.2 for days 111-113/98). There is a smaller difference for the Si charge-states.
- If interpreted as temperatures in the source region, the Fe charge states give ~ 2.3 x 10^6K for the impulsive event and 1.4 x 10^6 K for the gradual event.
- These charge state values are somewhat lower than the 22-flare sum from ISEE-3, but the SEPICA energy range is also lower. SEPICA is now investigating event to event variations in the charge states.





Eberhard Mobius and Mark Popecki of The University of New Hampshire

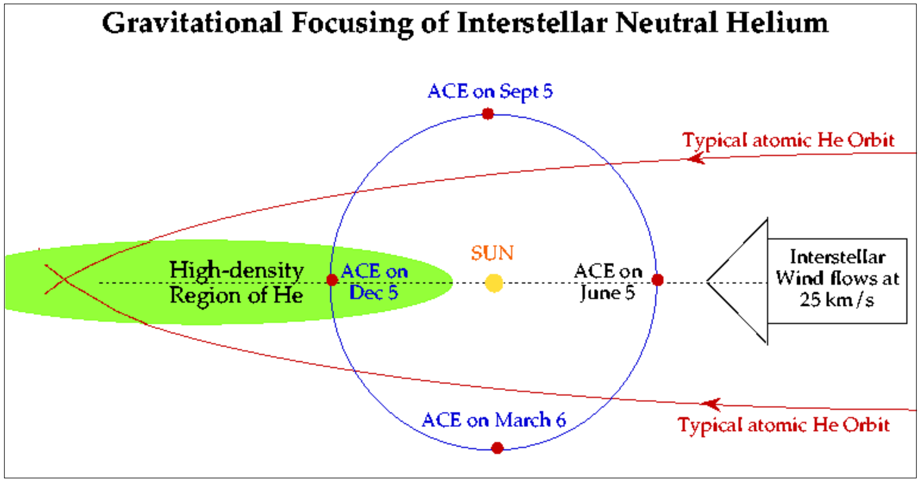
N

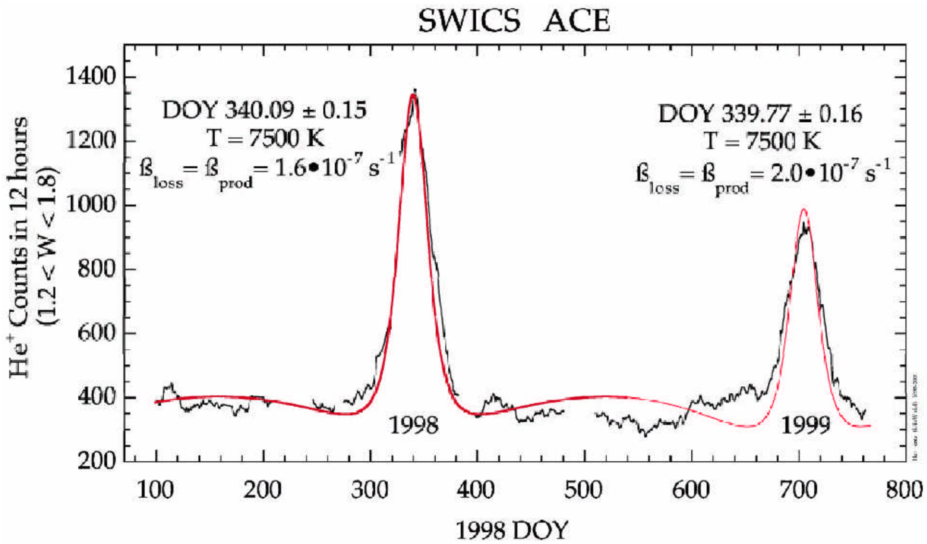
ACE uses Solar Gravitational Lensing of Interstellar Helium to infer Interstellar Gas Temperature

- The temperature of the interstellar gas surrounding our solar system has been inferred from observations of pickup ions with the SWICS instrument on ACE.
- As neutral interstellar helium atoms flow into the solar system their trajectories are bent by the Sun's gravity, as illustrated at right.
- The size of the high-density region produced by this gravitational focusing depends strongly on the temperature of the inflowing gas - higher temperatures produce a wider region. In early December of each year ACE samples the maximum interstellar He density.
- Pickup He+ is produced from interstellar atomic helium by photoionization at a typical rate of 10^{-7} s^{-1} with a density proportional to the neutral He density.
- The density of He^{+} pickup ions measured by SWICS/ACE shows a pronounced peak in early December (~ Day 340), as expected. The best fit to the density profile gives a temperature of ~7500 K and an ionization rate of ~1.6 x 10^{-7} s^{-1}.

Provided by George Gloeckler, University of Maryland

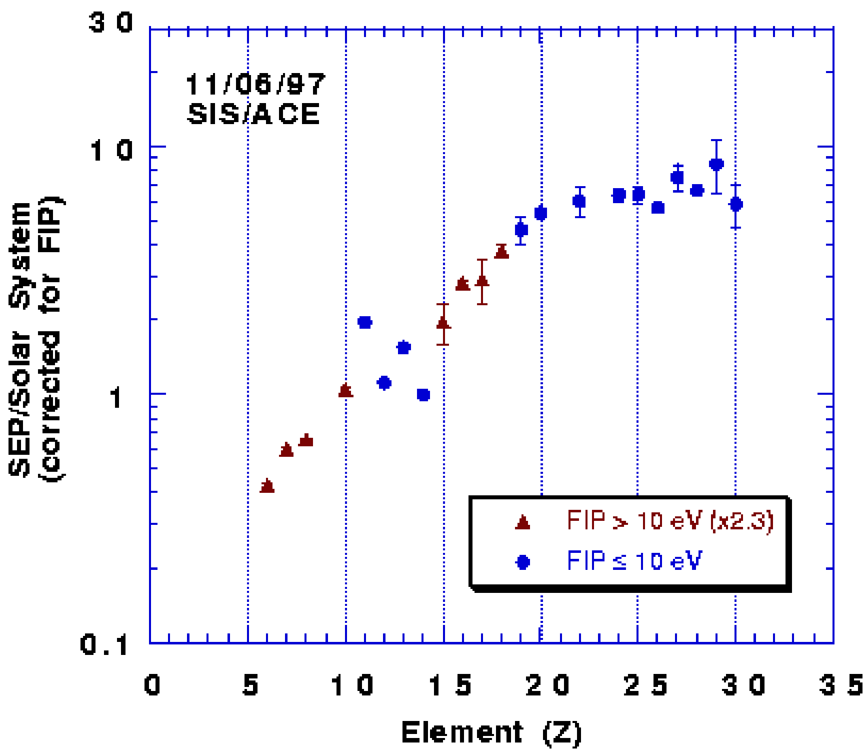
Updated August 2001 by A. Davis





Abundances in Solar Energetic Particle Events

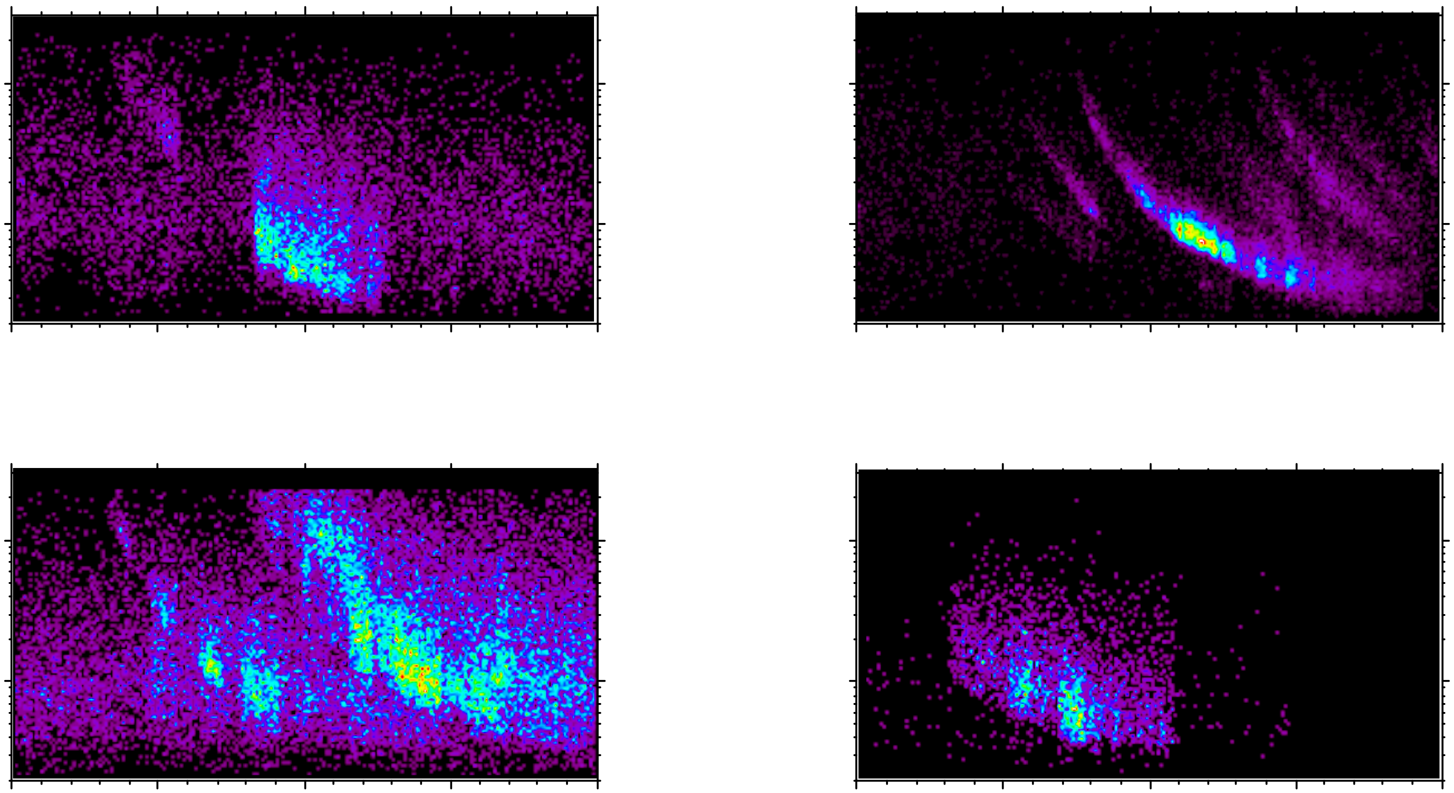
- **Solar Energetic Particle (SEP) events reflect the coronal composition, modified by fractionation effects associated with particle acceleration and transport.**
- **In the SEP event of 11/6/97 the SIS instrument on ACE identified 22 of the 25 elements with 6=Z=30, the most ever in a single SEP event.**
- **Compared to "solar system" abundances, this SEP event is enriched in heavy elements, presumably due to charge-to-mass (Q/M)-dependent acceleration effects (elements with Z>6 are not fully stripped in the corona).**
- **The enhancement of odd-Z elements (e.g., Z = 11, 13) is further evidence of Q/M-dependent fractionation (these elements are neutron-rich).**
- **In addition, elements with first ionization potential (FIP) >10 eV are depleted by ~X2 (similar to fast solar wind).**
- **Data such as these will provide improved coronal abundances for several rare species.**



Provided by Richard Mewaldt, Christina Cohen and Luke Sollitt, Caltech

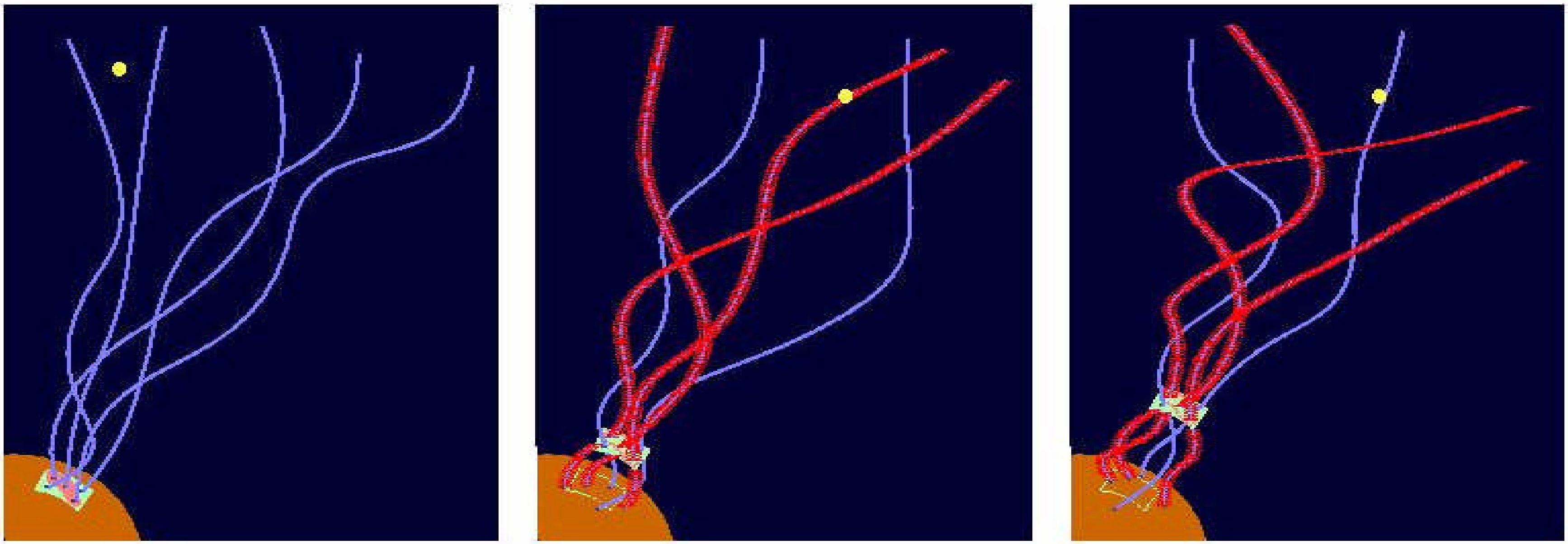
Possible Connection Between Solar Supergranulation and Temporal Variations of Solar Energetic Particles

Joe Mazur/Aerospace Corporation and Joe Giacalone/University of Arizona



- ACE/ULEIS observations of Carbon-Iron ions in SEP events show short-lived flux “drop-outs”
- The faster particles arrive earlier than slower particles. The overall profile is sporadically interrupted.
- These drop-outs can be simulated in a numerical model of particle transport developed by the Arizona group.

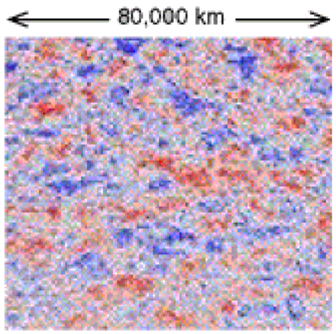
Possible Connection Between Solar Supergranulation and Temporal Variations of Solar Energetic Particles



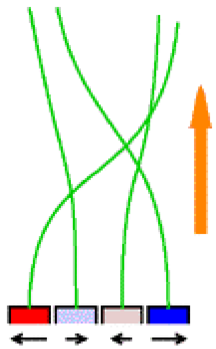
•In this model, particle events originate near the sun are constrained to follow the interplanetary magnetic field lines, which are anchored in the supergranulation network. The ends of the field lines execute a random walk resulting in large-scale field fluctuations that are carried into the interplanetary space by the solar wind.

Possible Connection between Solar Supergranulation and Temporal Variations of SEPs

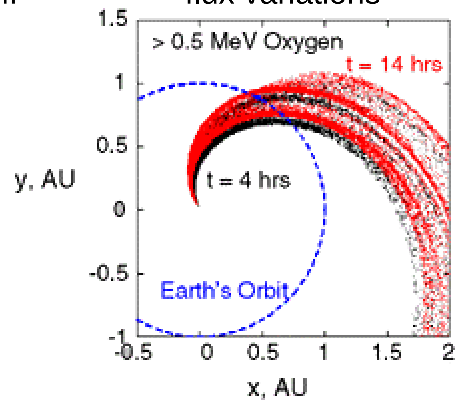
Photospheric Supergranulation...



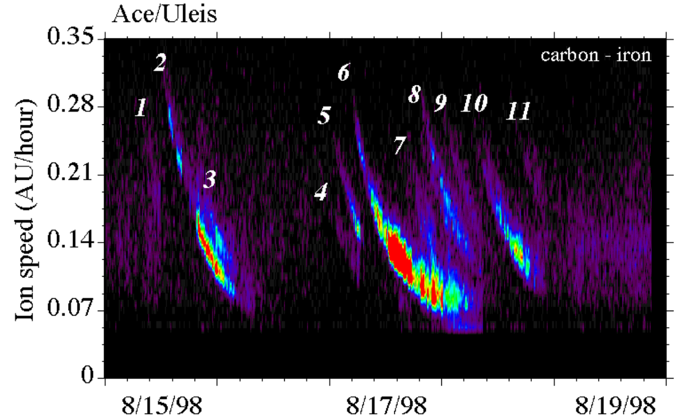
produces large-scale Fluctuations in IMF



causing SEP flux variations



…that may correspond to ACE observations



- **ACE measurements of the intensity patterns of solar energetic particles (SEPs) may be indirectly related to the supergranulation of the Sun's photosphere.**
- **These particle events originate near the sun and are constrained to follow the interplanetary magnetic field lines as they travel from the Sun to ACE, so they serve as unique tracers of the interplanetary magnetic field's structure.**
- **The ULEIS sensor on ACE often observes SEP events with short-lived (<1 hour) flux "drop-outs" (e.g. #5 and #8 above right).**
- **These drop-outs also occur in a numerical model of the particle transport that uses an interplanetary magnetic field whose field lines are anchored in the supergranulation network.**
- **The ends of the field lines execute a random walk in the photosphere, resulting in large-scale field fluctuations that are carried into interplanetary space by the solar wind.**
- **The long-wavelength turbulence affects the particle propagation in the model, producing similar features to those observed.**
- **ACE observations, backed by theoretical modeling, may therefore allow us to use these particle events to probe the large-scale structure of the heliospheric magnetic field.**

Provided by J. Giacalone of U. of Arizona and J. Mazur of Aerospace Corp.

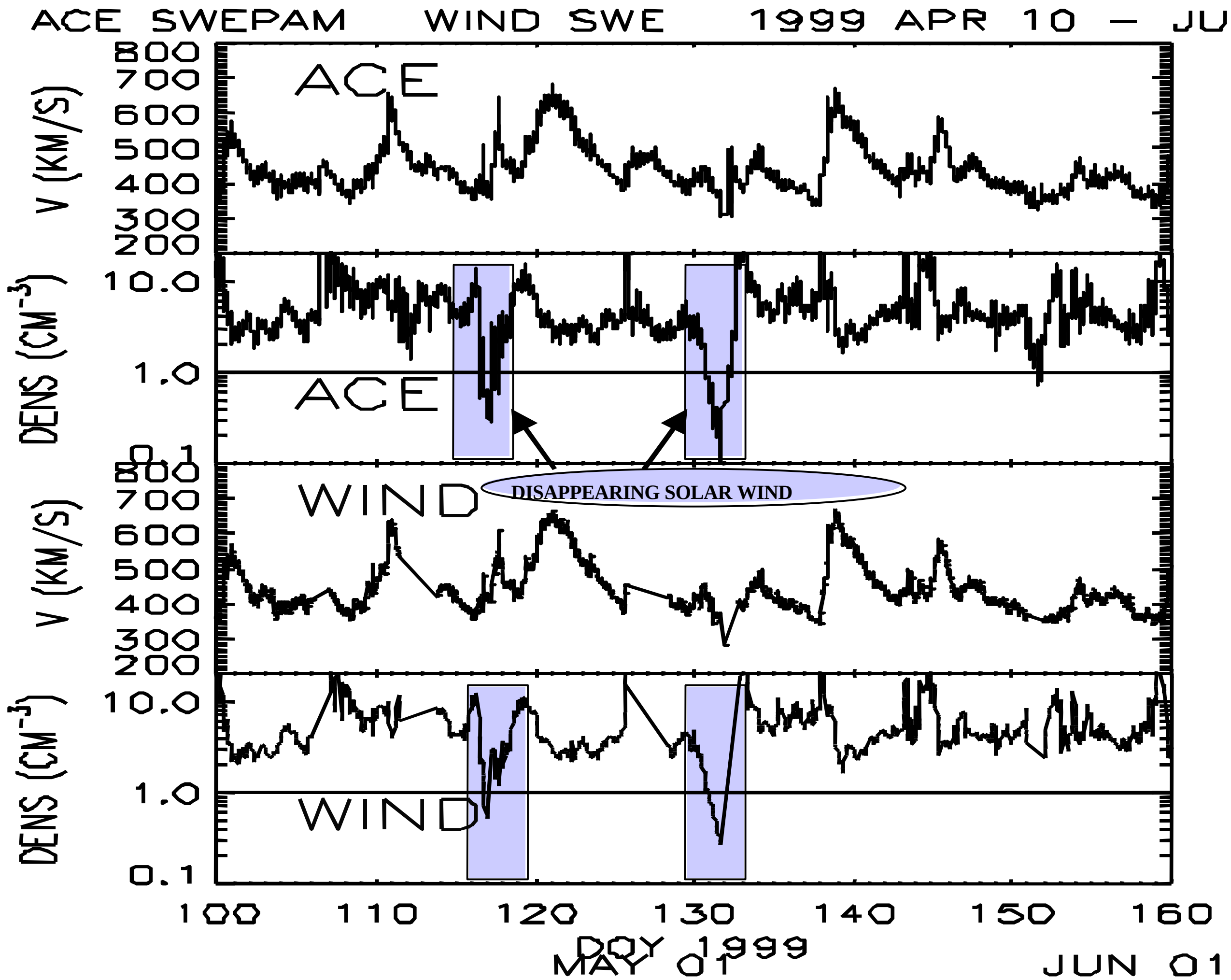
Heliospheric/ISTP Missions Science Highlights

James C. Ling
presented at the OSS Science Review
October 20, 1999

- **"Disappearance of Solar Wind"**
  - John Steinberg/LANL -ACE (SWEPAM), WIND, INTERBALL, IMP-8, & GEOTAIL
  - ISTP Team - LUNAR PROSPECTOR & ISTP MISSIONS
  - George Gleockler/Maryland - ACE (SWICS)
  - Dan Baker/Colorado & Shrikanth Kanekal/GSFC-SAMPEX & POLAR
- **"Evidence for Connection between Supergranulation and Interplanetary Magnetic Field and Solar Energetic Particles"**
  - Joe Mazur/Aerospace Corp. - ACE
  - Joe Giacalone/Arizona - Modeling

Disappearing Solar Wind

April 26-27 & May 10-12, 1999

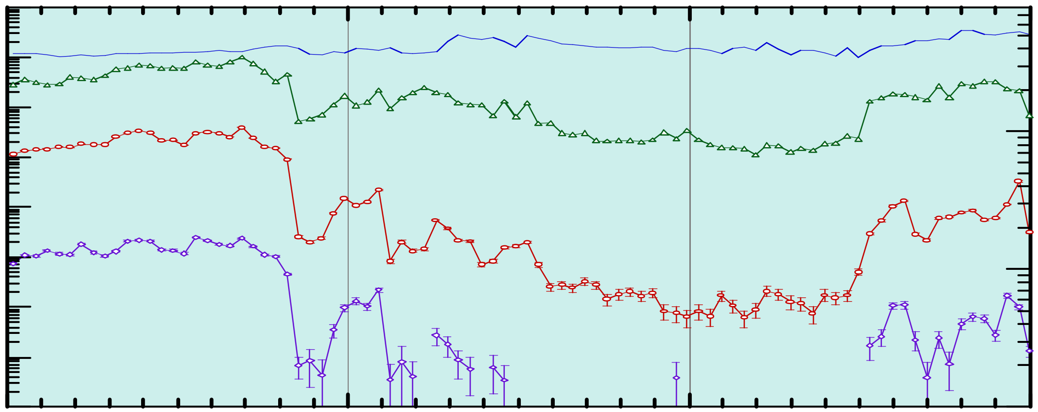


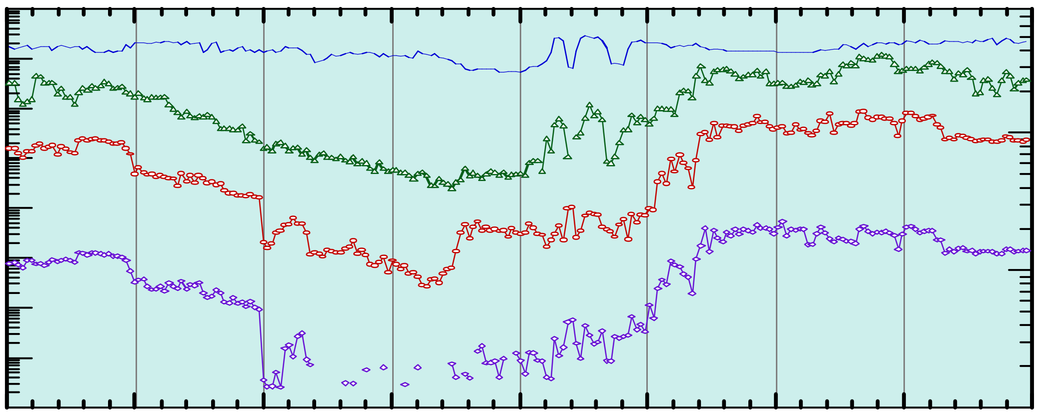
- SOLAR WIND DENSITY BELOW 1 CM $^{-3}$ IS RARE
- UNUSUALLY LOW SOLAR WIND DENSITY SEEN TWICE DURING APRIL-MAY 1999
- SEEN AT MORE THAN ONE SPACECRAFT
- THE SECOND EVENT LASTED FOR *MORE THAN A DAY*

J.T. Steinberg
LANL

Disappearing Solar Wind

April 26-27 & May 10-12, 1999



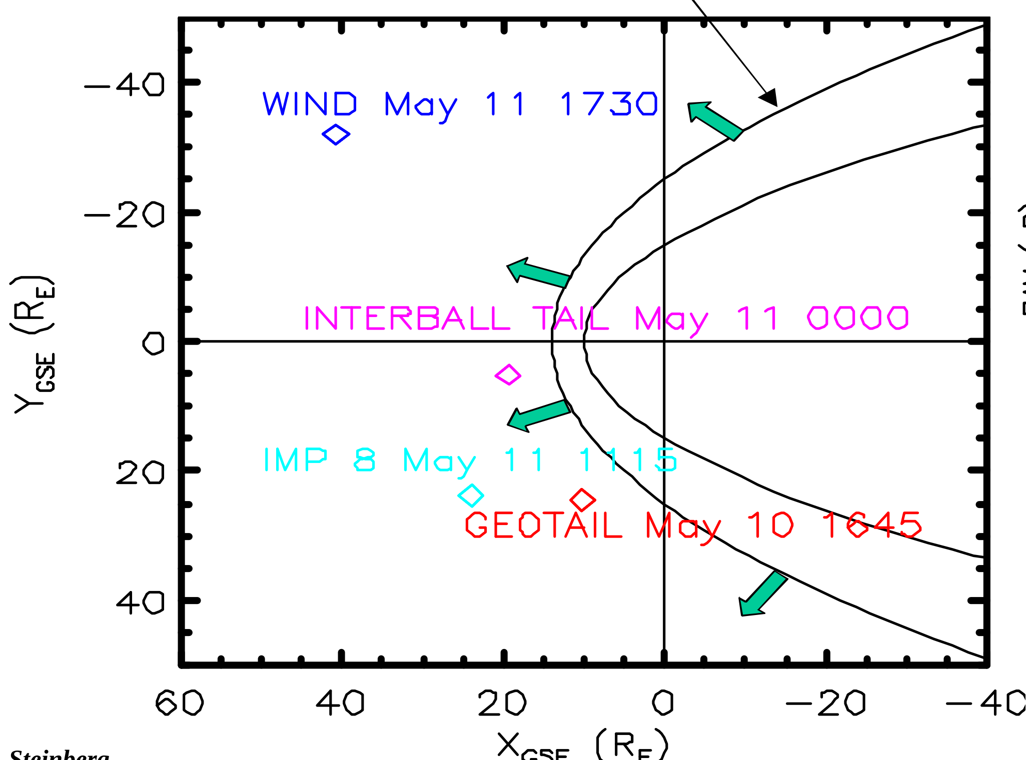


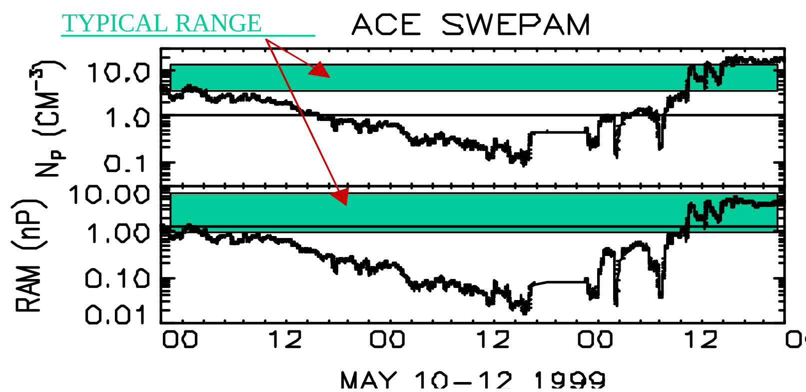
Disappearing Solar Wind

Bow Shock Crossings Observed by GEOTAIL, INTERBALL, IMP-8, WIND, AND LUNAR PROSPECTOR

EARTH'S BOW SHOCK EXPANDS DUE TO LOW SOLAR WIND RAM PRESSURE.
SEVERAL S/C CROSSED BY SHOCK AT *UNUSUALLY LARGE* UPSTREAM DISTANCES

Bow shock location for typical solar wind



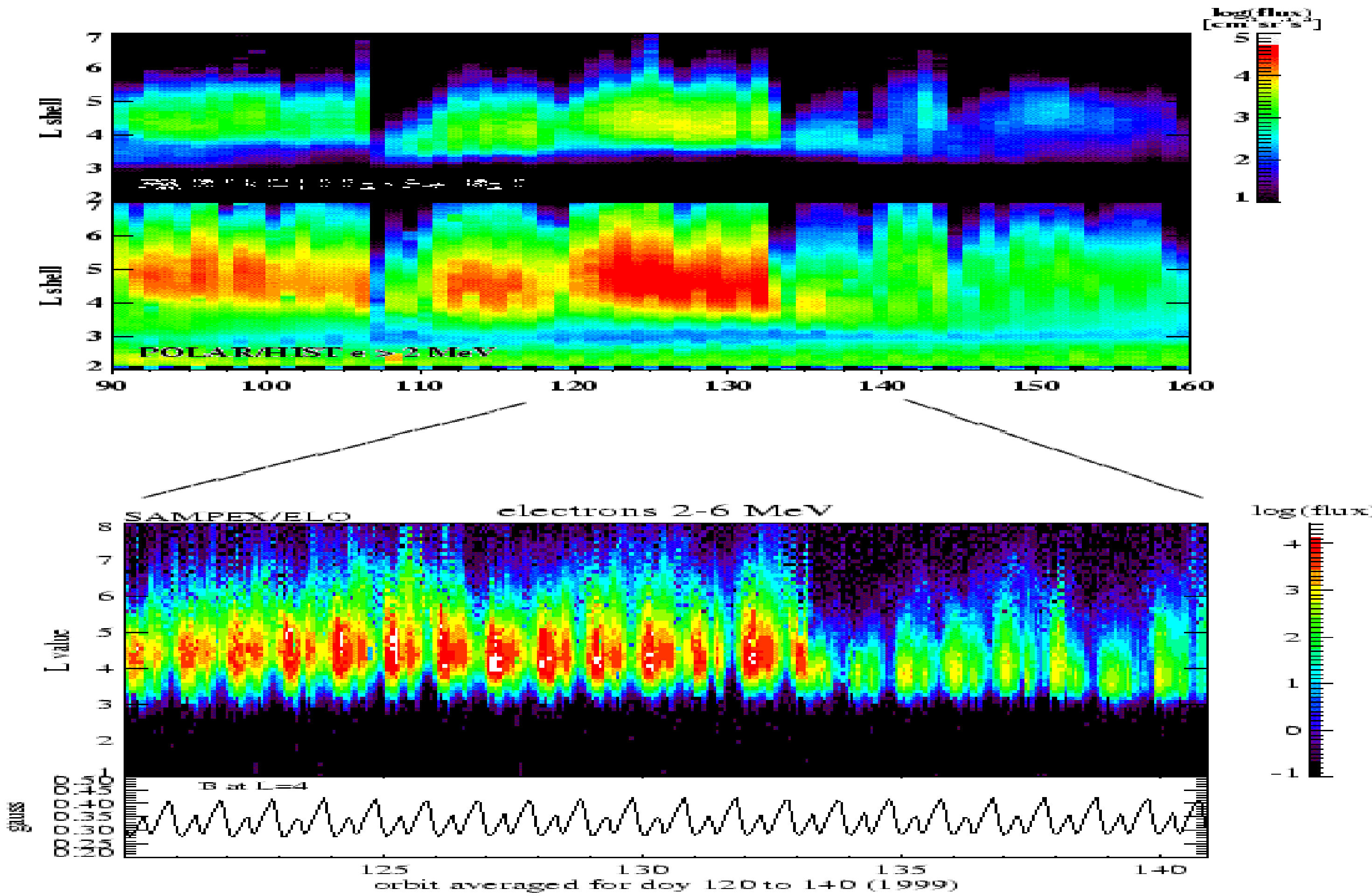


Location and time of bow shock encounter shown for GEOTAIL, INTERBALL TAIL, IMP 8, and WIND

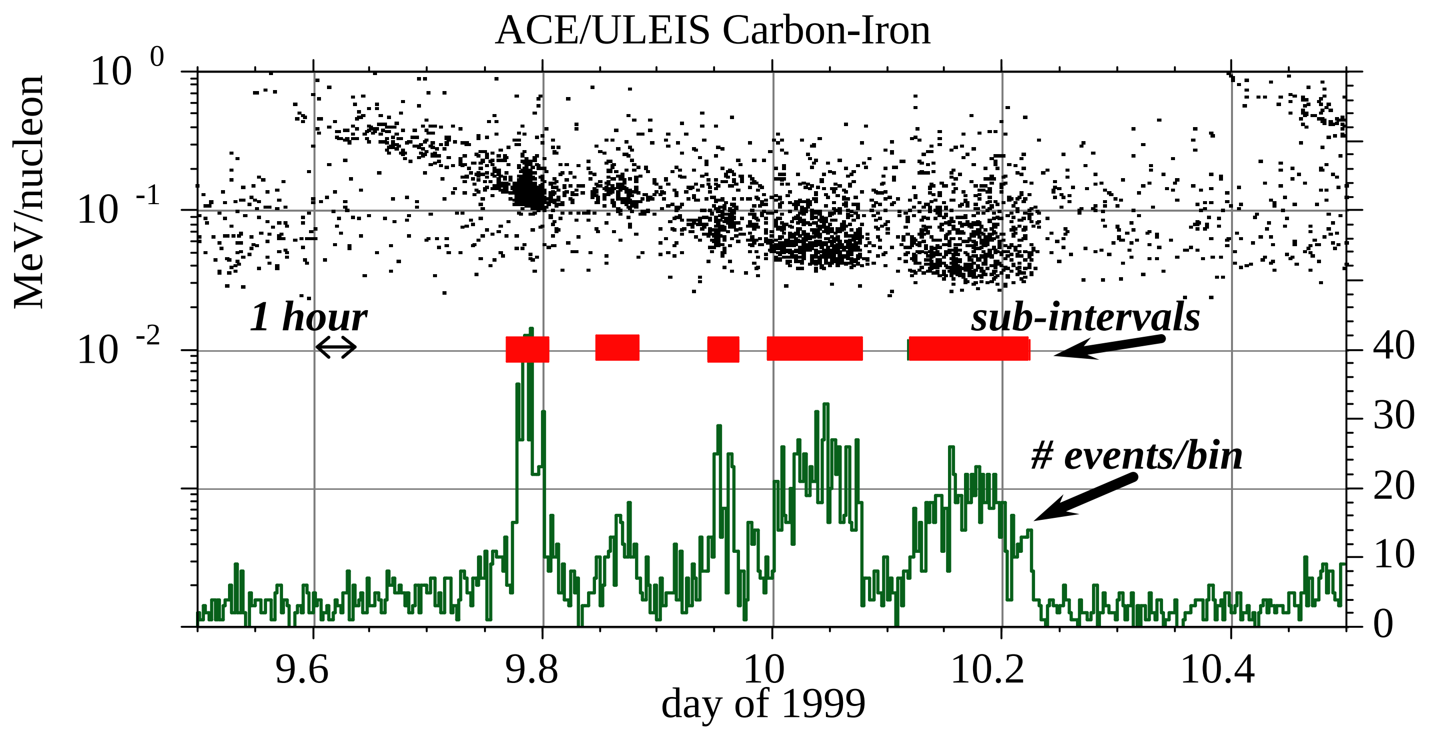
J.T. Steinberg
LANL

Disappearing Solar Wind Event

SAMPEX & POLAR - 2-6 MeV Electrons Intensity at Different Lvs.Time

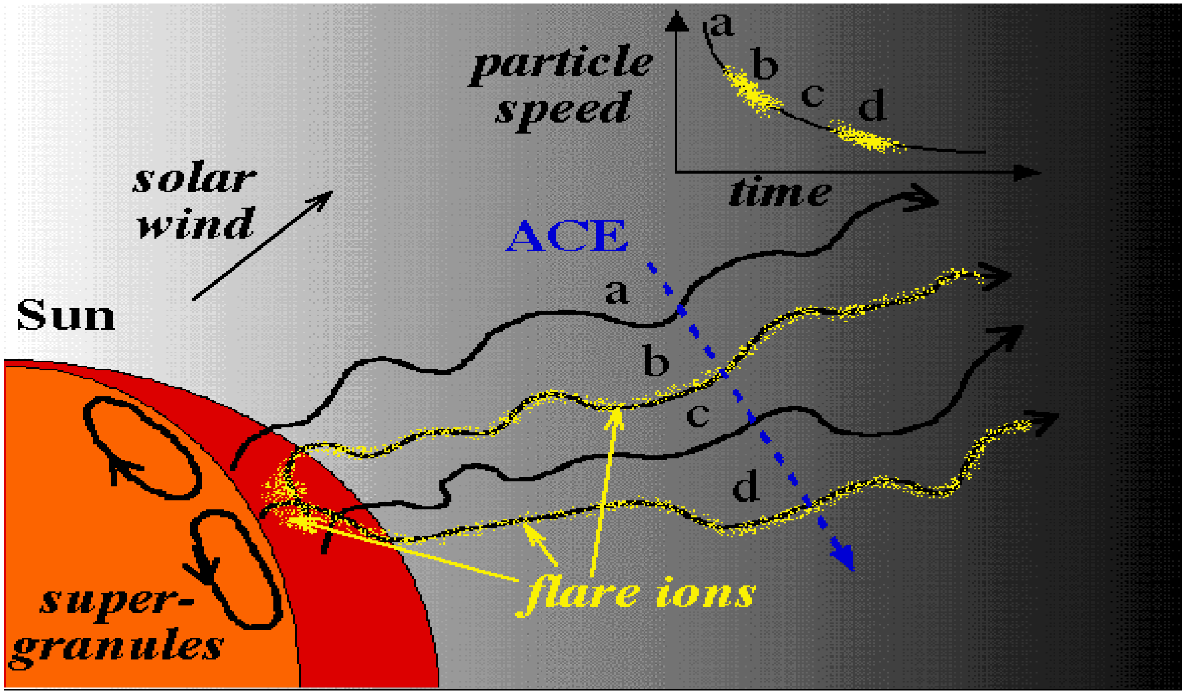


ACE: Evidence for Connection between Supergranulation and Interplanetary Magnetic Field and Solar Energetic Particles



- This is an example of particles from a solar flare observed on ACE that show short-lived flux “drop-outs”.
- The faster particles arrive first as expected, but the overall profile is sporadically interrupted.
- These drop-outs also occur in a numerical model of the particle transport that uses an interplanetary magnetic field whose field lines are anchored in the Sun’s supergranulation network.

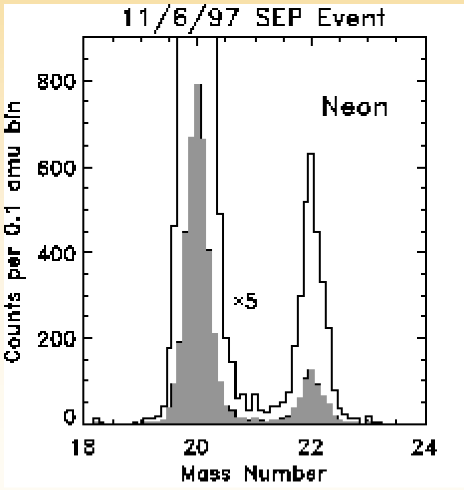
ACE: Evidence for Connection between Supergranulation and Interplanetary Magnetic Field and Solar Energetic Particles

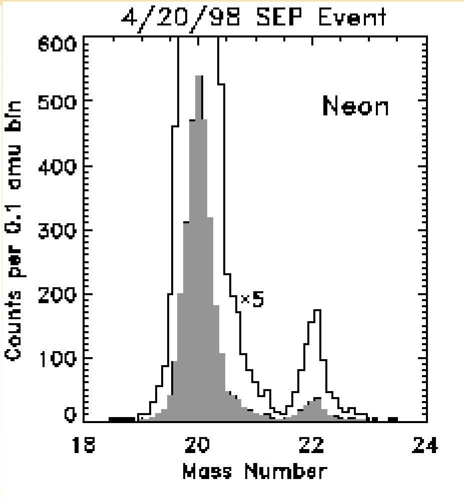


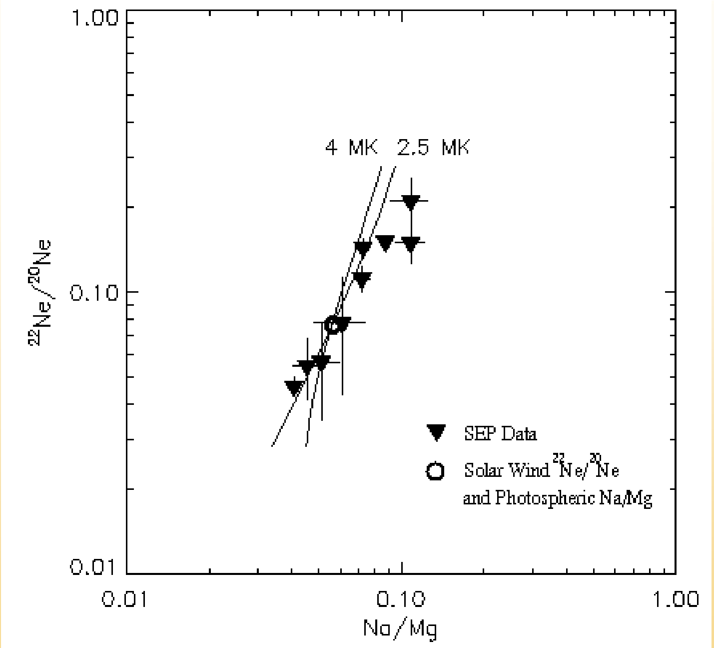
- In the model, the ends of the Sun's field lines execute a random walk in the photosphere, resulting in large-scale field fluctuations that are carried into interplanetary space by the solar wind.
- The long-wavelength turbulence leads to some field lines at ACE on which no flare particles travel.
- The ACE observations, backed by theoretical modeling, may therefore allow us to use these particle events to probe the large-scale structure of the heliospheric magnetic field.

Mass Fractionation in the Composition of Solar Energetic Particles

- Although it is well known that elemental abundances vary from one solar energetic particle (SEP) event to another, until recently little was known about whether the isotopic composition of heavy elements also varies.
- Data from ACE/SIS now show that some isotope ratios such as 22Ne/20Ne can vary by a factor of 3 or more from event to event.
- In the 11/6/97 event a ratio of ^{22}Ne/^{20}Ne ~ 0.15 was observed, approximately twice that measured in the solar wind, while in the 4/20/98 event the ratio was only ~0.05.
- The correlation of ^{22}Ne/^{20}Ne with elemental abundance ratios such as Na/Mg is consistent with a charge/mass-dependent fractionation process of unknown origin if the charge states reflect temperatures of ~2 to ~4 MK.
- Although the long-term average of SEP ^{22}Ne/^{20}Ne is not yet known, these variations may shed light on the unknown origin of a component of Ne (with ^{22}Ne/^{20}Ne ~ 0.09) found in lunar soil.



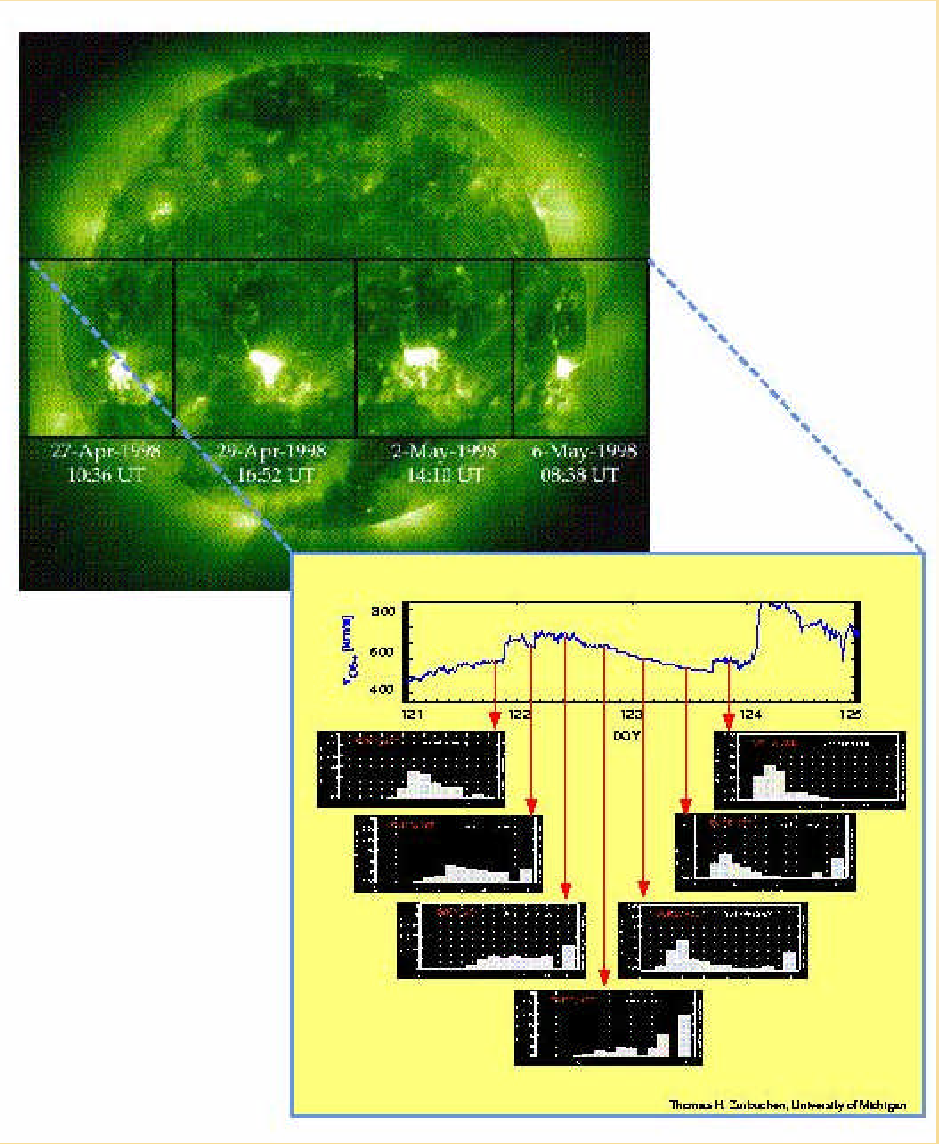




ACE

ACE and SOHO
Reveal Unusual Thermal History of a CME

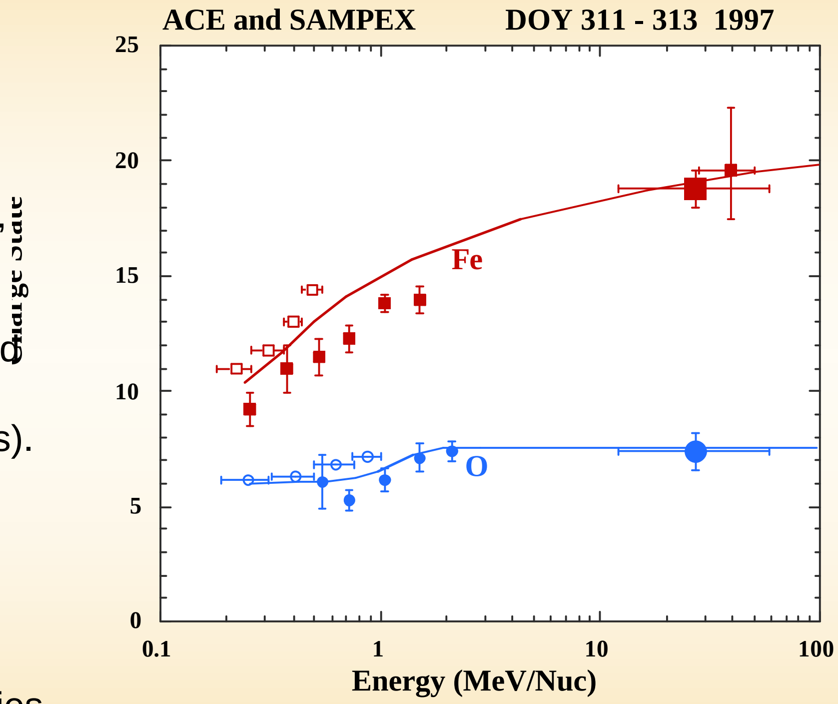
- In April/May 1998 a series of flares were observed from active region 8210 (see SOHO/EIT images at right). The April 29 event led to a CME observed by SOHO instruments LASCO and UVCS.
- A few days later the ACE/SWICS instrument observed the CME plasma in situ, providing ionic charge state data with unprecedented resolution.
- The observed charge-states in a CME plasma are an imprint of the electron temperature distribution a few solar radii above the solar surface.
- The iron charge states imply a surprisingly wide range of temperatures. Until midway on 98:122 Fe^{16+} dominates, implying temperatures of several million degrees.
- About a day later very cold (~10^5 K) plasma is observed, including the first observations of solar wind Fe^{3+}. Indeed, Fe^{3+} and Fe^{16+} co-exist .
- These data provide a missing link between CME images and in situ observations of electron & proton temperatures in plasma at 1 AU.



ACE

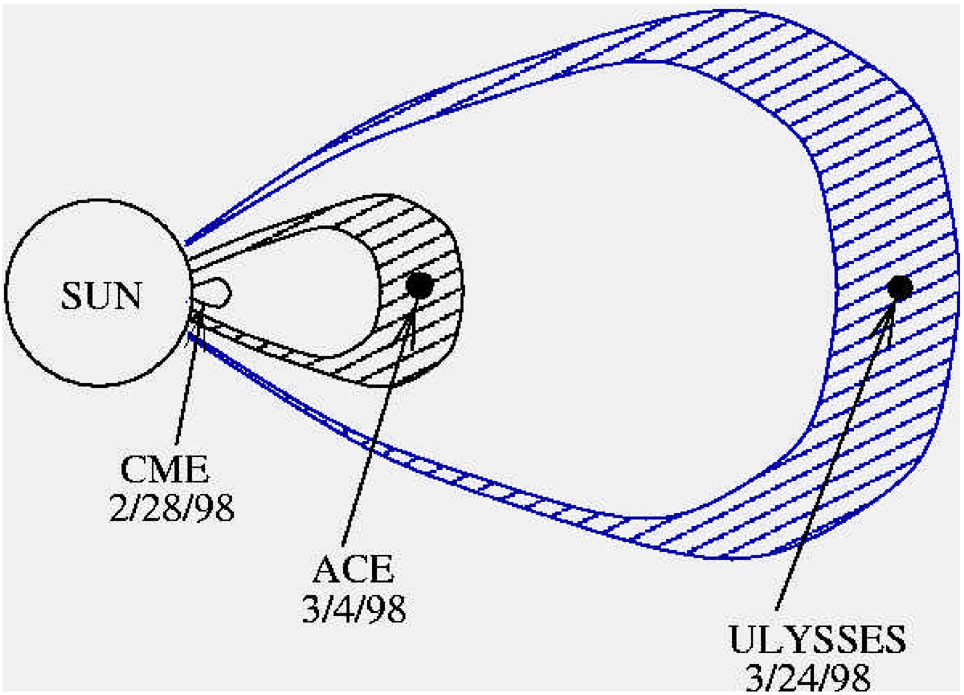
Energy Variation of Solar-Particle Charge States Observed with ACE and SAMPEX

- Ionic charge states of solar energetic particles (SEPs) reflect the temperature at their source and effects of acceleration and transport processes.
- Previous ISEE-3 measurements below 1 MeV/nuc found average charge states for O and Fe indicative of T = 1-2 MK, with no detectable energy dependence.
- However, new charge state determinations in the Nov. 6, 1997 event increase with energy, including direct determinations from ACE/ SEPICA (open symbols), SAMPEX data using the geomagnetic cut-off method (filled symbols), and charge states inferred from mass/charge dependent fractionation with ACE/SIS (large filled symbols).
- The new measurements are consistent with the ISEE-3 data where they overlap, but reveal that SEP events are more complex than previously thought.
- The substantial energy variation observed for Fe, which supports earlier SAMPEX reports at higher energies, implies source temperatures of ~ 10^6 K at low energies and ~ 10^7 K at the highest energies. The cause of this energy dependence is as yet unknown.



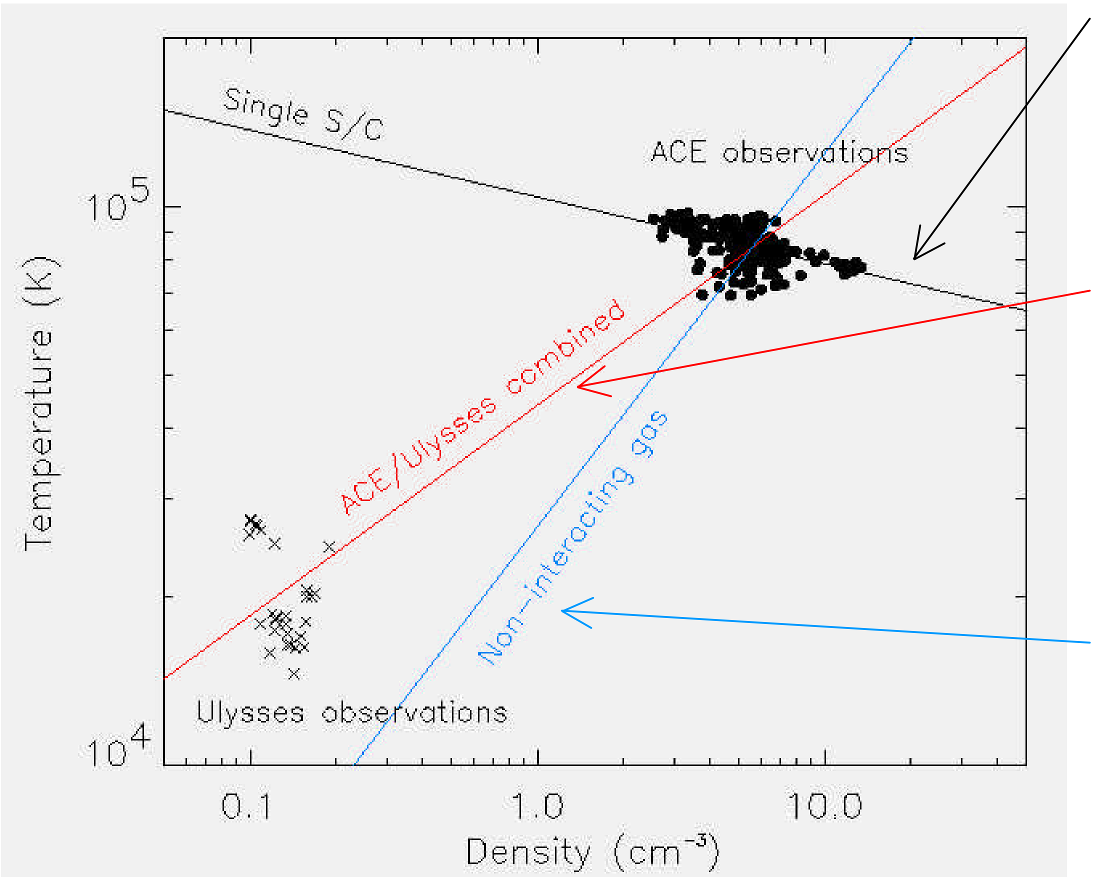
ACE

A coronal mass ejection (CME) observed in the solar wind by both ACE (1 AU) and Ulysses (5 AU)



- ~1/3 of coronal mass ejections (CMEs) are seen as magnetic clouds in interplanetary space
- 25 years of single-spacecraft observations of CMEs and clouds cannot explain how CMEs expand
- In March, 1998, the ACE and Ulysses spacecraft were radially aligned with respect to the Sun
- This lineup provided the first solar wind observations of the same CME, which was also a magnetic cloud, at two very different distances from the Sun

Plasma density and temperature variations as the CME expanded from 1 to 5 AU



- Single-spacecraft measurements suggest that temperature may increase as the CME expands
- In contrast, two-spacecraft observations show that both density and temperature decreased as the CME expanded
- The temperature decrease was less than that expected for a non-interacting gas, allowing quantification of the interaction between solar wind particles

ACE Instrument Status Report

Cosmic Ray Isotope Spectrometer (CRIS)

Normal Operation.

Electron Proton Alpha Monitor (EPAM) and Magnetometer (MAG)

Normal Operation.
RTSW data was valid during the July 14-16 event.

Solar Energetic Particle Ionic Charge Analyser (SEPICA)

SEPICA is presently generating science data on half of Fan 3. Diagnostic tests are in progress to determine the cause of anomalies with several data channels required to produce good science from the other half of Fan 3. The science data within SEPICA will be redirected to a spare portion of instrument memory to test the possibility that the existing memory has been damaged. A procedure to perform this step is in final test, and may be uploaded to the instrument this week.

Fan pressures have been stable for approximately eight months.
Fan 2 is still just below the threshold for operation, and
Fan 3 is at a completely nominal pressure.

ACE Instrument Status Report (cont.)

Solar Isotope Spectrometer (SIS)

Normal Operation.

July 14 event: Because of the large geometry factor of the instrument, SIS count rates were saturated for several days during event, rendering the RTSW data invalid for the period. Detector thresholds were raised in order to reduce the count rates. However, raising these thresholds causes NOAA RTSW data processing software to calculate incorrect fluxes. The thresholds were lowered when particle intensities dropped sufficiently. The SIS team is considering options for improving the instrument response to events like this in the future. SIS continued to return pulse-height data during the event, and analysis of these data is underway.

Solar Wind Electron Proton Alpha Monitor (SWEPAM)

Normal Operation. No changes to instrument operation in recent months.

July 14 event: High background counts caused a breakdown in the onboard algorithm which chooses the energy range to measure. Because of the high counts, the instrument always measured the lowest possible energy range (~250 eV to 1.8 keV). During the event, the solar wind speed was sufficiently high that this energy range did not include the main solar wind proton beam. The instrument was healthy, it just was looking in the wrong place. The SWEPAM RTSW data was not valid for ~36 hours during the event because of this effect. However, SWEPAM also has a mode which measures the full energy range (250 eV to ~17 keV) once each half hour. These data do show the solar wind peak, and we should eventually be able to solar solar wind moments from them.

ACE Instrument Status Report (cont.)

Solar Wind Ion Composition Spectrometer (SWICS) and
Solar Wind Ion Mass Spectrometer (SWIMS)

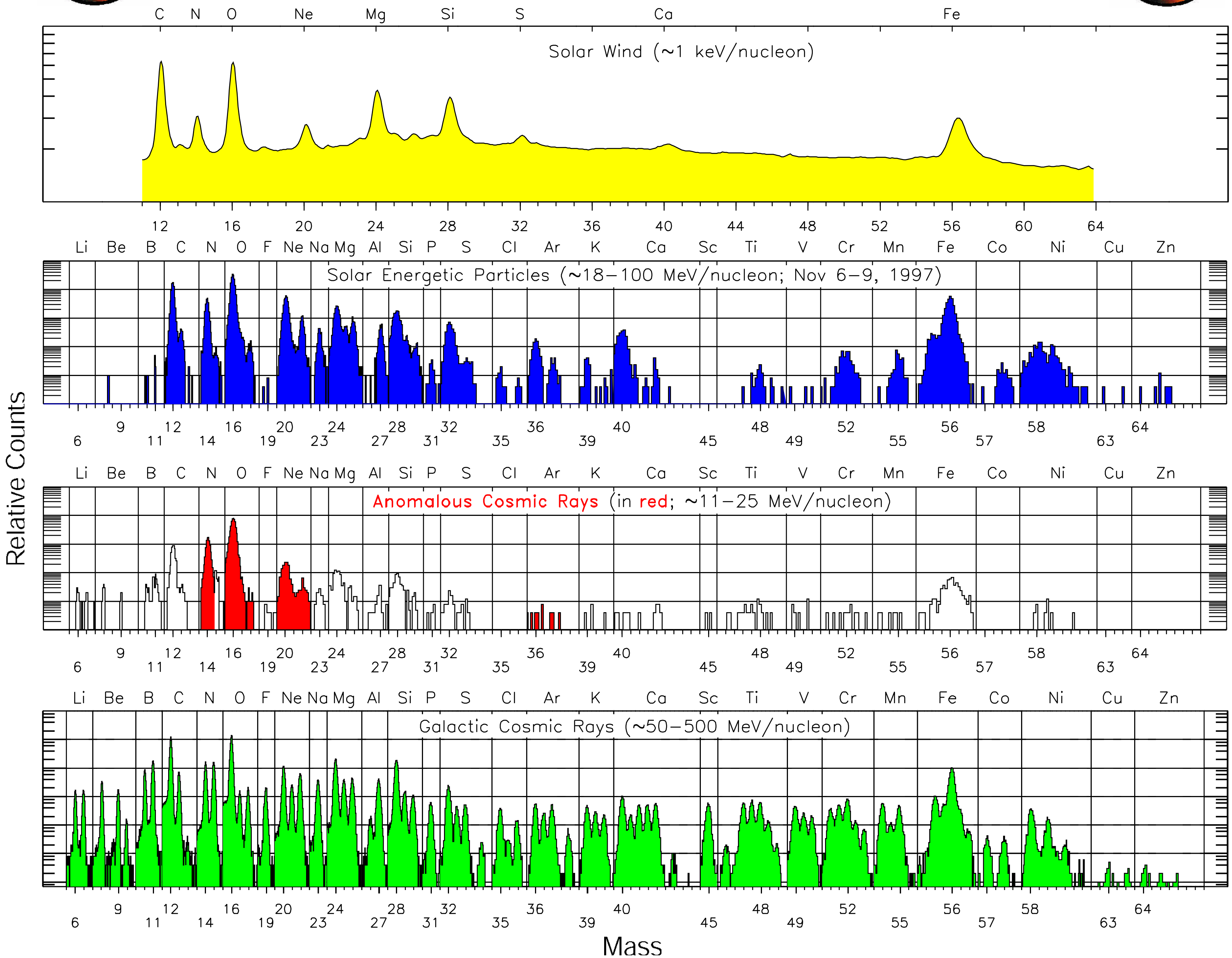
Normal Operation.

SWICS and SWIMS are just fine, with no anomalies whatsoever. In May of this year the level of the SWICS Post Acceleration Power Supply was increased to about 26.1 kV (from its previous 22.8 kV) and it has operated there without incident since then. The higher voltage level increases the energy range of SWICS measurements. Except for extremely high count rates, there were also no anomalies during the solar storm period of July 14-16, 2000.

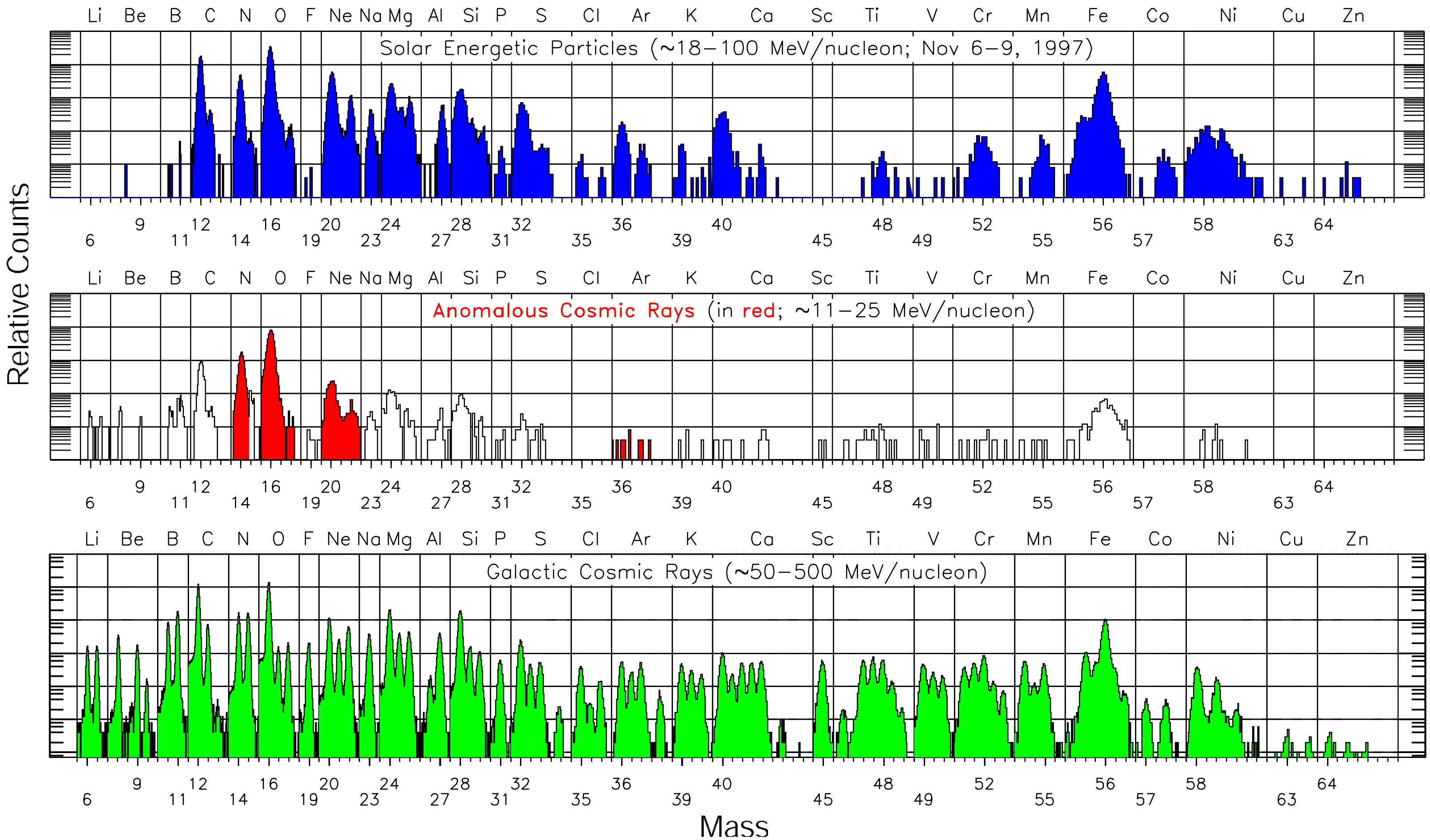
Ultra Low Energy Isotope Spectrometer (ULEIS)

Since April 3, 2000 one of the two redundant TOF systems in ULEIS (TOF-1) has not returned reliable data. Therefore the ULEIS team has turned off the high voltage on the TOF-1 system to minimize the risk of high voltage discharge. The command was executed on June 19, 2000. The ULEIS team has found that the mass resolution from the remaining TOF-2 system is quite good, and isotopes such as ^{3}He and ^{22}Ne are still resolved.

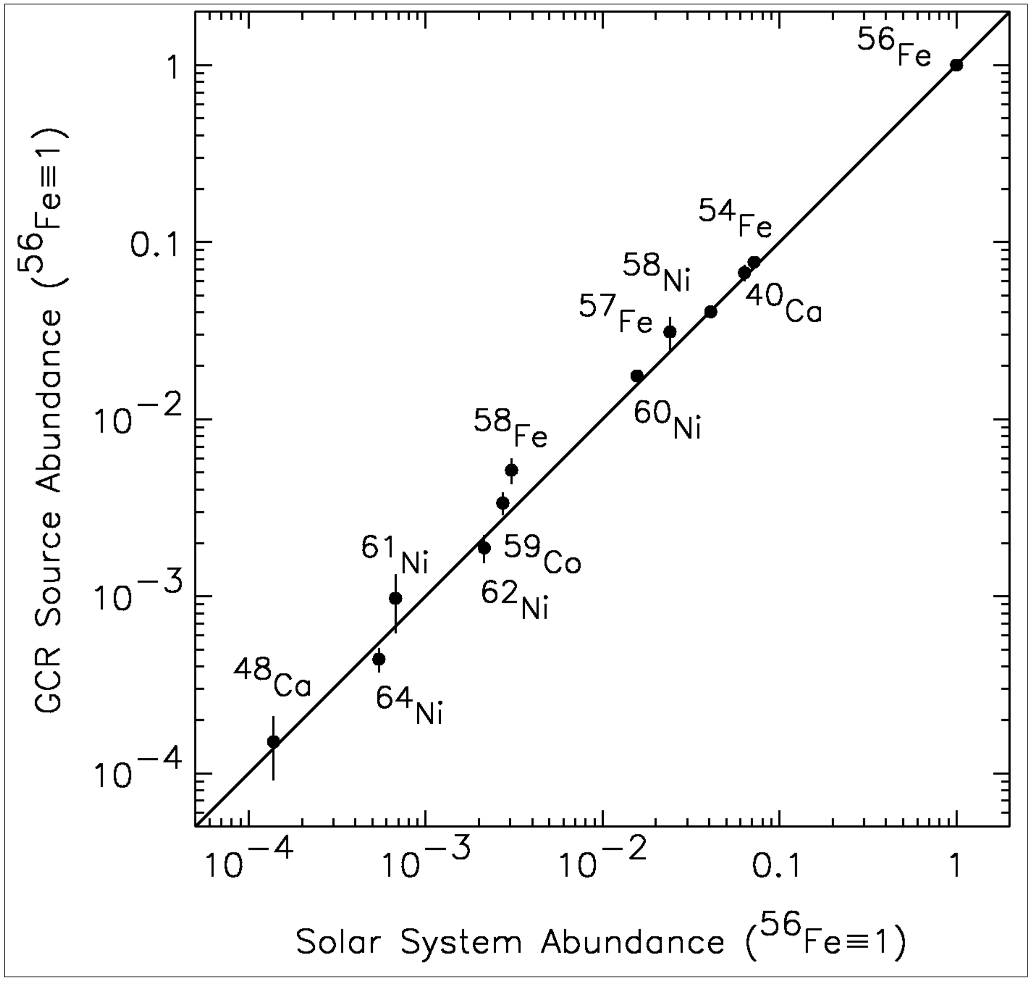
Four Samples of Matter from ACE



Three Samples of Matter from ACE



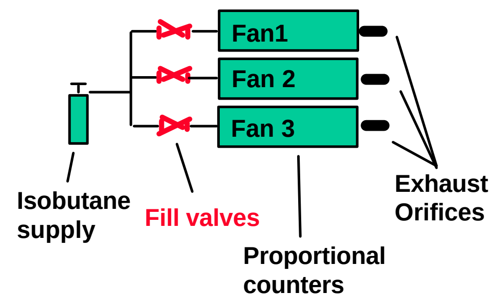
Cosmic-Ray Isotope Abundances Compared with Solar System

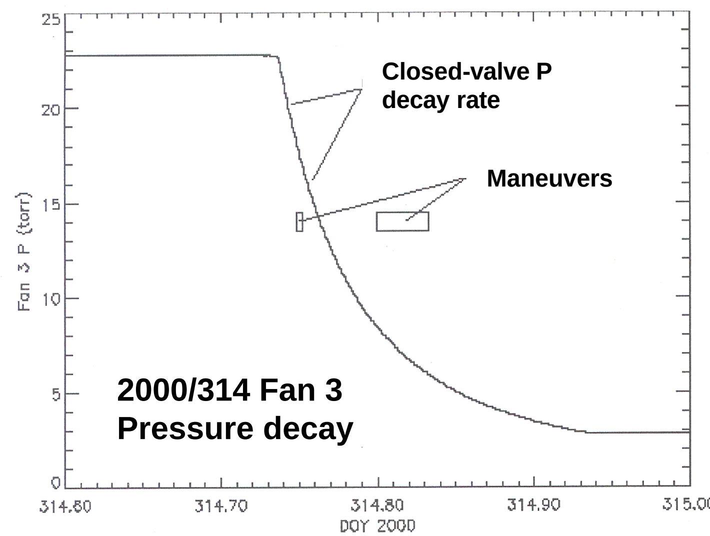


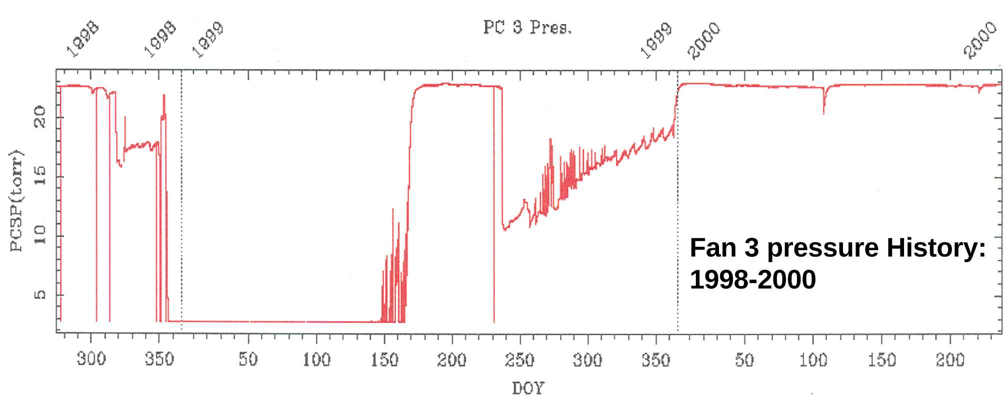
- Cosmic-ray source abundance have been obtained for 12 isotopes of the elements Fe, Co, Ni, and Ca using data from the ACE Cosmic-Ray Isotope Spectrometer (CRIS).
- In comparing the derived composition with that of primordial solar system material, it is found that although the abundances range over a factor of nearly 10^4, the compositions of these two populations of matter are very similar, differing by less than a factor of 2 for each of these isotopes.
- A possible interpretation of these similarities is that the cosmic-rays were derived from interstellar matter, as was the solar system. If this is the case, then the composition comparison probes the extent of chemical evolution of interstellar matter between the time when the solar system formed ~ 4.6 Gyr ago and when the cosmic-rays were accelerated only ~ 15 Myr ago

SEPICA Gas System

- The isobutane pressure in the SEPICA Fan-3 suddenly decayed on day 2000/314, as had also occurred on previous occasions.
- Isobutane is delivered through fill valves, then exhausted to space; the isobutane supply is still xx% full.
- Valves were designed to be normally closed & electrically opened.
- Electrical paths have broken on Fans 1 & 2, but valves may still open and close spontaneously.
- Fan 3 pressure decay on day 314 is not unusual.
- Fan 3 valve is still electrically operable, but no active. operation is planned at this time.



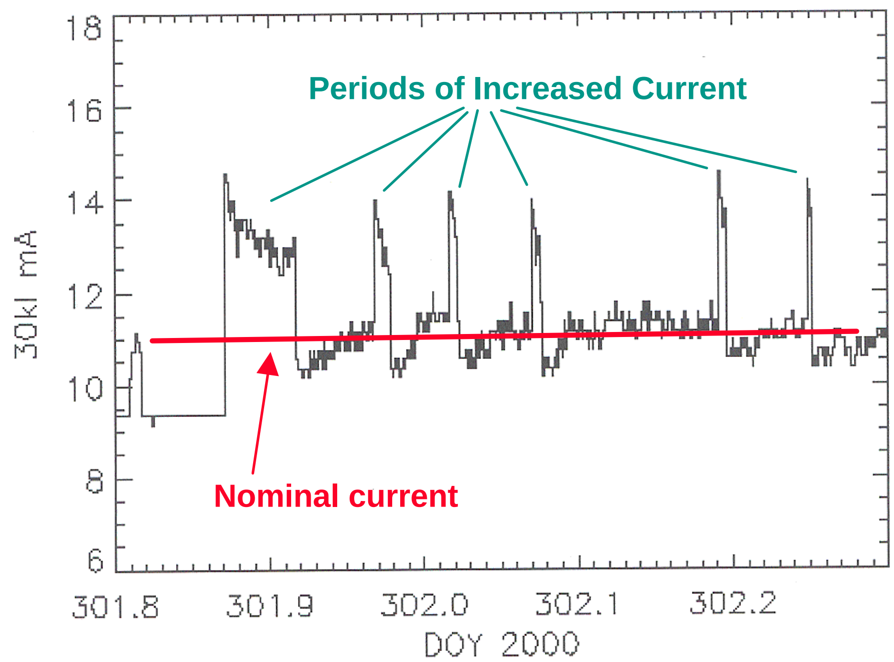




SEPICA 30kV Anomaly

- The SEPICA 30kV supply was shut down by the S3DPU on 2000/299 (Oct. 25) for a high current limit violation.
- It would not restart with the usual procedure because of subsequent current violations.
- Operation at low HV has shown a current behavior that may be consistent with a part failure in the HV supply.
- Discussions with the original engineers are in progress. Lab tests are planned to reproduce the anomaly with a spare HV unit.
- An instrument restart is planned to address the possible role of logic latchups.
- The high voltage supply is still functional, however high voltage levels may be limited in the future. This may limit the range of measurable charge states, or the energy range over which they can be measured.

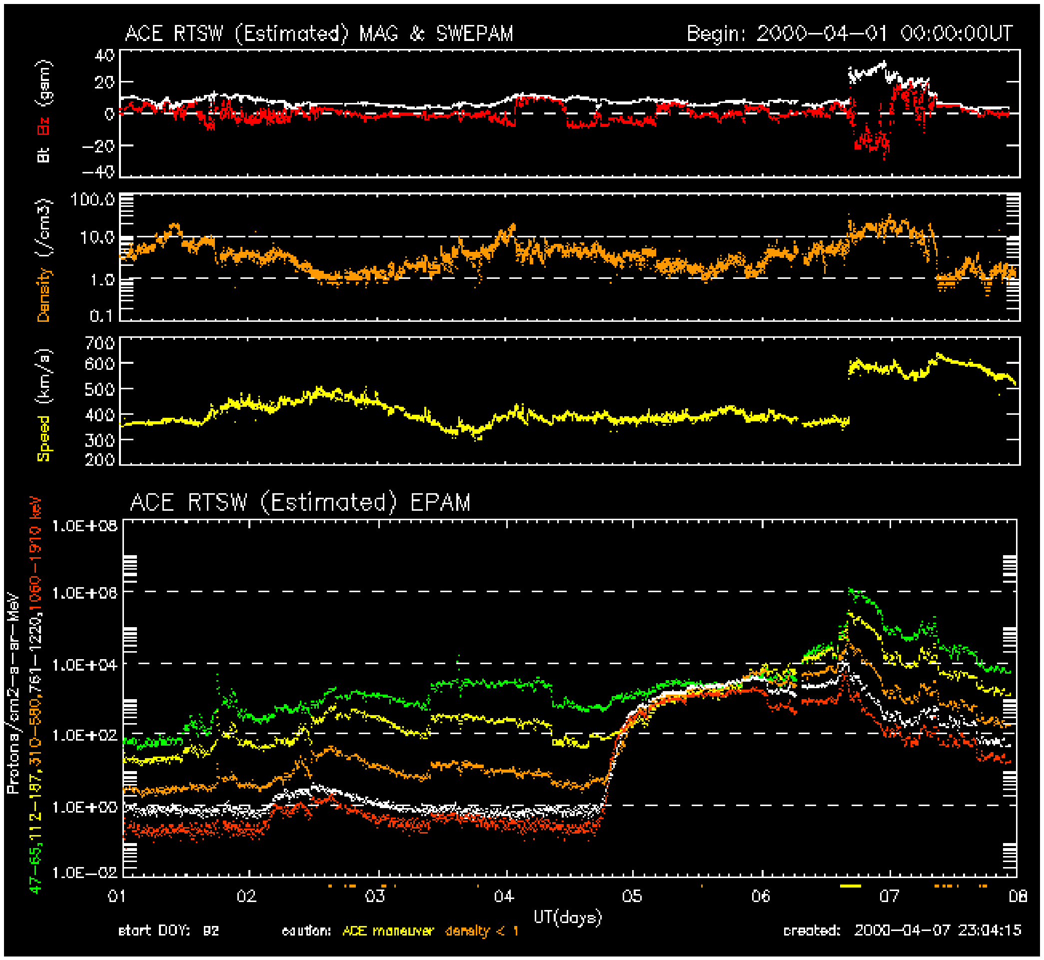
30kV current at Low HV after the 00/299 Shutdown



SEPICA Effects on ACE Level-1 Requirements

- **To meet its Minimum Mission Success Criteria, ACE had to accomplish at least seven of ten measurement objectives. During the first two years at L1, all ten of these objectives were accomplished.**
- **SEPICA contributed to four of these ten objectives, but it is not required to continue addressing these objectives if the other instruments perform as designed.**
- **To meet its own Level-1 performance requirements, SEPICA must be able to measure both elemental and ionic charge-state composition.**
- **Charge-state measurements require a high voltage of at least 5 to 10 kV; element composition studies require only that the gas flow be restored.**
- **Although we are hopeful that SEPICA capabilities will be restored, the loss of SEPICA data will not prevent ACE from continuing to accomplish its scientific goals.**

Added-Value Users of ACE Real Time Solar Wind (RTSW) Data

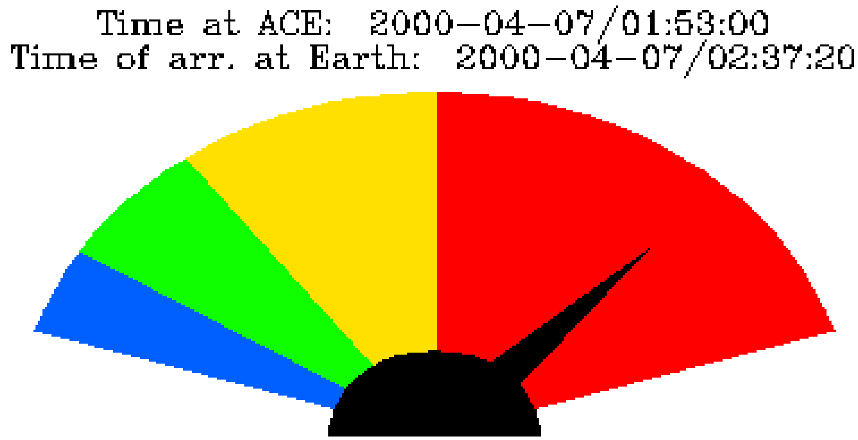


ACE RTSW magnetic field strength and Bz, solar wind proton density and speed, and energetic proton intensities, from April 4 to April 8, 2000.

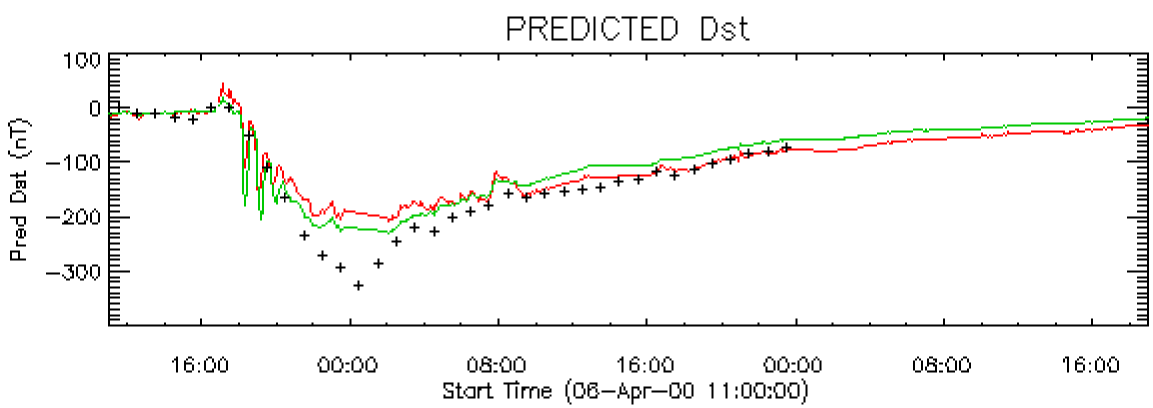
- **Severe geomagnetic storms disrupt communications, increase drag on orbiting spacecraft, and may cause electric utility blackouts over a wide area. Real-time solar wind data from ACE at L1 enables NOAA to give about a one hour advance warning of impending geomagnetic activity.**
- **Since ACE data are available on the web, other groups also use these data for real time forecasts. The figures here show ACE data from the April 6, 2000 interplanetary shock, which caused the the largest geomagnetic storm in years.**
- **Severe storms are triggered by prolonged periods of negative Bz (which then reconnects with the Earth's field). Note the period at 2000 UT on May 6, when an interplanetary shock with negative Bz arrives..**

Dst Index Predictions Using RTSW Data from ACE

- The Dst Index measures the magnetic perturbation at the Earth's surface due to geomagnetic storms.
- Predictions of the Dst index can be obtained from the solar wind and interplanetary magnetic field conditions. ACE RTSW data can be used to forecast both the timing and magnitude of a magnetic storm.

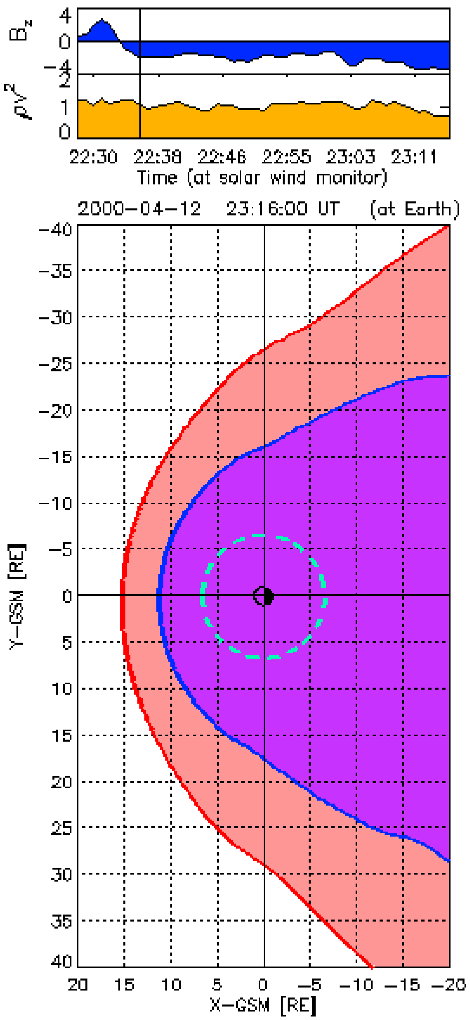


The Space Physics Research Group at Berkeley provides this Dst predictor at http://sprg.ssl.berkeley.edu/dst_index/. If the Pointer is in the red (extreme Dst), a storm is imminent.



The Nonlinear Dynamics and Space Physics Group at GSFC provides this Dst prediction (colored lines), compared here with the Quicklook Dst from the World Data Center C2 in Kyoto.
http://lepgst.gsfc.nasa.gov/nrt_predictions.html

Other Users of ACE RTSW Data

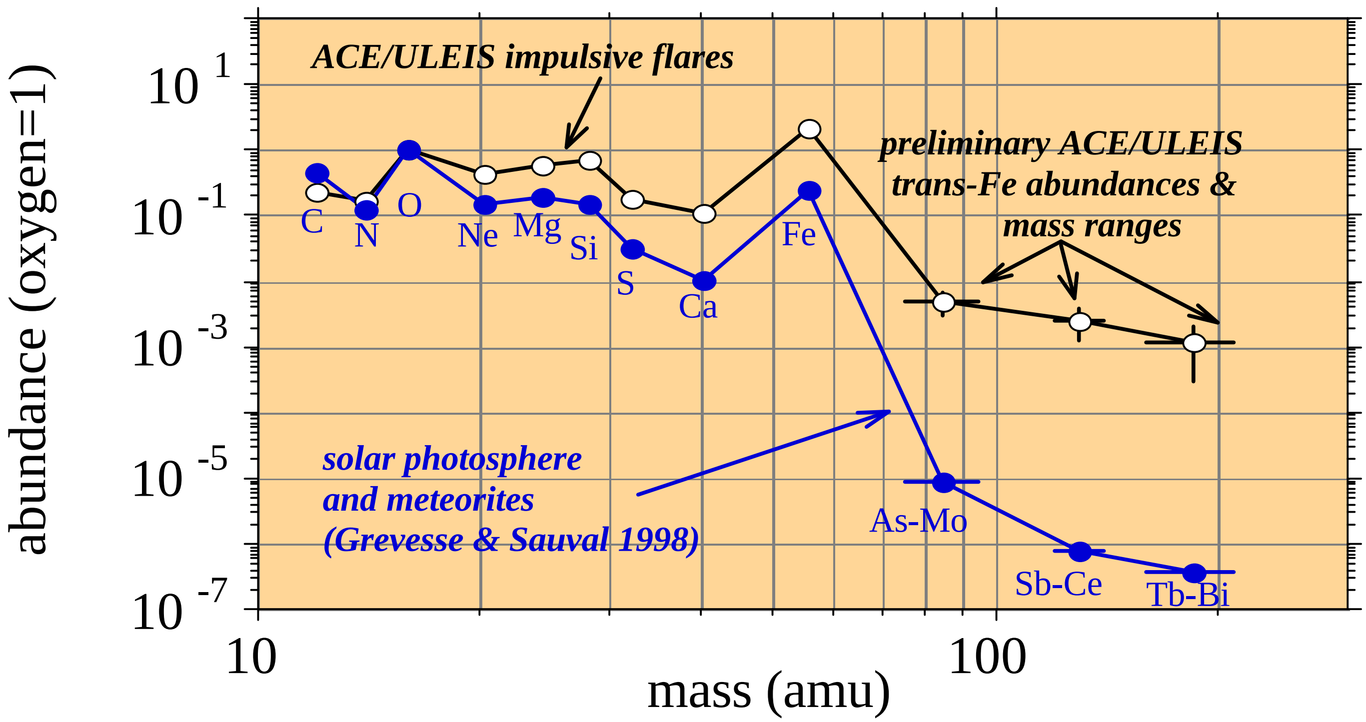


- **Dynamic modeling of the Earth's bow shock** and magnetopause, by Steve Petrinec of the PIXIE/Polar team is shown at left. (http://pixie.spasci.com/DynMod/.)

Other examples include:

- Predictions of auroral electrojet **AE index** and geomagnetic **Kp index**, at Lund Space Weather Center, Sweden. http://nastol.astro.lu.se/~henrik/spwrealfo.html
- The **Chandra Science Operations Team** uses ACE RTSW data for alerts of large solar proton events which could damage the Chandra CCDs.
- **Ionospheric forecasting** at the University of Alaska and the Arctic Region Supercomputing Center (ARSC). http://www.pfrr.alaska.edu/~sergei/
- For more examples…see http://www.srl.caltech.edu/ACE/ASC/related_sites.html

Enhancement of Trans-Iron Elements in Impulsive Solar Flares



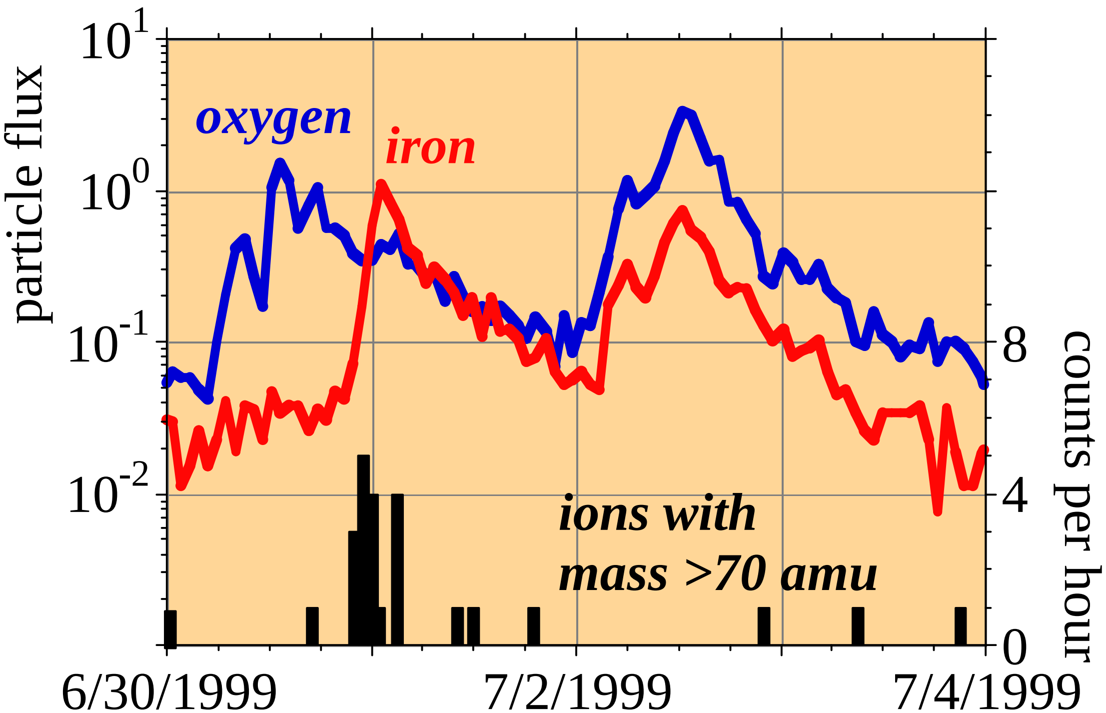
•Trans-iron elements are extremely rare in the solar system composition: in the mass range from germanium to bismuth (32=Z=83), their total meteoritic abundance is only ~10^{-4} that of iron.

•We report a preliminary search for trans-iron particles from flares using the ACE/ULEIS instrument which is sensitive at energies (>30 keV/nuc) where solar-particle fluxes are highest.

•The figure shows abundances from a sum of at least 8 flares (black trace). The ULEIS mass scale beyond 70 is preliminary and will be verified by accelerator calibration of a backup unit.

•Compared to meteorites and the photosphere (blue trace) we find > 100-fold enrichments of elements beyond iron in particles from flares. Reames has also recently reported large enhancements of trans-iron elements in impulsive flares above ~3 MeV/nucleon.

Enhancement of Trans-Iron Elements in Impulsive Solar Flares (2)



•The impulsive flare particles are easily seen at the beginning of 7/1/99 where the high iron/oxygen ratio is typical for flares. The count rate of ultra-heavy ions peaked at the same time as the iron.

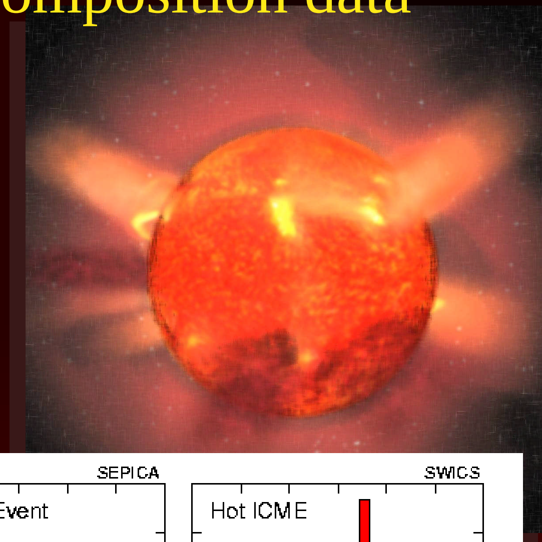
•The composition was more coronal-like on 7/2/99, but there were far fewer ultra-heavies.

•Most of the ions with mass > 70 amu arrived at ACE during impulsive solar flares. Shown above are oxygen and iron fluxes at ~0.2 MeV/nucleon energy for 4 days in 1999.

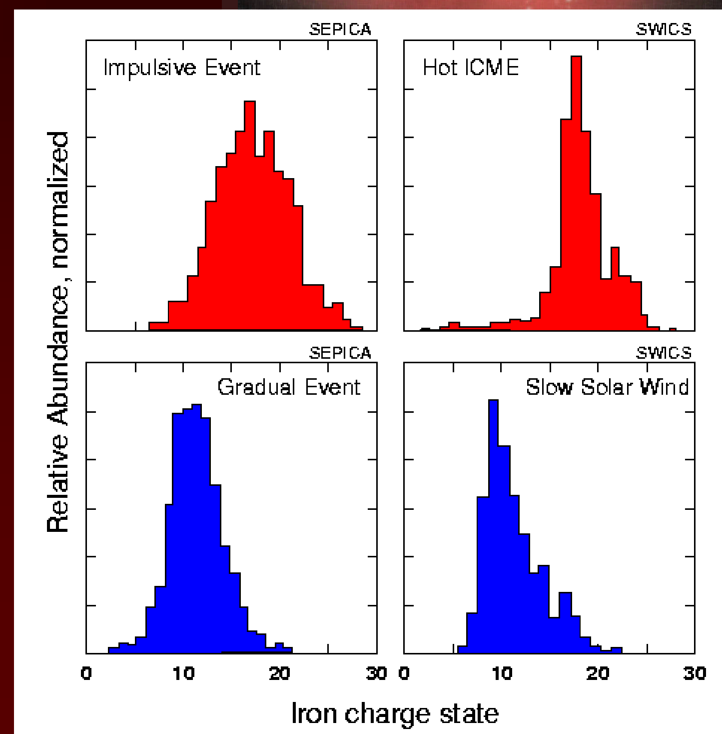
•These preliminary results show that either before or during acceleration, an enrichment mechanism favoring higher mass species brings the rare trans-iron abundances within reach of present instrumentation.

Contributed by Joe Mazur, Glenn Mason, Joe Dwyer, Rob Gold and Tom Krimigis

Sources of solar energetic particles revealed by composition data

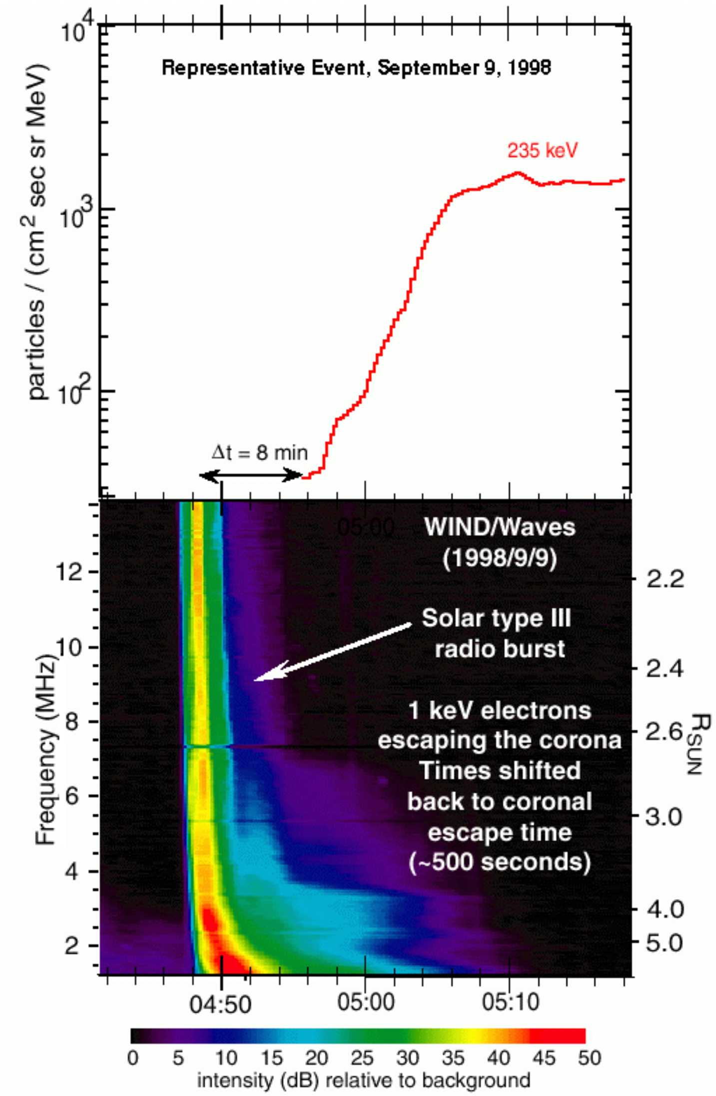


- **The charge compositions of solar energetic particles (SEPs) reflect the properties of their source regions and acceleration process.**
- **SEPICA on ACE has observed a wide variety of SEP charge distributions. Two examples, from a gradual and an impulsive event, are shown in the left-hand side of the figure.**
- **The solar wind charge state distribution, as measured by SWICS-ACE, shows similarly diverse distributions. The right-hand side of the figure shows data from two CME periods.**
- **These compositional patterns are used to trace solar energetic particles and solar wind plasma to their respective source in the solar corona and determine the physical conditions in their respective acceleration regions.**



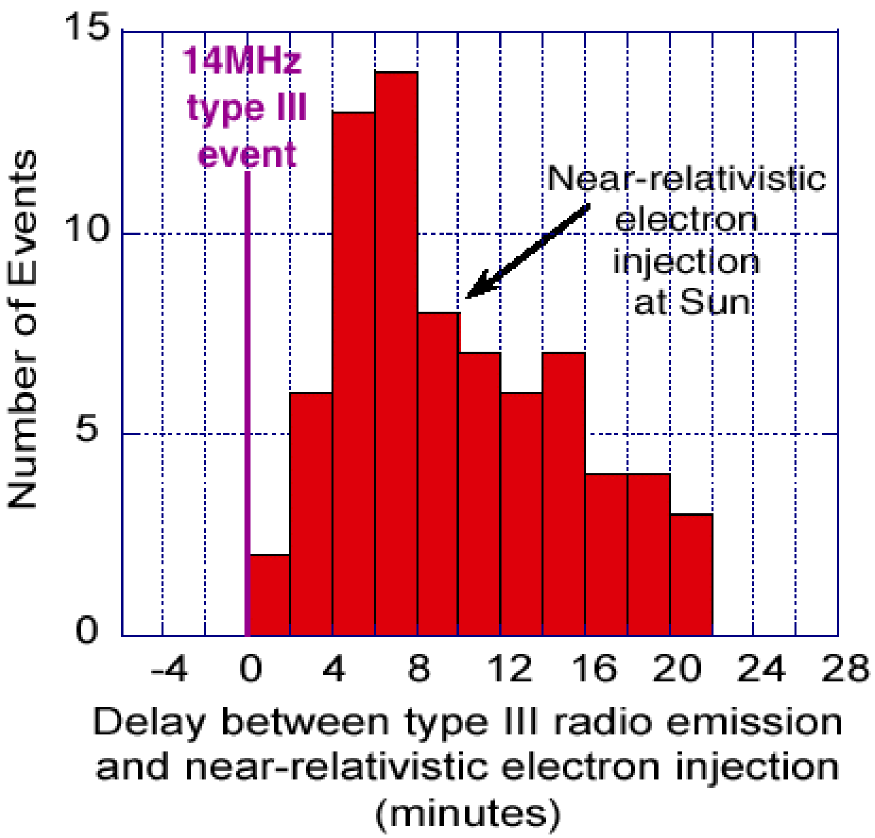
Contributed by Thomas Zurbuchen, University of Michigan, and Mark Popecki, University of New Hampshire.

Near-Relativistic Electrons Leave the Sun ~10 minutes after Type-III Solar Radio Bursts: Evidence for Acceleration by Coronal Shocks



- In the example of an impulsive solar electron event at the left, the arrival of a 235 keV electron beam at ACE/EPAM is adjusted back to its coronal escape time (13.7 minutes earlier).
- A Type-III radio burst measured by Wind/Waves is also adjusted back (by ~500 seconds). Such bursts are generated by a beam of electrons with energies ~1 keV moving out through the corona
- Surprise! The near-relativistic electron beam was released from the Sun ~8 minutes after the Type-III radio emission.

Results of a 3-year Statistical Survey including 81 ACE/EPAM Electron Events



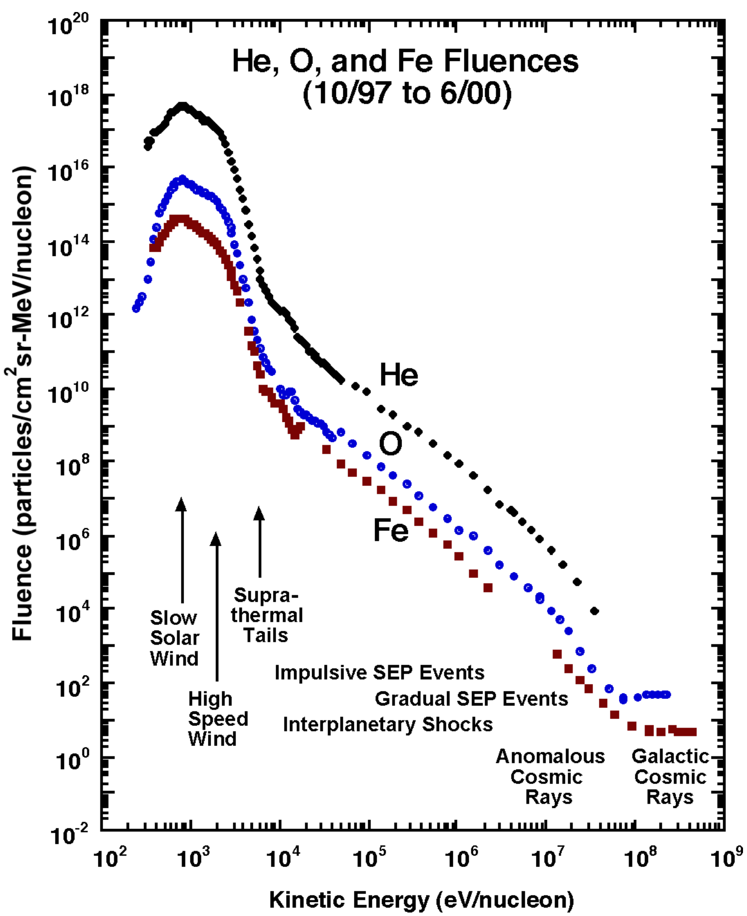
- On average, near-relativistic electrons were injected ~10 minutes after the ~1 keV electrons that cause the Type-III solar radio bursts

- Explanation: Energy release at the Sun produces a coronal shock with velocity ~1000 km/sec that promptly accelerates the ~1 keV electrons that generate the Type-III radio burst

- As the shock moves out, the acceleration process extends to higher energies, so that the near-relativistic electrons are released when the shock has traveled another solar radius higher into the corona

Submitted by Dennis Haggerty and Edmond Roelof of Johns Hopkins University/Applied Physics Laboratory

Energetic Particle Fluences from Solar Wind to Cosmic Ray Energies



- **Time-integrated intensities (fluences) of He, O, and Fe have been obtained that extend from solar wind to cosmic ray energies (from ~300 eV/nuc to ~300 MeV/nuc).**
- **The data were obtained by the SWICS, ULEIS, SIS and CRIS instruments on ACE from 9/1997 to 6/2000, a period that included both solar minimum and solar maximum conditions.**
- **The peak at ~800 eV/nuc is due to ~400 km/s solar wind. Occasional high-speed streams produce a "shoulder" on the solar wind distribution. The origin of the suprathermal tails is presently being debated.**
- **From ~10 keV/nuc to ~10 MeV/nuc as many as 100 or more solar and interplanetary events combine to give a power-law spectrum with -2 slope. Galactic cosmic rays dominate at energies >100 MeV/nuc.**
- **These are the first spectra to extend continuously from solar wind to cosmic ray energies. Given the varied composition of the contributing events, the overall similarity of these spectra is surprising.**

Contributed by R. Mewaldt, G. Gloeckler, and G. Mason