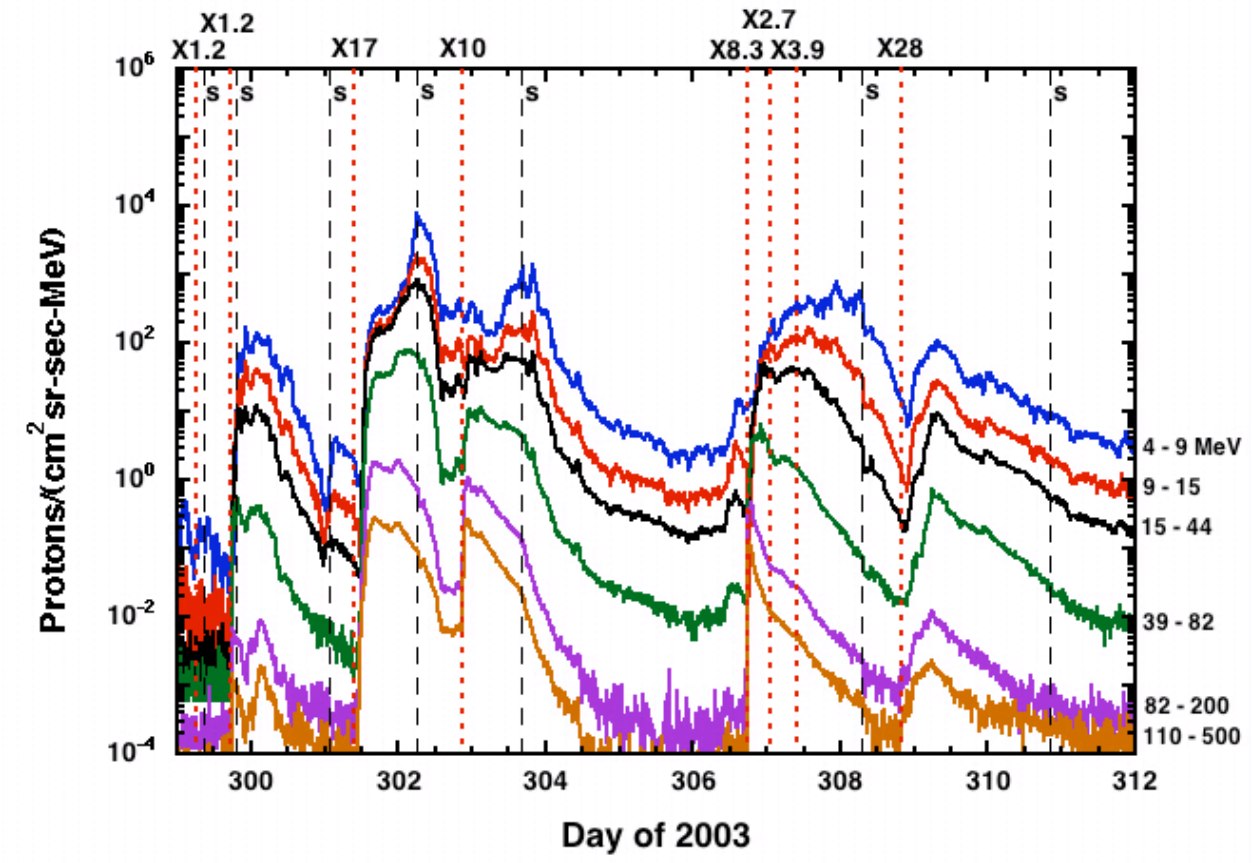

Figure 1: Time history of energetic protons measured by GOES-11 in six different energy intervals during the period from October 26, 2003 to November, 9, 2003. The occurence of X-class flares (obtained from NOAA) are indicated by dotted vertical lines with the intensity labeled above each line. Interplanetary shocks are indicted by dashed vertical lines labeled by an "s".

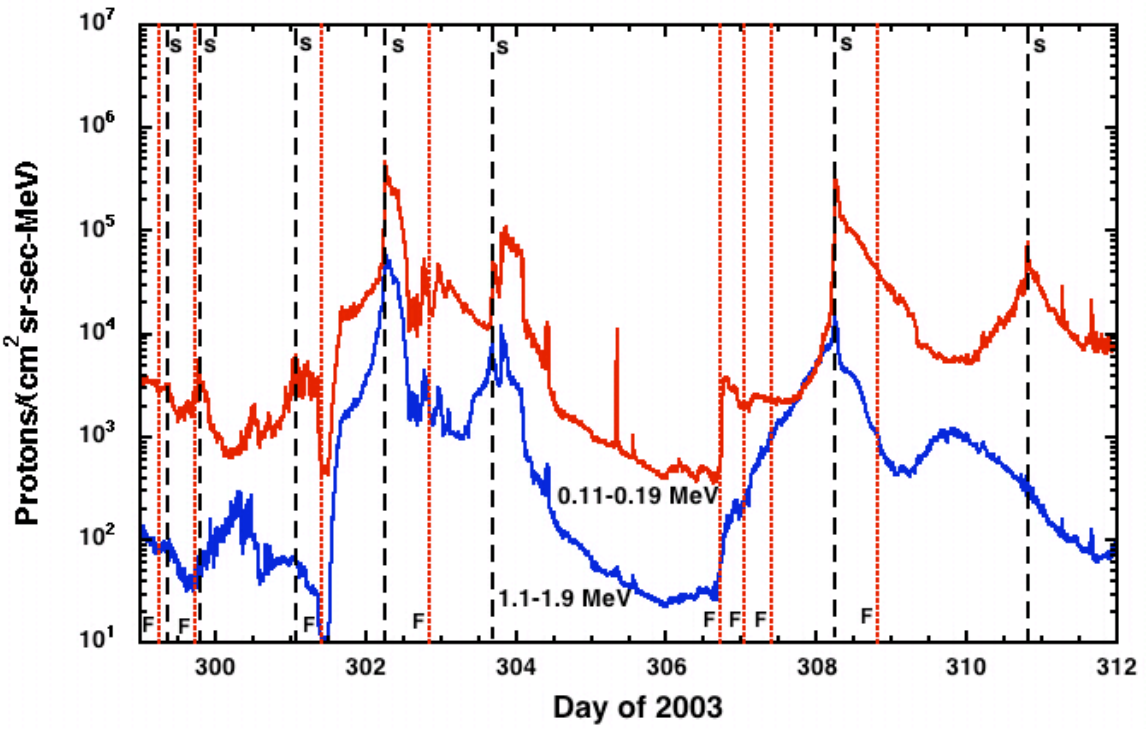

Figure 2: Time history of low-energy protons measured by the EPAM experiment on ACE. The occurrence of X-class flares (dotted vertical lines labeled "F") and interplanetary shocks measured by ACE (dashed vertical lines labeled "s") are indicated as in Figure 1.

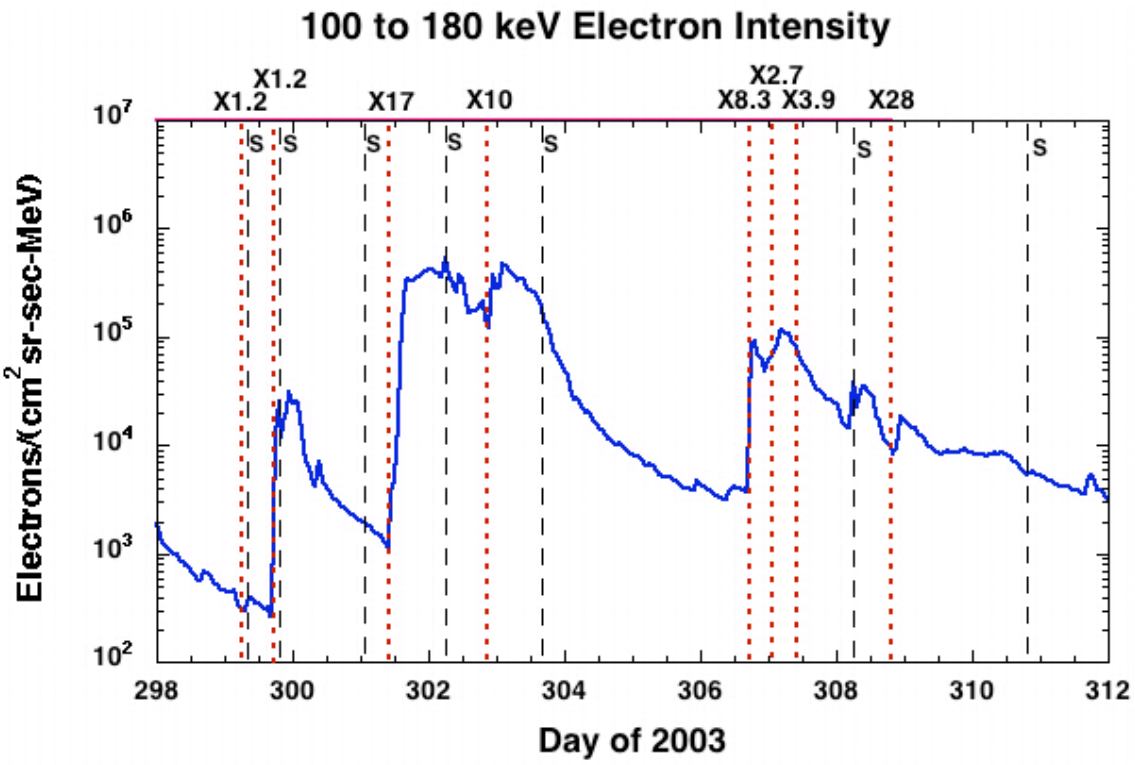

Figure 3: Time history of energetic 100-180 keV electrons measured by the ACE/EPAM experiment from 10/25 to 11/08, 2003. The occurrence of X-class flares and interplanetary shocks are indicated as in Figure 1.

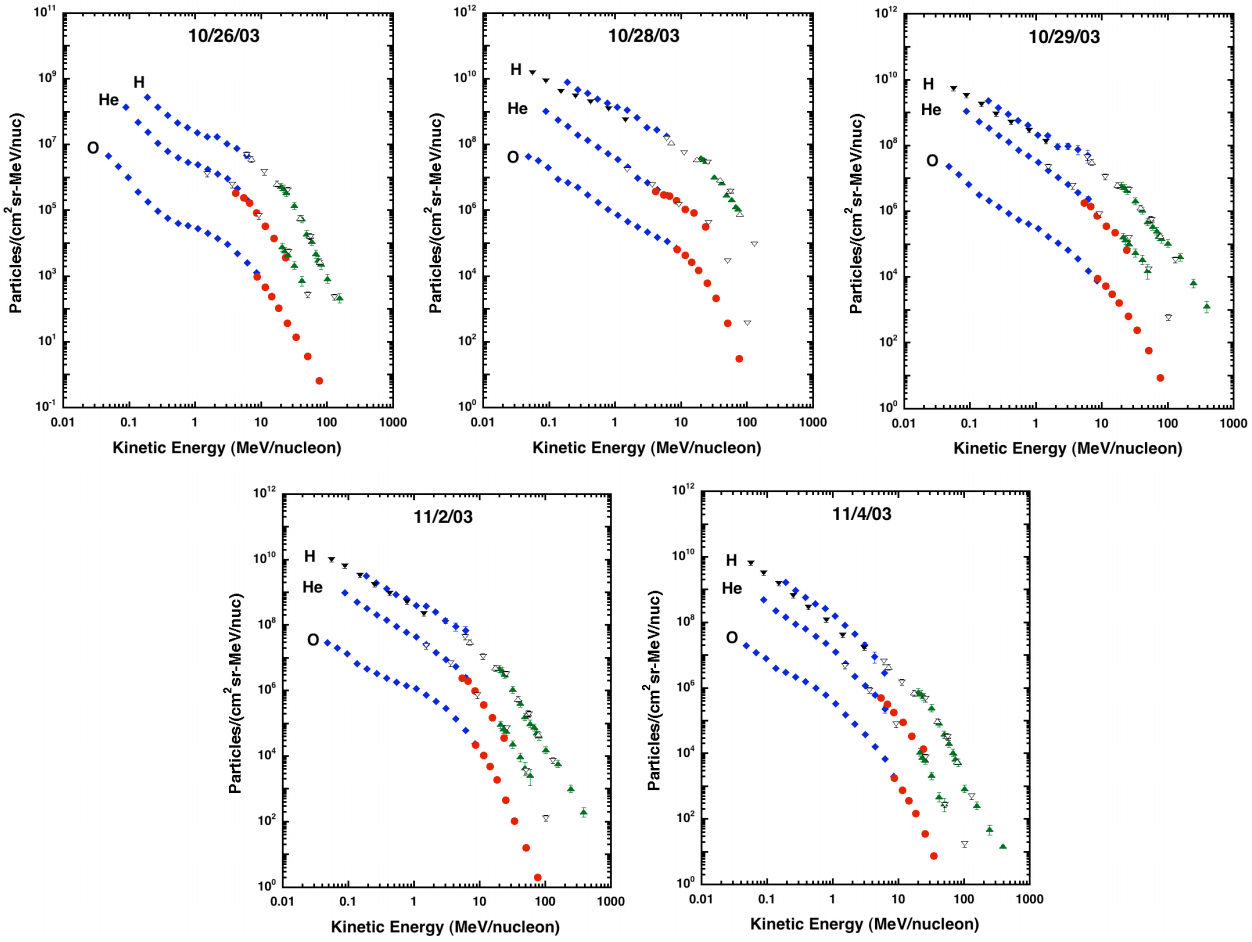

Figure 4. Integrated fluence spectra of H, He, and O for the five SEP events in this study. The data are from ULEIS (filled diamonds), EPAM (downward filled triangles), SIS (filled circles), PET (filled upward triangles), and GOES-11 downward open triangles).

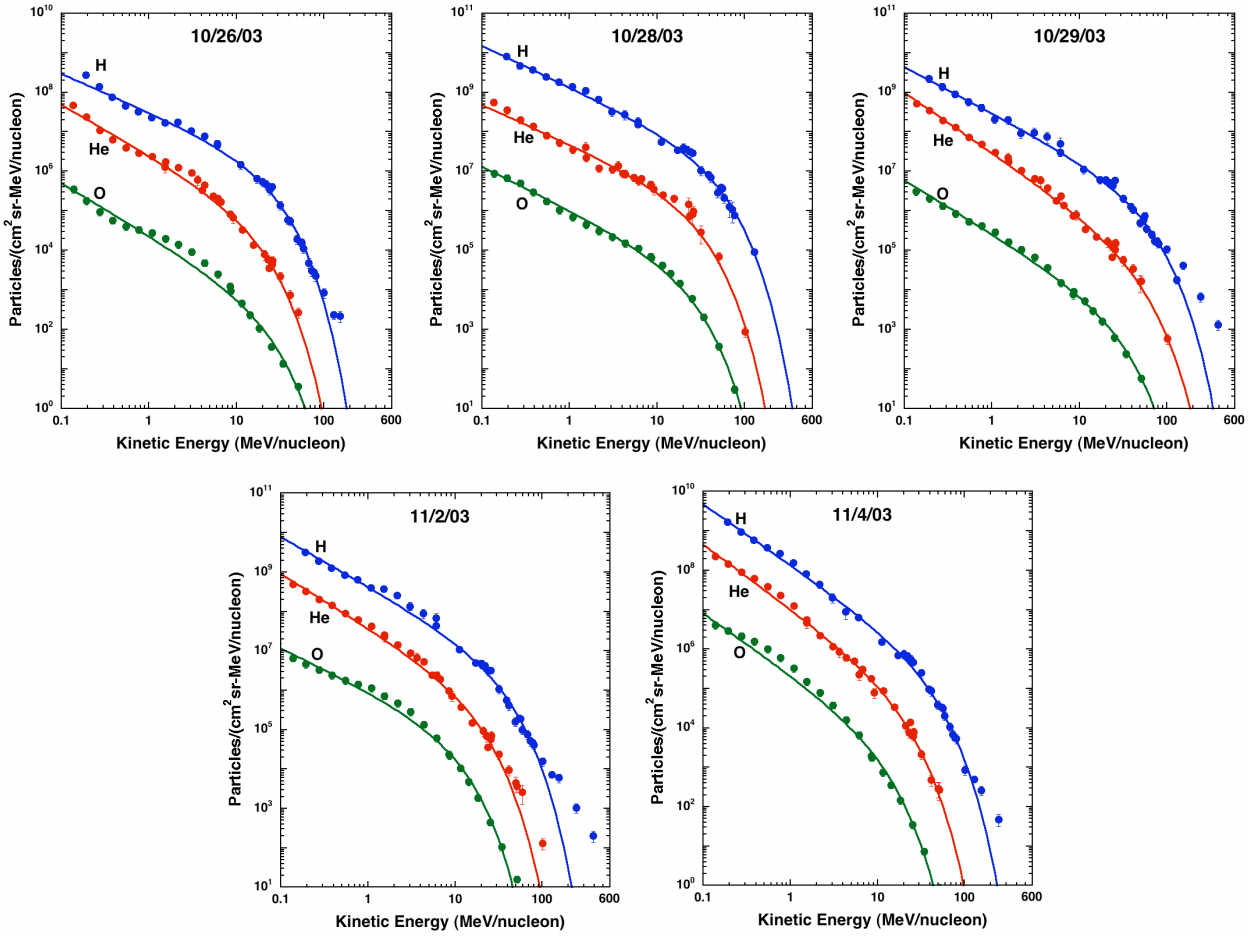

Figure 5: Fits to the fluence spectra of H, He, and O using the Ellison-Ramaty spectral shape (Eq 1) are shown for the five solar events. The data points are the same as in Figure 4.

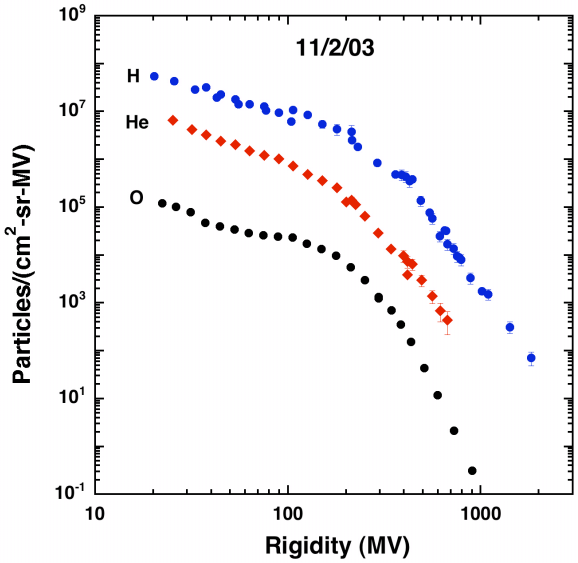

Figure 6: The fluence spectra from the 11/2/04 event are plotted as differential rigidity spectra. The data points are the same as in Figure 3, but they have been converted to differential rigidity measurements.

Need to add G-11 He to this.

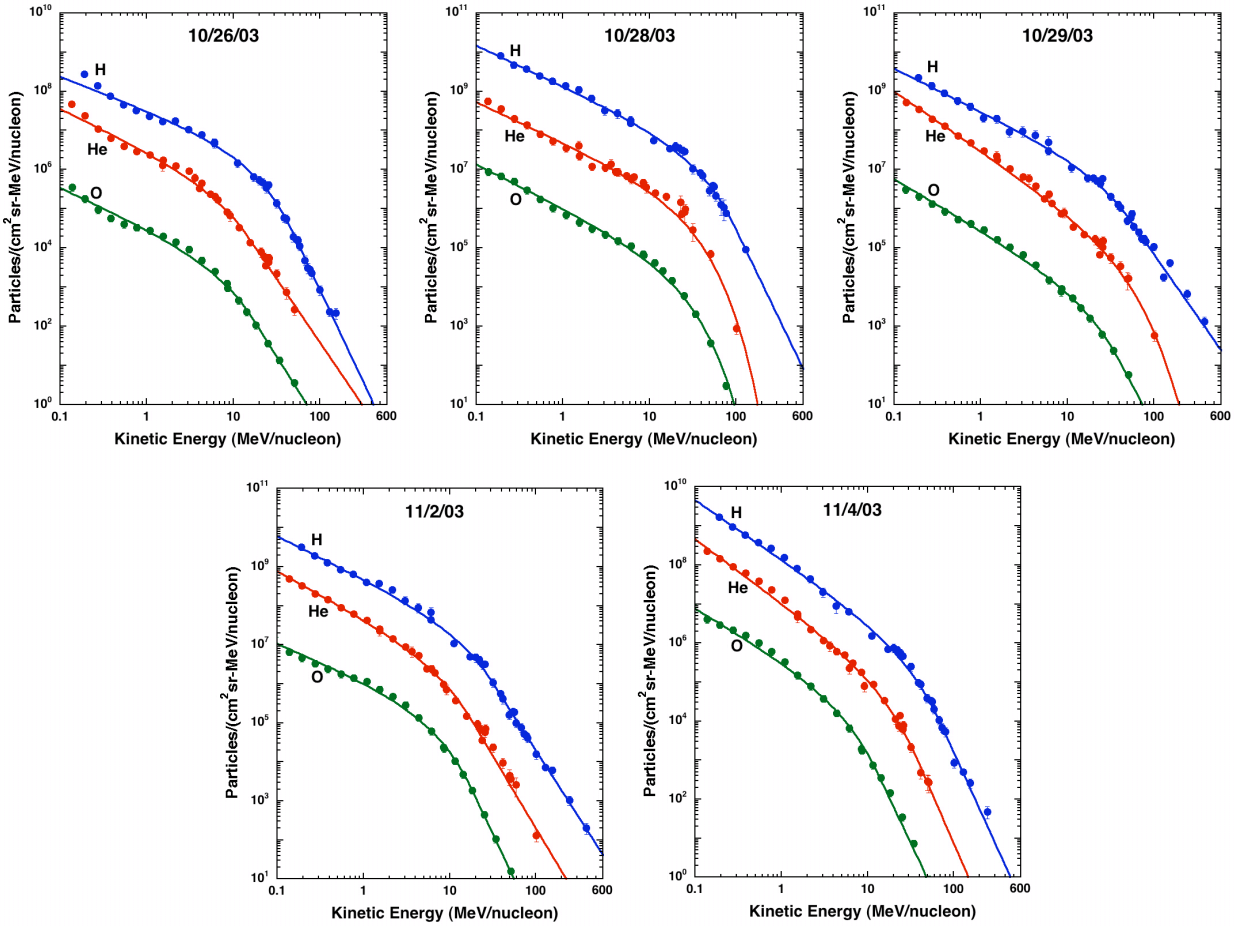

Figure 7: Fits to the fluence spectra of H, He, and O using the Band et al. (1993) spectral shape (Eq 2) are shown for the five solar events. The data points are the same as in Figure 4.

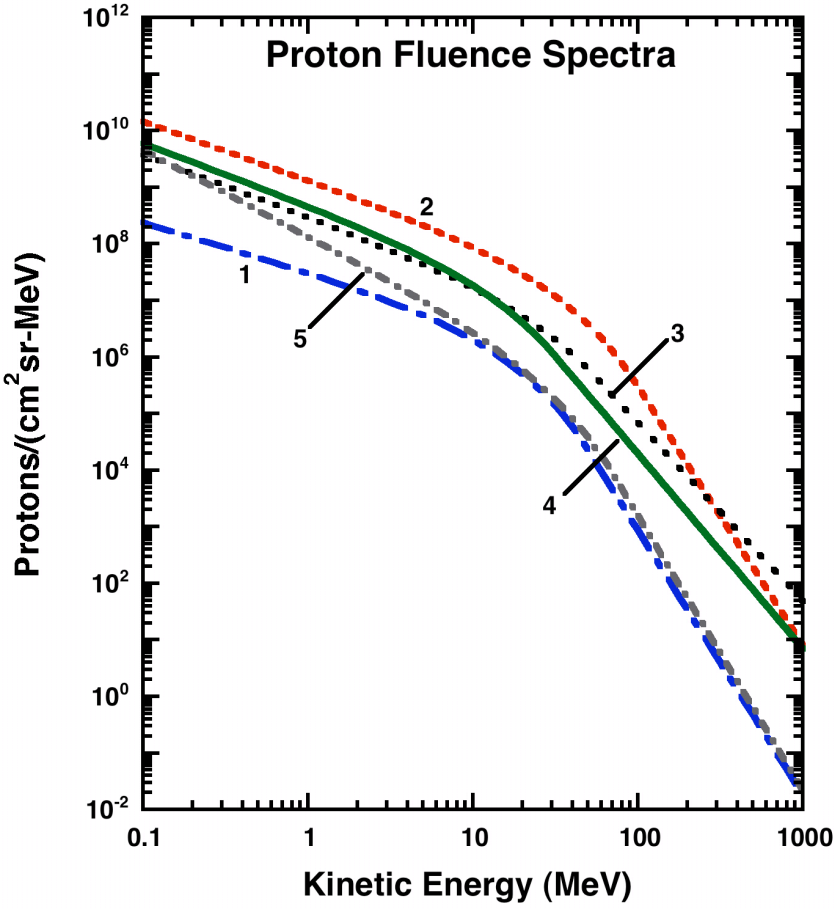

Figure 8: A comparison of the double-power-law fits to the proton spectra for Events 1 to 5.

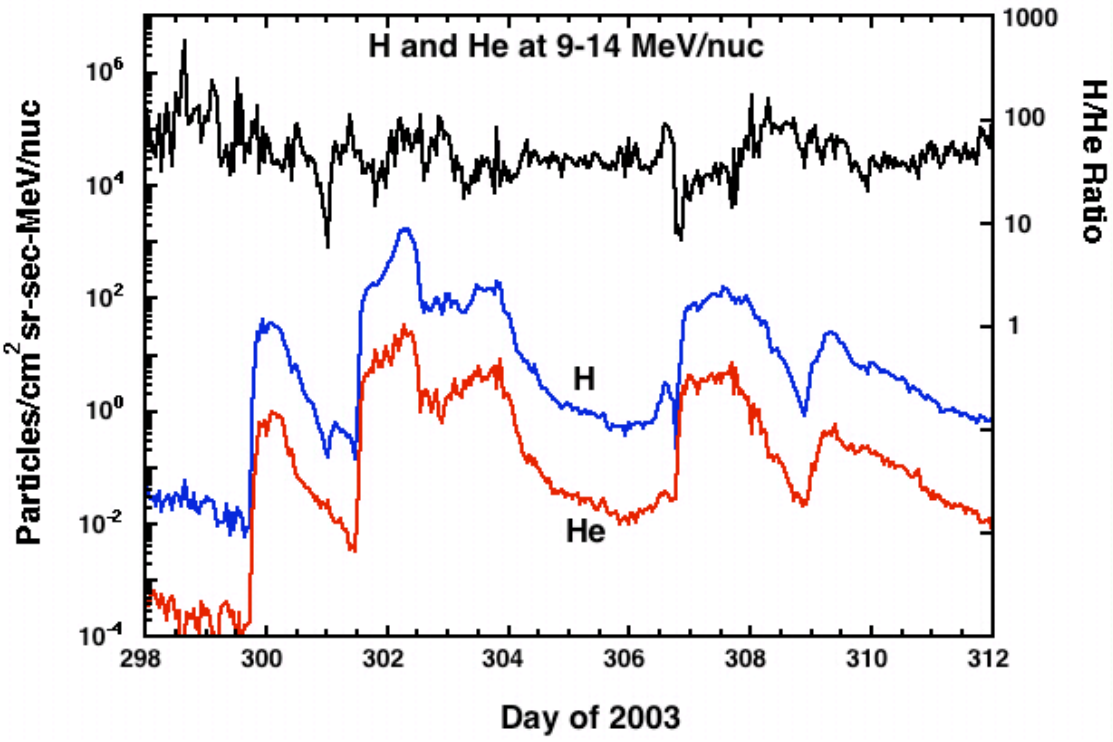

Figure 9: The intensities of 9 to 15 MeV/nucleon H and He are shown as a function of time, along with the resulting H/He ratio. The H data are from GOES-11 and the He data are from ACE/SIS.

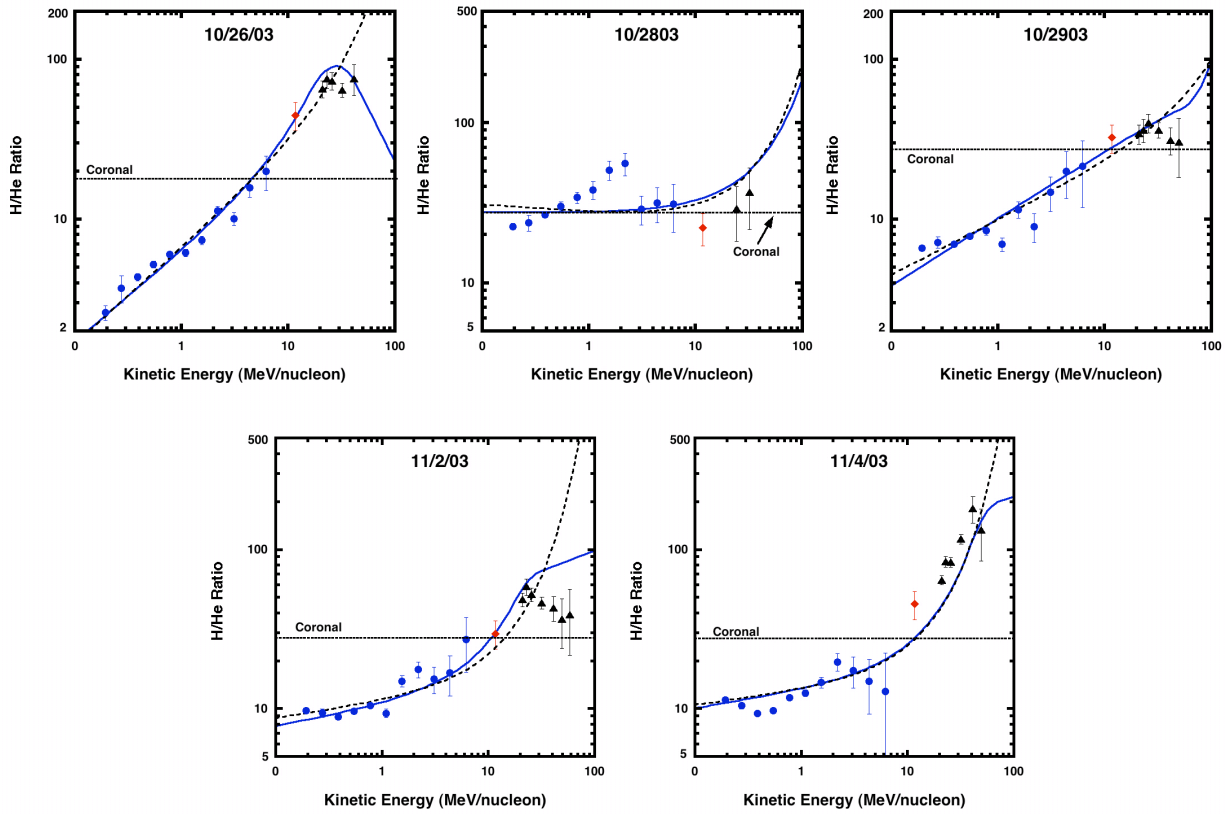

Figure 10: The H/He ratio is shown as a function of energy based on data from ACE/ULEIS (filled circles), GOES-11 and ACE/SIS (filled diamonds), and SAMPEX/PET (filled upward triangles). Also shown are the H to He ratios that result from the fits to the spectra using the functions proposed by Ellison and Ramaty (dotted lines) and Band et al. (solid lines).

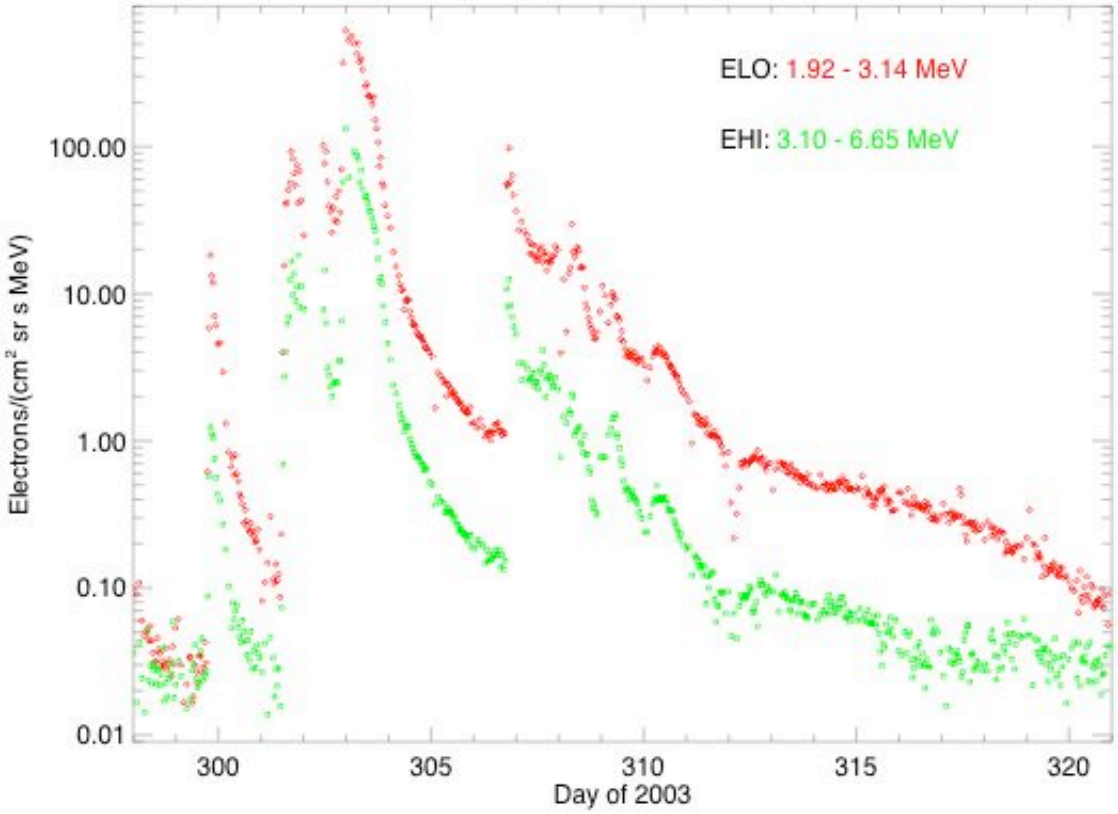

Figure 11: The time history of energetic electrons measured by PET/SAMPEX is shown in two energy intervals from October 25, 2003 to November 18, 2003 (Days 298 to 321). The points are averaged over separate polar passes, including only data obtained at invariant latitudes >75°. It is likely that the intensities shown near the end of Day 303 through Day 304 (October 29 SEP event), are over-estimated because of background contributions background as discussed in the text.

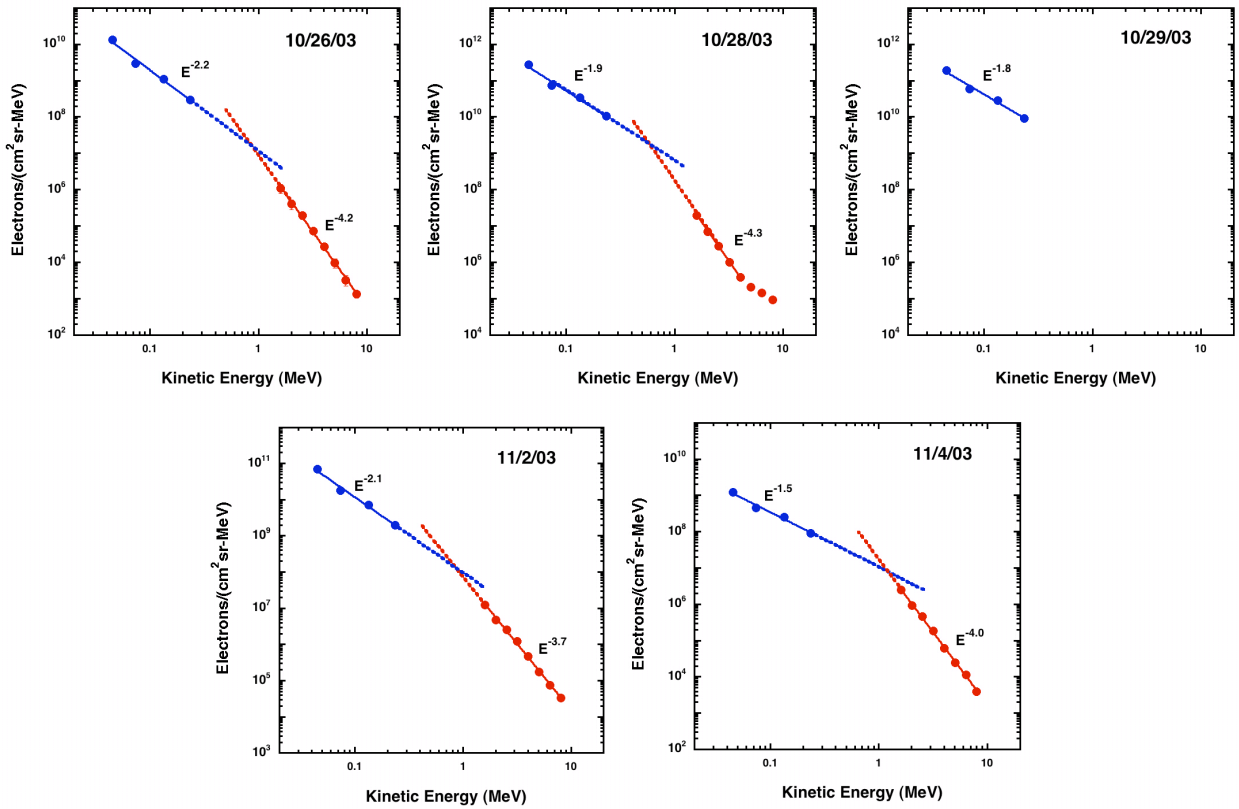

Figure 12: Energy spectra of energetic electrons in the five SEP events cover by this study, including 0.04 to 0.34 MeV data from ACE/EPAM and 1.8 to 8 MeV data from PET/SAMPEX. The slopes of power-law fits to the low-energy and high-energy data are indicated. These fits have been extrapolated into the region of overlap (dotted lines). The high-energy data from the 10/29 event are not shown because of possible background contributions (see text).

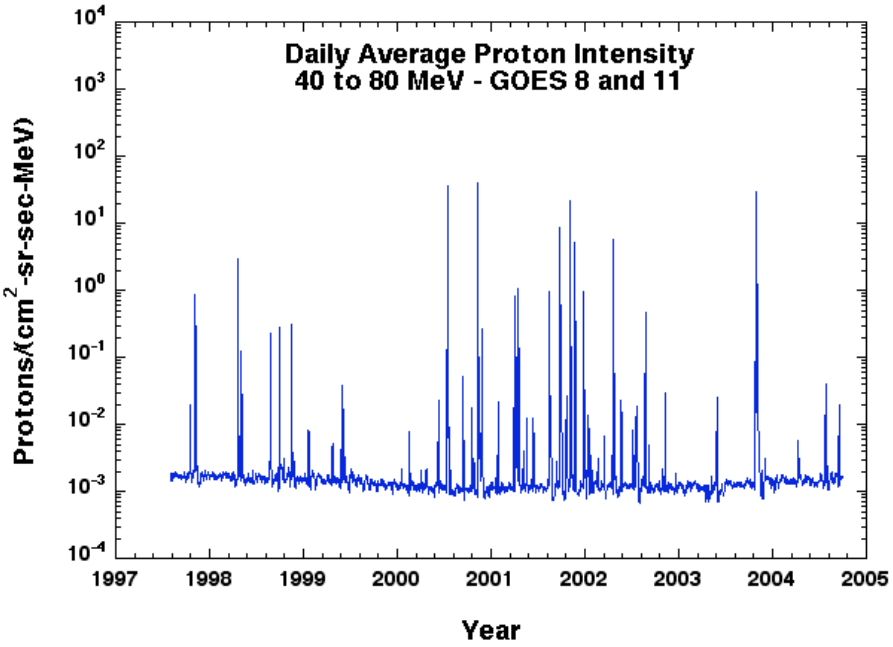

Figure 13: Daily averages of the intensity of 40 to 80 MeV protons measured by GOES-11 from late 1997 through late 2004. The dates of some of the largest SEP events are indicated.

Plan to Label some big events

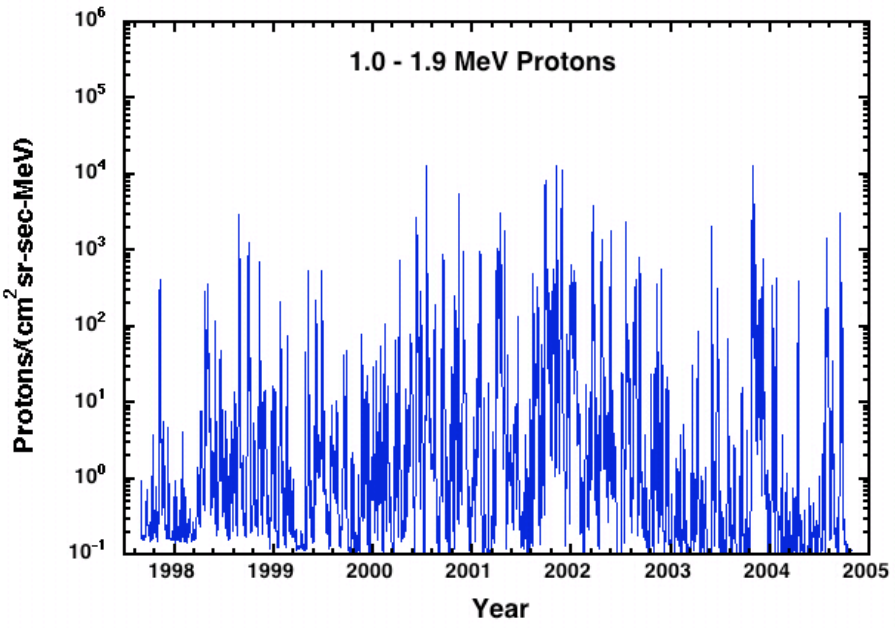

Figure 14: Daily averages of the intensity of 1 to 1.9 MeV ions (mainly protons) measured by ACE/EPAM from late 1997 through late 2004. The dates of the largest SEP events are indicated.

Label some events

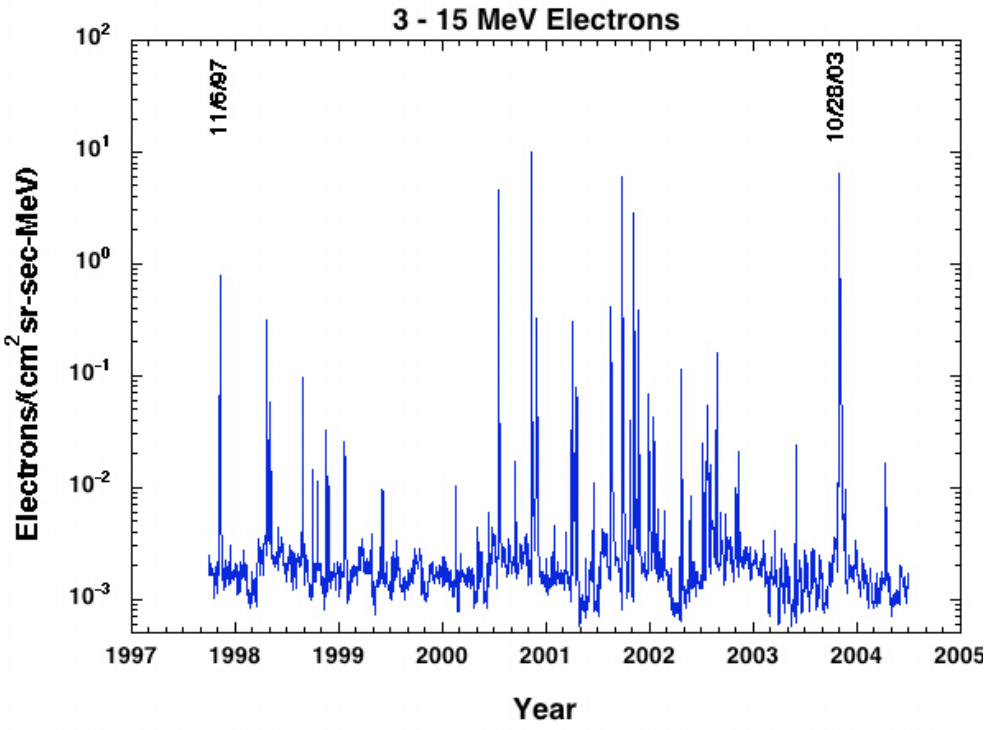

Figure 15: Daily averages of 3 to 15 MeV electrons measured by the PET instrument on SAMPEX from late 1997 through mid 2004. The dates of some of the largest SEP events are indicated.

Label more events

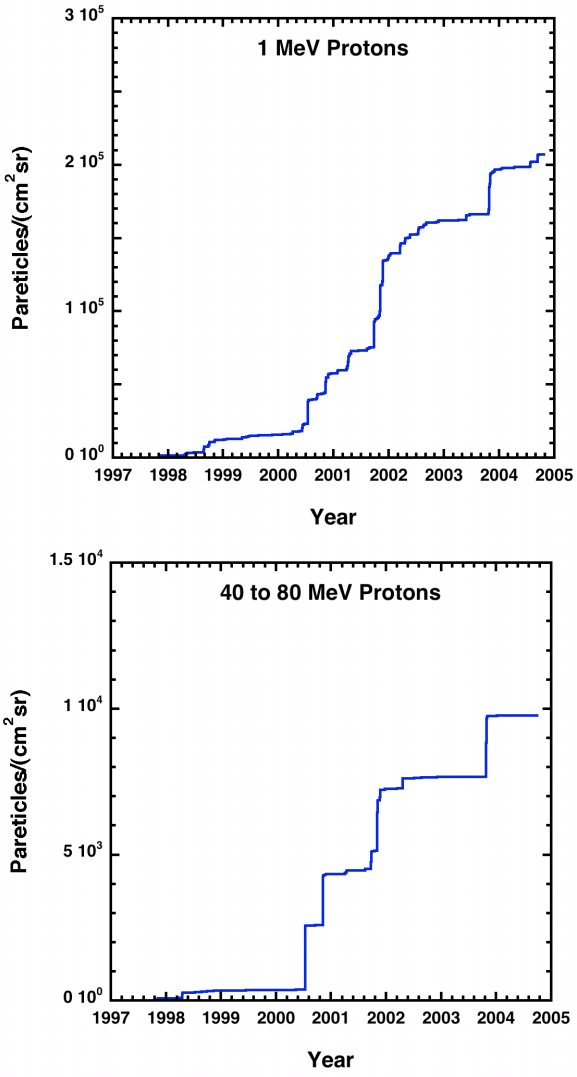

Figure 16: Fluences of 1 MeV (top panel) and 40 to 80 MeV protons (bottom panel) integrated from October 1997 to late 2004.

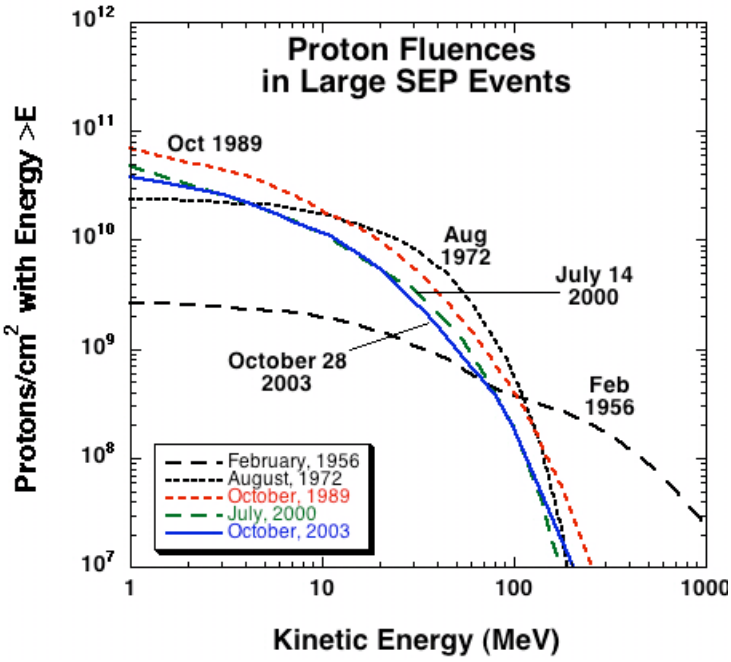

Figure 17: Proton fluence spectra are shown for some of the largest SEP events of the last 50 years. Spectra for the events prior to this solar cycle are adapted from Turner, 1997. The July 14, 2000 spectrum has been derived from data in Tylka et al. 2001. The October 28, 2003 spectrum is from this paper.

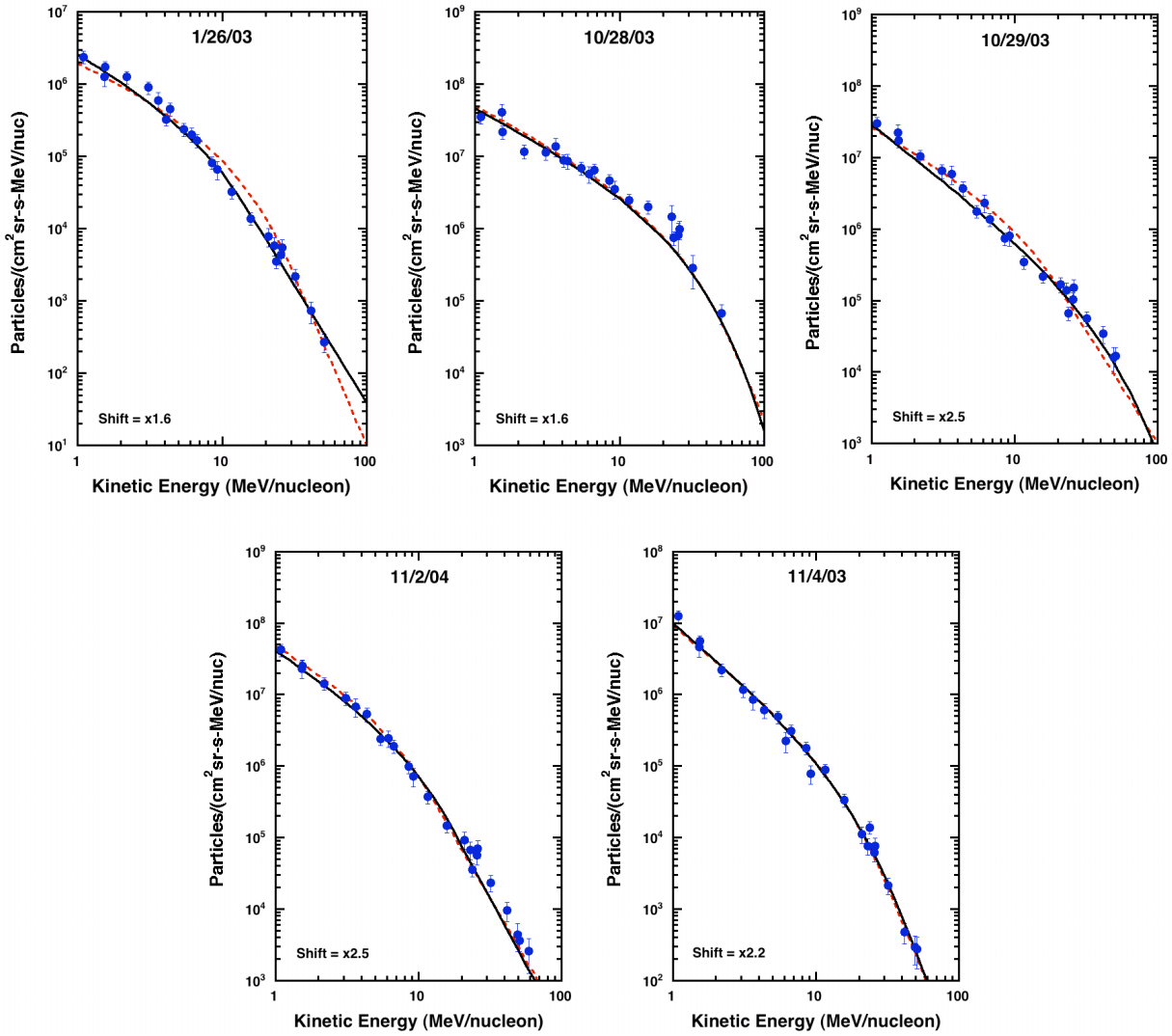

Figure 18: The double power-law fits to the proton spectra are shifted in energy by the amounts indicated and adjusted in intensity to lie on the He data (dashed line). The fits to the He spectrum are shown as the solid line. In Events 2, 4, and 5 the H and He fits are virtually indistinguishable.

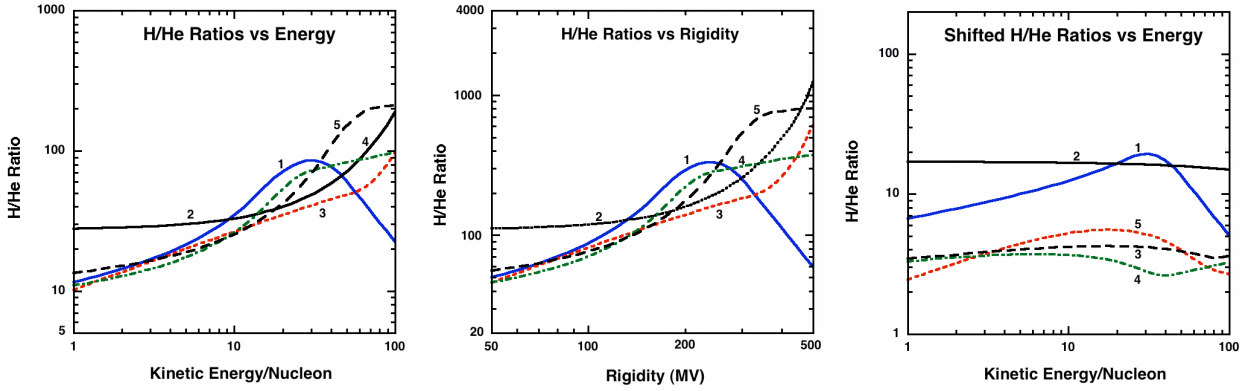

Figure 19: The ratio of the double power-law fits to H and He (Figure 7) is shown for three different approaches to computing the H/He ratio. The left panel shows the ratio of the fits in Figure 7 as a function of kinetic energy per nucleon for Events 1 to 5. In the middle panel the fits were converted to differential rigidity spectra before computing H/He as a function of rigidity. In the right panel the He spectra were shifted in energy by factors chosen to minimize the variation in the H/He ratio over the energy interval from 1 to 100 MeV/nucleon. The vertical scale is a factor of 200 in each case – note that the variation in H/He in the individual events is minimized in the right panel.

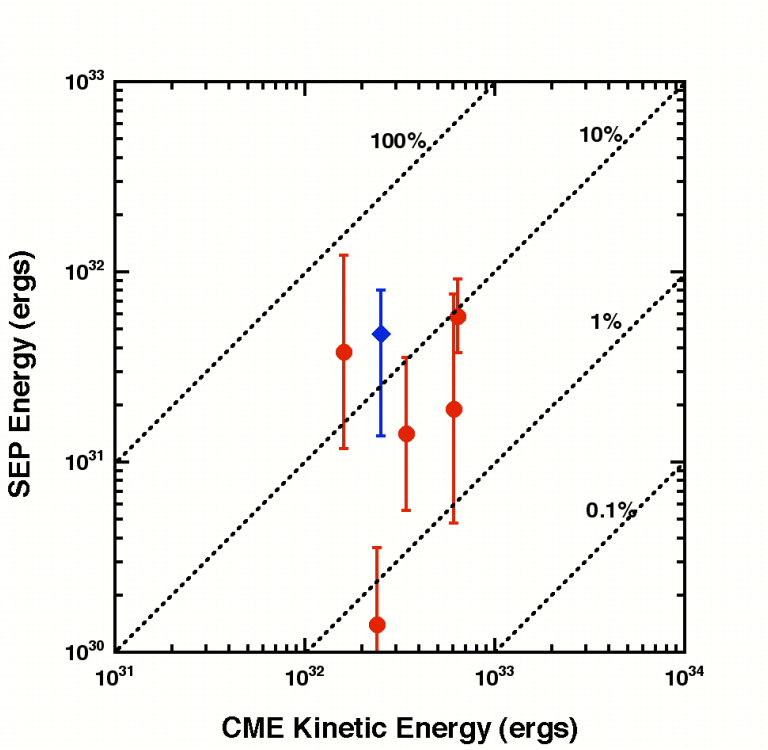

Figure 20: The total SEP energy of the five events from late 2003 (see Table 9) is plotted vs the CME kinetic energy (Gopalswamy et al. 2004). Also shown is the 4/21/02 event (diamond).