HIGH-RESOLUTION GAMMA-RAY SPECTROSCOPY IN SUPPORT OF PASO

Fundamental Question:

- How are particles accelerated and transported at the Sun and what is their energetic relationship to flares and CMEs? What are the characteristics of the flare plasma?

Why is this question important?

- Solar energetic particles are a hazard for astronauts and can damage satellite systems
- Predicting the occurrence and intensity of particle events is critical to space program
- Provides an astronomical laboratory for understanding eruptive processes in other sources in the Universe

Science Objectives:

- Measure the spectrum and composition of accelerated ions from ~0.5 to 100 MeV/nuc at the Sun
- Understand electron/ion acceleration and transport in flaring magnetic loops
- Determine energetic importance of accelerated ions and electrons in relation to the total energies in flares and CME's
- Measure the abundance and isotopic composition of He in the photosphere and in the accelerated particles
- Measure the density, temperature, and composition of the flare plasma in the lower corona and chromosphere

Mission Description:

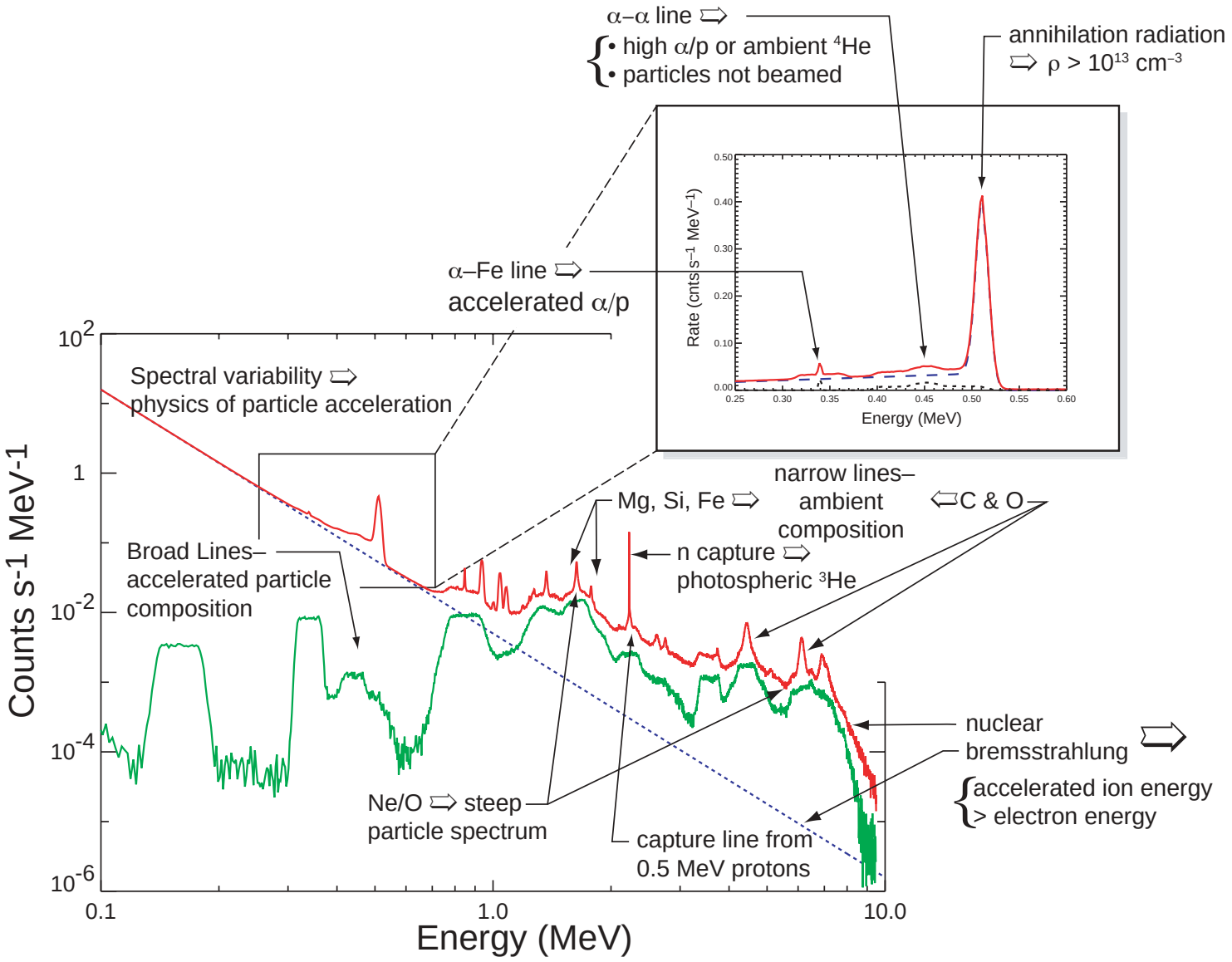
- PASO or Low-Earth/ low-inclination orbit satellite
- 4 – 5 year duration to cover the rise, maximum, and fall of solar cycle 24

Measurement Strategy:

- High spectral resolution (~2 keV) gamma-ray spectrometer from ~5 keV to 20 MeV
- 10 times more sensitive to nuclear de-excitation lines than HESSI
- Excellent Compton rejection in order to reveal broadened lines from interacting heavy-accelerated ions. Compare these measurements with heavy ion observations in interplanetary space
- Measure shapes of nuclear de-excitation lines to reveal particle directionality
- Use hydrogen neutron capture line to search for accelerated ions in microflares and ^{3}He abundance in the photosphere
- Detect weak lines from radiative capture to determine accelerated proton spectrum <1 MeV
- Use temporal evolution of Ne/O line ratio to determine spectral evolution of accelerated particles.
- Use temporal evolution of line ratios to track changes in composition and to understand FIP-dependent fractionation in the flare plasma

Technology Requirement:

- No new developments required


α–α line ⇨
• high α/p or ambient 4He
• particles not beamed
annihilation radiation
⇨ ρ > 10^13 cm^-3
α–Fe line ⇨
accelerated α/p
Rate (cnts s^-1 MeV^-1)
Energy (MeV)
Spectral variability ⇨
physics of particle acceleration
Broad Lines–
accelerated particle
composition
Mg, Si, Fe ⇨
narrow lines–
ambient
composition
⇦C & O
n capture ⇨
photospheric 3He
Ne/O ⇨ steep
particle spectrum
capture line from
0.5 MeV protons
nuclear
bremsstrahlung ⇨
accelerated ion energy
> electron energy
Counts s-1 MeV-1
Energy (MeV)