# 3.1.0 Explore in depth the SEP properties

**Gradual SEP events:**

- **electrons up to tens of MeV, ions at GeV**
- **once per month near solar maximum**
- **dominated by protons (small e/p fluence ratios)**
- **variable composition and charge states**
- **extend over > 100° in solar longitude**
- **generally associated with large solar flares & fast CMEs**
- **believed to be due to acceleration by CME-driven shocks and not by flares.**

**Impulsive SEP events:**

- **Low energy electrons: 1-100 keV**
- **Ions: 0.01-1 MeV/nucleon**
- **$>10^4$ events per year near solar maximum**
- **large e/p ratios**
- **enhanced abundances of 3He and of heavy ions**
- **high charge states**
- **enhanced alpha/proton ratio**
- **extend over 30° in solar longitude**
- **associated with type III bursts**
- **many clearly come from flares/microflares, but often not even a microflare or soft X-ray burst is observed.**

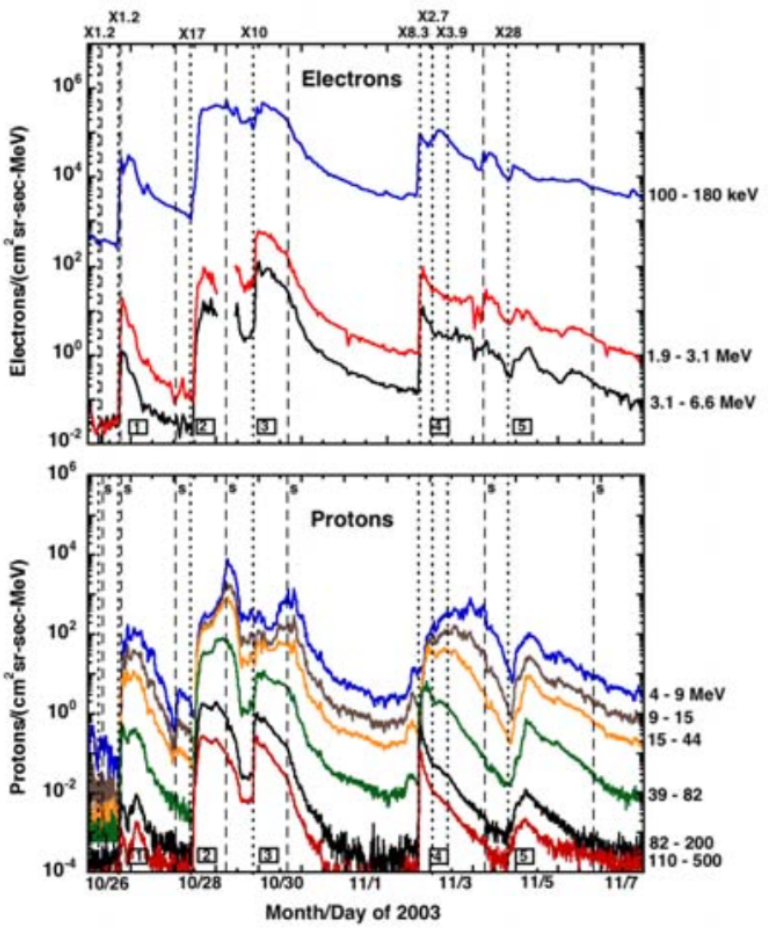


*Figure 1.1.1: Time history of energetic protons (lower plot, from GOES-11) and electrons (upper plot: top trace, EPAM/ACE; bottom traces, PET/SAMPEX) from the "Halloween Storms", 26 October to 7 November 2003, (adapted from Mewaldt et al. 2005a). Major proton events are labeled 1 to 5. Flux increases for ions up to a few tens of MeV energy at interplanetary shocks (dashed lines) suggest in situ acceleration, but electrons and higher energy ions and appear to be accelerated close to the Sun near the time of the X-class flares (dotted lines).*

**Expected number of events**

***(To be verified for current sensitivity of STEP & update the table for current mission phases definitions. Also per orbit.)***

Observations from the Wind 3DP instrument over the solar cycle 1995 -2006 show that the occurrence frequency distribution for impulsive electron events observed at ~ 1AU follows a power law with an average exponent of –1.4, with the rate varying with solar activity. In 2004-2005 and 1995-1998, the same near-solar minimum phase as the SolO prime mission, WIND detected 376 events. Taking into account that STEP is about 50 times more sensitive than Wind 3DP in the key ~2-20 keV energy range, and assuming a conservative inverse-square radial dependence of the peak electron flux and an average radial distance of ~0.7 AU for SolO, we expect STEP to detect ~2400 impulsive electron events during the prime mission, with about 50 events during closest approach (<~0.4 AU, about 142 days around solar minimum). We estimate that >~90% of these impulsive electron events will be accompanied by a solar type III radio burst, and STIX will provide X-ray locations for more than half, or ~25 events during closest approach, and ~1000 events over the nominal mission.

| | **Pri-me** | **Mi-ssion** | **Exten-ded** | **Mi-ssion** |
|---|---|---|---|---|
| | 2015-2020 | within 0.4 AU | 2020 – 2025 | within 0.4 AU |
| **Duration** | 5 years | ~142 days | 5 years | ~399 days |
| **# X-ray flares** | $7x10^4$ | 2,000 | $24x10^4$ | $6x10^4$ |
| **# electron events** | 2,400 | 50 | 5,000 | 1,200 |