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Abstract: The SEPServer is hosting activities related to the scientific analysis of SEP event observations, including data analysis using both data-driven and simulation-based methods. The scientific conclusions of this effort are drawn with the implementation and release to the SEP community of multiple SEP event catalogs based on different spacecrafts and instruments, covering a broad timescale from 1975 to 2013 as well as a variety of distances from 0.3 to ~5 AU in the heliosphere. SEP events from Helios A & B missions, going back to 1975, at distances 0.3-1 AU, together with their Electromagnetic (EM) counterpart from OSRA data are being released for the first time. A catalog covering solar cycle 23 based upon the Solar and Heliospheric Observatory (SOHO)/ Energetic and Relativistic Nuclei and Electron (ERNE) high-energy (~68 MeV) protons at 1 AU with parallel analysis of SOHO/ Electron Proton Helium Instrument (EPHIN) and Advanced Composition Explorer (ACE) / Electron, Proton and Alpha Monitor (EPAM) data, including the relevant EM associations has also been delivered. Furthermore, the first complete Solar TERrestrial Relations Observatory (STEREO) SEP catalog based on the Low Energy Telescope (LET) protons (6-10 MeV) and the Solar Electron Proton Telescope (SEPT) electrons (65-105 keV) covering the rising phase of solar cycle 24 has been implemented. Moreover, the Cosmic Ray and Solar Particle Investigation (COSPIN) Kiel Electron Telescope (KET) data of 38-125 MeV has been used to identify a new catalog of SEP events observed in and out of the ecliptic plane over solar cycle 23, with simultaneous analysis of electrons recorded by the Heliosphere Instrument for Spectra, Composition and Anisotropy at Low Energies (HISCAL). For selected cases simulation based analysis has been applied in order to identify the timing of the injection history and to provide a cross reference to the EM emissions, leading to a comprehensive treatment of these events and to the corresponding testing of the data-driven analysis methods. SEPServer brings together a wealth of SEP data, analysis methods and diverse but at the same time interconnected solar and heliospheric communities. It thus provides an open tool that will advance our understanding of SEP propagation and acceleration, under different conditions, an important element of Space Weather.

SEPServer project:

✓ SEPServer is a three year collaborative project funded through the 7th Framework Program of the EU and coordinated by the University of Helsinki. SEPServer project aims to provide a new tool, which greatly facilitates the investigation of solar energetic particle (SEP) events and their origin. This is achieved via an internet server (<http://server.sepsserver.eu>) that provides access to high-quality SEP data, related EM observations, state-of-the-art analysis methods and comprehensive catalogues of observed SEP events from 1975 to 2012 (Malandraki et al., 2012).

✓ The SEPServer project has produced a new tool, which greatly facilitates the investigation of solar energetic particles (SEPs) and their origin. This is an Internet server providing:

- high-quality SEP data
- related electromagnetic (EM) observations and state-of-the-art analysis methods
- a comprehensive catalogue of the observed SEP events

SEPServer project, also provides educational and outreach material on solar eruptions and the space environment on its website (www.sepsserver.eu).

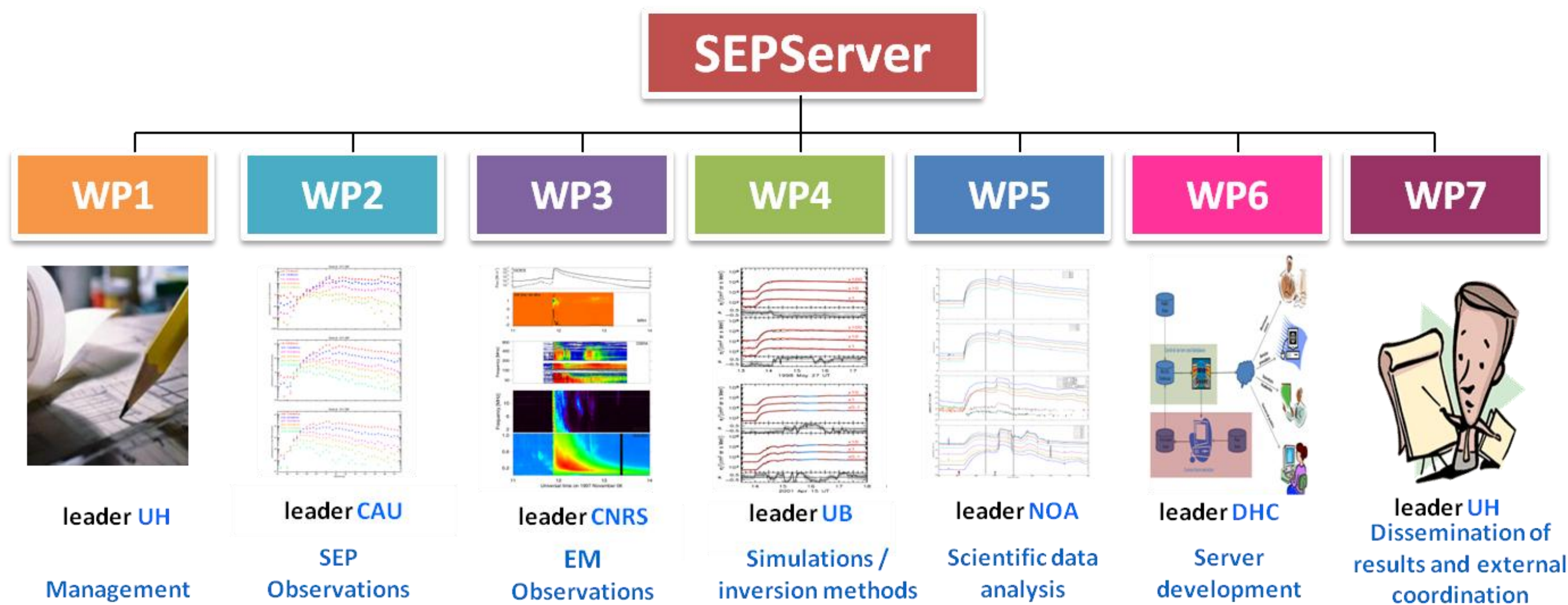


Figure 1. Illustration of the scanning on STEREO/LET data that led to the compilation of the SEPServer STEREO Catalogues. The background of the 6-10 MeV channel [2×10^{-5} particles/cm² sr s MeV] is presented in each diagram (red dashed line for STA and blue dashed line for STB)

SEPServer available datasets:

✓ SEPServer provides public access to a number of SEP datasets that have been previously either unavailable or available only through the PI team. SEP experiments to be included in the database come from a number of European and American missions:

- SOHO: COSTEP, ERNE (electrons 44 keV – 9 MeV, ions 1 – 100 MeV/n)
- ACE: SIS, EPAM (electrons 40 – 310 keV, ions 0.05 – 100 MeV/n)
- Wind: 3DP (electrons 30 – 500 keV, protons 0.07 – 7 MeV)
- STEREO: SEPT and LET (electrons 30 – 400 keV, ions 0.07 – 30 MeV/n)
- Helios: E6 (electrons 0.3 – 2 MeV, ions 2 – 50 MeV/n)
- Ulysses: COSPIN/KET and LET, HI-SCALE (electrons 30 keV – GeV, ions 50 keV – 2 GeV/n)

SEPServer will also provide streamlined access to the data from ground-based Neutron monitors.

✓ In addition to energetic particle data, SEPServer provides access to a comprehensive set of electromagnetic emissions related to the SEP events. These include:

- Spectrographic radio observations from AIP/Tremisford, ARTEMIS, Nancay Decameter Array and Wind/WAVES.
- Radio imaging observations from Nancay Radioheliograph
- Microwave observations from the University of Bern
- X-ray and gamma-ray observations from INTEGRAL, RHESSI, GRANAT/Phebus, Compton/BATSE

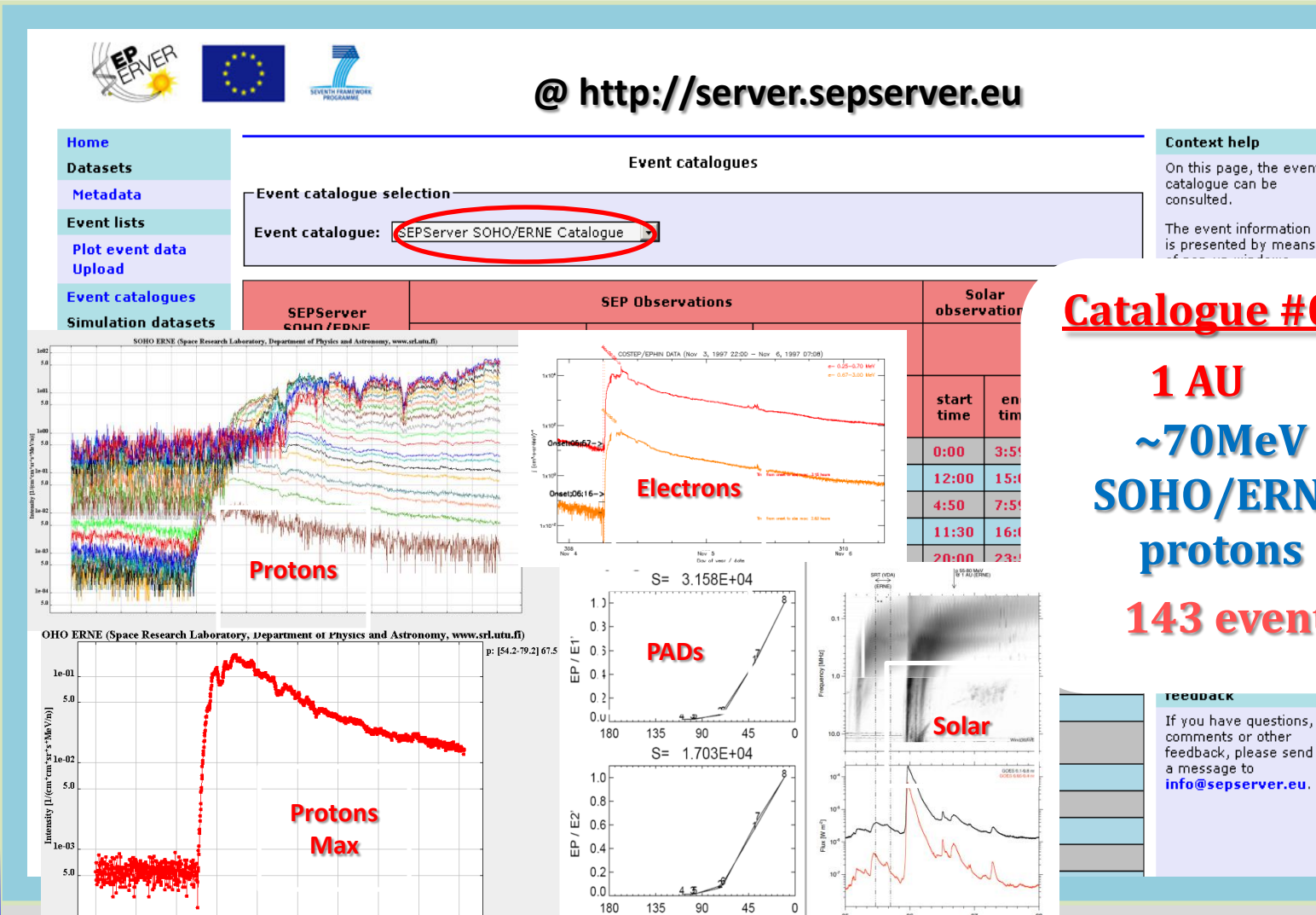
All datasets will be accompanied with reports on the assessment of their quality

For details on SEPServer datasets please refer to Vainio et al., 2013

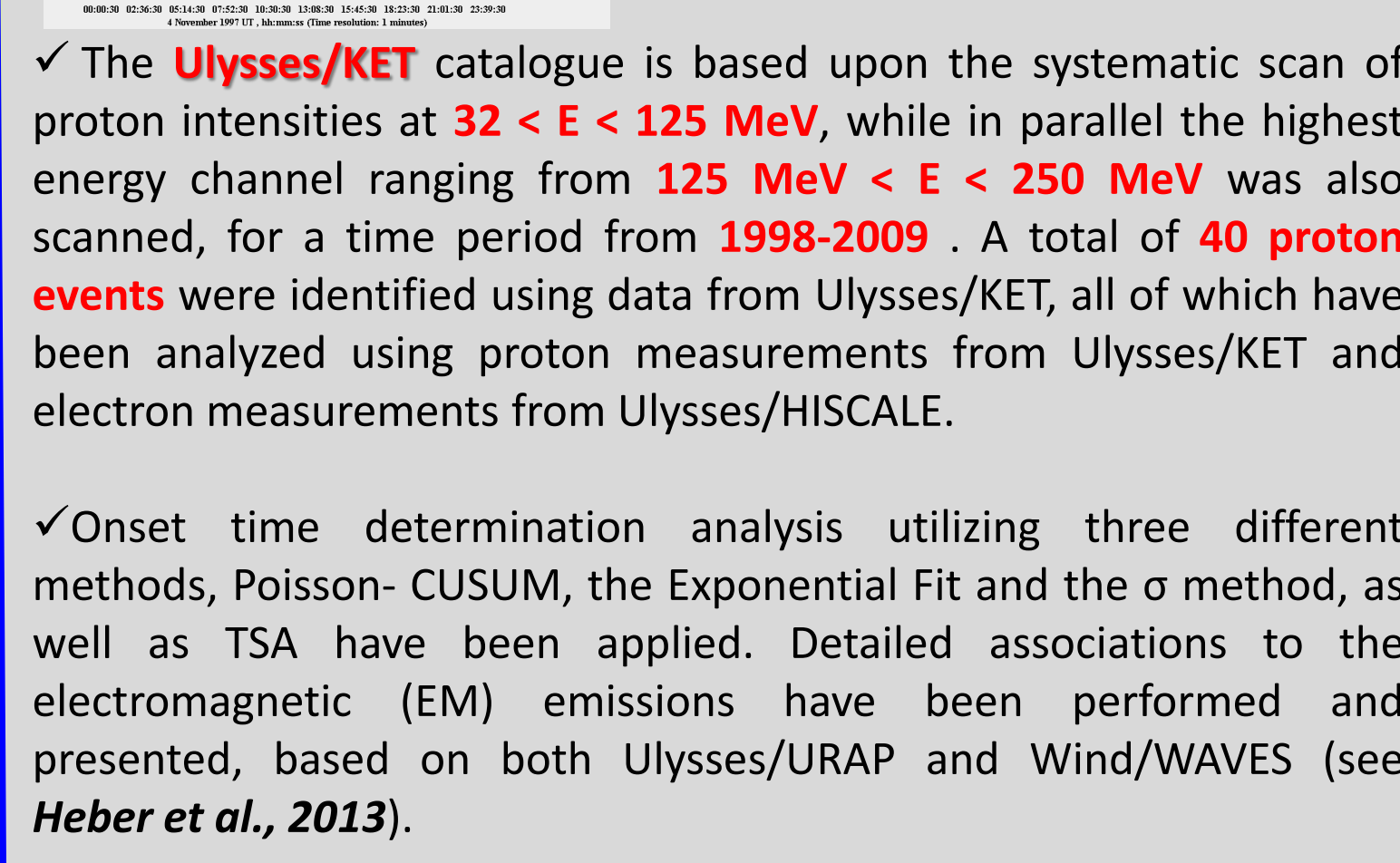
References:

- > Malandraki et al., Sol. Phys., 281, 333, 2012 > Malandraki et al., Proc. of the 11th He. I. As. Conference, 2013
- > Heber et al., Proc. of the 33rd ICRC, 2013 > Papaioannou et al., Proc. of the 11th He. I. As. Conference, 2013a
- > Papaioannou et al., ESWW10, 2013b > Vainio et al., JSWSC, 3, A12, 2013

SEPServer SEP event Catalogues:

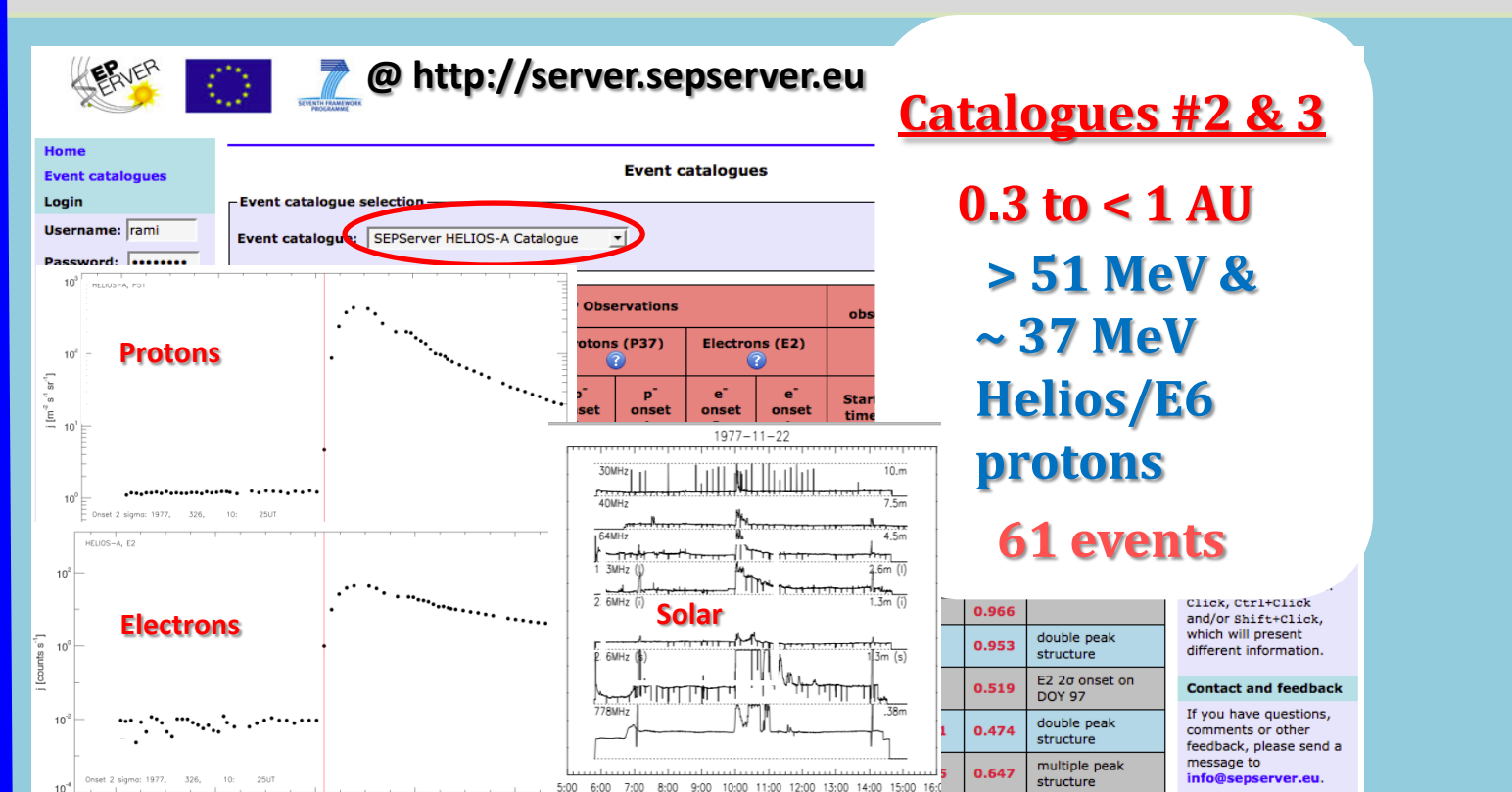


[A] The SOHO/ERNE catalogue is based upon the systematic scan of proton intensities (~68 MeV) observed from 1996-2012. A total of 143 proton events were identified using data from SOHO/ERNE. For the first 115 events analysis has been performed for SOHO/ERNE, SOHO/EPHIN and ACE/EPAM, resulting to the first comprehensive Catalogue of SEPServer. Within this catalogue the results of the aforementioned scientific analysis has been tabulated. Onset time determination analysis utilizing two different methods, velocity dispersion analysis (VDA) and time-shifting analysis (TSA), in order to get estimates of the particle release times close to the Sun has been applied. Detailed associations to the electromagnetic (EM) emissions have also been performed and presented (see Vainio et al., 2013).



✓ The Ulysses/KET catalogue is based upon the systematic scan of proton intensities at $32 < E < 125$ MeV, while in parallel the highest energy channel ranging from $125 \text{ MeV} < E < 250$ MeV was also scanned, for a time period from 1998-2009. A total of 40 proton events were identified using data from Ulysses/KET, all of which have been analyzed using proton measurements from Ulysses/KET and electron measurements from Ulysses/HISCAL.

✓ Onset time determination analysis utilizing three different methods, Poisson-CUSUM, the Exponential Fit and the σ method, as well as TSA have been applied. Detailed associations to the electromagnetic (EM) emissions have been performed and presented, based on both Ulysses/URAP and Wind/WAVES (see Heber et al., 2013).

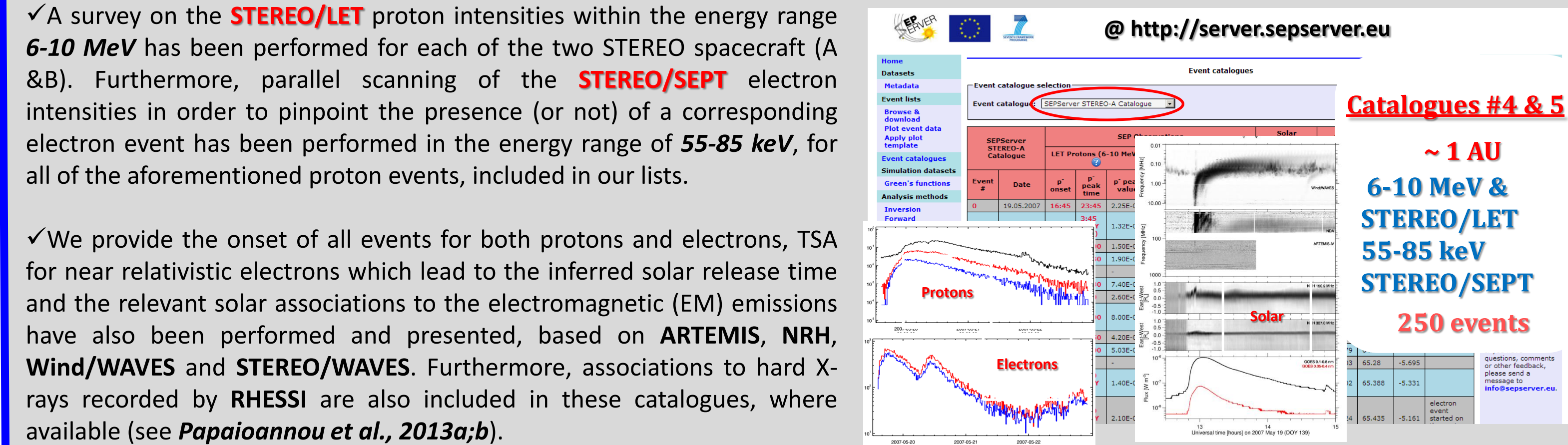


✓ A survey on the STEREO/LET proton intensities within the energy range 6-10 MeV has been performed for each of the two STEREO spacecraft (A & B). Furthermore, parallel scanning of the STEREO/SEPT electron intensities in order to pinpoint the presence (or not) of a corresponding electron event has been performed in the energy range of 55-85 keV, for all of the aforementioned proton events, included in our lists.

✓ We provide the onset of all events for both protons and electrons, TSA for near relativistic electrons which lead to the inferred solar release time and the relevant solar associations to the electromagnetic (EM) emissions have also been performed and presented, based on ARTEMIS, NRH, Wind/WAVES and STEREO/WAVES. Furthermore, associations to hard X-rays recorded by RHESSI are also included in these catalogues, where available (see Papaioannou et al., 2013a;b).

✓ The Helios (A or B) catalogues are based upon the systematic scan of proton intensities at 37 MeV, while parallel scanning of the integral proton intensities at 51 MeV and electrons at > 2 MeV took place for a time period from 1975-1982 (for Helios A) and 1977-1980 (for Helios B). A total of 61 events were identified using data from Helios spacecraft.

✓ Onset time determination analysis utilizing one method that has proven to work more efficiently for these datasets, the σ method, has been applied. Detailed associations to the electromagnetic (EM) emissions have also been performed and presented, based on OSRA available data (see Malandraki et al., 2013).



Conclusions:

✓ One of the most important scientific conclusions of SEPServer is the implementation, and release to the SEP community, of multiple SEP event catalogues based on different spacecraft and instruments, covering a broad timescale from 1975 to 2012 as well as a variety of radial distances from 0.3 to ~5 AU in the heliosphere. In particular, SEPServer hosts six catalogues of SEP events based on SOHO/ERNE [1], Ulysses/KET [2], Helios-A & B [3], and STEREO A & B [4].

