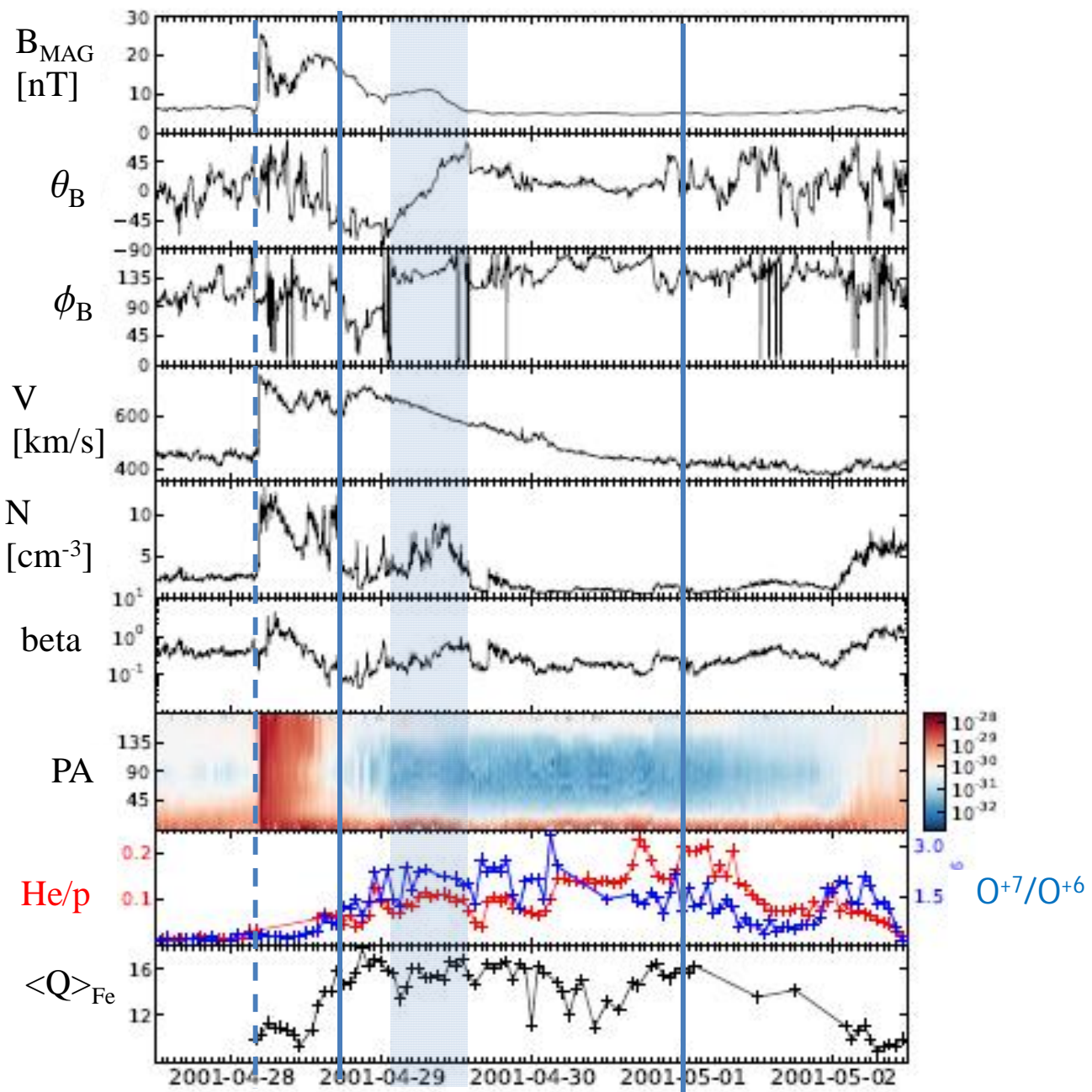


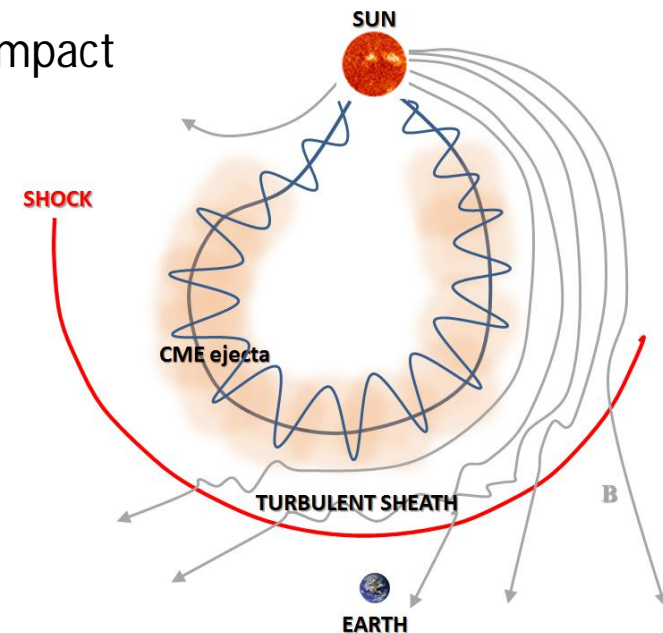
WP4 Task 4.2: Comparing to in-situ measurements

- Compile a comprehensive in-situ ICME catalog (related to CMEs analyzed in WP3)
- Compare ICME and CME properties
- Instruments used: STEREO, Wind, ACE, Venus Express, MESSENGER, Ulysses, MSL
- Role of participants:
 - UH: CME categorization/cataloguing (L1 & STEREO), GS reconstruction
 - UNIGRAZ: CME categorization/cataloguing (other S/C), GS reconstruction, multi-point heliospheric analysis
 - Imperial: multi-point L1 analysis
 - UPS: sheath/sub-structure analysis
 - UGOE: Minimum Variance Analysis (MVA)



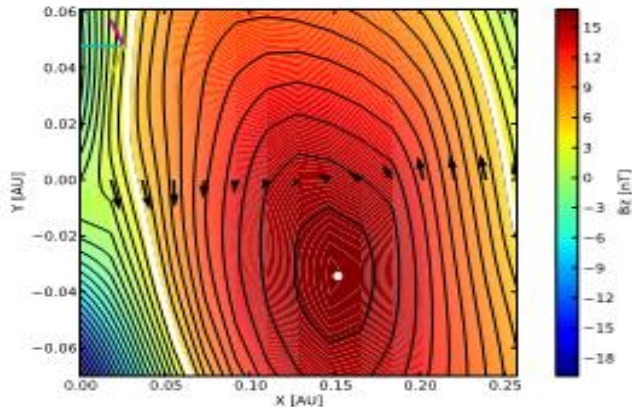
1. Categorizing CMEs based on their physical structure in-situ

- Flux rope/non-flux rope (complex) ICMEs:
 - Is there a flux rope embedded? (*unperturbed* flux rope)
 - If there is, does flux rope boundaries coincide with the other ICME signatures? (see e.g. Kilpua et al., www.ann-geophys.net/31/1251/2013/, 2013)
 - complex ICMEs
- Interacting ICMEs
 - Are there signatures of ICME-ICME interaction?
 - Are there successive and interacting CMEs in coronagraph and HI?
- Calculating and cataloguing relevant parameters
 - closest approach distance (compared with the HI impact predictions)
 - flux rope type and chirality, axis orientation
 - average magnetic field and plasma parameters
 - expansion speed (how affects the density profile?)
 - shock stand-off distance
 - etc.
- ICMEs encountered by multiple spacecraft



2. Modelling of flux-rope CMEs

- Grad-Shafranov reconstruction (Wind, ACE, STEREO, Ulysses)
 - e.g., Hu et al, 2002; Möstl et al., 2009, Isavnin, Kilpua and Koskinen, 2011
 - assumes magnetohydrostatic equilibrium, magnetic field exhibits a translational symmetry with respect to the invariant axis (i.e. 2.5-D structure)
 - picks the *unperturbed* flux rope
 - boundaries are the output of the model
- Minimum variance analysis (MESSENGER, VEX)
 - straightforward to use
 - provides the flux rope axis orientation
- Other methods applied if needed
 - e.g., non-force-free elliptical expanding flux rope model (Hidalgo et al., 2002)



(MSL has only energetic particles data)

3. Categorizing CMEs based on ambient solar wind speed/ interplanetary magnetic field structure.!

- Categorize the ambient solar wind structure around the ICMEs:
 - within the slow solar wind
 - in the declining portion of a fast stream
 - close to a slow-fast stream interaction region and stream interfaces
(connection to WP5: Producing a definitive catalogue of CIRs imaged by STEREO/HI that includes verified model-derived kinematic properties)
- Interplanetary magnetic field structure
 - are there sector boundary crossings near the ICME?
- how the ambient solar wind structure affects the ICME properties, in particular density structure (e.g. density increase due to compression by a trailing fast stream)

4. Analysis of sheath/CME density substructures

- Separate physically different ICME structures (sheath, unperturbed flux rope, perturbed/non-flux rope ICME parts) using a wide range of solar wind parameters
- Focus will be on the density structures (to compare with the HI data)
- Different layers and substructures in sheath regions (pile-up sheath or compressed coronal arcades)

- Task 4.2 time line:
 - Months 10-36 (data and analysis tool processing starts earlier)
 - Analysis can begin when estimated arrival times of a few CMEs from WP3 are ready
 - Extended as new CME events arrive from WP3
 - Start from a simple catalog (the level of complexity can be increased later)
- Relevant Deliverables:
 - *D4.1*: Establishing an online catalogue of potentially associated solar source **and in-situ phenomena** for the timeframe 2007-2015, *Month 24*) (jointly with Task 4.1)
- Some discussion topics:
 - What are sheath and ICME parameters that will best benefit comparison with HI?
 - What are sheath/ICME substructures we should focus on?
 - Details of the ICME catalog: How the catalog will be implemented, displayed and updated?
 - Do we need search options (cf. LASCO CME catalog)
 - How to deal with the large variety of ICME events to be included in the catalog and with complex and unclear events?
 - Connection between the ICME and HI CME catalogs (same formats etc)

