Susanna Parenti, Royal Observatory of Belgium and the EUI team

Solar Orbiter – METIS
3rd Science and Technical Meeting
Solar Orbiter Science goals

1. How and where do the solar wind plasma and magnetic field originate in the corona?
2. How do solar transients drive heliospheric variability?
3. How do solar eruptions produce energetic particle radiation that fills the heliosphere?
4. How does the solar dynamo work and drive connections between the Sun and the heliosphere?
To achieve Orbiter science goals

- **Step 1**: to have **consistent data** from *in-situ* and RS.
  - **How**: choice of targets with **connectivity** to the *in-situ* instruments:
    - Sources of open/closed magnetic field in quiescent regions
    - Sources of eruptions/transients

- **Step 2**: to have tools to validate the connectivity of a target
Coordinated activities

- **Before the science windows:**
  - Identify which precursor observations we need
  - Work on the optimization of common observing programs (SOOPs)
    - Similar cadence?, FOV, observables….
  
- **After the observations:**
  - We need to ensure to download same SOOPs data.
    - E.g: coordination on reaction to flags
    - Organization of packet stores in the SSMM
  - Inputs to RSWG, SOWG
  - Involve *in-situ* teams

See A. De Groof talk.
Planning for the $N_i$ orbit: an example

**STEP A:**
RS precursor observations:
- EUI/FSI thumbnails
  - (comp > 103)
- PHI full disk B maps
- METIS WL corona

Small data volume to be downlink within 1 single pass

**STEP B:**
- Extrapolation of photospheric magnetic field (~ 2 Rsun)
- Use theory/modeling for B and wind paths
Planning for the N$_i$ orbit: cont’s

STEP C:
- Use theory/modeling for B and wind paths
- Lower boundary condition given by STEP B
- MHD heliospheric model (e.g. ENLIL)

STEP D:
- Identify the spacecraft orbit within the large scale magnetic/wind structure.

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Planning for the $N_i$ orbit: cont’s

STEP E:
Identify the paths on the Sun with connectivity with the S/C

RS high resolution FOV for the $N_i$ orbit

We can miss the connectivity!

Prediction of possible connectivity for SEP/CMEs

Prediction of connectivity for wind
## EUI instrument and performances

<table>
<thead>
<tr>
<th>Channel</th>
<th>Parameter</th>
<th>Values</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Dimensions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Optical bench</td>
<td>550x175x785mm</td>
</tr>
<tr>
<td></td>
<td>- Electronic box</td>
<td>120x300x250mm</td>
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<tr>
<td></td>
<td>Mass (incl. margins)</td>
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<tr>
<td></td>
<td>Nominal power</td>
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<td>Telemetry</td>
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<td>FSI dual EUV</td>
<td>Wavebands</td>
<td>174 Å et 304 Å</td>
</tr>
<tr>
<td></td>
<td>Field of View</td>
<td>5.2 arcdeg × 5.2 arcdeg</td>
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<tr>
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<td>Resolution (2 px)</td>
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<tr>
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<td>Cadence</td>
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<td>HRI</td>
<td>Wavebands</td>
<td>174 Å</td>
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<td>Field of View</td>
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<tr>
<td></td>
<td>Resolution (2 px)</td>
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<tr>
<td></td>
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<tr>
<td></td>
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<td>&lt; 1s</td>
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SolO/METIS - 121.6nm

He II 304 channel

Bemporad

SolO at 0.28 AU

EUI Full Sun Imager (FSI)

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EUI High Resolution Imager (HRI)

Fe IX/X  174

HRI res.: ~200 km @ 0.3AU

SPICE FOV: 16’ x 13’

17’

H Ly α

PHI/HRT FOV: 16.8’ x 136.8

PHI res: ~200 km
SPICE res: ~ 1000 km
Addition of an occulting disk ... 

- Simple occultor design OK @ 174 & 304
- Door modifications are implemented
- Limited number of operations
  - Campaign mode
  - Only when far from the Sun (0.4 AU)?
- Occulter dimension TBD
The corona viewed by METIS & EUI

- METIS WL + UV: Ne, \( \nu \) maps
- A proxy for Ly\( \alpha \) disk intensity: use the known Ly\( \alpha \) – He II relation on the disk and the He II disk measures (FSI)
- EUI occulted 304 images
  - \( \leq 2 \) Rsun: we see Si XI
  - >2 Rsun: He II
  - Attempts to obtain \( \nu \) maps, abundance variations
- EUI occulted 174 images:
  - Use Ne from METIS to get T
  - + 304 (< 2Rs) (only an attempt)
An example: How and where do the solar wind plasma and magnetic field originate in the corona?

What is the role of magnetic topology in controlling the wind speed?

### Situation for 2012

**EUI**
**FSI:** Maps of $I$ in He$^+$ 304 and Fe X 174
- He$^+$ coronagraph mode on-off
- 10 min-1h cad, 18” spatial res.

**HRI:** Maps of $I$ 174 & Lya
- <30 sec and <15 sec cad.

**METIS**
Maps of $N$ (VL), $v$ of H$^0$
- 5-10 min cad, 20” spatial res.

**SPICE** (Composition Mapping)
- Scan (4” spatial res), > 120 min

**PHI:** full FOV + high resolution

### Situation for 2013

**EUI**
**FSI:** Maps of $I$ in He$^+$ 304 and Fe X 174
- He$^+$ coronagraph mode on-off
- 1 min-1h cad, 18” spatial res.

**HRI:** Maps of $I$ 174 & Lya
- <30 sec and <15 sec cad.

**METIS (MAGTOP)**
Maps of $N$ (VL), $v$ of H$^0$
- 5-10 min cad, 20” spatial res.

**SPICE (Composition Mapping)**
- Scan (4” spatial res), > 120 min

**PHI:** full FOV + high resolution

See Solanki & Spadaro talks
Eruptions

- **To image the source regions** at high spatial resolution
  - Very difficult for EUI/HRI - SPICE – PHI. Low spatial resolution images for most of the time
  - Turn-around time of 2-3 days (off-pointing probably only once)
- **Corona:** we have data with partial superimposed FOV, hot and cold plasma tracers.
- **Flags:**
  - EUI -STIX flags used by METIS & SPICE for CMEs programs?
    - But limited margin of manoeuvre: e.g. change exposure time but not total used resources.
  - METIS flag (**TBC**): if not a flag in EUI-STIX, then we can recover FSI context images.

See Bemporad talk
SoFAST: automated flare detection with the PROBA2/SWAP EUV imager [Bonte et al., 2012, SolPhys]

A prototype system for onboard flare triggering in Solar Orbiter EUI/FSI 174 images. Tests on the 304 are also planned (filaments eruption)
Onboard response/action

Possible response when an event is detected (TBD):

- Retrieve eventual priority from the detection parameters
- Send notification / main event parameters / priority to ground (to check)
- No further response at all: action in response to trigger algorithm disabled
- If enabled, copying a pattern of the corresponding (HRI-FSI) data from the 1hr queue to the s/c buffer
- If required, changing observation sequence to e.g. increase exposure time...
- If required, send priority to other instruments (to be coordinated)
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S. Parenti, A. Bemporad, A. Verdini

The science with future solar missions, from the Sun to the Heliosphere

Solar Orbiter, Probe Plus, Interhelios and more…