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In situ measurements at the L5 Lagrange point - summary

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In situ measurements at L5

Jonathan Eastwood	Magnetic field measurements at the L5 Lagrange point
Duncan Mackay	L5 Mission: Improving the Predictive Capability of Local and Global Magnetic Field Models
Andrew Fazakerley	What can we learn from solar wind observations at L5?
Francois Bocquet	Improvements to CME arrival prediction using L5 data
Break	
Dhiren Kataria	In-situ particle environment monitoring: Operational needs and the state of the art
Bob Bentley	Solar Energetic Particles: Operational needs and L5
Mike Marsh	Pushing the Boundary of Solar Energetic Particle Science with an Operational Mission
Emilia Kilpua (Skype)	L5 in-situ measurements: Potential improvements to future space weather forecasting and science

Hassler: Space weather at Mars

Laitenen: Solar Energetic Particles

In situ measurements

- Bulk plasma – speed, density, temperature (composition)
- Magnetometer – magnetic field strength and orientation
- Energetic particles – electrons, ions
- Why?

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Why?

- Triple threat:

- The geoeffective structure itself
  - Stream interaction regions (aka Co-rotating interaction regions)
  - Fast solar wind streams
  - Takes several days for source to rotate from L5 to L1 line of sight

- The solar wind *into which* geoeffective structure propagates
  - The St. Patrick's day March 2015 CME was *significantly affected* by the solar wind ahead of it (Kataoka et al., GRL, submitted, 2015)

- Knowledge of Solar Energetic Particles
  - Solar proton event energy, anisotropy, spectra
  - Electrons can tell you about the topology of the solar wind

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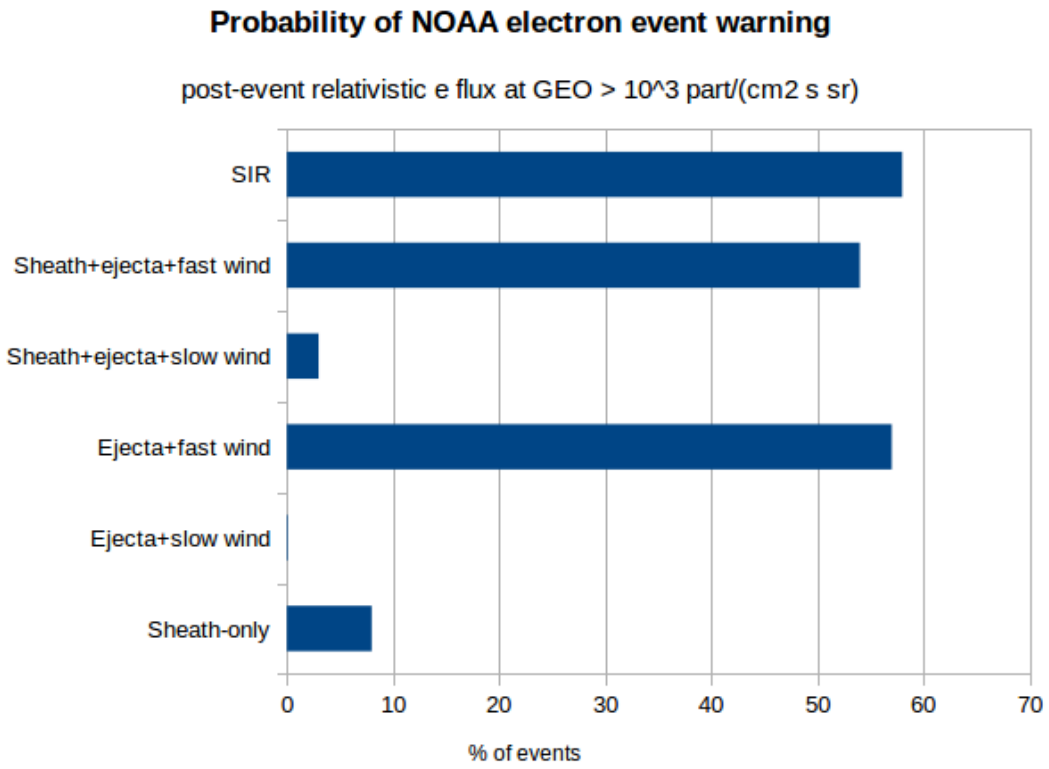
Image credit: H. Hietala
Hietala et al. 2014, Kilpua et al., 2015

Stream interaction regions

- Observed at L5 insitu several days before they are seen at L1
- They cause significant post-event electron flux at GEO
- Persistence of bulk structure known from STEREO L5 – L1 studies
- More detailed investigation on science side still required (fold in ENLIL/modeling, skill scores etc.)



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The 'background' solar wind

- We go to L5 to get a better forecast of when the 'Carrington' CME will arrive at Earth (my opinion)
  - Precise 'cost/benefit' to be studied by IPSP
  - CMEs are affected by the medium into which they propagate
  - The CME sheath region is compressed ambient solar wind and can be geoeffective
  - Is there a southward magnetic field in the CME sheath region?
- Several day warning of SIR driven storms (arguably a different class of storm)
- Another data point to constrain simulations and forecasts
  - Continuous data assimilation from L5 and L1 to improve forecasts
- (Interplanetary field enhancements and Near Earth Objects)

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Energetic particles

- Positively charged
  - Solar Proton Events
  - Implications for interplanetary space weather
  - Anisotropy
- Negatively charged
  - Electron strahl
  - Connectivity of solar wind magnetic field
  - Topology of magnetic field assists detection of CME magnetic clouds for example

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Thoughts on payload

- An in situ package will make a significant difference to our ability to forecast the arrival of geoeffective structure at Earth
- Instruments required to deliver any desired measurement have high TRL
  - Strong heritage thanks to previous science investment
- Prioritisation
  - Ultimately depends on requirements
- Personal thoughts
  - Physics: “geoeffectiveness” is physically defined by the magnetic field and the solar wind speed
  - The in situ package will be a small part of the overall payload by any metric