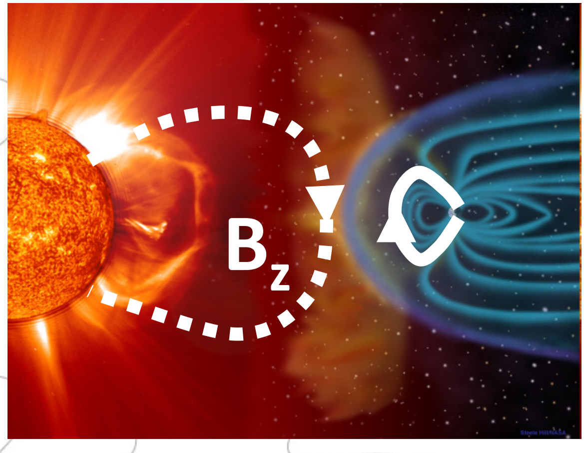
Summer School Alpbach 2013 - Innovative Space Weather Missions

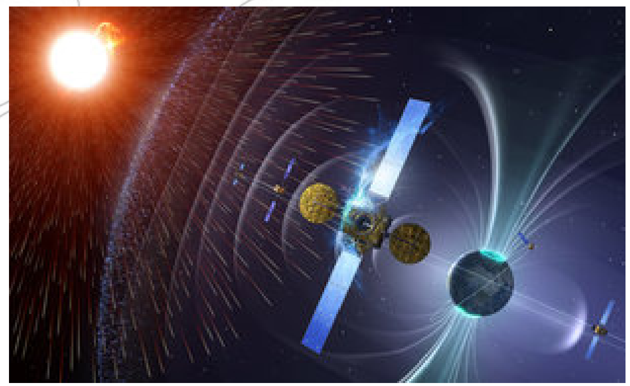
Contents

- Space weather and its impact on Earth
- Summerschool Alpbach at a glance
- Proposed missions *CARETAKER*, *PAC2MAN*, *ADONIS*, *OSCAR*
- Scientific aspects of mission *CARRINGTON*
- Engineering feasibility of mission *CARRINGTON*

Space weather and its impact on Earth

- CMEs affect navigation, communication, power grids, spacecraft, radar systems, etc.
- Forecast and proper lead time to protect systems: safe mode, standby, etc.
- Prediction of space weather events: solar winds, CMEs, etc.
- Model development of the Sun
- Geoeffectiveness: Strongly depends on the magnetic structure (Bz) of a CME





Summerschool Alpbach at a glance

- Annual ten-day event at Alpbach, Tyrol in July / August
- 60 European students work on space-related topics

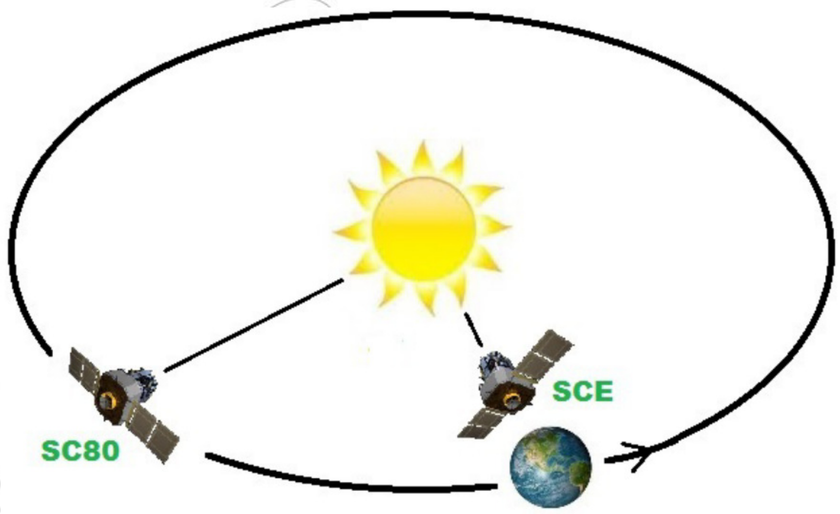
- Lectures from universities and major companies give interesting talks
- Four teams (15 students each) develop independent mission concepts
- Awards for best science case, best engineering, most competitive, etc.
- Hands-on experience in various space science / engineering fields
- Networking and organization of international collaborations

Summerschool Alpbach at a glance

FFG

PAC2MAN

- Understand and predict CMEs and flares
- Near real-time forecast
- 2 spacecraft at L1 and around the Sun (80° to Earth)
- 2 Soyuz launchers
- Cost Budget b€ 1.18

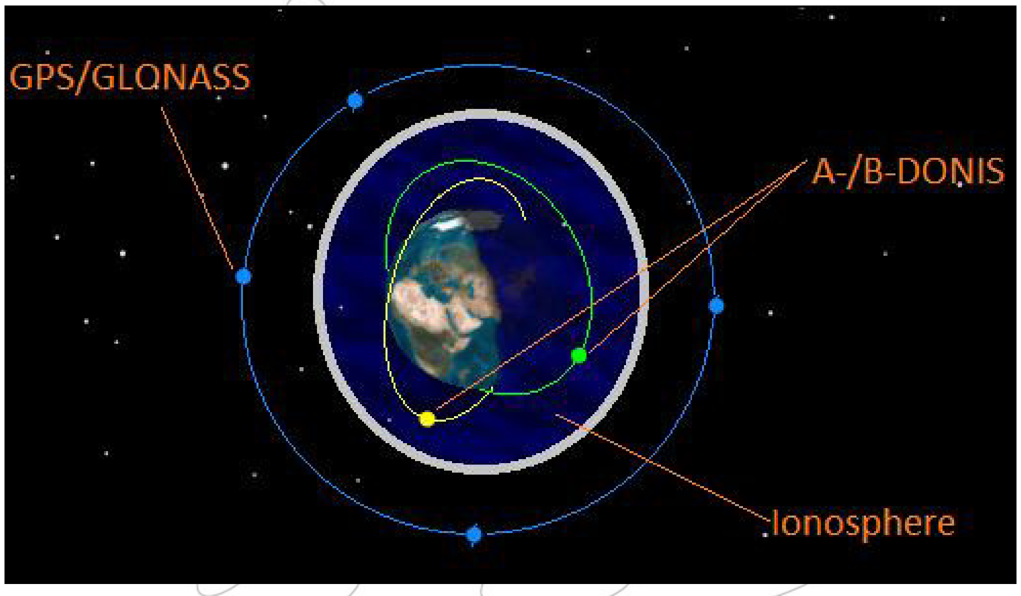


Summerschool Alpbach at a glance

FFG

ADONIS

- In-situ measurement of drag parameters
- Correlation with SWE
- Data to improve ionospheric models



- 2 spacecraft around Eart (90° separation)
- One VEGA Launcher
- Cost Budget M€ 45

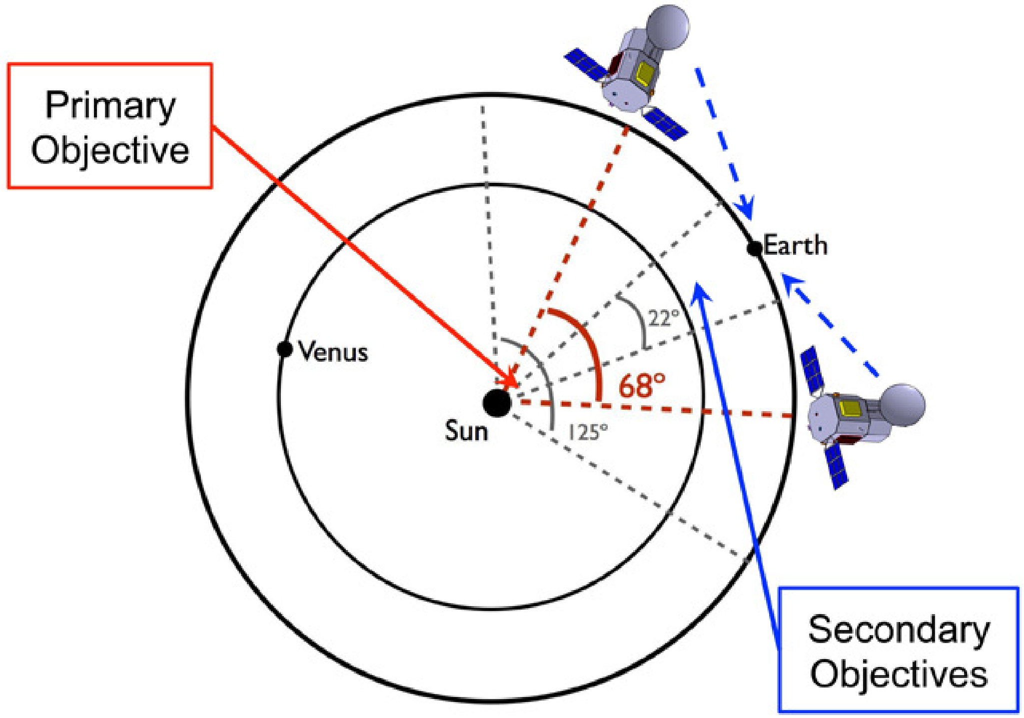
Summerschool Alpbach at a glance

FFG

OSCAR

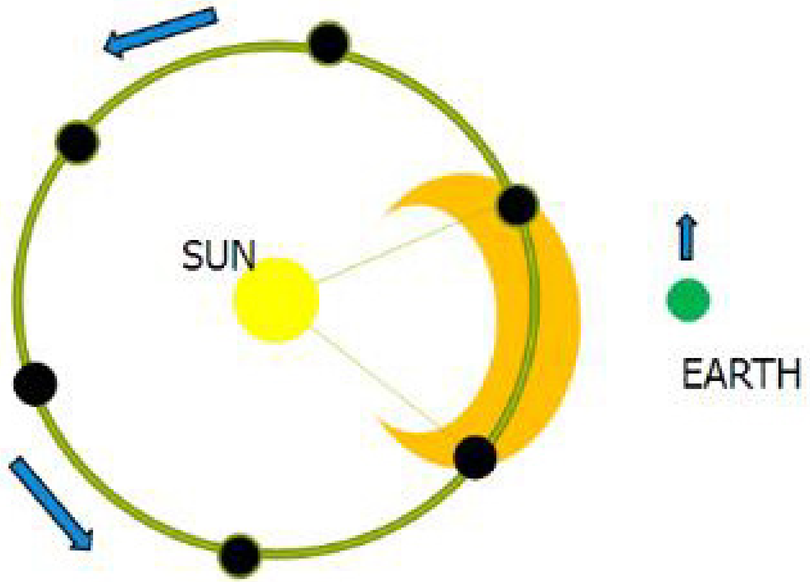
- Near real-time forecast and CME trigger study
- Stereoscopic observation

  In-Situ and Remote
- 2 spacecraft around Sun (each 68° from Earth)
- 1 Soyuz launcher
- Cost Budget M€ 650



CARETAKER

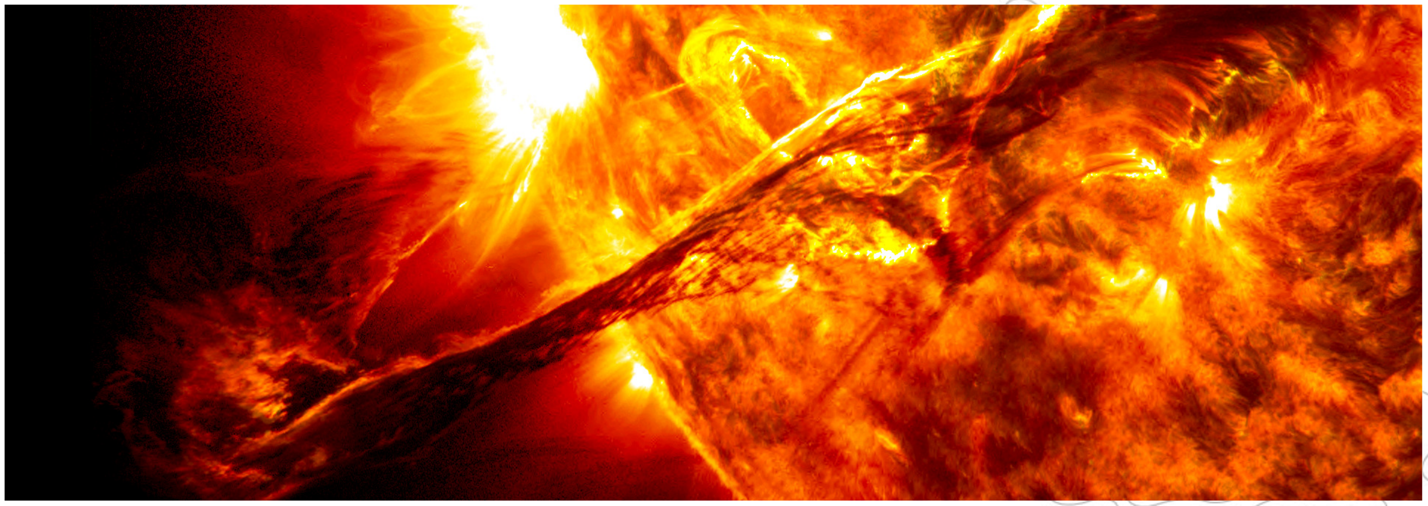
- Warning System Service
- Continuous In-Situ and Remote Determination of Velocity and Severity of CME's
- 6 Spacecraft @ 0.7AU
- 1 Ariane-5 Launcher
- Cost Budget b€ 1.44



Summerschool Alpbach at a glance

http://www.summerschoolalpbach.at -> **Student Presentation**

THE CARRINGTON MISSION



Mission Statement:

“Provide a CME forecast system for earth at least 3 hours in advance”

Mission objectives

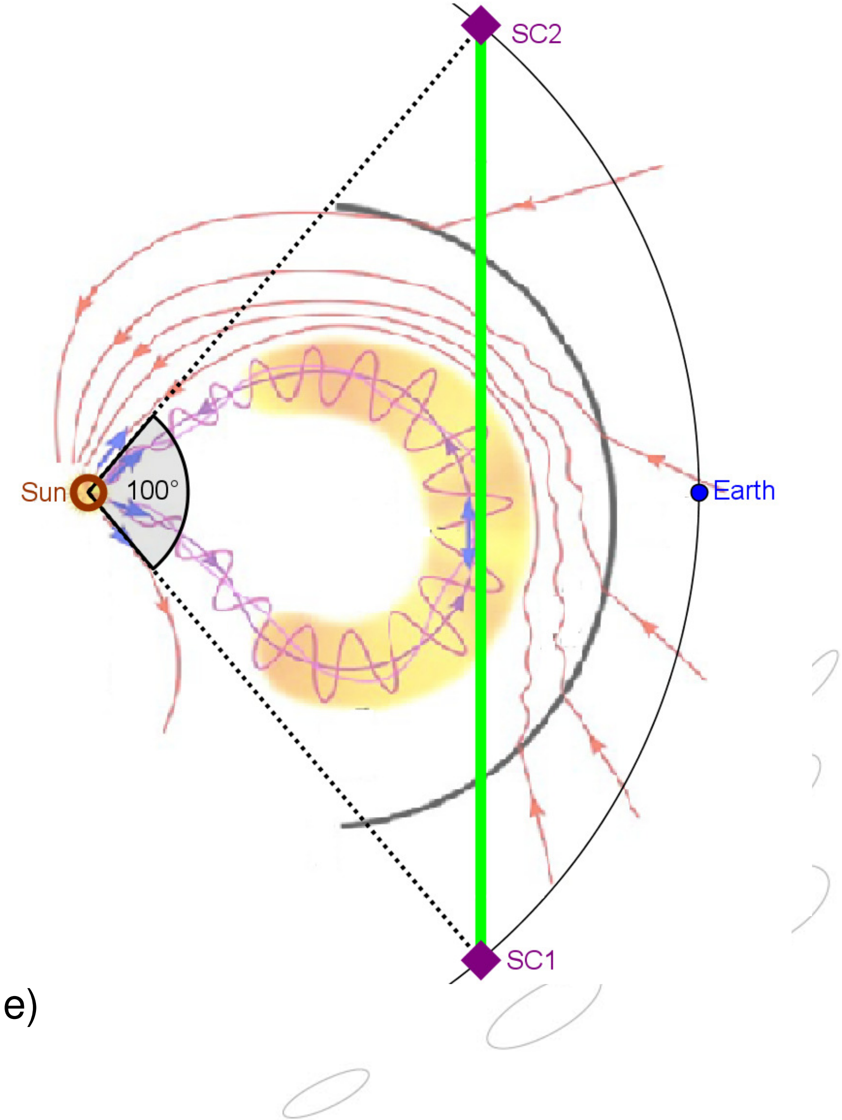
Primary:

- CME propagation trajectory and speed
- CME 3D structure
- CME shock front
- CME magnetic field orientation and magnitude

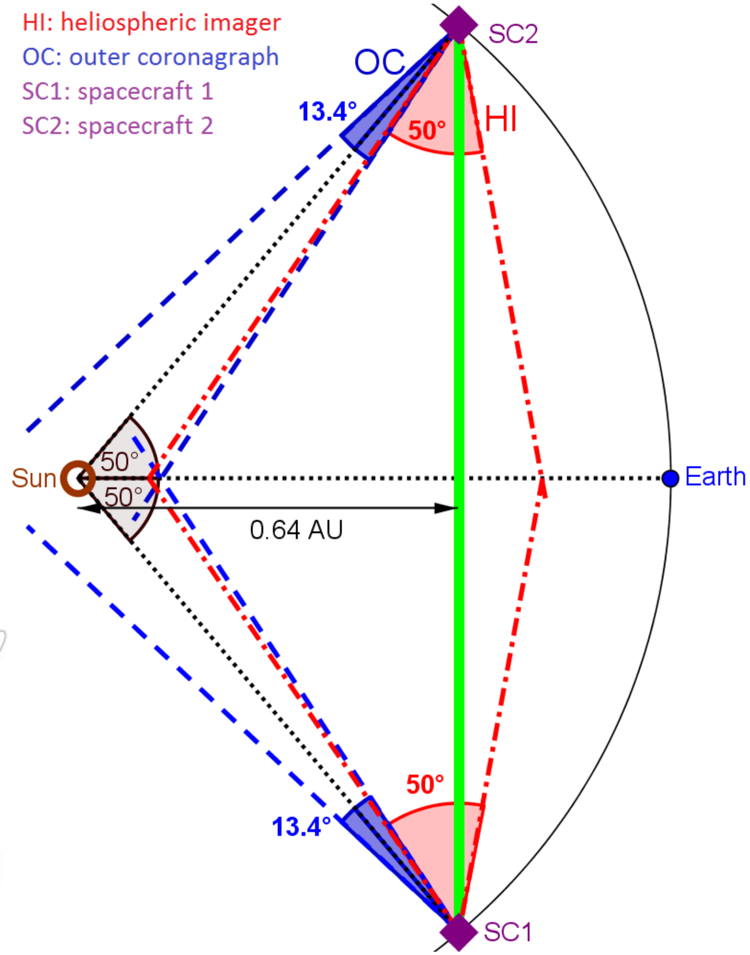
Secondary:

- CME magnetic structure at the origin
- CIR forecast

Mission concept



(Not to scale)



ICME speed measured at 1 AU:
290 - 1300 km/s
(Cane and Richardson, 2010)

Instruments

- Inner Coronagraph: spectropolarimetric measurement

  ⇨ magnetic field in the corona

- Outer Coronagraph: white light imaging between 2.5 and 30 solar radii

  ⇨ track the CME path

- Heliospheric imager: white light imaging between 30 and 167 solar radii

  ⇨ CME trajectory forecast and plasma density

- Faraday-Voigt Instrument: measure the magnetically induced birefringence with interferometry

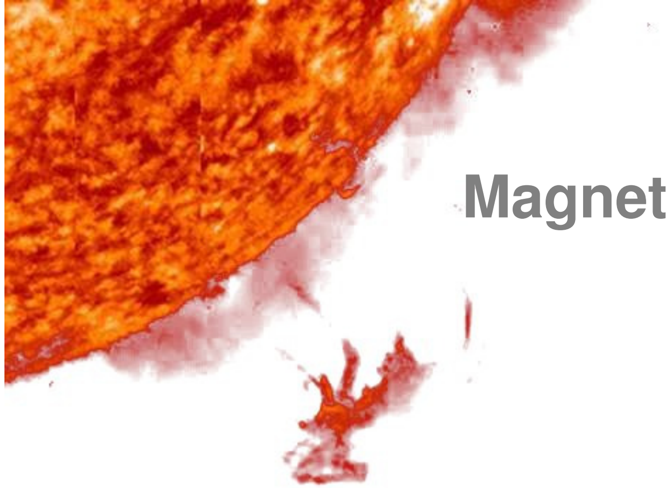
  ⇨ determination of the magnetic field orientation and strength of the CME

- Magnetometer: in-situ magnetic field measurement

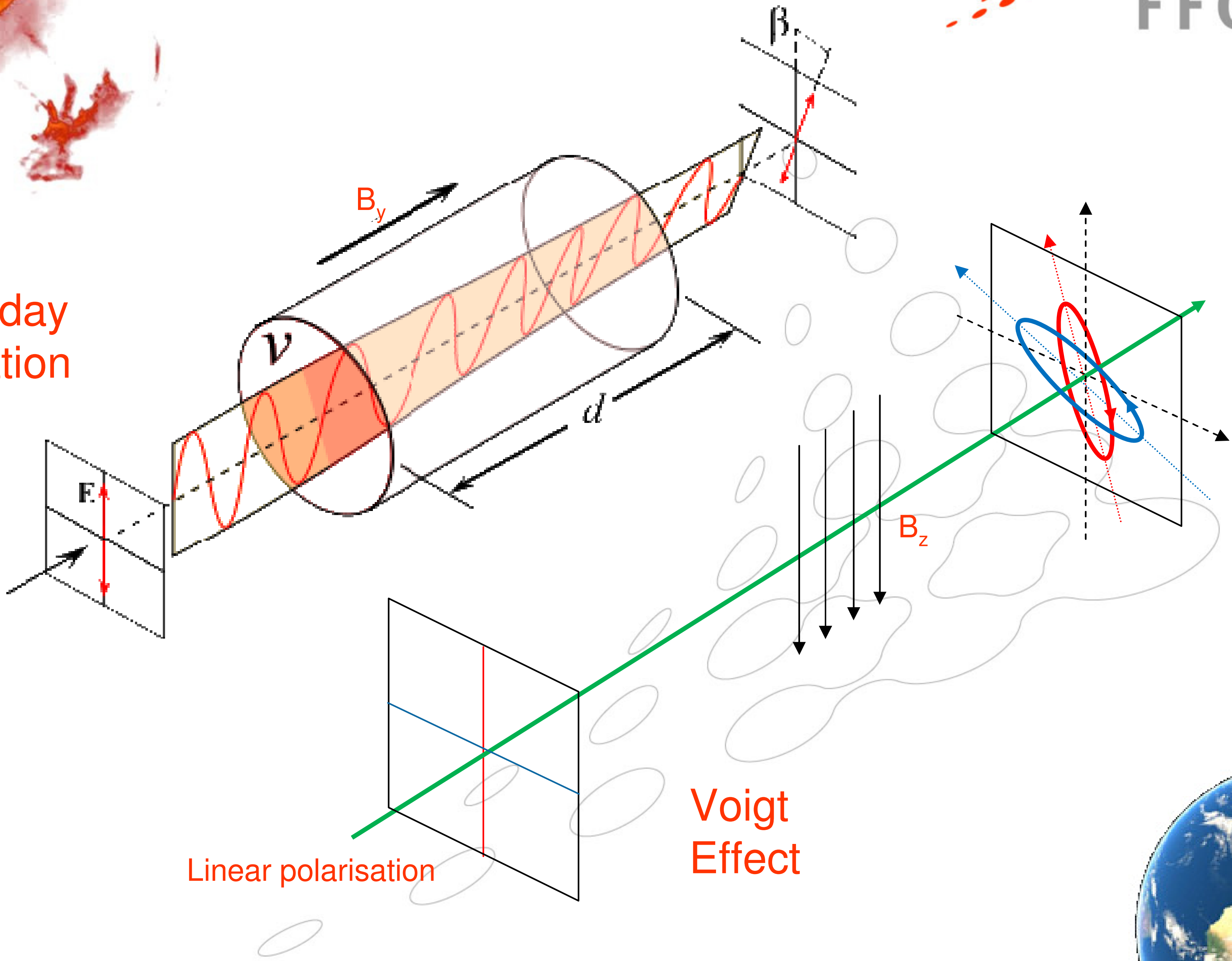
  ⇨ verification of the remote magnetic field measurements

- Plasma package: in-situ measurement of electron and ion parameters

  ⇨ CIR detection



Magnetic field measurement

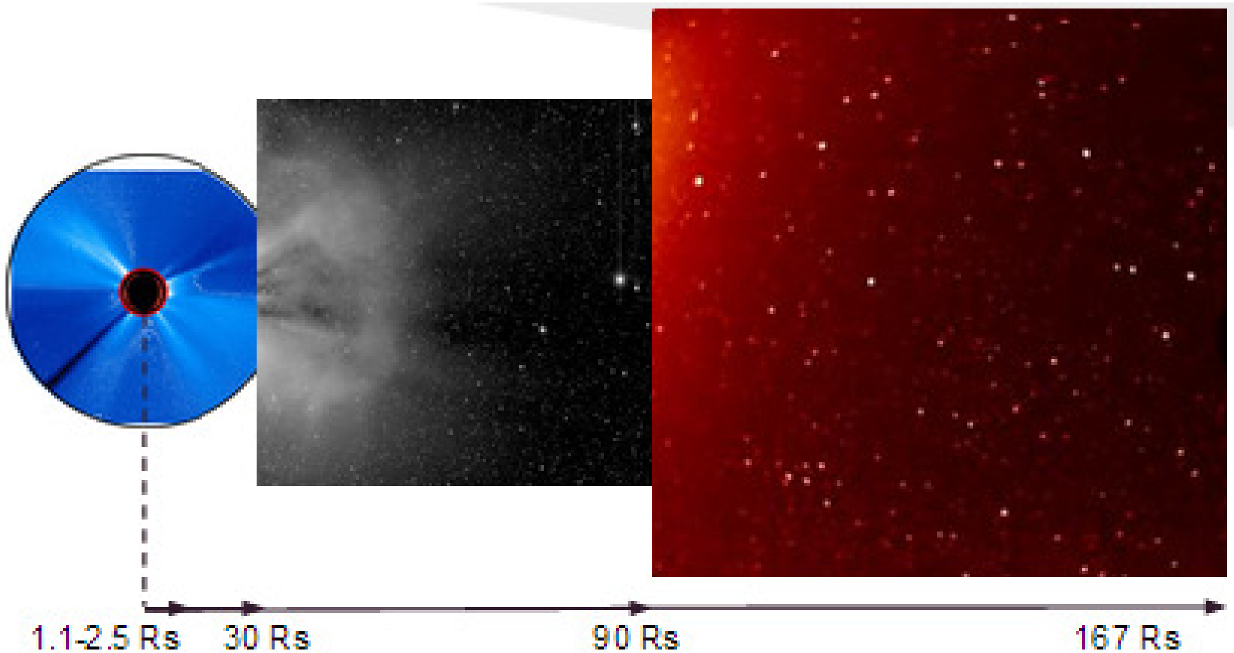


Imagers

Observations:

Primary:
Stereoscopic observation of the CME (scattered light)

Secondary:
measurement of the magnetic field vector in the plane of sky at the onset of CMEs



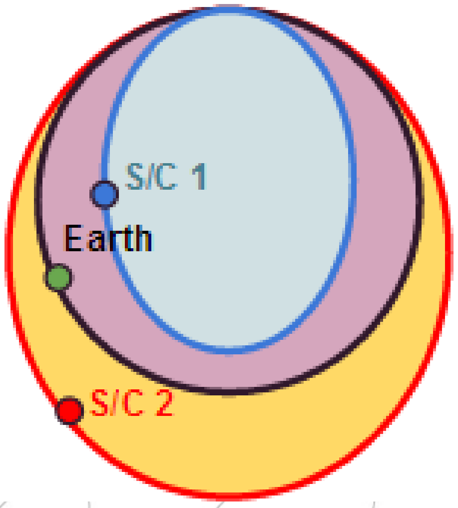
3 remote sensing instruments

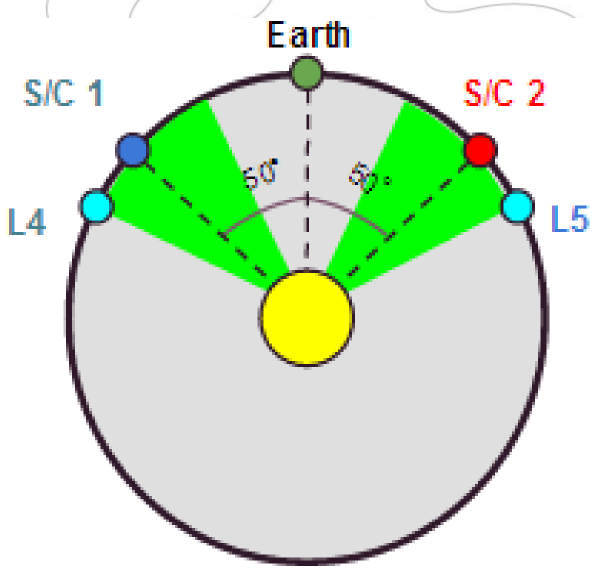
- Inner coronagraph: spectropolarimetric imager
- Outer coronagraph: visible light coronagraph
- Heliospheric imagers (inner and outer): visible light imager

Orbit Selection

50° separation:

- Laser path as small as possible
- Forecast time requirement
- Stereoscopig imaging





Spacecraft

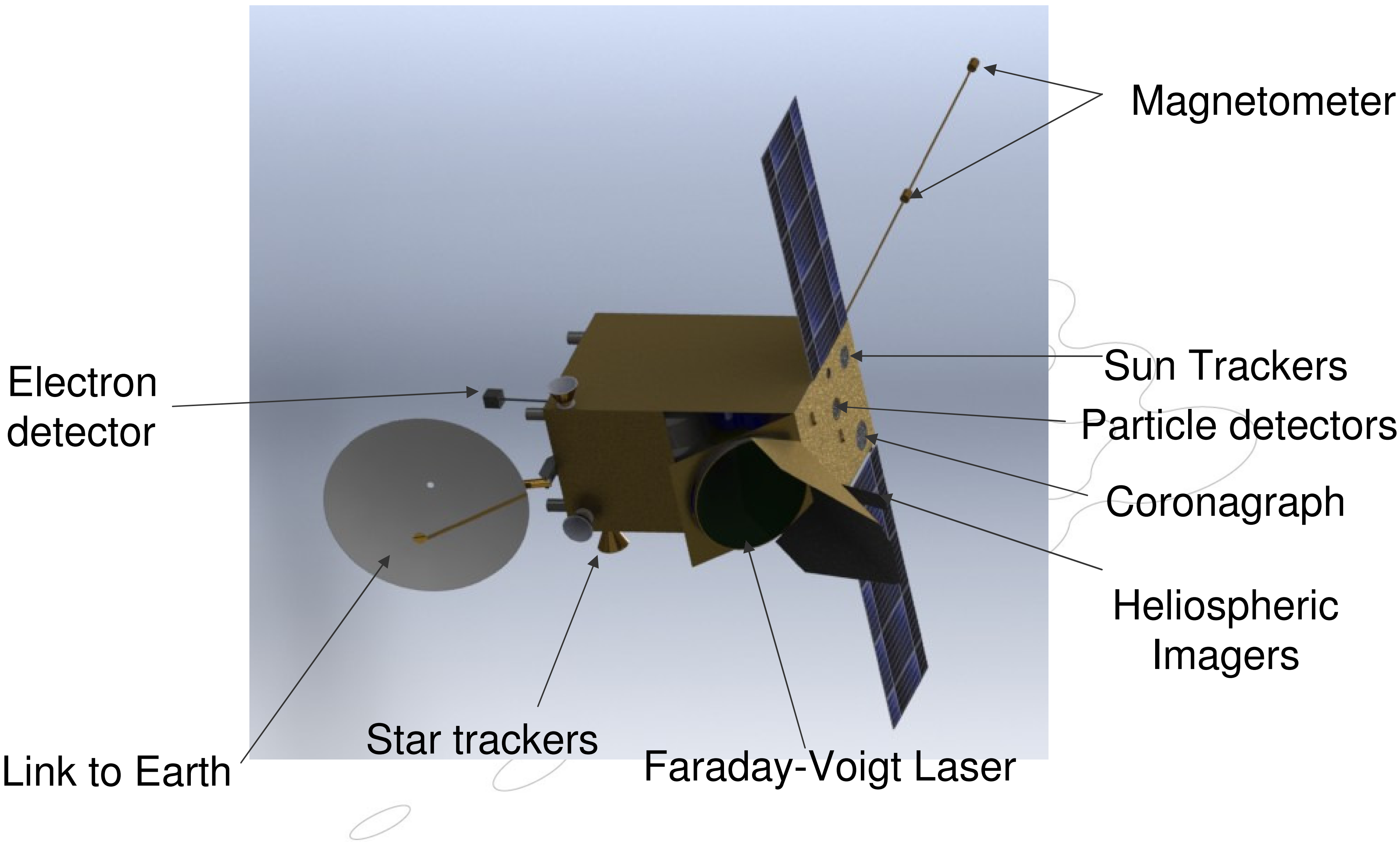
- Launcher: two Soyuz
- Transfer time 13.7 months
- Spacecraft mass: 460 kg
- Power budget: 850 W

Mission time:

6 years (possible extension of 6 years)

SOYUZ

Spacecraft

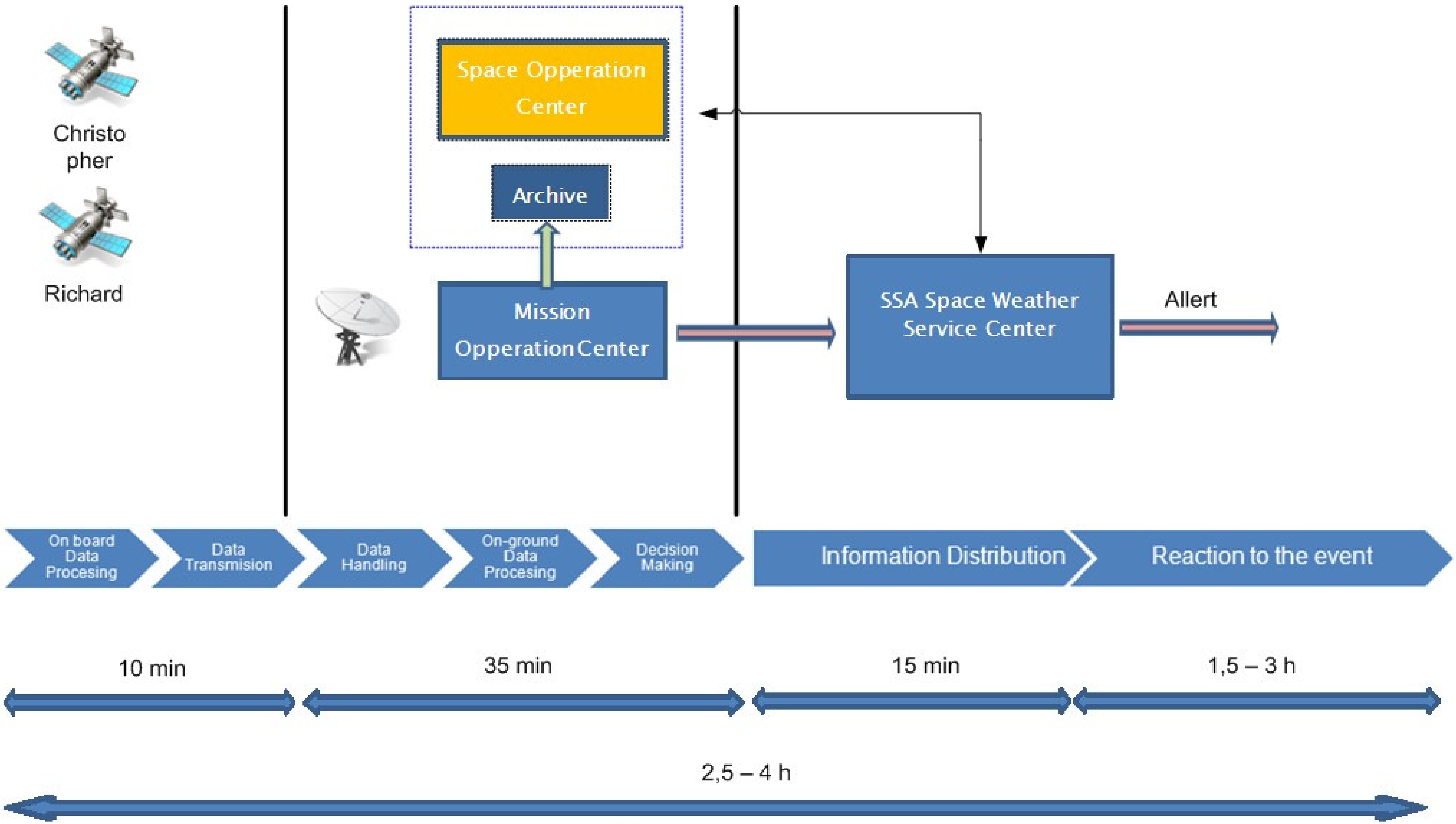


Magnetometer
Sun Trackers
Particle detectors
Coronagraph
Heliospheric Imagers
Electron detector
Link to Earth
Star trackers
Faraday-Voigt Laser

Communication and Ground Operations

Utilizing existing ESA locations where possible.

Communication and Ground Operations



Carrington – Space Weather Mission

- Two Soyuz Launchers
- Budget 920 M€
- Two Spacecraft @ 1 AU out to 50°
- Continous measurements of earthbound CMEs
- Warning System Providing
  - Timely deliver and processing of data
  - Determination of properties of CMEs