Summer School
Alpbach 2013 -
Innovative Space
Weather Missions
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**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
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
ADONIS

- In-situ measurement of drag parameters
- Correlation with SWE
- Data to improve ionospheric models
- 2 spacecraft around Earth (90° separation)
- One VEGA Launcher
- Cost Budget M€ 45
Summerschool Alpbach at a glance

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
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

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

(Not to scale)
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
Faraday Rotation

Linear polarisation

Voigt Effect

Magnetic field measurement
**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
50° separation:

- Laser path as small as possible
- Forecast time requirement
- Stereoscopic 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)
Utilizing existing ESA locations where possible.
Carrington – Space Weather Mission

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