Weather Sentinel

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Joint Scientific Space Mission Chinese Academy of Science (CAS) - European Space Agency (ESA)
Science objectives

Main science objective:
understanding emission and transmission through heliosphere
of energetic particles in correspondence of different kinds of SEEs,
by measuring energy spectra and the angular distributions,
of the energetic tail of SEEs (electrons, protons, ions and neutrons),
and their time evolution,
continuously and on a long period of time, possibly a full solar cycle

In particular:
knowledge of evolution in time of the angular distribution as a
function of energy of electrons and protons in the CME type of
events, the most energetic and high fluence SEEs.

maximum importance for the future manned exploration
of the solar system:
“knowledge of the arrival direction of the energetic electrons
allows the spacecraft to take countermeasures against the
shortly arriving, by the same direction, protons and ions”.  

Electromagnetic signal
Start of the solar event
Arrival of relativistic electrons

Dangerous E range for astronauts health

Minimum Time of Flight from the Sun to the Earth orbit

KE = 5 MeV

SR2S meeting, Trento April 15, 2013
The Instruments

Main instrument:

SPhERA

- *Arrival angle* of the charged particle
  (by coincidence of pixels of two concentric spheres)
- *Energy* of the charged particle
  (by ToF between the two pixels)

Possible complementary instruments:

INTERACTOR

- *neutron energy*
  (by position of the neutron interaction +
  angle, amplitude and time of the recoiling proton
  in the SPhERA instrument)

SUNSPOT MAP

- time evolution in several bands (UV+optics)
  (by filters + CCD image)

RADIATION DOSIMETRY

- time evolution in diamond detectors
  (by two dosimeters)
SPhERA sensors

scintillator pixels ($\approx 1000$)
large sphere
($R \approx 12\,\text{cm}, \text{surface} \approx 2000\,\text{cm}^2$)

BGO pixels ($\approx 2 \times 50$)
small sphere
($r \approx 2\,\text{cm}, \text{surface} \approx 50\,\text{cm}^2$)
Joint Scientific mission CAS-ESA First
Workshop Chengdu 25-26 February 2014

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large sphere
(R≈12cm, surface ≈ 2000 cm²)

BGO pixels (≈2x50)
small sphere
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SPhERA sensors
Joint Scientific mission CAS-ESA First Workshop Chengdu 25-26 February 2014

Time resolution

Track 1 – up to 1° BGO

Track 2 – up to 2° BGO

Track 3 – up to 4° BGO

Track 4 – up to 2° scintillator

ΔE_e (MeV)

ΔE_p (MeV)

ΔE_e (MeV)

ΔE_p (MeV)

ΔE_e (MeV)

ΔE_p (MeV)
INTERACTOR instrument

(Side view (perpendicular to the ecliptic plane))

Scintillating fiber matrix

Time of Flight - 1

Time of Flight - 2

(Recoil proton trajectory)

ecliptic plane
### Main parameters of the instruments:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Mass of the sensors</th>
<th>Number of channels</th>
<th>Power consumption</th>
<th>Mass of the electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPhERA</td>
<td>3kg</td>
<td>4k</td>
<td>10W</td>
<td>5kg</td>
</tr>
<tr>
<td>INTERACTOR</td>
<td>20kg</td>
<td>50k</td>
<td>10W</td>
<td>5kg</td>
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Total: $\approx 30$kg

Total: $20$W

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$\leq 20$kg

$\leq 20$W
Arrangement on the spacecraft

Corpus of the spacecraft

SPhERA

INTERACTOR

Solar pannels
Arrangement on the spacecraft (without detection of neutrons)

- Corpus of the spacecraft
- Solar panels
- Other possible instruments
- SPhERA
Suggested locations in space

(a) – ‘Sun soriented’ spacecraft in very high Earth orbit

Very High Earth Orbit, plane fixed in space
‘Looking to Sun’ attitude of the spacecraft
Orbit fully outside the terrestrial magnetic field
(through magnetic tail only for few % of time)
preferred location in space

(b) -- Earth-Sun L1

Orbit around L1
Spacecraft attitude: looking to Sun
Time interval to alarm Earth: several minutes

-- Chemical fuel: about 60% of the total mass!

-- Ion thrusters:
  fuel (Xe) 25% of the total mass
with one Hall effect Truster HT400 (ALTA-Space)

→ spiraling + ballistic insertion (10+7 months)
for each HT400 thruster needed 500W → several m² of solar panels
Thanks for the attention