CHESS: Constellation of High Energy Swiss Satellites

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Outline

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Mission overview

- Collaboration between EPFL Space Center and Paul Scherrer Institut (PSI)
- Flight proven payload: Hard X-Ray Compton polarimeter
- Constellation of 4 (or +) 3-Units Cubesats
- Low sun synchronous orbit - 550 km
- Flight time of 3.5+ years
- Multiple science objectives:
  - Gamma Ray Bursts
  - Solar Flares
  - Space Weather
Science objectives

1 - Permanent monitoring of the sky for Gamma Ray Bursts

- Detection of Gamma Ray Bursts (GRBs)
  - light-curves, spectra and conditional polarization (very strong GRBs)
- Event direction determination via triangulation
Science objectives

2 - Permanent observation of the Sun in hard X-ray energies

- Detection of Solar Flares
  - Light-curves, spectra and polarization
- Direct pointing, constellation cross-coverage
- Polarization measurement would be new and give essential constraints on beaming (measuring electron distribution)
Science objectives

3 - Observations of Space Weather events

- Measurement of particle fluxes and spectra (e, p, heavy ion)
- Detection of energetic injections
- Observation of temporality and 3D dynamic
- Permanent mapping of LEO radiation
- Unique set of identical monitors
Data goals

- To correlate observation with other missions:
  - Solar Orbiter (Solar Flare)
  - Ligo & Virgo (Gravitational wave correlation with GRBs)
  - Be part of the Interplanetary Network (GRBs)
  - Be part of D3S network (SWE)?
Main payload

POLAR Heritage

- POLAR - space-borne hard X-ray Compton polarimeter
- Built by a collaboration of institutes from Switzerland, China and Poland.
- Purpose - precise determination of the GRB polarization
- And very well suited for measurements of Solar Flares and Space Weather
- Launched in space on the Chinese Space Laboratory TG-2 on Sep 15th, 2016
POLAR for CHESS

- Fast plastic scintillators
- Array of 8x8 bars
- Coupled to photomultiplier
- Weakly shielded with carbon-fibre enclosure
- Field of view > 2pi (half of the sky)
- Particle and energy sensitivity:
  - X-rays       10 keV – 1000 keV
  - Electrons   300 keV - > 10 MeV
  - Protons     10 MeV - > 300 MeV
  - Heavy ion   > 10 MeV/n
Main payload

Example of observations data from POLAR on TG2:

From October 2016 to April 2017, POLAR detected:

- 50 Gamma Ray Burst
- 17 Solar Flare (Only week one < B)
- 77 Storm Events
CHESS attractiveness

Lots of payload but little embarkation opportunities

Ideas for other payloads:

- Time of Flight mass spectrometer - Bern University
- Miniaturised plasma wave receiver from BepiColombo - Kyoto University
- Other…?
Incorporation of CHESS in SWE program

- Part of SSA Distributed SWE Sensor System (D3S)

- Providing data for:
  - Radiation environment research
  - Monitoring of particle fields in a constellation
  - Contribution to forecasting of SWE events
  - Issuing alerting messages to community
CHESS will regroup institutions from all-around Switzerland, with EPFL as project lead.
Project Timeline

Phase 0: Pre-phase A
Phase A: Feasibility
Phase B: Preliminary definition
Phase C: Detailed definition
Phase D: Production, qual. testing

PRR: Preliminary Requirements Review
PDR: Preliminary Design Review
CDR: Critical Design Review
AR: Assembly Review
Launch + Fly
Three strengths:

- Constellation of 4+ identical Cubesat
- One sensor for a multipurpose mission
- Launch time under 3 years thanks to:
  - Flight proven payload
  - EPFL Space Center expertise in space missions
Thank you!

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