


# CHES:

Constellation of  
High Energy Swiss  
Satellites

A satellite view of Earth from space, showing the blue atmosphere and dark surface with city lights at night.

Nicolas Martinod  
Alfonso Villegas

Darmstadt  
24/10/2019

	<b>1</b> Mission Overview		<b>2</b> Science Objectives		<b>3</b> Data Goals	
<b>4</b> Main Payload		<b>5</b> Observation from POLAR		<b>6</b> CHES attractiveness		<b>7</b> Project Organisation
	<b>8</b> Conclusion					
						

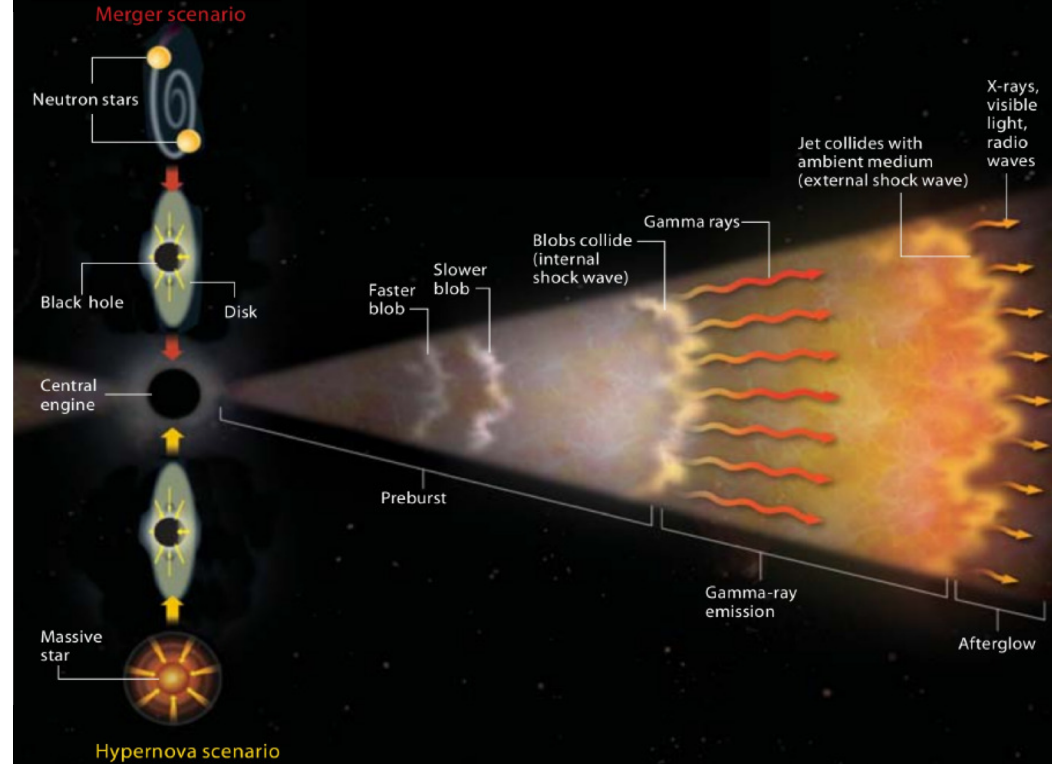
# Mission overview

- 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



## 1 - Permanent monitoring of the sky for Gamma Ray Bursts

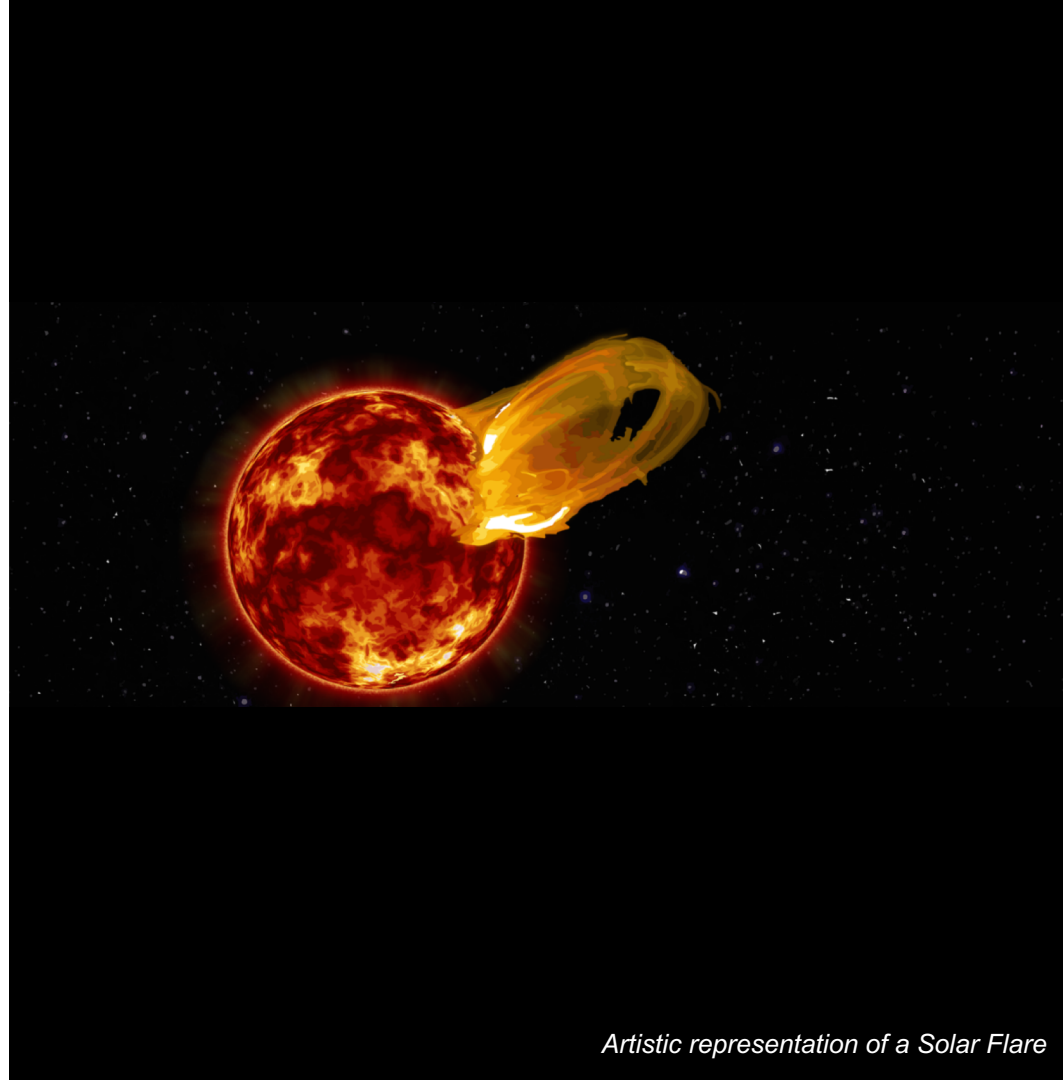
- Detection of Gamma Ray Bursts (GRBs)
  - - light-curves, spectra and conditional polarization (very strong GRBs)
- Event direction determination via triangulation



*Illustration of the most common type of Gamma Ray Bursts*

## 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)

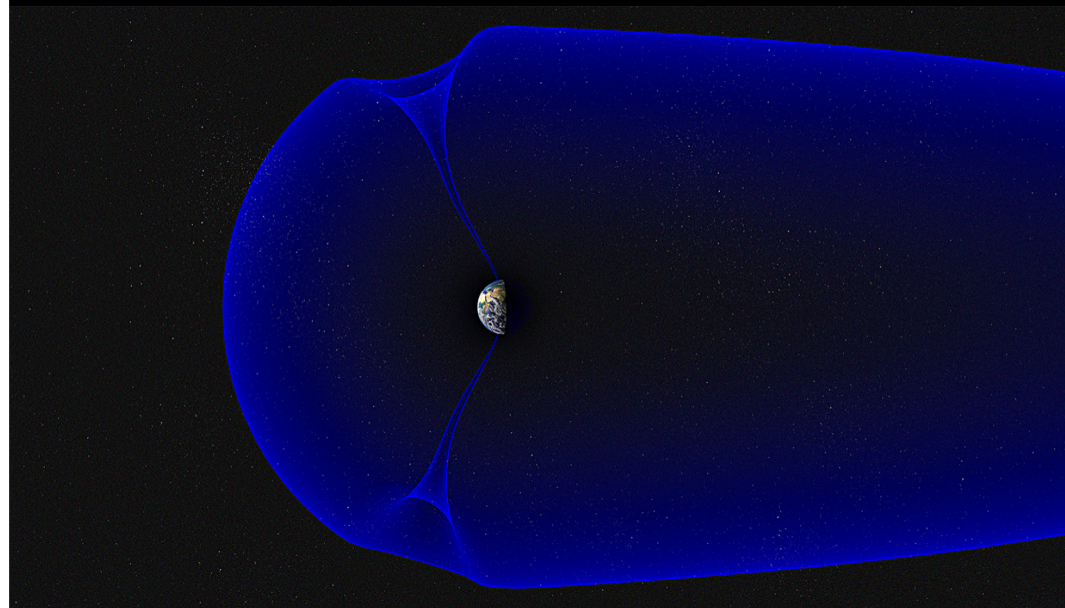
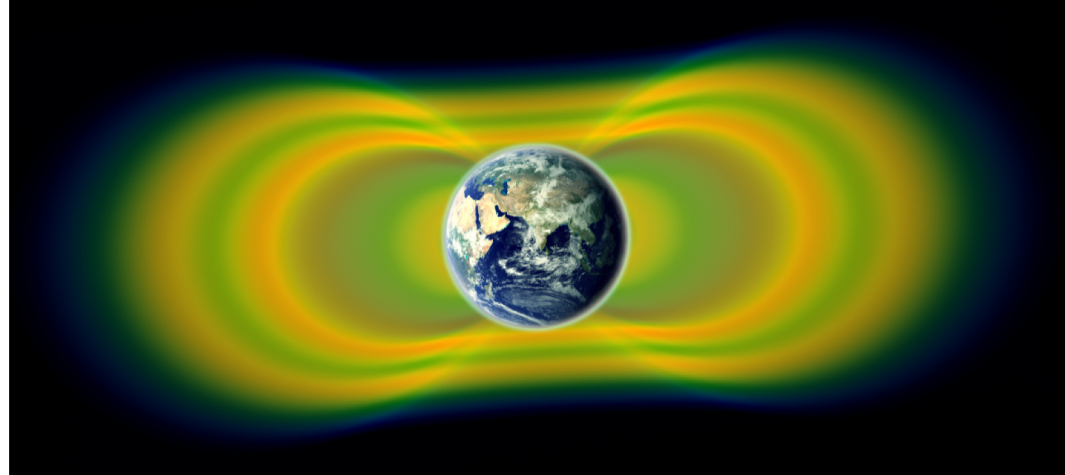


*Artistic representation of a Solar Flare*

# Science objectives

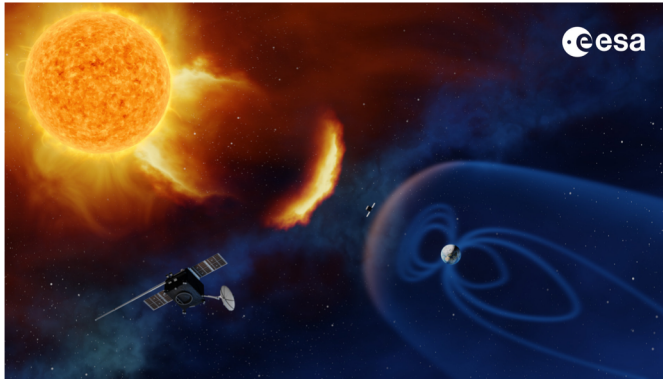
## 3 - Observations of Space Weather events

- 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





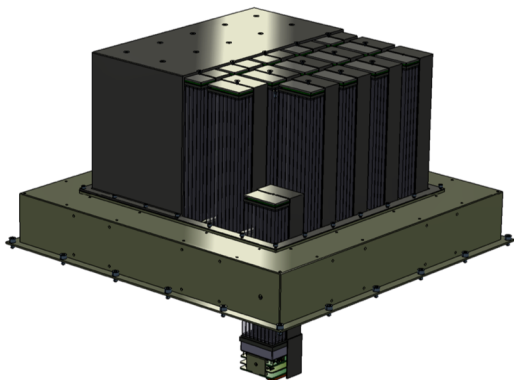
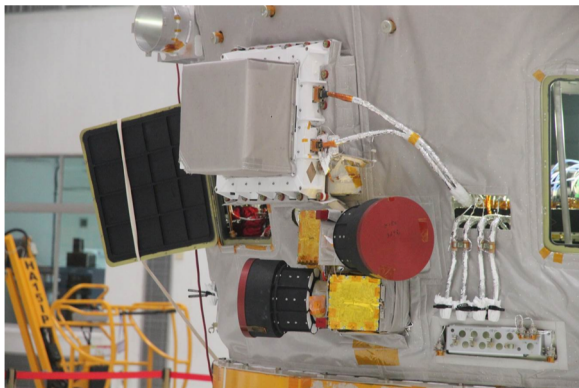
*Artistic representation of Solar Orbiter observing a solar flare*



*SSA SWE network*

# 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)?**

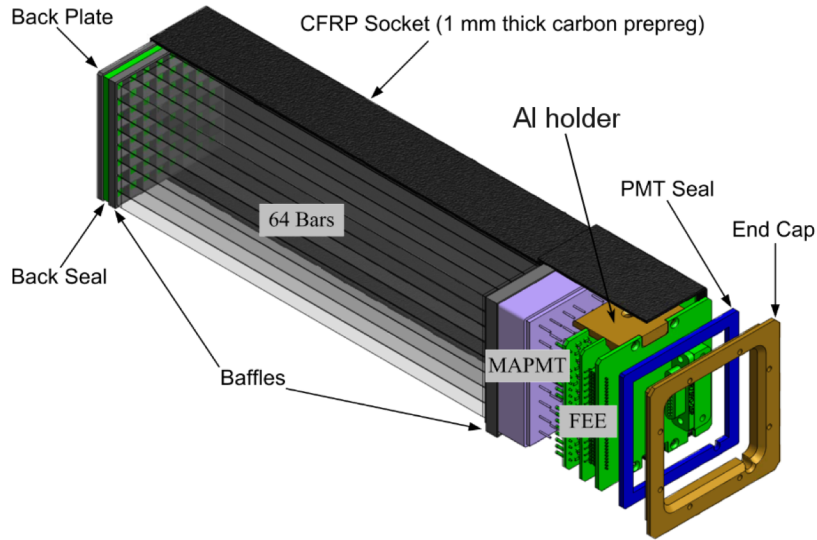


# Main payload

## 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





# Main payload

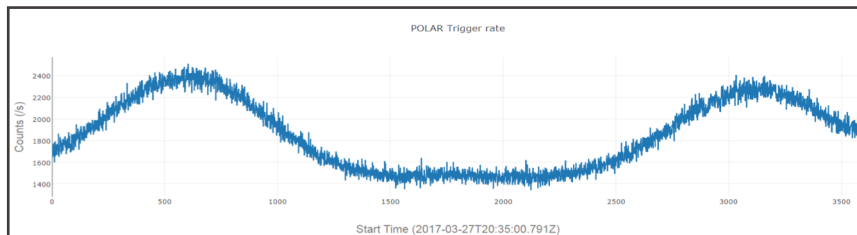
## POLAR for CHESS

- Fast plastic scintillators
- Array of 8x8 bars
- Coupled to photomultiplier
- Weakly shielded with carbon-fibre enclosure
- Field of view  $> 2\pi$  (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

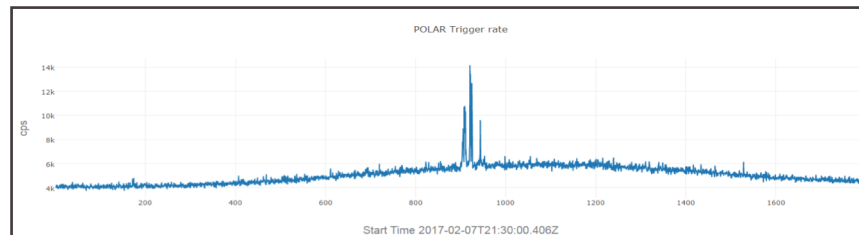
## Example of observations data from POLAR on TG2:

From October 2016 to April 2017, POLAR detected:

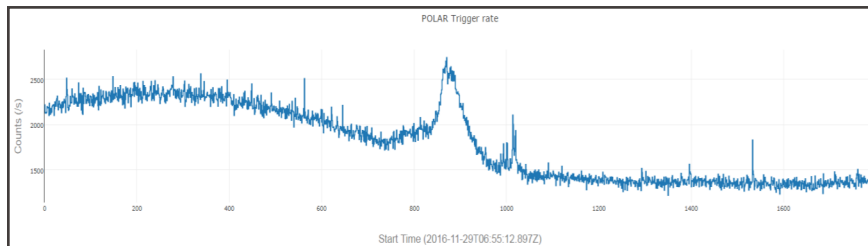
- 50 Gamma Ray Burst
- 17 Solar Flare (Only week one < B)
- 77 Storm Events



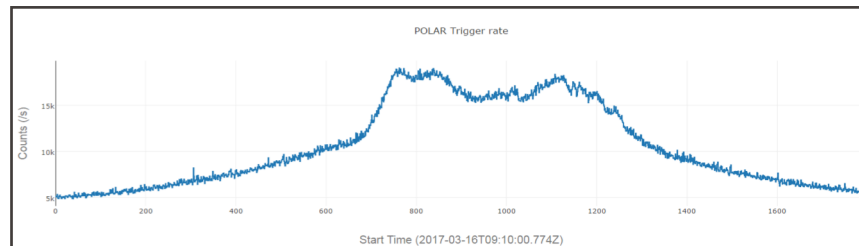
*Quiet period*



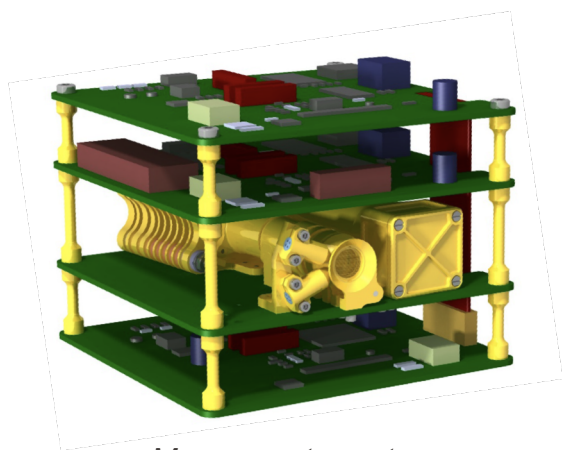
*Gamma-Ray Burst*



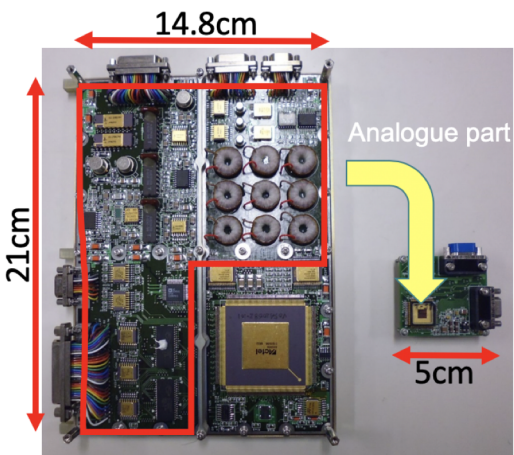
*Solar Flare*



*Storm Event – relativistic electrons*



*Mass spectrometer*



*Plasma wave receiver*

# CHES

## attractiveness

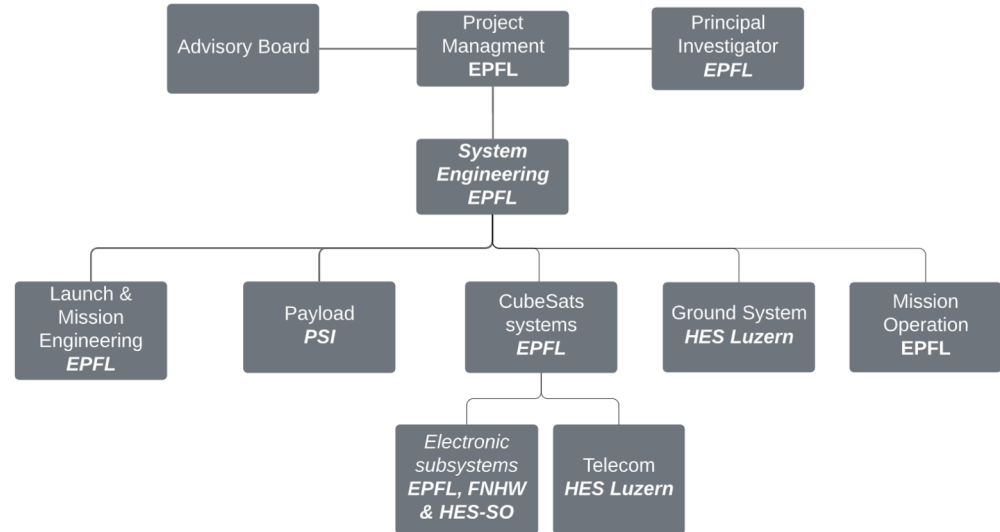
Lots of payload but little embarkation opportunities

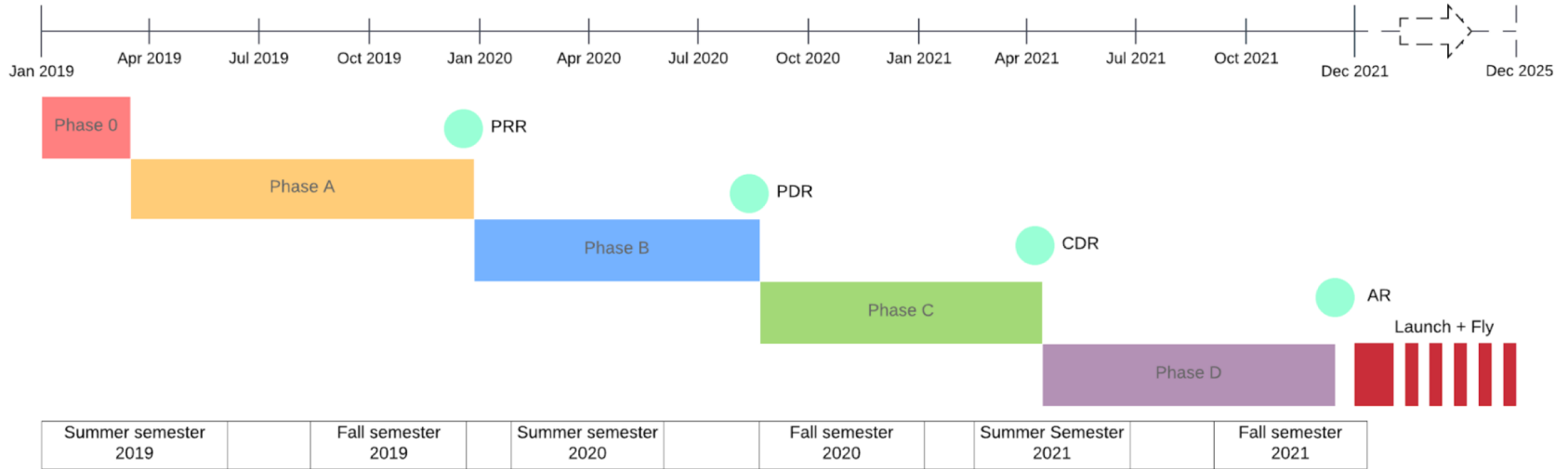
*Ideas for other payloads:*

- Time of Flight mass spectrometer - Bern University
- Miniaturised plasma wave receiver from BepiColombo - Kyoto University
- Other...?

- 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

CHESSE will regroup institutions from all-around Switzerland, with EPFL as project lead.





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

# Why CHESSE now?

## 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!**

**Nicolas Martinod  
Tristan Trébaol  
Alfonso Villegas**