

# Development of a Star Tracker for Observation of a Dedicated Astronomical Target

Peter Hinderberger | LRSM

Stephan Paul

Martin Losekamm

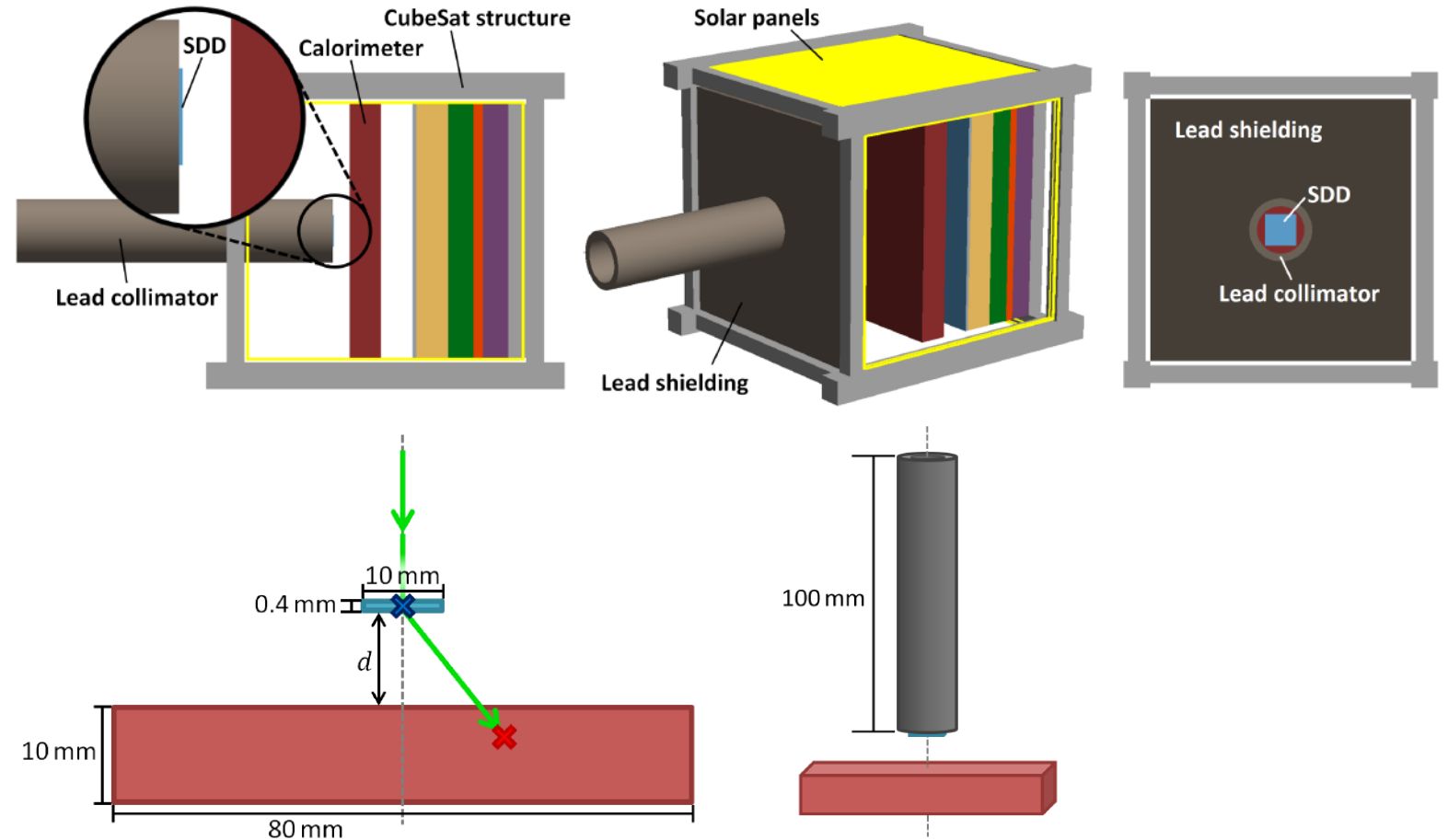
Sebastian Ruckerl



# Context

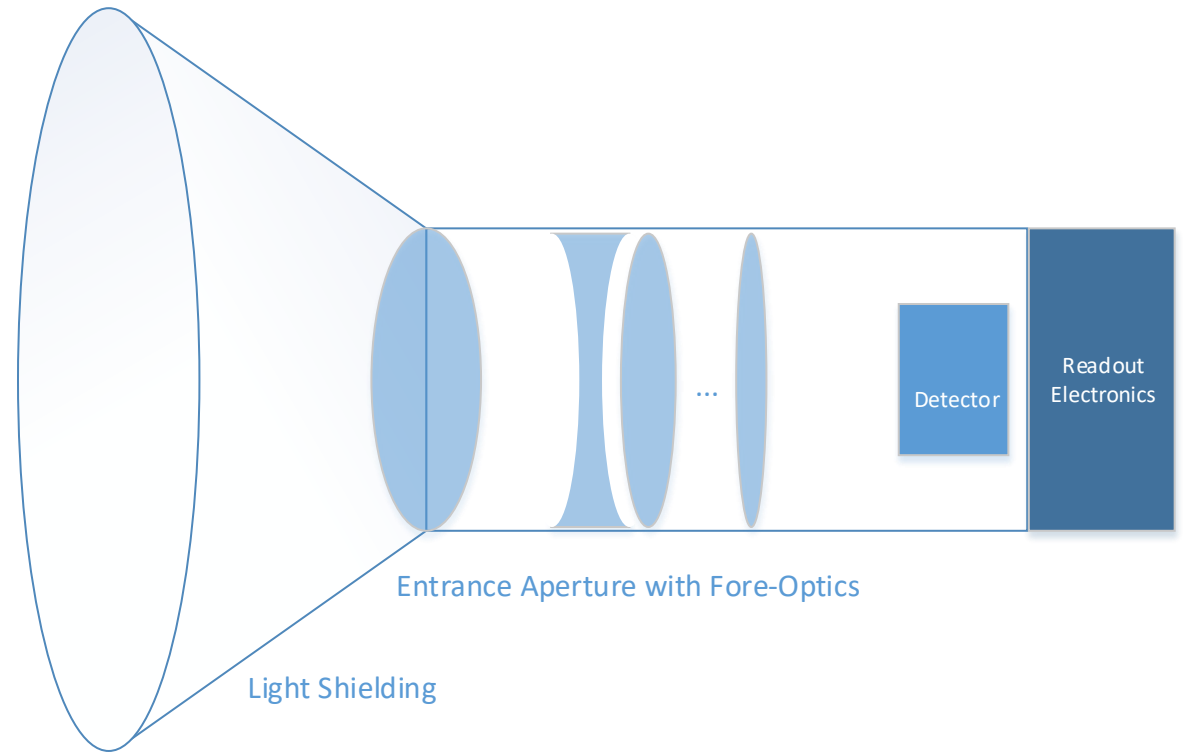
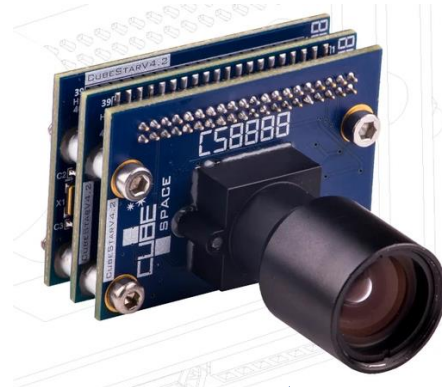
- ComPol: Compton Polarimeter observing the Cygnus X-1 black-hole binary system
- Planned as prototype as part of IOV-1 on the ISS
- As 3U-CubeSat mission

Target pointing  
knowledge:  $< 0.01^\circ$



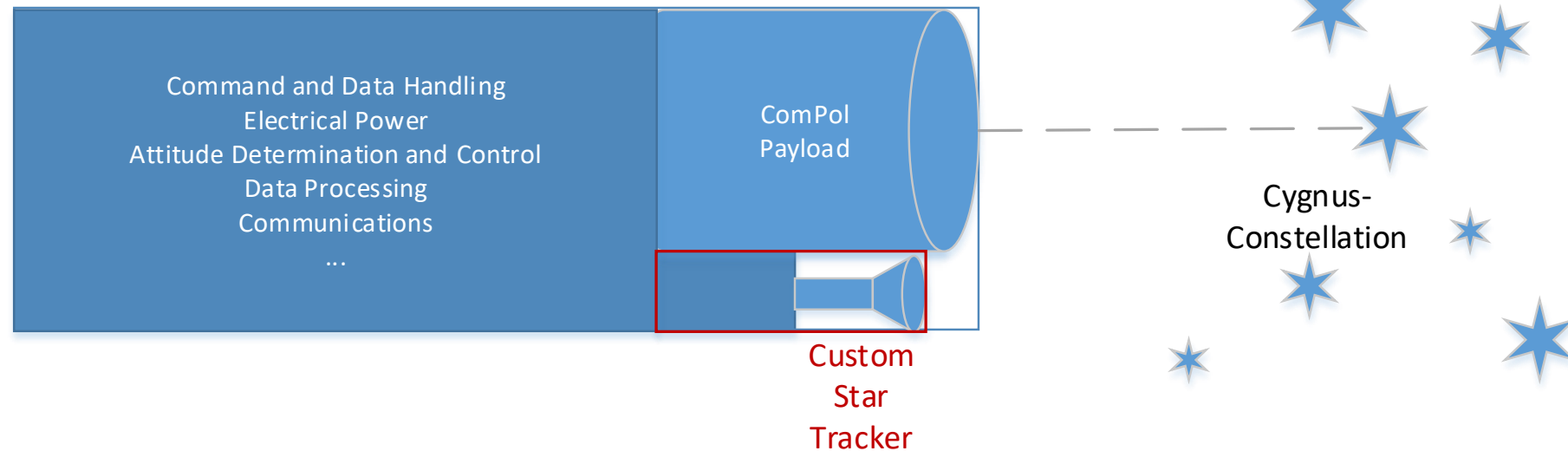
# Principle

- Star Trackers: Observing night sky for determination of satellite attitude



# Intention

- Dedicated star tracker for precise pointing knowledge
- Observation of fixed area in sky (Cygnus)
  - Slim, finely tuned optical design
  - Small, light-weight device
  - Simple data processing approach



# Intention

- Dedicated star tracker for precise pointing knowledge
- Observation of fixed area in sky (Cygnus)
  - Slim, finely tuned optical design
  - Small, light-weight device
  - Simple data processing approach

✓ **Primary Objective:** Proof of concept with laboratory setup

- General feasibility
- Verify miniaturisation approach

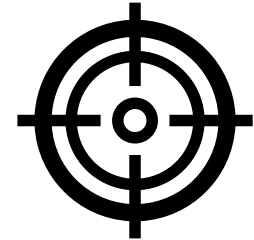
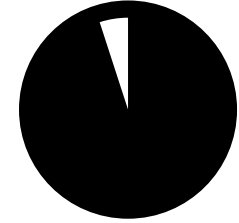
✓ **Secondary Objective:** Demonstration of prototype on the ISS



# Challenges

*and how to overcome them*

- **Little volume available**
  - Custom design
  - Low demand on optical imaging quality
  
- **High precision and refresh rate desired**
  - Pointing to fixed area
  - Possible usage of simpler and/or unusual algorithms



# Scientific Benefits

- **Fulfill payload requirements, allow more precise measurements**
- **Test and verify opportunities for fixed-target star tracker**
  - If possible: First tech demo as part of IOV-1 on the ISS, planned for 2023

## Secondary Benefits:

- Algorithm testing for optical and general applications
- Testbench for testing and calibration of optical payloads
- Educational aspects
- ...

- **Demonstration of fixed-target star tracker for improving measurement precision of ComPol**
- Verification of custom star tracker design for CubeSat missions
  - Opportunity for further research in CubeSat optics and ADCS
- Fixed Target: Unusual approach for CubeSats, opportunity for minimization and simplification
- Optical capabilities for other payloads
  - Atmospheric Sodium D-Line observation Prof. Fierlinger



# Summary

- ComPol CubeSat project: Exact knowledge of pointing direction needed
- Tight volume, mass and power restrictions
- Dedicated star tracker as slim and finely tuned device to fulfill precision and volume requirements with little capability overhead
- ✓ Plan: Optical breadboard system for testing and calibration, detectors and optical elements for experimenting with designs, components for device integration

# Requested Funding

CONFIDENTIAL – For Internal Use Only



10

#	Component Name	Purpose	Price before tax
1	Optical Breadboard Set	Assembly, Testing and Storage of Optical Systems and Elements	7.500,00 €
2	Optical Elements, Lenses and Mirrors	Realization of different optical setups and auxiliary devices	7.700,00 €
3	Camera Lenses	General purpose, comparison, testing of algorithms	2.550,00 €
4	Detector	Light detection, testing of image acquisition and processing	5.500,00 €
5	Alignment and Illumination	System alignment, angle and distance measurement	1.100,00 €
6	Optomechanical Mountings	Fixation, alignment and controlled movement of optical elements	3.600,00 €
7	Blackout Equipment	Prevent stray light from deteriorating system performance	450,00 €
8	Lab Supplies	Cleaning, Storage, Maintenance, Assembly, Laser Safety, Tools	1.200,00 €
9	Spectrometer	Calibration, inspection, testing	3.200,00 €
			<b>32.800,00 €</b>