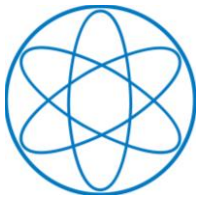
ComPol's Way to Space:
Preparing a CubeSat Compton Telescope for its in-orbit-verification (IOV) at the ISS

Katrin Geigenberger - Master Candidate

MPP-Rehearsal for DPG-Frühjahrstagung 2022

17.03.2022



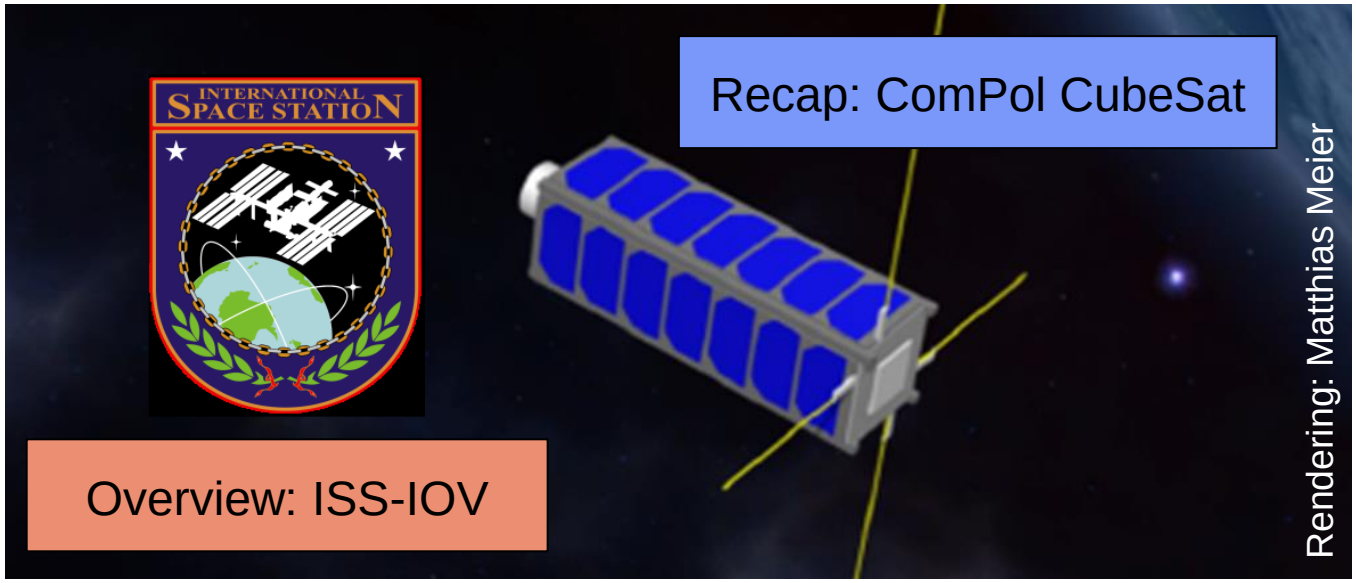
KATRIN / TRISTAN Group

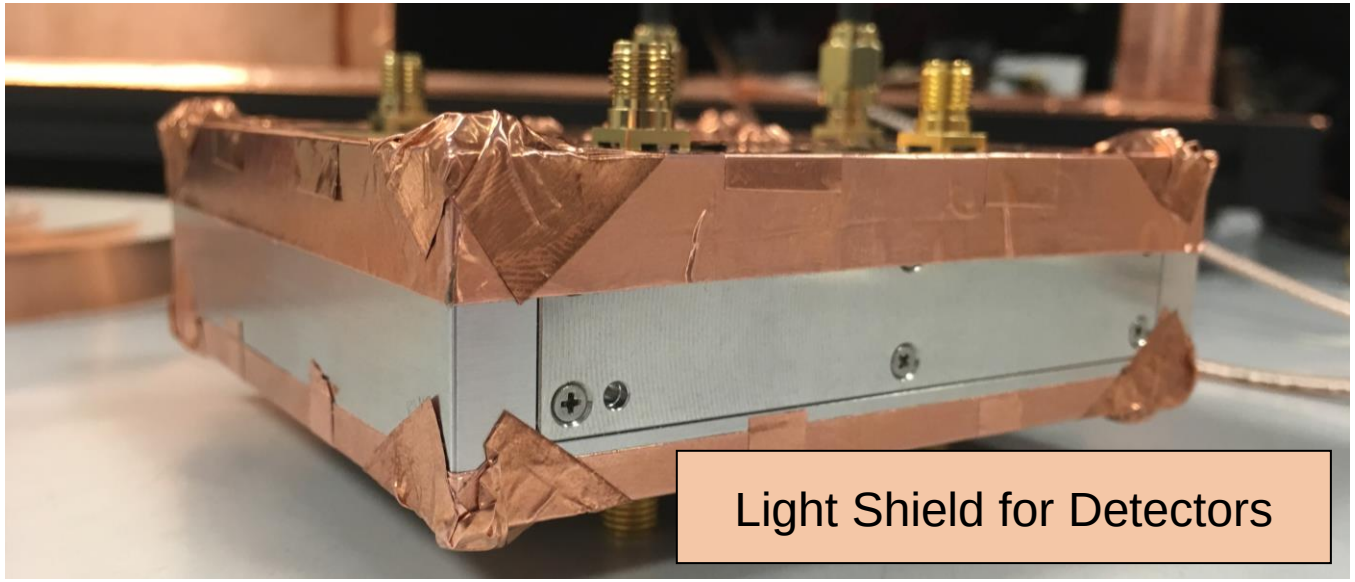
Max-Planck Institut für Physik

Physics Department

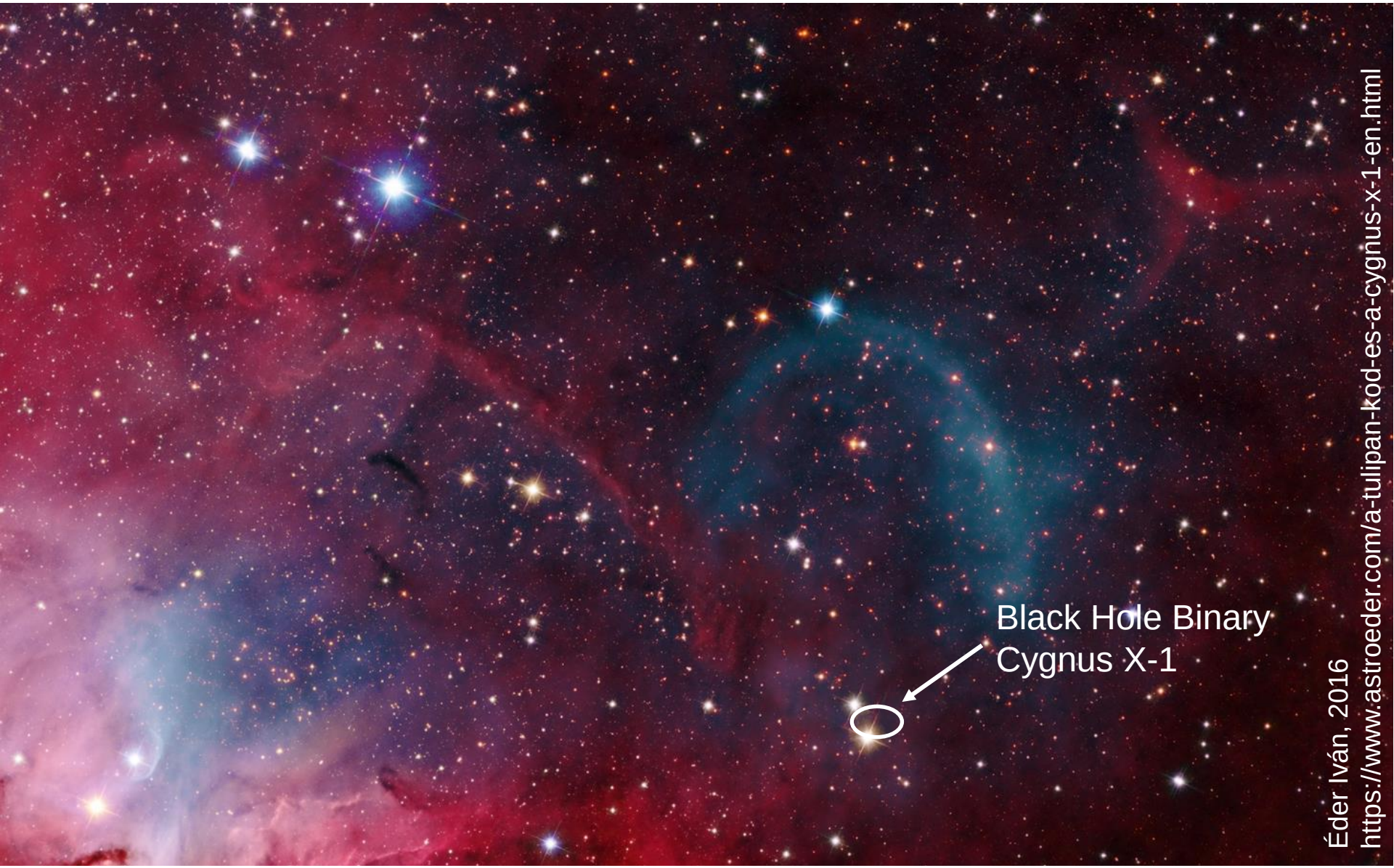
Technische Universität München

Structure of this Talk

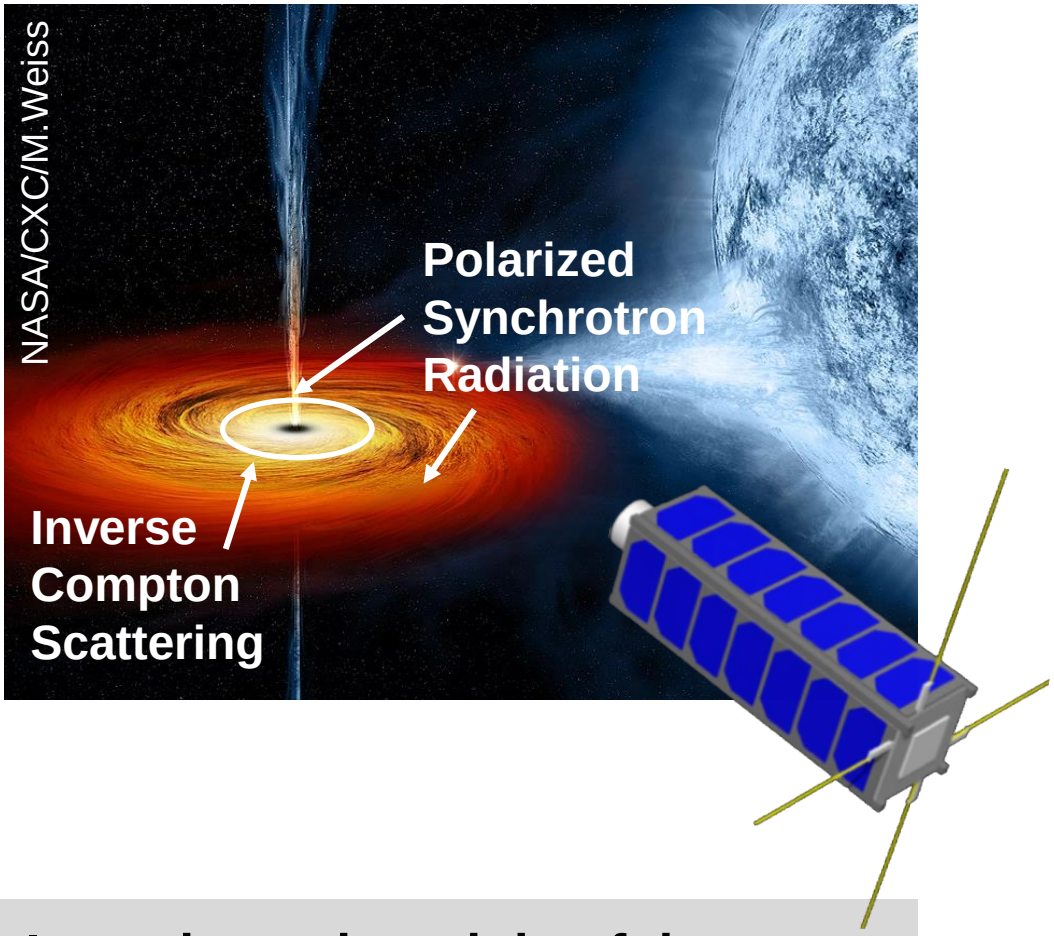




The Scientific Motivation

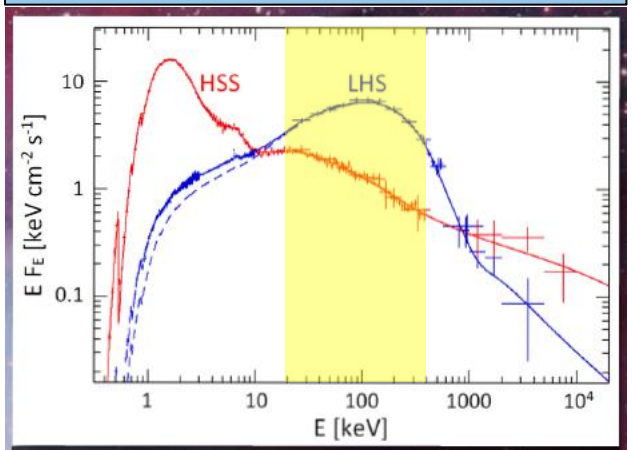


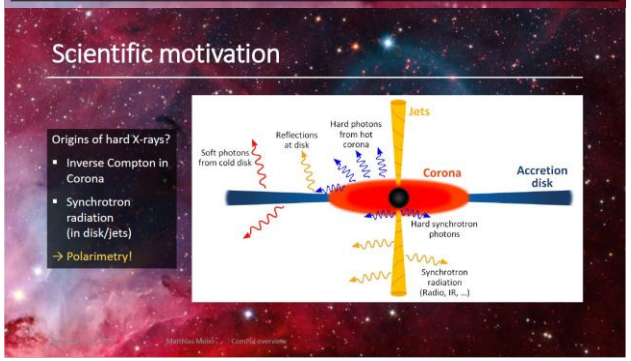
How Polarized is the X-ray Emission?



Investigate the origin of the x-rays

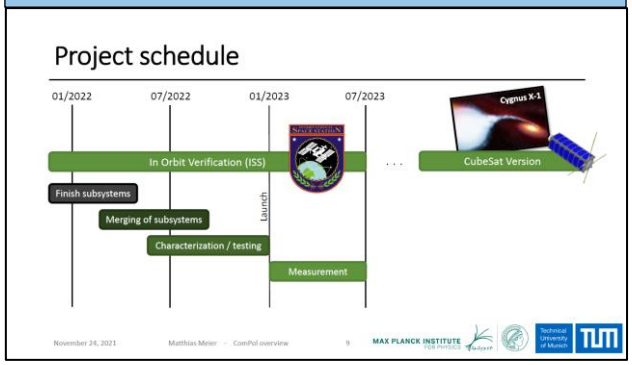
Remember from Matthias‘ Talk

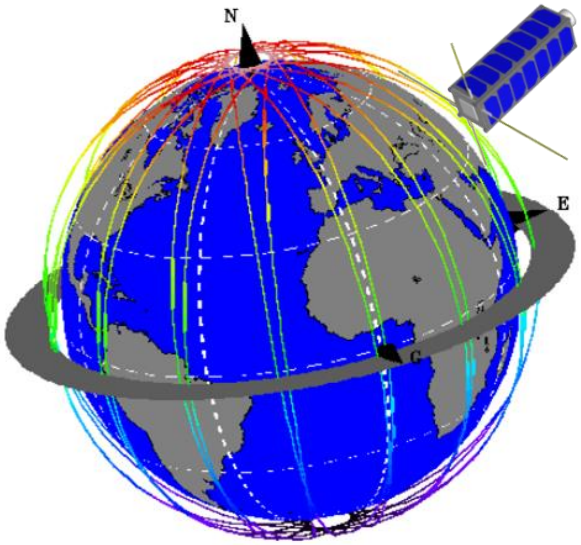




ComPol-ISS: IOV-Mission at the ISS

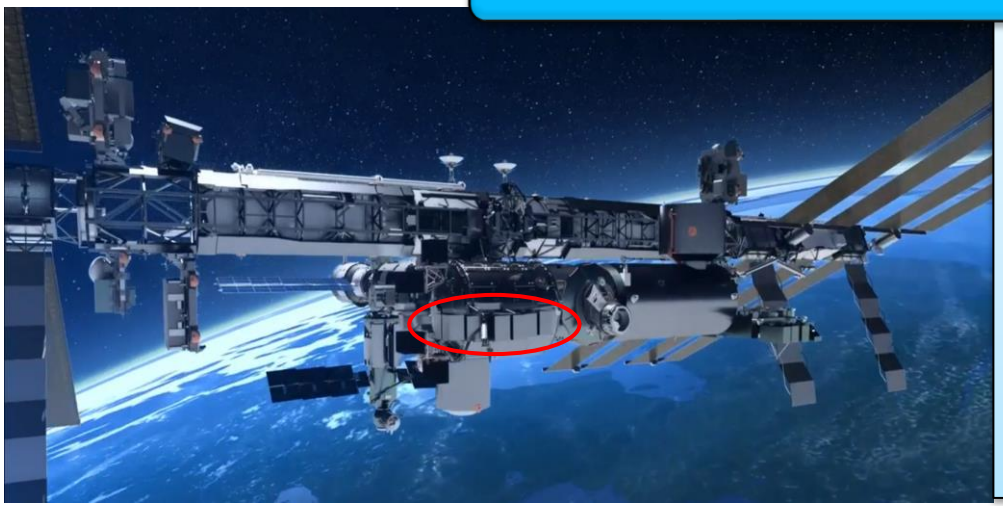
Remember from Matthias‘ Talk





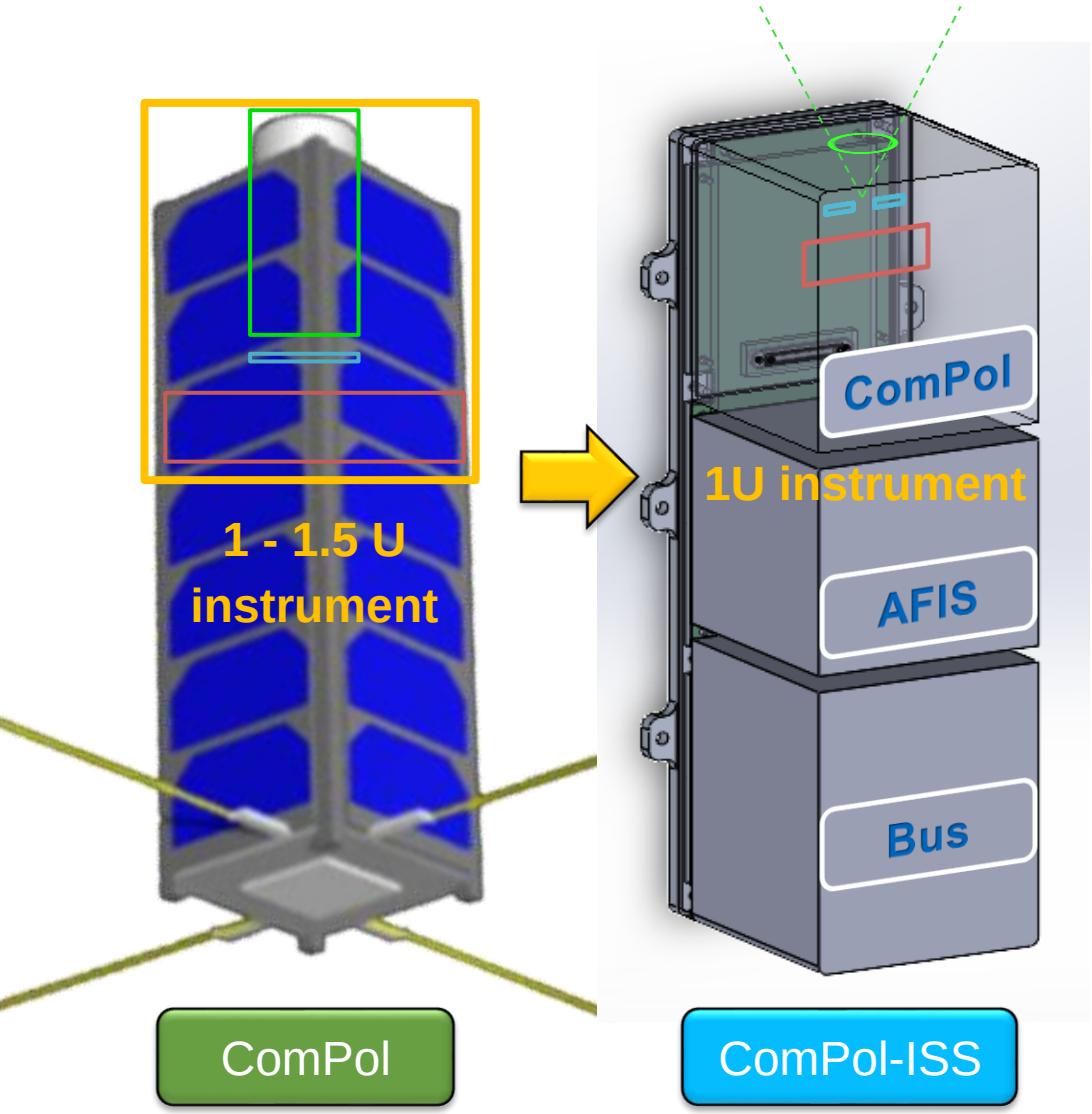
Long-term Goal: LEO CubeSat

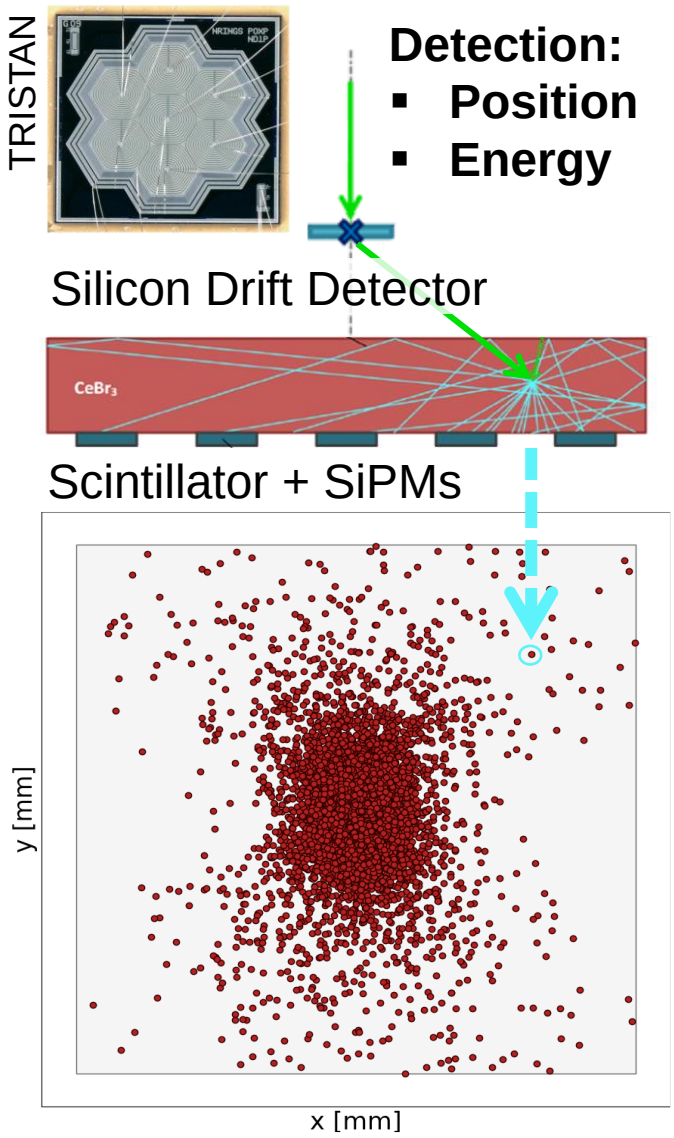
1st Step: In-Orbit-Verification @ISS



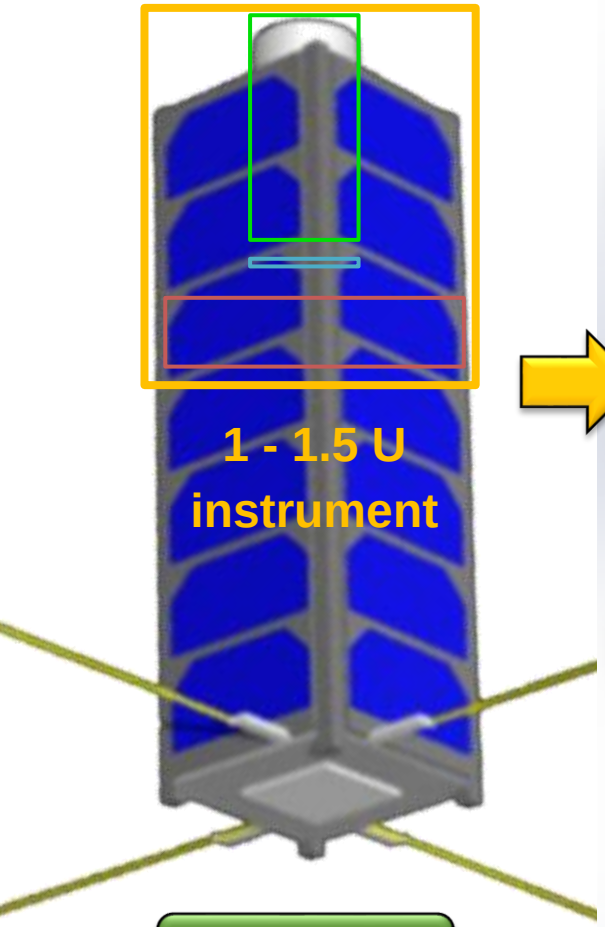
- Demonstration of Performance in **Space Environment**
- Measuring Real Background
- Focus on **Proof-of-Principle**
  - ✓ No power constraints
  - ✓ Broad Data Downlink
- **Lower Risk** of Mission Failure

ComPol-ISS: A Scaled-Down Version

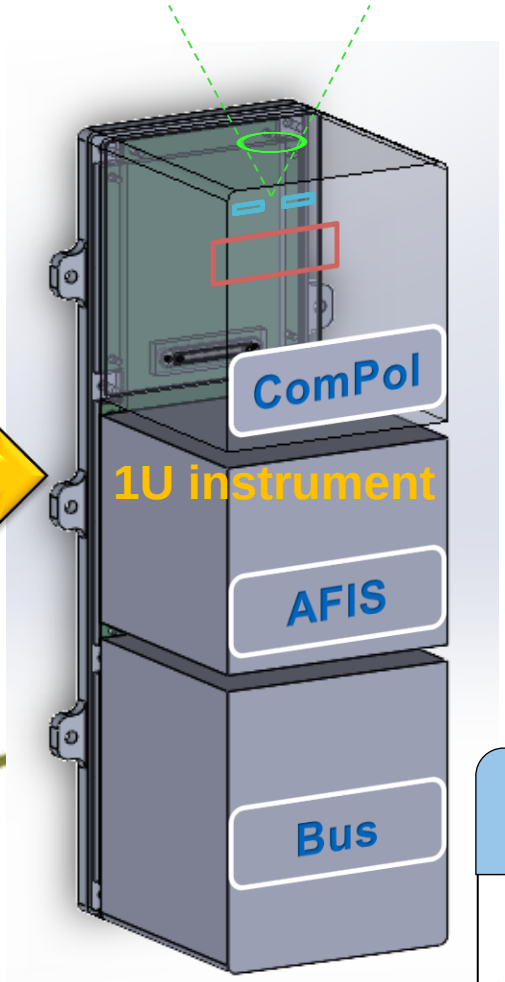




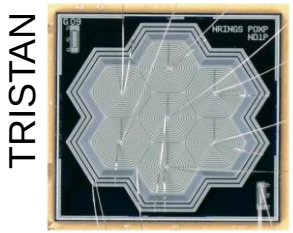
ComPol-ISS: A Scaled-Down Version



ComPol

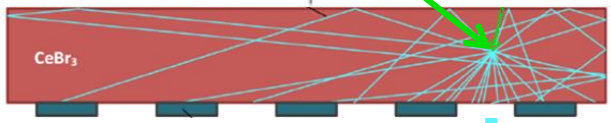


ComPol-ISS



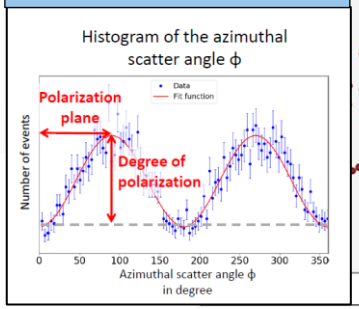
Detection:
- **Position**
- **Energy**

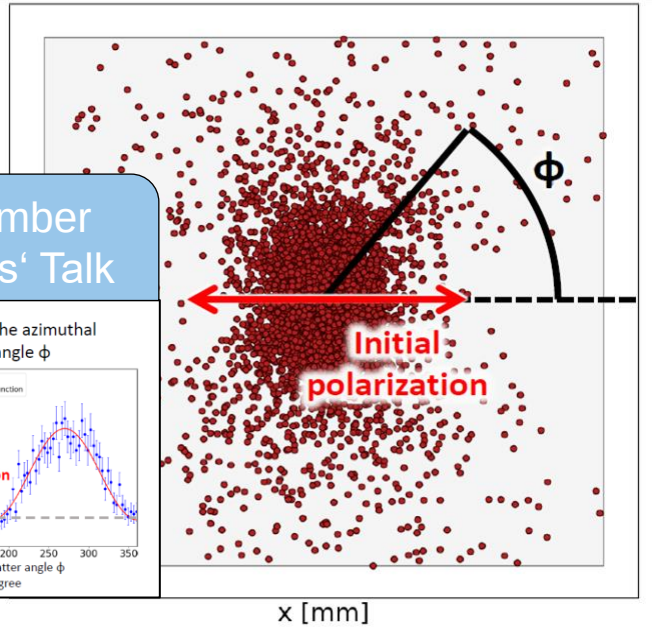
Silicon Drift Detector



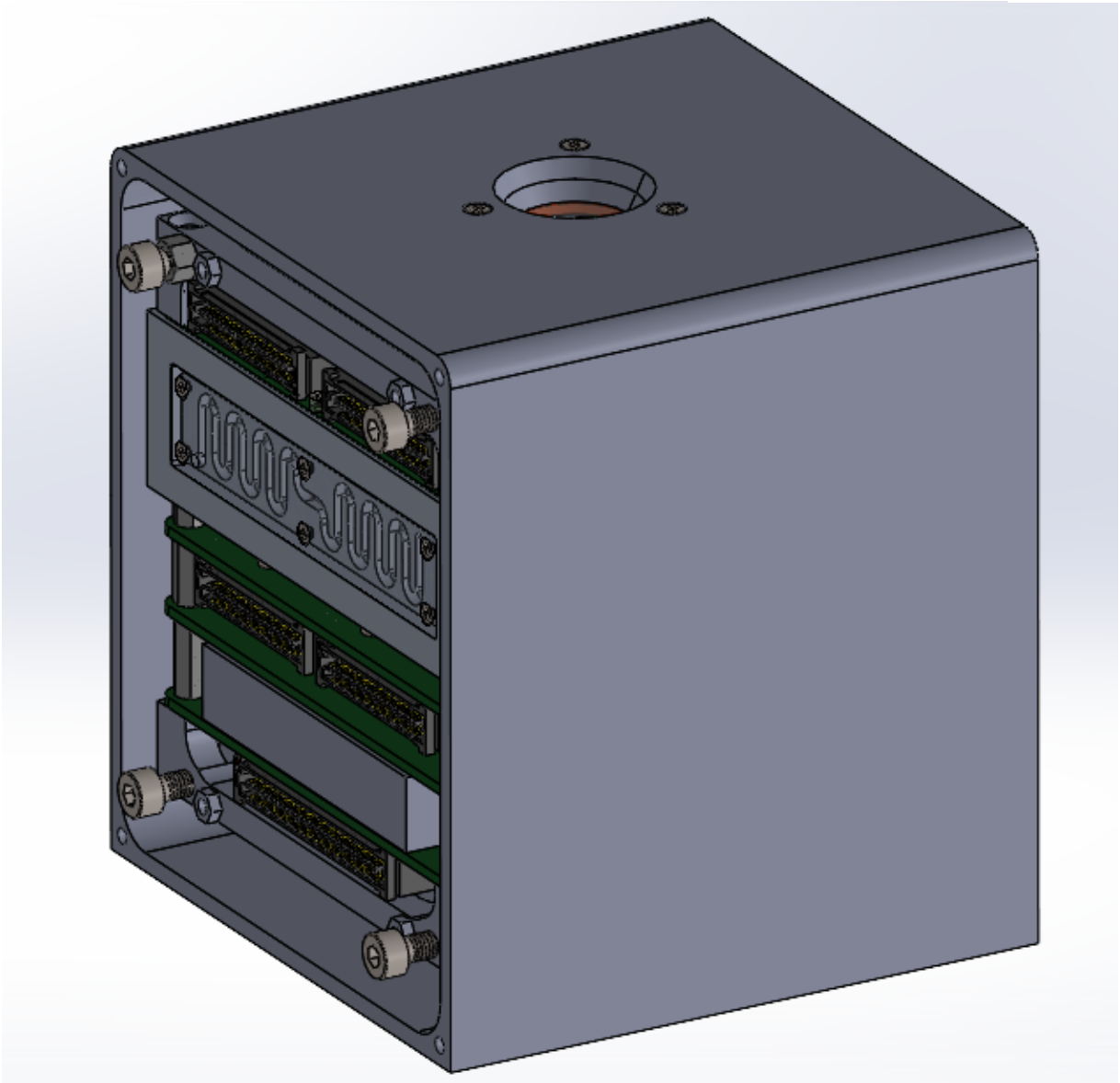
Scintillator + SiPMs

Remember Matthias‘ Talk

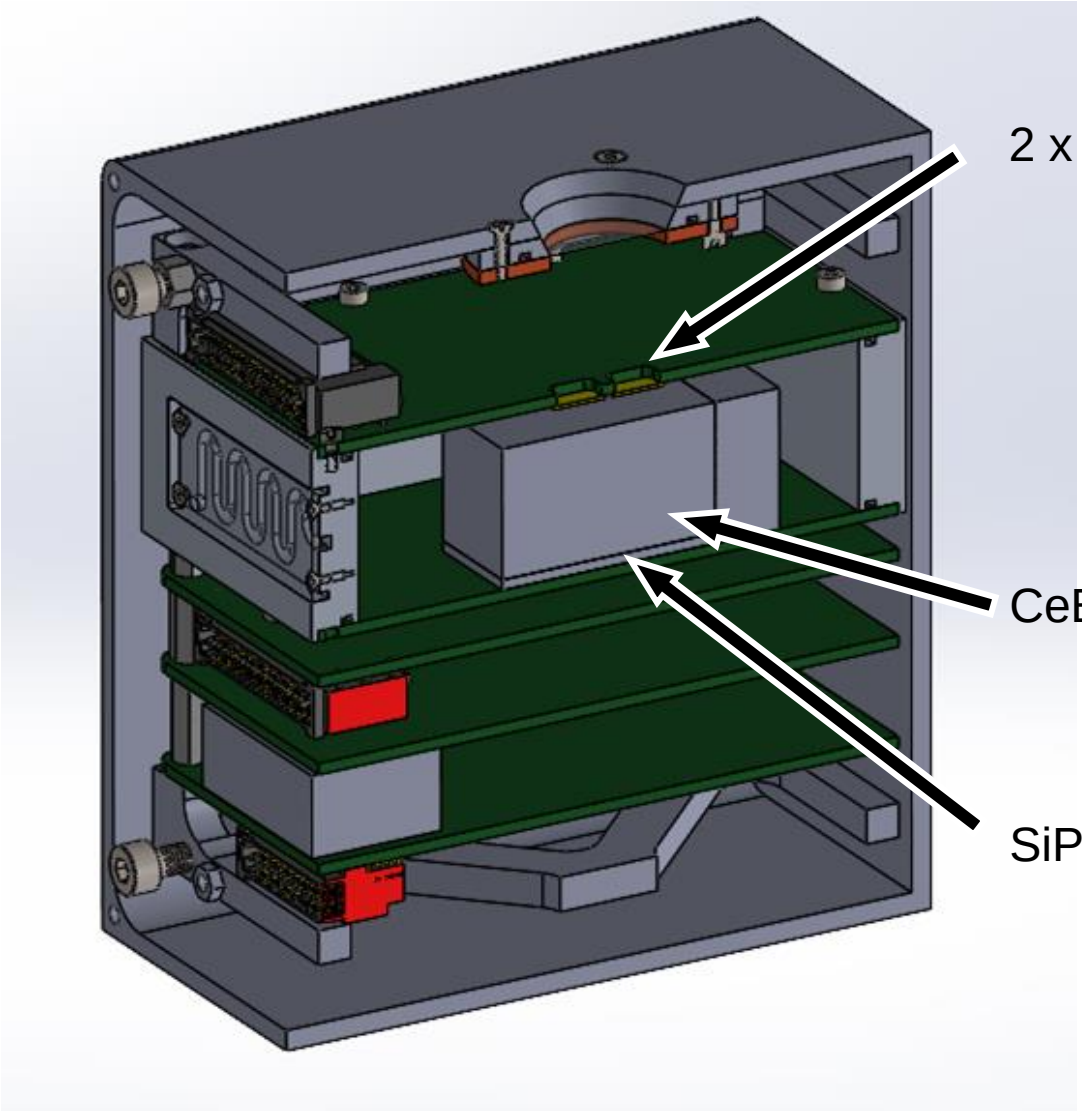




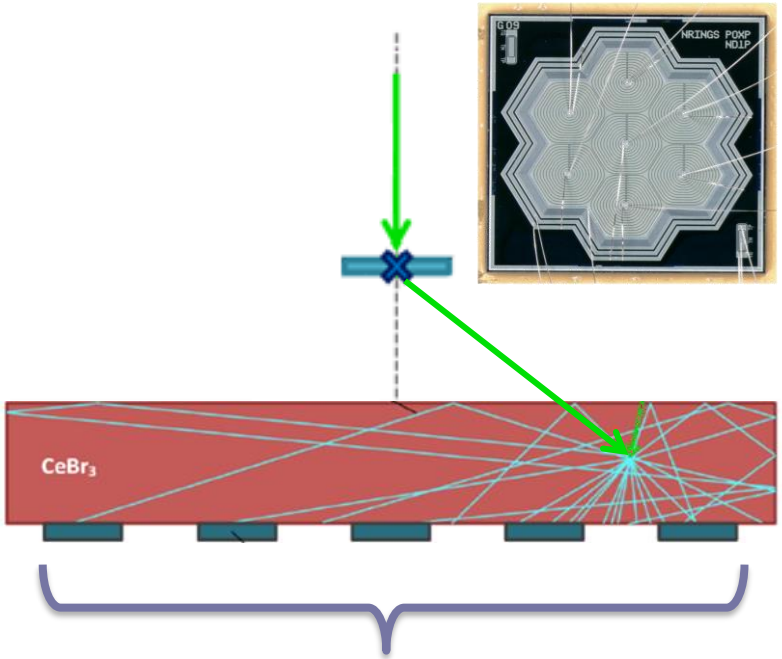
Current ISS-Hardware Model



Current ISS-Hardware Model

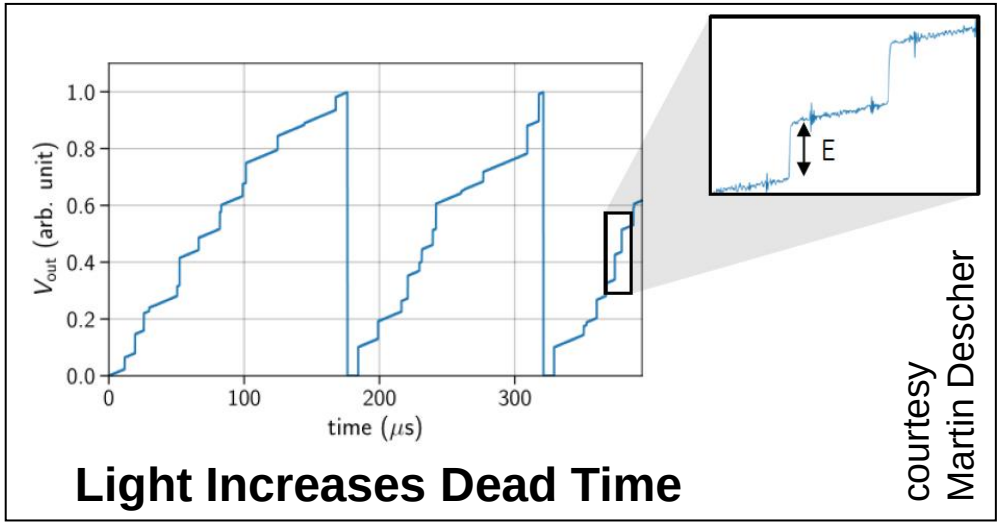


What if Optical Photons Hit Detectors?

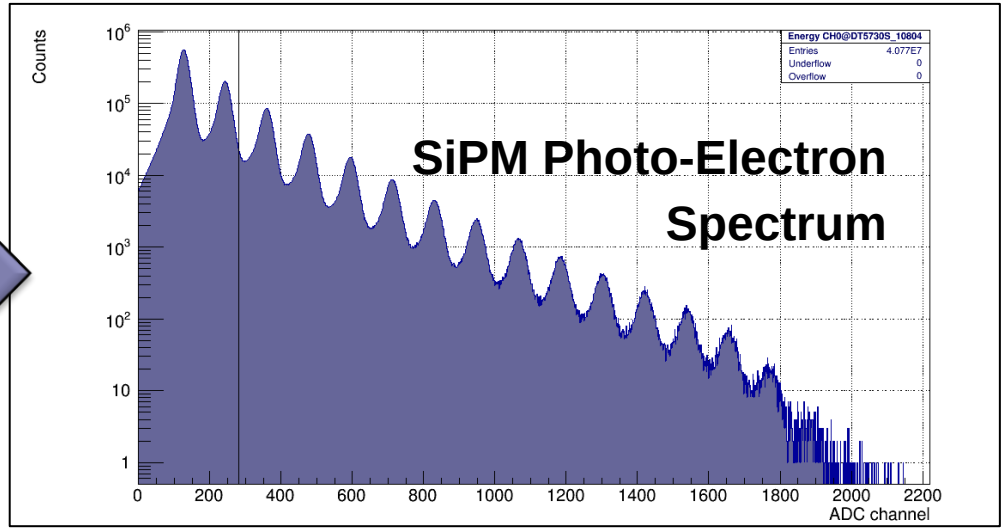


SiPM Array

Single Photon Sensitive

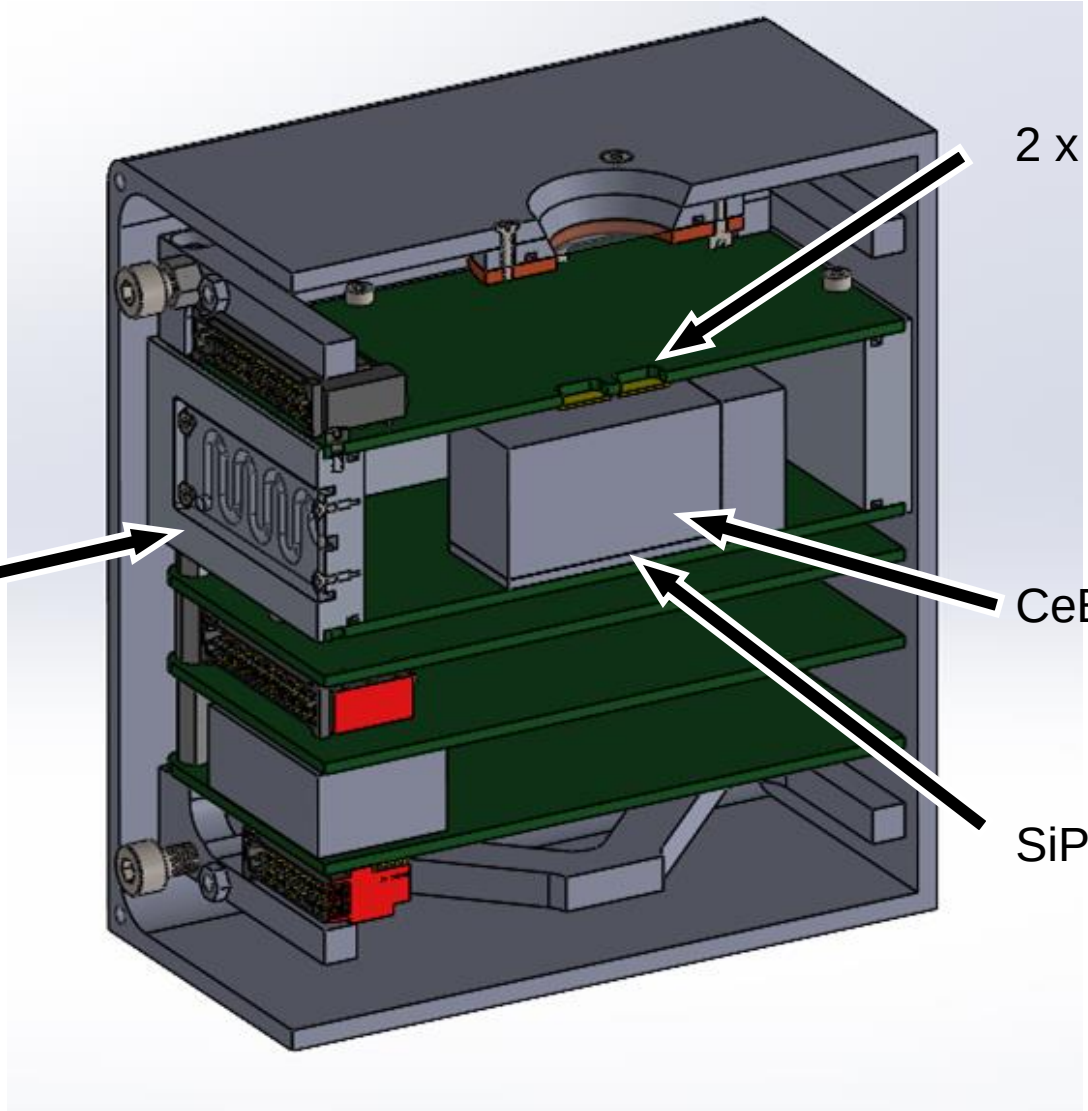


Light Increases Dead Time

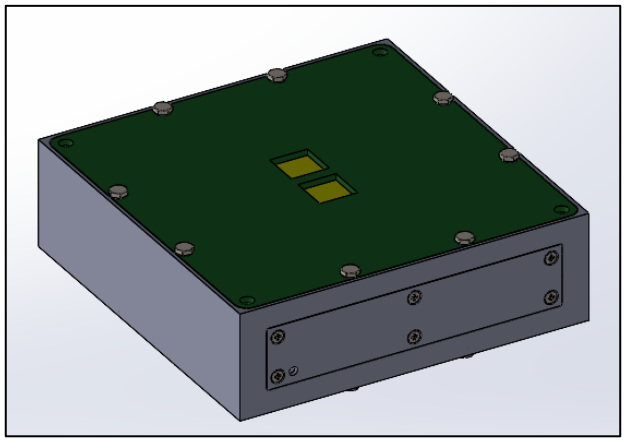


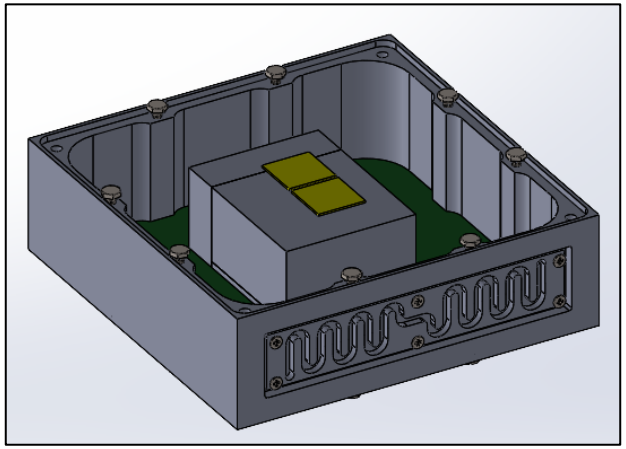
SiPM Photo-Electron Spectrum

Focus on the Light Shield



Light Shield Design





Requirements

- ❑ Light tight
- ❑ Not gas tight

Solution

Meander with minimal venting area

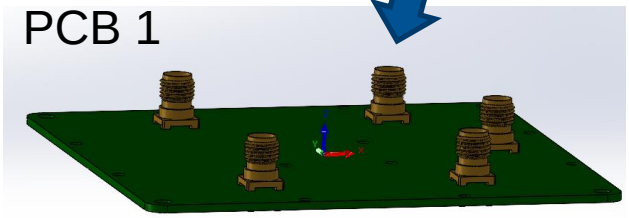
Simple Test

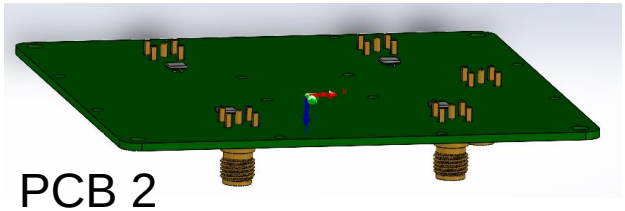
Single SiPM Readout

Additional Requirements?

- ❑ Anodizing to reduce reflectiveness?
- ❑ Flat PCB interface sufficient?
- ❑ …

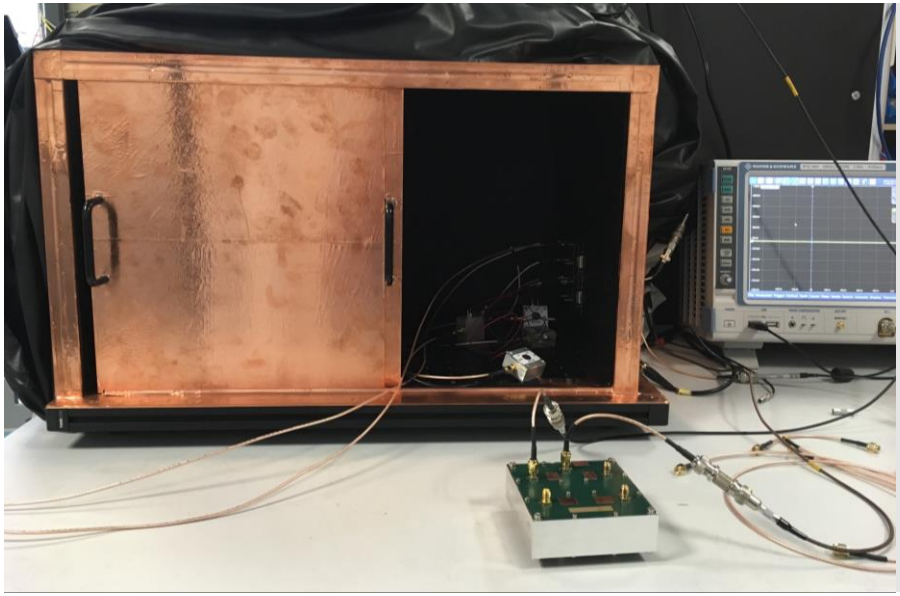
PCB 1





PCB 2

Test with SiPM in Dark Box



1. **SiPM as Photo-Diode**
   → Measuring Photo Current
   - Dark Condition
   - LED-Light in Dark Box
   - On Table in diffuse Ceiling Light
   - Repeated: other PCB facing light

2. **SiPM Photo-Electron Spectrum**
   ► Histogram of Photon Number
   ► Count Rate in Dark & LED-Light

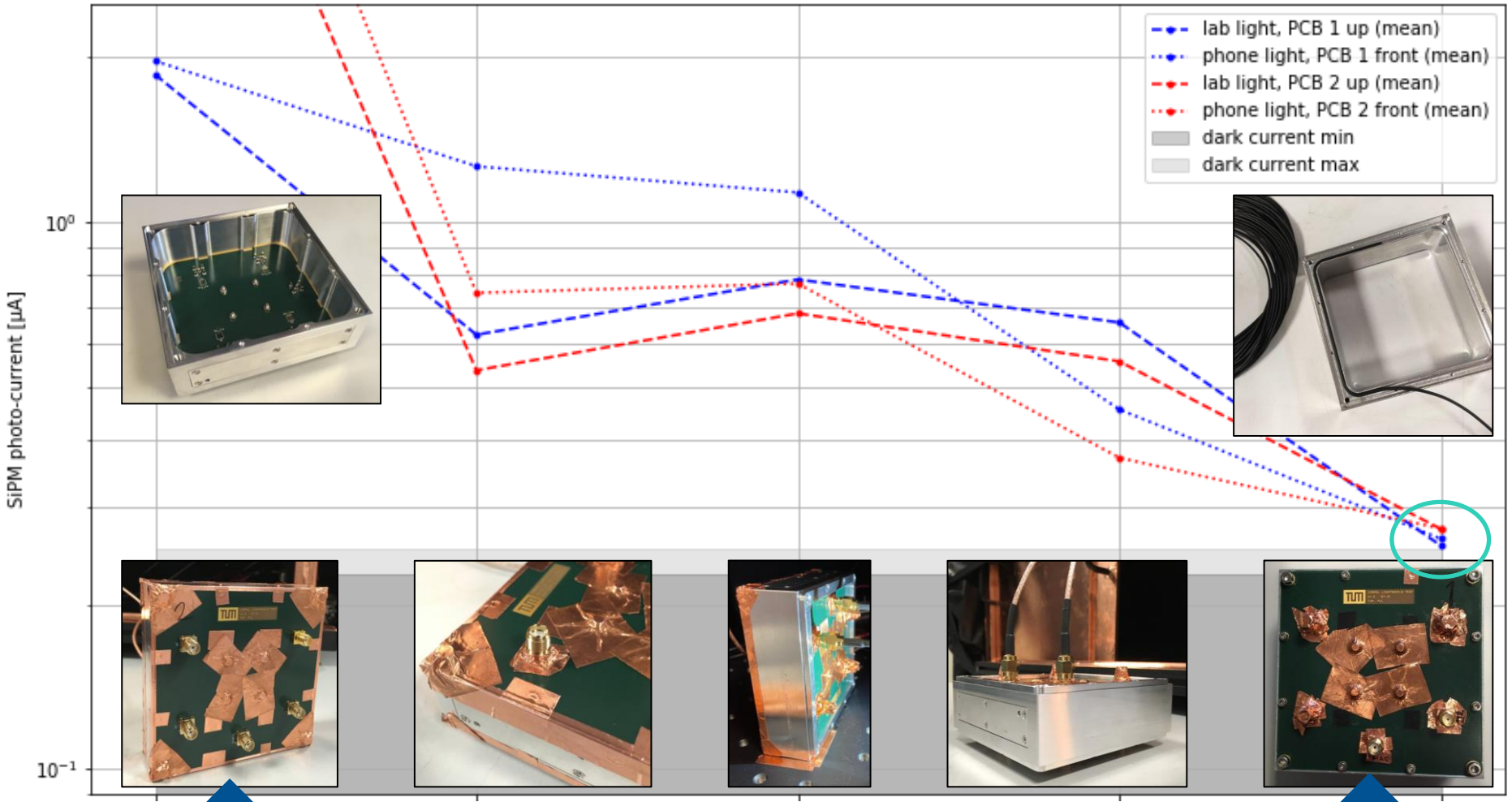
Additional Requirements?

- ❑ Anodizing to reduce reflectiveness?
- ❑ Flat PCB interface sufficient?
- ❑ …

First Test Results: Not Light-Tight
→ No, meander completely light-tight
→ Strong leakage by flat PCB interface
Additionally problematic:
→ Screws, trough-hole components

Test of interface

Iterative Test of Various Configurations

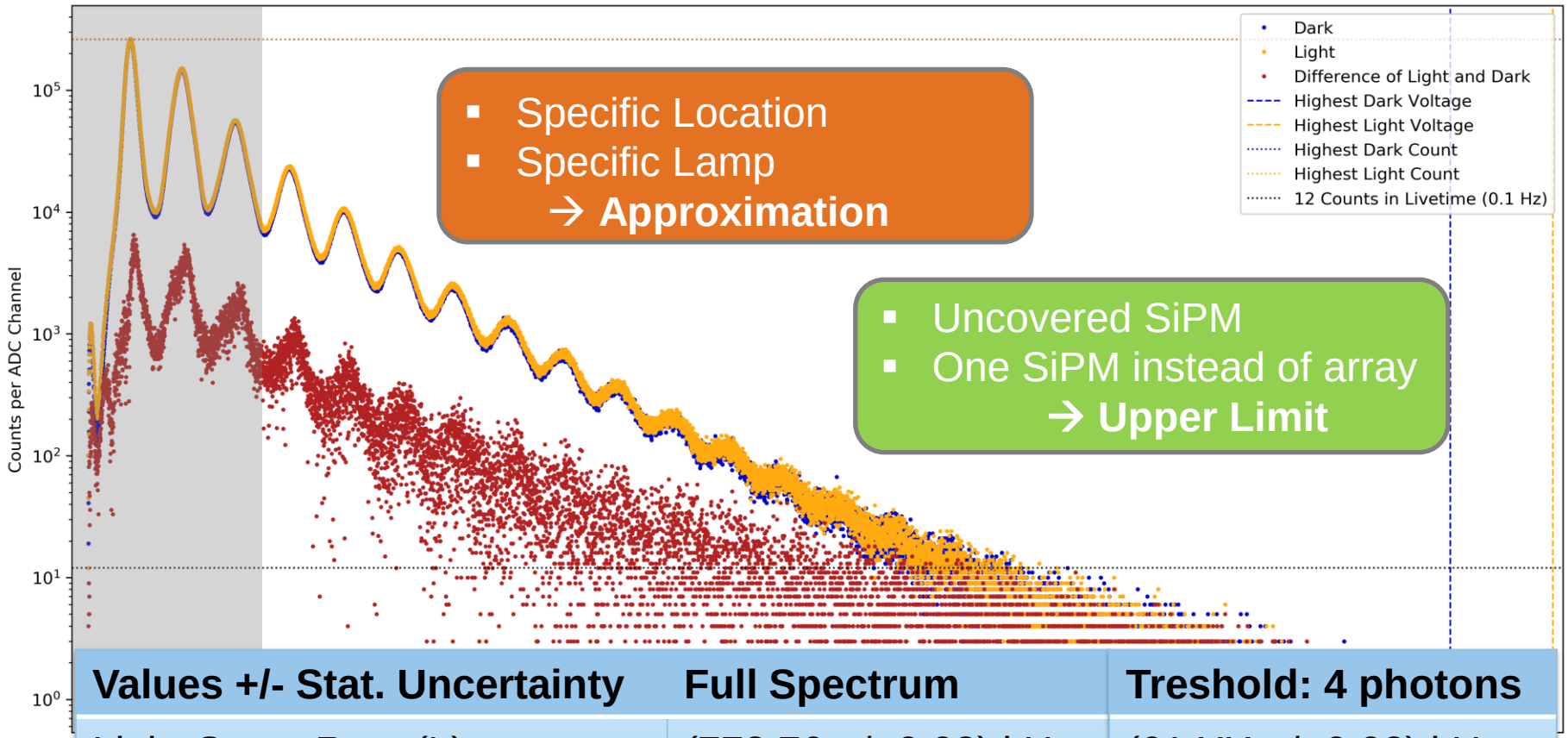


Flat Interface + Some Tape

More Tape & Intermediate Versions

O-Ring Interface + Less Tape

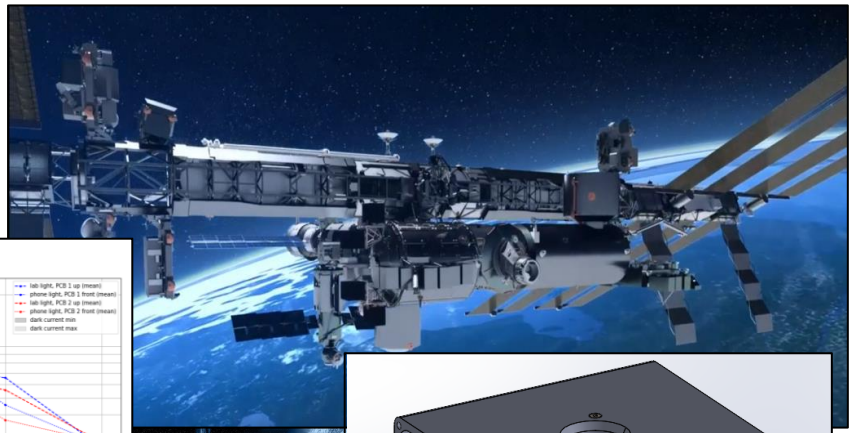
SiPM Spectrum of Best Configuration



Values +/- Stat. Uncertainty	Full Spectrum	Treshold: 4 photons
Light Count Rate (L)	(772.76 +/- 0.08) kHz	(61.XX +/- 0.02) kHz
Difference to Dark Rate (D-L)	(25.72 +/- 0.11) kHz	(2.9 +/- 0.X) kHz
Relative Difference (D-L/D)	3.4 % light excess	5.0 % light excess

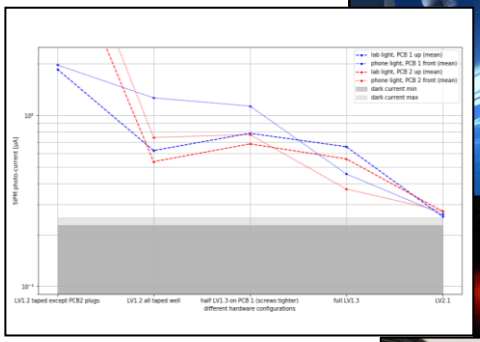
Summary

- Overview about IOV-ISS Mission
- Designed CAD-Model



- Evaluated Light Shield

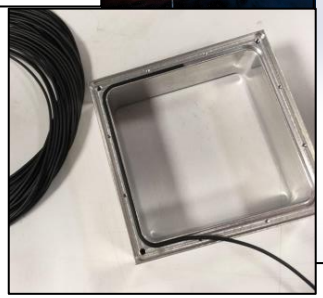
  → Iterative Approach



- Light Shield with Sealing Ring

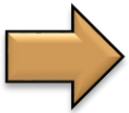
  → Light Rate comparable to Dark Rate

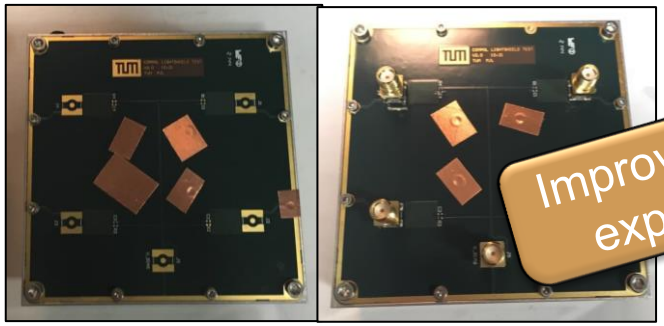
  → 5 % Light Excess



Outlook: PCB Update

- Metallized Edges
- SMD Connectors & Burried Vias





Happy to Work with These Nice People

Thank you for your attention!

Do you have Questions?