GROND=GRB Optical/NIR Detector for the MPI/ESO 2.2m Telescope

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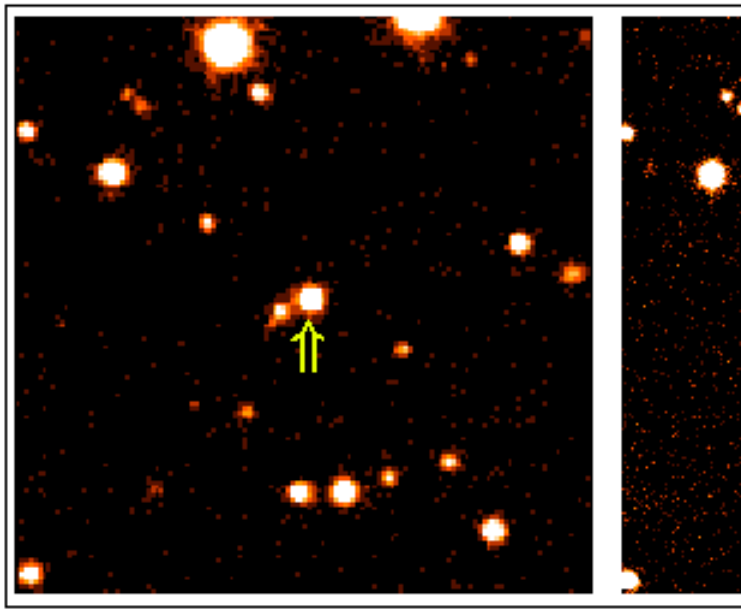
Outline

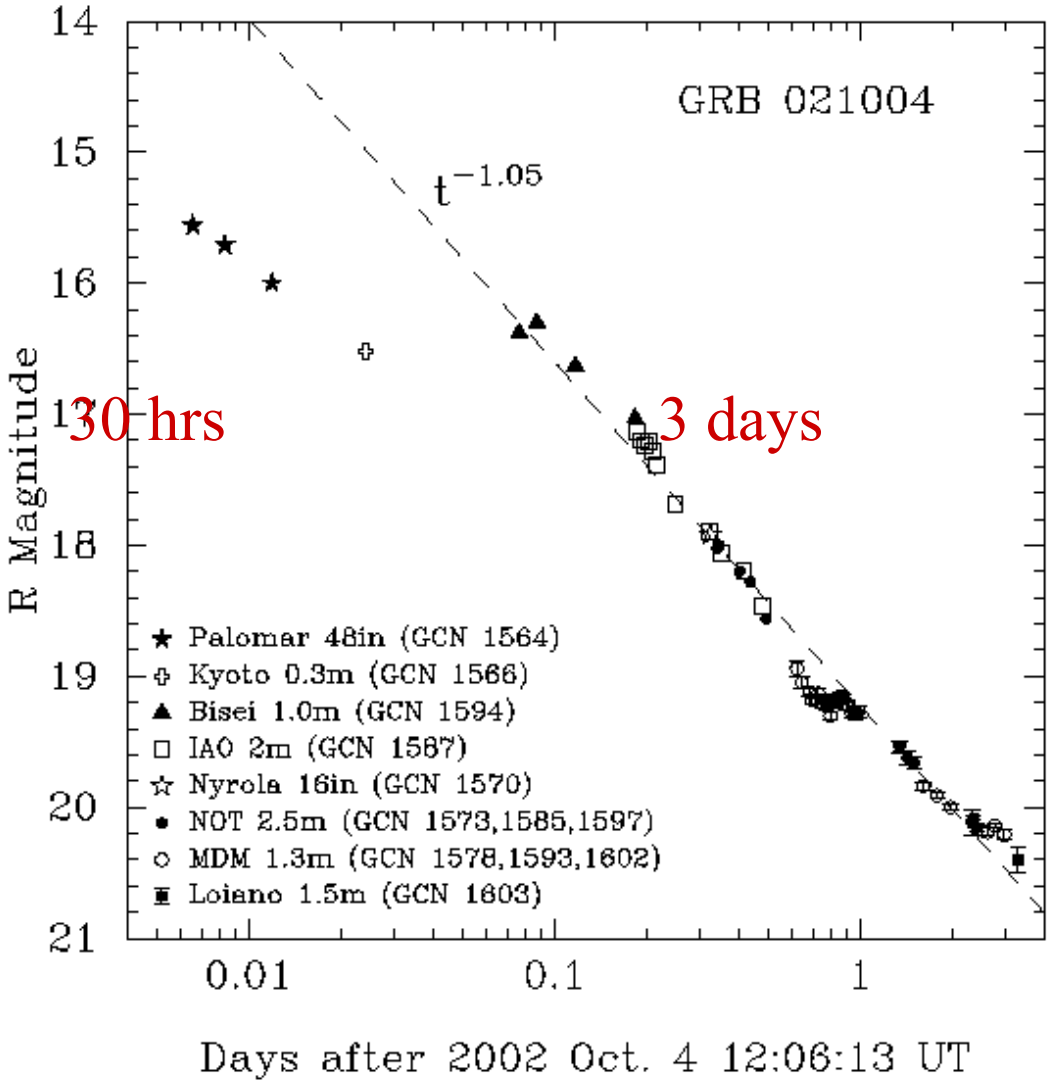
- **Main goals: GRBs → Instrument-Characteristics**
  1. **high-redshift GRBs**
  2. **Broad-band afterglow spectrum**
- **Optical Concept**
- **MPG/ESO 2.2m Telescope: co-existence with WFI/FEROS**
- **Status**

GRB Afterglow and Light Curve

Afterglow emission at radio, optical, and NIR wavelengths

ISAAC/J at 8 hrs





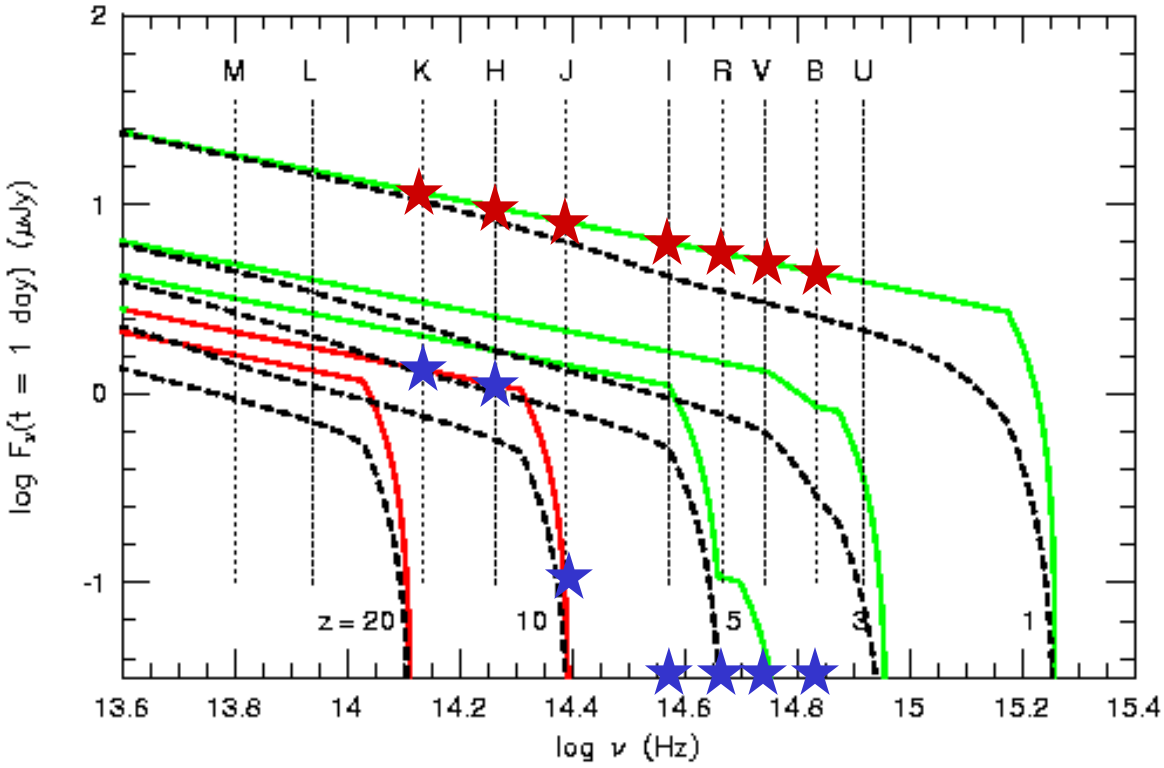
30 hrs

3 days

GROND

Quickly finding high-redshift GRBs

- **Due to characteristic spectrum of GRB Afterglow:**
  - **Photometry in 7 filters simultaneously, from that derive redshift**
  - **If redshift >5, then follow-up spectroscopy in the same night at 8m-class telescopes and with satellites (VLT, LBT, Spitzer, XMM, …)**



Requirements for GROND Camera

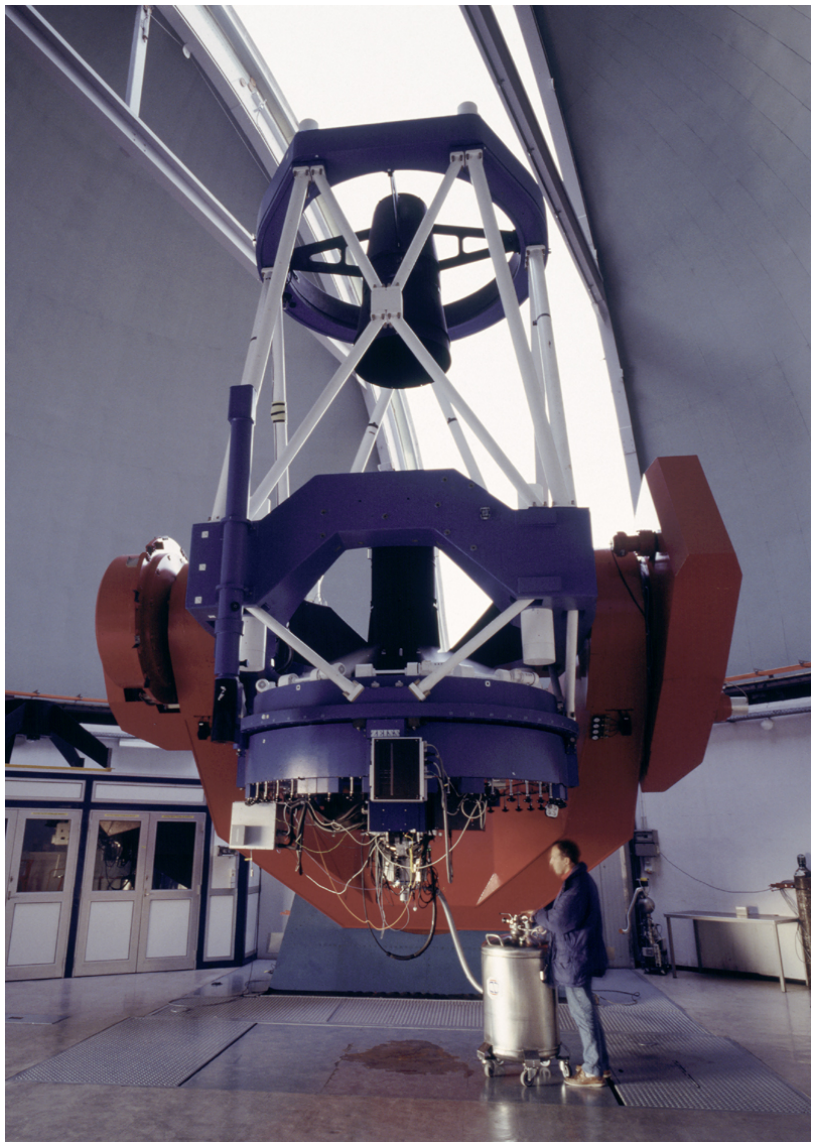
- **7 filters: Sloan g', r', i', z' and J, H, K**
- **1 detector for each filter-channel**
  - **3 HAWAII 1K*1K Arrays**
  - **4 E2V 2K*2K CCDs**
- **Due to small NIR-Arrays: Focal-Reducer in NIR**
- **Concept technically never realized so far, because**
  - **Shutter (moving parts) in cold environment**
  - **Temperature gradient (65 K for IR, 160 K for optical detectors)**
  - **Dithering of K-band channel in instrument/cryostat**
- **R-K ~ 2-4 mag → typical GRB-Brightness: R ~ 16-22 mag**

  K ~ 14-20 mag

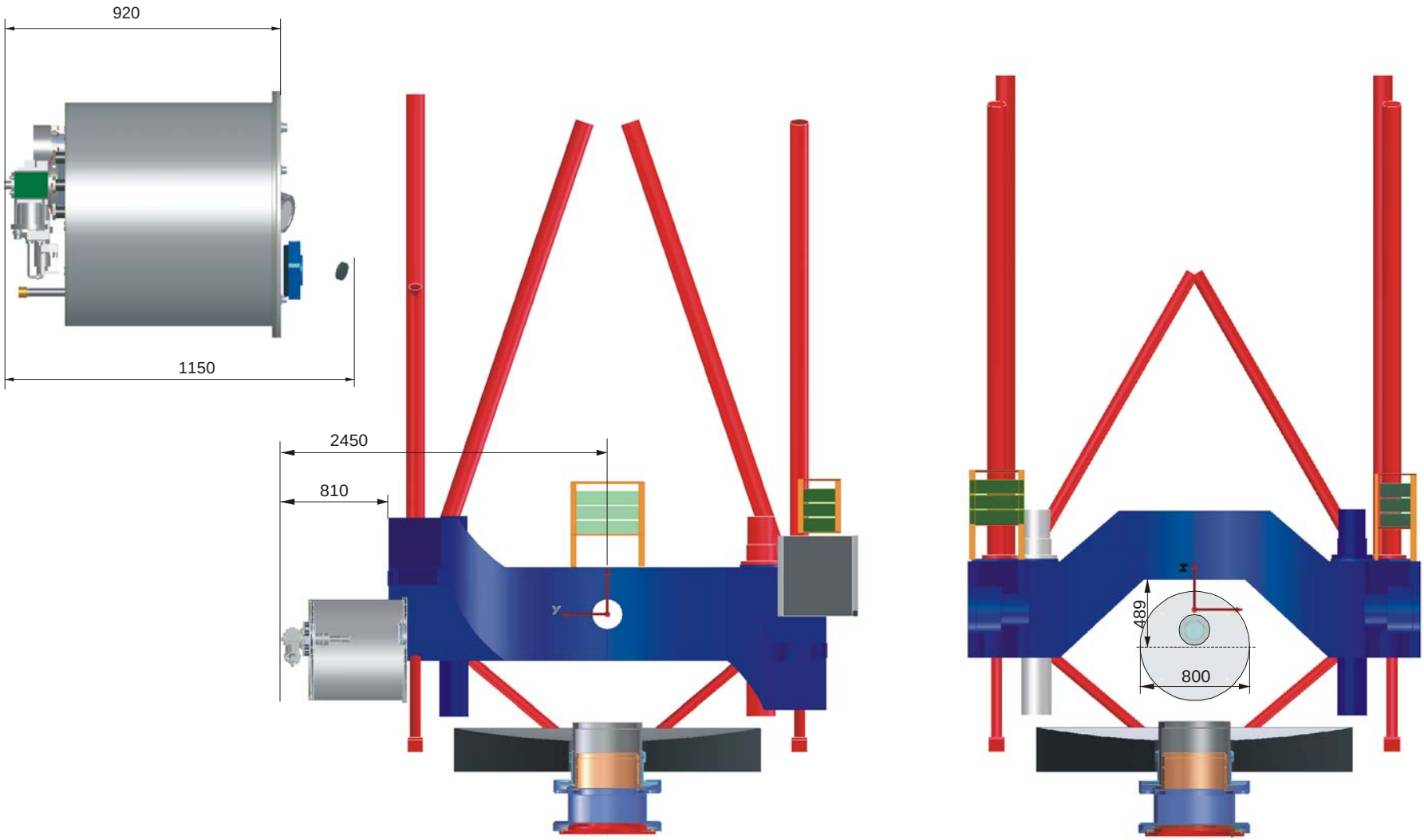
→ **same exposure time in JHK + in pairs of 2 optical CCDs**

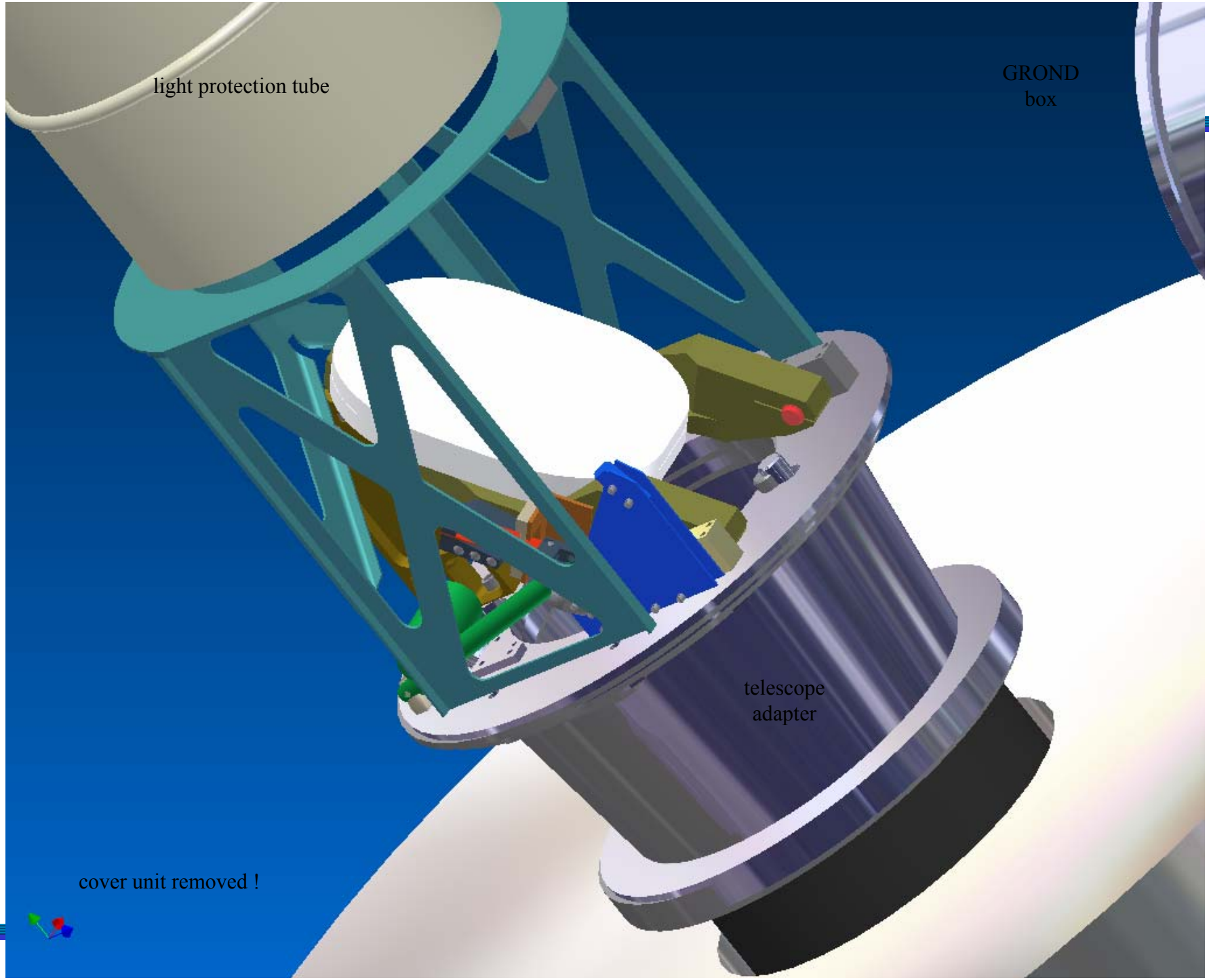
At the 2.2m Telescope in Chile

- **Co-existence with WFI+FEROS**
- **GROND should be VLT-compliant**
- **Rapid availability (10 min)**
- **Needs M3-Flip-Mirror!**
- **“Bad” Location: Water/He above M1!**
- **Low as possible maintenance (cooling, vacuum; data handling)**

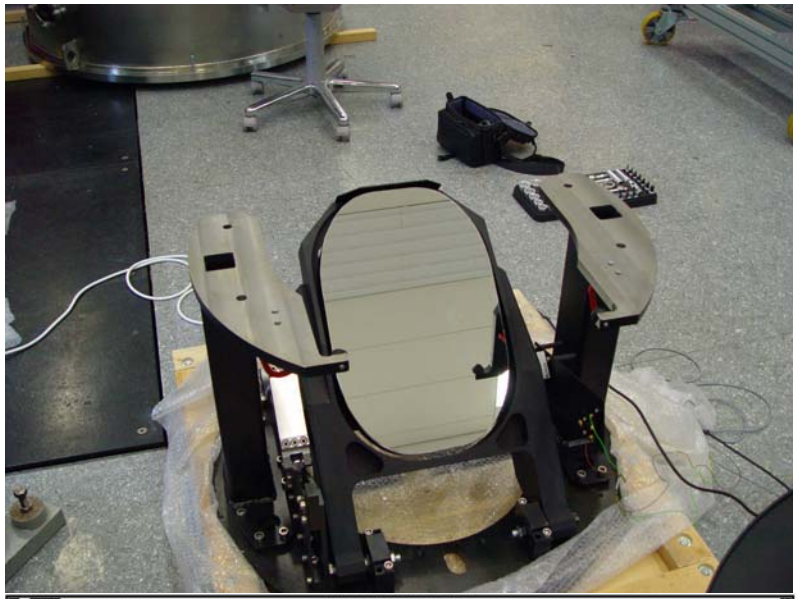


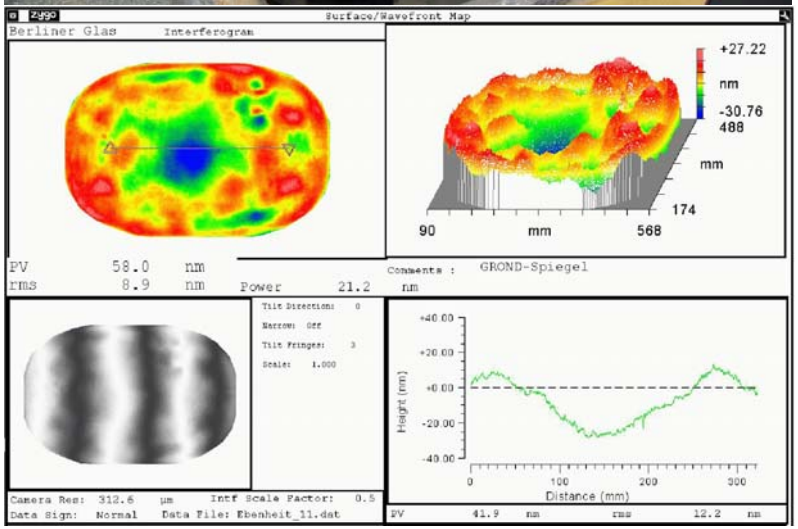
GROND Dimensions

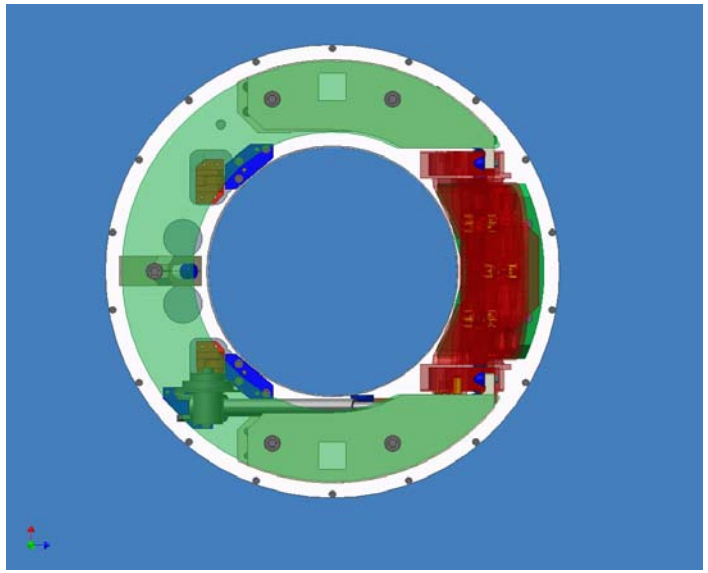


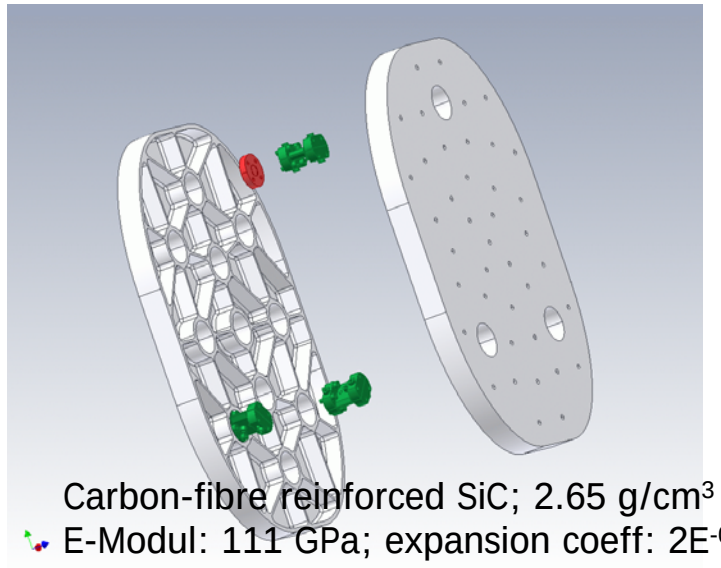

light protection tube
GROND
box
telescope
adapter
cover unit removed !

M3









Carbon-fibre reinforced SiC; 2.65 g/cm^3

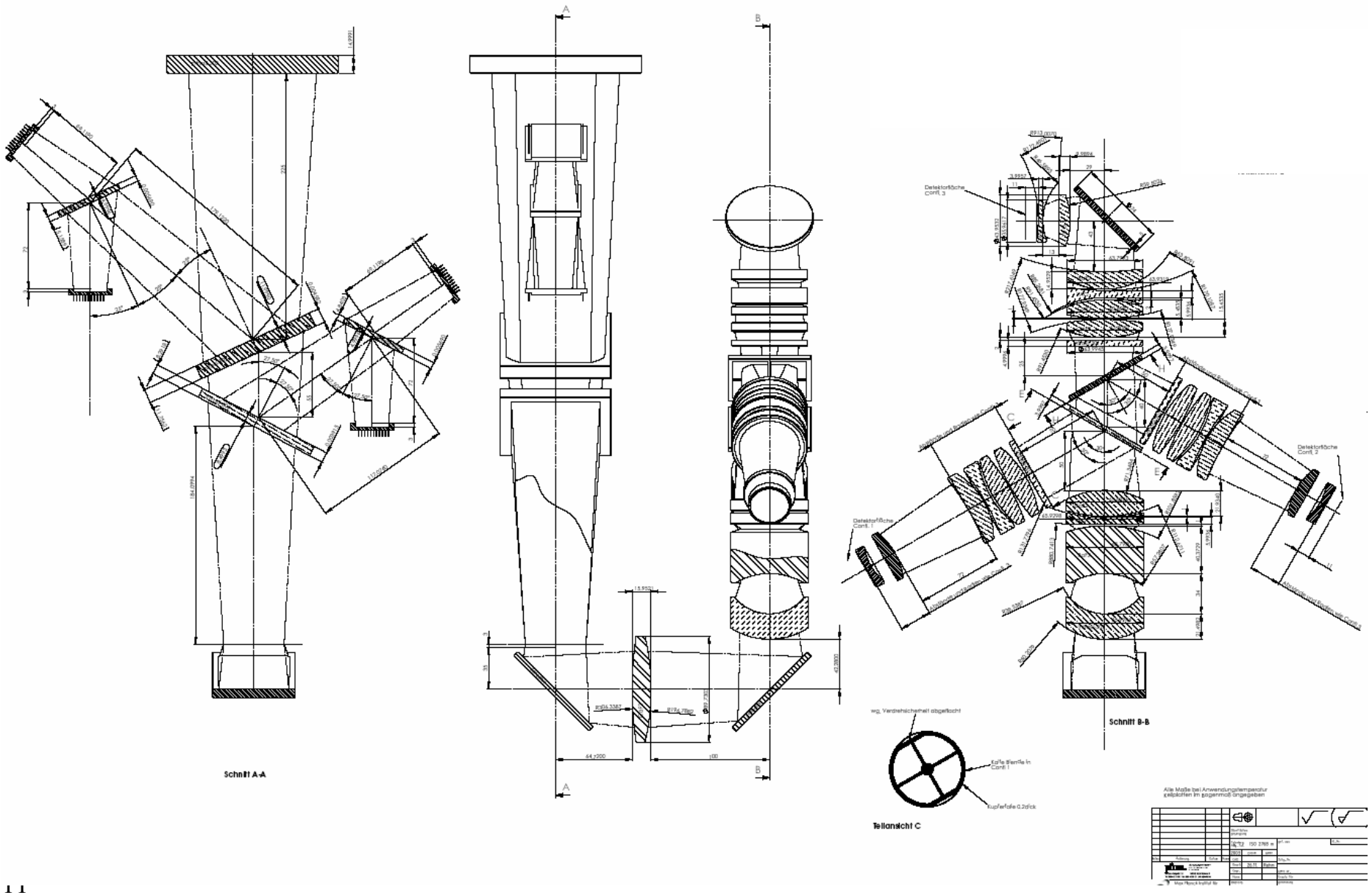
E-Modul: 111 GPa; expansion coeff: 2E^{-06} / K

General Design

- **2.2m telescope is RCC – 2200/17600 (1:8)**
- **Visual part: just dichroics, no re-imaging**

  2Kx2K CCD with 13.5 µm: 5.4´x5.4´ (7.6´ encircled)
- **NIR part: focal reducer (from 17600 to 6330)**
  this allows to image a 10´x10´ FOV onto 1Kx1K HAWAII
- **All reflections at dichroics tuned to minimize intrinsic polarization effects**
- **One detector for one filter band (no movable filters)**
- **Dithering by rotating mirror in K-band beam**

GROND Optics

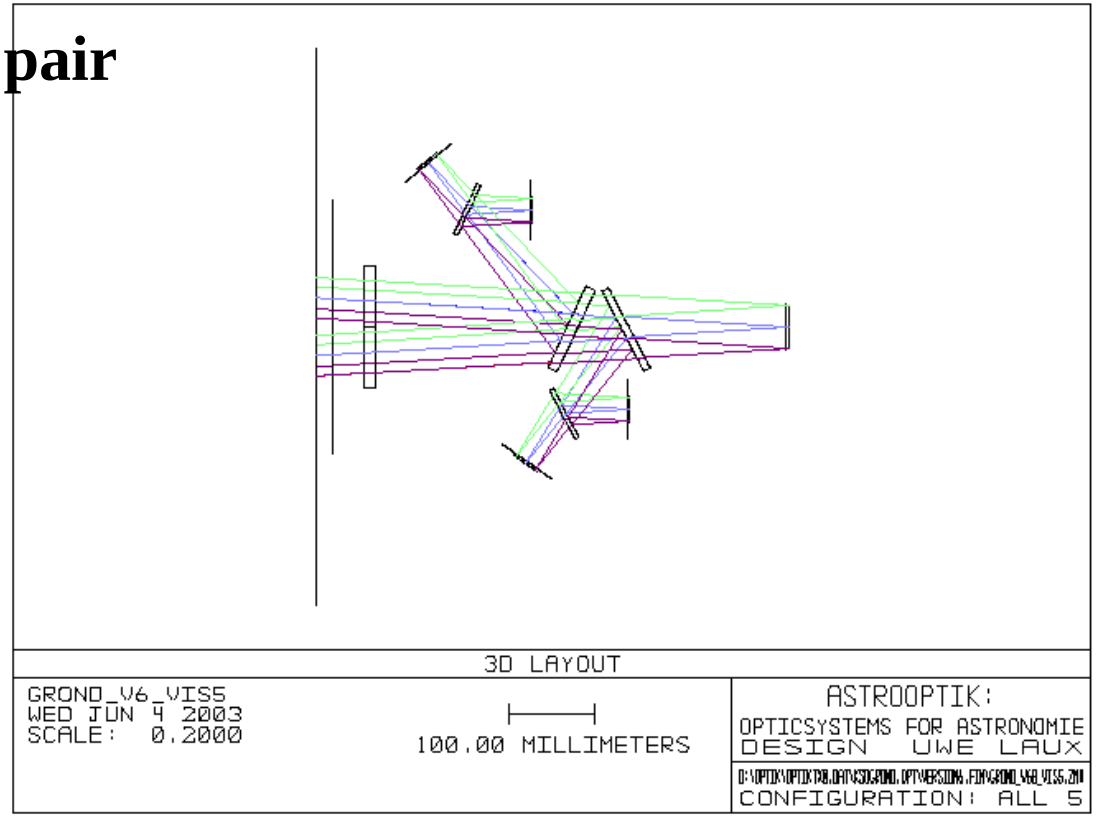


Visual Channels

- **Dichroics in convergent beam – need to correct for astigmatism and CVD (chromatic field size)**

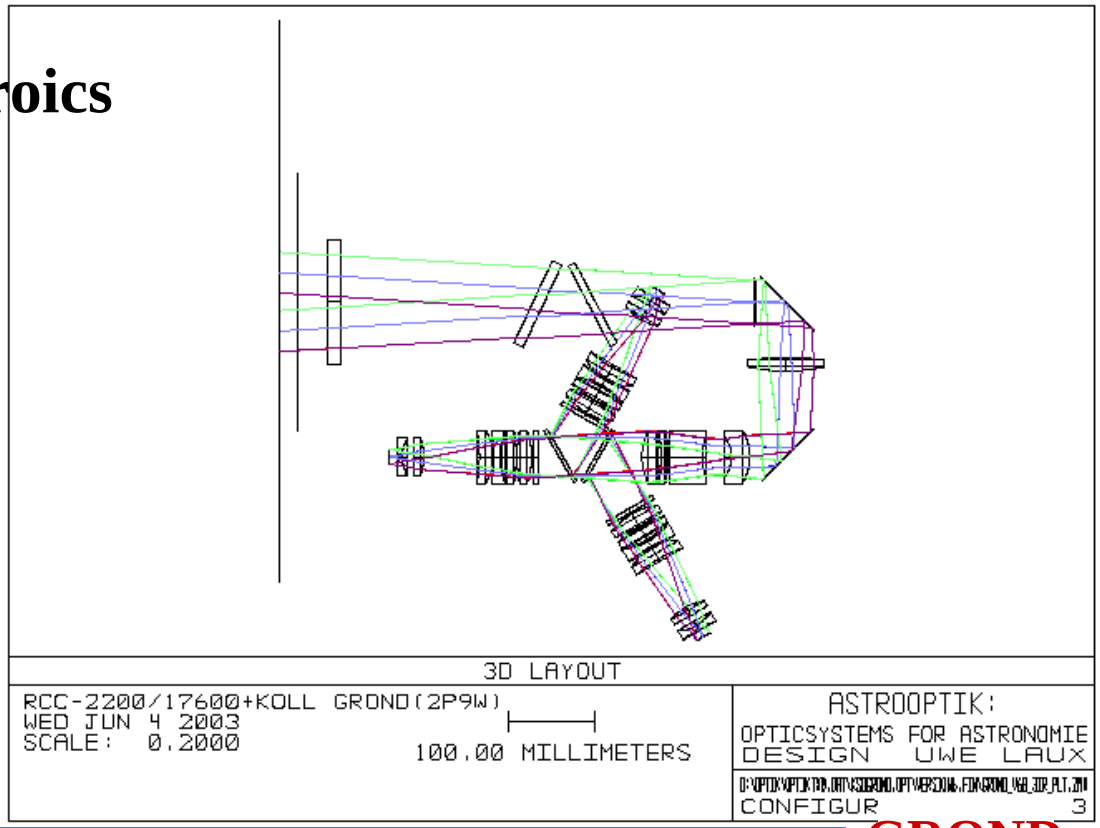
  Self-correction through non-parallel dichroic plates

- **Shutter for each CCD pair**

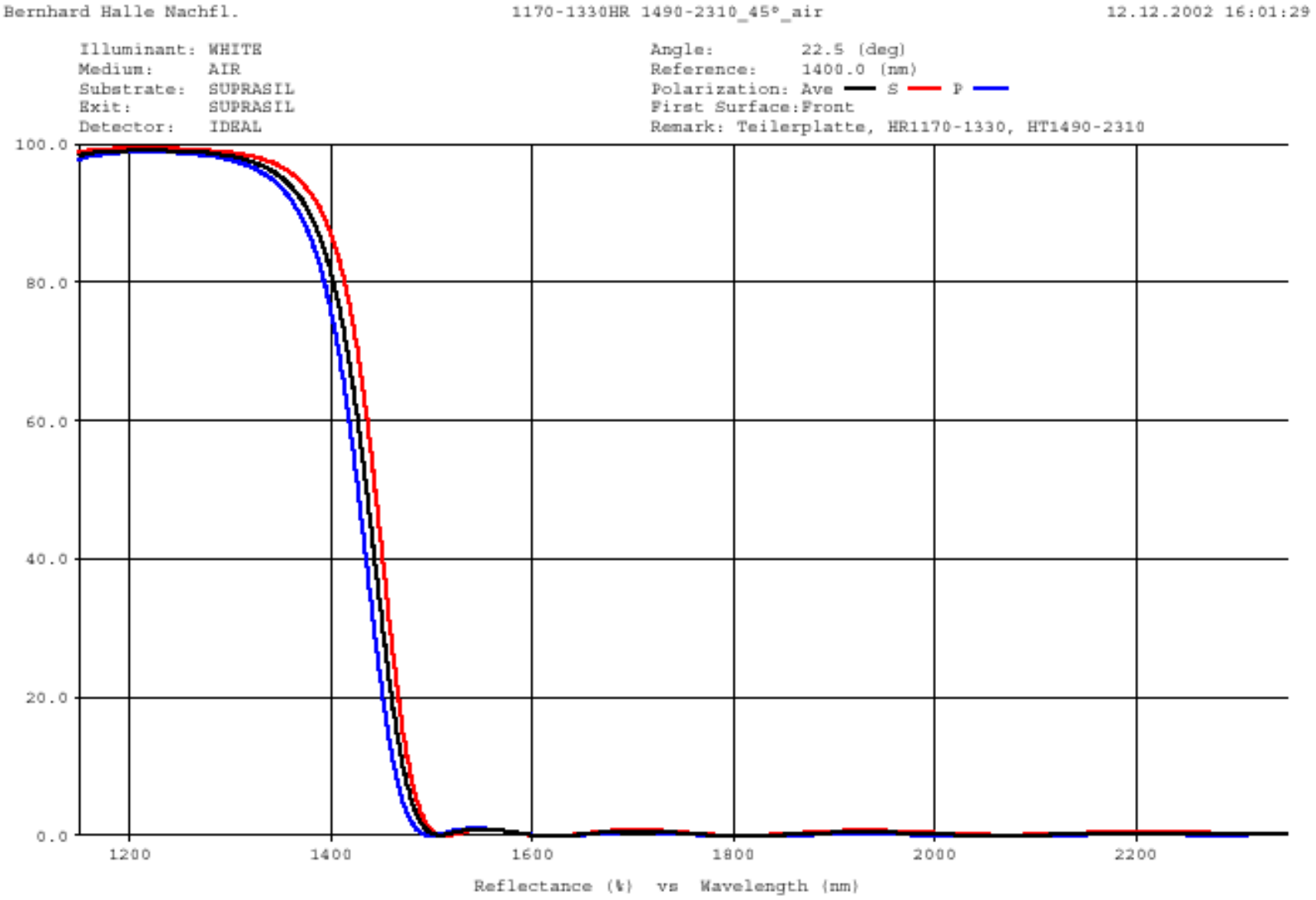


NIR Channels

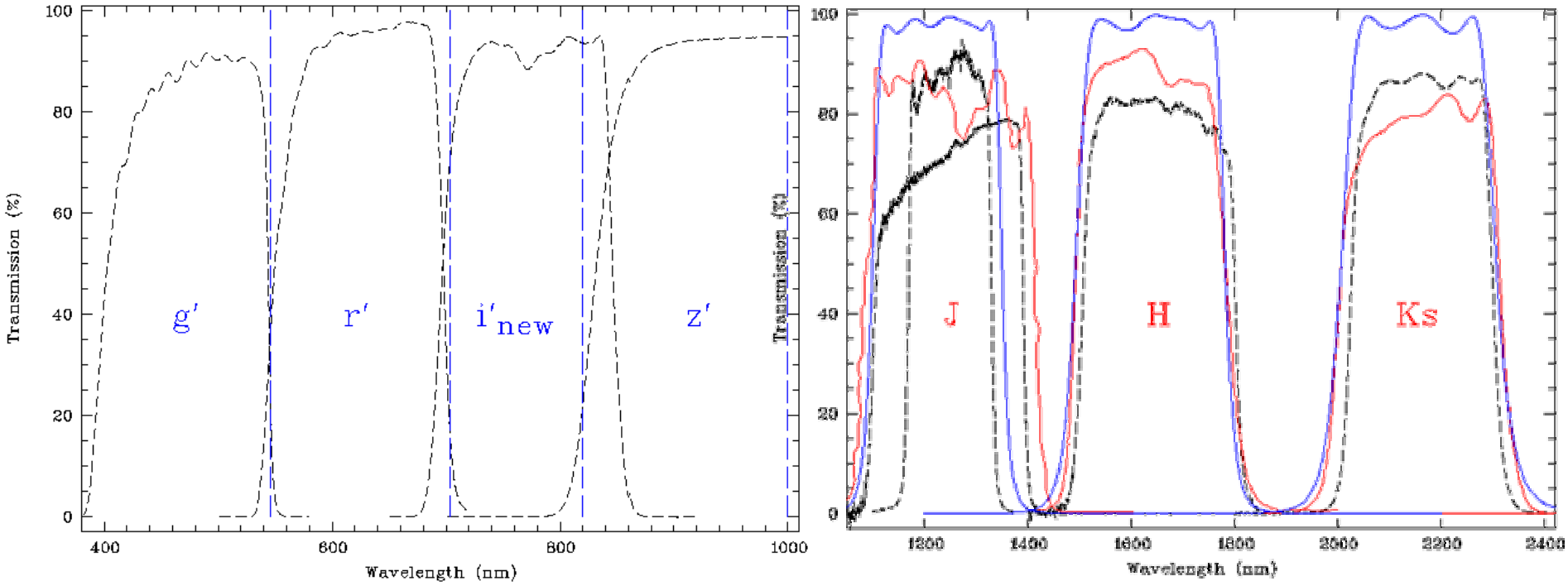
- **Folding by 2x90 deg to reduce size**
- **Collimator (1:8, f=360) and 3 identical camera objectives**
- **Dichroics in parallel beam**
- **JHK filter behind dichroics**



Dichroics


Bernhard Halle Nachfl.
1170-1330HR 1490-2310_45°_air
12.12.2002 16:01:29
Illuminant: WHITE
Medium: AIR
Substrate: SUPRASIL
Exit: SUPRASIL
Detector: IDEAL
Angle: 22.5 (deg)
Reference: 1400.0 (nm)
Polarization: Ave S P
First Surface:Front
Remark: Teilerplatte, HR1170-1330, HT1490-2310
100.0
80.0
60.0
40.0
20.0
0.0
1200
1400
1600
1800
2000
2200
Reflectance (%) vs Wavelength (nm)

7 (filter) channels



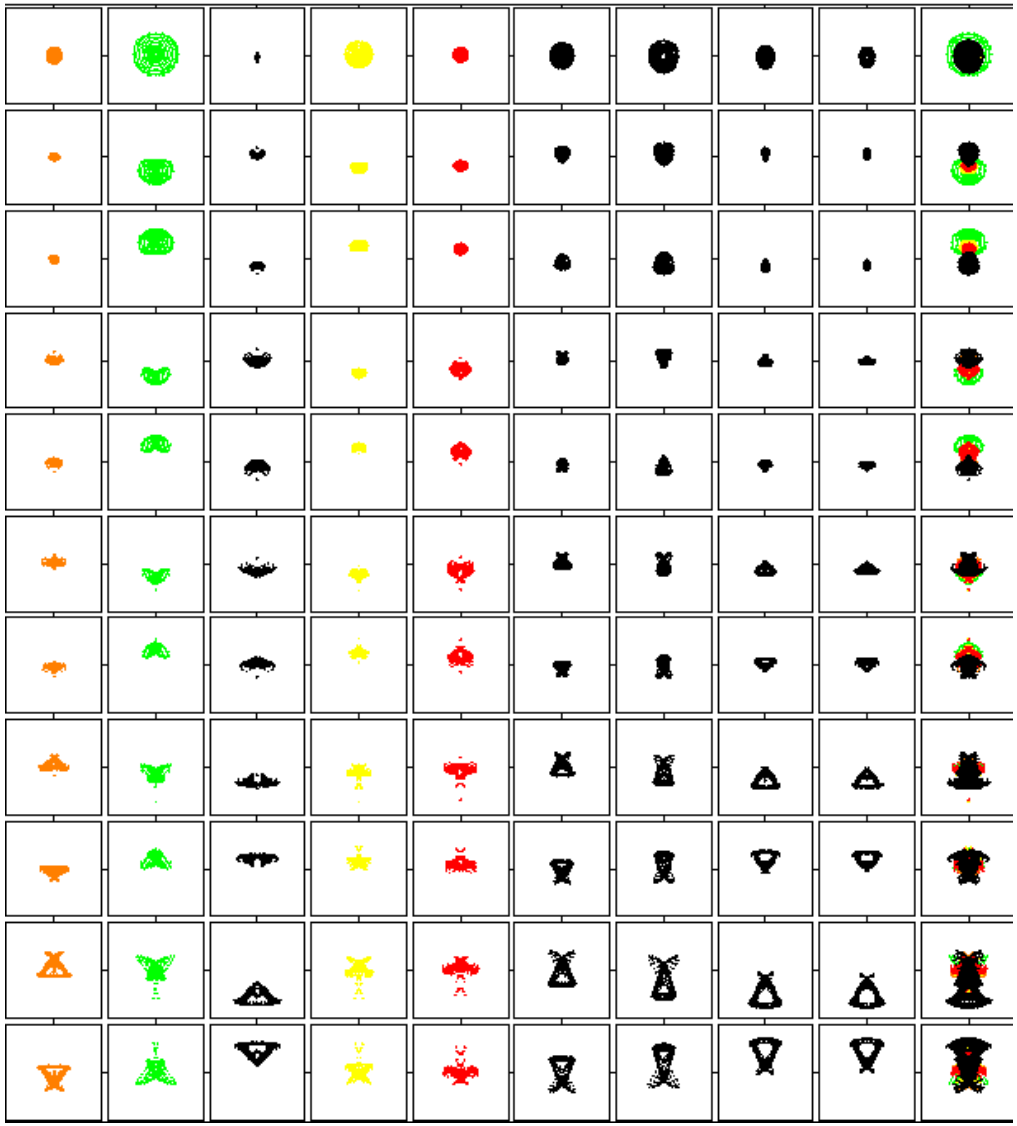
GROND

Spot Diagram collimator/camera

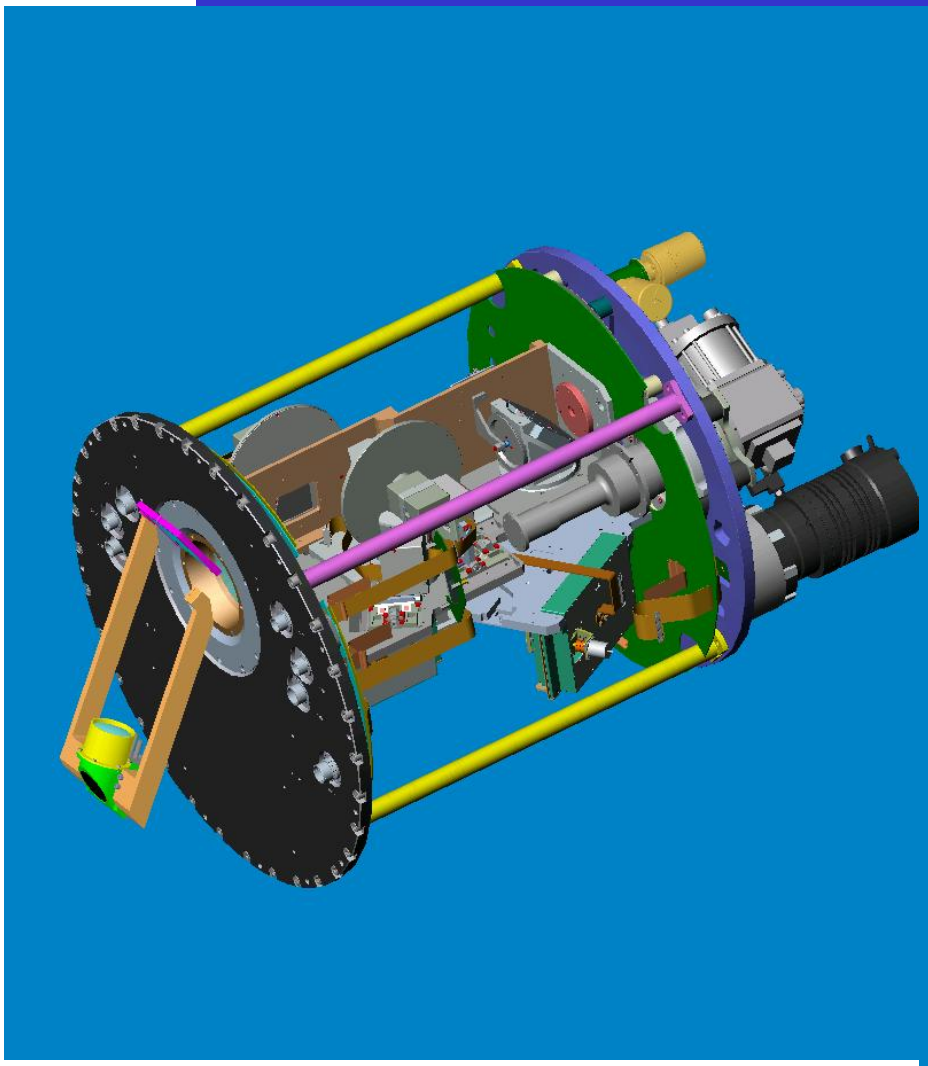
•Camera optics determined by imaging geometry, not by wavelength range

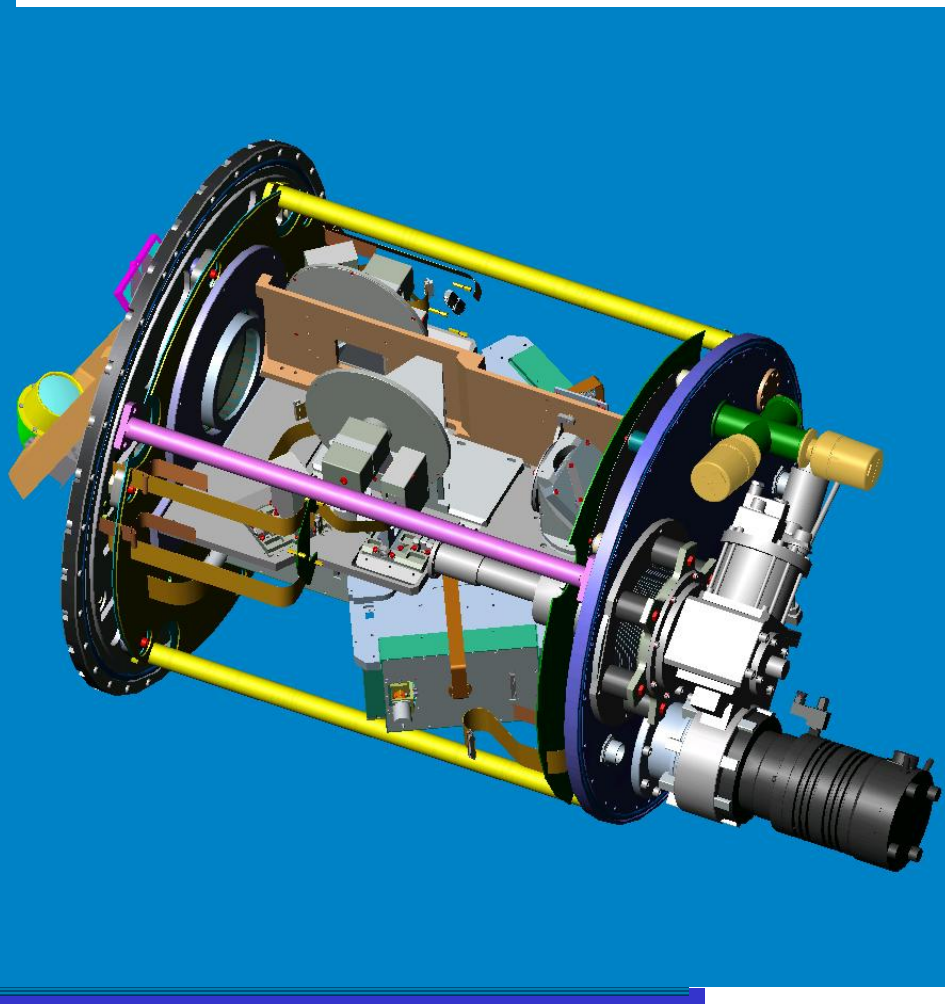
Thus all identical.

•Three identical camera objectives advantageous for calibration



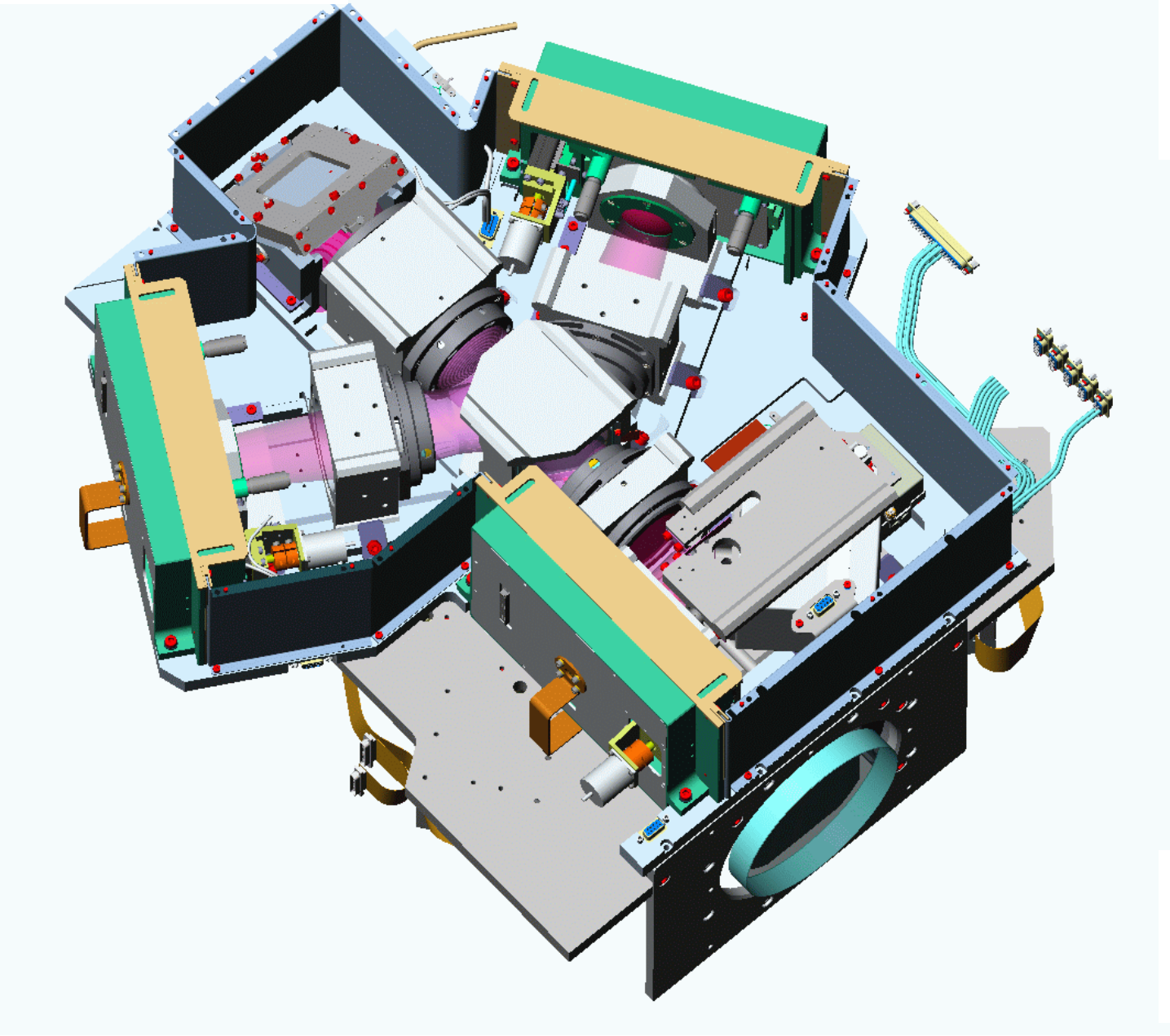
GROND Mechanics





GROND Vessel

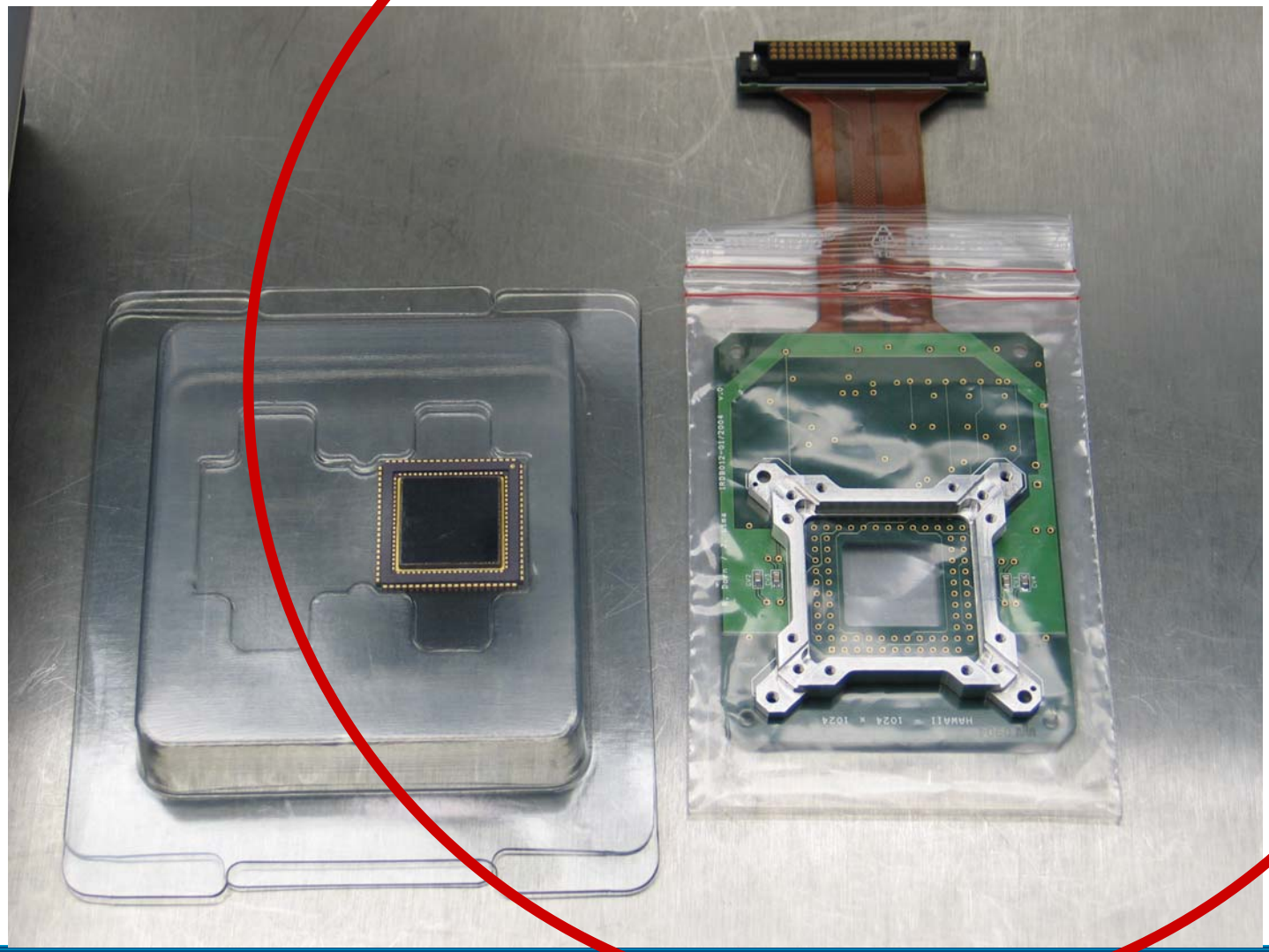
Construction example: IR beam



IR Detector

Original ESO board size

Hawaii 1024*1024 HgCdTe Infrared Detector with detector board



Operational Scheme

- **GRB alert from SWIFT satellite directly to computer/RITZ about 1-2x per week**
- **general override status**
- **GRBs at night: RRM; otherwise as early as possible**
- **switch M3 to GROND, re-point telescope, and start exposure within less than 10 min (pre-prepared OBs)**
- **Data reduction pipeline; selective VLT triggers**
- **GROND observation for <3-4 hrs**

Will use about 10% observing time at 2.2m

Present Status and Plan

- **June 2005: M3 delivered to La Silla**
- **Jul/Aug 2005: commissioning of M3; impact on WFI/FEROS**

- **Now: assembly of GROND at MPE**

- **Oct/Nov 2005: Interface structure + Guide Camera to La Silla**
- **Dec. 2005: new 2.2m pointing model; focus-model**
- **Early 2006: GROND to La Silla**