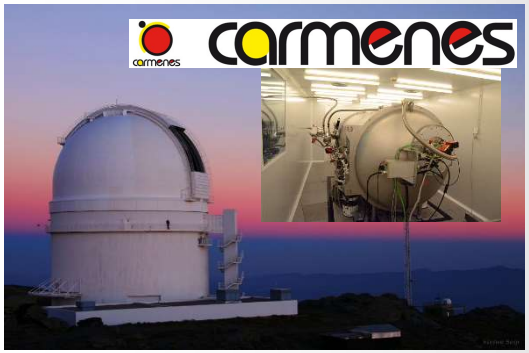
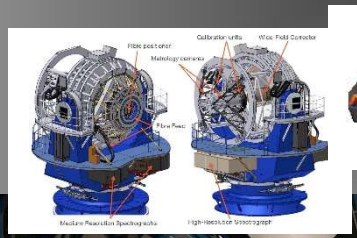
# Instrumentation @LSW









Walter Seifert

Landessternwarte Heidelberg

# LSW organization and funding

- Landessternwarte Heidelberg (LSW) is – with ITA and ARI – part of the Zentrum für Astronomie der Universität Heidelberg
- Project funding mainly externally via Verbundforschung (BMBF) and/or the Großgeräte funding of the DFG
- The University provides us with a modern infrastructure to be part of consortia for large telescope instrumentation with a significant and visible contribution
- LSW has its own work shop: production of prototypes during early phases of the projects and manufacturing of (part of) the actual instrument hardware (Lutz Geuer, Edwin Lutz)

# LSW HW infrastructure

- Optics lab
- Integration Facility

# LSW Instrumentation Group

- Instrument Scientist, System Engineering, Head Mechanics / Optics / Integration / AIT, Commissioning etc
  Julian Stürmer, Walter Seifert

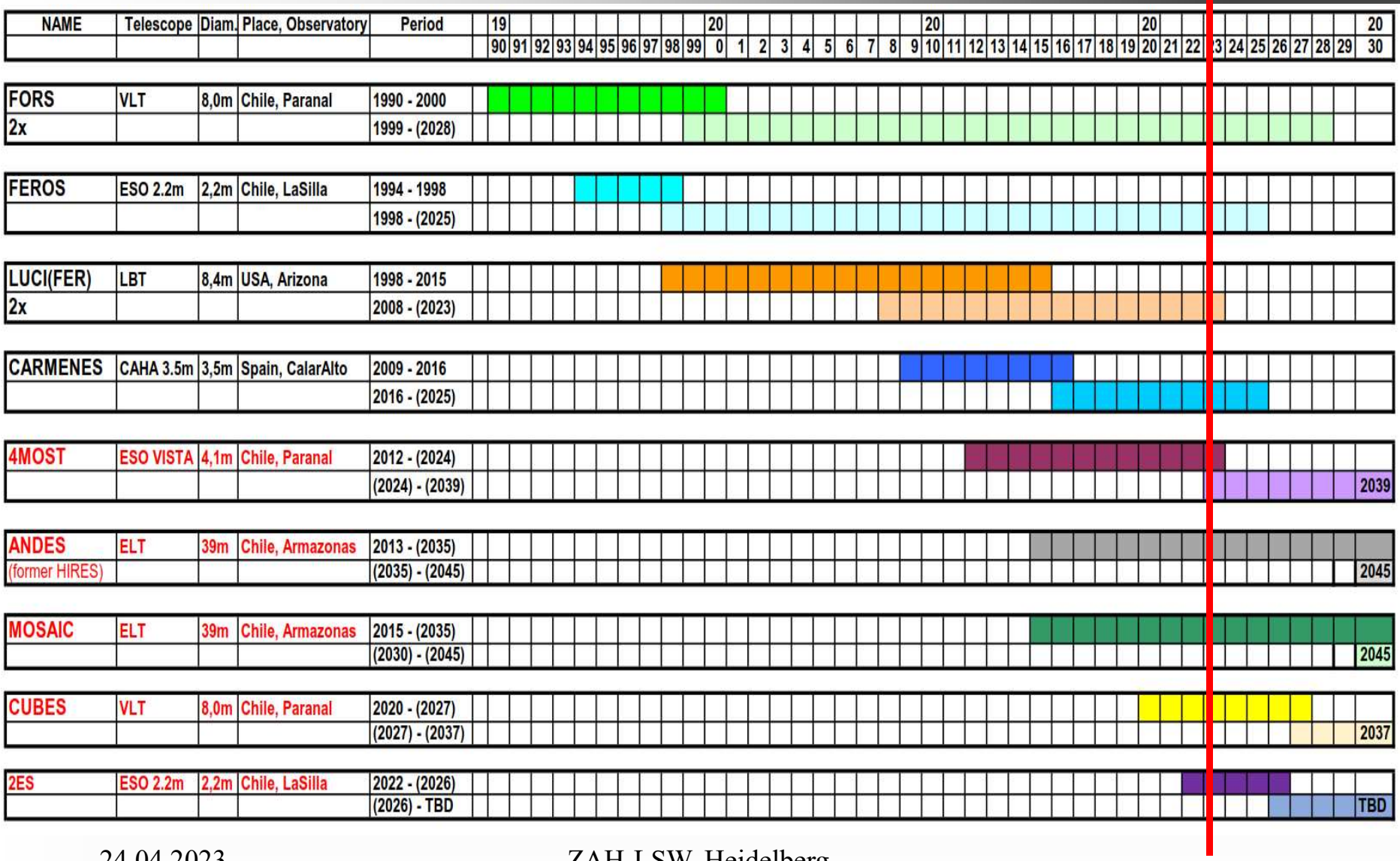
- Optical Engineering
  Wenli Xu (OSE, external)

- Mechanical Engineering and Analyses
  Carmen Feiz, Christopher Ritz

- Software Engineering , Head SW, Local project Management
  Ingo Stilz, Florian Rothmaier, Alexander Pramskiy, Adrian Kaminski

- BLUE: project related positions from third party funding

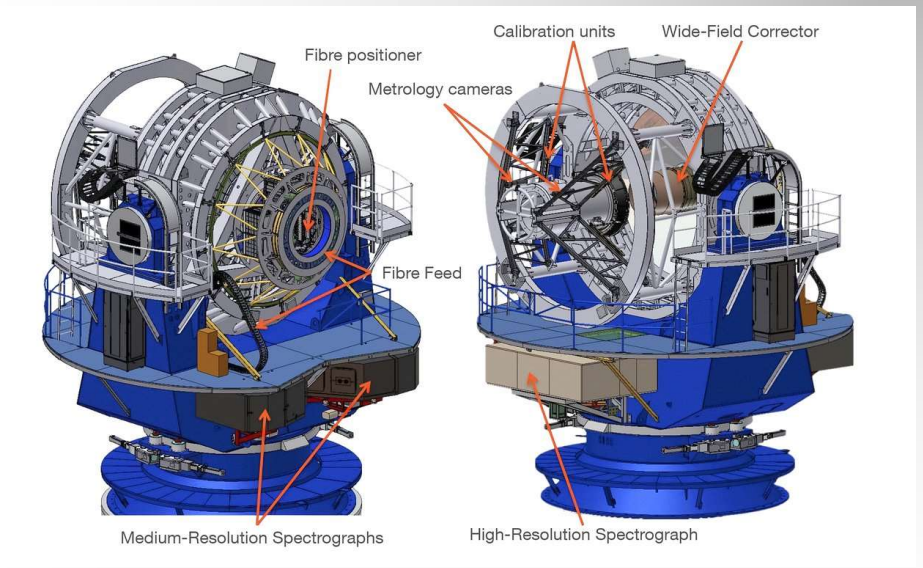
# Overview of Instrumentation

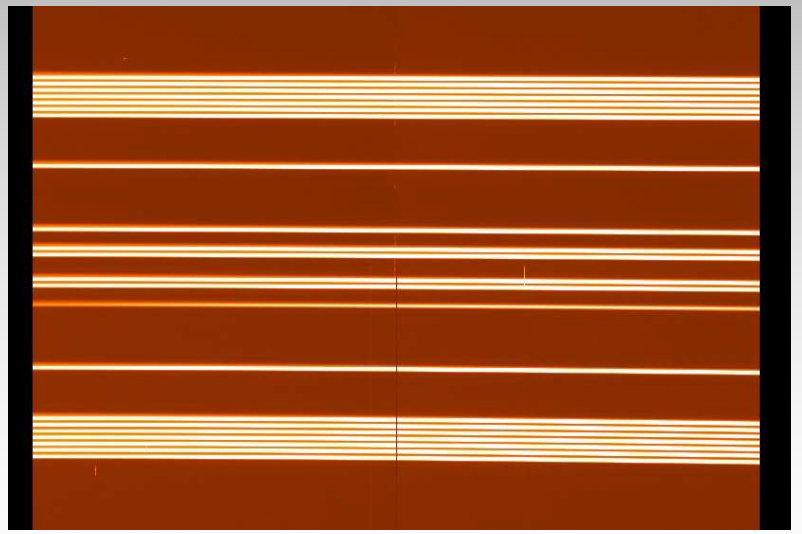


| NAME | Telescope | Diam. | Place, Observatory | Period |
|---|---|---|---|---|
| FORS | VLT | 8,0m | Chile, Paranal | 1990 - 2000 |
| 2x | | | | 1999 - (2028) |
| FEROS | ESO 2.2m | 2,2m | Chile, LaSilla | 1994 - 1998 |
| | | | | 1998 - (2025) |
| LUCI(FER) | LBT | 8,4m | USA, Arizona | 1998 - 2015 |
| 2x | | | | 2008 - (2023) |
| CARMENES | CAHA 3.5m | 3,5m | Spain, CalarAlto | 2009 - 2016 |
| | | | | 2016 - (2025) |
| 4MOST | ESO VISTA | 4,1m | Chile, Paranal | 2012 - (2024) |
| | | | | (2024) - (2039) |
| ANDES | ELT | 39m | Chile, Armazonas | 2013 - (2035) |
| (former HIRES) | | | | (2035) - (2045) |
| MOSAIC | ELT | 39m | Chile, Armazonas | 2015 - (2035) |
| | | | | (2030) - (2045) |
| CUBES | VLT | 8,0m | Chile, Paranal | 2020 - (2027) |
| | | | | (2027) - (2037) |
| 2ES | ESO 2.2m | 2,2m | Chile, LaSilla | 2022 - (2026) |
| | | | | (2026) - TBD |

# 4MOST für ESO VISTA

## 4-metre Multi Object Spectroscopic Telescope



# 4MOST

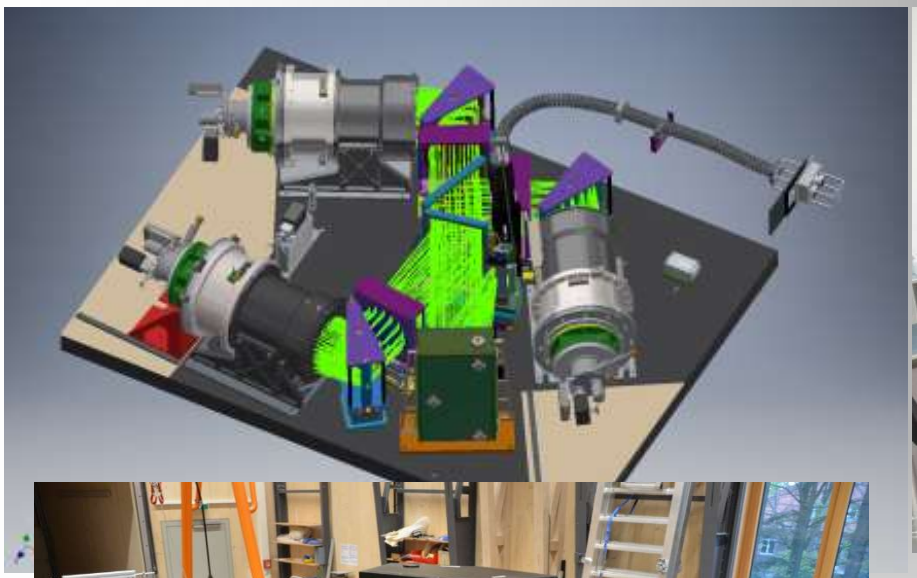
- Fiber-fed multi-object spectroscopic survey facility
- Installed at VISTA, being the only instrument for 15+ years
- Up to 2450 objects per exposure using 3 spectrographs:
  2x Low resolution (CRAL),
  1x High Resolution
- Presently system integration and testing at AIP; first light expected in 2024
- 3 spectrographs: 2x Low resolution (CRAL), 1x High Resolution
- **LSW contribution**

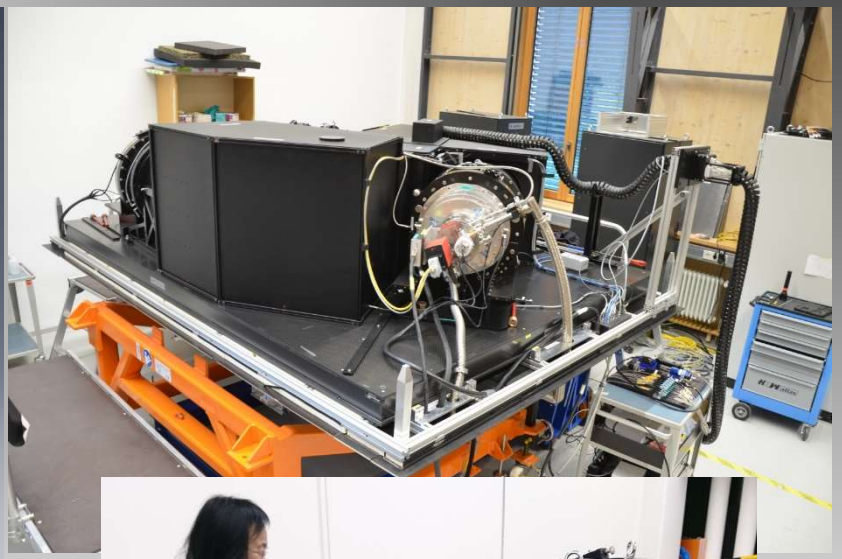
  High Resolution Spectrograph (R>18000, 390-435nm, 515-575nm, 610-680nm)
  (Wenli, Carmen, Walter, Peter Buschkamp, Ahmed ElHaddad)

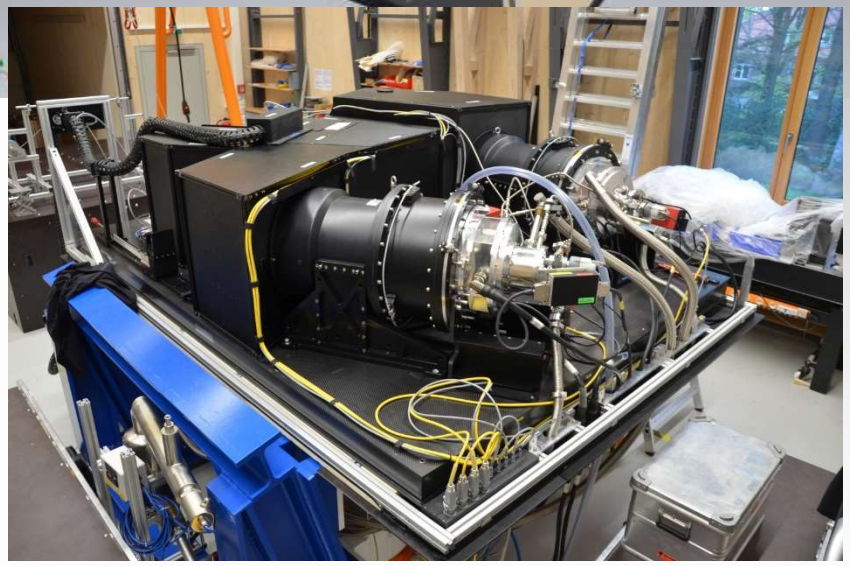
  Instrument Control SW (Ingo, Florian, Alexander)

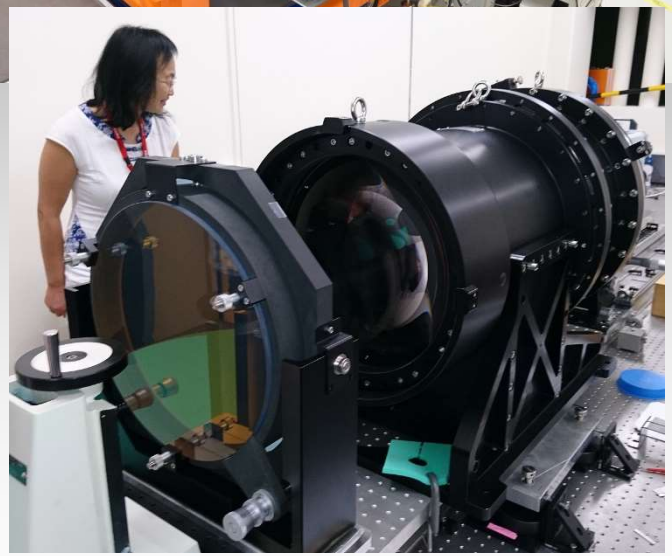
# 4MOST

## High Resolution Spectrograph









# 4MOST

## Integration and Test

Integration & Testing @LSW

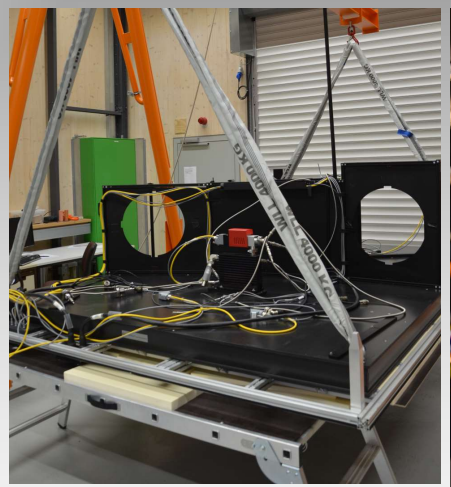
mid of 2019 to mid of 2022

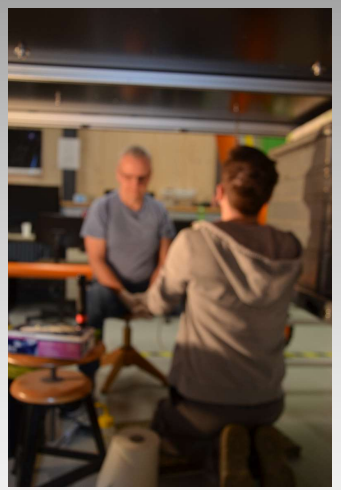
significant delay caused by a coating issue of the camera lenses

made return to KSO NewZealand / US necessary

COVID19 did not help …. Nor for transport, nor for repair

CFRP bench issue: thread inserts broken due to sub-optimum design of the bench support system





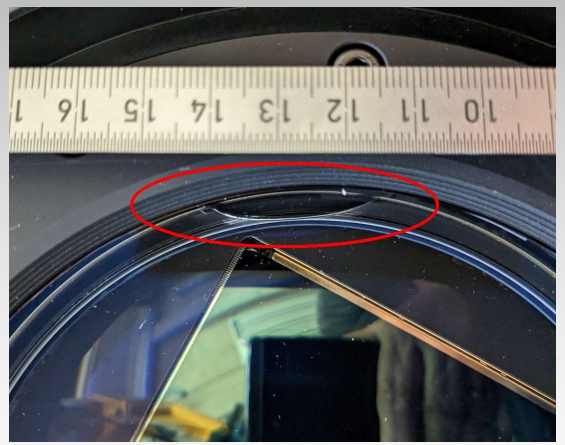
Performance testing of the spectrograph was finally successful and the HRS packed for transport to AIP…

# 4MOST

## Present status

Re-integration and test of the HRS in
August / September 2022 at AIP
waiting for system integration / tests

All fine and ready ?
… not really
… DV field lens broken…
cause of damage in final evaluation and
repair in preparation…



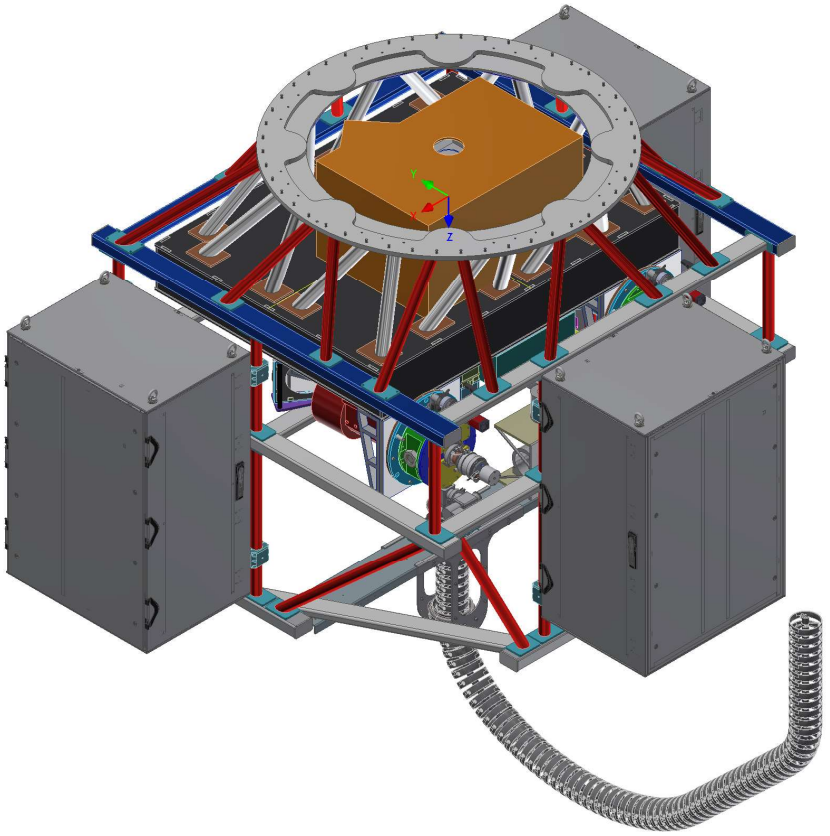
(Still) expecting to pack the instrument
late this year for transport to Paranal

# CUBES for ESO VLT

## Cassegrain U-band Efficient Spectrograph

- UT Cassegrain focus
- Slit 1.5 x 10 arcsec, Image Slicer 6 x 0.25“
- Lithographic binary grating by IoF with >85% efficiency

→ Most efficient UV spectrograph worldwide in the range of 300 to 400nm



- Phase C started and FDR will be in early spring 2024
- Operation expected from 2027 on

- **LSW contribution**

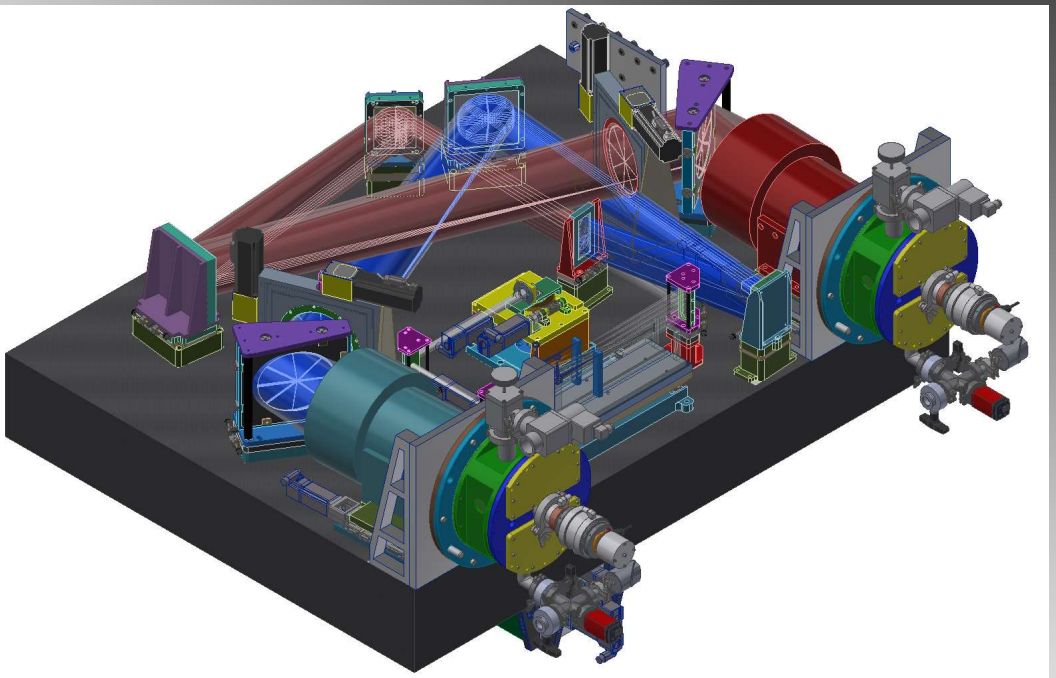
  HW: Mechanical design,WP Optics Head

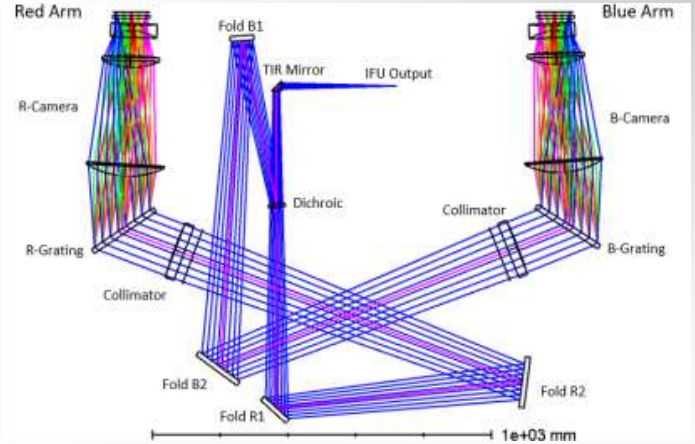
  SW: Templates & Maintenance

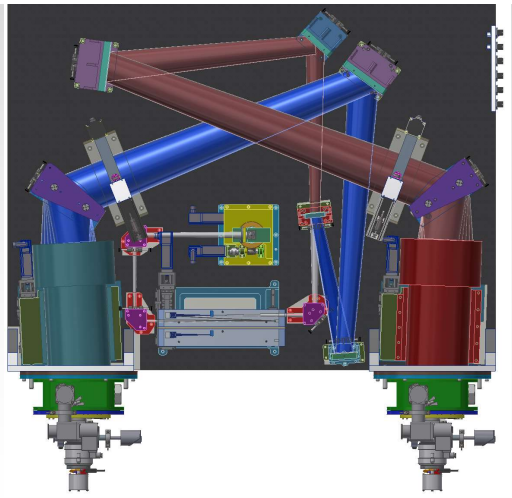
# CUBES

## UV (300-400nm) spectrograph

- Fore-Optics (incl. A&G, Calib projection
- Image Slicer
  HR (20000) and
  LR (5000) (slit width 6“)
- Spectrograph: splitting in 2 channels:
  BLUE: 300-350nm
  RED: 350-405nm



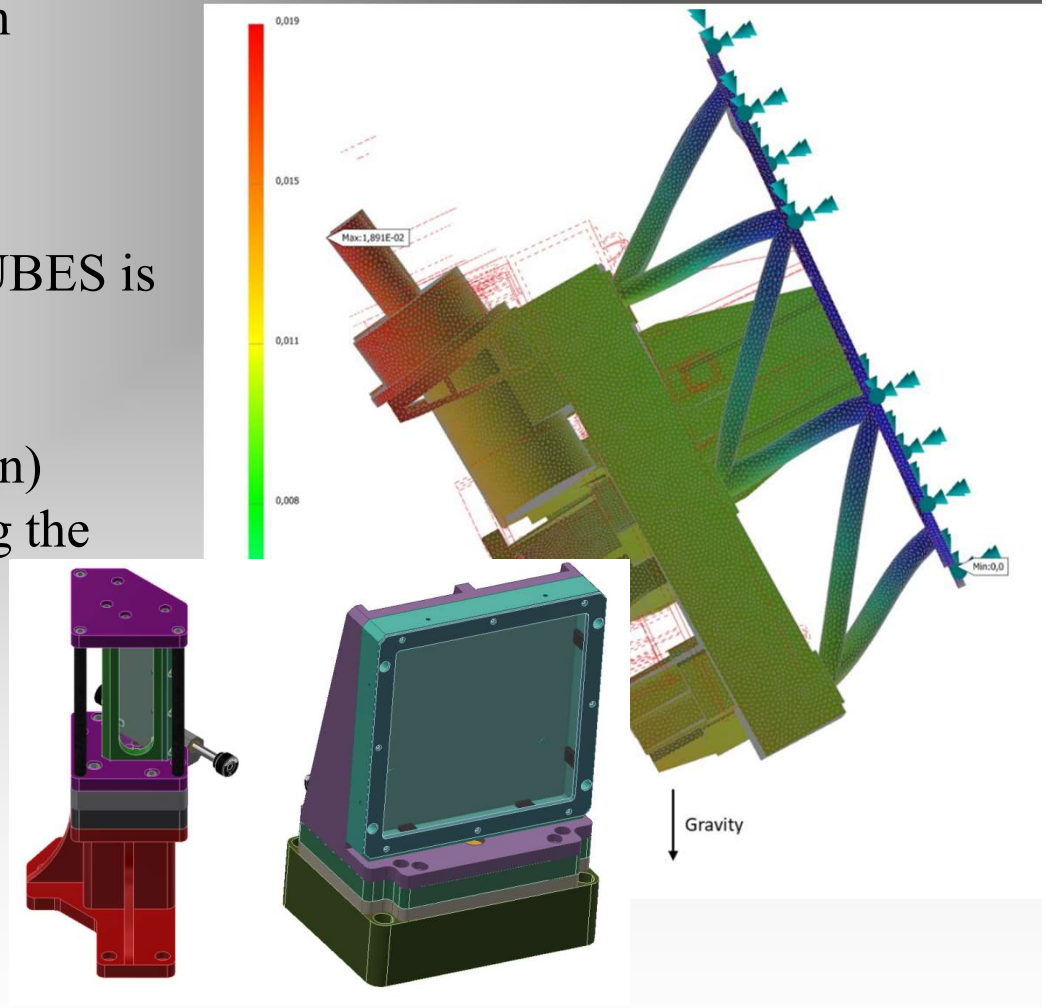


# CUBES

## Mechanical Design and Analyses (Julian (Head), Carmen, Christopher)

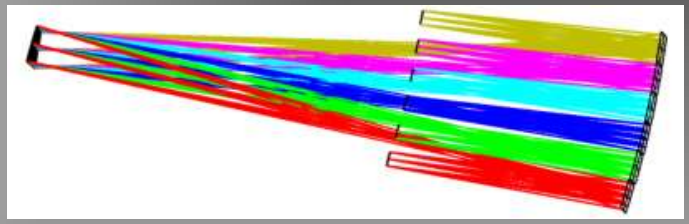
- Weight saving: CFRP optical bench
- Design of the opto-mechanics
- Detailed FEA is a major task as CUBES is installed at the Cassegrain focus
- AFC (Active Flexure Compensation) system will be implemented using the collimator lenses for compensatioon of image movement



# CUBES

## Optics (Walter (Lead), Hans Dekker, Durham, UK ATC)

- Image Slicer (Winlight)
  Pre-manufacturing phase started



- Grating (IoF)
  Prototype produced

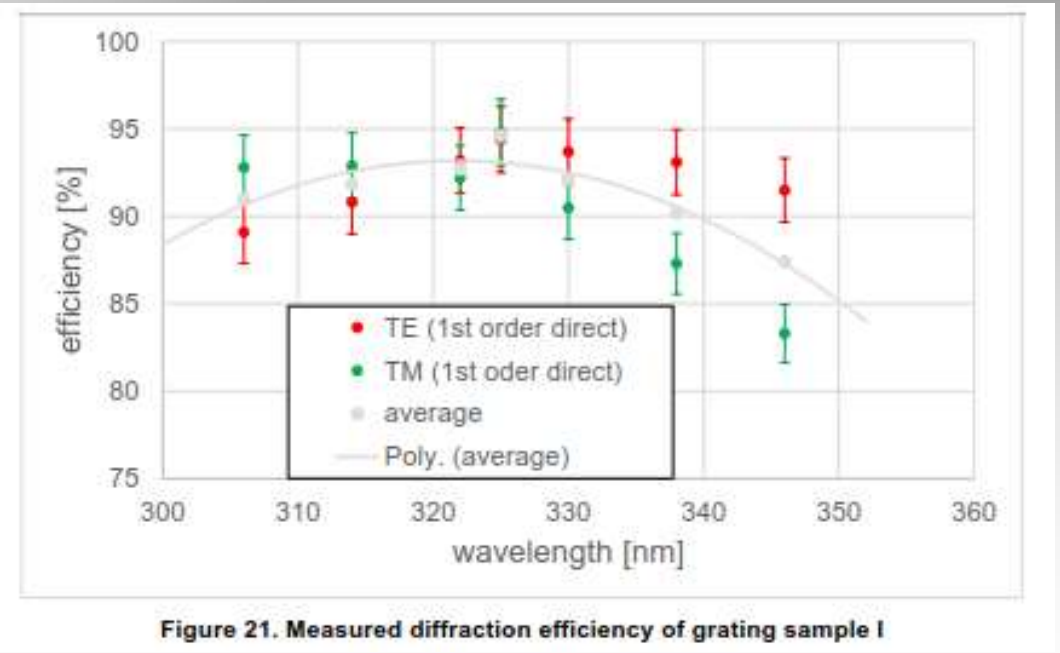



**Figure 21. Measured diffraction efficiency of grating sample I**

# CUBES

## SW: Templates & Maintenance (Ingo, Florian)

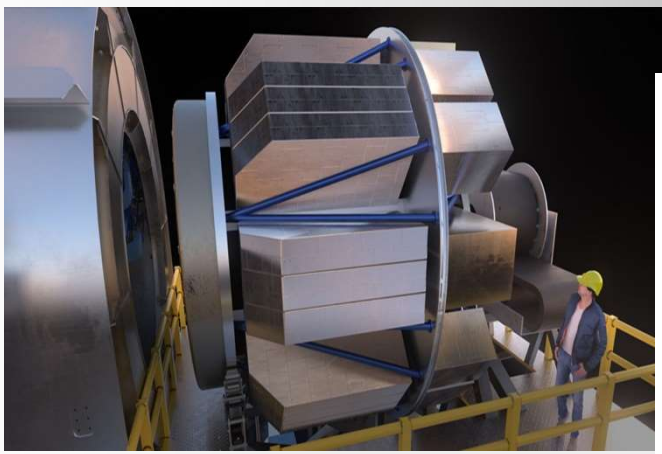
- Templates: software mapping the various observational scenarios and calibration procedures of CUBES to so-called “sequences”
- Code development is done within the new ELT-SW framework

# MOSAIC for ESO ELT

## Multi-Object Spectrograph for Astrophysics, Intergalactic-medium studies and Cosmology

Conceptual design Phase A finished; **Phase B.1 just started**

LSW is sharing work with NOVA on the VIS spectrographs;
Optical design (Wenli, Walter)



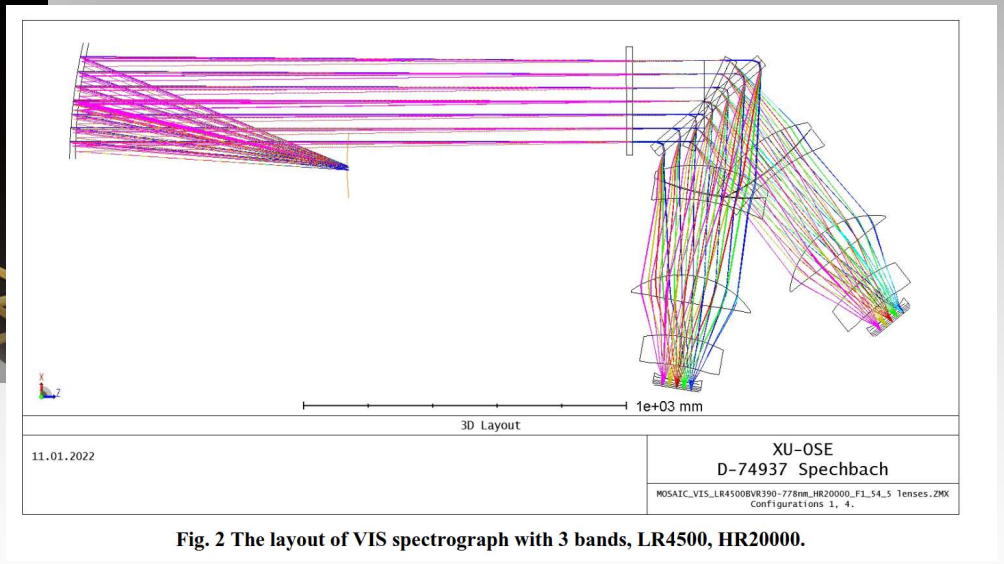



**Fig. 2 The layout of VIS spectrograph with 3 bands, LR4500, HR20000.**

# ANDES for ESO ELT

## ArmazoNes high Dispersion Echelle Spectrograph

**LSW contribution**

- Control software of three out of four spectrographs
  UBV, RIZ and K (Adrian, Ingo, Florian)

- Optical concept for the K-band spectrograph (Wenli, Walter)
  under lead of MPIA

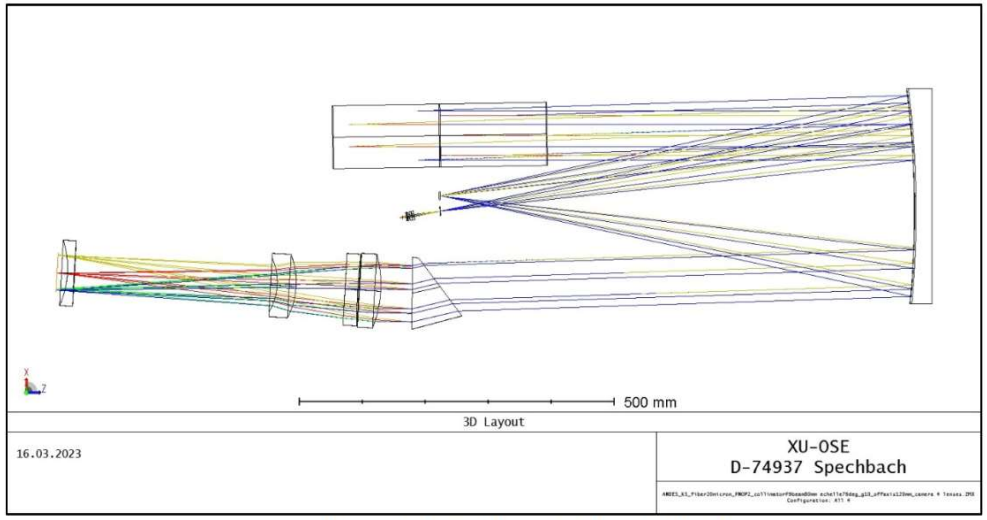



**Figure 1 Optical layout of the ANDES KS.**

# 2ES for ESO 2.2m, LaSilla

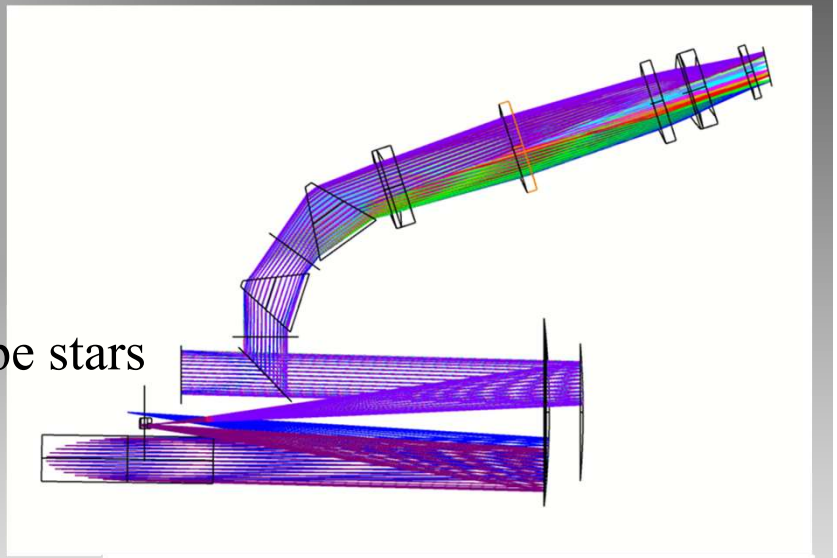
## UltraStable RV Spectrograph to detect Earthlike exoplanets

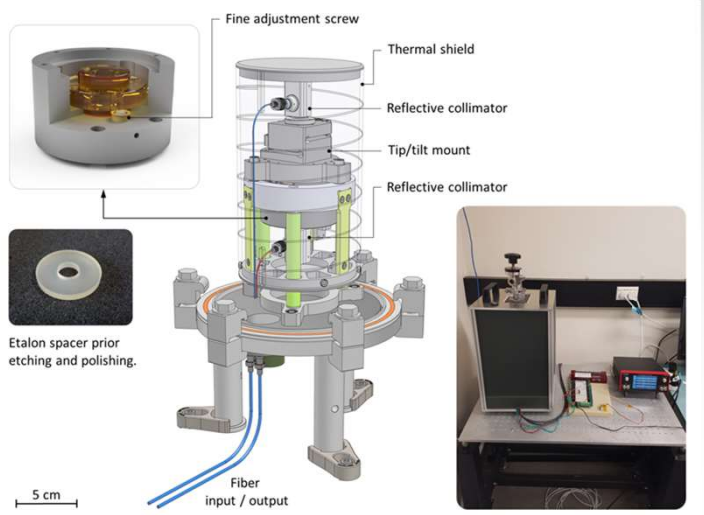
- Precise (<10cm/s) RV spectrograph, 390 – 900nm **→ Julian**
- Single object, fiber coupled
- R ~ 120000
- Science: search for earth twins around solar type stars
- 2ES – how to reach 10cm/s RV precision ?

Ultra-stable calibration sources:

Laser frequency comb for absolute calibration

Fabry-Perot etalon for drift measurement





# HESS & CTA

## Cherenkov Telescope Observatories

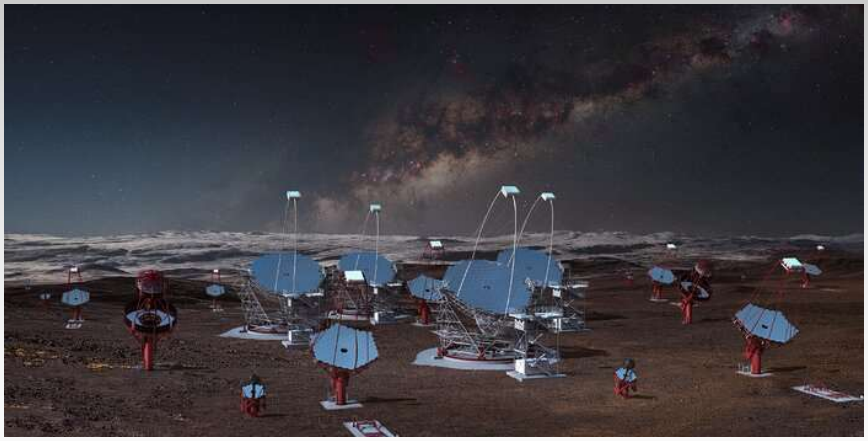
**HESS (High Energy Stereoscopic System)**

**→ Stefan Wagner and his group**

ATOM: former LSW 'Zeiss telescope' at HESS site as robotic 70cm telescope for optical monitoring; uses an EMCCD and polarization optics (Felix Jankowsky)

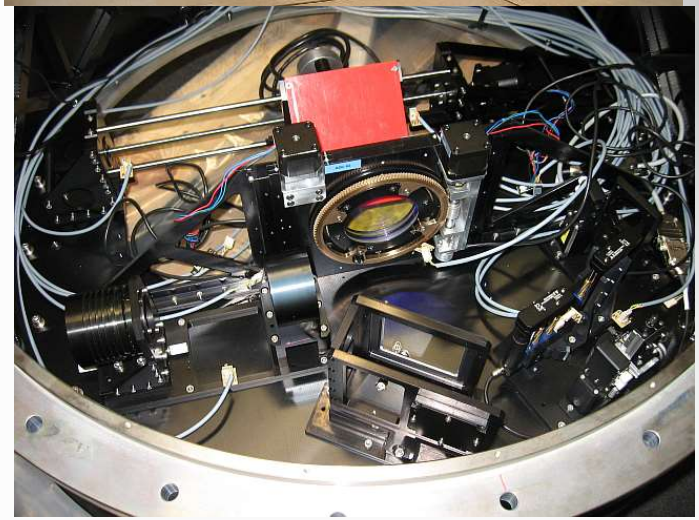
**CTA (Cherenkov Telescope Array)**

**→ Stefan Wagner**



# CARMENES für CAHA 3.5m

## RV spectroscopy for exoplanets; dv~1.5m/s



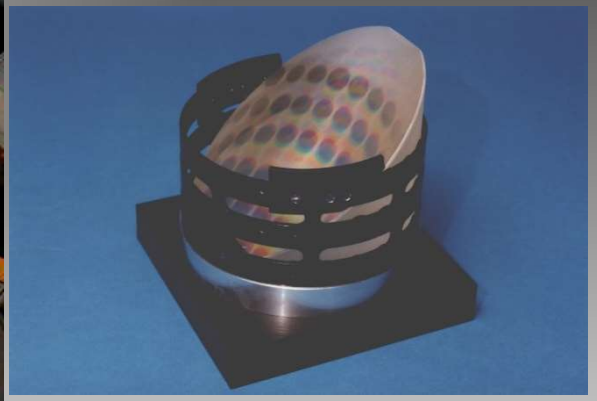
# FORS für das ESO VLT

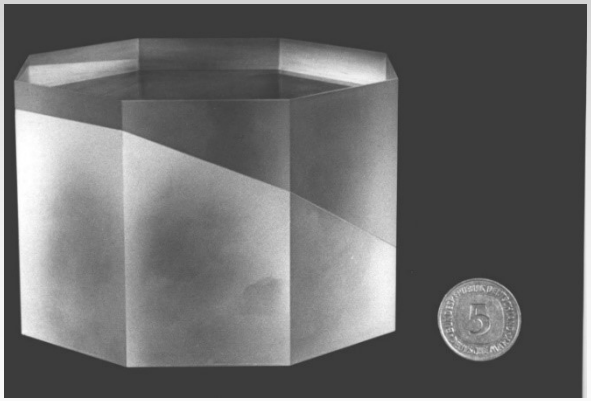
## VIS Imaging, Multi-Object Spectroscopy, Polarimetry

The FORS Twins at VLT ANTU and KUEYEN

ESO PR Photo 40a/99 ( 17 November 1999 )







# LUCI(FER) für das LBT

## NIR Imaging, multi-object spectroscopy, also in AO mode