



# ARTN & VATT

Fr. Paul Gabor, S.J., Ph.D.



# *Portal to another dimension*



Tom Horn & Cris Putnam  
"Mt. Graham is a portal to another dimension"



# VATT

## ■ Mount Graham



Vatican  
Advanced  
Technology  
Telescope  
dedicated  
1993





# VATT

## ■ Mount Graham



Vatican  
Advanced  
Technology  
Telescope

$D = 1.8 \text{ m}$   
 $f/D = 1$





# Frye Fire



Sat Jun 18, 12:27  
"VATT is in trouble"

Credit: Kevin Newton



# Frye Fire



Credit: Gary Bowman



# Frye Fire



Google Earth



# Frye Fire



June 27, 2017



# Frye Fire





# Frye Fire



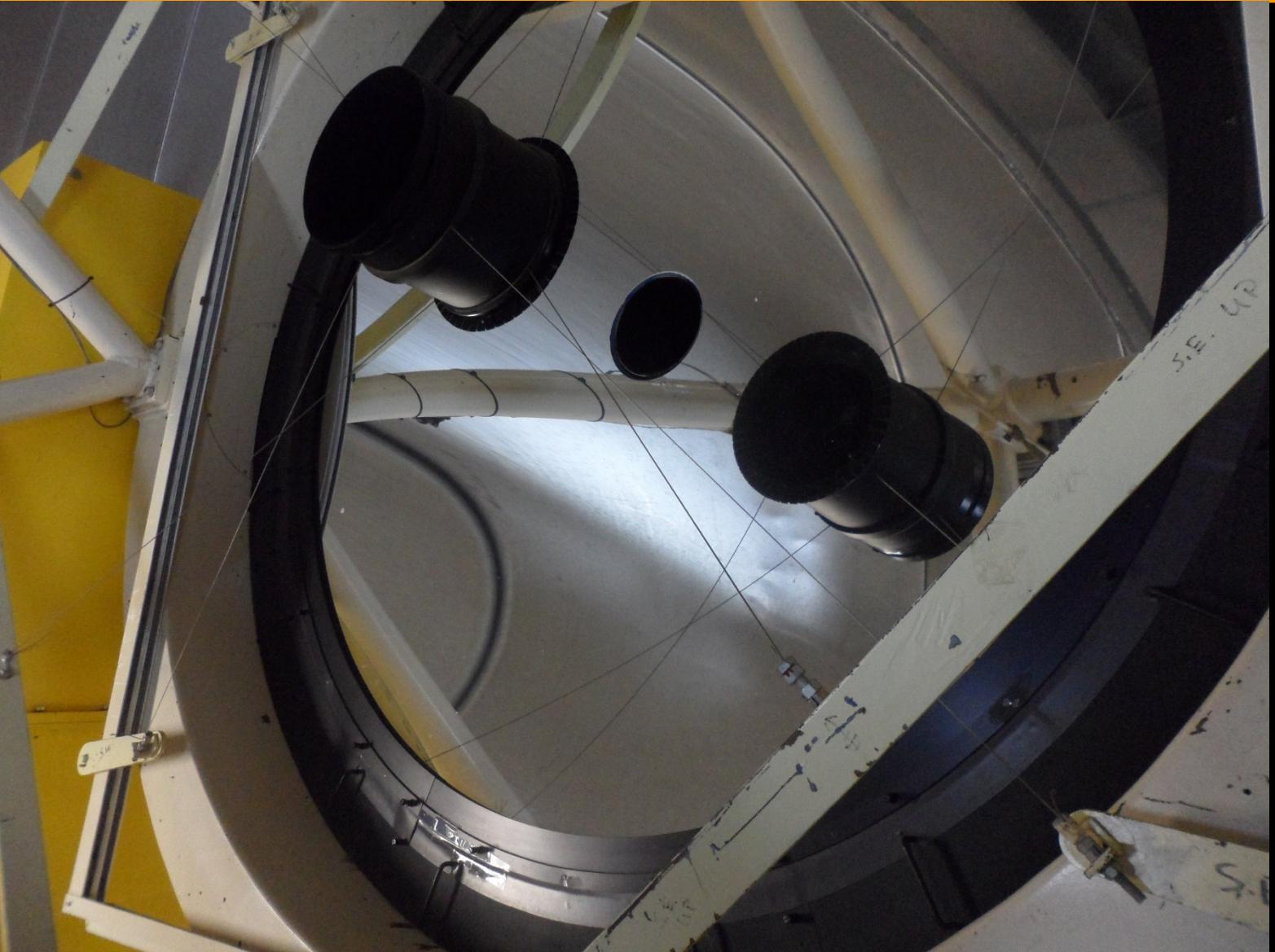


# Frye Fire





# Frye Fire





# VATT's Future



Original philosophy: testing prototype for technologies implemented on LBT (eg primary mirror thermal control capable of keeping mirror within 0.01 K of ambient).

Incremental upgrade in 2010: remote obs.

Complete overhaul under way: robotization

Arizona Robotic Telescope Network



# VATT's robotization & ARTN



1993: dedication

2010: remote-operation capable

2012: received robotization quote from 3<sup>rd</sup> party

2013: Steward begins VATT's robotization

Steward intends ARTN

2016:

Steward-Vatican MOU



# 2016 ABOR–Vatican MOU



Nov 1, 2016

very firm commitment to ARTN

ABOR : Vatican stakeholdership in VATT is 25% : 75%

ABOR : Vatican stakeholdership in ARTN is 22.9% : 77.1%

time allocation: semi-annual, by consensus (reflecting stakes & current financial contribution towards ARTN; if above stake, compensation by services & observing time)



# VATT overhaul

drives, encoders

servers

M2 positioning (hexapod)

ngTCS

purchases to date  
\$210,000

modular architecture: arduino-based PLC-like LCUs

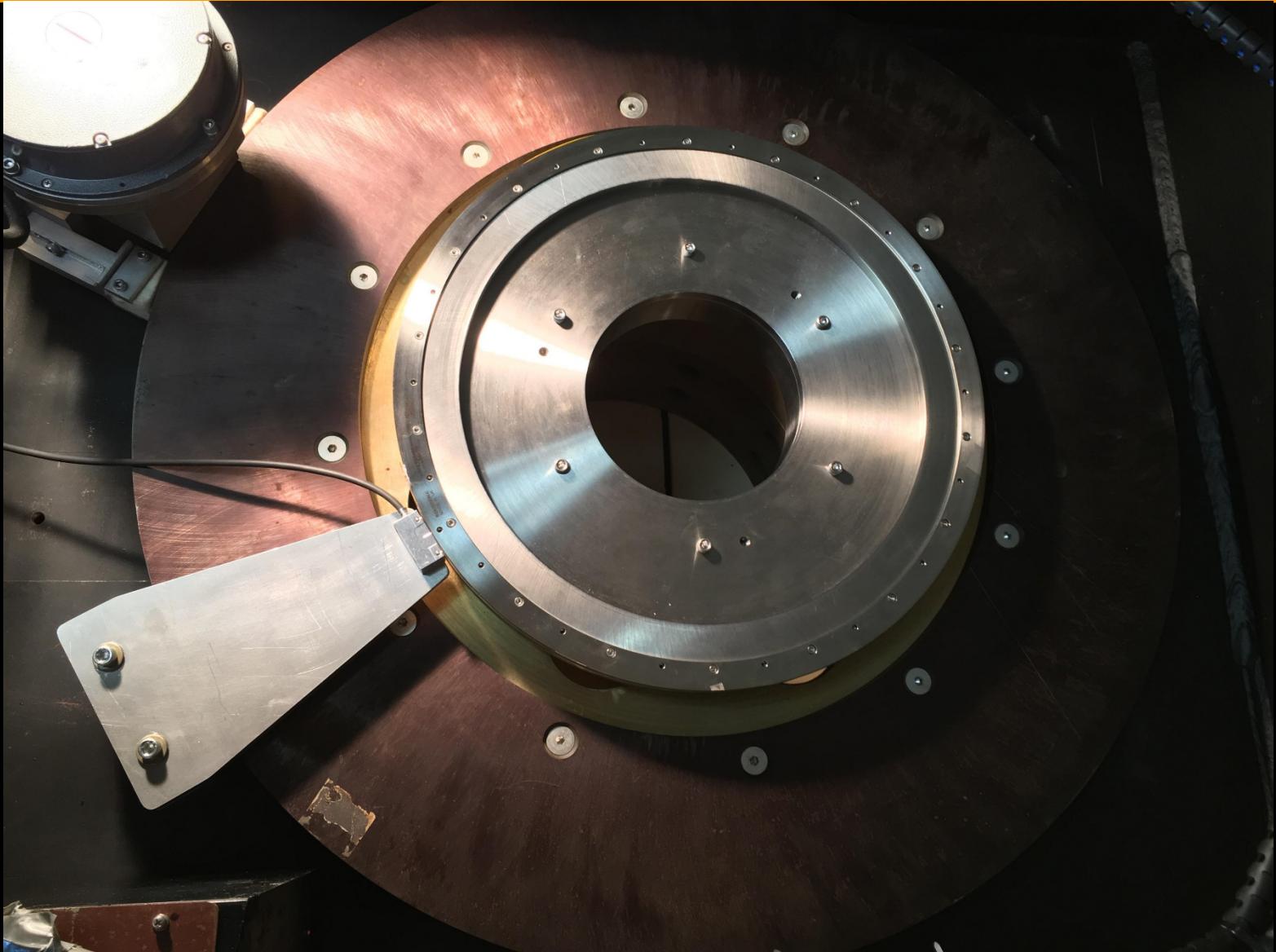
safety: ladder logic, redundancy

state machine

SW layer of RTS2 drivers – only required for high-level scripts



# New Encoders



Credit: Michael Franz



# VATT overhaul

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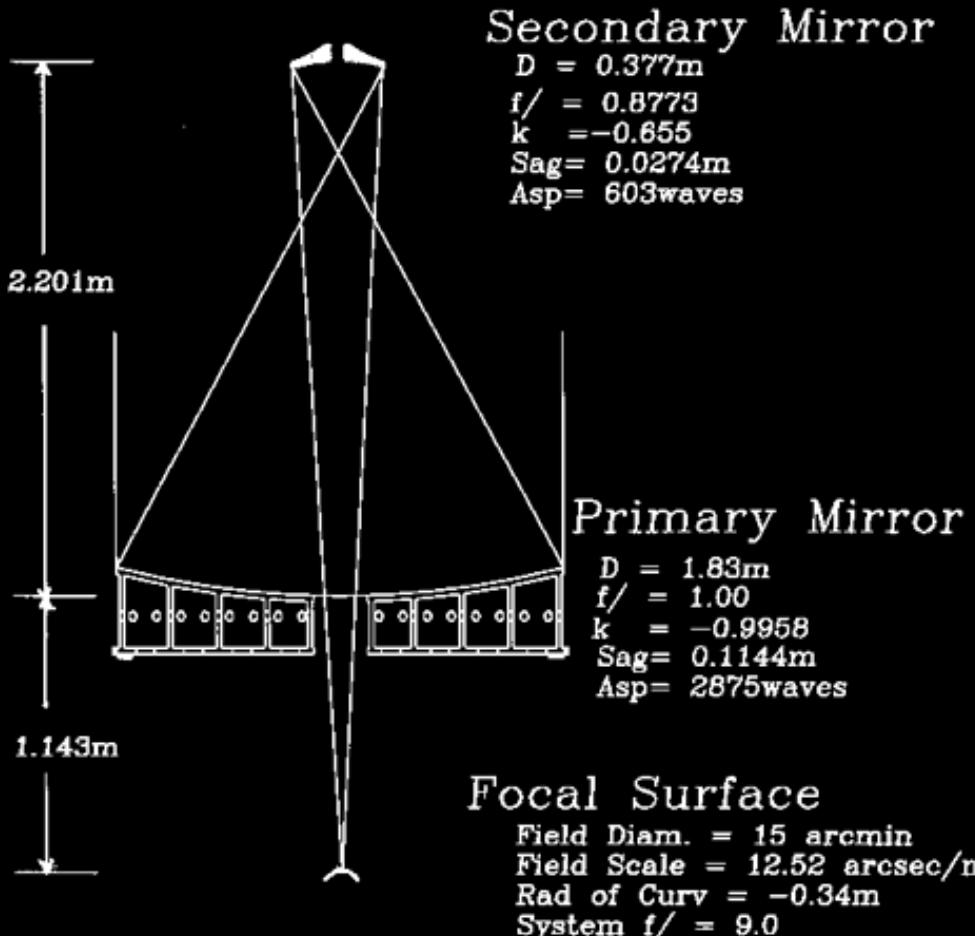
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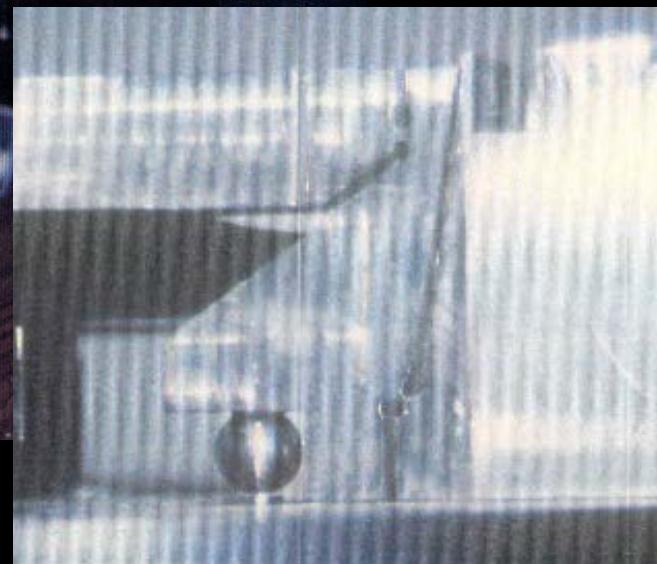


## Vatican Advanced Technology Telescope Optics Aplanatic Gregorian



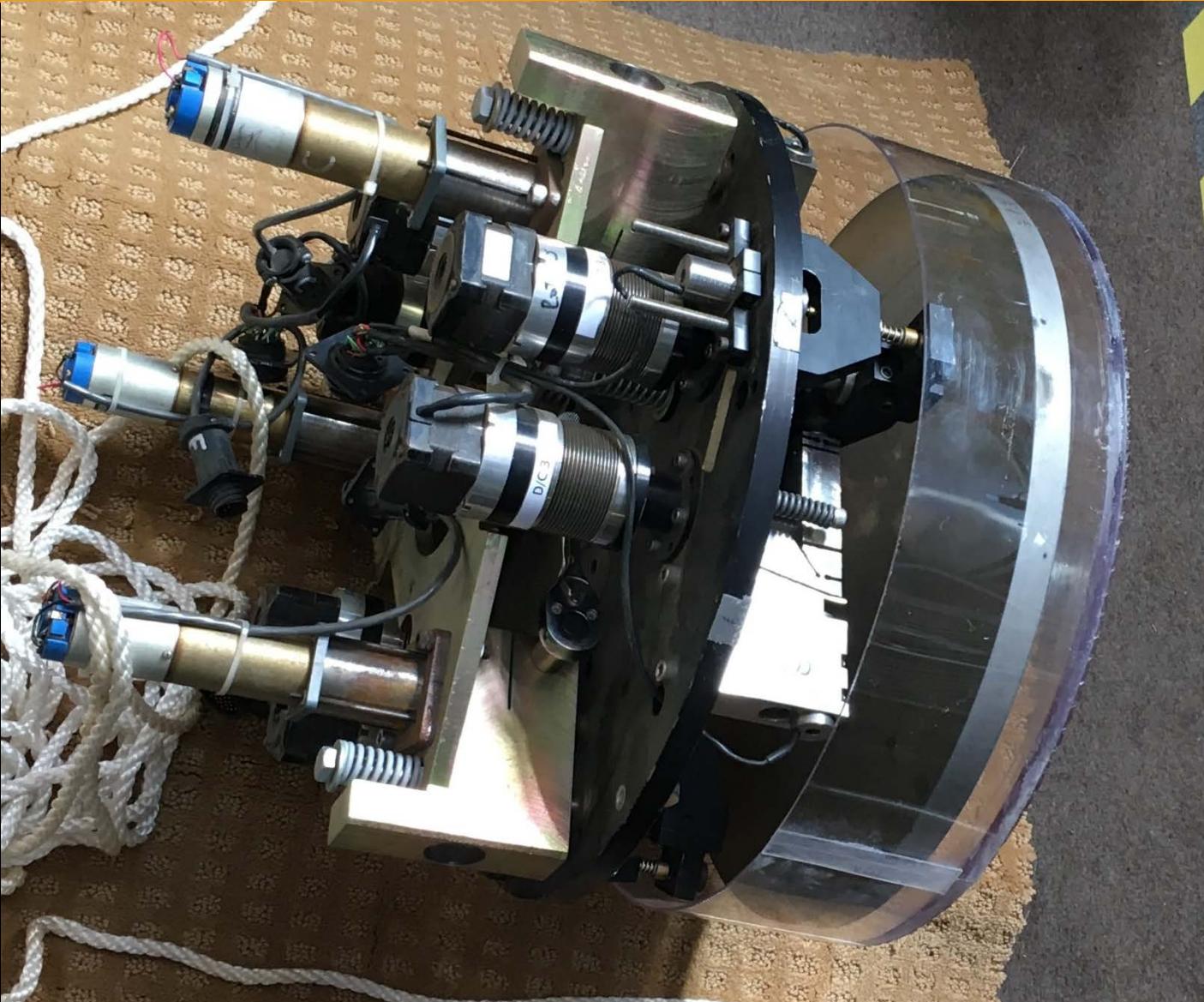


# Old M2 Support



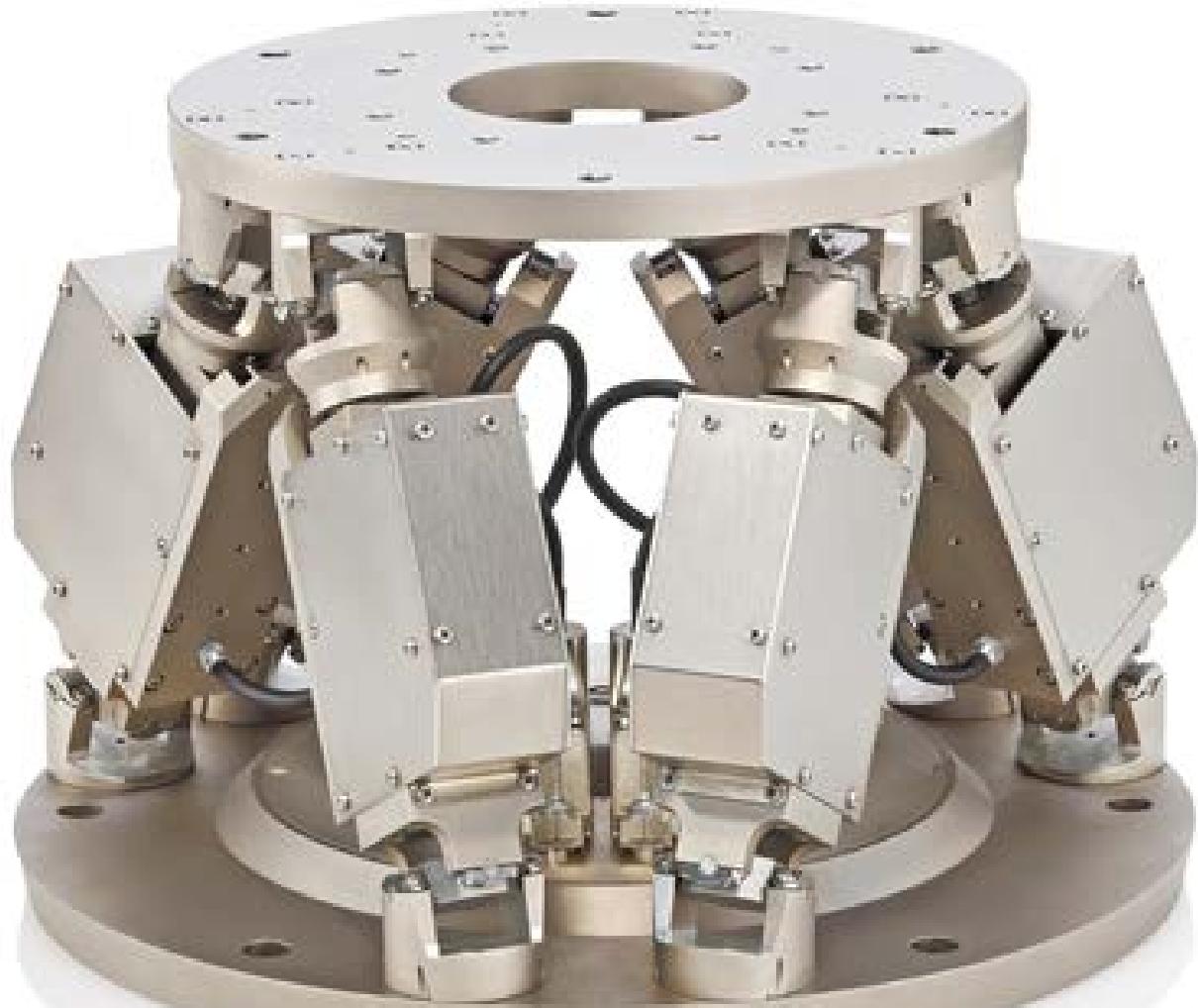


# Old M2 Support





# New M2 Support



Physik Instrumente, Hexapod H-824

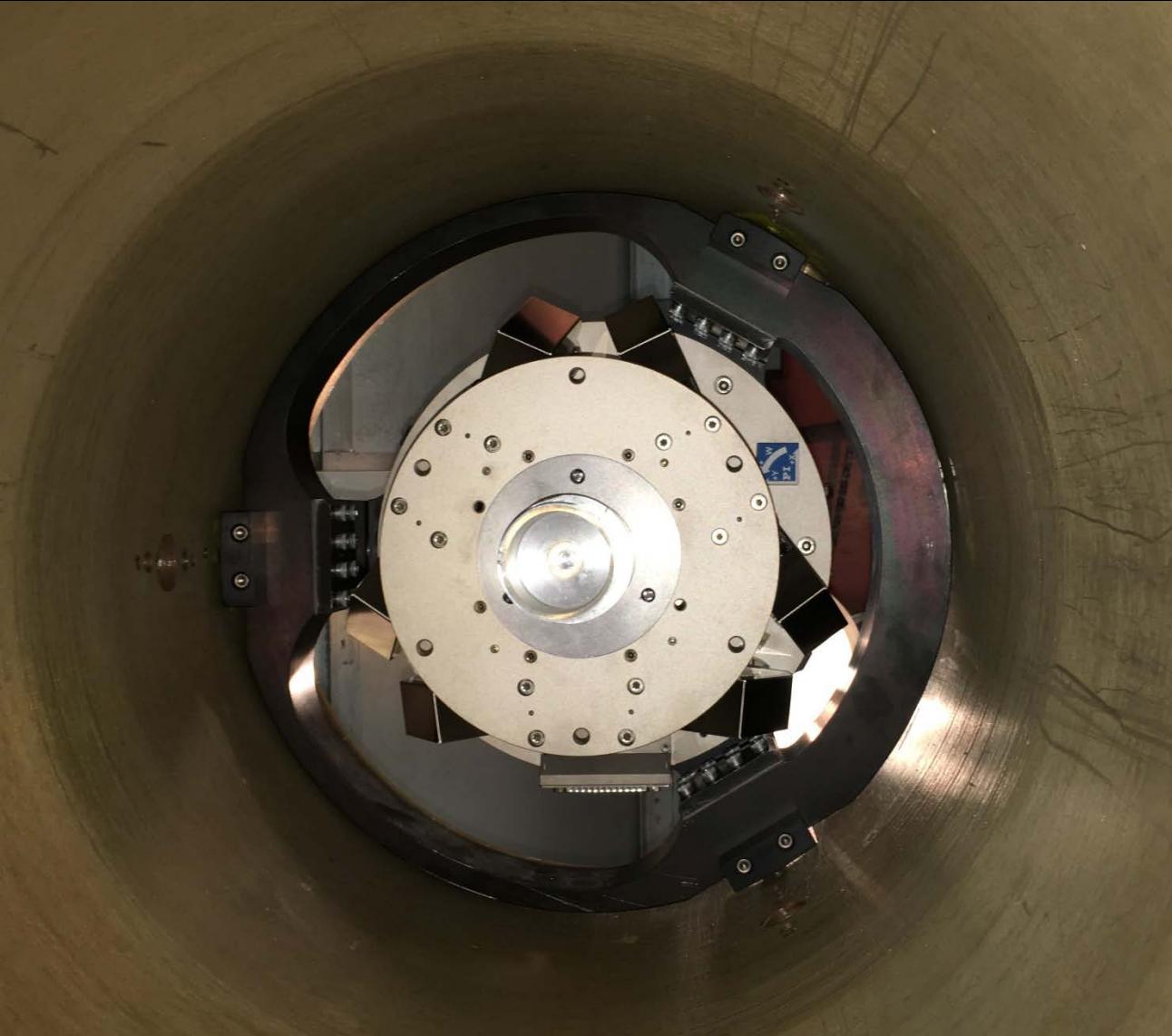


# New M2 Support





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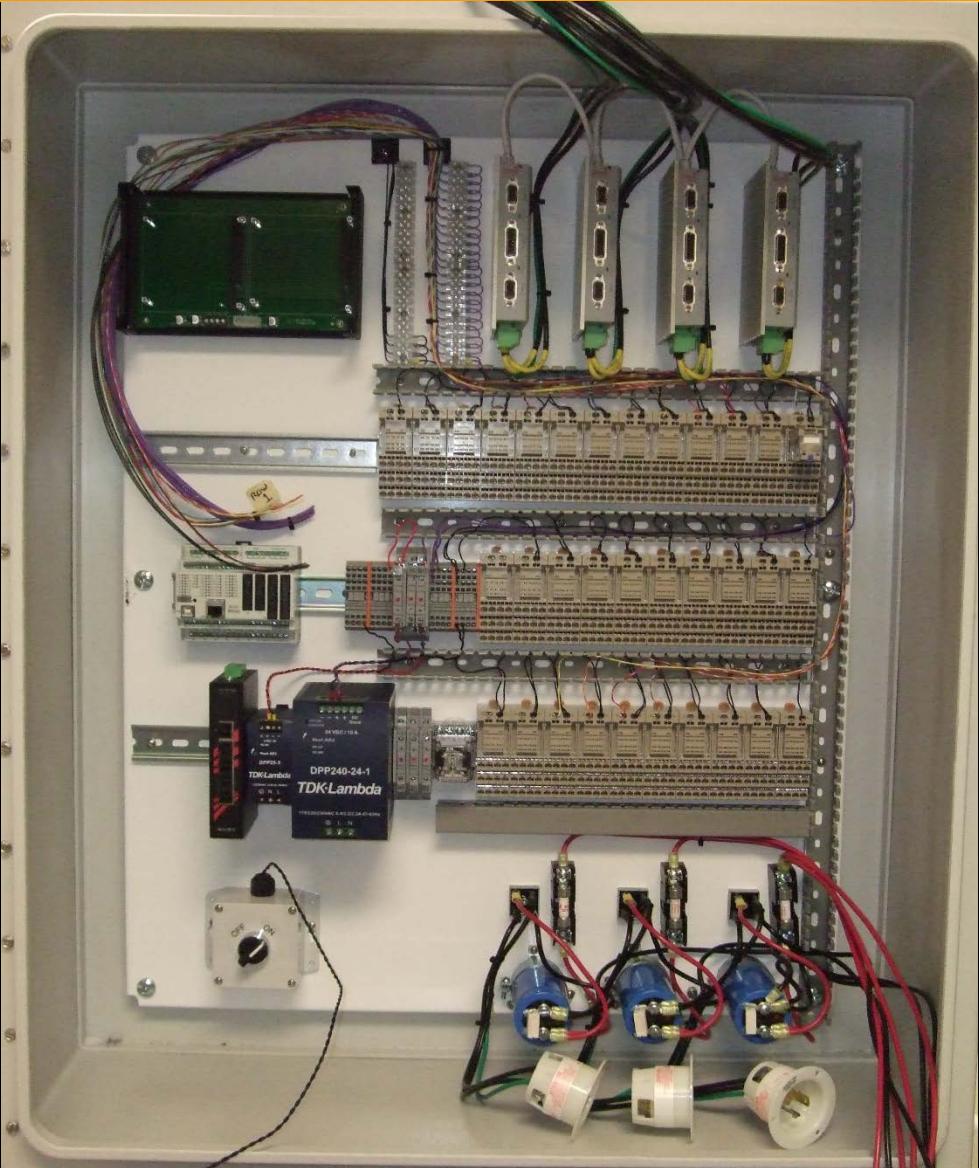
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# Ladder Logic



(clockwise from top left) the berth for the computer stack, four ELMO drive units, ladder logic relays, capacitors, fuses and power supply units, and the Arduino unit (Controllino Mega)



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# VATT-PEPSI



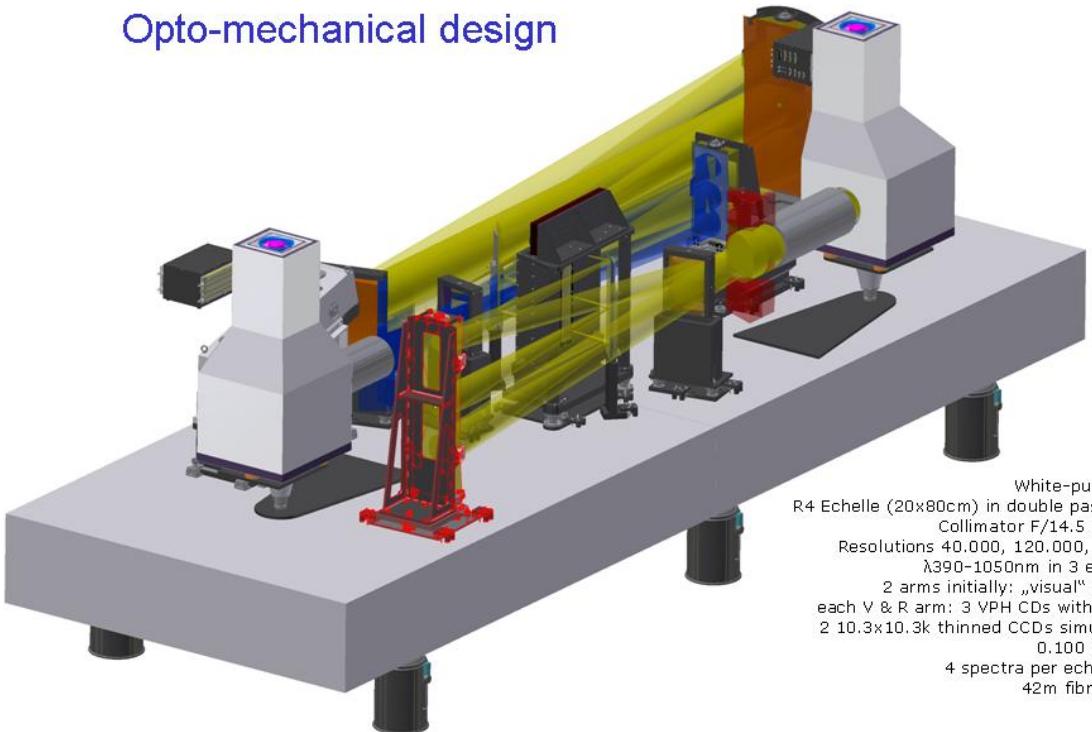
fiber link  
~ 400 m

VATT  
1.8 m



## Spectrograph:

Opto-mechanical design



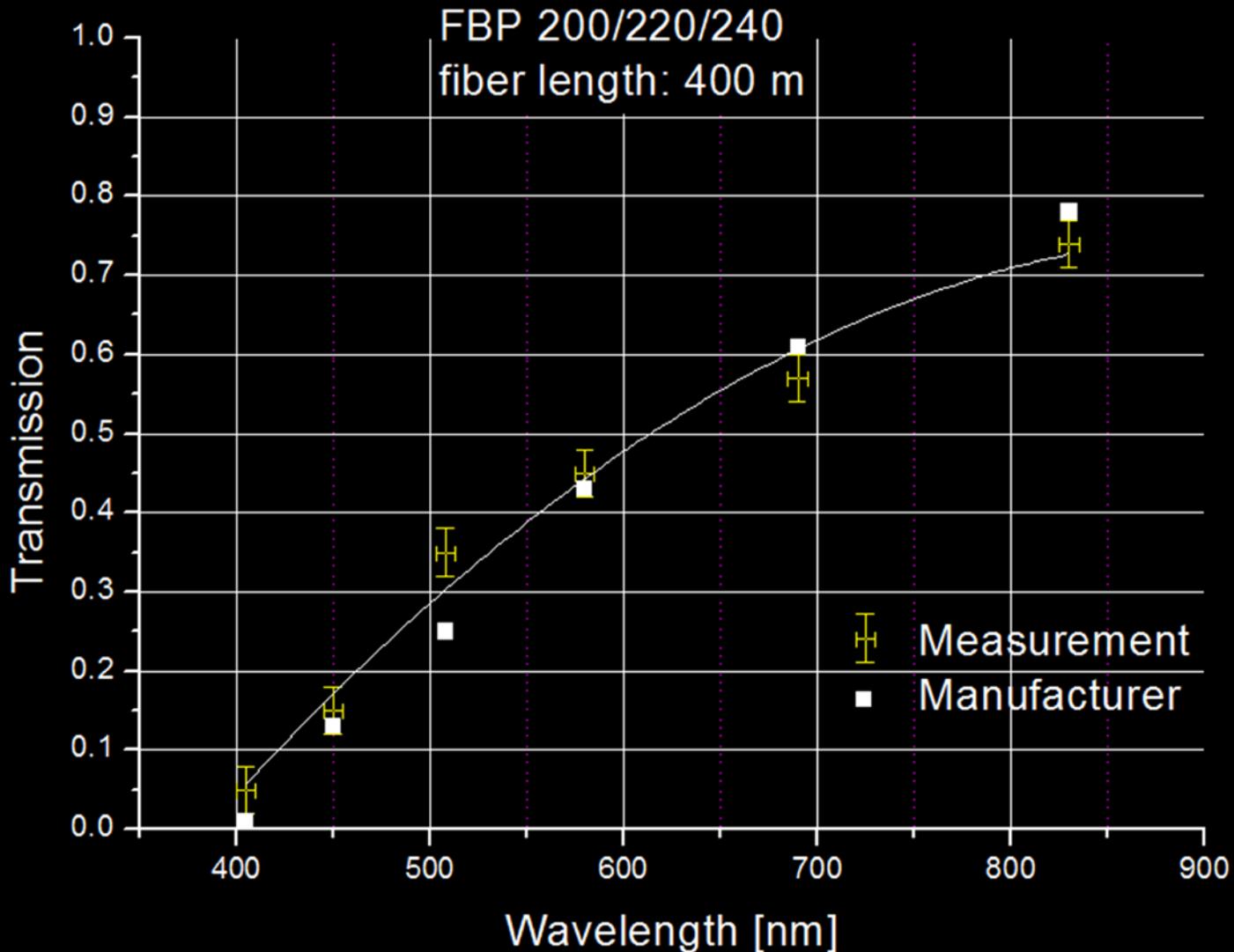
White-pupil design  
R4 Echelle (20x80cm) in double pass Littrow  
Collimator F/14.5 Maksutov  
Resolutions 40.000, 120.000, 300.000  
 $\lambda$ 390-1050nm in 3 exposures  
2 arms initially: „visual“ and „red“  
each V & R arm: 3 VPH CDs with 2 prisms  
2 10.3x10.3k thinned CCDs simultaneous  
0.100 arcsec/px  
4 spectra per echelle order  
42m fibre bundle

PEPSI, PI instrument @ LBT  
stabilized, in LBT pier  
Astrophysics Institute, Potsdam



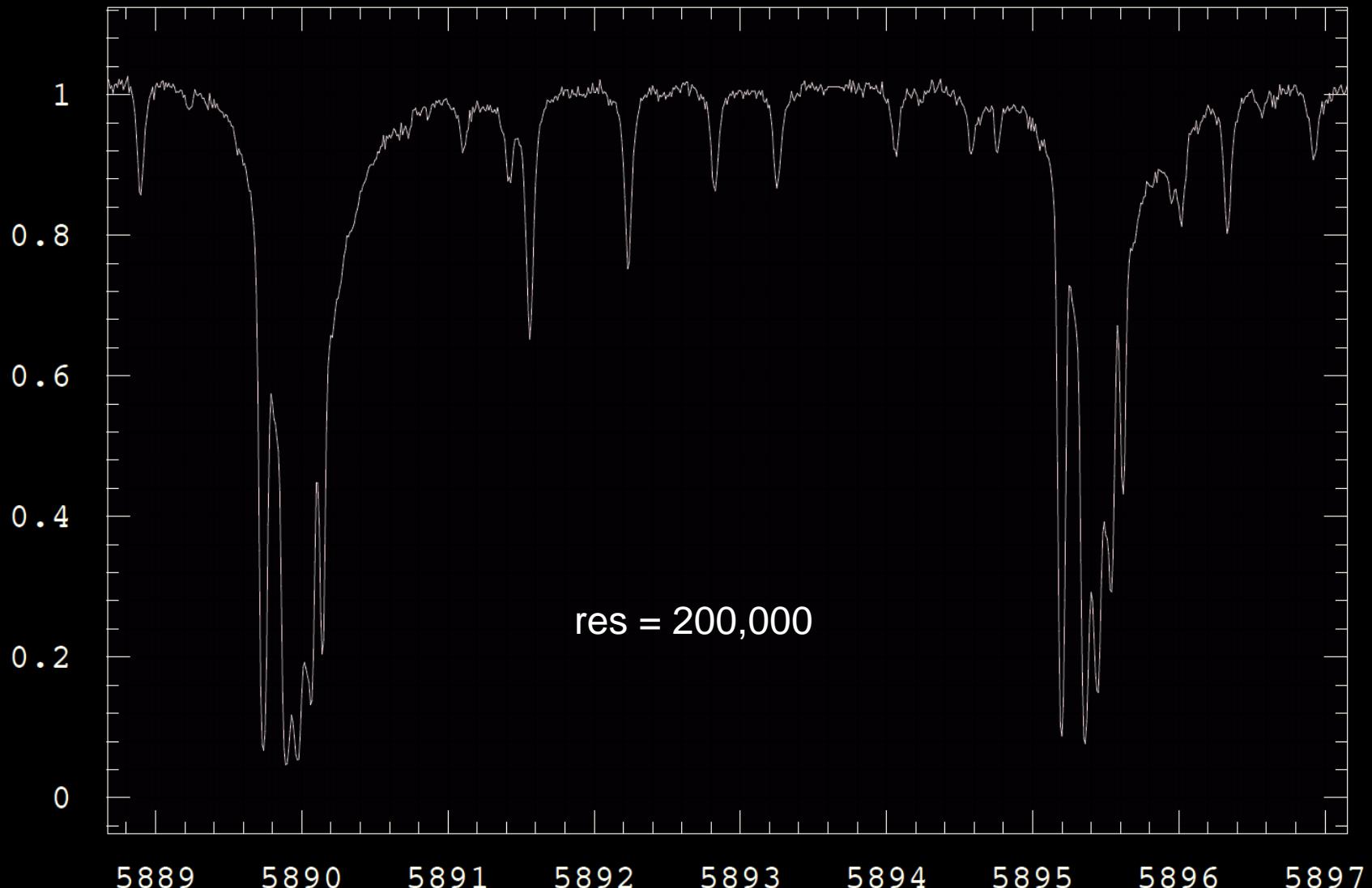


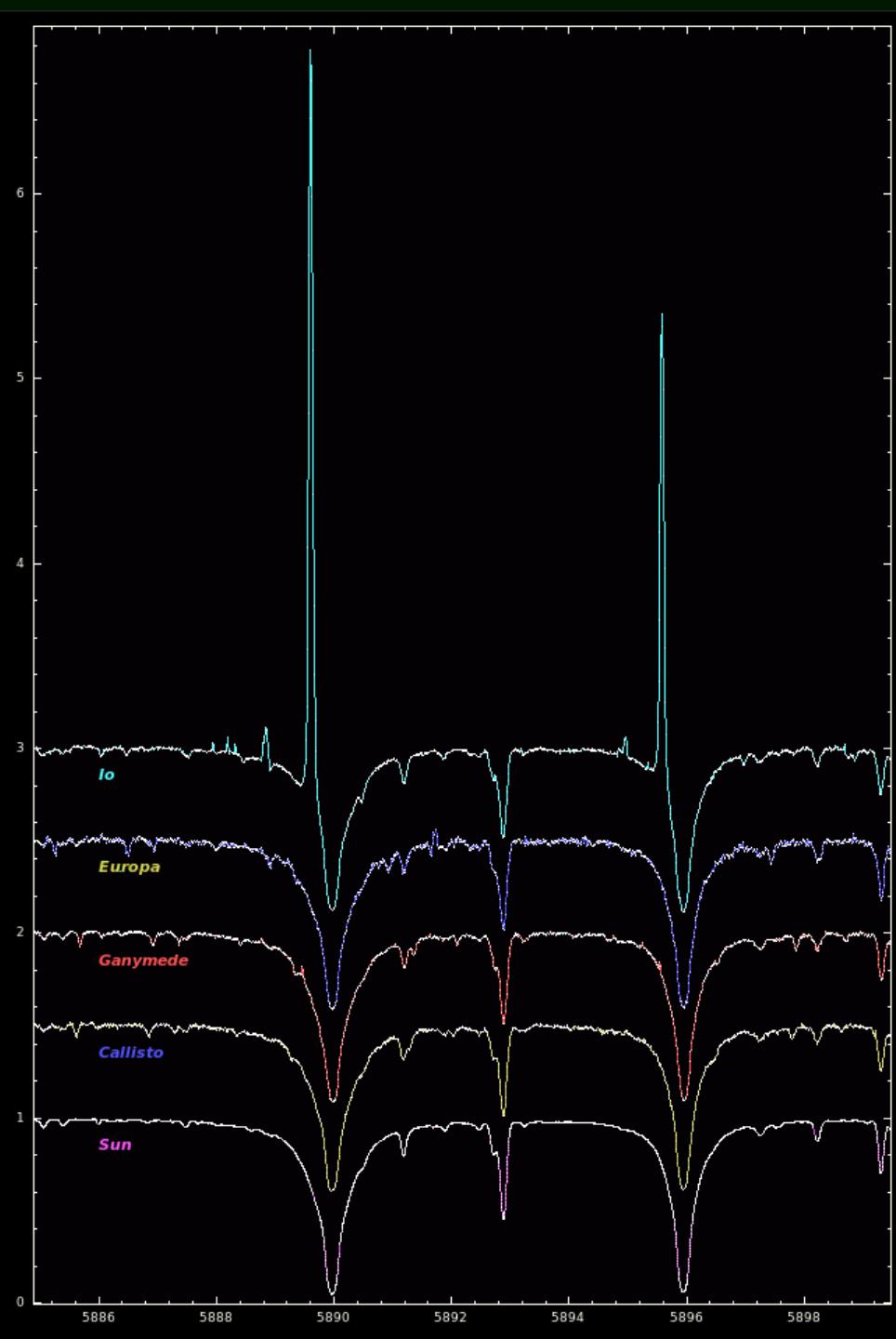
# Fiber Transmission





# Vega's Na Doublet with VATT





Credit: Strassmeier+ 2015

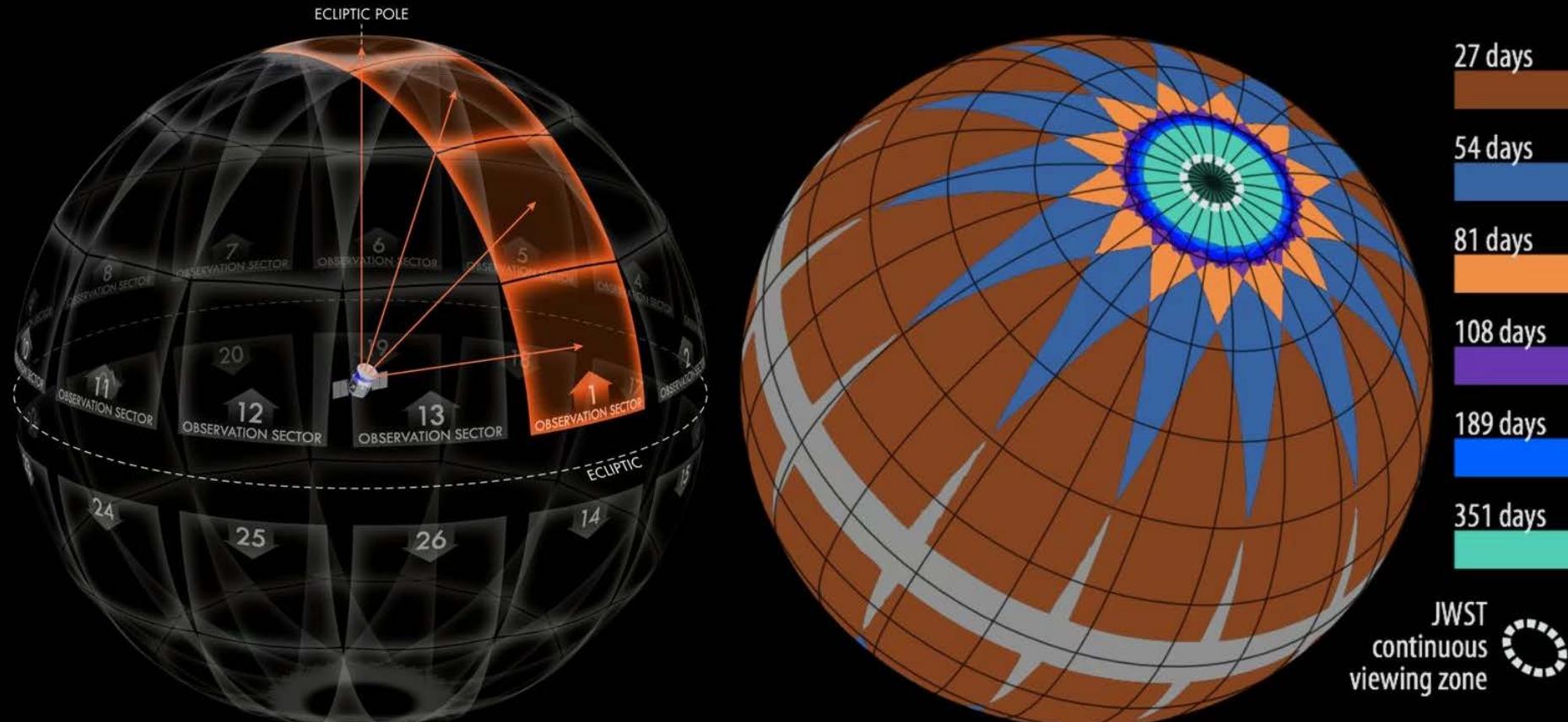


# VATT-PEPSI-TESS survey





# VATT-PEPSI-TESS survey





# VATT-PEPSI-TESS survey



A high-resolution spectroscopic survey of future TESS stars around the northern ecliptic pole (NEP). The NEP field comprises of approximately 800 square degrees with 311 main-sequence stars brighter than V=8.5mag and cooler than F0 (FGK). Our aim is the characterization of these stars already prior to TESS data release. Two R=200,000 spectra would be obtained for each of these stars at different epochs. The first visit shall cover the wavelengths 480-544nm and 628-741nm, the second visit shall re-use the 480-544nm region but extend in the red to 741-912nm. Predicted S/N ratios for the limiting magnitude of 8.5mag in V for a single spectrum for a 90-min exposure are 100:1 in the red and 50:1 in the blue. Typical S/N ratios would be more like 150 in the red and 120 in the blue. The survey requires 50 nights each year around culmination of the NEP (May-July) for 3 years.



# VATT's Instrumentation



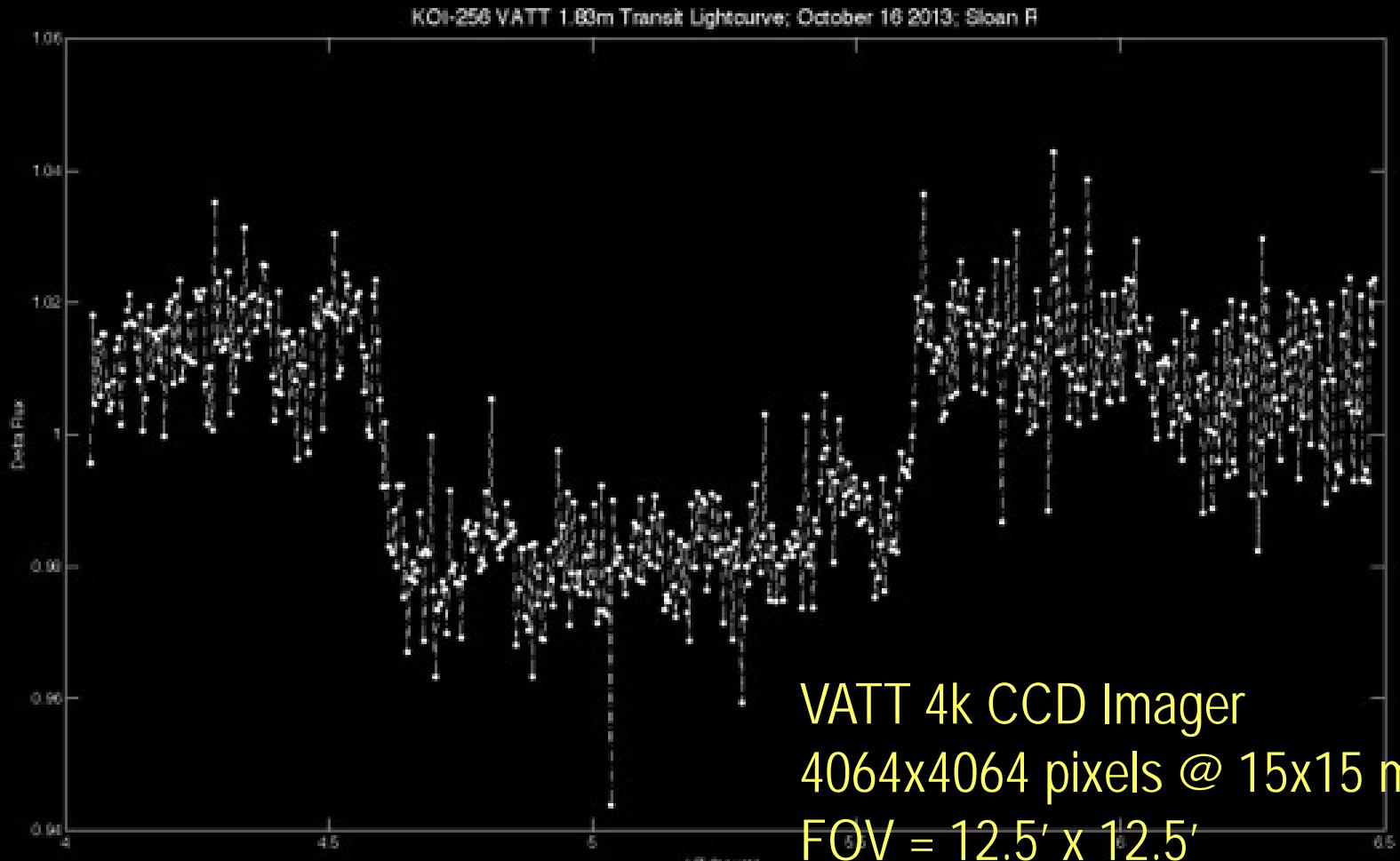
VATT 4k CCD Imager  
4064x4064 pixels @ 15x15 microns  
FOV = 12.5' x 12.5'  
300-1000 nm

Galway UltraFast Imager (GUFI)  
FOV = 3' x 3'  
readout time = 2 ms

VATT CCD Spectrograph  
slit length 30", width 1"  
360-950 nm  
3 gratings - resolutions: 0.1, 0.2, 0.4 nm



# VATT 4k CCD Imager





# VATT Spectrograph

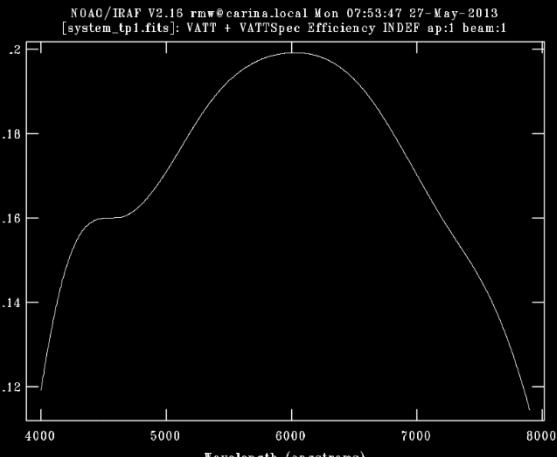
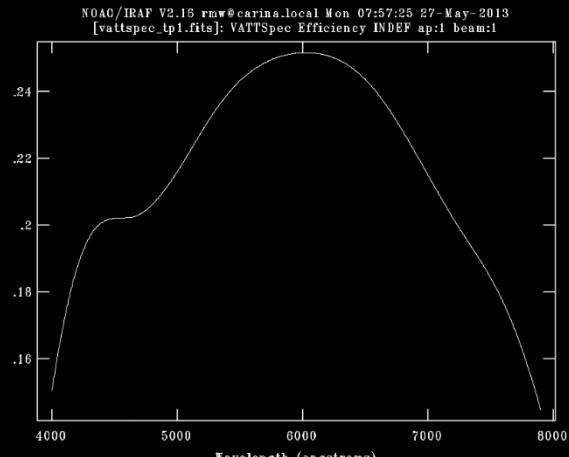
## VATT CCD Spectrograph

optical region spectrograph with AR coated refractive optics, with a beam size at its camera of 125 mm, giving ...

- slit length: 30 arcsec
- wavelength range: 360 - 950 nm
- spectral coverage: 100 nm at 0.1 nm resolution
- spectral resolutions: 0.1, 0.2, and 0.4 nm with 1 arcsec wide slit

detector: back illuminated, low noise CCD STA0520A CCD, with very nice cosmetics, 2688x512 pixels

- efficiency: peaks at 6000 Ang with 25% (VATTSpec alone), with 20% (with VATTSpec and telescope)
- bandpass filters available: S8612 (red blocking); GG-400, GG-475, OG-550 (cut-offs to the blue in nm)





# Thank you

*"Do there exist many worlds,  
or is there but a single world?  
This is one of the most noble and exalted  
questions in the study of Nature."*



*St Albertus Magnus (c. 1200 – 1280)*

*De caelo et mundo lib. I, tract. III, cap. I*