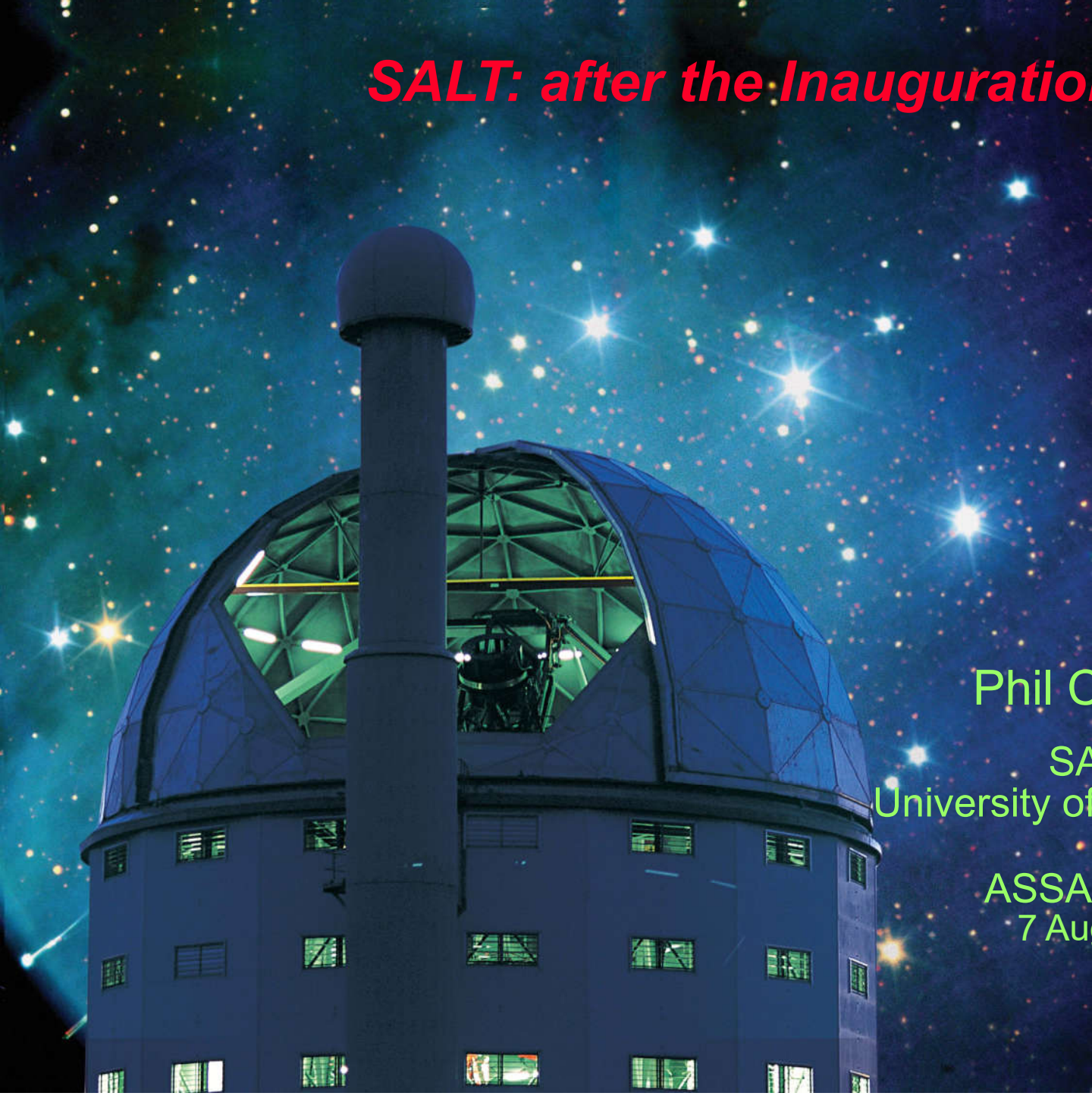
SALT: after the Inauguratio



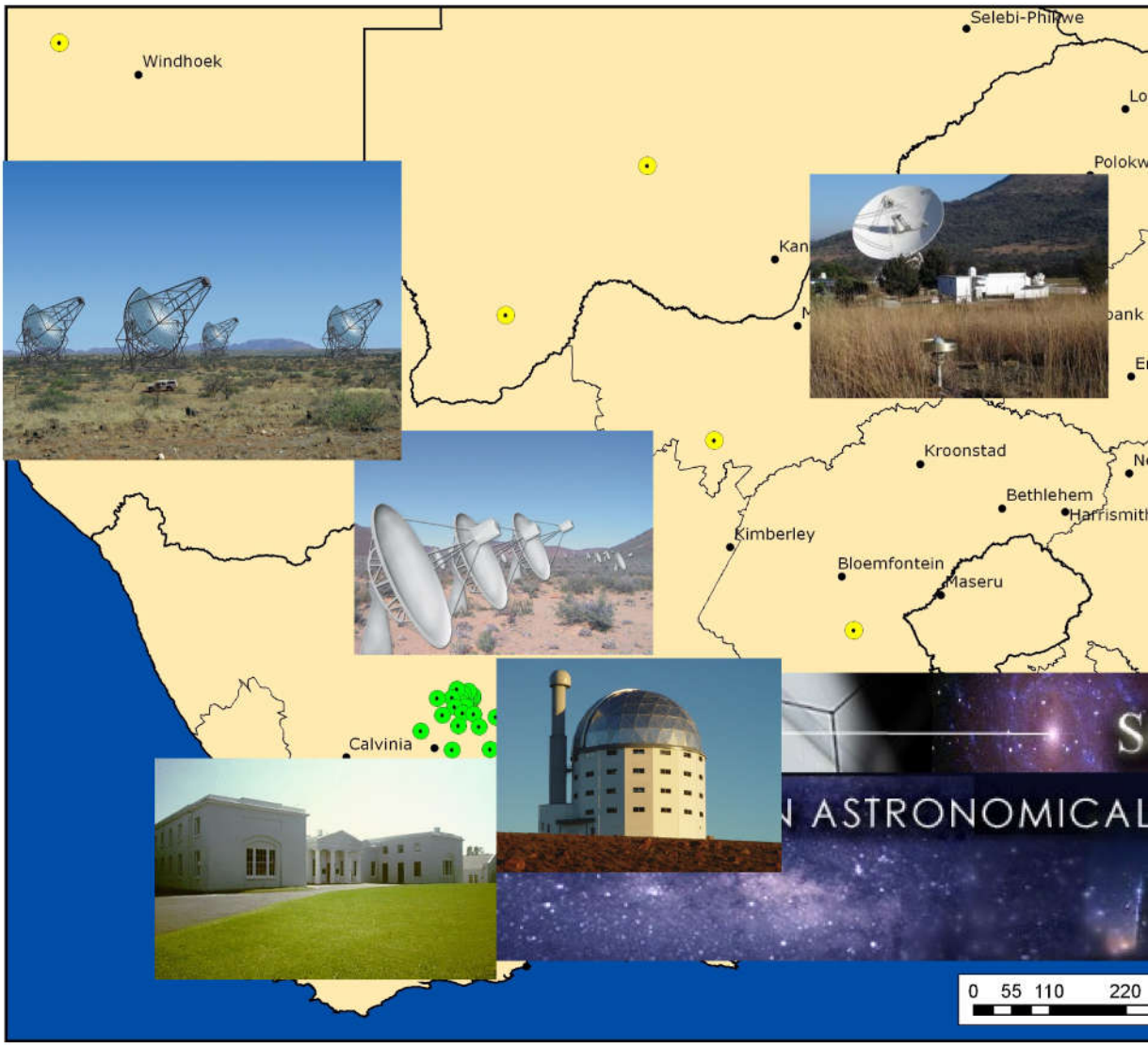
Phil C

SA
University of

ASSA
7 Au

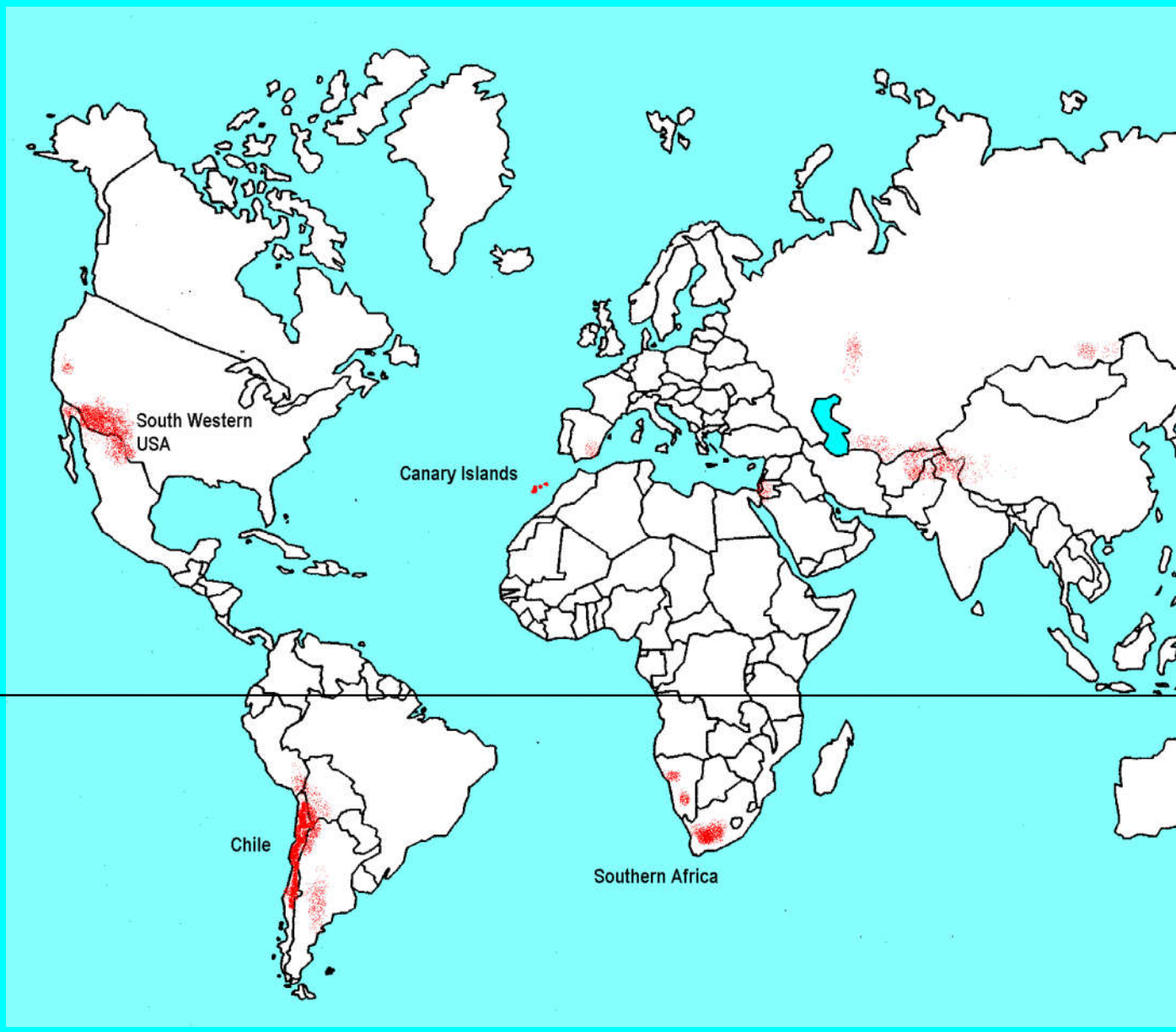

SALT: inaugurated 10 Nov 2005

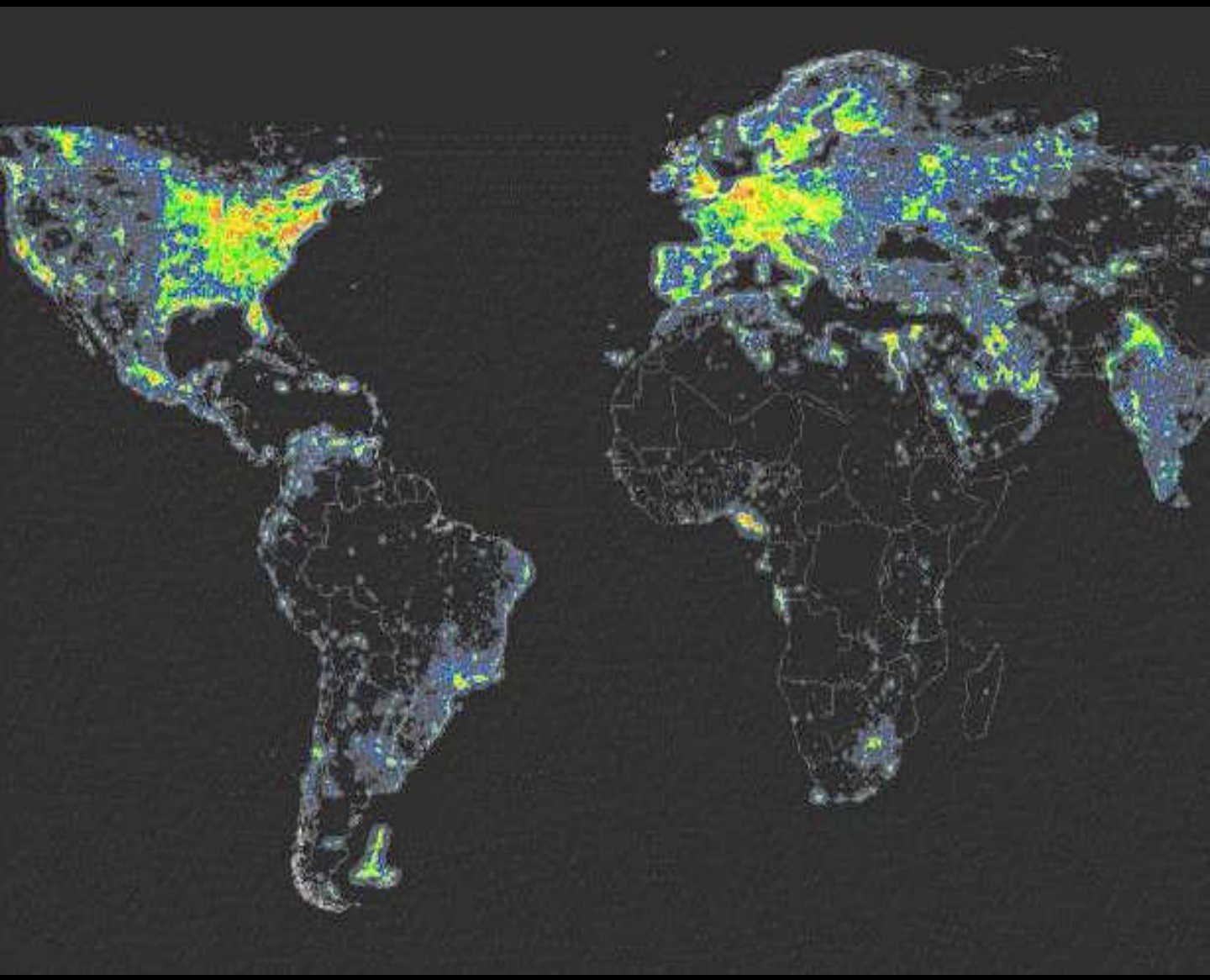
Astronomy in South Africa

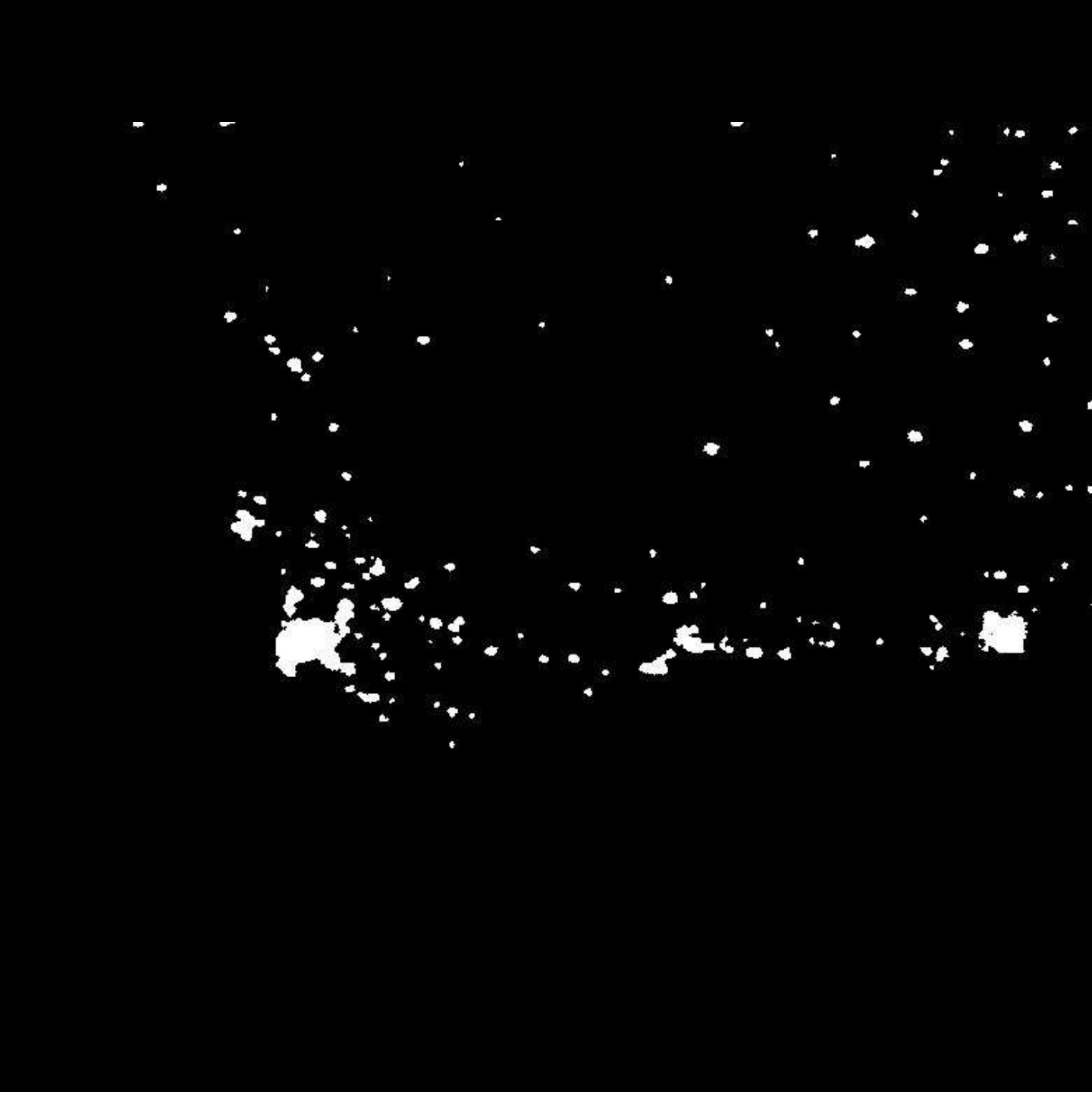



SAAO & SALT HQ

Locations of the best astronomical sites:







Our Geographic Advantage:

- SA and Chile are the only regions in Southern H where world-class astronomy is possible
- Hence important globally --> international intere
- With major advantages for SA:
  - Can participate in global scale science projects as partn SA provides location
  - International partners provide technical/financial resour
  - SA exploits these as opportunity to grow S&T
  - e.g. SALT:
    - » 2/3 funding externally
    - » 2/3 SALT built internally
  - Aiming to repeat with SKA bid! Once again in the Karoo
- Therefore need to protect this environment aga
  - Light pollution (residential, industrial)
  - Dust pollution (traffic, industry)
  - Radio interference (all forms)

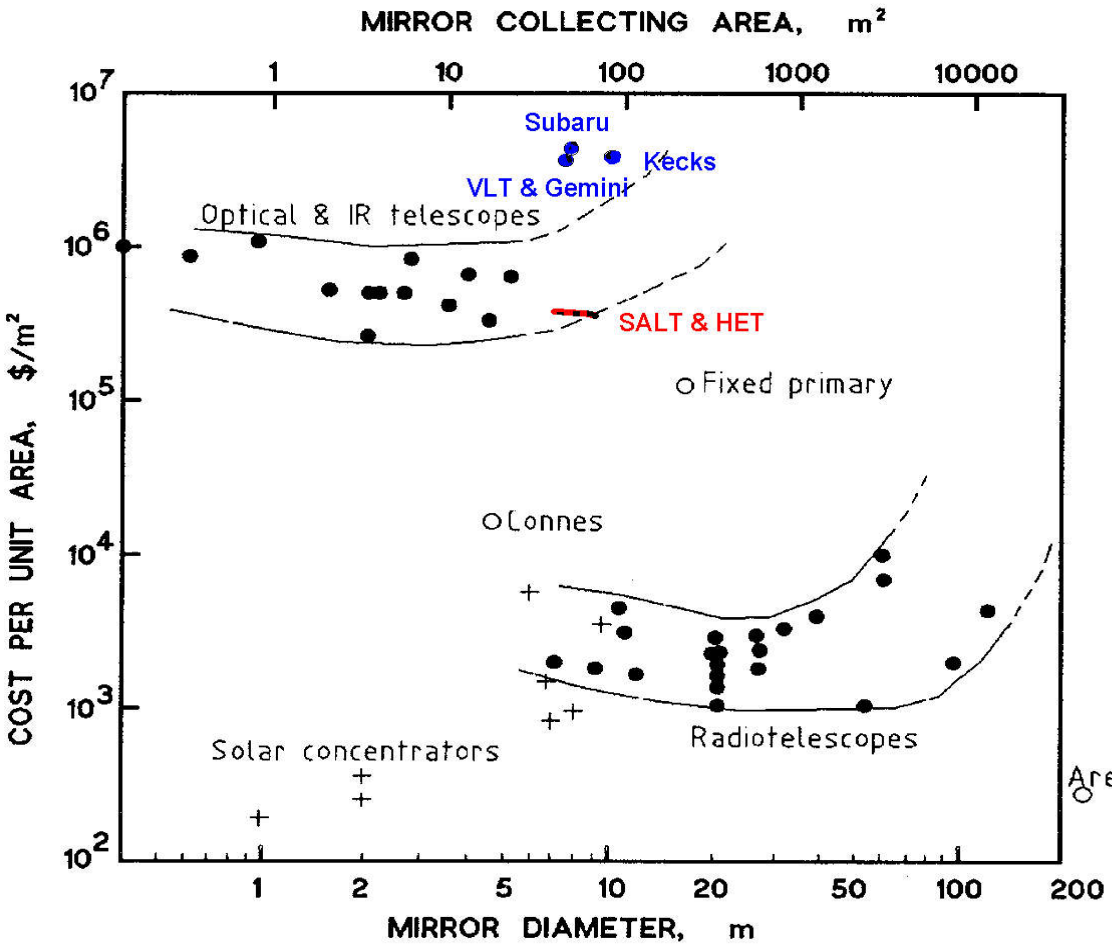
Legislation: Astronomy Geographic Advantage Act

- Empowers the Minister for Science and Tech declare protected areas around strategic ast by publication in the Government Gazette.
- The Act empowers the Minister to prohibit ov
- The Act covers both radio and optical astron
- Three tiers of protected areas:
  - Core area – the physical area of the observatory /
  - Central area – surrounds the core area. Minister p activities / categories of activities in this area
  - Coordination area –Minister sets standards which comply with
- Protected areas apply to existing and new ac
- Sizes of protected areas depend on the astro activity, but are large e.g. RFI for KAT!

Why SALT ?

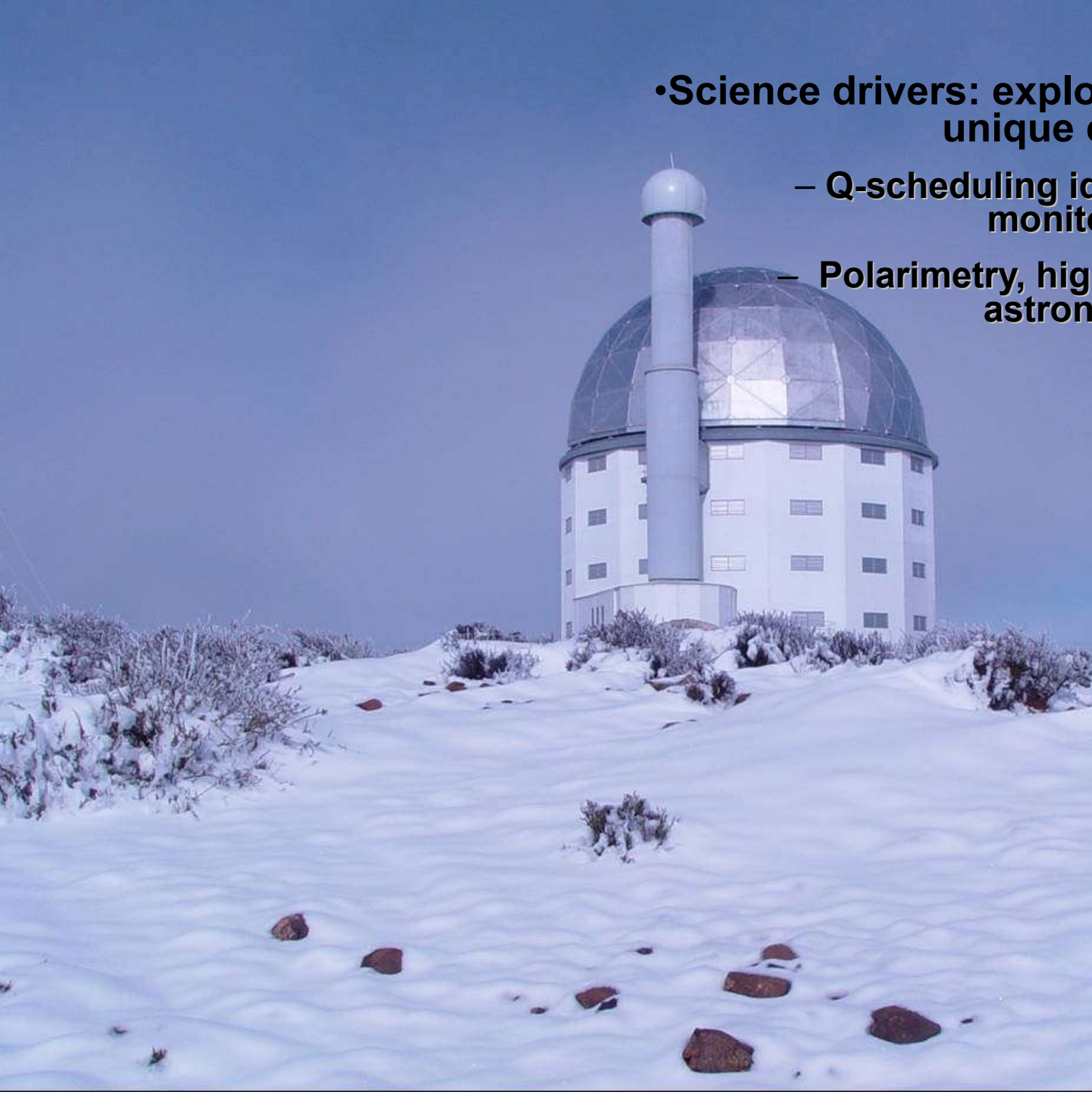
• A cost-effective and innovative design for a large 10-m c
(developed from HET "prototype" in Texas)

**70% of the sky accessible (12.5% at a time) for only 1
cost of a 'conventional' telescope--> new paradigm
telescope design**



The existin

• Collateral
Educational
Technology
A 'flagship'



•Science drivers: explo
unique

– Q-scheduling id
monit

– Polarimetry, hig
astron

Astrophysics on the shortest timescales:

- eclipses, eclipse mapping
- asteroseismology
- flickering in accretion disks
- DNOs, QPOs, etc
- echo mapping
- pulsar studies
- black hole/neutron star inner orbits
- occultations/eclipses of accretion spots, etc.

Time resolution capability of ~50-100 ms from frame transfer C

Such a capability in photometry, spectroscopy and spectropol phenomenology and physics of many accreting systems

Who owns SALT: the shareholders

- National Research
- University of Wisc
- CAMK (Poland)
- Rutgers University
- Dartmouth College
- Goettingen Univers
- University of Cante
- UK SALT Consorti

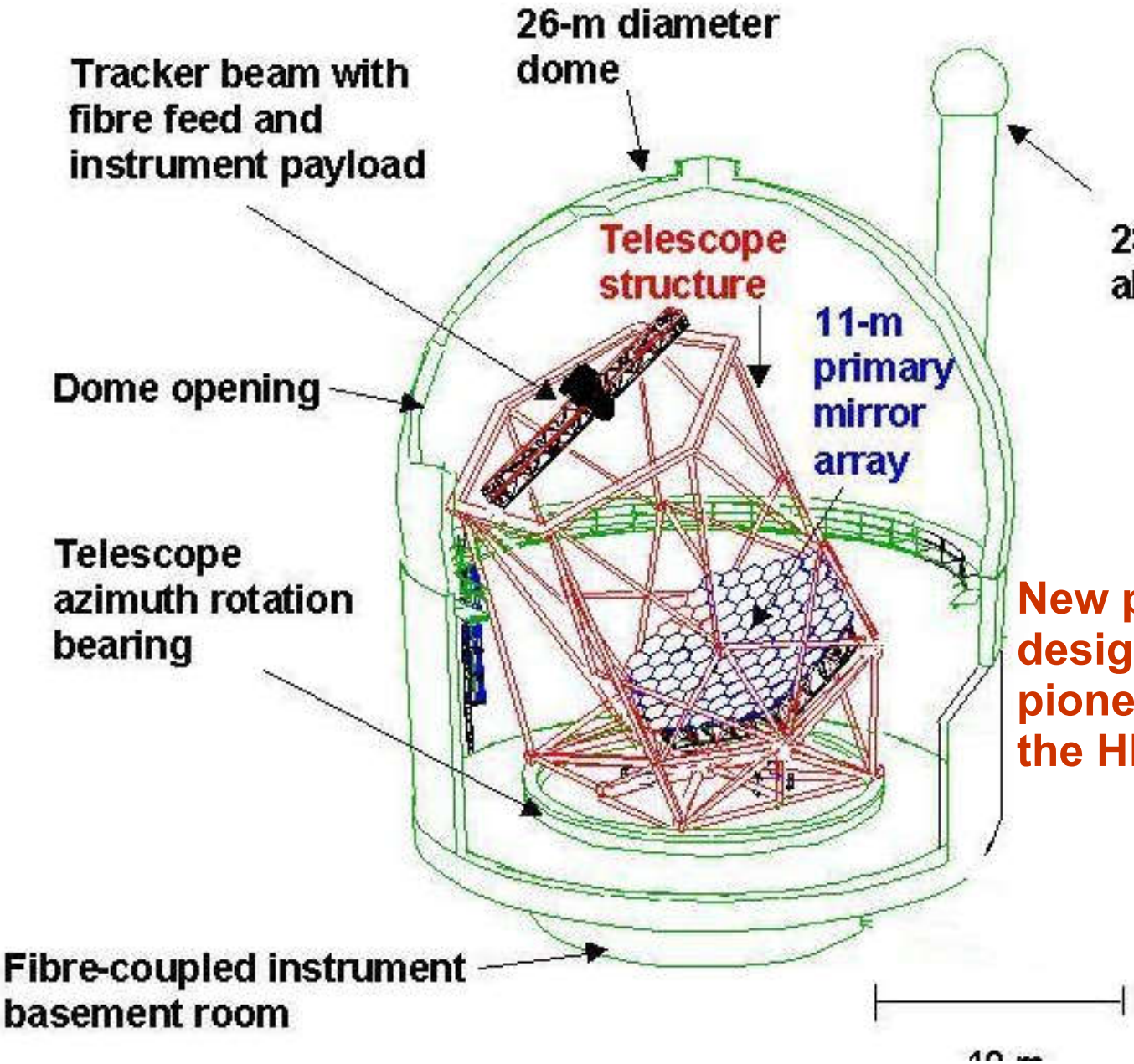
Total Cost is ~$45M

~$22M: telescope construction
~$9M: 3 first-gen instruments
~$14M: 10 years operations

2007

SALT First Light Press Release: Sep 1, 2005

Southern African Large

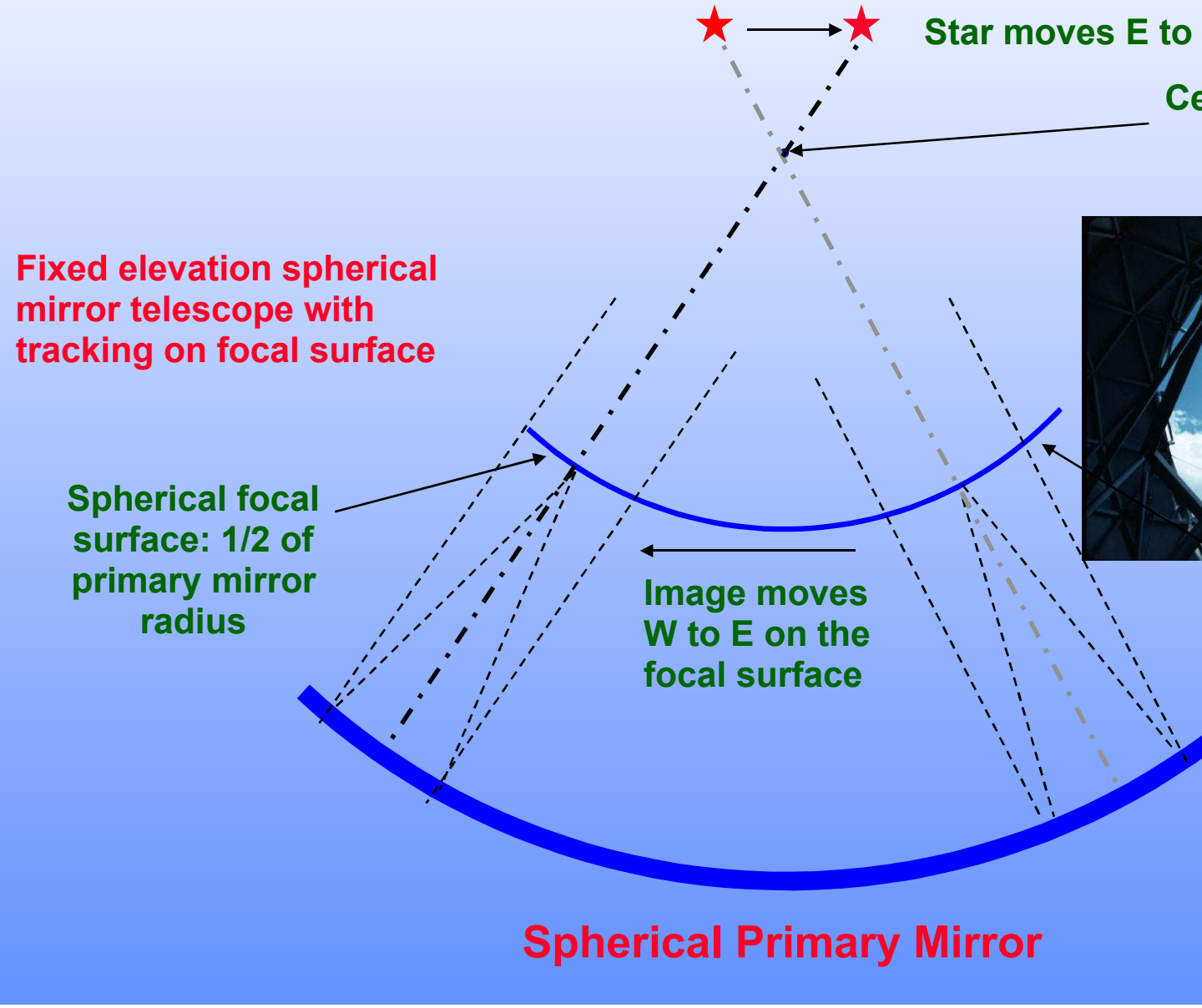


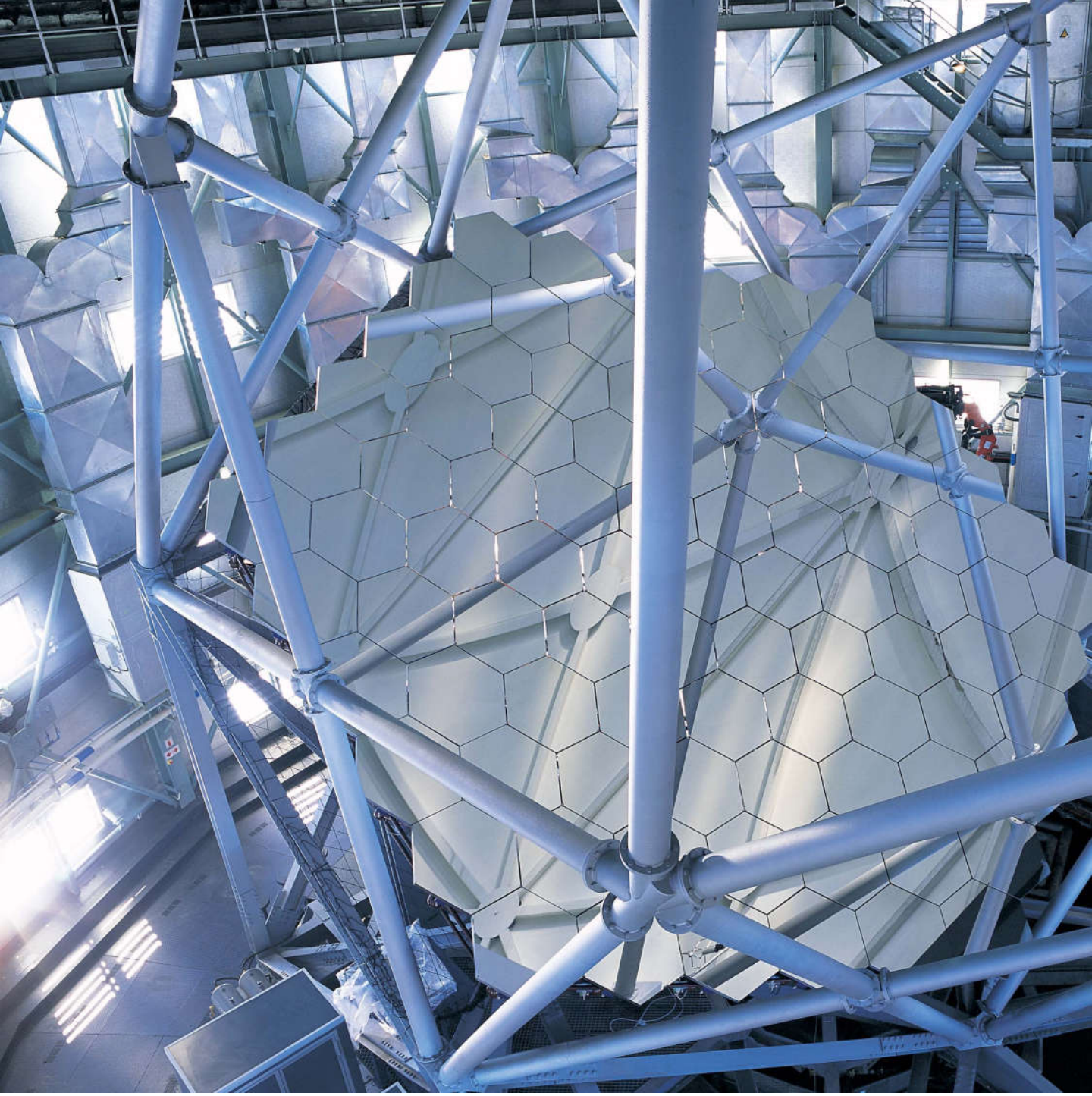
SALT: *A Fixed Elevation Optical-IR Telescope modelled on the Hobby-Eberly Telescope*

BASIC ATTRIBUTES

- **PRIMARY MIRROR ARRAY**
  - Spherical Figure
  - 91 identical hexagonal segments
  - Unphased (i.e. not diffraction limited 10-m, just 1-m)
- **TELESCOPE TILTED AT 37°**
  - Declination Coverage $+10^{\circ} < \delta < -75^{\circ}$
  - Azimuth rotation for pointing only
- **OBJECTS TRACKED OVER 12° FOCAL SURFACE**
  - Tracker contains Spherical Aberration Corrector (SAC) with 8 arcminute FOV (*Prime Focus*)
  - Large instruments fibre-coupled
- **IMAGE QUALITY**
  - Designed to be seeing limited (median = 0.9 arcsec)

The Arecib

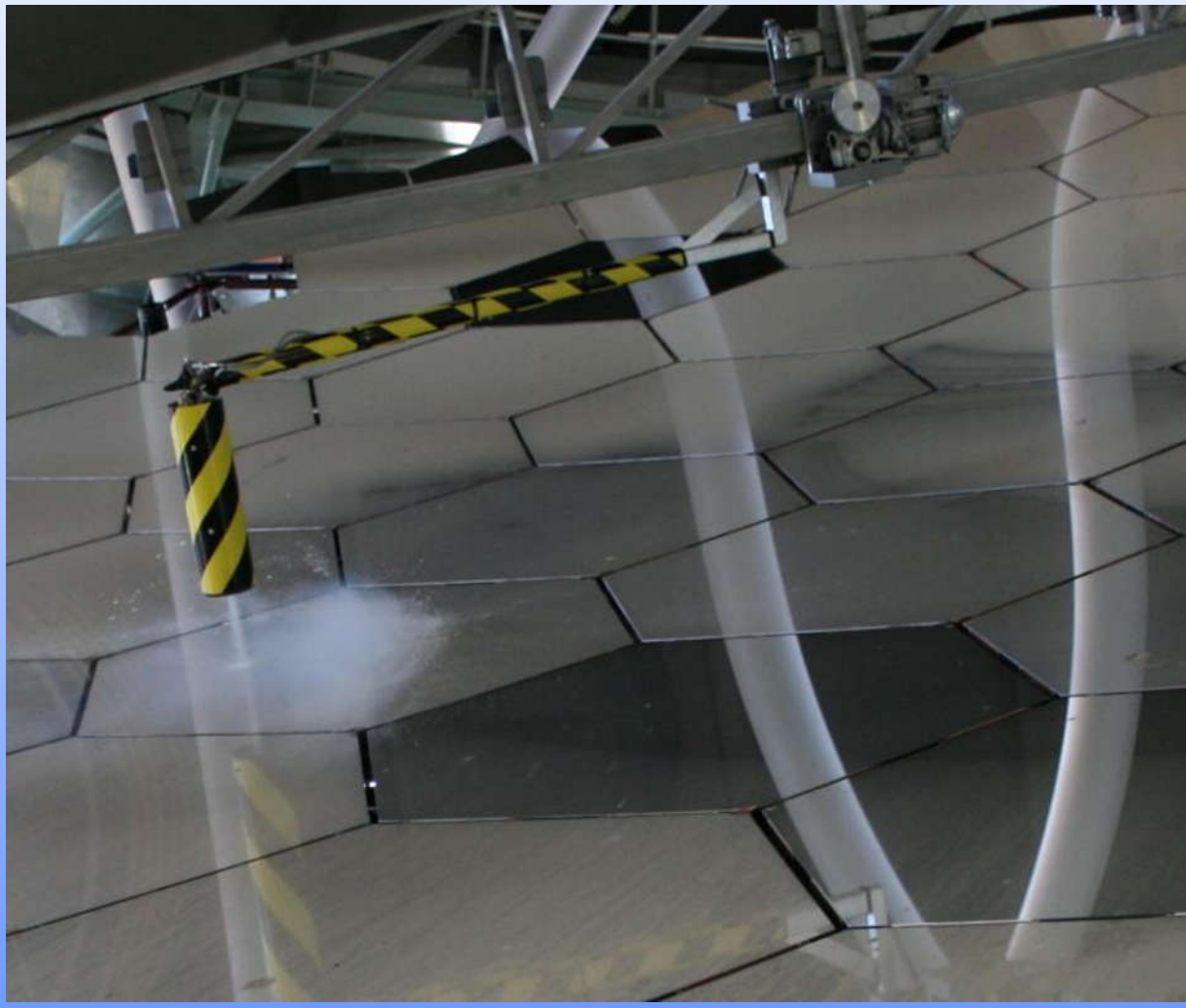

Star moves E to
Ce
Fixed elevation spherical mirror telescope with tracking on focal surface
Spherical focal surface: 1/2 of primary mirror radius
Image moves W to E on the focal surface
Spherical Primary Mirror



Lat
mir

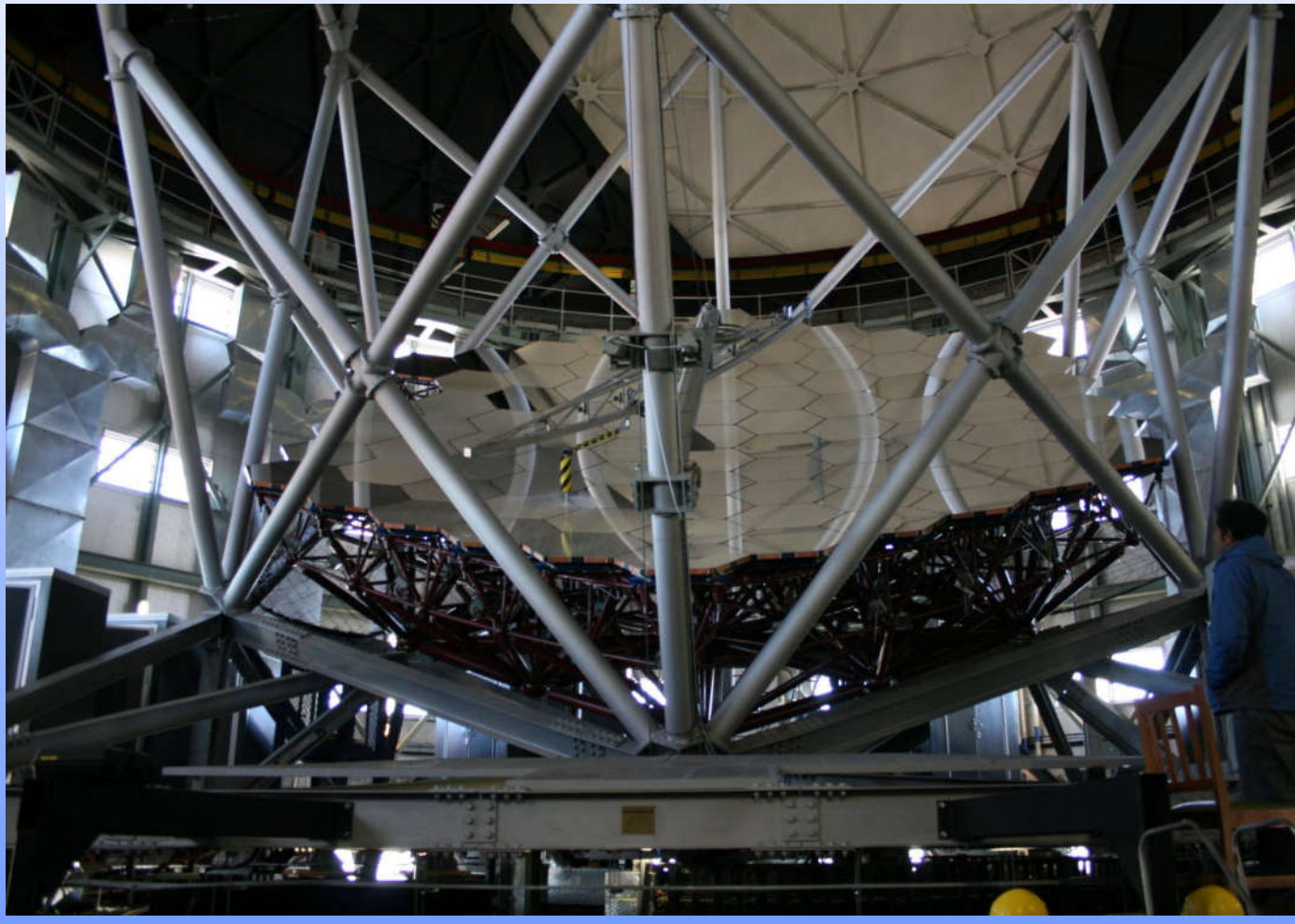
SALT Technical Stat

Primary Mirror Clean



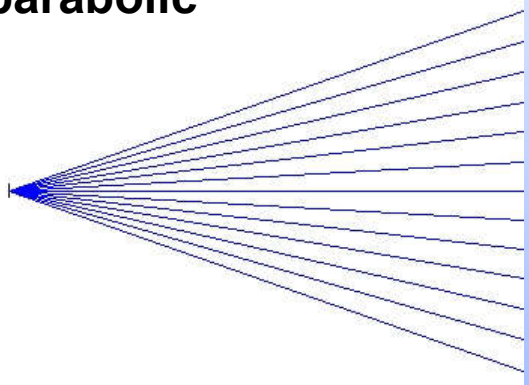
SALT Technical Stat

Primary Mirror Clean



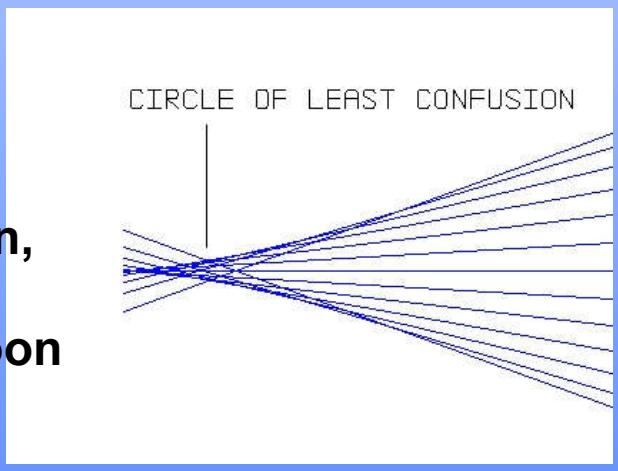
Spherical Aberration in the HET &

If the primary were parabolic

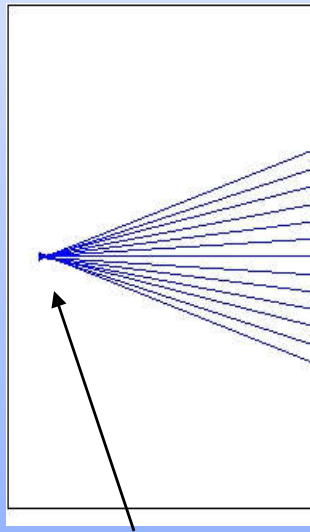


Perfect image

… BUT the primary is spherical



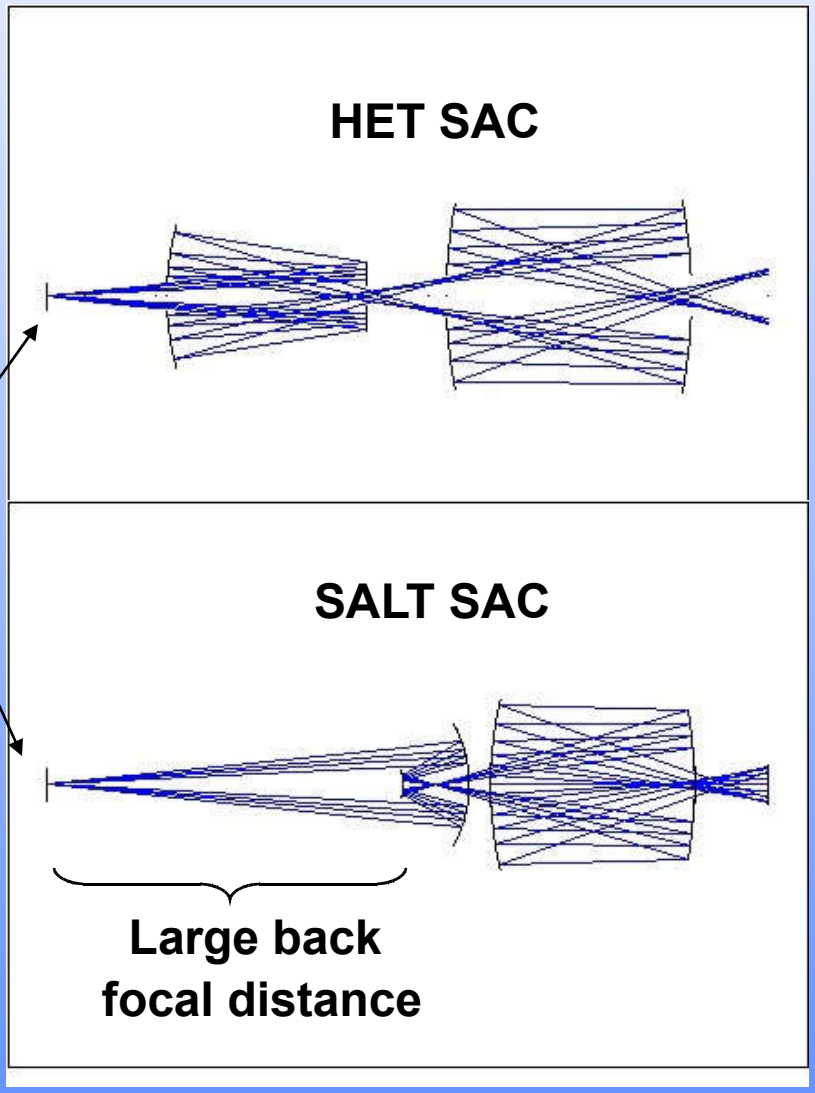
Very bad Image: ~10 arcmin, about 1/3 size of moon



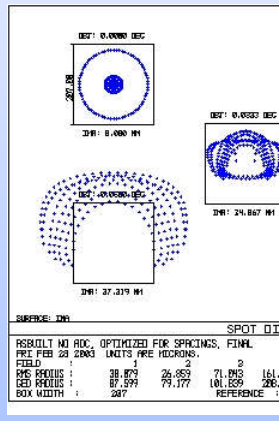
Prime Focus

Therefore both HET employ a prime-foc Aberration Correcto

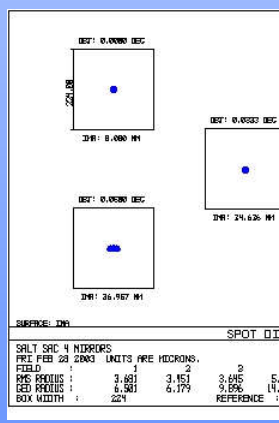
Spherical aberration correct comparisons



Focal Plane



Spot d

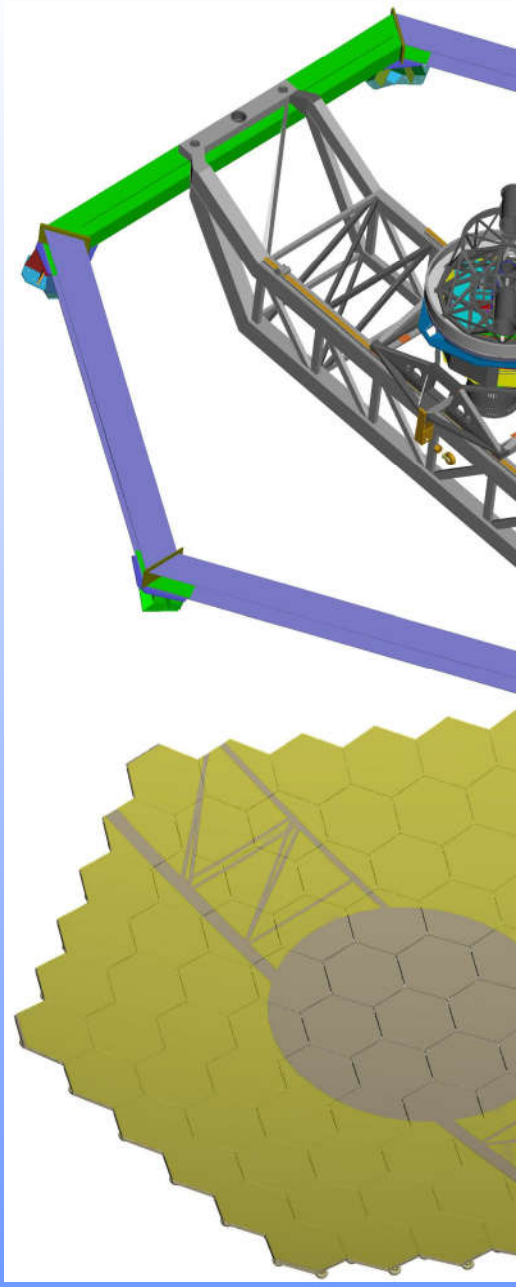


SALT/HET Tracking Principle

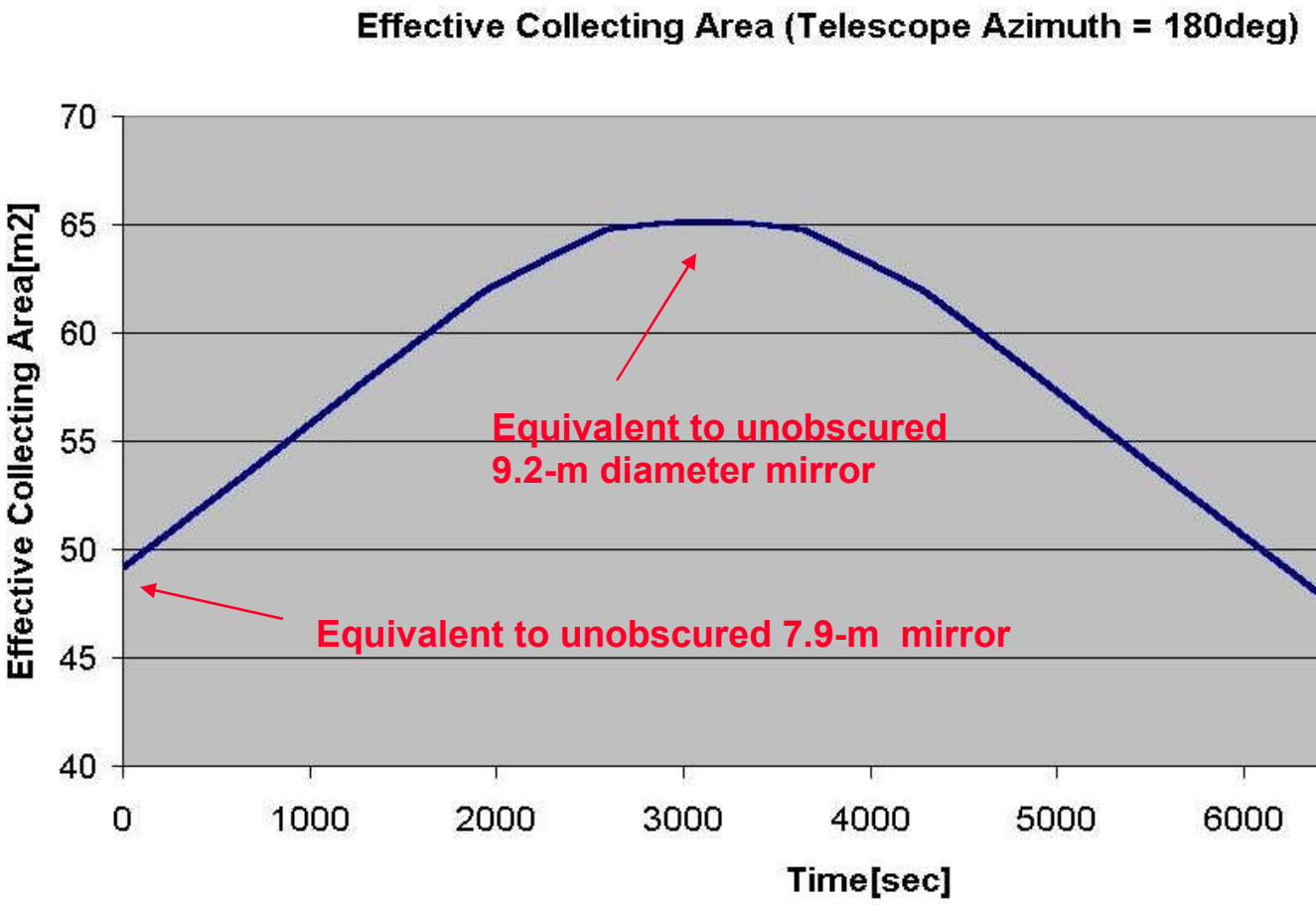
Tracker off-centre
and pupil partially on primary mirror array. At worst extreme, still a ~7 m telescope.

With tracker and 11-m pupil centred on primary mirror array, use full diameter of telescope (HET only 9.1m pupil)

Pupil is always underfilled (→ baffled at exit pupil)



SALT characteristics

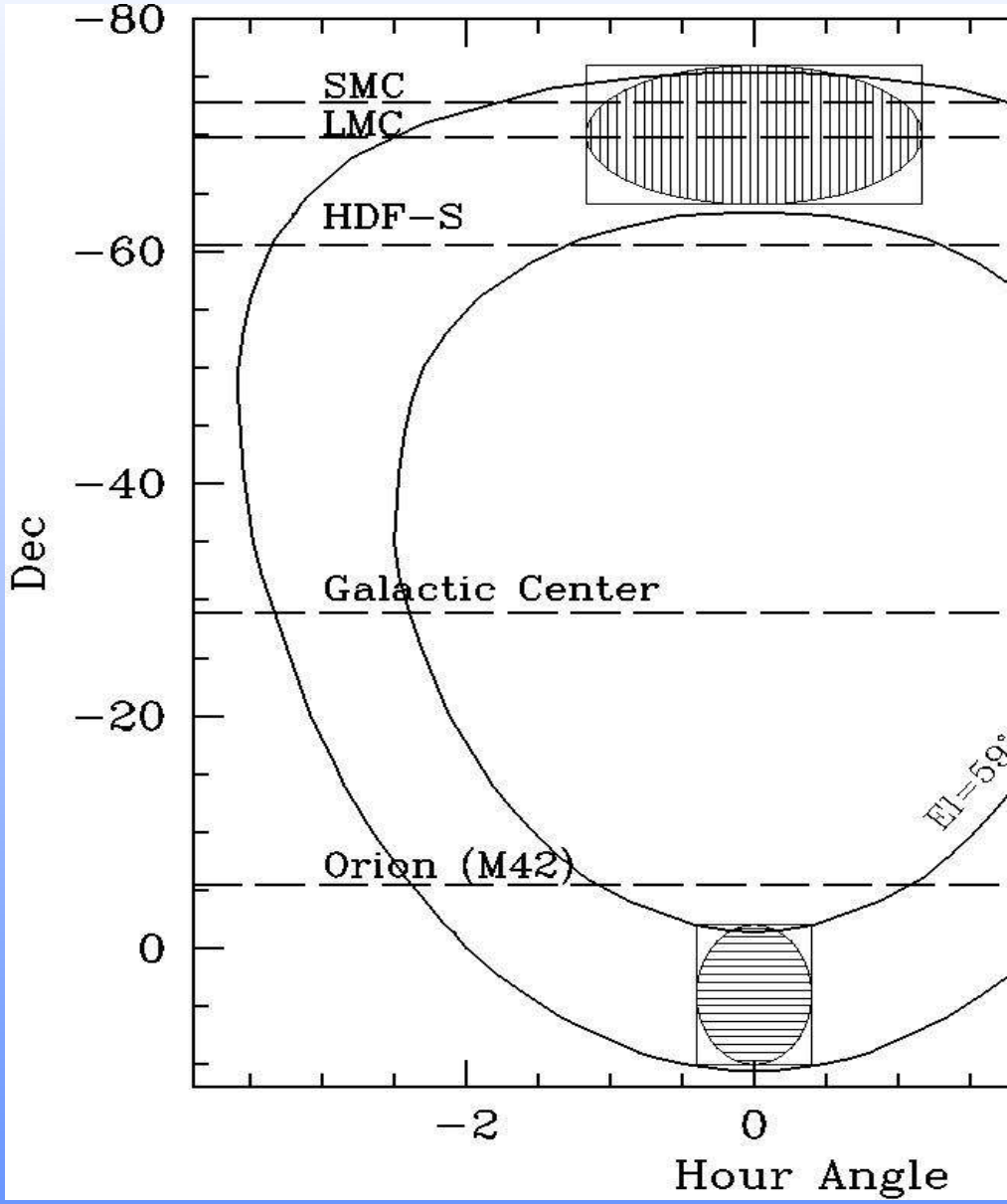


Annulus of visibility for SALT:

12.5% of visible sky

Shaded regions continuously visible

Rotate in azimuth, to access different parts of sky



SALT Prime Foc

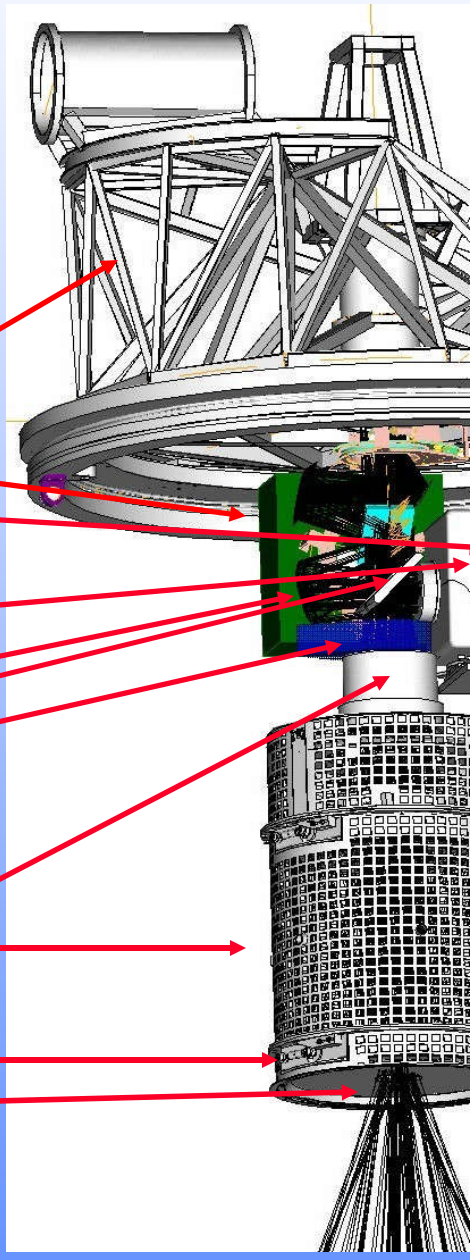
Prime Focus Payload (~1000 kg) mounts via hexapod to tracker and comprises of:

Science instruments:

- **Prime Focus Imaging Spectrograph (PFIS)**
- **Fibre Instrument Feed (FIF)**
- **SALTICAM (optical imager)**

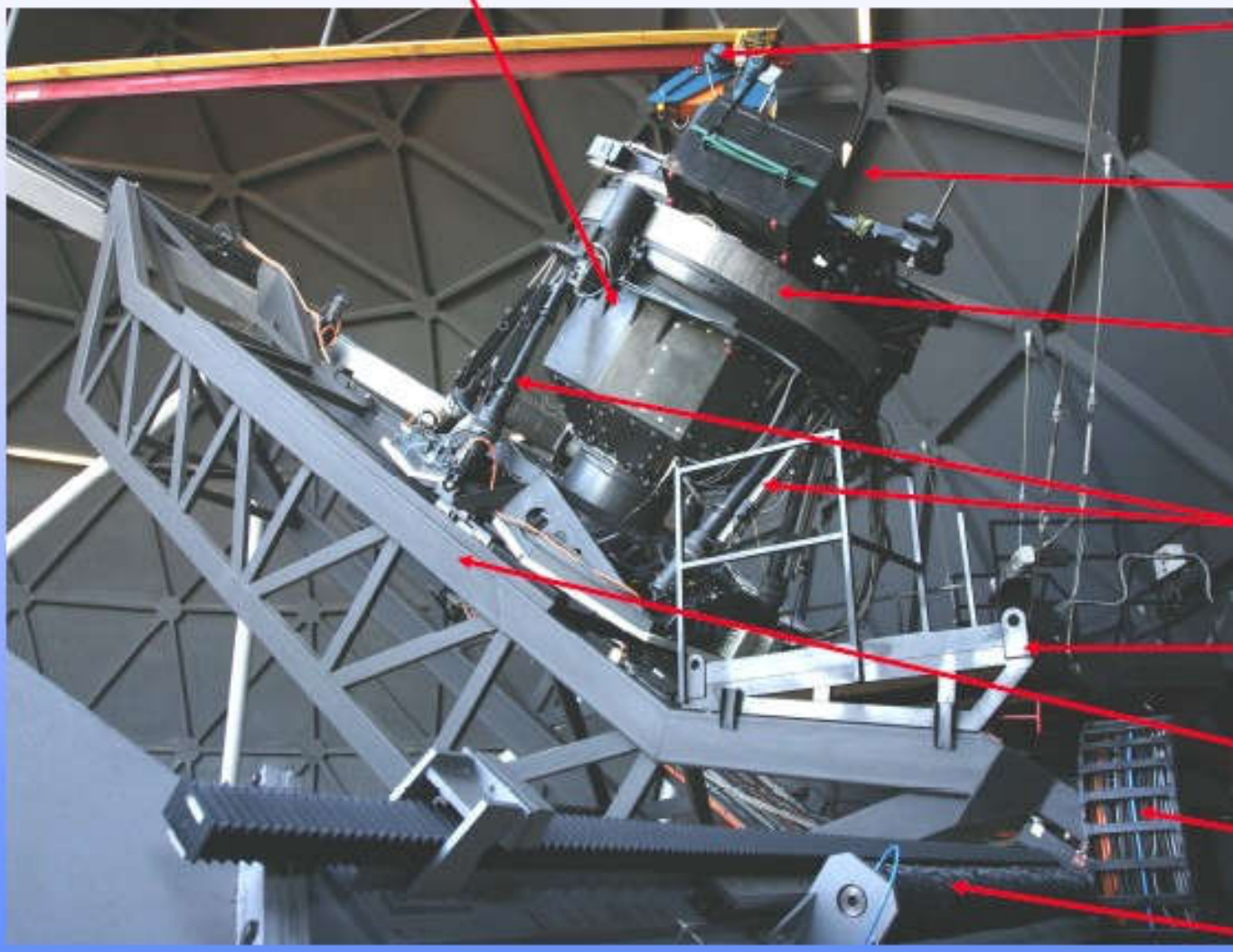
Facility instruments:

- **Acquisition camera (SALTICAM)**
- **Guidance & focus system**
- **PFIS slit-viewing optics**
- **Fold mirrors (to 3 focii)**
- **Moving pupil baffle**
- **Atmospheric Dispersion Compensator (ADC)**
- **SAC structure**
- **Payload alignment system (autocollimator and interferometer)**
- **Calibration system (flats, arcs)**

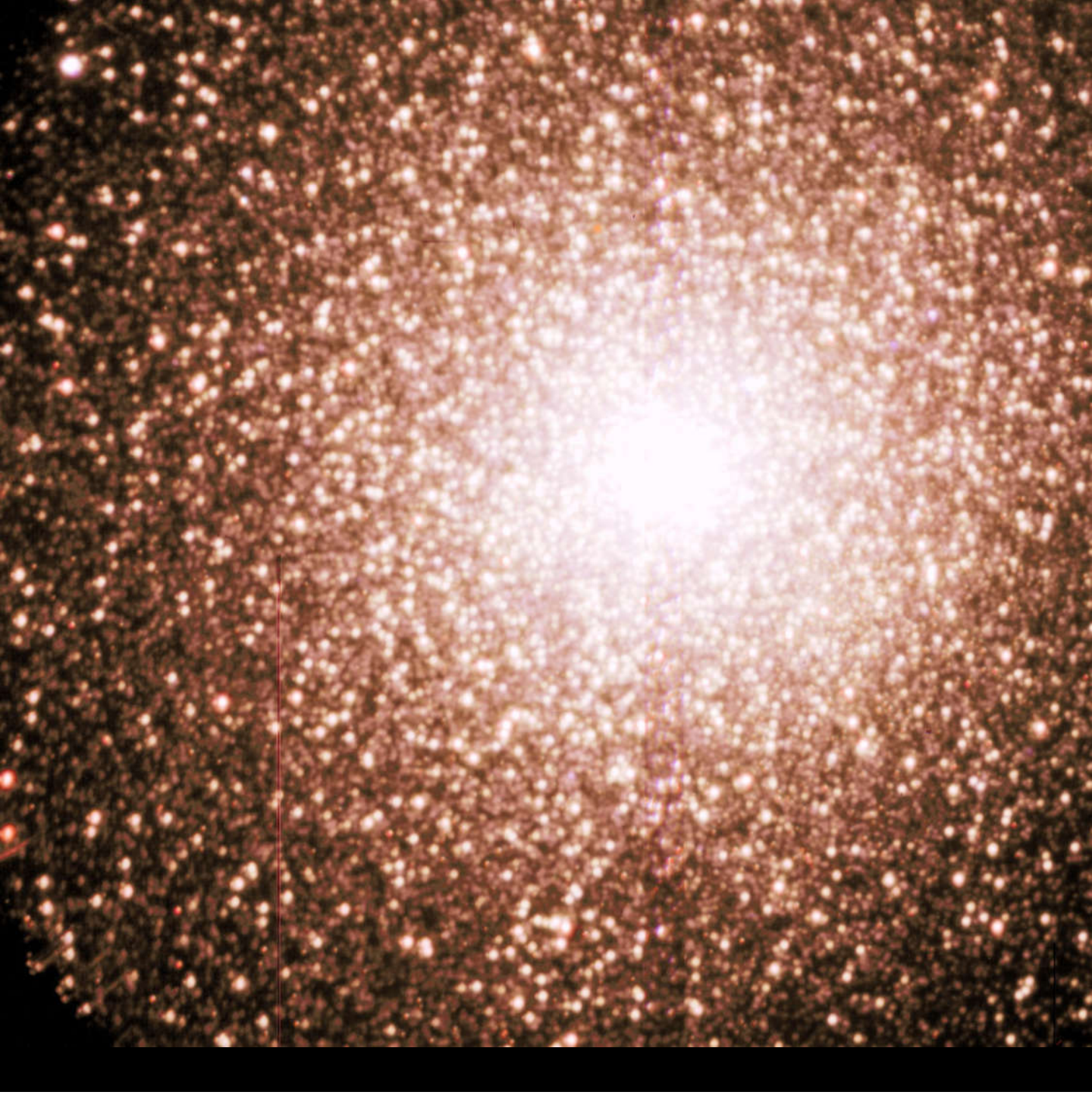


Facility Instrument
mounted on Prime

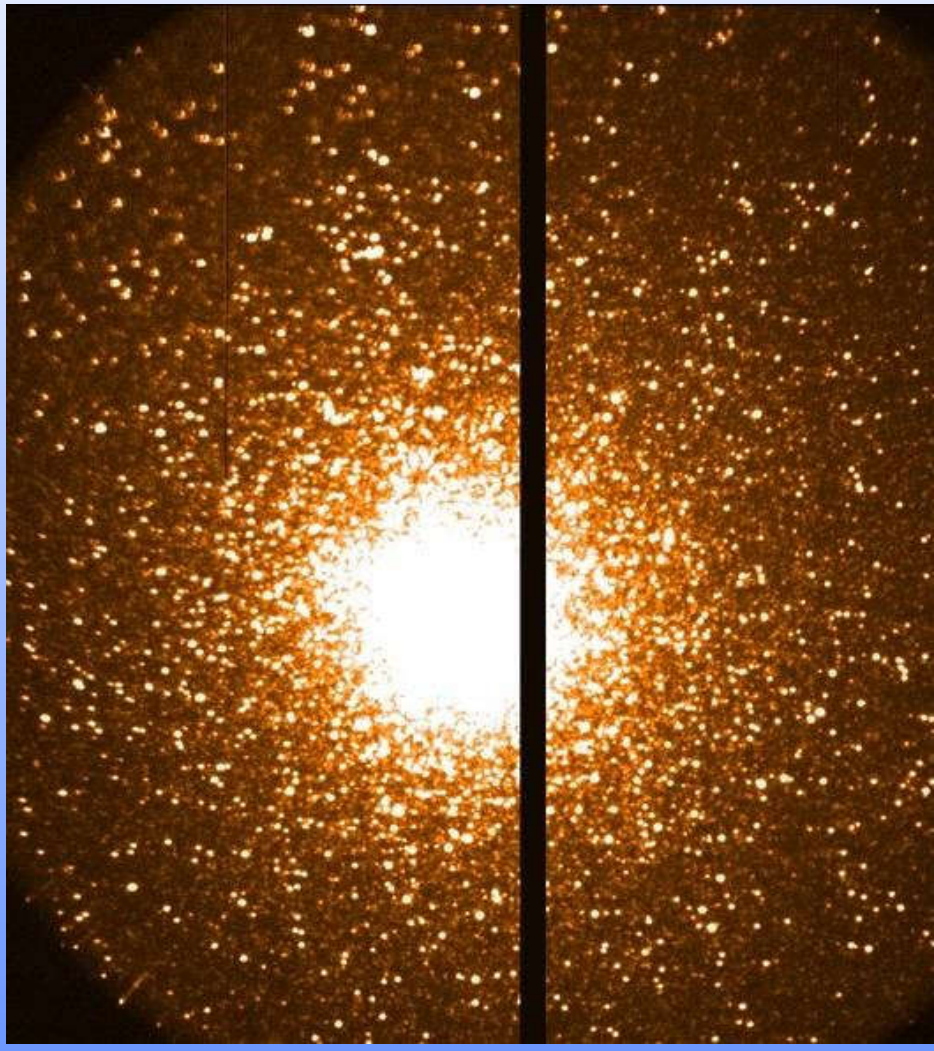
Payload structure (rotating & non-rotating componen
composite



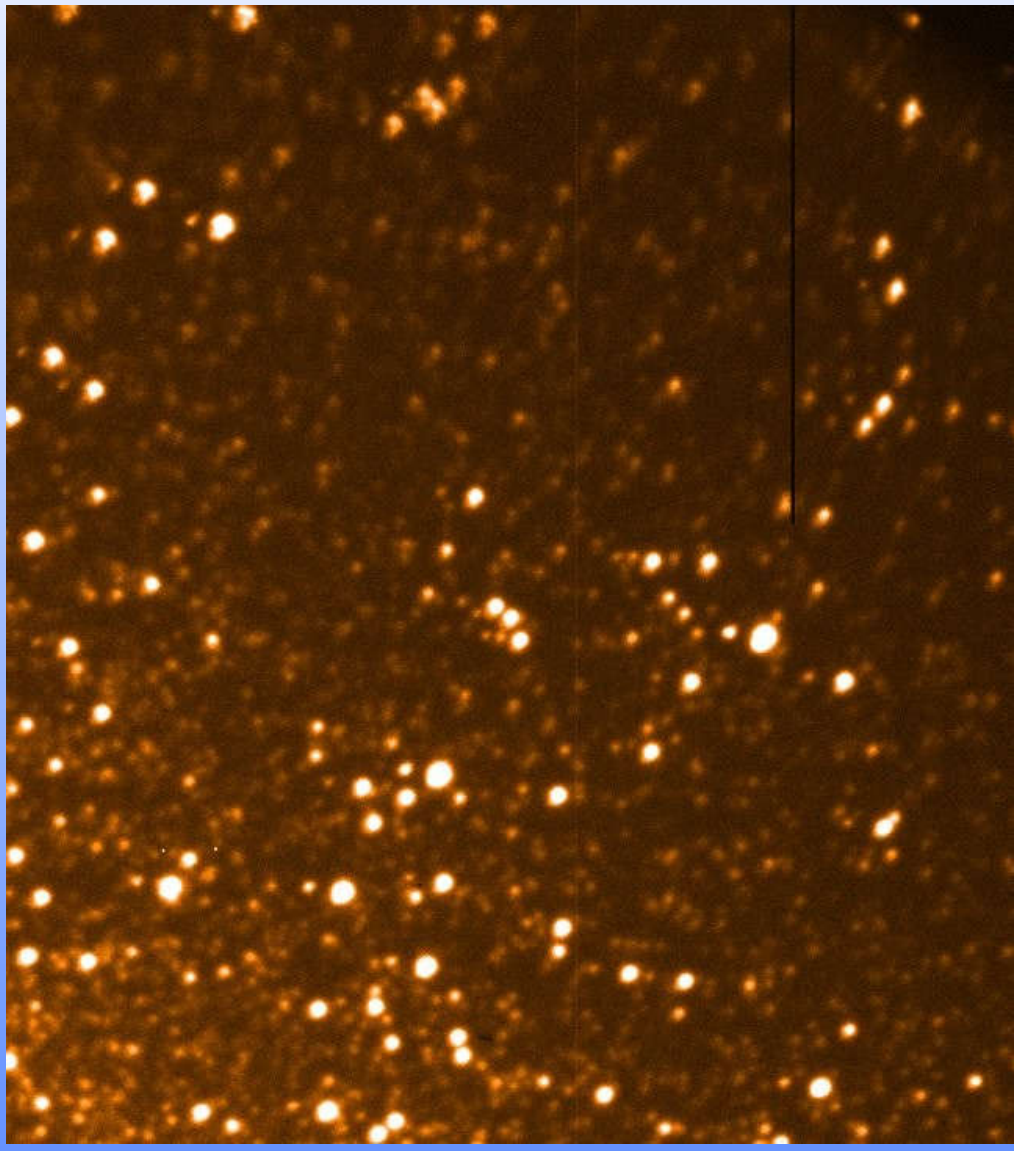
Cleaning and aluminizing



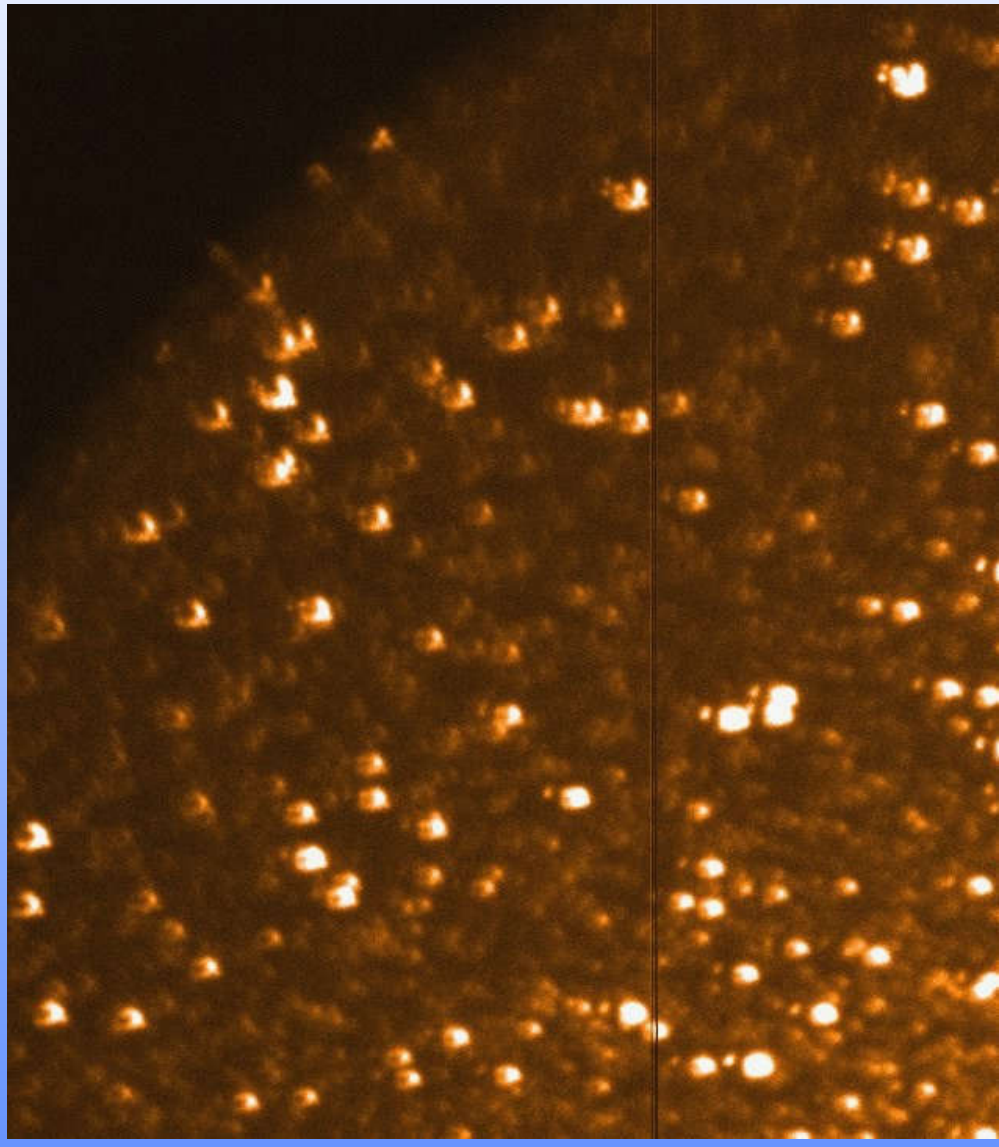
47 Tuc: S200511240007.fits: Nover



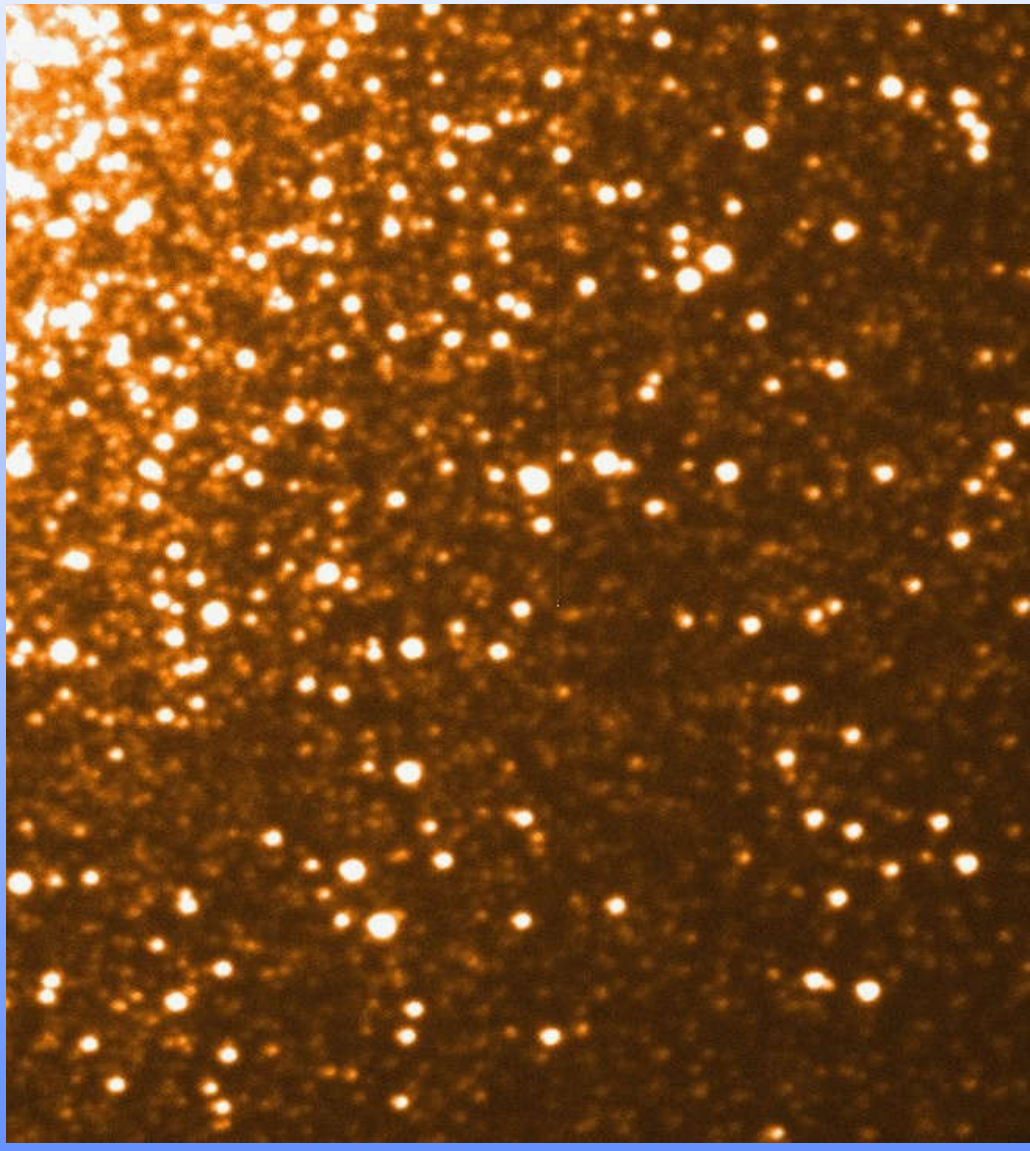
47 Tuc: S200511240007.fits: top



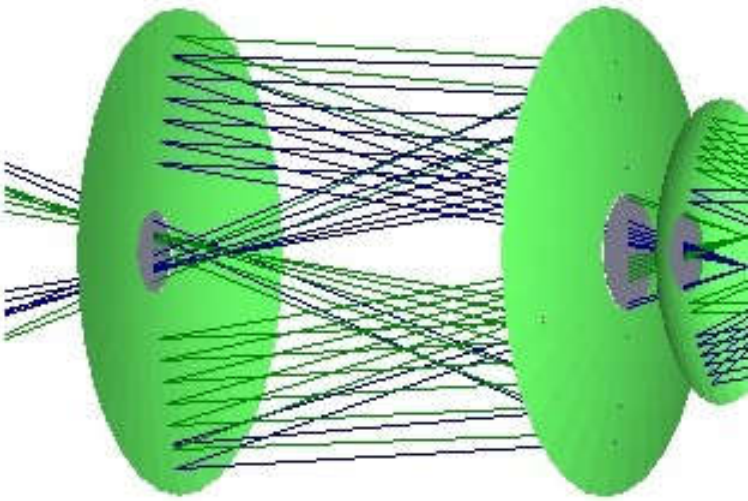
47 Tuc: S200511240007.fits: top



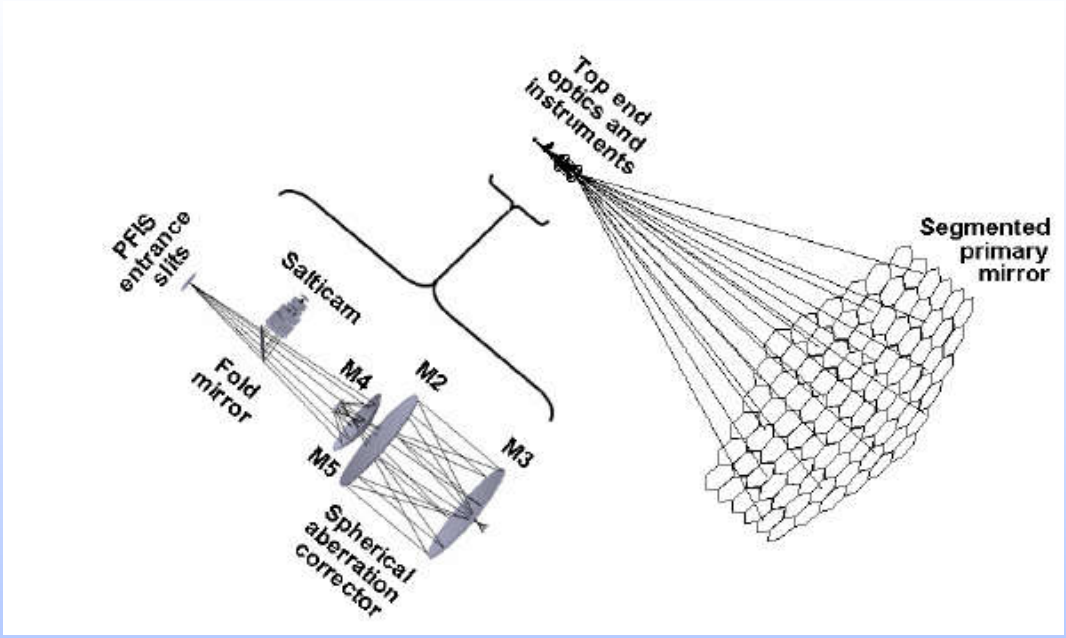
47 Tuc: S200511240007.fits: botto

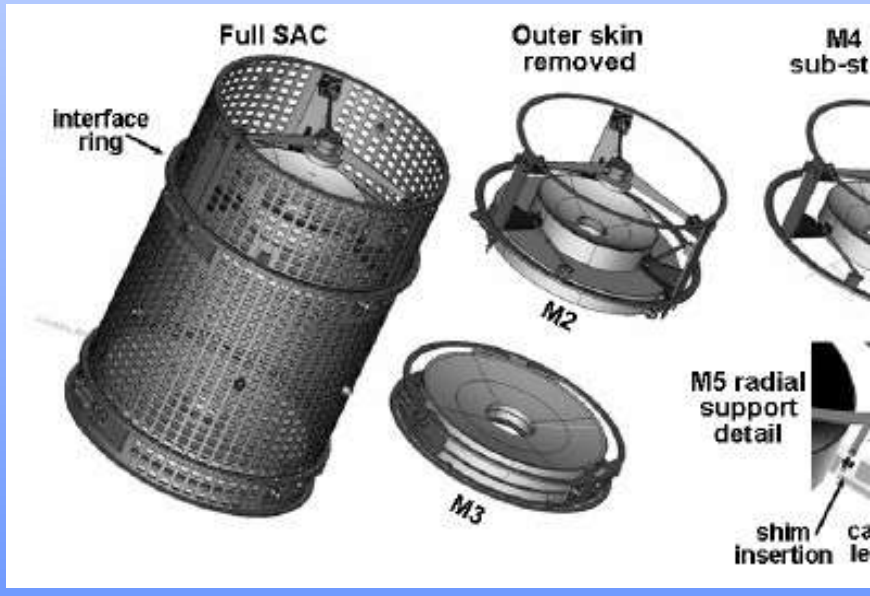


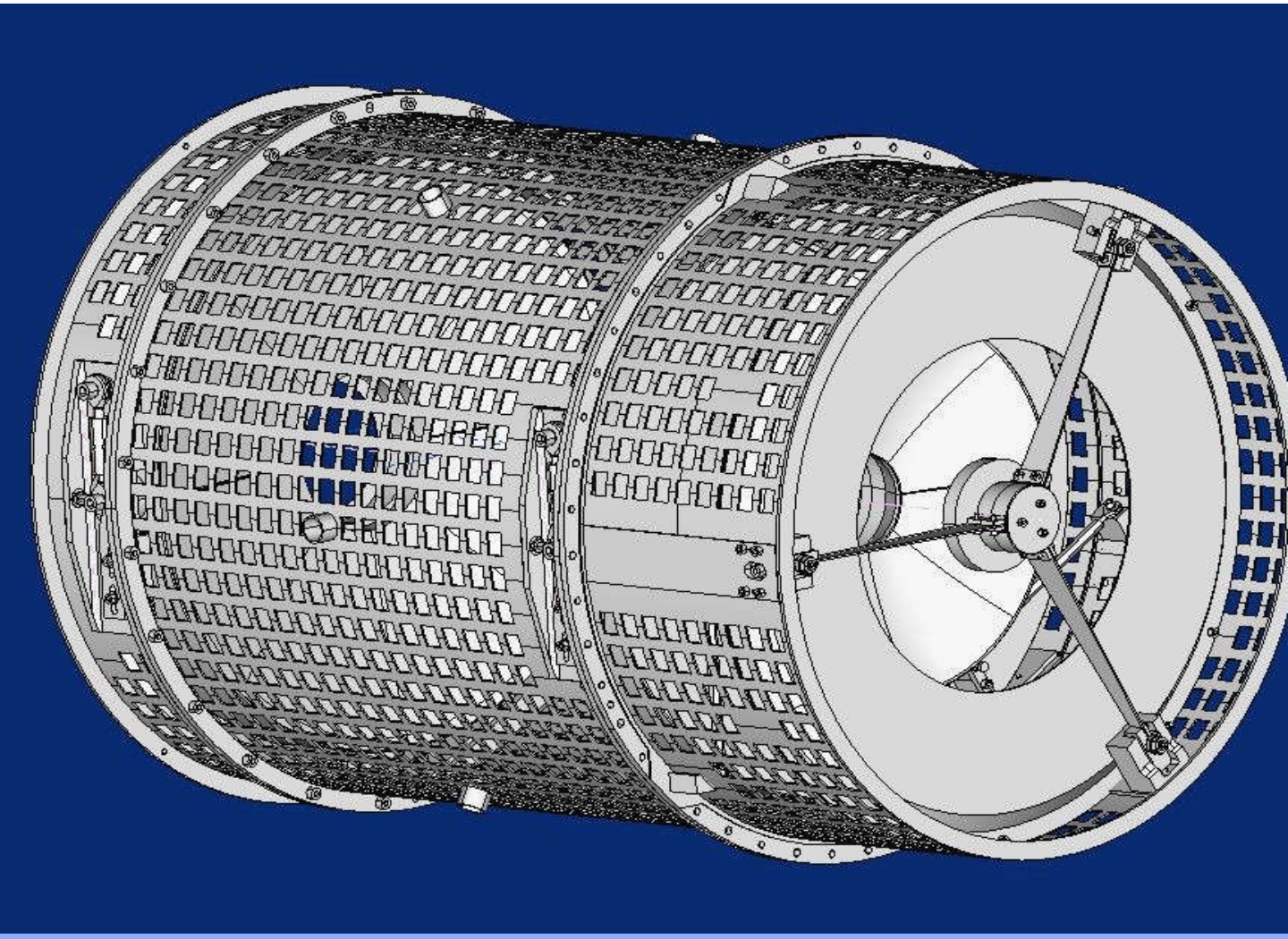
The Bad News: It's The SA

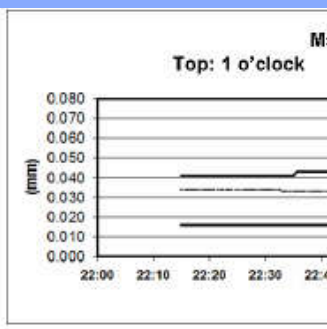


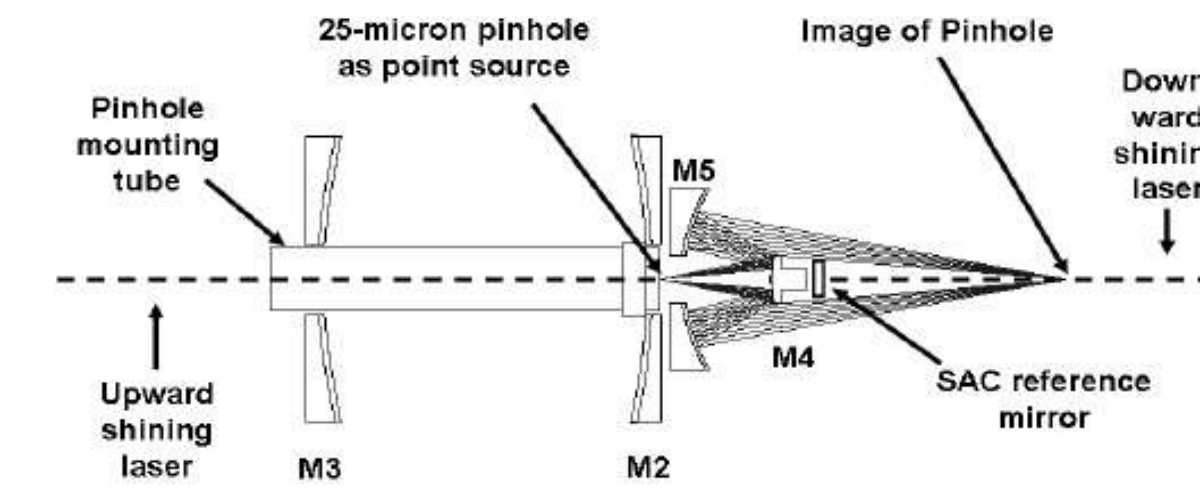
M3 M2

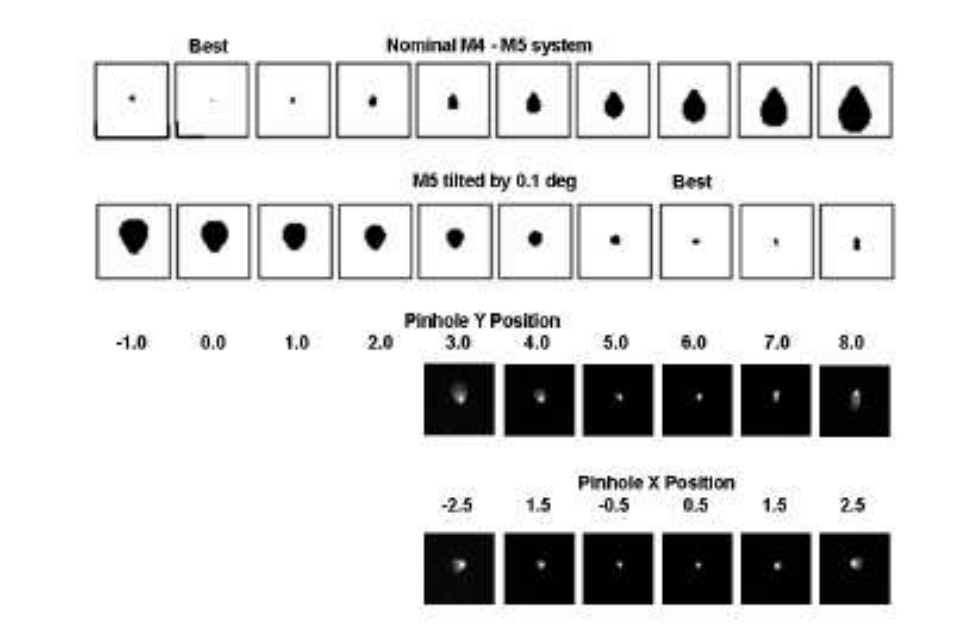

Top end optics and instruments
Segmented primary mirror
PFIS entrance slits
Salticam
Fold mirror
M4
M2
M3
M5
Spherical aberration corrector


Full SAC
Outer skin removed
M4 sub-st
interface ring
M2
M3
M5 radial support detail
shim insertion




Top: 1 o'clock
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
(mm)
22:00
22:10
22:20
22:30



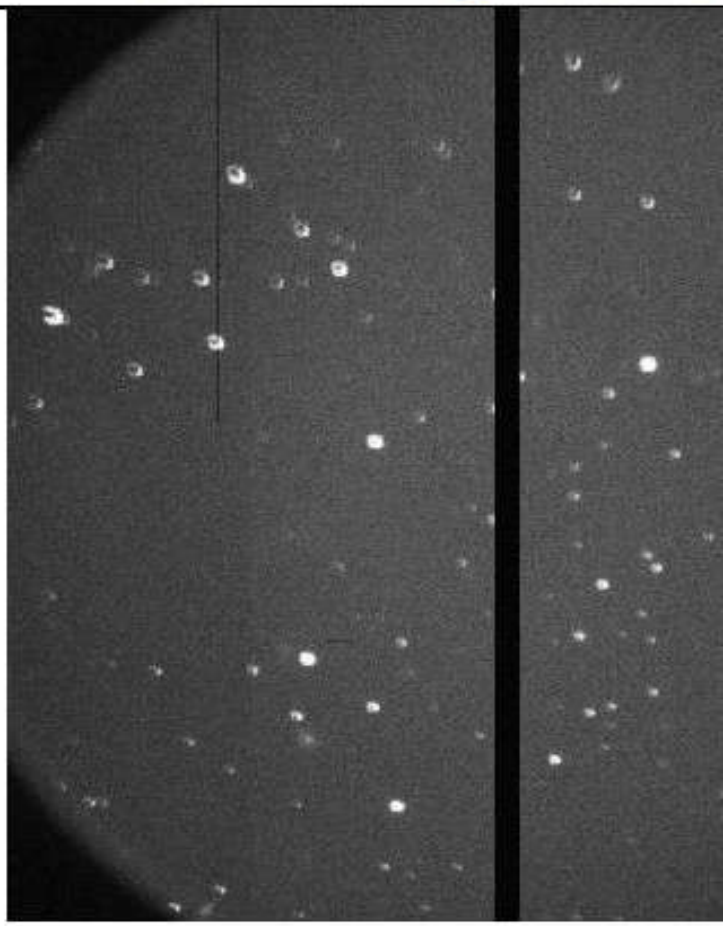


From O'Donoghue et al 08 SPIE

I

- Focus gra
- Rho deper
- Field depe aberration
- Diagnosin been a lon process
- Some rece (SAC *is* th
- Re-alignm and new m planned for early 09

SALT Image Qualit

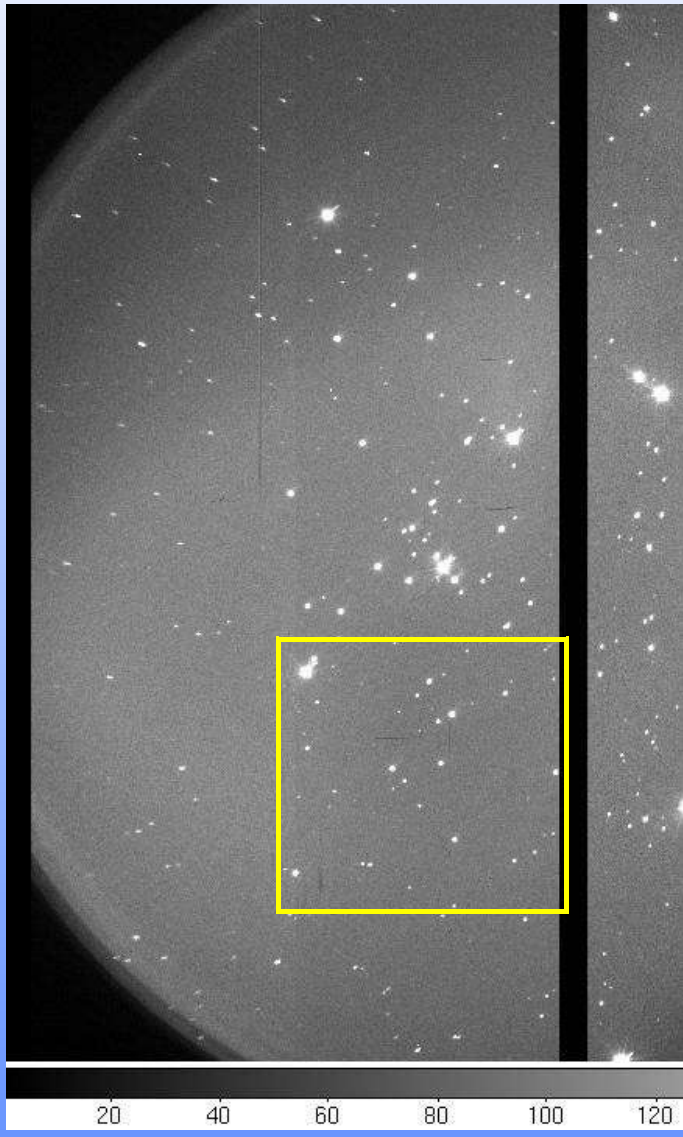


Relative focus: +0.6

Azimuth = 0
Rho = 0

Good images do occur!

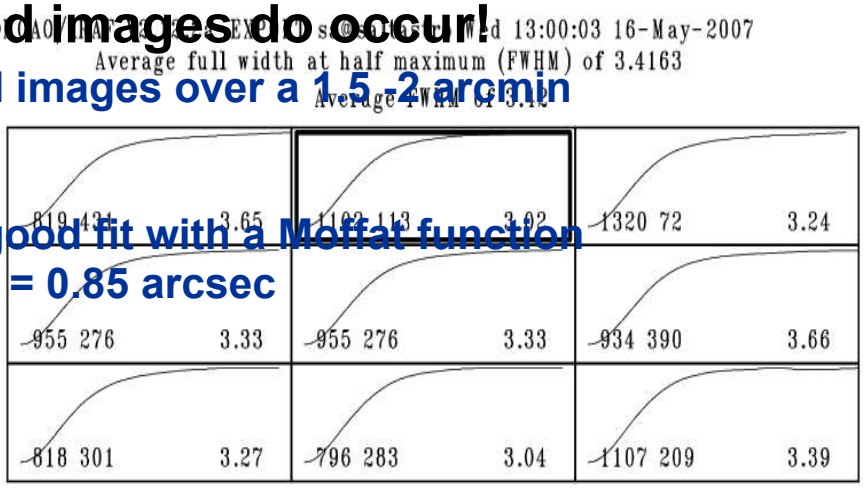
- Indicates hope!
- Rho dependency
- Field dependency of aberrations
- Diagnosing cause has been a long (~2 yr) process
- Some recent progress (SAC *is* the cause)
- But… still unclear when there will be a solution

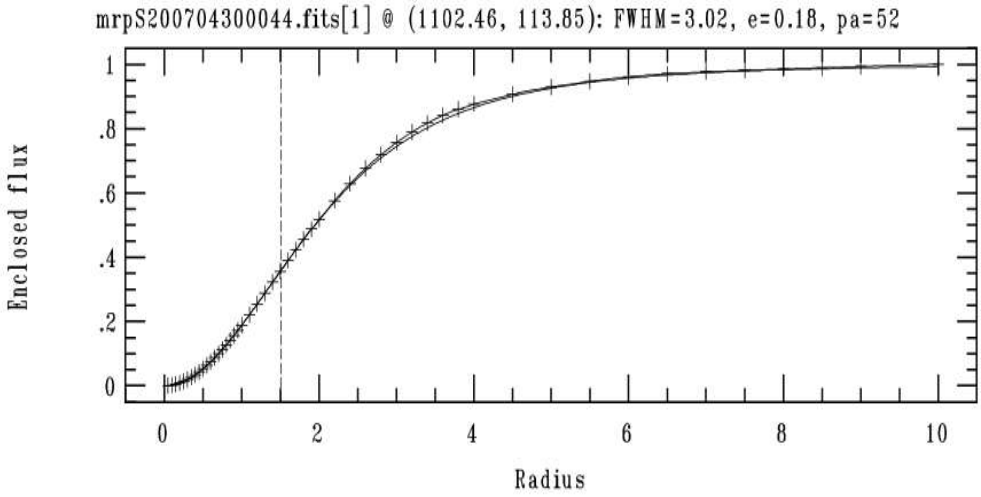


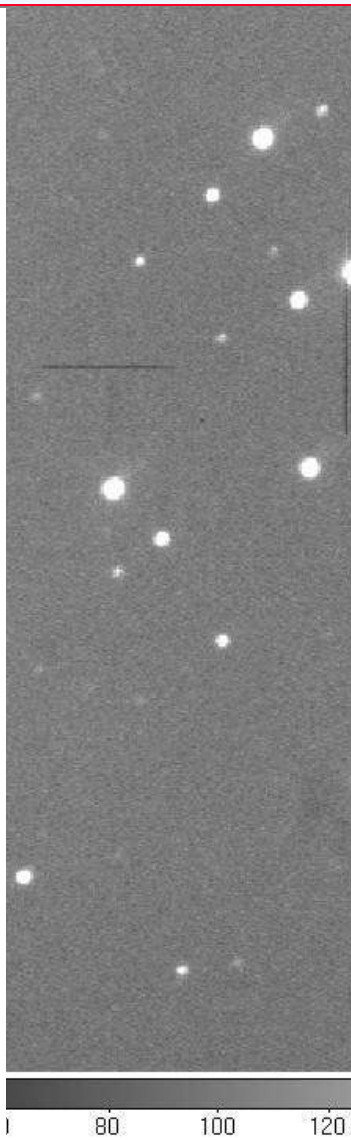
Good images do occur!

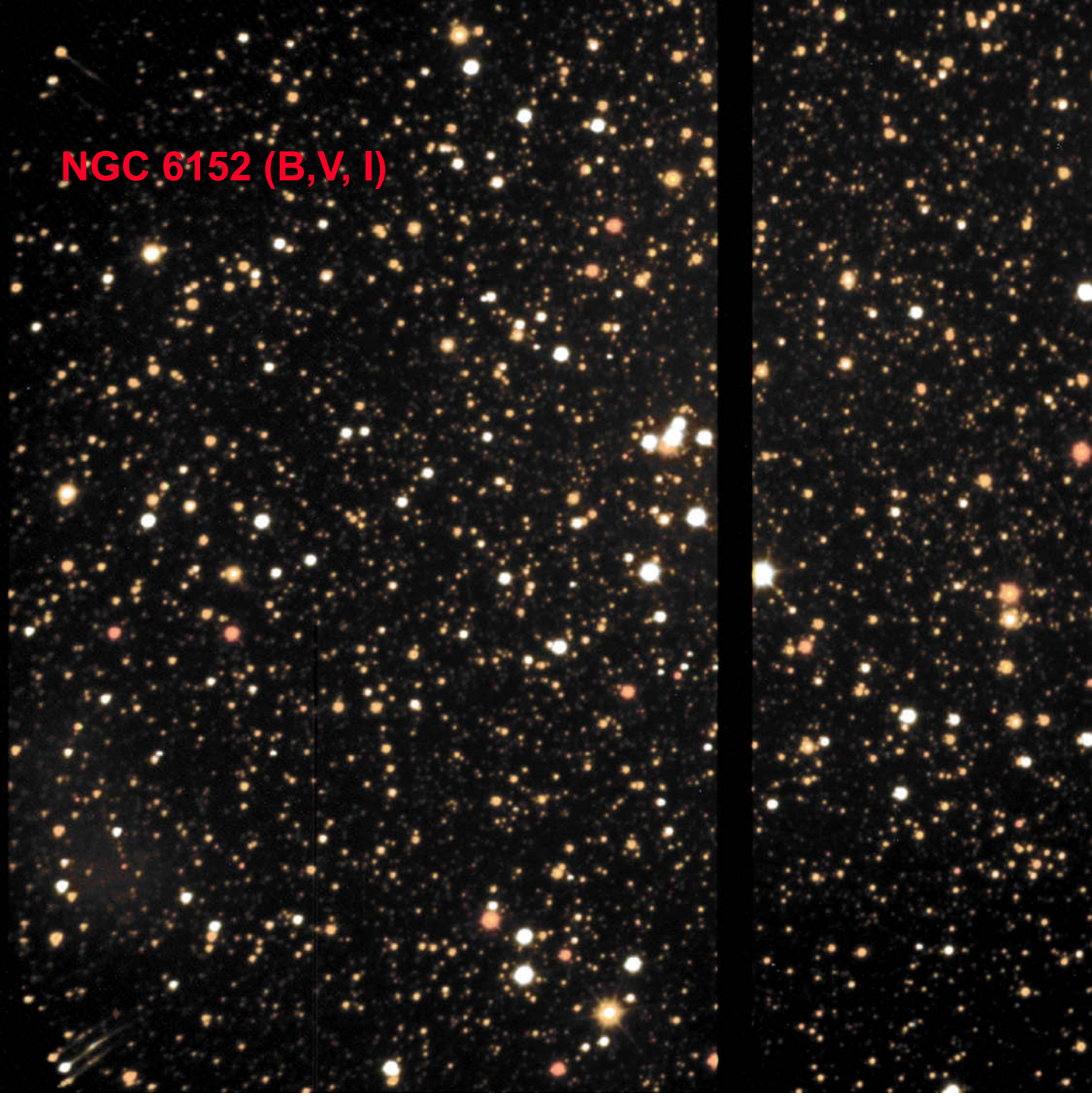
Good images over a 1.5-2 arcmin FoV

e.g. good fit with a Moffat function
EE50 = 0.85 arcsec








NGC 6152 (B,V, I)

SALT INSTRUMENTS

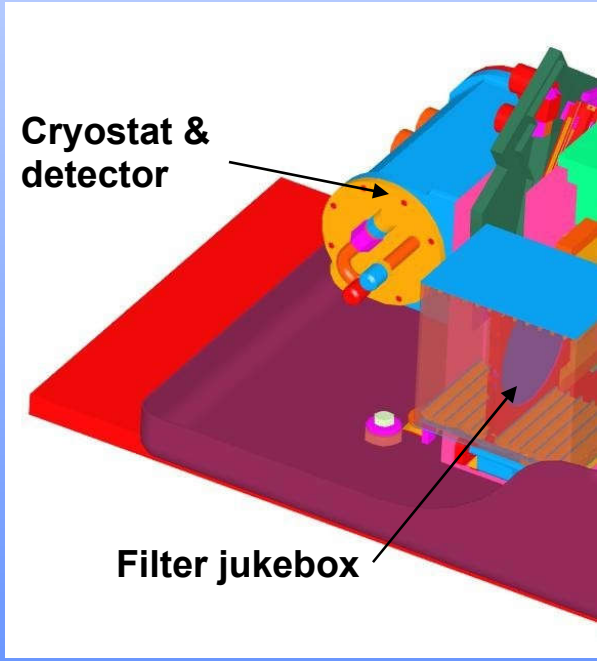
SALT

1. SALTICAM
(funded by Univ. of Goettingen)

PI: Darragh O'Donoghue (SAAO)
An efficient CCD imager
(8 arcmin FOV).

.

SALTICAM will enable unique science, particularly UV and fast photometry (~70-50 ms).



SALTICAM: how do you make a CCD operate in “fast” mode?

Answer: use moveable frame-transfer mask

Full Frame Readout Mode (using shutter)

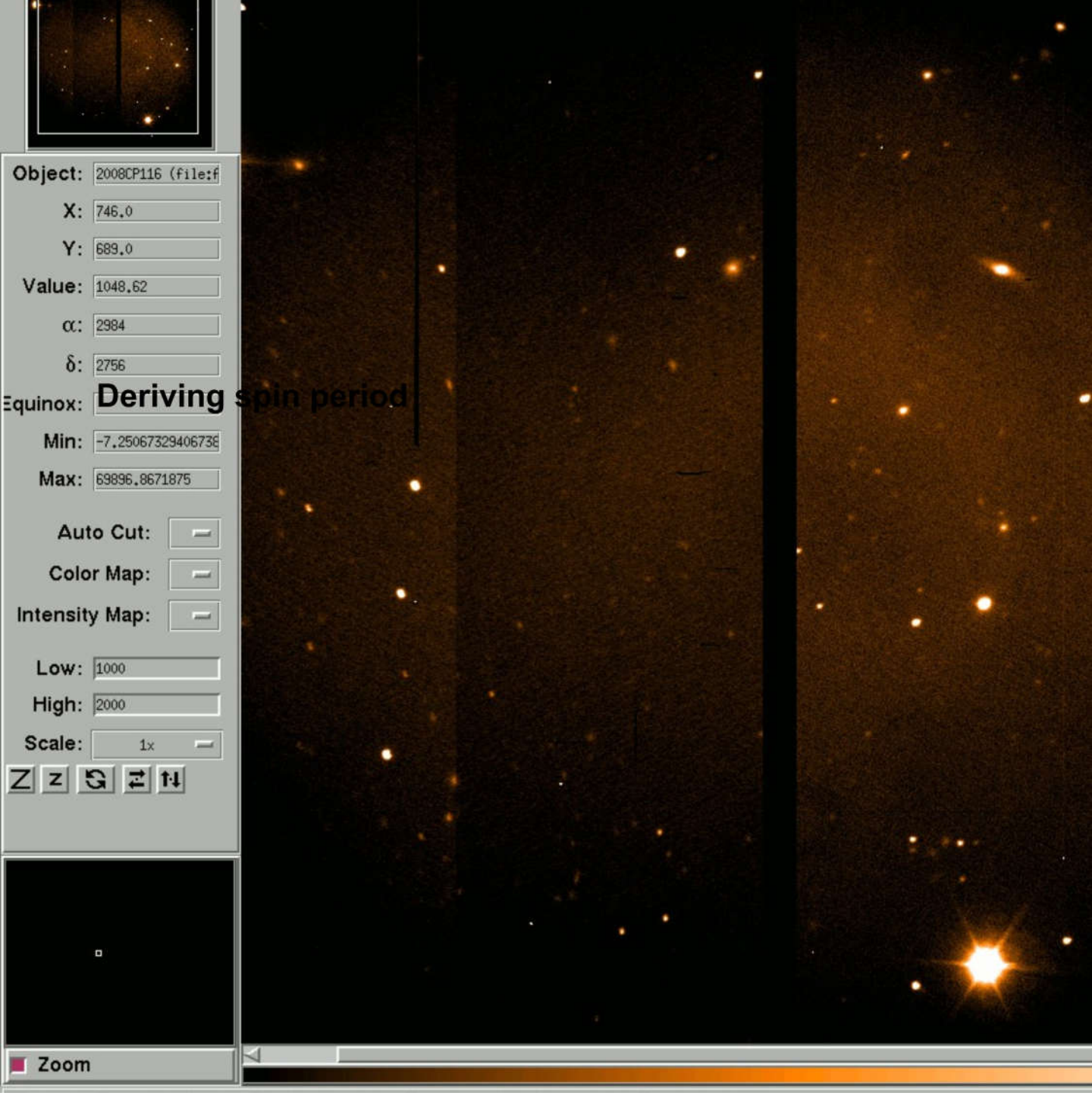
8 arcmin FoV:	12.3 sec (@3.3e read noise)
	4.6 sec (@5e)

Frame Transfer Mode

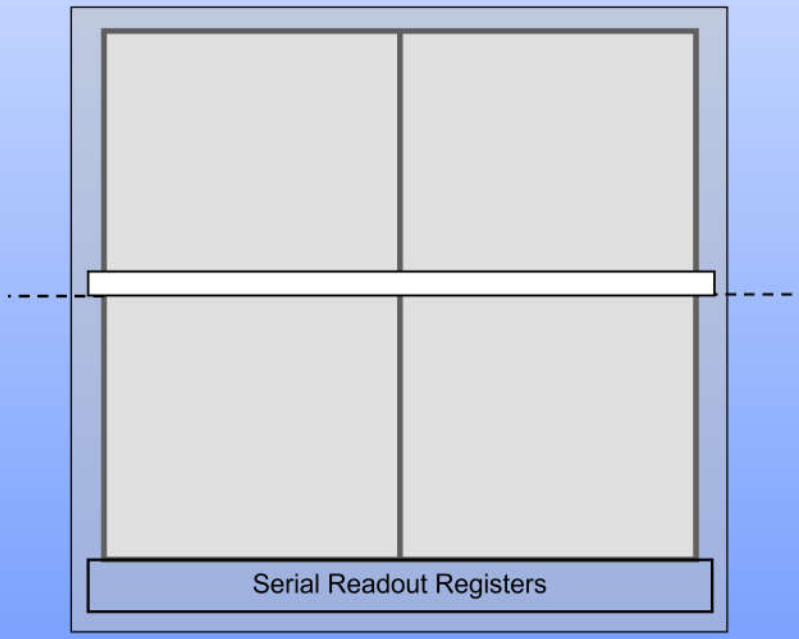
Half of 8 arcmin circular FoV	6.3 sec (@3.3e)
	2.4 sec (@5e)

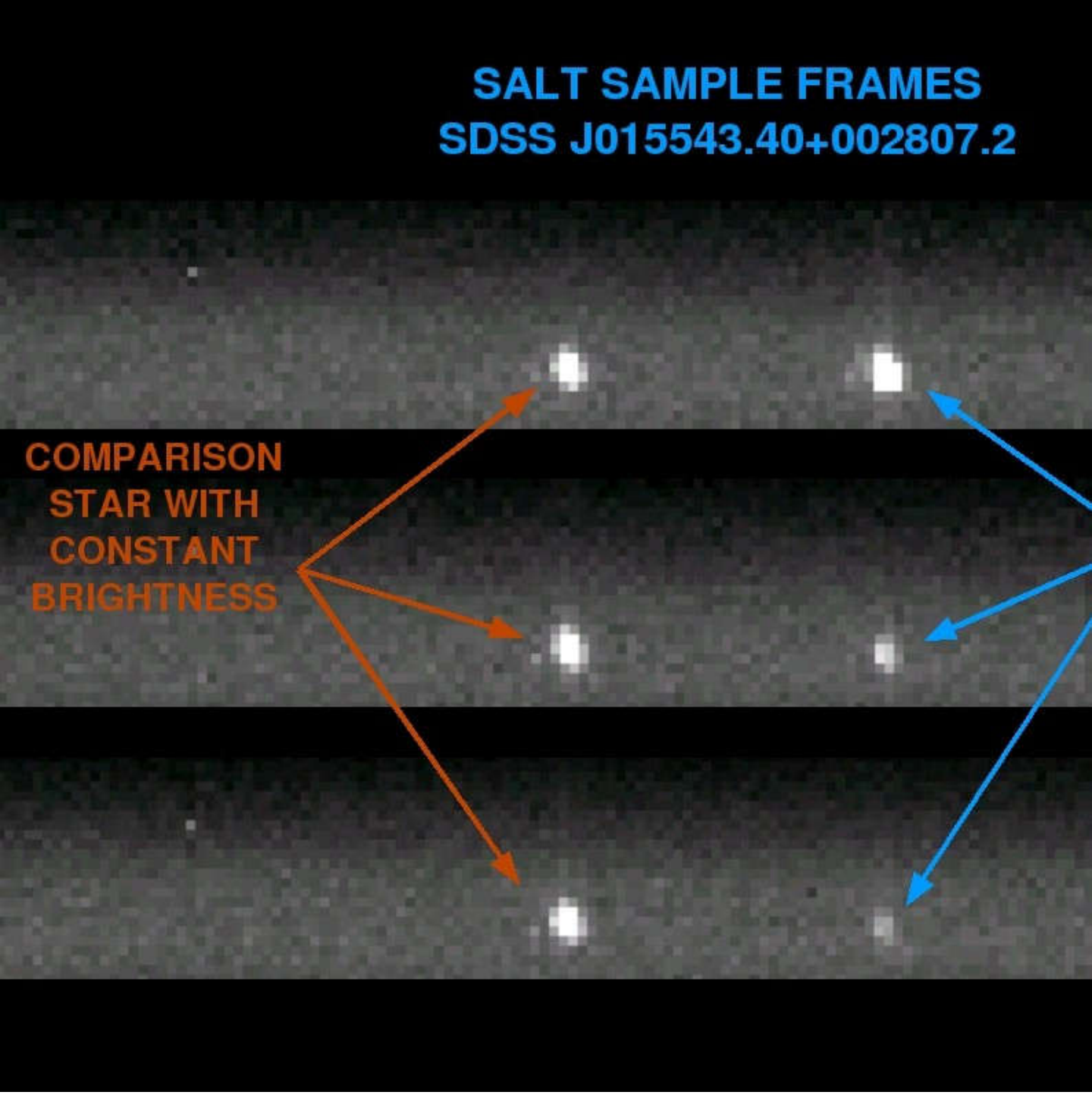
Fastest windowed photometry

Slot mode	0.089 sec (@5 e)
Slot + windowed mode	0.058 sec

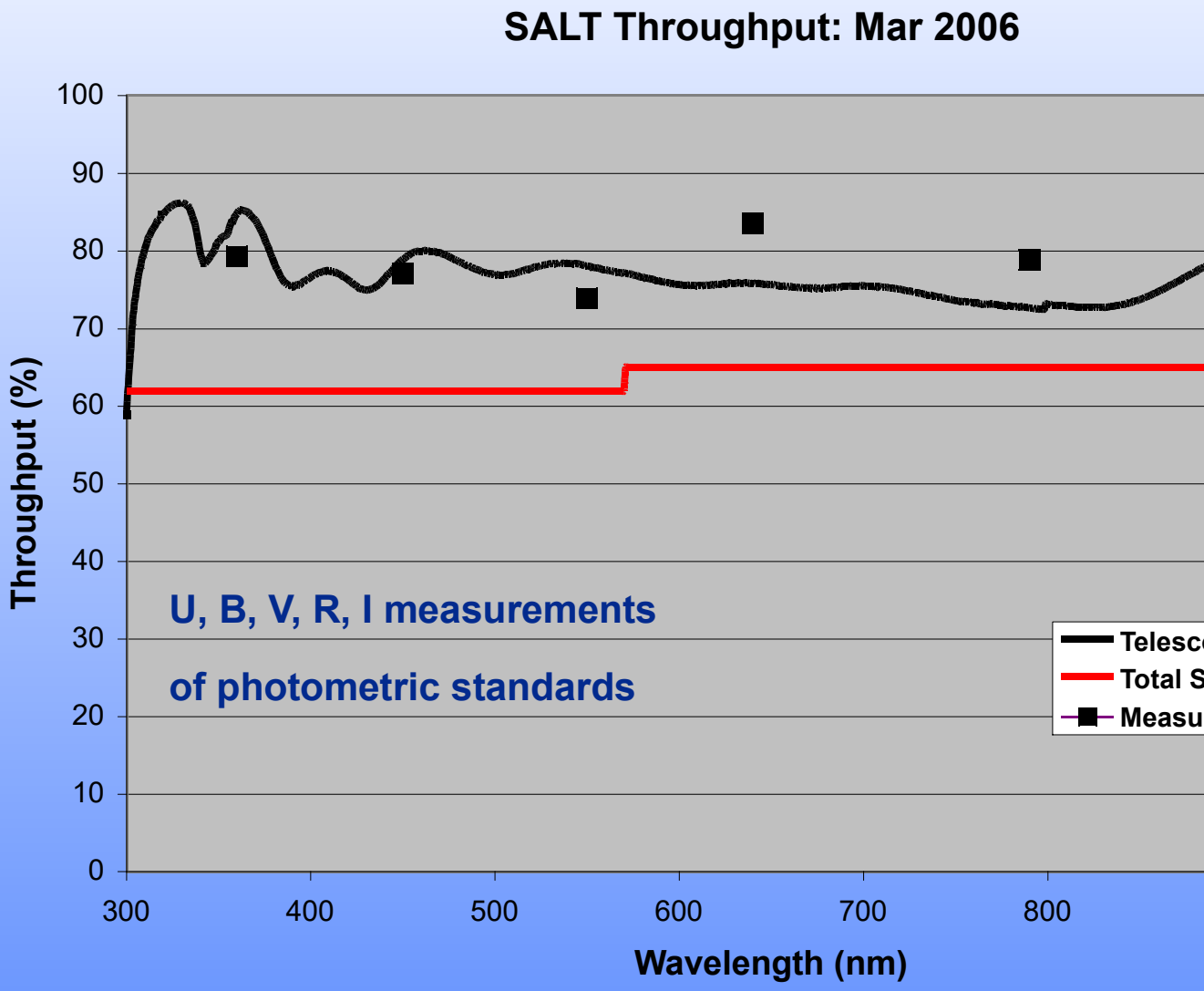

Object: 2008CP116 (file:f
X: 746.0
Y: 689.0
Value: 1048.62
α: 2984
δ: 2756
Equinox:
Min: -7.25067329406738
Max: 69896.8671875
Auto Cut:
Color Map:
Intensity Map:
Low: 1000
High: 2000
Scale: 1x
Zoom
Deriving spin period

Frame Transfer Mask in Slot Mo
for ~0.1 sec sampling

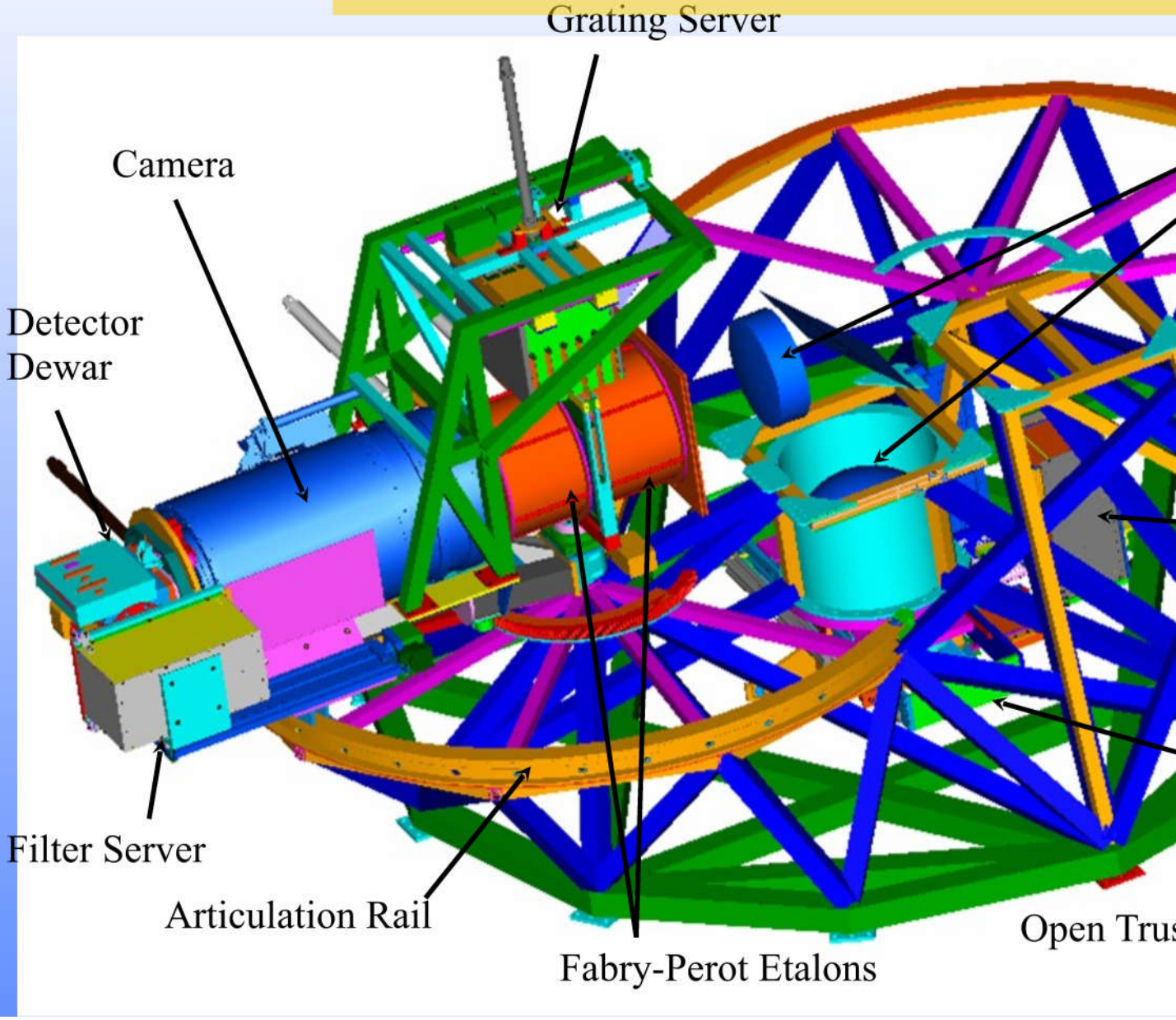



SALT SAMPLE FRAMES
SDSS J015543.40+002807.2
COMPARISON
STAR WITH
CONSTANT
BRIGHTNESS

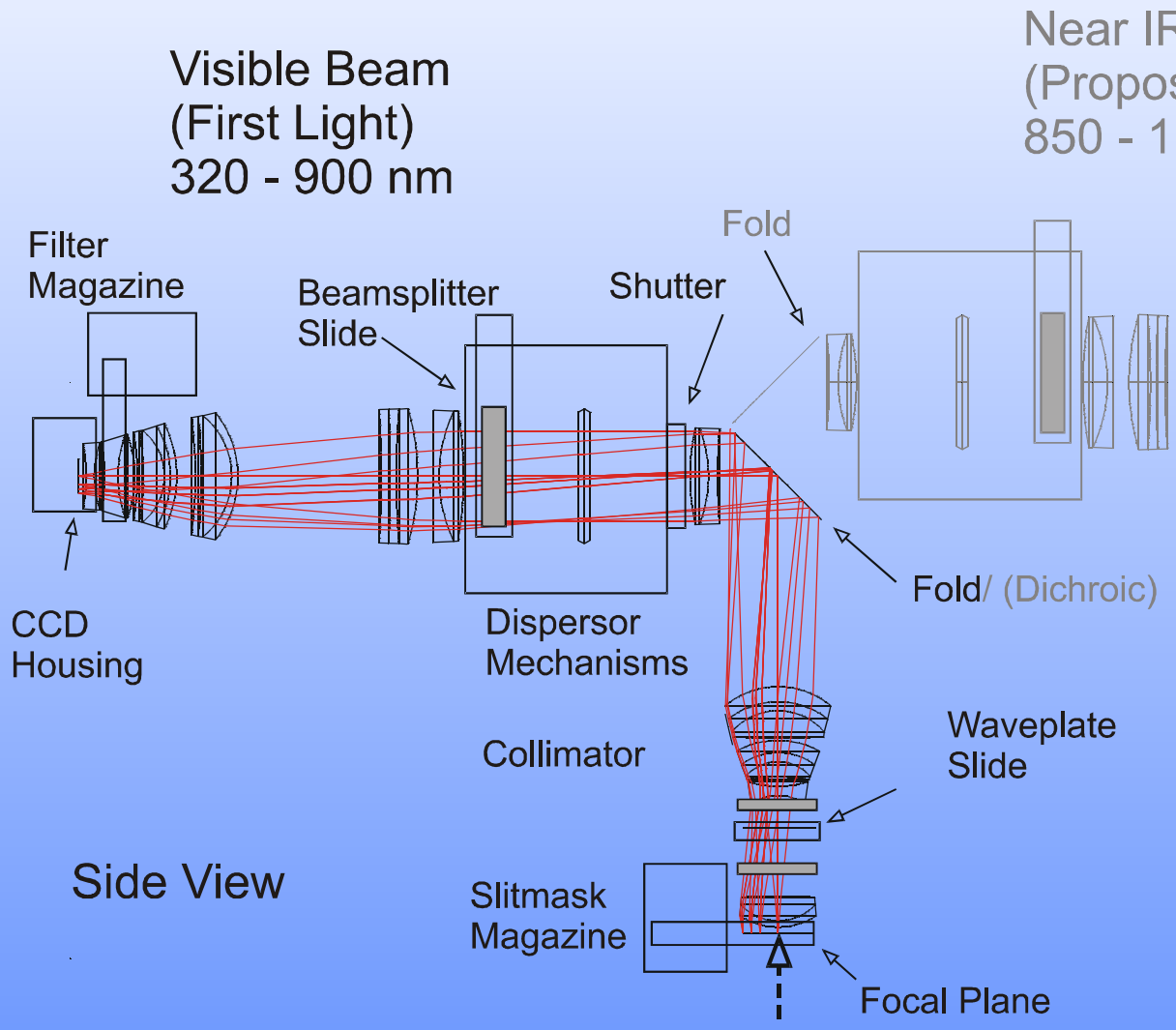
Measured SAL



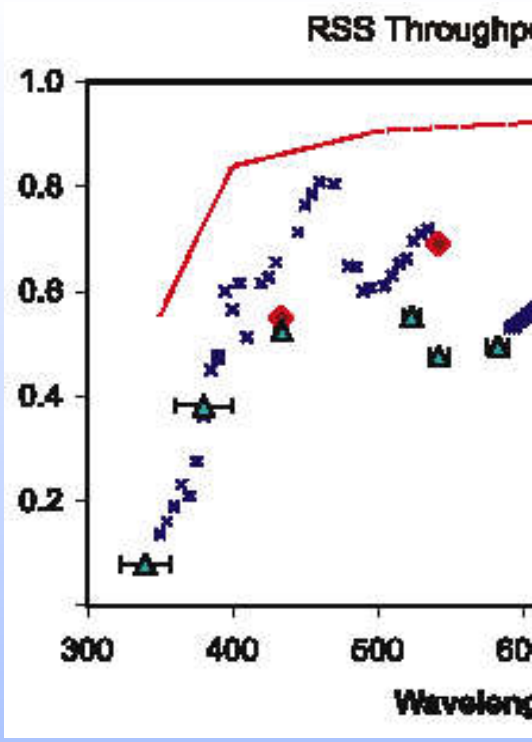
2. PFIS: Prime Focus Imaging Spectrogra
(now renamed *Robert Stobie Spectrograph*
PI: Ken Nordsieck, University of Wisconsin-Madison

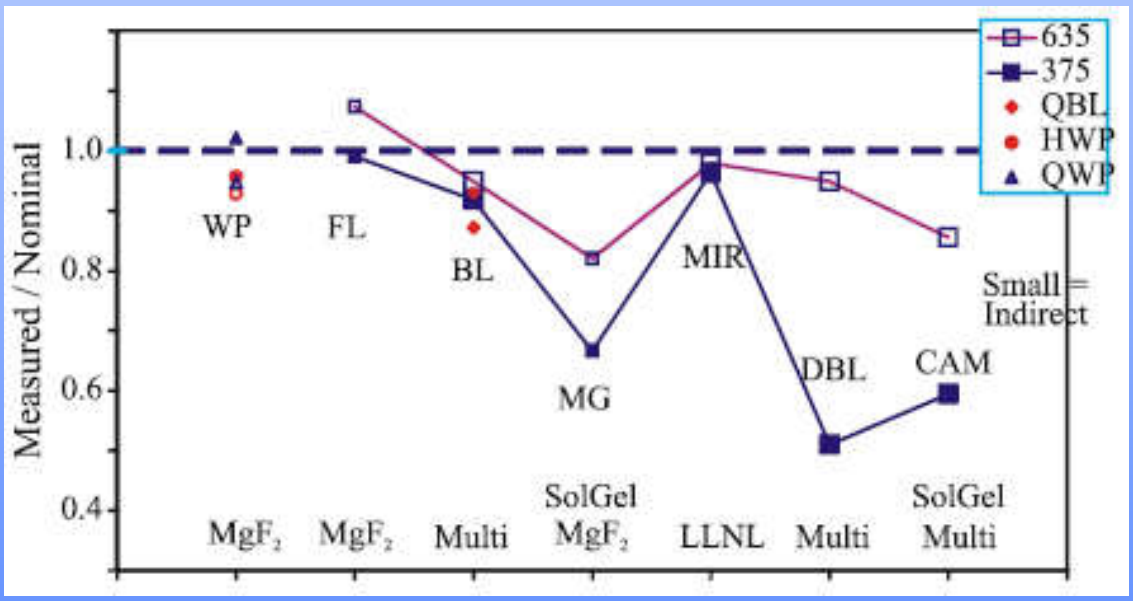


RSS Lay


Visible Beam
(First Light)
320 - 900 nm
Near IR B
(Propose
850 - 170
Filter
Magazine
Beamsplitter
Slide
Shutter
Fold
Fold/ (Dichroic)
CCD
Housing
Dispersor
Mechanisms
Collimator
Waveplate
Slide
Side View
Slitmask
Magazine
Focal Plane

Early commissioning showed that RSS throughput significantly less than specification!



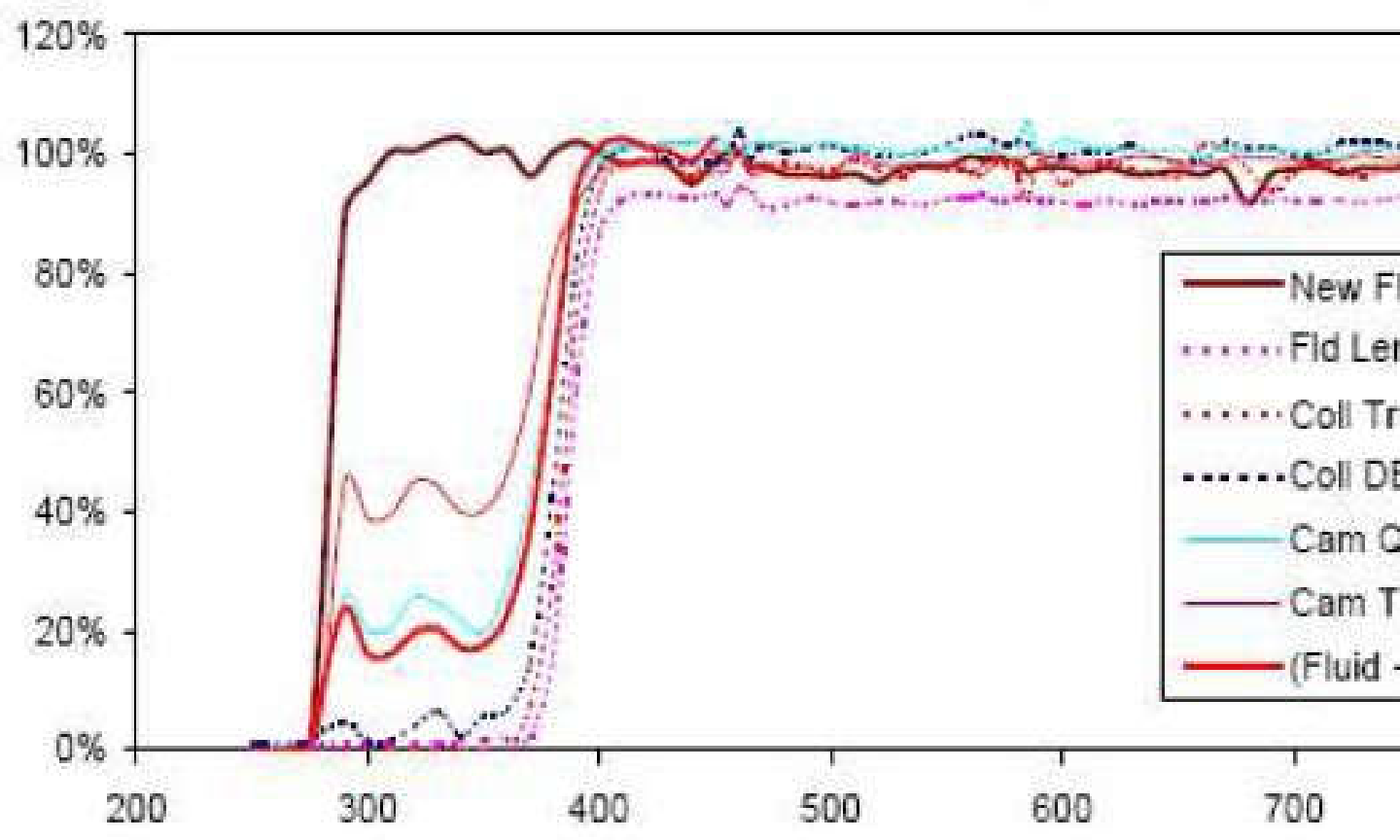


In situ tes
suspect c

Collimato
Collimato
Camera

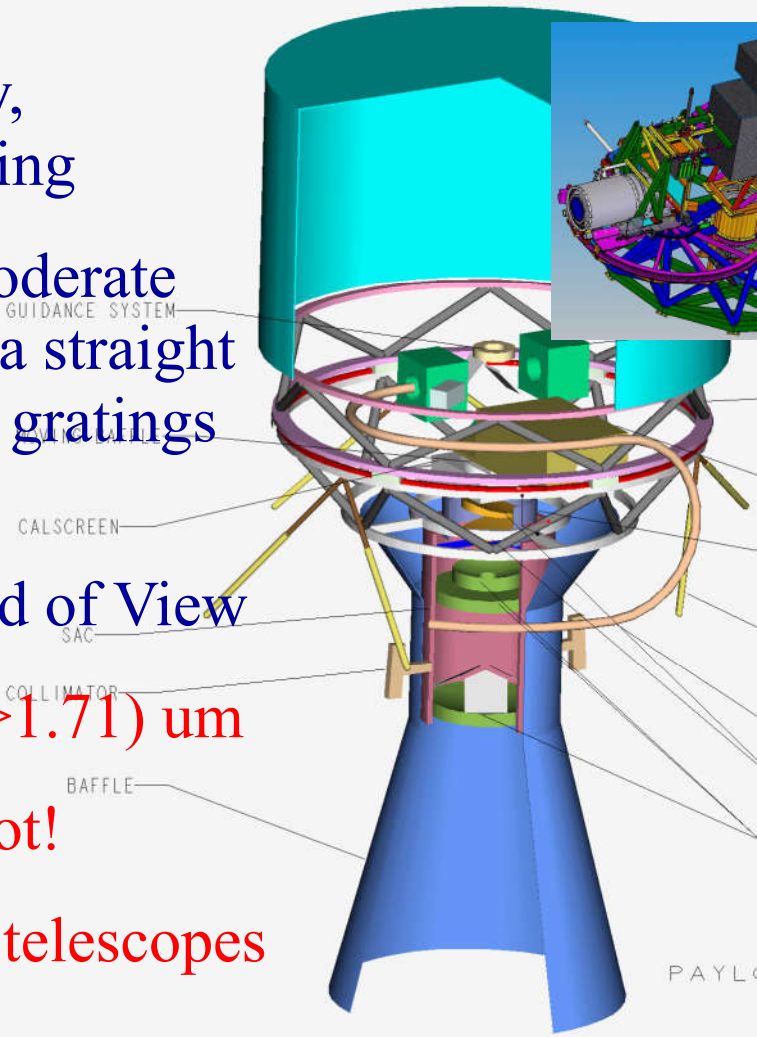
Removal of RSS from telescope in orc
dismantle the optics (Nov 16):

The problem? It was the lens coupl

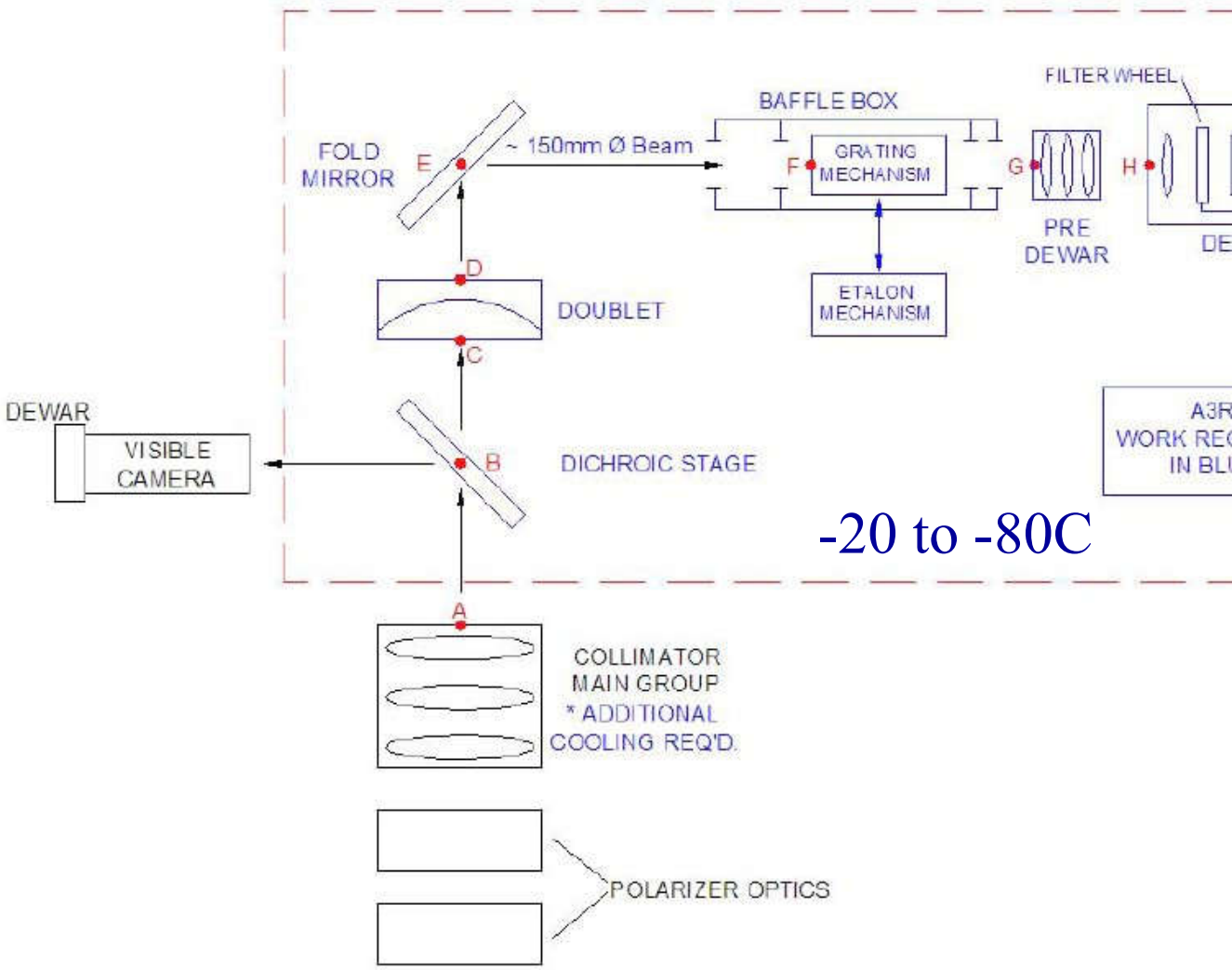


Latest development: RSS/NIR Bea

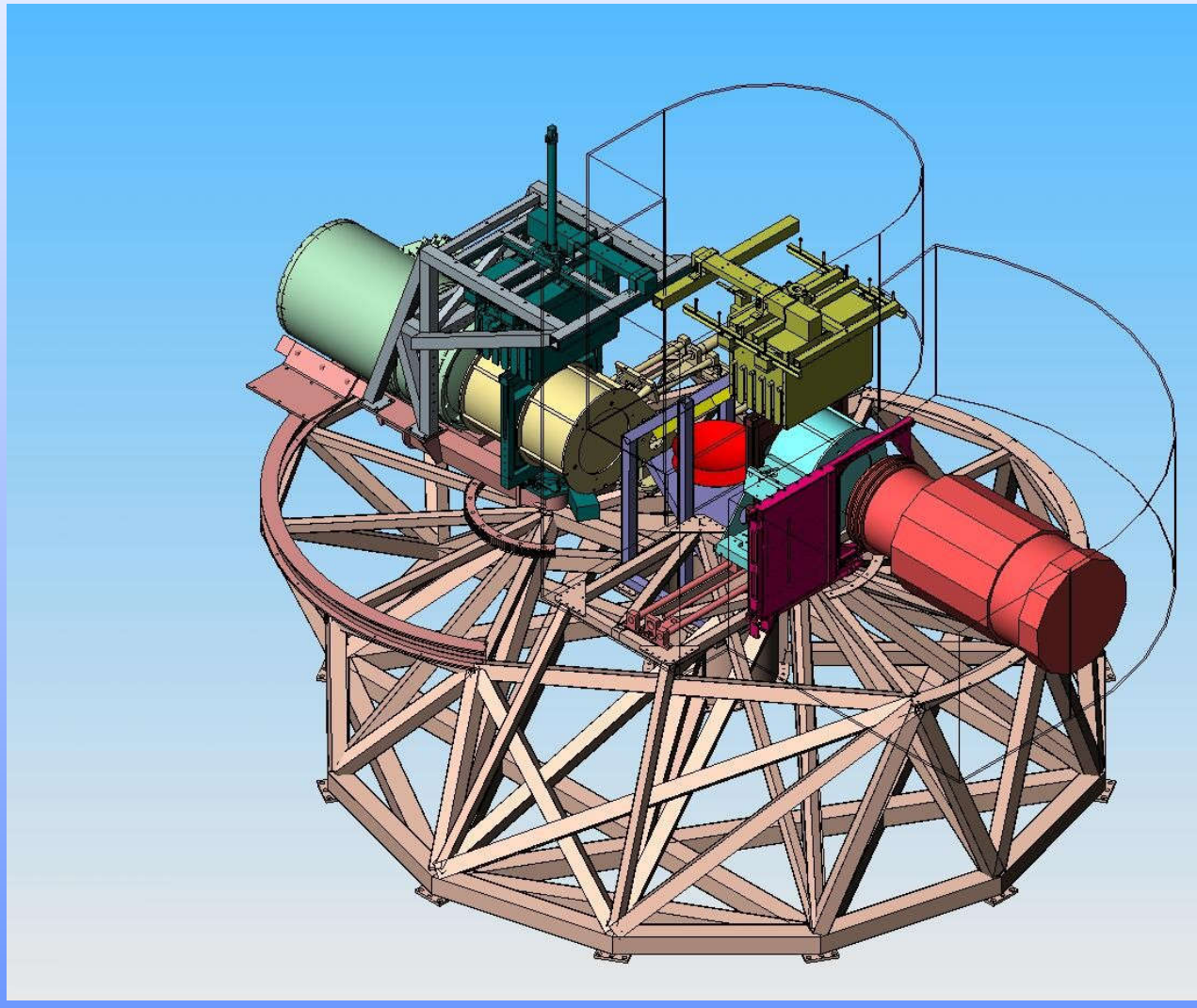
- Major upgrade to the prime focus spectrometer
- Imaging, spectroscopy, polarimetry, F-P imaging
- High-throughput + Moderate resolution achieved via straight through design +VPH gratings +high camera angle
- 8 arcmin diagonal field of View
- Response 0.85 -(1.54>1.71) um
- 0.3 - 1.7 um in one shot!
- UNIQUE at 10-meter telescopes



RSS/NIR Beam: Highlights

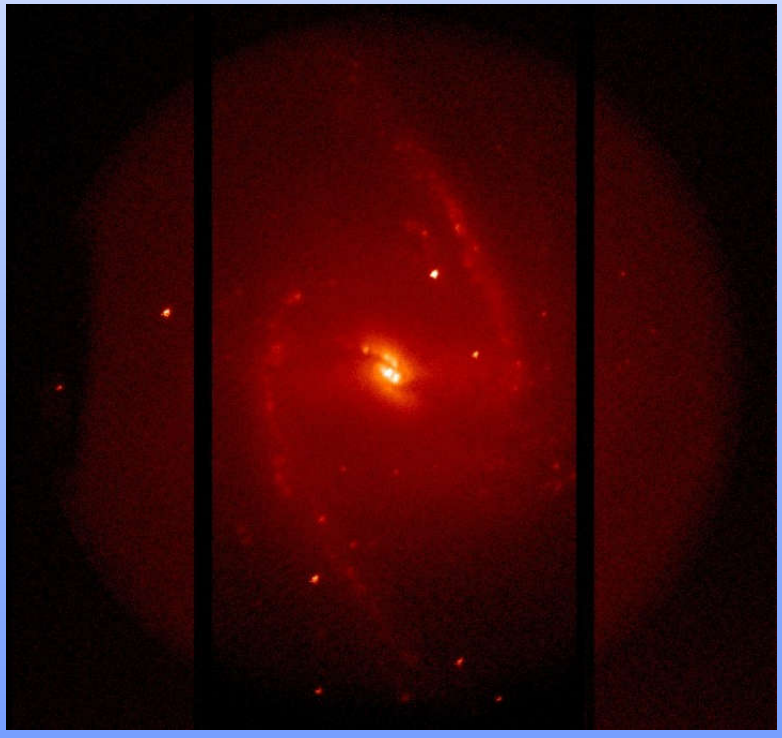


Articulating, “Full Enclosed”
(View 2 of 2)

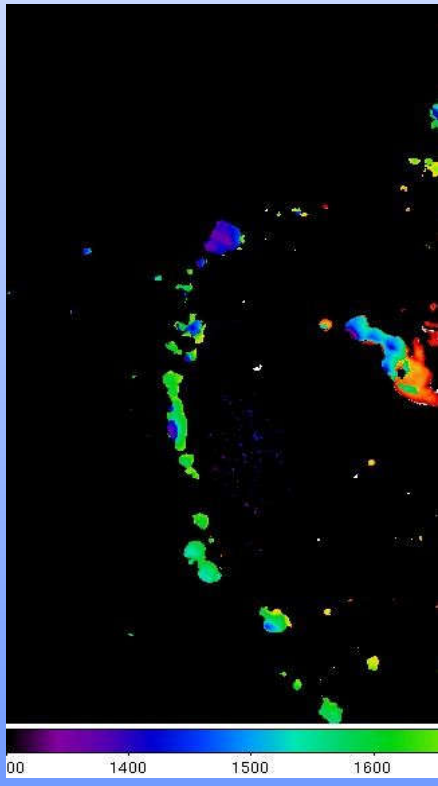


NGC 1365 (nearby, barred spiral)

8.5Å image centered on Hα

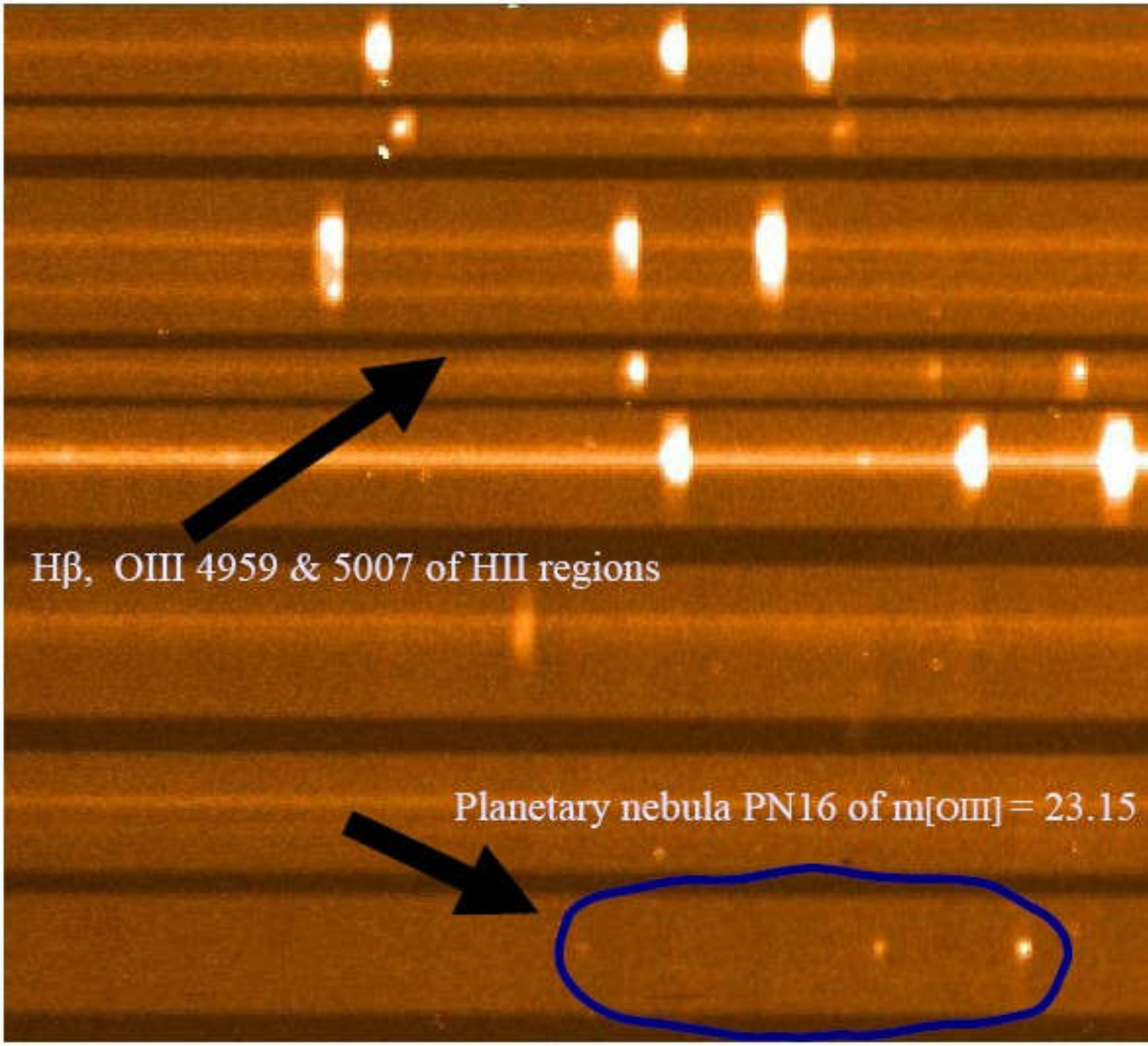


vel map from 18x1min



N.B. For serious velocity mapping, would use 4x higher resolution.
This was first ever SALT FP observations, map was produced within 24 h

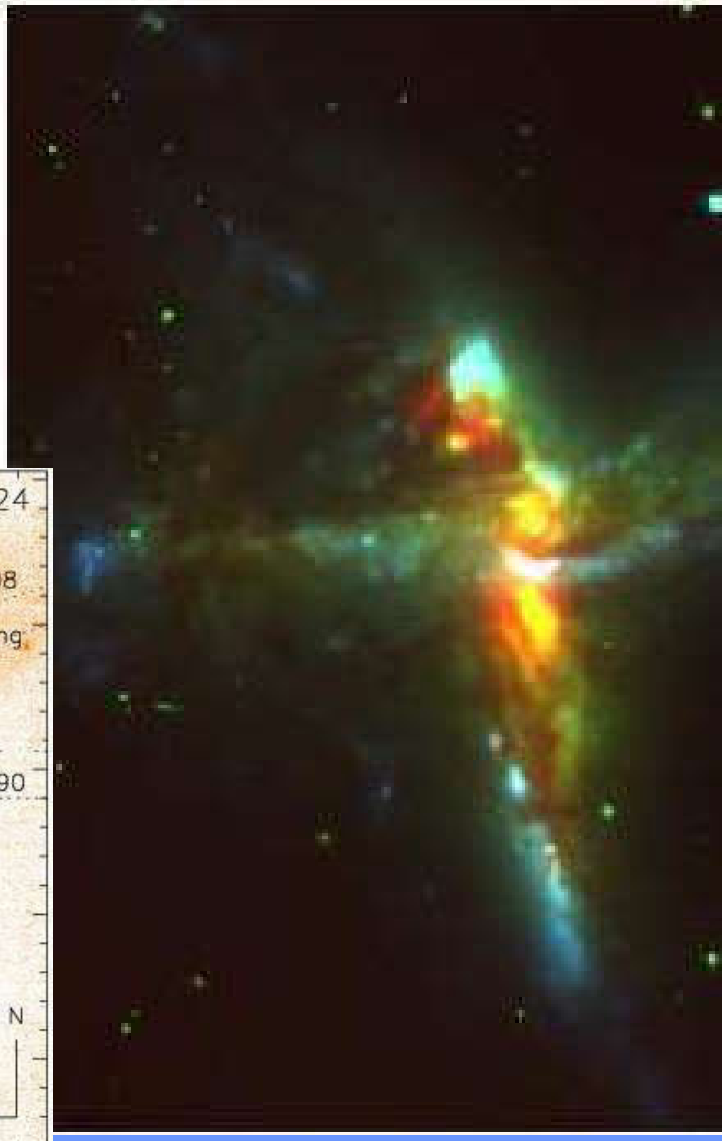
first tests of the MOS mode:

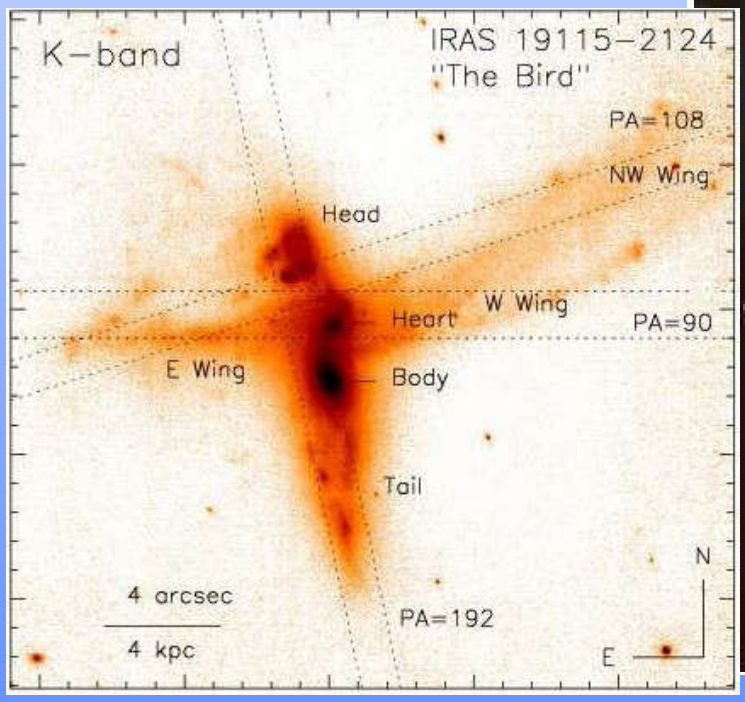


MOS spectra of PNe & HII regions in the dwarf irregular galaxy NGC

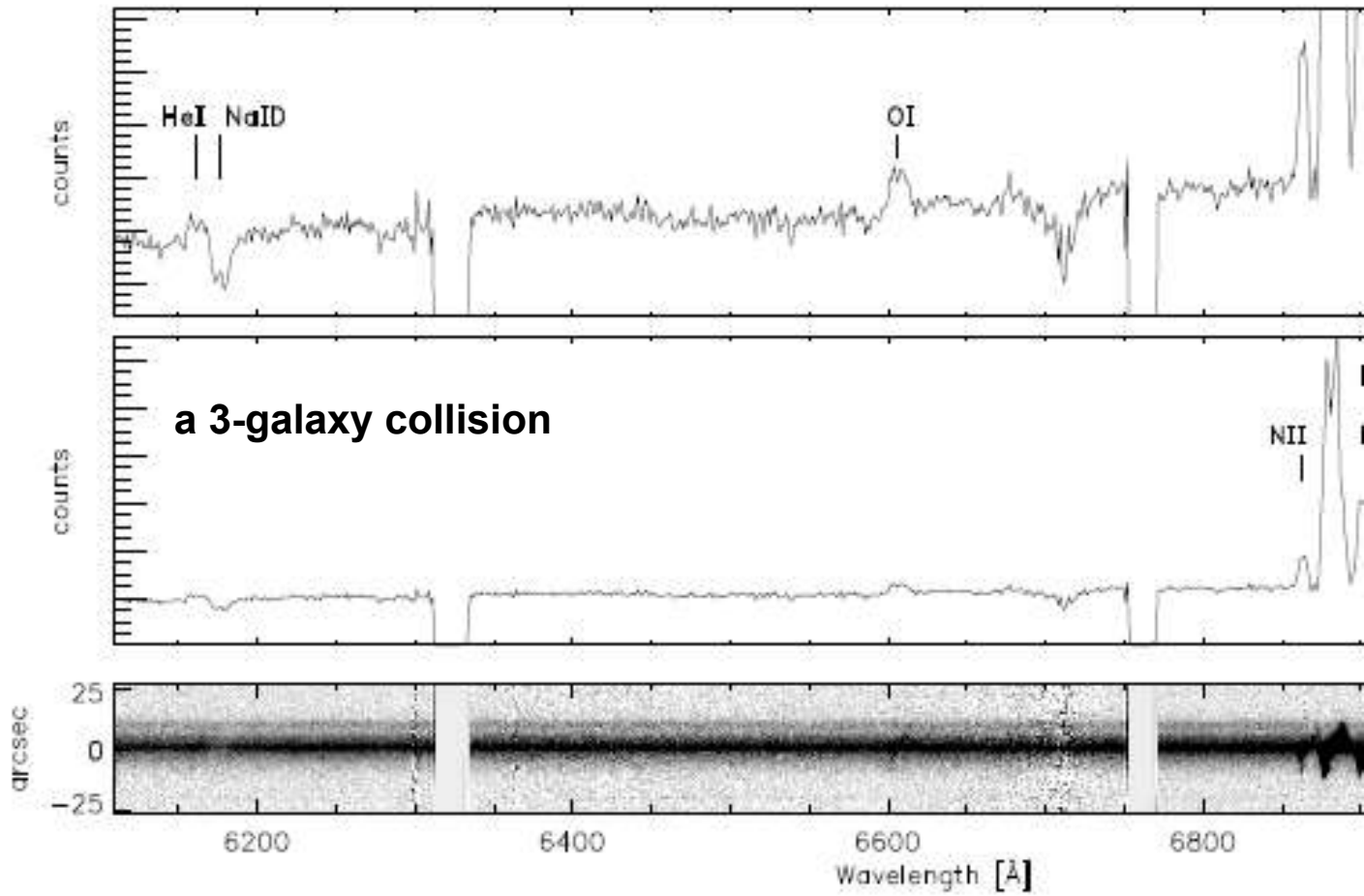
Anatomy of “The Bird”: a triple galaxy c
(Väisänen et al.)

- **A-O images from the VLT**
- **Spectroscopy from SALT**
  - **Kinematics point to a 3-galaxy collision**

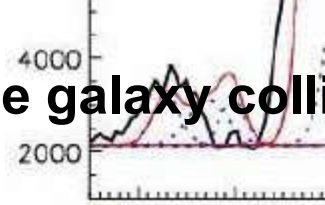


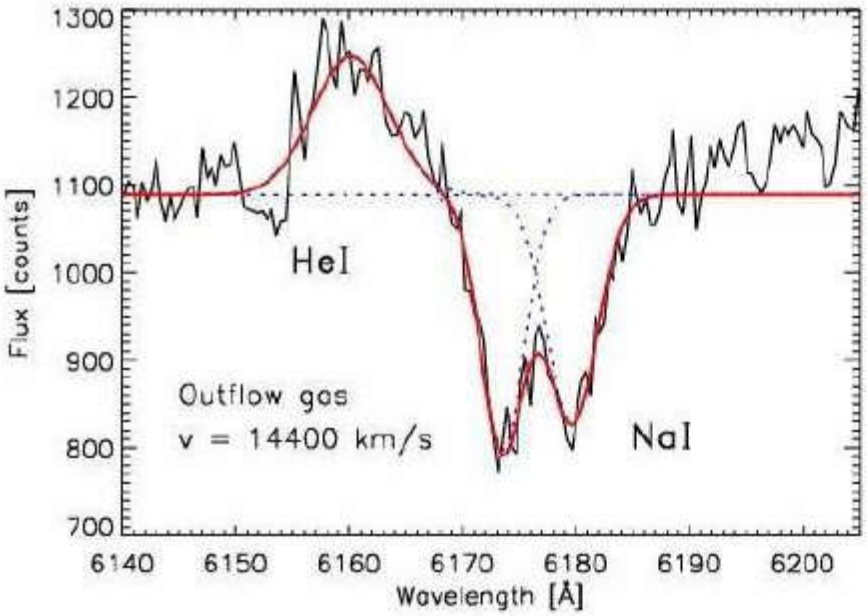


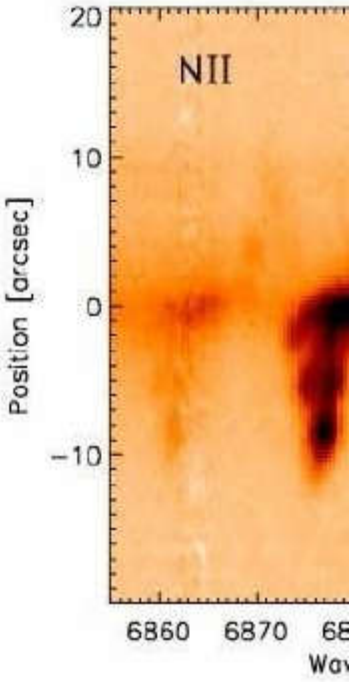
Anatomy of “The Bird”: a triple galaxy colli

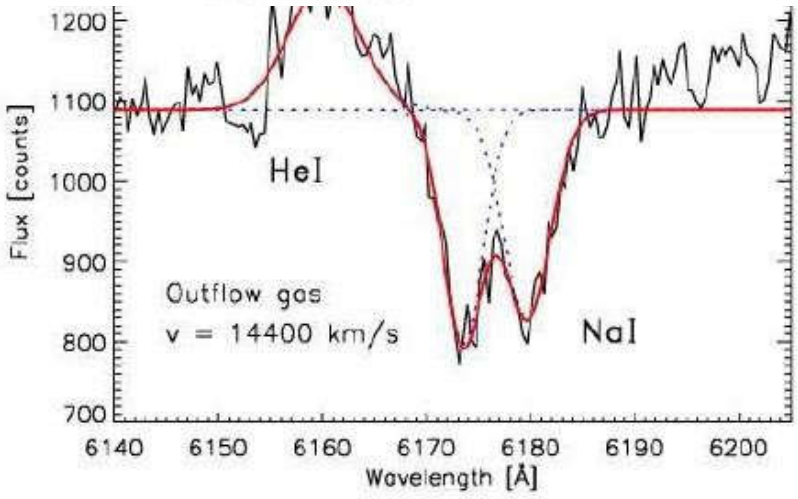


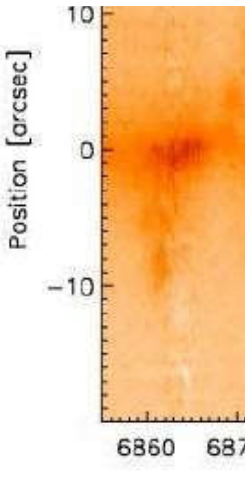
Anatomy of “The Bird”: a triple galaxy colli







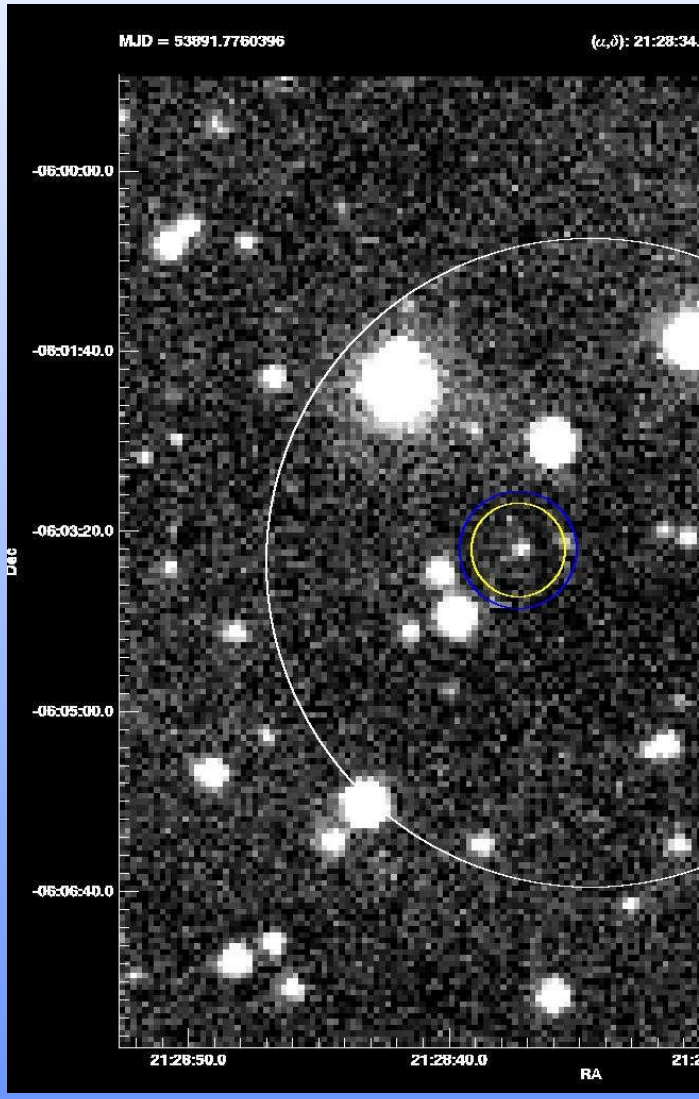




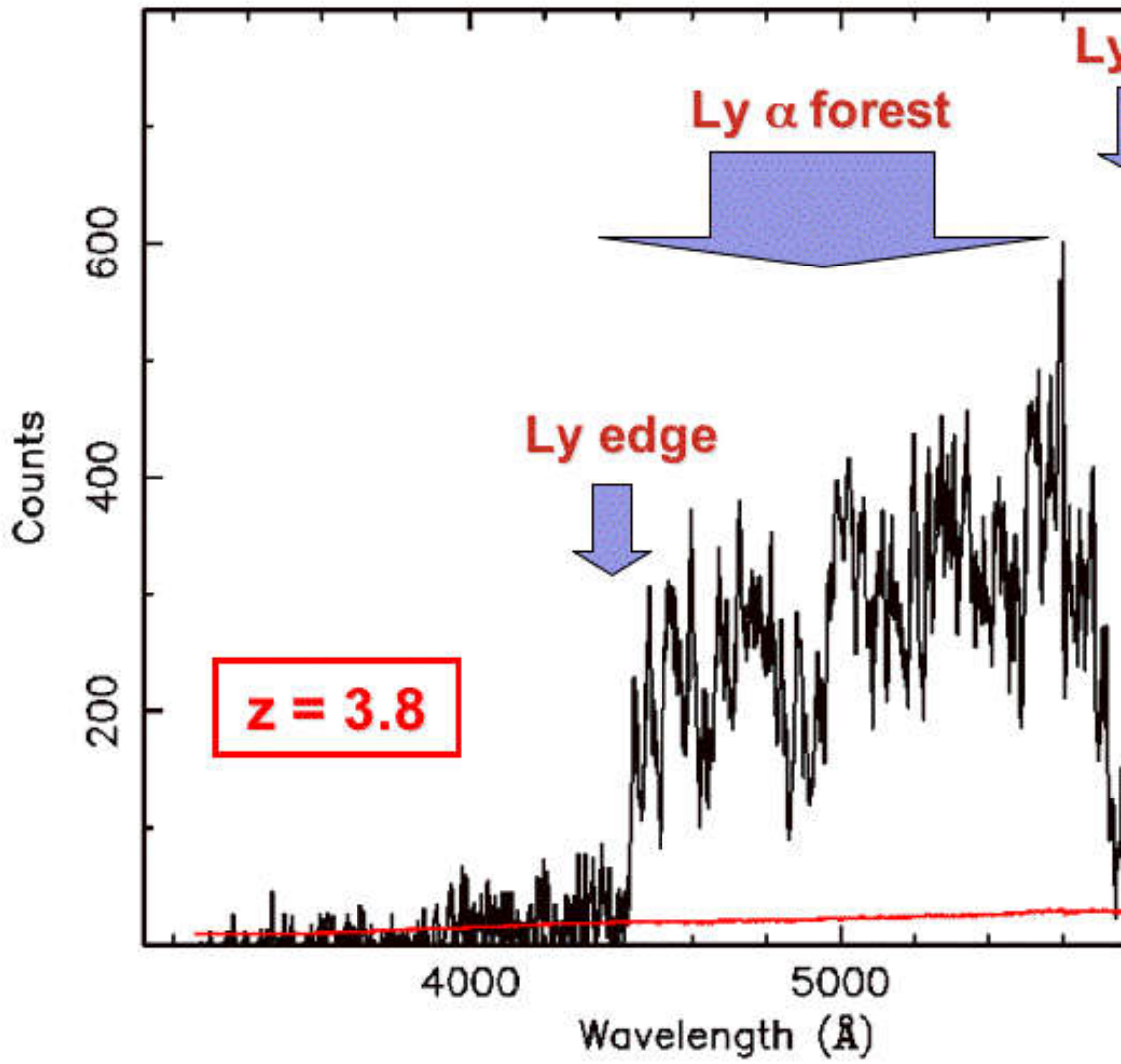
GRB 0606
(SA & U. North

SALT Observations ~8 hours After alert

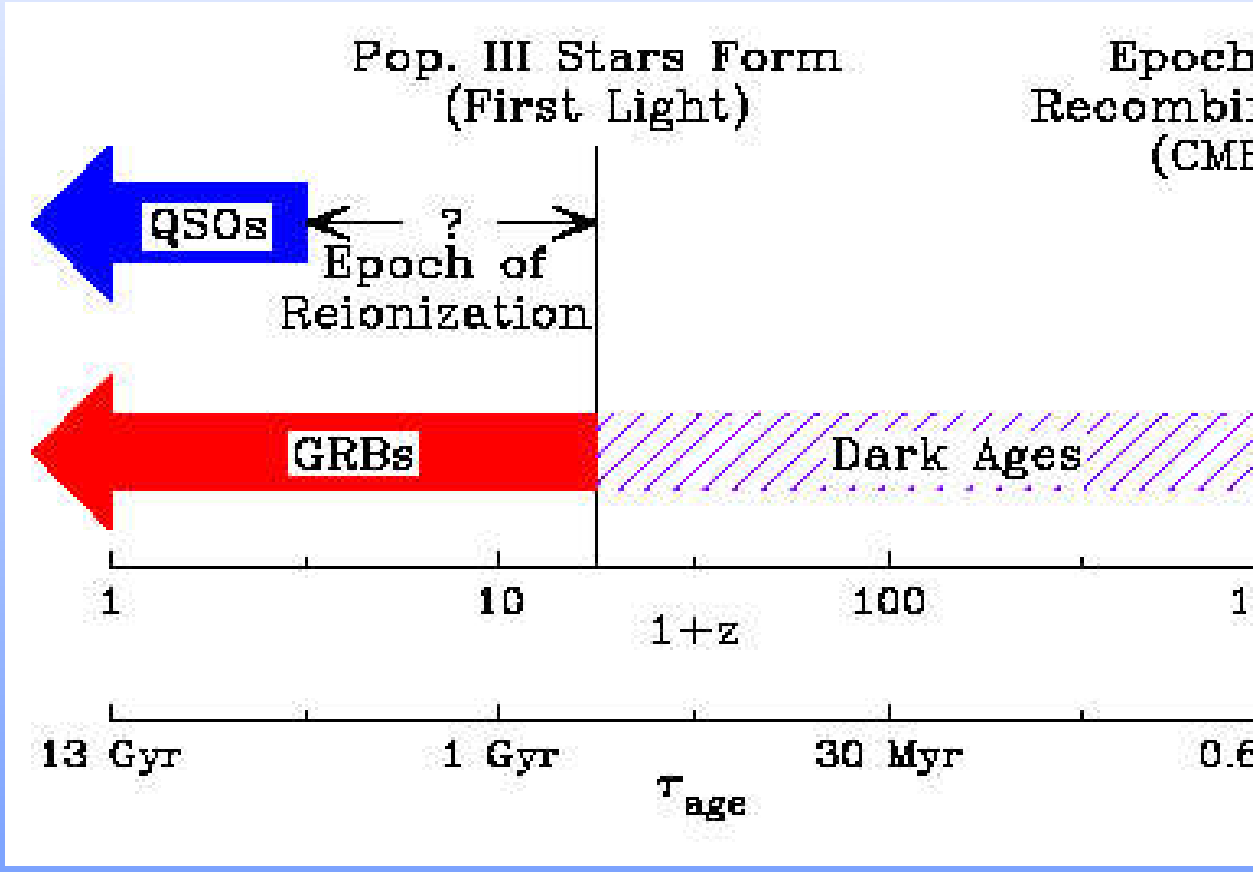
- **MSSSO obs. at V ~ 15**
- **SAAO obs. at V ~ 20**



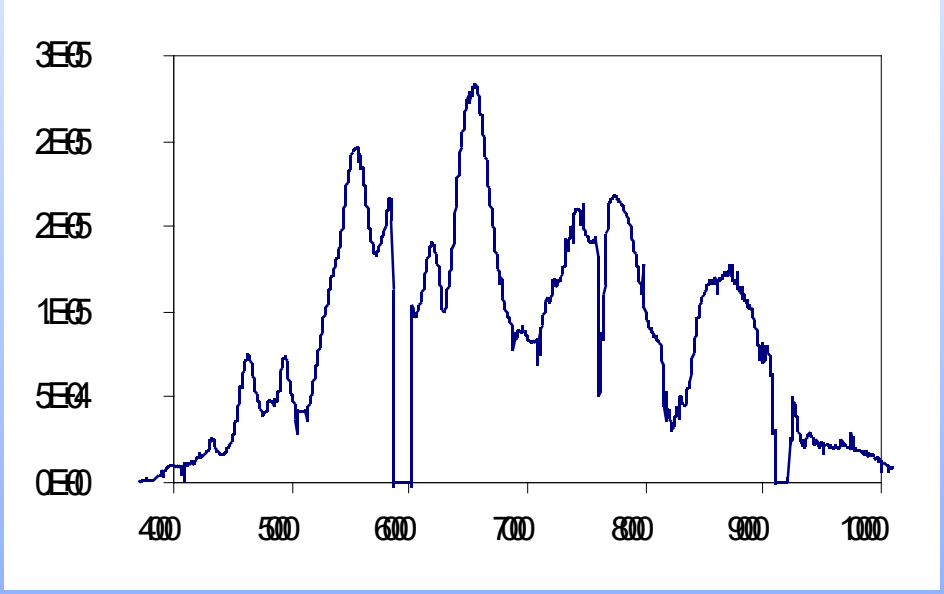
GRB 0606
(SA & U. North C

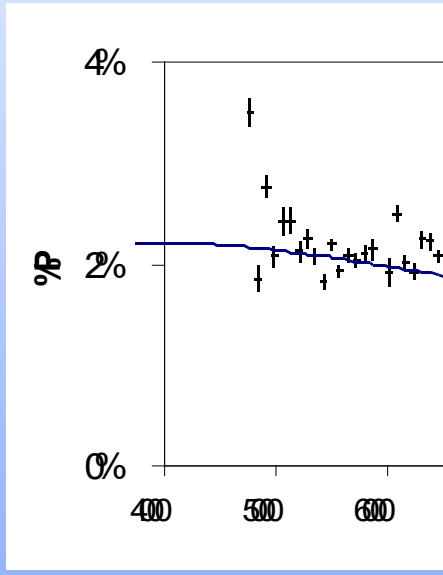


Importance of GRBs:



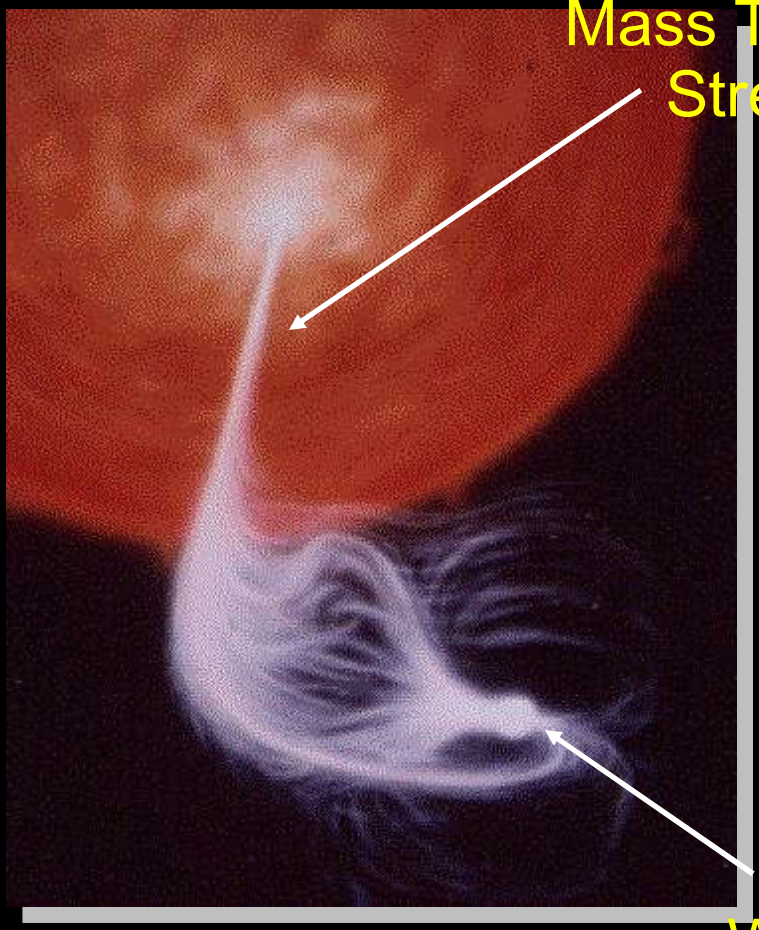
On-sky RSS polarimetry commissioning (
Spectropolarimetry of SNe (Nordsieck,





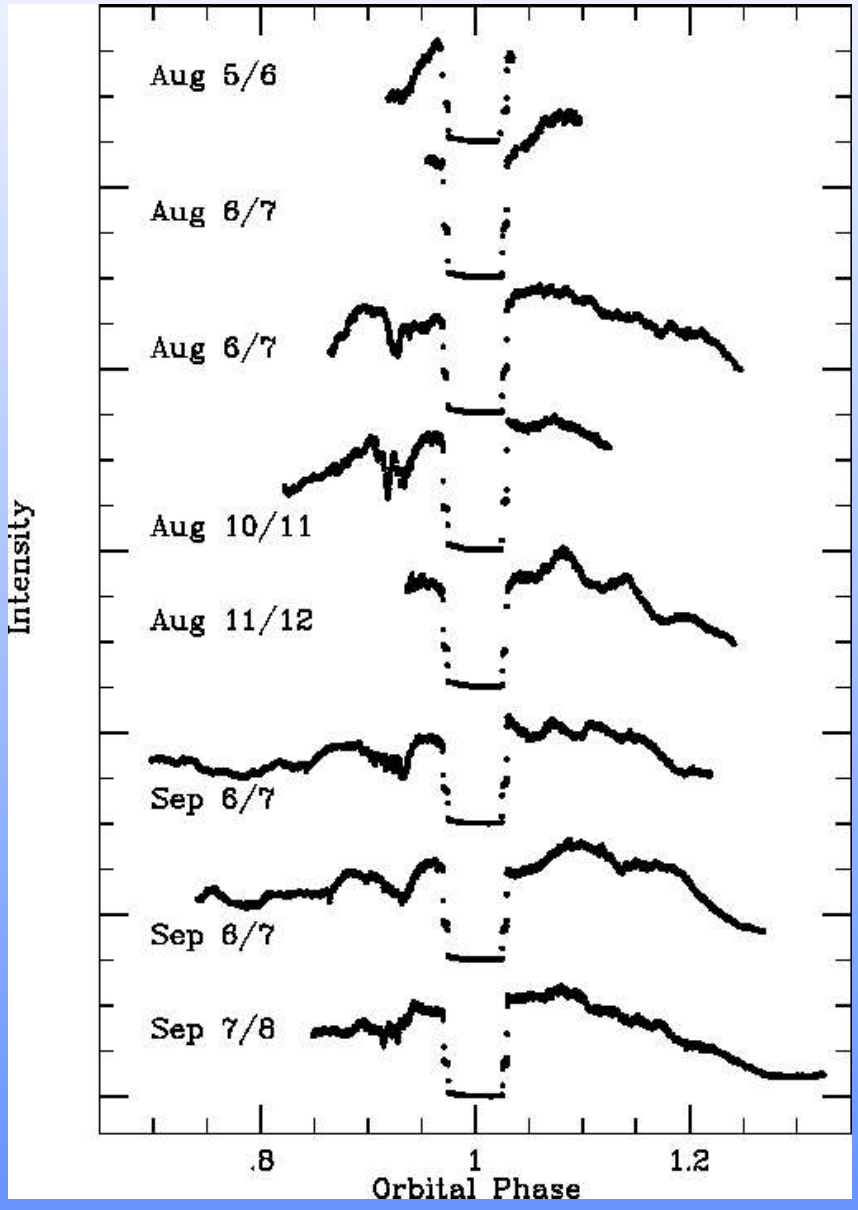
Spectropolarimetry of SN2006mq

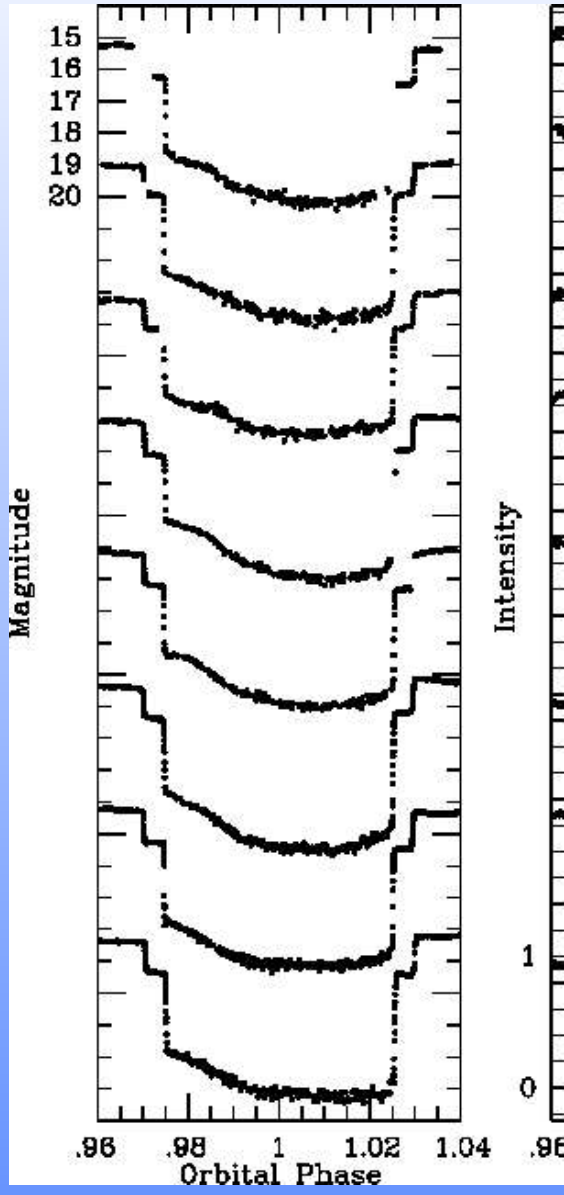
Polars (Magnetic CVs)

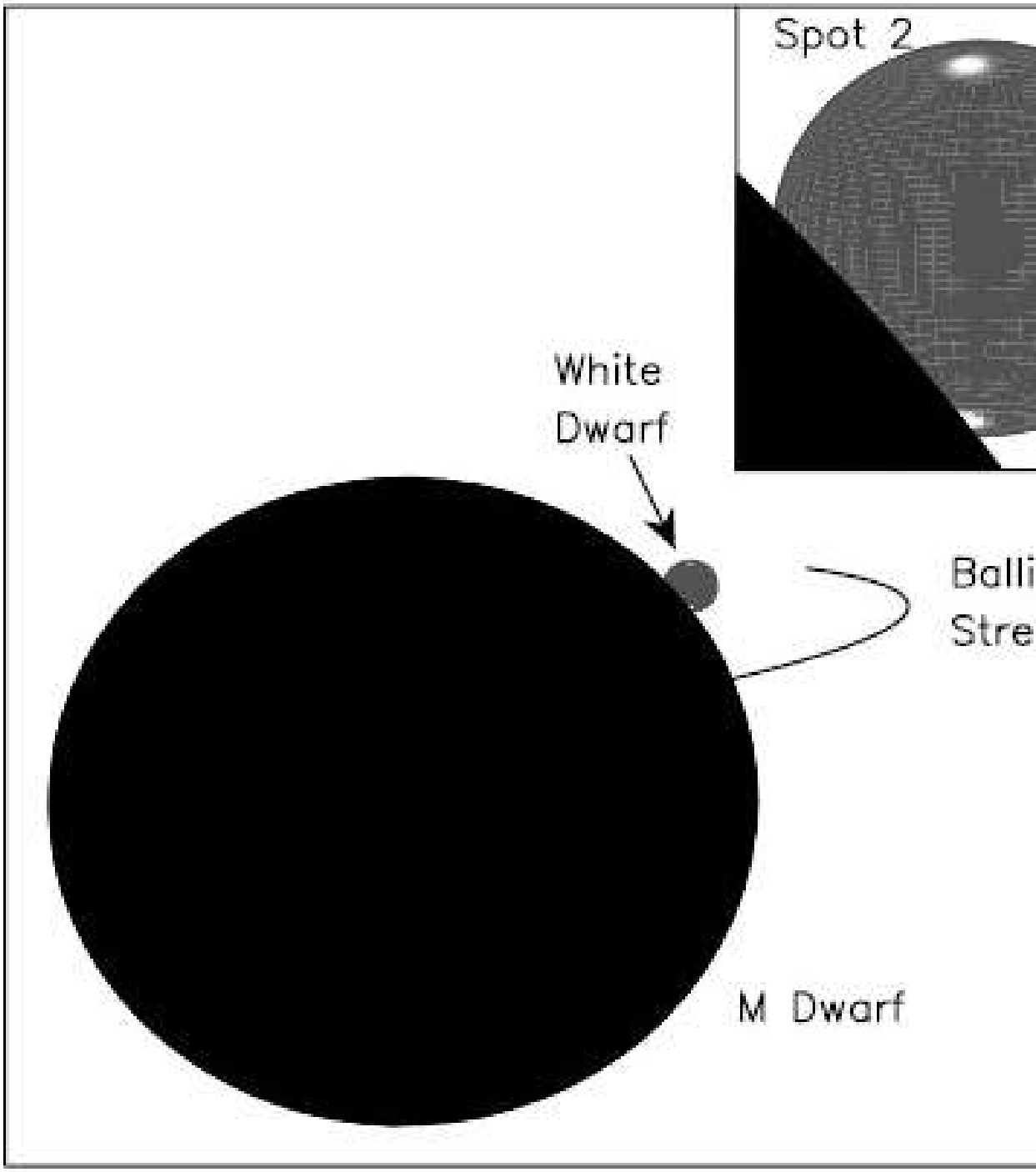


- Strongly magnetic inhibits accretion
- Instead, magnetic channels accretion magnetic poles of
- White dwarf magn huge: 10-200 Meg

Eclipse curves of SDSS J015543.30+002807.2






Spot 2
White
Dwarf
Balli
Stre
M Dwarf

Concluding remarks:

INTERNATIONAL YEAR OF ASTRONOMY 2009

THE UNIVERSE : YOURS TO DISCOVER

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