
The Future of the SALT &
Opportunities for BRICS Participation
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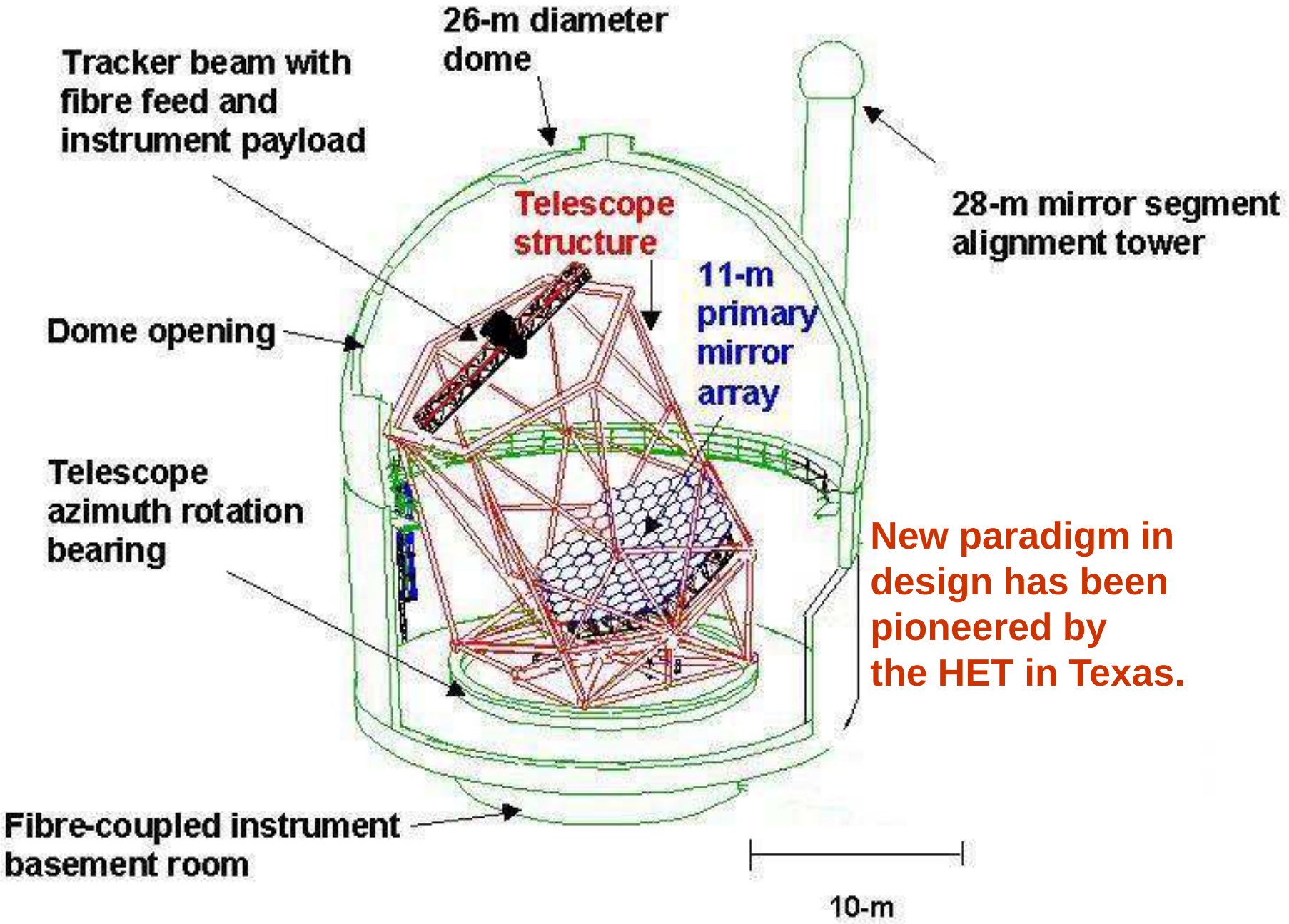
SALT

One of the "Big Five": Segmented Mirror Telescopes

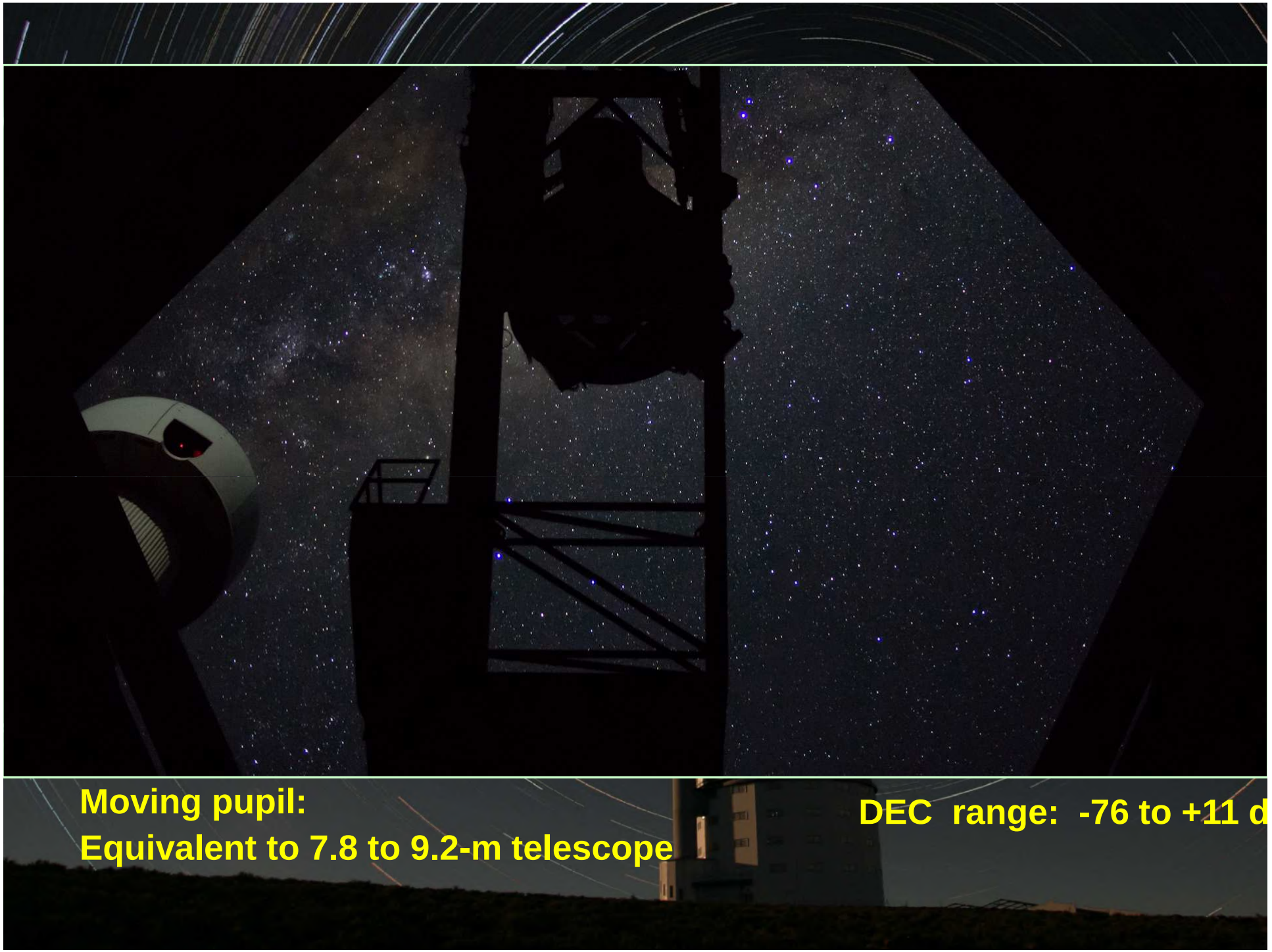
- Keck I (1993) & Keck II (1996): Hawaii, USA
- HET (1999): Texas, USA
- SALT (2005): South Africa
- GRANTECAN (2009): Canary Islands, Spain

These telescopes currently have the largest light grasp

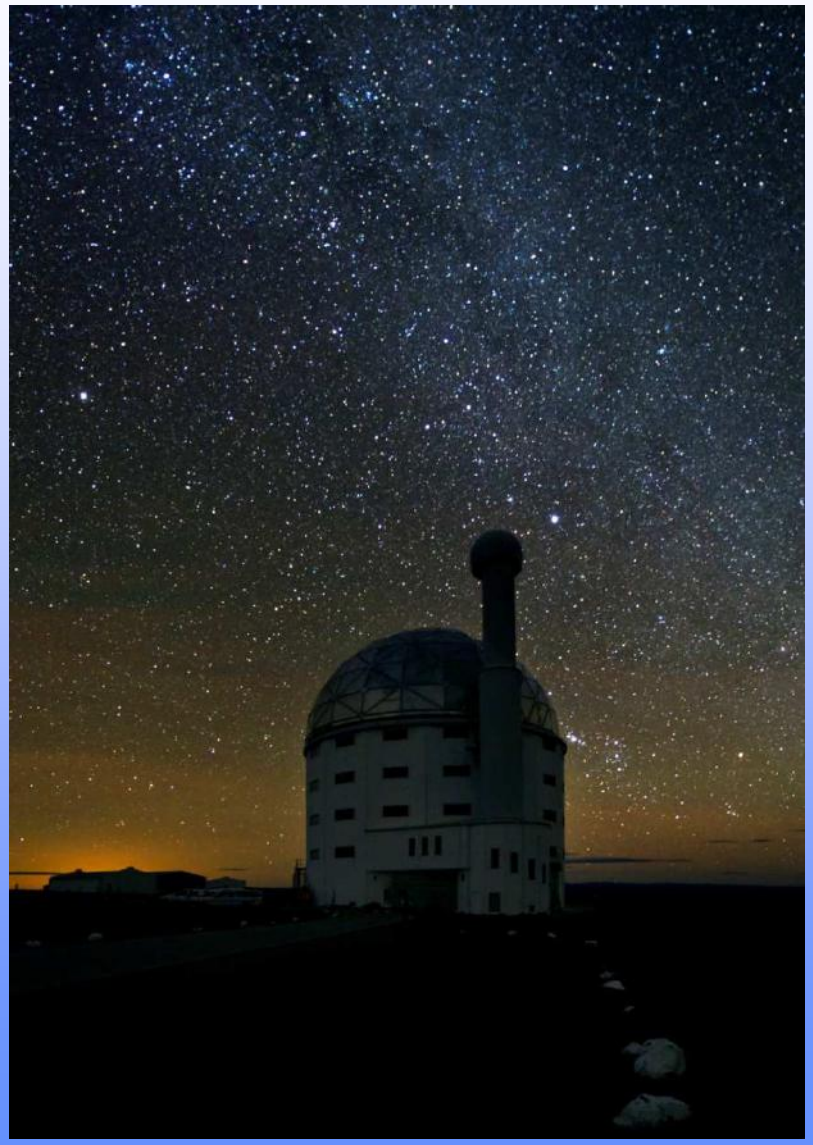
Southern African Large Telescope



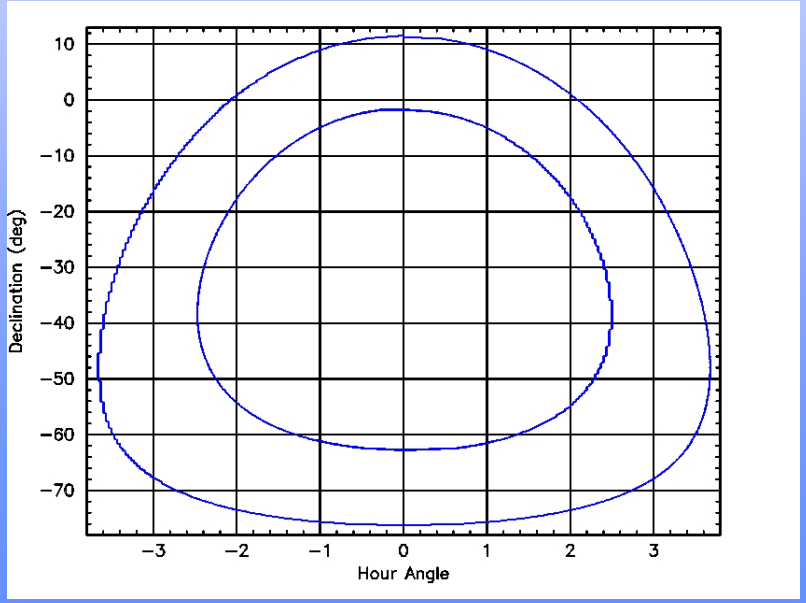
New paradigm in design has been pioneered by the HET in Texas.


Moving pupil:
Equivalent to 7.8 to 9.2-m telescope
DEC range: -76 to +11 d

Observing With SALT



- 100% queue scheduled service observing
- Variety of instruments/modes
- Rapid instrument changes and mode configurations
- Scheduling allows for synoptic monitoring at difference cadences
- Targets of Opportunity can be done at short notice
- Ideal for followup of transients



SALT Partners

It is a good time to be a SALT Partner.

New collaborations sought (~10% opportunity)

South Africa is a 35% Partner

Poland is a 10%Partner

NRF National Research Foundation | SAAO South African Astronomical Observatory

IUCAA

Nicolaus Copernicus Astronomical Center

Dartmouth

The University of North Carolina at Chapel Hill

Rutgers The State University of New Jersey

The Open University

Keele University

uclan

The University of Nottingham

University of Southampton

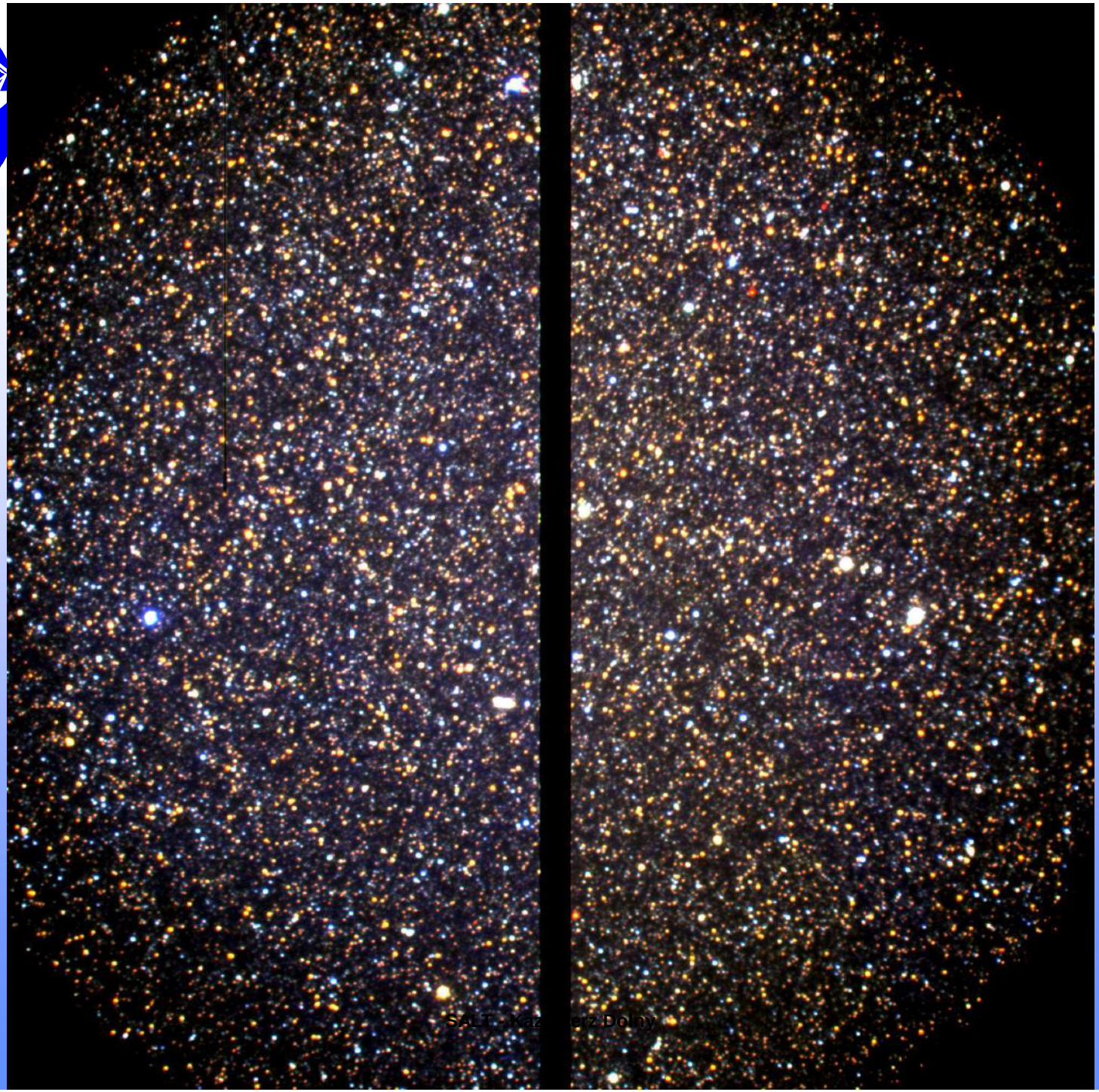
Armagh Observatory

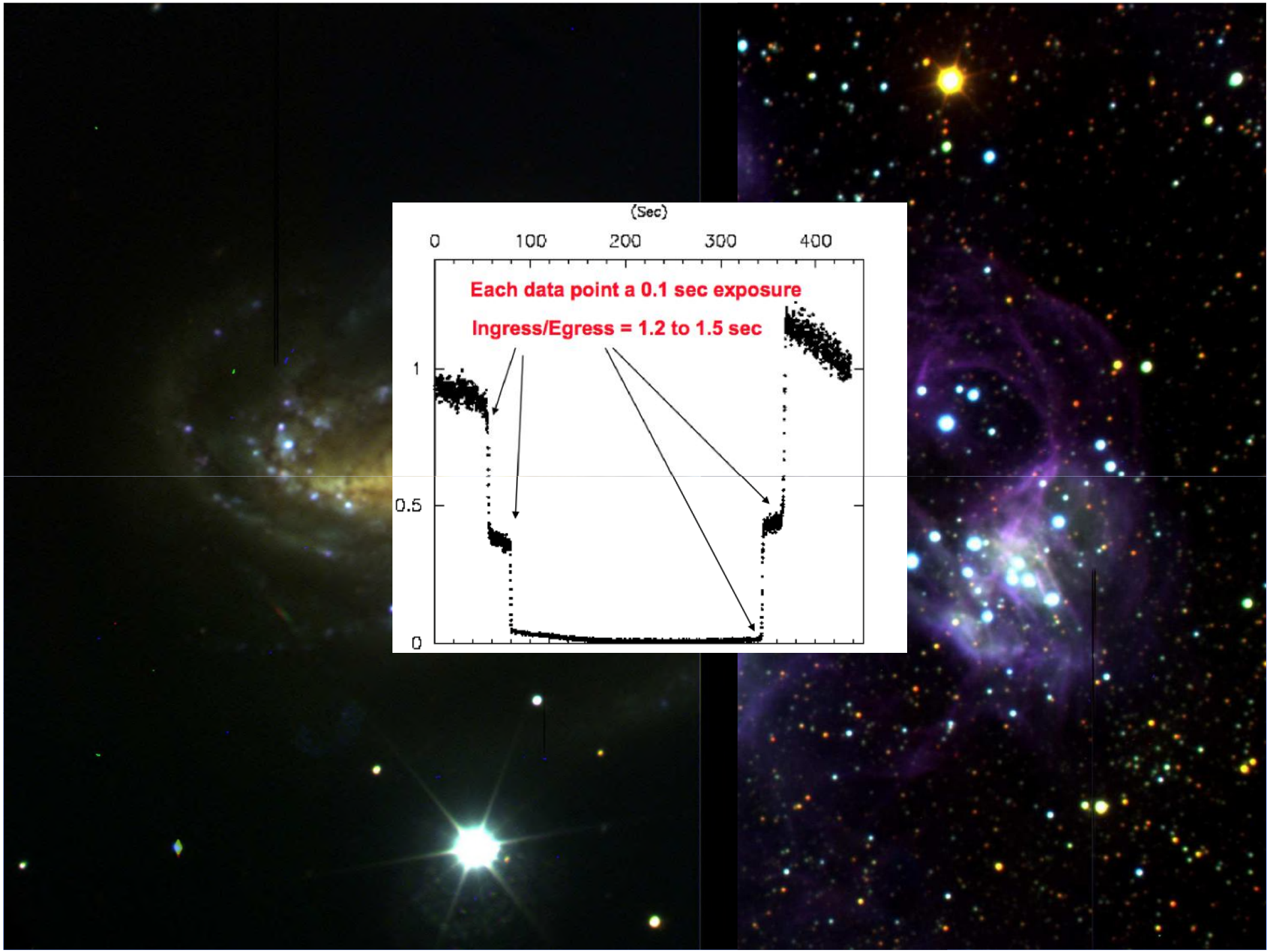
WISCONSIN

American Museum of Natural History

SALT First-Generation Science Instruments

- Instruments chosen to give SALT a wide range of capabilities
- Ensure competitiveness with niche operational modes
  - UV, Fabry-Perot, high-speed, polarimetry
- Take advantage of SALT design and *modus operandii*
- Nominally budgeted for 3 “first generation” instruments
- First two (‘first light’) instruments:
  - SALTICAM: a sensitive “video camera” (up to ~15 Hz)
  - Robert Stobie Spectrograph (RSS):a versatile imaging spectrograph
  - Both installed in 2005
- Last one, a fibre-fed High Resolution Spectrograph
  - Delivered and installed in Sep 2013
  - Fully operational since Apr 2014



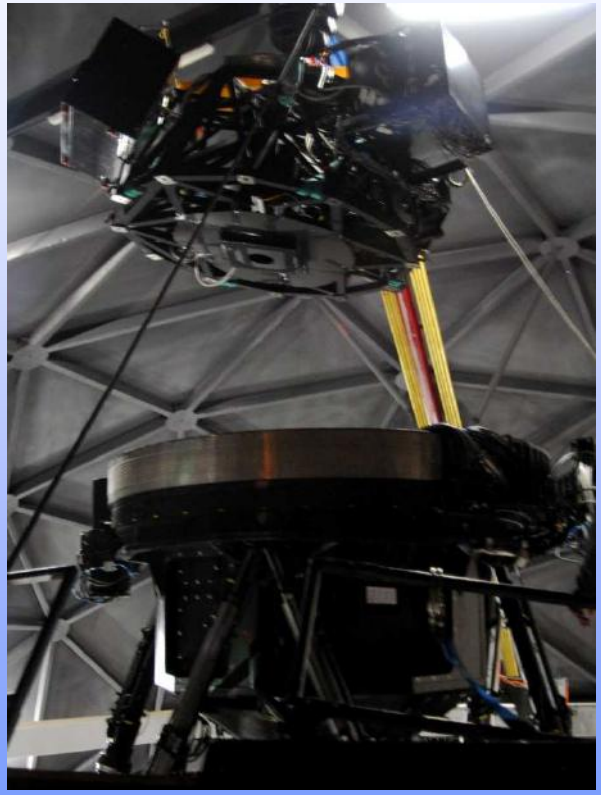

(Sec)
0
100
200
300
400
Each data point a 0.1 sec exposure
Ingress/Egress = 1.2 to 1.5 sec
1
0.5
0

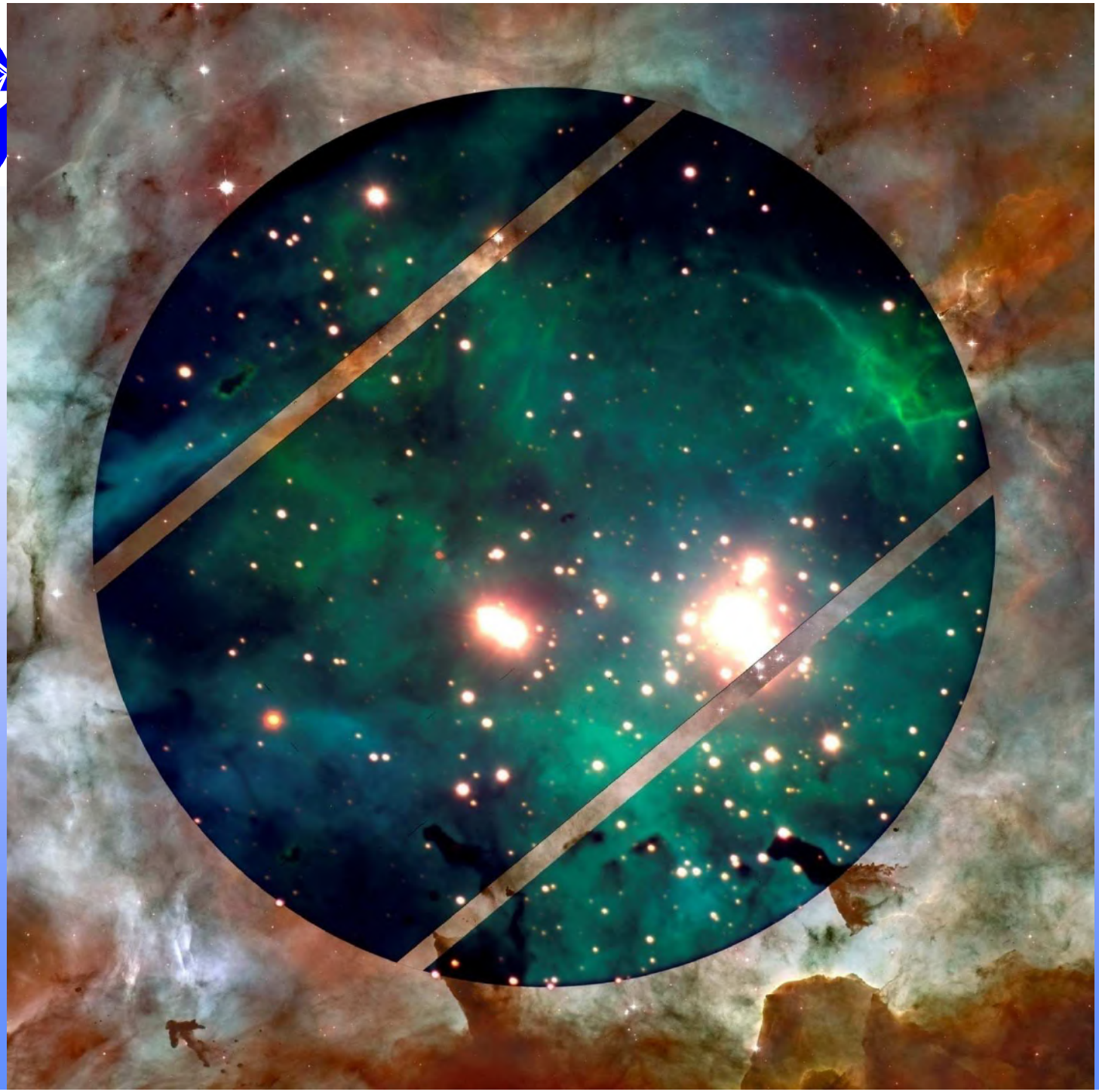
RSS:Robert Stobie Spectrograph

- Efficient Prime Focus imaging spectrograph
- Covers ~320 – 900nm
- Long slit and multi-object (~50) spectroscopy
  medium resolution, *R* ~ 350 to 10,000
- Very flexible Resolution and wavelength coverage.
- Fabry-Perot imaging spectroscopy
- Imaging polarimetric and spectropolarimetric modes
- High Time resolution ~100 ms spectroscopy

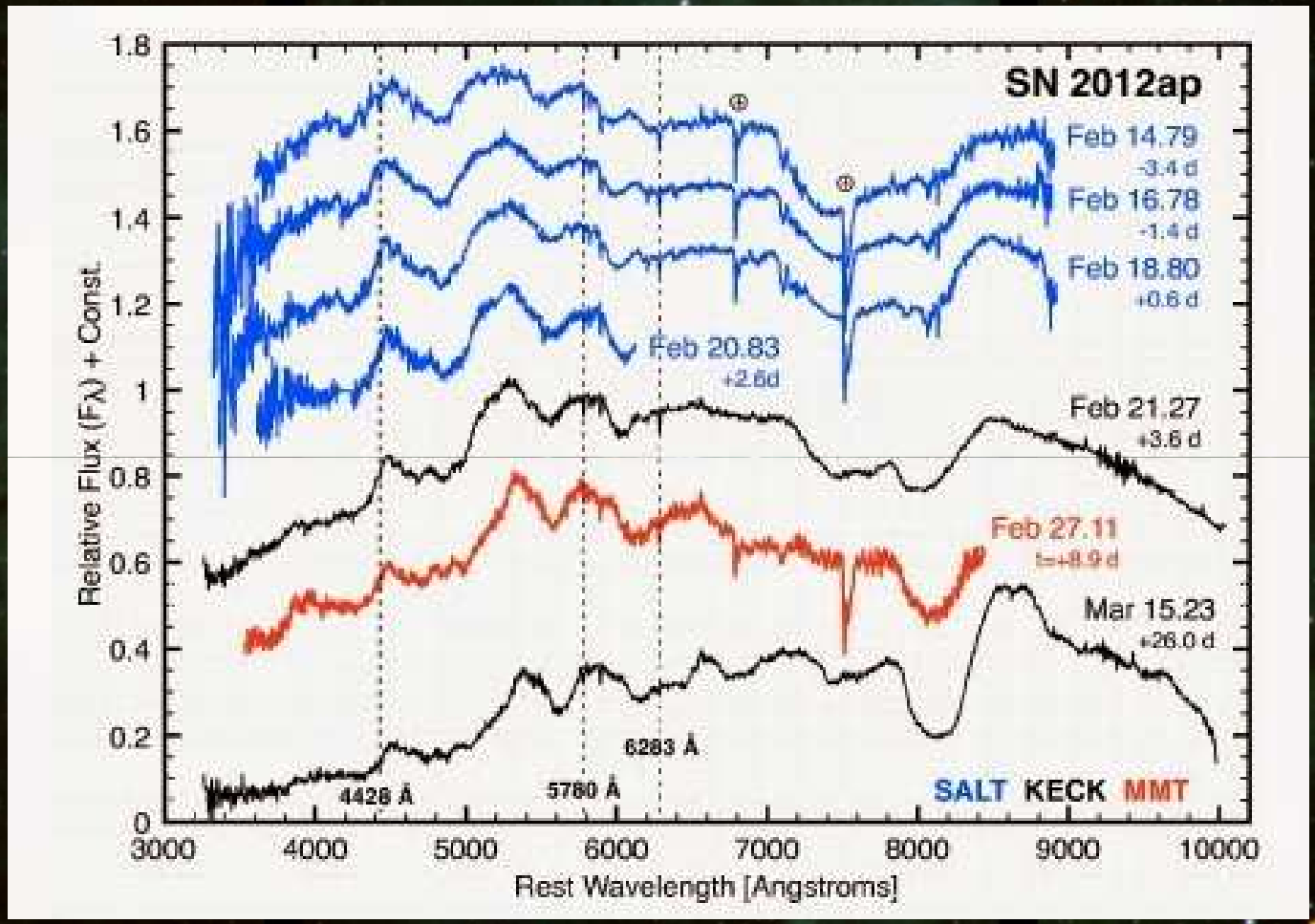
- The work-horse instrument on SALT

- Upgrade to near-IR beam IFU unit (J,H) in 2019/20

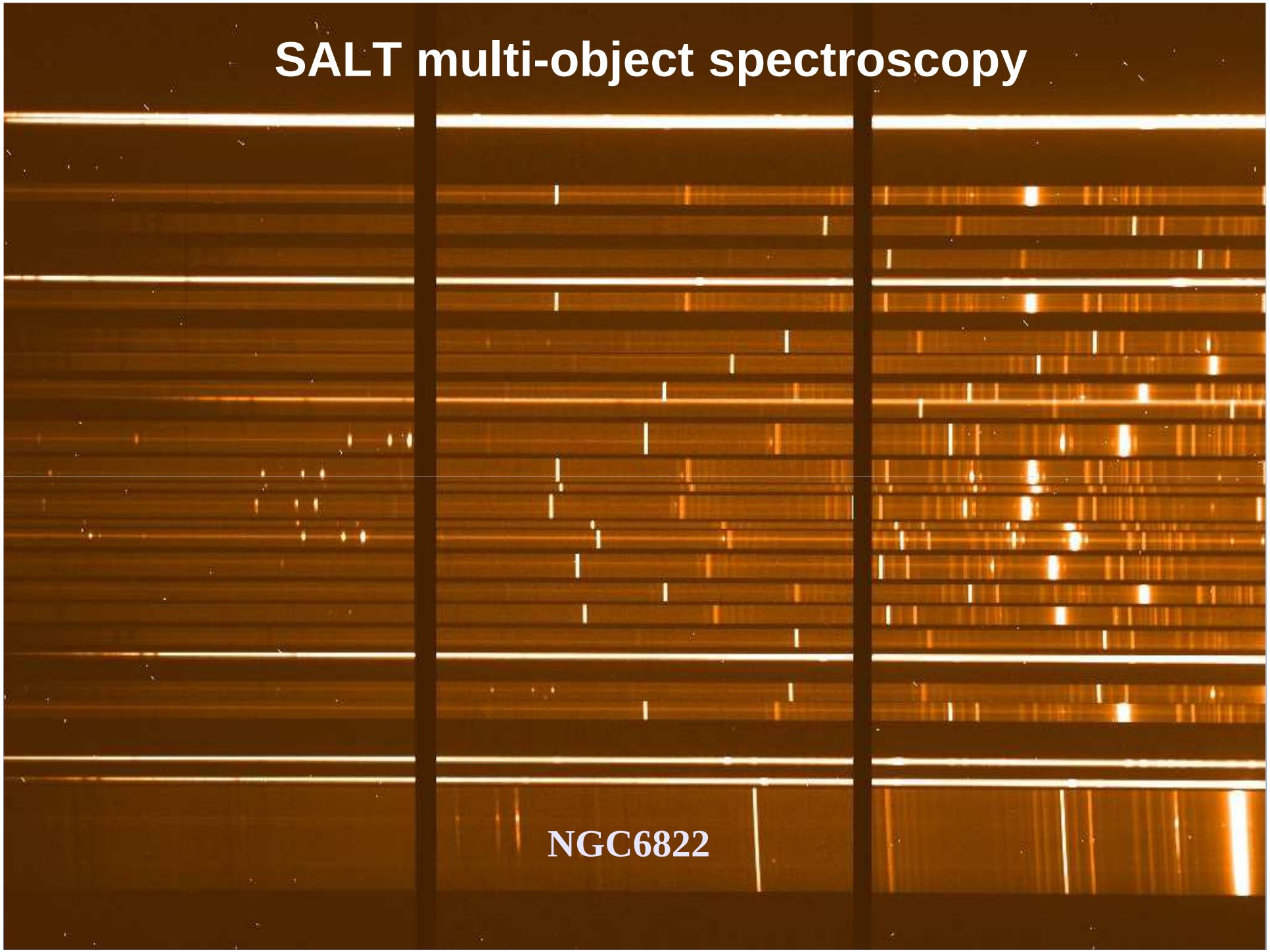



S·A·L·T

SALT long-slit spectroscopy

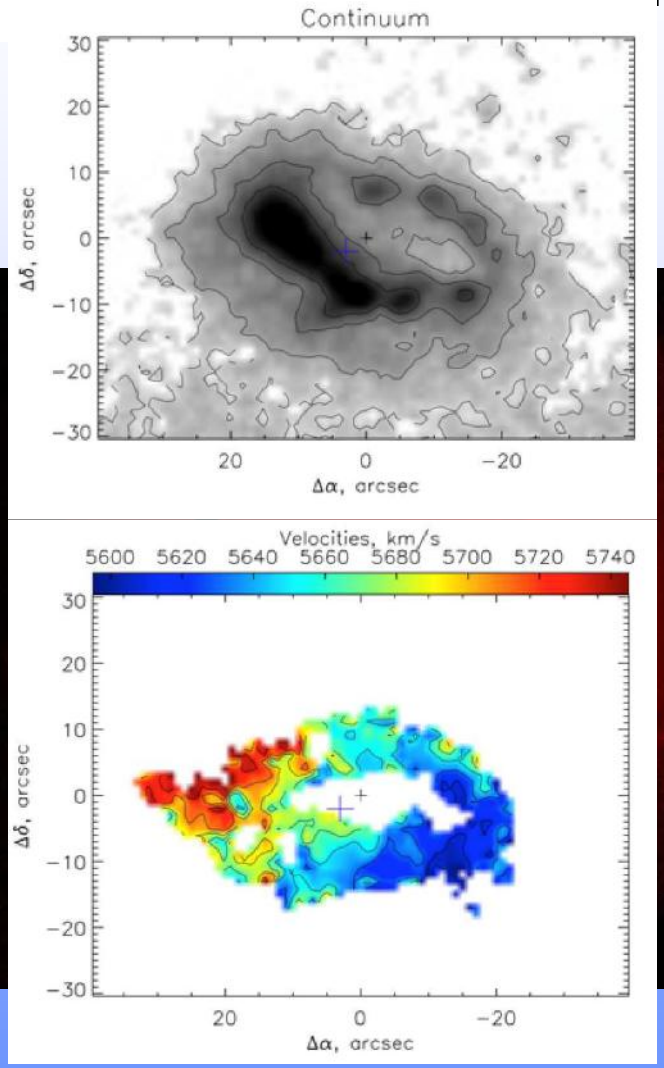


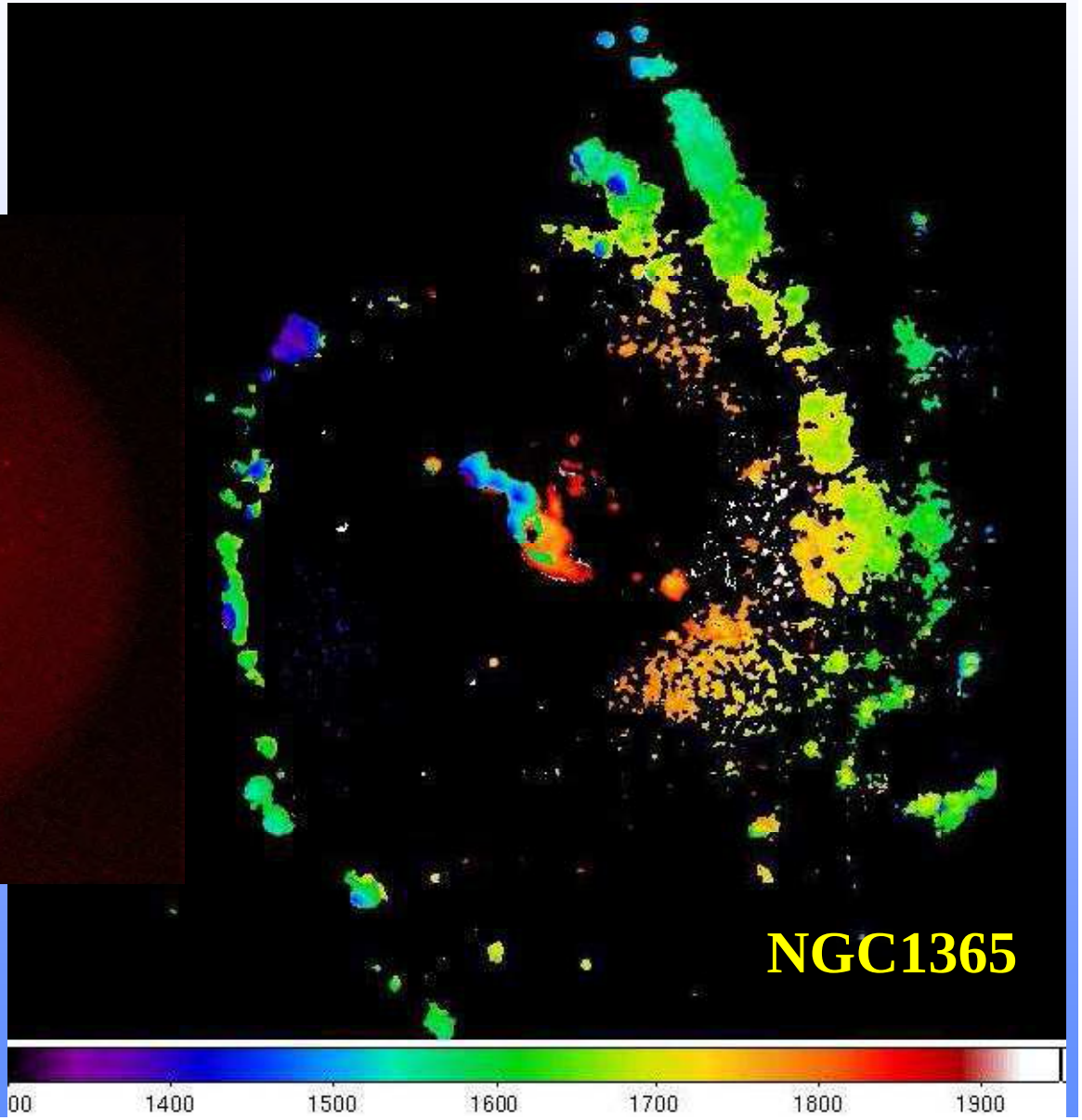
SALT multi-object spectroscopy



Using Fabry-Perot imaging spectroscopy

spectral resolutions between 300 and 9000
Velocity fields of ionised gas in galaxies

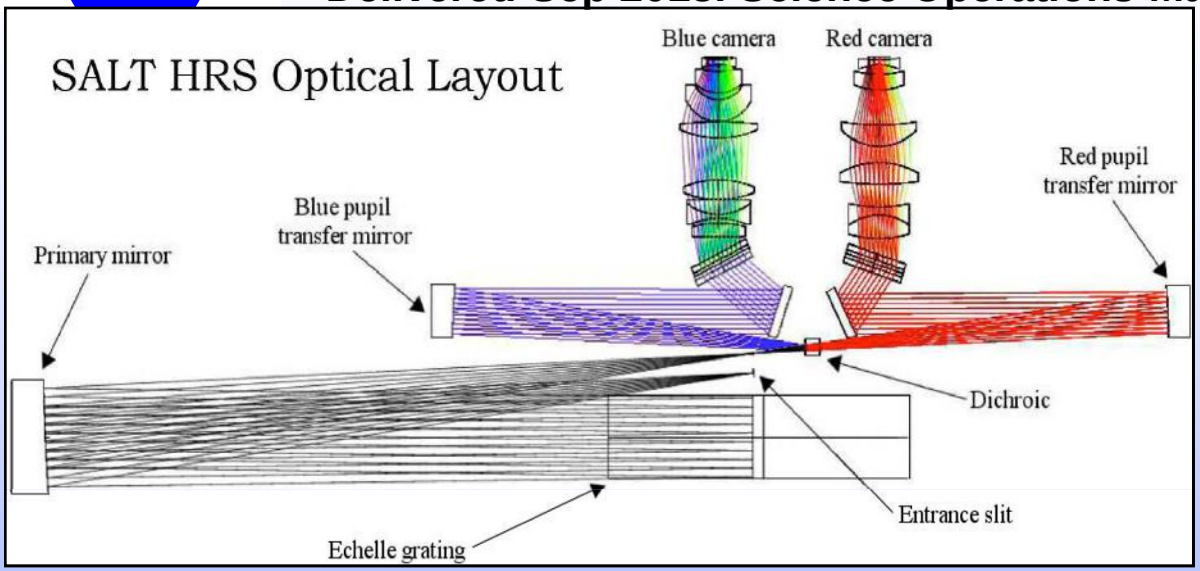


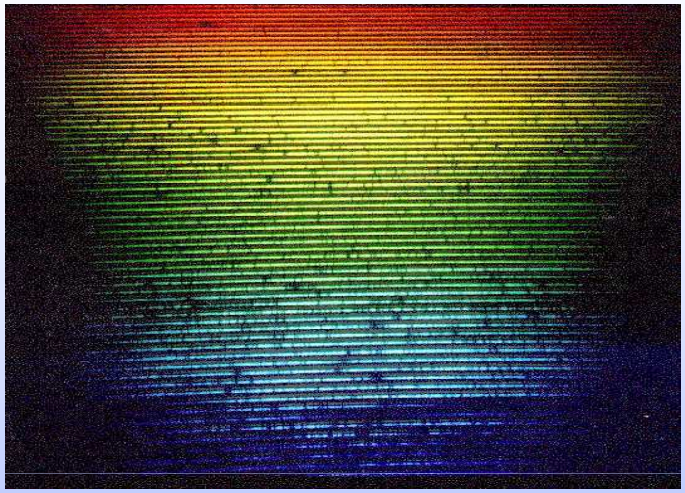


Blue- approaching;
Red- receding

SALT High Resolution Spectrograph (HRS)

Delivered Sep 2013. Science Operations May 2014.



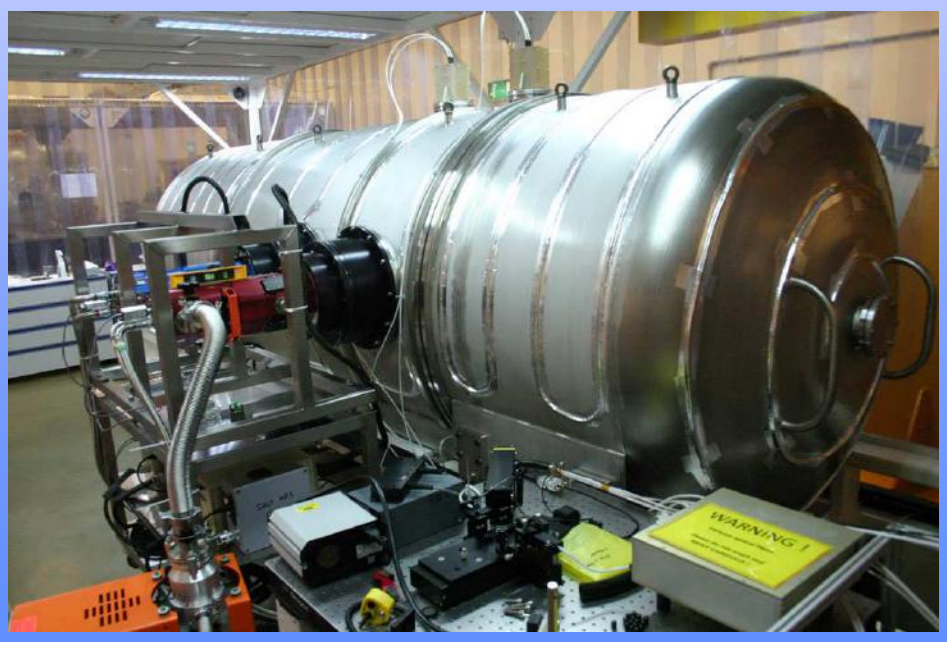


Fibre-fed with dual fibres for star/sky

Three resolution modes R ~ 16,000 – 70,000
λ ~ 380 – 890 nm

Designed for very *high stability*

- **Housed in vacuum tank**
- **Temperature stabilized**
- **Minimize air index effects**
- **Minimize dimension changes**
- **Precision radial velocities (m/s)**
  - **extra-solar planets**



What is SALT especially good at?

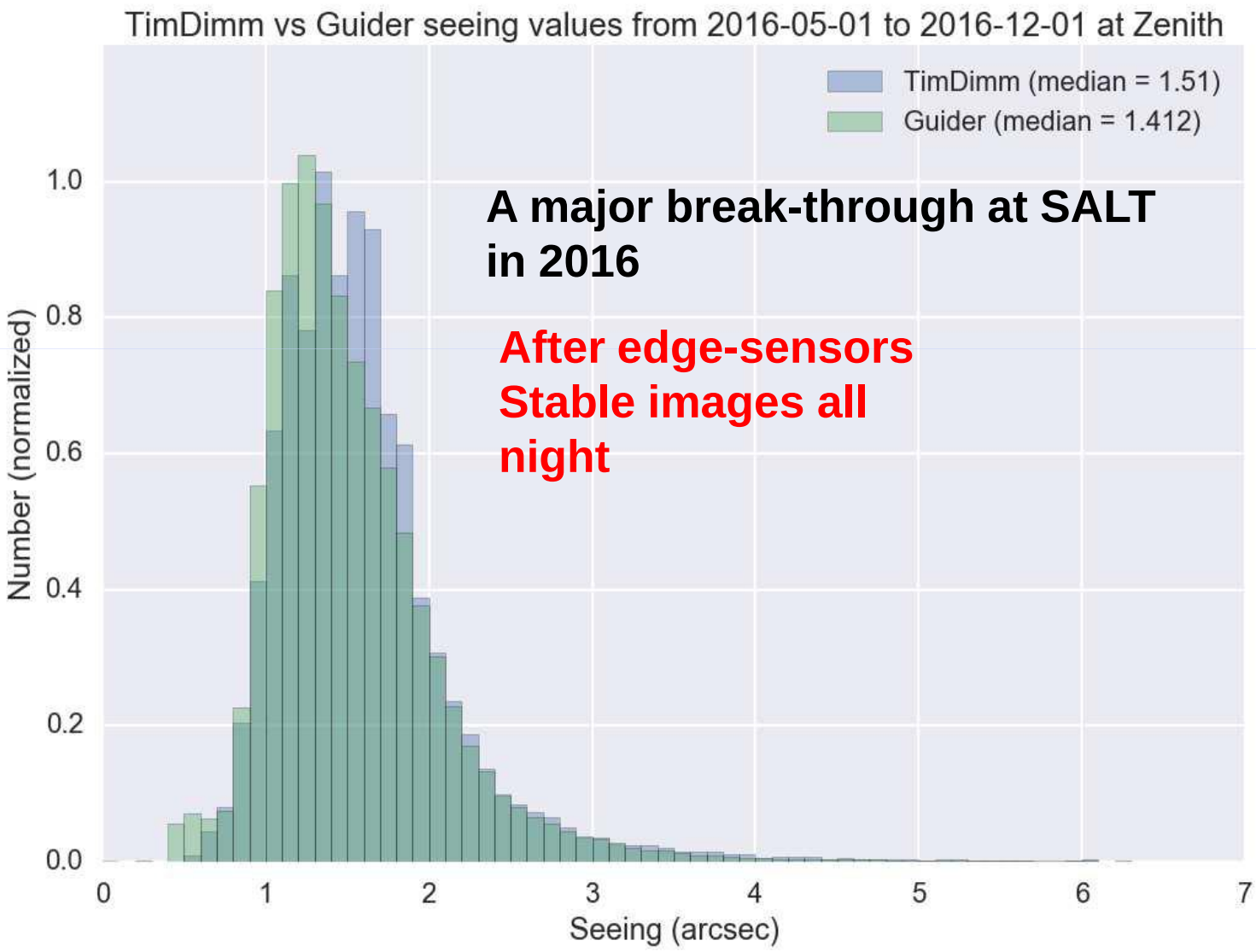
Telescope: Huge collecting power.

Site: Skies are very dark (V ~ 22 mag/arcsec^2).

- **Diffuse low-surface-brightness spectroscopy very competitive.**
- **Objects above background observed very efficiently.**
- **Can change instruments and observing modes in seconds.**
- **Rapid reaction to transients and ToOs**
- **Some *rare modes for large telescopes* (Fabry-Perot, Polarimetry, mixed modes, high-time resolution)**

• SALT as an excellent *spectroscopic survey telescope.* Most efficient programs are surveys with large pools of targets over the sky.

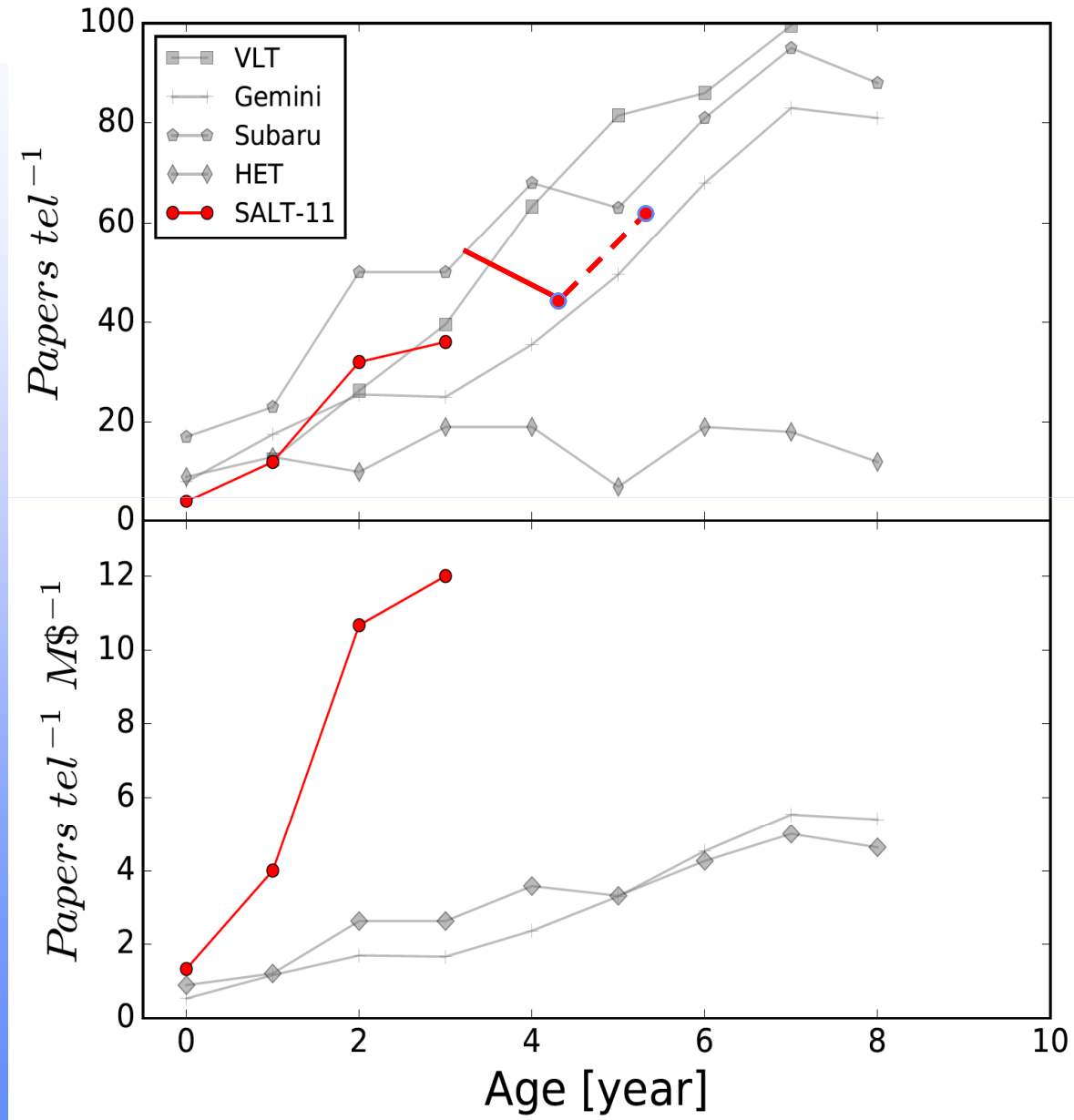
Recent advance: improved imaging



A major break-through at SALT in 2016

After edge-sensors Stable images all night

SALT Productivity and Cost Effectiveness



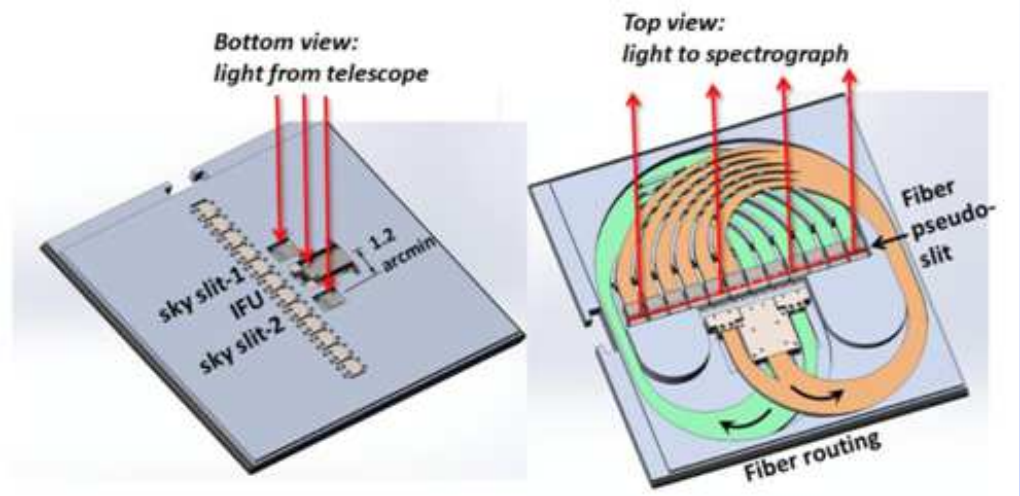
SALT Publication Rate

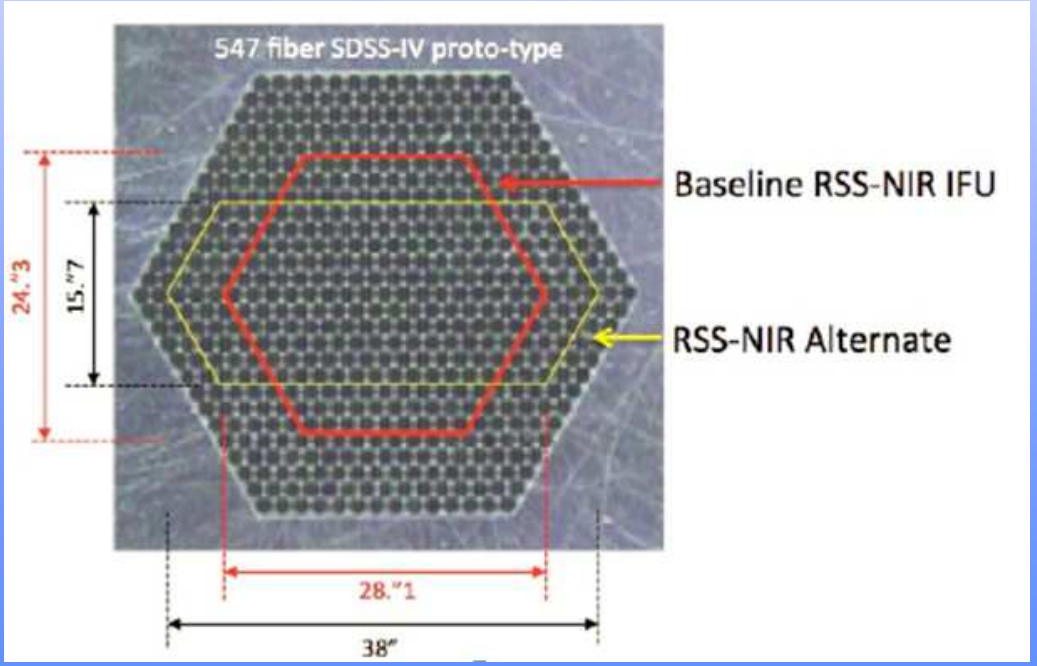
So far following Major Telescope trends when counting stats from start of science observations (late 2011).

When normalized by operating costs, SALT is seen to be very cost-effective!

Looking to the future

- **RSS upgrade (2019/20)**
  - Autoguider replacement (done)
  - Collimator refurbishment
  - CCD detector upgrade
  - New grating (700 l/mm)
  - Slit IFU (~15 x 30 arcsec)
  - Near-IR (900-1700nm) arm with IFU
  - R = 2000 - 6000





Future generation instruments

Strategic science white papers completed in 2017

Three major focus areas identified

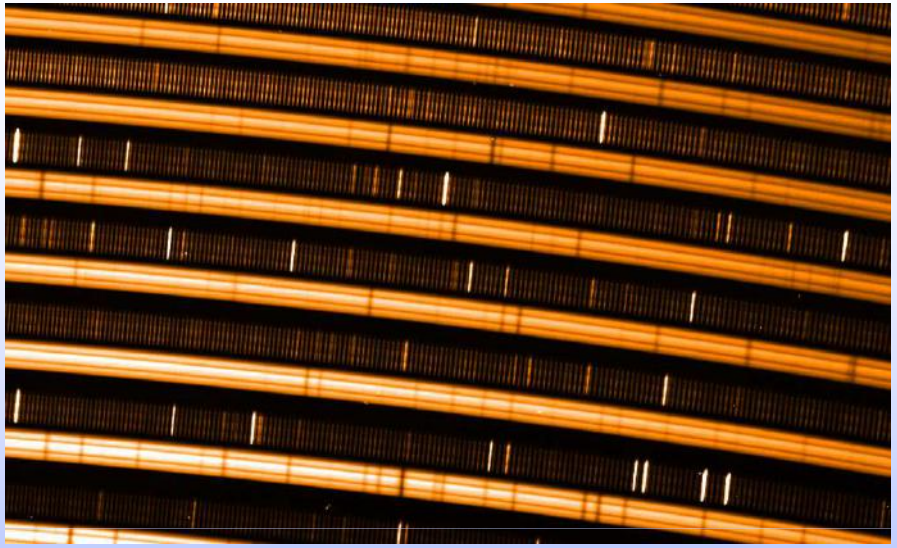
- **transients & variable objects**
- **extragalactic astronomy**
- **extra-solar planets**

Aligning both SALT and SAAO goals and purposes to be competitive in the 2020s

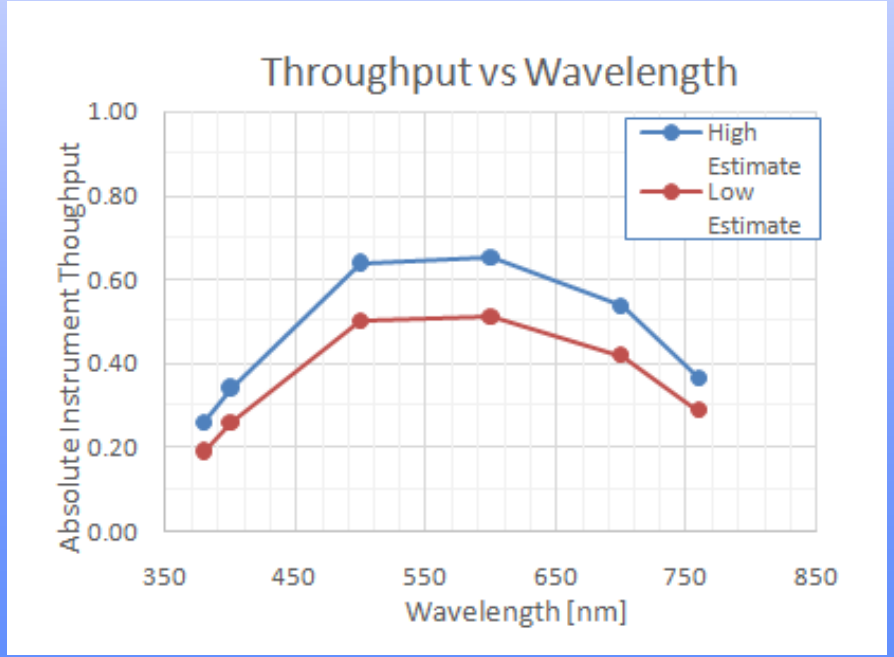
These will drive the next generation instrumentation developments (near term (~2 yr; “Gen 1.5”) and longer term (~5 yr; Gen 2)

Generation 1.5 Instrumentation

- **HRS**
  - Fully utilize high stability mode (exoplanets)
  - Implement precision radial velocity data reduction pipeline
  - Improve radial velocity precision with a laser frequency comb



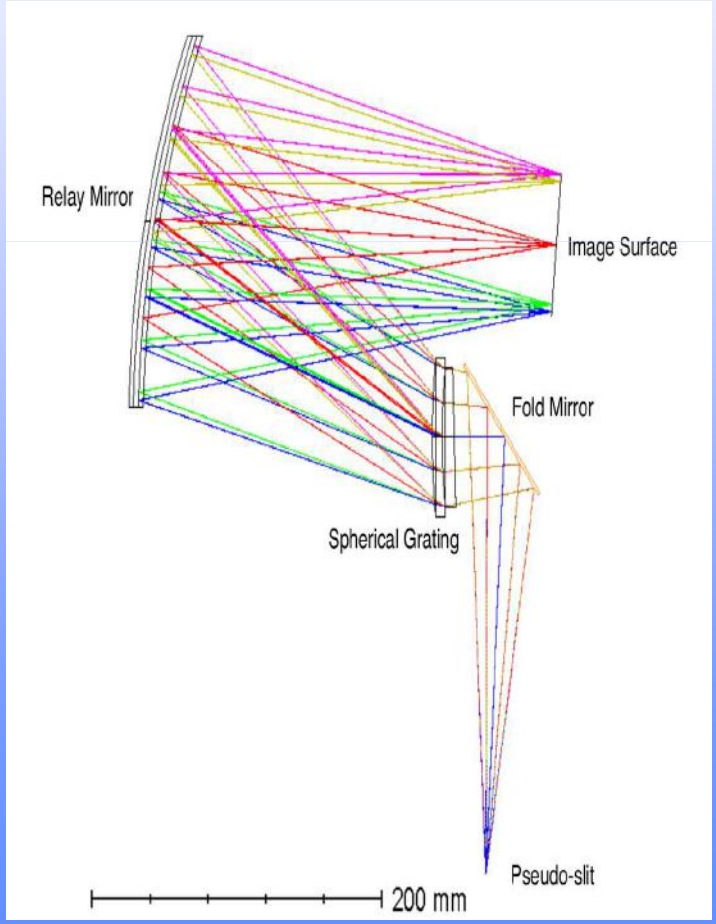
- **A new highly efficient low dispersion spectrograph (MaxE)**
  - Novel but simple design
  - Few moving parts
  - Fed by mini-IFU (20 arcsec)
  - High throughput (reach to V ~22-23)
  - High observing efficiency
  - Ideal for supporting transient science and multi-wavelength astronomy (e.g. support MeerKAT LSPs)
  - 2 yr development

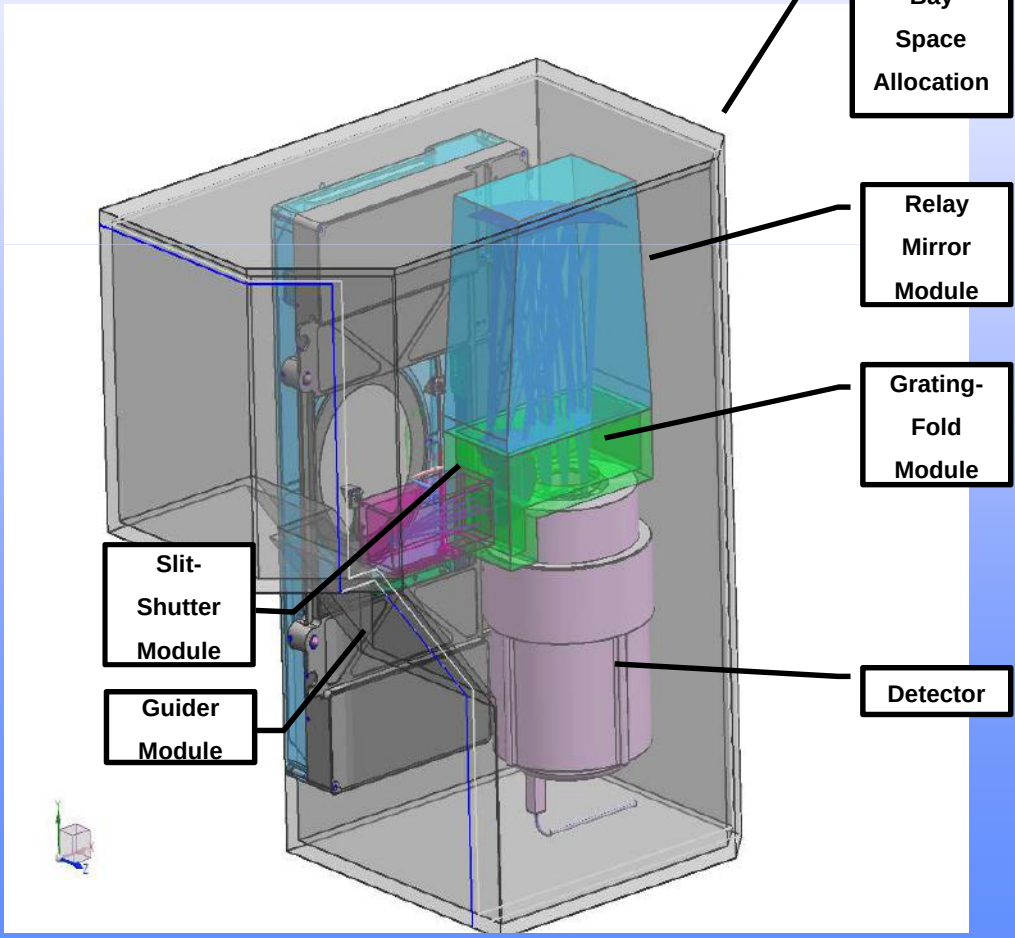


MaxE spectrograph design

Efficient low dispersion spectrograph for rapid and efficient transient followup

- compact (0.5 m), simple, fixed format
- funded (~$2.5M), on telescope in 2020





SALT Partnership/Access Opportunities

SALT is working well, producing forefront science and is continually evolving.

SALT is the most cost-effective large telescope and science producer in the world

We are well advanced in the process of developing future strategies, aligning both SALT and SAAO goals and purposes to be competitive in the 2020s

<u>We welcome new collaborations and partnership at the ~10% level</u>

BRICS could join as a bloc, maybe for a key science programme?

Janus Brink

SALT OBSERVING & SHAREHOLDING COSTS
BRICS WORKING GROUP MEETING: 28-31 OCT. 2018
DURBAN-SOUTH AFRICA

SALT OBSERVING TIME COSTS

Purchasing time on a semester-semester basis:

- **Only useable observing hours are charged**
- **Minimum Hours/Semester (6 months period) = 50 h**
- **Maximum Hours /Semester- subject to proposal requirements and Board approval**
- **Ordinary/premium time rates:**

  Ordinary Time - $2,100/hour

  – **50 h would cost $105,000 per semester**

  Premium Time - $2,900/hour (highest priority time)

  – **50 h would cost $145,000 per semester**

SALT SHAREHOLDING COST

- Seeking a new partner with a 10% Shareholding
- Gives on going access to telescope
- Includes investment in future instrumentation development (1.5 GEN and 2nd GEN)
- Shareholding cost is $8.7M
- In addition, annual operating levy is $300K
- Annual observing hours allocated to this shareholding is ~200 hours
- Payment can be spread over 3-5 years for shareholding
- Annual levy to be paid at beginning of year (1st April)
- If BRICS were to buy in, could give all their astronomy communities immediate access to SALT


PARTNER with us
Realise the POTENTIAL