What is SALT ?

An Introduction to SALT

General:

- **SALT is a 10 metre class telescope which will be built in South Africa.**

- **It will be the largest single telescope in the Southern Hemisphere**

- **SALT is being built by an international consortium consisting of the following partners:**

  - **South Africa (host institution: the South African Astronomical Observatory).**
  - **Poland (through the Nicholas Copernicus Astronomical Centre, Warsaw).**
  - **Rutgers University, New Jersey, USA.**
  - **Göttingen University, Germany.**
  - **The Hobby-Eberly Telescope Board (consisting of partners in the USA & Germany).**
  - **Carnegie Mellon University, Pittsburgh, Pennsylvania, USA.**
  - **University of Wisconsin, Madison, Wisconsin, USA.**
  - **New Zealand (founding institution: the University of Canterbury).**

What is SALT ?

The Hobby-Eberly Telescope (HET)

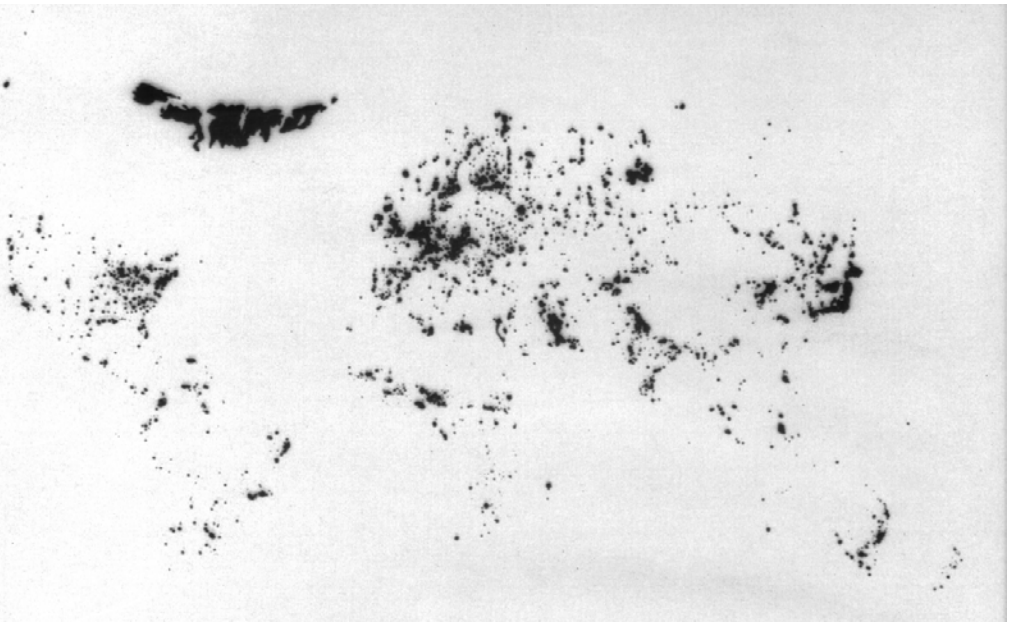
- SALT will be the southern ‘twin’ of the HET.
- The HET is a consortium of universities in the US (Texas, Penn State & Stanford) and Germany (Göttingen and München).
- The HET was completed in 1997 and began full science operations in 1999.
- SALT will be very similar to the HET, but will take advantage of lessons learnt with the HET, and subsequent technological developments.

The Hobby-Eberly telescope is located at the McDonald Observatory near Fort Davis Texas

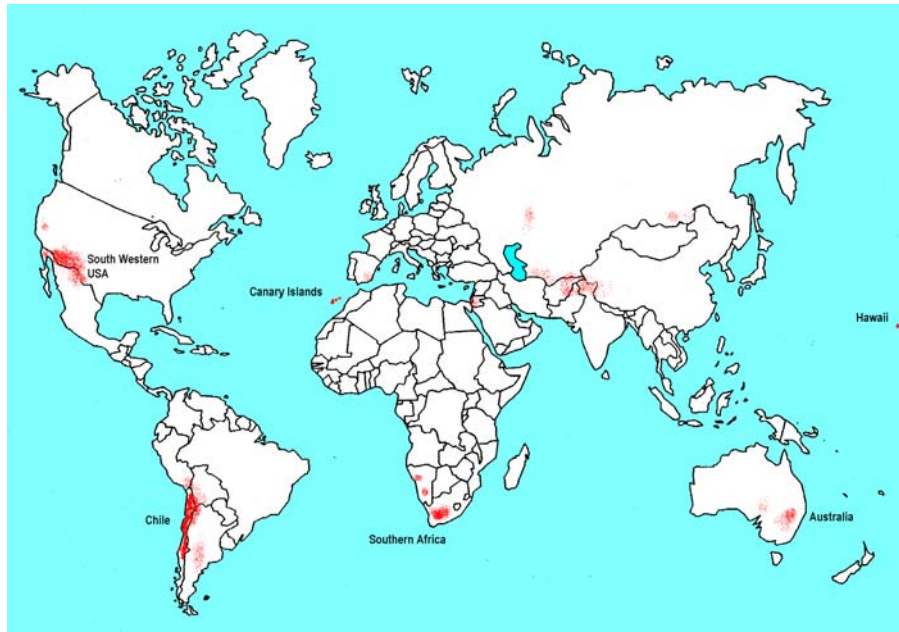
What is SALT ?

SALT Motivations

- Largest ***single*** telescope in southern hemisphere.
- SALT will enable South Africa to remain internationally competitive in astronomy (lifetime > 30 years).
- Specific local advantages which South Africa offers to international astronomy (geographical position, climate, observing conditions, good scientific track-record). These include clear, dark skies, good 'seeing' conditions (sharp, clear images), and a site which can access the southern skies at different times to other southern hemisphere observatories (i.e. during their daylight hours).



The Earth from space at night showing mostly man-made lights. Good observing sites should be free of light pollution, like Southern Africa.

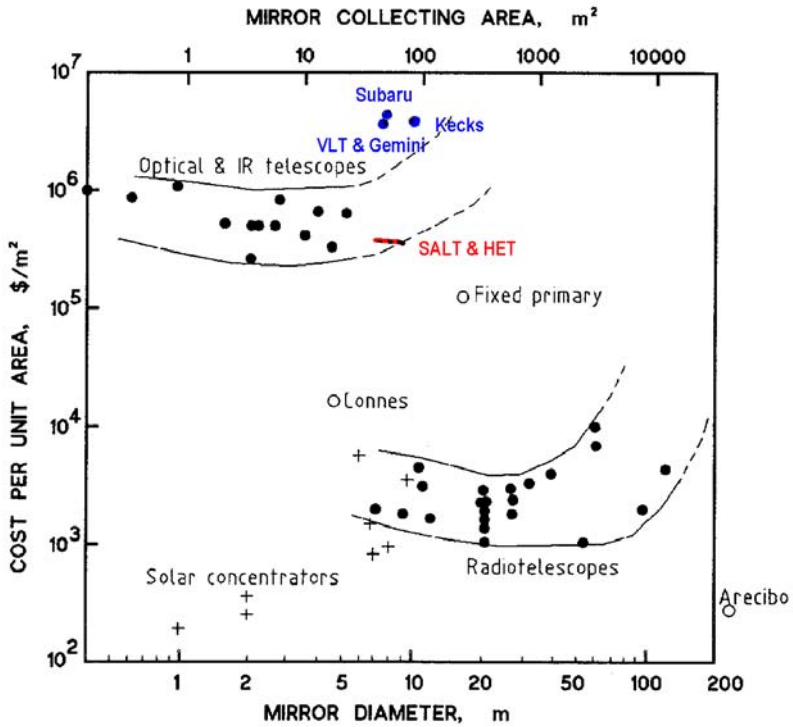


The best observing sites in the world (red). Those in the southern hemisphere are situated in Chile, South Africa and Australia.

What is SALT ?

Further motivations for SALT

- **Current SA telescopes becoming obsolete, or more, irrelevant in the era of 8 to 10-m class telescopes (current largest telescope is the pre-WW2 1.9-m 'Radcliffe reflector').**
- **A cost-effective and innovative design for a large telescope: 70% of the sky accessed for only 20% of the cost of 'conventional' telescopes).**



The 1.9-m (74 inch) telescope at Sutherland, currently the largest in Africa.

What is SALT ?

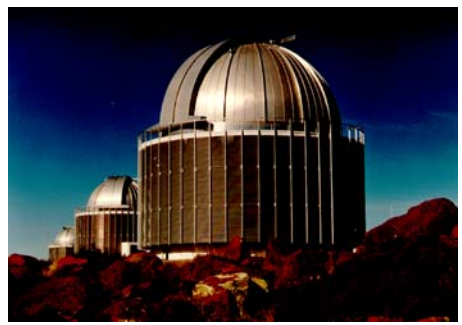
SALT Motivations: collateral benefits

The HET in west Texas.

- Opportunities to generate a public appreciation of science (plans for extensive visitors centre).
- Spin-offs in exciting young people into careers in science, engineering & technology (vital for the future of South Africa and the region).
- Serious interest by potential international partners with matching funding (also the potential for growing the SALT user community locally and regionally).
- Support consistent with South African Govt. policy on Science & Technology (e.g. 1996 White Paper).

A 'Flagship' S&T Project for the African continent

Existing telescope domes at Sutherland

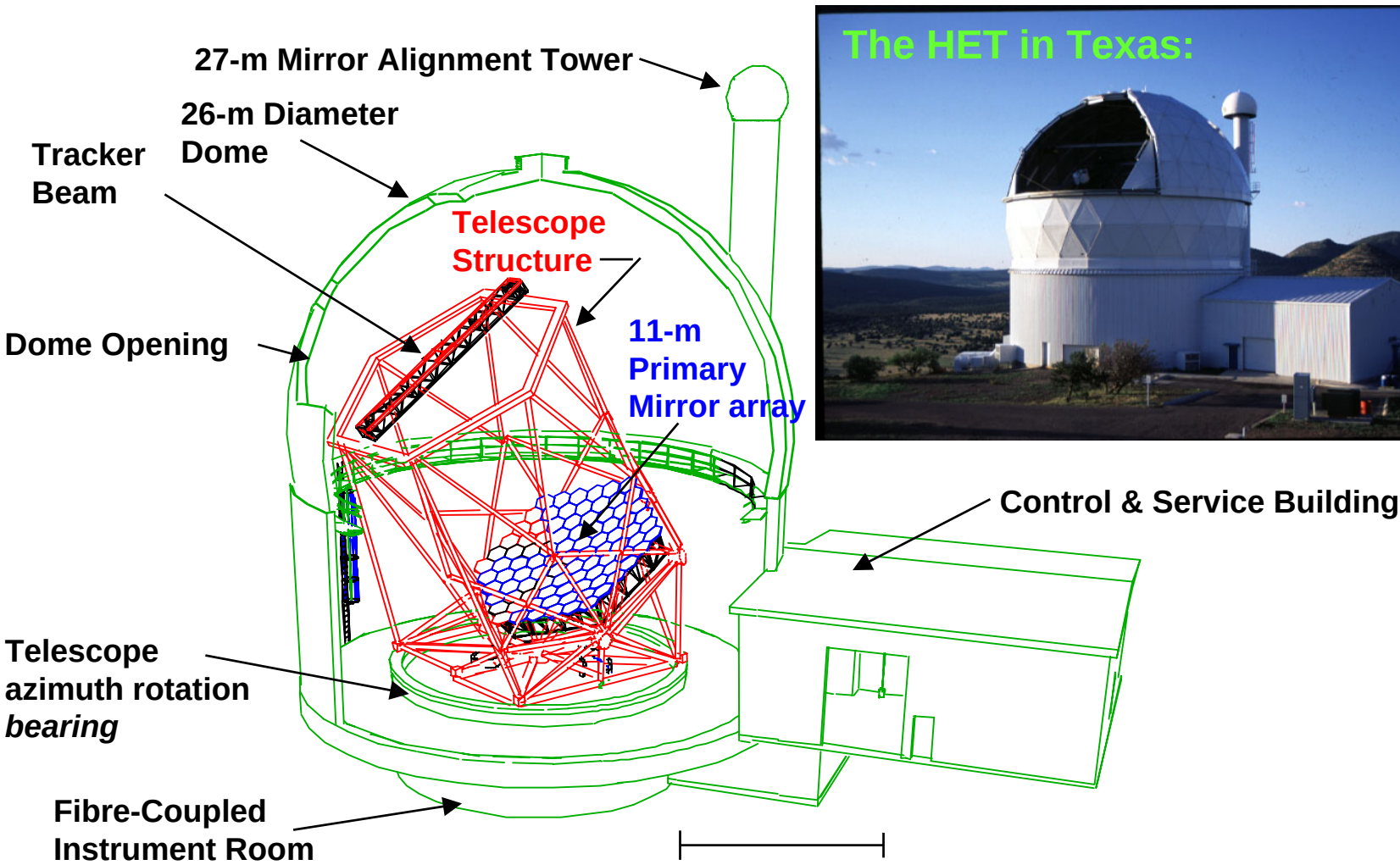


What is SALT ?

Where SALT will be situated: near Sutherland on the Great Karoo plateau

What is SALT ?

An early concept diagram of SALT

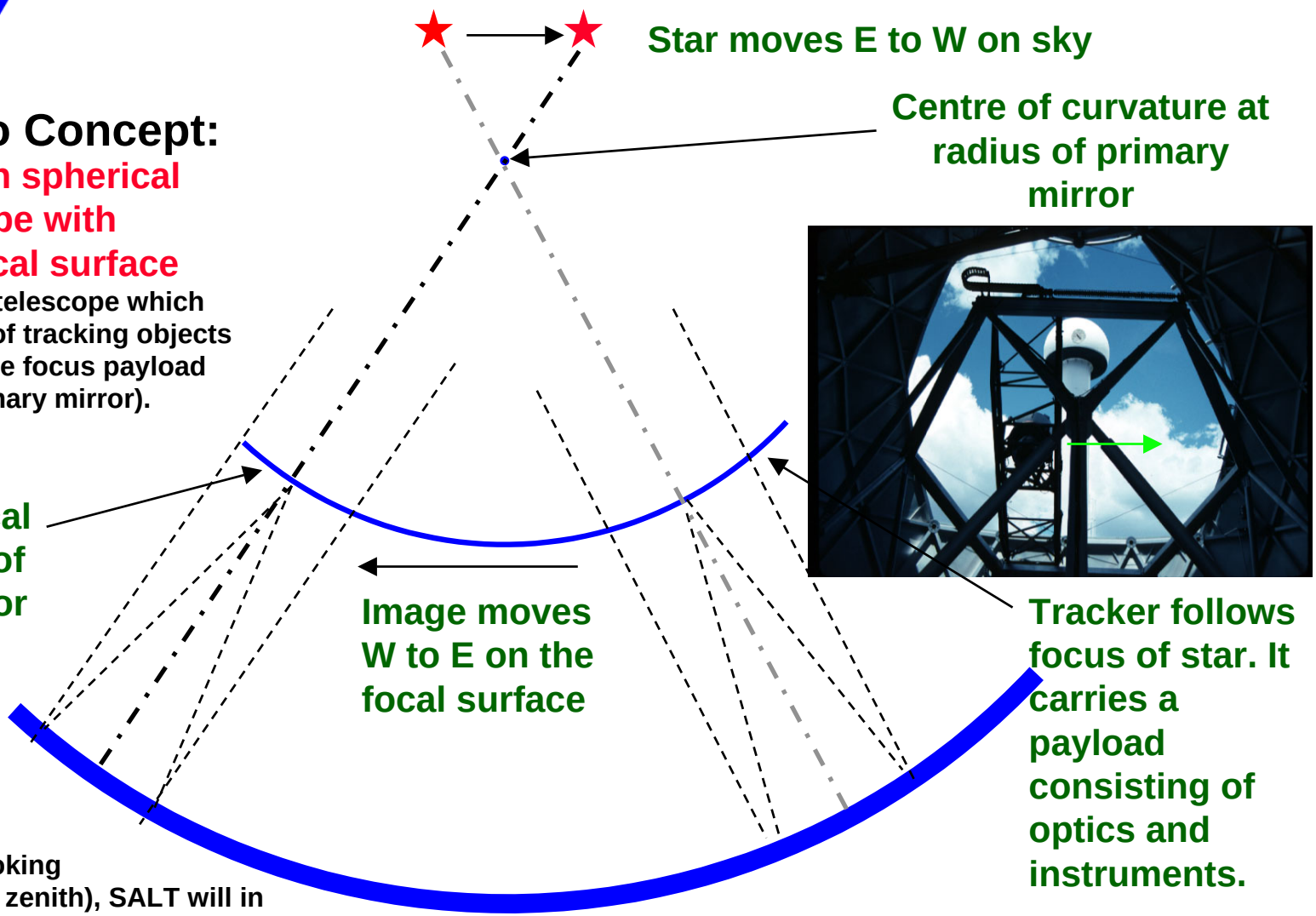


What is SALT ?

The Arecibo Concept:

Fixed elevation spherical mirror telescope with tracking on focal surface

(Arecibo is a radio telescope which first used the idea of tracking objects by moving the prime focus payload rather than the primary mirror).

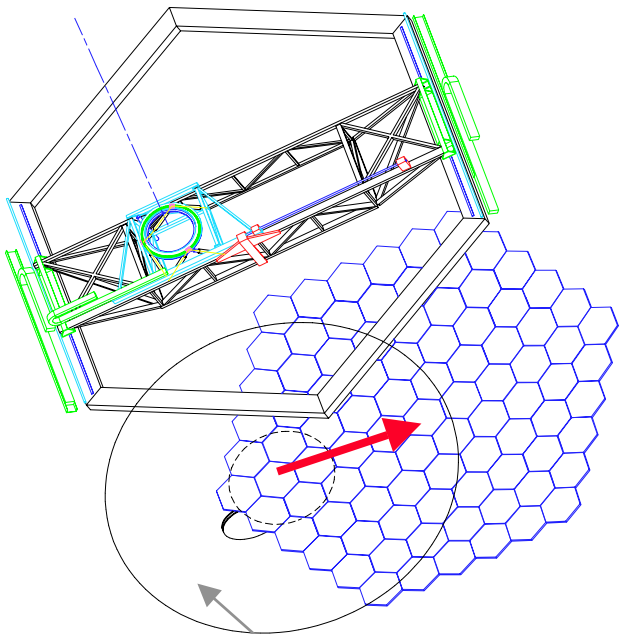


Although pictured looking straight up (i.e. at the zenith), SALT will in fact be tilted 37º from the zenith.

What is SALT ?

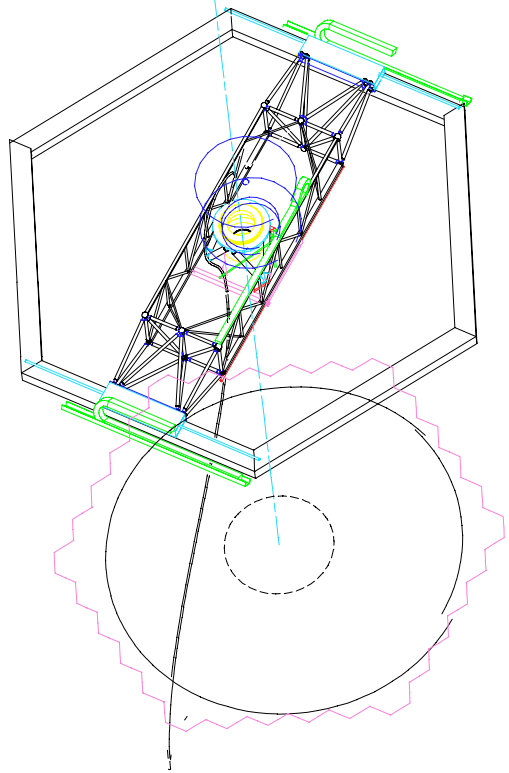
How the telescope tracking works

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



Part of pupil off mirror is baffled at exit pupil position

Tracker centred and pupil centred on primary mirror array. Full 9.2 metre collecting area.

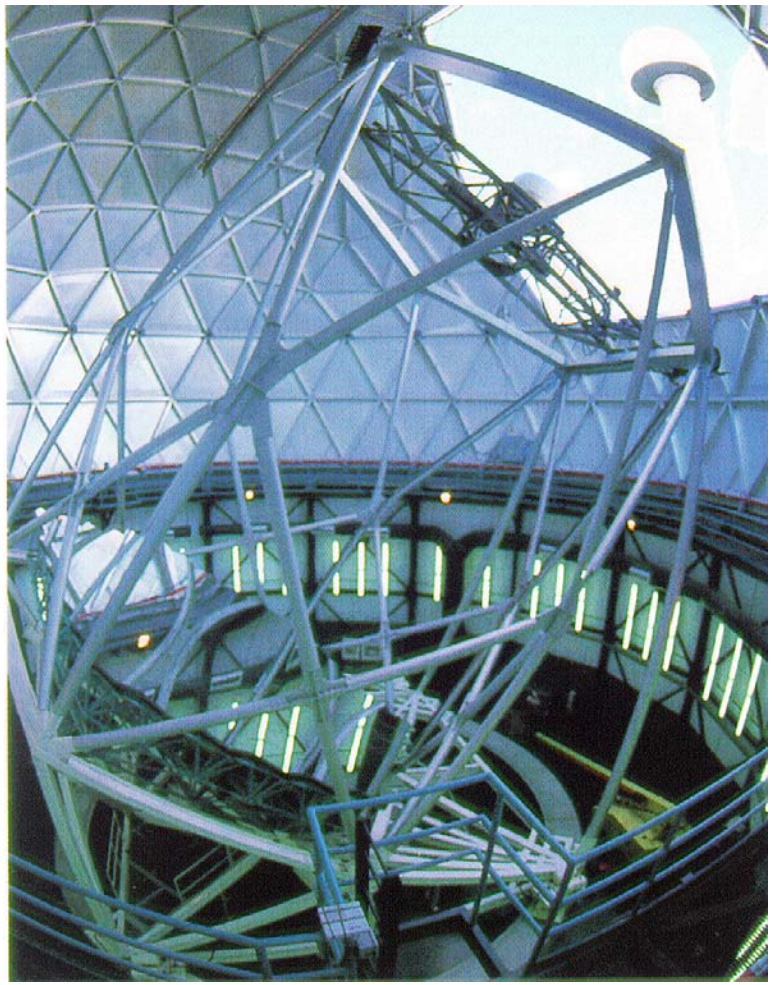


What is SALT ?

SALT: *A Tilted Arecibo-like Optical-IR Telescope*

BASIC ATTRIBUTES

- **PRIMARY MIRROR ARRAY**
  - Spherical Figure
  - 91 identical hexagonal segments
  - Unphased (i.e. not diffraction limited)
  - Mirrors supported on a steel structure
- **TELESCOPE TILTED AT 37^{o}**
  - Declination Coverage $+10^{o} < \delta < -75^{o}$
  - Azimuth rotation for pointing only
- **OBJECTS TRACKED OVER 12^{o} FOCAL SURFACE**
  - Tracker executes all precision motions (6 d.o.f.)
  - Tracker contains Spherical Aberration Corrector (SAC) with 8 arcminute FoV (*Prime Focus*)
  - Large spectrograph instruments fibre-coupled
- **IMAGE QUALITY**
  - Telescope error budget of 0.5 arc-second FWHM



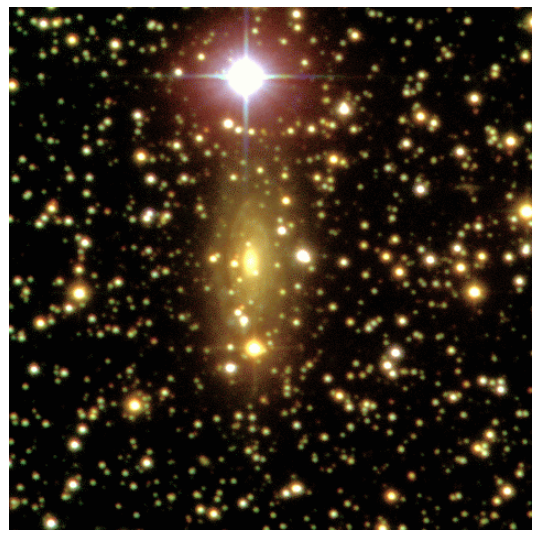
What is SALT ?

Facts & Figures

Astronomical

- **SALT will be the largest single optical-infrared telescope in the southern hemisphere.**
- **SALT will detect objects one billion times dimmer than the faintest visible to the unaided eye. It will gather 23 times ax much light as the 1.9-m telescope at Sutherland, currently the largest in Africa.**
- **SALT will have the power to tackle fundamental questions about the Universe:**
  - ***What was the Universe like when the first stars and galaxies were forming ?***
  - ***What kind of worlds orbit other suns ?***
  - ***How are the stars in nearby galaxies different from those in the Solar neighbourhood ?***
  - ***What can these stars tell us about the scale and age of the Universe ?***
  - ***How do quasars and gamma ray bursts outshine trillions of stars like the Sun ?***

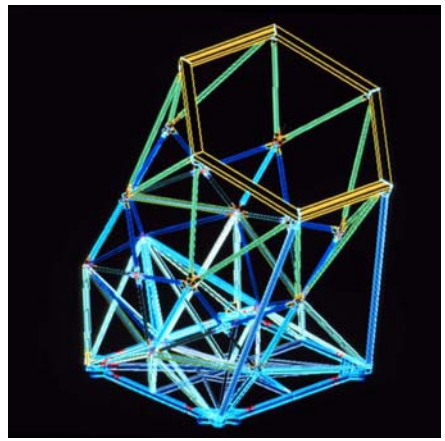
Tarantula nebula, or 30 Doradus (SAAO)



A galaxy in the ‘zone of avoidance’
(Courtesy Dr P. Woudt, University of CapeTown)

What is SALT ?

Facts & Figures: telescope



Telescope

- Design: modified version of Hobby-Eberly Telescope.
- Telescope length 13 metres, mirror array 11 × 10 metres.
- Mass of telescope: 82 tonnes.
- Light collecting area of array: 77.6 sq. metres
- Wavelength coverage: 340 nm to 2500 nm (ultraviolet to near infrared).
- Telescope rotates in azimuth on 8 air bearings to acquire targets, with a precision of 3 microns. A tracker with 10 degrees of freedom then follows the target, as the Earth rotates, for up to ~2.5 hours.
- The telescope can be moved from one object to another in < 5 min.
- Optical fibres can relay light from several objects (10-20) in the field to instruments in the the basement.
- The tracker will consist of a Prime Focus Instrument Platform, consisting of an efficient imaging spectrograph capable of observing many objects at once.

What is SALT ?

Primary Mirror Array

Attributes:

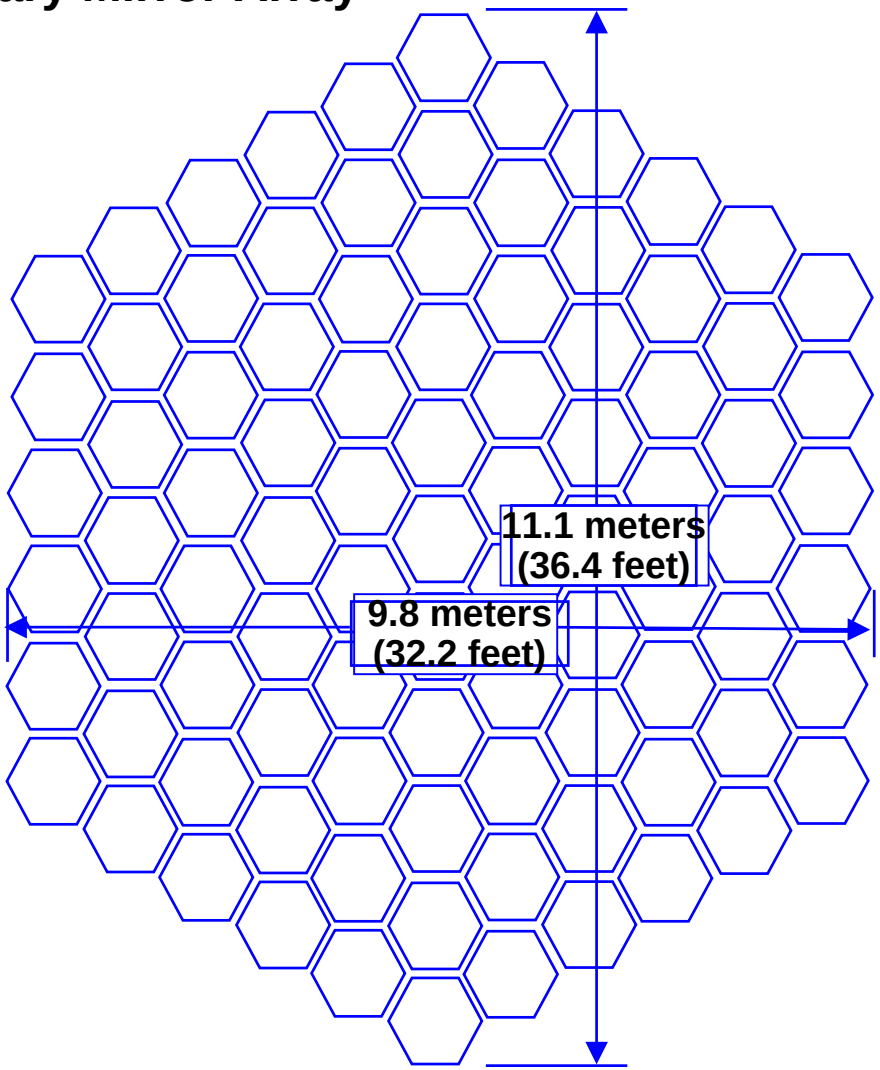
- **segmented array of hexagons, each 1 metre wide (edge-to-edge) and 50 mm thick**

- **maximum mirror diameter:**
11 m

- **accuracy of mirror surface:**
0.052 microns (1/10th wavelength of light
(smooth to 5/100,000 th of a mm)

- **Field of view:**
8 arcmin *(~1/4 size of Moon)*

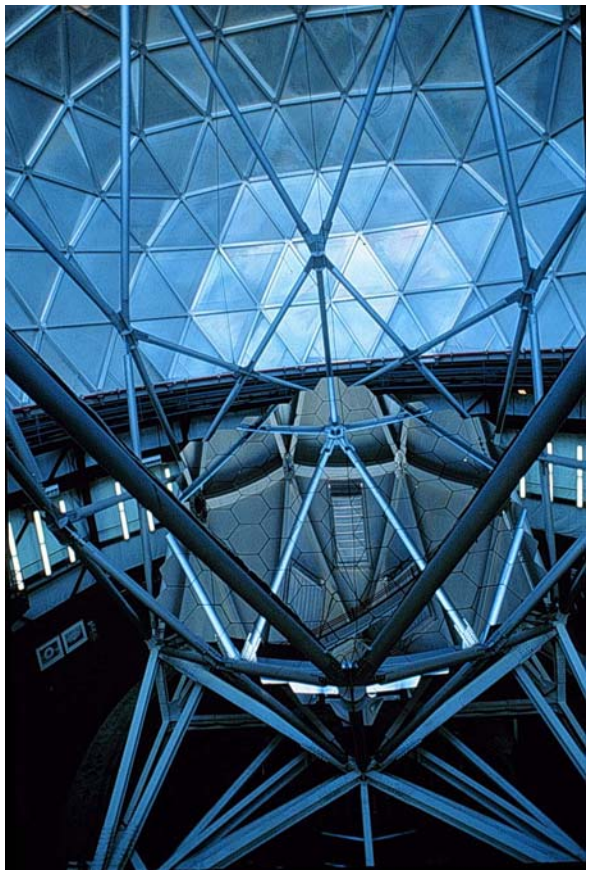
- **Resolution:**
0.25 – 0.5 arcsec
(size of R2 coin at 10 km)
- **Mirror array supported on steel 'space frame' truss containing 1,747 struts and 383 nodes, precise to 4 mm over the entire truss.**



What is SALT ?

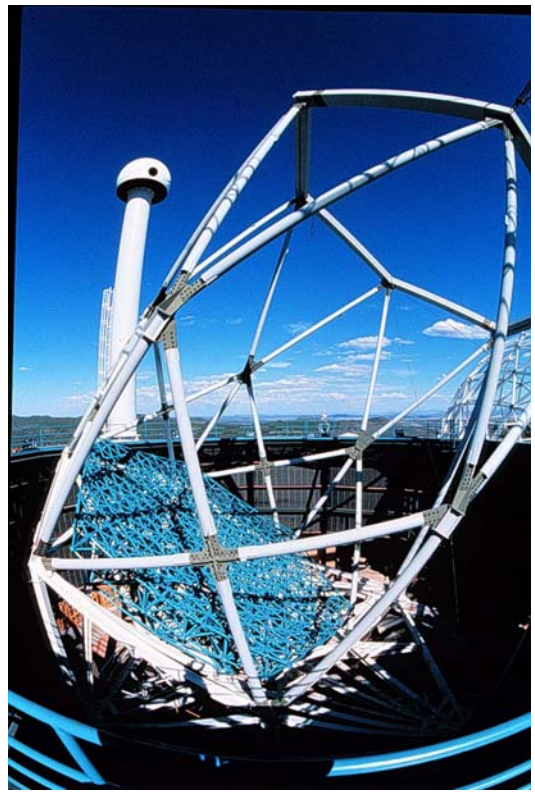
Picture gallery of HET

Photographs of the Hobby-Eberly Telescope. Most of the SALT subsystems will look very similar.



View of telescope with all 91 hexagonal mirrors installed.

Lowering a segment into place on the truss.



The HET before dome installation.

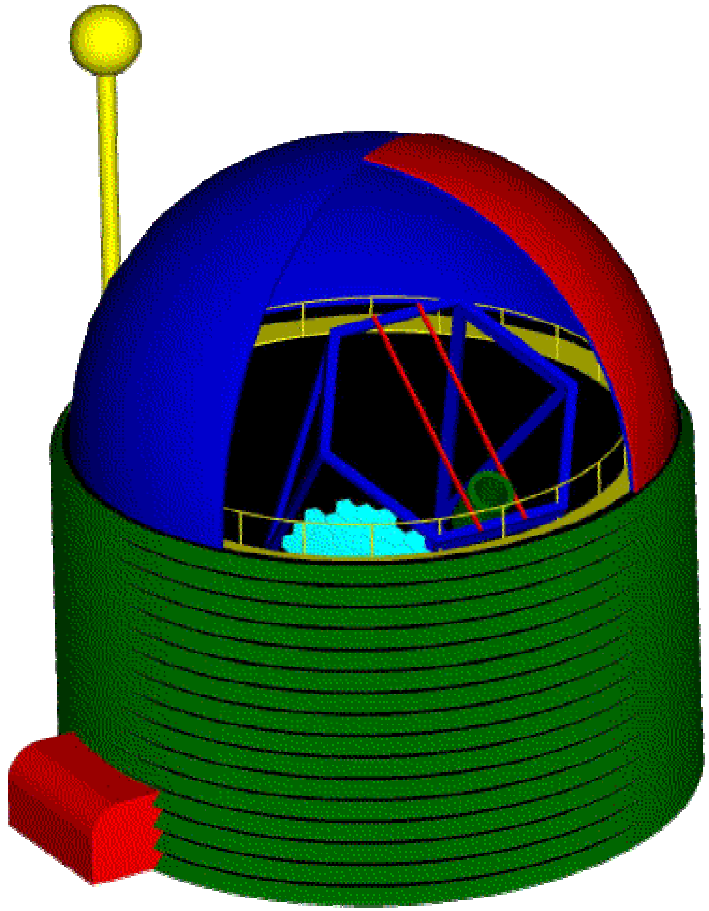
(Photos courtesy of Tom Sebring)

What is SALT ?

Building and Dome

Early concepts:

- **Geodesic dome, hemispherical in shape.**
- **Active air conditioning during the day and ventilation at night will keep the temperature of the telescope as close as possible to that of the ambient night-time atmosphere.**
- **A 28 metre tall tower will house a centre of curvature instrument used to align all of the 91 mirror segments.**
- **Control room, work rooms, labs, etc, will be thermally isolated from the telescope enclosure, possibly in an adjacent building.**



What is SALT ?

SALT as it may appear at Sutherland...

Summary of some facts & figures:

- largest single optical telescope in the Southern Hemisphere
  - 23X collecting power of existing 1.9-m telescope
  - 11-m inscribed mirror diameter
  - 13-m Primary Mirror Paraxial Focal Length

- entrance pupil diameter = 10.5 or11m
- f/ratio = 4.2, effective focal length = 44.1 or 46.2m
- science field of view = 8 arcmin
- telescope mass = 80 tonnes
- tracker mass = 4.5 tonnes
- wavelength coverage:
  ~340-2500 nm