The Southern African Large Telescope (SALT)

By
Encarni Romero Colmenero
Head of SALT Astronomy Operations

Director of the SAAO

Director
Petri Vaisanen
petri@salt.ac.za

SALT Observatory Scientist

SALT Observatory Scientist
Lisa Crause
lisa@saao.ac.za

Astronomy Operations

Head of Astronomy Operations
Encarni Romero Colmenero
erc@salt.ac.za

Astronomer
Lee Townsend
lee@salt.ac.za

Astronomer
Enrico Kotze
ejk@saao.ac.za

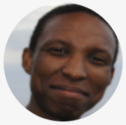
Astronomer
Alexei Kniazev
akniazev@salt.ac.za

Astronomer
Rudi Kuhn
rudi@saao.ac.za

Astronomer
Rosalind Skelton
ros@saao.ac.za

Astronomer
Solohery Randriamampandry
solohery@saao.ac.za

Astronomer
Daniël Groenewald
dgroenewald@saao.ac.za



Astronomer
Moses Mogotsi
moses@salt.ac.za

Software Engineer
Christian Hettlage
hettlage@salt.ac.za

Software Developer
Nhlavutelo Macebele
nhlavutelo@saao.ac.za

Software Developer
Chaka Mofokeng
cmofokeng@saao.ac.za

SALT Fabry-Pérot Postdoc
Elizabeth Naluminsa
liz@saao.ac.za

Telescope Operator
Veronica van Wyk
veronica@salt.ac.za

Telescope Operator
Thea Koen
thea@salt.ac.za

Telescope Operator
Xola Ndaliso
xola@salt.ac.za

Where is SALT?

Headquarters are in Cape Town, at the headquarters of the South African Astronomical Observatory (SAAO) in Observatory

The actual telescope is in Sutherland.

Where is Sutherland

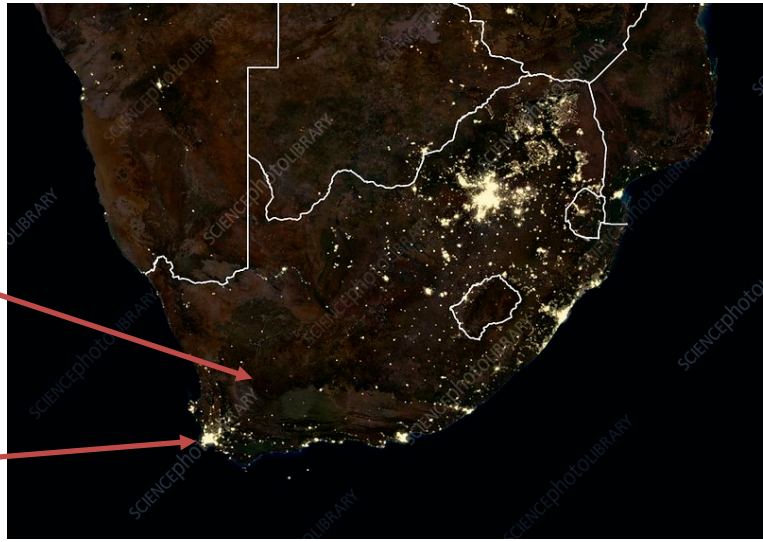
400 km from Cape Town

Semi-arid Karoo region

Why Sutherland?

Dark skies!

No strong seasonal weather impact on sky



SALT – A very brief history

- **First light and inauguration in 2005**
- Severe image quality issues discovered soon after, and a Spectrograph throughput problem
- Some science done while limping along and diagnosing 2006-2008
- Off-line for repairs for 2009-2010, fixed late 2010.
- **Second light in September 2011**

In full science operations since late 2011

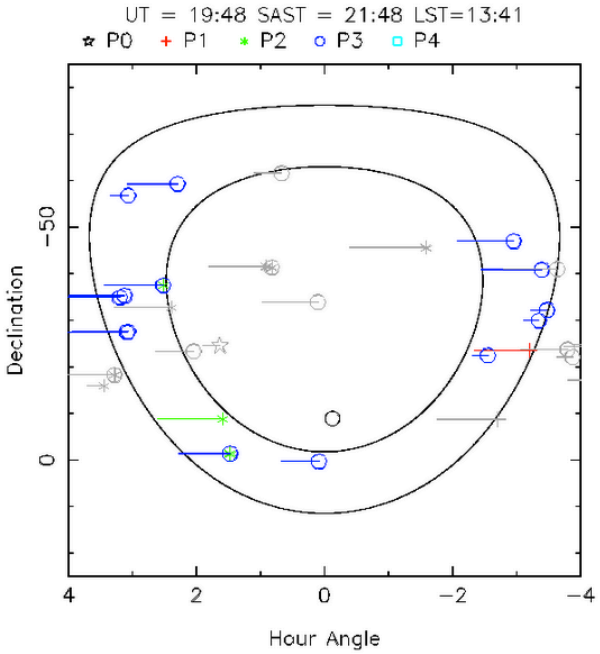
SALT – the telescope

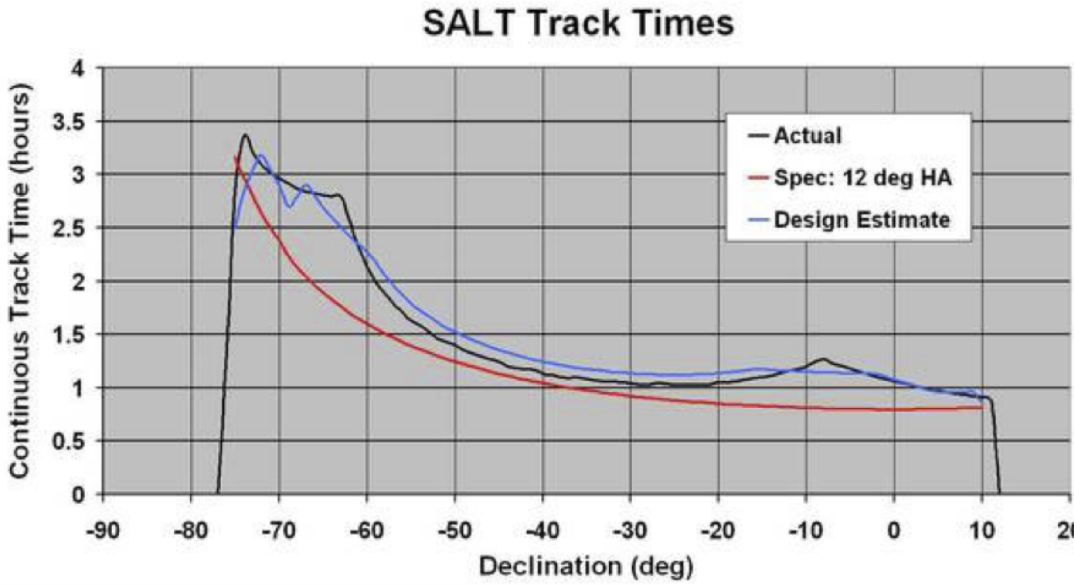
SALT

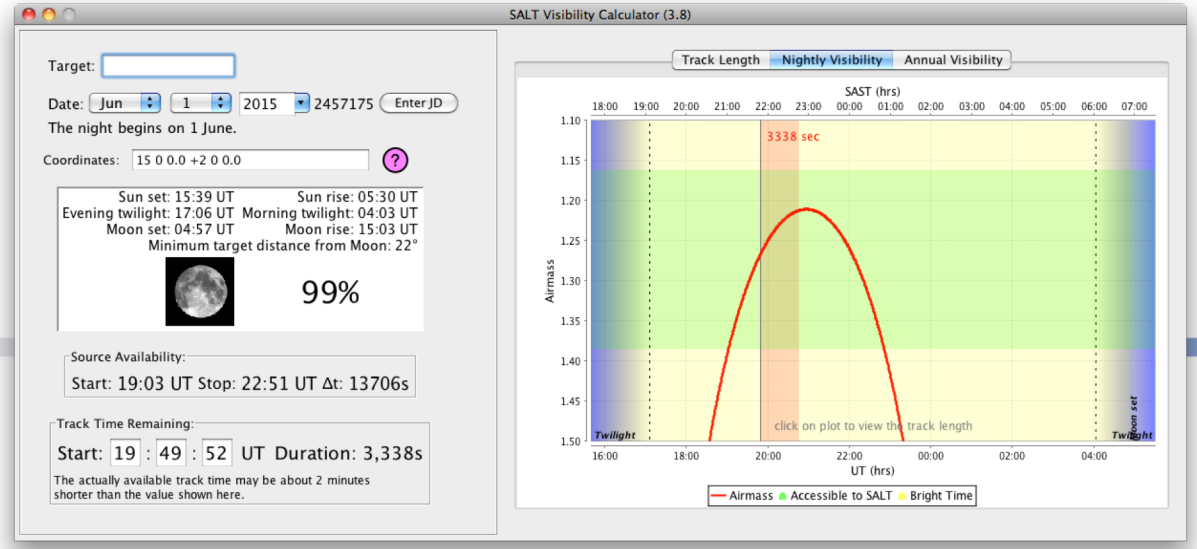
- 91 x 1m primary mirror array, 11m across in diameter
- Edge sensors keep mirrors aligned for > 1 week
- Private: partner institutions (+collaborators!) + ORP + Africa
- Fixed in altitude
    - fully queue-scheduled
    - OBs ~1 hour long

WE HAVE TO WAIT FOR “TARGETS” TO COME INTO OUR VISIBILITY ANNULUS…

The “toilet seat” diagram!







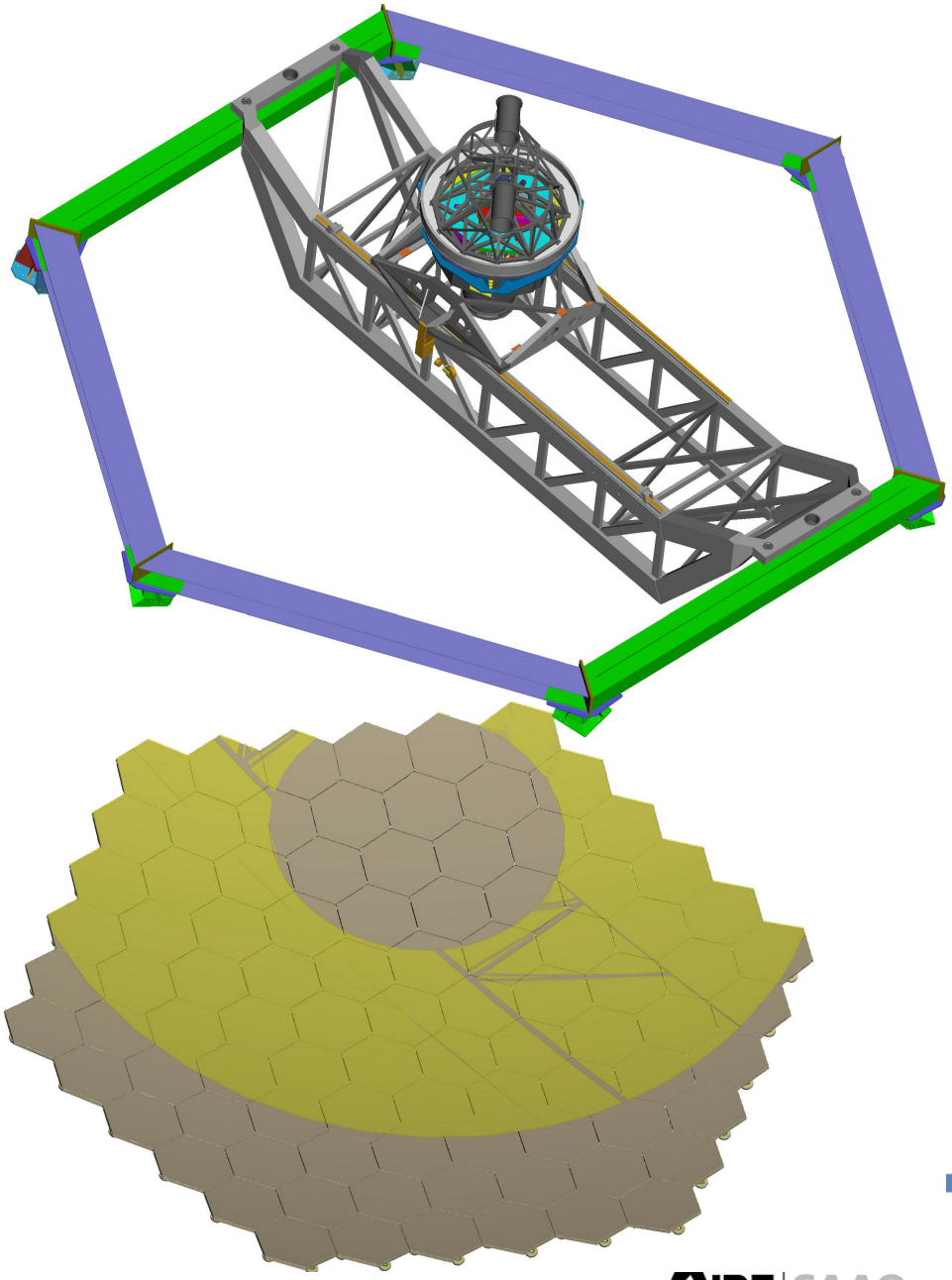
Moving pupil

With tracker and 11-m pupil centred on primary mirror array and central obstruction, equivalent to a 9 metre telescope.

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

Tracker window (12 x 12 deg) / field of view of SALT (8 arcmin)

CANNOT DO ABSOLUTE PHOTOMETRY WITH SALT ALONE



HOW DOES SALT WORK?

- Researchers apply for time on SALT (directly to SALT using the PIPT, or via ORP tools), with a scientific case – what exactly do they want to do, how, what for.. Two calls per year.
- Proposals are reviewed by AstroOps for technical issues, and then scientifically by the Time Allocation Committees (TACs)
- Time is allocated per proposal, in priority class (0=must do urgently, 3=queue filler) – and some are rejected!
- Researchers then take their allocated time and priority and split it into observations *that fit in the visibility windows*
- All the observations are put in a queue. Blocks remain in the queue until they are observed and accepted by the SALT Astronomer, or the semester ends.
- The SALT Astronomer + SALT Operator at the telescope take all the observations (we work in shifts of a week)

WHAT HAPPENS TO SALT DATA?

- Transferred to CT immediately.
- Pipelined (primary reductions) and placed on PIs ftp site, PIs notified via email. Usually < 24hrs, faster access to raw data if requested.
- Very efficient and responsive SALT helpline: salthelp@salt.ac.za
- Night summary (and random posts) in the SALT blog: http://saltastro.blogspot.com
- Data held in SALT Data Archive, available once data are public from archive website: https://ssda.saao.ac.za

WHAT ARE SALT'S SPECIALTIES?

Telescope: Large collecting power.

Site: Skies are very dark (22 mag/arcsec^2). Seeing only modest (median 1.4")

- Diffuse low-surface-brightness spectroscopy.
- Objects above background also observed very efficiently.
- Can change instruments and observing modes during pointing.
- Blocks can be submitted independently at any time -> Rapid reaction to ToOs.
- Some rare modes for large telescopes (Polarimetry, mixed modes, high-time resolution)

- **SALT is a *spectroscopic survey telescope.* Most efficient programs are surveys with large pools of targets over the sky.**

SALT CURRENT INSTRUMENTS

SALTICAM - first instrument on SALT

An imager over 8 arcmin (SAAO)

Capable down to 320nm, high sensitivity in the UV and blue.

Cousins, Johnsons, Stromgren and Sloan filters, plus some narrow-band.

Broad and intermediate-band imaging and *high time-resolution photometry* (down to 50 ms).

Looking into possible replacement in the near future

RSS: Robert Stobie Spectrograph

University of Wisconsin-Madison

- Long slit and multi-object spectroscopy
  medium resolution, *R* to 10,000
- Wide range of resolution and wavelength coverage.
- Fabry-Perot imaging spectroscopy
  - Currently under refurbishment.
- Imaging polarimetric and spectropolarimetric modes
- High Time resolution ~100 ms spectroscopy

- **The work-horse instrument for good weather/dark skies**
- **Upgrades in progress (more later – See Lisa's talk)**

HRS: High Resolution Spectrograph

Durham University

- Low Resolution (LR) – R ~ 14000
- Medium Resolution (MR) – R ~ 40000
- High Resolution (HR) – R ~ 65000

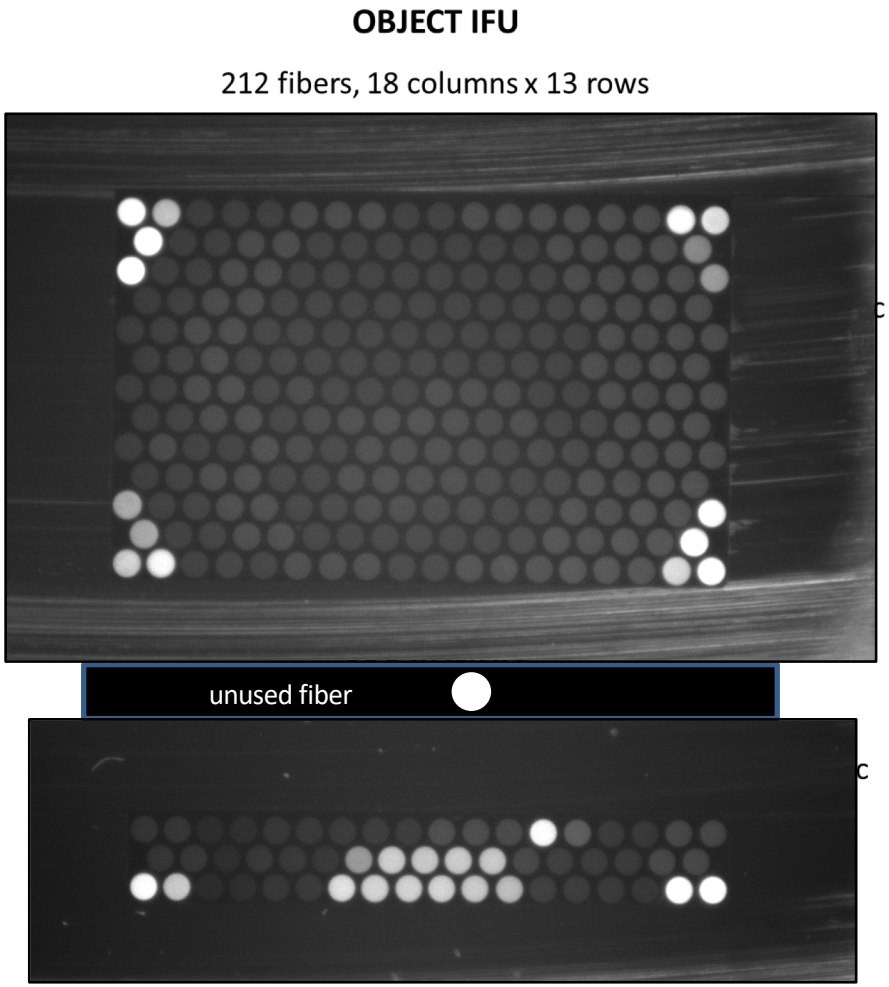
- High Stability Mode – R ~ 65000, but with highest wavelength accuracy, down to 3-5 m/s using our Iodine Cell or simultaneous ThAr for calibrations [exoplanet science]

- **Workhorse instrument for poorer weather/bright Moon**
- **Upgrades in progress (more later – See Lisa's talk)**

IT'S ALL HAPPENING! - NIR

- Wavelength Coverage: 800-1700 nm
- Spectral Resolution: 2000 – 5000
- Plate Scale: 4.4 pixels/arcsec
- Fiber Fed
- Resolution Element: 5.8 pixels/fiber

- Science IFU
  - Number of Fibers: 212
  - Field of View: 18 x 29 arcsec
  - Fiber Size: 1.3 arcsec
- Sky Bundle
  - Number of Fibers: 36
  - Field of View: 4 x 29 arcsec
  - Distance from IFU: 49 – 159 arcsec



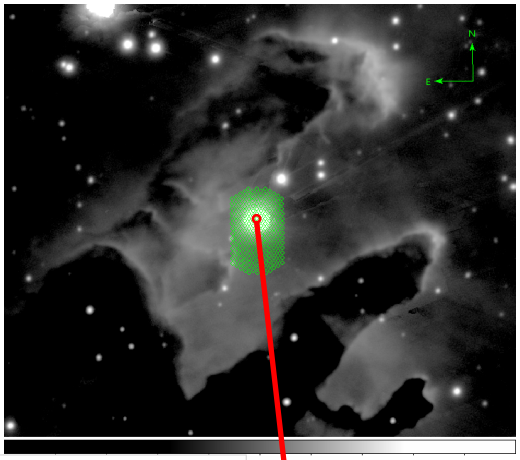
NIR FIRST LIGHT

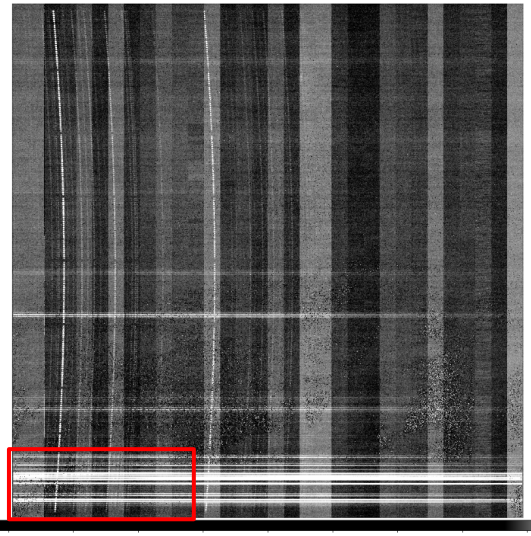
First light on 7 July 2022

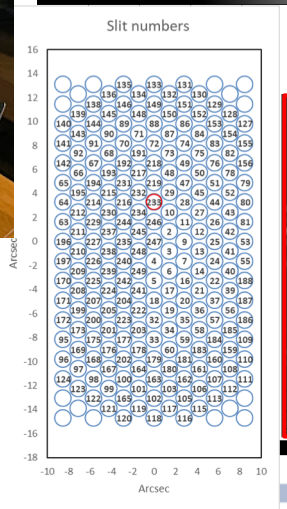
On-sky science commissioning started in October 2022

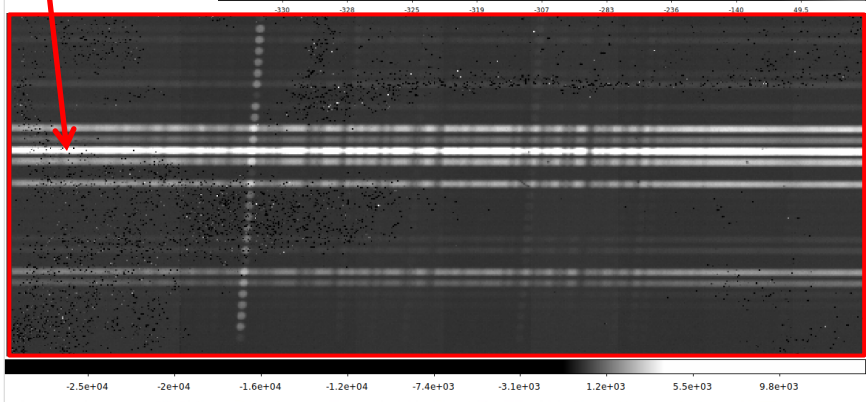
Shared risk in 2023

Eagle Nebula





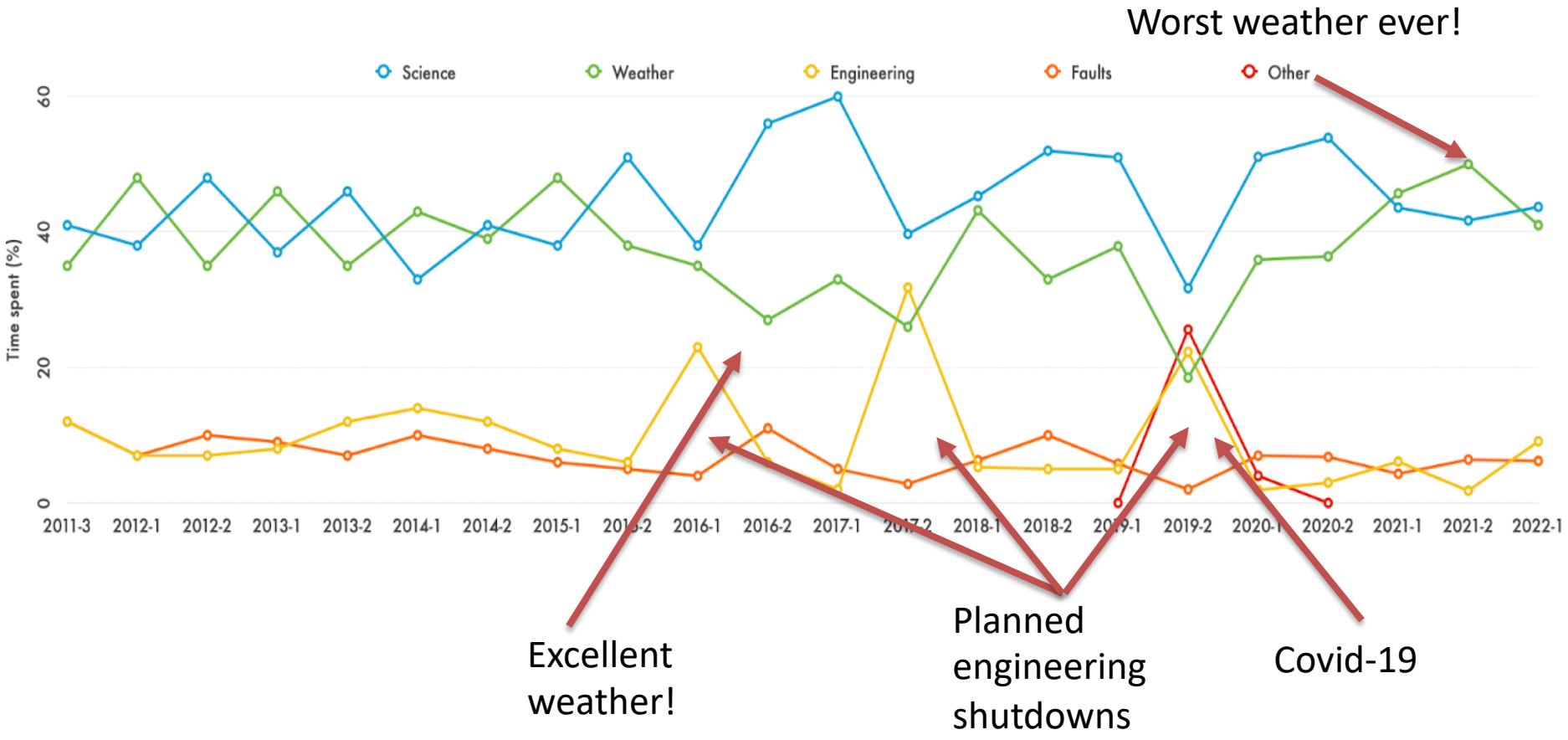




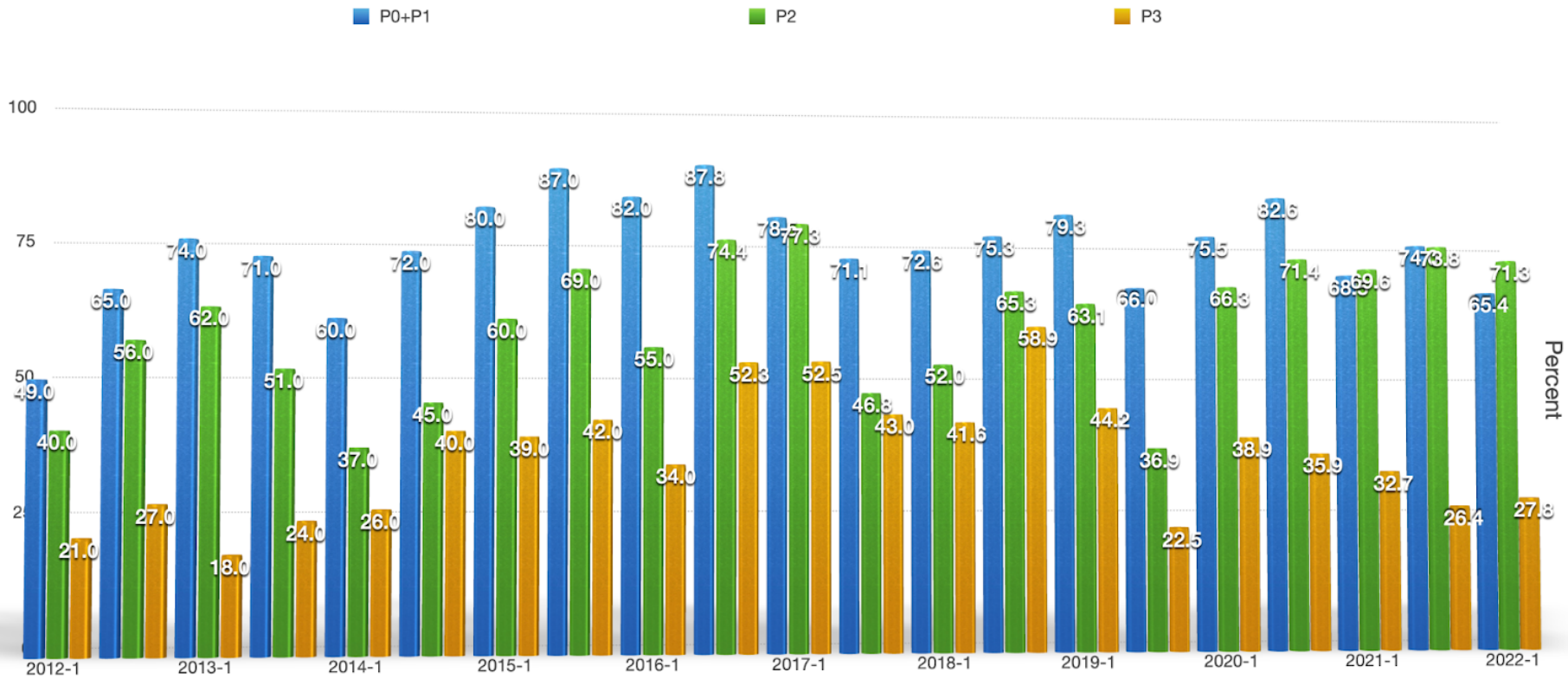
OBSERVING STATS

SALT TIME USAGE PER SEMESTER

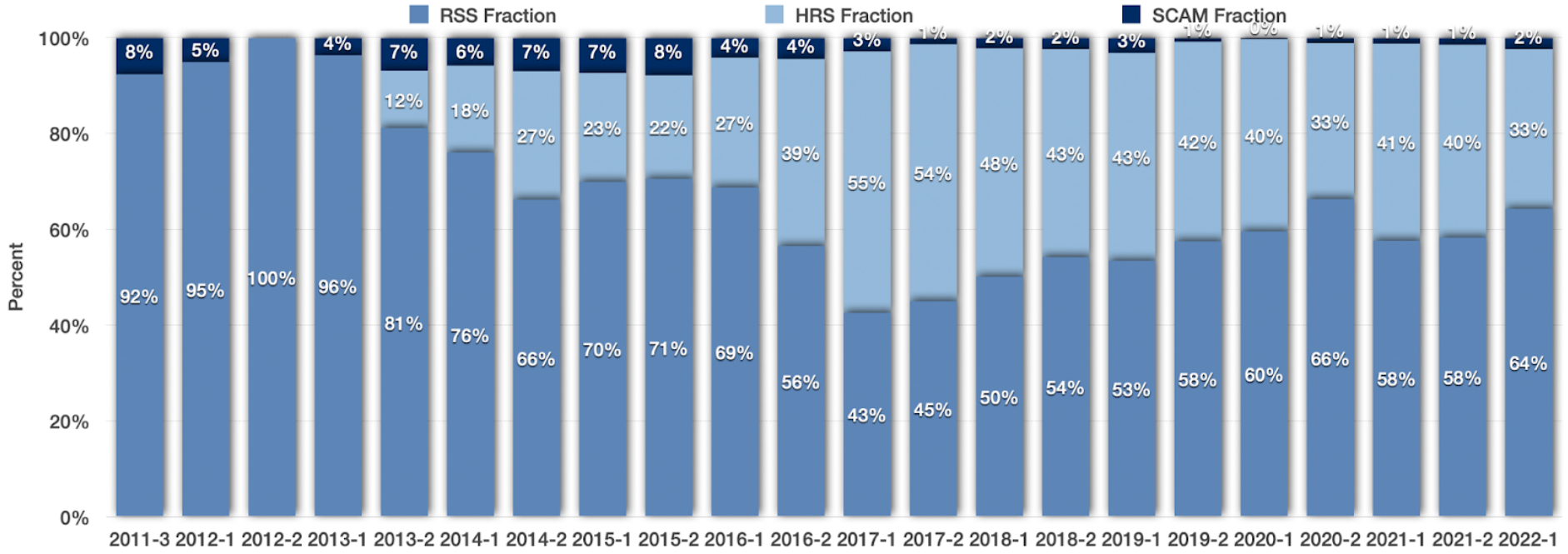
INCLUDING COVID-19 AS "OTHER"



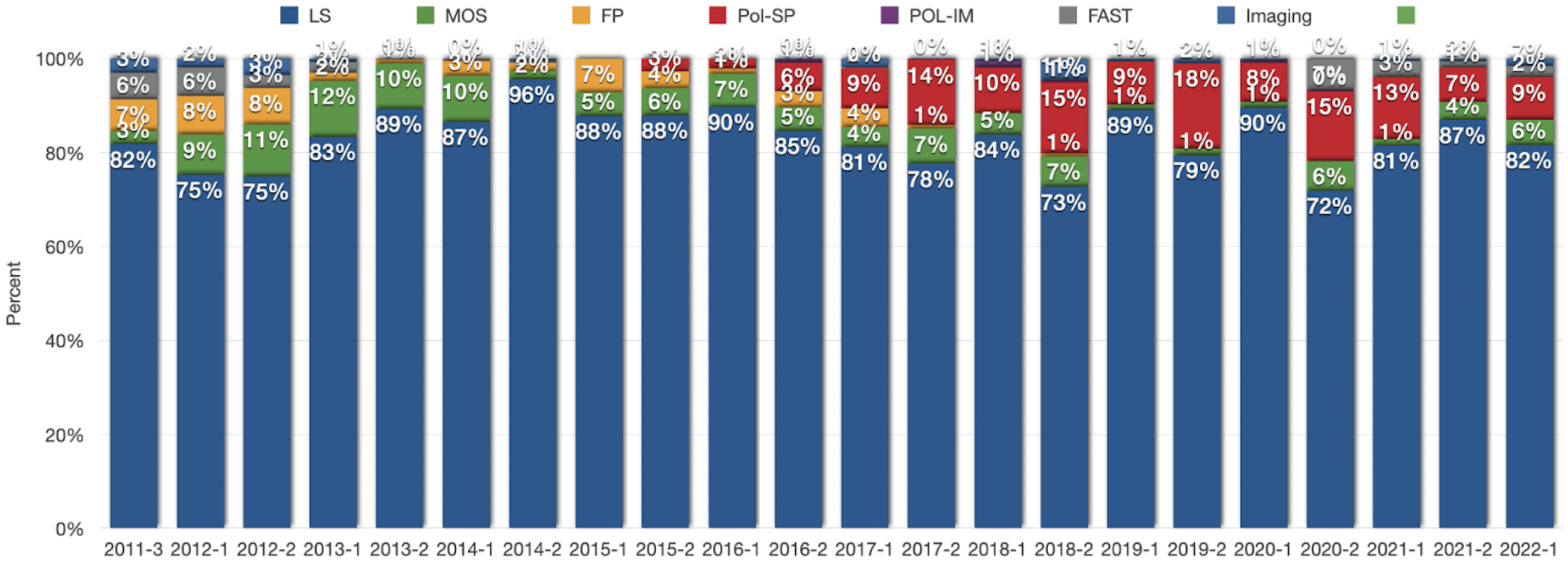
SALT PRIORITY COMPLETION PER SEMESTER



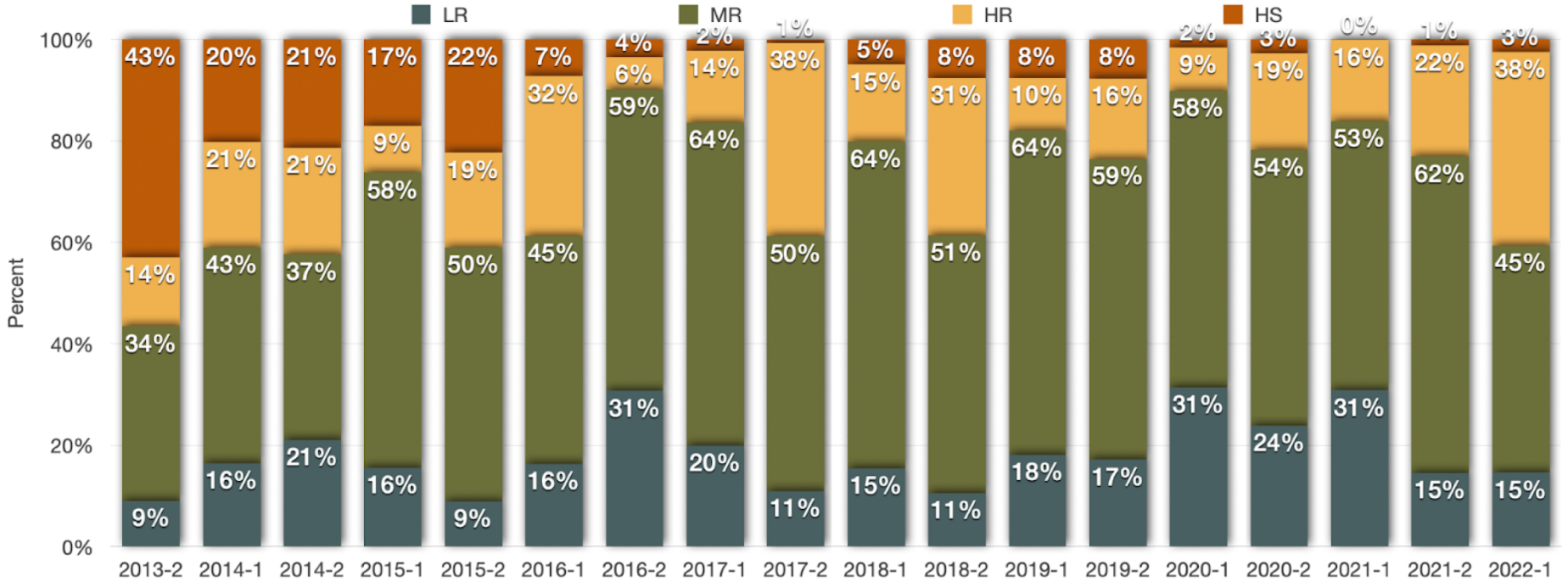
SALT INSTRUMENT USAGE PER SEMESTER



RSS USAGE PER SEMESTER – BY MODE

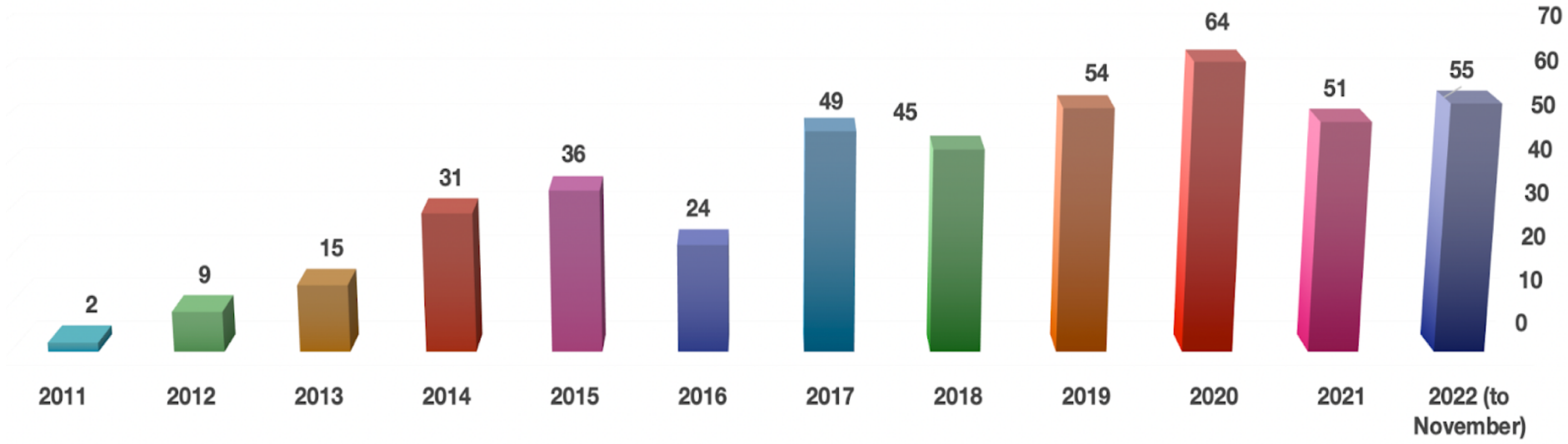


HRS USAGE PER SEMESTER – BY MODE

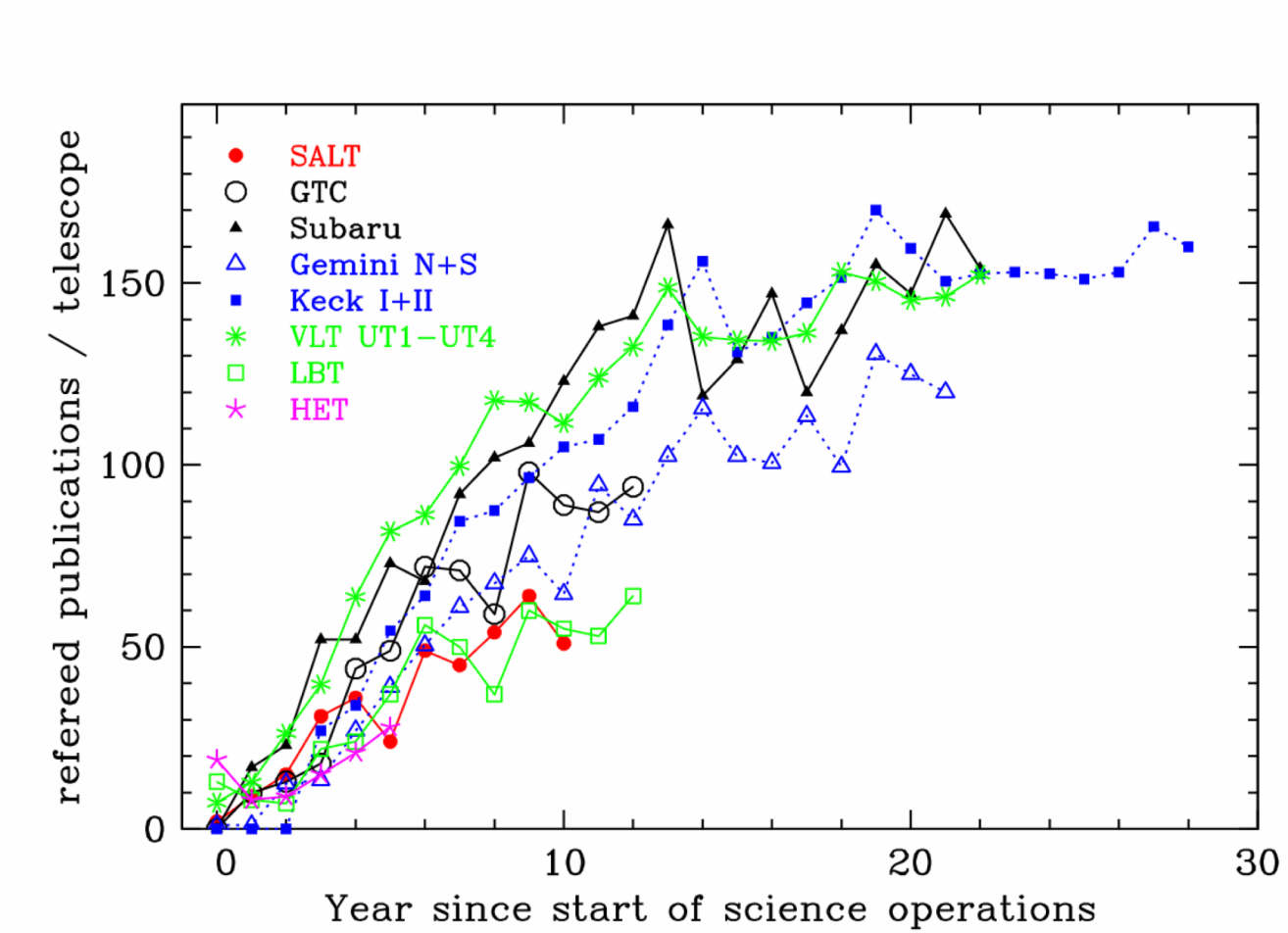


SCIENCE STATS

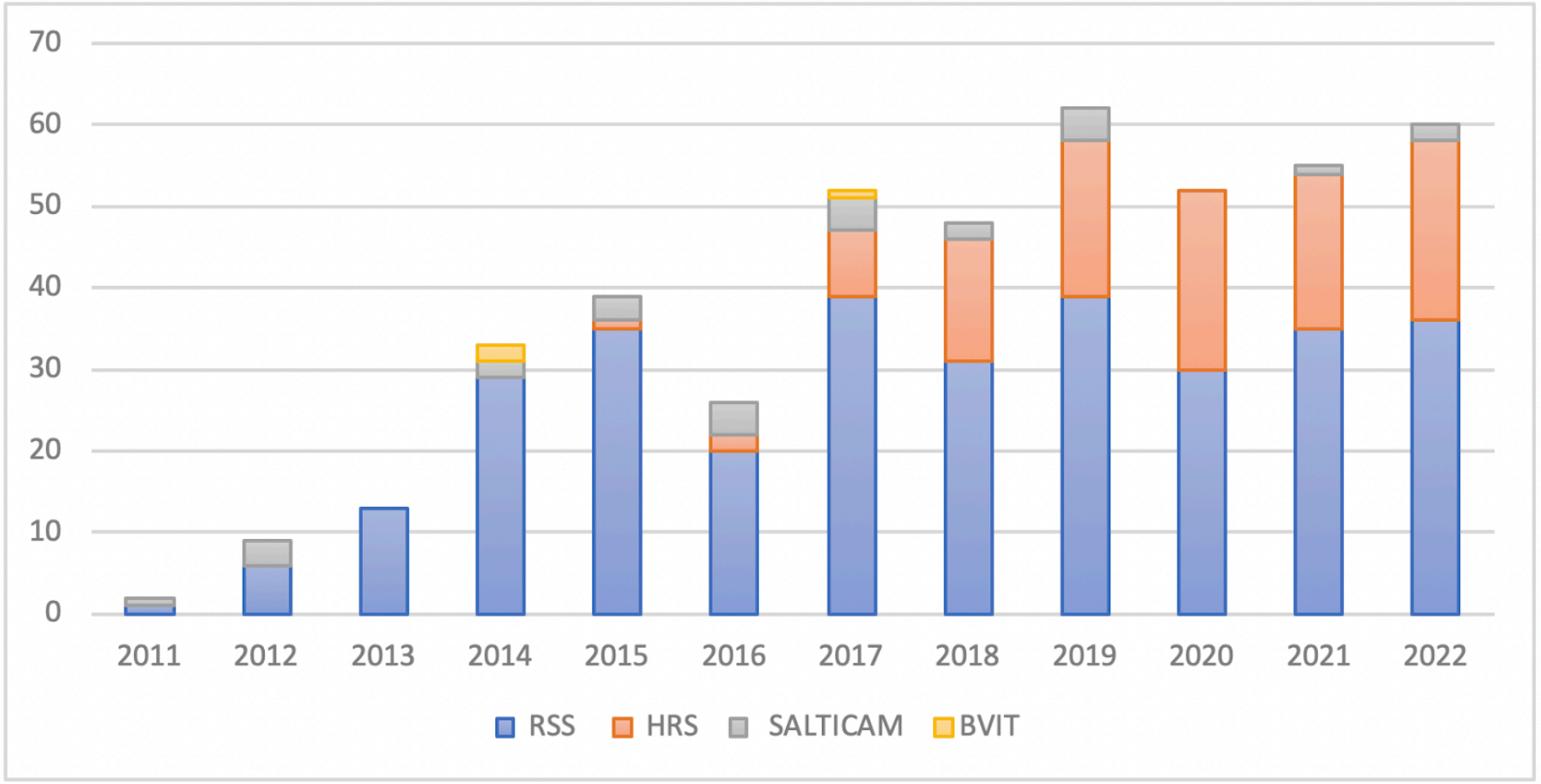
SALT PUBLICATIONS PER YEAR



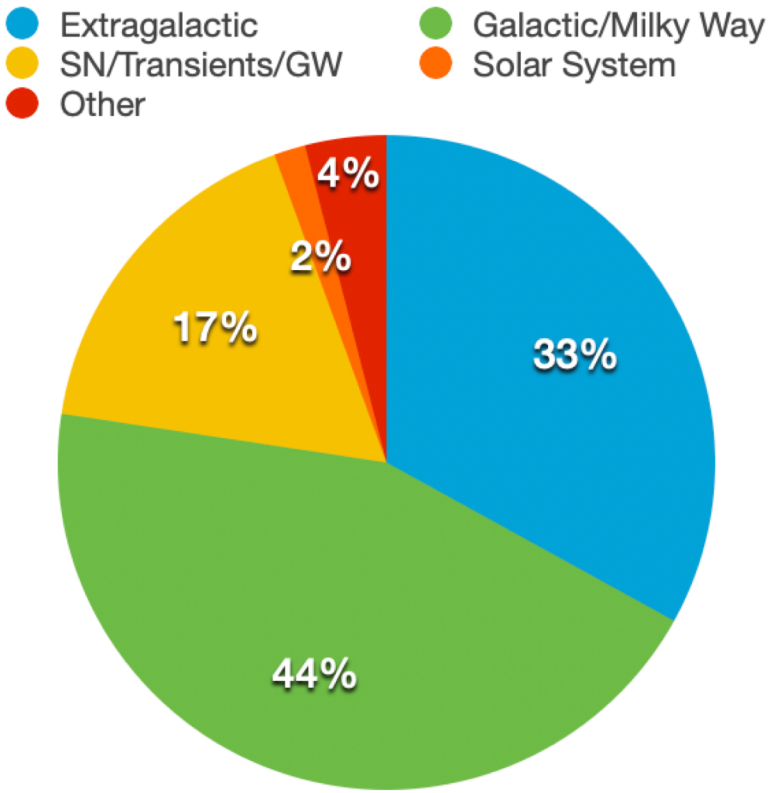
PUBLICATION RATE PER TELESCOPE



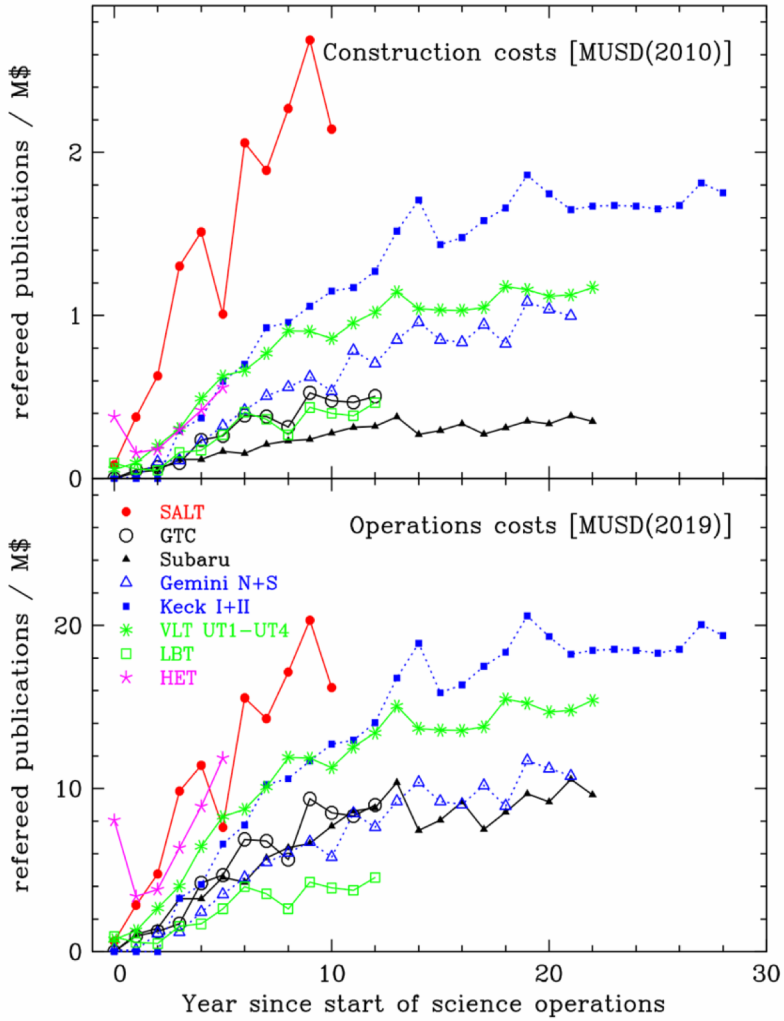
SALT PUBLICATIONS PER INSTRUMENT



PAPERS UNTIL MAY 2022 – BY BROAD SCIENCE



SALT IS VERY COST EFFECTIVE



SUMMARY

- SALT is a 10m-class telescope, available to partner institutions (and collaborators), + ORP + African PIs
- SALT takes some getting used to, but it is an ideal spectroscopic survey telescope. It has large collecting power in dark skies (but modest seeing), able to change instruments 'on the fly', fully queue scheduled with ~rapid response to ToOs and rare instrument modes.
- SALT is performing well and its publication rate is comparable to that of other large telescopes across the world, but at a much lower cost.
- We are commissioning a new IFU specgtrograph that will extend the wavelength coverage of the telescope to 1700nm.
- Most of our instrumentation is also undergoing improvements.

Over to Lisa!

THANK YOU!