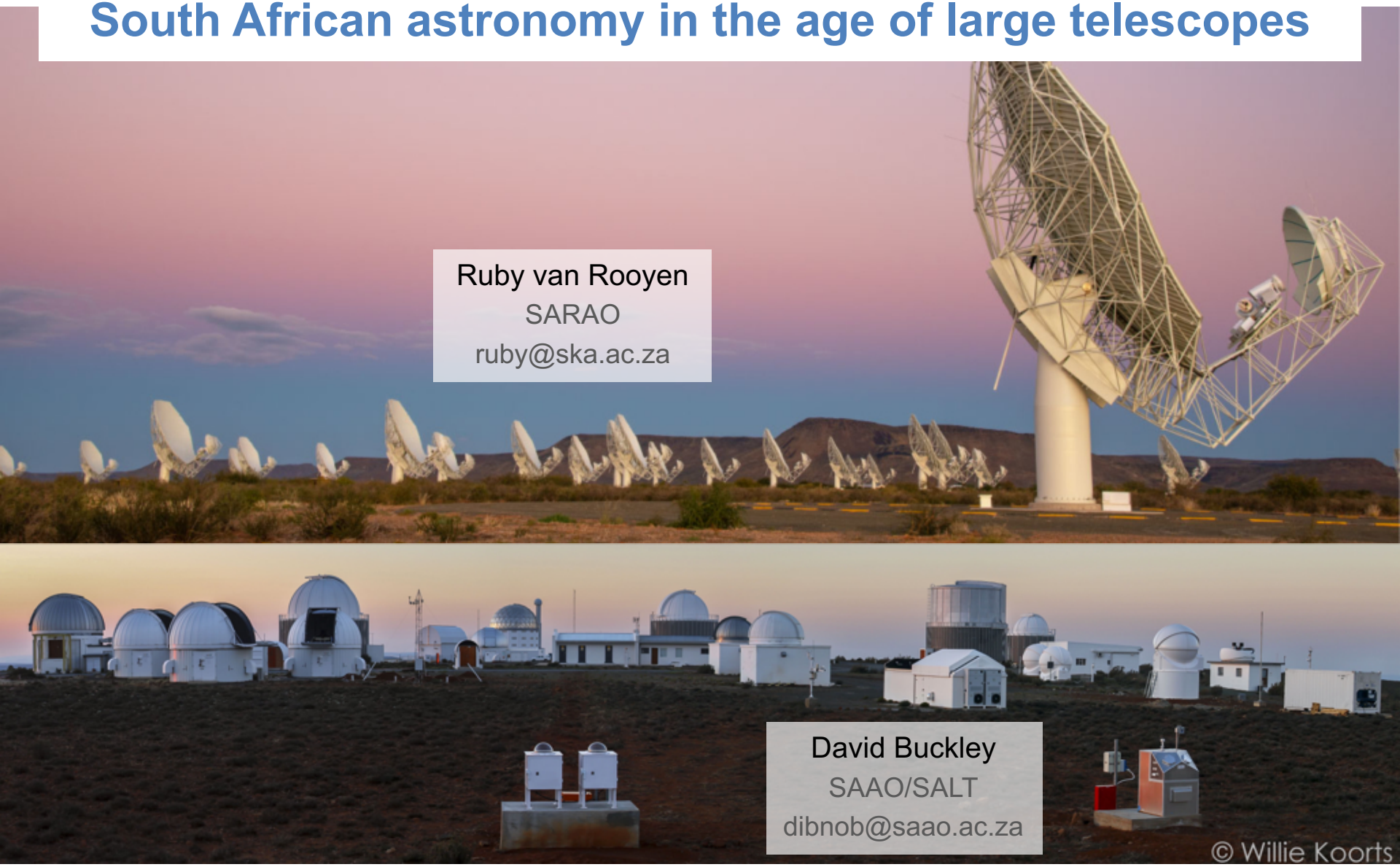
South African astronomy in the age of large telescopes



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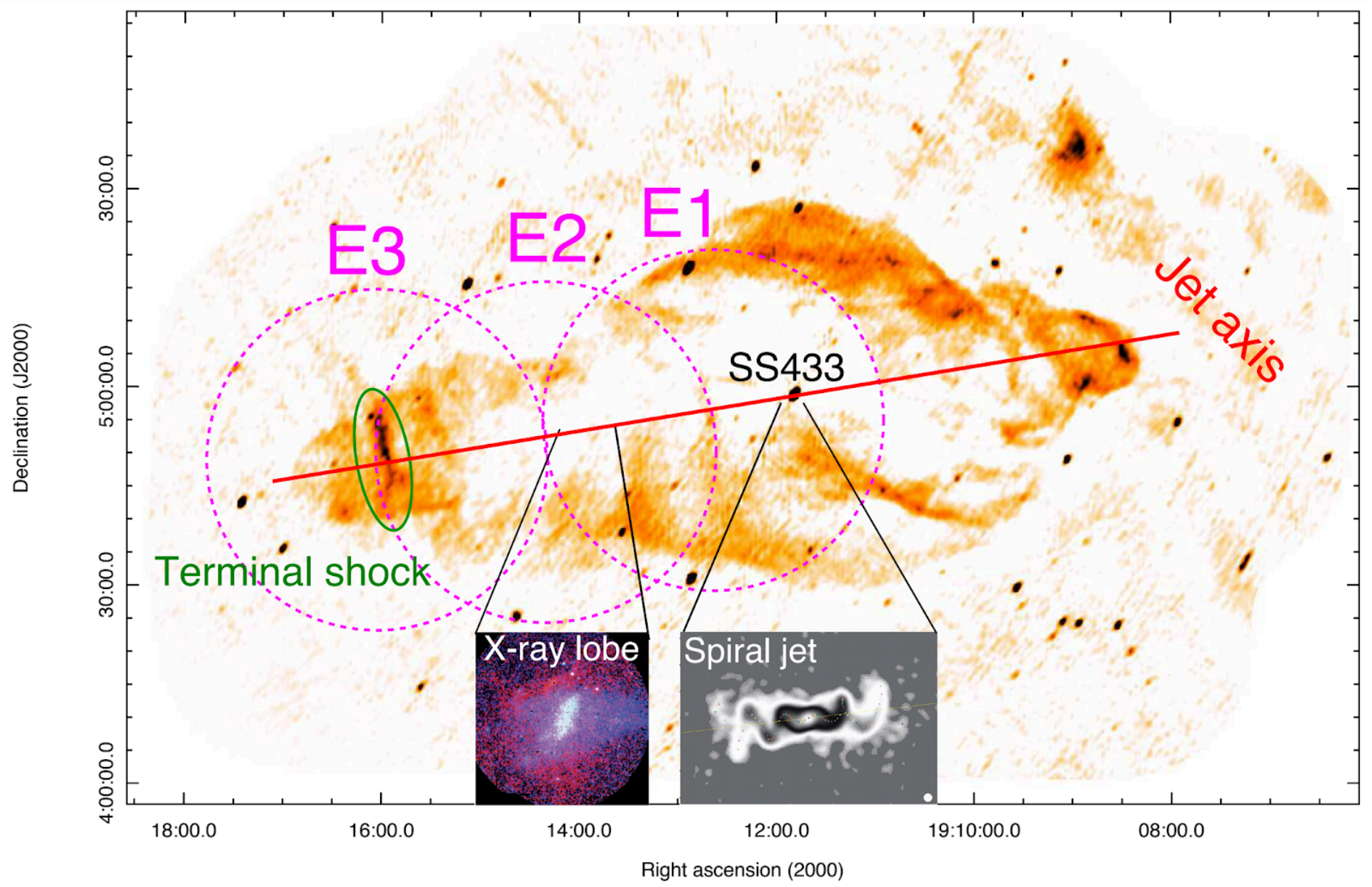

E3
E2
E1
Jet axis
SS433
Terminal shock
X-ray lobe
Spiral jet
Declination (J2000)
30:00.0
5:00:00.0
30:00.0
4:00:00.0
18:00.0
16:00.0
14:00.0
12:00.0
19:10:00.0
08:00.0
Right ascension (2000)

Transients

Time domain and transient astronomy is a growing science promising many new discoveries

Increasing number of facilities and surveys leading to discoveries of transients of all classes

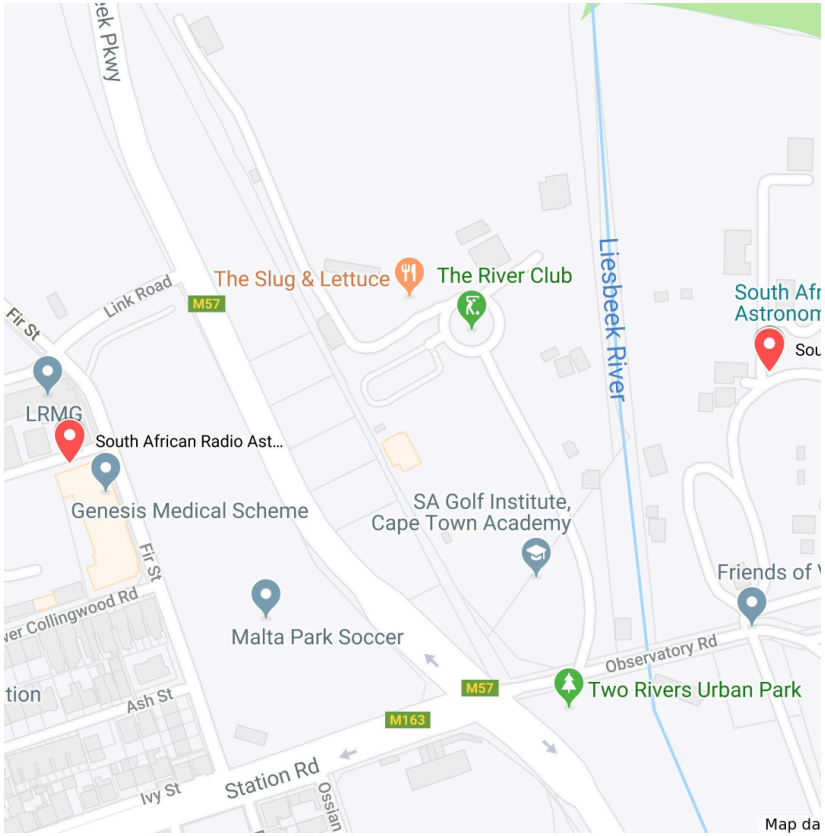
- Some dedicated to specific classes of objects (e.g. supernovae)
- Others finding many different classes of transients as a by-product of wide-field surveys (e.g. Gaia, OGLE, PanSTARRS, ZTF, TESS)

Observe transient behaviour over a wide range of objects and timescales

Both ground-based and space-based facilities are sources of alerts

SA optical and radio telescopes

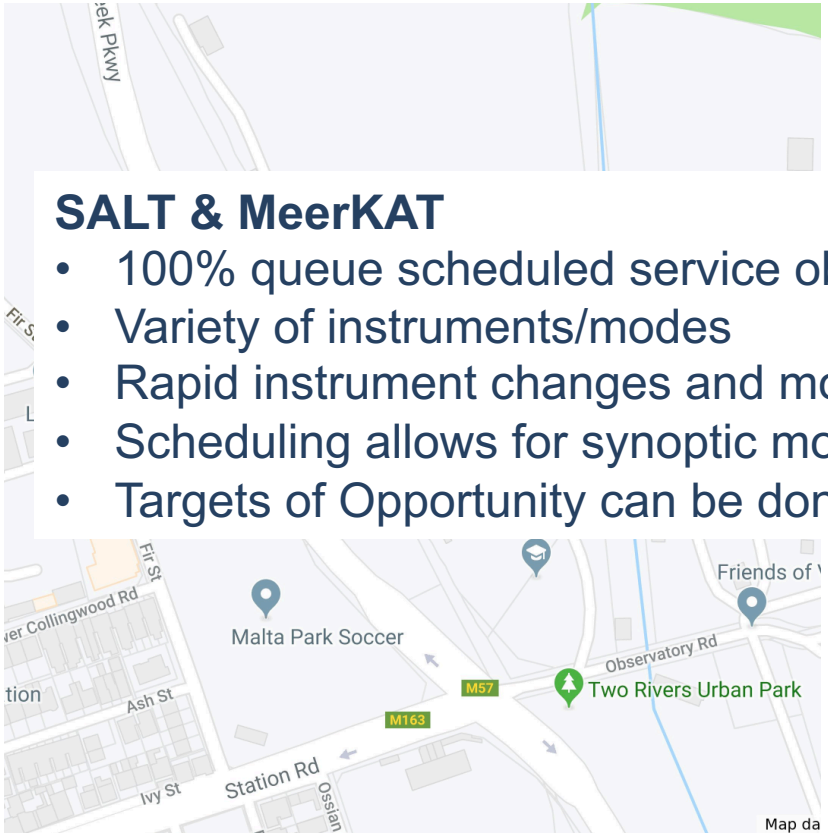
SARAO & SAAO Cape Town offices (500m apart)



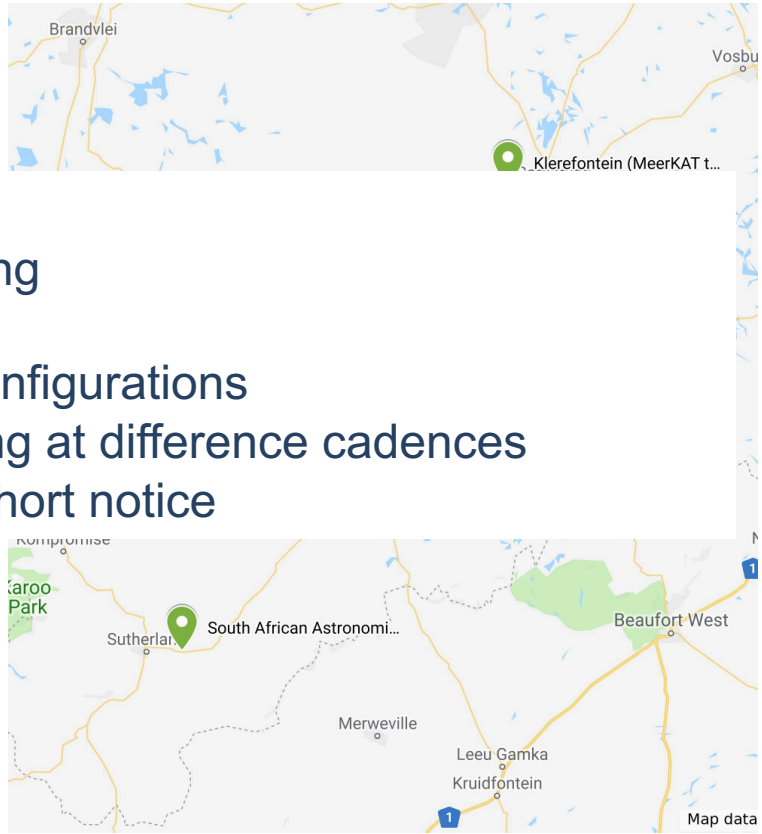
SAAO Sutherland site & MeerKAT telescope (200km apart)

SA Optical and Radio Telescopes

SARAO & SAAO Cape Town offices (500m apart)



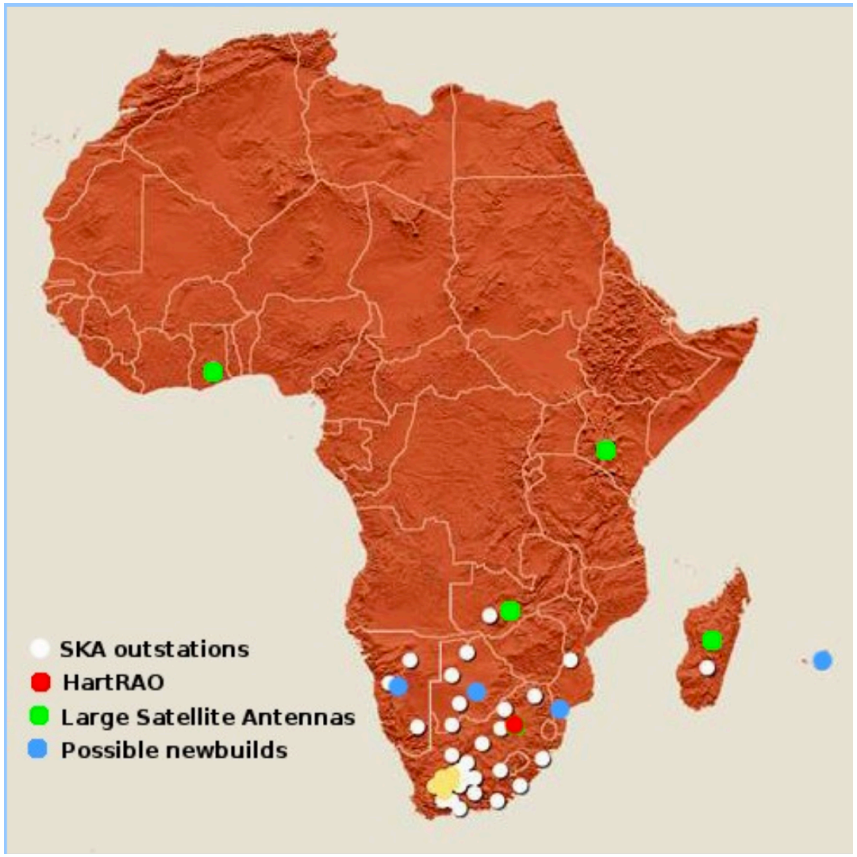
SAAO Sutherland site & MeerKAT telescope (200km apart)



SALT & MeerKAT

- 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

Radio telescopes take up slightly more space



Transient projects

SALT

- South Africa has developed its own ground-based optical detection facilities
- A SALT large science programme on transients began in 2016
- Paving the way for the next big transient discovery machine: *the Large Synoptic Survey Telescope (LSST)*
  - Large allocation 400ksec / semester
  - High fraction (60%) in highest priority (e.g. ToO) class
  - Can monitor objects on different cadences
  - Basic pipeline reduced data available in < 12 h (raw data immediately)
  - *Recently extended for 3 more years*

MeerKAT

MeerKAT 8 LSPs, with 3 Time domain projects:

- **MeerTime**: Testing Einstein's theory of gravity and gravitational radiation - Investigating the physics of enigmatic neutron stars through observations of pulsars.
- **ThunderKAT**: (The Hunt for Dynamic and Explosive Radio Transients with MeerKAT) - eg gamma ray bursts, novae and supernovae, plus new types of transient radio sources.
- **TRAPUM**: Searching for, and investigating new and exotic pulsars (e.g. FRBs).

USE commensals:

- FBFUSE (~1000 beams)
- APSUSE (accelerated pulsar search)
- TUSE (transients)
- BLUSE (SETI)

Multi-institutional/multi-partner program

SALT

- 5 South African institutions (SAAO, UCT, UFS, NWU, UJ)
- 4 other SALT partners (Poland, India (IUCAA), UK, U. Wisconsin)
- 32 investigators (incl. many graduate students)
- Now being expanded to include other international participation (e.g. China, Russia)

MeerKAT

- **MeerTime** Professor Matthew Bailes, Swinburne Centre for Astrophysics and Supercomputing, Australia
- **ThunderKAT** Professor Patrick Woudt, University of Cape Town, South Africa; Professor Rob Fender, University of Southampton, UK
- **TRAPUM** Dr Benjamin Stappers, Joddrell Bank Centre for Astrophysics, UK; Professor Michael Kramer, Max Planck Institute for Radio Astronomy, Germany
- **Breakthrough Listen** Andrew Siemion, Berkeley SETI LABS

Next 3 years

Intelligent observatory

How all of SAAO operates/functions

Merging human decisions/work with algorithms, hardware and data -- autonomous systems

Space based observatories: Gaia, X-ray, Gamma ray missions

MeerKAT/MeerLICHT, Ligo/Virgo

SKA, CTA, LSST

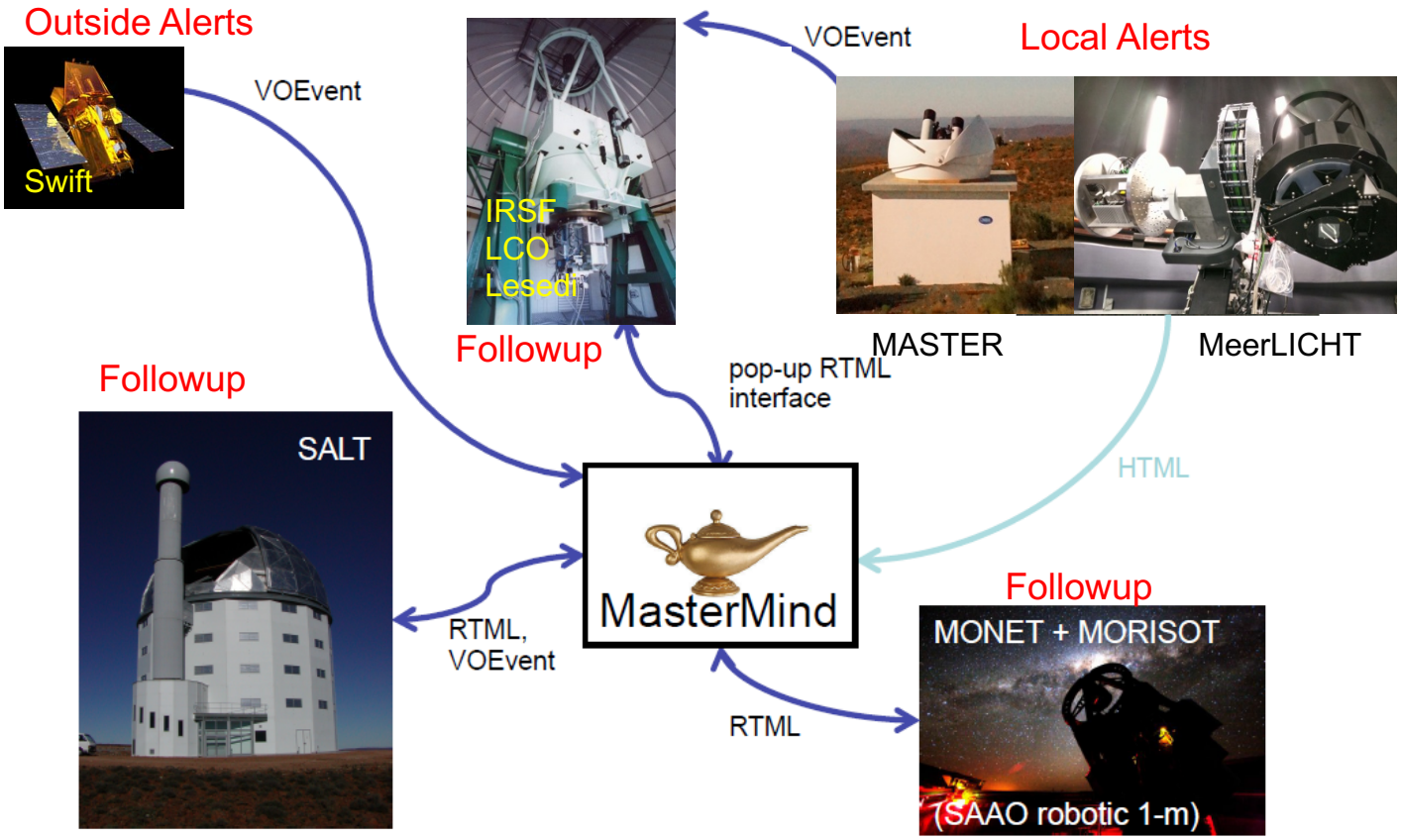
- developing automatic followup systems at SAAO/SALT to react to triggers from LSST observing brokers,
- development of autonomous and intelligent telescope/instrument scheduling systems as part of the SAAO's new "Intelligent Observatory" programme
- using data from shallower wide-field transient alert facilities (e.g. MeerLICHT and MASTER) to test automated classification software (e.g. from their light curves) through potential machine learning,
- undertaking mini-surveys with facilities like MeerLICHT (e.g. in the twilight programme) and MONET-South to test detection algorithms and automated light curve classifications,
- participation in the SALT/SAAO transient programme, particularly in regard to how it should be structured in the LSST era and expanding to include multi-wavelength facilities (e.g. MeerKAT and HESS)

MeerKAT extension

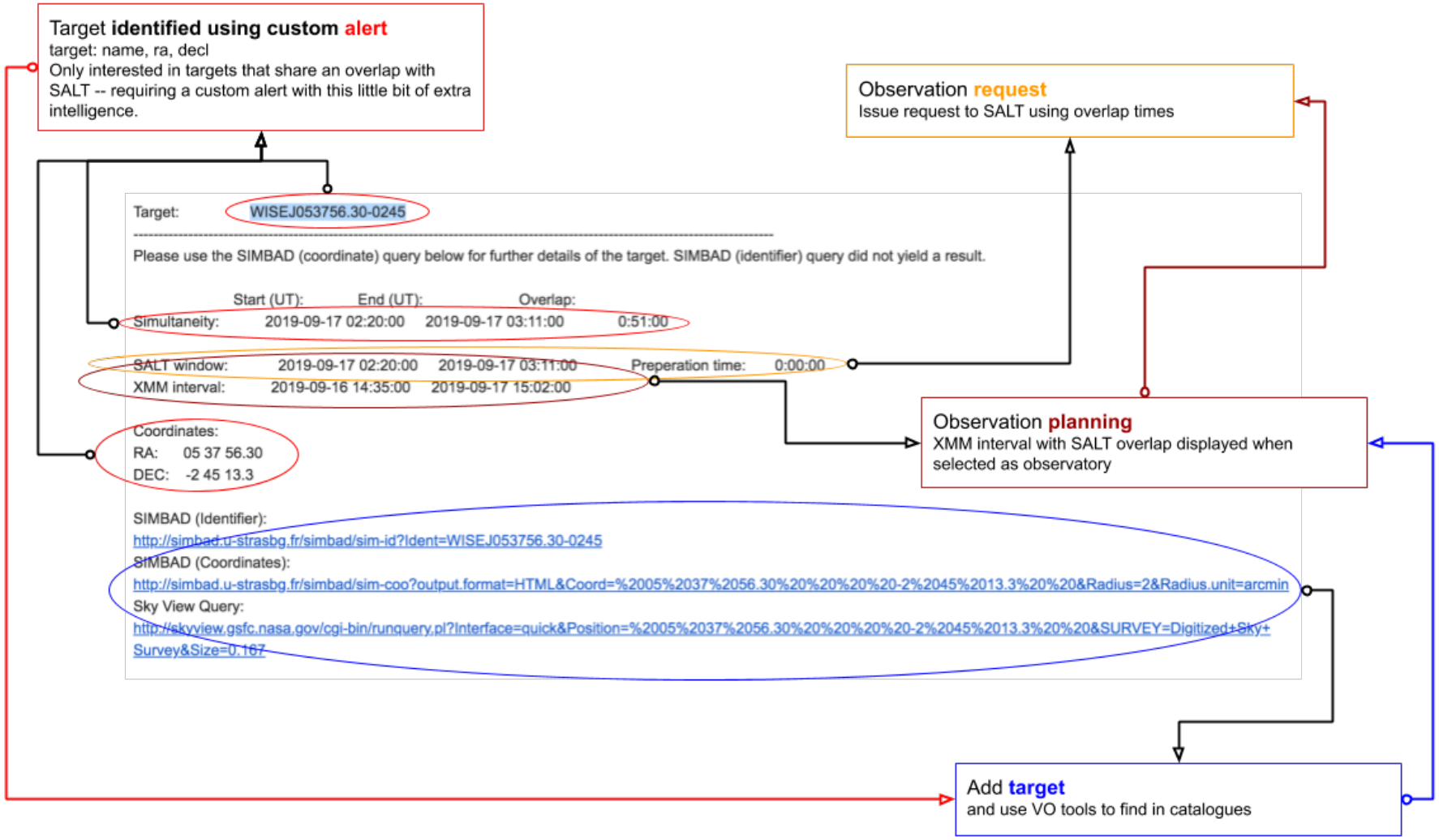
Simultaneous L-band and S-band surveys

SALT

Automated Transient Follow up



X-ray/SALT overlap TOMs



MeerKAT TOMs prototype

Rob Fender
to Sean, James, Astronomer, Patrick

Fri, 13 Sep, 11:27 (6 days ago)

Dear Sean,

We would like to add in a new source which we have just detected with AMI, for a 15-min scan:

MAXIJ1807
RA(J2000) = 18h 08m 07.57s
Dec(J2000) = +13d 15m 04.6s

thanks,
Rob

[AoD] MeerKAT ATEL

Sharmila Goedhart
to Operators, Astronomer, Thomas

Hi all

Just thought I'd send you some feedback on the classical novae observations - V3890 Sgr.
Miriam is a PhD student at UCT and this will be part of her thesis.
http://www.astronomerstelegram.org/?read=13089

We'll be continuing to follow the radio evolution of this source, with very short SBs every two days or so.

Cheers,
Sharmila

Sean Passmoor
to Rob, James, Astronomer, Patrick

Thu, 12 Sep, 12:59 (7 days ago)

Dear Rob , James & Patrick

I am taking over from Sarah as AOD.
Please let me know if you want to change the schedule for this weekend. It is currently planned for the evening of the 14th of September

Last week the schedule included these 5 targets:
Targets observed :
EXO 1846-031 observed for 900.0 sec
GRS1915+105 observed for 900.0 sec
GX_339-4 observed for 600.0 sec
MAXI J1820+070 observed for 900.0 sec
SAX J1808.4-3658 observed for 900.0 sec

Here is an outline of the observing planned for the 14 of September.
The Target list

```
# bpcal
- name=J1939-6342 | 1934-638, radec=19:39:25.05 -63:42:43.63, tags=delaycal bpcal, duration=300
# GX_339-4
- name=J1744-5144 | 1740-517, radec=17:44:25.47 -51:44:43.1, tags=gaincal, duration=120
- name=GX_339-4, radec=17:02:49.36 -48:47:22.8, tags=target, duration=600
- name=J1744-5144 | 1740-517, radec=17:44:25.47 -51:44:43.1, tags=gaincal, duration=120
# MAXI J1820
- name=J1733-1304 | NRAO530, radec=17:33:02.66 -13:04:49.1, tags=gaincal, duration=120
- name=MAXI J1820+070, radec=18:20:21.94 7:11:07.2, tags=target, duration=900
- name=J1733-1304 | NRAO530, radec=17:33:02.66 -13:04:49.1, tags=gaincal, duration=120
# EXO 1846-031
- name=J1911-2006 | 1908-201, radec=19:11:09.69 -20:06:55.5, tags=gaincal, duration=120
- name=EXO 1846-031, radec=18:49:16.99 -03:03:55.3, tags=target, duration=900
- name=J1911-2006 | 1908-201, radec=19:11:09.69 -20:06:55.5, tags=gaincal, duration=120
# SAXJ1808
```

Questions