# ThunderKAT: Transients with MeerKAT

**ThunderKAT: A MeerKAT Transient Key Science Project (PIs: Patrick Woudt & Rob Fender)**

SKA AFRICA
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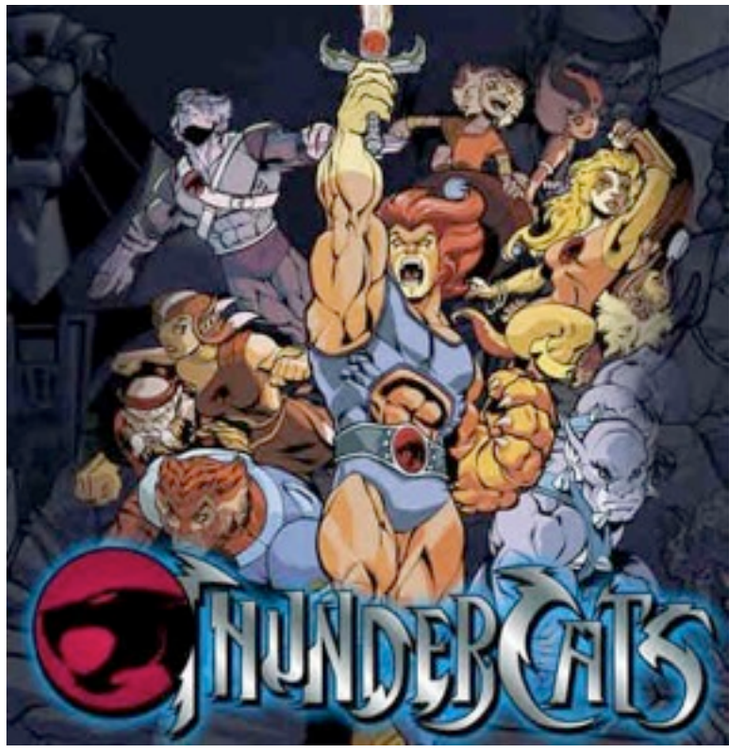
# ThunderKAT: Transients with MeerKAT

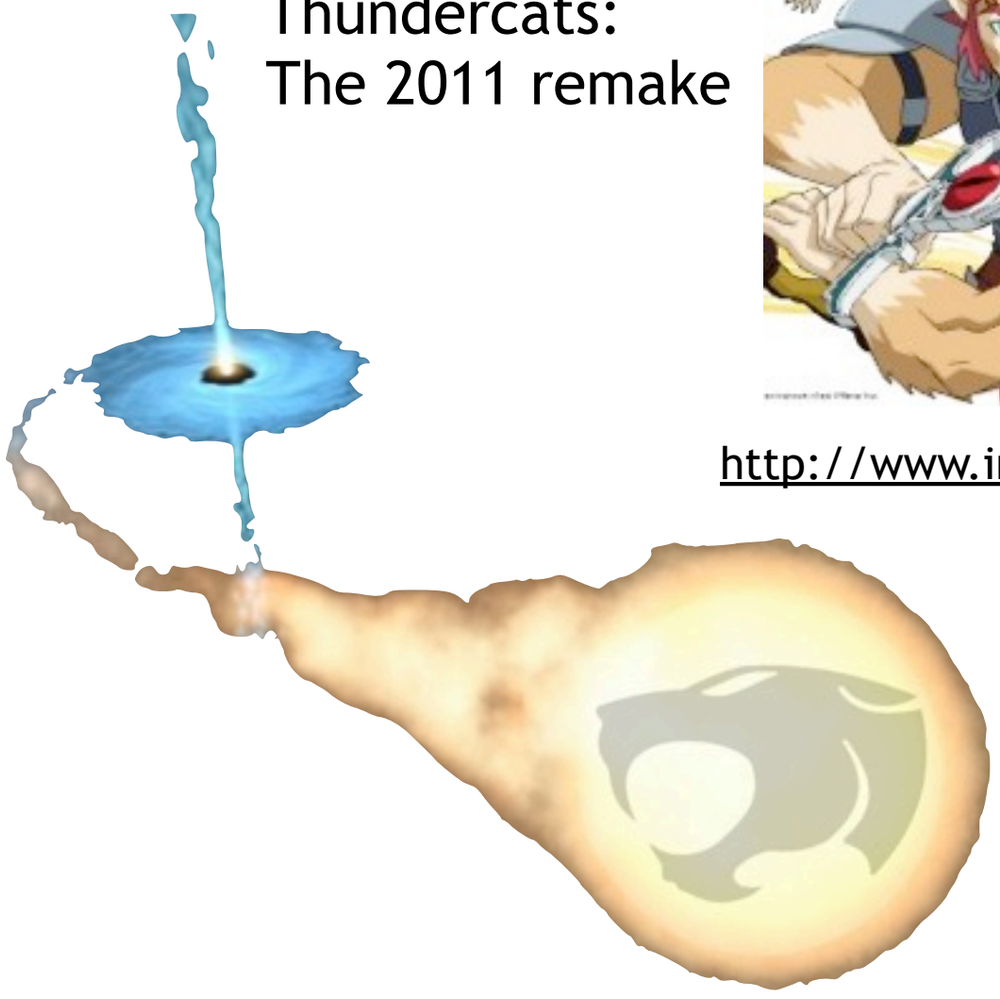
**ThunderKAT: A MeerKAT Transient Key Science Project**




Thundercats:
The 80s series

Thundercats:
The 2011 remake

http://www.imdb.com/video/imdb/vi466394393/



ThunderKAT: A MeerKAT Large Survey Proposal (2010-2019)

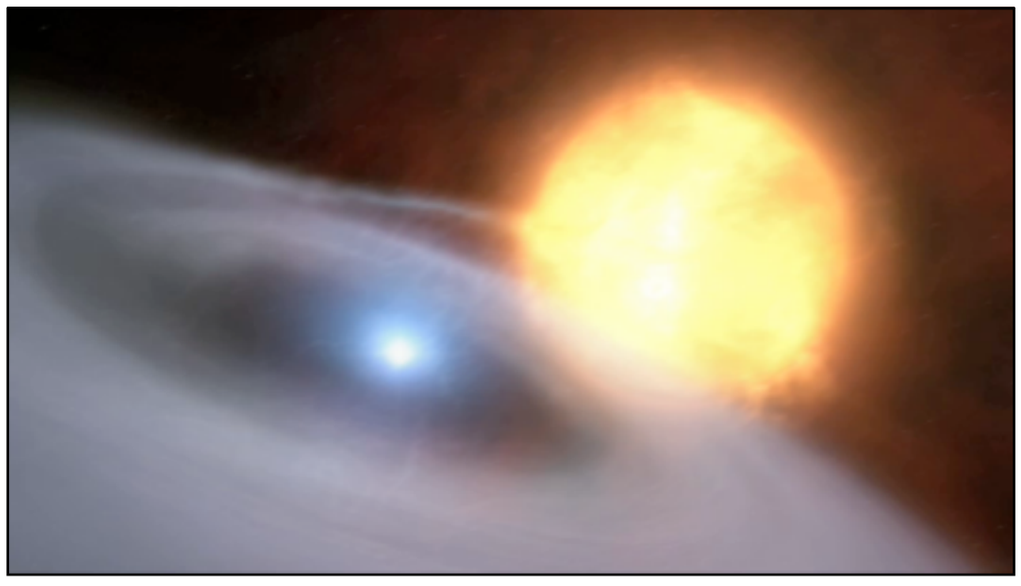
# ThunderKAT: Transients with MeerKAT

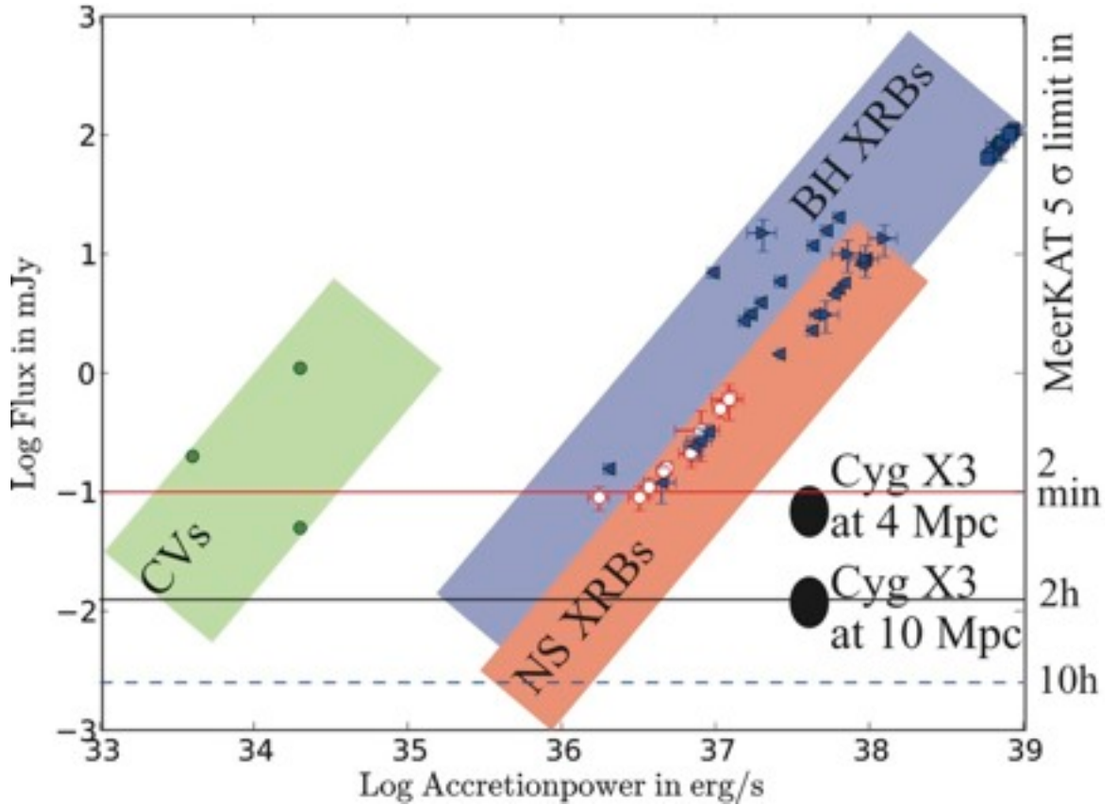
**Science highlights from the ThunderKAT proposal**

Galactic relativistic jets
(microquasars, jets in WDs, outflow from novae)

Extragalactic X-ray binaries

Supernovae and Gamma-Ray Bursts,
Magnetar outbursts






Based on specs in the RFP (2 GHz instantaneous bandwidth, needs to be modified given the current specs)

# ThunderKAT: Transients with MeerKAT

**Feedback from the MeerKAT TAC**

**ThunderKAT**: **T**he **Hun**t for **D**ynamic and **E**xplosive **R**adio Transients with Meer**KAT**
(PI: Woudt & Fender)

**This proposal is to observe a mixture of explosive events, which mostly result from accretion of matter onto compact objects and stellar collapse**.

The Committee thought that there was **potential for much interesting science using MeerKAT's unique configuration**, although they found the case for the Galactic bulge survey for faint-bursting XRBs less compelling than other studies.

In recognition of the high quality of other proposals that also deserved time, **the Committee judged that a total allocation of 3000 hours of telescope time would be sufficient to allow the proposers to achieve the most exciting results.** The Committee also was concerned about the ambit claim for whole classes of sources as part of the ToO case.

It recommends that the proposers be required to **specify carefully the triggers by which the ToO would be initiated** for each class of source. The Committee also encouraged the proposers to pursue **commensal observation with all other projects**.

# ThunderKAT: Transients with MeerKAT

**MeerKAT capabilities (Phased stages)**

2011: KAT-7 7 dishes of 12-m, cooled receivers ($T_{sys}$ = 35 K), L band [2011]

**MeerKAT design: 64 gregorian offset dishes, effective area 13.5 m, 8 km baseline**
Frequency bands: 0.58 - 1.015 GHz, 1 - 1.75 GHz, 8 - 14.5 GHz

Phase 1: Frequency range: 1 - 1.75 GHz [bandwidth: 435 MHz, sub-bands]
[2013: commissioning of 1st dish, 2014: 20 dishes, 2015: science]

Involvement of science teams in MeerKAT-16, MeerKAT-32, etc.

Phase 2: Roll-out of additional receivers: 0.58 - 1.015 GHz [750 MHz]
and 8 - 14.5 GHz [2 GHz, aim 4 GHz]

East-west spur (additional dishes out to 60 km)

MeerKAT PDR [July 2011]

# ThunderKAT: Transients with MeerKAT

**Coordination between the various transient surveys**

**MeerKAT**: ThunderKAT

**LOFAR**: LOFAR Transients KSP

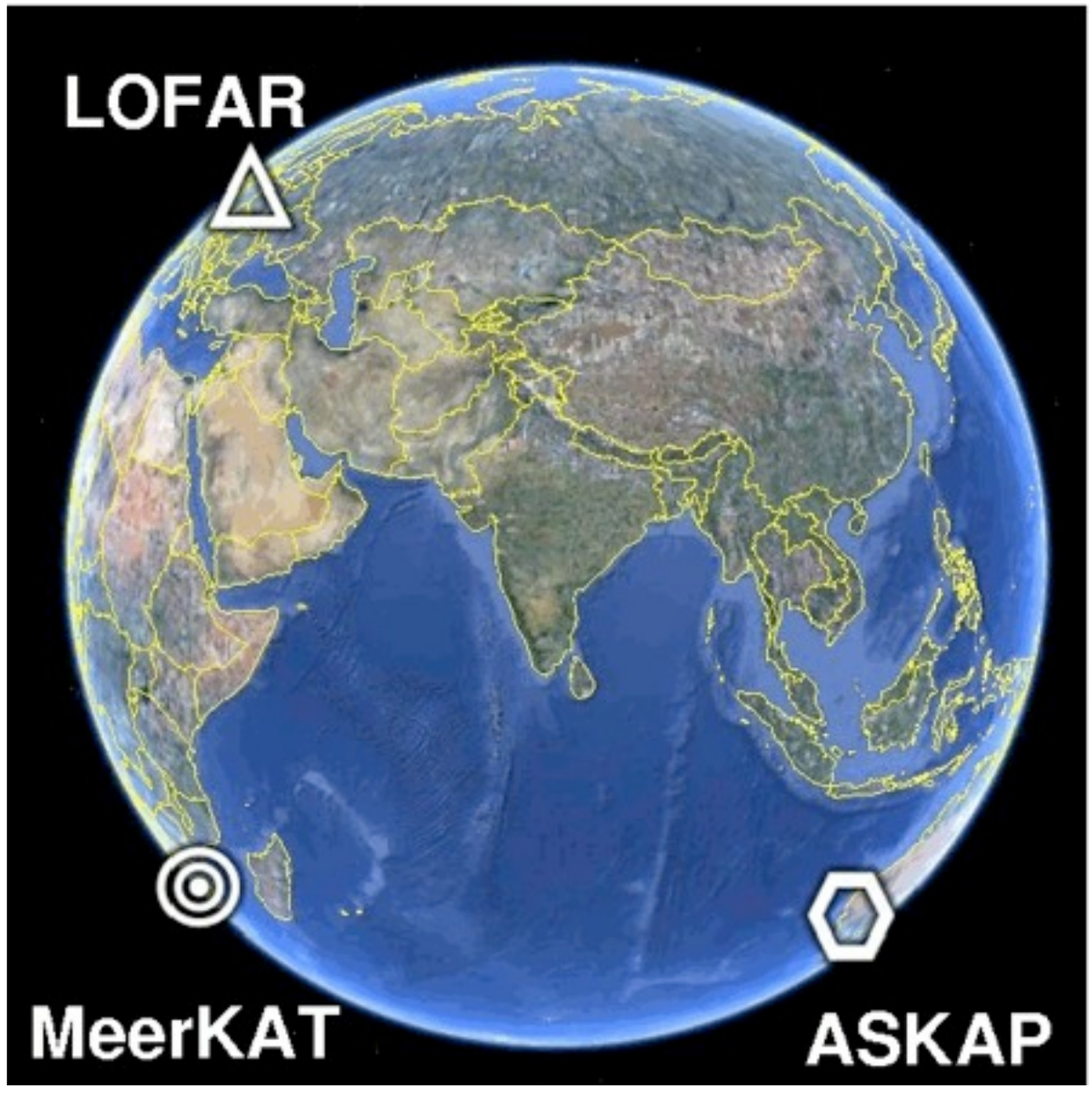
**ASKAP**: Variables and Slow Transients (VAST)

**Discussion:**

How to optimize the interaction/ coordination between the groups?

Exchanges? Time-scales?

Coordinated (bi-)annual workshops (e.g. in the style of the HI pathfinder workshops, PHISC?)




WUN
Worldwide Universities Network

# The MeerKAT Large Survey Projects

**Commensal observing**

- Radio Pulsar Timing (Bailes) [7860 h]
- LADUMA: Ultra-deep pencil beam HI survey (Blyth, Holwerda, Baker) [5000 h]

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- MESMER: MeerKAT Search for Molecules in EoR (Heywood) [6500 h]
- MeerKAT Absorption Line Survey (Gupta, Srianand) [4000 h]
- MHONGOOSE: MeerKAT HI Observations of Nearby Galactic Objects: Observing Southern Emitters (de Blok) [6000 h]
- A MeerKAT HI Survey of Fornax (Serra) [2450 h]
- MeerGAL: MeerKAT High Frequency Galactic Plane Survey (Thompson, Goedhart) [3300 h]
- MIGHTEE: MeerKAT International GigaHertz Tiered Extragalactic Exploration (Jarvis, van der Heyden) [1950 h]
- TRAPUM: Transients and Pulsars with MeerKAT (Stappers, Kramer) [3080 h]
- ThunderKAT: The Hunt for Dynamic and Explosive Radio Transients with MeerKAT (Woudt, Fender) [3000 h = 100 min/day for 5 years]
- VLBI (Bietenholz), SETI.... to be developed (VLBI) and explored (SETI)

# ThunderKAT: Transients with MeerKAT

## Commensal observing

TAC recommendation: **pursue commensal observing with all other projects.**

Some examples:

- **MHONGOOSE**: 30 nearby galaxies at 200 h / galaxy
- **Fornax**: multiple pointings across the Fornax cluster (100 h / pointing)
- **MeerGAL**: 280 < l < 350, |b| < 1

**Discussion:**

Will all our transients be detected commensally or will we survey our own set of galaxies or regions around the Galactic centre?

# ThunderKAT: Transients with MeerKAT

**Commensal observing**

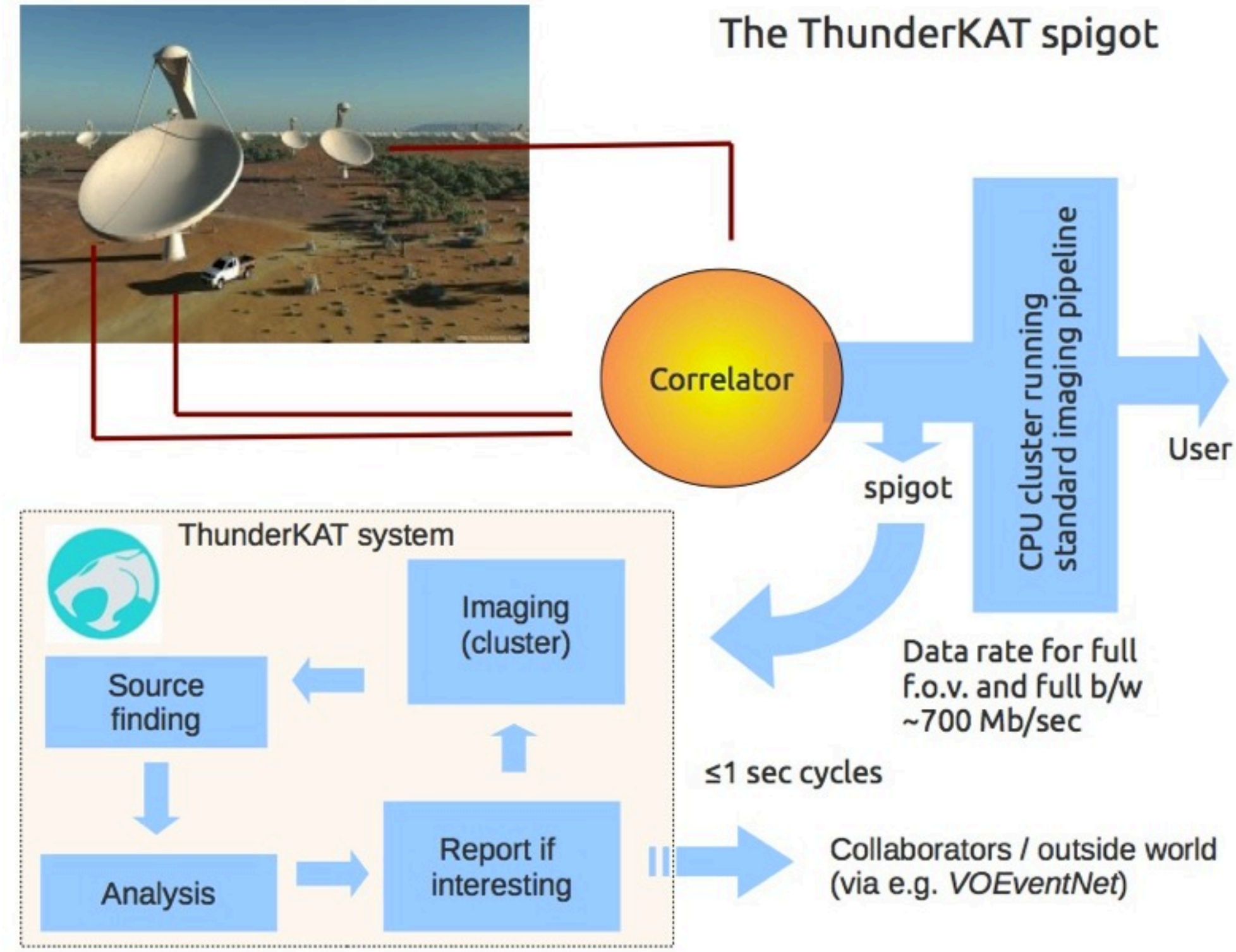
- **Commensal** transient detection

- Galactic relativistic jet sources (accretion state / jet formation), supernovae,
  **possibly yet unknown transient phenomena**

- **100 min/day for 5 years** for follow-up of newly found transients and selected targets
  radio transients: ASKAP, LOFAR, MeerKAT
  optical transients: CRTS, PTF, etc.
  targets: X-ray binaries, Cataclysmic variables, Supernovae, Gamma-ray bursts

# ThunderKAT: Transients with MeerKAT

**Commensal observing / The ThunderKAT spigot**



# ThunderKAT: Transients with MeerKAT

## Software developments

- **ThunderKAT transients to be reported via VOEventNet**

  immediately available to the global community

- **Create infrastructure to detect a ThunderKAT transient in real-time**

  software development (2011+) based on LOFAR expertise, KAT-7 test-bed

- **Create infrastructure to respond to a ThunderKAT transient in real-time**

  Target of opportunity (on MeerKAT, SALT, IRSF, .... range of MW facilities.)

- **SALT/IRSF, SA robotic telescopes and ThunderKAT (& KAT-7!)**

  long-term monitoring

  immediate response (imaging, spectroscopy, high-time domain)

# ThunderKAT: Transients with MeerKAT

**Multi-wavelength coordination**

**Coordinating the multi-wavelength follow up:**

One of the strengths of ThunderKAT is the expertise in the team across a very wide range of the EM spectrum

**Discussion:**

What structures do we need to put in place now for ToO follow up of KAT-7 transients (e.g. SALT)?

Role of the smaller facilities (optical / near-infrared)

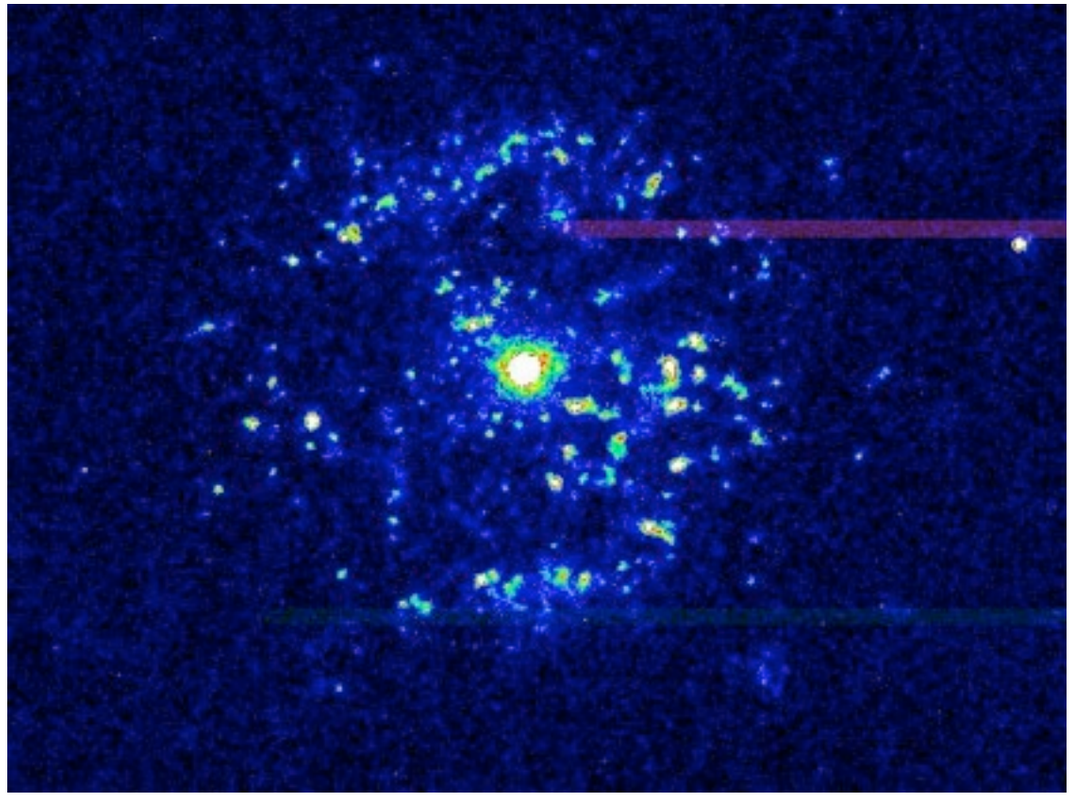
# ThunderKAT: Transients with MeerKAT

**Multi-wavelength coordination (showcase)**

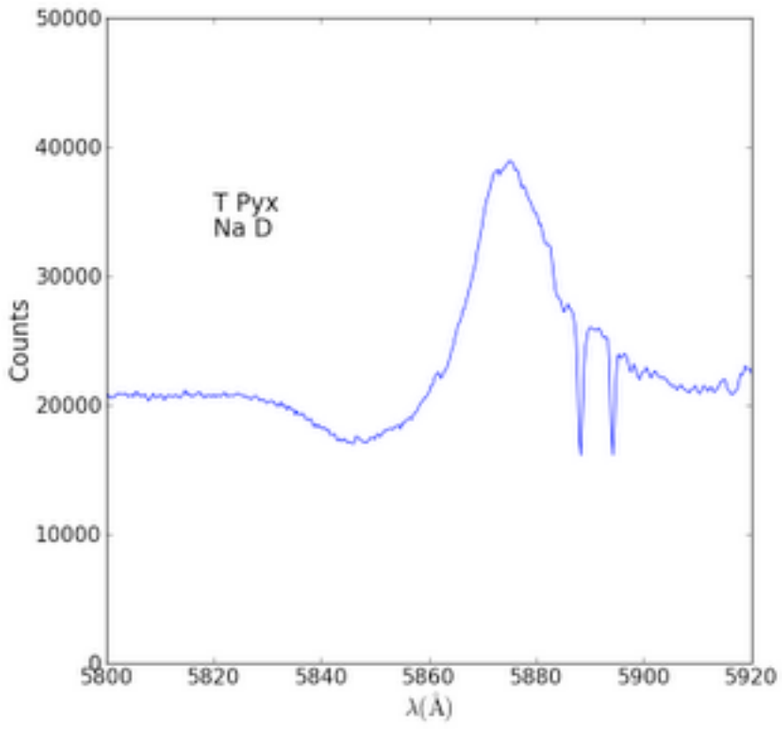
## 2011 outburst of recurrent nova T Pyxis

T Pyx (recurrent nova) went into outburst on 14 April 2011.

SALT's first target that was observed during the recommissioning of the RSS was T Pyx (15 April 2011)



HST image of the nova shell of T Pyx (Shara et al. 1997)




SALT spectrum of T Pyx during 2011 outburst

Excellent showcase of the ToO operation mode of SALT.

The recurrent nova T Pyx falls within the ThunderKAT science case.

Tuesday 26 April 2011

Tuesday 26 April 2011

# ThunderKAT: Transients with MeerKAT



## Science with KAT-7

MeerKAT team will issue a call for commissioning proposals to the MeerKAT Large Project teams (focussed on the commissioning needs, and on a shared-risk basis).

Targets: to be discussed at this workshop (XRBs/GRBs)

Timescales: imminent!  who will work on these data?

Computing: UCT server.

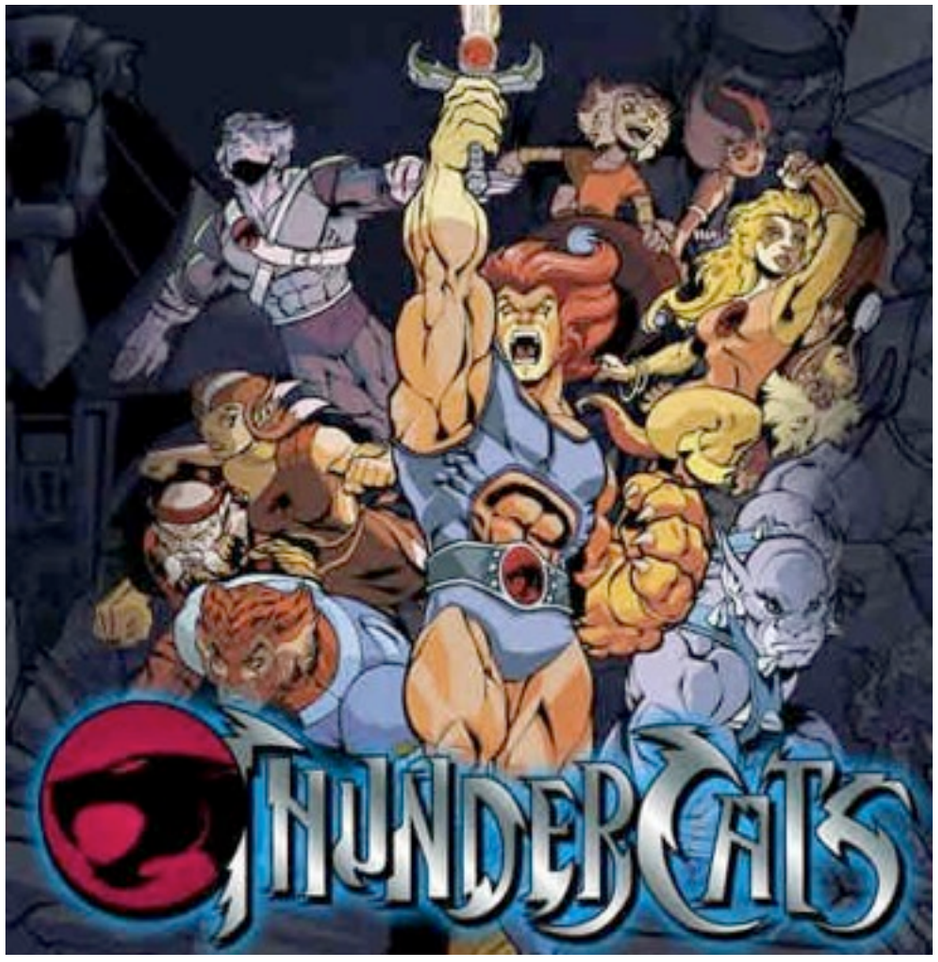
**Discussion:**
Involvement with SA SKA office (software/science)

# ThunderKAT: Transients with MeerKAT

## Organisational structure

**Established workgroups:**

- XRBs (Fender)
- CVs (Woudt/Koerding)
- GRB/SN (Wijers)
- Algorithm & Infrastructure (Miller-Jones)
- Coordination follow-up (Schurch)
- Commensal observing (+PIs of other surveys)
- Commissioning (group leaders)




**Discussion:**

- KAT-7 (2011-2014)?
- how do our workgroups interact with other MLP teams?
  (source detection, imaging pipeline)
- new members (e.g. commensal group)?

# ThunderKAT: Transients with MeerKAT

**Student involvement**

## Human capacity development

### Postdocs

PDRA awarded SA SKA (2011-2013) to work on ThunderKAT  (aligned with proposal)

### Students

1 MSc student working on remote aspects of ThunderKAT (Deanne de Bude)

SA / Europe exchange:
SAPIENT (UCT/Nijmegen)  2 PhD students (1 ThunderKAT / 1 SALT)

**Discussion:**
Room for more student projects (KAT-7 transient monitoring, simulations of transients in MeerKAT);  SA + partners

# ThunderKAT: Transients with MeerKAT

## Desired outcomes of this workshop

**Prepare commissioning proposal for KAT-7**

**Software readiness for KAT-7 data** (to run on UCT machine)

**Plan for ThunderKAT exchanges** (amongst member institutes, funding?)

**Coordinate MWL observations of KAT-7 targets** (ToO, planned)

**Roadmap for MeerKAT transient science** (KAT-7, simulations, MeerKAT-16, -32, -64)

# ThunderKAT: Transients with MeerKAT

**Desired outcomes of this workshop**

**Roadmap for MeerKAT transient science**
(KAT-7, simulations, MeerKAT-16, -32, -64)

**Looking ahead at $SKA_1$**