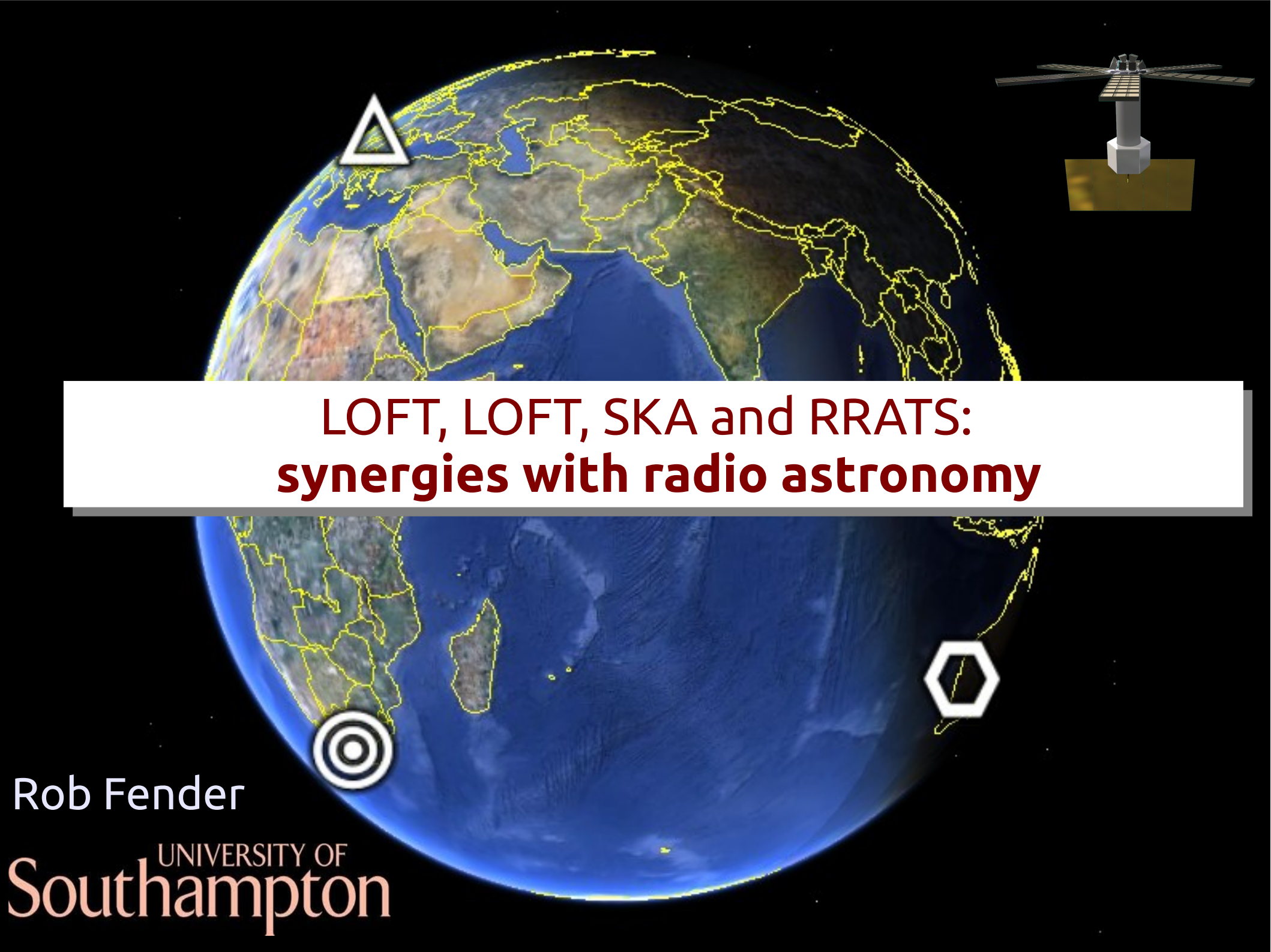
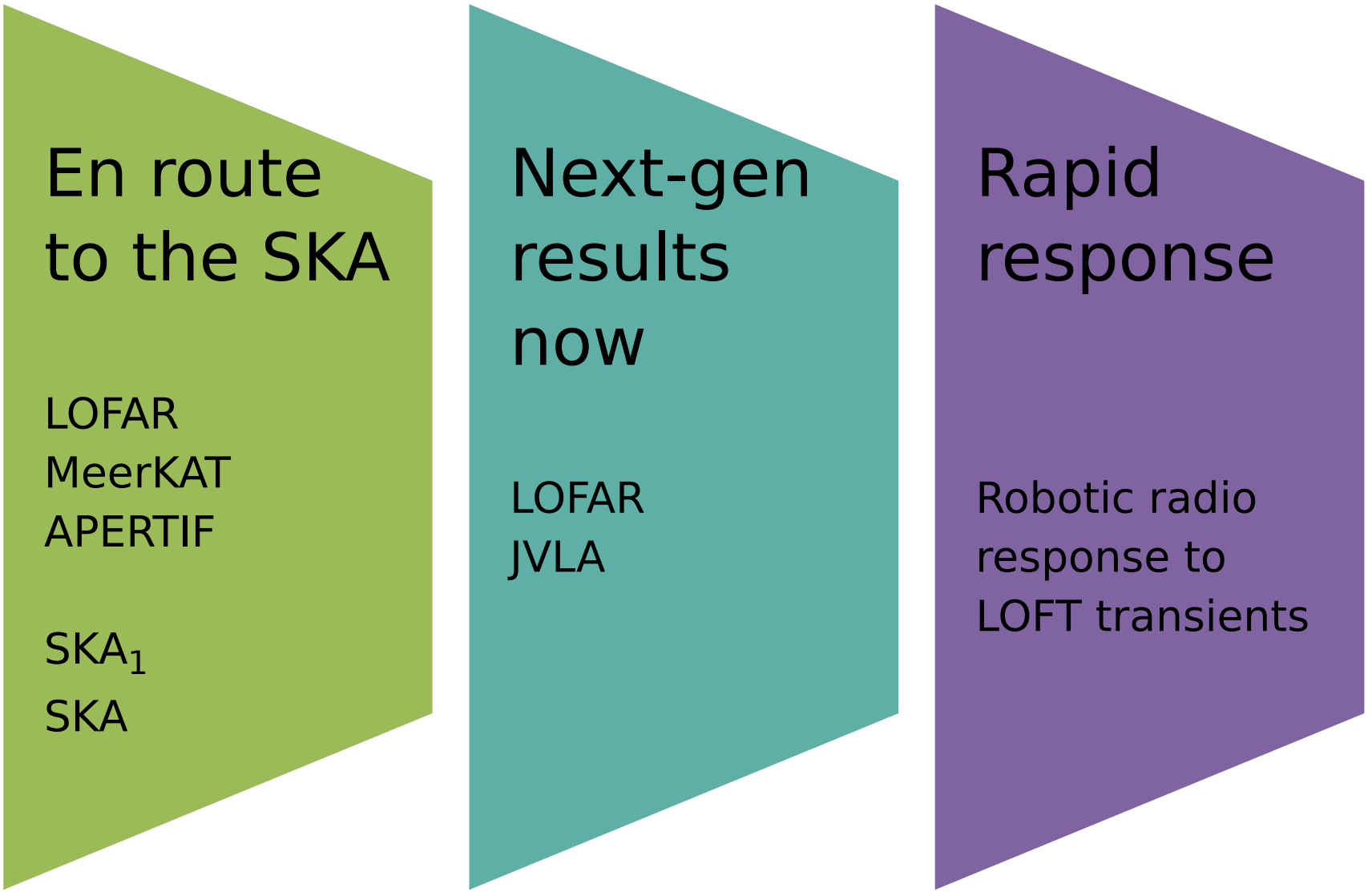
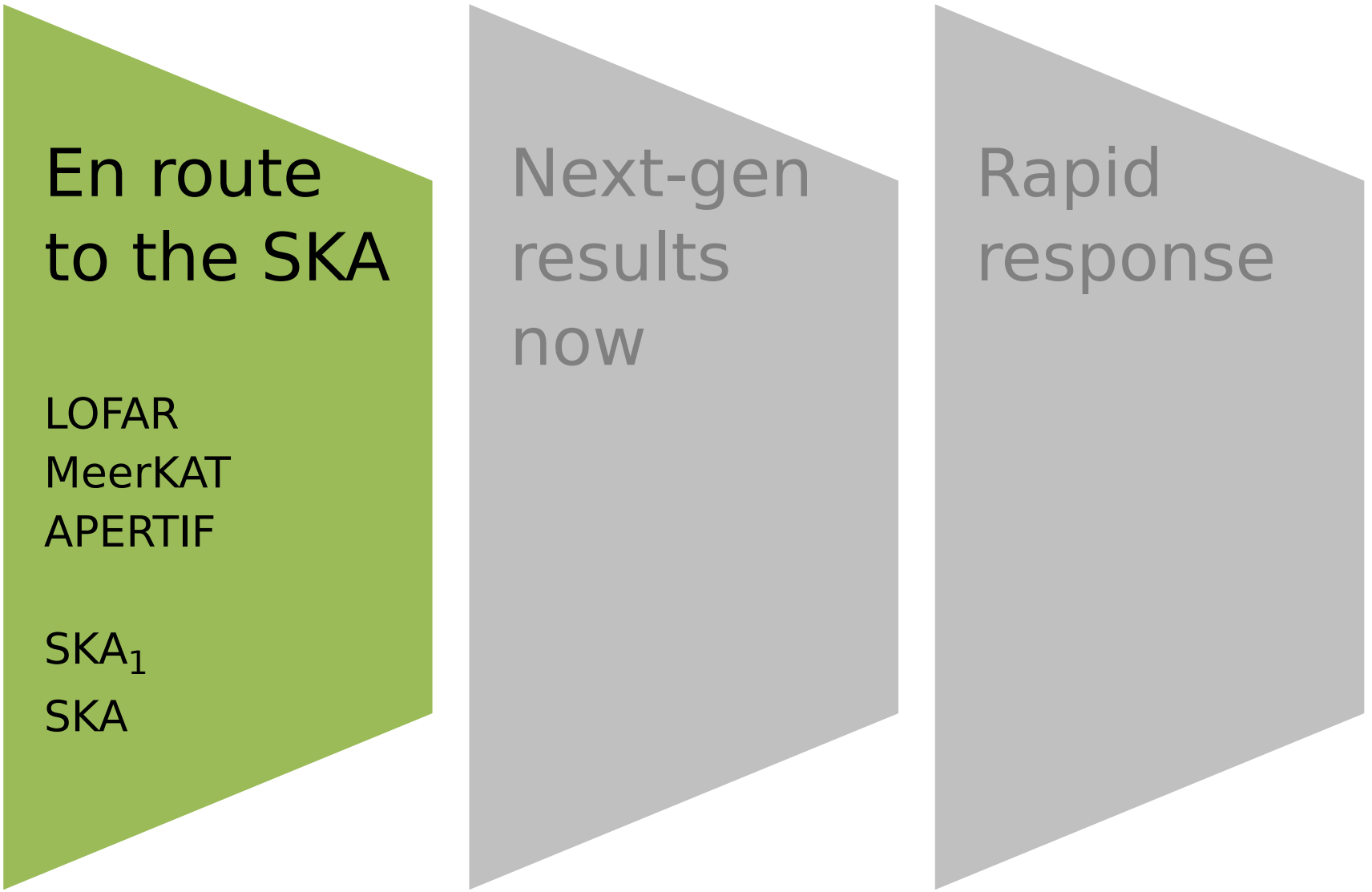


LOFT, LOFT, SKA and RRATS: **synergies with radio astronomy**

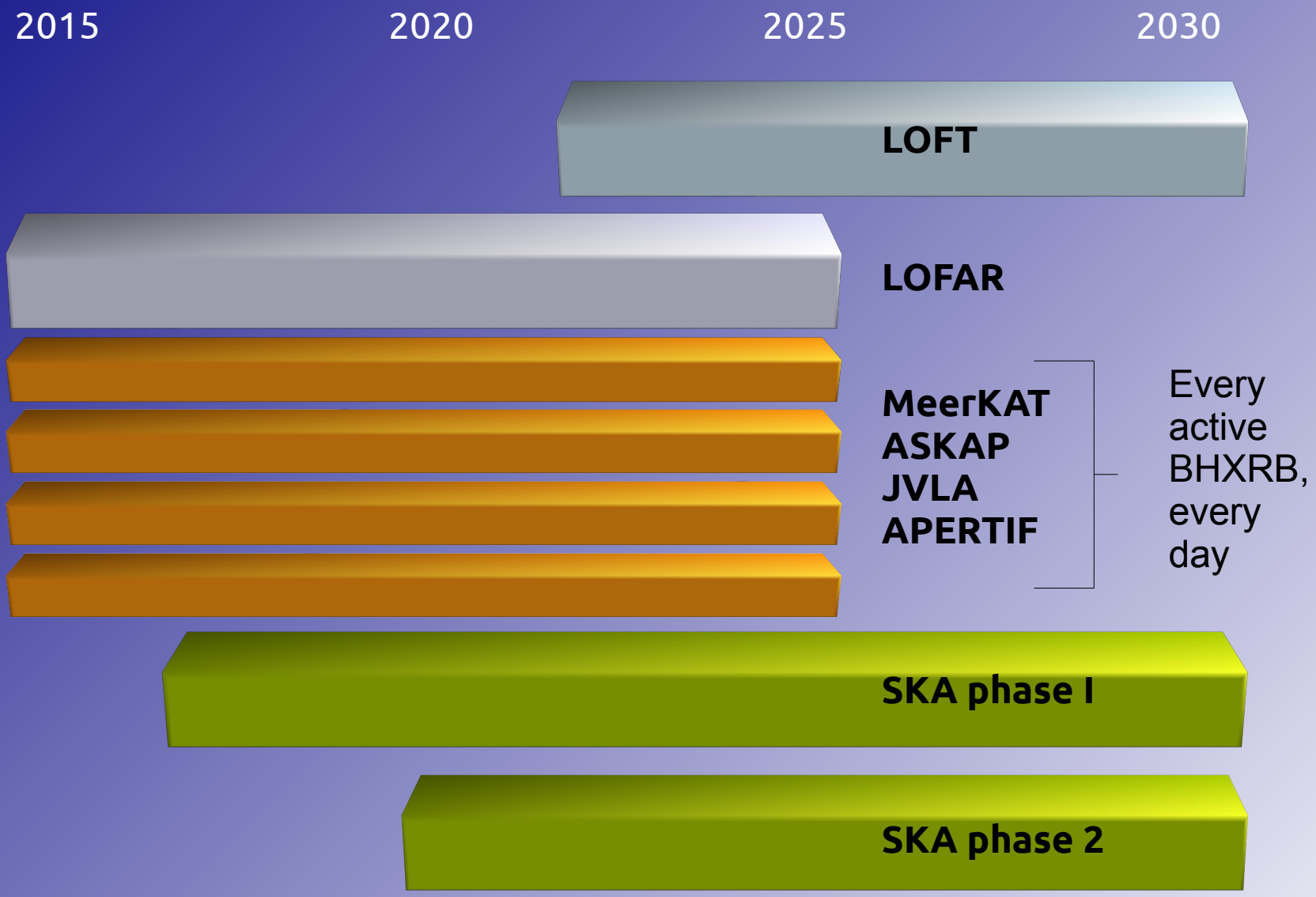
Rob Fender

UNIVERSITY OF Southampton

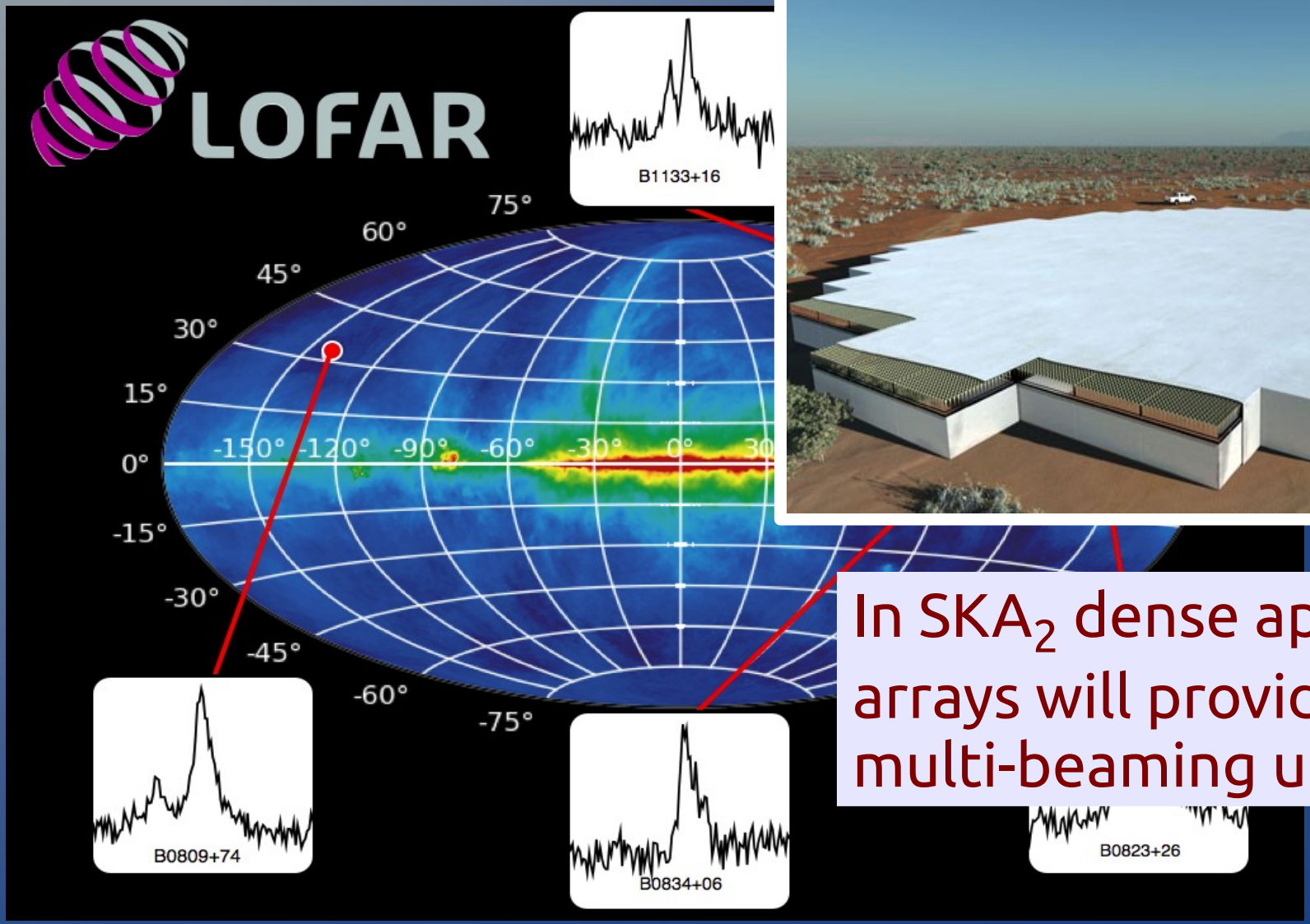

En route to the SKA
LOFAR
MeerKAT
APERTIF
SKA1
SKA
Next-gen results now
LOFAR
JVLA
Rapid response
Robotic radio response to LOFT transients


En route to the SKA
LOFAR
MeerKAT
APERTIF
SKA1
SKA
Next-gen results now
Rapid response

Synergies with next-generation radio telescopes



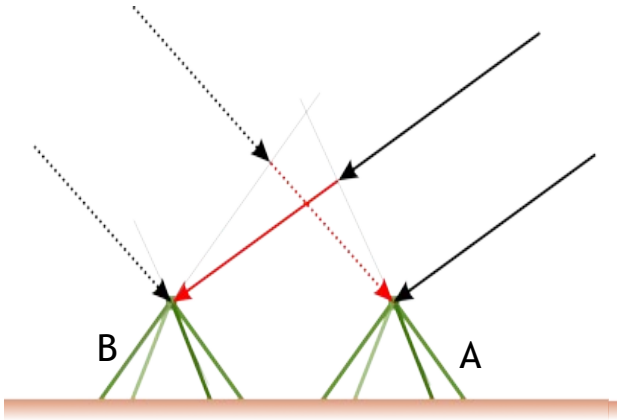
'next gen' capabilities



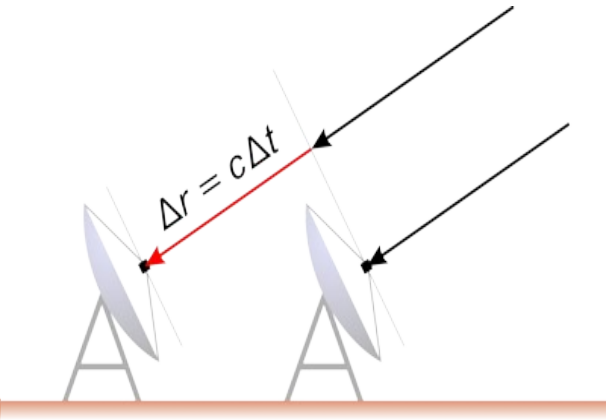
In SKA_2 dense aperture arrays will provide all-sky multi-beaming up to ~1 GHz

Multiple simultaneous beams in different directions:
Huge total f.o.v. / monitor transient while doing survey ++

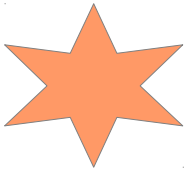
Mutiple fields / very rapid response



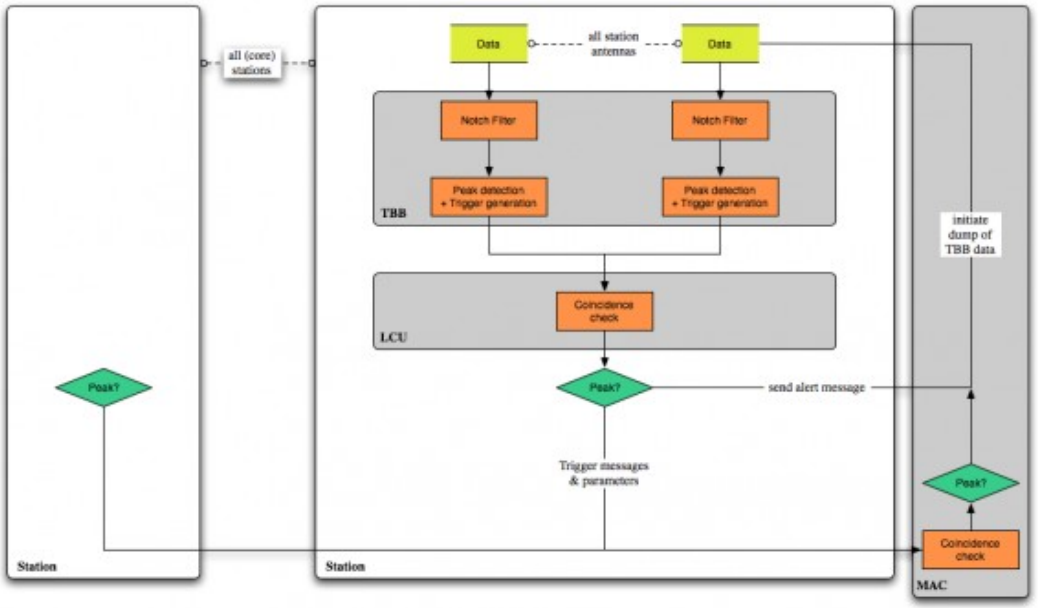
LOFAR software adds delays so signal arriving at antenna A should arrive first



Traditional dishes slew and point directly at object of interest



Interesting star over here



Short-term storage of raw antenna-level data allows retrospective application of beamforming → **look back in time, anywhere in the sky**

SKA phase 1 deployment plan

SKA_1 low (western australia)

Super-LOFAR / Operates 50 – 350 MHz
Key science: Pulsars and EoR

SKA_1 survey (western australia)

Built out of ASKAP / Focal plane arrays / 1.7 GHz band
Relatively wide and shallow

SKA_1 mid
(northern cape, south africa)

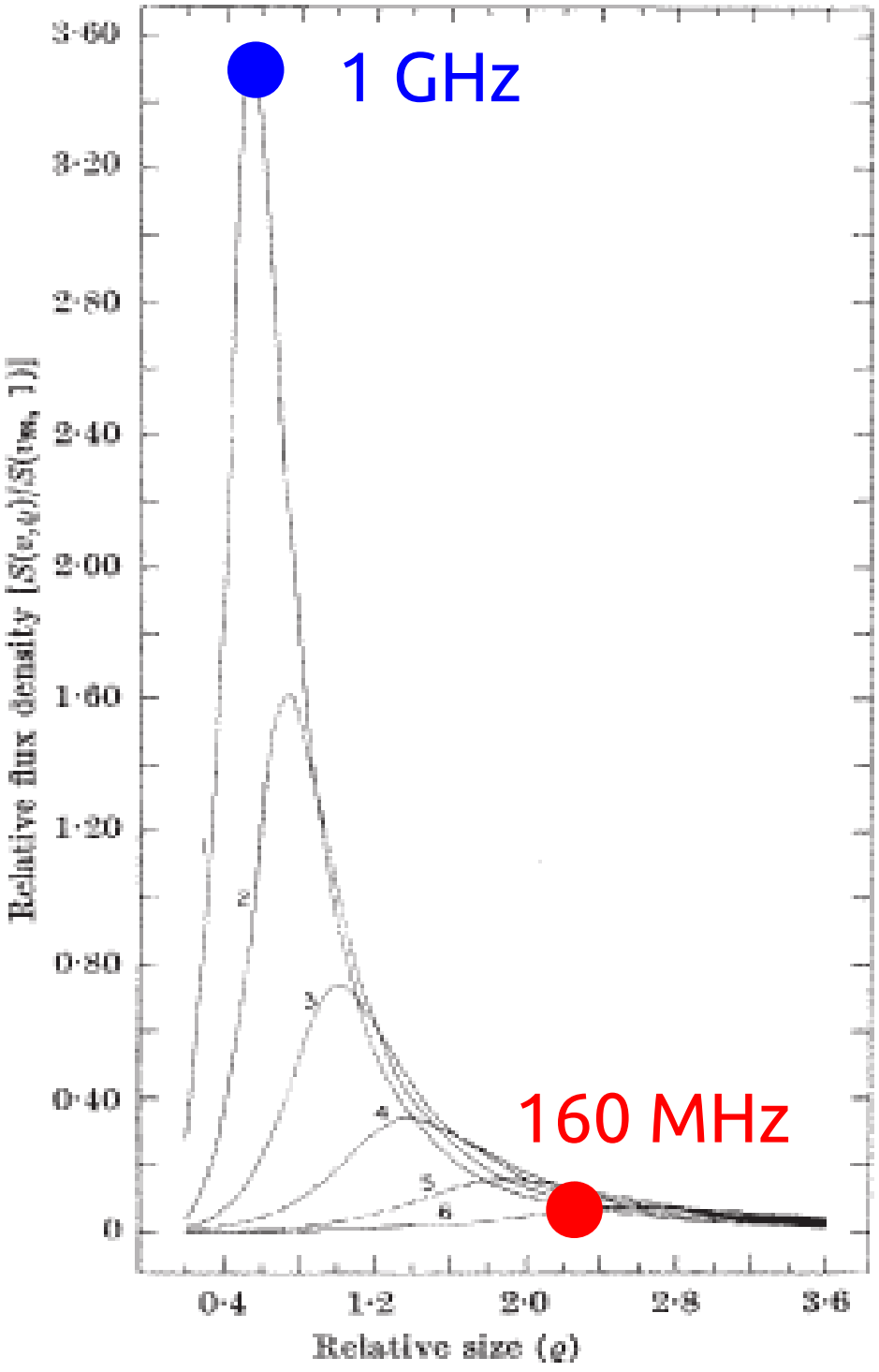
Built out of MeerKAT / Single pixel feeds / 1.7 GHz band
Best point-source sensitivity (monitoring/follow-up)

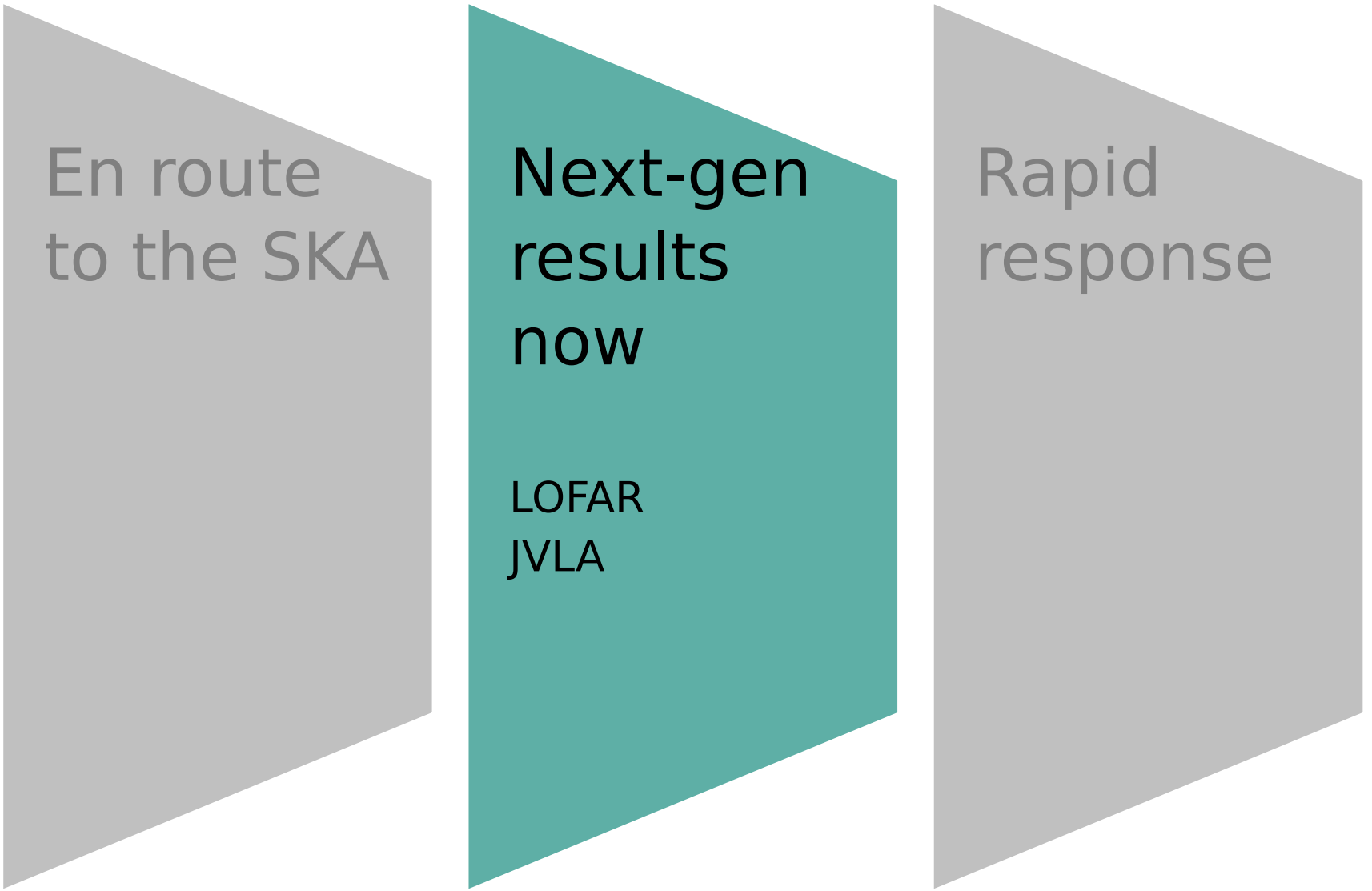
All explosive / jet-like events produce synchrotron emission which peaks lower and later with decreasing frequency

For explosive 'LOFT' events want higher (GHz) frequencies → SKA_1 survey/mid

Coherent transients want LOFAR/SKA_1 low

van der Laan (1966)




En route
to the SKA
Next-gen
results
now
LOFAR
JVLA
Rapid
response

First JVLA surveys for radio transients (Mooley, Frail, Kulkarni et al.)

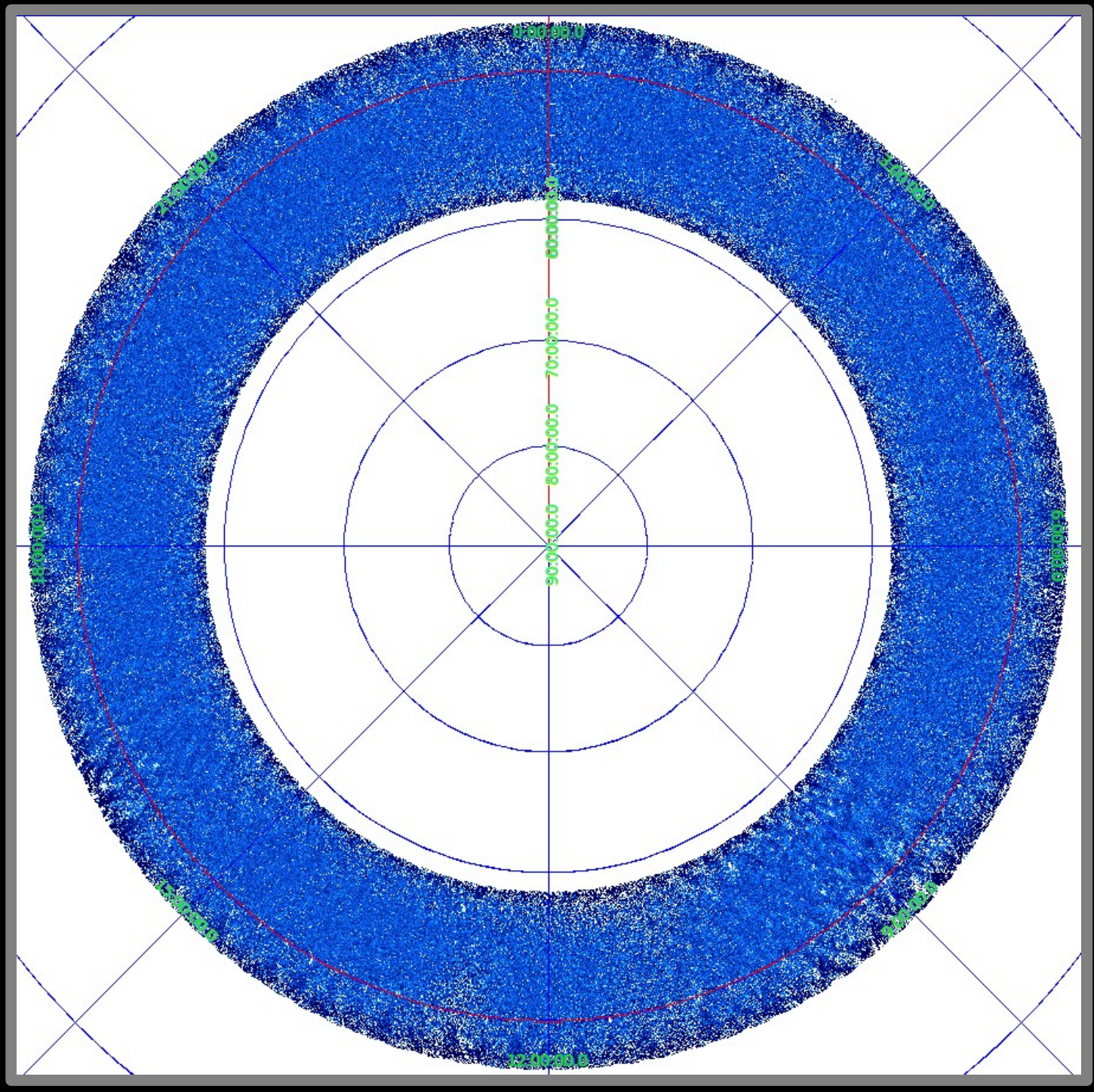
Simultaneous JVLA and PTF monitoring of SDSS stripe 82 (Dec -1 to +1).
Three epochs → 75 μJy , mag 21

12 Transient candidates, including

- Possible TDE at z~0.3
- Young AGN
- RS Cvn binary
- Unusual pulsar

→ TDE rate at MeerKAT sensitivities 0.1—10 per day

LOFAR Transients Key Science Project



Zenith monitoring programme (Fender PI)

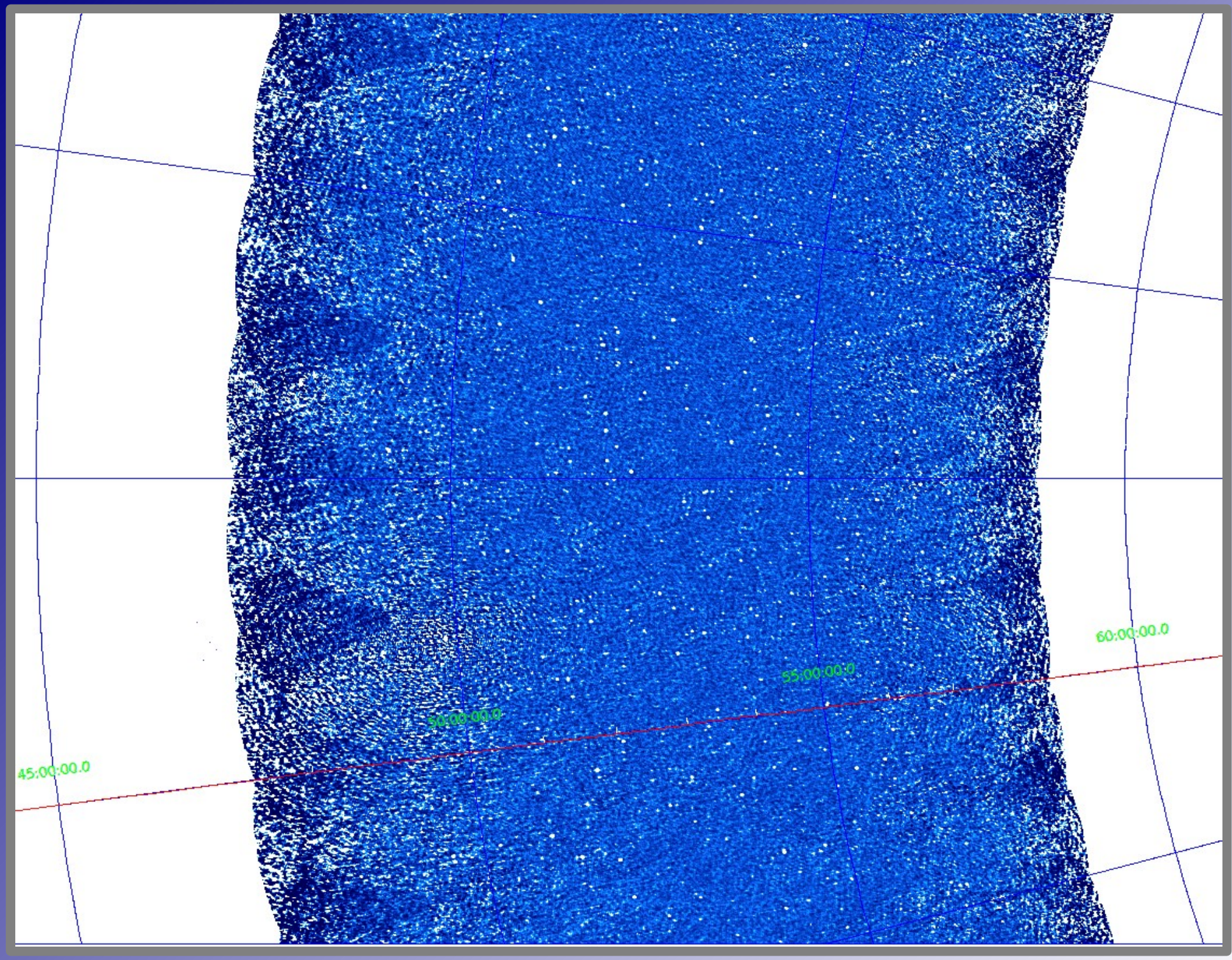
1500+ sq. deg. monitored monthly

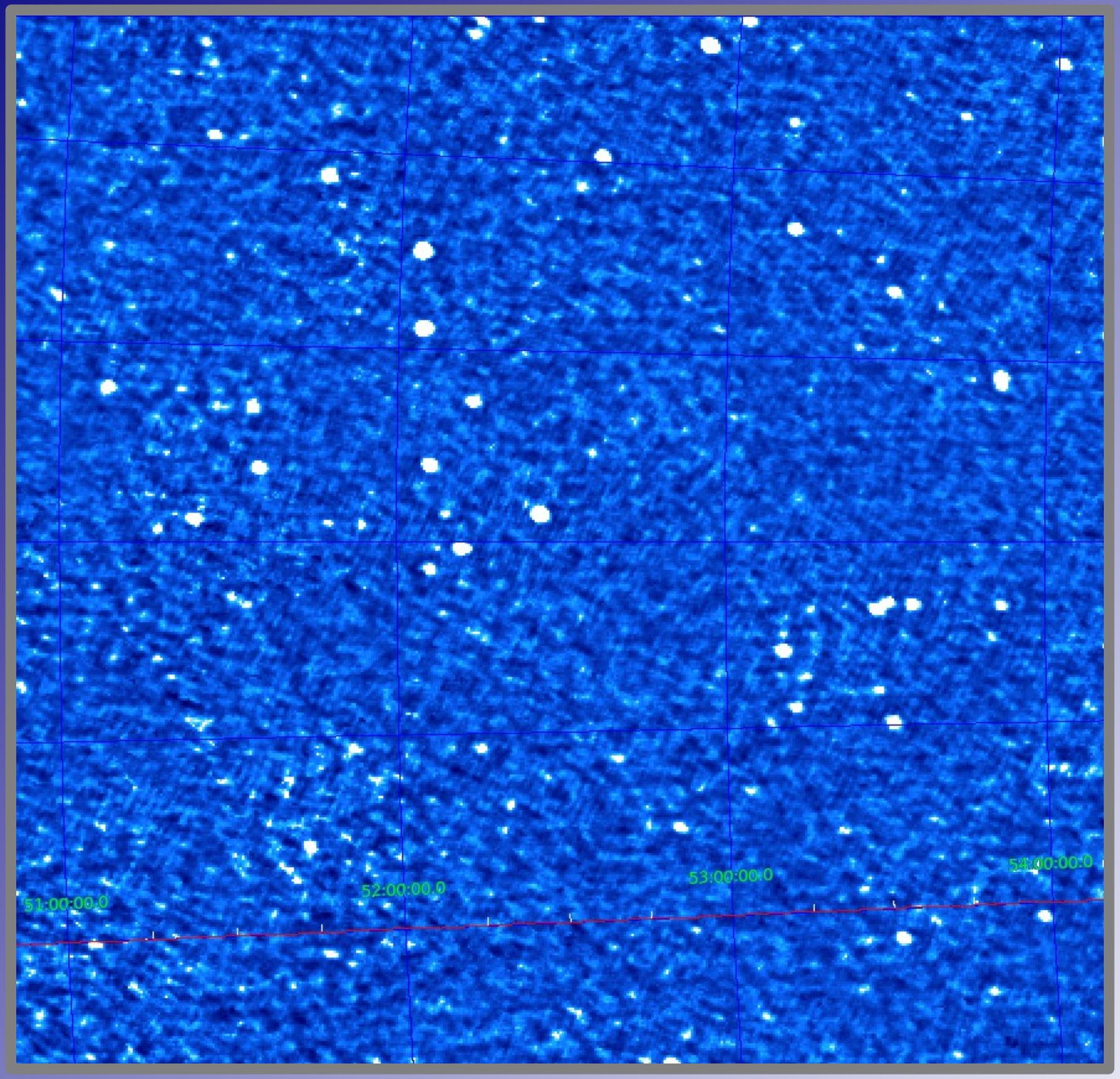
Five epochs to date

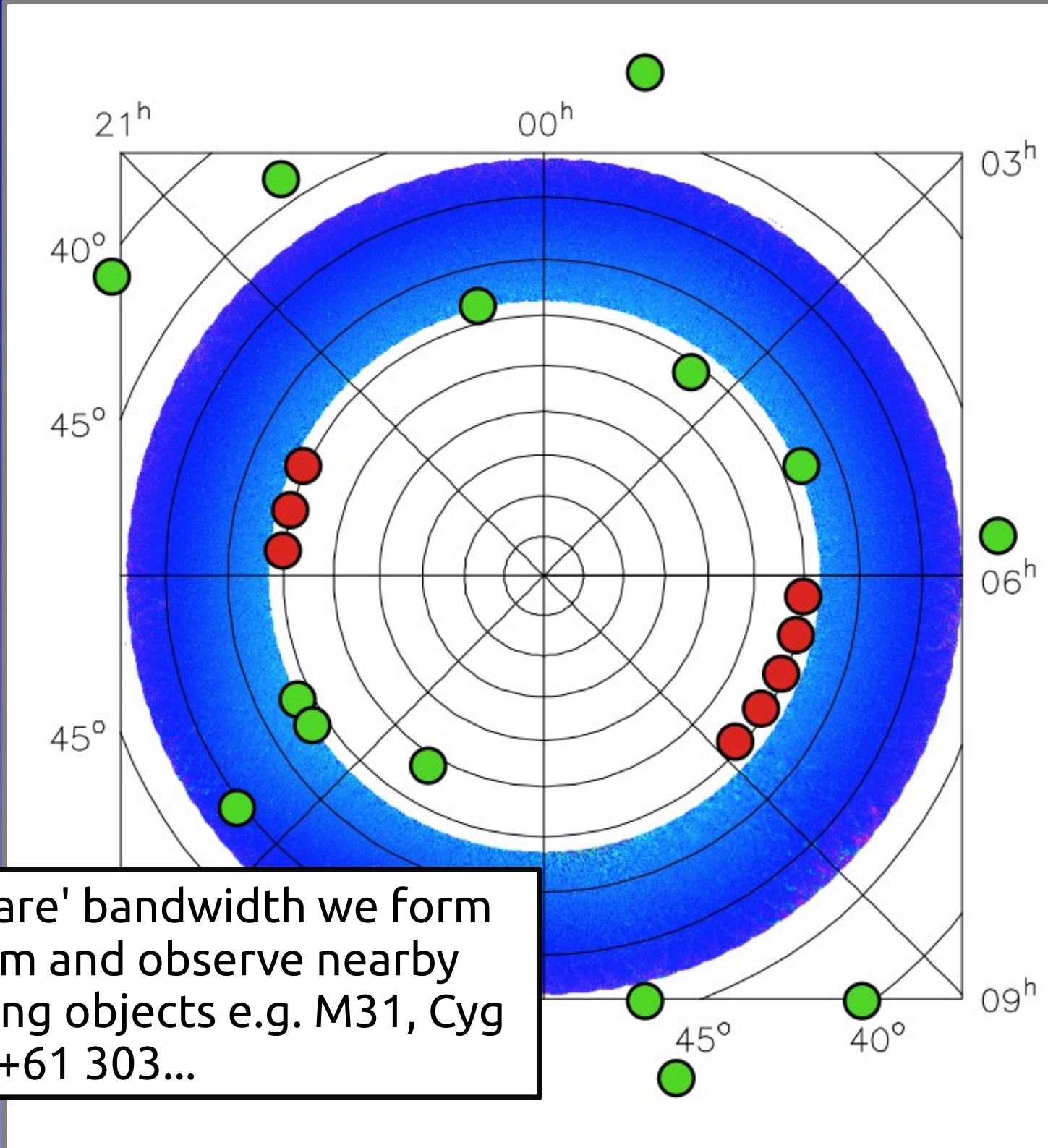
Over 10 000 sources detected

Software problem to efficiently search for transients

Broderick/Stewart/ Rowlinson/Breton/ Staley/Hassall

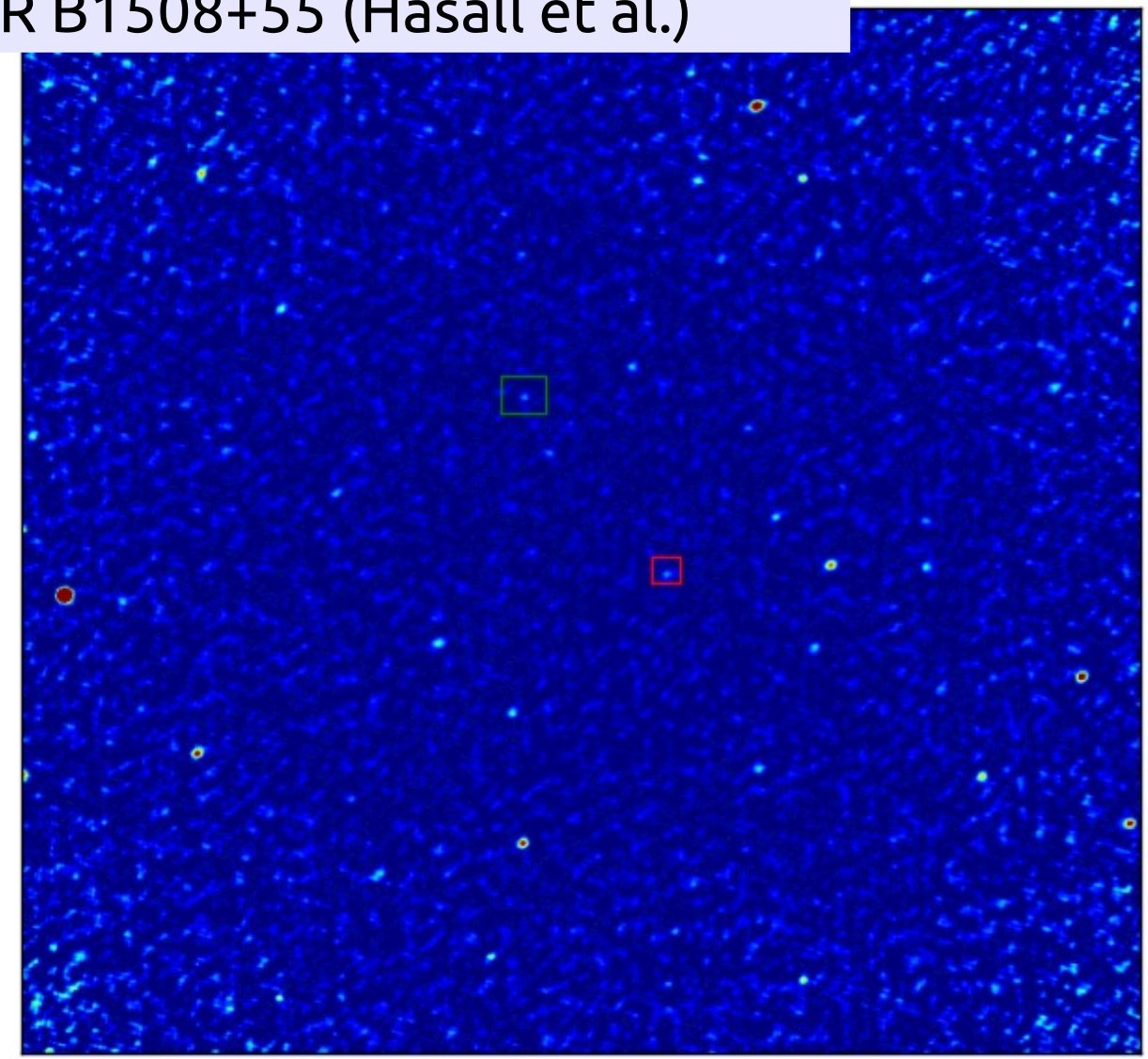

60;00;00.0
55;00;00.0
50;00;00.0
45;00;00.0


51:00:00.0
52:00:00.0
53:00:00.0
54:00:00.0

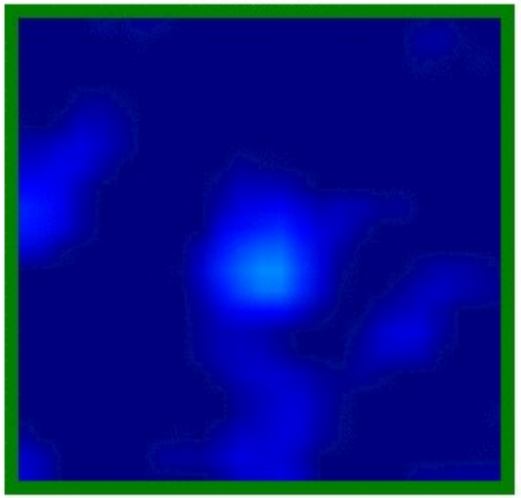


With 'spare' bandwidth we form a 7th beam and observe nearby interesting objects e.g. M31, Cyg X-3, LS I +61 303...

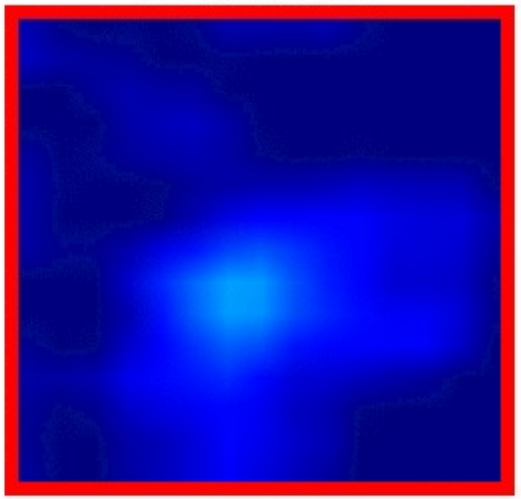
PSR B1508+55 (Hasall et al.)

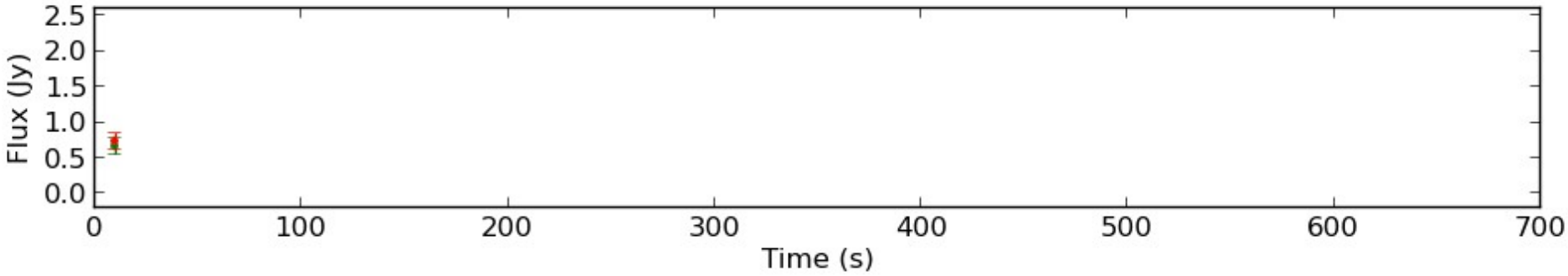


Variable

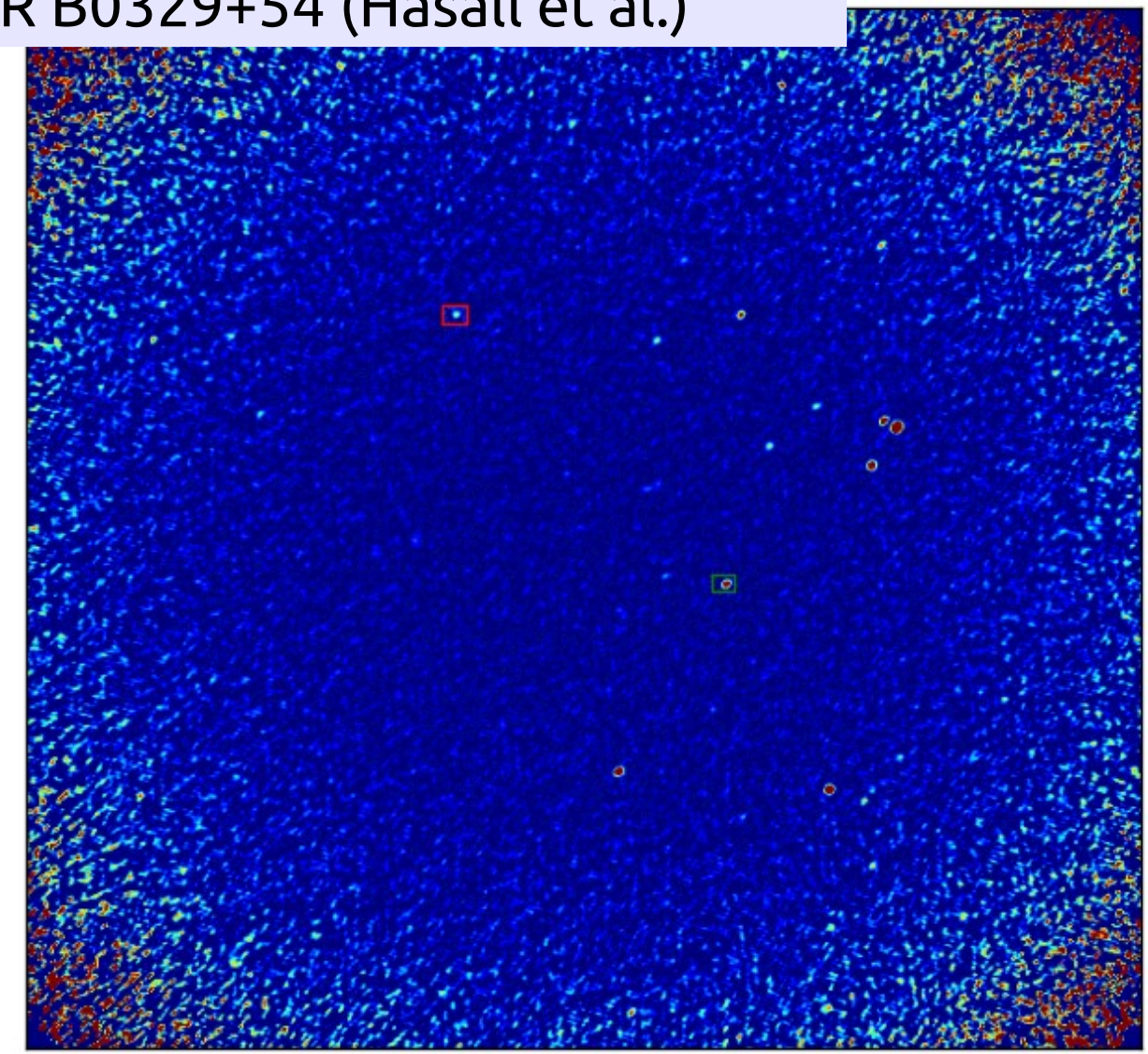


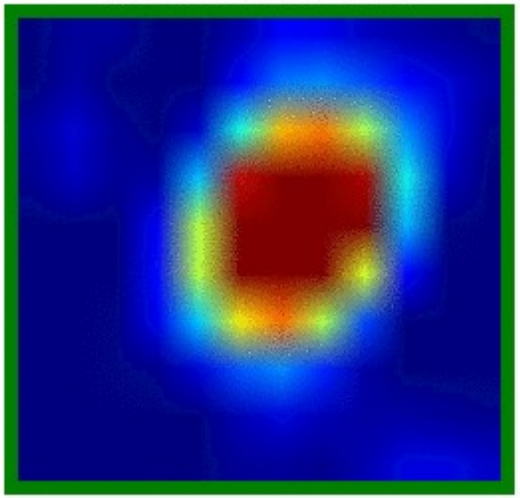
Field Source

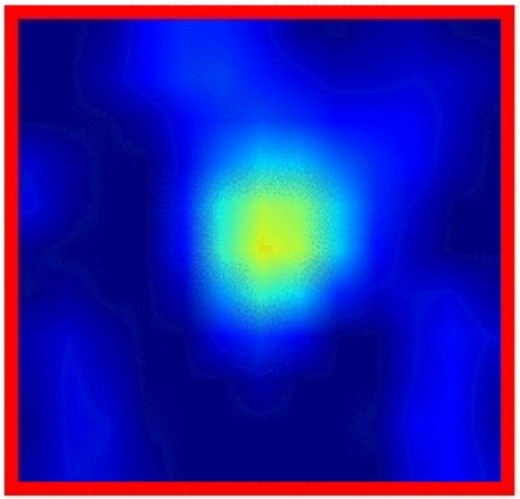


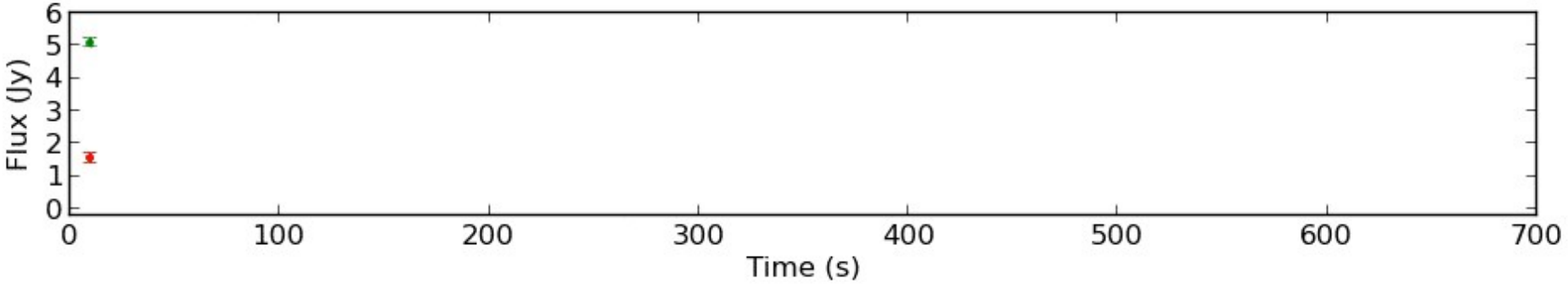


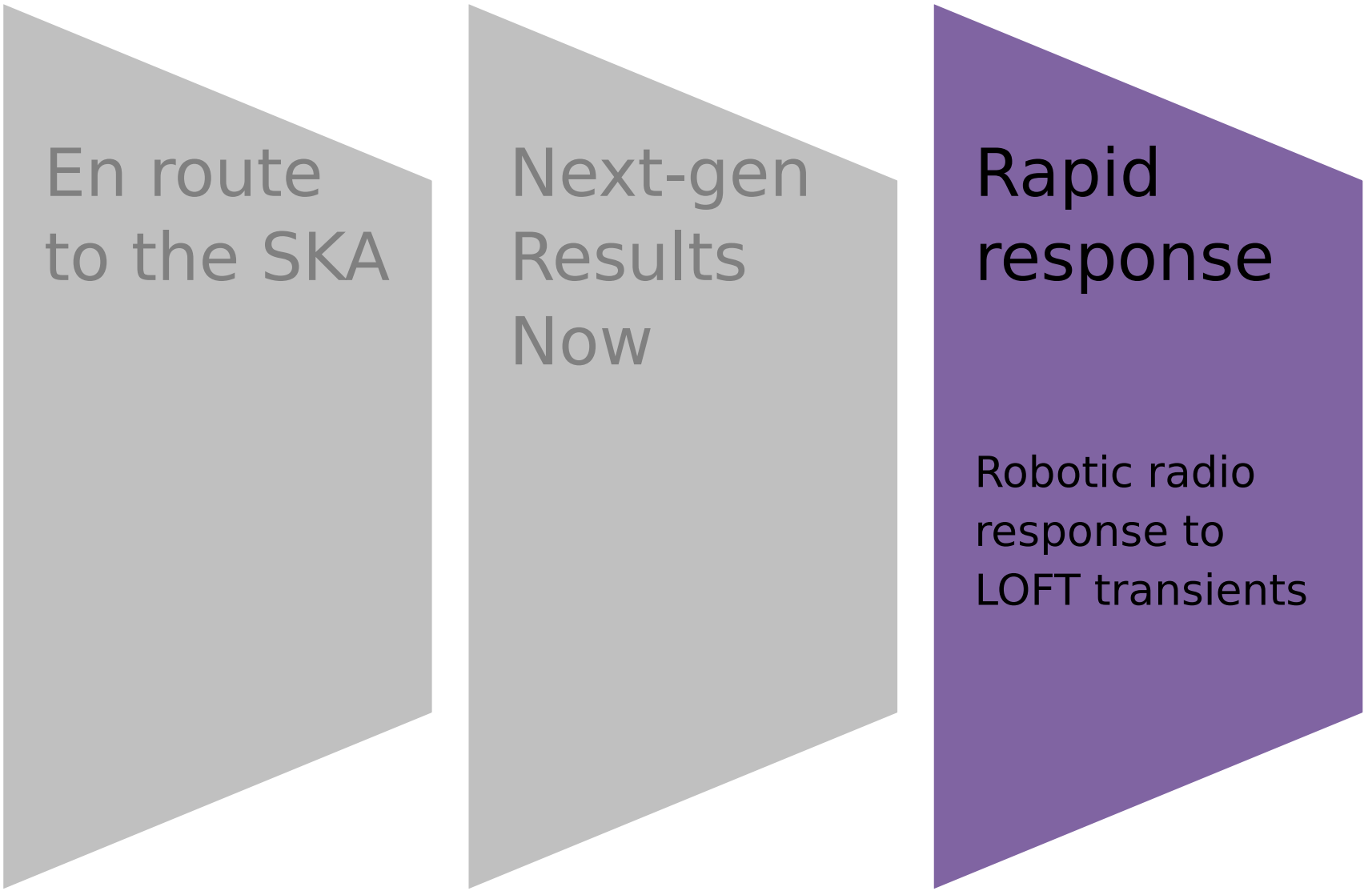
PSR B0329+54 (Hasall et al.)



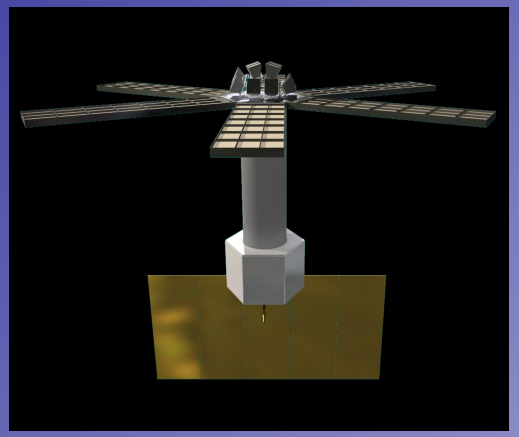







En route to the SKA
Next-gen Results Now
Rapid response
Robotic radio response to LOFT transients

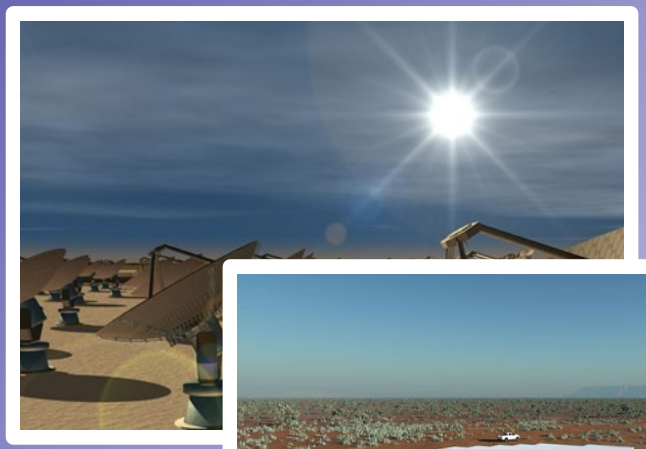
LOFT burst alerts: automated rapid response networks

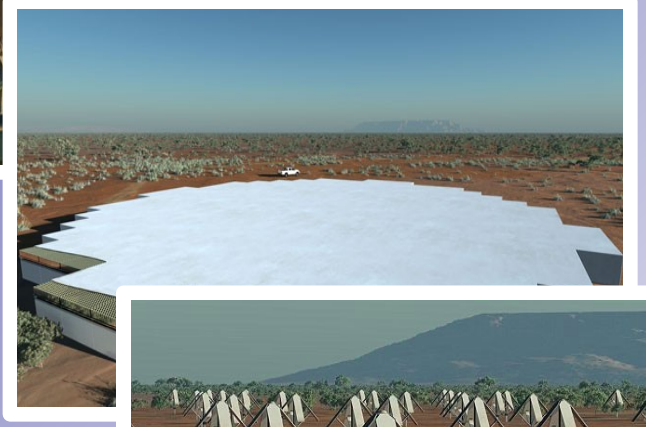


VHF

four π sky

VOEvents



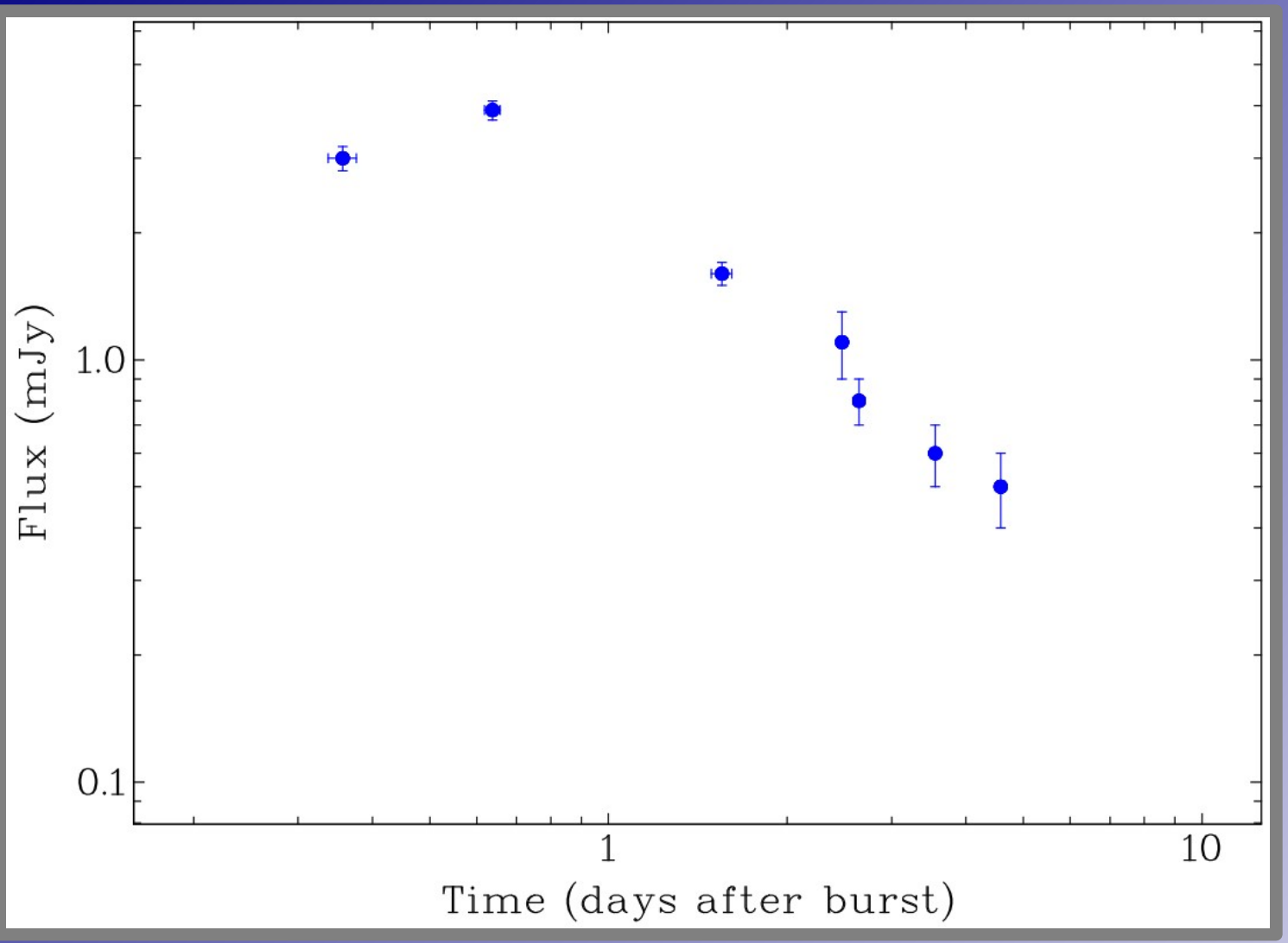


Arcminute Microkelvin Imager Large Array (AMI-LA)

MicroJy sensitivity @ 15 GHz: Automated response to transients

World's first robotic radio telescope
(Staley et al. 2012)

Robo-AMI: the earliest ever GRB radio peak



GRB 130427A

AMI triggered **completely automatically** on Swift GRB

Source below horizon at trigger, scheduled for next good elevation: 6hr

Clear detection at ~6hr, peak at ~12hr

Possible detection of reverse shock

Anderson, RF et al.

In 15+ years of GRB follow-up VLA has never detected an afterglow this early

Considera

1. LOFT – particu
should work with

2. Consider in mo
based transient-
Describe protoco
types of respons
Plenty of experti

Also, **you can influence the SKA design**

The SKA (phase 1) baseline design is now released and is taking comments for next ~12 months

Google '**ska phase 1 baseline**'

I am chair of SKA Transients SWG: please feed me comments regarding high-energy astrophysics/transients

Summary

- The radio band has a great synergy with X-rays: relation between accretion/explosion and outflow
- The 'next gen' radio arrays are now being built, road to SKA is clear(-er) , and all existing structures embrace transient/high-energy astrophysics as high priority. Transients and variables now being found.
- LOFT will work well with ground-based radio follow-up, in particular very rapid (robotic) response