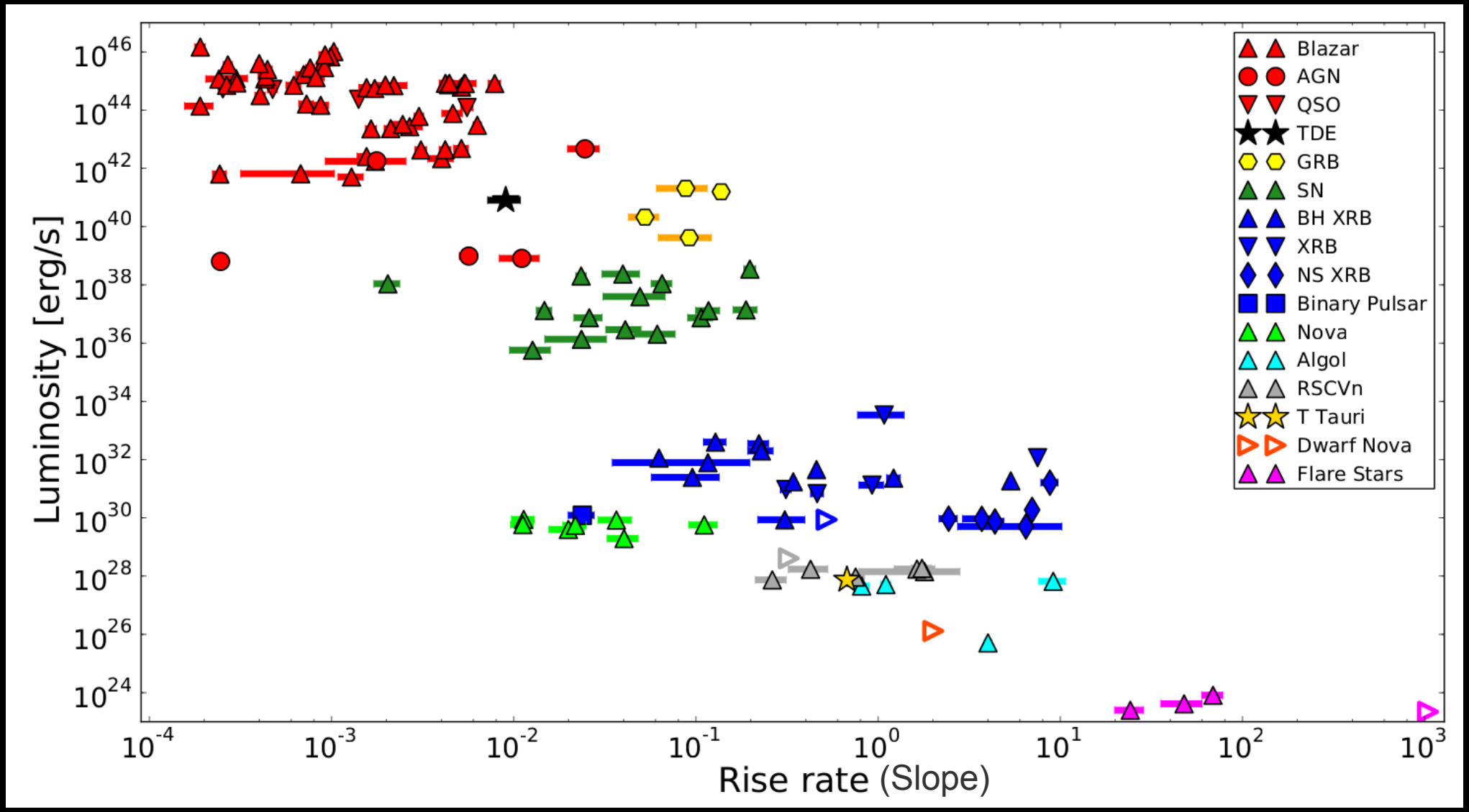
Synchrotron events: variability timescales

$$L = 4\pi d^2 F_{peak} [\frac{erg}{sec}]$$

Pietka, Fender & Pretorius, in prep



slow *fast*

Commensal and rapid-response science

Commensal modes
Near-real-time searching of all data for transient events → automated pipelines → global public alerts

Increase the number of detected transients by an order of magnitude, discover the “once-in-a-millenium” rather than the “once-in-a-decade” event

Real-time response to alerts
Robotic response to external alerts, allowing very rapid follow-up of high-priority events which may have very early-time radio emission (coherent or very prompt synchrotron)

This is not impossible to achieve, but it is **all too easy** to design it out at an early stage.

Existing/near-future examples:

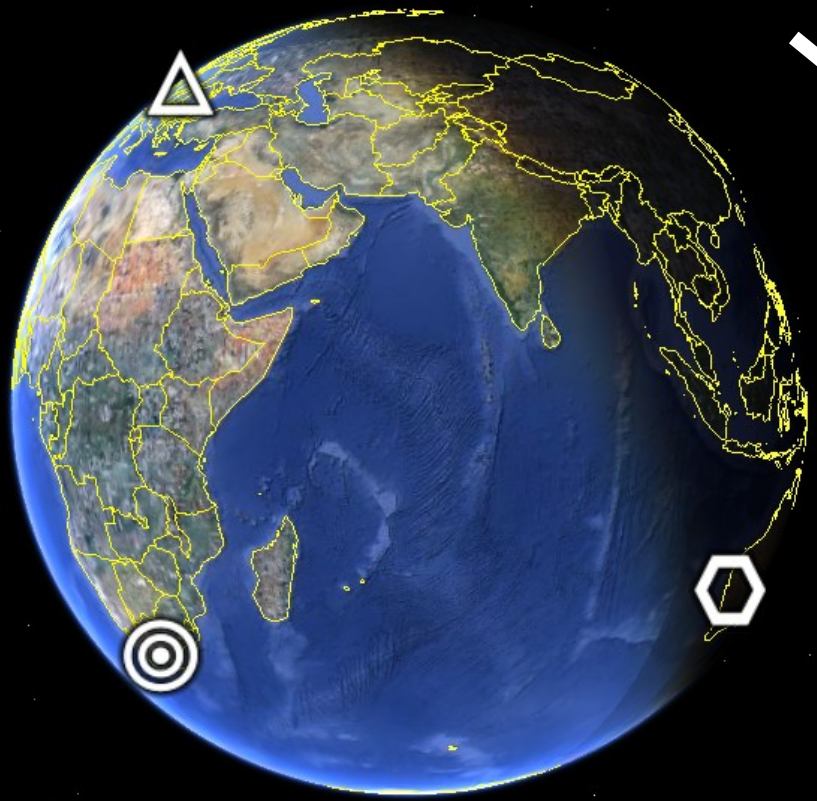
* Retro-roboticisation of AMI-LA

* KAT-7 → MeerKAT

* LOFAR-UK / ARTEMIS

4 PI SKY: rapid automated detection and follow-up of transients

Telescope monitors sky...
Software finds new transient source!



4 PI SKY

Interesting?
Appropriate
follow-up?

radio

X-ray

Analyse /
re-evaluate /
feedback (IA)

4 PI SKY pathfinding: robotic radio telescope response to GRBs

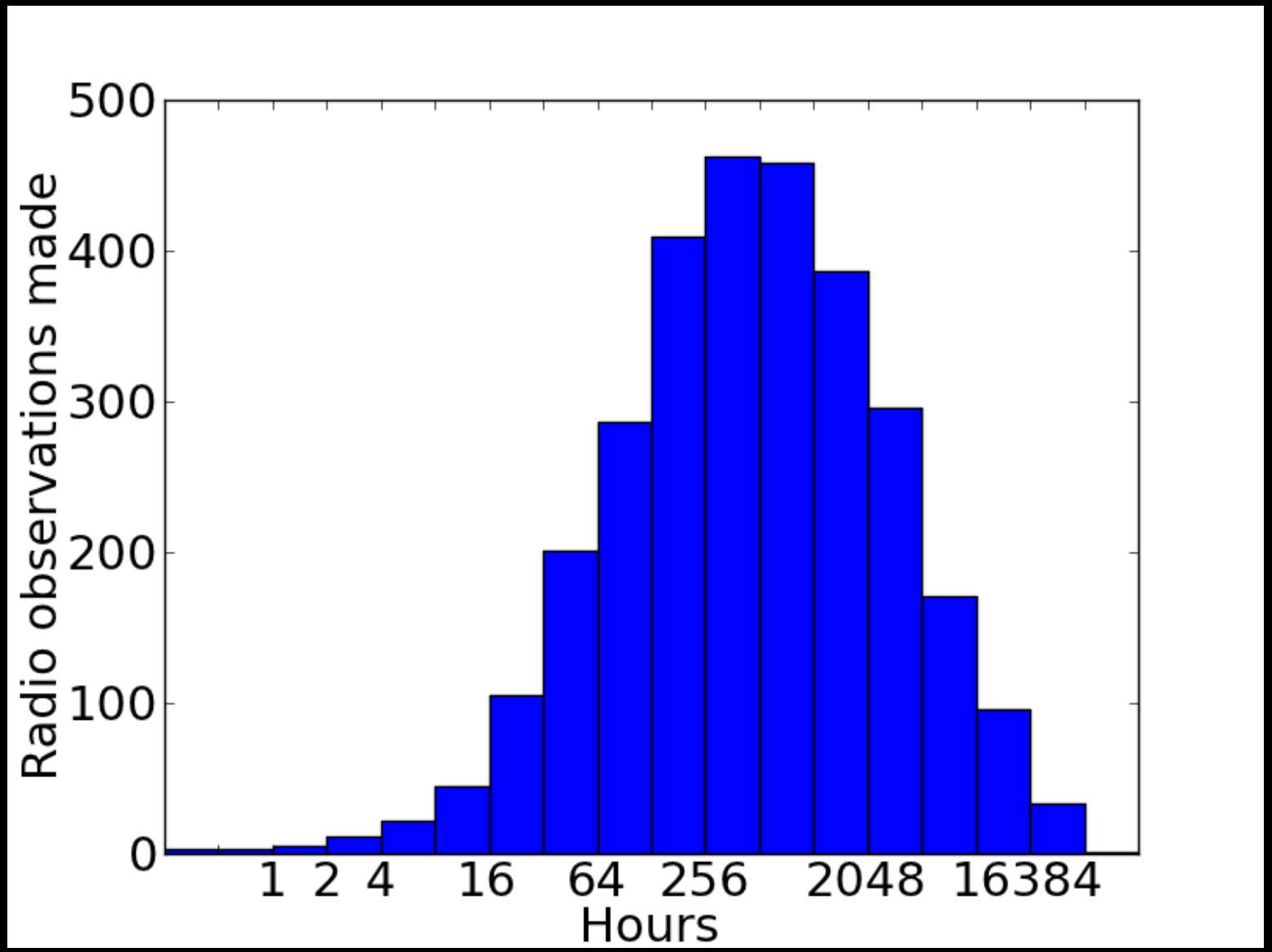
NASA GSFC

VO Event

4 PI SKY

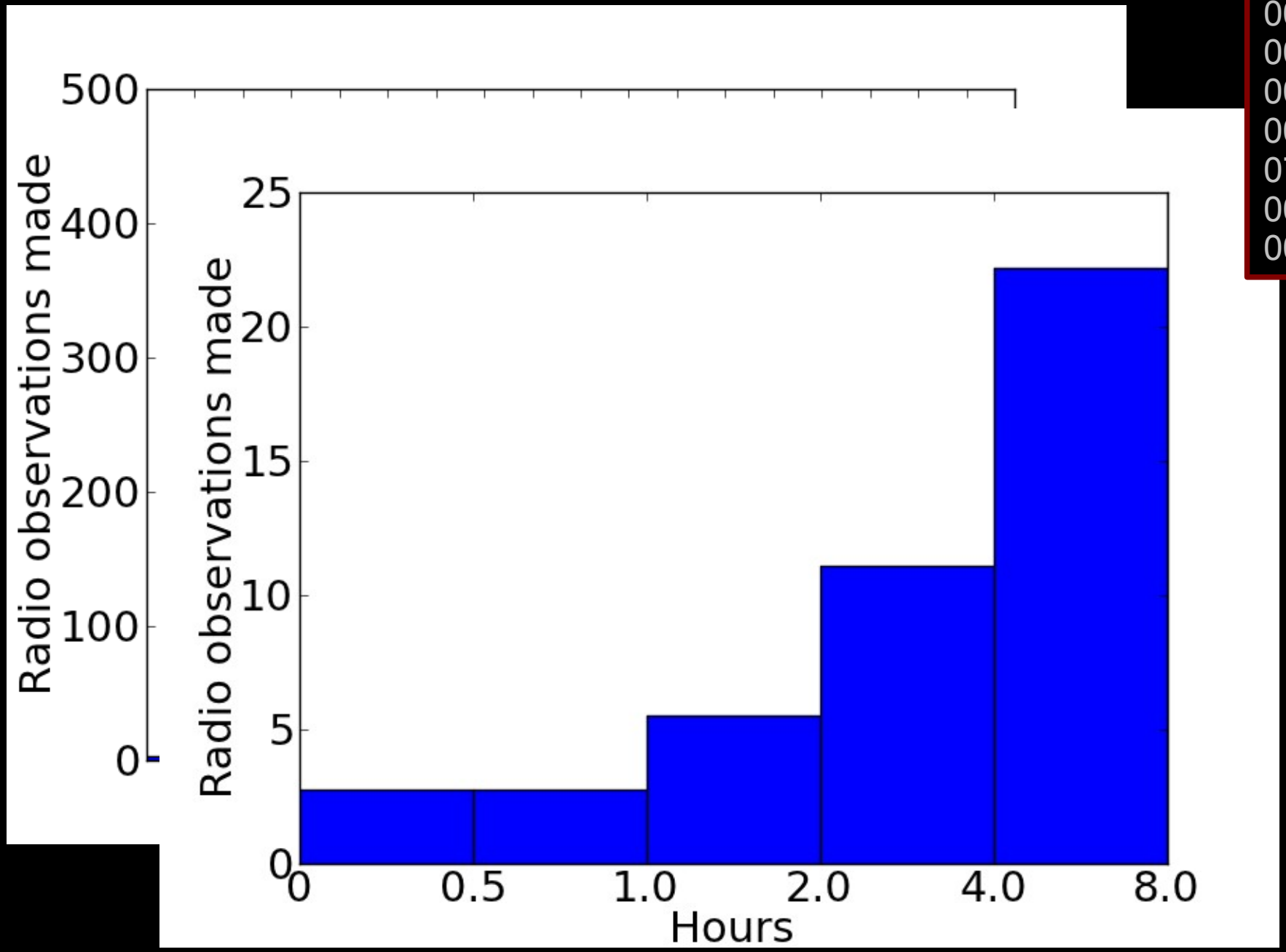
Timescale from Swift detection of first photon to observing command sent to follow-up telescope: 30s

GRB radio telescope response times



00:04:29.05
00:04:50.35
00:04:22.68
00:06:07.40
00:04:26.67
07:04:23.72
00:15:43.00
00:04:51.00

GRB radio telescope response times



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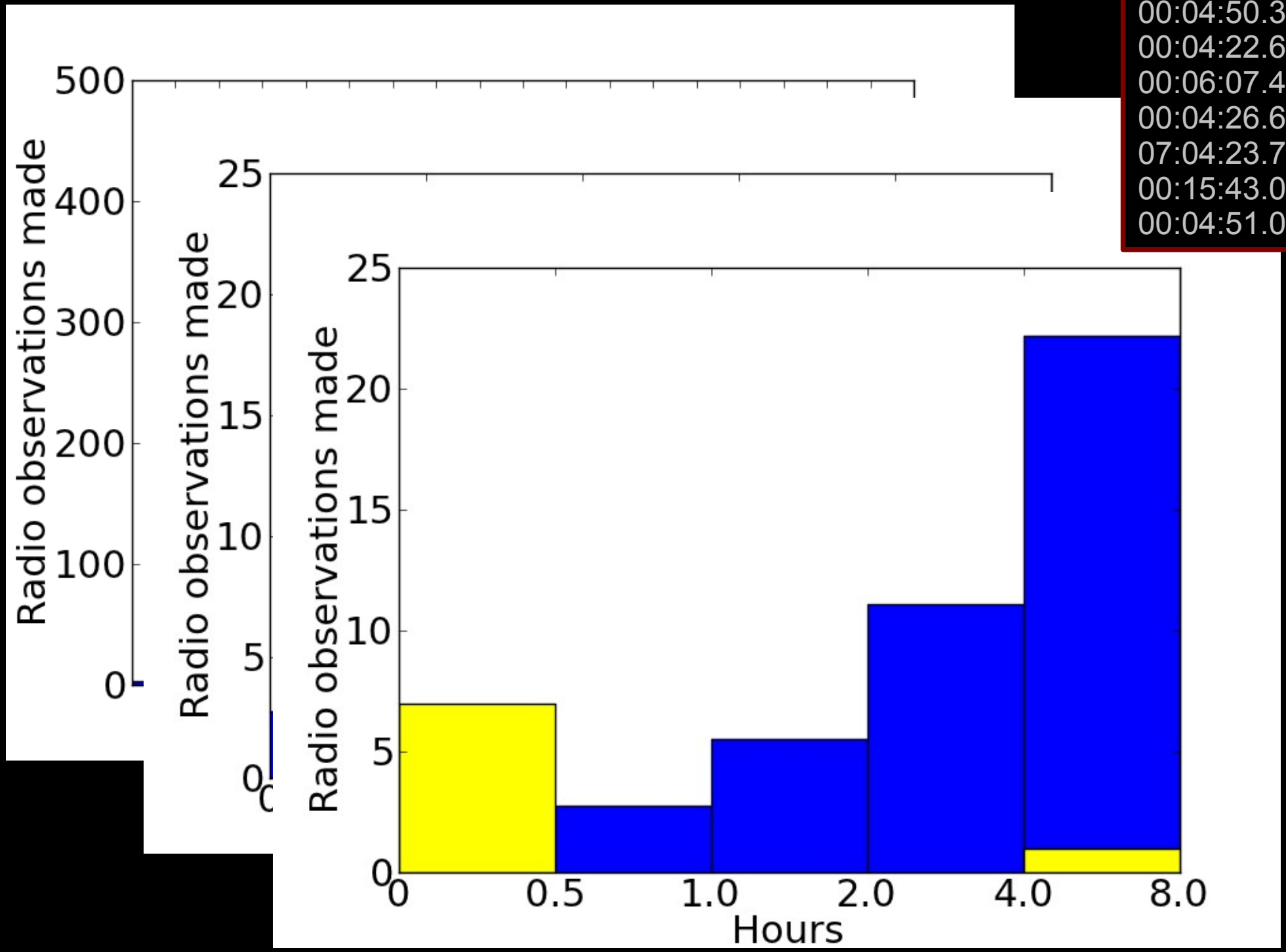
GRB radio telescope response times



00:04:29.05
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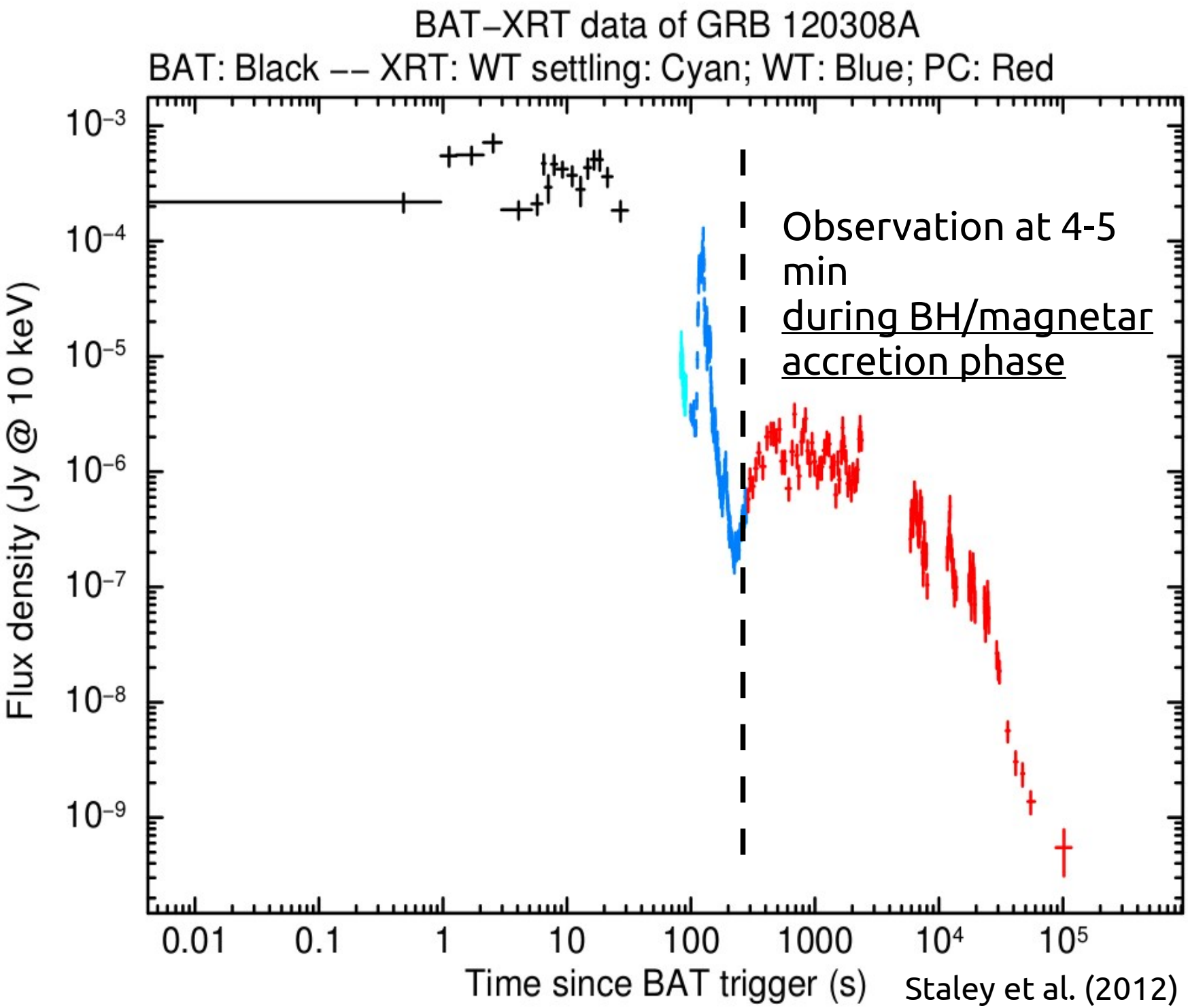
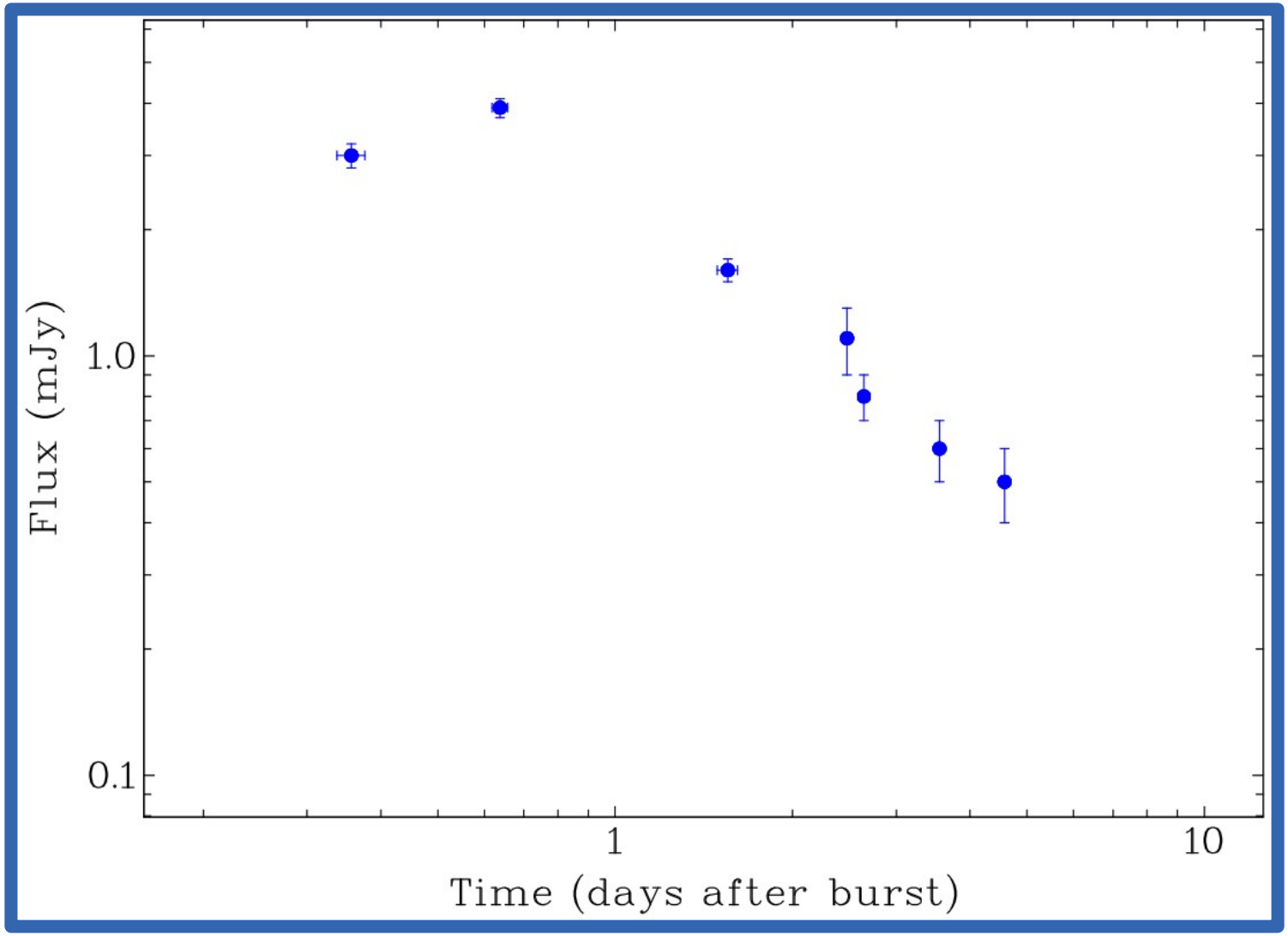


Staley et al. (2012)

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

Probable detection of reverse shock

Anderson, RF et al.

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

Triggered LOFAR-UK station

4 PI SKY

Beamforming: no moving parts – no slew time

Duration from Swift photon timestamp to first recorded LOFAR data = **51 sec**
(for significantly dispersed burst this is effectively immediate)

What SPO want[?]

Use case[s]/sys. req. for

* commensal imaging
* commensal BF
* fast ToO response
* slow[er]/more complex ToO response (e.g. LIGO example)

e.g. use case[s]/sys. req. for <u>synchrotron transients</u>

* commensal imaging

For >seconds timescales → synchrotron → 1 minute real-time imaging and commensal searching @ SKA1-Mid (specify desired r.m.s. in multiples of natural weighting) [fast timescale allows detection and reporting while high-energy processes still occurring]

* fast ToO response

Minutes (dishes, automatic alerts)
[non-slew latency 30sec]