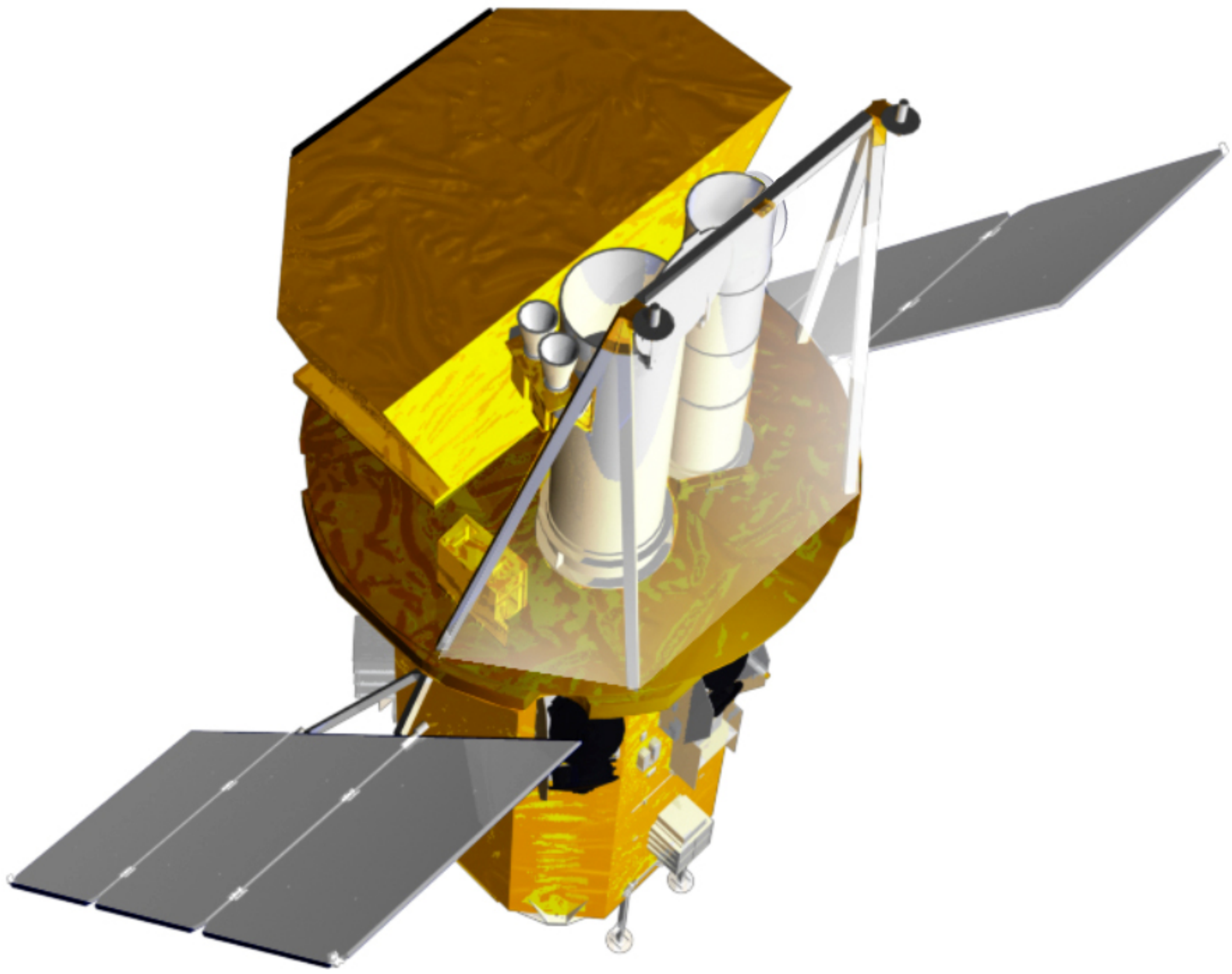
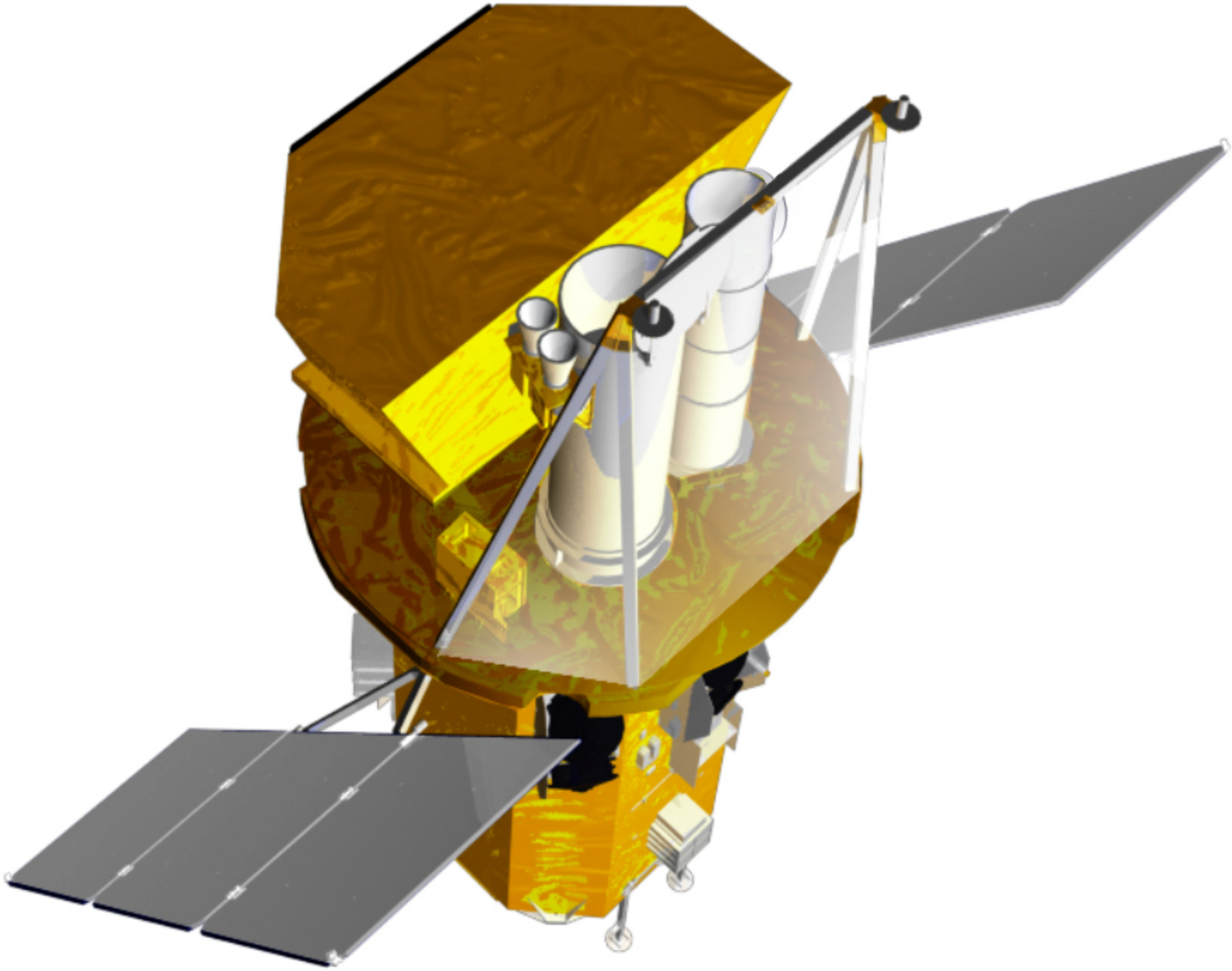
Potential Partners:
The Neil Gehrels Swift Observatory



Phil Evans

Brief overview of Swift

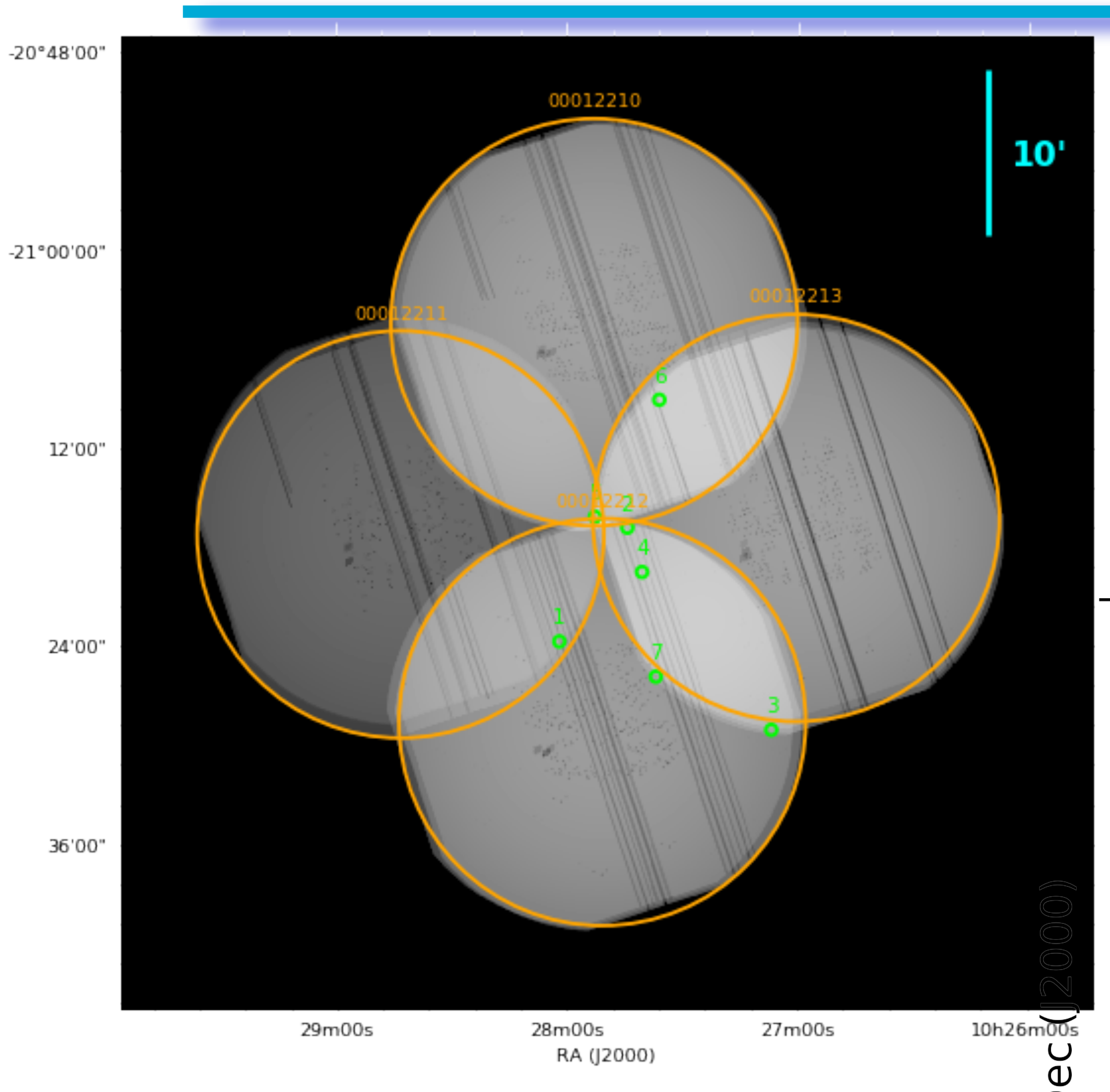


3 Instruments:

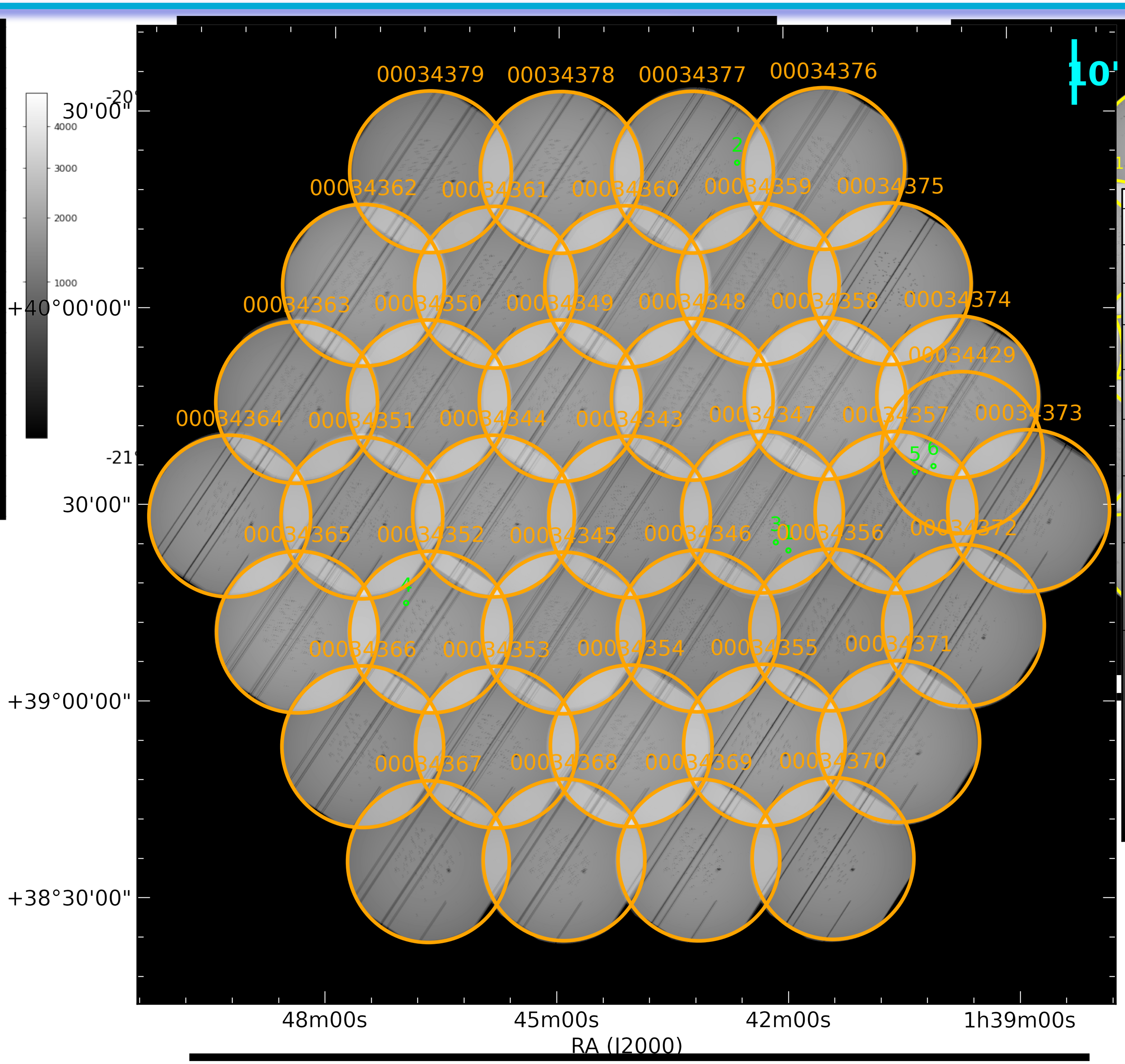
- BAT: 15-350 keV, mainly serendipitous
- XRT: 0.3-10 keV; 12' radius fov
- UVOT: 170-650 nm; 17'x17' fov

- Rapid slewing spacecraft ~ 0.75 deg/sec.
- Flexibly planned; *fast* ToO capability.
- On-board tiling patterns for easy ~circular coverage
- Multi-messenger astronomy is a key science goal.

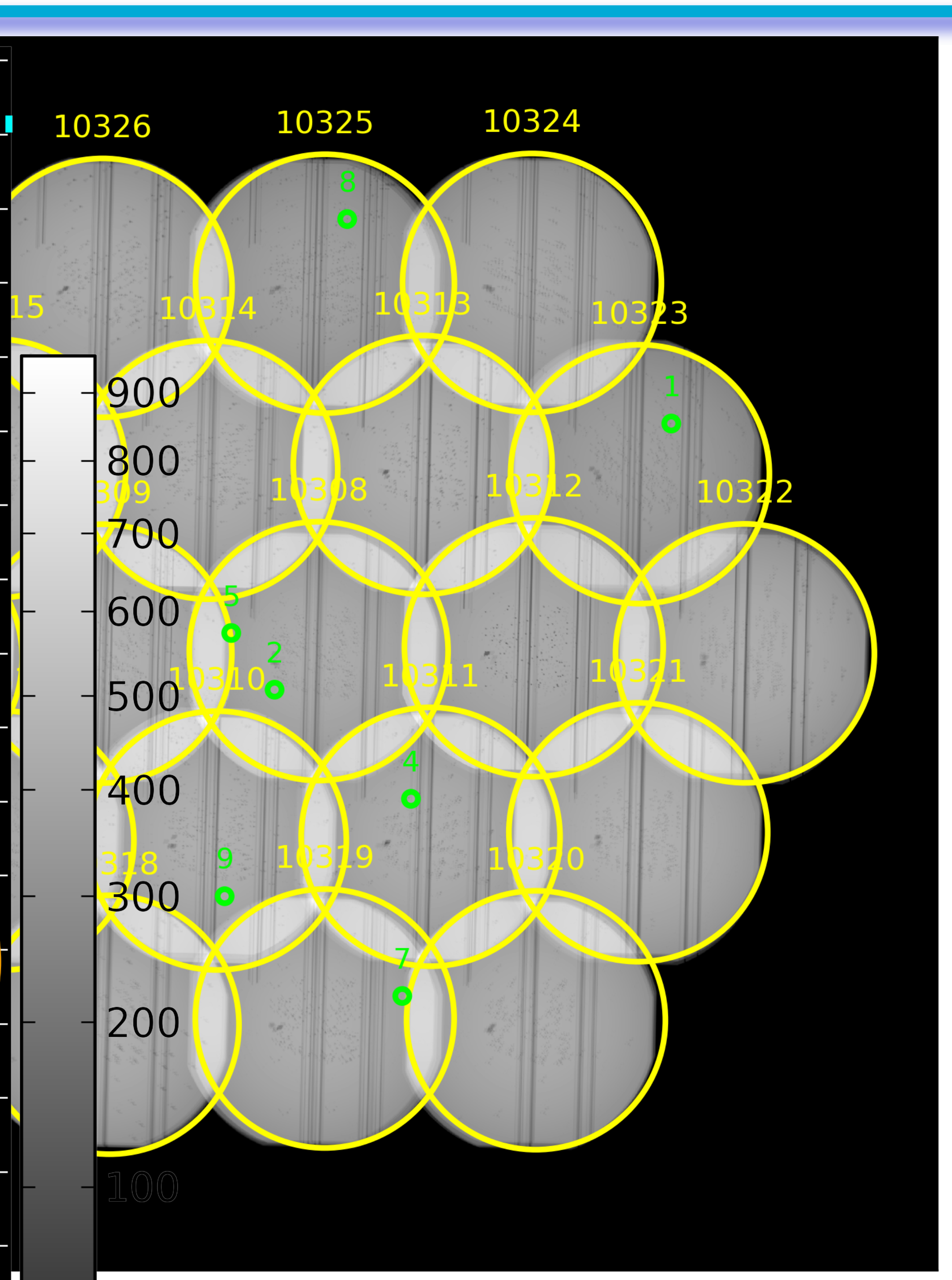
Tiling



~0.8°

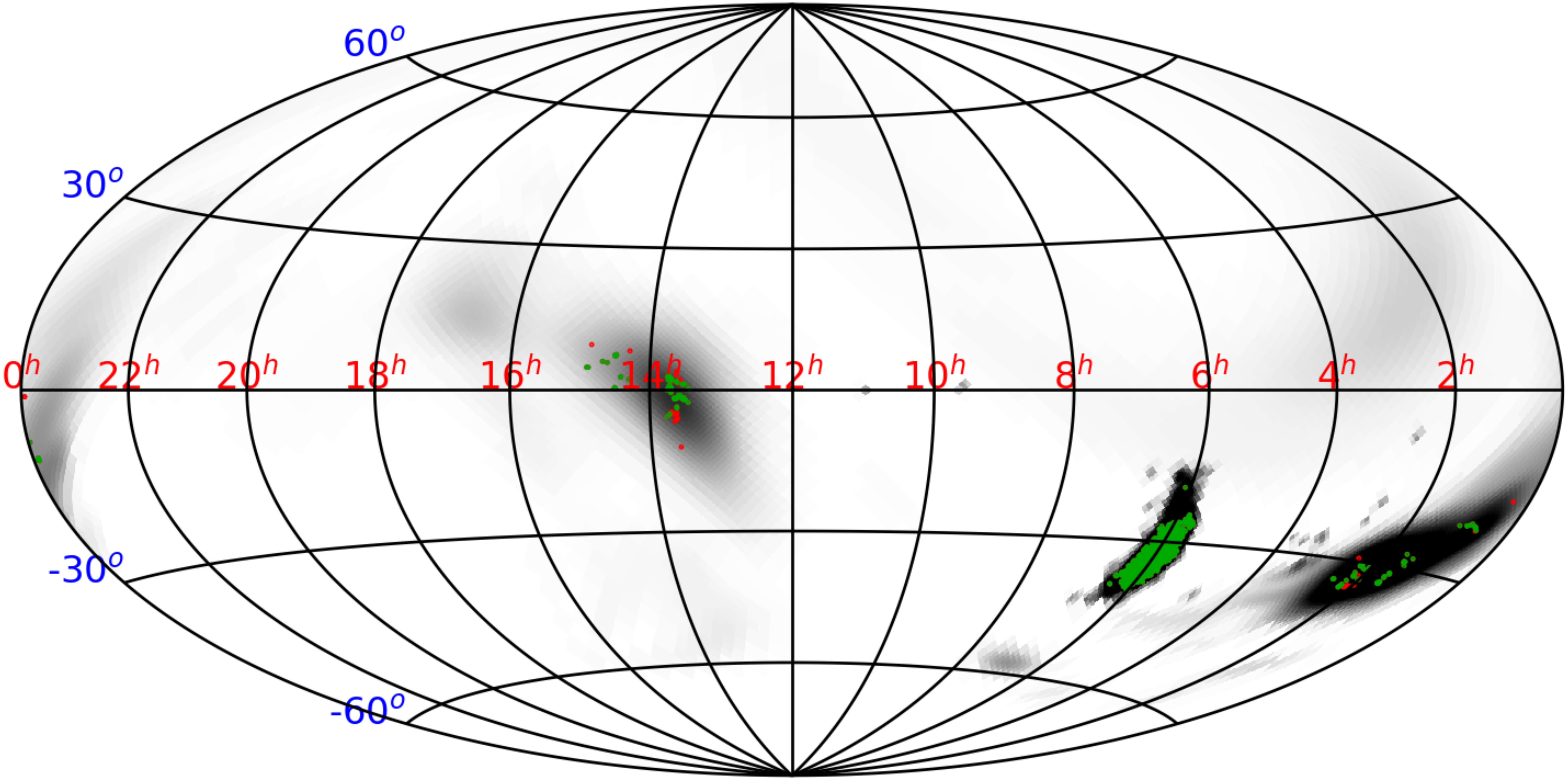


~2.7°



~1.7°

Tiling



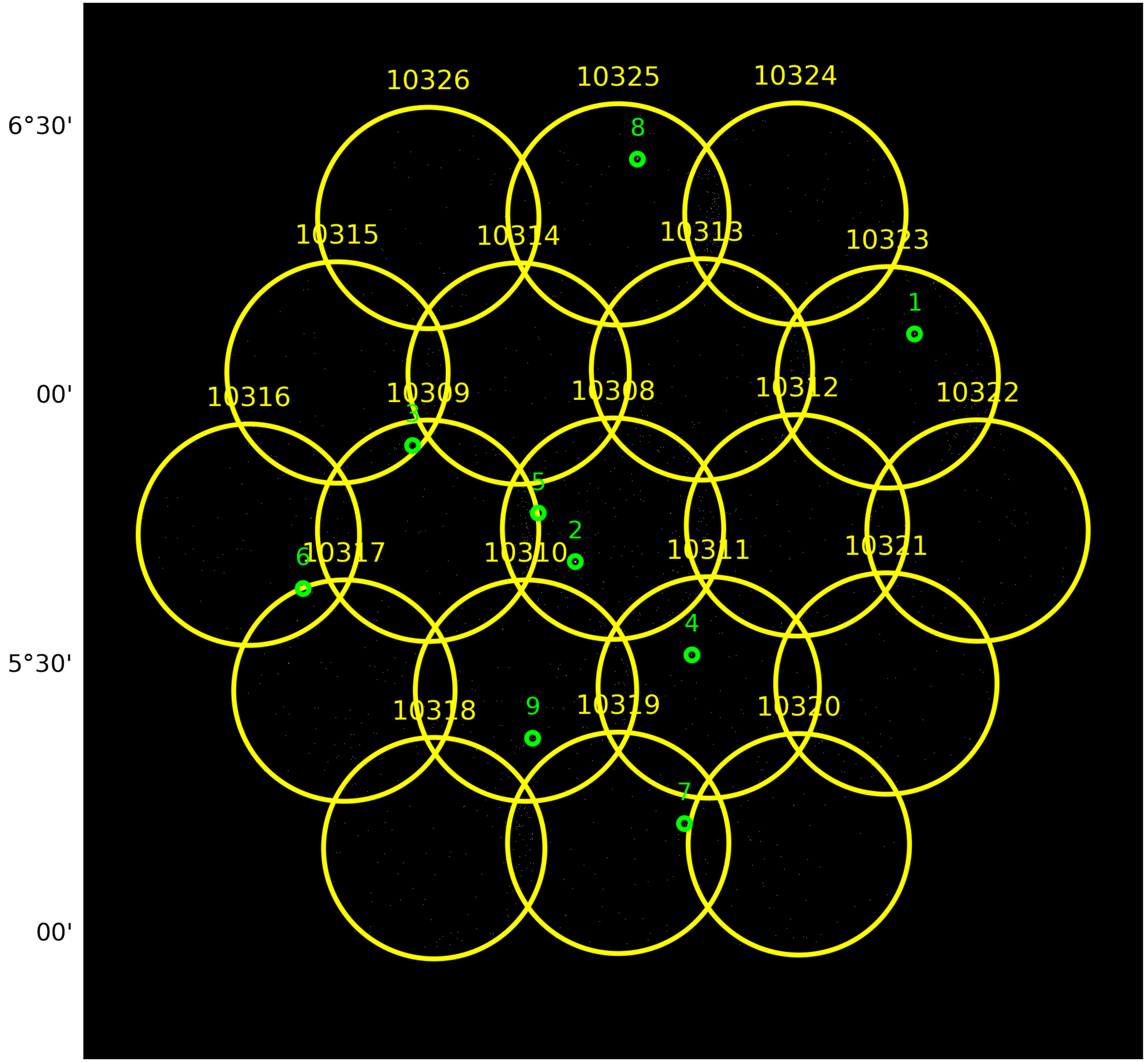
Neutrino follow up to date

Swift has been following neutrino alerts since March 2011.

- 42 from IceCube:
  - Doublets (Evans+ 2015) [7 tiles]
  - Triplet (Aarsten+ 2017) [37 tiles]
  - High energy (ICC+ 2018/in prep; Keivani+ 2018) [19 tiles]
- 21 from ANTARES (Adrián-Martínez+ 2016) [4 tiles]

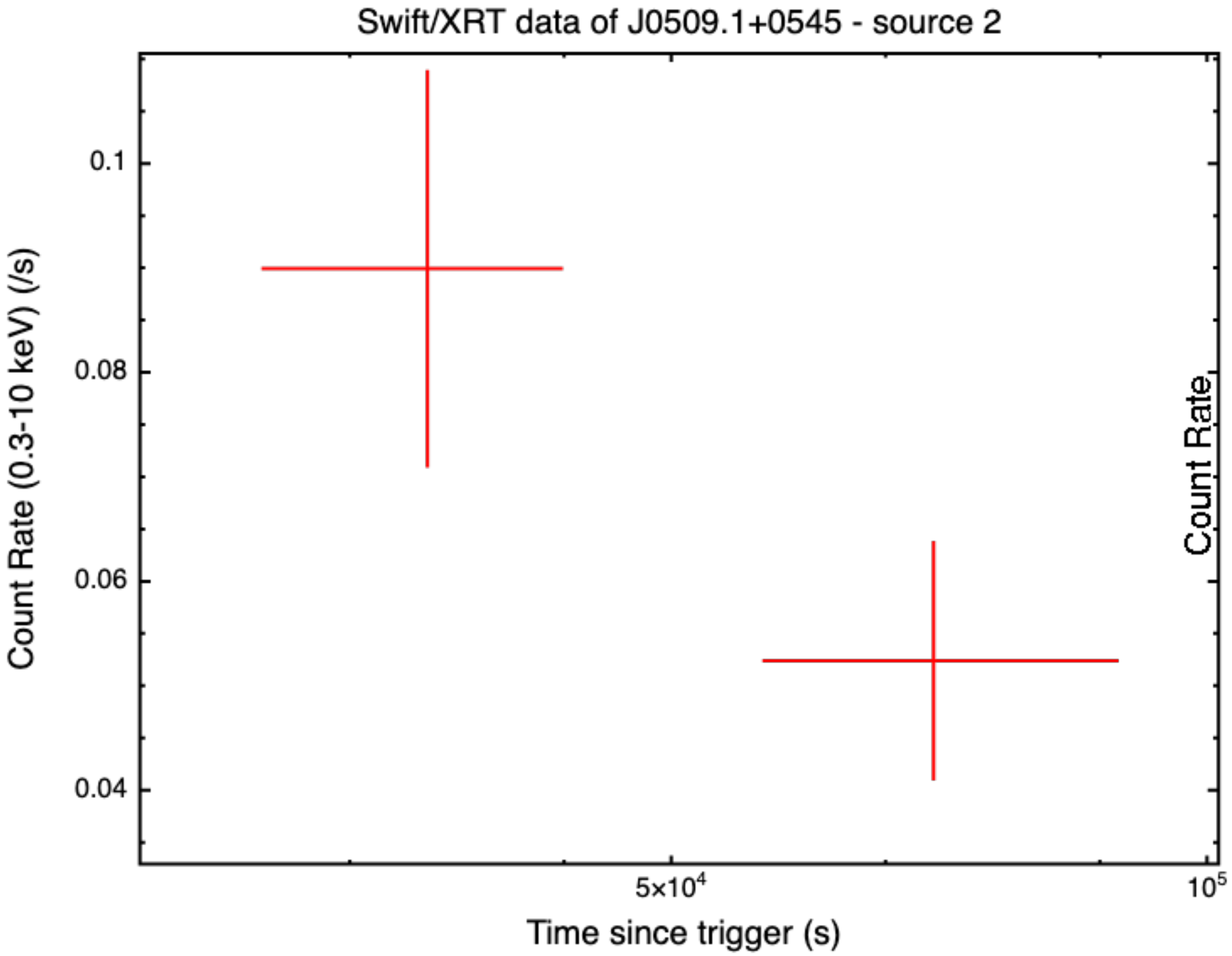
One counterpart identified…

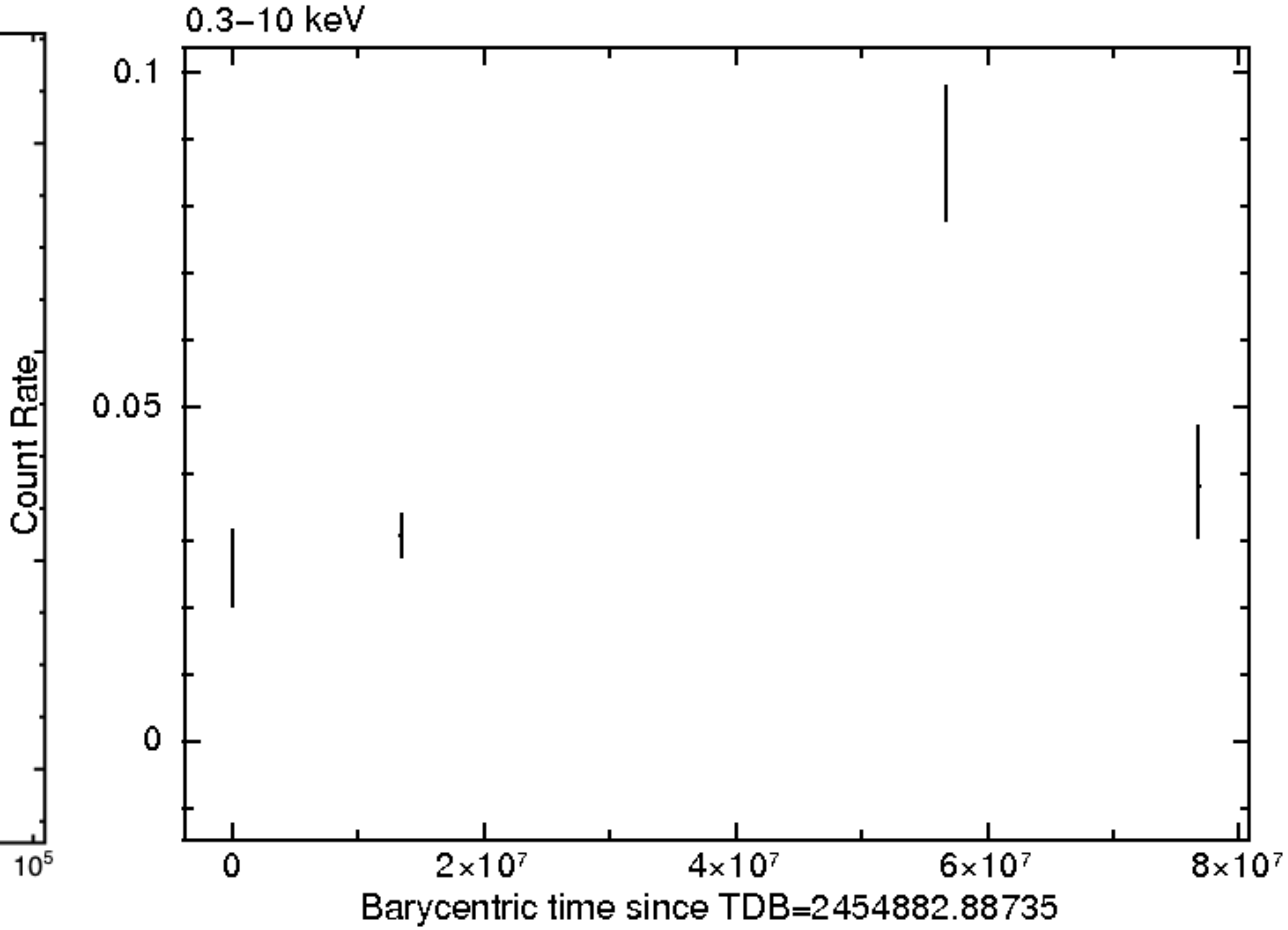
First result: IceCube 170922A



- 9 sources identified.
- Reported in Keivani+ (GCN 29130)
- Source 2 identified as QSO J0509+0541 = TXS 0506+056
- BUT, not initially identified as doing anything interesting…

First result: IceCube 170922A

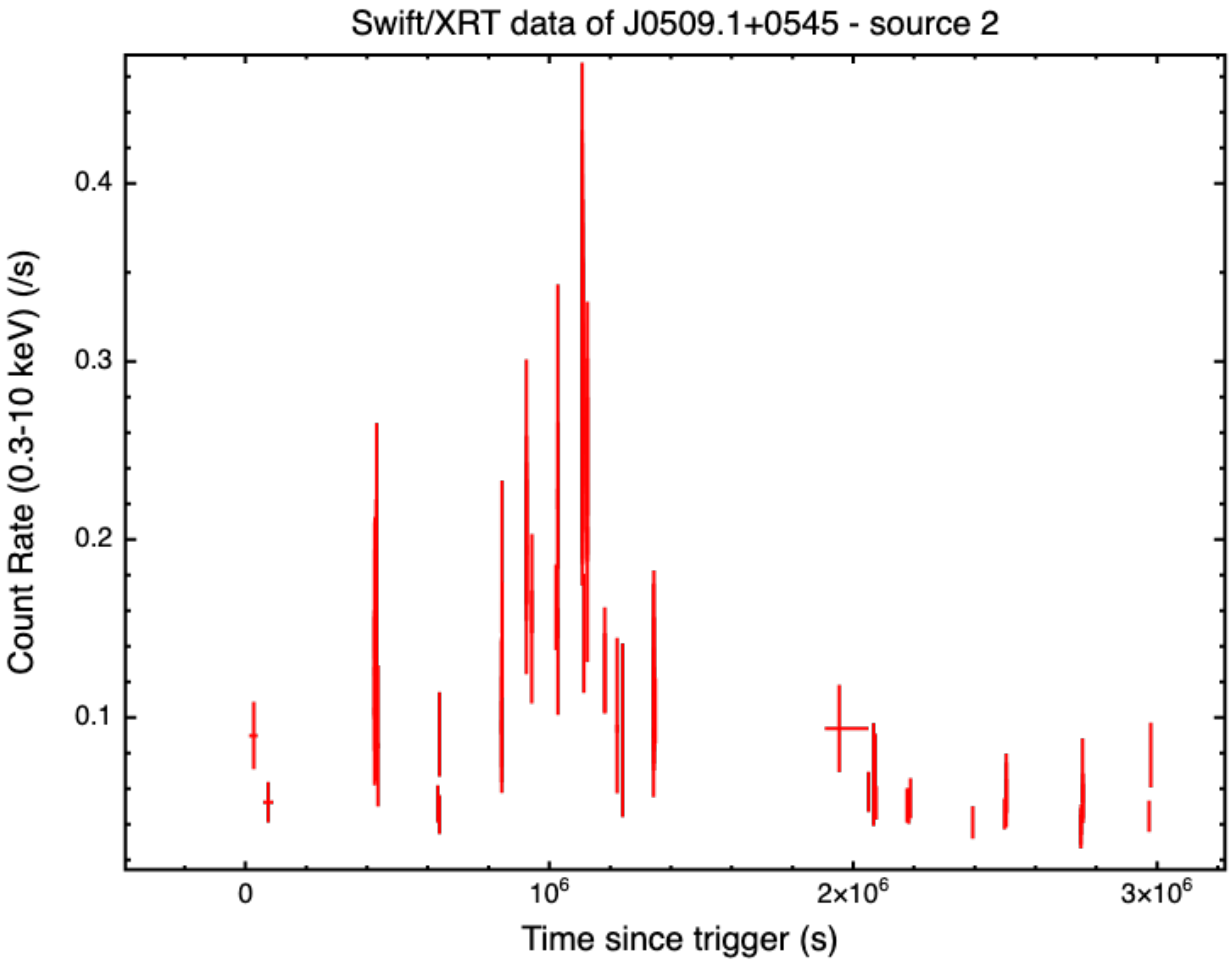




1SXPS J050925.9+054134/

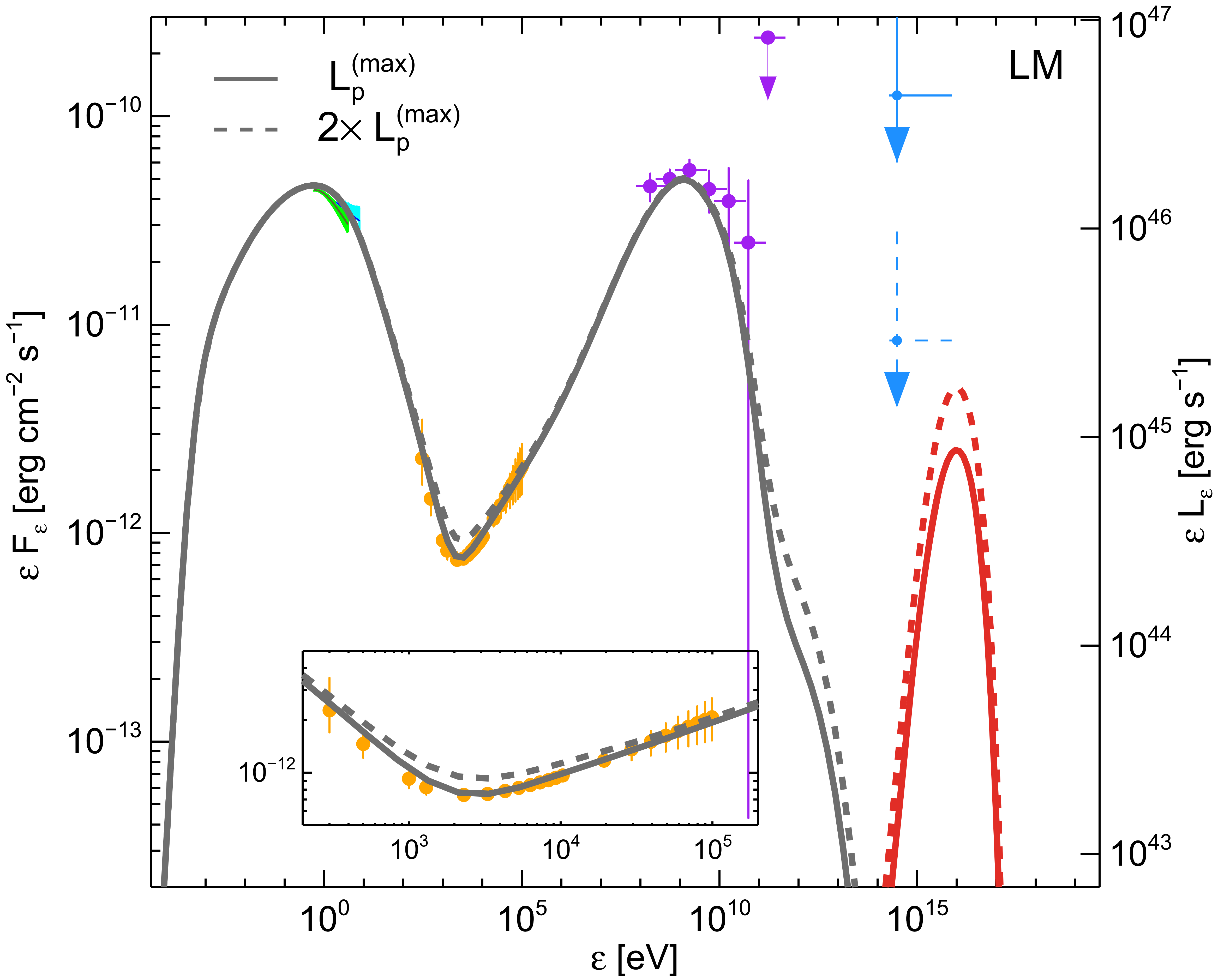
First result: IceCube 170922A

- Fermi noted (Kopper & Blaufuss, GCN 21916) that this blazar was apparently flaring above 800 MeV.
- Swift re-observed and confirmed an X-ray outburst (Evans+, GCN 21941).
- Continued to monitor for some time (last observtion at T+173.6d)



Importance of X-rays

- Keivani+ (2018) modelled the broadband SED to identify the emission mechanisms.
- They required a leptonic model.
- Site of neutrino production not consistent with being a UHECR accelerator.
- **The X-ray data were crucial**, as EM cascades tend to fill the bump between the two peaks (synchrotron and IC), so the X-ray data place strong constraints on neutrino and proton luminosities.



What can we do for KM3NeT

- Multi-wavelength follow up of triggers.
- Standard on-board tiling (easier), or custom patterns (harder; need warning and examples to develop tools).
- Need to decide which triggers we would follow, and how we will share our data…

Route 1: Public triggers (preferred)

If KM3NeT triggers are public:

- We will identify an appropriate threshold to trigger, which will be relate to false alarm rate and total exposure.
  - Very keen to discuss appropriate levels (this meeting will help); my expectation would be 500-1000 s per tile.
- We will analyse the data, and disseminate results via GCN / ATEL.
- We would look to create a public website sharing results, after human verification.

This is very much our preferred mechanism.

Enables quick sharing of results among teams (vital for TXS 0506).

Makes coordinating and arranging follow up easier.

Facilitates the best science return.

Allows *Swift* to better incorporate KM3NeT follow up among other priorities.

***Swift* data are ALL public**.

Route 2: Private triggers

If KM3NeT triggers are proprietary:

- We would need to create an MoU, laying out details of the information exchange.
- Observing scenario as public data, but potentially less flexibility.
- We will analyse the data, but how to disseminate?
- No public website, possibility of password-controlled area for MoU partners.

BUT…

Risks a lack of rapid information exchange, may hinder of prevent identification of counterpart.

Less ability to coordinate with external facilities for follow up.

Impacts the science return due to lower data collection.

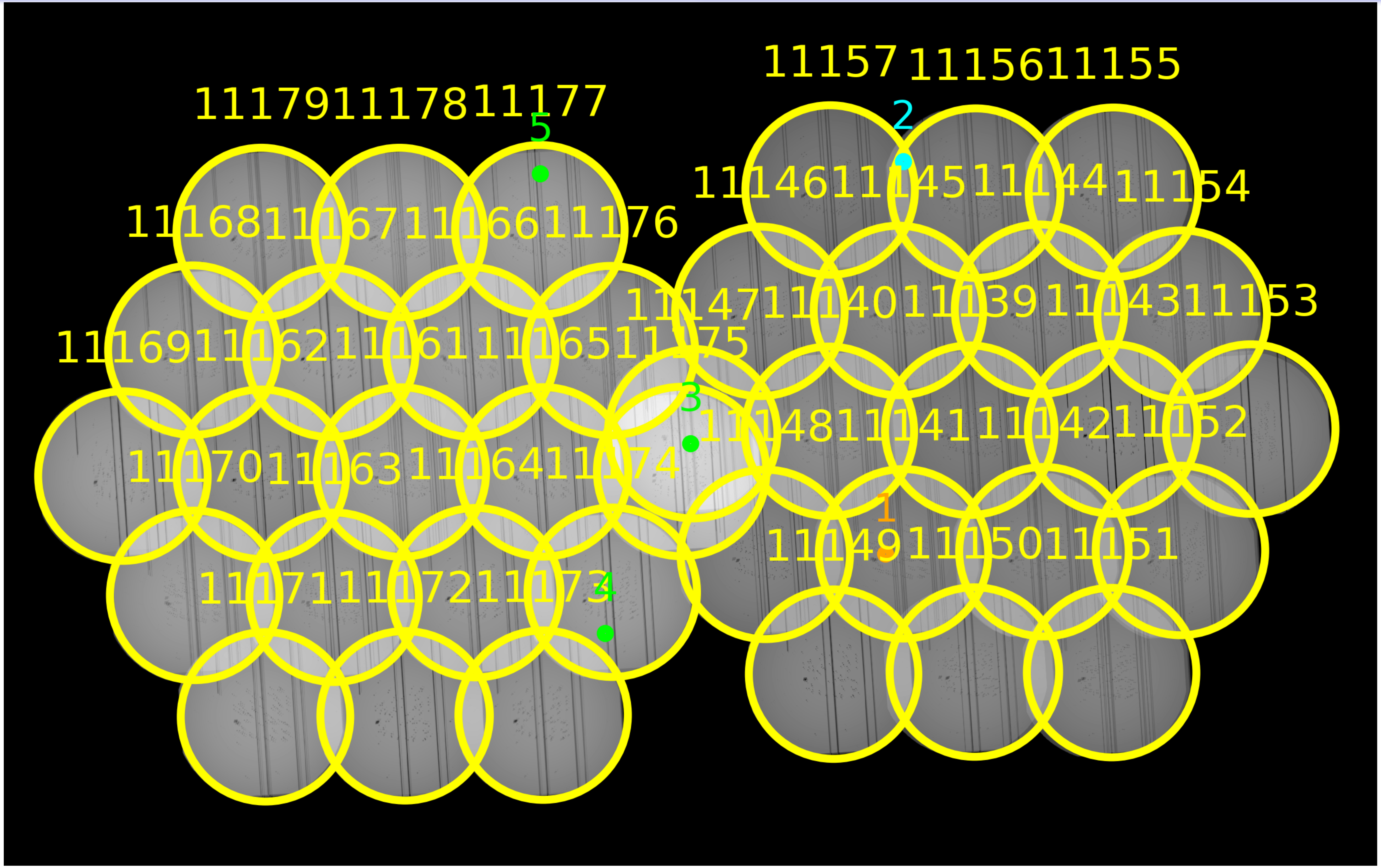
More complex to evolve follow up or balance KM3Net against, e.g. LIGO.

***Swift* data are ALL public**, we can obfuscate name, but the data are still accessible to all.

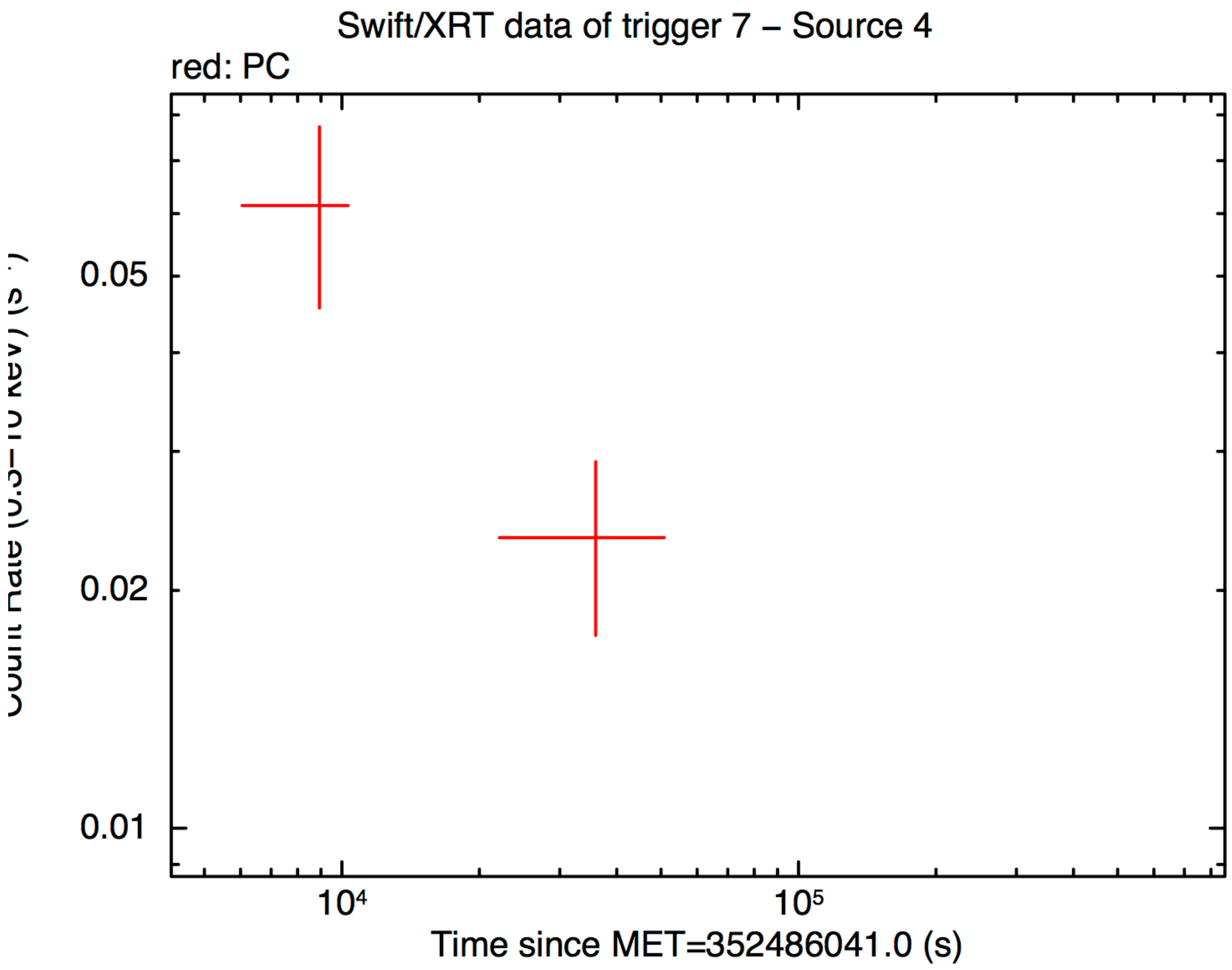
Summary

- Despite its modest field of view, *Swift* can perform high-quality neutrino follow up.
- For TXS 0506, we were the first to detect the EM counterpart, although not to identify it.
- X-ray data were critical to proper modelling of the SED and understanding the emission mechanisms in the blazar.
- Swift will be able to respond to KM3NeT triggers; our strong preference is for public triggers and coordinated, but independent, response from EM partners.

Challenges (1) moving error regions



Challenges (2) counterpart identification



Challenges (2) counterpart identification