

# SKA Pathfinder Lessons: The 2015 Outburst of V404 Cyg

Gregory R. Sivakoff (U. Alberta)



Image Credit: Tetarenko+2015 (UAlberta), in prep  
Movie Credit: Miller-Jones+2015 (Curtin), in prep



# Coordination Enabled By



Alex Tetarenko  
2nd Yr PhD

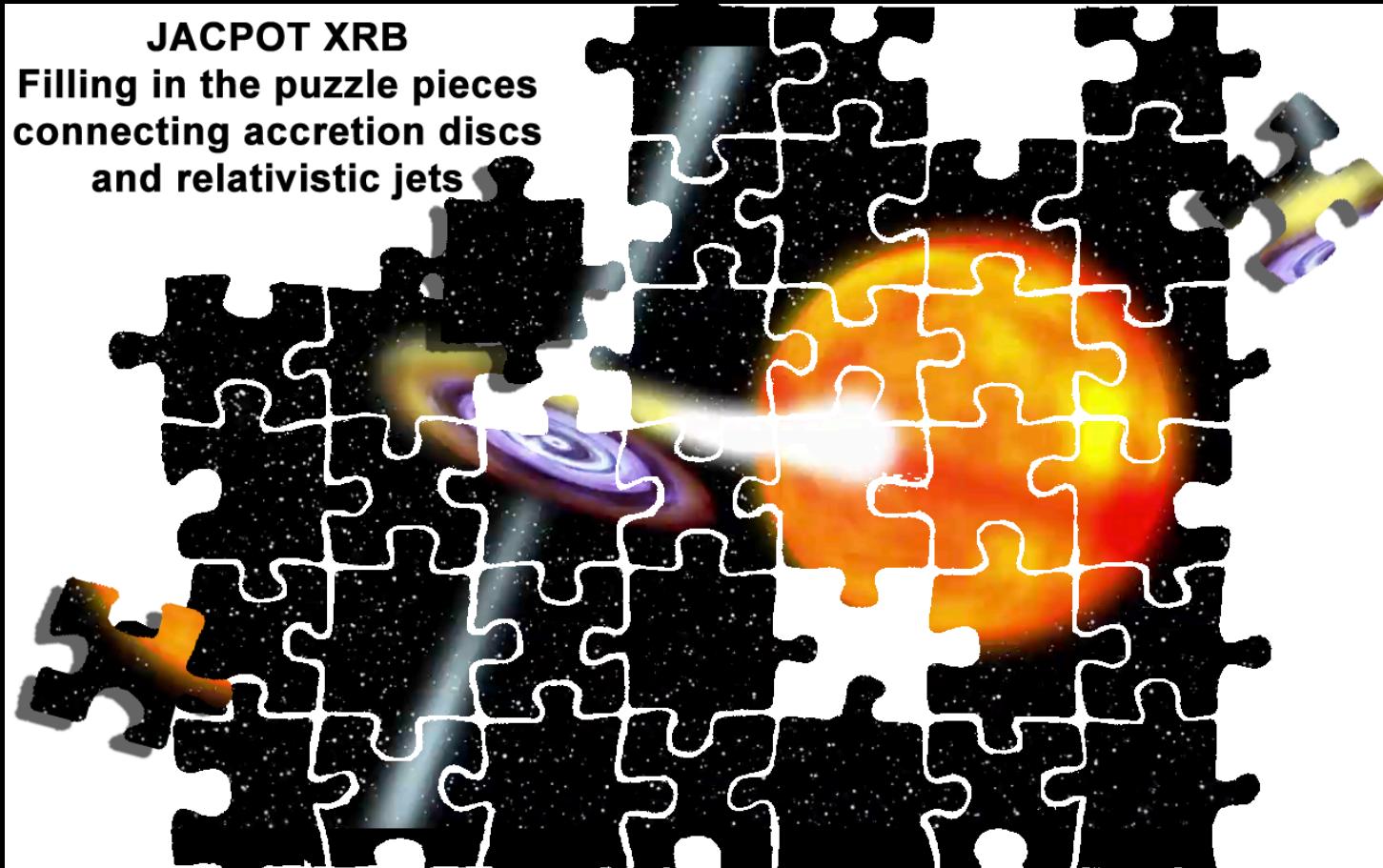


Arash Bahramian:  
Final Yr PhD

## Among Many Others



# Accretion – Jet Coupling



H1743-322:  
NASA/GSFC & G. Sivakoff et al.



# Why All the Fuss?

**The Fuss: 68 ATels, 15 GCNs, 3 Press Releases**

**Known distance, companion type, BH mass,  
system inclination**

**Northern Summer (non-teaching) nighttime object**

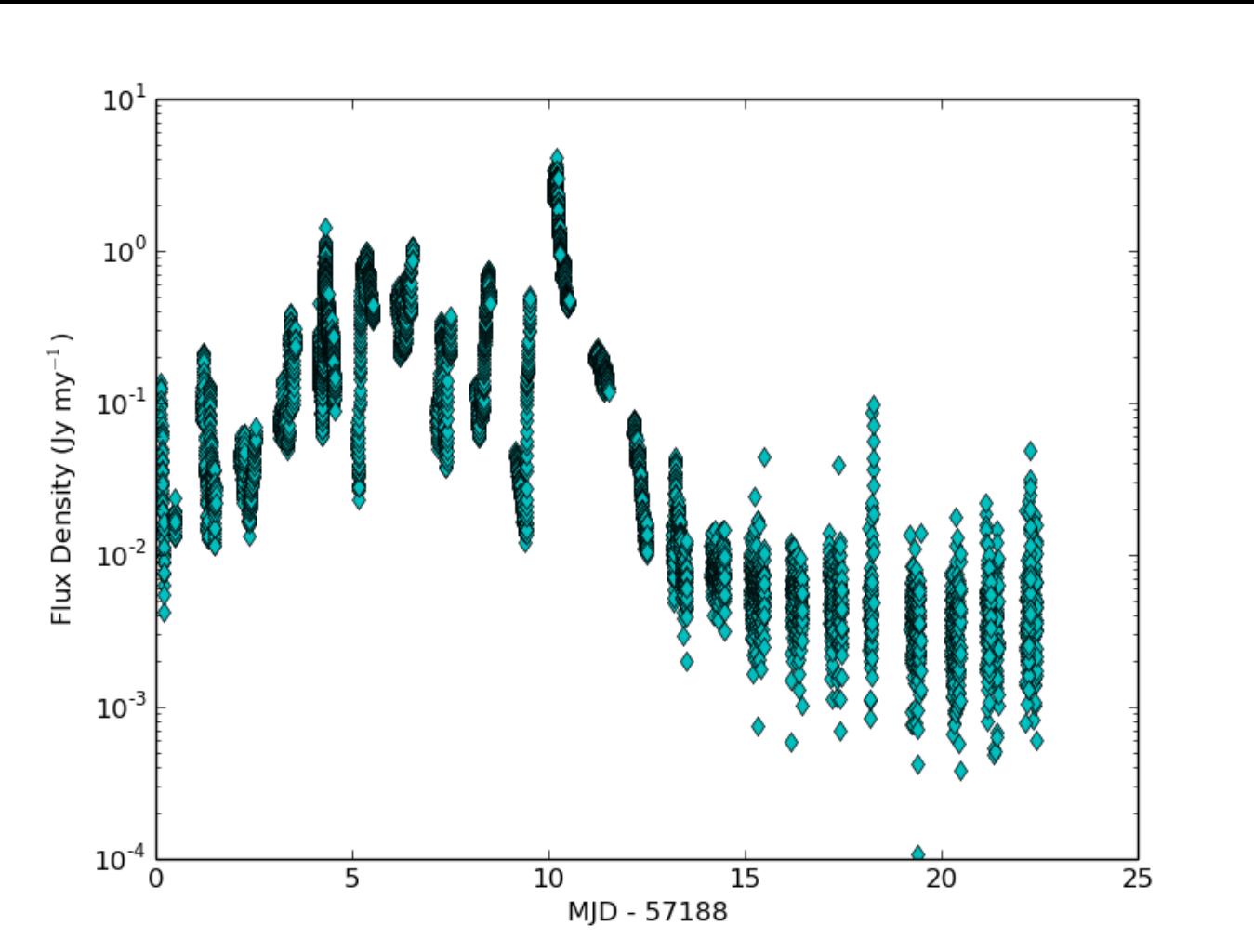
**It got VERY Bright VERY quickly.**

**New facilities / capacities since last great BH  
outburst**

**New modes of collaboration / communication**



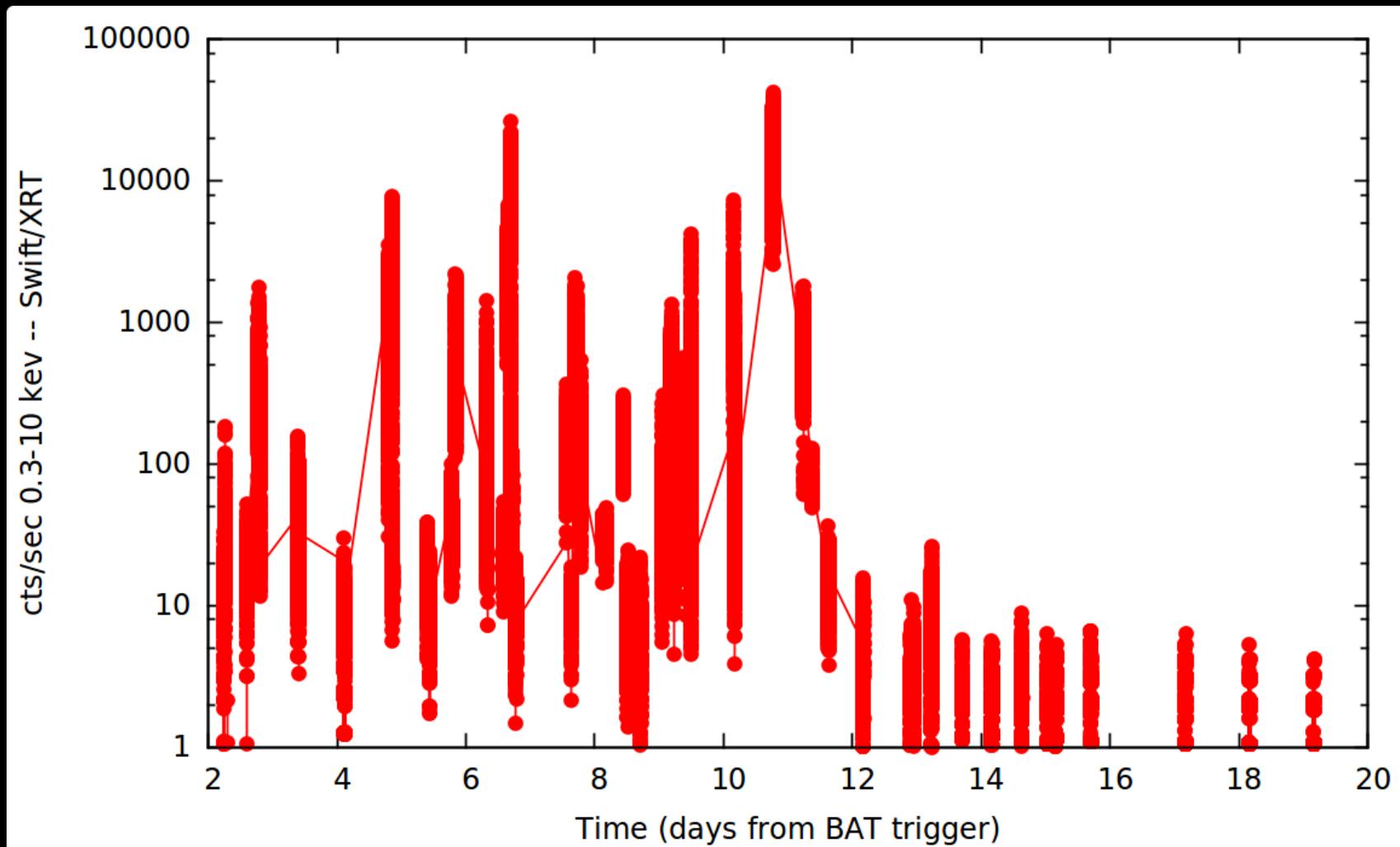
# Outburst Overview



Credit:  
Mooley,Fender+2015 (ALARRM/4PI SKY team)



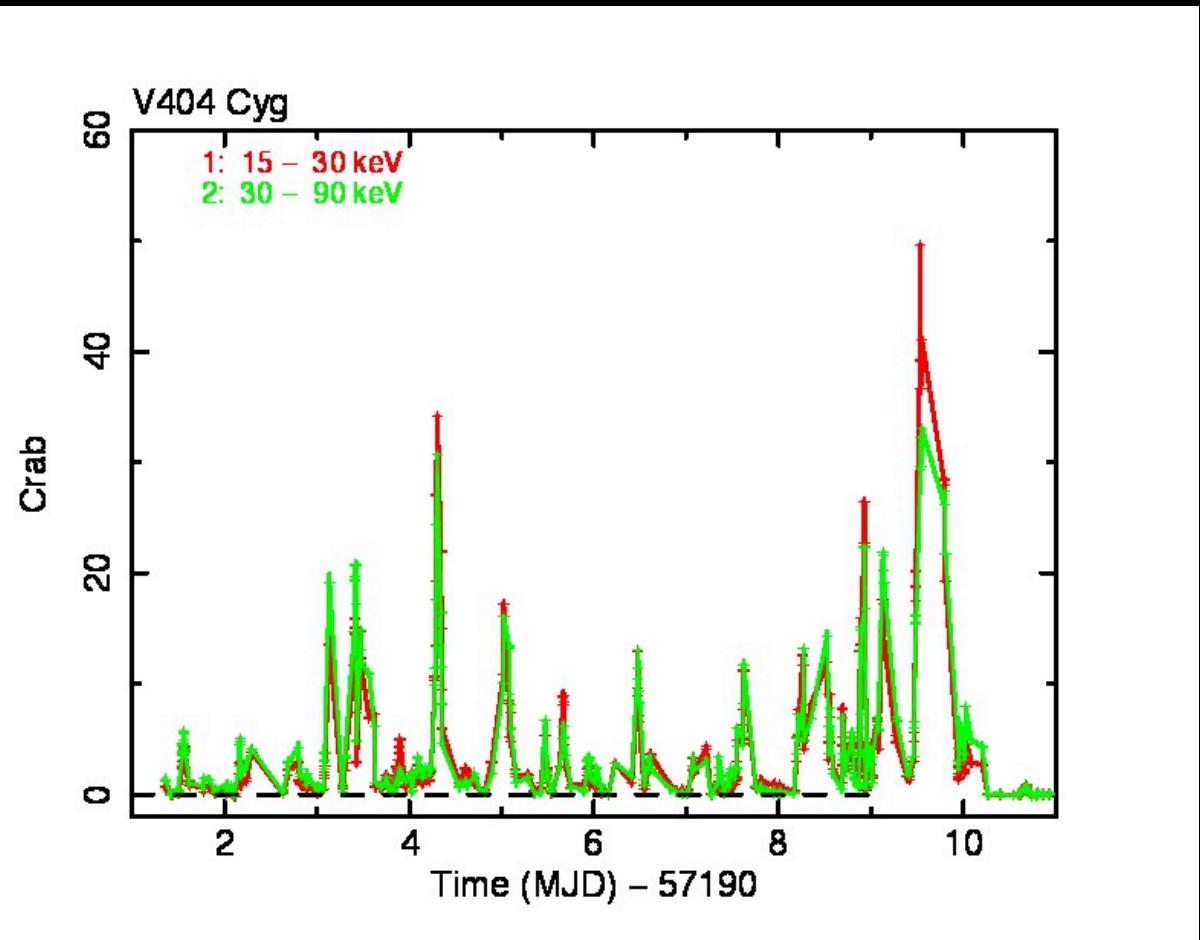
# Outburst Overview



Credit:  
Altamirano,Motta+2015, in prep



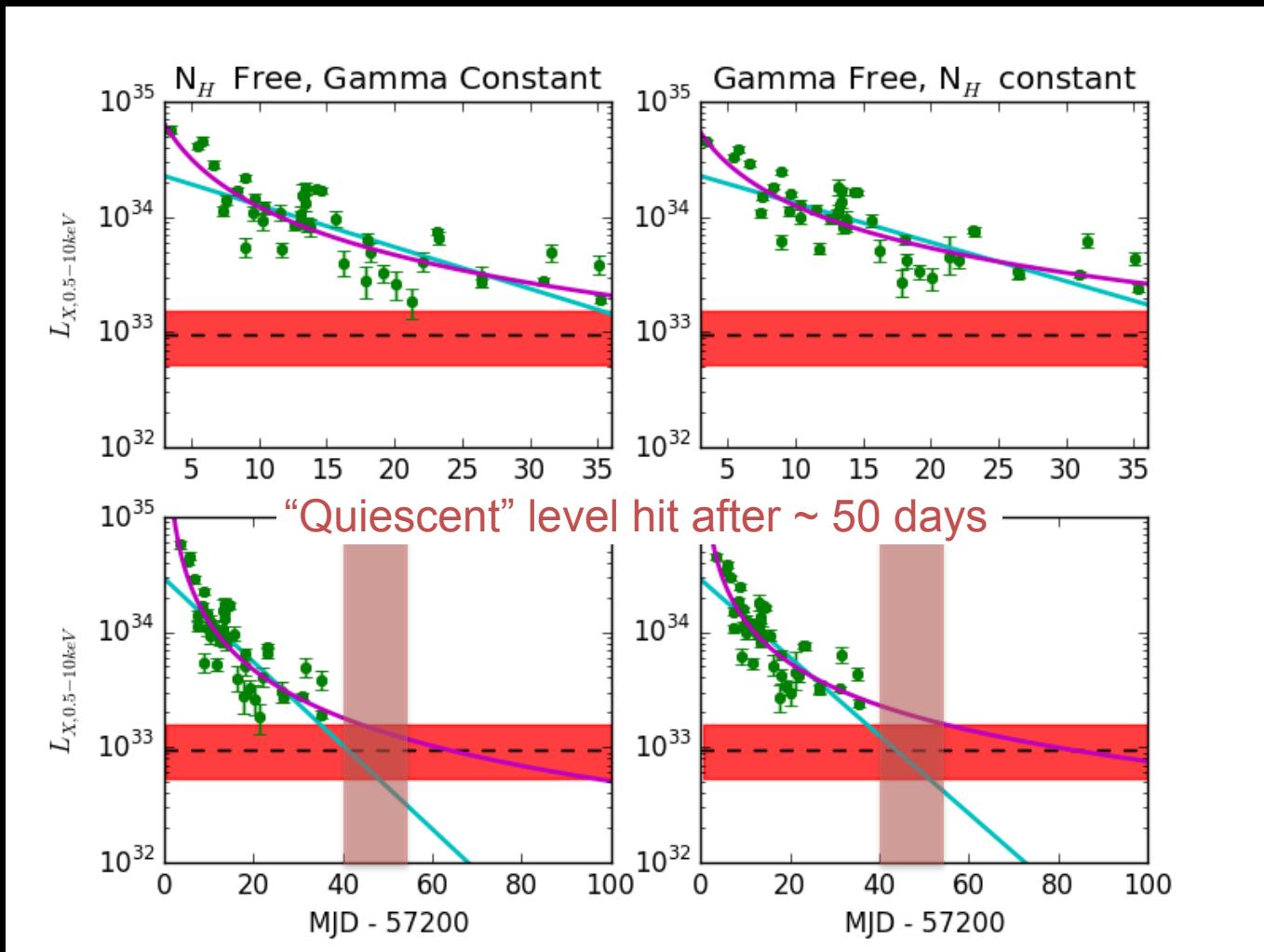
# Outburst Overview



Credit: Segreto+2015 (INAF/IASF-Palermo)  
ATel 7755



# Outburst Overview



Credit: Sivakoff+2015 (UAlberta)  
Updated from ATel 7788



# Organization: Social Media



LongHotSummer.pdf · version 1

Portable Document Format

[Download](#)

[Preview](#)

Unlike · Comment · 6 3

You, [REDACTED] and 4 others like this.



**Gregory R Sivakoff** Who would have thought that Facebook would be one of the leading manifestations of "a worldwide network of computers for realtime communication," enabling us to test X-ray novae?

June 24 at 4:16pm · Like · 3

[REDACTED] Astronomers use anything they can to alert our colleagues that something interesting is happening. V404 Cyg is "blowing" us away.

June 24 at 4:29pm · Like · 2

[REDACTED] You guys should write a review for JAAVSO. And soon!!!! 😊

June 24 at 4:53pm · Edited · Like · 3



# Organization: Mailing List/Web

**v404-mwc@lists.soton.ac.uk:**

(Thanks to Christian Knigge for starting this)

≥114 messages (and I'm only responsible for 28)

≥132 subscribers

[http://deneb.astro.warwick.ac.uk/phsaap/v404cyg/  
data/](http://deneb.astro.warwick.ac.uk/phsaap/v404cyg/data/)

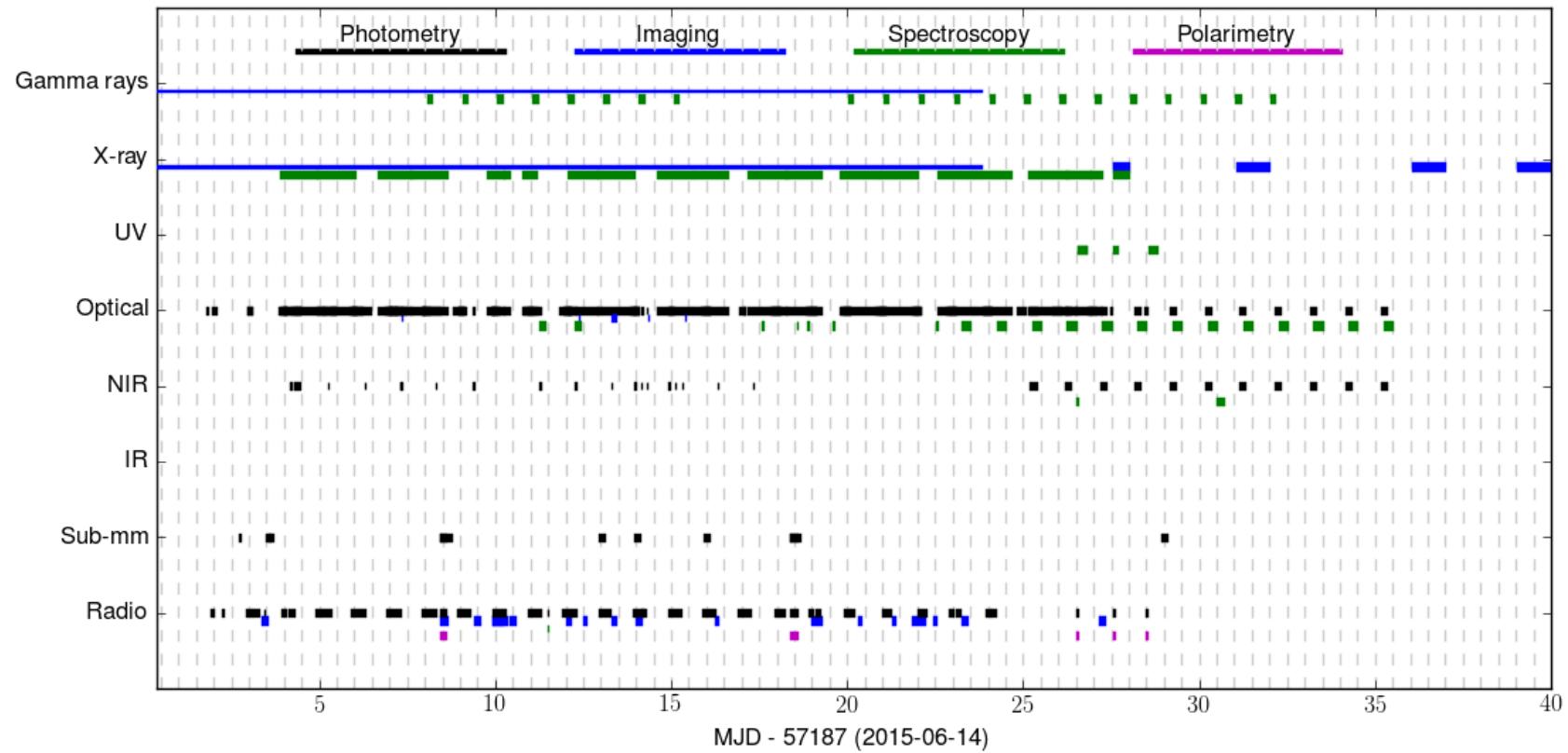
(Thanks to Tom Marsh for starting this)

≥119 public submissions

≥577 observing windows



# Organization: Mailing List/Web



# **Organization: Broad Wavelength Coverage**

**Radio (150 MHz, 341 MHz, 1-26 GHz):  
Photometry (<0.50 Hz), spectroscopy,  
polarimetry, high resolution imaging**

**mm/sub-mm (97 GHz, 140 GHz, 230 GHz,  
355 GHz, 666 GHz):  
Photometry (<0.033 Hz)**



# **Organization: Broad Wavelength Coverage**

**IR (JHK):**

**Photometry (<10 Hz),  
spectroscopy, polarimetry**

**UVOIR detections (190-1000 nm):**

**Photometry (<100Hz),  
spectroscopy, polarimetry**



# **Organization: Broad Wavelength Coverage**

**X-ray (0.1 – 100 keV):**

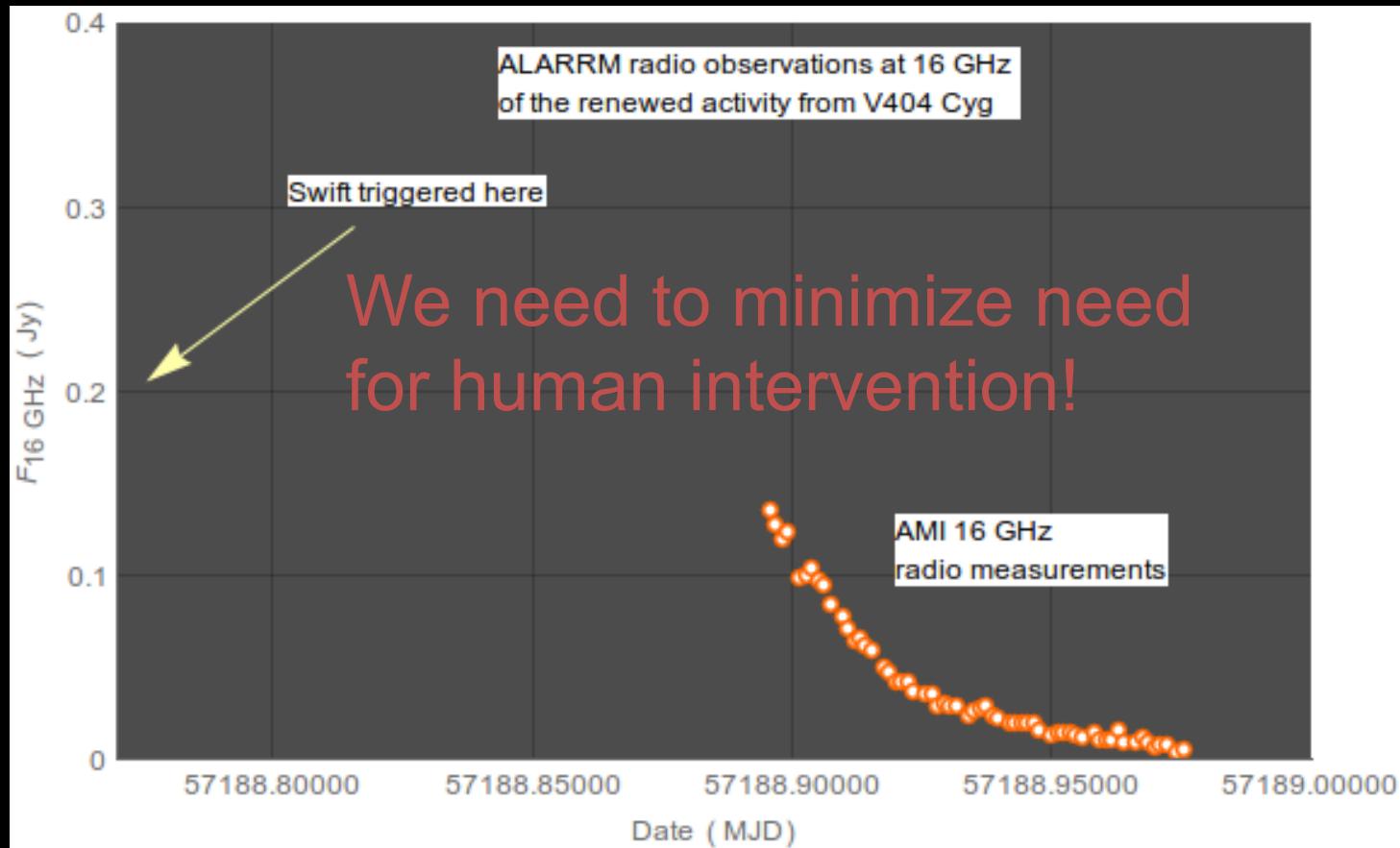
**Photometry (<450 Hz), spectroscopy**

**Gamma-rays (100 keV – 10 TeV) :**

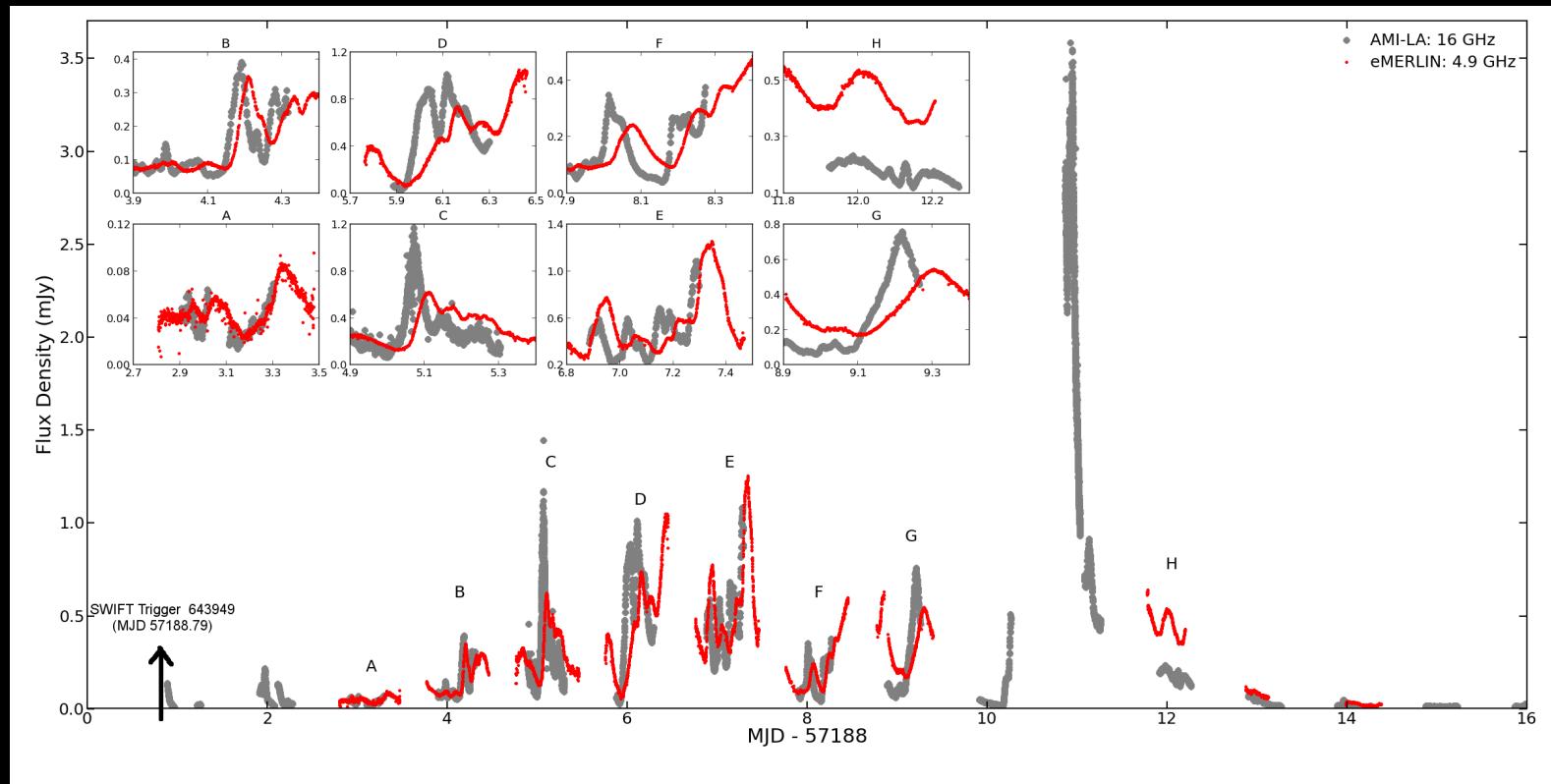
**Photometry, spectroscopy**



# Triggering: Rise of the Machines



# Continuous Monitoring: AMI (& others) Stare at V404 Cyg



Incredible potential of continuous monitoring.

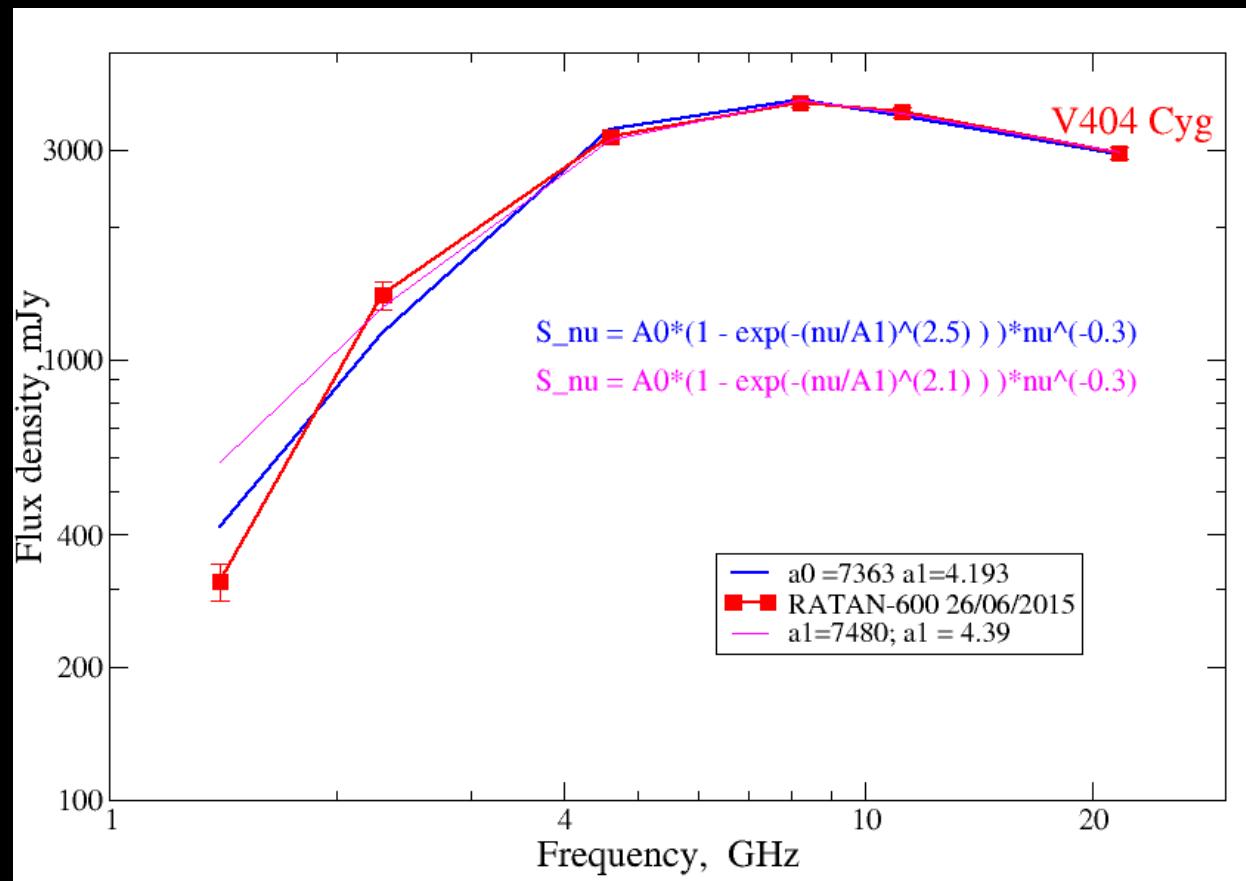


Credit: Mooley+ 2015, Beswick+2015  
in prep

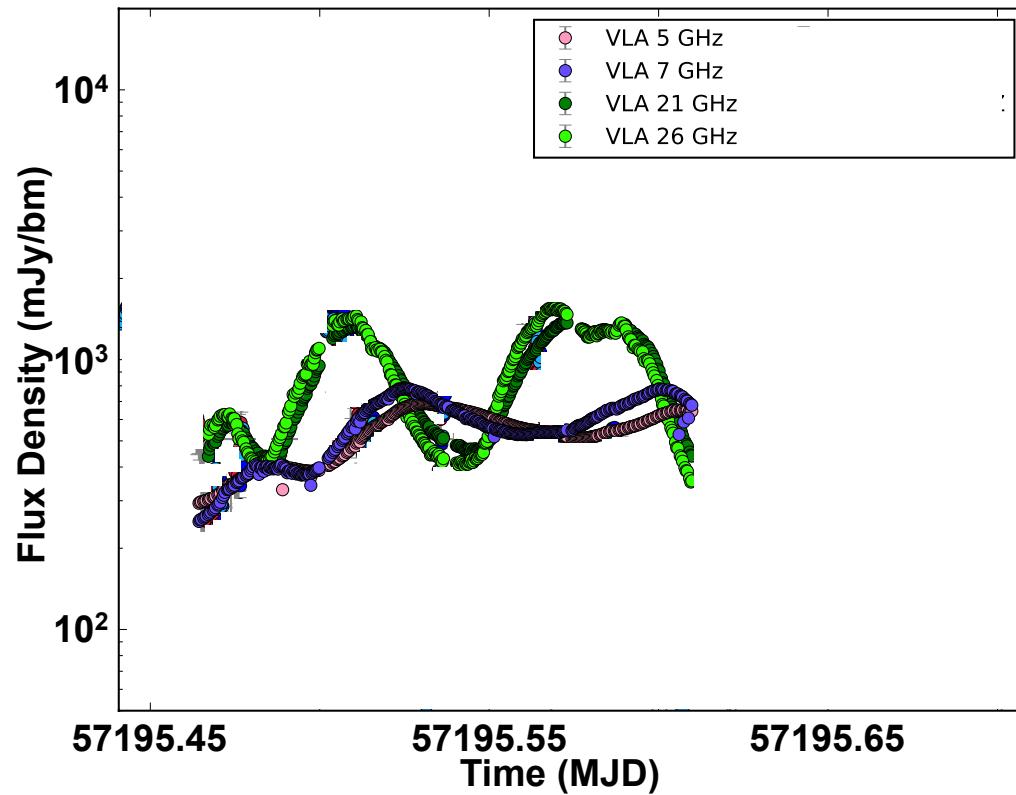


# Broad Multi-band Coverage

Self-absorption synchrotron spectrum at peak



# Strict Simultaneity + Sub-array Value

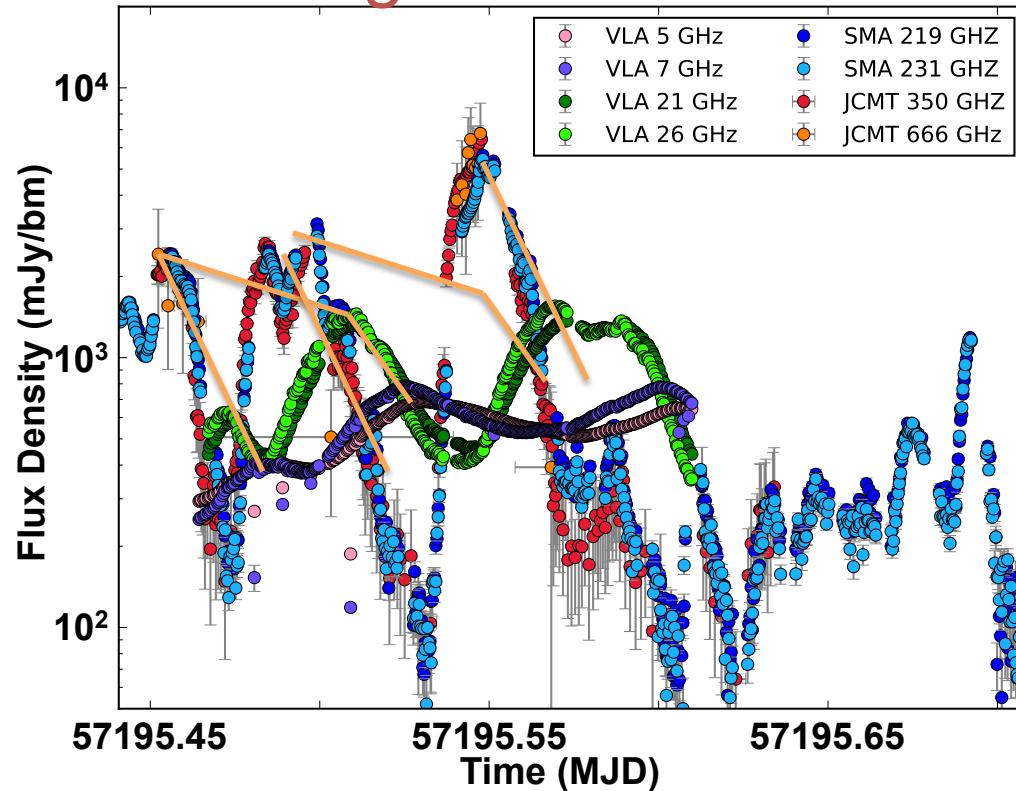


Subarrays enable new observing modes (e.g., great simultaneous spectral coverage or continuous light curves).



# Strict Simultaneity + Sub-array Value

We're suffering from Black Hole Jet Lag

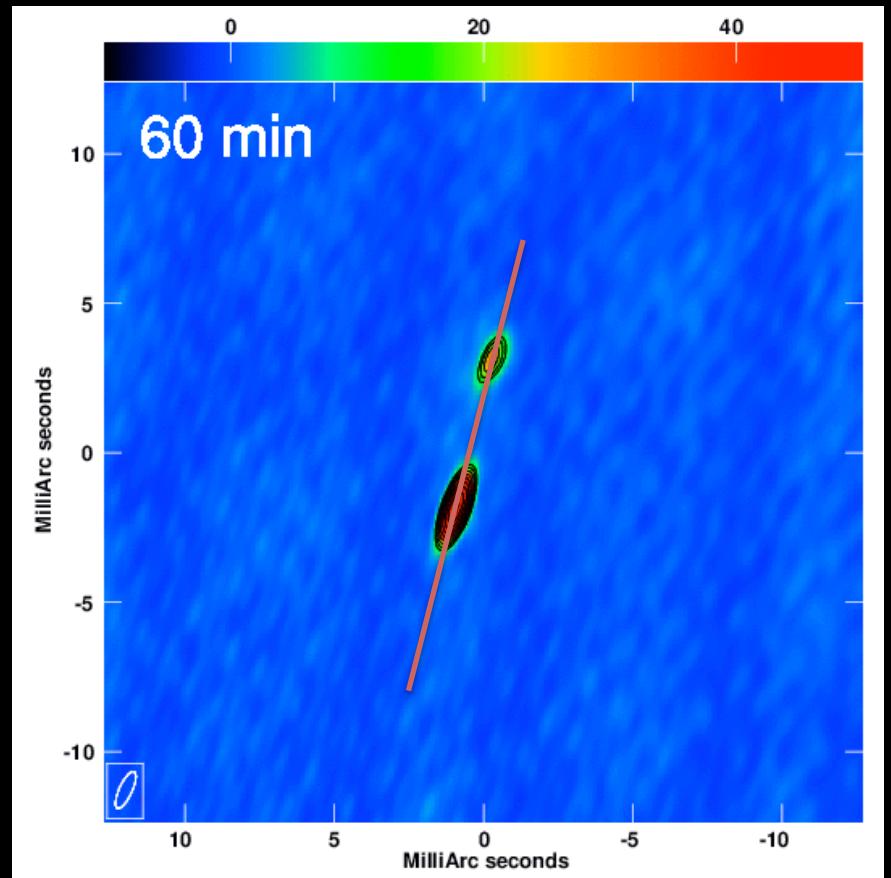


Also detected at  
31 $\sigma$  at 341 MHz  
over 4 hrs.  
Time series to  
come.



# Strict Simultaneity + Imaging Value

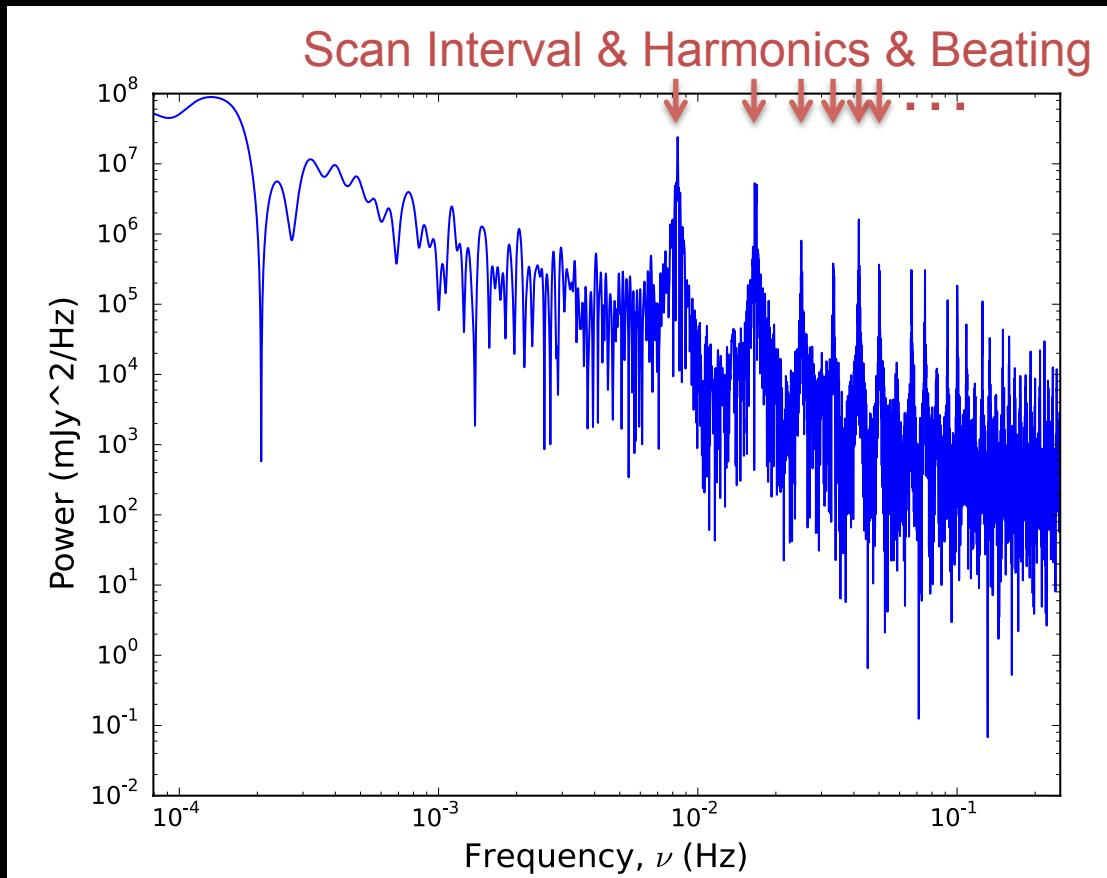
Very preliminary, but:  
we see jet ejecta; different  
speeds; potentially  
different launching angle



Credit: Miller-Jones+2015 (Curtin)  
in prep



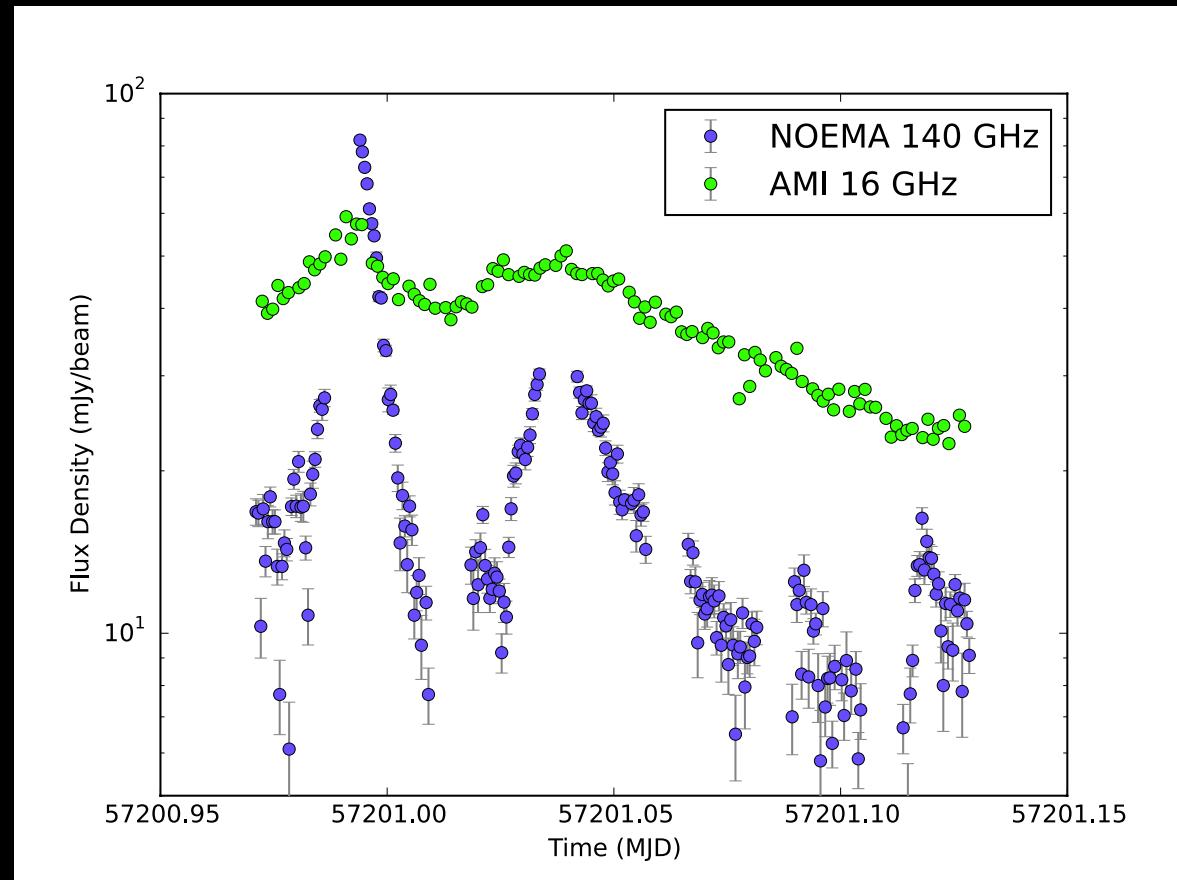
# High Time Resolution Imaging (Beware Regularly Spaced Scans)



Credit: Tetarenko+2015c (Alberta)



# Strict Simultaneity + mm Value



“Strange” sub-mm  
shape ~ 1 day past  
peak



# Summary

**Most interesting BH outburst in >10 years.**

**Strong community response, both in data collected and potential for collaboration.**

**Need more time to determine full lessons learned, but...**



# Eight Lessons Learned

1. Broad wavelength coverage will be essential for unlocking physics.

**SKA Pathfinders may need MOUs with telescopes and should invest in a multiwavelength ambassador.**

2. Swift response could be crucial.

**Remove the human being for triggering if at all possible in SKA Pathfinders and transient followup.**



# Eight Lessons Learned

3. Long continuous stares filled in missing parts from most monitoring campaigns.

**SKA Pathfinders should have plans to stare at exemplary transients.**

4. Subarrays revealed great value with just one array.

**For bright sources ( $>10\sigma$ ), users of SKA Pathfinders should consider subarrays.**



# Eight Lessons Learned

5. VLBI-imaging revealed incredible views.

**SKA Pathfinders need to work with VLBI facilities.**

6. Coordinated sub-mm data show increased variability and get closer to the action.

**SKA Pathfinders need to start working with ALMA now on transients.**



# Eight Lessons Learned

## 7. High temporal resolution now an option.

**SKA Pathfinders need to be prepared for time-domain studies of bright transients (including non-regularly spaced phase calibration).**

## 8. VLBI-imaging crucial for revealing true picture.

**SKA Pathfinders need to work with VLBI facilities. (It's worth saying twice.)**

