

slow

ES04: Transient Key Project

ES04 team

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Mickael Coriat (IRAP)

Alan Loh (LESIA/Obspm)

Baptiste Cecconi (LESIA/Obspm)

Ismael Cognard (LPC2E)

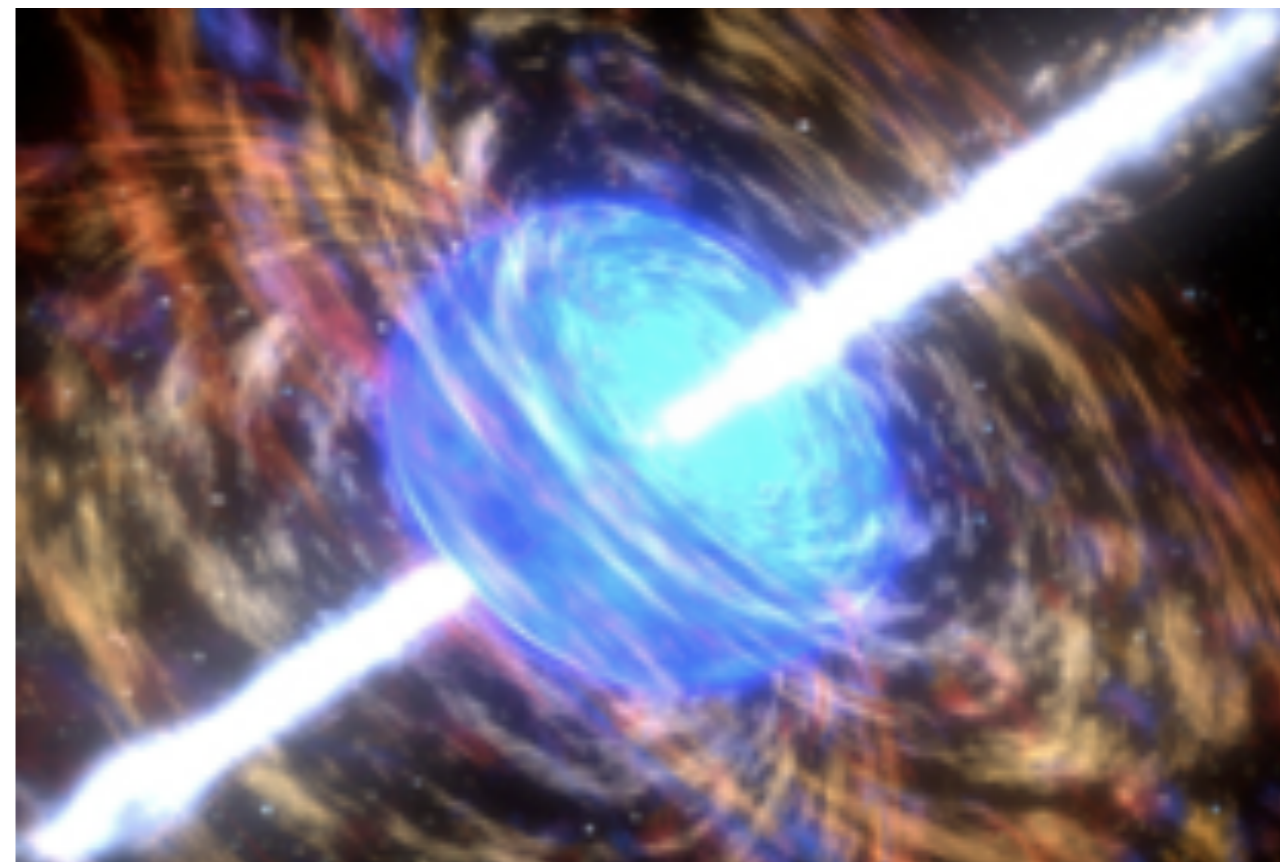
Jean-Luc Starck (AIM/CEA)

Cyril Tasse (GEPI/Obspm)

Vyacheslav Zakharenko (IRA)

Christian Gouiffès (AIM/CEA)

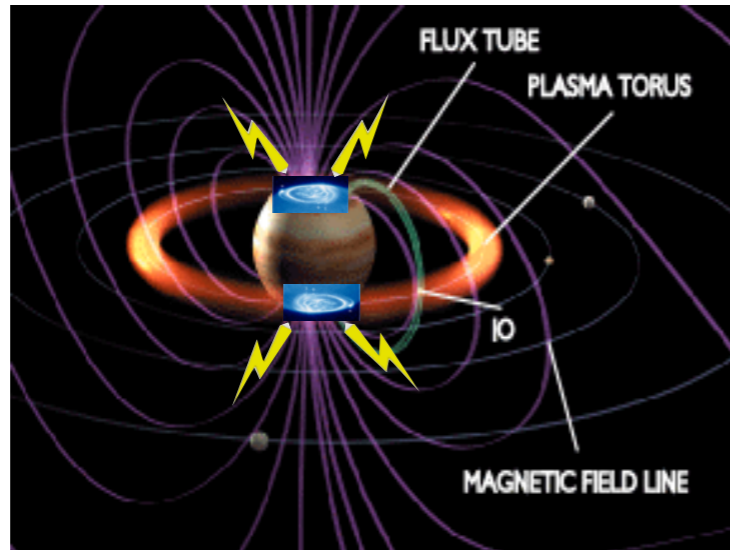
Eric Chassande-Mottin (APC/P7).



Main objectives

- **Contribute to the definition & building of the imaging mode**
- **Study slow transients at low frequencies in the image plane with NenuFAR**
- **Conduct future definition and implementation of transient pipelines for the imaging mode.**

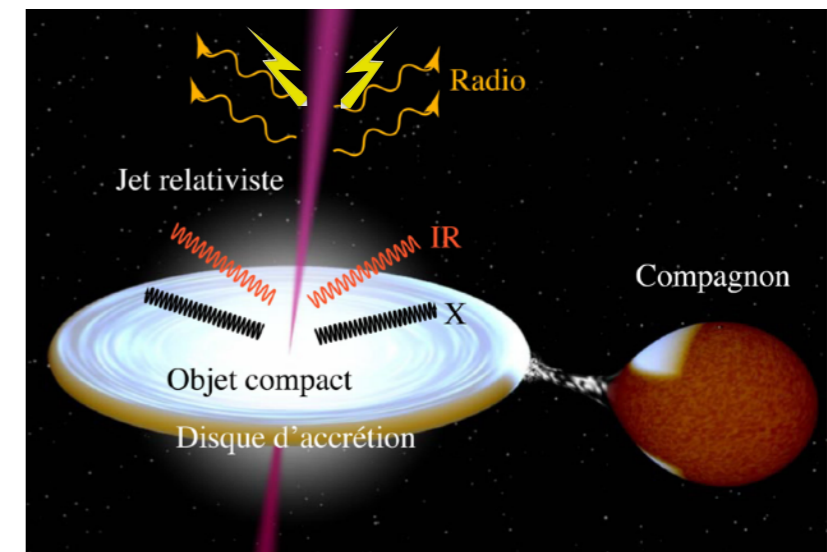
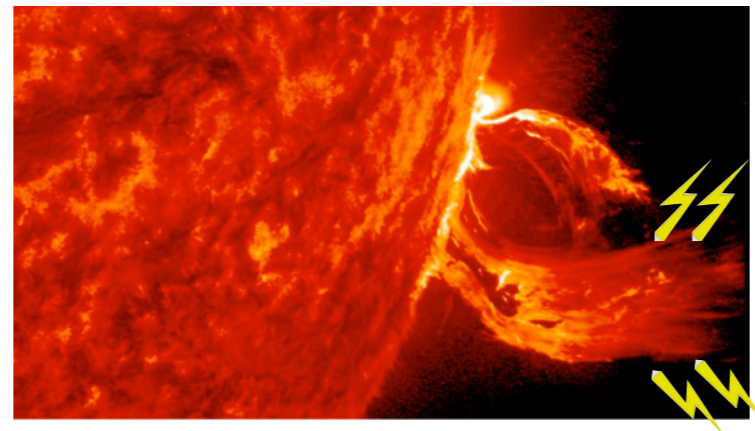
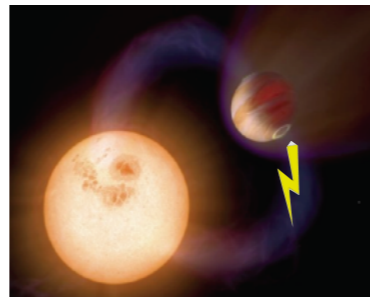
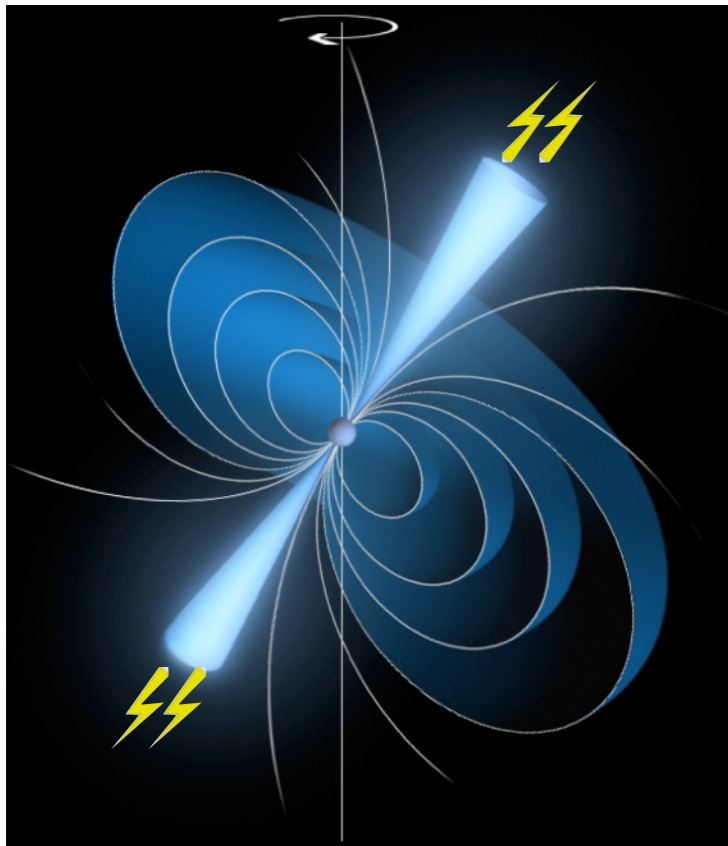
Diversity of transient radio sources



Radio signatures

- mark the presence of magnetic fields
- have a rich spectral and temporal features
- associated to catastrophic events

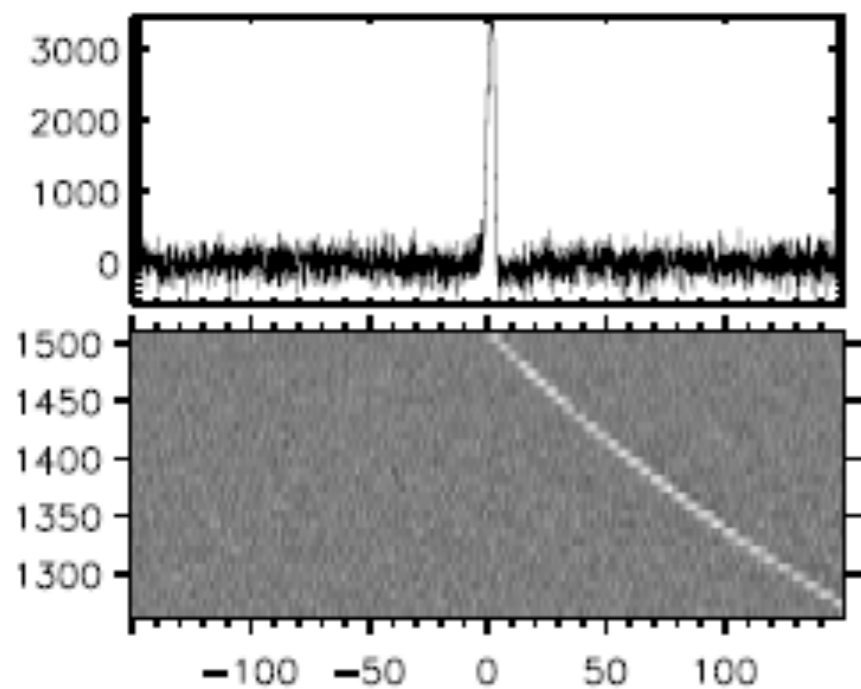
at all scales in energy, distances, durations...



Observing (fast) transients at low frequencies



"Fast" transient sources



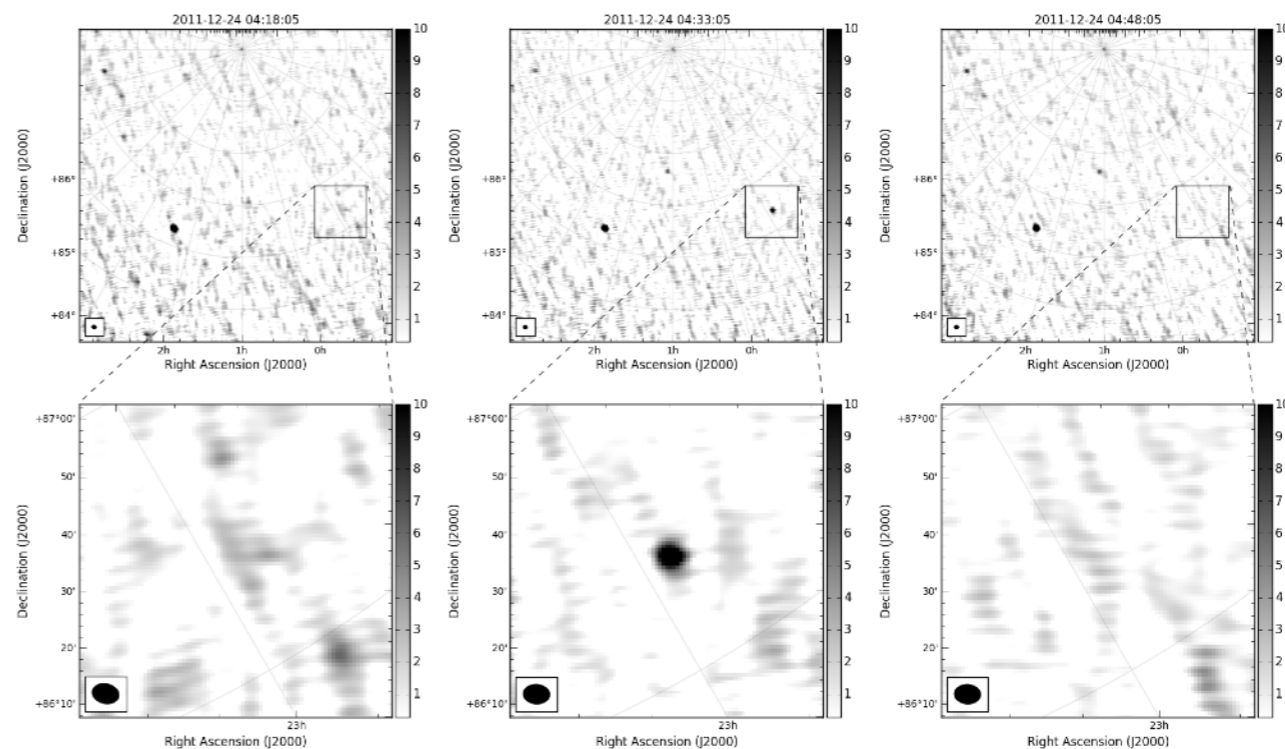
Lorimer, 2007

Time series

- High time resolution
- Low instantaneous SNR

Detection problem

"Slow" transient sources



Stewart et al. 2015

Imaging

- Longer integration time
- Potentially higher SNR

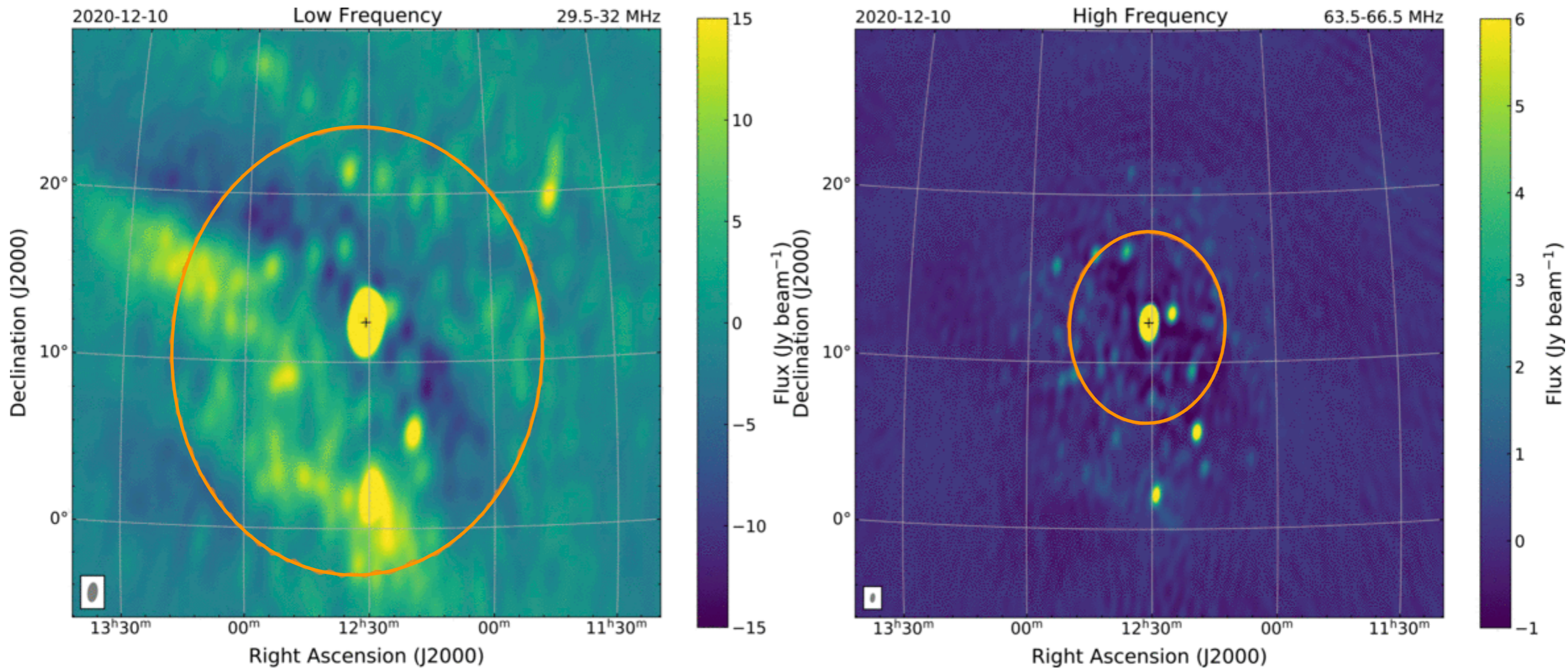
Dilution problem

Need for robust & fast imaging mode

Contribution to the instrument

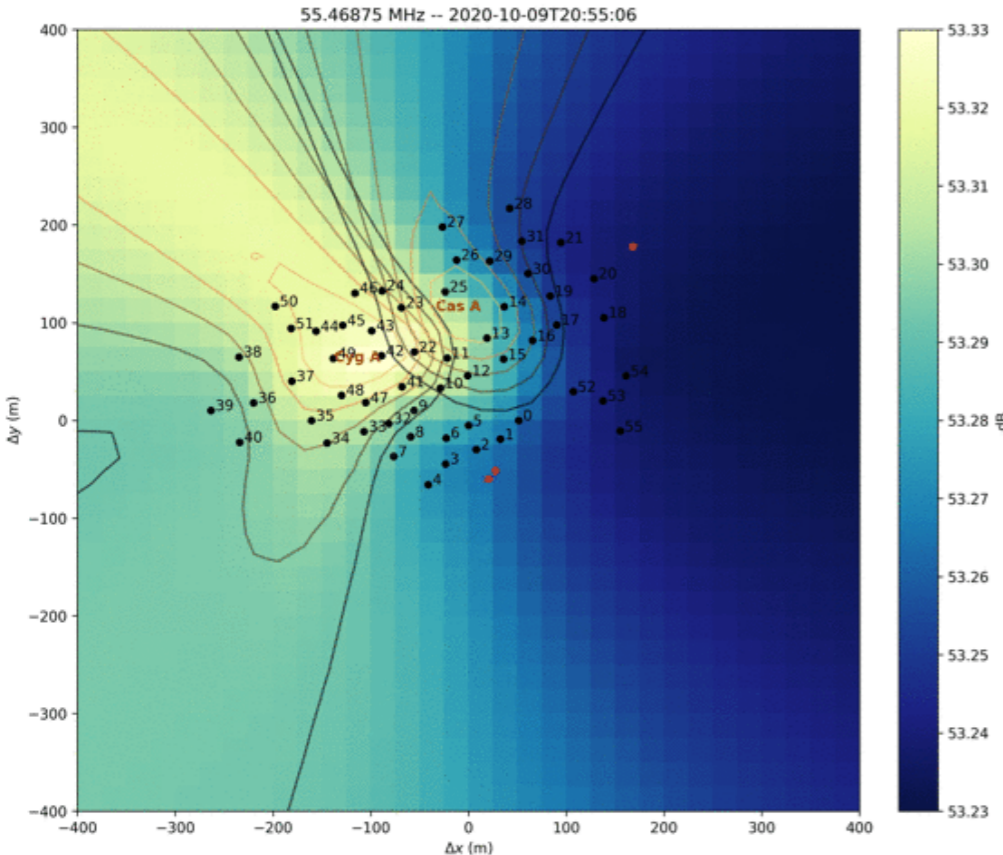
NICKEL correlator : first light (Virgo-A)

NenuFAR Imager Correlation Kluster Elaborated from LOFAR's

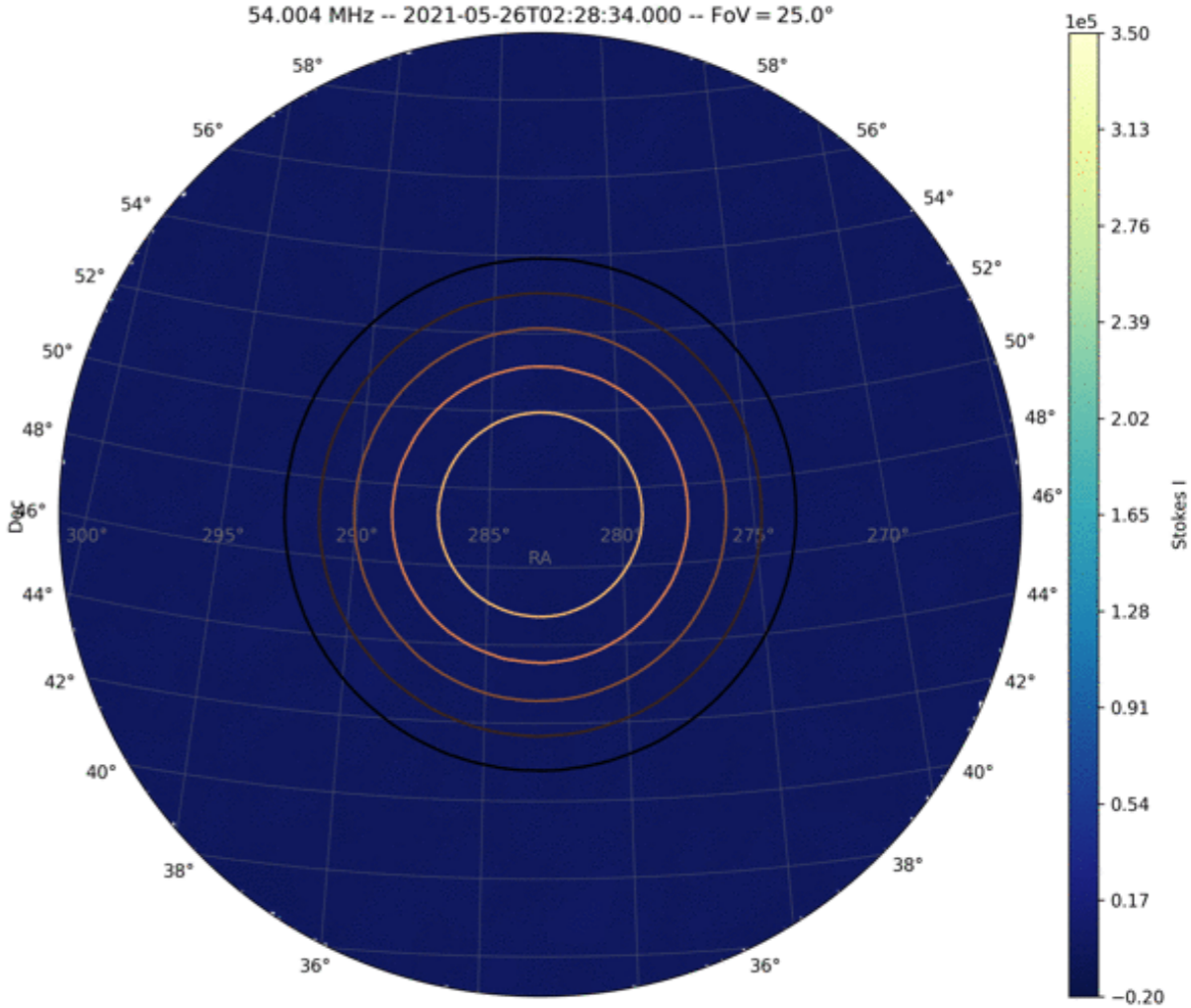


- <https://nenufar.obs-nancay.fr/2021/01/06/premiere-lumiere-du-nenufar-radio-imager/>
- <https://www.astron.nl/dailyimage/main.php?date=20210201>

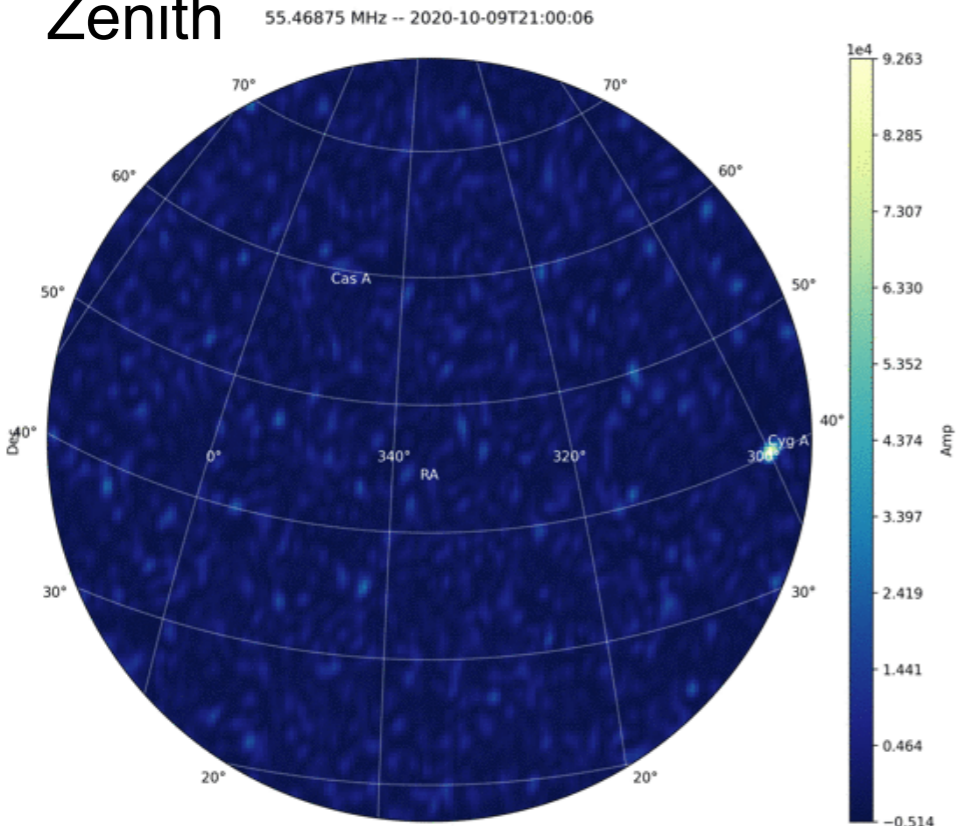
Near-field



Beam

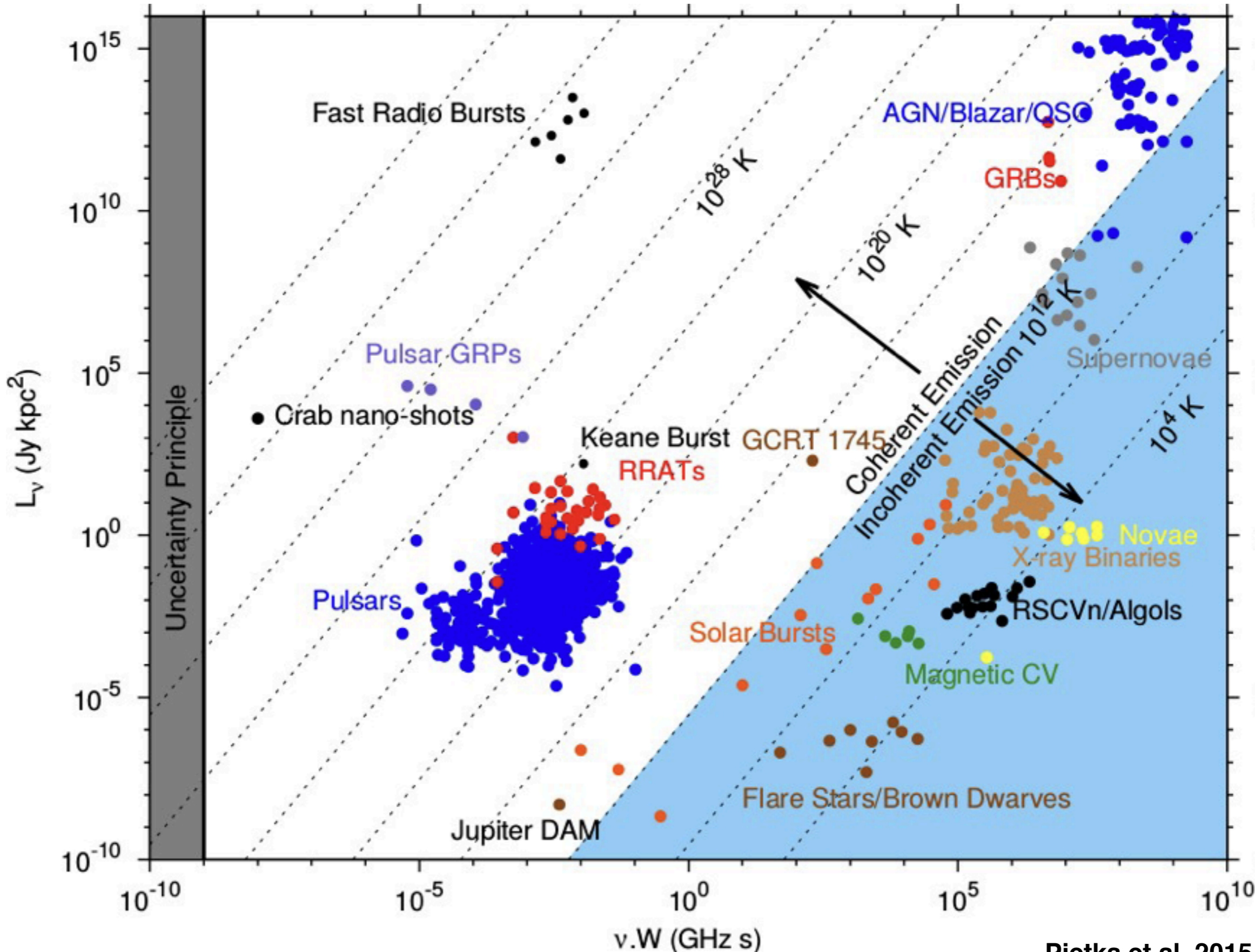


Zenith



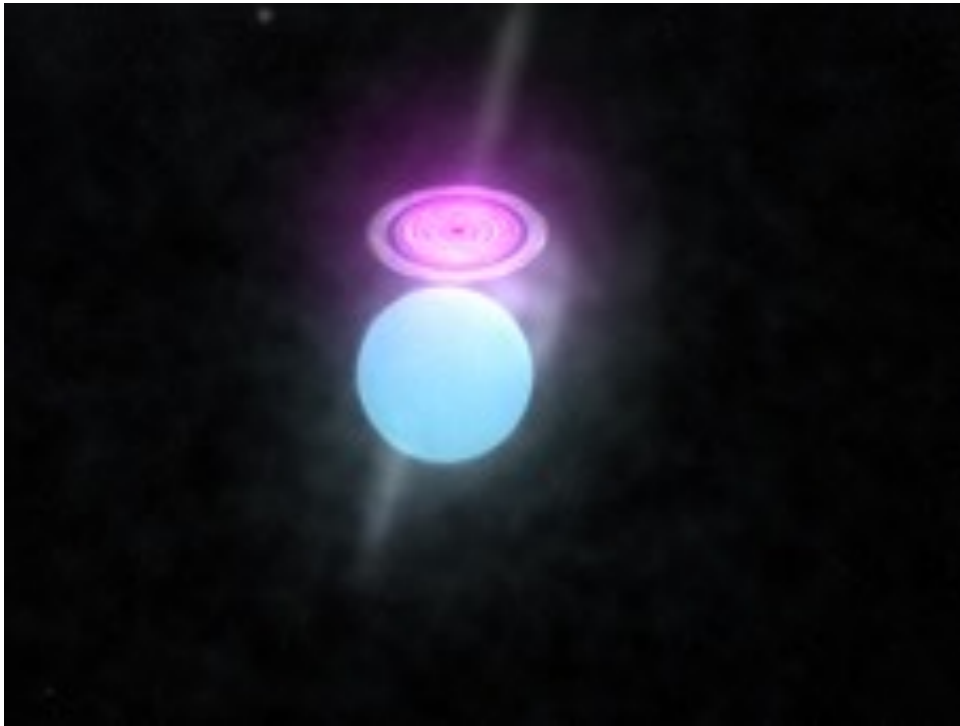
➔ <https://nenufar.obs-nancay.fr/nenufar-tv/>

Transients Luminosity vs. variability timescale



NenuFAR ES04

Early Science Phase - Transient program:



- Monitoring of the Cygnus X region (Cyg X-3, Cyg X-1)
- Developing tools for image plane transient detection and monitoring

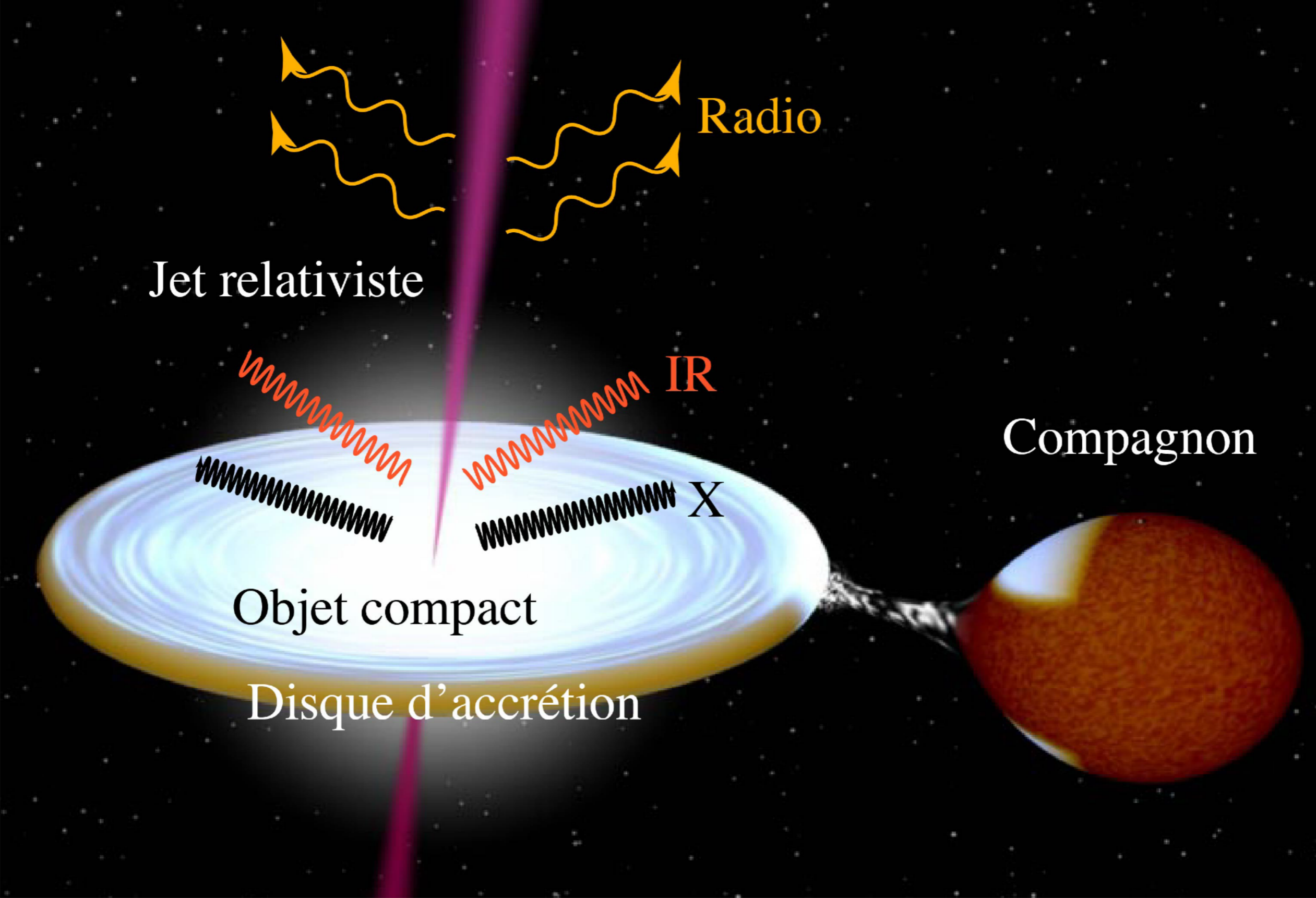
- 2 years of data

~2-4h / month

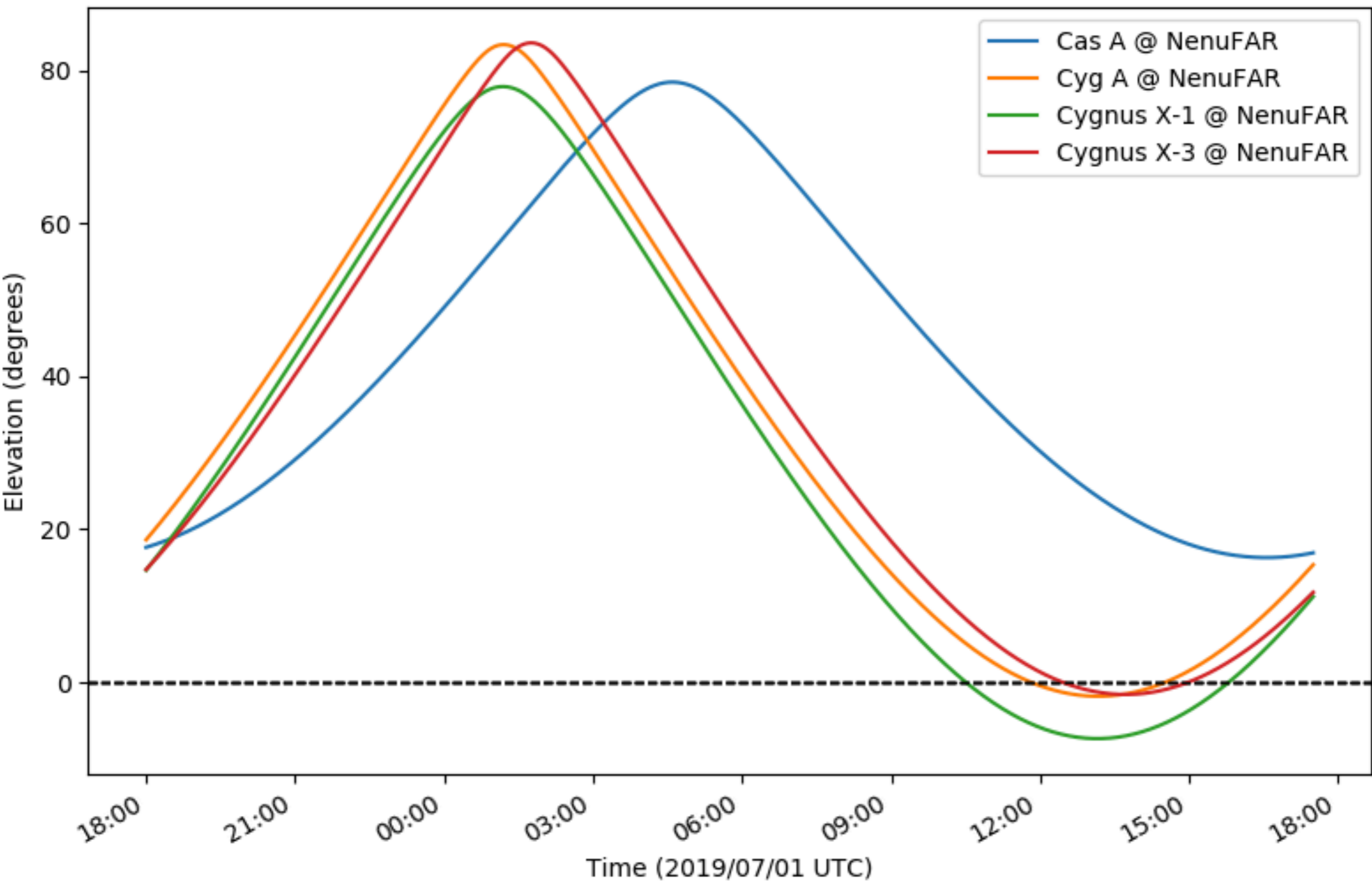
- ToO observations during June 2019 & 2020 & 2021 outbursts
- Simultaneous campaign (Nov 2019)

with INTEGRAL (Cyg X-1) - J. Rodriguez & Potentially
VLA / SMA / JCMT / AMI / Swift / Nicer / SRT - E. Egron

Cyg X-3



Cyg X-3



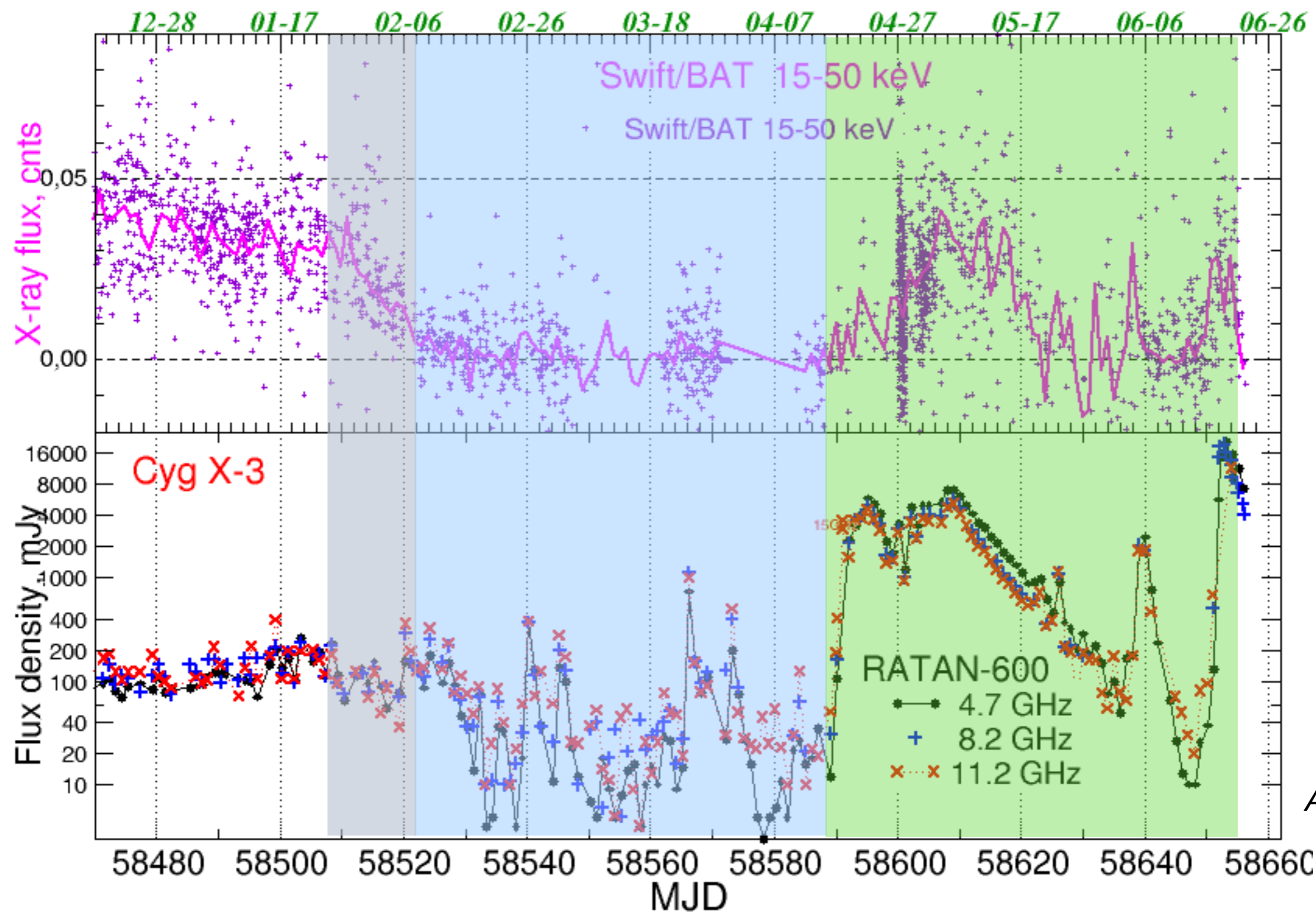
Cyg X-3 May-June 2019 outburst

17-02-2019 Trushkin et al. Cyg X-3 entered a quenched radio state
Hypersoft X-ray state

ATel #12510
~10-30 d

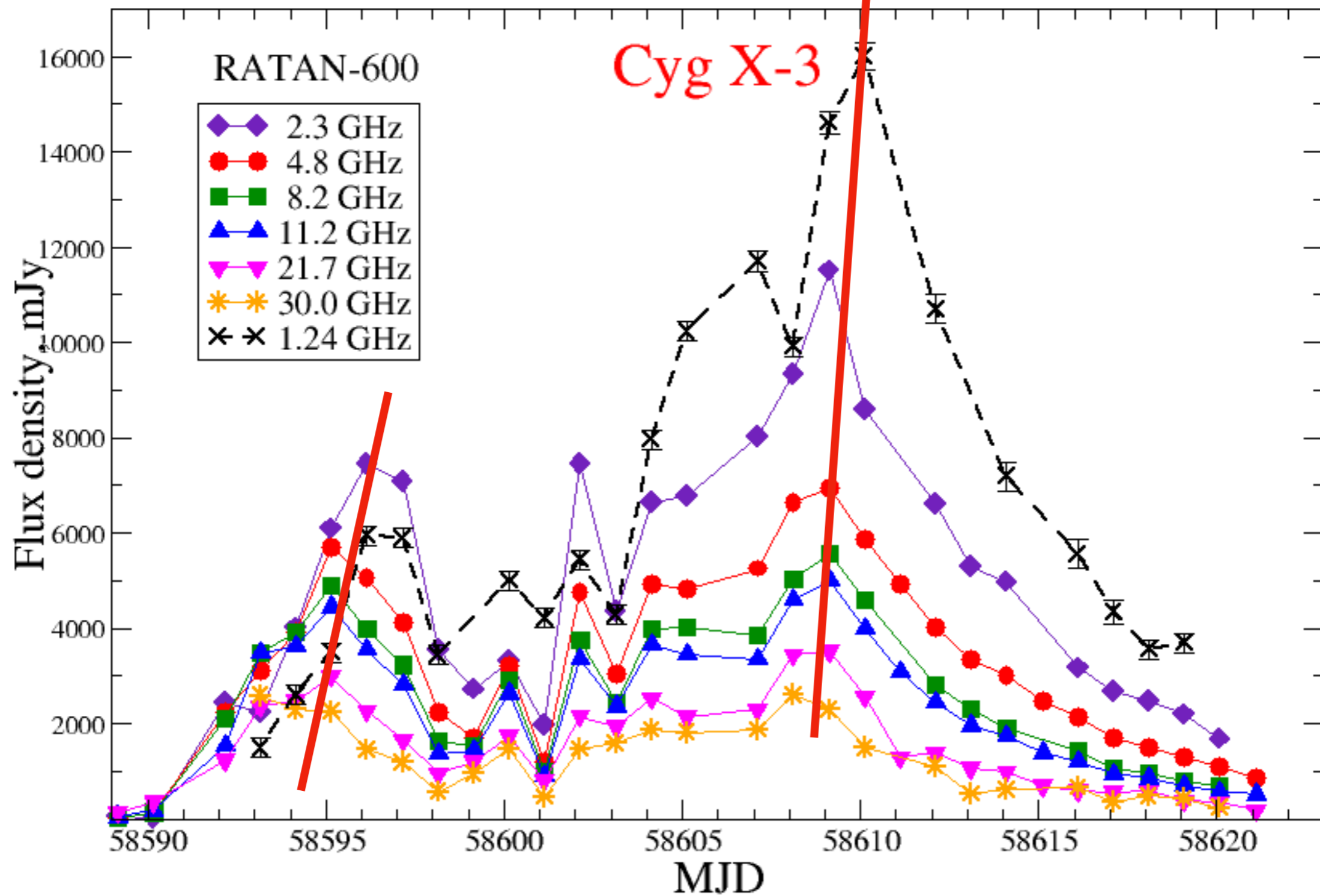
18-04-2019 Koljonen et al. Radio detection at 37 GHz

ATel #12668



ATel #12510

Cyg X-3 May-June 2019 outburst

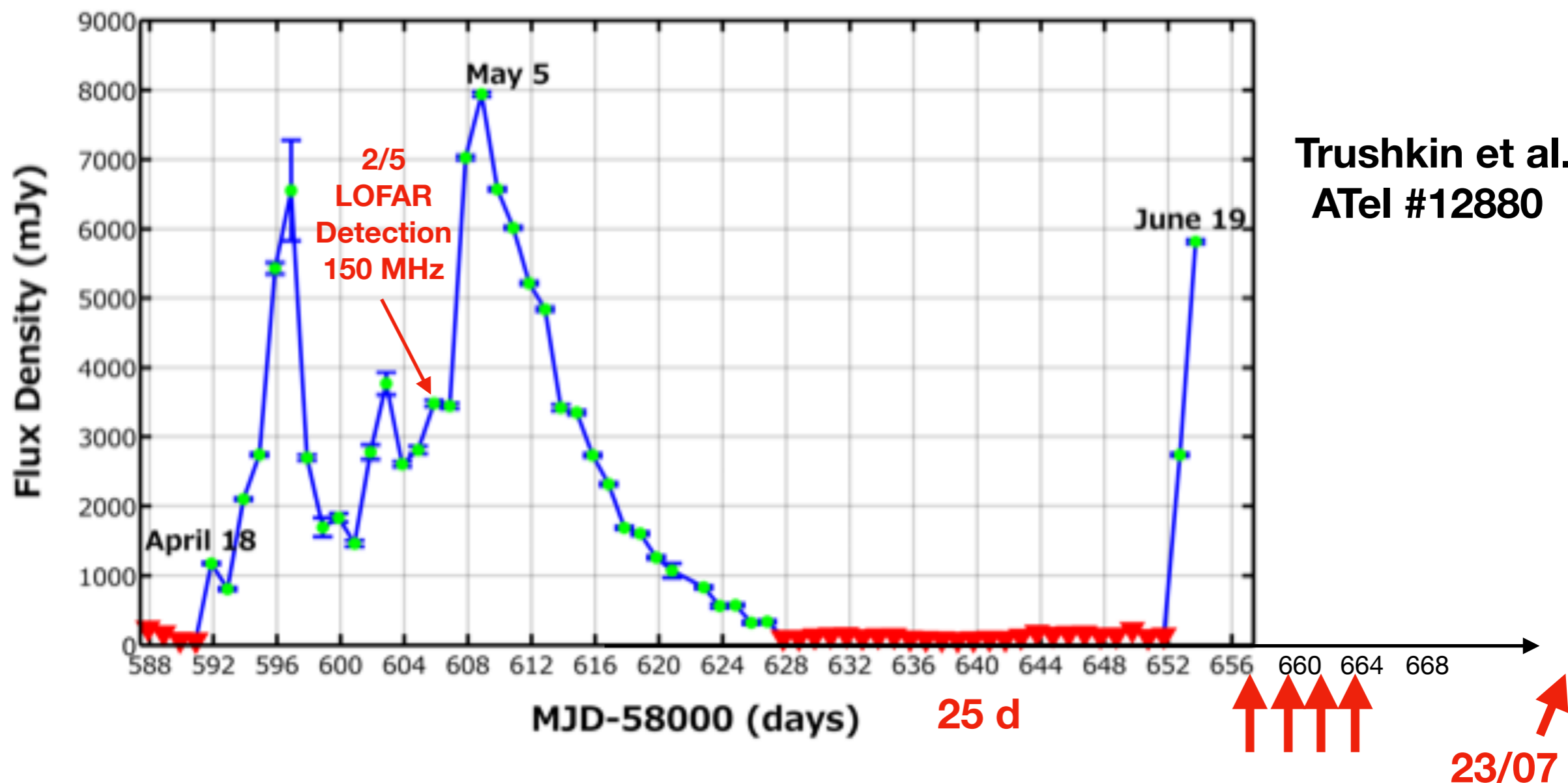


Trushkin et al., ATel #12701

Cyg X-3 May-June 2019 outburst

Cyg X-3 light curve at 1.4GHz (preliminary)

(67 days from: 2019 April 14 22:00 to: June 19 17:37 UTC)



LOFAR

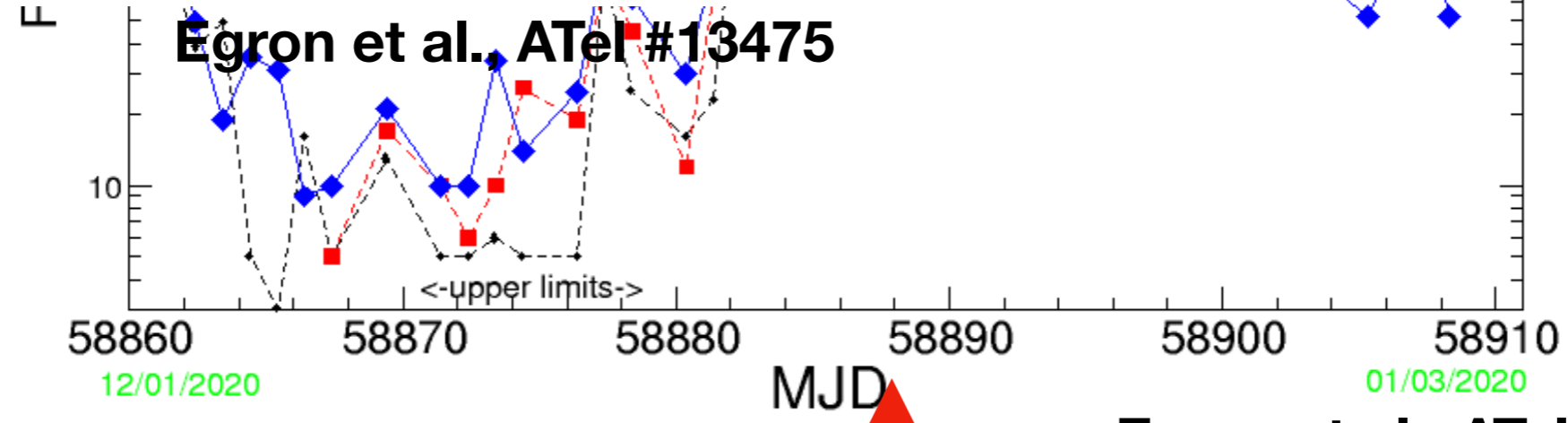
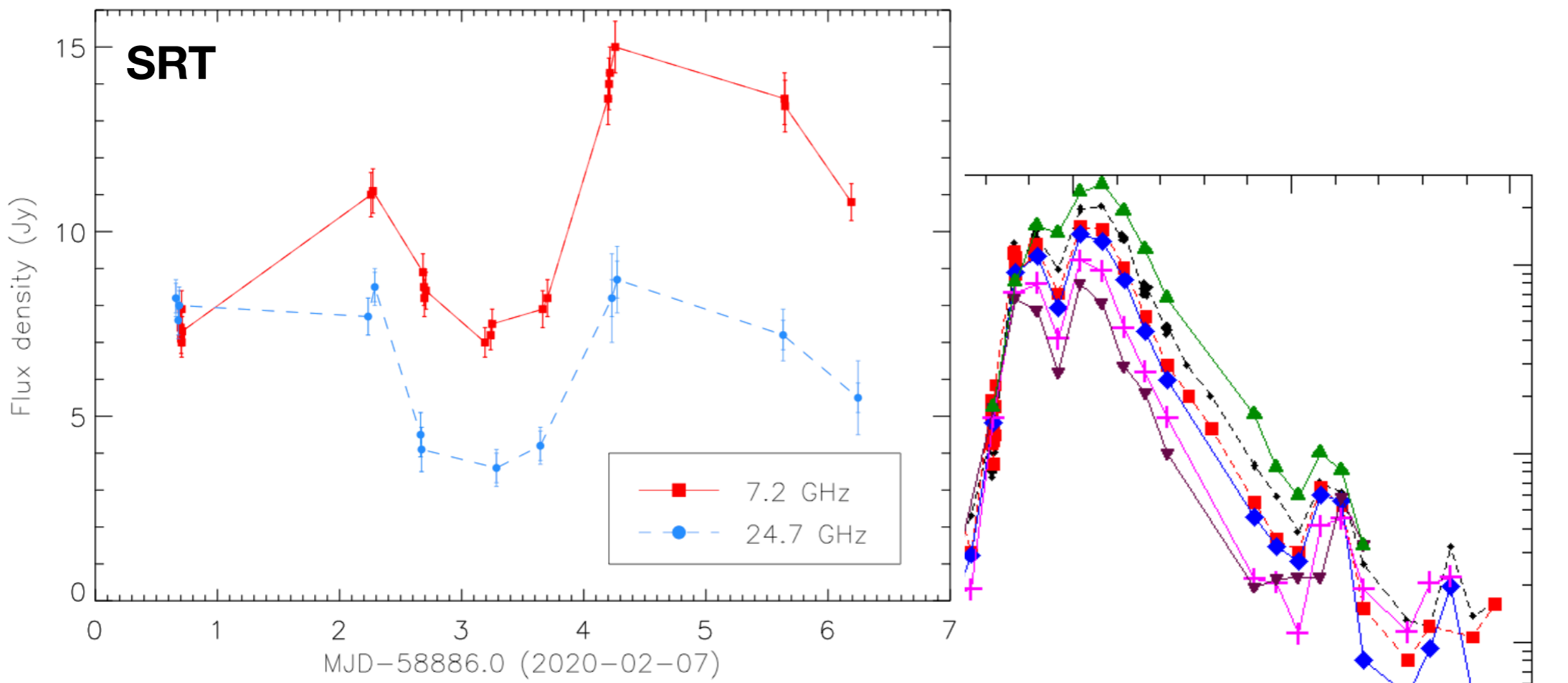
500 mJy - 1.5 Jy

LOFAR observations of the 2019 April–May flaring activity from Cygnus X-3

J. W. Broderick,^{1*} T. D. Russell,² R. P. Fender,³ S. A. Trushkin,^{4,5} D. A. Green,⁶ J. Chauhan,¹ N. A. Nizhelskij,⁴ P. G. Tsybulev,⁴ N. N. Bursov,⁴ A. V. Shevchenko,⁴ G. G. Pooley,⁶ D. R. A. Williams,³ J. S. Bright,³ A. Rowlinson^{2,7} and S. Corbel^{8,9}

¹International Centre for Radio Astronomy Research, Curtin University, GPO Box U1987, Perth, WA 6845, Australia

Cyg X-3 Feb 2020 outburst



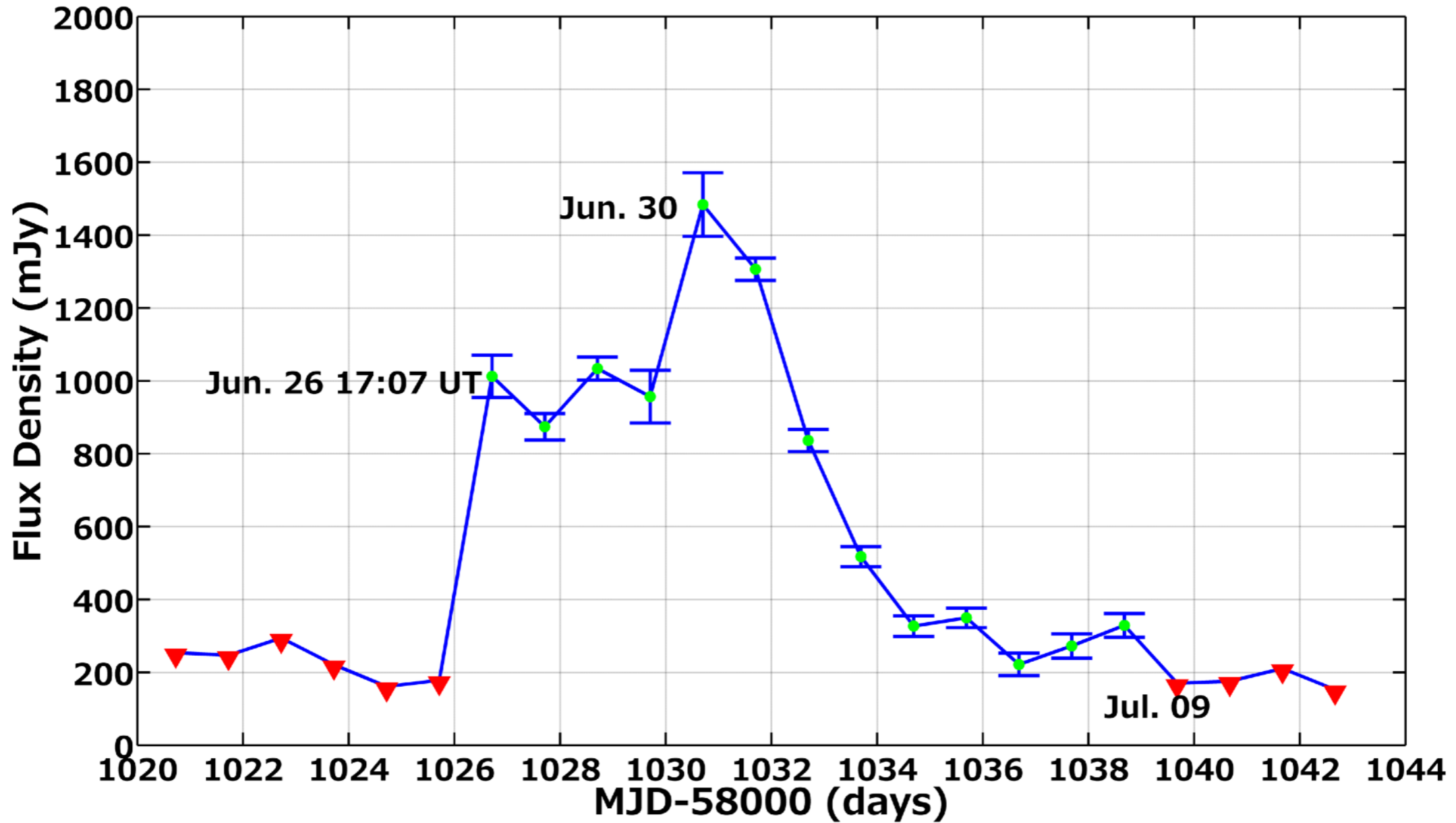
MJD ↑

Egron et al., ATel #13461

Cyg X-3 June 2020 outburst

Cyg X-3 light curve at 1.4GHz (preliminary)

(23 days from: 2020 June 20 17:30 to: July 12 16:03 UT)

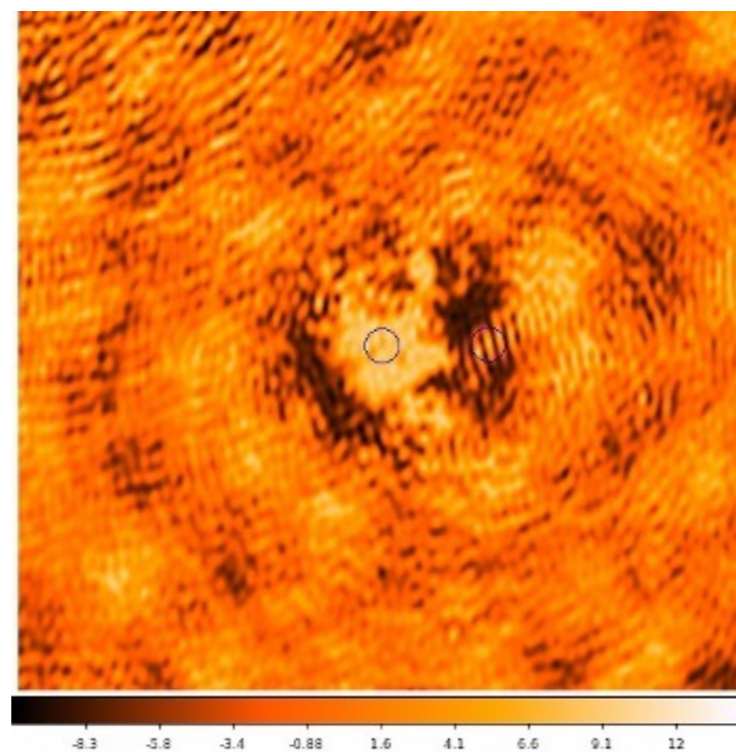
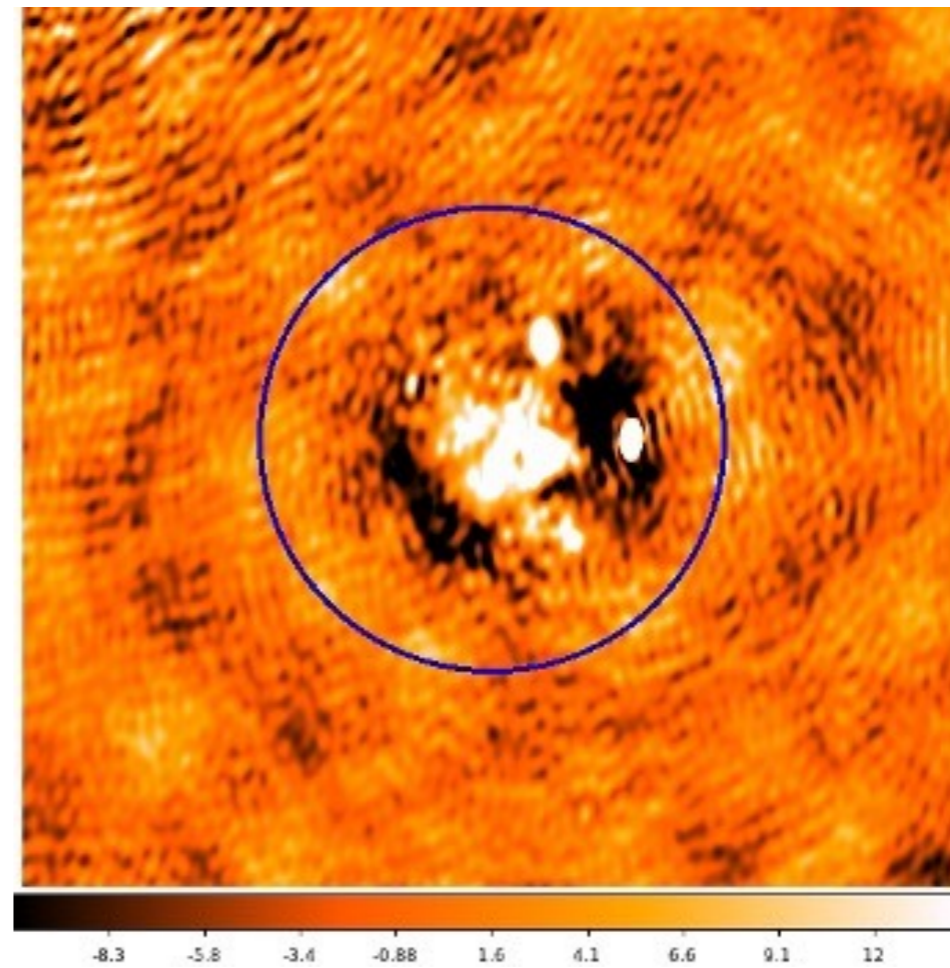
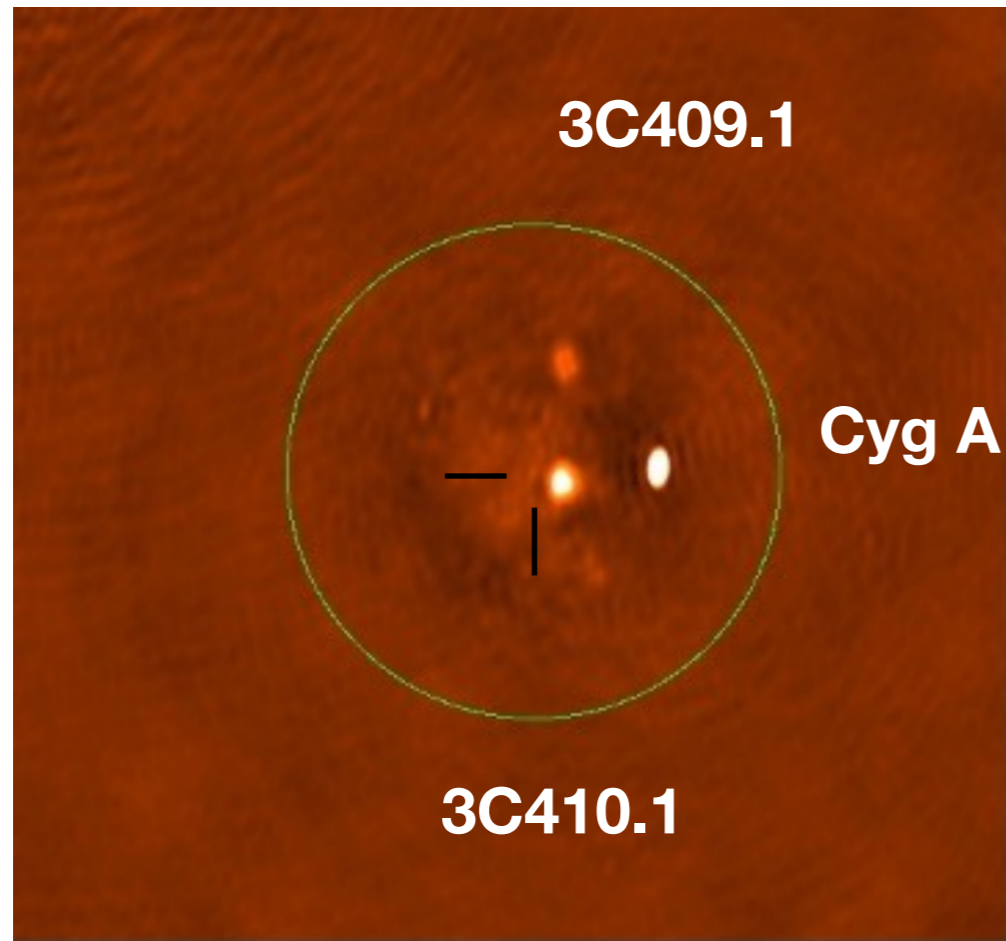


Trushkin et al., ATel #13835

10/6 & 16/6



NenuFAR ToO Observations



Available data & data size

Semester	Obs time requested	Obtained/ Observed	Actually observed	Size on disk (L1)
S1: 06/2018 -> 11/2019	12h	100 %	12h	67 GB (XST)
S2: 12/2019 -> 05/2020	12h	100 %	12h	379 GB (XST)
S3: 06/2020 -> 11/2020	18h	177% (ToO)	32h	28,75 TB* (NRI L0+L1)
S4: 12/2020 -> 05/2021	44 h (24h monitoring + 20 Deep field)	81 %	36h	1.9 TB (NRI)
S5: 06/2021 -> 11/2021	44 h (24h monitoring + 20 Deep field)	86% (to this day)	38h	2,59 TB (NRI)
Total	100 %	130 hr	33,1 TB	

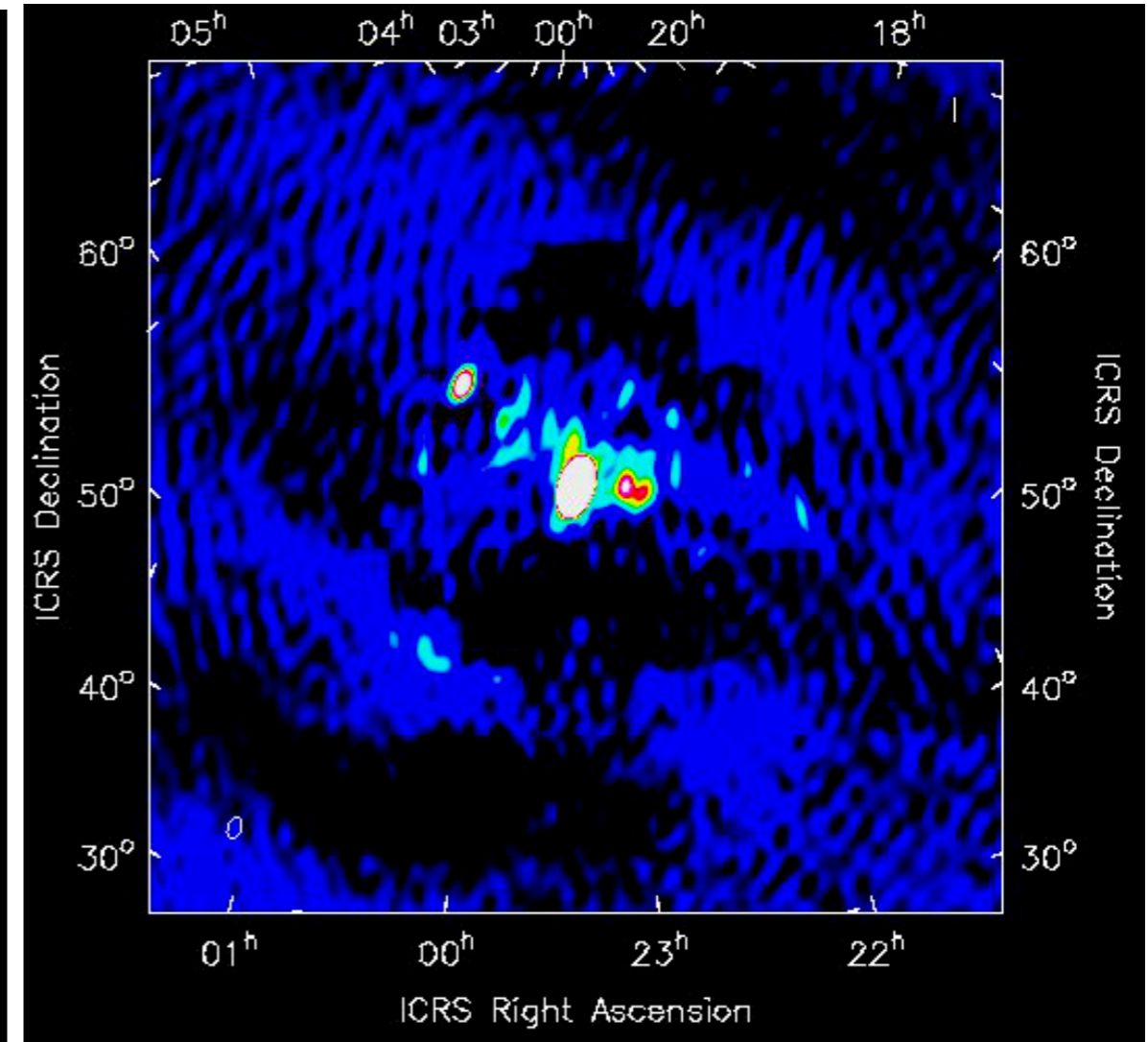
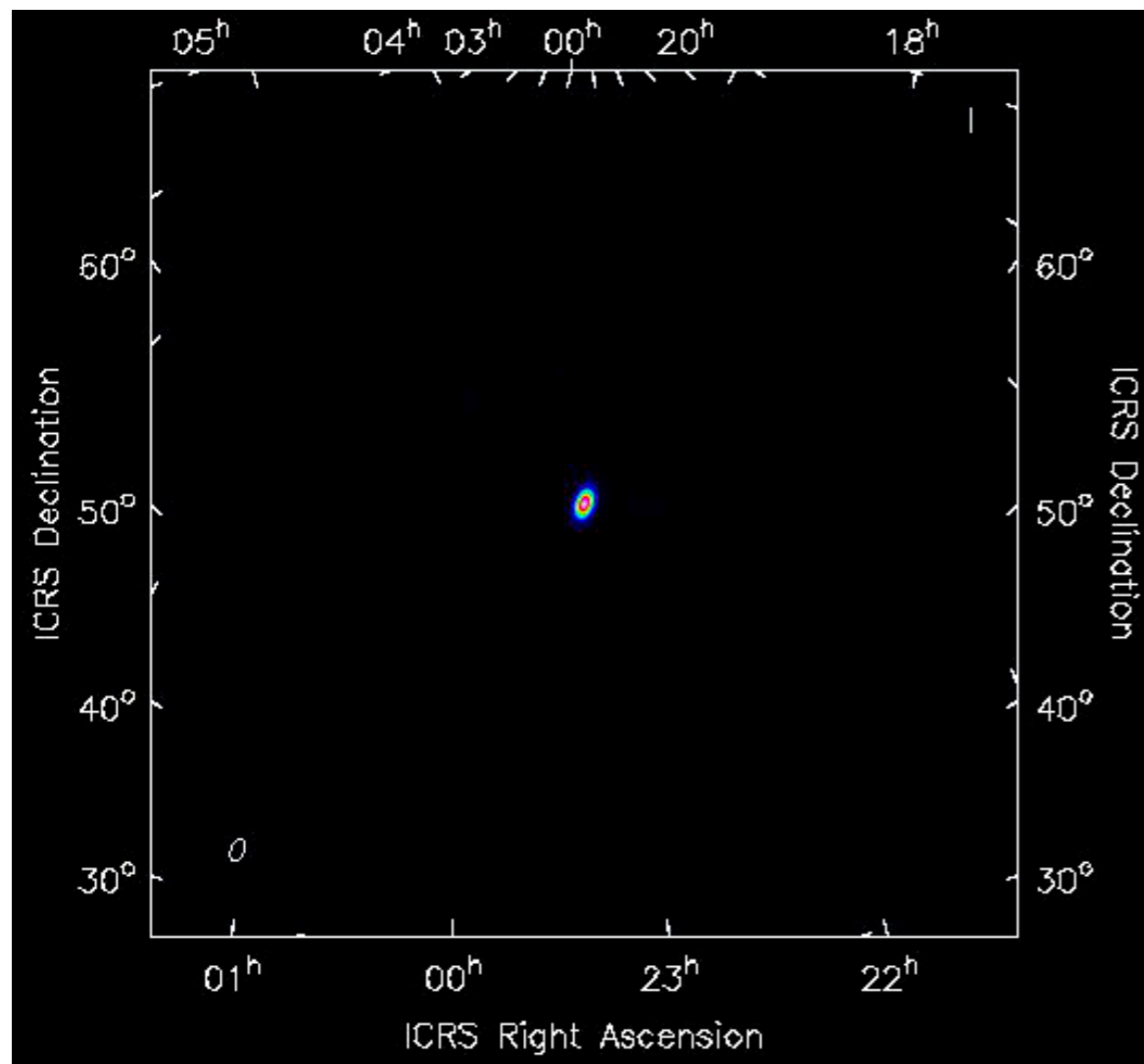
ES04 Priorities

- 1) Assess the data quality in the scope of ES4 program,
- 2) Make a deep, steady model of the Cygnus A region
- 3) Direction-dependent effect calibration and imaging and source peeling

Open to new members to help us with that !

Conclusion for Cyg X-3

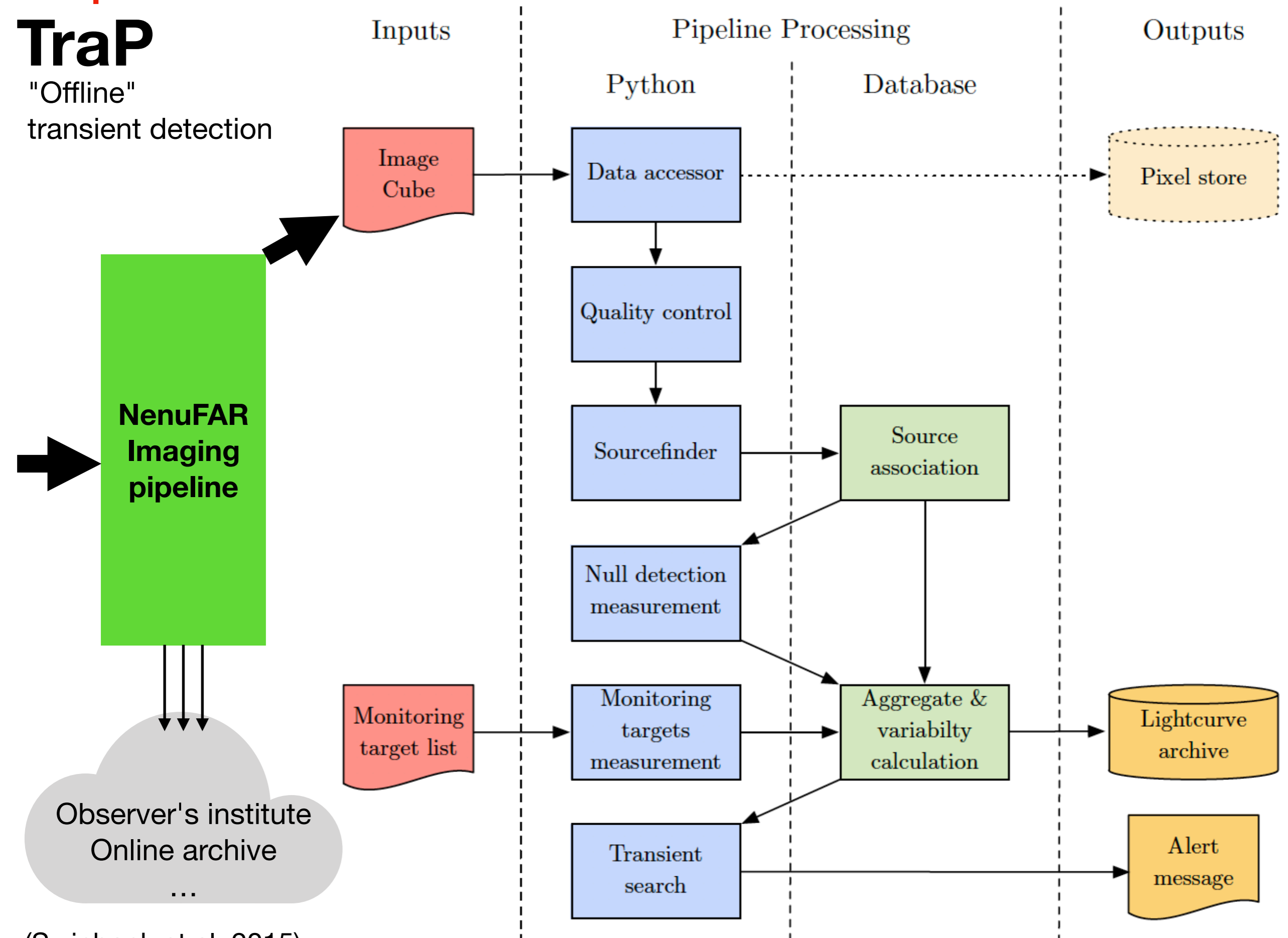
- Spectral turn-over ?
- Angular resolution ($\sim 1.8^\circ \times 0.7^\circ$)
- Strong A team sources to subtract (Cyg A - ~ 17 kJy)
- Confusion limited ($\sim 1-10$ Jy)
- Direction-dependent calibration & peeling



Perspectives

TraP

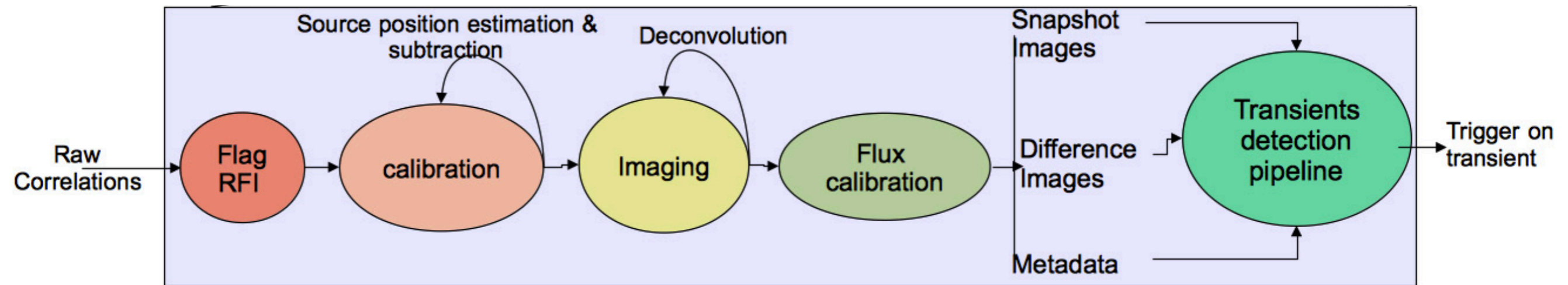
"Offline"
transient detection



(Swinbank et al. 2015)

Near Real-time transient pipeline for NenuFAR ?

AARTFAAC-like ?



(Adapted from Prasad et al., 2014)

