The 2017 INTEGRAL campaign of the Fast Radio Burst FRB121102: results and prospects

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M. Dennefeld - IAP
V. Savchenko - ISDC
+ ….

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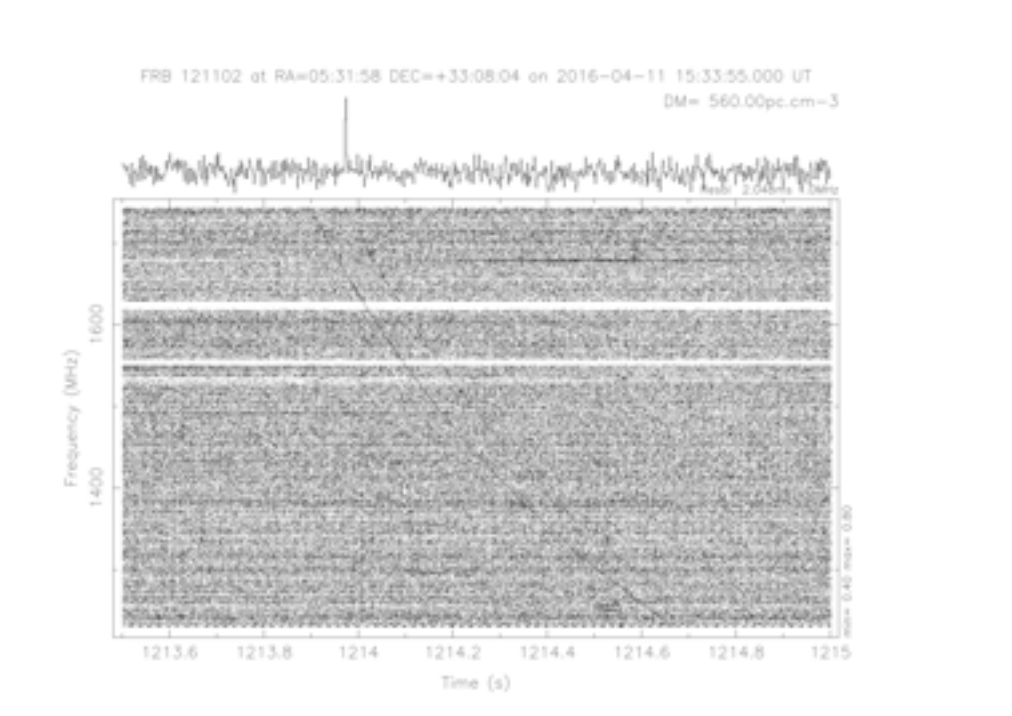
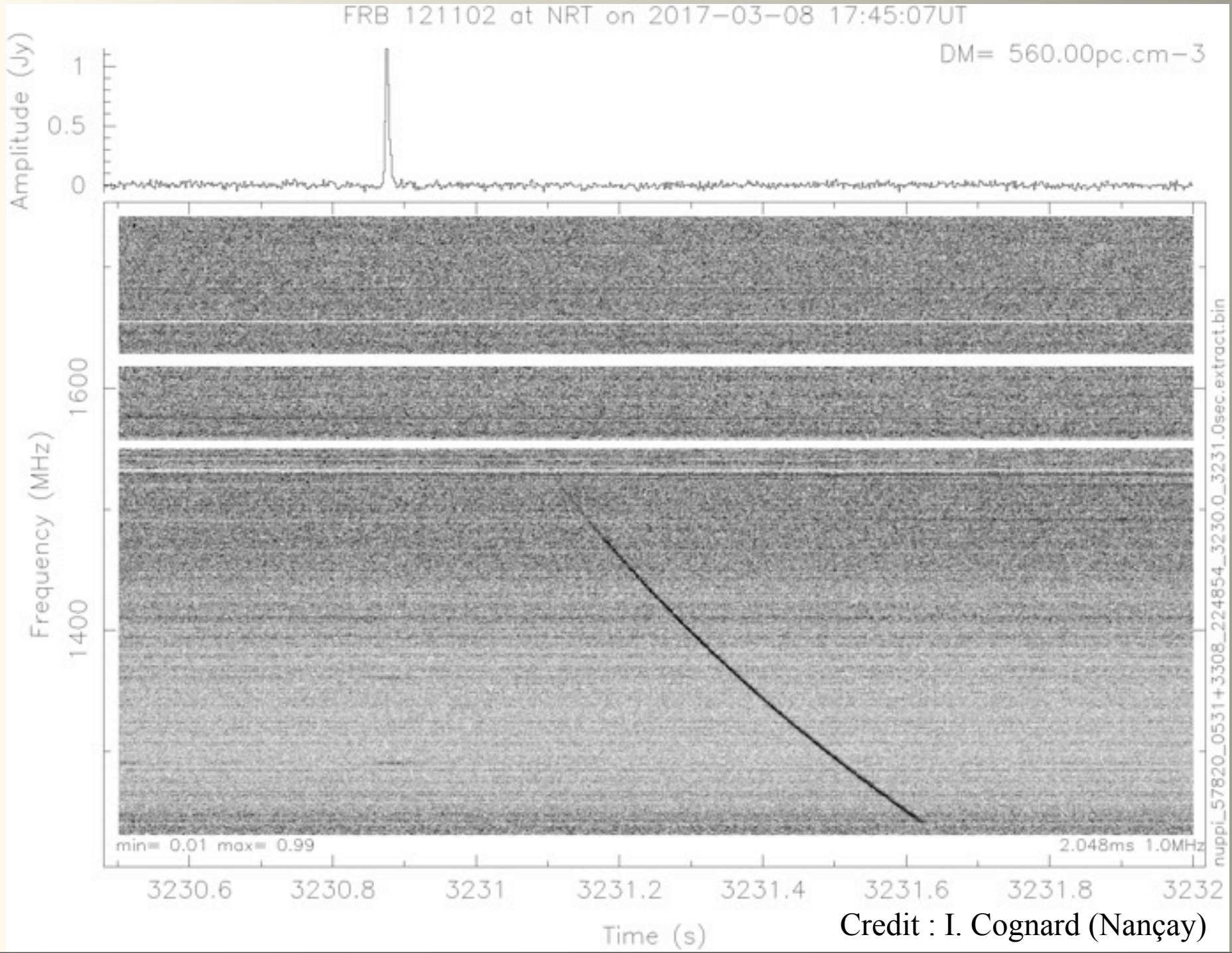
Fast Radio bursts

- Discovered in 2007 (Lorimer burst)
- Bright, short radio pulses
- High dispersion measure (DM)
- Extragalactic origin
- Cataclysmic event ?





Credit : I. Cognard (Nançay)

FRB Catalogue

75 FRBs on 2019, Feb, 11th

This catalogue contains up to date information for the published population of Fast Radio Bursts (FRBs). This site is maintained by the FRBCAT team and is updated as new sources are published or refined numbers become available. Sources can now be added to the FRBCAT automatically via the VOEvent Network, details of this process are given in Petroff et al., 2017. FRBs confirmed via publication, or received with a high importance score over the VOEvent Network, are given 'Verified' status and are shown on the default homepage; to see all events (including unverified candidates received via the VOEvent Network) toggle the "Verified events/All events" button below.

Information for each burst is divided into two categories: observed parameters from the available data, and derived parameters produced using a model. Cosmological values are obtained using the Cosmology Calculator (Wright, 2006). The observed parameters are sometimes either lower or upper limits, due to the limitations of the data acquisition systems. Where multiple fits or measurements of a burst have been made each one is provided as a separate sub-entry for the FRB.

You may use the data presented in this catalogue for publications; however, we ask that you cite the paper (Petroff et al., 2016) and provide the url (http://www.frbcat.org). Any issues relating to the use of the catalogue should be addressed to FRBCAT team (primary contact: Emily Petroff).

An up-to-date CSV file containing all parameters for all FRBs is available at the following stable link: http://www.frbcat.org/frbcat.csv

Visible columns | Verified events | Export to CSV | Search | Clear

	FRB	UTC	Telescope	RAJ	DECJ	gl	gb	DM	Width	S/N
+	FRB180817.J...	2018/08/17 01:49:20.202	CHIME/FRB	15:33	+42:12	68	54	1006.84±0.002	0.37	69.9
+	FRB180814.J...	2018/08/14 14:20:14.440	CHIME/FRB	15:54	+74:01	108	37	238.32±0.01	0.18	29.7
+	FRB180814.J...	2018/08/14 14:49:48.022	CHIME/FRB	04:22	+73:44	136	16	189.38±0.09	2.6	24
+	FRB180812.J...	2018/08/12 11:45:32.872	CHIME/FRB	01:12	+80:47	123	18	802.57±0.04	1.25	19.8
+	FRB180810.J...	2018/08/10 22:40:42.493	CHIME/FRB	11:59	+83:07	125	34	169.134±0.002	0.28	56.7

http://www.frbcat.org (Petroff et al, 2016)

Till 2018, only one repeating Fast Radio Burst : FRB121102

A very brief history of the Fast Radio Burst FRB121102

- ✓ Discovery at Arecibo /PALFA survey, 2012 November 2 (Spitzer et al, 2014)
- ✓ Follow-up Arecibo 10 new bursts detected —> **FRB121102 is a repeating burst** (Spitler et al, 2016)
- ✓ Follow-up: Arecibo, Effelsberg, Green Bank telescope, Lowell telescope, VLA
  ➔ 6 more bursts (Scholz et al, 2016)

N=17 bursts

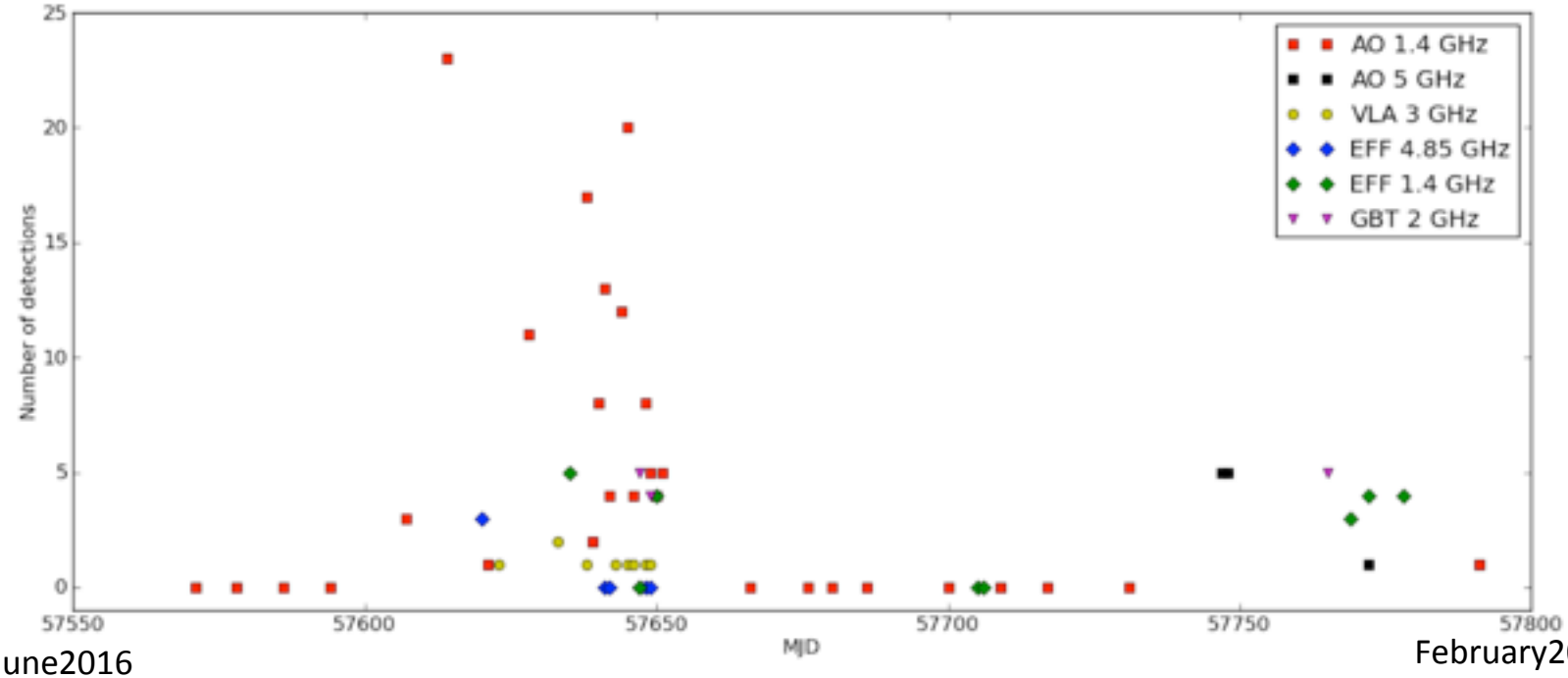
- ✓ VLA follow up: 83h distributed over 6 months ➔ 9 bursts detected in 2016
  + Optical identification of the host galaxy (Chatterjee et al, 2017)
  - accurate localization <100 mas
  - persistent radio and optical counterpart

N=26 bursts

✓ European VLBI networks + 305m-Arecibo telescope : detects both the bursts (4) and persistent radio emission at millisecond angular scale, persistent radio source less than 0.7 pc (Marcote at al, 2017)

N=30 bursts

✓ Gemini + GMOS Optical observation : low-metalicity dwarf galaxy at z=0.192, Persitent radio source offset by 200 mas from the galaxy's center
No optical signatures for AGN activity (Tendulkar et al, 2017)



June2016

February2017

(Spitler, private com.)

Many theoretical models proposed for FRB121102

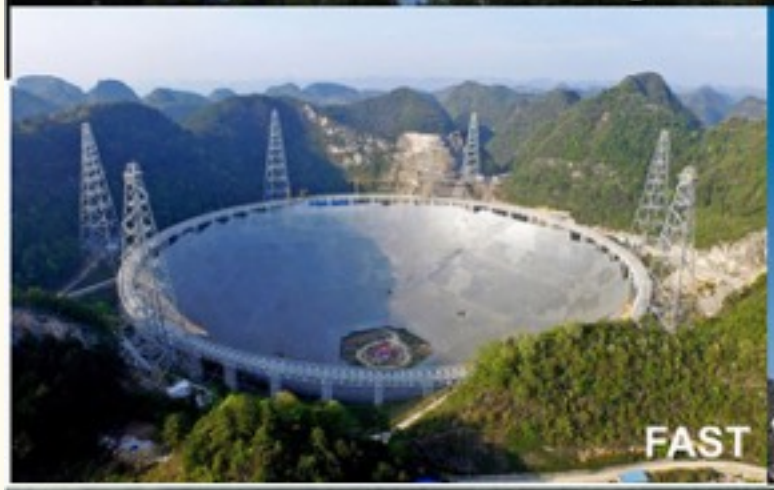
- Collapses of supra-massive neutron star into black hole (Falcke et al, 2014, Zhang et al, 2014)
- Magnetar pulse-wind interactions (Lyubarsky, 2014)
- Charged black hole binary mergers (Zhang et al, 2016)
- Giant pulse emissions from pulsars (Cordes et al, 2016)
- Giant flares from magnetars (Katz at al, 2014, Kulkarni et al, 2014, Pen et al, 2015)
- Unipolar inductor model (Wang et al, 2016)
- Double neutron stars mergers (Totani et al, 2013)
- Encontering of many asteroids with a highly magnetised pulsar (Dai et al, 2016)
- Radio emissions from pulsar companions (Mottez et al, 2014)
- Magnetic energy release in magnetar magnetosphere (Katz J.I, 2016)
- Extreme environment : ‘‘An extreme magneto-ionic environment associated with fast radio burst source FRB121102.’, Michilli et al, *Nature*, January 11th, 2018 : Polarization (nearly 100%) → emission close to a massive black hole or within a very powerful nebula
- …

Several arguments to search for a counterpart/afterglow of FRB's in lambda ≠ radio

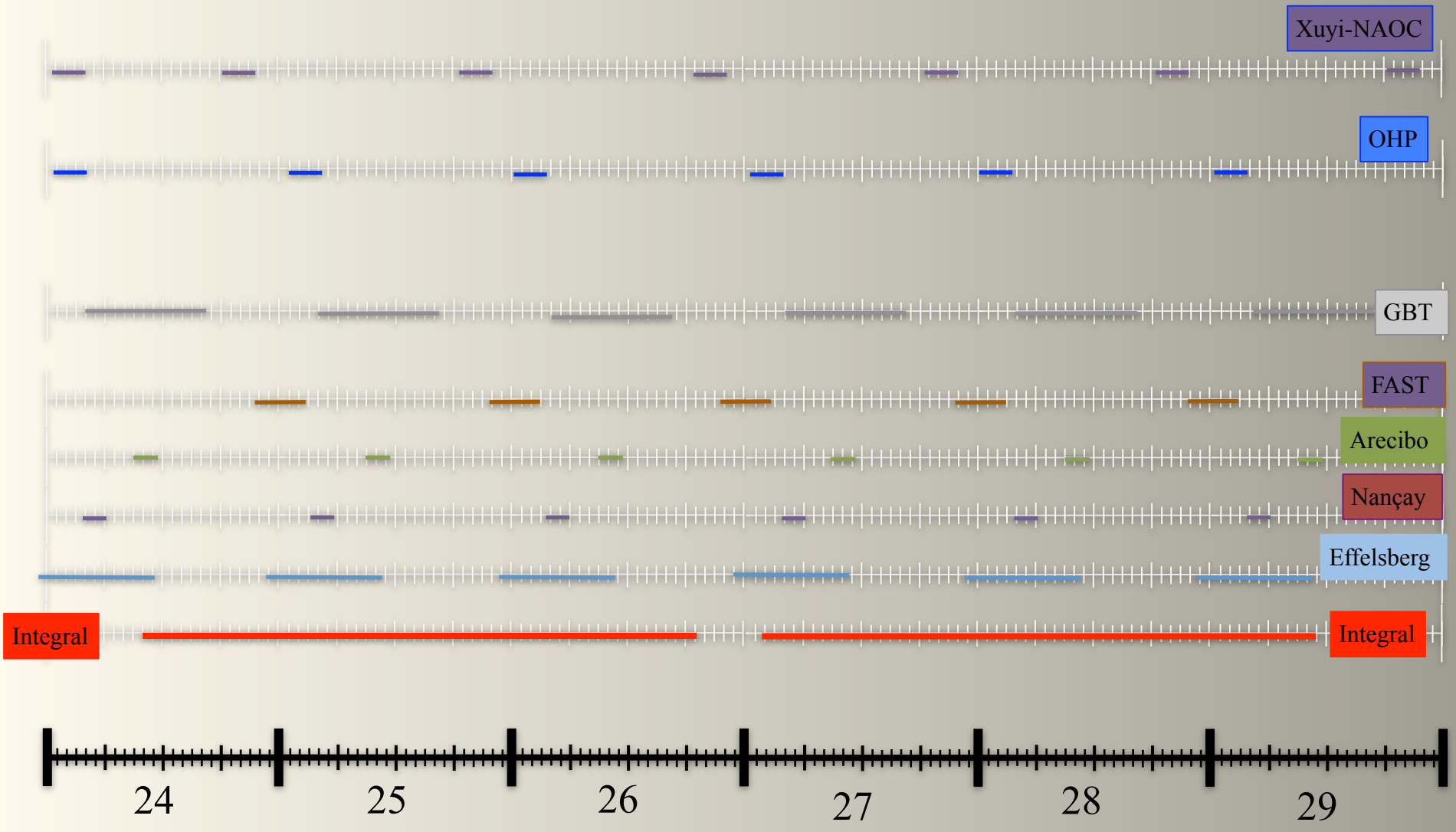
- Important to look for afterglow
- Several models predict extended gamma-ray emission (Murase et al, 2017)
- Search for the host galaxy when possible (precision of the localization)
- A possible afterglow detected by Swift/BAT from FRB131104 (Delaunay et al, 2016)

Two orbits allocated late September 2017, multi-lamda campaign organized

Several facilities involved



INTEGRAL : 2 orbits



The optical/radio campaign (planned)

Several facilities involved
BUT….


Effelsberg telescope


OHP


Arecibo telescope


FAST


GBT


NRT : Nançay Radio Telescope

J.-P. Letourneur, CRDP Orléans


Arecibo telescope

But Nature sometimes not very cooperative :

- Hurricane Maria
- Nançay technical problem


NRT : Nançay Radio Telescope

J.-P. Letourneur, CRDP Orléans

Radio coverage

- **Effelsberg** (Laura Spitler)

1. 2017-09-24 23:17:54.000 UTC to 2017-09-25 08:19:17.000 UTC
2. 2017-09-25 23:19:57.000 UTC to 2017-09-26 08:21:20.000 UTC
3. 2017-09-26 23:28:52.000 UTC to 2017-09-27 08:06:42.000 UTC
4. 2017-09-27 23:26:49.000 UTC to 2017-09-28 05:27:48.000 UTC

- **GBT** (Ryan S. Lynch)

Sept 24 10:45 -- 14:00 UT
Sept 25 06:00 -- 08:00 UT
Sept 25 10:45 -- 17:45 UT
Sept 26:05:45 -- 08:30 UT
Sept 27 06:00 -- 08:30 UT
Sept 27 10:45 -- 18:00 UT
Sept 28 06:00 -- 08:30 UT

- **FAST** (Lei Qian)

20170929 06:45-07:45 —> UT 2018 09 28 22h45-23:45
20170928 07:43-07:55 —> UT 2018 09 27 23h43-23h55
20170926 07:00-08:00 —> UT 2018 09 25 23h00-24h00
20170925 07:25-08:00 —> UT 2018 09 24 23h25-24h00

VHE complementary observations

(thanks to support from Fabian Schussler, CEA)

- **MAGIC (**susumu.inoue@riken.jp)

24-25.9.2017 02:34 - 04:35 UT
25-26.9.2017 02:30 - 04:28 UT
26-27.9.2017 02:27 - 04:25 UT
27-28.9.2017 02:23 - 04:21 UT

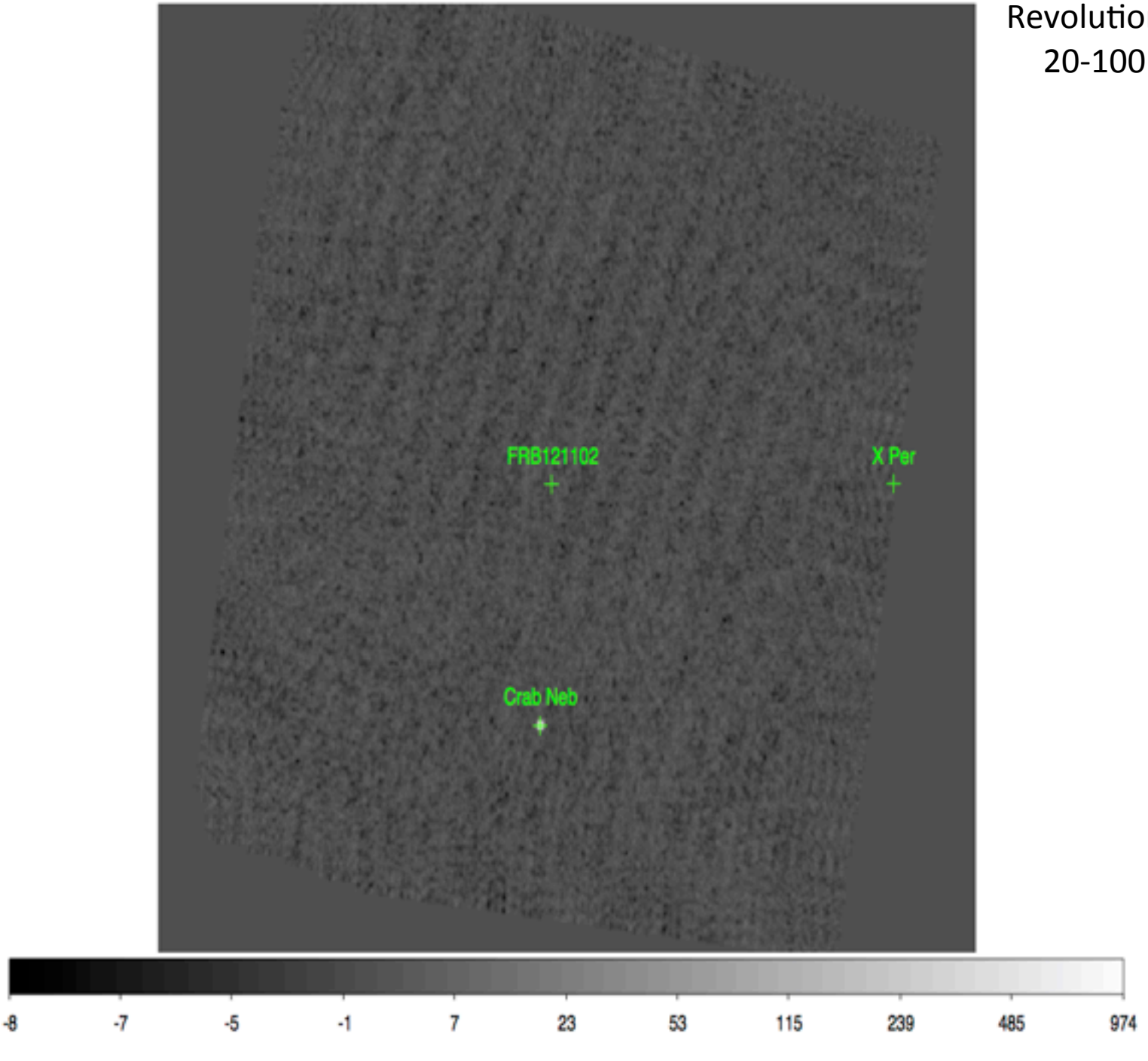
- **VERITAS** (ralph.bird.1@gmail.com)

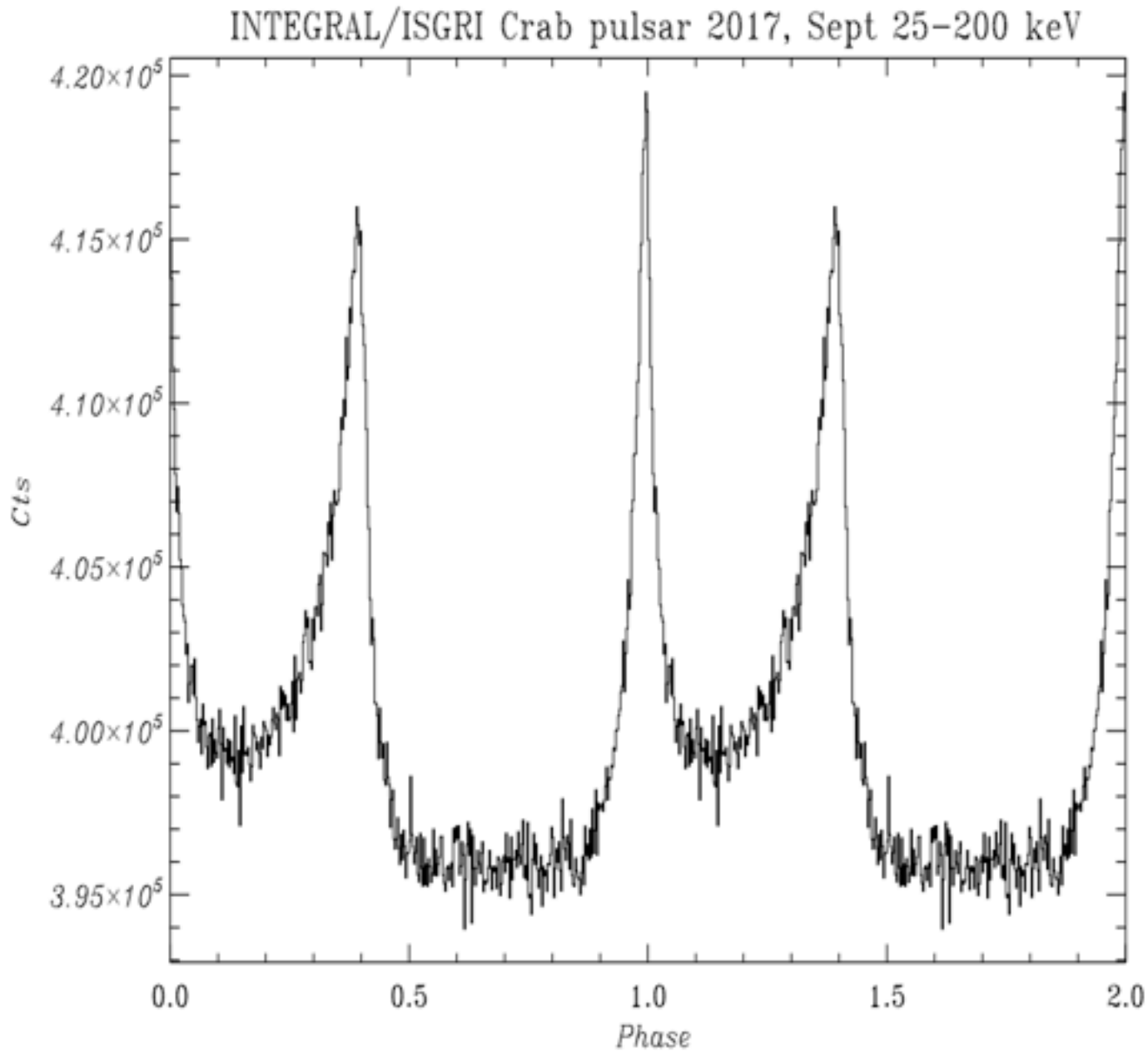
09/25 10:45-12:00 UT
09/27 10:45-11:45 UT

- **HESS** (fabian.schussler@cea.fr)

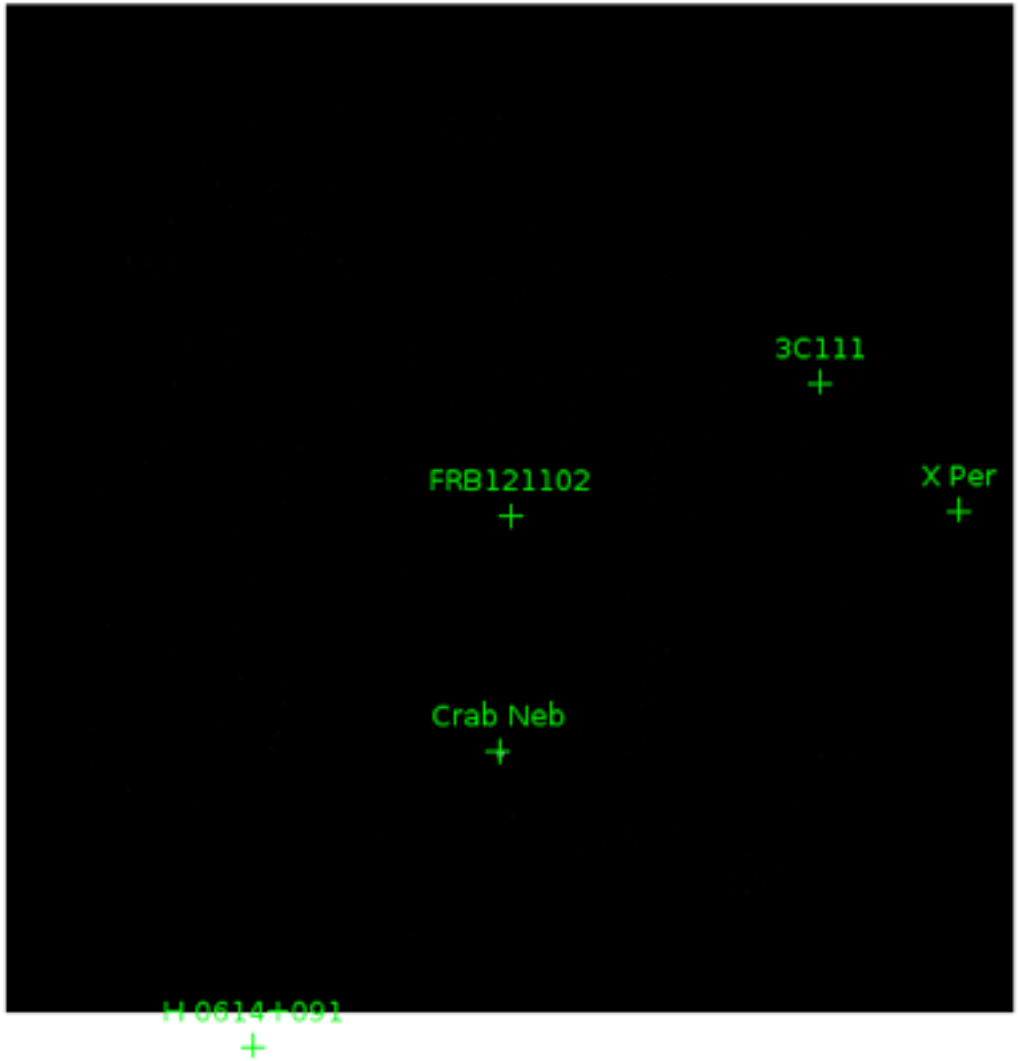
26/27 Sep 2017: 2:29 - 3:22 (~2min gap at 02:57)
27/28 Sep 2017: 2:20 - 3:17 (~2min gap at 02:48)

Revolution 1867
20-100 keV



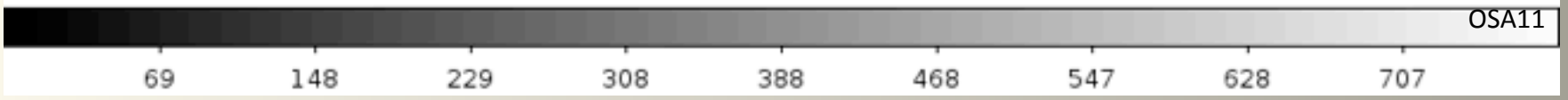

INTEGRAL/ISGRI Crab pulsar 2017, Sept 25-200 keV
4.20×10^5
4.15×10^5
4.10×10^5
4.05×10^5
4.00×10^5
3.95×10^5
Cts
0.0
0.5
1.0
1.5
2.0
Phase

INTEGRAL/Isgri 2017, Sept 24-26 (Rev. 1866) 20-40 keV

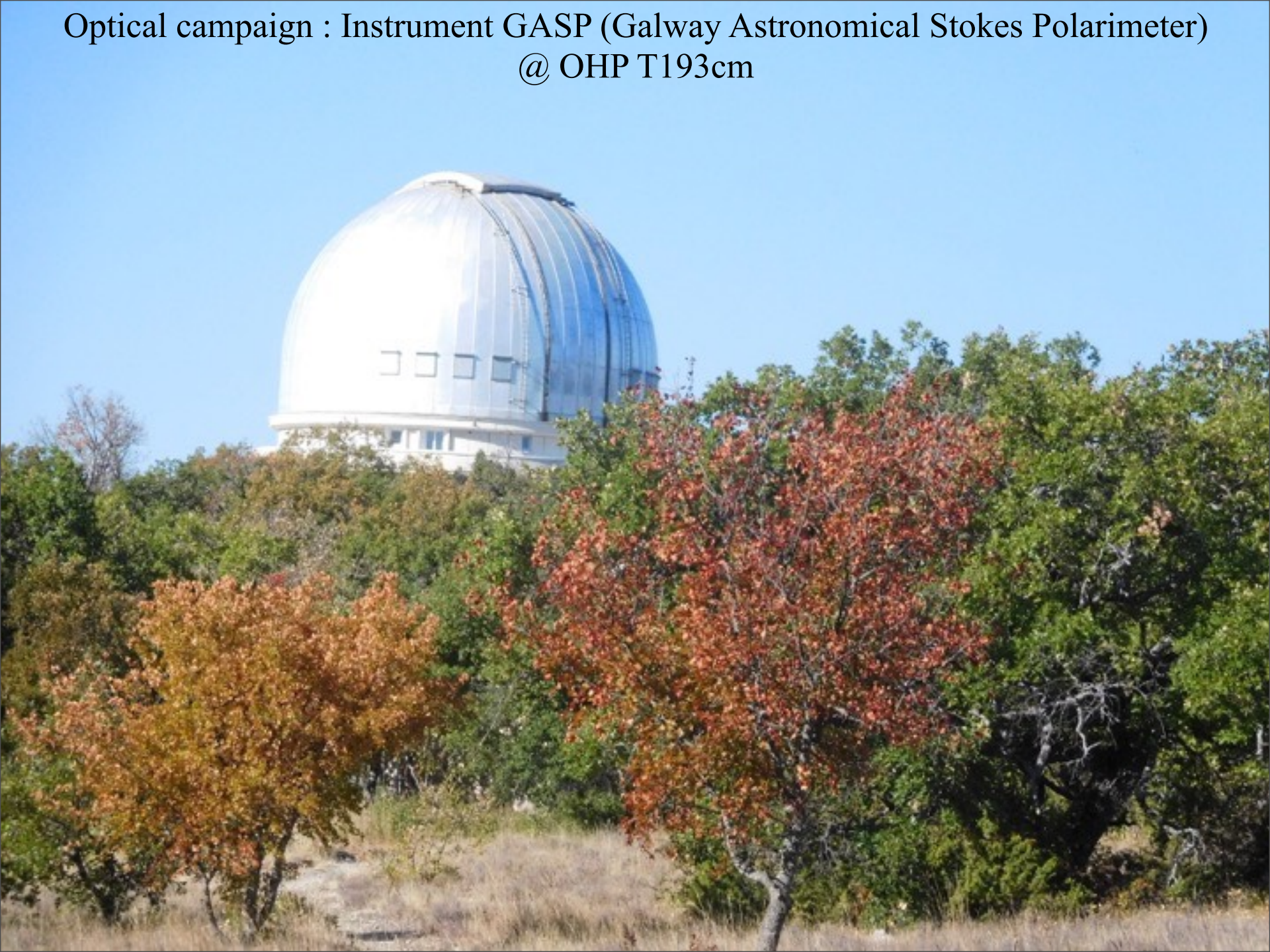


20 – 40 keV : 0.95 sigma
40 – 60 keV : 1.01 sigma
60 – 100 keV : -0.22 sigma
100 – 200 keV : 0.55 sigma

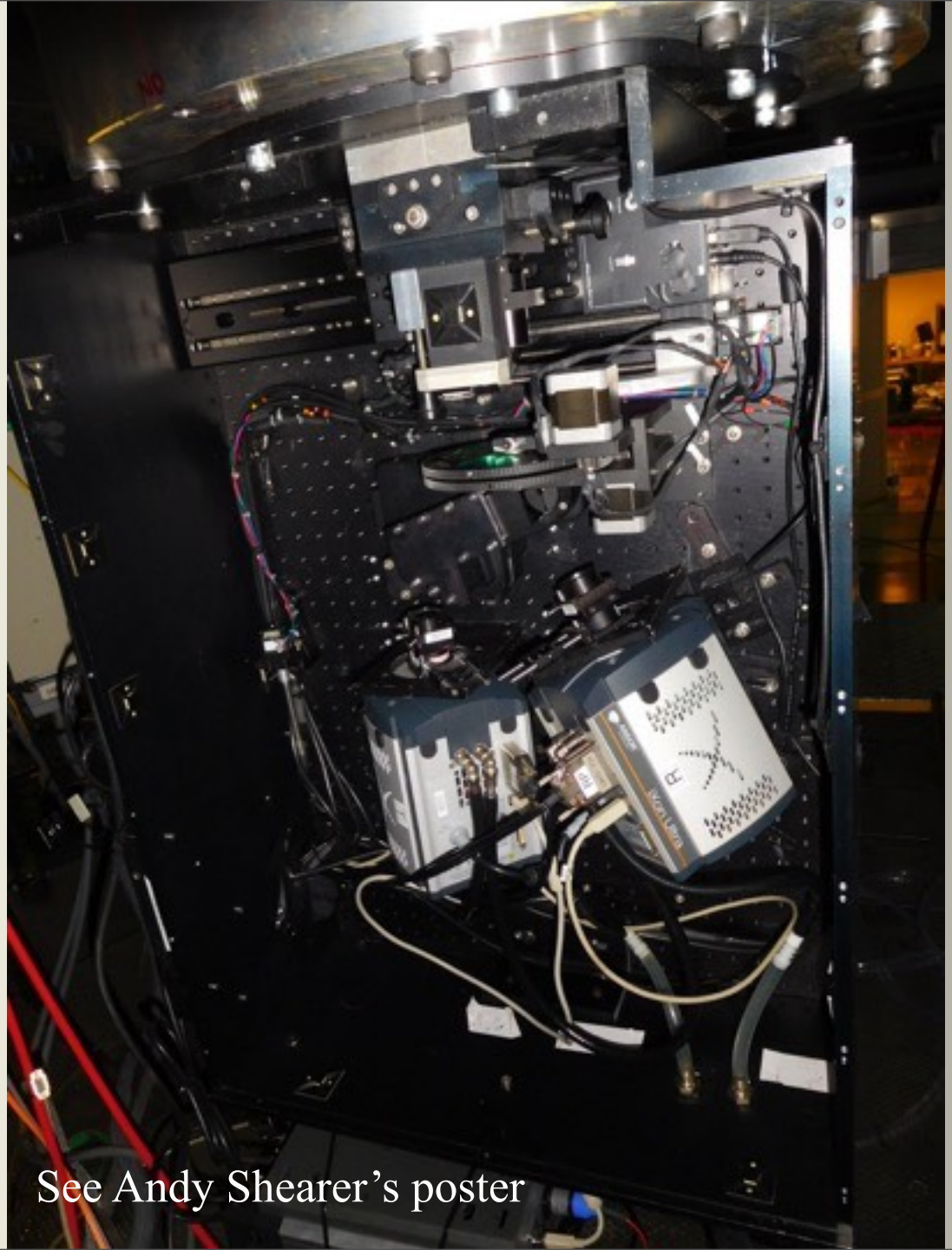
OSA11



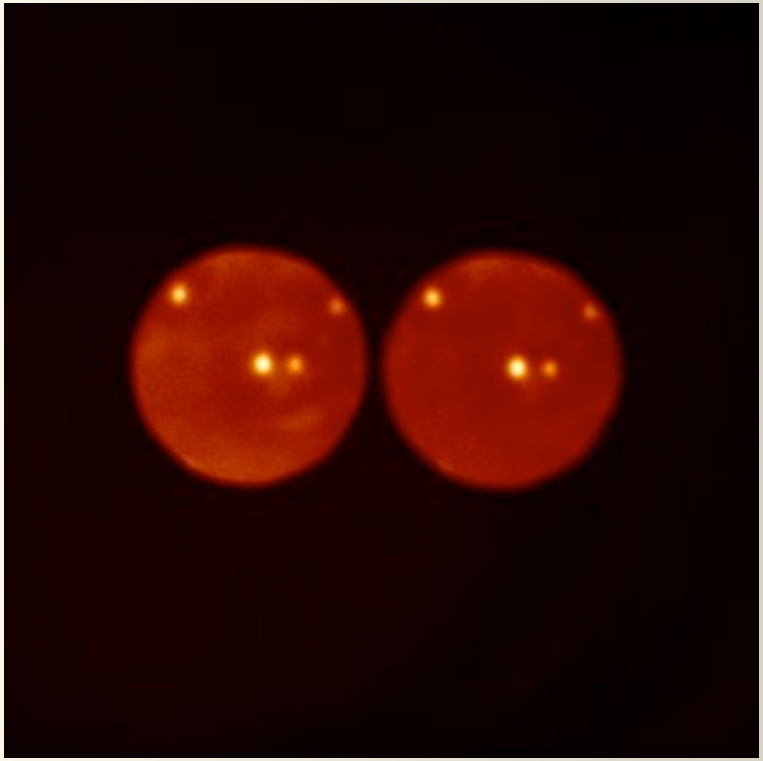
Optical campaign : Instrument GASP (Galway Astronomical Stokes Polarimeter)
@ OHP T193cm

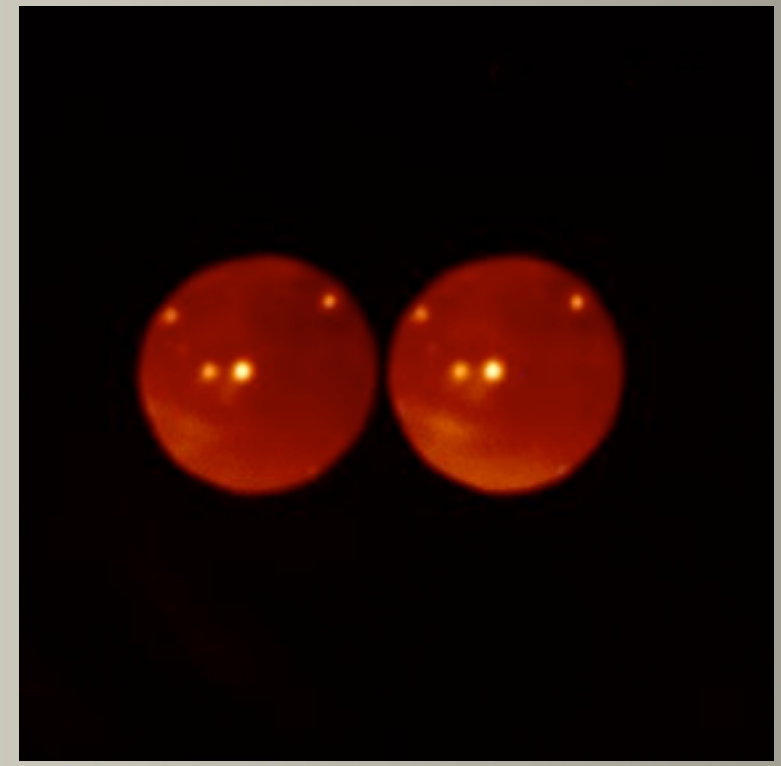


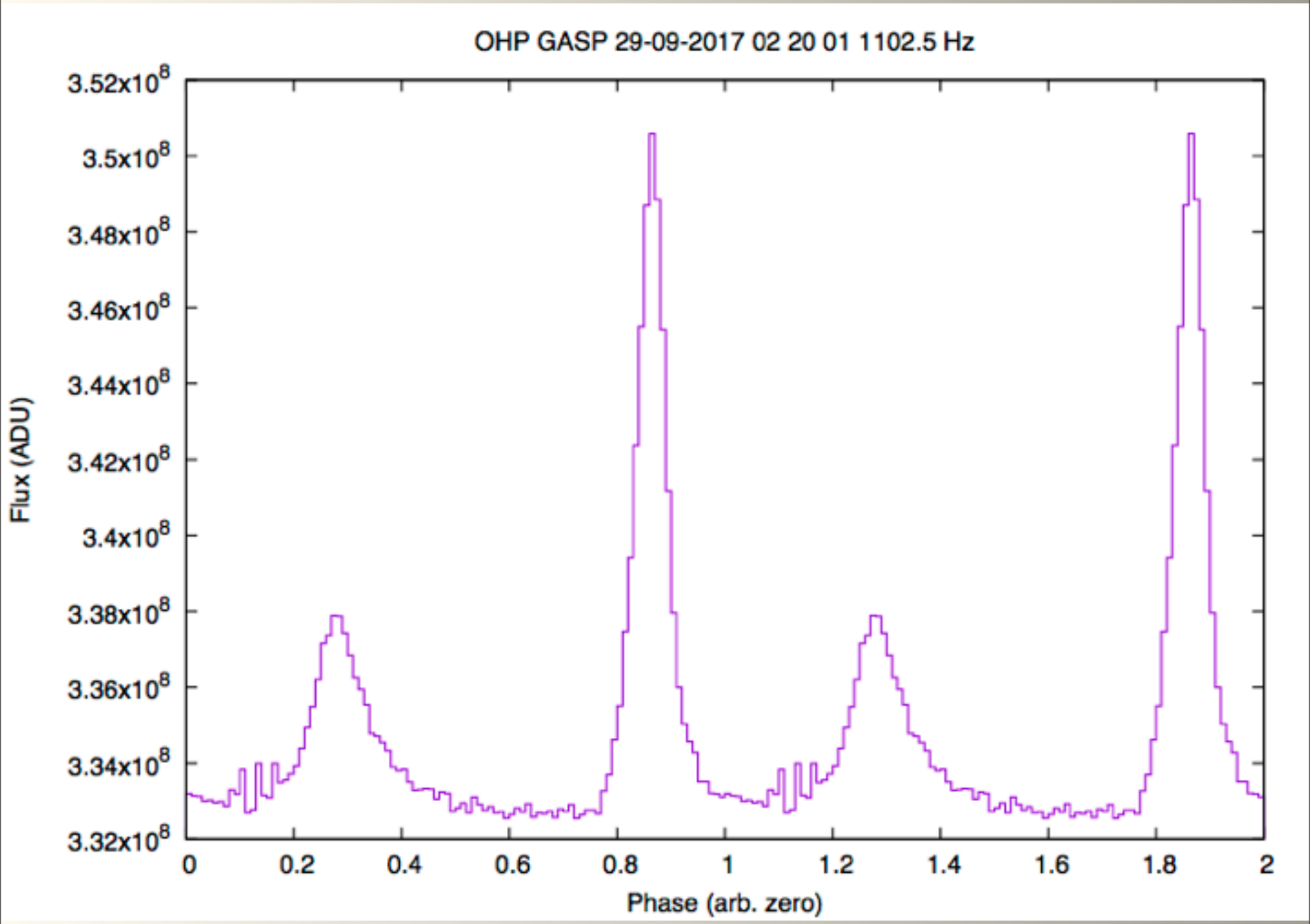

GASP
See Andy Shearer's poster


See Andy Shearer’s poster

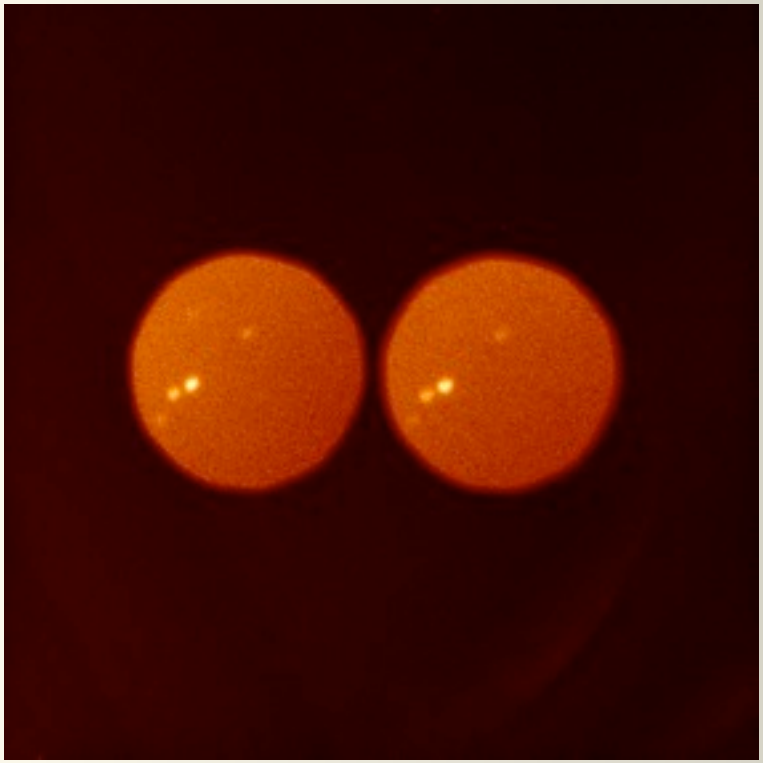
Crab @ OHP193cm+GASP
2017, September

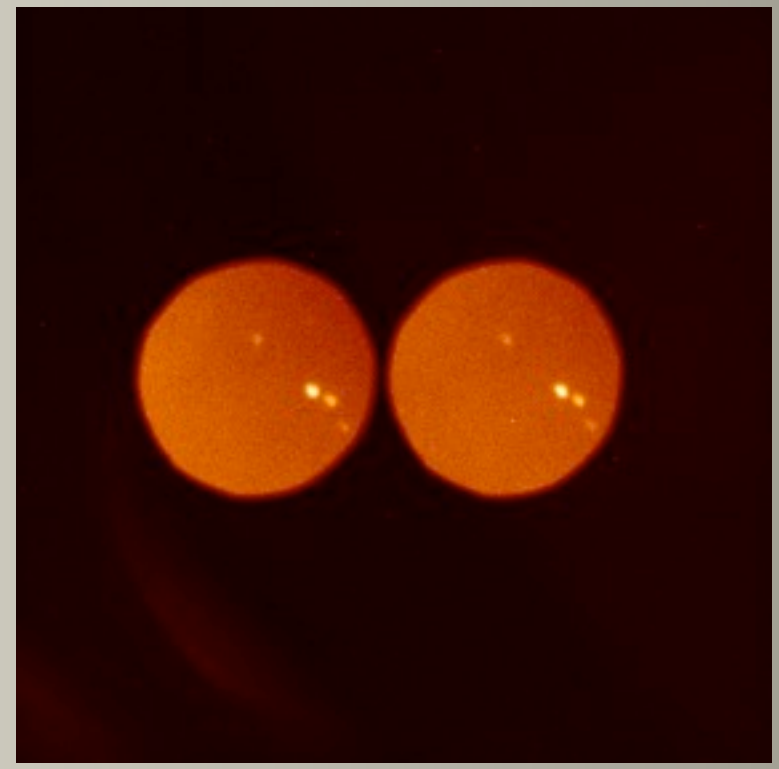





OHP GASP 29-09-2017 02 20 01 1102.5 Hz
Flux (ADU)
3.52x10^8
3.5x10^8
3.48x10^8
3.46x10^8
3.44x10^8
3.42x10^8
3.4x10^8
3.38x10^8
3.36x10^8
3.34x10^8
3.32x10^8
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Phase (arb. zero)

FRB121102 at OHP193cm+GASP
10x1 sec expo, R filter

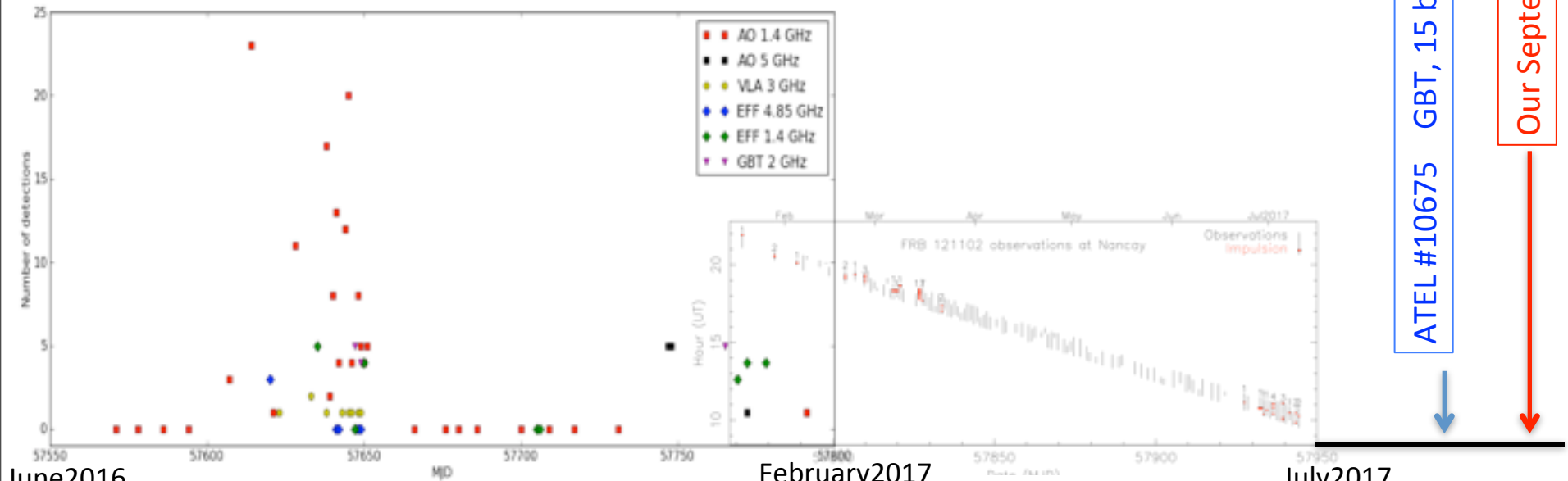




The campaign, Sept. 2017

- ✓ INTEGRAL OK
- ✓ Good radio coverage (even if Arecibo and Nançay not part of the campaign)
- ✓ Some extra VHE observations
- ✓ OHP+T193cm + GASP excellent run

BUT No radio bursts detected in 60 hours from Effelsberg + GBT (means no trigger for INTEGRAL/OHP analysis)



ATEL #10675 GBT, 15 bursts in 1 hour

Our September 2017 campaign

June2016 February2017 July2017

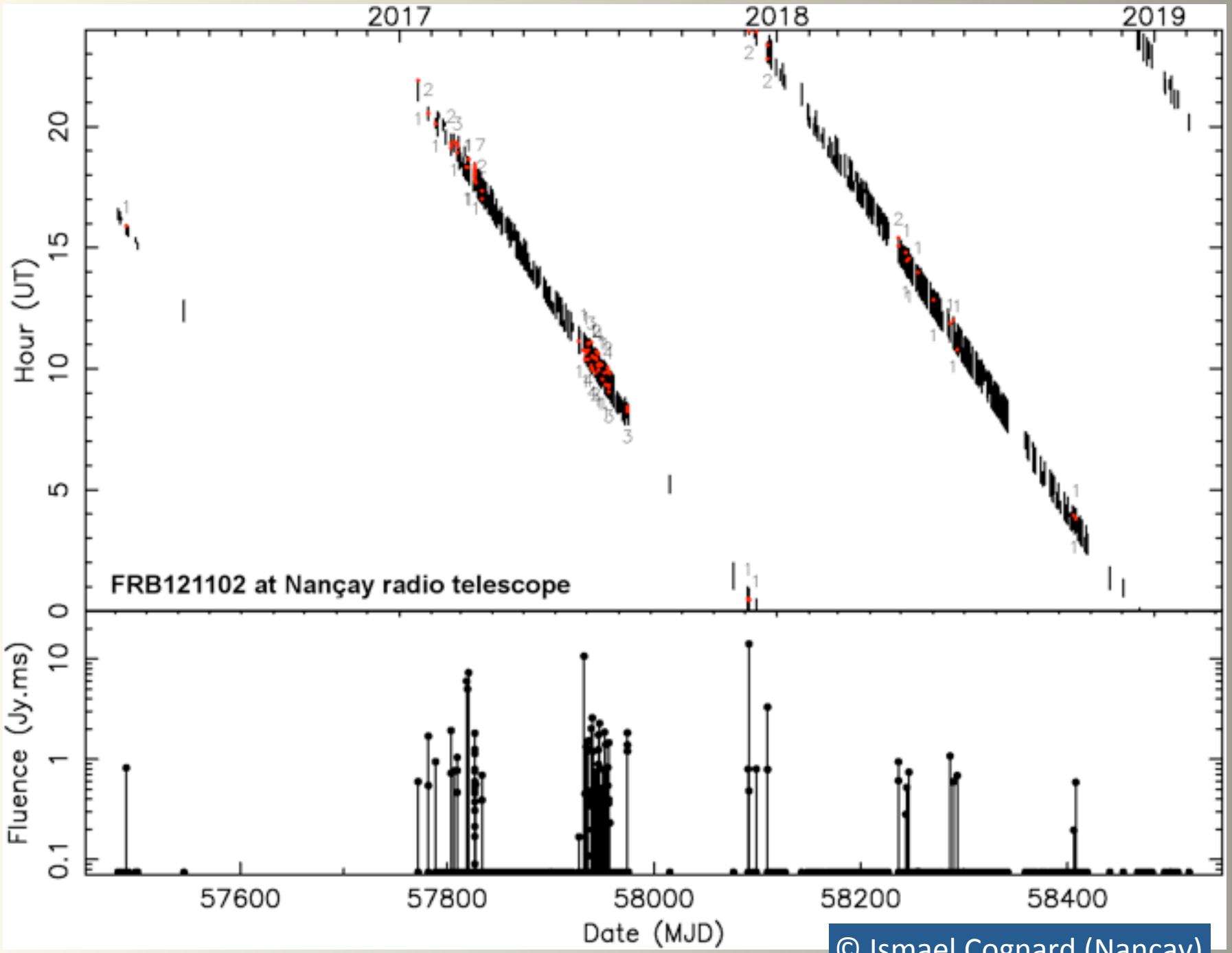
Date (MJD)

Active Quiet Active Quiet ?

New strategy

Daily monitoring of FRB121102 with the Nançay Radio Telescope

Criteria : Trigger the INTEGRAL ToO (+others) when radio bursts detected in at least in 2 over 3 one hour long successive observations with NRT (Nançay Radio Telescope) (+supporting observations with Arecibo and Effelsberg)



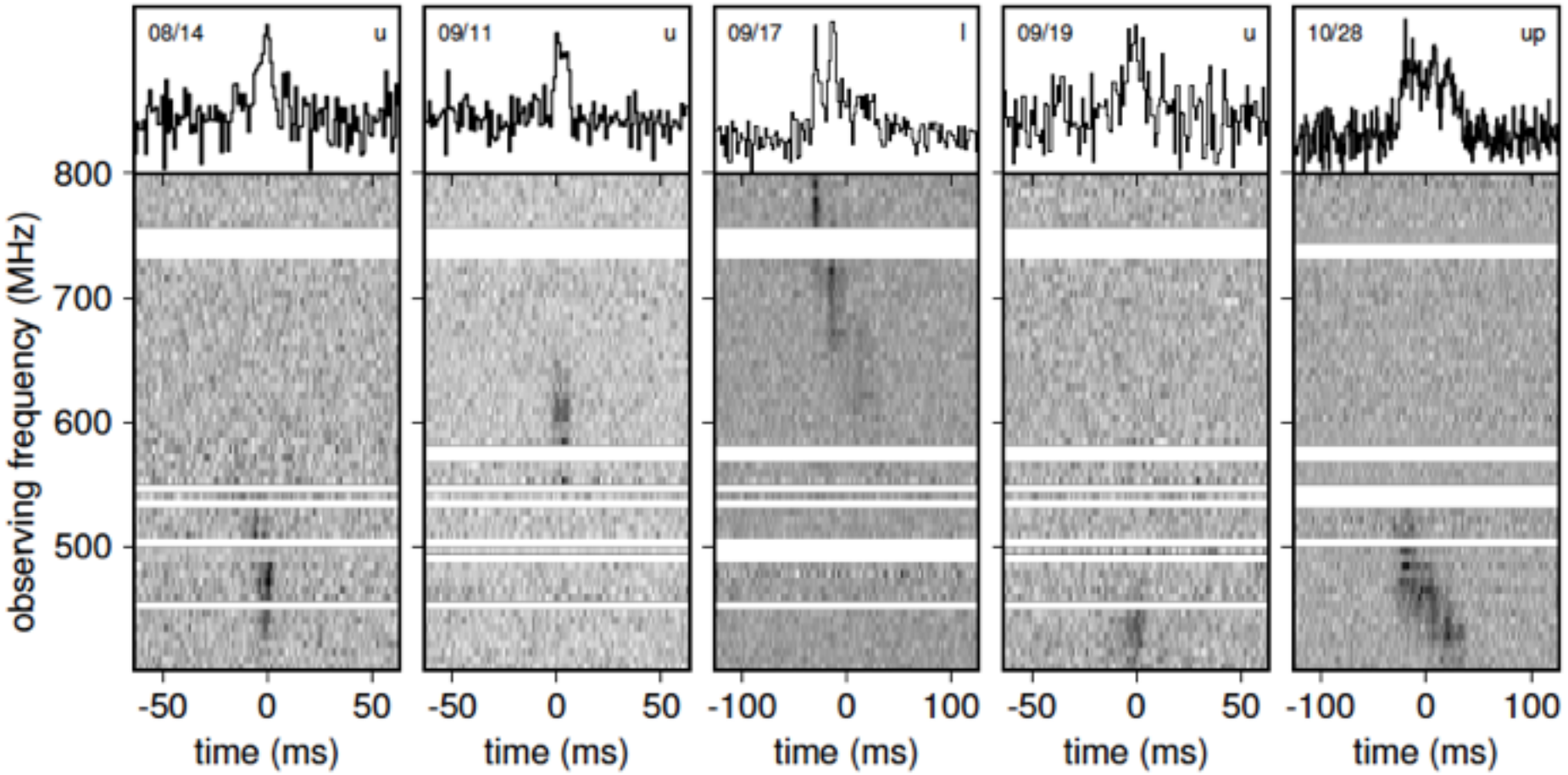
Prospects/actions :

- ✓ Monitoring with Nançay (+ other supports) going on : Stay tuned !
- ✓ Welcome to participate/join to the radio/optical campaign (please contact us)
- ✓ Next week (18 - 20 February, 2019) FRB2019 meeting at Amsterdam on « Fast radio bursts and their possible neutron star origins »
- ✓ FRB and GRB : some similarities (discovery, timescale of the phenomena, unknown type of sources, alert, follow-up strategy, instrumental developments, etc)
- ✓ Surely more FRBs discovered very soon (CHIME, ASKAP) with much more precise localization (a key issue to study FRB's environment)
- ✓ Repeating vs no repeating : 2 different types of sources ?

CHIME
The Canadian Hydrogen Intensity Mapping Experiment

Discovery of a second source of Repeating Fast Radio Bursts
FRB 180814.J0422+73
(Chime collaboration, 2019, Nature)

Discovery of a second source of Repeating Fast Radio Bursts
FRB 180814.J0422+73



Chime collaboration, 2019, Nature

A final remark :

FRB121102 and FRB 180814.J0422+73 nearly same right ascension (and both northern objects)

→

can be observed with the same facility (optical, radio) if triggered

Difficult choice if both active at the same time !

Thank You