An aerial photograph of a research facility. In the foreground, there is a large array of dark blue solar panels arranged in a grid. To the right, a large, light-colored circular area contains a dense array of small, dark, circular detectors. The facility is surrounded by green trees and vegetation. A green text box is overlaid on the top left, and another green text box is overlaid on the bottom center.

Science with FR606@Nançay + NenuFAR

J.-M. Griessmeier

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jean-mathias.griessmeier@cnrs-orleans.fr

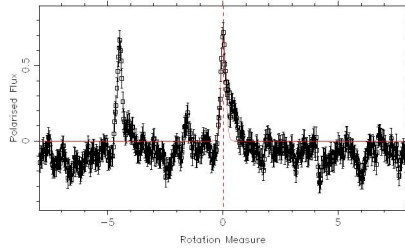
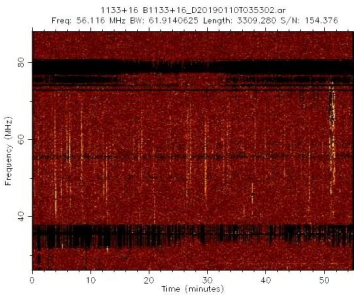
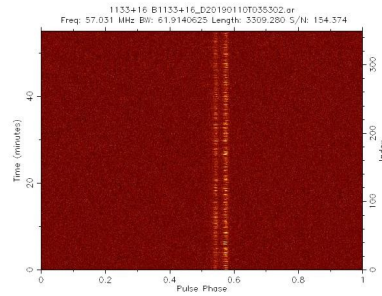
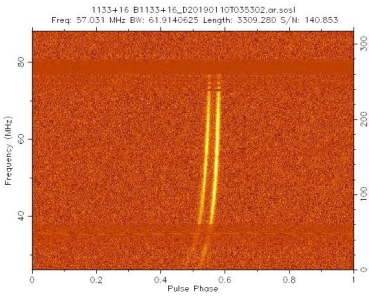
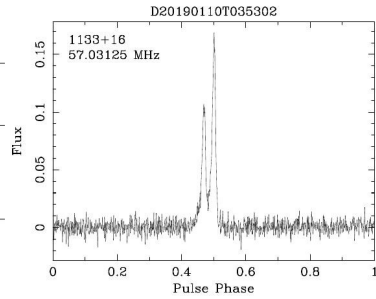
Activities

- FR606 science
- NenuFAR update

FR606 pulsar polarisation

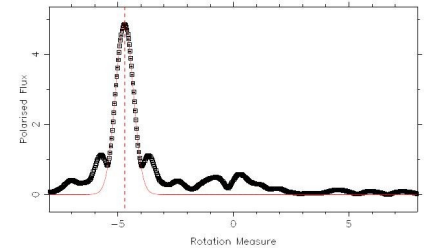
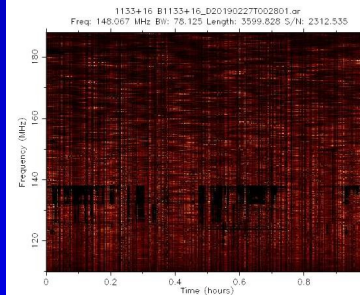
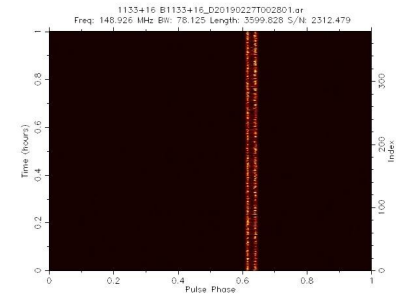
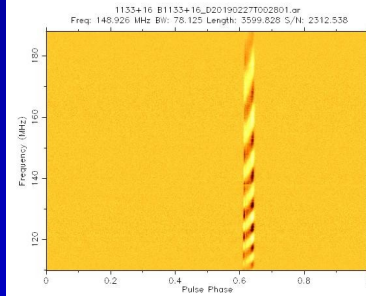
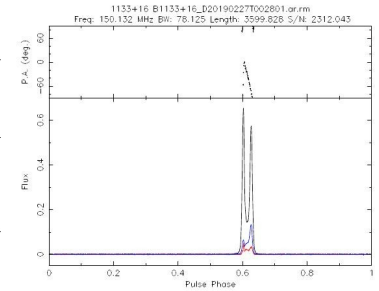
LBA

observatory	fr606
obs.id	B1133+16_D20190110T035302
PSRNAME	B1133+16
JNAME	1133+16
P0	1.18781633249461
DM	4.86110639572144
length	3309.28017408002
nsubint	349
center freq.	57.03125
BW	61.9140625
S/N	242.51
%RFI	16.85
quicklook created	March 7, 2019
by	process-and-calculate.sh (version 1.60.01, 07.03.2019)



HBA

observatory	FR606
obs.id	B1133+16_D20190227T002801
PSRNAME	B1133+16
JNAME	1133+16
P0	1.18789430843865
DM	4.86110639572144
RM	3.97
length	3599.82818304001
nsubint	379
center freq.	148.92578125
BW	78.125
S/N	3321.29
%RFI	8.46
quicklook created	March 12, 2019
by	process-and-calculate.sh (version 1.62.00, 12.03.2019)



FR606 LBA monitoring

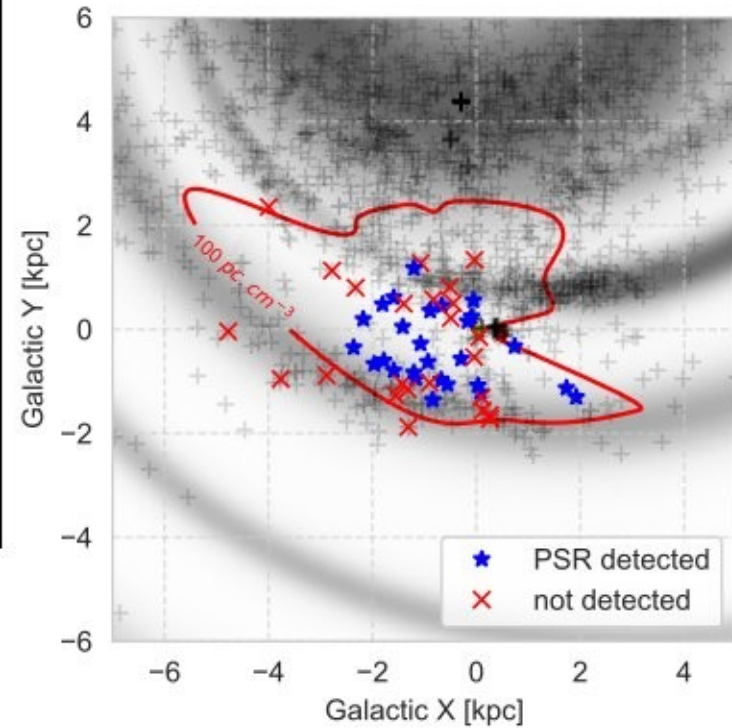
project:

- pulsar population < 100 MHz
- international LOFAR station FR606 using LBA
- data processing at Nançay
- observations 2016-2017

status:

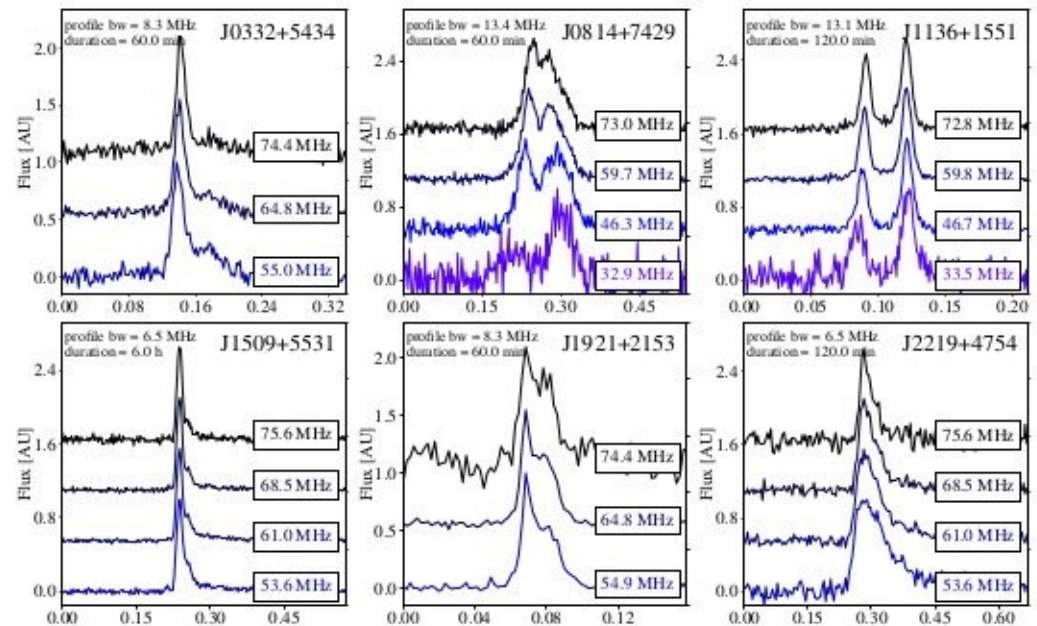
- done!
- 102 pulsars observed \rightarrow 69 pulsars detected
- NenuFAR preparation (Bondonneau et al. 2020 in prep.)

FR606 LBA monitoring



FR606: 102 pulsars / 69 detections

Bondonneau et al. 2019



FR606 LBA monitoring

Astronomy
October 2019

submitted to Astronomy & Astrophysics

019

A census of the pulsar population observed with the international LOFAR station FR606 at low frequencies (25-80 MHz)

L. Bondonneau¹, J.-M. Grießmeier^{1,2}, G. Theureau^{1,2,3}, A. V. Bilous⁴, V. I. Kondratiev^{5,6}, M. Serylak^{7,8}, M. J. Keith⁹, and A. G. Lyne⁹

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³ Laboratoire Univers et Théories LUTH, Observatoire de Paris, CNRS/INSU, Université Paris Diderot, 5 place Jules Janssen, 92190 Meudon, France

⁴ Anton Pannekoek Institute for Astronomy, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands

⁵ ASTRON, the Netherlands Institute for Radio Astronomy, Postbus 2, 7990 AA Dwingeloo, The Netherlands

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⁷ South African Radio Astronomy Observatory, 2 Fir Street, Black River Park, Observatory, Cape Town 7925, South Africa

⁸ Department of Physics and Astronomy, University of the Western Cape, Cape Town 7535, South Africa

⁹ Jodrell Bank Centre for Astrophysics, Department of Physics and Astronomy, The University of Manchester, Alan Turing Building, Oxford Road, Manchester, M13 9PL, UK

Version of October 2, 2019

ABSTRACT

Context. To date, there are only 69 pulsars with detected pulsed radio emission below 100 MHz. A LOFAR-core LBA census (companion paper, Bilous et al. 2019) and a dedicated campaign with the Nançay LOFAR station in stand-alone mode (this paper) were led in the years 2014-2017, in order to extend the known population in this frequency range.

Aims. In this paper, we aim at increasing the sample of known radio pulsars at low frequencies and at producing a catalog in the frequency range 25-80 MHz. This will allow to probe the local Galactic pulsar population, to help understand their emission mechanism, to better characterize the low-frequency turnover in their spectra, and to obtain new information about the interstellar medium by studying dispersion, scattering and scintillation.

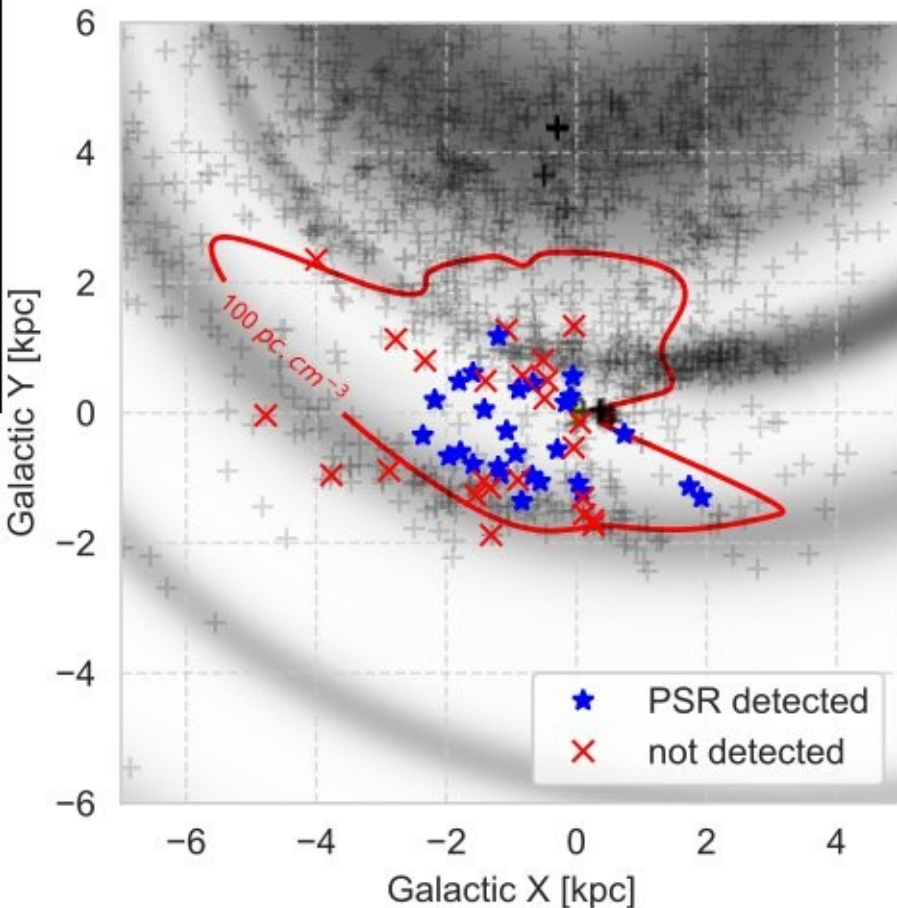
Methods. We have observed 102 pulsars known to emit radio pulses below 200 MHz and with declination above -30° . We have used the the Low Band Antennas (LBA) of the LOFAR A-Array (LOFAR) international station FR606 at the Nançay Radio Observatory in standalone mode, recording data from 25-80 MHz.

Results. Out of our 102 targets, 64 pulsars have been detected. We confirm 10 pulsars that have been detected for the first time below 100 MHz by the LOFAR LBA census (Bilous et al. 2019), and add two more pulsars that have never been detected in this frequency range before. We provide average pulse profiles, DM values and mean flux densities (or upper limits in the case of non-detections). The comparison to previously published results allows us to identify a previously unknown spectral turnover for five pulsars, confirming the expectation that spectral turnovers are a widespread phenomenon.

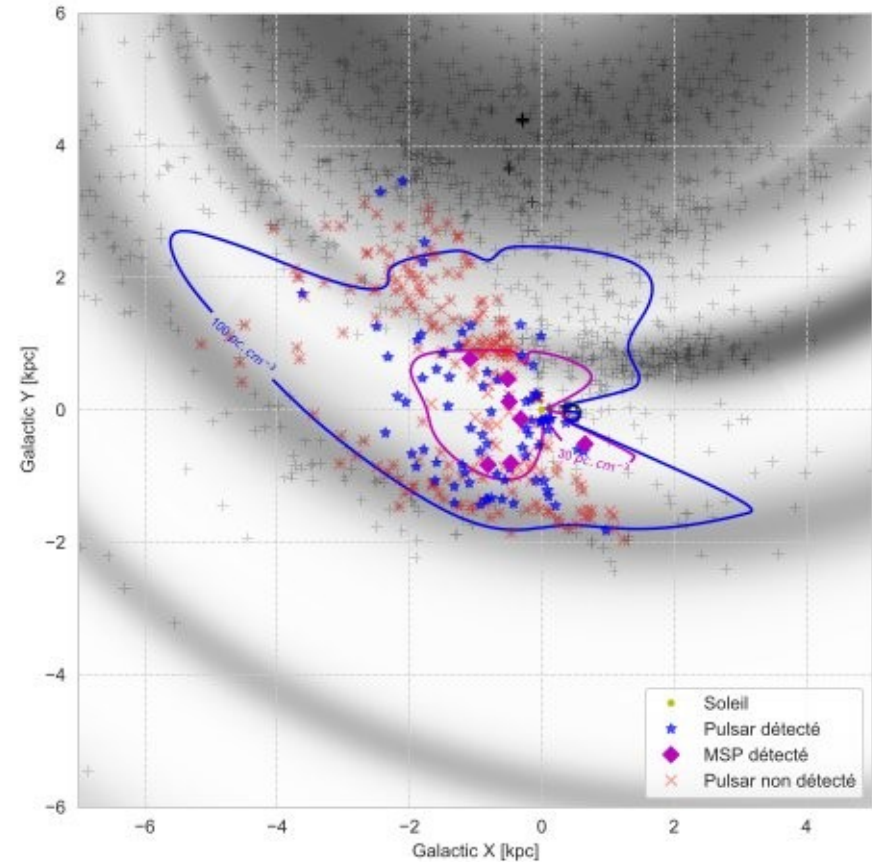
Key words. Pulsar, Low Frequency

PhD
student
until
2019-11-08

FR606 LBA monitoring



FR606: 102 pulsars / 69 détections



NenuFAR: 513 pulsars / 140 détections

Pulsar spectra

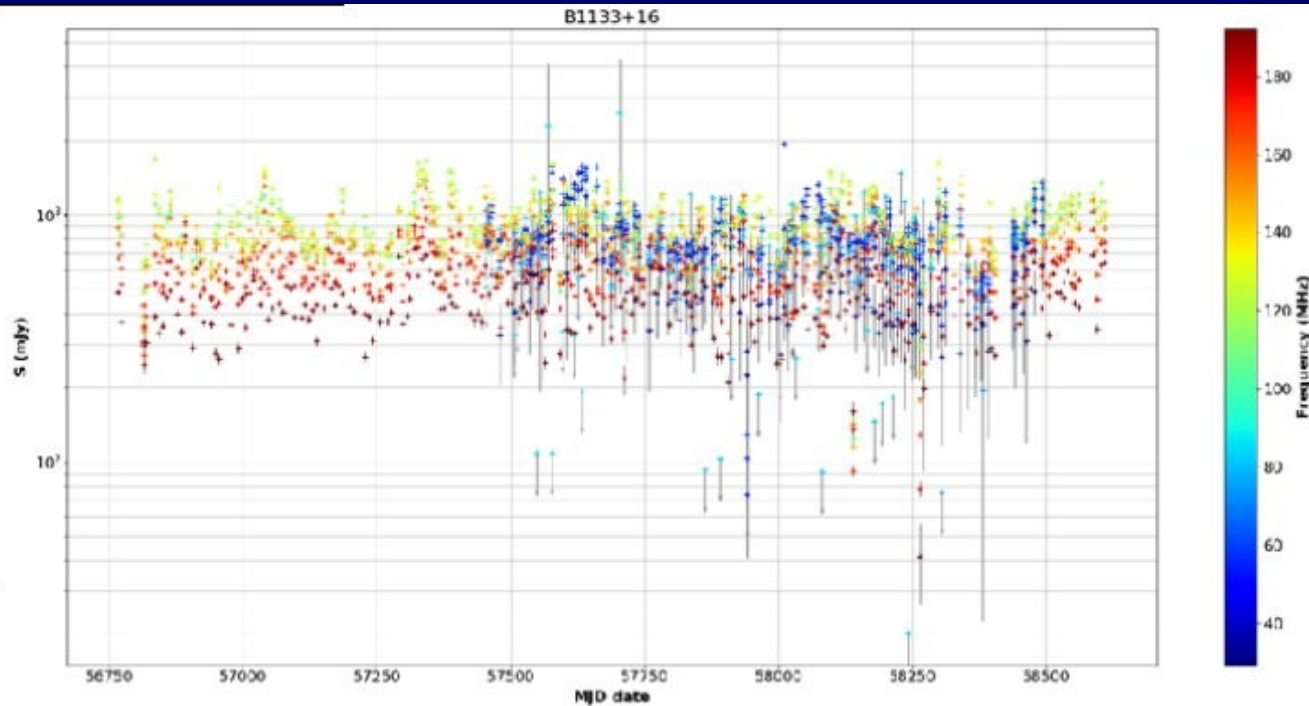
project:

- pulsar spectra 25-190 MHz
- international LOFAR stations using LBA + HBA
- weekly monitoring of 16 pulsars (started ~02/2017)

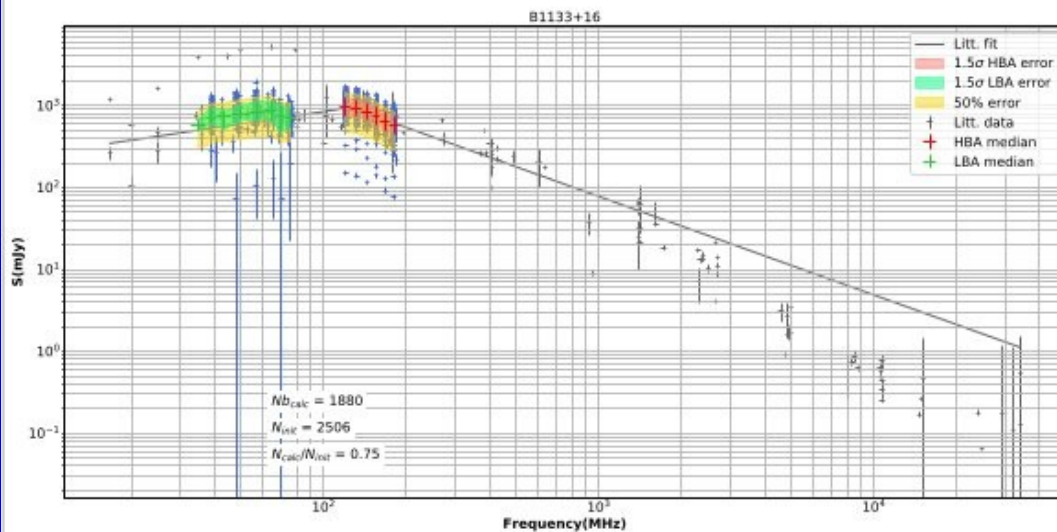
status:

- ongoing!
- Brionne et al. 2020?

Pulsar spectra



Future publication



- Spectre absolu
- Estimation des durée de scintillation

Monitoring DM variations

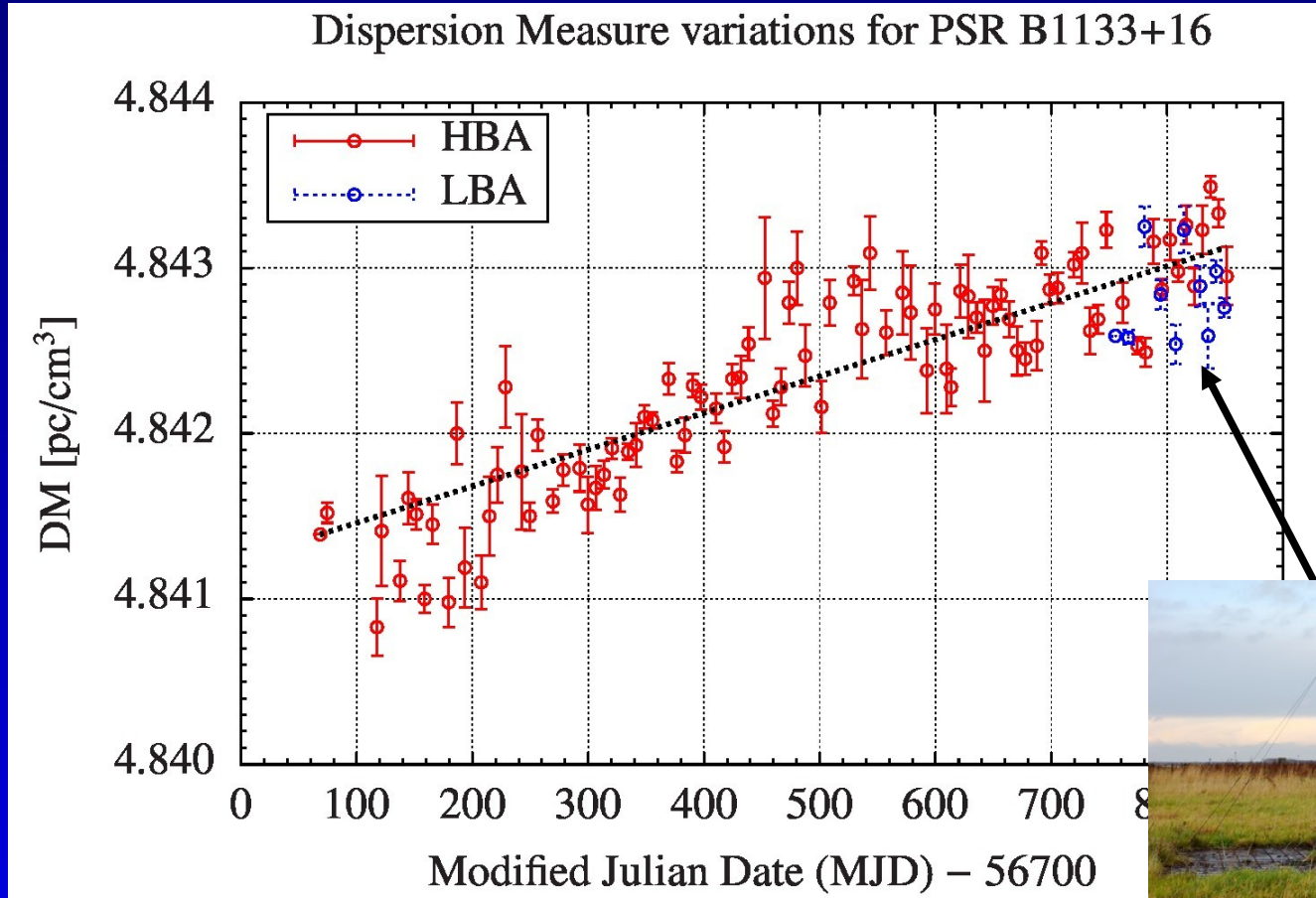
project:

- DM monitoring
- international LOFAR stations using HBAs (+ LBAs?)
- ~100 pulsars observed on ~6 international stations
- weekly observations since 2012!
- could make great use of “filler time”

status:

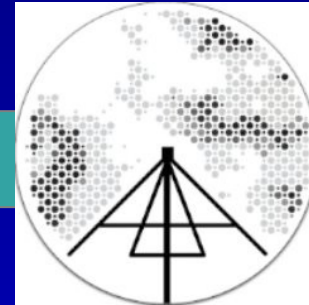
- ongoing!
- Ibrahim et al. 2020?

Monitoring DM variations

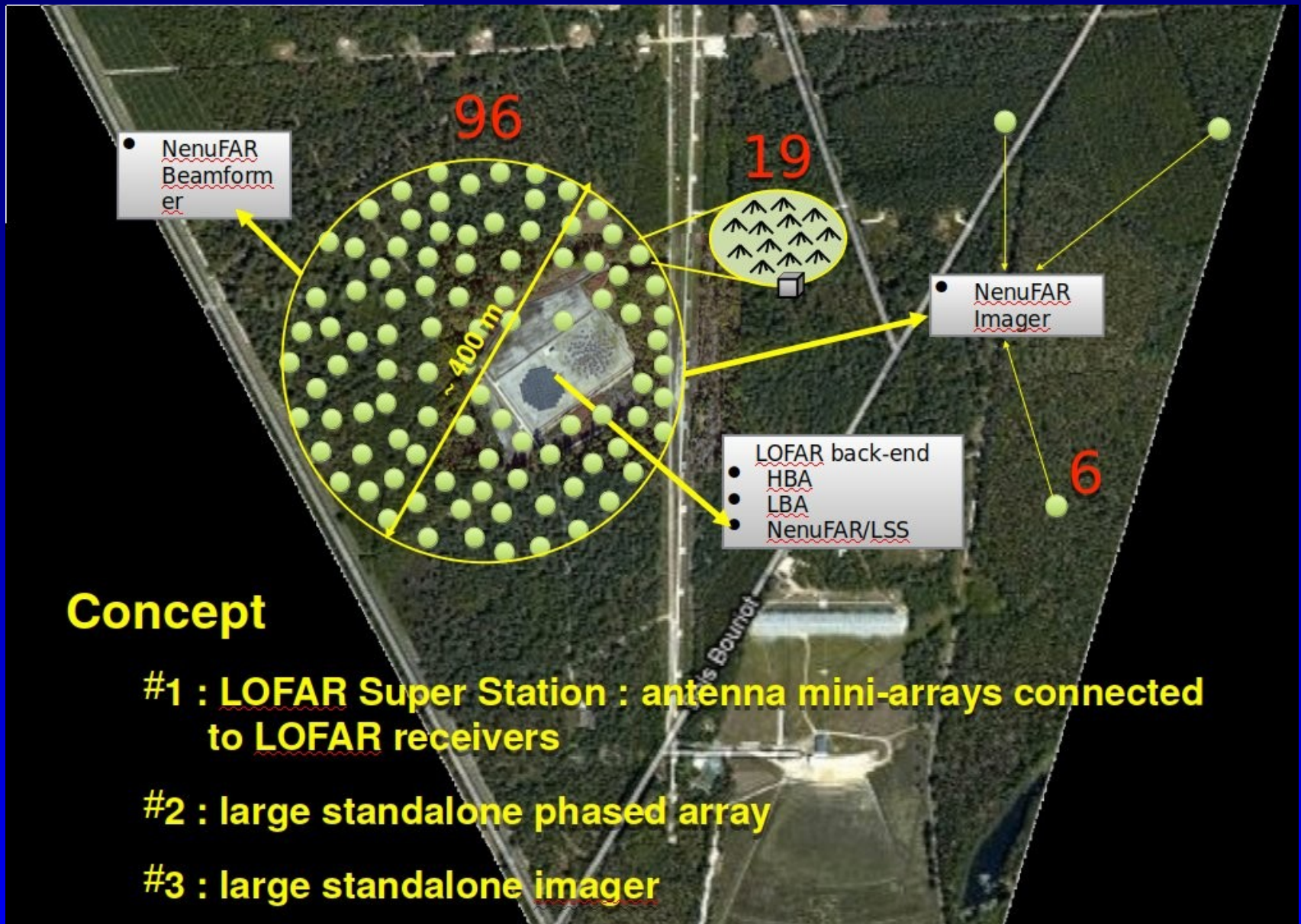


Activities

- FR606 science
- NenuFAR update



3 instruments in 1



Timeline

- 2009-2013: Design study (prototype of 3 x19 antennas)
- 2014: 2nd workshop in Paris; science case
- 2019-10-03: NenuFAR inauguration

NenuFAR numbers

- 56 mini-arrays built (1064 antennas)
- by end 2020: 76 mini-arrays (1444 antennas)
- 4 “remote” MA: funded; site selection
- up to 4 digital beams
- calibration table version 1
- early science: started 07/2019
- 15 Key Projects
- <https://nenufar.obs-nancay.fr/>

KP List	
ES1	Cosmic Dawn
ES2	Exoplanets & Stars
ES3	Pulsars
ES4	Transients
ES5	Fast Radio Bursts
ES6	Planetary Lightning
ES7	Joint Jupiter studies
ES8	Cluster of galaxies & AGNs
ES9	Cluster Filament & Cosmic Magnetism
ES10	Radio recombination lines
ES11	Sun
ES12	Radio Gamma
ES13	SETI
ES14	Cas A
ES15	Large Scale Background Survey

NenuFAR GUI

NenuFAR v3.17.2

URSAE_MINORIS_TRANSIT_24H ▶ 2 hours left

22:17:54 UTC

Stairway To Heaven

Planning 13

Coordinates

Real time

Google map

Survey

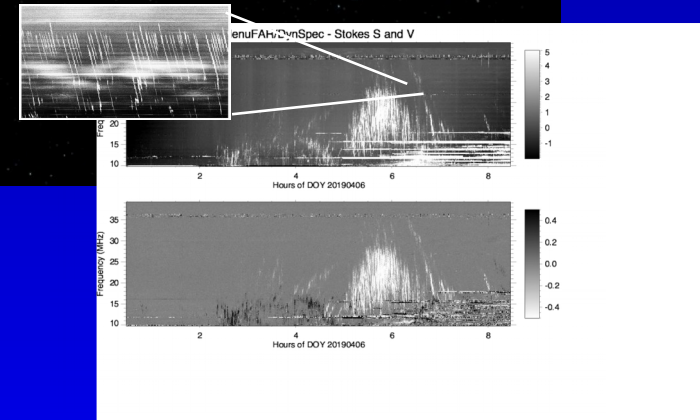
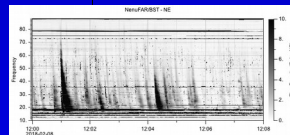
Documentation

Nov 4 – 10, 2019

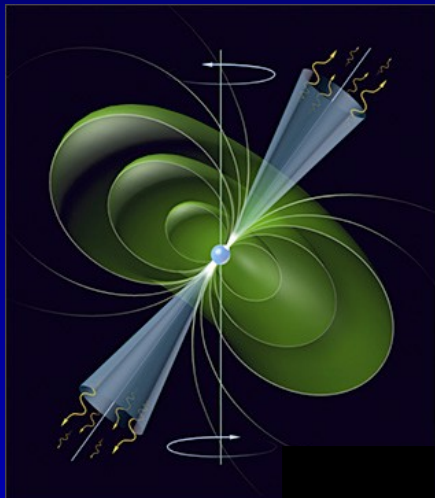
timetable week

	Mon 11/4	Tue 11/5	Wed 11/6	Thu 11/7	Fri 11/8	Sat 11/9	Sun 11/10
00:00			23:59 - 00:01 URSAE_MINORIS_TRANSIT_24H			22:00 - 02:00 UPS_AND_TRACKING	
02:00						02:00 - 05:00 COROT-7_TRACKING	
04:00				04:20 - 06:19 VIR_A_TRANSIT_4X2MRS	05:00 - 07:00 55_CNC_TRACKING	05:00 - 07:00 55_CNC_TRACKING	
06:00				06:19 - 08:18 VIR_A_TRANSIT_4X2MRS	07:00 - 10:00 LP_212-62_TRACKING	07:00 - 10:00 LP_212-62_TRACKING	
08:00				08:19 - 10:17 VIR_A_TRANSIT_4X2MRS	10:00 - 14:00 TAU_BOO_TRACKING	10:00 - 14:00 TAU_BOO_TRACKING	
10:00	10:00 - 11:46 SUN	10:00 - 12:46 SUN		10:17 - 12:16 VIR_A_TRANSIT_4X2MRS	14:00 - 18:00 HD_189733_TRACKING	14:00 - 17:00 HD_189733_TRACKING	11:33 - 13:31 CYG_A_TRANSIT_4X2MRS
12:00	12:15 - 18:40 JUPITER_TRACKING	13:25 - JUPITER_TRACKING		12:16 - 14:15 VIR_A_TRANSIT_4X2MRS	18:00 - 22:00 HAT-P-11_TRACKING		13:34 - 15:32 CYG_A_TRANSIT_4X2MRS
14:00				14:15 - 16:14 VIR_A_TRANSIT_4X2MRS			15:35 - 17:32 CYG_A_TRANSIT_4X2MRS
16:00				16:14 - 18:13 VIR_A_TRANSIT_4X2MRS			17:32 - 19:30 CYG_A_TRANSIT_4X2MRS
18:00				18:13 - 20:12 VIR_A_TRANSIT_4X2MRS	22:00 - 02:00 UPS_AND_TRACKING		19:31 - 21:29 CYG_A_TRANSIT_4X2MRS
20:00				20:12 - 22:11 VIR_A_TRANSIT_4X2MRS			
22:00				22:11 - 00:10 VIR_A_TRANSIT_4X2MRS			

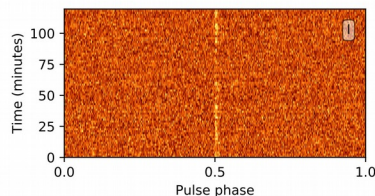
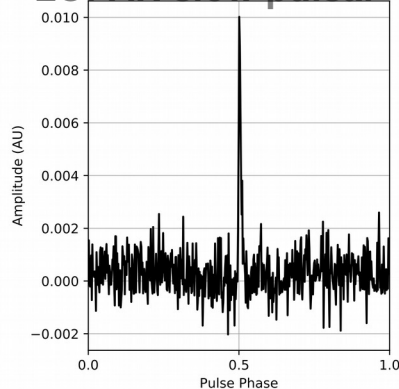
Key Project "Exoplanets and Stars"



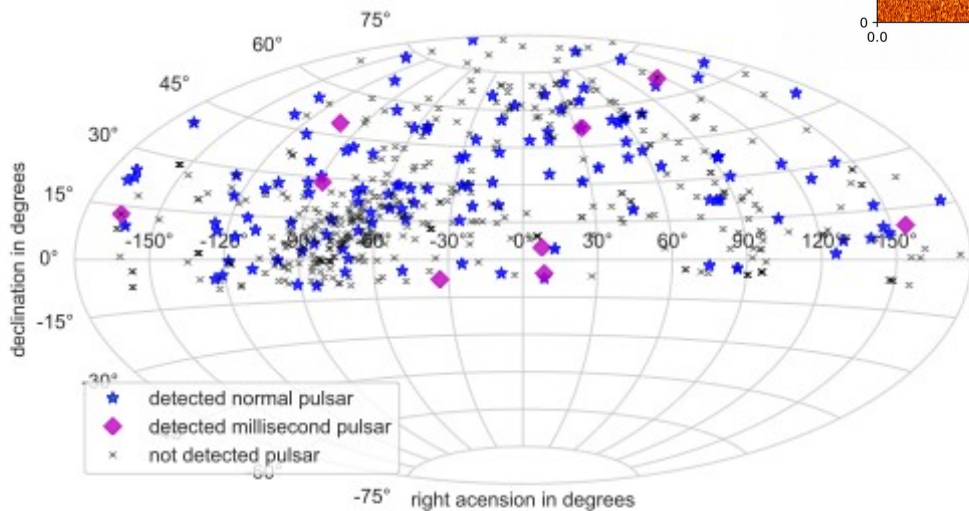
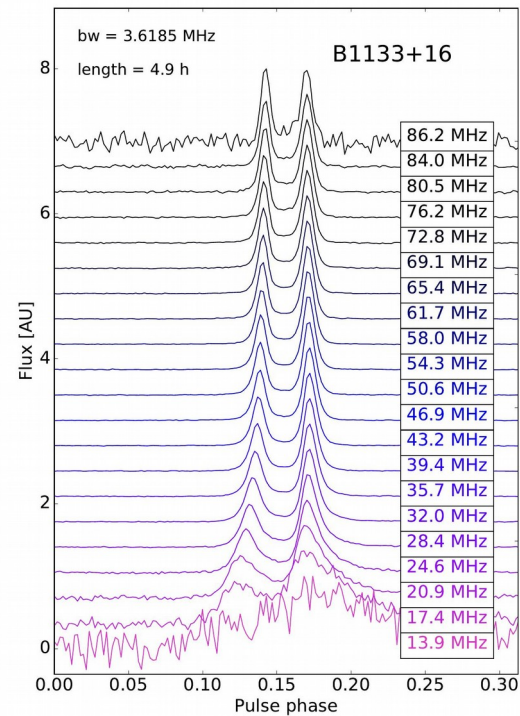
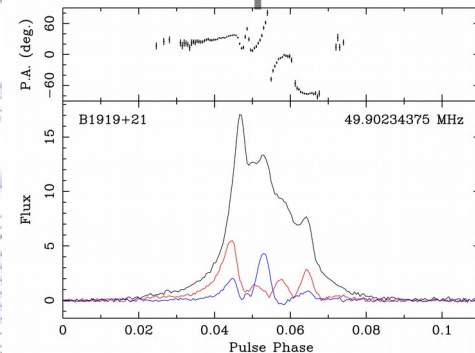
Key Project "Pulsars"



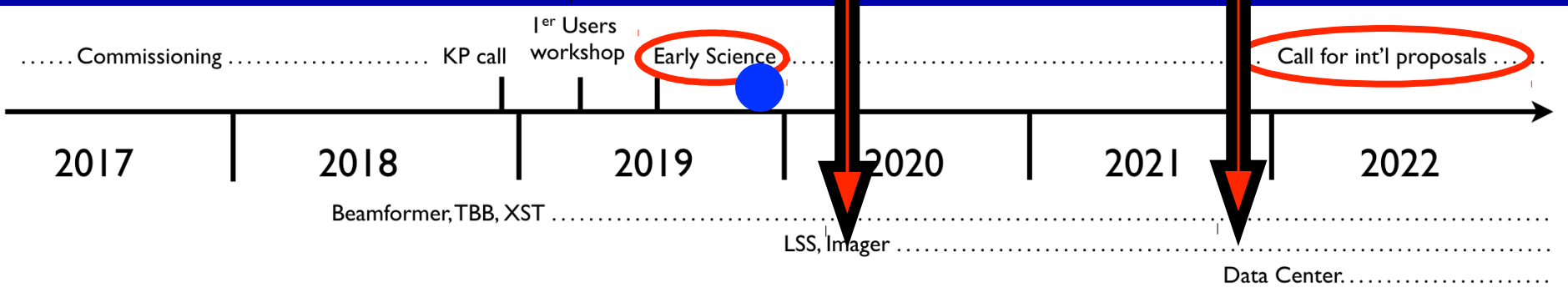
LOFAR slow pulsar



J. Bell's pulsar



Timeline



... ongoing work!

