

## Pulsar Busy Week 2

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# LOFAR Busy Weeks



## Goal:

- Bring together astronomers, technicians, developers, engineers, and observers to close the loop on development.
- Use astronomical observations to test the system.
- Make leaps in functionality and push forward the various pipelines.
- e.g. Pulsar Busy Week 1 solved the long-standing issue of tracking with the HBAs and identified several good test sources.

# Beam-formed Observations Before Pulsar Busy Week 2

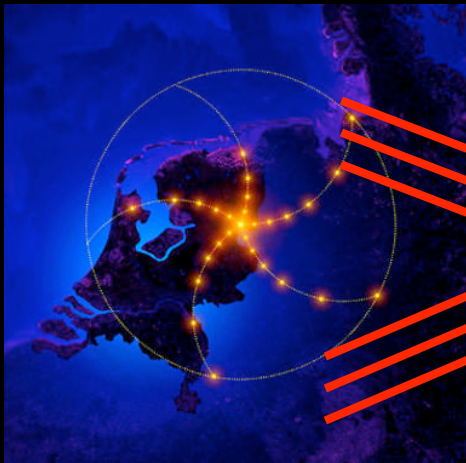


## Before: dumping raw station data

~250 GB/hr recorded

Heavy post-processing to  
e.g. fix missing packets

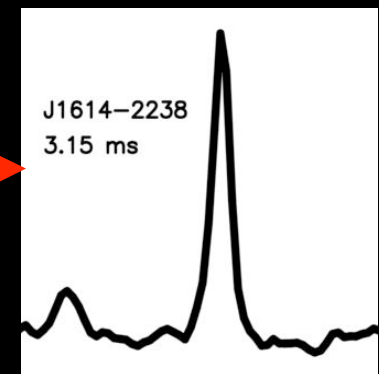
## "Version 1.0" of the Known Pulsar Pipeline



~2 GB/hr recorded

Quick post-processing

A *lot* more functionality  
implemented on BG/P



# Pulsar Busy Week 2

March 5th-11th, 2009

ASTRON

## Main achievements:

- On-line "version 1.0" of the Known Pulsar Pipeline.
- Creation of "filterbank" data (multiple channels per subband).
- Create multiple tied-array beams.
- Various observational firsts for LOFAR and ~150hrs of data!
- Now in a position to greatly accelerate the rate and usefulness of (beam-formed) commissioning tests through astronomical observations.

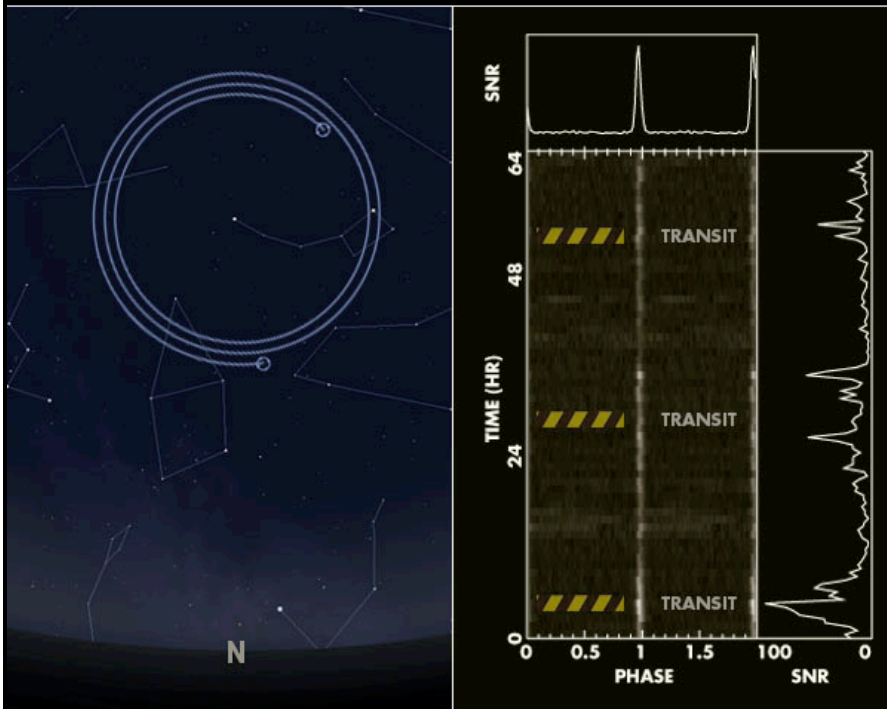
# Pulsar Busy Week 2

## Version 1.0 of the known pulsar pipeline

- “On-line” data-taking. i.e. data streams to BG/P, is mostly processed there, and is written out in a mostly complete format.
- Greatly reduces the amount of data we need to store and the amount of off-line processing that needs to be done (e.g. 250GB/hr --> 2GB/hr, 1day --> 5min turnover).
- Means we can now observe pretty much indefinitely.
- Hopefully soon be observing pulsars live: *great tool for the observers to use to check the system* (takes less than 5 minutes total).

# B0809+74 - 64hrs!

## 64 PULSAR HOUR PEOPLE



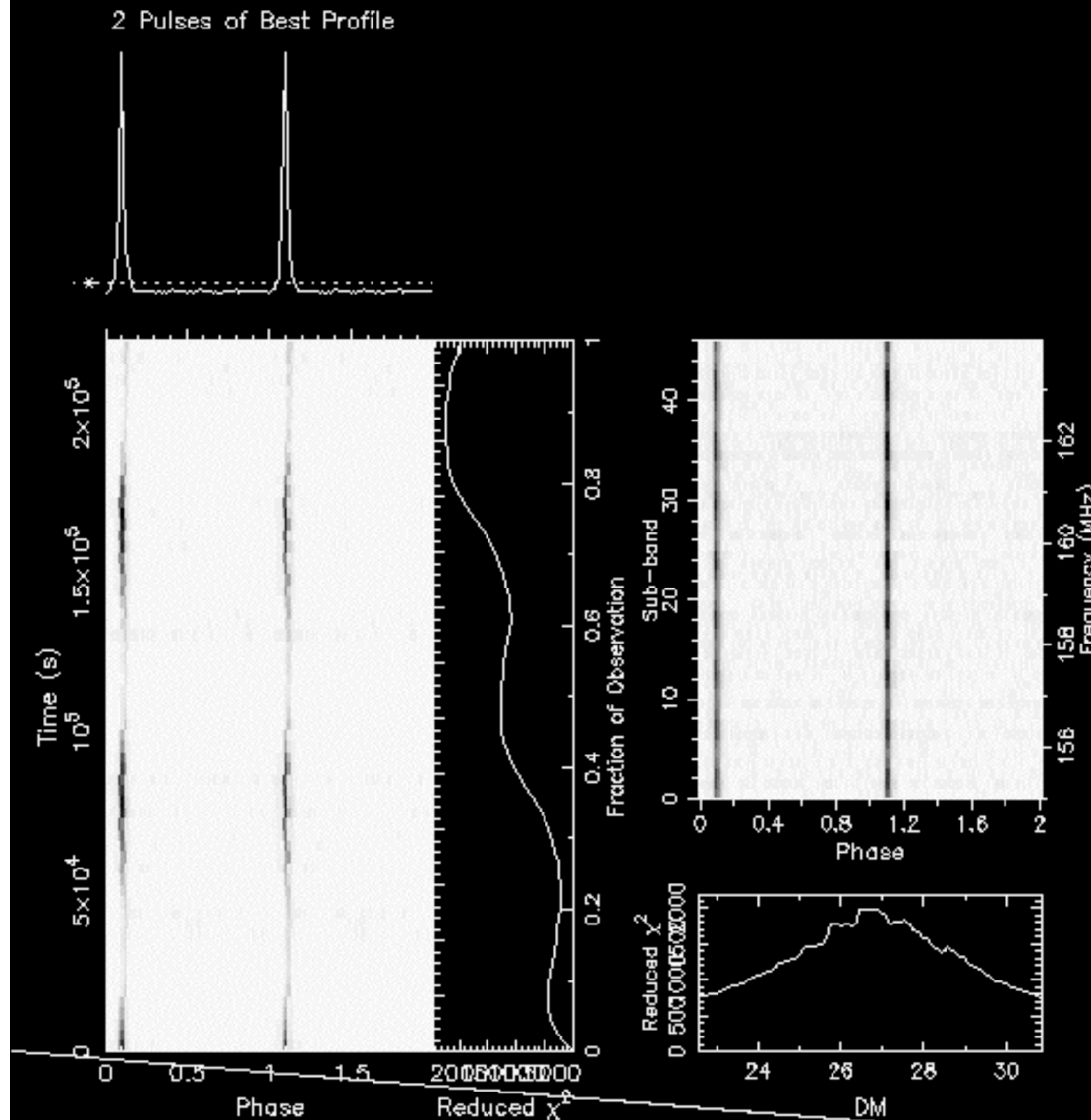
- Observed *continuously* for 64hrs from March 6th-9th, 2009.
- One of the longest pulsar observations ever, on any telescope!
- Got me really excited about LOFAR again.
- Tracking works.
- Brightness variations dominated by scintillation we believe.

### PULSAR BUSY WEEK 2

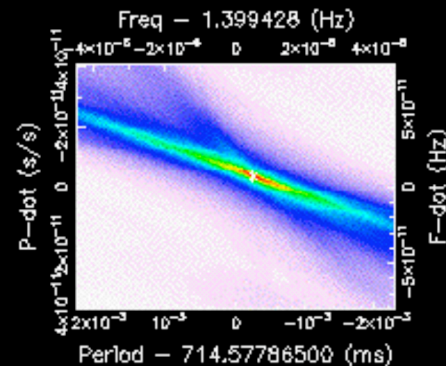
PULSAR B0809+74  
MULTIPLE PENCIL BEAMS

VARIABLE POLYPHASE FILTER  
ONLINE DATA TAKING

# B0329+54 - 62hrs!

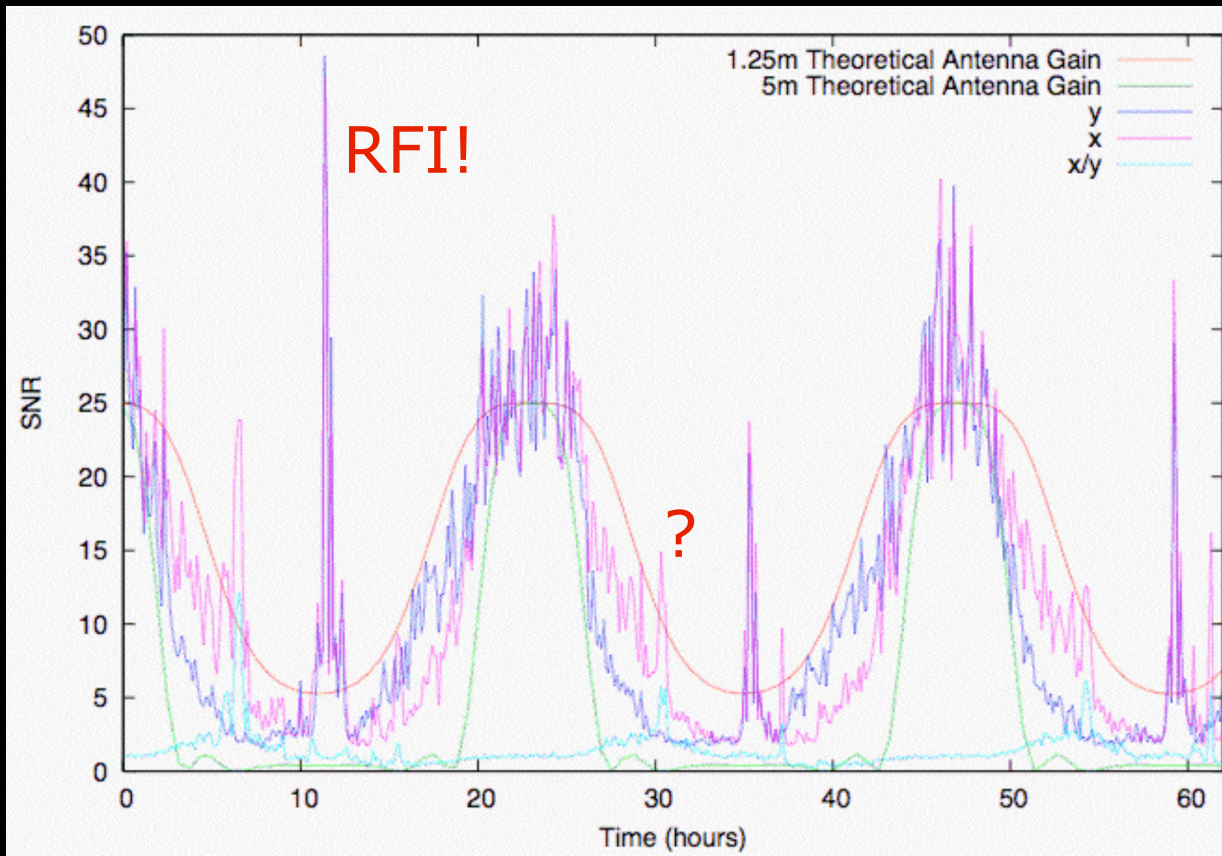


- Observed *continuously* for 62hrs from March 13th-16th, 2009.
- Tracking works.
- Brightness variations dominated by instrumental response.



# B0329+54 - 62hrs!

## Comparison with *simple* beam model

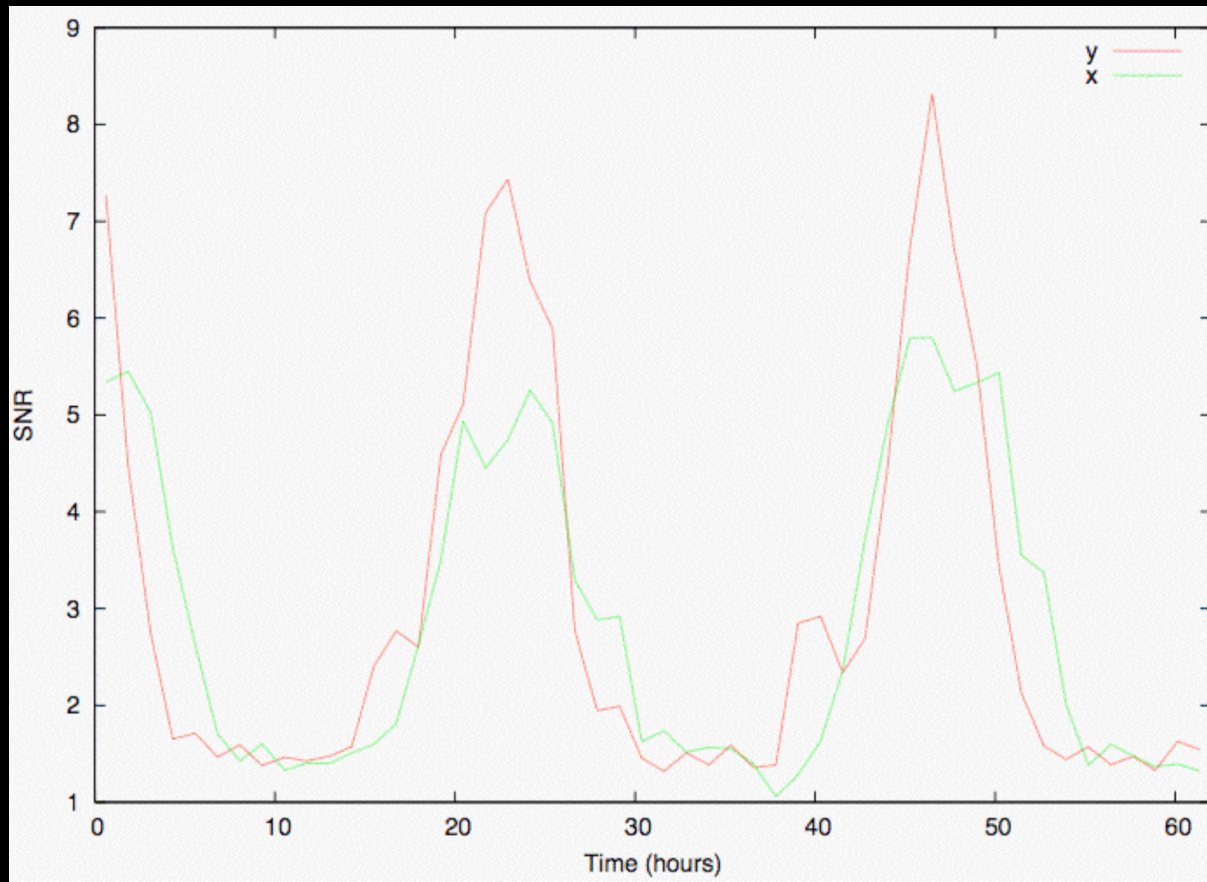


- Recorded X and Y powers separately.
- Need to compare more closely with Sarod's beam model.
- Repeating RFI in either time of day or direction!
- Other feature may be a sidelobe effect???



# B0329+54 - 62hrs!

## Within one subband...



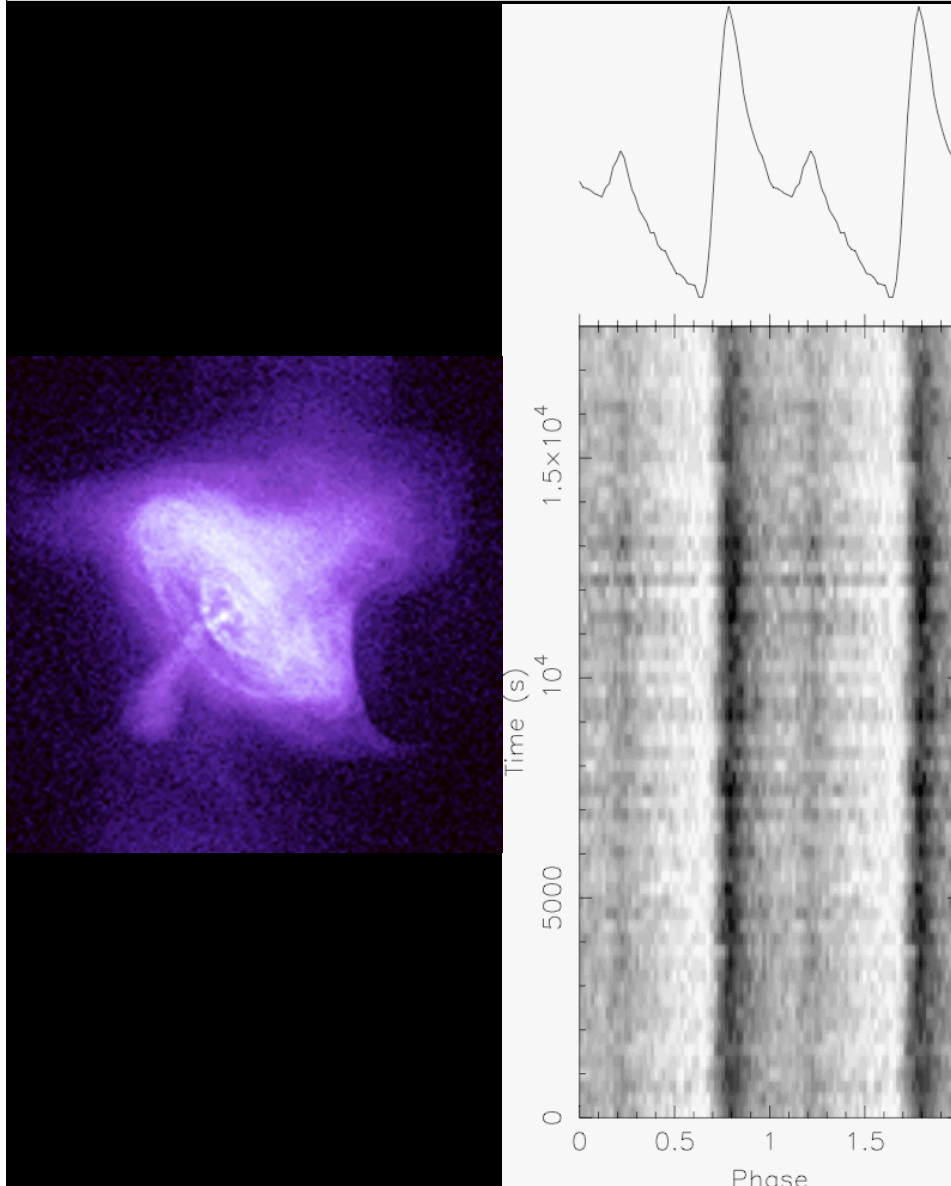
- Faraday rotation washes out intrinsic pulsar polarization over the 46 subbands.
- Still visible if you look at just one subband.

# Pulsar Busy Week 2

## Variable polyphase filter

- Can now channelize the subbands with e.g. 16, 32, 64, 128, and 256 channels.
- Crucial for incoherent dedispersion and for performing a blind survey for pulsars and other fast transients.
- Known pulsars will likely be *coherently* dedispersed (i.e. remove chirp function from complex voltages).

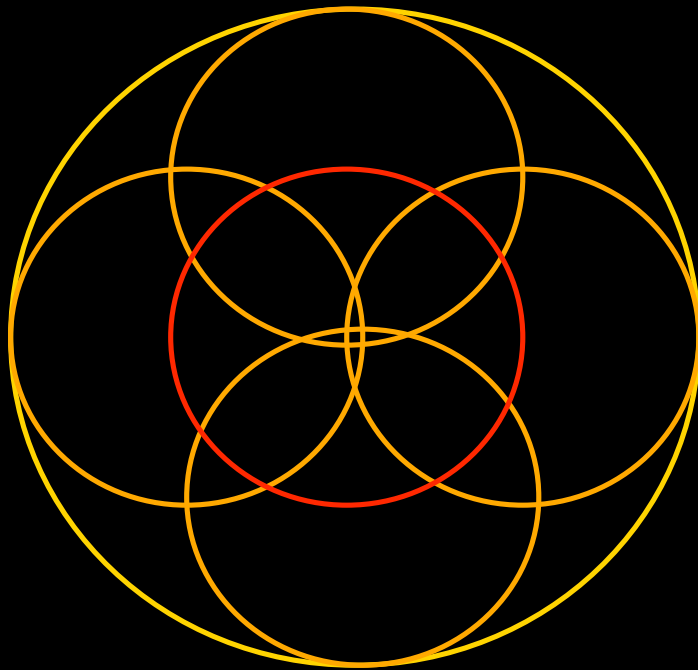
# B0531+21 - 5hrs



- Famous Crab pulsar.
- At  $P=33\text{ms}$ , *much* faster spinning than what we've observed before.
- To (incoherently) dedisperse, we needed to form 32 channels across each subband.
- Resolution (freq/time) could be 4x better.
- Profile dominated by interstellar scattering.
- Really shows system (e.g. clock) is working quite well.
- Try *real* MSP once we have a full station.

# Tied-Array Tests

## Multiple Tied-Array Beams



$\sim 20^\circ$

- Forming hundreds of “tied-array” beams is also required for an effective pulsar/fast transient survey.
- Can now do a first version of this on BG/P!
- With 4 tiles, only need  $\sim 4$  beams to tile out the HBA FoV.
- Tests showed that this mostly worked but that there is likely a positional error (possibly a flip).

# Lots to do still...

- Understand period derivatives in the long observations. Could just be barycentering. This verifies the clock stability.
- Investigate origin of baseline variations and other features in the data, including RFI environment.
- Compare brightness variations with Sarod's HBA beam model.
- Improve bit packing in conversion from floats to shorts.
- Search the data for single pulses, Crab giant pulses, and potentially new sources?
- Sort out pointing of multiple tied-array beams.
- Provide observers with a quick-look tool.

# In Pulsar Busy Week3...

- Hopefully in another  $\sim 1.5$  months time.
- Bring the pipeline closer to a user-friendly state by including metadata directly in the file.
- Write directly to HDF5 format.
- Try controlling the data-taking through SAS/MAC?
- On-line folding and dedispersion on BG/P?
- Should put us on a good time-line for MS<sup>3</sup>.