

## Pulsar Pipeline: first tests

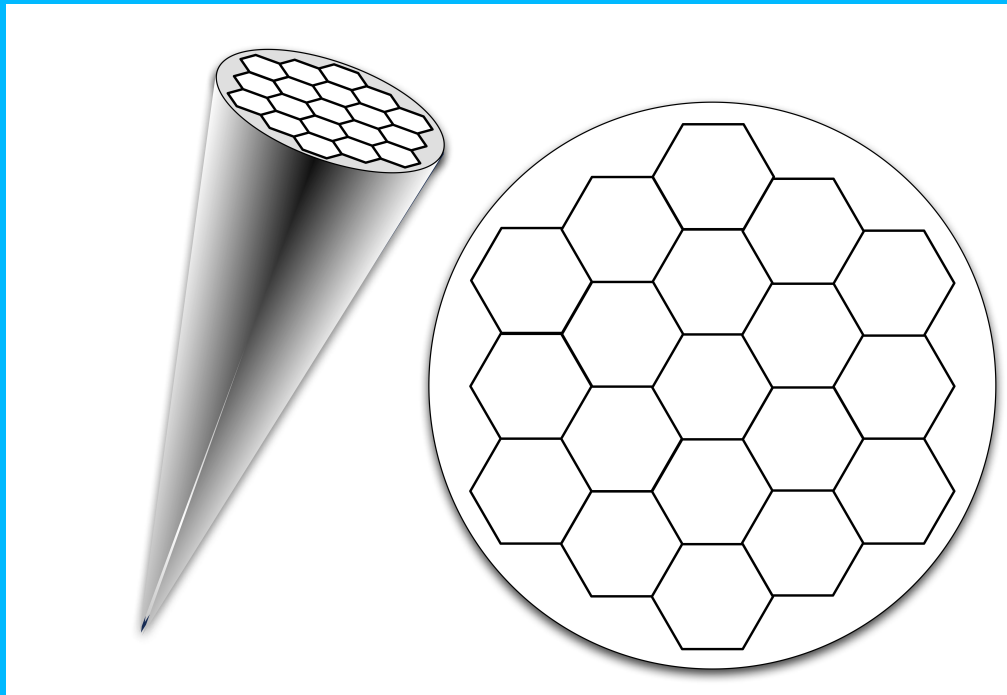
A vibrant, multi-colored image of a galaxy, likely a spiral galaxy, set against a dark background filled with numerous small, bright stars. The galaxy's core is bright yellow and orange, with blue and green hues in the surrounding spiral arms.

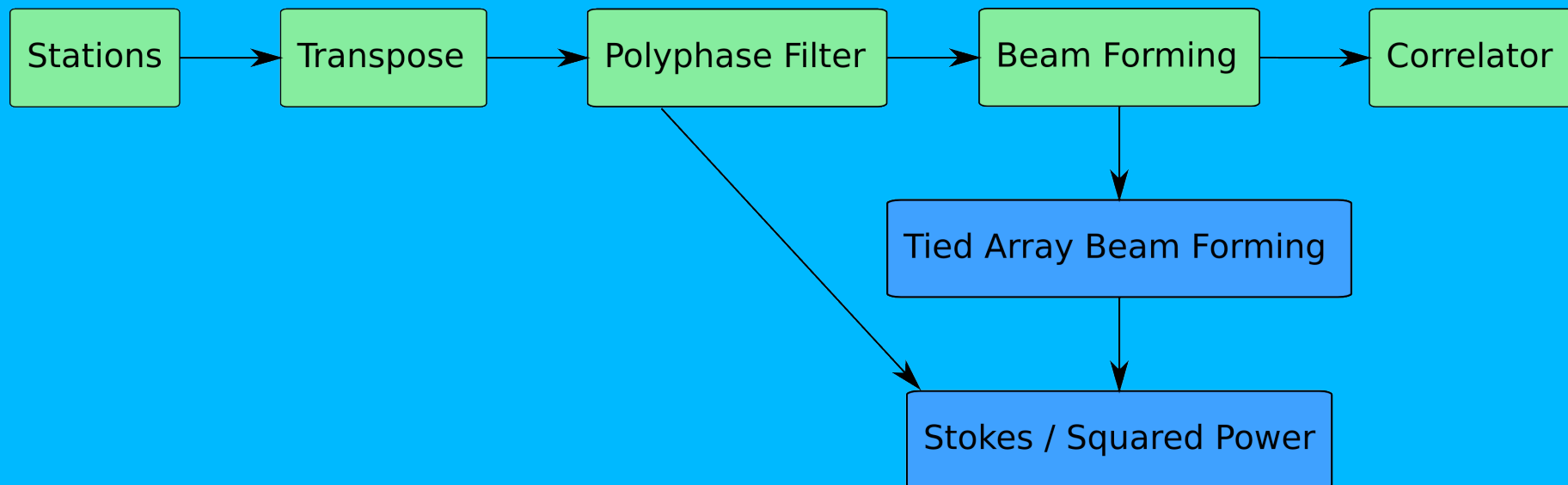
LOFAR status meeting  
*Jan David Mol*

- LOFAR can adjust its aim in software
  - *Coherent* observation
  - Look at *known* pulsars
- LOFAR can observe the whole sky at once
  - *Incoherent* observation
  - Search for *unknown* pulsars

# Coherent: Tied-Array (Pencil) Beams

- Focus can be shifted within a beam (phase adjustments)
- Focus on multiple objects within a beam at the same time
- Limited by processing power and output bandwidth





- Green: (existing) imaging pipeline
- Blue: (new) pulsar pipelines

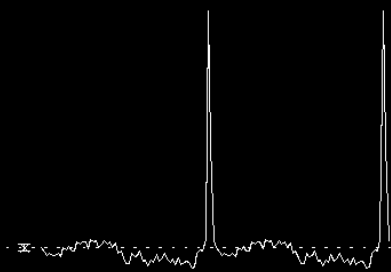
# First test

- Track pulsar B0329+54 using CS010
- Compute squared power on BlueGene
- Convert results for PRESTO
- Run result through PRESTO

# B0329+54 as seen from CS010 (4 HBA tiles)

ASTRON

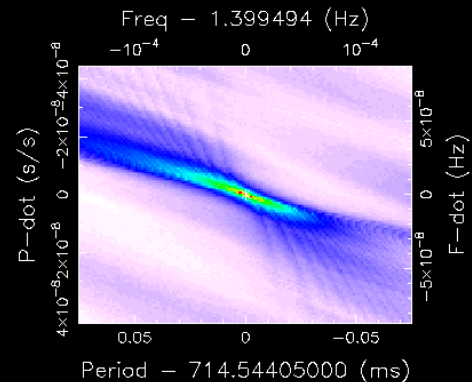
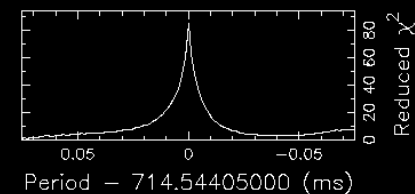
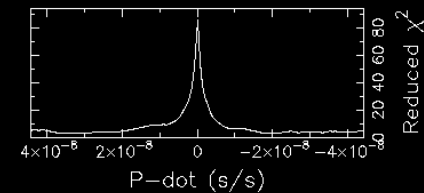
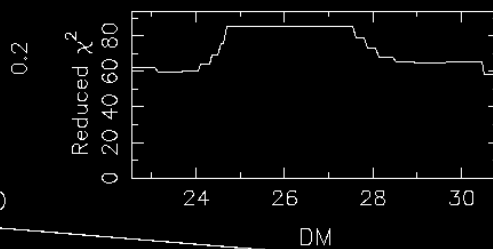
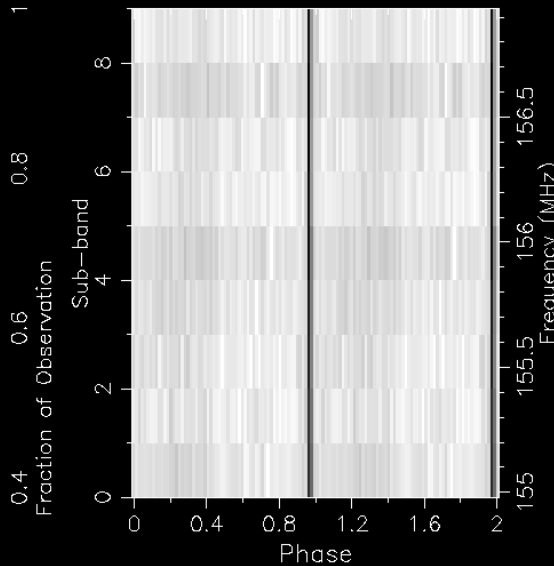
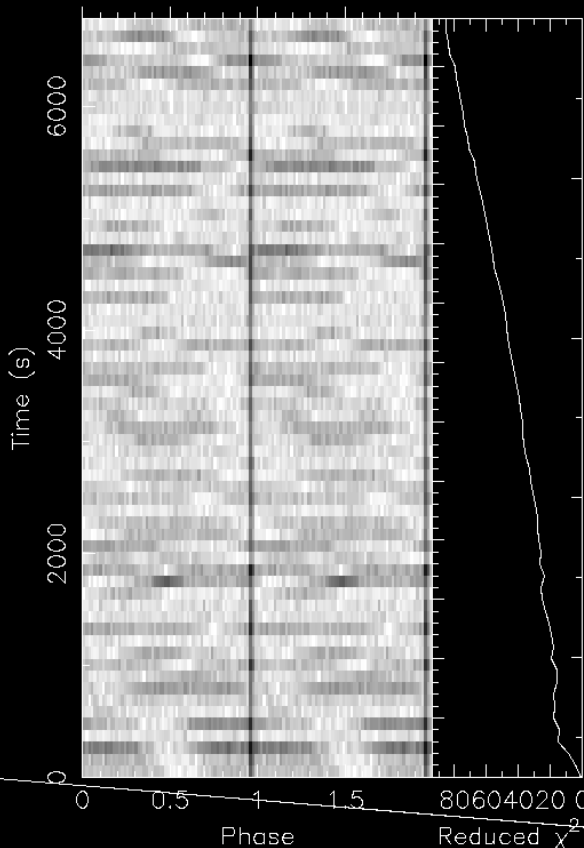
2 Pulses of Best Profile



Candidate: 714.54ms\_Cand  
 Telescope: GBT  
 Epoch<sub>topo</sub> = 54774.00416323508  
 Epoch<sub>bary</sub> = N/A  
 T<sub>sample</sub> = 0.0013107  
 Data Folded = 5177344  
 Data Avg = -1.292  
 Data StdDev = 214  
 Profile Bins = 64  
 Profile Avg = -1.043e+05  
 Profile StdDev = 6.086e+04

Search Information

RA<sub>J2000</sub> = 03:29:00.0000      DEC<sub>J2000</sub> = 54:00:00.0000  
 Folding Parameters  
 Reduced  $\chi^2$  = 85.297      P(Noise)  $\sim$  0  
 Dispersion Measure (DM) = 26.700  
 P<sub>topo</sub> (ms) = 0.0(0.0)      P<sub>bary</sub> (ms) = N/A  
 P'<sub>topo</sub> (s/s) = 0.0(0.0)      P'<sub>bary</sub> (s/s) = N/A  
 P''<sub>topo</sub> (s/s<sup>2</sup>) = 0.0(0.0)      P''<sub>bary</sub> (s/s<sup>2</sup>) = N/A  
 Binary Parameters  
 P<sub>orb</sub> (s) = N/A      e = N/A  
 a<sub>1</sub>sin(i)/c (s) = N/A       $\omega$  (rad) = N/A  
 T<sub>peri</sub> = N/A



# Milestones

- Support for multiple pipelines implemented
- Pulsar pipeline connected with Astronomy Group
- Preliminary tests successful

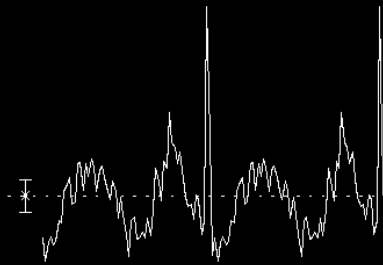
# A lot more to do

- Time/frequency averaging
- Band pass filter
- Variable polyphase filter
- .. and more, if processing power allows
  
- Convert critical code to assembly
- More testing!



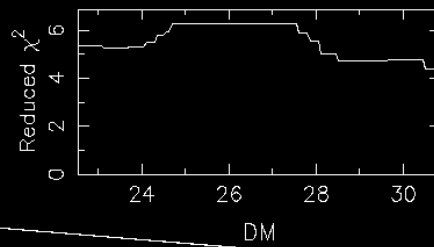
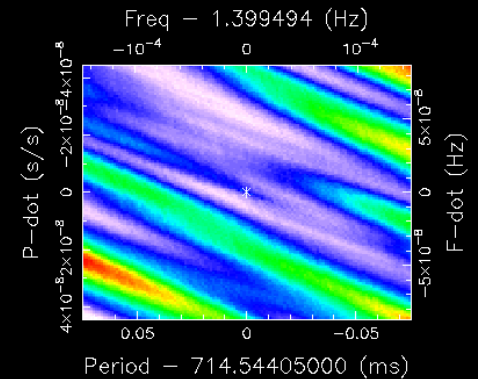
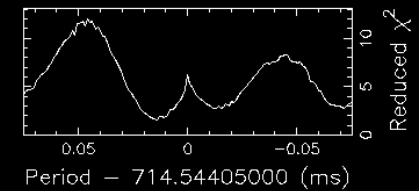
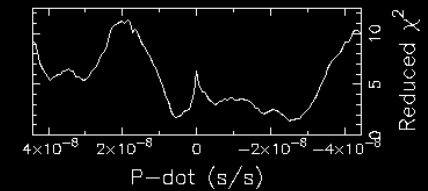
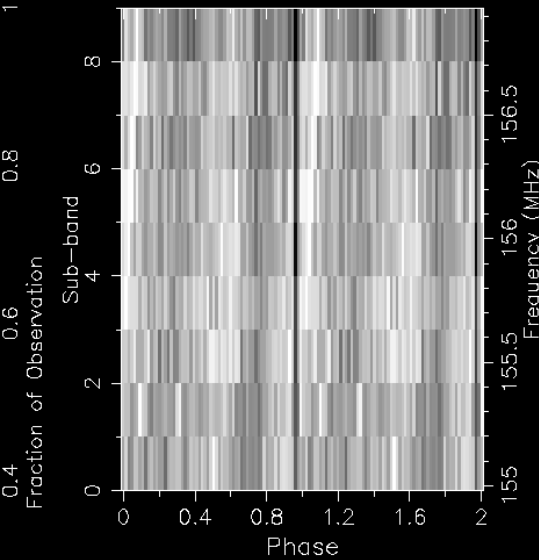
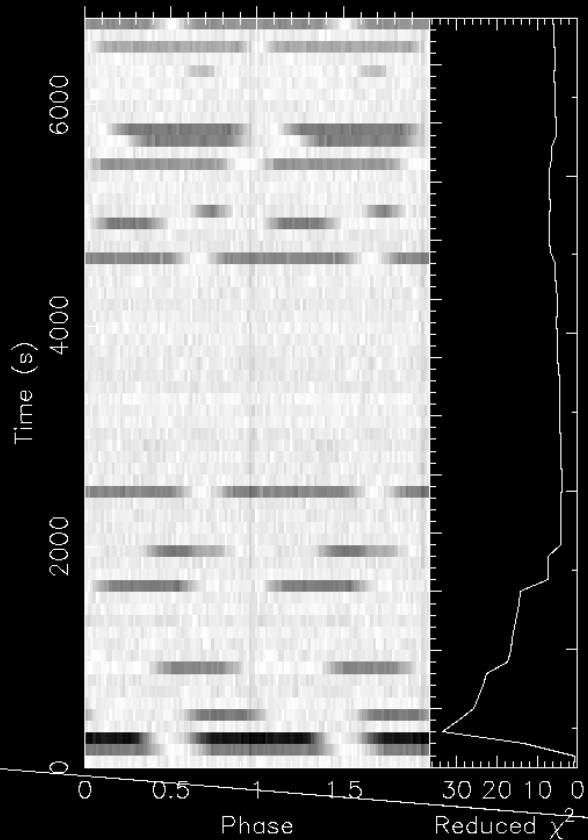
# Tile 1

2 Pulses of Best Profile



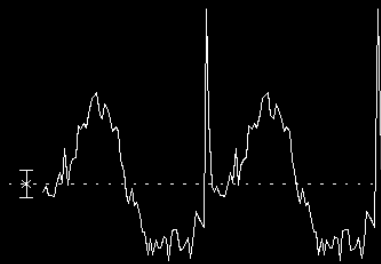
Candidate: 714.54ms\_Cand  
 Telescope: GBT  
 Epoch<sub>topo</sub> = 54774.00416323508  
 Epoch<sub>bary</sub> = N/A  
 T<sub>sample</sub> = 0.0013107  
 Data Folded = 5177344  
 Data Avg = -25.69  
 Data StdDev = 938  
 Profile Bins = 64  
 Profile Avg = -2.077e+06  
 Profile StdDev = 2.668e+05

Search Information  
 RA<sub>J2000</sub> = 03:29:00.0000      DEC<sub>J2000</sub> = 54:00:00.0000  
 Folding Parameters  
 Reduced  $\chi^2$  = 6.257      P(Noise) < 1.96e-49 ( $\approx 14.7\sigma$ )  
 Dispersion Measure (DM) = 26.700  
 P<sub>topo</sub> (ms) = 0.0(0.0)      P<sub>bary</sub> (ms) = N/A  
 P'<sub>topo</sub> (s/s) = 0.0(0.0)      P'<sub>bary</sub> (s/s) = N/A  
 P''<sub>topo</sub> (s/s<sup>2</sup>) = 0.0(0.0)      P''<sub>bary</sub> (s/s<sup>2</sup>) = N/A  
 Binary Parameters  
 P<sub>orb</sub> (s) = N/A      e = N/A  
 a<sub>1</sub> sin(i)/c (s) = N/A       $\omega$  (rad) = N/A  
 T<sub>peri</sub> = N/A



# Tile 2

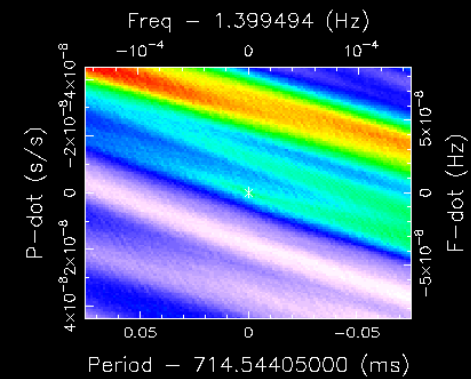
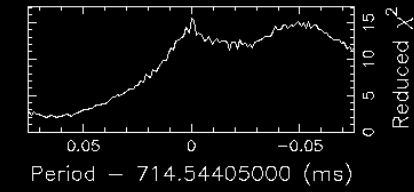
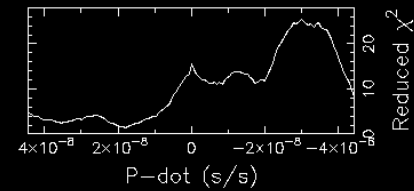
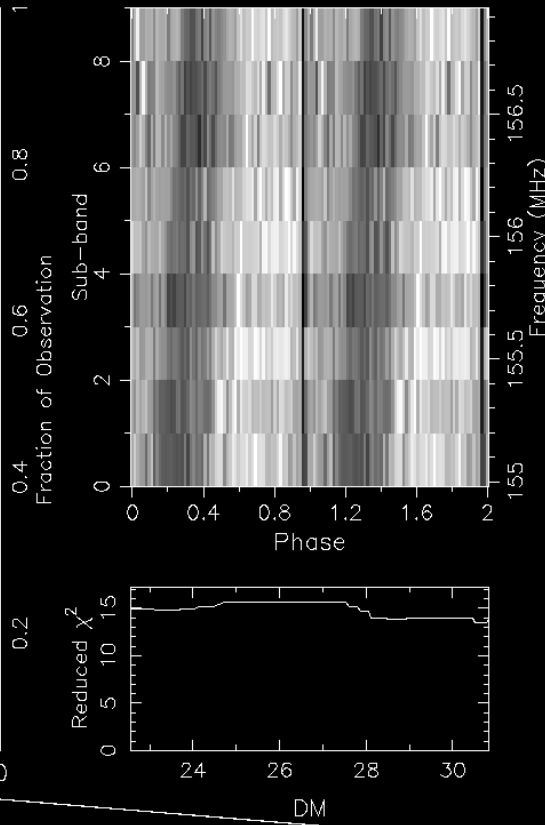
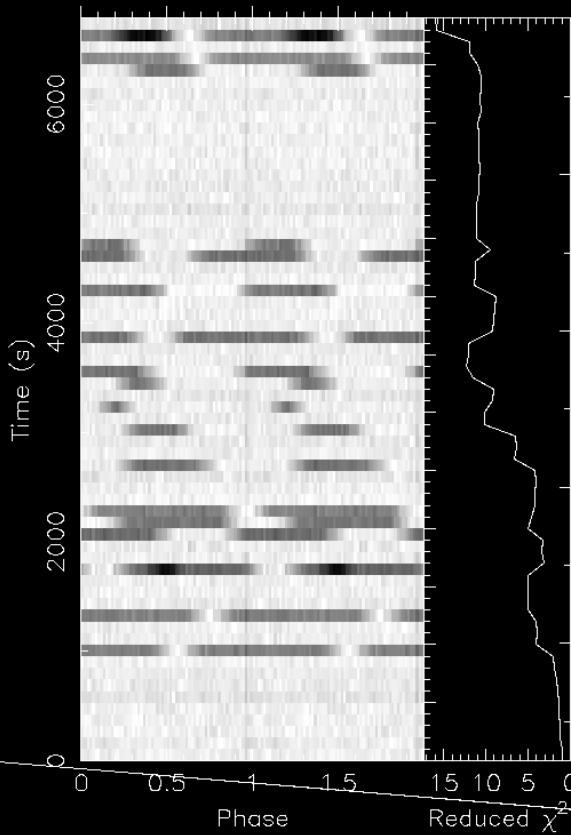
2 Pulses of Best Profile



Candidate: 714.54ms\_Cand  
 Telescope: GBT  
 Epoch<sub>topo</sub> = 54774.00416323508  
 Epoch<sub>bary</sub> = N/A  
 T<sub>sample</sub> = 0.0013107  
 Data Folded = 5177344  
 Data Avg = -40.68  
 Data StdDev = 1057  
 Profile Bins = 64  
 Profile Avg = -3.291e+06  
 Profile StdDev = 3.008e+05

Search Information

RA<sub>J2000</sub> = 03:29:00.0000      DEC<sub>J2000</sub> = 54:00:00.0000  
 Folding Parameters  
 Reduced  $\chi^2$  = 15.675      P(Noise) < 3.73e-166 ( $\approx 27.4\sigma$ )  
 Dispersion Measure (DM) = 26.700  
 P<sub>topo</sub> (ms) = 0.0(0.0)      P<sub>bary</sub> (ms) = N/A  
 P'<sub>topo</sub> (s/s) = 0.0(0.0)      P'<sub>bary</sub> (s/s) = N/A  
 P''<sub>topo</sub> (s/s<sup>2</sup>) = 0.0(0.0)      P''<sub>bary</sub> (s/s<sup>2</sup>) = N/A  
 Binary Parameters  
 P<sub>orb</sub> (s) = N/A      e = N/A  
 a<sub>1</sub>sin(i)/c (s) = N/A       $\omega$  (rad) = N/A  
 T<sub>peri</sub> = N/A



# Tile 5

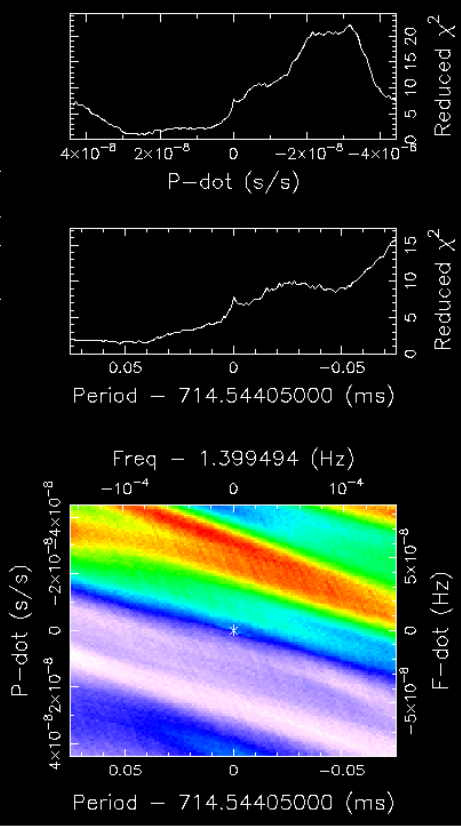
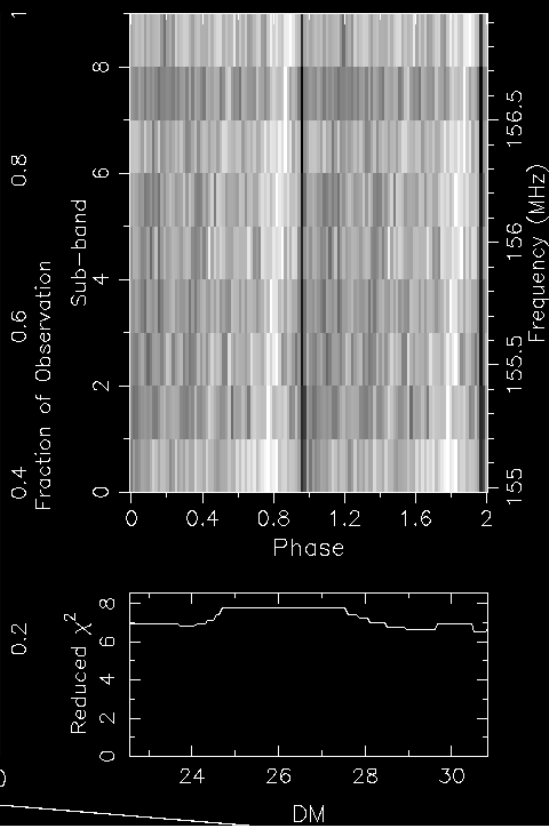
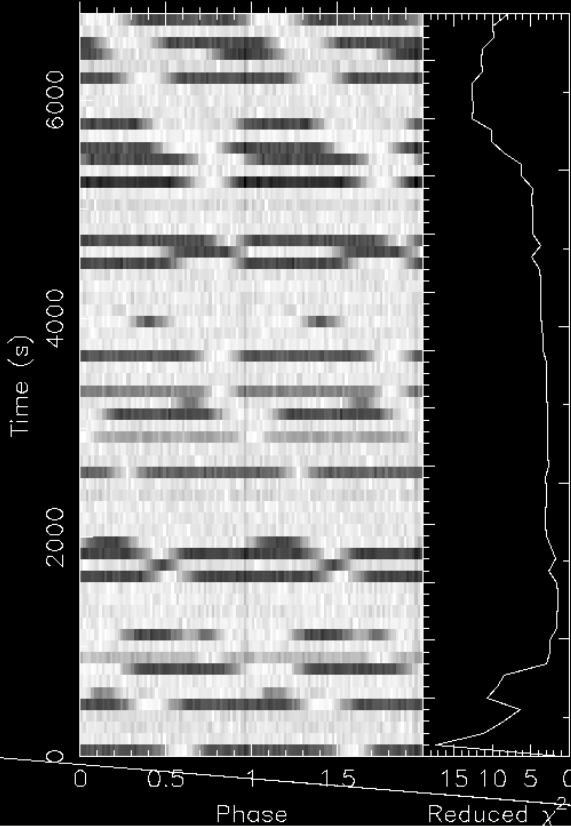
2 Pulses of Best Profile



Candidate: 714.54ms\_Cand  
 Telescope: GBT  
 Epoch<sub>topo</sub> = 54774.00416323508  
 Epoch<sub>bary</sub> = N/A  
 T<sub>sample</sub> = 0.0013107  
 Data Folded = 5177344  
 Data Avg = -28.51  
 Data StdDev = 1059  
 Profile Bins = 64  
 Profile Avg = -2.306e+06  
 Profile StdDev = 3.013e+05

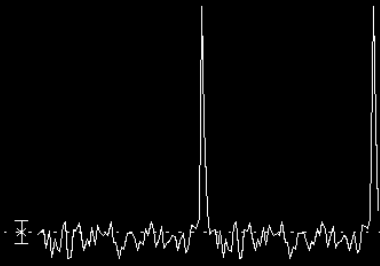
Search Information

RA<sub>J2000</sub> = 03:29:00.0000      DEC<sub>J2000</sub> = 54:00:00.0000  
 Folding Parameters  
 Reduced  $\chi^2$  = 7.798      P(Noise) < 1.3e-67 ( $\approx 17.3\sigma$ )  
 Dispersion Measure (DM) = 26.700  
 P<sub>topo</sub> (ms) = 0.0(0.0)      P<sub>bary</sub> (ms) = N/A  
 P'<sub>topo</sub> (s/s) = 0.0(0.0)      P'<sub>bary</sub> (s/s) = N/A  
 P''<sub>topo</sub> (s/s<sup>2</sup>) = 0.0(0.0)      P''<sub>bary</sub> (s/s<sup>2</sup>) = N/A  
 Binary Parameters  
 P<sub>orb</sub> (s) = N/A      e = N/A  
 a<sub>1</sub>sin(i)/c (s) = N/A       $\omega$  (rad) = N/A  
 T<sub>peri</sub> = N/A



# Tile 6

2 Pulses of Best Profile



Candidate: 714.54ms\_Cand  
 Telescope: GBT  
 Epoch<sub>topo</sub> = 54774.00416323508  
 Epoch<sub>bary</sub> = N/A  
 T<sub>sample</sub> = 0.0013107  
 Data Folded = 5177344  
 Data Avg = -37.14  
 Data StdDev = 775.1  
 Profile Bins = 64  
 Profile Avg = -3.004e+06  
 Profile StdDev = 2.205e+05

Search Information  
 RA<sub>J2000</sub> = 03:29:00.0000      DEC<sub>J2000</sub> = 54:00:00.0000  
 Folding Parameters  
 Reduced  $\chi^2$  = 8.617    P(Noise) < 1.68e-77 ( $\approx 18.6\sigma$ )  
 Dispersion Measure (DM) = 26.700  
 P<sub>topo</sub> (ms) = 0.0(0.0)      P<sub>bary</sub> (ms) = N/A  
 P'<sub>topo</sub> (s/s) = 0.0(0.0)      P'<sub>bary</sub> (s/s) = N/A  
 P''<sub>topo</sub> (s/s<sup>2</sup>) = 0.0(0.0)      P''<sub>bary</sub> (s/s<sup>2</sup>) = N/A  
 Binary Parameters  
 P<sub>orb</sub> (s) = N/A      e = N/A  
 a<sub>1</sub>sin(i)/c (s) = N/A       $\omega$  (rad) = N/A  
 T<sub>peri</sub> = N/A

