



The search and localization of single pulses in VLBI observation

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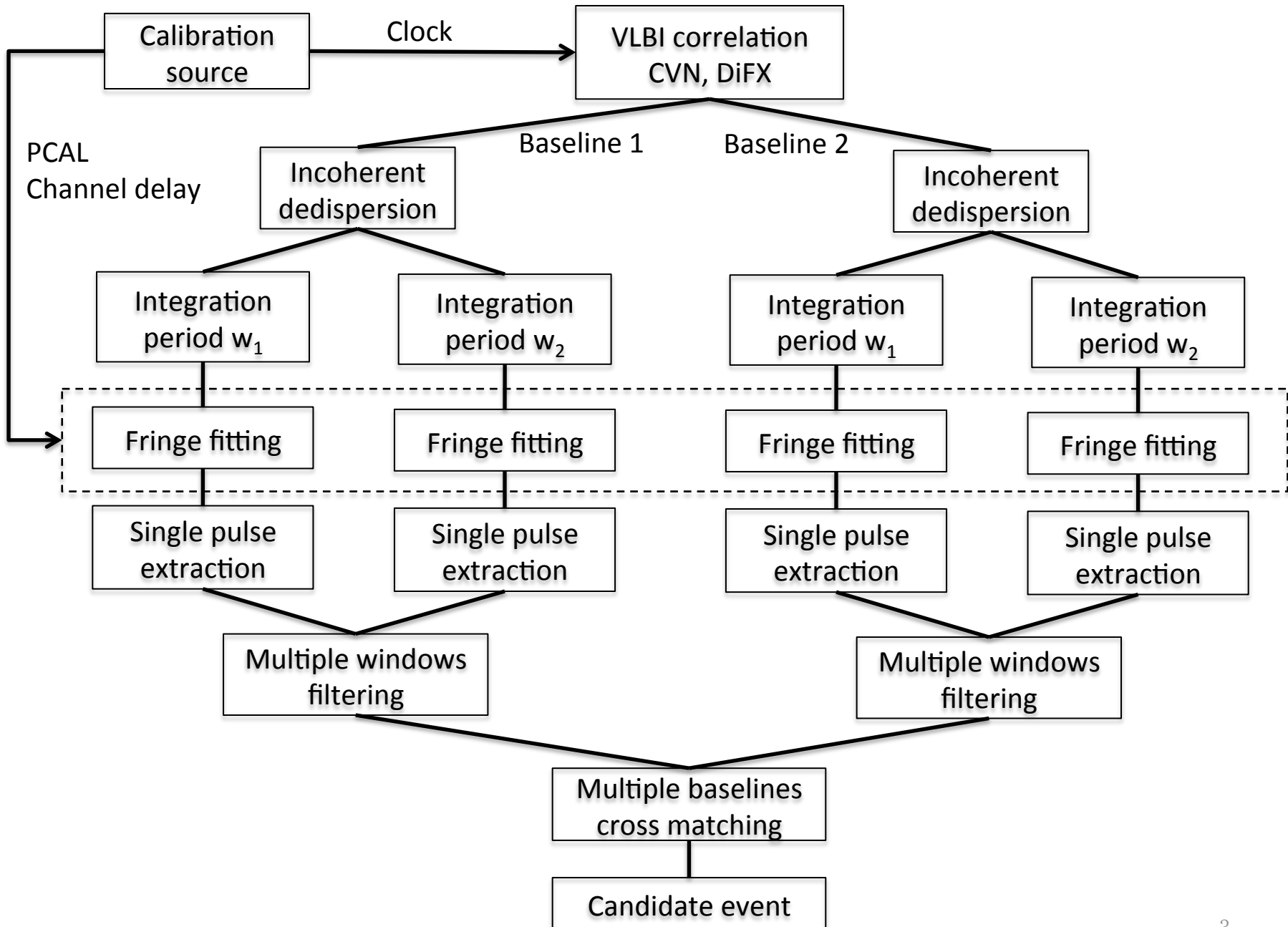
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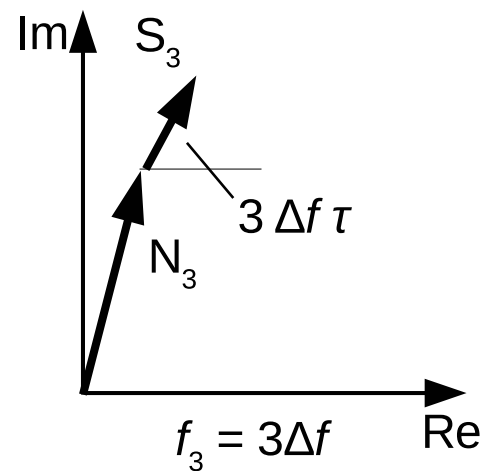
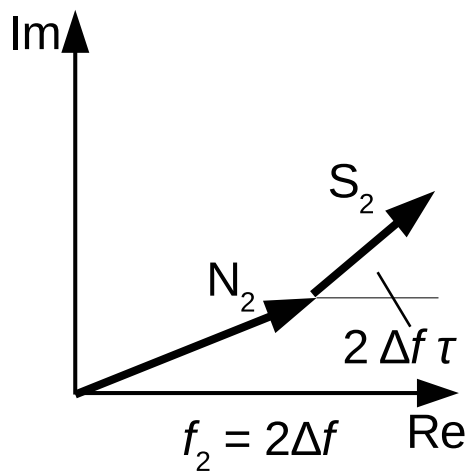
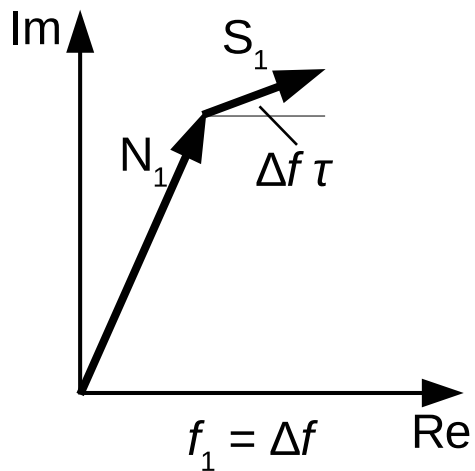
Jul. 5, 2018 @ FPS7, Guangzhou



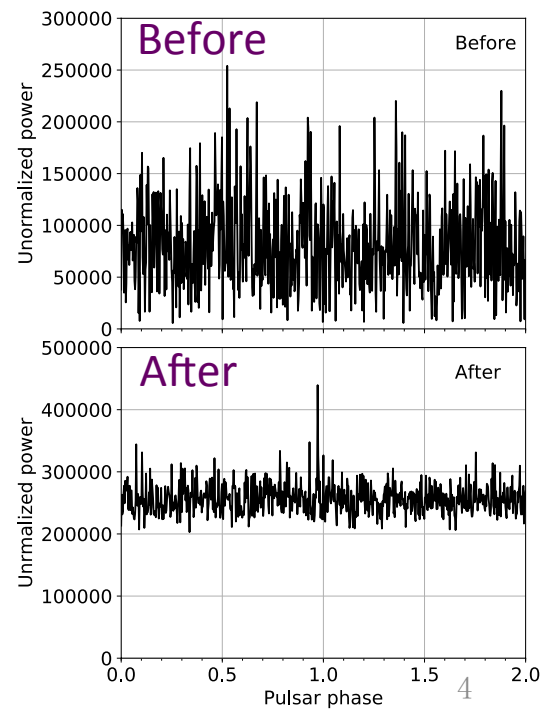
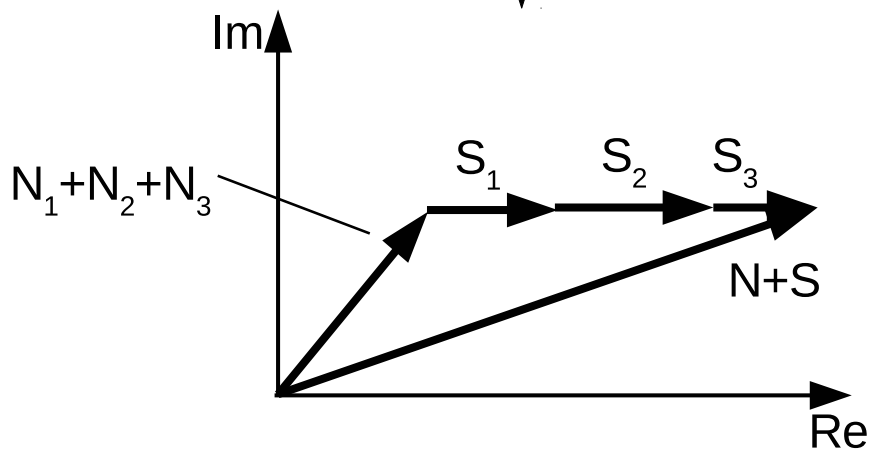
Outline

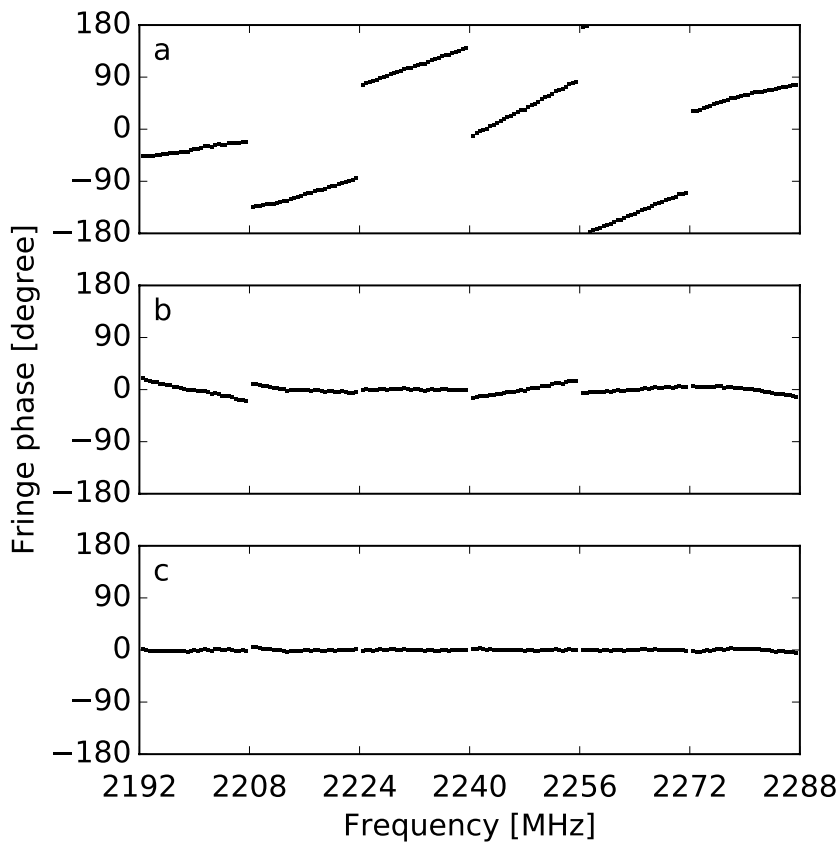
- Single pulse search method
 - VLBI cross spectrum based
 - Designed for FRB search in VLBI observation
 - Extract single pulses from RFI contaminated data
- Localization of single pulses
 - Radio imaging
 - Direct solving





Fringe Fitting





Raw cross spectrum

Fringe fitting:
Phase calibration only

Fringe fitting:
Phase + channel delay calibration

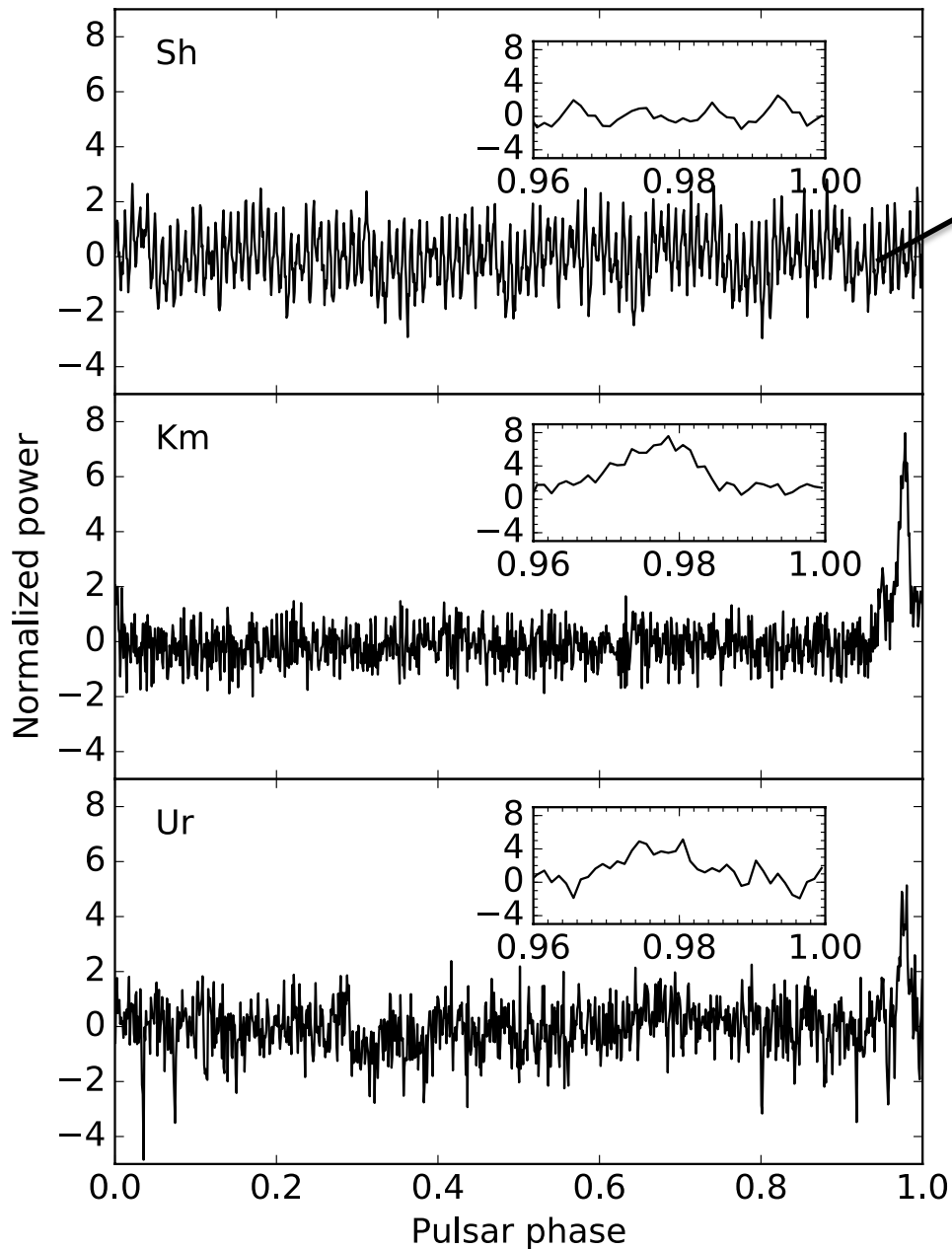
$$G_{k_0, l}(\Delta\tau_s, \Delta\tau_m) = \sum_{n=0}^{N-1} \sum_{j=1}^{J-1} S_{k_0, l}(n, j) e^{-i[2\pi f_j \Delta\tau_s + 2\pi(f_0^n - f_{\text{ref, fit}}) \Delta\tau_m + 2\pi(f_j - f_{\text{bw}}/2) \Delta\tau_0^n + \Delta\phi_0^n]}$$

Single band delay Multiple band delay Cross spectrum Channel delay calibration Phase calibration



Single pulse search in pulsar data set

- Experiment psrf02 (CVN)
 - Time Feb. 25, 2015
 - Stations Sh, Km, Ur
 - Target source J0332+5434
 - Phase reference source J0347+5557
 - Calibration source 3C273
 - S band, 2192 MHz - 2288 MHz, 6 channels
-

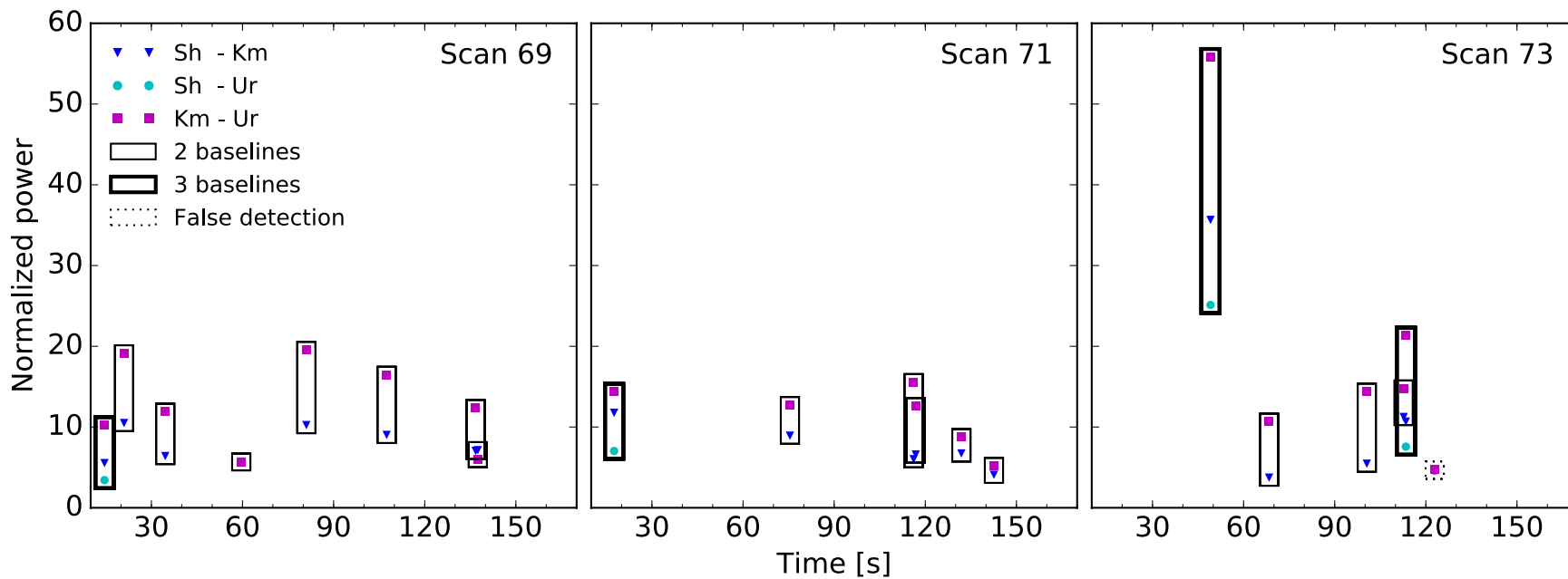


J0332+5434

Period: 714.5 ms
DM: 26.833 pc cm⁻³
Flux: 0.1 Jy @ 2.2 GHz



Detection result

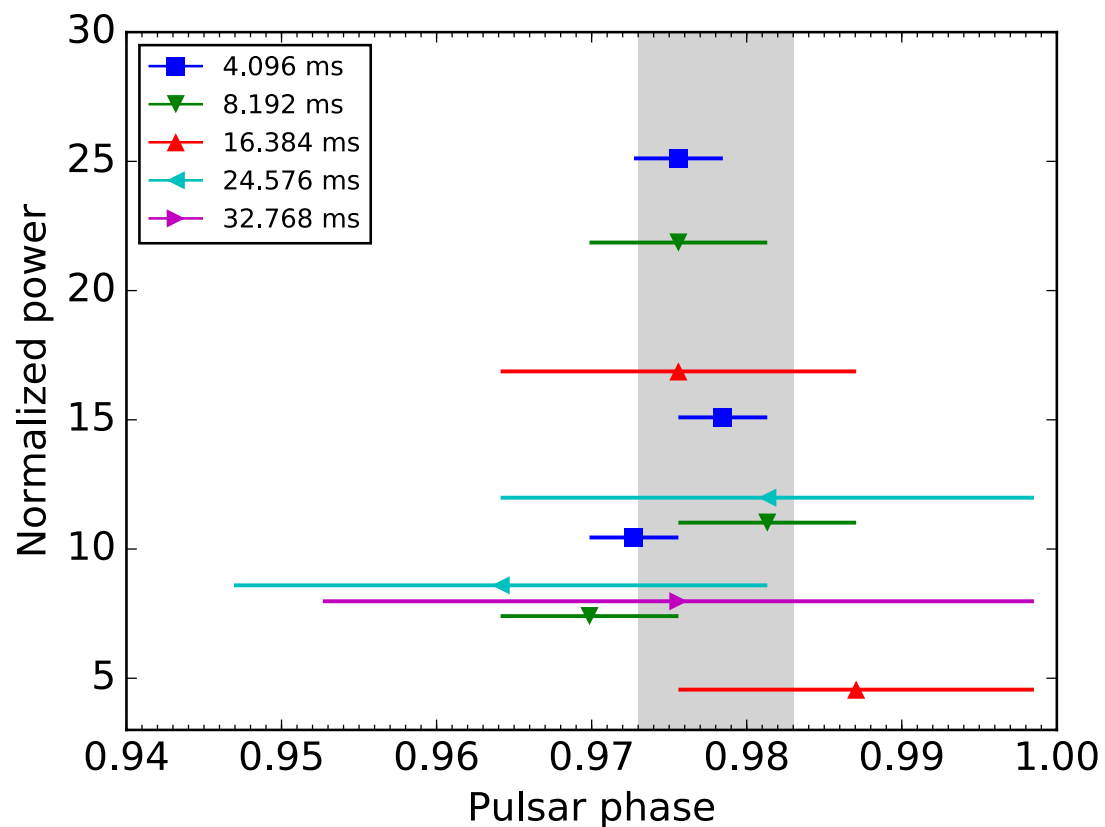
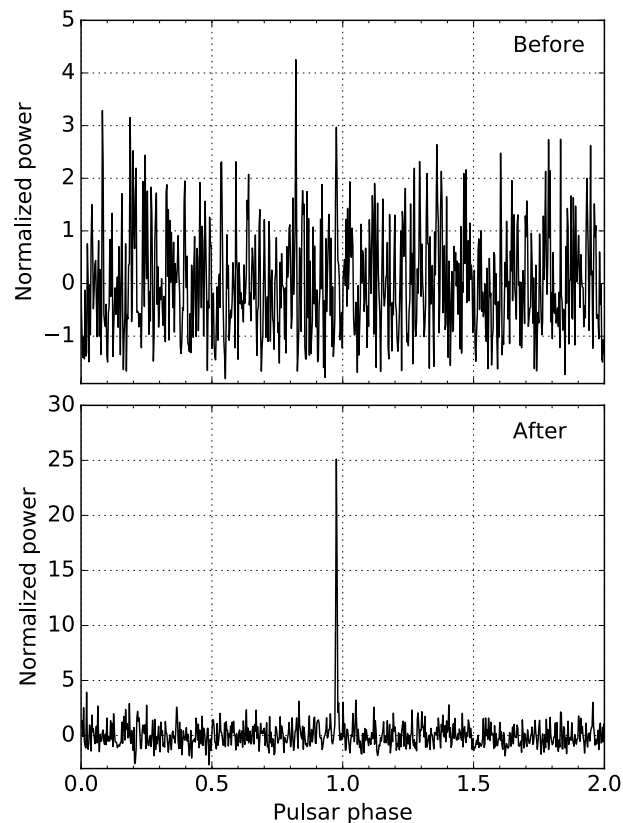


2 baselines: 16 (15)

3 baselines: 4 (4)



Single pulse extraction: Sh-Ur





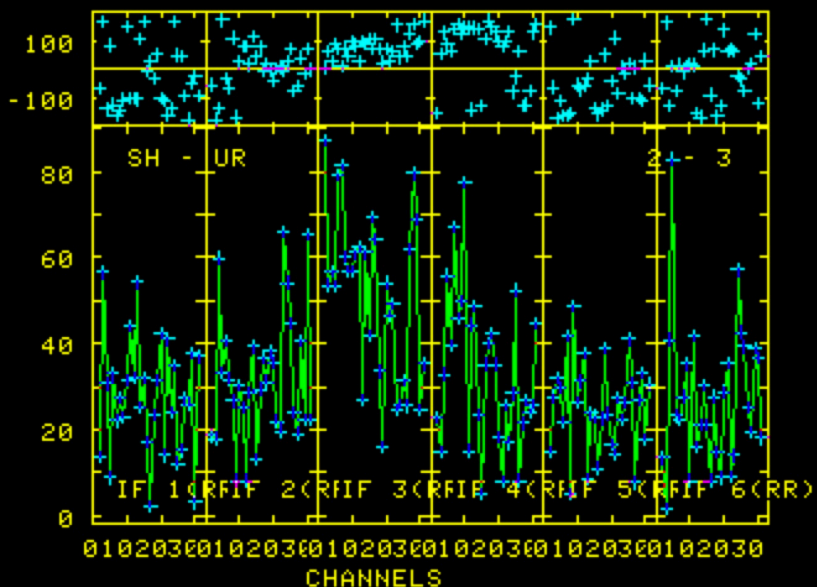
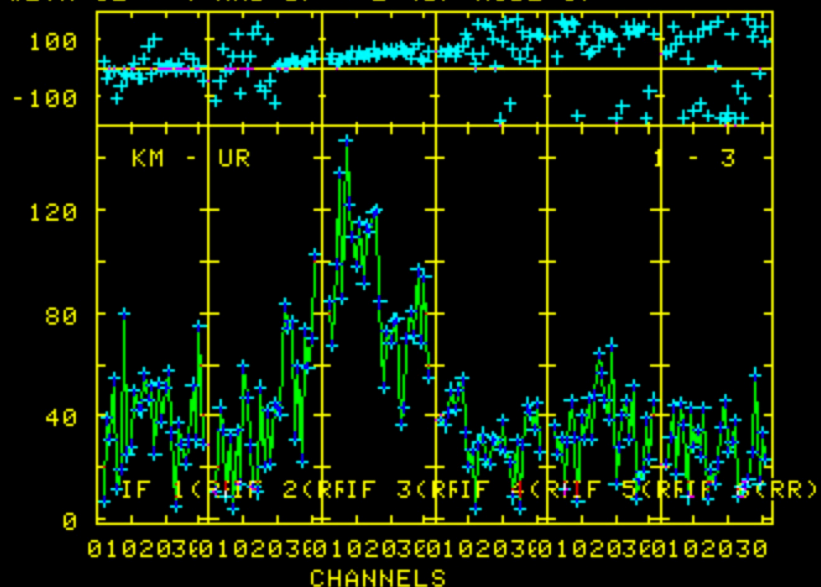
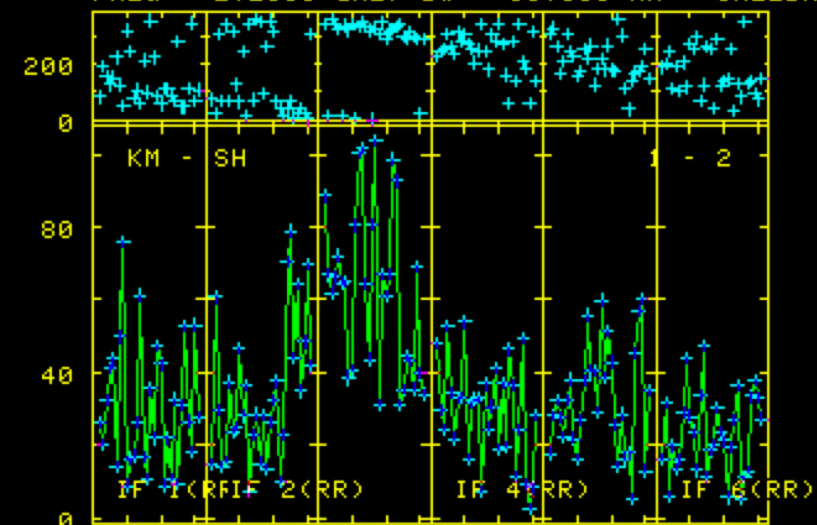
Radio imaging

- Phase reference
 - Reference source: J0347+5557 (1.8 degree)
- AIPS (31DEC18)
- 4 ms integration

PLOT FILE VERSION 0 CREATED 26-JUN-2018 22:13:27

J0332+5434 MULTI.DBCON.1

FREQ = 2.2000 GHZ, BW = 16.000 MH CALIBRATED WITH CL # 4 AND BP # 2 (BP MODE 1)

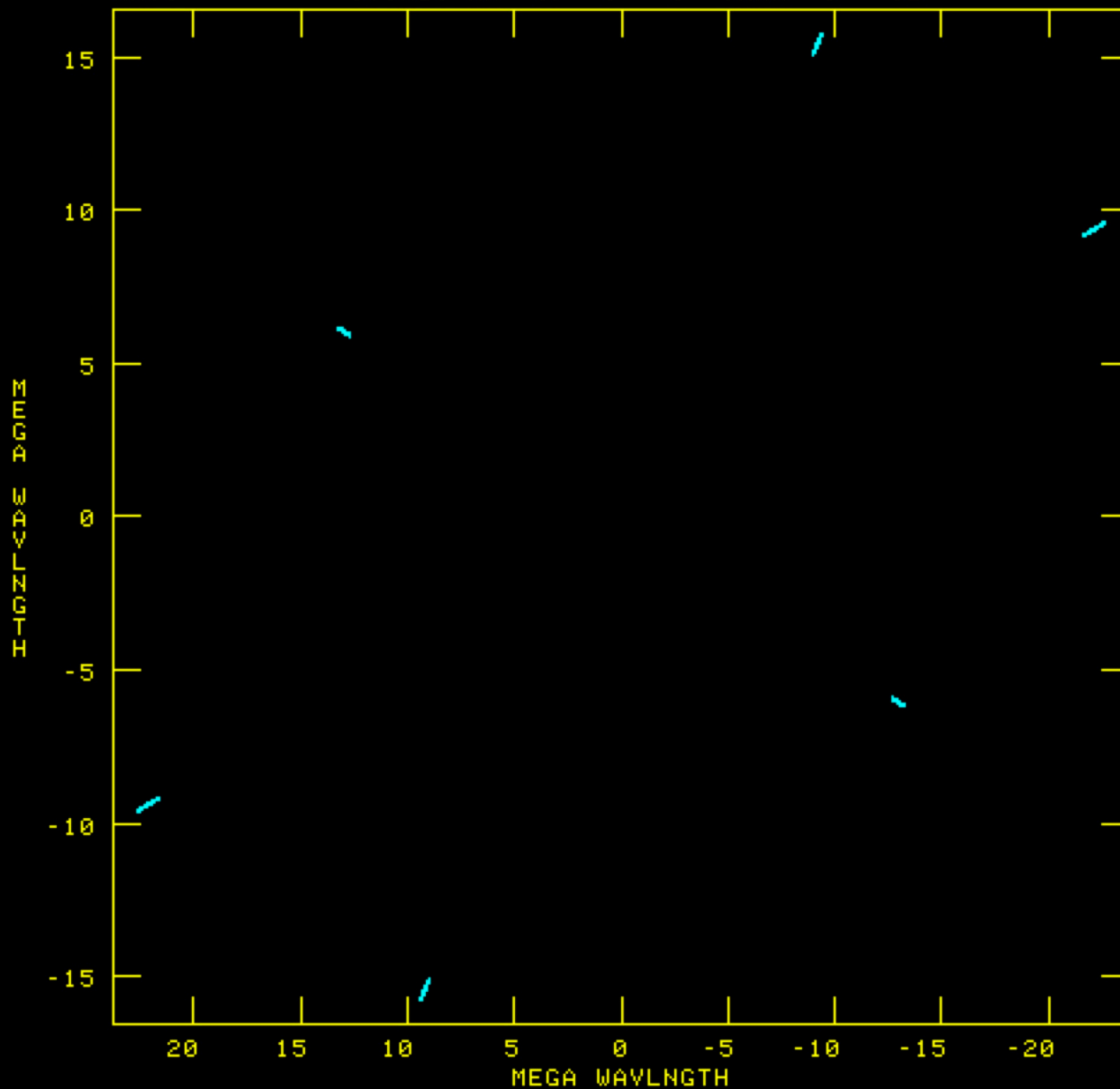


LOWER FRAME: MILLI AMPL JY TOP FRAME: PHAS DEG

VECTOR AVERAGED CROSS-POWER SPECTRUM SEVERAL BASELINES DISPLAYED

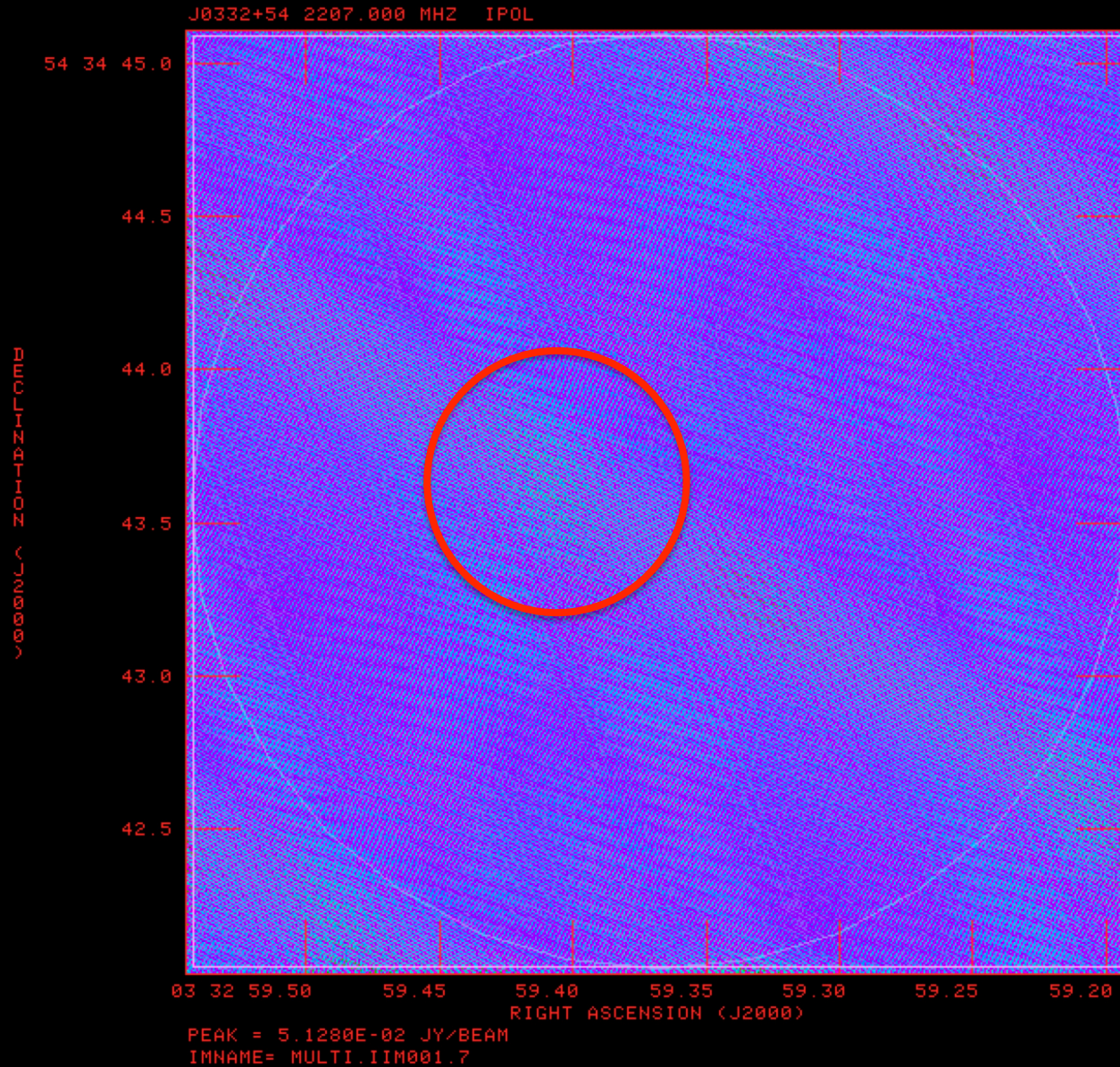
TIMERANGE: 00/10:58:20 TO 00/10:58:21

PLOT FILE VERSION 0 CREATED 02-JUL-2018 14:37:55
V VS U FOR MULTI.DBCON.1 SOURCE: J0332+5434
ANTS * - * STOKES RR IF# 1 - 6 CHAN# 1 - 32



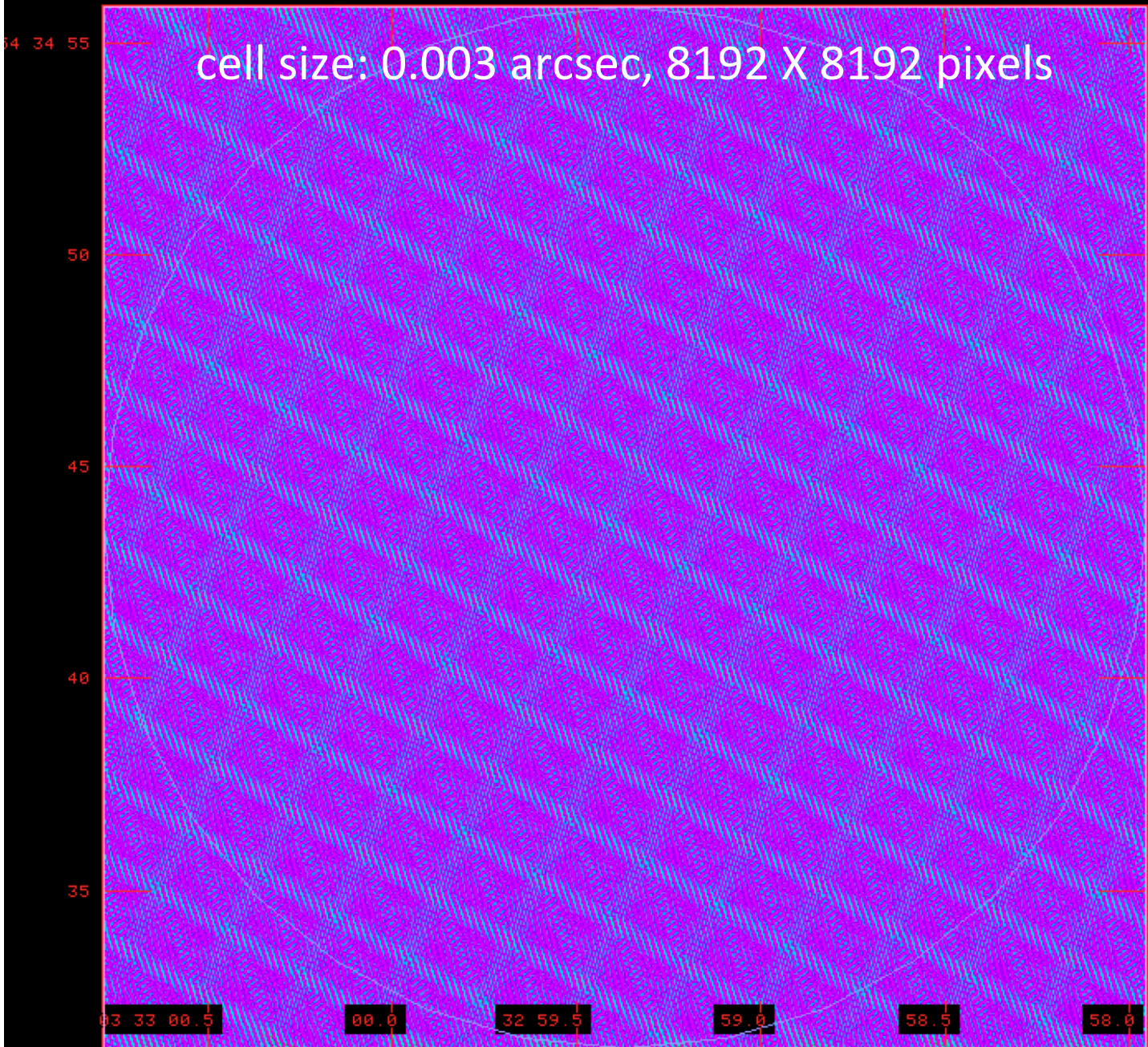
FREQ = 2.2000 GHZ, BW = 16.000 MHZ
FROM 0/10:58:20 TO 0/10:58:21

cell size: 0.003 arcsec, 1024 X 1024 pixels



J0332+54 IPOL 2239.750 MHZ

cell size: 0.003 arcsec, 8192 X 8192 pixels



RIGHT ASCENSION (J2000)



Direct solving:

$$\Delta\tau = \frac{\partial\tau}{\partial\alpha}\Delta\alpha + \frac{\partial\tau}{\partial\delta}\Delta\delta$$

- Geodetic VLBI
 - vSolve
 - MBD only
 - Ambiguity ~ 100 ns
- Phase reference
 - Delay fitting across the band
 - Much larger searching area



Summary

- VLBI cross spectrum based single pulse search method
- A full set of single pulse study tools
 - DiFX, CVN correlator support
 - Fringe fitting, multiple windows filtering, multiple baselines cross matching, etc.
- Localization
 - Phase reference
 - Direct solving
- Planned observations: CVN, EVN, geodetic VLBI

Thank you!