RadioAstron

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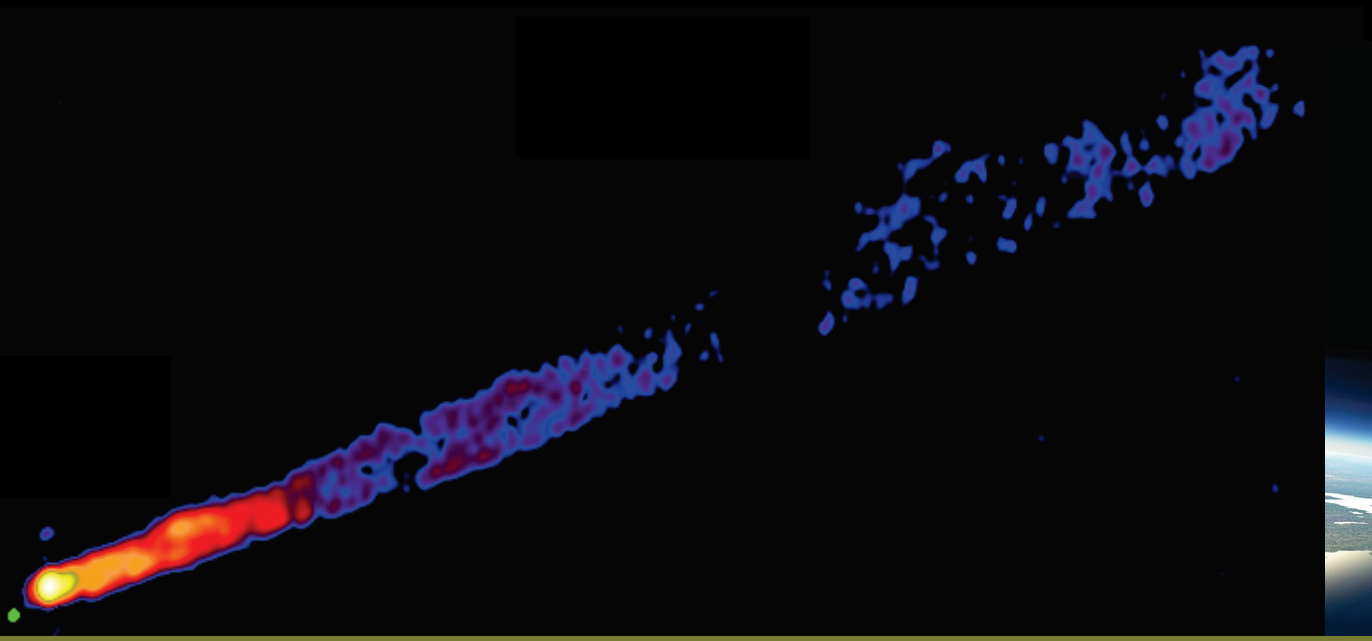
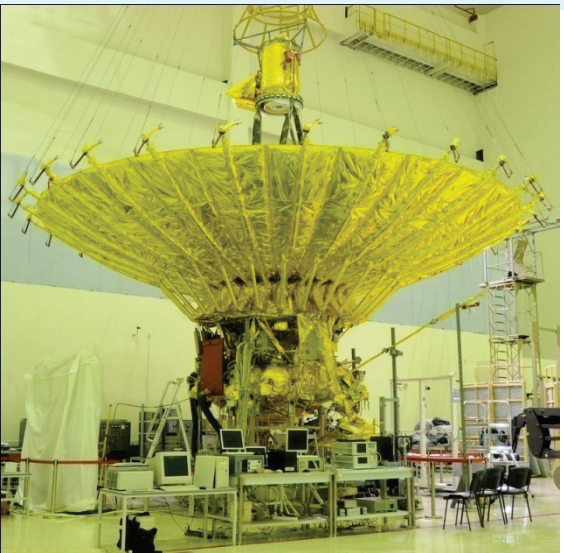


General information

The RadioAstron Space Observatory (the Spectr-R project) equipped with 10-m mirror antenna, is dedicated to investigate a structure of various objects in the Universe at centimeter and decimeter wavelengths with an angular resolution of up to a few millionth of arcsec (i.e., millions time better than human eye's resolution).

Such resolution is achievable for the radio interferometer consisting of a space telescope orbiting with an apogee of up to 350,000 km, and largest ground based radio telescopes.

The Spectr-R project has been included in the Federal Space Program of Russia for 2006-2015.



Frequency bands: 0.3, 1.6, 5, 22 (18-25) GHz
Expected lifetime: 5 years

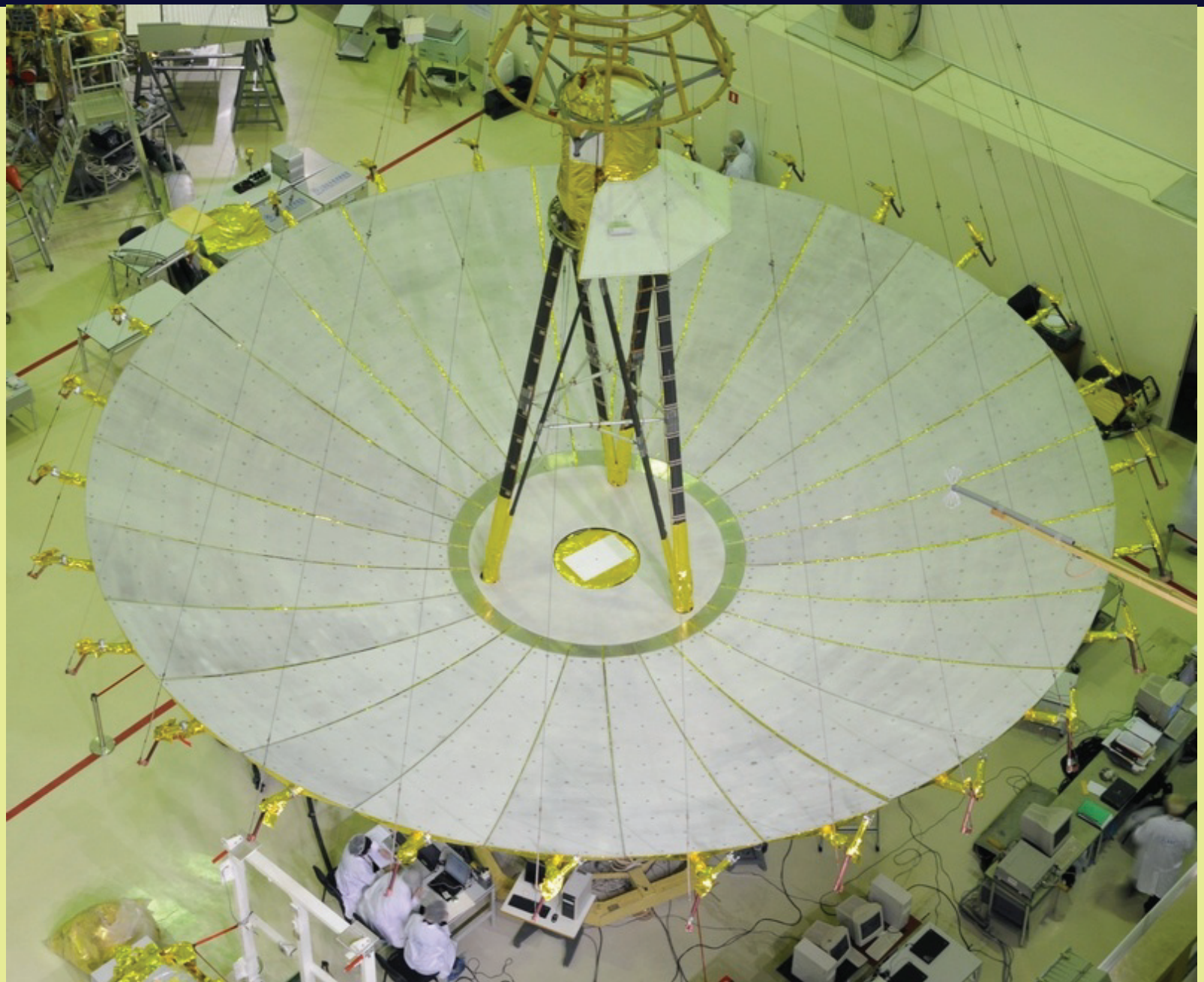
Science

- Active galactic nuclei: jets, super-massive black holes
- Masers (star formation), mega-masers (disks around super-massive black holes)
- Pulsars and interstellar medium
- Gravitational experiments / general relativity

Current status: Spektr-R is in Space.

Assembled together: SRT+Bus Tested Launched on July 18, 2011

Space radio telescope was successfully unfurled on July 23



(original) Schedule after launch

- Months 1-3: unfolding solar panels, deploying the antenna, engineering tests, calibration, orbit determination, pointing corrections, H-maser tests, tracking station tests, etc.
- Months 4-6: fringe search
- Months 7-15?: early science program (ESP) — organized by RadioAstron ESP working groups (AGN, pulsars, masers)
- Since month 16?: open science programs

The hydrogen maser was turned on and reports to work properly

RadioAstron basic parameters: receivers

(recently rebuilt: C and K)

Band	P	L	C	K
Frequencies (MHz) of observations	327	1665	4830	18392-25112
Bandwidth (MHz) for each polarization	4	32	32	32
Fringe size (μas) [base line 350 000 km]	540	106	37	7,1 -10
1σ RMS with GBT for 300 s integration time and 16 MHz wide channel (mJy)	42	4	4	10

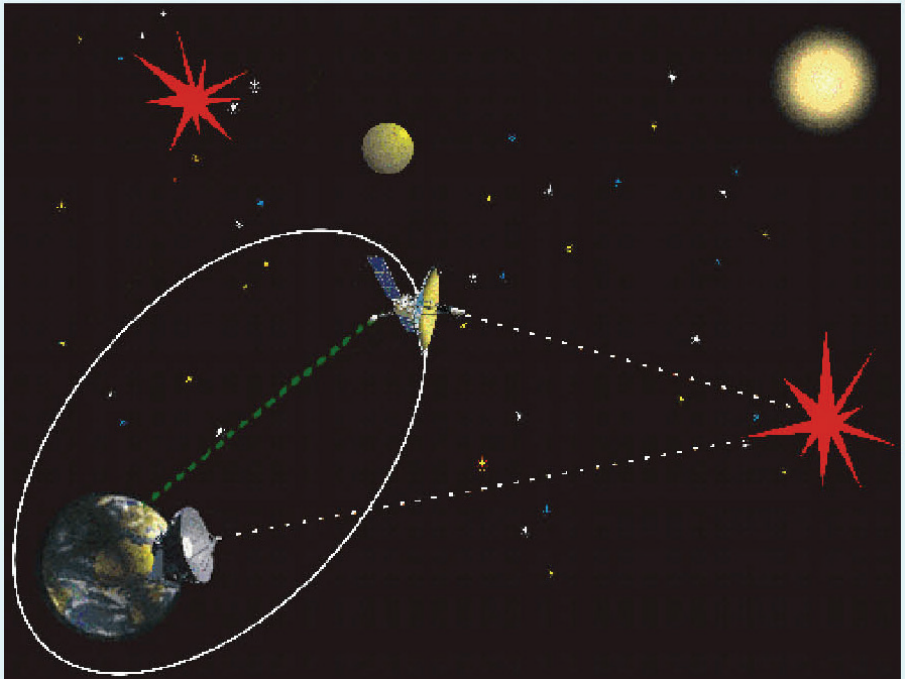
Dual polarization, 128 Mbps bit rate,
Simultaneous single-pol. observations in two bands are possible.

Orbit: parameters and measurements

The orbit of the RadioAstron gravitationally perturbed by the Moon has the following parameters:

Perigee radius:	≥10,000 km
Initial inclination:	51.6^0
Average apogee radius:	350,000 km
Average period of revolution:	9.5 d

The ground-space radio interferometer (artist's view)



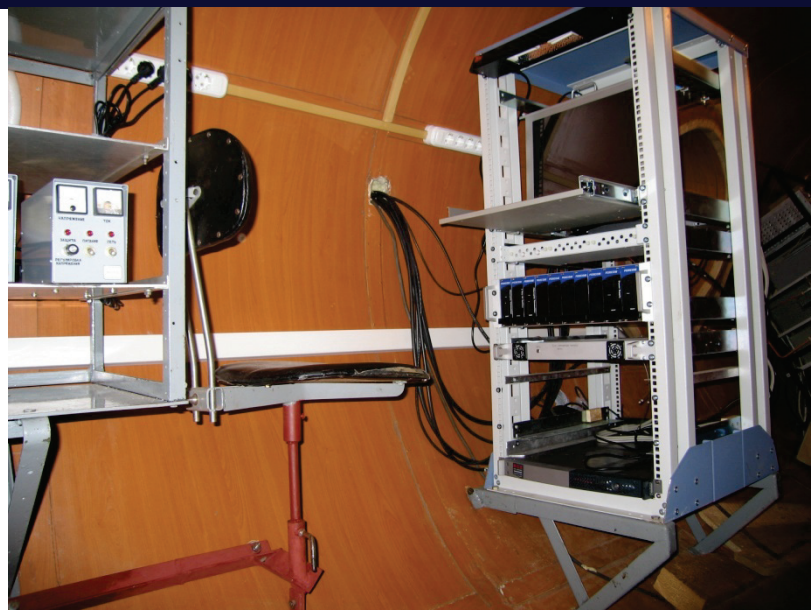
Five methods to measure orbit parameters:

- Radiometric measurements provided by the Flight Control Center from telemetry sessions run at the DSN antennas in Ussurijsk and Bear Lakes (distance/velocity data).
- Closed/open-loop Doppler measurements of velocity by tracking stations.
- Optical measurements of sky position.
- VLBI measurements of the SRT state vector (PRIDE).
- Distance measurements by laser rangers (~100 retro-reflectors are installed on board).

Required position/velocity accuracies: 600 m, 20 mm/s.

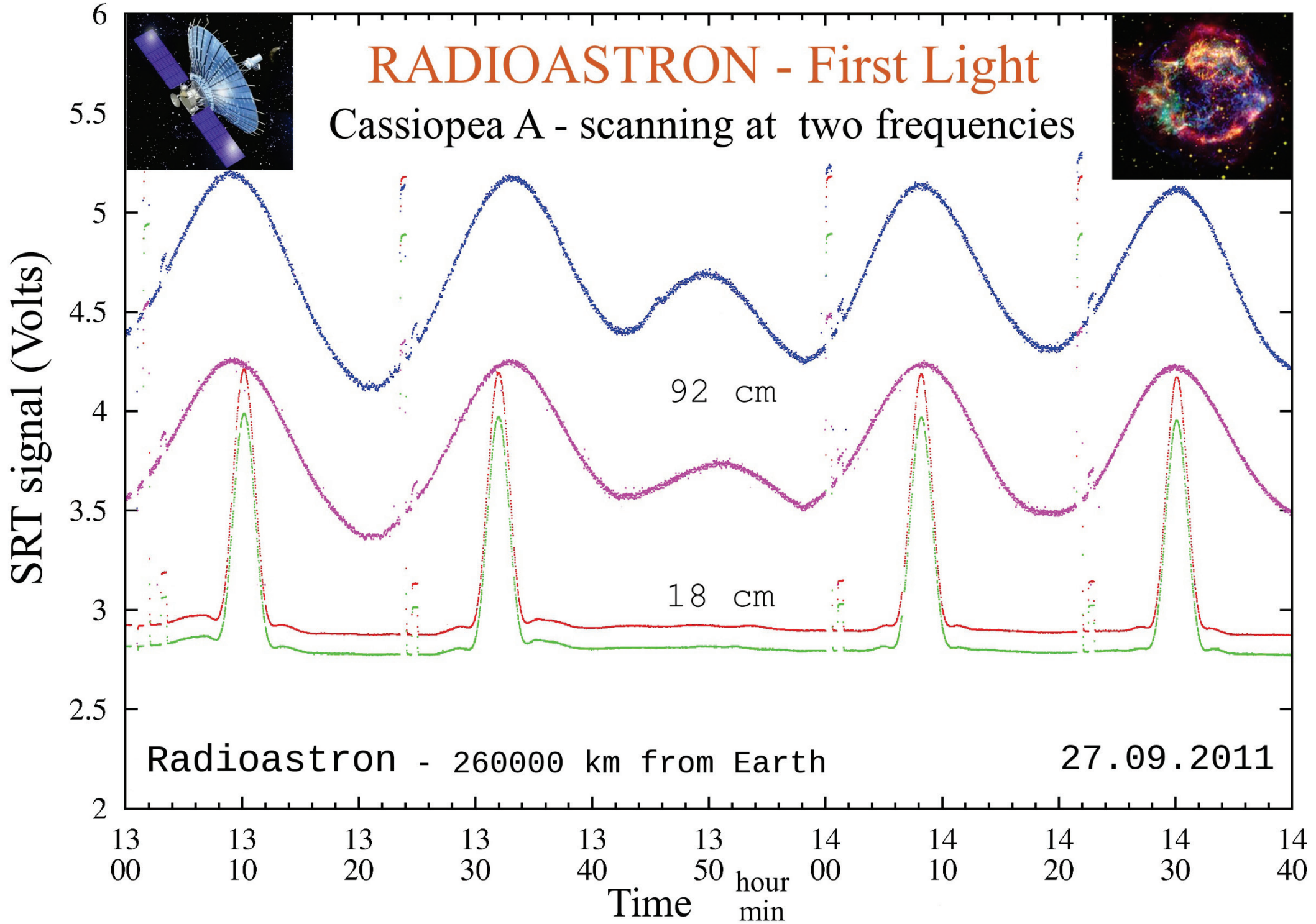
Tracking station and correlation

Doppler measurements, data link

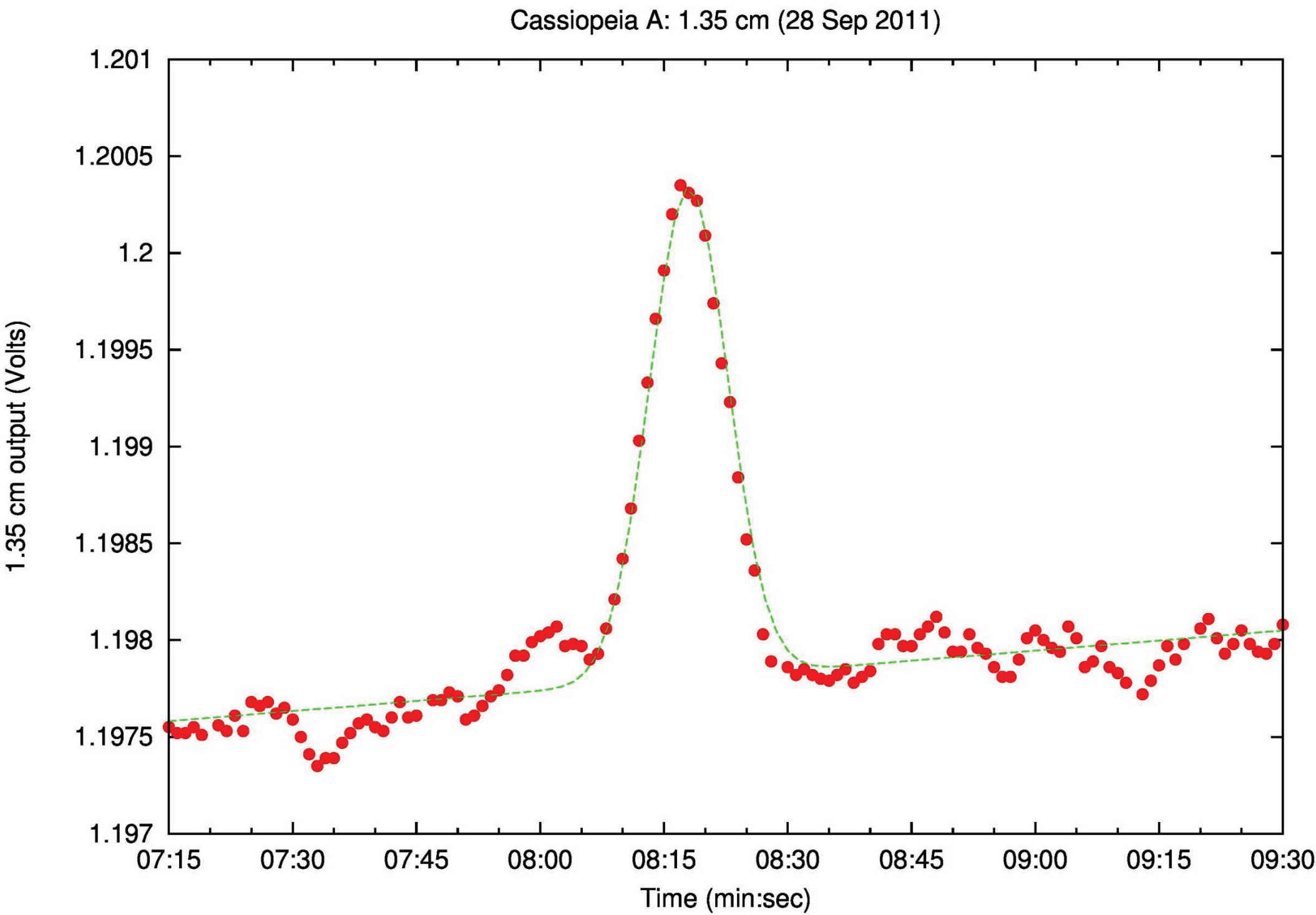


One tracking station is available and works routinely: Pushino, Moscow region, Russia.
Three-band design: 15 GHz telemetry/data stream (144 Mbps), 7.3/8.4 GHz uplink/downlink stream for orbit determination and synchronization.
Three tracking stations are needed. Several under consideration including USA, SA, NZ.

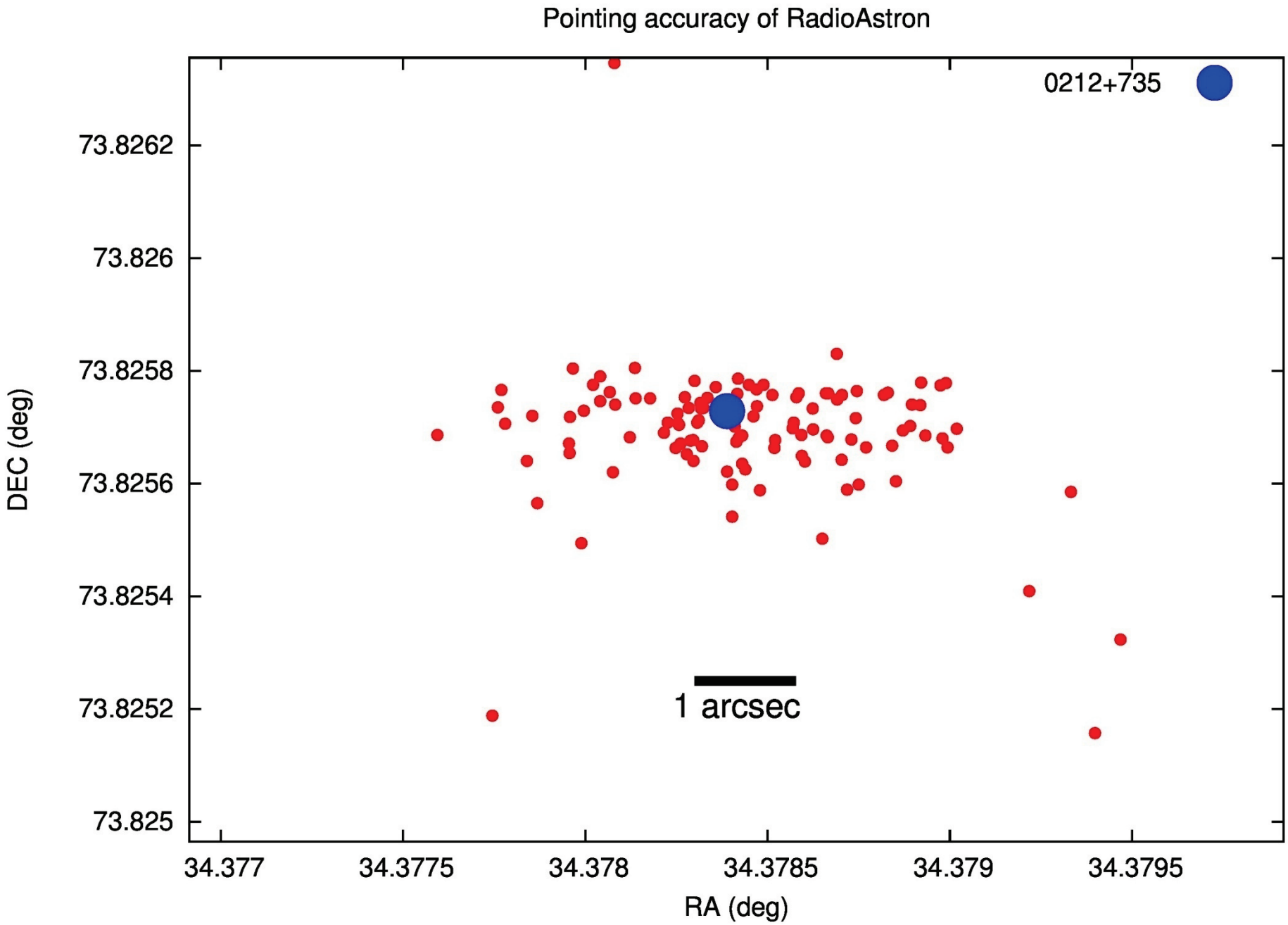
Correlation: software correlator in ASC.

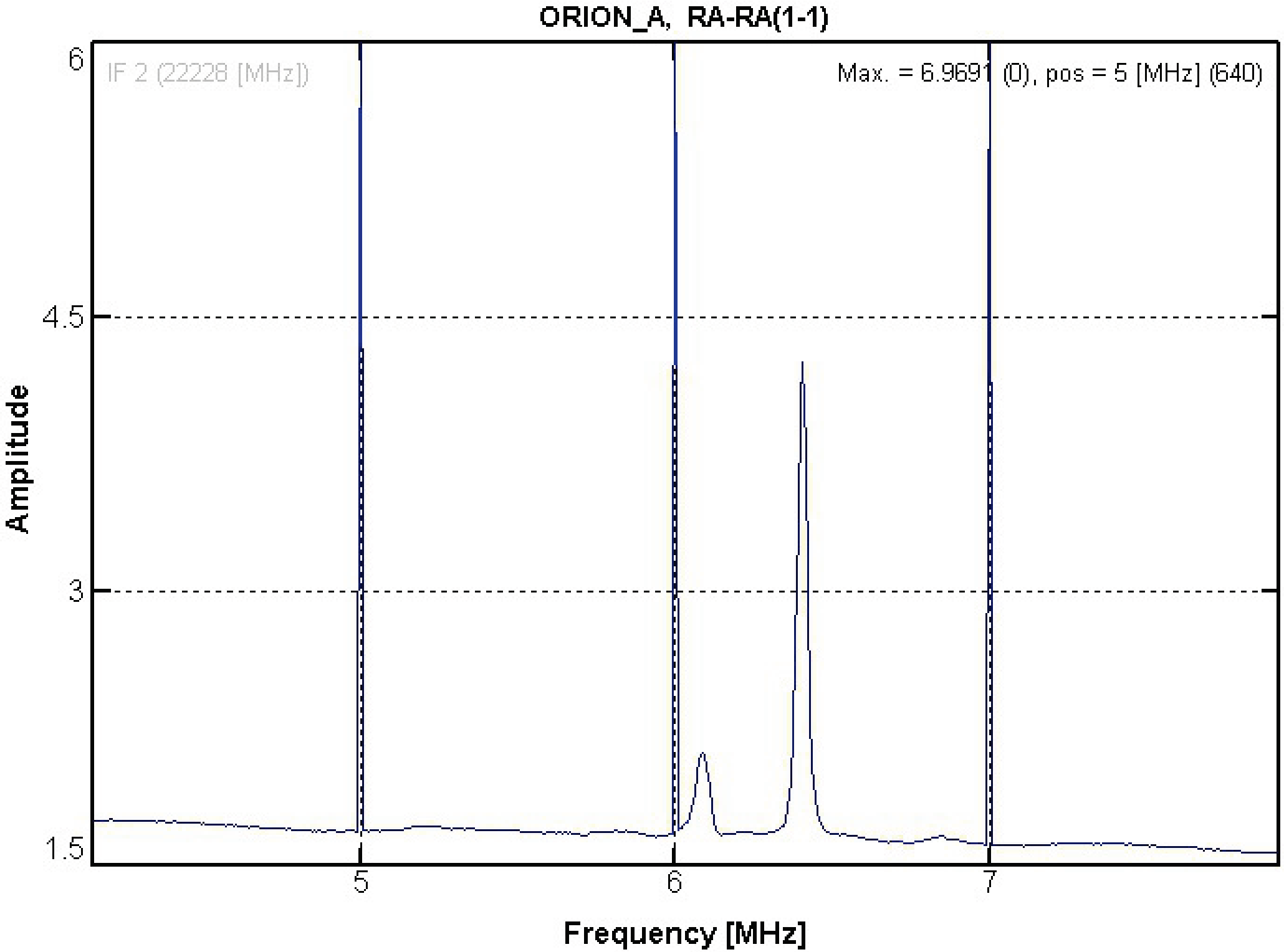

RADIOASTRON - First Light
Cassiopea A - scanning at two frequencies
92 cm
18 cm
Radioastron - 260000 km from Earth
27.09.2011
SRT signal (Volts)
6
5.5
5
4.5
4
3.5
3
2.5
2
13 00
13 10
13 20
13 30
13 40
13 50
14 00
14 10
14 20
14 30
14 40
Time
hour
min

RadioAstron: 1.3 cm

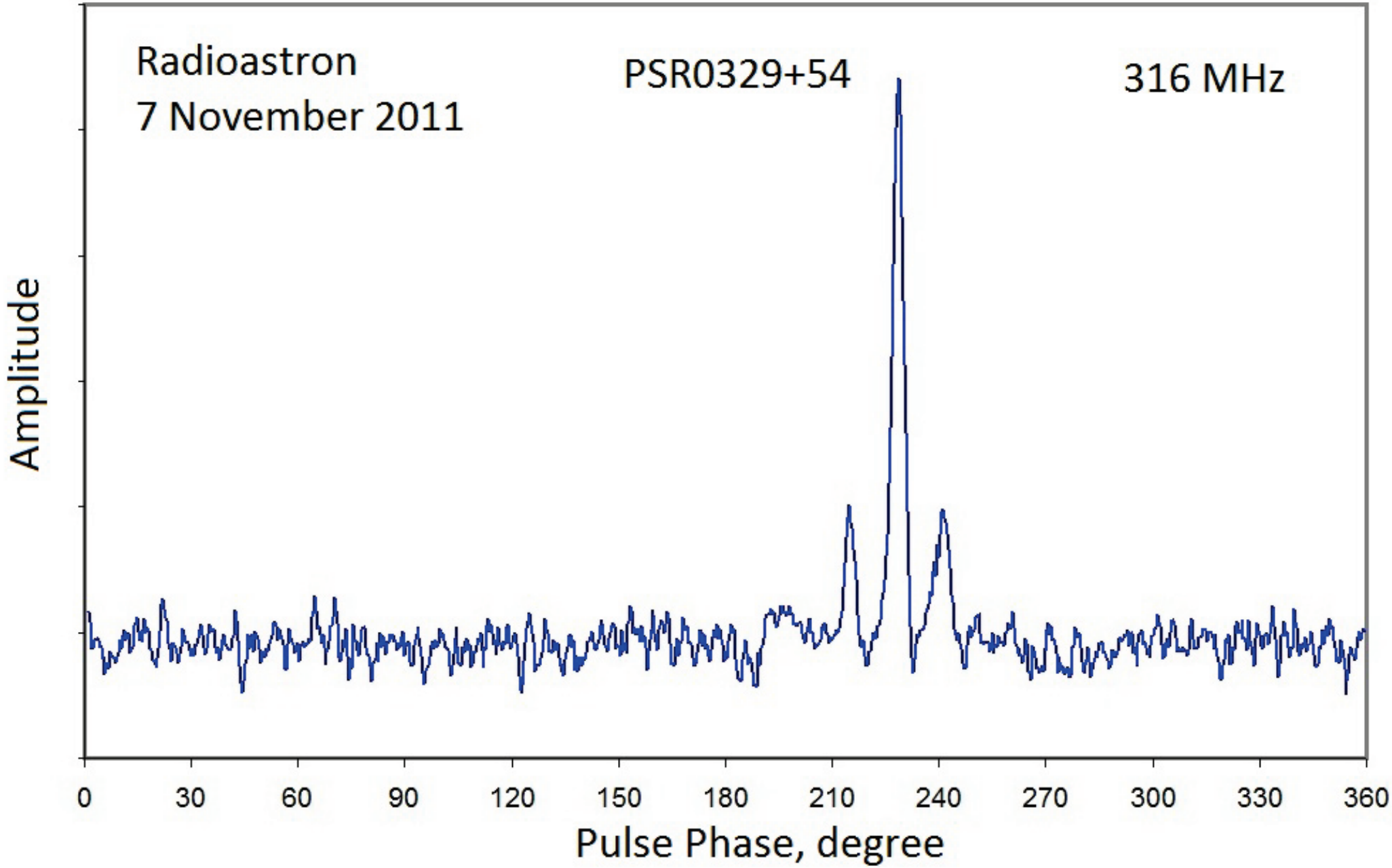


SRT pointing accuracy and stability




ORION_A, RA-RA(1-1)
IF 2 (22228 [MHz])
Max. = 6.9691 (0), pos = 5 [MHz] (640)
Amplitude
6
4.5
3
1.5
5
6
7
Frequency [MHz]

Spektr-R pulsar profile: PSR B0329+54



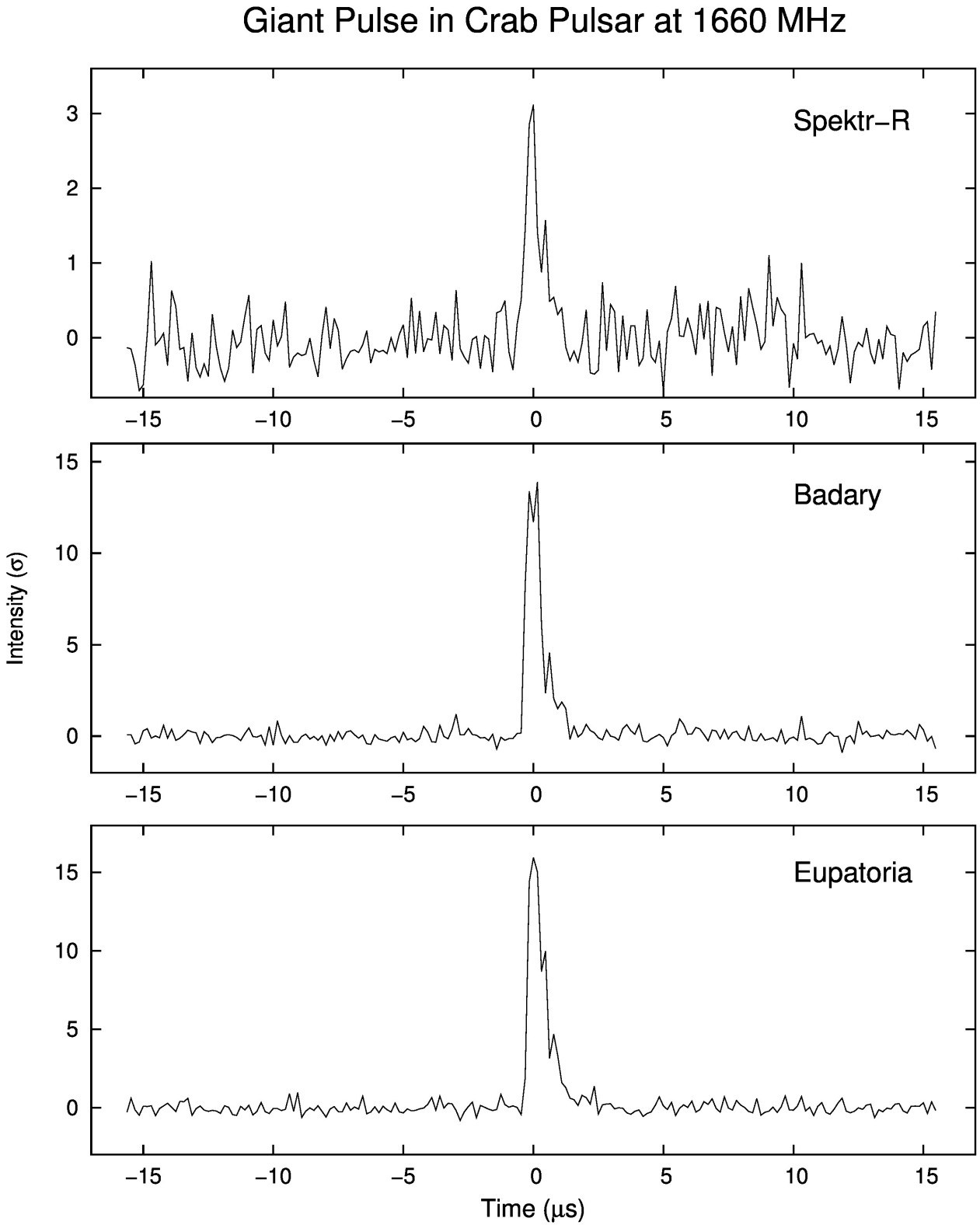
Ground radio telescopes – fringe search

Russian Quasar network, Eupatoria, Effelsberg, Medicina, Yebes, WSRT, GBT, Arecibo, Usuda, etc.









Giant Pulse in Crab Pulsar at 1660 MHz
Spektr−R
Badary
Eupatoria
Intensity (σ)
Time (μs)
−15
−10
−5
0
5
10
15

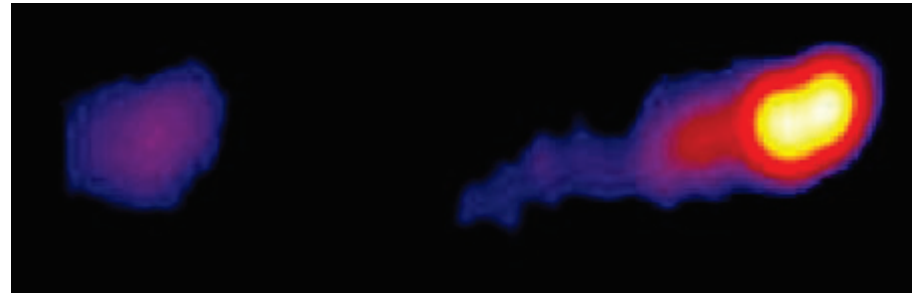
RADIOASTRON

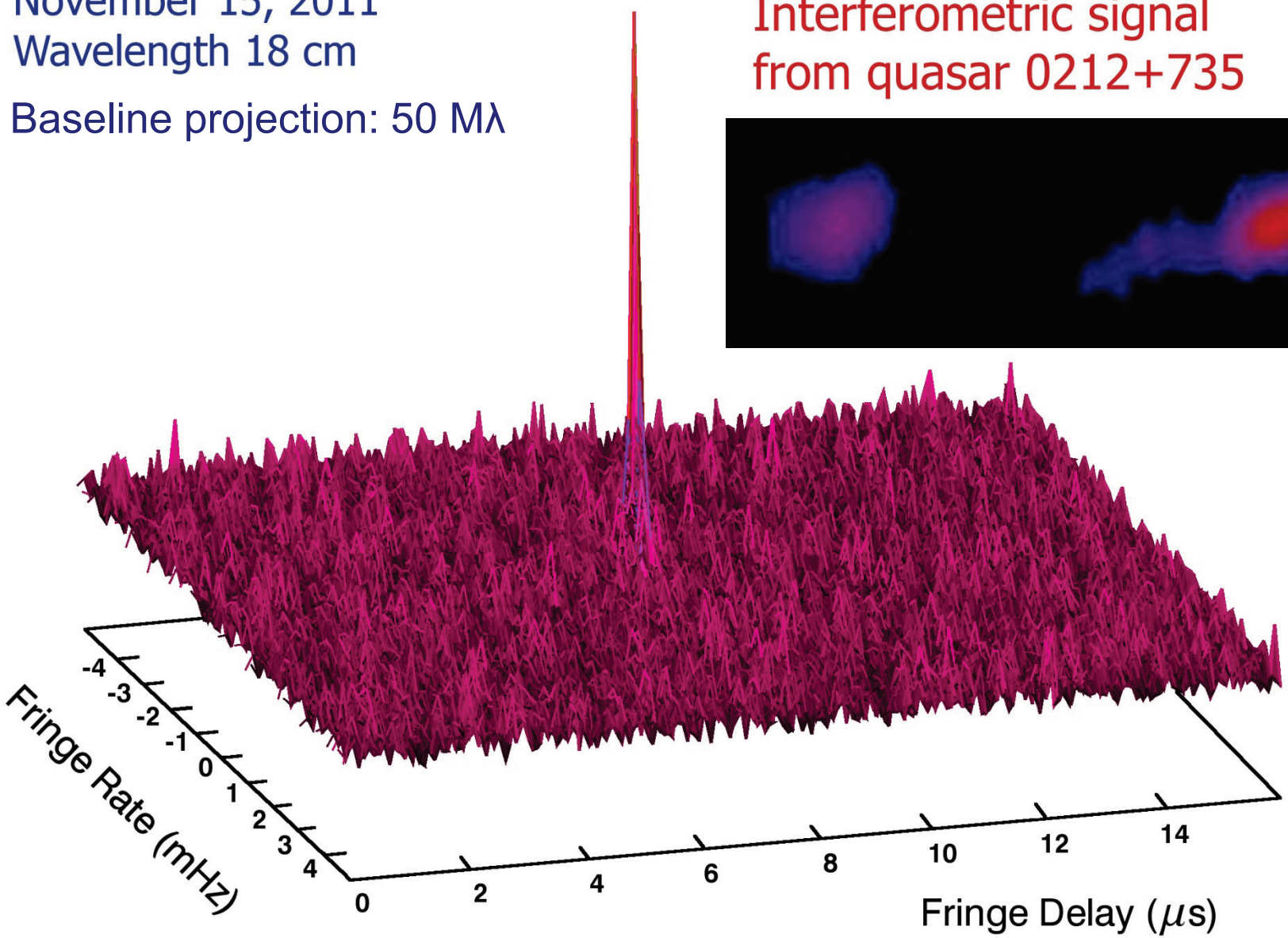
100 000 km from Earth

November 15, 2011
Wavelength 18 cm

Baseline projection: 50 Mλ

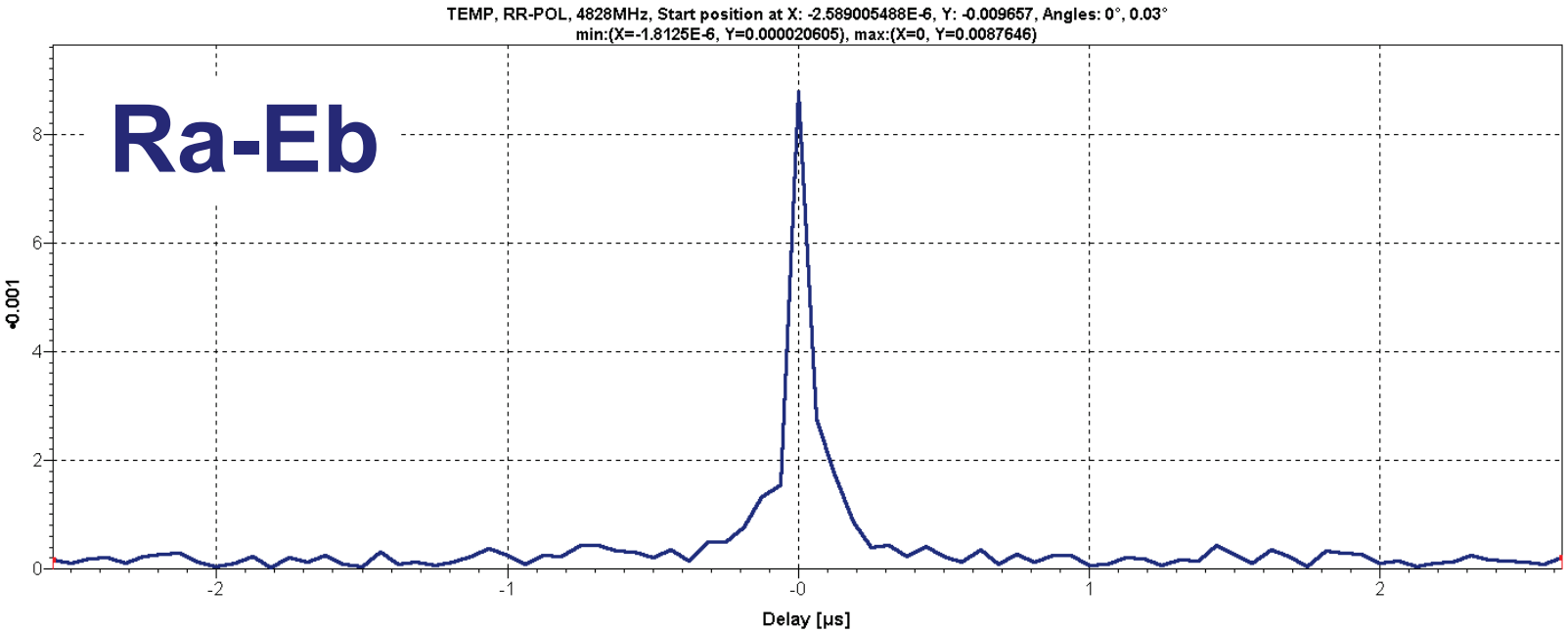
Interferometric signal
from quasar 0212+735

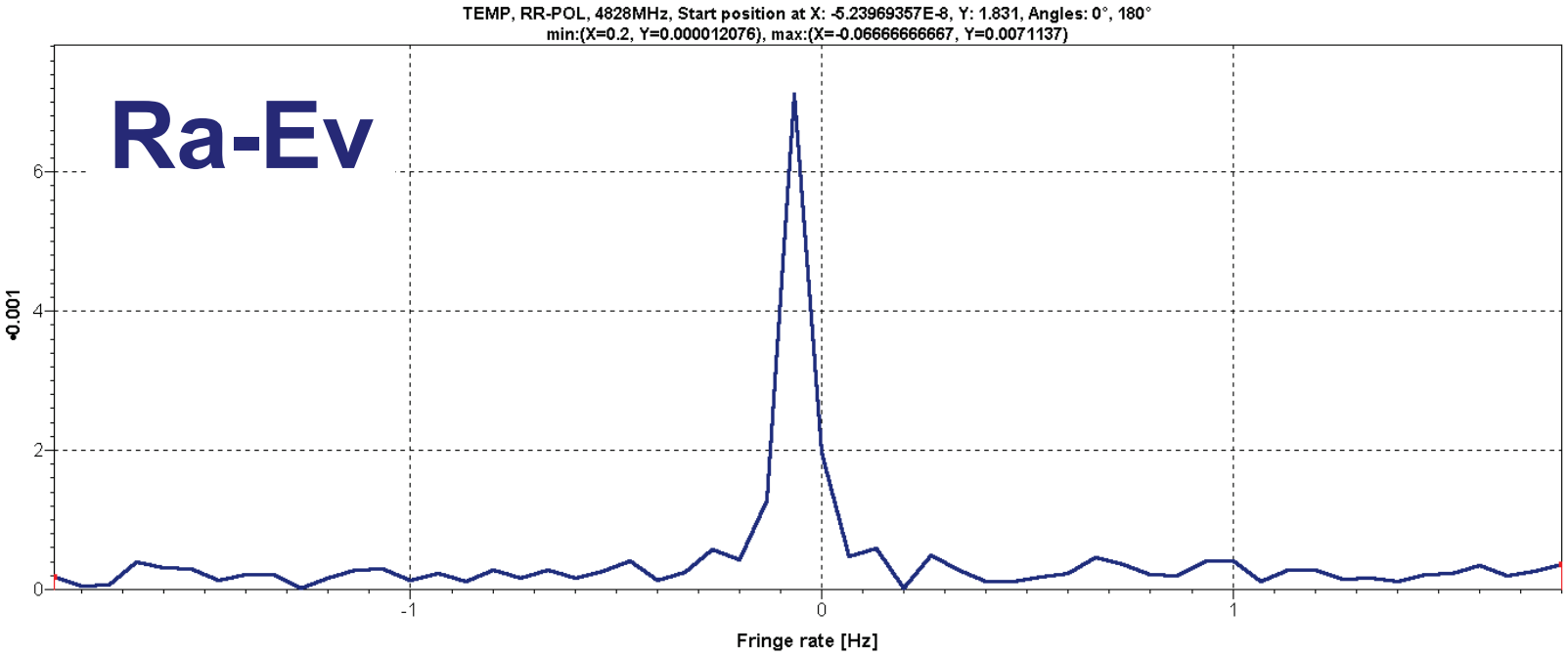




First fringes at 6 cm

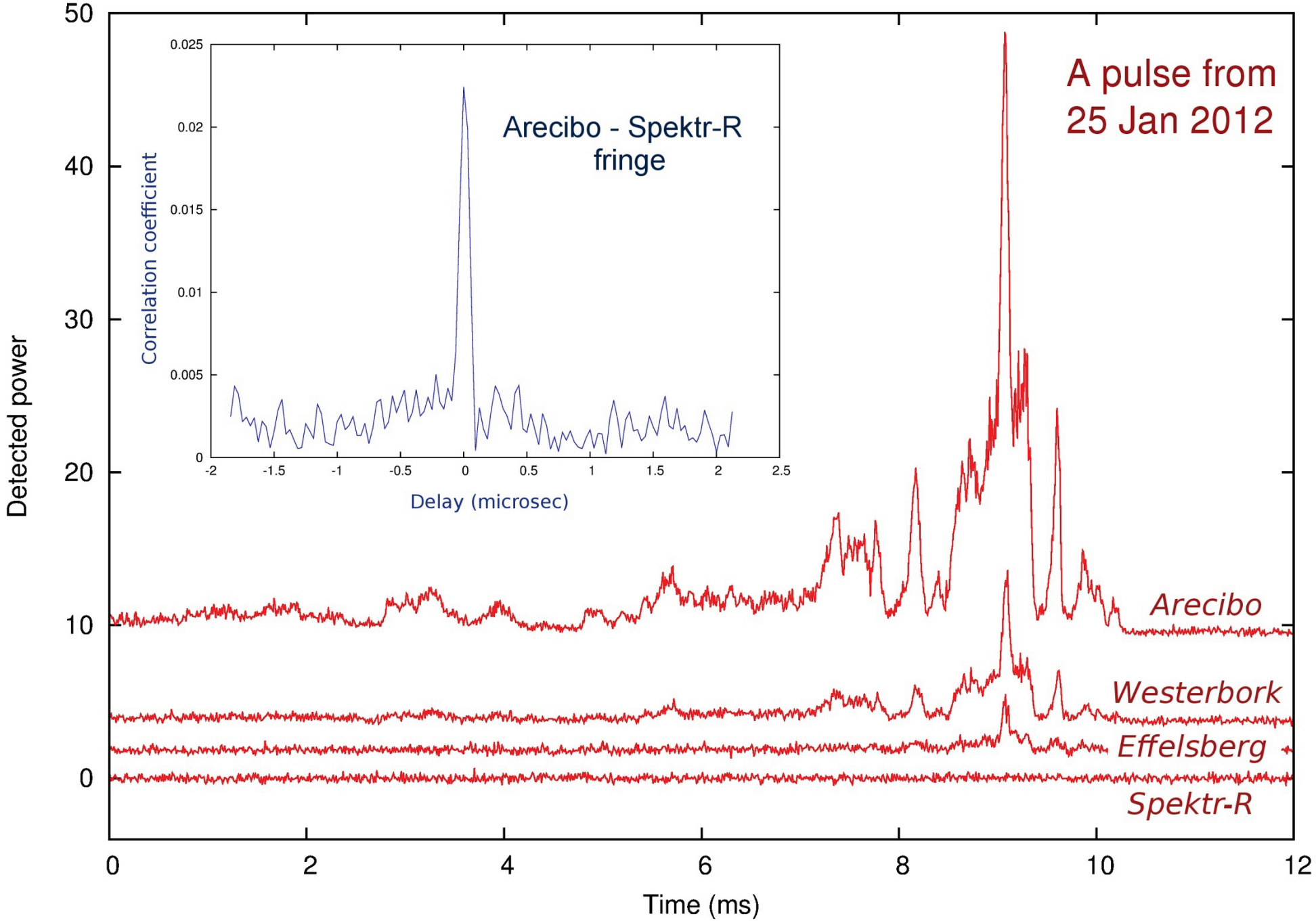
BL Lacertae, observations December 1, 2011





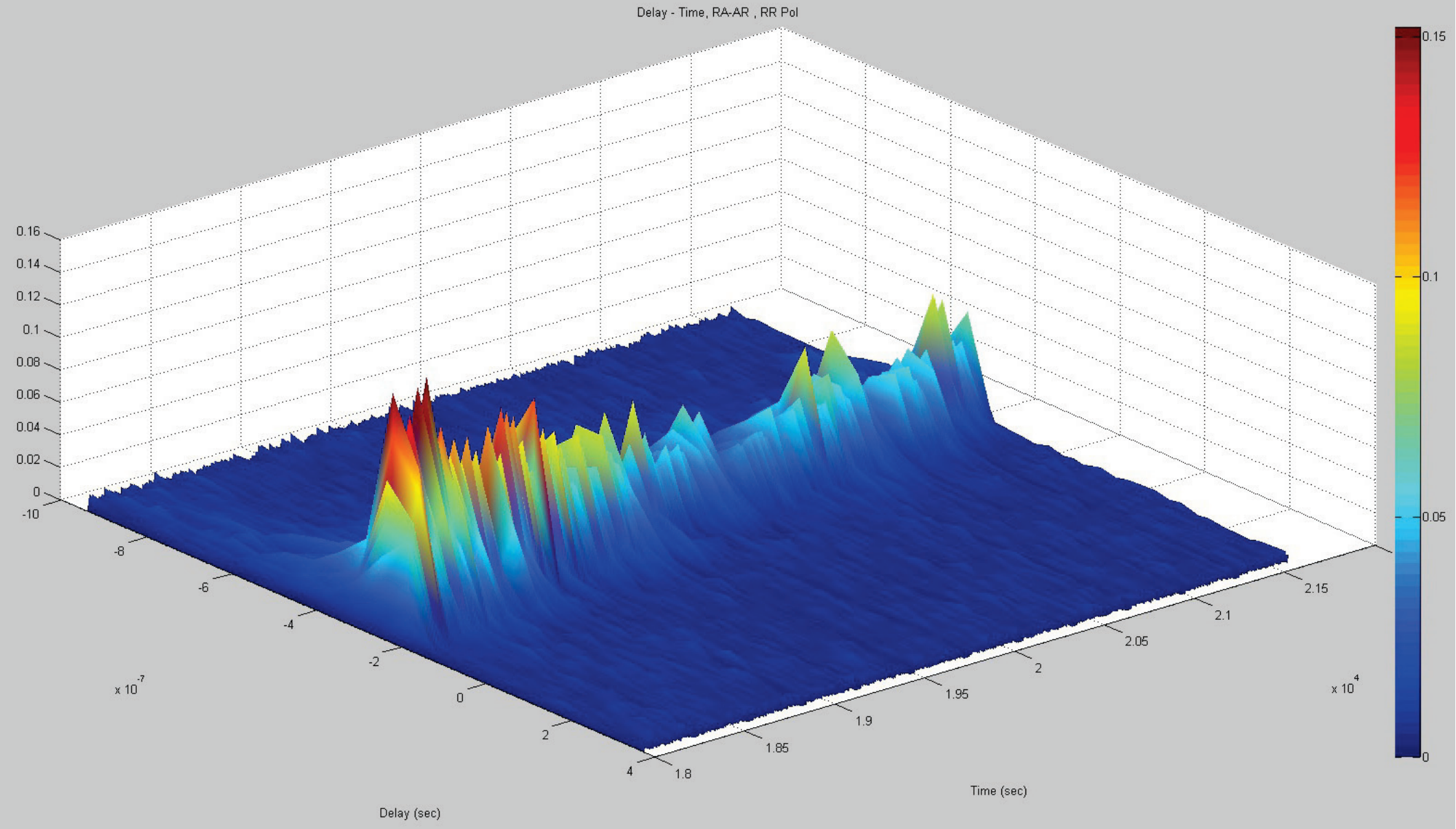
RadioAstron observations at 92 cm of the pulsar B0950+08

220 000 km projected baseline



PSR B0950+08: correlated signal Spektr-R – Arecibo

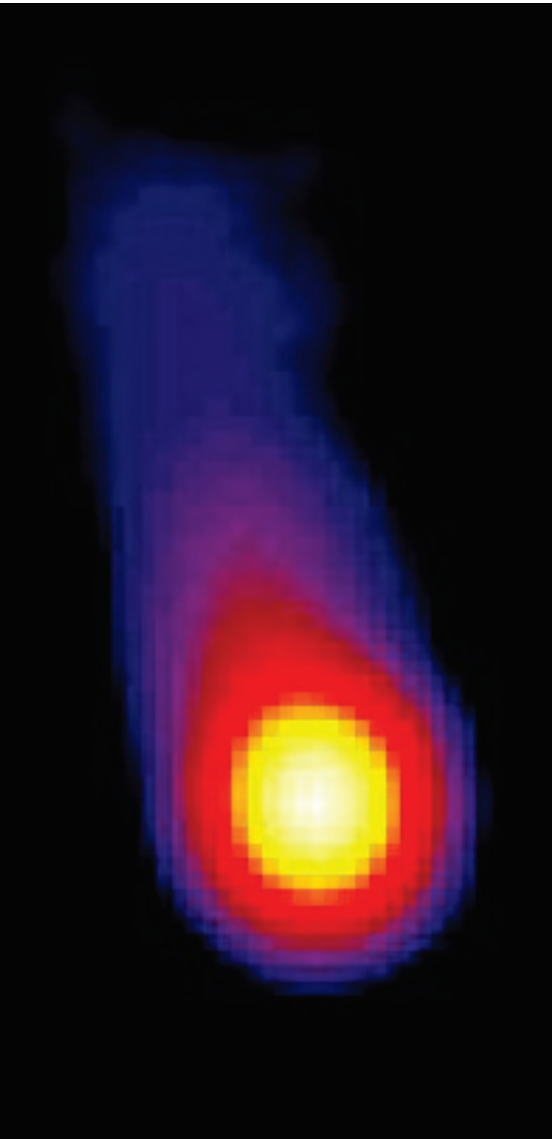
Significant variations of the signal in time is due to interstellar scintillations of the pulsar emission.

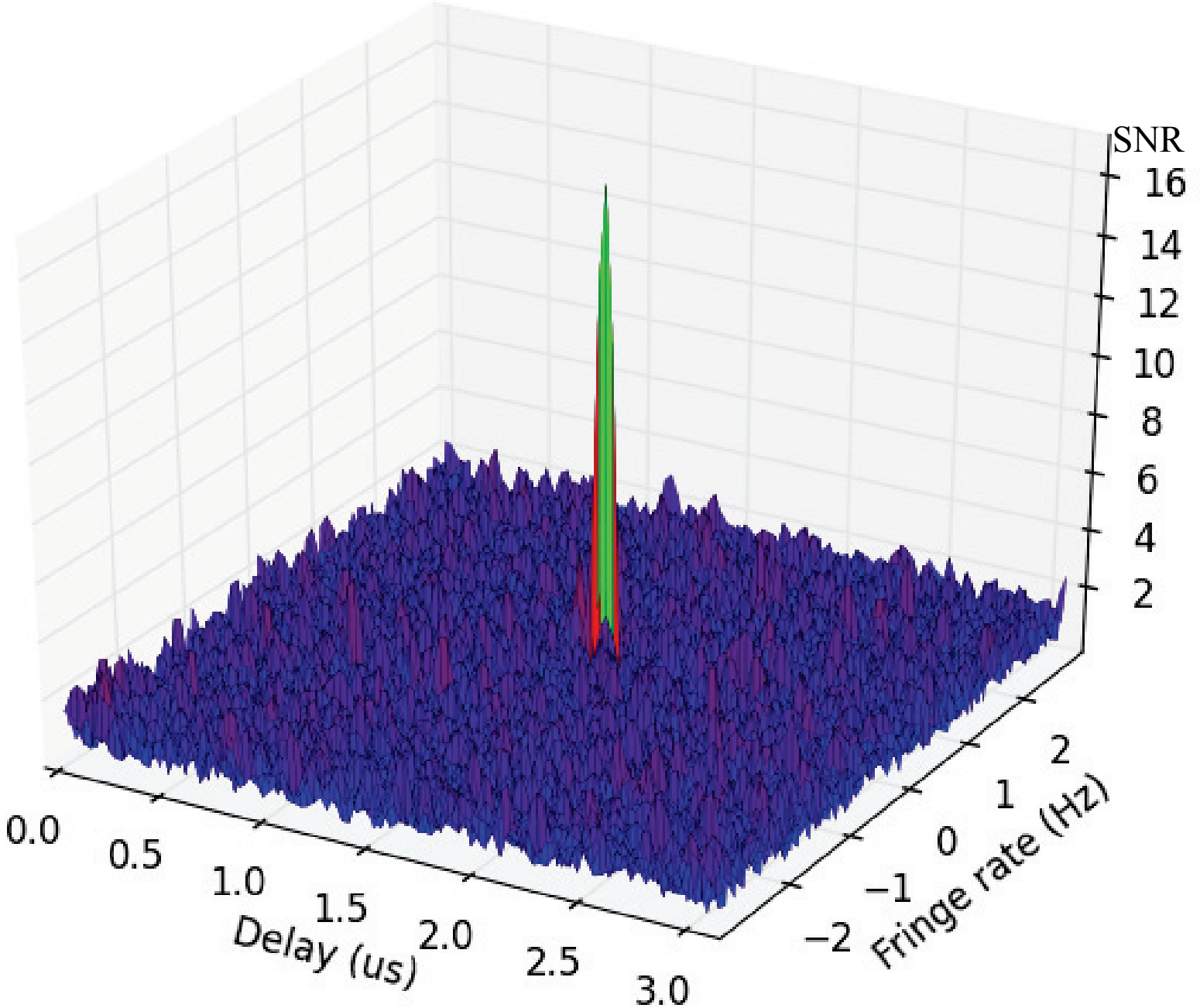


First RadioAstron-EVN imaging of an AGN jet

Baseline projections: 1.5-4.5, 5.5, 7.5, 15 Earth diameters; wave length: 6 см

0716+714





RadioAstron: current status

- K-band fringe-search continues

- Early science program started in February and will continue for about a year. Positive results are already achieved by the the AGN and pulsars/ISM teams

- Preparations are ongoing for the move to the open sky observations to start very early 2013.


ИППИ

Thank you