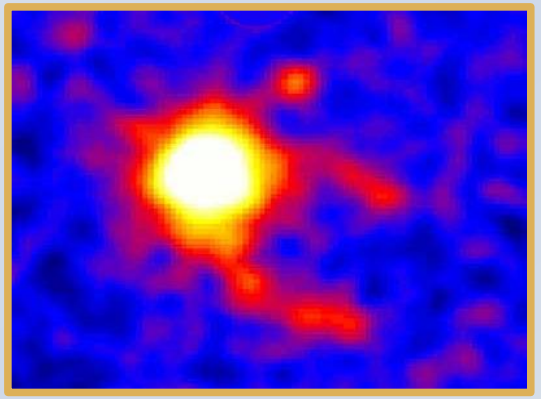


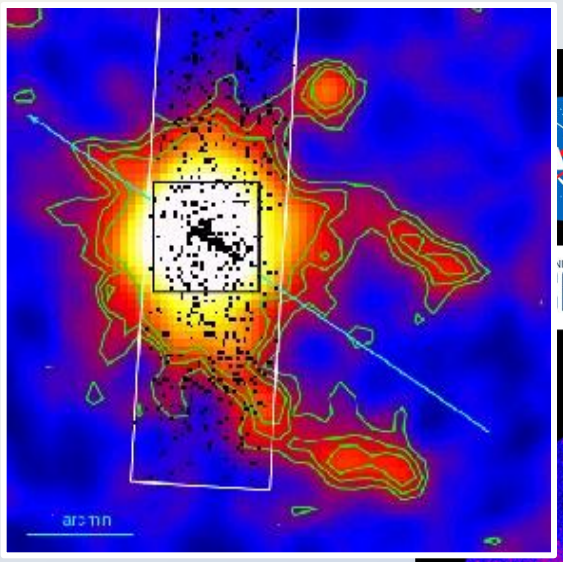
Radio Emission from Geminga

Malofeev V., Malov O.,
Teplykh D., Logvinenko S.

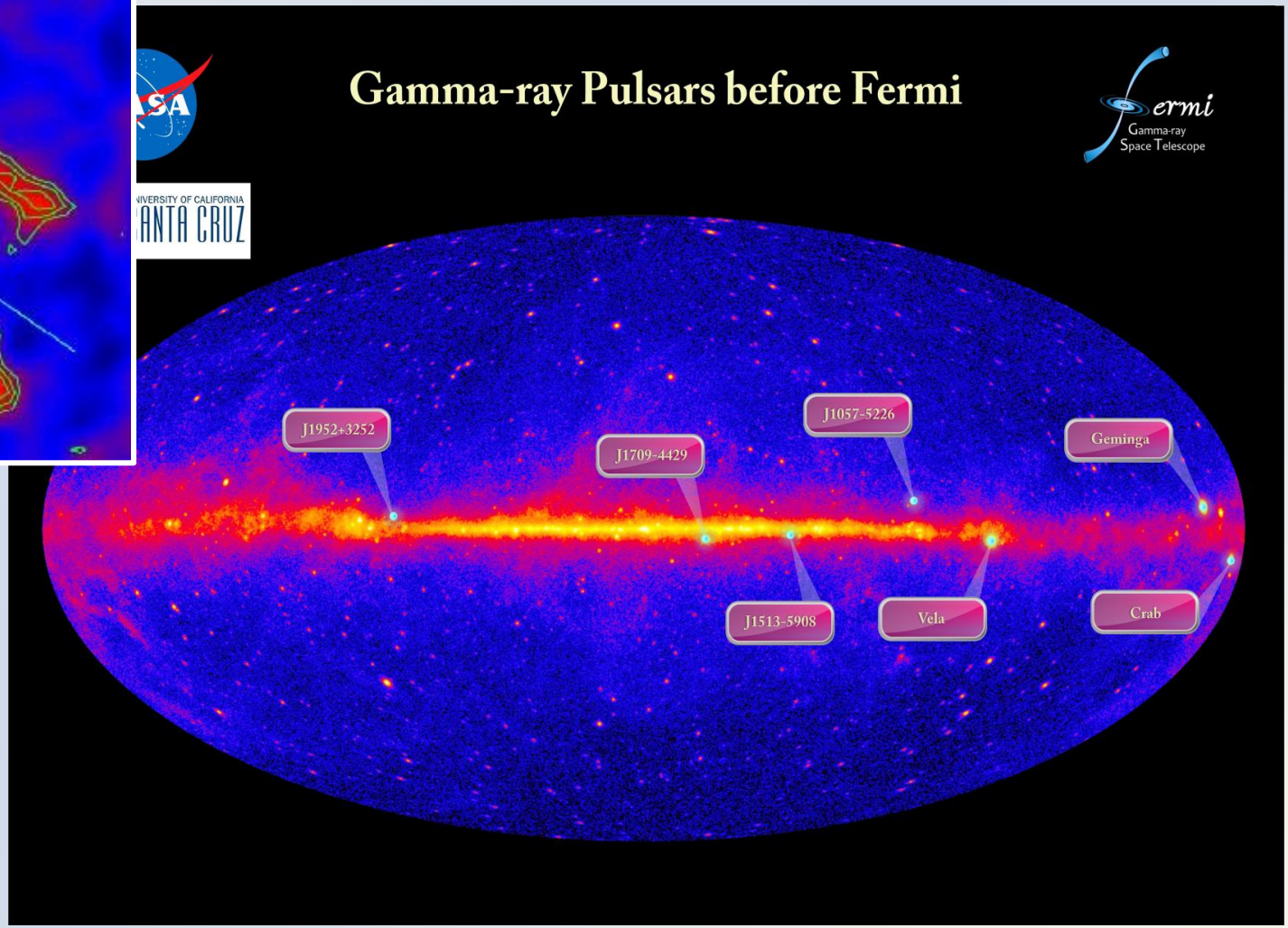
Pushchino Radio Astronomy Observatory of Lebedev Physical Institute, Russia

Geminga

"Gemini gamma-ray source"
gh'è minga = "it's not there"



X-ray image of Geminga neighbourhood



Geminga

short history of searching and discoveries

Fichtel et al., 1975,
- dicovery of gamma-ray object

Bignami et al., 1987,
- searching in radio, no detection

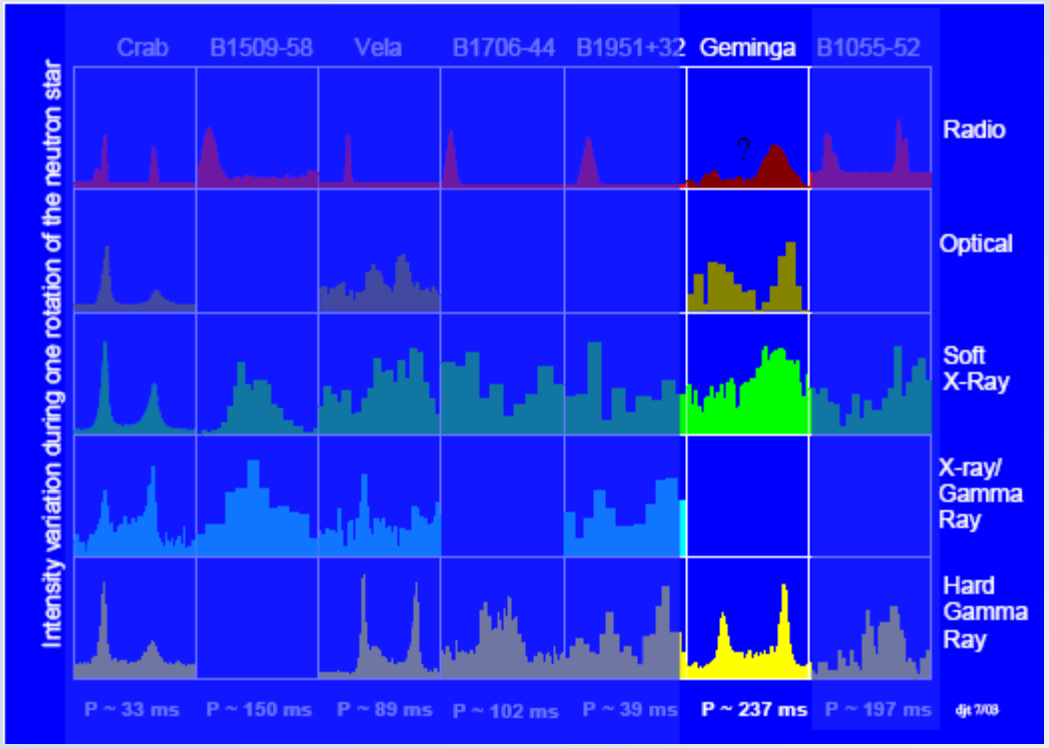
Halpern & Holt, 1992,
- detection of soft X-ray pulsations

Bertsch et al., 1992,
- detection of gamma-ray pulsations

Caraveo et al., 1996,
- discovery of optic source

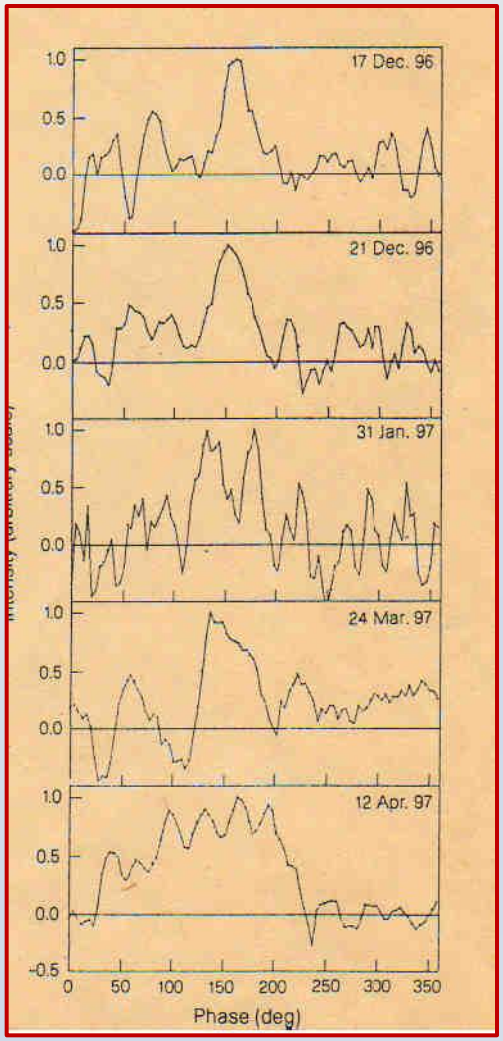
Shearer, 1999,
- detection of optic pulsations

Shibanov et al., 2003
- detection in near red range



Pulse profiles of multifrequency pulsars

Geminga *radio observations*



Malofeev & Malov, 1997 — 102 MHz

Kuzmin & Losovskii, 1997 — 102 MHz

Shitov & Pugachov, 1997 — 102 MHz

Shitov, Malofeev et al., 1997 — 61, 41 MHz

Vats et al., 1998 — 103 MHz

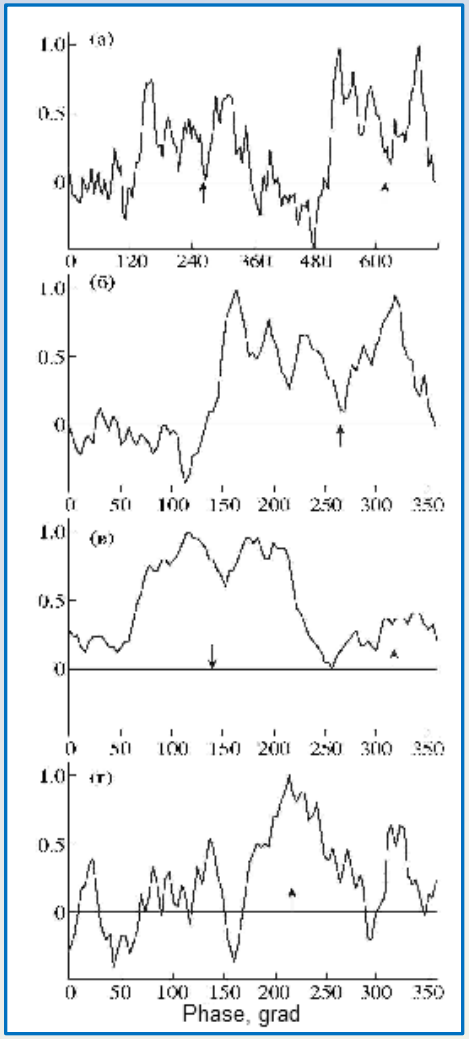
Pellizzoni et al., 2011 — 4.8 GHz (cont. sourse)

Mean profiles at 102 MHz

Malofeev & Malov, 1997

Mean profiles at 87, 58 and 39 MHz

Malofeev & Malov, 2000



Observations

LPA: 111.5 ± 1.5 MHz,

$3.3^{m} / \cos\delta$, $A_{ef} \approx 20\,000\ m^2$

DKR - 1000: 62 MHz, 42 MHz

$15^{m} / \cos\delta$, $A_{ef} \approx 5 - 8 \times 10^3\ m^2$

Receivers: 64 × 20 kHz, Δt = 25.6 ms, 51.1 ms, 61.9 ms

Digital receiver: 512 × 5 kHz, $\Delta t \geq 0.2$ ms

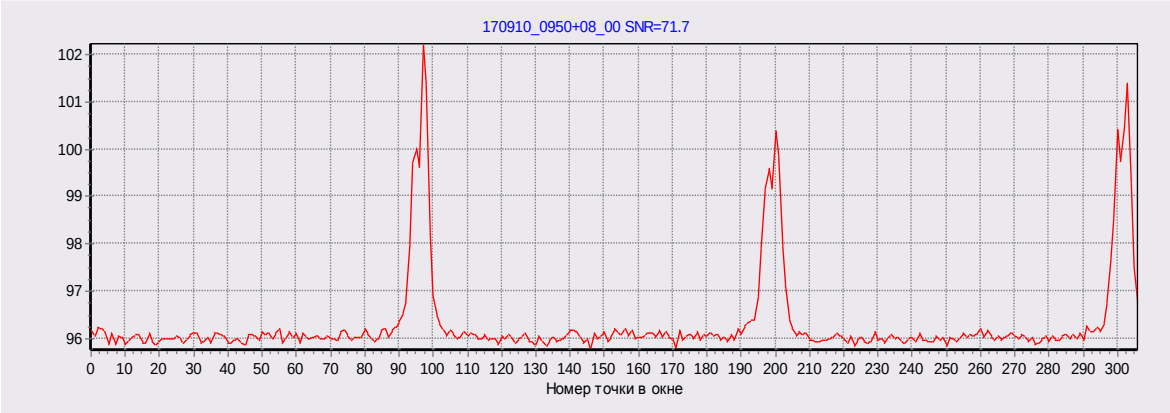
During one observational session of B 0633+17:

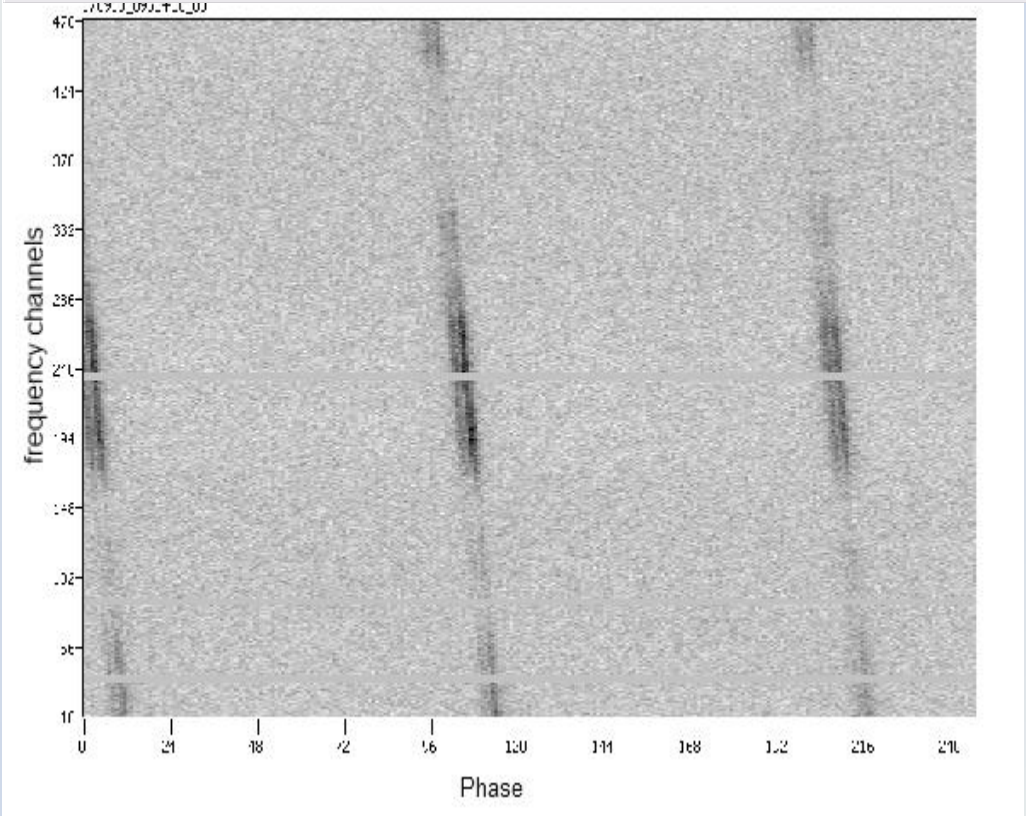
– 840 periods at 61, 42 MHz

– 280 periods at 111 MHz

For certainty all observations have been carried out with triple period.

Observations of B0950+08 at 111 MHz

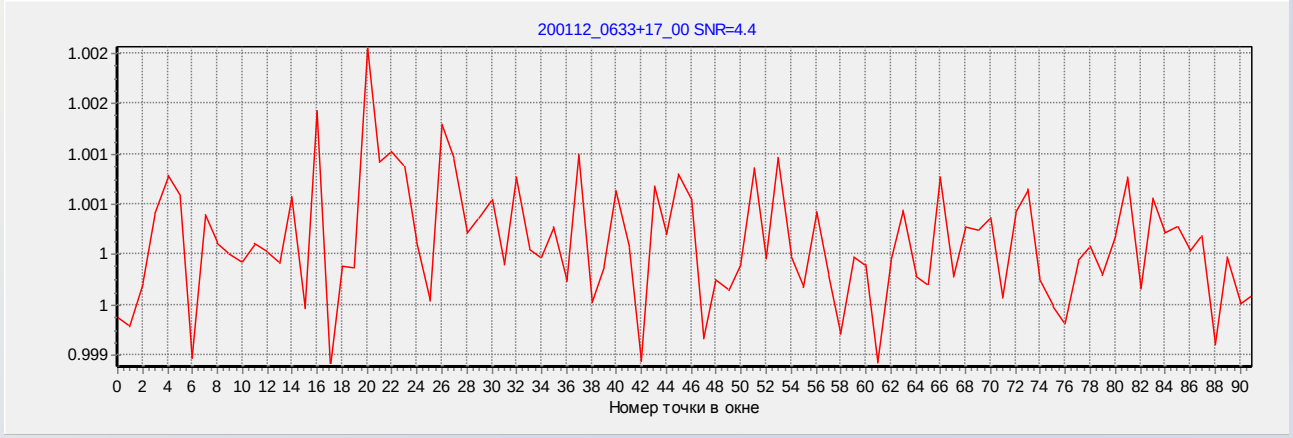




Example of observation using new digital receiver

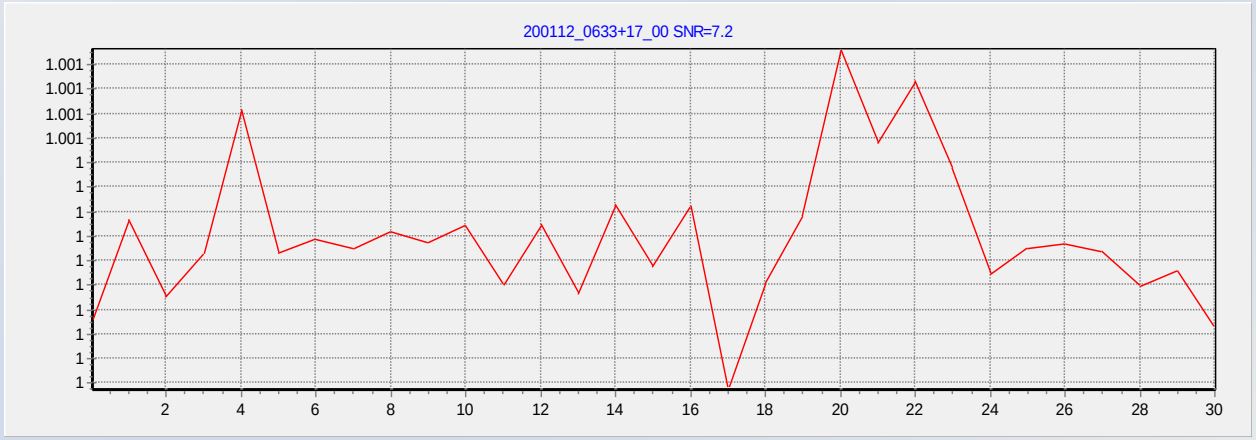
Observations of B0633+17 (Geminga) at 111 MHz

20.01.12



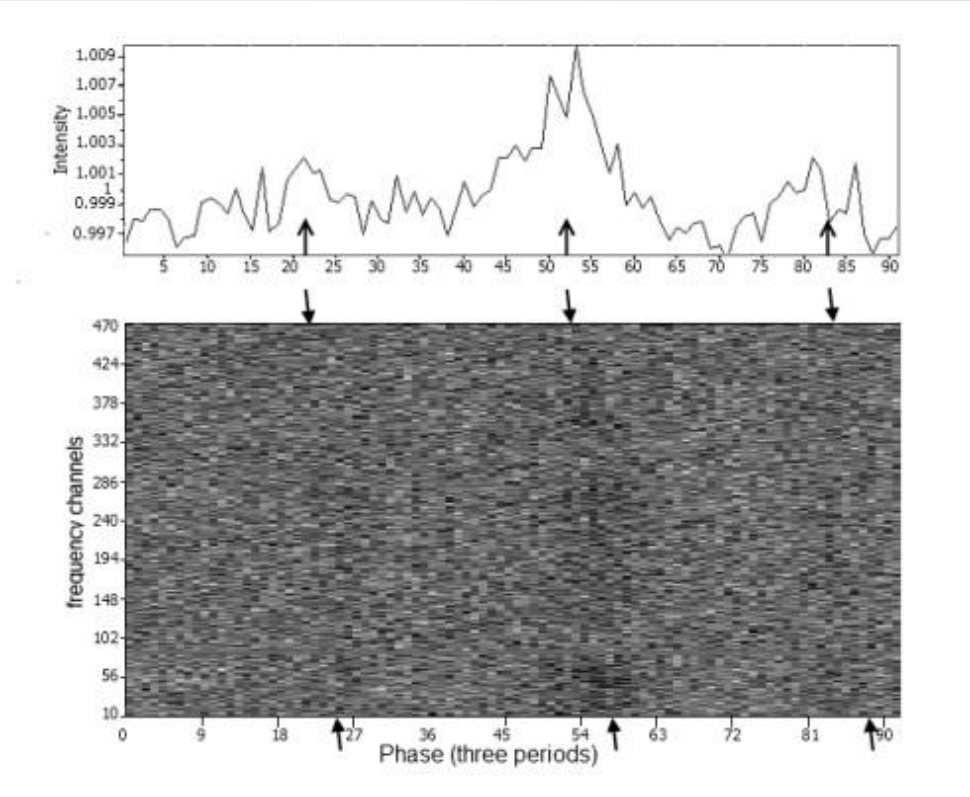
The integrated groups

Dm=2.89,
Sum of 266 groups,



Sum of 3x266 pulses, “0”=5-15, S/n= 7.2

B0633+17, 111 MHz



20.01.12

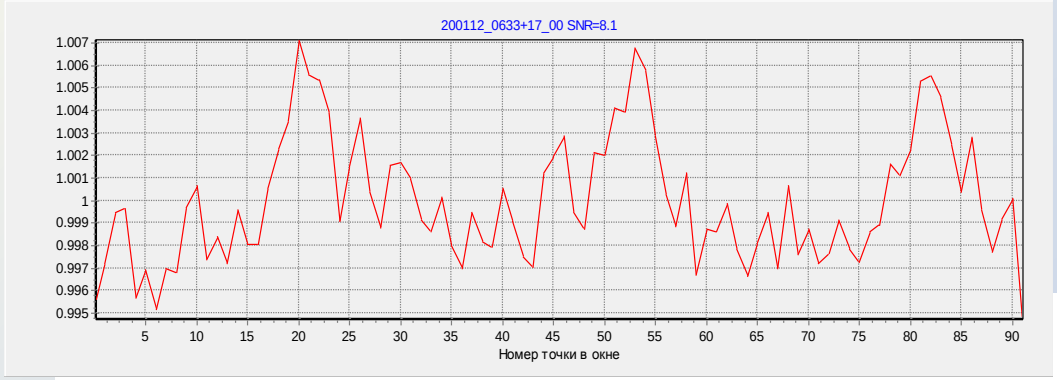
The integrated selected pulses

DM = 2.95, sum of 51groups, “0” = 60-75

Example of a pulse profile (upper) and a dynamical spectrum (lower) of Geminga at 111 MHz, obtained by summing 36 selected groups (triple periods) on the 20.01.12. The integration was carried out at phase sample 52 + 3. The horizontal axis is in samples of the triple period of the pulsar. One sample is equal 7.5776 ms and one period is equal to 31.29 samples. The dispersion track is marked by arrows.

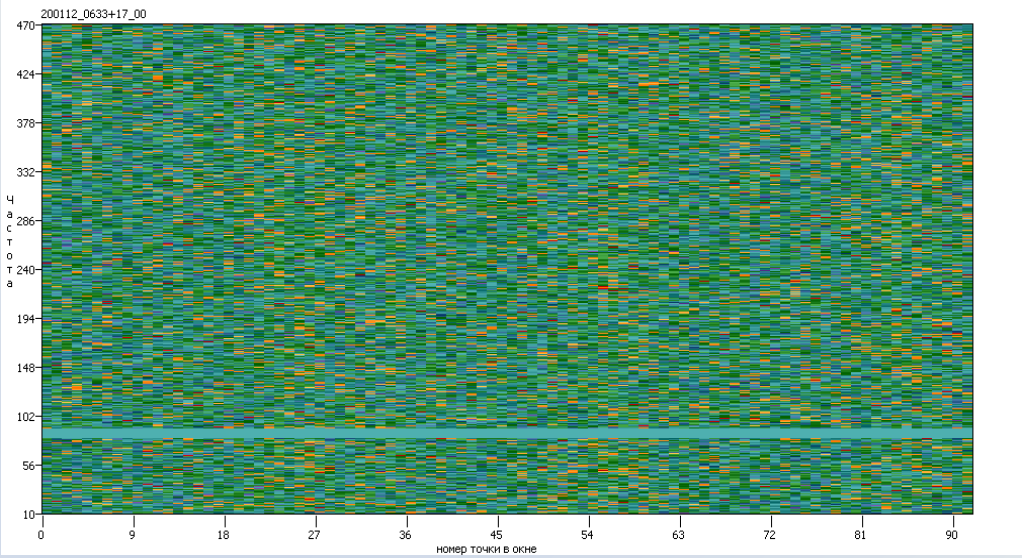
B0633+17, 111 MHz

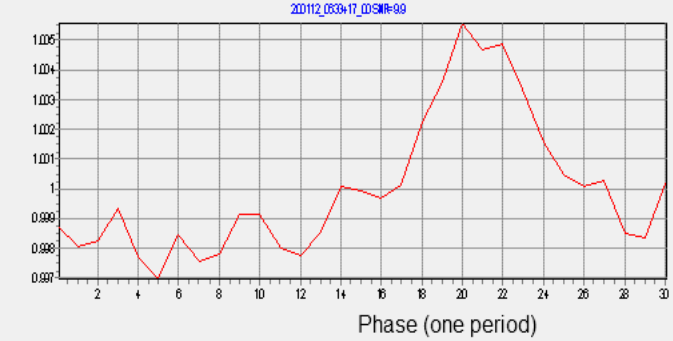
20.01.12



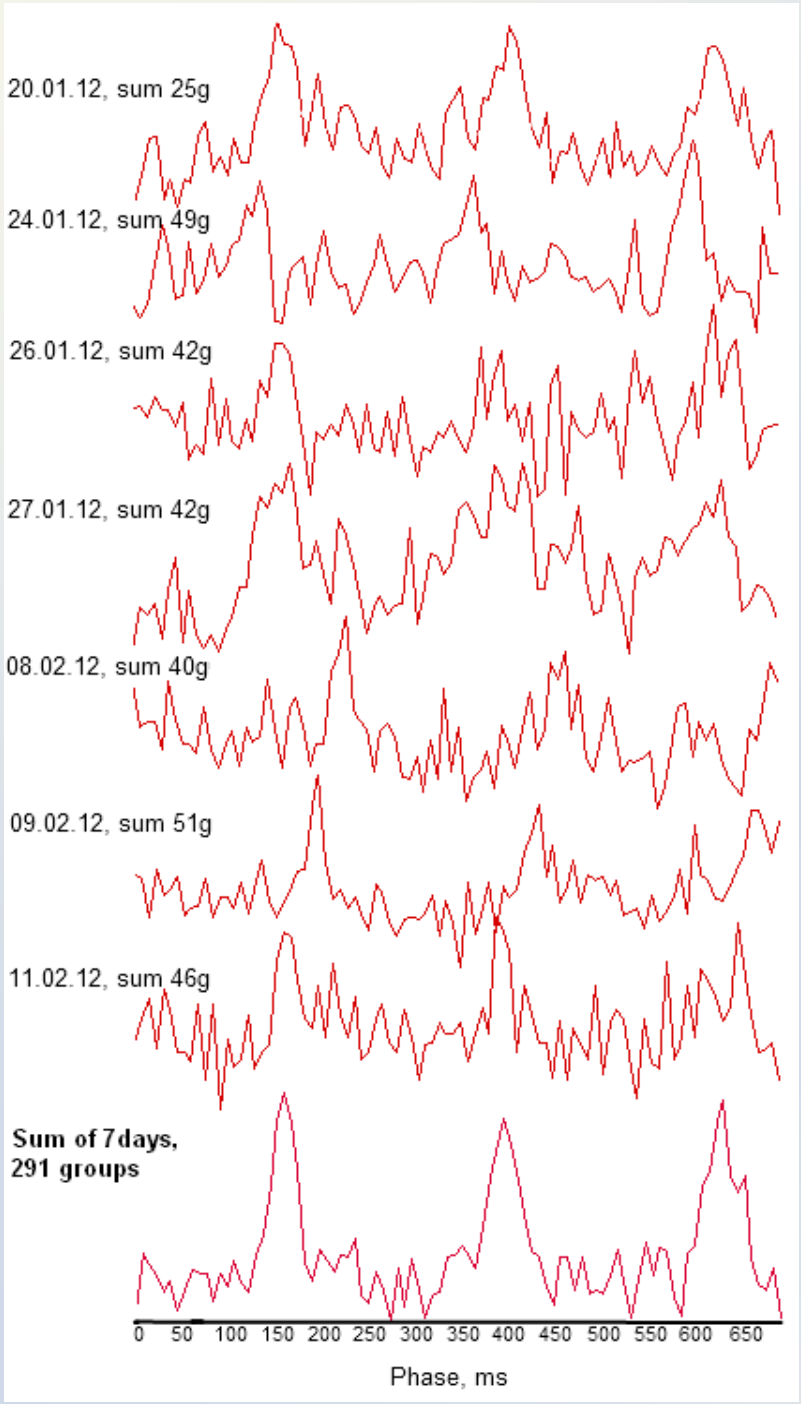
The integrated selected groups

Dm=2.95, sum 25g,
“0”=60-25



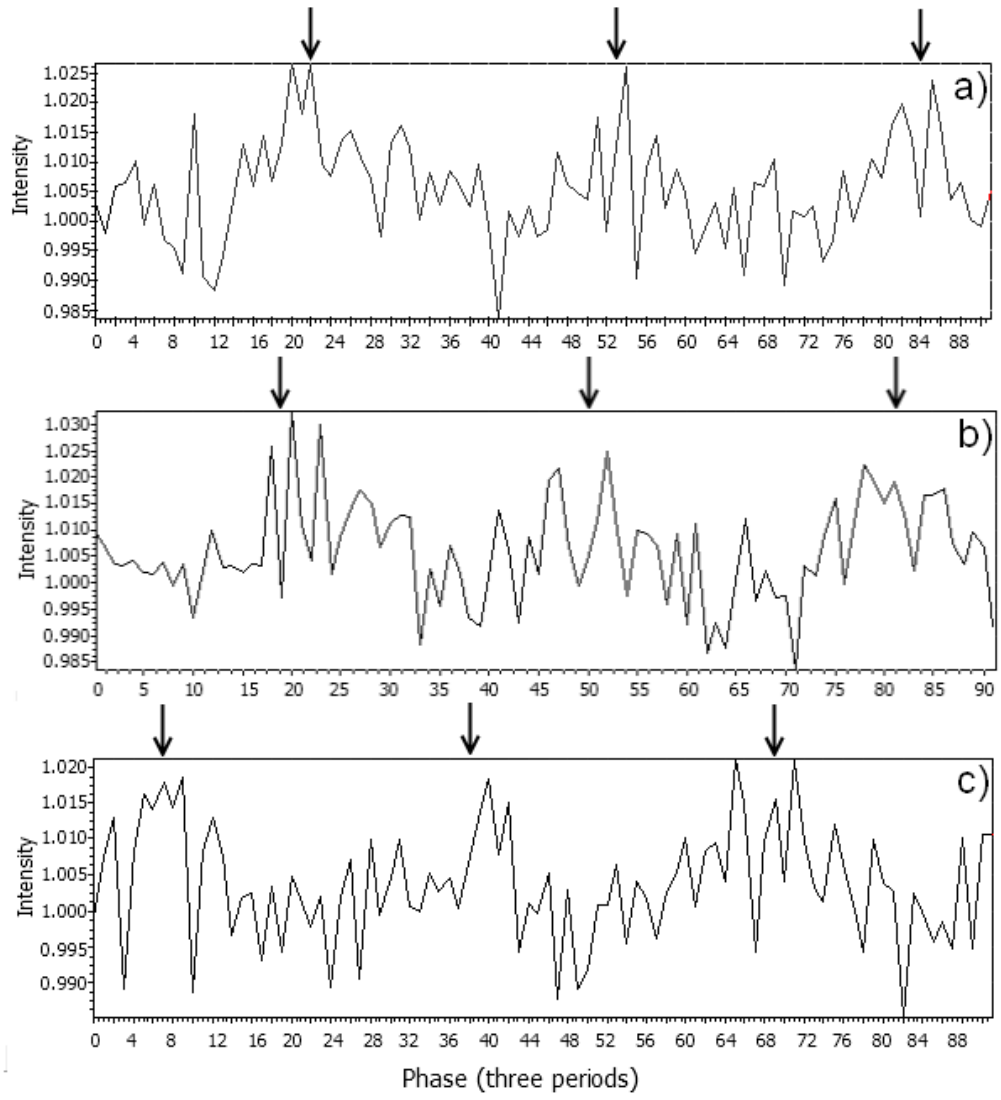


Sum of 3x25p =75 pulses (27%),
s/n= 18, ‘0’=1-10



111 MHz, Jan.-Feb. 2012,

The integrated selected groups

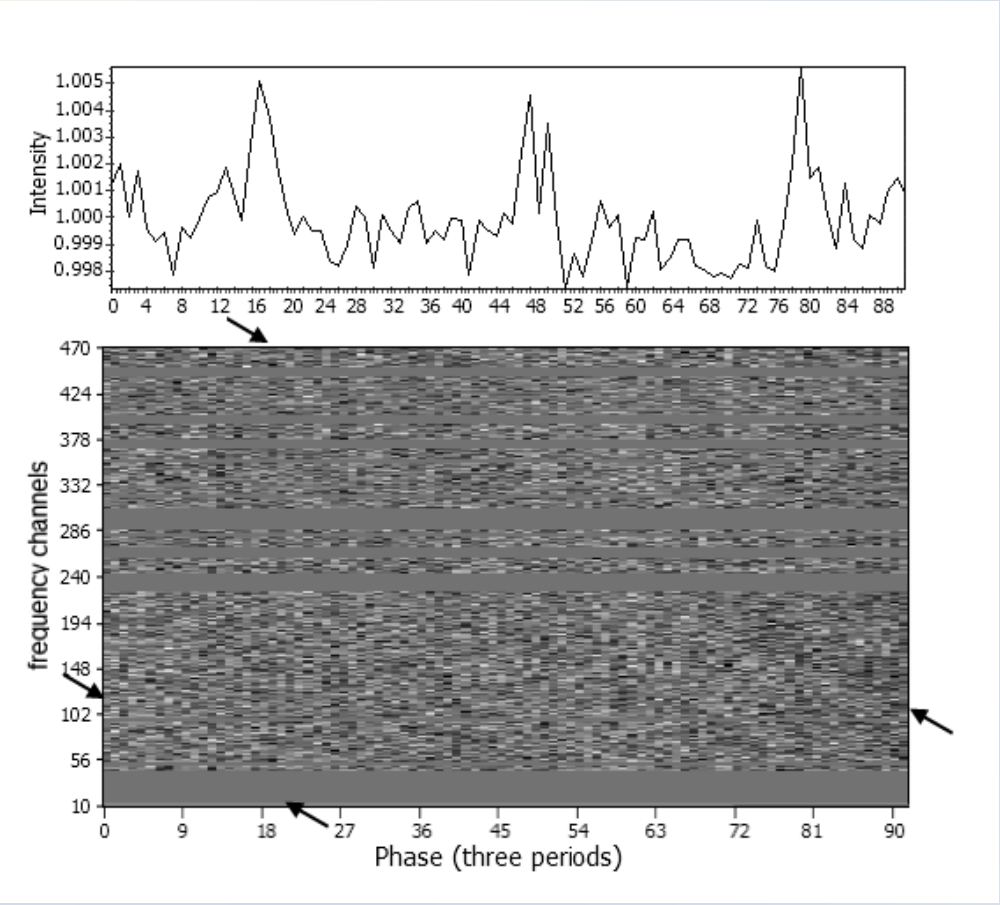


111 MHz, 20.01.12

The individual pulses

Examples of an individual pulse profiles of Geminga at 111 MHz on the 20.01.12. The horizontal axis is in samples of the triple period of the pulsar. The phases of pulses are marked by arrows.

B0633+17, 42 MHz



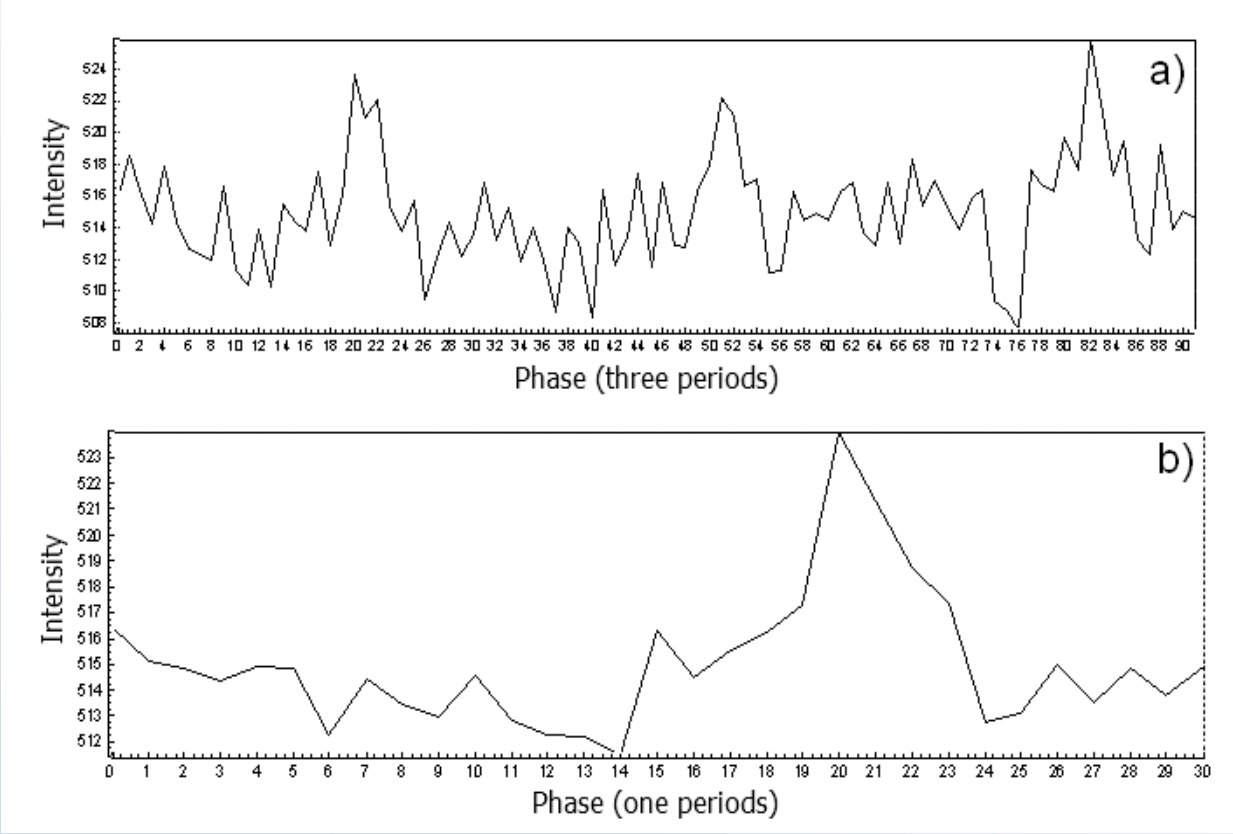
The integrated selected groups

Example of a pulse profile (upper) and a dynamical spectrum (lower) of Geminga at 42 MHz, obtained by summing 23 selected groups (triple periods) on the 21.01.12. The dispersion tracks are marked by arrows.

Observations of B0633+17 at 62 MHz

20.01.12

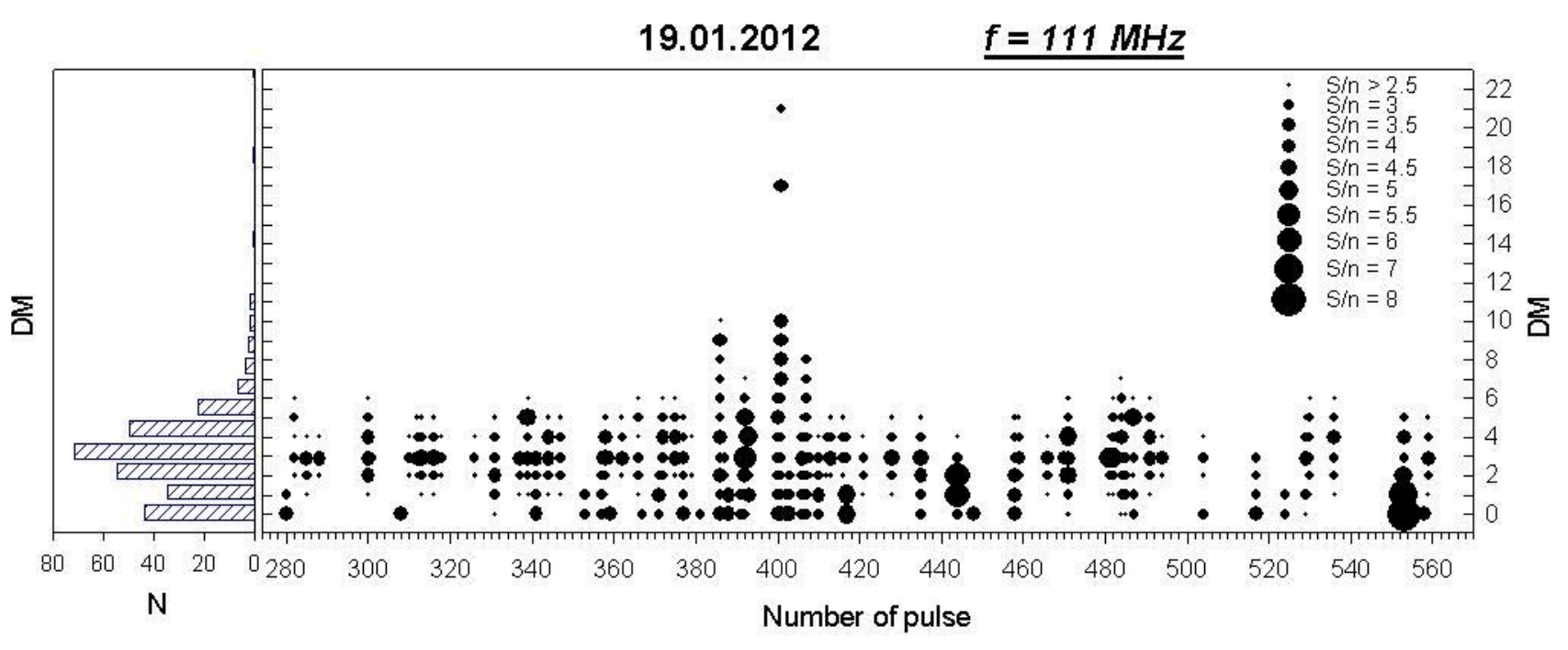
The integrated selected groups



DM = 2.89 ± 0.02 пк/см^3

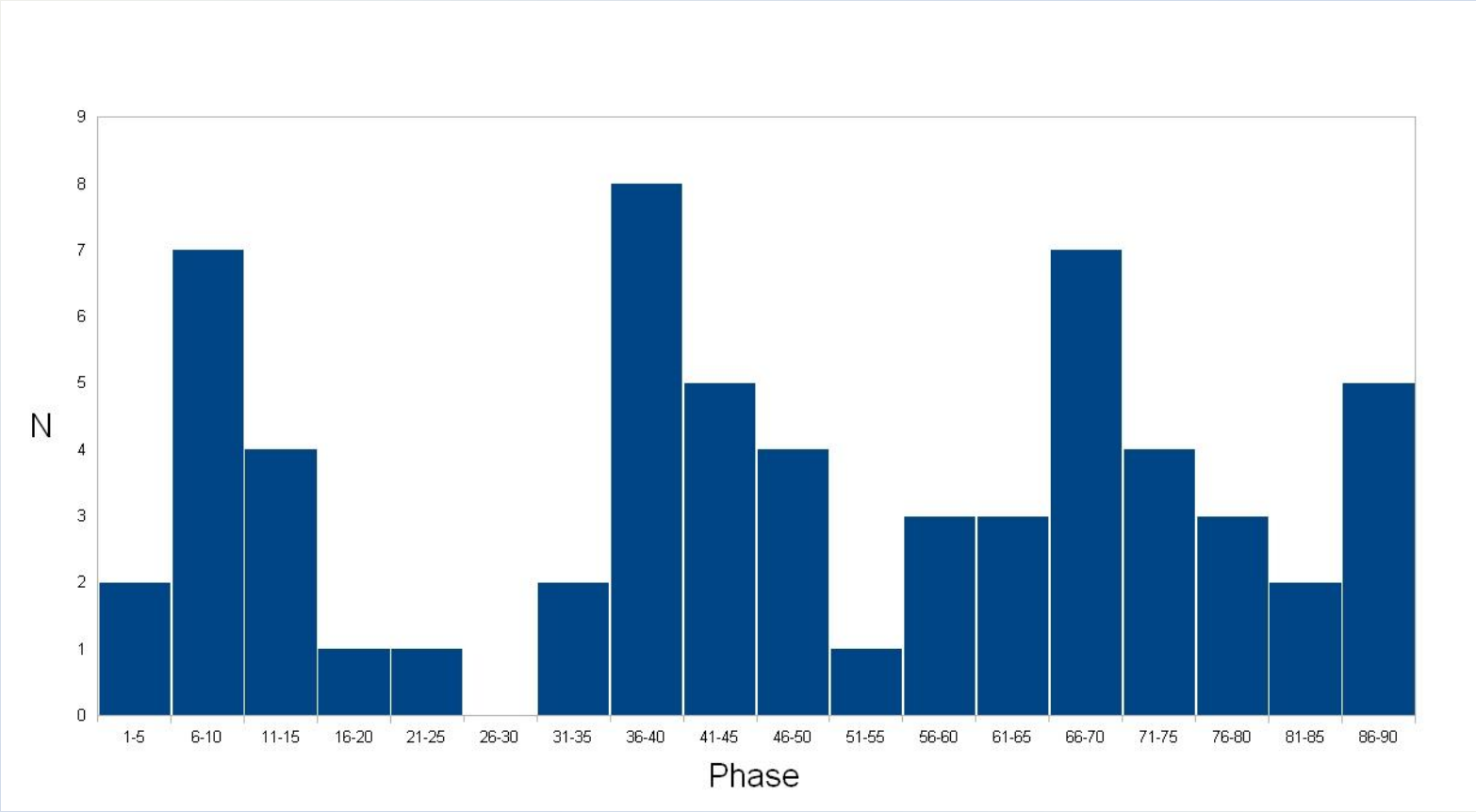
(a) Example of a pulse profile of Geminga at 62 MHz, obtained by summing 20 selected groups (triple periods) on the 20.01.12. (b) The mean profile for one period obtained by the folding of data. The horizontal axis is in samples of the triple period (a) and one period (b) of the pulsar.

B0633+17, 111 MHz



The right panel shows events with S/N >2.5 vs number at pulse (time) DM with larger circles denoting stronger signal. The left panel shows the histogram of the number of events vs DM

B0633+17, 111 MHz



The histogram of the events with S/N > 2.5 versus of phase of triple period for 19.01.2012

Conclusions:

- We confirm the presence of periodic signal with dispersion at three low radio frequencies
- We measured precise value of the dispersion measure (DM=2.89+-0.02) using the simultaneous observations at 111, 62 and 42 MHz.
- We discovered the strong long term (a few years) intensity variations

Attempt to explain the geometry of the emission