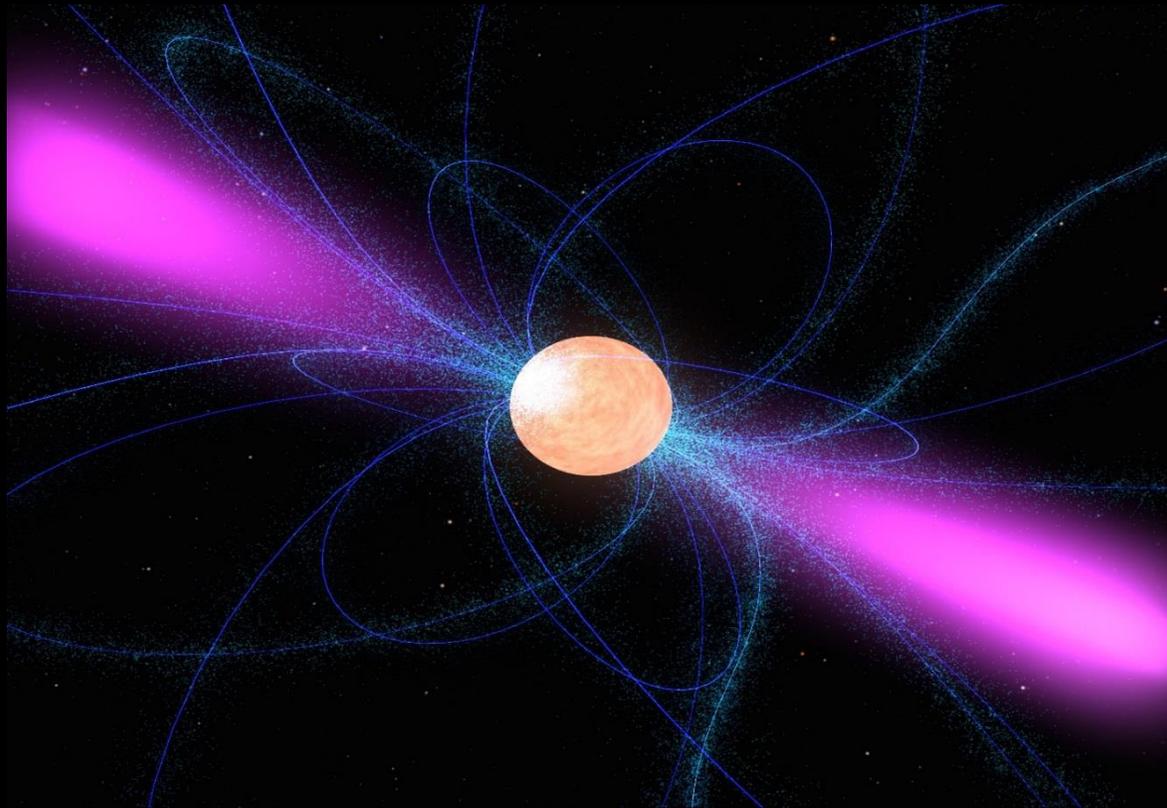
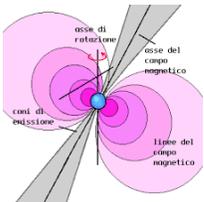


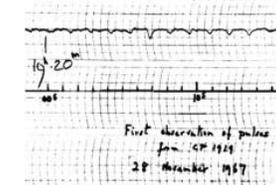
Osservazione di stelle Pulsar con un setup EME



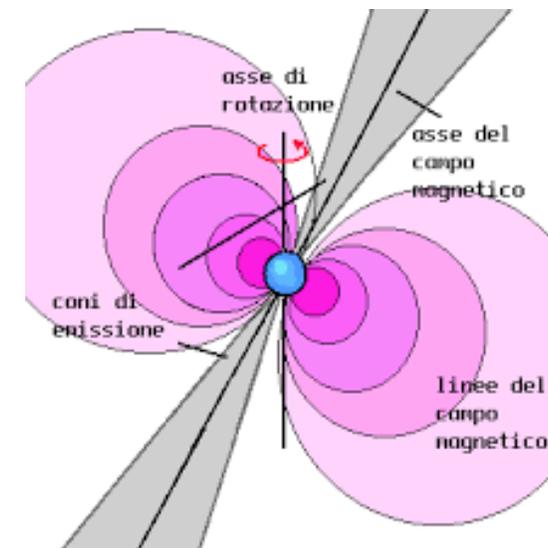
- **Introduzione alla ricezione delle stelle Pulsar**
- **Status delle osservazioni**
- **Setup HW/SW**
- **Esempi di ricezione**
- **Sviluppi futuri**



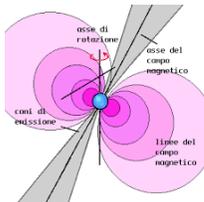
Caratteristiche principali delle Pulsar



- Una stella Pulsar è caratterizzata da una emissione direzionale a larga banda
- In rapida rotazione, produce impulsi regolari con un meccanismo simile ad un «faro»
- Le bande tipiche di osservazione sono 70cm e 23cm
- Flusso estremamente basso: PSR0329+54 ha un flusso medio di 1.5Jy a 400Mhz contro 4700Jy del CignoA !!
- Difficoltà della tecnica di ricezione, necessità di una porzione ampia di spettro libera.
- Caratteristiche principali di una Pulsar:

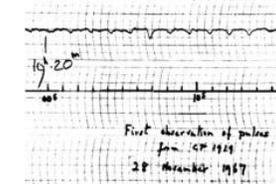


- P0 : Frequenza di ripetizione dell'impulso
- W50 : Larghezza di impulso al 50% dell'altezza
- DM : Dispersion Measure
- S400,S1400 : Flusso medio a 400MHz e a 1400MHz

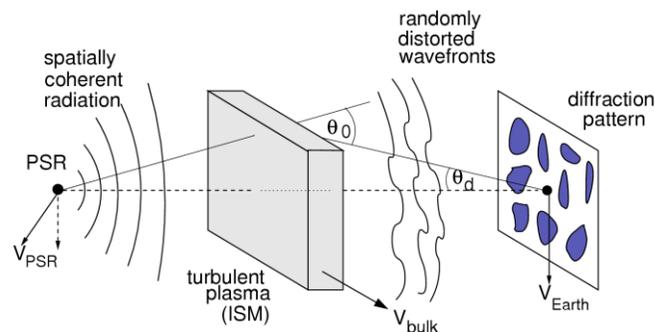


Scintillazione e Dispersione – Interazione con ISM

(ref. "Handbook of Pulsar Astronomy" by D. Lorimer & M. Kramer)



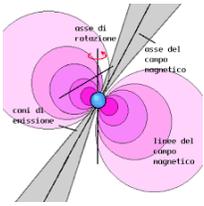
- **SCINTILLAZIONE** Le non omogeneità del mezzo interstellare (ISM) causano una deviazione casuale dei percorsi radio. La somma dei percorsi dalla sorgente all'osservatore causa figure di diffrazione che si trasformano in variazioni repentine di ampiezze e tempo di arrivo degli impulsi.



- **DISPERSIONE** A causa del plasma costituente l'ISM, le componenti frequenziali più basse arrivano ritardate rispetto a quelle alte. DM = Dispersion measure si misura in pc cm^{-3}

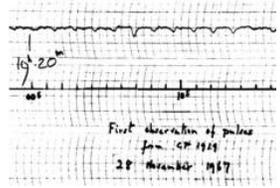
$$\frac{\Delta t}{\Delta f} = 8.3 \cdot 10^3 \text{ DM } f^3$$

- Per le Pulsar vicine al piano galattico si può stimare $N_e = 0.03 \text{ cm}^{-3}$ per cui dalla DM si può ricavare la distanza della pulsar.



L'equazione del radiometro

(ref. "Handbook of Pulsar Astronomy" by D. Lorimer & M. Kramer)



- Consente di calcolare il minimo flusso ricevibile per un dato set-up
- Consente di studiare l'influenza dei parametri che governano la ricezione

Flusso minimo ricevibile

$$\Delta S_{min} = \beta \frac{2k_b (S/N_{min}) T_{sys}}{A_e \sqrt{n_p t_{int}} \Delta f} \sqrt{\frac{W}{P - W}}$$

S/N minimo=6

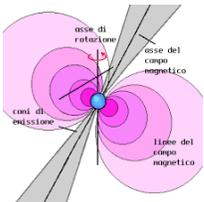
Temperatura di sistema
Tsky+Tspillover+Telettronica

Area equivalente dell'antenna

Tempo di osservazione

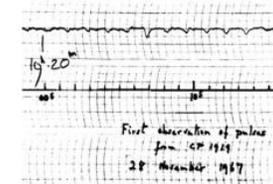
Banda di osservazione

Duty Cycle Pulsar



Programma «MURMUR»

(Realizzato da Mario Natali IONAA)



- Consente di determinare la lista delle pulsar potenzialmente ricevibili per un dato set-up
- Disponibile sul sito : www.aripg.it

| | | | | | |
|--------------------------|----------------------------|-----------------------------|--|--|---------------------|
| Location Barga | Latitude 44.0625 | Longitude 10.4583 | UTC Time 08/10/2016 15:08:19 | Local Time 08/10/2016 17:08:19 | Rev. History |
|--------------------------|----------------------------|-----------------------------|--|--|---------------------|

SAVE current set as default SET Observation location CALCULATE

TRACK noise sources Next 24h Pulsar visibility Next 24h Pulsar tracking

1 Month Pulsar visibility 1 Month Pulsar tracking

EXIT

Dish antenna Other antenna

Antenna gain 17.8 dBi

Frequency 422 Mhz

Line loss before LNA 0.1 dB

LNA Noise figure 0.3 dB

LNA gain 24 dB

Line loss after LNA 3 dB

Receiver noise figure 1.5 dB

T sky 45 K

T spillover 20 K

T atmosphere 0 K

Integration time 7200 sec.

Integration bandwidth 2000 KHz

Wave length 0.71 m

Effective ant. aperture 2.42 m²

System noise temp. 95.13 K

System noise figure 1.23 dB

MDS 902.41 mJy

The analysis does not take into account the polarization of the signal as this parameter is strongly depending on the specific Pulsar. Please evaluate carefully case by case as this may deteriorate performance up to 3dB.

List of detectable PULSARS
based on ATNF Pulsar catalogue
(limited to the strongest 60 Pulsars)

Minimum S/N >6

S/N >6 suggested for reliable results

B0833-45

B0329+54

B1749-28

Right Ascension (J2000) 53.25 deg

Declination (J2000) 54.58 deg

Width of pulse at 50% of peak 6.6 msec.

Barycentric period 0.71452 sec.

Dispersion measure 26.76 cm⁻³ pc

Flow 400Mhz 1500.0 mJy

Flow 1,400Mhz 203.0 mJy

Max. integration bandwidth (without de-dispersion) 1.130 KHz

Calculated S/N 17.22

Azimuth 12.74 deg

Elevation 10.40 deg

Evaluation done only for following frequency intervals : 390Mhz-500Mhz and 1,000Mhz - 1,500Mhz

Caratteristiche del radiotelescopio

Parametri dell'osservazione

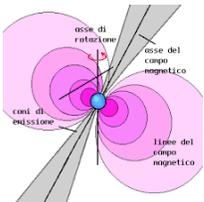
Lista delle Pulsar potenzialmente ricevibili

Caratteristiche della Pulsar selezionata

Rapporto S/N
aspettato = 17.2

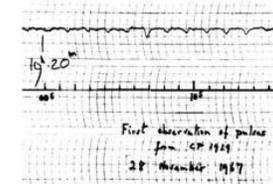
Posizione attuale della Pulsar

Esempio di applicazione del programma al setup IW5BHY 3D Corner



Questione di.. TEMPO

(Joe Taylor K1JT et al.)



- La tecnica di ricezione del «synchronous averaging (Folding)» necessita di conoscere esattamente la frequenza di ripetizione degli impulsi.
- E' necessario in riferimento frequenza di alta stabilità (TCXO o preferibilmente Rubidio/GPS)
- Il programma «TEMPO» consente di predire la frequenza istantanea tramite una polinomiale.
- Dedispersion. Compensazione dell'effetto di dispersione

POLYCO FILE
 C:\TEMPO\polyco.dat

line string

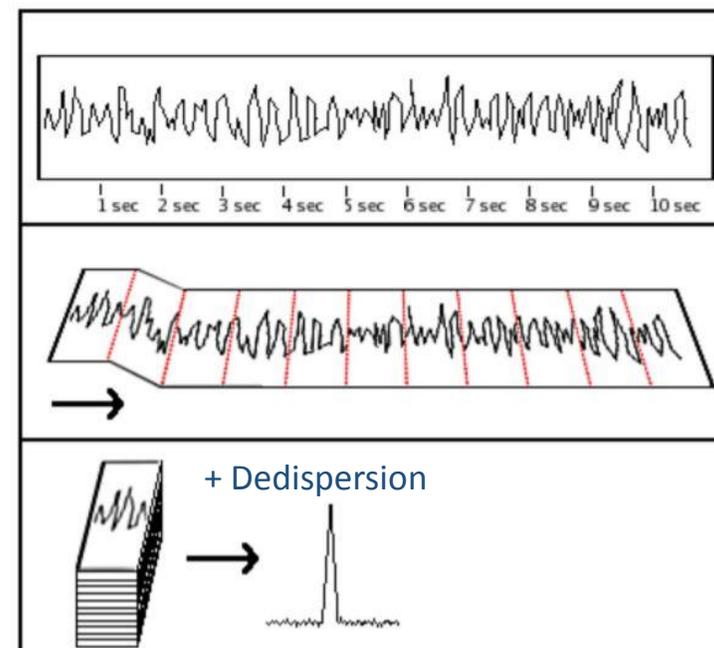
```
0329+54 10-APR-16 133000,00 57488,5625000000 26,776000 0,582 -4,240
931273958,349676 1,399540389960 19 1080 5 422,000
-0,83014714016067803E-04 -0,50437633711156778E-02 -0,84373067413568656E-07
-0,25907029290295860E-11 0,14195441175307922E-12
```

| | | | | | |
|--------------|--------------------|-------------------------|-----------------------|------------------------|---------|
| 0329+54 | PULSAR NAME | 931273958,349676 | RPHASE | -8,3014714016067803E-5 | C1 |
| 10-APR-16 | DATE | 1,3995403899600 | F0 | -5,0437633711156778E-3 | C2 |
| 133000,00 | UTC (hhmmss.ss) | 1,3994563272371 | F@UTC | -8,4373067413568656E-8 | C3 |
| 57488,562500 | MJD | -2,5907029290295860E-12 | | | C4 |
| 3,54314E+9 | SECONDS | 1,4195441175307922E-13 | | | C5 |
| 26,776 | DM | | | | |
| 58,20000 | DOPPLER (ppm) | 422,000 | FREQ | | |
| -4,24000 | RMS RESIDUAL | 9 | DATA SPAN (+/- hours) | | |
| 1,36360E-7 | RMS RESIDUAL (sec) | 19 | OBSERVATORY | 5 | N COEFF |

Data e ora della culminazione

Coefficienti della approssimazione polinomiale

Validità della predizione

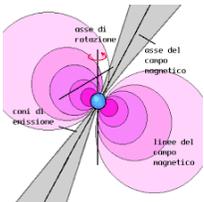


Timeseries

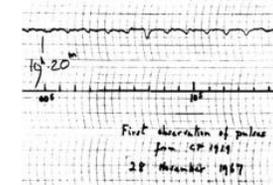
Folding

Profile

$$F = F_0 + \frac{1}{60} (C_2 + 2 \cdot \Delta t \cdot C_3 + 3 \cdot \Delta t^2 \cdot C_4 + 3 \cdot \Delta t^3 \cdot C_5)$$

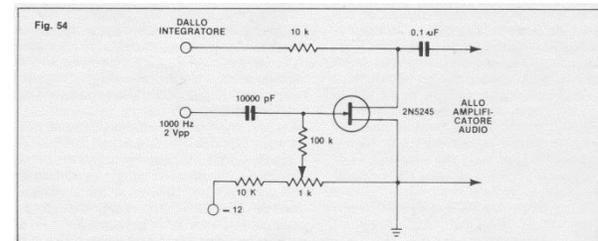


Ricezioni radioamatoriali di stelle Pulsar

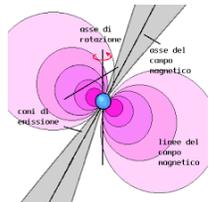


| SIGLA | A R | | Dec. | Periodo sec. | DURATA DELLA IMPULSO millisec. | ENERGIA DELLA IMPULSO 10^{24} joule $m^{-2} Hz^{-1}$ | FLUSSO DI PICCO f.u. | FLUSSO MEDIO f.u. |
|------------|-----|----|------|-----------------|---|--|-------------------------------|-------------------------|
| | h | m | | | | | | |
| CP | 03 | 29 | +54 | 0,714 | 8,7 | 1,20 | 138 | 1,7 |
| NP (Crab) | 05 | 31 | +21 | 0,033 | 1,9 | 0,016 | 8 | 0,5 |
| PSR (Vela) | 08 | 33 | -45 | 0,089 | 1,7 | 0,4 | 235 | 4,5 |
| CP | 08 | 34 | +06 | 1,273 | 17 | 0,1 | 6 | 0,1 |
| CP | 09 | 50 | +08 | 0,253 | 9,5 | 0,06 | 6 | 0,2 |
| CP | 11 | 33 | +16 | 1,187 | 18 | 0,12 | 7 | 0,1 |
| PSR | 17 | 49 | -28 | 0,562 | 6 | 0,5 | 83 | 0,9 |
| CP | 19 | 19 | +21 | 1,337 | 25 | 0,19 | 8 | 0,1 |
| JP | 19 | 33 | +16 | 0,358 | 6,5 | 0,04 | 6 | 0,1 |
| AP | 20 | 16 | +28 | 0,557 | 14 | 0,1 | 7 | 0,2 |

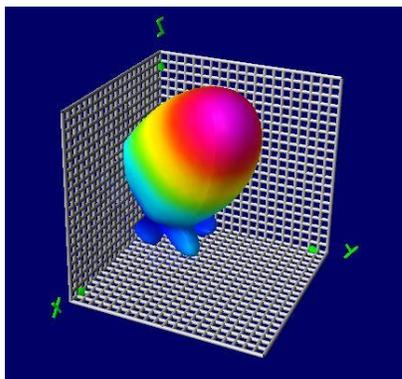
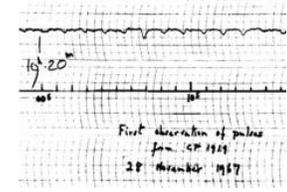
Prof. Gianfranco Sinigaglia
I4BBE (1977)
Pioniere della
radioastronomia
professionale e amatoriale!



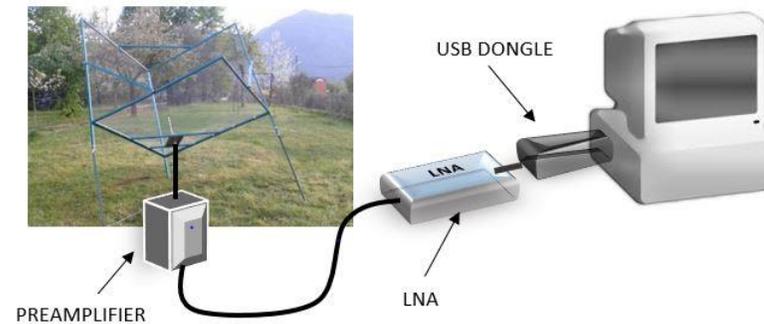
| Nominativo | Anno | Banda | Setup | #Pulsar(70/23) |
|-----------------|------|-----------|------------------------|----------------|
| K5SO | 2007 | 70cm | 8.6mt dish | 2 |
| I1NDP | 2014 | 23cm | 10mt dish | 2 |
| DL0SHF | 2015 | 23cm | 9mt dish | 4 |
| IK5VLS & IW5BHY | 2015 | 23cm | 4mt dish | 1 |
| IW5BHY | 2016 | 70cm | 4mt dish/ corner 18dBi | 1 |
| F1EHN | 2016 | 23cm | 3.3mt dish | 4 |
| I0NAA | 2017 | 23cm/70cm | 5mt dish | 1/1 |
| OE5JFL | 2017 | 23cm/70cm | 7.3mt dish | 11/23 |



Osservatorio B0329+54 - 3D Corner – IW5BHY



| | |
|------------|---------------------|
| Fobs | = 422MHz |
| BW | = 2MHz |
| Tint | = 120 min |
| Tpre | = 30K |
| Tspillover | = 20K |
| Tsky | = 45K |
| Gain | = 18dBi |
| Ae | = 2.5m ² |



HW Setup



Italian Amateur Radio Station **IW5BHY** JN54FB Barga - Lucca - Italy

Pulsar B0329+54
Radio Telescope status: Idle

[Home](#) | [RadioTelescope](#) | [Observation plan](#) | [PSR B0329+54](#) | [I4BBE](#) | [Contact](#)

Statistics for this month

September 2016

| | | | | | | |
|----|----|----|----|----|----|----|
| Su | Mo | Tu | We | Th | Fr | Sa |
| 28 | 29 | 30 | 31 | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 1 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |

Waterfall colour palette
Black Blue White

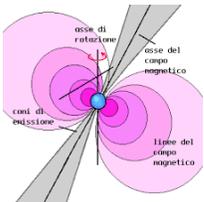
Saturation min: 15.0 mdB

Saturation max: 8.0 mdB

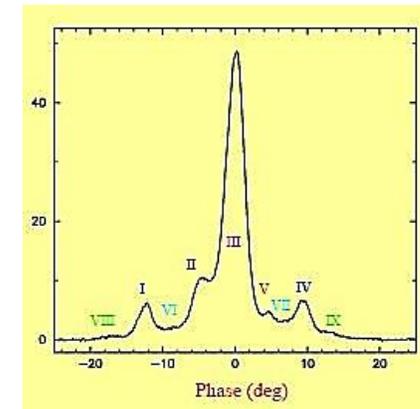
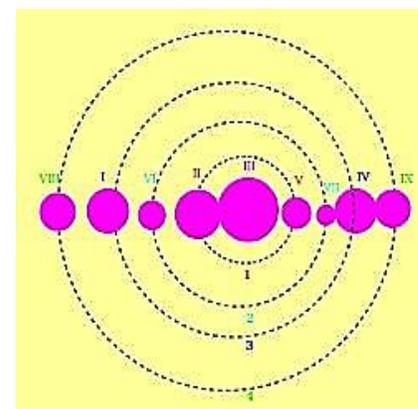
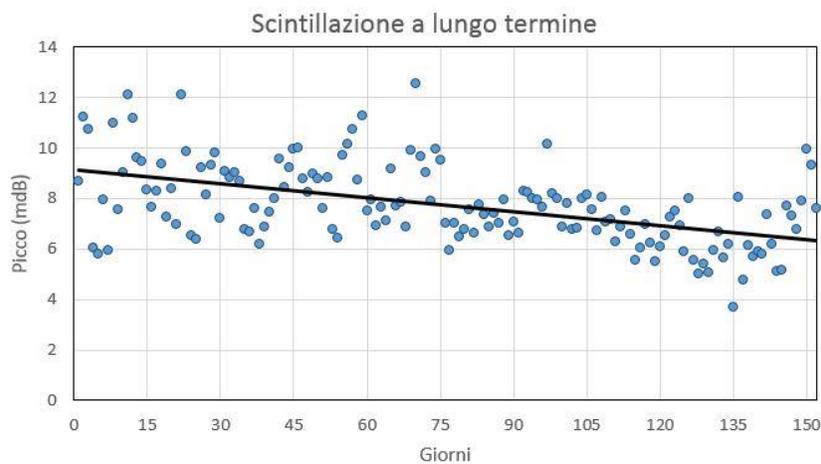
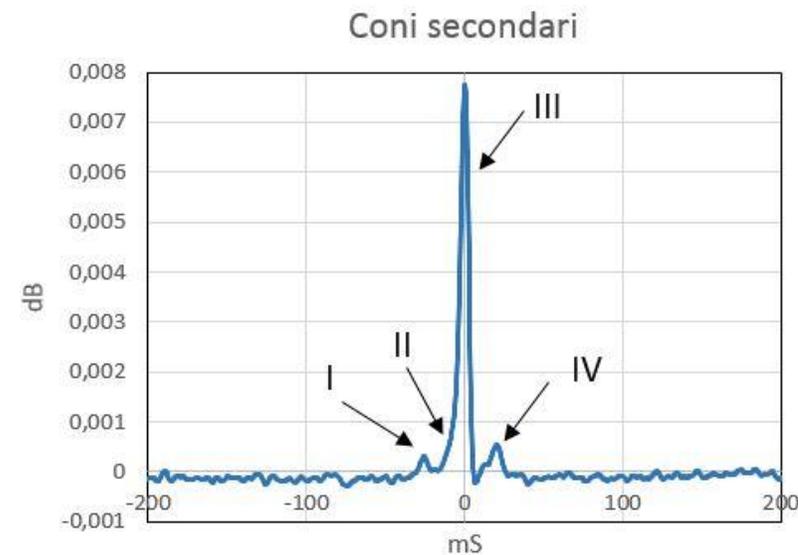
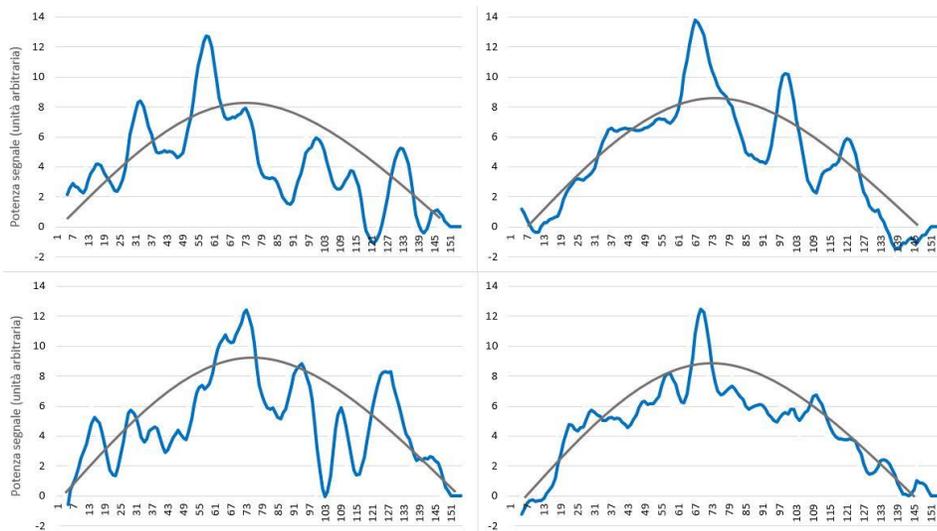
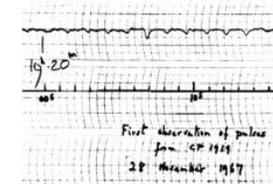
Date: 18/9/2016
 Start hour: 01:30 UTC
 End hour: 04:30 UTC
 Fobs: 422.0 MHz
 BW: 2.0 MHz
 De-dispersor: ON (2.8mS/MHz)
 F: 1.399644 Hz
 Peak: 12.09 mdB
 S/N: 24.66

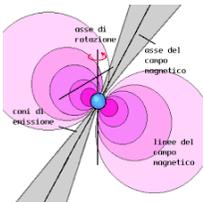
Created and designed by Giorgio Dell'Immagine, using html5 (canvas) css and js. Daily visits: 1074

Interfaccia WEB

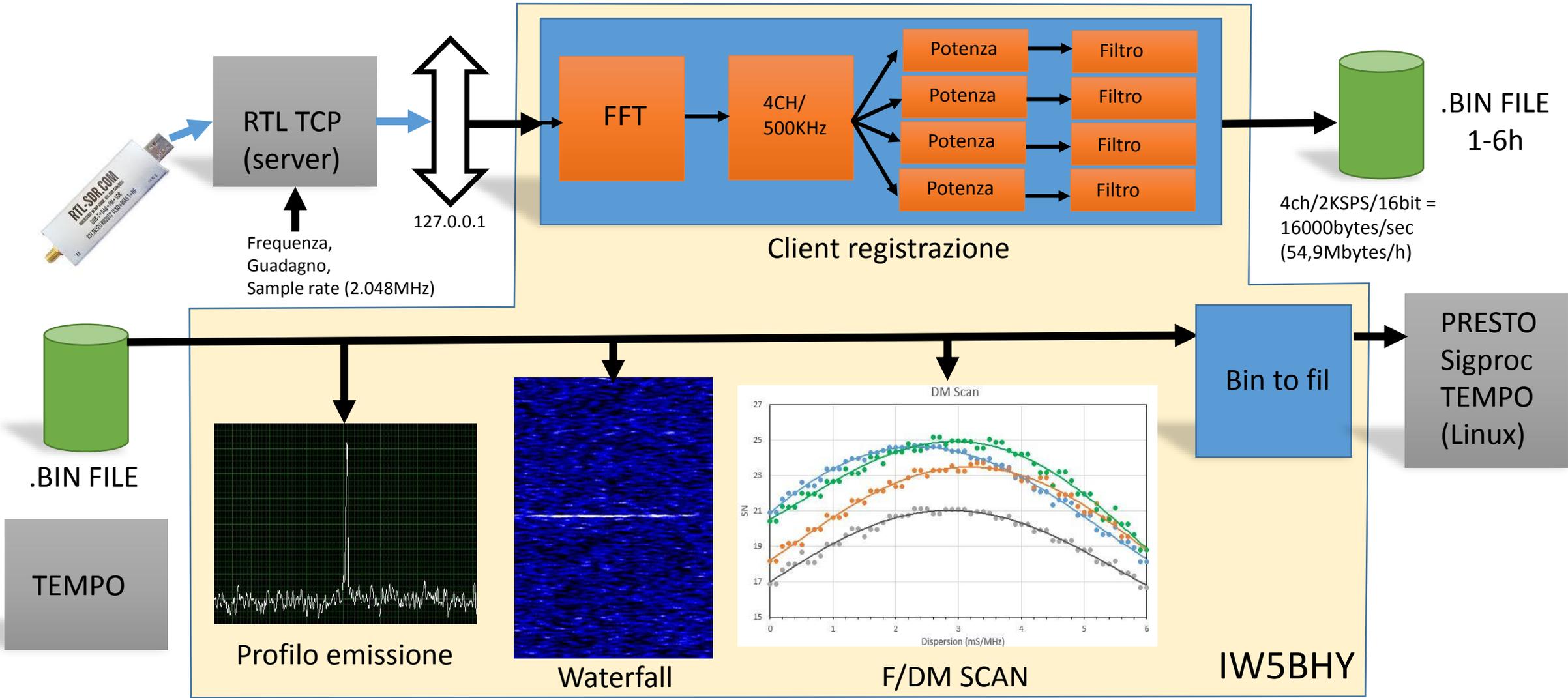
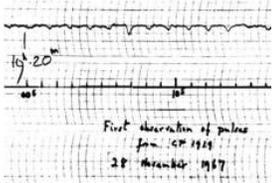


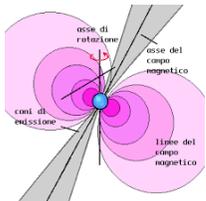
Osservatorio B0329+54 - Risultati



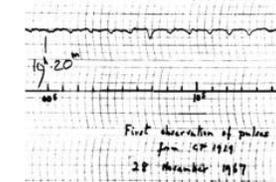


HW/SW di registrazione ed elaborazione



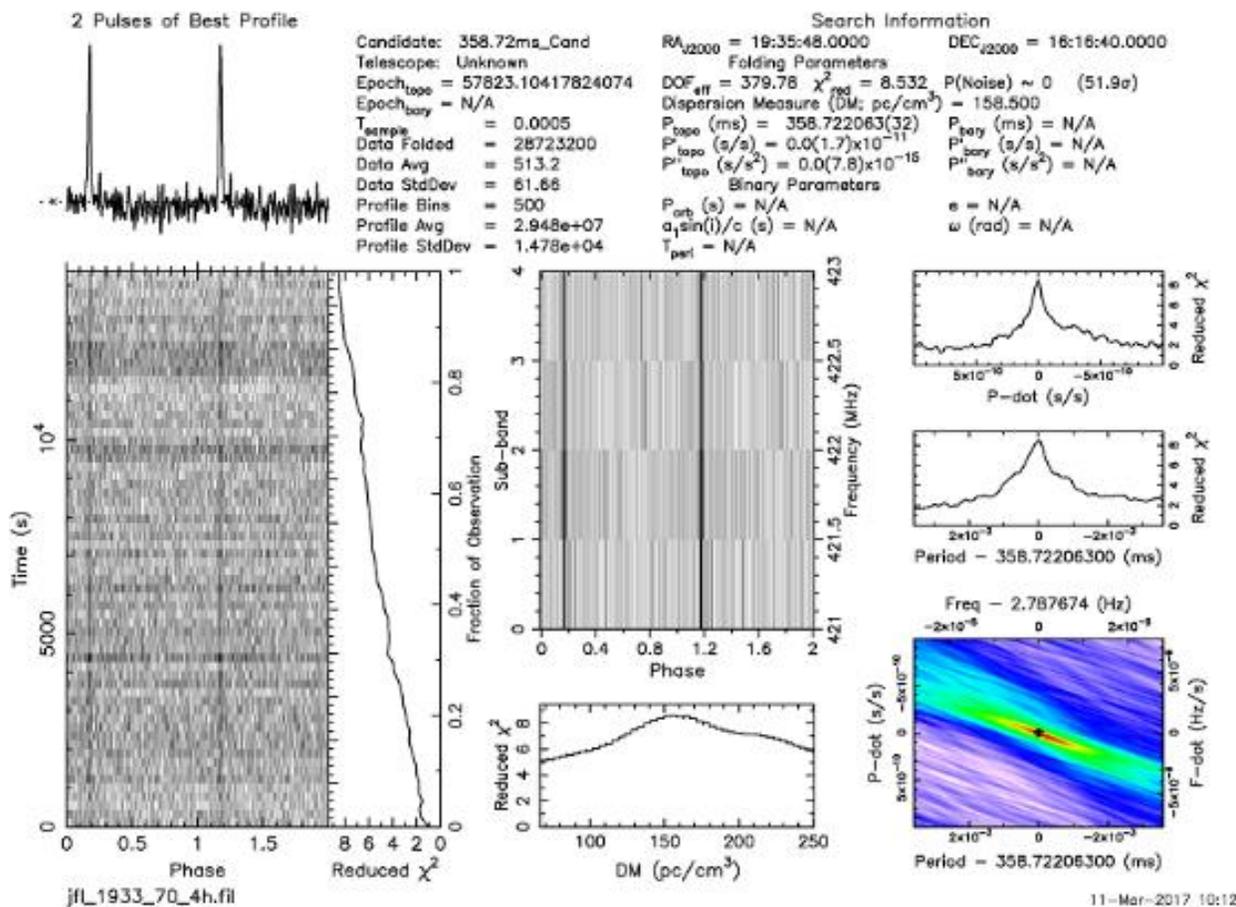


PRESTO – Esempio di elaborazione (B1933+16,OE5JFL)

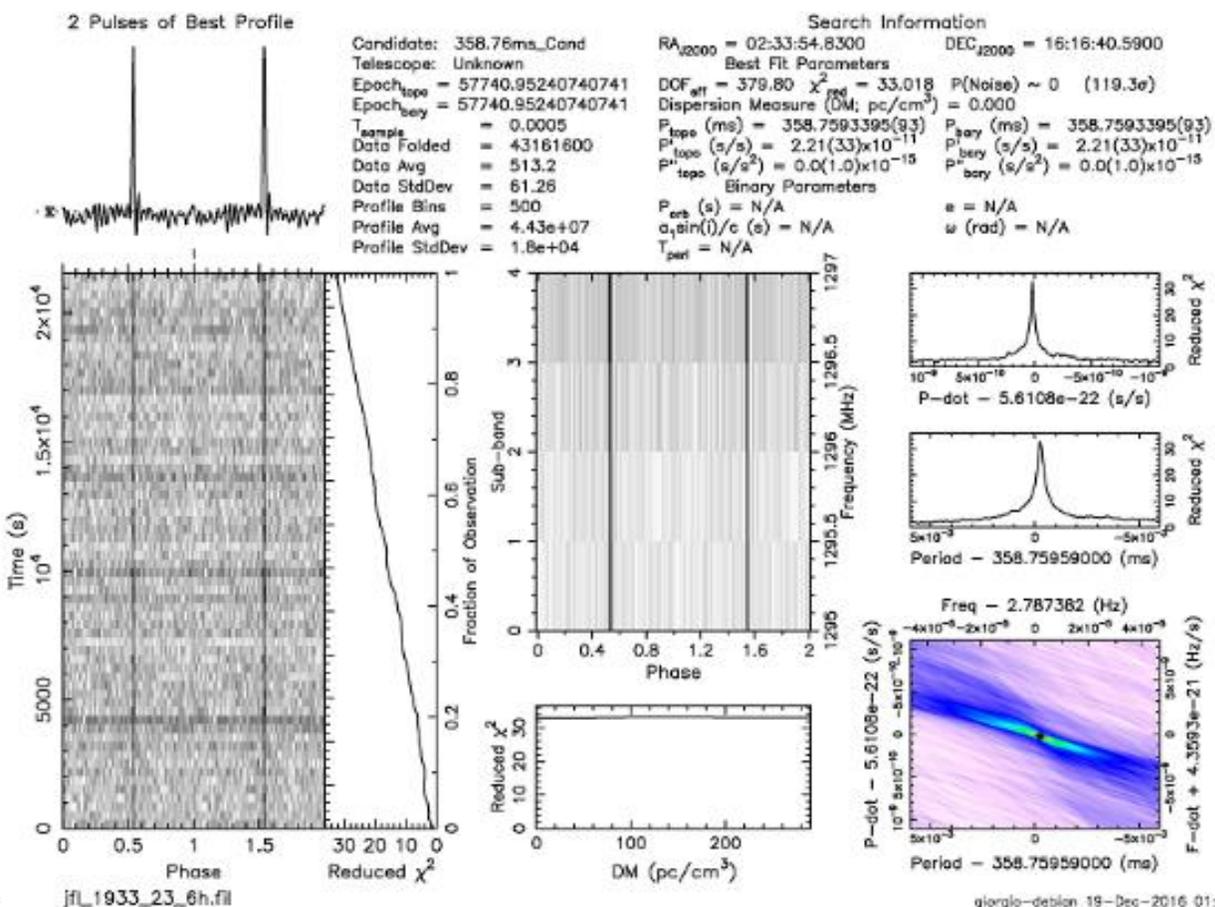


70cm

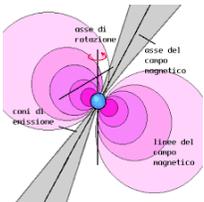
23cm



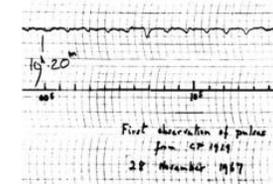
11-Mar-2017 10:12



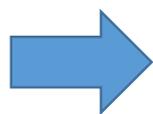
giorgio-deblin 19-Dec-2016 01:17



Sviluppi futuri



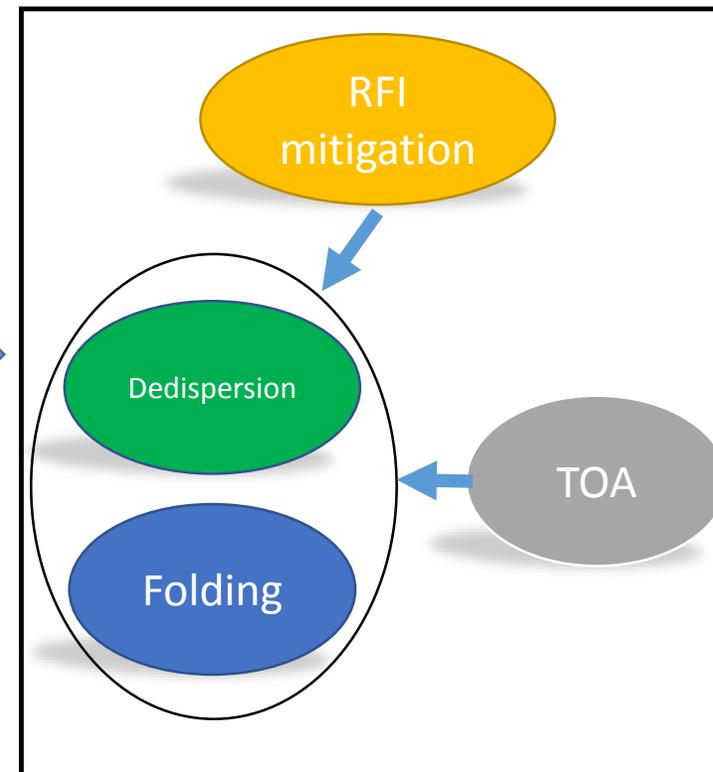
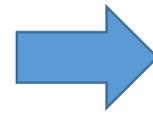
- Estensione della banda di osservazione
- Maggiore range dinamico (resistenza alle interferenze fuori banda)
- Mitigazione RFI efficiente



Raw data to Filterbank Channelizer



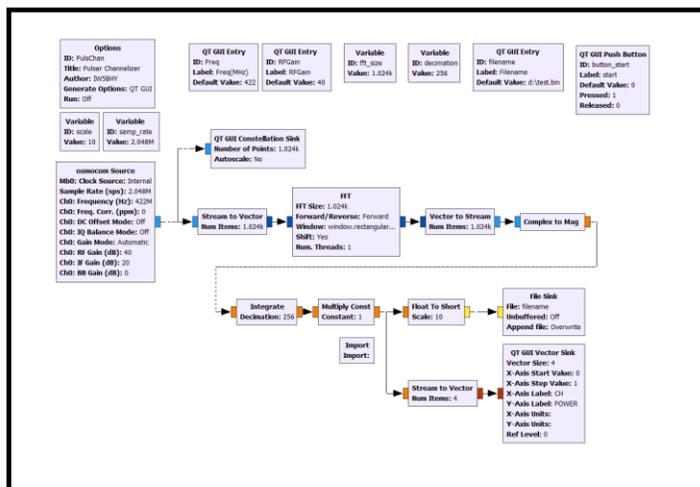
Filterbank File



AirSpy (10MHz)



Ettus USRP (50MHz)



GNU Radio