RFI MITIGATION IMPLEMENTATION FOR PULSAR RADIOASTRONOMY

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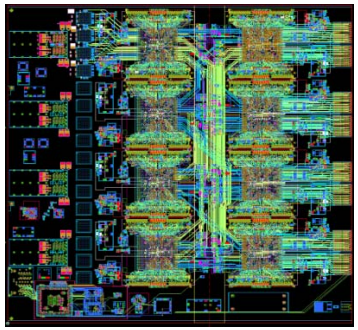
Outline:

I.Robust radar Detector

II.CycloDet: A cyclostationary RFI detector

III.Giant pulse detector

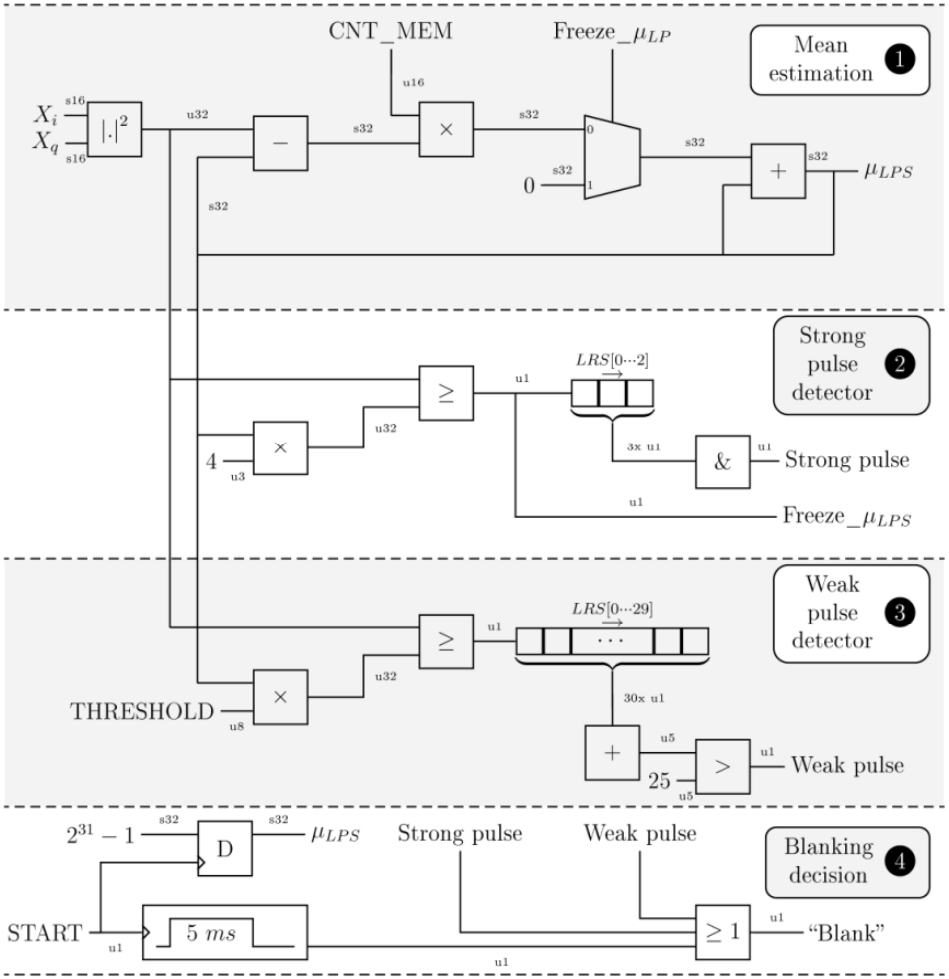
part of the Uniboard project



These 2 algorithms will be implemented in a pulsar binning machine developed by the University of Manchester

I.Robust Radar Detector (1)

Architecture optimized for efficient hardware implementation : Shift registers, comparators, multipliers, glue logic



Robust mean power estimation

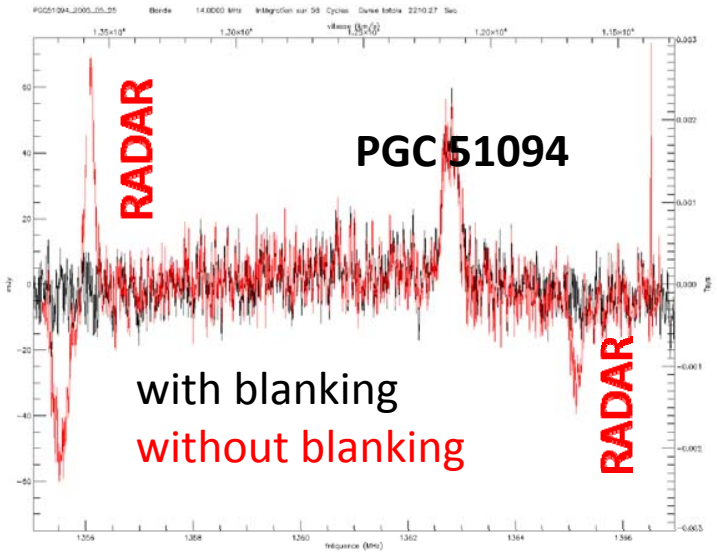
Strong pulses strategy
3 samples window
~3σ detection

Weak pulses strategy
30 samples window
~0.8σ detection

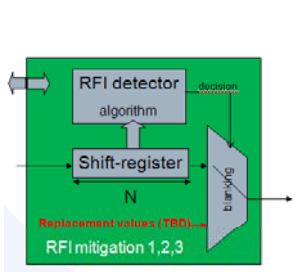
Blanking decision logic

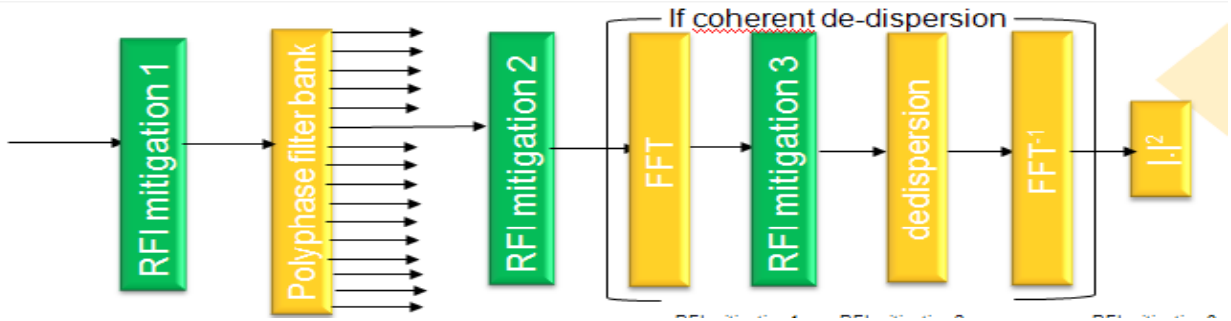
I.Robust Radar Detector (2)

Testing of the radar blanker on real data in real time
(Nançay digital backend)



In Uniboard, possible Implementation at position 1 or/and 2





II.Cyclostationary detector (1)

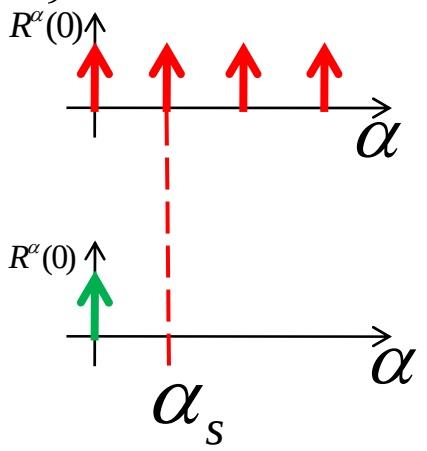
Principle :

α = the cyclic frequency

Cyclic correlation: $$R_{x,x^*}^{\alpha}(\tau) = E\left\{ x(t+\frac{\tau}{2}) x^*(t-\frac{\tau}{2}) e^{-i2\pi\alpha t} \right\}$$

For the RFI, there are some $\alpha_s = \frac{k}{T_{sym}}, k \in \mathbf{Z}$ ⇒ $R_{s,s^*}^{\alpha} \neq 0$

For the stationary noise, for all α≠0, ⇒ $R_{n,n^*}^{\alpha_s} = 0$

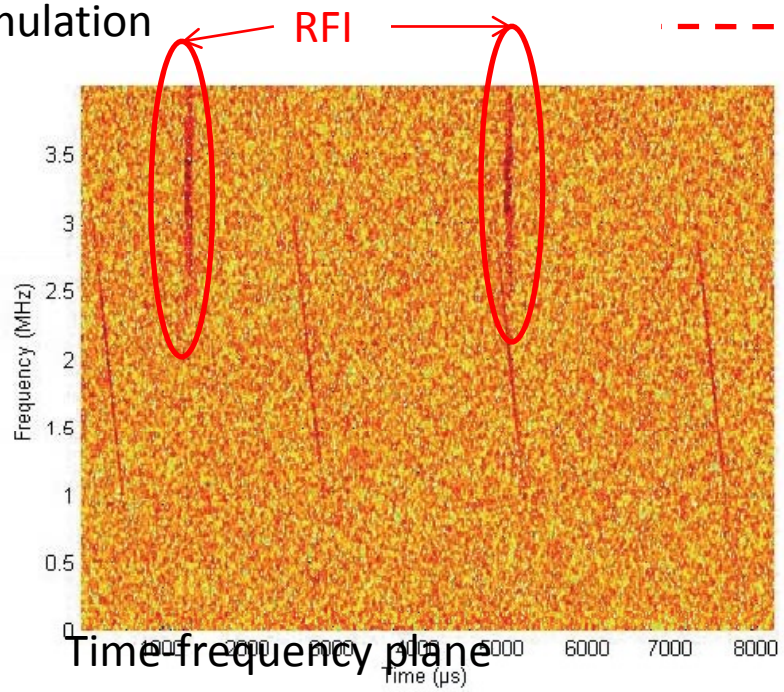


Cyclostationary detector: $$D_N^{\alpha} = \frac{\sqrt{N} C_N^{\alpha}}{C_N^0}$$

where $$C_N^{\alpha} = \frac{1}{N} \sum_{n=0}^{N-1} \left| \mathrm{Re}(x(n)) \right|^2 \exp(-j2\pi\alpha n)$$

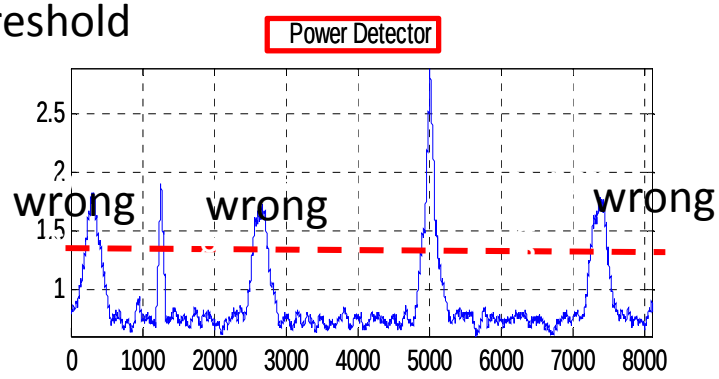
II.Cyclostationary detector (2)

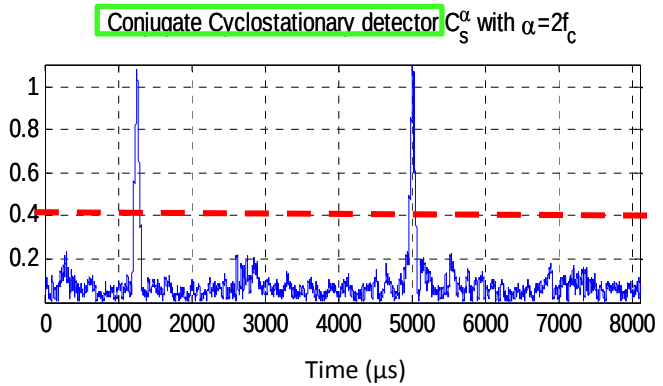
Simulation



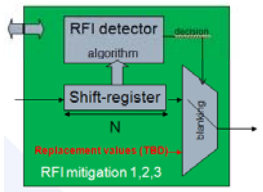
Time-frequency plane

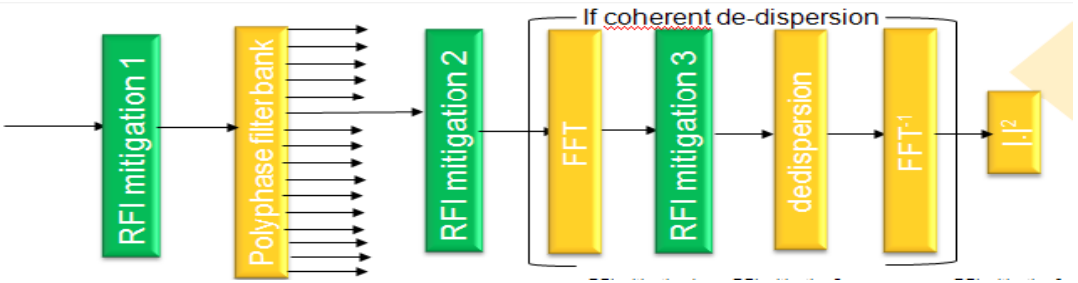
Threshold



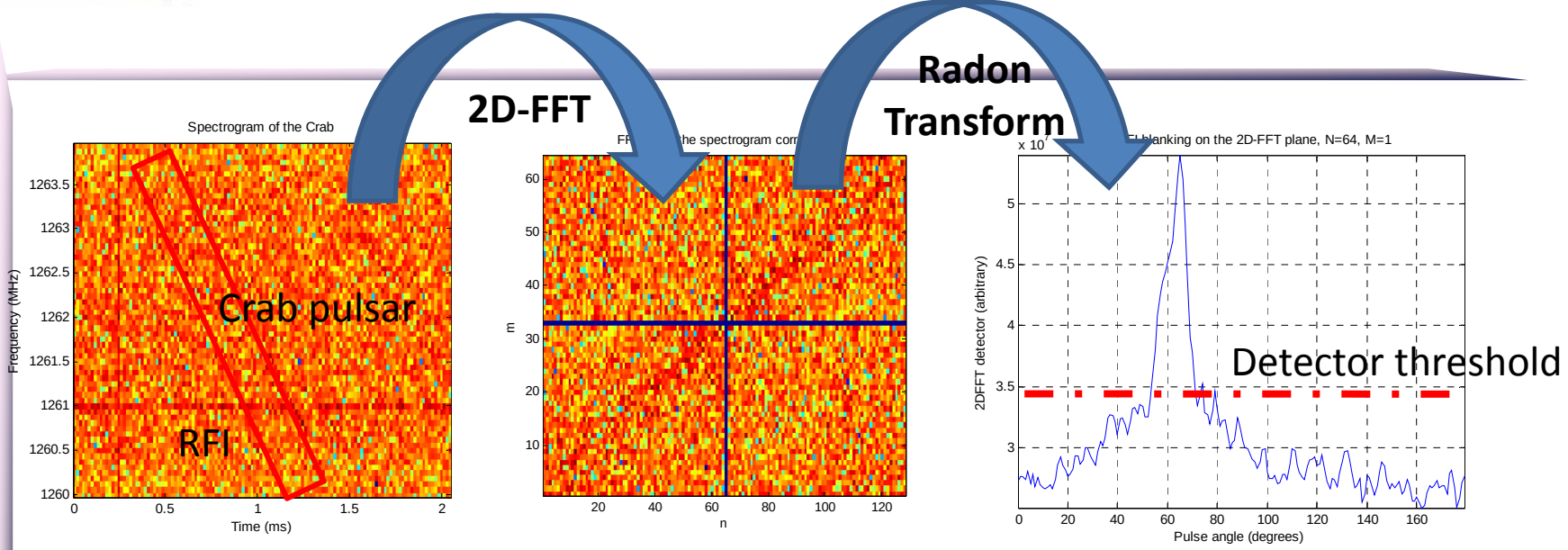


In Uniboard, possible Implementation at position 1,2 and 3





III. Blind Giant Pulse Detector



- The pulsar DM does not to be known
- Zero DM RFI and spectral line RFI are easily removed
- very simple to implement

But less sensitive than a classical dedispersion with known DM

Next step : Implementation on GPU and replay of some pulsar surveys