The use of adaptive predictor filter as a trigger mechanism in simulated cosmic rays radio signals corrupted with Gaussian noise

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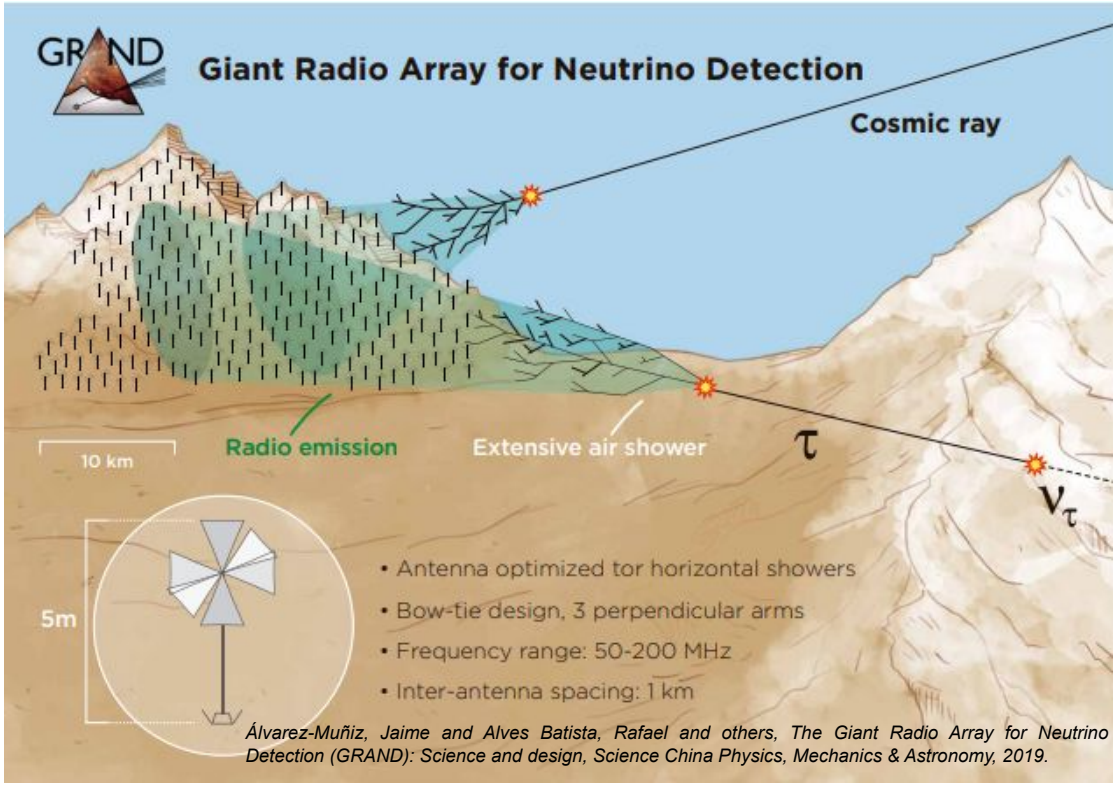
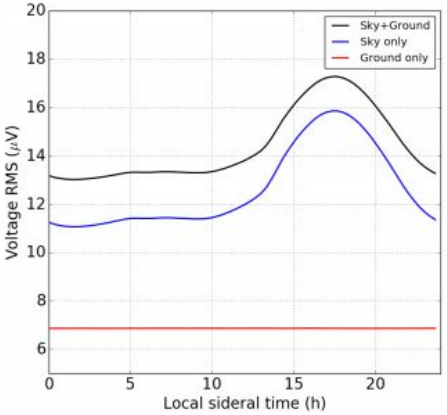
Motivation



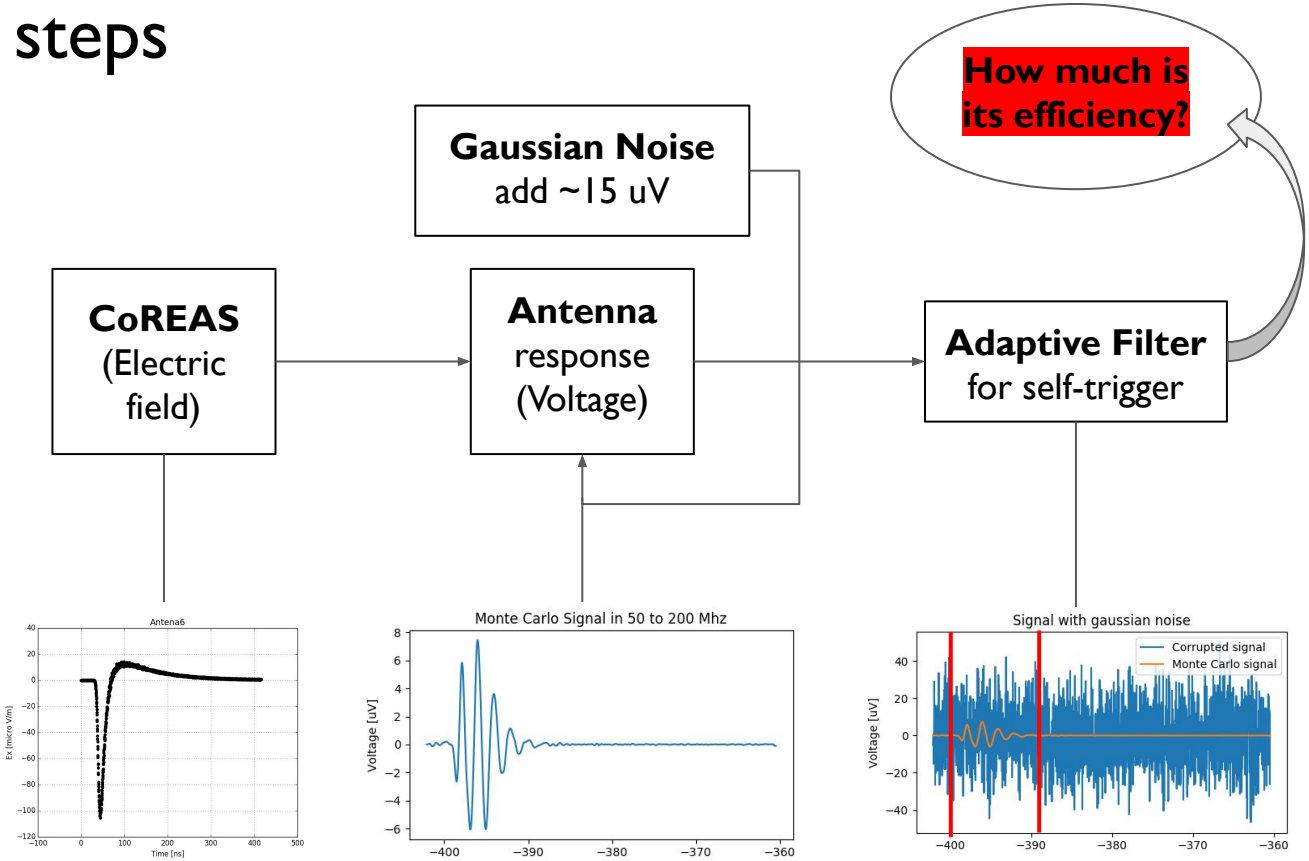
Álvarez-Muñiz, Jaime and Alves Batista, Rafael and others, The Giant Radio Array for Neutrino Detection (GRAND): Science and design, Science China Physics, Mechanics & Astronomy, 2019.



- Desert locations around the world with a background mainly composed by a Gaussian distribution.

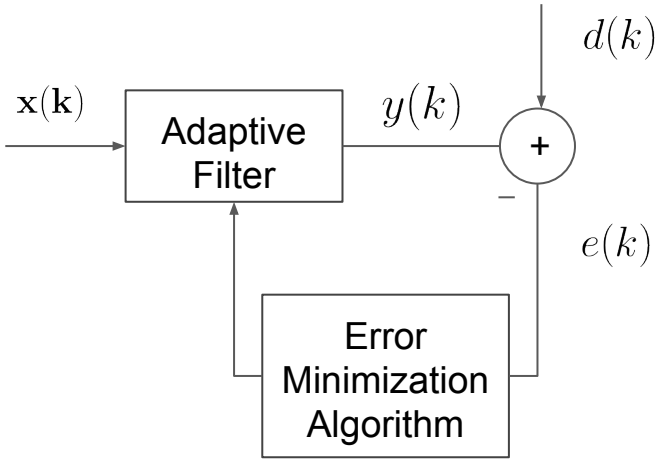
- Task of self-trigger in cosmic rays induced radio signals experiments.

Simulation steps



- Simulated (Coreas) data and simulated (gaussian distribution) background.

Adaptive Filter

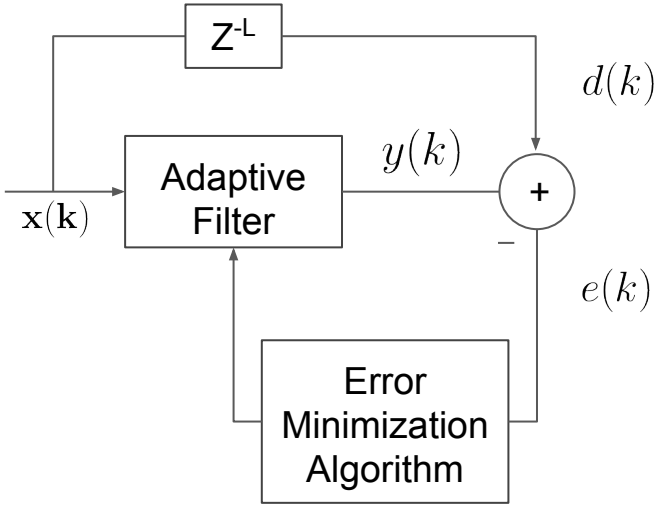


$$y(k) = \mathbf{w(k)}^T \cdot \mathbf{x(k)}$$

$$e(k) = d(k) - y(k)$$

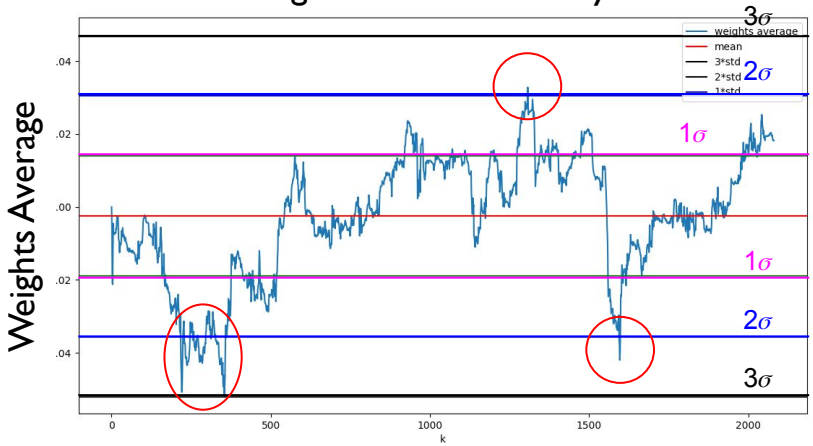
$$\mathbf{w(k+1)} = \mathbf{w(k)} + \mu \mathbf{x(k)e(k)}$$

The Predictor

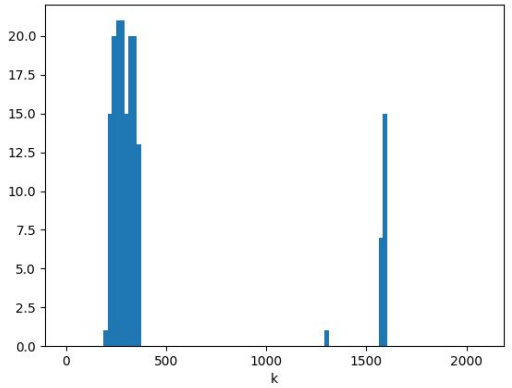


- The desired signal **d(k)** is a delayed version of the signal. The weight vector **w(k)** as a estimator.

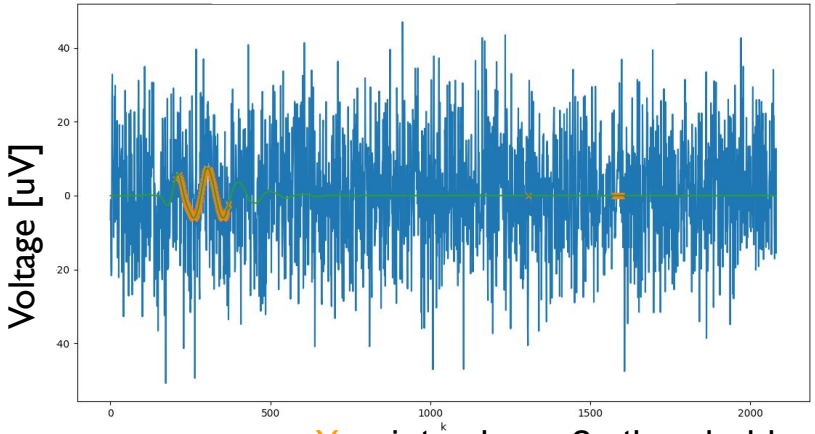
Weights "transient" analysis



Peak detection histogram

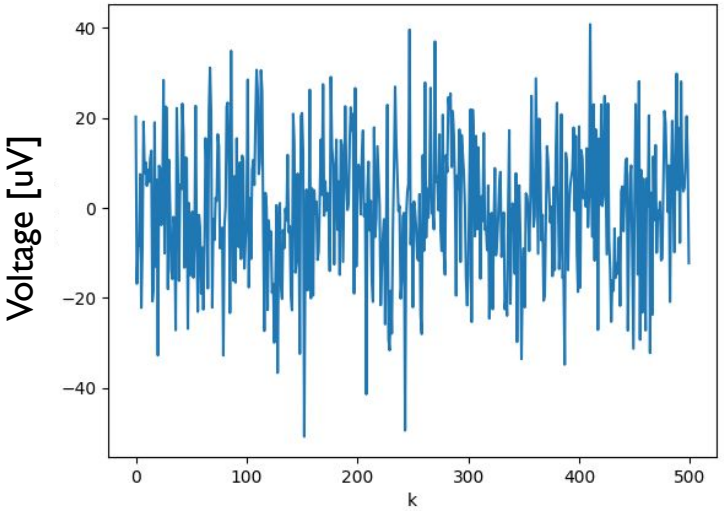


Peak detection



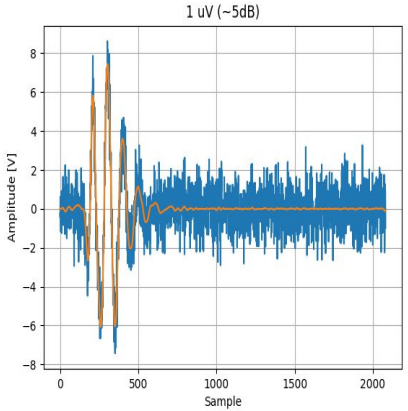
X points above 2σ threshold

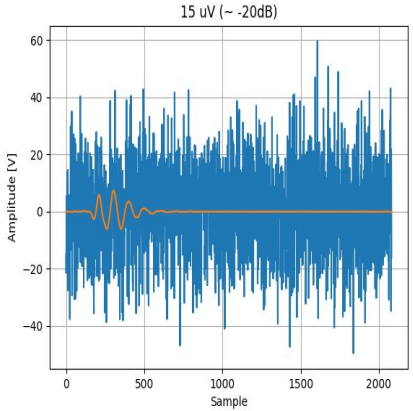
Window selection*

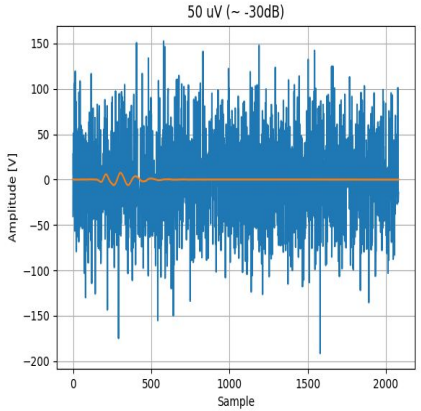


Single template analysis

Background standard deviation varying from 1 uV to 50 uV (1 uV step). This provides a range of SNR (-30 dB to 5dB):

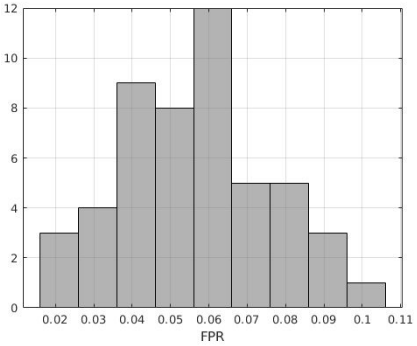


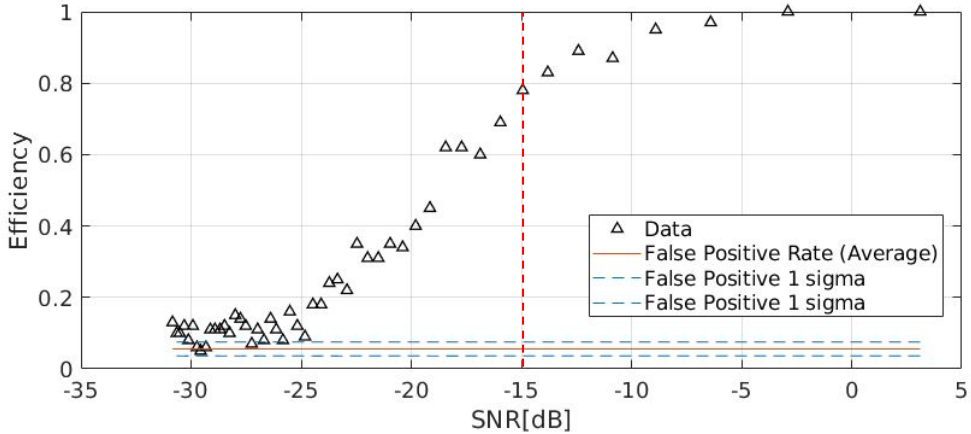




False Positive Rate & Efficiency

- FPR of 6% per 2082 samples
- GRAND sampling rate of 500 Mhz, i.e., each sample = 2ns
- **FPR ~ 15 kHz**





- Efficiency over 80% above -15 dB.