Burst wave analysis of TAMA300 data with the ALF filter

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and the TAMA collaboration

Abstract

- We present analysis status with **ALF filter** which is a kind of the slope filter.
- In our work, target signals are burst gravitational waves from **stellar core collapses**.
- We studied on **detection efficiency** for the galactic event and the **trigger rate**.

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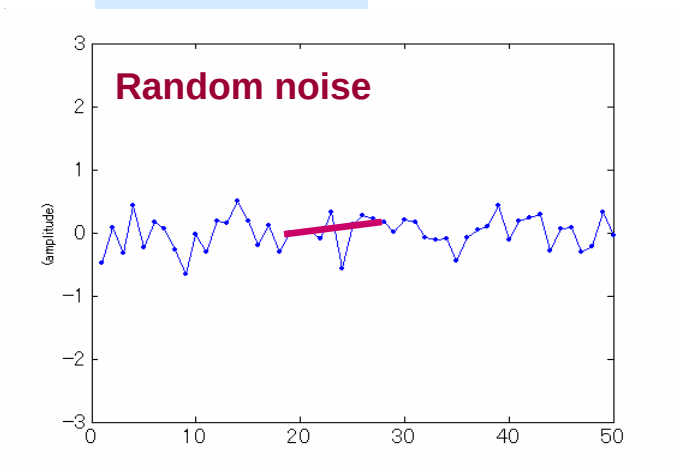
1.1 ALF filter

Alternative Linear Fit filter P.R.D 63, 042002 (2001)

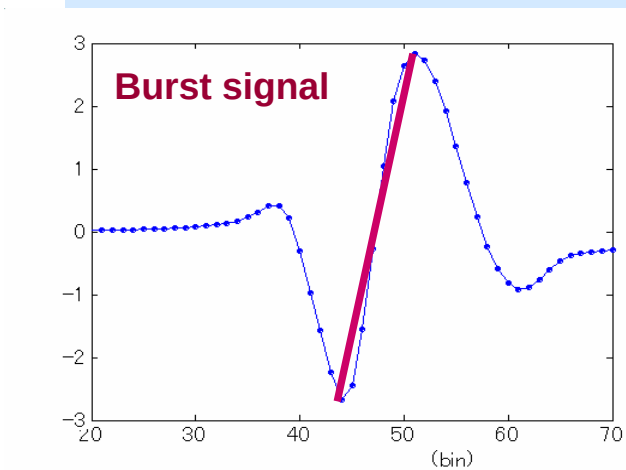
ALF filter { Amplitude information
Phase information → *The filter is expected to be Effective for burst signals.*

Basis idea

slope : low



slope : high > threshold



→ Event !

1.2 ALF filter

Mathematical expression

Fitting the data (*N* samplings) to a linear function $at + b$

→ a Slope b Offset

→ Normalization $X_a = \frac{a}{\sigma_a}, X_b = \frac{b}{\sigma_b}$ σ_a, σ_b its standard deviation

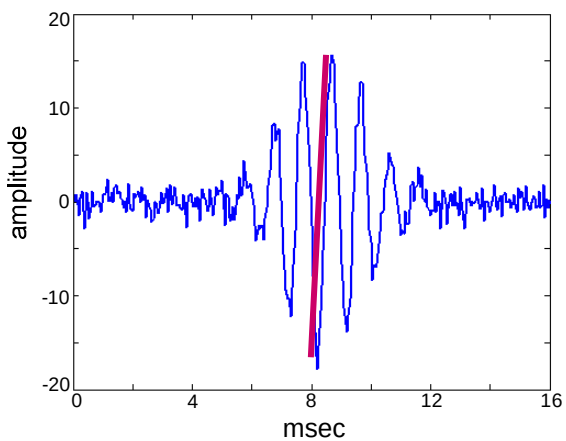
Correlation between *Xa* and *Xb* should be taken into account.

output of ALF filter

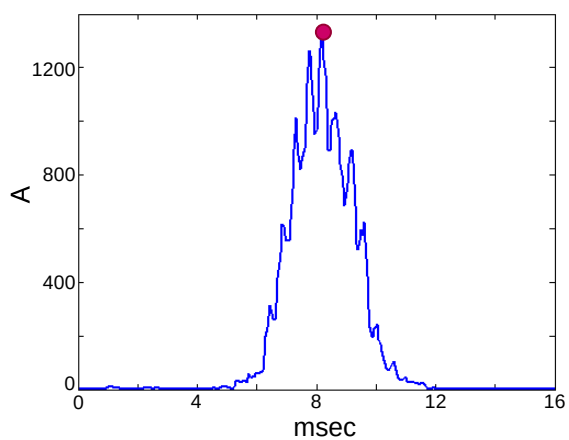
$$A = \frac{X_a^2 + X_b^2 - 2\alpha X_a X_b}{1-\alpha^2}$$

α is a covariance of X_a and X_b

- *example*



ALF filter



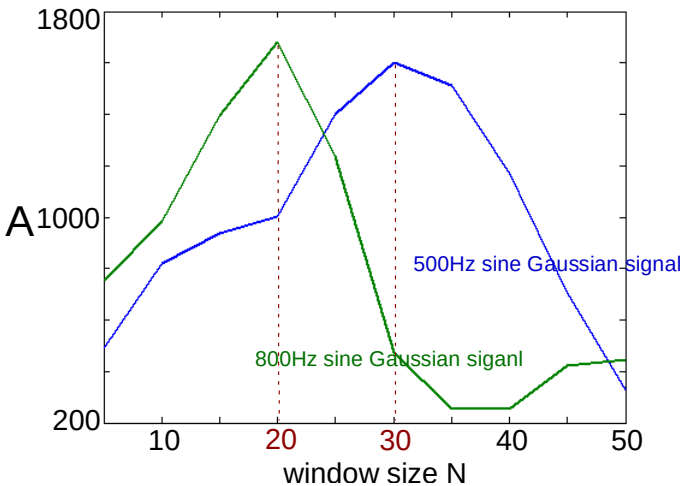
1kHz Sine-Gaussian signal + Gaussian noise

Output of ALF filter

2.1 Optimization of window sizes

Effective window size of ***N*** depends on waveform and duration time of the signals.

window size { too long / too short → Decrease of A



example

	Optimal window size ***N***
500Hz sine-Gaussian signal	30
800Hz sine-Gaussian signal	20

Optimization of *N* is important for the filter.

We have to find an effective combination of window sizes for burst event search.

Parameters to be selected

1. number of windows; p
2. window size; N_i $(i=1,p)$

For example,

A combination of window size N=(10,20,30) → p=3

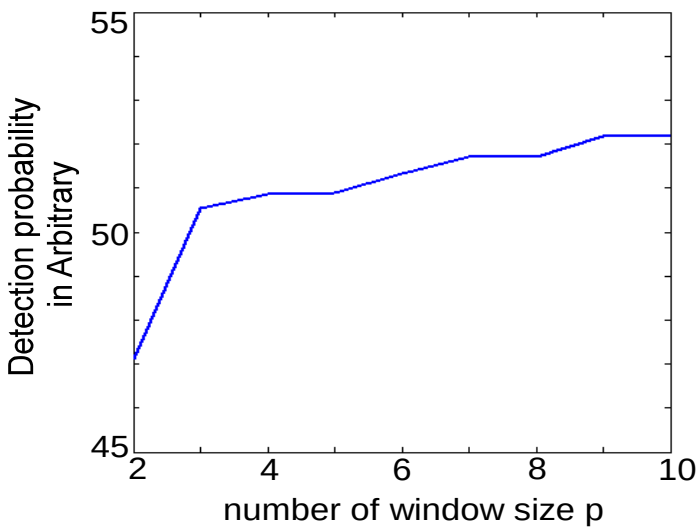
2.2 Optimization of window sizes

Applied signal for parameter optimization → *sine-Gaussian signal 500Hz~2500Hz*

1. Optimal combination of window sizes for a given *p*

p	*optimal window size N*
2	(8,12)
3	(8,12,18)
4	(8,12,14,20)
5	…..

2. Dependence of *p*



p ↗ up → Detection probability ↗ up

p>3 derivative rate became less

→ ***p*=4**
***N*=(8,12,14,20)**

3 Performance

Performance relative to Matched Filtering for the DFM catalogue signals

burst signal *Dimmelmeier et el A&A 393 523*

back ground white noise

performance

N=(8,12,14,20) ➡ 80%

Detection efficiency for the galactic events

data

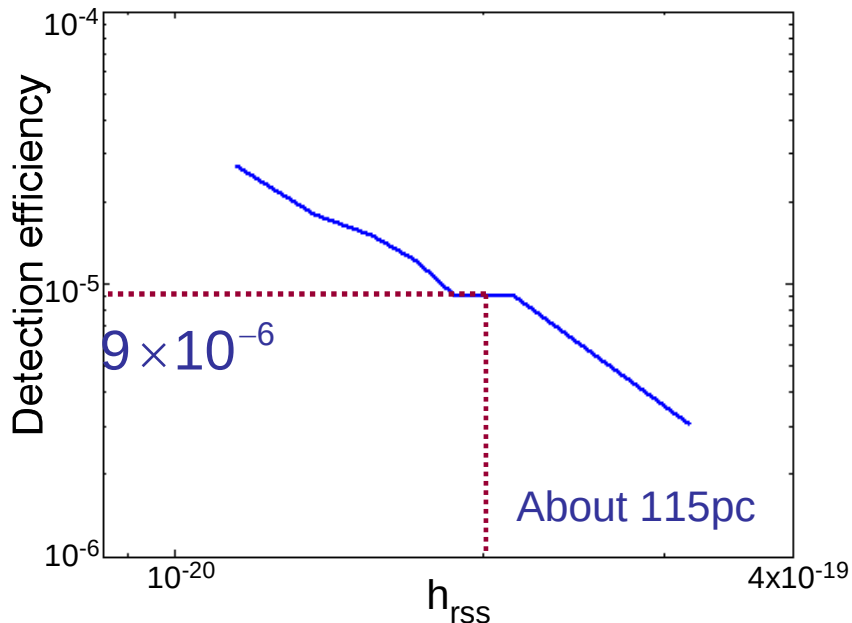
A part of TAMA300 DT9

Injection signal

26 kinds of signals from the DFM catalogue

model

A & A 125 1958

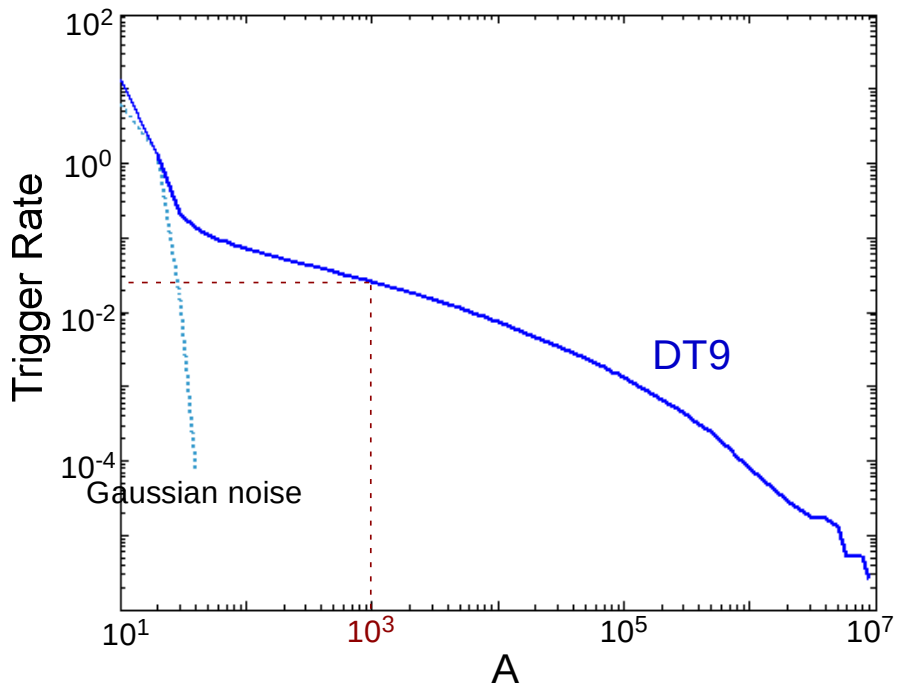


4 Trigger rate

Processing data

About **360 hours** data of *DataTaking9* *(24/12/2003 ~ 10/1/2004)*

- Trigger rate with the filter (Events/sec)



Typical trigger rate $A = 10^{3}$ about 320pc ➡ 2.6×10^{-2} (events/sec)

5 Summary and future work

Summary

- Study of ALF filter which is expected effective for burst event search
- Performance relative to Matched Filtering ➡ 80%
- Typical trigger rate ➡ 2.6×10^{-2} (events/sec) at 320pc

Future work

Reduction of fake events

Veto analysis

➡ Upper limit