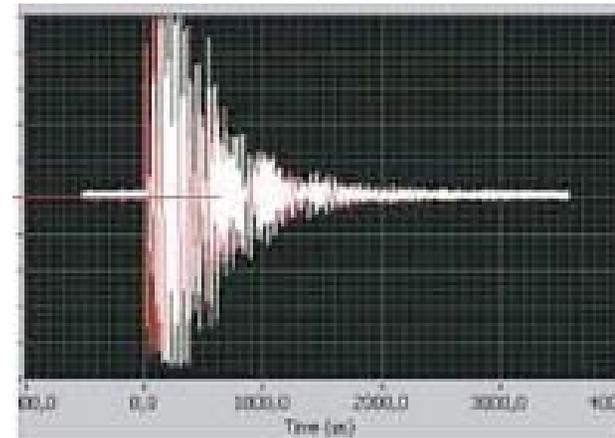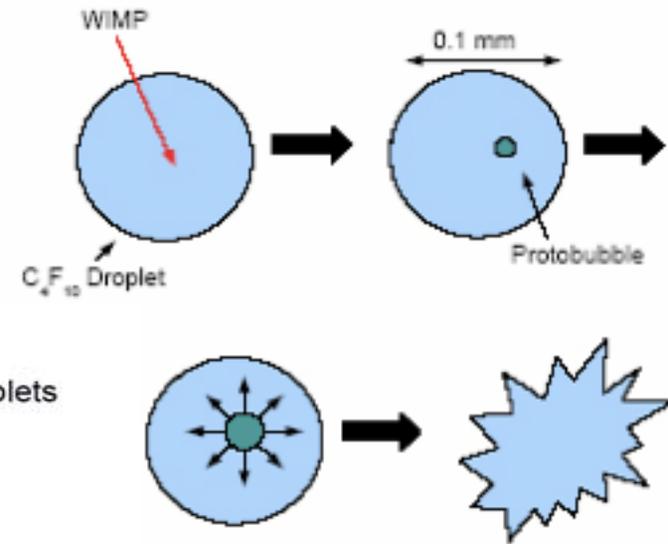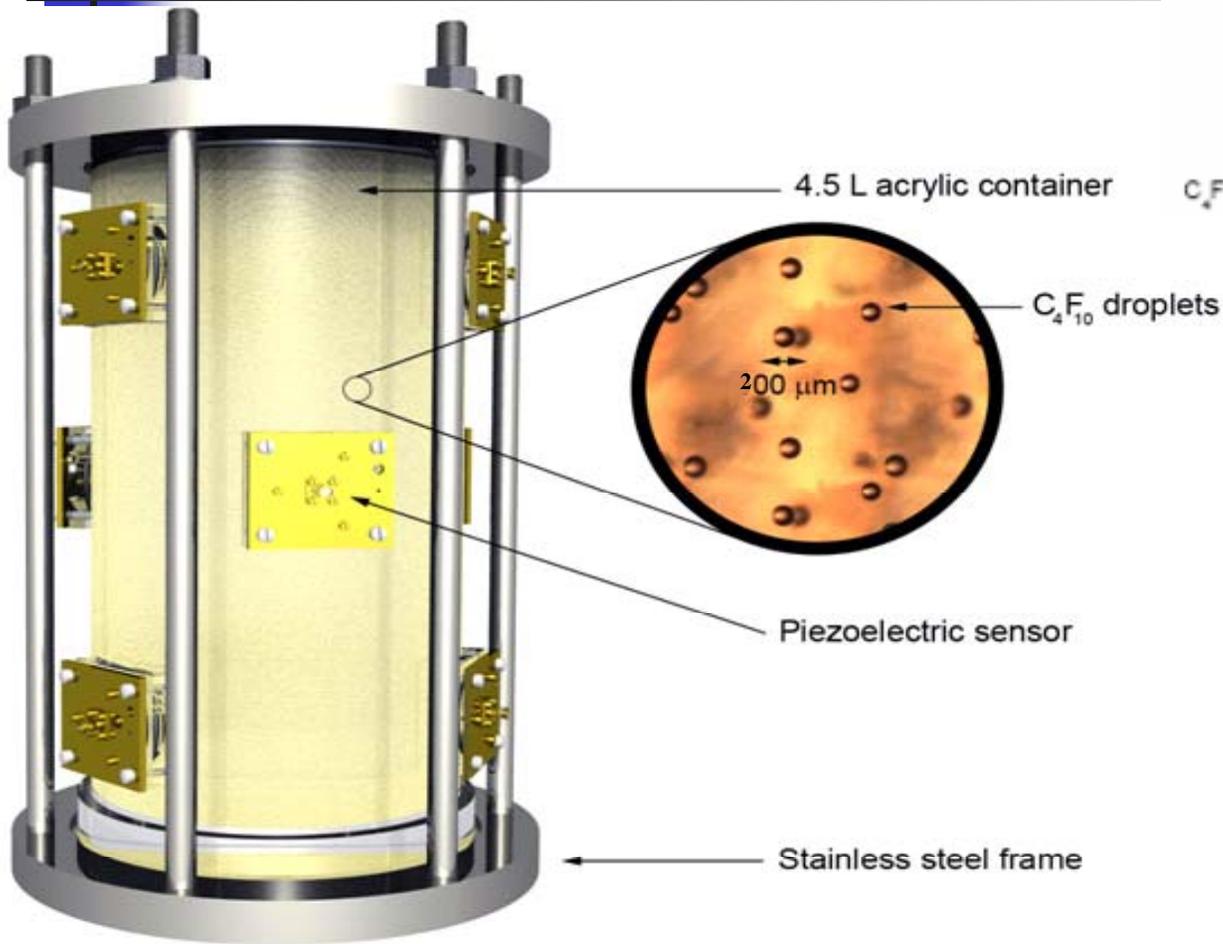# PICASSO Event Discrimination
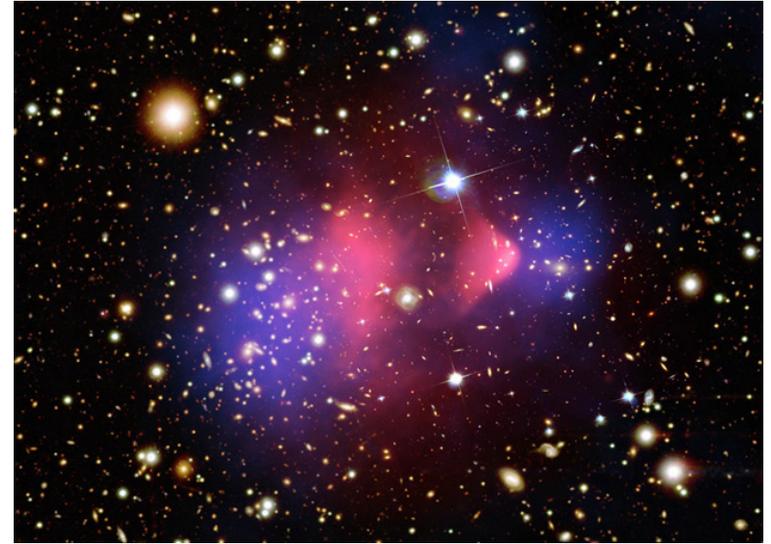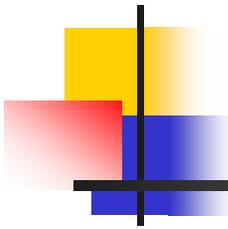

Distinguishing different types of events by signal analysis

by
Simon Archambault

Université de Montréal

Introduction

4.5 L acrylic container

C_4F_{10} droplets

200 μm

Piezoelectric sensor

Stainless steel frame

WIMP

0.1 mm

C_4F_{10} Droplet

Protobubble

Introduction

- The piezo-electric sensors can record different types of events :
    - Particle-induced droplet burst
    - Acoustic noise (Excavation blasts)
    - Fractures inside the gel
    - Electronic noise
- It is important to introduce variables to discriminate against those non particle-induced events

Raw Triggers

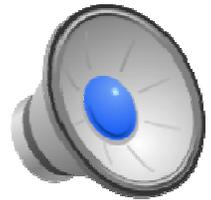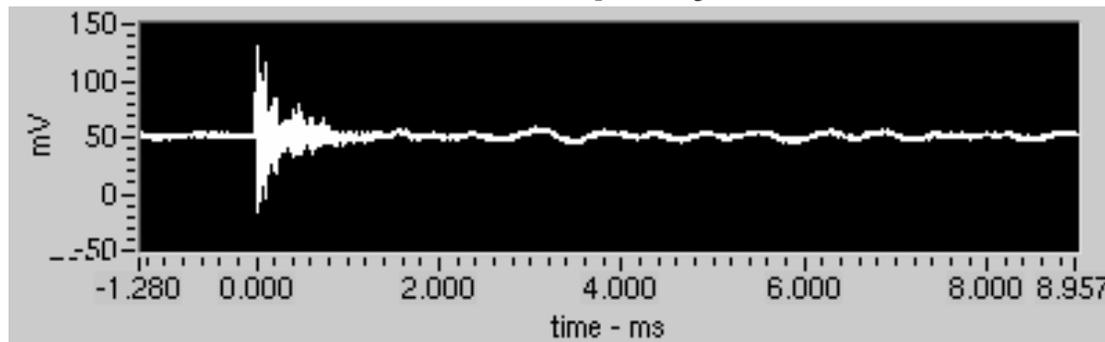- A particle-induced waveform :
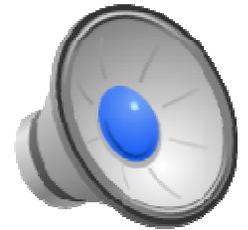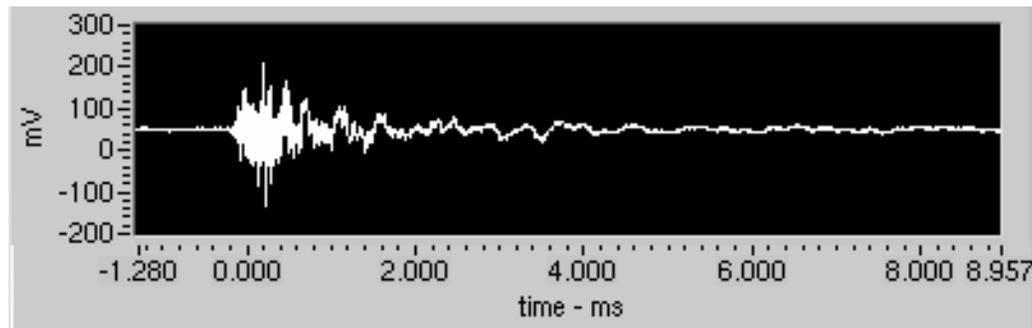
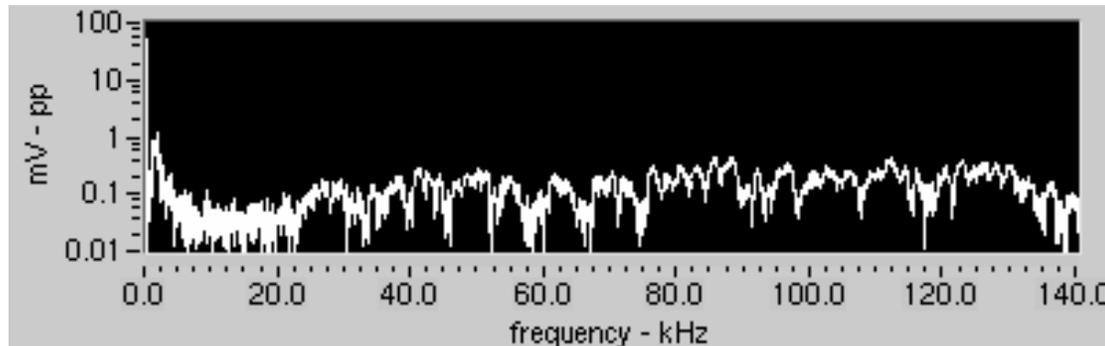- Associated Fast Fourier Transform :
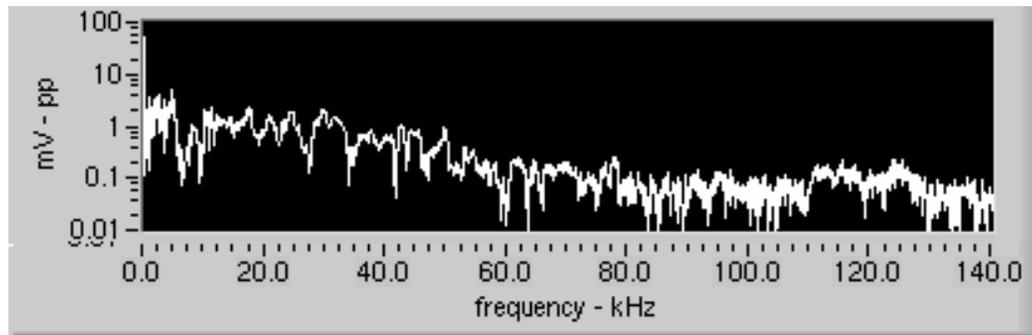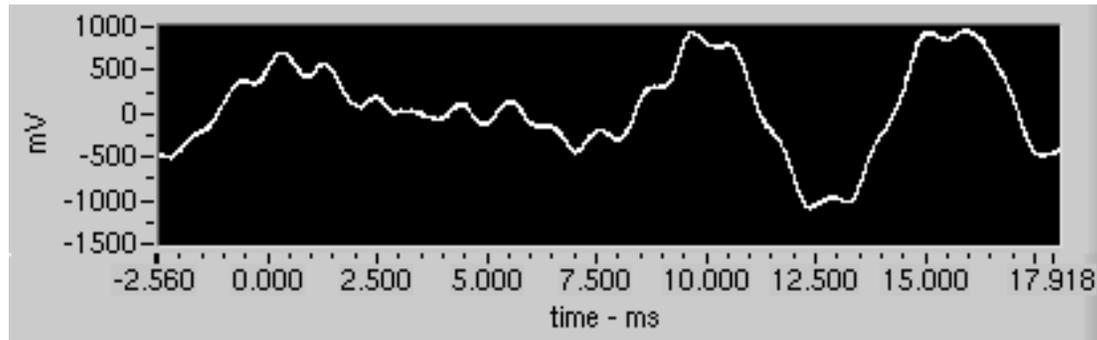
Raw Triggers

- Fractures inside the polymer:
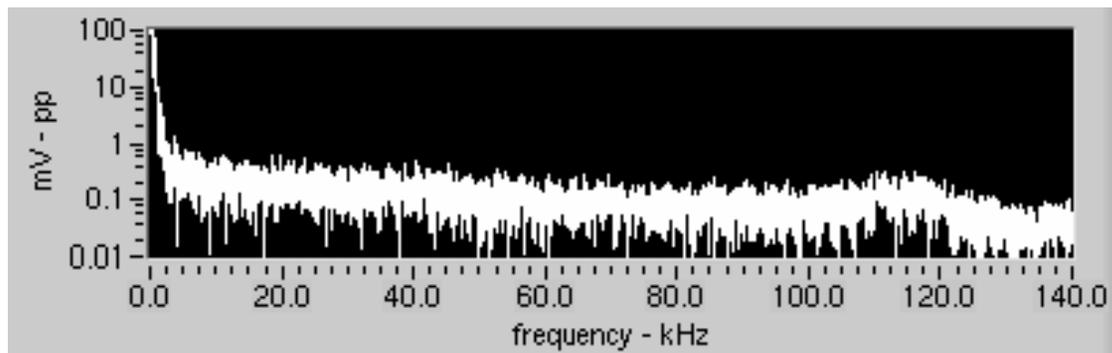

- And its FFT:
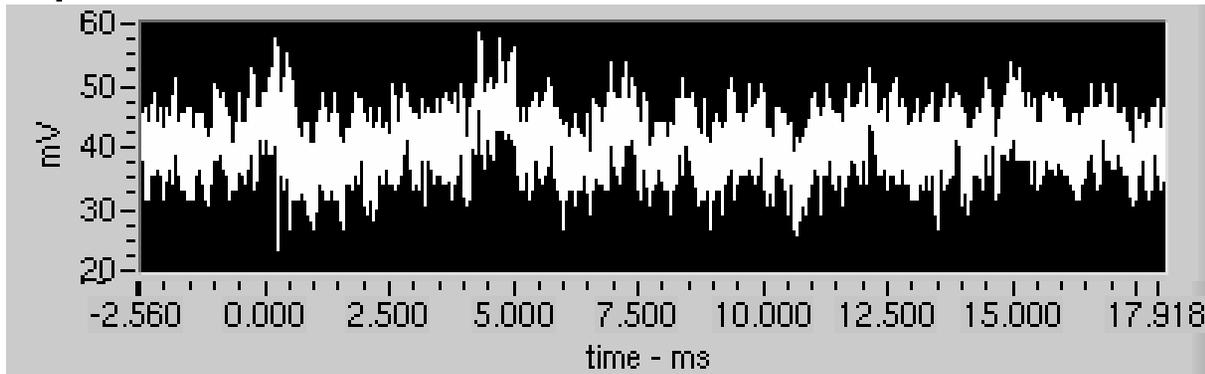
Raw Triggers

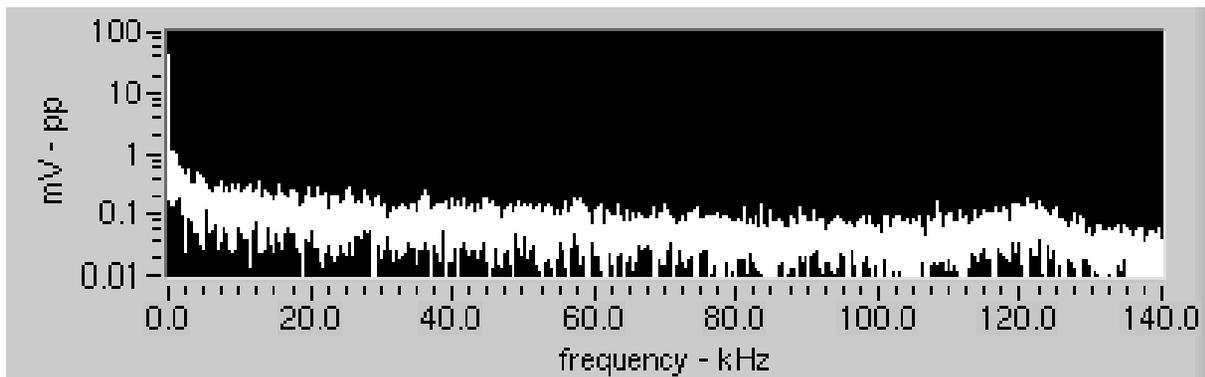- Excavation blasts :

- And its FFT :

Raw Triggers

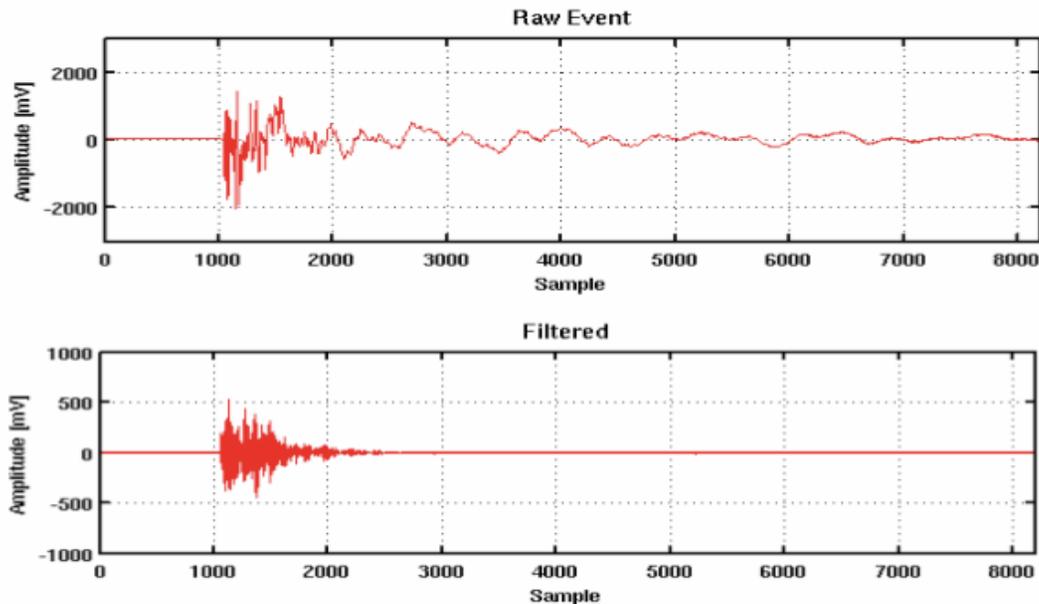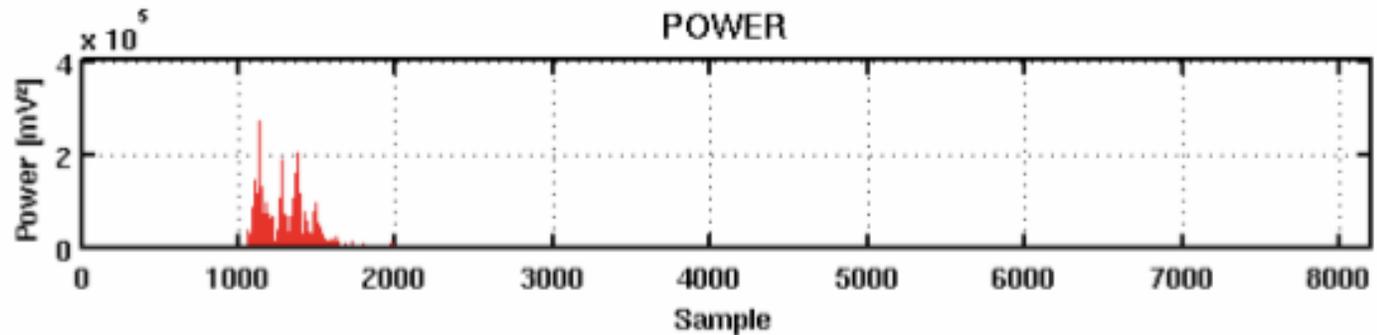- Sporadic electronic noise :

- And its FFT :

Discriminating Tools : Signal Power

- Use intensity of waveform
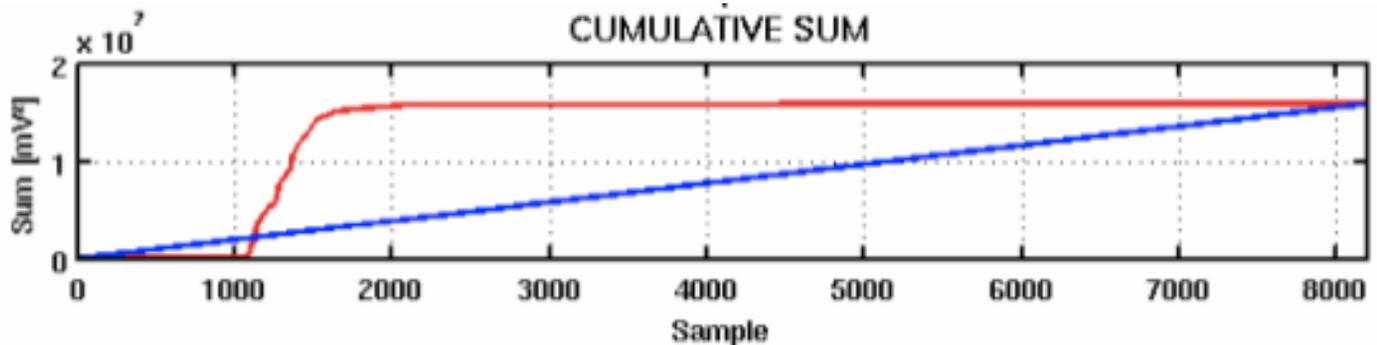- Step 1 : High-pass Filter of the raw signal

Discriminating Tools : Signal Power
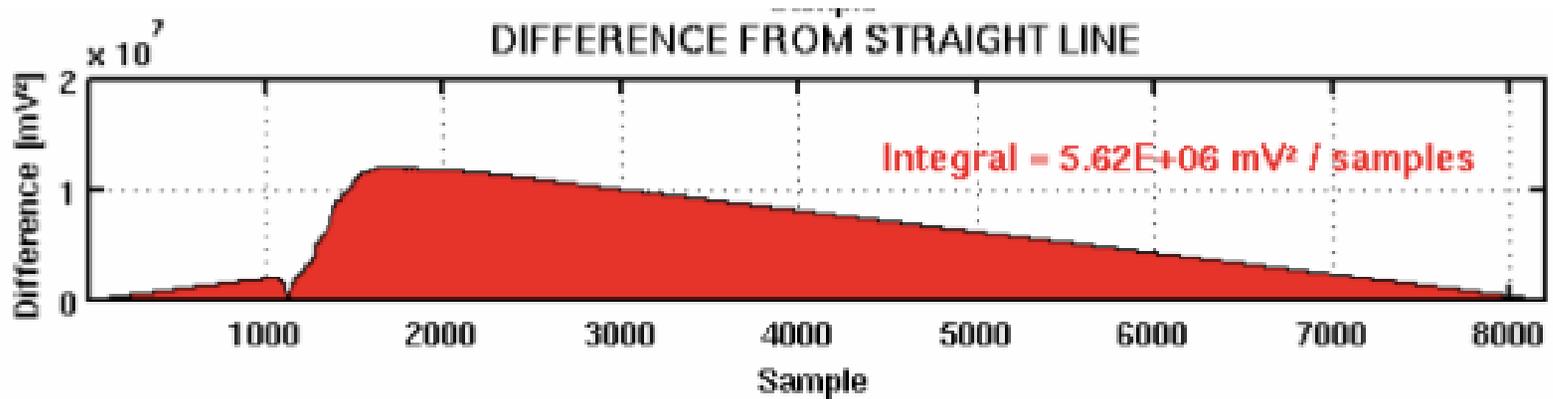
- Step 2 : Square the filtered signal

- Step 3 : Construct cumulative sum

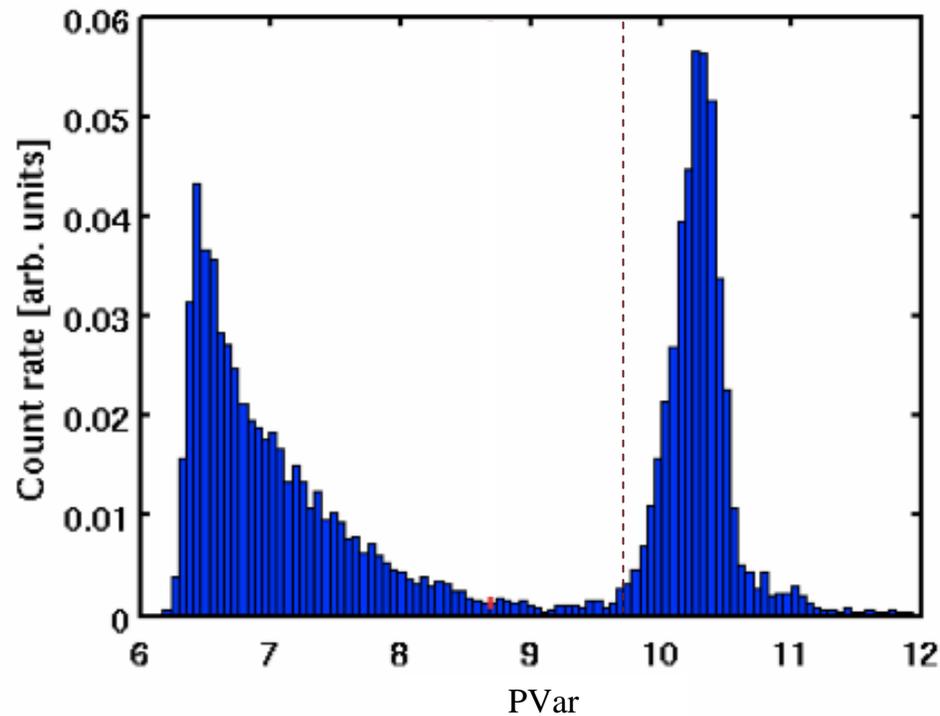# Discriminating Tools : Signal Power

- Step 4 : Subtract background

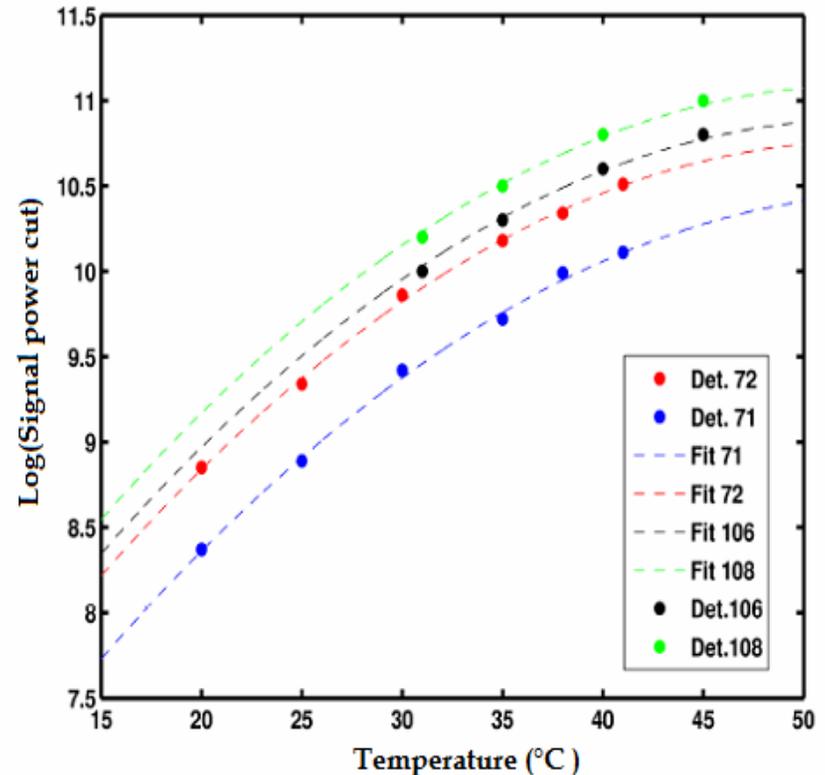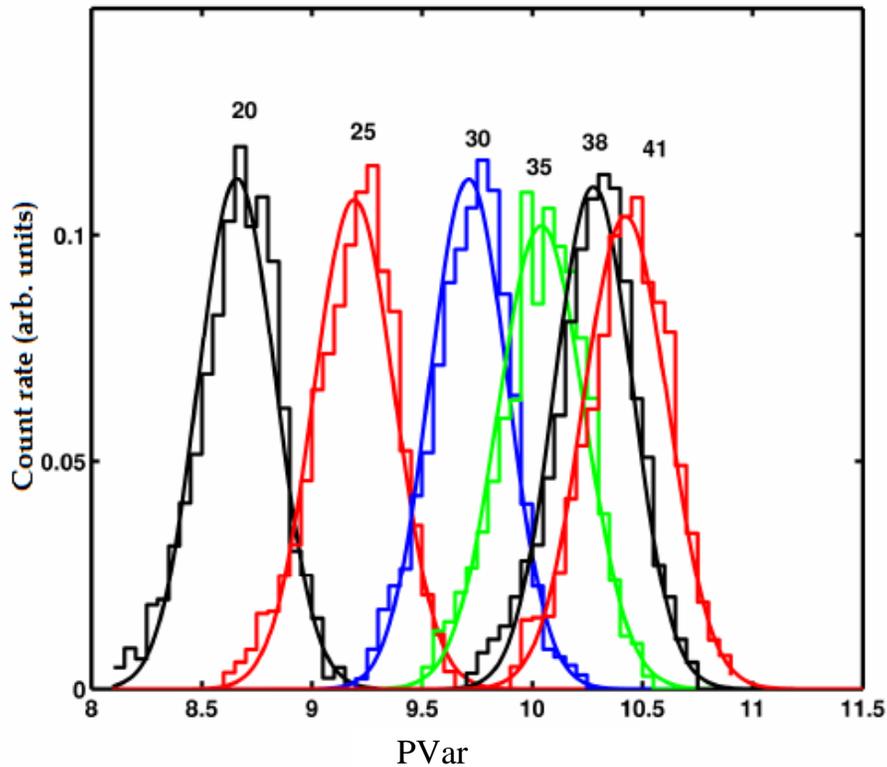- Step 5 : Take log of integral $\rightarrow$ PVar

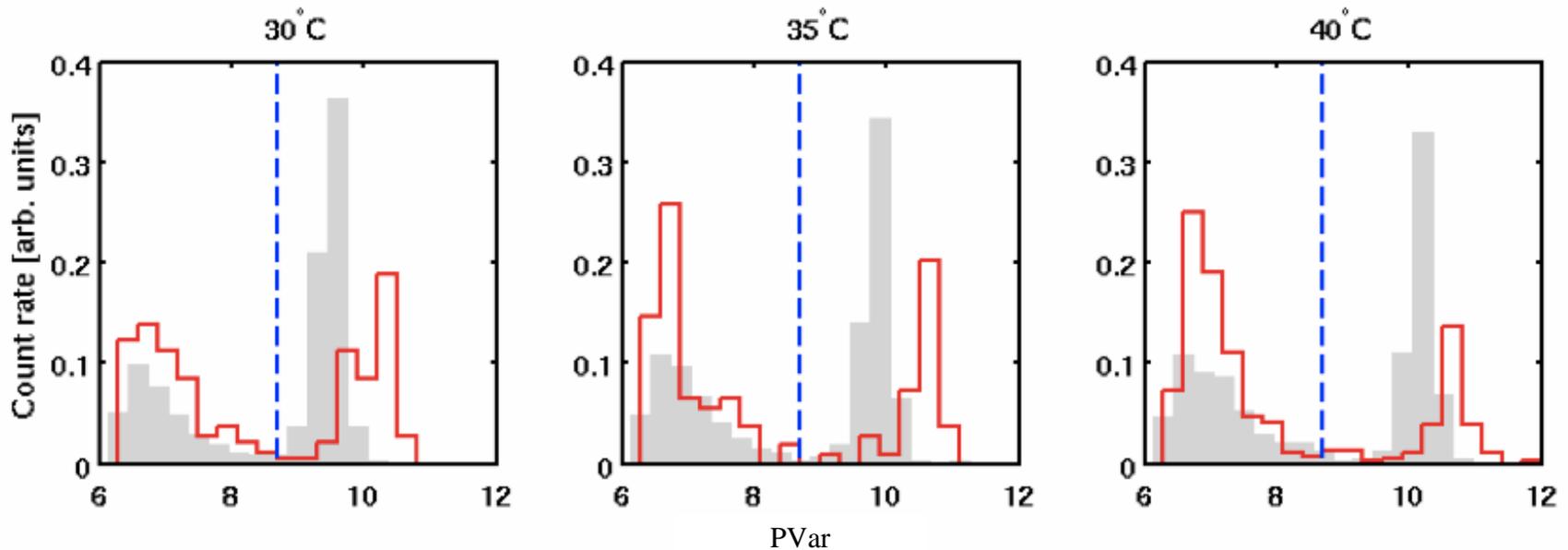# Discriminating Tools : Signal Power

- PVar distribution :

Discriminating Tools : Signal Power
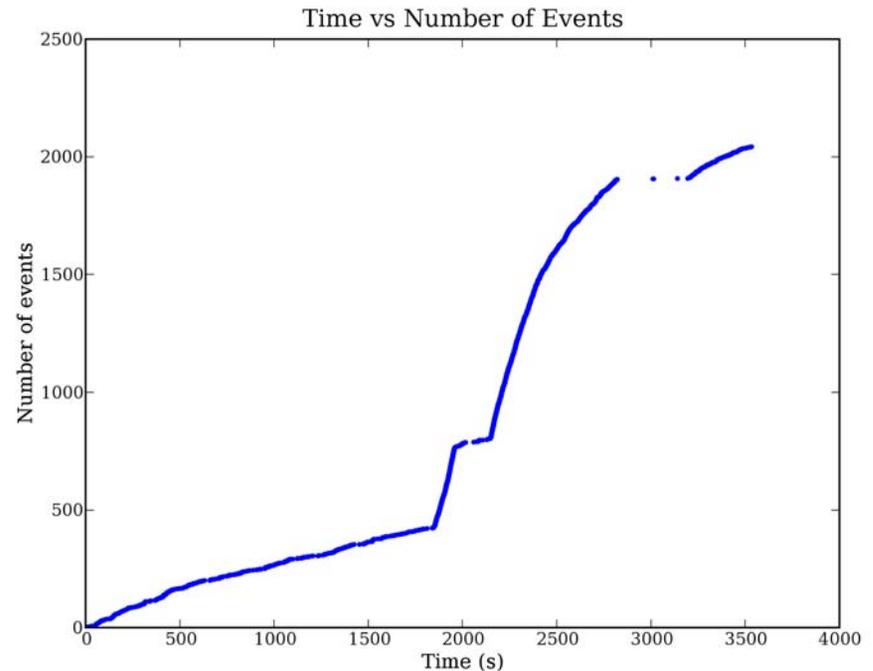
- Pvar is also temperature dependant

Discriminating Tools : Signal Power

- PVar discriminates neutrons and alphas

Discriminating Tools : Frequency Content

- Fractures can create

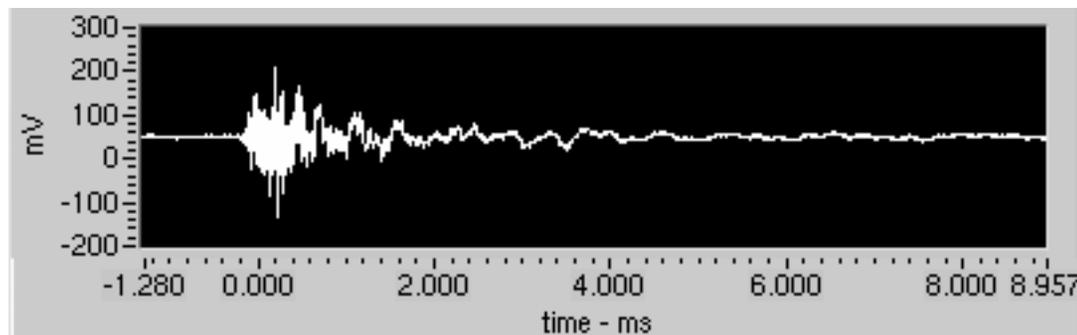chain reaction

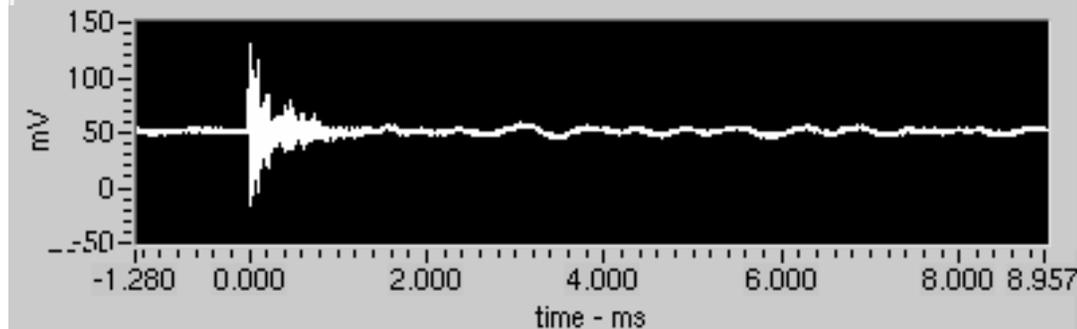Time vs Number of Events

- Happens occasionally

Discriminating Tools : Frequency Content

- Problem : waveforms of good events and fractures similar!
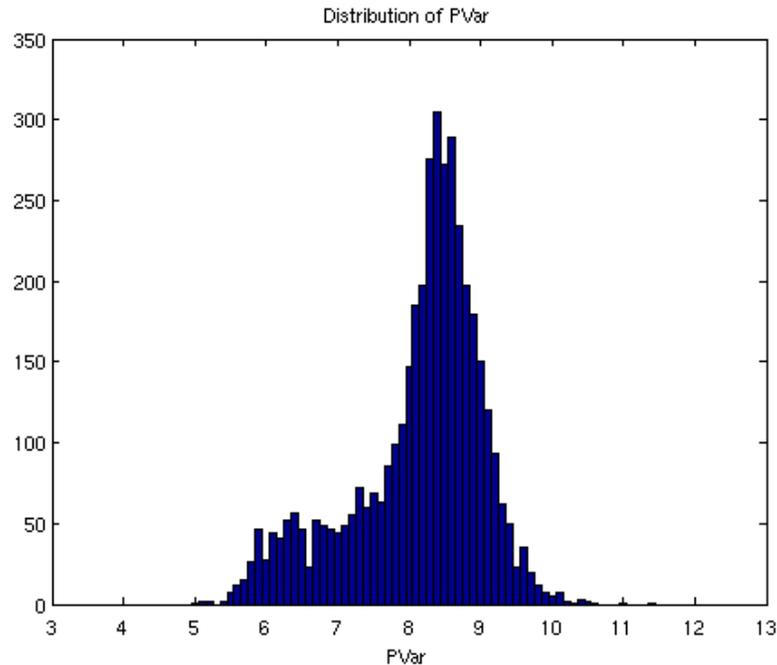
Bubble Event

Fracture Event

Discriminating Tools : Frequency Content

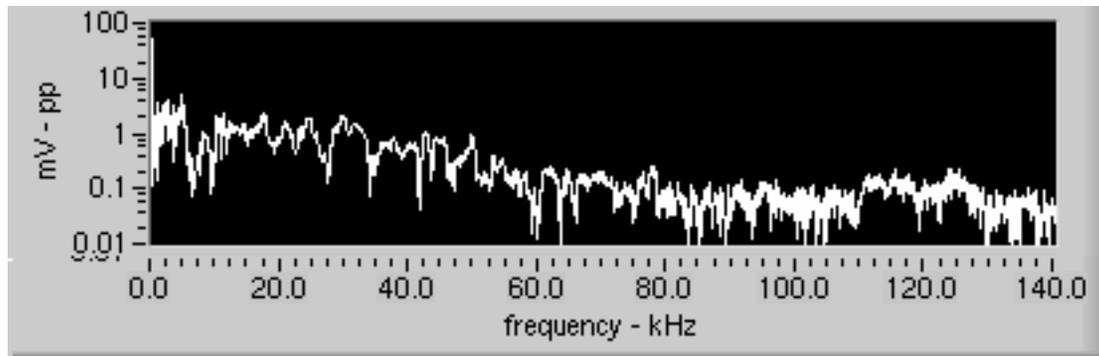- PVar distribution of fracture events
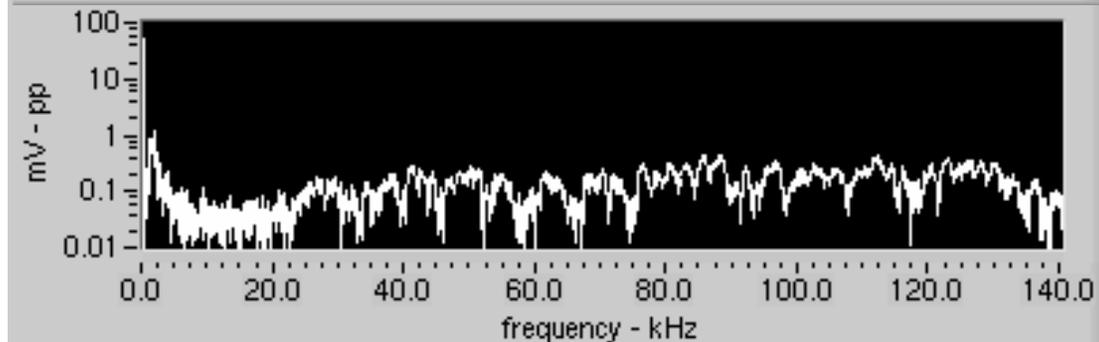

- New variable needed

Discriminating Tools : Frequency Content

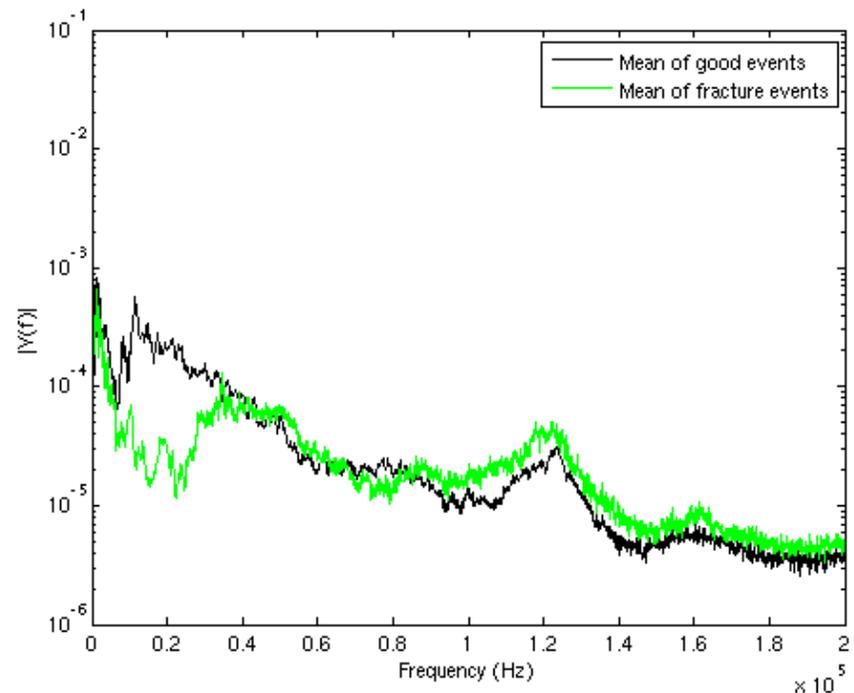■ Solution : Use frequency content in FFT

Bubble Event

Fracture Event

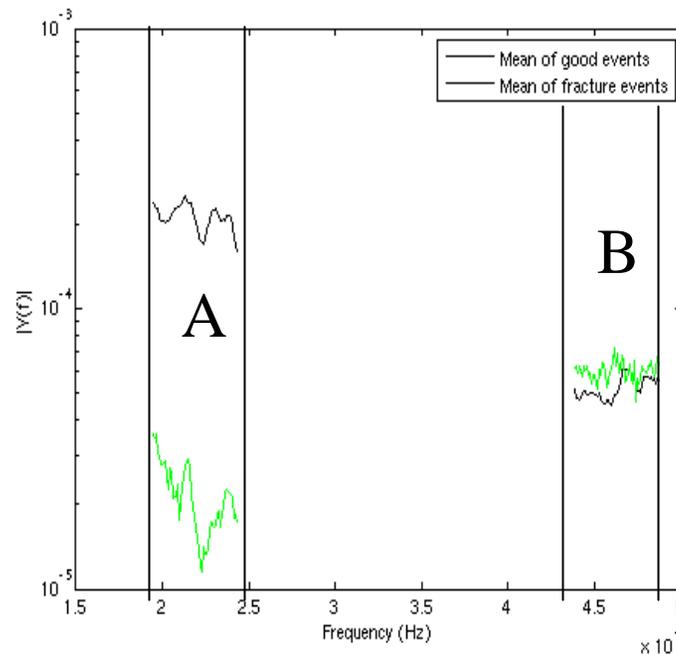# Discriminating Tools : Frequency Content

- Comparing good and fracture events :

- Significant difference at low frequency
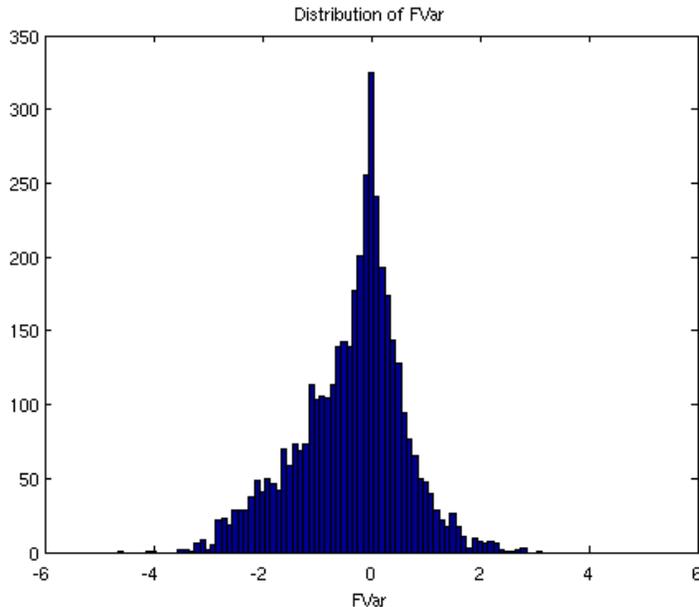
Discriminating Tools : Frequency Content

- Step 1 : Isolate regions

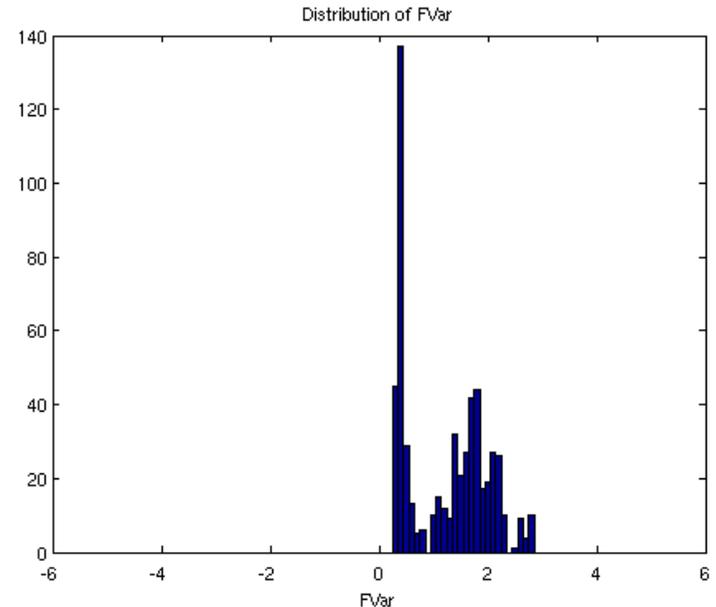- Step 2 : Take the mean of the regions A and B

Discriminating Tools : Frequency Content

- Step 3 : Take In of A/B $\rightarrow$ FVar
- And then the distributions become :

Fracture run

Normal run

FP-Plots
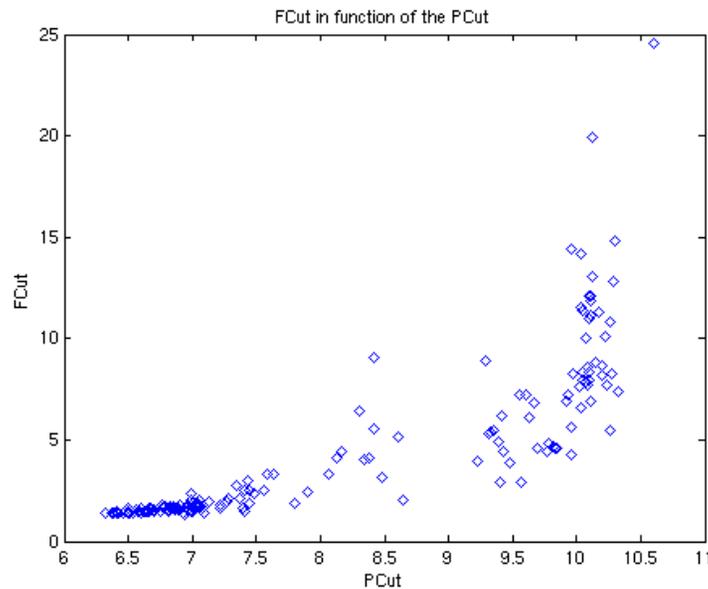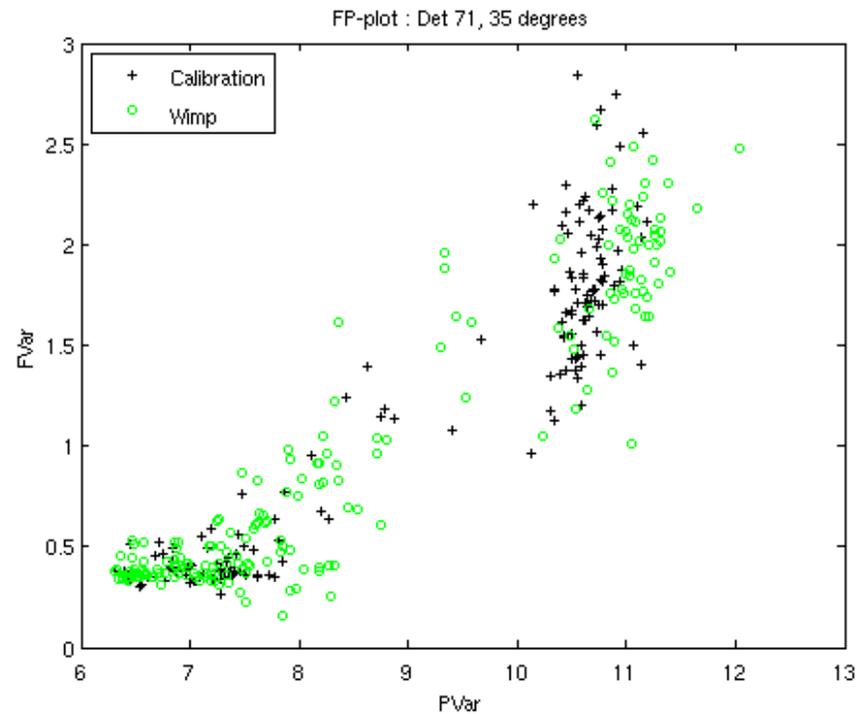
- Comparing FVar and PVar in a scatter plot
- Background (WIMP) run :

FCut in function of the PCut

FP-Plots

- Separation between neutrons and alphas

FP-plot : Det 71, 35 degrees

FP-Plots

- Fractures in a badly damaged detector :
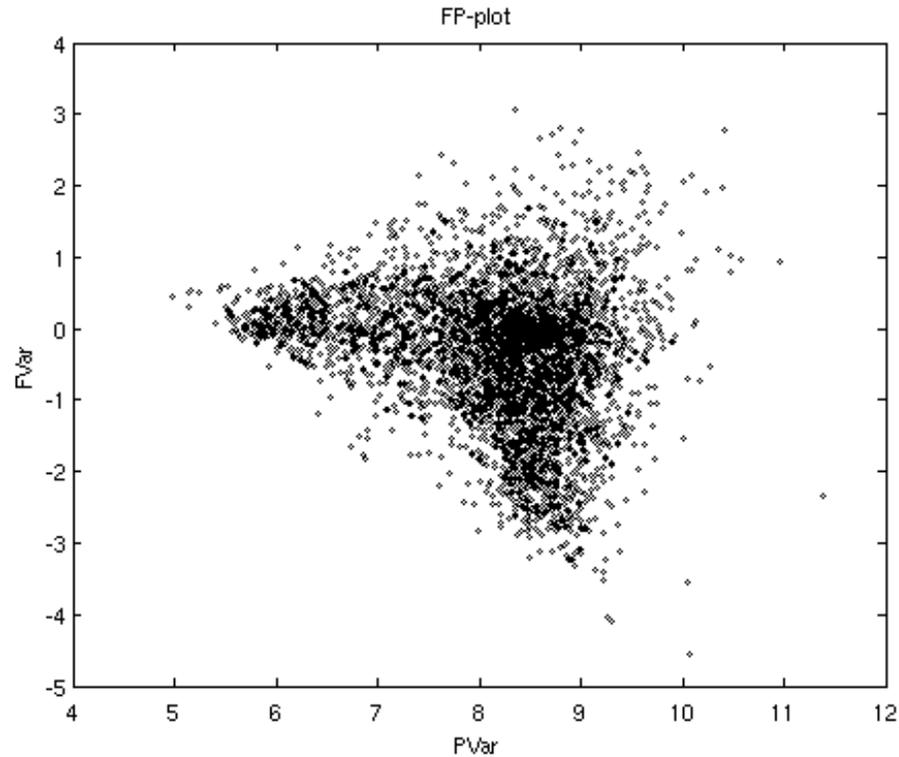
FP-plots

- Combining everything :

Noise

Blast

Fracture

Neutrons (WIMPs) Alphas

FVar vs PVar

Legend:
- + Det 93
- ◆ Fracture
- ○ Freonless
- × Air bubbles
- ＊ Blast

I

II

III
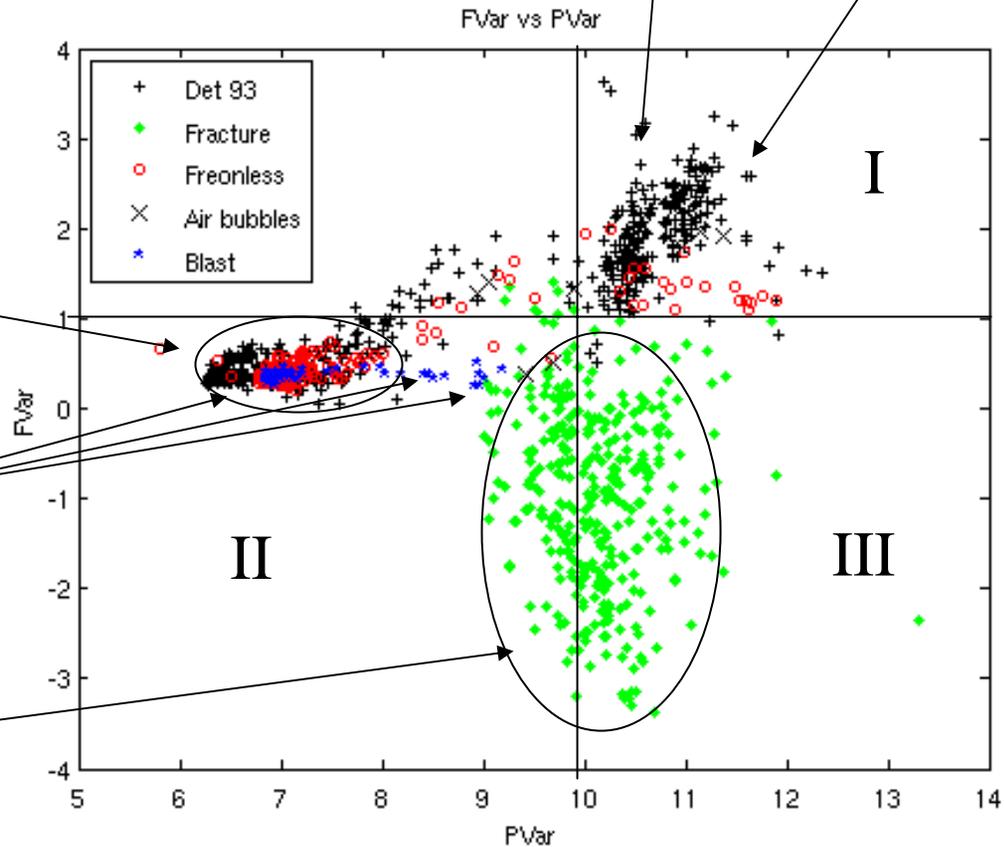
Conclusion

- PVar and FVar are powerful discrimination tools, PVar for separating neutrons and alphas induced events, FVar for identifying fractures

- Used in conjunction, it becomes easy to identify what type of event was triggered and in which proportion

- Major backgrounds now understood; gammas and air bubbles are now the main source of interference in the detectors