

# EMC Feature Extraction Algorithms

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for the PANDA Collaboration

## Photosensors:

- Large Area Avalanche Photo-Diodes

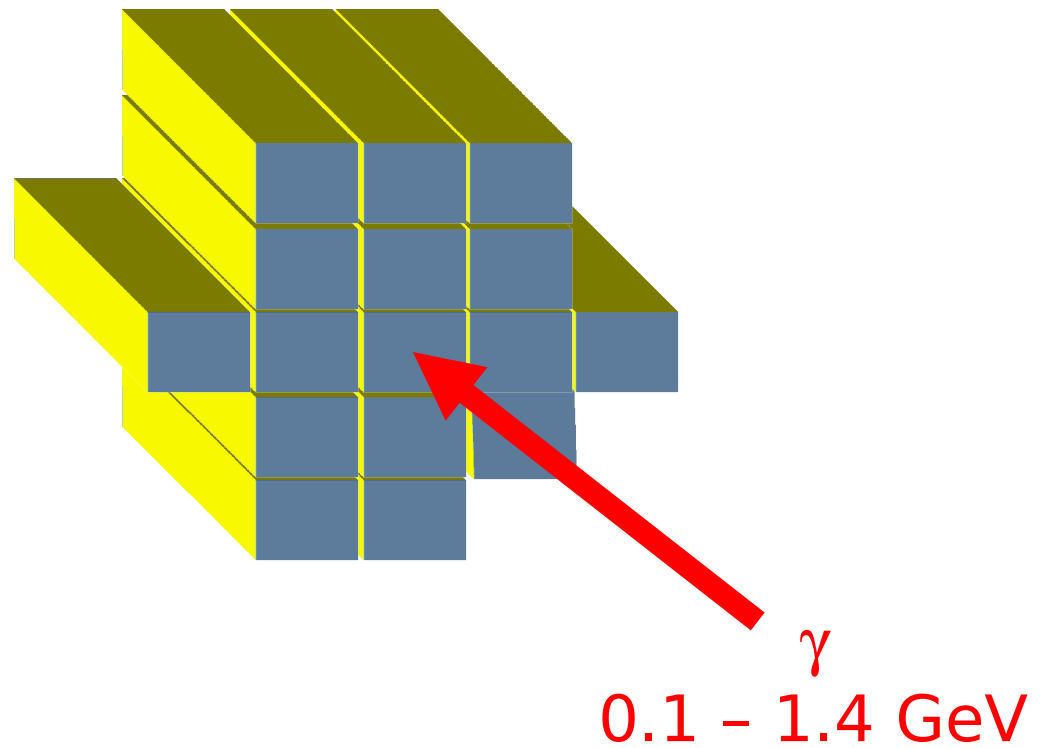
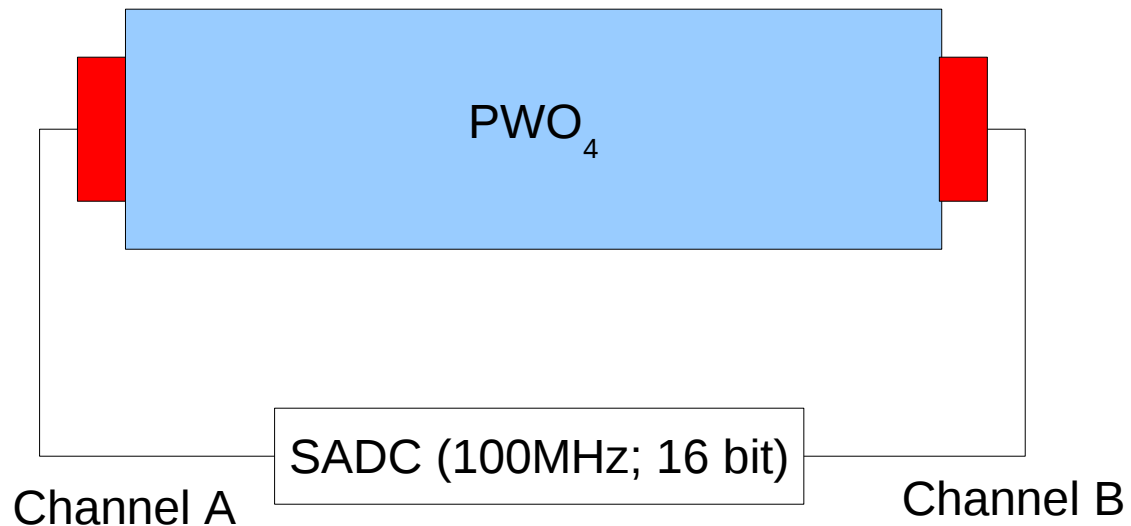


## Preamplifiers:

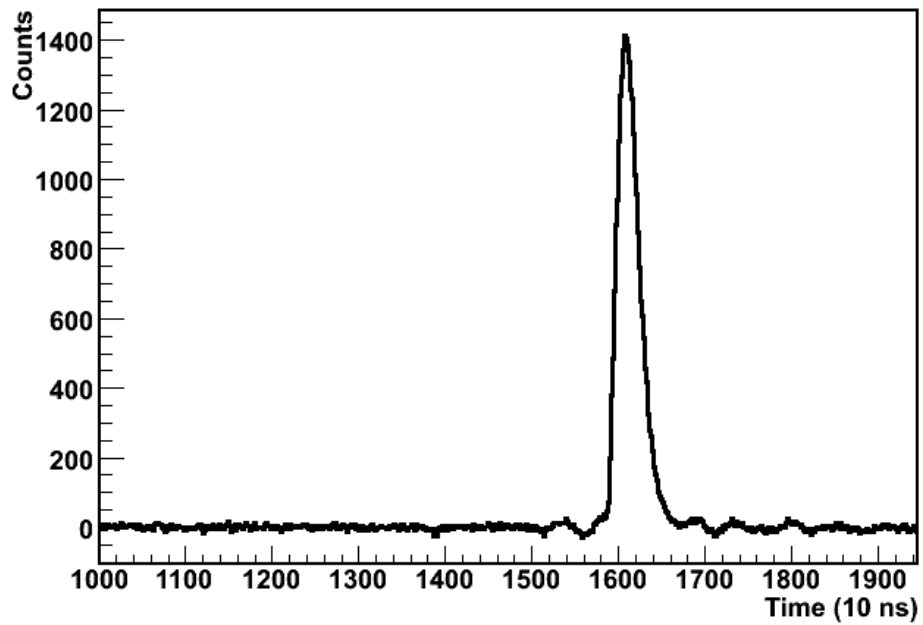
- Low Noise Low Power (LNP) (Basel)
- APFEL ASIC (GSI)

## Measurements with:

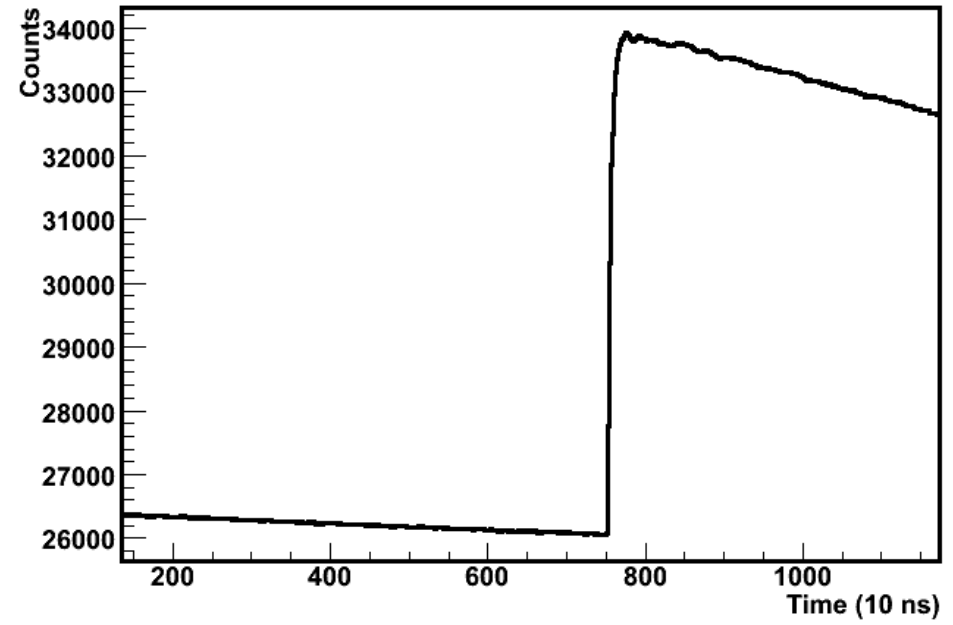
- LED Light pulser
- Cosmic rays
- Ion beam ( ${}^6\text{Li}$  2 A·GeV)
- High-energy gammas (0.1-1.4 GeV)

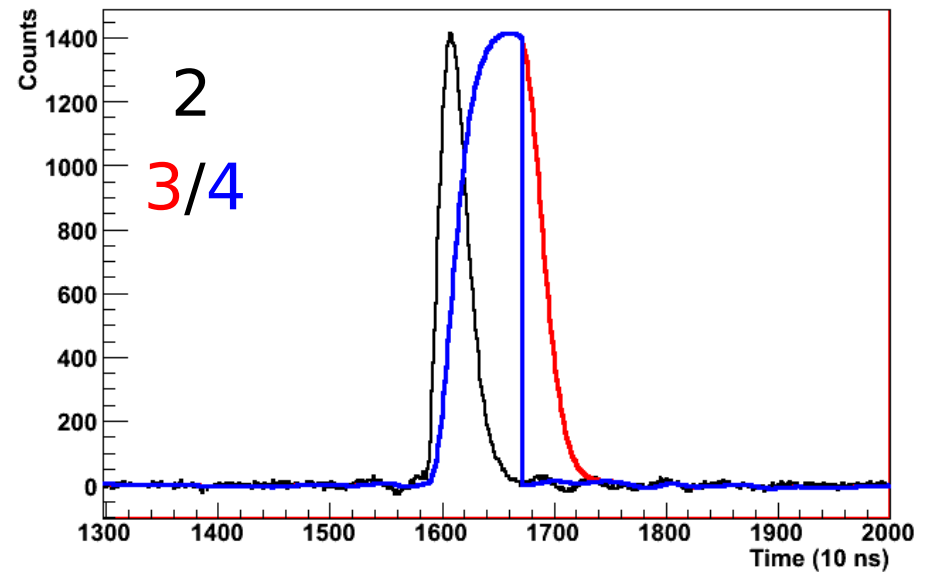
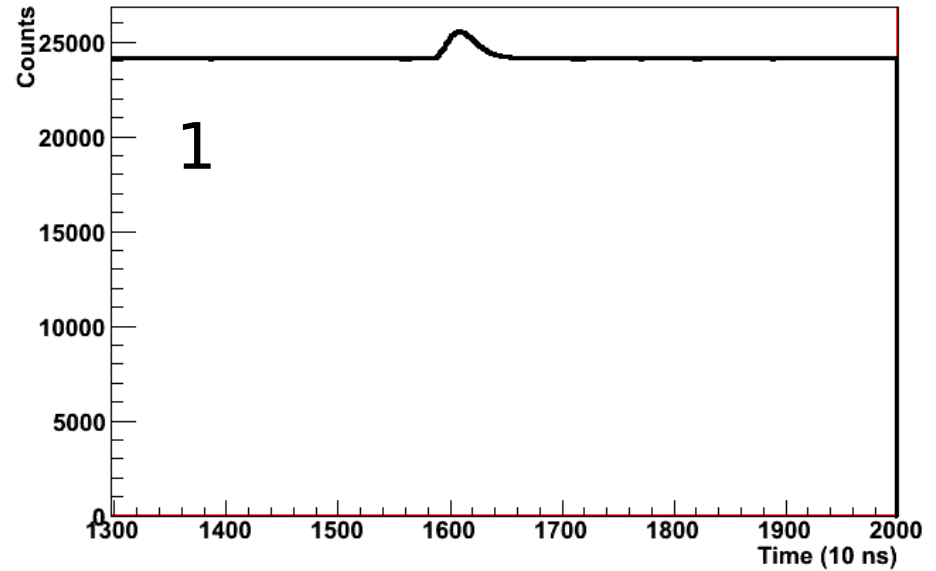
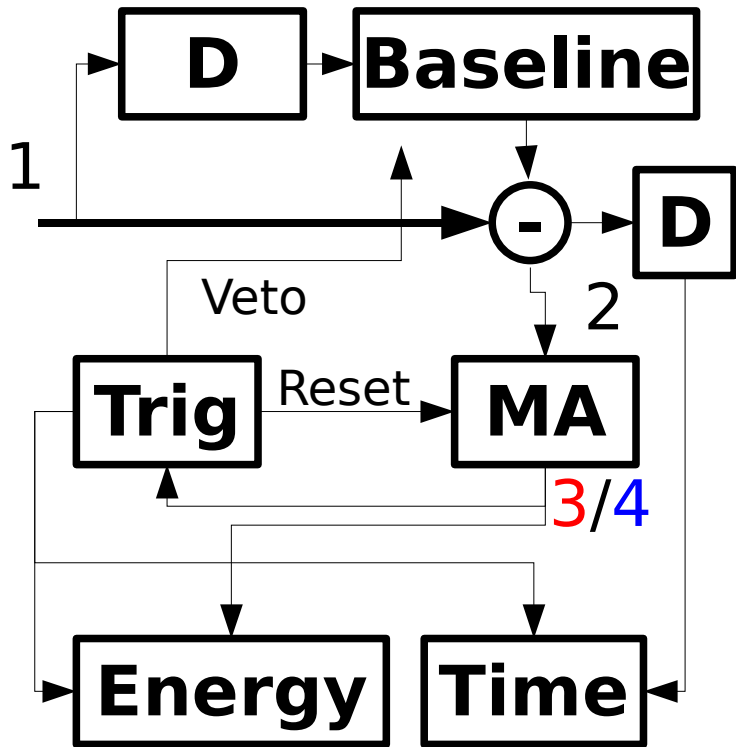


ASIC

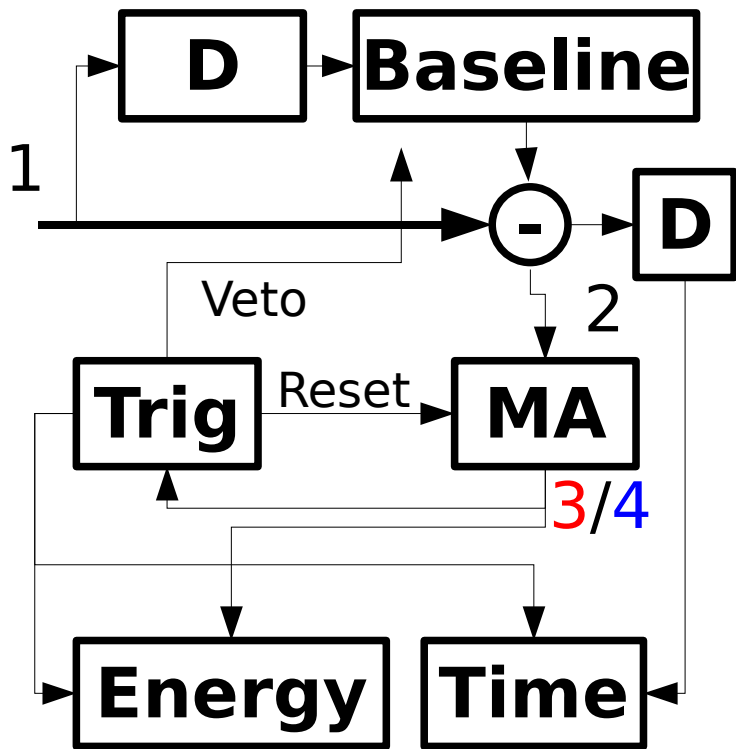


LNP

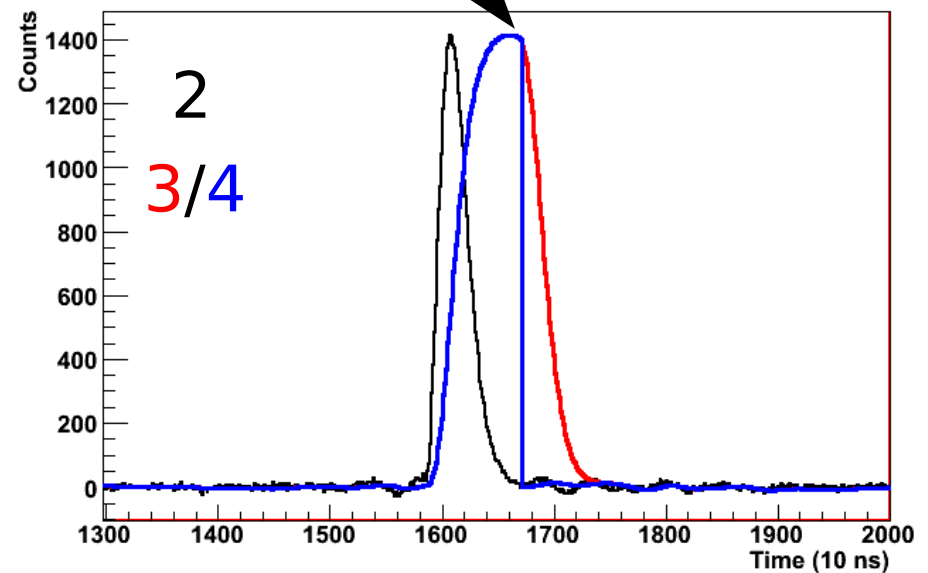
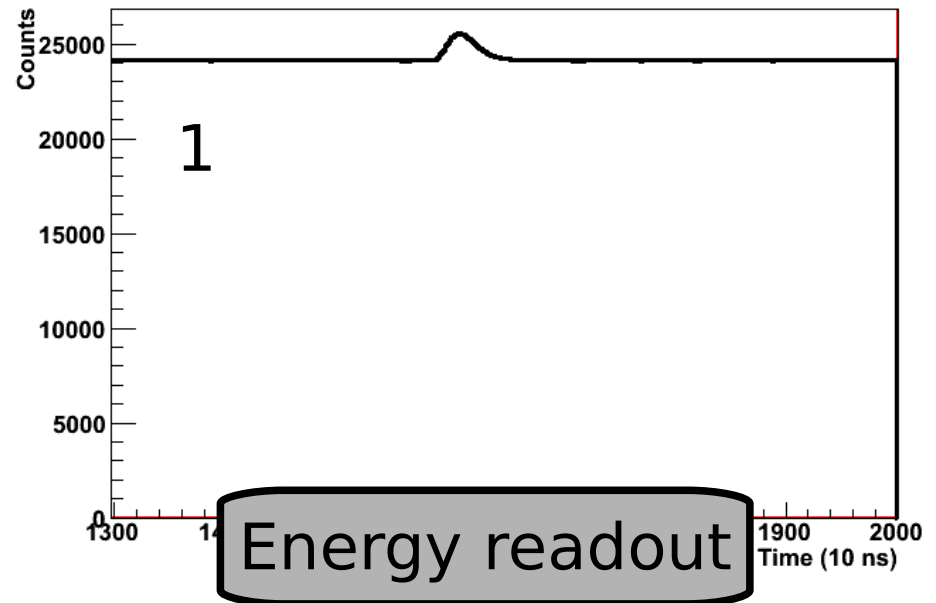


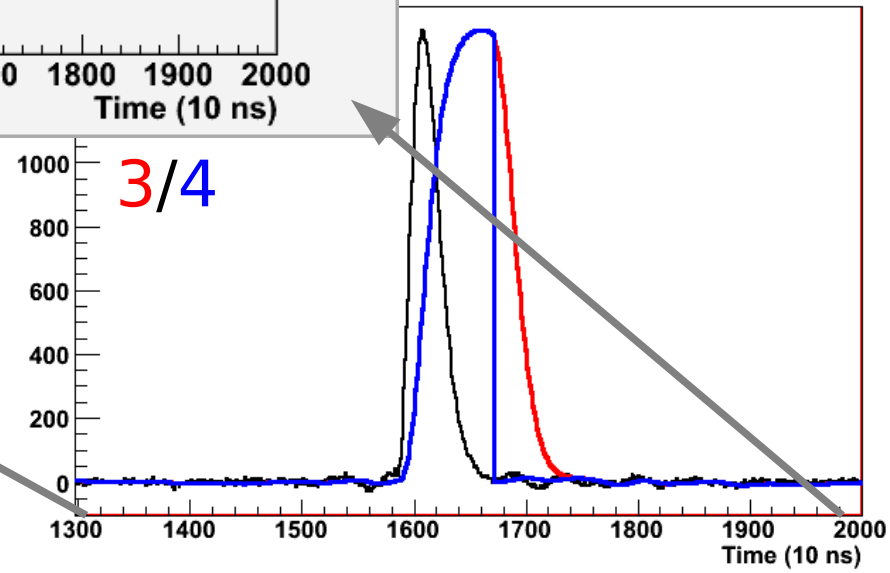
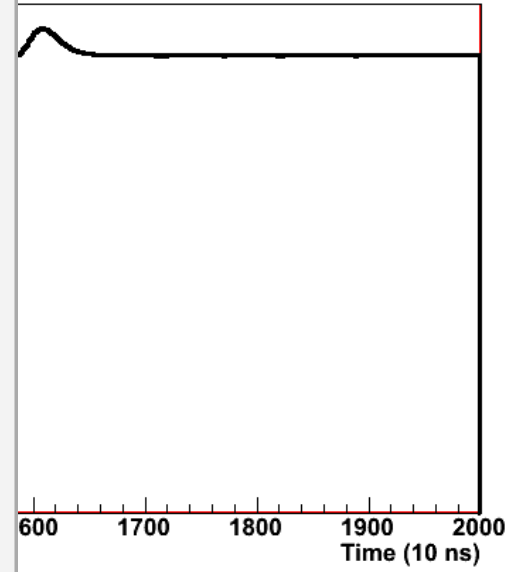
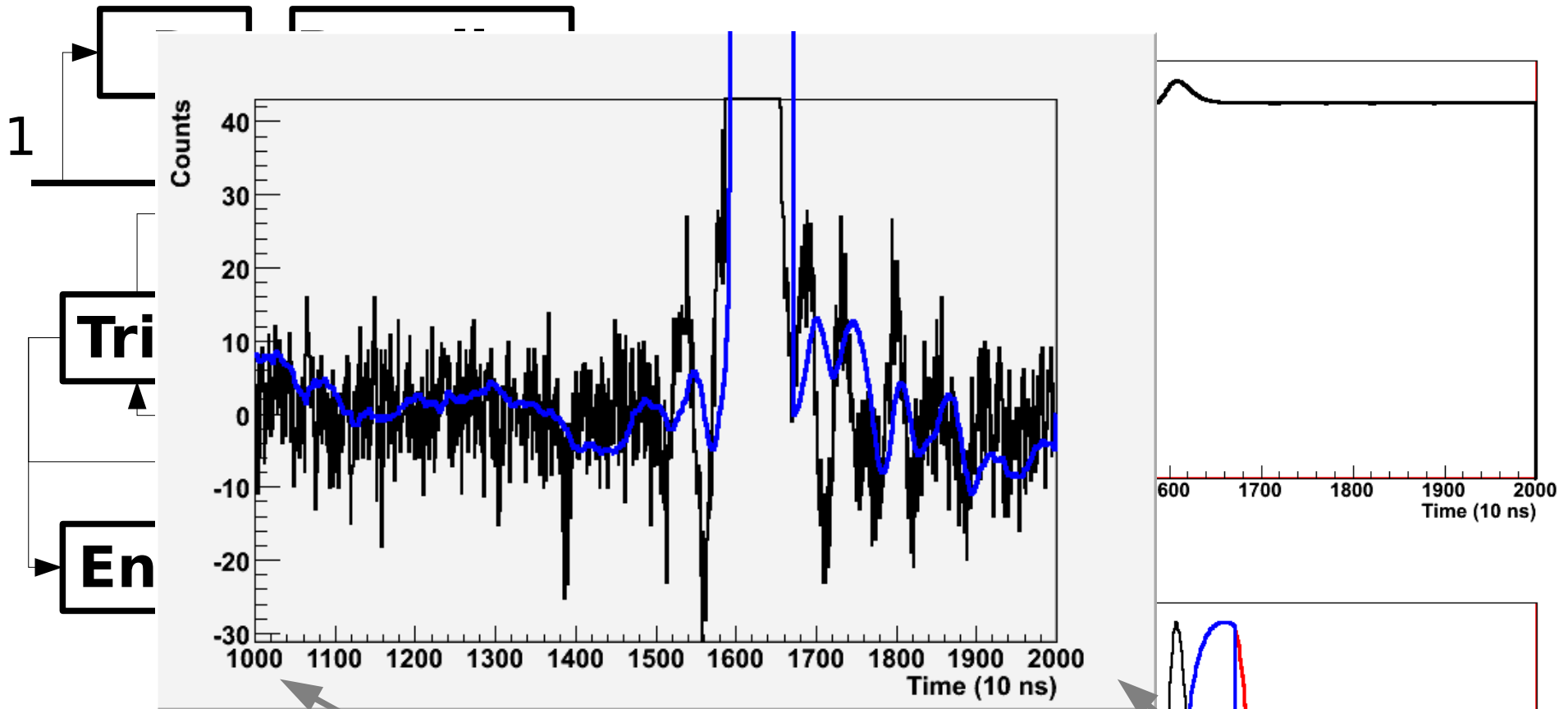


**D** - Delay  
**MA** - Moving Averaging  
**Trig** - Trigger logic

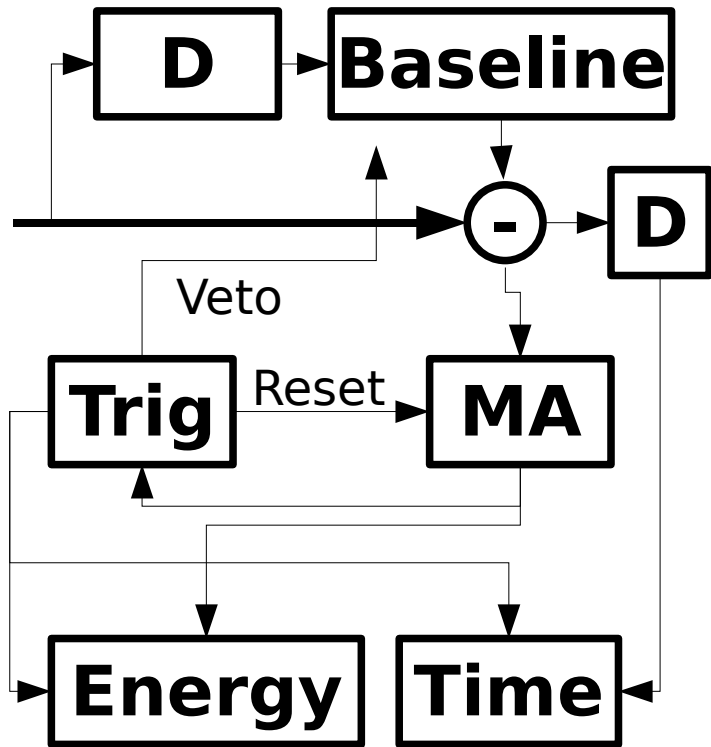


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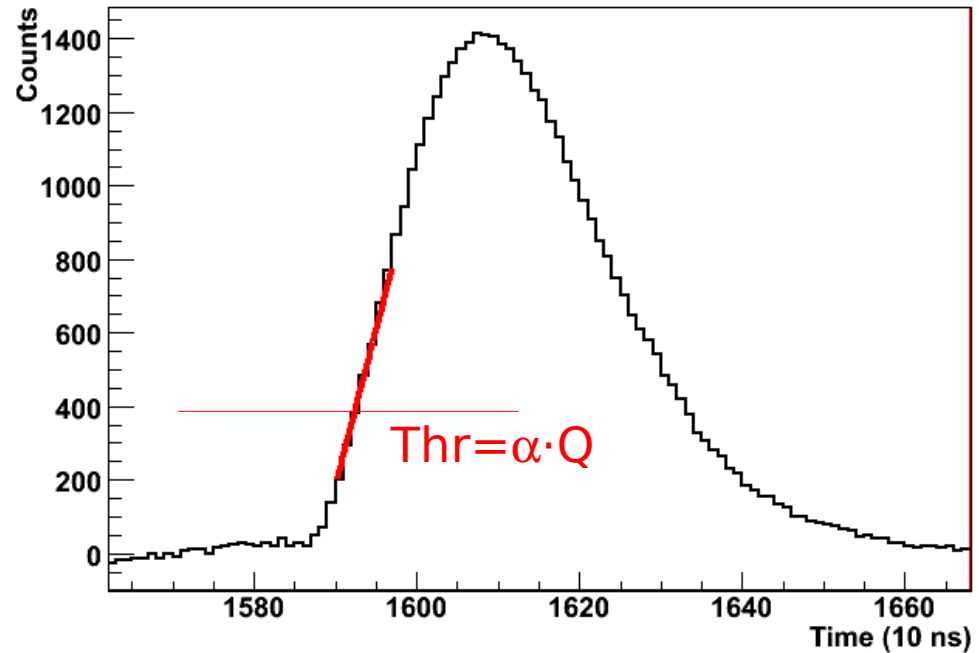
**D** - Delay

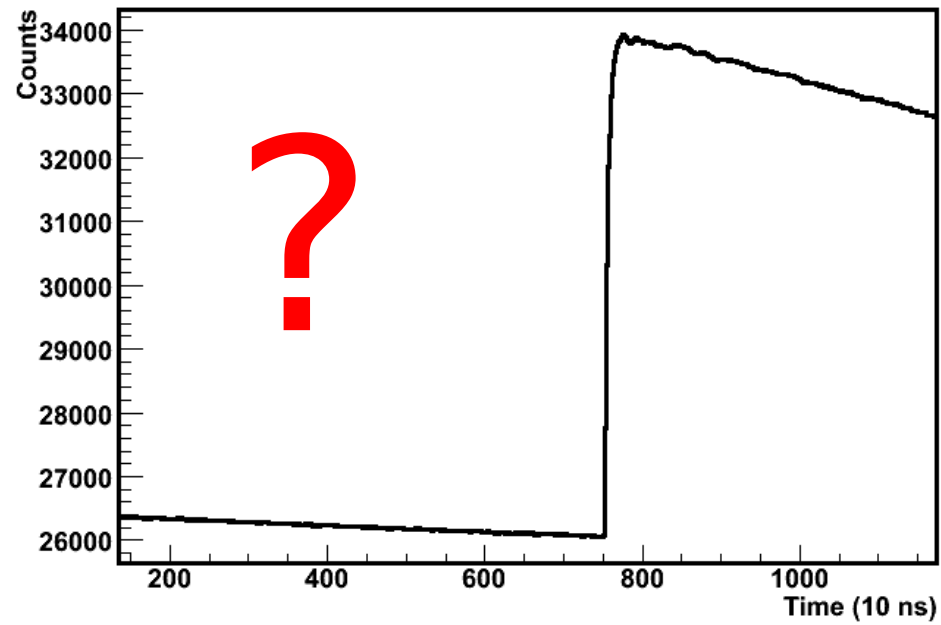
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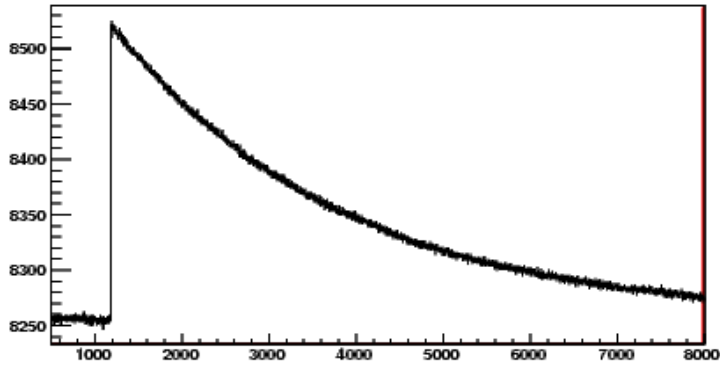
## Time stamp generation:

- Explicit Constant Fraction
- Constant Fraction
- Leading Edge

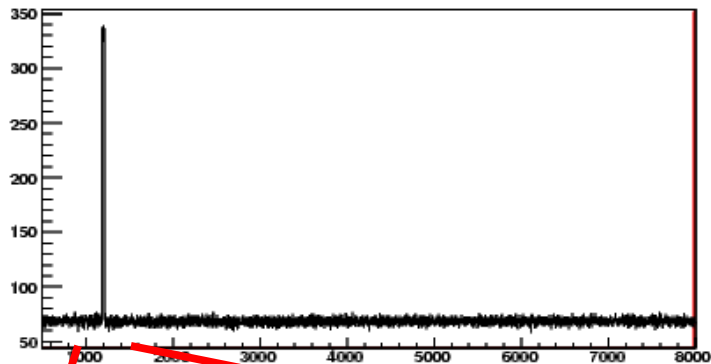






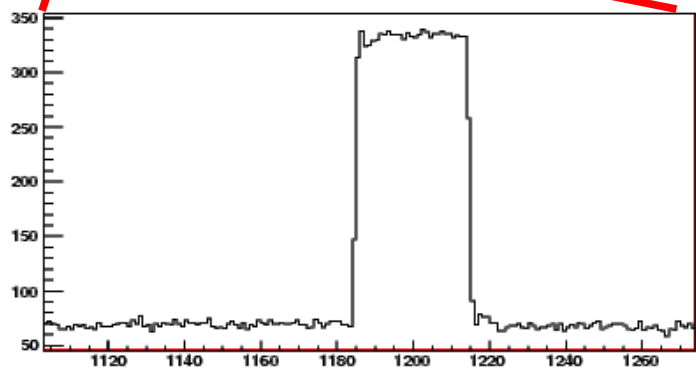


Preamplifier signal trace (80μs long)

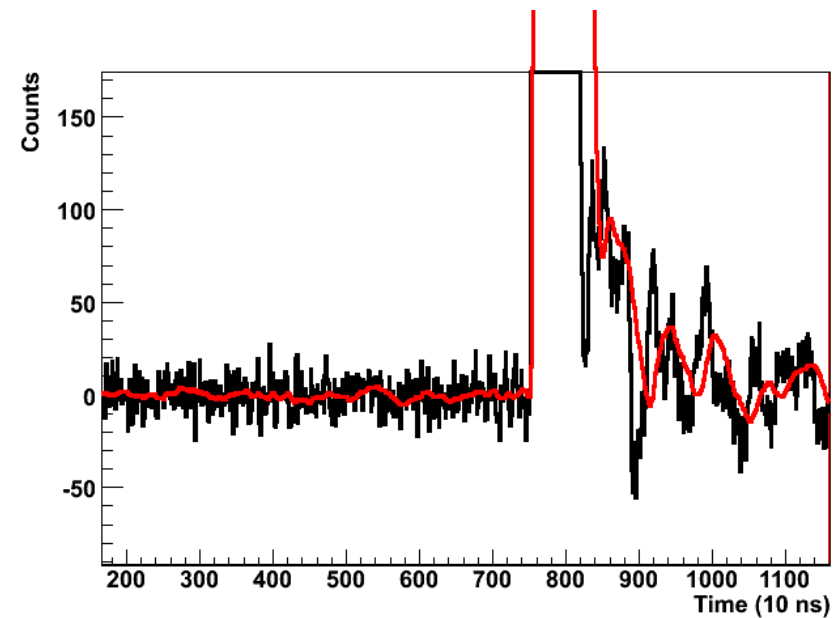
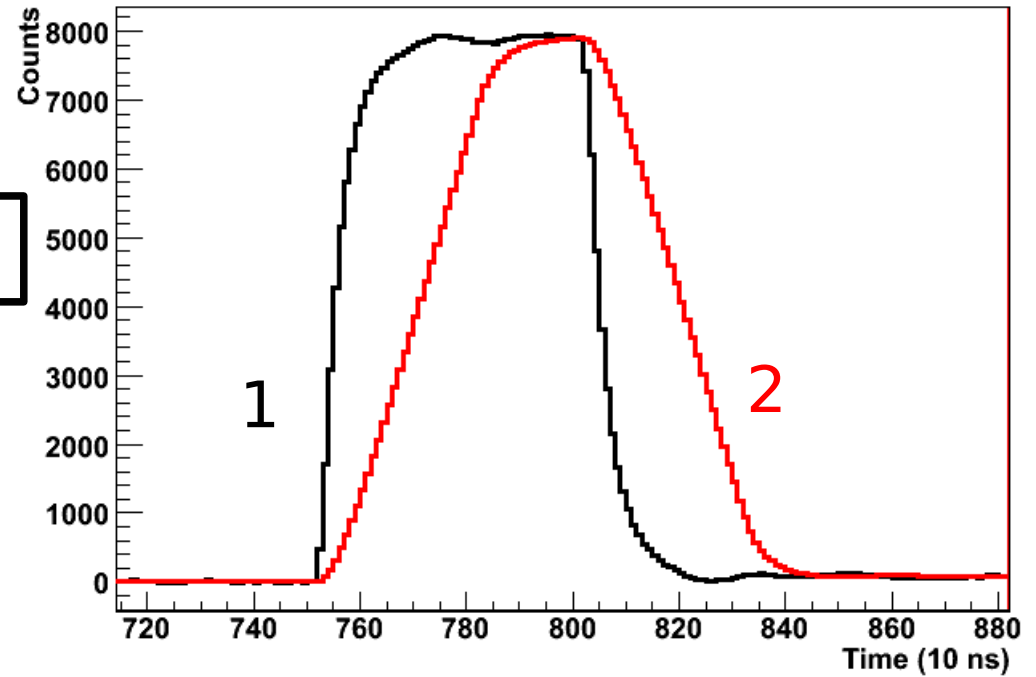
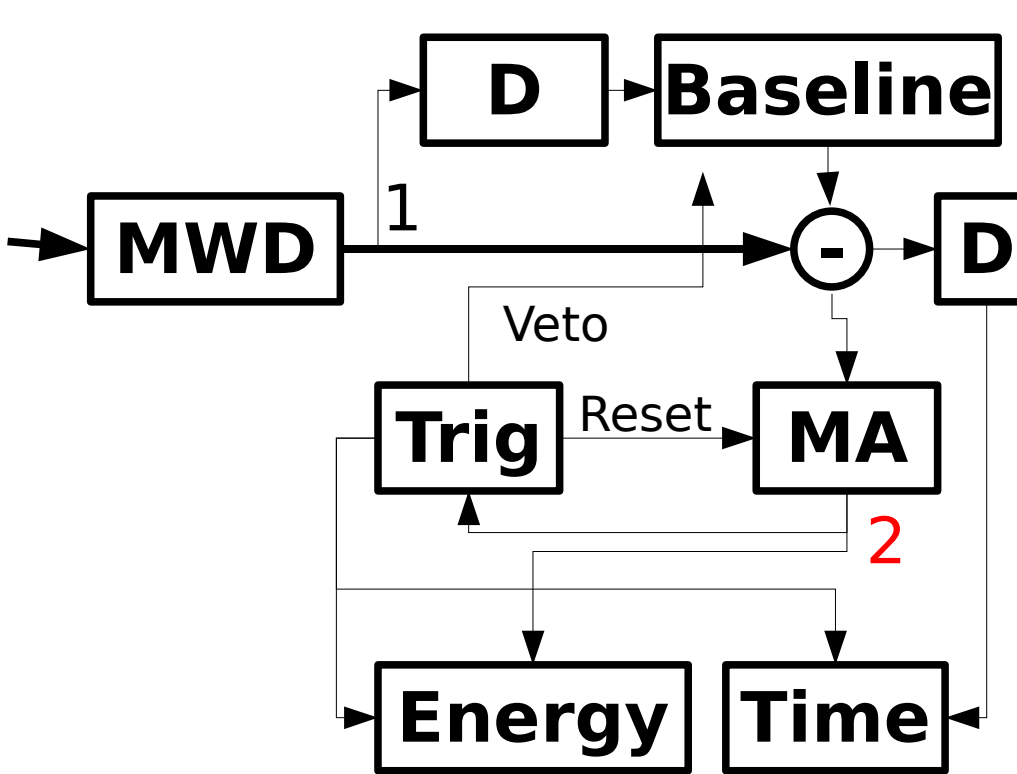


Resulting signal after Moving Window Deconvolution (**MWD**) filtering:

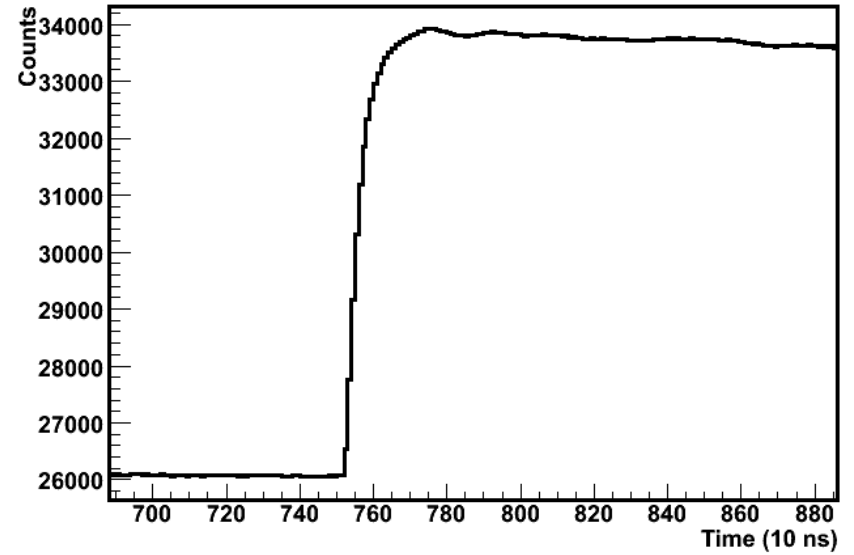
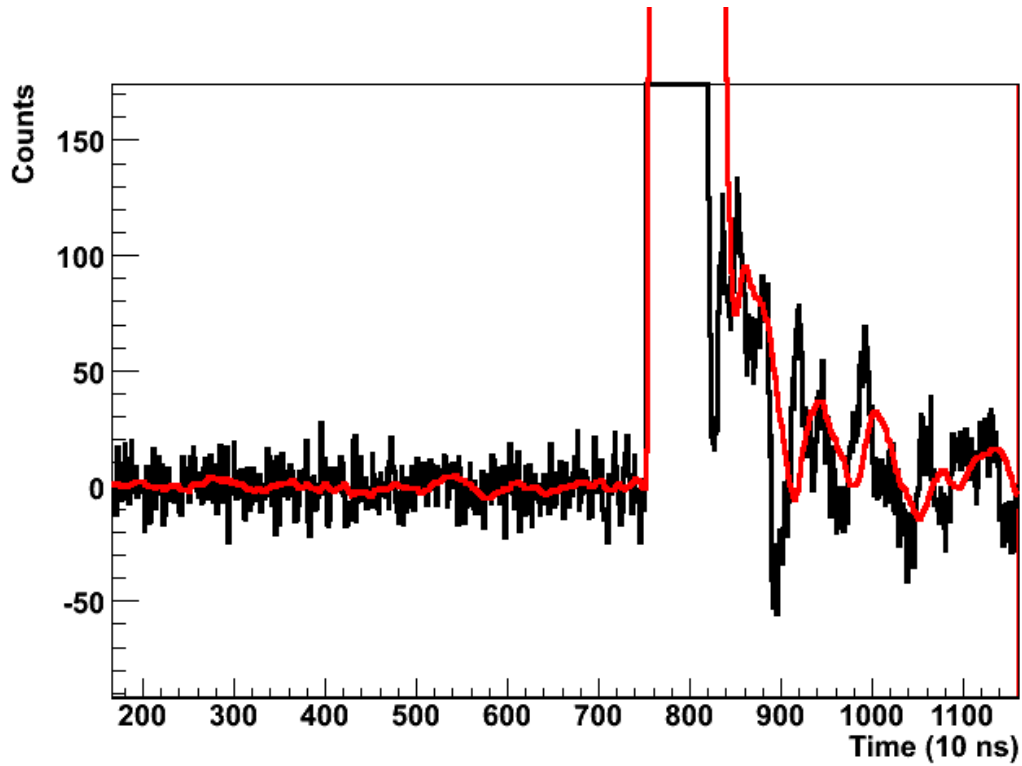
$$MWD_M(n) = x_n - x_{n-M} + \frac{\ln 2}{\tau} \sum_{i=n-M}^{n-1} x_i$$



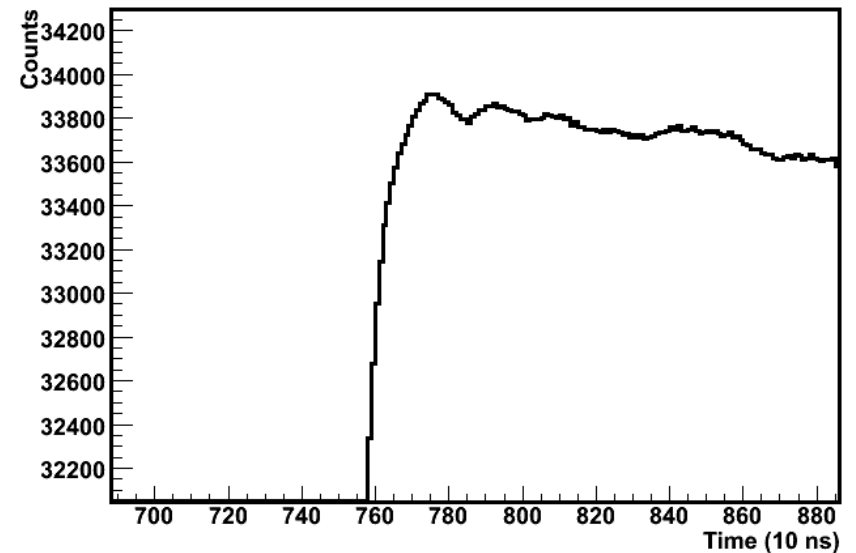
The **M** value defines the length of the flat top!!!



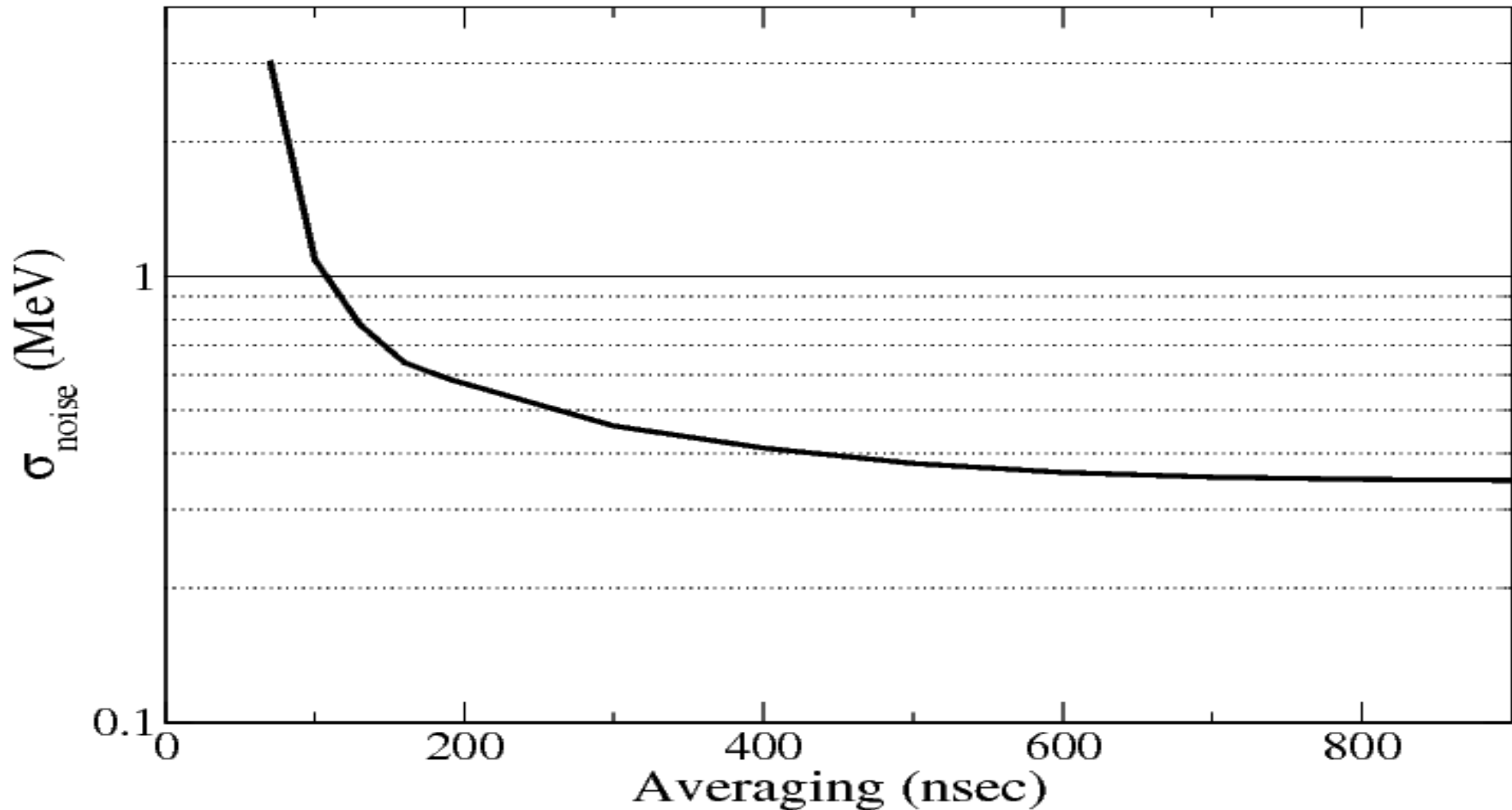
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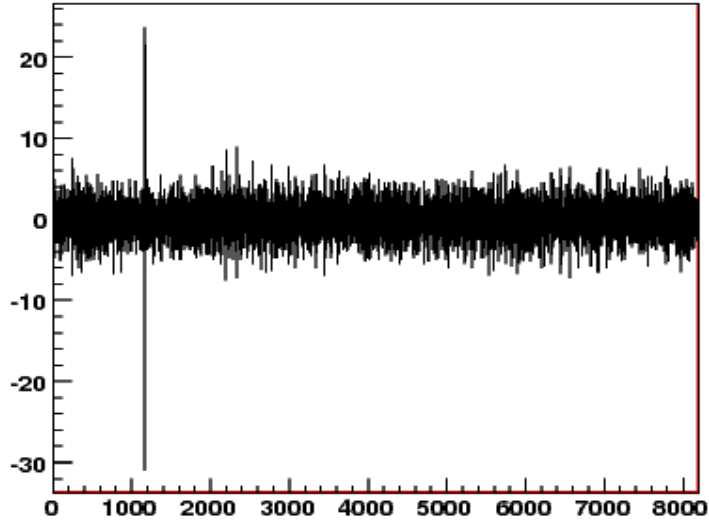


Afterpulses are visible only  
for large energy deposits  $\sim 1$  GeV

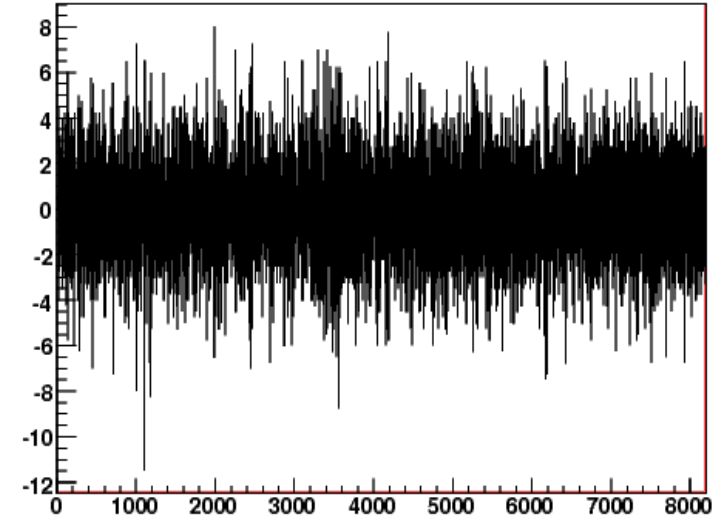


To achieve best signal/noise ratio one has to average signal within  
**300 – 400 nsec**

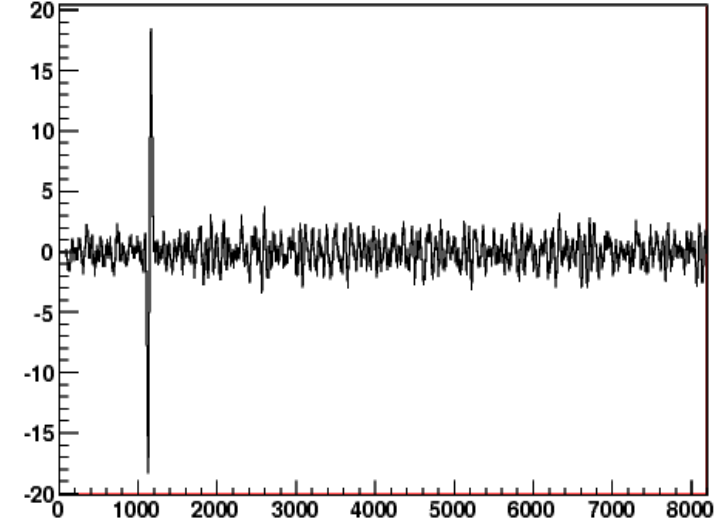
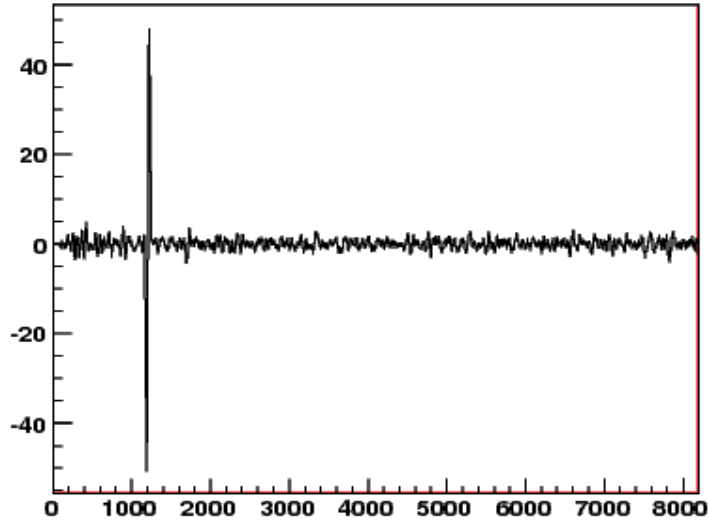


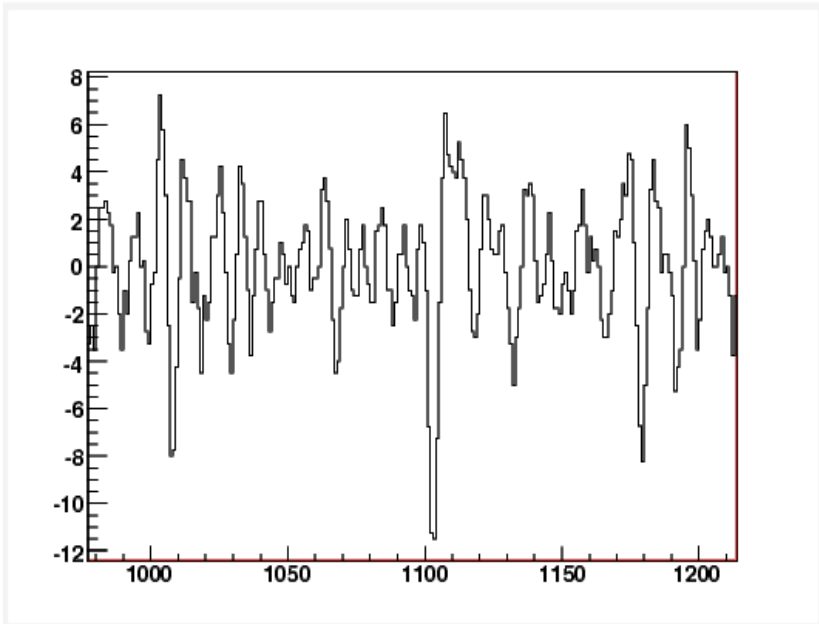


Shorter filter  
length  
(better time  
resolution)

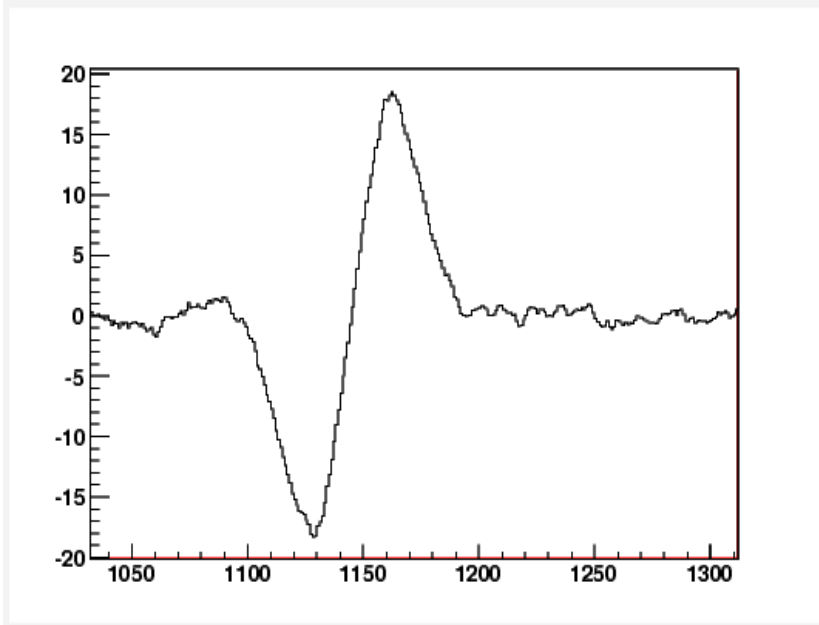


Longer filter  
length  
(worse time  
resolution)

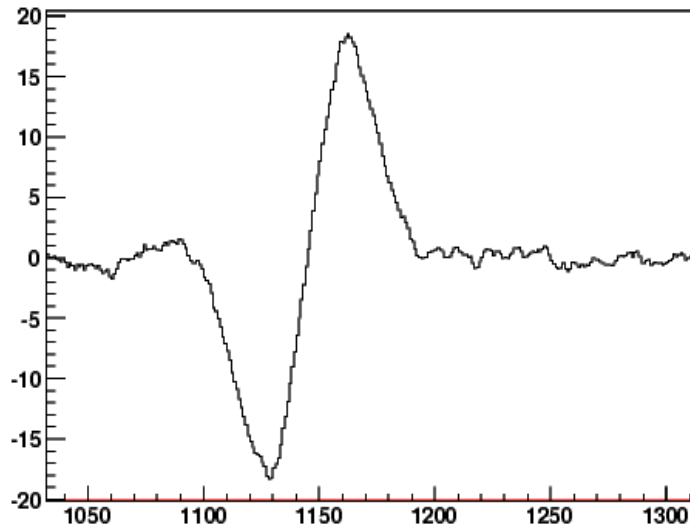
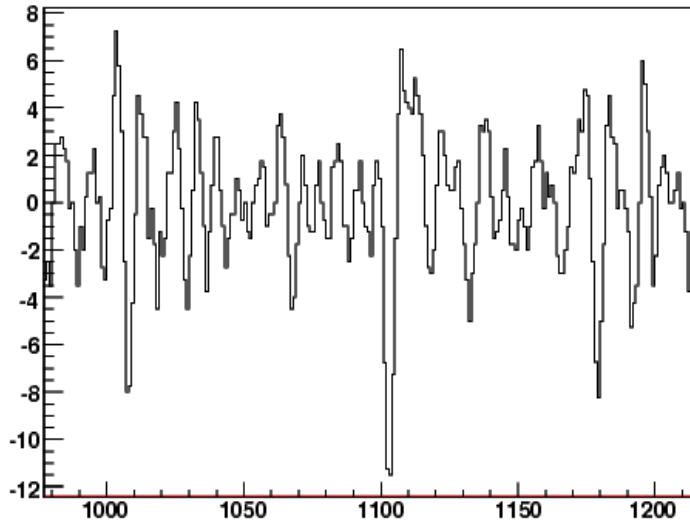




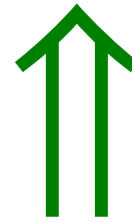
**Still** contain time information  
(base line == 0, by defenition)



**Easy** to make trigger



Get precise timing



Make trigger / Get rough timing

- Presented feature-extraction algorithms provide additional (to analogue) noise reduction, good energy and time resolution
- The walk effect for the digital implementation of CFD has to be investigated in more details
- VHDL implementation is in progress (all “building blocks” are implemented; expected tests with hardware end of summer)
- Performance of algorithms with ASIC signals will be tested with cosmic and  $\gamma$  rays (prototype build by GSI)
- Continuous sampling has advantages over analogue “zero suppression” (analogue discriminators)