Time Performance of Large GEMs for CMS

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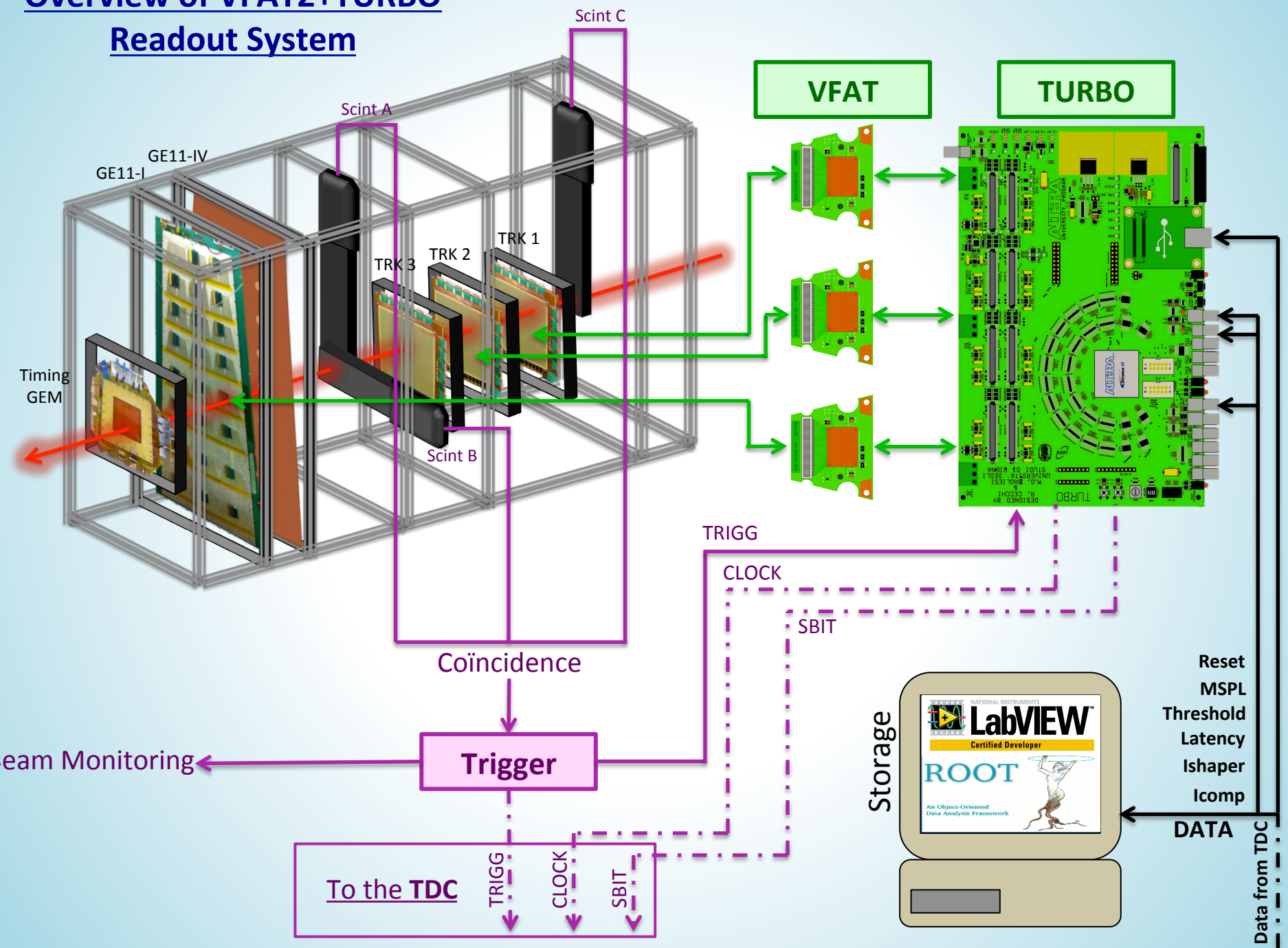
On Behalf of the CMS GEM CERN Group

Overview of VFAT2+TURBO Readout System



Time Measurement in Asynchronous Mode

From **TURBO & SCINT**

TRIGG

CLOCK

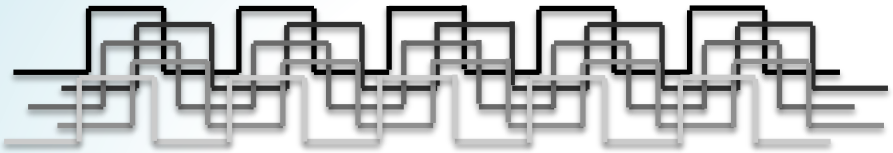
SBIT

Data from TDC

trigger

SBIT

25 ns



Delay

random position of the trigger with respect to the clock

TDC

TDC Common Stop

TDC INPUT

TDC OUTPUT

Stop

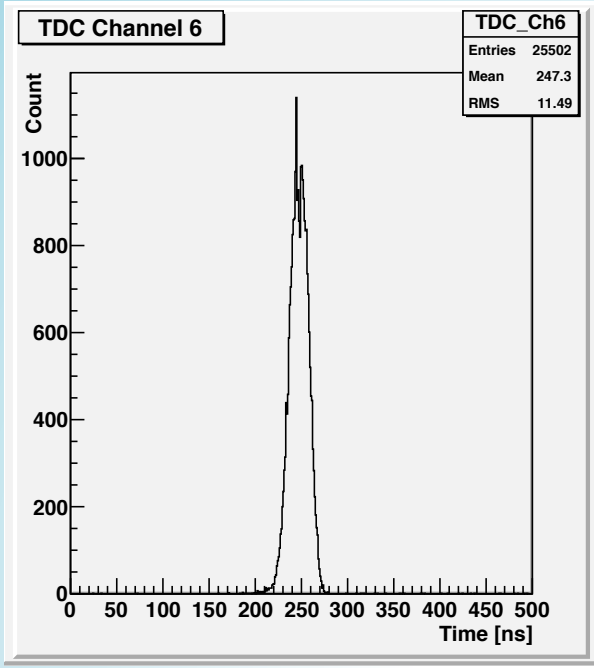
Few us window

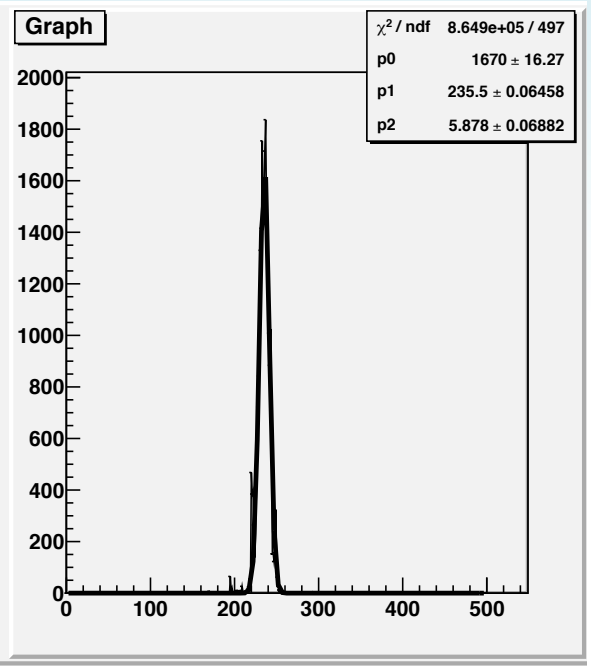
Time

Time

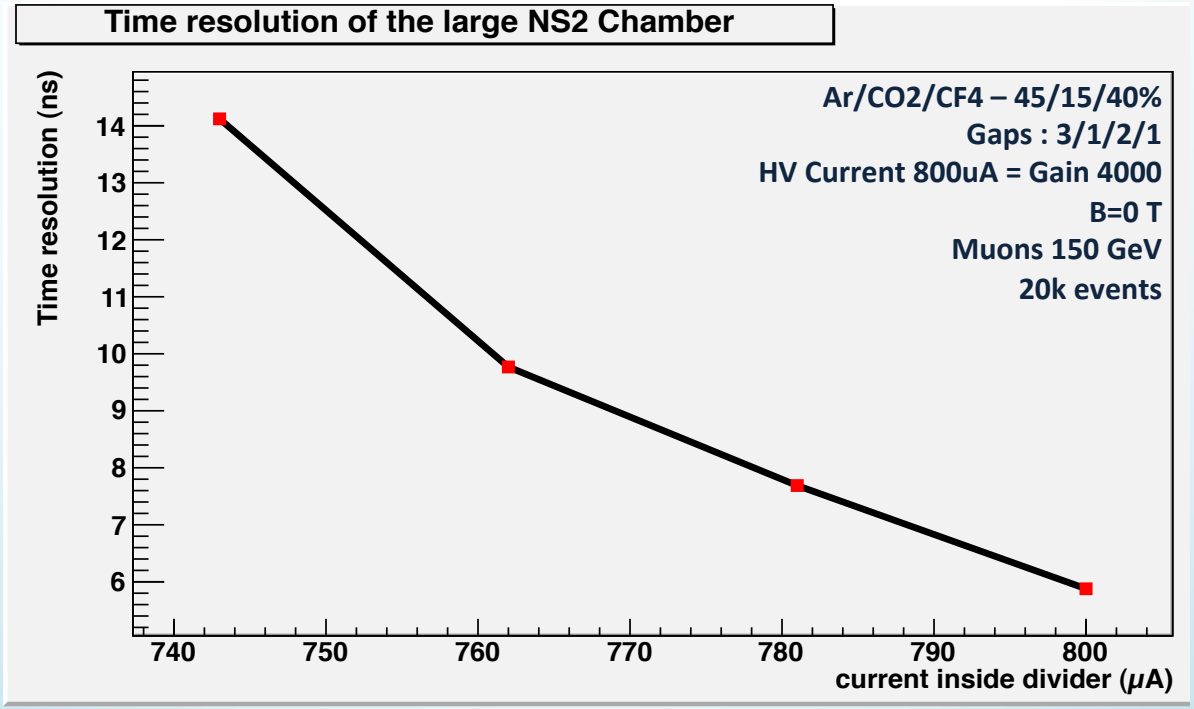
Time Distribution

Time

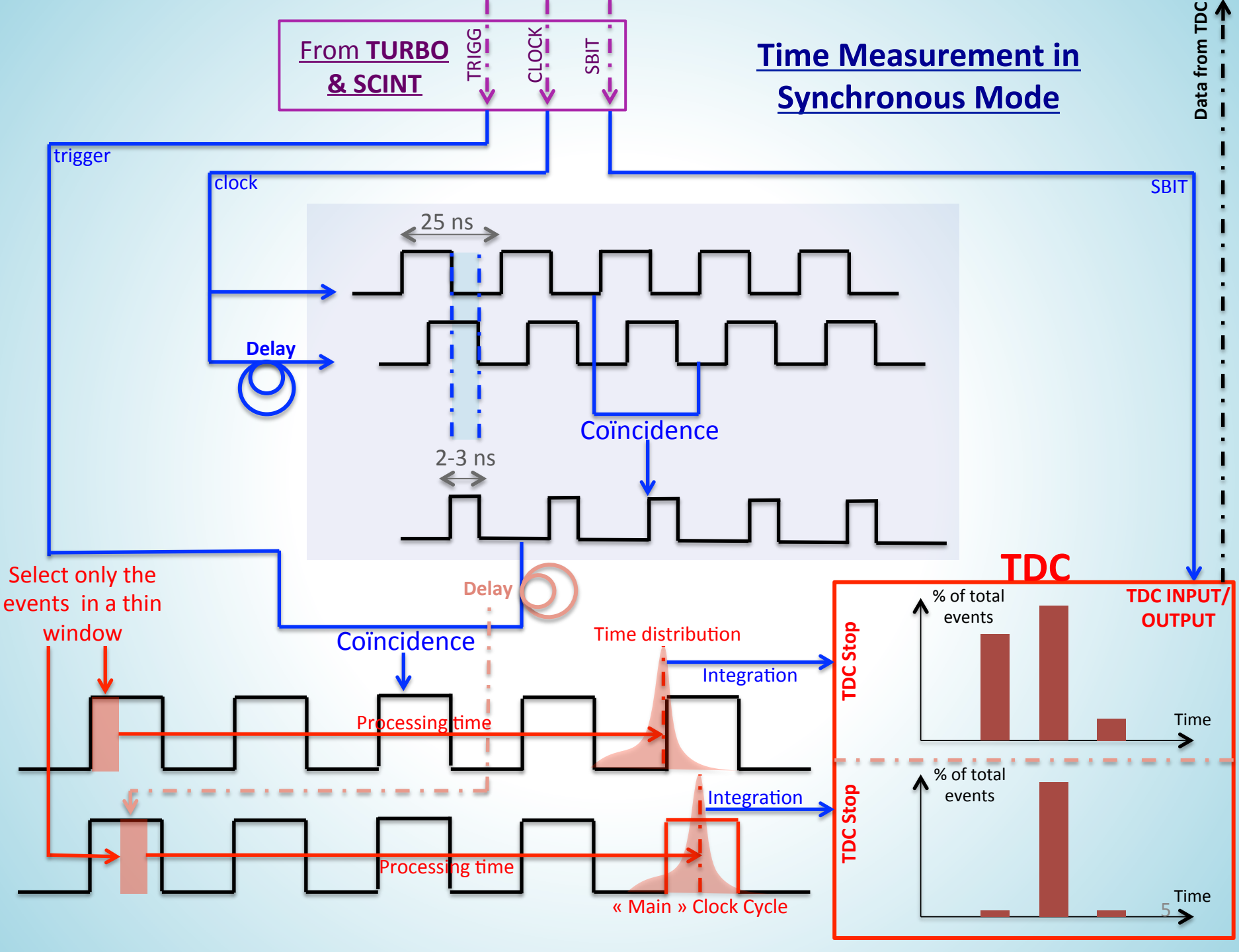




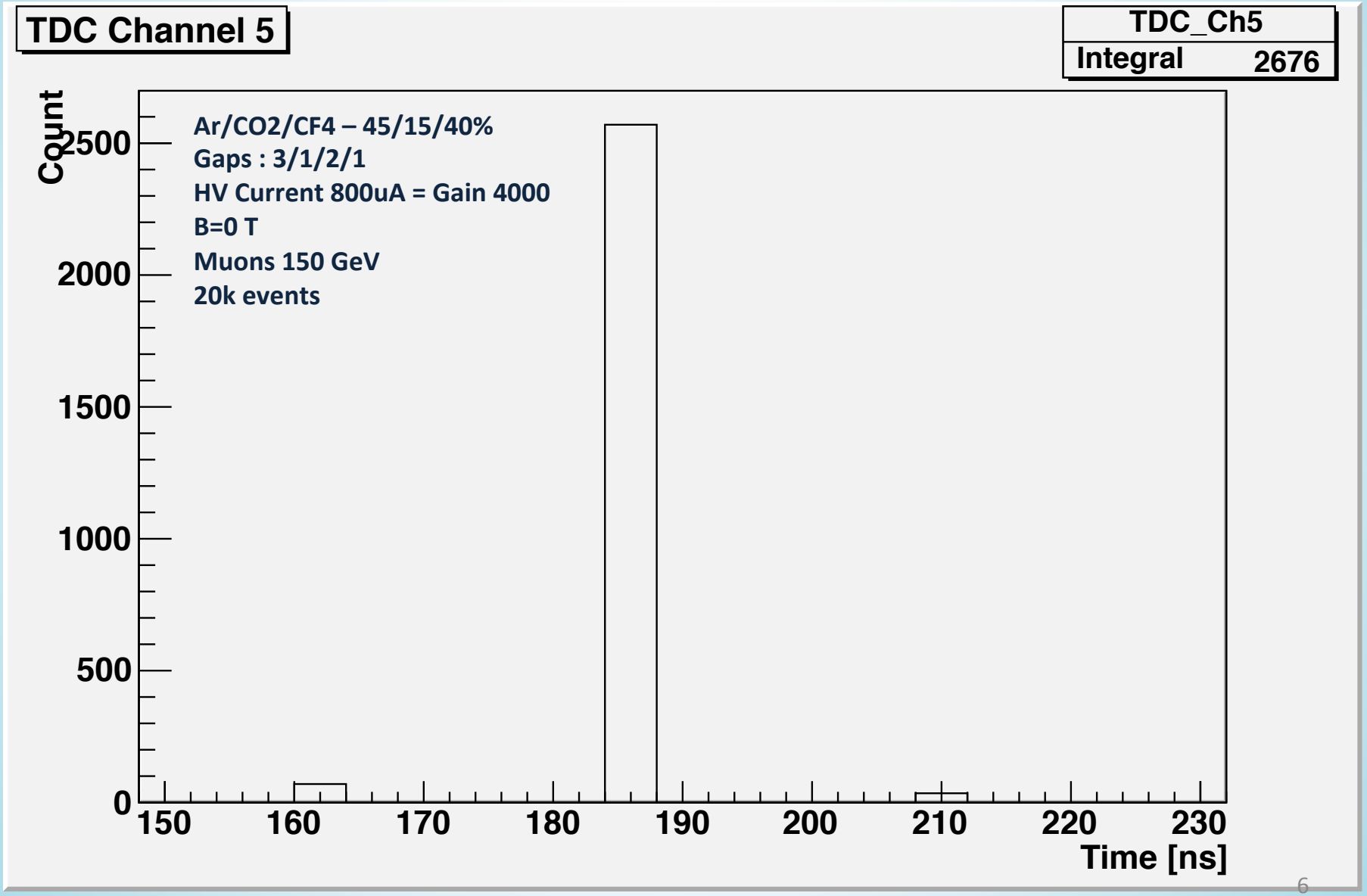
Preliminary Results from November 2012



Time Measurement in Synchronous Mode

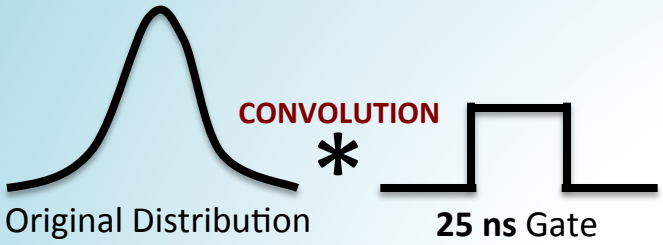


Preliminary Results from November 2012

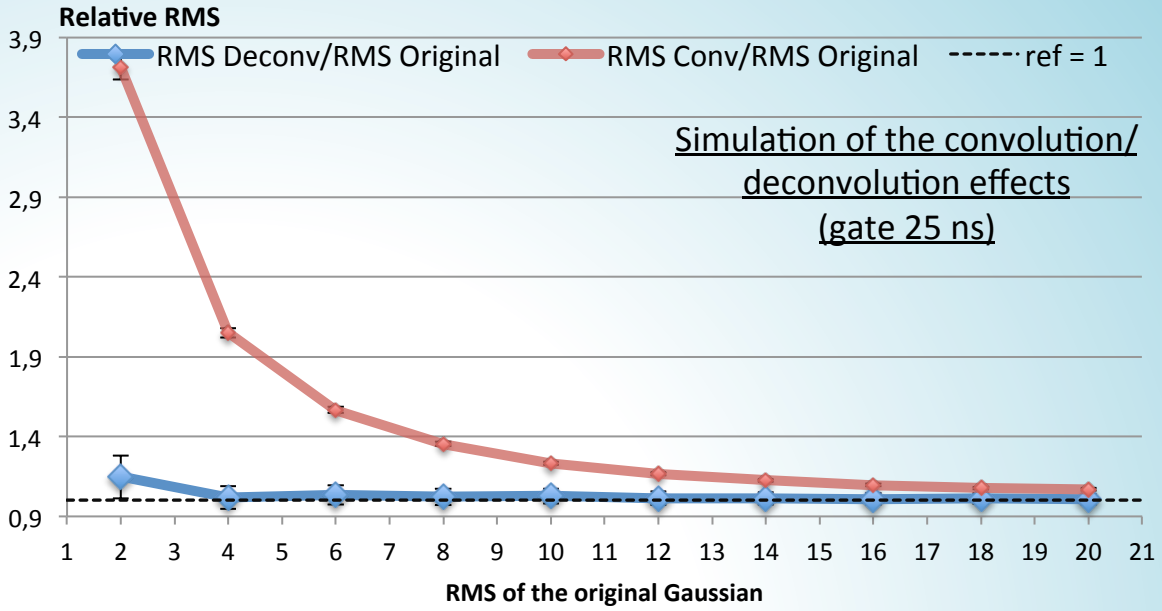


Asynchronous Measurement :

Significant effect on the convoluted signal especially for low RMS

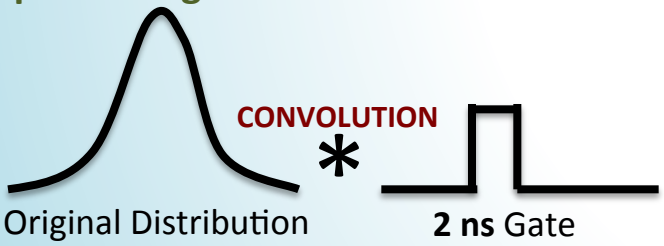


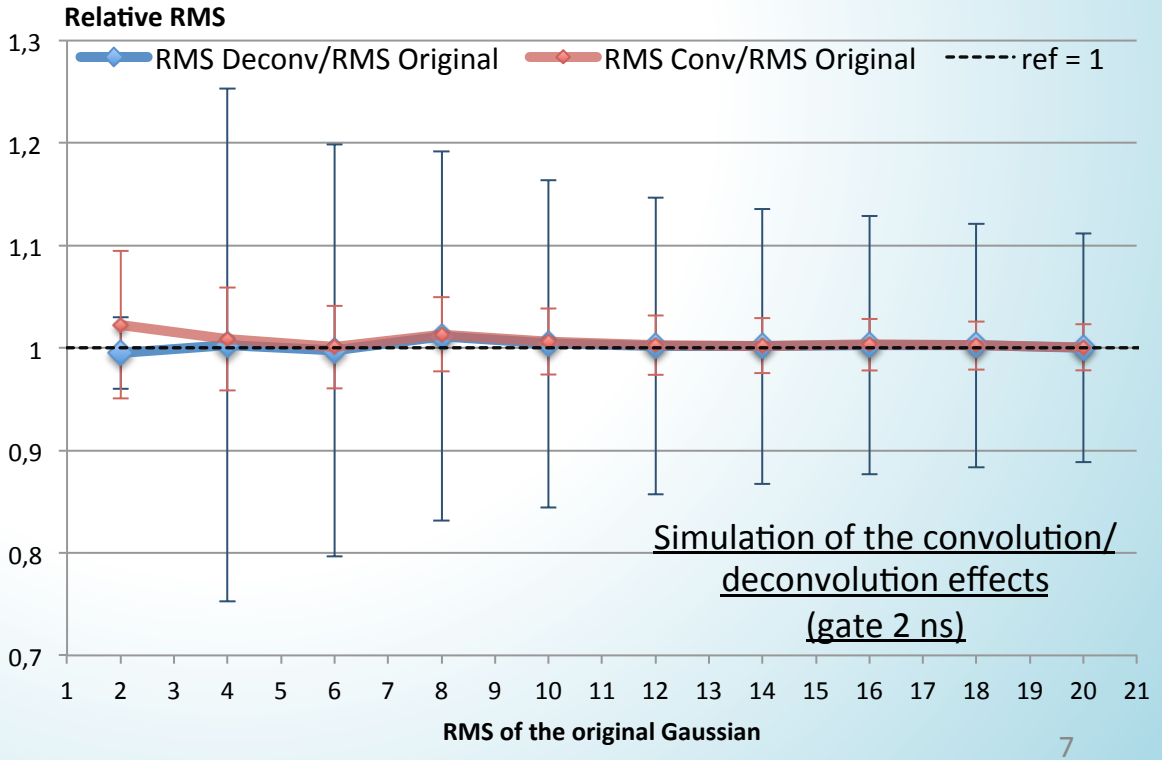
The deconvolution process can recover the original RMS
→ But it is signal processing



Synchronous Measurement :

The convolution effect is reduced
→ Can be measured without signal processing

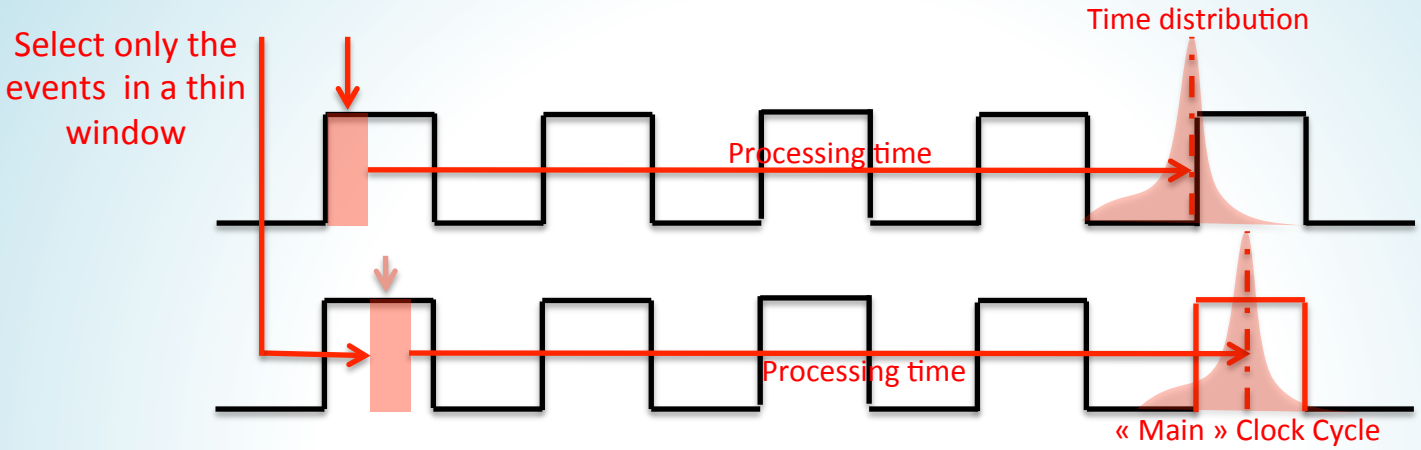




Note : for the simulation, noise has been added to the distributions to test the strength of the deconvolution process. The deconvolution is done by ROOT while the convolution is done manually in order to avoid the trivial matching between function and inverse function

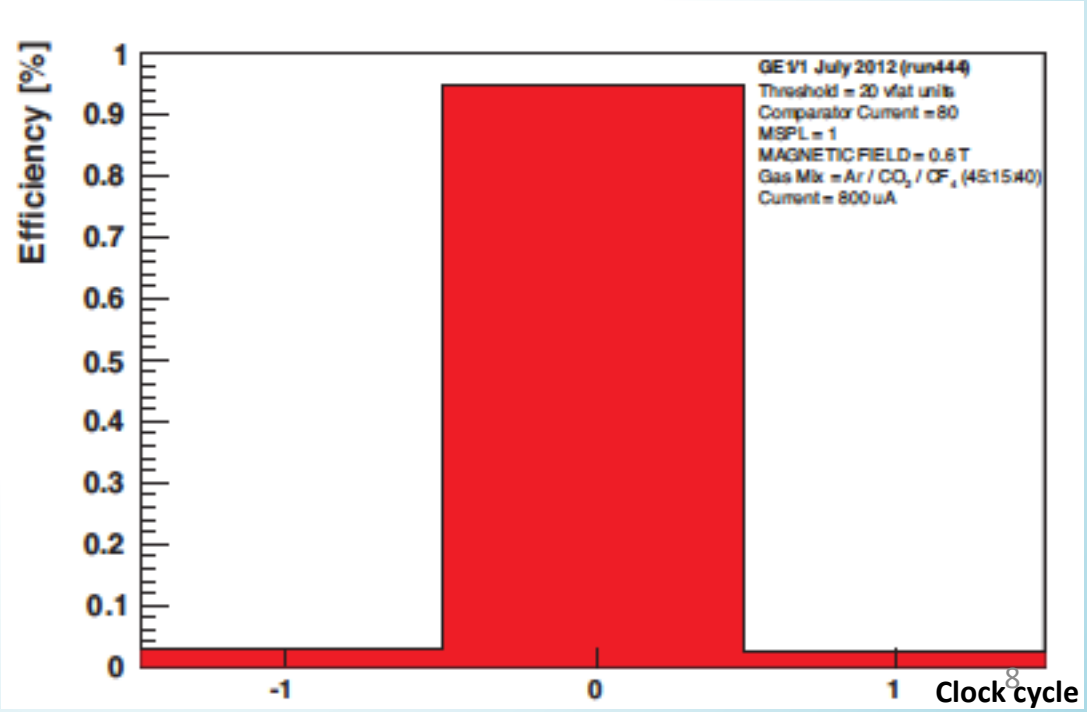
Synchronous Measurement : Important parameters

- Selection of the events in a 2 ns window synchronized with the clock
- Adjustment of the window's position to center the response of the detectors in one cycle

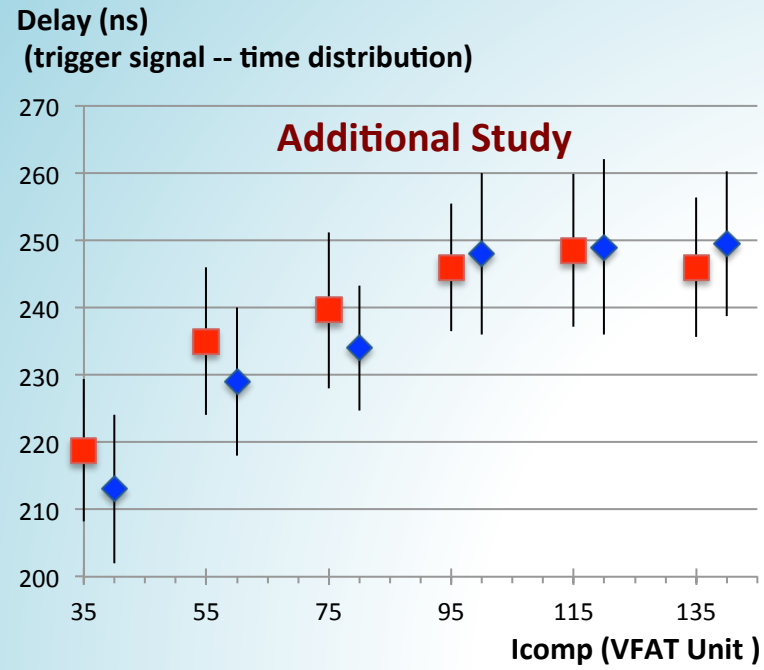


→ Add different delays on the installation (hardware)

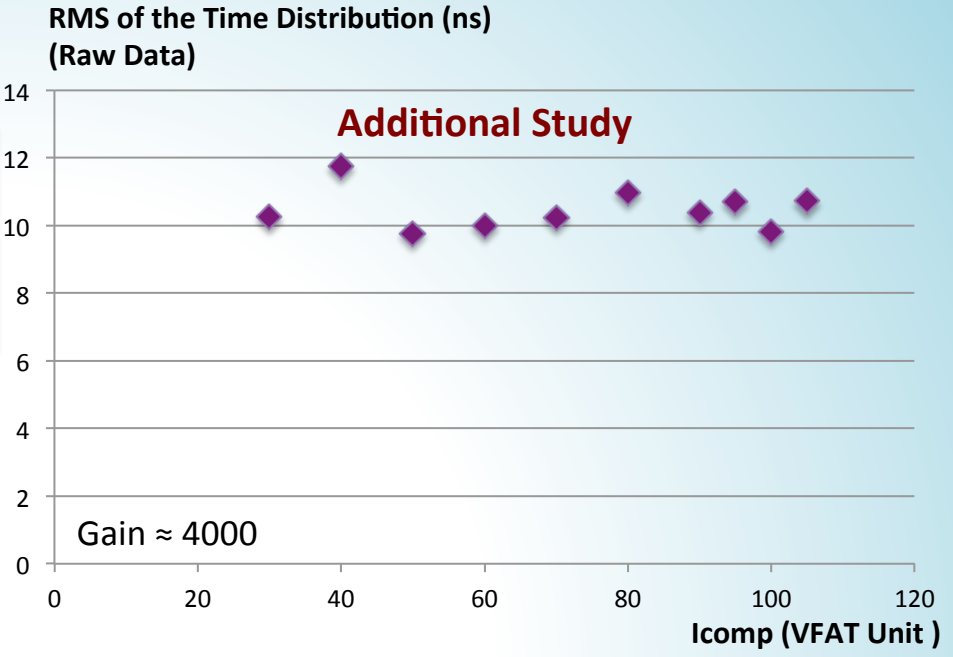
→ Adjust the delay by changing the Icomp* parameter in the VFATs configuration



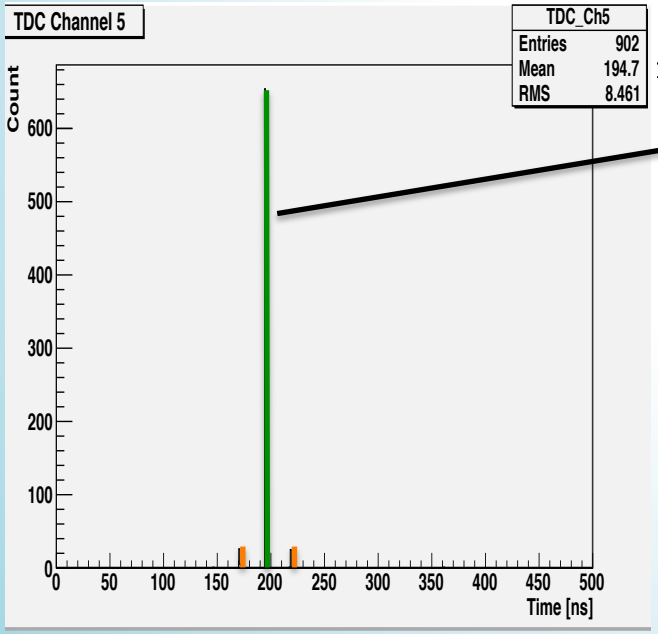
*Icomp : to power the comparator stage

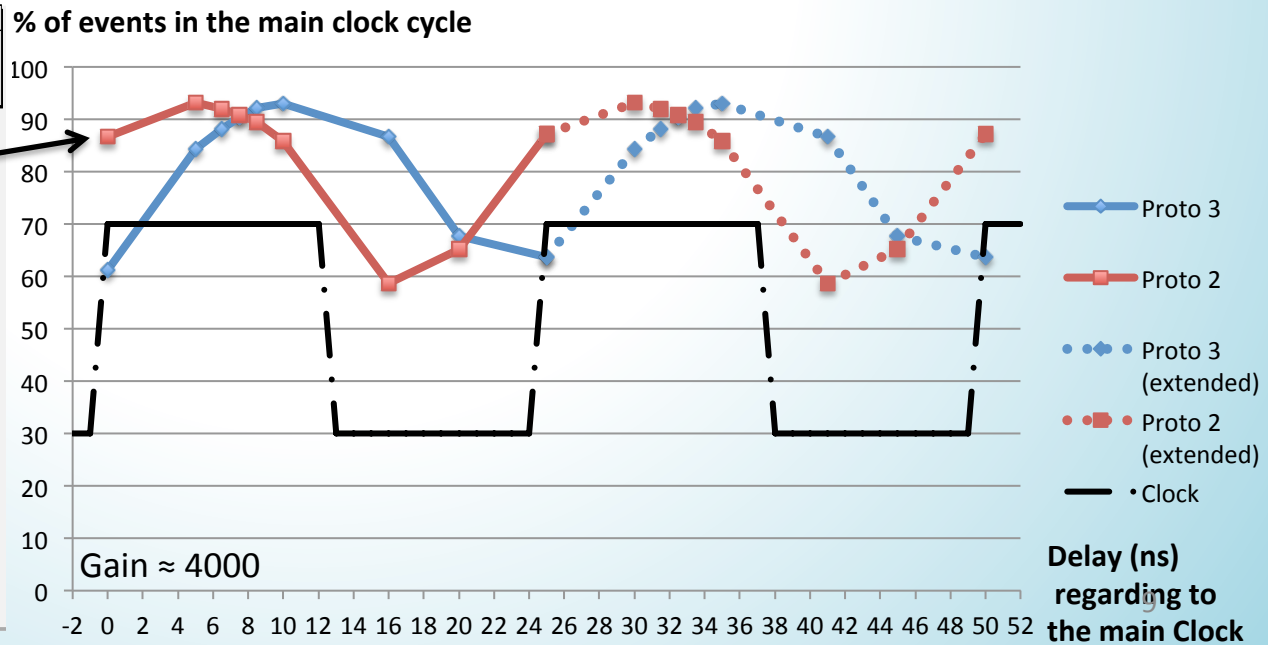


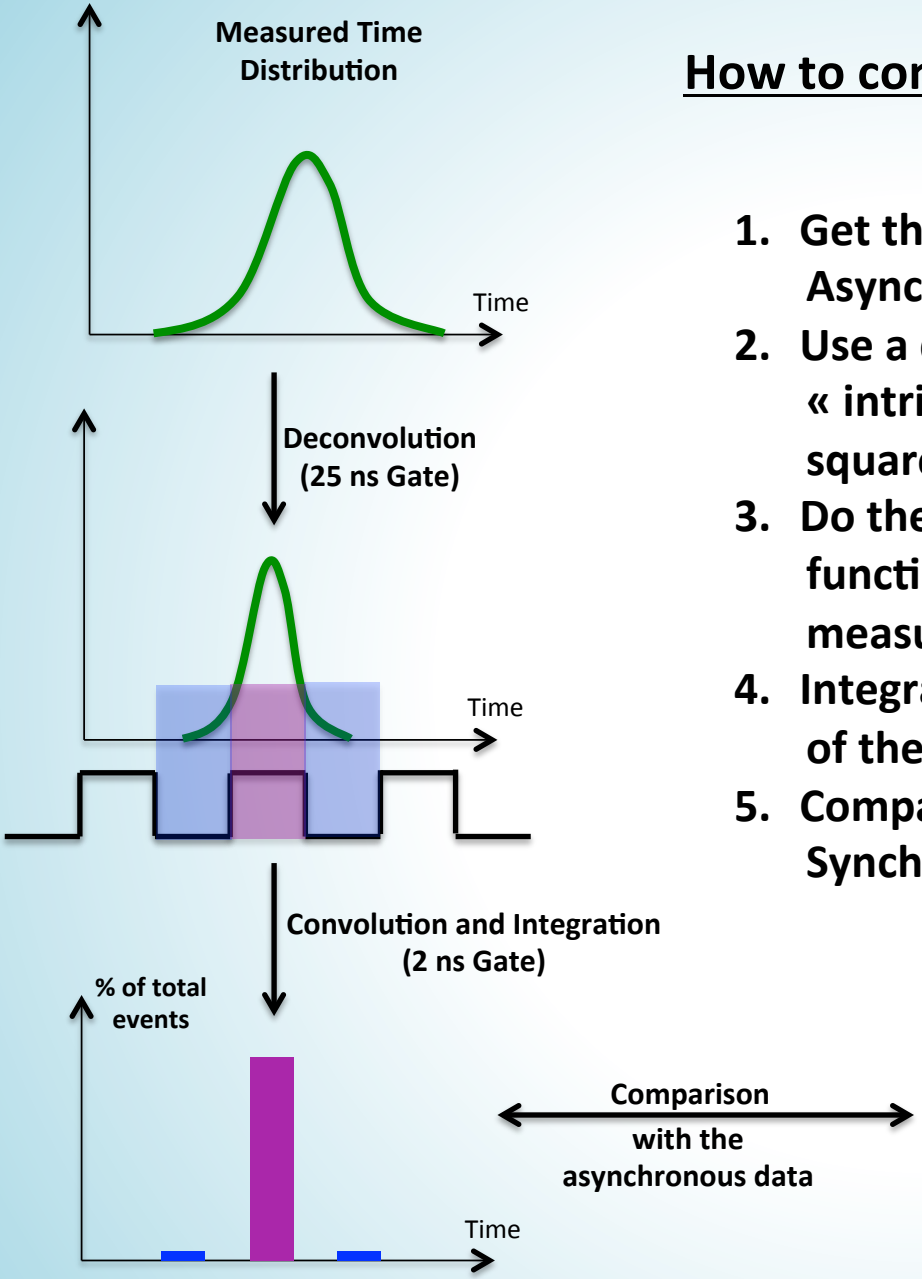
Constant Delay (Hardware)
- 12 ns
- 23,5 ns



Real Data from November 2012

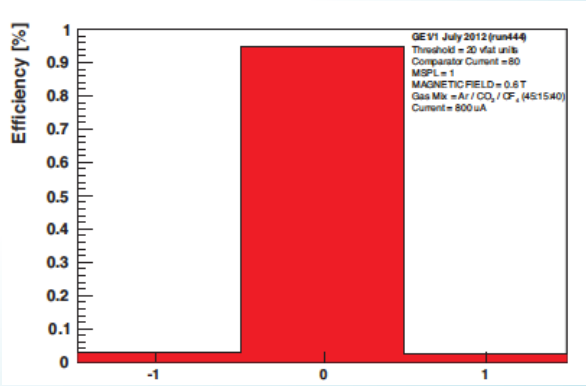


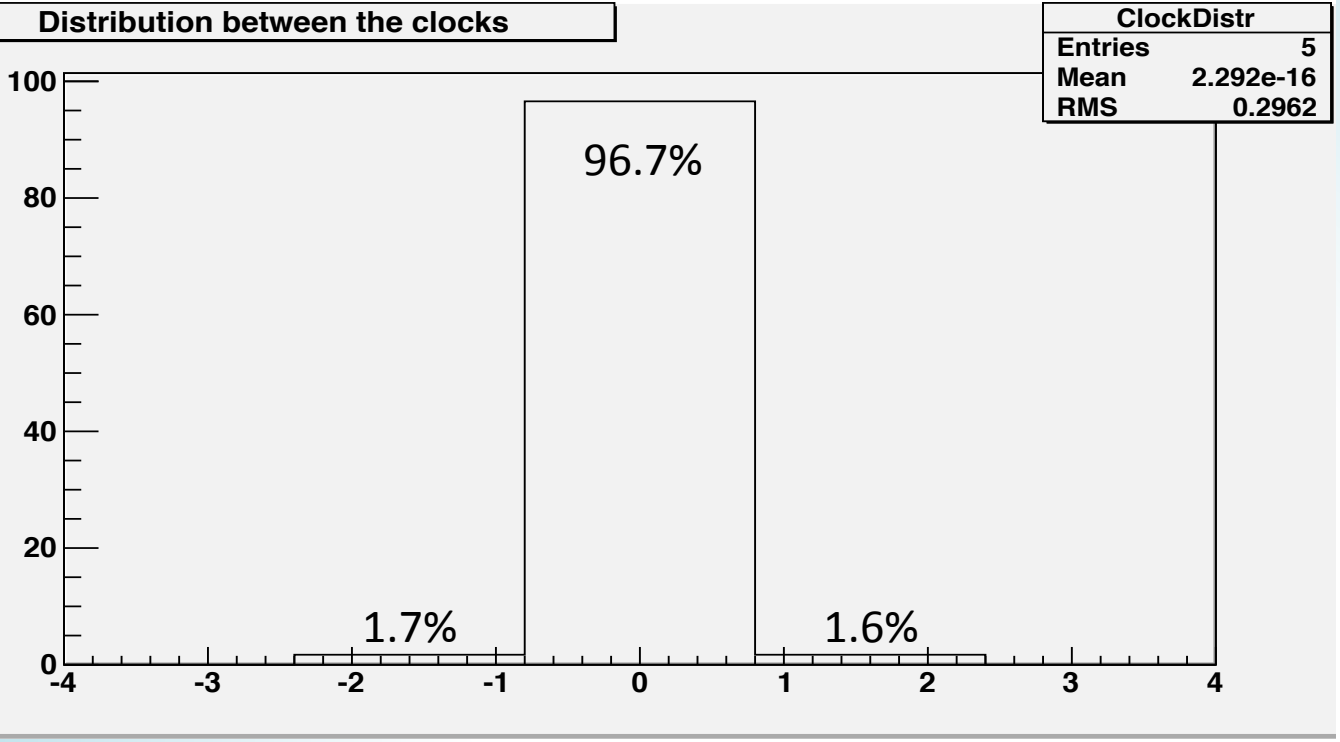




How to confirm the quality of the Synchronous measurement

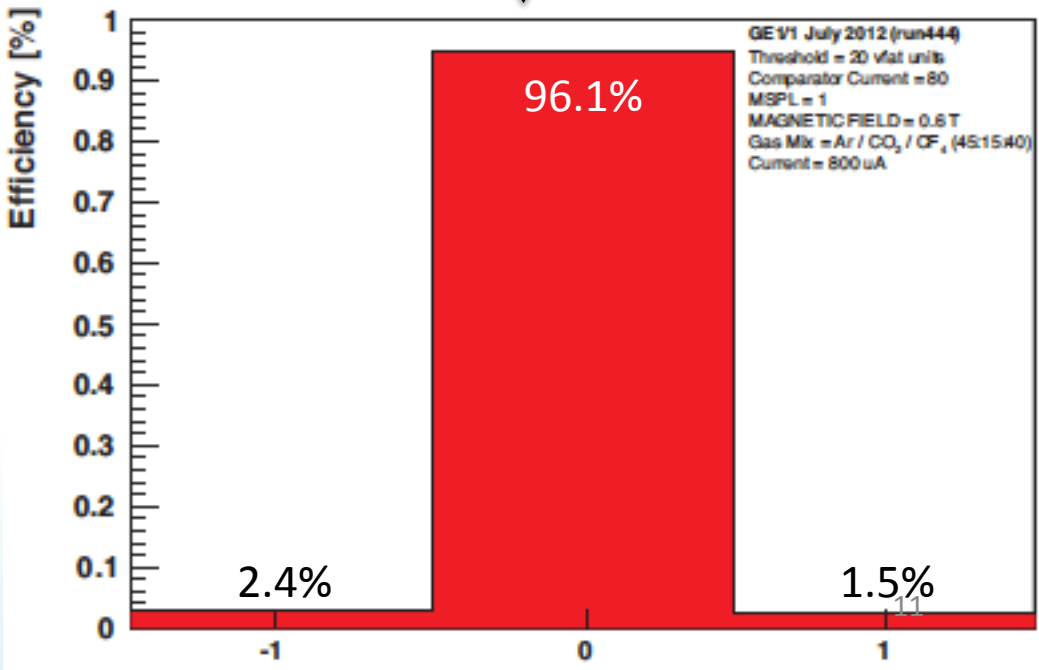
1. Get the time distribution from the Asynchronous measurement
2. Use a deconvolution function to recover the « intrinsic » time distribution (using 25ns square function)
3. Do the convolution with a 2ns square function to match with the Synchronous measurement parameters
4. Integrate the new distribution over the clock of the VFATs
5. Compare with the data from the Synchronous measurement





← Based on the Asynchronous distribution

Data from Synchronous measurement (July 2012)



Synchronous measurement is consistent with the previous data and more relevant because :

→ **No signal processing**

→ **Closer to the reality (LHC 2ns protons bunches)**

Synchronous results can be easily used to extend the analysis to a system of N aligned detectors

With 4 aligned detectors (2 super-chambers)

Detection efficiency

Time efficiency

```
root [1] Proba(0.96,0.96,4)

*****************************************
**-------------------------------------**
** Nb GEMs  |  Nb Planes  |  Probability **
**-------------------------------------**
**-------------------------------------**
**    4     |      1      |   99.9962 %  **
**-------------------------------------**
**    4     |      2      |   99.8186 %  **
**-------------------------------------**
**    4     |      3      |   96.6862 %  **
**-------------------------------------**
**    4     |      4      |   72.1389 %  **
**-------------------------------------**
*****************************************
```

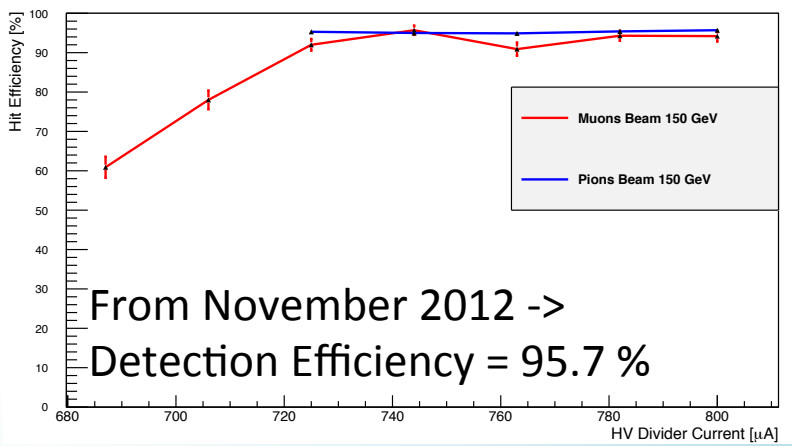
Number of « active » detectors

Total number of detectors

MSPL 1 : each event is written in one clock cycle

Based on the Binomial distribution :
Gives the probability to detect the event in the same clock cycle regarding to the number of required detectors

Exemple :
96.7 % probability that the event is detected by 3 detectors in the same clock cycle



Stand-alone mode ? Probability to have events in two consecutive clocks ? How many detectors for a good trigger/tracking ?

Thank you

GE1/1 – NS2 Prototype 1 : Effective Gain VS Current