SuperB EMC TB: Time Resolution

06/04/2011

Stefano Germani & Matteo Cardinali

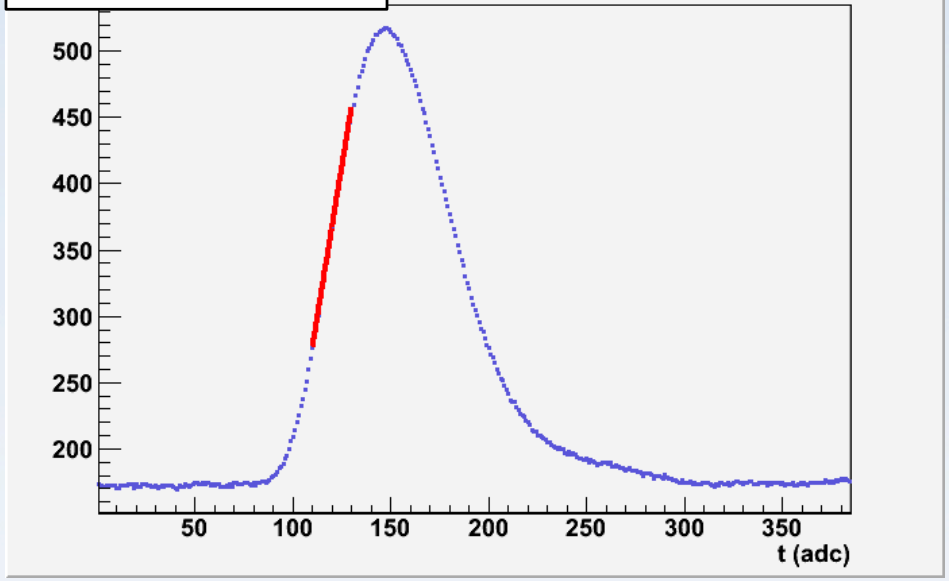
Università di Perugia
INFN Sez. Perugia

Summary

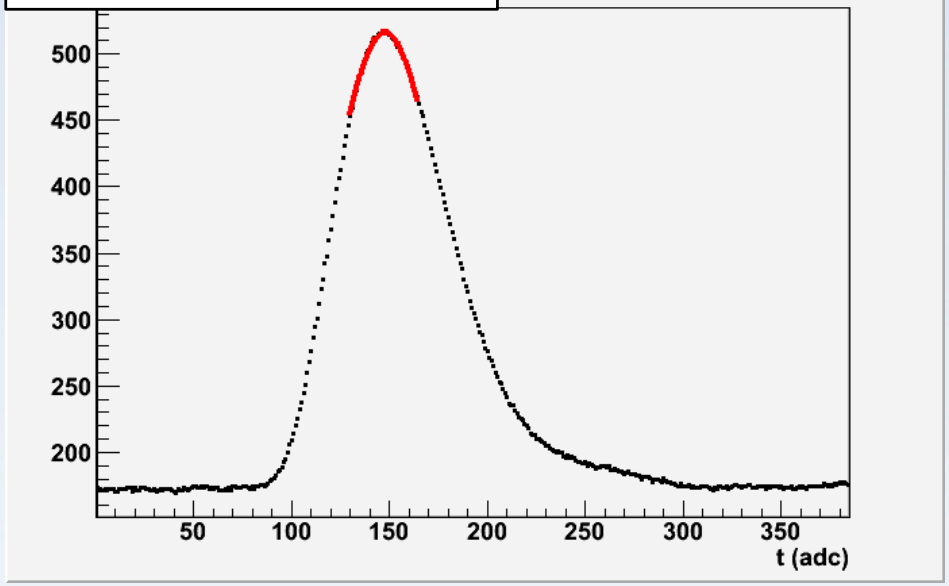
- Development of an algorithm to measure TIME RESOLUTION from EMC data
- Test the capability of the system, using Cern Teast Beam data
- Data Analysis
- Outlooks
- Conclusions

Arrival time of the signal

Linear Fit



Peak Fit

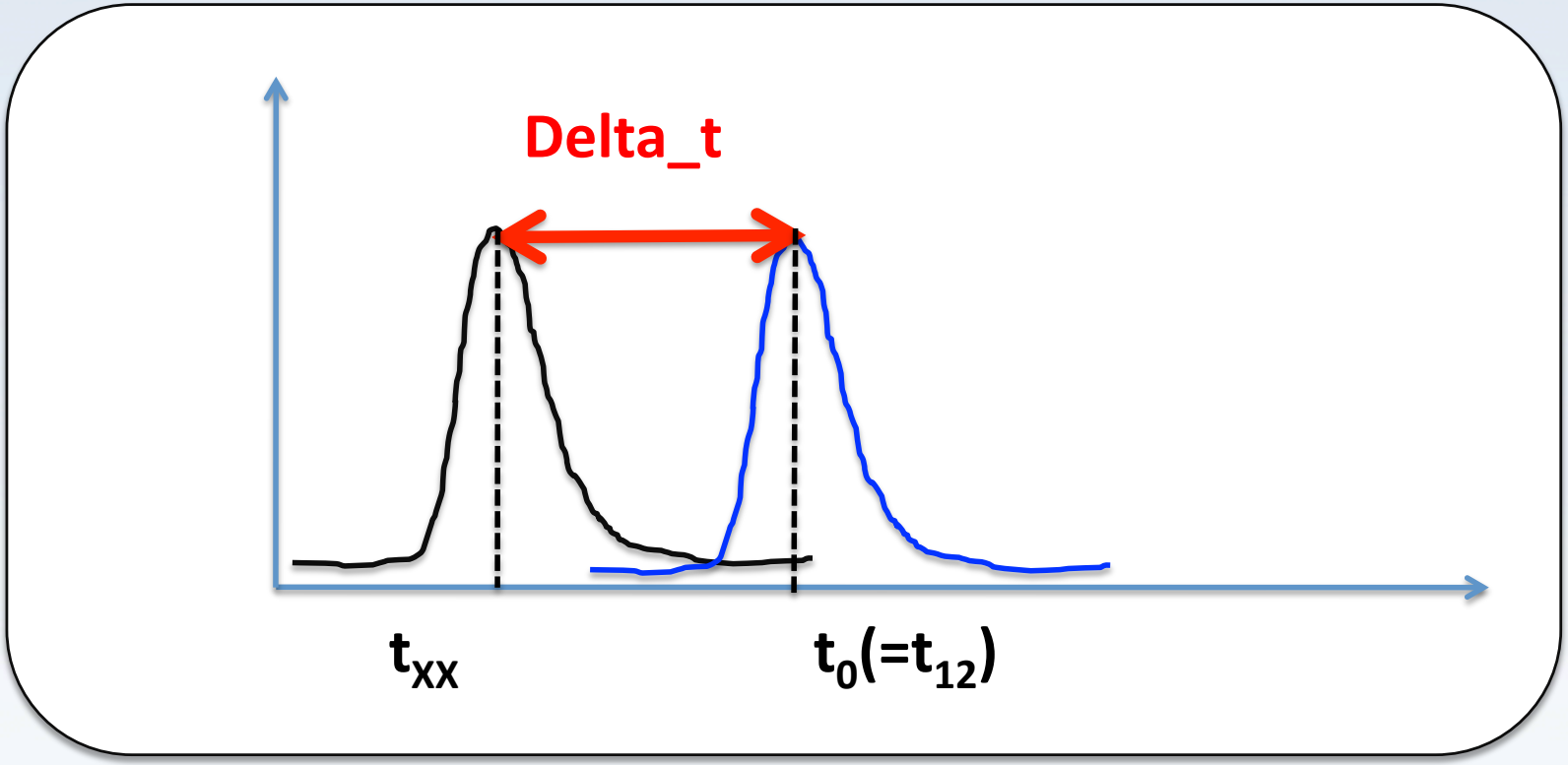


Time measure

1. **Linear Fit**: time from the extrapolation to the baseline using a linear fit (pol 1)
2. **Peak Fit**: time from the mean value of signal gaussian fit

Relative Time

- Needs of a reference time t_0 :
  1. external clock
  2. time of one of the 25 crystal

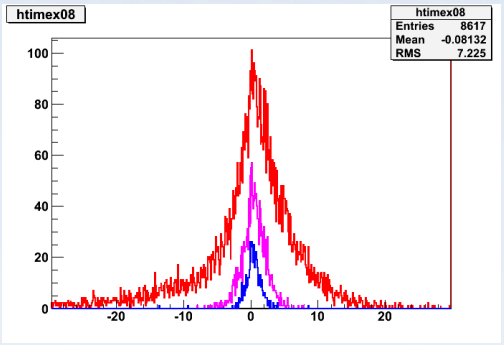


Drawing histograms of time difference Delta_t = t_{XX}-t_0 (with data from one or a lot of runs) we should find a gaussian distribution where time resolution is $\frac{\sigma}{\sqrt{2}}$

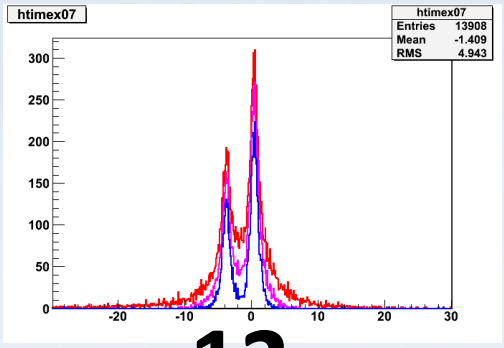
Linear Fit: Run350 (20264 events) $t_0=t_{xtal12}$

Threshold
- 10 ADC
- 50 ADC
- 100 ADC

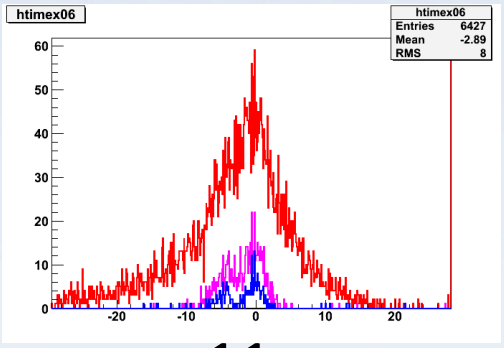
8



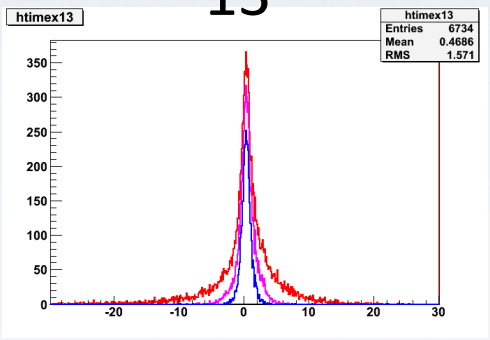
7



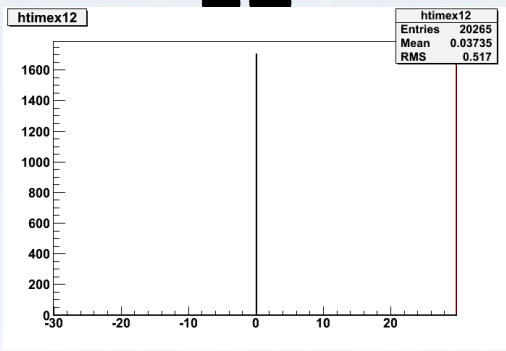
6



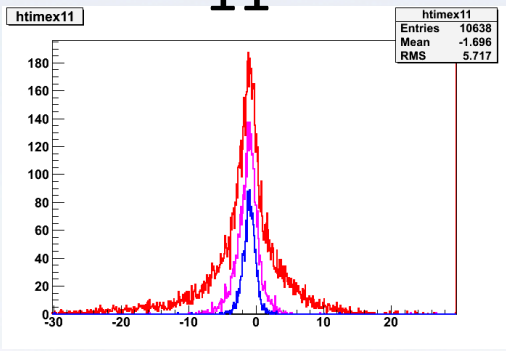
13



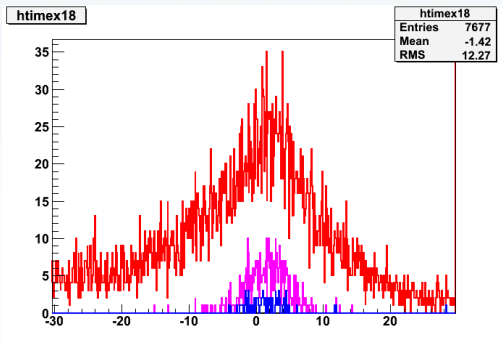
12



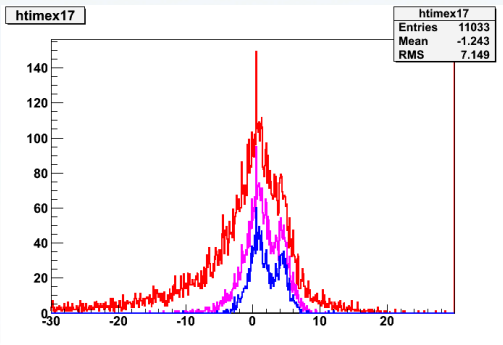
11



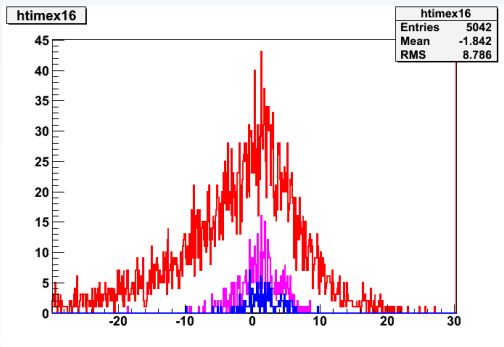
18



17

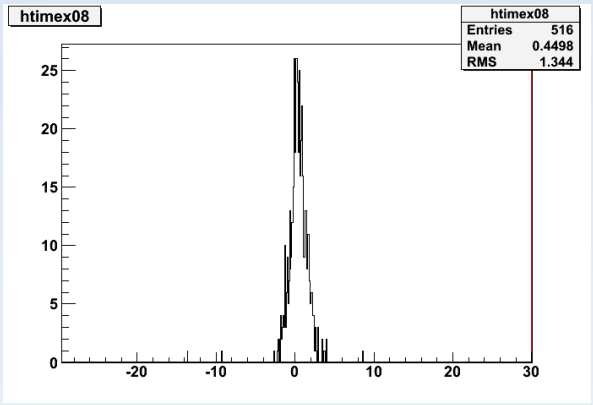


16

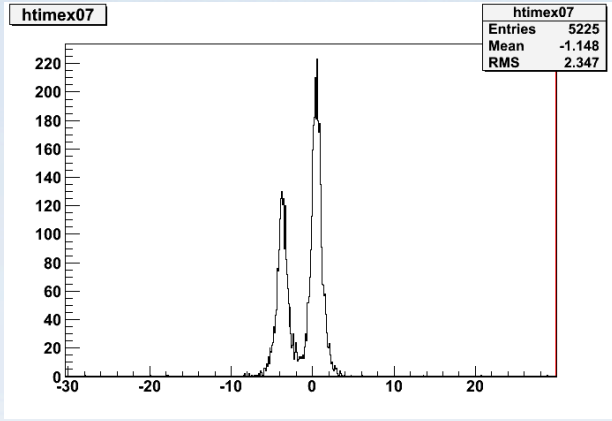


Linear Fit: Run350 (20264 events) $t_0=t_{xtal12}$

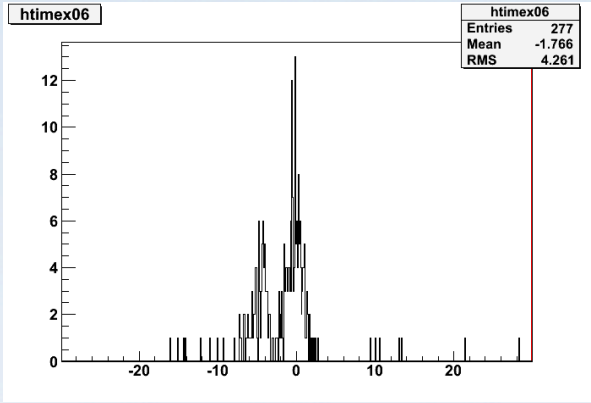
8



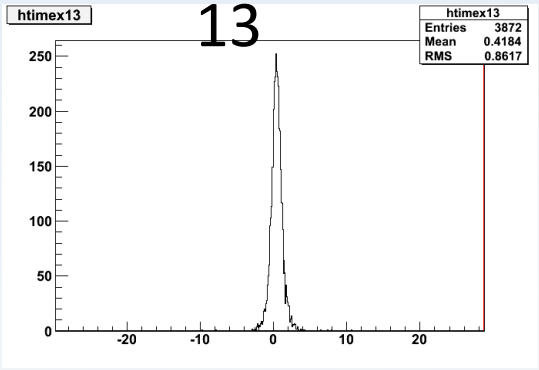
7



6

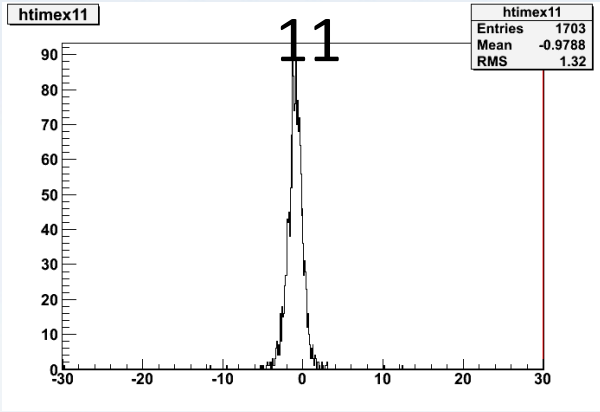


13

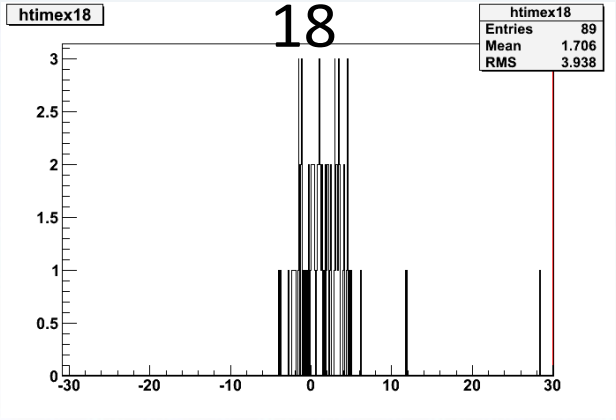


12

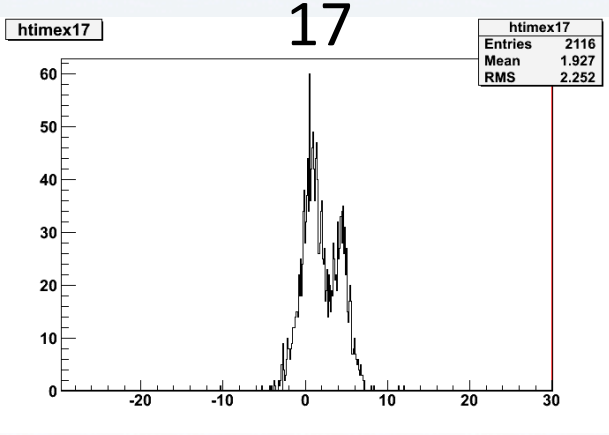
11



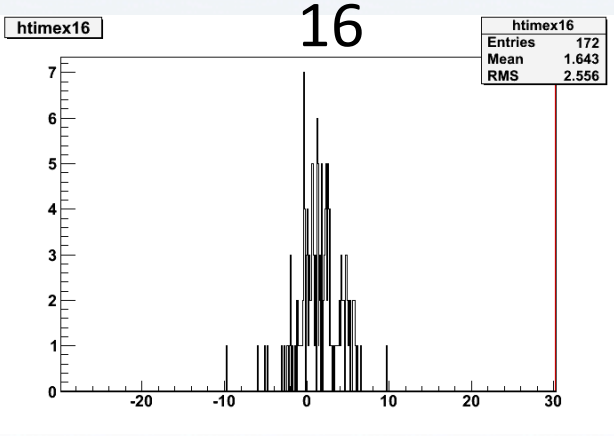
18



17



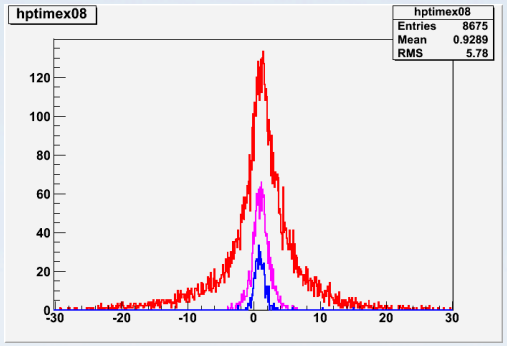
16



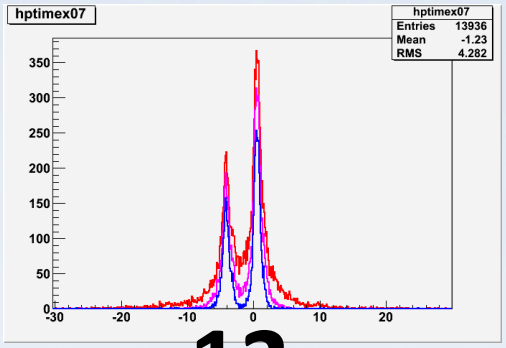
Peak Fit: Run350 (20264 events) $t_0=t_{xtal12}$

Threshold
- 10 ADC
- 50 ADC
- 100 ADC

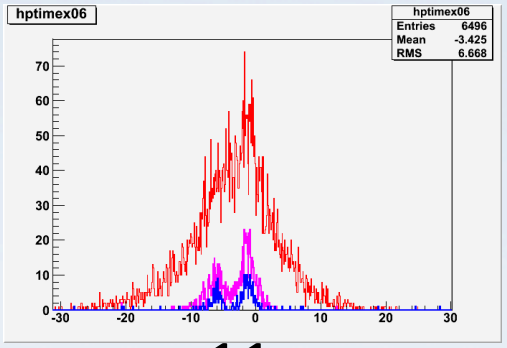
8



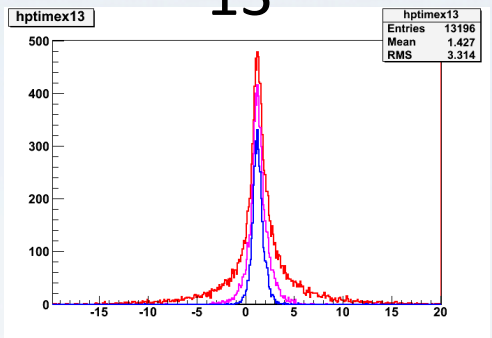
7



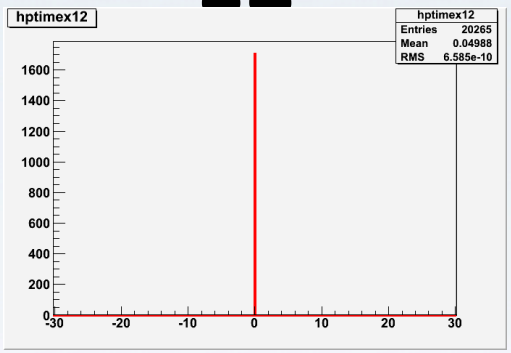
6



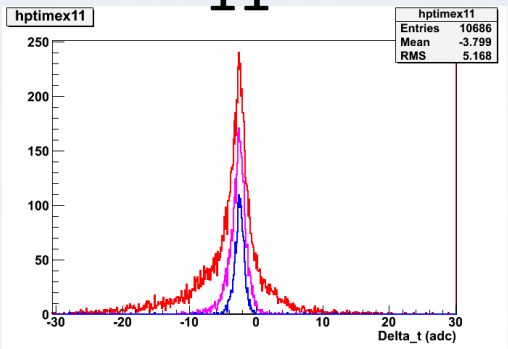
13



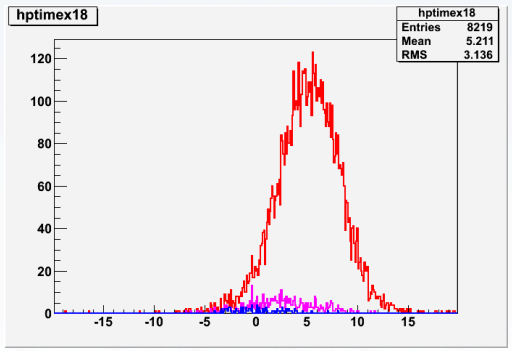
12



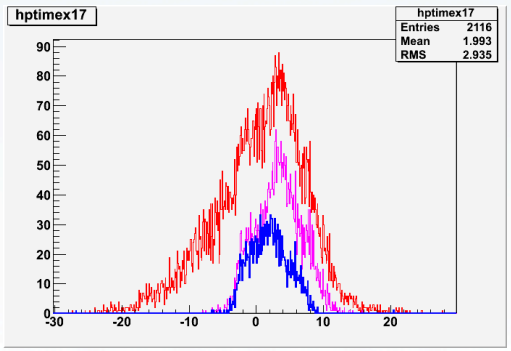
11



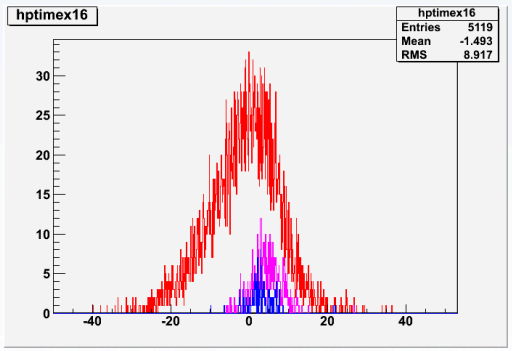
18



17

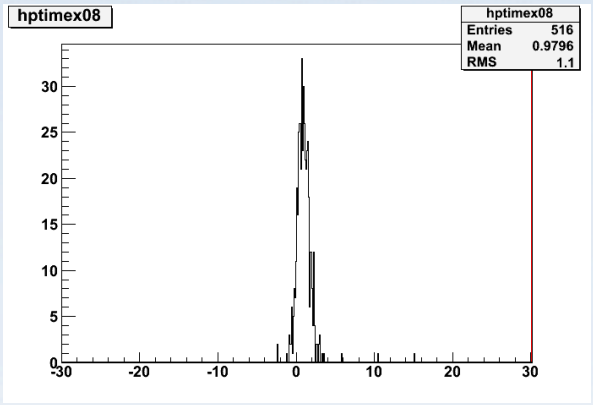


16

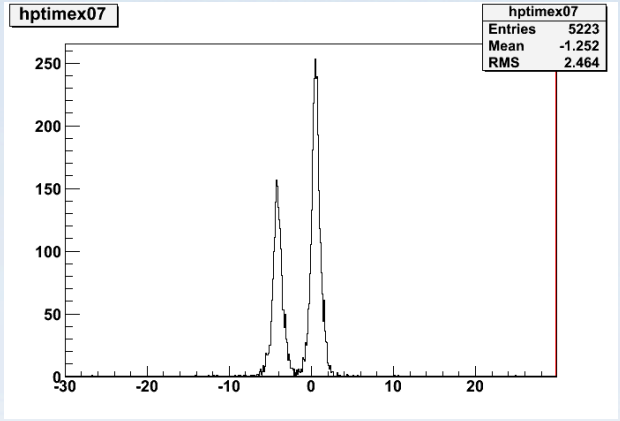


Peak Fit: Run350 (20264 events) $t_0=t_{xtal12}$

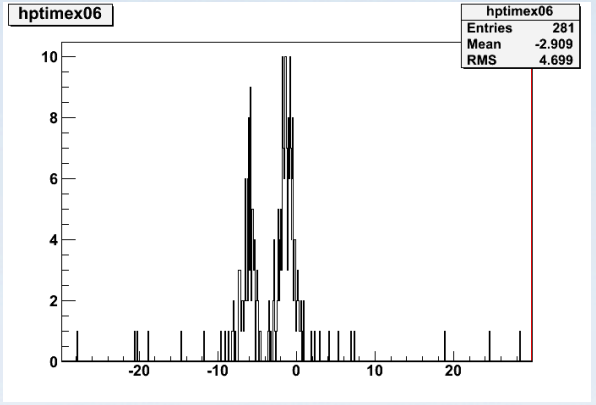
8



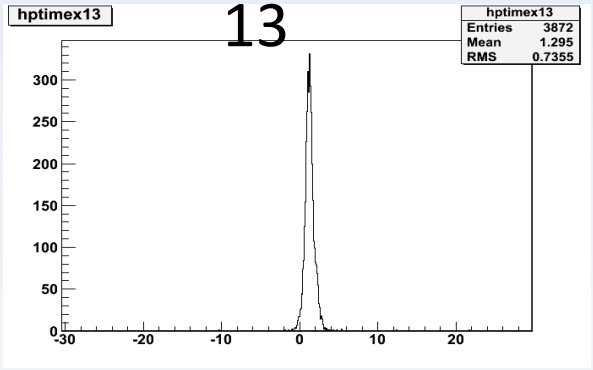
7



6

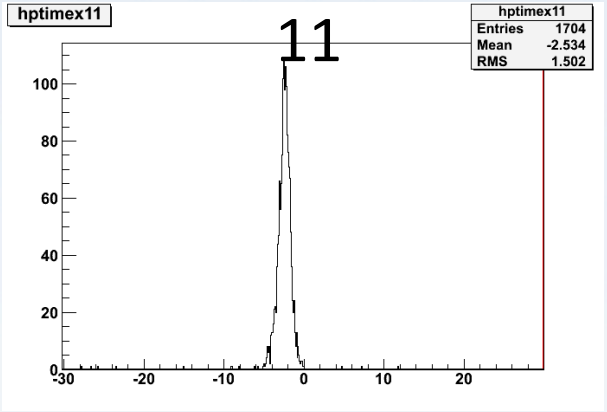


13

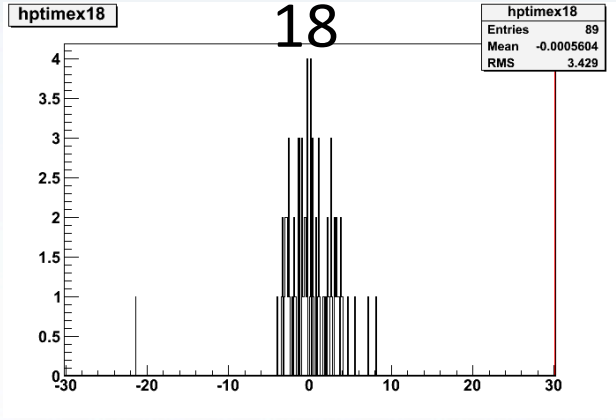


12

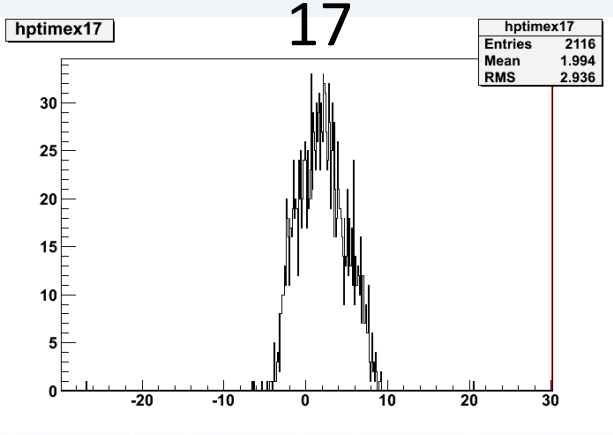
11



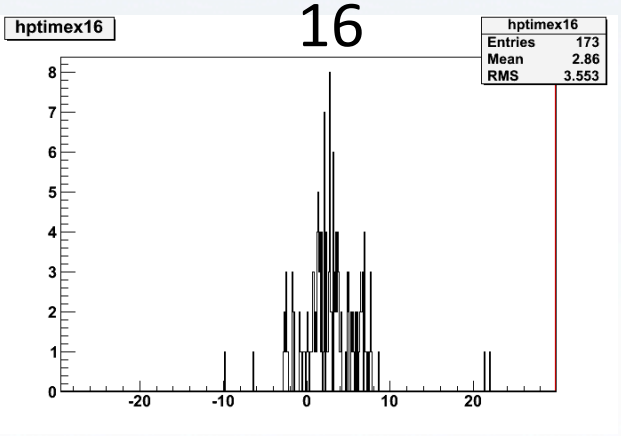
18



17



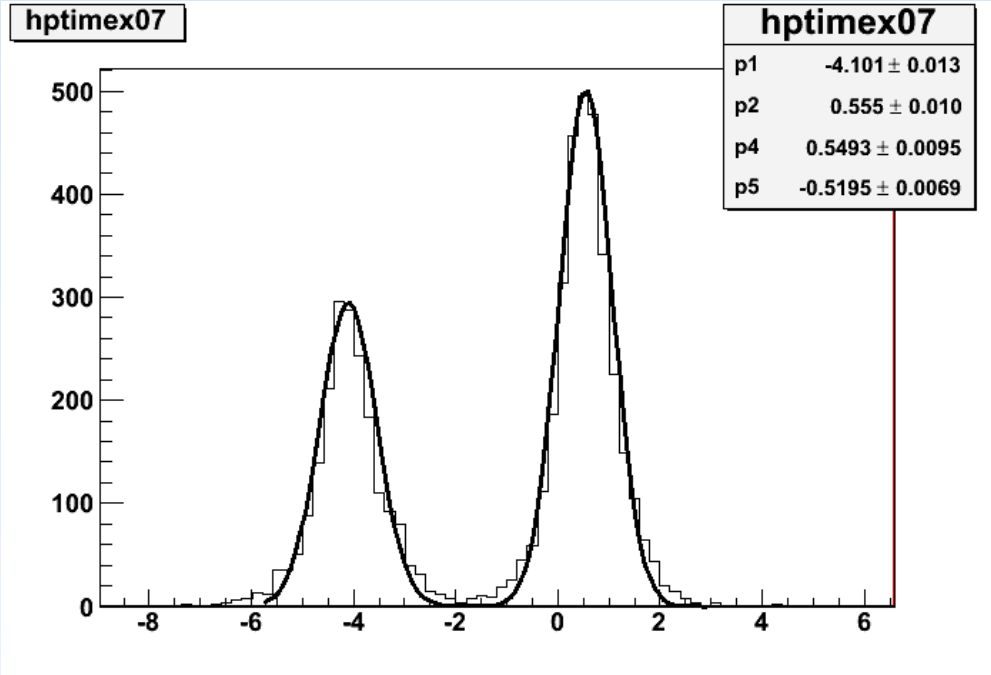
16



Trigger Problem

ADC 0	ADC 1	ADC 2	ADC 3	
4	3	2	1	0
9	8	7	6	5
14	13	12	11	10
19	18	17	16	15
24	23	22	21	20

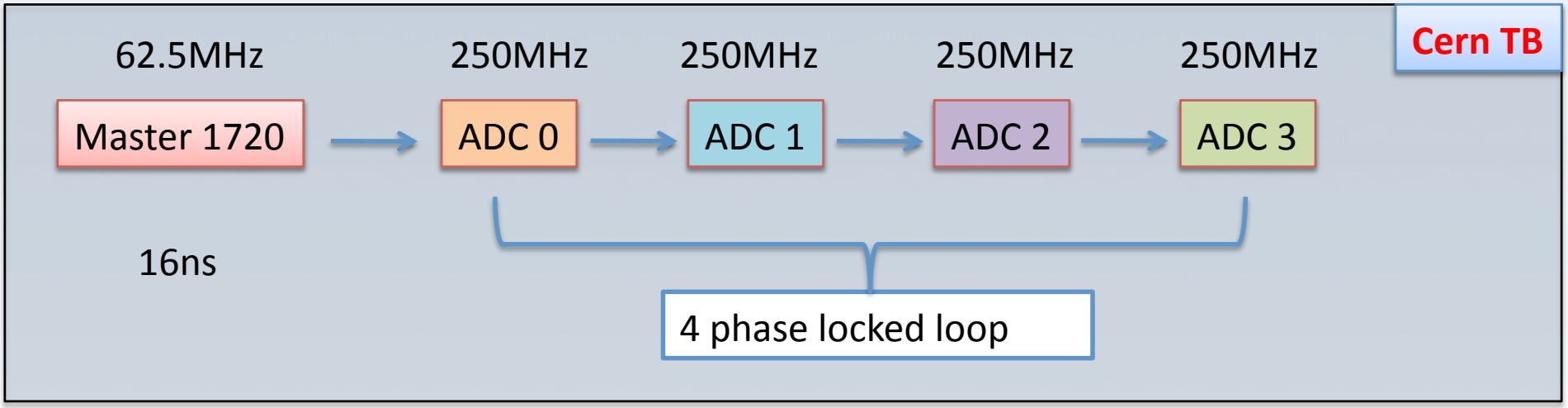
Trigger Problem 2



distance between peaks about 4 adc sample

1 adc sample = 4 ns

4x4 = 16 ns



When ADC X lost phase, there is a 16 ns shift, which could be positive or negative

JITTER PROBLEM!

"All-Runs check"

8	7	6
13	12	11
18	17	16

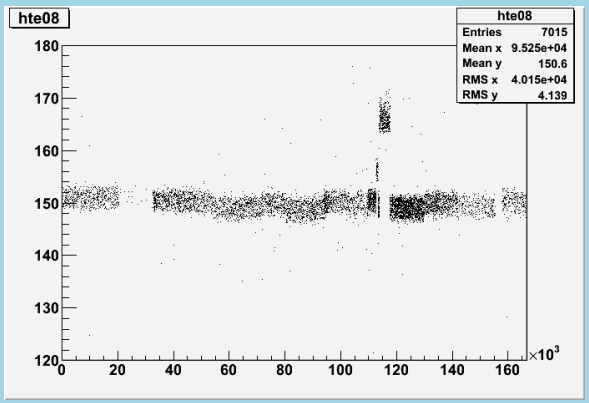
Let's focus on crystal 12 centred runs (1, 1.5, 2, 3 GeV) and plot:

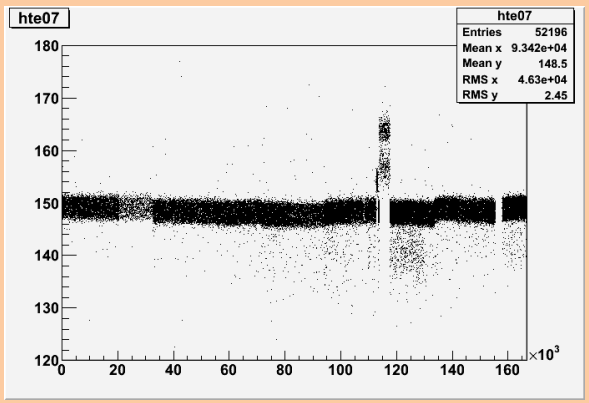
1. **t_{XX} vs # events**

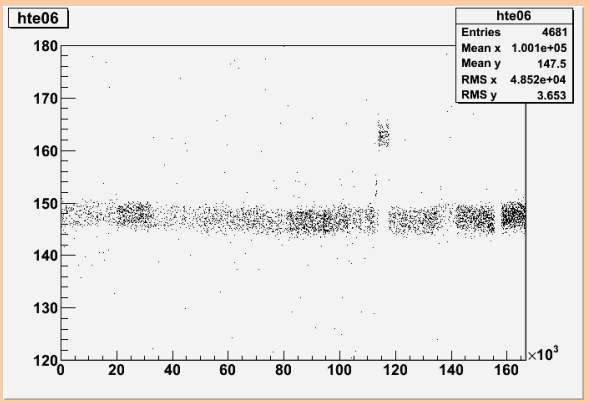
2. **t_{XX}-t_{12} vs # events**

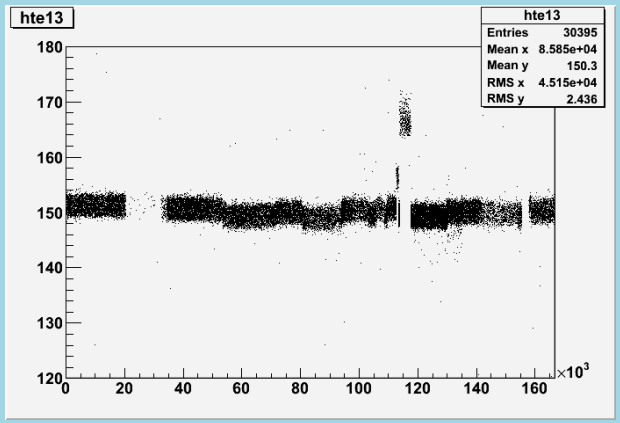
Investigated Runs:
350,351,361,362,369,370,371,390,391,407,408,409,410,411,412,413,414,415,419
,420,421,422,429,430,431,432,435,437,438,439,440,441

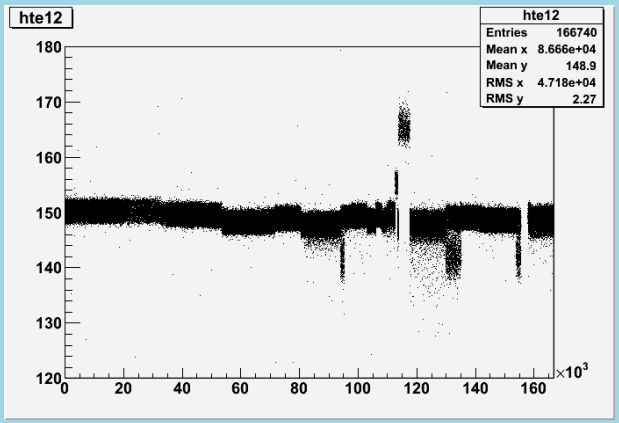
All Runs on Crystal 12: t_{xx} vs events

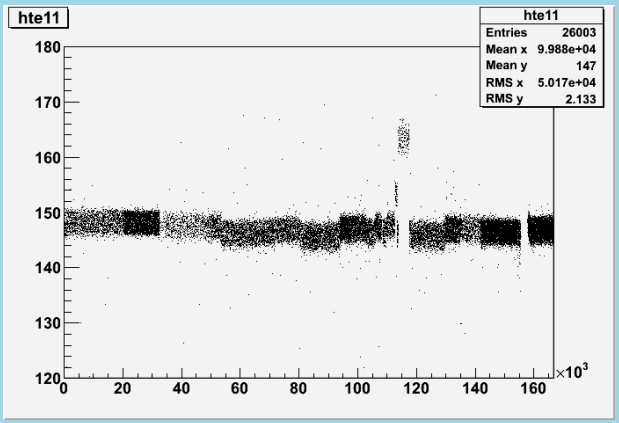


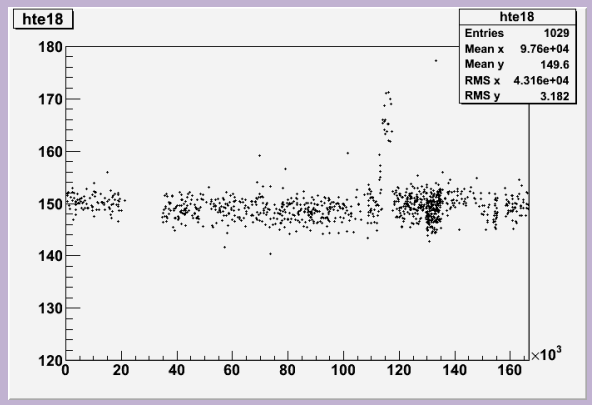


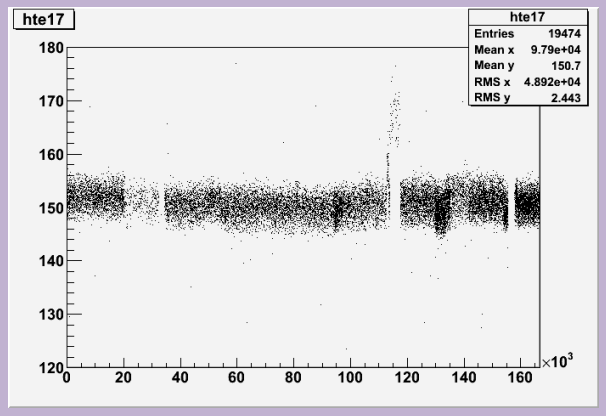


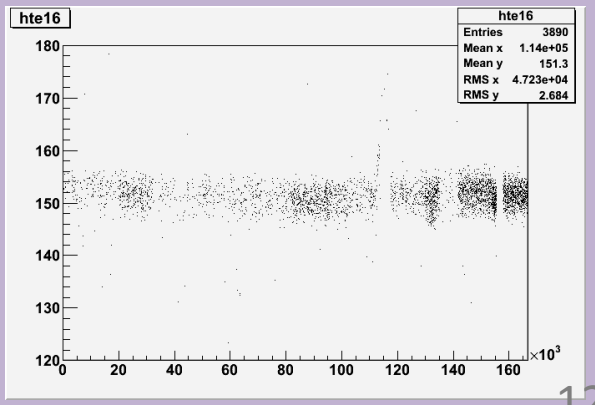




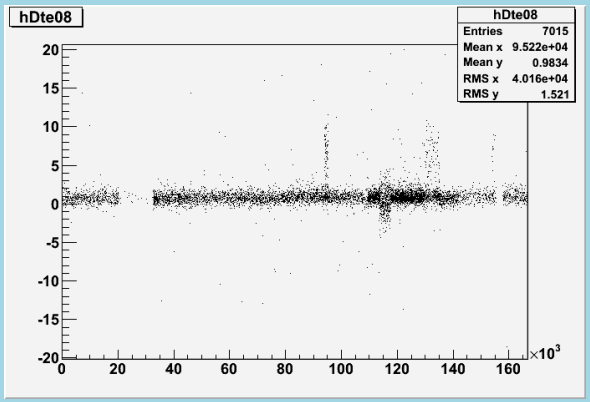


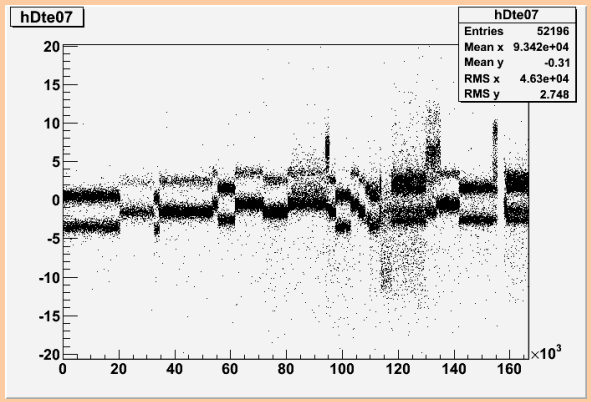


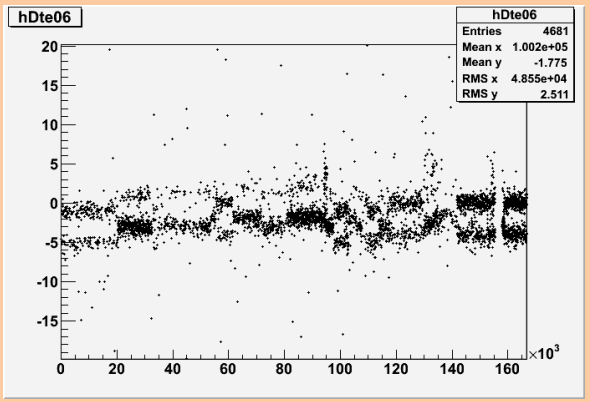


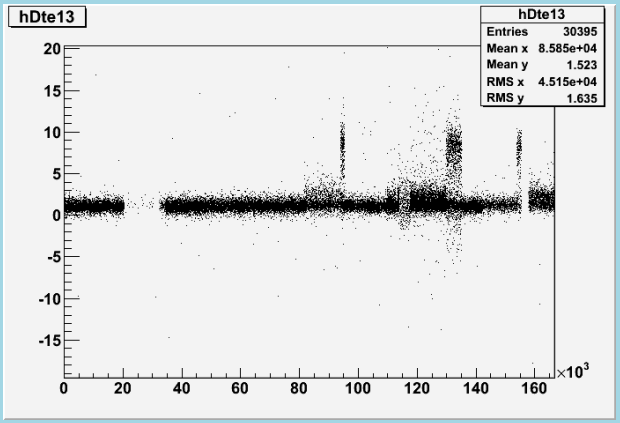


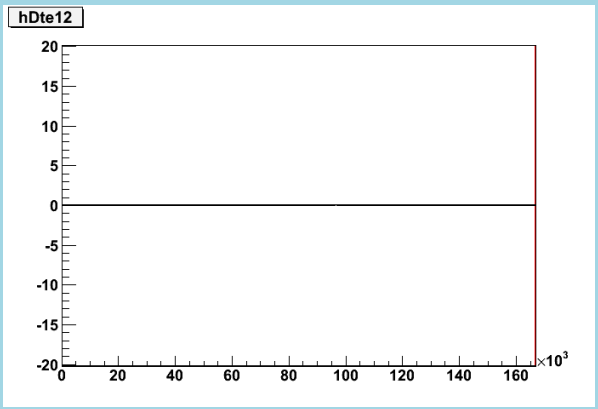
All Runs on Crystal 12: t_{xx}-t_{12} vs events

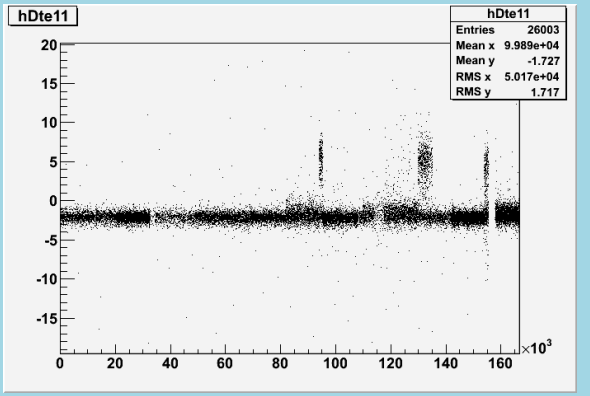


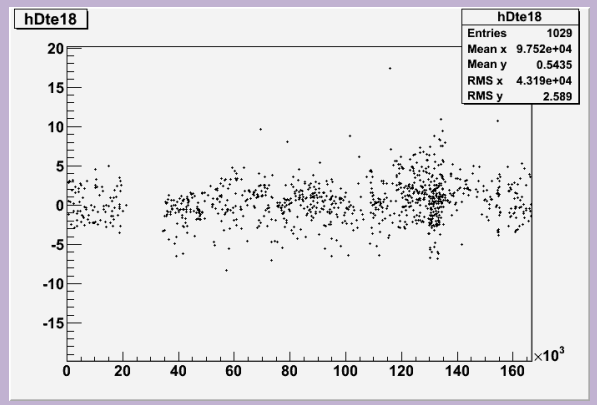


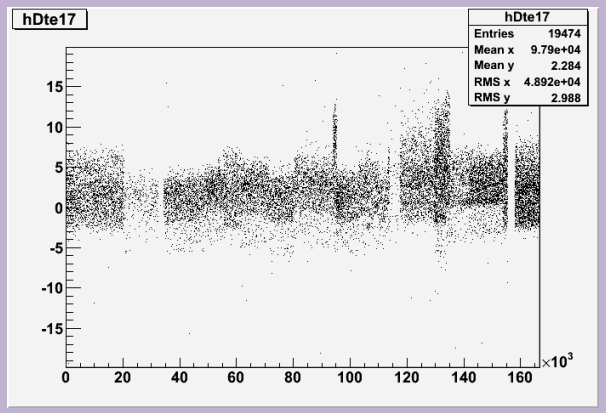


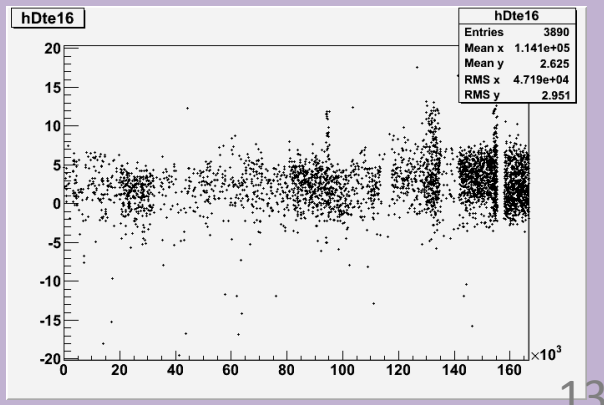




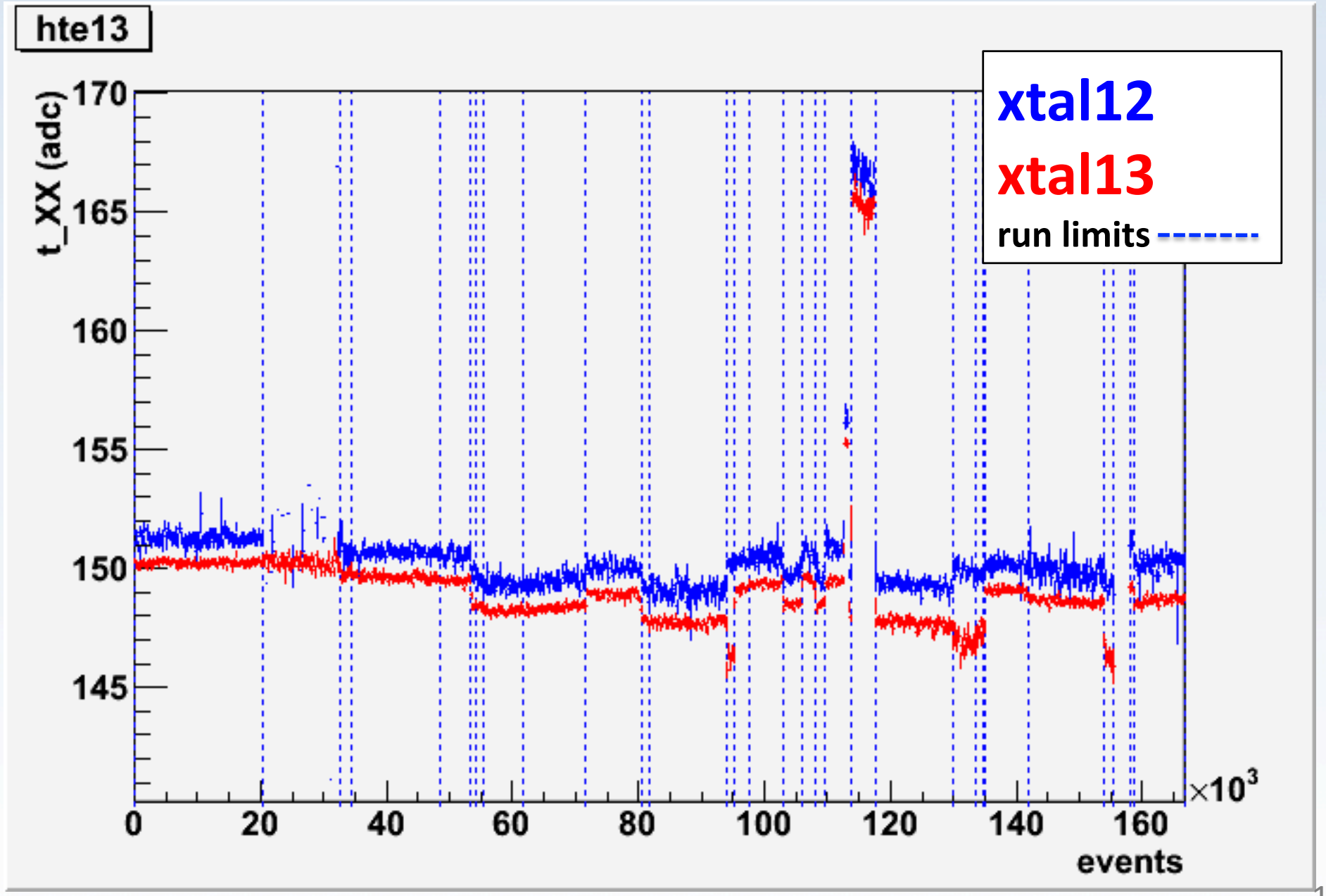




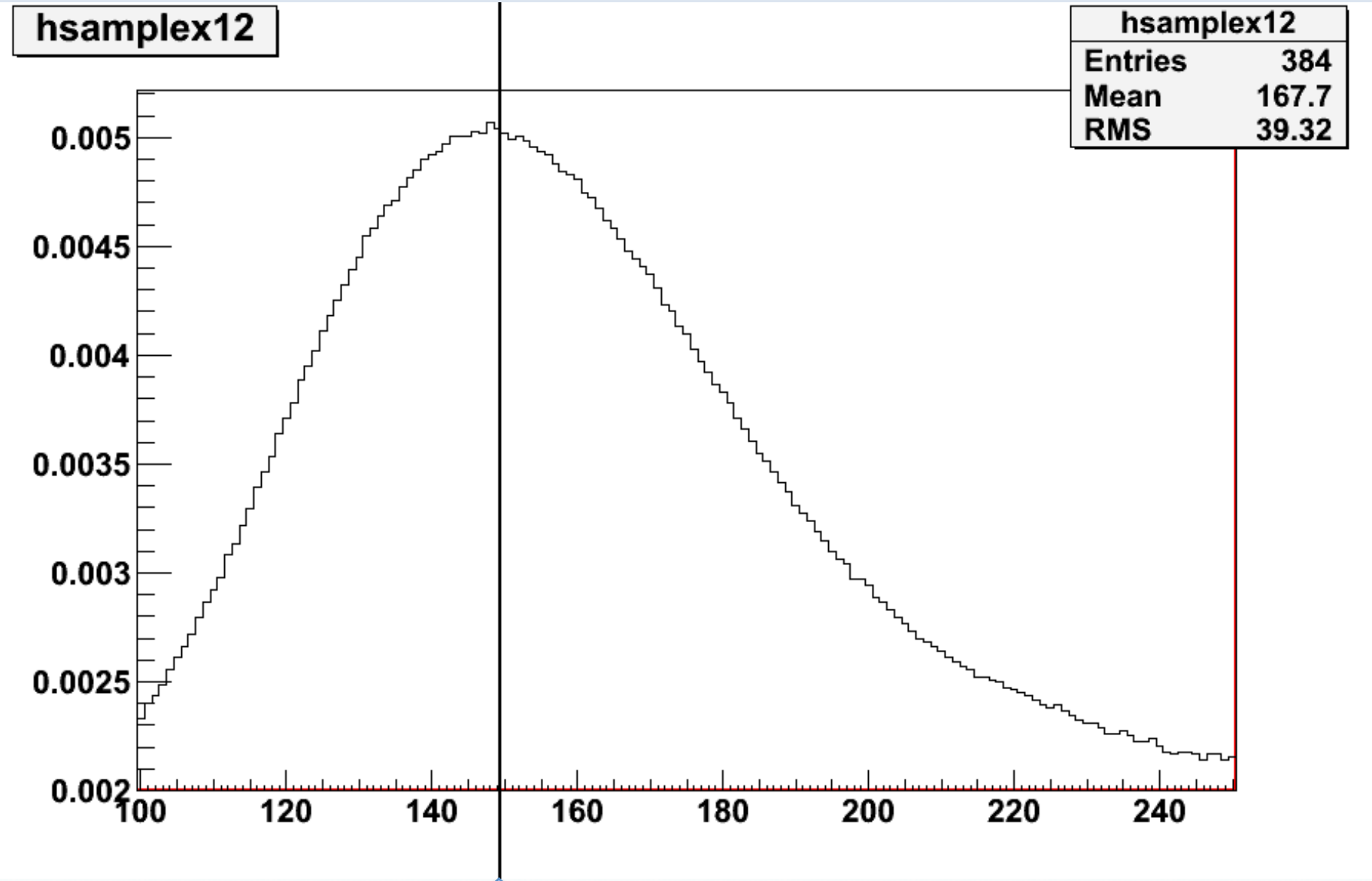




ProfileX (t_XX vs events)



"All runs" 166400 events (step =500)

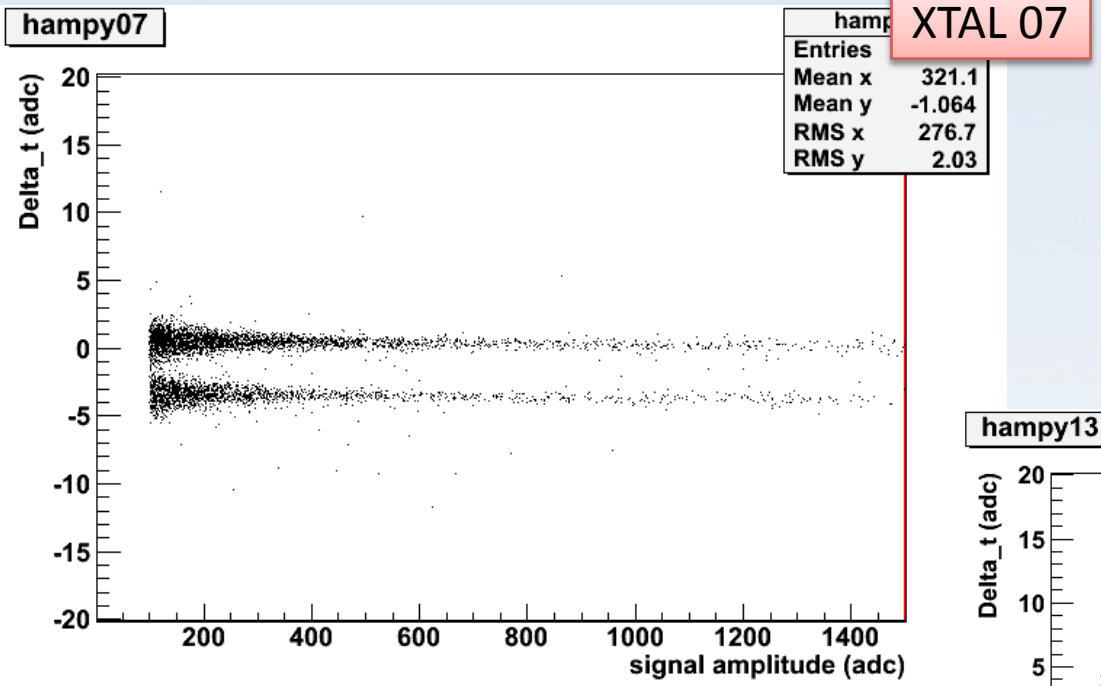


t_{12} from gaussian fit

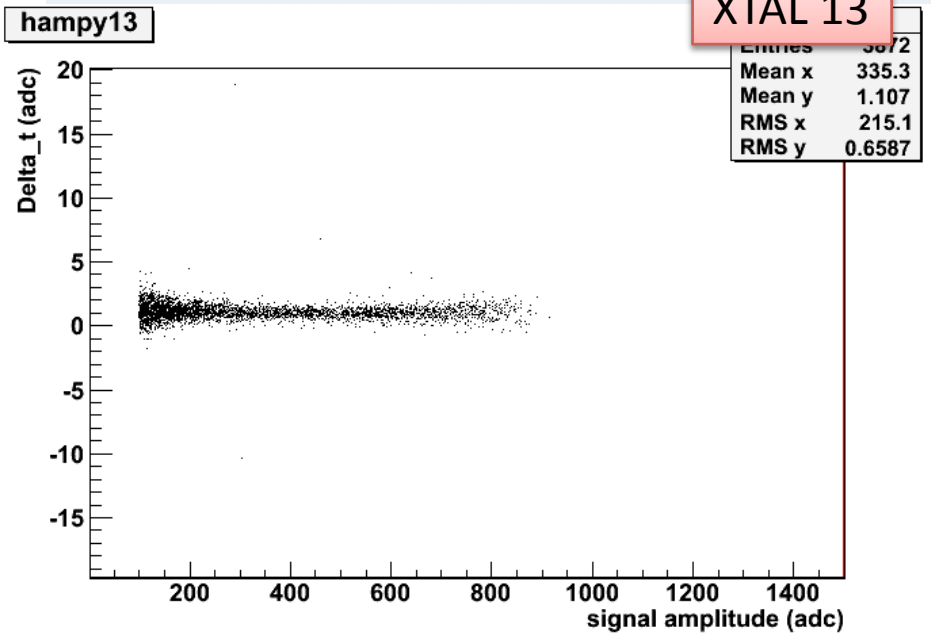
Delta_t vs Amplitude

Testing amplitude dependence from Delta_t

XTAL 07

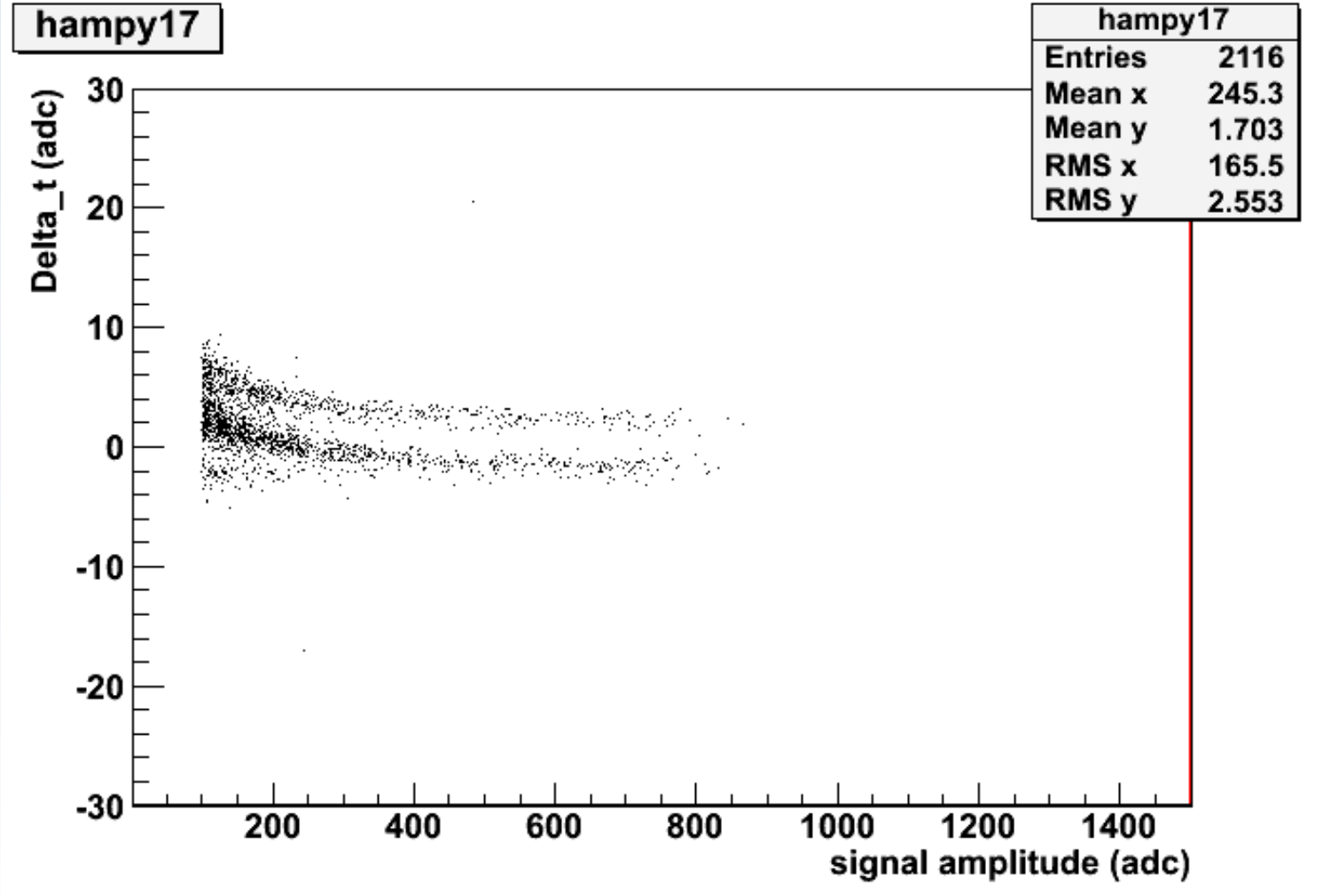


XTAL 13



Delta_t vs Amplitude

Problems with ADC n.2

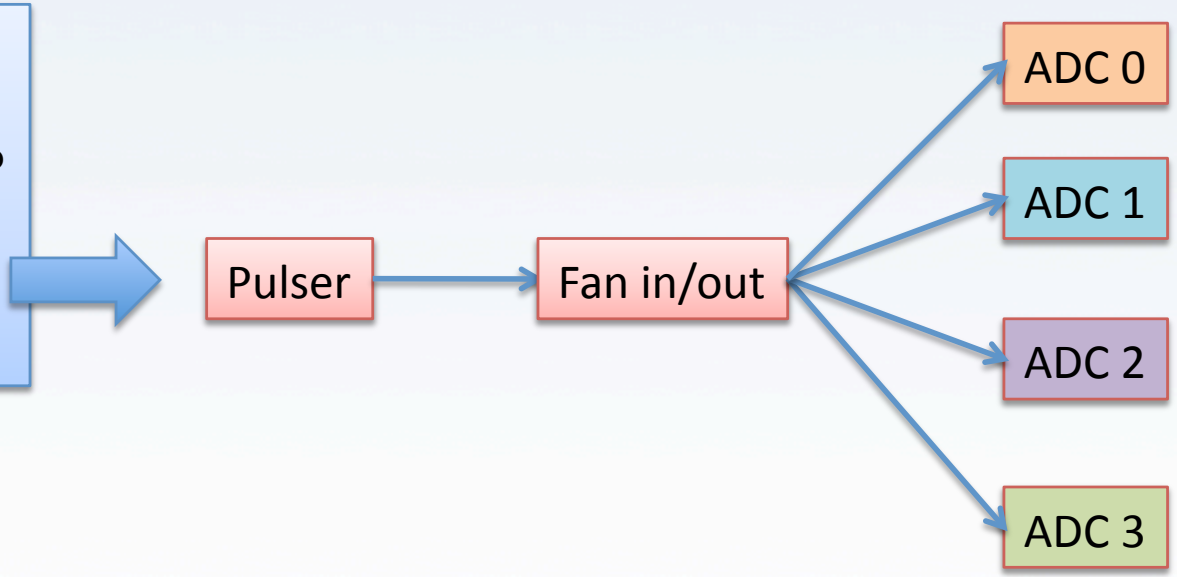


List of problems

- Asynchrony between ADC modules (Jitter-16ns)
- Asynchrony between ADC channels
- Degradation of signal in ADC 2

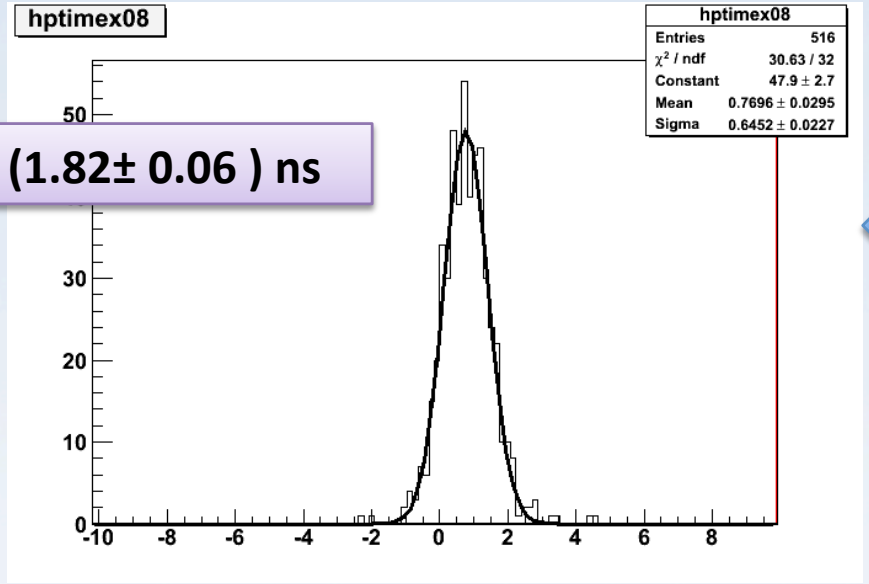
Possible solution (test setup at INFN laboratory, Roma1)

1. **Reproduce problems**
2. **Offline correction algorithm?**
3. **Try to solve with Fan In Out**



Time Resolution

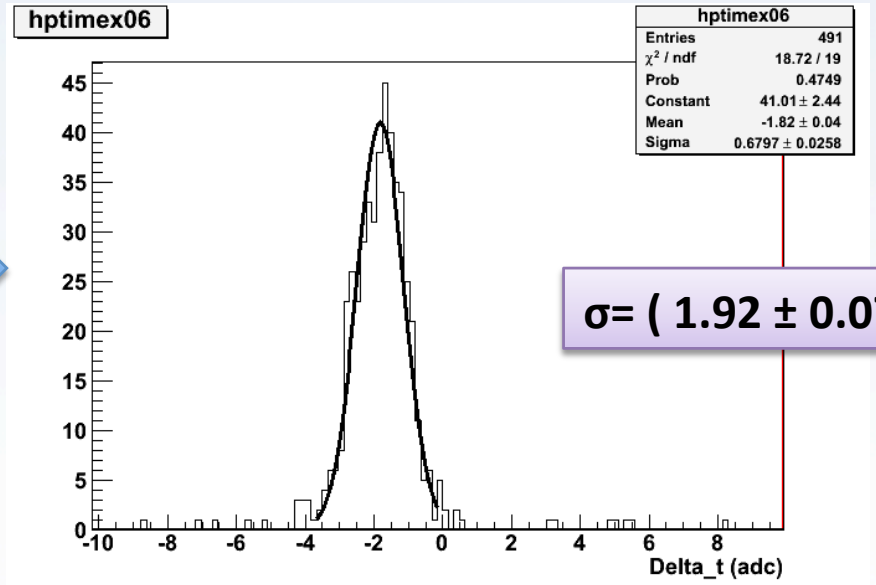
Considering only crystal in the same ADC unit, however it's possible to extimate the time resolution of the system.



σ= (1.82± 0.06) ns

RUN 350 centered on crystal 12
Delta_t = t_{08}-t_{12}

RUN 357 centered on crystal 7
Delta_t = t_{07}-t_{12}



σ= (1.92 ± 0.07) ns

Conclusions

- **Need of an experimental test of the trigger system (fan in/out configuration)**

- **Try to investigate a possible offline solution to synchronize the times**

- **Time Resolution is about 2 ns but it needs to be fixed for the whole system**