

# Feature extraction algorithms for EMC readout

*E. Guliyev, M. Kavatsyuk, P.J.J. Lemmens,  
H. Löhner, T.Poelmann, G. Tambave*

XXIX PANDA Collaboration Meeting  
June 15-19, 2009 @ Turin, Italy

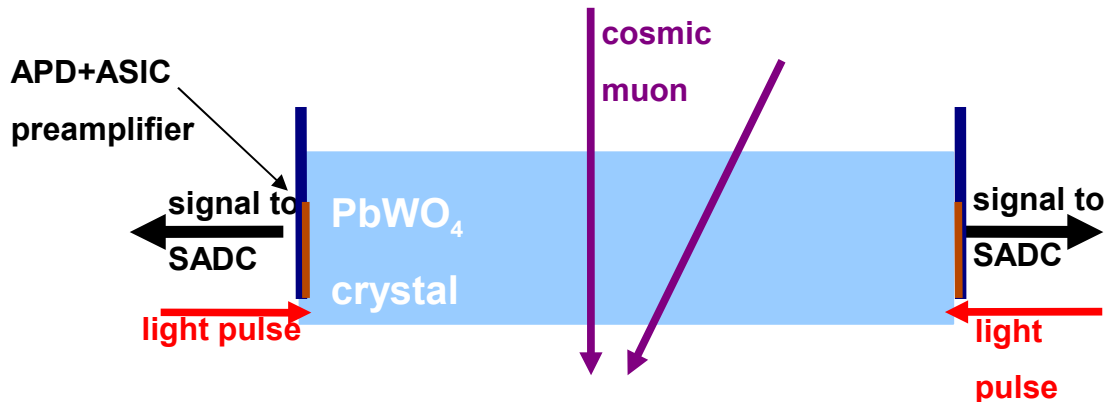
## Outline:

**1. Signal analysis with ASIC preamplifiers**

**2. Noise level estimation**

**3. Signal timing analysis**

# Experimental Setup

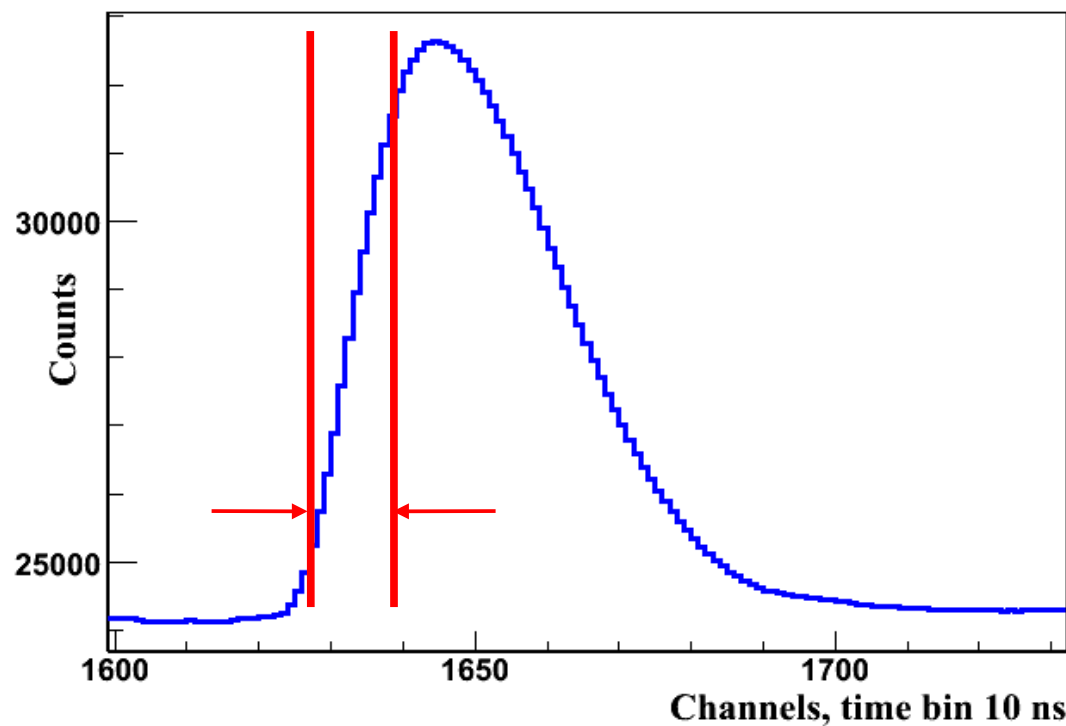


## For measurement used:

20x20x200 mm PbWO<sub>4</sub>

1 cm<sup>2</sup> LAAPD

100 MHz 16 Bit SADC (STRUCK)



ASIC trace

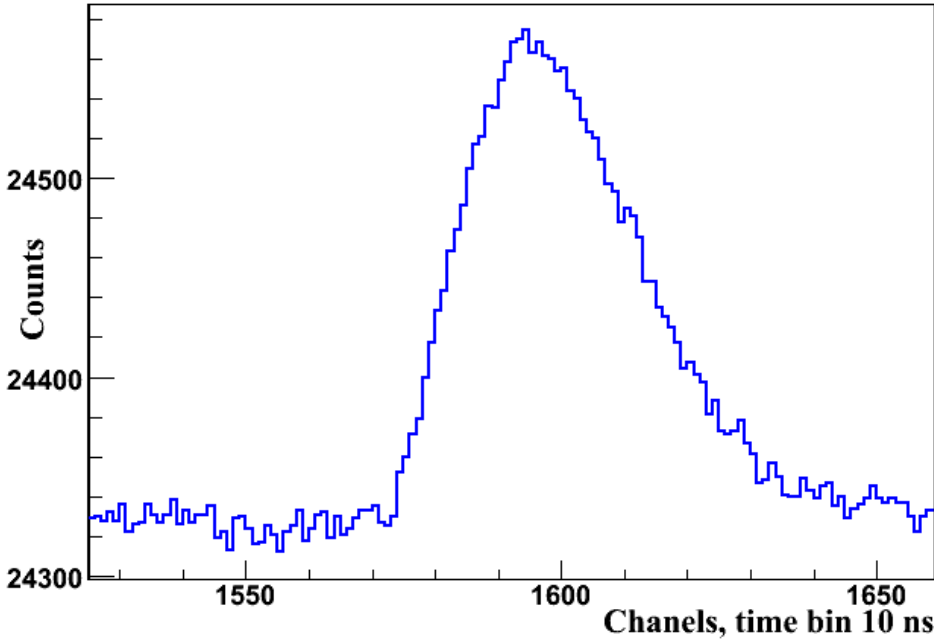
Rise time ~ 15 time bins or  
150 ns

# Experimental Setup

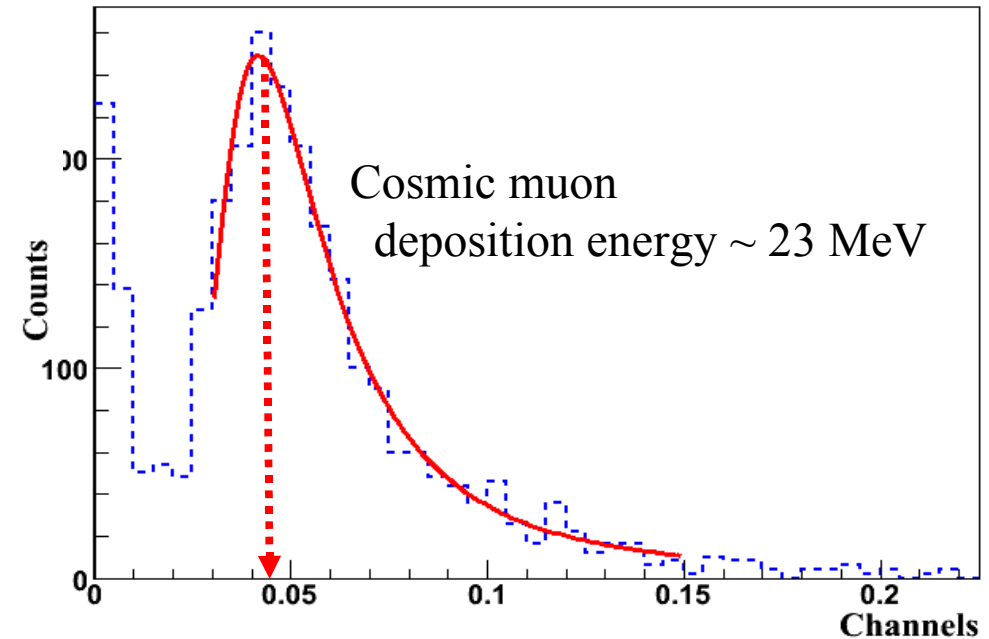
## Cosmic muon used for Calibrations



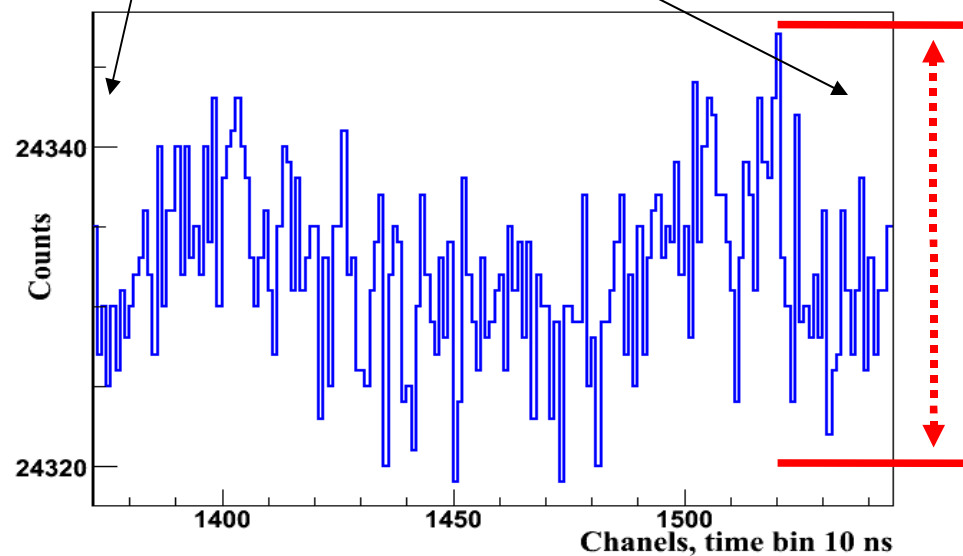
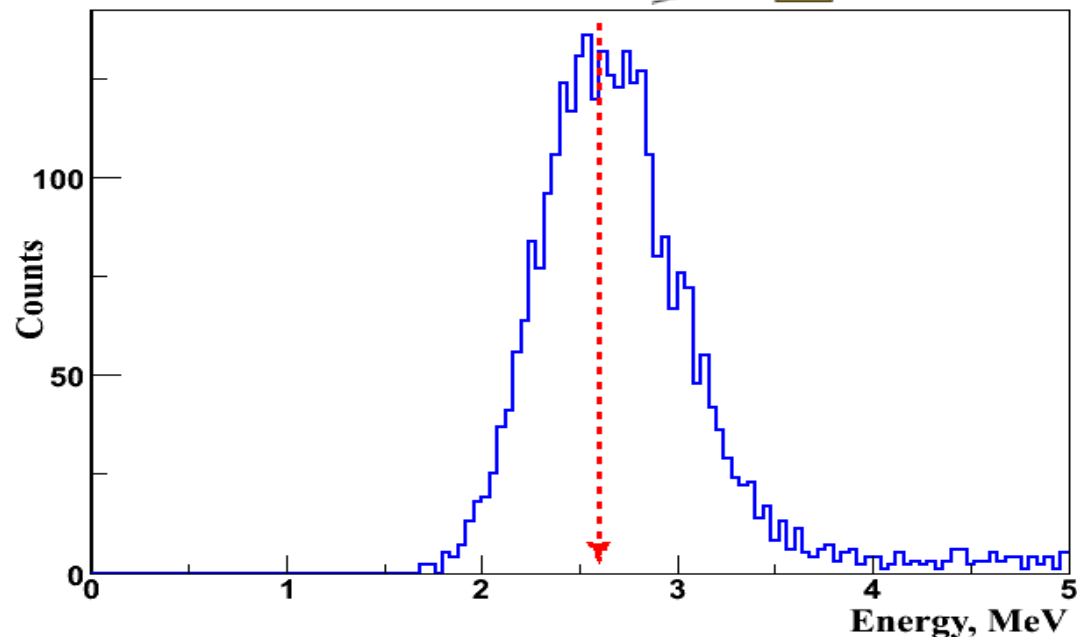
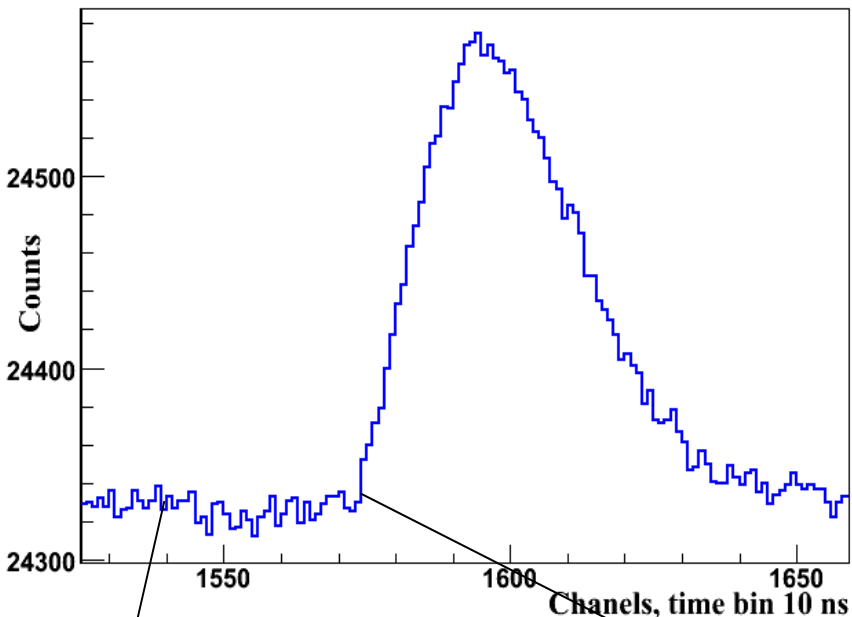
### Signal trace for Cosmic muon measurements



**Signal Rise time ~  
15 time bins  
or 150 ns**

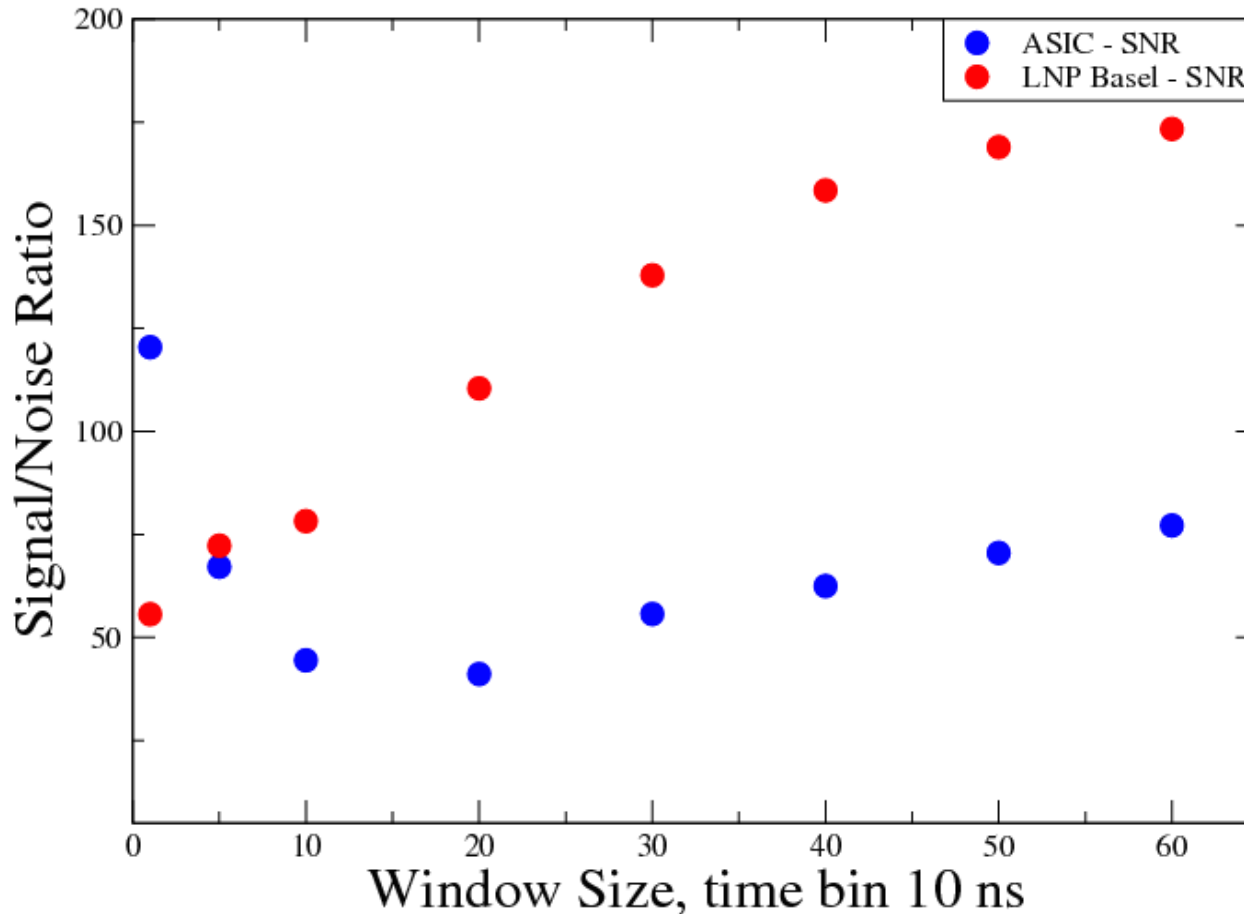


# Noise Level Estimation



**Use Cosmic muon calibration:  
estimated noise level rms~ 2.6 MeV !  
{Offset voltage for ASIC was same  
room temperature}**

# Signal / Noise Analysis for ASIC{APFEL} and LNP Basel preamplifier

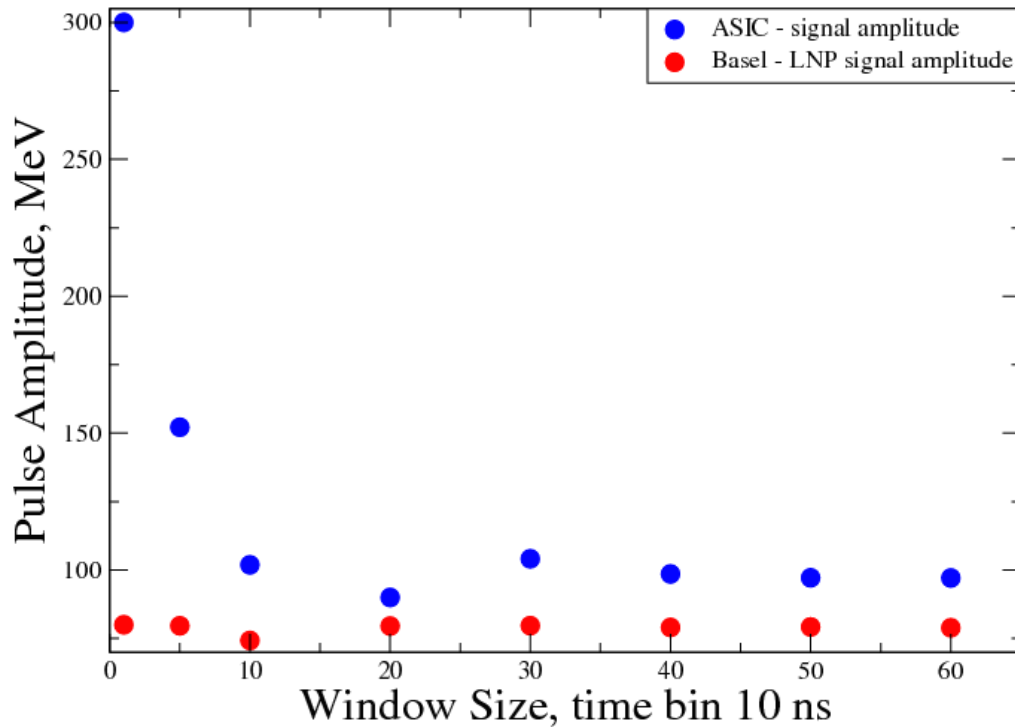


**For filtering the Moving Average method is applied !**

**Both LAAPD Gain x 50**

**Light intensity from LED light pulser kept constant**

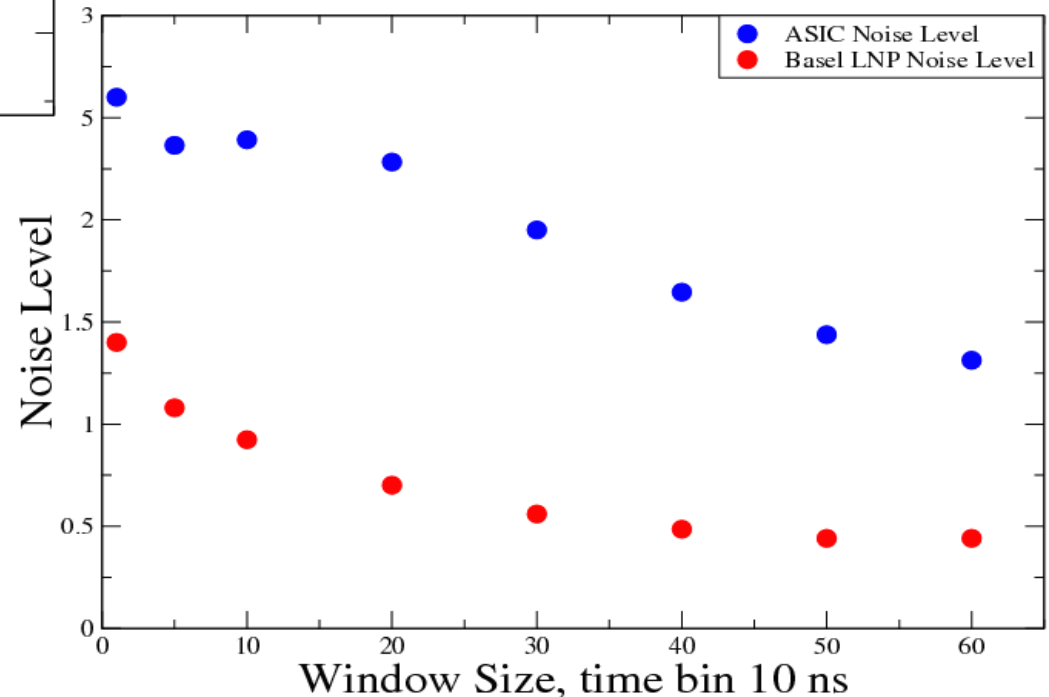
**SNR improves for ASIC window size  $\leq 20$  time bins!**



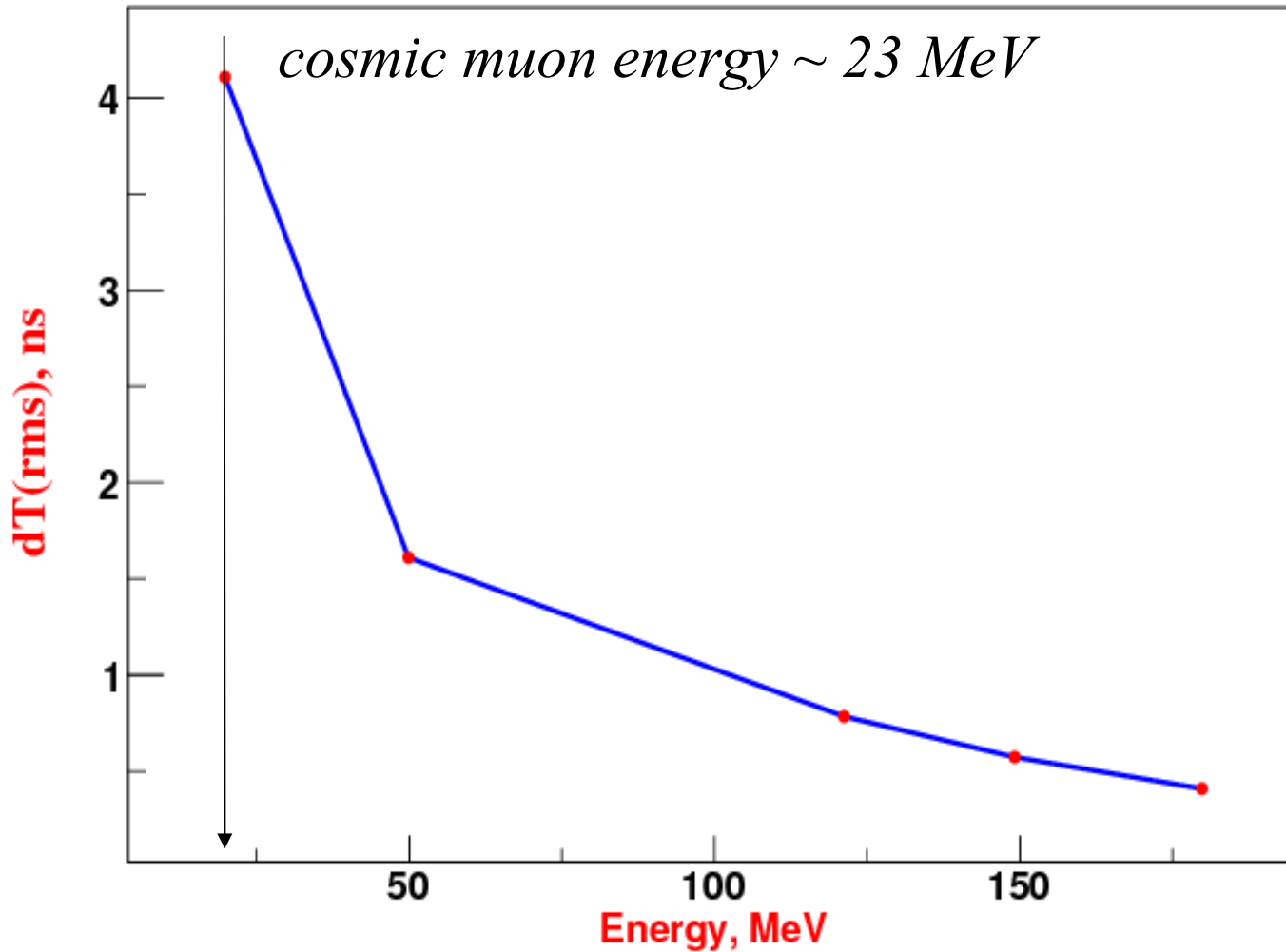
**Amplitude dependence on window size;**  
**ASIC signal amplitude increases at small window size,**  
**LNP amplitude stays constant;**  
**ASIC already strongly shaped!**

**Noise level dependence on window size;**

**LNP noise level decreases faster with increasing window size**



# Timing Analysis for ASIC{APFEL}preamplifier



rms time difference  
between 2 ASIC:

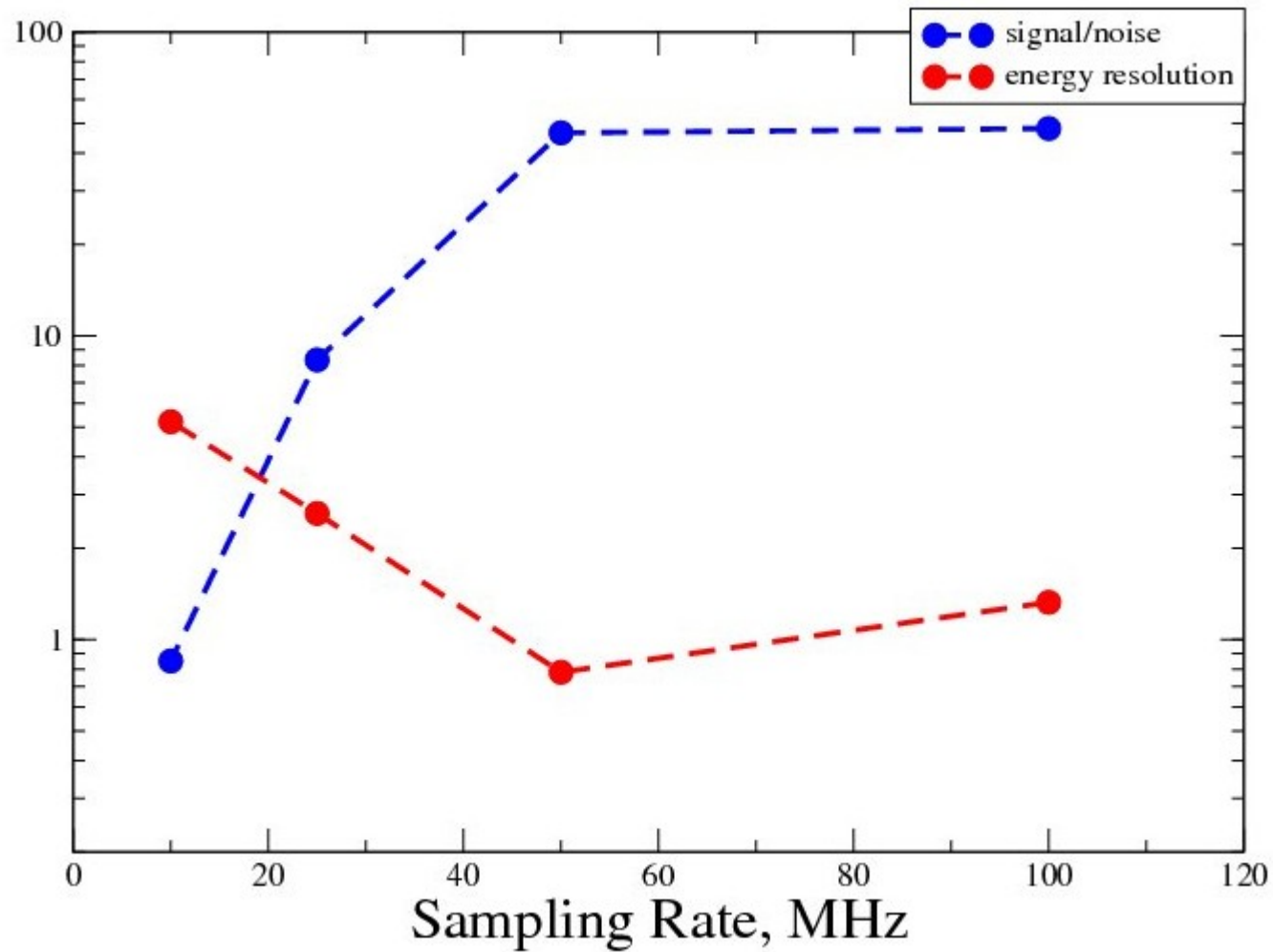
$dT_{\text{rms}} < 1 \text{ ns}$   
@  $E > 100 \text{ MeV}$



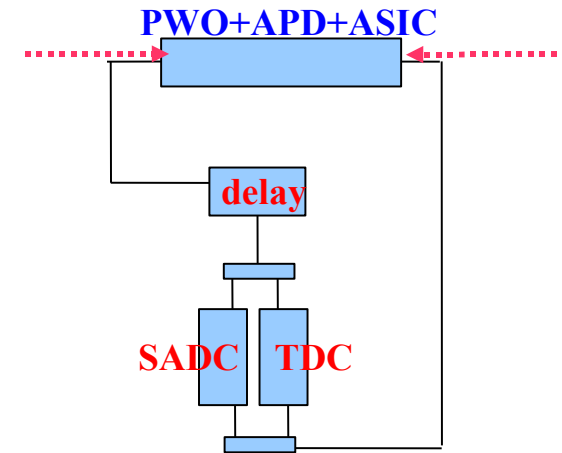
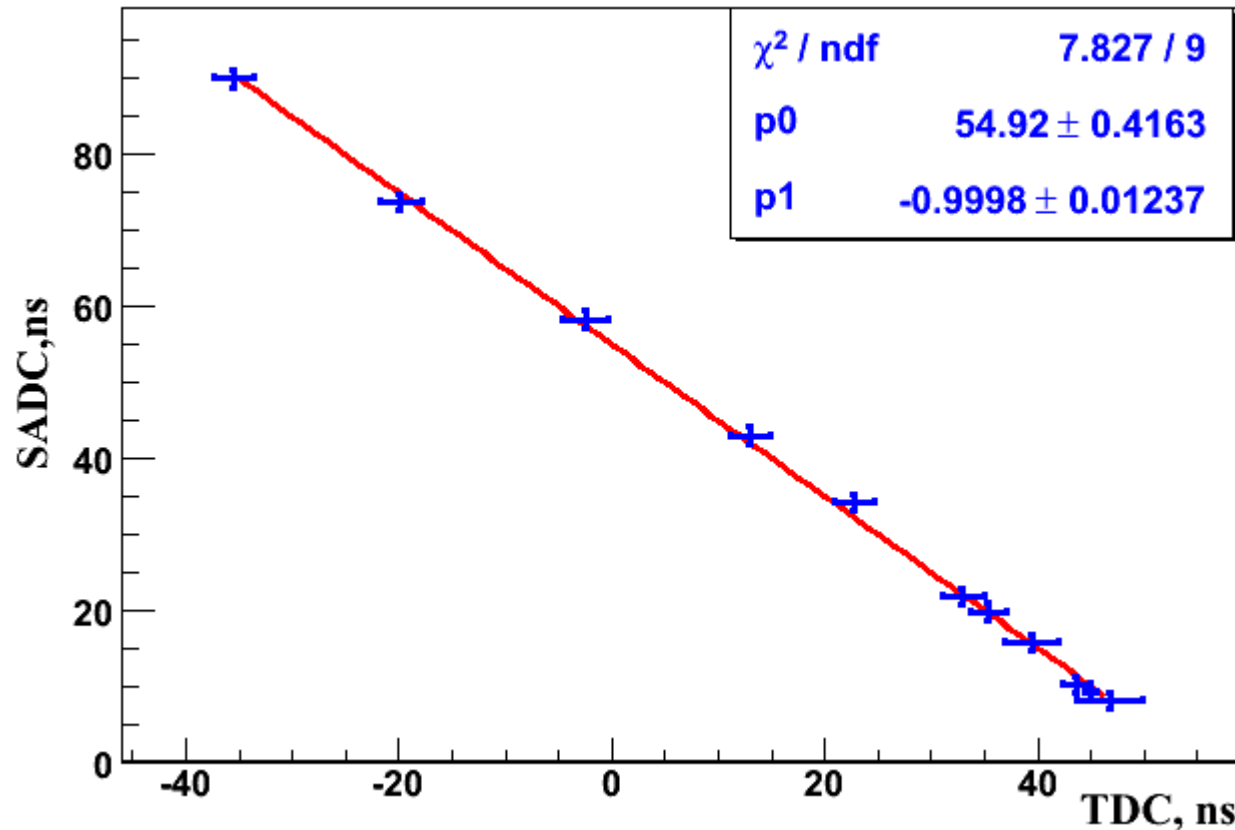
Sampling Rate (MHz)	RMS time difference (time bins)	Time bin (ns)	Time resolution (ns) $dt(rms)/\sqrt{2}$
100	0.117	10	0.82
50	0.0575	20	0.81
25	0.0271	40	0.78

**Time resolution independent of sampling rate 100 , 50 and 25 MHz  
{ ASIC bandwidth 5 MHz}**

# But Energy Resolution depends on sampling rate!



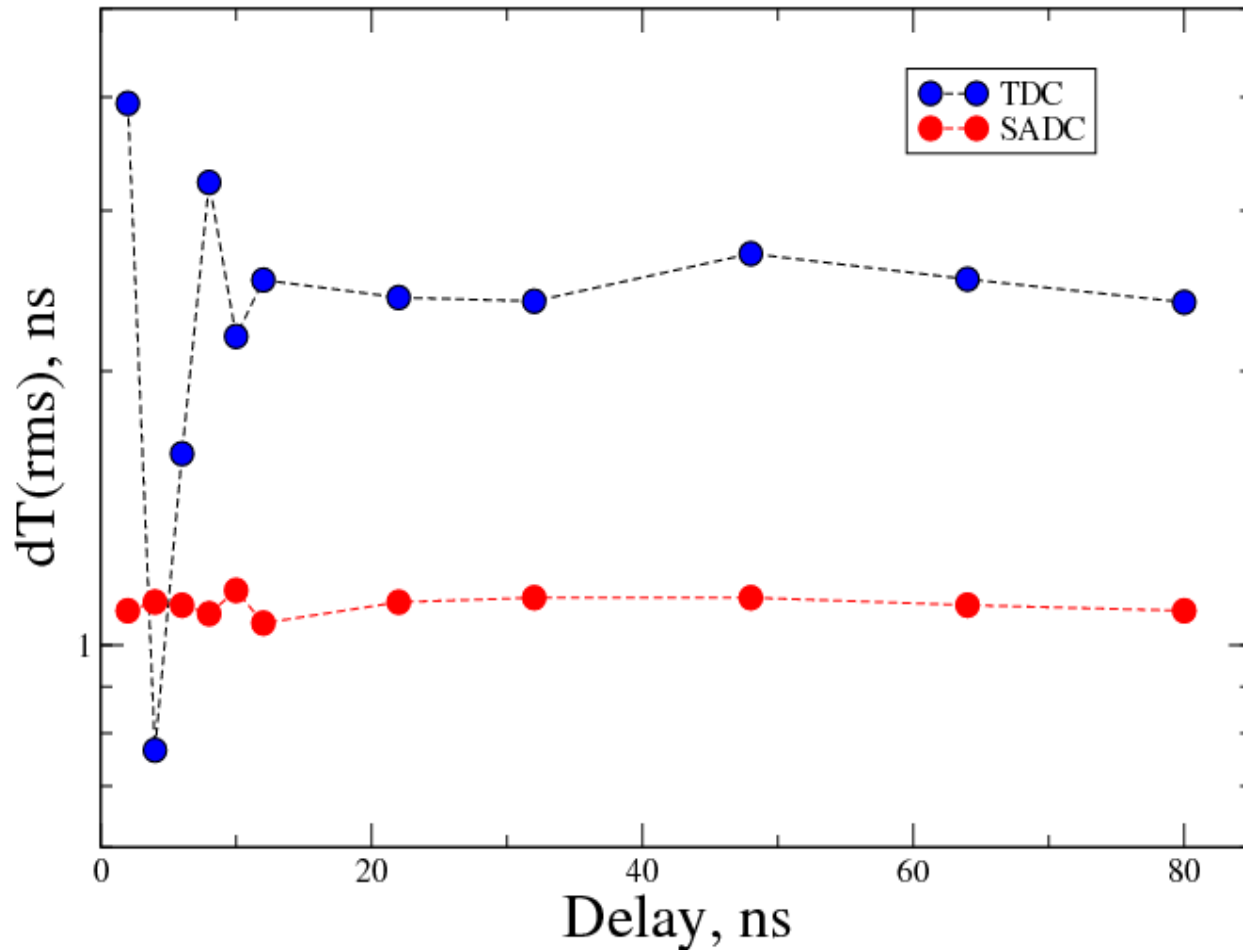
# Timing Analysis for ASIC{APFEL}preamplifier: SADC vs. TDC



**Time stamp obtained from time difference for 2 LAAPD  
@ 100 MHz SADC  
@ TDC  
with different delay**

**Linear dependence confirms correct SADC timing measurement!**

# Timing Analysis for ASIC{APFEL}preamplifier: SADC vs. TDC



**rms time difference  
between 2 ASIC:**

**$dT(\text{rms})$  results for SADC  
better than for TDC!**

## **Conclusion:**

- 1. SADC signal analysis using LED light pulser and Cosmic muons for ASIC preamplifier.**
- 2. ASIC and LNP Basel preamplifier signal and noise ratio investigated for different MA window sizes.  
LNP Basel performs better than ASIC at large window sizes.**
- 3. Timing analysis done with different sampling rate for ASIC:  
No dependence.**
- 4. Time stamping and resolution compared to TDC results:  
Confirms correct timing analysis.**