



R&D activities in Perugia

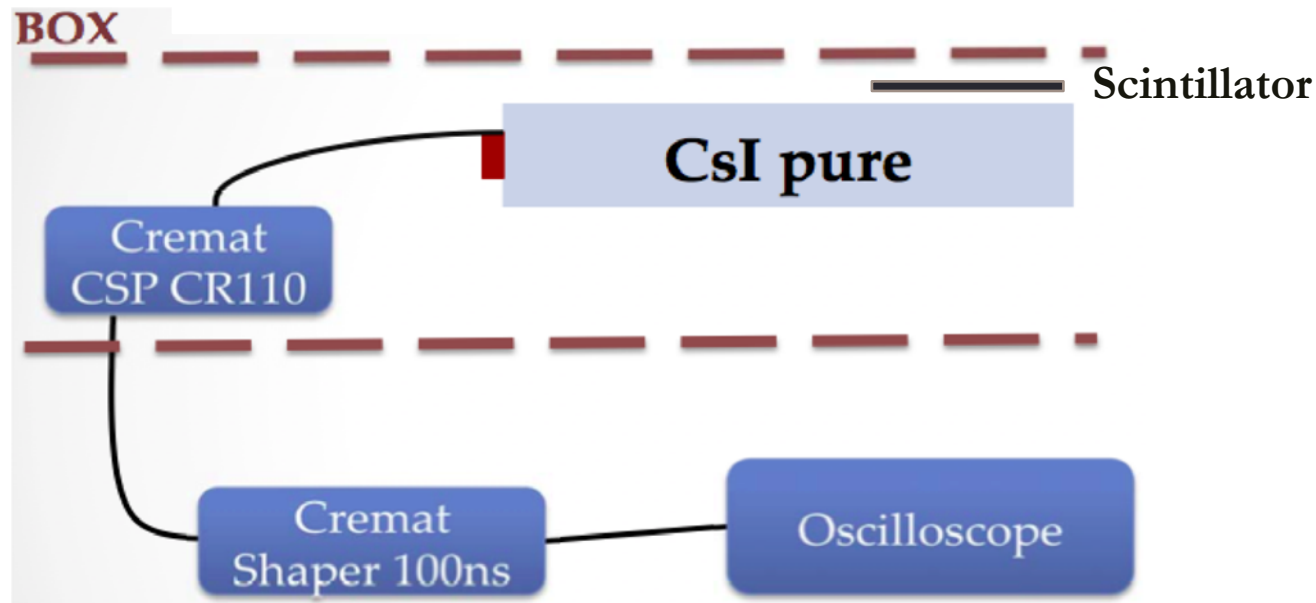
Elisa for the Perugia's group

ECL-IT meeting, LNF
Dec 18th, 2013



ADVANCED PHOTONIX APD

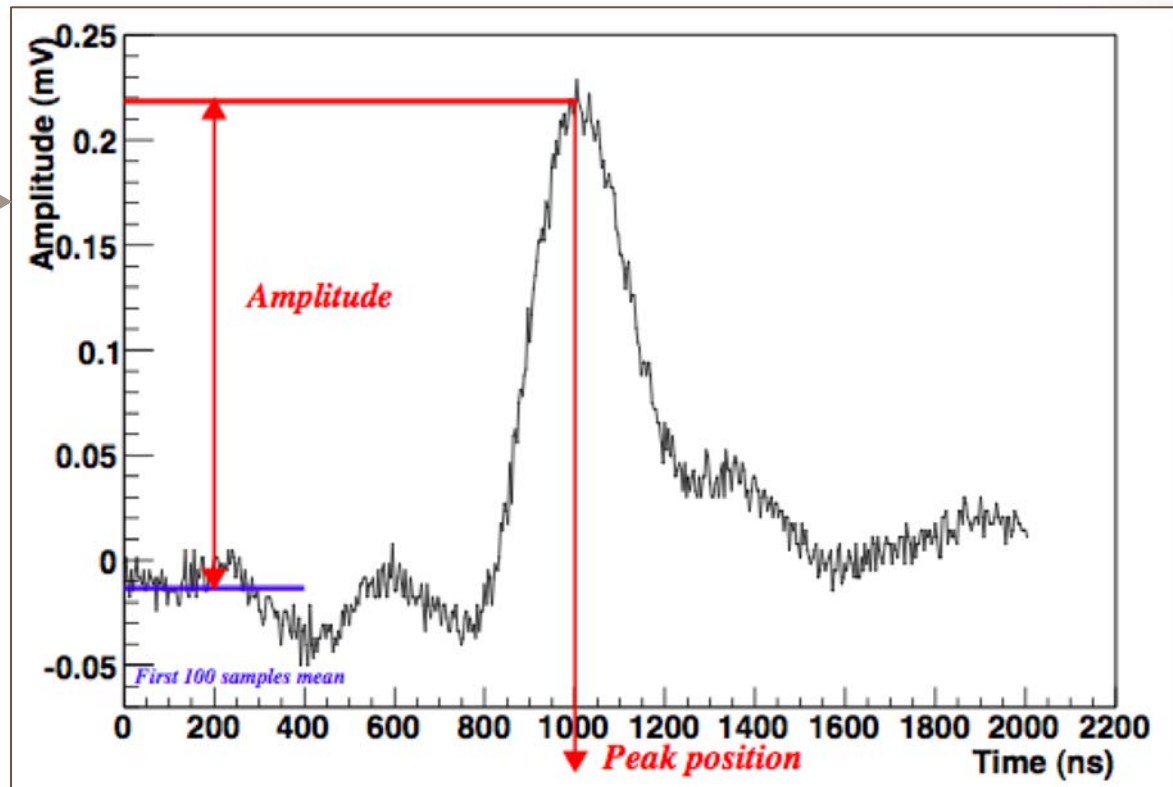
Experimental Set-up



- APD UV (989-05-01) attached to CsI xtal with a mechanical structure (no glue, no resin)
 - estimated light loss due to air gap between xtal and APD $\sim 20\%$
- APD $V_{\text{bias}} \sim 1860 \text{ V}$, gain ~ 250
- Cremat CSP CR-110: 1.4 V/pC
- Cremat shaper: shaping time 100 ns
- trigger: scintillator ($7 \times 7 \text{ cm}^2$) + xtal coincidence

Data acquisition

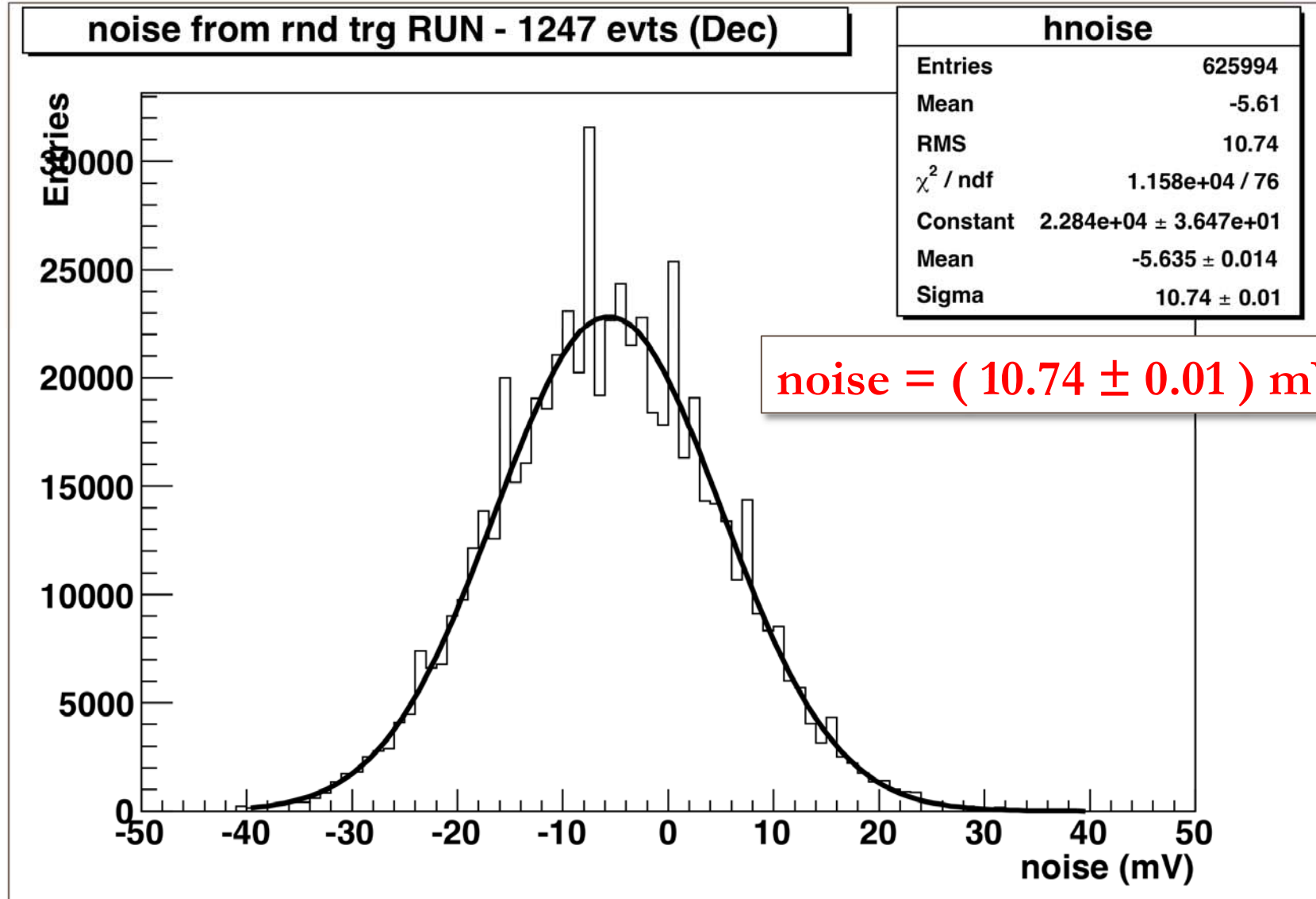
- Waveform sampled @ 250 MS/s
- 500 samples (2000ns)
- Cosmic run:
 - First 100 samples used to evaluate the baseline
 - Signal amplitude = Max value in the full range - baseline



- Random trigger run:
 - Distribution of signal amplitude using all samplings
 - Noise = RMS from gaussian fit

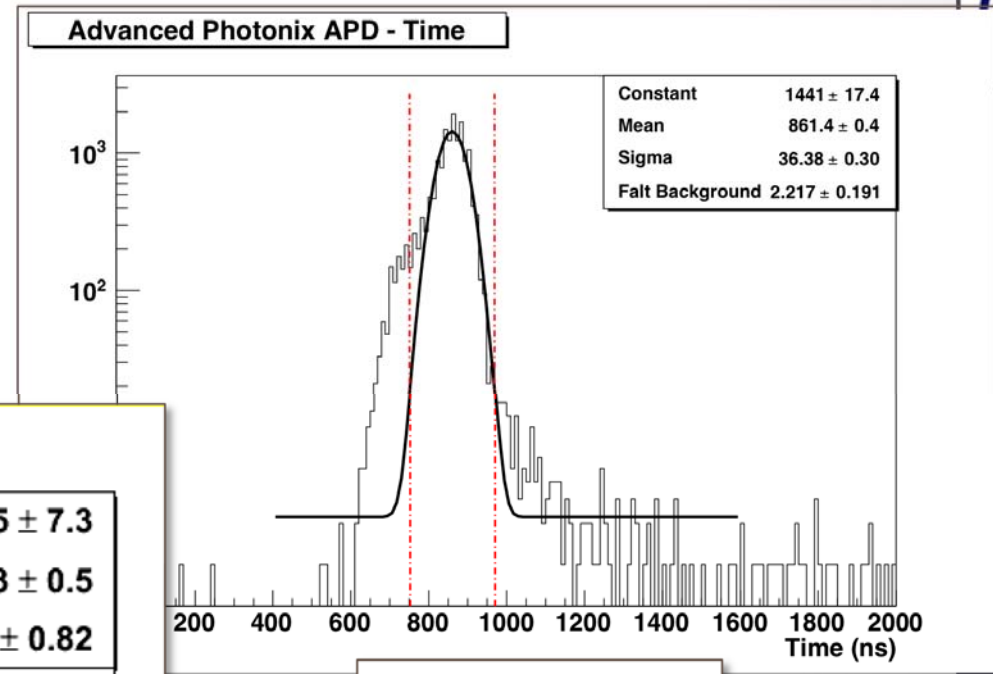
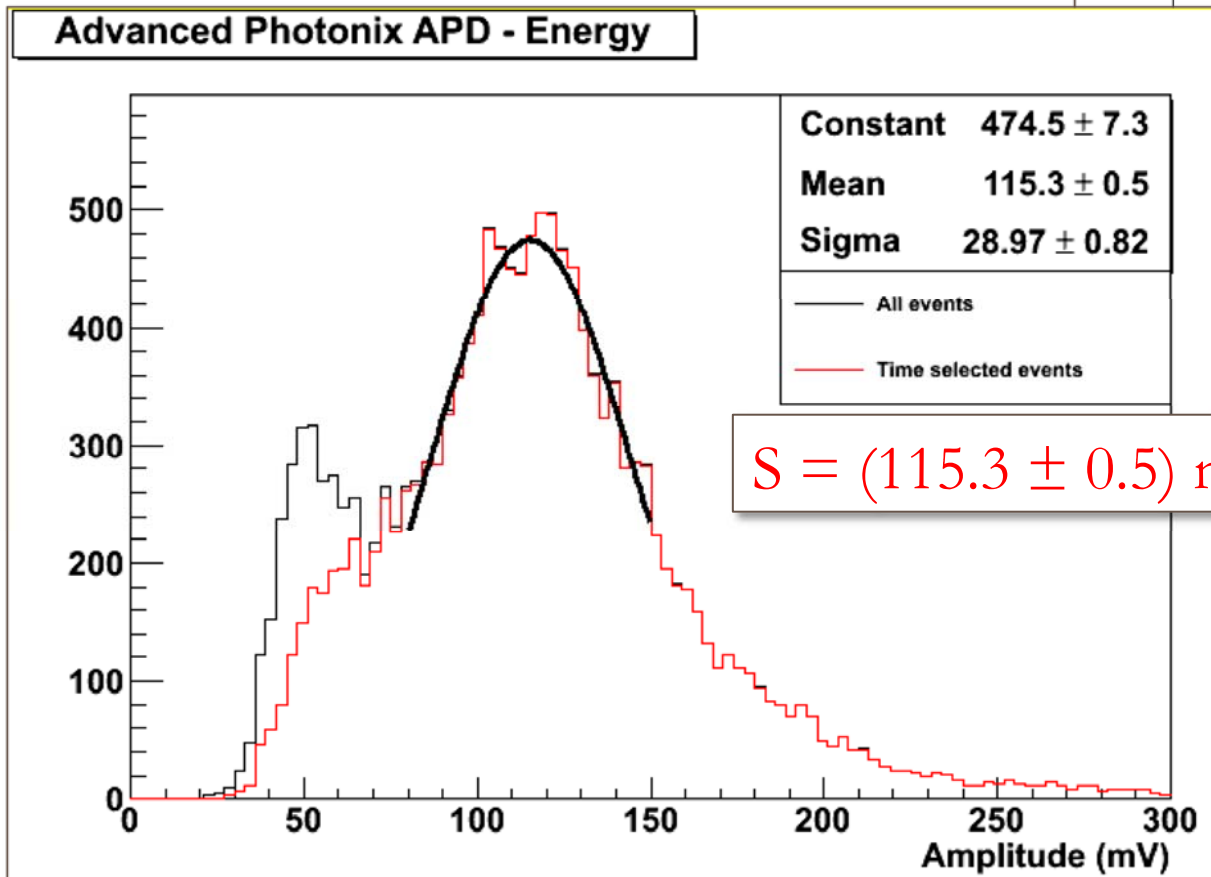
Noise

- From run with random trigger



Time resolution and signal amplitude

- From cosmic run
- Selection: $t(\text{peak}) \in [t - 3\sigma, t + 3\sigma]$



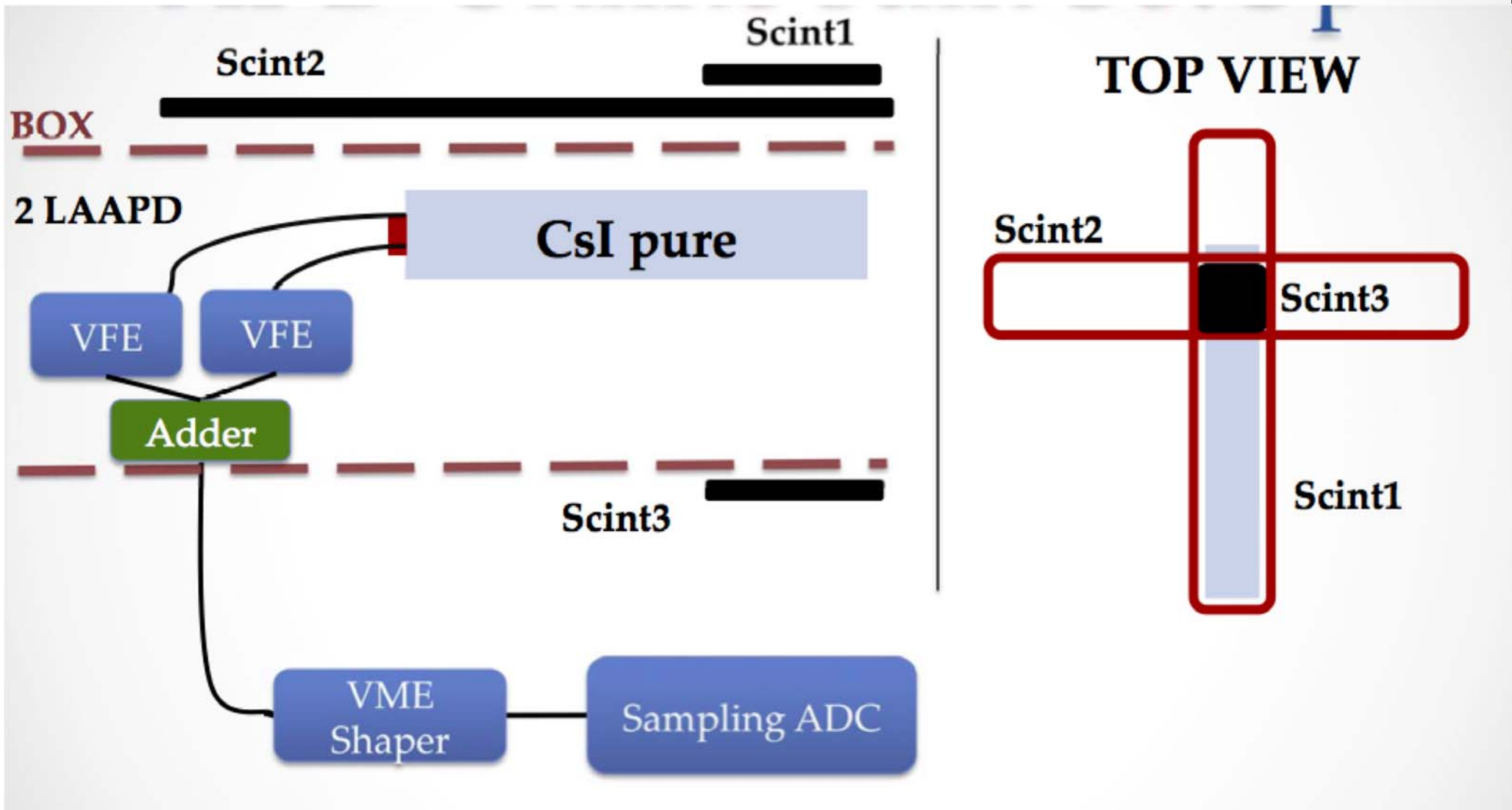
$$\sigma(t)/t = 4\%$$
$$(\sigma(t) = 36\text{ns})$$

Equivalent noise calculation

- Noise from random trigger run: 10.7 mV
- Signal: 115.3 mV
- $S/N = 10.8$
- Mean cosmic deposition: 30 MeV
- **Equivalent noise: 2.8 MeV**
- (accounting for 25% light loss: Eq. Noise \sim 2.2 MeV)

HAMAMATSU LAAPD

Lab measurements: Set up



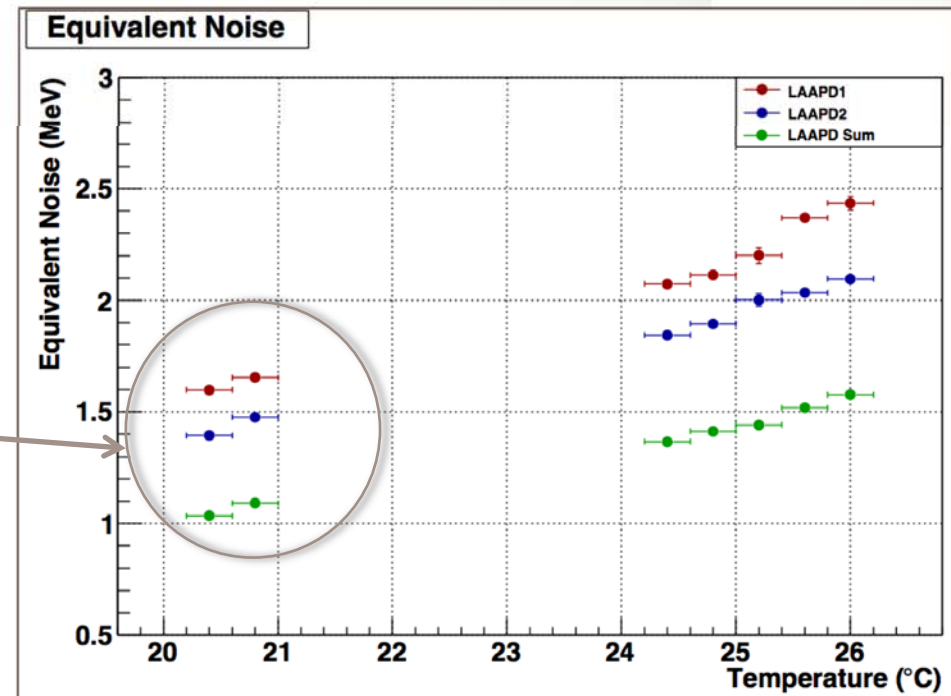
- APD $V_{\text{bias}} \sim 400 \text{ V}$, gain $\sim 160-190$ (depending on the LAAPD)

Lab measurements: Data acquisition, analysis and results

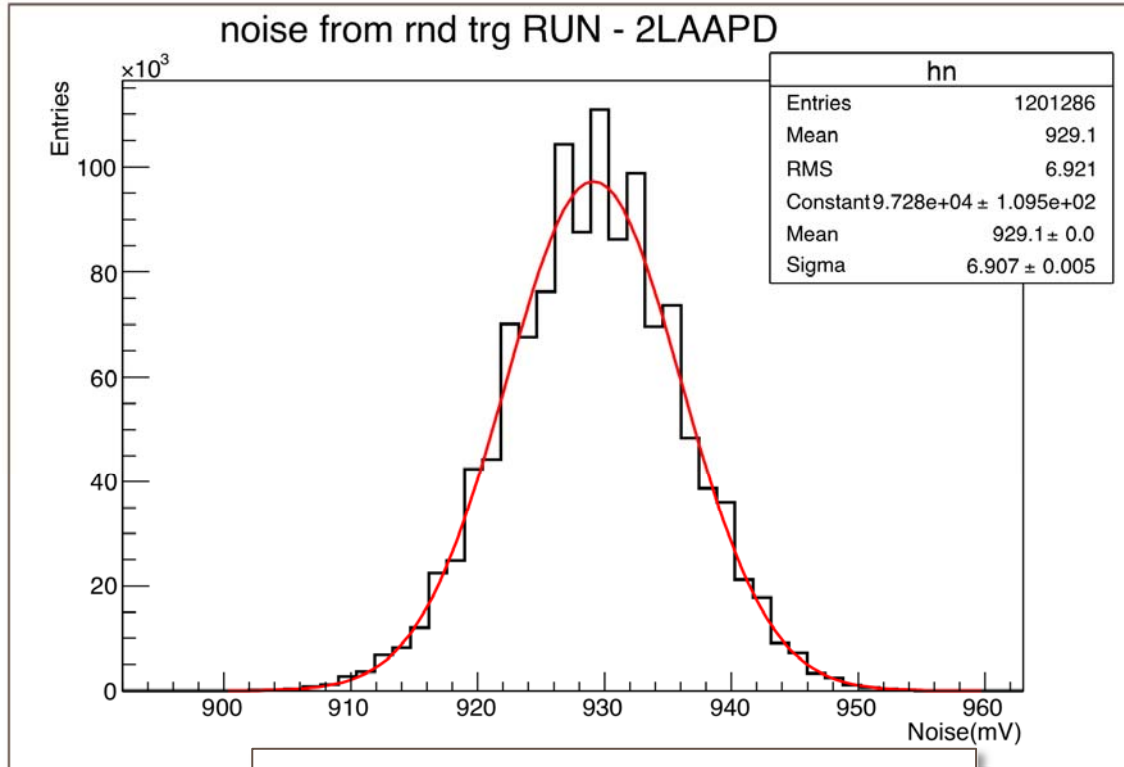
- Waveform sampled @ 250MS/s
- 384 samples (~1500ns)
- First 60 samples used to evaluate baseline
- Amplitude equal to the difference between the baseline and the maximum value in all range

- Peak position is used to compute the time resolution
- A selection on the peak position is also applied (3σ cut around mean position)

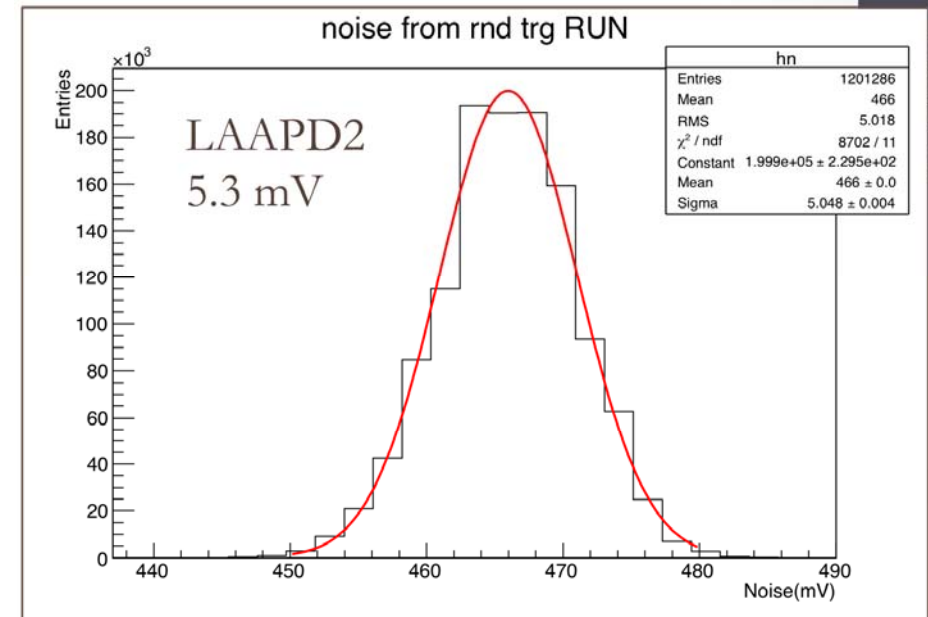
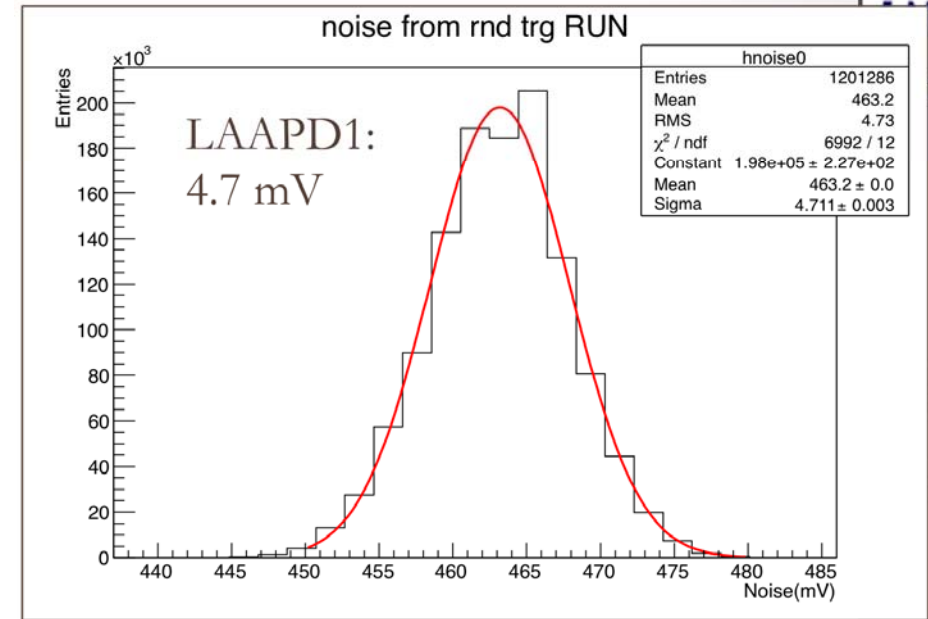
BTF temperature $\sim [20^{\circ}\text{C}, 22^{\circ}\text{C}]$



TB data : noise

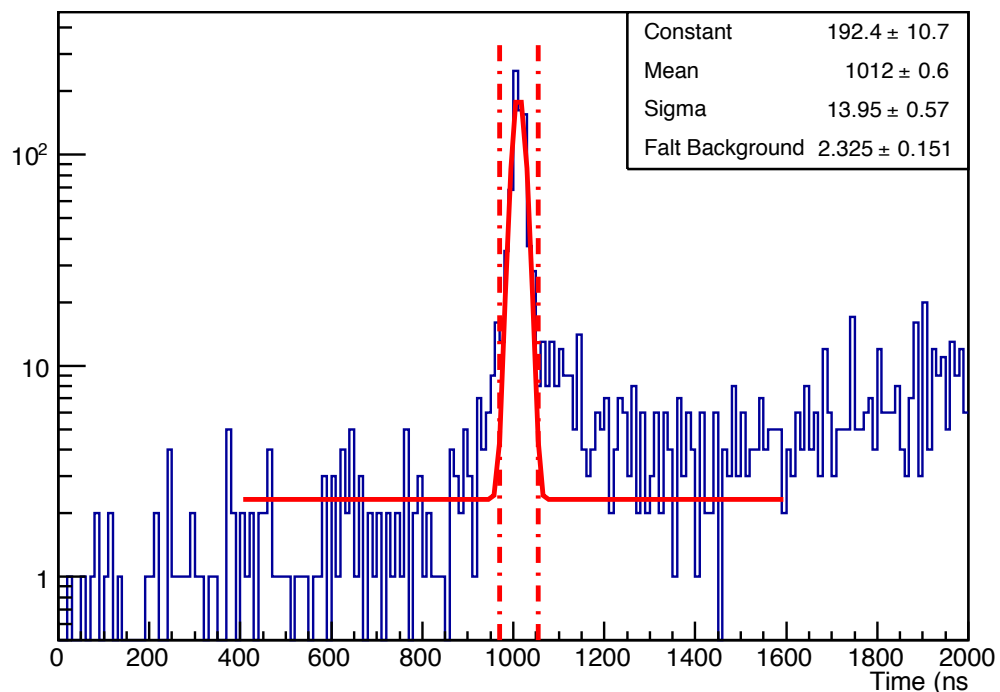


**LAAPD1+LAAPD2 TOT
noise : (6.907 ± 0.005) mV**

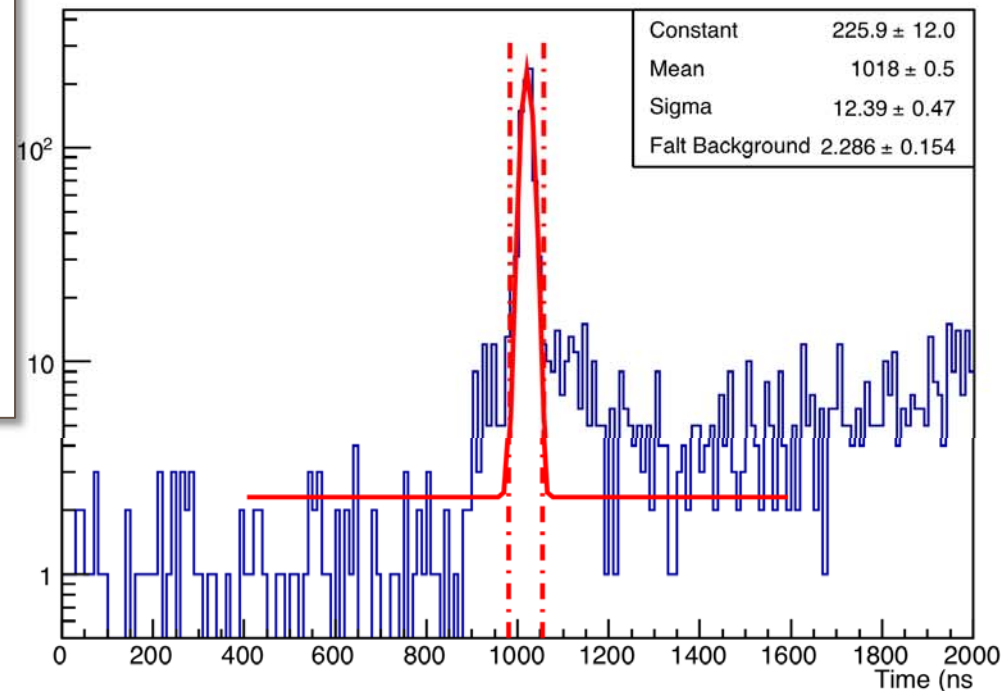


TB data: 99 MeV, time resolution

LAAPD1 - Time



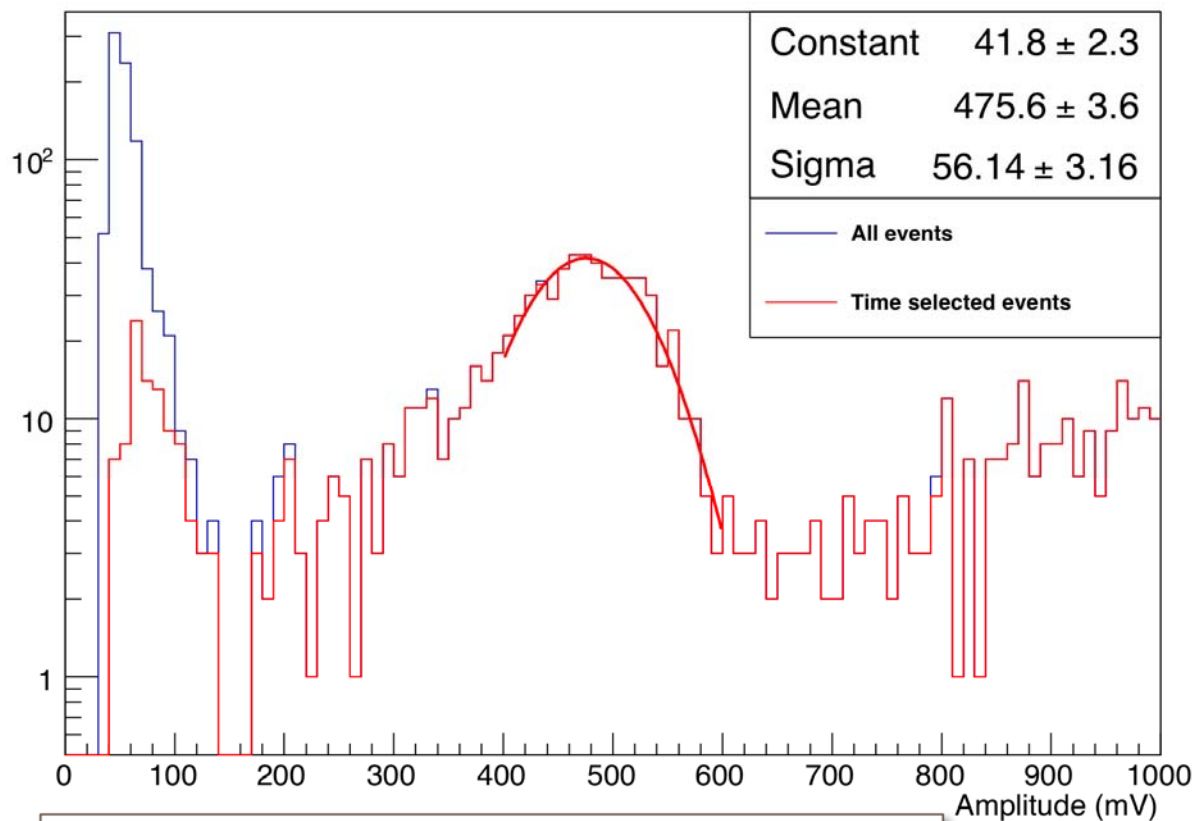
LAAPD2 - Time



time resolution: 13.9 ns (LAAPD1), 12.4 (LAAPD2)

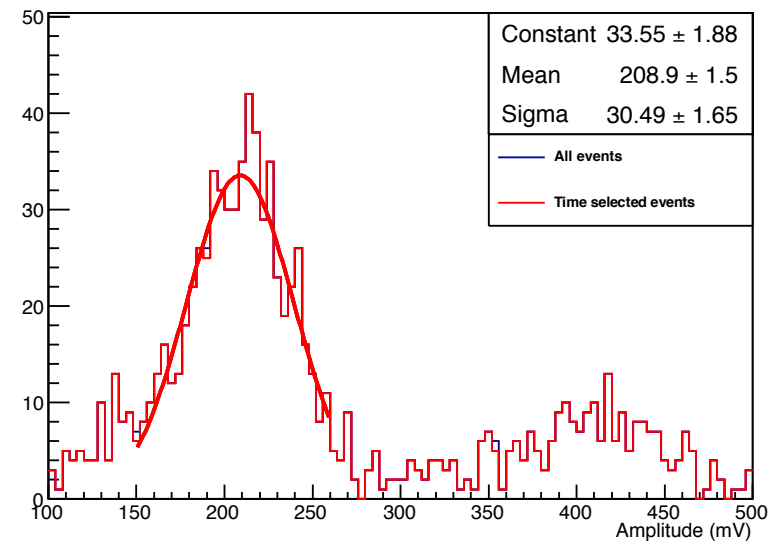
TB data: 99 MeV, signal amplitude

LAAPD Sum - Energy

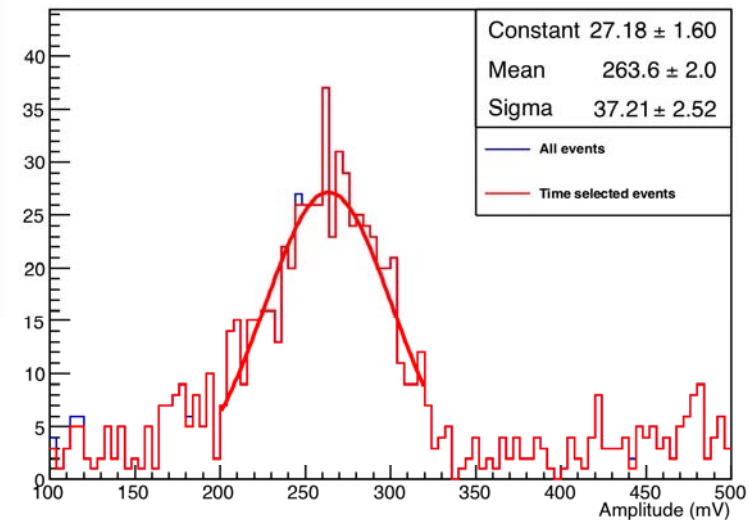


**LAAPD1+LAAPD2 TOT
signal amplitude : (475 ± 4) mV**

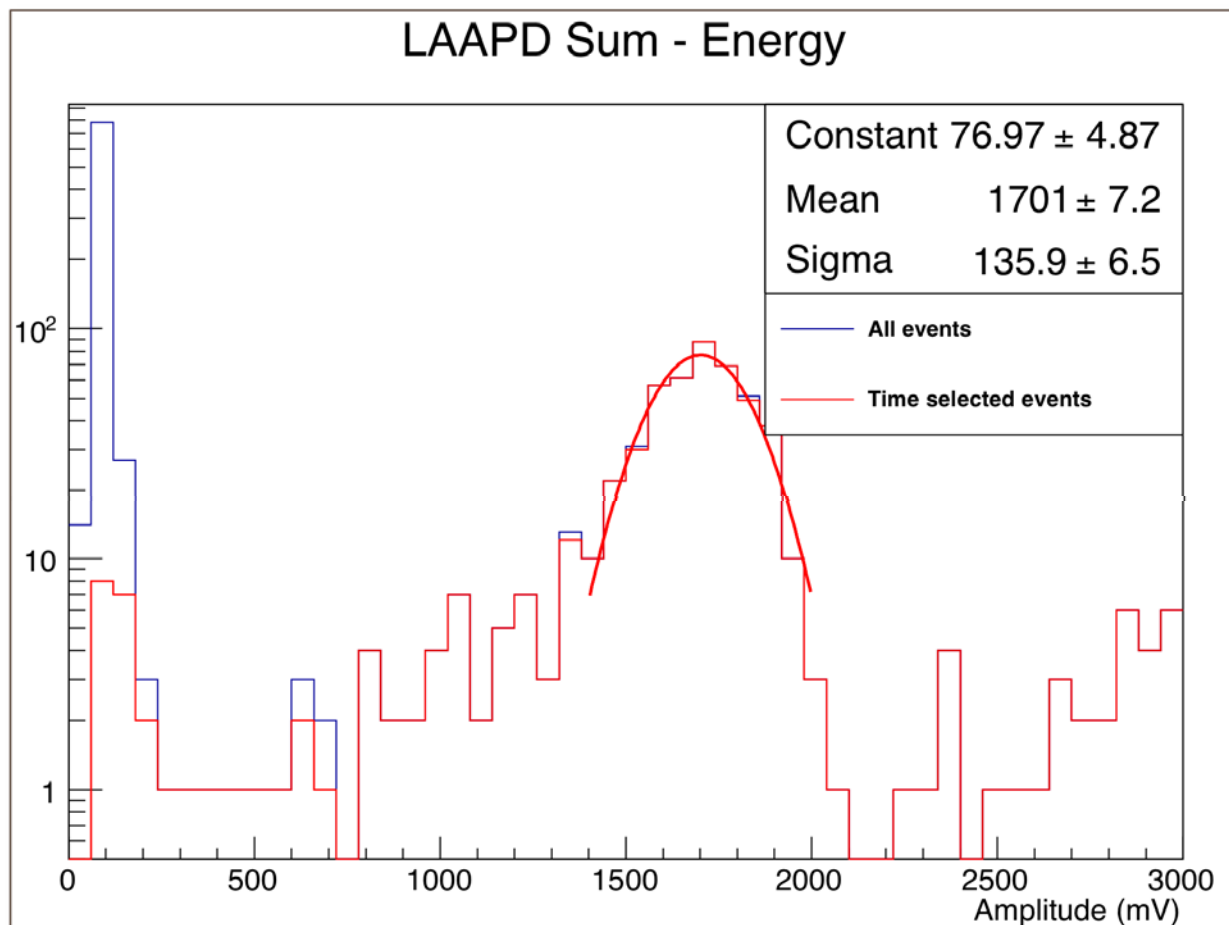
LAAPD1 - Energy



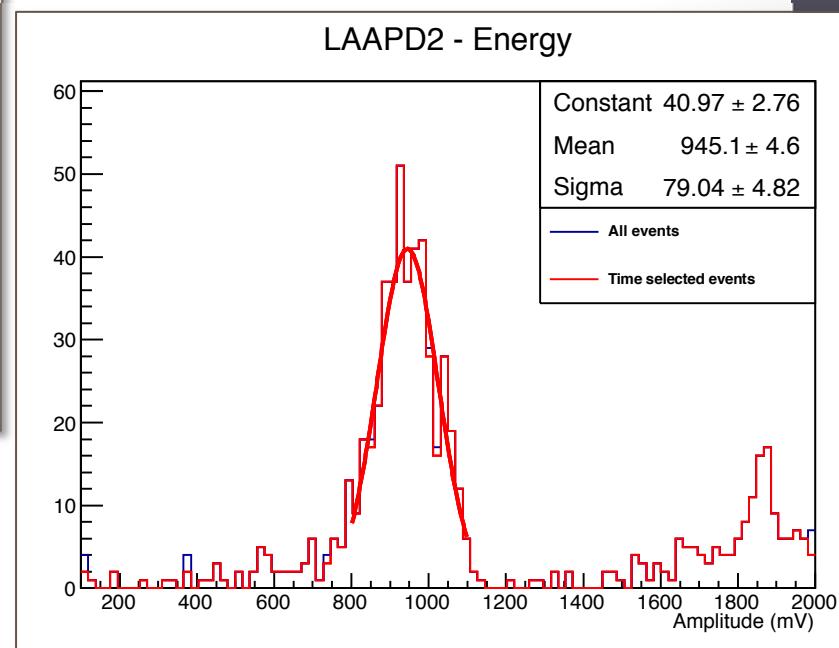
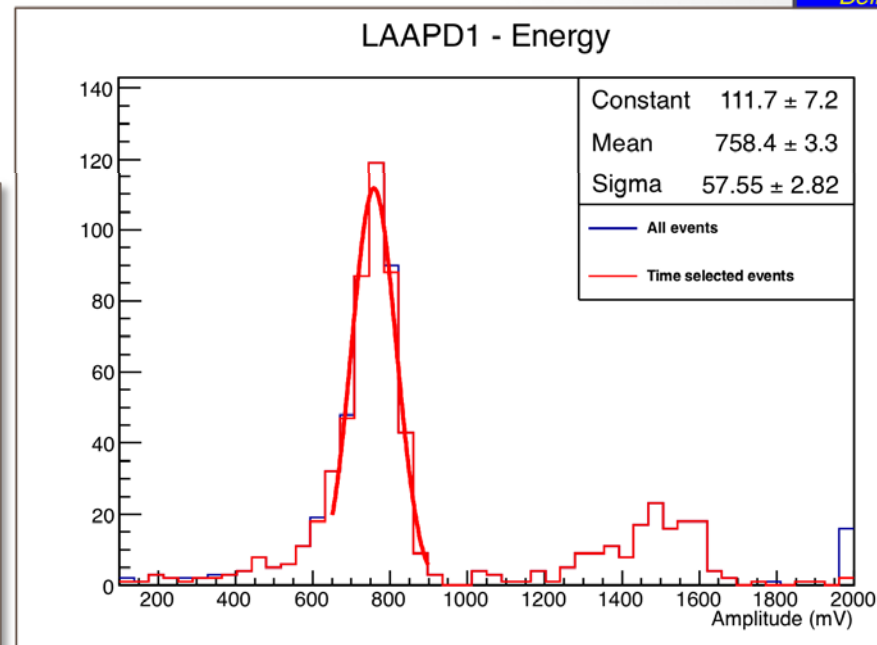
LAAPD2 - Energy



TB data: 397 MeV, signal amplitude



**LAAPD1+LAAPD2 TOT
signal amplitude : (1701 ± 7) mV**



TB data: Equivalent Noise calculation

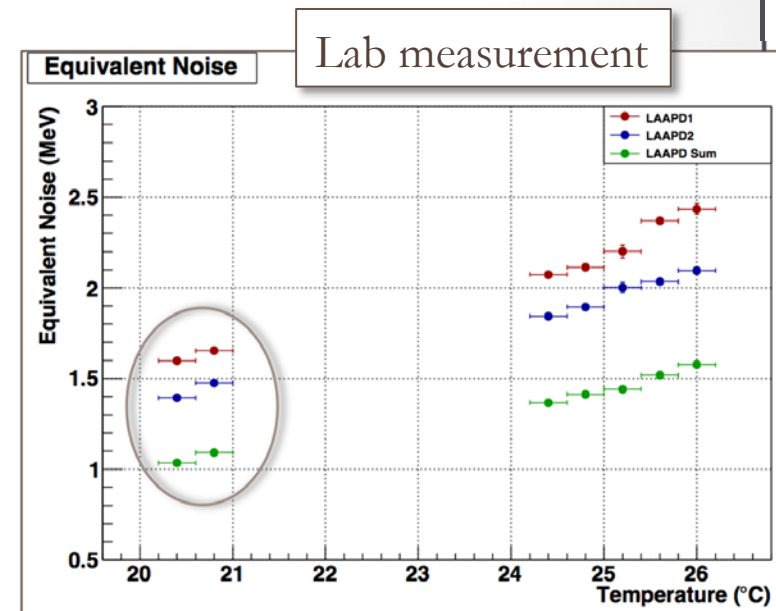
- Noise: 6.9 mV
- Fraction of deposited energy from MC : 80%

- 99 MeV

- Signal Amplitude: 475 mV
- S/N = 69
- Equivalent Noise: $80\% * 99 \text{ MeV} / 69 = \mathbf{1.15 \text{ MeV}}$ (mean temp : 20.9°C)

- 397 MeV

- Signal Amplitude: 1701 mV
- S/N = 246
- Equivalent Noise: $80\% * 397 \text{ MeV} / 246 = \mathbf{1.29 \text{ MeV}}$ (mean temp : 21.4°C)



Conclusions

Advanced photonix APD-UV:

- Equivalent noise = **2.8 MeV** (2.2 MeV expected with resin and glue), lab measurements
- To-do-list:
 - Improve trigger configuration
 - Improve cabling to reduce noise
 - Use resins and glues to avoid xtal-apd air-gap effect and to protect APD

LAAPD

- Equivalent noise = **1.2-1.3 MeV** from both btf and lab data
- Refine test beam data analysis
- Use CAEN CSP with higher gain in use by Japanese colleague
- Modify shaper to reduce shaping time from 100ns to 30 ns

EXTRA SLIDES

stima deposito da MC

Energy (MeV)	Peak Pos (GeV)	Energy fraction
100	$7.98499e-02 \pm 2.77629e-04$	80%
200	$1.60414e-01 \pm 3.21012e-04$	80%
300	$2.39634e-01 \pm 5.55813e-04$	80%
400	$3.19318e-01 \pm 5.76568e-04$	80%
500	$3.96682e-01 \pm 5.13496e-04$	79%