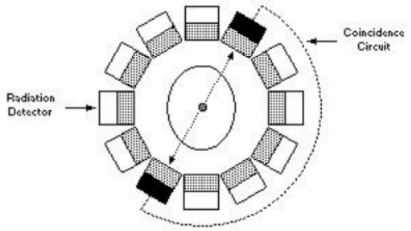
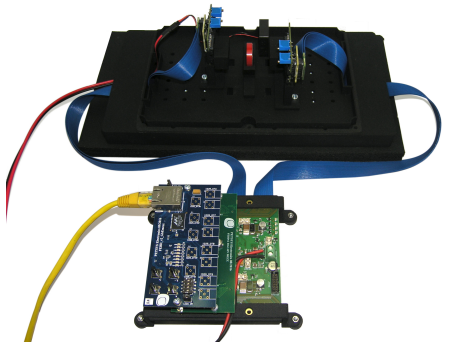
PETsys Electronics





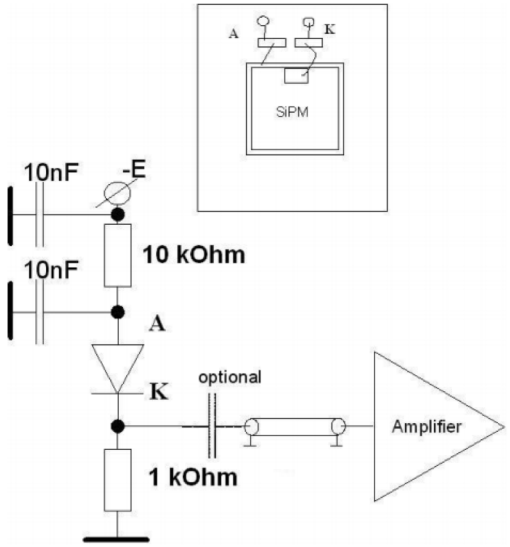


Figure 1.8: SiPM connections

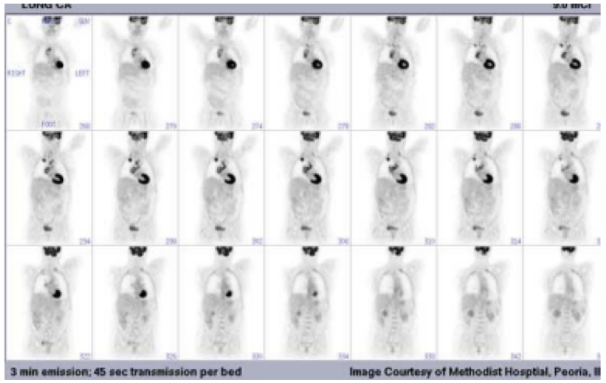
High-precision timing detectors for HL-LHC

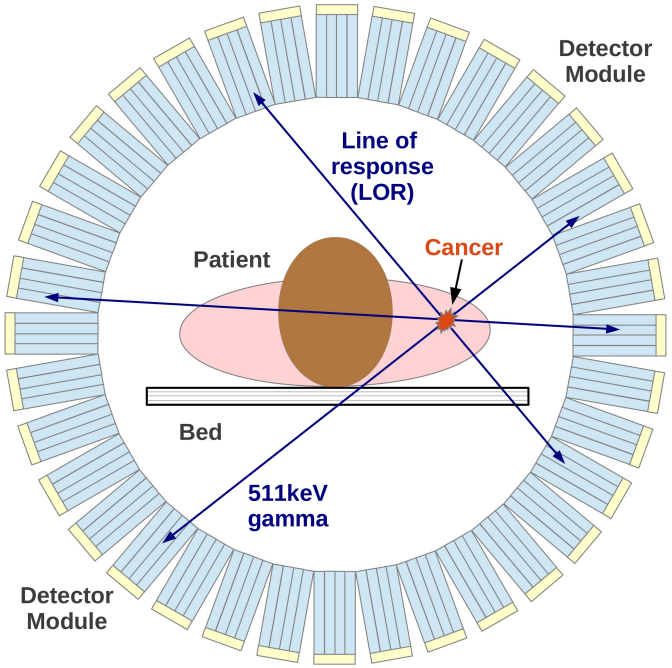
Student: Nelson Rebelo

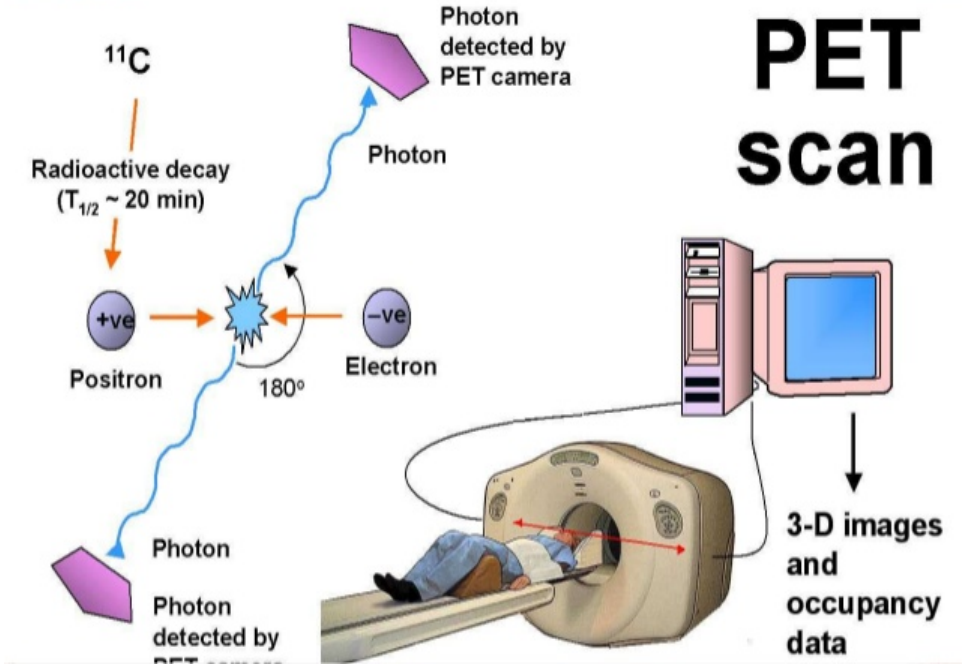
Supervisor: Tahereh Niknejad

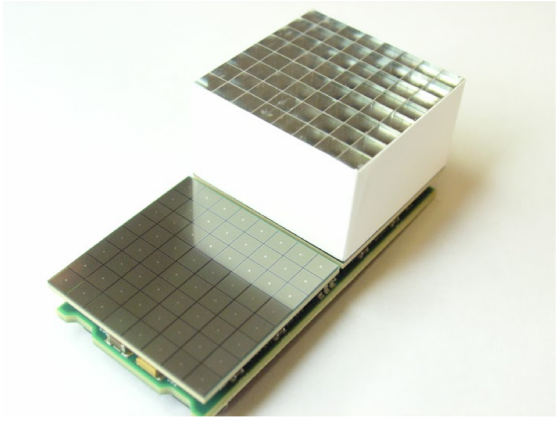
LIP

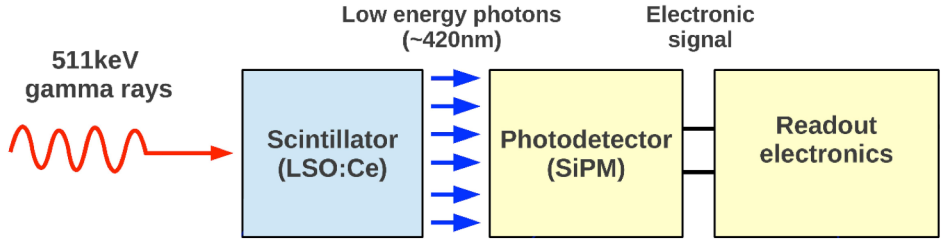
Positron Emission Tomography - PET











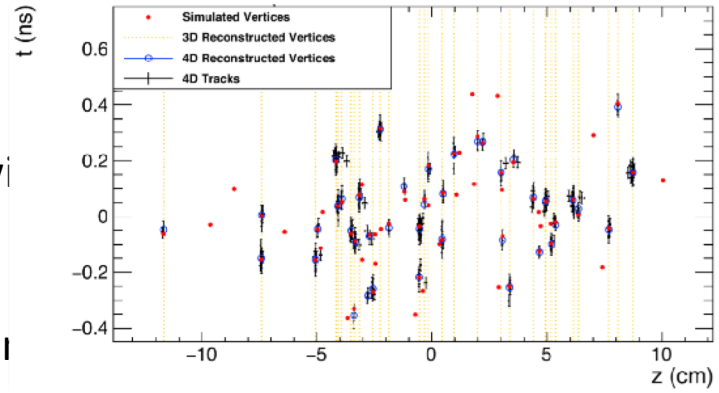
CMS – Barrel Timing Layer (BTL)

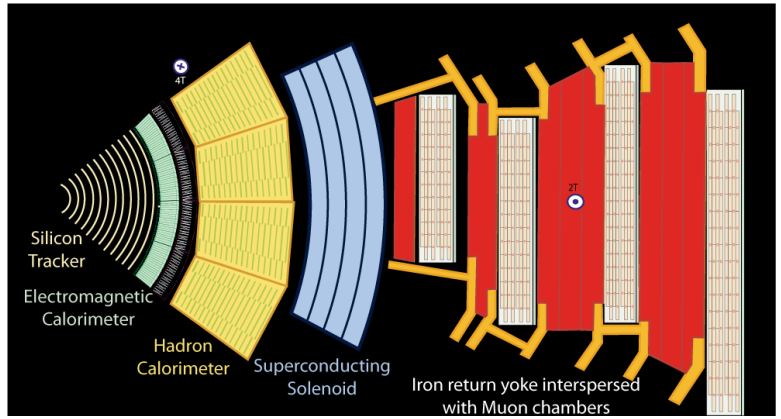
Fact: At the HL - LHC an average of 140 – 200 pileup events (collisions per bunch crossing) wi occur

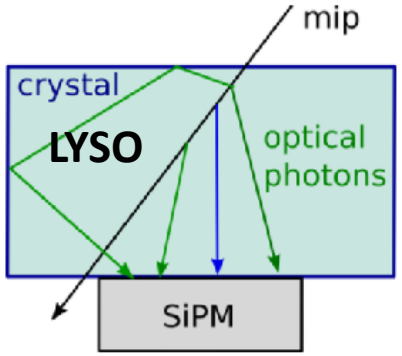
Problem: This can degrade the identification ar the reconstruction of the interaction

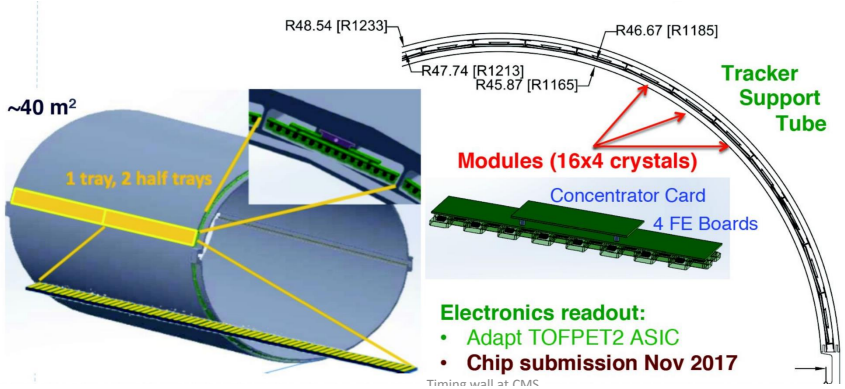
Solution: Use precise time stamp of particles

Requirements: Dedicated detector for precise timing (~30 ps timing resolution)

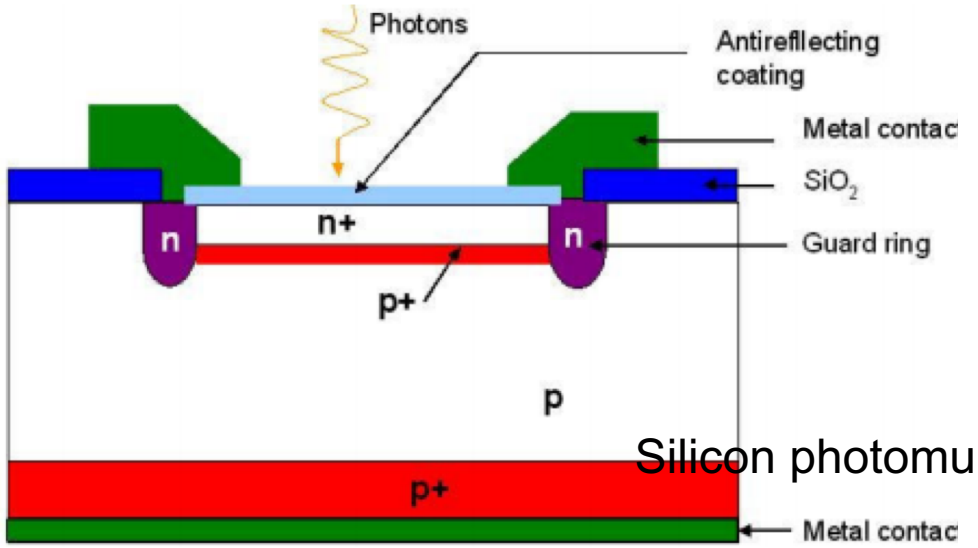




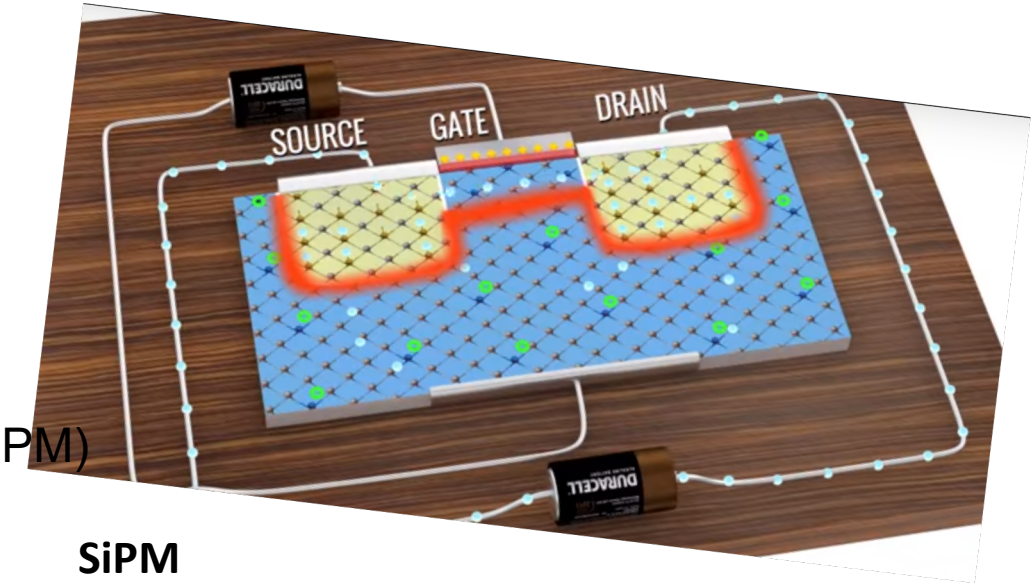




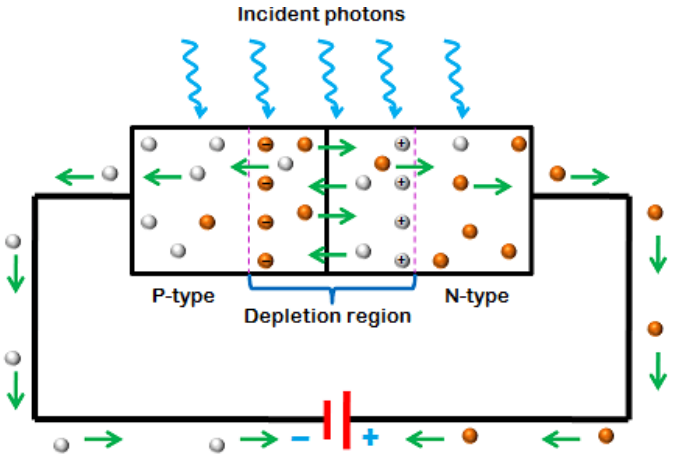
Silicon photomultiplier (SiPM)



APD – Avalanche Photodiode



Silicon photomultiplier (SiPM)



P-N Junction photodiode

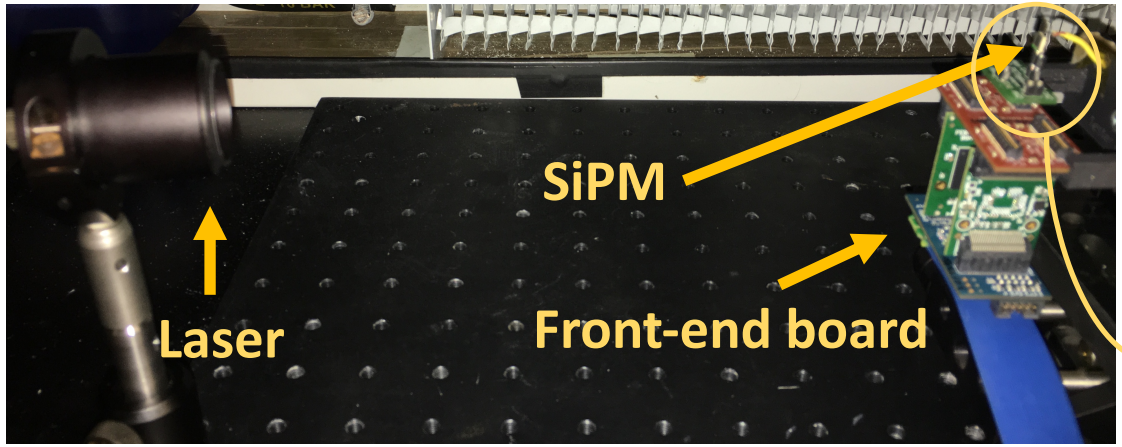
SiPM

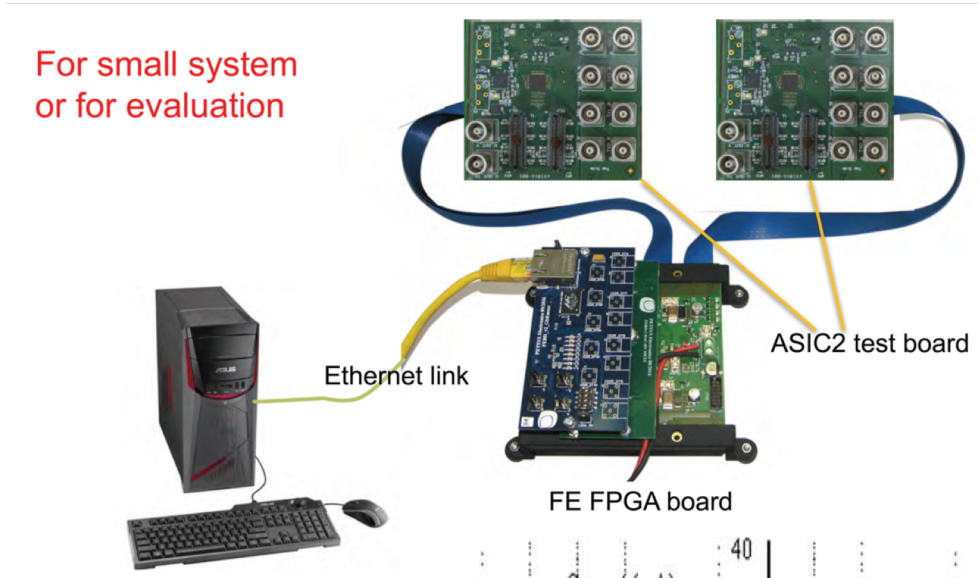
- Single photon resolution
- High photon detection efficiency
- High gain and high signal to noise ratio
- Very compact devices
- Low bias voltage
- Insensitive to magnetic fields
- Short recovery time
- Superior time resolution
- Simple calibration and monitoring

-Not damaged by day light

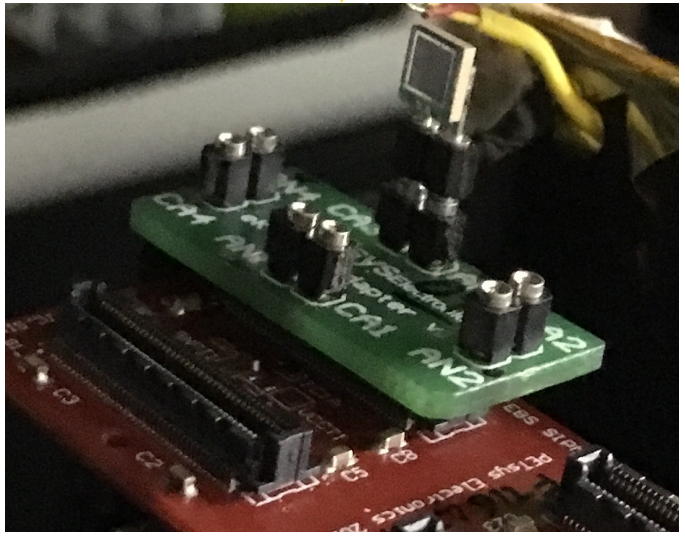
- Low costs

Experimental set-up



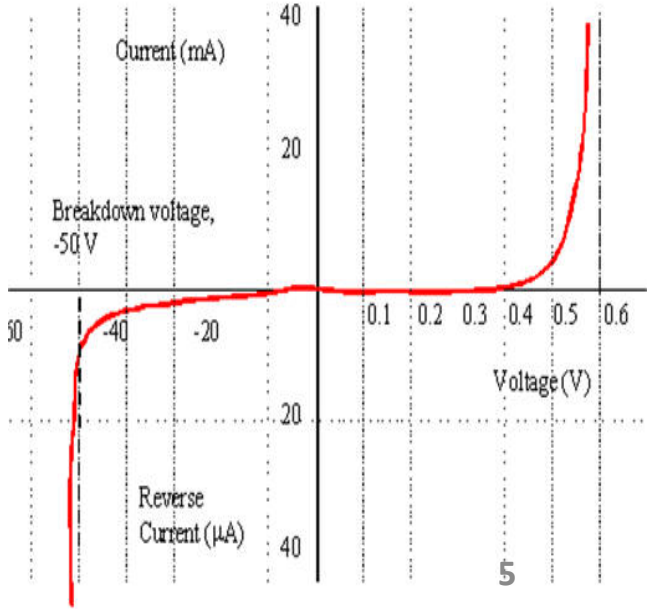


- The Setup is placed in a light tight box
- The temperature is kept at 18ºC

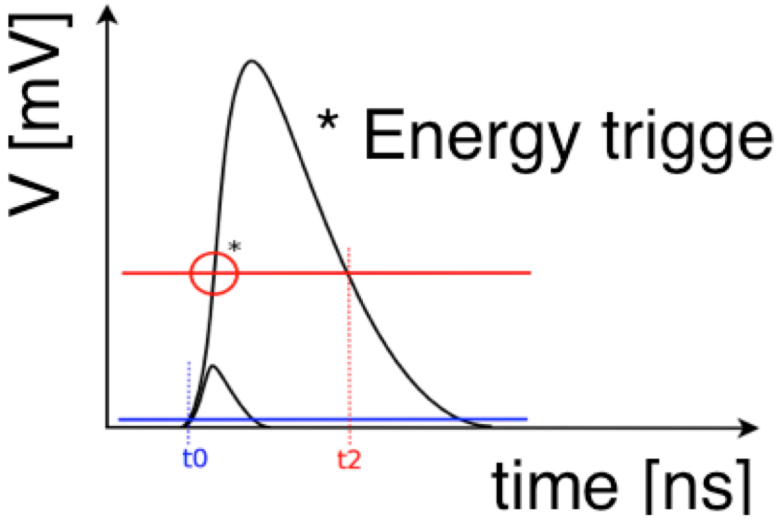


→SiPM operating voltage:

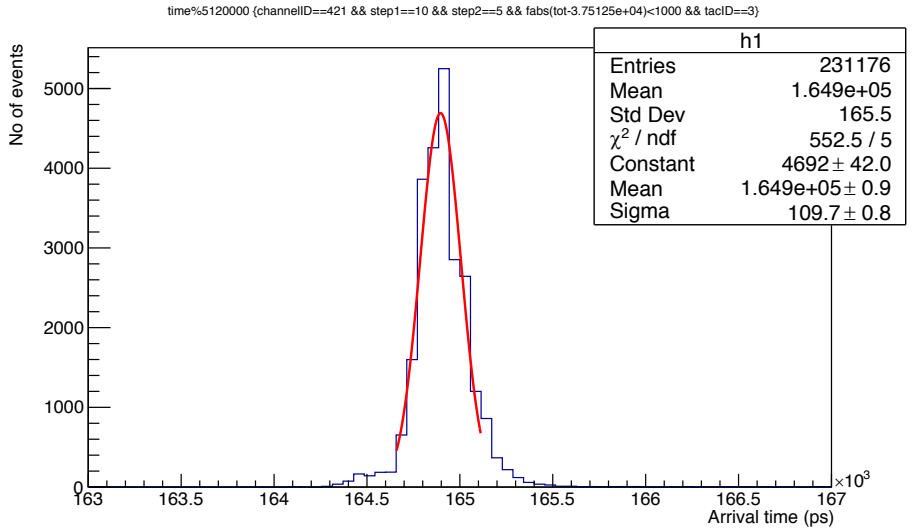
Vbias=Vbr+Vov



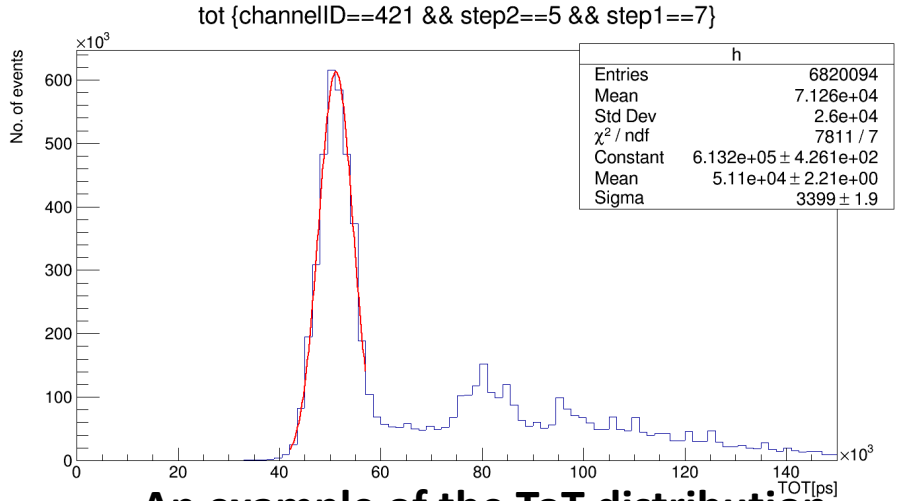
Events digitization



ToT (energy meas) = t2 - t0



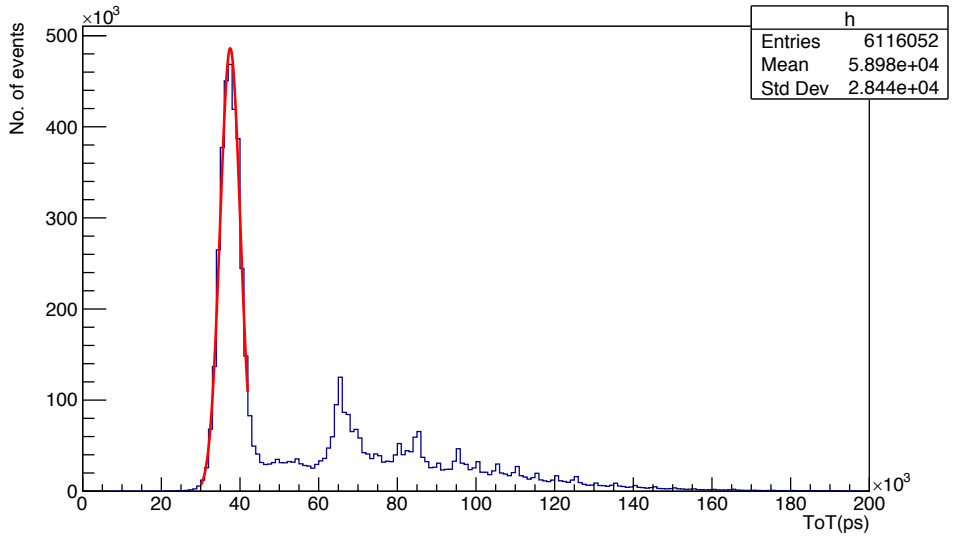
An example of the Time distribution



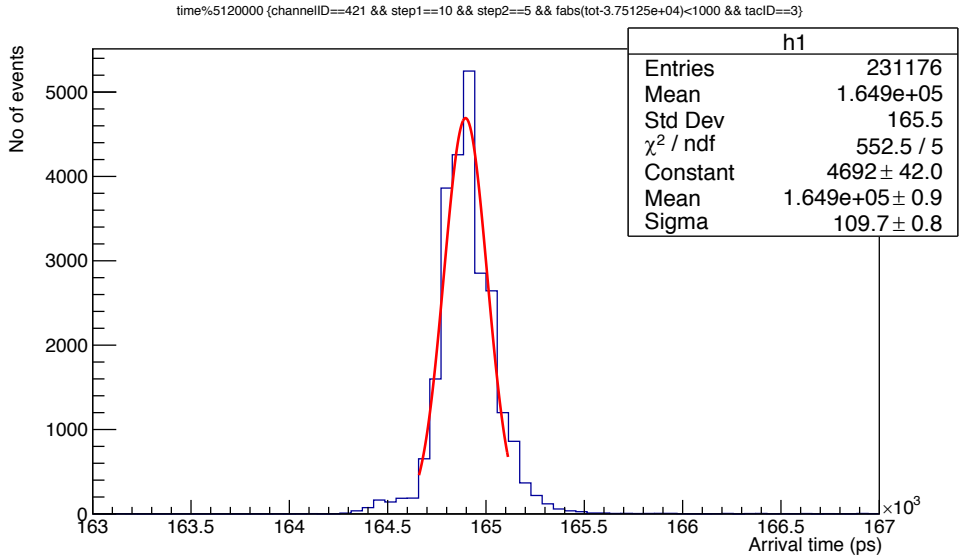
An example of the ToT distribution

Hamamatsu SiPM array (S13361-4050AE-04)

→ 4x4 array
→ Breakdown Voltage 52.3 V
→ Recommended OV 3.5 V
→ Only one channel is tested
→ Temperature 18ºC

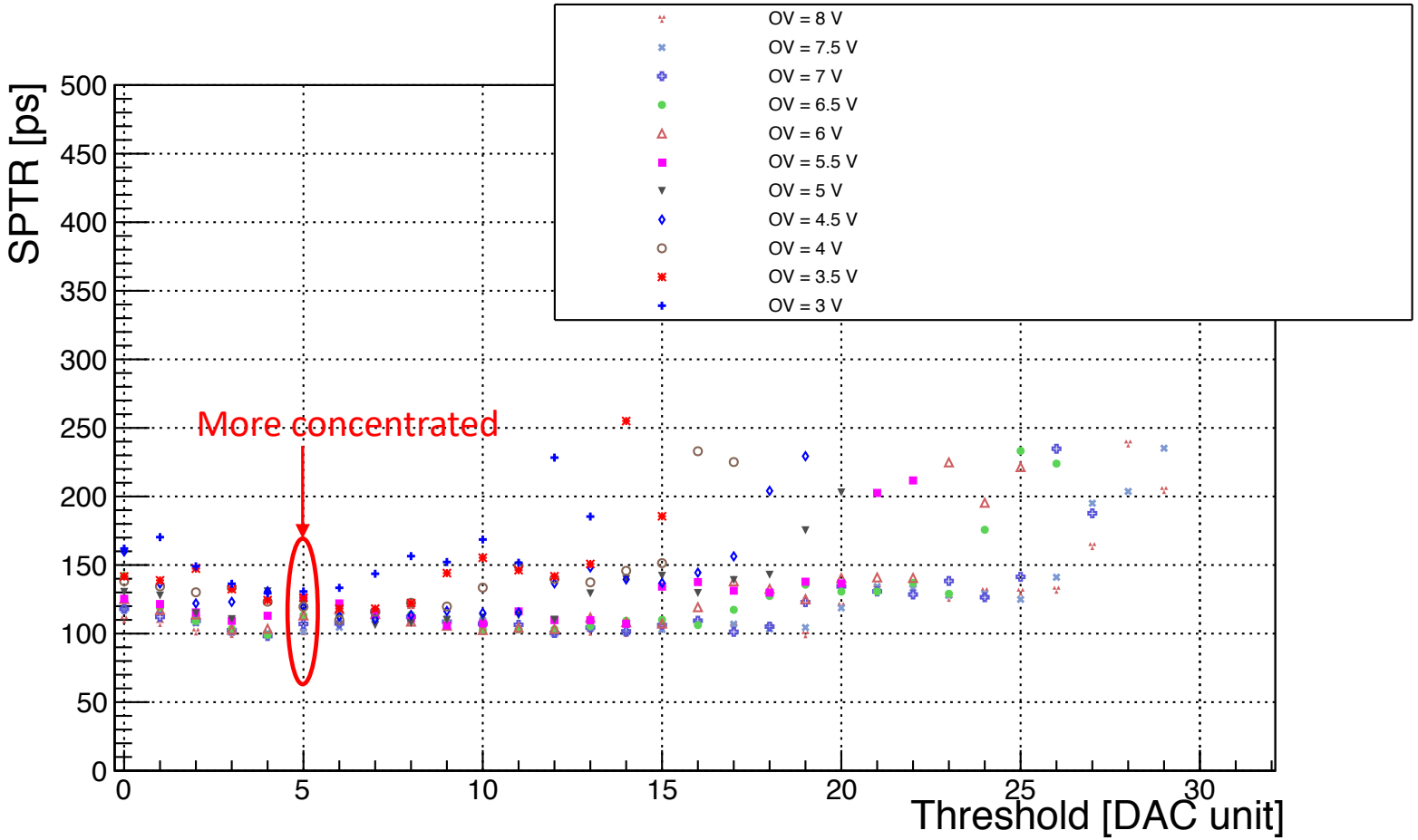


→ Laser is attenuated (OD5) to get one photo-electron
→ Events within $\pm 1ns$ of the photopeak are selected for SPTR measurements



SPTR vs Threshold (in DAC unite) for different OV

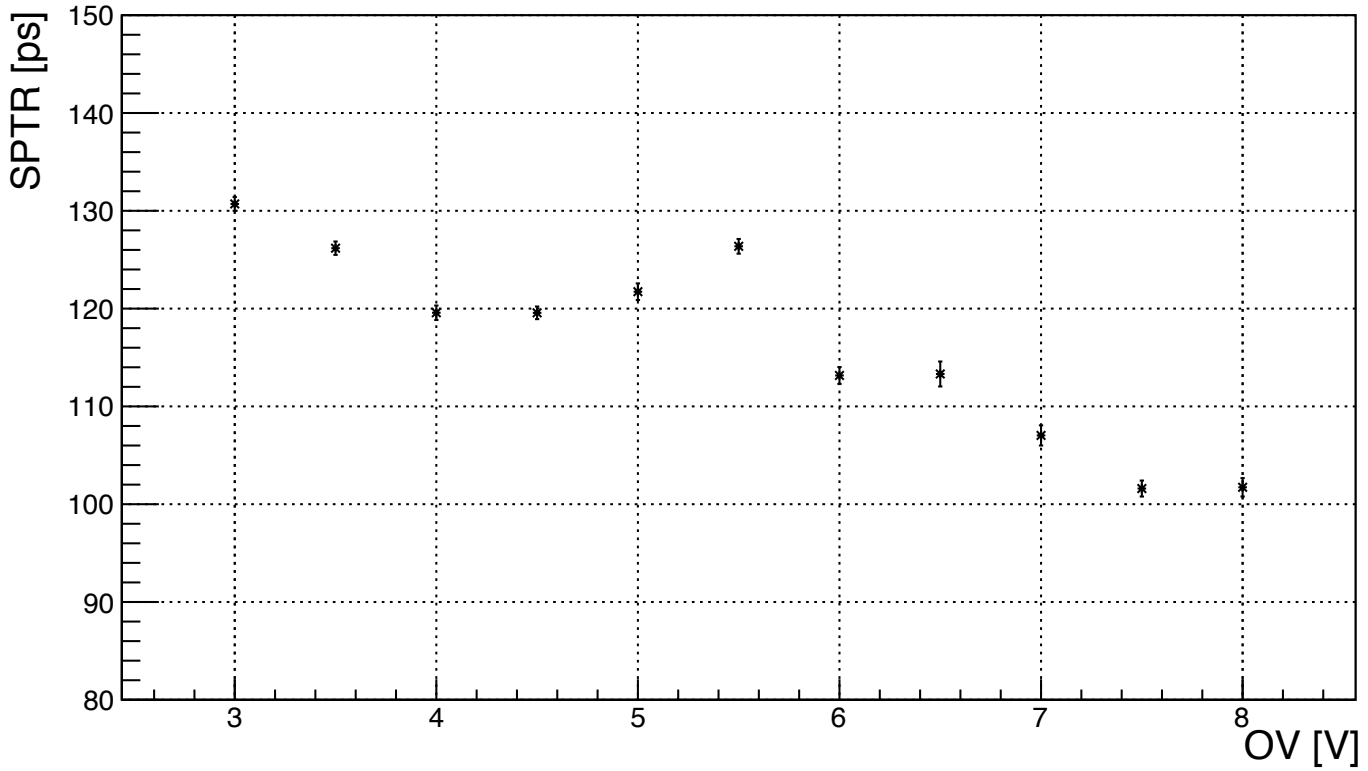
→ One single channel of 4x4 array -Hamamatsu (S13361−3050AE−04)



SPTR vs Overvoltage

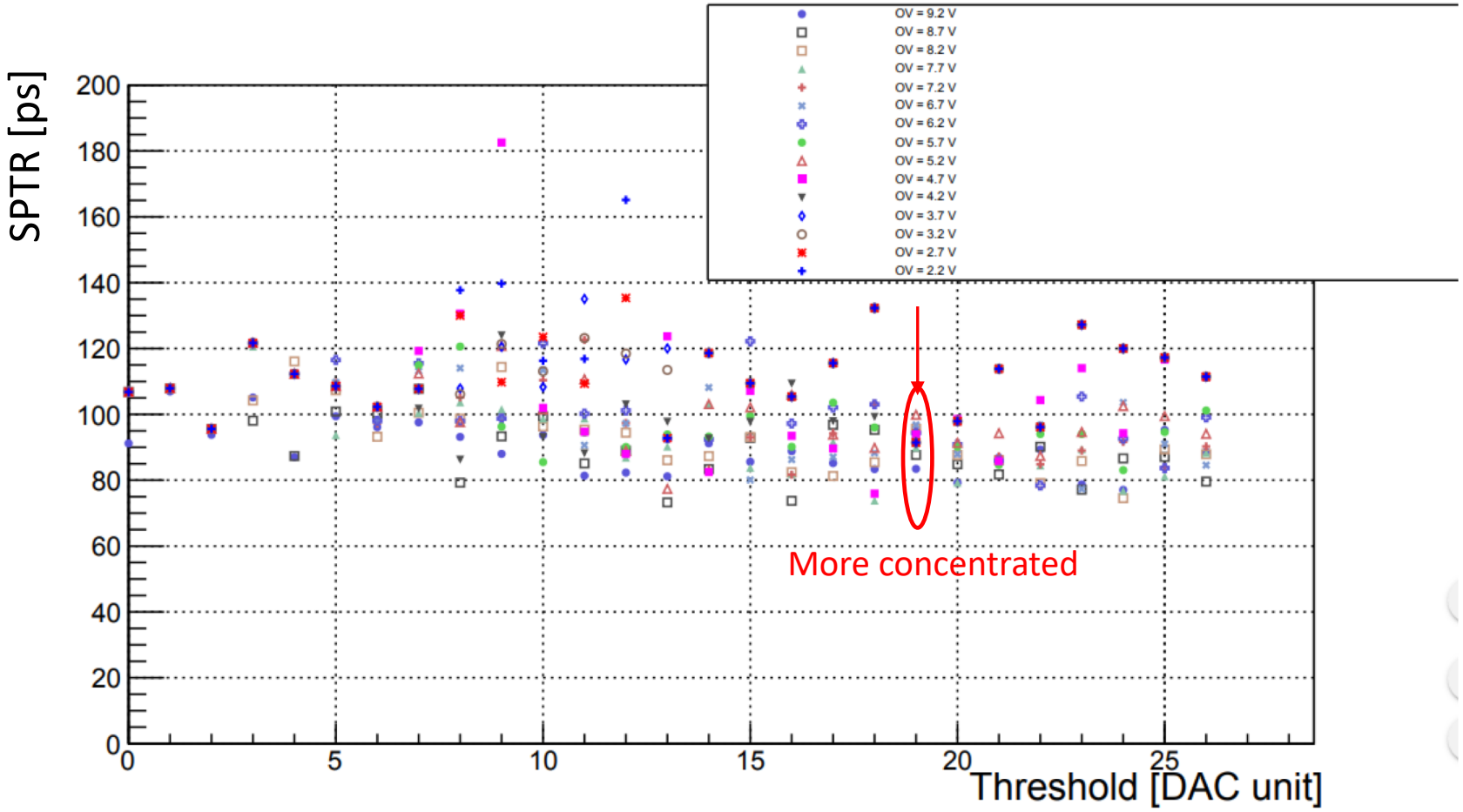
→ One single channel of 4x4 array - Hamamatsu (S13361−3050AE−04)

→ Threshold (5 DAC unite)



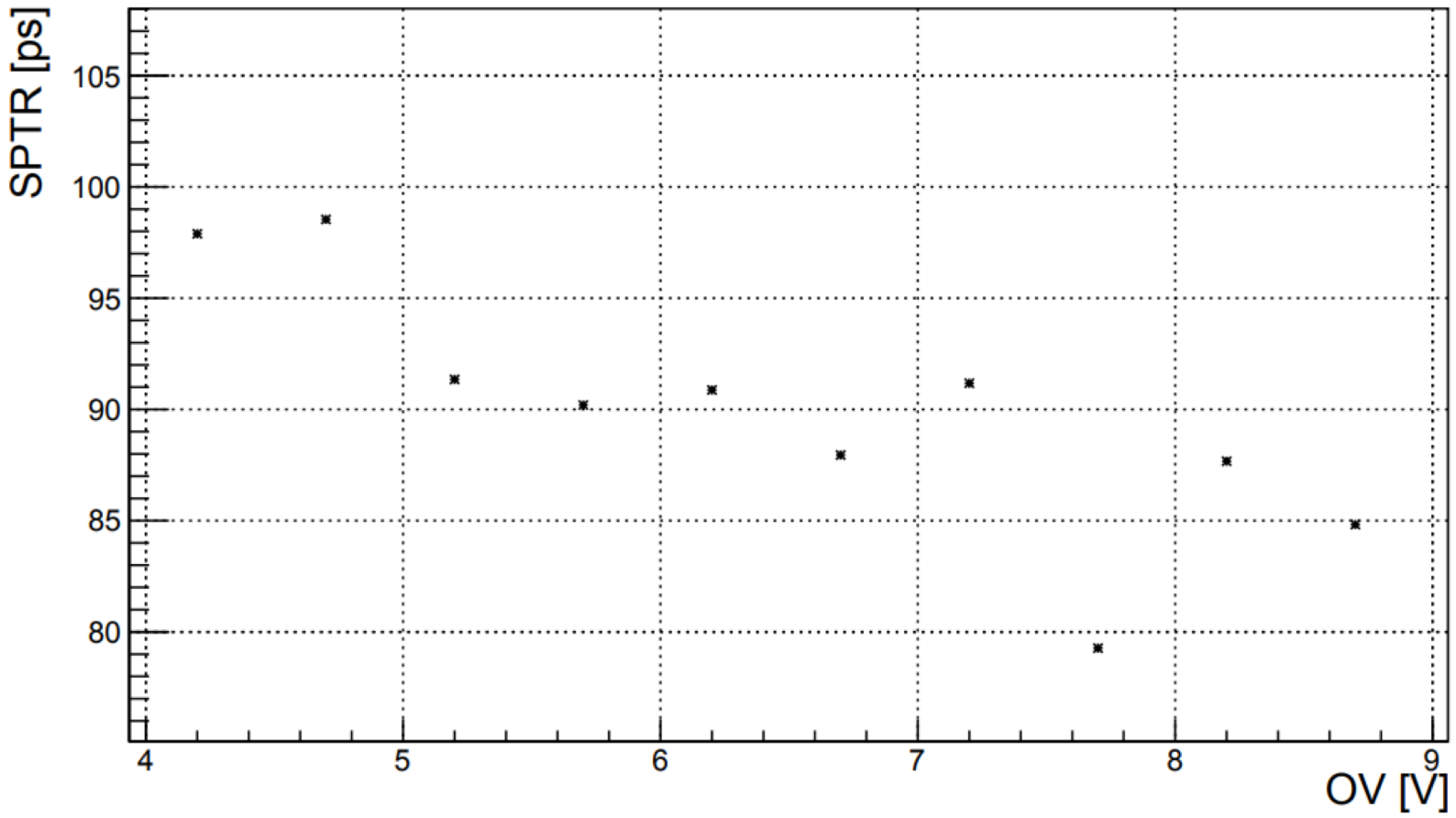
SPTR vs Threshold (in DAC unite) - Hamamatsu SiPM (S14160)

→ One single pixel
(Hamamatsu S14160)



SPTR vs Overvoltage - Hamamatsu SiPM (S14160)

→ One single pixel (Hamamatsu S14160)
→ Threshold (20 DAC unite)



Summary and remarks

- Familiarization with the physics of SiPM and its applications in medical and high energy physics
- Getting trained to use the hardware and the software to perform experimental works
- Learning to analyze the data with ROOT
- Characterization of few SiPM samples to be used in PET and CMS (BTL)

Thank you for your attention