

Commissioning of a beta setup for time resolution measurements

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Wiehe

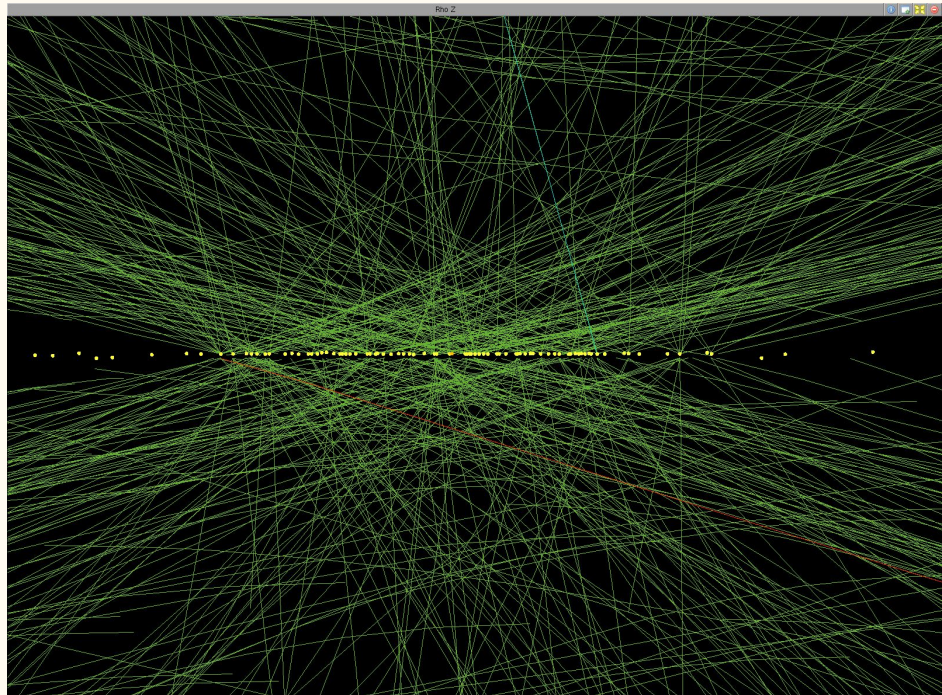
Myself

- From Meyrin
- Studying Mathematical Physics with Pure Mathematics Minor at the University of Waterloo, Canada
- Winner Beamline for Schools 2017 (Charging Cavaliers)
- Hobbies: Basketball, Swimming, Physics and Mathematics
- Summer Project in the SSD group

Why timing

HL-LHC upgrade will have 200 collisions per bunch crossing.

- Solution: add time dimension with time sensitive detectors
- Timing systems based on silicon photomultipliers and silicon detectors (LGADs)



CMS tracking reconstruction - 78 collisions

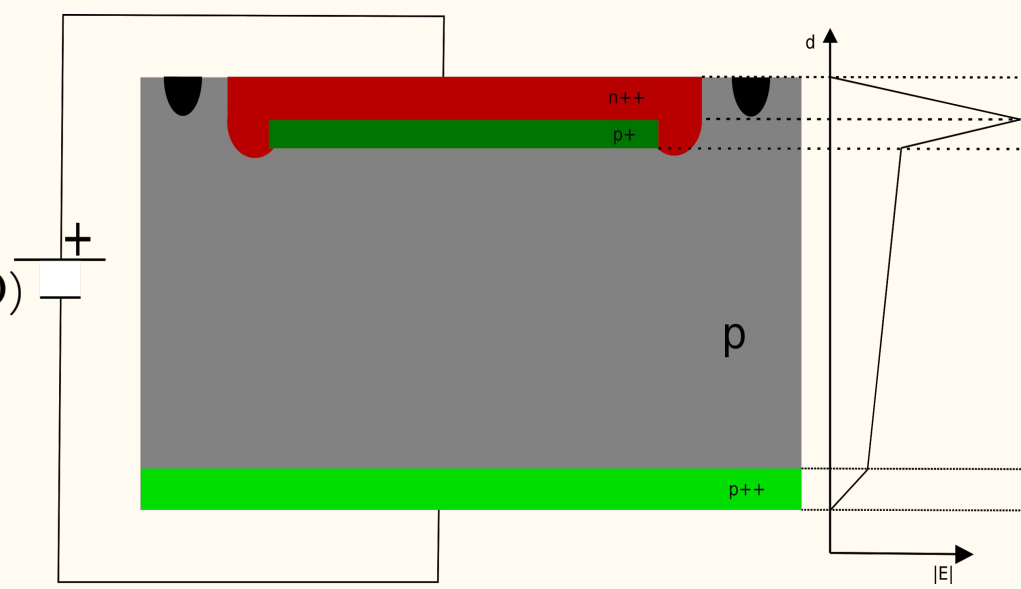
What is a LGAD

Low **Gain** Avalanche Detectors (LGAD)

Time resolution $\sim 30\text{ps}$

ATLAS: High-Granularity Timing Detector (HGTD), ATLAS Forward Proton (AFP) detector

CMS: Endcap, CMS-Totem Proton Precision Spectroscopy detector (CT-PPS)



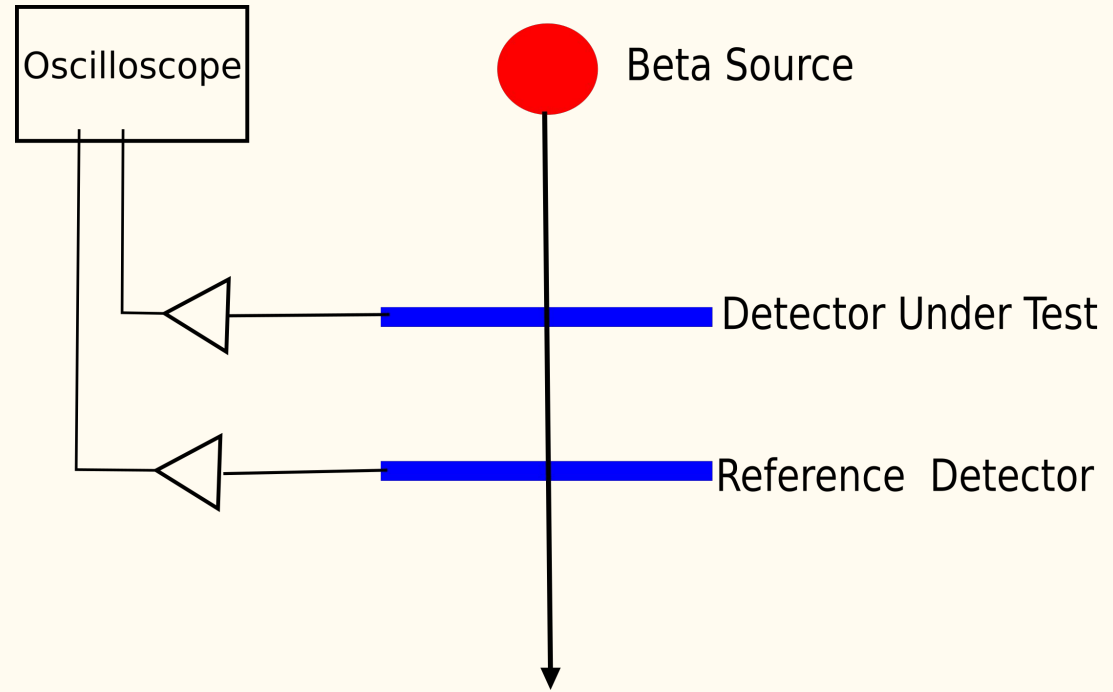
Schematics

Faraday cage and climate chamber

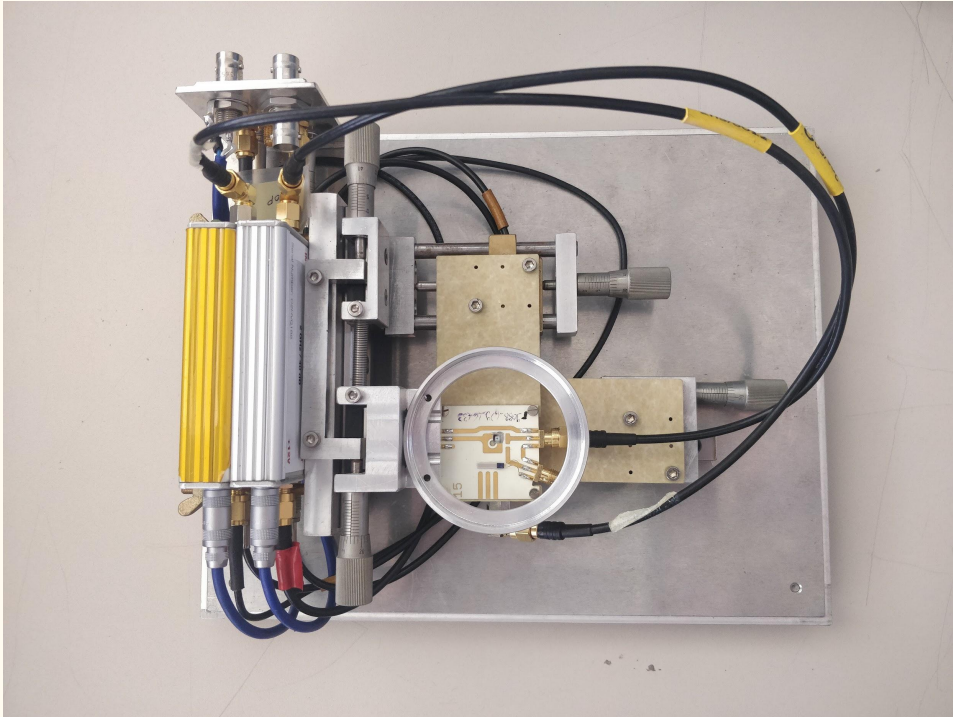
Parameter controls:

- Temperature
- Bias voltage

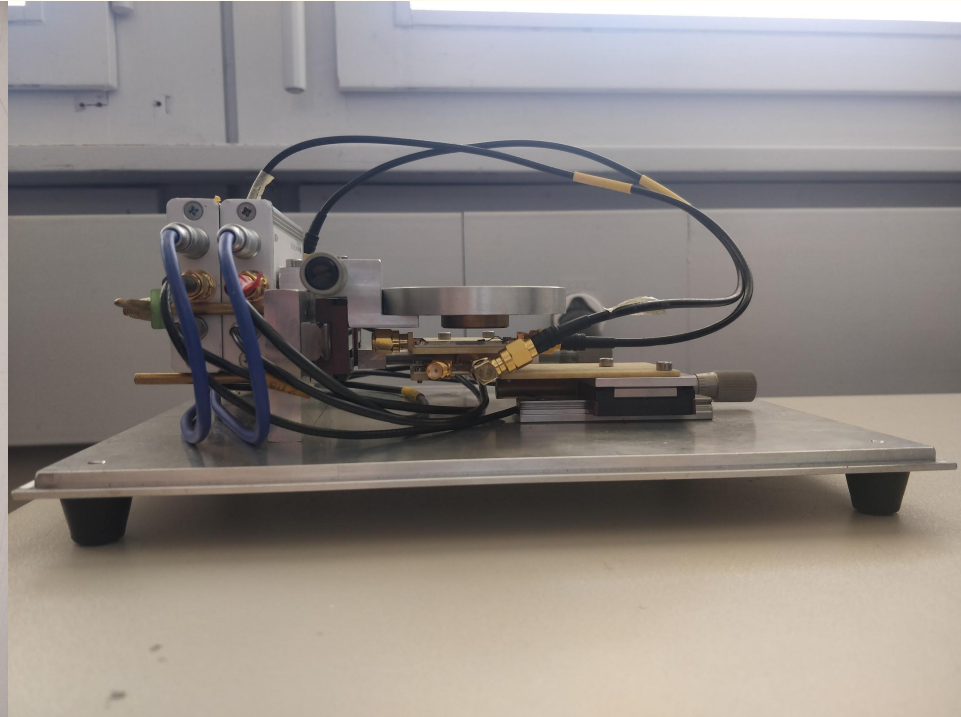
Trigger on the bottom detector



Setup

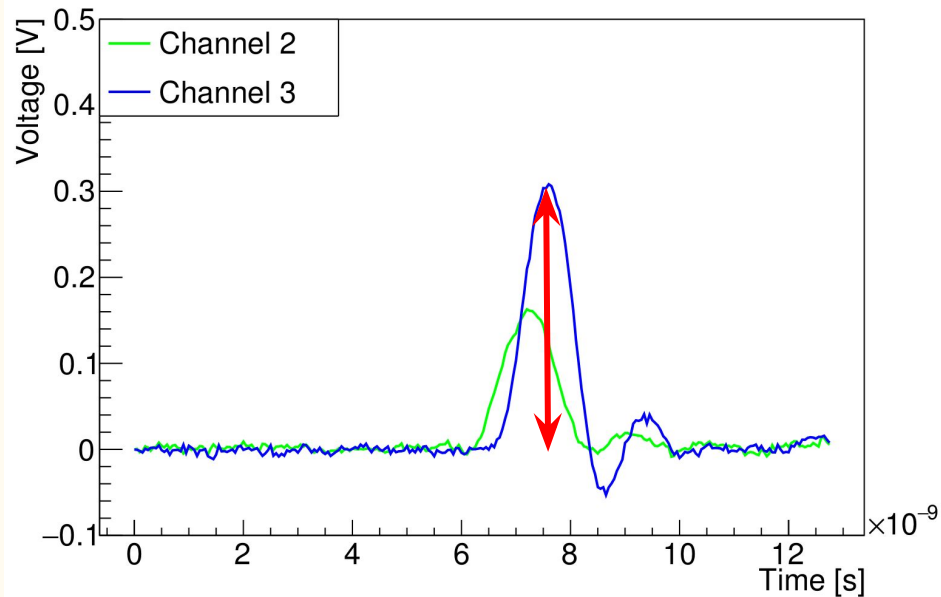


Top view

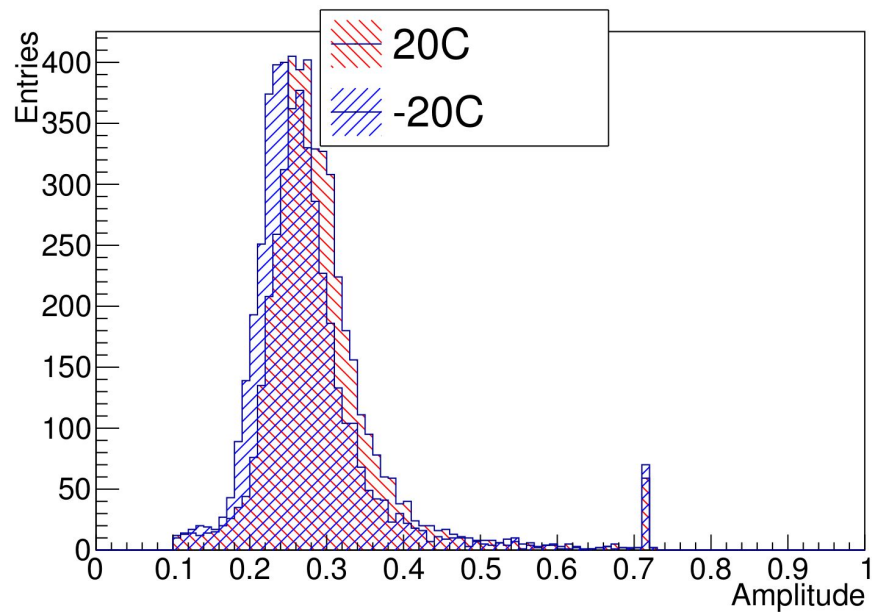


Side view

Amplitude

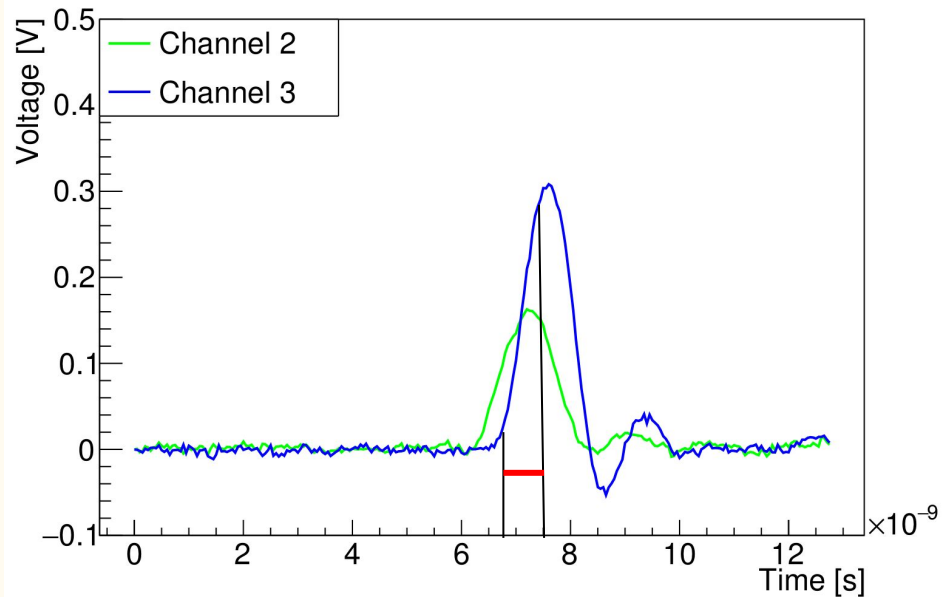


Signal shapes

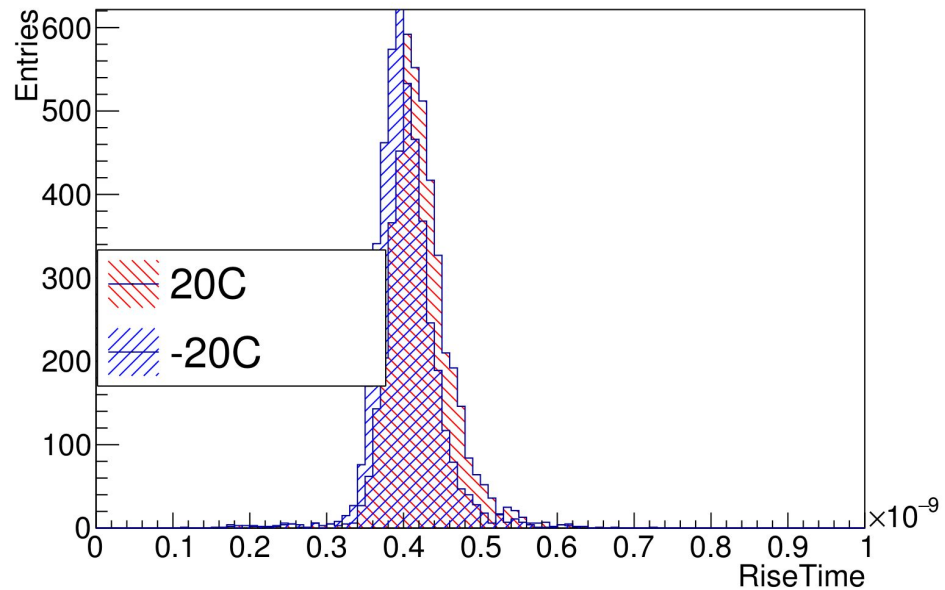


Follows a Landau distribution

Risetime

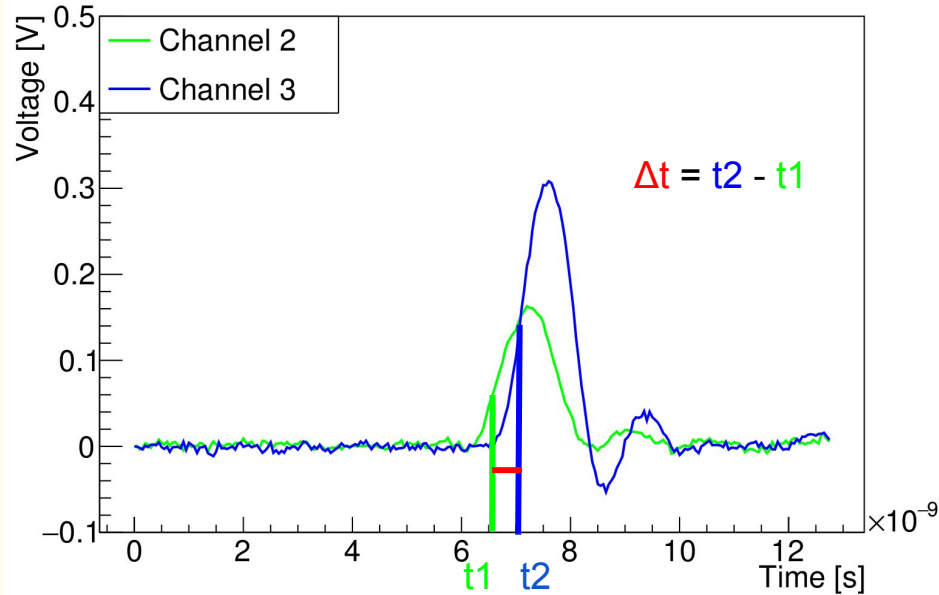


Signal shapes



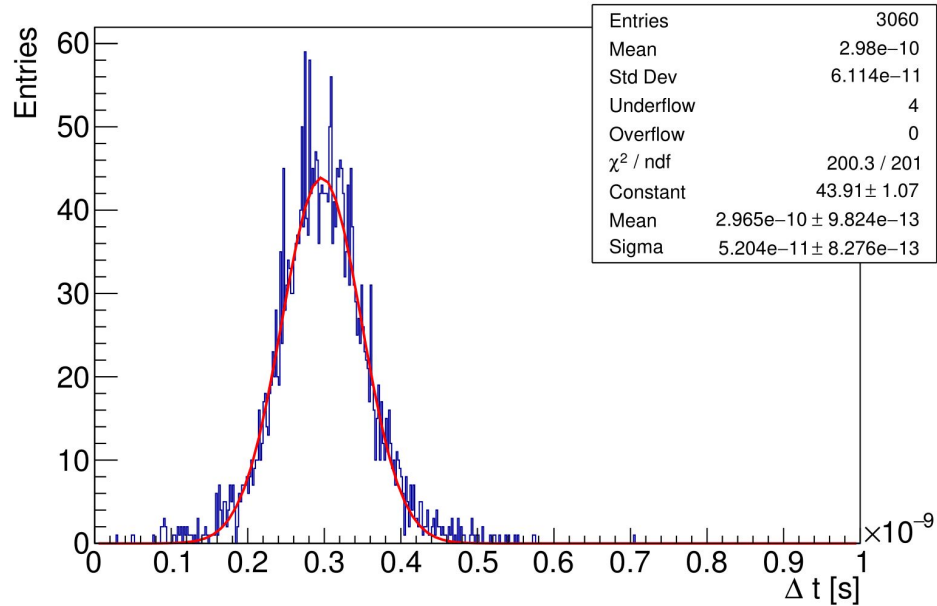
20-80% risetime around 400 ps

Time Resolution



Signal shapes

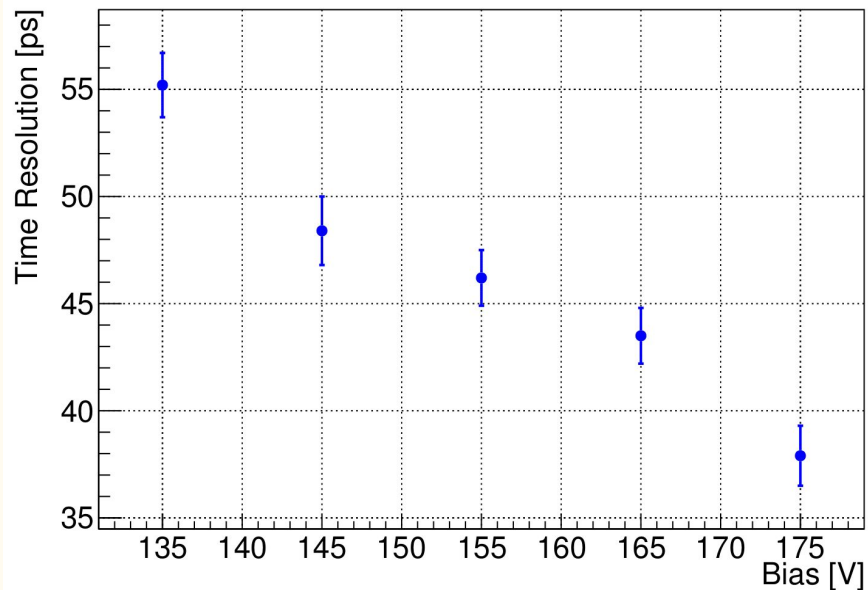
Determined time resolution of reference detector: 34-39ps (T, V dependent)



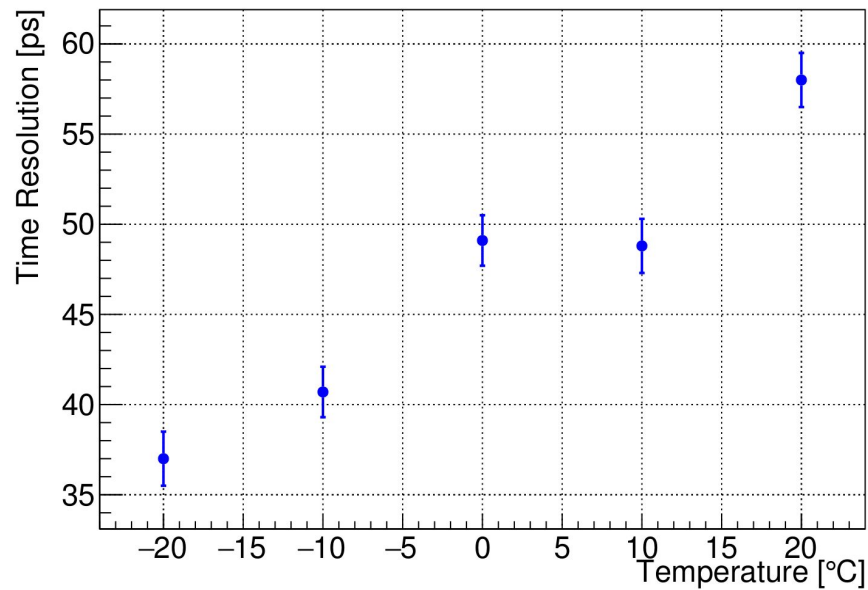
System time resolution

$$\sigma_{sys}^2 = \sigma_{dut}^2 + \sigma_{ref}^2$$

Examples of studies



Fixed temperature at -20C



Fixed bias voltage at 175V

Sensor behave as expected

Conclusion

- SDD group needed a beta setup for timing measurements
- Contribution in developing the setup
 - Characterize the reference detector for different temperature
 - Reduce noise
- Using the calibrated reference for detector characterization