Activity status

Red Futuros Aceleradores

IFCA, Santander, nov 19, 2018

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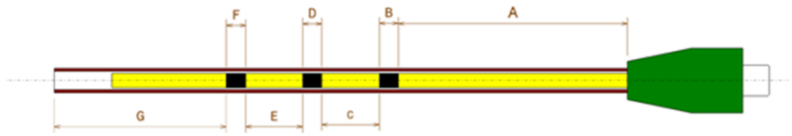
Outline

- ILC related activities.
- Planning for the future.

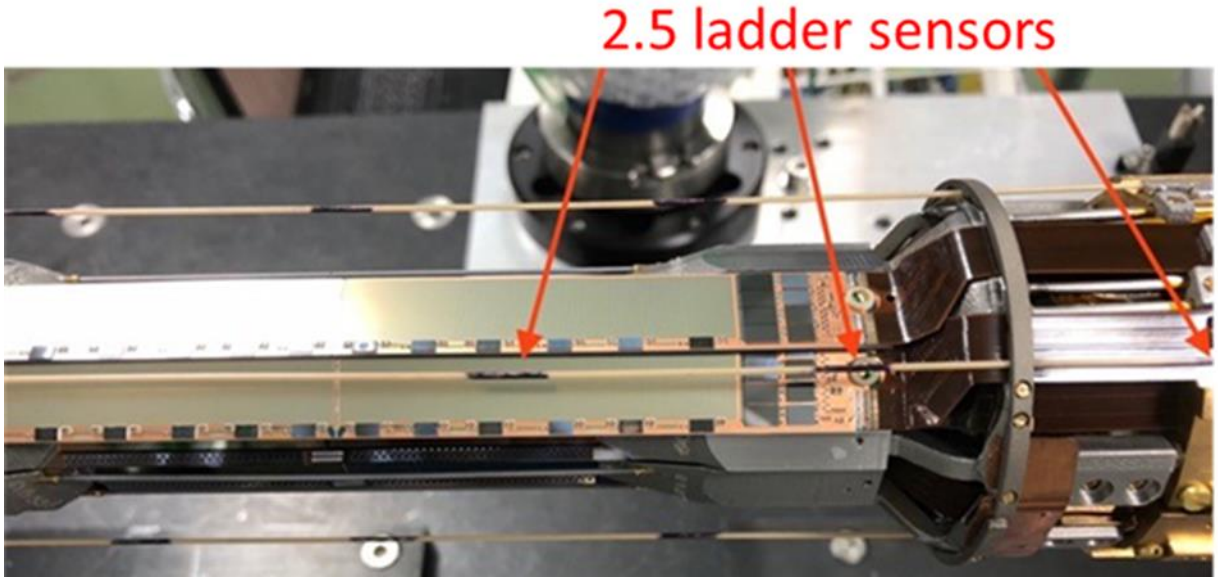
Related Past & current activities

- Fiber Optical Sensors for temperature monitoring of Belle-2 PXD detector (Completed)
- Mechanical mockup of FTD disk for thermomechanical studies (on hold)
- 4th dimensional tracking based on ILGADs (in progress)

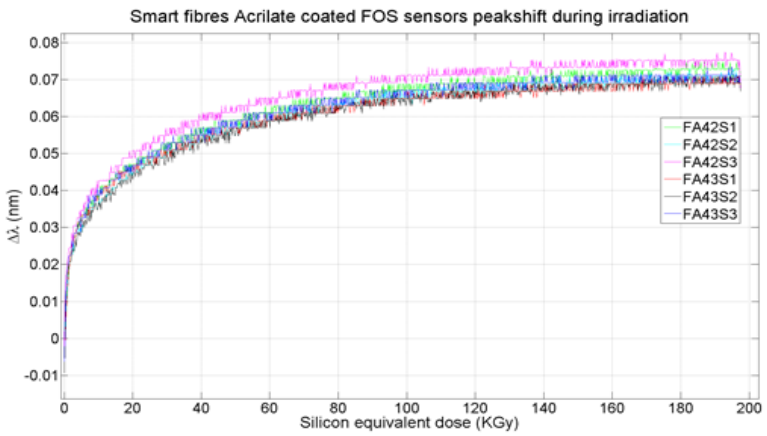
FOS at Belle-2

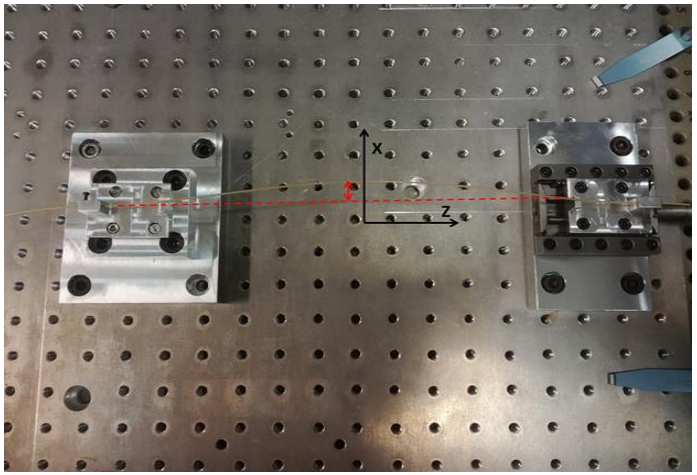


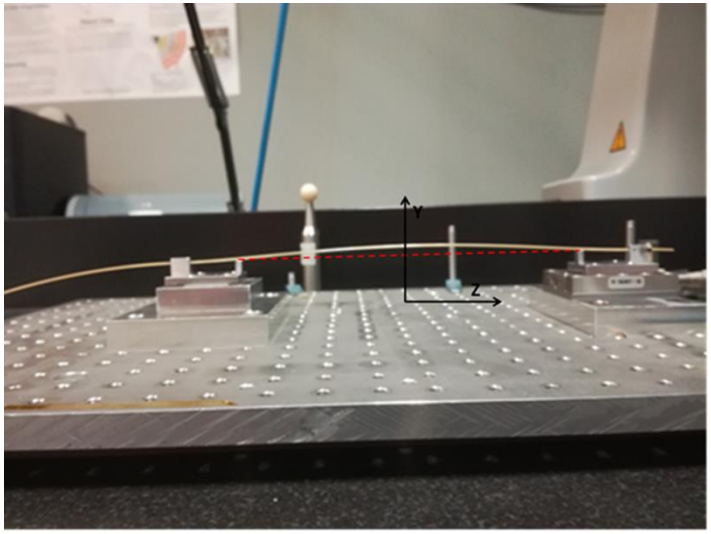
Fiber	A (m)	B (m)	C (m)	D (m)	E (m)	F (m)	G (m)	Ladder
SN142847	2.23	0.01	0.044	0.01	0.042	0.012	0.114	2.3
SN142848	2.34	0.016	0.036	0.014	0.036	0.016	0.03	2.5
SN142849	2.27	0.012	0.042	0.01	0.042	0.01	0.1	Spare
SN142851	2.27	0.012	0.036	0.014	0.046	0.01	0.103	2.9
SN142852	2.29	0.01	0.042	0.01	0.044	0.01	0.09	2.11

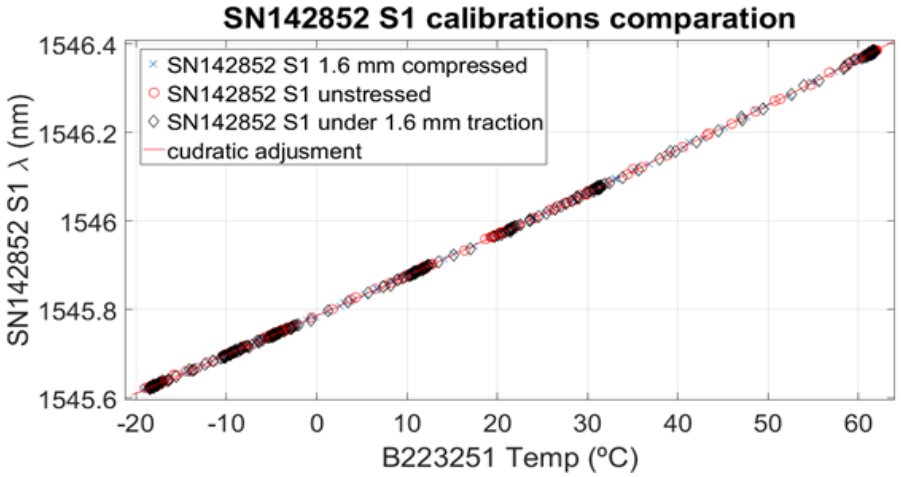


FOS at Belle-2



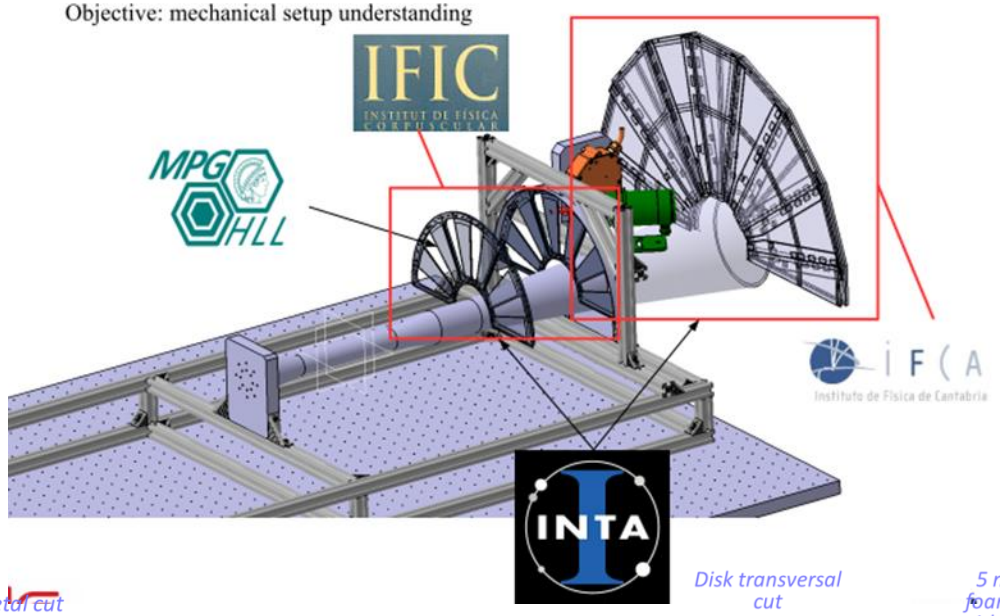






FTD Thermo-mechanical mockup

– No progress since the last year (lack of funds).

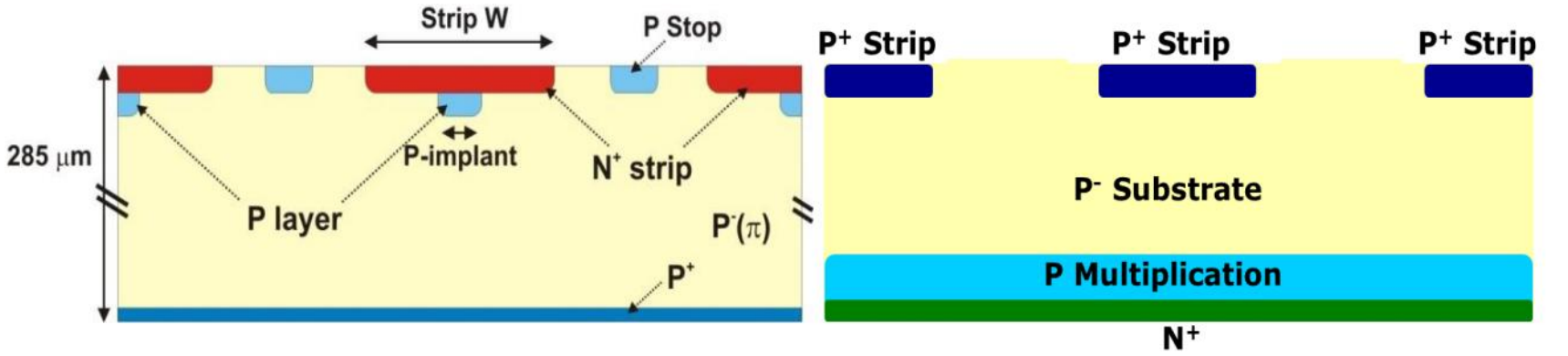


Inverse-LGADs

I-LGAD: a 4th dimensional tracking sensor

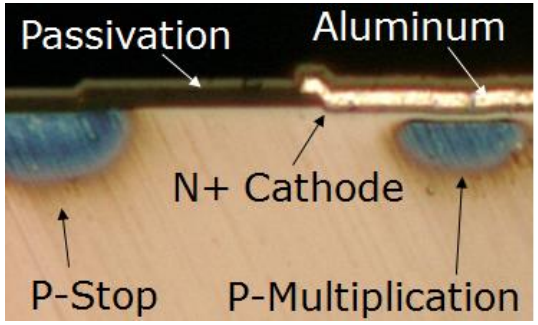
Multiplication layer divided into strip
Collects negative carriers (e)
Simple single side process

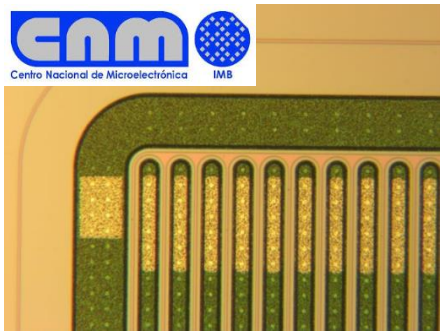
Multiplication layer extended over the electrode
Collects positive carriers (h)
Complex double side process



LGAD N on P microStrip

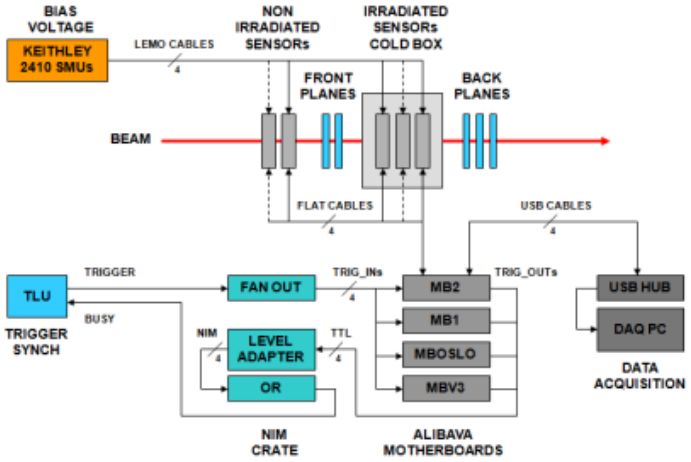
P on P microStrip **iLGAD**

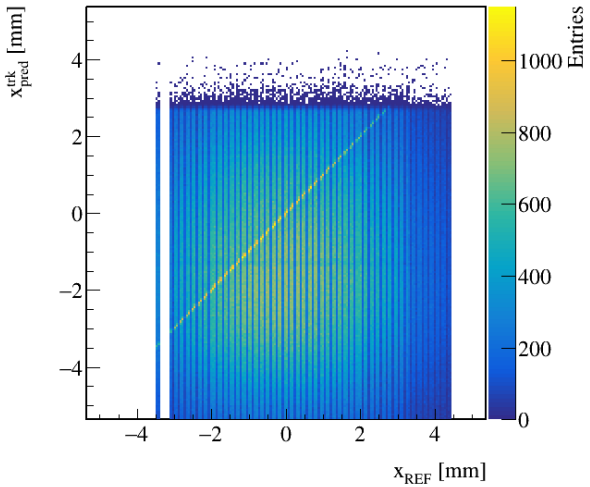


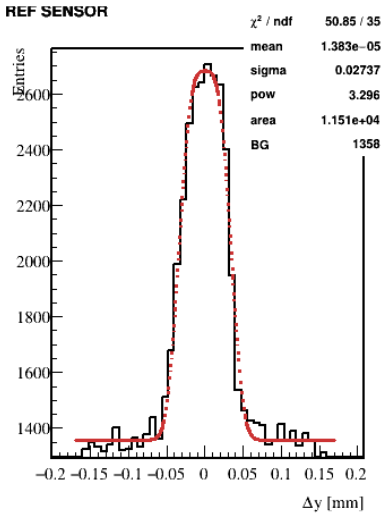


Tracking performance: Reference strip sensor

- Challenges:
  - Difficult synchronization between Alibava daq (x3) and Eudaq.
  - Saturation of the Alibava ADC.

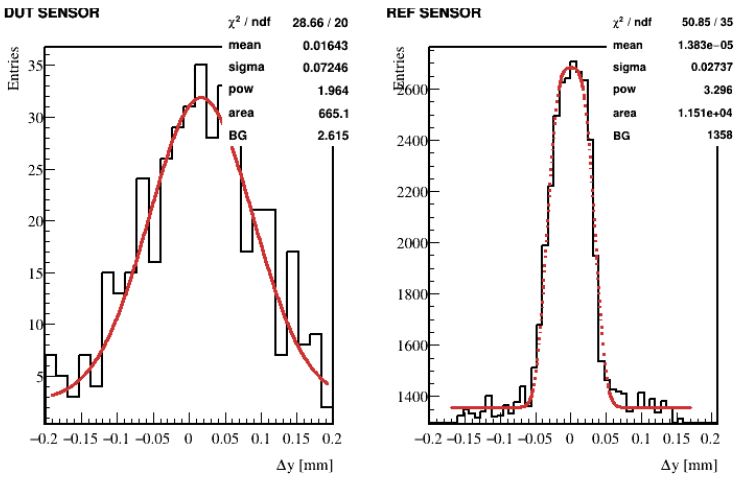






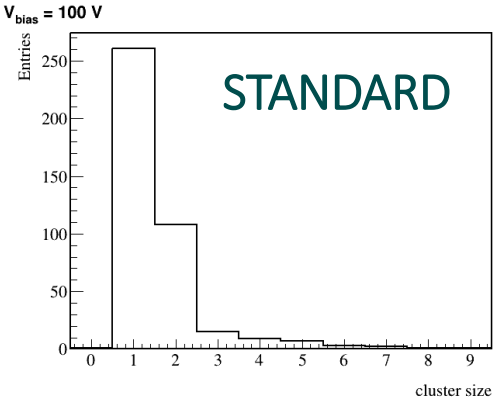
Tracking performance: I-LGAD strip sensor

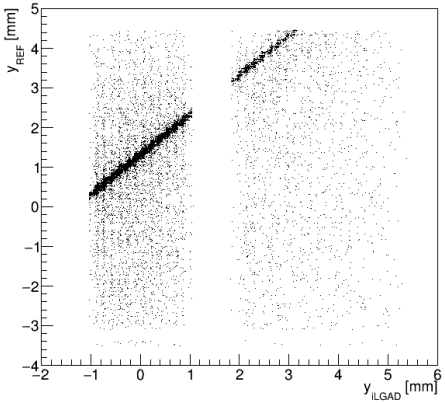
– Hit resolution biased by saturation of the Alibava ADC ?

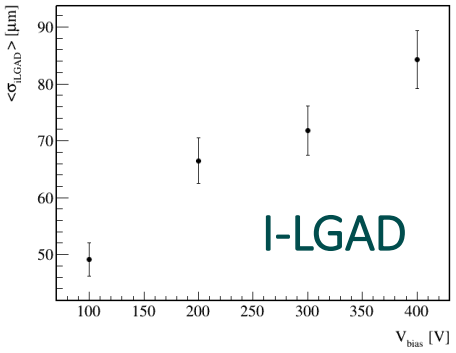


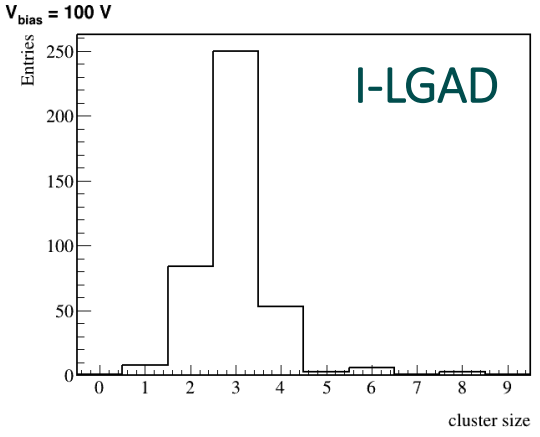
I-LGAD

STANDARD

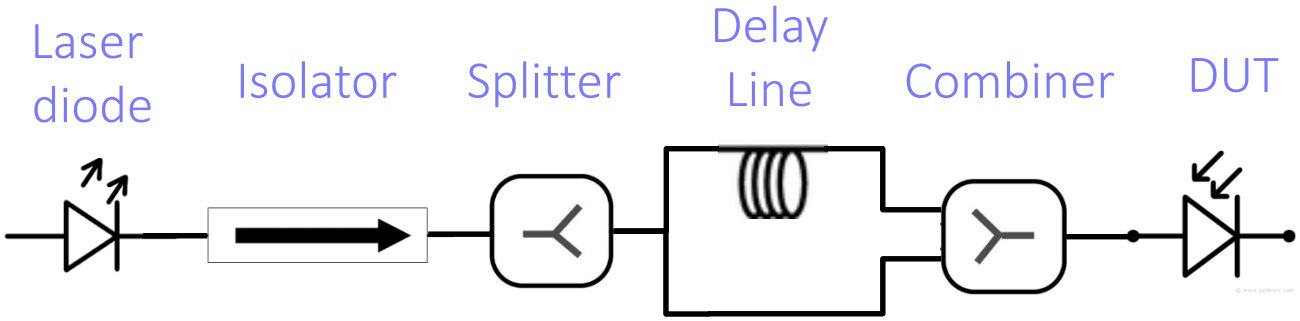


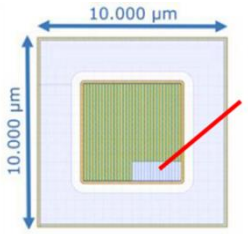






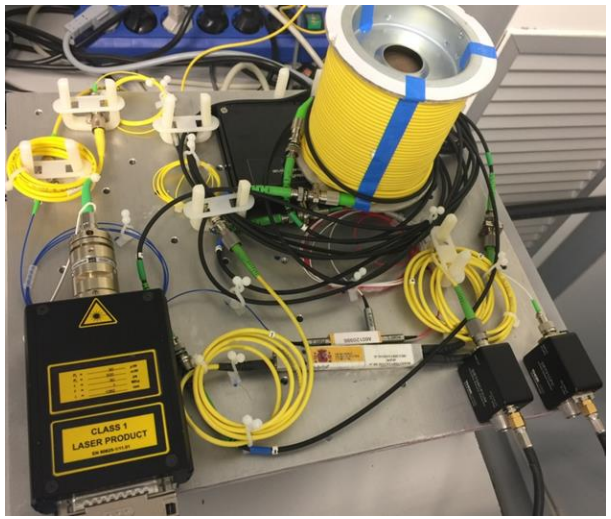
Set-up for timing characterization and DUT





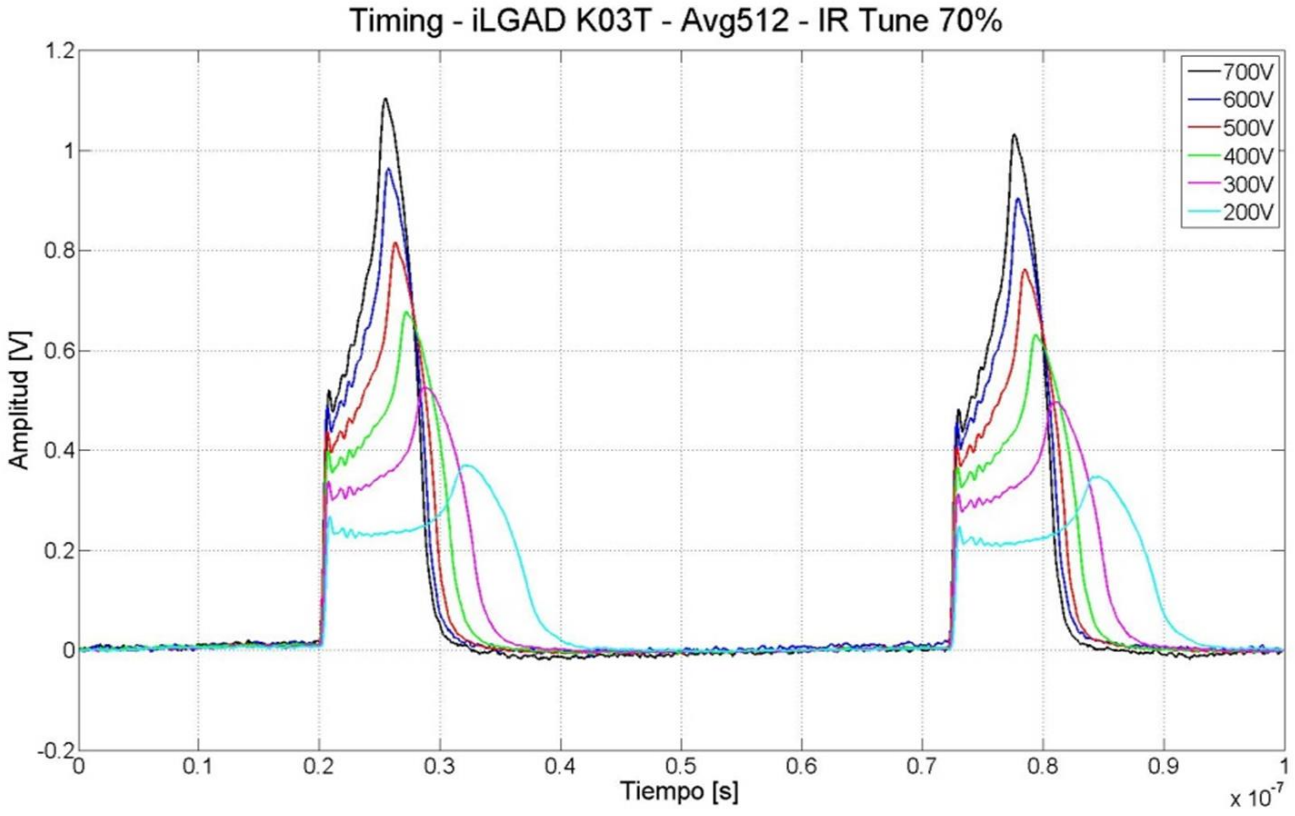
45 strips
Pitch 160 µm

- **Time standard:** constant time interval between two picosecond IR laser pulses (1060 nm)
- Fixed time interval between laser pulses generated by optical splitting and delayed recombination of a single laser pulse.



Set-up for timing characterization and DUT (2)

- Signal amplified (60db, miteq 1660) & digitized (20Gs)
- Acquired averaged waveform from I-LGAD with a time interval of 52.23 ns between pulses.



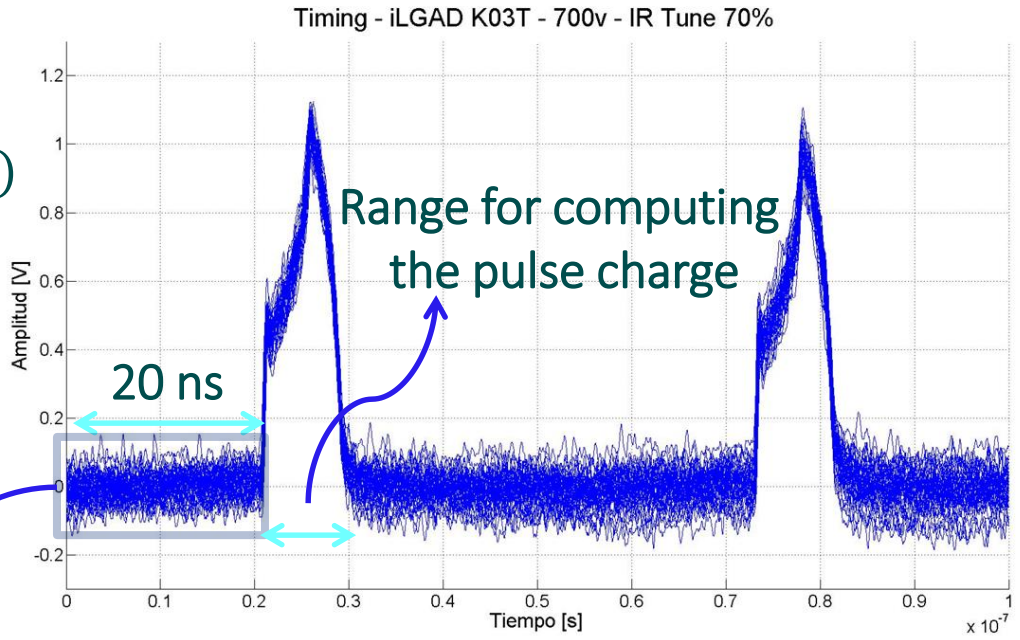
Parameter extraction of the waveform.

- Single-shot (non-averaged) superposition of signals
- For each shot measured: Rise time, Signal amplitude and noise.
- **Signal estimation** as the charge under the transient waveform
- **Noise estimation** as the RMS of charge (from the first 20ns of the waveform)

$$\sigma \equiv RMS\ (Charge\ baseline)$$

$$SNR \equiv \frac{Signal\ Charge}{\sigma}$$

Waveform section from where the baseline noise is estimated



I-LGAD Timing error estimation

- For each Bias voltage five thousand waveform acquired.
- The timing error $\sigma_{\Delta t}$ estimated from the width (sigma) of the distribution of the measured time intervals (Δt)
- Assuming timing errors similar for both pulses then σ_t for I-LGAD is given by $\sigma_{\Delta t} / \sqrt{2}$ (quadratic sum of errors)

Vbias [V]	Rise Time 1 [ps]	Rise Time 2 [ps]	Vp1 [V]	Vp2 [V]	$\sigma_{baseline}$ [au]	SNR1	SNR2	Charge 1 [u. a.]	Charge 2 [u. a.]	Δt [ns]	$\sigma_{\Delta t}/\sqrt{2}$ [ps]
700	334	357	1.105	1.034	13.5	20.6	19.41	279.0	262.0	52.23	25.45
600	326	327	0.965	0.905	14.8	17.02	15.99	252.0	236.6	52.23	26.87
500	330	327	0.815	0.762	14.8	16.0	14.97	237.0	221.6	52.23	27.58
400	357	353	0.677	0.631	14.4	14.3	13.34	206.0	192.1	52.23	31.82
300	357	355	0.526	0.496	15.1	11.5	10.77	174.8	162.6	52.23	37.48
200	354	358	0.370	0.347	14.6	9.5	8.63	139.0	126.0	52.23	46.67

Time error dependence with the SNR

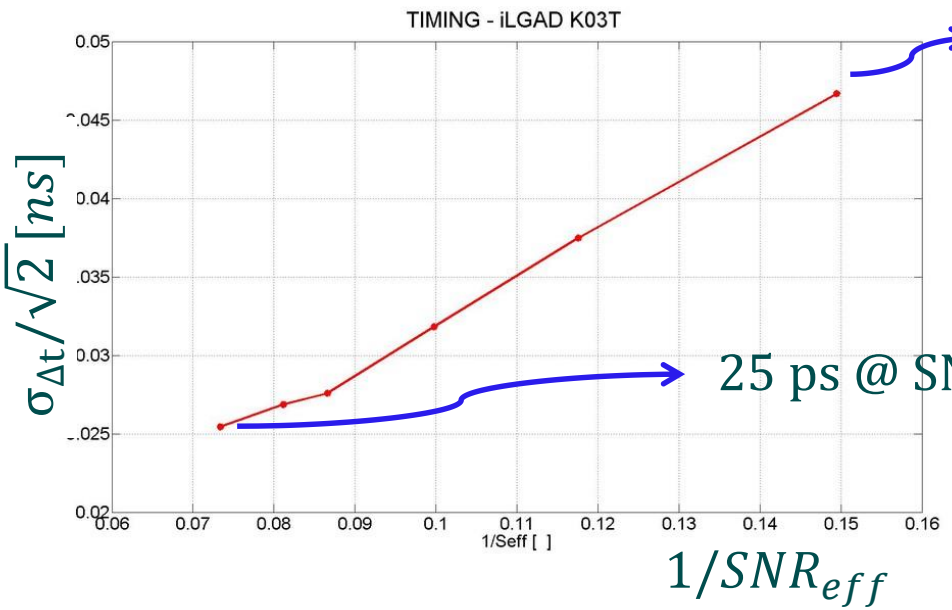
Expected time error dependence with SNR

$$\sigma_t \propto \frac{\text{rise time}}{\text{SNR}}$$

Defining the effective SNR as

$$SNR_{eff} \equiv SNR_1 SNR_2 / \sqrt{SNR_1{}^2 + SNR_2{}^2}$$

$$\sigma_{\Delta t}{}^2 = \sigma_{t1}{}^2 + \sigma_{t2}{}^2 \Rightarrow \sigma_{\Delta t} \propto \frac{1}{SNR_{eff}}$$



Future

- In case of ILC approval we should consider renewing our strategy.
- Avanced Silicon Tracking System:
  - Feature oriented: 4th dimensional tracking based on LGADs
  - Cost oriented (outer tracking): Depleted CMOS.
- To build the physics, performance and cost case.