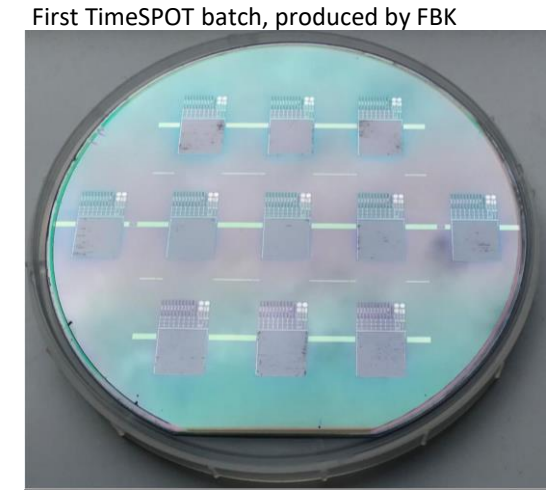
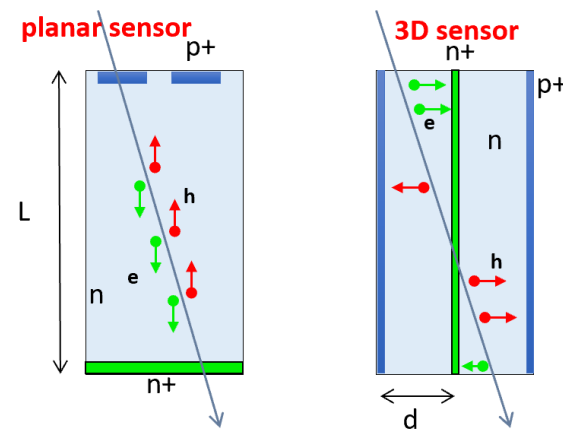
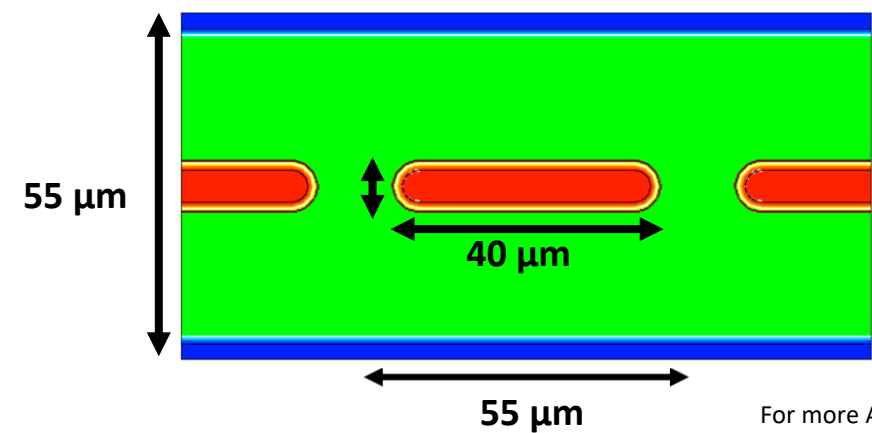
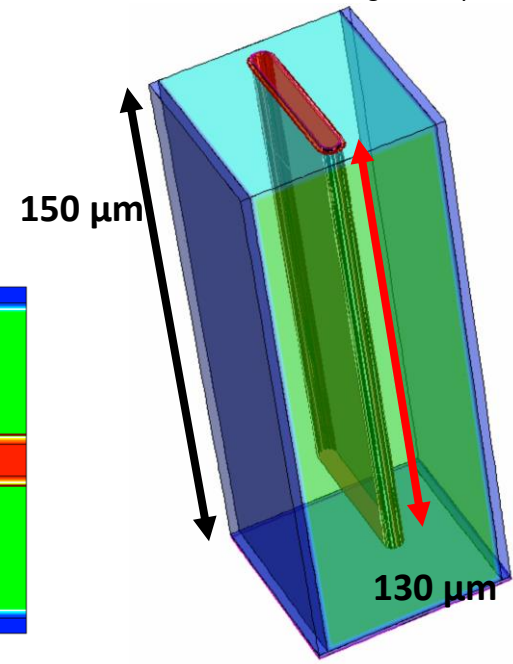


Technology and design

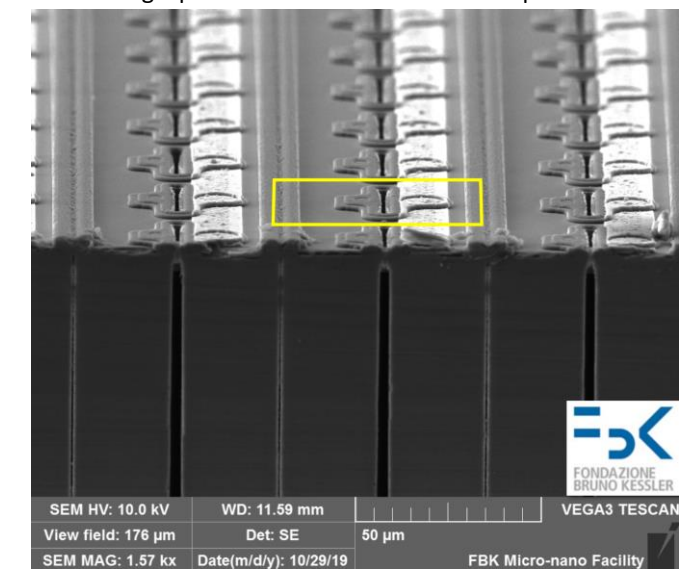
- The approach within TimeSPOT was to use 3D silicon (and Diamond) sensors to achieve fast timing
 - Reducing inter-electrode distance
 - Reducing charge collection time
 - As well improving intrinsic time resolution
 - Increasing radiation hardness
- The final geometry selected for the fast timing 3D sensor is the “parallel-trench”
 - Already produced in two batches (2019 and 2021) by FBK



TCAD model of the selected geometry

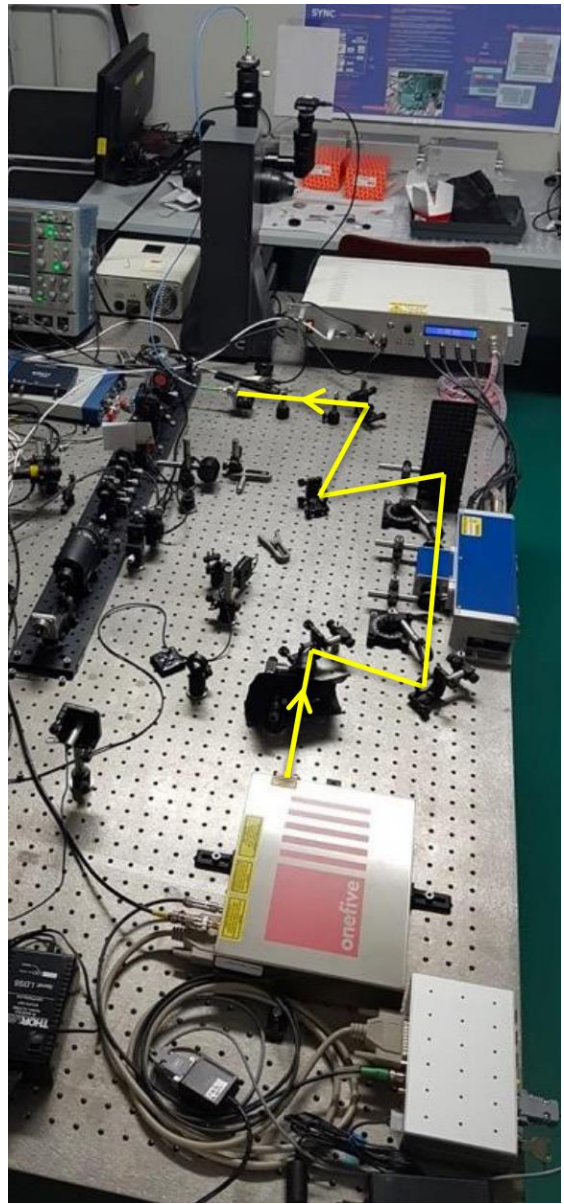


Cut along a parallel trench device based strip sensor



For more A. Loi <https://iris.unica.it/handle/11584/284136>

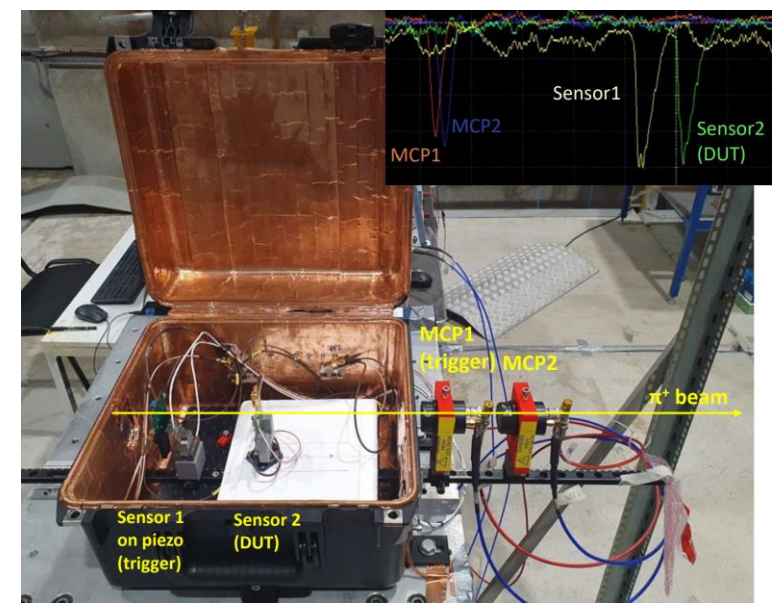
TimeSPOT TCT setup



Measurements

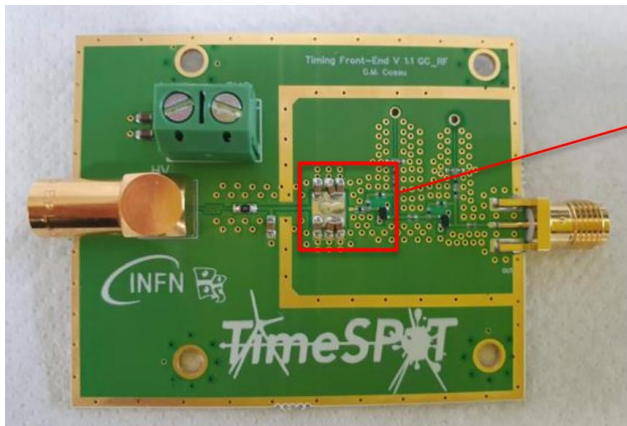
- Sensor has been characterised
 - Test beams (10/2019, 10/2021 and 5/2022) →
 - Intrinsic time resolution
 - Performance by tilting the device
 - Sensor Efficiency
 - Performance after radiation
 - ← Own constructed TCT setup in Cagliari
- Customised fast readout has been developed in order to fully explore sensor performance ↓

Test beam setup for intrinsic time resolution characterisation

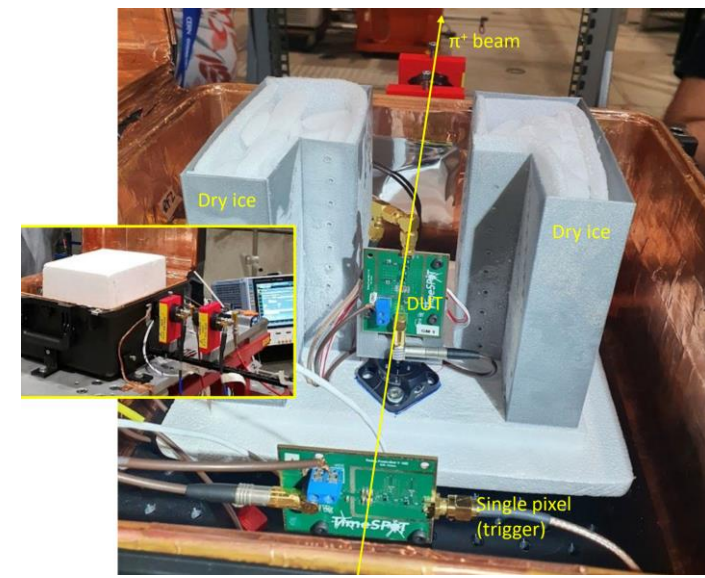
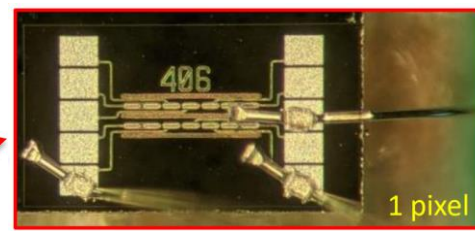


Dry ice enclosure for rad hard measurements

TimeSPOT fast-electronics



Single pixel test device

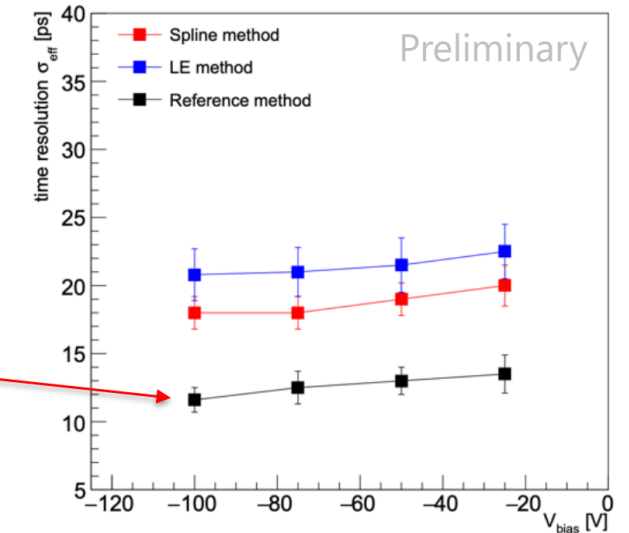
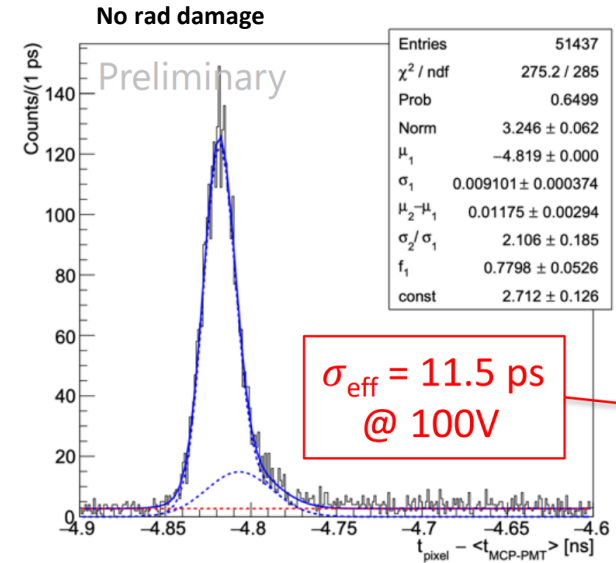


For more G.M. Cossu <https://arxiv.org/pdf/2209.11147.pdf>

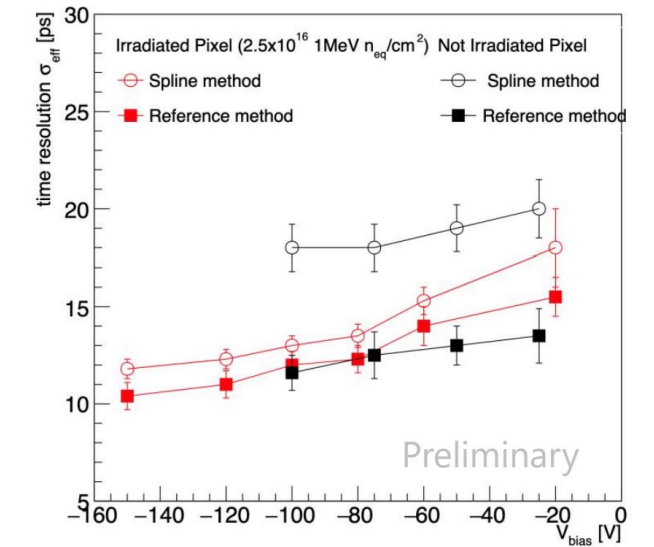
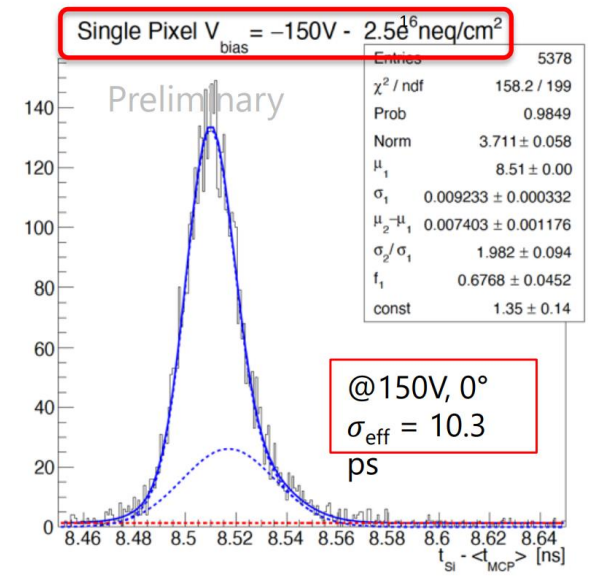
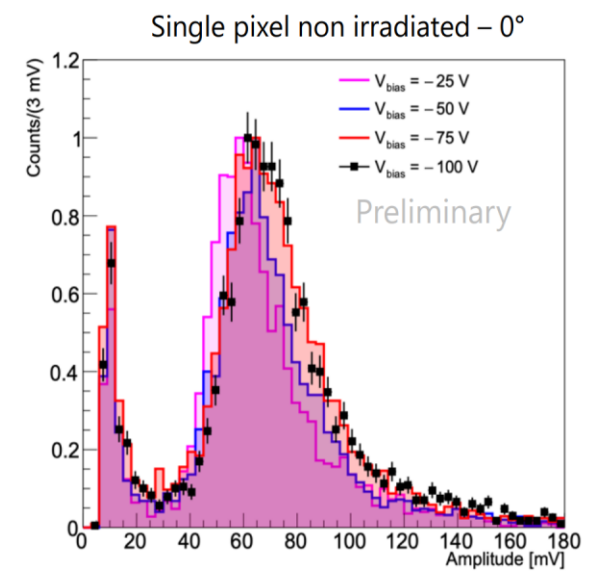
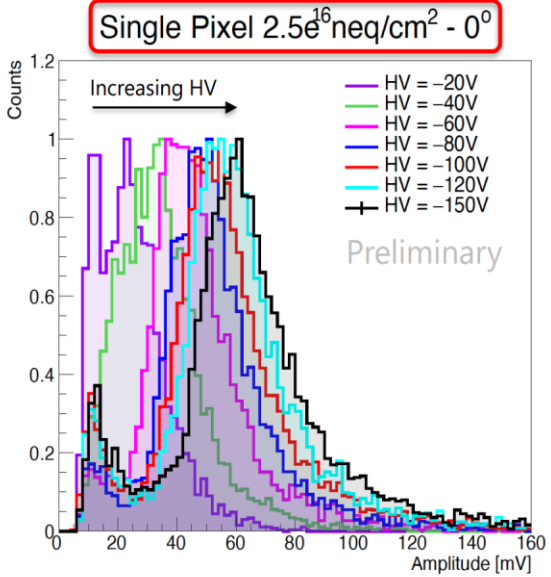


Results (1)

- Intrinsic time Resolution before and after radiation damage above 10^{16} n_eq



After rad damage ↓

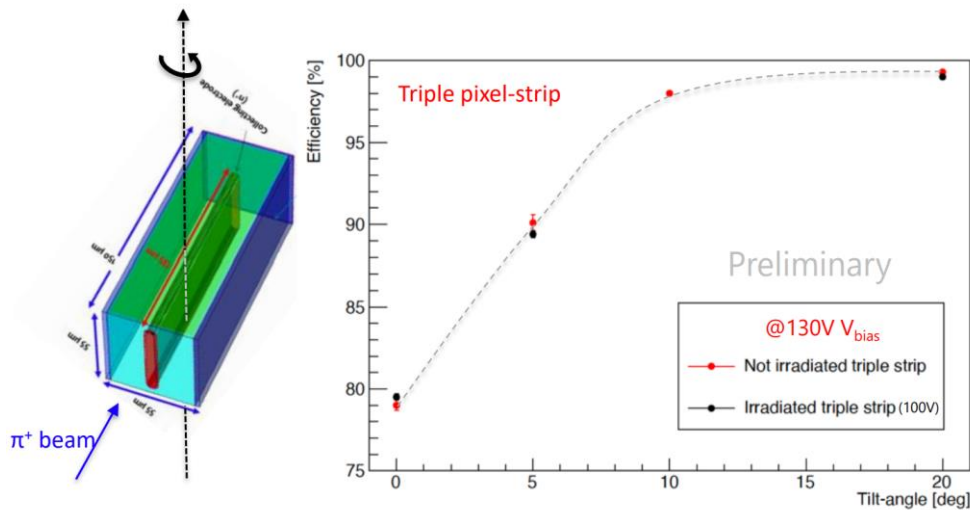
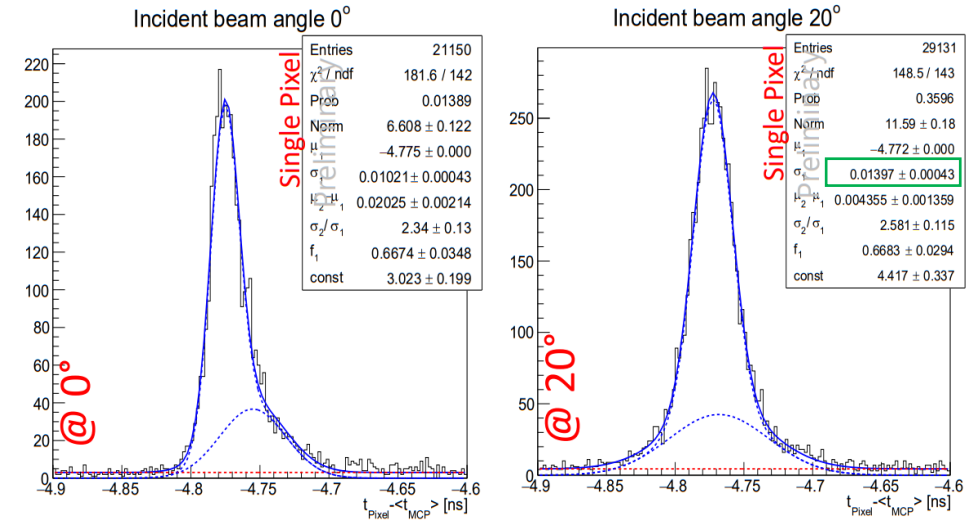


With a slightly larger bias voltage (w.r.t. non-irradiated pixel working point) the signal amplitude of irradiated sensors is recovered!

For more info: A. Lampis
https://indico.cern.ch/event/1120714/contributions/4867208/attachments/2472539/4242526/Andrea_Lampis_iworld2022.pdf
https://indico.cern.ch/event/1127562/contributions/4954529/attachments/2511647/4317271/TimeSPOT_TWEPP2022_Final.pdf

Results (2) and outlook

- Sensor behaviour has been studied also by tilting it
 - ToA distribution at 20° becomes more gaussian
 - The inefficiency (at normal incidence) due to the dead-area of the trenches is fully recovered by tilting the sensors around the trench axis
 - It also works for irradiated sensors



• Outlook:

- 32x32 pixel matrix has been bump-bonded on the TimeSPOT-1 ASIC and currently tested. Future 4D tracking detector and its components are under test and characterisation (more about it on Lorenzo's slides)

