3D n-on-n Detectors

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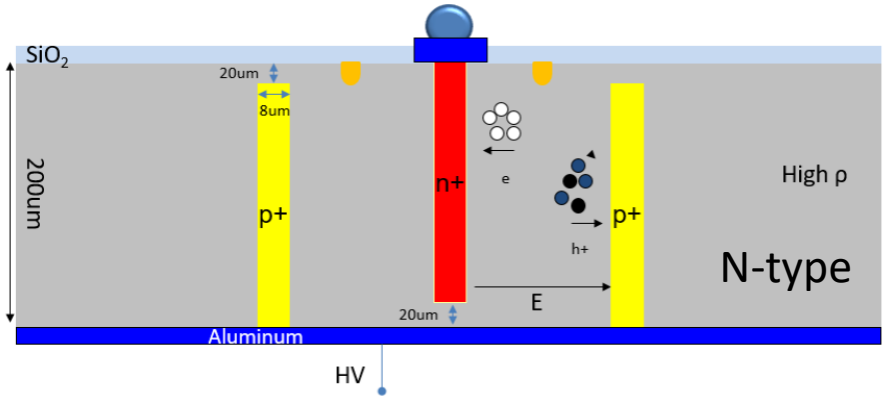
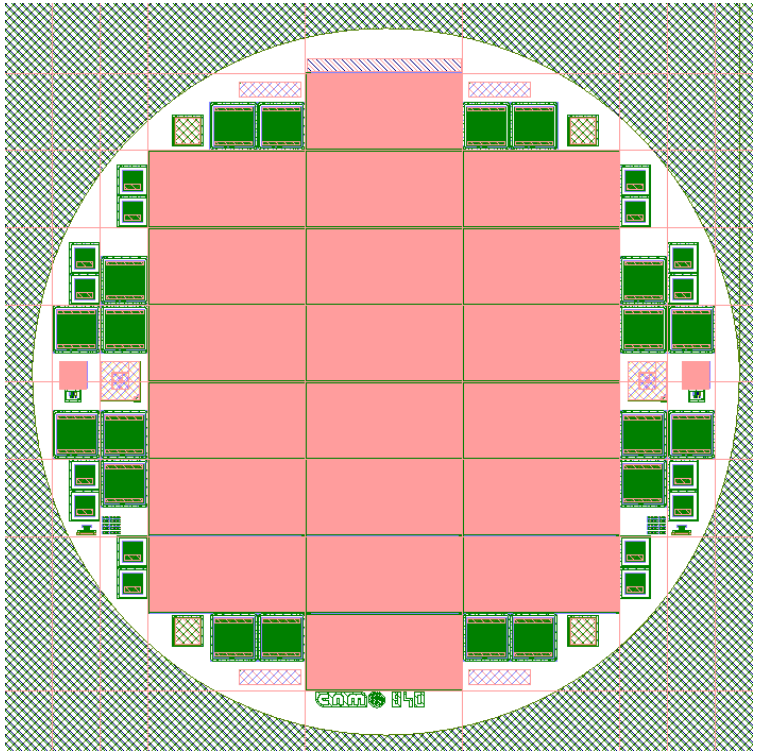
- I-V measurements
- TCT measurements
- Conclusions and future work

Introduction



- 200µm-thick, high resistivity, n-type wafers
- 180µm-deep columns
- 8µm of diameter for columns



List of devices:

- 9 RD53 50x50um^2 (1-x)
- 9 RD53 25x100um^2 2E (2-x)
- 2 RD53 25x100um^2 1E (3-x)
- 9 Diodes 50x50um^2 (5-x)
- 16 Diodes (small pad) 50x50um^2 (6-x)
- 6 Diodes 25x50um (7-x)
- 6 Diodes 25x100um^2 (8-x)
- 4 MOS (9-x)

N- type wafer makes p-n junction to happen in the backside → n+ column is shorted: High current expected

After irradiation, electron traps act as acceptors → substrate type inversion: normal current expected

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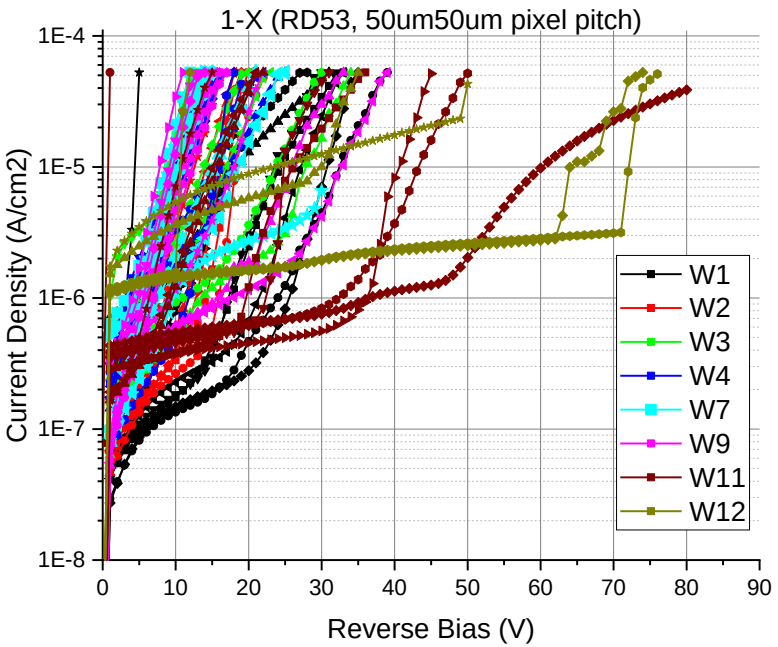
Irradiation

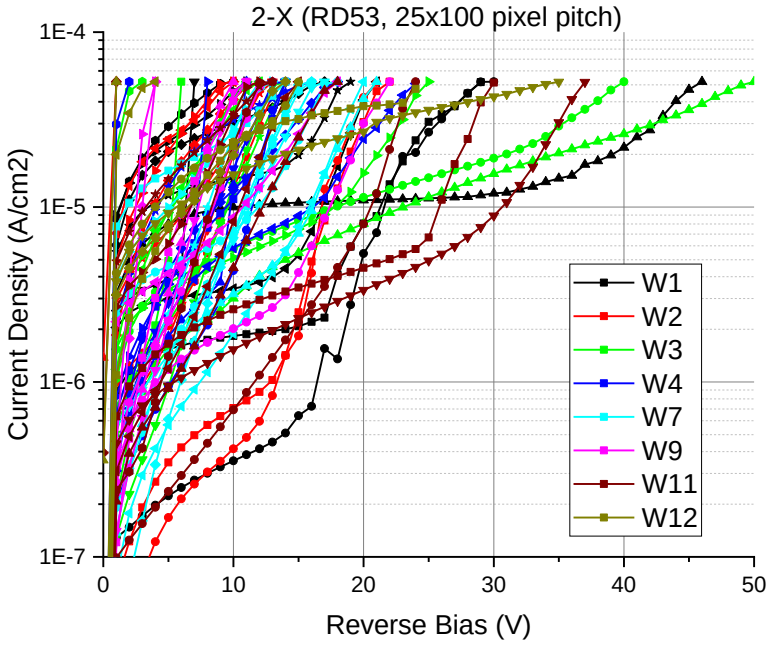
- Devices have been irradiated at Jožef Stefan Institute at the fluences of: 1e14cm^{-2}, 1e15cm^{-2}, 5e15cm^{-2}, 1e16cm^{-2}, 5e16cm^{-2}, 1e17cm^{-2}.

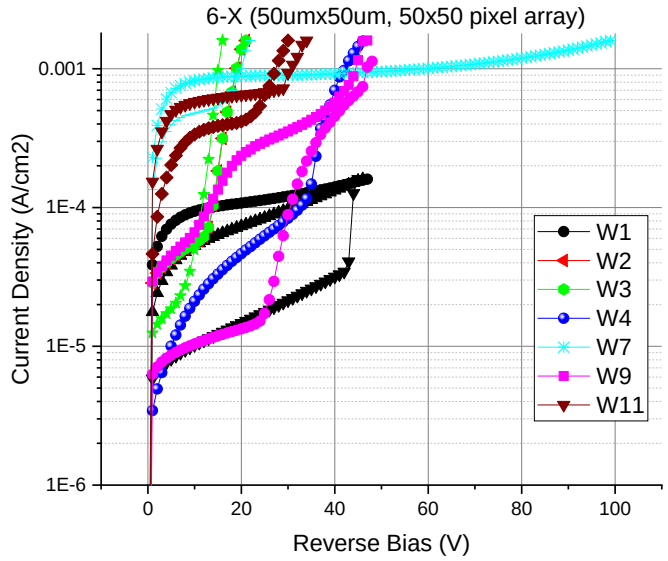
- Devices chosen for irradiation:
  - RD53 50µmx50µm
  - RD53 25µmx100µm
  - Diodes 50µmx50µm →50x50pixel array
  - Diodes 25µmx100µm → 100x100 pixel array
  - Small 50µm50µm test structure diodes for timing measurements

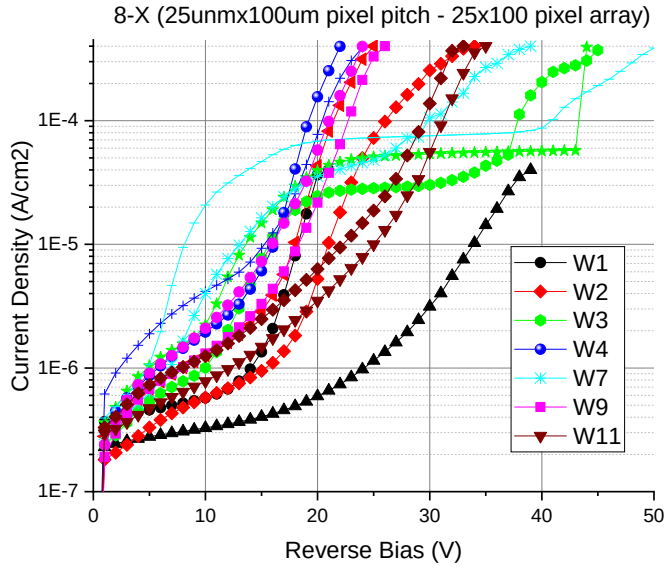
I-V measurements

I-V measurements – Before irradiation





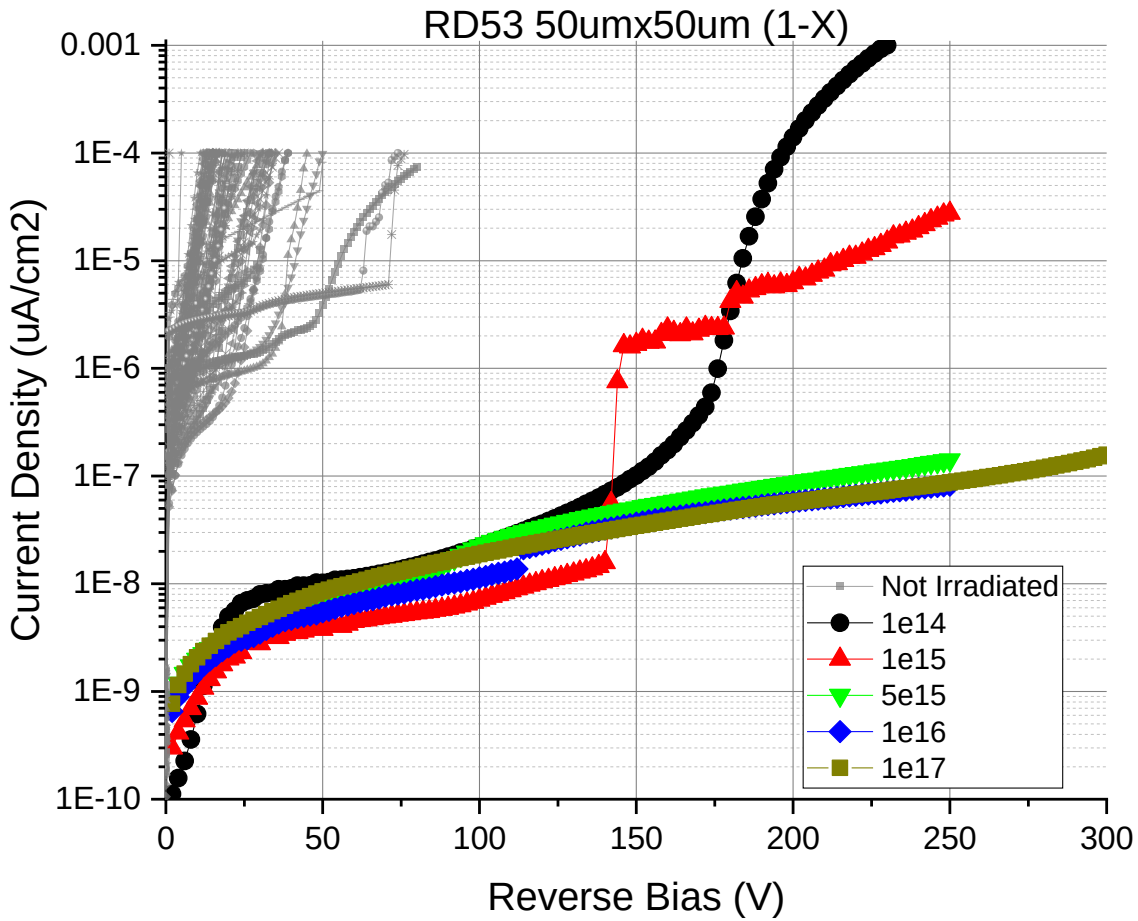


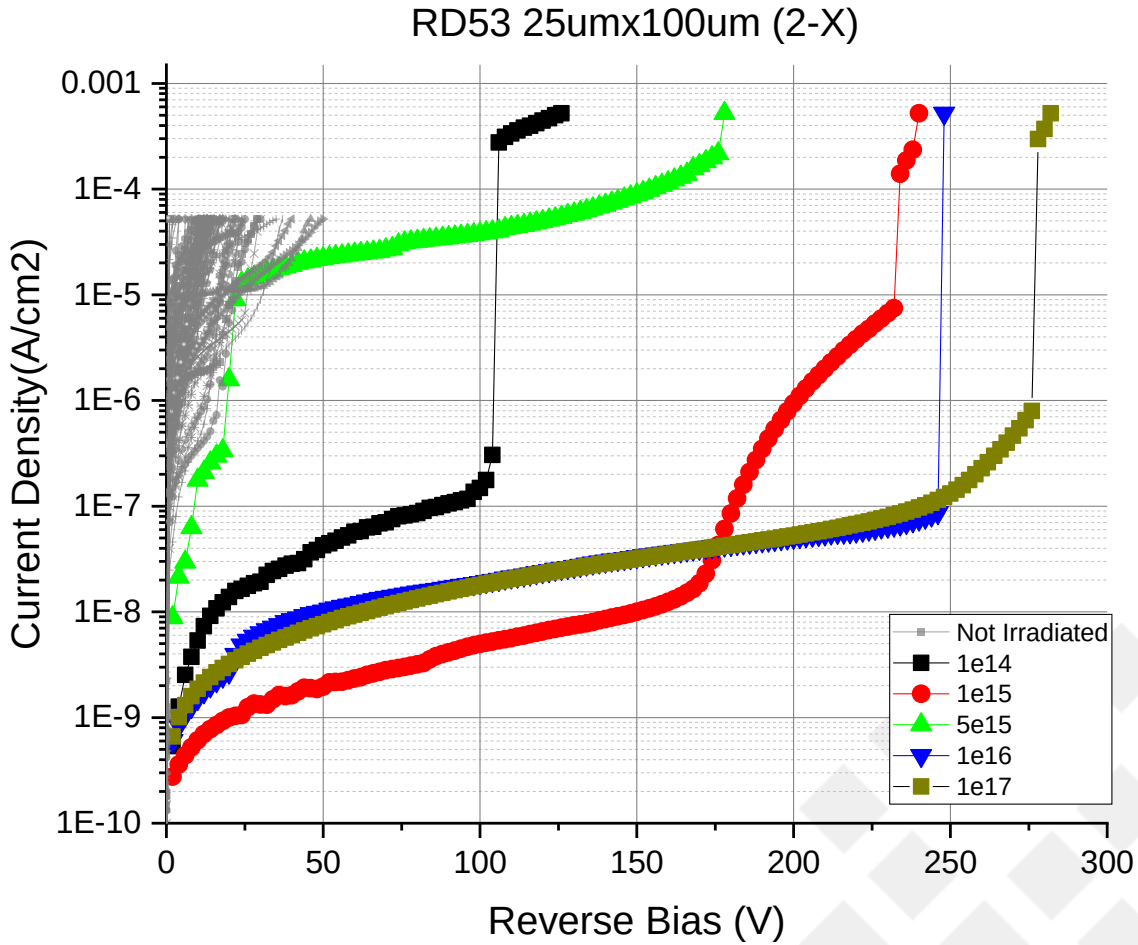


I-V measurements on wafer, T = 20ºC

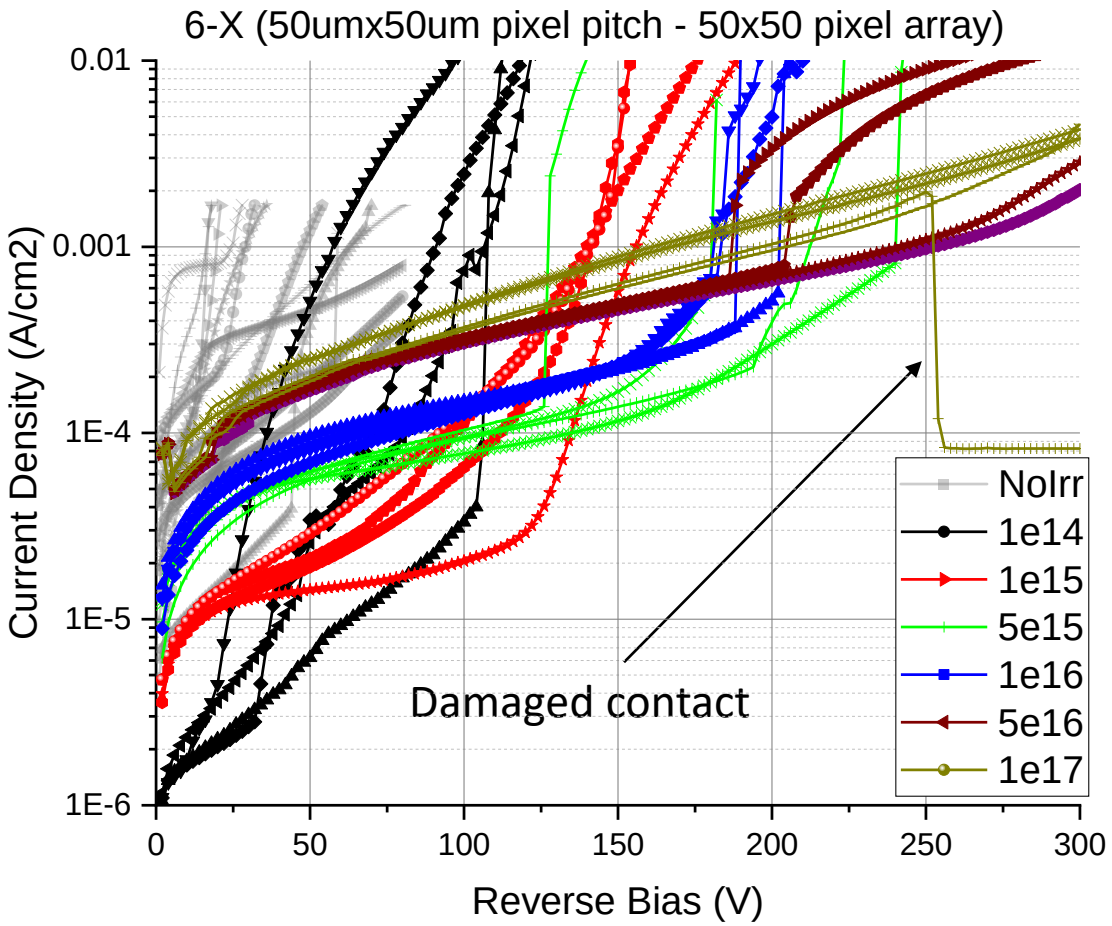
High leakage current and low Vbd

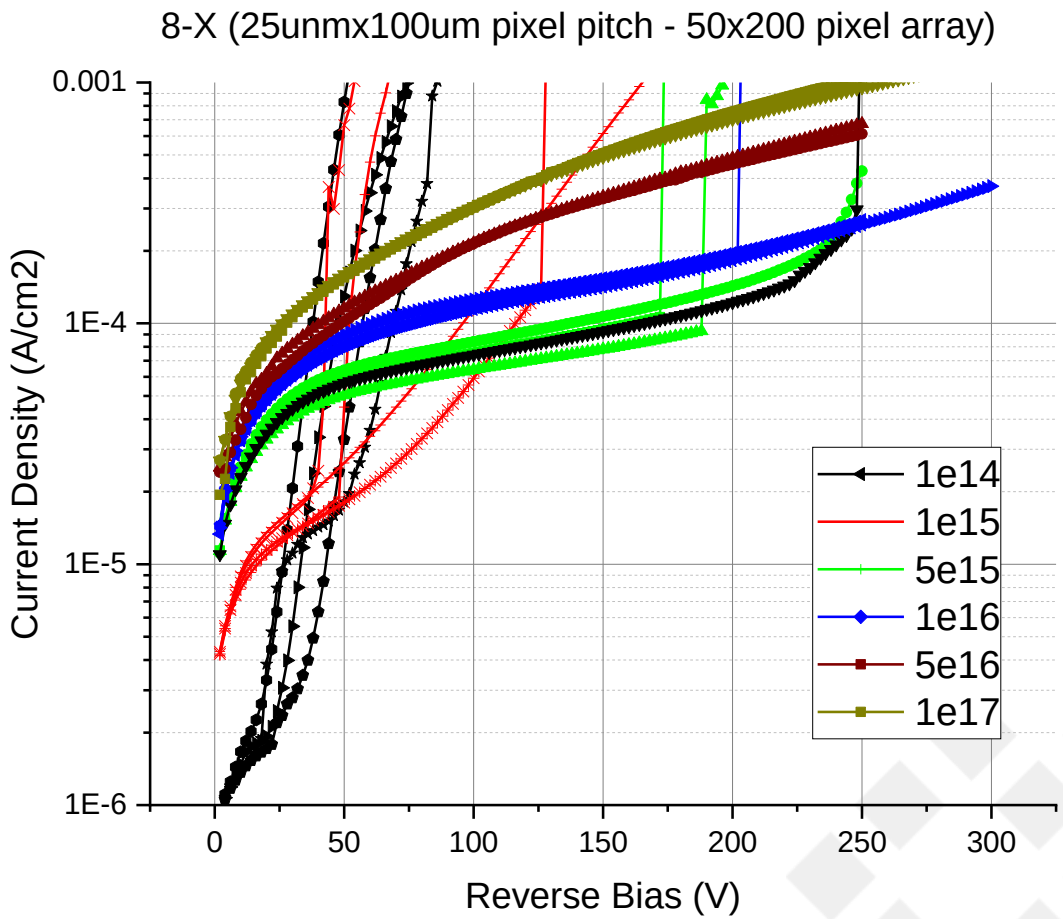
I-V measurements (T = -20ºC)





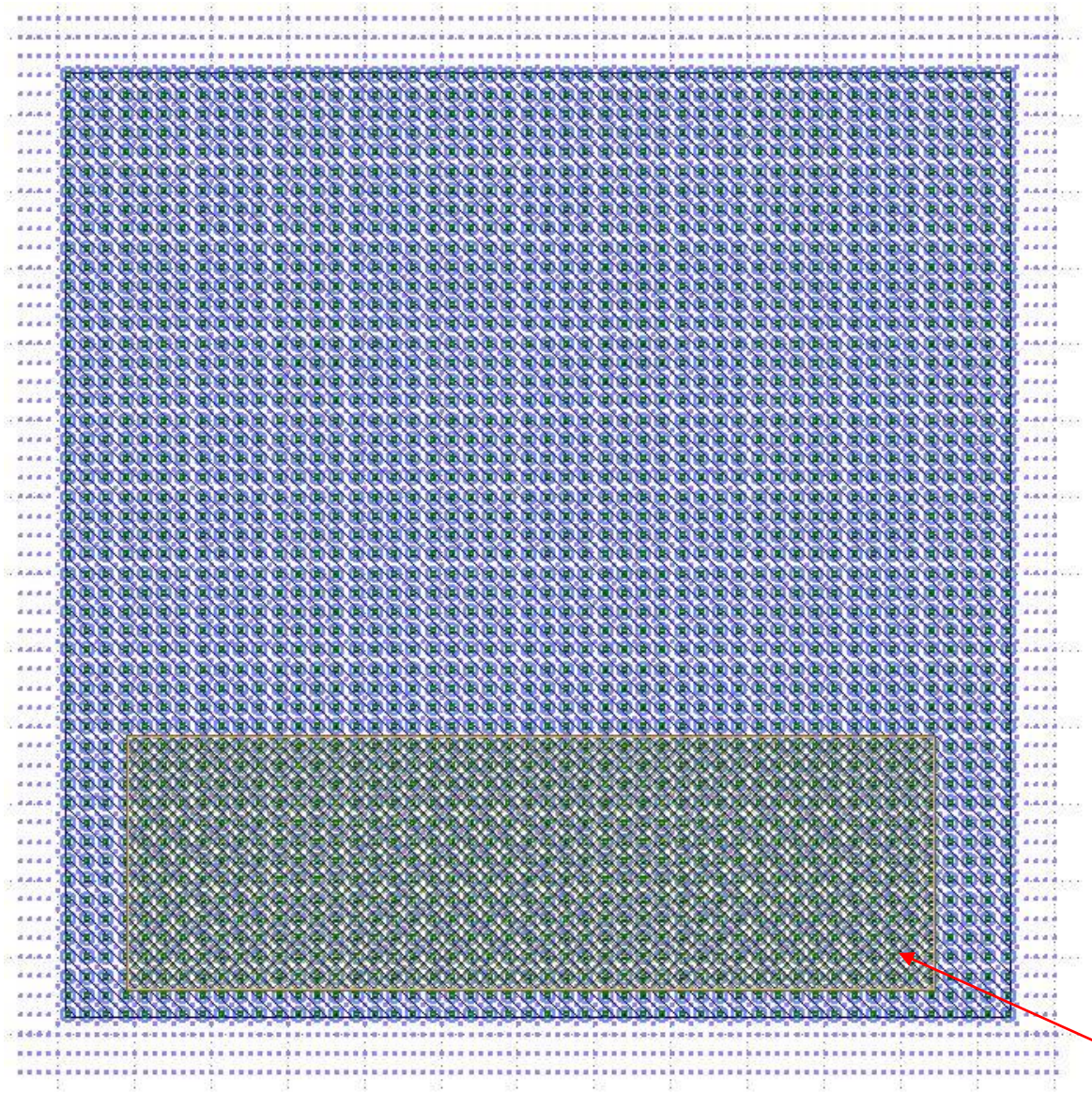
I-V measurements (T = -20ºC)





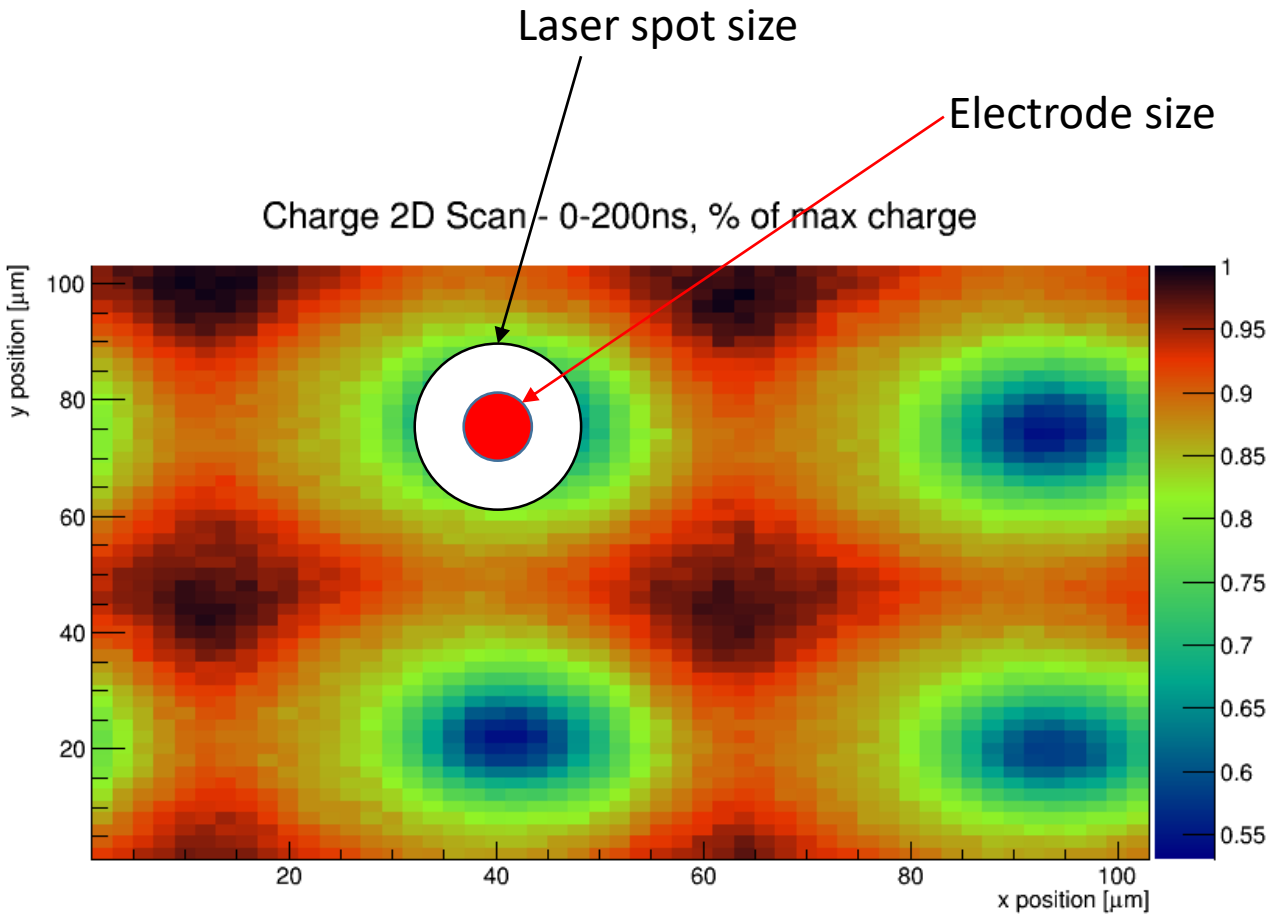
TCT measurements

TCT measurements – DUT

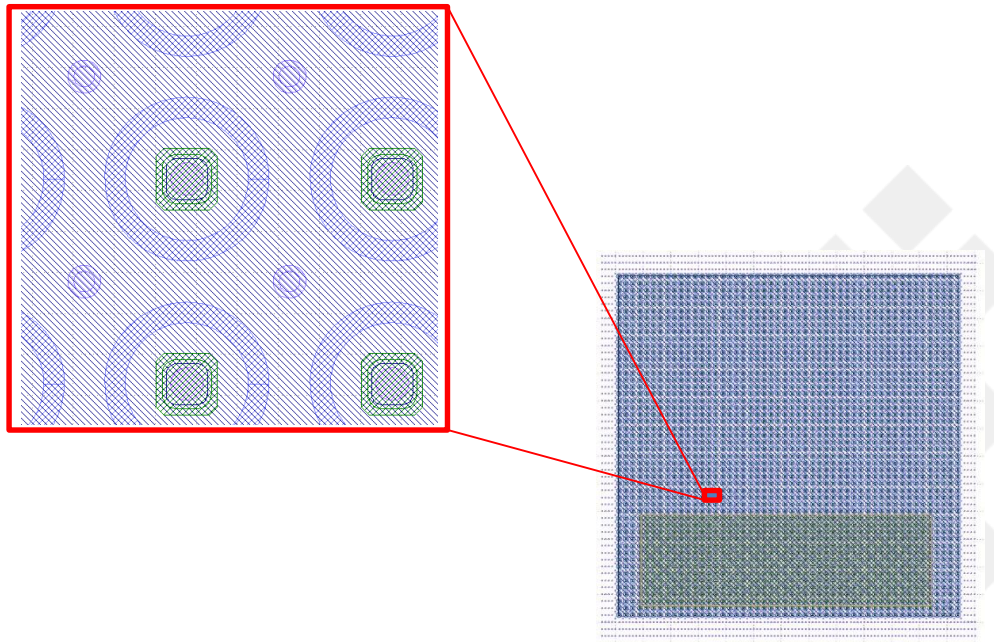


- 50x50 pixel array with 50µmx50µm pixel pitch
- Diodes shorted with highly doped polysilicon on top
- Pad made of metal (for wire bonding)
- Reverse bias voltage = 20V
- T = 20ºC
- Laser spot size ~30 µm

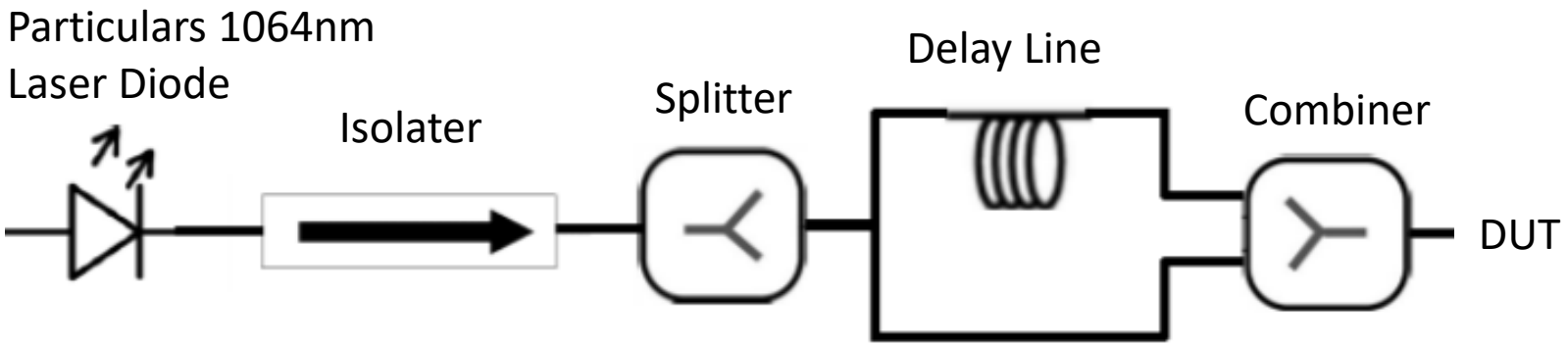
TCT measurements – Charge Collection



- On the electrodes, no charge should be collected
- Laser spot size > electrodes → no region with no charge collection

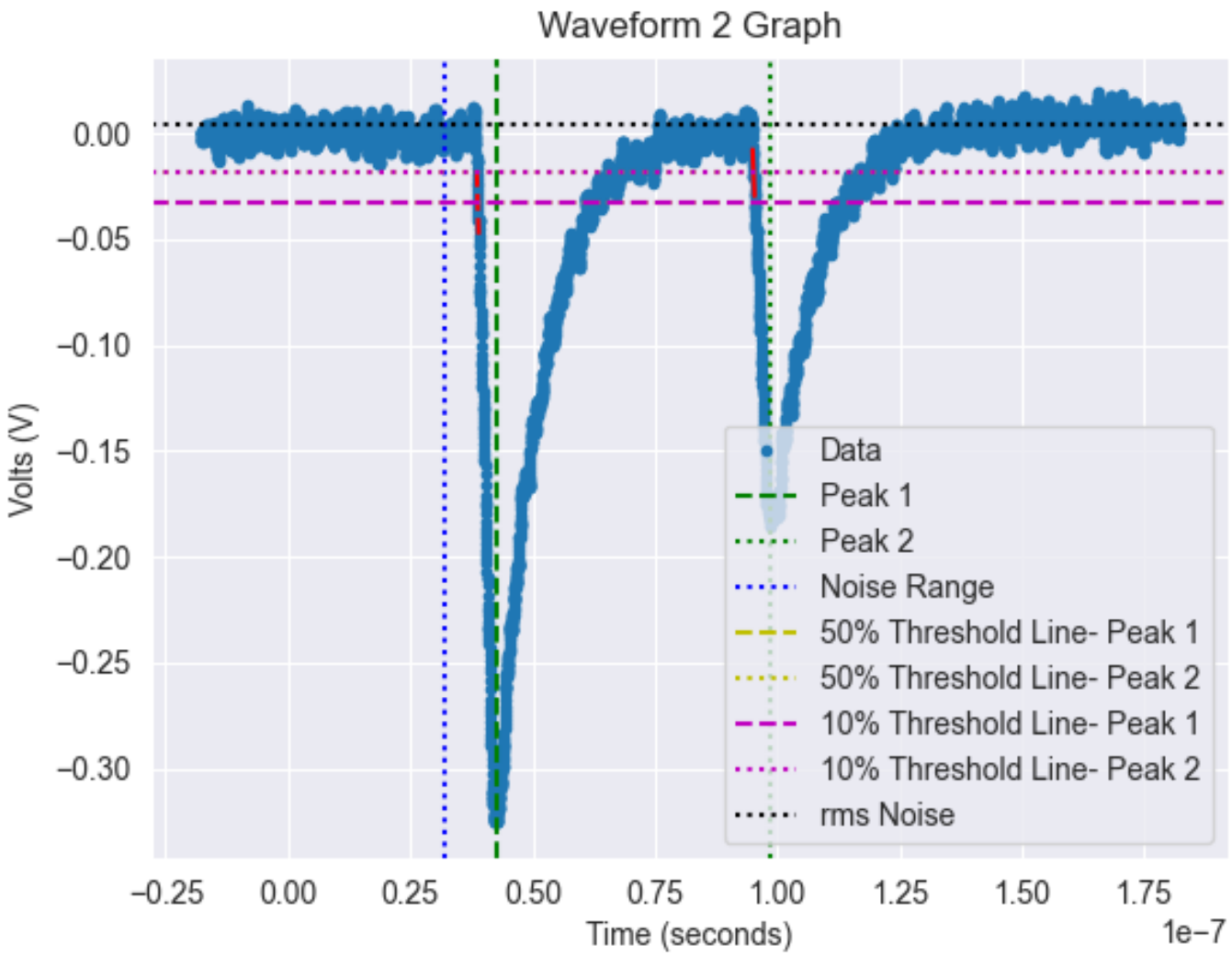


Timing setup



- IR laser Split into two paths
- One path, delays the laser pulse roughly 50ns. This pulse is used as the reference signal
- The second is not affected
- The two pulses are recombined and shined on the DUT

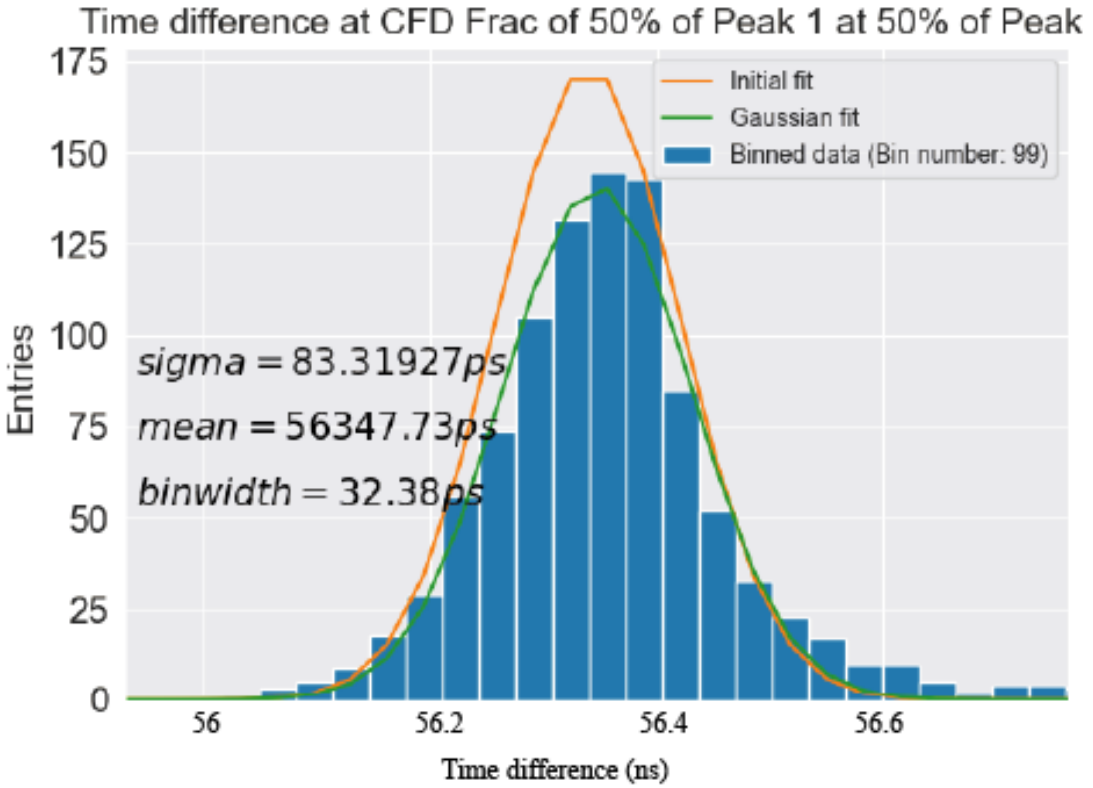
TCT measurements – Timing

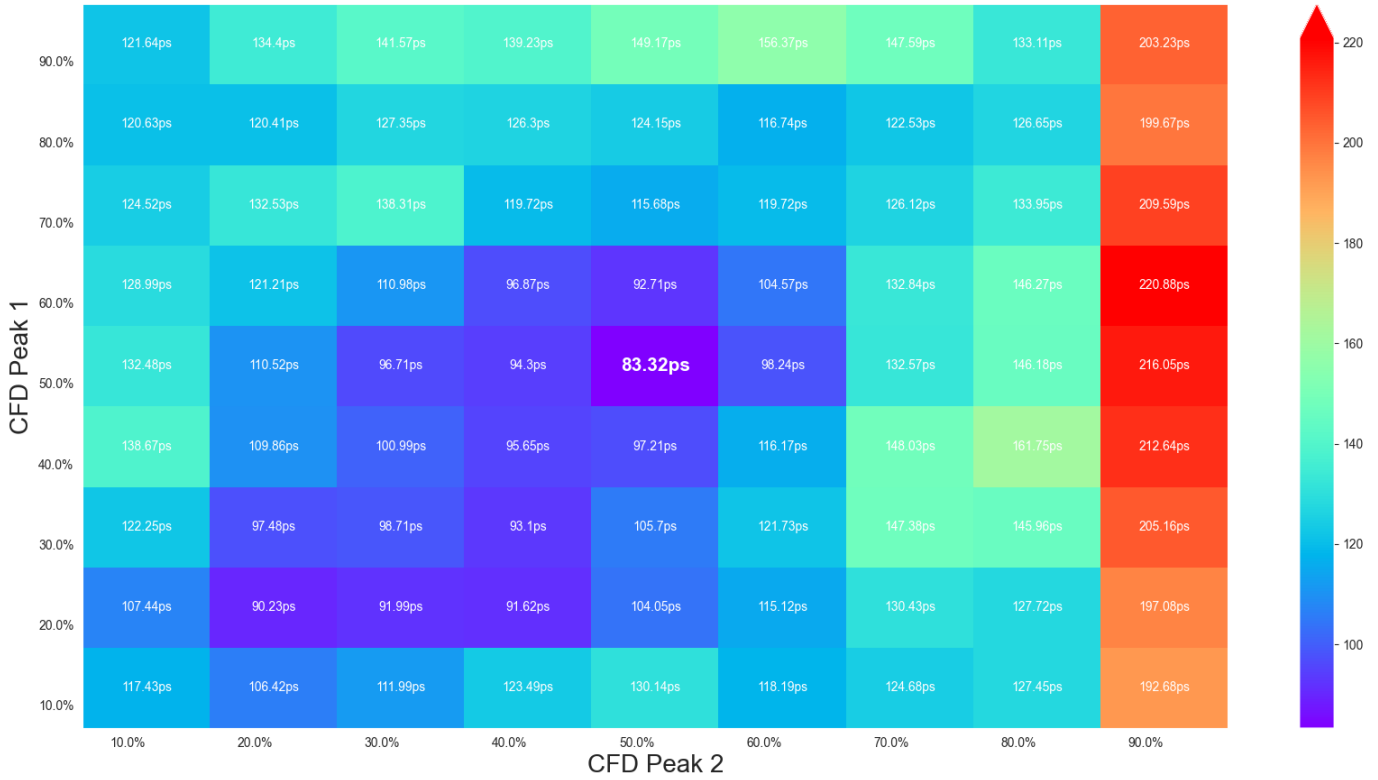


- 1st peak almost double the large as the 2nd → in future measurements, corrected with an attenuator
- First 1000 points used for evaluating noise and baseline correction.
- Peaks fitted with a 2 degree polynomial with 4 points
- Linear fit using 9 points for the CFD
- T = 20ºC
- Bias voltage = 20V

TCT measurements – Timing

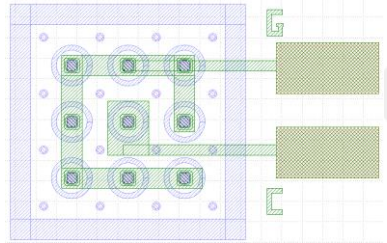
Timing results





Conclusions and future work

- N-on-n 3D detectors have high leakage current and low V_{bd} before irradiation
- I-V measurements show that they can work after irradiations of fluences up to $1e17N_{eq}/cm^{-2}$.
- TCT measurements show potentially good CCE and timing performance, but better measurements have to be performed (attenuator, low temperature…)
- Irradiated devices are to be tested with the TCT.
- Smaller diode arrays (3x3) will be used for timing measurements (less noise due to capacitance). Also, TCT will be calibrated as a MIP.



Thank you for your attention