CNM Activities on LGADs at the RD50 Framework

35th RD50 Workshop

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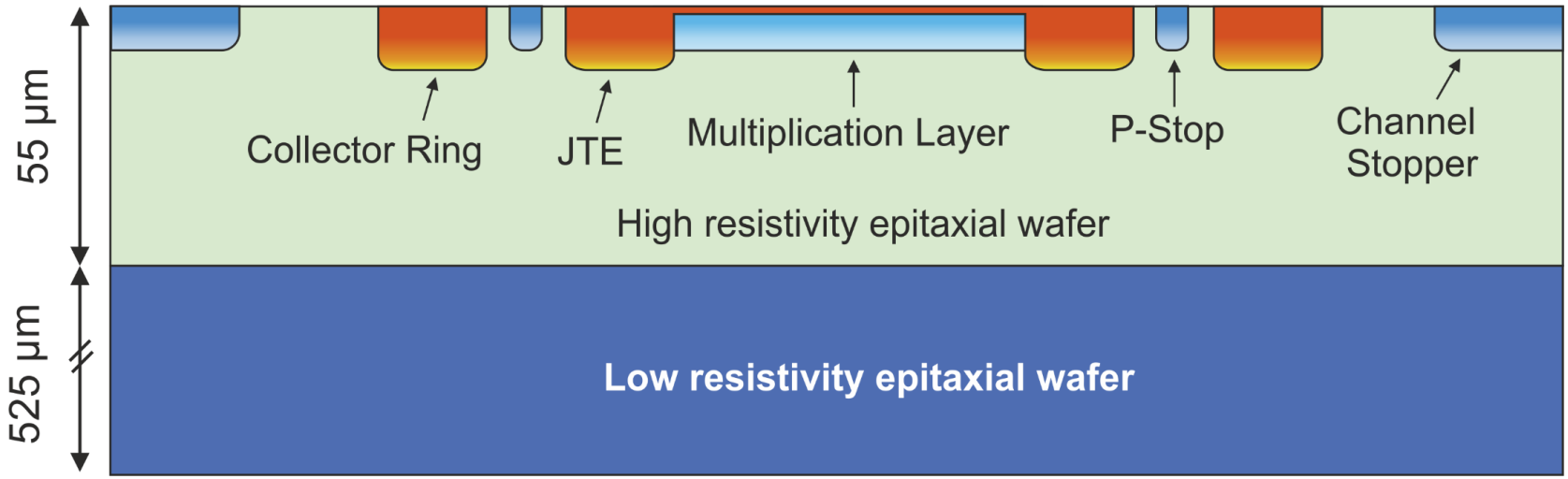
Current status of LGAD Runs

- 3 LGAD runs produced in 2019 by CNM.
- **Run 11486** fully characterized.
- **Run 12916** is preliminary characterized.
- **Run 13002** is expected to finish at the end of 2019.

Run	Description	Status
11486	First 6-inch run in 50/350 µm SOI wafers	Finished (14/02)
12916	Repetition of Run11748 (AIDA 2020)	Finished (31/10)
13002	Repetition of Run11486 (6 inches) in epitaxial wafers	In process

Run 13002 specifications

- **4 wafers:** different dose/energy values for the p-type multiplication layer. Calibration with run 11486.
- 6-inch 55/525 µm epitaxial wafers.
- Same mask as Run 11486.

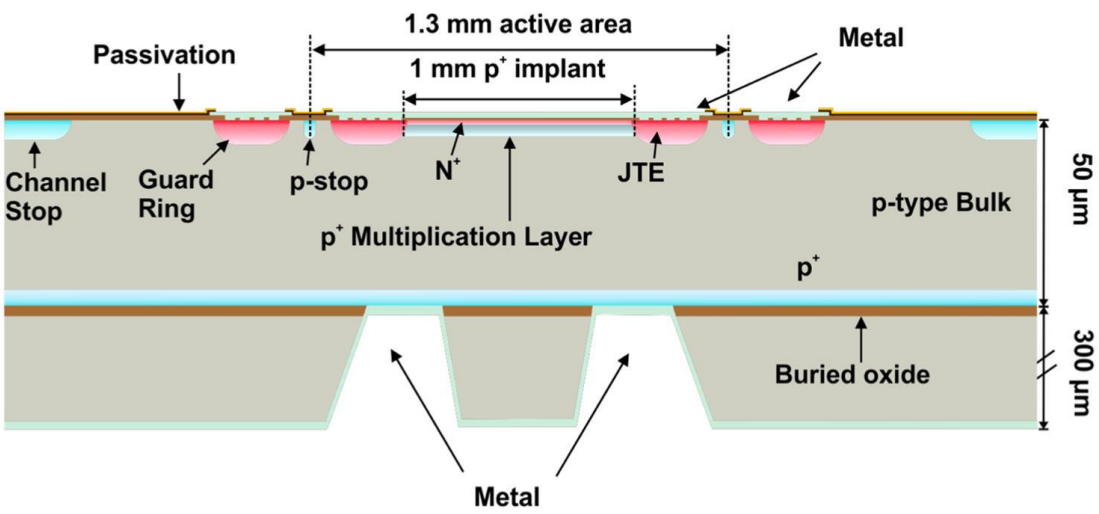


Run11486 specifications

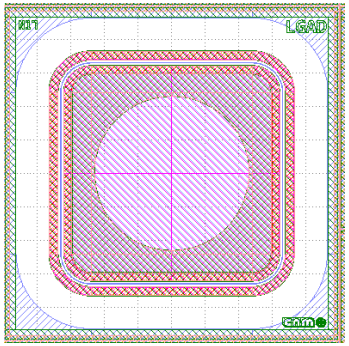
- **Run11486**: 7 wafers (5 measured + 2 broken)
- Wafer mapping IV (586 devices).
- IV/CV measurements on-wafer.
- Wafers **2,3** and **5** will be delivered.
- Wafer **1** had a problem with the metallization and wafer **7** has too much gain.

Wafer	Dose (at/cm²)	Energy (keV)
1	Low	Low
2	Med	Low
3	High	Low
4	Med	Med
5	High	Med
6	Low	High
7	Med	High

Silicon on Insulator wafer: 50 µm FZ+ 1 µm Oxide + 300 µm CZ

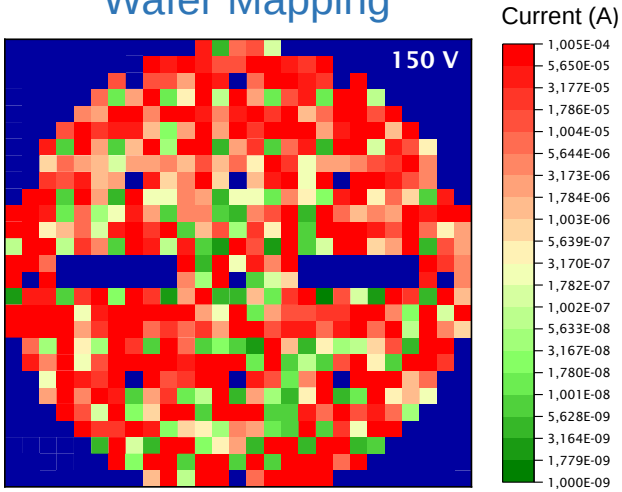


Pad diodes

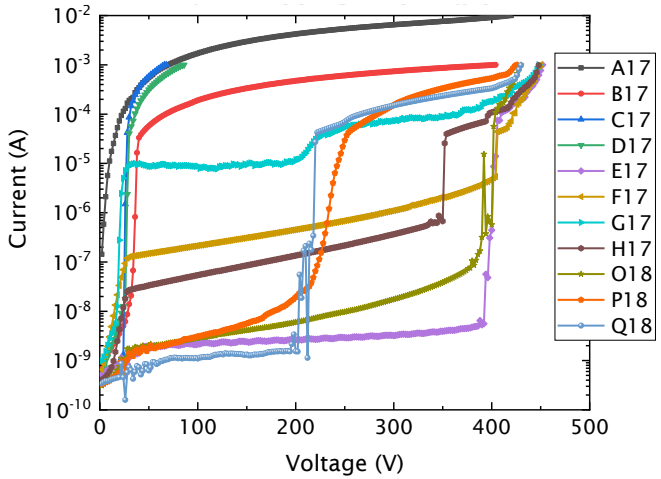


Wafer 1: Low dose – Low energy

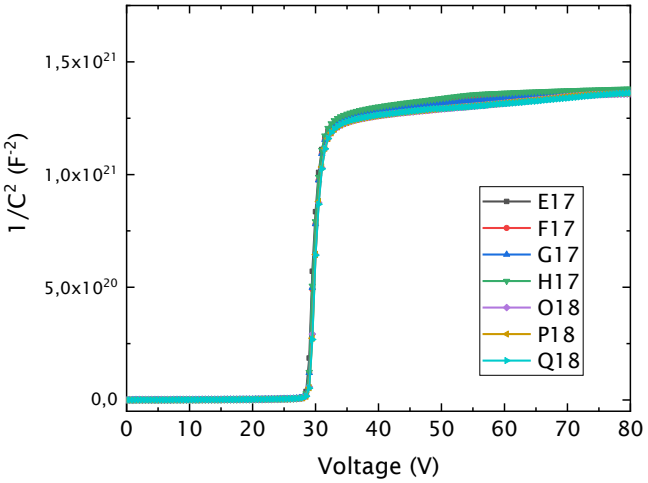
Wafer Mapping



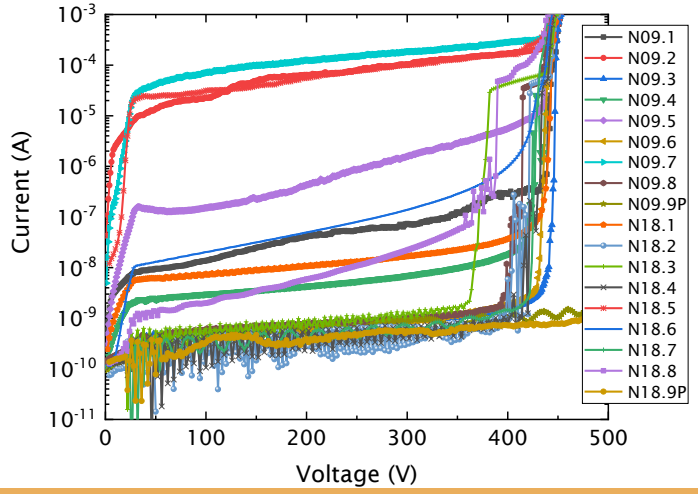
Active area = 3.3x3.3 mm²



C-V Measurements

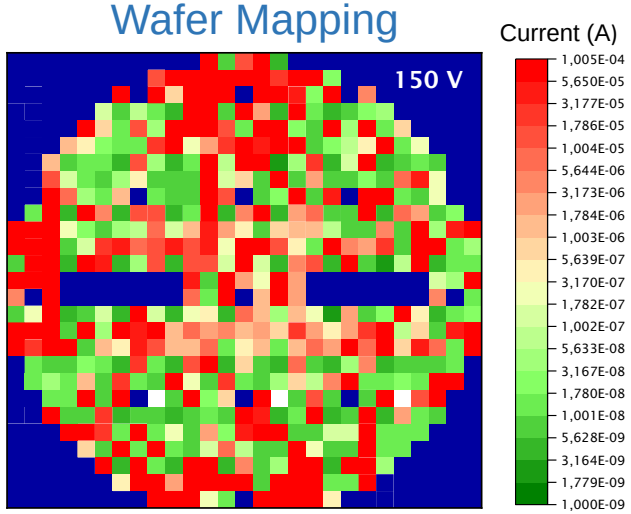


Active area = 1.3x1.3 mm²

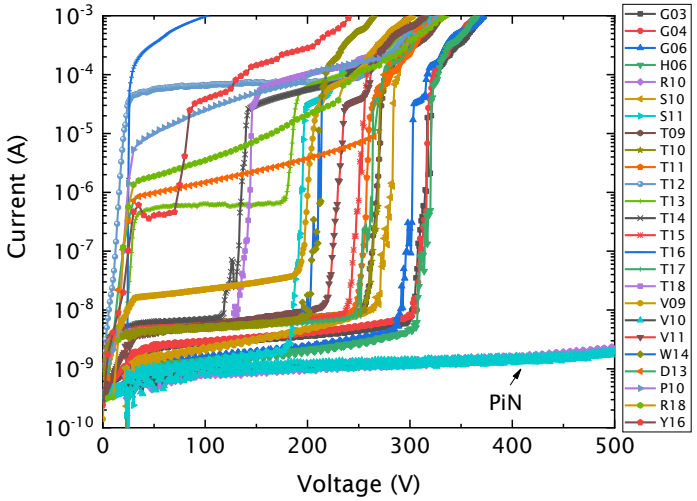


Wafer 2: Medium dose – Low energy

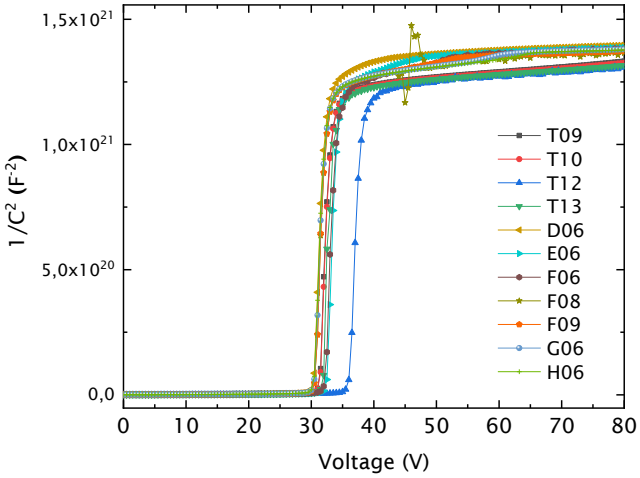
Wafer Mapping



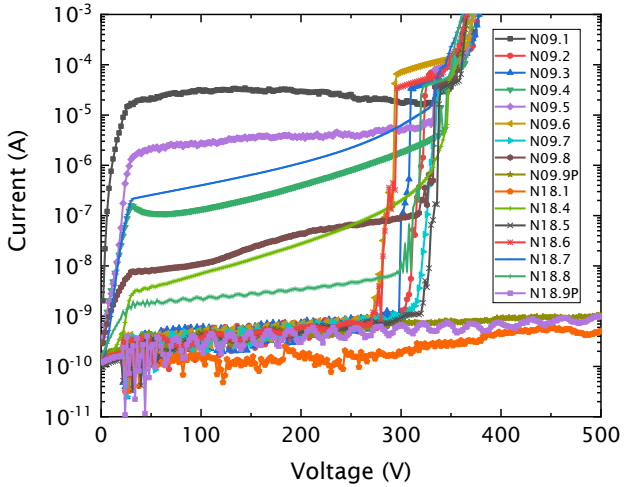
Active area = 3.3x3.3 mm²



C-V Measurement

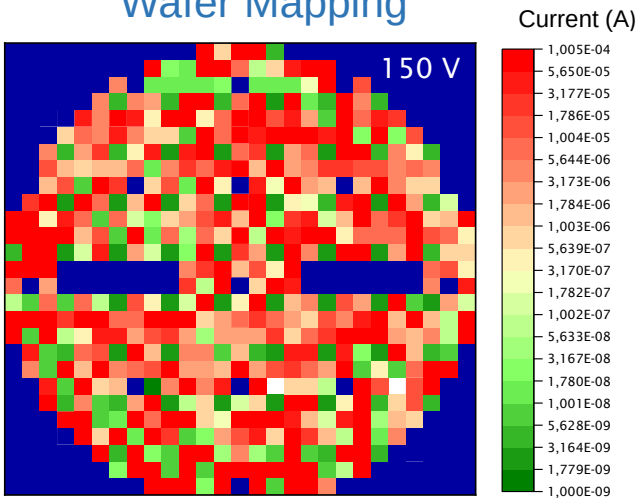


Active area = 1.3x1.3 mm²

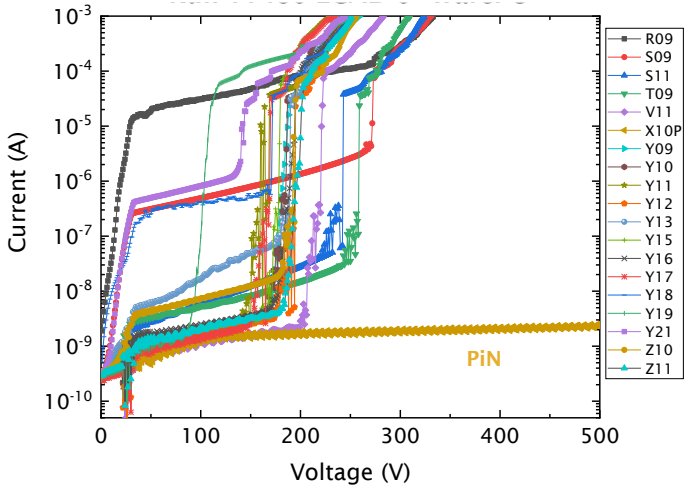


Wafer 3: High dose – Low energy

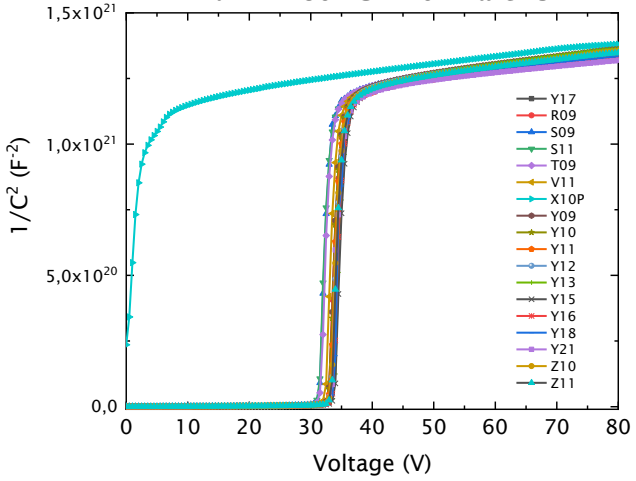
Wafer Mapping



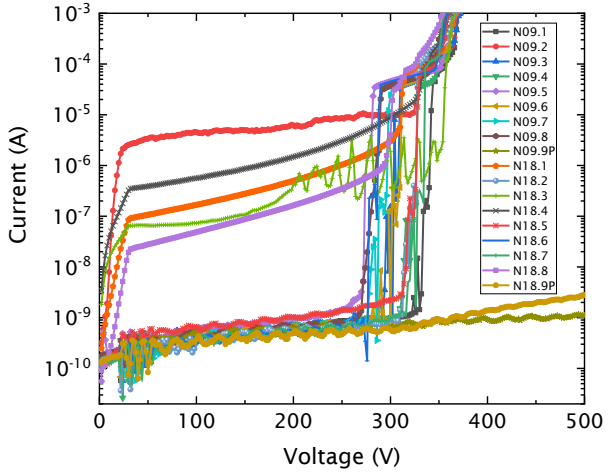
Active area = 3.3x3.3 mm^2



C-V Measurement

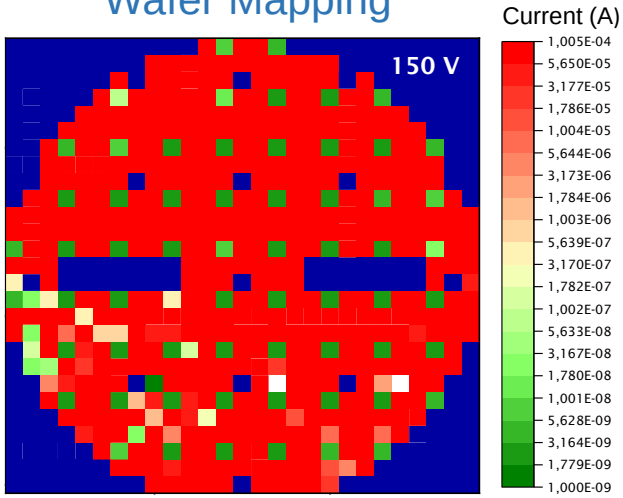


Active area = 1.3x1.3 mm^2

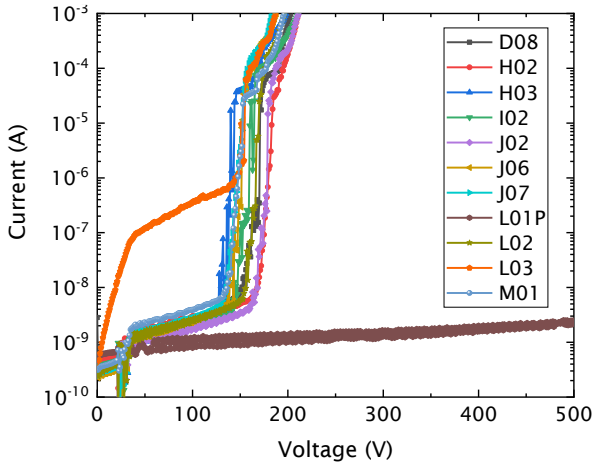


Wafer 5: High dose – Medium energy

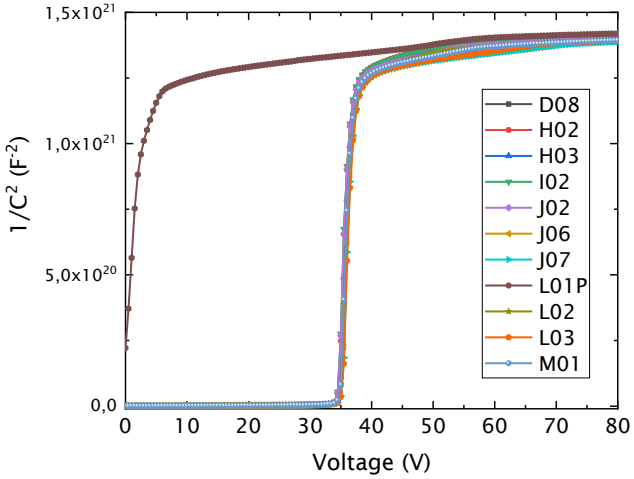
Wafer Mapping



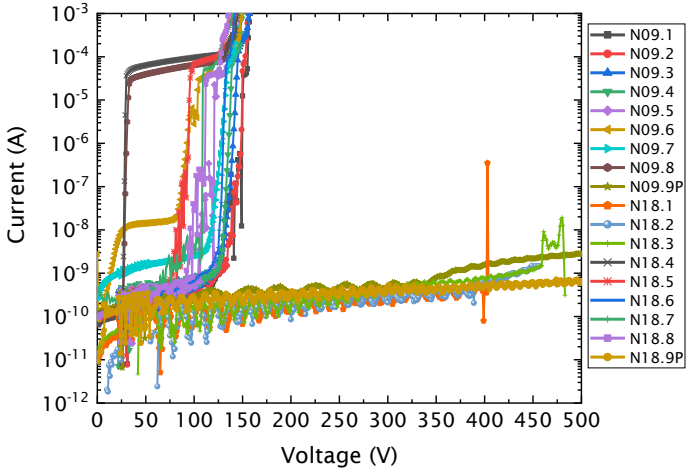
Active area = 3.3x3.3 mm^2



C-V Measurement



Active area = 1.3x1.3 mm^2



Run 11486: Conclusions and future work

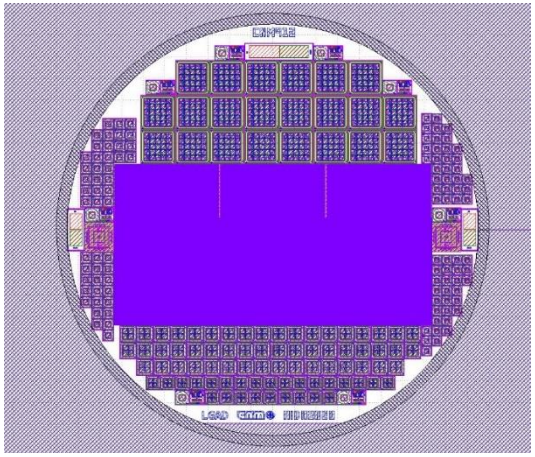
- All the wafers have been electrically characterized in terms of I-V and C-V.
- Measurement of leakage current at 150 V and rupture for some diodes with different sizes.
- Some devices have been already sent to irradiation campaigns.

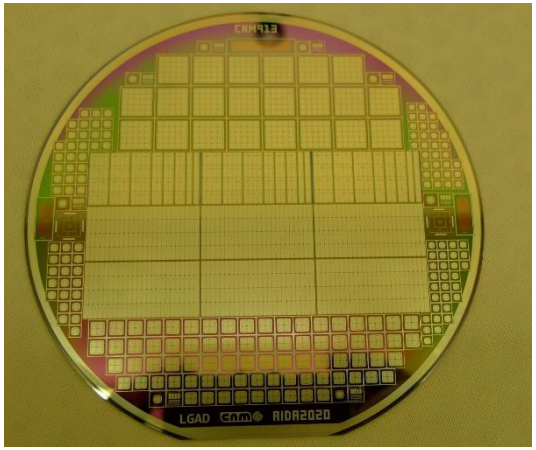
Institution / Research Centre	Wafer
IFAE. Vagelis Gkougkousis	2,3
CERN. Moritz Wiehe	2,3
SCIPP (Santa Cruz). Simone Mazza	3
STFC RAL. Giulio Villani	3
IFCA. Iván Vila	2,3,5

Run 12916 – AIDA 2020 specifications

- **4 wafers** with the same dose/energy parameters.
- **New AIDA2020 run**. Repetition of the previous run due to high leakage current.
- IV/CV measurements on wafer (preliminary). Only pads were measured.

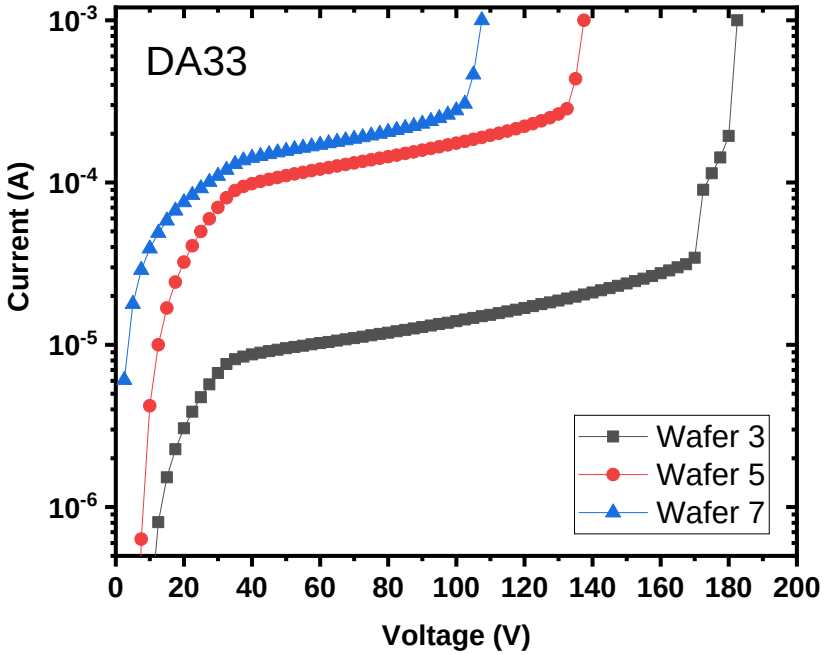
Wafer	Thickness (μm)	Dose (at/cm^2)	Energy (keV)
1-4	50	Medium	Low

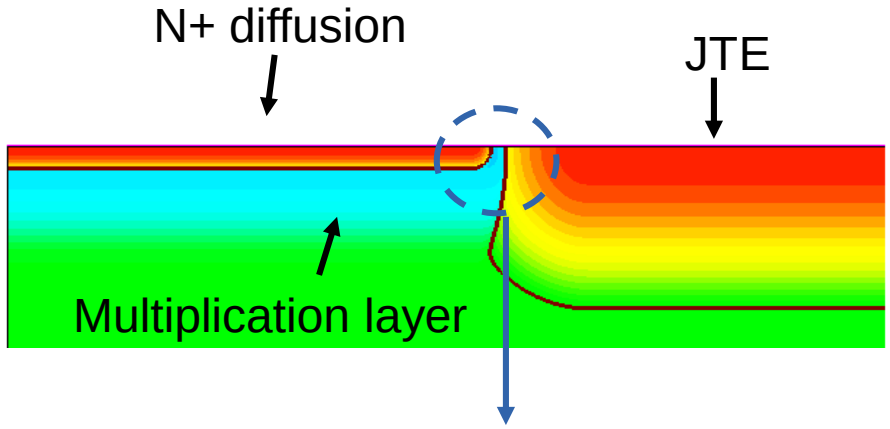




Previous AIDA2020: Run 11748

High leakage current

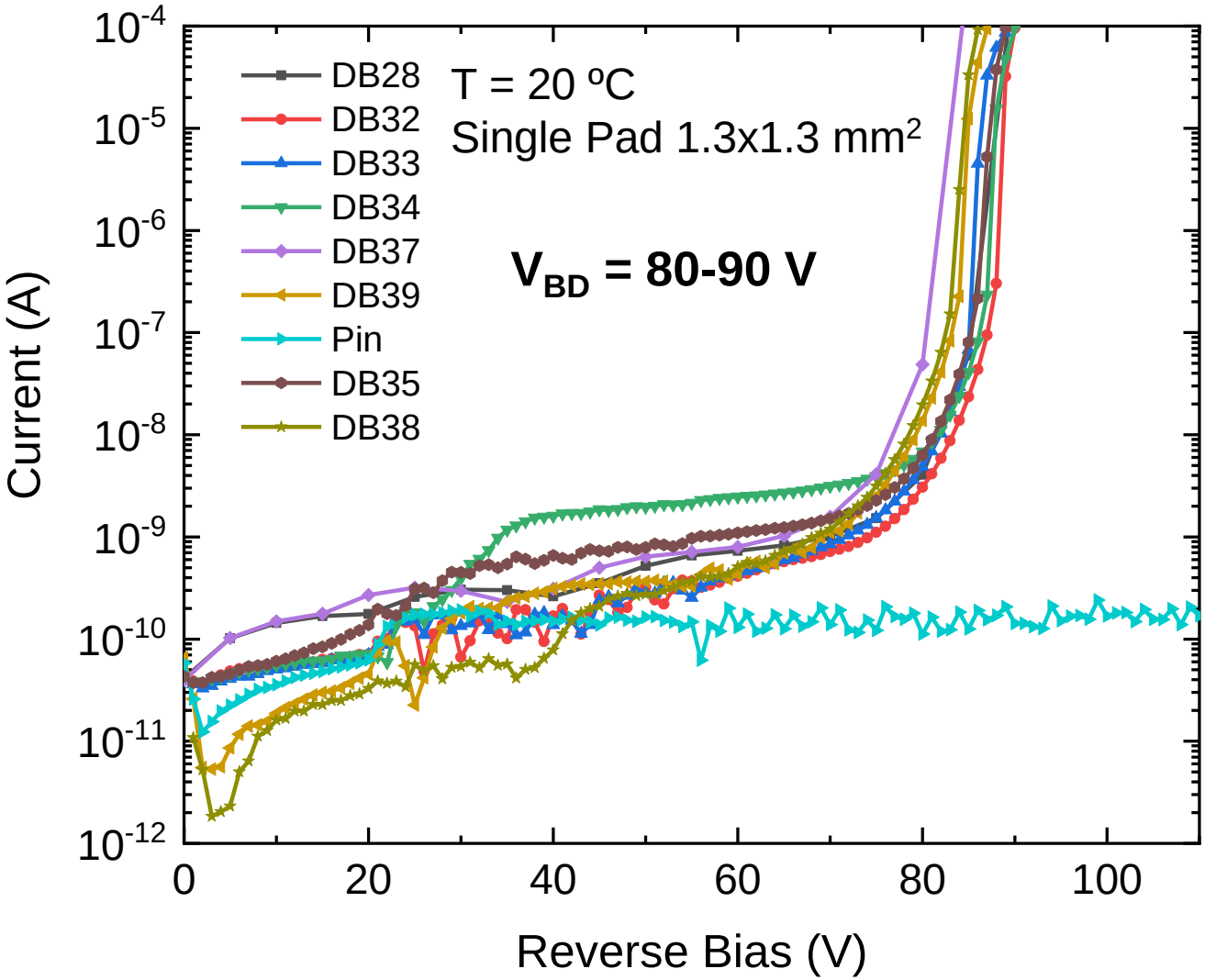




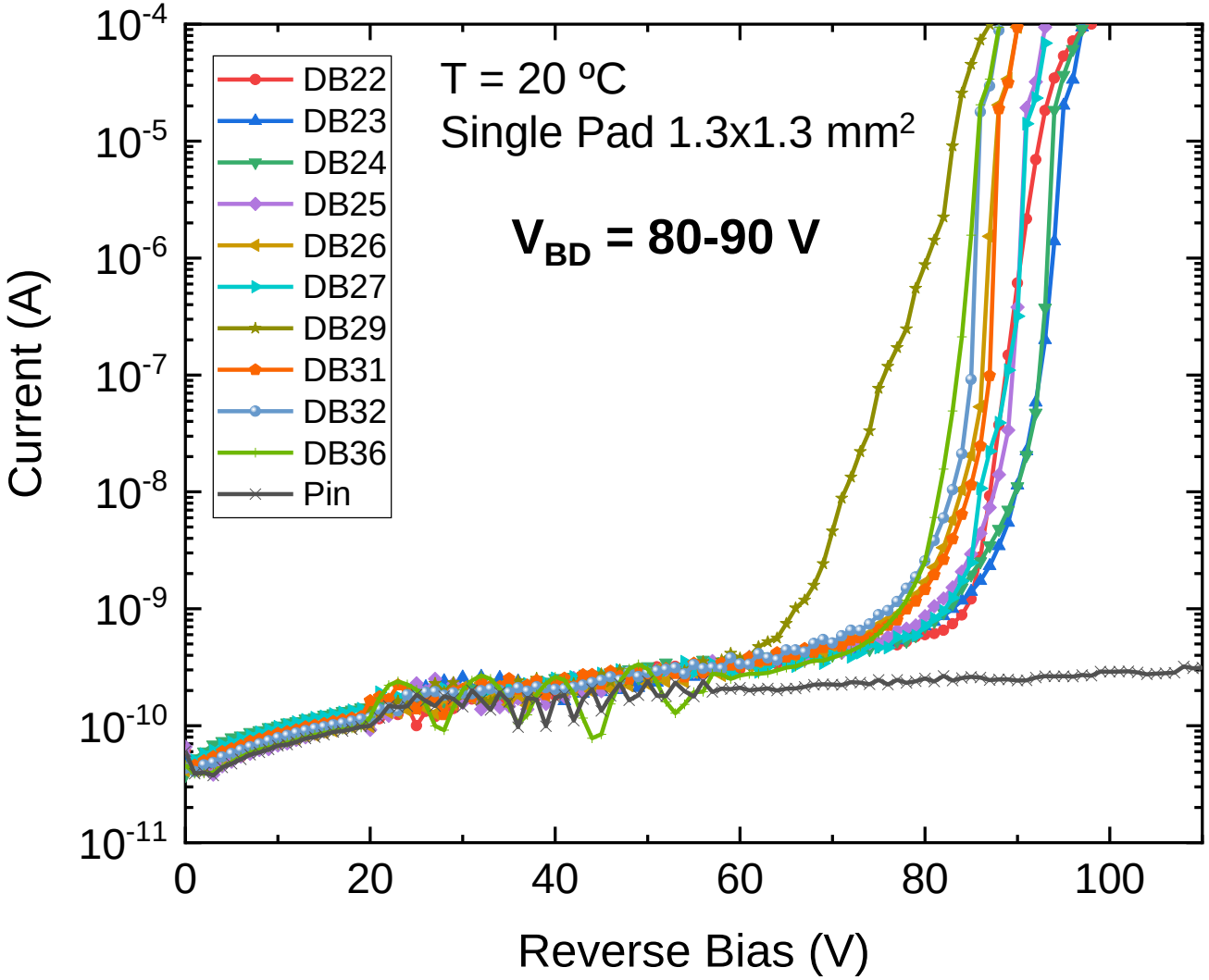
TCAD Simulations assuming that the N+ diffusion does not reach the JTE diffusion and an overlap exists between them.

We have corrected the design of the mask in order to make the overlap between N+ and JTE larger. Now, N+ is diffused until the end of the JTE to assure its continuity along the periphery

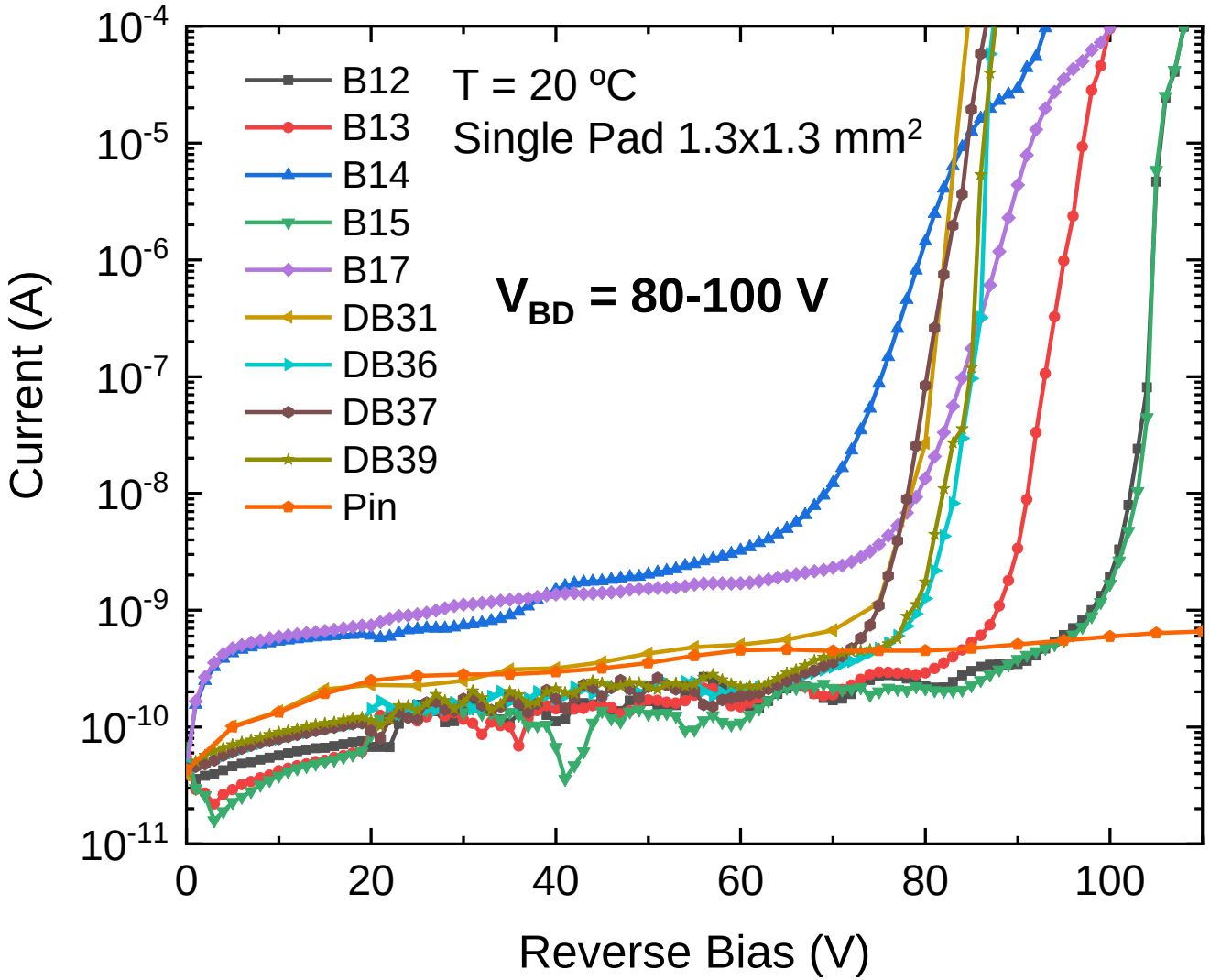
I-V Measurements: Wafer 1



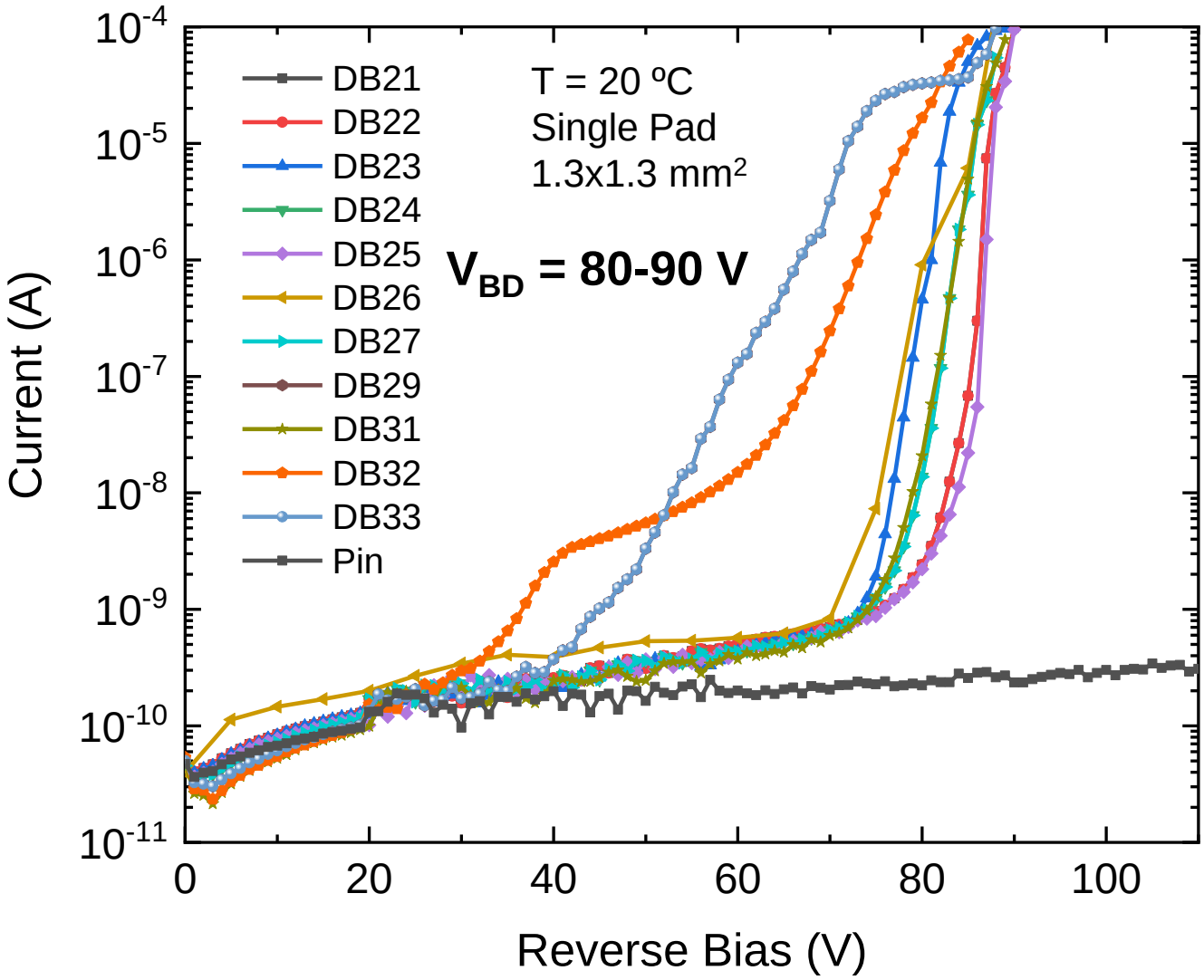
I-V Measurements: Wafer 2



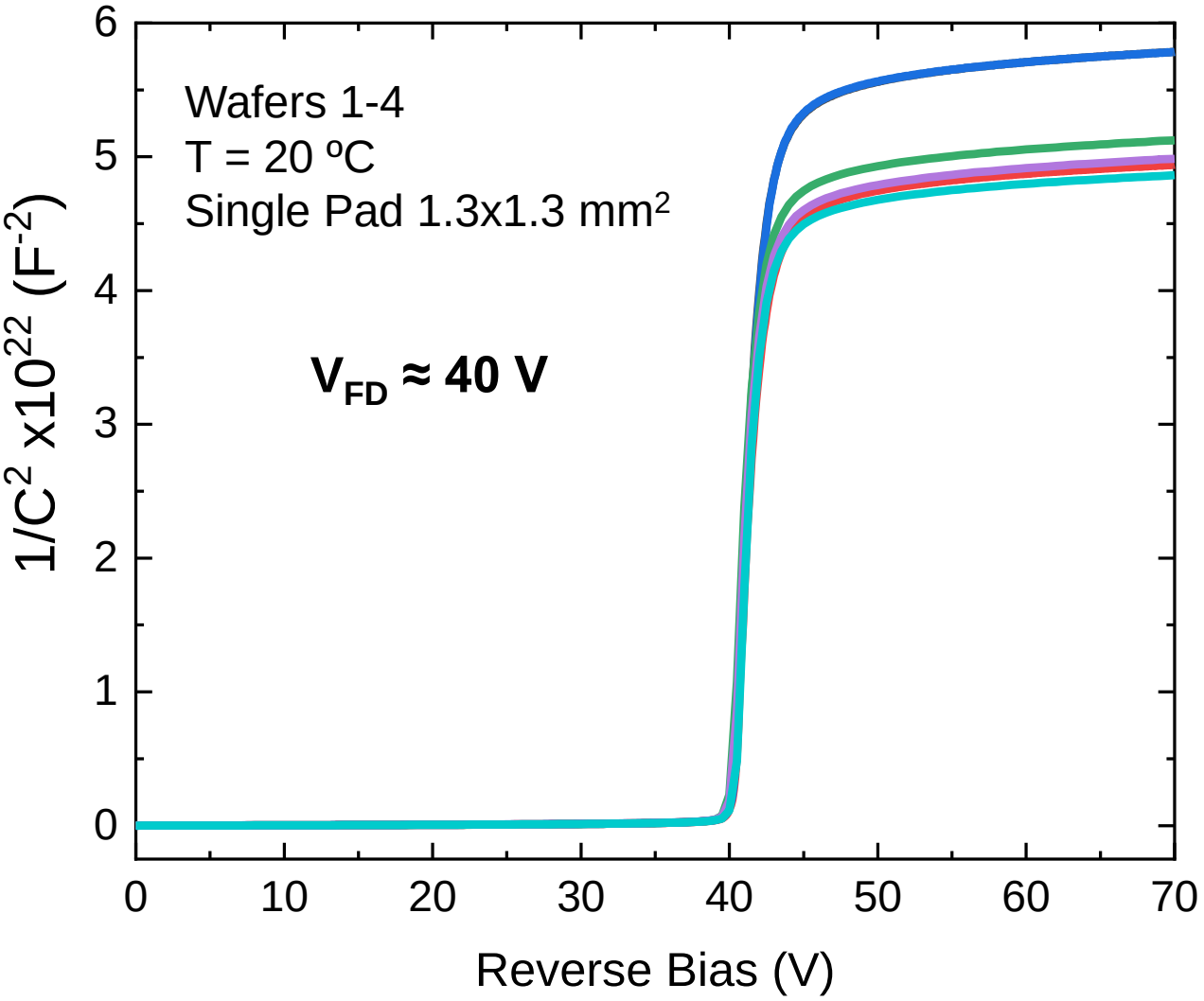
I-V Measurements: Wafer 3



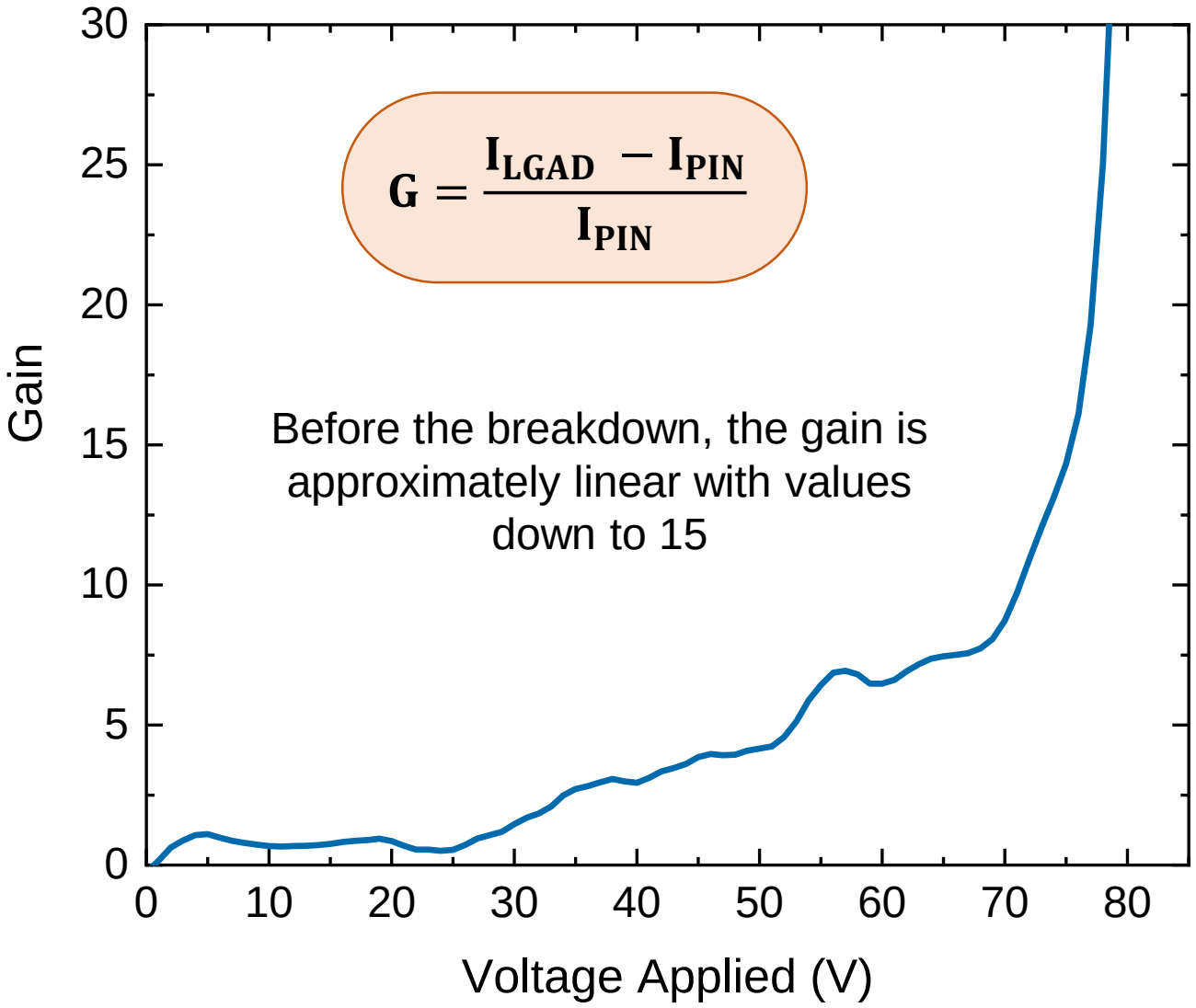
I-V Measurements: Wafer 4



C-V Measurements



Gain estimation



Run 12916 : Conclusions and future work

- ✓ **Preliminary** measurements in terms of I-V and C-V.
- ✓ Leakage current values are the expected (0.1-1 nA).
- ✓ Voltage breakdown and full depletion correspond to **high dose value** (change in drive-in process).
- ✓ Gain estimation shows a value around 15.

Future work:

- Dice the devices and sent them to irradiation campaigns.
- TCT measurements: gain studies.
- Electrical characterization of 2x2 and 5x5 arrays.

Thank you for your attention!