

Performance Of Thin Edgeless *n-on-p* Planar Pixel Sensors for ATLAS Upgrades

A. Bagolini¹, M. Bomben², M. Boscardin¹, L. Bosisio³, G. Calderini^{2,4},
J. Chauveau², G. Giacomini¹, A. La Rosa⁵, G. Marchiori², N. Zorzi¹

1 - Fondazione Bruno Kessler (FBK), Trento, Italy

2- Laboratoire de Physique Nucleaire et de Hautes Énergies (LPNHE), Paris, France

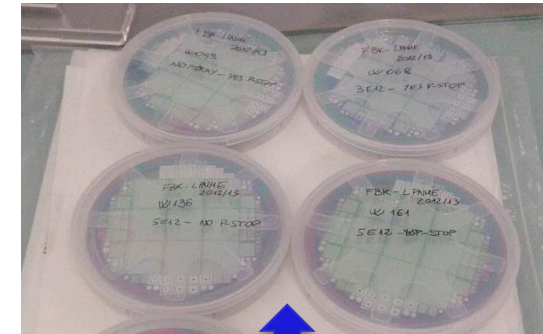
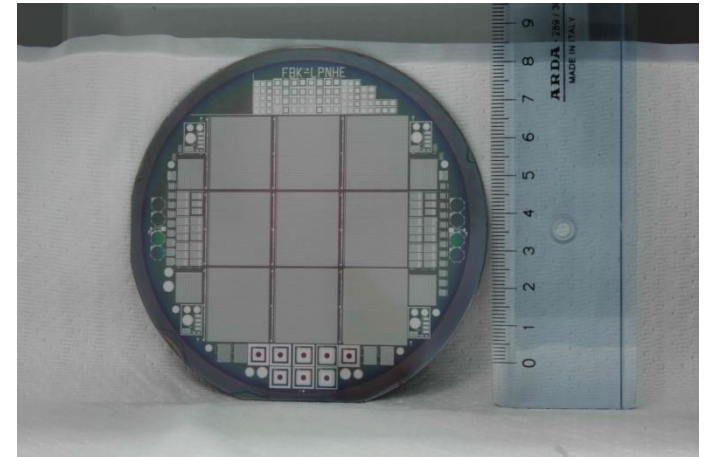
3- Università di Trieste, Dipartimento di Fisica and INFN, Trieste, Italy

4- Dipartimento di Fisica, Università di Pisa, and INFN Sez. di Pisa, Pisa, Italy

5- Section de Physique (DPNC), Université de Genève, Genève, Switzerland

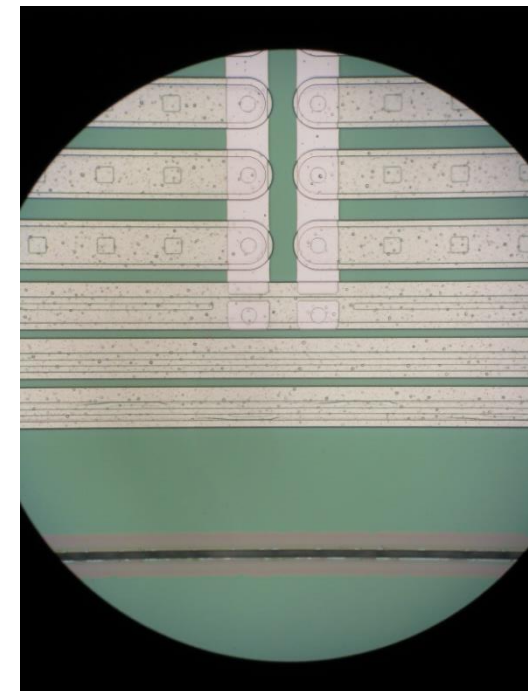
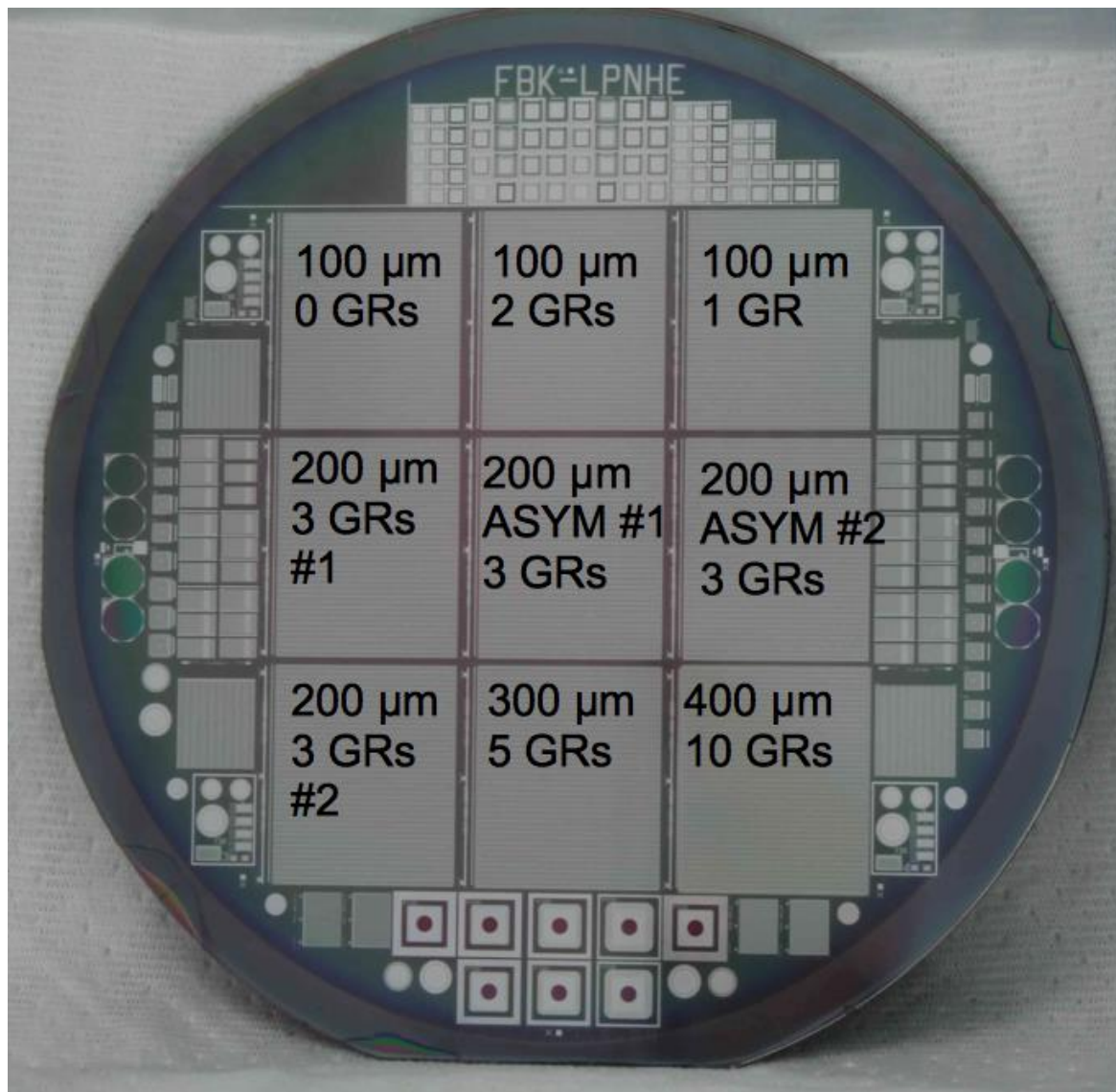
**9th “Trento” Workshop on Advanced Silicon Radiation Detectors
(3D and p-type Technologies)
Genova, February 26th-28th 2014**

- Joint **FBK-LPNHE** project
 - Goal: thin, **edgeless** pixel sensors
 - Target: **intermediate layers**
 - How: make the **border a damage free ohmic contact by DRIE**
- **200 μm thick n-on-p** production
 - 500 μm temporary support wafer
- **Pixel-to-trench distance as low as 100 μm**

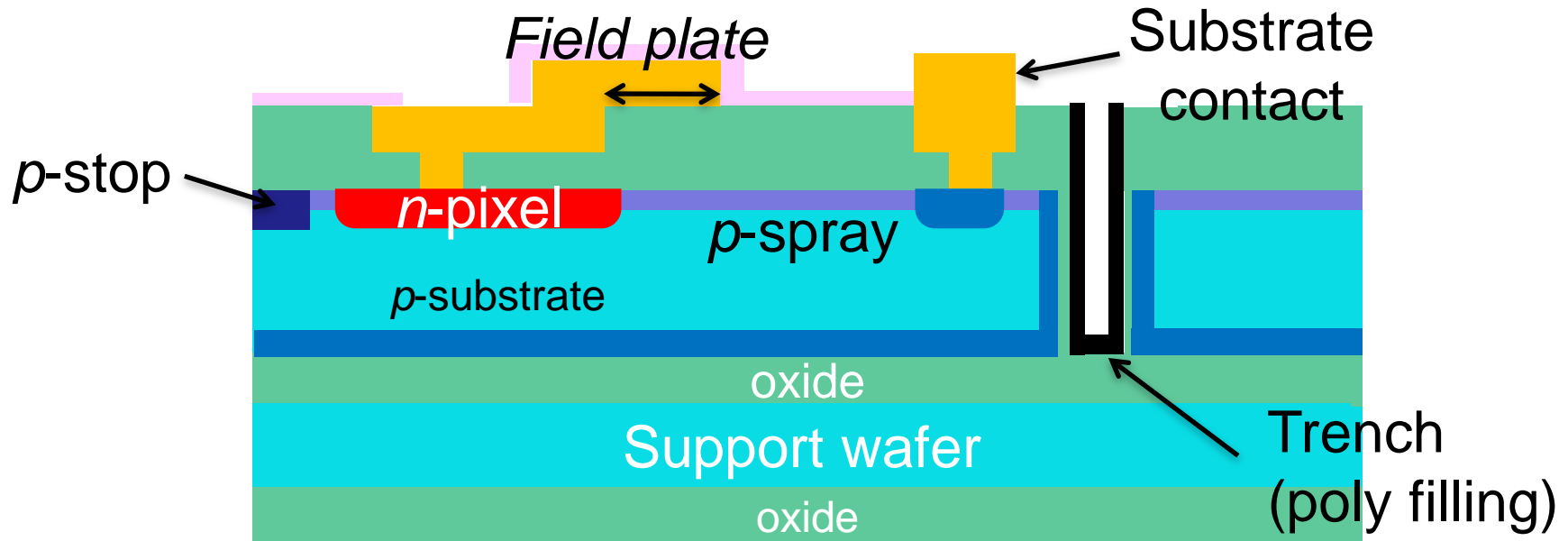
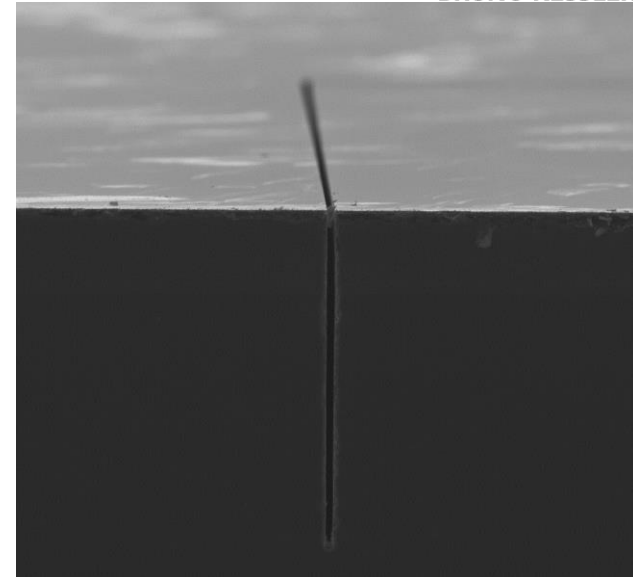


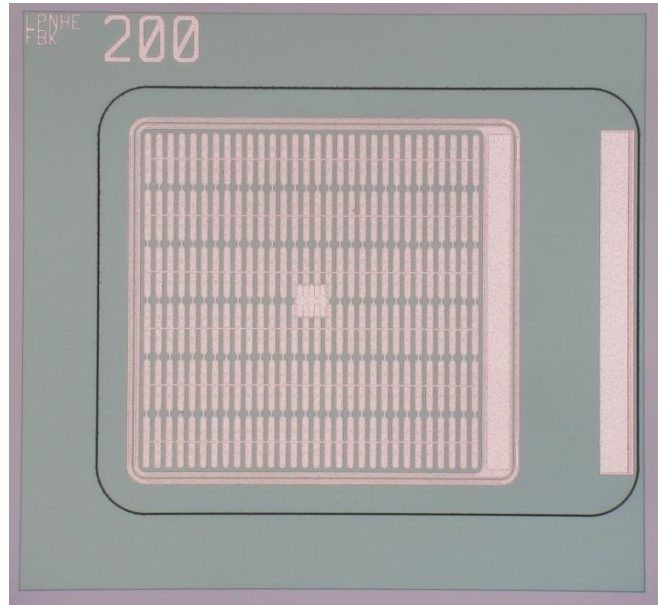
Main production splits:

- p-spray dose
- p-stop: present/absent
- metal overhang: present/absent
- 1 wafer with no DRIE



- Goal: HL-LHC ATLAS intermediate pixel layer
- n -on- p production
- Pixel/trench distance as low as $100\ \mu\text{m}$



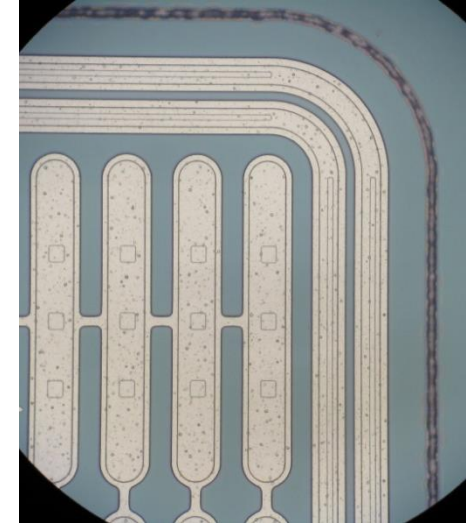
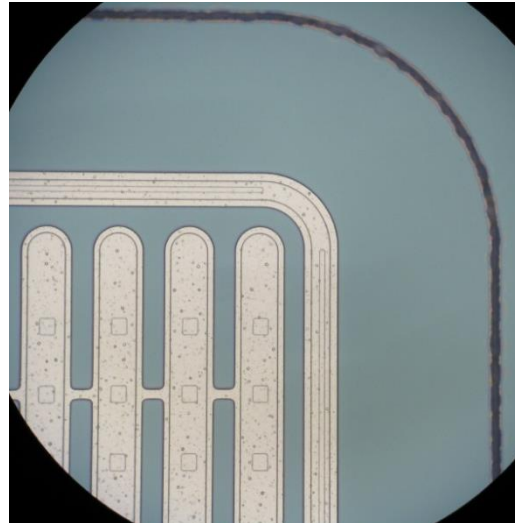
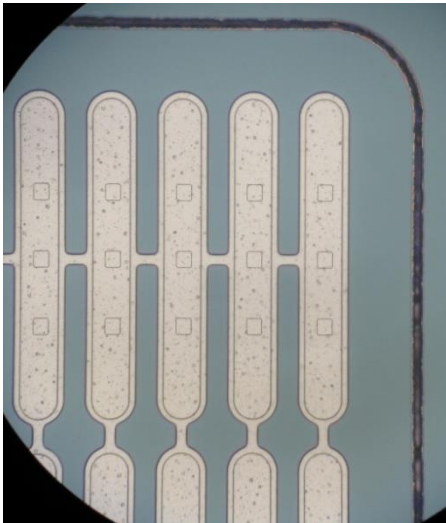


Pixel pitch =
 $250 \mu\text{m} \times 50 \mu\text{m}$

No GR

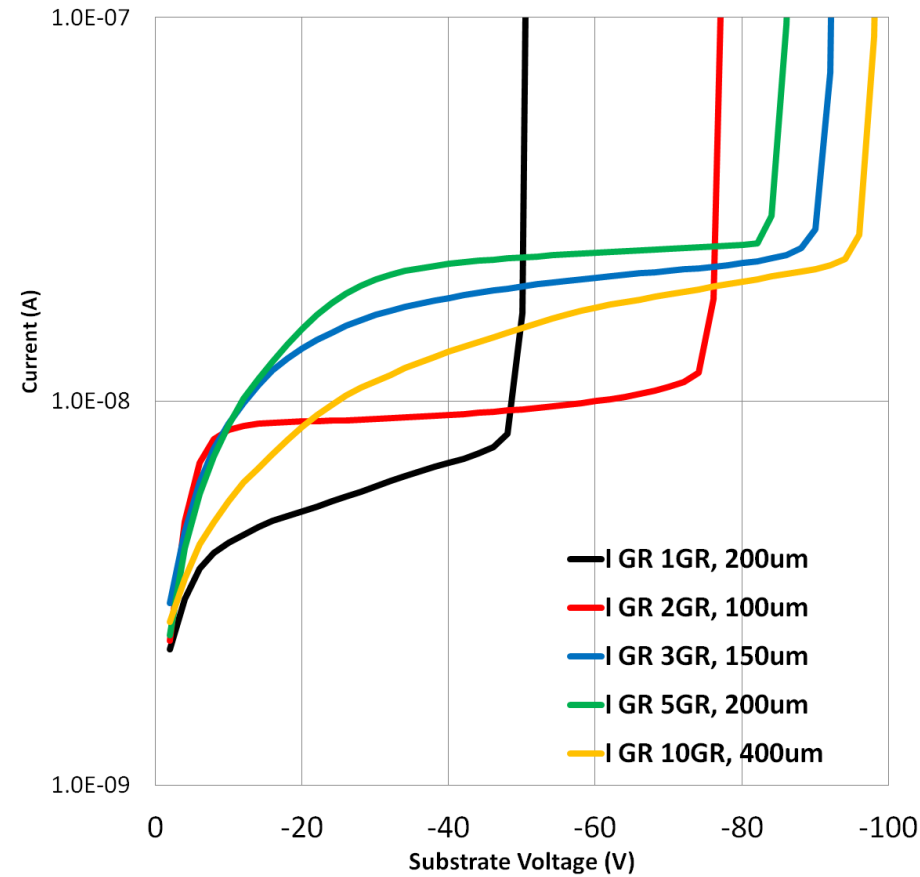
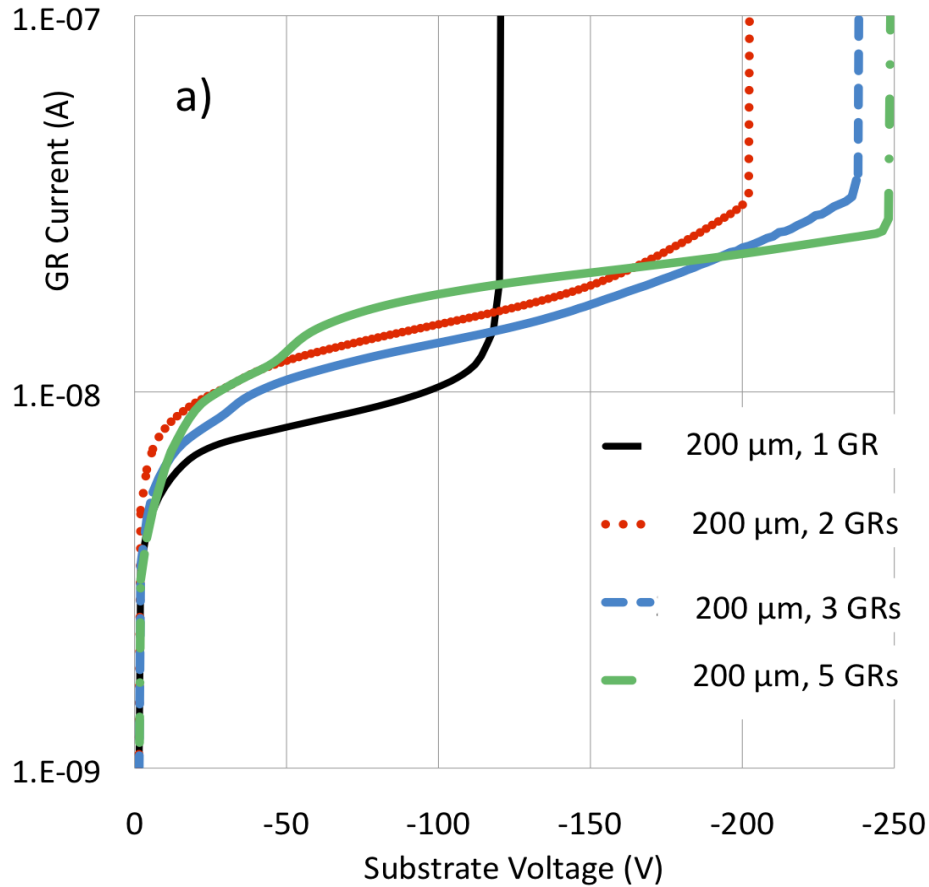
1 GR

2 GR



ρ -spray dose = $3e12 \text{ cm}^{-2}$

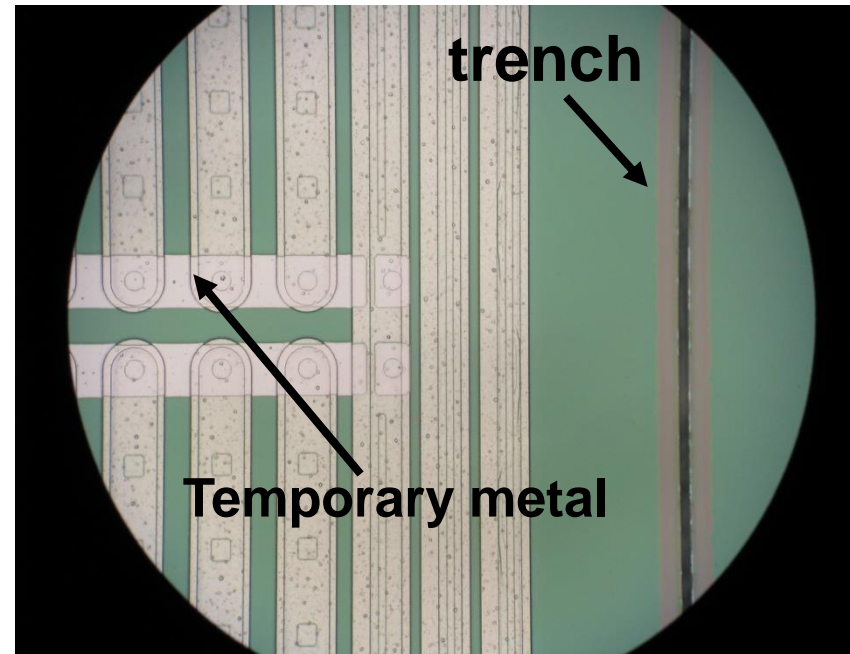
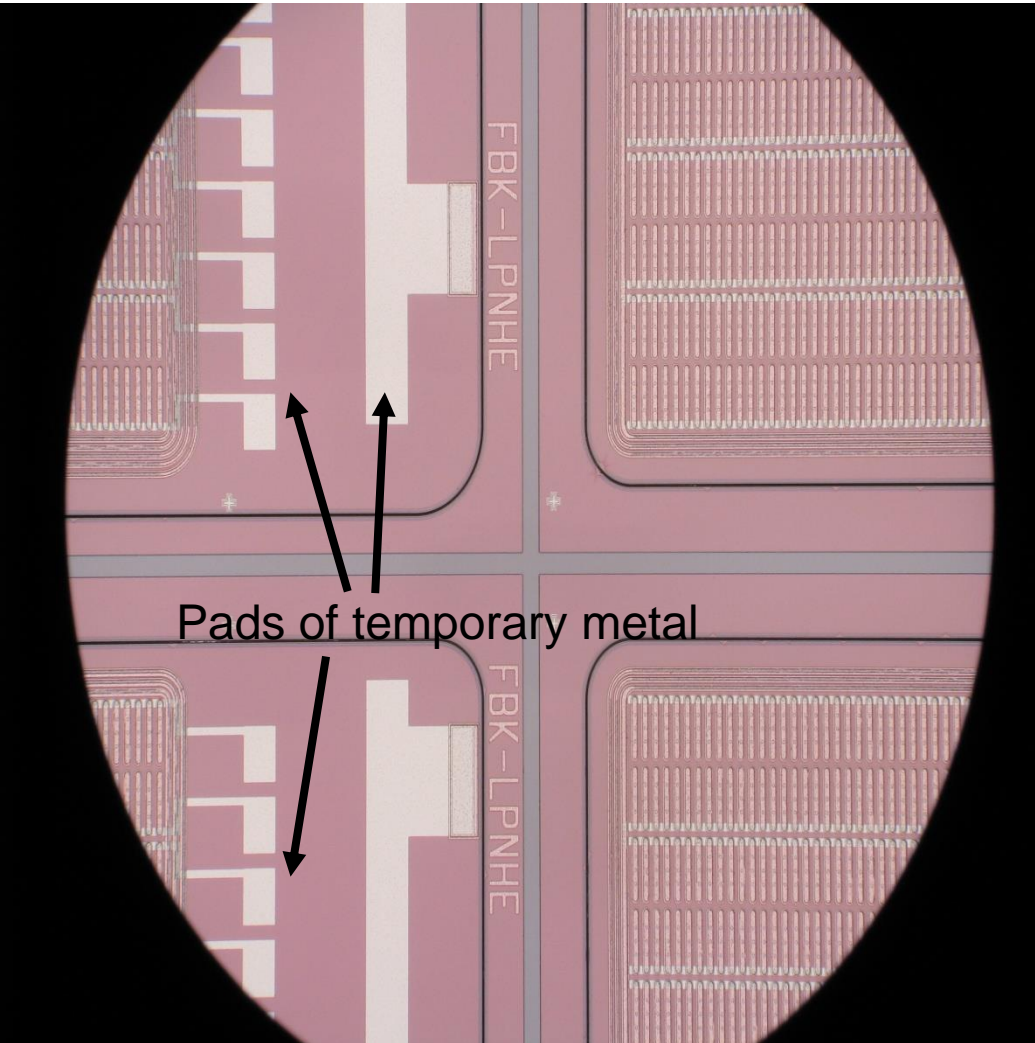
ρ -spray dose = $5e12 \text{ cm}^{-2}$



Little dependence on trench distance

I-V on FE-I4 sensor

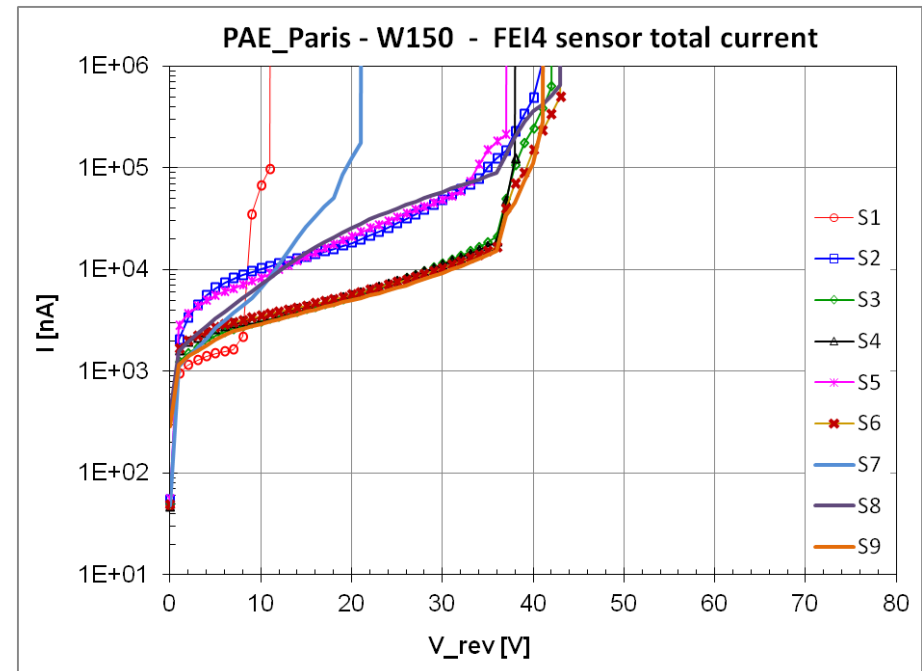
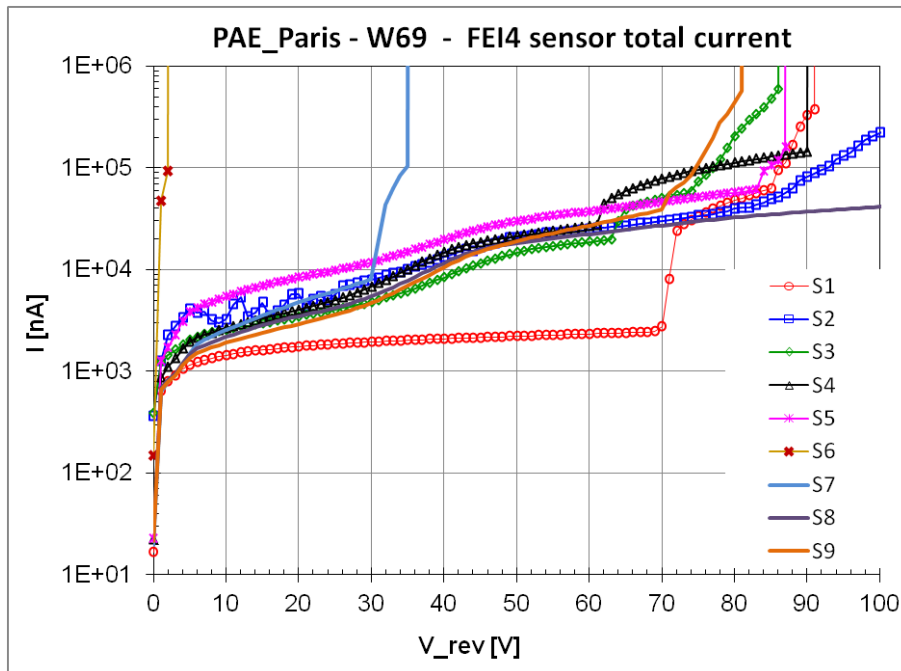
Automatic measurement with Temporary metal



I-V vs p -spray doses

p -spray dose = $3e12 \text{ cm}^{-2}$

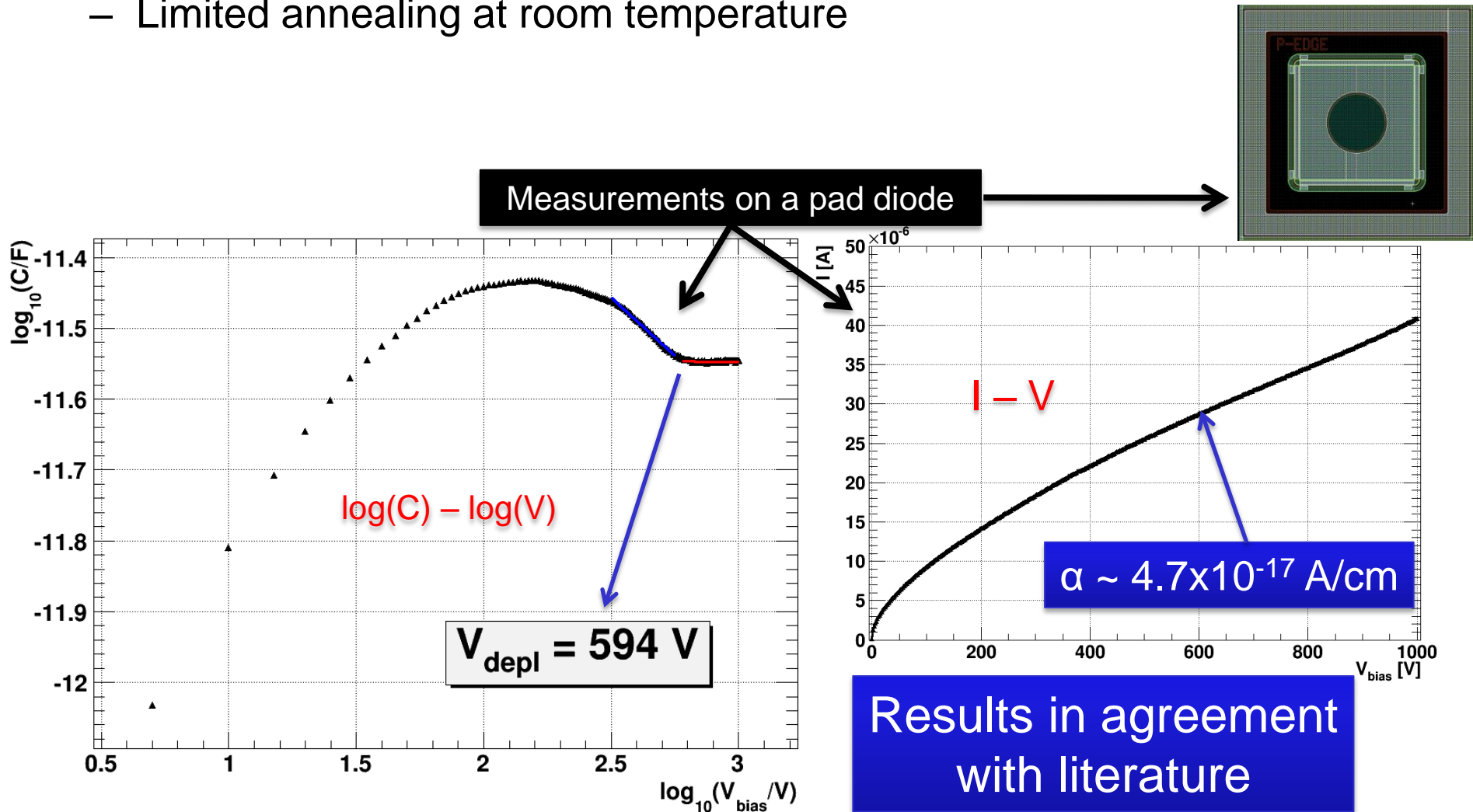
p -spray dose = $5e12 \text{ cm}^{-2}$

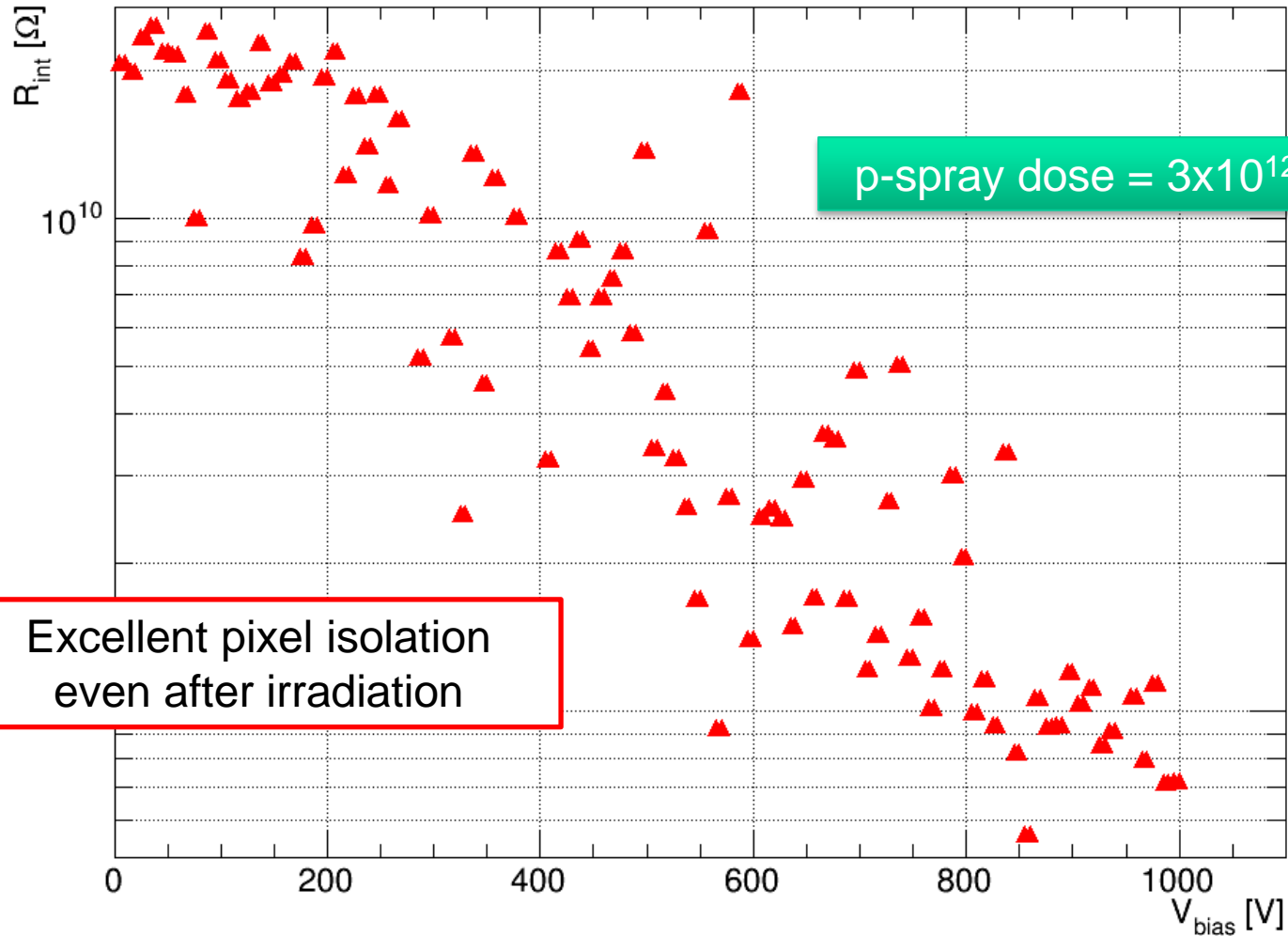


➤ V_{BD} as expected from IV on test structures

$\Phi: 2.5E15 \text{ 1-MeV } n_{eq}/\text{cm}^2$

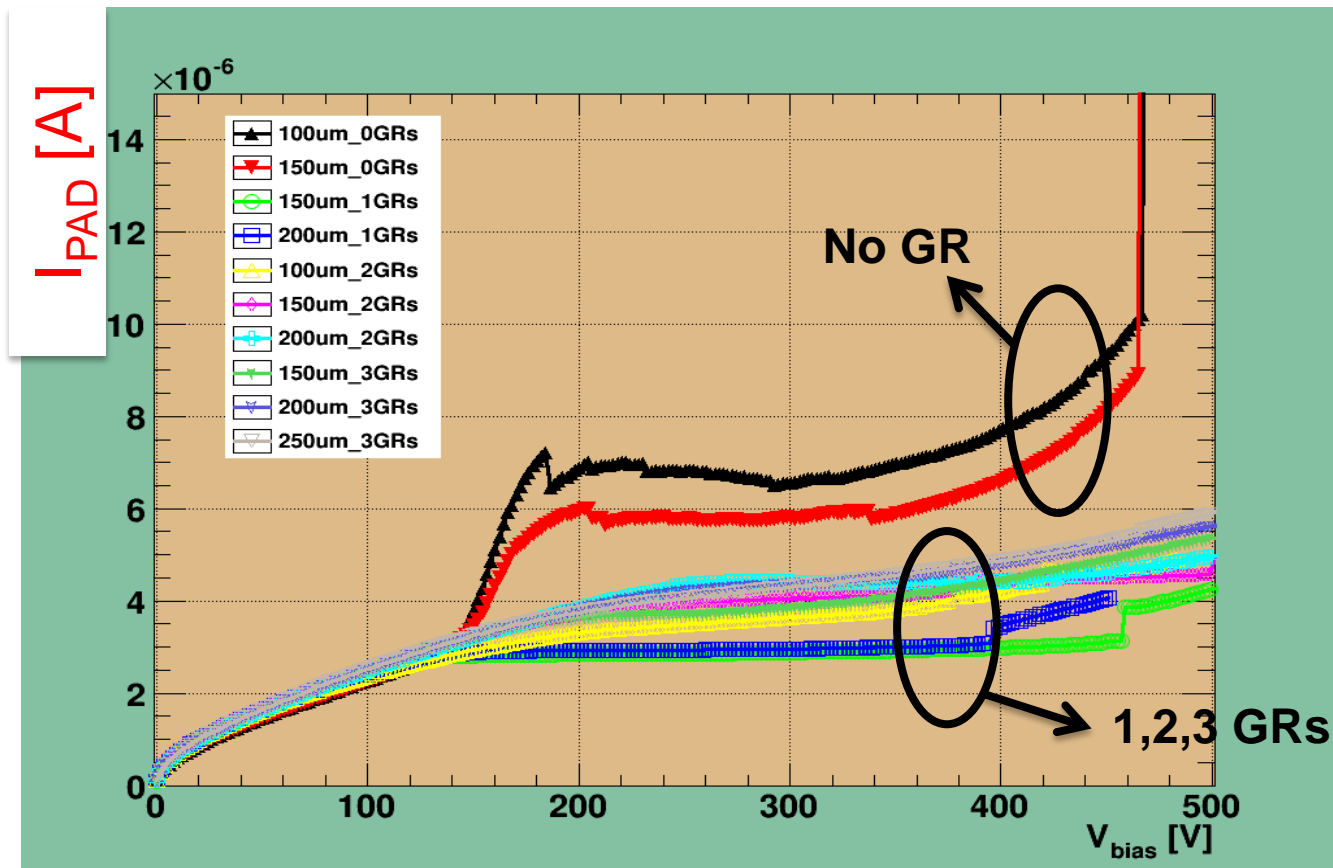
- Samples were irradiated with reactor neutrons (JSI, Ljubljana)
 - Limited annealing at room temperature

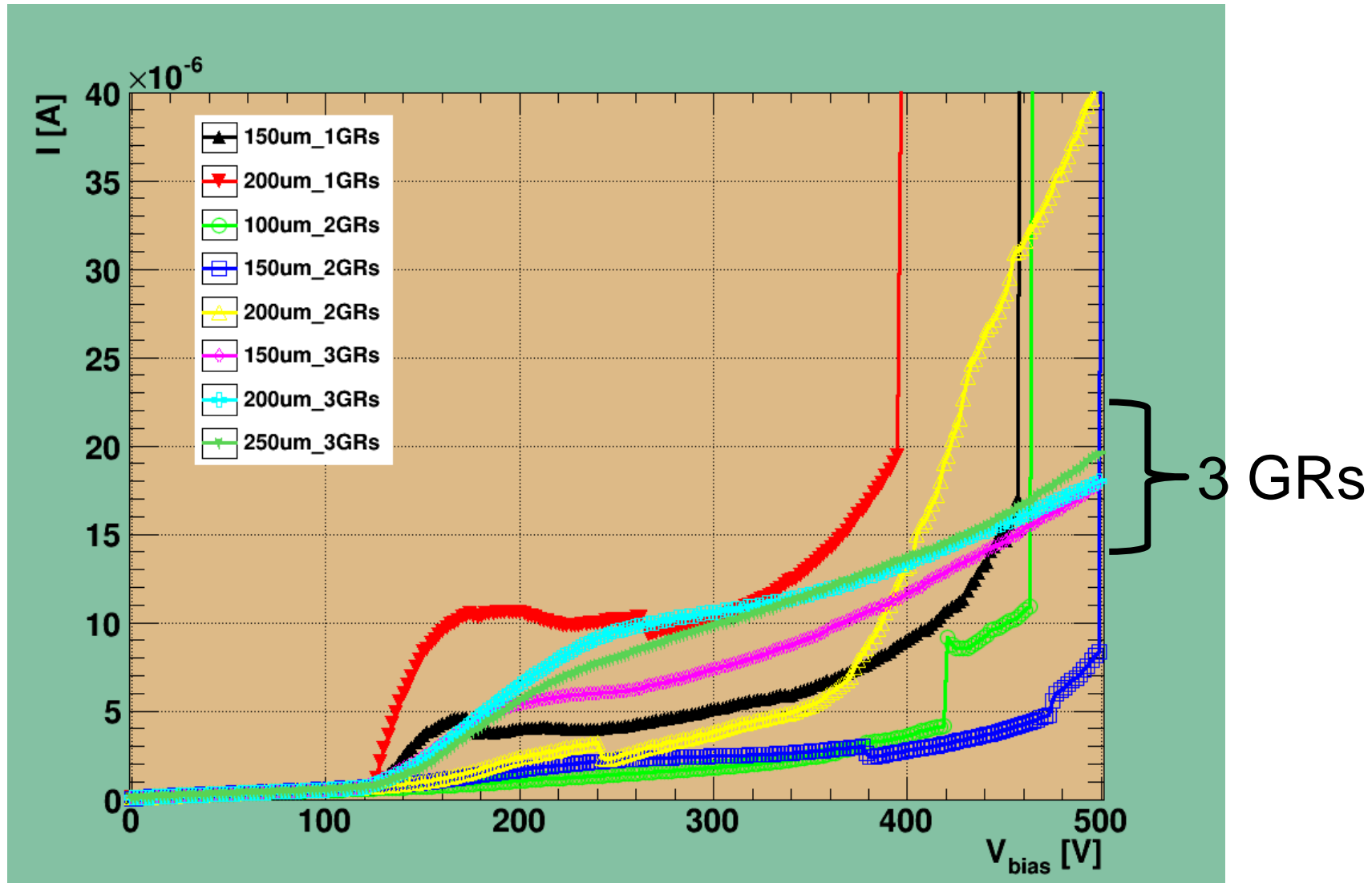




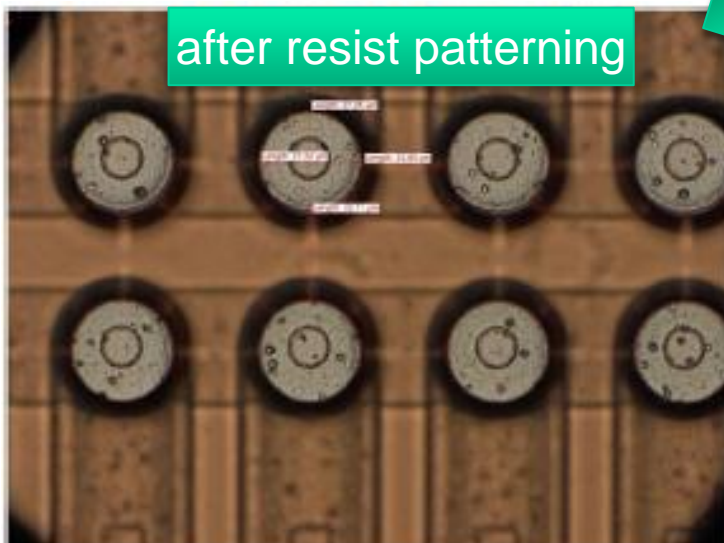
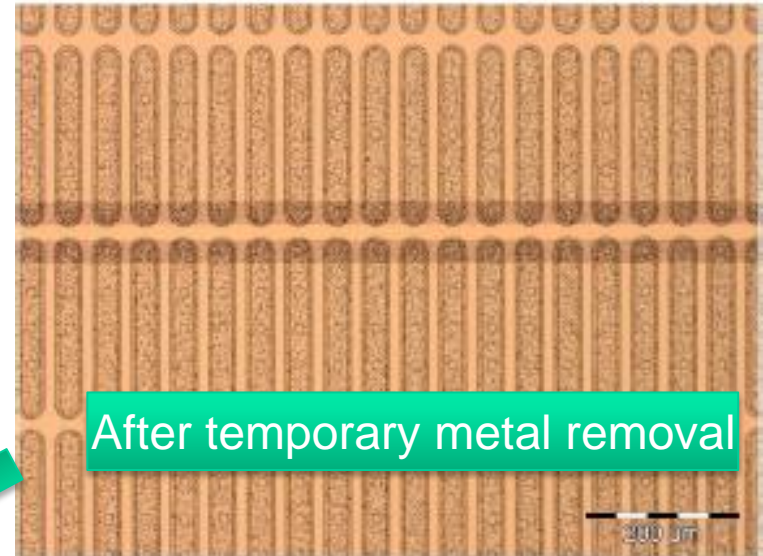
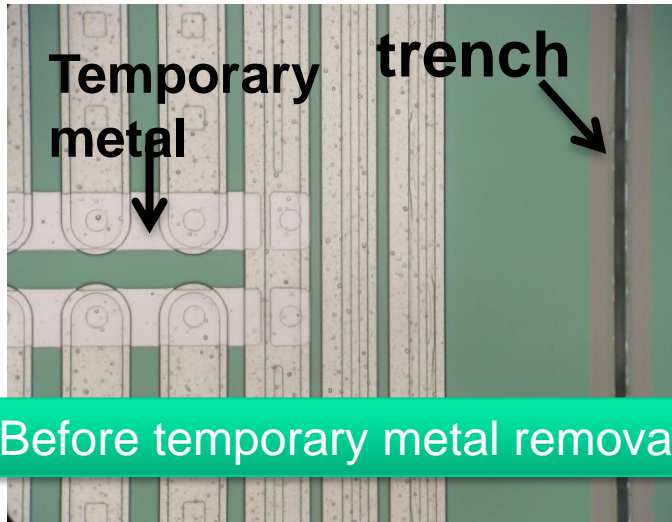
Irradiated FEI4 test structures

p-spray dose = $3 \times 10^{12}/\text{cm}^2$



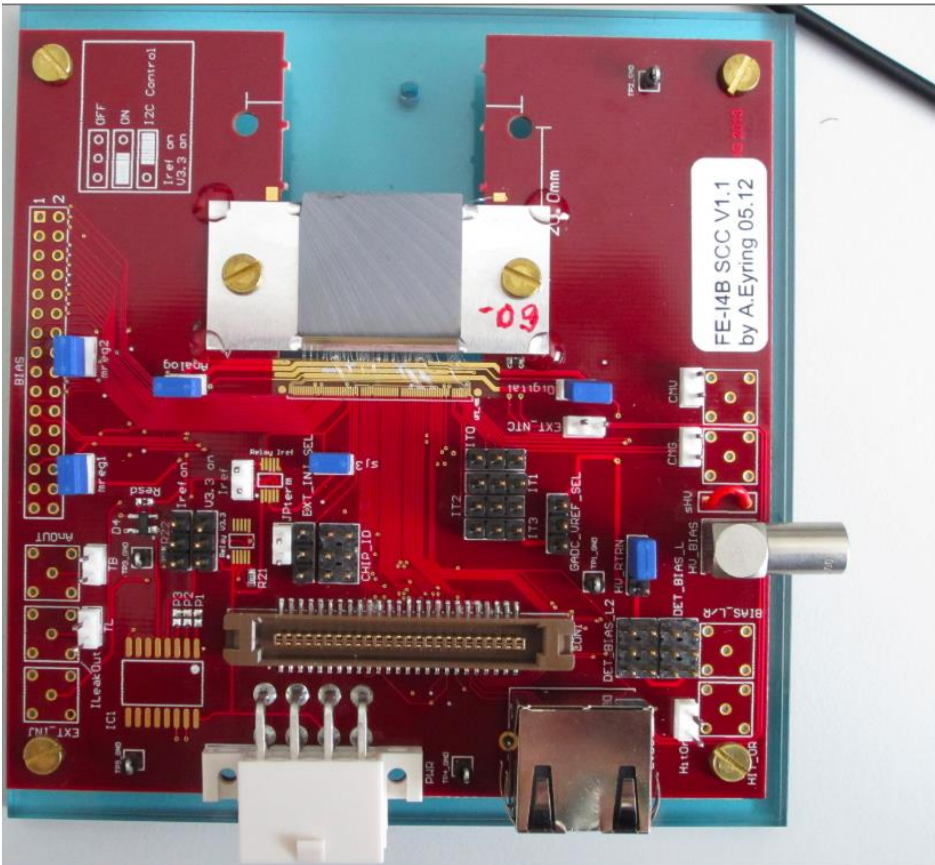


FE-I4 modules



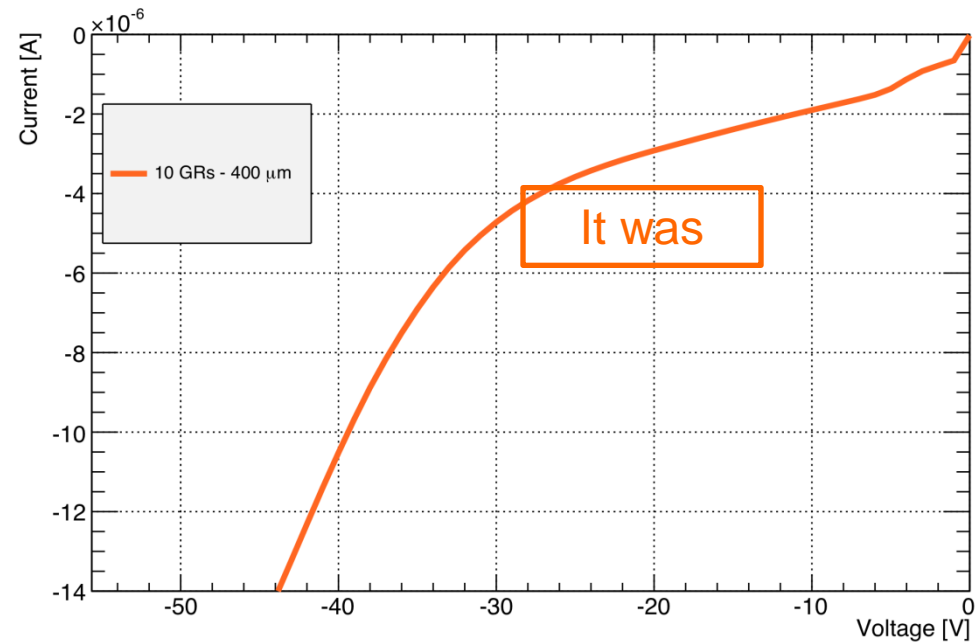
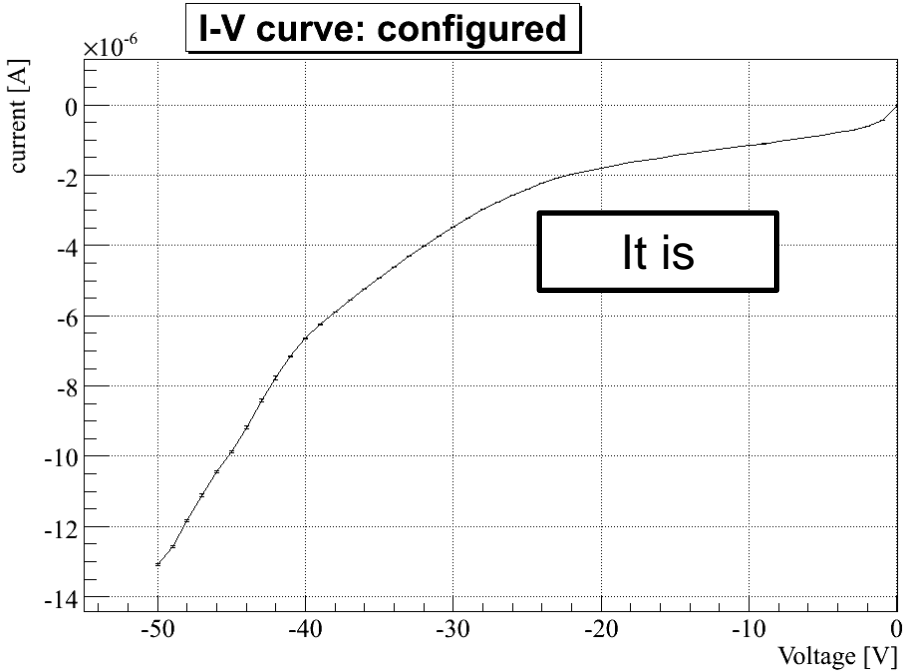
- Modules are being assembled at IZM by bump-bonding a few FE-I4 sensors to FE-I4B ROC
- Delivery expected by end of November

2 modules assembled for test

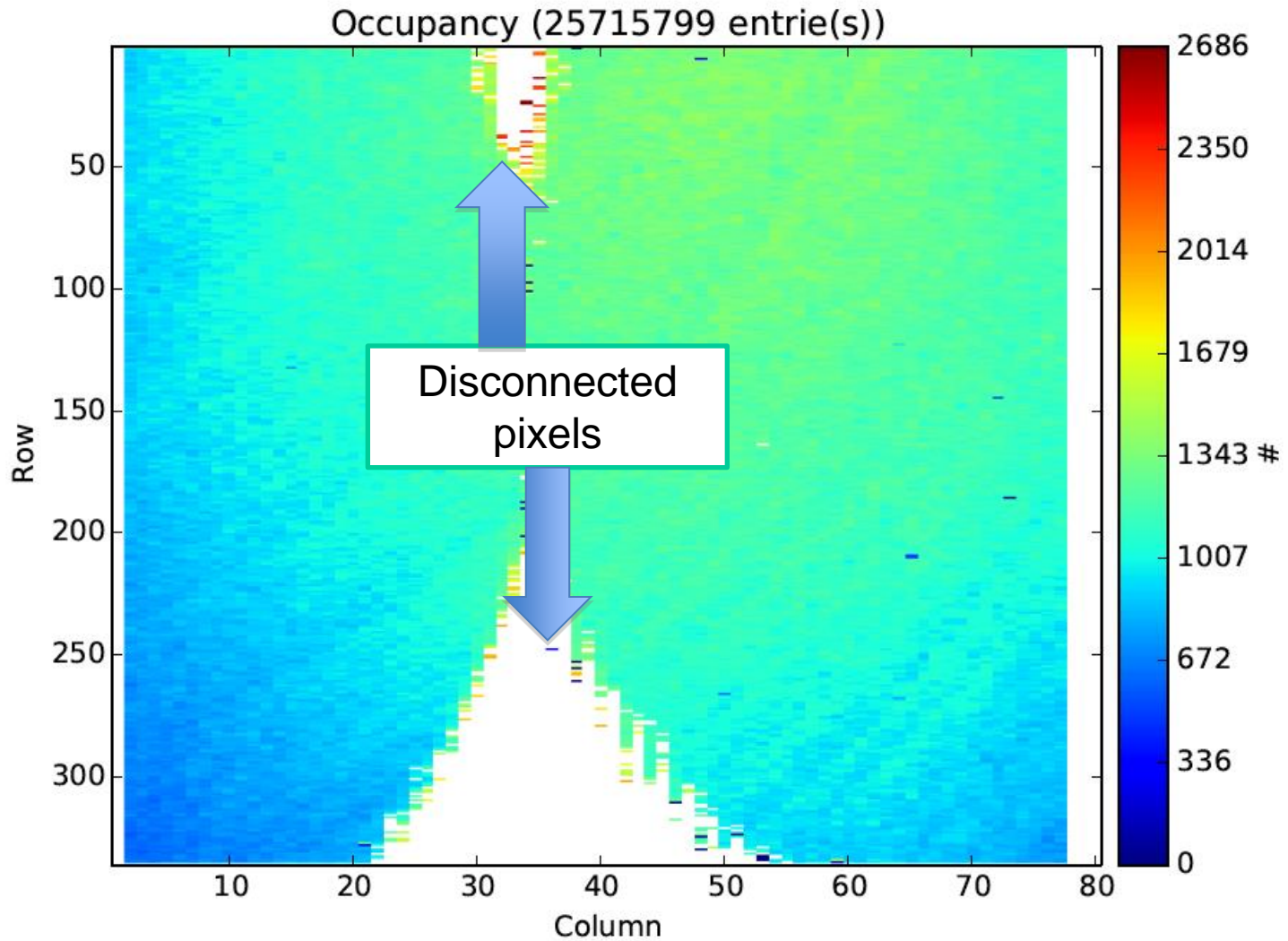


- sensor S9 ⇔ 400 μm & 10 GRs
- sensor S7 ⇔ 200 μm & 3 GRs

400 μm , 10 GRs



Source scan



Conclusions & Outlook

- Irradiates structures: OK
- FE-I4 two test modules: mixed results
 - Tackling issues
- Next: 10 modules to be assembled
- Goal: on beam next autumn