



Centre Nacional de Microelectrònica



IMB

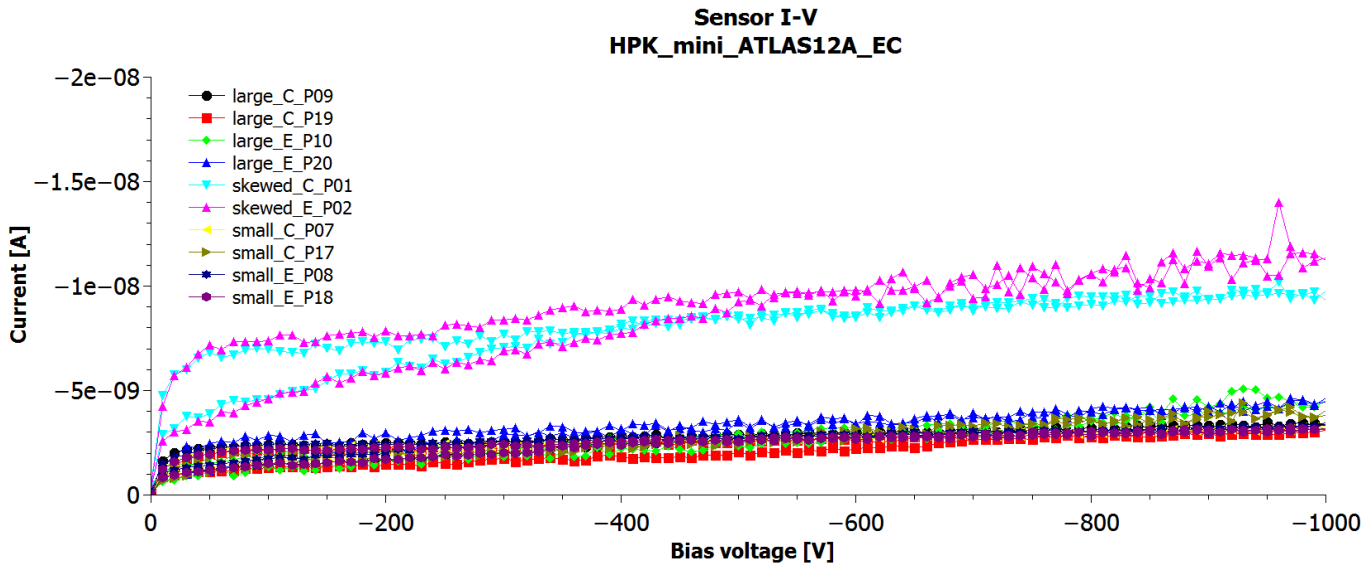


Measurements on irradiated HPK ATLAS12A EC mini sensors

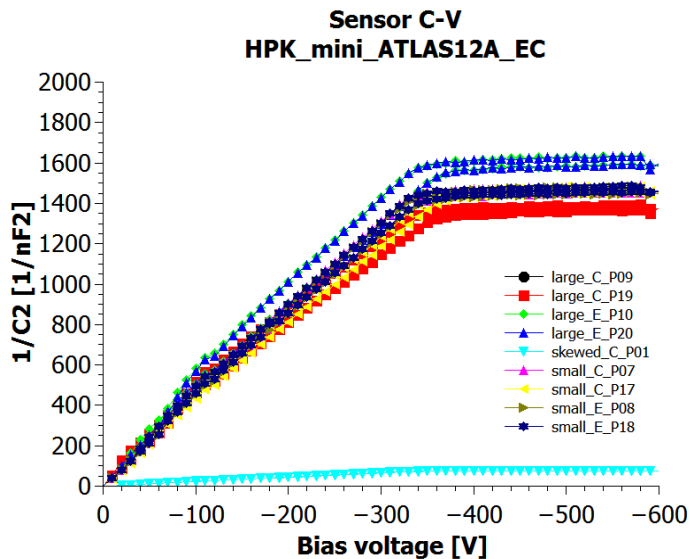
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Non irradiated sensors



- No breakdown observed up to 1000 V sensor bias.
- Current @ 600 V:
 - $3.1 \pm 0.2 \text{ nA/cm}^2$
 - $2.6 \pm 0.2 \text{ nA/cm}^2$ (skewed)
- For irradiated sensors, currents below 1 mA @ 600 V, measured at -25 °C, are accepted.

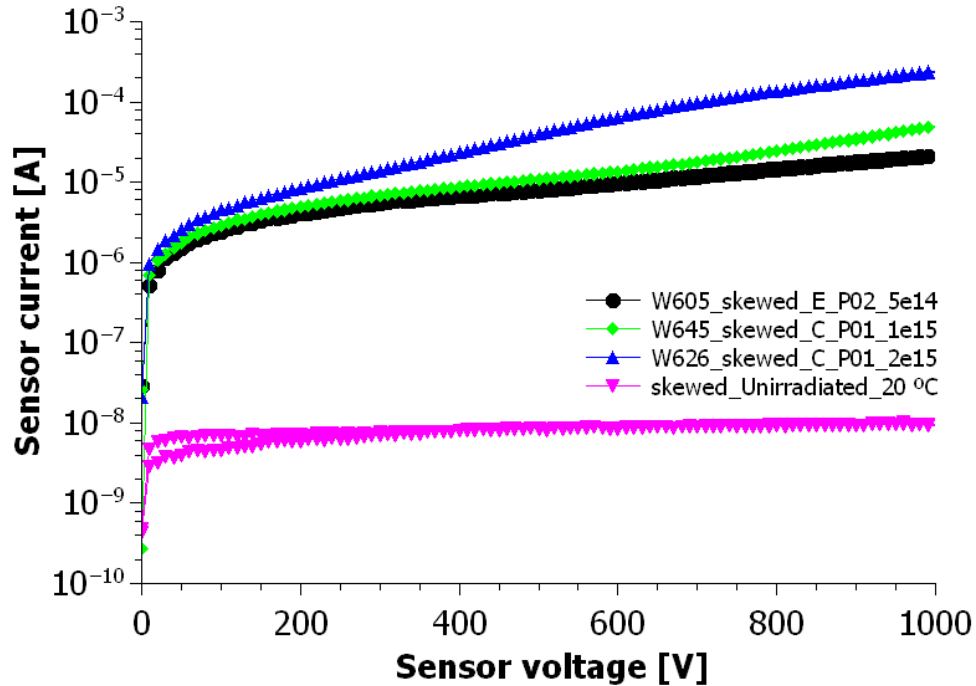


- Full depletion voltage higher than 300 V.
 - $330.5 \pm 7.3 \text{ V}$
- For irradiated sensors, no acceptance criteria is specified.

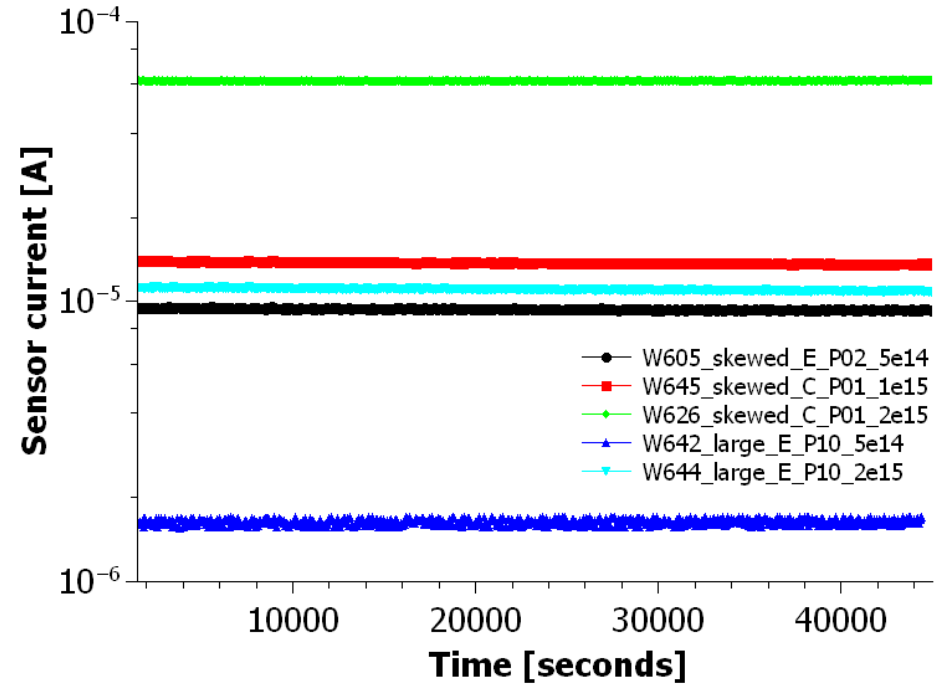
- **Sensors irradiated in Birmingham with protons. Different fluences: 4×10^{14} , 10^{15} and $2 \times 10^{15} \text{ Neq/cm}^2$**
- **Freiburg received the sensors and has kept them inside a freezer.**

Irradiated sensors: IV

HPK_ATLAS12A_skewed
No_annealing_-25°C



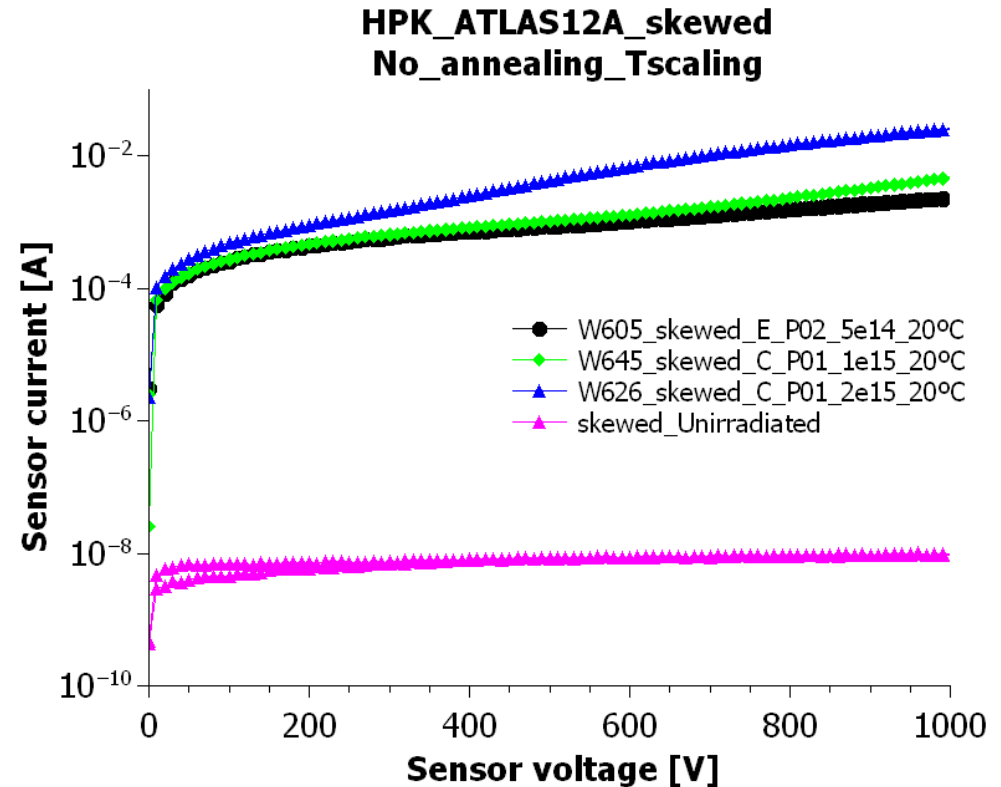
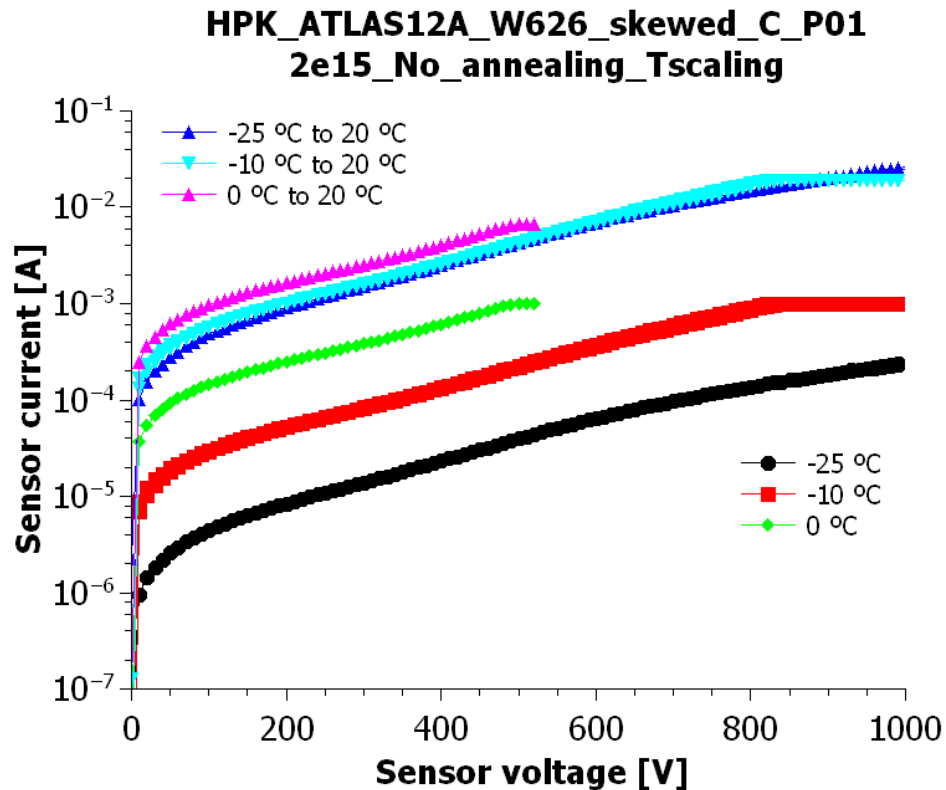
HPK_ATLAS12A_mini_sensors
No_annealing_-25 °C



- Currents below 1 mA and no breakdown.
- More than 3 orders of magnitude increase, without temperature scaling.

- Stable behavior on time.
- Variation around 5 % observed after 11 hours.

Irradiated sensors: Temperature scaling

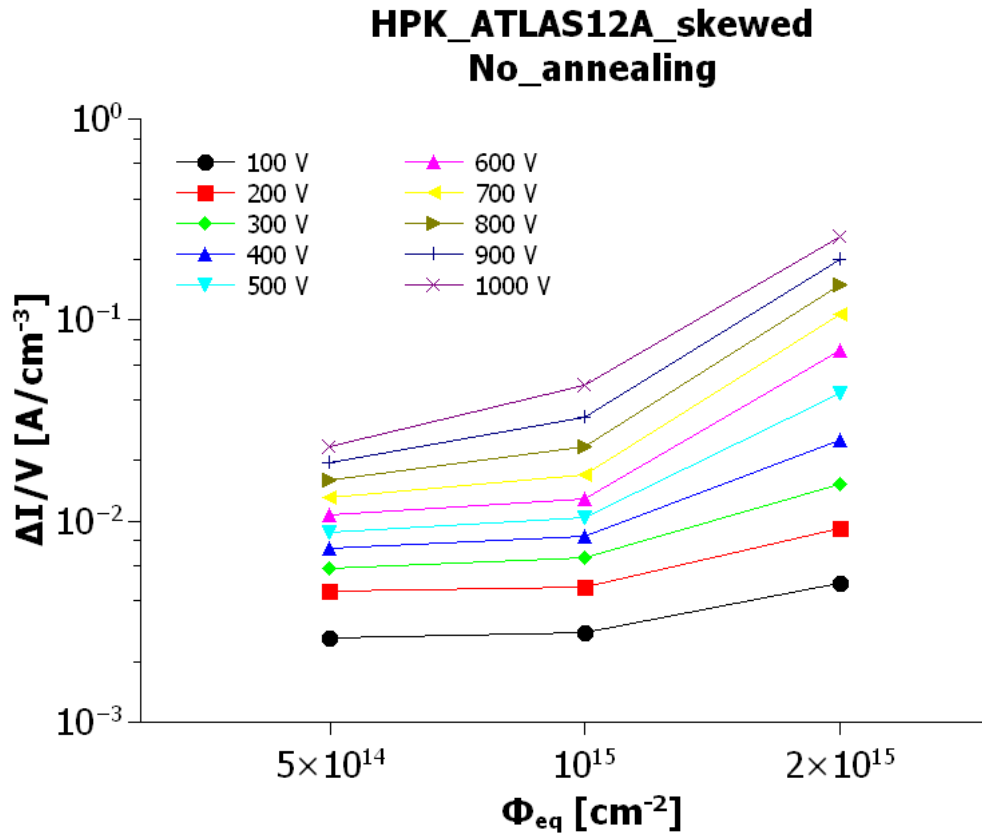


$$I[T1] = I[T2] (T1/T2)^2 e^{-(Eg/2k) (1/T1-1/T2)}$$

- $E_g = 1.214 \pm 0.014$ eV (RD50)
- -10 °C and -25 °C scaled currents fit quite nicely.

- Temperature scaled currents are 5 orders of magnitude bigger.

Irradiated sensors: Damage rate



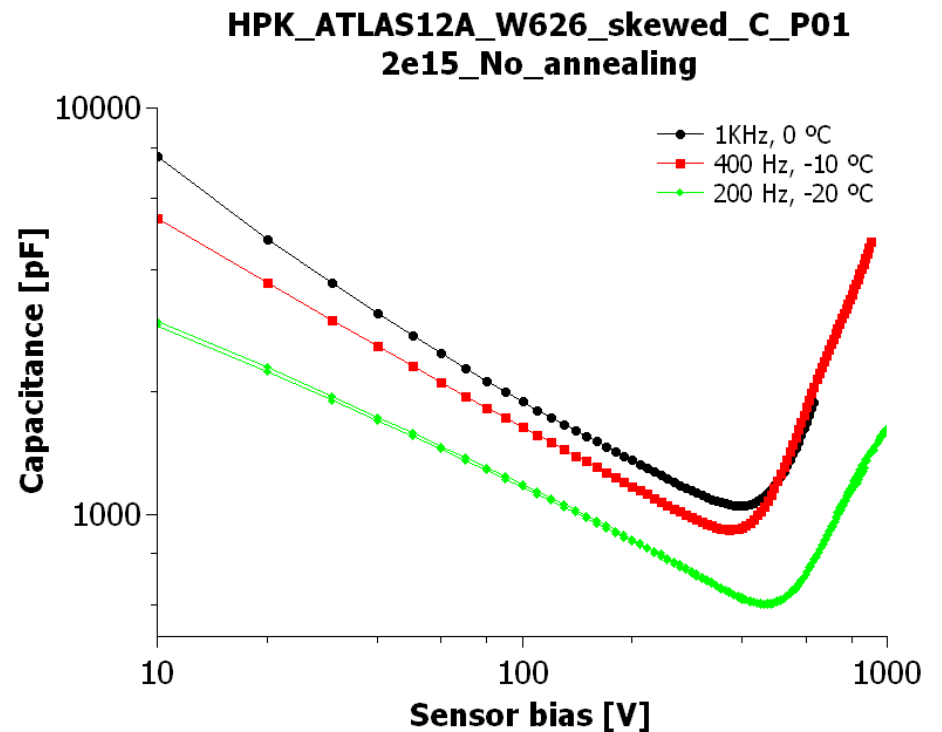
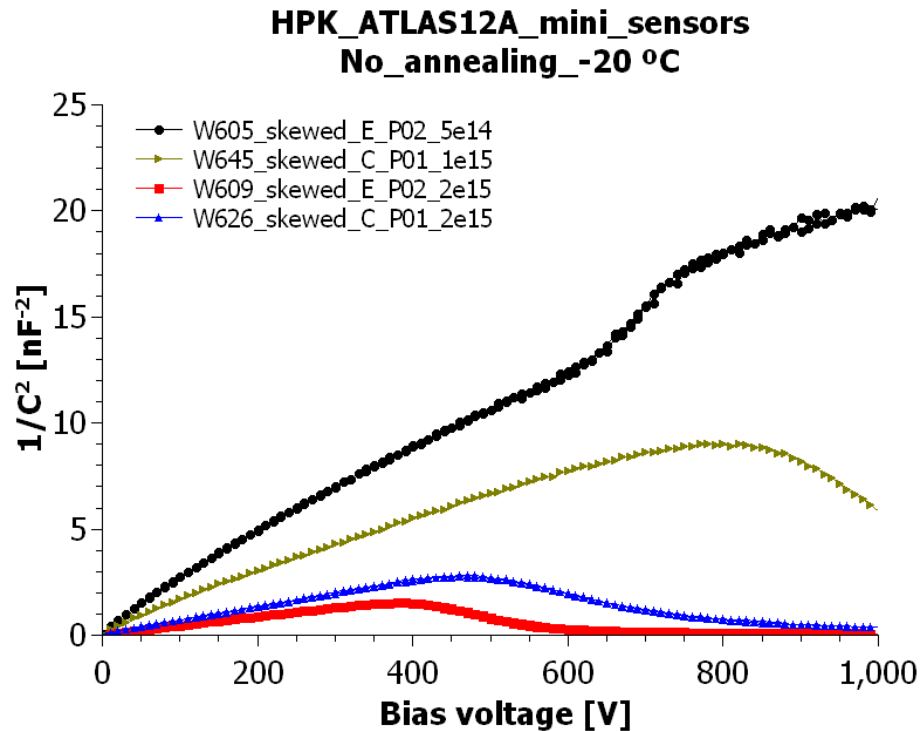
- Linear fit leads to values of α (current related damage rate)

Bias [V]	α [10^{-17} A/cm]	R^2
200	0.33	0.918
400	1.28	0.922
600	4.23	0.912
800	9.41	0.920
1000	16.48	0.942

- No lineal behavior seen in log scale.
- Wafers of 320 μm thickness considered.
- Active area: (HPK slides AUW2013)
 - Skewed: 3.10 cm^2
 - Large: 0.690 cm^2
 - Small: 0.686 cm^2

- Interesting to see how this will evolve with annealing.

Irradiated sensors: CV



- Full depletion is not reached.
- Capacitance increases at some point as bias raises.
- Only 5×10^{14} neq/cm² irradiated sensor does not show this behavior.

- Following ATLAS12 specs recommendations, the lower the temperature, the lower the frequency to get similar results.
- Charge collection measurements will be done before annealing.

Freiburg status

- Measurements without annealing are being performed.
- Charge collection measurements to be done soon on both non irradiated and irradiated sensors.
- Annealing (80 minutes @ 60 °C) will follow and measurements will be repeated.
- On the other side, a low dose irradiation (12 ec mini sensors for irradiation to Karlsruhe with doses of $2 \cdot 10^{13}$, $5 \cdot 10^{13}$, $1 \cdot 10^{14}$ and $2 \cdot 10^{14}$) will be done with small edge sensors.
- Also, 6 ec minis were glued with SE4445 and SE4468 without fishing lines and SE4468 with 140um fishing lines. They are at Karlsruhe for irradiation to $5 \cdot 10^{14}$ and $2 \cdot 10^{15}$.

