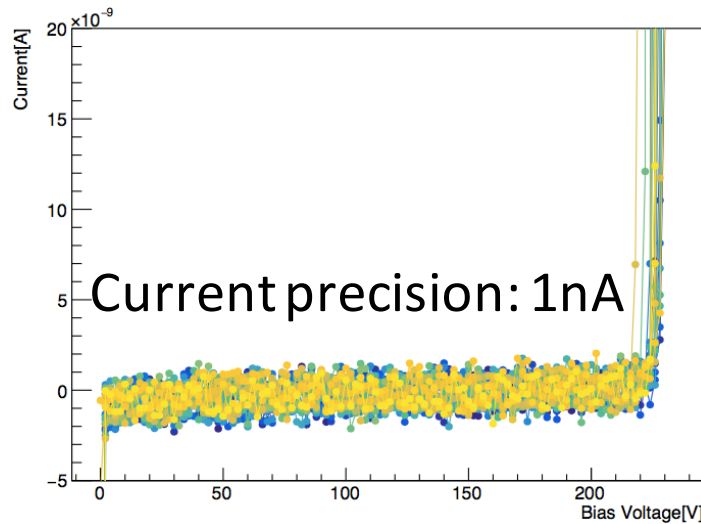


Updates on sensor tests

Liaoshan Shi

Feb. 28, 2019

Towards higher precision in IV measurements to compare the dark current with and w/o UBM

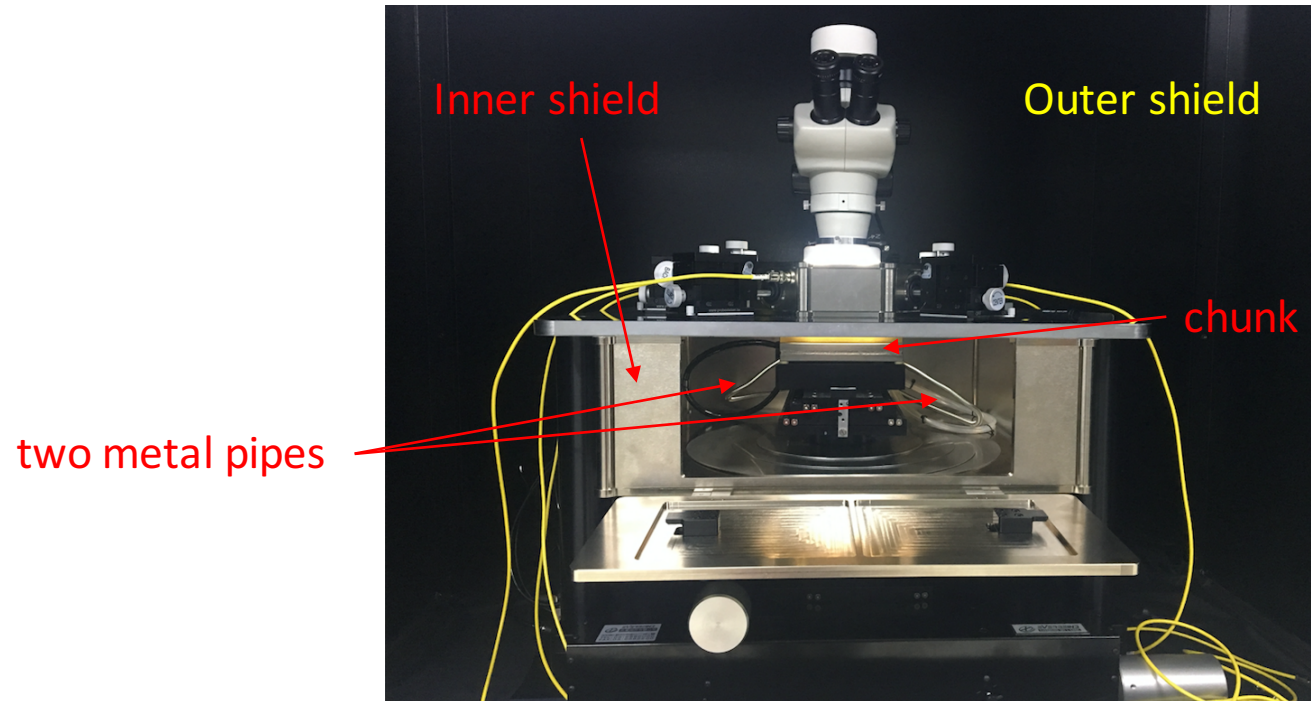


Comment from ATLAS HGTD meeting:
2410 can achieve a better precision.
Check your setup or use a Pico ammeter.

- Plan

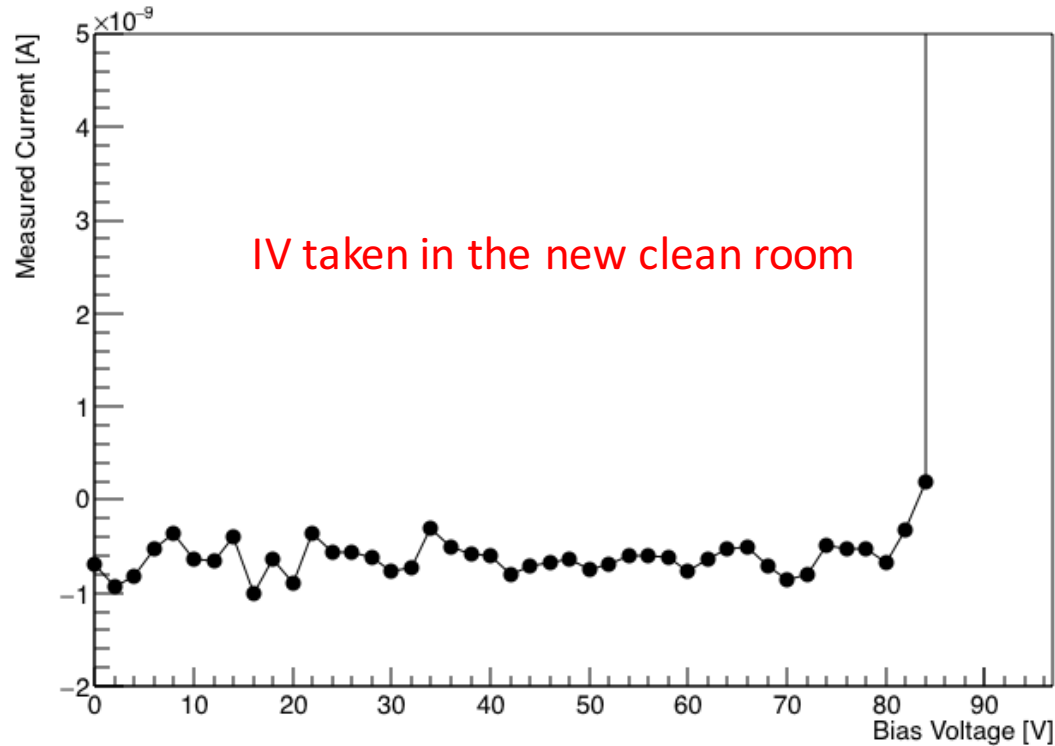
- Try 2410's filter mode:
 - The filter mode and take an average of several measurements to reduce noise.
 - Plan to try in the next few days.
- Use 6487 pico ammeter:
 - Longer term plan.

Progress in understanding the new probe station



- The chunk is directly connected to the two metal pipes.
- When the two pipes touch the shields, they connect the chunk to the shields.
- The shields are connected to ground via BNC cables.
- So the chunk is unintended connected to the ground via these metal pipes, resulting in confusing measurement results.
- Now I temporally isolate the chunk from shields by covering the metal pipes with some papers.

Another issue after isolating the chunk



The zero point of the measured current seems to be shifted.
There is a constant leakage current at -1 nA level that I do not understand.

Doping profile from CV results

Extract doping profile from CV results

$$N(W) = \frac{2}{q \cdot \epsilon_{si} \cdot \epsilon_0 \cdot A^2} \left[\frac{d}{dv} \left(\frac{1}{C^2} \right) \right]^{-1}$$

$$W = A \cdot \epsilon_{si} \cdot \epsilon_0 \left(\frac{1}{C} - \frac{1}{C_{ox}} \right)$$

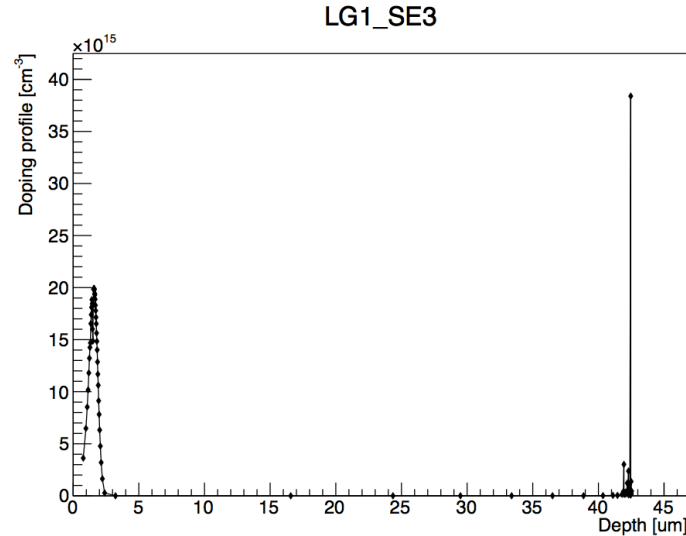
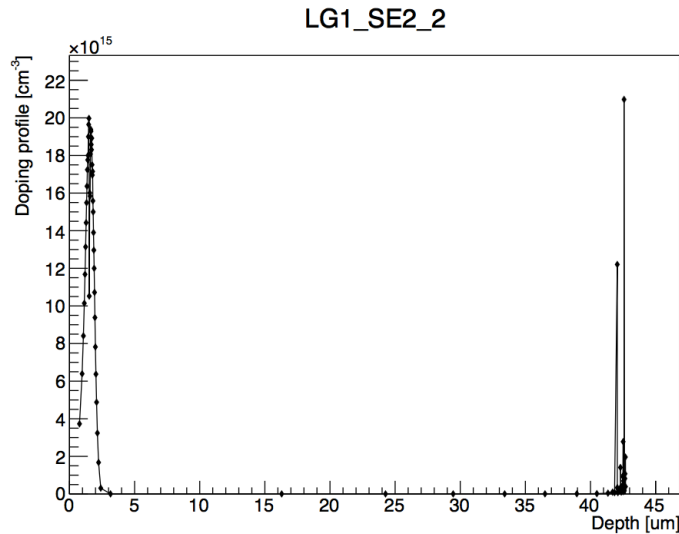
where

C is the measurement capacitance, in Farads; and
 W is the depth, in cm.

```
double A = 0.13*0.13; // [cm^2] -- active area
double esi = 11.7; -- dielectric constant of Si
double e0 = 8.854E-14; // [F/cm] -- free space permittivity
double q = 1.602E-19; // [C] -- electric charge
```

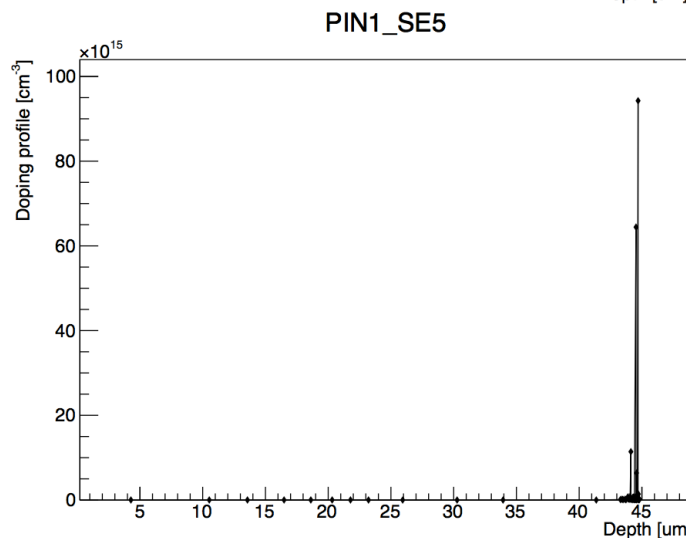
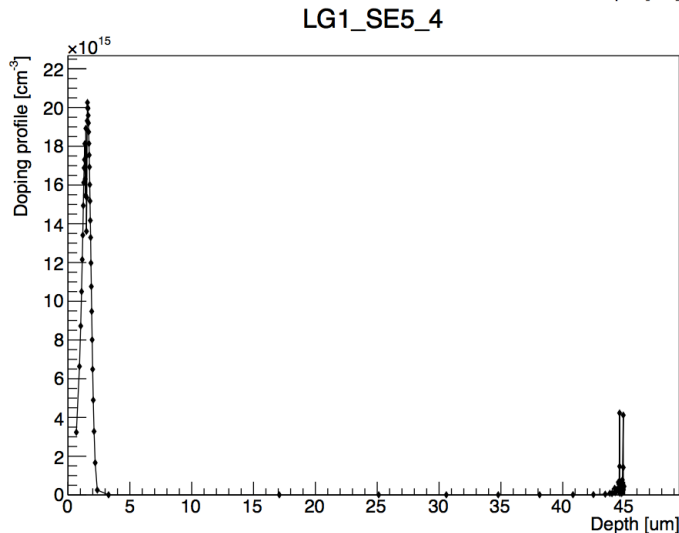
Doping profile of HPK W8 (50um thick; low doping)

Compare LG1_SE2/SE3/SE5 and PIN1_SE5



Peak:

- 2.0E+16 cm⁻³ for all LGADs.
- Close to 0 for PIN.



Max depth:

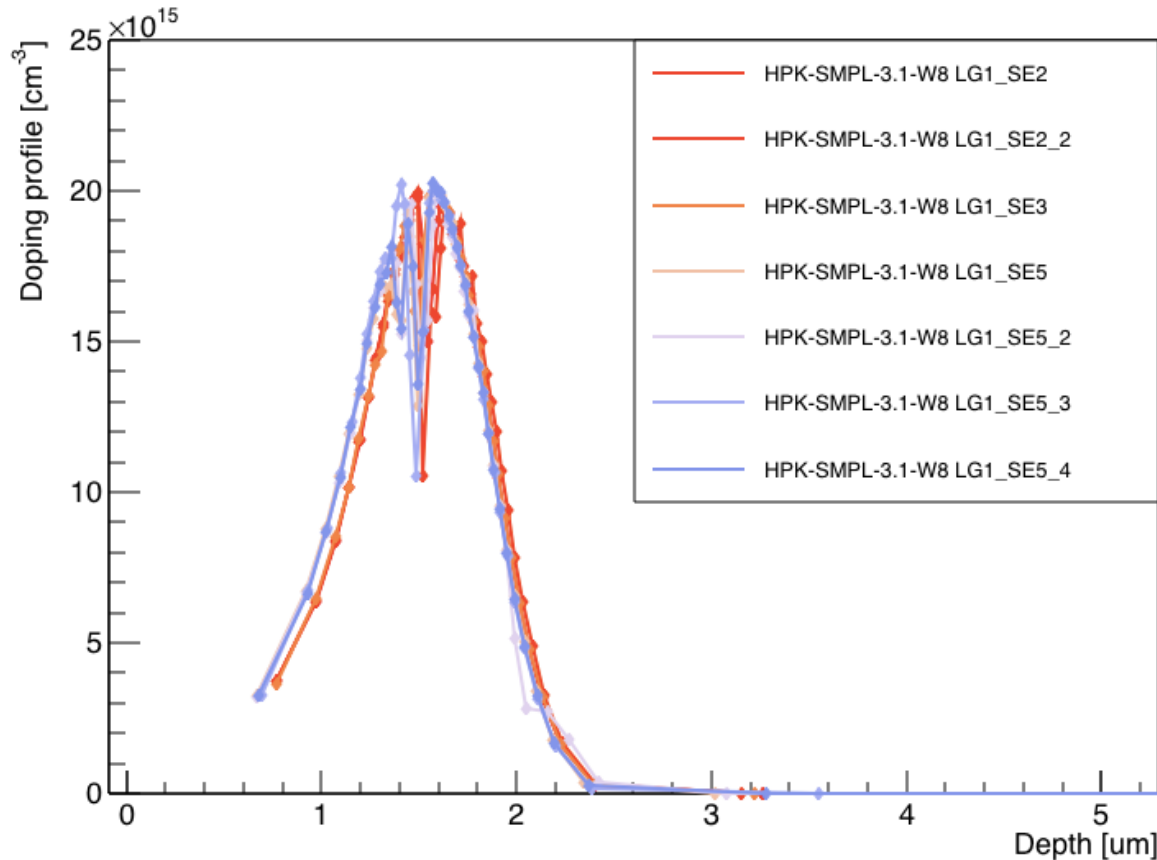
- 43um for SE2 and SE3.
- 45um for SE5.

Doping profile calculated assuming $A=0.13 \times 0.13 \text{ cm}^2$.

Difference between SE2/SE3 and SE5 in maximum depth might suggest different active area?

Doping profile of HPK W8 (50um thick; low doping)

Zoom into the gain layer



	Dose [cm ⁻²]
SE2	1.66E+12
SE2_2	1.66E+12
SE3	1.66E+12
SE3_2	1.67E+12
SE5	1.71E+12
SE5_2	1.70E+12
SE5_3	1.70E+12
SE5_4	1.70E+12
SE5_NM	1.70E+12

*Dose from integration of the doping of gain layer

Distortions present at similar depth for different sensors

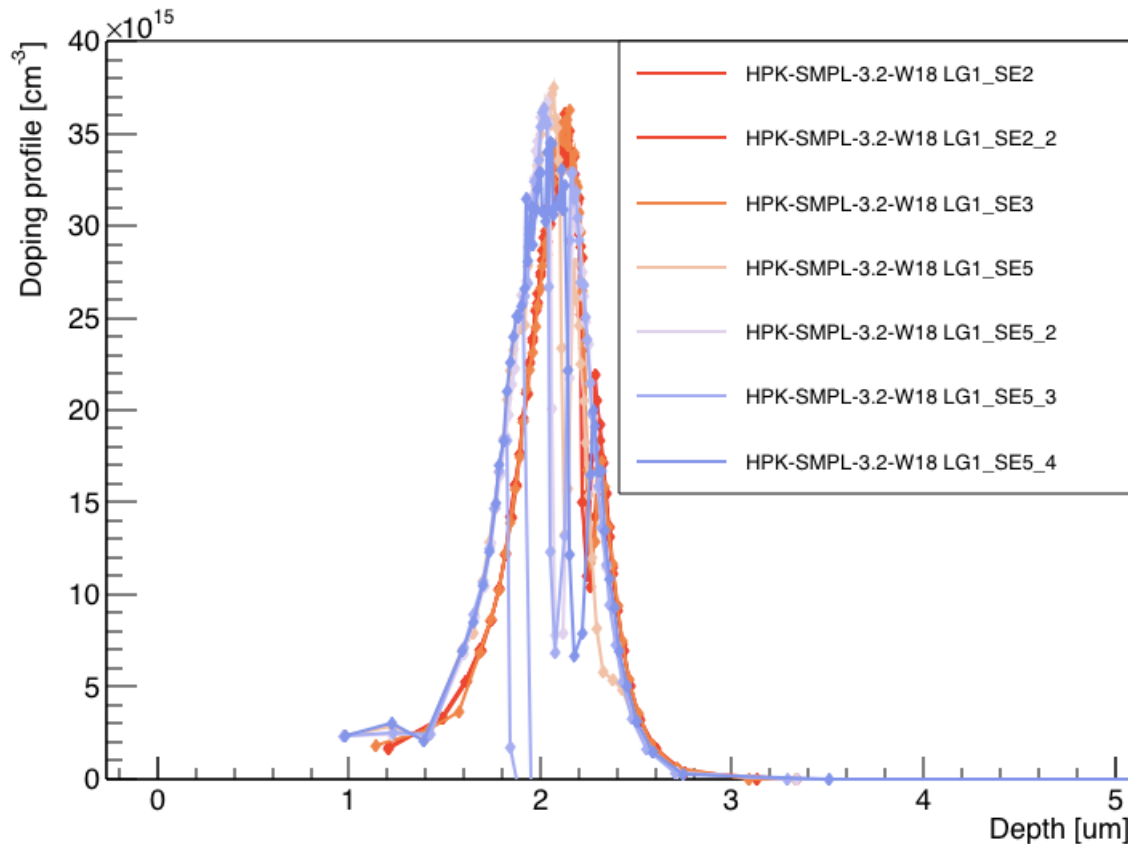
- suggesting a problem in measurement?
- Maybe time delay before reading is too short and sensor is not in equilibrium.

Small scale difference between SE2/SE3 and SE5

- suggesting a difference in active area?

Doping profile of HPK W18 (50um thick; high doping)

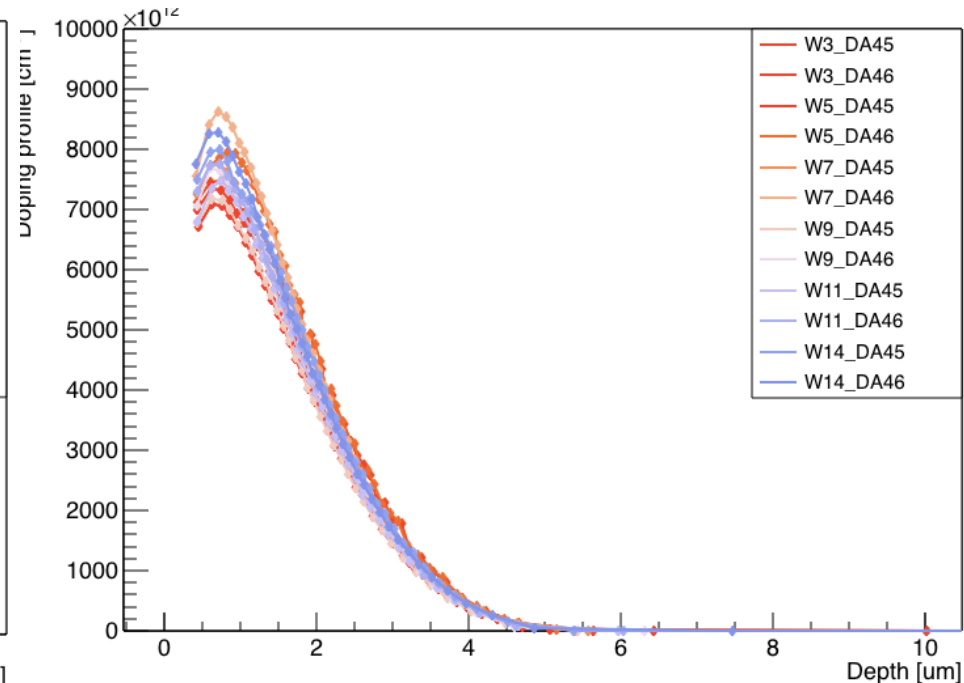
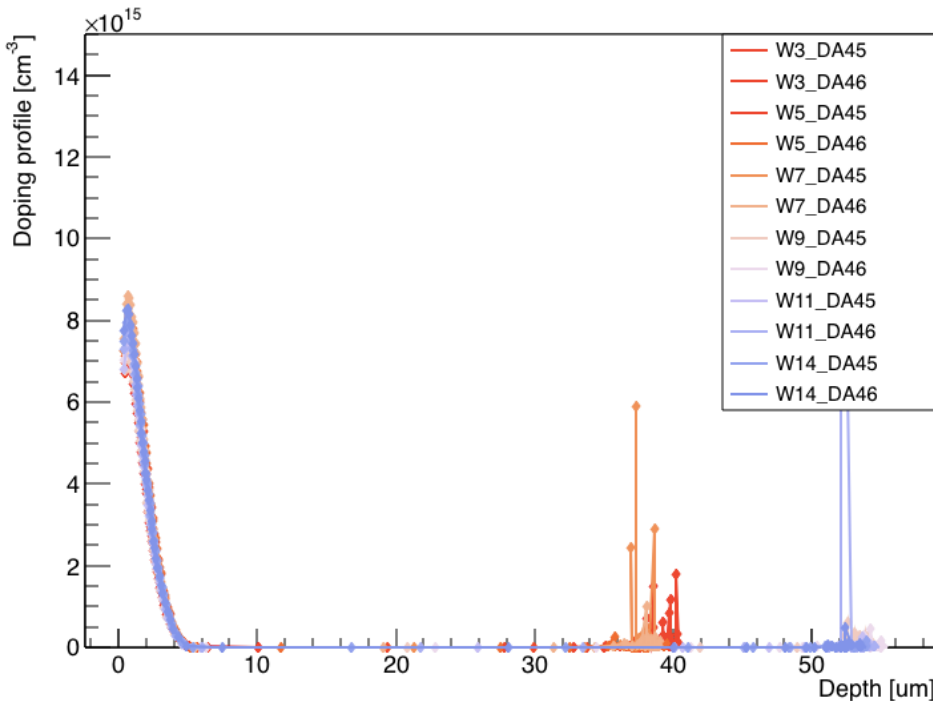
Zoom into the gain layer



	Dose [cm ⁻²]
SE2	1.71E+12
SE2_2	1.72E+12
SE3	1.73E+12
SE3_2	1.74E+12
SE5	1.80E+12
SE5_2	1.78E+12
SE5_3	1.78E+12
SE5_4	1.79E+12
SE5_NM	1.74E+12

Doping profile of CNM sensors

Zoom into the gain layer



Two groups:

- W3-W7 are thinner.
- W9-W14 are thicker.

Dose (x1E+12 cm⁻²) if assumed A=0.13x0.13cm⁻²

Wafer#	3	5	7	9	11	14
DA45	1.31	1.49	1.46	1.31	1.38	1.51
DA46	1.38	1.57	1.57	1.43	1.46	1.51

Summary of doping profile for all tested sensors

