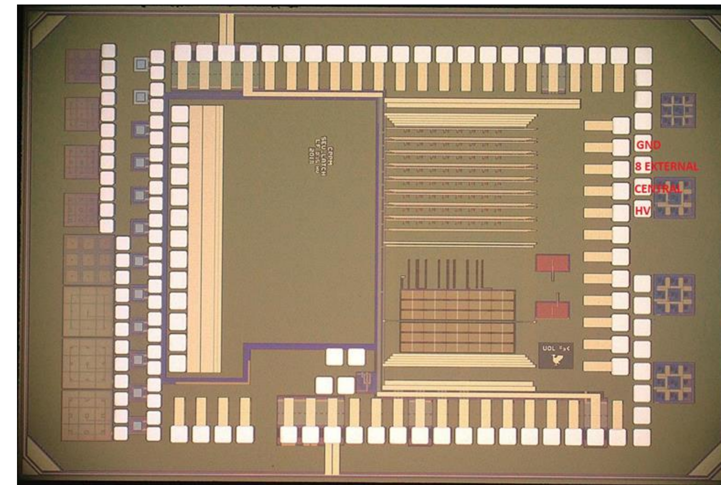
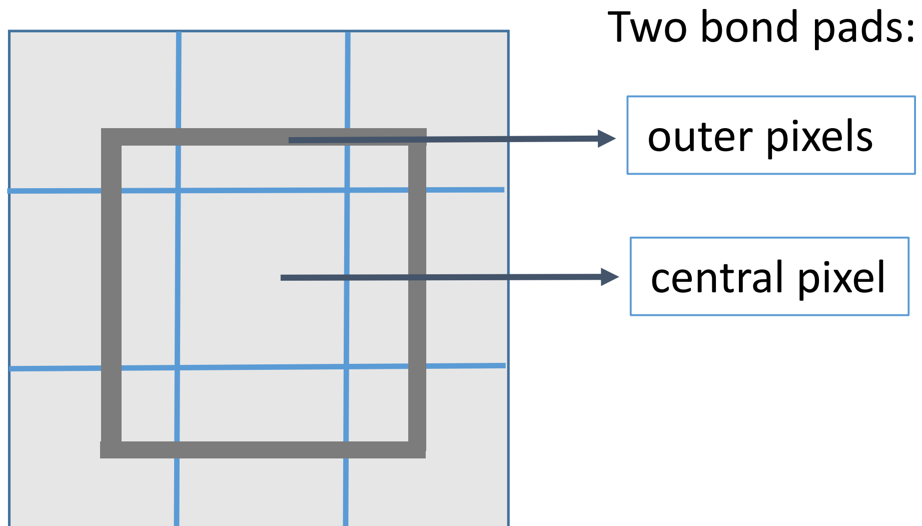
RD50 MPW2 Test structure

- RD50 project
- LFoundry, 4 resistivities
- followup of RD50-MPW1 → (low breakdown)



- 60 um x 60 um pixel
- 3x3 pixel array
- central pixel one bond pad
- outer pixels connected together another bond pad

Two bond pads:



In our setup:

DNWELL connected to + HV

Substrate (HV) to GND

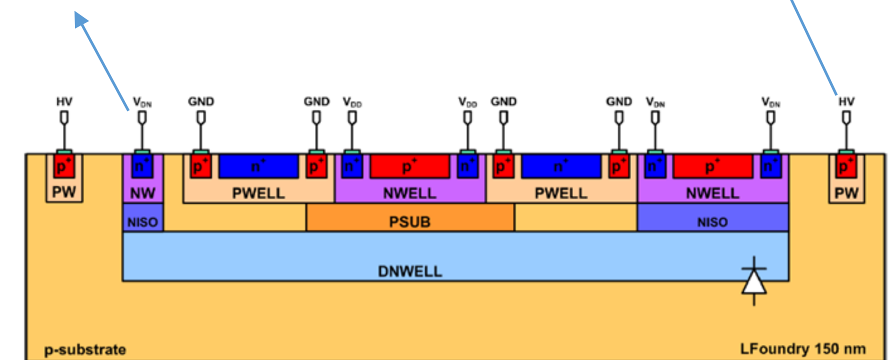
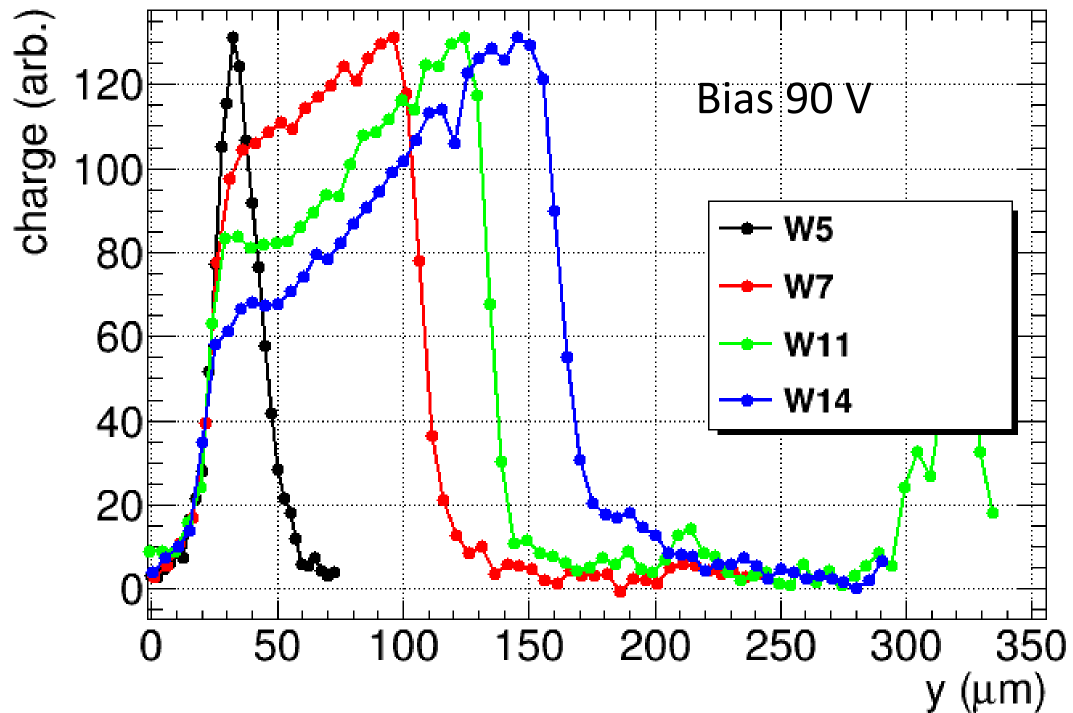


Figure 12. Simplified cross-section of one pixel

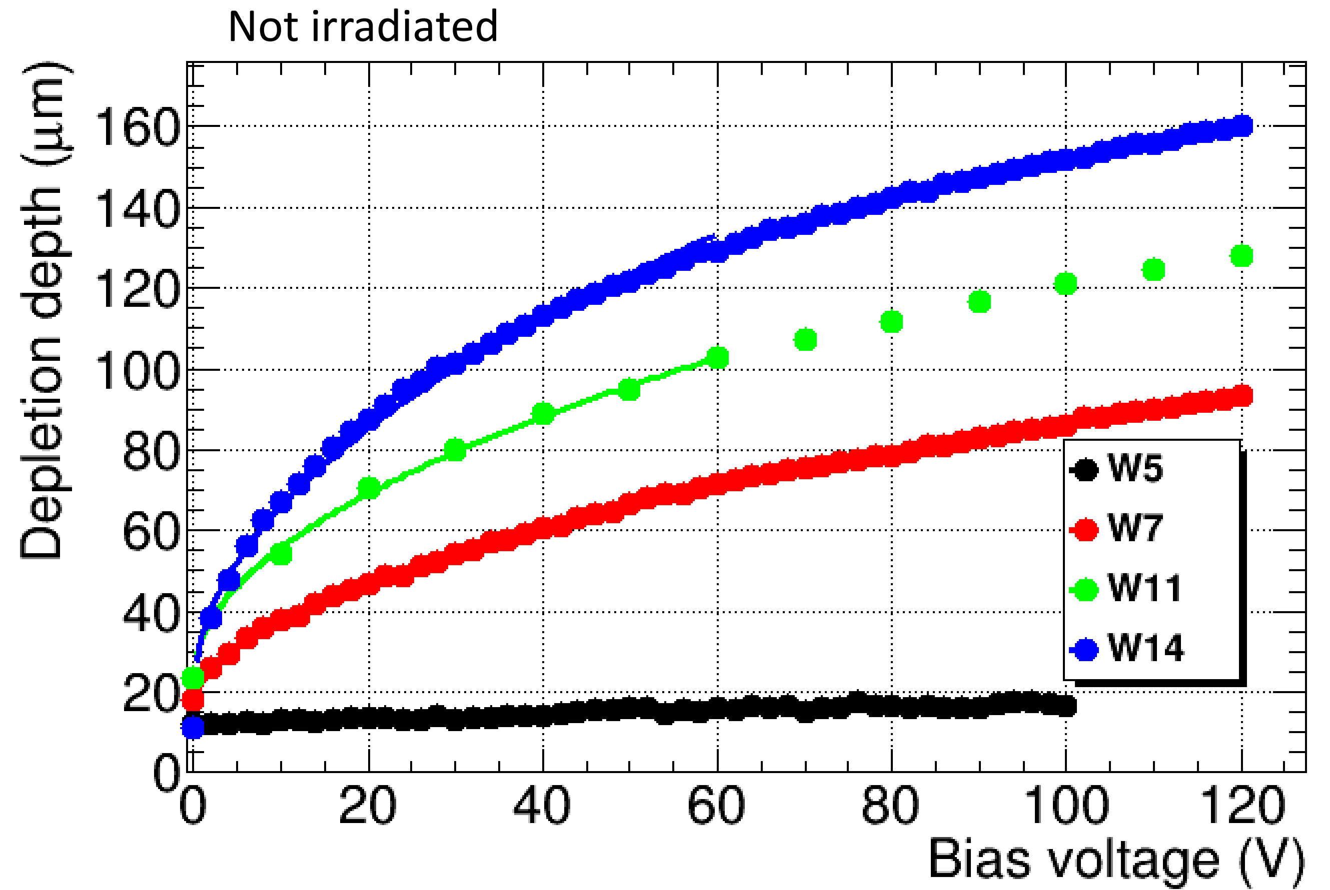
Charge collection profile

- bias up to 120 V, low current
  (W5 to 100 V, breakdown at ~ 105)



- scan across centre of central pixel
- profiles normalized to same maximum

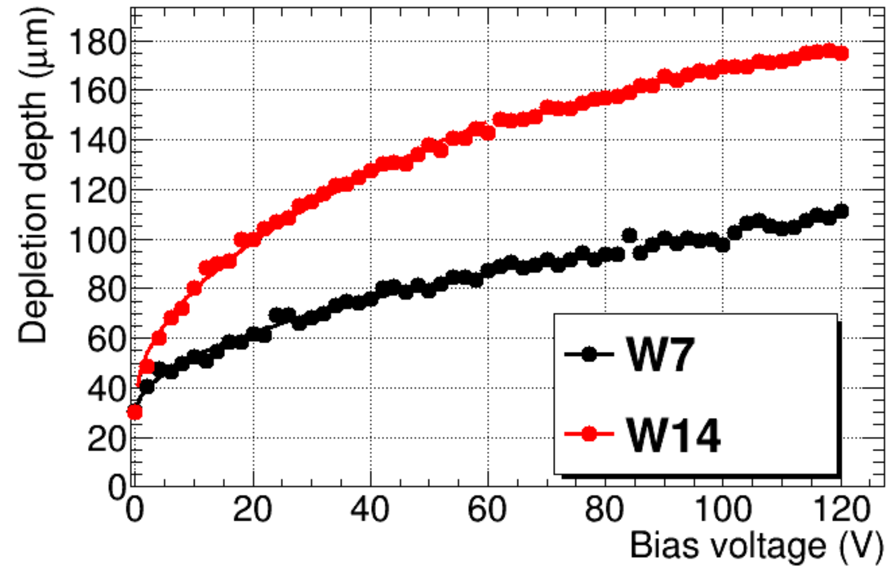
Not irradiated



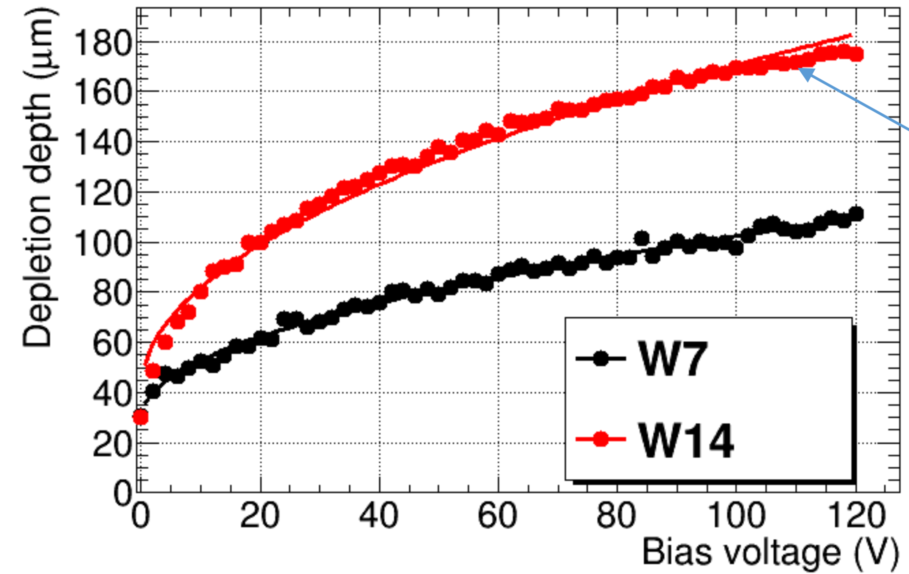
W5: N_{eff} = 3.2e15 cm^{-3} → 4 Ωcm
W7: N_{eff} = 2.4e13 cm^{-3} → 0.5 kΩcm
W11: N_{eff} = 1.2e13 cm^{-3} → 1.1 kΩcm
W14: N_{eff} = 5.9e12 cm^{-3} → 2.2 kΩcm

→ numbers accurate to ~ 20%, W5 worse

Fit up to 60 V



Fit up to 120 V



slabši fit
kot do 60 V

Fit:

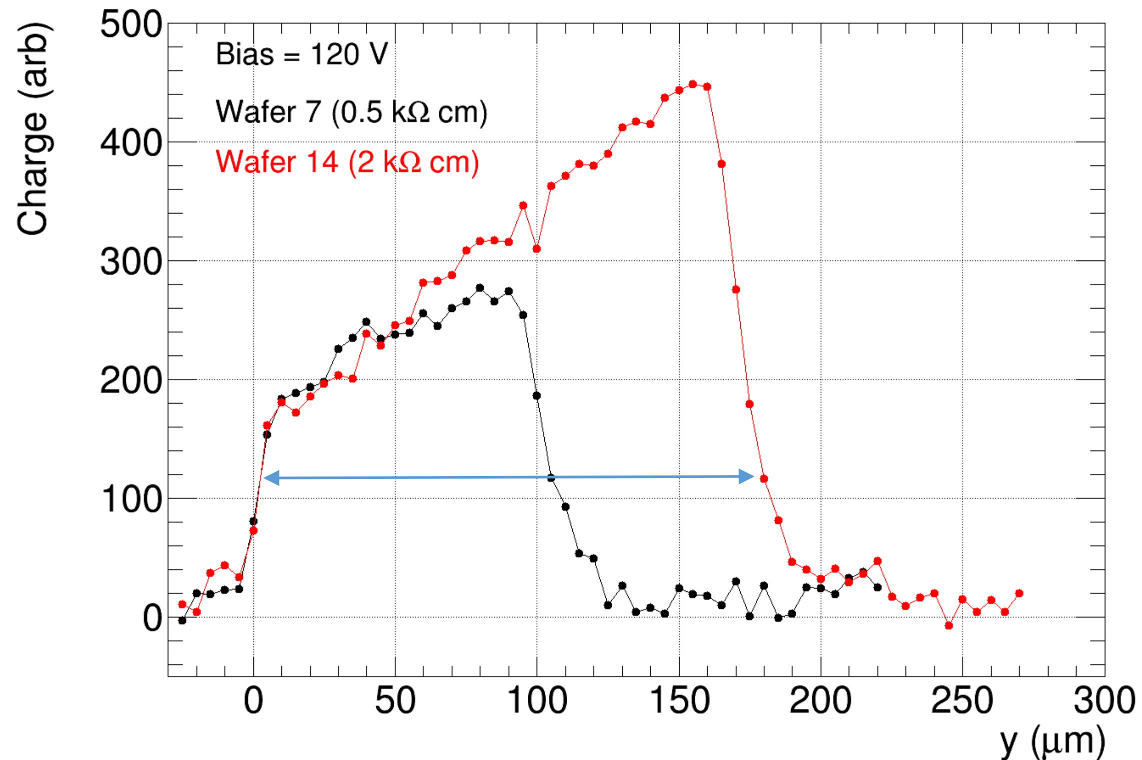
$$d = d_0 + \sqrt{\frac{2\varepsilon\varepsilon_0}{e_0 N_{eff}} \cdot V_{sub}}$$

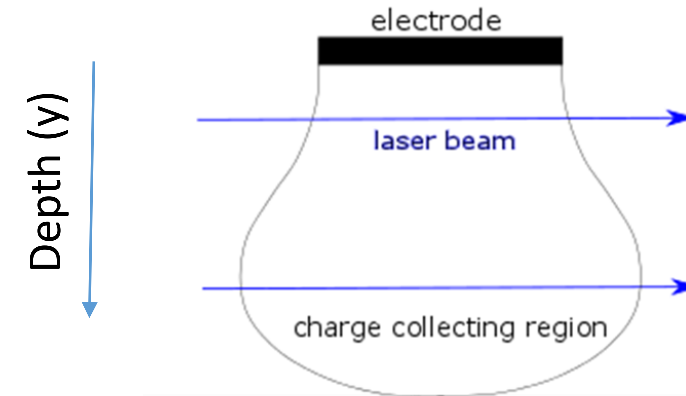
Fit up to 60 V:
Neff_w7 = 2.4e13
Neff_w14 = 6e12

Fit up to 120 V:
Neff_w7 = 2.5e13
Neff_w14 = 8e12

Pri w14 precejšnja razlika če fit do 60 V ali do 120 V

Charge collection profile





- more charge collected at larger y (depth) because length of laser beam inside charge collection region increases because of the shape of the region

Čudna oblika depletiranega območja

➔ kako dobro enačba opiše odvisnost d od V in Neff?
➔ kako bi se dalo to preštudirati za magisterij?

$$d = d_0 + \sqrt{\frac{2\varepsilon\varepsilon_0}{e_0 N_{eff}} \cdot V_{sub}}$$

Scan x and y under central pixel

Reflection

W14 (120V)

y (μm)

Charge (arb)

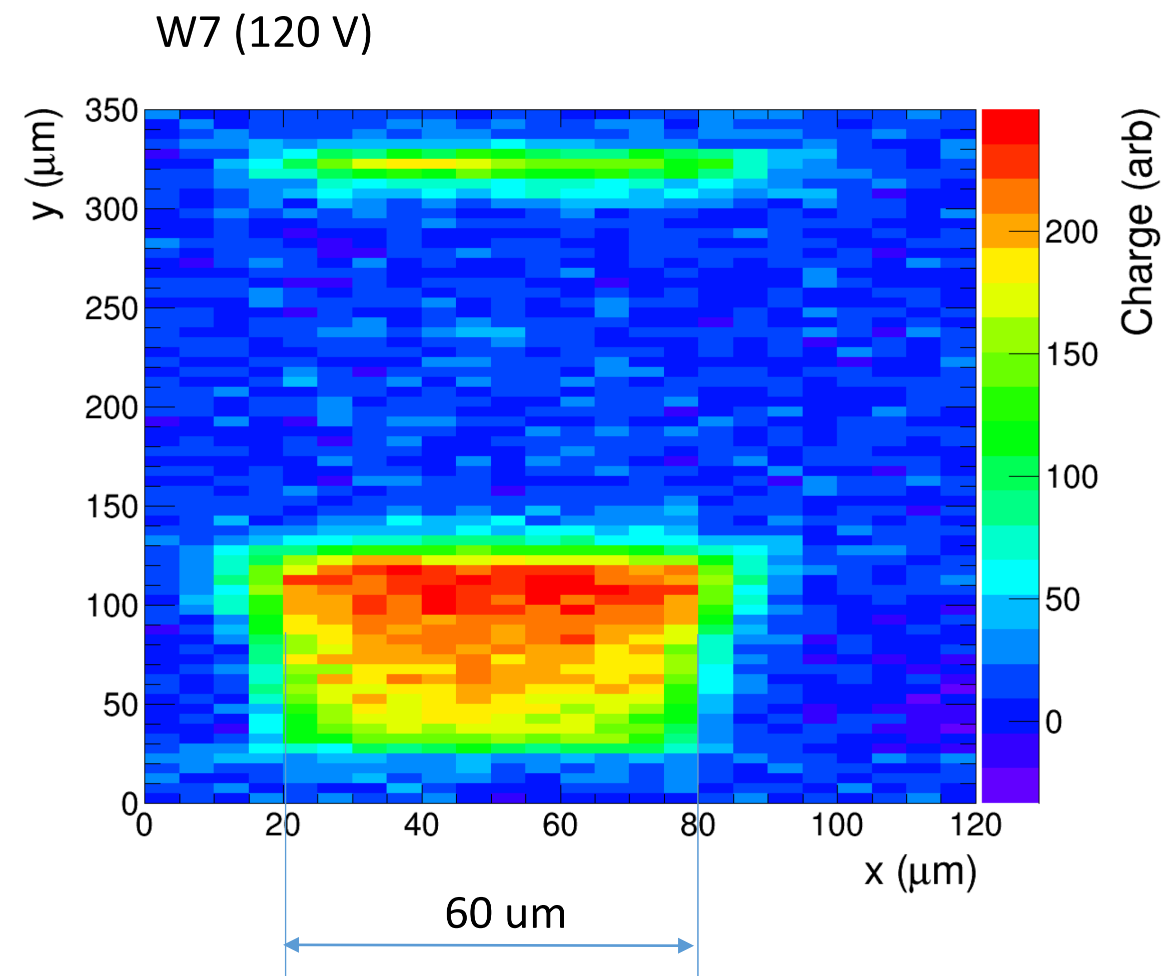
x (μm)

Depth (μm)

chip surface

60 um

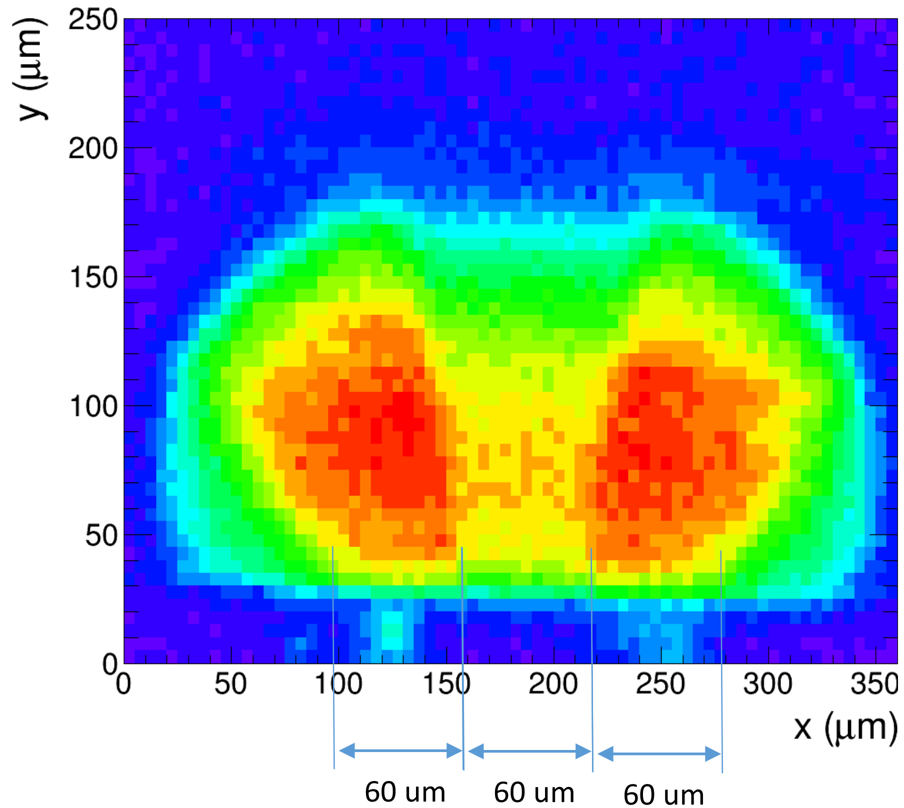
W7 (120 V)

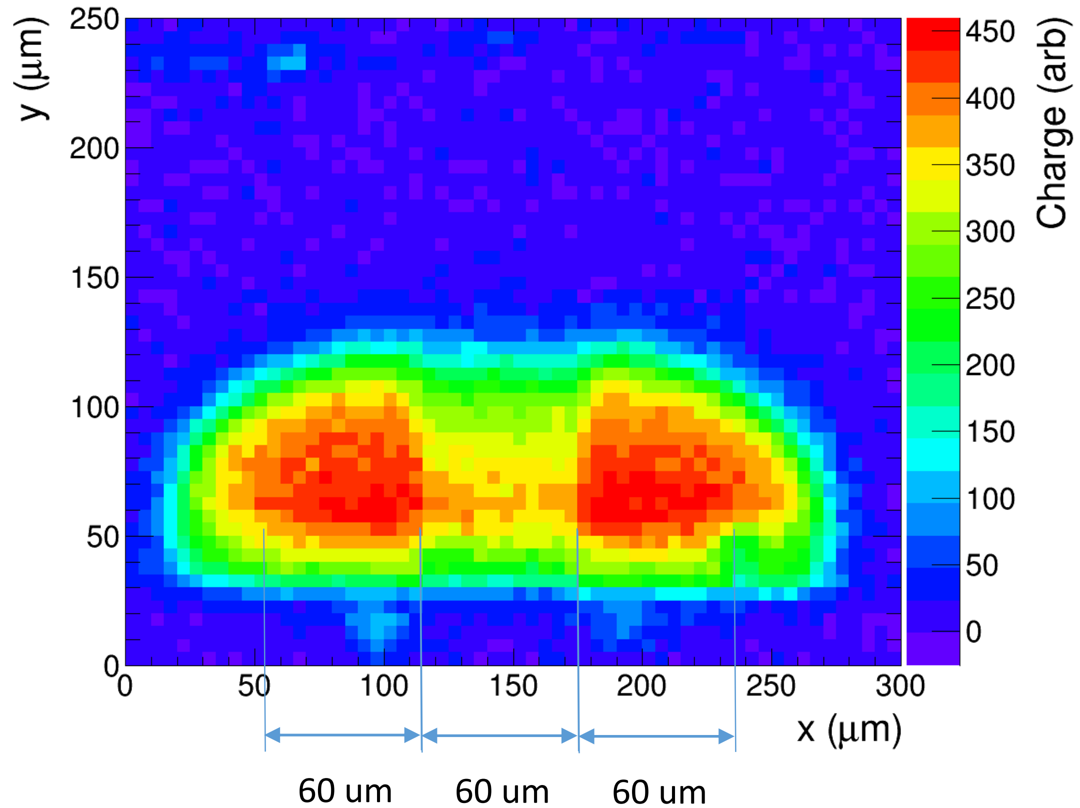


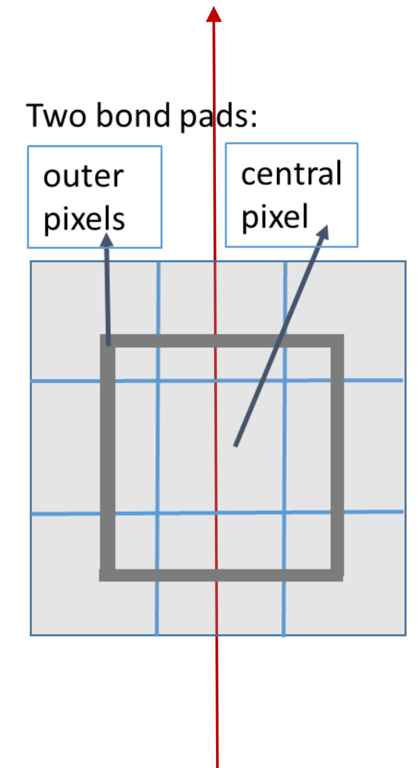
60 um

- charge collection region width increases at large depletion depths
- Known effects, seen before in several other samples

Charge from induced signals on outer 8 pixels (without central one)



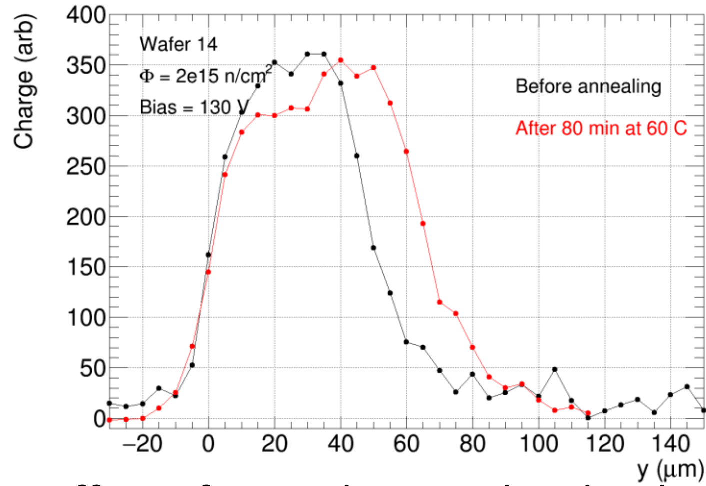




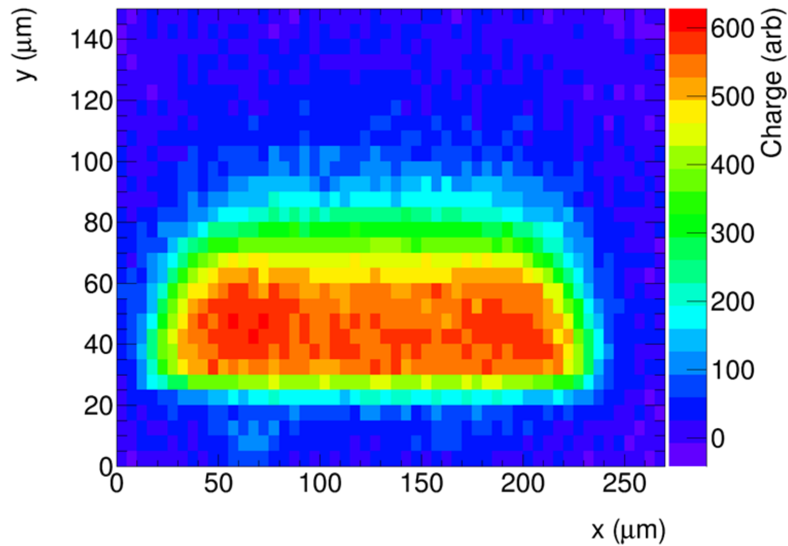
Charge collection region extends beyond dimension of the test structure
→ depletion region shape and diffusion from undepleted substrate

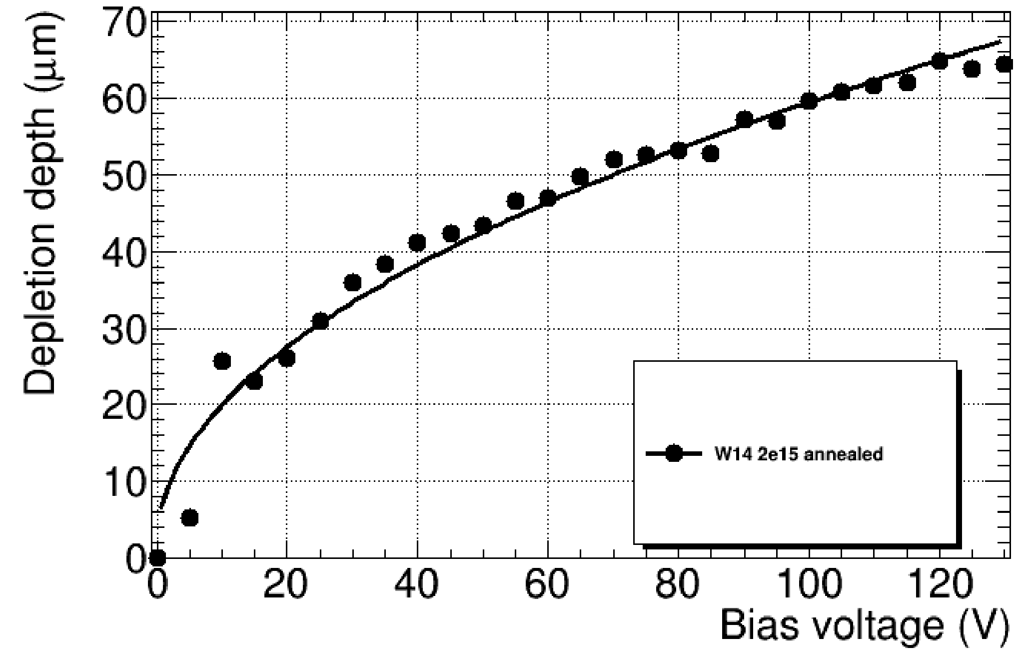
Charge from central pixel not included

W14 (high resistivity), 2e15



- effect of annealing can be clearly seen



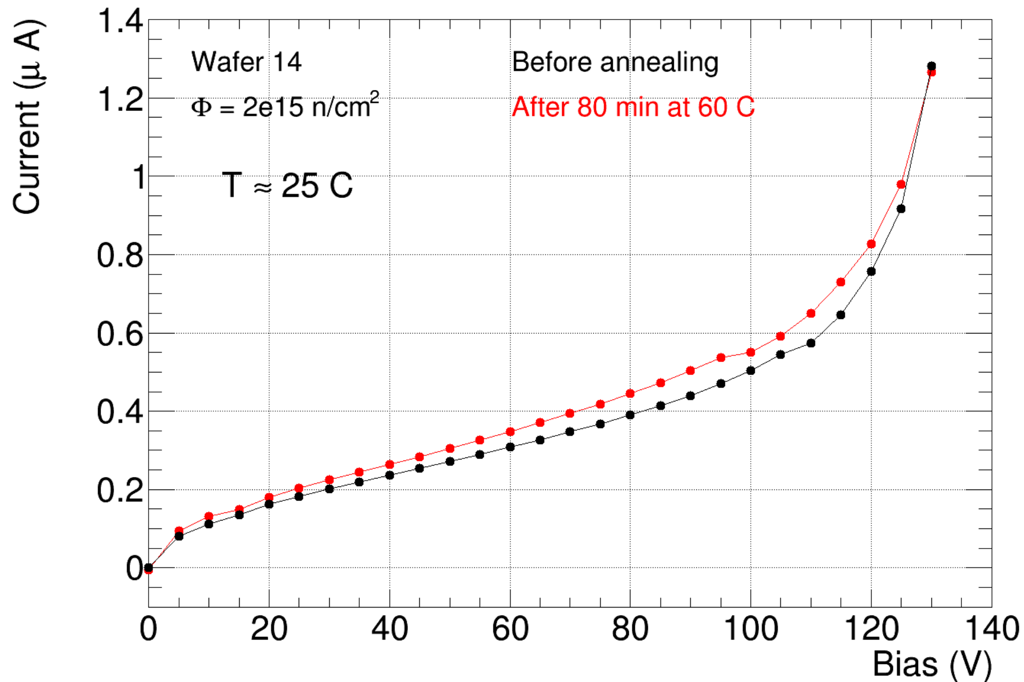


N_{eff} = 4e13 cm^{-3}

$N_{eff} = g_c * \Phi \rightarrow g_c = 0.02$ cm^{-1}

W14 irradiated to 2e15

Current from 9 pixels (measured on e-TCT setup)



$I = \alpha * \Phi * V$,

α = 4e-17 cm^{-1} (at 20 C)

Φ = 2e15 n/cm^2

V = (180 μm)**2 * 50 μm = 1.6e-6 cm^3

I = 130 μA

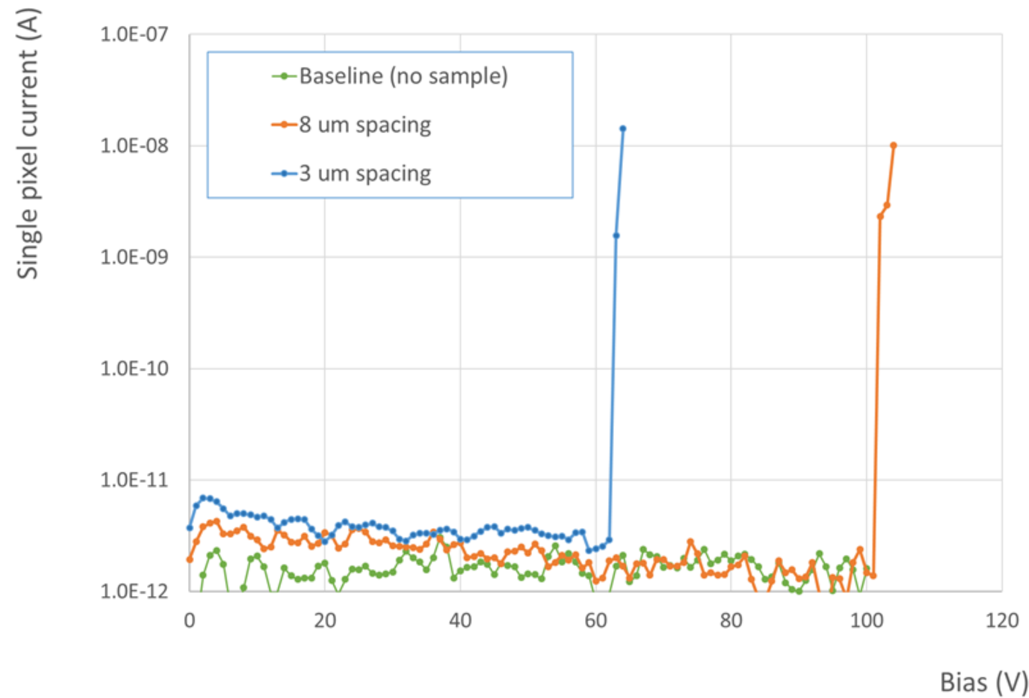
➔ measured current right order of magnitude but somewhat larger because of:

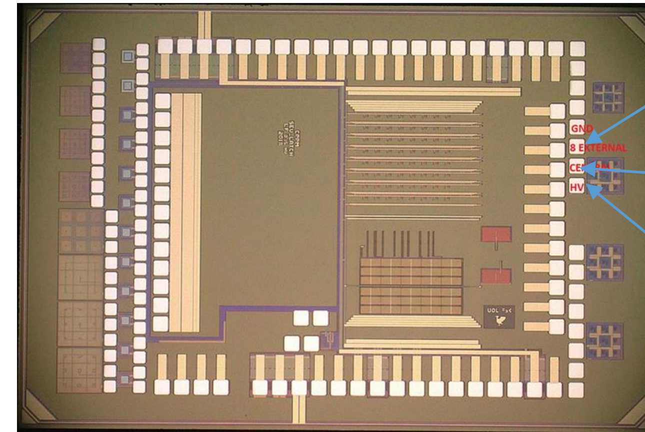
→ depletion (in x direction) wider than 3X60 um (see E-TCT)

→ temperature higher than 20 C

- similar breakdown voltage as before irradiation
- slight increase of current after annealing
  → related to the increase of depletion depth with annealing

IV on W5 (std. resistivity)





Outer pixels to 0 V (guard ring)

Central pixel to 0 V
→ measure current on this pad

- HV

- sensitivity of the setup ~ 10 pA
- current in MPW2 near or less than the sensitivity
- breakdown: 63 V for pixel with 3 um spacing
  102 V for 8 µm spacing