Year 2 Semester 1 updates: RD50-ENGRUN1 TCAD Simulations (Internal)

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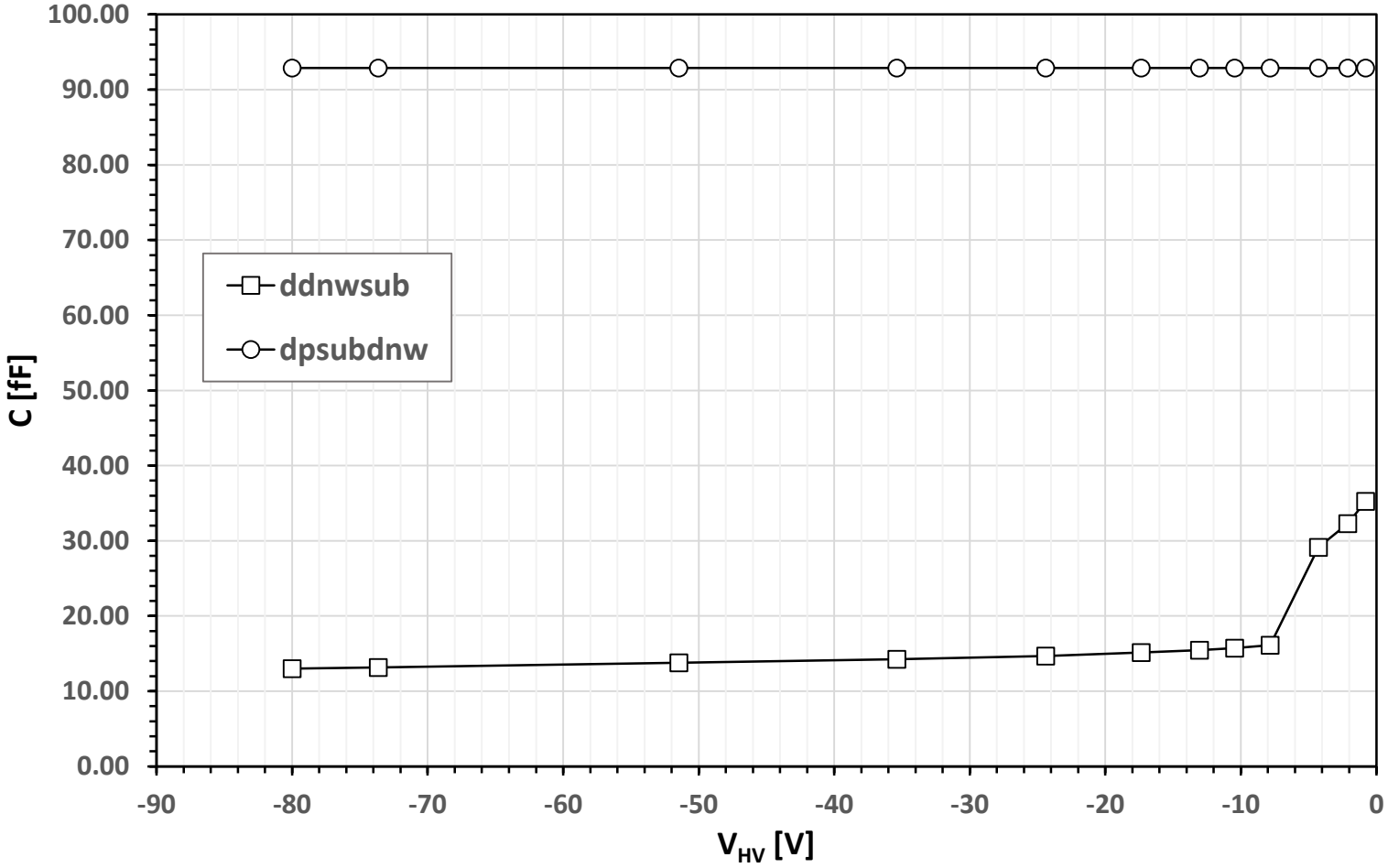
Last few weeks: (Internal)

Using TCAD models of the RD50-MPW1 pixel to prepare for simulations of RD50-ENGRUN1 pixel (in matrix 5?)

- Parasitic Capacitance
  - Mixed-mode simulation with small AC analysis
  - Negative capacitances?
- Radiation Damage
  - Pennicard charge trapping
- Multiple pixels with spacing
  - Models dynamically created with spacing nz as input parameter

Parasitic capacitance simulations (Internal)

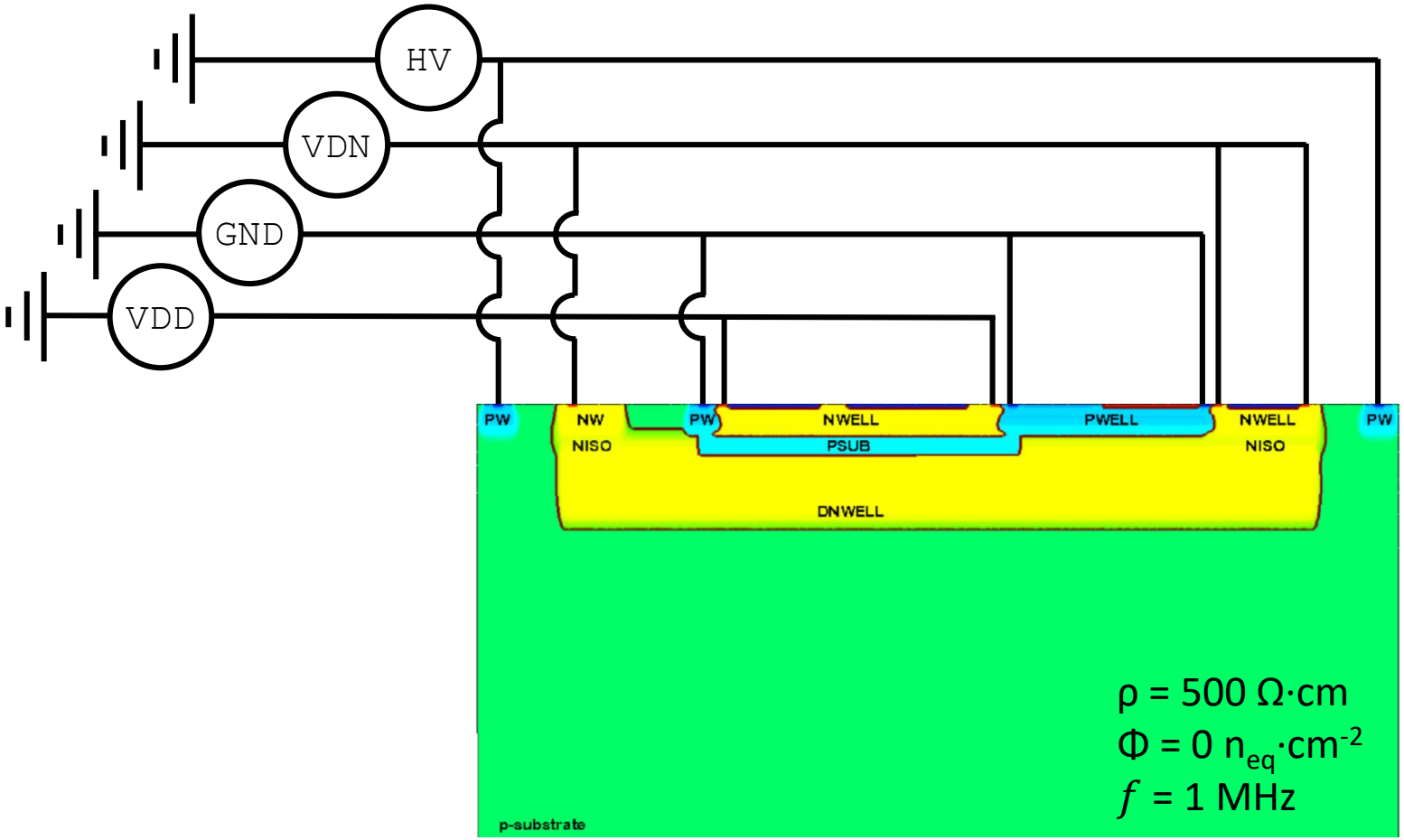


Using **RD50-MPW1** pixel simulations:

- Modelling parasitic capacitance
- (The capacitances come out negative!)
- $C_{ddnwsub}$ too small → ≈ 70 fF @ -60V

dpsubdnw depth = 14.42 µm
ddnwsub depth = 42.5 µm

Mixed-mode simulation schematic (Internal)



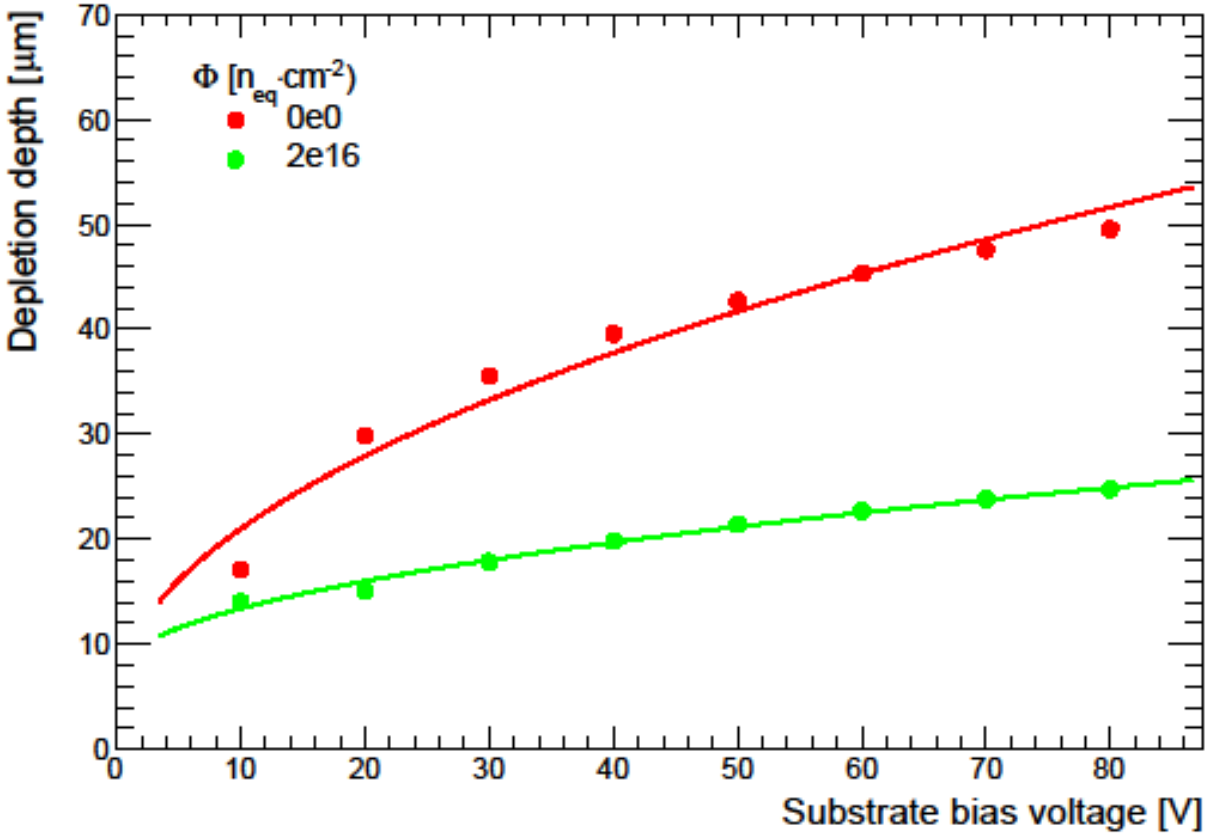
SPICE syntax:

```
Vsource_pset HV (n1 0) {dc = 0}
Vsource_pset VDN (n2 0) {dc = 0}
Vsource_pset VDD (n3 0) {dc = 0}
Vsource_pset GND (n4 0) {dc = 0}

...

Goal {Parameter=VDD.dc Voltage=1.8}
...
Goal {Parameter=VDN.dc Voltage=1.8}
...
Goal {Parameter=HV.dc Voltage=-80}
```

Radiation damage simulation and analysis (Internal)



Using **RD50-MPW1** pixel simulations:

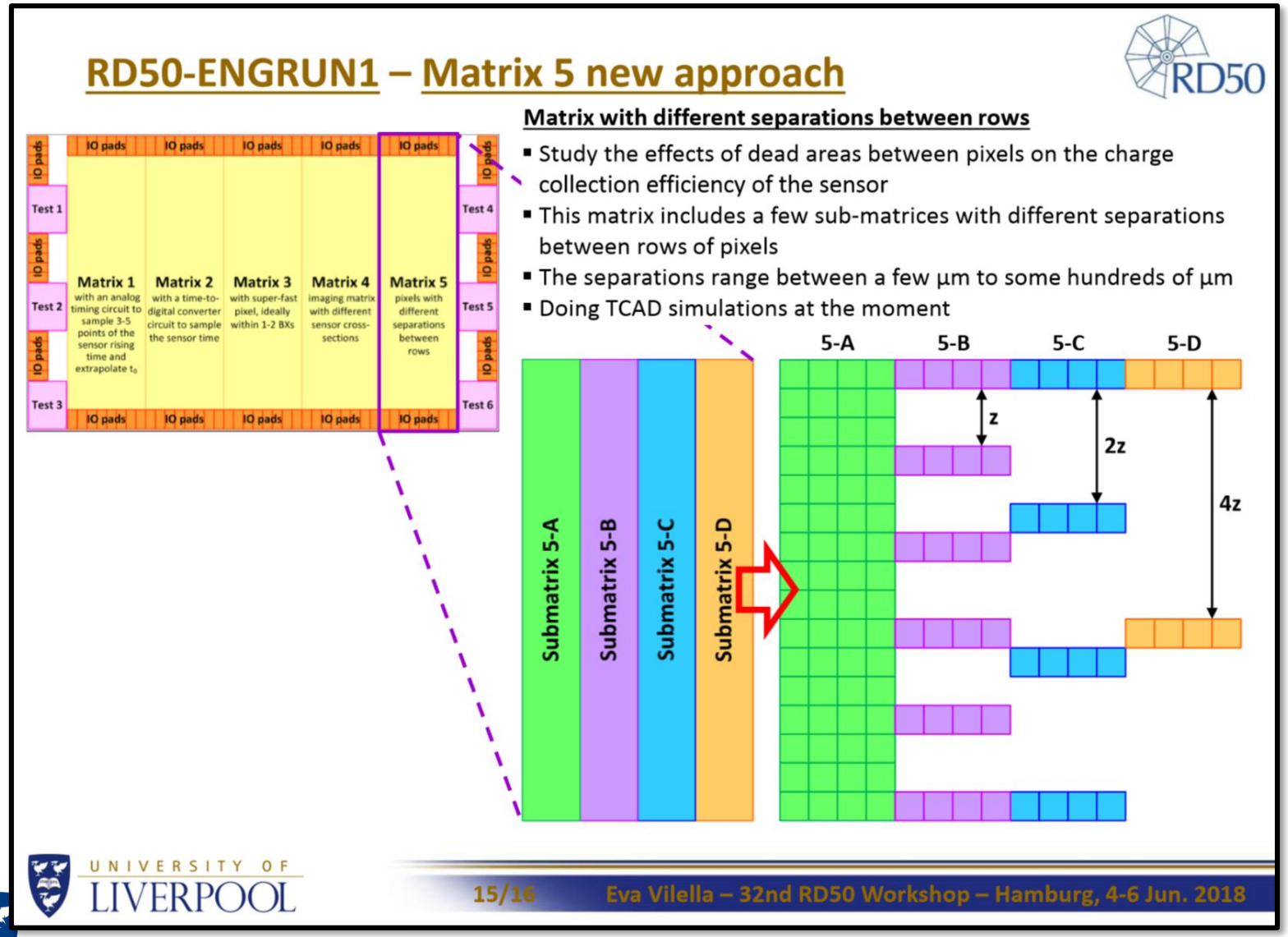
- Modelling radiation damage using charge trapping (D. Pennicard)
- Initial simulation comparing "non-irradiated" pixel with one irradiated to 2E16 $n_{eq}cm^{-2}$

Type	Energy (eV)	Trap	σ_e (cm^2)	σ_h (cm^2)	η (cm^{-1})
Acceptor	Ec-0.42	VV	$9.5*10^{-15}$	$9.5*10^{-14}$	1.613
Acceptor	Ec-0.46	VVV	$5.0*10^{-15}$	$5.0*10^{-14}$	0.9
Donor	Ec+0.36	CiOi	$3.23*10^{-13}$	$3.23*10^{-14}$	0.9

Table 1: *D. Pennicard, UoGlasgow, PPT*

Spacing between pixels

(Internal)



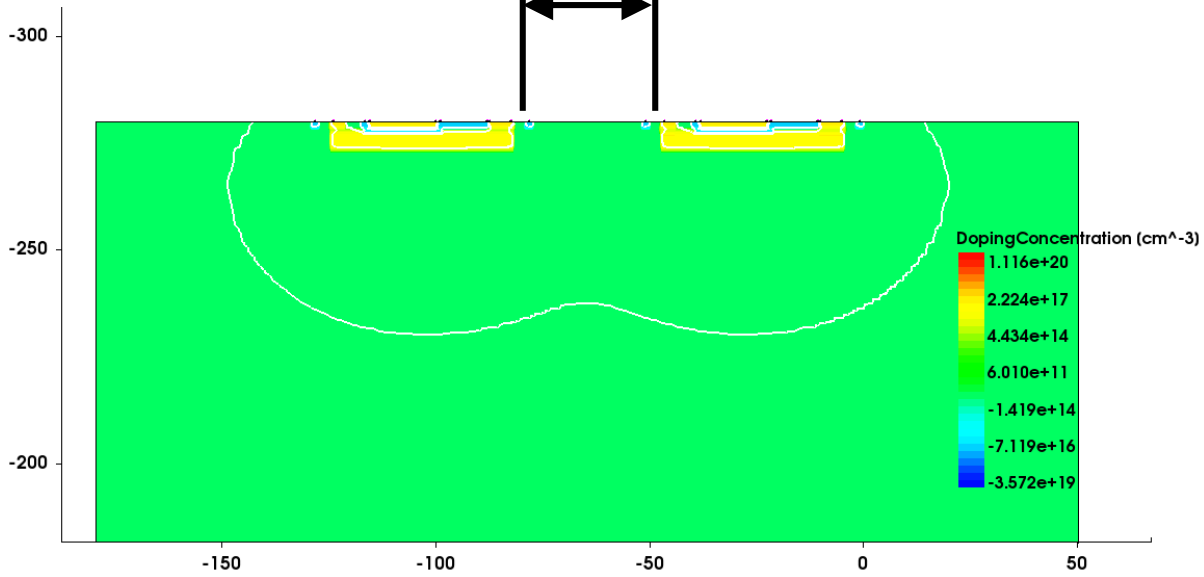
Using **RD50-MPW1** pixel simulations:

- $z = 25$ µm (or whatever we choose... ≈ 50 µm on the diagram)
- Pixel models can be dynamically created for two pixels of spacing $1z$, $2z$, $4z$ etc.

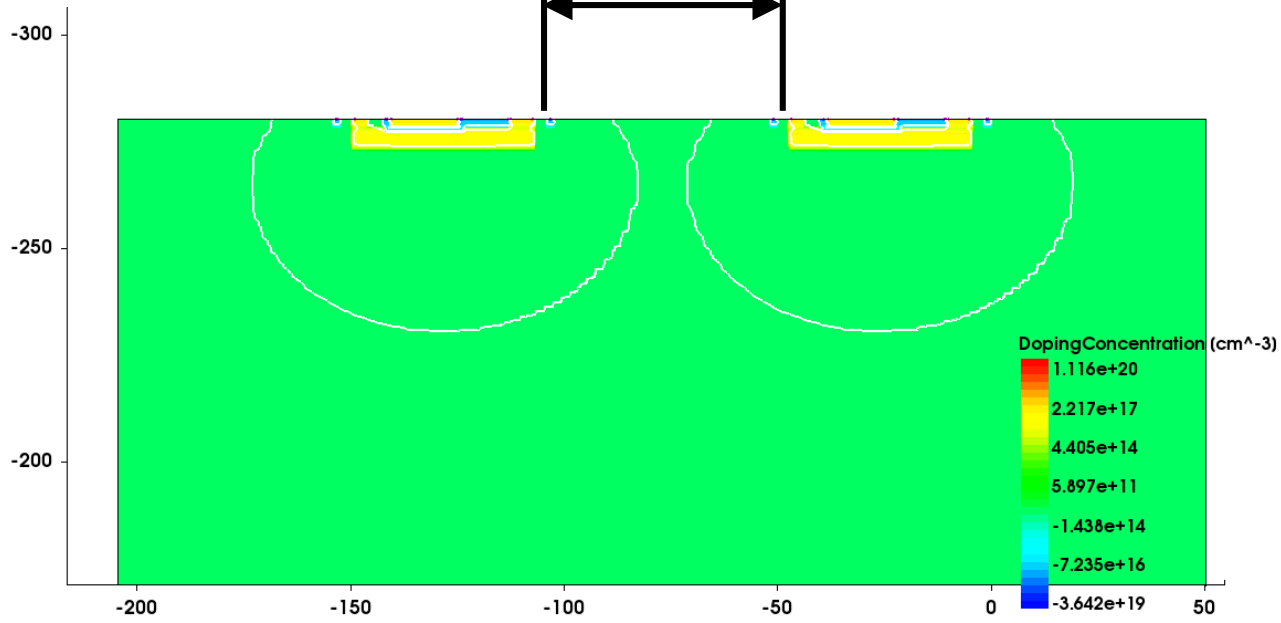
E. Vilella, 32nd RD50 Workshop

Spacing between pixels (Internal)

$z = 25\mu m$



$2z = 50\mu m$



$\rho = 500\ \Omega\cdot cm$

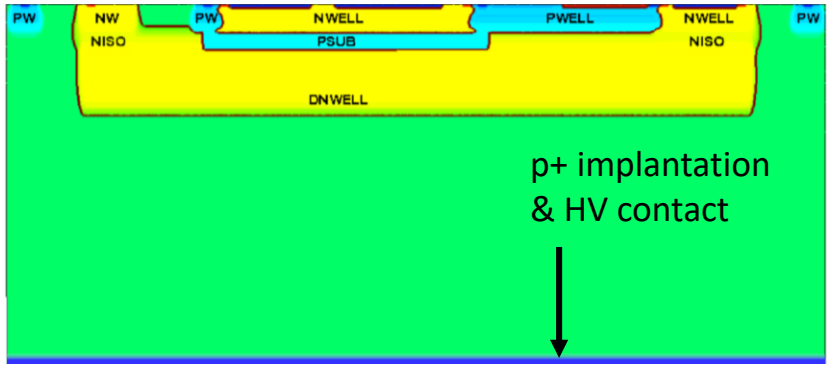
$\Phi = 0\ n_{eq}\cdot cm^{-2}$

$V_{sub} = -80V$

Next steps: (?)

(Internal)

- ENGRUN1 simulations
  - Remove topside contacts (backside biasing) →
  - Thinning? (thickness currently 280 µm)
  - Guard rings?



- Radiation Damage
  - More fluences (2E13, 2E14, 2E15 etc.)
  - How does irradiation affect depletion region merging between two pixels?
- Multiple pixels with spacing
  - Radiation damage (previous point)
  - Higher z
  - Same simulations for 1.9 kΩ·cm → increased depletion region size