

TCAD simulation VIII

E. Giulio Villani

Overview

- **Simulation example of 2D PN junction using SPROCESS and SDEVICE**
- **Charge generation and collection**

TCAD Synopsys Simulation

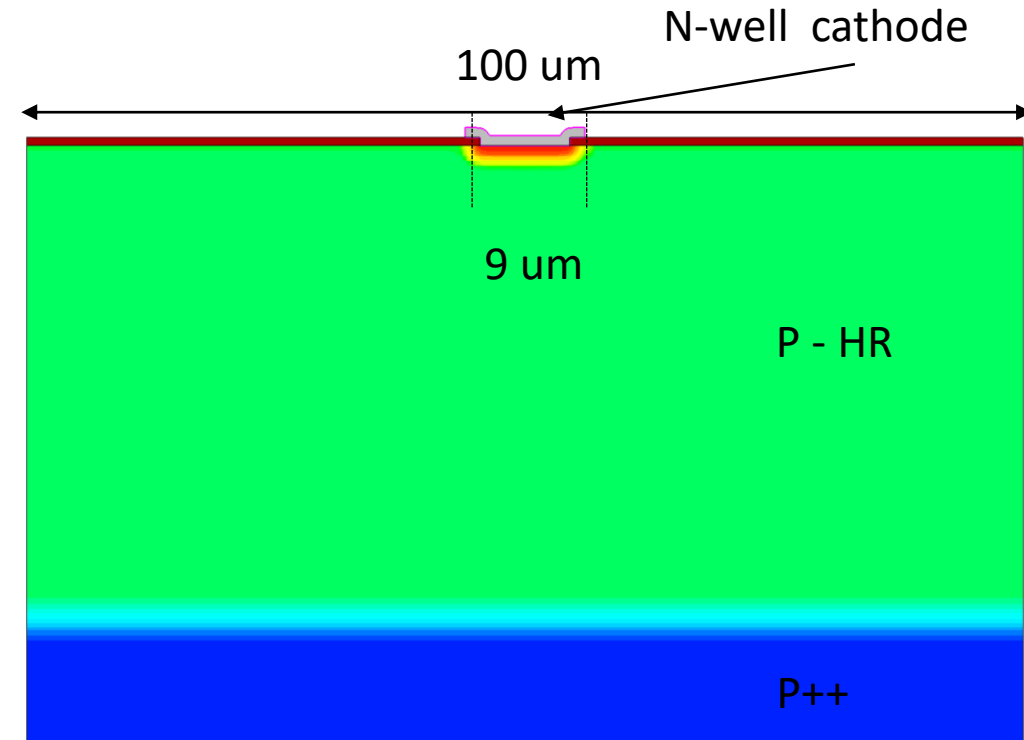
- SDEVICE simulation of 2D pn junction
 - **Charge generation**
- **Within SDEVICE, charge injection by particles can be modelled using the models for carrier generation by gamma radiation, alpha particles and heavy ions (optical generation is also available)**
- **Heavylon generation:**

Glet: linear energy transfer(LET) generation density

R(w,t): spatial distribution (exponential/Gaussian)

T(t): temporal profile

			
deviceIV_FW	deviceCV_RE	TwoDsprocessHIT	sdeviceCCE
[n7] --	[n10] --	[n31] --	y
		[n30] -5	[n16] --
			Vbias
			[n13] 100



TCAD Synopsys Simulation

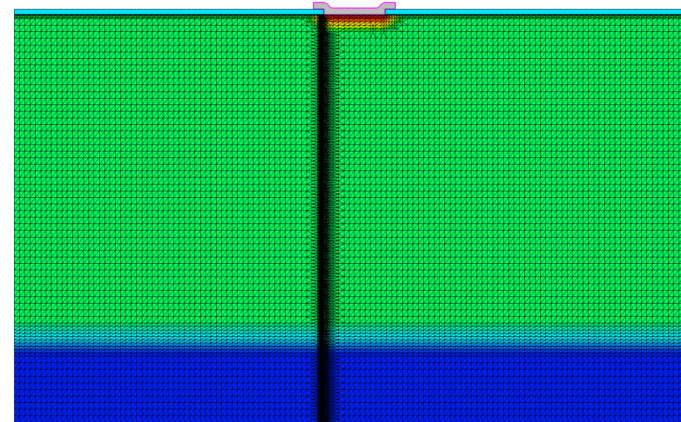
- Additional SPROCESS to increase the mesh resolution in the region of the hit: vertical hit at coordinate (0,Y)
- SDEVICE command file: physics section

```
### if {$HIT} {  
## MIP
```

```
### From G4 MIP sims, the meshing in the track region needs to be as small as  
nm's...
```

```
refinebox Silicon name= HIT min= {0 @<@y@-0.1>@} max=  
{@<@Epi_thick@+@Sub_thick@>@ @<@y@+0.1>@} xrefine= {.05 .05 .05}  
yrefine= { .05 .05 .05}
```

```
### }
```



TCAD Synopsys Simulation

- SDEVICE command file: physics section
 - **The ionisation is obtained by a Minimum Ionising Particle (MIP)**
 - **Details of the ionisation are included in a file (MIP_EXC) which has the LET and spatial parameters required for MIP emulation**

```
Physics {
```

```
#####if "@Ionization@"=="MIP"
```

```
#include "MIP_EXC"
```

```
...
```

```
#define WT_hi 0.1
```

```
        Heavylon (
```

```
Time = HitTime
```

```
Location = (0, 0) ##### Hits at the top surface, right in the middle of the device
```

```
Direction = (1.0,0.0) ##### Perpendicular hit
```

```
#####LET_f = [1.28e-5 1.28e-5 1.28e-5] ##### 80 e/h per micron is 1.28E-5 for THICK sensor
```

```
LET_f = [1.056e-5 1.056e-5 1.056e-5] ##### 66 e/h per micron as MPV for 50 um thick  
active region
```

```
##### LET_f = [1.15e-5 1.15e-5 1.15e-5] ##### 72 e/h per micron as MPV for 300 um thick  
active region
```

```
Wt_hi = [WT_hi WT_hi WT_hi] ##### ro = 0.1/0.2 micron
```

```
Length = [ 0.0 20 60 ] ##### LET @ different depths, irrelevant for a MIP
```

```
PicoCoulomb
```

```
Gaussian
```

```
)
```

TCAD Synopsys Simulation

- MIP transient
 - **Effects due to different bias**
 - **Charge collection vs. hit location**
 - **Charge collection vs. meshing resolution**
 - **Charge collection vs. doping**

Thank you

giulio.villani@stfc.ac.uk

- Simulation example : 2D pn using SPROCESS
- MIP Charge generation and collection