Solutions to Exercise: Leakage

PF@SuS@UniHD 2019

In[101]:=
```
SetOptions[Plot, {Frame → True, Filling → Axis,
    ImageSize → 500, PlotStyle → {Thick, Blue}, PlotLegends → None}];

(* All units are mm and A *)
```

In[105]:=
```
LX = 50 (* length of detector in x *);
LY = 50(* length of detector in y *);
T = 0.3(* thickness of detector *);
NSTRIP = 512;
Rbias = 1 × 10^6;
Il = 500 × 10^-9 / 1000 (* divide by 1000 to convert cm^3 to mm^3 *);
HitRate = 40 × 10^6;
```

In[106]:=
```
LX / NSTRIP // N(* Strip pitch is roughly 100 μm *)
```

Out[106]=
```
0.0976563
```

1. Leakage Current in one strip

In[107]:=
```
Vdetector = LX LY T;
VStrip = Vdetector / NSTRIP (* Silicon Volumen seen by one strip *)
```

Out[108]=
```
1.46484
```

In[109]:=
```
Istrip = VStrip Il (* current into one strip in A *)
```

Out[109]=
```
7.32422 × 10^-10
```

2. Average Current due to signals

In[110]:=
```
Qmip = 20 000 × 1.6 × 10^-19; (* rough charge deposition in 300μm silicon *)
```

In[111]:=
```
ImipDet = 2 HitRate Qmip
```

Out[111]=
```
2.56 × 10^-7
```

In[112]:=
```
ImipStrip = ImipDet / NSTRIP
```

Out[112]=
```
5. × 10^-10
```

3. Voltage Drop

In[113]:=
```
Vdrop = Rbias Istrip
```

Out[113]=
```
0.000732422
```

4. Discussion

The detector works fine, as long as it is fully depleted, so that the strip voltage must just be ‘large enough’
Different voltages lead to field distortions, so that the charges drift more to the strips with highest voltage, bus as long as the relative voltage difference is small, this should not be a large effect.
If voltages of adjacent strips/pixels are too different, punch-through current may flow. This will equalize the voltages back again, but may introduce spurious signals. The punch through voltage depends on strip distance but is certainly larger than a few volt.
-> A few volt of drop would be acceprable.

Note that both currents increase if the strips get longer or wider.