



# Attività 2014 Trento e simulazioni preliminari

PixFEL kick-off meeting



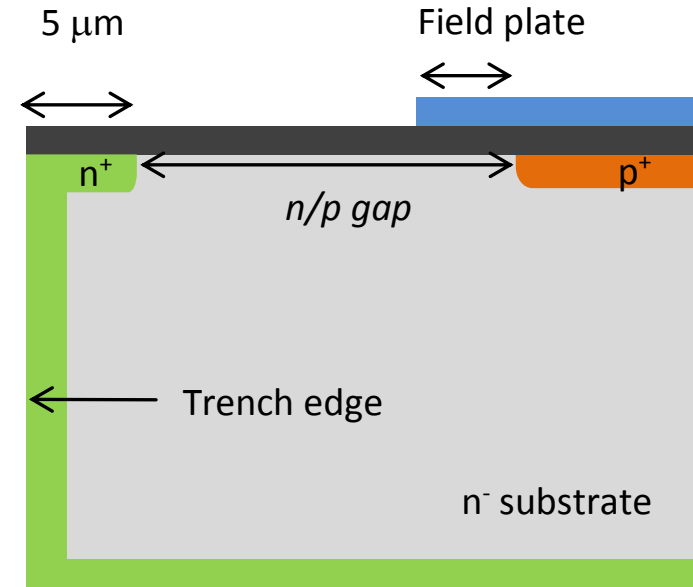
# Attività 2014

## Sensori a pixel in silicio ad alta resistività:

- Studio specifiche e letteratura attinente
- Simulazioni TCAD  
(effetto plasma, danno da radiazione, ecc.)
- Progetto e layout primo lotto sensori  
(p-on-on, da valutare dettagli di processo back-side)
- Fabbricazione primo lotto a FBK
- Caratterizzazione elettrica strutture di test su fetta
- Caratterizzazione funzionale strutture di test montate su PCB fetta con laser, sorgenti e tubo a raggi X
- Studio danno da radiazione X su strutture di test (LNL)

# Detector requirements

- Pixel size: 100 $\mu\text{m}$ :  
maximum n/p gap  $\sim 30\mu\text{m}$
- XFEL repetition rate 5MHz:  
complete charge collection  
in a few 10s of ns
- Detector thickness: 450 $\mu\text{m}$ :  
operation voltage  $\sim 200\text{V}$  for full  
depletion and fast charge collection





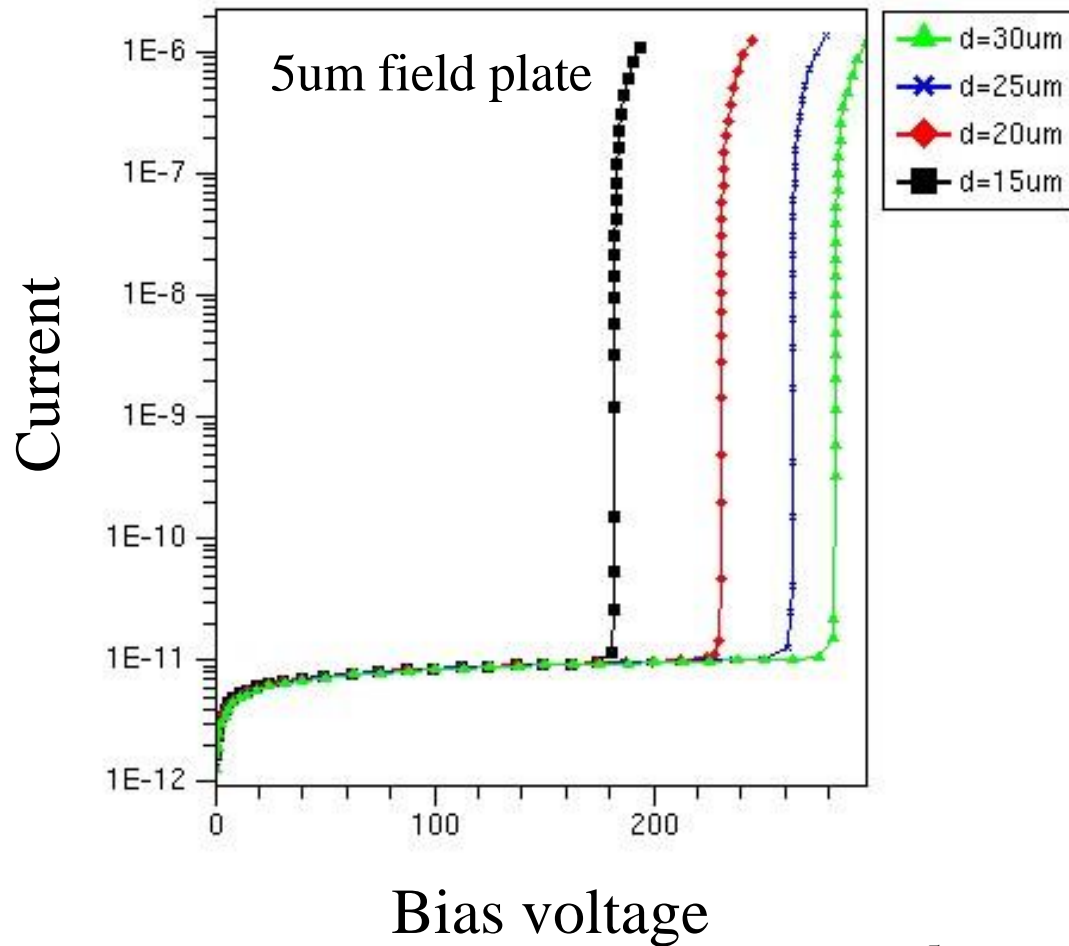
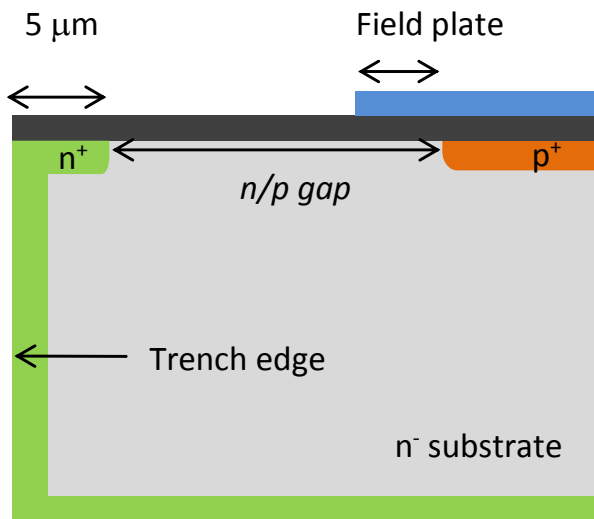
di Trento

# TCAD preliminary simulations

- Breakdown voltage dependence on device geometry
- Depletion region
- Charge collection efficiency and speed

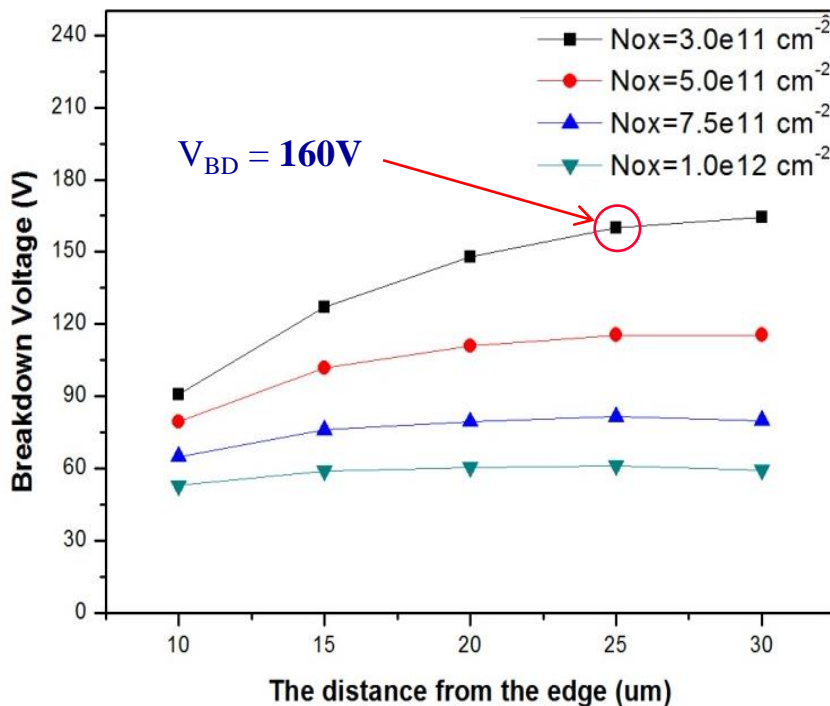
# Effect of p/n gap of $V_{BD}$

Gap > **25 $\mu\text{m}$** :  $V_{BD} > 250\text{V}$

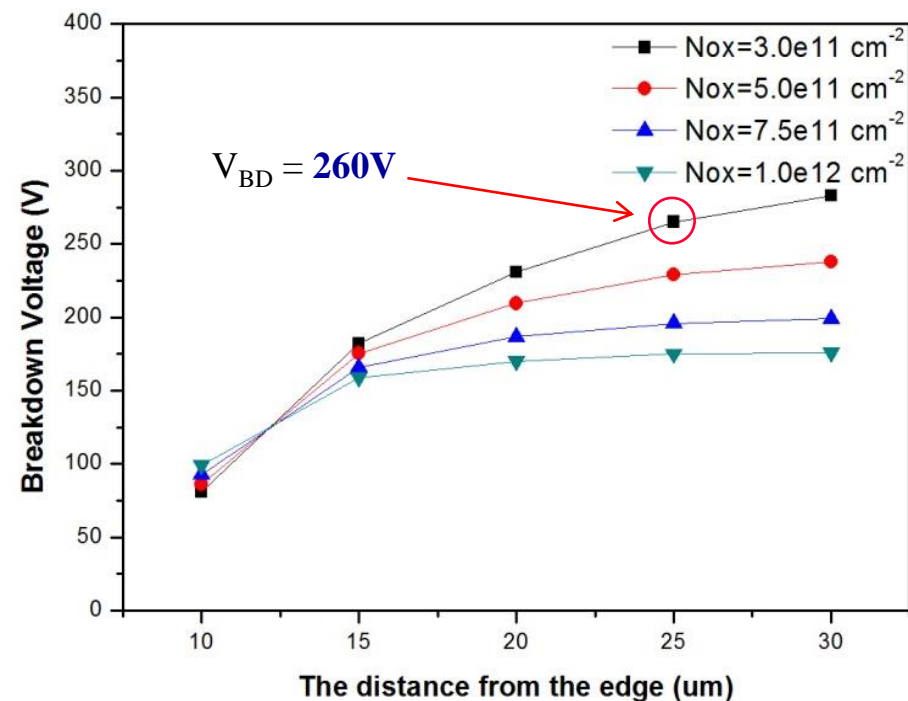


# Effect of field plate and oxide charge on $V_{BD}$

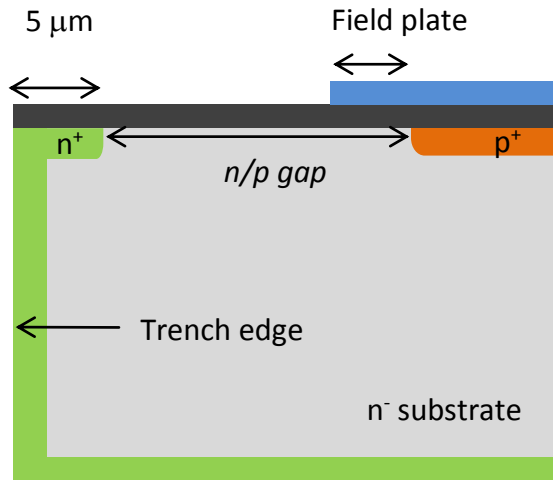
No field plate



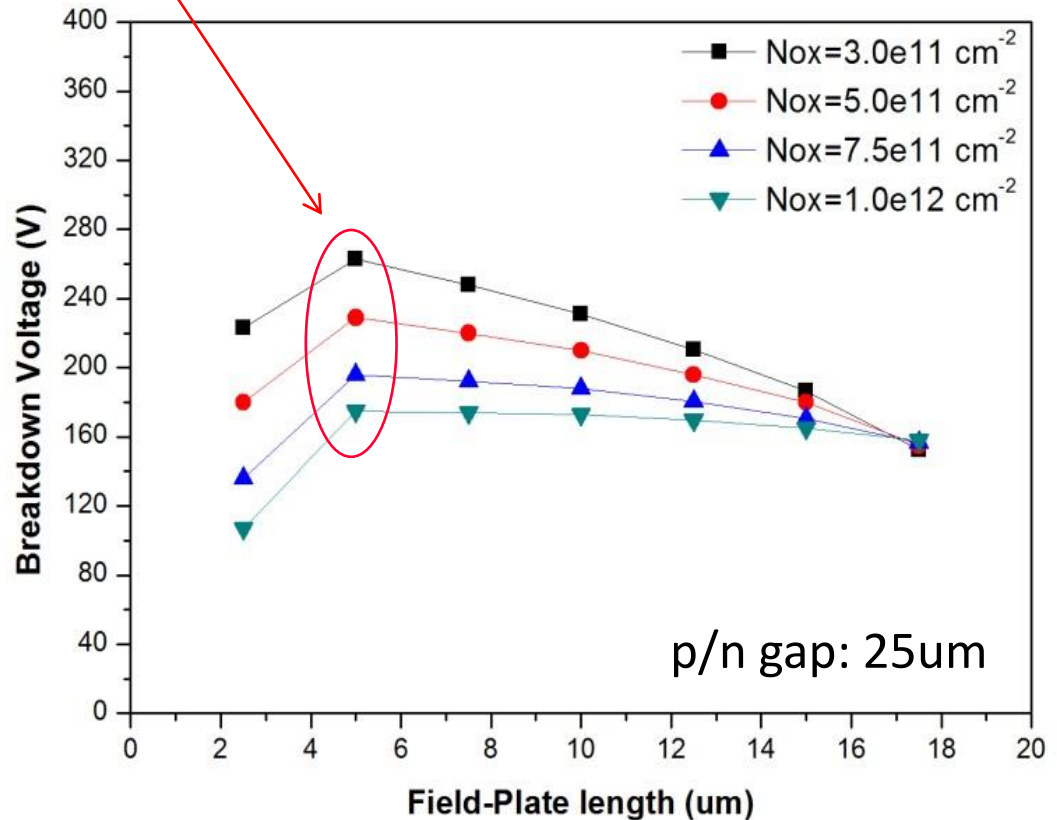
5um field plate



# Optimal field plate length

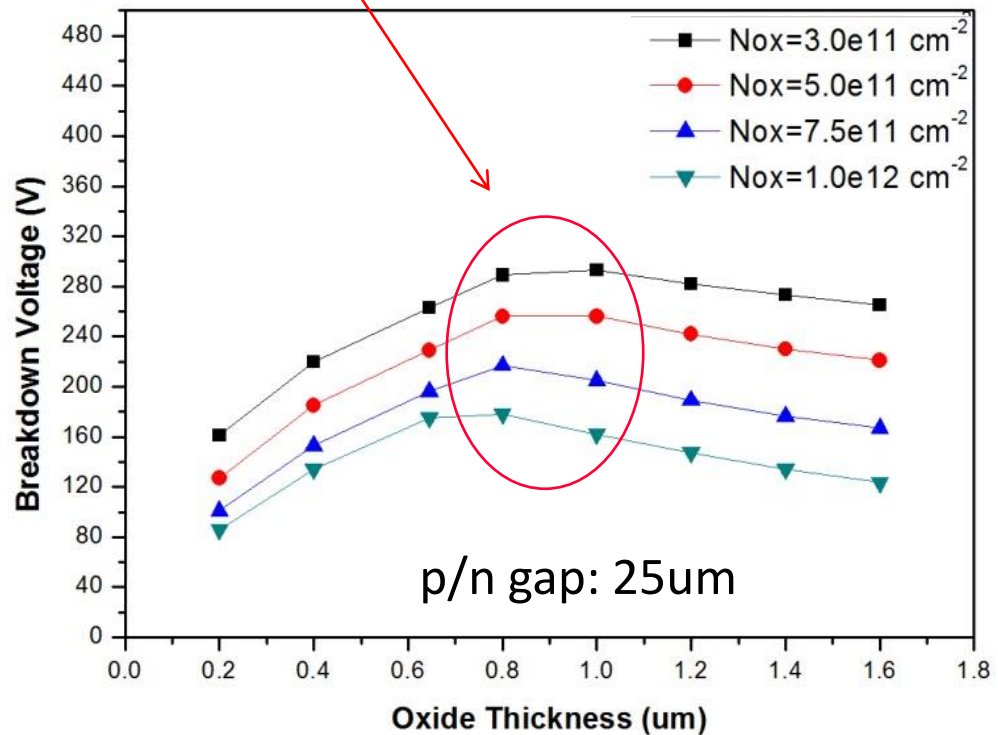
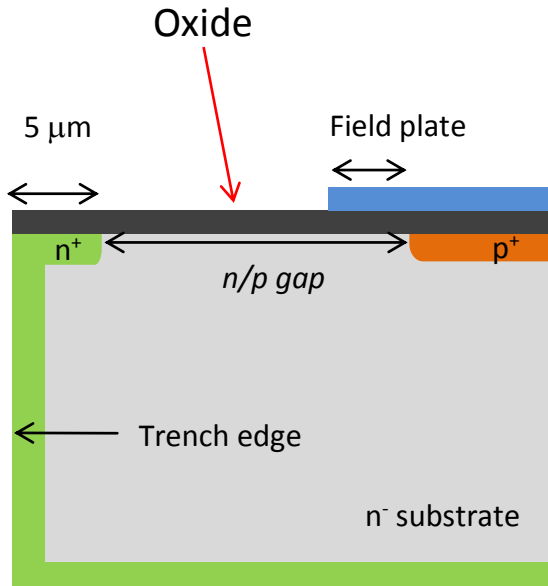


5um plate length



# Optimal oxide thickness

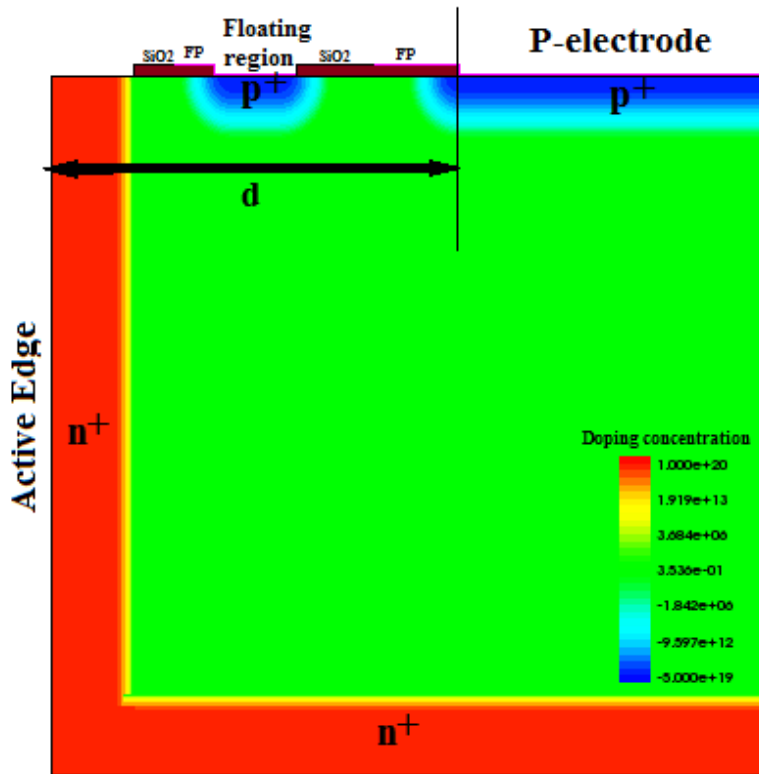
0.8 - 1um oxide thickness





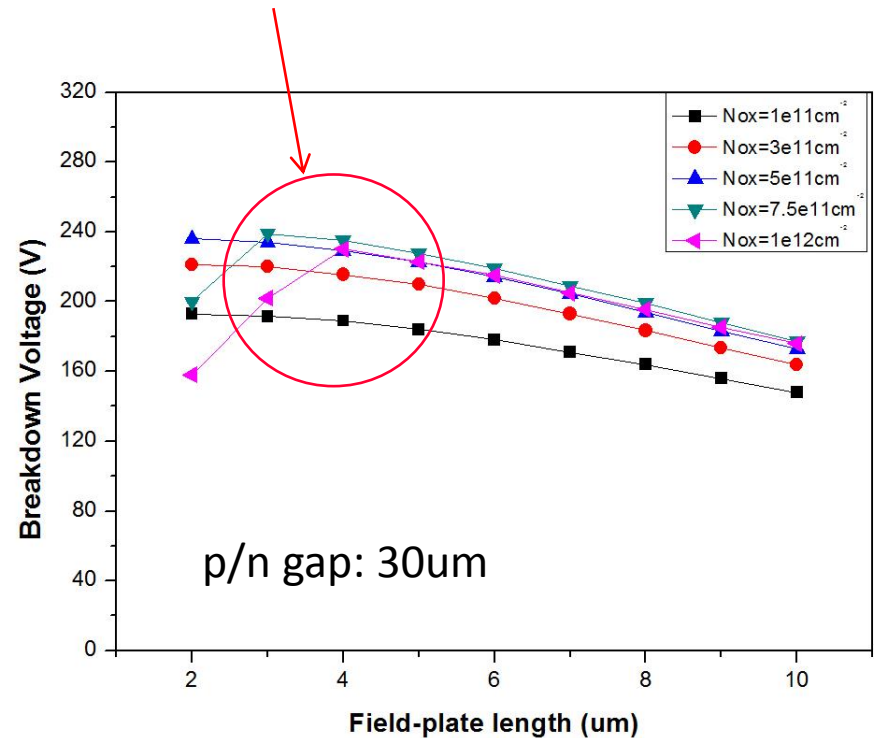
# Breakdown control by floating region + field plate

p-in-n sensor with a Floating region and a FP on the P<sub>e</sub> electrode



Preliminary result:

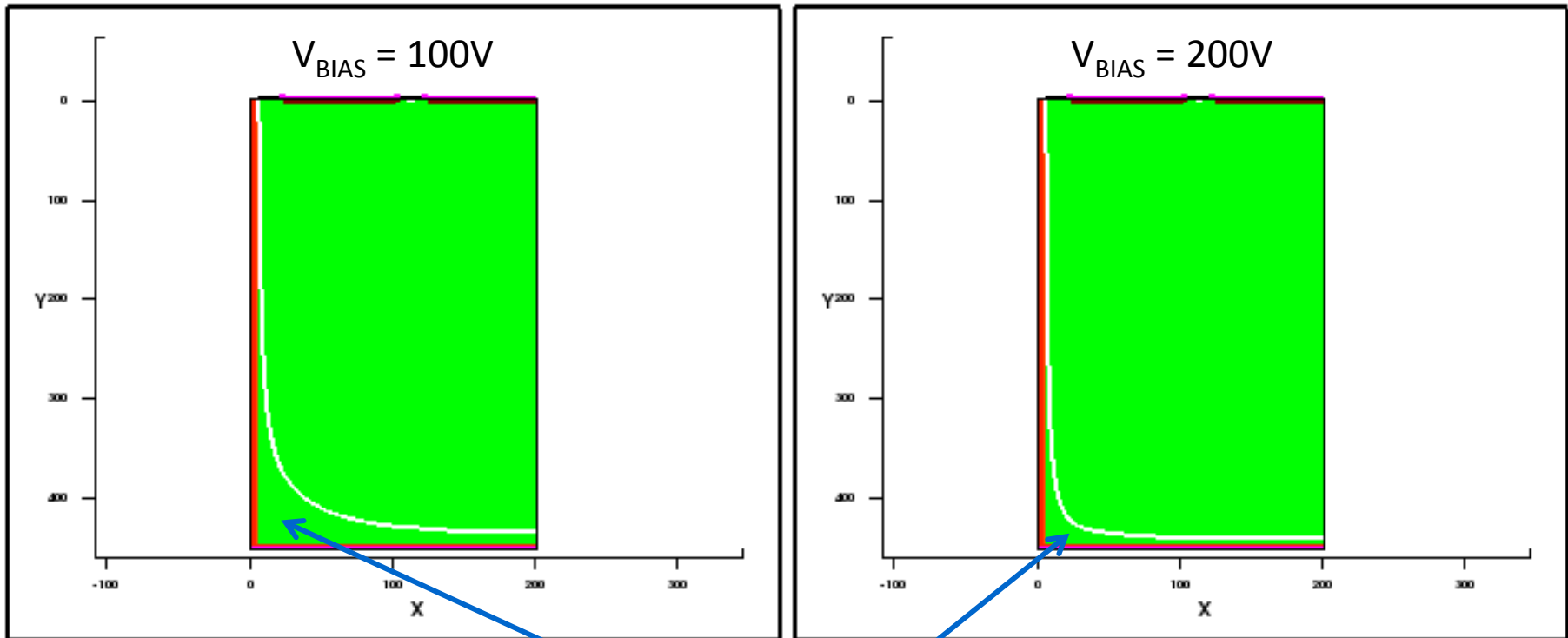
$V_{BD}$  slightly lower than FP only but higher at high  $N_{OX}$   
 Further parameter optimizations to be done





# Depletion region

Doping concentration  $10^{12} \text{ cm}^{-3}$   
p+ electrode size 75 $\mu\text{m}$  pitch 100 $\mu\text{m}$

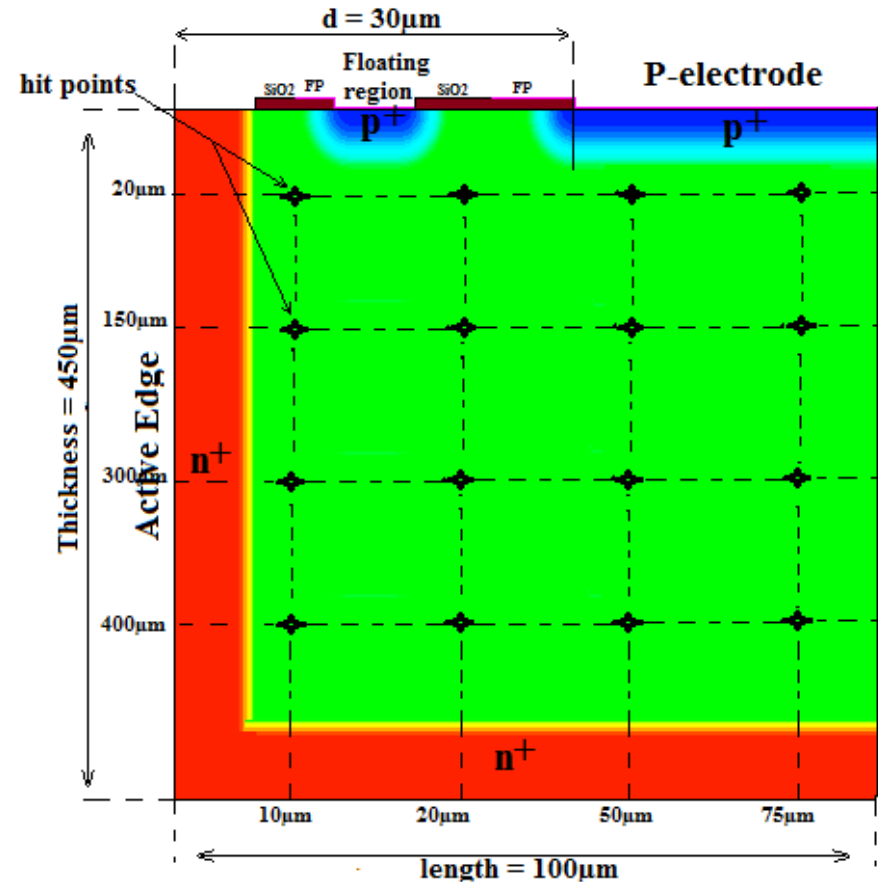


Undepleted volume



# Charge collection

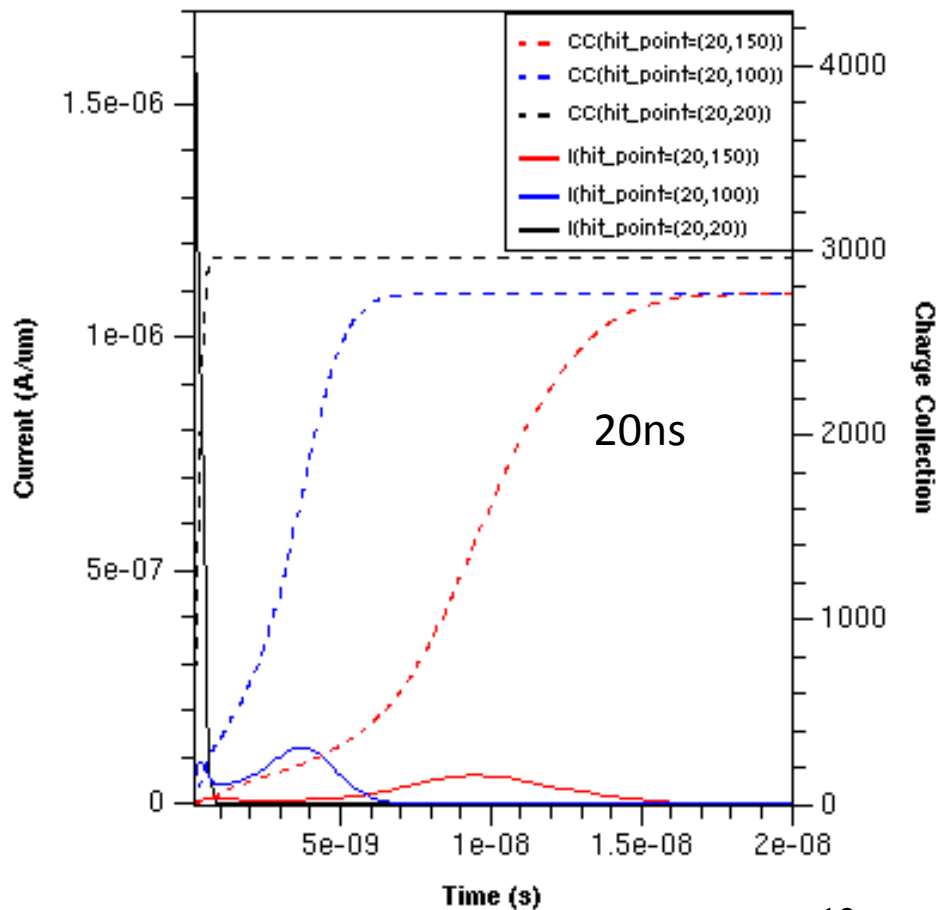
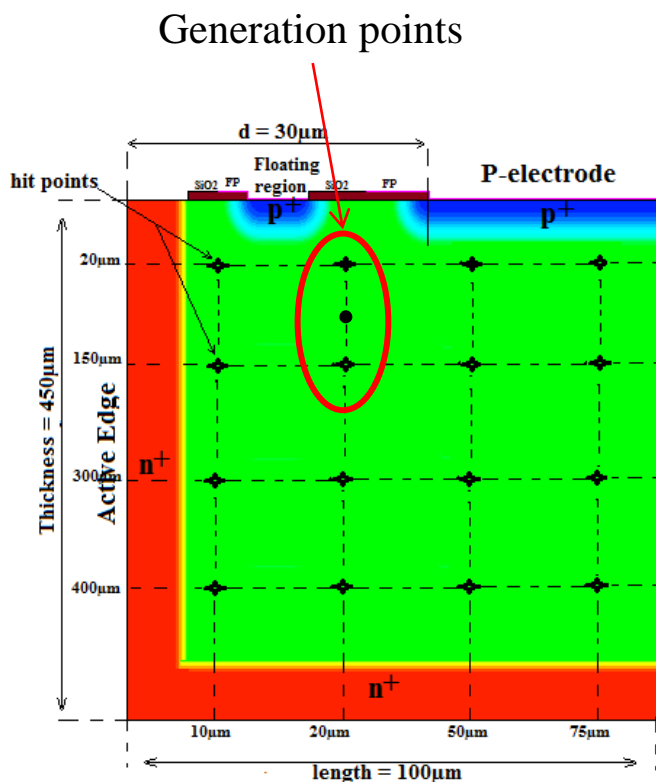
Charge generated in different device regions:  
simulation of collection **time**  
and **efficiency**





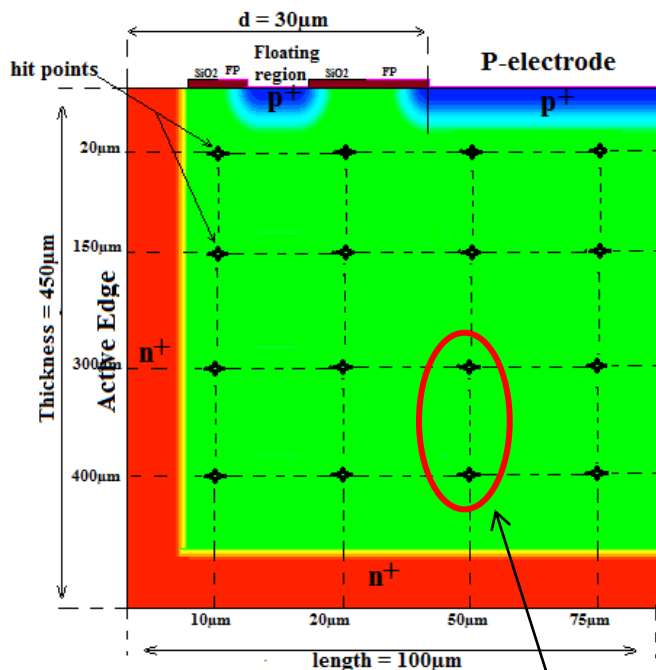
# Charge collection: device top

$V_{BIAS} = 100V$





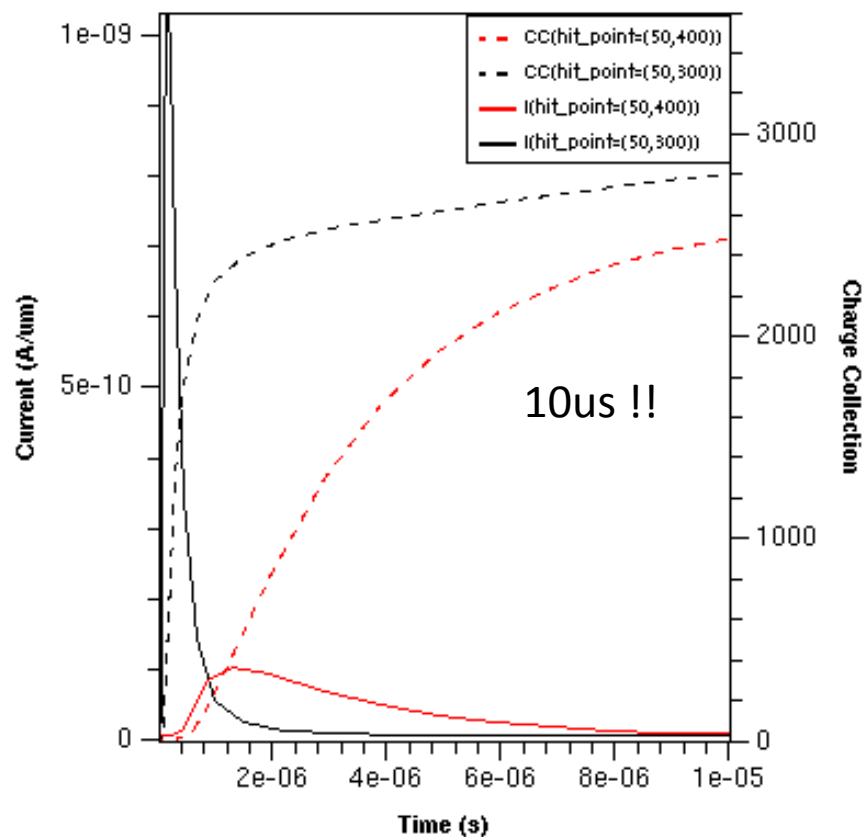
# Charge collection: bottom



Generation points

100V are not sufficient for an efficient and fast charge collection from the device bottom

$V_{BIAS} = 100V$





# Simulation work in progress

- Optimization of edge termination at high oxide charges ( $N_{OX} > 10^{12}$ ) due to radiation damage
- Charge collection efficiency and speed
- Plasma effect