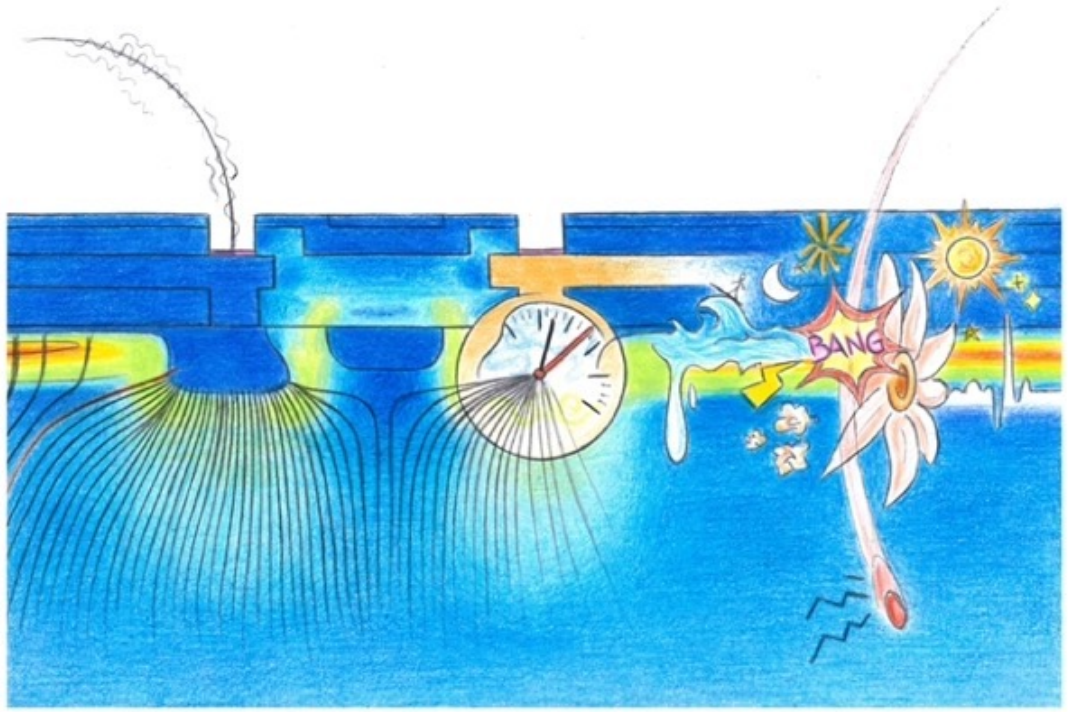
Topics in LGAD design

- SEB-resistant (Single Event Burn-out) LGAD design
- DC-RSD



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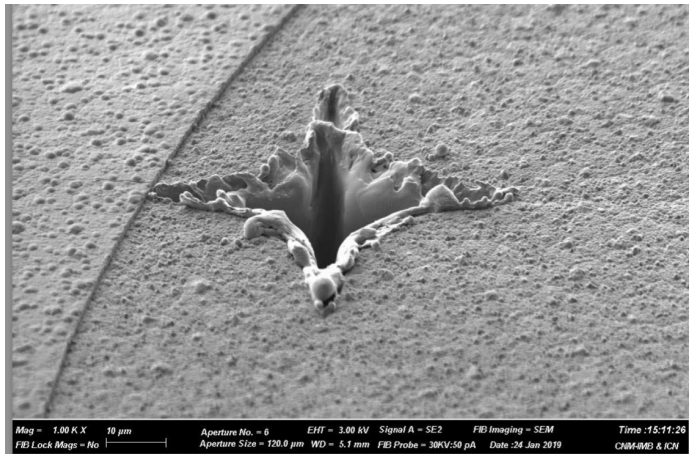
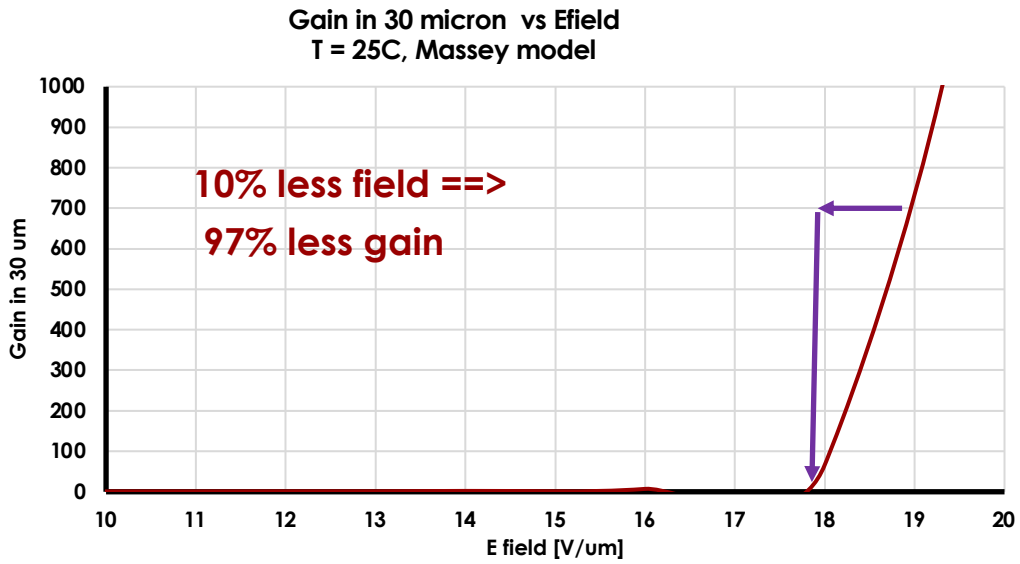
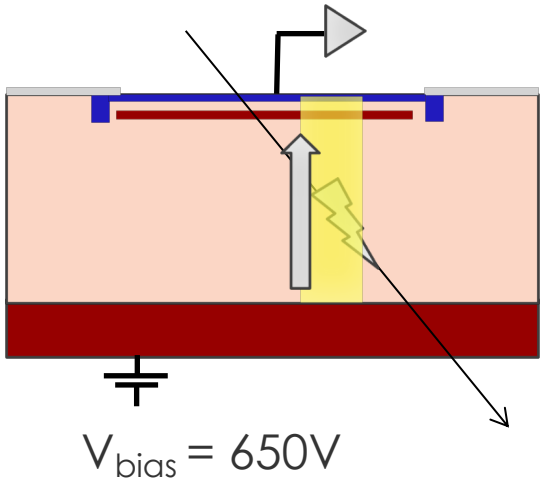
Part I: SEB-resistant LGAD design

- **50 μm thick LGAD** sensors exposed to 120 GeV/c protons, when biased at 625V or higher (**12.5V/μm**) , break down permanently.
- **45 μm thick LGAD** broke down at 550V (**12.2V/μm)**
- 50 μm thick LGAD sensors, biased at 575V or less (**11.5V/μm**), did not break.
- **55 μm thick LGAD** survived many hours at 600V (**10.9V/μm**).

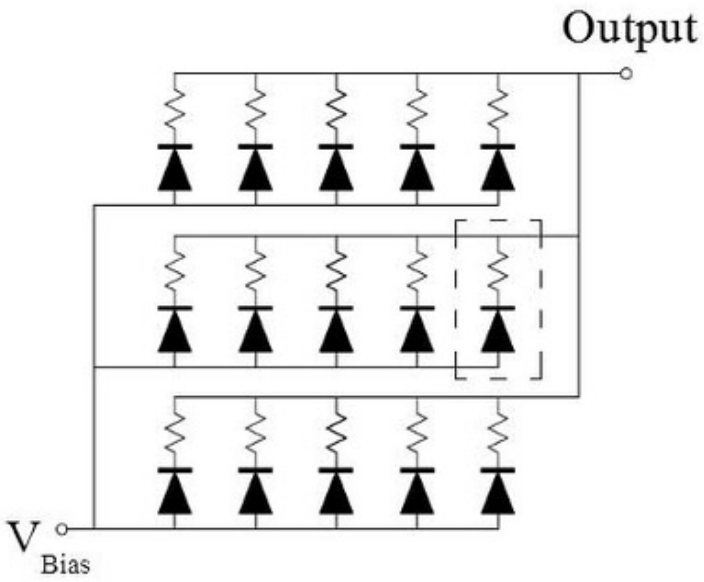


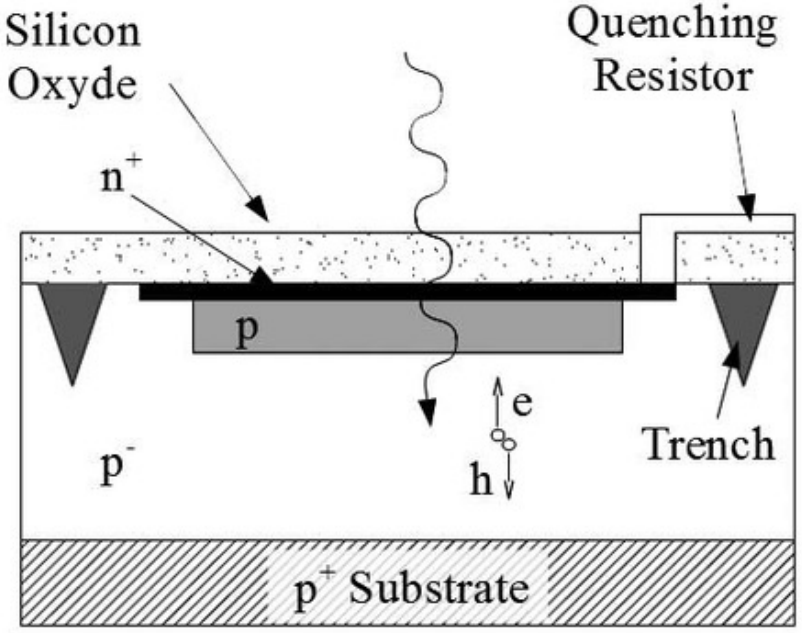
Threshold effect: SEBs happen quickly if the Electric field is high enough





SiPM: aide mémoire

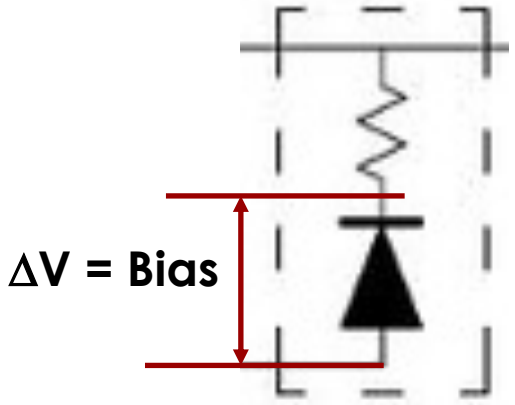




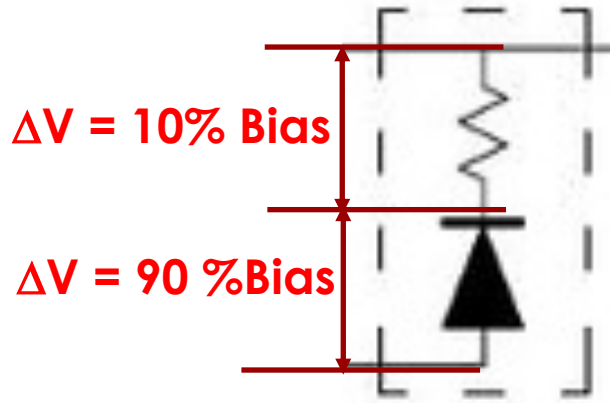
SiPM: one single bias, working in avalanche mode

SiPMs do not burnout. Why?

1) A SiPM goes into avalanche
2) A large current flows
3) A fraction of ΔV shifts from the capacitor to the resistor
4) The voltage on the silicon bulk drops,
5) The avalanche is quenched
6) The capacitor does not discharge, ΔV is preserved



No signal



Signal

SEB-resistant LGAD design

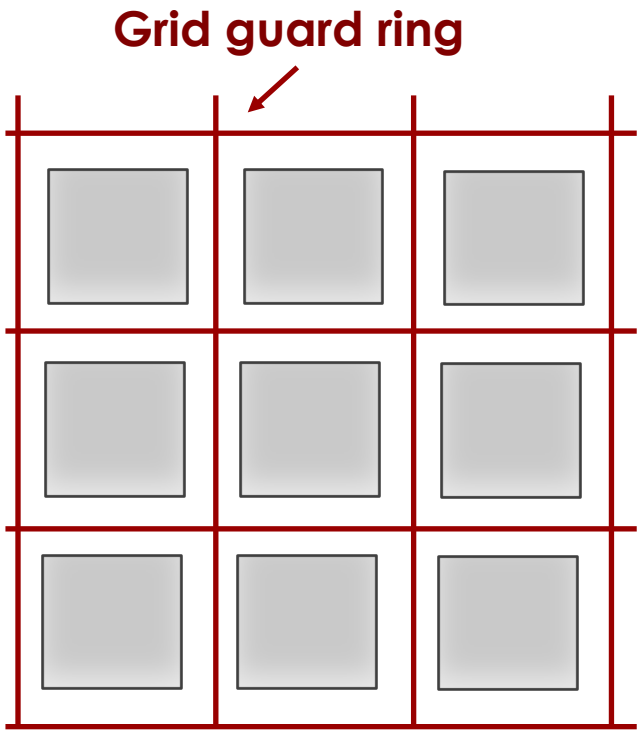
Can we add a quenching resistor in LGAD?

What are the consequences?

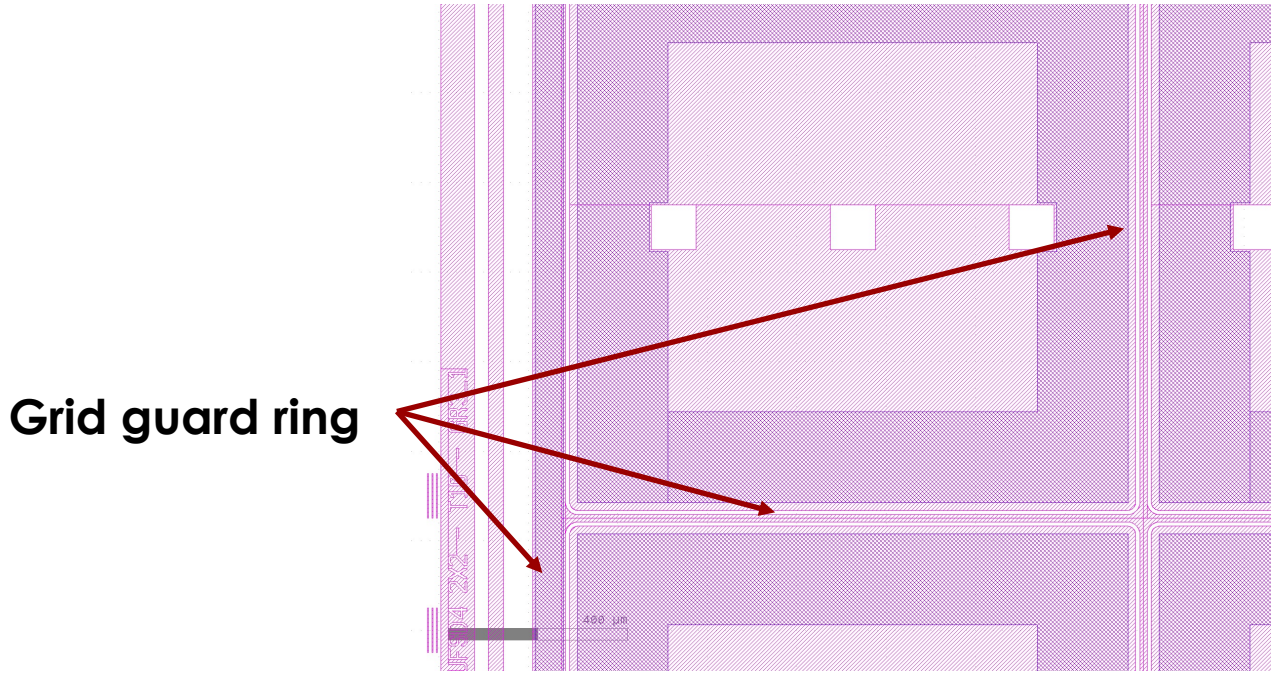
- **Where do we connect the resistors to ground?**
- **Do we spoil the signal shape?**
- **Do we increase dramatically the fill factor?**
- **How do we do this study?**

LGAD matrix with grid guard-ring

Independently from the SEB issue, FBK has developed LGAD matrices with a grid guard-ring, i.e., there is a ground grid among the pads (the so-called FBK UFSD Type10)



No-gain region ~ 70 um



We have a design where each pad has a near-by ground. Can we use it?

LGAD: aide mémoire

Signal formation:

- The signal is formed on the n++
- It is AC-coupled to the metal
  ==> that is why the timing is not "position dependent" as it is in "not metallized" LGADs.
- Charges travels along the n++
- The signal on the metal and the charges on the n++ combines
  ==> that is why the signal is unipolar and not bi-polar

Oddly, the LGAD read-out is a mixture of AC- and DC-modes