LGAD Discussion session

LGADs – points for discussion

- SEB limits the operation of LGADs
  - It driven by the average electric field in the device – safe <11 V/μm, danger >12 V/μm
  - Limits the operation voltage range and ability for compensation of radiation damage
  - Can we increase it by the device design? HPK-P4 run failed to achieve it – sensors died in the same way as the others.

ATLAS : https://iopscience.iop.org/article/10.1088/1748-0221/18/07/P07030/pdf
CMS : https://indico.cern.ch/event/1029124/contributions/4411270/

Not much we can do but understand it.

- Improvement of radiation hardness
  - C enrichment mastered to the level that sensors can survive 2.5e15 cm^{-2} (HL-LHC) timing was mastered by FBK/IME (IHEP,USTC) – it looks like c~1e-16 cm2 is the "natural limit"
  - Half-activated-Boron approach of HPK is currently investigated (first tests at INFN-TO and JSI) – an improvement has been seen, but not to the same level as with carbon.
  - Compensated LGADs (INFN-TO) may be a solution, but this requires good knowledge and control of B and P removal and super fine tune. HPK tested their devices utilizing compensation and the outcome was not promising – actually very little difference to reference LGADs. This approach is also AIDAINNOVA blue sky project.

RD50 project

Val's ERC

- Understanding the origin of the damage
  - Can we invent some other impurity that would reduce the removal constant even further? Replace the B with something else? - Ga has failed, but not understood so well – supprisingly similar removal as for B?
  - Understanding the acceptor removal on microscopic level:
    - BiOi
    - Bi role in the silicon - various defects it can form.
    - g_{Bi}-g_{BiOi}= ?

RD50 project

LGADs – points for discussion

- Understanding the operation
  - screening effects (angled tracks, irradiated sensors, current gain)
  - Impact ionization at very high fluences (preparation of the RD50 project on super-doped LGADs that would only work at very high fluences – and probing of the impact ionization will be possible – collecting the interest – is use of multiplication possible at extreme fluences?)
  - cp/cn ratio for different charged hadrons

Lots of progress in understanding

RD50 project

Why and how worried we should be?

- Improvement of inter-pad distance (progressing fast on many fronts)

  TI-LGADs, iLGADs , DJ-LGADs, AC-LGAD, DC-RSD

- Detection of non-mip particles for use in medicine, nuclear physics, X-ray.

- We should start implementing the LGADs in simulations/digitization/operation scenarios for the HL-LHC experiments!
  - more complicated than strips/pixels
  - role of annealing in running scenarios
  - tools/ideas to monitor and understand the performance during operation

- **Marriage of CMOS and LGADs….**