Discussion session on LGAD

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Milestones at th *Prolongation request* (May 2018)

Understanding the radiation effects [9] in LGADs is under intensive investigation within RD50 and will be a priority for the next five years. Different technological solutions are been investigates, such as Carbon or Gallium doping, and new fabrications with thinner sensors with a variety of gain values will be carried out within the RD50 collaboration manufactures. Recent analysis suggests that the decrease in gain can be ascribed to "acceptor removal" which changes the electric field, and to effects associated with a "double junction". This last effect is the presence of a strong electric field located very close to the backside ohmic junction caused by the hole current dependent and that exhibits strong dependence on annealing.
New geometries such as the Inverted LGAD (iLGAD) will also be explored in thin substrates in order to increase the fill factor in large area experiments.

- M1: Understand the effect of Carbon and Gallium on gain after irradiation (Q1/2019)
- M2: Model the acceptor removal effect after irradiation (Q3/2019)
- M3: Produce new LGAD design to increase the fill factor (Q2/2020)
- M4: Design and simulate new LGAD geometries for operation at $1\times10^{17} n_{eq}/cm^2$ (Q4/2022)

Ongoing projects (some of them completed)

2017-01 LGAD based on EPI wafers (G.Pellegini, CNM, Barcelona)

2017-03 LGAD fabricated with epitaxial layer (G.Pellegrini, CNM, Barcelona)

2017-05 50 µm thin LGAD fabricated with Ga multiplication layer (Joern Lange, IFAE Barcelona)

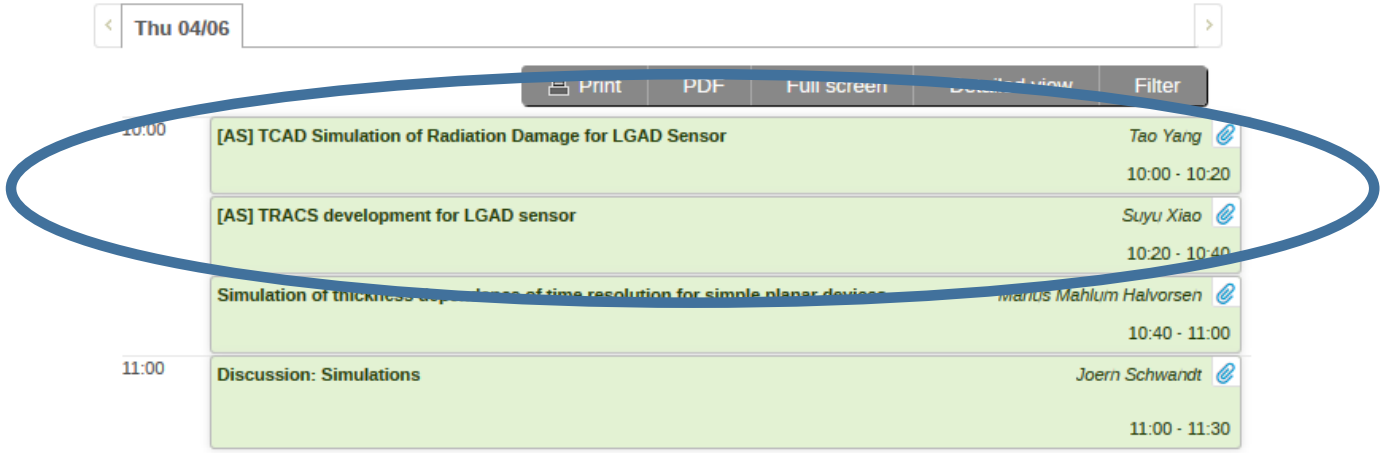
2017-06 Thin LGADs characterization using IBIC and time-resolved IBIC at CNA (Carmen Jiménez-Ramos, Sevilla)

2017-08 50 µm thin AC-LGAD (Mar Carulla, CNM Barcelona)

2018-01 Development of Segmented LGAD with small pixels and high Fill-Factor (Giovanni Paternoster, FBK)

2020-02: Proof-of-concept and radiation tolerance assessment of thin pixelated Inverse Low Gain Avalanche Detectors (ILGAD) (Ivan Vila, UC-CSIC, Santander)

Hot topic at this workshop (11+2 talks)



Study topics (old and new)

TOPICS (LGAD)	Sub-topic	APPROACHES/COMMENTS	MENTIONED IN TALKS
Radiation Tolerance	Q > 4fC @ 2.5 Neq/cm2, 2MGy Delta_t< 70ps Mixed irradiation (protons and neutrons with different mixtures).	Alternative dopands: Galium Enhancing E field at GL junction: bulk thinning. Suppression of BiOi defect formation: Carbon infusion. Gain Layer profile engineering (shallow vs deep)	3
Radiation Tolerance (LGAD+ASIC)	Highly Ionizing Particles	Sensor fine at least for alpha particles (LGAD + ASIC ?)	1
Radiation Tolerance: (LGAD+ASIC)	max. revers current < 5uA/1.3x1.3x0.05mm3	Pay attention to bulk reverse current (bulk material)	1
Radiation Tolerance:	extreme fluences 1e17	Optimized thinkness (balance between multiplication region GL and BJ)	0
System aspects:	Max. power dissipation O(100mW/cm2)	Additional limit on the max Vbias.	1
Reliability:	Long term stability	Signal stability and annealing	1
Reliability:	Spurious Pulses (PCN, self-triggering)	Quantify the and define acceptance criteria (max. rate?)	1
4D tracking: Increase fill factor	AC-LGAD, RSD, I-LGAD (BNL, FBK, CNM)	Complementary strategies : Capacitive coupling, segmentation of ohmic junction.	3
Technology spreading		Increasing number of manufactures BNL, CNM, FBK, HPK, IHEP-NDL	-