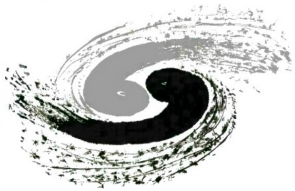
IHEP HGTD Sensor Test Status and Plan



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Outline

- Introduction
- Probe station tests
- Laser and beta source tests
- Irradiation tests
- Beam tests
- Targeting for TDR
- Synergy with ITk
- Radiation hard research

Introduction

- 2018.09.03: Expressed IHEP group interests on HGTD Sensors meeting – by Joao
- 2018.09.19: IHEP HGTD Sensor Group Update – by Xin
- IHEP ATLAS HGTD Testing Tasks
  - Leading tasks:
    - IV, CV: ”single” probes: singes, 2x2 arrays (cold)
    - IV: Probe card: 5x5 arrays
  - Contributing tasks:
    - TCT with Laser: 2x2 arrays
    - I-V: probe card 15x15 arrays
    - IV: Breaking (X-rays)
    - ASIC Read-out
  - Test beam participation

More in Liaoshan's Talk

Probe station tests

- Measure I-V, C-V, probe card, cold
- Develop automatic probe card (5x5) test scheme (or other intelligent and reliable test methods)
- Todo: Upgrade to -30/-40C cold facility
- Goal: Identify the key measurements and priotize the test tasks

Laser and Beta source tests

- Laser for timing measurement
- TCT scan to study internal structure
- Beta source to evaluate the MIP interaction with LGAD
- Goal: What's the new detector physics we can learn?

Irradiation tests

- X-Ray tests
- Proton irradiation tests
- Goal: what's the radiation hardness for the sensors we can learn and how to improve?

More in Mohamad & Xuai

Beam Tests

- Evaluate the timing capabilities under beam conditions with/without irradiation
- Converge on data analysis.

Targeting for TDR

Taken from Hartmut's June 3rd Report

N.B. No expectation for new production of LGAD before TDR

- **TID** (Xray, CYRIC): Xray in China started : results by summer at ~3 MGy
- Done also with proton at CYRIC (already accumulated 4 MGy)
- **Proton:** starting soon in China; CYRIC in July 19→result by end of year (results from CERN-PS already available)

Best sensors performance: TDR New Goal 3E15

HPK (3.2) , 50 µm with deep and narrow implementation

FBK 60 µm with Carbon infused wafers

Testing needed:
Finish testing: HPK (3.2), 50 µm

Ready for initial testing
HPK (1.1, 1.2, 2) 35 µm

Next HPK Prototype

1st Prototype Common ATLAS-CMS Run

50 um Type3-1, Type3-2

35 um Type1-1, Type1-2, Type2

by June 2019 : Evaluation of 1st prototype: might be tight with 35 um samples

2nd Prototype Common ATLAS-CMS Run

Mid May to Mid June : Discussion about Designs of 2nd prototype

- No carbon
- Both 50 um and 30 um ? Depends on comparison of irradiated samples
- More aggressive inter-pad gap
- Tighter spread of gain layer doping? (If observed gain spread of SEn structures is caused by the spread of the gain layer doping)
- Optimize gain layer doping for low fluences
- Reduction of bias voltage and power
- Reliability
- UBM

June to Aug : Photo mask design and preparation of wafer process

Aug to Dec : Production

End January 2020 : Delivery of 2nd prototype

Feb to May 2020 : Evaluation of 2nd prototype

Synergy with ITk Strips

- Milestones for ITk Strip Detector
  - Q3-2019:
    - Sensor production Readiness Review
    - ASICs Production Readiness Review
  - Q1-2020:
    - Modules Production Readiness Review
- IHEP ITk Strips plan
  - Ready for pre-production Q4-2019
  - Ready for site-qualification Q1-2020

Radiation hard study

- Radiation Damage and Defect Characterization
  - Identify defects responsible for trapping, leakage current, change of CCE, N_{eff} or electric field
  - Understand if this knowledge can be used to mitigate radiation damage (e.g. defect engineering)
  - Deliver input for device simulations to predict detector performance under various conditions

- LGAD related R&D
  - Radiation hardness with Gallium and Carbon implantation
  - Fill-factor: new inter-pad terminations (with trenches) and AC-coupled readout

Discussion and Plan

- Identify the key deliverables for the testing with each sub-task organizers
- Collect the issues/ideas for the testing
- Circulate the roadmap by the end of Wednesday
- Fully discuss within HGTD-Sensor group and release the plan v1.0 by Thursday meeting
- Call for contribution and start MOVING!