



Liverpool activities and plans

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on behalf of Liverpool team

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WP1 face-to-face meeting – 28/06/2023

APTS-SF laboratory tests (in LSDC)



- APTS test system fully functional since Oct. 2022 → verified with ⁵⁵Fe source measurement in Oct. 2022
- Jonathan Witte (Erasmus+ traineeship): Sep. 2022 Feb. 2023
- Daniel Matthew Jones (PhD student mainly on physics analysis): started from March 2023



28/06/2023 J. Liu

Analogue Pixel Test Structure (APTS) **ALICE**



- TPSCo 65 nm CiS technology with high resistivity epi-layer
- 6x6 pixel matrix
- Direct analog readout of central 4x4 pixels
- Two types of output drivers
 - Source follower (APTS-SF)
 - Fast OpAmp (APTS-OA)
- AC/DC coupling
- Pitch: 10, 15, 20 and 25 μm



APTS-SF laboratory tests (in LSDC)



- Measurement with ⁵⁵Fe source for APTS B/P split 2/3 sensors in Jan. and Feb. 2023 (Birmingham + Liverpool)
 - Data analysis done in Birmingham (see James' talk)
- ⁹⁰Sr measurements started since Nov. 2022 (internal trigger)
 - First measurement done last Dec. for AF15P
 - Measurements ongoing for split 2/3 AF15P/B (4 chips bonded in Birmingham)

APTS-SF beam tests (at CERN)

- Involved in two test beam campaigns in May 2023
 - PS-T10, 10 GeV: 3-10 May
 - SPS-H6, 120 GeV: 17-24 May
- Goal: complete the study on detection efficiency and spatial resolution for P-type sensors (10, 15, 20, and 25 µm) with and without irradiation (up to 5e15 1MeV n_{eq}/cm²)
- Trigger
 - Scintillator to align the beam to telescope
 - AF25P W22 at Vbb = 1.2V







APTS-SF test beam data analysis



- Involved in the test beam data analysis since Feb. 2023
- Currently analyzing the data from PS/SPS tests done in 2022 and 2023
- Corryvreckan framework + home made scripts for resolution extraction and plotting
- Telescope alignment
 - Performed excluding the DUT
 - Using AlignmentMillepede
 - No ROI (reject_by_roi = false)
- DUT alignment
 - reject_by_roi = true
 - 4 steps with decreasing spatial cut abs
 - Spatial cut abs decreases starting from 4*pitch to the APTS pitch



Some results – efficiency



• AF15P non-irradiated: >99% with threshold lower than around 170 e-



Some results – efficiency



• AF15P 1x10¹⁵ 1MeV n_{eq}/cm²: >99% achieved when threshold lower than 100 e-



APTS software



 Constantly contributing to the development and maintenance of MLR1 DAQ software and ITS Corryvreckan tools



Plans

- Complete ⁹⁰Sr measurements and compare results with beam tests
- Separate backbias, i.e., PWELL and VSUB
- A cooling system for irradiated sensor measurement and an external triggering system for ⁹⁰Sr source under preparation (LSDC)
- Liverpool undergraduate summer student (Mia Mylne) to be at CERN next week (to early August)
 - APTS-SF laboratory test
 - APTS-MUX test beam at SPS (week 30)
 - Test beam data analysis
- Plans for V2 (re-submission with ER1) sensors to be discussed
- Possibly 6 months service work for a PhD student in ITS3 sensor characterization next year
- Propose 1-2 MPhys Project(s) for detector performance simulations (in both academic years 2023-24 and 2024-25)
- Testing of future prototype modules and ladders in LSDC to be discussed



Summary



- MLR1 APTS-SF test system fully functional in LSDC since Oct. 2022
- Laboratory tests with ⁵⁵Fe and ⁹⁰Sr ongoing
- Cooling system and external triggering system for ⁹⁰Sr under preparation
- Contributing to APTS beam tests and data analysis
- Involvement of undergraduate and PhD students
- Plans for V2 sensors and future prototype modules/ladders to be discussed

Backup

MLR1 (Multi Layer Reticle 1)

- From TowerJazz 180 nm (ITS2) to TPSCo 65 nm (ITS3)
- Stitching on 300 mm
- 3 process variations
 - Standard (no modifications)
 - Modified (low dose n-type implant)
 - Modified with gap (low dose n-type implant with gaps)
- 4 process splits
 - Default
 - First intermediate optimization
 - Second intermediate optimization
 - Fully optimized process
- Lower power consumption
- Possibly better radiation hardness









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