PhD course of National Interest in Technologies for Fundamental Research in Physics and Astrophysics

Annual report

Name and surname: Michele Rignanese
Cycle and a.a.: 39th – 2023/2024
Supervisor: Piero Giubilato

- **Research activity carried out during the year**

The goal of the CAP R&D project is the development and characterization of novel Monolithic Active Pixel Sensors (MAPS) realized in 65 nm CMOS technology. The final objective is to realize a large area, low power single die sensors (even through the application of the stitching technique) aimed at all those applications where instrumenting a very large detection area (tens of square meters) is a key requirement.

During my first year of PhD, my primary activity has been working with the ARCADIA sensors. ARCADIA is a 110 nm CMOS MAPS, developed by INFN as a research technological testbed for different kind of applications, from HEP future experiments to space applications. Characterization measurements are important to quantify the performances and limitations of the sensor, and benchmark them against the requirements of the different applications. I started the characterization of ARCADIA test sensors with laboratory measurements, a well-established first step for chips characterization, looking at first to determine the pixel charge thresholds, i.e. the collected signal level at which the pixel "fires" reporting a hit. One of the goals of these first measurements were to calibrate the pixel threshold itself, so to have an absolute reference in term of elementary charges to discriminate between signal and noise. To achieve this goal, I analysed sensor response to reference monochromatic X-rays sources, using both a ^{55}Fe radioactive source and X-rays emitted by fluorescence. Thanks to these measurements I learned how to operate the device, and I also acquired a deeper knowledge of the ARCADIA chip itself. Parallelly, I have also done measurements and tests on passive test structures developed with the same ARCADIA technology. After initial laboratory measurements, I also helped organising and participated to a test beam at Fermilab, between the end of June and beginning of July. I have been involved to the experimental setup preparation, acquisition software development and various testing activities. The goal of the test beam is to further characterize the ARCADIA chip against MIP-like particles (120 GeV protons) to evaluate its spatial resolution and tracking efficiency. During this first year, I also joined the ALICE experiment at CERN. The ALICE collaboration is working on an upgrade of the Inner Tracking

System (ITS3) detector, aiming to enhance particle tracking capabilities thanks to ultra-thin stitched MAPS. While my research activities during this year were mainly devoted to the ARCADIA project as detailed above, in the last few weeks I also started working for the ALICE collaboration. I spent two weeks at CERN, during which I took part in laboratory measurements on baby-MOSS sensor, the new stitched prototype for the ALICE ITS3 upgrade. I also took part to another test beam, where, thanks to the experience gained working for the ARCADIA project, I was able to actively participate to experimental setup preparation, data taking and data analysis.

- **List of attended courses and passed exams**
  - Embedded Design with FPGA: exam passed on June 11th, 2024. This course is from UniPD Information engineering PhD school
  - Machine Learning for Physics: I have attended the course, and I plan to do the exam by the end of the first year
- **List of attended conferences, workshops and schools, with mention of the presented talks**
  - 4th ALICE Upgrade Week in Torino: conference to discuss about ALICE detector upgrades for LHC-Run4 and Run5
- **List of published papers/proceedings**
- **Thesis title (even temporary)**

  Temporary title: CAP: CMOS – Advanced Pixels

Date 12/09/2024 **Signature** Michela Rignanese

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