SCIENCES & BIOENGINEERING SCIENCES

The Research Group
High Energy Physics

has the honor to invite you to the public defence of the PhD thesis of

Eduardo Plörer

to obtain the degree of Doctor of Sciences

Joint PhD with University of Zürich

Title of the PhD thesis:

From Jets to Pixels:
Flavour Tagging and Monolithic Pixel Sensors at the FCC-ee

Supervisor:
Prof. dr. Michael Tytgat (VUB)
Co-supervisor:
Prof. dr. Florencia Canelli (University of Zürich, CH)

The defence will take place on

Monday, September 15, 2025 at 10 a.m.

VUB Etterbeek campus, Pleinlaan 2, Elsene, auditorium I.0.02

The defence can be followed through a live stream:

https://cern.zoom.us/j/67683304977?pwd=S9yNpwgkXNTbloJqZGtoKTjfmtI1H3.1

(Meeting ID: 676 8330 4977, Passcode: 917796)

Members of the jury

Prof. dr. Sophie de Buyl (VUB, chair)

Prof. dr. Bjoern Penning (University of Zürich, CH)
Prof. dr. Loukas Gouskos (Brown University, USA)
Prof. dr. Jochen Dingfelder (Universität Bonn, DE)

Curriculum vitae

Eduardo Ploerer obtained his BSc in Physics from McGill University in 2019, before obtaining a MSc in Physics at the University of Zurich under the supervision of Prof. Dr. Florencia Canelli in 2021.

As a joint PhD student at Vrije Universiteit Brussel and the University of Zurich, his research on the FCC-ee has focused on both jet flavour tagging and the characterization of monolithic active pixel sensor test structures. This work has resulted in multiple peer-reviewed publications, including first-author work, and presentations at international conferences such as DIS, FCCWeek, and iWoRiD.

Abstract of the PhD research

The FCC-ee is the first stage of a two stage project which would envision a 92 km tunnel being used for an electron-positron collider experiment starting around 2045, and a proton-proton collider in the 2070's. The FCC-ee offers unprecedented precision tests of the Standard Model, owing to its clean leptonic collision environment and exquisite luminosity. The precise identification of decay products at future colliders is instrumental to the exploitation of the full physics potential. In this thesis two facets of this problem are explored: jet flavour tagging and charged particle tracking.

Jet flavour tagging describes the algorithmic identification of the initiating parton from hadronic decays. The prospect of identifying strange quark jets has emerged as a promising avenue to study a multitude of largely unexplored processes, including $Z \rightarrow ss$ production and rare Higgs boson decays. DeepJetTransformer is a transformer-based multiclassifier neural network developed by the CMS jet tagging team at the VUB, achieving state-of-the-art performance while being relatively lightweight. This thesis combines DeepJetTransformer with secondary vertexing and a novel implementation of K-short reconstruction at the FCC-ee to discriminate strange jets. Through the inclusion of different levels of $K^{\pm}/\pi^{\pm}$ discrimination, strange tagging efficiencies ranging from 31.6% to 57.8% were obtained at a u, d jet efficiency of 10%, highlighting the need for charged Kaon discrimination at future colliders.

Monolithic Active Pixel Sensors (MAPS) combine the sensing node and readout circuitry into the same substrate, thus offering several advantages with respect to their hybrid counterparts. The Circuit Exploratoire 65 nm (CE-65), and its evolution CE-65v2, are MAPS test structures produced in the 65 nm TPSCo CMOS process to explore charge collection properties for a variety of configurations, including variations in pixel pitch, process modification, amplification scheme, and matrix geometry. In this thesis the lab characterisation of the CE-65v1 and CE-65v2 chips is reported, where charge collection efficiencies of 96% were achieved for all variants. In a subsequent beam test at CERN SPS a sub 3 µm spatial resolution was obtained for Standard process variants, satisfying FCC-ee requirements. The characterisation of the CE-65 family of chips has supplemented the APTS and DPTS studies in the validation of the 65 nm TPSCo process as a candidate technology for advanced particle detection applications, directly informing the development of future tracking detectors, including the OCTOPUS project targeting the FCC-ee.