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From detector design to physics insights: how instrumentation shapes particle physics measurements

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In recent decades, instrumentation for high-energy particle and nuclear physics has advanced dramatically, enabling the detection of rare signals with unprecedented precision and leading to numerous discoveries and high-accuracy measurements. To meet the stringent requirements of modern physics experiments, particle detectors must achieve exceptional spatial, momentum, and time resolution—continuously pushing the frontiers of current technology.

This presentation offers a concise overview of the process of converting raw data from a particle detector into meaningful physical information about particles produced in hadronic collisions. It focuses on track and decay-vertex reconstruction, and examines how varying detector specifications influence physics performance. These principles are illustrated through a real-world example: the upgraded Inner Tracking System (ITS3) of the ALICE experiment at the CERN Large Hadron Collider. ITS3 employs an innovative technology that, for the first time, enables the use of ultra-thin, wafer-scale, bent silicon sensors—minimizing the detector's material budget to an unprecedented level.

BIOGRAPHY

Fabrizio Grosa received his degree in Nuclear and Subnuclear Physics from the Università di Torino and earned a PhD in Physics from the Politecnico di Torino (Italy) in 2020. After completing a postdoctoral research position at INFN, he joined CERN in 2021, where he is currently a research staff member.

He has been a member of the ALICE Collaboration at the CERN Large Hadron Collider since 2015. His research focuses on the measurement of particles containing heavy quarks (charm and beauty) produced in high-energy proton-proton and heavy-ion collisions. These studies aim to test quantum chromodynamics (QCD)—the theory describing the strong nuclear force—under extreme conditions of temperature and energy density.

Within the ALICE Collaboration, he has held several leadership roles, including coordination of the physics working group dedicated to the study of hadrons containing heavy quarks and oversight of the work package focused on simulation and performance studies for the upcoming upgrade of ALICE's silicon vertex detector, the Inner Tracking System 3. Most recently, he has been appointed deputy trigger coordinator of the ALICE experiment.

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