

Summary of eRD29 R&D needs for CD3/TDR

Accomplishments to date: In this new R&D project, we have accomplished comprehensive studies of LGADs-based timing layer design and performance via full GEANT4 simulations for particle identification (PID) and tracking. Our studies have clearly demonstrated the advantage of LGADs-based timing layers in simultaneously providing PID and tracking capabilities (e.g., momentum resolution) that meet EIC physics requirements. Different specifications of sensors, in time resolution and pixel granularity, are studied and compared in detail, which will guide our R&D work next. Despite of COVID-19 difficulties, we are in the process of acquiring new LGADs sensors to prepare for their testing and characterization in the next phase of this project.

Assessment of technological readiness: The LGADs technology is being applied to the upgrade of CMS and ATLAS timing layers for the high-luminosity LHC program. Many technical and engineering challenges for constructing and operating a full detector are being addressed there. Therefore, the LGADs is a mature technology that is ready for EIC detectors. At EIC, the detector radiation hardness is not a concern but requirements on the precision of PID and tracking are more demanding, requiring targeted R&D efforts to take advantage of most recent LGADs technologies and develop readout electronics with finer granularity and better power efficiency.

Assessment of work remaining for a TDR: With initial R&D work of sensors completed in this project, the priority and potentially challenge next is to develop a strategy toward developing the readout electronics needed. ASIC chips developed at CMS and ATLAS can serve as a starting point but more work is needed to optimize the jitter, power consumption and demonstrate the feasibility of reducing the granularity to as small as 500 μm . Efforts on initial designs of modules, mechanical structure, cooling service, data flow, clock distribution etc. are required for the TDR, by leveraging and optimizing designs at LHC experiments. A detailed cost estimate is also needed.

Cost estimate and timeline: We estimate that at least two full FTEs of postdocs and/or engineers, costing about \$220k/year, are needed to carry out project R&D work for developing a full technical design report and complete initial prototyping, over the next 3 years. One FTE focusing on developing readout electronics is necessary, while the other FTE will be split into LGADs sensor R&D and system-level designs. As stated earlier, designs of timing detectors at CMS and ATLAS will serve as important reference for developing the TDR for EIC detectors.