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NEXT R&D Path towards the Ton-Scale

The NEXT experiment aims to detect neutrinoless double-beta decay using a high-pressure xenon gas time projection chamber with electroluminescence. To successfully reject background, the detector relies on excellent energy resolution and high-performance tracking capabilities.

Scaling traditional photomultiplier tube (PMT) technology for the future ton-scale phase of the experiment presents significant challenges. Consequently, the collaboration is actively developing an alternative system: optical wavelength-shifting fibers surrounding the detector barrel, read out by Silicon Photomultipliers (SiPMs). This new design aims to match or exceed the light collection efficiency of the current NEXT-100 configuration. Additionally, a dedicated ASIC is under development to handle the growing channel count and provide a highly scalable readout architecture. Furthermore, to move toward a zero-background regime, the collaboration is developing a barium tagging system to identify the specific ^{136}Xe daughter ion produced in double-beta decay.

In this presentation, we will review the technical challenges of realizing the ton-scale experiment and explain how the wavelength-shifting fiber barrel addresses them. We will present the development of the first fiber barrel prototype along with its measured light collection efficiency. Next, we will discuss the construction and preliminary performance of the 5 kg demonstrator (NEXT-HD-DEMO) instrumented with 18 fiber panels around the barrel read out by 36 SiPMs. Finally, we will outline the roadmap for integrating this fiber technology into both the NEXT-100 detector (NEXT-100U) and the future ton-scale detector (NEXT-HD) alongside with a description of the ASIC and the barium tagging system, for which we'll show the sensitivity achievable under the Ba tagging hypothesis.

Primary author: TORELLI, Samuele (Donostia International Physics Center)

Presenter: TORELLI, Samuele (Donostia International Physics Center)