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5D tracking active target development for the PIONEER experiment

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PIONEER is a next-generation experiment to measure the charged-pion branching ratio to electrons vs. muons and the pion beta decay with an order of magnitude improvement in precision. A high-granularity active target (ATAR) is being designed to provide detailed 4D tracking information, allowing the separation of the energy deposits of the pion decay products in both position and time. The chosen technology for the ATAR is Low Gain Avalanche Detectors (LGAD). These are thin silicon detectors with moderate internal signal amplification. To achieve a ~100% active region, Trench Insulated LGADs (TI-LGADs) without a support wafer (total thickness ~120um) are considered. Since a range of deposited charge from Minimum Ionizing Particle (MIP, a few 10s of KeV) from positrons to several MeV from the stopping pions/muons is expected, the detection and separation of close-by hits in such a wide dynamic range will be the main challenge. Furthermore, the compactness and the requirement of low inactive material of the ATAR present challenges for the readout system, forcing the amplification chip and digitization to be positioned away from the active region. The contribution will start with a brief introduction to the LGAD active target idea for PIONEER, then go into the details of sensor, readout, and mechanics R&D. We'll present results on devices thinned to 60um total thickness with an active thickness of 55um.

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