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## An LGAD-based full active target 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,  $R_{e/\mu}$  and pion beta decay (Pib)  $\pi^+ \rightarrow \pi^0 e \nu$ .  $R_{e/\mu}$  provides the best test of  $e-\mu$  universality and is extremely sensitive to new physics at high mass scales; Pib could provide a clean high precision value for  $V_{ud}$ . PIONEER was approved with high priority at the Paul Scherrer institute (PSI), with the plan to start data taking as early as 2028.

PIONEER features a high granularity active target (ATAR), designed to suppress the muon decay background sufficiently so that the  $e\nu$  tail can be directly measured. In addition, the ATAR will provide detailed 4D tracking information to suppress other significant systematic uncertainties, and to separate the energy deposits of the pion decay products in both position and time.

The chosen technology for the ATAR is Low Gain Avalanche Detector (LGAD): thin silicon detectors with moderate internal signal amplification (up to a gain of  $\sim 50$ ). LGADs have fast rise time and short full charge collection time, and are capable of providing measurements of minimum-ionizing particles (MiP) with time resolution as good as 17 ps. The ATAR baseline design is 48 planes of  $2 \times 2$  cm strip LGADs with  $120 \mu\text{m}$  of active thickness. To achieve a  $\sim 100\%$  active region, several technologies still under research are being evaluated, such as AC-LGADs and TI-LGADs. As dynamic range from MiP (positron) to several MeV (pion/muon) of deposited charge is expected, the detection and separation of close-by hits in such a wide dynamic range will be a main challenge.

In the contribution, a brief introduction to the PIONEER experiment will be presented, then studies made on ATAR candidate LGAD sensors with TCT laser and particle beam will be shown. Furthermore, results with integrated amplifier chips and interposed flex cable will be presented.

### Collaboration

PIONEER

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