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First experimental time-of-flight-based proton and helium radiography using low gain avalanche diodes

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Low Gain Avalanche Diodes (LGADs) are ultra-fast silicon detectors that allow the simultaneous measurement of an ion's position and time-of-arrival with a precision better than 100µm and 100ps, respectively. This excellent 4D-tracking capability enables the reconstruction of single-particle tracks even in high-luminosity environments, such as those encountered in high-energy physics experiments or ion beam therapy (IBT).
One particularly promising application for LGADs is ion computed tomography (iCT), an imaging modality designed to enhance treatment planning for IBT by directly determining the relative stopping power (RSP) map within a patient. Employing LGADs for iCT offers the dual advantage of maintaining clinically acceptable image acquisition times (typically under a few minutes) and integrating time-of-flight (TOF) measurements directly into the imaging process, a technique referred to as TOF-iCT.
In this work, we will present our progress in developing a TOF-iCT demonstrator system. This system incorporates single-sided LGAD strip detectors from FBK and a custom FPGA-based readout system developed at GSI. We will report on our initial ion imaging experiments at MedAustron, including the first Sandwich TOF-proton radiography of a small aluminium stair phantom and the first TOF-helium radiography of a mouse phantom. Finally, we will outline our plans for the development of a clinically viable TOF-iCT system based on LGADs.

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