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Digital FDIRC: a Focused Differential Internal Reflection Cherenkov imaged by SiPM arrays

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A prototype of an Internal Reflection Cherenkov detector, with a SiO₂ (Fused Silica) radiator bar optically connected to a cylindrical mirror, was tested at CERN SPS in March 2015 with a beam of relativistic ions obtained from fragmentation of primary argon nuclei at energies 13 and 30 GeV/n. The detector, designed to identify cosmic nuclei, features an imaging focal plane of dimensions ~4 cm x 3 cm equipped with 16 arrays of NUV-SiPM (near-ultraviolet sensitive silicon photon avalanche detector) for a total of 1024 sensitive elements. The outstanding performance of the photodetectors (with negligible background in between adjacent photo-peaks), allowed to apply the technique of photon counting to the Cherenkov light collected on the focal plane. Thanks to the fine granularity of the array elements, the Cherenkov pattern was recorded together with the total number of detected photoelectrons increasing as Z^2 as a function of the atomic number Z . In this paper, we report the performance of the SiPM arrays and the excellent resolution achieved by the Digital Cherenkov prototype in the charge identification of the elements present in the beam.

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