Isotopic Identification in Astroparticle Physics with an FDIRC prototype readout by SiPM arrays

Direct measurements of the abundance ratio of a number of secondary to primary isotopes of astrophysical interest are important probes to test models of cosmic-ray propagation in the galaxy. A well known example is the energy dependence of the $^{10}$Be/$^9$Be ratio that can measured below 1 GeV/n using the dE/dx vs. E identification technique with a stack of silicon detectors. Mass separation of Be isotopes can also be achieved using a magnetic spectrometer coupled with an independent measurement of the particle’s velocity using the detection of Cherenkov light generated in a suitable radiator.

In this paper we discuss experimental results obtained with a prototype of a Focused Internal Reflection Cherenkov (FDIRC) equipped with a single Fused Silica radiator bar optically connected to a cylindrical mirror and an imaging focal plane, of dimensions ~4 cm x 3 cm, covered with 16 high-granularity SiPM arrays for a total of 1024 NUV sensitive photosensors. The detector was exposed in March 2015 to relativistic ions of 13 and 30 GeV/n obtained from fragmentation of a primary Ar beam at CERN SPS. It was operated in photon counting mode thanks to the excellent performance of the SiPM arrays. The complete simulation of the detector was extended to the case of a planar device with multiple bars covering a sensitive area of the order of 1m$^2$. Its operation inside a (balloon or space-borne) magnetic spectrometer was studied to evaluate its expected mass resolution for the identification of $^9$Be and $^{10}$Be at energies of several GeV/amu with the goal to extend the energy reach of the present data.

J.E. Suh$^{a,b,*}$, P.S. Marrocchesi$^{a,b}$, G. Bigongiari$^{a,b}$, P. Brogi$^{a,b}$, A. Sulaj$^{a,b}$

a Dept. of Physical Sciences, Earth and Environment, Via Roma 56, 53100 Siena, Italy
b INFN Sezione di Pisa, Largo Bruno Pontecorvo 3, 56127, Pisa, Italy

(*) corresponding author : jungeun.suh@pi.infn.it