Radiation studies on resistive bulk-micromegas chambers at the CERN Gamma Irradiation Facility

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Abstract

Two resistive bulk-micromegas chambers were installed in May 2015 at GIF++ exposed to an intense $\gamma$ irradiation with the aim to study the detector behavior under high irradiation and long-term aging. The results of the detector performance after this long-term irradiation period will be presented.

Gamma Irradiation Facility (GIF++) at CERN

Located in the north area of the SPS accelerator at CERN [1]

Unique place where high energy charged particle beams (mainly muons) are combined with a flux of high energy photons (662 keV)

The high source activity, $^{60}$Co, produces a very intense background gamma field allowing to accumulate doses equivalent to High Luminosity LHC (HL-LHC) experimental conditions in a reasonable time

Measurements and simulations (Geant4) of the photon field were provided [1] and used as benchmarks for our measurements

Filter system permits the attenuation of the photon rate in several steps to reach attenuation factors of several orders of magnitude ($\sim 10^4$ - $10^6$)

Description of the MicroMegas used in GIF++

- Two resistive bulk-micromegas chambers (T5 & T8) [2] built at CERN
  - Active area of 10x10 cm$^2$
  - Single readout plane with strip pitch 400 $\mu$m and strip width 300 $\mu$m
  - Readout strips covered with a 50 $\mu$m thick Kapton foil carrying high resistivity (~1M$\Omega$/sq) carbon strips $\rightarrow$ spark protection
  - Mesh consisting of 18 $\mu$m diameter wires with 64 $\mu$m pitch
  - Amplification gap of 128 $\mu$m, drift gap of 5 mm

Data-taking and Working Conditions

Data acquired with APV25 front-end ASICs [3] and RD51 Scalable Readout System (SRS)[4]

Data-taking varying attenuation filters and amplification voltages
- Att. Factors: 1, 2.2, 4.6, 10, ..., 100
- Amplification Voltage Scan: 420-540 V
- Drift Field: 600 V/cm
- Source ON/OFF + Muon Beam

Working conditions:
- Gas: ArCO$_2$ 93%, 7%, Gas Flow: 5 l/h

Integrated Charge

After $\sim 2$ years of exposure to an intense $\gamma$ irradiation the desired accumulated charge of more than 0.2 C/cm$^2$ has been reached for one of the two chambers: the equivalent charge expected after 10 years of HL-LHC operation

Chambers exposed at GIF++ from May 2015 to March 2017

Conclusions

The efficiency, gain and particle rate measurements have been presented. After two years of irradiation at GIF++ no aging effects have been observed in either of the two chambers. This confirms earlier results obtained in a $\gamma$ ray exposure at CEA Saclay [5].

References

[1] D. Pleifler et al., arXiv:1611.00299v1