

The FOOT experiment drift chamber performance assessment

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Particle therapy

A form of radiotherapy that uses hadrons for the treatment of solid tumours



Main properties:

- Proton (50-250 MeV); Carbon ion (50-400 MeV/u)
- Max dose release in the Bragg peak
- Better dose conformation over the tumor volume with respect to conventional radiotherapy
- High biological effectiveness for heavy ion therapy

Nuclear interactions in PT:

- Target fragmentation in proton therapy
- Projectile fragmentation in heavy ion therapy

Need of differential cross section data to improve the treatments and study new PT ions

Radioprotection in space missions



Radiation hazard in future long term and far from earth space missions to the Moon and Mars:

- Galactic Cosmic Radiations:

 Protons:
 -Relium
 -Helium
 -Heavy nuclei with Z>2:
 -1%
 -Energies up to 10²⁰ eV
- Solar Particles events:

 Protons:
 -Helium:
 -Heavy nuclei with Z>2
 -1%.
 -Energies up to hundreds of MeV/u

The HZE (High Z and Energy) particles are the most dangerous

Need of nuclear interaction differential cross section data to optimize shielding design and strategy for shielding

The FOOT (FragmentatiOn Of Target) experiment



FOOT aims to measure the nuclear fragmentation cross sections relevant in PT and space radioprotection

Emulsion spectrometer:

- Z \leq 3 and θ <70°
- Emulsion technology from the OPERA exp.
- A compact detector composed of emulsion layers alternated with target and absorber material

Electronic spectrometer:

- Z≥3 and θ<10°
- Composed of different sub-detectors
- To measure the fragments TOF, momentum, dE/dx and kinetic energy

The Beam Monitor detector





The detector goal is to measure the beam direction and position

Detector specs:

- Dimensions: 11.2 cm x 11.2 cm x 21 cm
- 6 staggered layers of cells on X and Y view
- Each layer composed of 3 rectangular cell (16 mm x 10 mm)
- 2 mylar windows at beam entrance and exit
- Filled with Ar/CO₂ at 80/20%
- 0.9 atm overpressure

BM characterization @ Trento



The BM has been characterized by means of an external independent tracking detector

Goals:

- Calibration of the BM space-time relations
- Efficiency
- Resolution



Experimental setup:

- Plastic scintillator for trigger and BM time ref.
- BM tilted horizontally at 0°, 5° and 10°
- 4 layers of micro-strip silicon detectors with a mean resolution of 45 μm
- Proton beams at 228 and 80 MeV

Space-time relations calibration



Calibration method:

- Exploits the 228 MeV proton to minimize the Multiple Coulomb Scattering (MCS)
- Uses a previous set of space-time relations to reconstruct the BM tracks and align the detectors
- Combines the BM time measurements with the MSD projected distances

New space-time relations evaluated

No relevant changes btw 228 and 80 MeV results

Efficiency



Hit efficiency = 0.929 ± 0.008 (HV=2200 V) Fraction of events with one or two hits detected on even (odd) planes, when three single hits on odd (even) planes have been



Efficiency as a function of the drift distance: Propagate the MSD tracks into the BM cells to check the

The BM is inefficient at the cell border

Inefficiency partially compensated by the cell staggering

Spatial resolution



BM track method:

Residual between the BM tracks and the BM hits.

- Uses only BM hits and tracks
- Depends on the BM reconstruction algorithm
- MCS negligible (verified by MC studies)
- Measures the detector upper limit
 - **Resolution:** 60 100 μ m (in the central part of the cell)

MSD track method:

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Residual between the MSD tracks and the BM hits

- External independent detector
- Independent from the BM reconstruction algorithm
- MCS included (verified by MC studies)
- Resolution: 150 μm (228 MeV) and 300 μm (80 MeV) (in the central part of the cell)

Conclusions and future perspectives





- Adopted in the emulsion data taking @ GSI with C @ 700 MeV/u and O @ 200 and 400 MeV/u
- Adopted in the first electronic setup test @ GSI with O @ 400 MeV/u





Next step: new data taking at CNAO with C ions

 Electronic spectrometer: almost full geometry data taking with: SC, BM, VTX, Tof-Wall and a 3x3 module of the Calorimeter

-Independent test of the MSD detector

 Emulsion spectrometer: data taking at CNAO with C ion beams