Deuteron identification with the AMS-02 RICH detector Eduardo F. Bueno



Secondary nuclei in Cosmic Rays (CR)

Secondary CR are produced from collisions of primary CR with the interstellar medium (ISM)



The fluxes of the secondary species are very important for the understanding of the origin and propagation of cosmic rays

- They carry information on the history of the travel and properties of ISM
- Most abundant species: Li, Be, B and light isotopes (³He and D)

The Alpha Magnetic Spectrometer



The Ring Imaging Cherenkov (RICH) detector (I)



The Ring Imaging Cherenkov (RICH) detector (II)

RICH radiators:

NaF: n = 1.33; 0.75 < β < 0.97 A<u>erogel = 1.</u>05; 0.96 < β < 0.996





Silicon tracker



Isotope identification with RICH in AMS-02



Mass measurement:



Rigidity: Inner tracker: $\Delta R \approx 10\%$ up to 20 GeV for Z = 1

Velocity:

• RICH-NaF: $\Delta\beta \approx 0.4\%$ at Z =1

and $\beta = 1$.

• RICH-Aerogel: $\Delta\beta \approx 0.1\%$ at Z =1 and β = 1.

Mass resolution (Z = 1)



Sources of background



- Fragmentation of heavier nuclei causes spurious Z = 1 signals.
- 2. Protons interacting inside AMS-02 and produce secondary particles which affect the mass measurement.

Event selection (I): charge



- Spurious events from fragmentation can be removed by requiring Z = 1 in different layers of the detector:
 - A. Tracker L1
 - B. Upper TOF
 - C. Inner Tracker
 - D. Lower TOF

Event selection (II): quality of velocity



- 2. The effects of interactions inside the detector on the RICH can be reduced by applying cuts on variables related to the ring reconstruction, such as:
 - a. Number of PMTs used (at least 3)
 - b. At least 50% of detected Cherenkov photons used in the reconstruction

Event selection (II): quality of velocity



- 2. The effects of interactions inside the detector on the RICH can be reduced by applying cuts on variables related to the ring reconstruction, such as:
 - a. Number of PMTs used (at least 3)
 - b. At least 50% of detected Cherenkov photons used in the reconstruction

• Consistency between TOF and RICH β:



Event selection (III): quality of rigidity



- 1 and 2 can be further reduced by requiring events to be well reconstructed in the tracker:
 - Single track
 - Good track fitting

Signal extraction

• **Template fit:** templates obtained from <u>MC simulations</u> of helium, deuterons and protons



Conclusion

- The measurement of cosmic ray deuterons is important to study the propagation of cosmic rays over large distances.
- AMS-02 complementary measurements of the charge allow an efficient removal of the background caused by fragmentation inside the detector.
- The RICH reconstruction provides variables which can be used to ensure a good quality of the reconstruction.

Backup slides

Main sources of systematics



- **Fragmentation:** protons and deuterons interact differently inside AMS. The number of protons and deuterons has to be corrected by using MC simulations.
 - **Template fit:** shape affected by several factors, such as:
 - Event selection
 - Corrections from data/MC comparison

Available measurements

