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Sensitivity studies and technological advancements for balloon-borne demonstrators of direct antimatter detection

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The development of next-generation cosmic-ray spectrometers requires a robust technological foundation to enable precise and high-sensitivity measurements. This work explores the technological advancements in superconducting magnets and pixel silicon-based trackers, focusing on their application in balloon-borne demonstrators as testbeds for future space missions. Balloon experiments offer a unique opportunity to validate detector technologies in near-space conditions, bridging the gap between laboratory developments and full-scale space missions.
In this contribution, we will present results from the sensitivity calculation of a large-acceptance magnetic spectrometer, outlining its capability to measure rare cosmic-ray components, including antimatter. In particular, we will show that the acceptance calculation for 30-day-long balloon flights leads to exposures as large as hundreds of cm^2 sr years, making them highly relevant for comparison with long-duration space missions. Additionally, we will showcase simulation results exploring possible layouts for the magnetic spectrometer, aiming to optimize tracking resolution, momentum measurement, and overall instrument performance. These studies provide critical input for the design and feasibility assessment of future space-based experiments, such as Aladino or AMS-100.
This work underscores the importance of high-precision detection technologies in the roadmap toward next-generation antimatter searches. By leveraging balloon-borne demonstrators, we can refine instrumental designs and validate key performance parameters in realistic conditions, paving the way for future space missions dedicated to high-energy cosmic-ray physics.

Collaboration(s)

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