Reconstruction of antinucleus-annihilation events in the GAPS experiment

Alessio Tiberio
on behalf of the GAPS collaboration

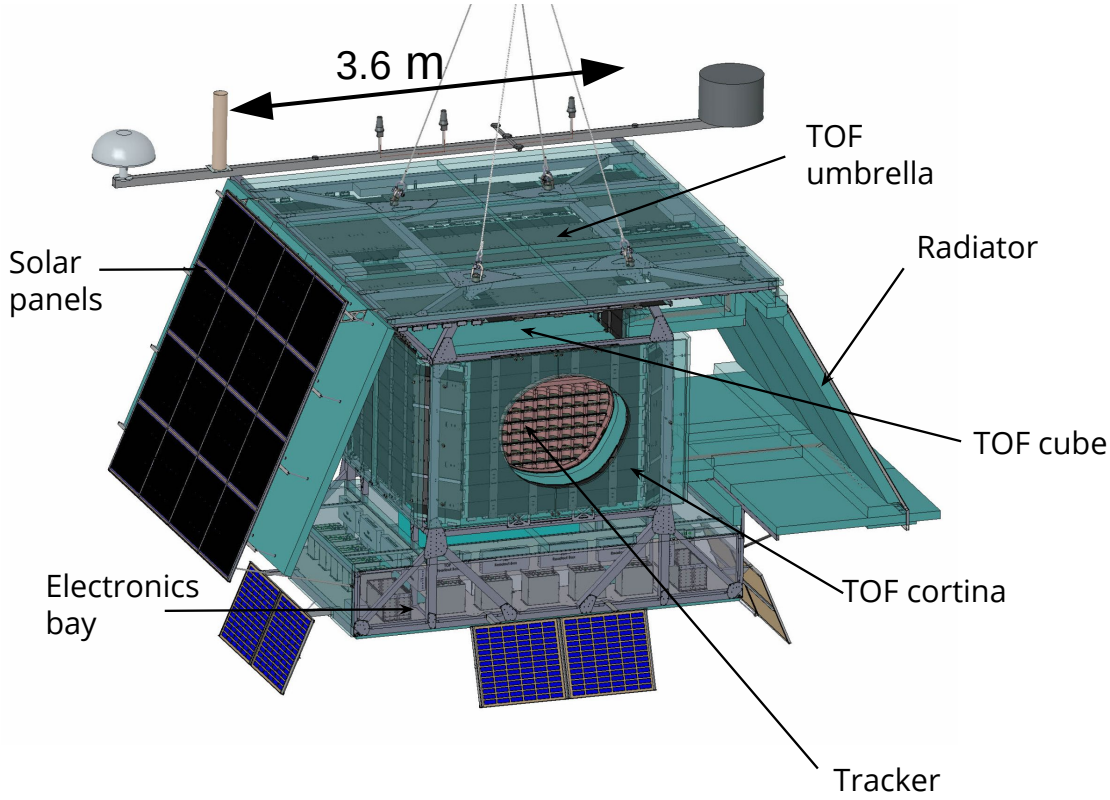
37th International Cosmic Ray Conference (ICRC 2021), 12-23 July 2021, Berlin, Germany (online)

The GAPS experiment

- Measurement of antinuclei as as a **signature of dark matter** annihilation or decay.
- Predicted flux of antideuteron and antihelium-3 from dark matter is two orders of magnitude above the astrophysical background below 0.25 GeV/n

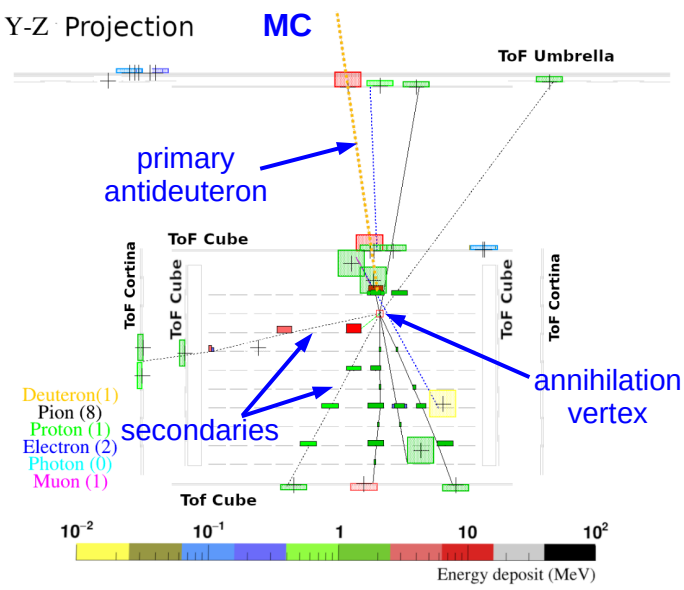
~ background-free measurement

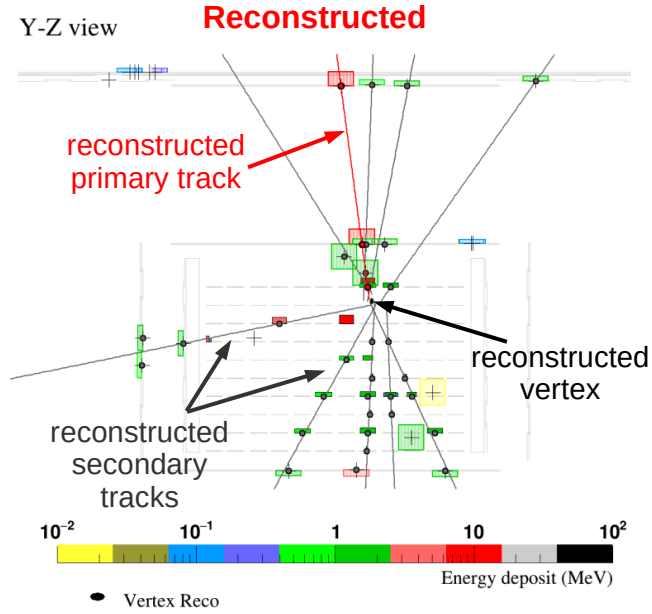
- Time-of-Flight (ToF) system surrounding a tracker.
- Antinucleus detection based on the observation of the particles produced in the annihilation of the antinucleus in the tracker volume
- Two algorithms developed for reconstruction:
  - **Hough-3D** transform
  - **“Star Finding”** (custom algorithm)



Reconstruction algorithm

- **"Star Finding"** algorithm
  - identify the primary track from the first ToF hits and associated other consistent hits to it
  - scan along the primary direction to find the position from which most of the hits can be intersected with trajectories originating from this point
  - find the vertex as the point which minimizes the distance from all the tracks
  - iterate the procedure after rejecting wrongly associated tracks and hits





- Reconstruction efficiency
  - Star Finding: **~90%**
  - Hough-3D: **~75%**
- Vertex resolution
  - Star Finding: peak at **~1 cm**, 68% within **9-12 cm**
  - Hough-3D: peak at **~1.3** cm, 68% within **~14 cm**