

General AntiParticle Spectrometer (GAPS)

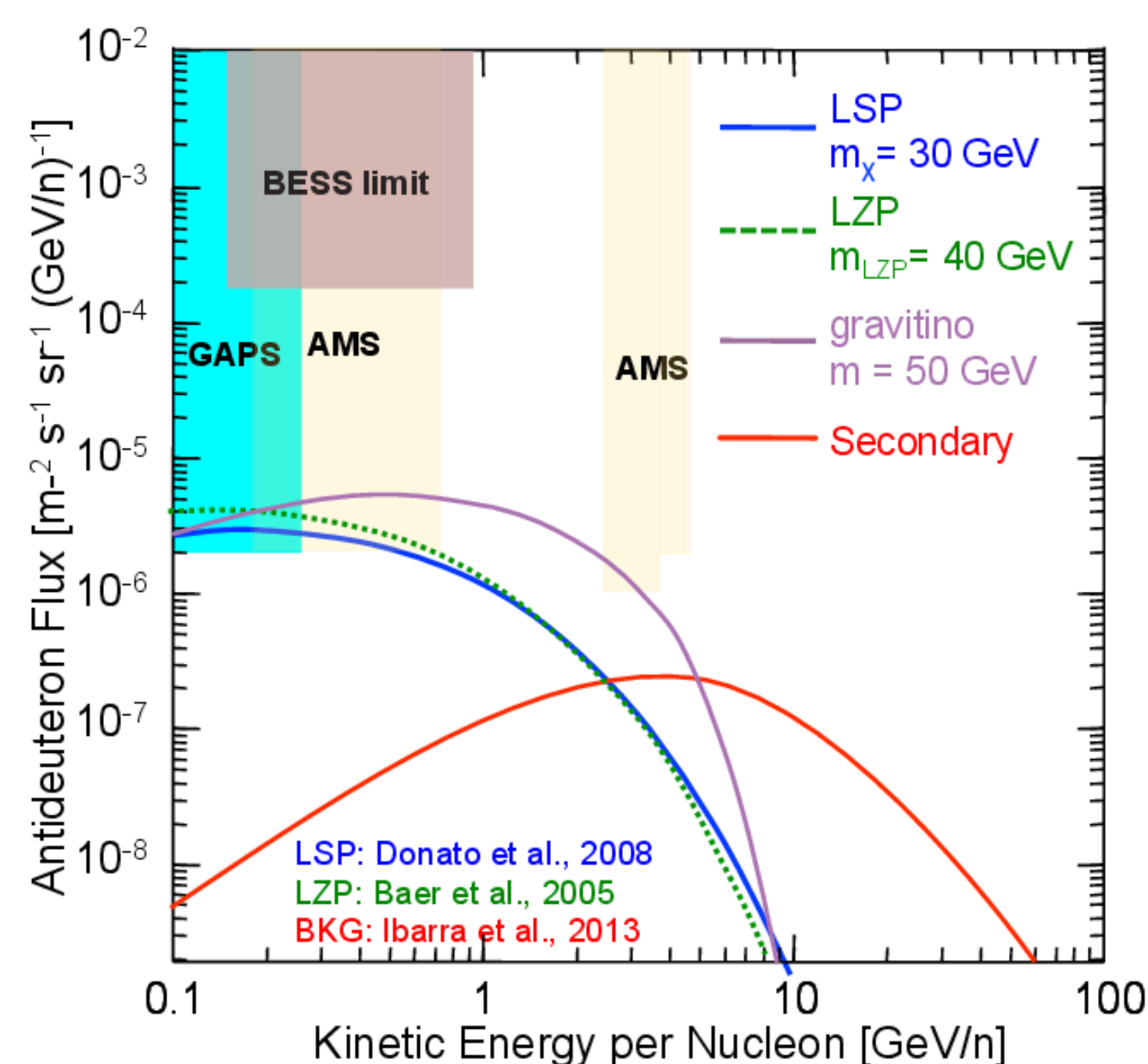
Hunt for dark matter using cosmic ray antideuterons and antiprotons

C. Hailey on behalf of the GAPS collaboration

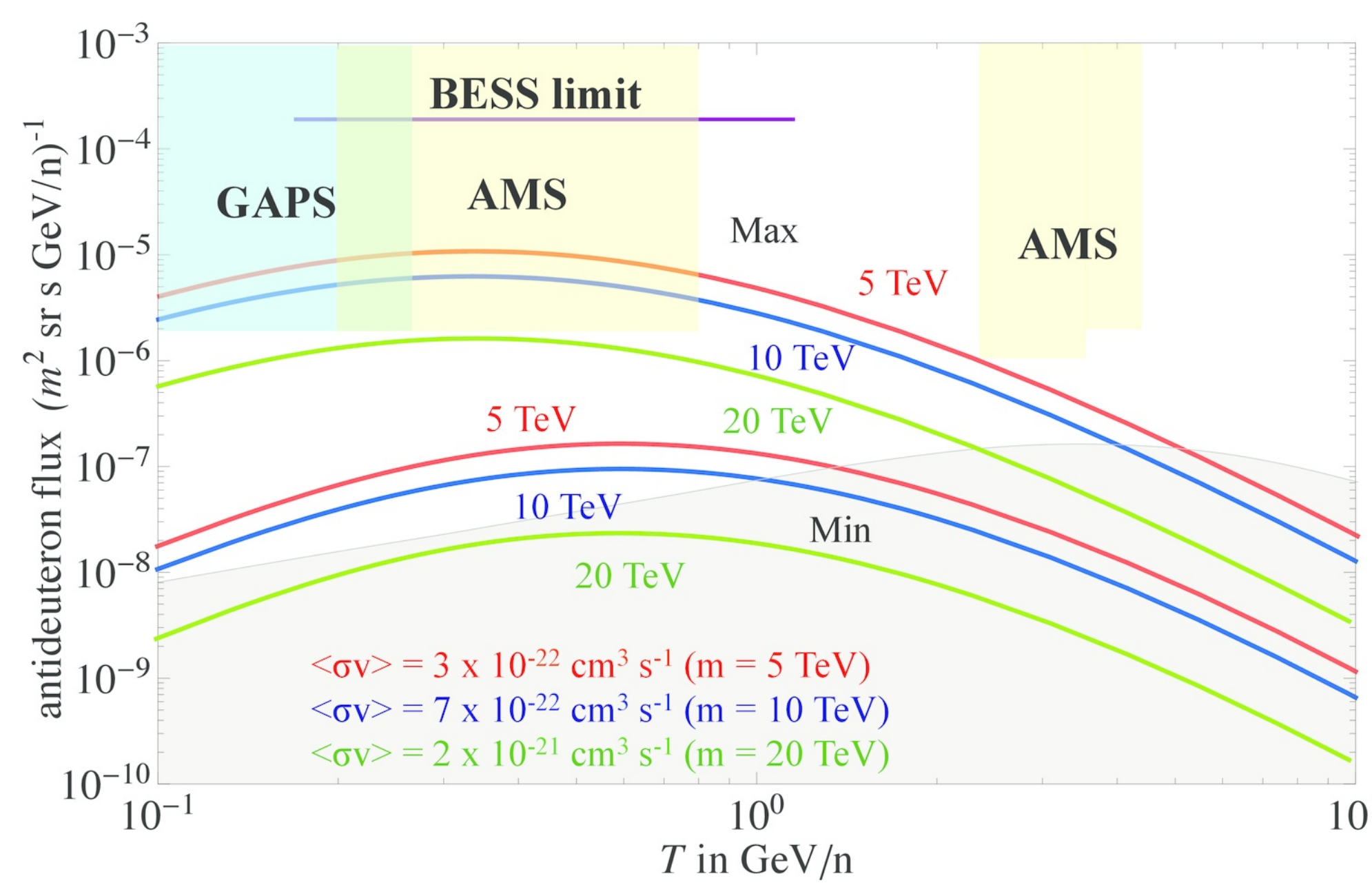


The GAPS experiment is foreseen to carry out a dark matter search by hunting for low energy cosmic ray antideuterons with a novel detection approach. The theoretically predicted antideuteron flux resulting from secondary interactions of primary cosmic rays, e.g. protons, with the interstellar medium is very low. So far not a single cosmic antideuteron has been detected by any experiment, but well-motivated theories beyond the standard model of particle physics, e.g., supersymmetry or universal extra dimensions, contain viable dark matter candidates, which could lead to a significant enhancement of the antideuteron flux due to self-annihilation or decay of dark matter particles. This flux contribution is believed to be especially large at low energies, which leads to a high discovery potential for GAPS. GAPS is designed to achieve its goals via a series of long duration balloon flights at high altitude in Antarctica and had a successful prototype flight in June 2012.

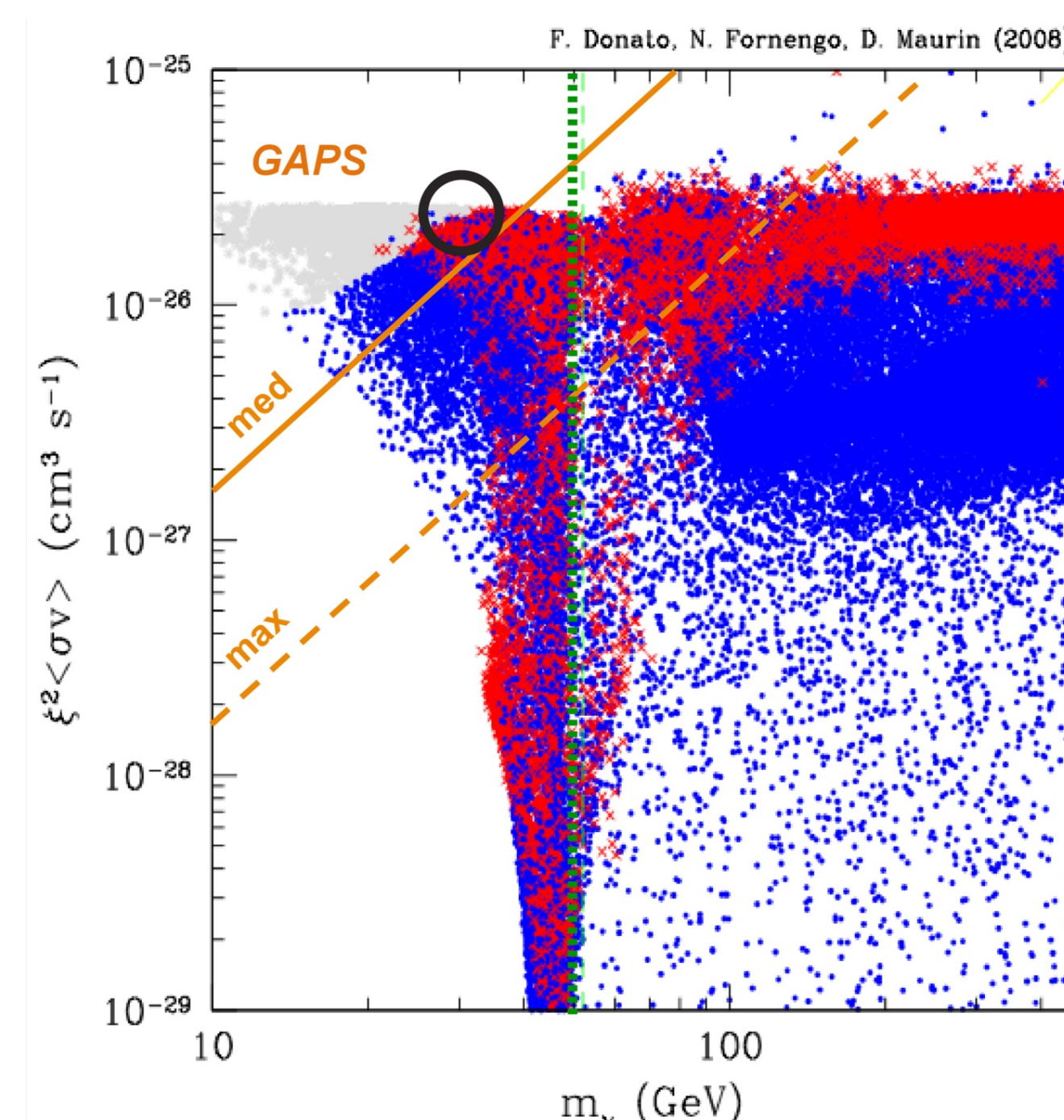
Motivation



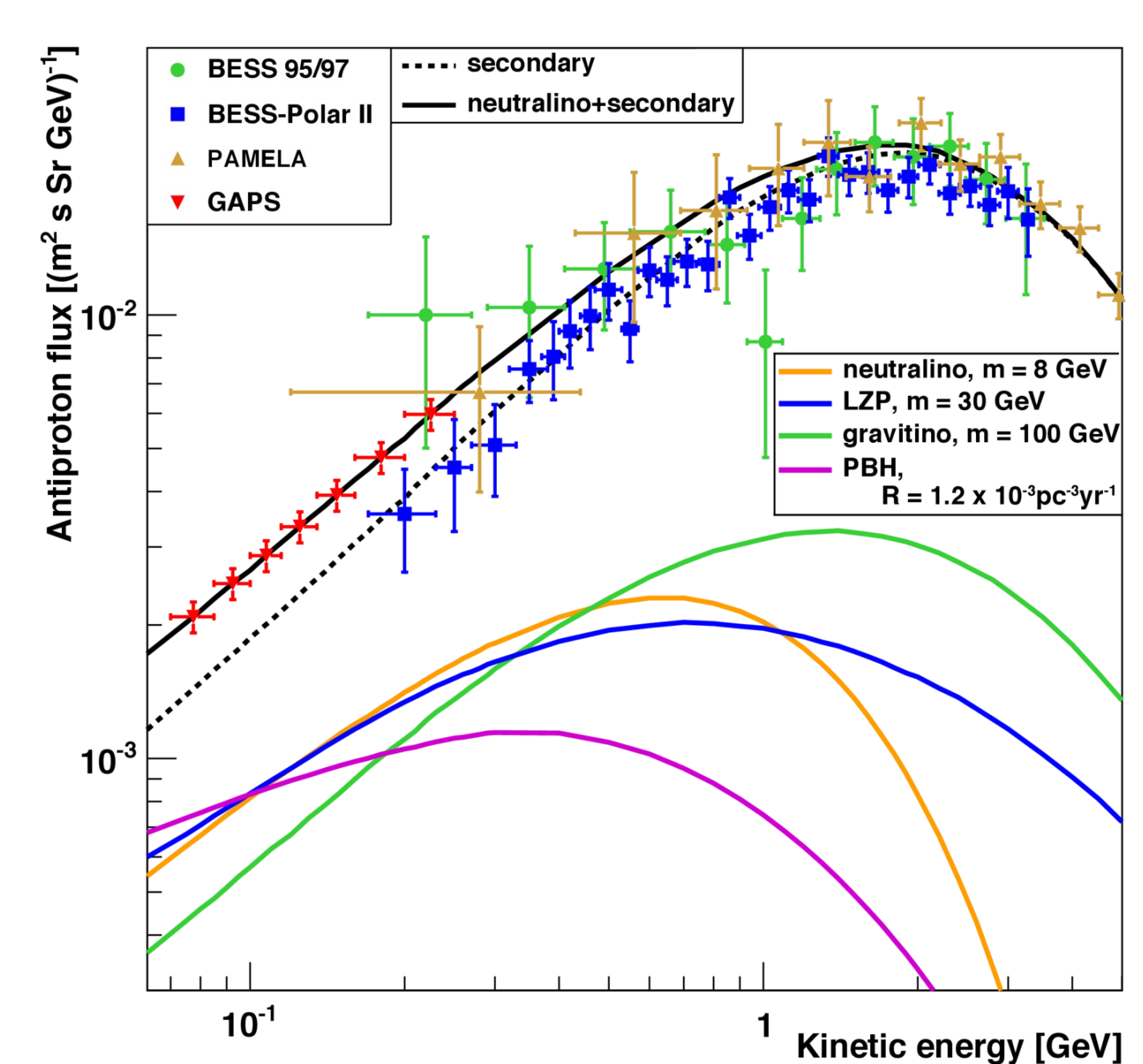
LSP, LZP, and gravitino models along with the antideuteron background and sensitivity of GAPS, BESS and AMS (for five years of operation)



Sensitivity of antideuteron searches for heavy DM annihilation with representative propagation uncertainty indicated

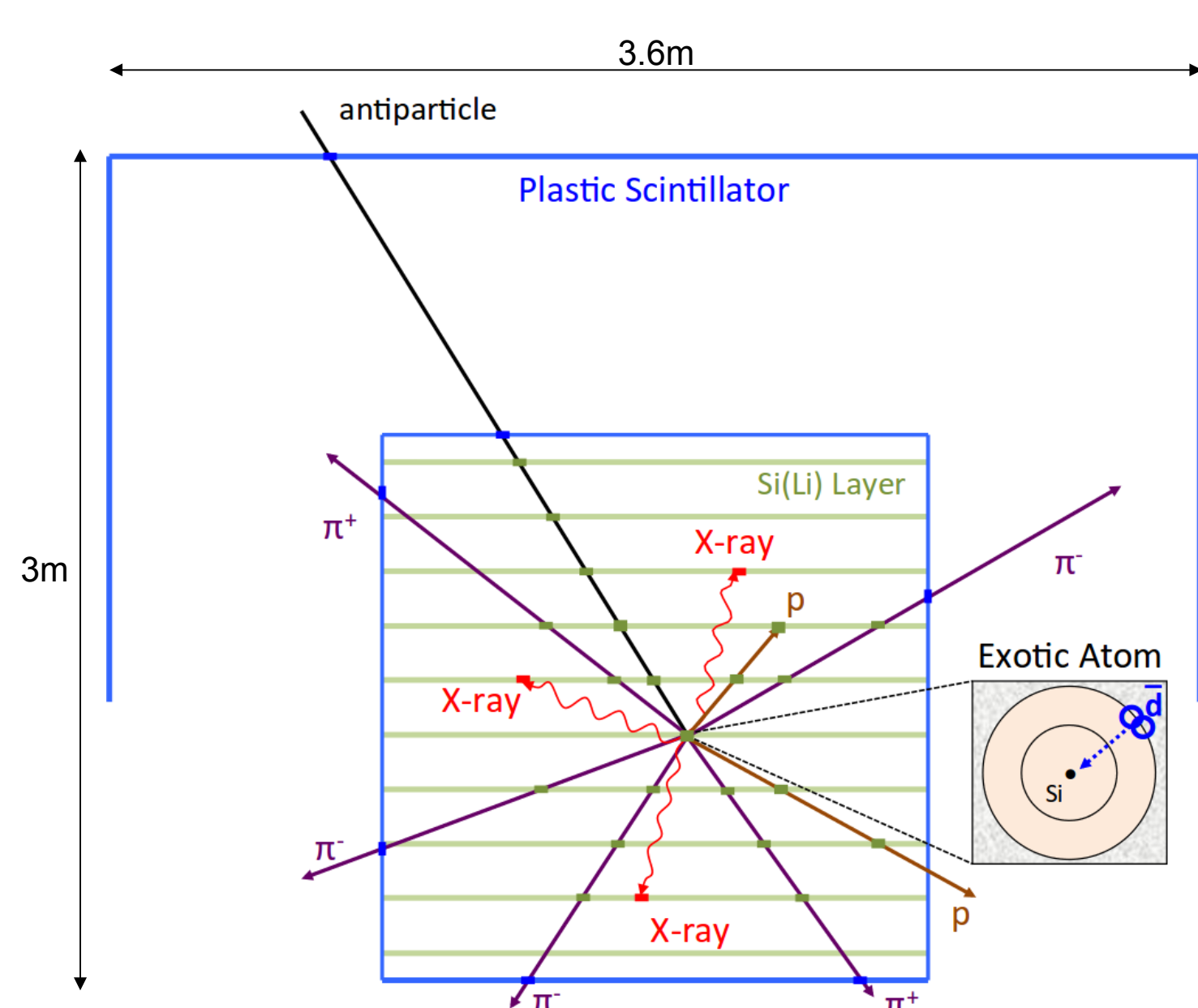


GAPS sensitivity to various SUSY models. The black circle is the phase space claimed by the Fermi DM discovery, which is detectable by GAPS.

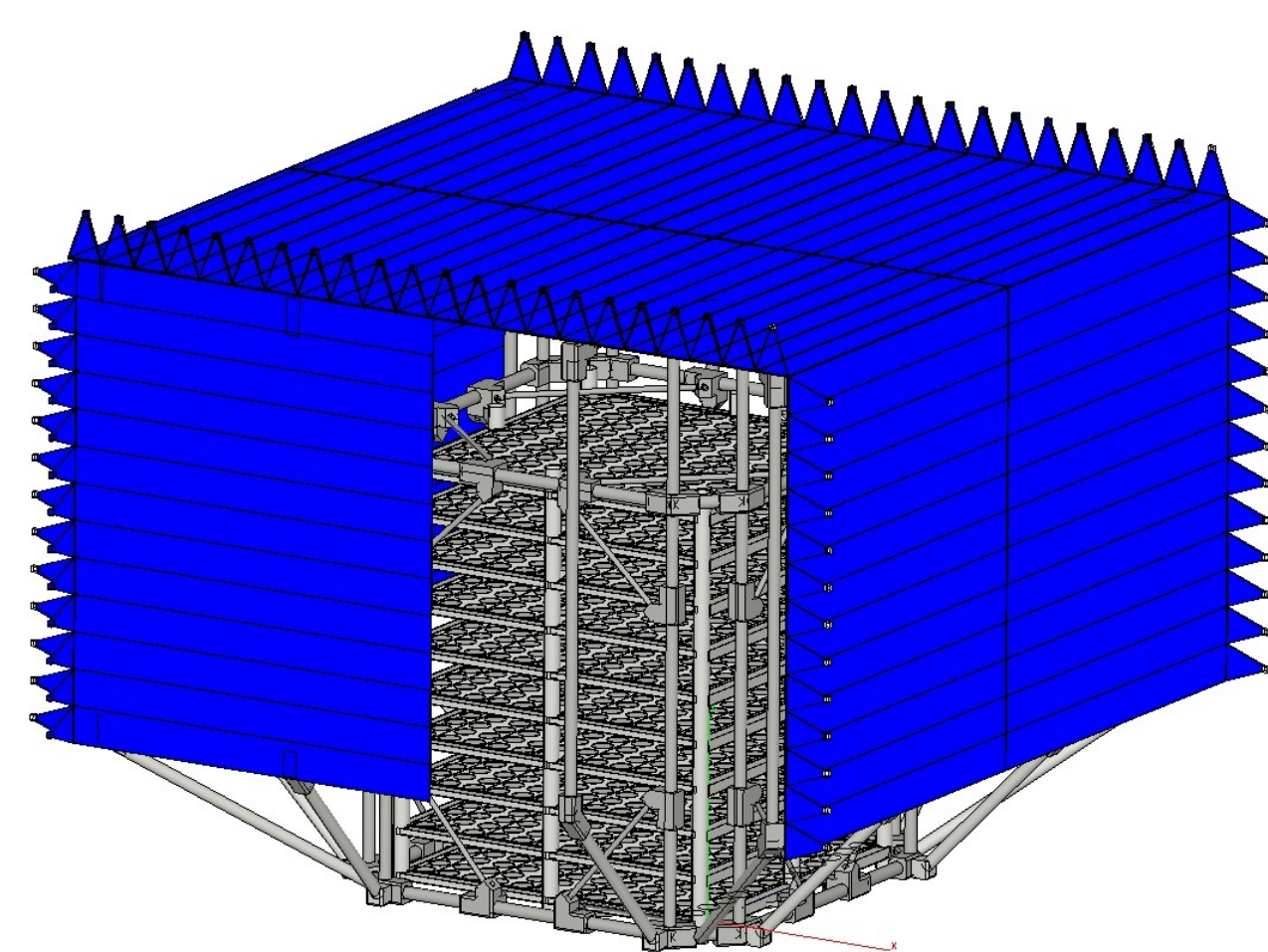
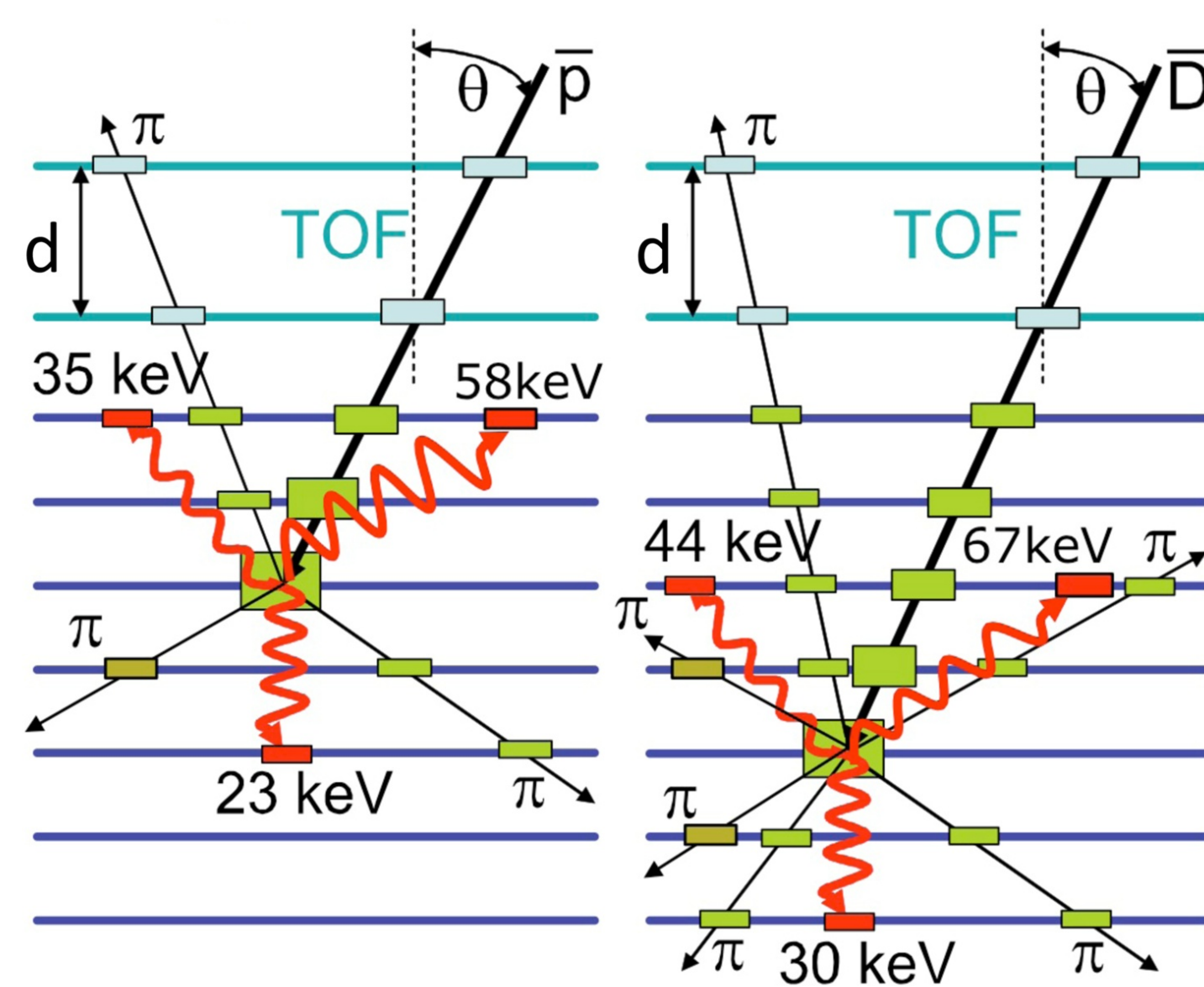


Predicted primary antiproton fluxes at TOA from neutralinos, LZPs, gravitinos, or PBHs, along with neutralino signals as seen by 1 GAPS LDB flight.

GAPS instrument



For the same measured TOF and angle (i.e., particle velocity), an antideuteron (right) will penetrate deeper, typically emit twice as many annihilation pions and protons and emit X-rays of different well-defined energies than an antiproton.



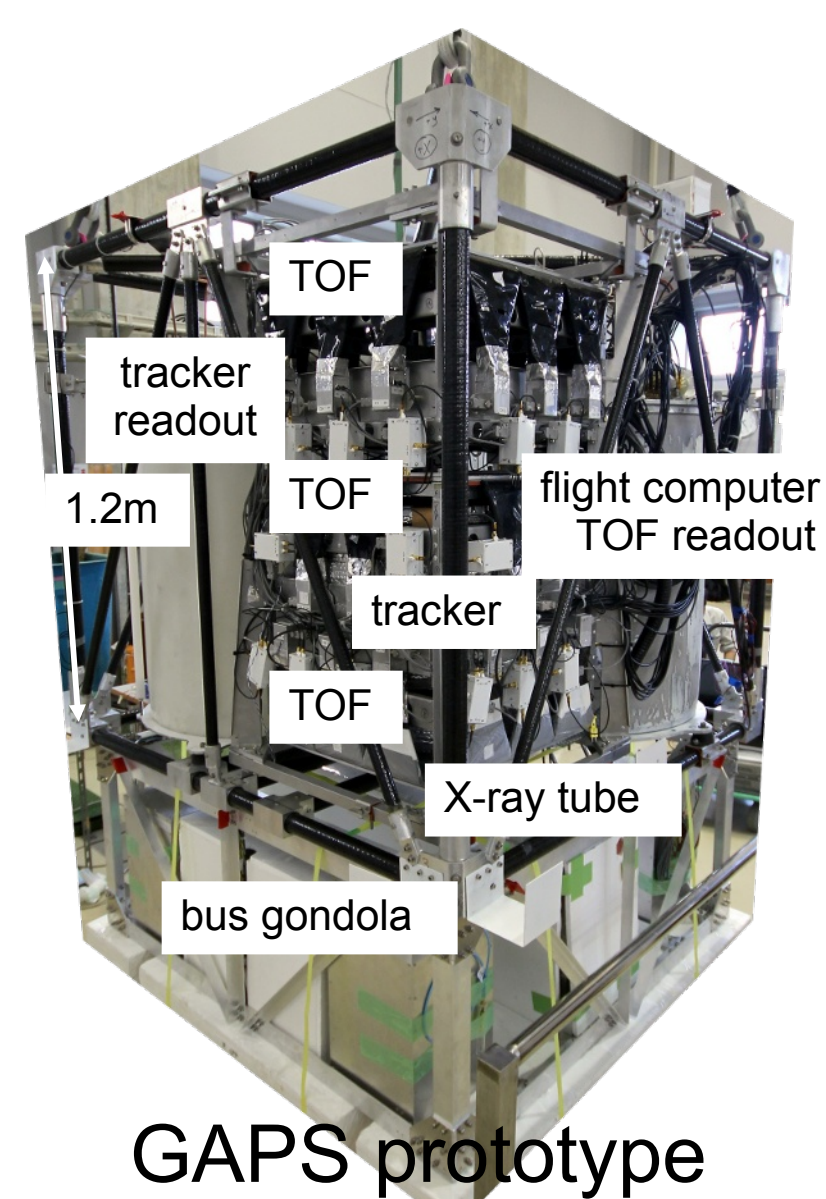
GAPS balloon long duration flights are planned from Antarctica for the 2018/19 ballooning season

	1 LDB	3 LDB
Energy range	0.05-0.25 GeV/n	
Geometrical Acceptance (no efficiency factor included)	22 m ² sr	
Observation time	~35 days	~105 days
Antideuteron Sensitivity (CL) (m ² sr s GeV/n) ⁻¹ (>99%)	6 · 10 ⁻⁶	2 · 10 ⁻⁶
Antideuteron bkgd events	~0.002	~0.006
Antiproton events	~1500	~4500

GAPS will:

- use antideuterons to search for DM from supersymmetric (SUSY) and extra dimension theories, with particular relevance to light DM, where positive detection is claimed and direct searches are in conflict, and to heavy DM, where direct searches are ineffective,
- search for decaying gravitino DM, which is inaccessible to direct searches but detectable by antideuterons over a broad mass range, and
- use precision ultra-low energy antiproton spectroscopy to provide stringent constraints on models of ~10 GeV DM, provide the best limits on primordial black hole evaporation on Galactic length scales and explore new discovery space in cosmic ray physics.

GAPS technology



- GAPS prototype flight in 2012 met 100% of its goals and demonstrated all key technologies
- Si(Li) detector fabrication well understood
- homemade Si(Li) detectors show good resolution

