

Gravitational interaction of \bar{H}

Gbar, AE \bar{g} is, ALPHA-g

박관형

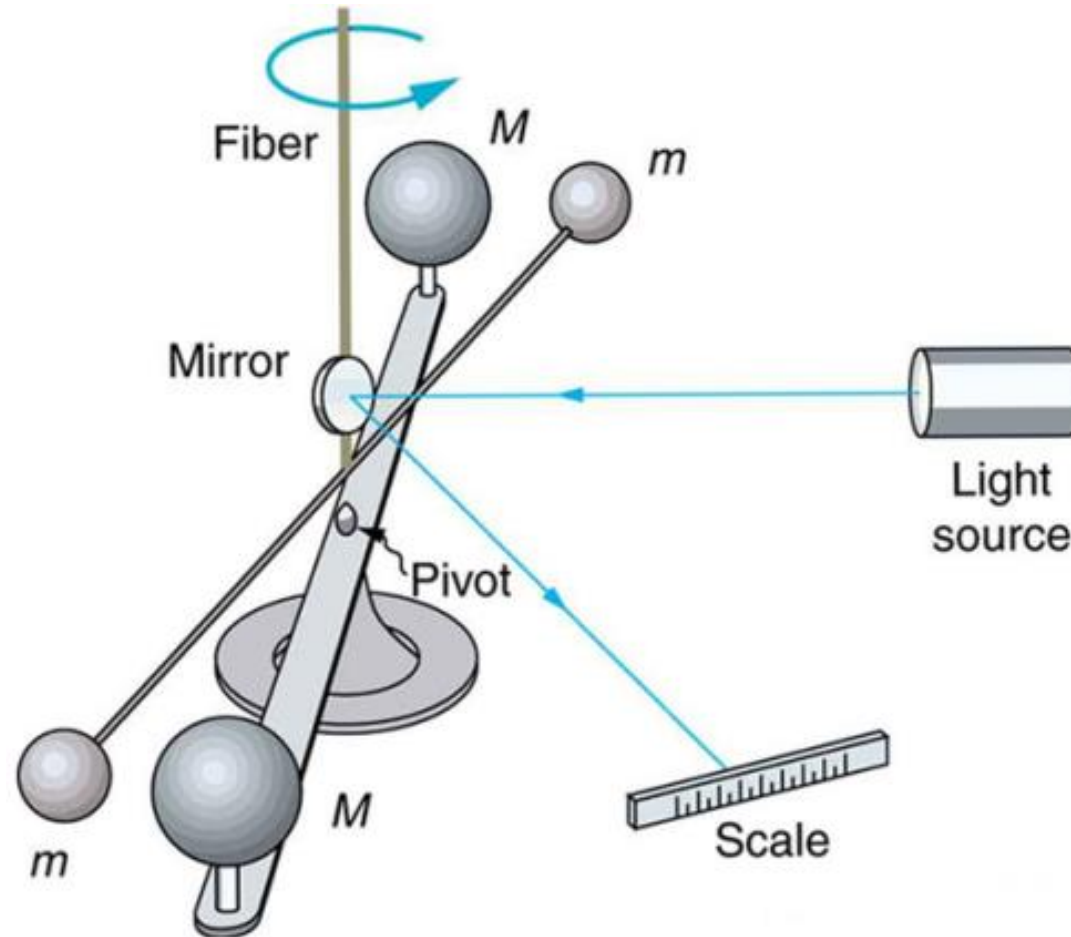
Motivation

- The matter-antimatter asymmetry problem
- The weak equivalence principle

$$m_i a = m_g g$$

- Many indirect measurement was done

Gravity for matter



Difficulties

- Problem of antimatter
 - Hard to make
 - Hard to store
- Problem of Gravity
 - So weak

Competition among colabs

THE DECELERATORS

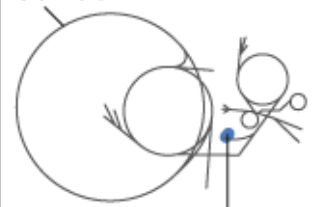
ANTIPROTON DECELERATOR

The 182-metre-circumference ring uses electromagnetic fields and beams of electrons to slow incoming particles to around 10% of their initial speed over 100 seconds.

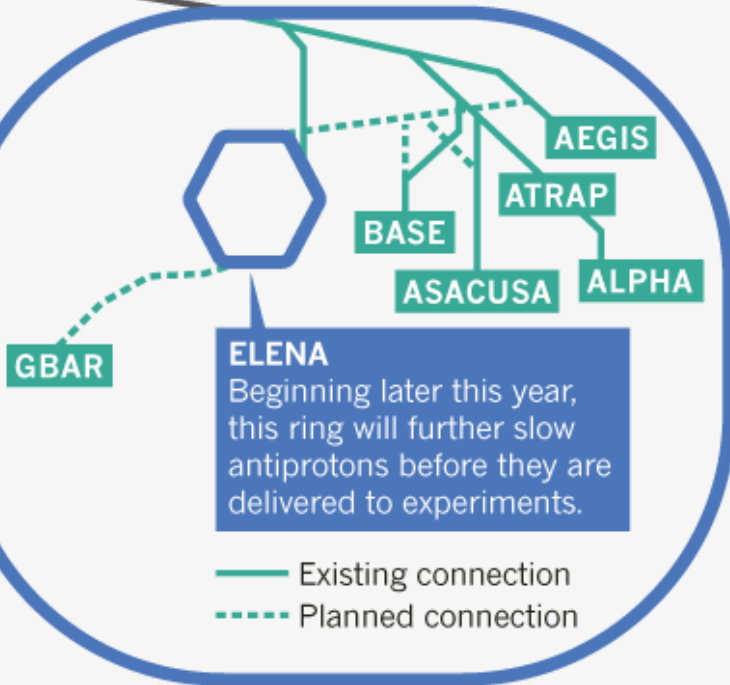
ANTIPROTON PRODUCTION

Protons from the CERN accelerator complex are fired into an iridium target to create antiprotons.

Large Hadron Collider



Antiproton decelerator



ELENA

Beginning later this year, this ring will further slow antiprotons before they are delivered to experiments.

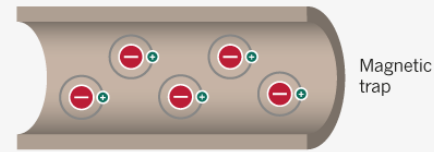
— Existing connection
- - - Planned connection

ALPHA

Started: 2005

Studies: Charge, spectroscopy and acceleration under gravity of antihydrogen.

How it works: Mixes antiprotons and positrons in a complex electromagnetic trap to create antihydrogen, which physicists probe with lasers.



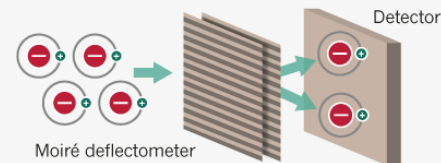
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AEGIS

Started: 2015

Studies: Gravitational acceleration of antihydrogen atoms.

How it works: Observes the pattern produced by parallel beams of excited low-energy antihydrogen atoms as they pass through a grating.



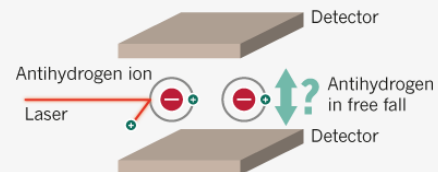
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GBAR

Starting: 2017

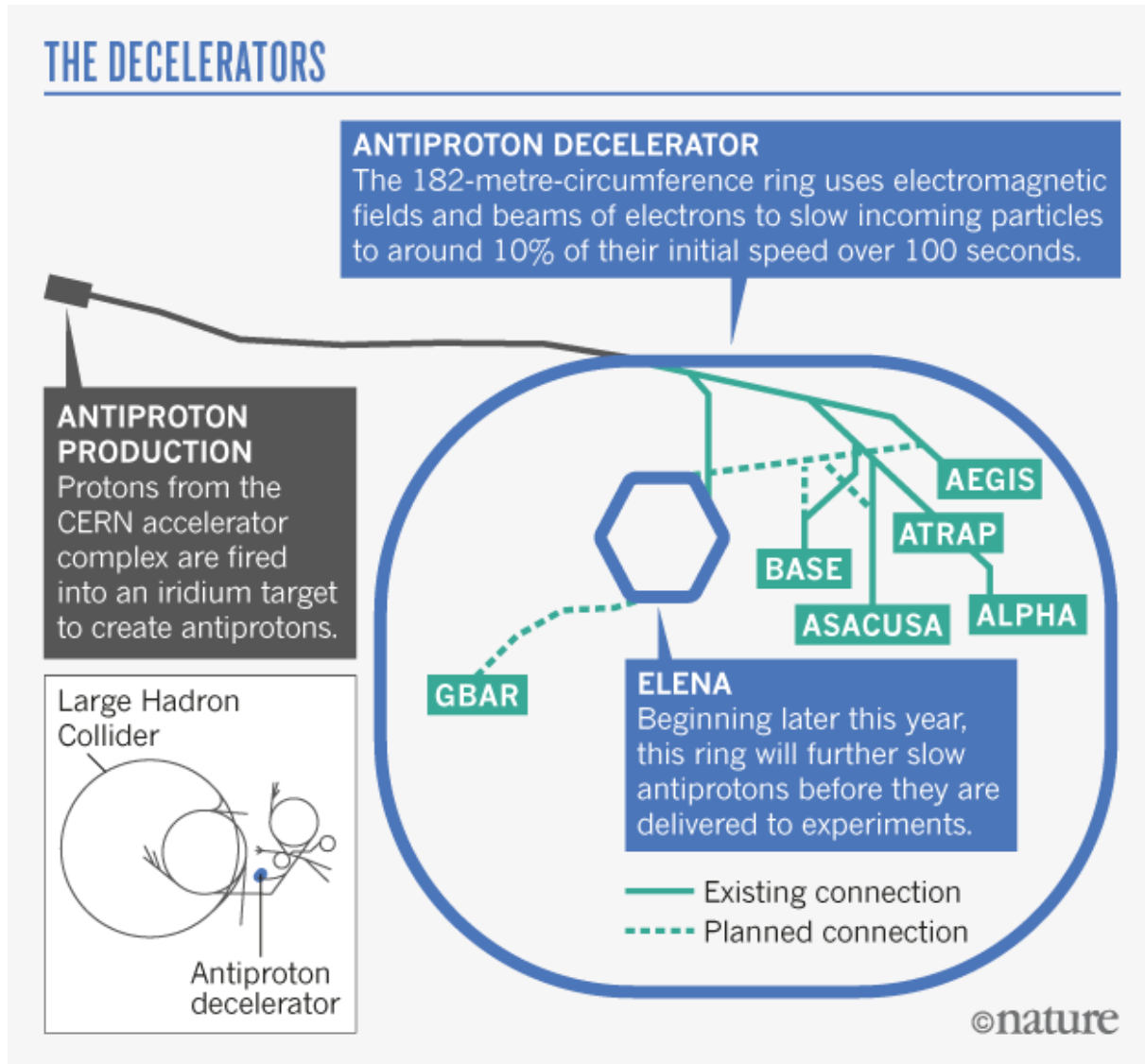
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How it works: Laser-cooled beryllium ions chill antihydrogen ions containing two positrons. A laser knocks off one positron, and the antihydrogen atom free-falls under gravity.



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Competition among colabs



We kindly ask that you treat this addendum confidentially (within the committee) if possible.
-From ALPHA-g proposal

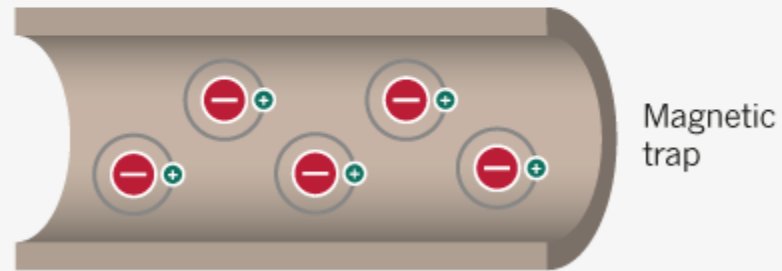
ALPHA

ALPHA

Started: 2005

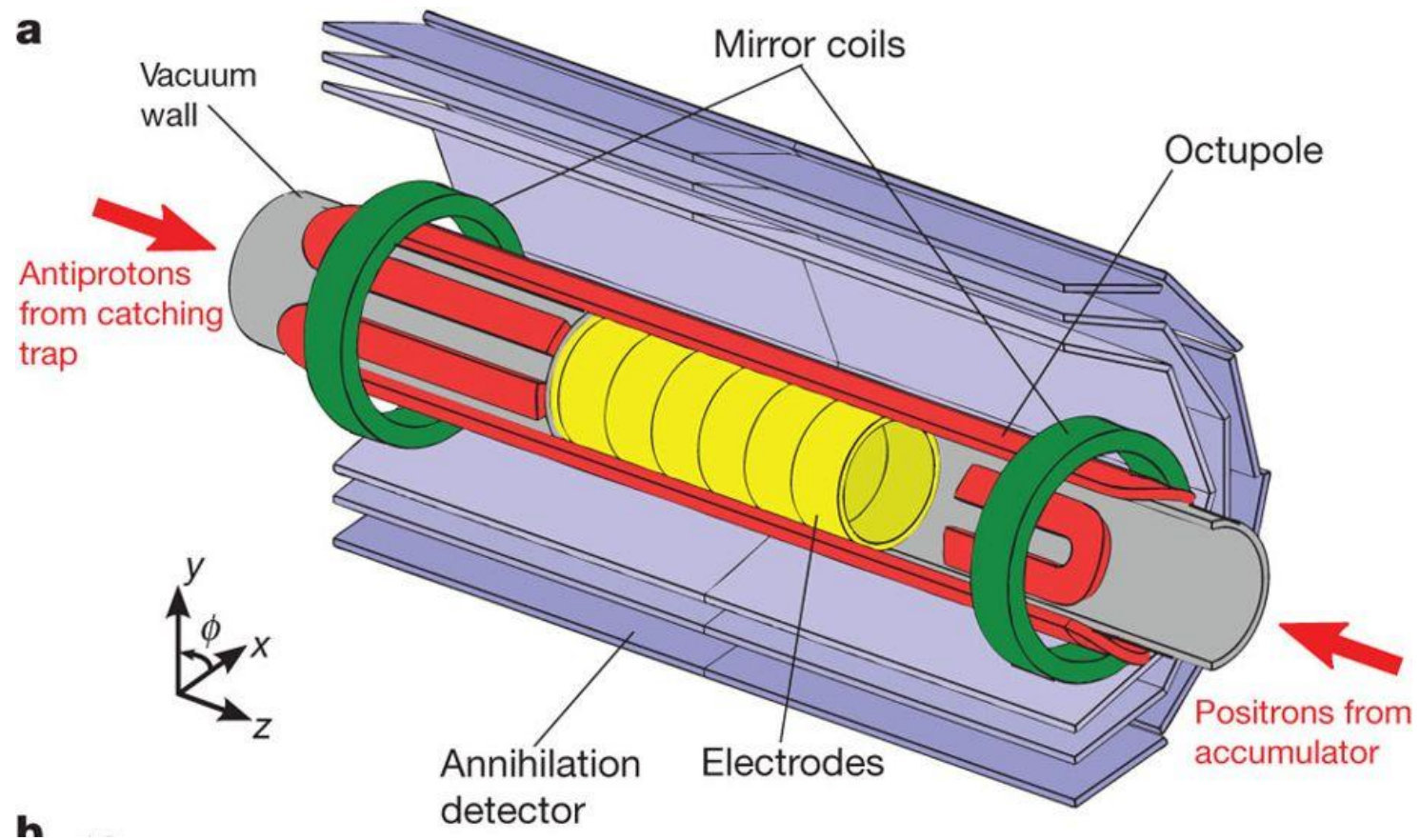
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ALPHA



$$10^7 \bar{p} + 7 \times 10^8 \bar{e} \rightarrow 38 \bar{H}$$

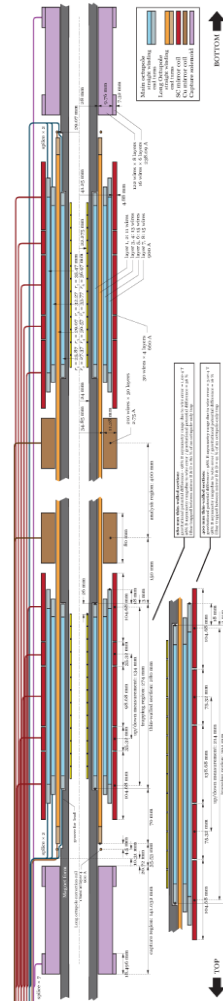
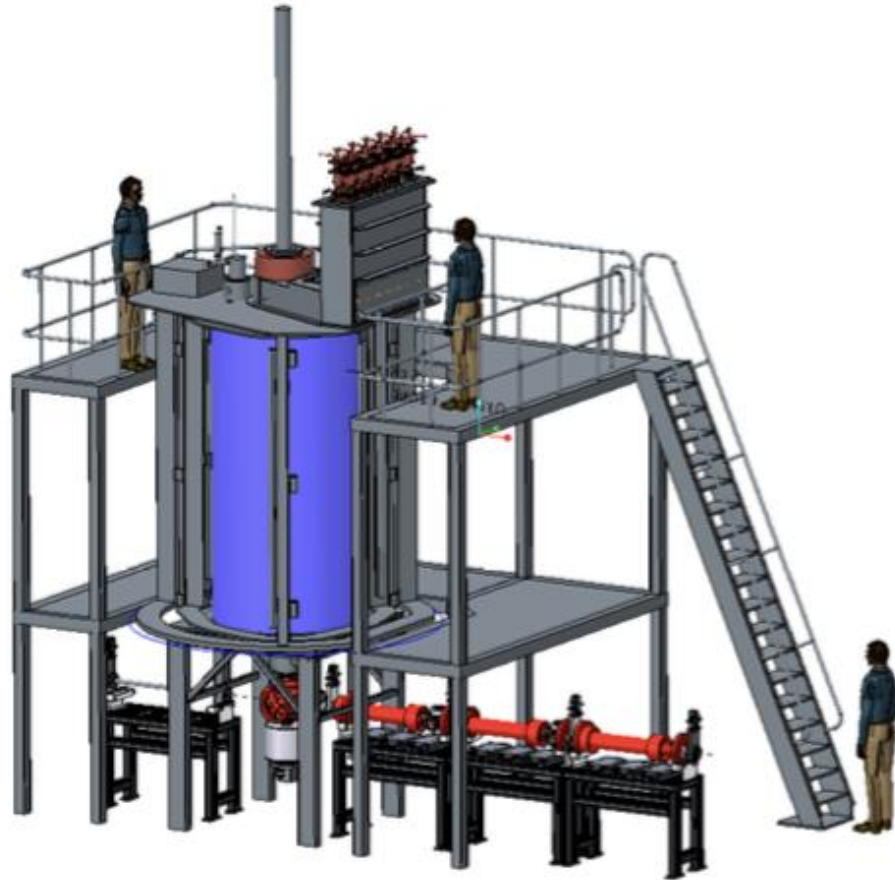
ALPHA

- First measurement is done by ALPHA

In the absence of systematic errors, we can reject ratios of the gravitational to inertial mass of antihydrogen >75 at a statistical significance level of 5%; worst-case systematic errors increase the minimum rejection ratio to >110

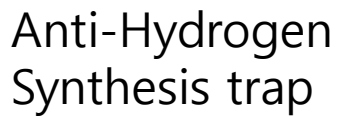
- ...But only 'proof-of-concept'

ALPHA-g



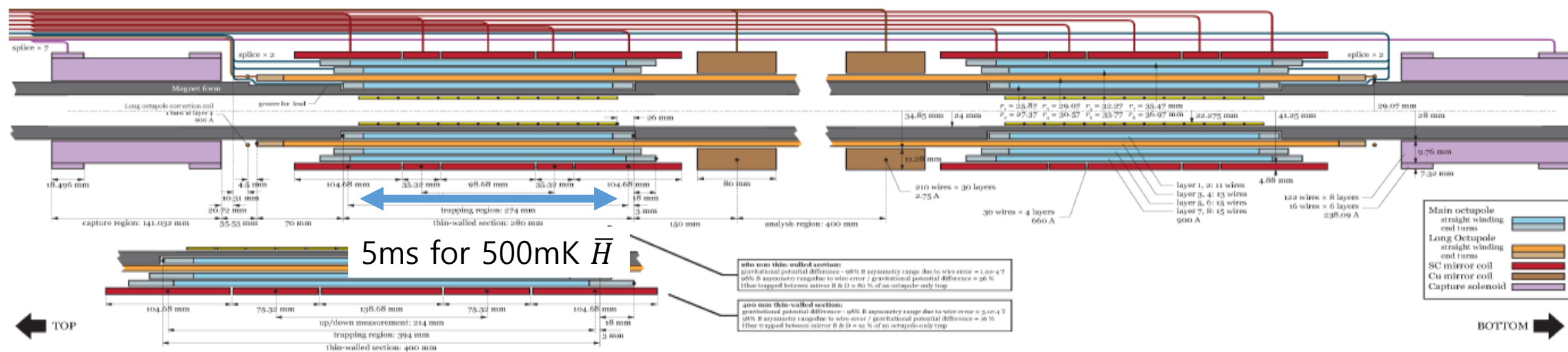
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ALPHA-g



Analysis zone

Anti-Hydrogen Trapping trap



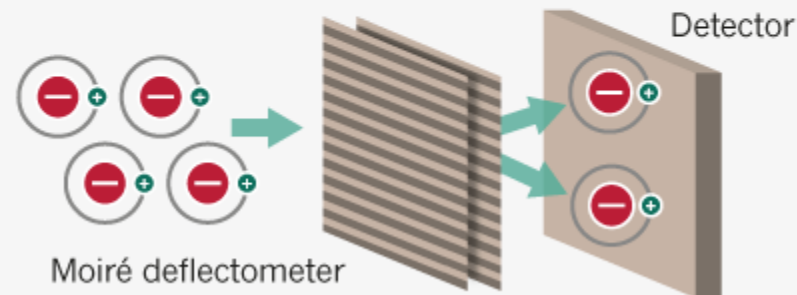
$A\bar{E}\bar{g}is$ (Antimatter Experiment: Gravity, Interferometry, Spectroscopy)

AEGIS

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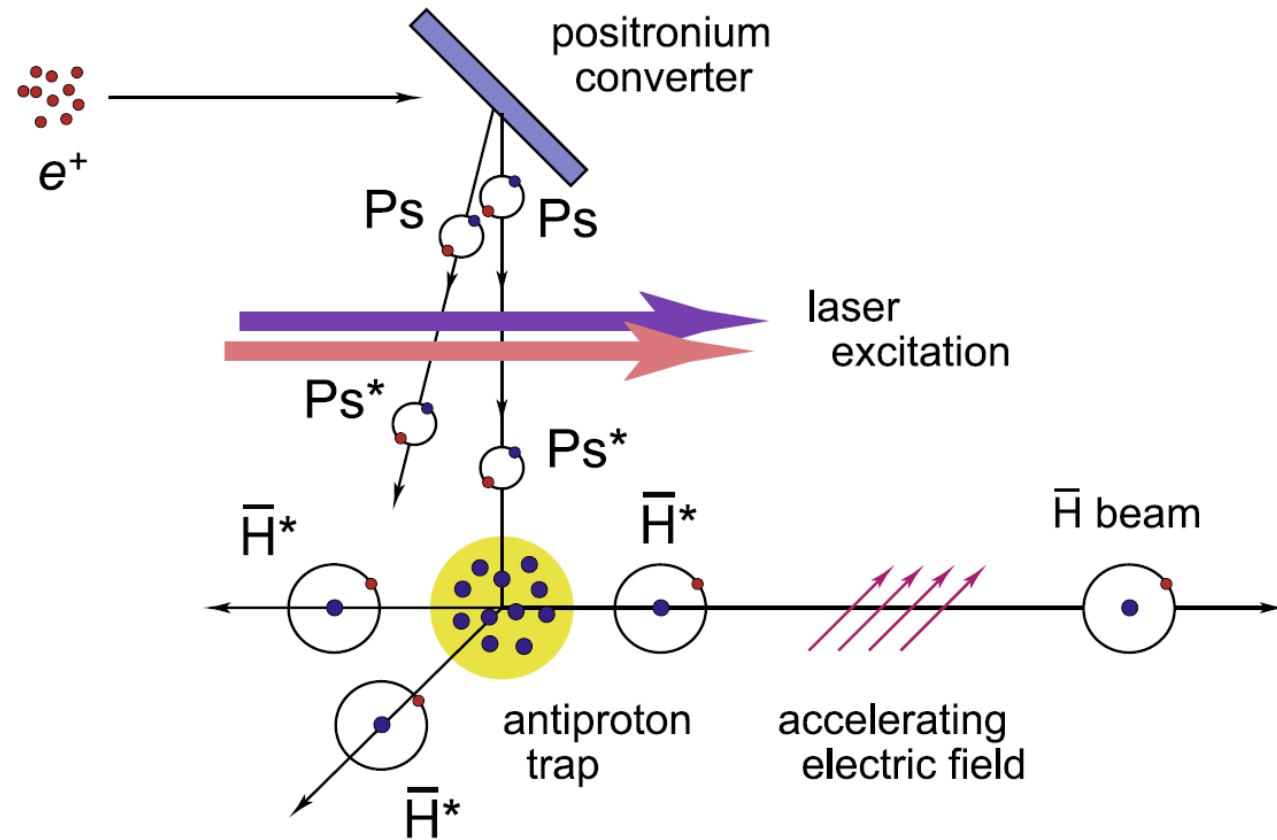
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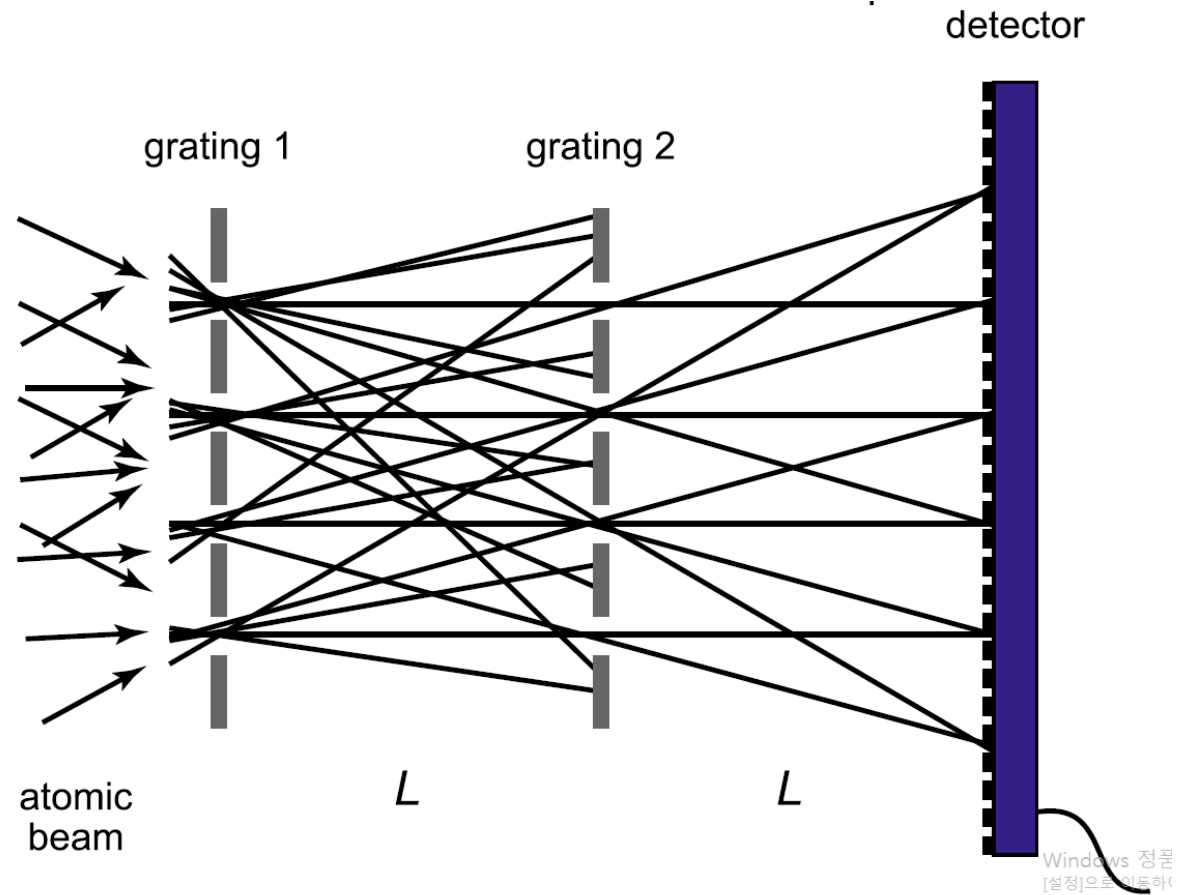


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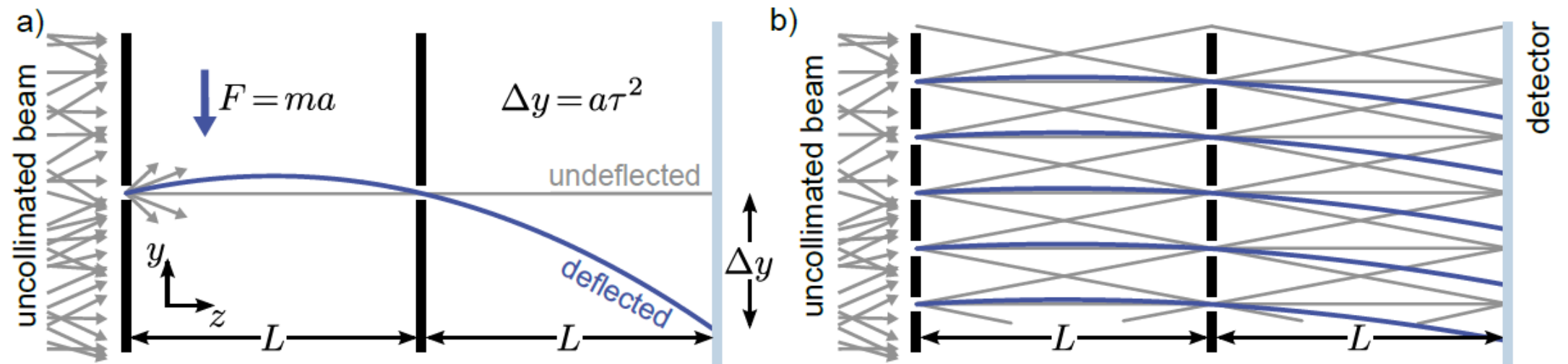
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$A\bar{E}\bar{g}$ is



$AE\bar{g}$ is



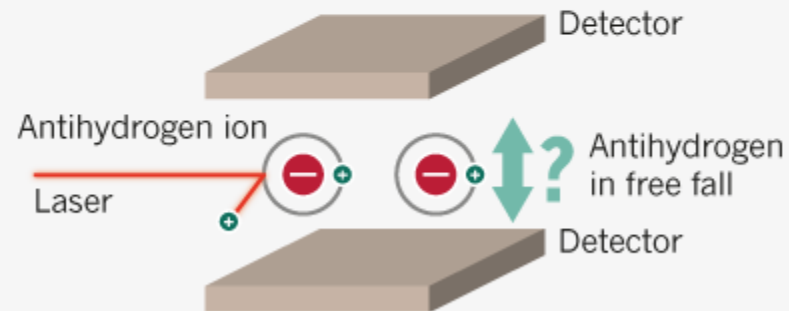
Gbar (Gravitational Behaviour of Antihydrogen at Rest)

GBAR

Starting: 2017

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Gbar (Gravitational Behaviour of Antihydrogen at Rest)

$$\bar{p} + \text{Ps}^* \rightarrow \bar{\text{H}}^* + e^- \quad (Hbar)$$

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Gbar (Gravitational Behaviour of Antihydrogen at Rest)

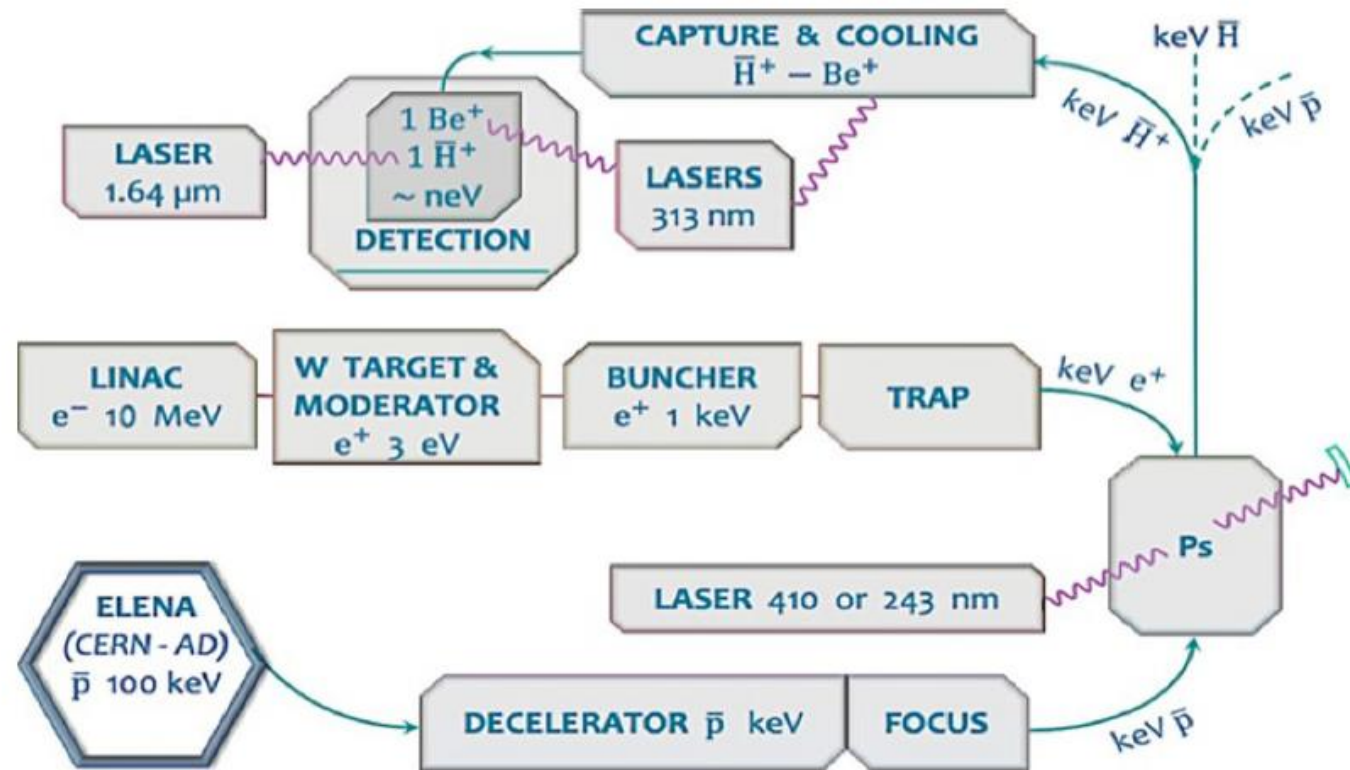


Fig. 2 Overall scheme of the GBAR experiment

Gbar (Gravitational Behaviour of Antihydrogen at Rest)

