Gravitational interaction of $\overline{H}$

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

박관형

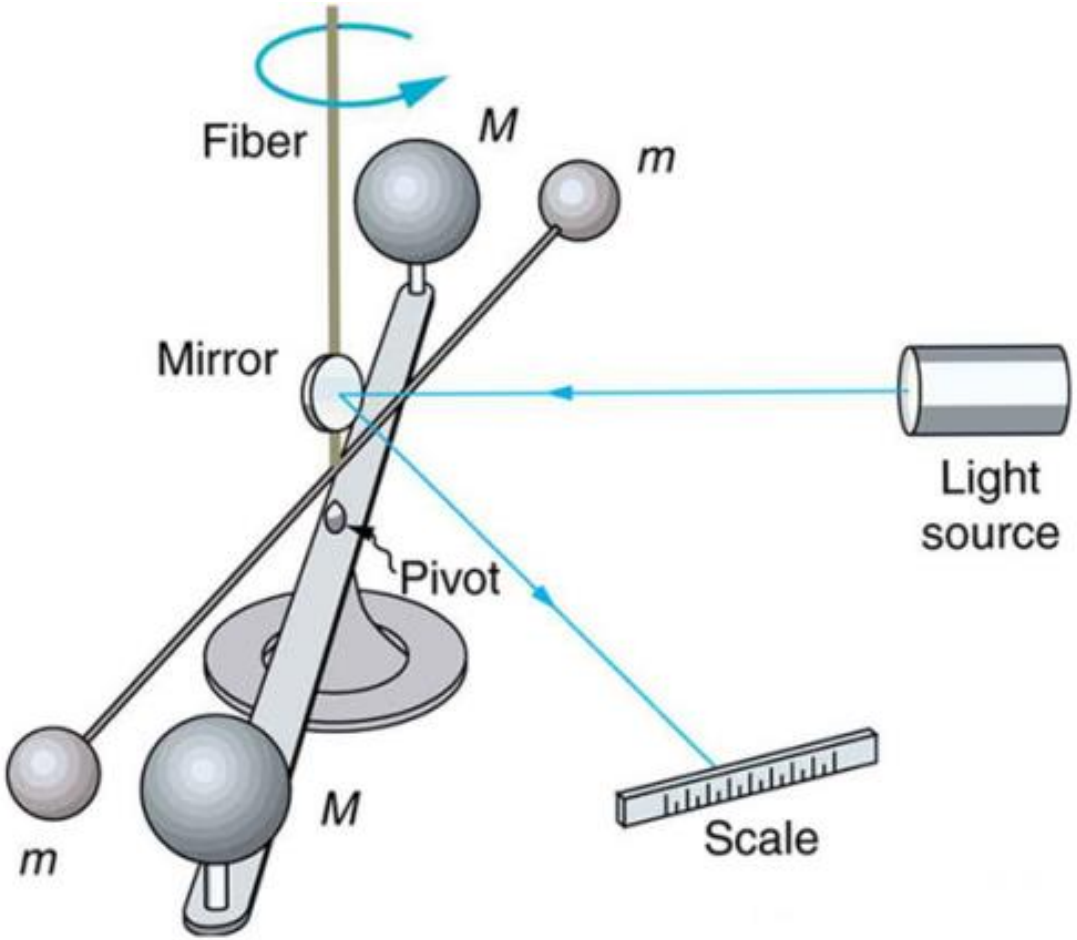
Motivation

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

$$m_i a = m_g g$$

- Many indirect measurement was done

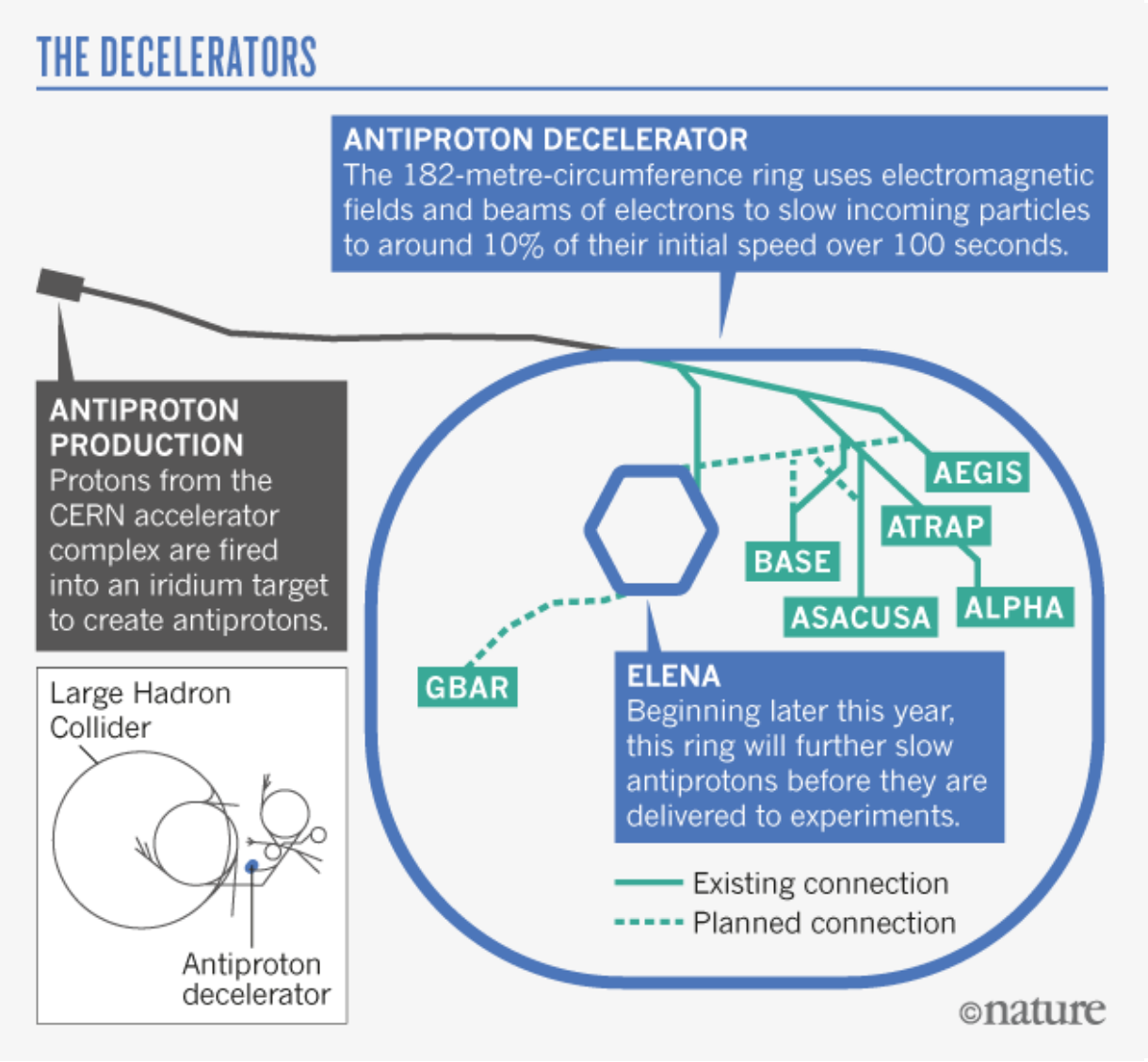
Gravity for matter

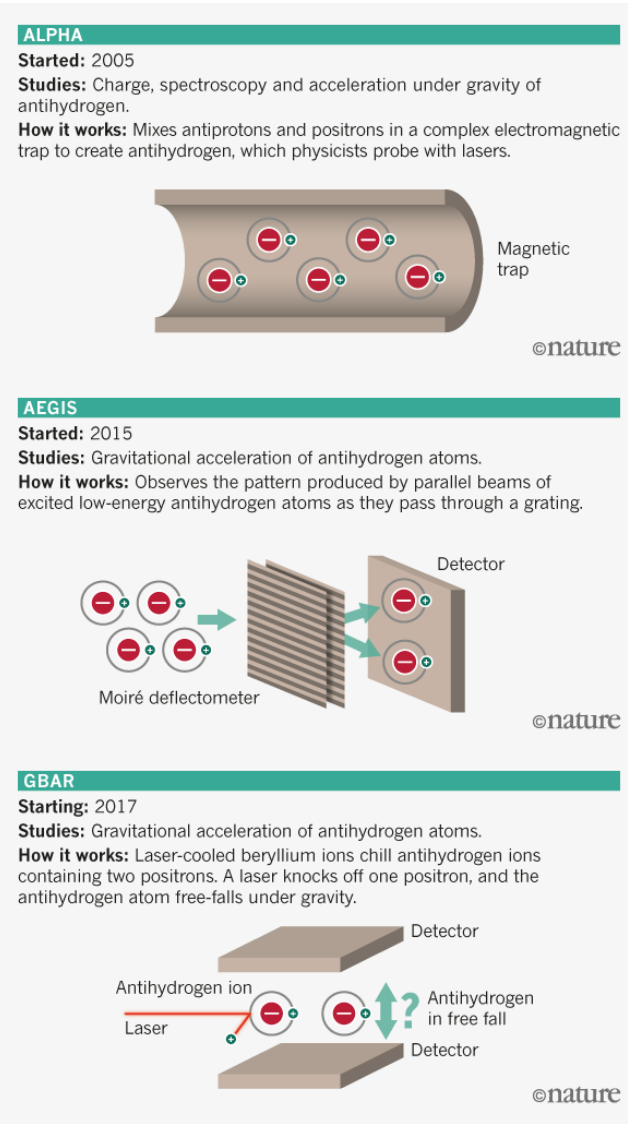


Difficulties

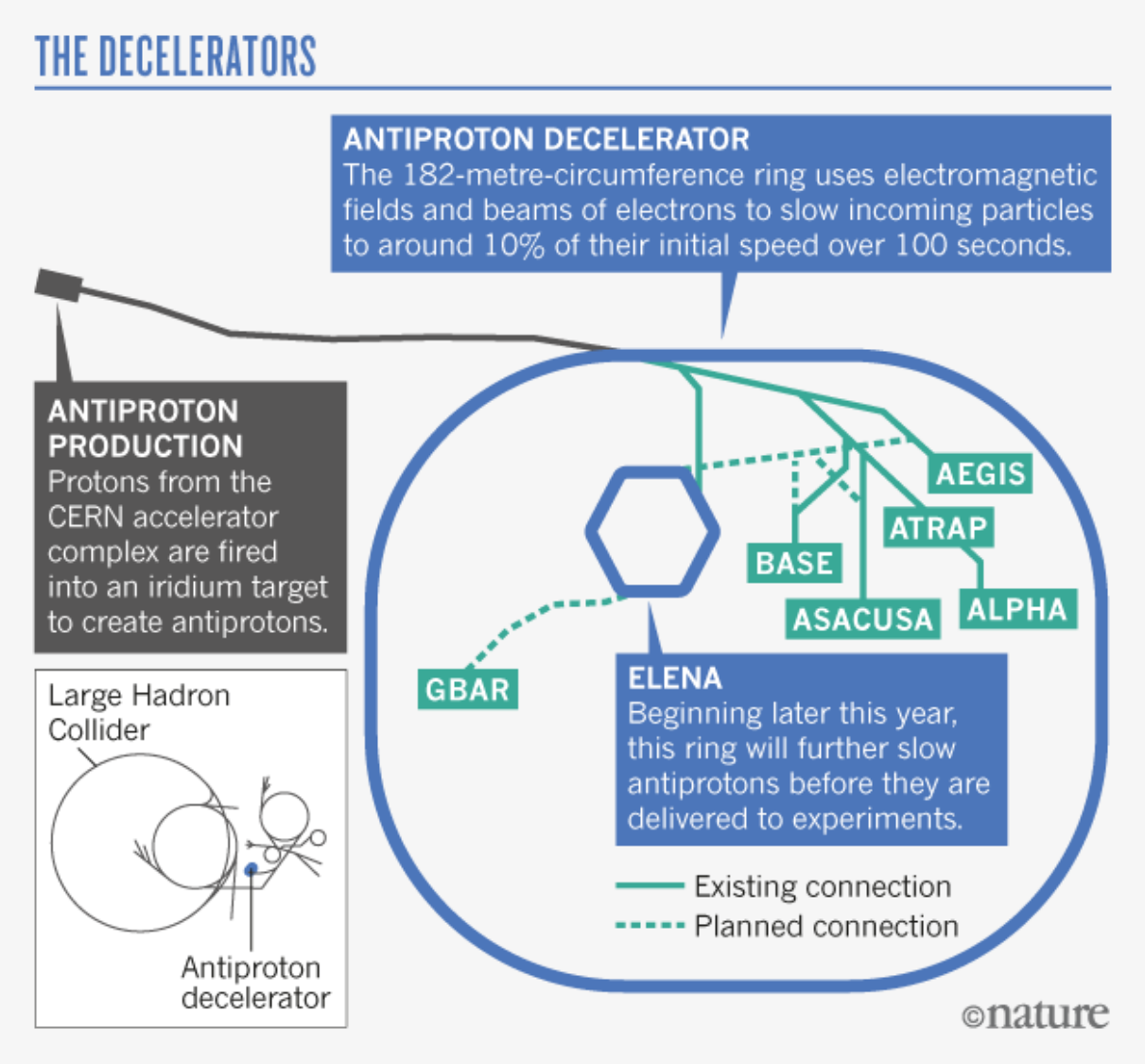
- Problem of antimatter
  - Hard to make
  - Hard to store
- Problem of Gravity
  - So weak

Competition among colabs





Competition among colabs



We kindly ask that you treat this addendum confidentially (within the committee) if possible.

-From ALPHA-g proposal

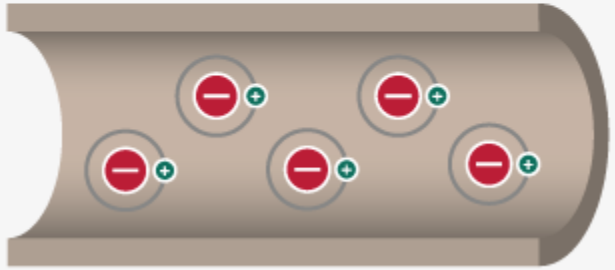
ALPHA

ALPHA

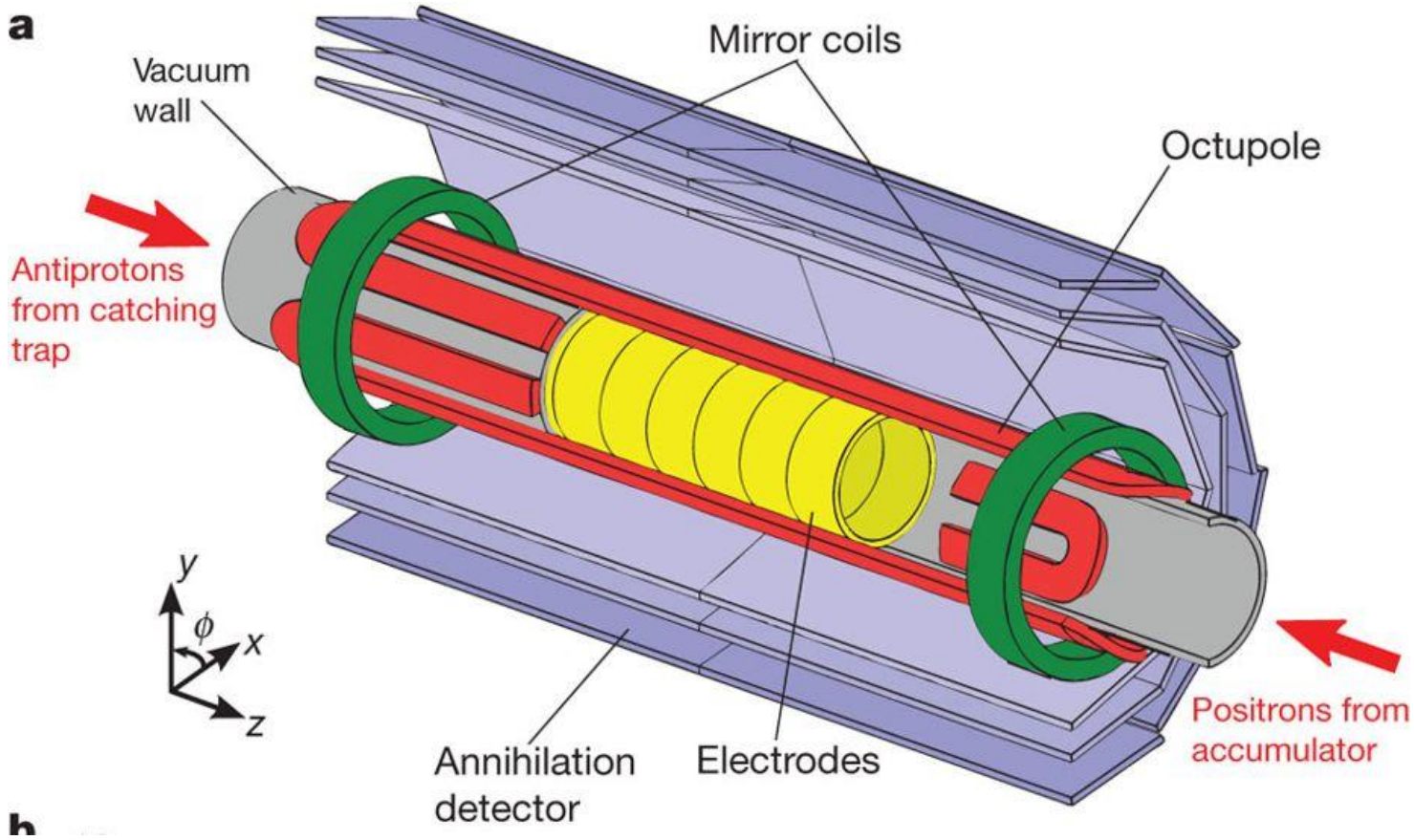
Started: 2005

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.



ALPHA



$$10^7\bar{p} + 7X10^8\bar{e} \rightarrow 38\bar{H}$$

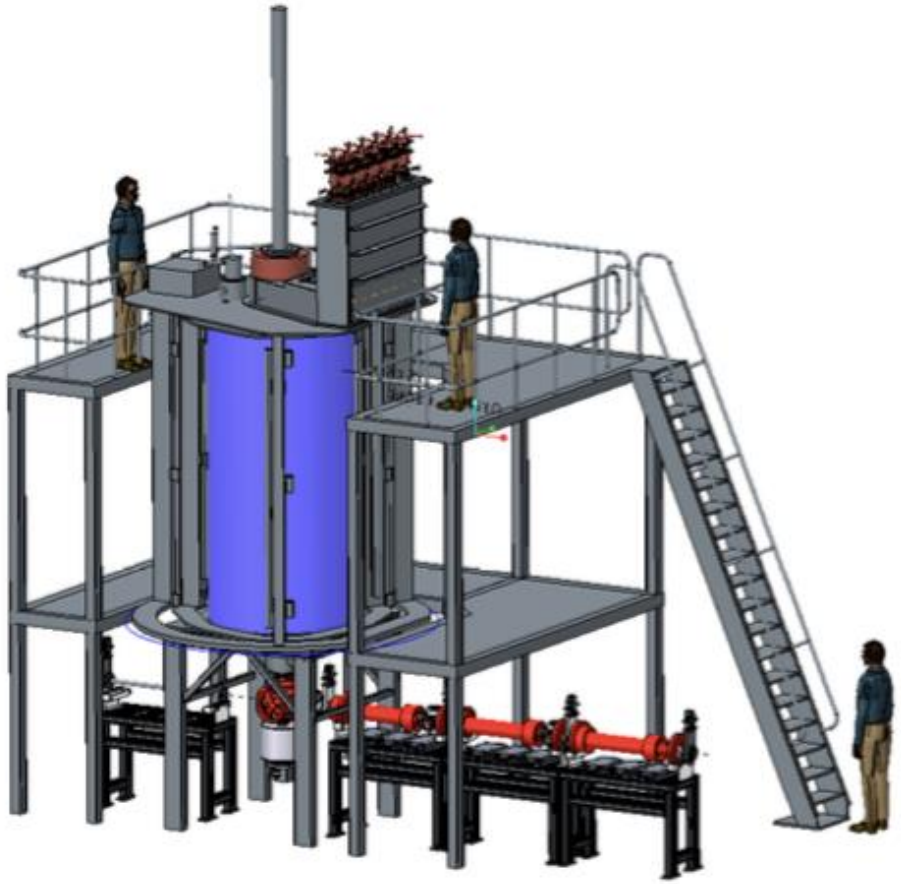
ALPHA

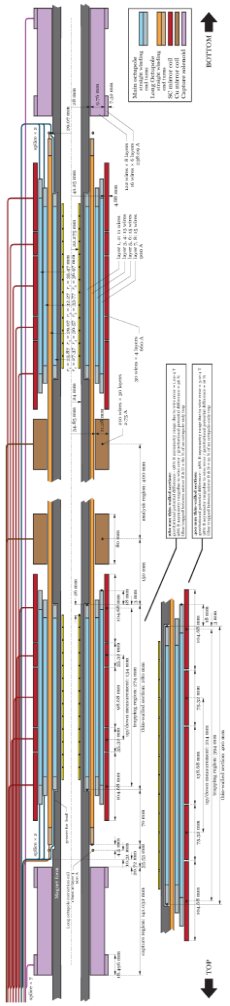
- First measurement is done by ALPHA

> 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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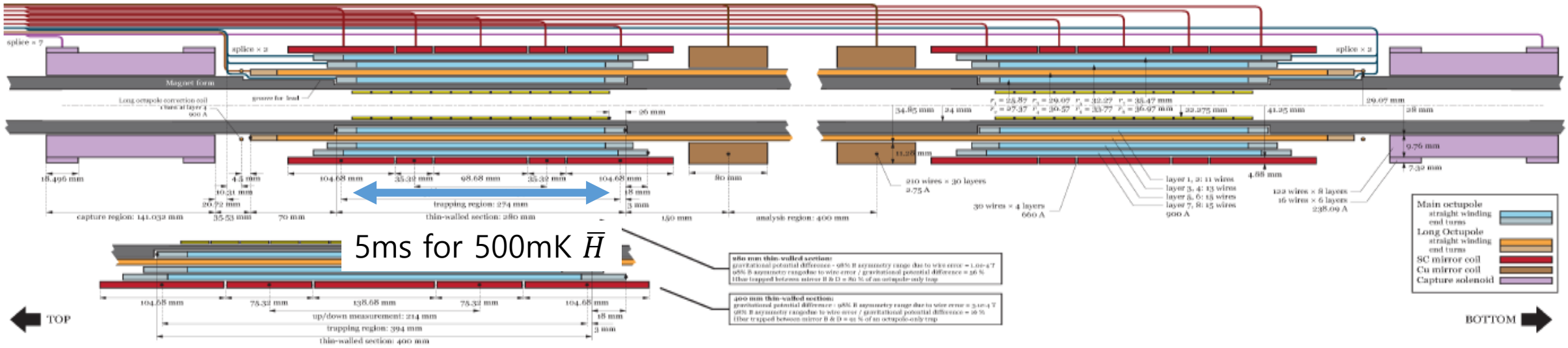
ALPHA-g

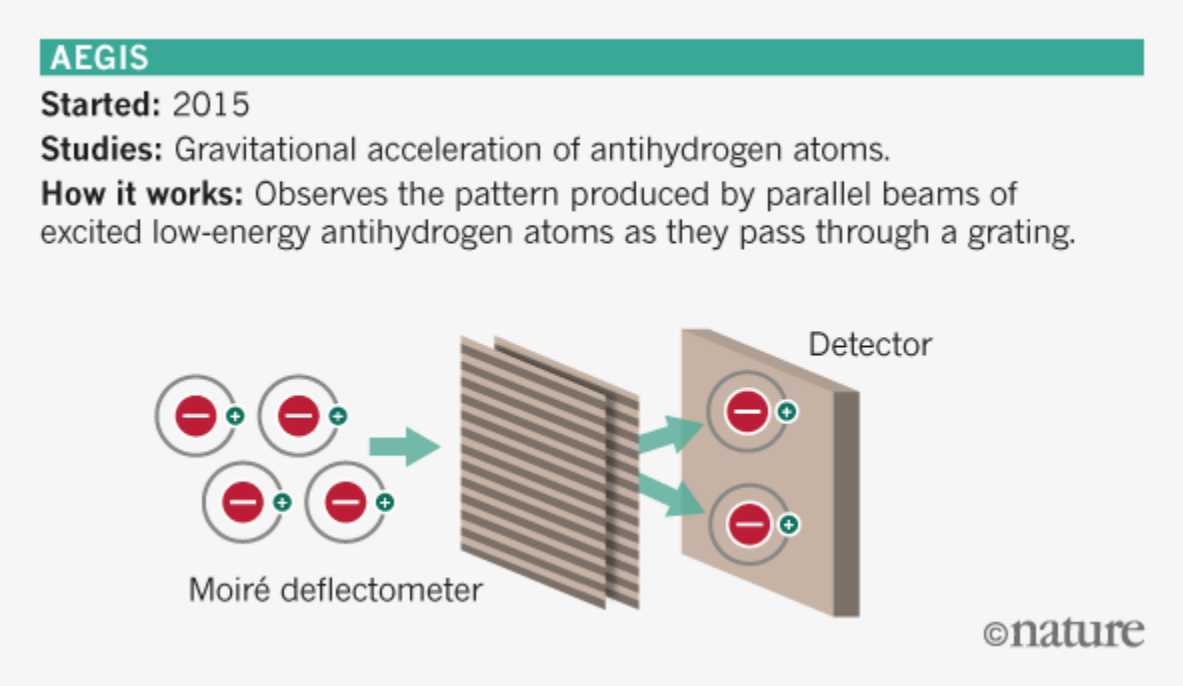
Anti-Hydrogen Synthesis trap

Analsis zone

Anti-Hydrogen Trapping trap



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



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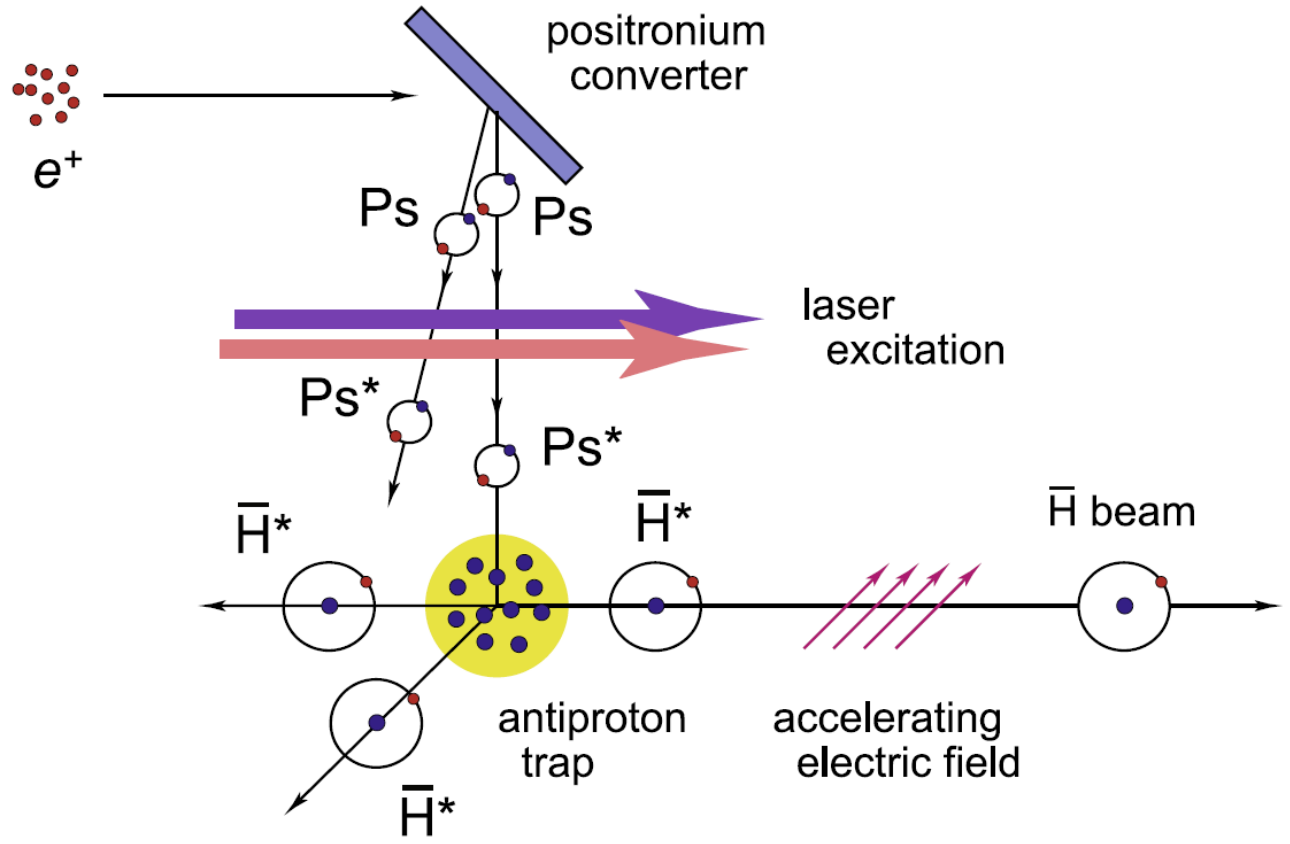
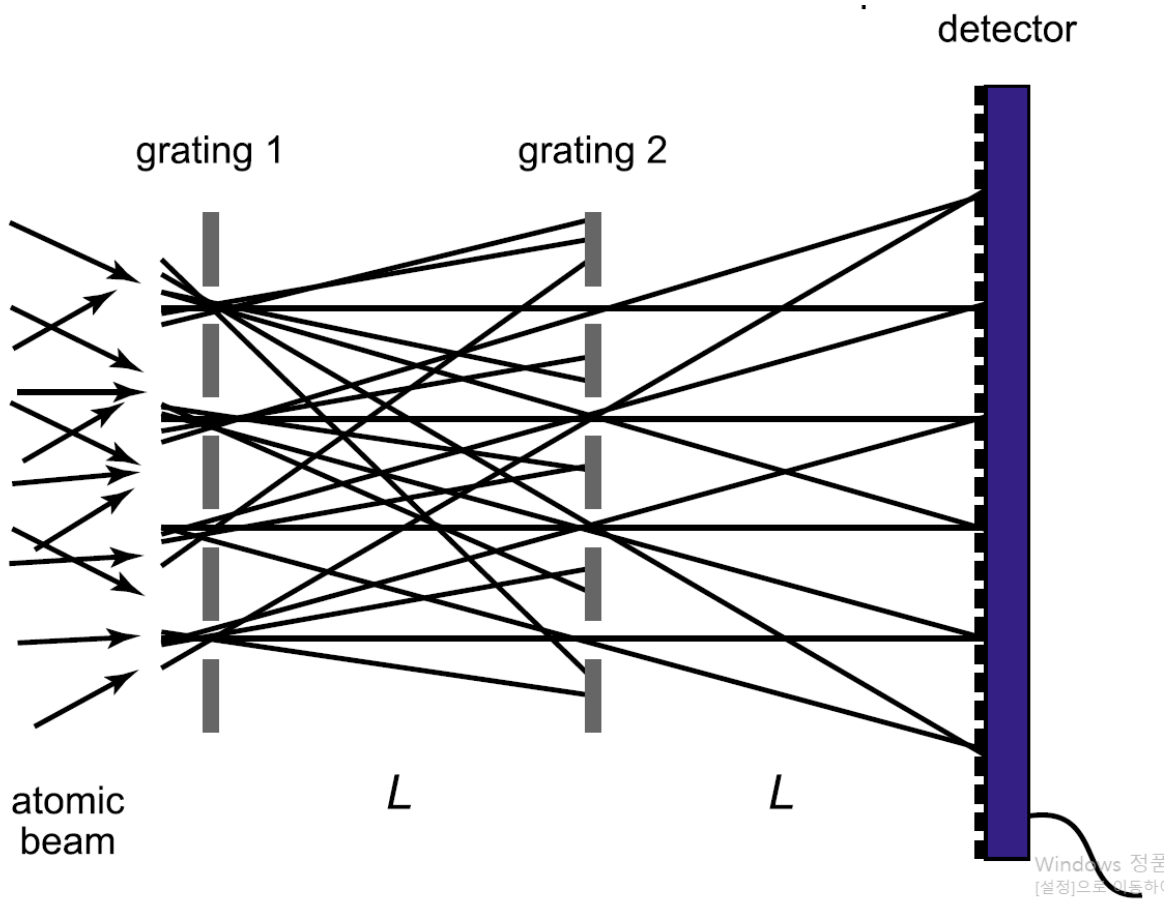
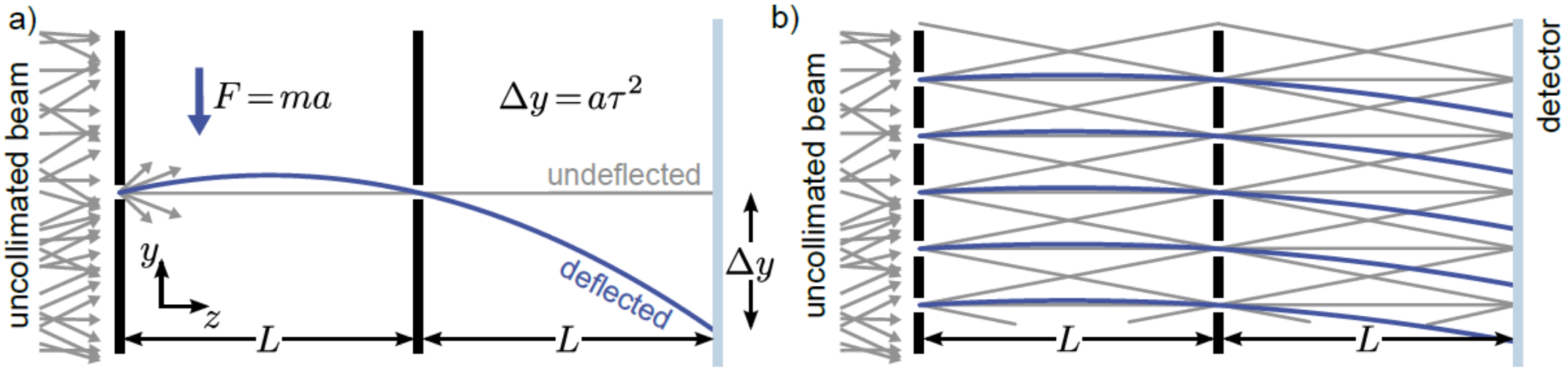


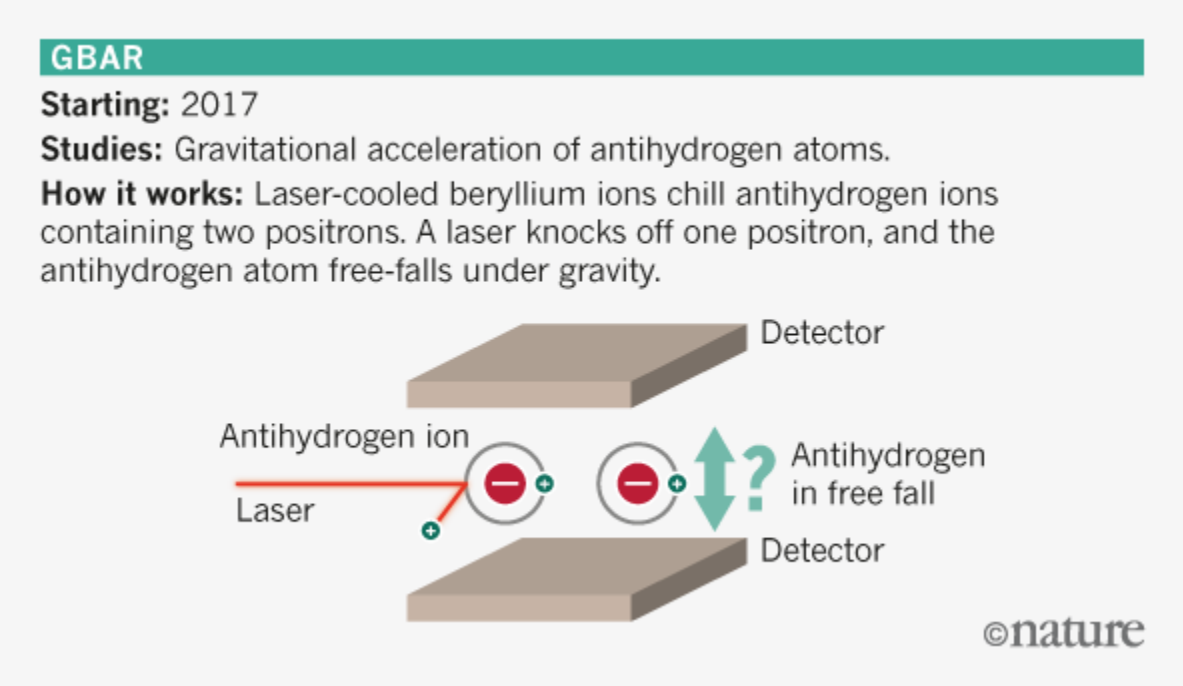
AE$\bar{g}$is



AE$\bar{g}$is


a)
uncollimated beam
$F = ma$
$\Delta y = a\tau^2$
undeflected
deflected
Δy
y
z
L
L
b)
uncollimated beam
detector
L
L

Gbar (Gravitational Behaviour of Antihydrogen at Rest)



Gbar (Gravitational Behaviour of Antihydrogen at Rest)

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

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

Gbar (Gravitational Behaviour of Antihydrogen at Rest)

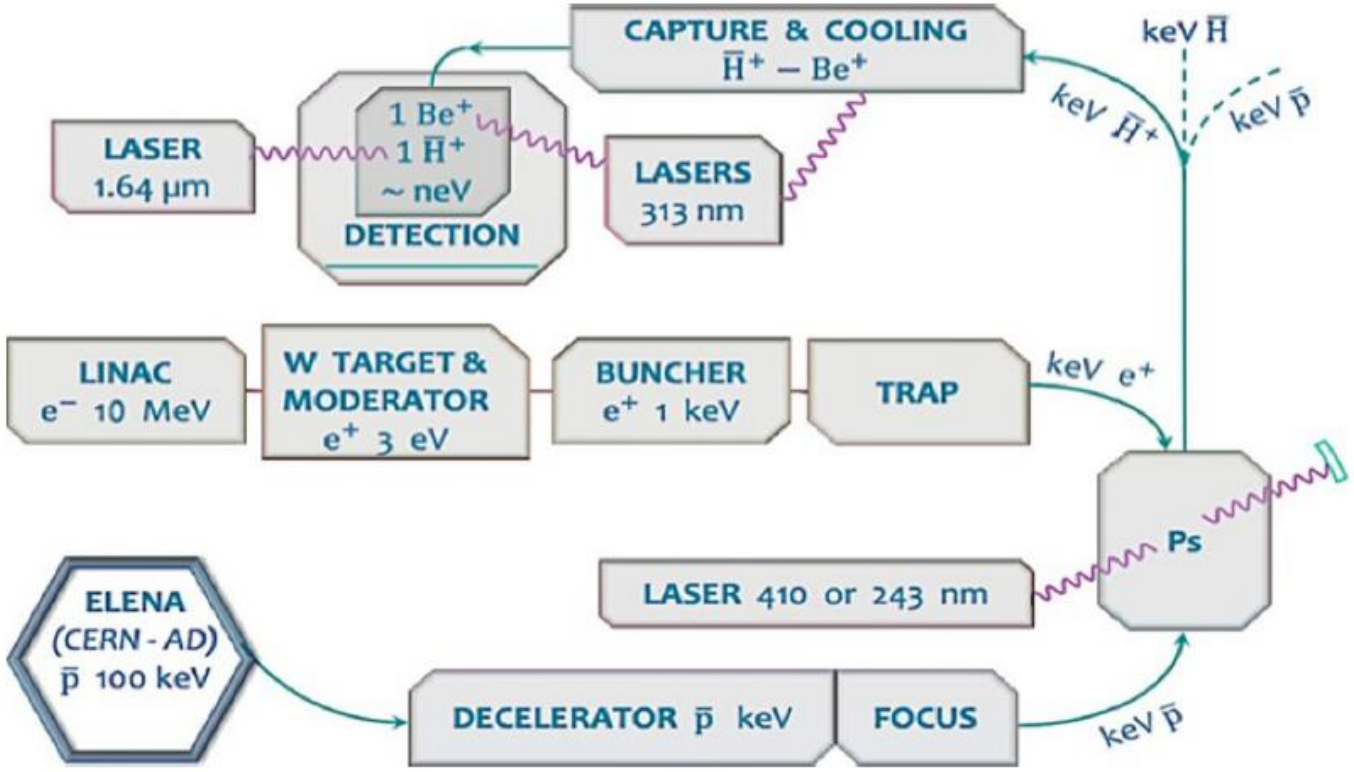


Fig. 2 Overall scheme of the GBAR experiment

Gbar (Gravitational Behaviour of Antihydrogen at Rest)