



Trip to CERN - Antimatter Factory

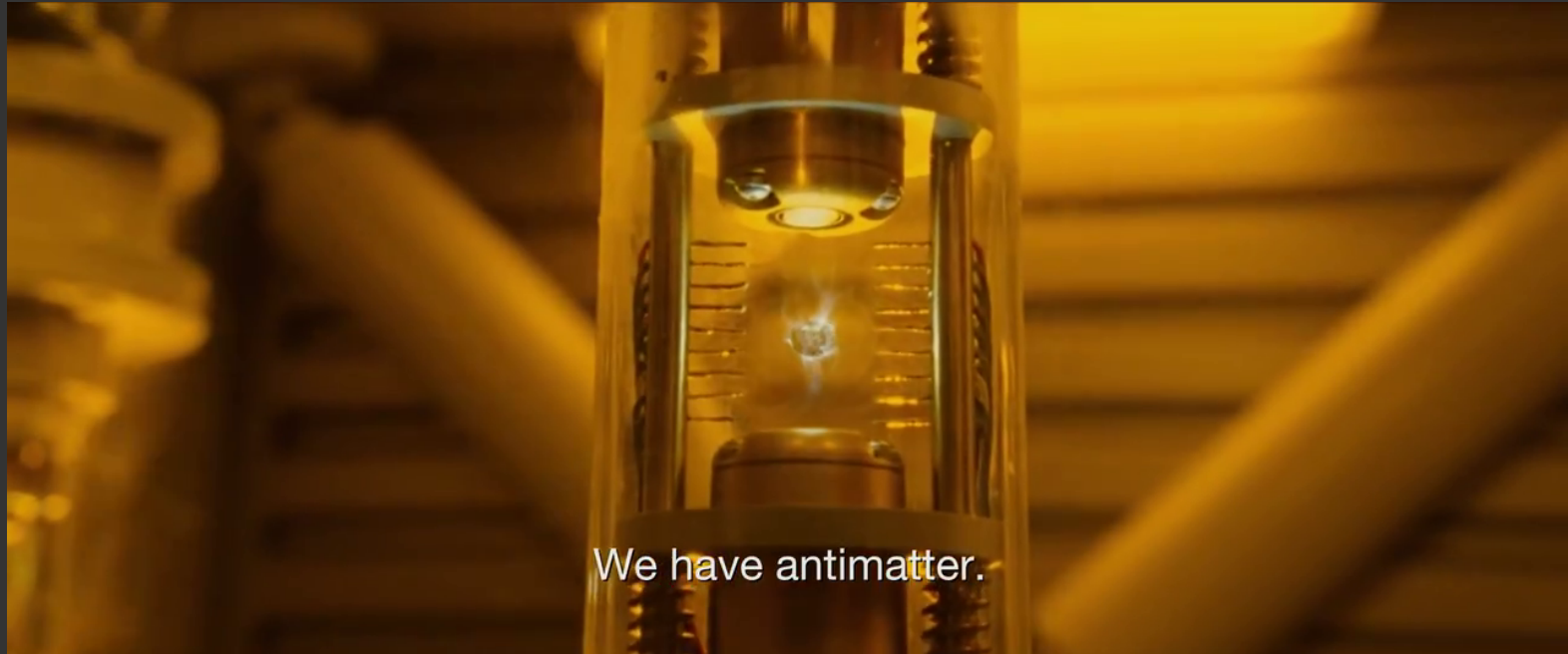
Depasse Antoine
25 Février 2025

 UCLouvain



 IRMP

What is antimatter?



What is antimatter?

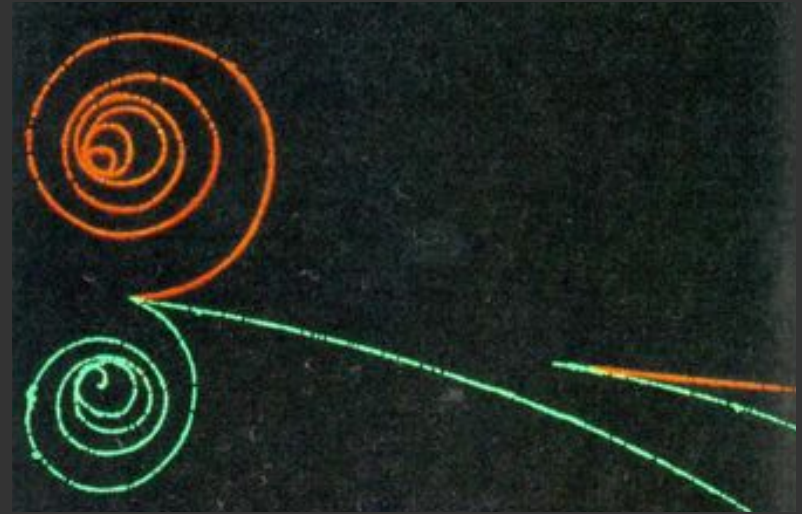
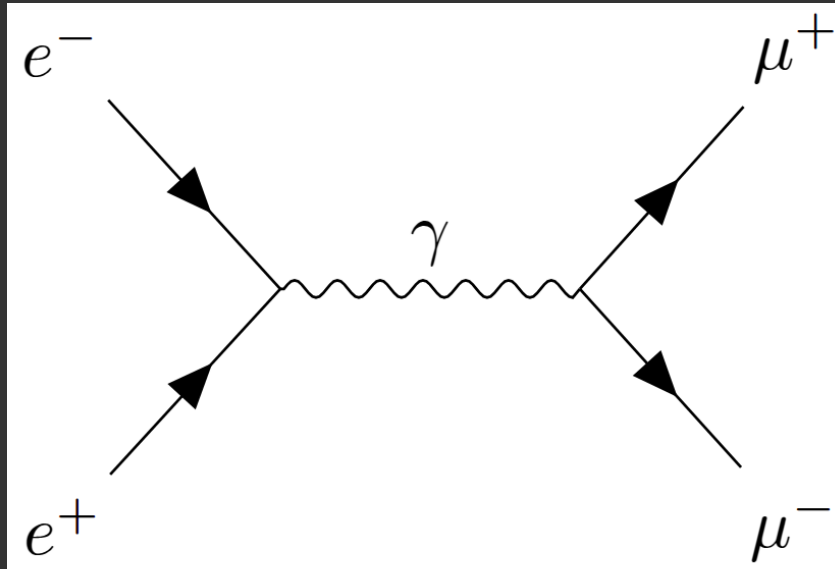
mass →	$\approx 2.3 \text{ MeV}/c^2$	$\approx 1.275 \text{ GeV}/c^2$	$\approx 173.07 \text{ GeV}/c^2$	0	$\approx 126 \text{ GeV}/c^2$
charge →	2/3	2/3	2/3	0	0
spin →	1/2	1/2	1/2	1	0
	u up	c charm	t top	g gluon	H Higgs boson
QUARKS	d down	s strange	b bottom	γ photon	
	$\approx 4.8 \text{ MeV}/c^2$	$\approx 95 \text{ MeV}/c^2$	$\approx 4.18 \text{ GeV}/c^2$	0	
	-1/3	-1/3	-1/3	0	
	1/2	1/2	1/2	1	
	e electron	μ muon	τ tau	Z Z boson	
LEPTONS	$0.511 \text{ MeV}/c^2$	$105.7 \text{ MeV}/c^2$	$1.777 \text{ GeV}/c^2$	$91.2 \text{ GeV}/c^2$	
	-1	-1	-1	0	
	1/2	1/2	1/2	1	
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	W W boson	
	$< 2.2 \text{ eV}/c^2$	$< 0.17 \text{ MeV}/c^2$	$< 15.5 \text{ MeV}/c^2$	$80.4 \text{ GeV}/c^2$	
	0	0	0	± 1	
	1/2	1/2	1/2	1	
					GAUGE BOSONS



	Particle	Antiparticle
Electron		Positron (antielectron)
Proton		Antiproton
Neutrino		Antineutrino

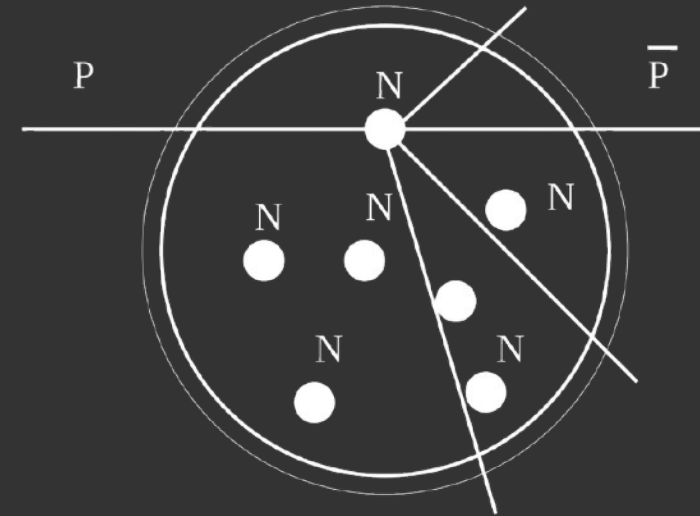
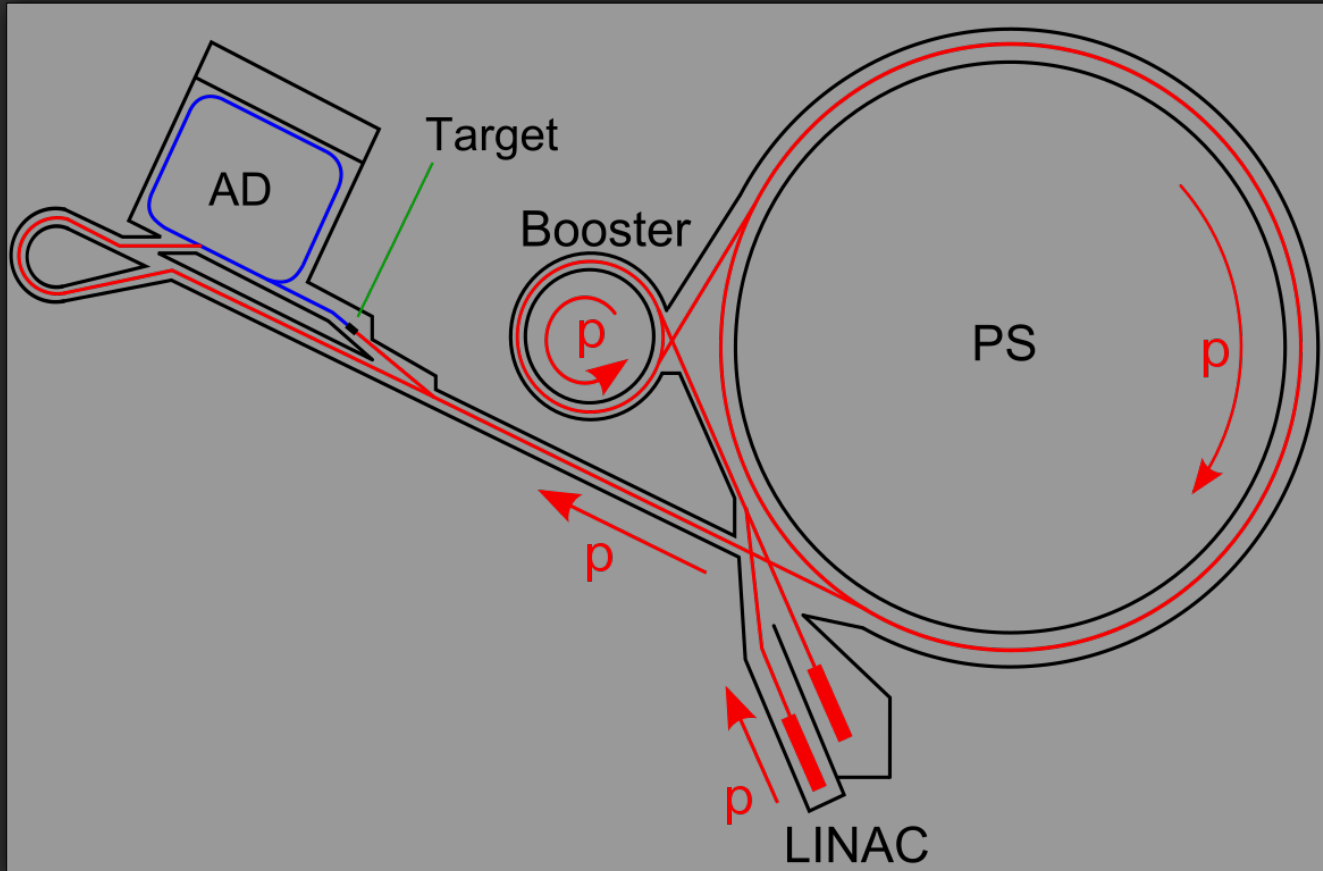
What is antimatter?

Allows *interesting* interactions (annihilation)



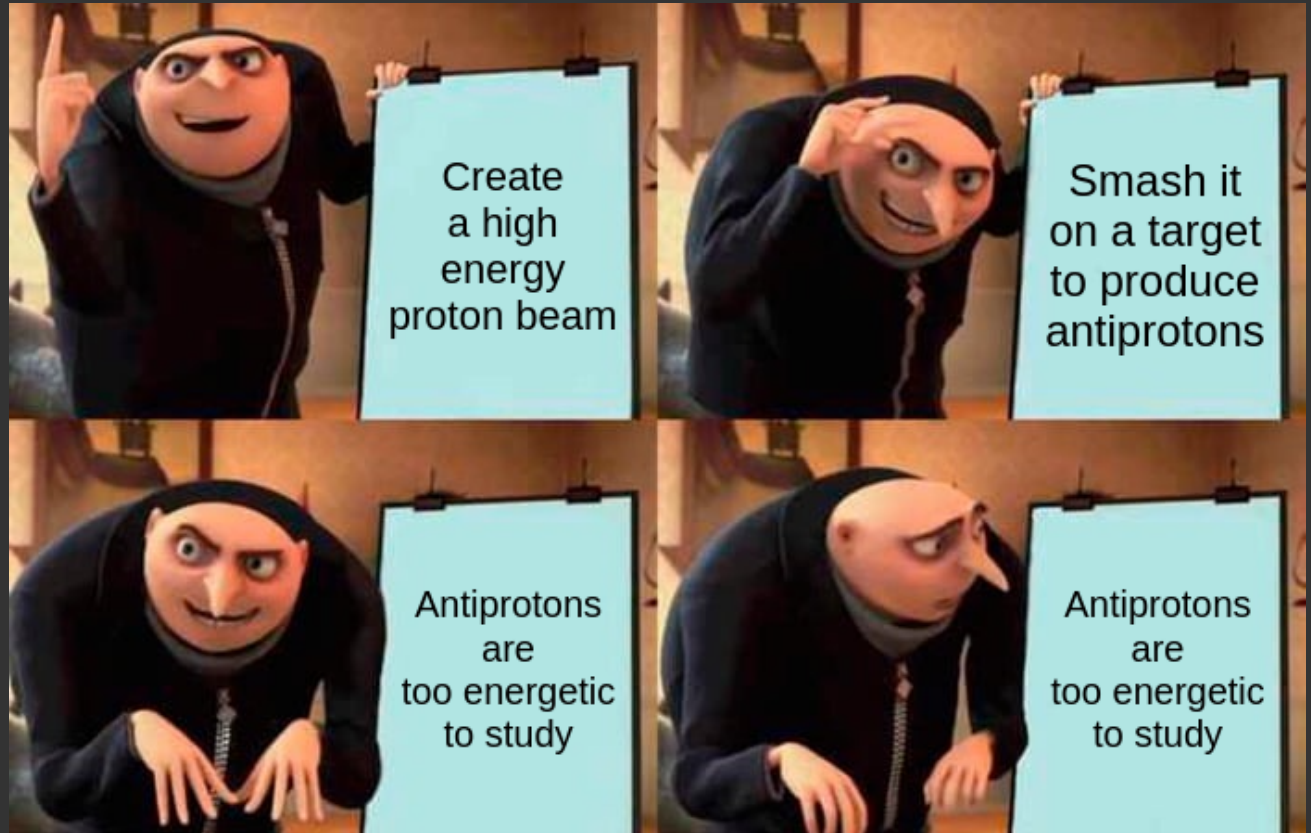
Conservation laws require that matter is created as pairs of particle and anti-particle

How to create Antimatter?

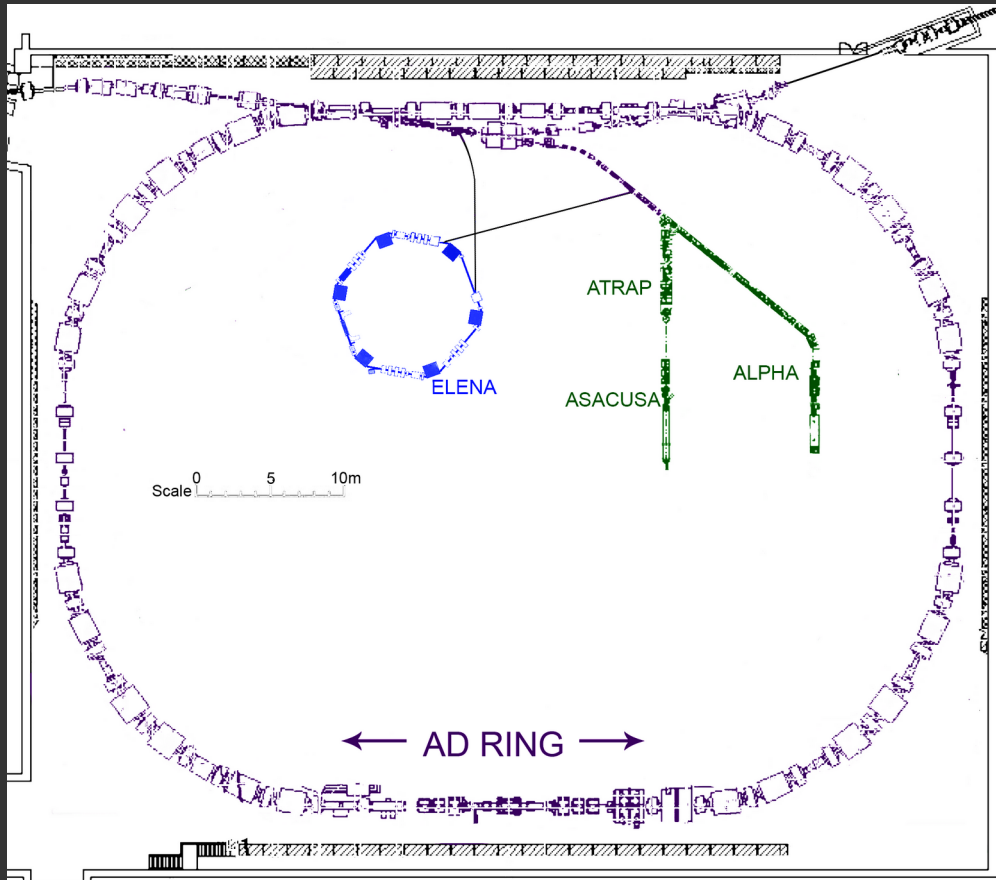


How to study Antimatter?

The incident
~26GeV/c beam
produces antiprotons
at 3.5GeV/c

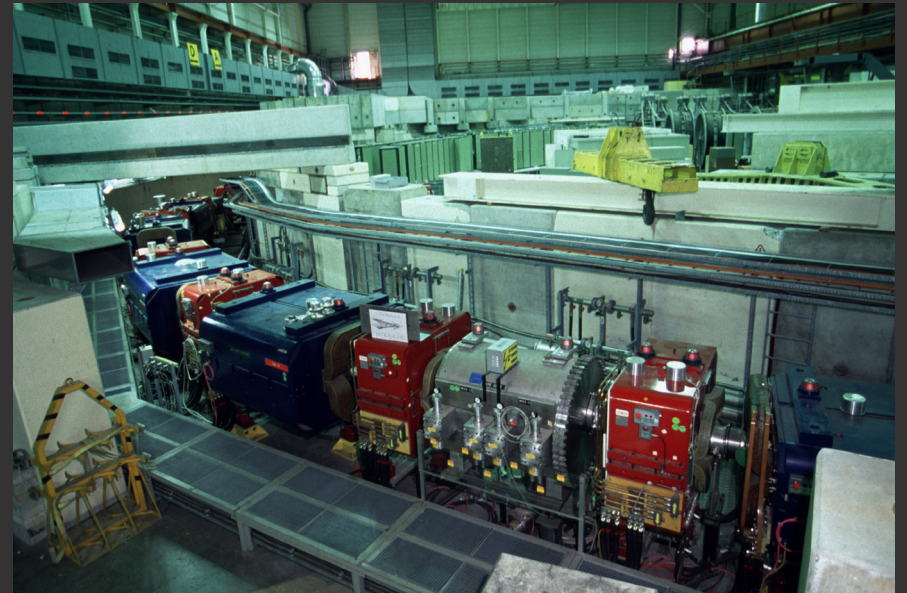


How to study Antimatter?

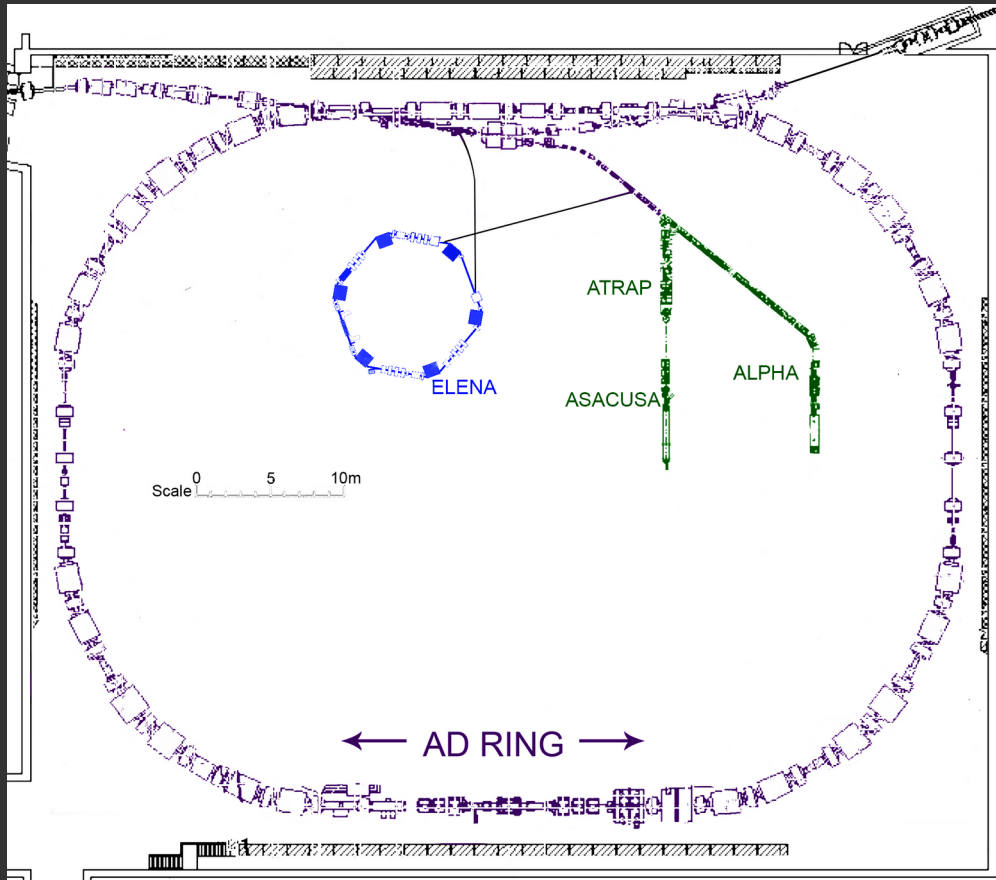


Antiproton Decelerator (AD)

Decelerate antiprotons
down to 5.3MeV

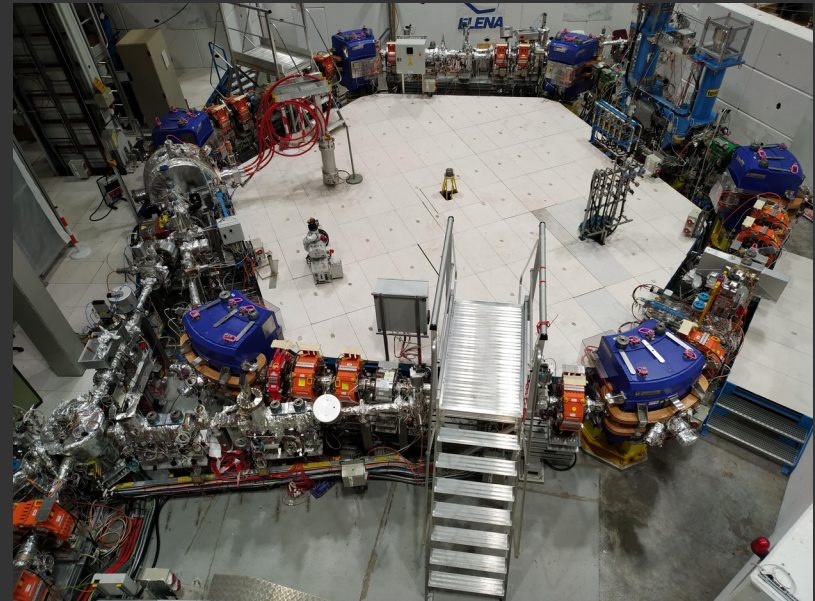


How to study Antimatter?



Extra Low Energy Antiprotons (ELENA)

Decelerate antiprotons
down to 100keV



Experiments in the Antimatter Factory



Production of a beam of antihydrogen

Analyses the drop of the beam across its flight to test the effect of gravity on antimatter



Precise measurement of charge-to-mass ratio and magnetic moment of the antiproton

Experiments in the Antimatter Factory



Measures antihydrogen hyperfine structure constant

Creation of hybrid Helium, replacing an electron with an antiproton
→ Allows for precise measurement of the antiproton mass



Production of anti-hydrogen atoms and drops them...

... Testing the equivalence principle.

Experiments in the Antimatter Factory

Synthesis and trapping of Antihydrogen



Measures the trajectories of antihydrogen as it leaves the atom trap to measure \bar{g}

Studies transition between the ground state and first excited state