ELENA antiproton decelerator

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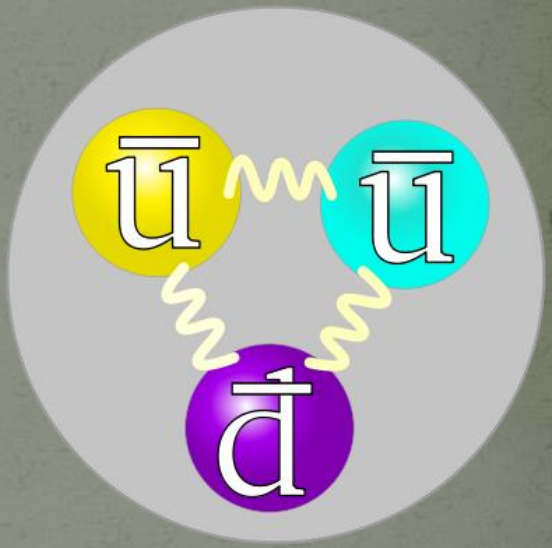
393
ANTIMATTER
FACTORY
ELENA
193
854

Antiproton

- Antiparticle of the proton
- Its properties match the corresponding ones of the proton
- Except: electric charge, magnetic moment are the opposite, and maybe still some *unknown differences*



Experiments

Why is deceleration needed?

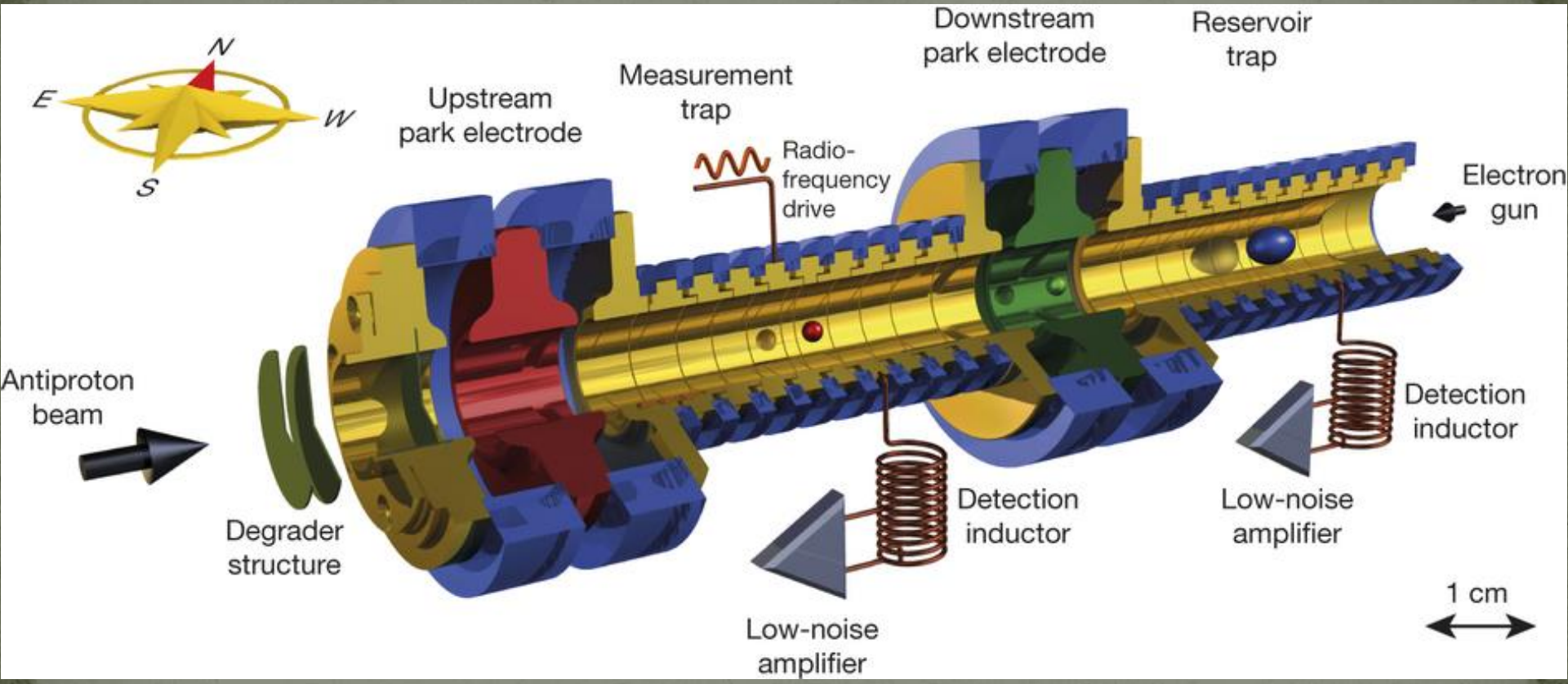
- Protons are accelerated and smashed into an iridium rod
- 1,5E13 protons coming from PS
- 4,5E7 antiprotons going to AD
- After the collision, it has a too much energy for experiments

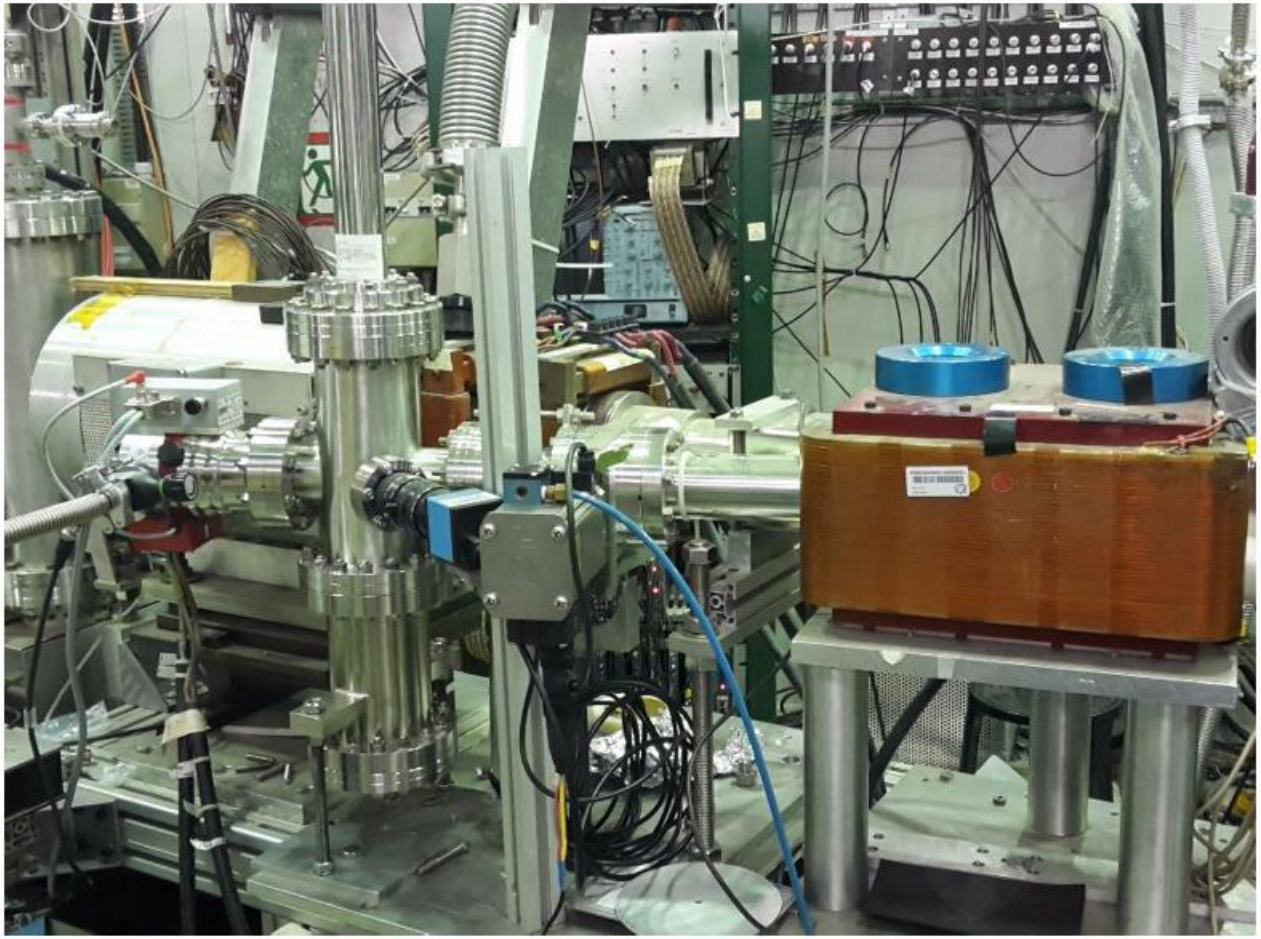
AD and ELENA

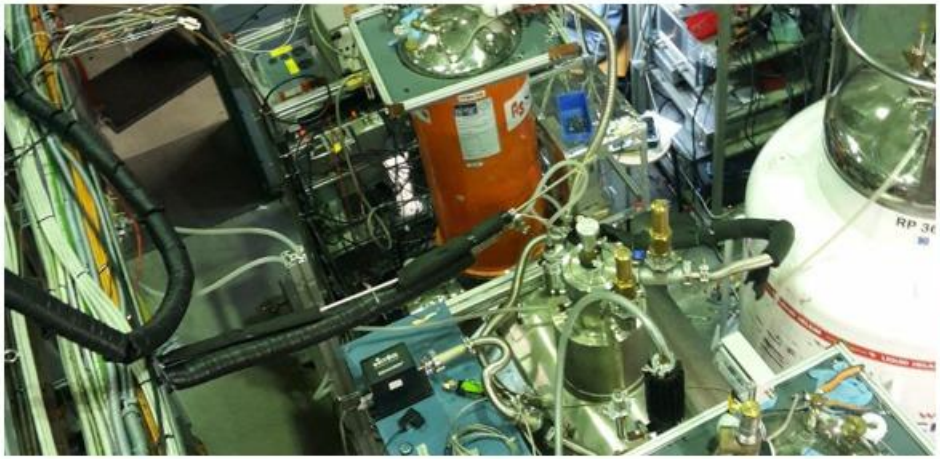
Experiments

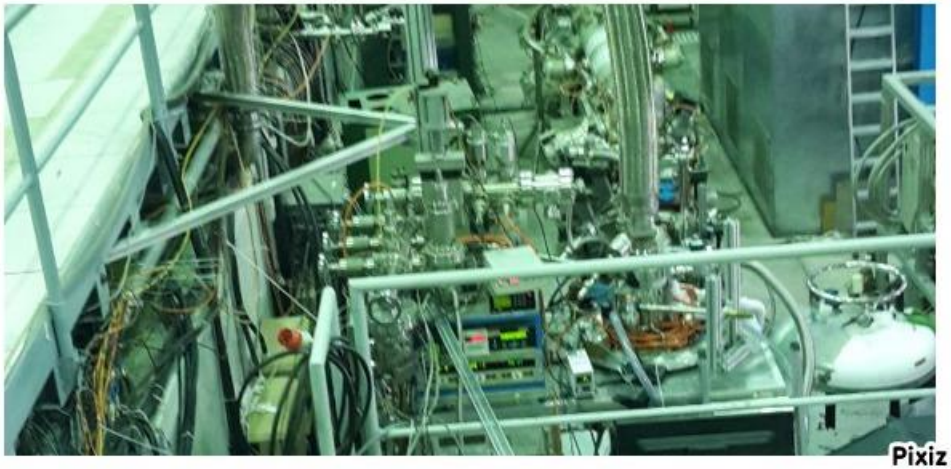
After slowing down, AD send antiprotons to different experiments, and in the future ELENA will do so:

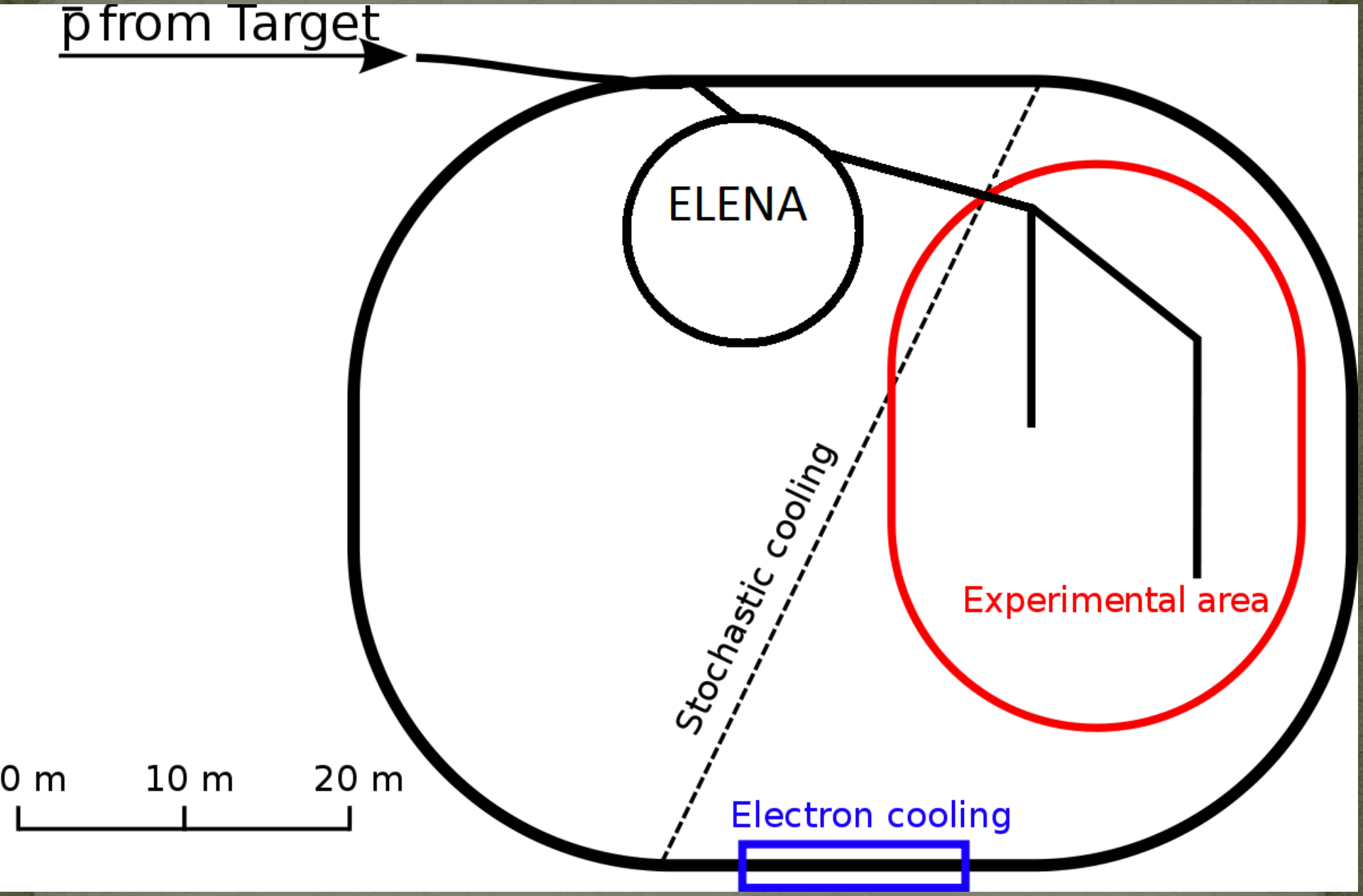
- ALPHA – antihydrogen spectroscopy
- ASACUSA – antiprotonic helium, antihydrogen spectroscopy
- ATRAP – magnetic moment of antiproton
- BASE – magnetic moment of antiproton
- AEGIS – the effects of gravity on antihydrogens (on the fly)
- GBAR – the effects of gravity on antihydrogens (very slow antihydrogen)


N
E
W
S
Upstream park electrode
Measurement trap
Radio-frequency drive
Downstream park electrode
Reservoir trap
Electron gun
Antiproton beam
Degrader structure
Detection inductor
Low-noise amplifier
Low-noise amplifier
Detection inductor
1 cm

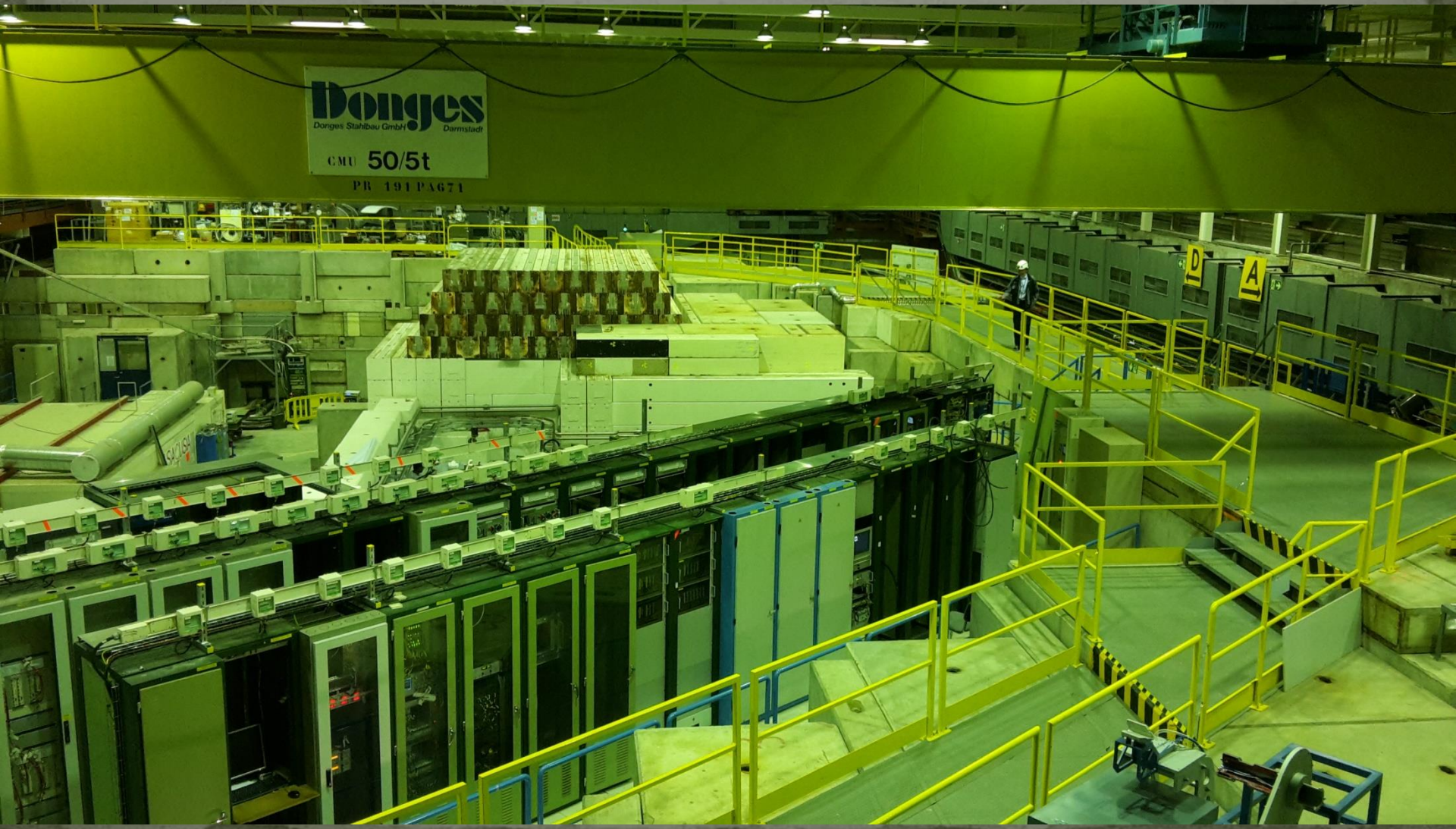







p̄ from Target
ELENA
Stochastic cooling
Experimental area
Electron cooling
0 m
10 m
20 m

AD (antiproton decelerator)



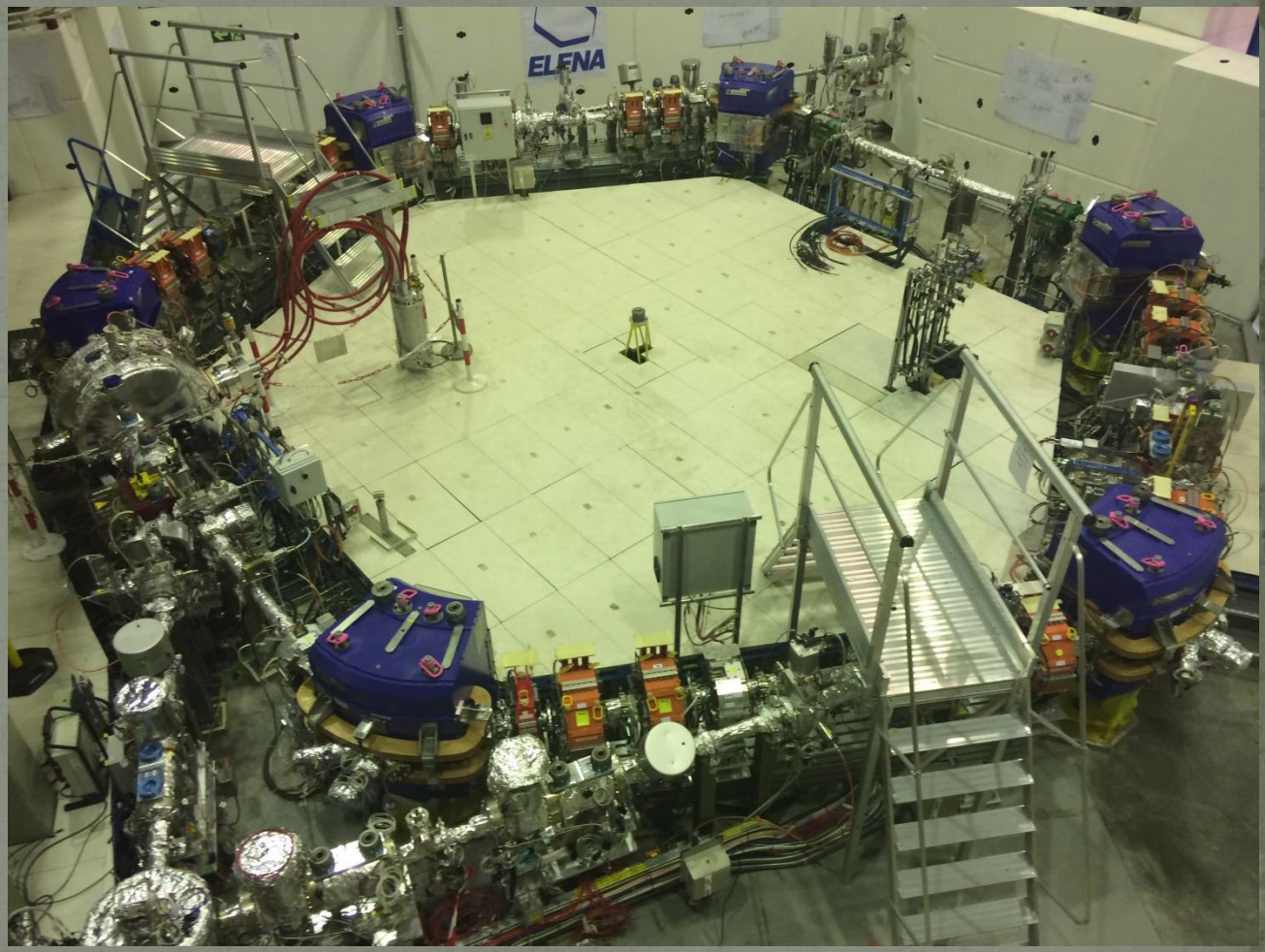
Quadrupole magnet

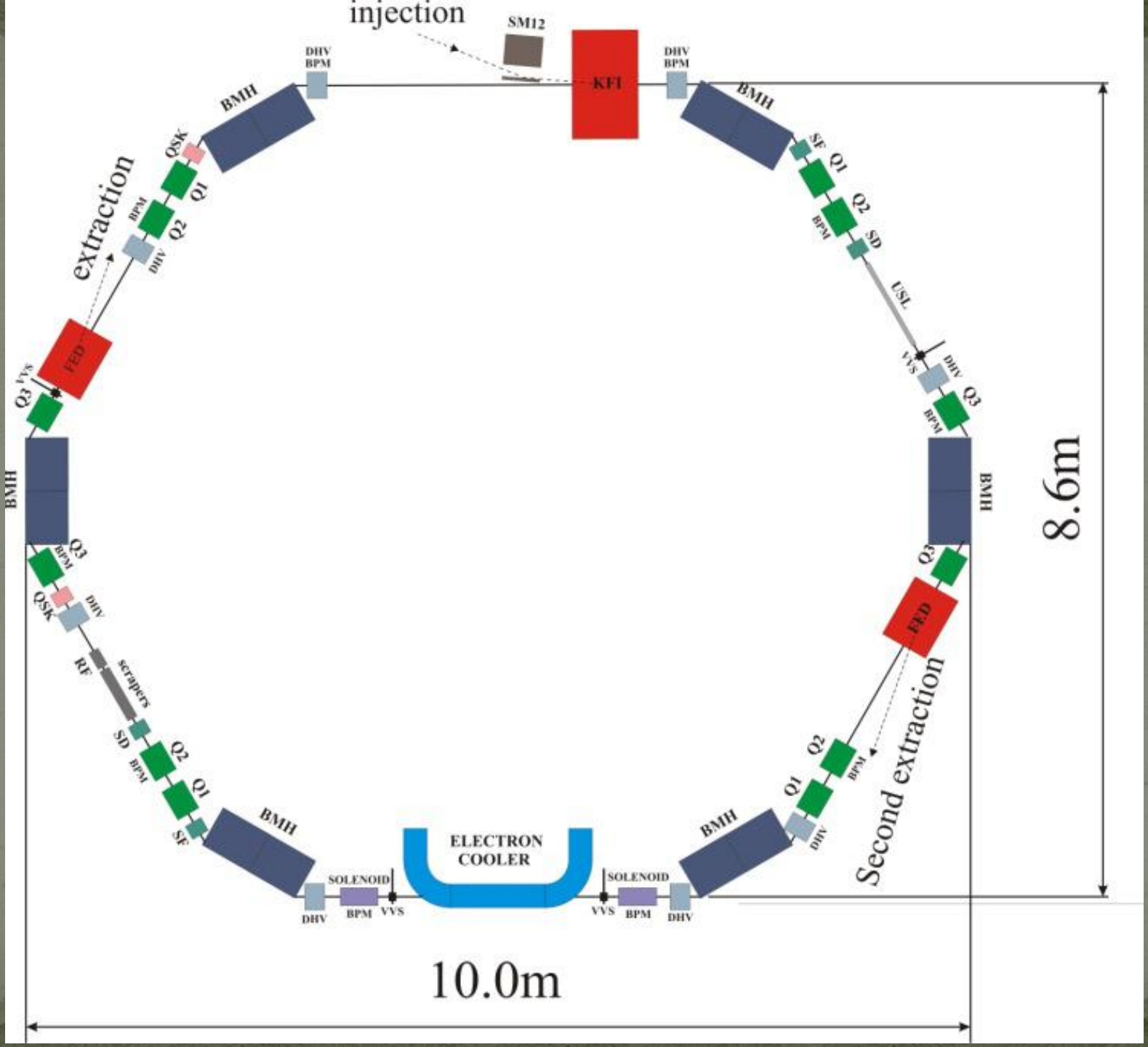
AD control room

Why is AD not enough? Why is ELENA needed?

- ELENA: **E**xtra **L**ow **EN**ergy **A**ntiproton
- Reduces their energy by a factor of 50, from 5.3 MeV to just 0.1 MeV
- Increases the beam density and improves trapping efficiency by a factor 10-100
- Circumference: 30 meters

ELENA




injection
SM12
KFI
DHV
BPM
BMH
QSK
Q1
Q2
BPM
DHV
extraction
FED
Q3
VVS
SF
SD
USL
RF
scrapers
ELECTRON
COOLER
SOLENOID
VVS
BPM
DHV
Second extraction
8.6m
10.0m

Antiproton Longitudinal Motion Simulator

- Longitudinal dynamics of the bunch on a flat-top

(constant currents in the magnets)

- Simulates how individual particles move in the bunch due to cavity
- dt = to - t


Bianka
ASUS

Longitudinal Motion Simulation

209,2

turns 1000

eEV 85000

dE[eV]

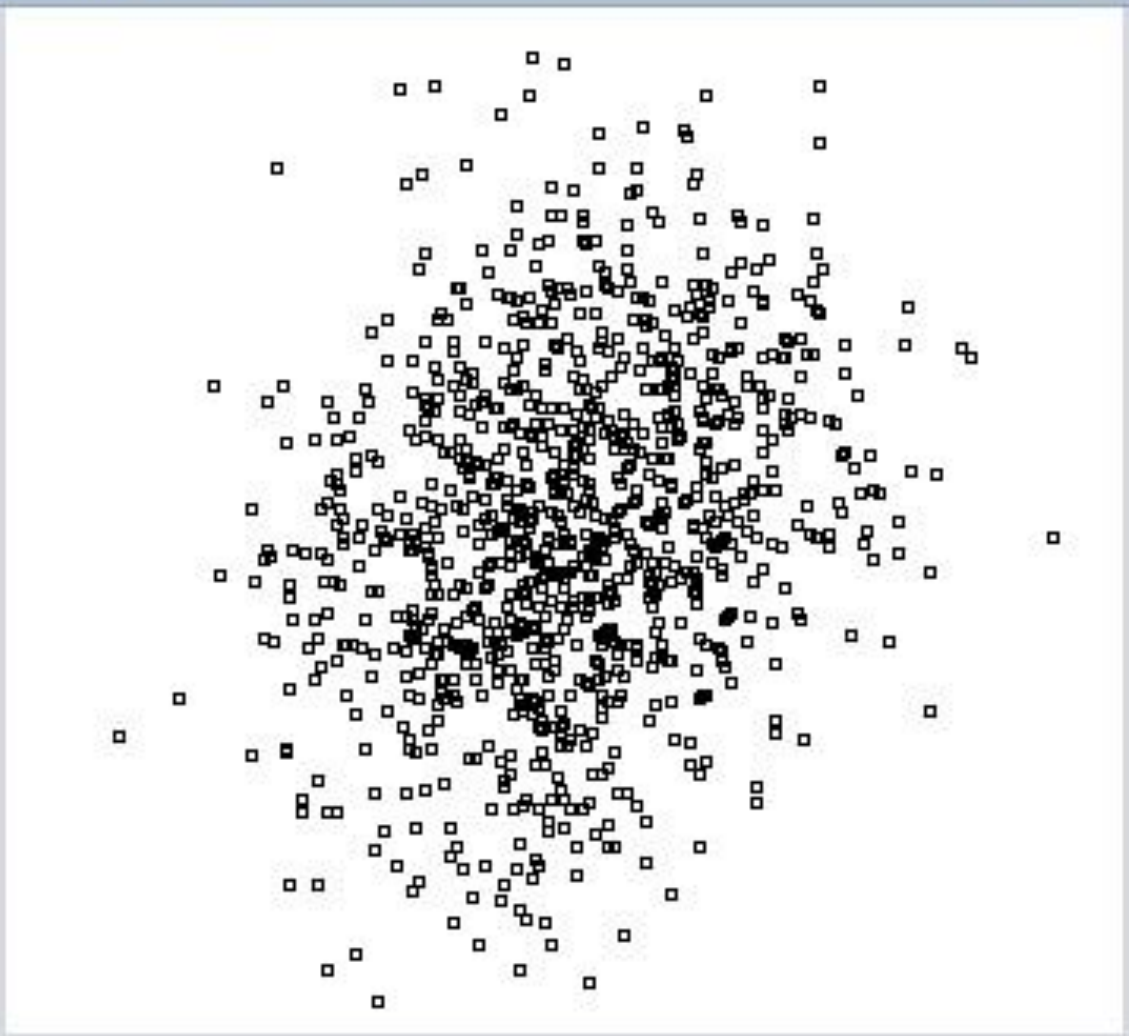
max voltage 0.9

initial delta E 0.001

delta t 1E-6

-209

Track



-17,6 dt[sec*1E-7] 17,4

Longitudinal Motion Simulation

turns 1000

eEV 85000

max voltage 100

initial delta E 0.001

delta t 1E-6

Track