

Towards measuring the ground state hyperfine splitting of antihydrogen - a progress report

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MOTIVATION

No observation of an antimatter universe:
 asymmetry at the cosmological scale

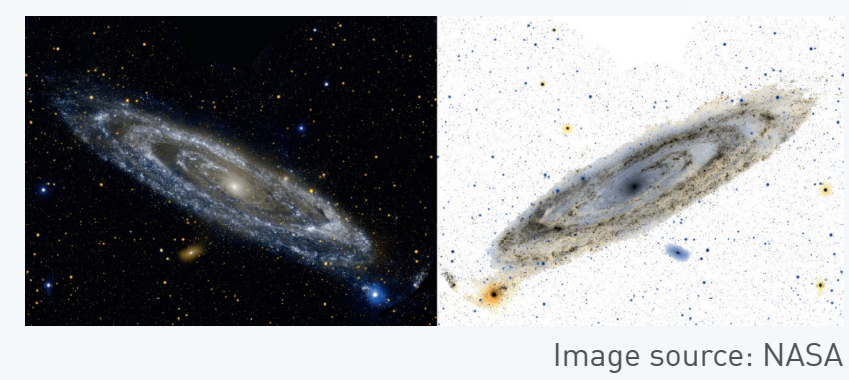
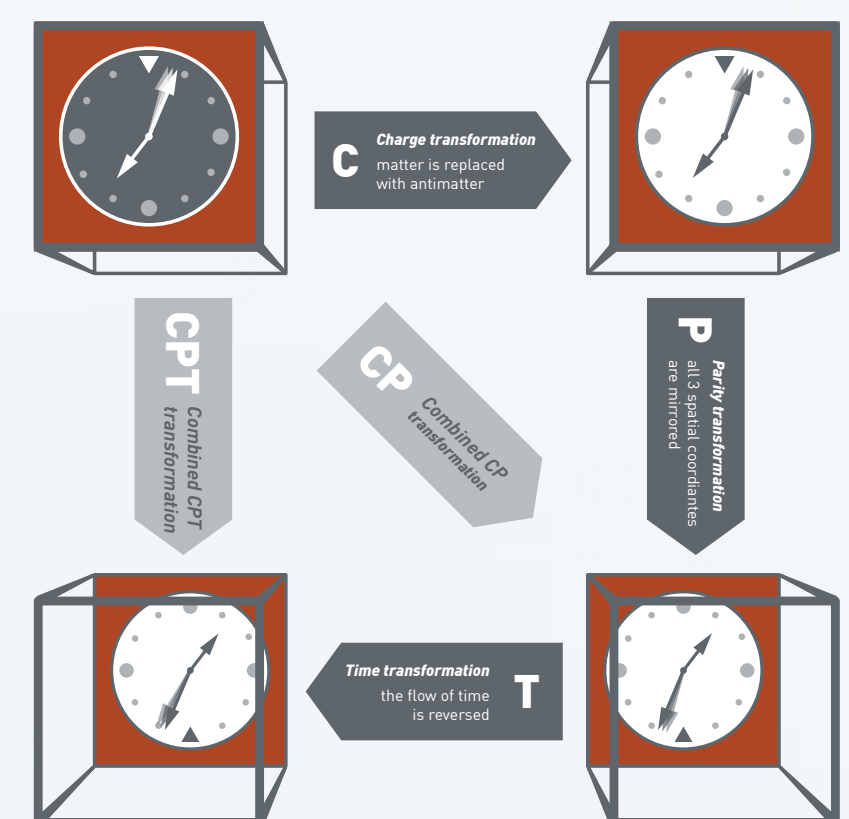
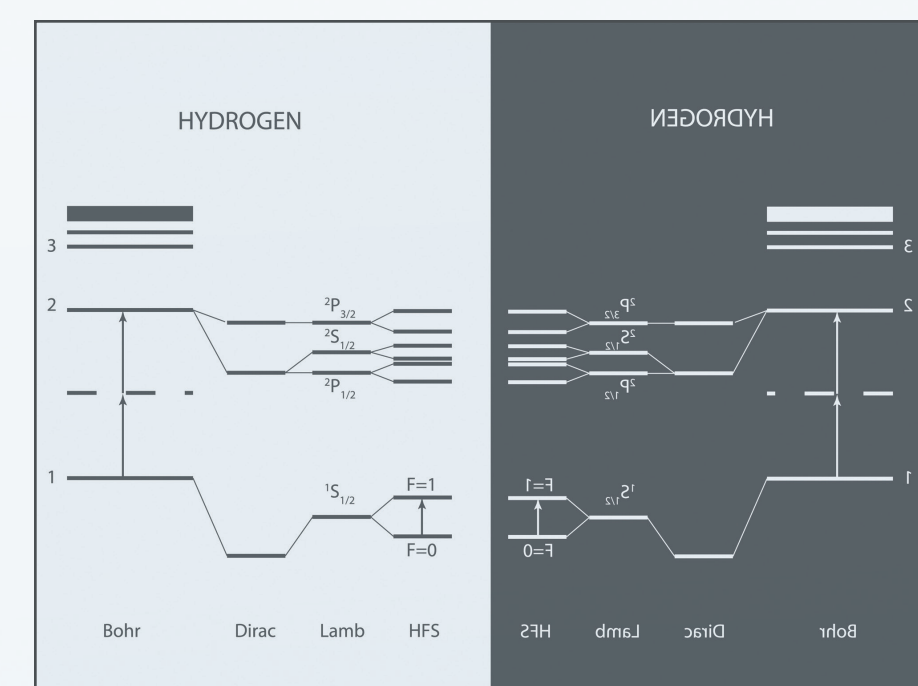
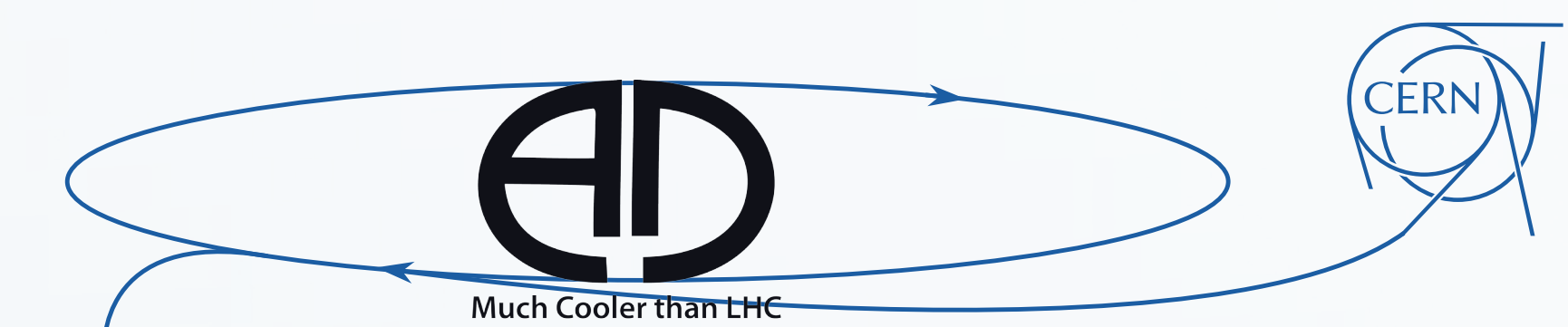


Image source: NASA

No violation of CPT observed to date:
 symmetry at the microscopic scale?

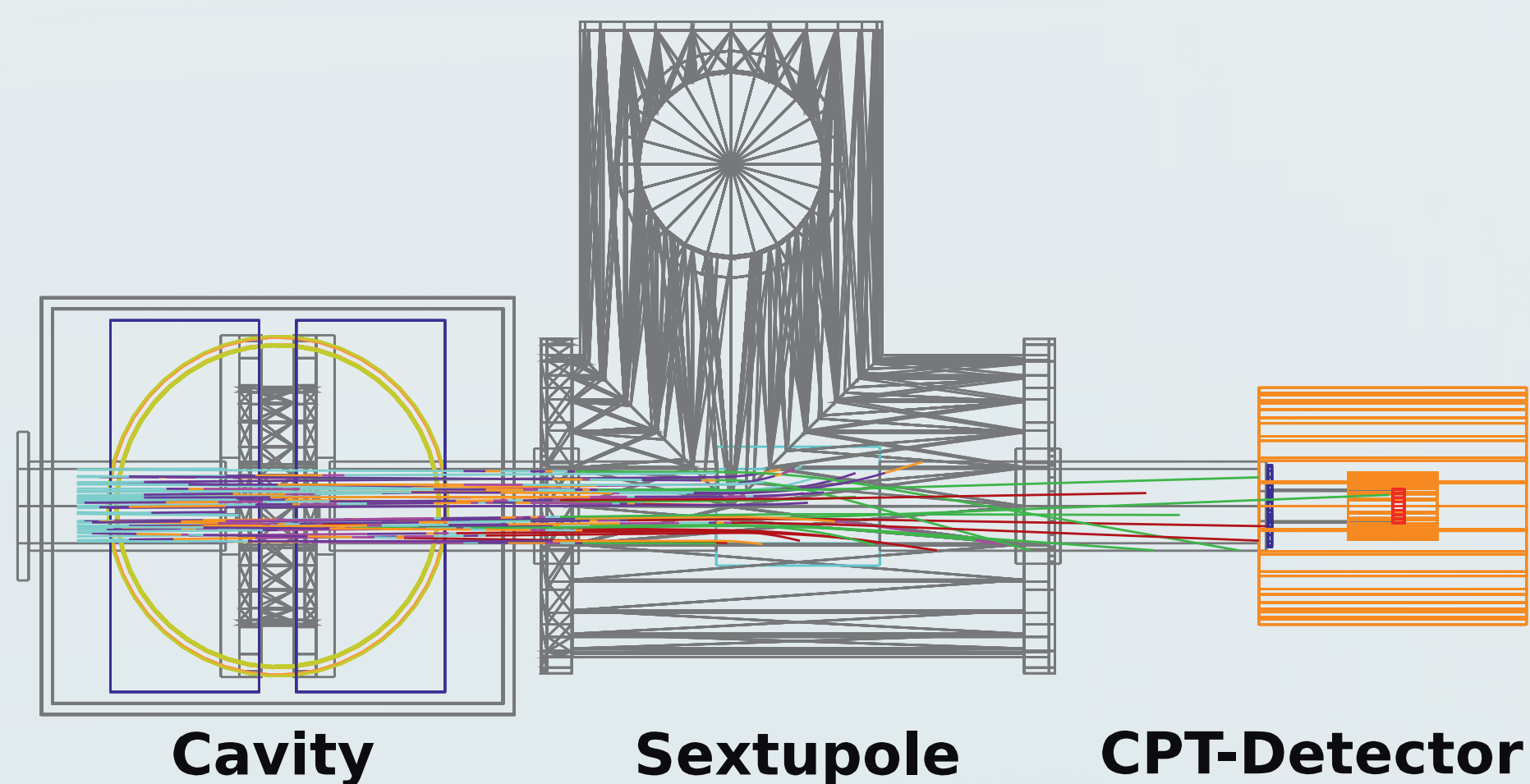


ANTIHYDROGEN PRODUCTION



- Slow antiprotons from Antiproton Decelerator (AD) + Radiofrequency Quadrupole Decelerator (RFQD)
- Positrons from ²²Na source
- Antihydrogen is formed from antiprotons and positrons within the CUSP trap by a process called mixing
- Anti-Atoms as neutral particles can leave the trap
- Counting antihydrogen at the detector via annihilation signal

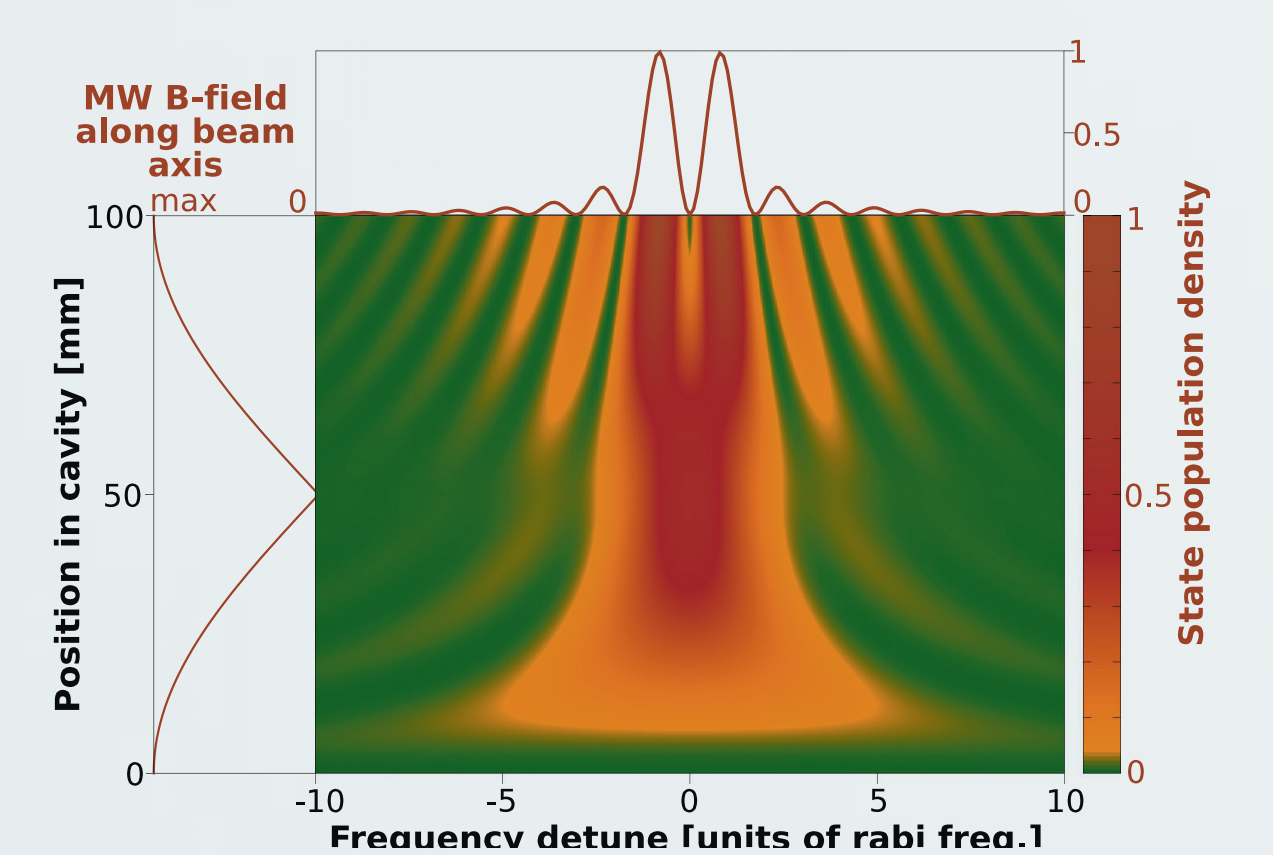
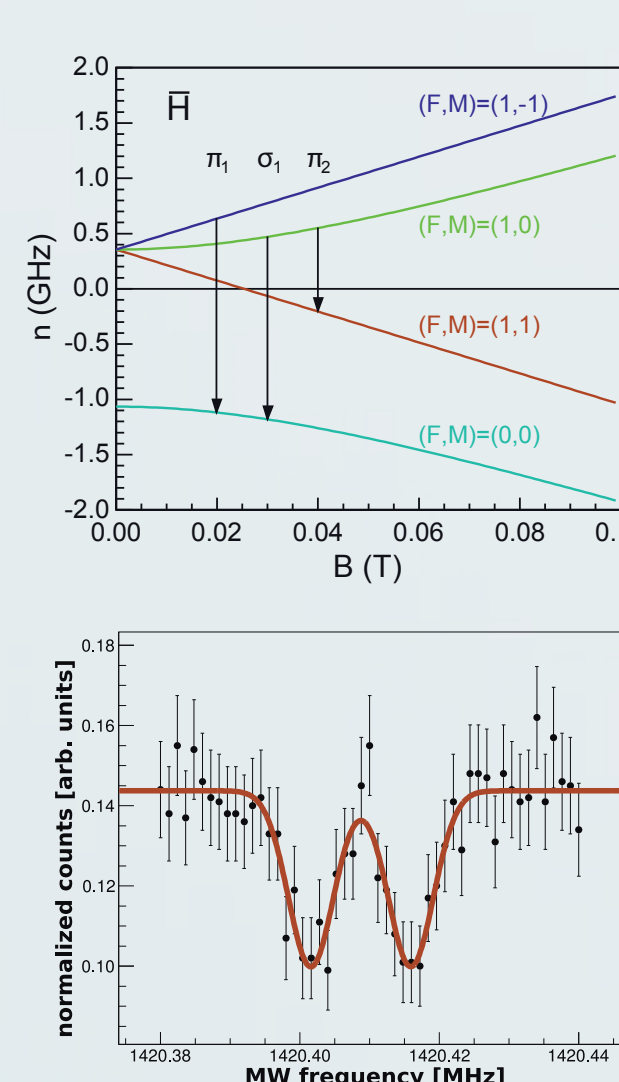
SPECTROSCOPY BEAMLINE



- Stripline microwave cavity, induces spin-flip
- Superconducting sextupole magnet, spin state analyser
- Detector, counting incoming antihydrogen atoms

CAVITY - MEASUREMENT PRINCIPLE

Geant4 simulation

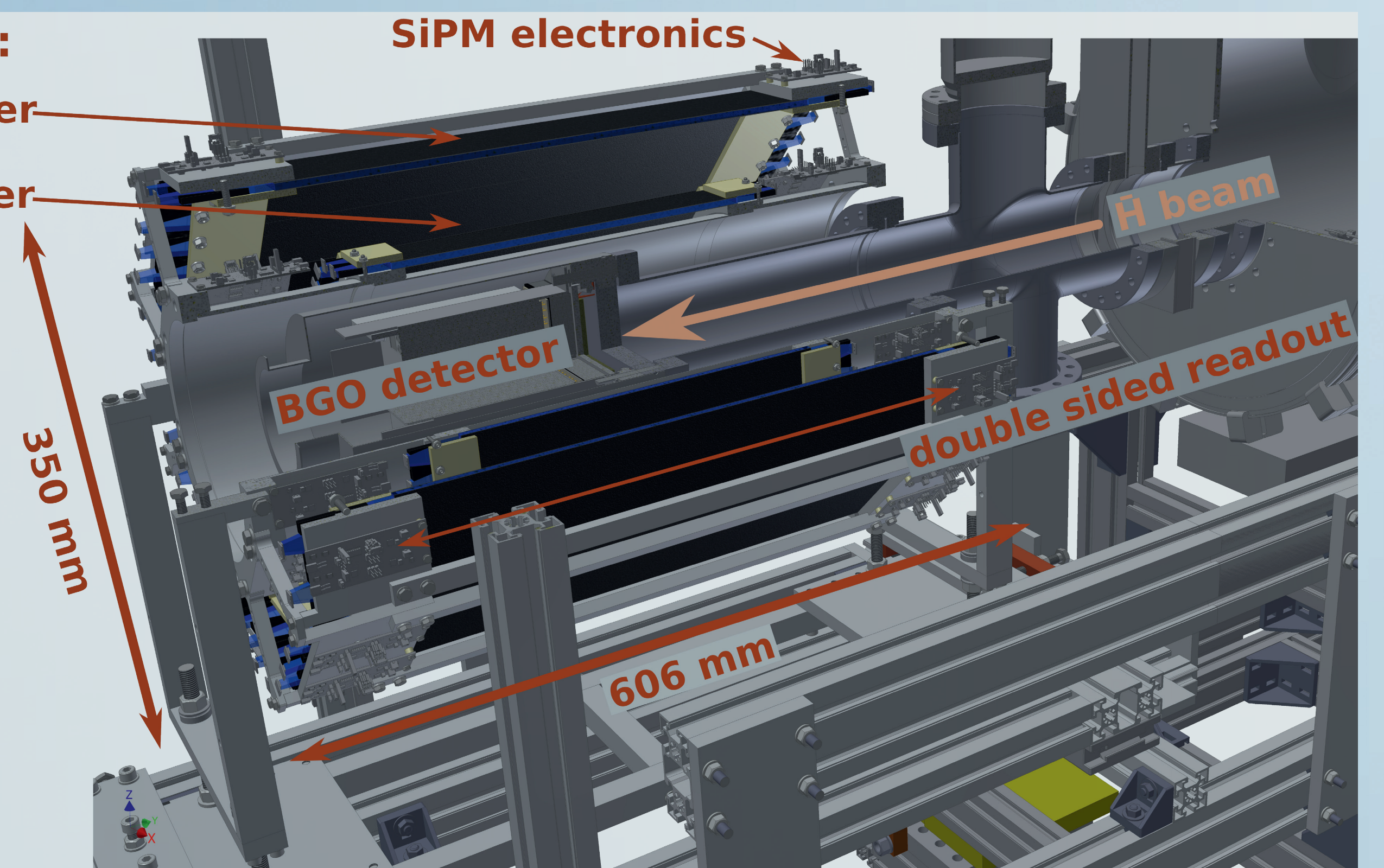


ANTIHYDROGEN DETECTOR

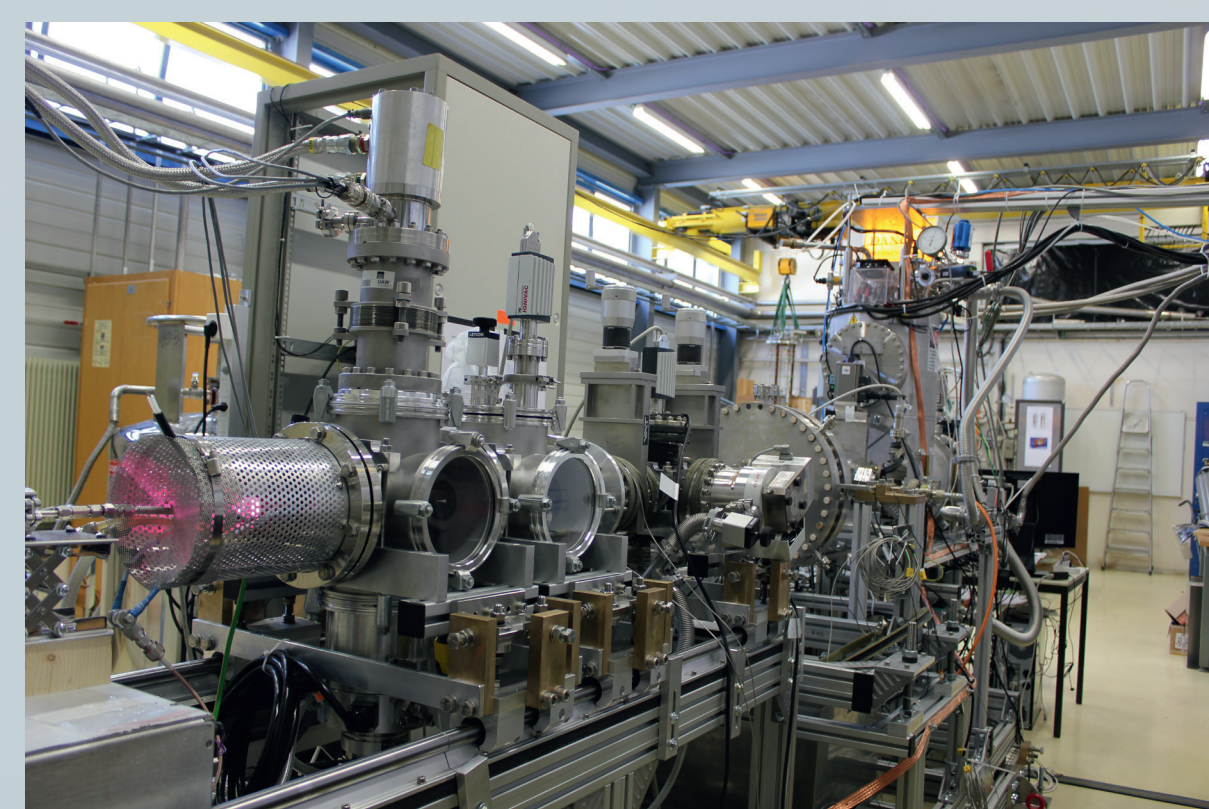
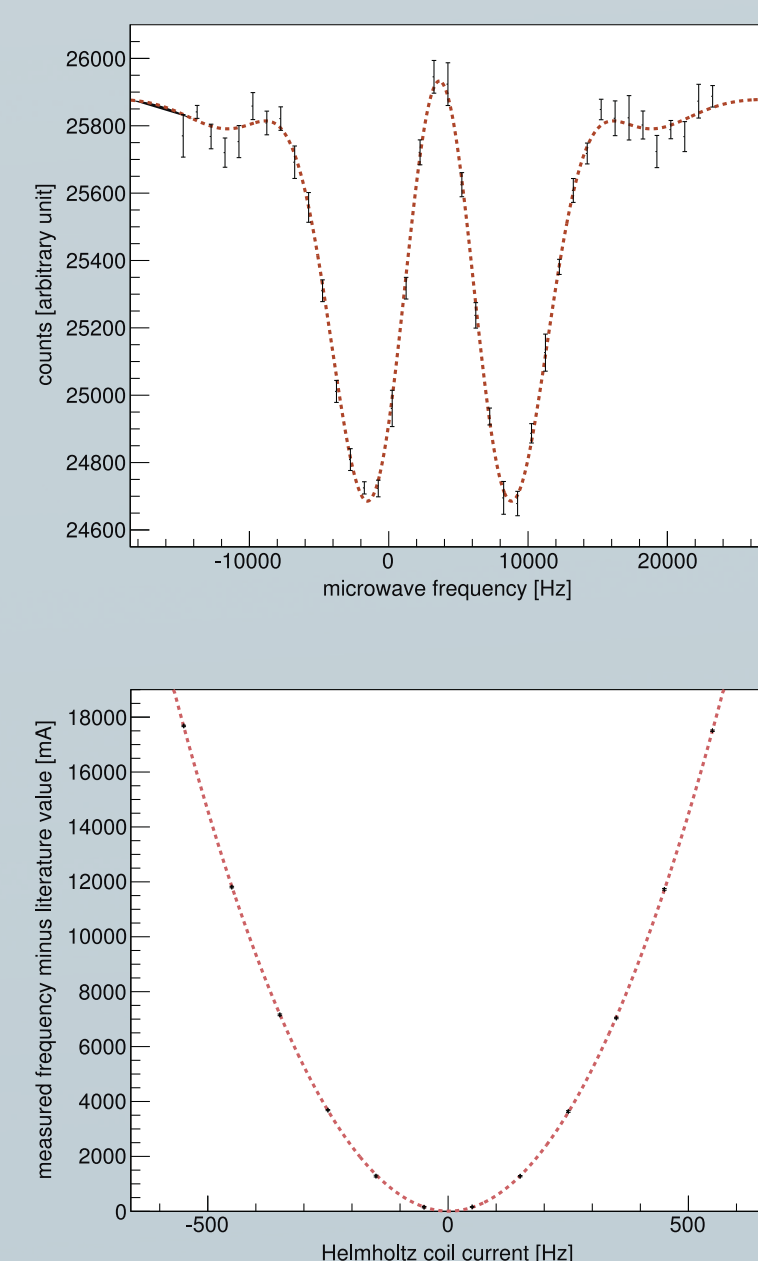
- Hodoscope with two layers
- 32 bars of plastic scintillators per layer
- double sided readout with SiPMs
- barrel detector with octagonal shape
- outer layer (per bar):
 - active surface: 450 mm x 35 mm
 - 5 mm thickness
- inner layer (per bar):
 - active surface: 300 mm x 20 mm
 - 5 mm thickness
- Detector material: EJ-200
- inner detector: BGO crystal with Multi Anode PMT
- two sided SiPM readout for position resolution and noise discrimination

Hodoscope:

- outer layer
- inner layer



IN-BEAM HYDROGEN SPECTROSCOPY



- beamline tested with polarised, cold atomic hydrogen beam
- σ_1 hyperfine resonance measured
- extrapolation to ground-state zero field hyperfine splitting
- accuracy $\Delta\nu/\nu < 10^{-8}$

ANTIHYDROGEN BEAMTIME 2014

