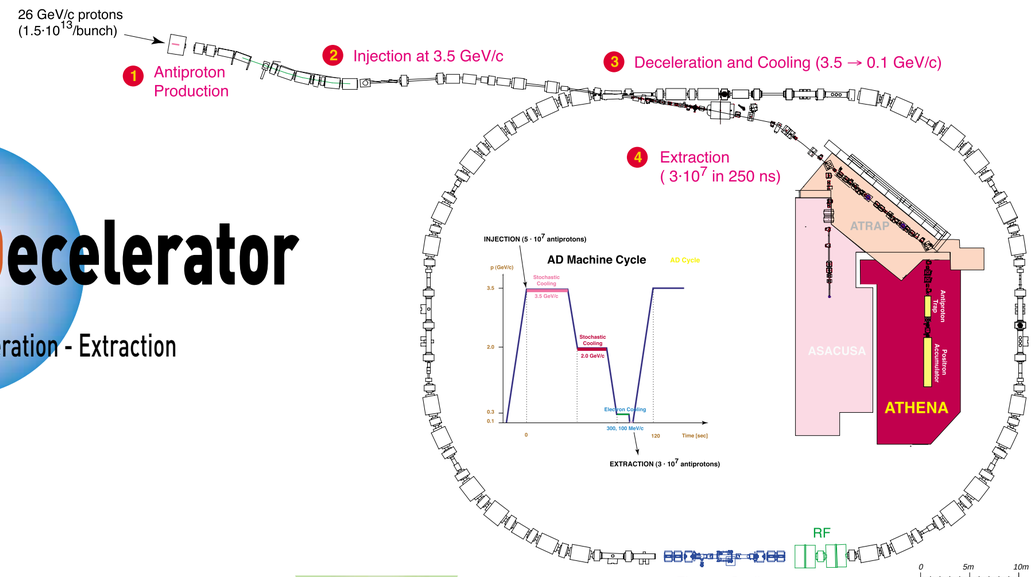
AD-Experiments

Antiproton Decelerator

Capture - Cooling - Deceleration - Extraction

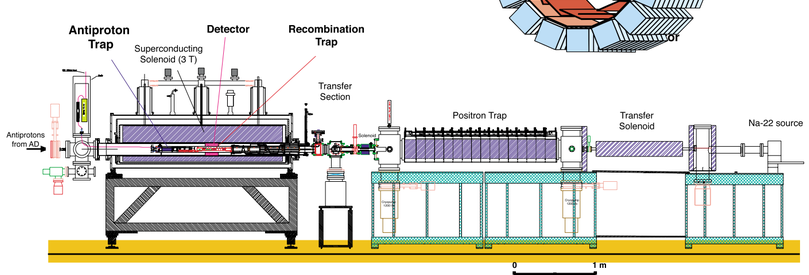


ATHENA

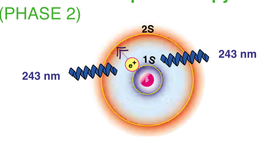
PRODUCTION AND SPECTROSCOPY OF SLOW ANTIHYDROGEN ATOMS

The goals of ATHENA and ATRAP are to produce slow antihydrogen atoms, and to compare the properties of antihydrogen to that of hydrogen to a very high accuracy.

1. Antiproton Capture into Penning Trap
   Goal: 10^5 antiprotons
2. Positron Accumulation from Na-22 source
   Goal: 10^8 positrons/minute
3. Positron-Antiproton recombination in separate trap
4. Antihydrogen **Detection**
   - Annihilation products: 2 layers x 16 Si Strip detectors (r, φ, z)
   - 511 keV Gammas: 192 CsI crystals + Photodiodes



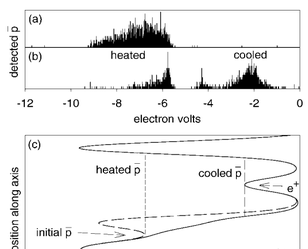
5. 2-Photon Laser **Spectroscopy**: ΔE (1S-2S) (PHASE 2)



Comparison $\bar{H}$: H with precision 10^{-12} ...10^{-15}
Start: July 2000
Duration: 4-6 years (incl. Phase 2)

ATRAP

1. Antiproton Capture
2. Positron Accumulation
3. Recombination
   in the same trap system



Demonstration of antiproton cooling by positrons in ATRAP.
The energy distribution of antiprotons is analyzed by slowly lowering the trap voltage.
a) Uncooled antiproton spectrum
b) Cooled antiproton spectrum
c) Potential wells for the positrons and antiprotons.

4. Antihydrogen **Detection**
   - Annihilation products: Scintillating Fibres
   - 511 keV Gammas: 12 BGO crystals

5. 2-Photon Laser **Spectroscopy**: ΔE (1S-2S) (PHASE 2)

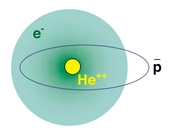
Comparison $\bar{H}$: H with precision 10^{-12} ...10^{-15}
Start: July 2000
Duration: 4-6 years (incl. Phase 2)

ASACUSA

ASACUSA (Atomic Spectroscopy And Collisions Using Slow Antiprotons) is an experiment comprising several objectives related to precision studies using slow antiprotons.

Antiprotonic helium spectroscopy

- Study of optical transitions (determination of Q^2/m of antiproton)
- Study of the hyperfine structure using laser-microwave-laser triple resonance method (determination of magnetic moment of antiproton)
- Study of formation process and of collisional quenching



$\bar{p}$-e^-He^{++} ' Atomcule '
Lifetime ~ few μs
n_p, L_p ~ 33 ... 39

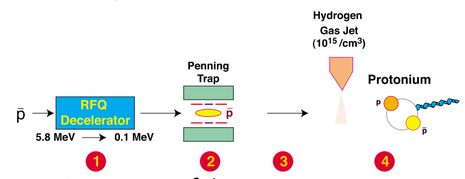
Atomic ionisation by very low energy antiprotons

Commissioning of an ultra-low energy antiproton facility for atomic spectroscopy using antiprotonic atoms

- High efficiency capture in Penning trap of up to 10^7 antiprotons using RFQ decelerator
- Electron cooling
- Re-extraction of antiprotons with adjustable time interval, energy in 1-1000 eV range

Production and study of antiprotonic hydrogen atoms (protonium)

- Formation process in very dilute gases
- Precision study of atomic transitions



ASACUSA : Interaction region with ESA (ElectroStatic Analyser)

COMPASS

Two-Stage Magnetic Spectrometer (1 - 150 GeV) with particle identification and calorimetry, to investigate nucleon structure and hadron spectroscopy with very high statistics

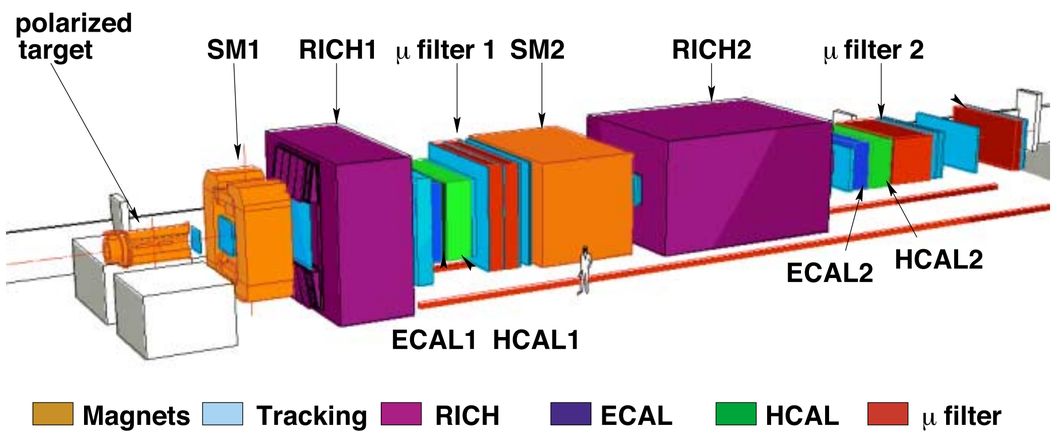
Nucleon Structure

- Gluon polarization $\Delta G/G$ (D meson asymmetry in open charm production, Λ polarization)
- Polarized (frozen spin) target
- Polarized muon beam: 10^8 μ / sec

Hadron Spectroscopy

- Production and decay properties of charmed particles (semi-leptonic decay widths, branching fractions)
- Primakoff reaction to measure electric and magnetic polarisabilities of pions and kaons $(\pi,K) + A \rightarrow (\pi,K) + A + \gamma$
- Spectroscopy of gluonic systems in central production (using proton, pion and kaon beams)
- $5 \cdot 10^7$ protons (pions) / sec

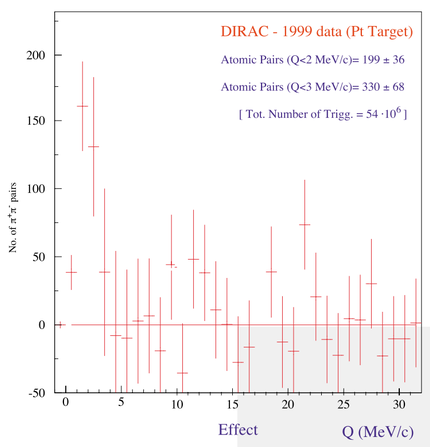
Data rates: 100 kHz → Online Filter → 35 MB/sec
Start data taking: 2001



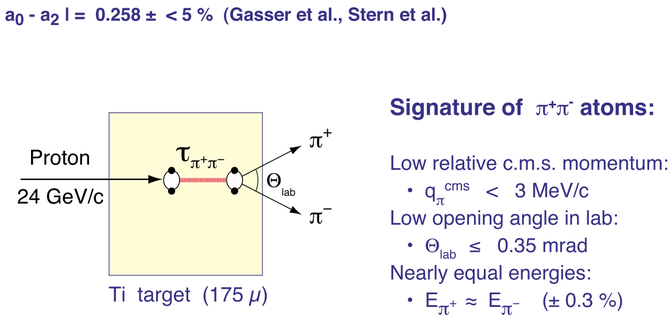
DIRAC

The aim of the DIRAC experiment is the measurement of the difference of the pion scattering lengths | $a_0 - a_2$ |, from the lifetime of the $(\pi^+\pi^-)$ Atom.

The ππ scattering lengths can be predicted from Chiral Perturbation Theory :
| $a_0 - a_2$ | = 0.258 ± < 5 % (Gasser et al., Stern et al.)



Distribution of Q, the relative c.m.s. momentum of $\pi^+\pi^-$ pairs emerging from $A_{2\pi}$ atoms. The signal is obtained by subtracting from the measured Q-distribution the underlying background from free pairs, estimated from the similar Q-distribution of accidental $\pi^+\pi^-$ pairs



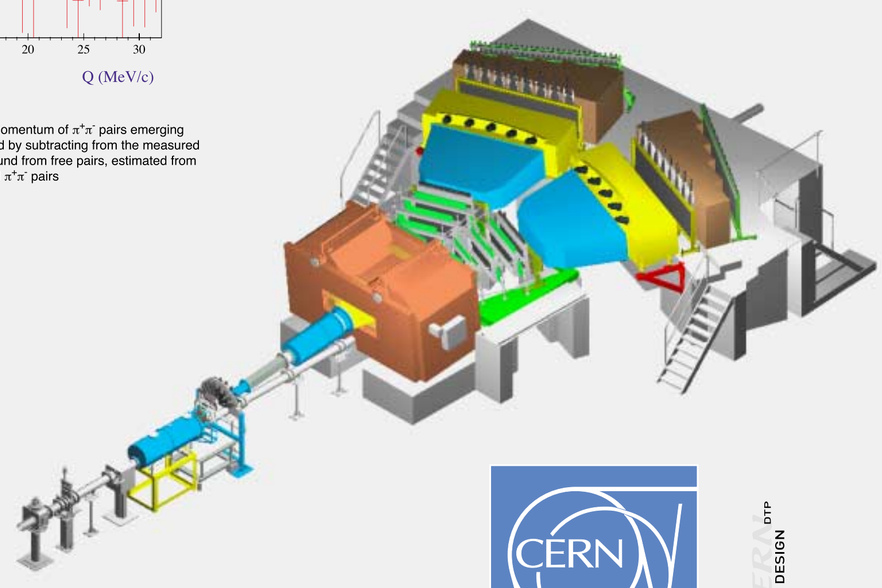
Signature of $\pi^+\pi^-$ atoms:

Low relative c.m.s. momentum:
- q_π^{cms} < 3 MeV/c

Low opening angle in lab:
- $\Theta_{lab} \leq$ 0.35 mrad

Nearly equal energies:
- $E_{\pi^+} \approx E_{\pi^-}$ (± 0.3 %)

Data taking: Autumn 1999 - 2002



PS and SPS

CERN DTP GRAPHIC DESIGN