

AEgIS

a brief status of the experiment

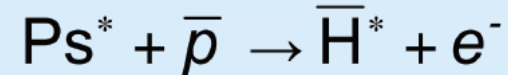
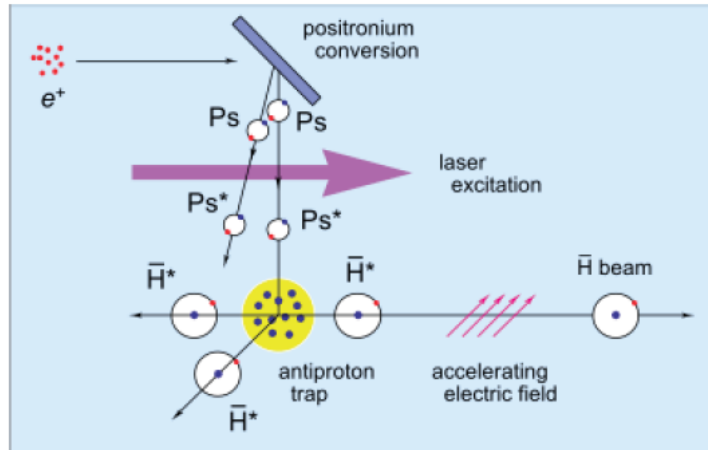
S. Haider

Overview

- The 3-step motivation
- Status of the experiment

Step i) antihydrogen formation

- Charge exchange reaction:



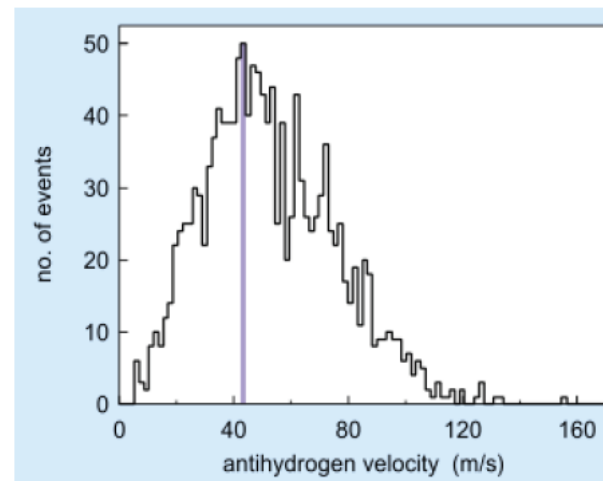
- cold antiprotons ($T \sim 0.1K$)
- production of Rydberg positronium
- production of antihydrogen atoms

- Principle demonstrated by ATRAP ($Cs^* \rightarrow Ps^* \rightarrow \bar{H}^*$)

[C. H. Storry *et al.*, Phys. Rev. Lett. **93** (2004) 263401]

- Advantages:

- Large cross-section: $\sigma \approx a_0 n^4$
- Narrow and well-defined \bar{H} n -state distribution
- \bar{H} production from \bar{p} at rest \rightarrow ultracold \bar{H}
- **pulsed** production of \bar{H}



At $T(p) = 100mK$,
 $n(Ps) = 35$

® $v(H) \approx 45 m/s$
 $T(H) \approx 120mK$

Step ii) beam formation

- Neutral atoms are not sensitive to static electric and magnetic fields
- Electric field gradients exert force on electric dipoles:

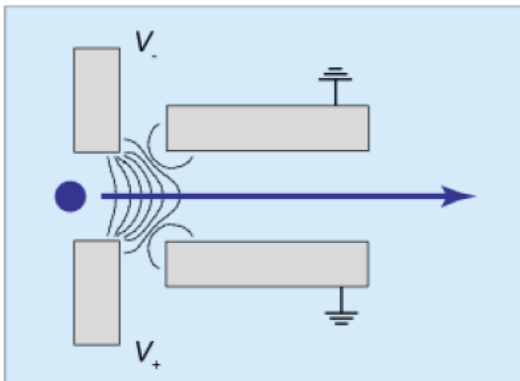
$$E = -\frac{1}{2n^2} + \frac{3}{2}nkF$$

$$\text{Force} = -\frac{3}{2}nk\vec{\nabla}F$$

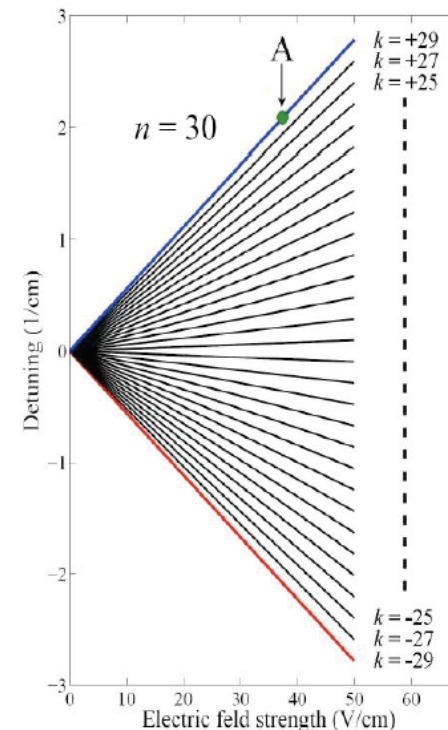
Ⓜ Rydberg atoms are very sensitive to inhomogeneous electric fields

- Stark deceleration of hydrogen demonstrated

[E. Vliegen & F. Merkt, J. Phys. B **39** (2006) L241 - ETH Physical Chemistry]



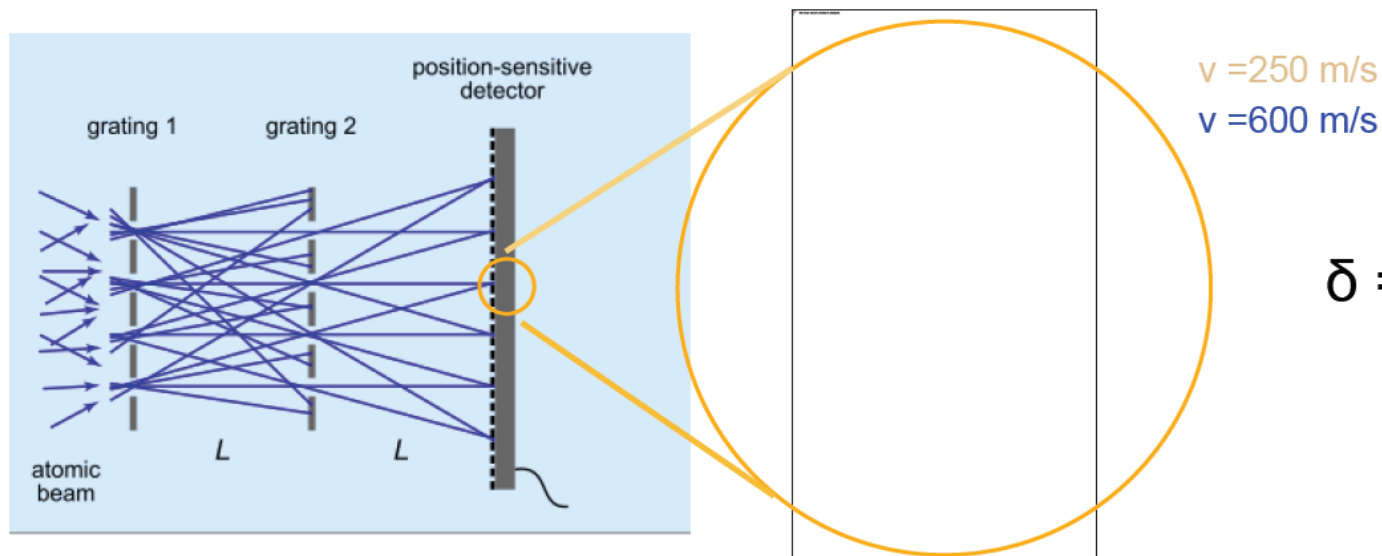
- $n = 22, 23, 24$
- Accelerations of up to $2 \times 10^8 \text{ m/s}^2$ achieved
- Hydrogen beam at 700 m/s can be stopped in $5 \mu\text{s}$ over only 1.8 mm
- ongoing work on Zeeman deceleration, Stark deceleration and trapping of H



Step iii) trajectory measurement

- Classical counterpart of the Mach-Zehnder interferometer
- Decoherence effects reduced
- “Self-focusing” effect – beam collimation uncritical

Fringe phase and phase shift identical to Mach-Zehnder interferometer!



$$\delta = \frac{gt^2}{a}$$

- Replace the third grating and detector by position-sensitive detector
- Ⓜ Transmission increases by \sim factor 3
- Has been successfully used for a gravity measurement with ordinary matter, $\sigma(g)/g = 2 \times 10^{-4}$
- with 10^5 H at 100mK, $\sigma(g)/g = 1\%$ (expected)

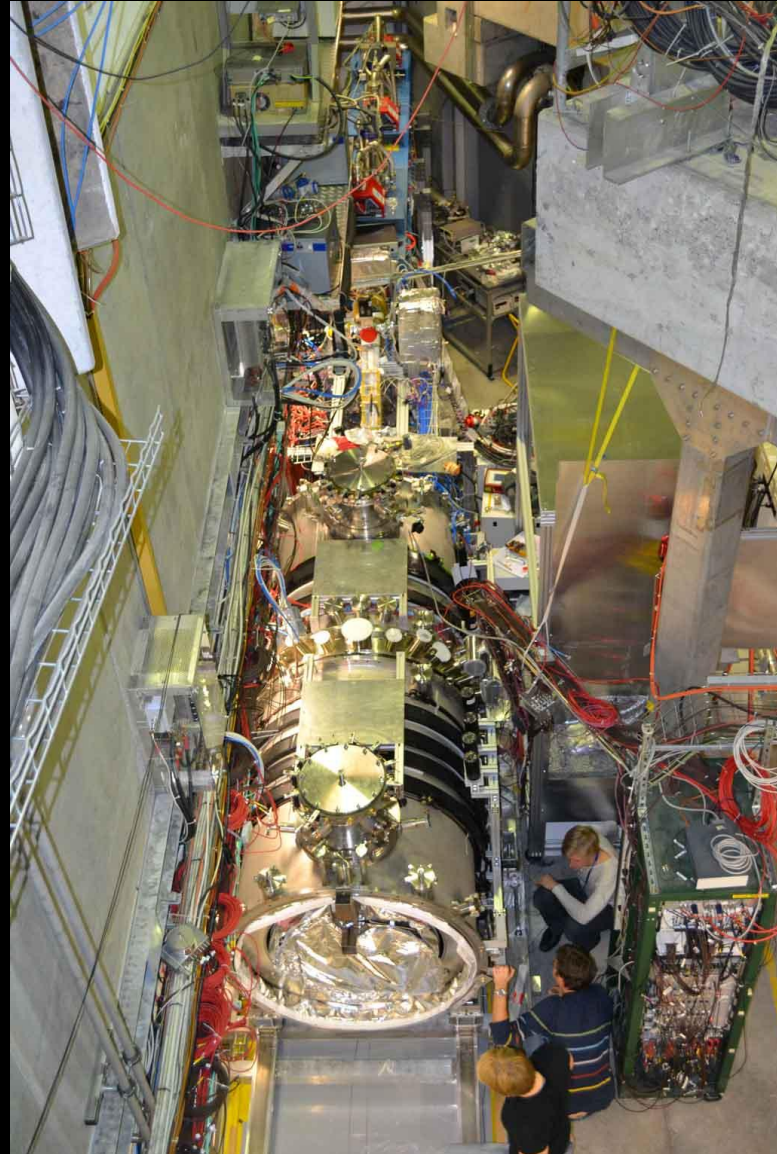
[M. K. Oberthaler *et al.*, Phys. Rev. A **54** (1996) 3165]

[A. Kellerbauer *et al.*, Phys. Rev. A **54** (1996) 3165]

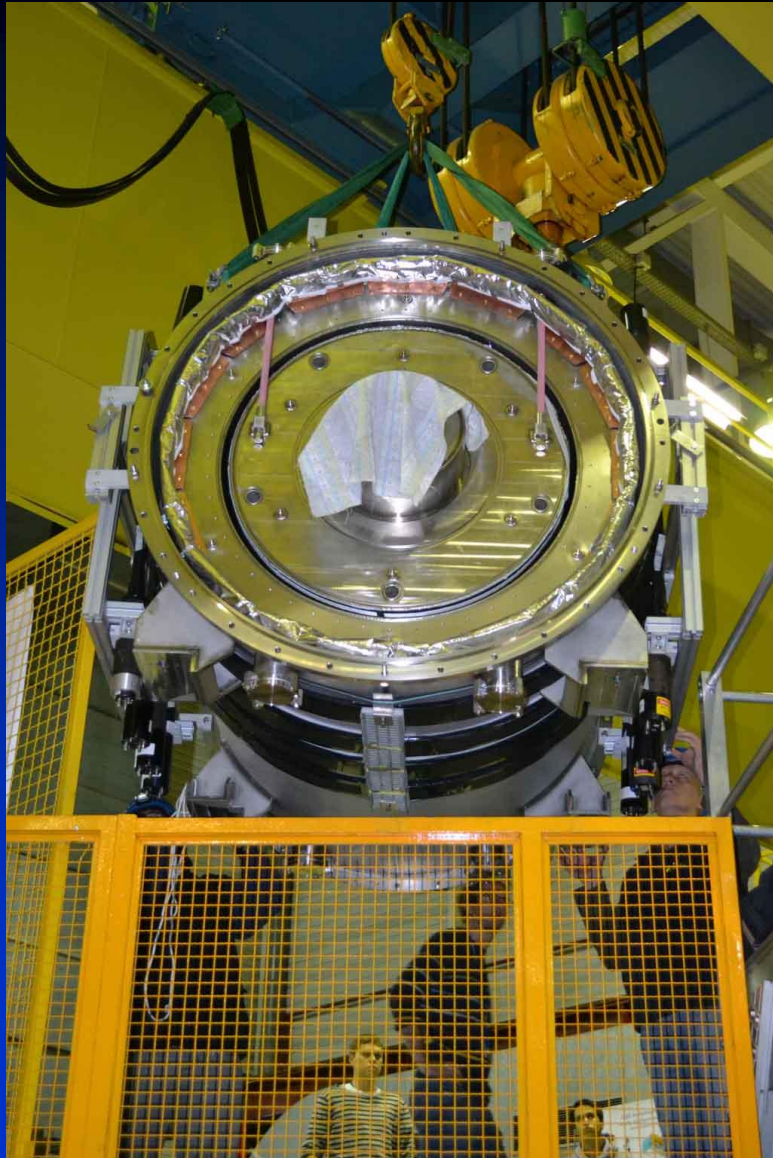
Sep. 2011



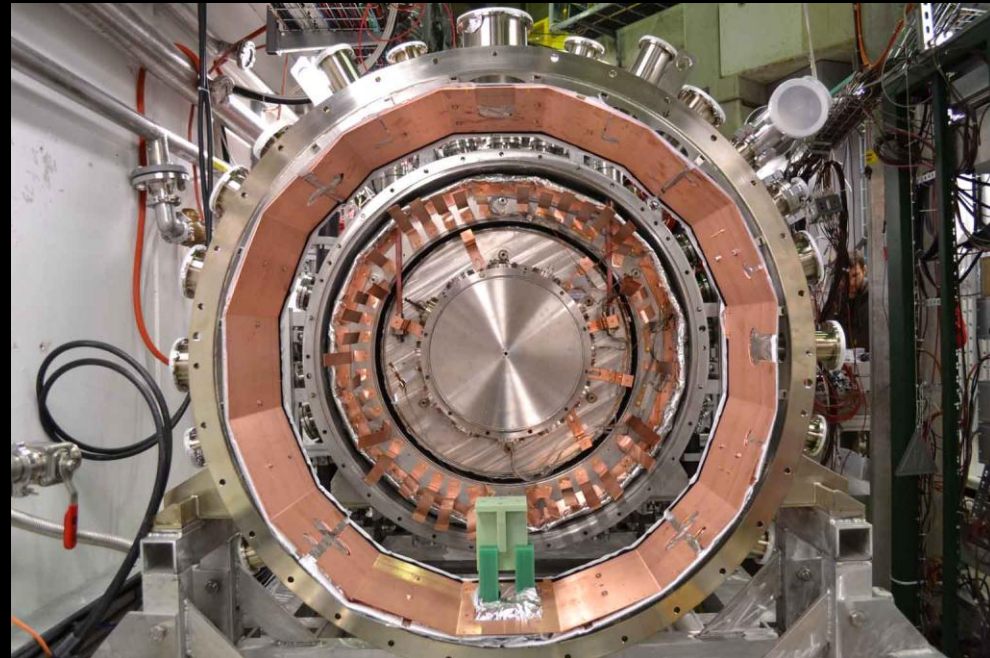
Nov. 2012

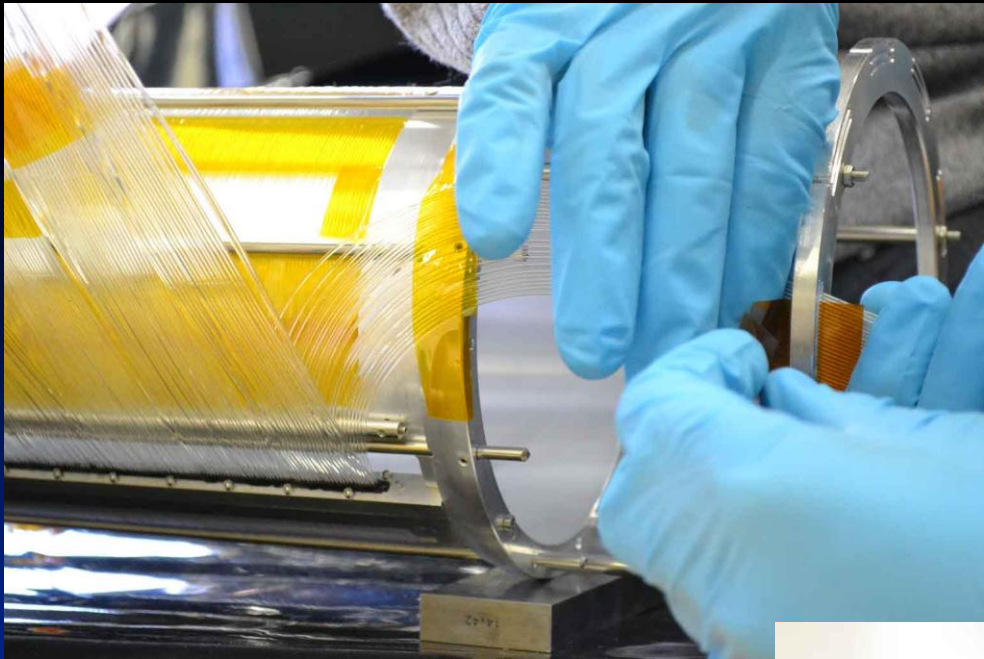


Transport of 1T cryostat

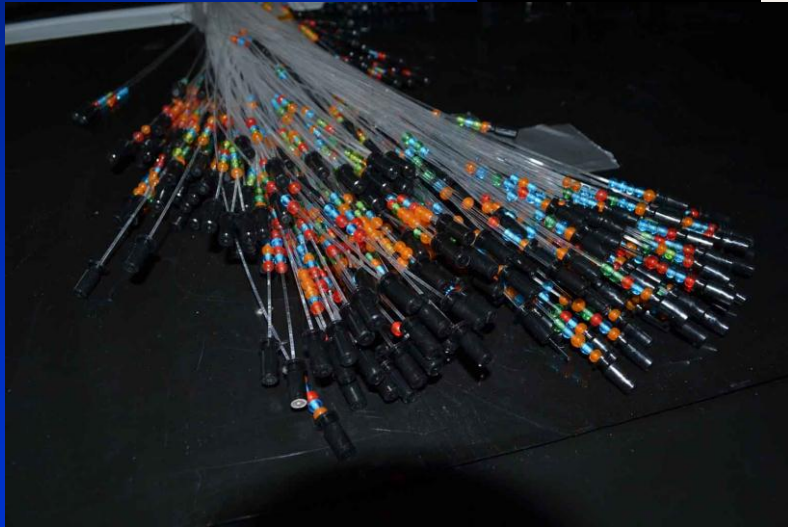


5T cryostat + central region
(before installation of cables and 1T trap)





Scintillating
fibre detector
for H-bar
detection



1T trap

