Towards a Cold Atomic Hydrogen Source @T-REX Mainz

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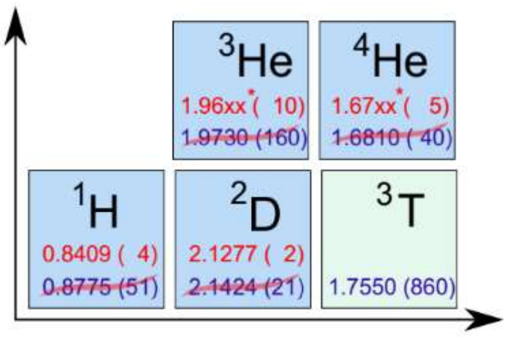
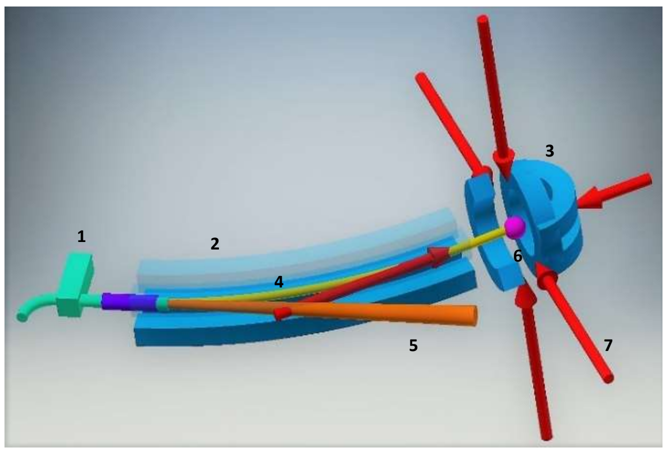
Motivation

- Charge radii of proton, deuteron, helion and alpha have recently been improved 10x [5]
- Triton is the "missing link" between Z=1 and Z=2
- Needs an accurate measurement of 1S -2S isotope shift
- Cannot be measured in beam setup → trap
- Previous H cooling techniques suitable for T [1][2] → trap via cold Li buffer gas



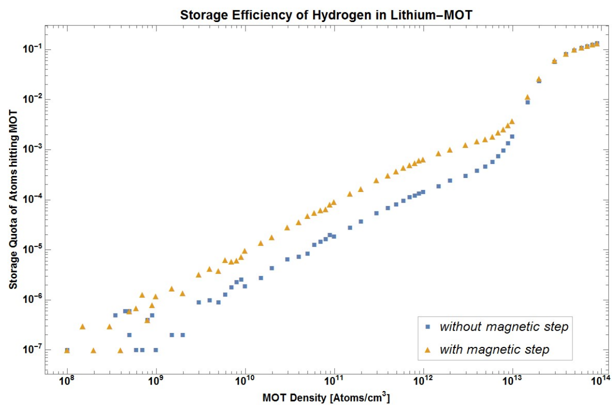
Triton-Radius EXperiment Mainz

Experimental idea



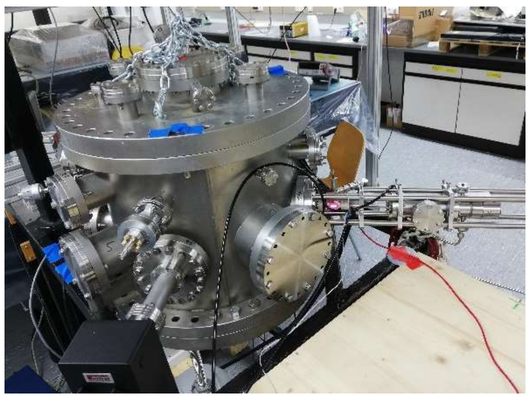
1: Hydrogen nozzle, 2: magnetic quadrupol, 3: magnetic trap,
4: Hydrogen beam, 5: untrapped hydrogen, 6: Li6-MOT, 7: MOT beams

- guiding and speed selection of atomic tritium with a magnetic multipole guide [3]
- cooling with a ^{6}Li-MOT as a buffer gas [4]
- full magnetic storage of T in a magnetic bottle
- laser spectroscopy of tritium
- testing stages with atomic hydrogen



Simulated fraction of hydrogen atoms stored in the magnetic bottle depending on the density of the MOT; the magnetic step refers to the higher magnetic potential atoms must pass to get into the trap

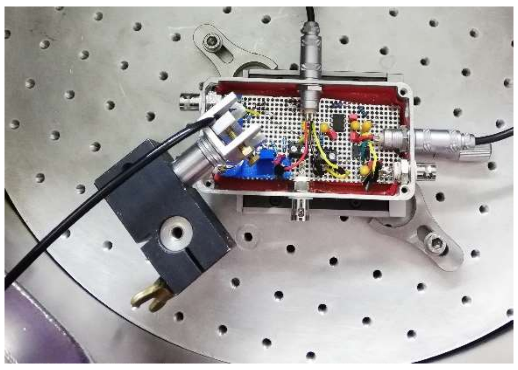
Current state



Vacuum chamber with discharge running on the right

Close-up of discharge region while running

- Rebuilt "Garching setup"
- Dissociation of H_2 via a Microwave Cavity
- Initial spark provided by a Tesla Coil
- Pyrex Tube with 1mm aperture
- Teflon tube guiding atoms into chamber



Wheatstonebridge hydrogen-detector [3]

Quadrupole-Halbach-guide [4]

- Discharge running stable @ min. 7W (~120W available)
- Detector prototype for atomic H built [2] (principle: heating of 25µm wire from H+H→H_2 + 4.5eV)
- RGA-measurements show reaction to discharge on/off
- Magnetic quadrupole guide built, awaiting tests with Rb, Li, H

Please also check our Posters by Andreas Wieltsch ("Simulation of an atomic Beam under magneto-optical influence"; A35.10/A108) and Lukas Schumacher ("A detector for atomic hydrogen"; A35.20/A203)

PDF download of AG Pohl posters

Literature

[1] J. Walraven, Isaac F. Silvera RSI **53**, 1167-1181 (1982)
[2] Hess, H.F. et al. PRL **59**.6 672-675 (1987)
[3] H-L Schumacher: Detector for Atomic Hydrogen (2019)
[4] M. Heppener: Aufbau und Charakterisierung einer magnetischen Quadupol-Transportstrecke für Atome
[5] A. Amroun et.al. NPA **579**, 596-626 (1994)

Outlook

- Unambiguous detection of atomic Hydrogen
- Optimizing source parameters (flow, power, pressure etc.)
- Installing cryostat
- Optimizing copper nozzle
- Study beam with improved wire detector