Detector for Atomic Hydrogen

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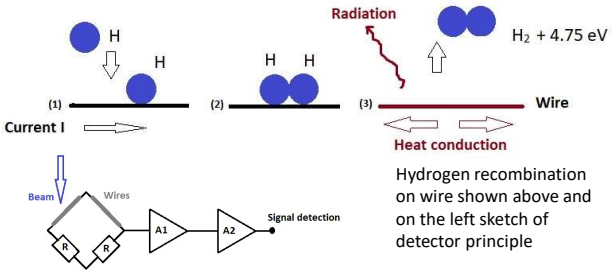
Motivation

- Detector needed for the Triton-Radius Experiment Mainz to analyse performance of hydrogen beam source
- Goal is to build inexpensive, small and movable detector for atomic hydrogen operable in vacuum
- Detector should be capable of measuring hydrogen flux and the profile of such a beam [1]

For a detailed view on T-REX Mainz have a look at the poster from Jan Haack:
Towards a Cold Atomic Hydrogen Source @ T-Rex, A 35.19, A 201.

Working Principle

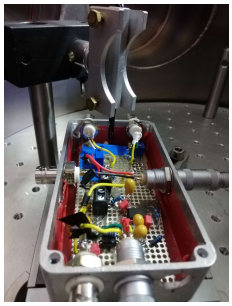
- 4.75eV of heat released upon recombination on metal surface [2]
- Heat relase measured with a 25 µm thick gold plated wire from LUMA Metall [5]
- Due to heating increase of wire resistance, which will be measured [3] via a Wheatstone bridge
- Signal will be amplified from nV to mV using elctronics
- Beam profiling with simple translational stage

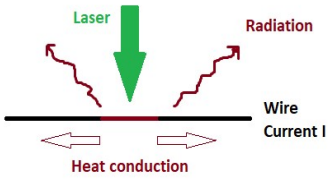


Hydrogen recombination on wire shown above and on the left sketch of detector principle

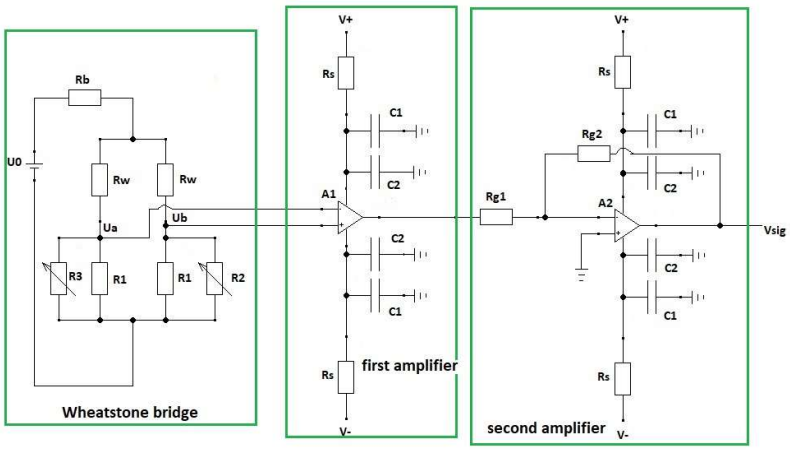
Current State

- Protoype build and tested in detail with a 532 nm laser with comparable power to the one expected from beam [4]



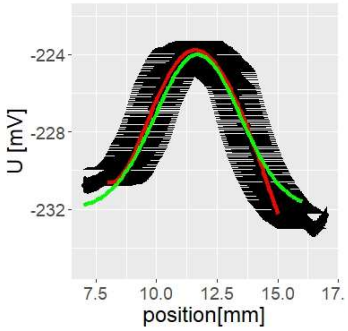


Picture of protoype on the left. Sketch of measurement with laser above



Schematics of the prototype. U0, V- and V+ supply voltages, A1 and A2 amplifier, C1 and C2 capacitors used with Resistor Rs for valtage stabilization, Rg1 and Rg2 resistors for amplifier gain, Rw 25 µm thick wires, R1 resistors, R2 and R3 potentiometers for balncing the bridge

- Beam profiles could be measured and properties like $1/e^2$ –radius calculated

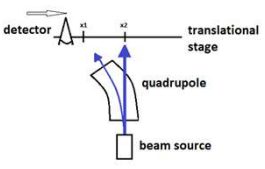


Beam profile obtained with detector in black and in red fitted a gaussian curve with linear beackground in green data from knife-edge method

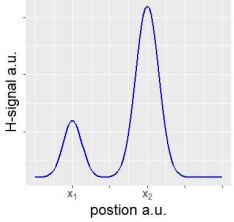
- Sensitivity for beam $Q_{min} = (1.5 \pm 0.06) \cdot 10^{14} \frac{H-Atoms}{S}$ and for the laser $P_{min} = (0.47 \pm 0.02)\, mW$
- Saturation is reached with beam for $Q_{max} = (600 \pm 0.06) \cdot 10^{14} \frac{H-Atoms}{S}$ and with laser for $P_{max} = (200 \pm 0.02)\, mW$

Future Plans

- Development of enhanced PCB version
- Tests with hydrogen beam, example on the right
- Designing translational stage for beam profiling in vacuum chamber



Plannend measurement of H-distribution after quadrupole velocity selection



Expected signal in dependency of detector position

For more information about projects in AG Pohl and a download of all posters of the group

Sources
[1] V. A. Trofimorov et al. "A Two-Coordinate Detector for a Beam of Atomic Hydrogen or Deuterium".In: *Instruments and Experimental Techniques* Vol. 48.No.1 (2005), pp. 122–126.
[2] A. Vassiliev. "OnLine monitor of the hydrogen (deuterium) atomic beam". preprint.
[3] A. Vassiliev et al. "Two-Dimensional Multiwire Monitor for the Investigation of the atomic Hydrogen Beam". preprint.
[4] H.-L. Schumacher, " Detector for Atomic Hydrogen", Bachelor Thesis JGU, Mainz
[5] https://luma-metall.com/wp-content/uploads/2017/01/LUMA-Tungsten-alloyed-with-rhenium_march2014.pdf