

Design and optimization of the magnetic field profile inside a cryogenic tritium atom source

Master's thesis at the Tritium Laboratory Karlsruhe

Motivation

The Karlsruhe Tritium Neutrino (KATRIN) experiment measures the neutrino mass by precision spectroscopy of the tritium beta-decay spectrum at its endpoint.

One of the limitations of next-generation neutrino mass experiments (following KATRIN) will be the broadening of the spectrum due to molecular final states. To avoid this, we are currently developing an atomic tritium source.

One possible concept is to dissociate a solid molecular tritium film, frozen at temperatures below 1 K with electrons generated by an RF-discharge. The working principle of such a source was demonstrated by our colleagues in Turku with hydrogen. Now we are cooperating with them to build such a source with tritium.

Before building a prototype, the magnetic field to guide the low-field seeking atoms from the dissociator through the buffer gas beamline into a trap needs to be optimized.

Goal

Designing the magnetic field profile and optimizing the buffer gas cooling inside a cryogenic tritium atom source.

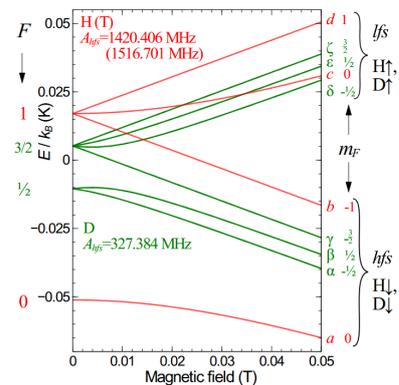
Tasks

Calculation of the magnetic field profile for a basic configuration of the source. The fields are used as input for Monte Carlo simulations to:

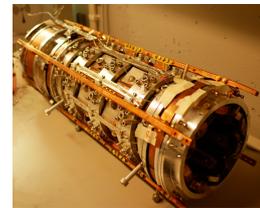
- Evaluate loss fractions of atoms inside the buffer gas beamline.
- Optimize the source geometry and investigate the radial confinement strength of the magnetic fields.
- Determine the velocity distribution of atoms exiting the beamline.

Scope of the thesis

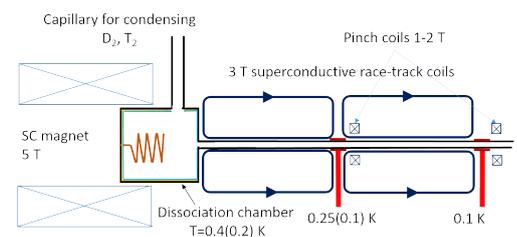
During the thesis, a simulation framework will be developed to solve the tasks listed above. Existing tools, such as Kasiopeia for the magnetic fields, will be utilized.



Hyperfine level diagram for hydrogen, tritium and deuterium.



Picture of a Ioffe trap built at University of Turku, Finland



Schematic for a cryogenic tritium atom source

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