Contribution ID: **532** Type: **Poster**

Atomic Hydrogen Beam Characterization Techniques for the Project 8 Experiment

Friday, 21 June 2024 17:30 (2 hours)

To achieve a sensitivity of 40 meV/c^2 in neutrino mass measurement, the Project 8 experiment relies on cyclotron radiation emission spectroscopy of beta decay electrons from an atomic tritium source. Due to the radioactive nature of tritium, initial R&D work for source and diagnostic tools development is carried out with a hydrogen beam. Presently, a thermally heated hydrogen atom source, capable of reaching temperatures up to 2400 K, is employed at JGU Mainz. Molecular hydrogen passes through a 1 mm tungsten capillary, generating atoms through surface contact catalyzing due to tungsten's dissociative adsorption isotherm for hydrogen. Various techniques are utilized to characterize the dissociation efficiency of this source. One such technique, able to measure the atomic dissociation fraction as well as the beam shape, is the wire detector.
Aging of the heating element, thermal shields, and capillary in the atom source will alter its surface structure over time, affecting the capillary's resistivity and surface emissivity. To accurately assess the capillary's temperature stability and establish the correlation between atomic fraction and temperature, a near-infrared (NIR) spectrometer and a visible range multi-channel camera are employed to measure the capillary's absolute temperature.
Results from measurements conducted at different flows (up to 20 sccm) and at various atom source temperatures will be presented for the wire detector, NIR spectrometer and camera. The source and beam results are crucial for optimizing the performance of the atomic tritium beam setup and advancing the goals of the Project 8 experiment.

Poster prize

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Session Classification: Poster session and reception 2

Track Classification: Neutrino mass