STATUS OF THE MARK-II POLARIZED HYDROGEN JET TARGET*

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Progress on the Mark-II ultra-cold polarized atomic hydrogen gas jet target is presented. We describe the performance and the present status of different components of the jet.

To study spin effects in high energy collisions, we are developing an ultra-cold high-destiny jet target of proton-spin-polarized hydrogen atoms (Mark-II). The target uses a 12 Tesla magnetic field and a 0.3 K separation cell coated with superfluid ^{4}He to produce a slow monochromatic electron-spin-polarized atomic hydrogen beam; an rf transition unit then converts this into a proton-spin-polarized beam, which is focused by a superconducting sextupole into the interaction region. Extrapolating our prototype jet experimental results [1], we expect to achieve a Mark-II target thickness of about 10^{13} atoms$\cdot$cm^{-2} with a 2 cm jet thickness crossing an accelerator beam.

A layout of the Mark-II is shown in Fig.1. Atomic hydrogen is produced in a room temperature rf dissociator and guided to the ultra-cold separation cell coated with superfluid ^{4}He to depress the surface recombination of atoms. The double walls of the cell form the mixing chamber of the dilution refrigerator. The cell's entrance and exit apertures are respectively located at about 95%

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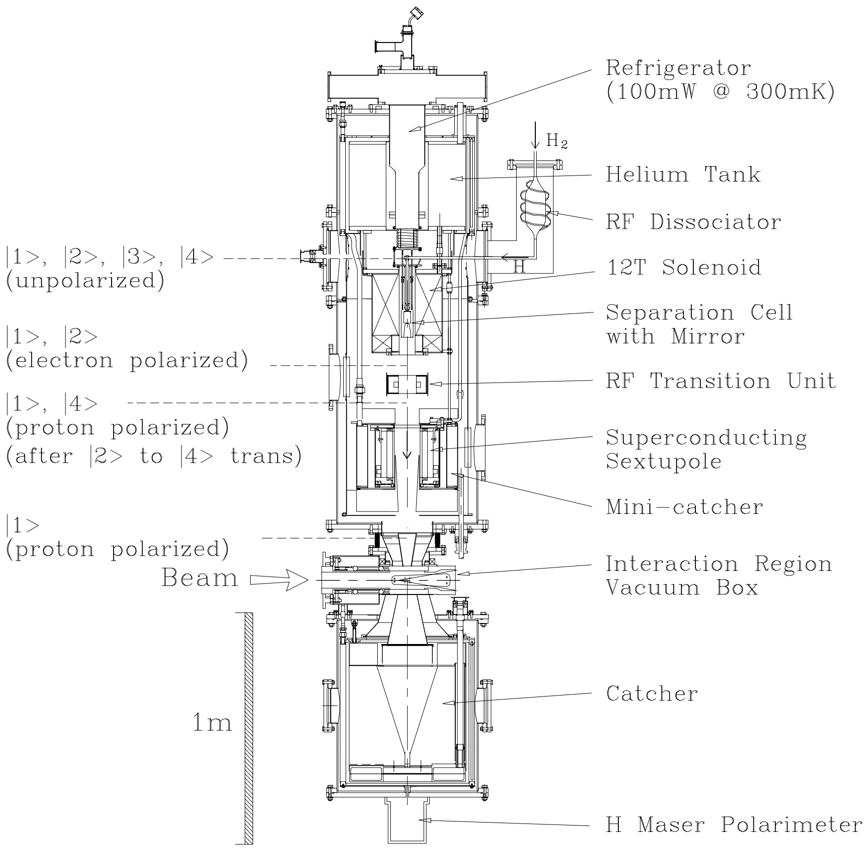

Figure 1: The layout of the Mark-II ultra-cold jet.

and 50% of the 12 Tesla central magnetic field of the superconducting solenoid. After the hydrogen atoms are thermalized by collisions with the cell surface, the magnetic field gradient physically separates the atoms according to their electron-spin states. The atoms in the two lowest hyperfine states ($\mid 3 >$ and $\mid 4 >$) are attracted toward the high field region and escape from the cell. They quickly recombine on bare surfaces and are cryopumped. The atoms in the two higher hyperfine states ($\mid 1 >$ and $\mid 2 >$) are repelled toward the low field region and effuse from the exit aperture, forming an electron-spin-polarized beam. We plan to later use a focusing mirror with a polished surface covered with superfluid ^{4}He film similar to the prototype mirror [1]; the mirror should significantly increase the jet density [3]. After an rf transition unit, which interchanges atoms in states $\mid 2 >$ and $\mid 4 >$, the beam passes through a superconducting sextupole. The sextupole selects atoms in electron spin state $+1/2$ by focusing atoms in state $\mid 1 >$ into the interaction region and defocusing atoms in state $\mid 4 >$, which are then cryopumped. The proton-spin-polarized beam then passes through the interaction region and is caught below by a cryopumping catcher. A maser polarimeter below the catcher monitors the beam's proton polarization.

Most of the Mark-II parts have been fabricated and successfully tested. This hardware includes: large vacuum chambers and pumping systems, liquid nitrogen tanks and shields, a 12 Tesla superconducting solenoid, a dilution refrigerator with a measured cooling power of about 50 mW at 300 mK, a 20 cm long superconducting sextupole magnet with iron poles and an 11 cm diameter bore, a cryocondensation pump with a measured [2] pumping speed of about $1.2 \cdot 10^7$ liters/sec ($4.2 \cdot 10^{26}$ atoms/torr$\cdot$sec) , a hydrogen maser polarimeter capable of monitoring the polarization to about $\pm 2\%$ in a few minutes, four superfluid ^{4}He film burners, a first Mark-II mirror [3], a compression tube detector, and instrumentation and computers.

The electron polarization of the beam will be converted into proton polarization by adiabatic passage through an rf transition unit with a novel ring dielectric resonator that accepts a 6 cm diameter beam. A room temperature prototype rf transition unit has been tested; its maximum measured transition efficiency is 97%.

We have started the first beam tests of the Mark-II.

References

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