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A next-generation inverse-geometry spallation-driven ultracold neutron source

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The concept of a next-generation spallation-driven ultracold neutron (UCN) source capable of delivering an integrated flux of about 1E9/s is presented. A novel "inverse geometry" design is used with 40 liters of superfluid 4He (He-II) as converter cooled with state-of-the-art sub-cooled cryogenic technology to ~1.6 K. Our design is optimized for a 100 W maximum thermal heat load constraint on the He-II and its vessel. We use a modified Lujan-Center Mark-3 target for UCN production as a benchmark, then present our baseline inverse geometry source design that gives a total UCN production rate of PUCN=2.4x10E8/s. In our geometry, the spallation target is wrapped symmetrically around the He-II volume and moderators to permit raster scanning the proton beam over a relatively large volume of tungsten spallation target to reduce the demand on the cooling requirements, which makes it reasonable to assume water edge-cooling is sufficient. Our design is refined in several steps to reach PUCN = 2.1E9/s under our other restriction of 1 MW maximum proton beam power. We also study effects of the He-II scattering kernel used and reductions in PUCN due to pressurization to reach PUCN = 1.8E9/s. Finally, we estimate the UCN transport efficiency to show that the total extracted rate out of the source can be Rex ≈ 6E8/s from a 18 cm diameter guide. These extracted rates are around an order of magnitude higher than the strongest proposed sources so far, and is around three orders of magnitude higher than existing sources.

Poster back-up

No

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