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High efficiency epithermal neutron detectors

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A 2.5 cm diameter epithermal neutron detector using thermal neutron sensitive glass fibers was designed, built and tested. The detector is intended to replace a 2.5 cm diameter, 15.25 cm long (active area) 10 atmosphere ^{3}He tube with .51 mm of cadmium shielding. The thermal neutron sensitive glass fibers are enriched in ^{6}Li (28 atom %) and emit scintillation light via Ce^{3+} emission. The fibers are multimode waveguides with glass cores ~110 um in diameter with a low refractive index silicone rubber cladding. The prototype detectors contain ~2,400 fibers embedded in moderator and connected to 1.3 cm photomultiplier tubes. Two versions of the detector were made: one ambient temperature detector using ~ 66 atom % hydrogen moderator and another for operation at 200 C using ~50 atom % hydrogen moderator and high temperature photomultiplier tubes. The effectiveness of the design was modeled using MCNP for neutron energies from 0.5 eV to 10 MeV. Initial epicadmium neutron efficiency measurements were made with a NIST traceable ^{252}Cf source and PuBe at ambient temperatures. The moderated fiber detectors were compared to a cadmium-shielded 10 atm ^{3}He tube in the same neutron field.