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# The A+ Low-Loss Faraday Isolators

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Advanced gravitational-wave detectors require low-loss Faraday isolators in the squeezer path, in order to maximize the benefits of the squeezed light injection. The University of Florida and Montclair State University have developed and are currently building two designs of low-loss Faraday isolators for the A+ upgrade, one output Faraday isolator (20 mm clear aperture) and two squeezer Faraday isolators (5 mm aperture). Both designs also serve as circulators. The required losses are <1% single pass, while maintaining an isolation ratio higher than 30 dB.

The designs use TGG as the magneto-optical material placed inside a vacuum-compatible magnet, with temperature tunability of the Verdet constant via a thermo-electric Peltier device. A single quartz rotator cut at 45 deg restores the initial polarization. The input polarizer is a wedged KTP prism while a thin film polarizer at the output allows for the injection of s-polarized light from the squeezer or the optical parametric oscillator. The output Faraday isolator design also includes a fused-silica wedge to compensate for the beam's angular displacement from the signal recycling mirror. All optics are super-polished and coated with high-performance IBS dielectric coatings. The Faraday devices assembled so far show 0.45% - 0.63% single pass loss, with better than 30 dB isolation.

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