The DarkLight Project

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The DarkLight experiment at Jefferson Lab's energy-recovery linac (LERF, Low-Energy Recirculator Facility) aims to discover a dark (or hidden) photon A' in the $e^- p \to e^- p\, A' \to e^- p\, e^+ e^-$ reaction [1]. The motivation is based on cosmological evidence for dark matter along with astrophysical observations of positron excess, suggesting the existence of a light dark force carrier with a mass of few MeV to the order of hundred MeV, which kinetically mixes with the photon of the Standard Model. The main point of DarkLight is to detect the full final state to take advantage of kinematical redundancy, and to provide a clear signature of candidate events. The signal for a hidden photon would be found as a peak in the invariant mass spectrum of the lepton pair, accompanied by a continuous, irreducible QED background. In order to be sensitive to very small couplings, the experiment requires a very high luminosity (provided by a 100-200 MeV energy-recovery linac and an internal gas target). The DarkLight project is pursued in several stages. In Phase 1, a setup with a solenoidal magnet, internal hydrogen gas target, and lepton detection with GEM detectors and thin SiPM read scintillators has been conceived, in order to demonstrate the high-luminosity capability and to probe hidden photon couplings in the region of the so-called g-2 welcome band. The ultimate (phase-2) DarkLight experiment is being developed with a fully integrated and optimized internal target region.

Phase-1 DarkLight has received full funding from NSF. A first engineering run (Phase 1a) has taken place in August 2016, with subsequent phases 1b and 1c envisioned until end of 2018. Phase 1b is set to measure low-energy Møller scattering with a different setup, consisting of a magnetic dipole spectrometer, to study radiative effects in Møller scattering with high precision. Phase 1c is now being designed as a dedicated search for the recently reported 17-MeV particle, by using a pair of magnetic high-resolution spectrometers for detection of the lepton pair. This work has been supported by NSF and DOE.

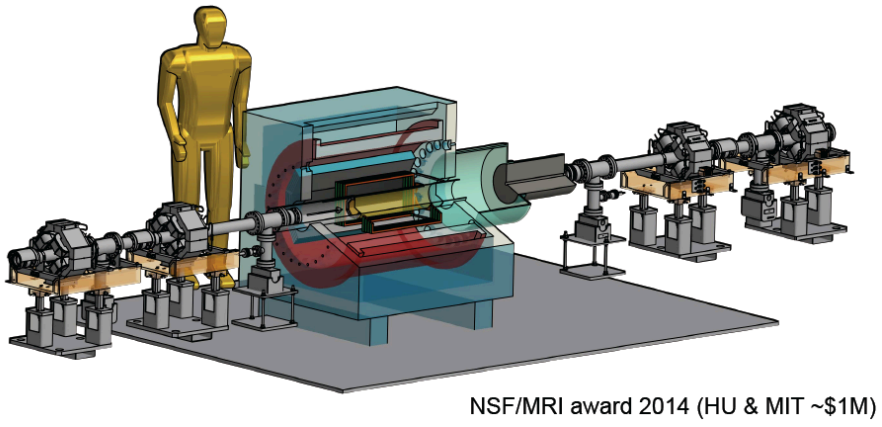

Figure 1: The DarkLight solenoid at LERF.

[1] J. Balewski *et al.*, (The DarkLight Collaboration), `arXiv:1412.4717`.