DarkLight: a search for dark forces at the Jefferson Laboratory Free Electron Laser

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1 Goal of experiment

DarkLight aims to search for A' bosons in the mass range 10-90 MeV with a sensitivity to couplings $\alpha' = 10^{-9} - 10^{-8}$ using the process

$$e^- + p \rightarrow e^- + p + A' \rightarrow e^- + p + e^- + e^+$$

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and searching for a resonance in the invariant mass of the $e^+ - e^-$ pair in the final state. Our experiment aims to reconstruct all four final state particles to minimize non-QED backgrounds and provide the best invariant mass resolution possible. We are also exploring using the same dataset to measure the proton charge radius and carry out electroweak measurements.

2 Experimental setup

DarkLight is a particle spectrometer using the 100 MeV JLab Free Electron Laser (FEL) beam on a windowless dense (10^{19}/cm^2) hydrogen target in a 0.5 T solenoidal magnetic field, Fig. 1. Surrounding the target is a proton detector (which has a gas based detector in the barrel and could have a silicon sensor in the forward direction) covering the angular range $5° - 90°$ followed by a lepton tracker covering angles $25° - 165°$. A lead scintillator sandwich surrounds the tracker.

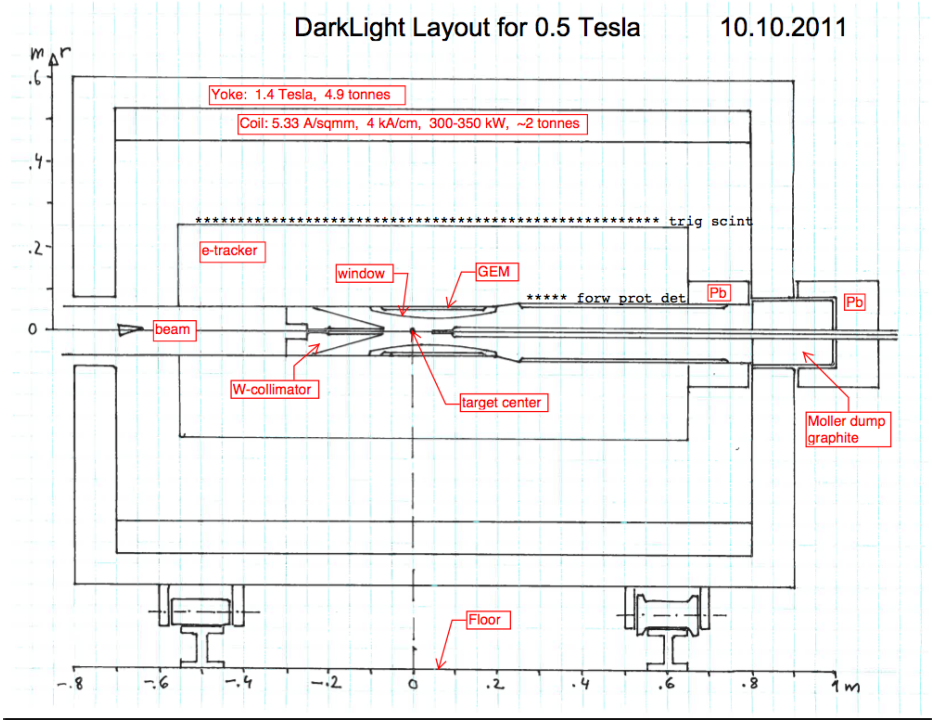

Figure 1: Cross section of DarkLight detector showing the major components and parameters.

3 Accelerator or Lab Facility

DarkLight plans to use the 100 MeV electron beam from the JLab FEL, 2. We have identified Location A1 as the site on the UV beam line for DarkLight. The FEL provides a beam power of 1 MW and, with the dense hydrogen target, will provide 1/ab of integrated luminosity per month of operation.

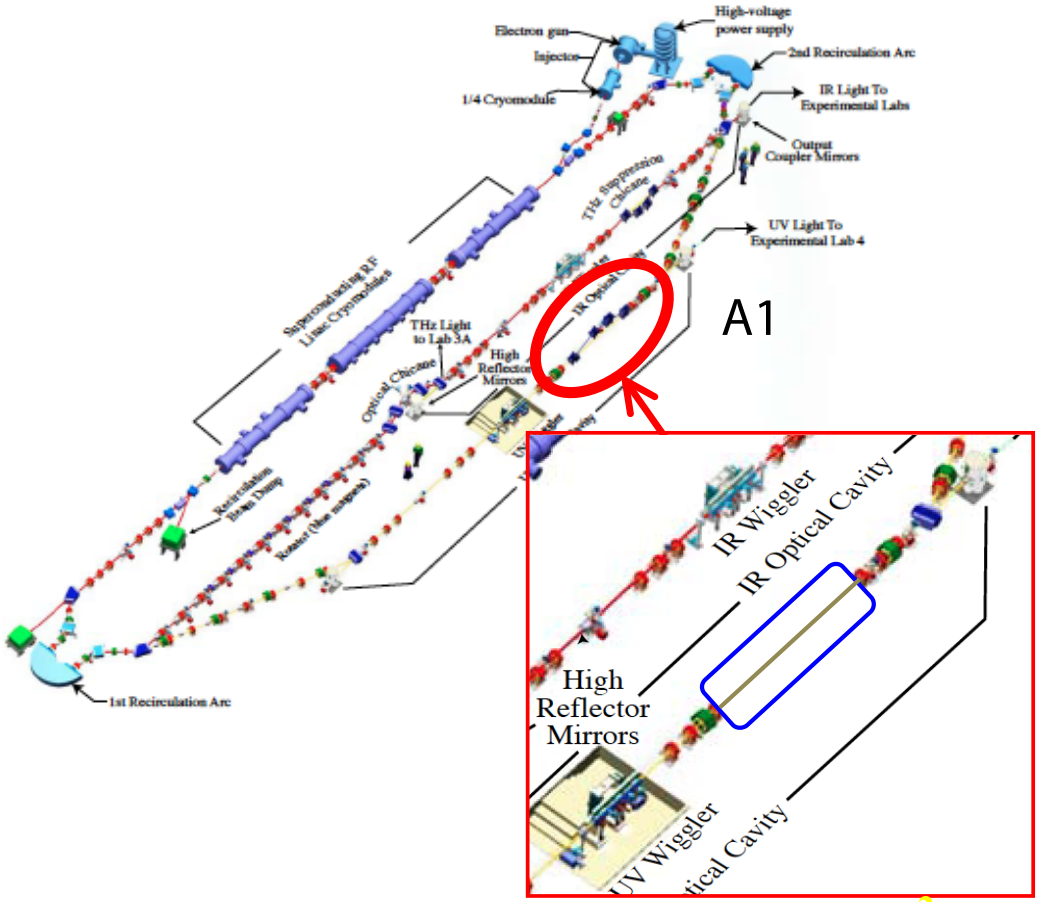

Figure 2: Layout and parameters for the JLab FEL. DarkLight will be located at position marked A1.

4 Physics Reach

The physics reach in A' mass and coupling parameter space is shown in Fig. 3, assuming one month of data taking at the FEL.

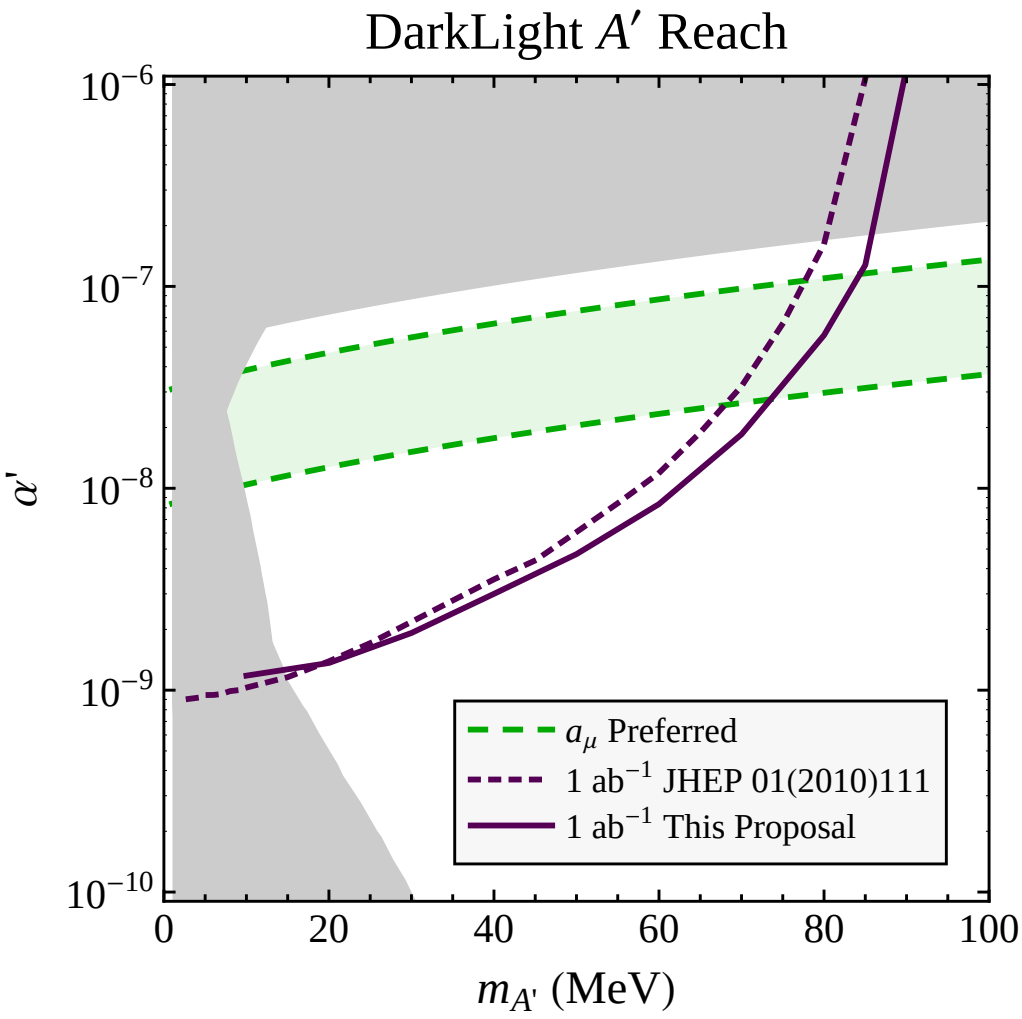

Figure 3: Estimated sensitivity for DarkLight assuming one month operation at the FEL.

5 Status and Schedule

A proposal was submitted to JLab PAC37 in Jan. 2011 requesting conditional approval to allow us to carry out beam tests at the FEL to ensure our target was compatible with the FEL beam and carry out beam halo measurements. Conditional approval was granted and JLab has allocated funds to carry out the beam test in June 2012. We are preparing a final proposal requesting full approval for PAC38 which meets in June 2012. We project data taking will start in mid-2015.

6 Future Plans

At this time, we have not made plans past the initial run.

7 Written Materials

The DarkLight PAC37 proposal may be found here: http://tinyurl.com/73bj5wj.