

Narrative

(10) Polarized electron/positron studies

Future lepton colliders require electron and positron beams to simultaneously have high peak beam intensity $> 5 \text{ A/cm}^2$ and high degree of spin-polarization $> 80\%$. The SLC polarized 100 kV e-gun demonstrated 10 A/cm^2 and $> 70\%$ spin-polarization from a GaAs photocathode. The JLAB 130 kV polarized e-gun demonstrates 4 A/cm^2 with spin-polarization of $\sim 90\%$. Recent advances offer easing the technical challenges of operating a polarized electron source in two ways, a) GaAs DBR (distributed Bragg Reflector) photocathodes suggest a QE improvement of $\sim 6\times$ also with high-polarization and b) a 400 kV photo-gun with inverted insulator suggest minimizing risk to field emission and XHV (extreme high vacuum). Secondly, such a polarized electron source offers a possibility to directly produce spin-polarized positron beams, viz a viz by polarized bremsstrahlung and polarized pair creation, so the resulting positrons now carry spin polarization. The collaboration between KEK and JLAB will advance the strategy for polarized electron/positron sources for future colliders.

At JLAB, this effort is supported by a 2-year DOE award "High Voltage Insulators and Electrodes for 500kV DC High Voltage Photo-gun with Inverted Insulator Design", a 1-year DOE HEP Stewardship award with Cornell Univ. for a photocathode experiment at the JLAB's Upgraded Injector Test Facility entitled "Demonstrating improved lifetime in superlattice photocathodes with robust activating coatings for high current, highly spin-polarized beam production", and a JLAB Laboratory Directed Research and Development award to evaluate the parameters for an e-driven polarized positron source. The collaboration with KEK under this proposal will support information exchange and selected hardware design. KEK has been developed the rotating target for the e-driven higher positron generation. Rotating target prototype will be installed on FY2021 and the performance test will continue till FY2022. Optimization of the positron generation system will be carried out on FY2023.

Separate Institutional Responsibilities

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KEK will evaluate through simulations the collection of the positrons produced in the bremsstrahlung and pair creation process of a conventional target. A focus will be to determine the compatibility of this approach to a conventional target scheme or to propose needed modifications. The optimization of the yield, beam phase space and correspondent spin polarization define the useful metric. JLAB will (a) hire a postdoc to perform electrostatic and mechanical design of a HV epoxy receptacle mated to a commercial cable with intervening SF6 layer between the receptacle and inverted insulator then test to 500 kV in SF6 filled chamber, (b) will add Cs/Sb/Te/O to a deposition chamber a 200 keV Mott polarimeter to a beam line then characterize charge lifetime and polarization of GaAs photocathode, and finally (c) hire a post-doc to implement a spin-tracking code to study polarized positron collection from an e-driven geometry.