Positron Working Group
News Letter

http://wiki.jlab.org/pwg

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The recently created Jefferson Lab Positron Working Group (PWG) is now developing scientific activities towards JPos17 International Workshop, to be held at JLab in 2017. Topical sub-groups have been created and are seeking for the contributions of interested persons to pursue new ideas and develop experimental projections within the CEBAF 12 GeV and JLEIC contexts.

Please contact the PWG coordinators of the topic of your interest.

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1 JPos17 International Workshop

We have successfully received a FY17 Jefferson Science Associates Initiative Award to support a proposed International Workshop on Positrons at Jefferson Lab (JPos17). This award effectively kicks-off the organization of the workshop which is anticipated to occur at Jefferson Lab in August or September of 2017. The exact dates will be fixed in January and announced thereafter.

JPos17 will be organized as a 3-4 day workshop with successive sessions corresponding to the physics reach of 12 GeV CEBAF, the proposed JLEIC, and sub-MeV positron applications. A specific accelerator session dedicated to positron production for each scenario completes the scientific program. If you wish to contribute or make a presentation at the workshop please contact the corresponding PWG sub-group coordinators.

2 Scientific information

Interference physics

The recent release of the results of the OLYMPUS experiment [1] did not bring a fully conclusive answer with respect to the role of the two-photon exchange mechanism in elastic electron scattering. This expresses the need for new experimental data, especially in a kinematic range where these higher order contributions are expected to be significant. The combination of a polarized positron beam with a large acceptance detector at reasonably accessible luminosities should provide a definitive answer to this problem. It would also be possible to examine Coulomb corrections for precision measurements on heavy nuclei. This is of interest in quasielastic scattering (e.g. for the Coulomb sum rule) and deep-inelastic scattering (DIS) kinematics (A dependence of R=σ_L/σ_T). However, systematics effects require carefull attention to allow powerfull comparaison of electron and positron responses, as for example in the case of the charge asymmetry observable of the DVCS channel.

In the CEBAF 12 GeV energy domain, polarized positron beam intensities ranging from tens up to hundreds of nA are anticipated. This intensity range is particularly adapted with the operation of polarized targets and opens exciting physics possibilities at CEBAF 12 GeV.

Charged current physics

Charged and neutral current DIS with a positron beam offers a unique opportunity to probe the partonic structure of nucleons and nuclei. With high-intensity polarized electron and positron beams at JLEIC, one can obtain the full flavor decomposition of the nucleon quark and antiquark distributions, as well as further our understanding of meson cloud effects and diffractive contributions to structure functions.

Inclusive production of charm and anticharm in charged current DIS also offers the best way to obtain information on strangeness in the nucleon. The availability of polarized positron and electron beams would provide the necessary tools needed to disentangle the strange and antistrange distributions unambiguously.

Plans are under way to organize a focused mini-workshop to identify and refine possible measurements with positrons that could significantly enhance our understanding of parton structure. We envision a 1-day meeting around March 2017, with local and remote participants, and the information gathered will provide useful guidance for the development of this topic at the JPos17 Workshop later in the year.

Test of the Standard Model

The production of an intense, high energy, and highly polarized positron beam represents a unique opportunity to produce and study light dark matter at accelerators. In the last few years new theoretical scenarios have been proposed to explain the lack of observation of galactic Dark Matter and a strong experimental activity, making use of high intensity electron and proton beams, is being carried out at many facilities around the world. Positron annihilation on electron is expected to be a clean and powerful technique to reveal an entire dark sector of new particles and interactions. Experiments have already been proposed with colliding (BaBar and Belle) and extracted (Padme, MMAPS) beams but the limited energy and intensity will only prove the principle, preparing the ground for the future high intensity and energy positron beam.

Positron applications

Considering accelerator based slow positron production, beam qualities for applications are essential in terms of useful intensity, spot size, angular dispersion, and technique to reach sub-MeV energies. A scheme of interest involves an efficient positron collection system followed by a decelerating section to reach at minima 10^{10} e^+/s and 50% polarization. For an initial electron beam in the tens of MeV range, produced positron energies are very similar to the ones of the International Linear Collider scheme. An optimized capture system could then potentially benefit not only the positron project at JLab.

Based on radioactive sources, slow positron research with polarized beams is starting to develop activities in connection with spintronics [2, 3] and magnetic moment measurements. Acccelerator based slow positron source can definitely bring not only high beam intensity and polarization, but also new investigation methods based on the easy spin reversal of the initial electron beam.

Positron source and beam physics

The positron source and beam physics sub-group is exploring stand-alone positron injector solutions that satisfy three key experiment parameters: positron intensity, positron polarization and suitable bunch structure. The initial parameters for CEBAF 12 GeV are intensity of 5 μA cw and

polarization greater than 60%, and for JLEIC a collision luminosity greater than 10^{33} cm^2/s (integrated luminosity about 10 fb^{-1}/year) and polarization larger than 40% with a suitable injection scheme. While the expected positron polarizations are not an issue with the PEPPo concept [4], the few μA high duty cycle beam intensity goal is definitely challenging.

With these conditions in mind the working group is developing a strategy to leverage the JLab highly spin polarized electron source and the PEPPo approach for efficiently transferring polarization from electrons to positrons. For both CEBAF and JLEIC the envisaged positron injector requires extending the polarized electron source intensity reach into the ∼mA range. A novel approach being considered for the JLEIC scheme is to charge an accumulation ring with MeV electrons before dispensing them to the positron conversion target with the required bunch structure. A polarized positron injector R&D plan based on this scheme for CEBAF/JLEIC has been submitted to the DOE Early Career Research Program by F. Lin from CASA. In addition, the Niowave Inc., within the context of a proposal submitted to DOE SBIR/STTR Phase IIB and partnered with JLab, is developing a high power (>10 kW) bremsstrahlung radiator to be tested as a suitable positron production target.

References

[1] B.S. Henderson *et al.* arXiv:1611.04685 (2016).

[2] A. Kawasuso, Y. Fukaya, M. Maekawa, H. Zhang, T. Seki, T. Yoshino, E. Saitoh, K. Takanashi, J. Magnetism and Magnetic Mat. **342** (2013) 139.

[3] M. Maekawa, H. Zhang, H. Li, Y. Fukaya, A. Kawasuso, JJAP Conf. Proc. **2** (2014) 011305.

[4] (PEPPo Collaboration) D. Abbott *et al.* Phys. Rev. Lett. **116** (2016) 214801.

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