Jefferson Science Associates, LLC
Managing and Operating the Thomas Jefferson National Accelerator Facility
for the U.S. Department of Energy

FY2017 JSA Initiatives Fund Proposal Summary Sheet

Proposal title JPos17, International Workshop on Positron Physics at Jefferson Lab

(●) New proposal ( ) Renewal **Total funds requested** $4,000 **Total leveraged support / Matching funds * See Note below.** $5,000

To be completed by JSA: Total funds awarded **$4,000**

Note: Identify in your budget proposal the source, type and amount of support from each institution.

Principal Investigator (PI) Eric VOUTIER

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Mailing address
Email / phone #

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Check one category: If PI is a Lab employee, your identification of the appropriate Associate Director below represents the acknowledgement of that AD with your submittal of proposal. **No signature required.**

( ) Lab employee	If Lab employee, Associate director (email / phone)	
(●) Lab user	If Lab user, University affiliation. Joint appointees, identify Lab division association.	Université Paris-Sud & Paris-Saclay
( ) Other	If Other, Institutional affiliation	

Executive summary including the projected begin/end dates. **Project Start Date** (mm/yy) 06/17 **Project End date** (mm/yy) 07/17
Add additional pages if necessary.

The benefits of polarized and unpolarized positron beams for answering specific questions of hadronic physics have been demonstrated in several experiments at Saclay, JLab, and DESY. In complement to electron beams, positron beams offer, for example, the possibility to reveal the importance of two-photon exchange mechanisms in the elastic scattering of leptons off protons. At high enough lepton beam energy, positron beams provide a unique window of investigation of the electroweak structure of the nucleon. Recent developments in polarized positron production demonstrated at the CEBAF injector, open new perspectives for the experimental hadronic physics program at JLab and a future EIC. The purpose of the JPos17 International Workshop on Positron Physics at Jefferson Laboratory is to discuss these new opportunities with respect to: interference physics, charged current physics, tests of the Standard Model, positron applications, positron production and beam physics. The Workshop will address the new physics opportunities offered by polarized positron beams in the context of the 12 GeV CEBAF, the LERF, and a proposed EIC. The essential ideas will be synthetized within the workshop proceedings that will constitute the basis for a White-Paper on Positron Physics at Jefferson Lab.

JPos17 will be held at JLab over the course of June 2017, and will gather about 50 participants from US and international universities covering theoretical and experimental physics related to positrons. Special attention will be dedicated for attendance of PhD students and postdocs. The scientific committee leading the organization of the workshop includes: J. Arrington (ANL, Argonne, USA), M. Battaglieri (INFN, Genova, Italy), T. Forest (ISU, Pocatello, USA), J. Grames (JLab, USA), C. Hyde (ODU, Norfolk, USA), W. Melnitchouk (JLab, USA), V. Morozov (JLab, USA), E. Voutier (IPN, Orsay, France), and X. Zheng (UVA, Charlottesville, USA). It reflects a long standing and sucessful involvement in the development of the experimental hadronic physics program, particularly at Jlab, and a sound expertise in organizing scientific events.

A total amount of $4000 USD is requested within the JSA Initiatives Fund Program to provide partial support for the attendance of key-speakers, and the participation of PhD students and postdocs. Matching funds from JLab ($3500 - Bob McKeown, $500 - Andrew Hutton) and IPN Orsay ($1000 - Eric Voutier) are completing the Workshop total budget detailed in the document attached to this form.

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Proposal title JPos17, International Workshop on Positron Physics at Jefferson Lab

Principal Investigator (PI) Eric VOUTIER

Synopsis of scientific, educational, technical, and/or business merits, and alignment with and significance to Lab's current program. Add additional pages if necessary.

Scientific, technical and educational merits:

- Development of a Positron Physics case unique to JLab in general, and JLEIC in particular;
- Assessment of accelerator technologies for an easy access to polarized positron beams;
- Formation of a positron user communitty gathered within the Positron Working Group;
- Introduction of PhD students and young postdocs to a growing field of research with perspectives ranging from solid state to high energy physics.

Alignment and significance with JLab's current program:

- The relevance of polarized positron beams for the determination of the electromagnetc form factors and the generalized parton distributions of the nucleon has been suggested previously. Continuing discussions and quantitative evaluations are necessary to assess the benefit of positron beams on that essential part of the 12 GeV science.
- Positron beams at 12 GeV CEBAF would extend the JLab experimental program on U-boson search to the inivisble decay channel.
- The perspective of polarized positron beams can potentially open a new field of research specific to JLEIC.

Proposed evaluation plan to measure success. If this is a request for renewal of funds, assessment of prior year performance. Add additioinal pages if necessary.

This workshop aims at defining the scientific basis for polarized and unpolarized positron beams at JLab. It will also contribute to refine and strengthen the technological developments required to achieve this science. Measures of the success of this initiative will be:

- Attendance and involvement of JLab and EIC communitties;
- Proceedings synthetizing the essential ideas and benefits of positron beams for hadronic physics;
- White-Paper on Positron Physics at JLab and a future EIC;
- Developments of collaborative efforts in positron physics, accelerator R&D, and detector projects;
- Formulation of new proposals for positron beam experiments at JLab.

Your proposal may include letters of endorsement and other supporting information. A maximum of 10 additional pages may be appended to this proposal form.

Budget Proposal

Proposal Title JPos17, International Workshop on Positron Physics at Jefferson Lab

Principal Investigator (PI) Eric VOUTIER

Total funds requested $4,000 **To be completed by JSA: Total funds awarded** $4,000

Item Description		Amount
Equipment. Lab users submitting proposals that include equipment to be used at the Lab must review with the appropriate Lab Associate Director.		
The provision of the name of the AD below represents the AD's acknowledgement. **No signature required.**		
Associate Director: _____		
Subtotal Equipment		$0
Travel Support. Provide break-out of estimates for registration fees, lodging and transportation, catering, and facility charges (room rentals, AV equipment; etc.)		
Support of travel/accomodations of certain identified conference participants:		
1 - key senior speakers requiring partial support for their particpation	$2,100	
2 - young researchers (PhD students and postdocs)	$1,900	
Subtotal Travel		$4,000
Supplies		
Subtotal Supplies		$0
Consultants/Subcontracts		
Subtotal Consultants/Subcontracts		$0
Other Expenses. Examples include stipends and honoraria, prizes, awards. The JSA Initiatives Fund Program does not support salaries and salary-related expenses, or indirect expenses. Describe other expenses below.		
Subtotal Other Expenses		$0
Total Budget Proposal		**$4,000**

Budget Justification and Leveraged Support/Matching Funds information. Identify the source, type and amount of support from each institution. For in-kind support, provide estimate of value. Your identification of the authorized representative who has committed institutional support for your proposal represents the acknowledgement of that individual. If support or funds are provided by the Lab, identify the associate director (or equivalent) as the authorized representative. Add additional pages if necessary.

The total budget of the workshop is detailed in the supplemental documentation and amounts to $11520 USD for 50 participants. It breaks into the JSA fund request ($4000), JLab matching funds ($3500 - Robert McKeown (bmck@jlab.org), $500 - Andrew Hutton (andrew@jlab.org)), IPN Orsay matching funds ($1000 - Eric Voutier (voutier@ipno.in2p3.fr)), and regsitration fees ($2520 for 36 paying participants).

JSA funds will be dedicated to travel and accomodations support of key-participants and Ph.D. students/postdocs.

Proposal for an

International Workshop on Positrons Physics at Jefferson Lab

JPos17

Organizers : John Arrington[1], Marco Battaglieri[2], Tony Forest[3], Joe Grames[4](Co-Chair), Charles Hyde[5] Wally Melnitchouk[4], Vasiliy Morozov[4], Eric Voutier[6](Co-Chair), Xiaochao Zheng[7]

[1] *Argonne National Laboratory, Argonne, Illinois 60439, USA*
[2] *Istituto Nazionale di Fisica Nucleare, 16146 Genova, Italy*
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[5] *Old Dominion University, Norfolk, Virginia 23529, USA*
[6] *Institut de Physique Nucléaire, Université Paris-Sud & Paris-Saclay, 91406 Orsay, France*
[7] *University of Virginia, Charlottesville, Virginia 22901, USA*

Summary

The benefits of polarized and unpolarized positron beams for answering specific questions of hadronic physics have been demonstrated in several experiments at Saclay, JLab, and DESY. In complement to electron beams, positron beams offer, for example, the possibility to reveal the importance of two-photon exchange mechanisms in the elastic scattering of leptons off protons. At high enough lepton beam energy, positron beams provide a unique window of investigation of the electroweak structure of the nucleon. Recent developments in polarized positron production demonstrated at the CEBAF injector, open new perspectives for the experimental hadronic physics program at JLab and a future EIC. The purpose of the JPos17 International Workshop on Positron Physics at Jefferson Laboratory is to discuss these new opportunities with respect to: interference physics, charged current physics, tests of the Standard Model, positron applications, positron production and beam physics. This proposal discusses the scientific motivations, objectives and organization of JPos17. In particular, the framework for a newly formed Positron Working Group is explained in the context of developing a successful scientific agenda and producing a White Paper on Positron Physics at Jefferson Lab.

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1 Scientific Context and Motivations

An experimental program with positron beams, both polarized and unpolarized, may provide valuable opportunities in the future program at Jefferson Lab. In the context of Hadronic Physics it can provide the required complementary tool for a precise and non-ambiguous understanding of

the electromagnetic structure of the nucleon, both in the elastic and deep-inelastic domains. At higher energies, typical of the Electron Ion Collider (EIC) project, it may provide a unique window of investigation to electroweak physics that offers new pathways in search of physics beyond the Standard Model.

In particular, the application of polarized positron beams within high energy accelerators has, until recently, been limited to the self-polarizing Sokolov-Ternov effect of stored positron beams. In the context of the International Linear Collider project, the creation of prompt polarized positrons has been demonstrated with the use of very high energy GeV electron beams to produce polarized gamma rays, with subsequent polarized positron production via e^+e^- pair production on heavy nuclear targets. But, very recently the PEPPo (Polarized Electrons for Polarized Positrons) experiment at the CEBAF injector demonstrated an alternative method that opens access to prompt polarized positron beams and using much lower MeV electron beam energies. Consequently, a new technology pathway for the JLab and EIC scientific community to exploit highly polarized positron beams is available for consideration.

In this framework, we are proposing an International Workshop on Positron Physics at Jefferson Lab (JPos17) with the intent to discuss the potential for a positron physics program and explore the associated technical challenges. Five focus sub-groups (described below) have been identified relevant to a scientific program at 12 GeV CEBAF, the LERF, or a future Electron-Ion Collider.

- *Interference Physics (Conveners: John Arrington, Charles Hyde)*

  The effort of this sub-group is to consider the benefits of the application of polarized positrons in the electromagnetic physics sector. In the energy range curently available at JLab, there is no specific difference with respect to the scientific information obtained with an electron or a positron probe. However, when more than one QED-based (Quantum Electro-Dynamics) mechanism contributes to a reaction process, the comparison between lepton beams of opposite charge allows one to uniquely distinguish the quantum interference between these mechanisms. This feature is expressed in the experimental measurement of the electromagnetic form factors of the nucleon where two-photon exchange mechanisms may reconcile cross section and polarization data, and also in the experimental measurement of the generalized parton distributions of the nucleon where the interference between the Bethe-Heitler and virtual Compton amplitudes is a key observable.

- *Charged Current Physics (Conveners: Wally Melnitchouk)*

  This sub-group will focus on the evaluation of the merits of polarized positron beams for electroweak physics, most likely accessible at EIC energies. Charged $W^{\pm}$ currents (CC) differentiate electron and positron beams as essentially different experimental probes, able to uniquely isolate positively or negatively charged quarks. CC Deep Inelastic Scattering (DIS) access combinations of quark flavors different from those measured with purely electromagnetic DIS, providing an alternative and novel source of information about parton distribution functions (PDFs), particularly for the unpolarized and polarized strange and to some extent charm PDFs. For example, the availability of polarized electron and positron beams would provide the necessary tools to measure the difference between the strange and anti-strange quark distributions as well as to investigate the isovector EMC (European Muon Collaboration) effect.

- *Tests of the Standard Model (Conveners: Marco Battaglieri, Xiaochao Zheng)*

  Electromagnetic and electroweak interactions with polarized electron and positron beams may provide new possibilities to probe the existence of physics beyond the Standard Model

(SM) description. Comparison between a left-handed electron beam and a right-handed positron beam will provide the first measurement of a charge-conjugation violation observable, the effective electron-quark coupling C_{3q}. The e^+e^- annihilation, on the other hand, is a promising channel in search of a U-boson or heavy photon, candidate of SM-Dark Matter interaction mediator. The combination of high energy and high intensity positron beam would provide the best reach achievable in terms of mass range and coupling constant in the invisible decay channel $e^+e^- \to \gamma U$. Polarization observables are here expected to leverage a significant role for suppressing background to identify the experimental physics signal of interest. The absence of right-handed charged currents within the Standard Model forces the CC DIS cross section to be zero at maximum beam polarization +(-)1 for $e^{-(+)}$. Measuring the beam longitudinal polarization sensitivity of the total CC cross section allows a natural test the Standard Model through searches for right-handed charged currents and setting limits on the right-handed W-boson exchange.

- *Positron Applications (Conveners: Tony Forest)*

  Positron annihilation spectroscopy (PAS) is a well-known technique for investigating the structural properties of materials. Because of the purity of the 2γ signal produced from the annihilation of positrons with atomic electrons, this technique is a very sensitive probe of material defects and constitutes an accurate method for the measurement of the momentum distribution of electrons. Nevertheless, the globally poor availability of intense positron beams at low energies (1-1000 keV) precludes efficient use of PAS. An MeV electron accelerator production of positrons, like that used in the PEPPo experiment, can easily provide two orders of magnitude greater beam intensities than the most powerful nuclear reactor based facility. Adding controlled and flexible polarization capabilities with the PEPPo technique at accelerator facilities, may constitute a technological breakthrough for PAS and help address the lack of low energy positron research facilities world-wide.

- *Positron Production and Beam Physics (Conveners: Joe Grames, Vasiliy Morozov)*

  The efficient transfer of polarization from electrons to positrons (>80%) has been demonstrated by the PEPPo experiment and offers a new pathway to use low energy polarized electron beams (10-100 MeV/c) to promptly produce polarized positrons suitable for acceleration at high energy. A challenging aspect of the positron injector is the optimization required to achieve the desired beam characteristics, such as beam intensity, transverse emittance (size), bunch length and energy spread (longitudinal emittance) necessary and be well-mated to the accelerator design (e.g. 12 GeV CEBAF, LERF, JLEIC). A core activity of this sub-group will be to to evaluate the user requirements, accelerator integration and assess the merits and risks of different schemes appropriate for JLab, in order to summarize and recommend the R&D needed for a successful positron physics program.

2 Objectives

We have recently announced the Jefferson Lab Positron Working Group (PWG) to explore physics possibilities for 12 GeV CEBAF, LERF and the proposed EIC. Organized into the five topical sub-groups described above, each will be served by conveners who will lead the life of the sub-group. Over the course of fiscal year 2017 the conveners are expected to hold discussions and short meetings (outside the scope of this proposal) to grow their respective sub-group, explore interests, develop priorities and refine their efforts into an informative and compelling session at JPos17. In

this regard, the essential ideas about a positron experimental program will be synthetized within the workshop proceedings, and in turn will be a basis for a Jefferson Lab Positron Physics white paper, expected near the end of 2017.

This global effort will set the scientific basis for polarized and unpolarized positron beams at JLab. It will also contribute to refine and strengthen the technological developments required to achieve this science, as was happening earlier with the JPos09 International Workshop on Positron at Jefferson Lab and the PEPPo experiment at the CEBAF injector.

3 Organization

The workshop will be held at JLab in the second half of June, 2017, and coordinated effectively with the Annual User Group Meeting. The workshop will contain 6 half-day sessions spanning 3-4 days, with one session devoted to each sub-group topic and one additional general session which will include a close-out with discussion of the goals, scope and deliverable of the PWG.

We anticipate 50-70 participants, including local, domestic and international attendees. Priorities will be given to support students, young scientists and key speakers to attend the workshop.

4 Evaluation

- Tne scientific output of this workshop in terms of attendance, proceedings, and a white paper deliverable will measure the success of this initiative.
- It is also expected to motivate and support further collaborative efforts in positron physics and R&D accelerator and detector projects related to JLab and EIC.
- Student and young scientist participation will be given high priority, especially to grown this new JLab working group.

5 Budget

The tentative budget (Table 1) for JPos17 is evaluated for a global number of 50 participants and includes partial support for 8 Ph.D. students/postdocs and 6 speakers. Conference fees are fixed to \$70/person considering 36 paying participants. The total funding request to JSA amounts to \$4000 that would be allocated to students/postdocs and key-speakers support.

Expenditures			**Funding prospects**	
Item	Unitary cost (\$ USD)	Total cost (\$ USD)	Source	Amount (\$ USD)
Speaker Support	350	2100	JSA Initiative Funds	4000
Student Support	240	1920	JLab/Deputy Director of Science	3500
Proceedings	3500	3500	Registration fees	2520
Breaks	40	2000	IPN Orsay	1000
Reception	40	2000	JLab/Accelerator Division	500
	Total	**11520**	**Total**	**11520**

Table 1: JPos17 tentative budget.