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 Accelerator Physics Education Outreach With Mexican Universities

○ New proposal ◉ Renewal **Total funds requested** $7,280 **Total leveraged support / Matching funds * See Note below.** $1,000

To be completed by JSA: Total funds awarded **$3,500**

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

Principal Investigator (PI) Carlos Hernandez-Garcia

Institutional affiliation / Mailing address / Email / phone #
Center for Injectors and Sources, Jefferson Lab
600 Kelvin Drive, Ste. 8, Newport News, VA 23606
chgarciar@jlab.org, (757) 269-6862

Co-PI (if more than 1 add pages with information) Matthew Poelker

Institutional affiliation / Mailing address / Email / phone #
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poelker@jlab.org, (757) 269-7357

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): Andrew Hutton, andrew@jlab.org, 757-269-7396

○ Lab user — If Lab user, University affiliation. Joint appointees, identify Lab division association.

◉ Other — If Other, Institutional affiliation

Executive summary including the projected begin/end dates. **Project Start Date** (mm/yy) 05/17 **Project End date** (mm/yy) 08/17
Add additional pages if necessary.

This proposal is to financially support one undergraduate student (Senior) rigorously selected from a Mexican University for 10 weeks, with lodging at the SURA Residence Facility and with per diem. The period in which the requested funds would be used is from May 29, 2017 to August 5, 2017. Travel to and from JLab is fully covered by the student's home institution, appears in the total leveraged support/matching funds box above.

The awarded student receives mentorship in accelerator physics R&D contributing to the Lab research program, particularly in electron guns. The PI has a verbal agreement with Dr. Hari Areti and with the JLab Education Department (via Lisa Surles-Law) to join the REU/SULI summer program. This has been key in the success of the Accelerator Physics Education Outreach program with Mexican Universities, that started back in 2009. Please see supporting supporting letter attached to this application.

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Proposal title Accelerator Physics Education Outreach With Mexican Universities

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

Since 2009, Jefferson Lab has hosted one student from a Mexican University each summer for 10 weeks, initially with funds from the FEL program. In 2013, funding for this activity continued through an SBIR Phase II grant contract between SVT and JLab's Center for Injectors and Sources group. Starting in 2014 and through 2016, partial funding was awarded through Jefferson Science Associates, LLC Initiative Fund Program. The program has been a fantastic success, with 8 out of 11 students enrolled in graduate studies, most of them in accelerator physics (see supporting documentation).
Under the mentorship of the PI and Co-PI, the students receive training in basic concepts of beam dynamics, and hands-on experience in electron photo-injectors.
Students in their senior year enrolled in Mexican Universities are rigorously selected amongst the best in a national competition started more than 20 years ago by the Division of Particles and Fields of the Mexican Physical Society. Out of about 100 students that participate in the contest, two students go the DESY, one to Fermilab, one to CERN, and since 2009, one to JLab. In 2016, we were fortunate to have additional funds to support two students, whom were also the first two female students in the program.
The second Mexican Particle Accelerator School was hosted by University of Guanajuato in November 2015, in which four of the students whom have benefited from this program participated giving lectures and being part of the organizing committee.
It is therefore thanks to the JSA support that bright and fully committed Mexican students are given the opportunity to learn about the multiple disciplines in accelerator physics and to experience working in an environment like Jefferson Lab, an experience that does not exists in Mexico but that

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.

The PI works directly with the student on a daily basis. The measure of success is based on:
a) The student participates actively and prepares a final report adhering to the SULI/REU guides, and
b) The student presents a poster at the end of the stay following the SULI/REU guides. The poster is presented to the JLab community.
c) The PI writes a final report on the student performance that is submitted to the student's home institution, to the student selection committee at the Division of Particles and Fields, and to JSA.

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 Accelerator Physics Education Outreach With Mexican Universities

Principal Investigator (PI) Carlos Hernandez-Garcia

Total funds requested $7,280

To be completed by JSA: Total funds awarded $3,500

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.)		
Lodging at the SURA residence facility for 10 weeks	$3,710	
	Subtotal Travel	$3,710
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.		
Per diem for 10 weeks	$3,570	
	Subtotal Other Expenses	$3,570
	Total Budget Proposal	**$7,280**

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 duration of the program is 10 weeks.

Lodging:
The cost per night at the SURA residence facility is approximately $50/night
70 night x $50 = $3,500
Tax 6% = $210
Lodging Total: $3,710

Per diem:

70 days at a rate of $51 per day
Per diem total: $3,570

August 1, 2016

Ms. E. Lawson
Jefferson Science Associates, LLC

Supporting information for proposal:

Accelerator Physics Education Outreach with Mexican Universities
JSA Initiatives Fun support program

PI: **Carlos Hernandez-Garcia**
Co-PI: **Matthew Poelker**

Dear Ms. Lawson:

This letter is supporting documentation for the proposal entitled: "Accelerator Physics Education Outreach with Mexican Universities", which is a renewal from the fiscal year 2016.

Thanks to JSA's award of this proposal in the previous three years, we have been able to provide partial support for one undergraduate physics student from Mexico each summer, giving them the opportunity to learn about the multiple disciplines in Accelerator Physics and to experience working in an environment like Jefferson Lab, something that does not exist in Mexico. A new generation of students, and future scientists, are seeking to change, and eventually, become the leaders in developing an accelerator physics program with the ultimate goal of designing, building and operating an accelerator user facility in Mexico. The Jefferson Lab Education Department has kindly allowed the students to join the SULI/REU program, which undoubtedly enriches their experience at JLab. The opportunity that JLab has provided to these students has had a tremendous impact in the long-term Mexican accelerator program: six out of eight students are currently enrolled, or have just finished their accelerator physics PhD degrees granted by ODU with their thesis work done at JLab, or granted by Mexican Universities through thesis work done at CERN. Other Mexican students are following similar paths at KEK (Japan), Fermilab (Chicago), and the Cockcroft Institute (UK). A total of 15 students are at the front of a new generation who is trying to establish the accelerator physics program in Mexico with support from their PhD mentors in their home institutions.

The list below shows all the Mexican students whom have spent their summer at JLab starting in 2009. All students have been selected through the national contest organized annually since 1985 by the Division of Particles and Fields of the Mexican Physical Society.

Year	Student Name	Project @ JLab	As of July 2016
2009	Cristhian Valerio	DC electron guns	Ph.D, Physics 2015 from U. of Sonora with thesis work at CERN on space charge dominated ion sources. Mexican Particle Accelerator School organizing committee member
2010	Salvador Sosa	Cyclotron Kids	ODU graduate student, thesis work @ JLab on material properties (coatings) for next generation SRF cavities (J. Delayen). Mexican Particle Accelerator School organizing committee member
2010	Luis Medina	Cyclotron kids	U. of Guanajuato graduate student, thesis work @ CERN on beam optics for the Future Circular Collider. Mexican Particle Accelerator School organizing committee member
2010	Alejandro Castilla	Crab cavity design	ODU Ph.D, candidate, thesis work @ JLab on Crab cavity design and testing. Now Postdoc at CERN. Mexican Particle Accelerator School organizing committee member
2011	Saul Cuen	2nd pass BPM electronics	U. of British Columbia graduate student, thesis work @ TRIUMF.
2012	Cesar Serna	Injector: Parametric beam dynamics simulations	Information not available.
2013	Gabriel Palacios	Characterization of strained multi-layer	ODU graduate student, with G. Krafft as thesis adviser.

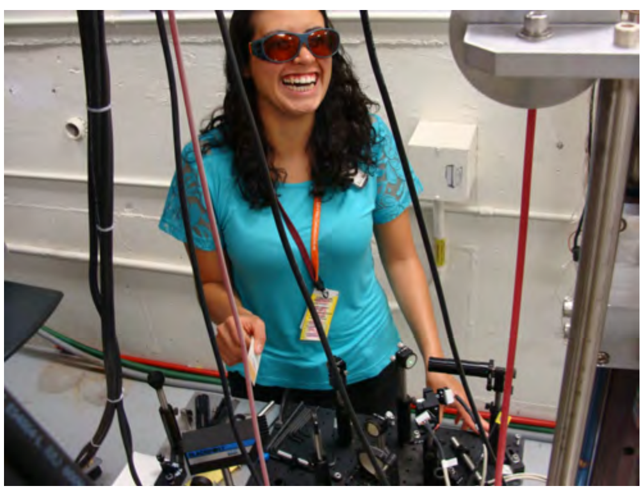
		GaAs photocathodes for polarized electron beam	
2014	Andres Sanchez	Design of next generation Mott polarimeter	Seeking graduate studies in accelerator physics.
2015	Edgar Abarca	Multi-alkali photocathode on Nb	Attended Mexican Particle Accelerator School in Nov 2015, has been awarded two-year fellowship to the Joint European Master Programme Advanced Materials Science and Engineering in Germany.
2016	Adriana Canales	Multi-alkali photocathode studies in 300kV inverted electron gun	First female student since program started in 2009. Adriana has been granted full scholarship to the Erasmus Mundus Master on Nanoscience and Nanotechnology, at Katholieke Universiteit Leuven, Belgium.
2016	Maria (Chio) Hernandez	Multi-alkali photocathode studies at LN2 temperatures	Thanks to Dr. H. Areti, we have the opportunity to host two students this summer, whom happen to be the first two female students since we started the program in 2009. Maria is actively exploring graduate studies opportunities at ODU.

The abstracts from Adriana's and from Chio's work are included below.

Multi-Alkali Photocathodes Performance in a DC 300 kV Inverted Geometry electron gun.

ADRIANA CANALES-RAMOS (Universidad Nacional Autónoma de México at Mexico City, Mexico, C.P. 04510)
CARLOS HERNÁNDEZ-GARCÍA, and MATTHEW POELKER (Thomas Jefferson National Accelerator Facility, Newport News, VA 23606).

The electron-ion collider (EIC) proposed by Jefferson Laboratory requires unprecedented hundreds of mA of un-polarized electron beam at MHz repetition rates (Continuous Wave, CW) to cool down the ion beam. As a viable alternative to Cs:GaAs photocathodes (in ~100 kV DC electron guns) for generating an electron beam that meets those stringent requirements we are studying multi-alkali photocathodes in a High Voltage Direct Current (HV-DC) inverted-geometry insulator electron gun. The performance of our in-house fabricated CsK2Sb photocathodes is characterized with the 1/e QE lifetime, showing great robustness in a 300kV DC inverted-geometry electron gun. Even severe damage caused by arcing at the photocathode electrostatic center did not affect QE in the laser-illuminated area; moreover no QE decay was detected while measuring lifetime at 0.1 and 0.5 mA sustained in each case for several hours. We present the highest electron beam current (1.0 mA DC) generated at the highest voltage (300kV) in an inverted-geometry electron gun with multi-alkali photocathodes. The next step towards higher current needed for the EIC is to run stable 5.0 mA electron beam with the same electron gun configuration.

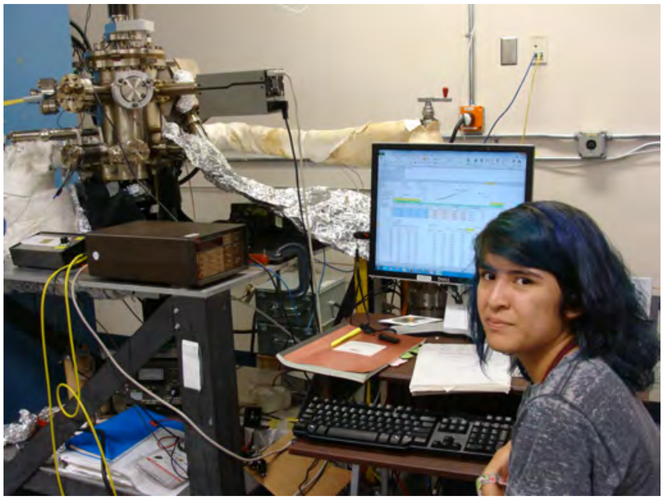


Adriana in the Gun Test Stand with the Quantum Efficiency Scanner

Effect of Water on Cryo-Cooled Bialkali Antimonide Photocathodes Grown on a Niobium Substrate.

MARIA DEL ROCIO HERNANDEZ-FLORES (Autonomous Metropolitan University Campus Azcapotzalco, Mexico, DF 02200), MD ABDULLAH A. MAMUN, MATTHEW POELKER, and C. HERNANDEZ-GARCIA (Thomas Jefferson National Accelerator Facility, Newport News, VA 23606).

The accelerator that will be used to implement electron cooling of the proton beam for the Jefferson Lab Electron Ion Collider requires continuous wave (CW) electron beam at high average current and high bunch charge. A superconducting radio frequency (SRF) photogun represents an ideal candidate electron source for this application, but only if the photocathode can provide high yield, or quantum efficiency (QE), when cooled to cryogenic temperatures. Furthermore, the photocathode QE must remain high for long periods of time while delivering beam, a metric referred to as Lifetime (LT). The focus of this project was to make a bialkali photocathode using a niobium substrate and study its QE behavior at different temperatures in two different vacuum conditions (non-baked and baked chamber). The photocathode was made via deposition of antimony and co-deposition of a mixture composed by potassium and cesium on the niobium substrate by controlling its temperature, the partial pressure of the antinomy and of the alkalies in the chamber and the deposition time. The photocurrent was measured by illuminating the photocathode surface with a 532 nm laser at room temperature (RT) and at 77 K for the two vacuum conditions. In this work, we present the results obtained during this research, which suggest that one can expect a certain percent of reduction in QE when an alkali-animonide photocathode is cooled to 2 K, which is the operating temperature of an SRF gun; also, they suggest that QE reduction due to contamination of the photocathode surface via adsorption can be minimized.



Chio evaluating one of the Nb-based multi-alkali photocathode she made.

Please do not hesitate to contact me if I can be of any further assistance.

Best Regards,

Carlos Hernandez-Garcia
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