UNIVERSITY OF LOUISIANA AT LAFAYETTE

STEP Committee

Technology Fee Application

Enhancing cutting-edge student research at the Louisiana Accelerator Center

Title

Harry J. Whitlow

Name of Submitter

(Faculty or Staff Only)

Louisiana Accelerator Center

Organization

Title: **Enhancing cutting-edge student research at the Louisiana Accelerator Center** Date: 1/15/2017

Name (Contact Person): Harry J. Whitlow, Director Louisiana Accelerator Center
Address: University of Louisiana at Lafayette, P.O. Box 43680, Lafayette, LA 70504
Phone Number: 337-482-6696 Email: hxw1673@louisiana.edu
Department/College/Org: Louisiana Accelerator Center/ University of Louisiana at Lafayette

ABSTRACT (250 words or less):

The Louisiana Accelerator Center (LAC) is a multidisciplinary research center with the mission of cutting-edge research and student training in applying ion accelerators to carry out support the research and industrial development needs of society. A core part of this work is training graduate and undergraduate students in research.

This proposal covers the acquisition of new network infrastructure and modern student office PCs and printer. The acquisition will: (i) Allow undergraduate and graduate research students to use state-of-the-art Windows-PC software and web data bases, which is simply not possible at the present time. (ii) Enable students at LAC to use and develop as part of their training new advanced instruments that are based on the Internet-of-Things (IoT) without compromising network security or the security of administrative and infrastructure control computers. The enhanced ability to use state-of-the-art software and other tools will not only improve the quality of our student research training but in doing so will enhance students skill-set making them more competitive in the future employment market.

Instruction Sheet:

1. Complete the cover page.
2. Complete the abstract page.
3. Give a description of your proposal in 12 pt. font, single spaced, addressing the following points:
    a. Purpose of grant and impact to student body as a whole
    b. Projected lifetime of enhancement
    c. Person(s) responsible for
        i. Implementation
        ii. Installation
        iii. Maintenance
        iv. Operation
        v. Training (with qualifications)
    d. The narrative of the proposal must include the purpose and justification for each of the items listed in the Budget Proposal.
4. Complete the Budget Proposal form.
5. Include any additional information relevant to your application.
6. Discuss all previous funded STEP projects (if any).

ONE ELECTRONIC COPY (Microsoft Word or Adobe PDF) OF PROPOSAL SHOULD BE EMAILED TO stepproposal@louisiana.edu BY DEADLINE DATE.

For additional submission instructions and deadlines, please visit http://cio.louisiana.edu/step-process

NO HARD COPY SUBMISSIONS WILL BE ACCEPTED!

Enhancing cutting-edge student research at the Louisiana Accelerator Center

PI: Prof. Harry J. Whitlow
Louisiana Accelerator Center
University of Louisiana at Lafayette
PO Box 43680
70504 LA
hxw1673@louisiana.edu
(337)-482-6696

1. Introduction

The Louisiana Accelerator Center (LAC) is a multidisciplinary research facility in the University of Louisiana at Lafayette. The Center is organizationally part of the Materials Research Center under the vice presidency for research, innovation and economic development. *The mission of the LAC is to carry out cutting-edge research and student training in applying ion accelerators to support the research and industrial development needs of society.* Current themes are the simulation of the effects of radiation in space, modification of materials to make novel energy harvesting and actuator devices, objective improvement of microscope images using mathematical methods, improvement of cash crops by ion irradiating seeds and mapping of the interaction of organic and biological molecules. The LAC researchers actively participate in about ten national and international research collaborations.

The LAC operates a 1.7 MV Pelletron accelerator with three ion sources that enable the delivery of MeV ion beams of almost all stable elements. Three experimental stations are currently operational; a general purpose facility for analysis of materials, MeV ion irradiation facility with a large area internal and small area external irradiations and a MeV ion microbeam. The latter is equipped for elemental mapping and direct writing of lithographic patterns with focused ion beams.

Since August 2016 when the new Director of arrived, the LAC has been upgraded. A central pillar of the work is providing training to undergraduate, graduate and even PhD students on frontline research. A second pillar is undergraduate courses using the research facilities at LAC to enhance student learning outcomes. Eight formal UL Lafayette courses are taught by LAC staff, or involving LAC including *physics* and *Ion beam analysis*; two new courses on: *Interactions of ion beams with focus on biological and polymeric materials* and *Vacuum science and technology* starting in the Spring Semester 2017.

2. Current status of student computing and network services at LAC

The computing faculties specifically used by students at LAC comprise four ancient (circa 2005-2006) PCs. These originally ran Windows 2000 and Windows NT and have been upgraded to Ubuntu in order to run at all. The analysis computer that currently runs the MeV ion microscope runs Windows-98. The PCs are connected with mostly 10base-t standard. (We may also have 10base2 in a dark corner!) There are currently two 2.4 GHz Wireless Access Points (WAP) one (Accelerator Hall) manages 32Mb/s upload/download; the other (office area) achieved 16.9 Mb/s with no other active download/upload traffic, according to tests. This will slow down further depending on the number of co-active downloads/upload and when traffic is high due to video chats etc. This infrastructure is slow, does not meet the university data security requirements. is difficult to access due to the need to use multiple passwords and has at best limited remote management configuration capabilities.

The Ubuntu PCs and slow network access present a considerable barrier to student learning. This is specifically because:

- Modern data bases such as the Protein Data Base (PDB) EXFOR nuclear data base, VMD etc. demand fast network connections and modern CPUs, especially where 3D visualization of molecular and crystal structures with many thousands of atoms are needed. We thus cannot use these as part of student assignments.
- No computers running Windows 7, or higher are available to students. This means that student training in using important standard accelerator-based analysis software including SRIM, GeoPIXE, GUPIX, OMDAQ, WinTRAX is at best restricted to a demonstration using the instructors computer.
- Internet of Things (IoT) is becoming increasingly common in lab instruments and systems. The current network is not compatible with this from a speed or security viewpoint.
- Access to the internet is troublesome for student users with the need to manage multiple passwords instead of the simple university-wide login procedure.
- A single TONP (Tired Old Network Printer) with poor image quality is used for printing for the entire LAC. This makes printing a time consuming procedure for students.

3. Implementation with technical motivation

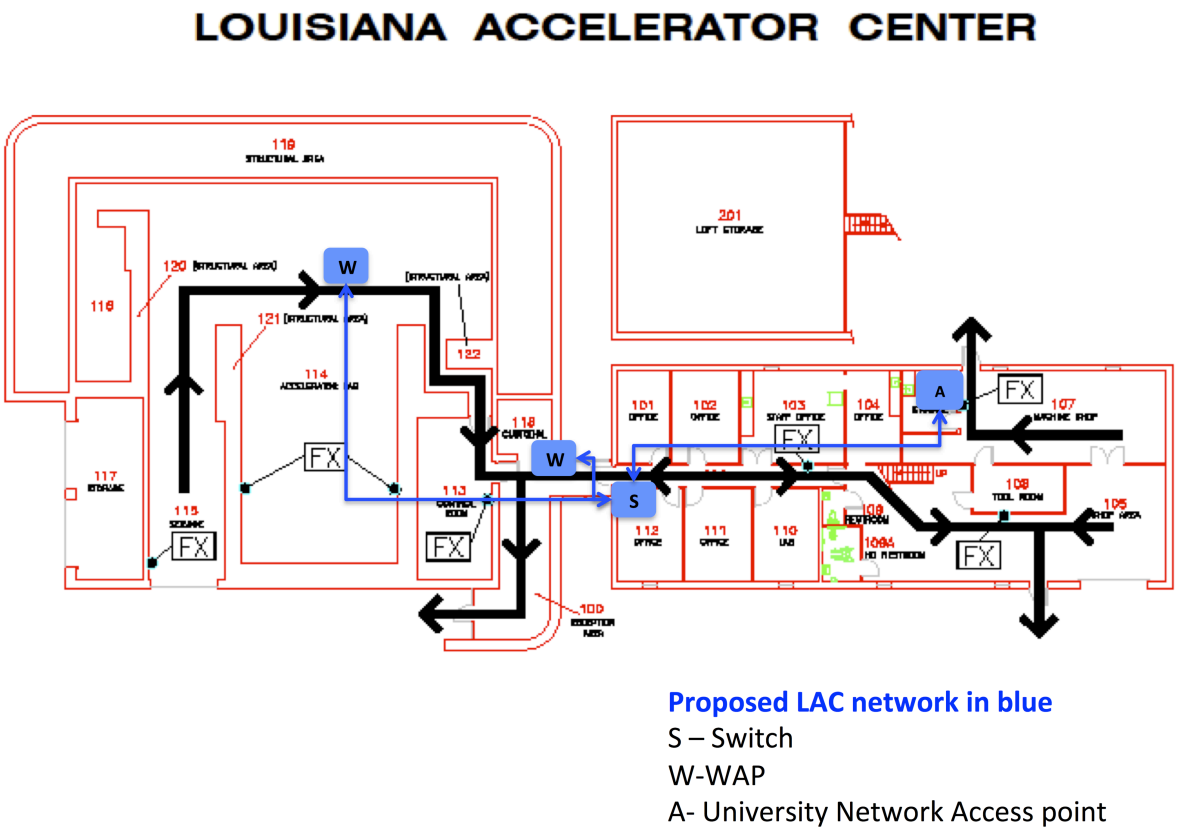

Figure 1: Proposed Network for LAC.

The implementation of the enhancement is based on replacing the existing network and wireless

hardware with modern compliant switch and WAPs as well as funding for new fast student PCs.
The special nature of the building means that one WAP is allocated to the office area and another WAP is located in the Accelerator Hall. This two-WAP configuration is necessary because the 1.2 m thick walls effectively shield 2.4-60 GHz wireless signals. The configuration is shown in Fig. 1.

(i) New Ethernet switch and WAPs

A new Power-over-Internet (PoE) switch and 2 WAPs with uninterrupted power supply and cables are needed. These are required to:

- Satisfy the University's network security requirements. The advantages conferred by this are that domain can be compartmentalized. This allows creation of a "sandbox" to mitigate the potential security venerability associated student research using and developing IoT instruments leading to illicit penetration of the University network and LAC administrative computers.
- Allow the standard University network login procedure can be used which will allow university staff and students who are not part of LAC, easy wireless network access while on site at LAC.
- The network infrastructure at LAC can be remotely managed.
- The existing network is old and a PoE switch and WAPs will mitigate end-of-life service issues before they happen.
- The PoE is more student-proof in a laboratory environment power often gets disconnected for a variety of reasons. A UPS will ensure the network functions during power outage. This is necessary as the internet is used for some building safety functions. (Hazmat data base.)

(ii) Four PCs with modern Windows operating systems.

These will replace the four Ubuntu PCs in the student offices and front-desk (used as research and study place by a student worker). This will:

- Facilitate student access to modern web-based databases
- Allow students to use essential PC based specialist analysis software directly on their office computers, which is not currently possible.
- Allow students to write reports and manuscripts for publication using MS Office software that is standard in the university. (Currently students are restricted to using Open Office)
- Facilitate off-line analysis of data.
- Facilitate student research development of specialized IoT instruments from the student workplaces.

(iii) A networked color laser printer for the student office.

This will enable students to make higher quality presentations than is afforded by the current TONP. In addition for students doing research with image data from the MeV ion microscope it will improve document their research results.

(iv) Replacement of the backbone Ethernet cables

To maintain a high performance we propose to replace the backbone Ethernet cables CAT 6 + fibre to from the University Network Terminal (within LAC building) to the switch and WAPs. 140 m of cable is estimated to be required.

(ii) Installation

The implementation is straightforward. The laying of the backbone cables within the building and setting-up and maintenance of the PCs will be done by a student worker at LAC (paid by LAC funds). The PCs will be supplied by the computer store. Purchase and connection of the switch and WAPs and backbone cables will be done IT personnel. The time frame is:

End April 2017	Acceptance/decline notification on funding.
End May 2017	Ordering of network and PCs. Decision on location of WAPs
End June 2017	Backbone cable laying in cable trays complete.
July 2017	VACATION
Early September 2017	Delivery of PCs and network components.
End September 2017	Installation of network components and PCs
End October 2017	Network acceptance complete, old PCs and network components decommissioned.

(iii) Maintenance

Configuration and management of the LAC Network backbone will be the responsibility to Network services. They will perform the tasks of setting-up the switch and WAPs and defining sector containment as is usual way. The PCs will be maintained by LAC student workers, one of which will be designated to see that software updates are performed on a regular basis.

(iv) Operation

The Network part will be operated by Network services as University Infrastructure. The student computers will be operated by the LAC students themselves.

(v) Training

Training in the use of the web-based databases and use of the special software will be given by LAC staff. This will be done during existing courses (discussed below) which will be adapted enhanced by accommodating the upgrade and special 1:1 instruction for specific projects. No special training is required for network access.

4. Impact of the proposed enhancement on student training and development

The enhancement will have a number of strong impacts impacts on student research and education. This is particularly because LAC is emerging as a strong cross-disciplinary research center in line with our plan to have projects across the whole University. (Although at first sight this sounds unrealistic with say Visual Arts, LAC collaborates with a research center in Switzerland in a study of techniques for conservation and authentication of object d'Art).

4.1 Enhancement of formal courses

LAC staff are involved in a number of formal courses where the enhancement of computer services for students at LAC will significantly enhance the learning outcome. This improvement in learning outcome will because the students can themselves work directly with modern computer databases and advanced analysis software. (Currently this is restricted to demonstrations on the instructor's computer.) This gives a much improved learning experience that will feedback to attract increasing numbers of future students. This will translate to higher levels of learning outcome. Moreover, the use of modern visualization techniques means the students will acquire skills that will enhance their employment prospects. A list of courses and specific enhancements is given in the Table below.

Course code	**Course Title**	**Student numbers**	**Enhancement(s) afforded by proposal which are not currently possible.**
PHYS460-001(G) / PHYS521-003(G)	Vacuum Science and Techniques	5	Design study will use realistic data and 3D images from manufacturers web sites. Use of 3D-CAD possible for students.
PHYS460-002/PHYS521-003(G)	Interactions of ion beams with focus on biological and polymeric materials	5-7 (biannual)	Use of protein database (PDB) and visualization (VMD), SRIM code, OM-DAQ and GUPIX programs
PYS521	Nuclear microscopy	3-5 (biannual)	OMDAQ off-line data analysis, Geo-PIXE software. SRIM simulation of ion matter interactions. NIST X-ray physics data bases.
PHYS301	Modern physics	5-10	Use of EXFOR nuclear reaction data base, Lund/LBNL decay data base. NIST X-ray data base
PHYS440	Nuclear Physics	1-12	Use of EXFOR nuclear reaction data base, Lund/LBNL decay data base. IAEA neutron data base
PHYS 597/598	Special Project I and II	1-2	OMDAQ for off-line data analysis
PHYS 594	(Non-Thesis Project)	~1	OMDAQ for off-line data analysis, Geo-PIXE software. SRIM simulation of ion matter interactions. NIST X-ray physics data bases.
PHYS599	Thesis-masters	~1	OMDAQ for off-line data analysis, Geo-PIXE software. SRIM simulation of ion matter interactions. NIST X-ray physics data bases.

4.2 Informal courses and training for students

Students working/attached to LAC must complete a number of informal training courses for safety etc. Currently this requires a trip to Campus to complete the courses. The enhancement of doing these on-site at LAC is that instructors are available for direct consultation and one can study the equipment directly.

Course Title	**Students 2016-17**	**Projected students 2018-19**	**Enhancement(s) afforded by proposal which are not currently possible.**
Tandem Accelerator Physics	12	12	Use of interactive ion optics programs. Viewing of safety videos.
Basic Radiation Safety course	9	15	On-line testing, On-line viewing from Moodle or PC
X-ray radiation safety course	4	10	On-line course from Moodle
Liquid radiation source safety course	2	5	On-line course from Moodle
NORM radiation course	4	10	On-line course from Moodle
SRIM simulation course	3	15	Hands-on tutorials
Chemical safety for LAC	12	18	Use of project oriented on-line safety and ethics training materials. E.g. The Safety Dance video,

4.3 Student research at LAC:

In addition to/and as part of, the taught course work above the upgrade will give other specific improvements to the student learning environment at LAC.

(i) *Presentation of student research:* presentation and documentation of findings is a core part of research training. The enhancement will enable students to use MS Office (which is a *del facto* standard inside and outside the University) for reporting and presenting their work. In particular the replacement of the TONP will enable students working on image analysis to document their work. (This requires a good quality image rendering because the changes may be small.) The improved documentation quality will promote the impact of LAC student research.

(ii) *Participation of students in international collaborations:* Several current LAC students are involved in international collaborative research projects: Today these require several Skype meetings a week. The increase in network speed will promote student participation through better quality Skype meetings allowing LAC students to become even more active participants.

(iii) Development of IoT-based measurements:

A clear trend is the emergence of IoT-based laboratory instruments and personal mobile devices. In particular it is useful in accelerator laboratories because it avoids the need to use many expensive cables. (Average cost about $10/meter.) but also it allows communication across potential differences, which may be millions of volts and also eliminates ground-loop problems in sensitive measurements. No strong technological trend that presents an

alternative to Wi-Fi technology and its enhancements has emerged, so one may expect the current technology to remain usable over a 10-12 years perspective with a progressively reduced relative performance to state-of-the-art. For security and safety reasons we should not expose IoT devices to internet outside of LAC. This is not possible with the current set-up but will be implementable in the proposed upgrade.

5.Concluding remarks

From the above motivation, is clear that the proposed upgrade to the computer network at LAC will be of great benefit to future generations of students. This is because it will allow state-of-the-art software and databases to be used hands-on by the students. This translates to a better student learning experience and outcome and will improve their employability.

Budget Proposal

1. Equipment	**$ 15,070**	
PoE switch and optics		$ 5000
Backup power supply		$ 2500
2 off Wireless Access Points (AP-325).		$ 1450
Data runs for Aps		$ 400
Cat 6 cable 140 m á 10$/m		$ 1400
4 off Windows PCs w screen etc á $ 980		$ 3920
1 off color laser printer		$ 1800

1. Software **$ 0 (Paid from LAC operations budget)**

1. Supplies **$ 0 (Supplies will be covered from the LAC operations budget estimated $1500/y)**

2. Maintenance **$ 0 (PC:s Student worker funded by LAC – estimated 500$)**

3. Personnel **$ 0 (PC:s Student worker funded by LAC) – estimated 500$)**

4. Other **$ 0**

TOTAL: **$ 15,070**