

UNIVERSITY OF LOUISIANA AT LAFAYETTE

STEP Committee

Technology Fee Application

**Improving Quality of Imaging Technique by
optimizing Scanning Electron Microscope at
Louisiana Accelerator Center**

Title

**Dr. Naresh T. Deoli and Dr. Harry
Whitlow**

Name of Submitter
(Faculty or Staff Only)

Louisiana Accelerator Center

Organization

Title: Improving Quality of Imaging Technique by
optimizing Scanning Electron Microscope at
Louisiana Accelerator Center

Date: July 15, 2019

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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 involved in solving real-world problems by performing cutting-edge research and training student. The LAC houses an ion accelerator and its associated beam-lines for various projects including but not limited to: high-energy ion microscopy, materials modification, and materials analysis. The accelerator-based ion beam analysis techniques are well complimented electron microscopy technique. The LAC has a JEOL JSM-6460 LV scanning electron microscope (SEM) purchased in 2001 that is located in the accelerator hall. Currently, there are about 16 students (10 graduate and 6 undergraduate students) whose research is directly dependent on electron microscopy techniques at LAC. Moreover, students and instructors from other departments (e.g. Department of Physics and Chemical Engineering) utilize SEM facility at LAC. While LAC staff is responsible for regular maintenance of the SEM system, recommended factory maintenance has not been performed on the machine for over 12 years. The SEM at LAC is at a point where it has become troublesome and unreliable to use and replacing it with a similar system will cost over \$300K. Replacement is not immediately possible and if the SEM at LAC breaks down, then lot of work will be lost. This proposal requests installation of new aperture, aperture disk, scintillator tip, and reconfiguration of infrared camera as per factory recommended settings. This renovation will benefit student research in LAC for next 10 years.

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!**

PROPOSAL DESCRIPTION:

(a) Purpose of grant and impact to student body as a whole

The purpose of this request is to improve quality of the electron imaging technique by optimizing JEOL JSM-6460LV Scanning electron microscope (SEM) at the Louisiana Accelerator Center (LAC). SEM produces images of various samples by scanning the surface with beam of electrons, providing information about the surface morphology and composition of the sample. The SEM system at LAC was obtained in 2001 and has been used since by researchers and students at LAC.

One of the main goals of LAC is to transform students at UL Lafayette in to future researchers and technologists. Hence, a central pillar of the work is providing training to undergraduate, graduate (MS and PhD) students by facilitating their participation in frontline research. This has been achieved by exposing students to cutting edge technology which enhances their skills in competitive job market.

While the exact SEM system at LAC is no longer manufactured by JEOL, USA Inc., similar systems costs in excess of \$300,000. JEOL recommends yearly factory maintenance (service plan) which costs around \$10,000 – \$16,000. There is no dedicated electron microscopist at LAC and LAC staff are responsible for supervising day-to-day use of the instrument by students and maintaining this machine. Normally, SEMs have the electron-optical column cleaned and realigned yearly as part of the service plan. Since purchase in 2001 this has only taken place once in 2007. This has to some degree been mitigated because of the high level of technical skill at the LAC in charged-particle optics through enabled simple maintenance such as changing the electron gun filament to be carried out. The SEM performance is showing signs of deterioration, i.e., the broken scintillator tip, apparent miscommunication between infrared detector and software, misalignment in electron optical system, and deteriorating objective aperture assembly. If not addressed, these issues might result in complete shutdown of the SEM system at the LAC that will have a major impact on student research and training. The grant will allow LAC to have service by a JEOL engineer and optimize the electron microscope by replacing the above mentioned components. We anticipate this will increase the life of the instrument by 10-15 years.

The table below shows list of courses and specific enhancements afforded by the SEM upgrade.

Course code	Course title	Student numbers	Enhancement(s) afforded by proposal
PHYS 460	Vacuum Science and Techniques	5	Allows instructor to include widely used microscopic technique and demonstrate applications of vacuum technology.
PHYS 460	Interactions of ion beams with focus on biological materials	(5-7) biannual	Electron microscopy is used as complimentary technique in addition to ion-beam microscopy. (Hands-on laboratory work)
PHYS 460	Quantitative Ion beam	(5-7)	Hands on laboratory work for calibrating

	Analysis	biannual	magnification in MeV ion microscope.
CHEE 403/4	Laboratory Course	65-70	Electron microscopy to be included in laboratory course as surface analytical technique.
PHYS 202	Electromagnetism (calculus based)	70-75 Possibly more	Practical demonstration of energetic charged particle deflection in a magnetic field.
PHYS 208	Electromagnetism (algebra based)	70-75 Possibly more	Practical demonstration of SEM as an imaging instrument.
PHYS 597/598	Special Project I and II	1-2	Electron microscopy for surface and elemental analysis.
PHYS 594	Non-thesis project	1-2	Electron microscopy for surface and elemental analysis.
PHYS 599	Thesis masters	1-2	Electron microscopy for surface and elemental analysis.

We have observed the SEM to captures students interest and sometimes they return with their own samples to study in the instrument. This is particularly noticeable in the demonstrations organized at LAC for PHYS 202 and PHYS 208 and we have been able to recruit several STEM students for UG research because of these class-wide demonstrations. This is no doubt because the SEM directly impacts 160 students a year and this will increase in 2019 to over 200.

Undergraduate research projects

LAC is deeply committed to enhancing undergraduate research by involving student in small mini-projects that are part of cutting-edge research projects lead by LAC staff and associated researchers. It is emphasized that the LAC as a university-wide Center is able to offer cross disciplinary projects in a way that is not possible in a single department or school. For example we can team biology and physics students to look at different aspects of problems. This will be an essential and verifiable part of the SCS accreditation process. The SEM has played a part in a number of projects including Development of a secondary electron detection system for MeV ion microscopy (<https://physics.louisiana.edu/news-events/news/20190617/physics-researchers-add-enhancements-lac>) (2 UG students), the characterization of stony meteorites lead by Dr. Manavi Jadhav. (Project chosen to represent UL Lafayette at Undergraduate research conference (3 UG students). Another example, this time with the Department of Chemical Engineering, the SEM has been used to study the morphology of exploded wood chips which are important in fluid bed scrubbers in the petroleum gas industry (One student). This was the past, in the future the following (2-students each). UG research projects are planned for 2019-20 where having a functioning SEM will be essential for us to be able to offer the project

- Development of proton beam writing using the new MeV ion microscope configuration.
- Fabrication of glass and PMMA microfluidic devices for micro-chemical analysis.
- Atomic number imaging of dental amalgam corrosion.
- Elemental loss from biological tissues during various histological fixing procedures (with NIRC)
- μ -PIXE imaging of welding joints.

Graduate Research projects

Since 2016 the LAC staff has completed supervision 3 MS students and 2 external PhD students. SEM imaging has played a crucial part in each of these theses. Two further graduate students are on the way through. One is a MS and the other a MS / PhD student on the new Energy and Earth Sciences PhD program. These will work on the BoR-funded OMILAC project which aims to develop organic molecule imaging at the LAC. The SEM will be an essential part of these students research because it will be used to image the sample before loading it into the MeV ion microscope to provide reference morphologic cell images for locating the analyzed region on the sample.

(b) Projected lifetime of enhancement

The JEOL 6460LV SEM enhancement is projected to last for approximately 10 years. The factory service has a life of one year and the PI's are competent to maintain and extend this over the period of several years. As mentioned in the purpose of the grant, the last maintenance from a by a manufactures engineer was performed in 2007. Since 2001, the LAC operating budget has been used to replace any failed components of this system. Apart from LAC staff, UL Lafayette's Chemical Engineering faculty (Ms. Ashley Mikolajczyk) and students are also responsible for use and maintenance of the SEM.

(c) Person(s) responsible for

i. Implementation

1. Dr. Naresh T. Deoli
2. Prof. Harry J. Whitlow

ii. Installation

An engineer from JEOL USA, Inc. will install the aperture assembly, scintillator tip, infrared camera, and realign the column (electron optical system). Dr. Deoli will oversee all the installation, alignment, and optimization of the machine.

iii. Maintenance

Dr. Naresh Deoli and Dr. Harry Whitlow.

iv. Operation

Dr. Naresh Deoli, Dr. Harry Whitlow, and certified users (see training).

v. Training (with qualifications)

To optimize the student access to the instrument for UG and postgrad research training requirements for the instrument are kept at a minimum. (a) For minor, or one-off student users a member of staff sits with the student to help them use it and perform tricky procedures. (b) The training program for more active SEM users (where repeated use of the instrument for the students' research program is required) is currently overseen by Dr. Deoli. This is in process of being updated to align with other user training programs and facilities at the LAC. The planned training program is as follows:

1. Prof. Whitlow will give a short course (approx. 3 hours) on overview of the basic principles of the SEM technique and how to interpret images from the SEM. Lectures notes will be provided and made available on UL Lafayette Moodle website.
2. Students are made familiar with JEOL instrument manual which describes the system operation, including hardware and software in detail.

3. Students are given in-person demonstration of the SEM system, instrument and software, by Dr. Deoli.
4. Students are required to hands-on use of the instrument under Dr. Deoli's supervision until the technique is mastered. It usually takes 3 times before a student can independently use the system.
5. Finally, after several operations, the student is considered a certified user, allowing them to use the SEM instrument and conduct research independently.

(d) The narrative of the proposal must include the purpose and justification for each of the items listed in the Budget Proposal.

Supplies for JEOL JSM-6460LV (\$1563.34): Include objective aperture, aperture disk, synthetic oil, and scintillator tip. In SEM, electron beam pass through the aperture. Diameter of the aperture can be varied. In addition to the final convergence angle of the electron beam onto the sample, these apertures also control the number of probing electrons which reach the sample. Scintillator tip is an important part of secondary electron detection system. It is already showing signs of deterioration and can malfunction anytime.

Others (\$8348): This include labor hours, travel hours, auto mileage, and per diem of approximately two days for JEOL engineer. The purpose of factory engineer is to optimize the performance of the JEOL SEM to substantially increase its life (approx. 10 years) providing significant enhancement of the microscopy technique at LAC. Replacement of the above mentioned parts by engineer from JEOL ensures the upgrade is correctly installed and function according to specification. Additional unplanned costs will be borne by the LAC Operations Budget.

Budget Proposal

- | | | |
|-----------|------------------|--|
| 1. | Equipment | \$ 0 (SEM worth \$300K already exists at LAC) |
| 2. | Software | \$ 0 (Inclusive of requested factory maintenance) |
| 3. | Supplies | \$ 1563.34 |

- | | | |
|----|-------------|---|
| 4. | Maintenance | \$ 0 (Regular maintenance performed by LAC staff) |
| 5. | Personnel | \$ 0 (LAC personnel paid through LAC operations budget) |
| 6. | Other | \$ 8348.00 |

TOTAL: \$ 9911.34

Additional information:

None

Previously funded STEP projects:

For Dr. Naresh Deoli: *None*

For Dr. Harry Whitlow: *Spring 2017; STEP Grant; Enhancing cutting-edge student research at the Louisiana Accelerator Center; \$15,070.*



Service Estimate

JEOL USA Inc.
11 Dearborn Rd. TEL 978-535-5900
Peabody, MA 01960 FAX 978-536-2205

ESTIMATE #	VERSION	DATE
1271	1	7/8/2019

Pricing valid for 60 days

TO: UNIVERSITY OF LOUISIANA
320 Cajun Dome Drive
Louisiana Accelerator Center
Lafayette, LA 70506 US

CONTACT: Naresh Deoli
940-293-7365
deoli@louisiana.edu

ACCT#	DISTRICT	INSTRUMENT	SERIAL#	TERMS	CURRENCY
10683	706	JSM-6460LV	MP18100066	NET 30	USD

DESCRIPTION OF SERVICE:
D/S PM . Alignment issues and IR camera not working

ITEMIZED ESTIMATED COSTS:				
QTY	DESCRIPTION	UNIT PRICE	EXTENDED PRICE	
16.0	Labor Hours	315.00	5,040.00	
8.0	Travel Hours	315.00	2,520.00	
1.0	Estimated Parts Use	400.00	400.00	
600.0	Auto mileage (portal to portal)	0.58	348.00	
2.0	Per Diem (US)	220.00	440.00	
1.0	APERTURE,(20,30,100) STRIP,P110906(01)	112.70	112.70	
1.0	APERTURE,2MM OD,0.2MM T,400U,DISK	107.64	107.64	
2.0	INLAND 45 SYNTHETIC DD RP OIL PER LITER	69.00	138.00	
1.0	SCINTILLATOR TIP P122153(0)4 20MM 6460 781151813	805.00	805.00	
TOTAL ESTIMATE:				\$9,911.34

This is not a bill. Price quoted is an estimate. All work will be subject to JEOL's current Demand Service Pricing and Terms and Conditions.

Additional time, materials and/or travel expenses other than that stated above will require a written change order for additional funding. A new estimate for the increased costs will be provided.

If scheduling and/or deadlines become a factor, it may be necessary to utilize personnel from another service district. JEOL will make every effort to avoid additional travel expenses by utilizing local staff.

Prices quoted do not include any applicable sales and/or use taxes.

Questions regarding this estimate or the service schedule should be directed to your local district service manager:

Jake Lafon
972-608-5365
service6@jeol.com

<p>JEOL Representative</p> 
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A confirming copy of your purchase order should be forwarded to Julie Meers meers@jeol.com, along with a completed, signed copy of JEOL's TERMS & CONDITIONS - DEMAND SERVICE (Time & Materials) document included herein.

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