Student Technology Fee Proposal:
Oscilloscopes for Physics Lab Courses

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Project Description

This proposal is aiming to substantially improve the quality of the education in the PHY3802L Intermediate Labs and PHY4822L Advanced Labs courses by acquiring *five basic oscilloscopes.* These two classes are of paramount importance for students graduating with Physics Major by providing practical training in designing, executing and interpreting an experiment. Both classes are at the core of the Physics Department STEM (Science, Technology, Engineering and Math) training, which is an area of increasing interest due to its long-term impact for our state and nation economy.

The tools to be acquired through this proposal will allow students to do a proper study of several experiments that requires analysis in time domain, as explained below. In addition, the oscilloscopes will impact potential future experiments since these labs update regularly the setups. It is essential to note that educational setups, which are available on the market for this kind of classes, do not provide "complementary tools" such as oscilloscopes, coaxial cables, resistors, etc. This award is therefore essential to provide a proper environment for current and future lab setups. The proposed oscilloscopes are basic (no options) units Tektronix TBS2072 of $1,200 a piece, shown in Fig. 1 below.

Figure 1. Oscilloscope Tektronix of series TBS2000. Pictures are from manufacturer website: http://www.tek.com/oscilloscope/tbs2000-basic-oscilloscope. The models shown here have the optional 4 channels; the current proposal is requesting the bare model (no options) TBS2072 with 2 channels.

Impact on Instruction

The Intermediate and Advanced Labs have as main course objectives to teach students how to independently design, perform and analyze an experiment aiming to demonstrate a particular physical phenomenon. Students are learning how to work with various statistical concepts and methods, how to perform error propagation studies and use graphic and analytical tools to extract the quantities of interest. In the process, they get acquainted with

experimental protocols such as identifying sources of random and systematic errors, and finding ways to average out or correct them. After performing an experiment, the students write detailed reports. It is important to note that PHY3802L Intermediate Labs is an *Upper Division Writing* as well as *Scholarship in Practice* course.

For the Intermediate Labs, the students are performing five labs during the semester while for Advanced Labs they perform four labs, which are more advanced and have to be done in a truly independent fashion. The students chose the labs from a list of :
a) 9 labs for Intermediate Labs: http://qsd.magnet.fsu.edu/course/phy3802experiments.html
b) 7 labs for Advanced Labs: http://qsd.magnet.fsu.edu/course/phy4822experiments.html

From the aforementioned lists, the current 9 setups that do require an oscilloscope are: The torsional oscillator and torque magnetometry, Bragg diffraction with microwaves, The Franck-Hertz experiment, The Geiger-Mueller counter (two identical setups), The Operational Amplifier (two identical setups), The determination of the muon lifetime and, finally, the Electron Spin resonance lab. Also, it is planned to add an oscilloscope to the setup Earth Magnetic Field and another one for a future setup which will require time domain analysis as well (on the speed of light in optical fibers). This raises the number of oscilloscope related setups to 11.

The lab has now 6 oscilloscopes of a very old generation, which are used in rotation through out the setup benches. They are about 10 year old. This brings several issues: the warranty being long time ago expired, any malfunction will have a serious negative impact on the courses; there is an inherent delay in executing the tasks if several groups are sharing the oscilloscopes; changing the settings from bench to bench is inefficient and prone to induce unwanted errors, the data saving capabilities are very limited and possible only on very old USB sticks. We have one such old memory stick in the lab. The data acquisition is very limited as well. For instance, the lab on Torsional Oscillator requires recording a slowly decaying oscillations for a relatively long time (~1 min) during which millions of data points need to be recorded. The old generation scopes perform poorly for such a demanding task. It is therefore needed to acquire five new oscilloscopes to complement the old ones. Providing that this proposal is successful, the old oscilloscopes will have to be replaced in the near future with another set of 5-6 scopes, which will be the subject of another techfee proposal. This is to smooth out the financial impact of replacing the oscilloscopes.

The enrollment for the Intermediate Labs is of 30 students while for the Advanced Labs course, it is 10. Both classes are offered in Spring and Fall semesters, bringing the total to an *enrollment of 80 students per academic year*. Taking into account the fact that the proposed tools require no maintenance for several years (the warranty is 5 years), it is expected that the total number of impacted students to be in the order of several hundreds during the operation of those tools. The impact of such a STEM infrastructure can not be overstated. In addition, one should note that the training has a significant impact on under-represented student categories in STEM fields. For instance, the Intermediate and Advanced Lab classes of Fall 2017 have a 25% and 75% women enrollment, respectively.

Project plan

The oscilloscopes will be acquired immediately once the funds will be made available. Also, they will be distributed to the course setups immediately upon reception. Since the funds are planned to be available mid-April, it is expected that the oscilloscopes will be tested during Summer and deployed starting Fall 2017 semester. They require little to no maintenance during their lifetime and they have a 5-year warranty. The acquisition and deployment of oscilloscopes will mark the completion of the current project. Its success will be analyzed during the years of their usage; it is expected that they will have a heavy usage, providing raw and averaged data, using text files as tables and also screen shots for all related experiments.

Impact on other university activities

The oscilloscopes will be used during the Fall and Spring offerings of Intermediate and Advanced Labs and there is no planned usage of them for any other purpose other than these two courses. The impact on other university activities can arise from the fact that the students registered in these classes are not only Physics majors. Some students are FSU undergraduates from College of Engineering or just other departments/majors from the College of Arts of Science.

Cost of ongoing support and plan for supporting the effort

It is proposed to acquire new instruments and therefore there is no ongoing support; there is also no planned support after the purchase because the oscilloscopes come with a five year warranty and do not require any maintenance.
Running the two courses Intermediate and Advanced Labs is an expensive operation in terms of setups, teaching assistantships, electronic engineer which repairs setups if needed, etc. But those expenses are part of the regular function of the Physics Department.

Project team

The project will be carried out by Physics Professor Irinel Chiorescu who will continue to teach these courses during the time of implementation.

Budget justification

As seen in the attached quote, ten oscilloscopes TBS2072 will cost 10 x $935 = $9,350 plus $126.30 shipping, for a total of $9,476.30.

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QUOTE NO.	QUOTE DATE	CUSTOMER NO.	SALES GROUP	VALIDITY PERIOD
20148950	11/17/2016	205692	Bedford, MA	11/17/2016 - 12/17/2016

QTY	PRODUCT	DESCRIPTION	LIST PRICE	UNIT PRICE	AMOUNT
10	TBS2072	Digital Storage Ocilloscope 70MHz 2CH Includes: A0 = North America Power Cord L0 = English Manual Quantity 2 in stock with balance of 8 pcs is 6-7 weeks ARO	1,200.00	935.00	9,350.00
1.00	SHPHDL-R	SHIPPING Charge		126.30	126.30
		Total w/o Taxes, Freight, Ins.			9,476.30

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