Project Primary Mentor: Chip Durfee, x3894, cdurfee@mines.edu  
(Name, phone, email)

Project Title: Particle-in-cell modeling of a electron acceleration with tilted laser pulses

Project Type: [ ] Team; Number of students \_\_1\_\_\_ [ opt ] Honors

Project Area: mark all that apply

[ x ] Theoretical [ ] Experimental [ x] Computational

Objective  
(What is the science and/or engineering in this project? Why would it be interesting to work on it?)

We are developing a system to use the pressure of intense laser light to accelerate electrons in vacuum. With our optics, we can shape the laser pulse so that the effective speed of the pulse is slowed down so that the electrons can be captured by the field and accelerated. As part of that experiment, we need to accurately model the acceleration process to compare with experiment, as well as to understand how to optimize the process. The modeling will use a commercial particle-in-cell (PIC) code called V-Sim. The non-standard use of this code will be to put the shaped laser pulse into the code. While we have a simple analytic model, the PIC code will more accurately describe the laser-field interaction. It will also include the Coulomb forces between the particles, which is neglected in our current model.

Prior Background  
(What is the history of your involvement with this topic, including previous student projects?)

This project has been funded by the NSF for three cycles. As noted above, we have a simpler analytic model which can be used for comparison. A former graduate student did some PIC modeling on a different platform that was more limited.

Student Expectations  
(What are the deliverables (in addition to the lab notebook and reports) for the two-semester project?)

The student will first learn how laser pulses can be described mathematically, then determine how to enter them into the code. The propagation of the beam in the code will be compared to analytic models. Then, including particles in the code, the acceleration process will be modeled.

Supervision Plan  
(Who will be directly interacting with the student(s), you, a post-doc, grad students, or others?)

The students will meet weekly and work with the PI and the David Flammer, a research scientist in the group.

Resources   
(What equipment, algorithms, and facilities are available, and what will be assembled as part of the project?)

We have a license for V-Sim, which is the main platform for this project. Resources are available to upgrade computing power, or once the code is operational, we can find larger clusters to run larger simulations. Open source programs such as Python can be used for visualization.

Technical References  
(Identify a few key starting points for the student(s); journal citations, prior reports, instruction manuals, etc.)

1. Wilhelm, A. M. & Durfee, C. G. Tilted Snowplow Ponderomotive Electron Acceleration With Spatio-Temporally Shaped Ultrafast Laser Pulses. *Frontiers in Physics* **7**, 3316 (2019).

Project Title:  
Particle-in-cell modeling of a electron acceleration with tilted laser pulses

Project Primary Mentor:

Charles Durfee

Co-Mentor(s):

David Flammer

Project Funding Source:  
(Materials and supplies, shop charges, poster printing, etc.)

Physics Department

Research Grant Banner Index # \_\_402331\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_