Hi Deborah,

Here is my implementation plan for this year.

I am planning on using the Particle Cards this year. Oddly enough, I have not ever used them with my students. My plan is to modify the particle cards to make them less informative in some way. *Still working on that part.* I will use this activity with my AP Physics 1 students at the start of my mini unit on Particle Physics. I will ask the students to design their own grouping of the cards and then present their findings to the class. After the presentations, I will use this activity as my introduction to the Standard Model.

I am also very curious about the coding activities, but not sure how or when I will use them. With the AP curriculum changing I am going to need to think about my pacing and placement of this mini-unit.

Mike

Mike Fetsko
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That the powerful play goes on and you may contribute a verse.
What will your verse be?

Joe Fehr
I'm interested in incorporating particle physics while discussing vectors.
I wanted to do Calculating Z Mass activity as a lab for vectors and vector addition. I do the vectors sub-unit before momentum and Energy, but I will have introduced the concepts of scalars and vectors. This means that I will just have to introduce these concepts as physics ideas, distinguishing vectors from scalars, and then introduce the long E=mc^2 equation. At this point I think explaining where the equation comes from is too much, so I will just refer to it as the long version of Einstein's famous equation.
We'll work on these in groups, a total of 8 values to measure so each group will do one or two (having extras will be fine) and then submit the data using a Google form or on paper. After gathering the data from several classes I will show the histogram and (hopefully) show how the mass values are all a big spike on the graph.
This can also be referenced when I have all students/ groups measure the same value and point out that a histogram would show some variation, but as long as they are close enough it should make sense (g= 9.8, or 9.7, or 10.0, but not 7.6).

Implementation Plan – QuarkNET at William and Mary, Aug of 2022

Mike Plucinski

Science & Engineering Practices

I am a big fan of the data analysis opportunities that many of the QuarkNET activities from the DAP provide. Generally much of what I've done with QuarkNET in my classroom has really affected the way I teach students to take and analyze data.

Implementation of QuarkNET Activities

Junior Year Honors Physics

1. **Python Notebook Coding** – Used for students to analyze data using python code. Importing (manually from in-class labs and from external web links) data, graph, linearize to find a proportional relationship, and produce a proportional equation that represents the original data. This is done throughout the year.
2. **Rolling with Rutherford** – Use to introduce ways to take and use data to indirectly measure something (the diameter of a ball bearing). Also use it to discuss error analysis, especially percent difference.
3. **Time of Flight** with data from in-classroom cosmic ray detector – Analysis completed using a python notebook where data processed for time-of-flight from the cosmic ray e-lab is imported by the students, histograms of time of flight between several detector panels at different distances is performed. These time values from the histogram are then graphed vs the paired distances, resulting in a straight line, whose slope is the speed of a cosmic ray muon.
4. **Top Quark** – Done as a 2D vector activity within the momentum unit. I've really appreciated the hands-on, vector application in the context of a particle physics collision that this provides.
5. **Lifetime Analysis** with data from in-classroom cosmic ray detector – Analysis completed using a python notebook where data processed for lifetime from the cosmic ray e-lab is imported by the students. Histogram of the lifetime values is graphed. The heights of the histogram bars are taken and turned into a scatter plot. This is then linearized on a log scale. The slope of the resulting line is the decay constant for a muon. Ties to relativity are used in their analysis of the result…connecting back to the Time of Flight experiment done earlier in the year too.

Senior Year Advanced Physics

1. **Python Notebook Coding** – Used similarly and throughout the year for lab analysis work throughout the year as previously described under the Junior Year Honors Physics Section
2. **Makin it Round the Bend** – Using a simulation, have students take data on charged particles as they move through electric and magnetic fields and eventually a mass spectrometer like apparatus. Really ties a lot of the key ideas from the E&M unit together, showing how the data taken matches with theory.