Center-Level Portfolio: Idaho State University

The following table, proposed implementation plans by participating teachers, and when available other examples are intended to provide an overall narrative about how and in what ways program participation has influenced teachers in using QuarkNet content and materials in their classrooms (and in-after class events). The value of these qualitative reviews is to expand on the instructional practices measured quantitatively via Teacher Survey responses to specific sets of questions/self-reported by teachers providing narrative examples of implemented or planned instructional practices in teachers' classrooms and in schools. This evaluation approach is consistent with the use of *authentic assessment* to evaluate performance, "teaching for understanding and application rather than for rote recall" (Darling-Hammond & Snyder, 2000, p. 523).

In keeping with Darling-Hammond, Hyler and Gardner (2017), we do not naively expect a single workshop (or event) to have a measurable impact on teachers' knowledge and subsequent classroom implementation. A characteristic of effective professional development is a program of sustained duration, providing "multiple opportunities for teachers to engage in learning around a single set of concepts or practices; that is rigorous and cumulative" (Darling-Hammond, et al., 2017, p. 15). As such, the table summarizes responses by teachers over the course of several program years and likely several QuarkNet programs and/or events.

These responses come from the Teacher Survey (either the full or update version) where each row represents the responses to open-ended questions from the same teacher over time. Also, each row starts with the original responses to the first time a teacher completes his/her full teacher. If a particular box in the table is blank, it likely means that that teacher did not participate in an event for that program year (or, the center may not have had a major event that year). The table provides the essence of these responses; a given response, as presented, may be a direct quote, a paraphrase, or lightly edited; the intent is to convey the overall idea or its essence from that particular teacher.

Because these are responses to open-ended questions, teachers are free (and encouraged) to provide information that he or she thinks most relevant. Each highlighted response is intentionally anonymous to respect the principles of collecting evaluation data (*Guiding Principles for Evaluators*, American Evaluation Association) and to help encourage teachers to respond frankly to these questions. If a reader is familiar with a given center, it may be possible to "reverse engineer" the identify of a particular teacher. We encourage readers to respect this anonymity. At various times, we may have identified a given teacher by name and/or school; when this happens the written approval of that teacher has been obtained. It is also important to note that the full breath of a response by a given teacher may not be fully articulated in this table. For example, responses related to how QuarkNet may have advanced the knowledge of a given teacher or bolstered a collegial network among participants are likely discussed elsewhere in subsequent evaluation reports.

The table is followed by examples of implementation plans, and at times teacher presentations and student presentations when available. The intent of providing these examples is to deepen the narrative as to what and how teachers have planned (and have used) QuarkNet content and materials in their classrooms and in-after class events (e.g., Physics Club). Examples from Annual Center annual reports may be highlighted as well.

Table

Self-reported Use of Data Activities Portfolio Activities: Based on Responses from the Full Survey and then Responses from the Update Survey in Subsequent Years: **Idaho State University Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Idaho State University	2019	2020	2021	2022	2023
	The time of Flight in the Cosmic Ray e-Labs will be very applicable to me and my students.				
	I do not know yet, since I have only barely learned of them, and will have to implement them in the upcoming school year.		Have used materials for conservation laws. I like to use cosmic ray detector as a final comprehensive lab.	Everton data for conversation law; Particle Deck.	
		I use Time of Flight from the Cosmic Ray lab for kinematics. I use an intro-duction to the Standard Model with mass and the scientific method. This state does not allow students to provide names for accounts. Everything must be done as a guest.			
	Quark Workbench (annually) - good intro to standard model Rolling with Rutherford (annually) - good intro to particle physics and the atom. Everyone likes this one. Cosmic Ray E Lab (once a year but only for HL Students)	Unit on programming or particle physics unit. Examples: Pennies, Z boson, mass, several I can't recall the names.	I use particle physics for examples in both classical mechanics and modern physics (IB content), Examples: Pennies, Workbench, Heisenberg.		Cosmic Ray E lab, Quarkbench, Rolling for Rutherford, What Heisenberg Knew, Mass of Pennies, Calculate the Z mass,
	I use the histogram activities. Since I also teach Math, it allows me to relate 'real-world' examples to the classes. They also provide a macro concept to what experiments measure on the nano scale.			Conservation laws, relativity Examples: pennies, dice, histograms	I use the pennies, dice, and histogram activities.

Table (con't.)
Self-reported Use of Data Activities Portfolio Activities: Based on Responses from the Full Survey and then Responses from the Update Survey in Subsequent Years: **Idaho State University Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Idaho State University	2019	2020	2021	2022	2023	2024
	I use the histogram activities. Since I also teach Math, it allows me to relate 'real-world' examples to the classes. They also provide a macro concept to what experiments measure on the nano scale.			Conservation laws, relativity Examples: pennies, dice, histograms	I use the pennies, dice, and histogram activities.	I use the activities that describe making histograms and dice (exemplifying decay) QuarkNet has given me hope that I can understand complex components of physics. The more I know that I can understand more challenging topics, the more I understand that I don't know very much at all! It's fun to see the horizon of knowledge stretch out before me, knowing that it doesn't end where I can currently see. Because of these feelings, I can help my students to have bigger educational goals than they otherwise would. The activities are easily recommended because they are located in one place and searchable by topic.

Table (con't.)
Self-reported Use of Data Activities Portfolio Activities: Based on Responses from the Full Survey and then Responses from the Update Survey in Subsequent Years: **Idaho State University Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year
Idaho State University	2021	2022	2024
	I have not dug into this resource due to time constraints but as I evolve away from my sports coaching it is my intent to make this happen.	I have implemented many items from the Teacher Institute; Rolling with Rutherford; the discussions on neutrinos. Model behavior of equity in the classroom. Examples: Dice, Histograms and probability, mass of U.S. Pennies, Step Up Women in Physics.	
	I will begin using these activities this year. Looking through some of them, I think the "Making it Around the Curve" activity would be great for AP Physics 2!		QuarkNet starts out with opportunities to learn, and experiment, and then can provide opportunities in the future for greater knowledge and more amazing opportunities.
	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year
	2022	2023	2024
	I haven't used them yet (early in the year) but I look forward to using the coding tools.	Cosmic Ray Workshop since that is all I can fit into my physics schedule. Examples: Dice half-life activity	
	Some are useful in teaching basic physics principles for freshman physical science.		My physics class breaks into pairs and each creates and undertakes an experiment with the cosmic ray detector. They then present to their classmates and the entire jr/sr high school. I also will be using a few activities in my chemistry and physics classes. Heisenberg's Laser Electron Diffraction The one with dice (I forgot the name).

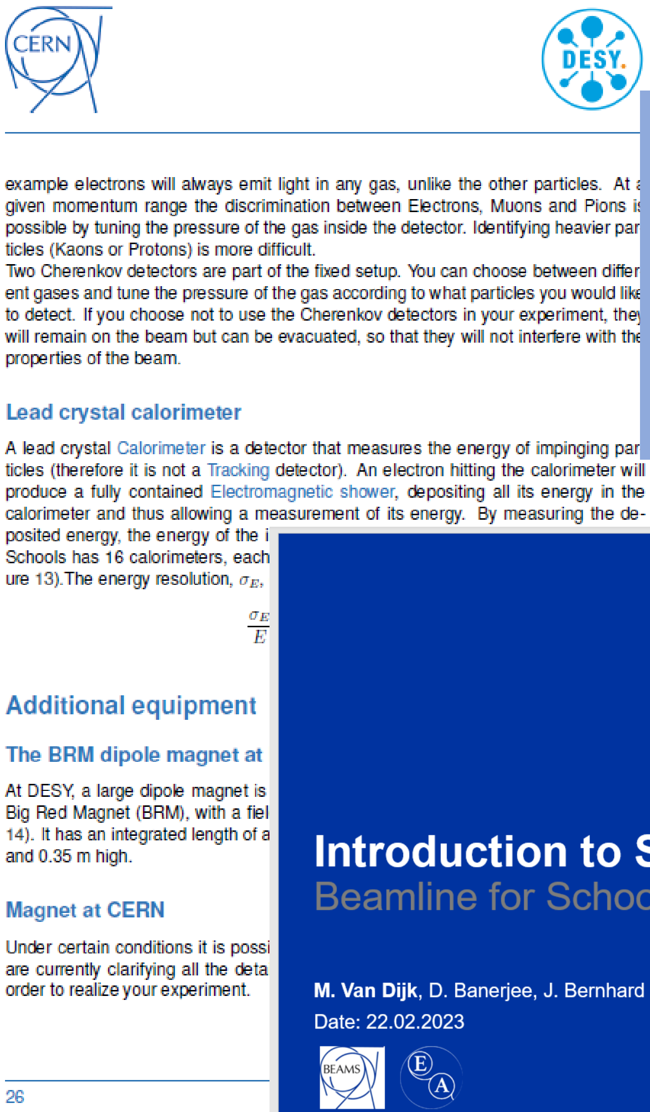
Note: Each row presents responses from the same individual teacher from a given center. Empty table cells indicate that the teacher did not participate in QuarkNet in that subsequent program year(s). Or, less likely did not complete the Update Survey; or did not answer specific questions about the use of DAP activities in their classrooms.

As an example of a teacher’s engagement and work, the next page provides a presentation that was given by a teacher, Alison Bulson during the Idaho State Center’s QuarkNet workshop held on July 24-27, 2023.

A Year of Contemporary Physics at West High School

WEST
HIGH SCHOOL™
EST. 1890

Research and Writing



example electrons will always emit light in any gas, unlike the other particles. At a given momentum range the discrimination between Electrons, Muons and Pions is possible by tuning the pressure of the gas inside the detector. Identifying heavier particles (Kaons or Protons) is more difficult.
Two Cherenkov detectors are part of the fixed setup. You can choose between different gases and tune the pressure of the gas according to what particles you would like to detect. If you choose not to use the Cherenkov detectors in your experiment, they will remain on the beam but can be evacuated, so that they will not interfere with the properties of the beam.

Lead crystal calorimeter

A lead crystal Calorimeter is a detector that measures the energy of impinging particles (therefore it is not a Tracking detector). An electron hitting the calorimeter will produce a fully contained Electromagnetic shower, depositing all its energy in the calorimeter and thus allowing a measurement of its energy. By measuring the deposited energy, the energy of the i
Schools has 16 calorimeters, each
ure 13).The energy resolution, σ_E,

$\frac{\sigma_E}{E}$

Additional equipment

The BRM dipole magnet at

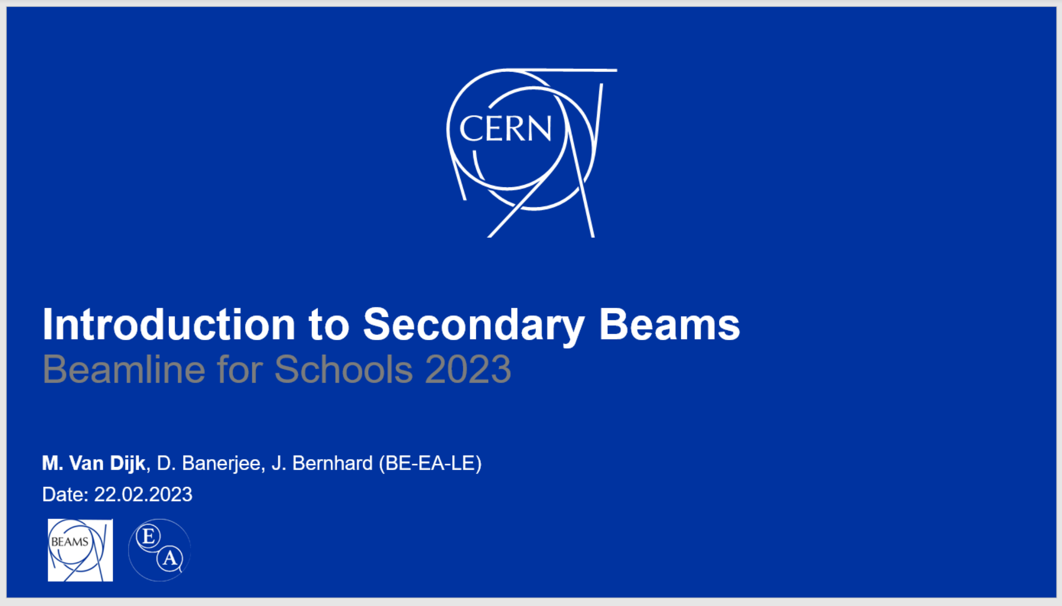
At DESY, a large dipole magnet is
Big Red Magnet (BRM), with a fiel
14). It has an integrated length of a
and 0.35 m high.

Magnet at CERN

Under certain conditions it is possi
are currently clarifying all the deta
order to realize your experiment.

26

BL4S Coordinators have provided documents and a variety of Zoom presentations with valuable background information.



Our team is truly student-led: Here, a student explains his understanding of how Bragg peaks work to two other students.

Utilizing Proton-Sensitive Film to Visualize Bragg Peaks

Cole Chu, Natalie Germanov, Thatcher Goff, Marriane Liu, Sanskriti Negi,
Christopher Pankow, Hanxiao Shi, Fiona Zara, Tony Zhang

2023 April 12

1 Motivation

On a visit to the Huntsman Cancer Institute Proton Therapy Department, we became intrigued about how high energy hadrons deposit ionizing energy as they travel through matter: Bragg peaks. Approximately one third of the world's population will be diagnosed with cancer in their lifetime — many of whom will choose to use proton therapy as a form of treatment. Bragg peaks can precisely target tumors and minimize collateral tissue damage, making this form of therapy especially preferable for more prevalent cases. However, the invisible, high-energy beam can be extremely disconcerting to the patient due to a lack of understanding of the technology. By harnessing proton-sensitive materials to create visualizations of a particle beam exhibiting Bragg peak behavior, we can not only assuage cancer patients' worries, but also combine art with science to provide valuable insight into the behavior of particle beams through different materials. While this behavior can theoretically be predicted with equations, a physical visualization can help expand our understanding.

2 Experimental Setup

Our experimental setup contains two phases: the first is to gather quantitative information to support theore

In our first phase

rule[7,9]. We first plac

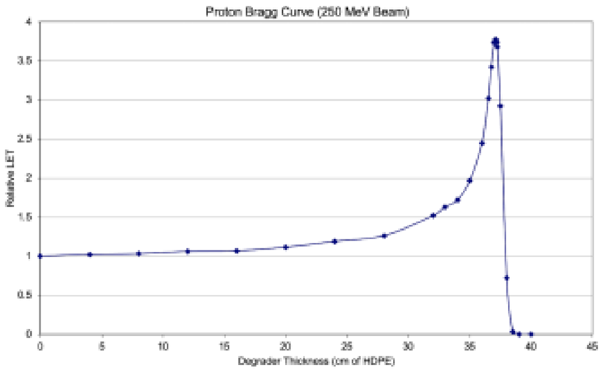
and radiochromic film

correspondent uses E

quantitative and visu

amount of uncertainty

Figure 4:
Graph created using data from BNL. 250 MeV.



We found a close correlation between the measured Bragg peak depth (26.1 cm at 205 MeV and 37.1 cm at 250 MeV) and our calculated values (26.33 cm and 34.67 cm, respectively).

In these graphs, the peak of the curve represents the Bragg peak. The inverse Bragg-Kleeman rule equation graphs a vertical asymptote, representing the mean position of the highest energy loss. However, the Bragg-Kleeman rule is an approximation because it does not account for all relativistic effects and other complex physics [7, 9]. For an in-depth explanation of our understanding of the more precise formulae, see: https://docs.google.com/document/d/1bxGBXjTn7FdMJ15IeN$_X nA3MsyxLY D_Q JBW J274Pz10/edit?usp = sharing$.

Once we confirm our understanding of the Bragg-Kleeman rule, we can use it to predict the position of our experiment's Bragg peaks. For example calculations, we will use stainless steel and lead at 1 GeV. Values for α and p of stainless steel and lead were found in Table 2 of "The Physics of Proton Therapy[7]." Example calculations:

teel:

$$\alpha = 5.659 \times 10^{-4}, p = 1.706$$
$$R_0 = 5.659 \times 10^{-4}(1000)^{1.706} \approx 74.257\text{cm}$$

$$\alpha = 6.505 \times 10^{-4}, p = 1.676$$
$$\alpha = 6.505 \times 10^{-4}(1000)^{1.676} \approx 69.382\text{cm}$$

at a proton beam at 1 GeV will respectively have an approximate Bragg inless steel and lead of 74 cm and 69 cm, respectively

Win or not, every year the students and I find value in the endeavor of producing a proposal. We learn physics content, practice technical writing, make connections with the physics community, and work collaboratively.
Win or not, every year I am proud of the students' final product.

Contemporary Physics in the General Physics Classroom

- Good
  - High student interest (as always)
  - Incorporated CRMD Time of Flight study this year, data discussion
  - Lots of discussion about statistical methods, thanks to Derek's interest
  - Fun projects – ATLAS coloring books, particle models
- Bad
  - End of year, student- and teacher burnout
  - Not enough time
  - Not enough background for students in rotation, EM
- To try 2023-24
  - Cram all of mechanics into Semester 1
  - Start Contemporary physics early spring
  - Incorporate a Master Class again (maybe not ATLAS, if we still have to use Hypatia)
  - CRMDs running all. of. the. time. We have 3 CRMDs now!
  - AP Phys 1: get ahead of the content enough to include contemporary physics a couple of times before the exam (?)

ID Quarknet Summer Camp, 2023

- Plateau counters for 2 detectors
- Performance Study for 6780
- Attempt to do a 2-detector shower study with Enrique
    - (zero events in 1 hour)
- Proper single detector shower study
    - (22 potential events in 40-ish hours)
- Thoughts for implementation 2023-24
    - 3 detectors at WHS!
    - “Steve Method”
    - More multi-detector studies
    - Altitude vs. Flux (Snowbird Octoberfest?)