Software Training Outreach
(in IRISHEP-QuarkNet)

26th International Conference on Computing in High Energy & Nuclear Physics (CHEP 2023)

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Overview

- IRIS-HEP workforce development activities contribute to the preparation of a highly qualified STEM workforce
- Several events organized
- Connect with Physics teachers
  - Growing partnership with QuarkNet
    - Run additional summer coding camps for K-12 teachers in US
  - Software training outreach in Puerto Rico
  - Social media (Facebook groups)
  - Society of Physics teachers
- Serves as an opportunity for the to perform public engagement and impact the nation’s STEM education

Danelix Cordero - Rosario - CHEAP 2023, Virginia, USA
### Outreach events

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Name</th>
<th>Participants/Tutors</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022</td>
<td>July</td>
<td>Coding Camp at Fermilab (1 week) with QuarkNet</td>
<td>21/5</td>
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<tr>
<td>2022</td>
<td>Mar</td>
<td>Data Analysis for Lab Research (Virtual) (1 day)</td>
<td>20/3</td>
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<tr>
<td>2021</td>
<td>Aug</td>
<td>Arduino Micro Controller and C++ programming (STEM Teachers) (In person) (2 days)</td>
<td>9/3</td>
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<tr>
<td></td>
<td>Feb</td>
<td>Machine Learning Basics for STEM teachers (Virtual) (2 days)</td>
<td>8/3</td>
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<tr>
<td>2020</td>
<td>July</td>
<td>Data Analysis for STEM teachers (Virtual) (2 days)</td>
<td>16/3</td>
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<tr>
<td></td>
<td>June</td>
<td>Data Camp for STEM teachers (Virtual) (1 day)</td>
<td>11/3</td>
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<tr>
<td>2019</td>
<td>June</td>
<td>An introduction to programming for STEM teachers (2 days)</td>
<td>16/1</td>
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<td></td>
<td>April</td>
<td>Machine Learning Workshop/Hackathon (3 days)</td>
<td>25/1</td>
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Workshop and Engagement

- Introduction to Programming
- Python, Jupyter notebooks, Colab
- hands-on Data analysis
- HEP data preview with CMS Open Data

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To implement a strategic plan for training high school teachers, IRISHEP and QuarkNet have developed a program to provide software training paths from science teachers.
IRIS-HEP/QuarkNet Partnership

QuarkNet

- Brings real research experience to high school Science teachers, students, and classrooms.
- QuarkNet has ~50 centers in universities and laboratories participating in high energy physics experiments.

IRIS-HEP

- Growing partnership with QuarkNet to run additional summer coding camps for K-12 teachers.
- Serves as an opportunity for public engagement and impact the nation’s STEM education.
• Teacher participation has increased over the years
• Teachers develop educational material at the end of the workshop e.g. python notebooks on physics topics for students
• Inclusive – more teachers of different specialties
• Increase the cross-cultural and diversity in the teacher's participation
Coding Camp content

- Coding Camp (google colab, Jupyter notebooks)
- Data Visualization: Plot a function with lines, pace and customize plots with pyplot, define a function.
- B-field Variation: Analyze data from mobile app
- Muon Tracks: Analyze tracker data from muons in CMS
- Muon Tracks with Machine Learning: Repeat the muon tracks analysis with several machine learning
Objectives

1. Review and reteach core concepts of particle physics, such as the framework of the Standard Model, the anatomy of a particle accelerator and detector, and the methods for calculating invariant mass from 4-vector data.

2. Review and apply basic aspects of computer programming in Python, such as conditional, math functions and plotting, and file manipulation.

3. Use simple programming tools to analyze large datasets generated from the CMS experiment in the 2010 and 2011 runs; and, run analyses of these data. Generate conclusions about these analyses that include both calculations and plots (e.g., of invariant or transverse mass).

4. Search for new scientific datasets available online and write code to perform analyses of these new data.

5. Design a series of code-centered activities that either add onto existing units in a high school physics course or replace an already existing activity; create a plan from implementation of these activities.
Implementation Plan

**“student hat” Engage, Explore, Explain**

- Teachers work in groups
- Running Python code
- Using pre-Jupyter notebook
- Review basic coding
- Use CMS data

**“teacher hat” Elaborate and Evaluate**

- Teachers develop implementation plans for their own classroom
- Writing Jupyter notebook
- Adapt and apply appropriately to their classroom
Upcoming Plans

• More Workshops across the nation
• More virtual Workshops - Spanish and English language
• More HEP data relevant to HS Physics content

Coding Camps
• Engage in Coding Techniques
• 2 or 3 days in basic programming
• More model-fitting and ML
Thanks for your attention!

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