Panel Discussion: IPPOG, Masterclasses and Formal Education

IPPOG Meeting

08.05.2020

Panelists

- Chris Bormann, high school teacher from NSW
- Shantha Liyanage, research coordinator at NSW Department of Education
- Christine Kourkoumelis, particle physicist from U of Athens
- Philipp Lindenau, didactics researcher from TU Dresden
- Shane Wood, QuarkNet Staff and District Science Supervisor from MN

Moderators

- Uta Bilow, TU Dresden and IMC Coordinator
- Ken Cecire, U of Notre Dame, QuarkNet and IMC co-Coordinator
- Christine Kourkoumelis, U of Athens

Focus and Aim

- present programs in IPPOG member states that address formal education, especially with masterclasses
- brainstorm how to:
  - overcome barriers and problems
  - support initiatives to interface with formal education
  - create a coherent effort
- pose critical, constructive questions
- examine the potential for IPPOG to support formal education

Questions to provoke thought

- Is connection to formal education an opportunity for IPPOG to expand its global reach significantly?
- What are the IPPOG goals in reaching out to formal education?
- How can IPPOG support national efforts in bringing HEP to the classroom?
- Should a masterclass be part of the curriculum?
- How do we motivate the teachers?

Housekeeping

- Input from the panelists (slides) in a row
- Followed by discussion

- For questions/comments: Raise your hand (in „Participants“, lower right corner. Or type „question“ in chatbox.

Particle physics masterclasses

"IPPOG, Masterclasses and Formal Education" Panel,

Montenegro, IPPOG meeting 7-8th May, 2020

Chris Bormann and Dr Shantha Liyanage

NSW Department of Education

NSW GOVERNMENT

What is a masterclass?

- A Masterclass is a class given to students of a particular discipline by an expert of that field.
  - Provides unique hands-on approach
  - Investigative and experiential components and action-orientated.
  - Elements of performative than contemplative learning.

NSW Schools initiatives

- NSW initiatives – Two masterclasses for Rural and Remote students – Parks and Dubbo with University of Melbourne involvement
- Masterclass presentation to Aurora College, Virtual visits to CERN
- Development of MOU and compiling Resources to support masterclasses (which is now being revised)

Challenges – scaling up to provide access to all schools, logistics- connection to CERN at odd hours (expert component)

Key issues to consider in masterclass formats

Five Basic Principles

- Basic Knowledge and Understanding –**Student centred Learning – Some prior knowledge and understanding**
- Learning Immersion – Lecturer/specialist interactions–**Student's Engagement with Specialists**
- Performative learning – Analysis of data from LHC to deep thinking of concepts. Use of software and identify particles – **Reflective learning by Students**
- Contemplative learning – Student questions, hypothesise and permutated combinations, resolve problems – **Knowledge Synthesis by Students**
- Reinforce learning – student and teachers engagement-evaluation of learning by reflection on knowing what they know and undertaking complex prediction tasks – learning cycles. – **Deep Learning with undirected or unsupervised future exploration – asking wicked questions.**

Physics education in NSW

Current situation

- The physics syllabus is structured using broad **inquiry questions**. These are used to frame the course content.
- Particle physics concepts have only recently been introduced to the mandatory curriculum in the final years of high school physics
- Inquiry questions for particle physics require students to **engage with evidence** and develop higher order thinking, for example:
  - **How is it known** that human understanding of matter is still incomplete?
  - Analyse the evidence that suggests that protons and neutrons are not fundamental particles
  - investigate the operation and role of particle accelerators in obtaining evidence that tests and/or validates aspects of theories
  - investigate, assess and model the experimental evidence supporting the nuclear model of the atom

Challenge: How can we build the capability and confidence of our teachers to meet these new expectations?

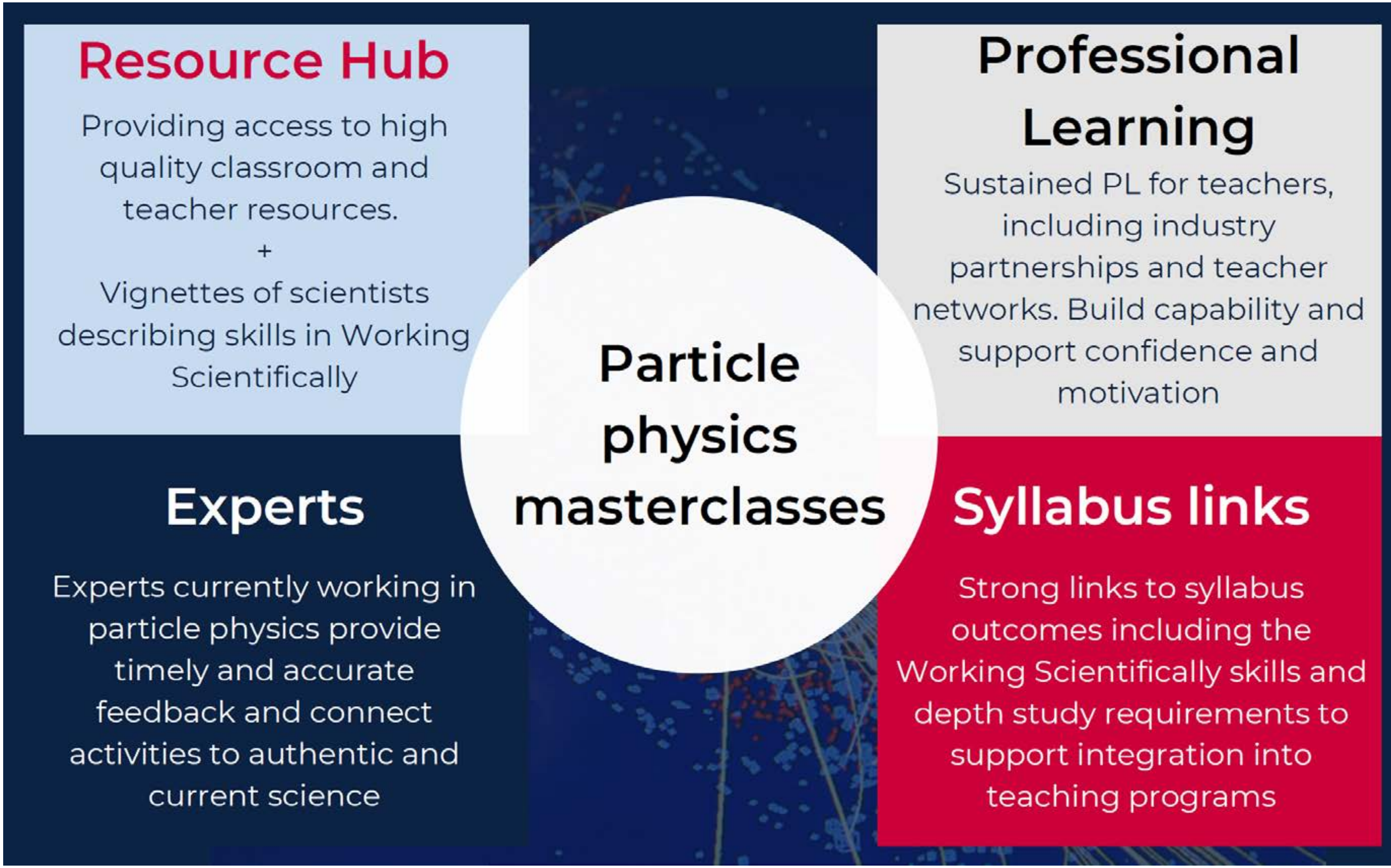
NSW GOVERNMENT

Working scientifically

What does this look like in contemporary physics?

- Science students develop their skills in “Working scientifically” as they progress through high school.
- The working scientifically skills are linked to inquiry processes and include,
  - Questioning and predicting
  - Planning and conducting investigations
  - Processing and analysing data and information
  - Problem solving, and
  - Communicating
- In Year 11 & 12, these skills must be formally assessed in a Depth Study assessment task. Students complete a depth study individually or in a group that includes up to 15 hours of class time. Depth studies are intended to further develop one or more course concepts and are not limited in scope.
- Module 3 in the Science Extension course also focusses heavily on data analysis and statistics.

Challenge: How can we use modern examples of working scientifically to support our students in building real skills for their future?


Resource Hub
Providing access to high quality classroom and teacher resources.
+
Vignettes of scientists describing skills in Working Scientifically
Professional Learning
Sustained PL for teachers, including industry partnerships and teacher networks. Build capability and support confidence and motivation
Particle physics masterclasses
Experts
Experts currently working in particle physics provide timely and accurate feedback and connect activities to authentic and current science
Syllabus links
Strong links to syllabus outcomes including the Working Scientifically skills and depth study requirements to support integration into teaching programs

C.Kourkoumelis

National and Kapodistrian University of Athens

How to introduce HEP to schools (experience from several EU funded projects on science communication, education and outreach)

EU projects->teacher training+resources created

1)The Learning with ATLAS@CERN (2009-2011)

http://www.learningwithatlas-portal.eu/

2)The PATHWAY IBSE Project (2011-2013)

http://www.pathway-project.eu/

3) Discover the_COSMOS (Sept 2011-Sept 2013)

http://portal.discoverthecosmos.eu/

4) Go-Lab (Nov.2012-Nov.2016)

http://www.go-lab-project.eu/

5)Inspiring Science Education (April 2013-Sept 2016)

http://inspiring-science-education.org/

6) CREATIONS (Oct 15-Nov 18)

http://creations-project.eu/

The main challenges for students:

- **To provoke students' curiosity for HEP (which in most countries is absent from the national curriculum)**
- **So far a lot activities exist for high school students: IPPOG's IMC, mini-masterclasses, virtual visits to the experiments, Quarknet prortfolio, etc etc)**
- **The students should get engaged in <u>hands-on</u> experimentation directly connected to top-level real-time research, discoveries and cutting-edge technology**

The main challenges for teachers:

- There is a lot of material (resources/scenaria) which is ready to be used in the duration of a school lesson
- They should be structured according to the Inquiry based principles
- It should not require "technical" knowledge
- Do they have the background/confidence to use them ?
- Do they have the available time slots to do it ?
- If they do it, they should have a way of assessing the success (or failure)

FRONTIERS

Bringing nobel prize physics to the classroom

Erasmus+ Sept 2018->Aug 2021

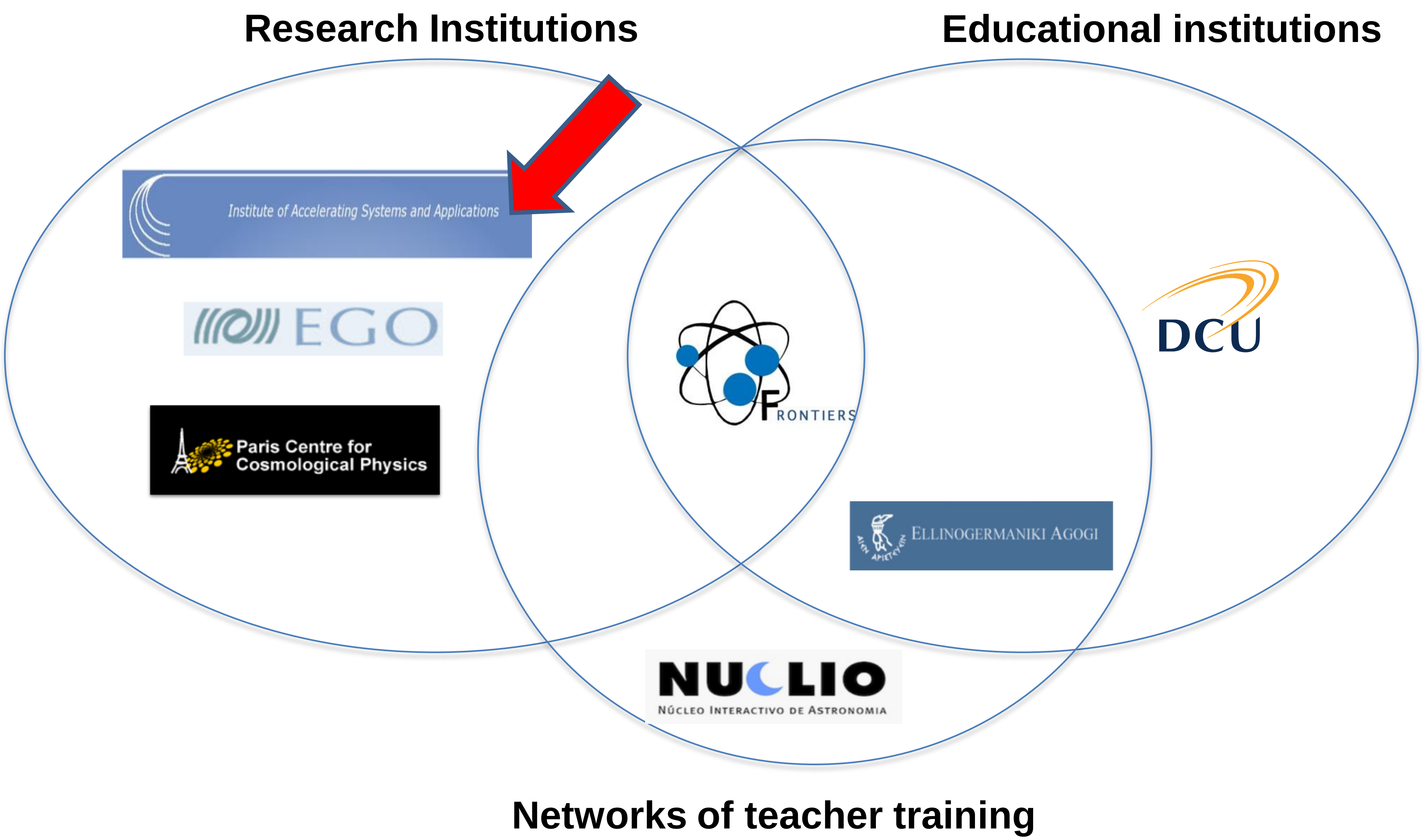
5 countiers (Italy,France,Ireland,Portugal,Greece)

- HEP
- Astroparticle physics
- Gravitational waves
- Cosmology Astronomy

www.frontiers-project.eu

Erasmus+

Brings together research and educational institutions from all over Europe



Structured educational scenaria

Formal inquiry-based learning (5 stages)

- **Orienting and Asking Questions**
  - Provoke curiosity
  - Define questions from current knowledge

- **Generation of Hypotheses or preliminary explanations**
  - Propose preliminary explanations or hypotheses
  - Plan and conduct active investigation

- **Plan Investigation**
  - Gather evidence from observation

- **Analyze evidence to discover a possible answer**
  - Explanation based on evidence
  - Consider other explanations

- **Conclusion-Reflection**
  - Communicate explanation

Open Discovery Space portal

https://portal.opendiscoveryspace.eu/en/community/bringing-nobel-prize-physics-classroom-854226

Browse the FRONTIERS Educational Resources

High Energy Physics

Search for the Z and Higgs Bosons ← HYPATIA
Study data from the Large Hadron Collider ← W2D2
How to accelerate particles ← LHC Game
The ALICE Experiment at CERN
The Magnetic Field and its applications

Gravitational Wave Astronomy

Earthquake Interferometer
Gravitational Wave Noise Hunting
Finding Black Holes in a Chirp
EGO Control (Class)room
VIRGO Virtual Visits

Astrophysics / Cosmology

These scenaria exist in English, French, Italian, Portuguese*, Greek

*Portuguese Community page
https://portal.opendiscoveryspace.eu/en/community/comunidade-frontiers-de-portugal-855297

All the scenarios are in the form below
(The HYPATIA scenario with FIVE stages)

- Trained about 200 teachers up to now (before Covid)
- Have feedback in form of pre/past questionnaires
- Currently training another 60 through webinars

Conclusions
(how to meet the challenges)

- **Structure scenaria so that to connect basic research with technology and applications**
- **Educate/train the teachers (workshops, webinars, summer schools, CERN teachers' program etc)**
- **Encourage the teachers to start the implementation with "light" scenarios**
- **Assess/monitor the effectiveness (questionnaires, built in indicators etc)**
- **Inform the general public and the stakeholders who influence the curriculum**
- **Keep the interest up (even in case of no discoveries)**

Particle Physics Masterclasses and Formal Education in Germany

Panel Discussion: IPPOG, Masterclasses and Formal Education

Philipp Lindenau

19th IPPOG meeting | Videoconference | 08.05.2020

NETZWERK TEILCHENWELT

Current state of PPMC in Germany

<u>2019</u>

- Roughly 100 PPMC with LHC data by Netzwerk Teilchenwelt in schools all over Germany
- 22 IMC at universities and research institutes
- All guided by researchers in the field

Current state of PP in German curricula

- Only in a few states a mandatory part
- Curricula get more and more competence-orientated
- Questions to be answered:
  → How can PP and PPMC foster the required competeces?
  → Which connections are there to established contents of curricula?

Competence-oriented learning goals

The formulation of learning goals with respect to competences helps „selling“ the topic to the education community, including teachers!

Especially those for which PPMC are especially suitable.

Other things to be considered

- ► Extensive teacher trainings necessary
- ► Teachers may feel a natural aversion towards new contents
- ► PPMC gain a lot of their educational and motivational power by their authenticity

→ Gets lost to some degree when supervised by teachers

- ► Teachers should have freedom to choose topics they are interested in and like to teach

→ PP could be approached in other contexts than LHC/HEP

→ PPMC maybe shouldn‘t be mandatory but an option to choose from!?

Thank you for your attention!

PROJEKTLEITUNG

TECHNISCHE UNIVERSITÄT DRESDEN

PARTNER

CERN

DESY.

SCHIRMHERRSCHAFT

DPG

FÖRDERER

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

Dr. Hans Riegel-Stiftung

NETZWERK TEILCHENWELT

QuarkNet

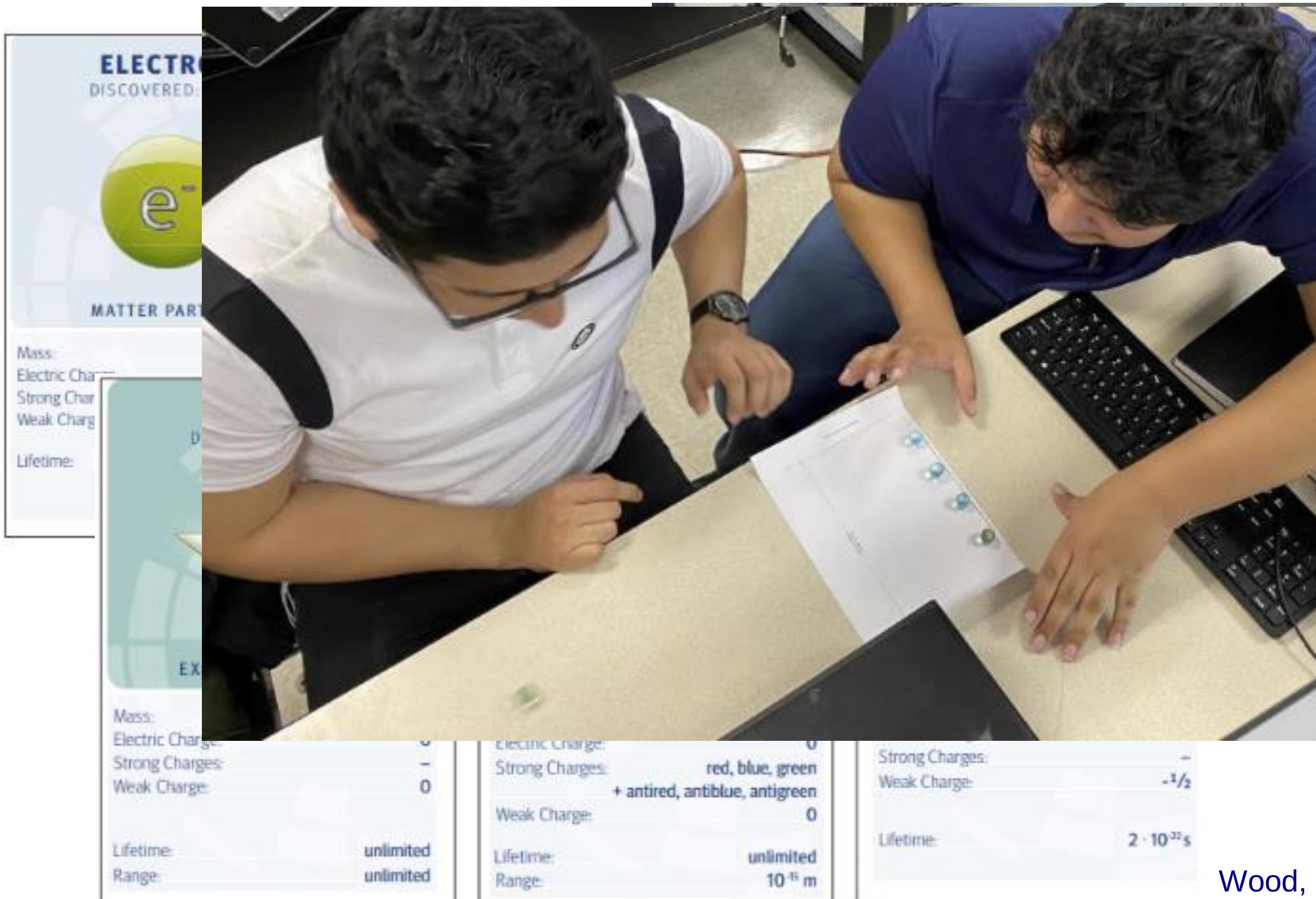
Masterclass Preparation

In the classroom – tied to curriculum:

QuarkNet

Masterclass Preparation

In the classroom – tied to curriculum:

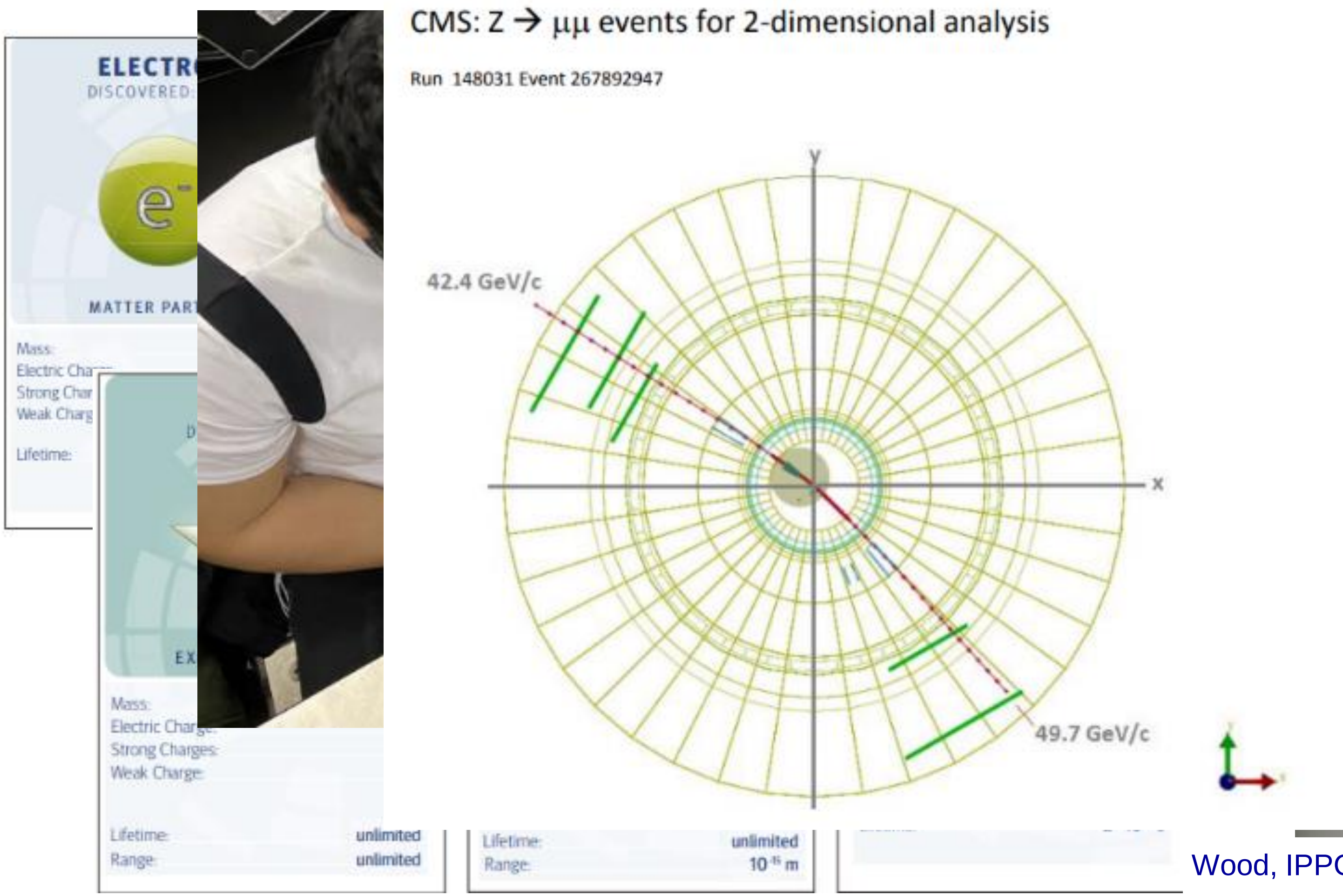


Wood, IPPOG Panel, May 2020

QuarkNet

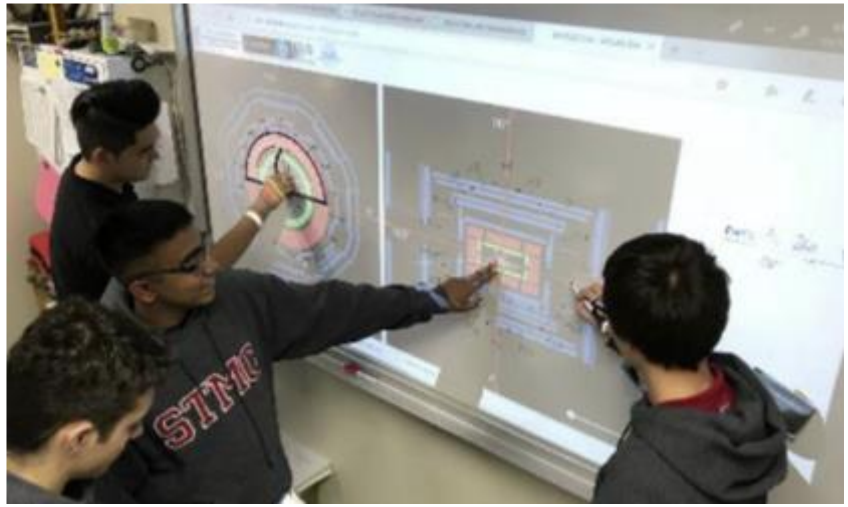
Masterclass Preparation

In the classroom – tied to curriculum:

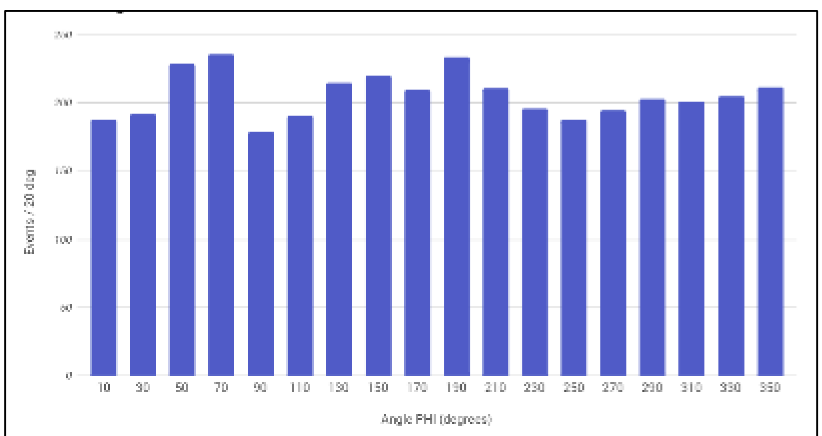


QuarkNet

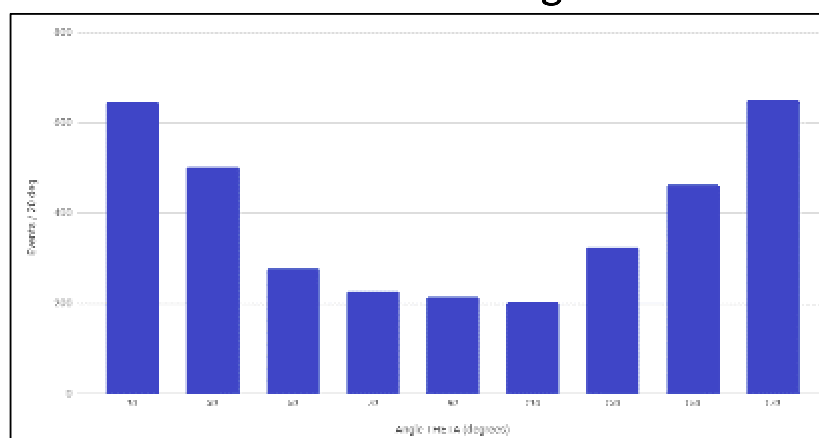
World Wide Data Day (W2D2)



PHI Histogram



THETA Histogram



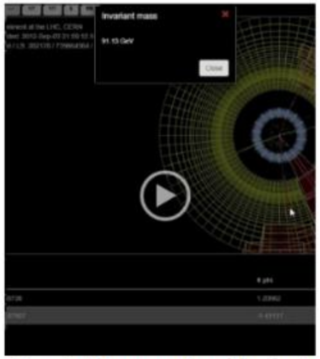
Helping Develop America's Technological Workforce

BAMC: Big Analysis of Muons in CMS

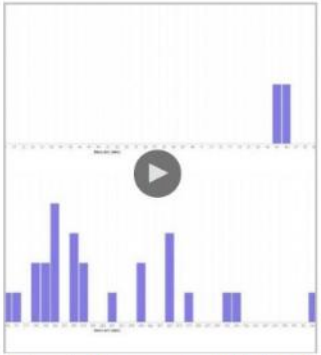
BAMC in 4 Steps / 4 Screencasts

Step 1: Intro (read below)

Step 2: Set-Up (read below)



Step 3: Measure (read below)


Step 4: Wrap-up (read below)

Back up

Any outreach project should include:

1) A pedagogical framework
2) Creation of educational resources/scenaria
3) Workshops for teachers->community support (three stage: before/during/final)
4) Pilots+Large scale Implementation
5)Dissemination and exploitation plan
6) Ways of measurement the impact, assessment

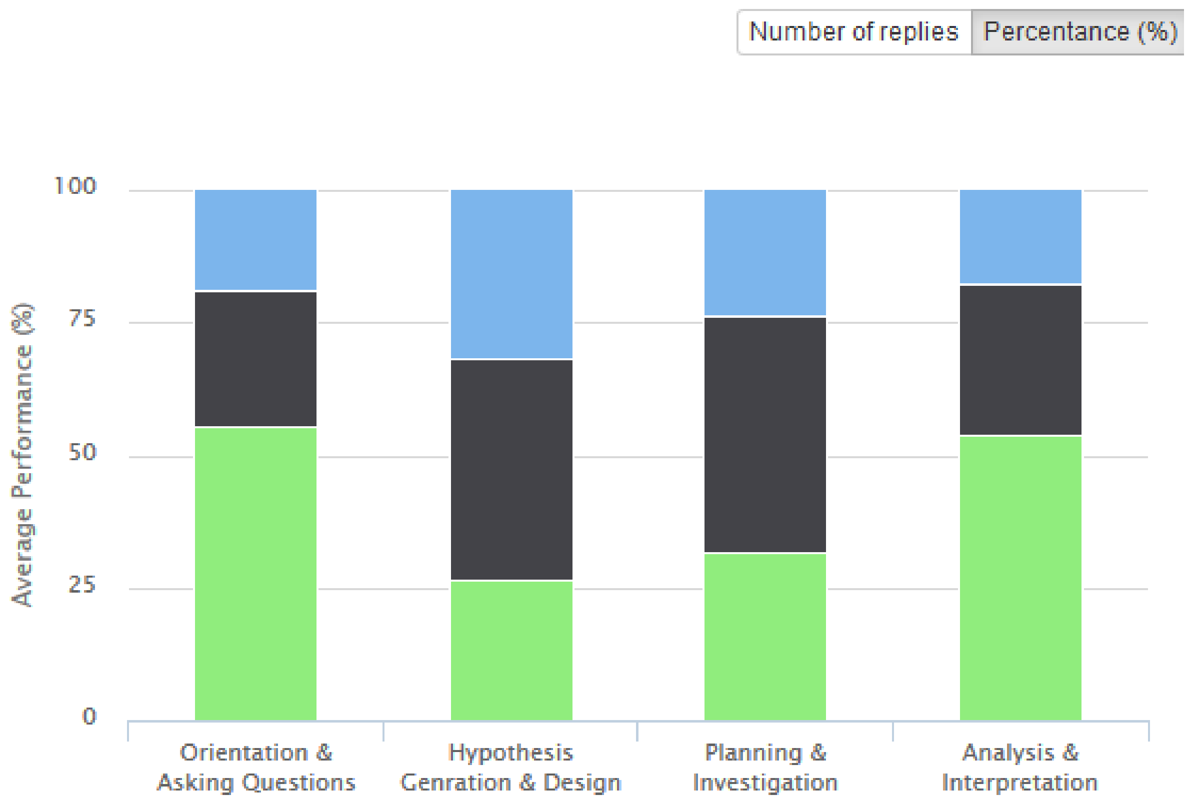
"Pisa like" assessment questions

Had 39 runs with ~520 students answering all 2*4 questions

General information

Total runs:	39
Run Avg. Duration:	1:27:20
Students Participated:	709
Students Completed PSQ:	518 (73.1%)
Period From:	02/05/2015
Period To:	03/11/2017

Class Profile



Results/phase
Green=L
Black-M
Blue=H

Students out perform the OECD averages

Mini masterclass@Greek schools
Lectures, VV, hands-on event analysis with HYPATIA tool