

INTERNATIONAL MASTERCLASSES HANDS ON PARTICLE PHYSICS

Report IMC & Masterclass SG
Uta Bilow + Ken Cecire
10.05.2023, Sofia



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International Masterclasses

19th International Masterclasses 2023



Each year more than 13.000 high school students in 60 countries come to one of about 225 nearby universities or research centres for one day in order to unravel the mysteries of particle physics. Lectures from active scientists give insight in topics and methods of basic research at the fundaments of matter and forces, enabling the students to perform measurements on real data from particle physics experiments themselves. At the end of each day, like in an international

New IMC participants in 2023



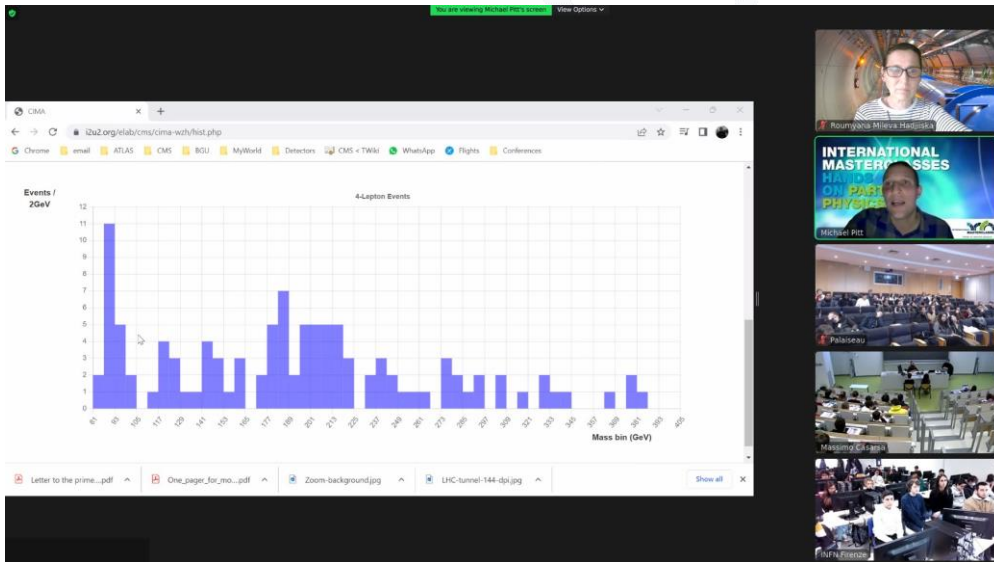
Hellenic Open University
Patra, Greece
[profile](#)

University of Zambia
Lusaka, Zambia
[profile](#)



Kharkiv National University
Kharkiv, Ukraine
[profile](#)

- Quito, Ecuador
Escuela Politécnica Nacional, [profile](#)
 - Near Quito: Cuenca, Montelibano
- Maputo, Mozambique
Universidade Eduardo Mondlane
- Ben Guerir, Morocco
Mohammed VI Polytechnic University



CMS Masterclass on Feb 13



ATLAS Masterclass in Oslo, March 1st



ATLAS Masterclass in Ljubljana, March 23





Podgorica, Montenegro [Report on Government website](#)





Masterclass in Konya, Turkey, on May 5 Postponed because of earthquake in February



Statistics for IMC23

numbers from 2022 in brackets

CERN LHC Masterclasses

211 MCs with
CERN VC (191)

- 99 ATLAS (94)
- 56 CMS (51)
- 26 LHCb (22)
- 30 ALICE (24)

Fermilab LHC Masterclasses

40 MCs with
Fermilab VC (32)

- 29 CMS (22)
- 11 ATLAS (10)

MINERvA Masterclasses

8 MCs (9)

NOvA Masterclasses

2 MCs new!

plus Off-Shell MC

KEK Belle II Masterclasses

16 MCs (11)
5 VCs (3)

Malargue Pierre Auger Masterclasses

12 MCs new!
3 VCs

GSI Hadron Therapy Masterclasses

30 MCs (28)
9 VCs (5)















Masterclasses with CERN

- WG VC with Ina Carli and Ana Peixoto
- All Zoom videocons set up as **meetings**
 - Waiting room, to allow moderators preparation time
- Moderators' orientation on Feb 6
- 58 Moderators, ~ 50% not at CERN
- 1 room for moderators at CERN 4/S-020
 - Tunnel roll-up for background decoration
- Kahoot not available for quiz
 - fall-back solution pen&paper
- Reception at CERN for moderators
 - R1 on April 13 late afternoon



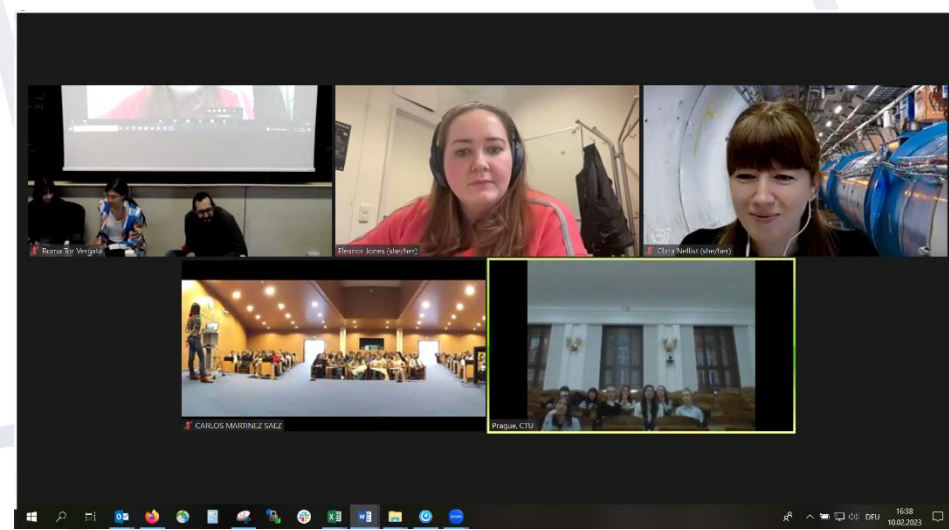
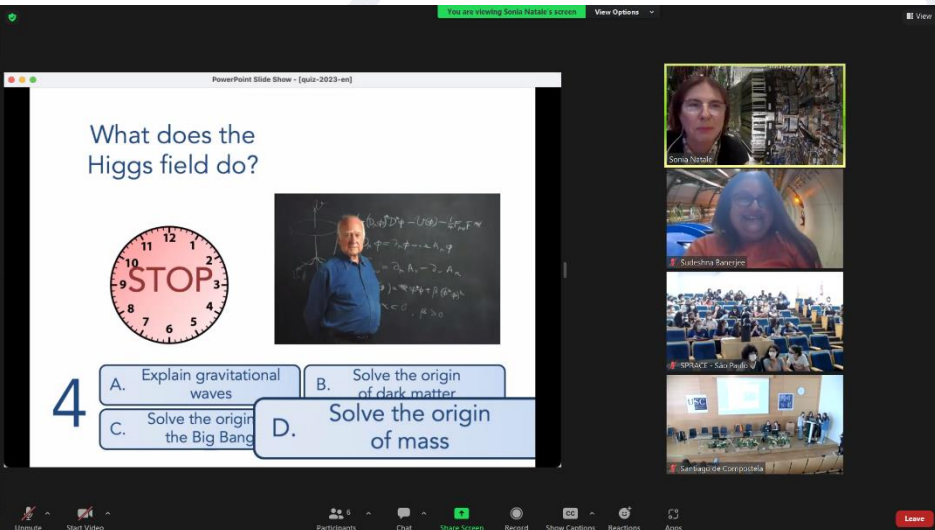
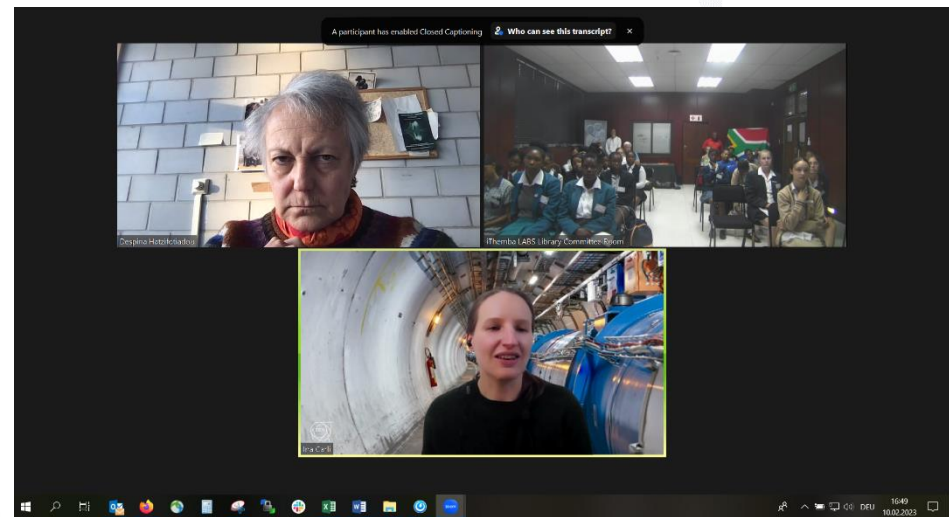
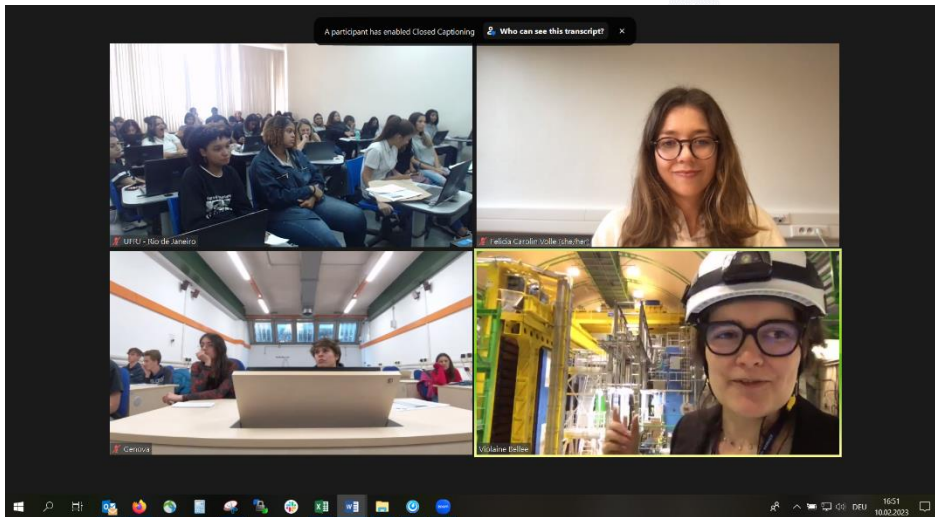
Int. Day of Women and Girls in Science

- LHC MCs for girls http://physicsmasterclasses.org/index.php?cat=women_in_science
- On Feb 10th (Friday)
- 14 groups participating (11)
- ~ 500 students (550)
- Female lecturers and tutors (as much as possible)
- 5 videoconferences at CERN (4)
- 10 female moderators (8)

	Feb 10, 2023	Feb 10, 2023	Feb 10, 2023	Feb 10, 2023	Feb 10, 2023
	VC 1 ATLAS W	VC 2 ATLAS Z	VC 3 CMS	VC 4 ALICE	VC 5 LHCb
moderators	Ana	Eleanor	Sudeshna	Despina	Violaine
moderators	Joni	Clara	Sonia	Ina	Felicia
	Cosenza 	Valencia 	São Paulo SPRACE 	Thessaloniki and Chania 	Rio de Janeiro, UFRJ 
	Rome Tre 	Rome Sapienza 	Santiago de Compostela 	Darmstadt, Frankfurt, Muenchen, Muenster (ALICE R_AA) webpage 	Genoa 
	Biblioteca Alexandrina 	CTU Prague 		Cape Town, iThemba LABS 	
		Rome Tor Vergata 			

In 2024, Feb 11 is a Sunday.
And it is in the middle of the
carneval season...

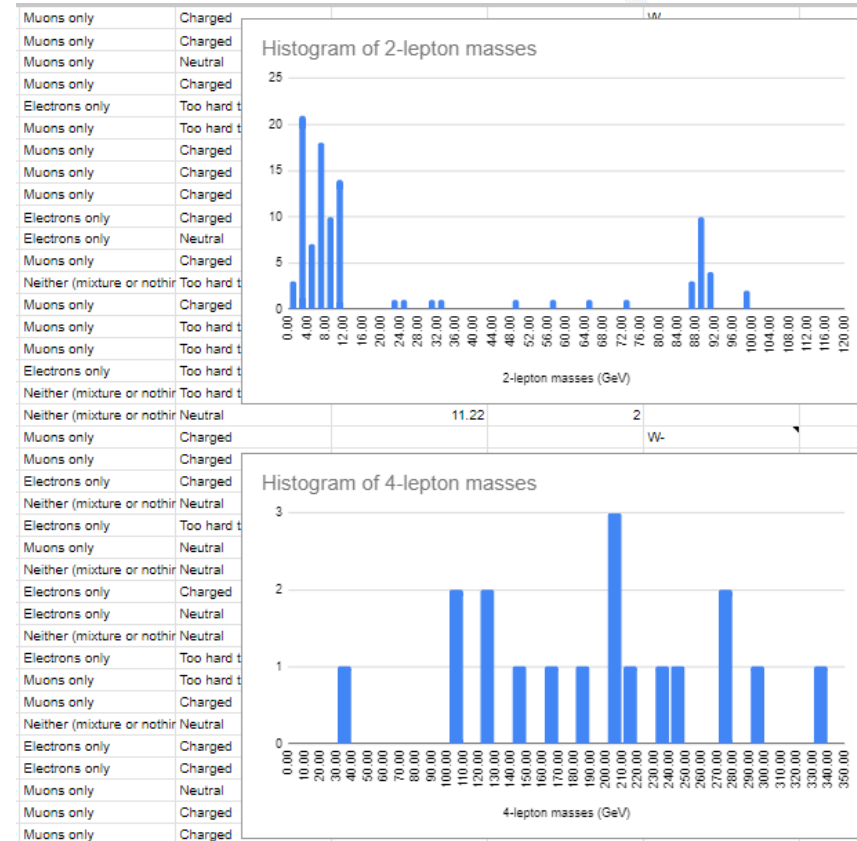
Photos from Intl Day of Women and Girls in Science



QuarkNet and Fermilab

Measurements

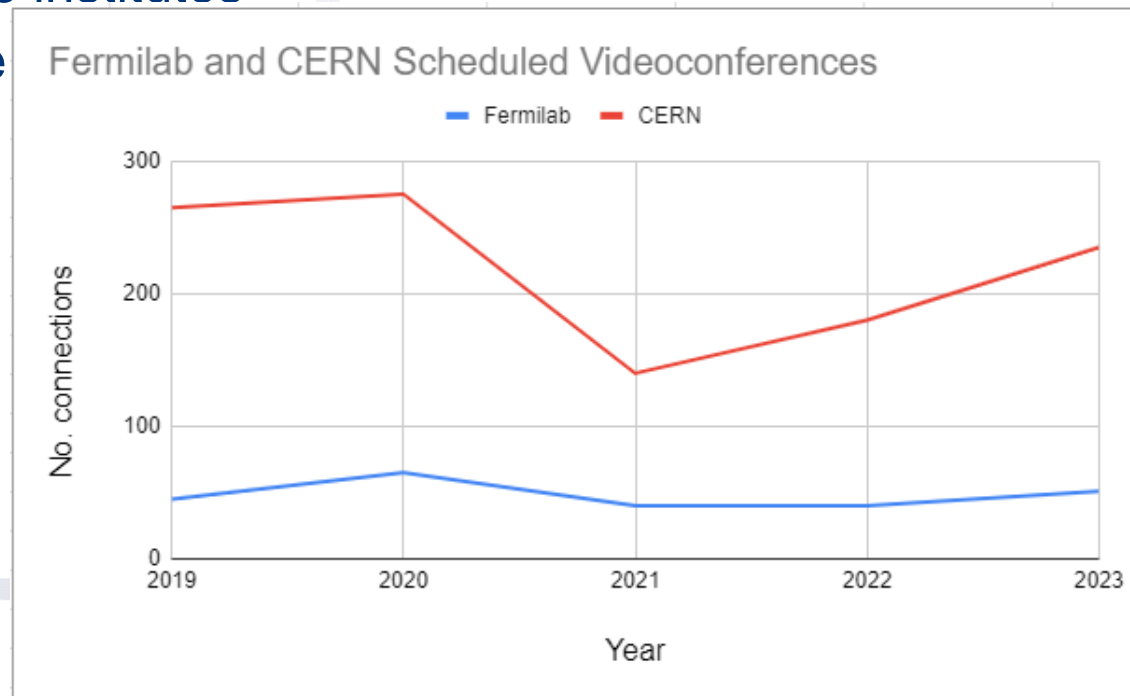
- CMS:
 - $W^+:W^-$ and $e:\mu$ not automatic
 - Piloted return to Google sheets
- MINERvA also works well → no changes
- NOvA multiple pilots → successful, plan to roll out for IMC
- ProtoDUNE delayed → work resumed
- ATLAS
 - Mostly continues as before
 - Tested using online HYPATIA and Google sheets → it worked



QuarkNet and Fermilab

Videoconferences

- Introduced videoconference quizzes
 - Particle Physics
 - Fermilab trivia
- Too many single institutes
- Numbers stable



BELLE II IMC IN 2023

R. Pestotnik: Belle II
IPPOG, May 10, 2023

ly in person masterclasses – **~400 students (+90% wrt 2022)**

The events announced through IMC and Belle II collaboration channels

- ❖ EU - 3 events with a final video conference (participation from Armenia, Yerevan)
- ❖ Events in 2 new regions: US (mainland +Hawaii), JP

Date	Institutes	Region	Participants
Mar. 7	3	EU	100
Mar. 14	3	EU	108
Mar. 23	5	EU	93
Mar. 24	3	US	95
Jan. 7	2	JP	6

*planned India (Kolkata) participation cancelled due to collision with the university timetable – will join next year

Instructor Tutorial @Belle II General Meeting + video clips + question time

Intro. + Virtual reality of the Belle II detector

Video conference - live connection to Belle II cavern

Quiz: own app and voting system – allows group ranking.

Survey: very high satisfaction of students



Events

BELLE II - EXERCISES

Two exercises on the menu – Choice of the institute:

- Spectroscopy – search for new particles 10 MEvents
 - <https://belle2.ijs.si/masterclass/>
 - Online server + client in the browser
 - able to handle more than 250 parallel users
 - Event display:
 - https://store.steampowered.com/app/810020/Belle_II_in_Virtual_Reality/

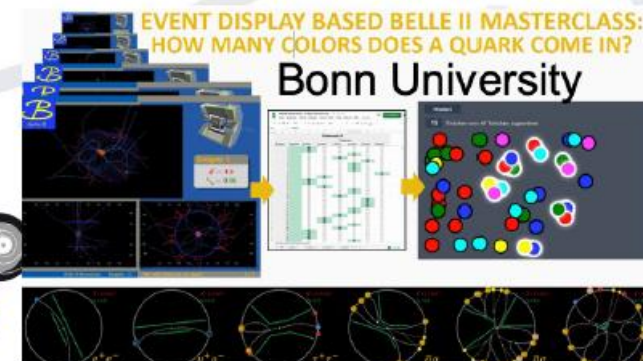
- Measure quark colors
 - similar to LHC experiments
 - <https://belle2.ijs.si/public/home/quark-colors/>
 - Limited sets of events

During the video conference, student presented different exercises to each other



2023:

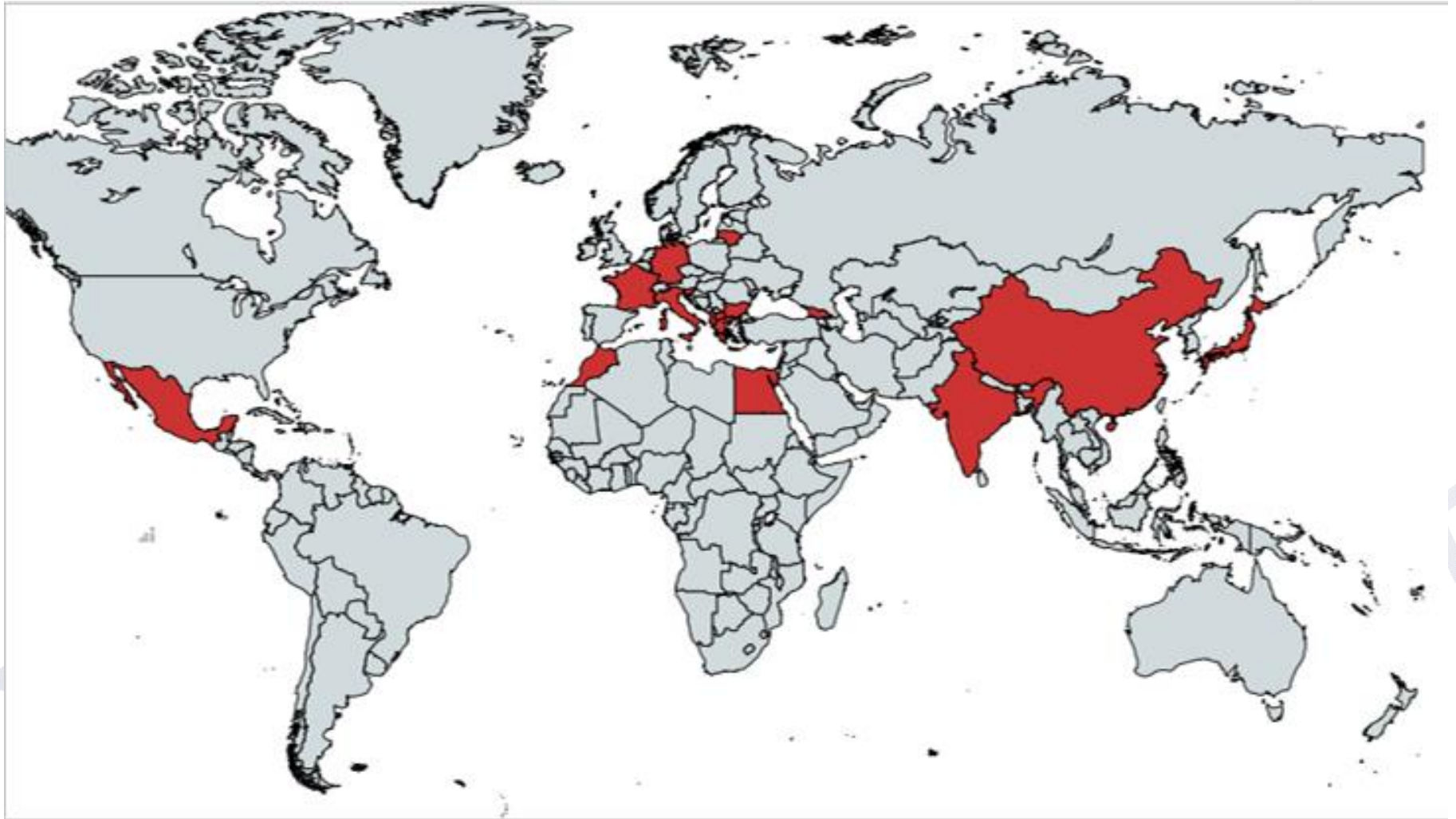
- 13x exercise 1
- 2x exercise 2
- 2x both



Particle Therapy Masterclass

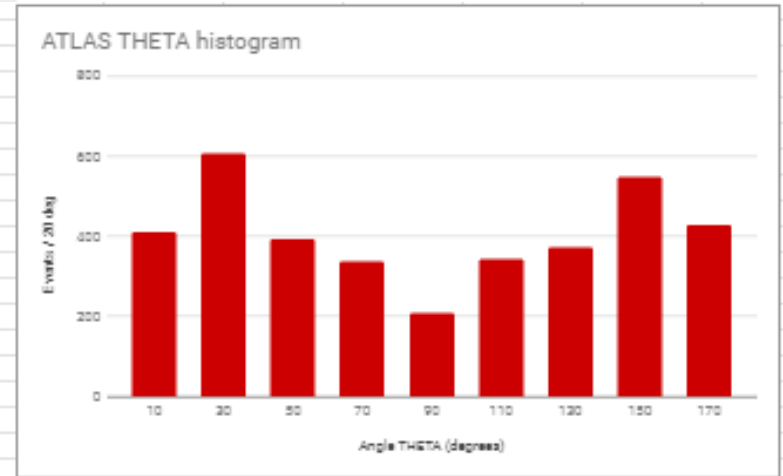
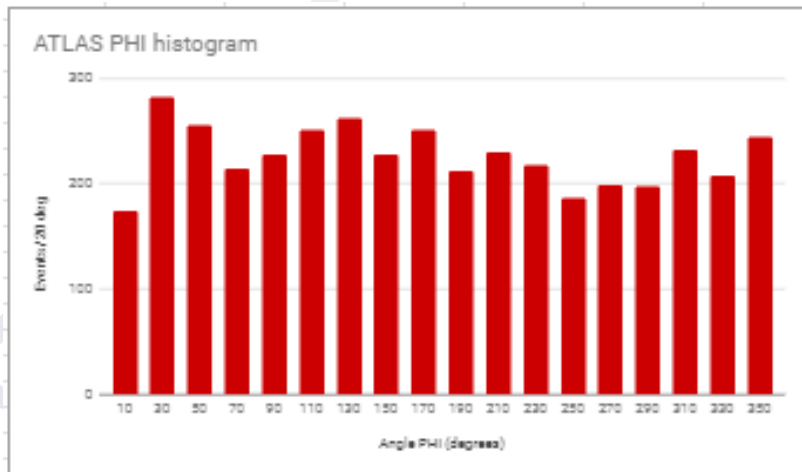


Particle Therapy Masterclass



World Wide Data Day 2022 (W2D2)

- Thursday, 10th November
- for high school students, guided by physics teachers
- simplified measurement with data from ATLAS and CMS
- measurement Φ and θ : turning $\Delta\Phi$ into a QuarkNet activity
- 42 classrooms in 11 countries – 6 classes in Bulgaria!



Results from IMC SG Meeting yesterday

3-D ATLAS Event Display

Tracer-EVD 3-Dimensional Event Display for ATLAS Masterclasses



SHARMAZANASHVILI Alexander
ZURASHVILI Nino
Georgian Technical University

- Rns in browser
- Low CPU usage
- Detector views
- Event display
- <https://tracer-evd-mc.web.cern.ch>

IMC at Georgian Technical University

- About 50 students participated
- All of them were joyful with the 3D Applications
- Events analyses are much easier and clear with 3D scenes than the 2D scenes
- TracerEVD results were proved with the results from other IMC, based on the Minevra
- We have estimated application performance having more than 30 parallel sessions
- TracerEVD is now ready for usage. IPPOG has good opportunity to profit



2.1.1 Browser-based Events 3D Visualisation Display application for the ATLAS experiment;

Results from IMC SG Meeting yesterday



The NOvA Masterclass

Spencer Pasero

Fermilab

spasero@fnal.gov

Shane Wood

QuarkNet

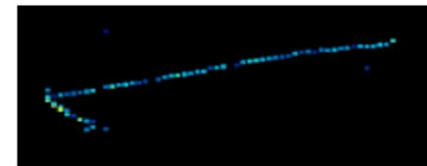
swood5@nd.edu

Piloting with Teachers (2021-2023)

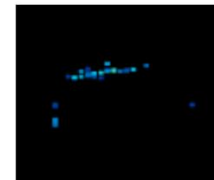
- University of MN Center Teachers 2021-22
- QN Neutrino Fellows - several iterations
- Summer-Fall 2022: Four QN workshops
- January 2023: Workshop @ AAPT WM23

Piloting with Students (2022-2023)

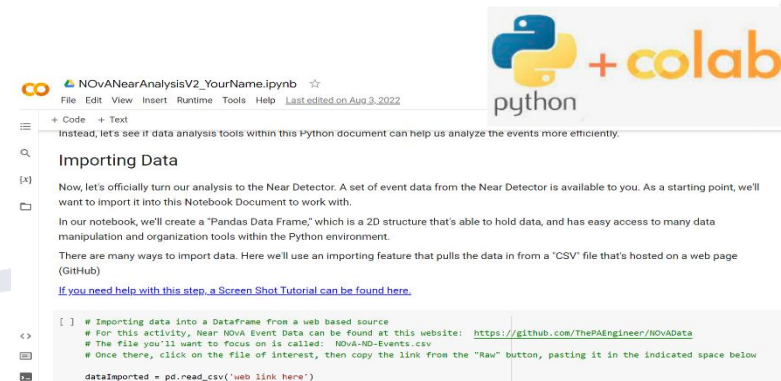
- April 23, 2022 at University of Minnesota
- Phase 2 pilot in IMC 2023:
Minnesota, UC-Irvine, SURF



*Charged-Current
Interactions*



*Neutral Current
Interactions*



Pierre Auger Masterclass

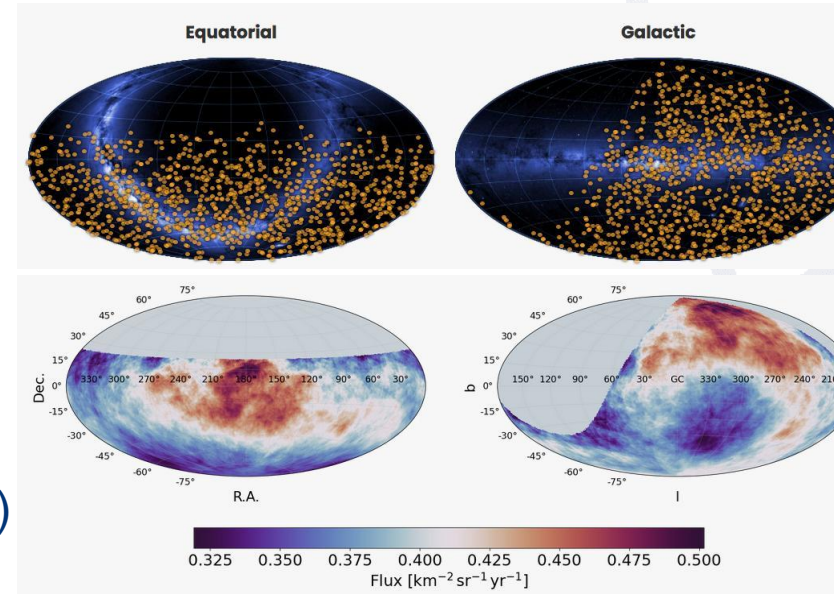
Raul Sarmiento, LIP
<https://augermasterclasses.lip.pt/>



- 3 days, 12 institutions, 550 students
- two preparatory meetings with participating institutions
- Talks, VR experience, hands-on, videocon with virtual visit and quiz



- Students results from the first Masterclass
- 1130 reconstructed and selected events
- Dipole pattern starts appearing (still low statistical significance)



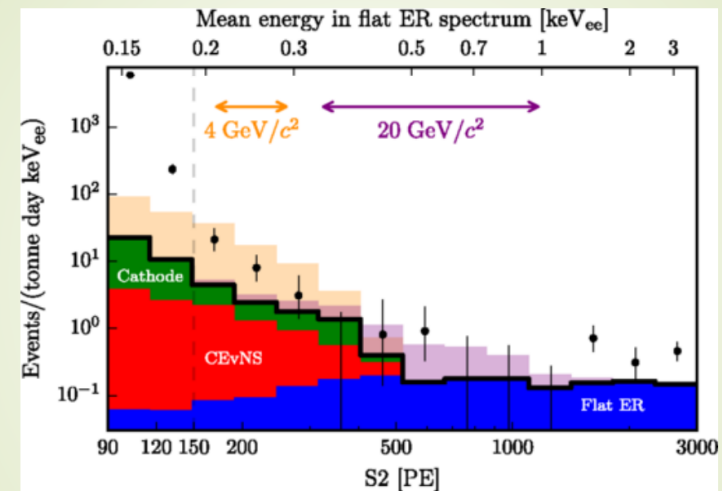
Small improvements to be implemented based on this first experience, feedback and surveys

Results from IMC SG Meeting yesterday

First pilot of a DM Masterclass using Xenon1T S2 Data

Peggy Norris (with help from Charlie Payne and his students) – May 2023

XENON1T Analysis (Aprile et al.)



- Students were able to:
 - Load detector response functions and binning
 - Generate the nuclear recoil energy spectrum for a particular WIMP mass
 - Convert that to an expected S2 signal in the detector
 - Find a region of interest for the WIMP model and calculate the cross section limit

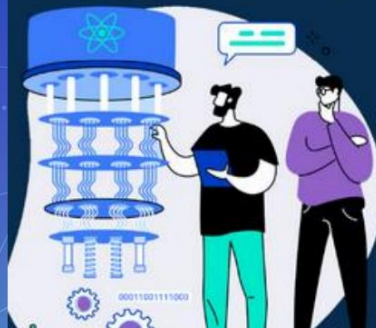
Results from IMC SG Meeting yesterday

1st exercise

Irais Bautista
&
Javier Mas



Quantum
SPAIN



QUANTUM
COMPUTER
MASTERCLASS

14 DE ABRIL

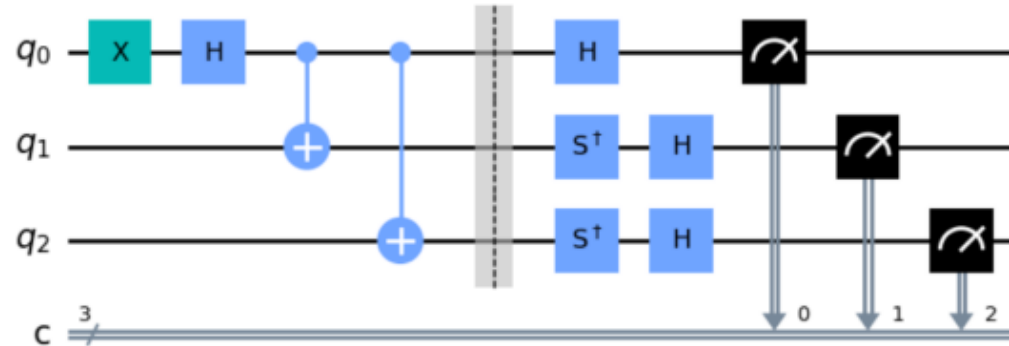
We have a simultaneous event in CESGA & USC - Santiago de Compostela, UAM-Madrid, IAC & CIDIHUB-Tenerife, BSC & CSUC-Barcelona, COMPUTAEX & CÉNITS –Cáceres.

This was announced as part of the World-Quantum-Day celebrations.

```
%matplotlib inline
import numpy as np
from qiskit import Aer, QuantumCircuit, execute

qc = QuantumCircuit(1,1)

qc.h(0)
qc.measure(0,0)
qc.draw('mpl')
```



<https://quantumspain-project.es/quantum-spain-celebra-el-world-quantum-day>

Results from IMC SG Meeting yesterday

- ~23 in attendance in-person and online
- Videoconferences discussion:
 - many quite good but not uniformly so
 - Already have good documentation
 - Send suggestions to Uta and Ken
- PTMC:
 - Increase in U.S.? Need a lead institution.
- Videocon quizzes
 - Shared experiences