

# INTERNATIONAL MASTERCLASSES HANDS ON PARTICLE PHYSICS

## Masterclass Report

Uta Bilow + Ken Cecire  
14.05.2025, Fermilab





Lavras, Brazil. ATLAS Masterclass on April 10



Dresden. ATLAS Masterclass on March 25







Yerevan. ATLAS, Belle II, CMS Masterclasses  
on March 18, 19, 20



# 3 Masterclasses in Ukraine



Karazin University:

1st - CMS masterclass on 25th of March 2025

2nd - LHCb masterclass on 28th of March 2025

3rd - PTMC masterclass on 4th of April 2025

<https://www.youtube.com/watch?v=3CyxpVxijlA>





# Statistics for IMC25 (numbers from 2024 in brackets)

## CERN LHC Masterclasses

237 MCs with  
CERN VC (233)

- 109 ATLAS (115)
- 62 CMS (67)
- 31 LHCb (26)
- 35 ALICE (36)

10.570 participants  
in 2024

## Fermilab LHC Masterclasses

34 MCs with  
Fermilab VC (40)

- 24 CMS (28)
- 10 ATLAS (9)

## MINERvA Masterclasses

6 MCs (8)

## NOvA Masterclasses

4 MCs (5)

1350 participants  
(1.410)

## GSI Hadron Therapy Masterclasses

57 MCs (47)  
11 VCs (8)

1.500 participants  
in 2024

## KEK Belle II Masterclasses

16/18 MCs (16)  
5/6 VCs (9)

750 participants  
(630)



















## Malargue Pierre Auger Masterclasses

21 MCs (17)  
6 VCs (5)

660 participants  
(530)

# International Day of Women and Girls in Science

- LHC MCs for girls
- On Feb 11th (Tuesday)
- 18 groups participating (14 in 2024)
- ~ 750 students (700)
- Female lecturers and tutors
- 4 videoconferences at CERN (3)
- 8 female moderators (5)
- [Webpage](#)

	Feb 11, 2025	Feb 11, 2025	Feb 11, 2025	Feb 11, 2025
	VC 1 ATLAS Z	VC 2 ATLAS W + CMS	VC 4 ALICE	VC 5 LHCb
moderators	Hassnae	Ana	Alba	Patricia
moderators	Jennifer	Shalini	Marika	Fionn
	Rome Sapienza 	Medellin (CMS) 	Thessaloniki (Strange Particles) 	University of Barcelona 
	Valencia 	Perugia (CMS) 	Copenhagen (Strange Particles) 	Rio de Janeiro, UFRJ 
	Rome Tor Vergata 	São Paulo, SPRACE (CMS) 	Kosice (ALICE R_AA) 	Santiago de Compostela 
	Birmingham 	Alexandria (ATLAS W) 	Darmstadt Frankfurt Münster (ALICE R_AA)  webpage	
	CTU Prague 	Cosenza (ATLAS W) 	Cape Town, iThemba (ALICE S.P.) 	



# W2D2



Join in real particle physics data analysis at your school.

Collaborate with students worldwide.

Discuss your findings with particle physicists.

**Next step: ask your physics teacher!**



## Numbers 2024 (2023)

- CMS schools – 31 (31)
- ATLAS schools – 18 (20)
- Combined countries – 10 (12)

## And...

- Stable measurements, good results
- Surprising new country: Cayman Islands
- Updated website,  
<https://cern.ch/w2d2>



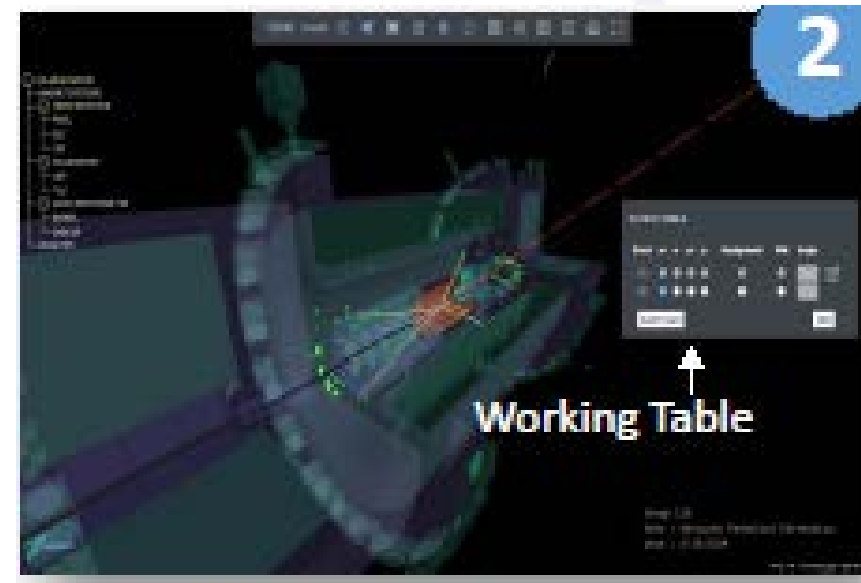
# Results from IMC SG meeting (13.05)

## Tracer 3D event display (Lasha Sharmazanashvili)

- Implemented in ATLAS W path [https://atlas.physicsmasterclasses.org/en/wpath\\_3D.htm](https://atlas.physicsmasterclasses.org/en/wpath_3D.htm)
- Used by 9 groups (out of 17)
  - Event analysis is easy and fast
  - Realistic representation is more enjoyable for students
  - No installation required
  - Runs on portable devices
  - Reliable parallel working sessions: 200 users

### Future plans:

- Automated upload of results is desired
- Extension to ATLAS Z path





# Results from IMC SG meeting (13.05)

## Revised concept for CERN videoconference (Uta)

- Addresses negative feedback from institutes (very few)
- [ATLAS](#), [CMS](#) and [ALICE](#) short videos, to illustrate every-day-life of moderators
- List of welcome question
- Animations for ATLAS and CMS, e.g. Higgs  $\rightarrow$  ZZ, 4l
- Rehearsal and audio tests with new moderators
- Focus on junior moderators

## Future plans:

- Replace quiz question on LHC power consumption
- investigate the possibility of using a quiz app



# Results from IMC SG meeting (13.05)

## Fermilab Masterclasses (Ken)

- Stable numbers for LHC and neutrino Masterclasses
- QuarkNet Masterclass library cleaned up <https://quarknet.org/mc-start>

## IMC SG

- 2 new members endorsed
  - Spencer Pasero: MINERvA
  - Shane Wood: NOvA
- Nicolas Arnaud has left the SG (on his own request)



# Results from MC2NC working group (08.05)

Meeting Attendance, 8 May: Uta, Spencer, Ana, Shane, Raul, Gillian, Krzysztof, Ken, Pedro

Ana first was a student in IMC in 2010 in Braga!

Masterclass Advancement:

ALICE – Bhutan and Korea

AUGER – Argentina (first in Americas)

CMS – Dominican Republic (inquiry)

Multi – Algeria (growth)

New ideas:

Toolkit for dealing with adverse circumstances, e.g. loss of electricity

Increase offline masterclass prep

Next meeting: Sept 2025



December 2024 : First ALICE Masterclass in Seoul, South Korea at the “Gyeonggi Science High School for the Gifted”

# Auger @ IMC 2025

- Auger's measurement **third edition** at IMC
- First-ever event for the **American continent**, with students from **Argentina and Mexico!**
- The video conference of the session for the Asian continent started with the **observation of a lunar eclipse** from the observatory site!
- For the first time, participation of students from **Bosnia-Herzegovina and Greece**



Argentina.gov.ar

Buscá en el sitio



miArgentina

Jefatura de Gabinete de Ministros / Comisión Nacional de Energía Atómica /

## Estudiantes de escuelas secundarias participaron en una masterclass del Observatorio Pierre Auger en la CNEA

El Centro Atómico Constituyentes fue la sede de esta actividad que se hizo por primera vez en la Argentina y Latinoamérica. Los estudiantes pudieron vincularse con expertos en el estudio de los rayos cósmicos.





# Auger @ IMC 2025

- **Increasing participation** relative to previous years, in particular from institutions outside the Pierre Auger Collaboration
- Innovation: inclusion and analysis/discussion of the highest-energy events from the published ***Top100 catalogue***
- Plans for the future:
  - to sustain the current level of participation
  - to update the measurement after the forthcoming public release of **additional 20% events** from Auger Phase-1

Auger Masterclasses at		IMC 2023	IMC 2024	IMC 2025
Events		3	5	6
Continents		2	4	4
Countries		5	10	12
Institutions		12	16	21
Institutions within Auger		10	10	10
Institutions outside Auger		2	6	11
Students		550	534	660



# BELLE II IMC IN 2025

R. Pestotnik: Belle II IMC SG@ IPPOG, May. 13, 2025

**Total ~750 participants – 19% more than in 2024**

- ❖ 5 events announced through IMC and Belle II collaboration channels
- ❖ **New participants from Armenia, Japan & India**
  - ❖ Events: EU x3, US x1, IN x1
  - ❖ **1 Indian event will be held in May**

Date	Institutes	Region	Participants
Mar. 11	6	EU	170
Mar. 19	6	EU	218
Mar. 25	2	EU	180
Mar. 25	2	US	180
May	2	IN	Exp. 40-60



- ❖ Mar.1: Instructor Tutorial & Question time @Belle II General Meeting
- ❖ Recorded instructions
- ❖ Video conference
  - ❖ live connection to KEK
  - ❖ Quiz: Belle II app and voting system – allows group ranking.

	INFN Pisa	INFN Padova	INFN Roma	INFN Torino	Uppsala Uni	CPPM IN2P3
Points	96	74	100	96	100	100
Total	716	620	740	758	771	800





# BELLE II – 2025 EXERCISES

R. Pestotnik: Belle II IMC SG@ IPPOG, May 13, 2025

Two exercises – Free choice of the participating institution:

## ❖ Spectroscopy – enriched data samples -10 Mevents – at 8 sites

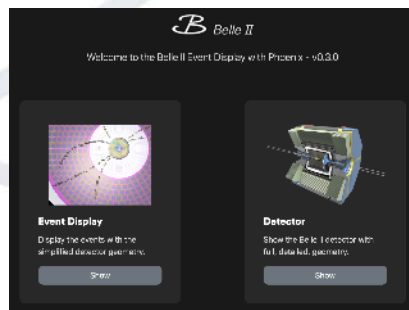
- <https://belle2.ijs.si/masterclass/> - runs on the server + client browser  
→ improved advanced mode for Uni Students with additional likelihood cuts

## ❖ Measure quark colours - at eight sites

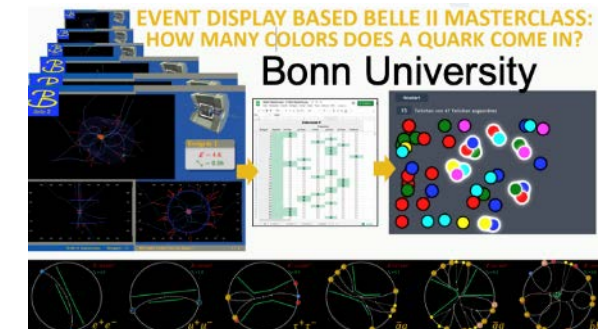
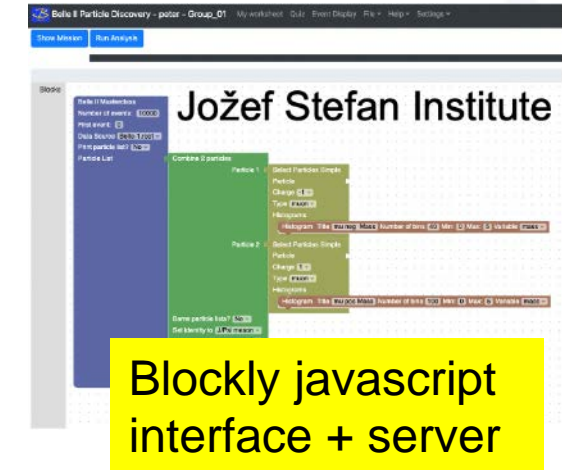
- <https://belle2.ijs.si/public/home/quark-colors/>
- similar to LHC experiments: limited set of events

## ❖ Support materials:

- ❖ New Event display: <https://display.belle2.org/>
- ❖ Virtual reality  
[https://store.steampowered.com/app/810020/Belle\\_II\\_in\\_Virtual\\_Reality/](https://store.steampowered.com/app/810020/Belle_II_in_Virtual_Reality/)



## ❖ Plans: Increase participation and organize IMC in new regions (CN)



→ Mixed video conferences:  
Students presented different exercises to each other