

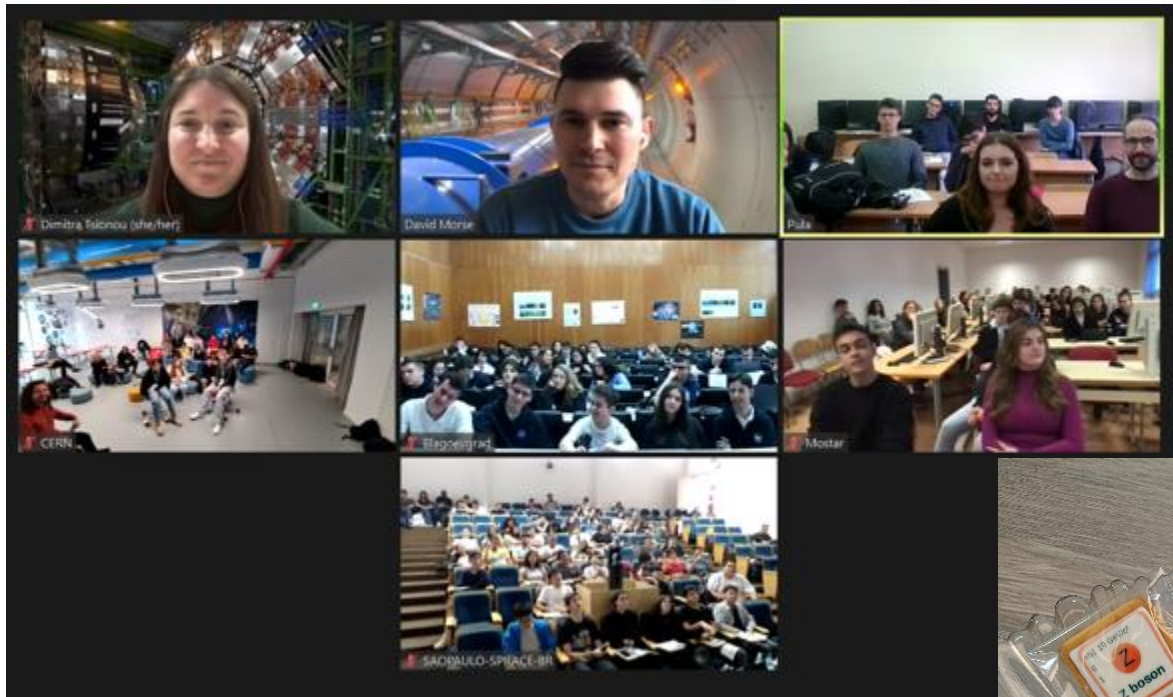
INTERNATIONAL MASTERCLASSES

HANDS ON PARTICLE PHYSICS

Report IMC & Masterclass SG

Uta Bilow + Ken Cecire

23.04.2024, Madrid











New participant in IMC24: University of Cape Verde

University of Cape Verde, Praia

90 students on March 9, ATLAS W Masterclass

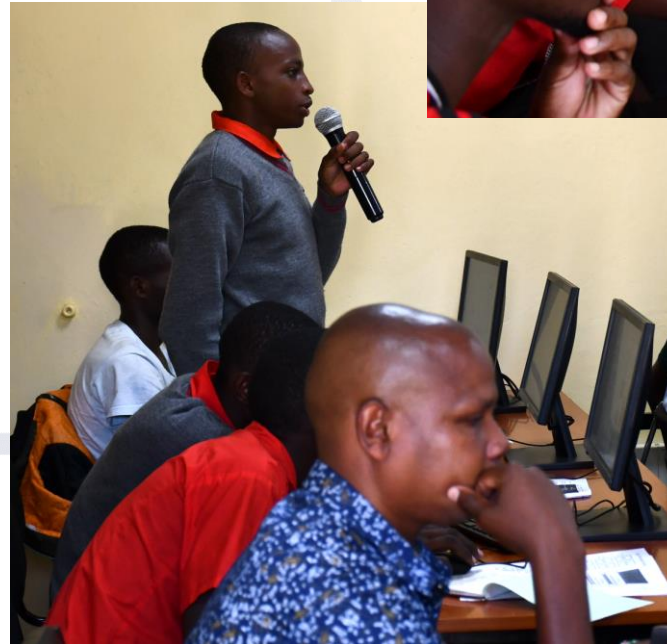
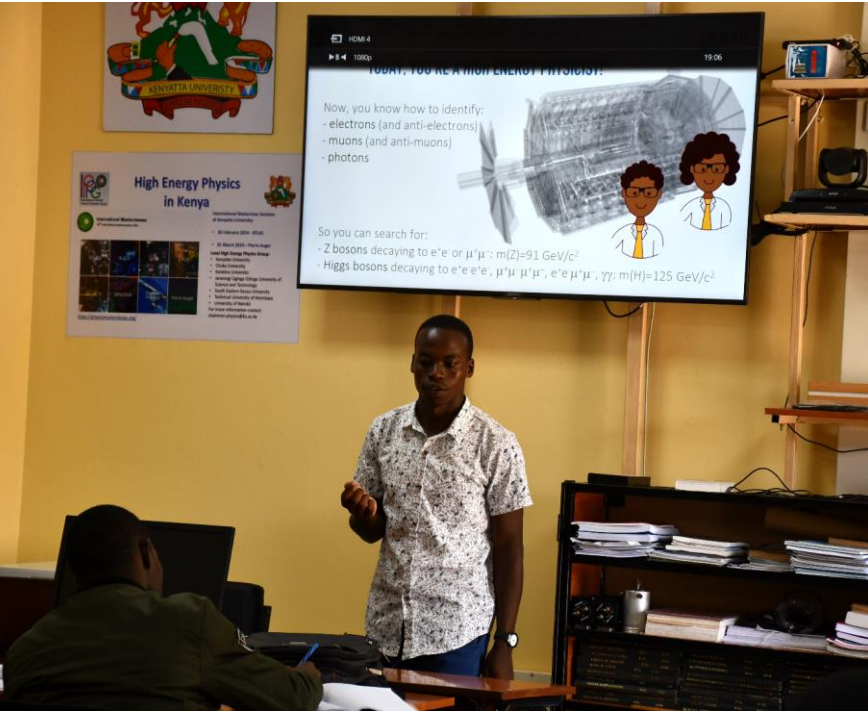
Contact facilitated by **Pedro**



Sat, Mar 09
VC 1: ATLAS W
André
Sofia
Beja 
Porto 
Bucharest 
Cluj-Napoca 
Praia 
Beira 

Pedro: „They had a problem with their data analysis. They did however participated in the videoconference.“

New participant: University of Kenya in Nairobi



„The school we have invited is in a poor area of Nairobi. For most of the students, if not all of them, it was their first time using a computer. I think they did very well.”

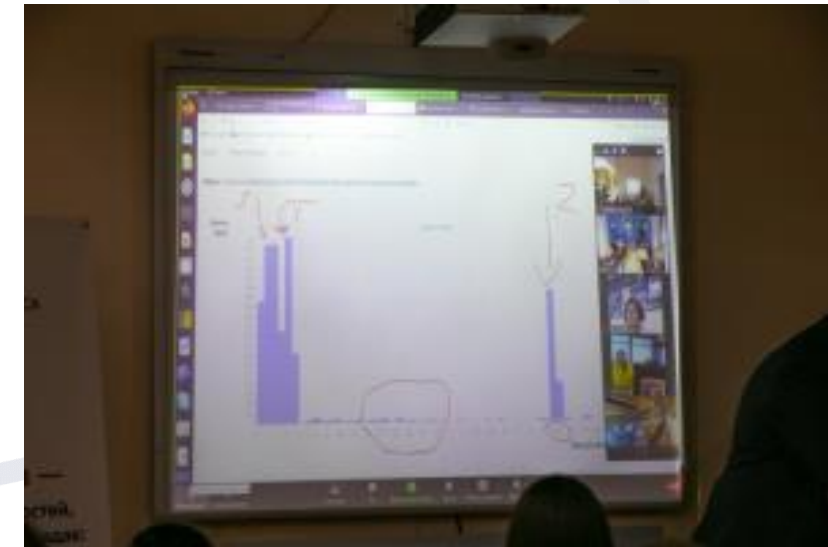
2 Masterclasses in Ukraine



CMS Masterclass on March 1
Particle Therapy Masterclass on March 15



„Both masterclasses were attended by more than 30 participants and it was a great success. I've received lots of positive messages from parents and students after the masterclasses.“



Statistics for IMC24 (numbers from 2023 in brackets)

CERN LHC Masterclasses

233 MCs with
CERN VC (211)

- 115 ATLAS (99)
- 67 CMS (56)
- 26 LHCb (26)
- 36 ALICE (30)

10.570 participants

Fermilab LHC Masterclasses

40 MCs with
Fermilab VC (40)

- 28 CMS (29)
- 9 ATLAS (11)

MINERvA Masterclasses

8 MCs (8)

NOvA Masterclasses

5 MCs (2)

1.440 participants

GSI Hadron Therapy Masterclasses

47 MCs (30)
8 VCs (9)

1.500 participants

KEK Belle II Masterclasses

16 MCs (16)
7+2 VCs (5)

630 participants

Malargue Pierre Auger Masterclasses

17 MCs (12)
5 VCs (3)

530 participants

In total: 14.670 participants

New webpage

CERN Accelerating science

Sign in Directory

International Particle Physics Outreach Group

About Resources Activities News Calendar

ACTIVITY

International Masterclasses

Hands on Particle Physics

- What is IMC
- Physics Masterclasses
- Take Part
- Events and Schedules
- Countries and Institutes
- History
- IMC Articles
- Contact & Acknowledgements

What is IMC?

Each year over 13,000 high school students from 60 countries step out of the classroom for a day to immerse themselves in the fascinating world of Quarks and Leptons. Hosted by 225 universities and research centres, these masterclasses offer a unique chance to unravel the mysteries 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 research collaboration, the participants join in a video conference for discussion and combination of their results. International Masterclasses aren't just events; they're a passport to discovery, an annual opportunity for 15- to 19-year-old students to ignite their curiosity in particle physics. International Masterclasses promise to make science come alive in a way that textbooks never could. Get ready to go beyond the classroom and into the forefront of scientific exploration!

Curious to uncover the secrets of Quarks and Leptons?

- Get out of school for one day and come to a nearby university or research centre
- Get insight into topics and methods of basic research at the fundamentals of matter and forces
- Perform measurements on real data from particle physics experiments at CERN
- Participate in an international video conference for discussion of results

Watch the video below to get an inside look at this electrifying experience!

IPPOG representatives during IPPOG conference at CERN 2022 (left: author)

Facebook

INTERNATIONAL MASTERCLASSES
hands on particle physics

<https://ippog.org/imc-international-masterclasses>

Organisation

- 17 circulars to local organizers
 - Bi-weekly in 2023, weekly in 2024
- Question time for measurements
 - Few (1-5) participants in each session
 - PTMC does extra training sessions
 - Feedback from MC authors: not much effort, some people had good questions, → keep it
- IMC photo competition
 - The jury is looking forward a diverse, refreshing and immersive snapshot of the IPPOG flagship programme as seen by those without whom it would not exist: you !
 - Proclamation of winners on Wed

International Day of Women and Girls in Science

- LHC MCs for girls
- On Feb 9th (Friday)
- 14 groups participating (14)
- ~ 700 students (500)
- Female lecturers and tutors
- 3 videoconferences at CERN (5)
- 5 female moderators (10)
- [Webpage](#)

	Feb 09, 2024	Feb 09, 2024	Feb 09, 2024
	VC 1 ATLAS W + Z	VC 2 CMS	VC 3 ALICE
moderators	Ana P.	Sudeshna	Despina
moderators	Eleanor	Ana V. B.	N.N.
	Valencia (ATLAS Z) 	Varna, Astronomical Observatory 	Thessaloniki (ALICE) 
	Rome Tor Vergata (ATLAS Z) 	Rome Sapienza 	Cape Town, iThemba LABS (ALICE) 
	Cosenza (ATLAS W) 	Santiago de Compostela 	CTU Prague (ALICE) 
	Alexandria (ATLAS Z) 	Sao Paulo, SPRACE 	Darmstadt Frankfurt Muenchen Muenster (ALICE R_AA)  webpage
		Debrecen 	
		University of Barcelona 	



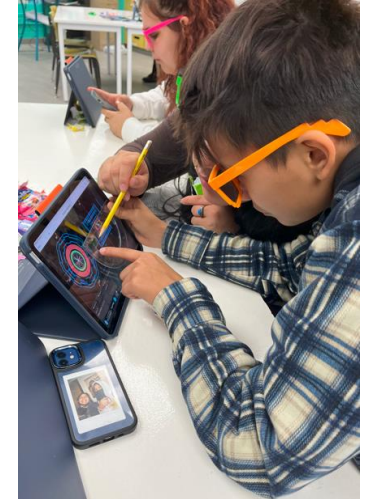
W2D2

Numbers 2023 (2022)

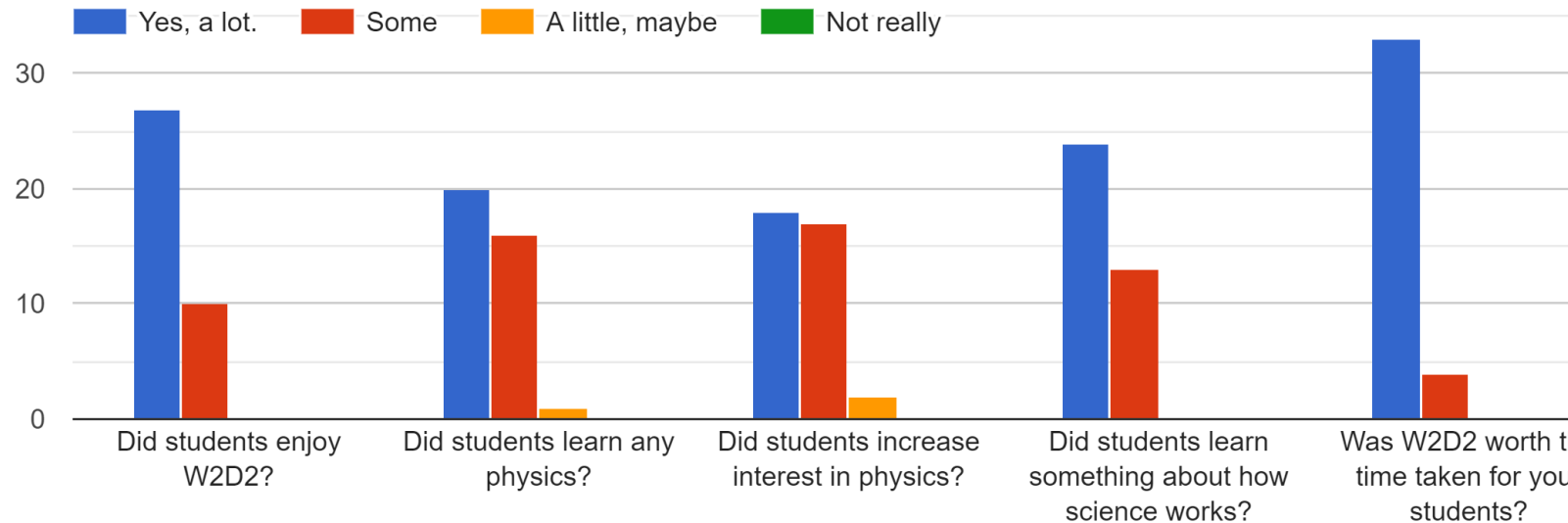
- CMS schools – 31 (25)
- ATLAS schools – 20 (16)
- Combined countries-12 (11)

And...

- Stable measurements, good results
- Surprising new country: Bhutan



Please rate responses of your students to W2D2-2023.



Results from MC2NC working group (16.04.)

Connections:

- Maputo bad connection in VC due to bandwidth
- Beira (Mozambique) could not upload results, but joined VC
- Angola (PT speaking) interested to join next year

Discussion:

- Possible workaround in case of power cut: build histogram with sticky notes, send picture to moderators or send text/numbers
- Download package that can be used in place of the videoconference
 - Virtual tour
 - „Dummy“ combination
 - Map
 - Quiz can be run locally

Results from MC2NC working group (16.04)

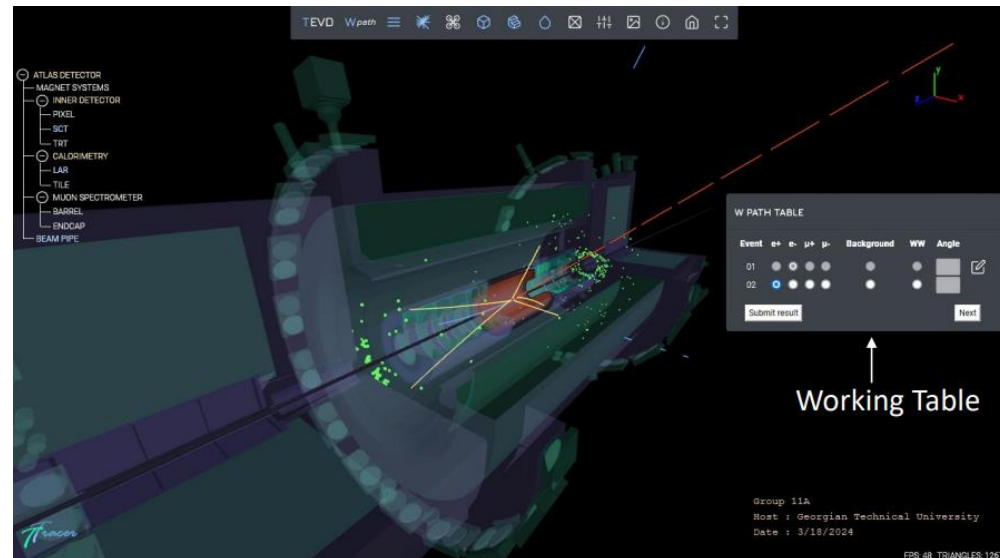
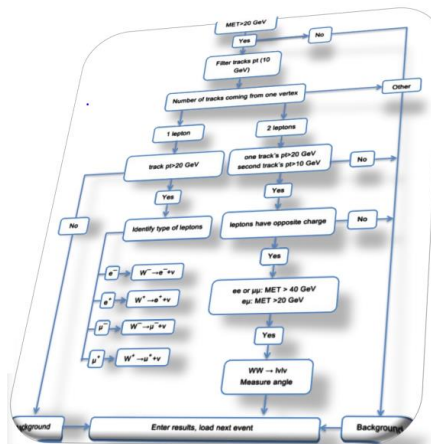
Follow-up from IMC

- We go to many countries with IMC, would be nice to include them in IPPOG collaboration.
 - Deliver brochure or „joining pack“
 - Candidate country needs HEP community (e.g. South Korea, Canada, Japan, Columbia....)

Result from IMC SG meeting

Tracer: Experience

- For ATLAS W-path
- No downloads needed
- Tested in multiple masterclasses in 2024 – five videoconferences
- Students follow a standard algorithm for event analyses and fill strings in the Working table



Tracer: Experience at GTU



- Done on the 30 Workstations



Tracer: Conclusions

1. We have had a successful experience of usage of the Tracer in the Masterclasses in Georgia
2. We **strongly** recommend IPPOG to use Tracer as a main tool for the ATLAS WW masterclasses
3. We are looking for feedback from the IMC steering group about the further improvements of the Tracer and masterclasses based on the Tracer
4. Let Tracer fill Physics analysis tables automatically? Then we need authorizations from you
5. We keep our eyes on the Tracer development for the ATLAS Z masterclasses

Backup slides from IMC steering group meeting

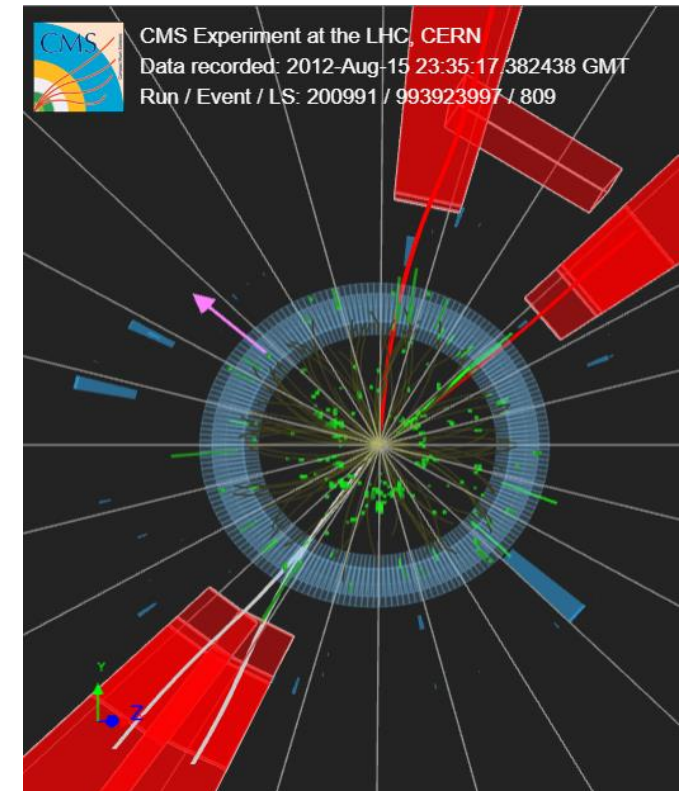
INTERNATIONAL MASTERCLASSES HANDS ON PARTICLE PHYSICS

Brief report on IMC24 from all moderation centers



What's New

- CMS Improvements and Innovations
 - Improved iSpy-webgl - *easier to pick tracks, radial lines to help with + and -, better look*
 - More 4-lepton events (almost double)
 - Tested Google Sheet alternative to CIMA
- Videoconferences
 - Mini-virtual-visits
- New(ish) Measurements
 - NOvA → normalized
 - Belle II → parallel with Jake Bennett, et al

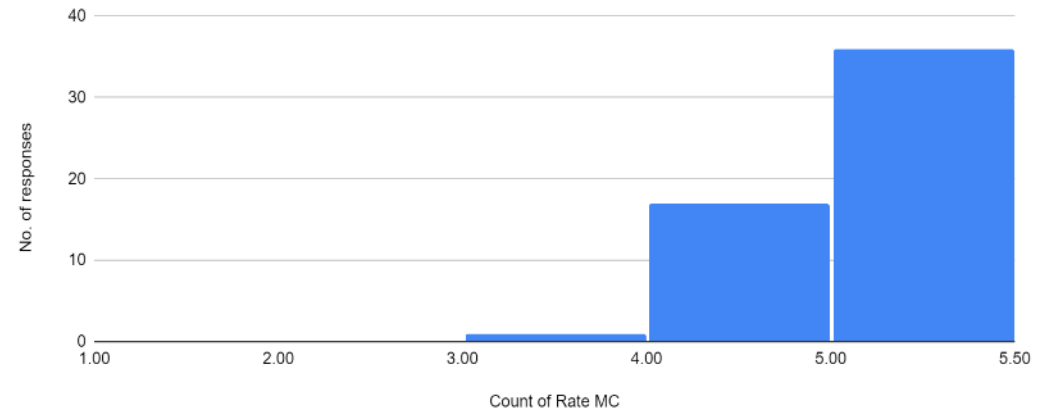




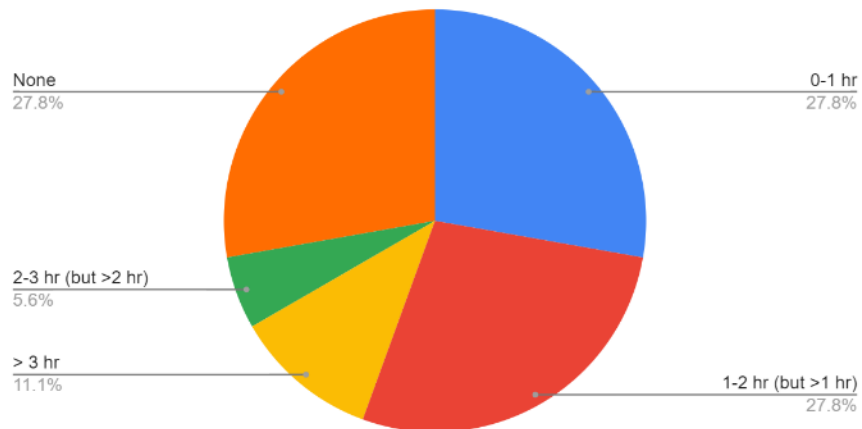
What Now?

- Feedback from tutors and teachers
- New and improved CIMA?
- More data?
- Moving toward DUNE...

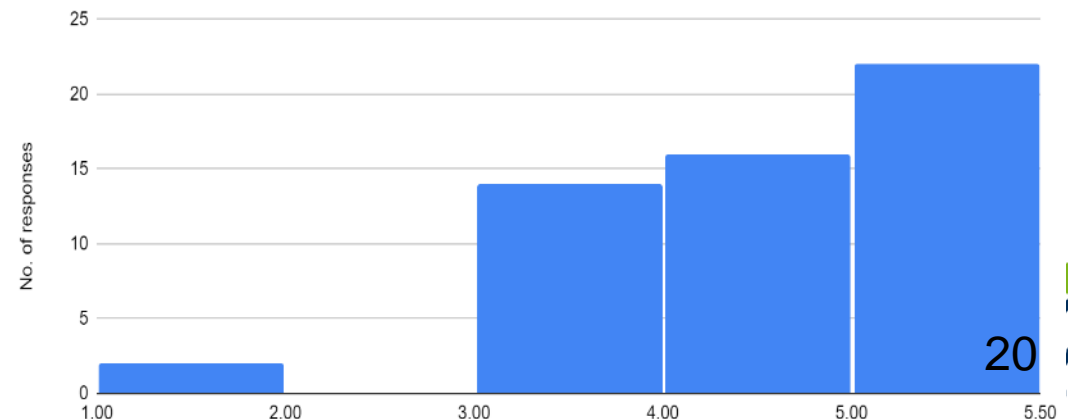
Overall, how would you rate the effectiveness of this masterclass for your students?



Count of How much in-school preparation did you give your students for the masterclass?



If your students participated in a videoconference for this masterclass, how would you rate it in terms of its effectiveness for students?



Auger @ IMC2024

assessment, improvements and challenges

- sentiment and feedback: highly positive
- making the learning curve for the video conferences
- new people involved, new suggestions and ideas
- updates/complements to the documentation

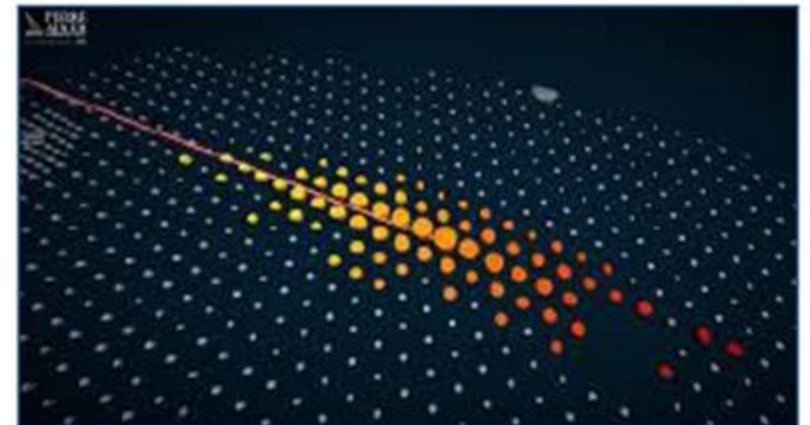
Auger Masterclasses at	IMC 2024	IMC 2023
Events	5	3
Continents	4	2
Countries	10	5
Institutions	16	12
Institutions outside Auger	6	2
Students	534	550

- reaching new regions: no precedent, smaller IPPOG reach, unfavourable calendar for organization

Auger @ IMC2025 and beyond

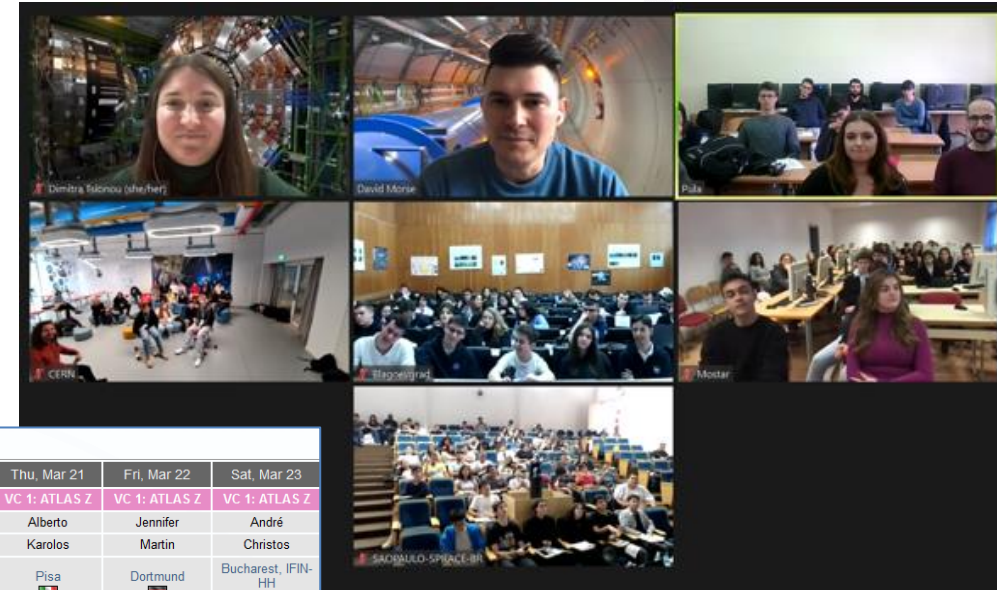
future plans

- **For next year:**
 - identify possible issues with this year students' analyses
 - how many sessions to target and actions needed?
- **Measurement(s):**
 - (2025) to include top100 catalogue events?
 - to move towards including the spectrum analysis?
 - (>2025) to create and offer an FD measurement?
 - continue to explore the recent and next open data releases?
- **Widening the project, reaching new audiences:**
 - general public, adapting it to a citizen-science project
 - teachers, by providing an oriented training programme



IMC24: CERN program

- ATLAS Z path: new OPlot website
 - CMS: see slide from Ken
 - All other measurements: stable
-
- 233 Masterclasses in 7 weeks
 - 62 videoconferences
 - Few no-shows
 - Special time slot for Kenya (+ Israel)
-
- Training for moderators on Feb 12, followed by a sandwich lunch
 - 64 moderators (shortage on ALICE side, theorists helped out)
 - 1 room at CERN (4/S-20), decorated with tunnel roll-ups



18.03. - 23.03.2024

	Mon, Mar 18	Tue, Mar 19	Wed, Mar 20	Thu, Mar 21	Fri, Mar 22	Sat, Mar 23
topic	VC 1: ATLAS W		VC 1: ATLAS Z	VC 1: ATLAS Z	VC 1: ATLAS Z	VC 1: ATLAS Z
moderators	Shalini		David R.	Alberto	Jennifer	André
moderators	Tom		Ennio	Karolos	Martin	Christos
	Tbilisi, GTU		Ponta Delgada	Pisa	Dortmund	Bucharest, IFIN-HH
	Rome Tre		Košice	Nie	Lavras	Lisbon
	Dresden		Athens, UoA	Athens, NTUA	Benasque	Iasi
	Bonn		Heidelberg	Oslo	São Paulo, USP	São Tomé e P.
			Krakow	Novi Sad	Timisoara	
					Čačak	
topic	VC 2: LHCb	VC 2: CMS	VC 2: ALICE	VC 2: ALICE R_AA	VC 2: CMS	
moderators	Piet, Jonathan	Silvia	Carolina	Nicolas	Michael	
moderators	Laurent	Stephane	Luigi		Soumya	
	Pisa	Palaiseau	Salerno	Darmstadt	Istanbul, YTU	
	Paris	Rijeka	Puebla	Münster	Nicosia	
	Warwick	Nicosia	São Paulo, USP	Frankfurt	Santander	
	Genoa	Varna	Vienna, SMI	Jyväskylä	Genoa	
	Oxford	São Paulo, SPRACE	Lyon		Sinj	

Future plans for CERN based program

- Feedback in general good
- Few reports of issues with videoconference

9. Rank your favorite parts of the masterclass?

[More Details](#)

- 1 The interactive computing parts
- 2 Meeting real particle physicists
- 3 The CERN linkup
- 4 The snacks!
- 5 The opening lecture
- 6 Meeting other students like you...

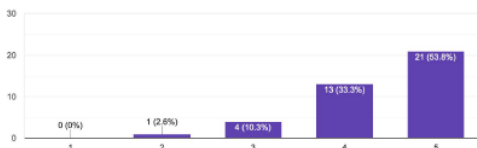


Laboratory visits

Milyenek találtad a laborlátogatásokat?

39 responses

[Copy](#)

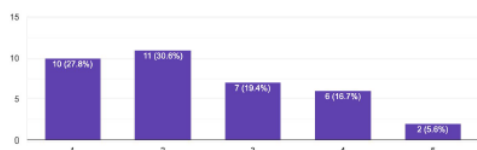


Closing video conference

Hogy tetszett a záró videokonferencia?

36 responses

[Copy](#)



- Quality management video conference
 - Preparation/selection of moderators
 - Make training even more better (use recorded sessions)
 - New platform for quiz. Difficulty: finding (+ paying) a suitable model
 - Invite more persons to working group (from institutes that sent poor feedback)
- Revise registration process
 - Receive confirmation, view other registrations
 - Earlier time slots for countries in eastern time zones
- Update repository of certificates etc.
 - updated logos, accessible gifs

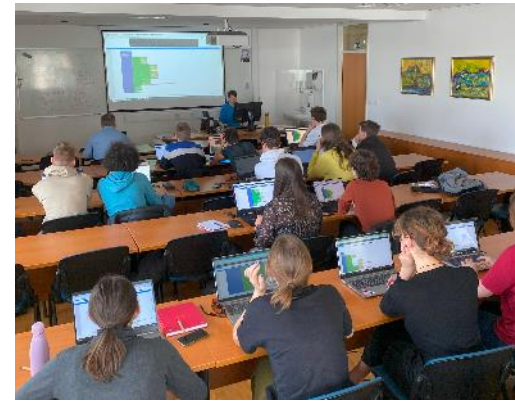
BELLE II IMC IN 2024

R. Pestotnik: Belle II IMC SG@ IPPOG, Apr. 22, 2024

Total ~630 participants –58% more than in 2023

- ❖ 9 events announced through IMC and Belle II collaboration channels
- ❖ **New participants from Armenia, Japan & India**
 - ❖ **Events: EU x4, US x2, JP x1, IN x2**
 - ❖ **2 Indian events will be held in May and in July**

Date	Institutes	Region	Participants
Mar. 5	2	EU	44
Mar. 13	3	EU	85
Mar. 26	6	EU	301
Feb. 23	1	EU	40
Mar. 30	2	JP	30
Mar. 5	2	US	~130
Mar.. 21	Quarknet	US	?
May	2	IN	Exp. 40-60
July	2	IN	Exp. 40-60



- ❖ Feb.1: Instructor Tutorial @Belle II General Meeting
- ❖ Feb. 28: Question time
- ❖ Recorded instructions
- ❖ Video conference
 - ❖ live connection to Belle II Control room
 - ❖ 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 – 2024 EXERCISES



R. Pestotnik: Belle II IMC SG@ IPPOG, Apr. 22, 2024

Two exercises – Free choice of the participating institution:

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

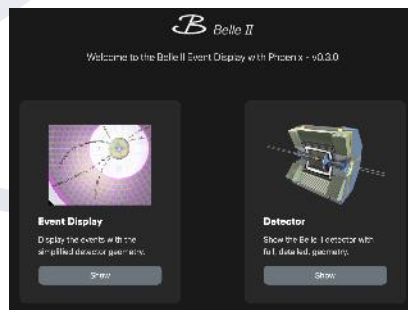
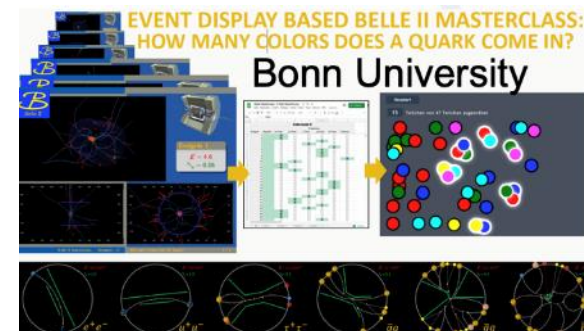
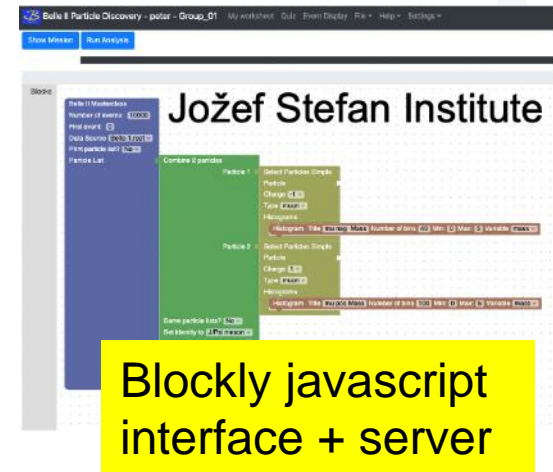
- <https://belle2.ijs.si/masterclass/> - runs on the server + client browser
→ improved advanced mode for Uni Students with additional likelihood cuts

❖ Measure quark colors - at 8 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/)



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

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

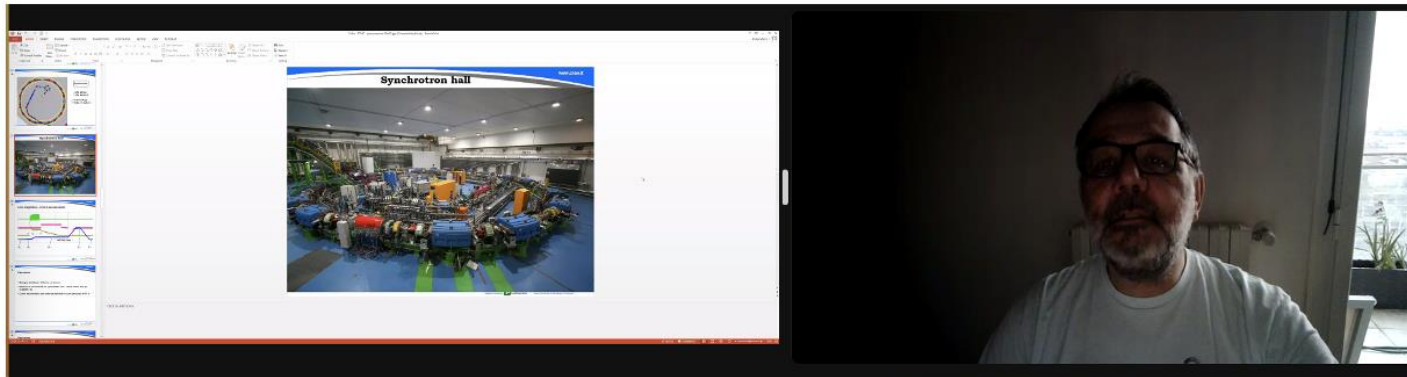


PTMC 2024: more than 1500 students participated from 22 countries and 47 institutes during 8 sessions

Including 11 Feb and 8 March women days

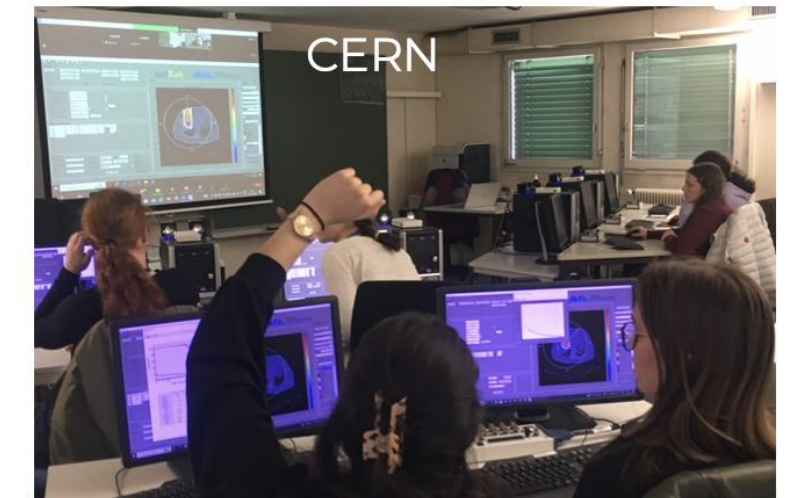
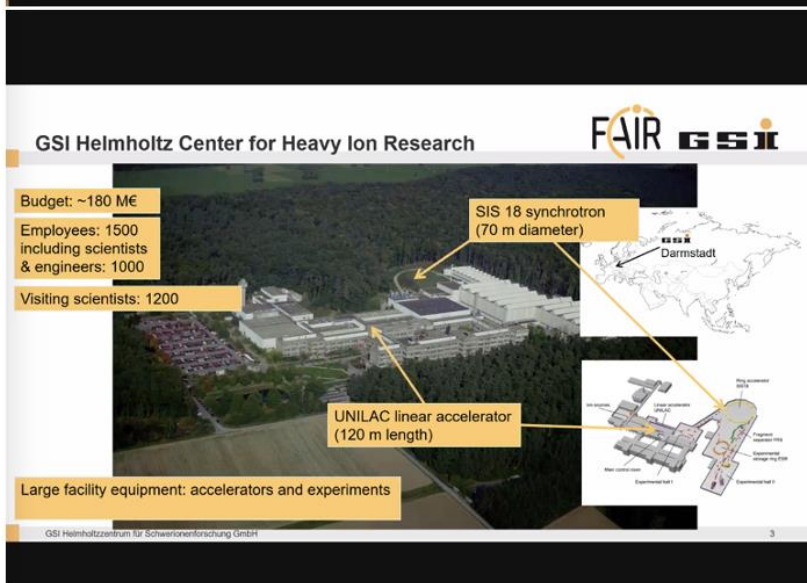


Some institutes had 2 sessions due to high demand. Online and hybrid sessions too. At least 8 of the core team tutors follow MSc or PhD in related field.



Real-time virtual visits

- CNAO therapy centre
- GSI
- ALICE



Example:

Skopje 2 sessions

- 275 in person
- 100 in person and online

