

INTERNATIONAL MASTERCLASSES HANDS ON PARTICLE PHYSICS

Masterclass Report
24th IPPOG meeting
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IMC 23: What do we expect?

Three settings:

- (1) Masterclasses at universities or research labs
- (2) Remote Masterclasses with students connecting individually
- (3) Remote Masterclasses with students in classrooms

→ **We have experience and are prepared for all 3 cases!**

Videoconference situation:

- Student groups connect (as before the pandemic)
- Individual students connect → **one dedicated online week at CERN (6.-11.3.2023)**
- Mixture of both. Not preferred, but cannot be avoided
- Moderators might not sit together

→ **Zoom videoconferences** (no webinars)

IMC23 dates

LHC Masterclasses



CERN program

- 13.2. - 31.3.2023 (6.-11.3. online week)
- Girls Masterclasses on 10.2.

LHC and Neutrino Masterclasses



Fermilab program

- 25.2. - 31.3.2023

Particle Therapy Masterclasses



GSI program

- 18.2., 8.3., 11.3., 24.3., 31.3.2023
- Girls Masterclasses on 10.2. and 11.2.

Belle II Masterclasses



KEK program

- 7.3., 15.3., 23.3.
- Additional dates for US and Japan tba

Process of registration

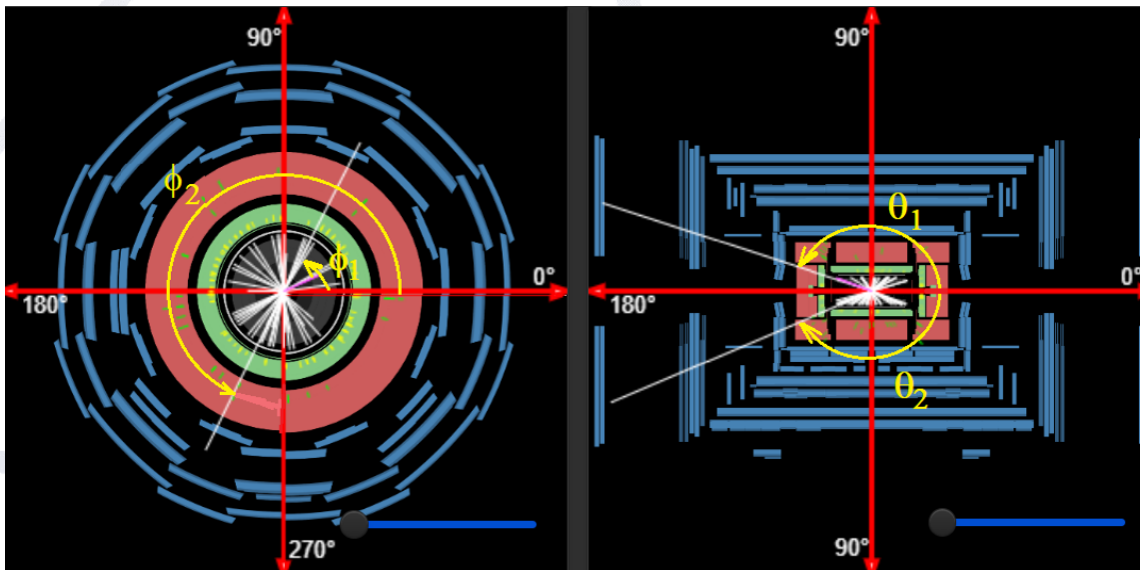
- 14.10.: Announcement of dates
- 28.10.: Announcement of schedule and registration procedure
- **11.11.: Registration opens**
- 16.12.: Release of schedules

- 9.12.: Announcement of Intl. Day of Women and Girls in Science

- More slots will be added to the initial plans if needed

World Wide Data Day 2022 (W2D2)

- Thu, November 10th
- for high school students, guided by physics teachers
- simplified measurement with data from ATLAS and CMS
- measurement Φ and θ , spin off $\Delta\Phi$ as a separate activity
- 24-hour-span videoconference with 30 min calls to share and discuss results



New developments

- **NOvA Masterclass**
 - Pilot events in 2023
 - Tested well in summer 2022 teacher workshops
- **CMS**
 - Collecting ideas for a new Masterclass
 - Same masterclasses, different motivations.
 - Connect to new questions in physics.
 - Create new prep activities.
 - Seek to adapt videocons to decentralized, “zoomed-out” age. (W2D2 as a partial model?)
 - QuarkNet LHC fellows will work on these next week at “Fellows Camp”.

New Pierre Auger Masterclass

Concept of Auger Masterclass

Question: What is the origin of ultra-high energy cosmic rays?

Experimental procedure:

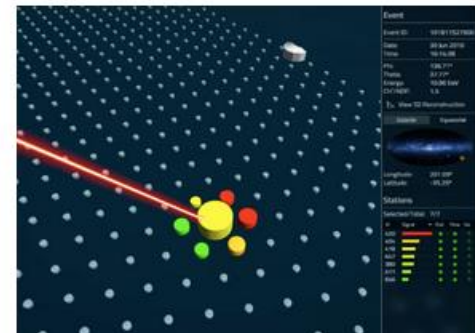
- reconstruct the arrival direction and energy of real Auger events + perform event selection
- a sky map with the reconstructed arrival directions of selected events is produced and discussed

Student starting point



Surface Detector stations timing and signal

Reconstructed event



← energy
← arrival direction

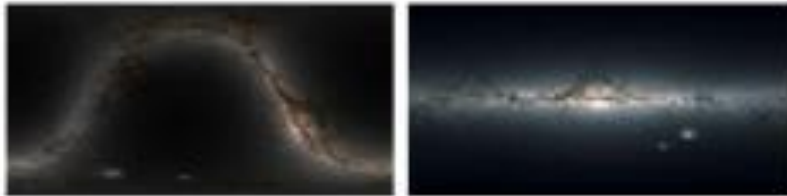
Results from 1 student



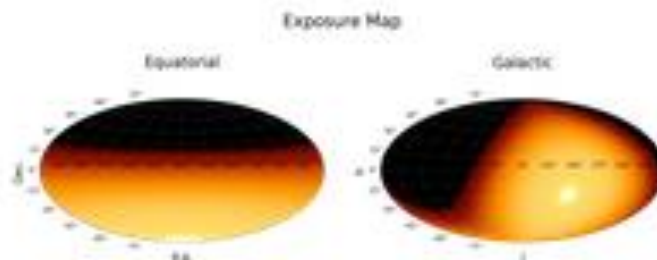
Combination and discussion of results

Auger Masterclass discussion of the results

1) sky-map coordinates

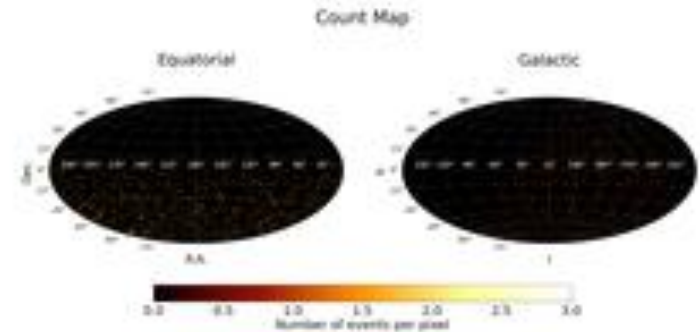


2) observatory exposure to the sky

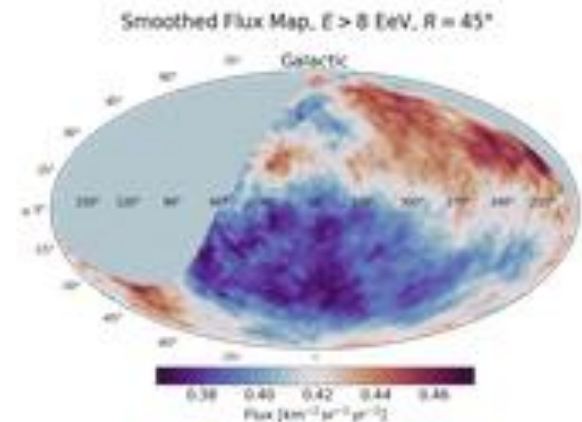


combining statistics of from all students

3) count maps of arrival directions



4) smoothed flux map



New Pierre Auger Masterclass

- Presented by Raul Sarmento to [IMC steering group](#)
- Auger collaboration released 10% of observatory data to public
- New Masterclass at: <https://wminho.lip.pt/augermasterclasses/>
- Material available so far:
 - Webpage with entries for masterclass events, software, datasets and results upload platform
 - Students guides (portuguese, italian, english translation on-going)
 - Template slides for introduction and discussion (portuguese)
- Pilot event in May with 80 high school students at 6 sites in Italy and Portugal

Next Steps:

- To reach students worldwide by proposing the activity to the IPPOG program of international masterclasses
- Formal proposal to Auger collaboration (Nov 18)
- Additional translations, documentation etc. as requested

Recent papers and presentations

- **Physics Masterclasses in Africa and the World.** Proceedings of the African Conference on Fundamental and Applied Physics, ACP2021, March 7-11, 2022, <https://arxiv.org/abs/2206.07004>
- **The Necessity of International Particle Physics Opportunities for American Education,** Snowmass 2022, <https://arxiv.org/abs/2203.09336>
- **QuarkNet in LHC Education and Outreach,** The Tenth Annual Conference on Large Hadron Collider Physics (LHCP2022), 16-20 May 2022, <https://pos.sissa.it/422/272/pdf>

Communication

Webpage

- Migration process to IPPOG website ongoing
- Site map and design defined and approved by IMC SG
- Content migration from html to Drupal after IMC23
- Should be finished by next summer and ready for IMC24

Social Media

- IMC have a twitter account, but not much activity on it
- Plan: Integrate IMC twitter account in IPPOG account
- IMC activities = content for IPPOG social media
- Numbers, special audience events, how to apply...
- Photos, poster, schedules...

