INTERNATIONAL MASTERCLASSES HANDS ON PARTICLE PHYSICS

Masterclass Report 22nd IPPOG meeting Uta Bilow, Ken Cecire 17.11.2021





IMC 22: What do we expect?

Three settings:

- (1) Masterclasses at universities or labs (high school students allowed on campus)
- (2) Remote Masterclasse with students in classrooms
- (3) Remote Masterclasses with individual students, connecting from home (or elsewhere)

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

Expected videocon situation:

- (1) + (2): Sessions with student groups connecting
- (3): Sessions with individual students connecting → one dedicated week March 7-12
- Moderators might not sit together

INTERNATIONAL MASTERCLASSES have no partie of physics

IMC 22: Registration

- Doodle registrations started on Nov 8
- More slots will be added (announcement in next circular on Nov 19)
- International Day of Women and Girls in Science on Feb 11

	ATLAS Z	ATLAS W	CMS	LCHb	ALICE S.P.	ALICE R_AA	ATLAS Z	CMS WZH	MINERVA
			CER	:N				Fermilab	
VC slots offered	120	35	60	45	25	5	many	many	many
registrations	79	16	53	20	19	4	5	5	2

Registration for Belle II and PTMC also ongoing

17.11.2021

Masterclass report

New developments in ALICE Masterclasses

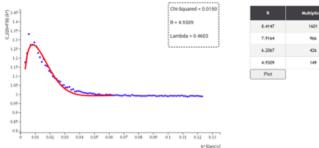


Updates with ALICE Strangeness MC

- New and more advanced online version, modes for students and tutors
- Back-end data base, results pushed automatically to database, create and store events
- No need for external tools, e.g. Google Docs

New MC on femtoscopy

- measurement of QGP source size by summer student/WUT
- obtain the source size of the QGP droplet created during Pb-Pb collisions
- based on the analysis of two-particle (two-pion) correlations in momentum space (based on momentum differences of two particles)
- Prototype presented to summer students on July 30



7.9164	166
6.2067	426
4.9309	149
Piot	

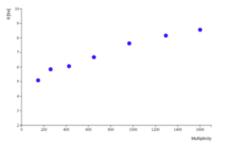


Figure 7.10: An example of the Radii vs Multiplicity plot.



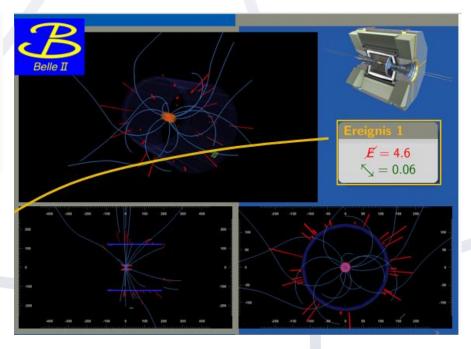
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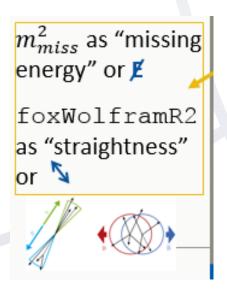
New Belle II Masterclass



- Concept: Based on event displays, classify event as $e^+e^-/\mu^+\mu^-/\tau^+\tau^-/\bar{q}q/\bar{b}b$
- Derive *R*-value: $R = \frac{N(\bar{q}q)}{0.5 \cdot [N(\mu^+\mu^-) + N(\tau^+\tau^-)]} = N_c \cdot \sum_{\text{Quarks}} q_{\bar{q}q}^2 = N_c \cdot \frac{10}{9}$
- Deduce number of quark colors

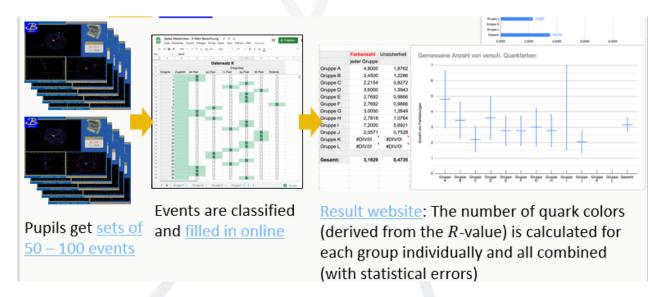








New Belle II Masterclass



MC data!

- Successful pilot Masterclass in July
- In German, currently translated to English, more languages will follow
- Will be offered in IMC22

17.11.2021

- Developed by physicists and teacher students
- Accompanying material: videos, interactive worksheet, quizzes
- https://www.pi.uni-bonn.de/outreach/netzwerk-teilchenwelt/belle2masterclass

Masterclass report International Masterclass

Developments from QuarkNet

- CMS Masterclass updates
 - iSpy WebGl event display: improved view, settings controls, picking and table views
 - Upgrade of underlying WebGL library
 - Upgrade histograms in CIMA
- OPAL Masterclass
 - Upgraded and adapted to modern design, responsive layout etc.
 - Purpose: couple with LHCb recent results to investigate lepton universality
- New NOvA Masterclass
 - NOvA: long baseline neutrino oscillation study
 - Combine Far Detector event display analysis (small number) with python notebook (many events from Near Detector)
 - Under development, concept tested with teachers
 - Limited trial Masterclasses in IMC22



Measuring Z⁰ decays

Measuring Z decays

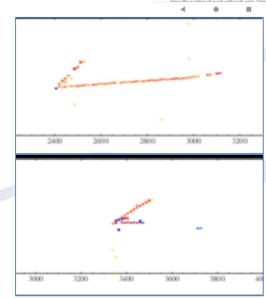
in the challenge part 2 you learned how to distinguis events in which a Z^0 decays to produce the differen of particle-antiparticle pairs. Now you might like to tr hand at one of the important measurements we mail

In this section you will be provided with a large numbe events containing particle-antiparticle pairs from Z^0 decays. Look at each one and keep a separate count of the number of: $e^+e^-\to e^+e^-, e^+e^-\to \mu^+\mu^-$,

efore proceding any further you need to multiply the umber of $e^+e^- \rightarrow e^+e^-$ events you have found by a sctor of 1.6. Don't worry, you don't have to understand here this factor comes from in order to do this challe owever, if you'd like to know more about this factor cire.

Once you have classified all the events there are a n of interesting questions to ask yourself:

- An important prediction of the Standard Model particle physics is that the probability for a Z^0 decay to an electron-positron pair should be this same as the probability for it to decay to a much antimum pair or a tau-antitiau pair. Are the num of $e^+e^- \to e^+e^-$ (cornected), $e^+e^- \to e^+$ and $e^+e^- \to e^+$ and $e^+e^- \to e^+$ e^- (entreetly and $e^+e^- \to e^+$).
- Another prediction of the Standard Model is that decay to quark-antiquark pairs much more frequently than to electron-positron, muonantimuon or tou-antitiau pairs. In fact, the numbe muon-antimuon pairs should be only about 0.04







17.11.2021 Masterclass report

World Wide Data Day 2021 (W2D2)

- Wed, December 1st
- for high school students, guided by physics teachers
- simplified measurement with data from ATLAS and CMS
- measurement Φ and $\Delta\Phi$ as last year; future tbd
- As of this morning, 64 registrations
- 24-hour-span videoconference with 30 min calls to share and discuss results

