

International Particle Physics Masterclasses - Current development to expand scope and global reach

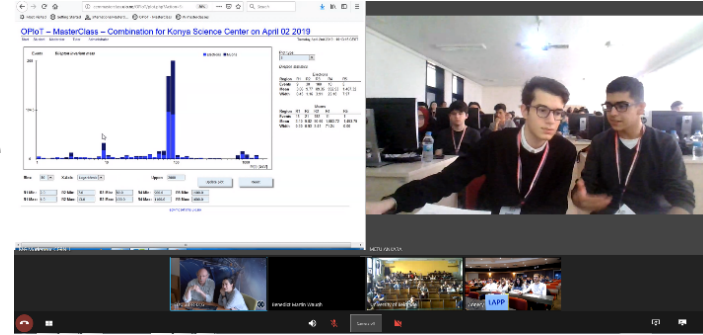
*Farid Ould-Saada, University of Oslo
On behalf of the IPPOG Collaboration*



IPPOG & IMC

❖ The International Masterclass programme on Particle Physics

- provides secondary students with access to particle physics data using dedicated visualisation and analysis software.
- In one day at a university Students meet scientists, learn about particle physics, accelerators and detectors, perform physics measurements and search for new phenomena, then compare results in an end-of-day videoconference with other classes
- We report on the evolution of Masterclasses in recent years, in both physics and computing scope, as well as in global reach



IMC 2019 (18) – the whole picture

- ❖ 54 countries, 10^4 students involved: 7.3-16.4
- ❖ Fermilab: 51 institutes (48)
- ❖ 54 LHC IMC (50)
 - 22 ATLAS (19) ; 32 CMS (31) (+Triumpf) ; 12 MINERvA



30.10.2019

- ❖ CERN
- ❖ 188 institutes (177)
- ❖ 266 LHC IMC (257)

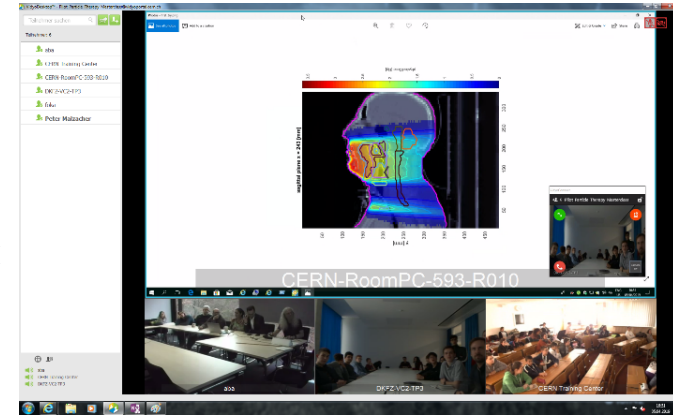
- 101 ATLAS-Z (104) ; 30 ATLAS-W (35) ; 64 CMS (58)
41 LHCb – D^0 lifetime (39)
27 ALICE Strange particle decays (18)
3 ALICE nuclear modification factor R_{AA} (3)



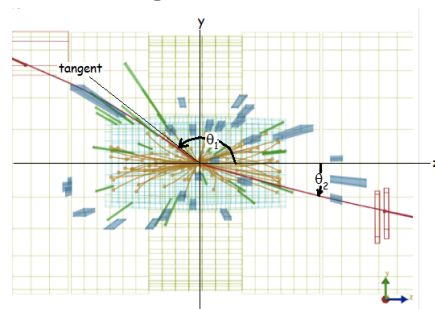
F. Ould-Saada CHEP2019 IPPOG/IMC

Towards a multi-path of International Masterclasses

- ❖ World Wide Data Day
- ❖ International Day of Women and Girls in Science
- ❖ New Physics measurements in addition to LHC data
 - Gravitational waves, Cosmic rays → currently outside IMC
 - Neutrino physics masterclasses – Minerva, MicroBooNe
 - Belle II, ATLAS & CMS plans
 - Astroparticle physics masterclasses – IceCube
- New masterclass developments for ALICE & particle therapy» → L. K. Graczykowski
- Instrumentation (building & testing cosmic-ray detectors, followed by data analysis)
 - to be adapted to IMC style? – measurement, interpretation & discussion within one day



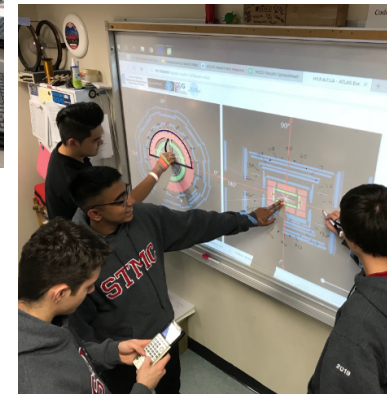
World Wide Data Day – W2D2



- Simple measurement: ϕ and θ of muons in events
- Can be done by teachers and students in school
- Worldwide combination of data
- 24-hour shift of videoconferences

❖ Get involved

- October-November each year since 2016
- Inform physics teachers
- Ideas, input welcome how to improve



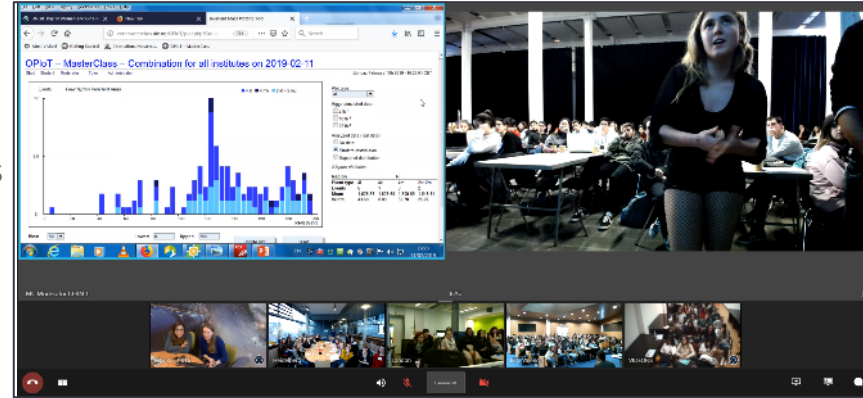
- Burnaby, BC, Canada
- Ottawa, KS, USA
- Shanghai, China



Participating groups – ? (66) (34) (21)
Students – ? (1064) (445) (354)
Moderators – ? (24) (14) (8)

Int. Day of Women and Girls in Science

- ❖ Proclaimed by the UN in 2016 (Feb 11th)
 - LHC masterclass measurements – By and for girls
 - Learn about particle physics – Discuss women in science
 - 2019 (2018)
 - 11 institutes participating (8)
 - 600 students (250)
- ❖ Get involved
 - Takes place Feb 11th each year
 - Recruit students, teachers, tutors
 - Women as role models
 - Encourage young women with a friendly physics environment



New – Neutrino & Belle II masterclasses

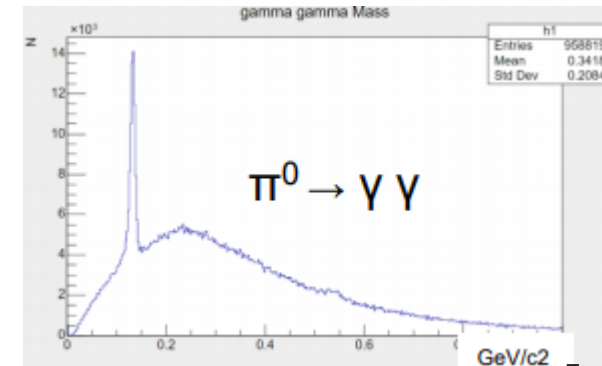
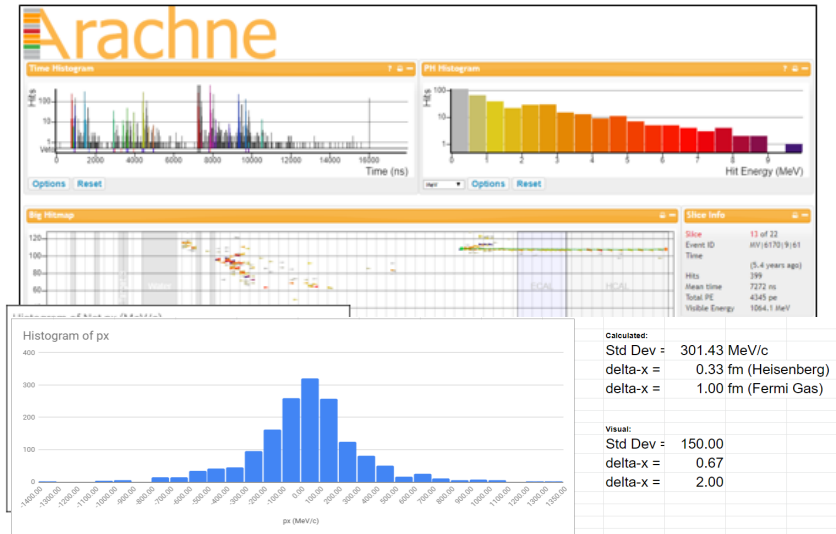
❖ MINERvA Masterclass

- Muon neutrinos interact with carbon target
- Discover Fermi motion
- Measure carbon nucleus to test interaction model
- Part of IMC2019

❖ MicroBooNE – expected for IMC2020

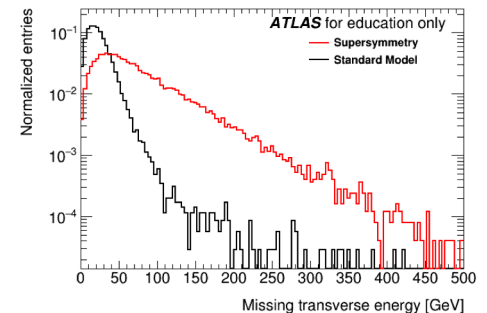
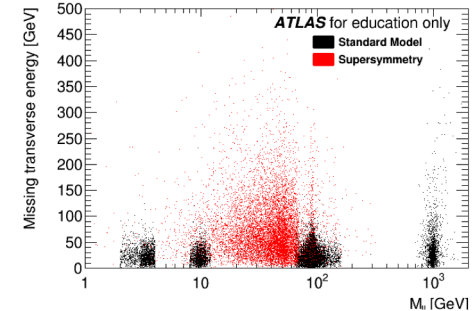
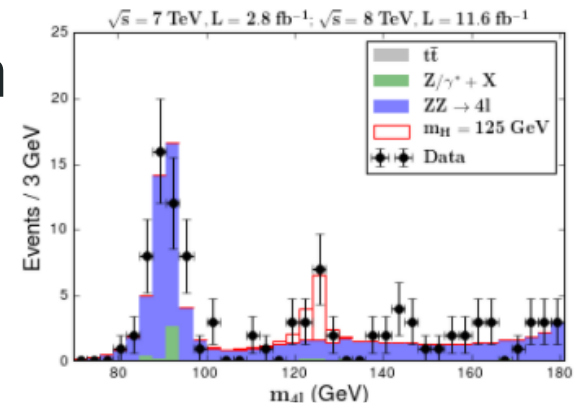
❖ Belle II shows students how to code B-physics analysis

- Tested in IMC 2019 – Ready for IMC 2020

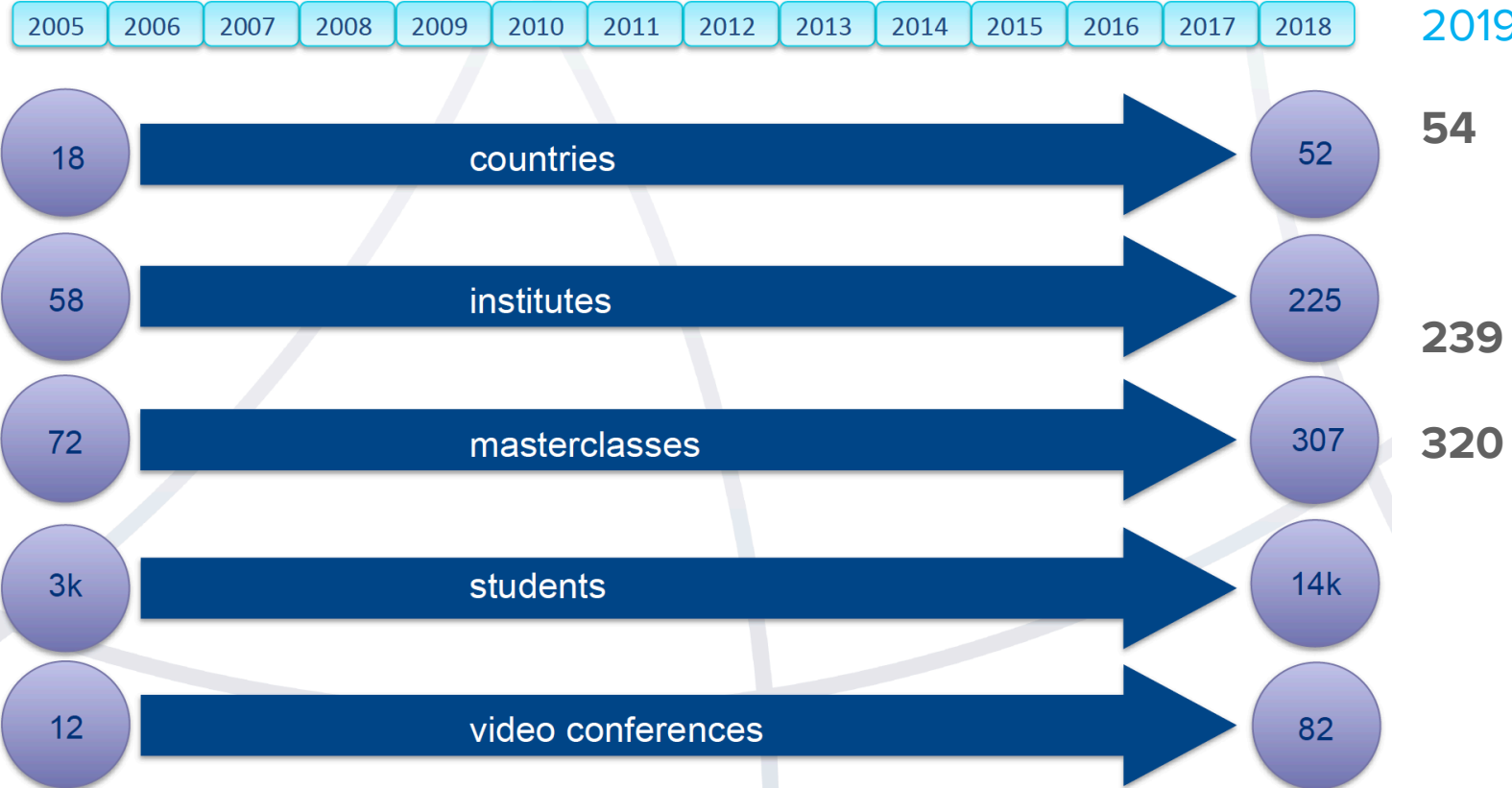


IMC with ATLAS & CMS – future plan

- ❖ CMS measurements adds a 4-lepton mass plot
 - Among others 4-leptons added for IMC 2019
 - Further future plans ...
- ❖ ATLAS measurements
 - Make use of 13-TeV Open Data (10fb^{-1})
 - Z-Path plans
 - Add di-lepton + E_T^{miss} and SUSY and Dark Matter simulation events → plans for 2020
 - Deploy Open Data and Tools at IMC (Notebooks in Python, Virtual Machines, improved visualisation, machine learning in addition to standard analysis) → longer term



Statistics – International Masterclasses



Conclusions and Outlook

- ❖ Particle physics masterclasses very successful
- ❖ 3D-expansion: reaching more students & teachers, more countries, more activities / fields involved
- ❖ Towards a multi-“Path” of Masterclasses – started
- ❖ Some scalability challenges to tackle
 - organisation & coordination ; 4+ centres for video-conferences ; Structure will expand
- ❖ Data access & processing & analysis
 - CHEP directly involved / concerned
 - How to minimise the overhead (programming, software installation, data downloading, ...) to concentrate on “research and measurements”
 - Will new masterclasses in new IT & computing & data science & ML technologies help?
 - Any feedback and suggestions are highly welcome

Communication with IMC

Twitter impressions

Top mention earned 15 engagements

Konya Bilim Merkezi
@KonyaBilim · Apr 16

@METU_ODTU işbirliği ile 3. kez gerçekleştirdiğimiz International Masterclasses @physicsIMC #LHCIMC etkinliği başladı.
ODTÜ Fizik Bölümü Öğretim üyeleri sayın Prof. Dr. Altuğ Özpineci, Prof. Dr. @BilgeDemirköz ve @MIT'den @TansuDaylan parçacık fizikine dair seminerler veriyor.
pic.twitter.com/sB7r0WetOI



1 7 33

Top Tweet earned 8,690 impressions

Most international day in #LHCIMC: high school students from 12 countries participating today! Celebrating the truly international character of science at @desy+@HumboldtUni, @Stockholm_Uni, @UNIZA_ZILINA, @UIB, @UniKarlova, @PhysicsAtSussex, @HebrewU, @Unipisa and others
pic.twitter.com/FOU6cXYQX



9 15

Top Tweet earned 331 impressions

YES YOU CAN do the particle physics masterclasses at home too! Follow the instructions for ATLAS atlas.physicsmasterclasses.org/en/index.htm or CMS cms.physicsmasterclasses.org/cms.html LHCb lhcb-public.web.cern.ch/lhcb-public/en... or ALICE aliceinfo.cern.ch/public/MasterC... pic.twitter.com/1m517eA5MG



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FEB 2019 SUMMARY

| | |
|-------------------|----------------|
| Tweet impressions | Profile visits |
| 11.1K | 21 |
| New followers | |
| 19 | |

MAR 2019 SUMMARY

| | |
|----------------|-------------------|
| Tweets | Tweet Impressions |
| 26 | 24.4K |
| Profile visits | Mentions |
| 1,967 | 78 |
| New followers | |
| 70 | |

Top Follower followed by 8,123 people




Yves Zieba
@Ziebayves · FOLLOWS YOU

Fondateur @syntezia @hackyourstyle @agilenetup #QVT #ODD #intelligencecollective

Top media Tweet earned 2,461 impressions

Students at the University of Udine had an amazing day learning about the @ATLASexperiment @CERN, searching for the Higgs Boson and reconstructing the Z boson from #LHC data, with ATLAS researchers from the INFN Udine and ICTP ATLAS Group! pic.twitter.com/JfTgInRvSy



1 5 11

APR 2019 SUMMARY

| | |
|----------------|-------------------|
| Tweets | Tweet Impressions |
| 17 | 30.2K |
| Profile visits | Mentions |
| 1,899 | 40 |
| New followers | |
| 31 | |

External Communication

❖ Twitter @physicsIMC

- #LHCIMC
- Team: Kate, Ken, Uta

April 2018:

- Schedule (Feb – April)

| Tweets | Following | Followers |
|--------|-----------|-----------|
| 462 | 257 | 730 |

May 2019:

| Tweets | Following | Followers | Likes |
|--------|-----------|-----------|-------|
| 694 | 262 | 1,064 | 287 |

