

INTERNATIONAL MASTERCLASSES HANDS ON PARTICLE PHYSICS

Report

Uta Bilow + Ken Cecire

IPPOG meeting, CERN
28.11.2019



?



© Anne Rockstroh

Scope of Masterclasses

LHC Masterclasses

Since 2005,
~ 14 k students,
225 institutes
in 54 countries

Neutrino Masterclasses

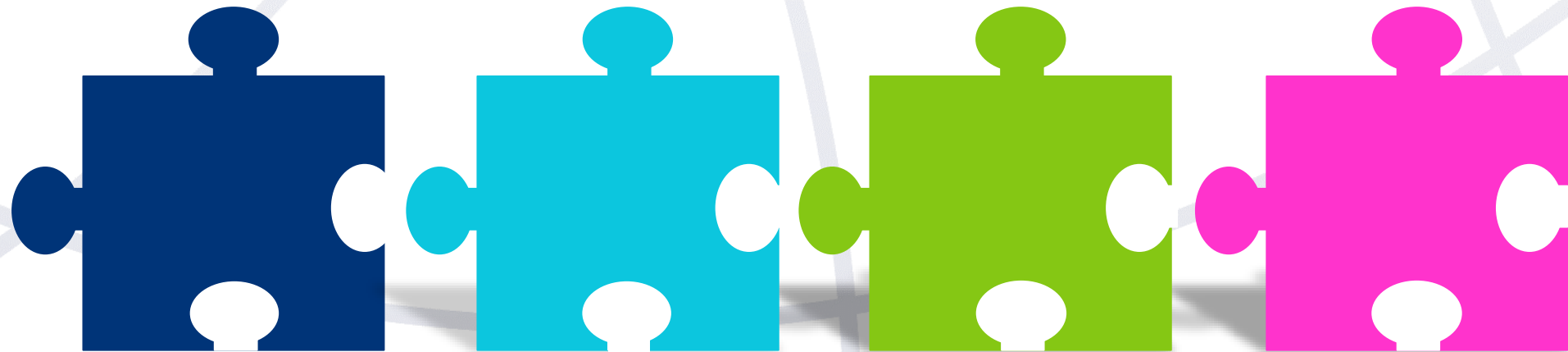
Since 2019,
300 students,
11 institutes
in 5 countries

Belle II Masterclasses

New in 2020 via
IPPOG

Hadron Therapy Masterclasses

New in 2020 via
IPPOG



LHC Masterclasses Updates

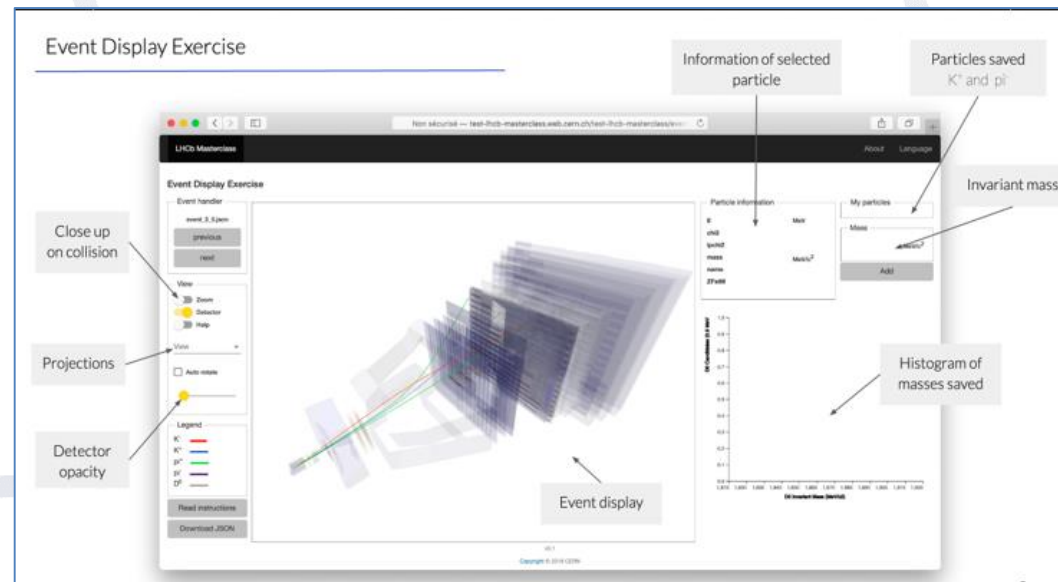
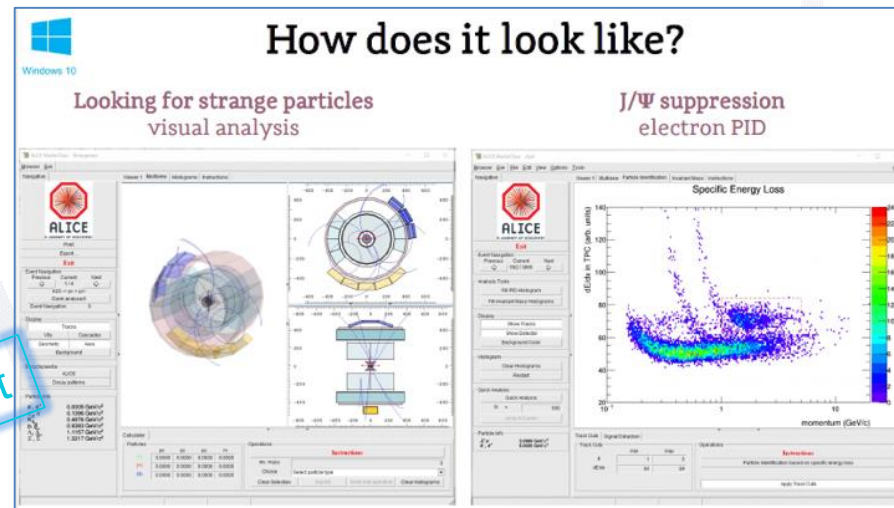
ALICE:

- Standalone app for all 3 measurements
- Easy to install
- Windows, Linux, virtual box machine

Funds via EU project

LHCb:

- Browser-based web version
- No full deployment in 2020, only on request
- Institutes are informed



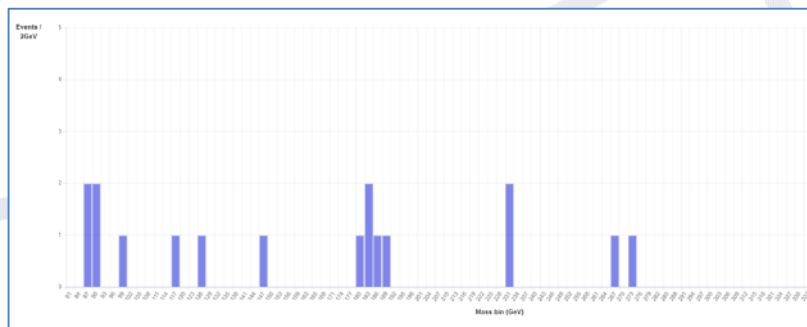
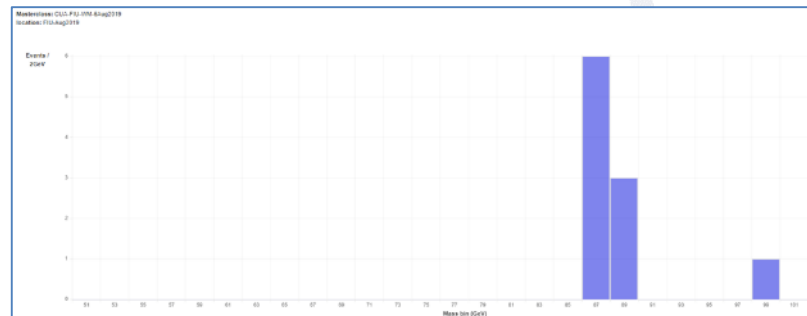
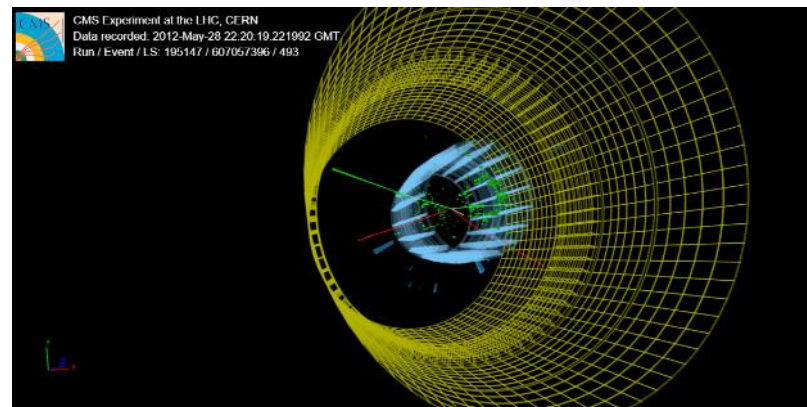
LHC Masterclasses Updates

CMS:

- Upgrade just about done
 - 1-, 2-, and 4-lepton events
 - Datasets grouped by class size
- CIMA
 - 1-lep, really lep + nu, W+/W-
 - 2-lep and 4-lep mass plots
 - histograms made automatically

ATLAS Z path:

- Short-term: DM + SUSY with 2 leptons
 - Start IMC day with measurement?
- Long-term: extend to Open Data and newer tools (VM+Jupyter notebook), hiding complexity (access to data, installation of software and tools, ..)



Neutrino Masterclasses Updates

- MINERvA in 2019, 2020,...
- MicroBooNE in 2020 (test), ...
- DUNE later
- Others (OPERA? NOvA? T2K?)
- Library <http://tiny.cc/nu2020lib>

MicroBooNE development

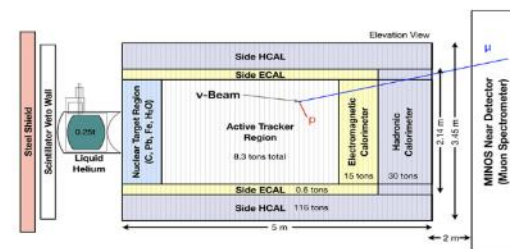
- Instrumentation masterclass
 - Argon purity
 - Electron drift velocity
- Test in IMC 2020
 - Fermilab VC
 - Small, select number of institutes



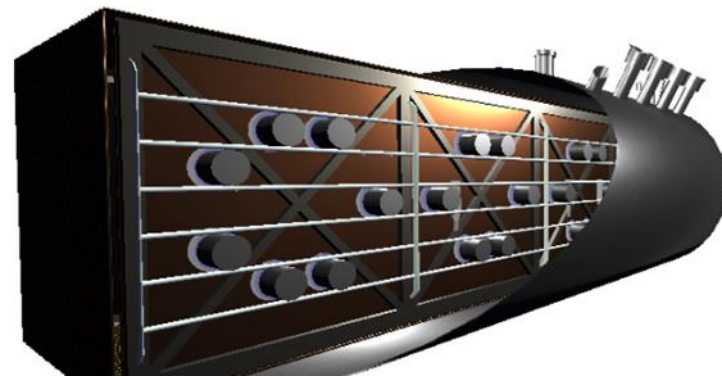
Overview
Introduction
Measurement
Events
MINERvA Experiment at Fermilab
All Things Neutrino
Library
International Masterclasses

MINERvA is about neutrinos

Our universe is awash in neutrinos. As you read this, millions of them pass right through you. Fortunately, they have negligible mass and negligible interactions with other matter, so you're OK. Regtable...but...that tiny amount of mass is enough to create mysteries about the nature of neutrinos and those tiny, rare interactions enable us to build dedicated detectors like MINERvA to study neutrinos.



Schematic of the MINERvA detector.



Belle II Masterclass Updates

- New webpage
<http://belle2.ijs.si/public>
- Running from the web or download virtual machine
- Basic/advanced level (fit peaks, determine width)
- 3 IMC dates with European institutes
- Interest from Asia: more dates?
- Training session for tutors at collaboration meeting in Feb
- Additional activity: VR, with educational aspects

Funds via EU project


Interactive web application

<http://belle2.ijs.si/masterclass>

Describe decays, make simple cuts, "discover" particles

Runs on a **web server** or in a **virtual appliance**

Particle	Process
π^0	$\pi^0 \rightarrow \gamma \gamma$
K_S	$K_S \rightarrow \pi^+ \pi^-$
ϕ	$\phi \rightarrow K^+ K^-$
J/ψ	$J/\psi \rightarrow e^+ e^-$
J/ψ	$J/\psi \rightarrow \mu^+ \mu^-$
D^0	$D^0 \rightarrow K^+ \pi^-$
D^0	$D^0 \rightarrow K^- \pi^+$
D^{*+}	$D^{*+} \rightarrow D^0 \pi^+$
D^{*-}	$D^{*-} \rightarrow D^0 \pi^-$
B^+	$B^+ \rightarrow J/\psi K^+$
B^-	$B^- \rightarrow J/\psi K^-$
Λ	$\Lambda \rightarrow p \pi^-$
Σ^+	$\Sigma^+ \rightarrow p \pi^0$




R. Pestovnik: Belle II MC@IPP06 - IMC SG, Nov 28, 2016

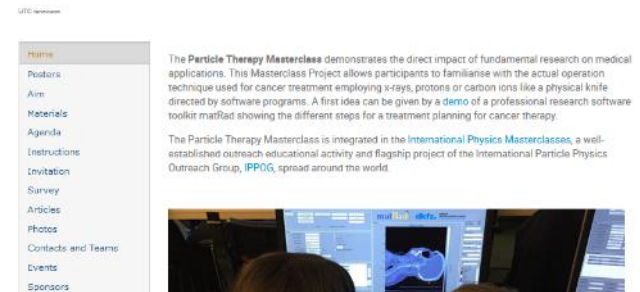
Hadron Therapy Masterclass Updates

- Material in webpage in several languages (presentations, posters, animations, instructions, workplan, demos,...) <https://indico.cern.ch/event/840212/>
- Huge involvement of summer students
- Simplified and full version
- Training sessions during summer + at CERN on Dec 10
- 5 IMC dates in 2020
- Participation of SEE region (science for peace)
- Presented at various conferences + CERN Open Days

Funds via private sponsor



Under development: Particle Therapy Masterclass (draft)



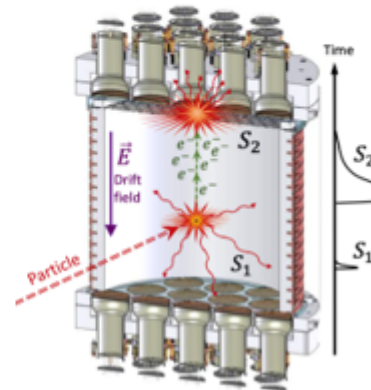


Darkside Masterclass (under developement)

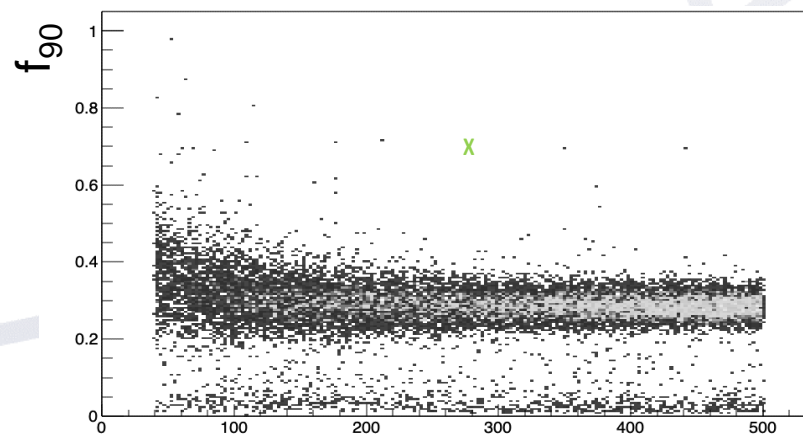
- By Francesca Carnesecchi, University and INFN of Bologna, Centro Fermi Roma, et al.
- Darkside experiment at Gran Sasso
- Dark Matter / WIMPs in a dual phase Ar TPC
- Talks on DM and Darkside experiment
- Data analysis via excel
 - Reconstruction position part (few events): to exclude background signals
 - Analysis of events (~ 20000) of background and few “good” WIMPs. Plot of f_{90} vs S_1 and then apply some cuts: to select WIMPs signals
- First test in Jan 2020

Darkside experiment: how to detect WIMPs

- WIMP-nucleus elastic collisions revealed by a detector capable of unambiguously identifying a small number of nuclear recoils



- **Dual phase (gas + liquid) Argon TPC** for direct detection of WIMPs



Scope of Formats

International Masterclasses

VC with
CERN or Fermilab
or KEK or GSI

Feb/March/April

Int. Day of Women and Girls in Science

Adressing girls
and involving
female physicists

VC with CERN

Feb 11

World Wide Data Day

Simplified
measurement
At schools/by
teachers

VC „everywhere“

Oct/Nov

Offshell Masterclasses

Various target
groups

No VC

Throughout the
whole year

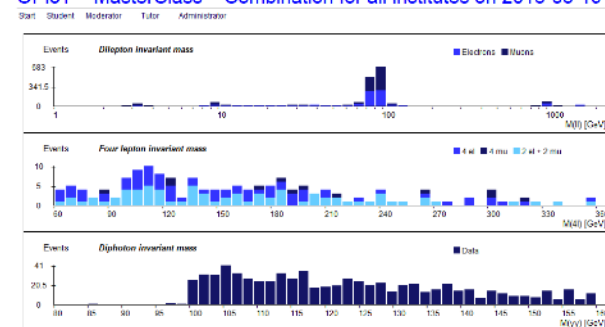


International Masterclasses

- IMC20: Feb 26 - April 8
- First announcement sent on July 5
- Mailing list now > 650 recipients
- Registration process since Nov 1
- Interest in joining expressed:
 - India, Jammu University: Ramni Gupta (ALICE)
 - India, Bose Institute Kolkata: Supriya Das (ALICE)
 - Egypt, Benha: Mahmoud Nassar (CMS)
 - Romania, University Politehnica of Bucharest: Calin Bira (ATLAS)



OPlOT – MasterClass – Combination for all institutes on 2018-03-19



Int. Day of Women and Girls in Science

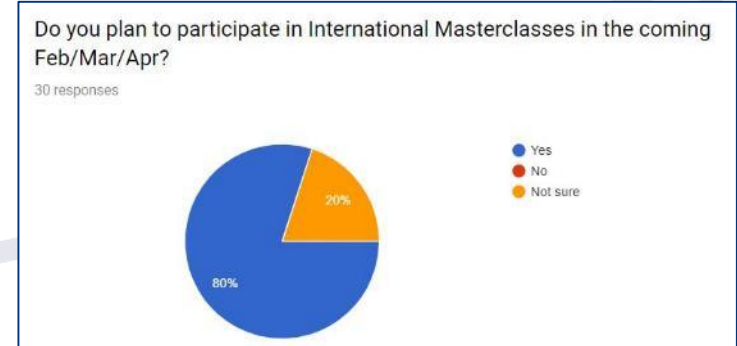
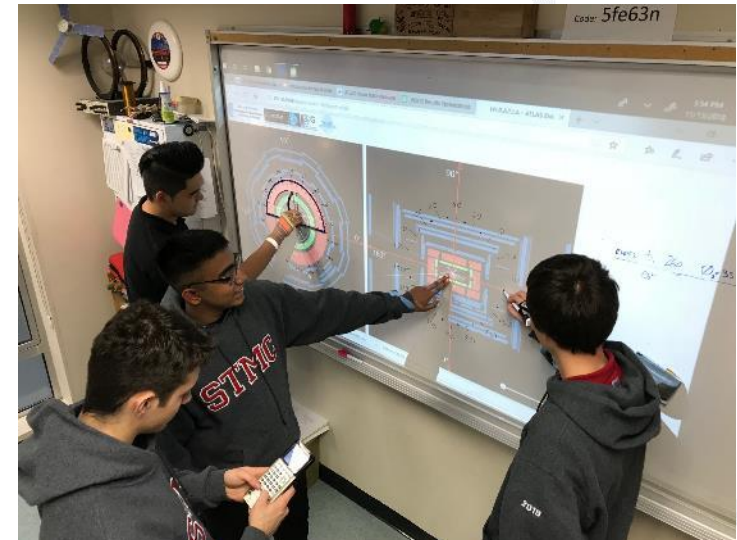
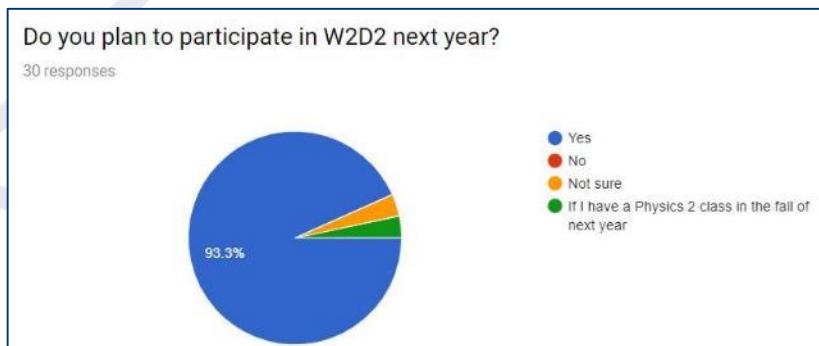
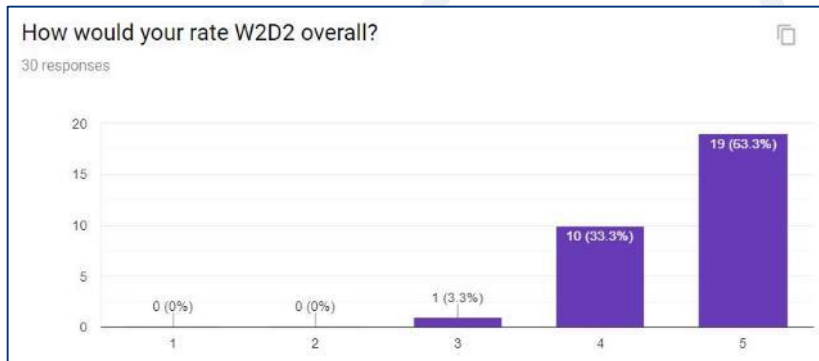
- Feb 11, declared by United Nations
- Masterclasses targetting girls + involving female scientists
- Will be offered again in 2020
- Advertisement starts tomorrow
- 10 institutes signed up already



World Wide Data Day



- 16th October 2019
- A bit fewer than 2018
- Well-received in evaluation



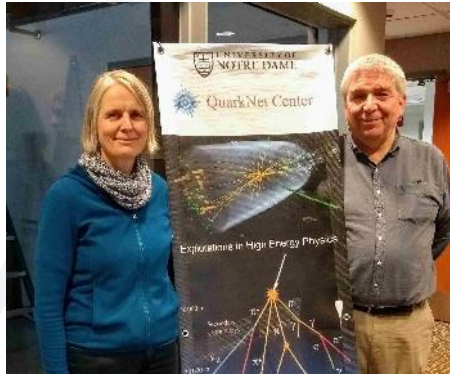
Timeline

Oct:

- World Wide Data Day

Nov:

- Registration
- Introductory MCs at CERN



Dec:

- Preliminary schedules
- Still open for more registrants

Jan:

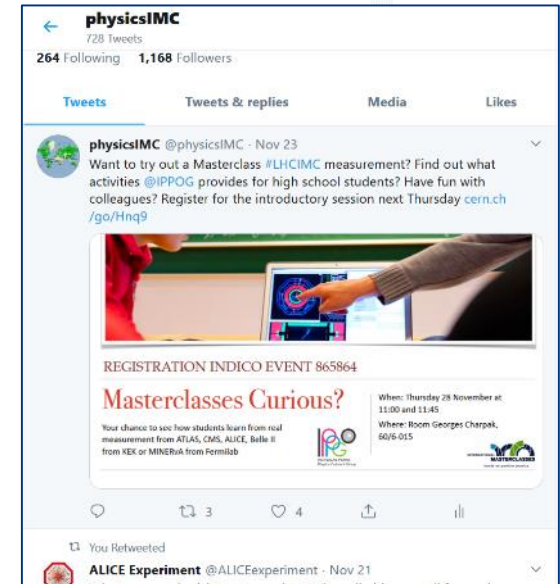
- Put moderators team together
- Vidyo tests

Feb:

- Question time
- Moderators training
- Int. Day of Women and Girls in Science

Communication

- Twitter
 - @physicsIMC
 - new hashtag: #physicsIMC
- Circulars
 - Biweekly Friday circulars from Oct 2019
 - Weekly Friday circulars in 2020



Circulars send to the e-mail list with information on International Masterclasses 2020

- Summer Circular (05.07.2019) - Dates for IMC20, W2D2, web form, IMC@conferences
- Circular 1 (27.09.2019) - World Wide Data Day
- Circular (15.10.2019) - IMC20: Dates for ALICE Masterclasses
- Circular (15.10.2019) - IMC20: Dates for LHCb Masterclasses
- Circular 2 (25.10.2019) - IMC20: Registration starts Friday next week
- Circular 3 (01.11.2019) - IMC20: Register now!
- Circular 4 (15.11.2019) - IMC20: New slots!

Conferences and Papers

- APS 2019, Denver
 - [International Masterclasses: Particle Physics for High School Students and Teachers](#)
- APS-DPF 2019, Boston
 - [New Directions in International Masterclasses](#)
- EPS-HEP 2019, Ghent
 - [Developments in International Masterclasses](#)
- Global Insights, II/2019
 - [Join the global physics collaboration!](#)
- Global Insights, 04/2019
 - [Global engagement in particle physics](#)
- Proceedings ICHEP 2018, Seoul
 - [Particle Physics Masterclasses: Sharing LHC Research and Discovery with High School Students](#)

booth



booth



Collected at: <https://physicsmasterclasses.org/index.php?cat=papers>

Summary

- Scope and format
 - Traditional LHC masterclasses → updated; new institutes
 - Neutrino, Belle II, Particle Therapy → started and more coming
 - Masterclasses are exploding! Increasing popularity, interest from other fields (Darkside, PANDA, Nuclear Astrophysics, Quantum Computing...)
 - IDWGS and W2D2 → growing
- Conferences and papers
 - Tables at conferences
 - Growing audience
- Introductory Masterclasses at CERN
 - Pilot on Nov 28, 13 attendees
 - Organize every other year?!

