INTERNATIONAL MASTERCLASSES
HANDS ON PARTICLE PHYSICS

A bit of history and present status

1996: Started in UK

2005: Adopted by EPPOG (European Particle Physics Outreach Group) for all Europe

Use data from LEP (the Large Electron Positron collider, CERN, 1989-2000)

OPAL Identifying Particles

DELPHI Hands on CERN

Z0 decays / calculation of branching ratios

2006: U.S. joined program

2010: preparing to move to LHC-based Masterclasses

2011: Start using data from LHC

ATLAS W+W- (MINERVA) structure of the proton

ATLAS Z0 (HYPATIA) mass, width (+Z' from MC)

CMS J/Ψ (in 2011) and W/Z (in 2012)

ALICE Looking for strange particles (V0 and cascade decays)

ALICE Nuclear modification factor

LHCB Measurement of the D^o lifetime

Central organisation TU Dresden (Uta Bilow, Michael Kobel)

International Particle Physics Outreach Group

INTERNATIONAL MASTERCLASSES

hands on particle physics

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Name:
International Particle Physics Masterclasses

International Masterclasses

10th International Masterclasses 2014

Each year about 10.000 high school students in 37 countries come to one of about 160 nearby universities or research centres for one day in order to unravel the mysteries of particle physics. Lectures from active scientists give insight in topics and methods of basic research at the fundaments 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. See here for media coverage.

International Masterclasses 2014 will take place from 12.3. - 12.4.2014, including **U.S. Masterclasses**.

Discover the world of Quarks and Leptons with real data

- 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 fundaments 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

A day of immersion in particle physics for 16-18 year old pupils

Typical day of International Masterclasses

Morning : introductory lectures on

- Particle physics (elementary particles, forces, Standard Model and beyond)
- Detectors – accelerators – experimental methods

Visit of laboratory / experimental site / discussion with scientists and graduate students

Lunch – typically offered by Host Institute

Afternoon : students do physics measurement

They work in groups of 2 per computer and analyse visually (in most cases) data from an LHC experiment

Summing of results of many groups – Discussion of results

At the end of the day : Video Conference

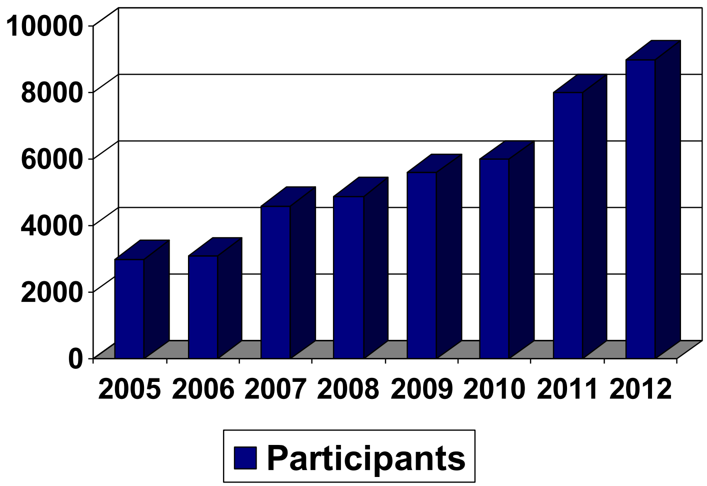
moderated by two physicists at CERN and connecting up to 5 institutes which did the same measurement that day

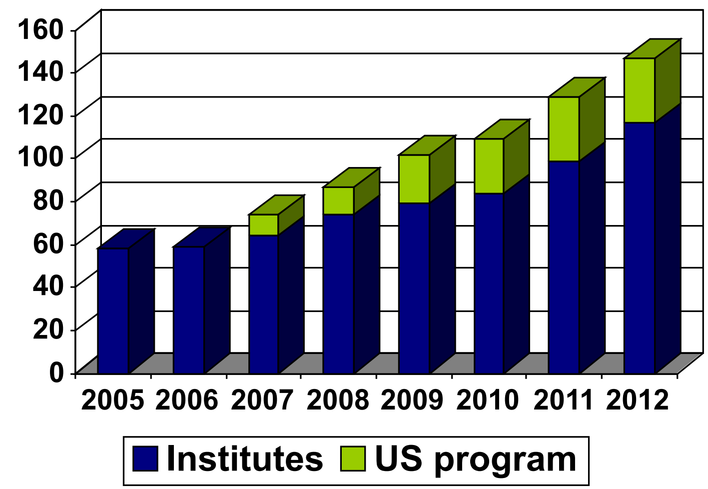
Some numbers from the International Masterclasses 2013
(reported by Uta Billow at the 5th IPPOG Meeting, Fermilab, April 2013)

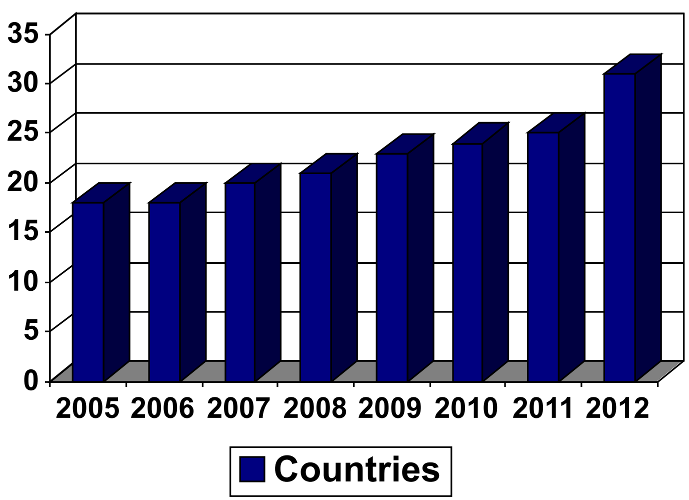
- Period: 25.2. – 22.3.2012 (22 days)
- 161 Masterclasses
  - ALICE: 10
  - ATLAS W: 55
  - ATLAS Z: 58
  - CMS: 38
- 37 video conferences with CERN
- 130 institutes registered

+ local masterclasses, teachers‘ days

Participation keeps increasing







Video Conference

Often it is the highlights of the day

Presentation of the moderators
Welcome of the participating institutes
General questions from the participating institutes
Presentation of the results of the measurements by institutes
Merging of results by moderators
Comments and discussion
Quiz

General appreciation of the International Masterclasses

Very positive
More countries participate every year

Some information

International Masterclasses are typically announced in October
In 2014 : 12 March – 12 April

Local organisation can differ from country to country:
In France, whole classes participate in a masterclass
In Greece and Germany : selected students (a few from each class)

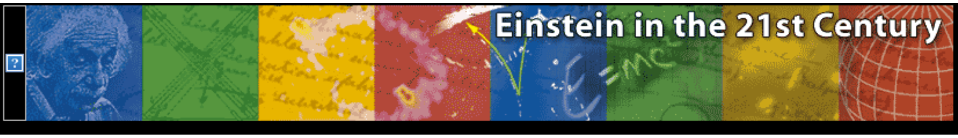
Limiting factors :
Computer rooms available at Institutes
Number of institutes per video conference (maximum 5)

In Sweden : Masterclasses in Uppsala – Lund – Stockholm (in 2013) ATLAS measurements

Last IPPOG Meeting : other forms of Masterclasses discussed
Mini-masterclasses (half a day) masterclasses done locally (in schools)

IPPOG http://ippog.web.cern.ch/
International Masterclasses http://physicsmasterclasses.org/

ALICE measurement http://aliceinfo.cern.ch/public/MasterCL/MasterClassWebpage.html



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Looking for strange particles in ALICE

1. Overview

The exercise proposed here consists of a search for strange particles, produced from collisions at LHC and recorded by the ALICE experiment. It is based on the recognition of their V0-decays, such as $K^0_s \rightarrow \pi^+\pi^-$, $\Lambda \rightarrow p + \pi^-$ and cascades, such as $\Xi^- \rightarrow \Lambda + \pi^-$ ($\Lambda \rightarrow p + \pi^-$). The identification of the strange particles is based on the topology of their decay combined with the identification of the decay products; the information from the tracks is used to calculate the invariant mass of the decaying particle, as an additional confirmation of the particle species.

In what follows the ALICE experiment and its physics goals are first presented briefly, then the physics motivation for this analysis. The method used for the identification of strange particles as well as the tools are described in detail; then all the steps of the exercise are explained followed by the presentation of the results; then all the steps of the exercise are explained followed by the presentation of the results as well as the method of collecting and merging all results. In the end the large scale analysis is presented.

2. Introduction.

ALICE (A Large Ion Collider Experiment), one of the four large experiments at the CERN Large Hadron Collider, has been designed to study heavy ion collisions. It also studies proton proton collisions, which primarily provide reference data for the heavy ion collisions. In addition, the proton collision data allow for a number of genuine proton proton physics studies. The ALICE detector has been designed to cope with the highest particle multiplicities anticipated for collisions of lead nuclei at the extreme energies of the LHC.

3. The ALICE Physics

Quarks are bound together into protons and neutrons by a force known as the strong interaction, mediated by the exchange of force carrier particles called gluons. The strong interaction is also responsible for binding together the protons and neutrons inside atomic nuclei.

Even though we know that quarks are elementary particles that build up all known hadrons, no quark has ever been observed in isolation: the quarks, as well as the gluons, seem to be bound permanently together and confined inside composite particles, such as protons and neutrons. This is known as confinement. The exact mechanism that causes it remains unknown.

Although much of the physics of strong interaction is, today, well understood, two very basic issues remain unresolved: the origin of confinement and the mechanism of the generation of mass. Both are thought to arise from the way the properties of the vacuum are modified by strong interaction.

The current theory of the strong interaction (called Quantum Chromo-Dynamics) predicts that at very high temperatures and very high densities, quarks and gluons should no longer be confined inside composite particles. Instead they should exist freely in a new state of matter known as quark-gluon plasma.