Liverpool Particle Physics Masterclass

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16th July 2024

Liverpool PP Masterclass Kick-off

UNIVERSITY OF LIVERPOOL

INTERNATIONAL MASTERCLASSES

International Masterclasses

- Each year 13,000+ students in >60 countries learn about the mysteries of particle physics as part of the International Masterclass series
  - https://physicsmasterclasses.org/
- In person one day session at a university/research centre, generally in March, with talks and hands-on activities
  - Many activities on several experiments provided to choose from
  - Have a VC with other institutes to combine/compare at the end of the day
- Generally aimed at 15-19 year olds (i.e. year 11-13 students)
  - Although year 12 ideal since they will have started A-levels and not yet applied for university so we can encourage them to choose Liverpool :)

UK Involvement

- Essentially all UK universities with particle physics groups participate
  - https://physicsmasterclasses.org/index.php?cat=country&page=uk

- 17 UK universities in 2024
  - + Daresbury and RAL
- UK responsible
  - Elizabeth Cunningham
  - PP/NP Outreach Officer, STFC
- Liverpool are conspicuously absent → plan is to fix that!
  - Tim G ran from 2004-2011

Birmingham:	University of Birmingham
Brighton:	University of Sussex
Bristol:	University of Bristol
Durham:	University of Durham
Edinburgh:	University of Edinburgh
Glasgow:	University of Glasgow
Lancaster:	Lancaster University
London:	Royal Holloway, University of London
London:	Queen Mary, University of London
London:	University College London
Manchester:	University of Manchester
Oxford:	University of Oxford
Plymouth:	University of Plymouth
Sheffield:	University of Sheffield
Southampton:	University of Southampton
Swansea:	Swansea University
Warwick:	University of Warwick

Suggested Agenda

- Generally an ≈8 hour day
- Morning
  - Registration + Icebreaker
  - A couple (2-3) talks (+quizzes?)
    - One general PP intro
    - One related to activity
- Group lunch + chat
- Afternoon
  - Hands-on PC activity
  - Video conference (4-5pm CET)
- Along with local tours etc

IPPP Example

09:00 → 09:15 **Registration**

09:15 → 09:45 **Particle Physics Card Game**
https://scoollab.web.cern.ch/particle-physics-games

09:45 → 10:15 **What is the Universe Made of?**
Talk by Dr Jessica Turner

10:15 → 10:45 **Why Neutrinos Matter**
Talk by Dr Yuber Perez-Gonzalez

10:45 → 11:15 **Break**

11:15 → 11:45 **Neutrino Detection**
Talk by Dr Aidin Masouminia

11:45 → 13:00 **Lunch Break**

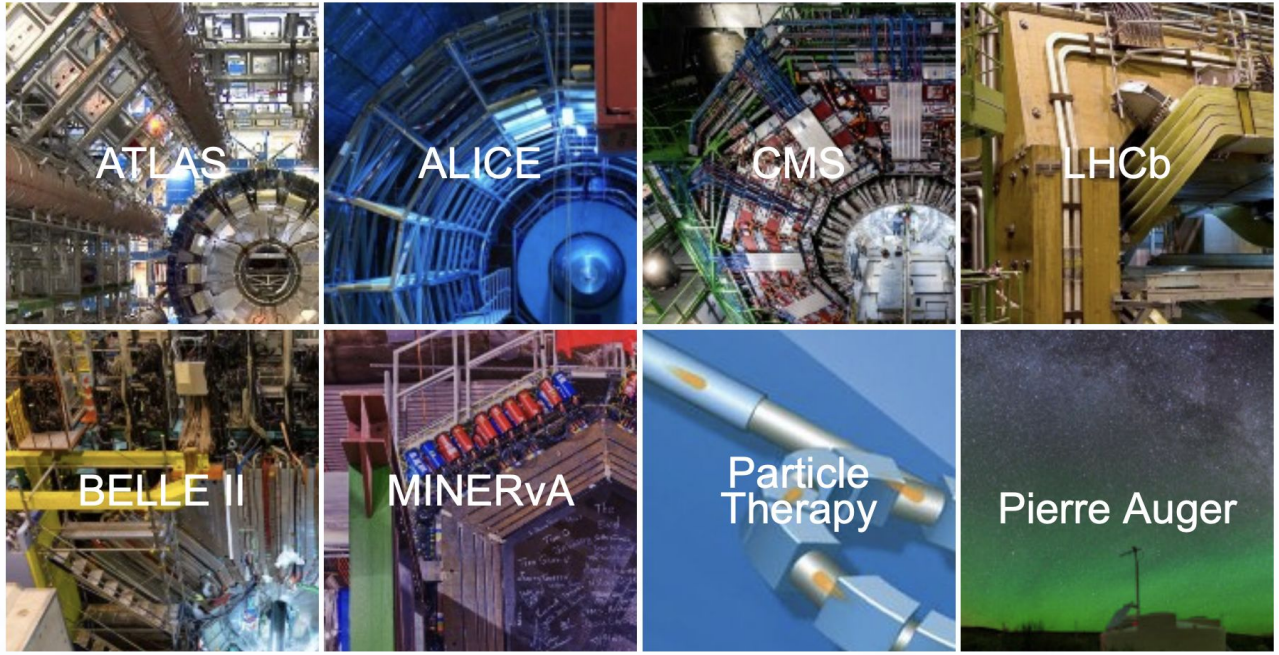
13:00 → 15:00 **Hands on activity**

15:00 → 16:00 **Share your Findings with Fermilab Scientists**

16:00 → 16:30 **Farewell**
Deliver of official certificates of participation

Hands-on Activities

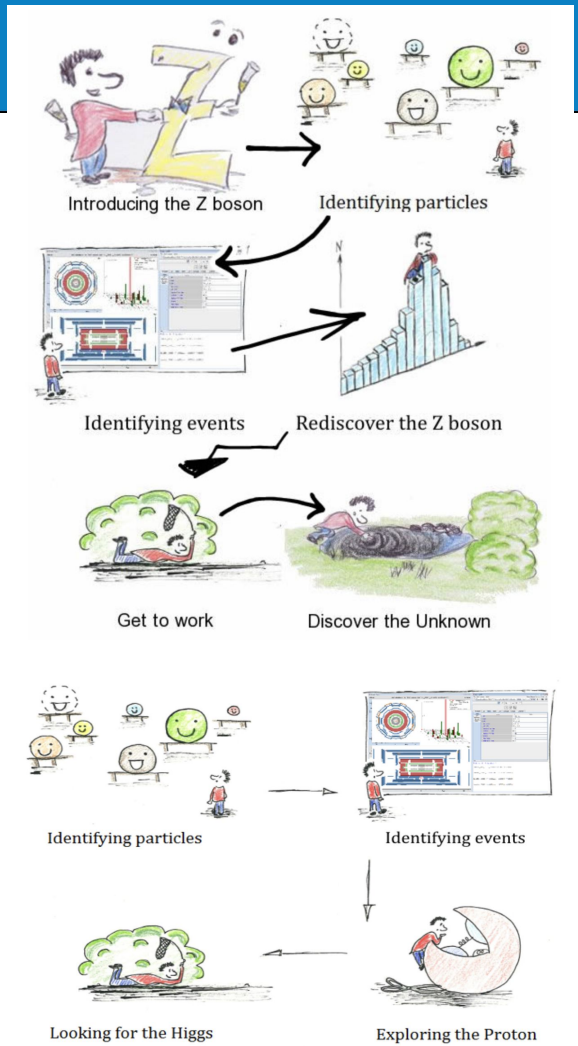
- Several areas: ATLAS or LHCb would be natural for us given involvement



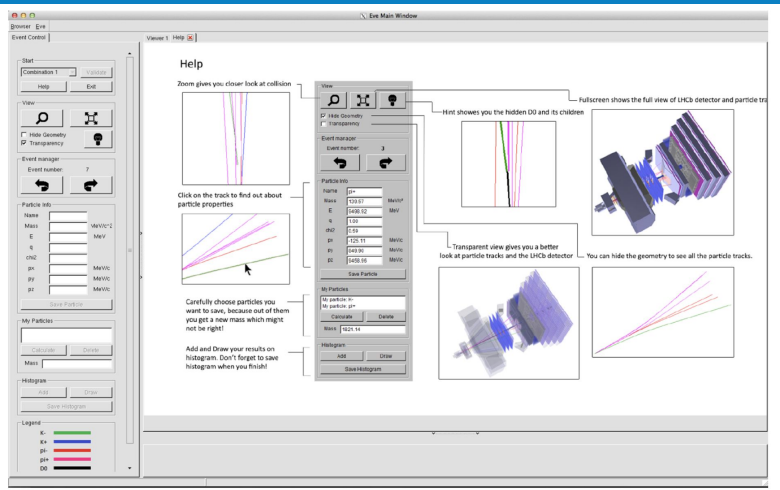
- Supporting material (tutor guide, intro slides, student cheat sheets) available
  - https://physicsmasterclasses.org/index.php?cat=local_organisation&page=measurements#atlas

Hands-on Activities: ATLAS

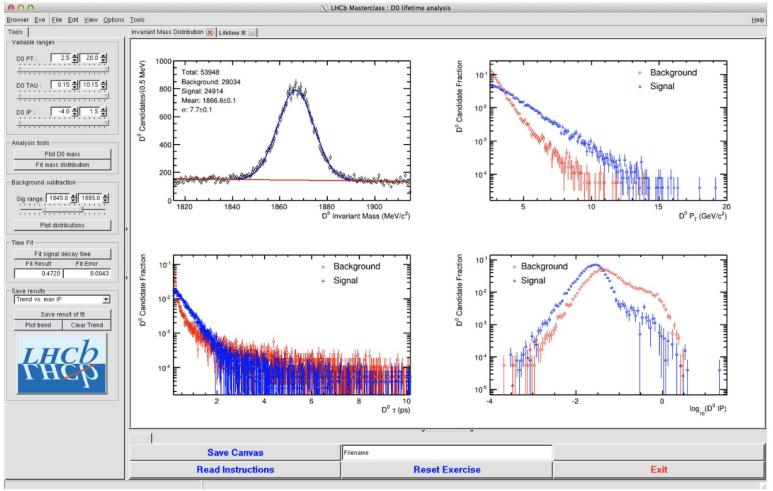
- General start:
  - Identifying particles and events
- Z Path
  - Search for Z→ll, H→yy and H→4l amongst background
  - Find invariant mass
- W Path
  - Search for W & WW events
  - W: Measure $R^{\pm} = W^{+}/W^{-}$
  - WW: Measure $\Delta\varphi_{ll}$
- Uses simplified event displays + tally sheets



Hands-on Activities: LHCb



- [Measuring D^0 lifetime]
  - Search for charmed particles amongst background
  - Plot mass and fit
  - Plot lifetime and fit



- Uses integrated visual analysis framework for event displays and histrogramming/fitting
  - Dave Hutchcroft recently used this at a school Y12 STEM day

Organisation Timeline

- Need to get moving soon to be ready for March 2025
  - Before below, register LIV with international masterclass and talk to UK rep

- Oct: register with your preferred dates and measurement when contacted by organizers
- Nov: preliminary schedule is created by organizers - make reservations for lecture hall with video conferencing facility and PC pool
- Dec: check your profile on www.physicsmasterclasses.org, does it need an update?
- Dec: prepare your local agenda and a link for registration
- Jan: send invitation letters to schools and students
- Feb: plan preparation talks
- Feb: introduce tutors to measurement, use the material here
- Feb: perform video test and prepare for the video conference, download the manual
- immediately before your event:
  - print tally sheets, if required for measurement
  - print answer sheet for quiz
  - download local language version of quiz
  - print certificates of participation
- after the event: send media coverage, photos, and lectures for our archive

Sarah Annand suggests to make contact with schools already before break to give advance warning

Also need to check software works on Uni computers

Points for discussion

- Ideas for how to structure the day
  - # of talks and topics to cover
  - Hands-on activities and discussions
  - CTL tours if possible
  - How many students? Suggestion: 50 students and charge a small fee
- Where we need people
  - People to give talks
  - Minimum 1 person per 10 students. Preferably 1 per 5.
  - Lab tour leaders (UG labs in CTL):
  - Extra people to chat to students over lunch or in dedicated discussions
  - Helping out before (testing the exercises and feedback)
  - Create web profile on physicsmasterclasses.org
- Suggested dates
  - Wednesday is best
  - March 2025

Next Steps

- Get in contact with schools early (before Summer holiday)
  - Sarah has a list of schools
- Timeline
  - Register with physics masterclasses and talk to UK rep (asap)
  - Decide preferred dates (Oct)
  - Decide hands-on theme/path exercise
    - Test out before deciding?
    - Make sure works on Uni computers
  - Make online profile (Dec)
- Talk topics and select speakers
- Room bookings
- Any questions?

Backup

Schedule example (Birmingham)

From 9.30 Arrival and welcome in Bridge Study Room (2nd floor, Poynting Building)

Free tea/coffee/juice available

10.30 - 11.45 Talks in Bridge Study Room (2nd floor, Poynting Building)

Talk 1 Introduction to Particle Physics & Accelerators (Prof David Evans)
Talk 2 The LHCb experiment at the Large Hadron Collider (Dr Phil Ilten)

11.45 – 13.30 Computing activity in Room P09 (Ground floor, Poynting Building)

Measure the lifetime of incredibly short-lived particles using real data from the LHCb experiment – an opportunity to use computer software to gain insights into detector technology and research techniques.

13.30 – 14.10 LUNCH in the Bridge Study Room (2nd floor, Poynting Building)

Lunch is available to purchase on campus or students can bring a packed lunch.

14.10 – 14.25 Discussion on the Physics Measurements in the Bridge Study Room

Announcement of results from the morning's computer activities.

14.25 – 14.55 Small Group Discussions in the Bridge Study Room

Break up into small discussion groups, led by a particle physics researcher.

15.00 - 16.00 Live link to CERN in Nuffield G13 (ground floor, Nuffield Building)

Discussion with physicists at CERN and other schools.

16:00 Departures

Birmingham Example