Outreach activities at LHCb

Marco Santimaria on behalf of the LHCb collaboration

EPS-HEP / Outreach, Education and Diversity

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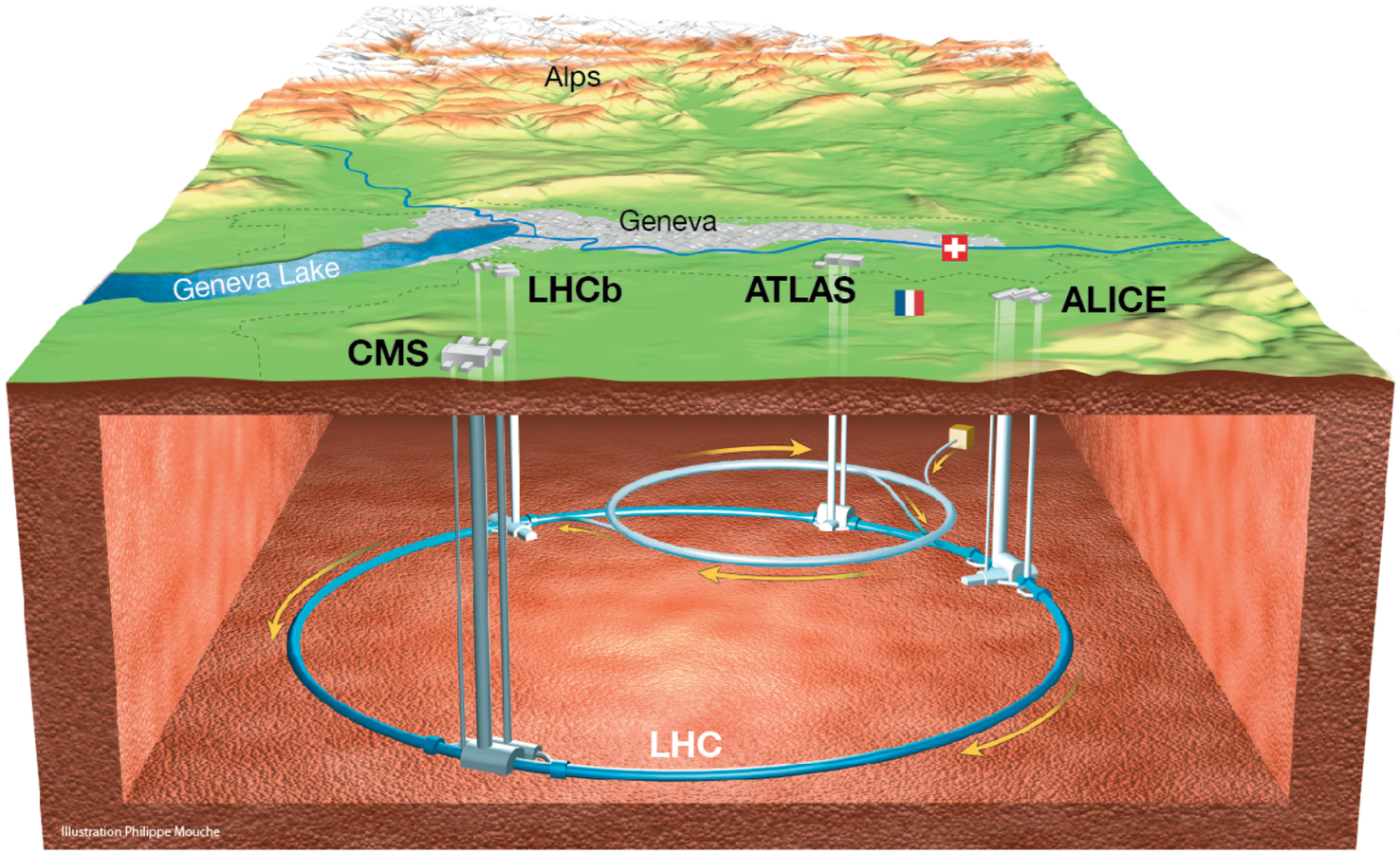
The LHCb experiment

- LHCb is located at the IP8 of LHC, ~100m underground in the Geneva area
- One of the four big LHC experiments (>1200 members), it's primarily devoted to b and c physics
- Main research topics concern CKM parameters, CP violation, rare decays: search for New Physics via precision measurements → high discovery potential
- LHC Run 2 at $\sqrt{s}$ =13 TeV ended in 2018, now upgrade phase towards Run 3 (2021)



https://cds.cern.ch/record/1708847

LHCb on web & social media

http://lhcb-public.web.cern.ch/lhcb-public/

LHCb public webpage with recent results

facebook.com/LHCbExperiment

~13.5k likes

instagram.com/LHCbExperiment

~6.3k followers

twitter.com/LHCbExperiment

~25k followers

youtube.com/LHCbExperiment

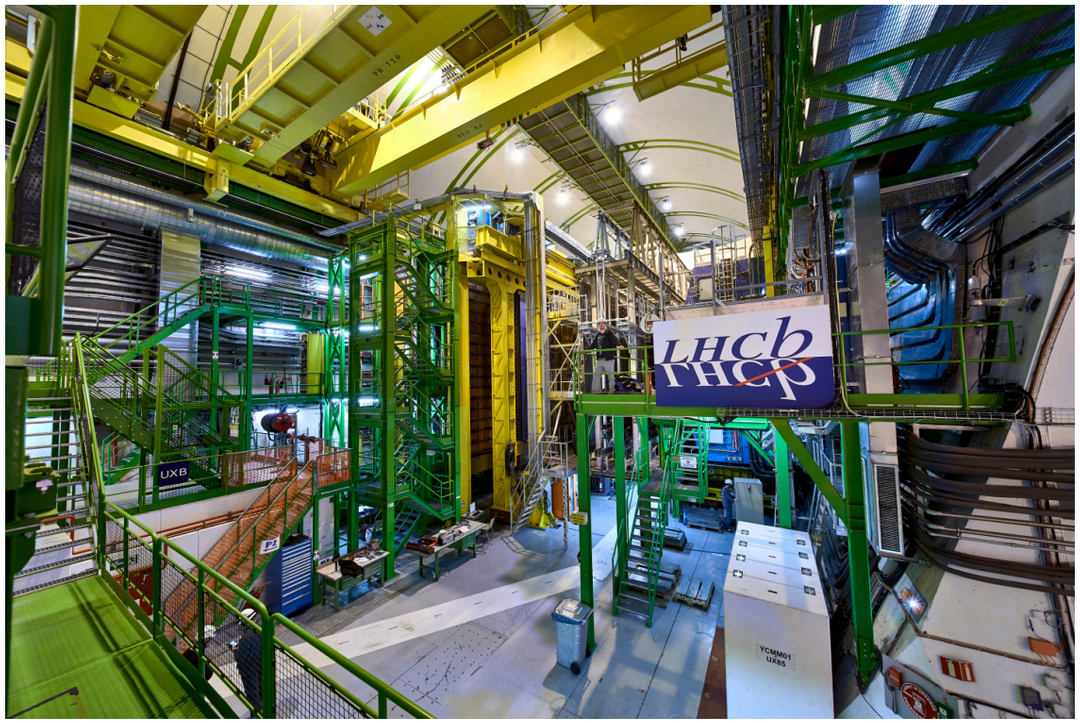
NEW: weekly videos on upgrade activities in the cavern

THE CONVERSATION
Academic rigour, journalistic flair

Online magazine with articles written by academics.
Republished on other platforms → large reach

Recent articles on pentaquarks and CPV in charm reached 45k and 100k views!

Photos from the upgrade



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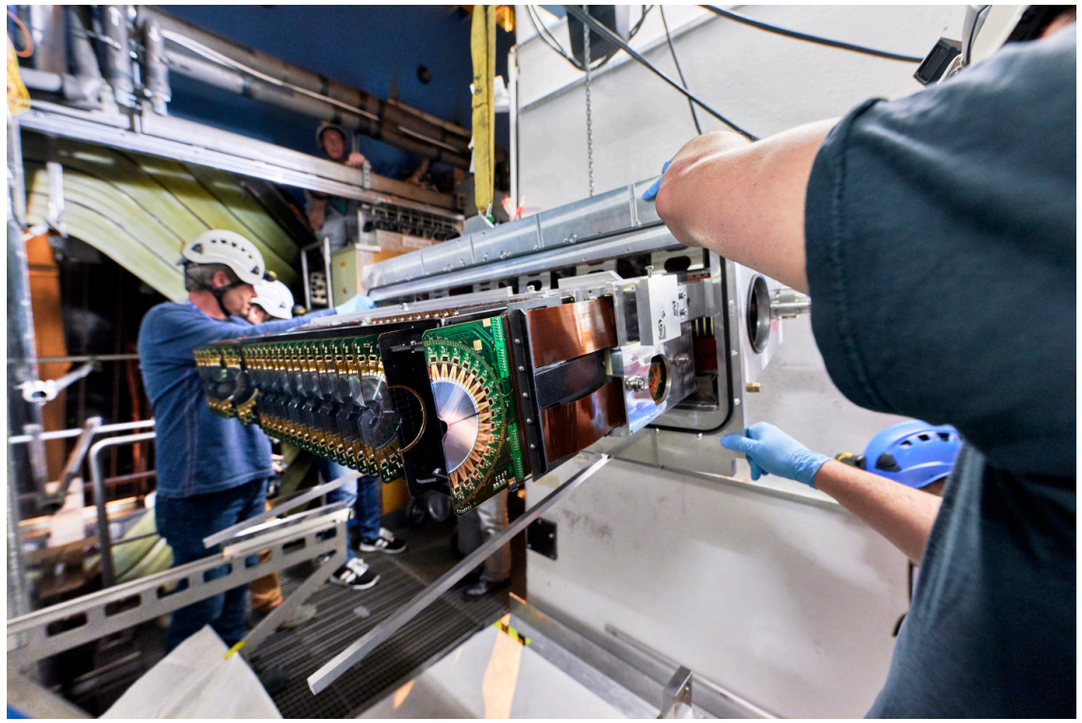

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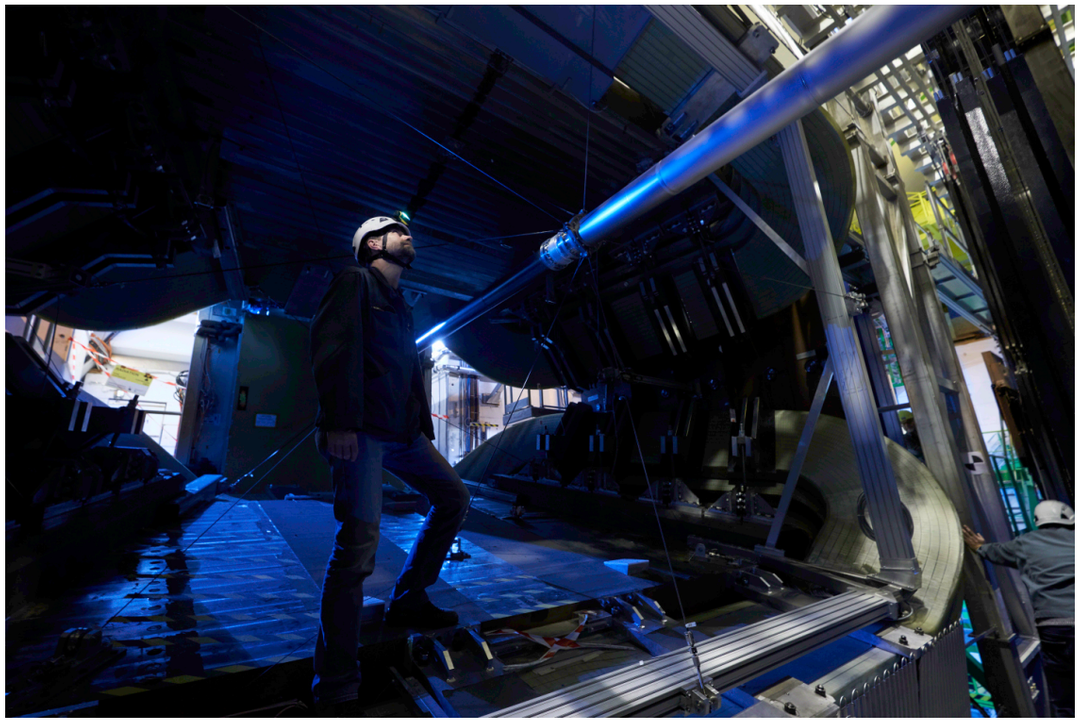
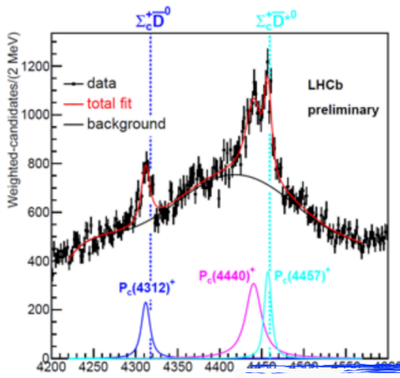


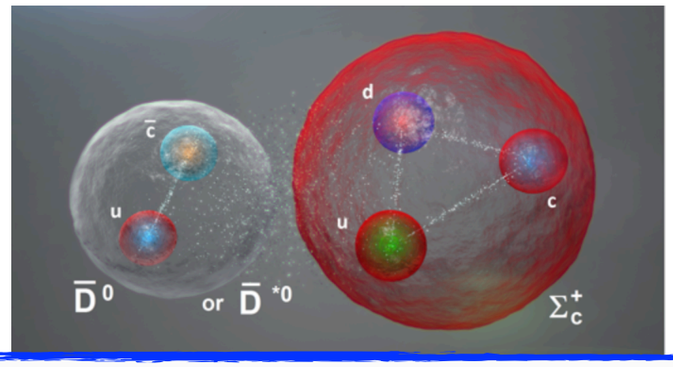
https://cds.cern.ch/record/2650174

https://cds.cern.ch/record/2653148

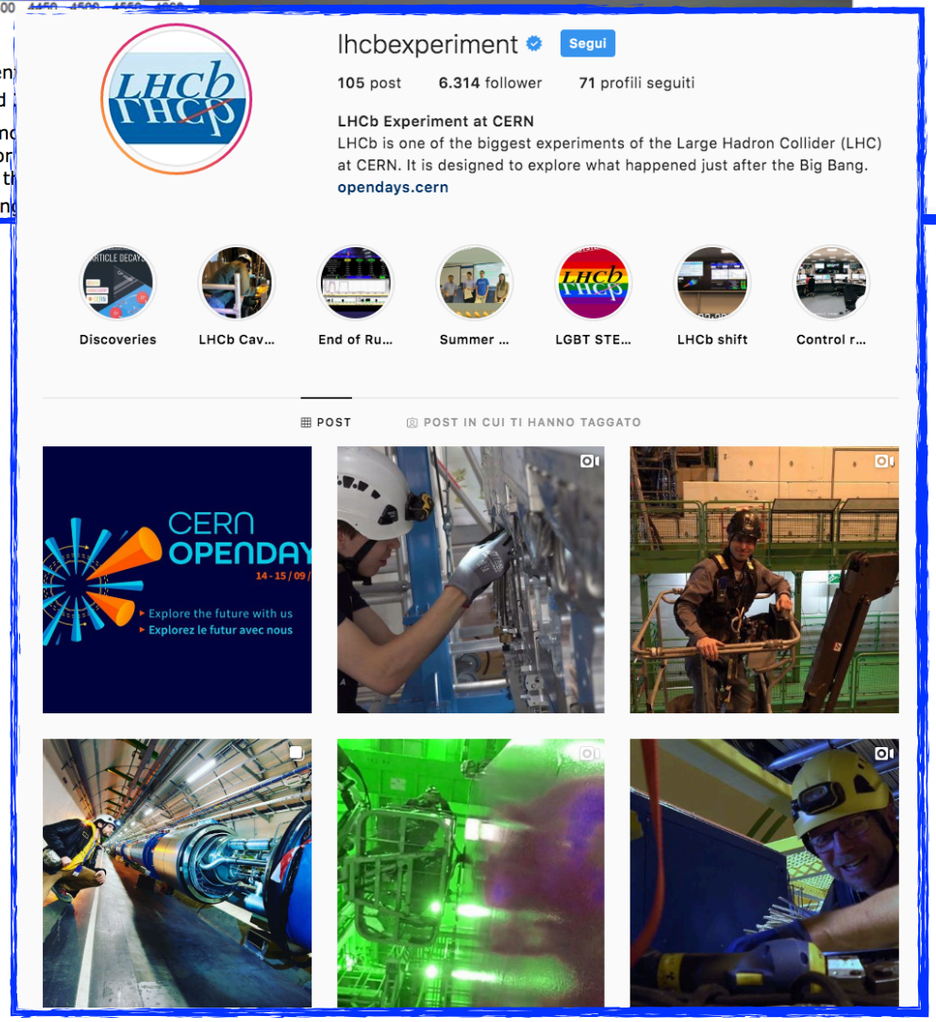
LHCb on web & social media

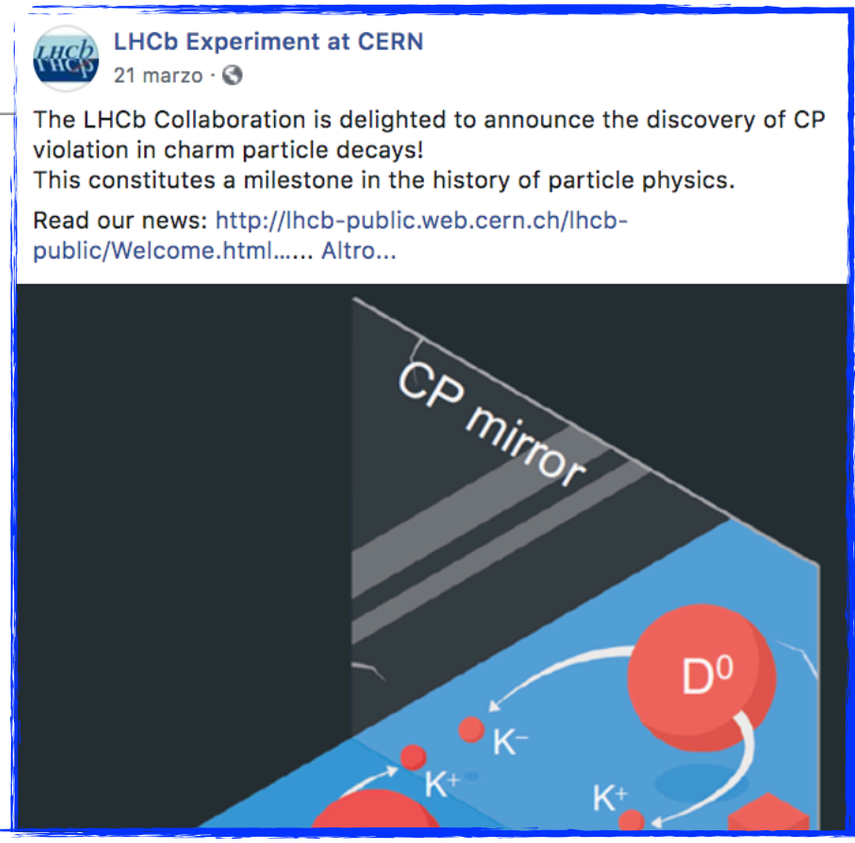
set was analysed in the same way as in the earlier 2015 paper and the parameters of the previously reported $P_c(4450)^+$ and $P_c(4380)^+$ structures were found to be consistent with the original results. However, analysis of the much larger data sample reveals additional peaking structures in the J/ψp invariant mass spectrum which were not visible in the data sample used before. A narrow peak is observed near 4312MeV with a width comparable to the mass resolution. The structure at 4450MeV is now resolved into two narrow peaks, at 4440 and 4457MeV. The images below show the contribution of these pentaquark states to the J/ψp invariant mass spectra.





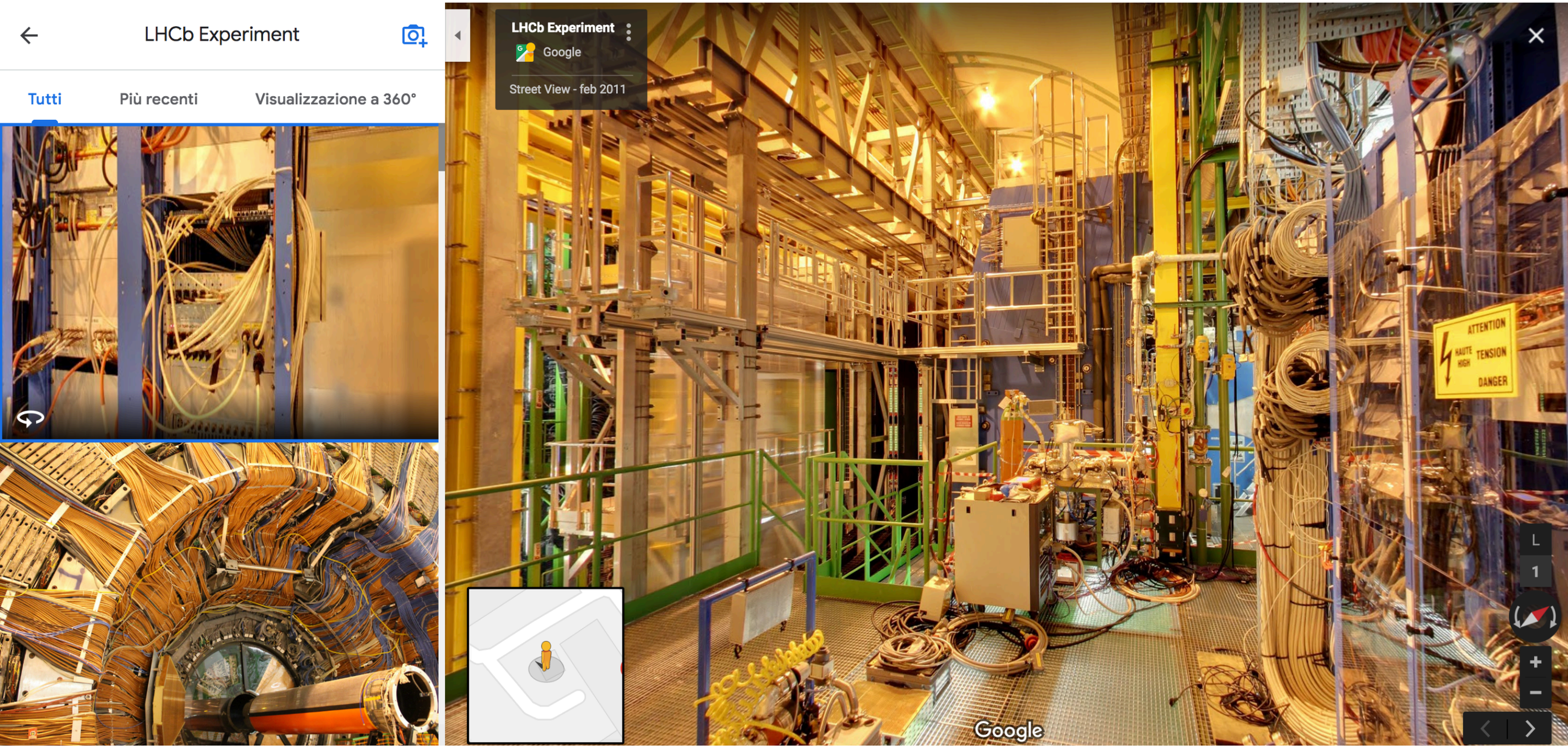
The minimal quark conten
just below the $\Sigma_c^+\bar{D}^0$ and
and a $\bar{D}^0$ or a $\bar{D}^{*0}$) by amo
experimental evidence for
interpretation is correct, t
would not decay by "fallin





Virtual tours

Walk around the cavern with Google StreetView

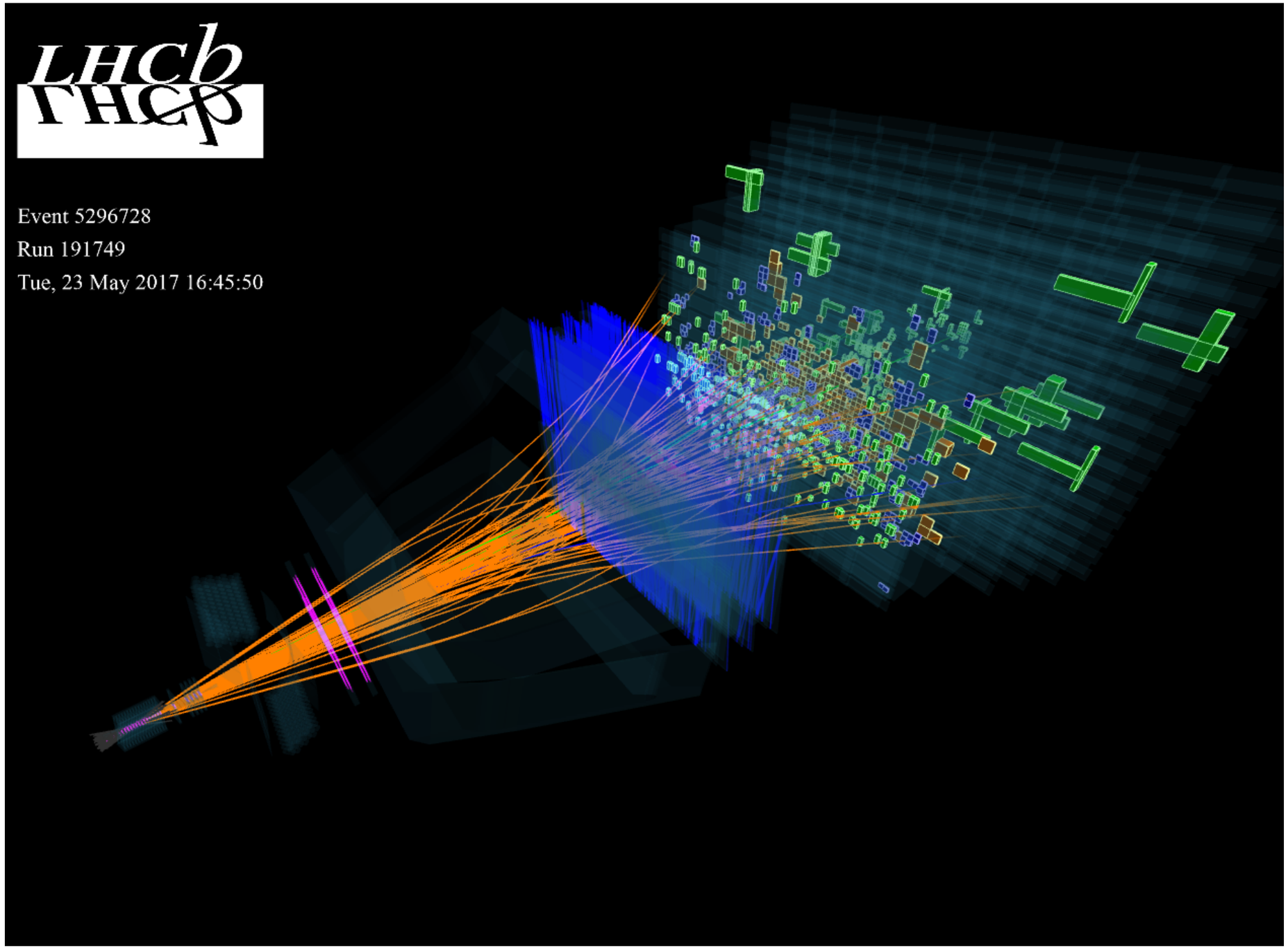


Interactive event display

lbevent.cern.ch/EventDisplay

3D view of live events (or history mode)

Rotate the camera, change colours and download the event

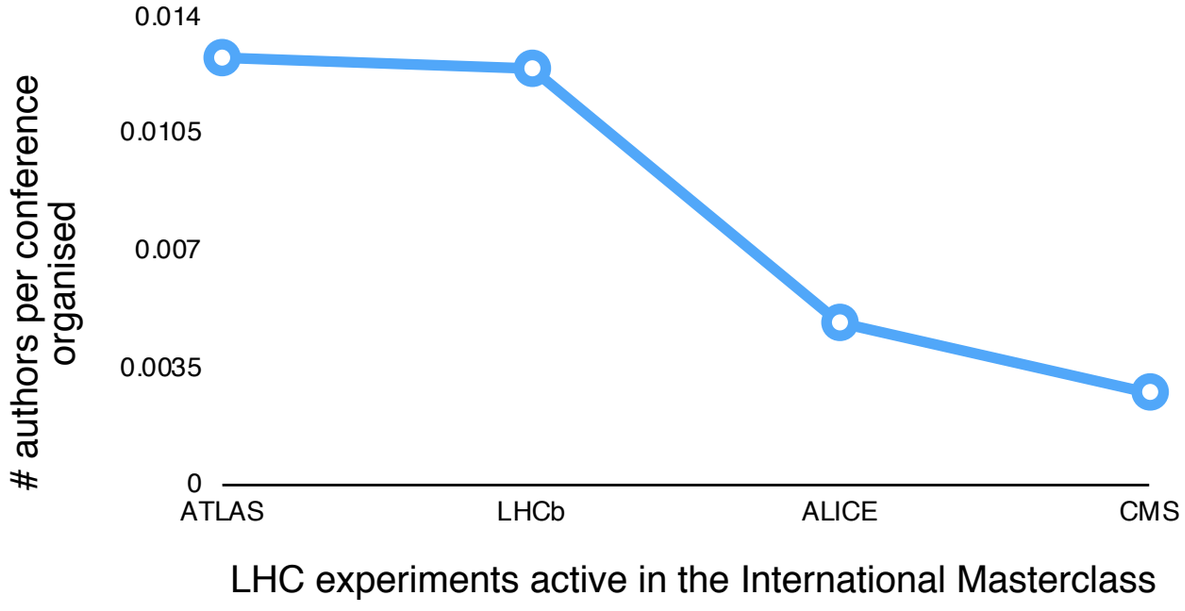


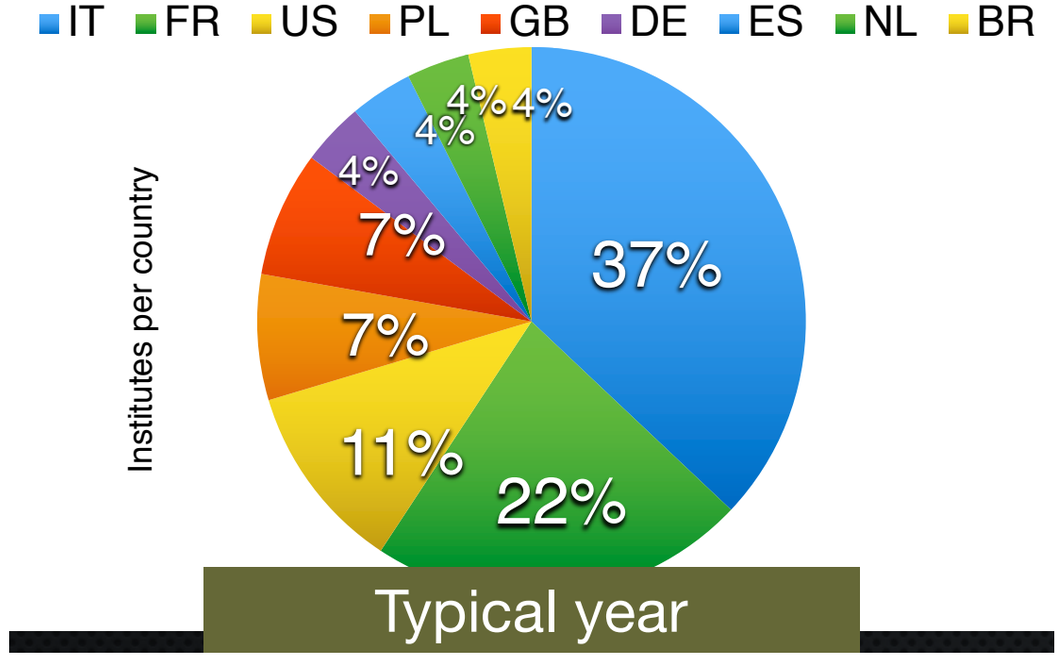
Masterclasses

A full-immersion day on data analysis for high school students

- Carried out in nearby universities / research centres all over the world
- Measurements on real LHCb data
- International video conference to discuss the results

A lot of masterclasses from LHCb!





The LHCb masterclass

LHCb masterclass website

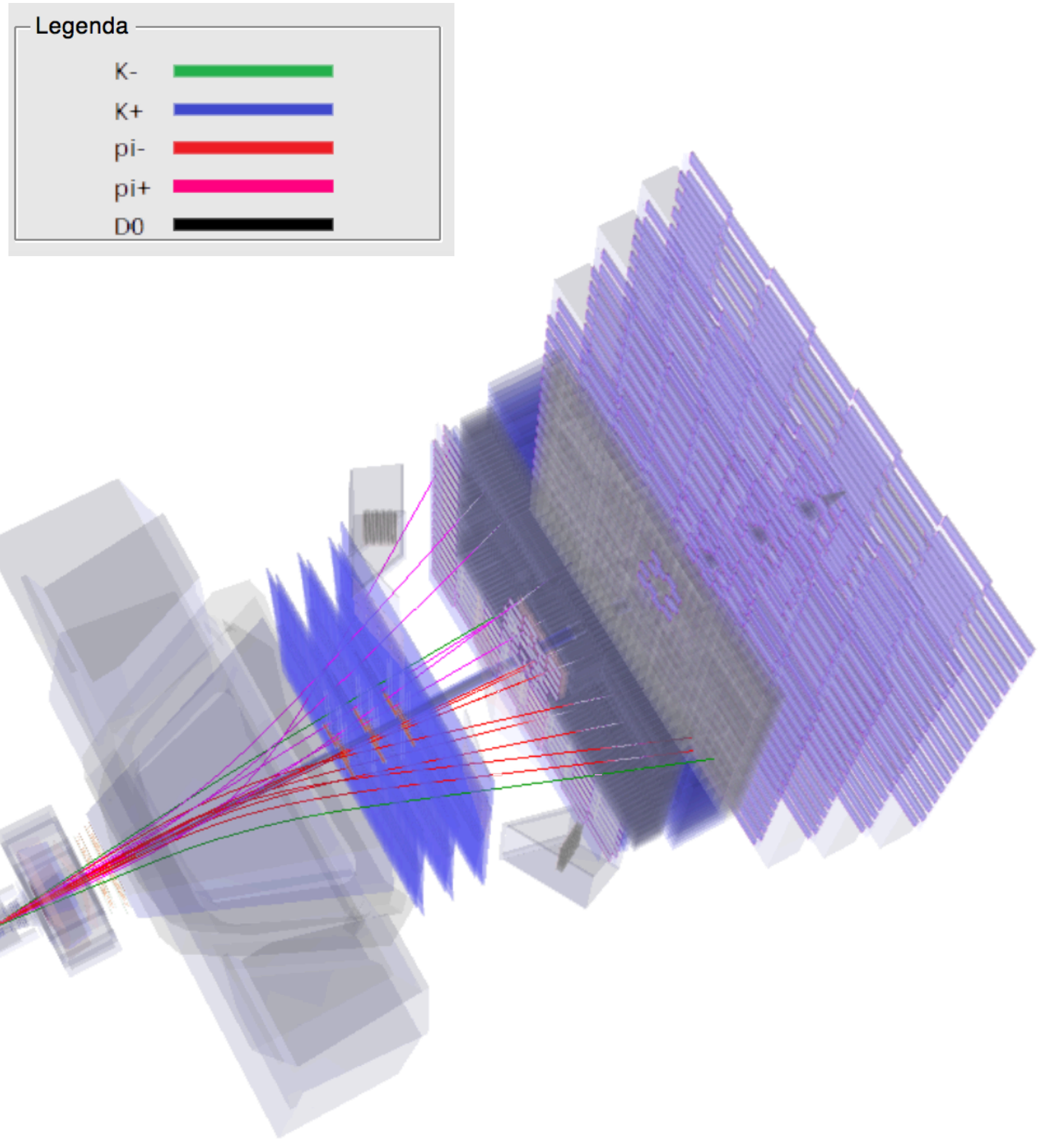
Exercise: “Measurement of the D^0 lifetime”

The analysis is divided into 3 main steps:

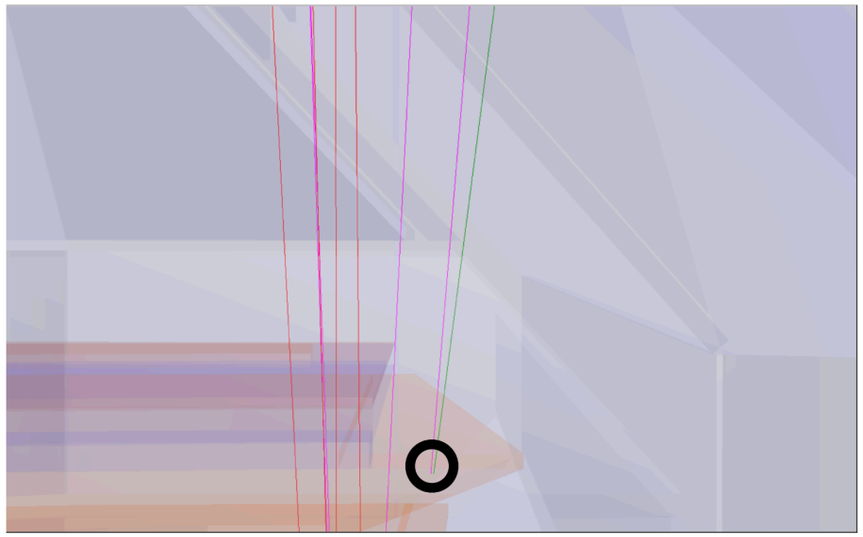
1. Interactive search for interesting events
2. Invariant mass fit and decay time measurement
3. Systematic study

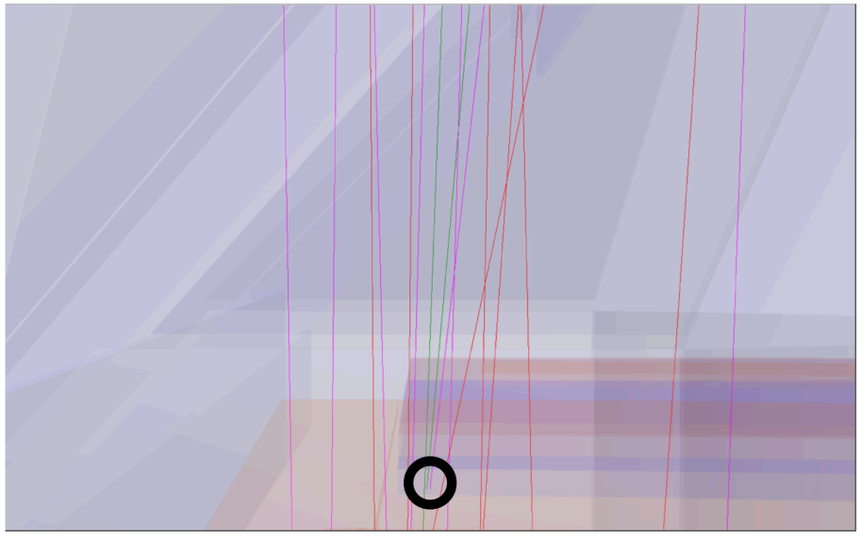
- Analysis code (based on ROOT) is compatible with Windows, Linux and OSX. (NEW: CERN virtual machines are also available)
- Groups of 2-3 students work on different bunches of data
- Detailed instructions and a video tutorial can be found on the website

1. Interactive search of D^0 tracks (K^- and π^+)



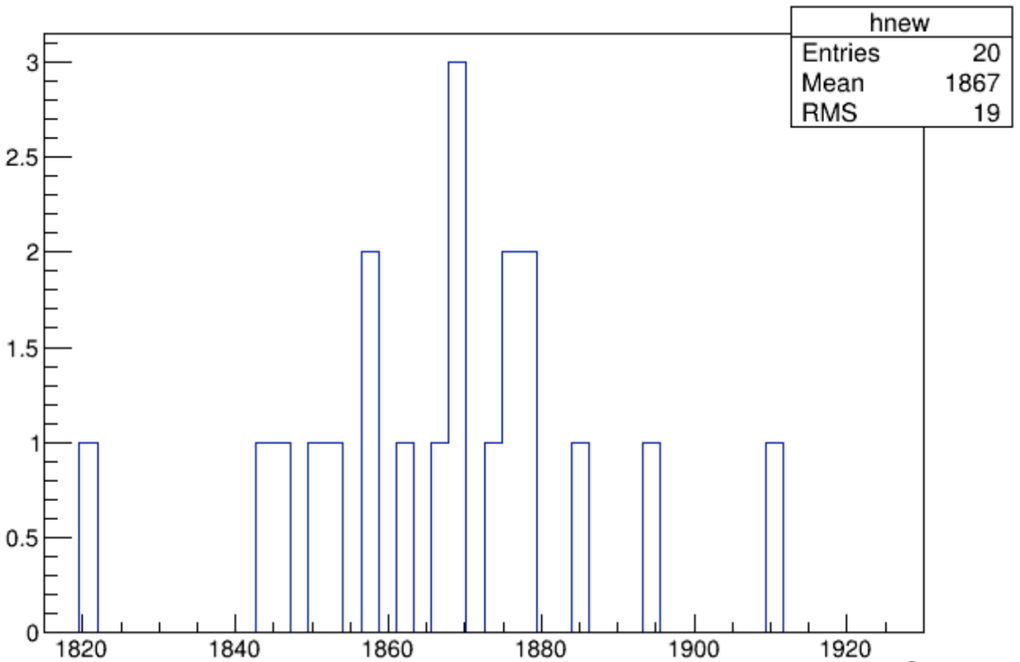
Rotate the view and zoom in to find the D^0 decay vertex among the background



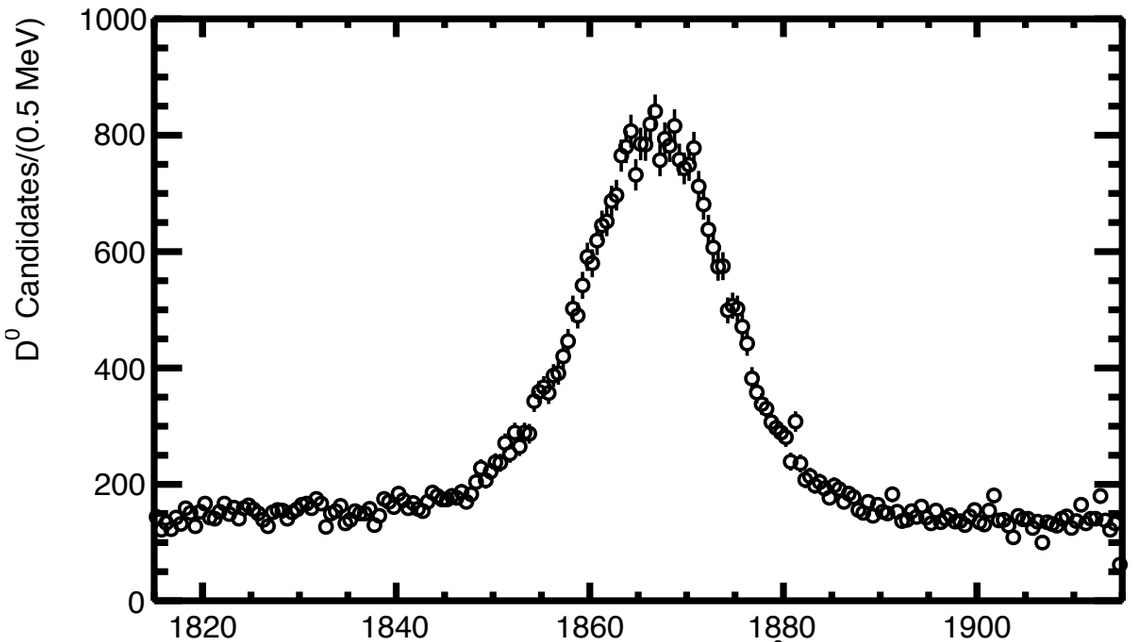


1. Build the mass histogram

Save the interesting events and fill the Kπ invariant mass histogram

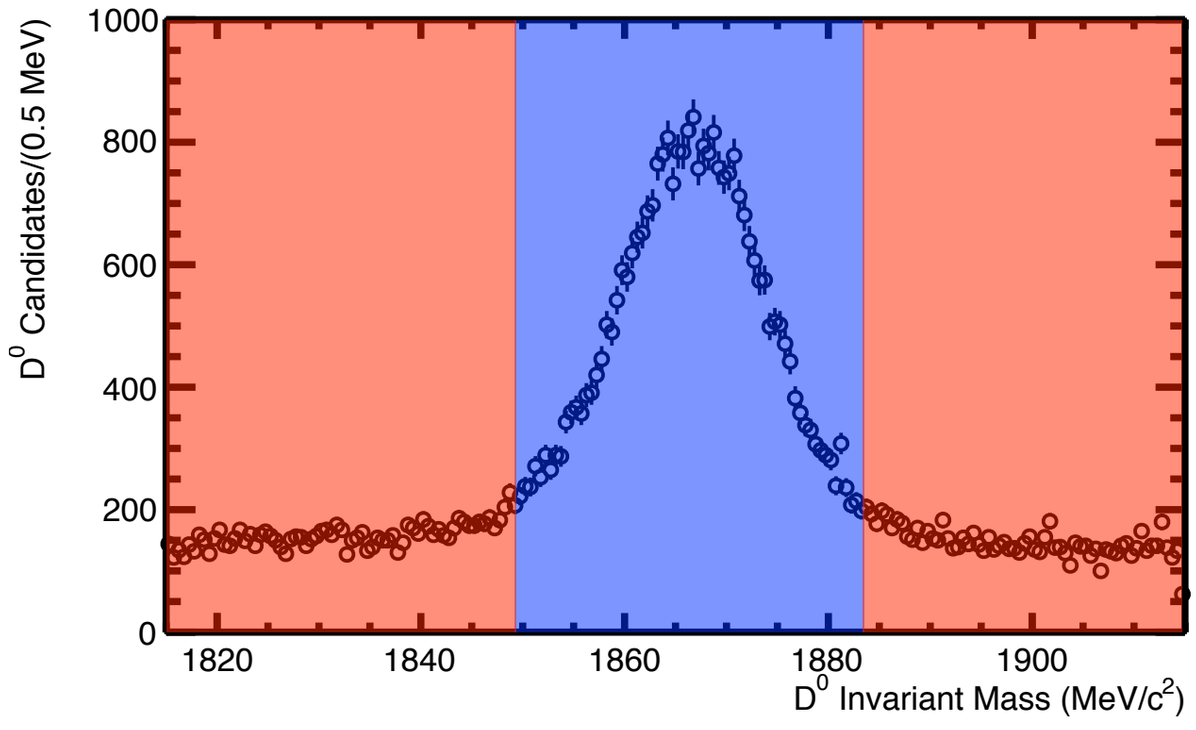


The 2nd part of the exercise starts with a larger dataset



Event selection

Signal vs combinatorial: introducing statistics



2. Measure the D^0 lifetime

LHCb Masterclass : D0 lifetime analysis

Browser Eve | File Edit View Options Tools | Help

Tools

Variable ranges

D0 PT : 2.5 – 20.0

D0 TAU : 0.15 – 10.15

D0 IP : -4.0 – 1.5

Analysis tools

Plot D0 mass

Fit mass distribution

Background subtraction

Sig range: 1845.0 – 1885.0

Plot distributions

Time fit

Fit signal decay time

Fit Result	Fit Error
0.4720	0.0043

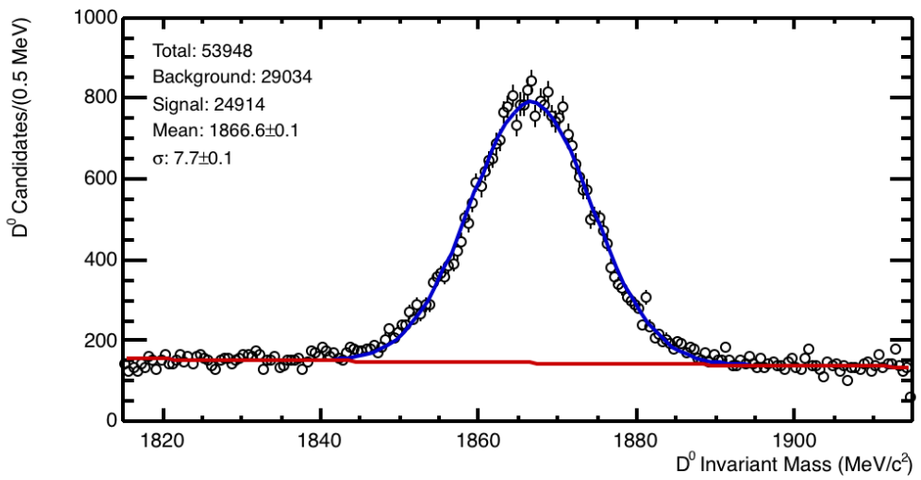
Save results

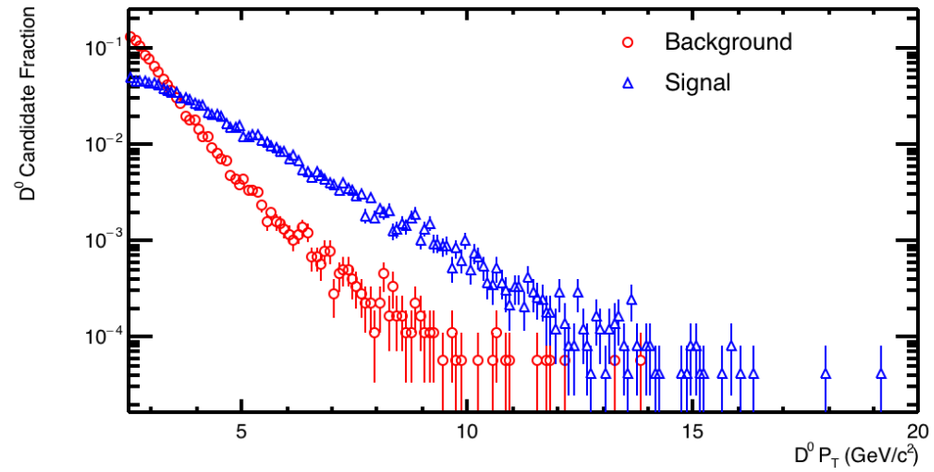
Trend vs. max IP

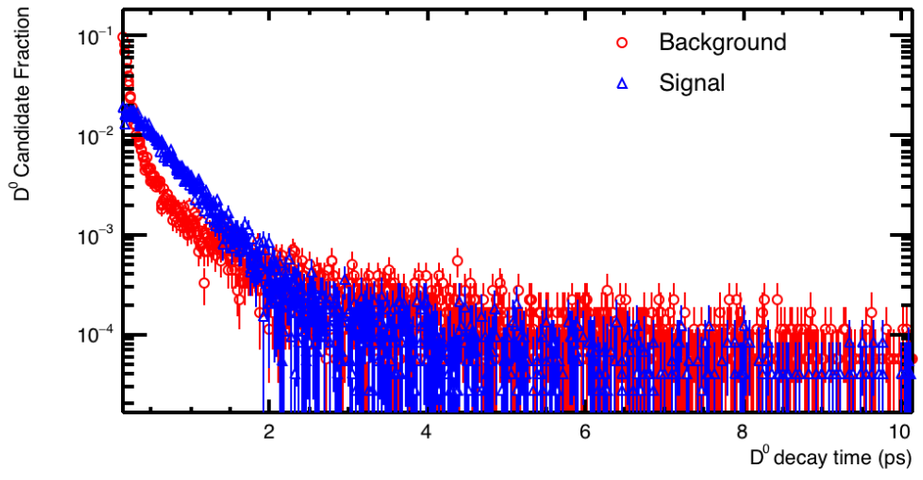
Save result and fit

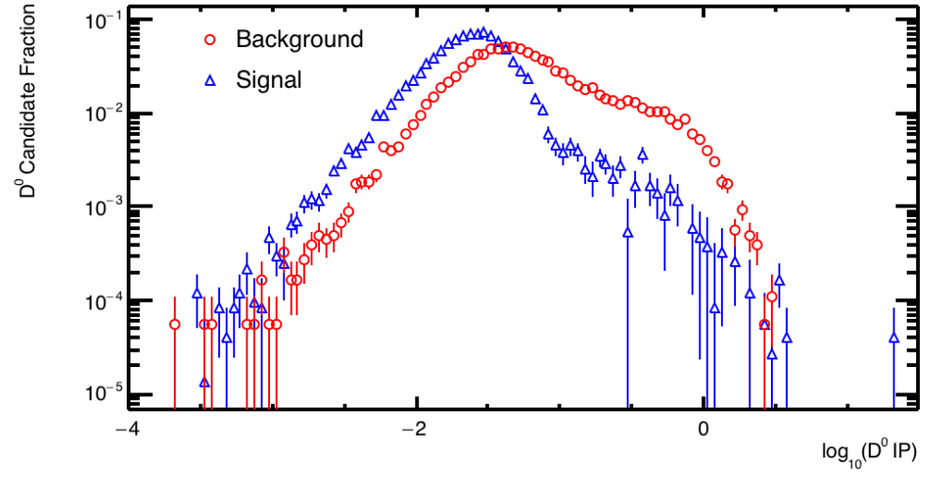
Plot trend | Clear Trend

Invariant Mass Distribution | Lifetime fit









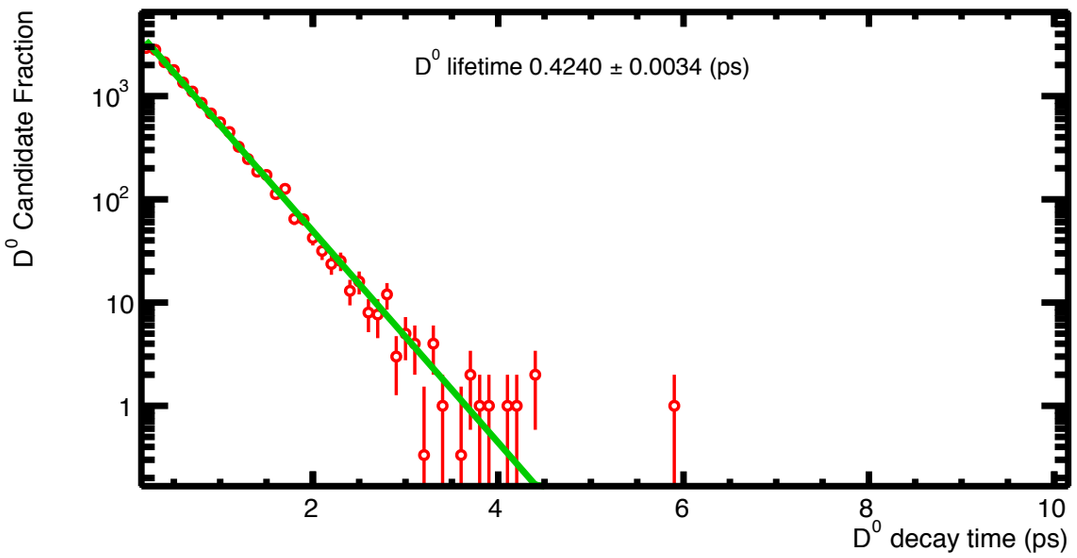
Save Canvas | Filename

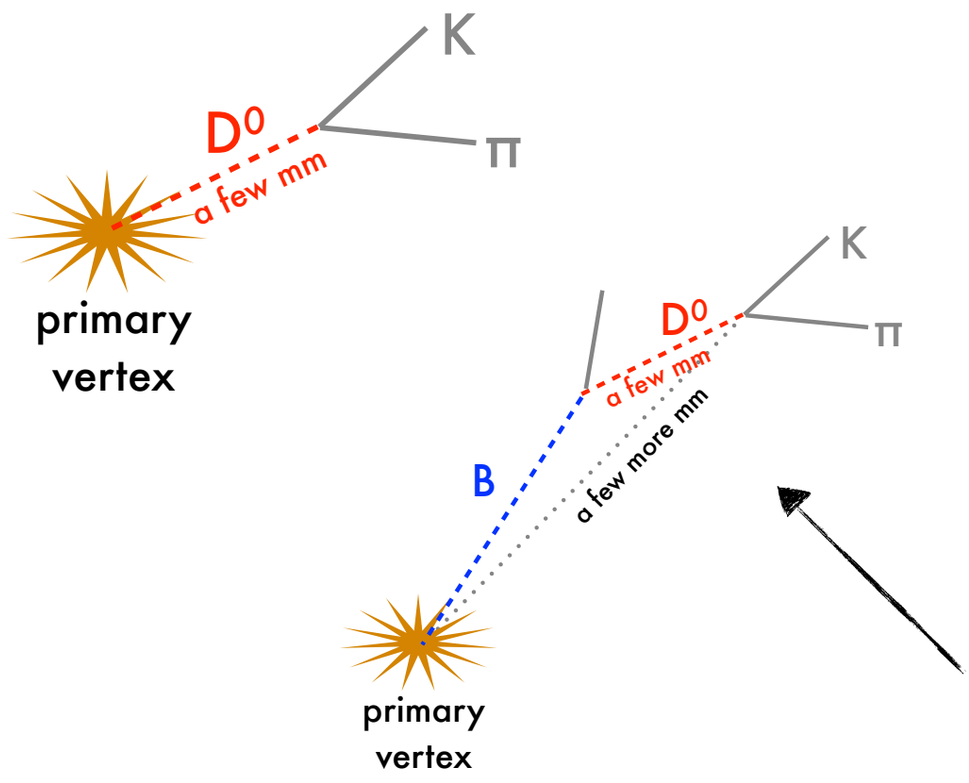
Read Instructions | Reset Exercise | Exit

1. play with selection cuts
2. mass fit & plots
3. decay time fit
4. save the result

3. Systematic study

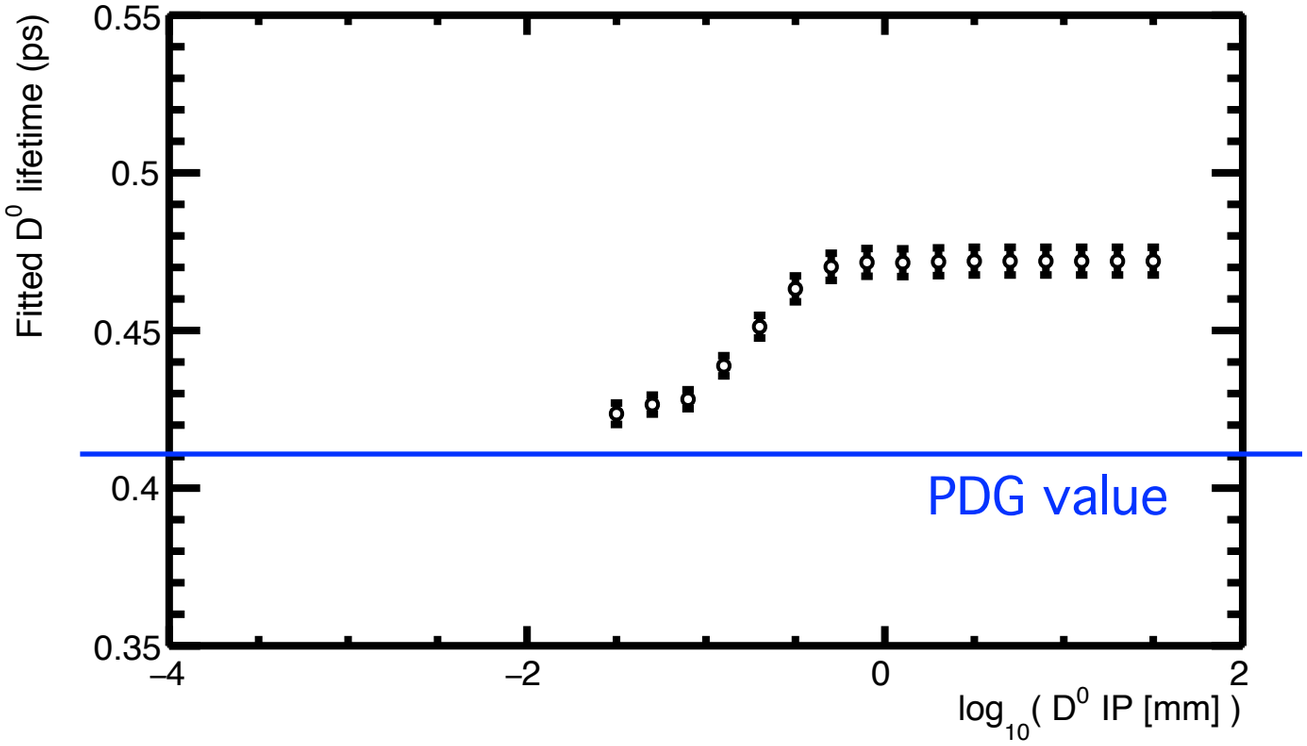
Lifetime fit example





Systematic study:

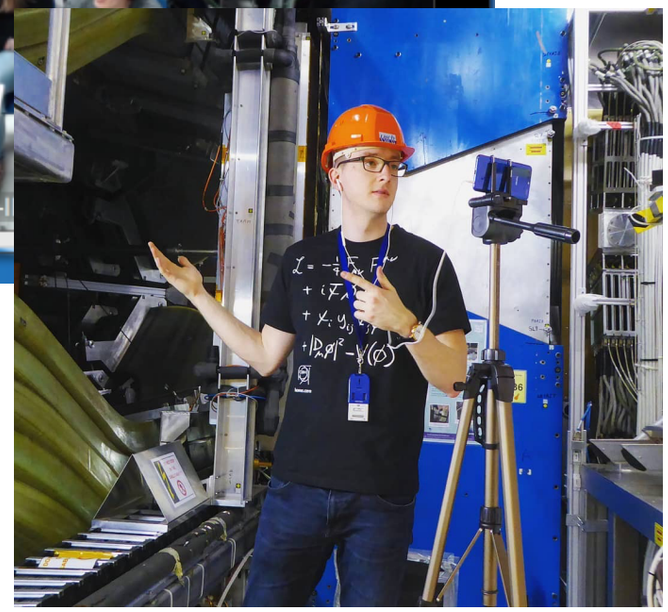
Repeat the fit while lowering Impact Parameter cut and plot the trend



Separating the two production mechanisms

4. Discussion!

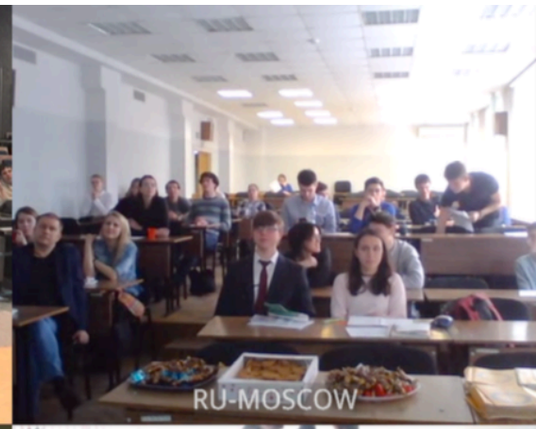
After the exercise, Video conference among participants and CERN



Live from the LHCb detector with Q&A

- Histograms of selected events are merged live
- Results are compared with discussions on the analysis strategy
- Final quiz

Masterclasses / photos



Masterclasses / photos

Masterclasses / TV news

Seicento ragazzi con Masterclass

In arrivo al Bo dalle scuole superiori di tutta Italia per un "viaggio" nella materia

Sono in arrivo a Padova, dal 12 marzo, più di seicento studenti provenienti dalle scuole superiori di tutta Italia. Passeranno tre giorni al Bo, insieme ai ricercatori dell'ateneo, per partecipare all'undicesima edizione delle "Masterclass", veri e propri viaggi nel cuore della mate-

computer. Accompagnati dai ricercatori, esploreranno i segreti di LHC (Large Hadron Collider), dove nel luglio 2012 è stato scoperto l'ormai celebre bosone di Higgs, noto al grande pubblico co
la "particella di Dio".

Le giornate si dividera
in due parti: la mattina

alla velocità della luce. Useranno i veri dati provenienti dall'esperimento di Higgs, per simulare negli esercizi l'epocale scoperta, ma si cimenteranno anche con i bo-

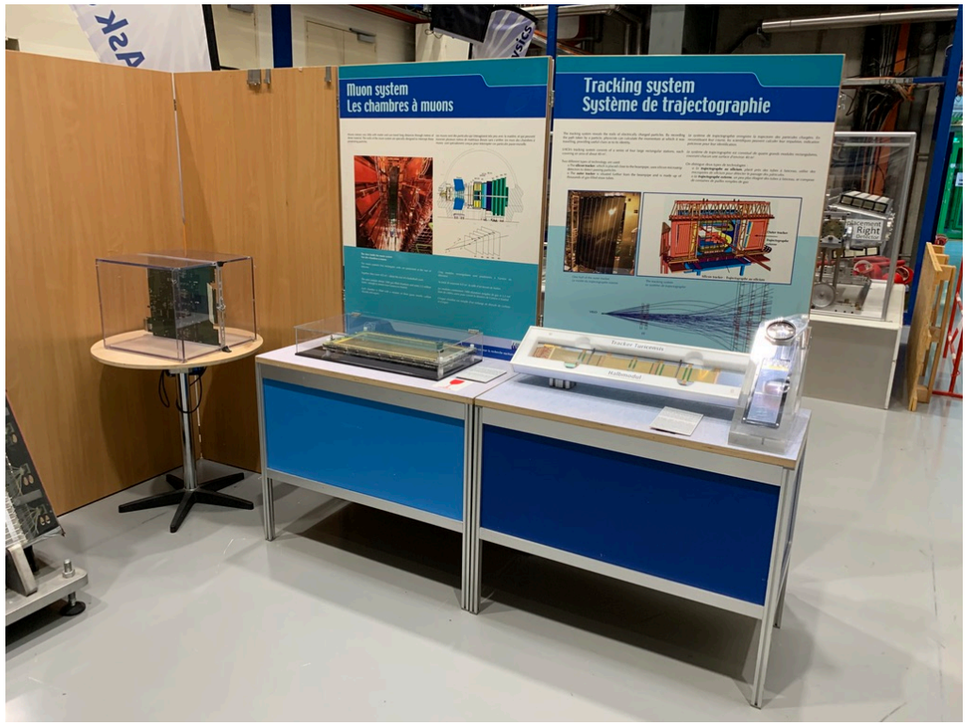
si. Il confronto sarà organizzato come un piccolo contest, con in palio simpatici gadget per gli studenti più attenti. L'iniziativa, coordinata dall'Istituto Nazionale di Fisi-

Exhibition at Point 8 / overview

- Shown to visitors entering the LHCb pit, providing informations in english and french
- The LHCb site is included in the CERN tours

Exhibition at Point 8 / stands

Stands with detector modules



Posters and panels

Exhibition at Point 8 / the LHCb construction

- Exhibition upgrade:
  - Short term: add upgrade detectors and recent results (for CERN Open Days)
  - Long term: complete overhaul + cinema room in the old control room (2021)

Exhibition at Point 8 / entrance

LHCb painting with 1:1 scale

Conclusions

- The outreach is an integral part of the LHCb experiment
- Many people committed in different fronts: presence on social media, masterclasses and visits for the general public
- The masterclass exercise may be considered hard but undoubtably a success: a challenge to stimulate curiosity!