



Web based LHCb masterclass

14 X 2020

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LHCb Masterclass project

Measuring D^0 lifetime

PART 1 - D^0 identification

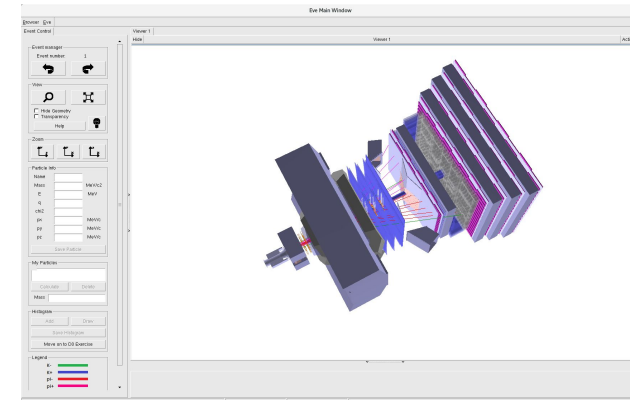
Locate displaced vertices belonging to D^0 particles for 30 events

PART 2 - D^0 lifetime fit

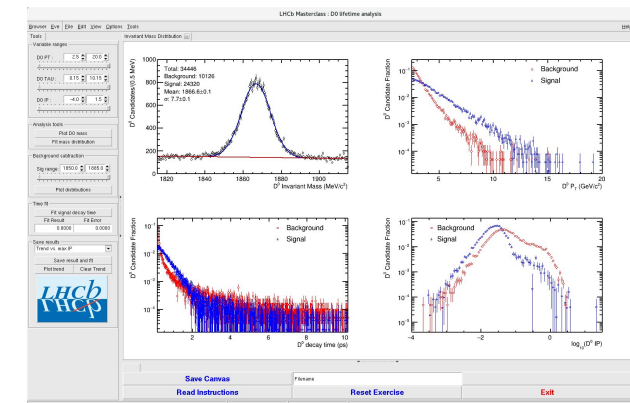
54 000 events

Fit data to measure signal properties and observe effect of IP cut on D^0 lifetime

Existing software



PART 1 - 3D scene



PART 2 - Data visualization

Technological choices

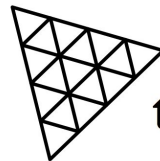


Angular 8

- Single Page Application (Client only)
- Typescript based
- Led by Google

Open source

Javascript libraries



three.js

Create 3D scene
Uses WebGL

Open source



D3.js

Create dynamic and interactive
data visualizations

BSD license

Homepage

The screenshot shows a web browser window with the URL `test-lhcb-masterclass.web.cern.ch/test-lhcb-masterclass/`. The page title is "LHCb Masterclass" and it includes links for "About" and "Language".

The registration form contains the following fields:

- Firstname: **Marine**
- Surname: **Blanchard**
- Grade: **1**
- Combination: **Combination 3** (dropdown menu)

A "Save" button is located below the form. A callout box with an arrow pointing to the button contains the text: "Complete et save the form to access exercises".

Below the form, there are two exercise options:

- Event Display**: Represented by an image of a particle detector.
- D0 Lifetime**: Represented by a histogram showing a distribution of data points.

At the bottom of the page, the version number "v0.1" and the copyright notice "Copyright © 2019 CERN" are displayed.

Event Display Exercise

The screenshot displays the LHCb Masterclass Event Display Exercise interface. The browser address bar shows the URL: `Non sécurisé — test-lhcb-masterclass.web.cern.ch/test-lhcb-masterclass/event`. The page title is "LHCb Masterclass" and it includes "About" and "Language" links.

Event Display Exercise

Event handler

event_3_0.json

previous

next

View

Zoom

Detector

Help

View

Auto rotate

Legend

K⁻ (red line)

K⁺ (blue line)

pi⁺ (green line)

pi⁻ (purple line)

D⁰ (grey line)

Read instructions

Download JSON

Particle information

Property	Value
E	MeV
chi2	
ipchi2	
mass	MeV/c ²
name	
ZFstM	

My particles

Mass

MeV/c²

Add

D0 Candidates (0.5 ns)

D0 Invariant Mass (MeV/c²)

The plot shows a distribution of D0 candidates with a peak around 1.86 MeV/c².

v0.1

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Event Display Exercise

The screenshot shows the LHCb Masterclass Event Display Exercise interface. The browser address bar displays "Non sécurisé — test-lhcb-masterclass.web.cern.ch/test-lhcb-masterclass/event...". The page title is "LHCb Masterclass" with "About" and "Language" links. The main content area is titled "Event Display Exercise" and includes an "Event handler" section with "event_3_0.json" and "previous/next" buttons. A "View" section contains "Zoom", "Detector" (checked), and "Help" (unchecked) options, along with an "Auto rotate" checkbox and a slider. A "Legend" section lists particles: K⁻ (red), K⁺ (blue), pi⁺ (green), pi⁻ (purple), and D⁰ (grey). Buttons for "Read instructions" and "Download JSON" are at the bottom left. The central "Event display" shows a 3D visualization of the detector with particle tracks. To the right, a "Particle information" table lists properties: E (MeV), chi2, ipchi2, mass (MeV/c²), name, and ZFstM. Below this is a "My particles" list with a "Mass" input field (set to MeV/c²) and an "Add" button. At the bottom right, a histogram shows "D0 Candidates (0.5 MeV)" vs "D0 Invariant Mass (MeV/c²)".

Information of selected particle

Particles saved
K⁺ and pi⁻

Invariant mass

Close up on collision

Projections

Detector opacity

Event display

Particle information

Property	Value
E	MeV
chi2	
ipchi2	
mass	MeV/c ²
name	
ZFstM	

My particles

Mass

MeV/c²

Add

Histogram of masses saved

D0 Candidates (0.5 MeV)

D0 Invariant Mass (MeV/c²)

v0.1
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Event Display Exercise

Non sécurisé — test-lhcb-masterclass.web.cern.ch/test-lhcb-masterclass/event

LHCb Masterclass About Language

Event Display Exercise

Event handler
event_3_0.json
previous
next

View
Zoom
Detector
Help
View
Auto rotate

Legend
K⁻
K⁺
pi⁺
pi⁻
D⁰

Read instructions
Download JSON

Particle information		
E	19612.373	MeV
chi2	1.152	
ipchi2	272.949	
mass	139.570	MeV/c ²
name	pi ⁺	
ZFstM	49.322	

My particles
K⁻
pi⁺
Mass
1864.903 MeV/c²
Add

Entries 1
Means: 1864.903
Std dev: undefined

DO Candidates (0.5 MeV)
DO Invariant Mass (MeV/c²)

v0.1
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Step 1 : find vertex

Step 2 : check if invariant mass is in the good range

Step 3 : Add to histogram

Event Display Exercise

The screenshot displays the LHCb Masterclass Event Display Exercise interface. The central area shows a particle event with tracks for K^- (red), K^+ (blue), π^+ (green), π^- (purple), and D^0 (grey). The control panel on the left includes an event handler for 'event_3_4.json', navigation buttons, view options (Zoom, Detector, Help), an auto-rotate checkbox, and a legend. The particle information table on the top right lists properties for the selected particle. The histogram on the bottom right shows the D^0 invariant mass distribution with a peak at approximately 1861 MeV/c².

E	44200.600	MeV
chi2	1.067	
ipchi2	5.306	
mass	139.570	MeV/c ²
name	π^+	
ZFstM	289.193	

π^+
K^-

1861.949	MeV/c ²
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Histogram data:

D^0 Invariant Mass (MeV/c ²)	D^0 Candidates (0.5 MeV)
1830	1.0
1860	1.0
1870	2.0
1890	1.0

Statistics for the histogram:

- Entries: 5
- Means: 1859.397
- Std dev: 26.381

Event Display Exercise

Non sécurisé — test-lhcb-masterclass.web.cern.ch/test-lhcb-masterclass/event

LHCb Masterclass

You have successfully completed MasterClassDisplay exercise.

Event Display Exercise

Event handler

event_3_30.json

previous

next

View

Zoom

Detector

Help

View

Auto rotate

Legend

K⁻

K⁺

pi⁺

pi⁻

D⁰

Read instructions

Download JSON

Particle information

E MeV

chi2

ipchi2

mass MeV/c²

name

ZFstM

My particles

Mass MeV/c²

Add

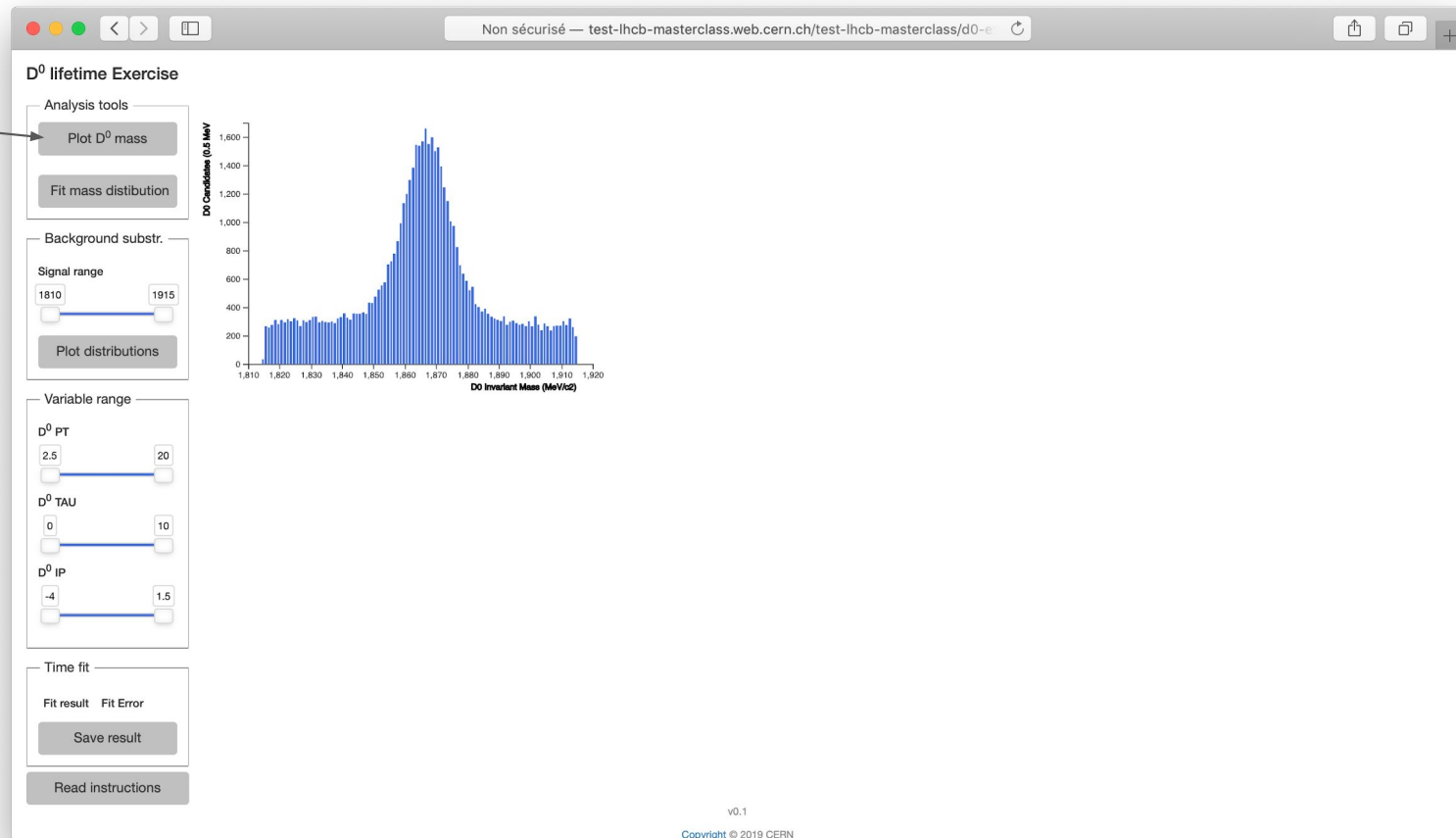
D0 Candidates (0.5 MeV)

Entries 30
Means: 1854.394
Std dev: 22.439

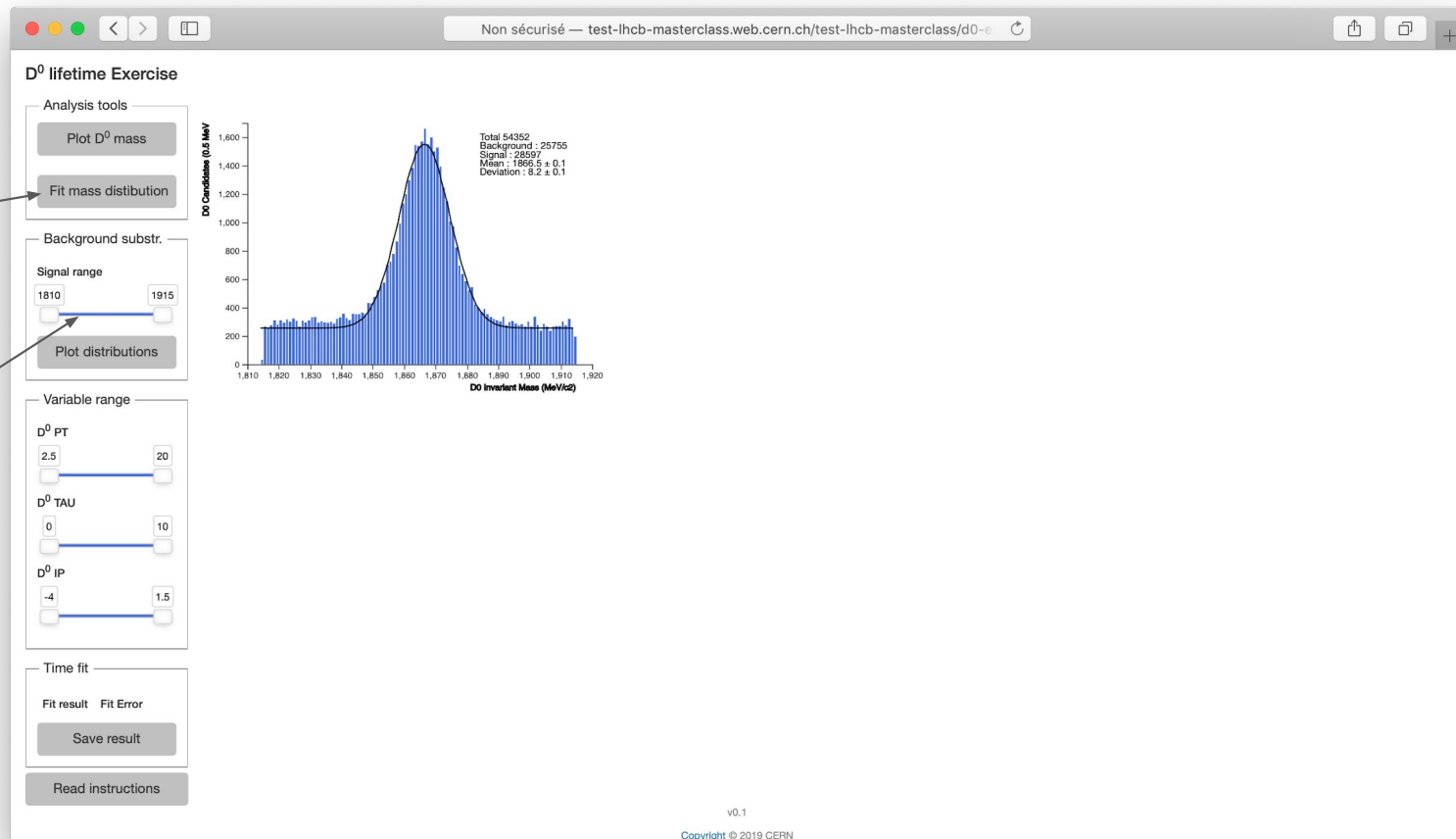
v0.1
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D⁰ Lifetime Exercise

Step 1 : plot the D⁰ mass distribution



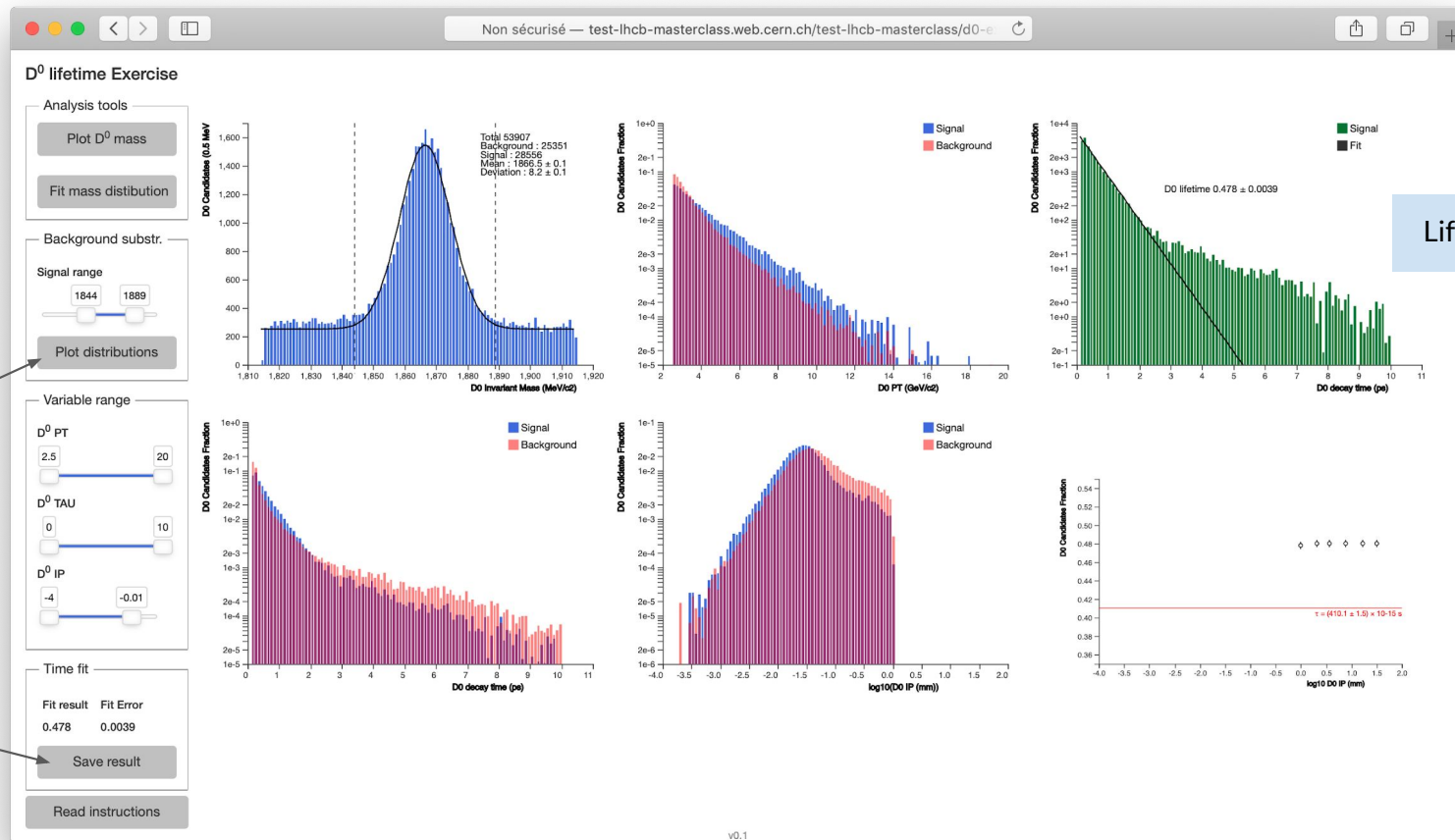
D⁰ Lifetime Exercise



Step 2 : fit the D⁰ mass distribution

Step 3 : determine the signal range

D⁰ Lifetime Exercise



D⁰ Lifetime Exercise

Non sécurisé — test-lhcb-masterclass.web.cern.ch/test-lhcb-masterclass/d0-e

D⁰ lifetime Exercise

Analysis tools

- Plot D⁰ mass
- Fit mass distribution

Background substr.

Signal range

1844 1889

Plot distributions

Variable range

D⁰ PT: 2.5 to 20

D⁰ TAU: 0 to 10

D⁰ IP: -4 to -1.94

Time fit

Fit result	Fit Error
0.447	0.0086

Save result

Read instructions

Step 6 : repeat step 4 varying upper D⁰ IP variable range

Step 7 : compare results to the PDG value

v0.1