



INTERNATIONAL
MASTERCLASSES

hands on particle physics

International Masterclasses - hands on particle physics



International Masterclasses

18th International Masterclasses 2022

But de l'exercice

- Identifier différentes particules à partir de leurs désintégrations

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- Identifier différentes particules à partir de leurs désintégrations

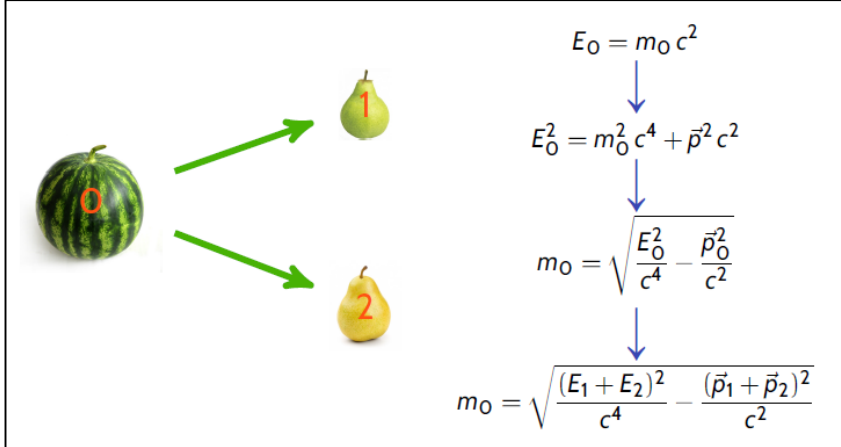


Grace à leurs masses

But de l'exercice

- Identifier différentes particules à partir de leurs désintégrations

Grace à leurs masses

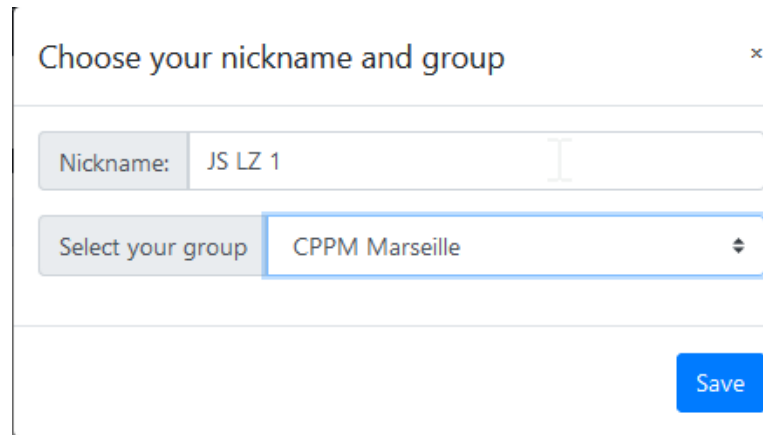


The diagram illustrates a decay process. On the left, a watermelon labeled '0' is shown. Two green arrows point from it to two pears labeled '1' and '2'. To the right of the pears, a series of equations are listed, connected by downward-pointing blue arrows:

$$E_0 = m_0 c^2$$
$$E_0^2 = m_0^2 c^4 + \vec{p}^2 c^2$$
$$m_0 = \sqrt{\frac{E_0^2}{c^4} - \frac{\vec{p}_0^2}{c^2}}$$
$$m_0 = \sqrt{\frac{(E_1 + E_2)^2}{c^4} - \frac{(\vec{p}_1 + \vec{p}_2)^2}{c^2}}$$

Détails pratiques

- Connectez vous au site <https://belle2.ijs.si/masterclass/>
- Mettez comme nickname vos initiales et numéro de binome



The image shows a web form with the title "Choose your nickname and group" and a close button (x) in the top right corner. Below the title, there are two input fields. The first is a text input labeled "Nickname:" containing the text "JS LZ 1". The second is a dropdown menu labeled "Select your group" with "CPPM Marseille" selected. At the bottom right of the form is a blue "Save" button.

Show Mission Run Analysis

Blocks

Belle II Masterclass
Number of events: 10000
First event: 0
Data Source: Belle-1.root
Print particle list? No
Particle List

Combine 2 particles

Particle 1

Particle 2

Same particle lists? No

Set identity to J/Psi meson

Min mass [GeV/c²]: 1

Max mass [GeV/c²]: 4

Histograms

Select Particles Simple

Particle

Charge -1

Type muon

Histograms

Histogram Title mu neg Mass Number of bins 40 Min: 0 Max: 5 Variable mass

Select Particles Simple

Particle

Charge 1

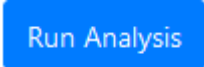
Type muon

Histograms

Histogram Title mu pos Mass Number of bins 100 Min: 0 Max: 5 Variable mass

Histogram Title mumu Mass Number of bins 100 Min: 1 Max: 4 Variable mass

Explication de l'exercice

- On va analyser des vraies données de Belle et de Belle II
- On combine différents blocs qui représentent les différentes parties du code nécessaire à analyser les données
- Le bloc **bleu** permet de charger les évènements: on peut choisir entre deux fichiers de données de Belle (le fichier Belle-1.root qui a 629000 évènements et le fichier Belle-2.root qui a 5, 600000 évènements) et le fichier de données de Belle II BelleII.root qui a 7000000 évènements. On peut aussi choisir le nombre d'évènements à analyser
- Le bloc **moutarde** permet de sélectionner des particules qu'on peut voir dans le détecteur (électrons, muons, photons, . . .)
- Le bloc **vert** permet de combiner deux particules et calculer leur masse
- Le bloc **marron** permet de dessiner un histogramme
- Cliquez sur 

$$K_s \rightarrow \pi^+ \pi^-$$

Belle II Masterclass
Number of events: 500000
First event: 0
Data Source Belle-1.root
Print particle list? No
Particle List

Combine 2 particles

Particle 1

Particle 2

Same particle lists? No
Set identity to kaon
Min mass [GeV/c²] : 0
Max mass [GeV/c²] : 1
Histograms

Select Particles Simple

Particle

Charge -1
Type pion
Histograms

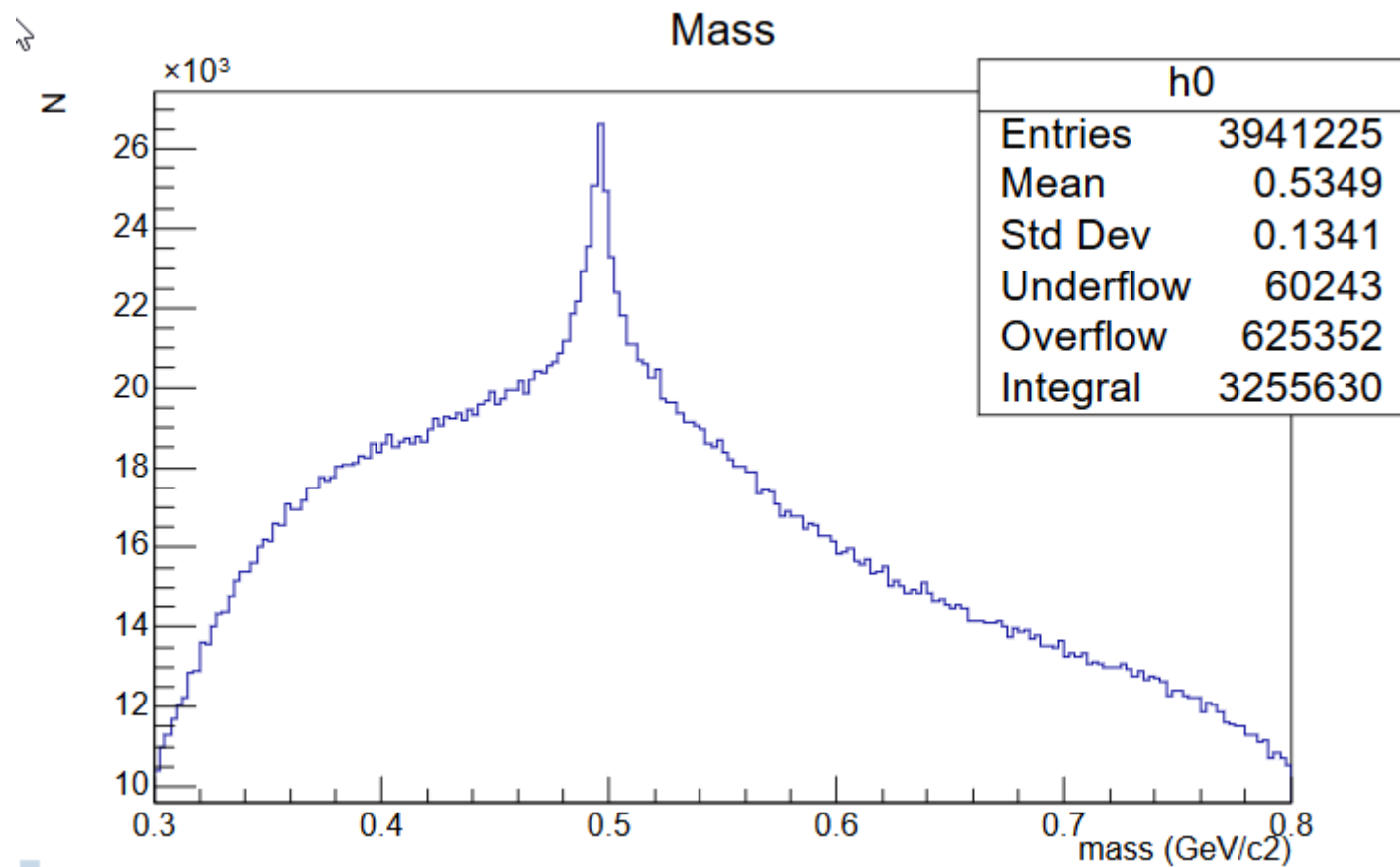
Select Particles Simple

Particle

Charge 1
Type pion
Histograms

Histogram Title Mass Number of bins 200 Min: 0.3 Max: 0.8 Variable mass

$$K_S \rightarrow \pi^+ \pi^-$$



$K_S \rightarrow \pi^+ \pi^-$ fit

Belle II Masterclass

Number of events: 500000

First event: 0

Data Source Belle-1.root

Print particle list? No

Particle List

Combine 2 particles

Particle 1

- Select Particles Simple
- Particle
- Charge -1
- Type pion
- Histograms

Particle 2

- Select Particles Simple
- Particle
- Charge 1
- Type pion
- Histograms

Same particle lists? No

Set identity to kaon

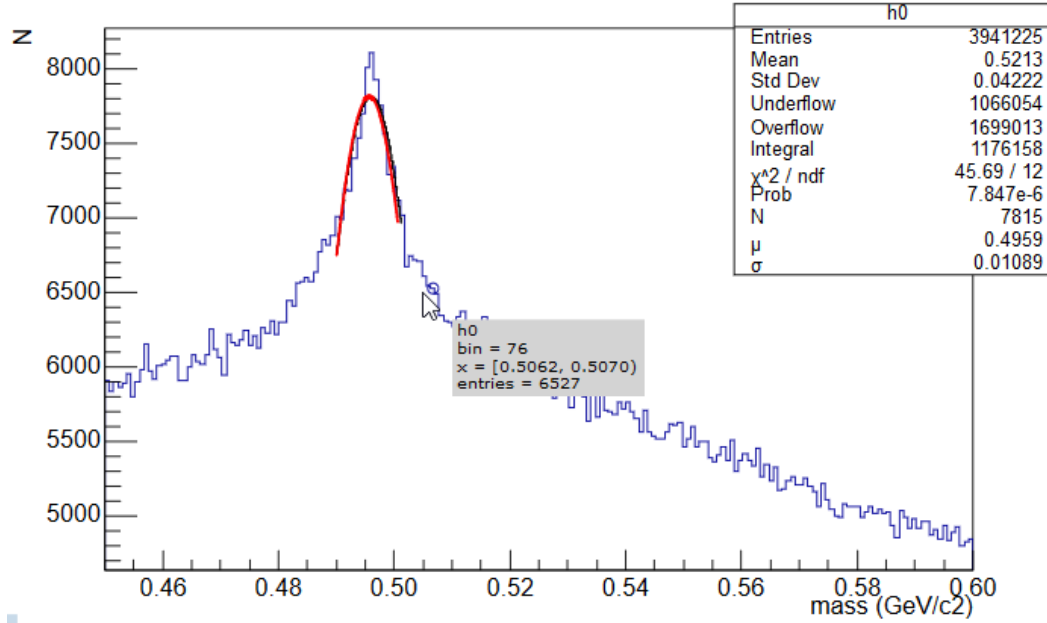
Min mass [GeV/c²] : 0

Max mass [GeV/c²] : 1

Histograms

Histogram Title Mass Number of bins 200 Min: 0.45 Max: 0.6 Variable mass

Mass



Click to fit

range: min = 0.490 (max = 0.501) $\chi^2/\text{ndf} = 45.86 / 12 = 3.822$ || $N_{\text{signal}} = 284693$

function: Gaus $N \cdot e^{-\frac{(x-\mu)^2}{2\sigma^2}}$

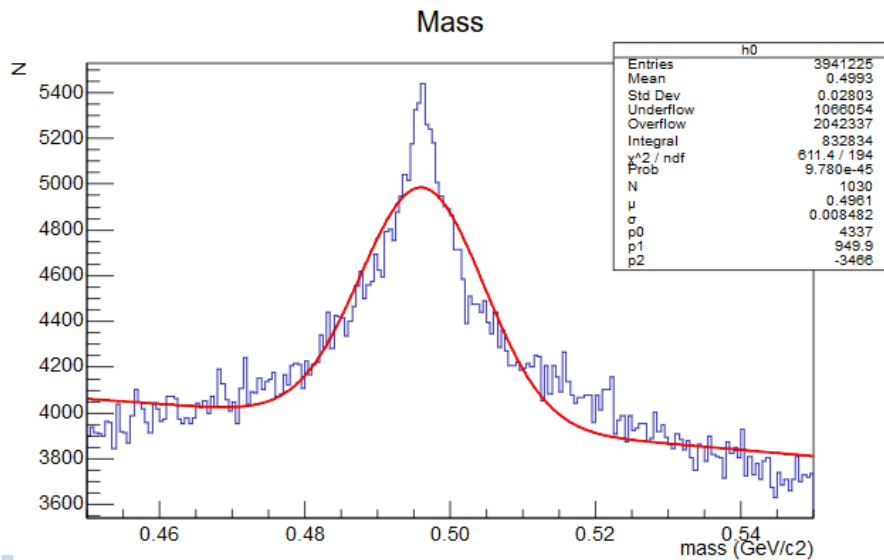
| Name | Value | Min | Set | Max | Step |
|--------------|-----------|------|-----------------------|-------------|--------|
| • μ : | 0.4959 | 0.45 | <input type="range"/> | 0.501168211 | 0.0001 |
| • σ : | 0.0109 | 0 | <input type="range"/> | 0.089291023 | 0.0001 |
| • N: | 7814.8838 | 0 | <input type="range"/> | 16218 | 0.0001 |

Show/Hide Fit Panel

To Process

Show/Hide Send result

$K_S \rightarrow \pi^+ \pi^-$ fit



Click to fit

Range: min = 0.45 max = 0.55 $\chi^2/\text{ndf} = 611.4 / 194 = 3.152$ || $N_{\text{signal}} = 43902$ || $N_{\text{background}} = 788476$

Function: Gaus + Polynomial $N \cdot e^{-\left(\frac{x-\mu}{4\sigma}\right)^2} + p0 + p1 \cdot x + p2 \cdot x^2$

| Name | Value | Min | Set | Max | Step |
|--------------|-----------|------|-----------------------|-------------|--------|
| • μ : | 0.4961 | 0.45 | <input type="range"/> | 0.55 | 0.0001 |
| • σ : | 0.0085 | 0 | <input type="range"/> | 0.020000000 | 0.0001 |
| • N: | 1030.2644 | 0 | <input type="range"/> | 10876 | 0.0001 |

Polynomial order: 2

| Name | Value | Min | Set | Max | Step |
|-------|-------------|-------------|-----------------------|-------------|--------|
| • p0: | 4336.8035 | -10 | <input type="range"/> | 60000 | 0.0001 |
| • p1: | 949.9035 | -10 | <input type="range"/> | 1551.088851 | 0.0001 |
| • p2: | -3465.94747 | -3465.94747 | <input type="range"/> | 10 | 0.0001 |
| • p3: | 0 | -10 | <input type="range"/> | 10 | 0.0001 |
| • p4: | 0 | -10 | <input type="range"/> | 10 | 0.0001 |

Show/Hide Fit Panel

To Process

Show/Hide Send result

Sauvegarder ses découvertes

Show/Hide Fit Panel To Process **Show/Hide Send result**

Particle name:


Particle charge:

Mass [GeV/c²]:

Width [GeV/c²]:


Events:

Save to your worksheet

 Belle II Particle Discovery - JS LZ 1 - CPPM Marseille **My worksheet** Quiz Event Display File Help Settings

Previous Next Run Analysis

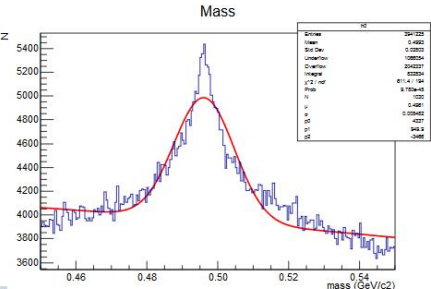


 Belle II Masterclass Student worksheet

Send results to server Clear worksheet Close Window

mission: 4
particle: K
charge: 0
mass: 0.461
width: 0.0085
events: 43902

Show diagram
Delete this mission



| Screen | SPD-232 |
|-----------|-----------|
| name | 1-4882 |
| file name | 1-02822 |
| location | 028234 |
| operator | 304257 |
| major | 82024 |
| event id | 8141-14 |
| file | 1-1044-03 |
| run | 100 |
| mu | 0.461 |
| sigma | 0.0085 |
| nt | 437 |
| nt | 948.3 |
| nt | 348 |

Die II Masterclass
Number of events: 500000
First event: 0
Data Source: Belle-1.root
Print particle list? (No)

Particle List

- Combine 2 particles
- Particle 1: Select Particles Simple
Particle:
Charge:
Type:
Histograms:
- Particle 2: Select Particles Simple
Particle:
Charge:
Type:
Histograms:

Some particle lists? (No)
Set identity to:
Min mass [GeV/c²]:
Max mass [GeV/c²]:
Histograms:

Histogram Title: Number of bins: Min: Max: Variable:

Missions

- Il y a 9 mission à accomplir
- Pas grave si vous n'arrivez pas à finir!
 - Essayez de faire 1 à 5 puis 6 et 8
 - Ou 1 à 5 puis 7 et 9
- N'hésitez pas à demander de l'aide si vous êtes bloqué !

Mission 1: number of reconstructed particles

In the data you fill find a list of reconstructed particles with their properties stored for each event. Each particle is described by its:

momentum $\mathbf{p} = (p_x, p_y, p_z)$,

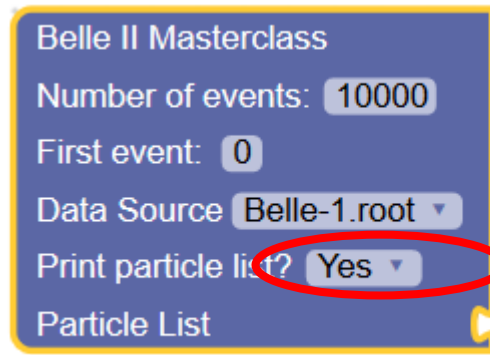
energy E ,

electric charge and

identity.

List the particles in the data for several events and plot a frequency histogram of the number of reconstructed particles per event. This is done by using the "Main" (blue) block and by pressing the "Run Analysis" button.

Try to change the number of events and the data source file and observe how the distribution changes.



Belle II Masterclass

Number of events: 10000

First event: 0

Data Source Belle-1.root

Print particle list? Yes

Particle List

Regardez en bas de la page pour voir le résultat

Au travail!

- Rendez vous a 14h30 pour discuter des résultats puis les partager avec les autres classes!