

Hands-on: ALICE masterclass

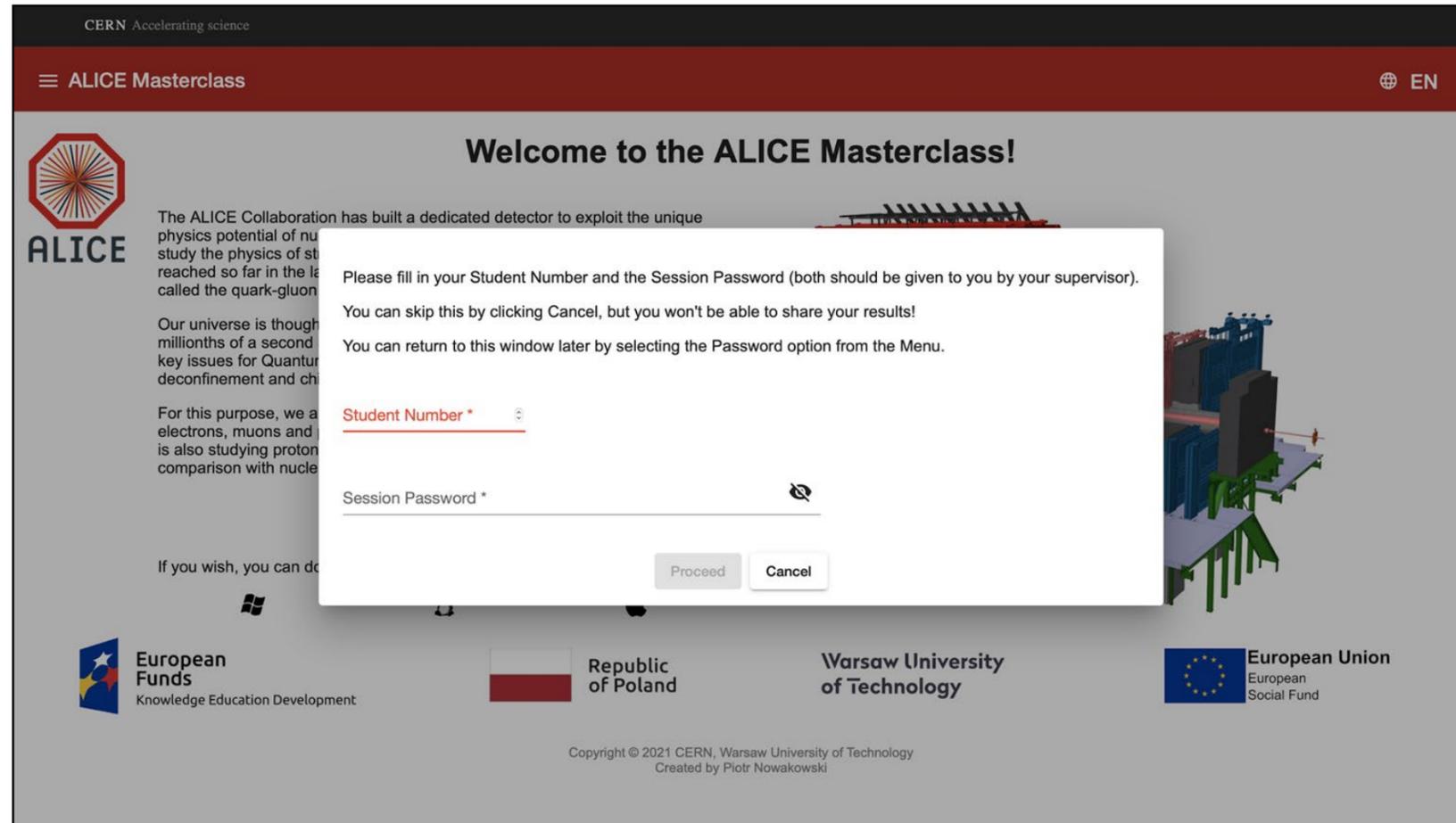
Fabio Colamaria, Domenico Colella

Bari, 14/03/2025

Hands-on – Introduzione

Login su:

<https://alice-web-masterclass.app.cern.ch/?password=password-per-nulla-creativa>



CERN Accelerating science

ALICE Masterclass EN

Welcome to the ALICE Masterclass!

The ALICE Collaboration has built a dedicated detector to exploit the unique physics potential of nuclei. It will study the physics of strongly interacting matter reached so far in the laboratory, called the quark-gluon plasma.

Our universe is thought to have spent a few millionths of a second in this state. Key issues for Quantum Chromodynamics are deconfinement and chiral symmetry breaking.

For this purpose, we are studying collisions of heavy ions, such as lead, at the Large Hadron Collider. We are also studying proton-proton collisions to compare with nuclear collisions.

If you wish, you can download the ALICE Masterclass application for your mobile device.

Please fill in your Student Number and the Session Password (both should be given to you by your supervisor).
You can skip this by clicking Cancel, but you won't be able to share your results!
You can return to this window later by selecting the Password option from the Menu.

Student Number *

Session Password *

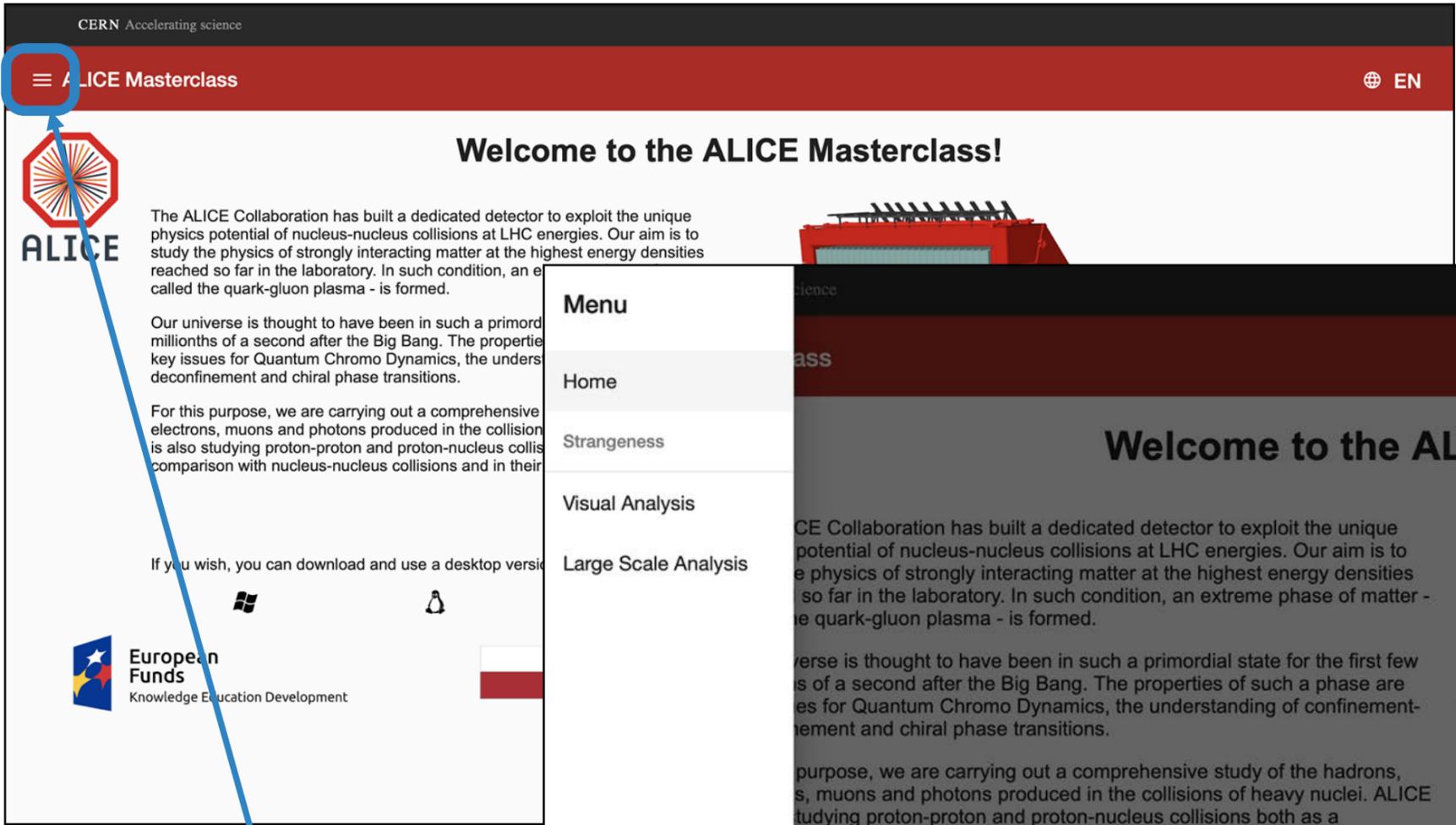
Proceed Cancel

European Funds Knowledge Education Development
Republic of Poland
Warsaw University of Technology
European Union European Social Fund

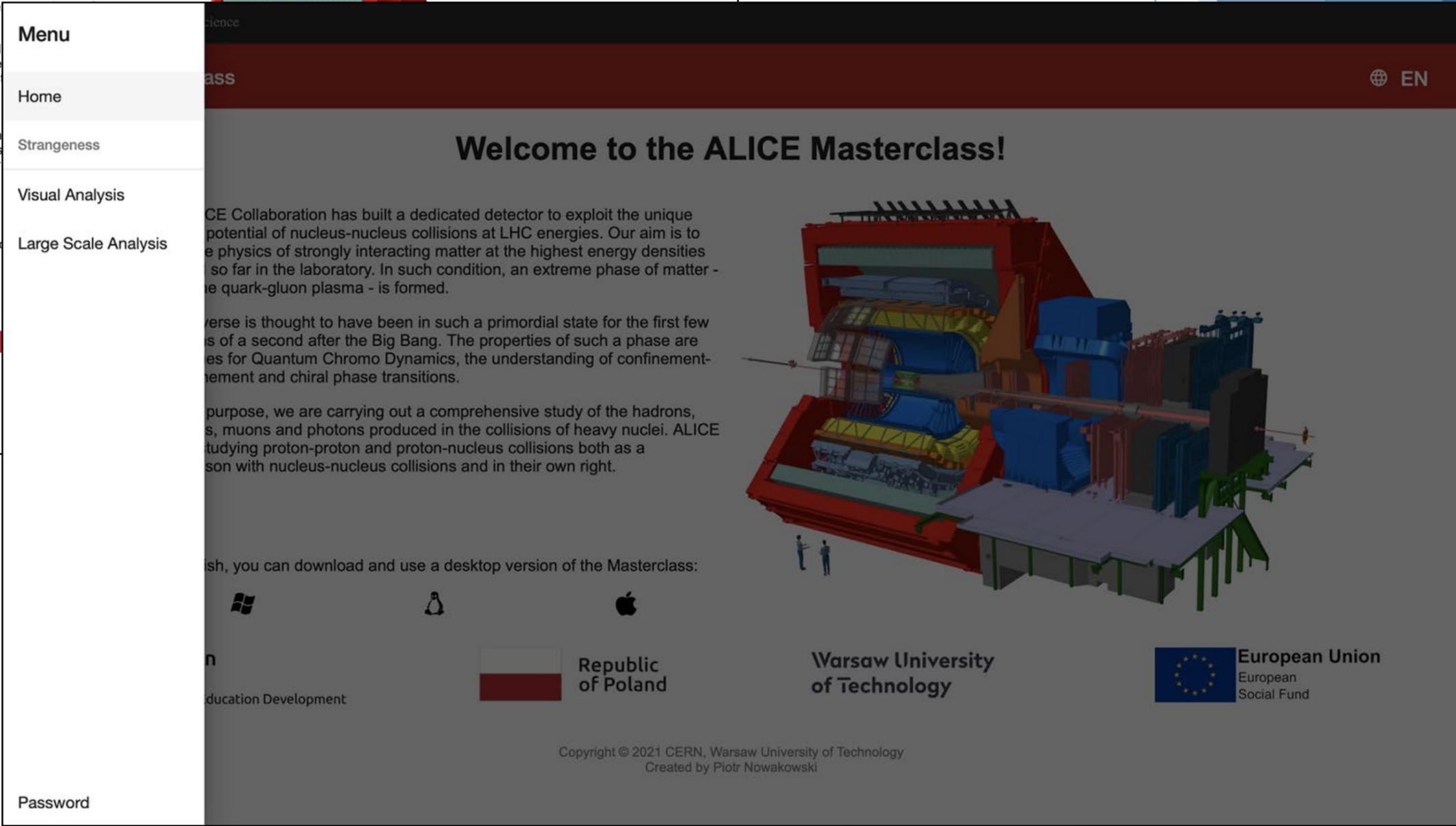
Copyright © 2021 CERN, Warsaw University of Technology
Created by Piotr Nowakowski

- Inserite il vostro “Student Number”
 - Corrisponde al numero riportato sulle vostre credenziali WiFi
- Inserite la “Session Password”: **password-per-nulla-creativa**
 - Se utilizzate il link in alto, dovrebbe essere automaticamente riportata
- Cliccate su “Proceed”

Hands-on – Introduzione



Pulsante per il menù principale



Hands-on – Introduzione

Fase 1
Costruire la
distribuzione di
massa invariante

Fase 2
Misurare il tasso di
produzione

The screenshot shows the ALICE Masterclass website. On the left, a 'Menu' sidebar contains the following items: Home, Strangeness, Visual Analysis, and Large Scale Analysis. The 'Visual Analysis' and 'Large Scale Analysis' items are highlighted with blue rounded rectangles. Blue arrows point from the text 'Fase 1' to the 'Visual Analysis' item and from 'Fase 2' to the 'Large Scale Analysis' item. The main content area features a dark red header with 'EN' in the top right. Below the header, the text reads 'Welcome to the ALICE Masterclass!' followed by a 3D cutaway illustration of the ALICE detector. The footer includes logos for the Republic of Poland, Warsaw University of Technology, and the European Union, along with copyright information: 'Copyright © 2021 CERN, Warsaw University of Technology. Created by Piotr Nowakowski'. A 'Password' field is visible at the bottom left of the page.

Hands-on – Introduzione

Fase 1
Costruire la
distribuzione di
massa invariante

Fase 2
Misurare il tasso di
produzione

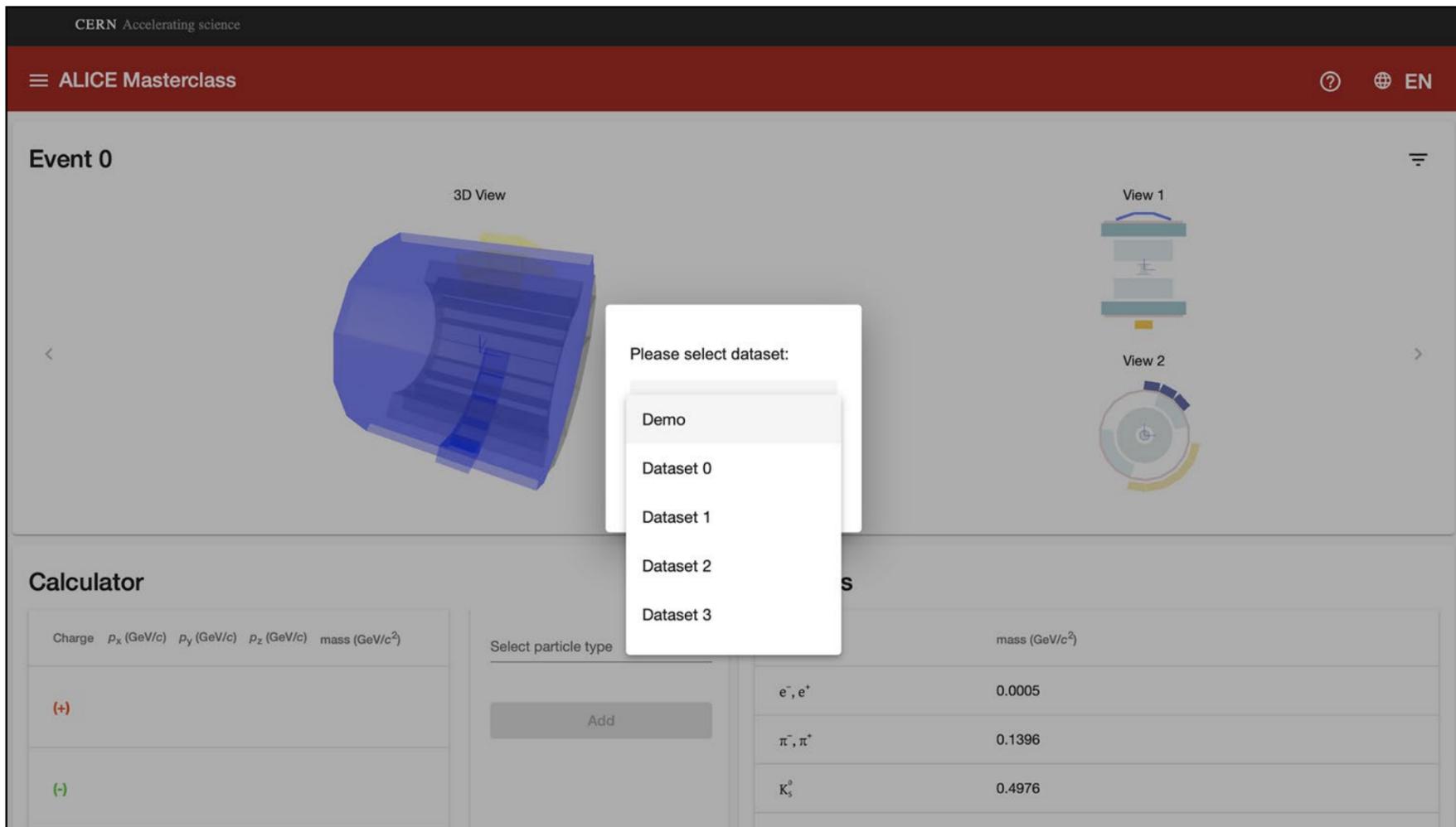
The screenshot shows the ALICE Masterclass website interface. A dark red header bar contains the text "Welcome to the ALICE Masterclass!" and a globe icon with "EN" next to it. Below the header, there is a large 3D cutaway illustration of the ALICE detector. To the left of the main content, a white menu box is overlaid with the following items: "Menu", "Home", "Strangeness", "Visual Analysis", and "Large Scale Analysis". The "Visual Analysis" item is highlighted with a blue rounded rectangle, and a blue arrow points from the "Fase 1" text to it. The "Large Scale Analysis" item is highlighted with a grey rounded rectangle, and a grey arrow points from the "Fase 2" text to it. The main content area contains several paragraphs of text describing the ALICE experiment and its goals. At the bottom of the page, there are logos for the Republic of Poland, Warsaw University of Technology, and the European Union. A copyright notice at the bottom center reads "Copyright © 2021 CERN, Warsaw University of Technology Created by Piotr Nowakowski". A "Password" field is visible in the bottom left corner.

Hands-on – Fase 1

19 dataset totali:

Il vostro corrisponde al resto della divisione del vostro “Student Number” per 19

- Student number: 14 → dataset 14
- Student number: 21 → dataset 2
- Student number: 43 → dataset 5



The screenshot shows the ALICE Masterclass interface. At the top, it says "CERN Accelerating science" and "ALICE Masterclass". The main area is titled "Event 0" and features a "3D View" of the detector. A dropdown menu is open, asking "Please select dataset:" with options: "Demo", "Dataset 0", "Dataset 1", "Dataset 2", and "Dataset 3". Below the 3D view is a "Calculator" section with a table for particle properties.

Charge	p_x (GeV/c)	p_y (GeV/c)	p_z (GeV/c)	mass (GeV/c ²)
(+)				
(-)				

Select particle type	mass (GeV/c ²)
e^-, e^+	0.0005
π^-, π^+	0.1396
K_s^0	0.4976

Selezionate il dataset assegnato sulla corrispondente schermata

Hands-on – Fase 1

CERN Accelerating science

ALICE Masterclass

Event 0

3D View

View 1

View 2

Calculator

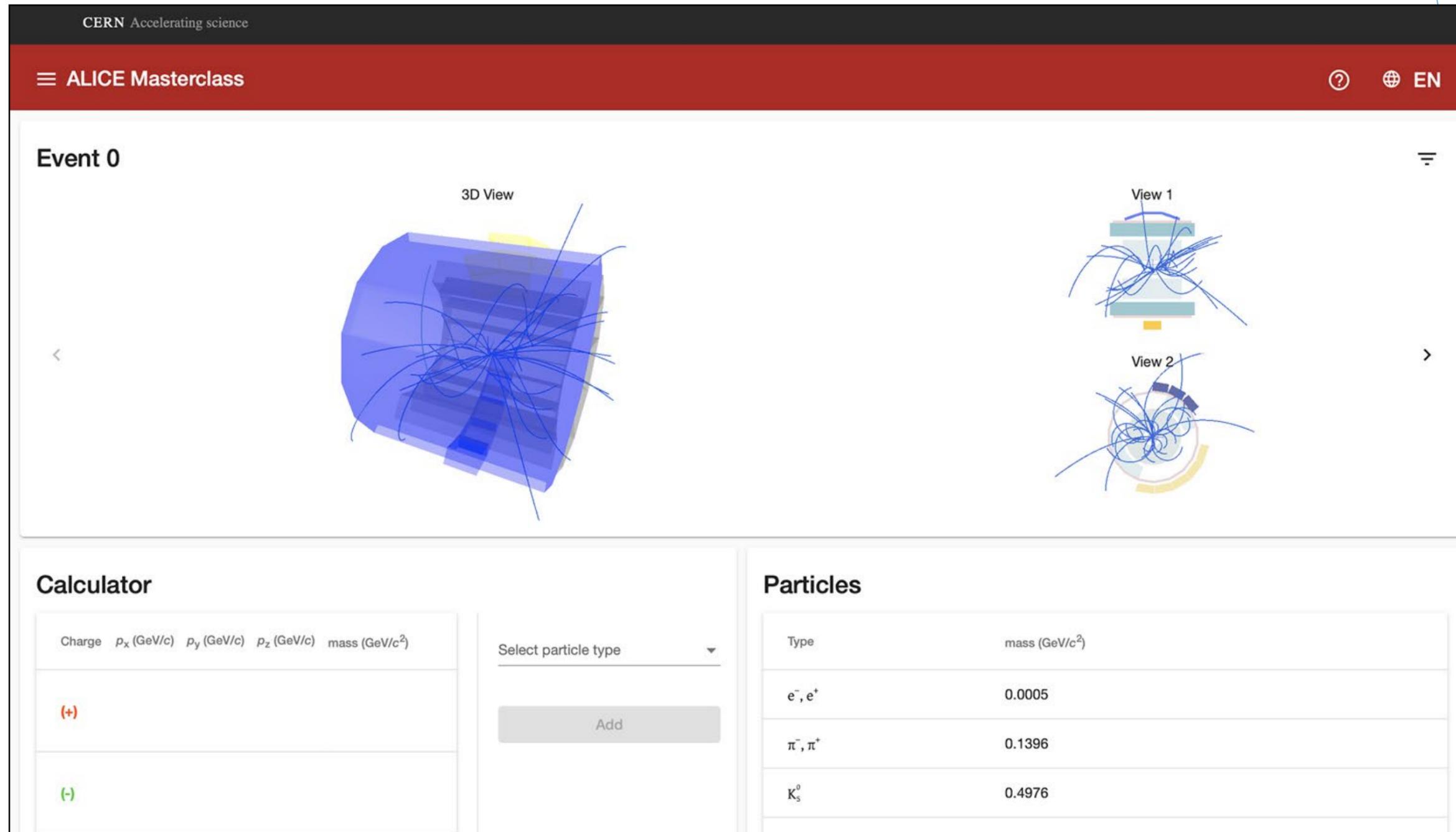
Charge	p_x (GeV/c)	p_y (GeV/c)	p_z (GeV/c)	mass (GeV/c ²)
(+)				
(-)				

Select particle type

Add

Particles

Type	mass (GeV/c ²)
e^-, e^+	0.0005
π^-, π^+	0.1396
K_S^0	0.4976



Ogni dataset contiene un piccolo numero di collisioni (o ‘eventi’) preselezionati, in cui è presente un decadimento di un adrone strano

Hands-on – Fase 1

CERN Accelerating science

ALICE Masterclass

Event 0

3D View

View 1

View 2

Calculator

Charge	p_x (GeV/c)	p_y (GeV/c)	p_z (GeV/c)	mass (GeV/c ²)
(+)				
(-)				

Select particle type

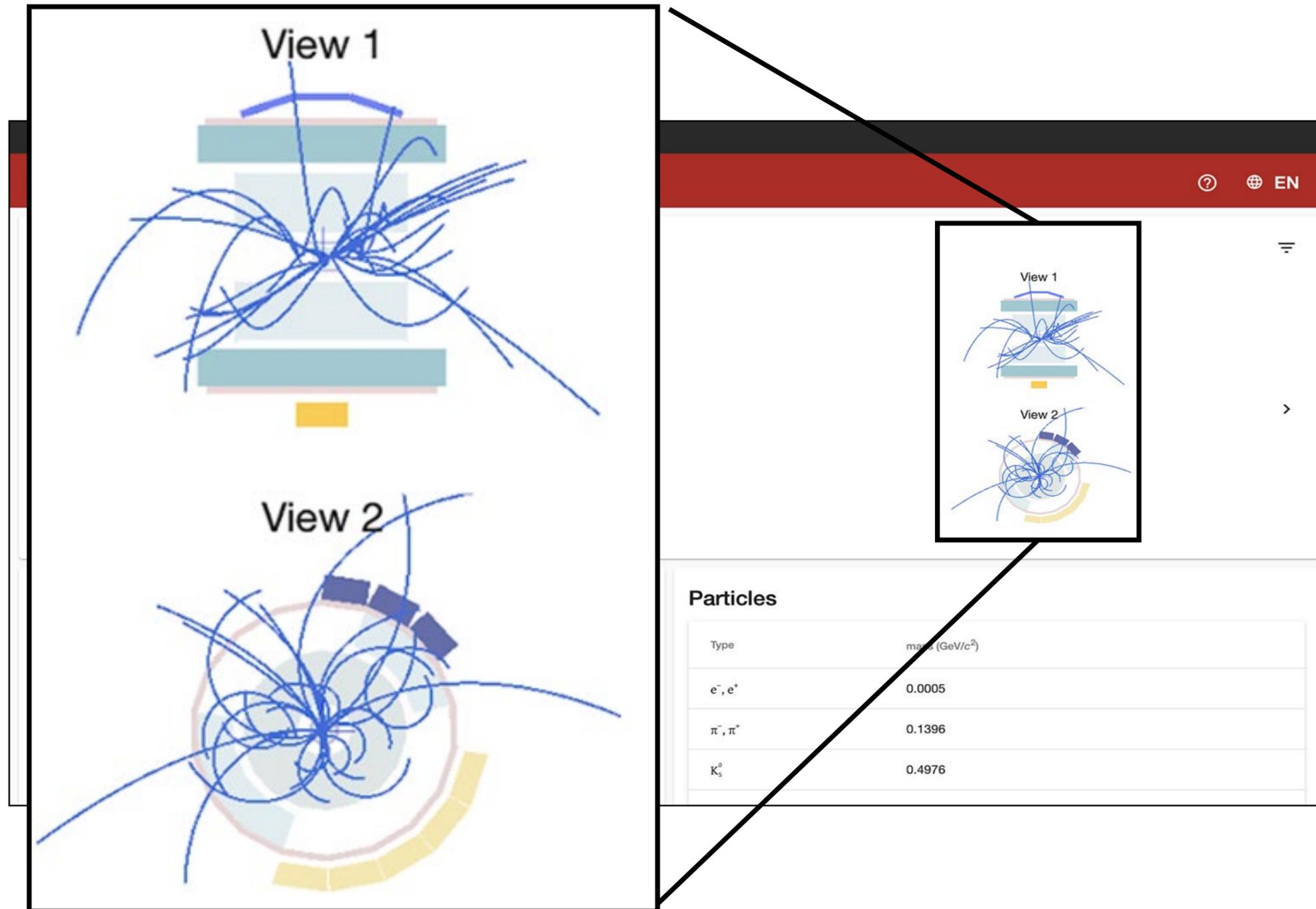
Add

Particles

Type	mass (GeV/c ²)
e^-, e^+	0.0005
π^-, π^+	0.1396
K_S^0	0.4976

Per esplorare le varie collisioni utilizzate le frecce

Hands-on – Fase 1



Ogni collisione contiene tante “tracce” di particelle ricostruite, di colore blu. In questa versione semplificata, le tracce relative a possibili “figlie” di adroni strane sono già identificate, e mostrate in colori diversi (rosso o verde).

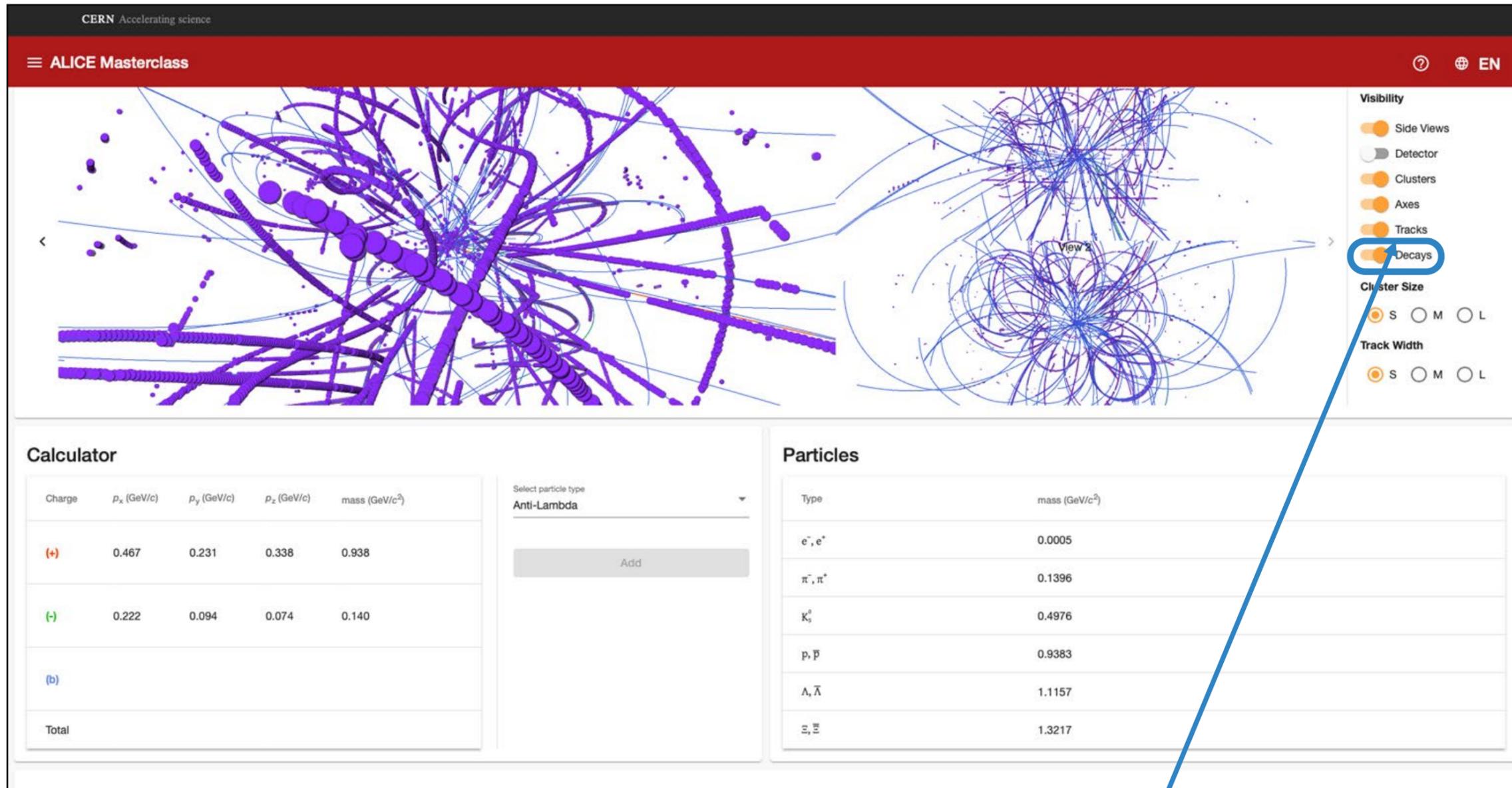
Hands-on – Fase 1

The screenshot displays the ALICE Masterclass interface. At the top, the header includes 'CERN Accelerating science' and 'ALICE Masterclass' with a menu icon. On the right, there are icons for help, a globe, and the language 'EN'. The main content area is titled 'Event 0' and features three views: a large '3D View' of a particle event, and two smaller 'View 1' and 'View 2' thumbnails. A blue box highlights a menu icon in the top right corner of the event view. Below the views, there are two panels: 'Calculator' and 'Particles'. The 'Calculator' panel has input fields for Charge, p_x (GeV/c), p_y (GeV/c), p_z (GeV/c), and mass (GeV/c²), along with a 'Select particle type' dropdown and an 'Add' button. The 'Particles' panel contains a table with particle types and their masses.

Type	mass (GeV/c ²)
e^-, e^+	0.0005
π^-, π^+	0.1396
K_s^0	0.4976

Apertura pannello opzioni

Hands-on – Fase 1



The screenshot displays the ALICE Masterclass interface. At the top, there is a red header with the text "CERN Accelerating science" and "ALICE Masterclass". Below the header, the main visualization area shows two views of particle tracks: a 3D view on the left and a 2D view on the right. A control panel on the right side of the visualization area includes a "Visibility" section with several toggle switches: "Side Views", "Detector", "Clusters", "Axes", "Tracks", and "Decays". The "Decays" option is highlighted with a blue circle and a blue arrow pointing to it. Below the visualization area, there are two panels: "Calculator" and "Particles".

Calculator

Charge	p_x (GeV/c)	p_y (GeV/c)	p_z (GeV/c)	mass (GeV/c ²)
(+)	0.467	0.231	0.338	0.938
(-)	0.222	0.094	0.074	0.140
(b)				
Total				

Select particle type
Anti-Lambda
Add

Particles

Type	mass (GeV/c ²)
e^-, e^+	0.0005
π^-, π^+	0.1396
K_S^0	0.4976
p, \bar{p}	0.9383
$\Lambda, \bar{\Lambda}$	1.1157
$\Xi, \bar{\Xi}$	1.3217

Assicuratevi che l'opzione per visualizzare le possibili figlie degli adroni strani ("Decays") sia attiva

Hands-on – Fase 1

Per rimuovere le tracce blu, (se ostruiscono la visuale), disattivate l'opzione 'Tracks'.
Resteranno visibili solo le potenziali tracce figlie: **rossa (positiva)** e **verde (negativa)**
Selezionatele cliccando su di esse nell'event display.

The screenshot shows the ALICE Masterclass event display interface. The top part displays two views of particle tracks: a 3D view on the left and a 2D view on the right. A control panel on the right allows adjusting visibility of various elements like Side Views, Detector, Clusters, Axes, Tracks, and Decays. Below the views are two panels: 'Calculator' and 'Particles'.

Calculator

Charge	p_x (GeV/c)	p_y (GeV/c)	p_z (GeV/c)	mass (GeV/c ²)
(+)	0.467	0.231	0.338	0.938
(-)	0.222	0.094	0.074	0.140
(b)				
Total				

Particles

Type	mass (GeV/c ²)
e^-, e^+	0.0005
π^-, π^+	0.1396
K_S^0	0.4976
p, \bar{p}	0.9383
$\Lambda, \bar{\Lambda}$	1.1157
$\Xi, \bar{\Xi}$	1.3217

Nel pannello "calculator" vi appariranno le relative informazioni cinematiche, assieme alla massa invariante dell'adrone strano "madre" (riga "Total")

Hands-on – Fase 1

The screenshot displays the ALICE Masterclass interface. At the top, there is a red header with the CERN logo and 'Accelerating science'. Below the header, the text 'ALICE Masterclass' is visible. The main area shows two views of particle tracks: a purple view on the left and a blue view on the right. A 'Visibility' panel on the right side allows users to toggle various elements: Side Views, Detector, Clusters, Axes, Tracks, and Decays. Below this, there are options for Cluster Size (S, M, L) and Track Width (S, M, L). At the bottom, there is a 'Calculator' and a 'Particles' panel. The 'Calculator' panel has a table with columns for Charge, p_x (GeV/c), p_y (GeV/c), p_z (GeV/c), and mass (GeV/c²). The 'Particles' panel has a table with columns for Type and mass (GeV/c²). A blue arrow points from the 'Particles' table to the text below.

Charge	p_x (GeV/c)	p_y (GeV/c)	p_z (GeV/c)	mass (GeV/c ²)
(+)	0.467	0.231	0.338	0.938
(-)	0.222	0.094	0.074	0.140
(b)				
Total				

Type	mass (GeV/c ²)
e^-, e^+	0.0005
π^-, π^+	0.1396
K^0	0.4976
p, \bar{p}	0.9383
$\Lambda, \bar{\Lambda}$	1.1157
$\Xi, \bar{\Xi}$	1.3217

Potete identificare la natura delle figlie (e della madre) confrontando il valore della massa con quello delle principali particelle note.

Hands-on – Fase 1

The screenshot displays the ALICE Masterclass interface. At the top, there is a red header with the CERN logo and 'Accelerating science' text. Below the header, the main area shows two views of particle tracks: a purple view on the left and a blue view on the right. A 'Visibility' panel on the right side contains several toggle switches for 'Side Views', 'Detector', 'Clusters', 'Axes', 'Tracks', and 'Decays'. Below the tracks, there are two panels: 'Calculator' and 'Particles'. The 'Calculator' panel has a table with columns for Charge, p_x (GeV/c), p_y (GeV/c), p_z (GeV/c), and mass (GeV/c²). The 'Particles' panel has a table with columns for Type and mass (GeV/c²). A blue box highlights the 'Add' button in the 'Particles' panel, with an arrow pointing to it.

Calculator

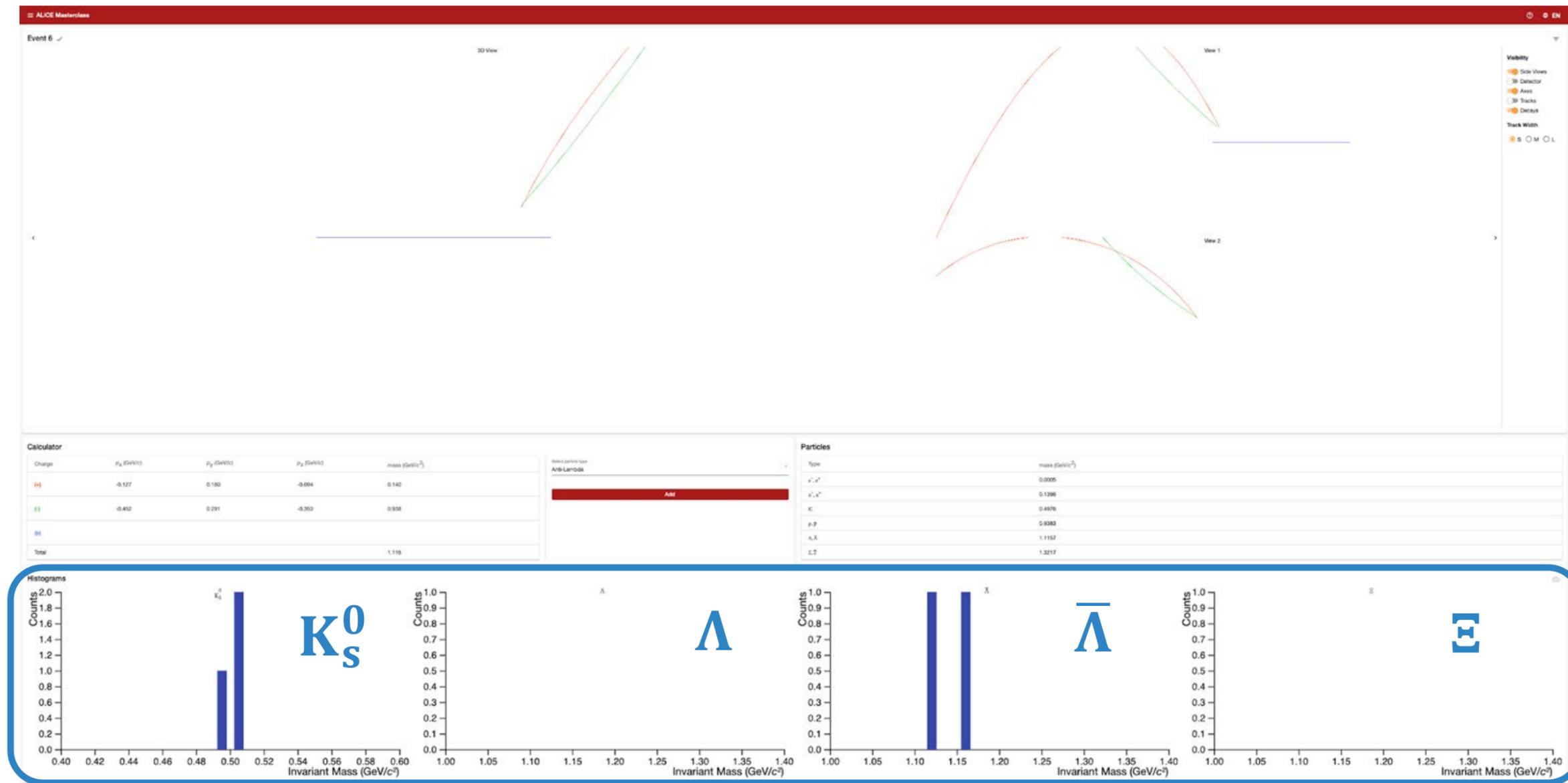
Charge	p_x (GeV/c)	p_y (GeV/c)	p_z (GeV/c)	mass (GeV/c ²)
(+)	0.467	0.231	0.338	0.938
(-)	0.222	0.094	0.074	0.140
(b)				
Total				

Particles

Type	mass (GeV/c ²)
e^-, e^+	0.0005
π^-, π^+	0.1396
K_S^0	0.4976
p, \bar{p}	0.9383
$\Lambda, \bar{\Lambda}$	1.1157
$\Xi, \bar{\Xi}$	1.3217

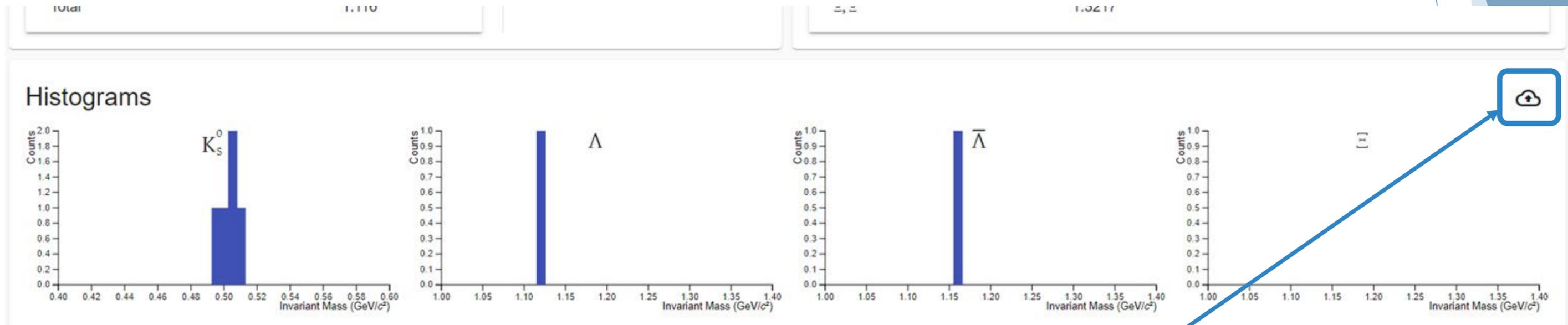
Quando avete identificato la natura della particella madre, selezionatela nell'elenco e cliccate su "Add".

Hands-on – Fase 1

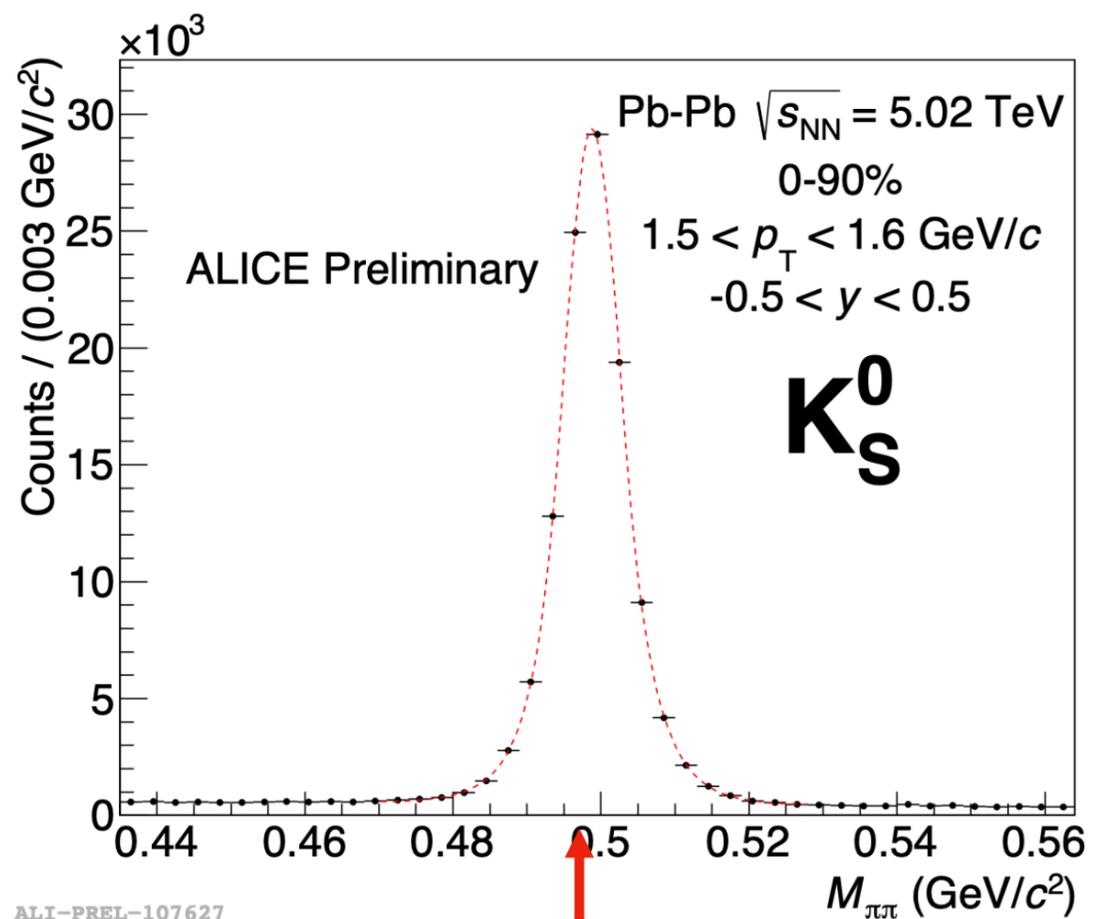


Aggiungendo candidate, queste vi compariranno nei rispettivi plot, che riportano la distribuzione di massa invariante per le potenziali particelle strane ricostruite

Hands-on – Fase 1

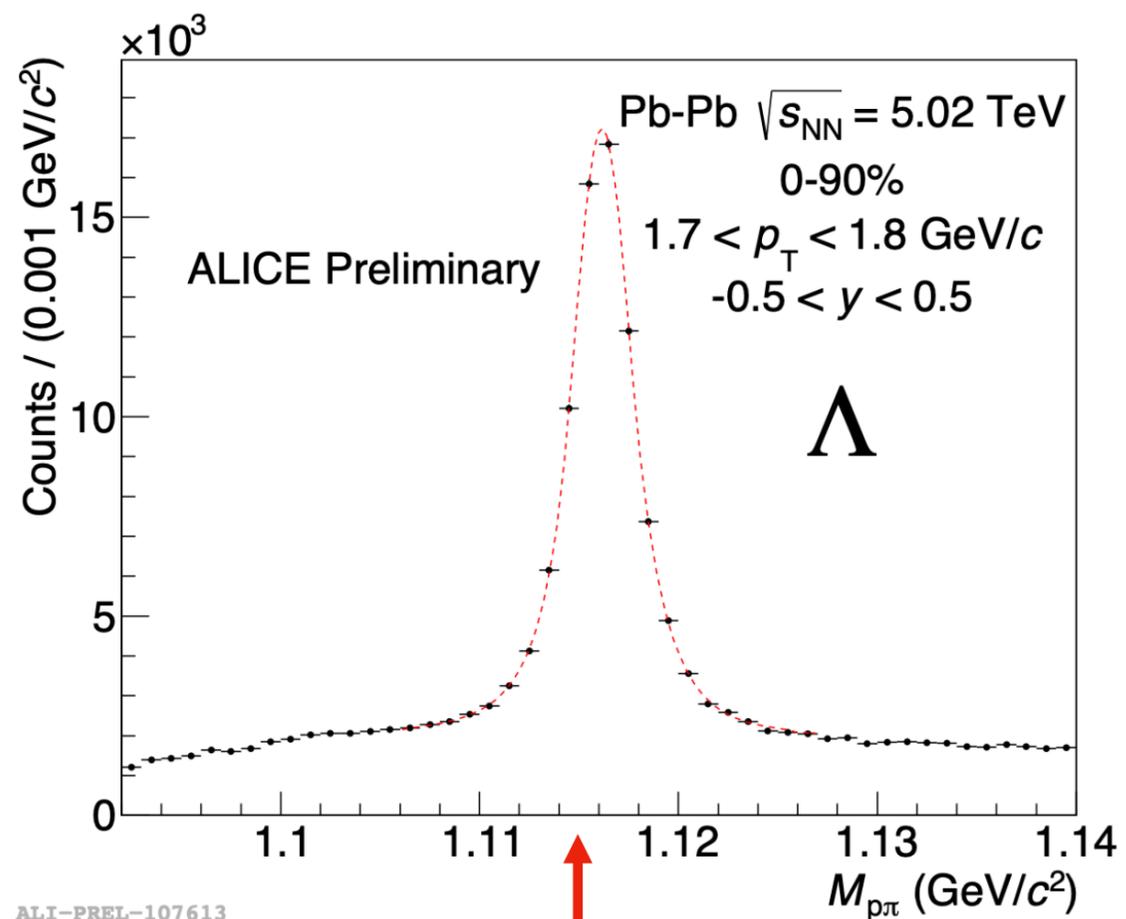


Quando avete terminato di analizzare l'intero dataset (e solo allora), cliccate sull'icona in alto a destra per condividere i risultati



ALI-PREL-107627

Massa reale: $497,614 \pm 0,024 \text{ MeV}/c^2$



ALI-PREL-107613

Massa reale: $1115,683 \pm 0,006 \text{ MeV}/c^2$

**Distribuzioni di massa invariante “ufficiali” misurate dalla
Collaborazione ALICE su un campione (enormemente più
grande) di collisioni piombo-piombo**

Hands-on – Fase 2

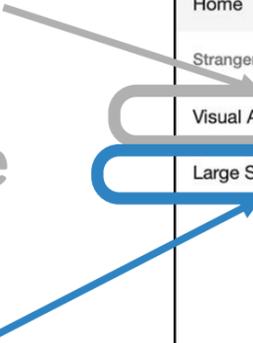
Fase 1

Costruire la distribuzione di massa invariante

Menu

- Home
- Strangeness
- Visual Analysis
- Large Scale Analysis

Password



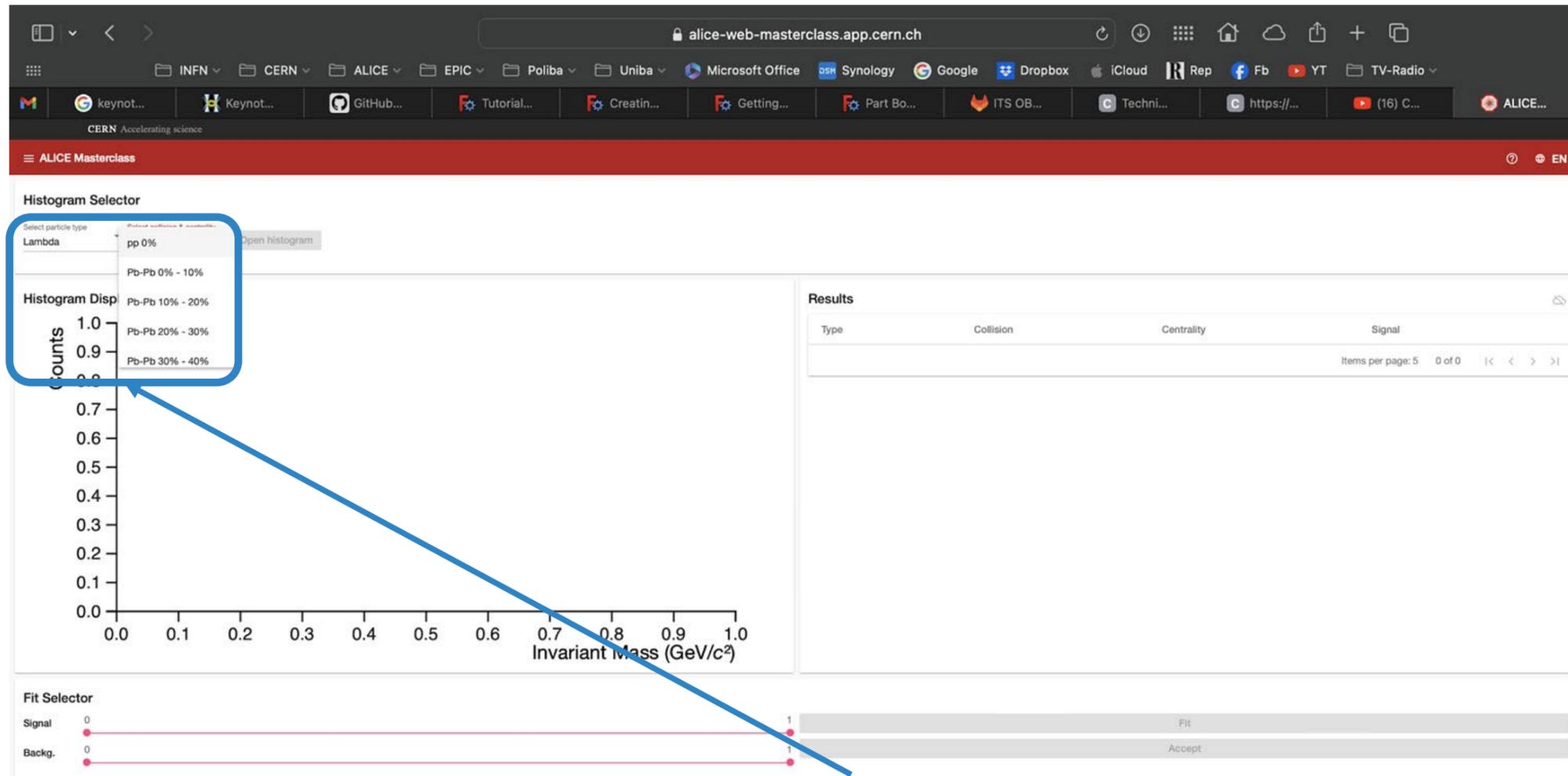
Fase 2

Misurare il tasso di produzione

The screenshot shows the ALICE Masterclass website. At the top right, there is a language selector 'EN'. The main heading is 'Welcome to the ALICE Masterclass!'. Below this, there is introductory text about the ALICE Collaboration and the detector. A 3D cutaway diagram of the ALICE detector is shown on the right. At the bottom, there are logos for the Republic of Poland, Warsaw University of Technology, and the European Union. A copyright notice at the bottom reads 'Copyright © 2021 CERN, Warsaw University of Technology Created by Piotr Nowakowski'. A 'Password' field is visible at the bottom left of the menu area.

Hands-on – Fase 2

In questa fase, a partire dalle distribuzioni di massa invariante misurate da ALICE, verrà calcolato il numero di adroni strain prodotti per collisione piombo-piombo (o protone-protone)

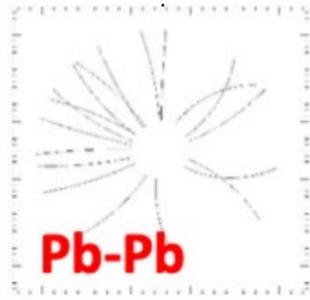
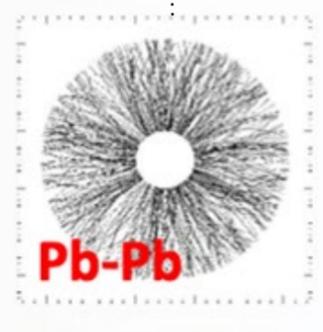
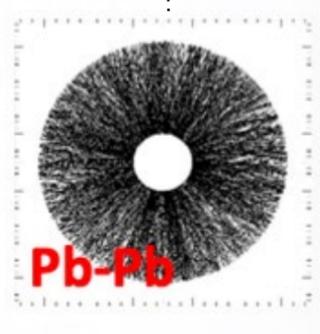
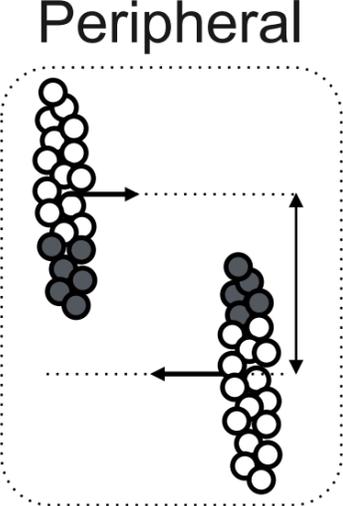
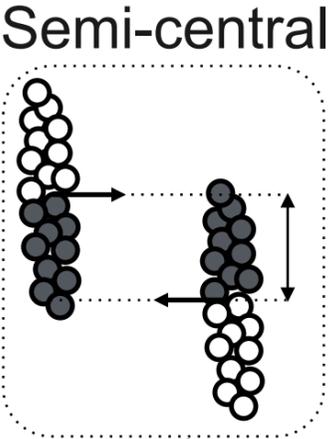
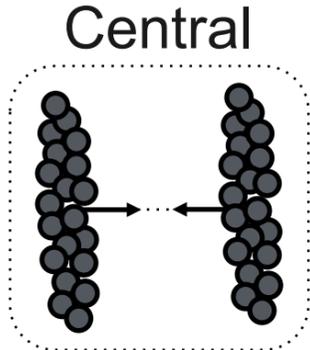


Selezionate la particella da analizzare

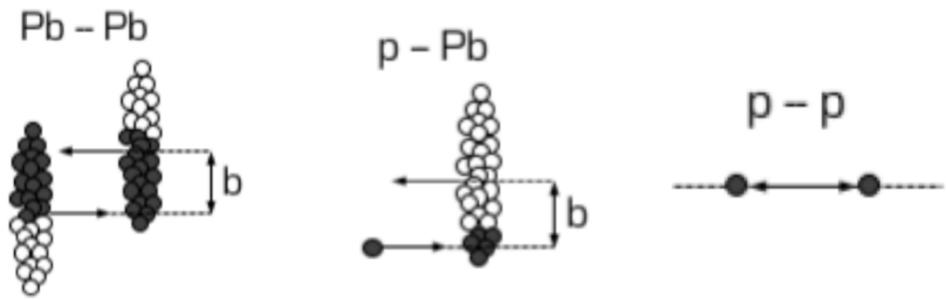
(dividete il vostro ID per 3 e prendetene il resto: 0 = K^0_s , 1 = Λ , 2 = $\bar{\Lambda}$)

Per ciascuna particella, dovete studiare tutti i range di centralità

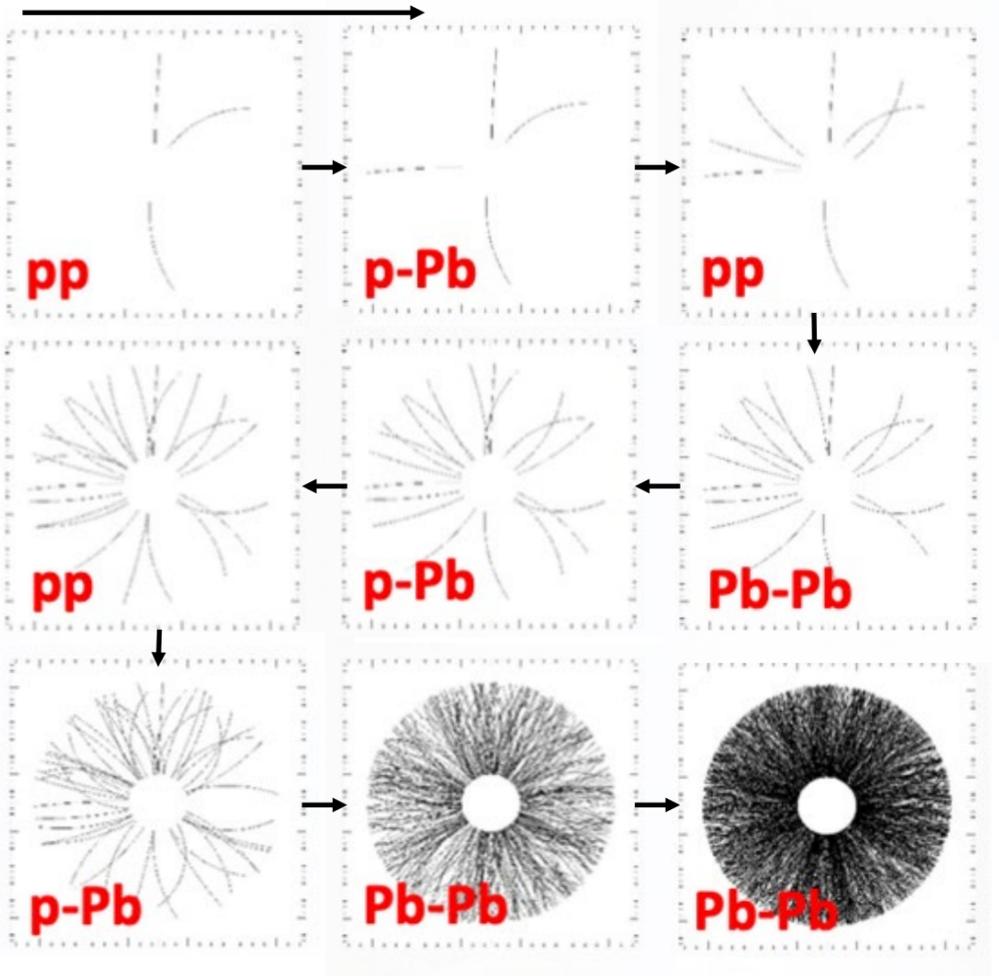
Hands-on – Fase 2



Hands-on – Fase 2



Increasing multiplicity



Hands-on – Fase 2

alice-web-masterclass.app.cern.ch

ALICE Masterclass EN

Histogram Selector

Select particle type: Lambda
Select collision & centrality: pp 0%

Open histogram

Histogram Display

Counts

Invariant Mass (GeV/c^2)

Results

Type	Collision	Centrality	Signal

Items per page: 5 0 of 0

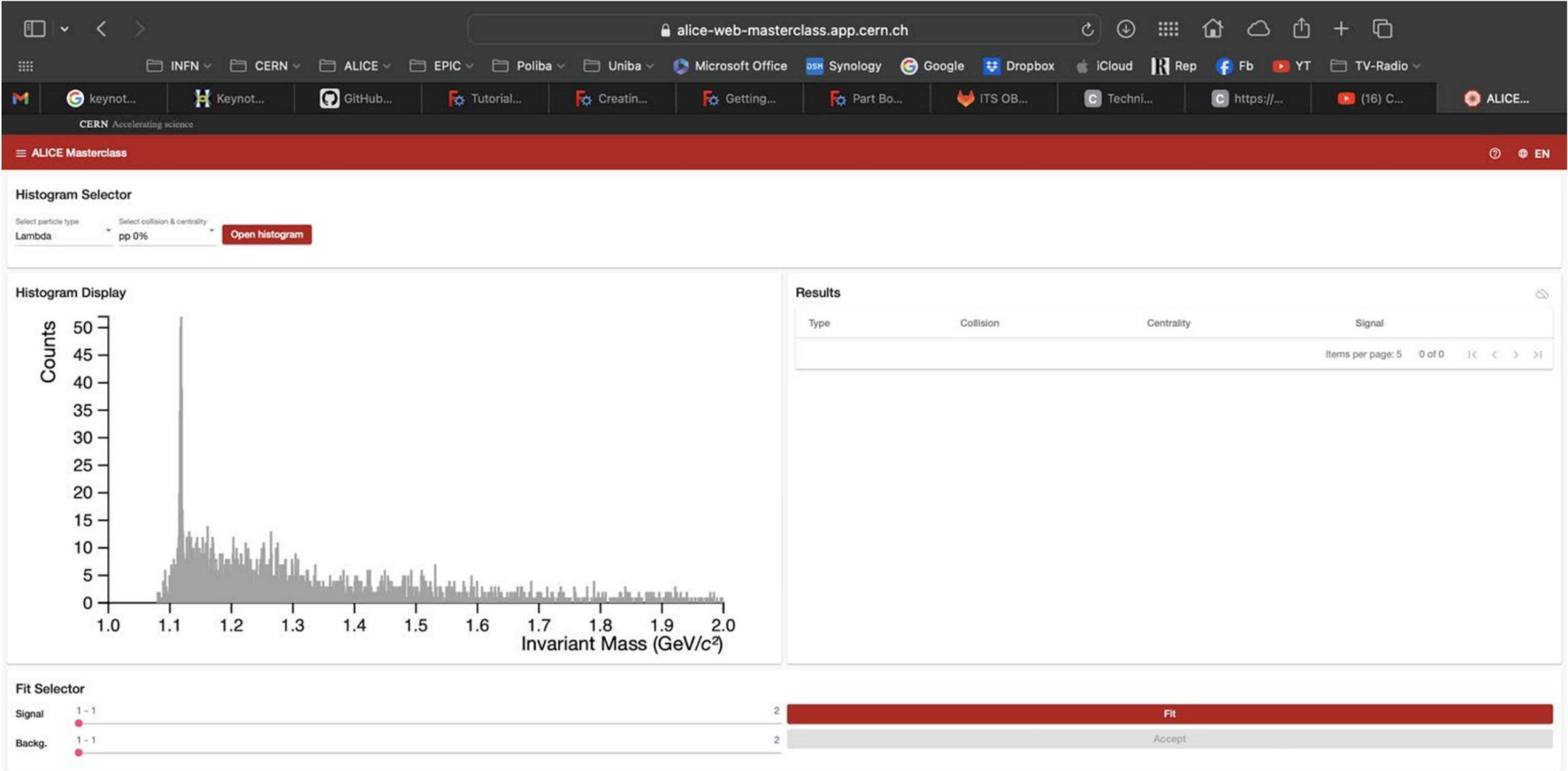
Fit Selector

Signal: 0
Backg.: 0

Fit
Accept

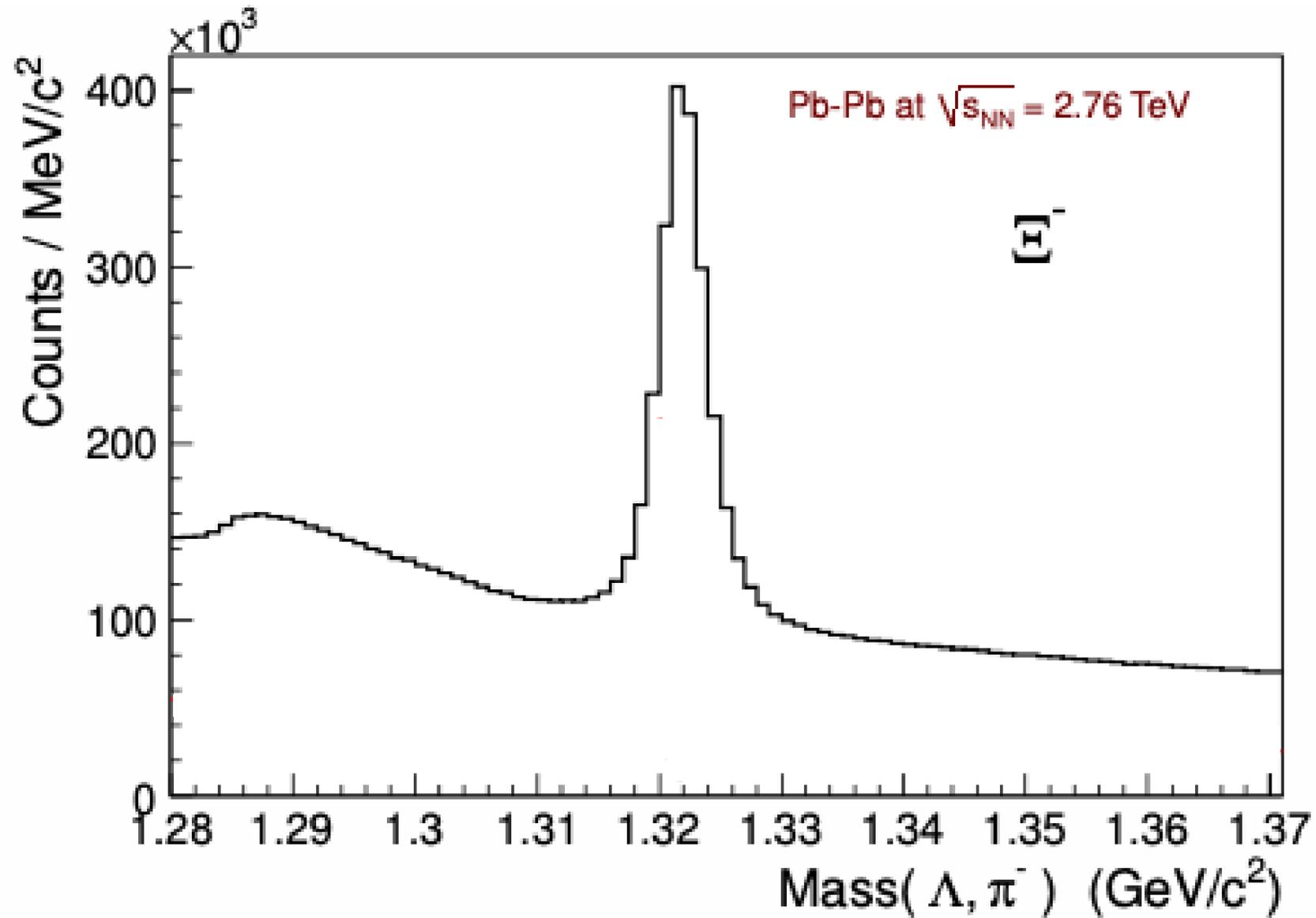
Aprite gli istogrammi corrispondenti (uno per volta)

Hands-on – Fase 2



Esempio di istogramma per la Λ , in collisioni protone-protone

Hands-on – Fase 2

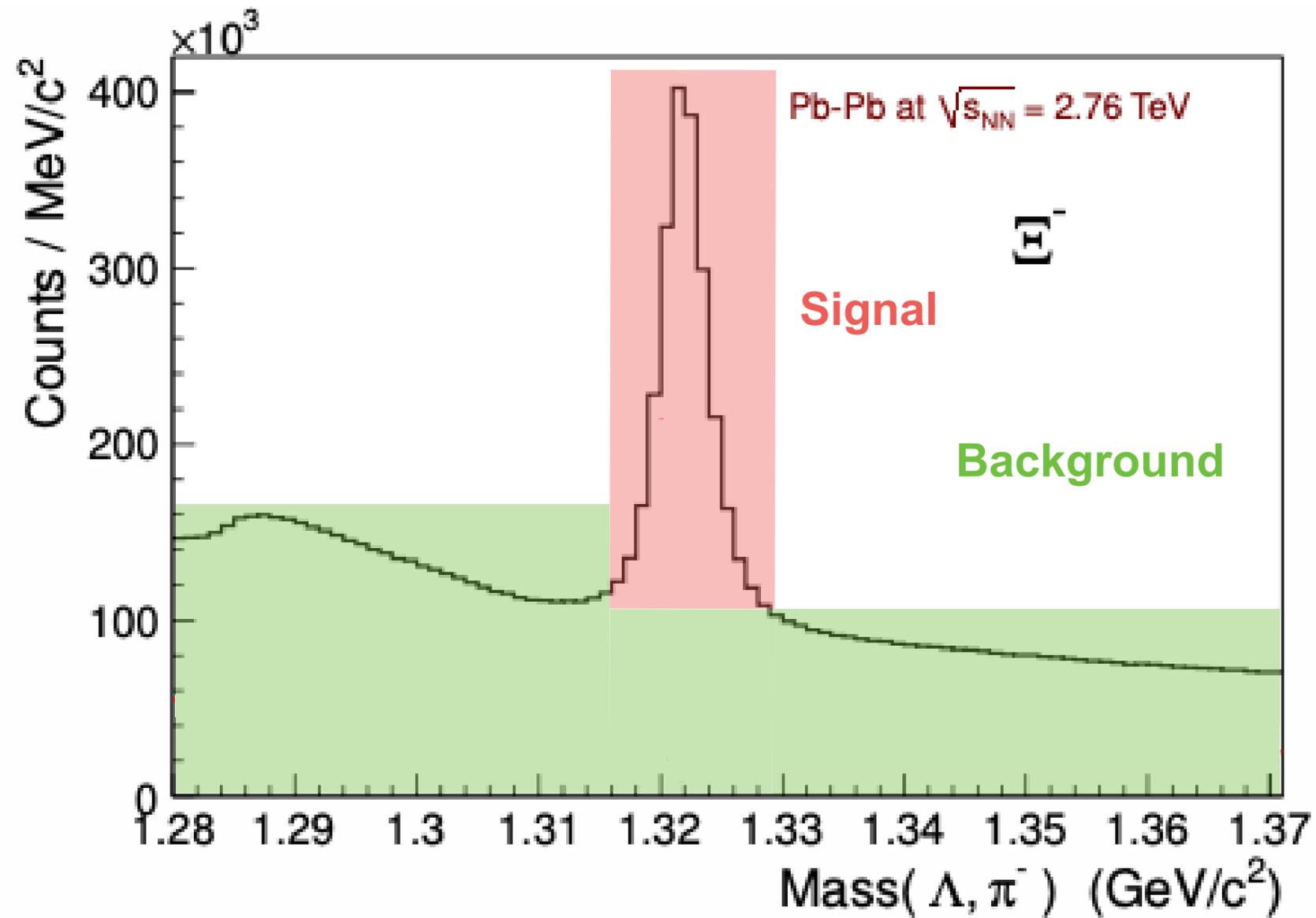


Solo alcune delle entrate dell'istogramma corrispondono a vere particelle, dal cui decadimento abbiamo ricostruito le figlie.

Queste sono contenute nel «**picco di segnale**», vicino al vero valore di massa.

Il resto delle entrate corrisponde a particelle inesistenti, di **fondo**, ottenute combinando tracce positive e negative che non sono prodotte nel decadimento

Hands-on – Fase 2



Solo alcune delle entrate dell'istogramma corrispondono a vere particelle, dal cui decadimento abbiamo ricostruito le figlie.

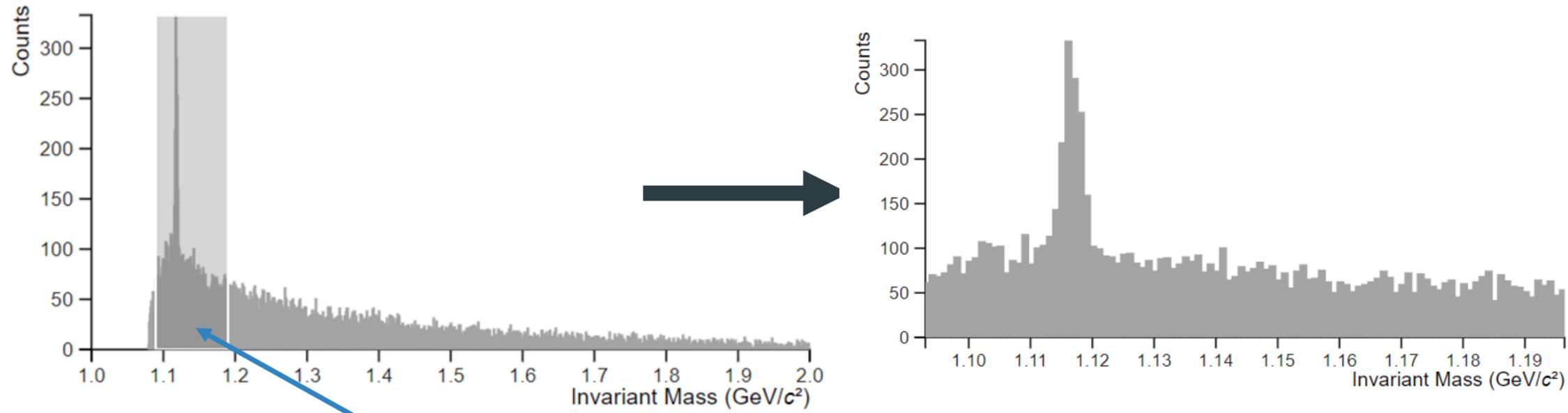
Queste sono contenute nel «**picco di segnale**», vicino al vero valore di massa. Il resto delle entrate corrisponde a particelle inesistenti, di **fondo**, ottenute combinando tracce positive e negative che non sono prodotte nel decadimento

Hands-on – Fase 2

The screenshot shows the ALICE Masterclass web interface. At the top, there is a navigation bar with the ALICE Masterclass logo and a hamburger menu. Below this is the "Histogram Selector" section, which includes dropdown menus for "Select particle type" (set to Lambda) and "Select collision & centrality" (set to pp 0%), along with an "Open histogram" button. The main content area is divided into two panels. The left panel, titled "Histogram Display", shows a histogram of "Counts" versus "Invariant Mass (GeV/c²)". The x-axis ranges from 1.0 to 2.0 GeV/c², and the y-axis ranges from 0 to 50. A prominent peak is visible at approximately 1.1 GeV/c². The right panel, titled "Results", contains a table with columns for "Type", "Collision", "Centrality", and "Signal". Below the table, there is a pagination control showing "Items per page: 5" and "0 of 0". At the bottom of the interface, there is a "Fit Selector" section. It features two horizontal sliders: "Signal" and "Backg.". The "Signal" slider has markers at 1.03 and 1.97, with a "Fit" button to its right. The "Backg." slider has markers at 1.02 and 1.91, with an "Accept" button below it. A blue box highlights the "Fit Selector" section, and a blue arrow points from the text below to the "Fit" button.

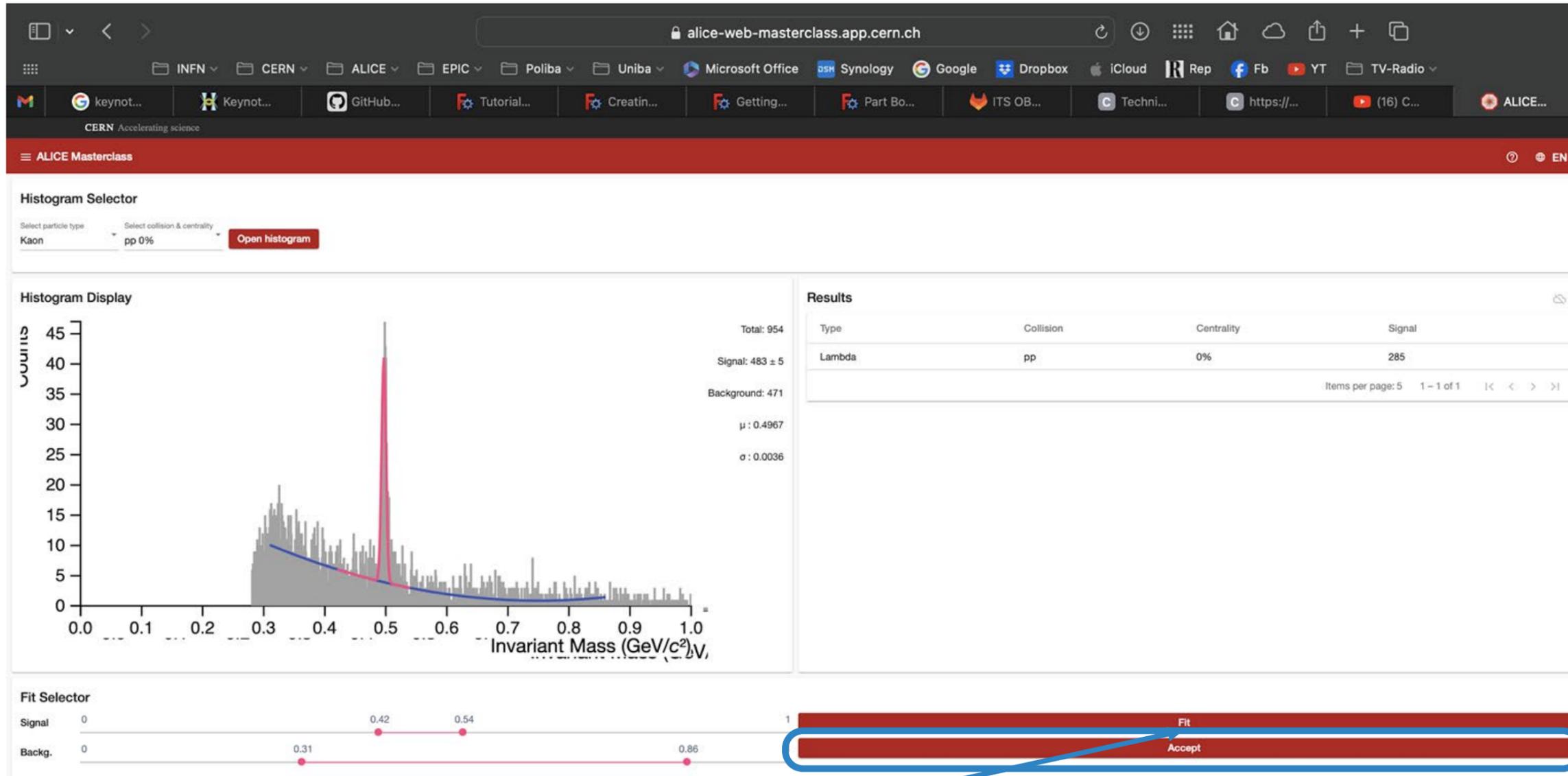
Modificate gli intervalli di massa invariante nei quali vi aspettate di trovare le vere candidate (il picco di segnale) e quelle non vere (il fondo combinatorio) e procedete cliccando su "Fit".

Hands-on – Fase 2



Potete anche cliccare e trascinare il cursore su una regione dell'asse x per effettuare uno zoom della distribuzione in tale regione

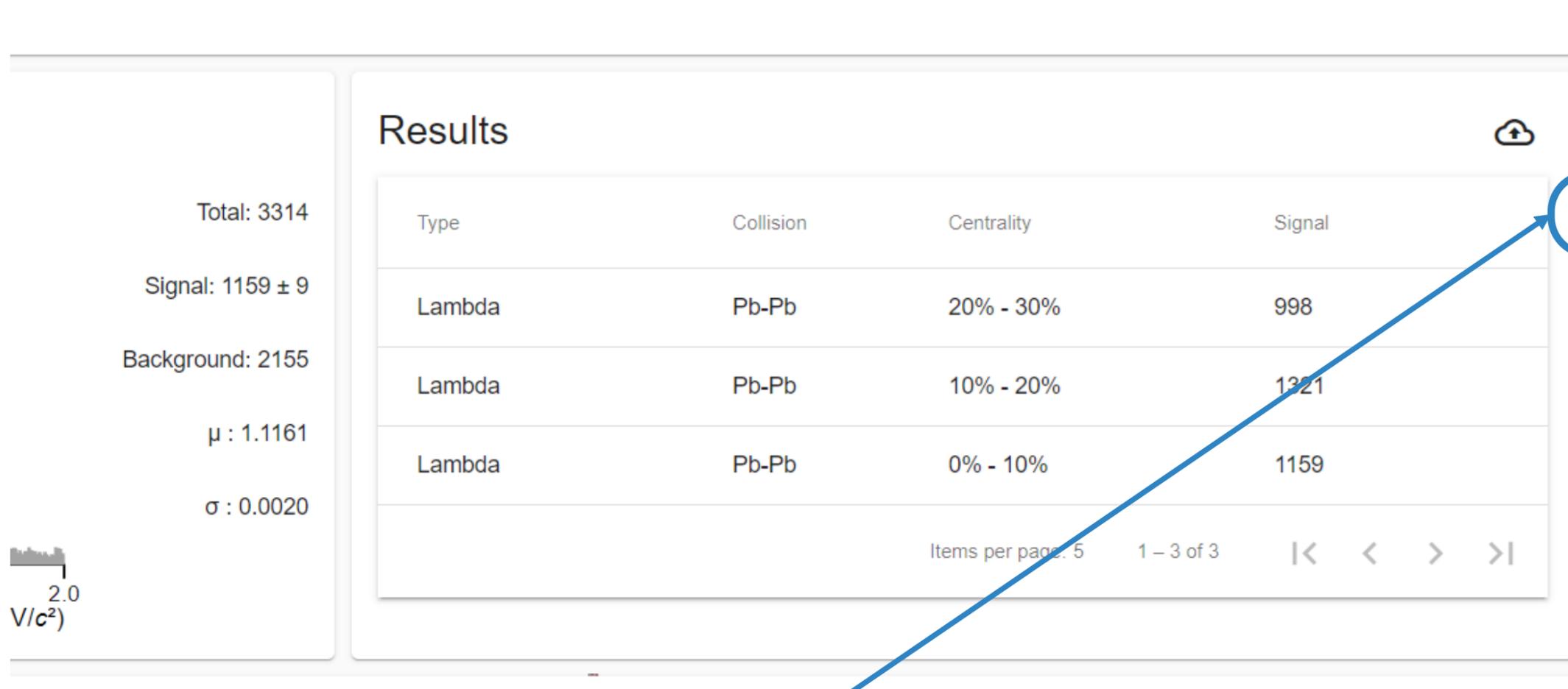
Hands-on – Fase 2



Se siete contenti del fit (sia il picco, sia il resto della distribuzione, sono ben riprodotti) “accettate” il valore trovato.

In “Results”, otterrete il conteggio delle particelle di segnale ricostruite sul campione di dati analizzato. Poi ripeterete l’operazione per le altre centralità.

Hands-on – Fase 2



Quando avete completato tutti i fit, cliccate sull'icona evidenziata per condividere i risultati

In fase di discussione dei risultati condivisi, parleremo di come dare una interpretazione di fisica alle misure da voi effettuate

Hands-on – Fase 2

