

Η σημερινή αναζήτηση

$$W^+ \rightarrow e^+ \nu_e$$

$$W^- \rightarrow e^- \bar{\nu}_e$$

$$W^+ \rightarrow \mu^+ \nu_\mu$$

$$W^- \rightarrow \mu^- \bar{\nu}_\mu$$

$$Z^0 \rightarrow e^+ e^-$$

$$Z^0 \rightarrow \mu^+ \mu^-$$

$$H^0 \rightarrow Z^0 Z^0$$

$$H^0 \rightarrow \gamma\gamma$$

Η άσκηση σήμερα

1. Θα δούμε πως σχεδιάζεται ένας ανιχνευτής σωματιδίων!
2. Θα αναλύσουμε μερικές συγκρούσεις πρωτονίων-πρωτονίων με το CMS
 - Θα ταυτοποιήσουμε κάποια σωματίδια και θα δούμε τι γίνεται
 - Αναλύοντας πολλά γεγονότα μπορούμε να αποκτήσουμε μια ιδέα για την θεμελιώδη φυσική που υπάρχει !

Η σημερινή εξάσκηση

- Θα χωριστείτε σε ομάδες 2 ατόμων
 - Κάθε ομάδα θα εξετάσει 100 γεγονότα
 - Κάντε login στο desktop:
 - **username:** msclX (όπου X αριθμός 01 – 30)
 - **password:** zve0422
 - Ανοίξτε το Firefox και πηγαίνετε στην οικοσελίδα

Τα εργαλεία που θα χρησιμοποιήσουμε

iSPY-webgl: πρόγραμμα απεικόνισης γεγονότων

<https://www.i2u2.org/elab/cms/ispay-webgl/>

CIMA: φύλλο εργασίας excel ειδικά για το CMS

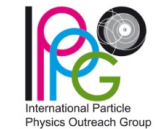
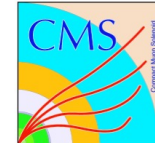
<https://www.i2u2.org/elab/cms/cima-wzh/>

Επιλογή του φύλλου εργασίας της ομάδας σας

<https://www.i2u2.org/elab/cms/cima-wzh/>

CIMA

CMS Instrument for Masterclass Analysis



Choose your Masterclass

- TestEvents-01Jan2022
- Santander-13May2024
- CERN-27Nov2023
- Salo-07Dec2023
- Sofia-13Dec2023
- CERN-LAMAP-08Dec2023
- MP-15Jan2024
- Cakovec-24Jan2024
- Bristol-27Mar2024
- CERN-09Feb2024
- Sandbox-31Dec2023
- CERN-20Feb2024
- CERN-26Feb2024
- CERN-29Feb2024
- CERN-22Feb2024
- CERN-01Mar2024
- CERN-04Mar2024
- CERN-06Mar2024
- CERN-08Mar2024
- CERN-11Mar2024
- CERN-13Mar2024
- CERN-19Mar2024
- CERN-22Mar2024
- CERN-27Mar2024
- FNAL-01Mar2024
- FNAL-08Mar2024
- FNAL-09Mar2024
- FNAL-13Mar2024
- FNAL-14Mar2024
- FNAL-15Mar2024
- FNAL-16Mar2024
- FNAL-22Mar2024
- FNAL-23Mar2024
- FNAL-26Mar2024
- FNAL-27Mar2024
- CERN-02Mar2024
- Belgrade-FF

Choose your location

- Palaiseau2024-B
- Rijeka2024
- Varna2024
- SaoPauloSPRACE2024-B
- Nicosia2024-A

Choose your data file

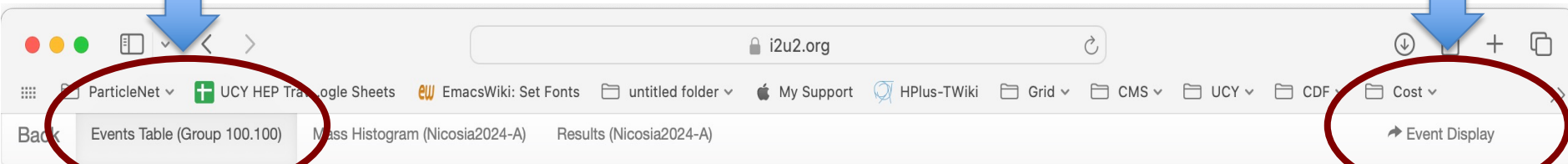
- 10.1
- 10.2
- 10.3
- 10.4
- 10.5
- 10.6
- 10.7
- 10.8
- 10.9
- 100.100
- 100.66
- 100.67
- 100.68
- 100.69
- 100.70
- 100.71
- 100.72
- 100.73
- 100.74
- 100.75
- 100.76
- 100.77
- 100.78
- 100.79
- 100.80
- 100.81
- 100.82
- 100.83
- 100.84
- 100.85
- 100.86
- 100.87
- 100.88
- 100.89
- 100.90
- 100.91
- 100.92



Φύλλο εργασίας ανάλυσης δεδομένων

Επιβεβαιώστε το δείγμα των
δεδομένων της ομάδας σας

Πιέστε για να πάτε στο
λογισμικό της απεικόνισης



Masterclass: CERN-19Mar2024

Location: Nicosia2024-A

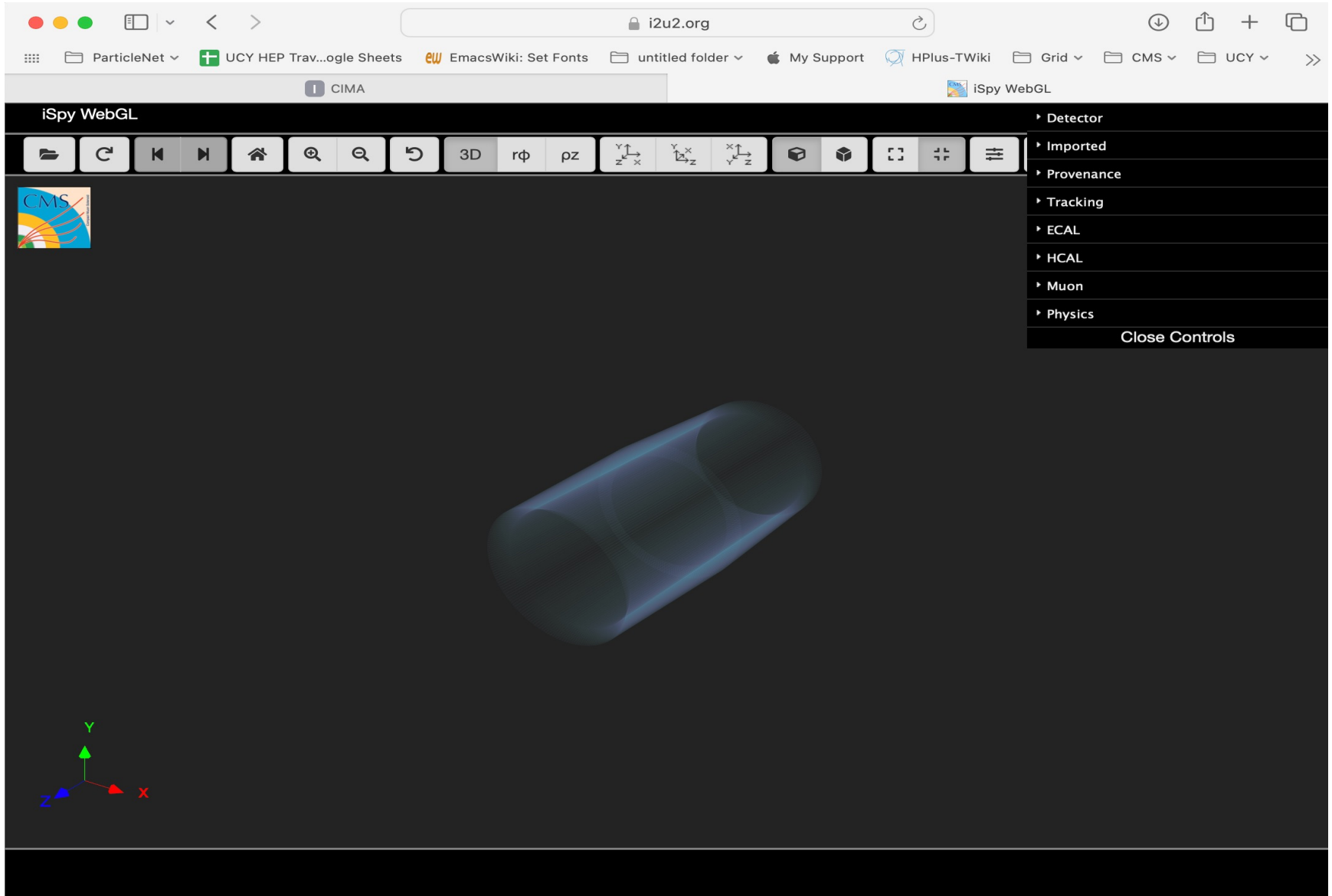
Group: 100.100

| | | | |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Select Event Event index: <input type="text" value="1"/> Event number: 100.100-1 | Final State <input type="radio"/> e v <input type="radio"/> μ ν <input type="radio"/> e e <input type="radio"/> μ μ <input type="radio"/> 4e <input type="radio"/> 4μ <input type="radio"/> 2e 2μ | Primary State Charged Particle: <input type="radio"/> W+ <input type="radio"/> W- <input type="radio"/> W± <input type="radio"/> Neutral Particle (Z, H) <input type="radio"/> Zoo | Enter Mass <input type="text"/> GeV/c ² <input type="button" value="Next"/> |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|

| Event index | Event number | Final state | Primary state | Mass |
|-------------|--------------|-------------|---------------|------|
|-------------|--------------|-------------|---------------|------|

Το λογισμικό της απεικόνισης γεγονότων: iSpy

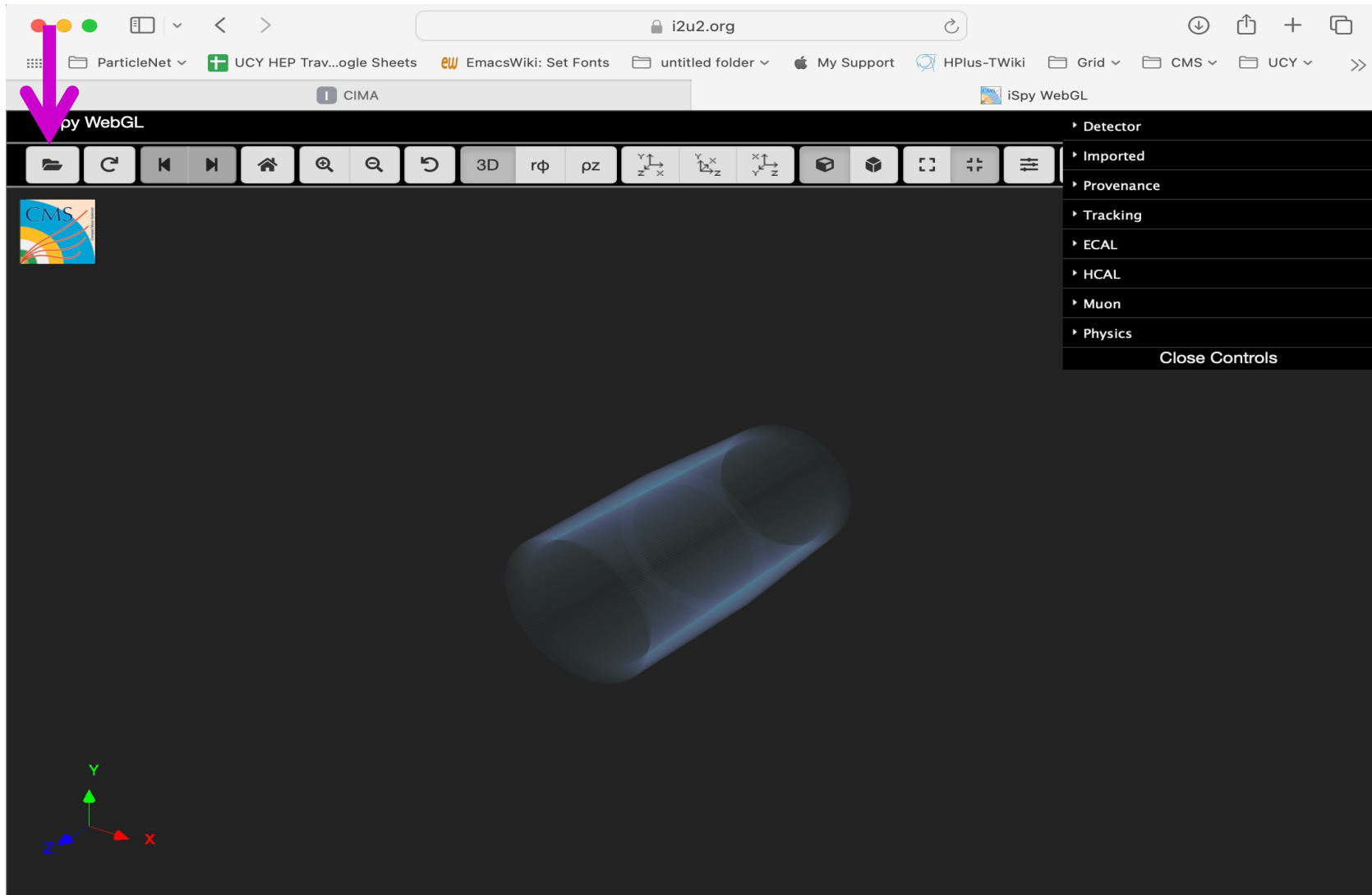
<https://www.i2u2.org/elab/cms/ispay-webgl/>



Το λογισμικό της απεικόνισης γεγονότων: iSpy

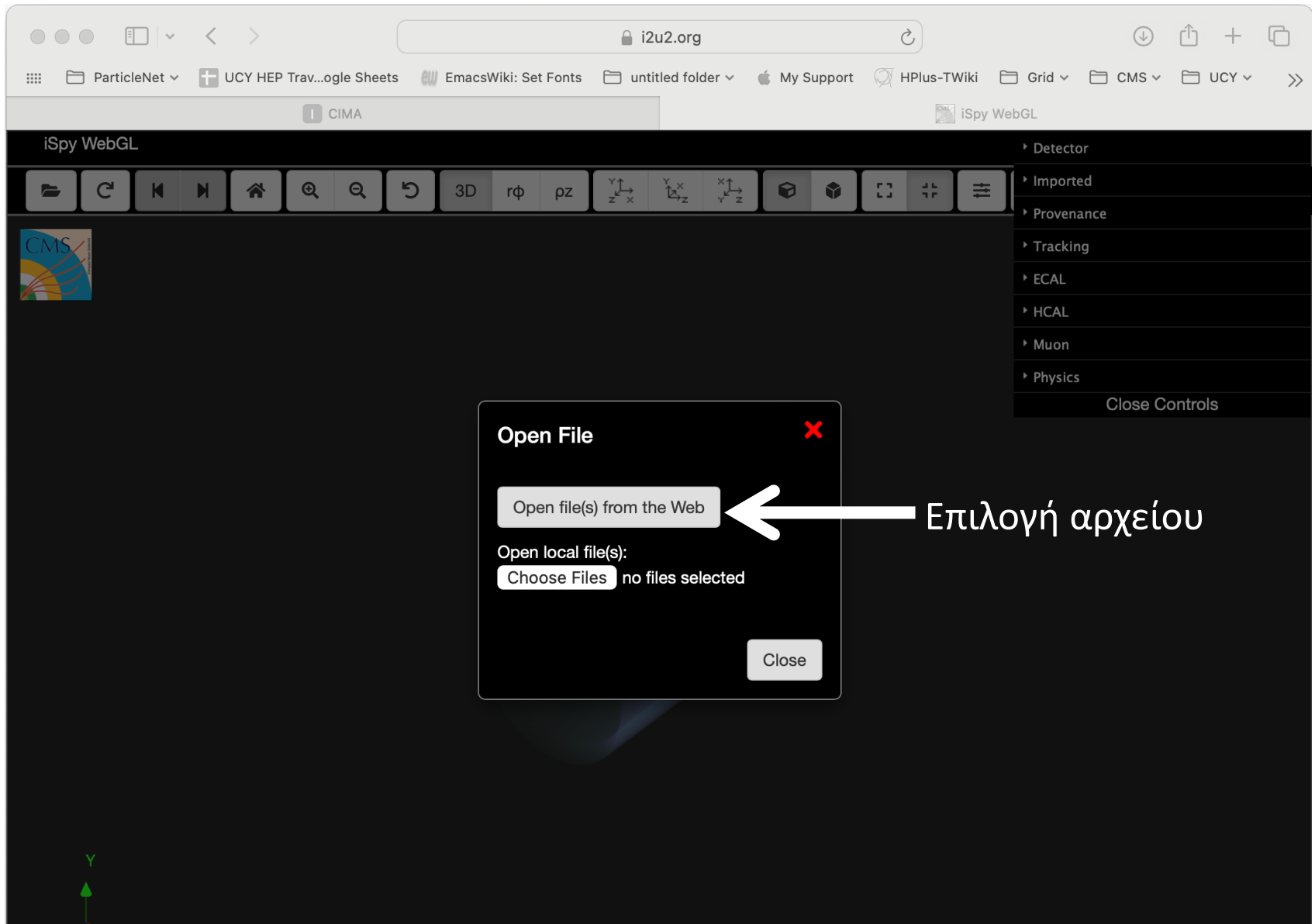
<https://www.i2u2.org/elab/cms/ispay-webgl/>

Επιλογή δεδομένων



Το λογισμικό της απεικόνισης γεγονότων: iSpy

<https://www.i2u2.org/elab/cms/ispay-webgl/>



The screenshot displays the iSpy WebGL interface within a web browser. The browser's address bar shows the URL <https://www.i2u2.org/elab/cms/ispay-webgl/>. The interface includes a top navigation bar with various icons and a sidebar on the right with a tree view of components like Detector, Imported, Provenance, Tracking, ECAL, HCAL, Muon, and Physics. A central 3D visualization area is partially visible. An 'Open File' dialog box is open in the foreground, featuring a red close button in the top right corner. The dialog has two main sections: 'Open file(s) from the Web' and 'Open local file(s):'. The 'Open file(s) from the Web' option is highlighted with a white arrow pointing to it from the right. Below this, the 'Open local file(s):' section shows a 'Choose Files' button and the text 'no files selected'. A 'Close' button is located at the bottom right of the dialog. To the right of the dialog, the Greek text 'Επιλογή αρχείου' (File selection) is written in white, with a white arrow pointing to the highlighted 'Open file(s) from the Web' option.

Το λογισμικό της απεικόνισης γεγονότων: iSpy

<https://www.i2u2.org/elab/cms/ispy-webgl/>

Open Event

| Files | Events |
|-------|--------|
| N5/ | |
| N10/ | |
| N25/ | |
| N50/ | |
| N100/ | |

Selected event

Close Load

Επιλέξτε με το ποντίκι το βασικό data group που σας αντιστοιχεί (N100, N50, N25, N10, N5)

Το λογισμικό της απεικόνισης γεγονότων: iSpy

<https://www.i2u2.org/elab/cms/ispy-webgl/>

The screenshot shows the iSpy WebGL interface. At the top, there is a browser address bar with the URL <https://www.i2u2.org/elab/cms/ispy-webgl/>. Below the browser, the iSpy WebGL application is running. The interface includes a top navigation bar with the text "iSpy WebGL" and a toolbar with various controls like "3D", "rφ", "pz", and coordinate axes. On the right side, there is a menu with options: "Detector", "Imported", "Provenance", "Tracking", "ECAL", "HCAL", "Muon", and "Physics". A "Close Controls" button is also visible.

In the center, an "Open Event" dialog box is open. It contains a list of event files:

- masterclass_94.ig
- masterclass_95.ig
- masterclass_96.ig
- masterclass_97.ig
- masterclass_98.ig
- masterclass_99.ig
- masterclass_100.ig

A blue arrow points to the file "masterclass_99.ig". A text overlay in the dialog says: "Click στο όνομα του αρχείου για να επιλέξετε το group σας (π.χ. 100.100)". Below the list, there is a "Selected event" input field and two buttons: "Close" and "Load".

At the bottom left, there is a 3D coordinate system with X, Y, and Z axes.

Το λογισμικό της απεικόνισης γεγονότων: iSpy

<https://www.i2u2.org/elab/cms/ispy-webgl/>

The screenshot shows the iSpy WebGL interface. At the top, there are tabs for 'CIMA' and 'iSpy WebGL'. Below the tabs is a toolbar with various icons for navigation and viewing. On the right side, there is a sidebar menu with categories like 'Detector', 'Imported', 'Provenance', 'Tracking', 'ECAL', 'HCAL', 'Muon', and 'Physics'. The main area displays a 3D visualization of a detector component, with a 'CMS' logo in the top left corner.

An 'Open Event' dialog box is open in the center. It contains a table with two columns: 'Files' and 'Events'. The 'Files' column lists several masterclass files (masterclass_1.ig to masterclass_6.ig). The 'Events' column lists a series of events (Events/Run_100/Event_1 to Event_7). Below the table is a 'Selected event' field and two buttons: 'Close' and 'Load'. An annotation in Greek, 'Κάντε click στο event', points to the first event in the 'Events' column. Another annotation, 'Πιέστε load', points to the 'Load' button.

| Files | Events |
|------------------|------------------------|
| ../ | Events/Run_100/Event_1 |
| masterclass_1.ig | Events/Run_100/Event_2 |
| masterclass_2.ig | Events/Run_100/Event_3 |
| masterclass_3.ig | Events/Run_100/Event_4 |
| masterclass_4.ig | Events/Run_100/Event_5 |
| masterclass_5.ig | Events/Run_100/Event_6 |
| masterclass_6.ig | Events/Run_100/Event_7 |

Κάντε click στο event

Πιέστε load

Το λογισμικό της απεικόνισης γεγονότων: iSpy

The screenshot displays the iSpy WebGL interface within a web browser. The browser's address bar shows the URL `localhost:8080`. The browser's tab bar includes several open tabs: ParticleNet, UCY HEP Trav...ogle Sheets, EmacsWiki: Set Fonts, untitled folder, My Support, HPlus-TWiki, Grid, CMS, and UCY. The iSpy WebGL interface features a top navigation bar with a 'CIMA' tab and a 'iSpy WebGL' title. Below this is a toolbar with icons for file operations, navigation, and 3D controls. The main display area shows a 3D visualization of a particle collision event, with a central point of interaction and various colored tracks (yellow, green, blue, red) extending outwards. A pink arrow points upwards from the center. The visualization is overlaid on a semi-transparent blue cylindrical detector structure. In the bottom left corner, there is a small 3D coordinate system with X, Y, and Z axes. On the right side, a vertical sidebar contains a list of detector components: Detector, Imported, Provenance, Tracking, ECAL, HCAL, Muon, and Physics, each with a dropdown arrow. A 'Close Controls' button is located at the bottom of this sidebar. At the bottom of the interface, a text prompt reads: 'Click on a name under "Provenance", "Tracking", "ECAL", "HCAL", "Muon", and "Physics" to view contents in table'.

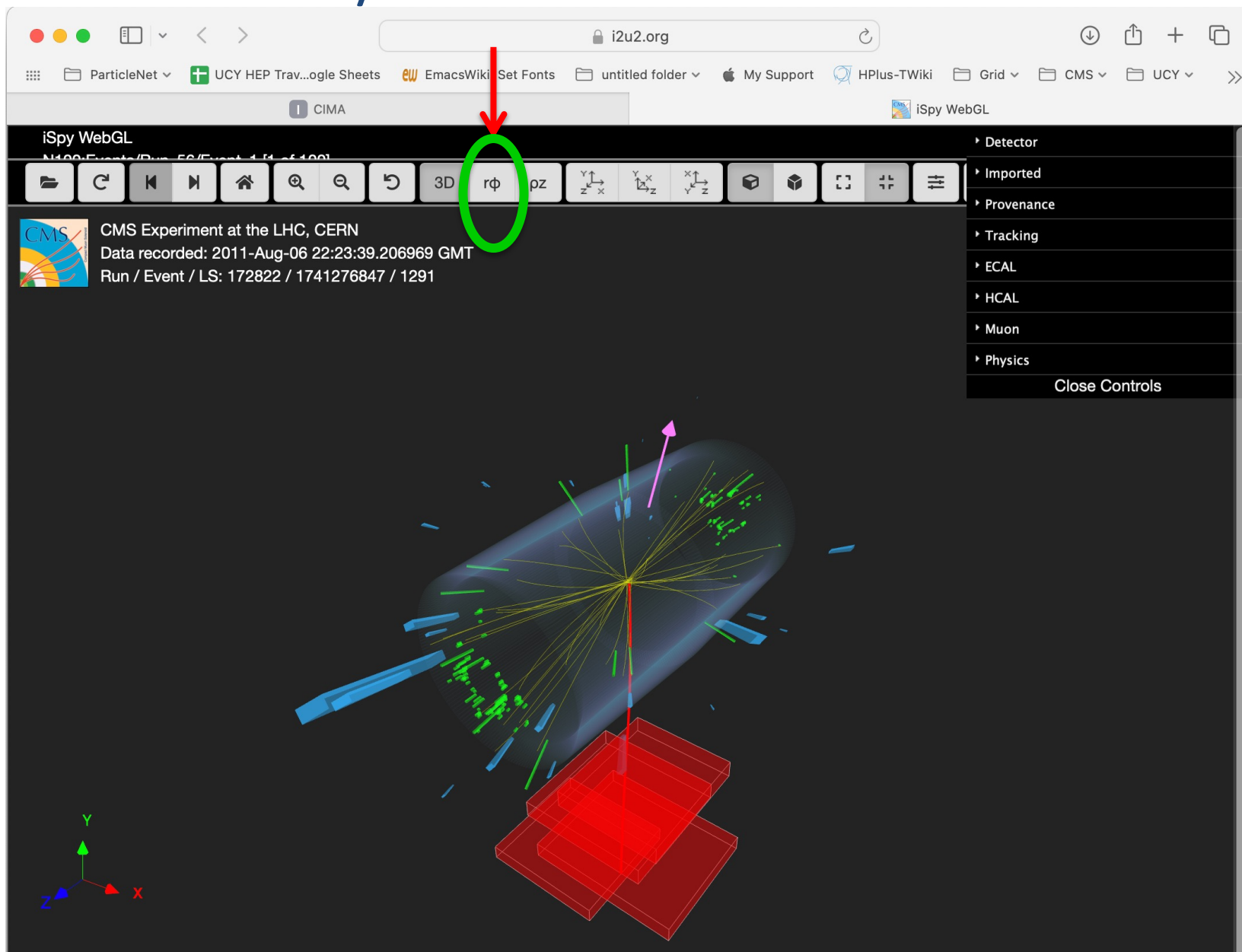
iSpy WebGL
N100-Events/Run_50/Event_114_of_100

CMS Experiment at the LHC, CERN
Data recorded: 2011-Aug-06 22:23:39.206969 GMT
Run / Event / LS: 172822 / 1741276847 / 1291

- Detector
- Imported
- Provenance
- Tracking
- ECAL
- HCAL
- Muon
- Physics
- Close Controls

Click on a name under "Provenance", "Tracking", "ECAL", "HCAL", "Muon", and "Physics" to view contents in table

CMS detector/event visualization software: iSpy



Click on a name under "Provenance", "Tracking", "ECAL", "HCAL", "Muon", and "Physics" to view contents in table

CMS detector/event visualization software: iSpy

The screenshot displays the iSpy WebGL interface in a browser window. The browser's address bar shows the URL `i2u2.org`. The interface includes a top navigation bar with various icons and a search bar. A red arrow labeled "Zoom in" points to the search icon, which is circled in green. The main visualization area shows a 3D model of the CMS detector, with a central event visualization. A pink arrow points to a track in the event, and a red arrow points to a track in the detector. The right sidebar contains a list of detector components: Detector, Imported, Provenance, Tracking, ECAL, HCAL, Muon, and Physics. The Tracking, ECAL, and HCAL items are circled in blue and orange, respectively. The bottom of the interface displays a table of ECAL: Barrel Rec. Hits.

Zoom in

CMS Experiment at the LHC, CERN
Data recorded: 2011-Aug-06 22:23:39.206969 GMT
Run / Event / LS: 172822 / 1741276847 / 1291

ECAL: Barrel Rec. Hits

| index | energy | eta | phi | time | detid | front_1 | front_2 | front_3 |
|-------|----------|------------|----------|---------|-----------|-------------------------------|-------------------------------|-------------------------|
| 0 | 0.124203 | -0.0302691 | 0.861745 | 32.5588 | 838861884 | 0.833479,0.988256,-0.0508939 | 0.833606,0.988403,-0.0273468 | 0.849292,0.973281,-0.0 |
| 1 | 0.350554 | -0.0302645 | 2.4 | 46.4148 | 838861972 | -0.960775,0.865347,-0.0508939 | -0.960917,0.865479,-0.0273468 | -0.945254,0.880626,-0.0 |

CMS detector/event visualization software: iSpy

iSpy WebGL
N100-Events/Run_58/Event_111 of 1001

CMS Experiment at the LHC, CERN
Data recorded: 2011-Aug-06 22:23:39.206969 GMT
Run / Event / LS: 172822 / 1741276847 / 1291

Click για να μην επιλεγεί

Click για να επιλεγεί

Click για να επιλεγεί

Click για να επιλεγεί

Tracking

Tracks (reco.)

number 56

key Tracks_V3

show

opacity 0.5

min_pt 1

color #fff00

ECAL

Endcap Rec. Hits

number 190

key EERecHits_V2

show

opacity 0.5

color #19ff19

Preshower Rec. Hits

Barrel Rec. Hits

number 64

key EBRecHits_V2

show

opacity 0.5

color #19ff19

HCAL

Barrel Rec. Hits

number 28

key HBRecHits_V2

show

opacity 0.5

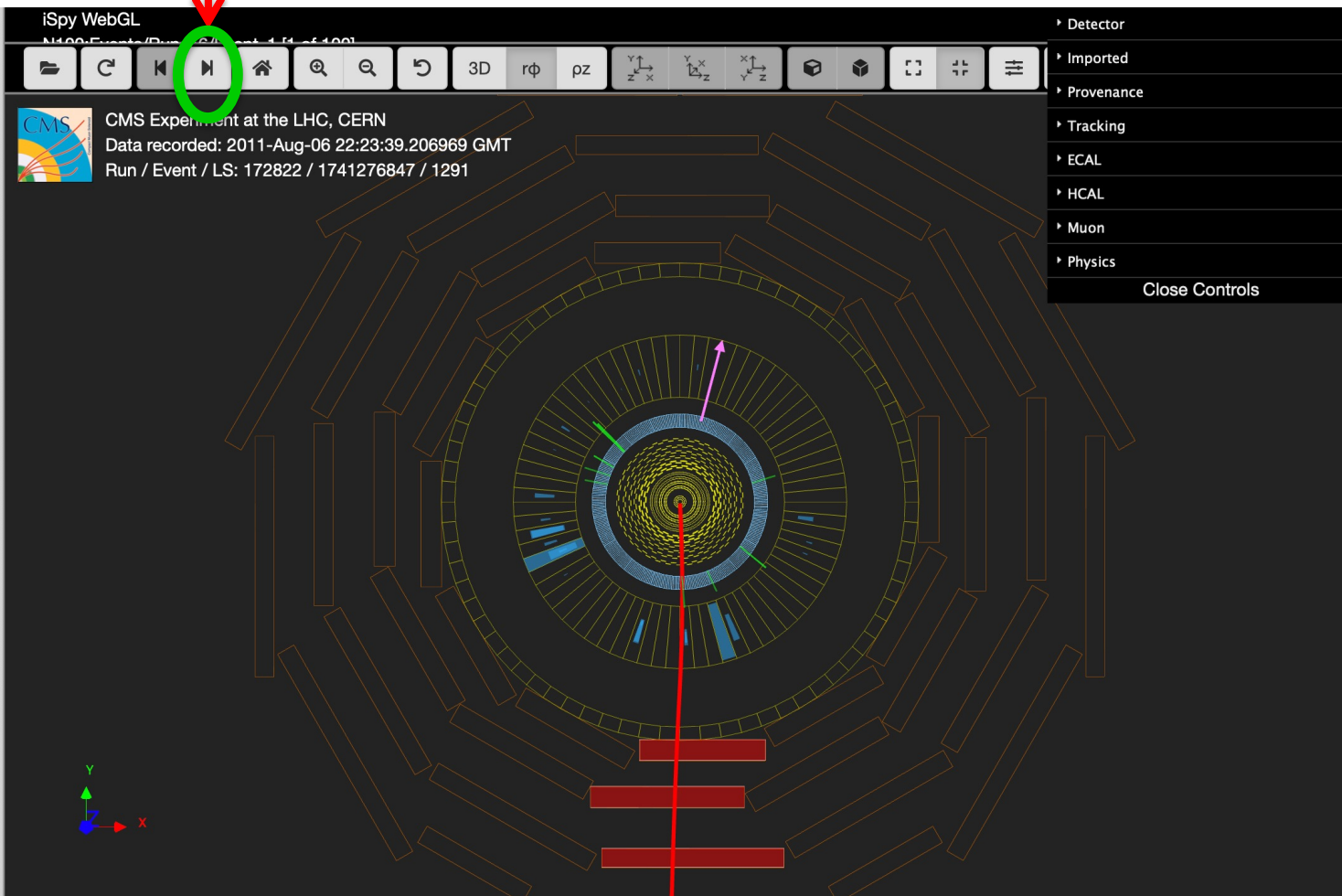
color #33b2ff

HCAL: Barrel Rec. Hits

| index | energy | eta | phi | time | detid | front_1 |
|-------|----------|---------|-----------|----------|------------|-----------------------------|
| 0 | 0.629988 | -0.4785 | -0.305433 | -23.7947 | 1107313477 | 1.75096,-0.469168,-0.81364 |
| 1 | 0.993199 | -1.0005 | -3.01069 | -7.54512 | 1107314214 | -1.78519,-0.314777,-2.01197 |

CMS detector/event visualization software: iSpy

Επόμενος γεγονός



iSpy WebGL
1100 Events / Run 2 / Event 111 of 100

CMS Experiment at the LHC, CERN
Data recorded: 2011-Aug-06 22:23:39.206969 GMT
Run / Event / LS: 172822 / 1741276847 / 1291

Detector
Imported
Provenance
Tracking
ECAL
HCAL
Muon
Physics
Close Controls

HCAL: Barrel Rec. Hits

| index | energy | eta | phi | time | detid | front_1 | front_2 | front_3 |
|-------|----------|---------|-----------|----------|------------|-----------------------------|----------------------------|----------------------------|
| 0 | 0.629988 | -0.4785 | -0.305433 | -23.7947 | 1107313477 | 1.75096,-0.469168,-0.81364 | 1.7034,-0.619989,-0.81364 | 1.7034,-0.619989,-0.989805 |
| 1 | 0.993199 | -1.0005 | -3.01069 | -7.54512 | 1107314214 | -1.78519,-0.314777,-2.01197 | -1.80583,-0.15799,-2.01197 | -1.80583,-0.15799,-2.25549 |

CMS detector/event visualization software: iSpy

The screenshot displays the iSpy WebGL interface for the CMS detector. At the top, there is a toolbar with navigation and view controls. Below the toolbar, the CMS logo and event information are shown: "CMS Experiment at the LHC, CERN", "Data recorded: 2011-Aug-06 22:23:39.206969 GMT", and "Run / Event / LS: 172822 / 1741276847 / 1291".

The main visualization area shows a 3D reconstruction of the CMS detector. A central vertical line represents the beam axis. A pink arrow points to a region labeled "Ελλειμματικό ισοζύγιο εγκάρσιας ενέργειας (missing ET)" with the text "There is a neutrino" in green. A green arrow points to a region labeled "Καμπυλώνει σύμφωνα με τη φορά των δεικτών του ρολογιού:" and "Θετική τροχιά". Blue arrows point to regions labeled "Ανιχνευτές μιονίων" and "Τροχιά μιονίου". A blue arrow points to a region labeled "Όταν περάσετε με το ποντίκι πάνω Από την τροχιά αυτή αλλάζει χρώμα και μπορείτε να την επιλέξετε".

At the bottom, there is a table of physics data for "Global Muons (Pico)":

| index | pt | charge | rp | phi | eta | E | px | py | pz | calo_energy | |
|-------|---------|--------|----|----------------------------------|---------|-----------|---------|--------|---------|-------------|---|
| 0 | 37.6667 | | | 0.0006638,0.000497136,-0.0099402 | -1.5215 | 0.0128385 | 37.6042 | 1.8562 | -37.621 | 0.483596 | 0 |

The excel spread sheet

Notice: Trying to access array offset on value of type int in `/home/quarkcat/sw/www-php/cima-wzh/DataTable.php` on line 114

Back Events Table (Group 100.56) Mass Histogram (NicosiaCyprus2024) Results (NicosiaCyprus2024) [➔ Event Display](#)

Masterclass: CERN-08Mar2024

Location: NicosiaCyprus2024

Group: 100.56

| | | | |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Select Event Event index: <input type="text" value="2"/> Event number: 100.56-2 | Final State <input type="radio"/> e v <input checked="" type="radio"/> μ v <input type="radio"/> e e <input type="radio"/> μ μ <input type="radio"/> 4e <input type="radio"/> 4 μ <input type="radio"/> 2e 2 μ | Primary State Charged Particle: <input checked="" type="radio"/> W+ <input type="radio"/> W- <input type="radio"/> W \pm <input type="radio"/> Neutral Particle (Z, H) <input type="radio"/> Zoo | Enter Mass <input type="text"/> GeV/c ² <input checked="" type="button" value="Next"/> |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|



| Event index | Event number | Final state | Primary state | Mass |
|-------------|--------------|-------------|---------------|------|
| 146001 | 100.56-1 | μ v | W+ | |

CMS detector/event visualization software: iSpy

Παραγωγή και διάσπαση ενός ουδέτερου σωματιδίου

iSpy WebGL
CMS Experiment at the LHC, CERN
Data recorded: 2011-Jul-25 01:00:42.969412 GMT
Run / Event / LS: 171446 / 601743651 / 478

Detector

- Imported
- Provenance
- Tracking
- ECAL
- HCAL
- Muon
- Physics

Close Controls

Αρνητική τροχιά ηλεκτρονίου

Θετική τροχιά ηλεκτρονίου

Κάνοντας click σε κάθε τροχιά και κατόπιν μπορείτε να πιέσετε `<ctrl> M` το οποίο θα σας δώσει την μάζα του συστήματος των δύο ηλεκτρονίων

Invariant mass

86.25 GeV

Close

Physics: Photons (Reco)

| index | energy | et | eta | phi | pos | hadronicOverEm | hadronicDepth1OverEcal | hadronicDepth2OverEcal |
|-------|---------|---------|----------|----------|------------------------------------|----------------|------------------------|------------------------|
| 0 | 72.1838 | 45.9544 | -1.02321 | 1.86366 | 0.000728237,0.000467666,-0.0211588 | 0 | 0 | 0 |
| 1 | 47.8463 | 31.9562 | 0.959958 | -1.10492 | 0.000728237,0.000467666,-0.0211588 | 0.192563 | 0.192563 | 0 |

The excel spread sheet

Back

Events Table (Group 100.56)

Mass Histogram (NicosiaCyprus2024)

Results (NicosiaCyprus2024)

➔ Event Display

Masterclass: CERN-08Mar2024

Location: NicosiaCyprus2024

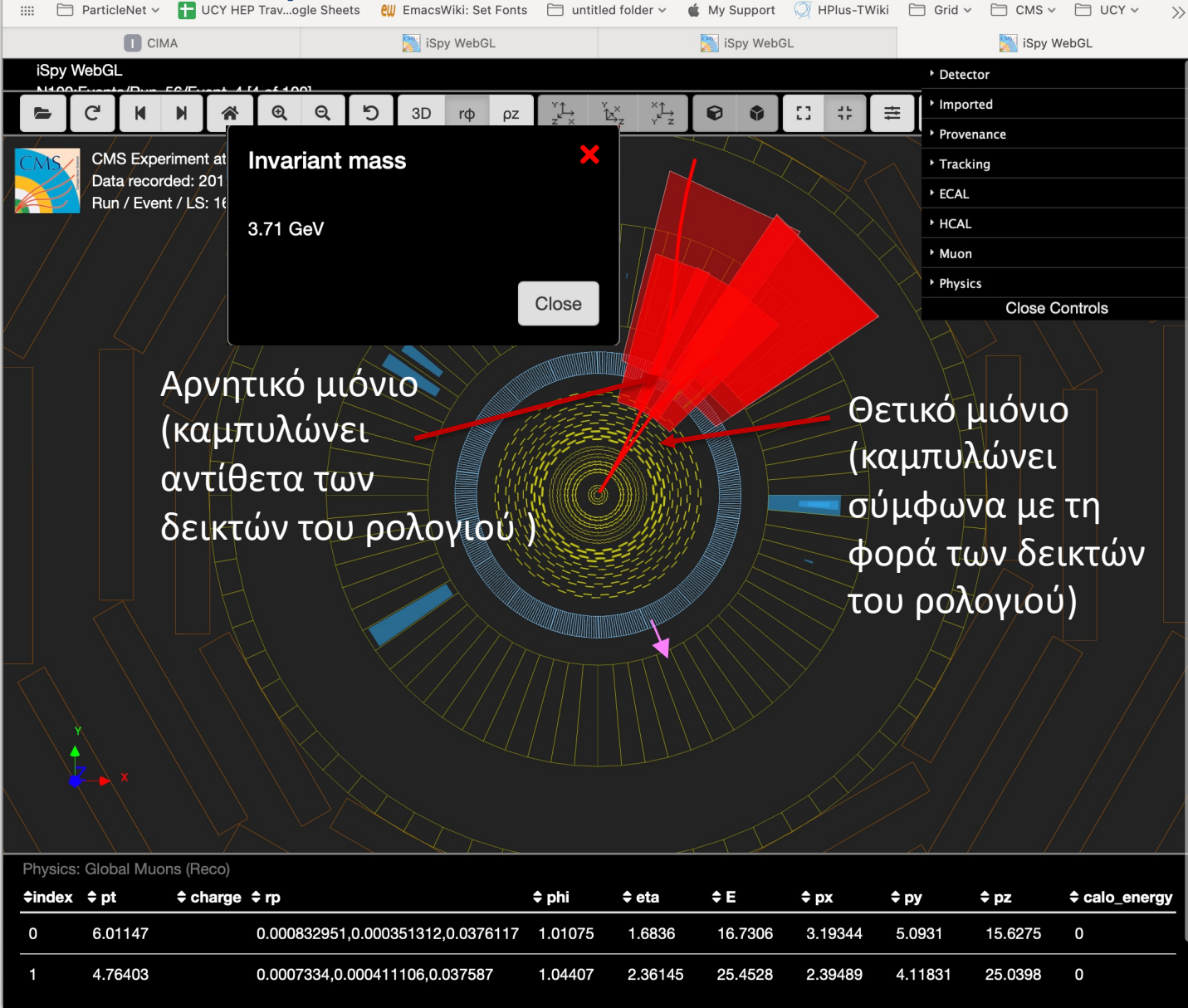
Group: 100.56

| | | | |
|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Select Event Event index: <input type="text" value="2"/> Event number: 100.56-2 | Final State <input type="radio"/> e ν <input checked="" type="radio"/> e e <input type="radio"/> 4e <input type="radio"/> 2e 2 μ <input type="radio"/> μ ν <input type="radio"/> μ μ <input type="radio"/> 4 μ | Primary State Charged Particle: <input type="radio"/> W ⁺ <input type="radio"/> W ⁻ <input type="radio"/> W \pm <input checked="" type="radio"/> Neutral Particle (Z, H) <input type="radio"/> Zoo | Enter Mass <input type="text" value="86.25"/> GeV/c ² <input type="button" value="Next"/> |
|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|

You should type in the mass from the previous step:

| Event index | Event number | Final state | Primary state | Mass |
|-------------|--------------|-------------|----------------|------|
| 146001 | 100.56-1 | $\mu\nu$ | W ⁺ | |

CMS detector/event visualization software: iSpy



The excel spread sheet

Notice: Trying to access array offset on value of type int in /home/quarkcat/sw/www-php/cima-wzh/DataTable.php on line 114

Back Events Table (Group 100.56) Mass Histogram (NicosiaCyprus2024) Results (NicosiaCyprus2024) [Event Display](#)

Masterclass: CERN-08Mar2024

Location: NicosiaCyprus2024

Group: 100.56

| | | | |
|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| Select Event Event index: <input type="text" value="3"/> Event number: 100.56-3 | Final State <input type="radio"/> e v <input type="radio"/> e e <input type="radio"/> 4e <input type="radio"/> 2e 2μ <input type="radio"/> μ v <input checked="" type="radio"/> μ μ <input type="radio"/> 4μ | Primary State Charged Particle: <input type="radio"/> W+ <input type="radio"/> W- <input type="radio"/> W± <input checked="" type="radio"/> Neutral Particle (Z, H) <input type="radio"/> Zoo | Enter Mass <input type="text" value="3.71"/> GeV/c <input type="button" value="Next"/> |
|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|

| Event index | Event number | Final state | Primary state | Mass |
|-------------|--------------|-------------|---------------|-------|
| 146002 | 100.56-2 | 2e | neutral | 86.25 |
| 146001 | 100.56-1 | μν | W+ | |

CMS detector/event visualization software: iSpy

Ενδιαφέρον γεγονός: Ζεύγος e^+e^- και $\mu^+\mu^-$ \rightarrow 2 ουδέτερα σωματίδια

Γεγονός με υποψήφιο Higgs: $H^0 \rightarrow ZZ^*$

iSpy WebGL
CMS Experiment at the LHC, CERN
Data recorded: 2012-Jul-04 03:19:28.393790 GMT
Run / Event / LS: 198213 / 2700461 / 31

Detector
Imported
Provenance
Tracking
ECAL
HCAL
Muon
Physics
Close Controls

Θετική τροχιά $\rightarrow e^+$
Αρνητική τροχιά $\rightarrow e^-$
Θετική τροχιά $\rightarrow \mu^+$
Αρνητική τροχιά $\rightarrow \mu^-$

Invariant mass
121.50 GeV
Close

Επιλέγοντας όλες τις τροχιές και πιέζοντας (cntrl-M)

CIMA - The excel spread sheet

Notice: Trying to access array offset on value of type int in /home/quarkcat/sw/www-php/cima-wzh/DataTable.php on line 114

Back

Events Table (Group 100.56)

Mass Histogram (NicosiaCyprus2024)

Results (NicosiaCyprus2024)

➔ Event Display

Masterclass: CERN-08Mar2024

Location: NicosiaCyprus2024

Group: 100.56

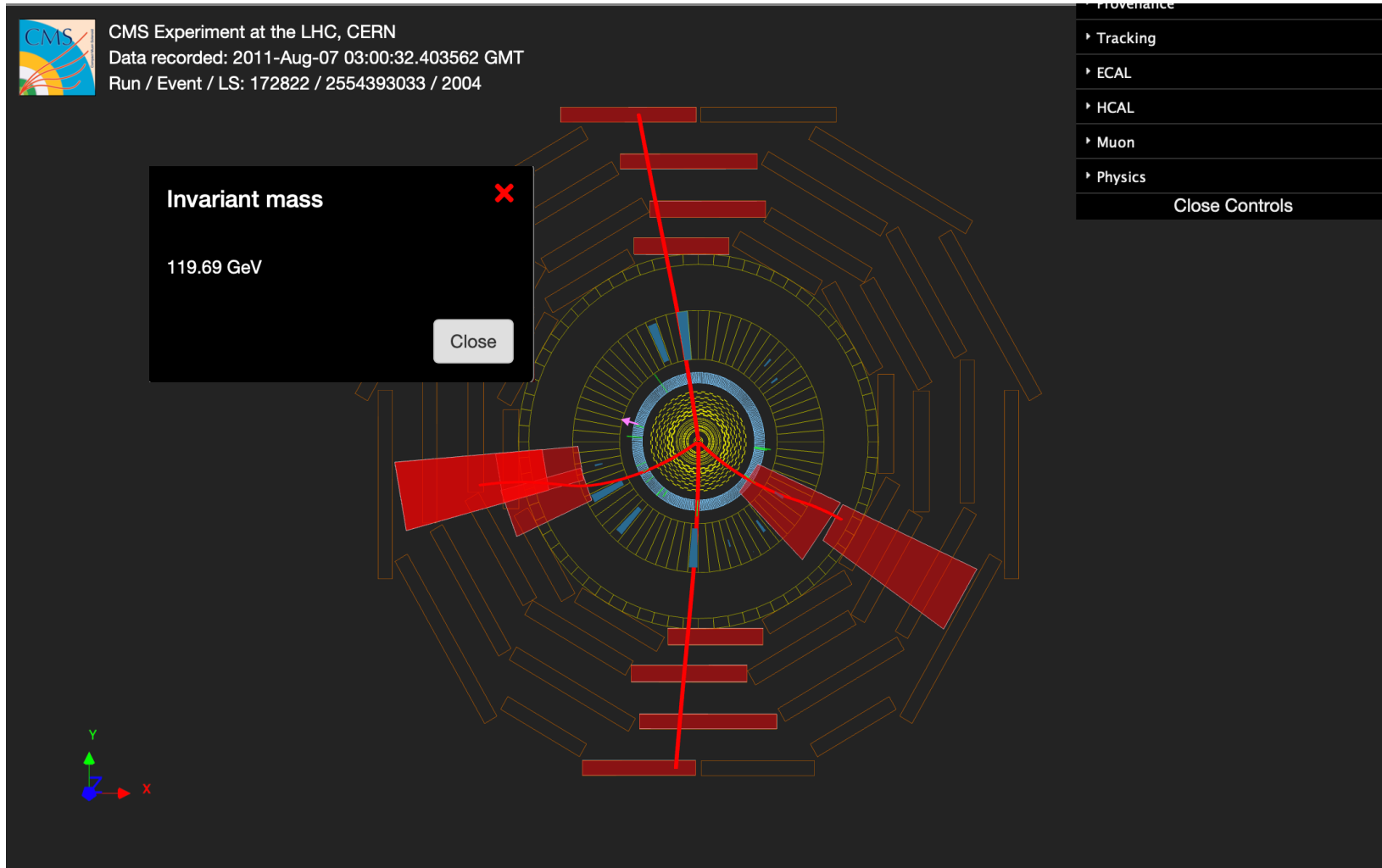
| | | | |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Select Event Event index: <input type="text" value="4"/> Event number: 100.56-4 | Final State <input type="radio"/> e v <input type="radio"/> μ v <input type="radio"/> e e <input type="radio"/> μ μ <input type="radio"/> 4e <input type="radio"/> 4 μ <input checked="" type="radio"/> 2e 2 μ | Primary State Charged Particle: <input type="radio"/> W ⁺ <input type="radio"/> W ⁻ <input type="radio"/> W \pm <input checked="" type="radio"/> Neutral Particle (Z, H) <input type="radio"/> Zoo | Enter Mass <input type="text" value="121.5"/> GeV/c ² <input type="button" value="Next"/> |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|

| Event index | Event number | Final state | Primary state | Mass |
|-------------|--------------|-------------|----------------|-------|
| 146003 | 100.56-3 | $\mu\mu$ | neutral | 3.71 |
| 146002 | 100.56-2 | 2e | neutral | 86.25 |
| 146001 | 100.56-1 | $\mu\nu$ | W ⁺ | |

CMS detector/event visualization software: iSpy

Ενδιαφέρον γεγονός: Two pairs of $\mu^+\mu^-$ → 2 neutral particles

Γεγονός με υποψήφιο Higgs: $H^0 \rightarrow ZZ^*$



CIMA - The excel spread sheet

Back

Events Table (Group 100.56)

Mass Histogram (NicosiaCyprus2024)

Results (NicosiaCyprus2024)

➔ Event Display

Masterclass: CERN-08Mar2024

Location: NicosiaCyprus2024

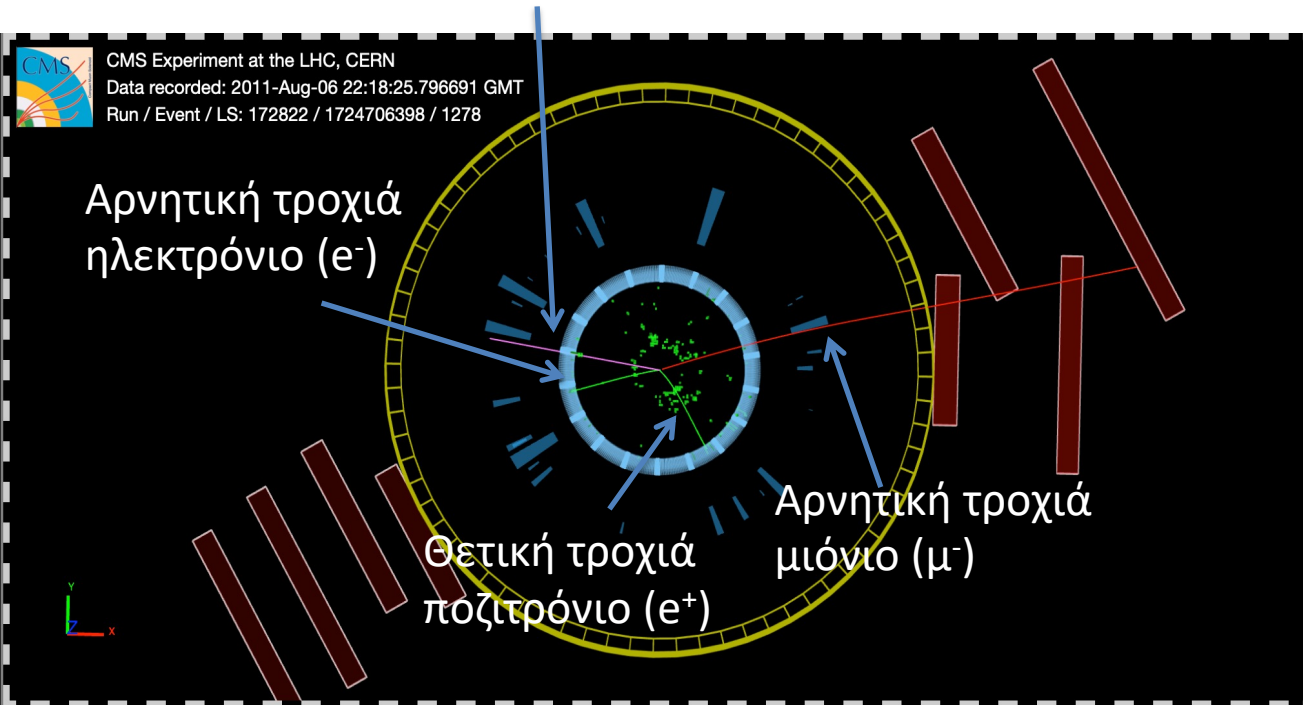
Group: 100.56

| | | | |
|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Select Event Event index: <input type="text" value="5"/> <input type="button" value="v"/> Event number: 100.56-5 | Final State <input type="radio"/> e v <input type="radio"/> μ v <input type="radio"/> e e <input type="radio"/> μ μ <input type="radio"/> 4e <input checked="" type="radio"/> 4 μ <input type="radio"/> 2e 2 μ | Primary State Charged Particle: <input type="radio"/> W+ <input type="radio"/> W- <input type="radio"/> W \pm <input checked="" type="radio"/> Neutral Particle (Z, H) <input type="radio"/> Zoo | Enter Mass <input type="text" value="119.69"/> GeV/c ² <input type="button" value="Next"/> |
|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|

| Event index | Event number | Final state | Primary state | Mass |
|-------------|--------------|-------------|---------------|-------|
| 146004 | 100.56-4 | 4 μ | neutral | 119.4 |
| 146003 | 100.56-3 | $\mu\mu$ | neutral | 3.71 |
| 146002 | 100.56-2 | 2e | neutral | 86.25 |
| 146001 | 100.56-1 | μ v | W+ | |

Το λογισμικό της απεικόνισης γεγονότων: iSpry

Έλλειμα εγκάρσιας
ενέργειας (missing ET)
Υπάρχει νεutrino



Περίεργο γεγονός

$e^- e^+$ και $1 \mu^-$

Ουδέτερο σωματίο?

ΟΧΙ

τα προϊόντα δεν είναι ίδιου τύπου

Έλλειμα ενέργειας
➔ ≥ 1 νεutrino

Θα μπορούσε να είναι $Z^0 W^-$

Κατηγοροποιείται ως
Z00

CIMA - Το φύλλο εργασίας

Notice: Undefined index: finalState in /home/quarkcat/sw/www-php/cima-wzh/DataTable.php on line 41

[Back](#) [Events Table \(Group 100.12\)](#) [Mass Histogram \(NicosiaA2020\)](#) [Results \(NicosiaA2020\)](#)

[Event Display](#)

Masterclass: CERN-07Mar2020

Location: NicosiaA2020

Group: 100.12

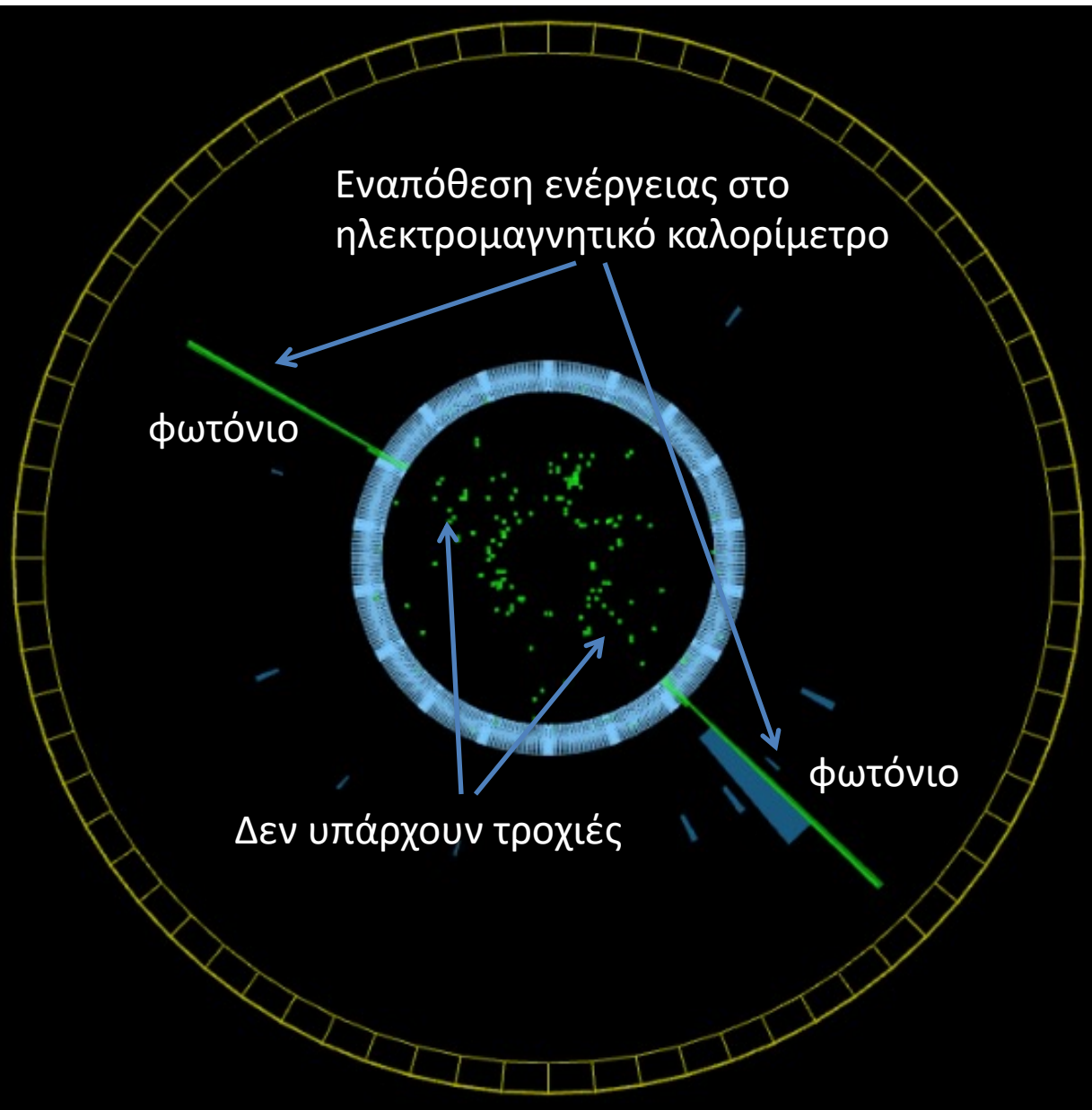
| | | | |
|----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Select Event Event index: <input type="text" value="1"/> Event number: 100.12-1 | Final State <input type="radio"/> e ν <input type="radio"/> μ ν <input type="radio"/> e e <input type="radio"/> μ μ <input type="radio"/> 4e <input type="radio"/> 4μ <input type="radio"/> 2e 2μ | Primary State Charged Particle: <input type="radio"/> W+ <input type="radio"/> W- <input type="radio"/> W± <input type="radio"/> Neutral Particle (Z, H) <input type="radio"/> Zoo | Enter Mass <input type="text"/> GeV/c² <input type="button" value="Next"/> |
|----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|

| Event index | Event number | Final state | Primary state | Mass |
|-------------|--------------|-------------|---------------|------|
| 102012 | 100.12-12 | | zoo | |
| 102004 | 100.12-4 | 2e | neutral | 2.73 |

Το λογισμικό της απεικόνισης γεγονότων: iSpry

Υποψήφιο γεγονός
Higgs

$$H^0 \rightarrow \gamma\gamma$$



CIMA - Το φύλλο εργασίας

Masterclass: CERN-13Mar2019

location: CyprusA2019

Group: 62

Instructions (also available as [screencast](#)):

1. For each event, identify the final state and select a primary state candidate.
 - For Higgs or Zoo candidate, no final state is chosen
 - If you cannot decide between W^+ and W^- , choose W instead
2. If you think the final state is a neutral particle (like a Z), but you don't know its exact type, select NP for "neutral particle." Find its mass from the Event Display and enter it.
3. Once you have selected everything, click "Submit".

In case of an error, double clicking the data line will reload it; you can then try it again.

| | | | |
|--------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Select Event Event index: <input type="text" value="44"/> Event number: 62-44 | final state <input type="checkbox"/> Electron <input type="checkbox"/> Muon (μ) | primary state candidate <input type="checkbox"/> W^- <input type="checkbox"/> W^+ <input type="checkbox"/> NP <input type="checkbox"/> W <input checked="" type="checkbox"/> Higgs <input type="checkbox"/> Zoo | NP Mass: <input type="text"/> GeV/c ² <input type="button" value="Submit"/> |
|--------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|

Event index

Event number

Chosen Values

Mass

| | | | |
|----|-------|---------------|--------|
| 29 | 62-29 | H | 121.89 |
| 13 | 62-13 | e, NP | 88.17 |
| 4 | 62-4 | μ , NP | 9.44 |
| 2 | 62-2 | e, W^- | |
| 1 | 62-1 | μ , W^+ | |

Σχεδιάζοντας έναν ανιχνευτή: Τι θέλουμε να βρούμε?

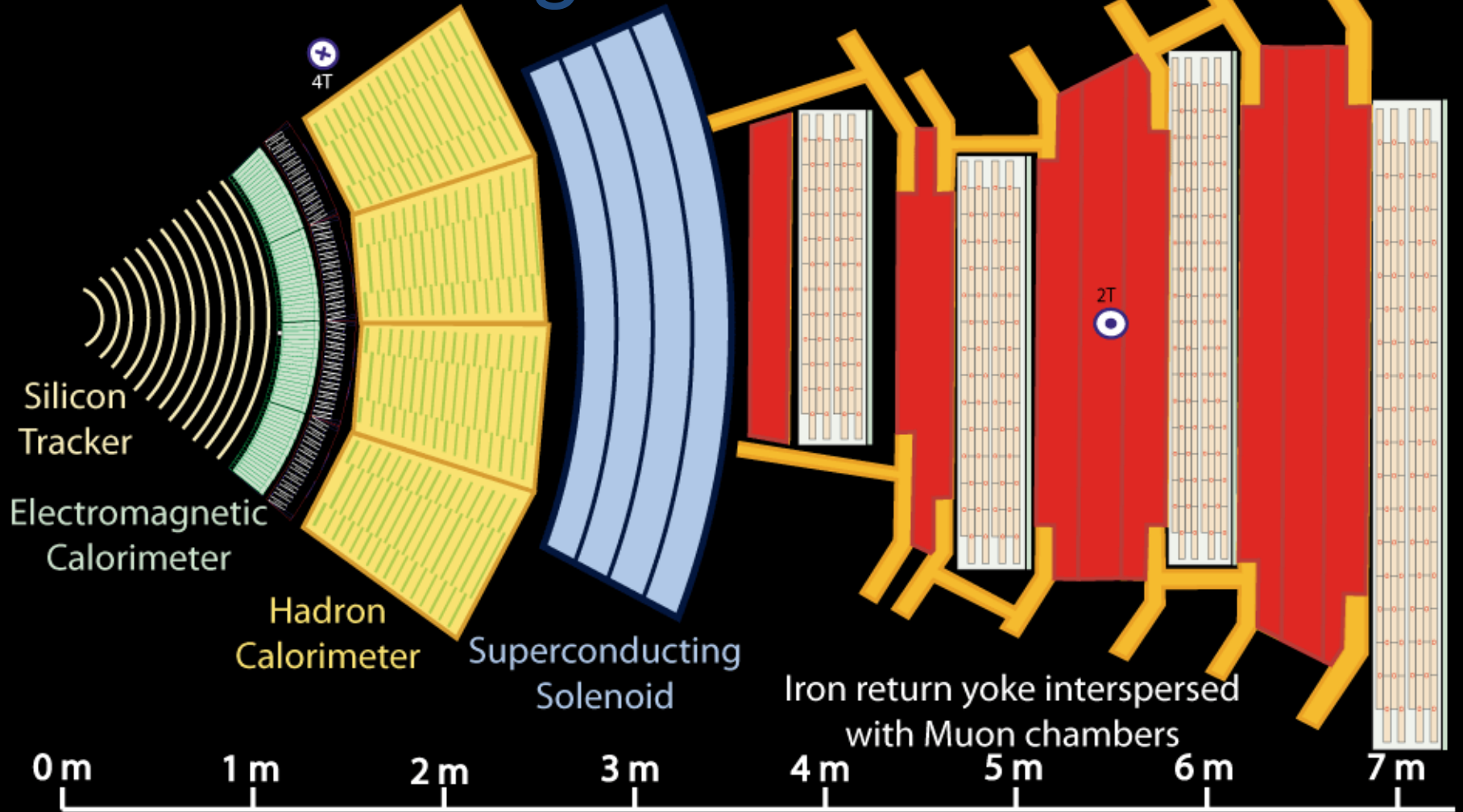
Τα σταθερά σωματίδια τα οποία απόμειναν από την διάσπαση κάποιων σωματιδίων, όπως του W^+ , W^- , Z^0 (και H^0)

- $W^+ \rightarrow \mu^+ + \nu_\mu$
- $W^+ \rightarrow e^+ + \nu_e$
- $W^- \rightarrow \mu^- + \nu_\mu$
- $W^- \rightarrow e^- + \nu_e$
- $Z^0 \rightarrow e^+ + e^-$
- $Z^0 \rightarrow \mu^+ + \mu^-$
- $H^0 \rightarrow \gamma + \gamma$
- $W^\pm \rightarrow \text{hadrons}$

Hadrons could be:
 π^+ , π^- , K^+ , K^- , Λ ..

- Ένα σωματίδιο “ i ” θα φύγει από το σημείο σκέδασης με ορμή p_i και ενέργεια E_i

A slice through the CMS detector



Key:

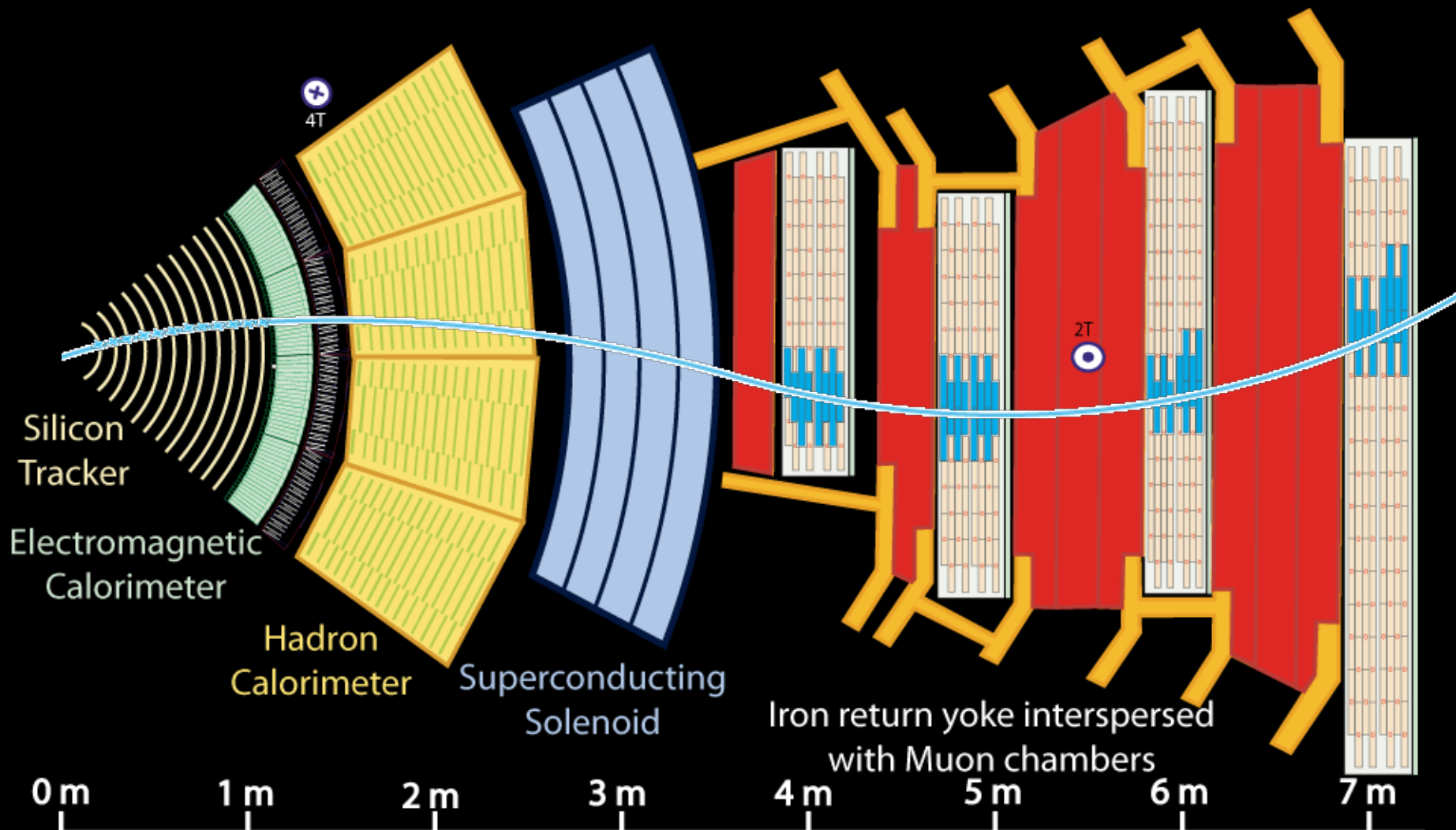
— Muon

— Electron

— Charged Hadron (e.g. Pion)

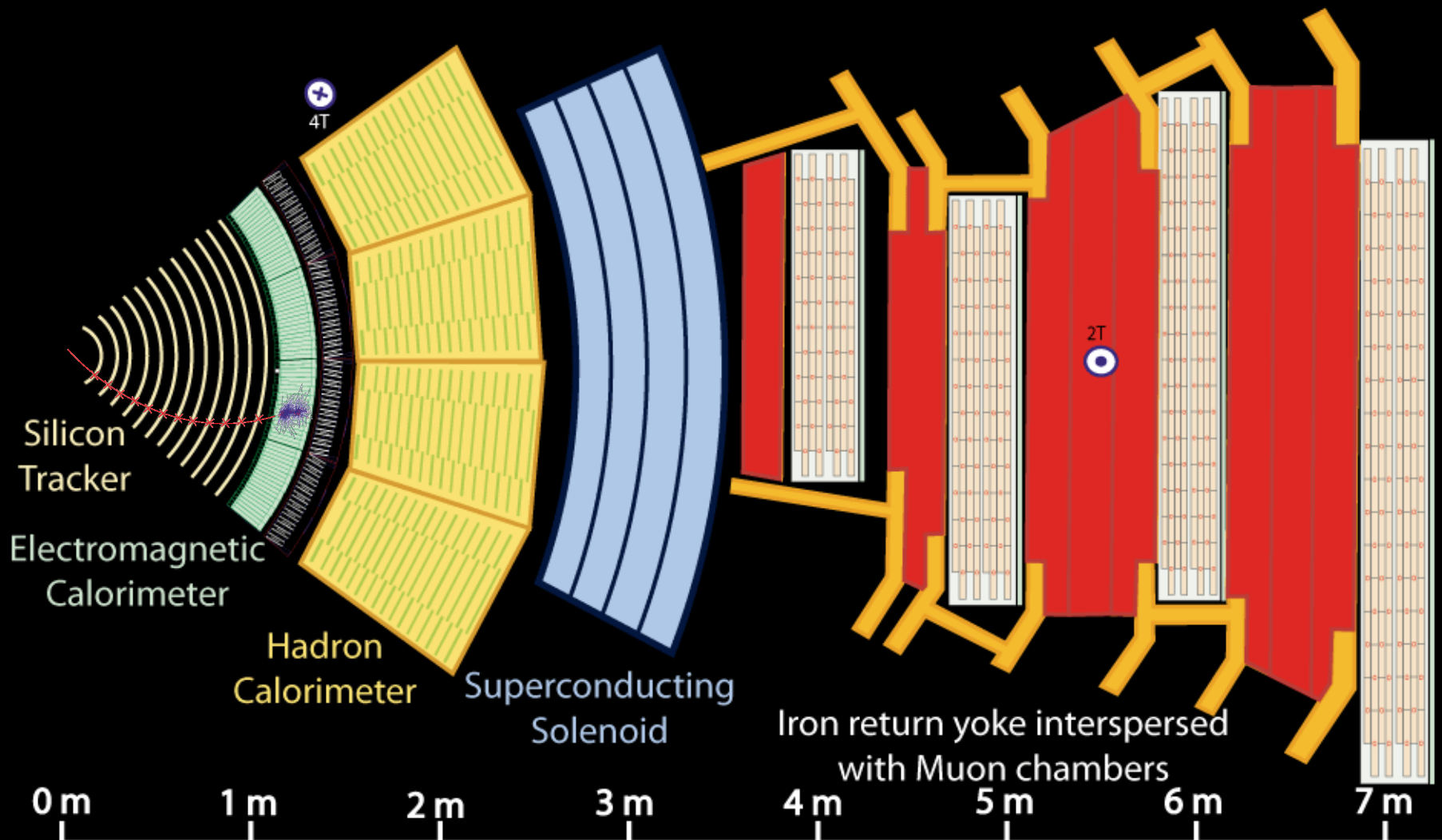
- - - Neutral Hadron (e.g. Neutron)

- - - Photon



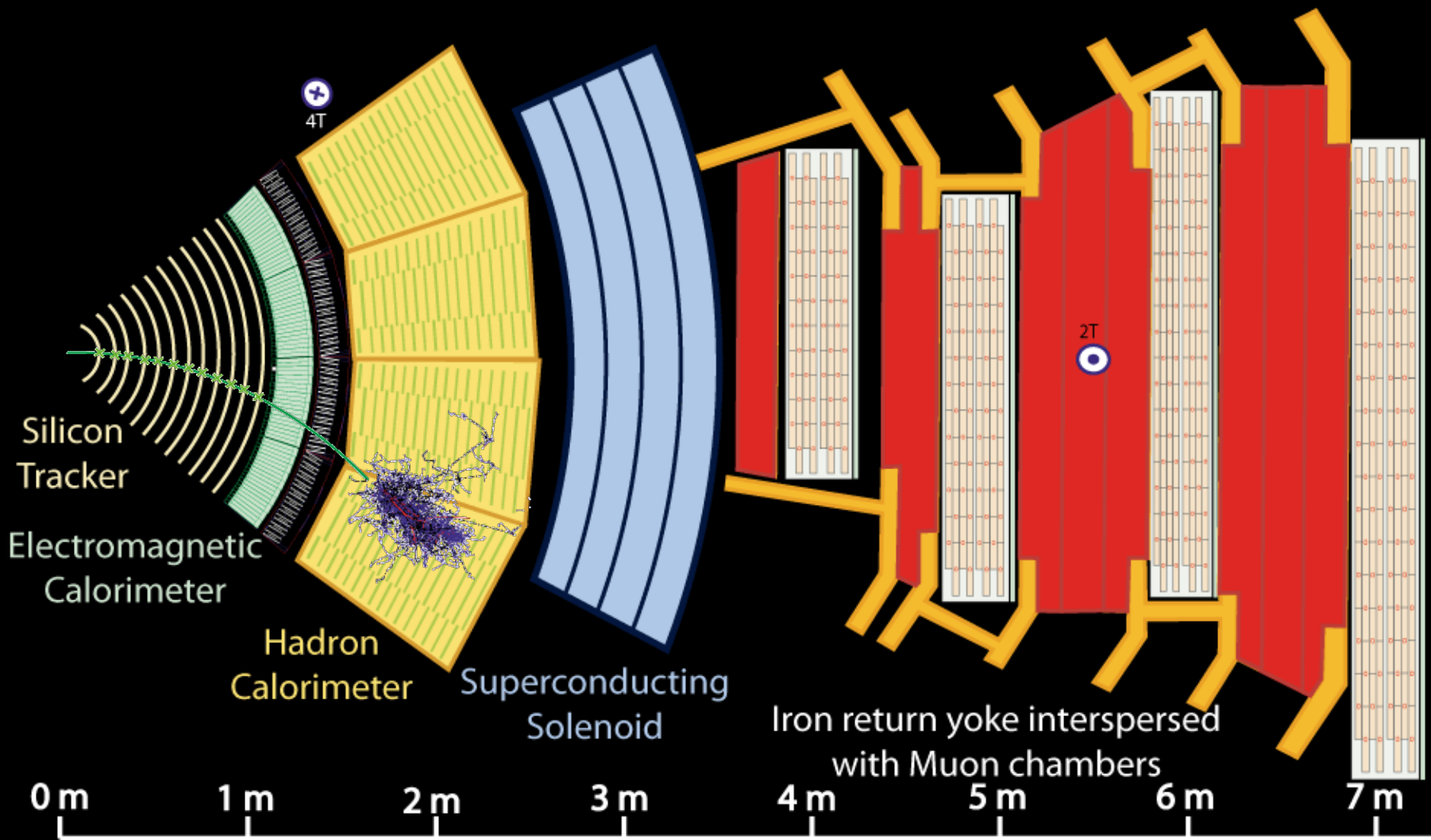
Key:

- Muon
- Electron
- Charged Hadron (e.g. Pion)
- - - Neutral Hadron (e.g. Neutron)
- - - Photon



Key:

- Muon
- Electron
- Charged Hadron (e.g. Pion)
- - - Neutral Hadron (e.g. Neutron)
- - - Photon



Key:

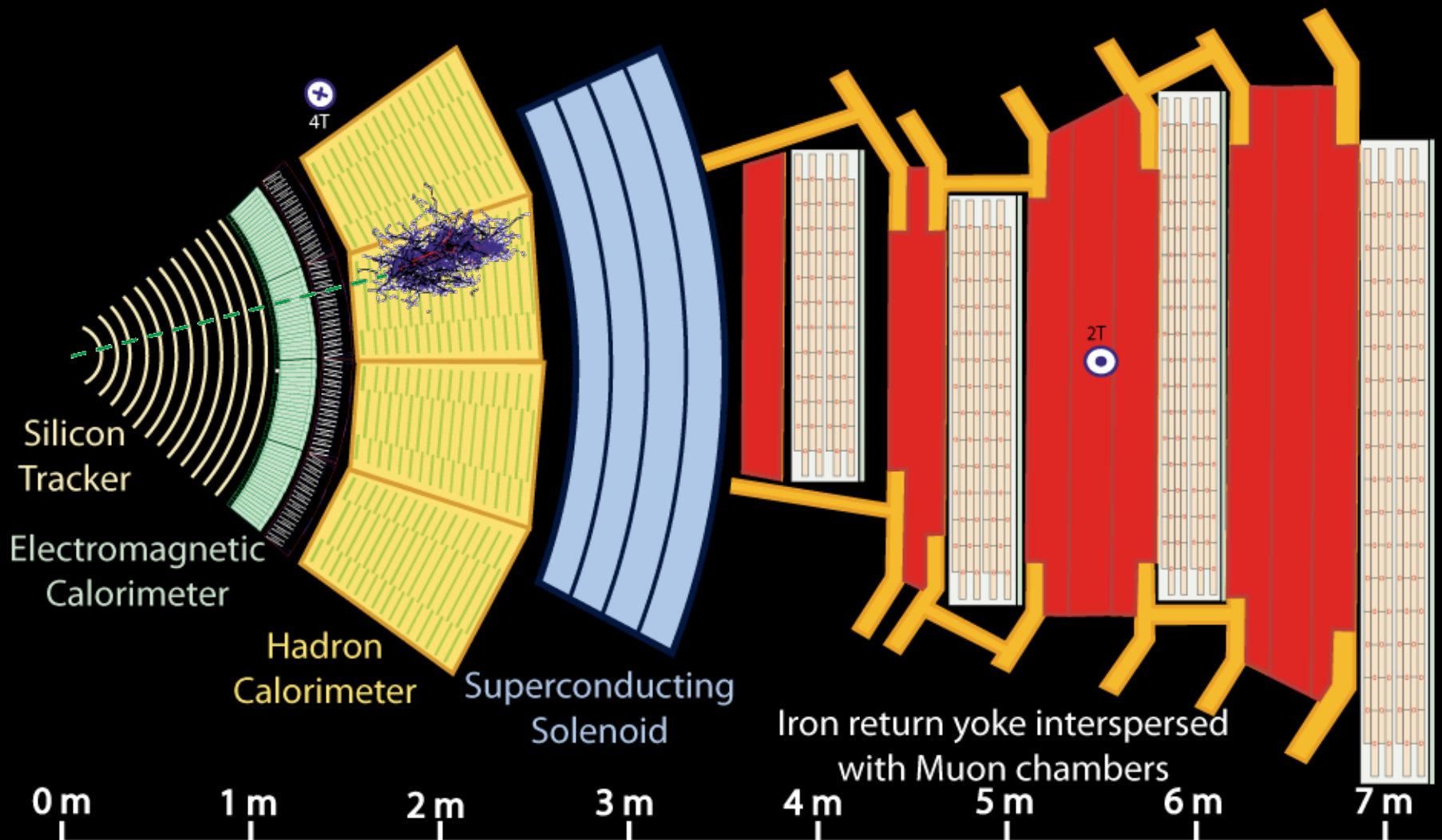
— Muon

— Electron

— Charged Hadron (e.g. Pion)

- - - Neutral Hadron (e.g. Neutron)

- - - Photon



Key:

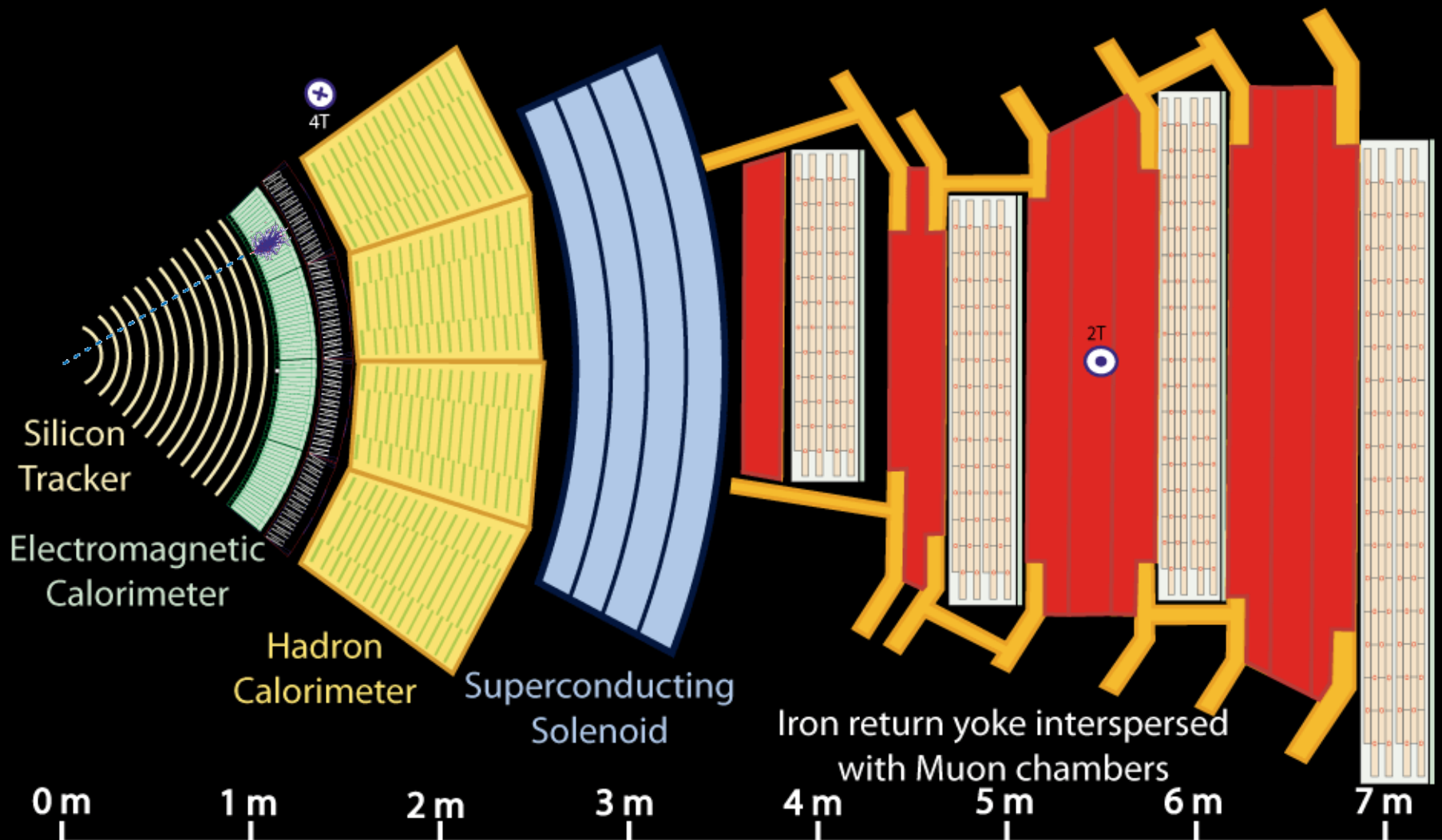
— Muon

— Electron

— Charged Hadron (e.g. Pion)

- - - Neutral Hadron (e.g. Neutron)

- - - Photon

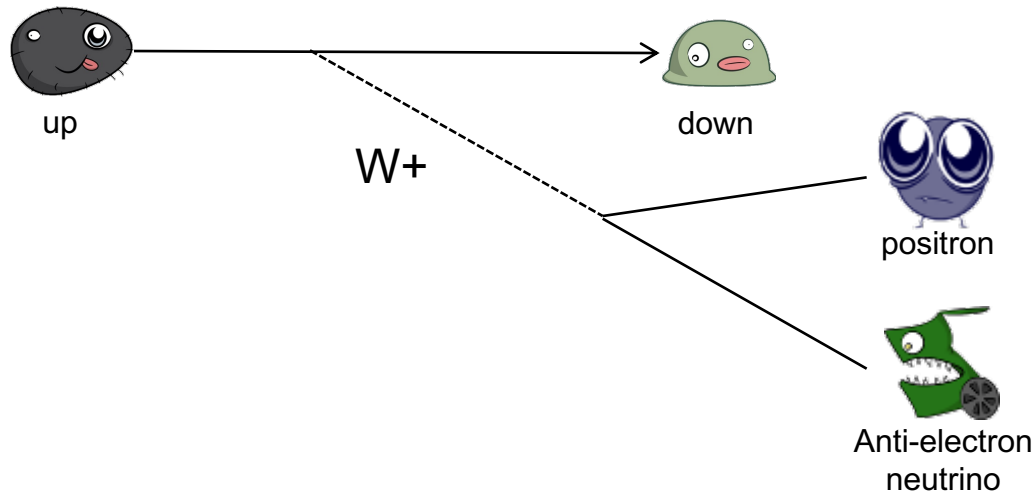


Key:

- Muon
- Electron
- Charged Hadron (e.g. Pion)
- - - Neutral Hadron (e.g. Neutron)
- - - Photon

Ο σκοπός της σημερινής άσκησης

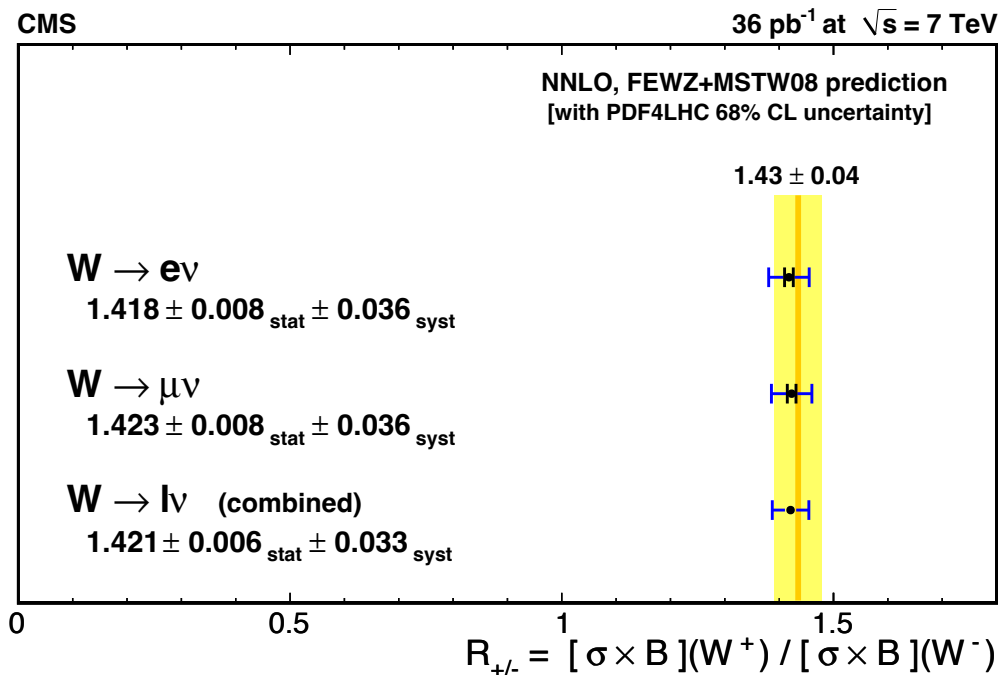
- Τα quarks μέσα στο πρωτόνιο μπορεί να είναι «διεγερμένα» (εξαιτίας της υψηλής ενέργειας της σύγκρουσης), και μετασχηματίζονται σε άλλου τύπου quark, εκπέμποντας ένα W



- Το down quark μπορεί να μετασχηματιστεί σε up quark εκπέμποντας ένα W^-
- Σήμερα: Μέρος της άσκησης είναι η μέτρηση του αριθμού των W^+ and W^- που παράγονται σε συγκρούσεις στο CMS
 - Γιατί? – θα δούμε αργότερα!

Συζήτηση ενός αποτελέσματος

- Ο λόγος W^+/W^- : δίνει πληροφορία για την εσωτερική δομή του πρωτονίου
- Τι περιμένετε να βρείτε?

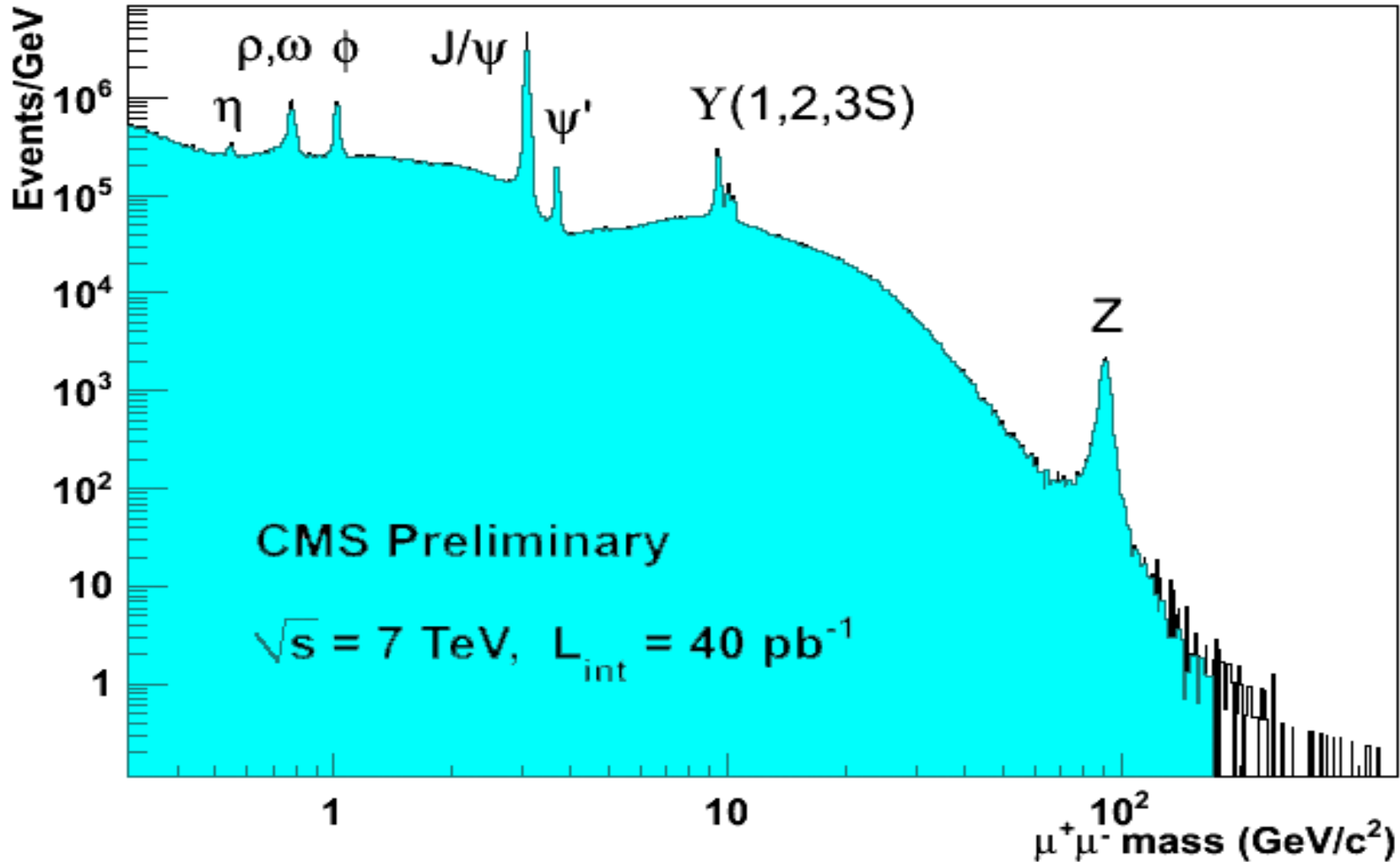


Τι σημαίνει αυτό?

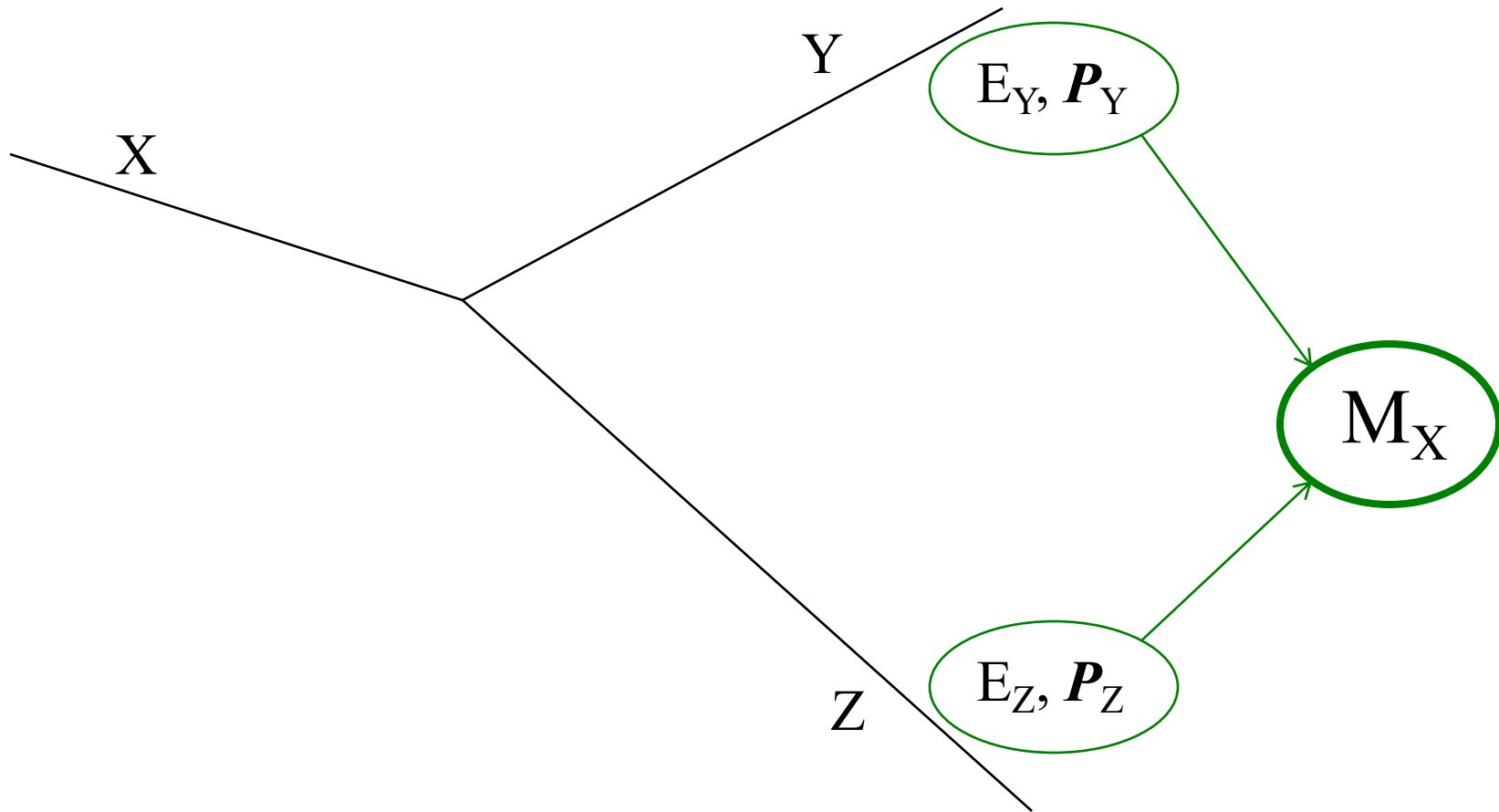
ότι το απλό μοντέλο του πρωτονίου (uud) δεν ισχύει.....

Backup

Κατανομή μαζών ζευγών μιονίου

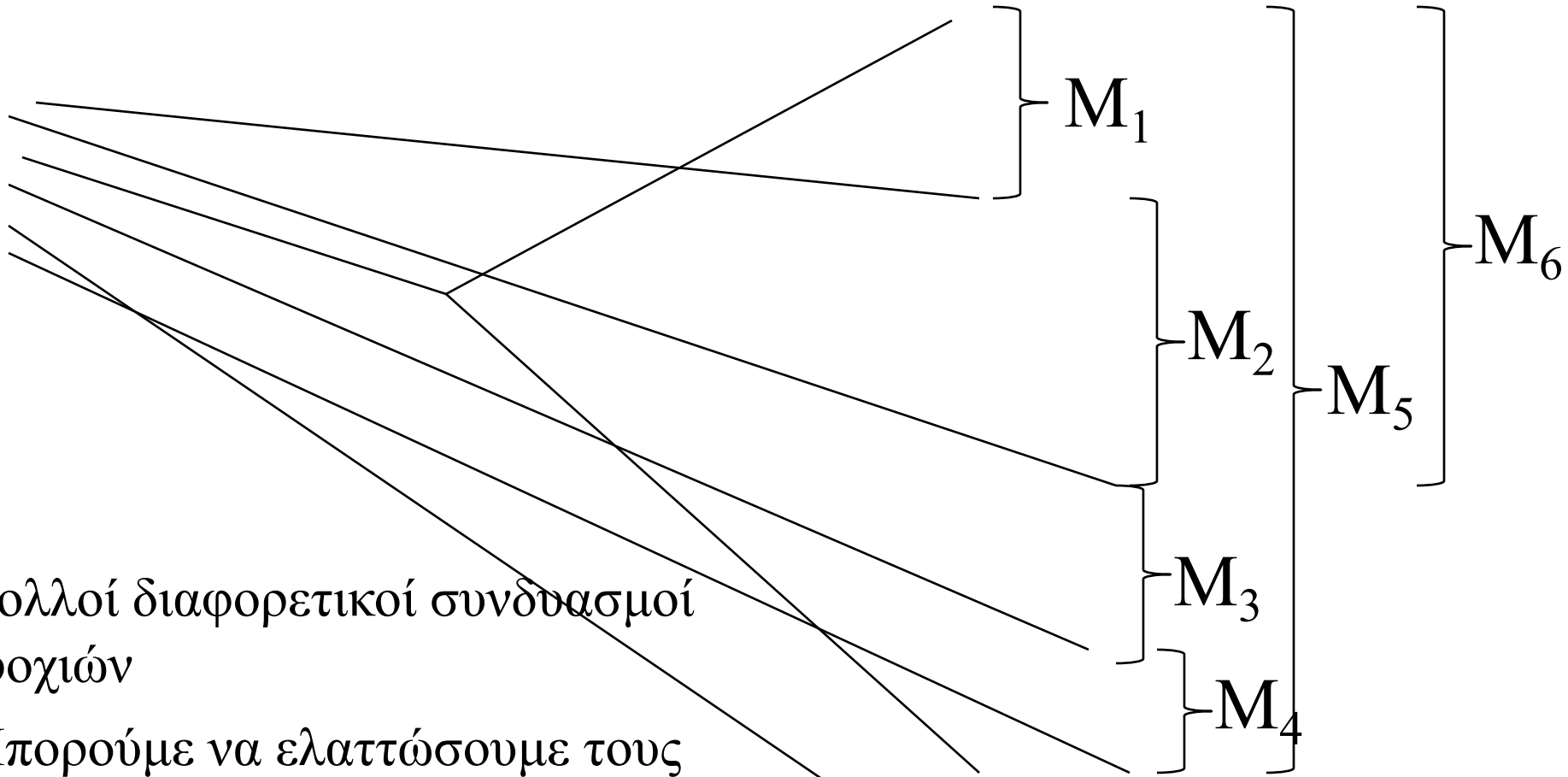


“Αναλοίωτη μάζα”



Συνδιασμός σωματιδίων δίνει την “αναλοίωτη μάζα” του σωματιδίου που μπορεί να τα παρήγαγε.

Αναλοίωτη μάζα (cont.)



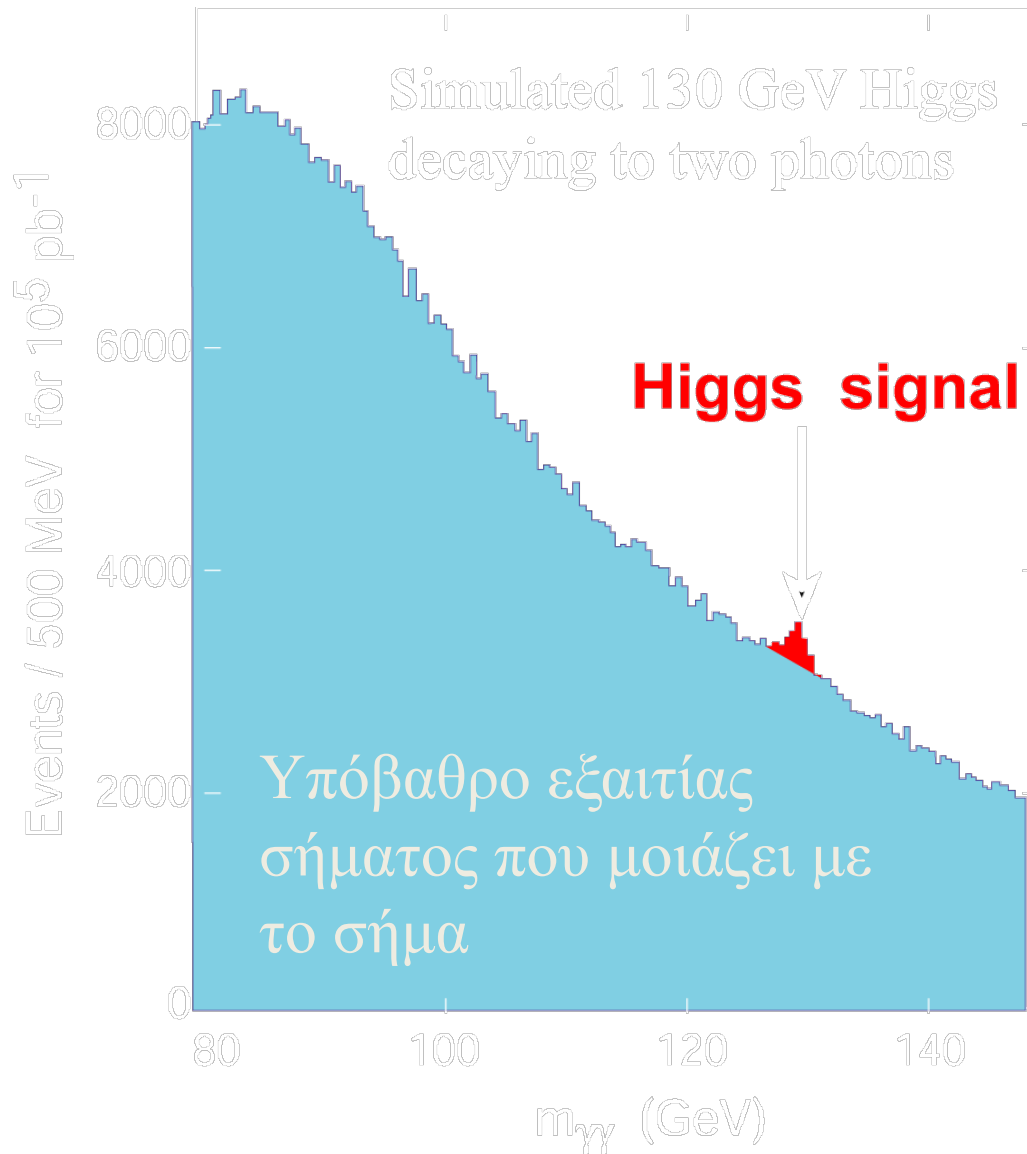
Etc.

Πολλοί διαφορετικοί συνδυασμοί τροχιών

Μπορούμε να ελαττώσουμε τους συνδιασμούς επιλέγοντας στην ποιότητα, ορμή των τροχιών ετω, .

Εναπομένει κάποιο υπόβαθρο. Ακόμα το M δεν μπορεί να μετρηθεί τέλεια – εξαρτάται από τον ανιχνευτή

Εύρεση του Higgs



Αυτό είναι το σήμα που βλέπουμε στον ανιχνευτή για το Higgs που διασπάται σε 2 φωτόνια...

Το εύρος του σήματος οφείλεται στην ακρίβεια του ανιχνευτή και στο φυσικό εύρος της μάζας του σωματιδίου