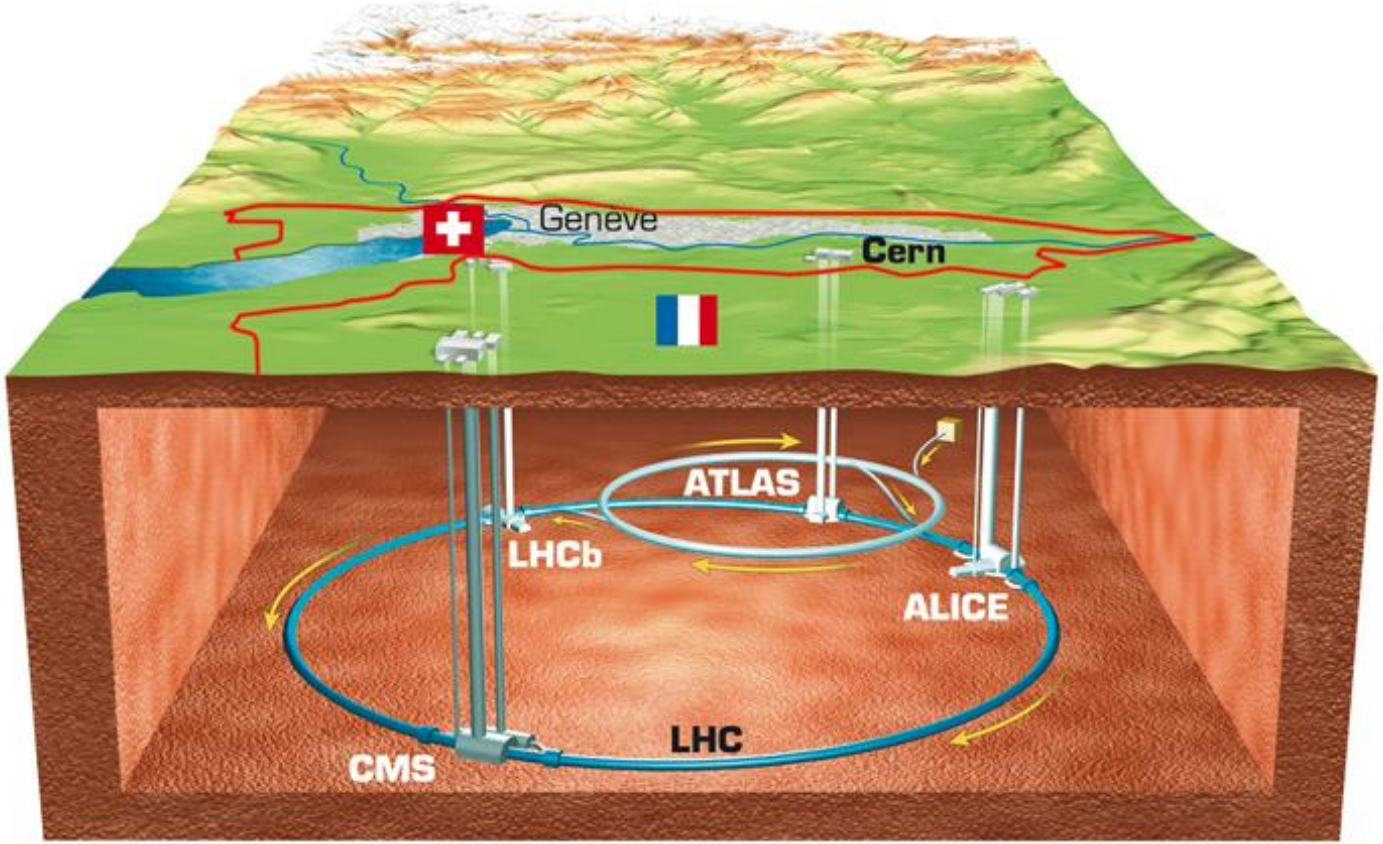
Analisi dei dati con HYPATIA

Masterclass Pisa 2018

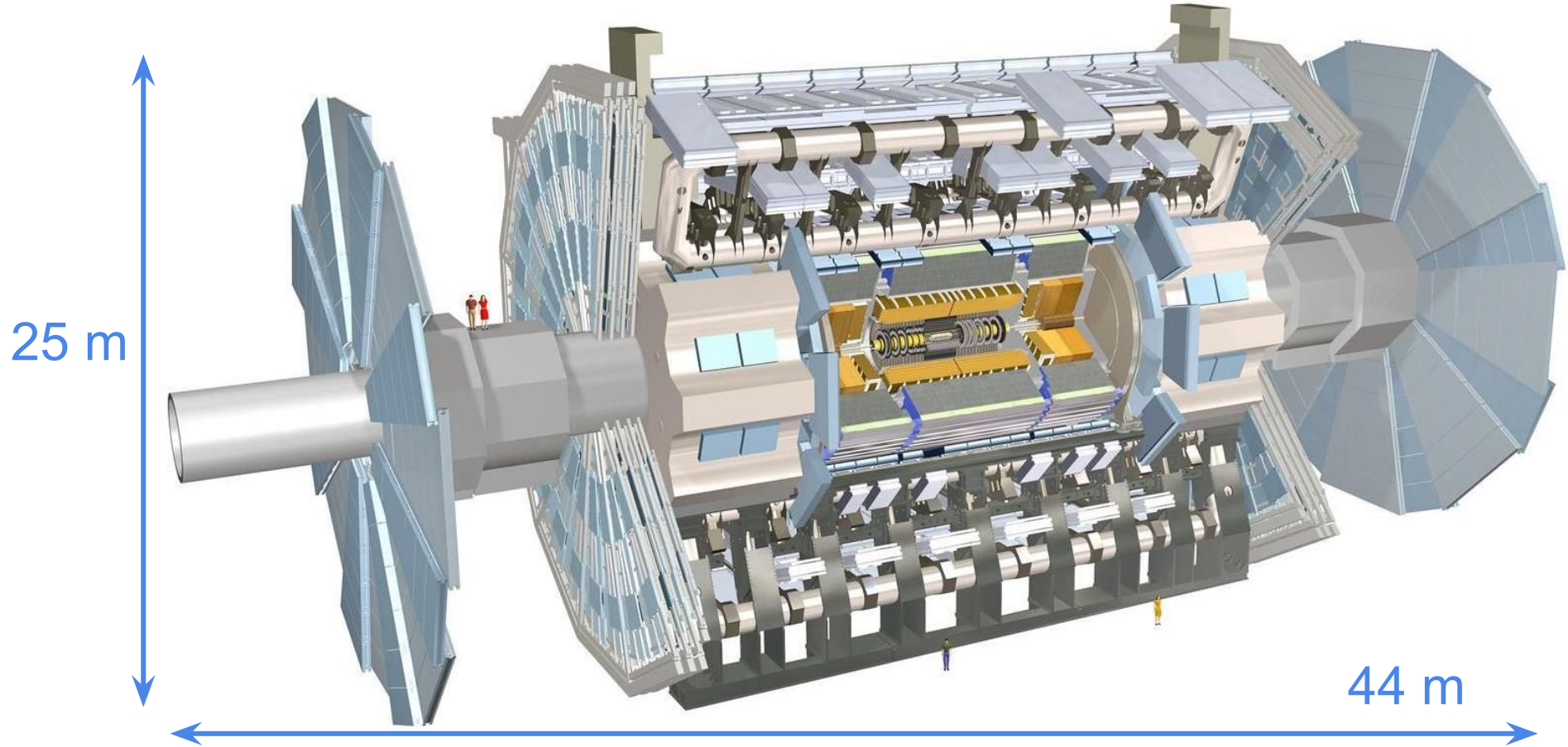
Milène Calvetti e Giulia Di Gregorio

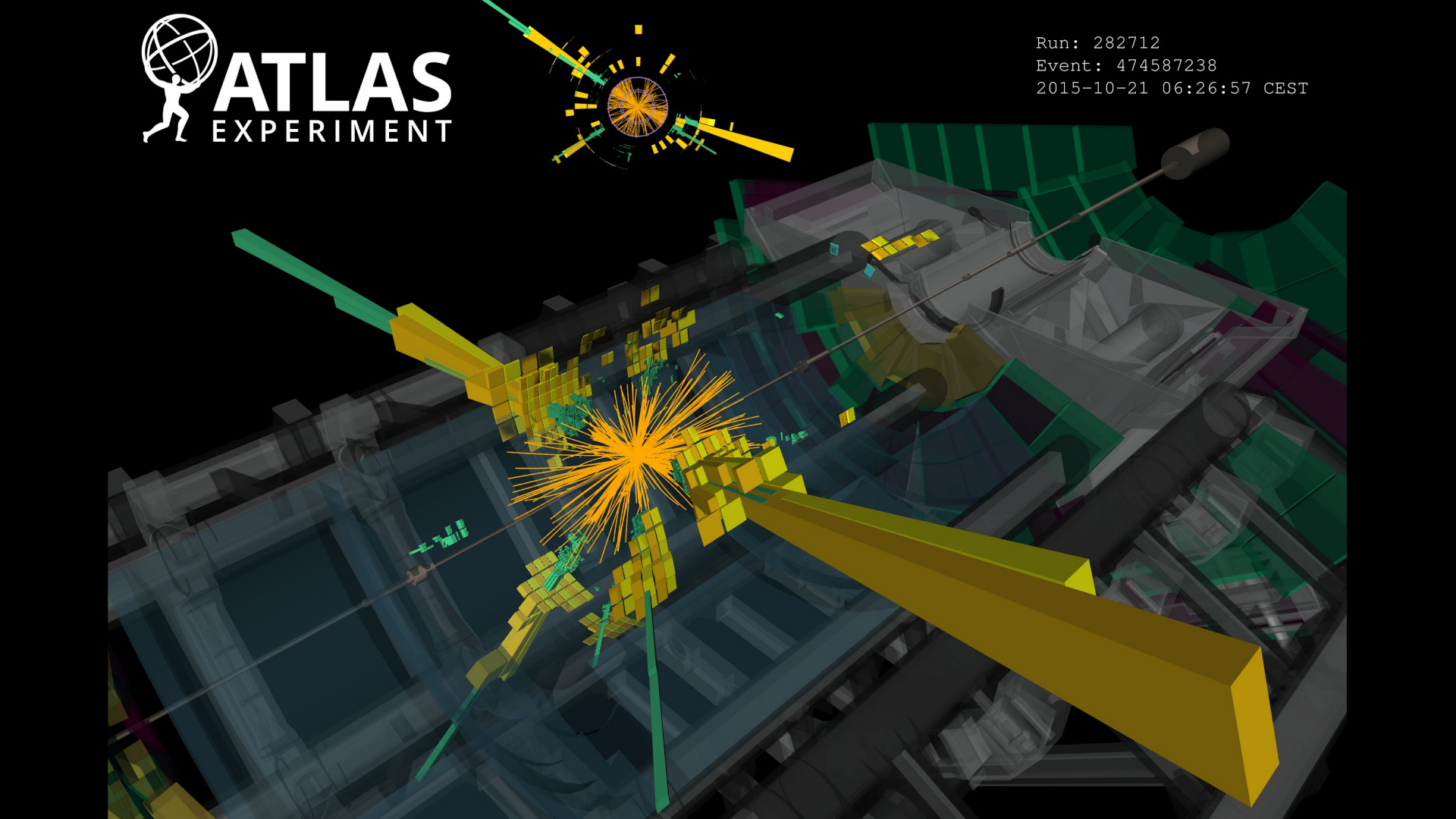
INFN e Università di Pisa

milene.calvetti@cern.ch giulia.di.gregorio@cern.ch

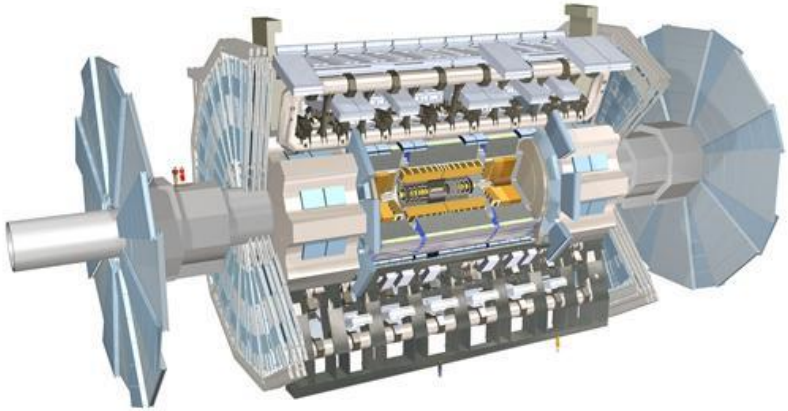

Geneve
Cern
ATLAS
LHCb
ALICE
LHC
CMS

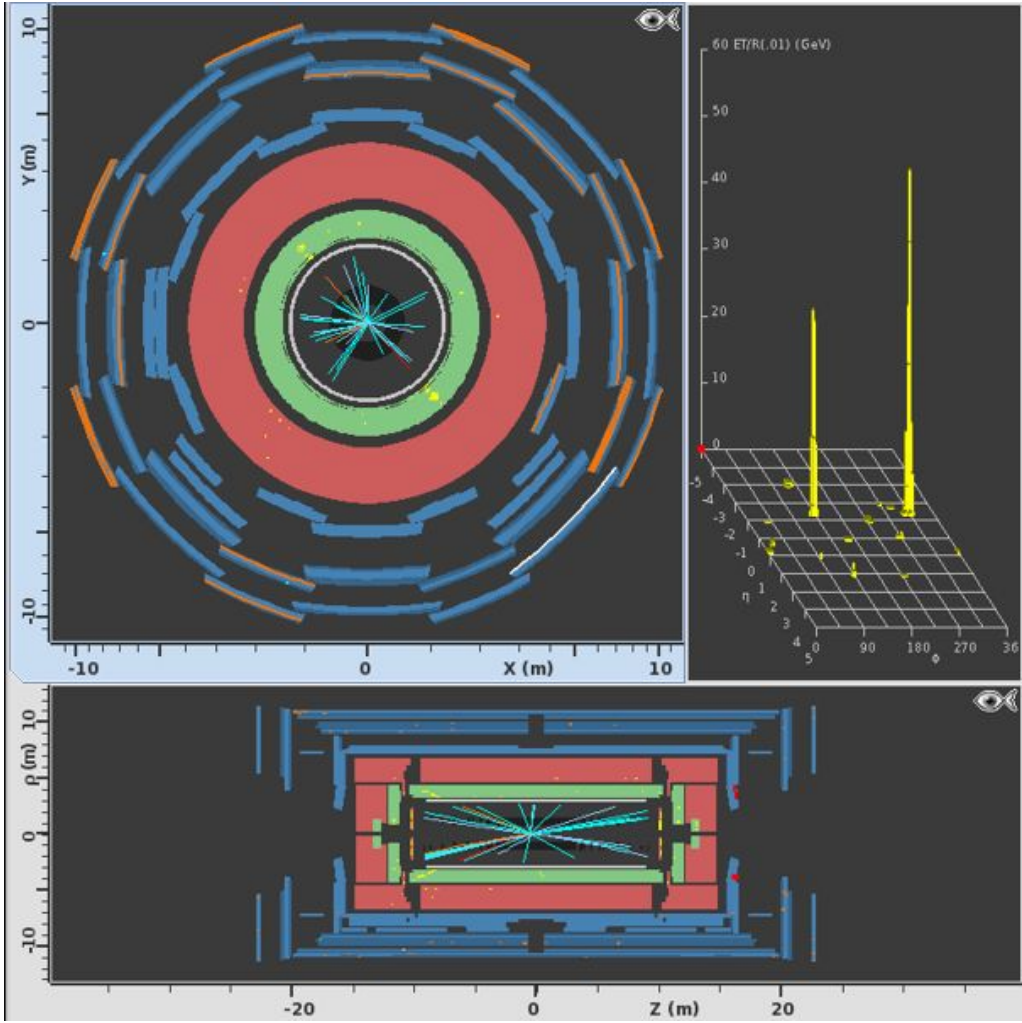
Rivelatore ATLAS



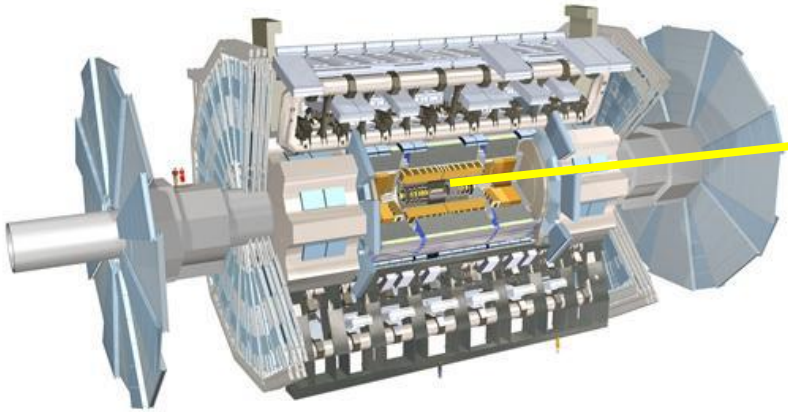

ATLAS
EXPERIMENT
Run: 282712
Event: 474587238
2015-10-21 06:26:57 CEST

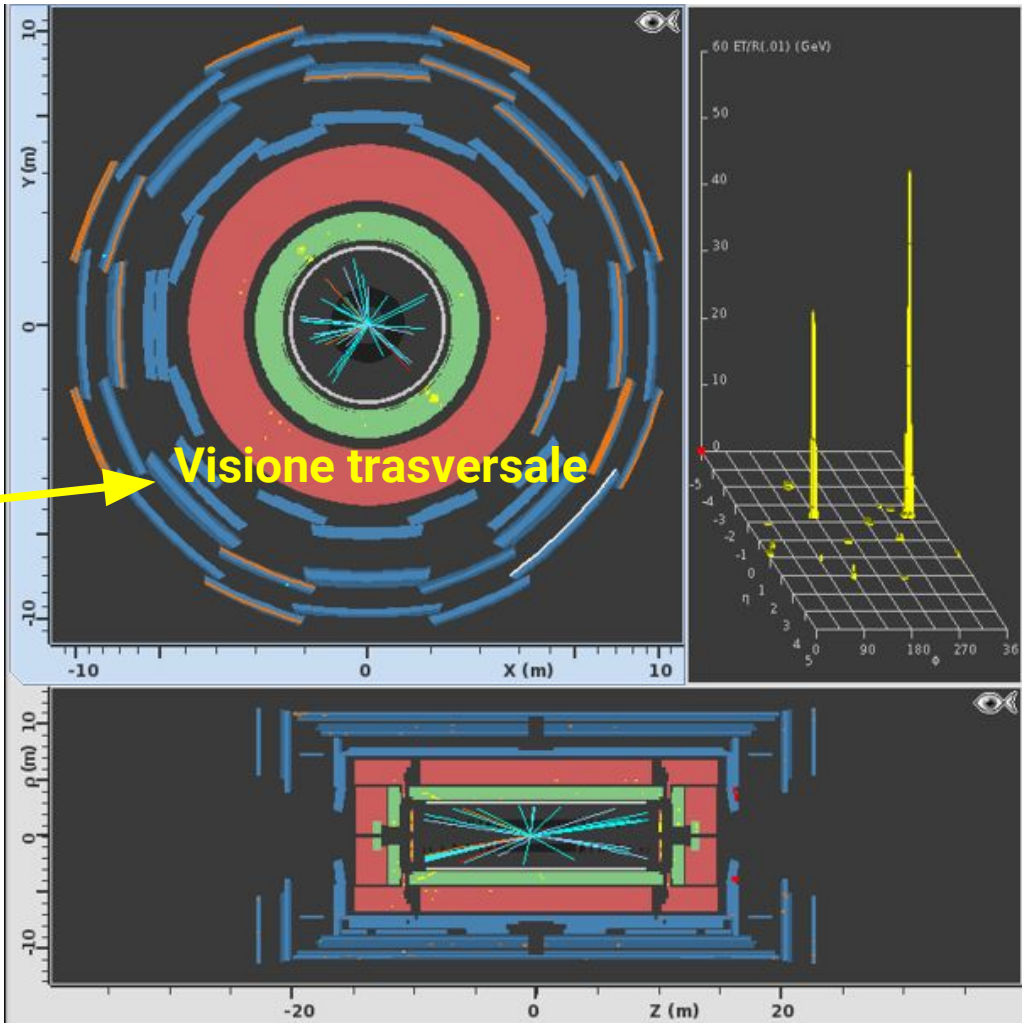
Rappresentare gli eventi



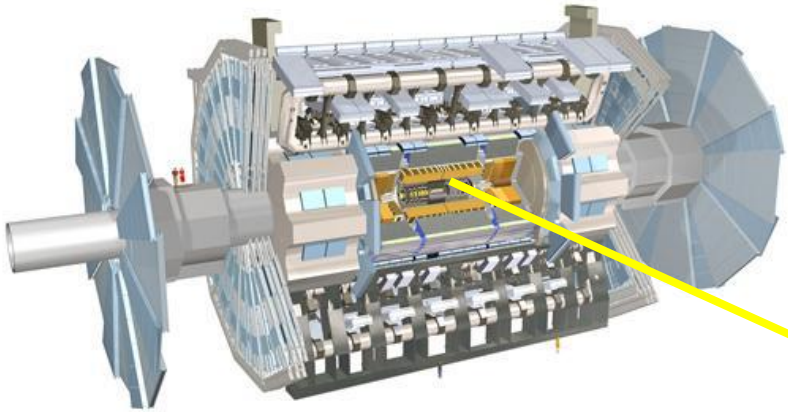


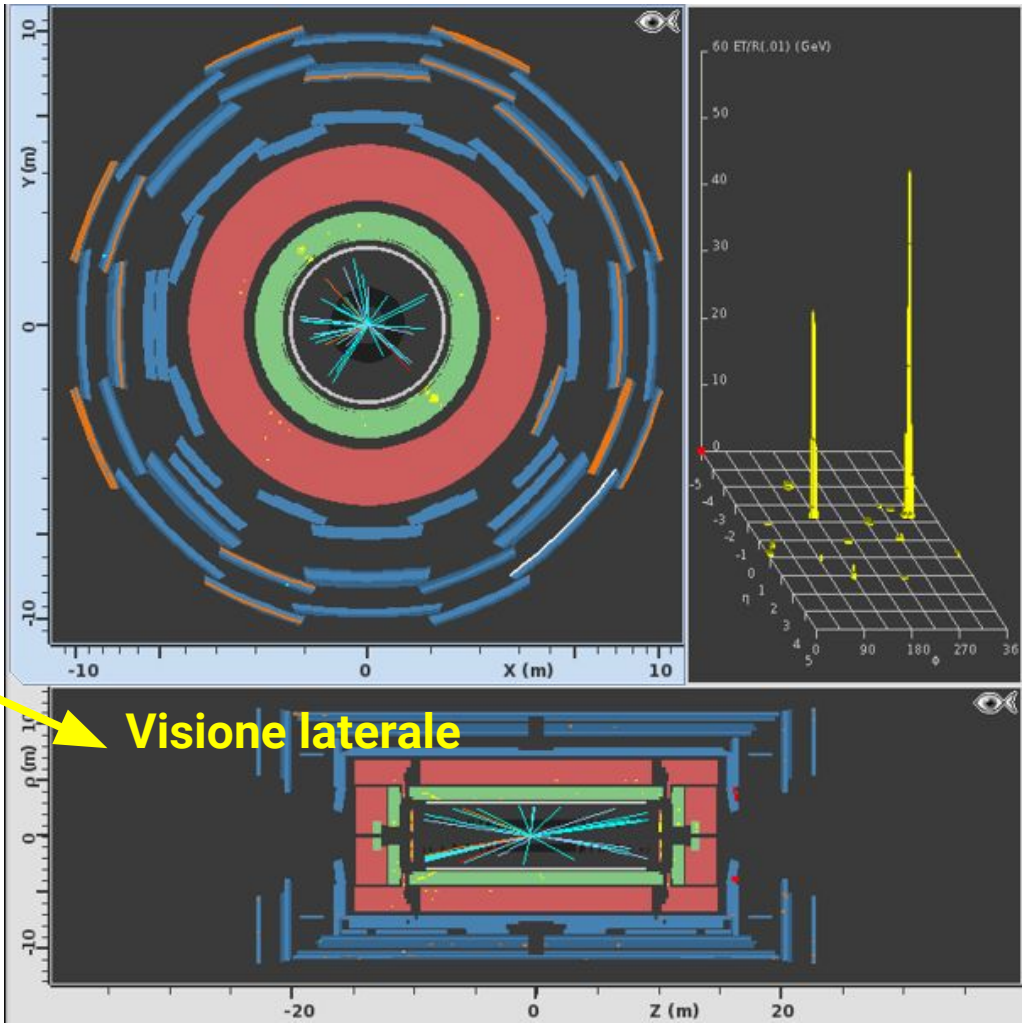
Rappresentare gli eventi



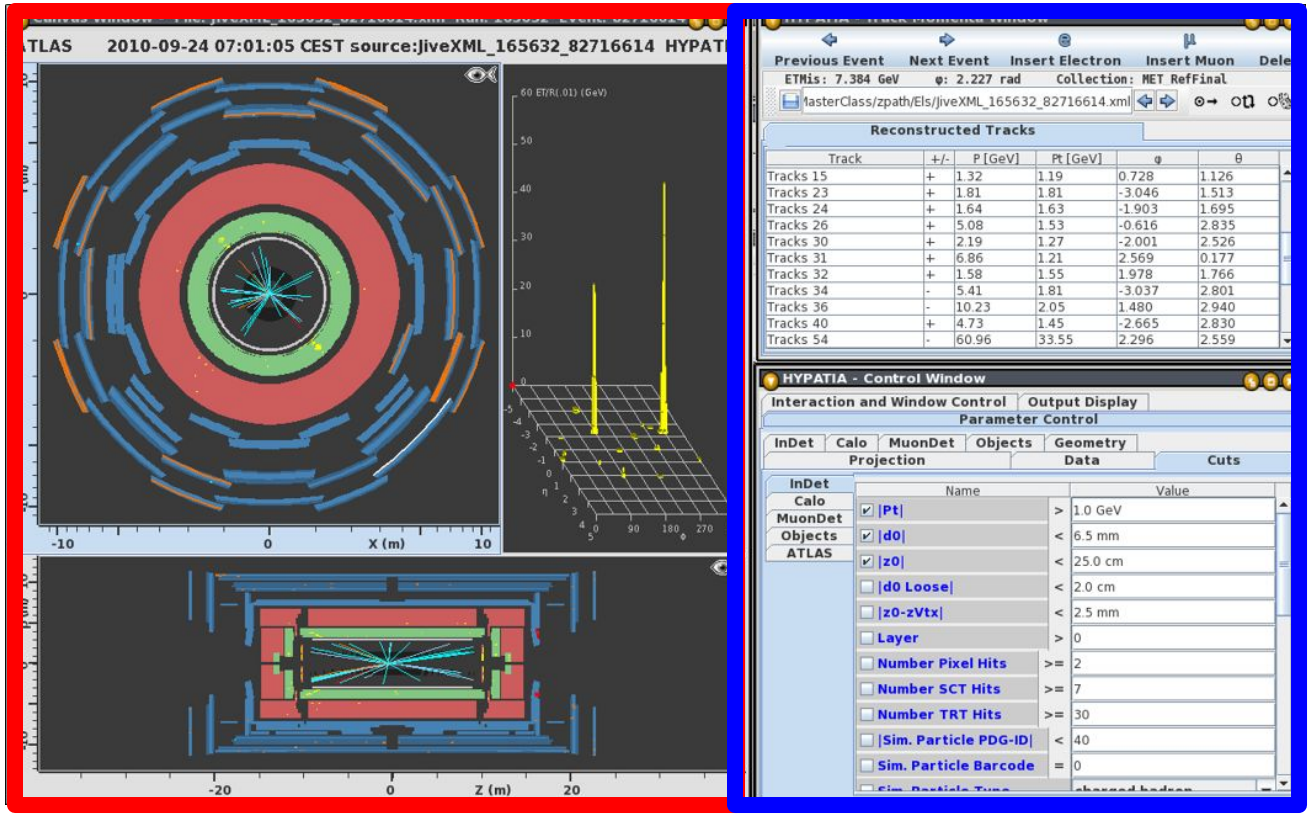


Rappresentare gli eventi





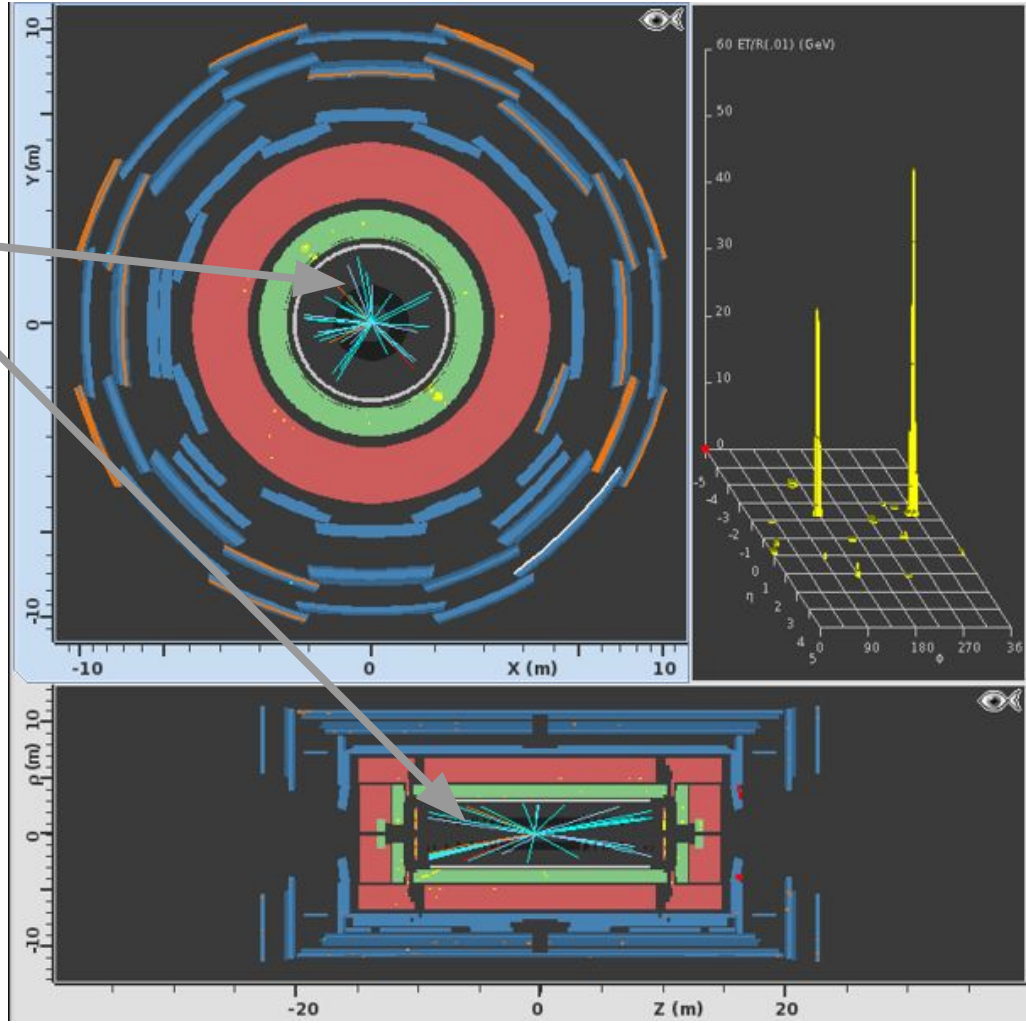
HYPATIA (**Hy**brid **P**upil's **A**nalysis **T**ool for **I**nteractions in **A**tlas)



Ipàzia
(Ὑπατία, Alessandria d'Egitto, 355/370 - 415)

Event display

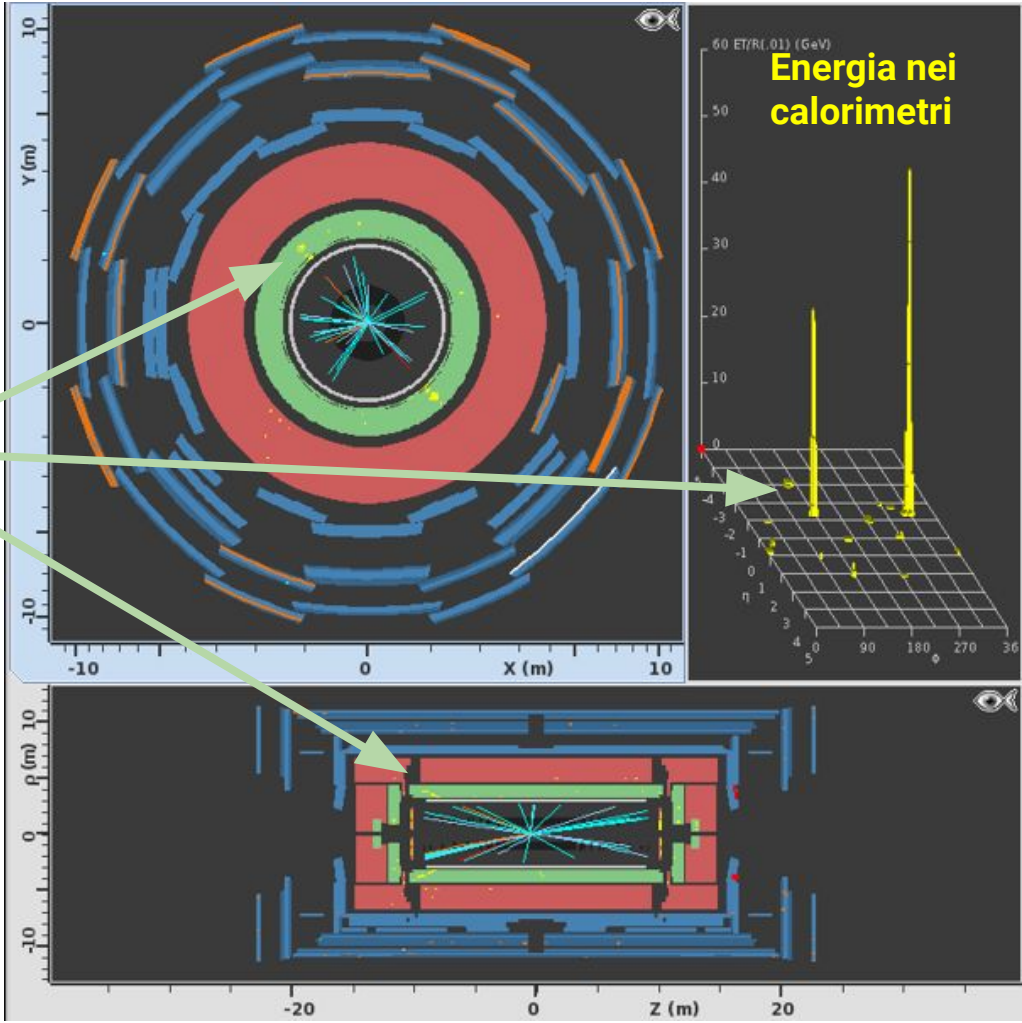
Tracciatore:
particelle cariche



Event display

Tracciatore:
particelle cariche

Calorimetro elettromagnetico:
elettroni (e-), positroni (e+) e fotoni.

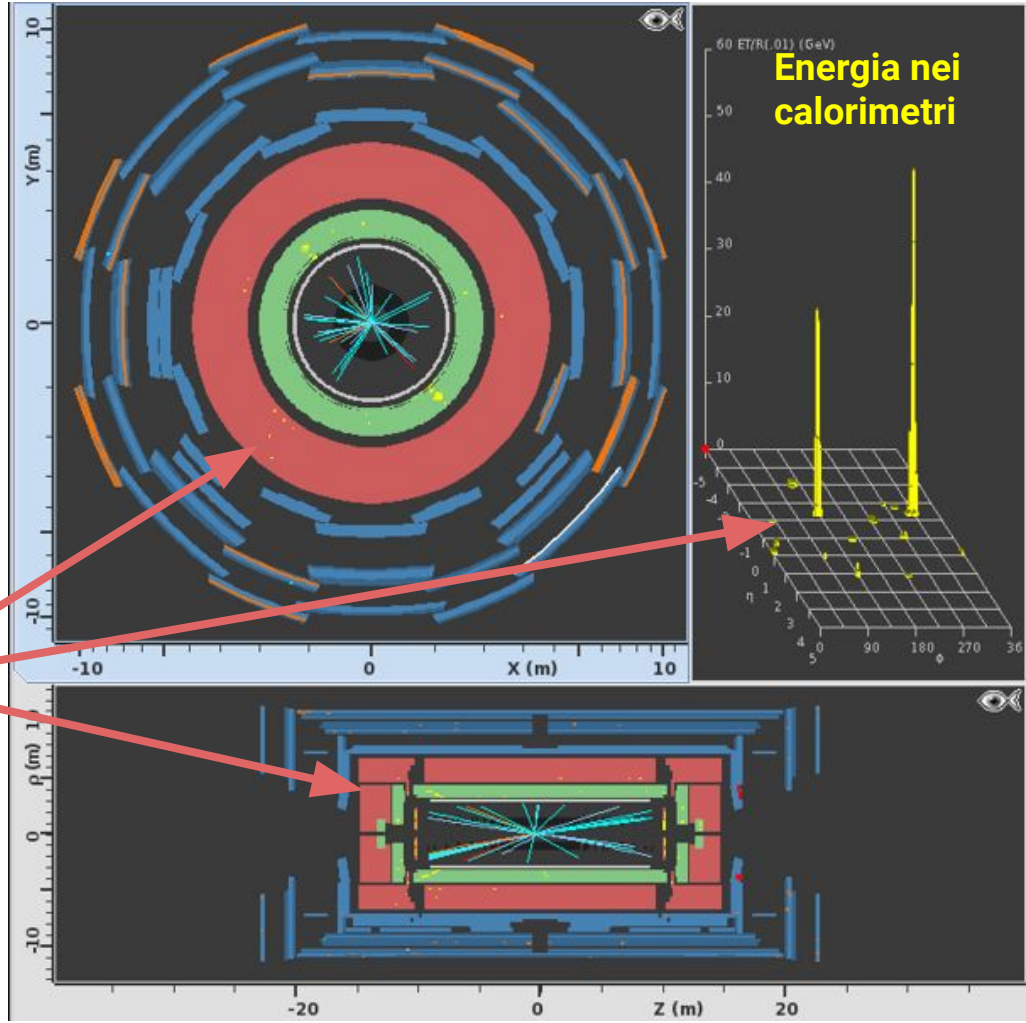


Event display

Tracciatore: particelle cariche

Calorimetro elettromagnetico: elettroni (e-), positroni (e+) e fotoni.

Calorimetro adronico: adroni (es: protoni, neutroni)



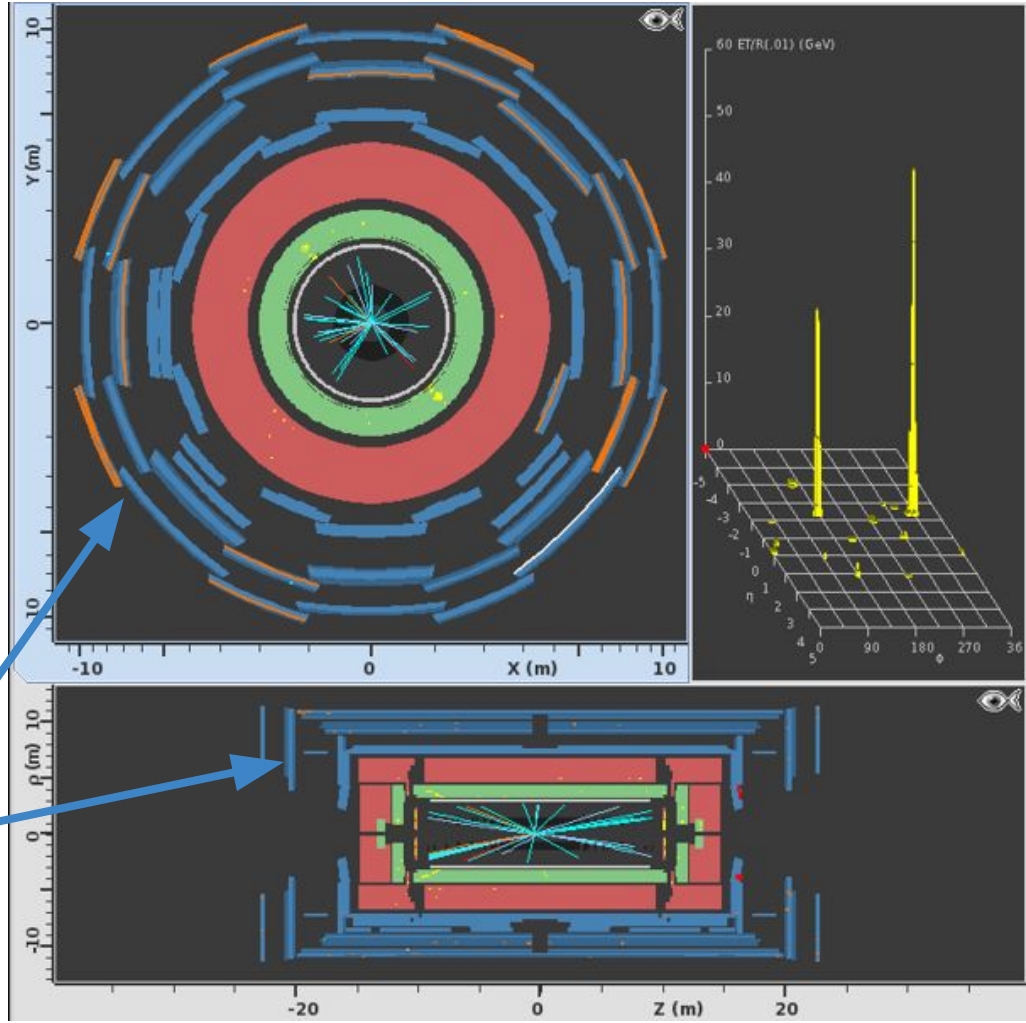
Event display

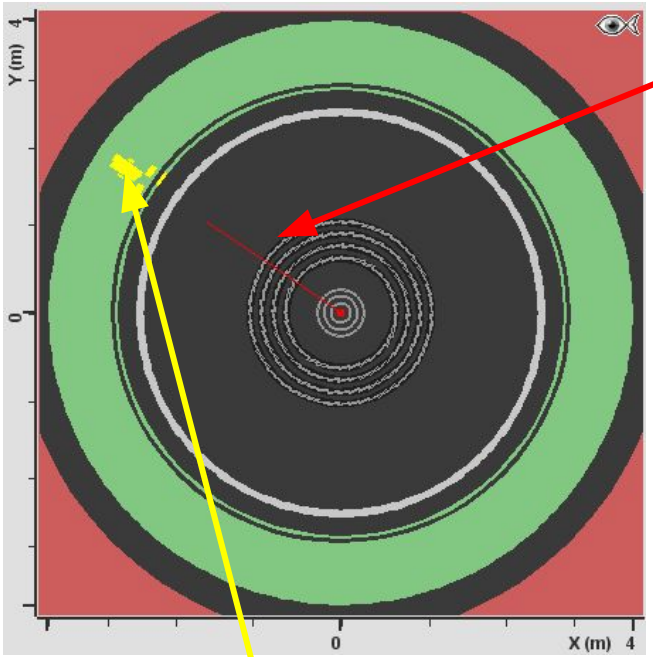
Tracciatore:
particelle cariche

Calorimetro elettromagnetico: elettroni (e-), positroni (e+) e fotoni.

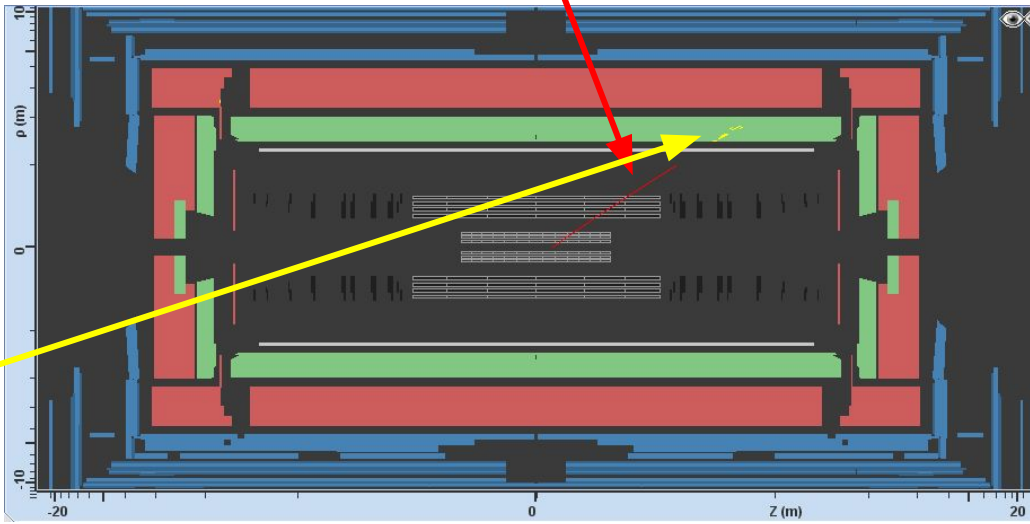
Calorimetro adronico: adroni (es: protoni, neutroni)

Rivelatori muoni



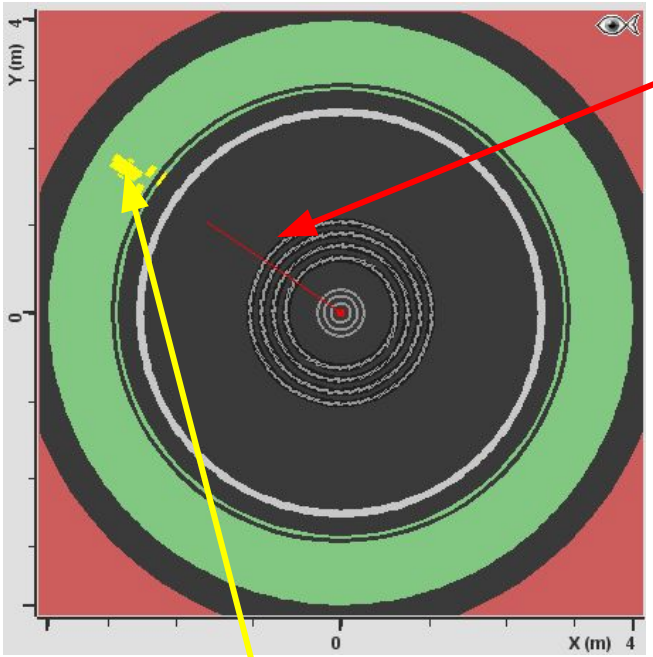


Traccia nel **tracciatore interno**



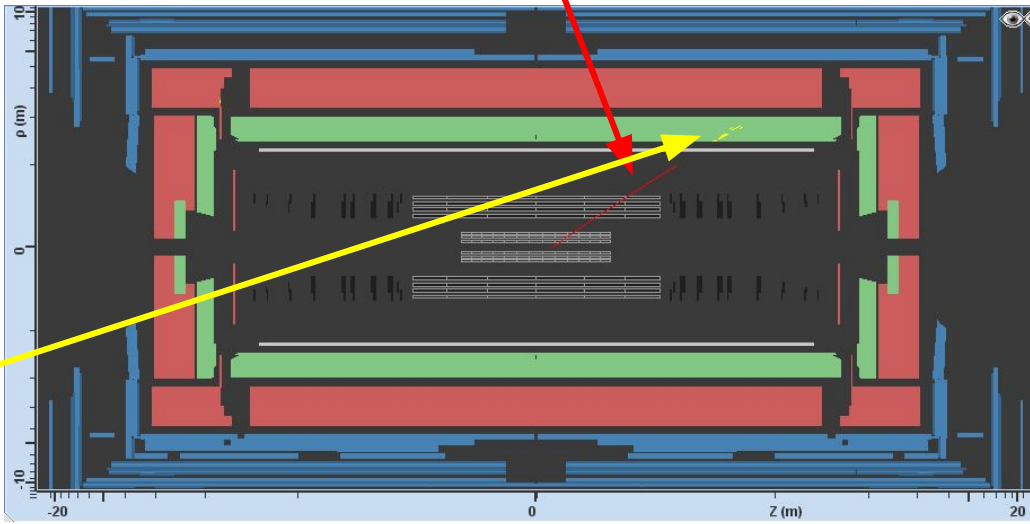
Energia nel **calorimetro elettromagnetico**

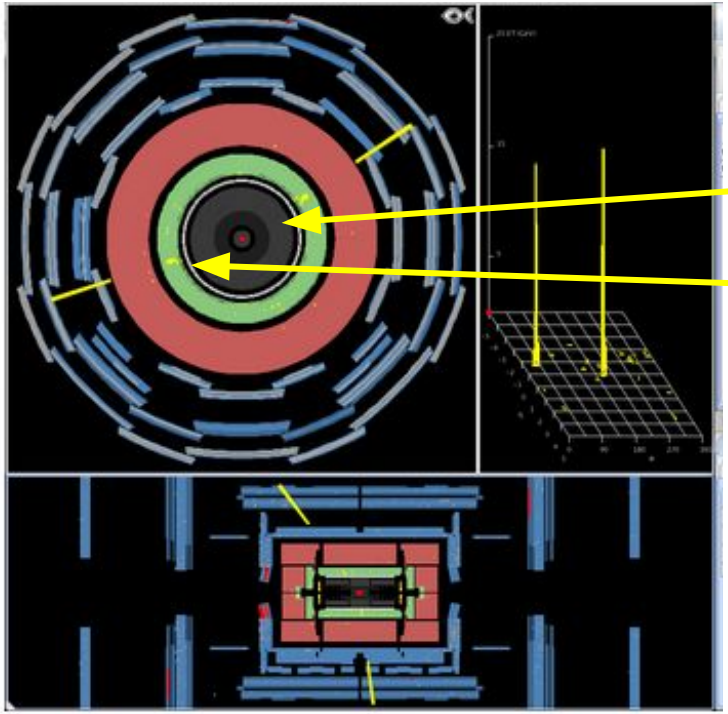
Identificazione elettroni (e^-) e positroni (e^+)



Traccia nel **tracciatore interno**

Energia nel **calorimetro elettromagnetico**

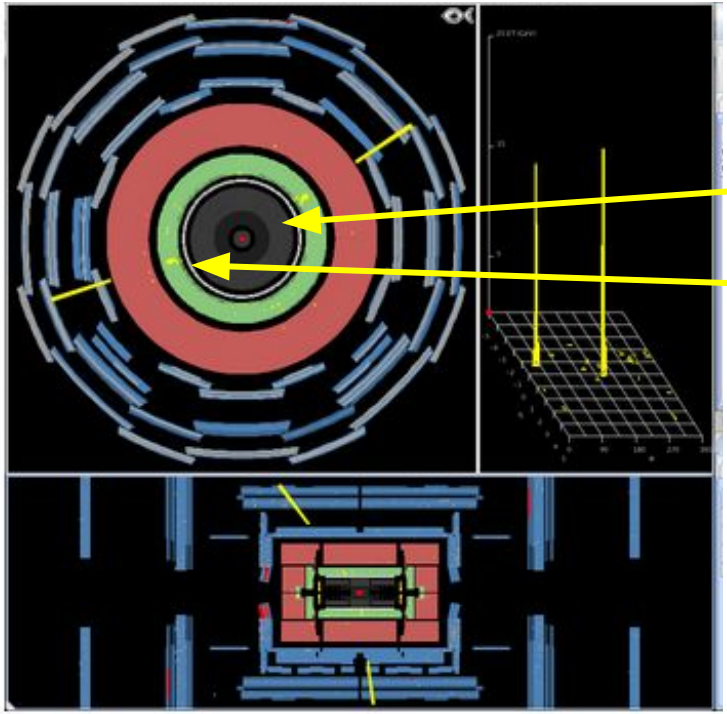




Neutri→ non lasciano tracce nel **tracciatore**

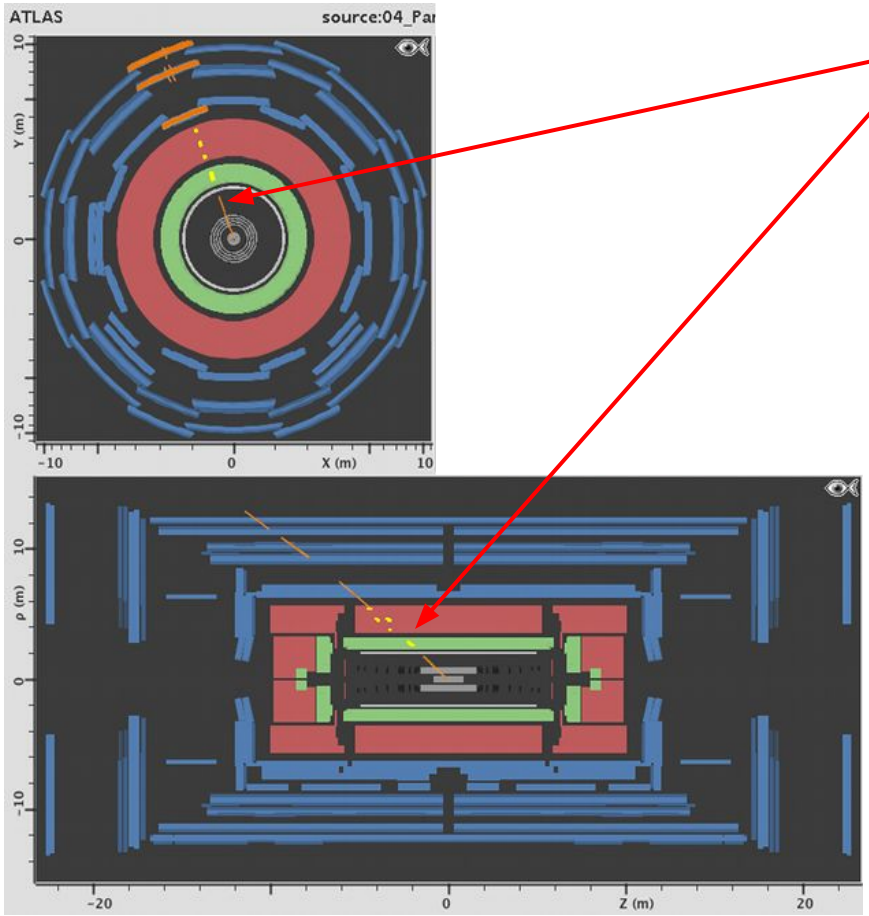
Solo nel **calorimetro elettromagnetico**

Identificazione fotoni

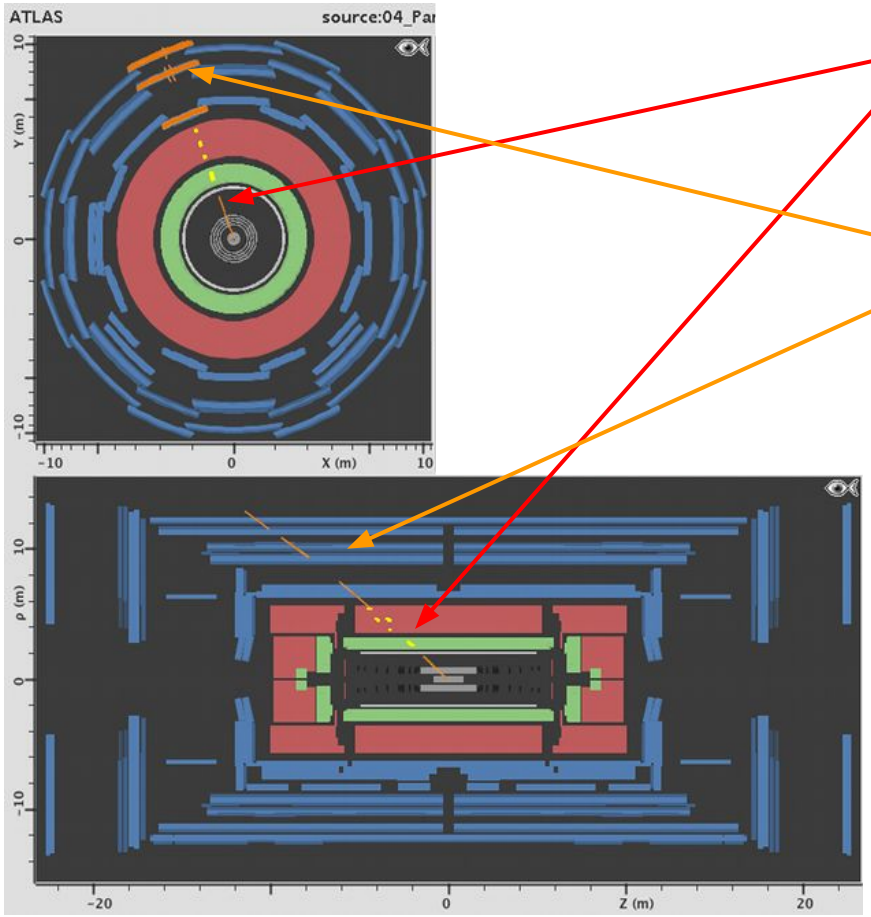


Neutri→ non lasciano tracce nel **tracciatore**

Solo nel **calorimetro elettromagnetico**



Traccia nel **tracciatore interno**

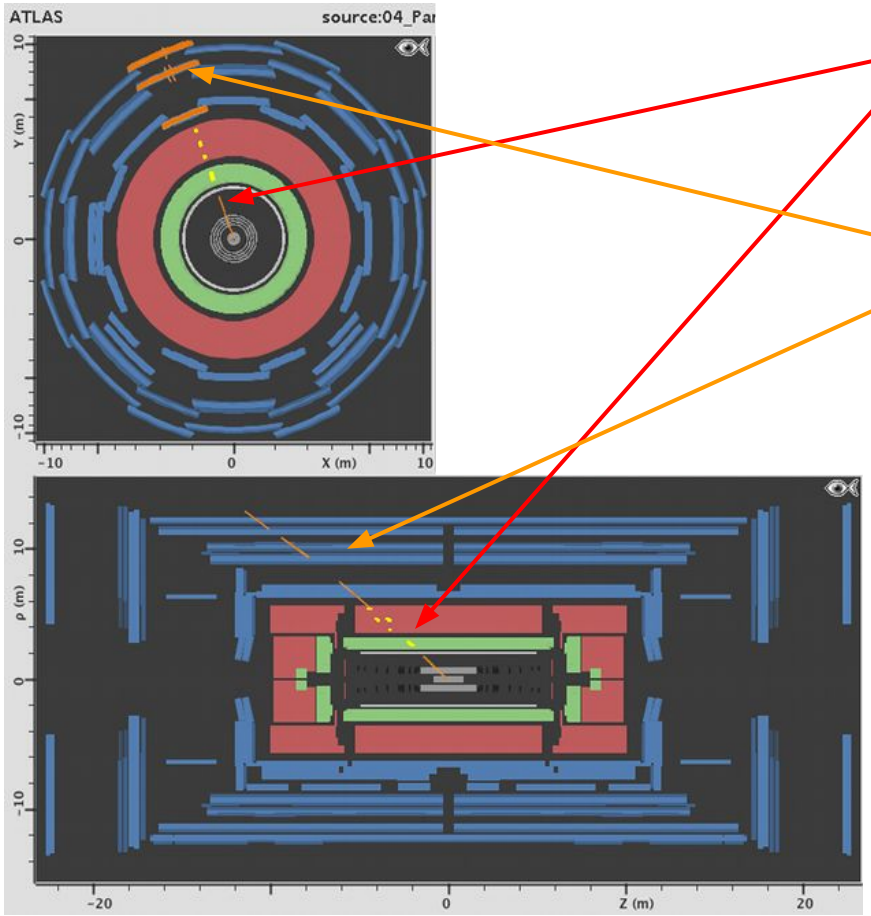


Traccia nel **tracciatore interno**

Traccia nel **rivelatore di muoni**

Poca attività nel **calorimetro elettromagnetico** e **adronico**

Identificazione muoni (μ^-) e antimuoni (μ^+)

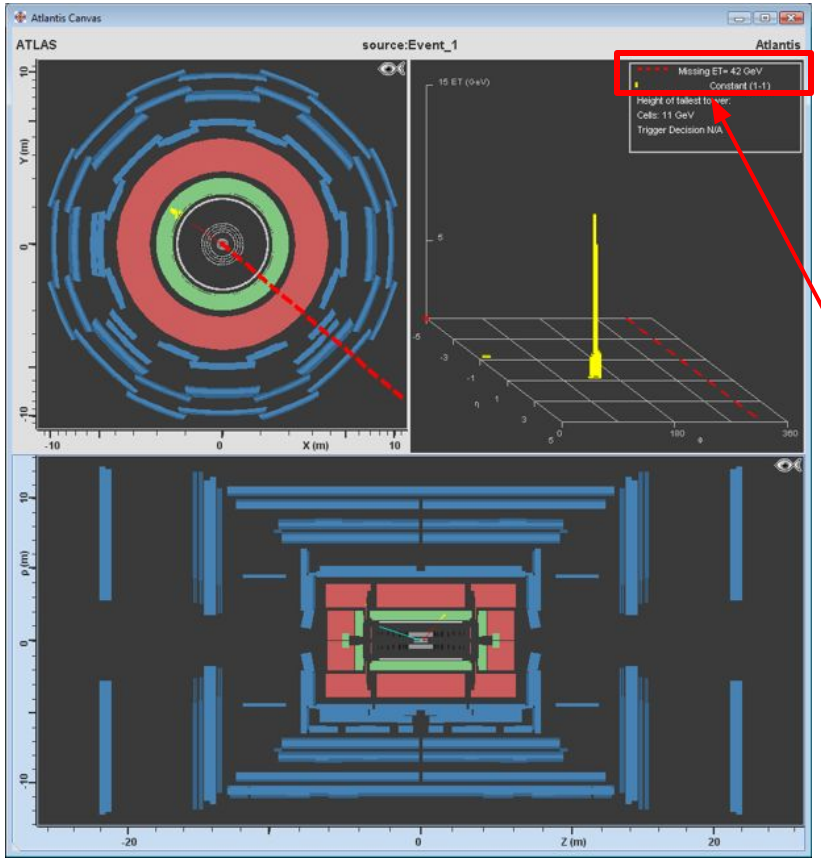


Traccia nel **tracciatore interno**

Traccia nel **rivelatore di muoni**

Poca attività nel **calorimetro elettromagnetico** e **adronico**

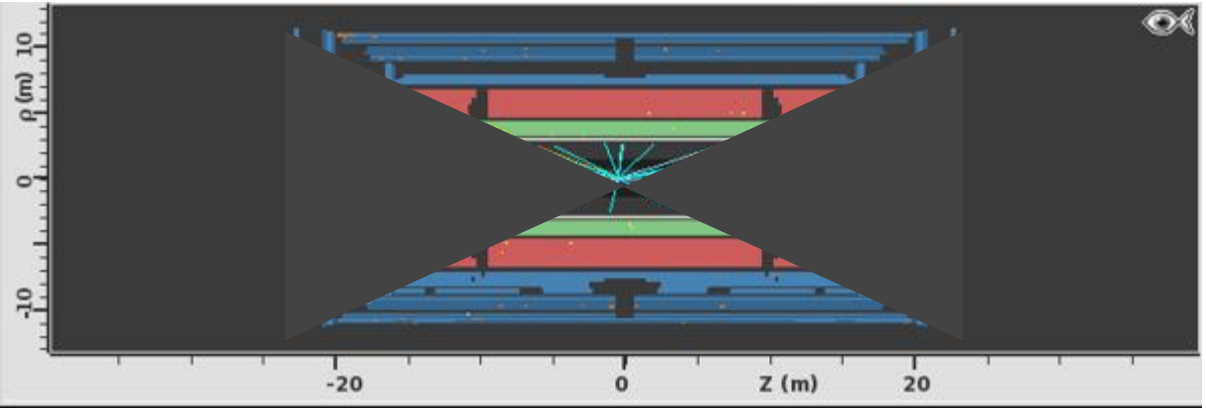
Identificazione neutrini

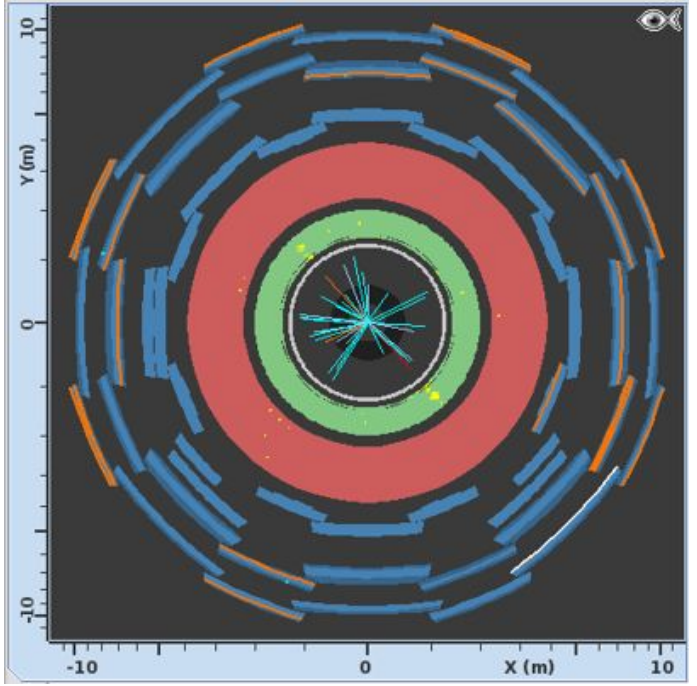


Trovati dal calcolo dell' "**impulso mancante**" sul piano trasverso

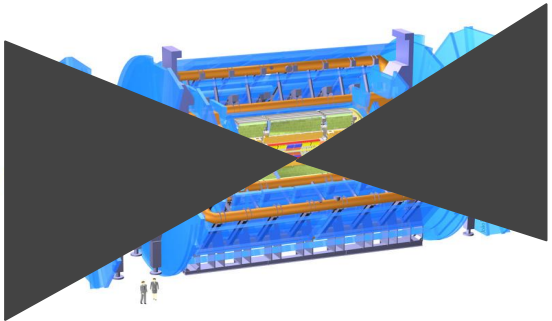
Valore dell'impulso del neutrino (Missing ET)

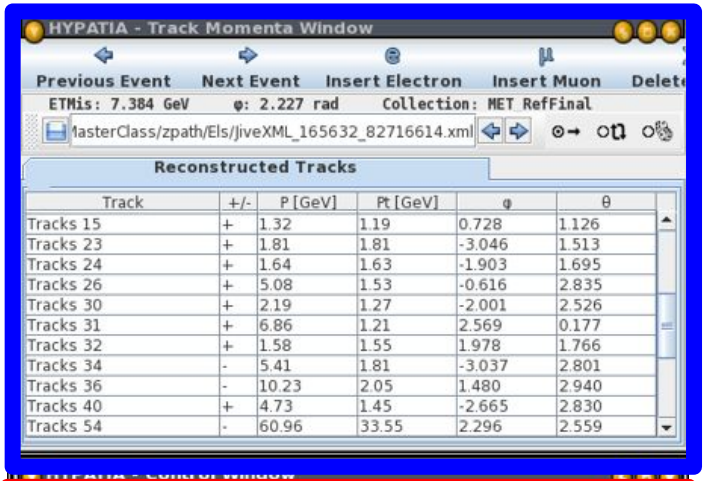
Event display



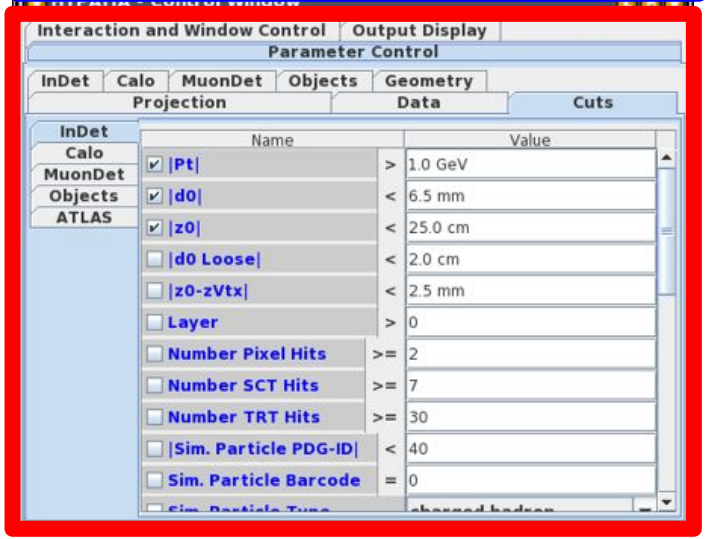


Solo le particelle ricostruite nella **regione centrale** sono visibili nella visione **trasversale**



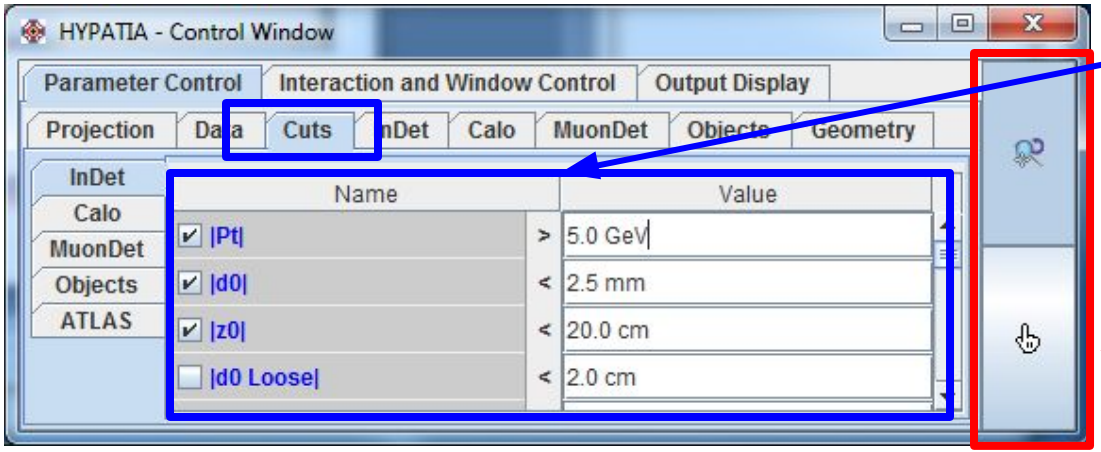


Particelle selezionate



Tagli sull'impulso

Selezione degli eventi



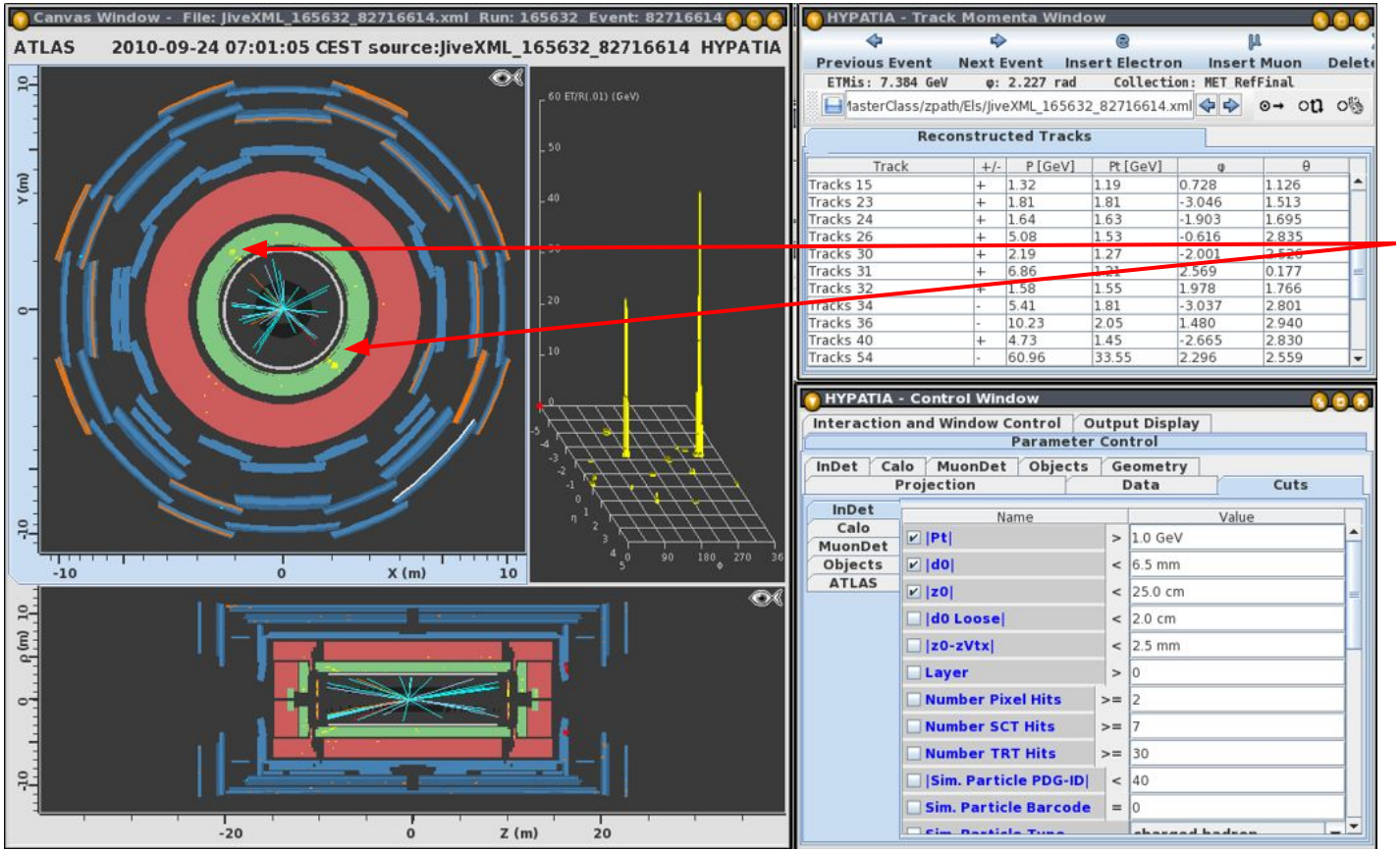
Tagli:criteri di selezione degli eventi

Zoom/Move/Rotate

Mostra informazioni per l'oggetto selezionato

$Z \rightarrow e^- e^+$

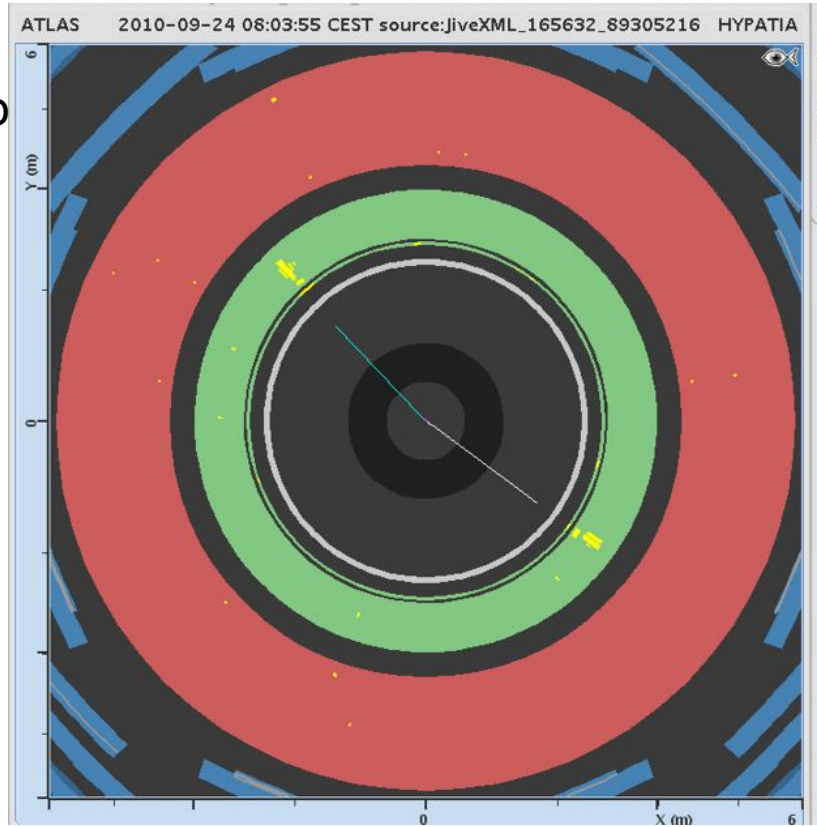
Il bosone Z è **neutro**.

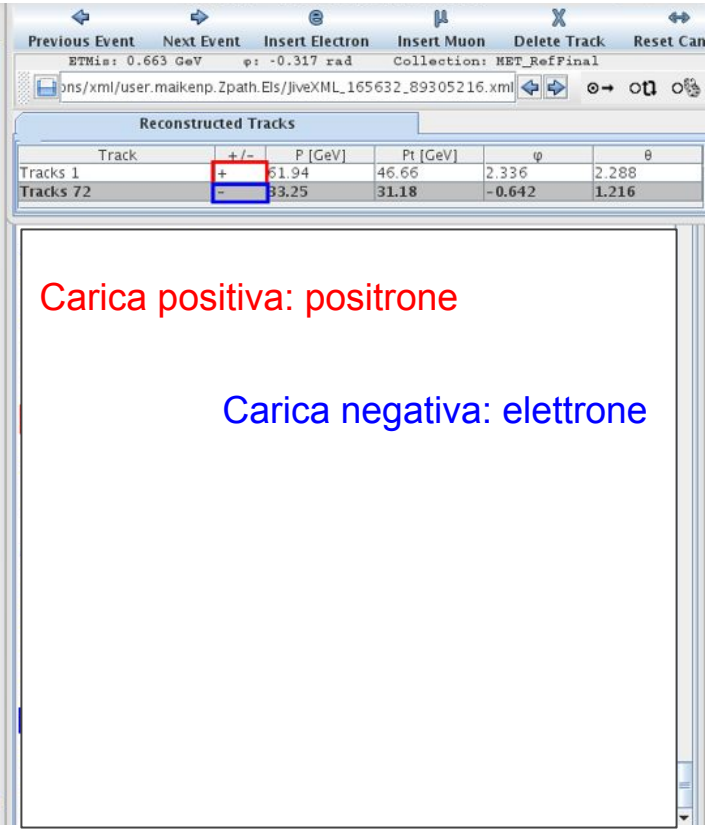


Elettrone e positrone

$Z \rightarrow e^- e^+$

Taglio sull'impulso
p_T>25 GeV

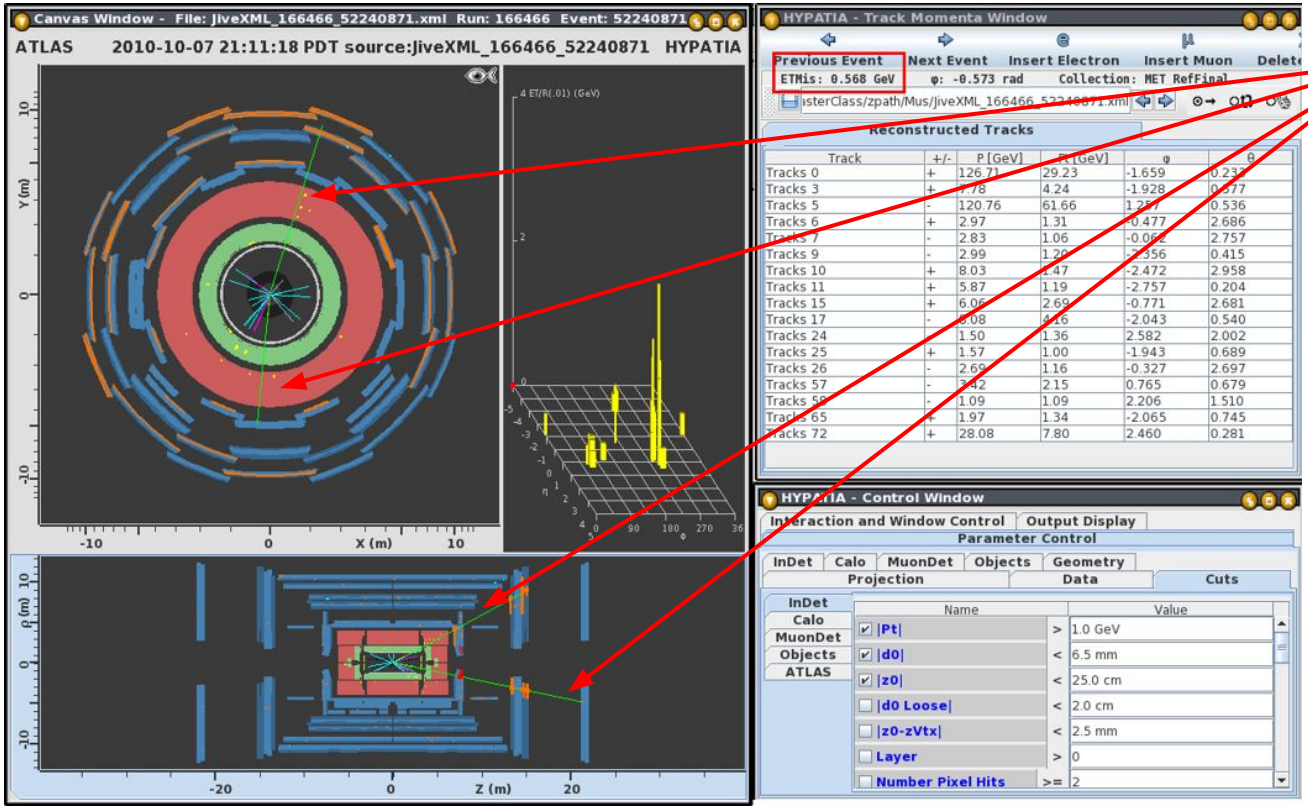




Carica positiva: positrone

Carica negativa: elettrone

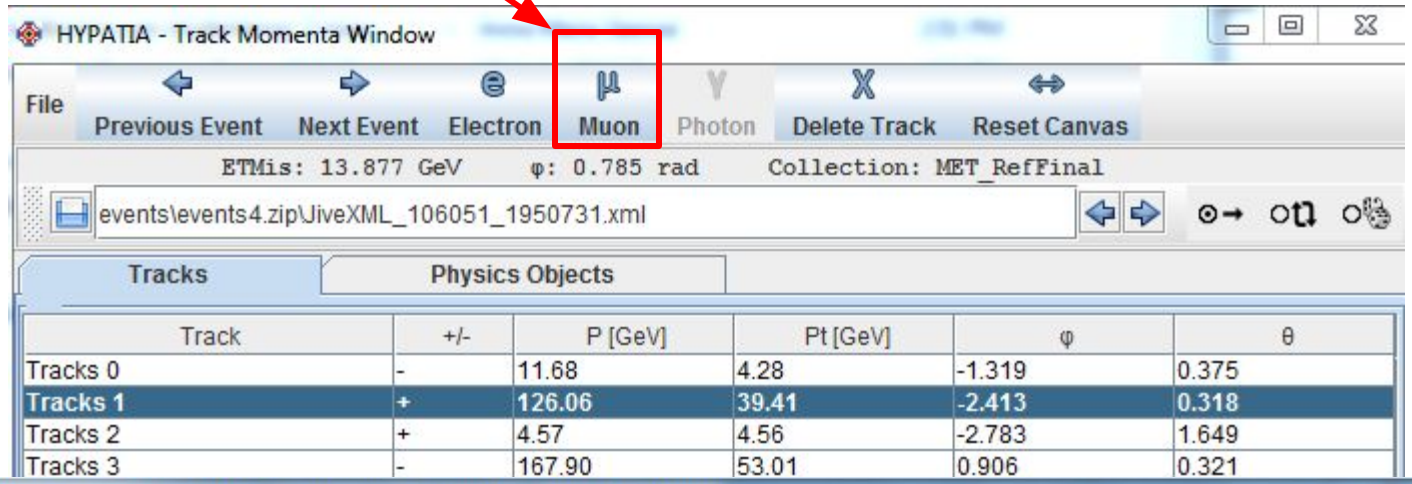
$Z \rightarrow \mu^{-}\mu^{+}$

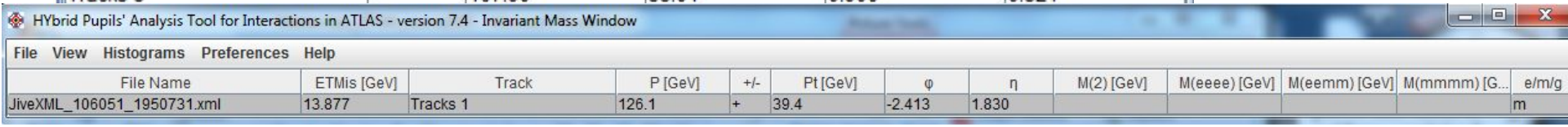


Muone e anti-muone

Cosa fare

Se pensi di aver visto una delle particelle sopra elencate, click sulla particella corrispondente

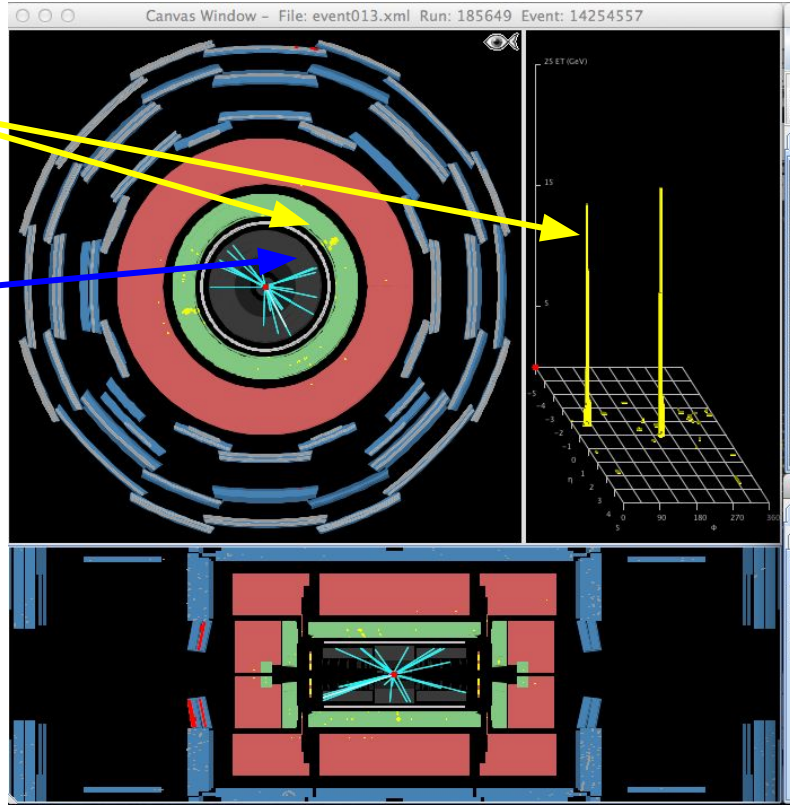


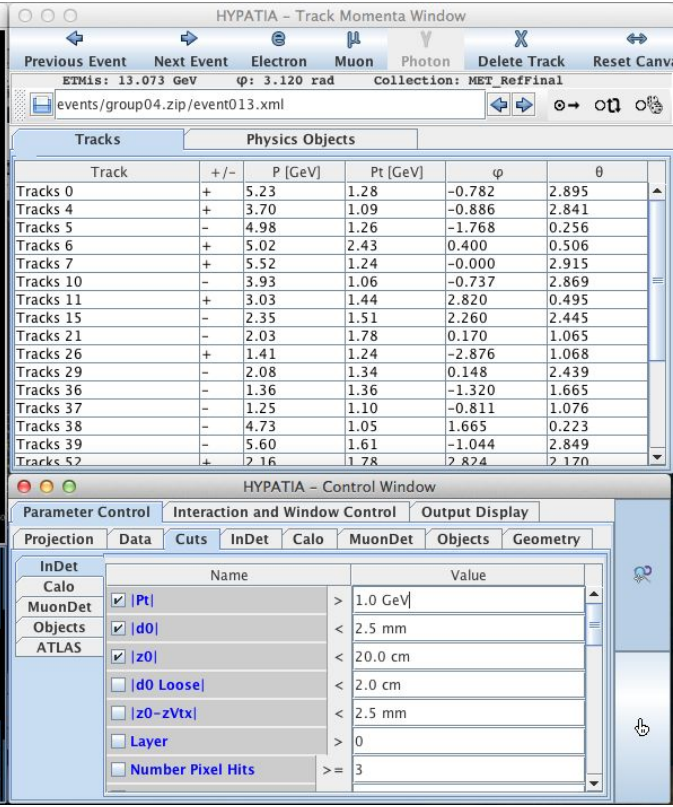


Higgs → fotone - fotone

Energia nel **calorimetro elettromagnetico**

No tracce vicino ai depositi → non sono elettroni

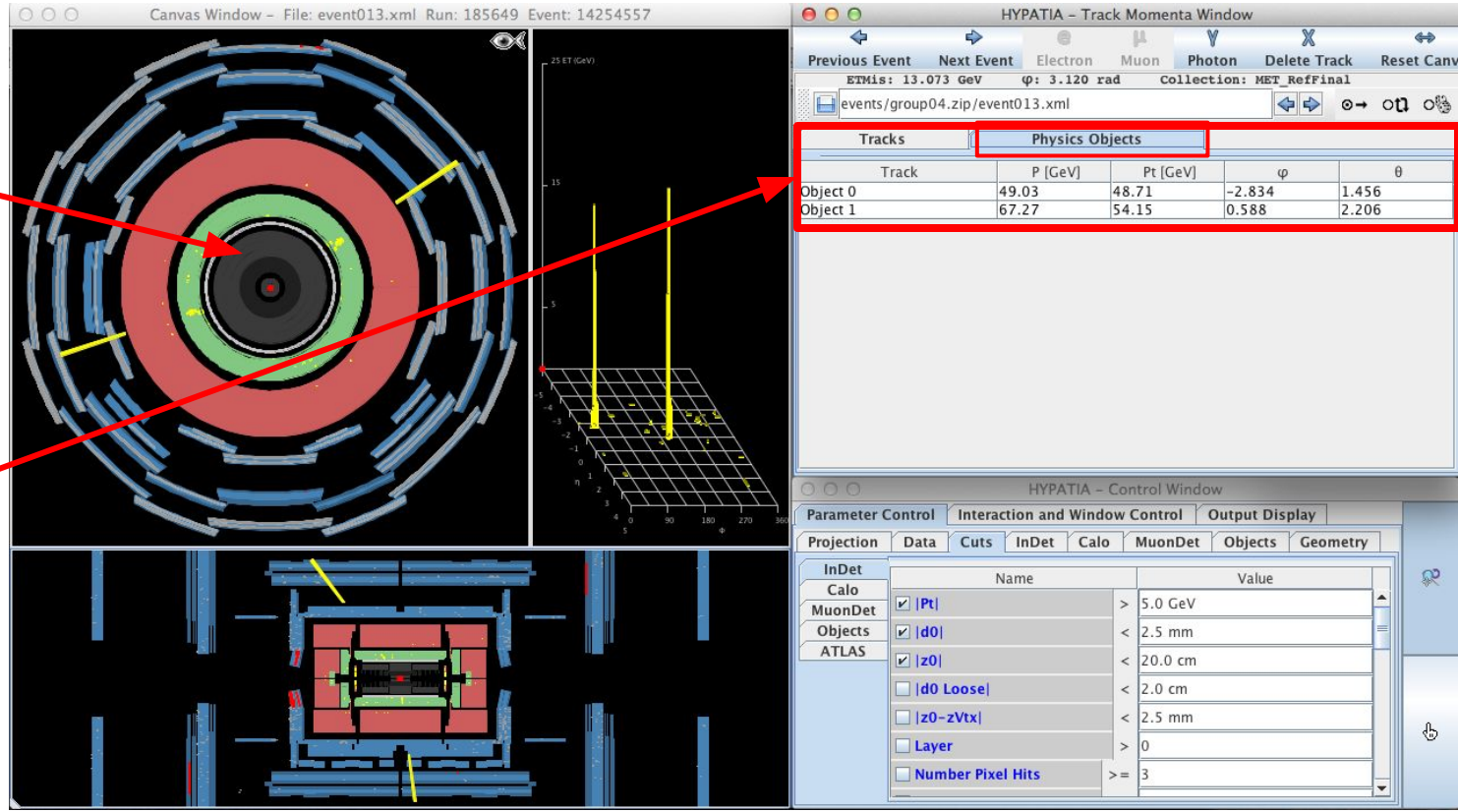




Higgs → fotone - fotone

Applicando un taglio p_T>5 GeV non vedo più le tracce nel **tracciatore**

I fotoni sono fra i "**Physics Objects**"



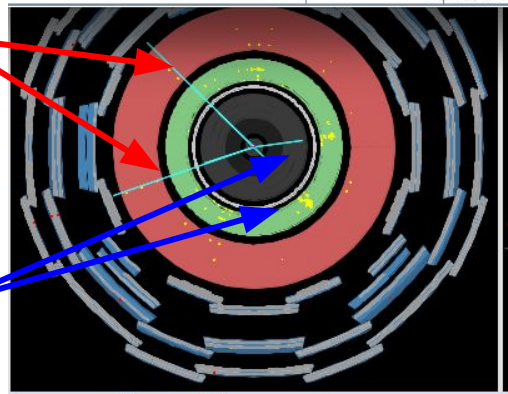
Higgs → 4 particelle cariche (es: H→ $e^+e^-\mu^+\mu^-$)

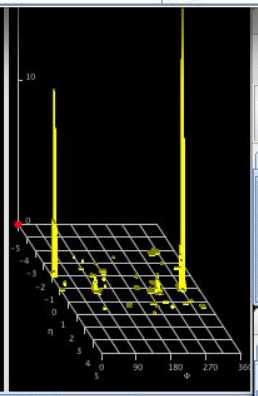
Il bosone H è **neutro**.

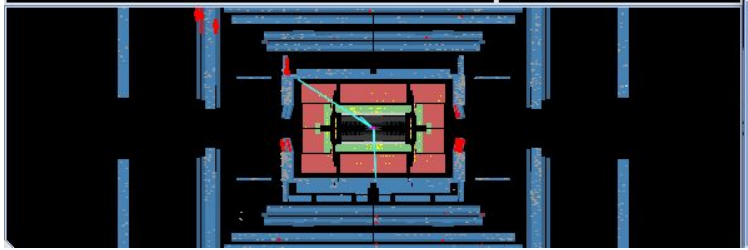
$\mu^+\mu^-$

e^+e^-

File Name	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	φ	η	M(2) [GeV]	M(4) [GeV]	e/m/g
event015.xml	8.258	Tracks 6	153.7	+	84.1	2.378	-1.212	91.056	291.010	m
		Tracks 72	35.5	-	35.4	-2.835	0.027			m
		Tracks 8	76.8	-	75.3	-0.804	0.200	89.645		e
		Tracks 11	67.6	+	44.9	0.154	-0.968			e







HYPATIA – Track Momenta Window

File | Previous Event | Next Event | Electron | Muon | Photon | Delete Track | Reset Canvas

ETMis: 8.258 GeV φ: 0.541 rad Collection: MET_RefFinal

events/group04.zip/event015.xml

Tracks | Physics Objects

Track	+/-	P [GeV]	Pt [GeV]	φ	θ
Tracks 6	+	153.74	84.09	2.378	2.563
Tracks 8	-	76.79	75.28	-0.804	1.372
Tracks 11	+	67.65	44.90	0.154	2.416
Tracks 72	-	35.46	35.44	-2.835	1.544

HYPATIA – Control Window

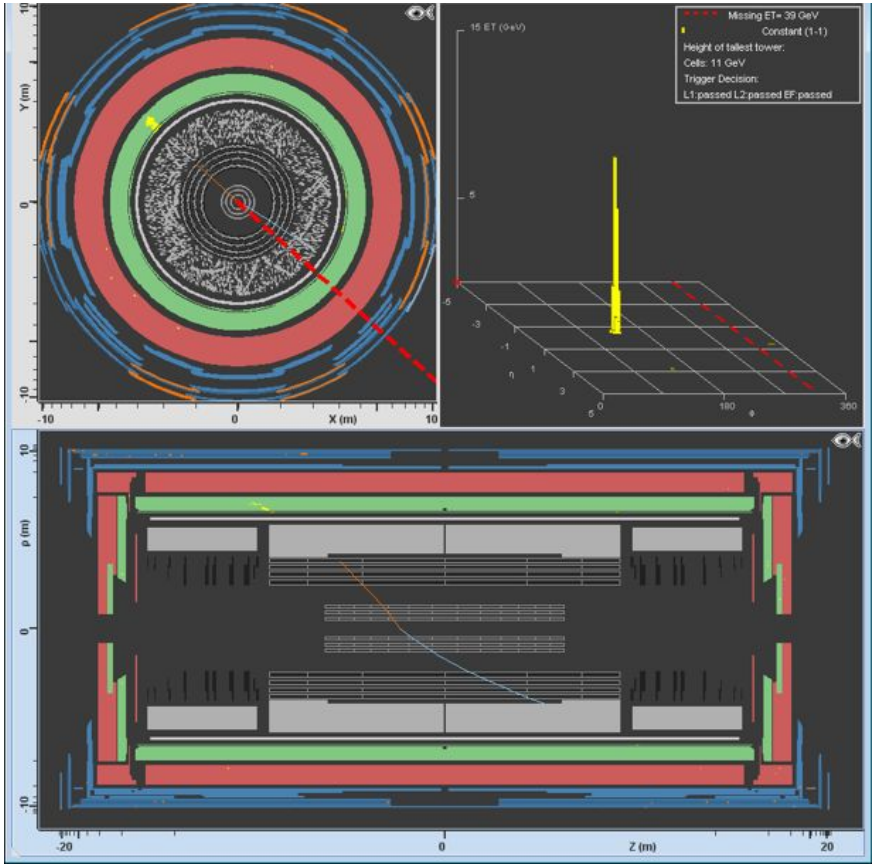
Parameter Control | Interaction and Window Control | Output Display

Projection | Data | Cuts | InDet | Calo | MuonDet | Objects | Geometry

InDet | Calo | MuonDet | Objects | ATLAS

Name		Value
☑ |Pt|	>	12.0 GeV
☑ |z0|	<	20.0 cm
☐ |d0 Loose|	<	2.0 cm
☐ |z0-zVtx|	<	2.5 mm
☐ Layer	>	0

Fondo: W→ ev



Riconoscere W→ ev (o W→μv)

- Grande impulso trasverso mancante
- Una sola traccia carica

Scopo dell'esercizio

Obiettivo: Misurare la massa del **bosone Z** e di **eventuali altre particelle** presenti nel campione di dati (compreso il **bosone di Higgs**).

Identificare eventi con Z (**da salvare**) nei decadimenti:

- Elettrone (e^-) -positrone (e^+)
- Muone (μ^-)-antimuone (μ^+)

Identificare eventi con Higgs (**da salvare**) nei decadimenti:

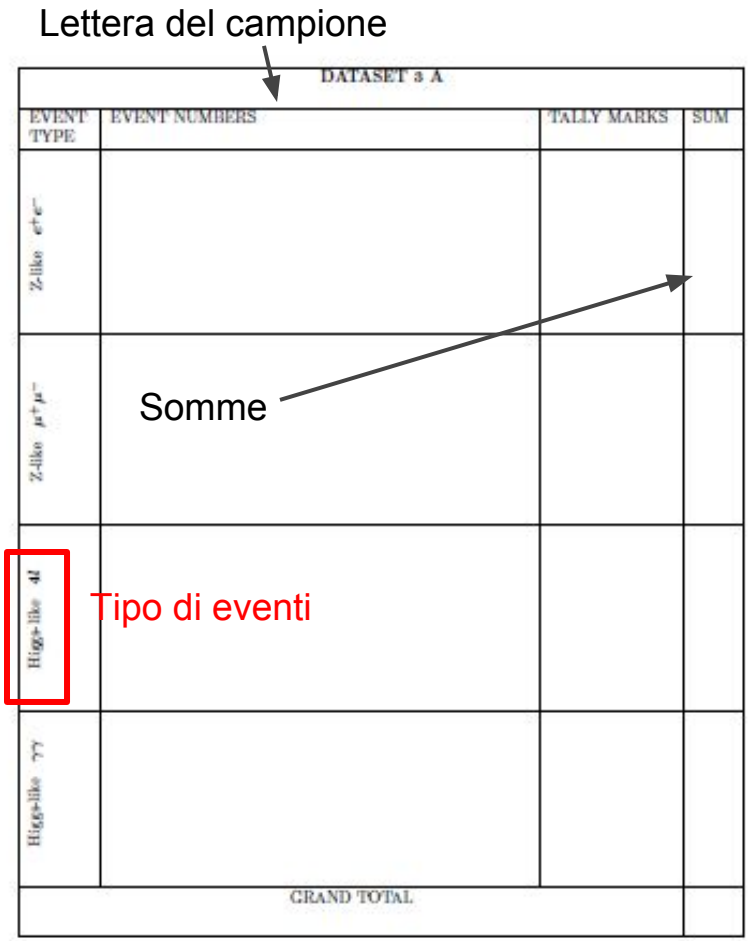
- Due coppie di particelle cariche (e^+e^- e^+e^-, e^+e^- $\mu^+\mu^-$, $\mu^+\mu^-$ $\mu^+\mu^-$)
- fotone - fotone

Identificare eventi dovuti ad altri processi (**da ignorare**):

- Jets
- Decadimenti di W (particella carica + neutrino)

Analisi dati

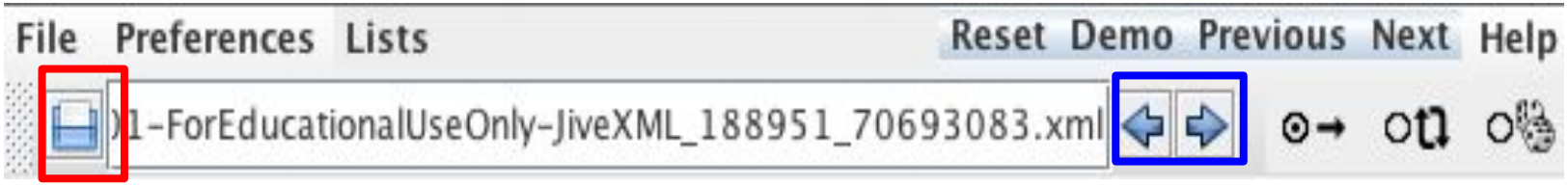
Ogni gruppo analizza un campione di **50 eventi** identificato con una lettera, indicata sul foglio



Aprire HYPATIA

1. Aprire ‘This PC’
2. Selezionare disco ‘share’
3. Selezionare ‘leone infn’
4. Selezionare ‘distribuzione’
5. Selezionare ‘ATLAS’
6. Selezionare ‘esercizio’
7. Doppio click su Hypatia_7.4_Masterclass Executable Jar File

Caricare gli eventi



Click sul dischetto e selezionare i dati che vi sono stati assegnati

Frecce blu → scorrere gli eventi

Cosa fare

- **Ignora** gli eventi di fondo:
  - Jets
  - Decadimenti di W (particella carica + neutrino)
- Ricorda di **selezionare** coppie coerenti:
  - elettrone (e^-) -positrone (e^+) } Z
  - muone (μ^-)-antimuone (μ^+) } Z
  - e^+e^- e^+e^-
  - e^+e^- $\mu^+\mu^-$
  - $\mu^+\mu^-$ $\mu^+\mu^-$
  - fotone - fotone

  } Higgs
- Dopo aver analizzato tutti gli eventi, **esporta** i risultati:
  - File→ Export Invariant Masses.
  - Save in: leone infn → risultati→ ATLAS
  - Il nome da dare al file e` Invariant_Masses_3**X**.txt
    con **X** corrispondente alla propria ‘lettera’