INTERNATIONAL MASTERCLASSES

hands on particle physics

Hands On session

Andrea Di Luca
per il comitato organizzatore

OBIETTIVO MISSIONE

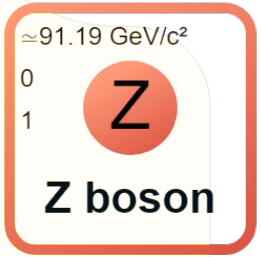
Misurare la massa del **bosone Z** e di eventuali altre particelle presenti nel campione di dati, compreso il **bosone di Higgs**.

1. **Identificare eventi con Z** nei decadimenti:
   a. Elettrone (e^-) -positrone (e^+)
   b. Muone (μ^-)-antimuone (μ^+)

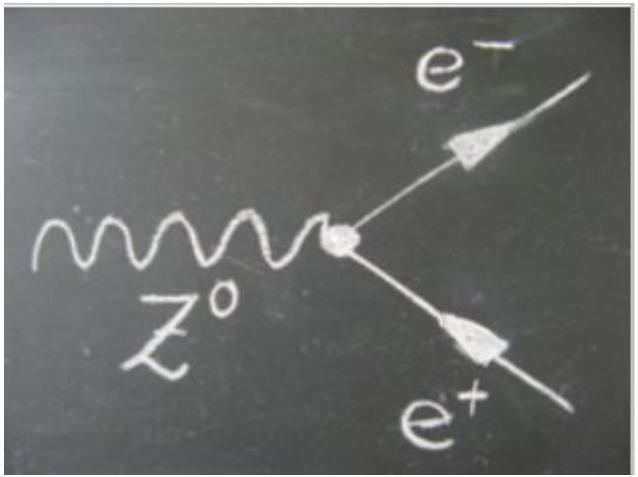
2. **Identificare eventi con Higgs** nei decadimenti:
   a. Due coppie di particelle cariche (e^+e^- e^+e^- , e^+e^- $\mu^+\mu^-$, $\mu^+\mu^-$ $\mu^+\mu^-$)
   b. fotone - fotone

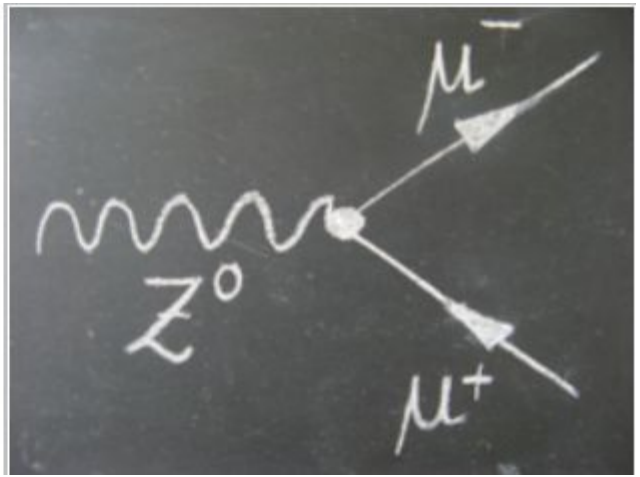
Obiettivo #1
bosone Z

mass
charge
spin



COPPIA
LEPTONE-ANTILEPTONE





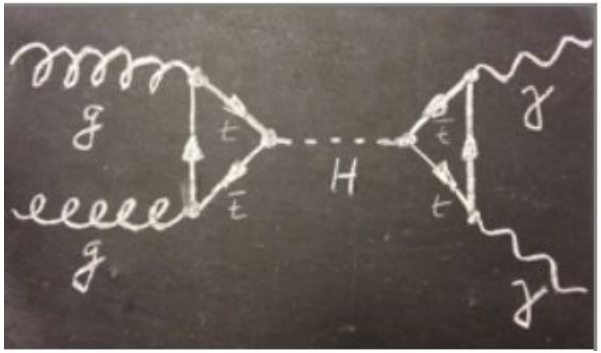
Obiettivo #2
bosone di Higgs

mass	≃124.97 GeV/c²
charge	0
spin	0

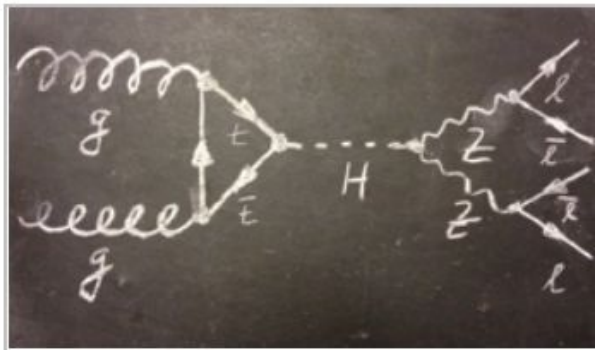
H

higgs

COPPIA FOTONE-FOTONE

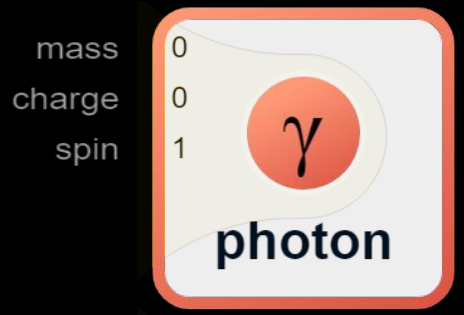


COPPIA BOSONI Z^0



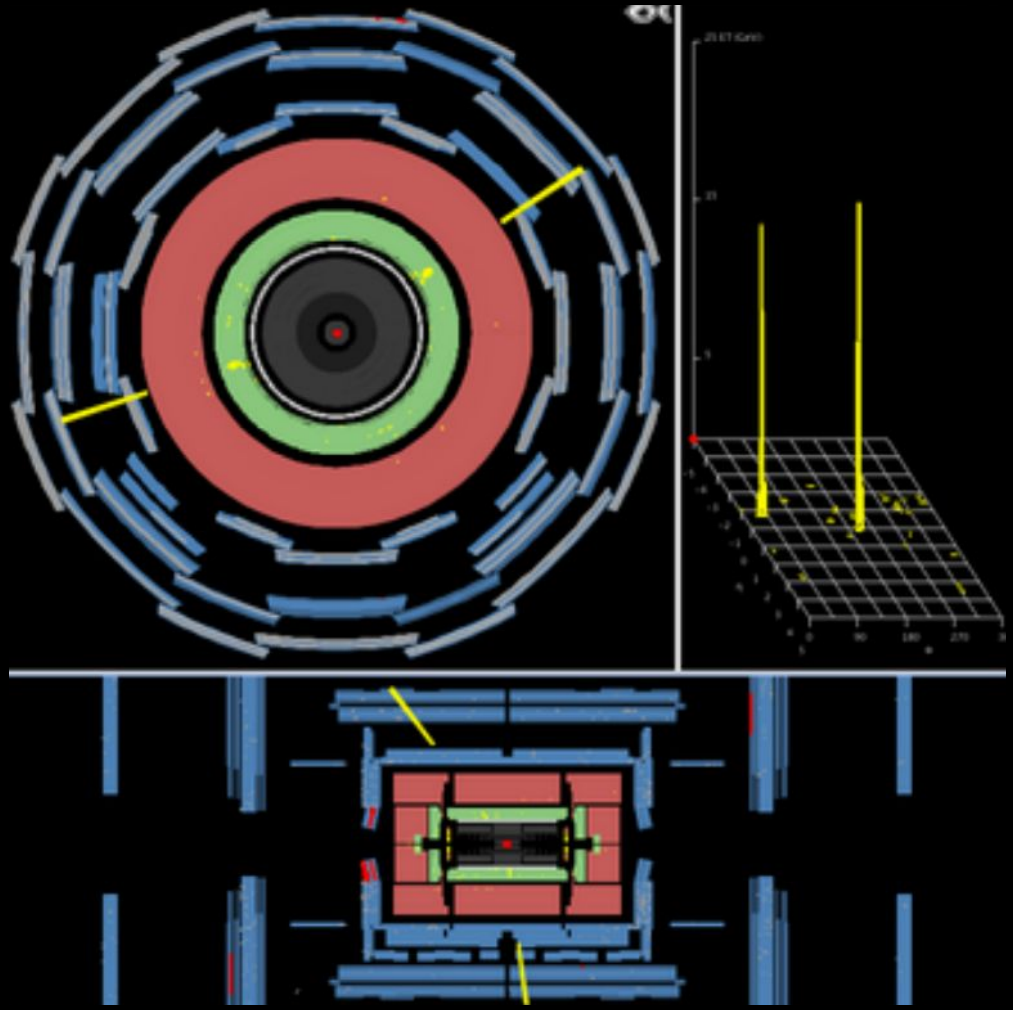
http://opendata.atlas.cern/books/current/get-started/_book/the-higgs-boson.html

Fotone



Non lascia traccia nel rivelatore interno.

Deposita tutta la sua energia nel Calorimetro Elettromagnetico.

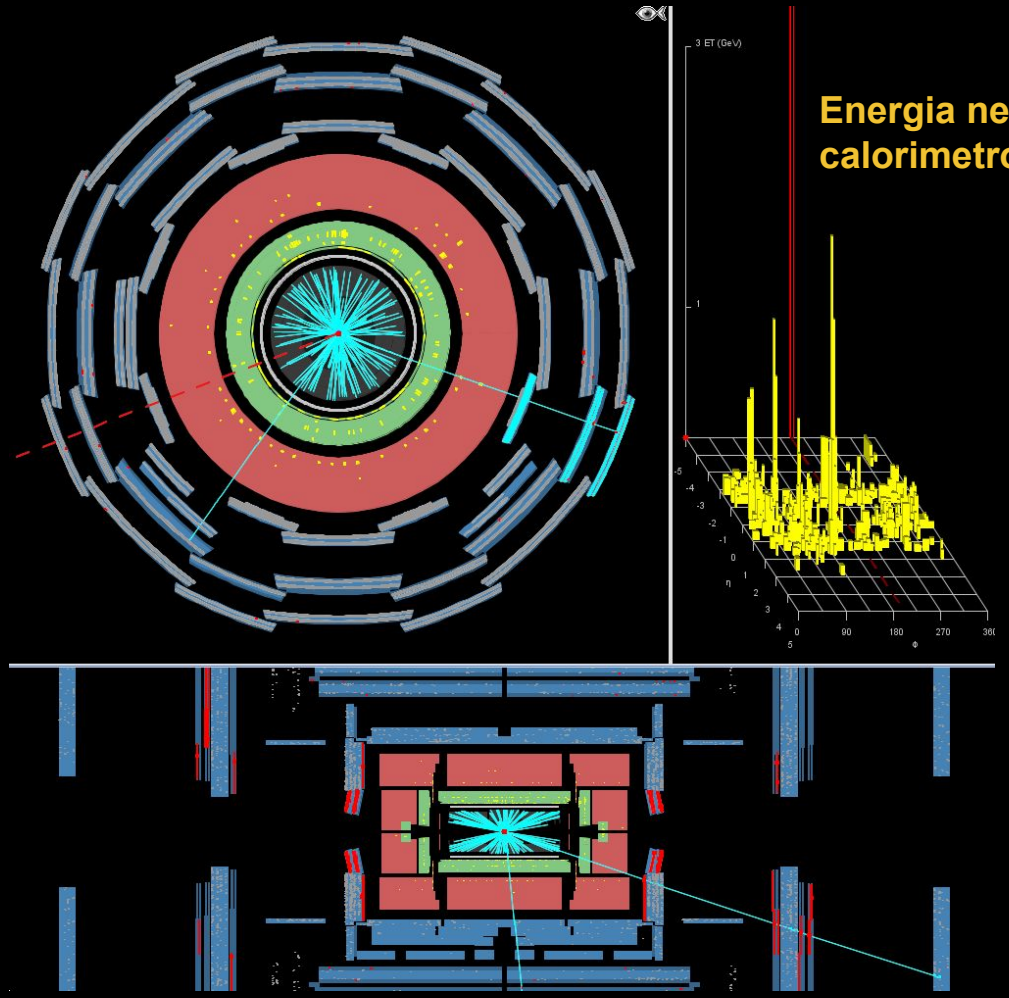


Tracciatore
particelle cariche

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

Calorimetro adronico
adroni (es: protoni, neutroni)

Rivelatori muoni

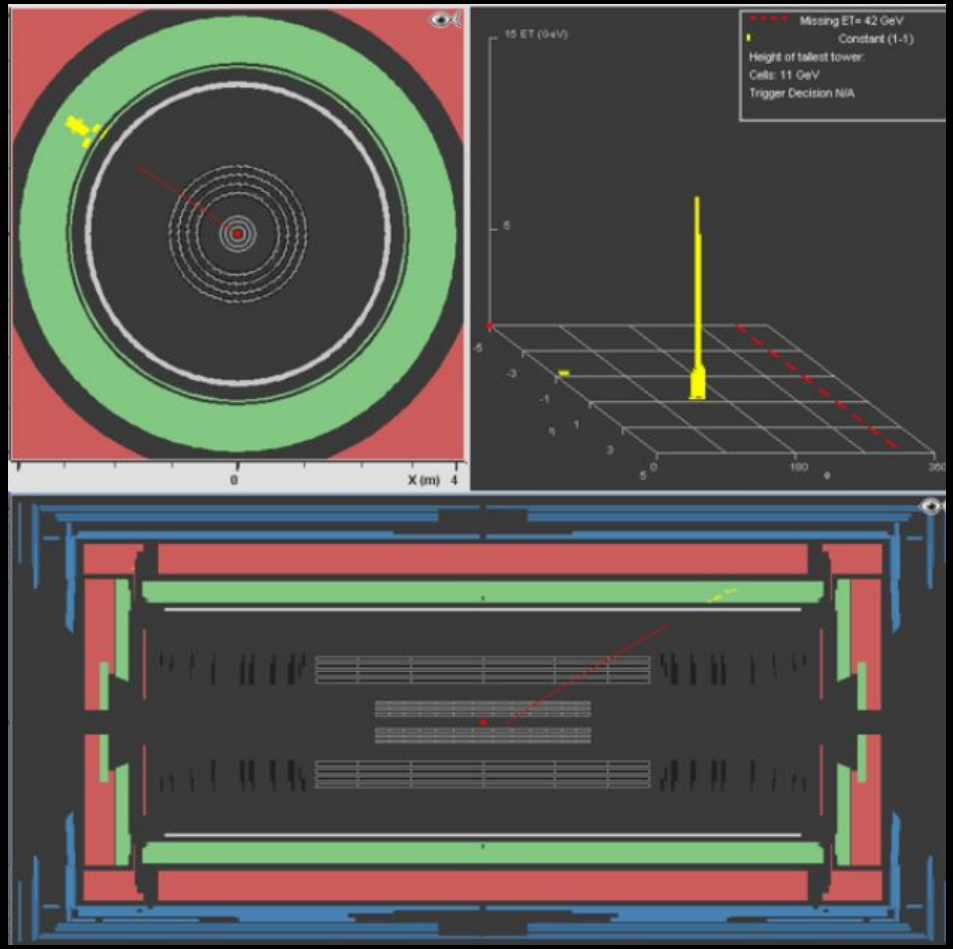


Elettrone

mass ≃0.511 MeV/c²
charge −1
spin ½

e

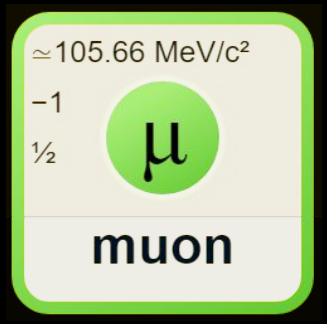
electron

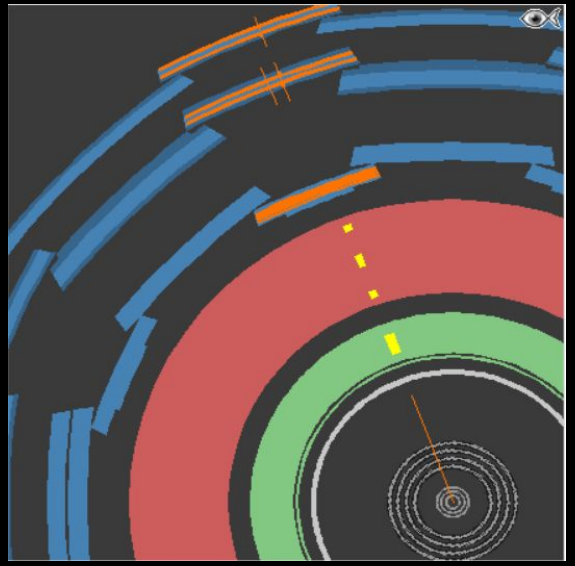


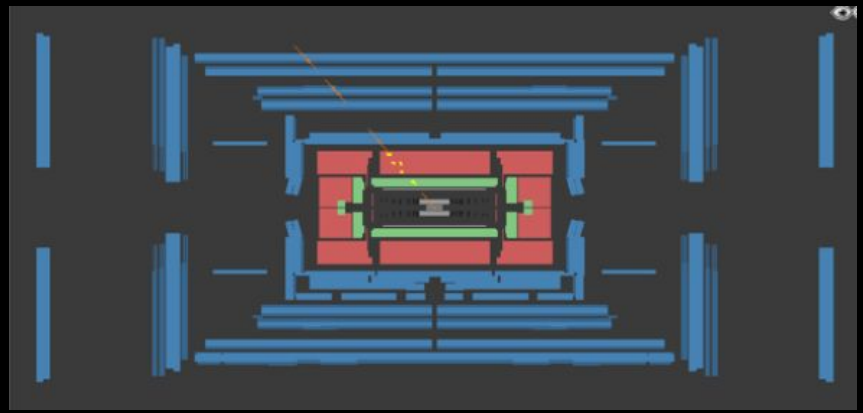
Lascia una traccia nel rivelatore interno

Deposita tutta la sua energia nel Calorimetro Elettromagnetico

Muone



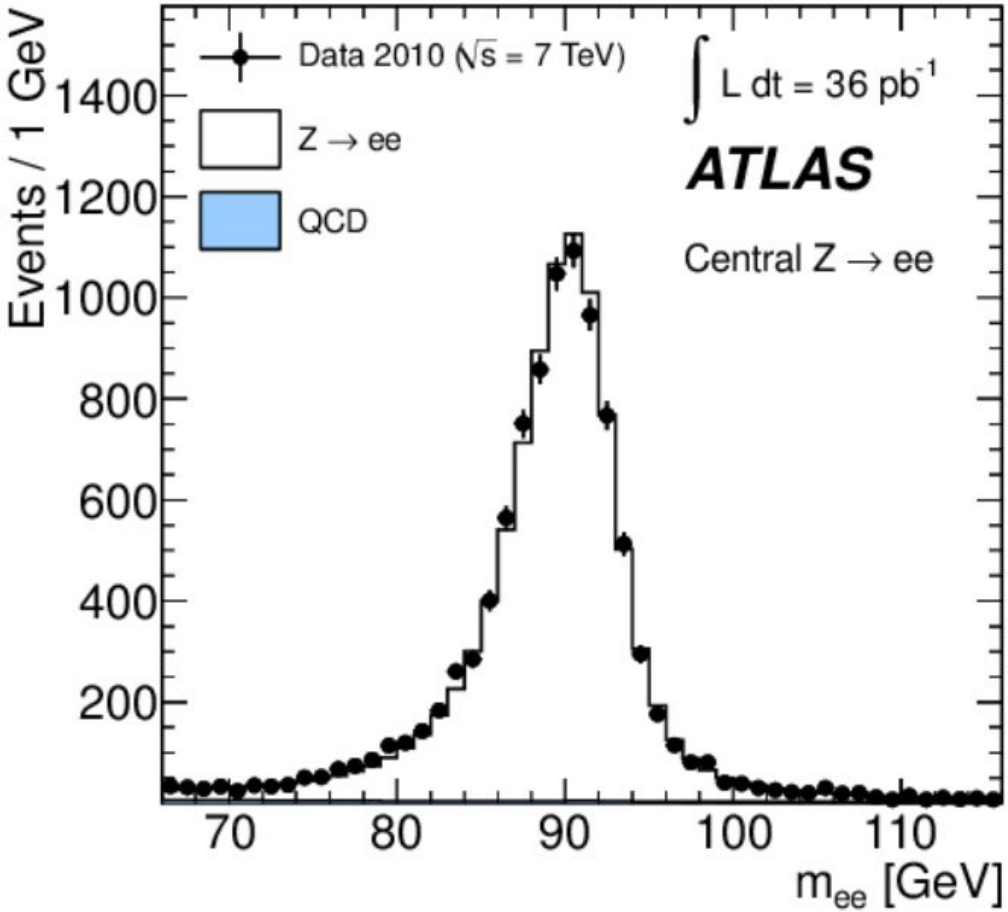




Lascia traccia nel rivelatore interno

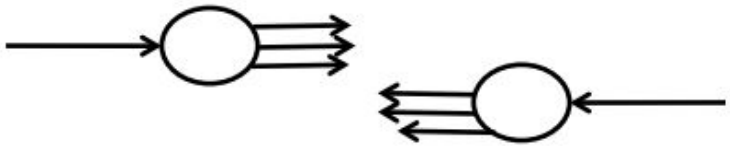
Pochissima energia nei Calorimetri

Raggiunge il rivelatore più esterno


Data 2010 (√s = 7 TeV)
Z → ee
QCD
∫ L dt = 36 pb-1
ATLAS
Central Z → ee
Events / 1 GeV
1400
1200
1000
800
600
400
200
70
80
90
100
110
mee [GeV]

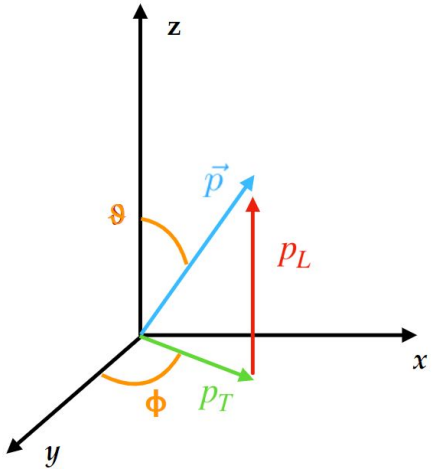
Taglia sul p_T !

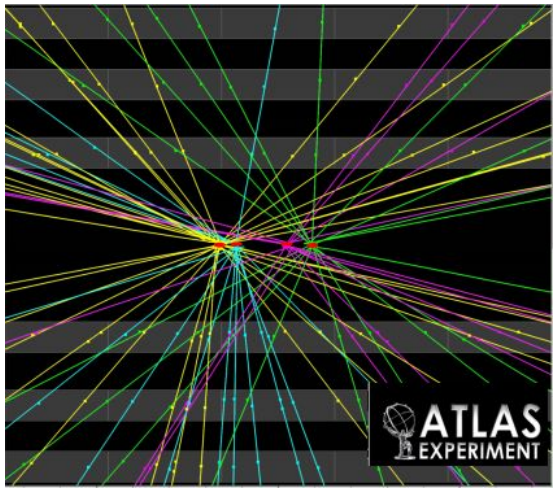
Eventi interessanti se il protone si frammenta:
hard scattering

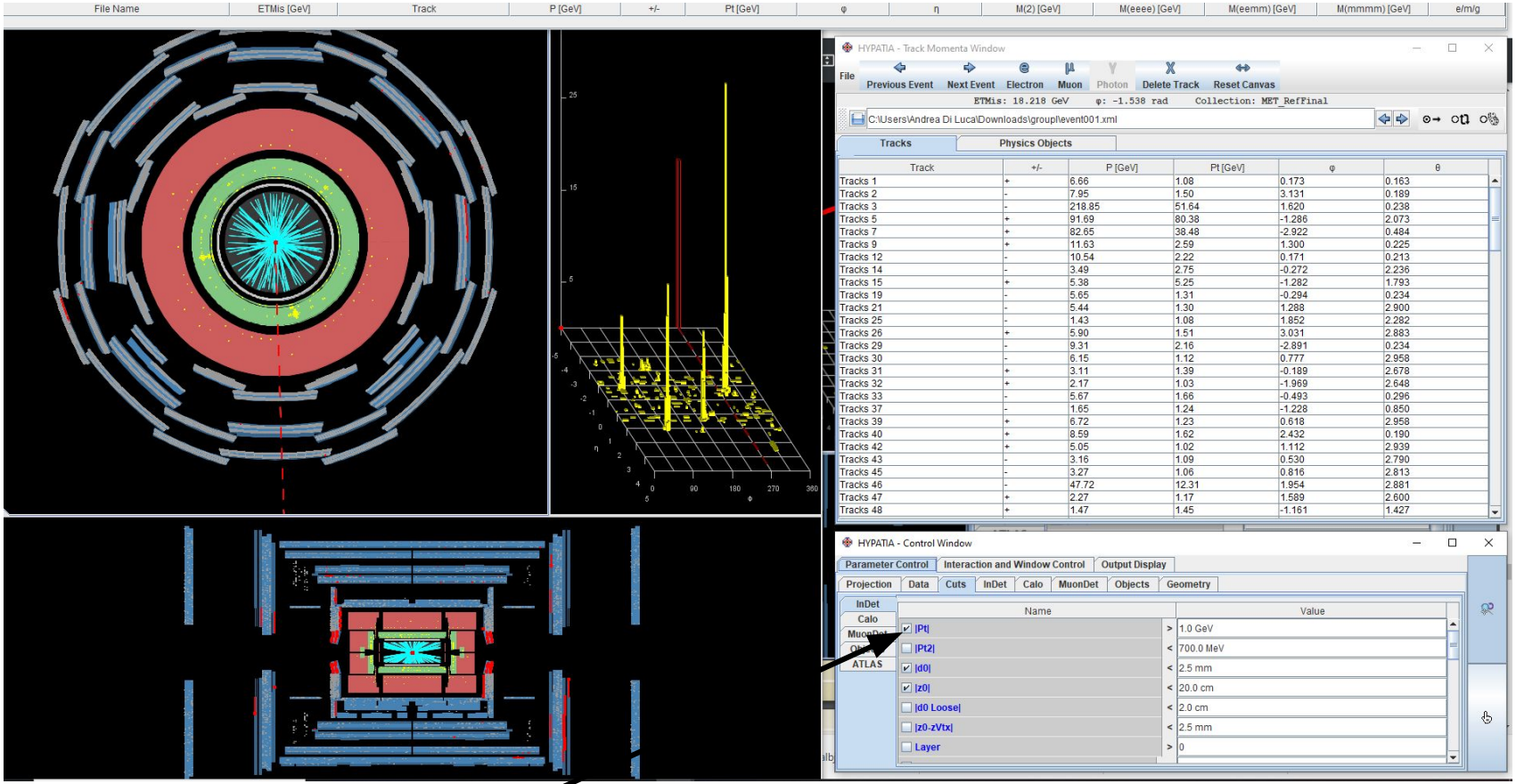


La maggior parte delle interazioni avvengono a grande distanza tra i protoni e con piccolo scambio di momento:
soft interaction

Le particelle nello stato finale hanno p_T basso.

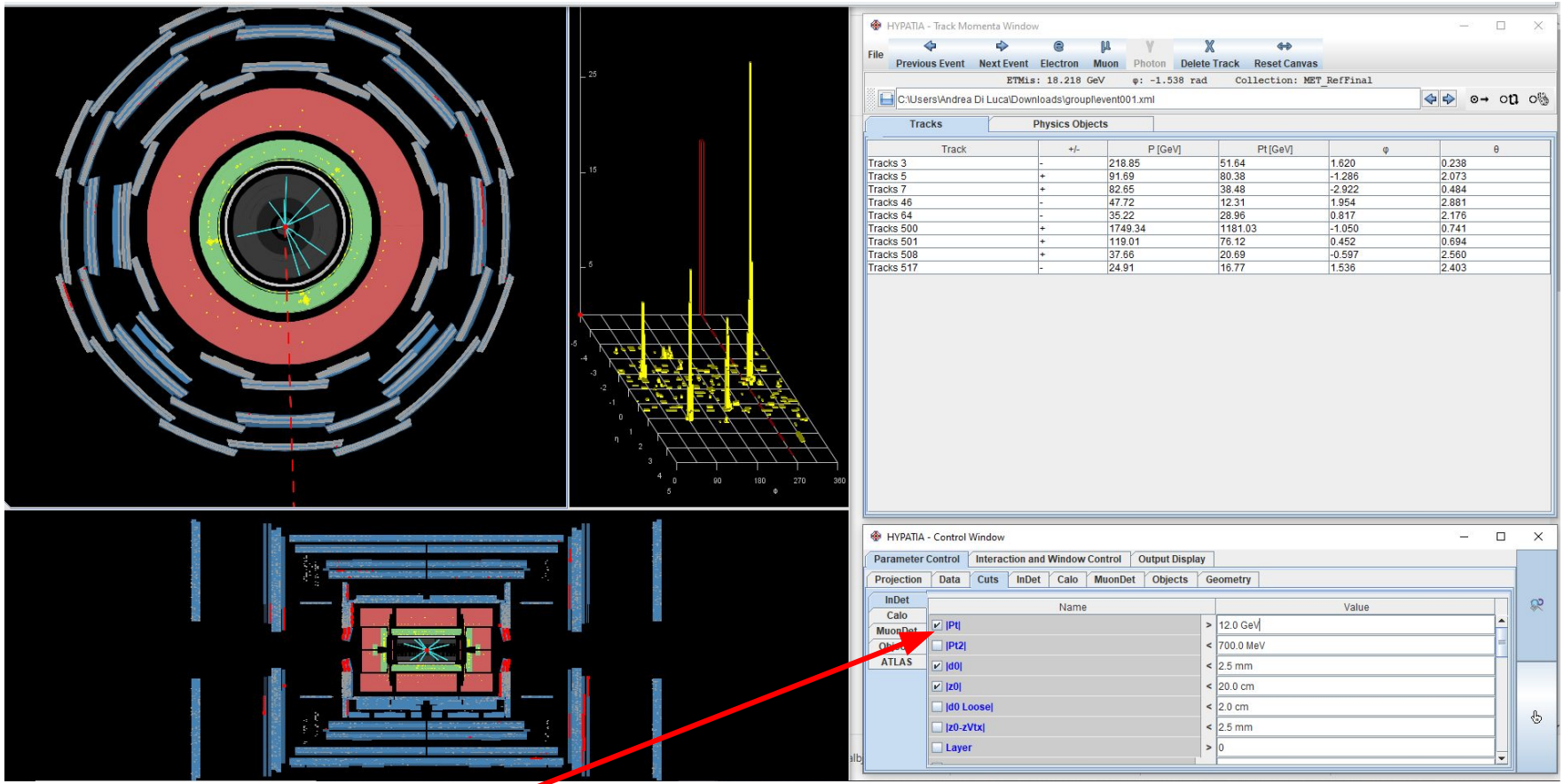






P_T > 5 GeV/c

Abbiamo più di 50 tracce nell'evento..



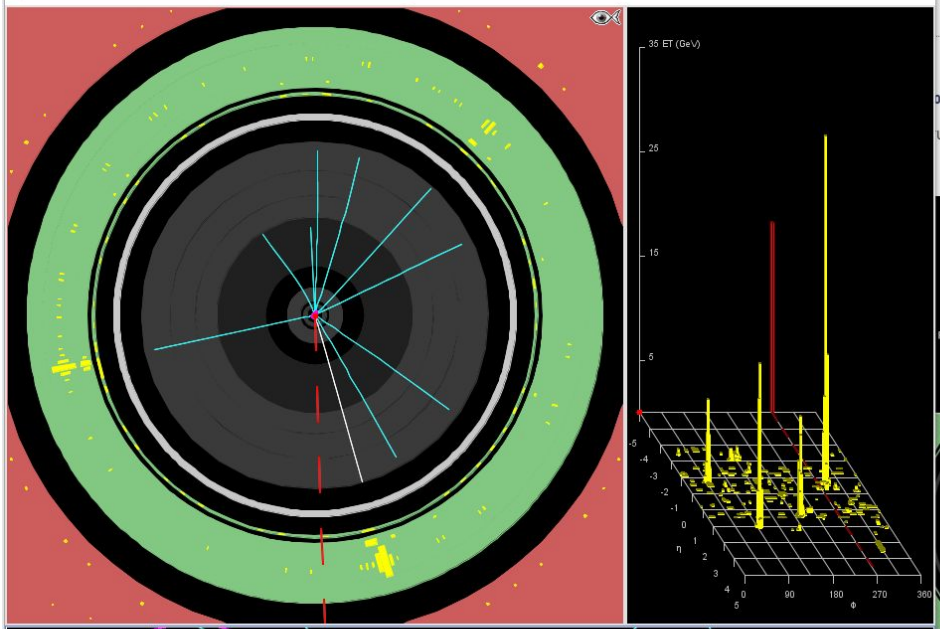
$P_T > 12GeV/c$

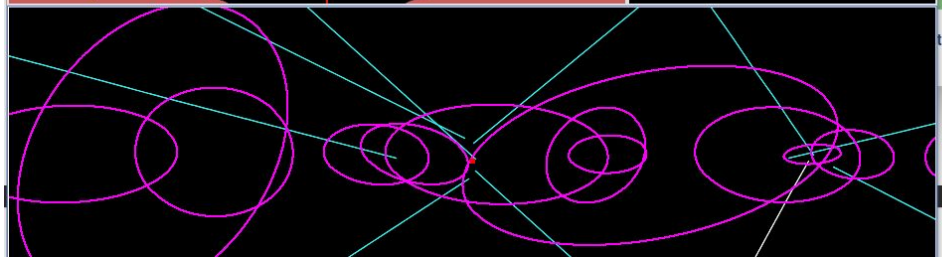
Dopo il taglio abbiamo 9 tracce

File View Histograms Preferences Help

File Name	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	φ	η	M(2) [GeV]	M(eeee) [GeV]	M(eemm) [GeV]	M(mmmm) [GeV]	
event001.xml	18.218	Tracks 5	91.7	+	80.4	-1.286	-0.524	83.979				e
		Tracks 64	35.2	-	29.0	0.817	-0.646					e

Canvas Window - File: event001.xml Run: 204954 Event: 19454464





HYPATIA - Track Momenta Window

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

ETMis: 18.218 GeV φ: -1.538 rad Collection: MET_RefFinal

C:\Users\Andrea Di Luca\Downloads\group\event001.xml

Tracks | Physics Objects

Track	+/-	P [GeV]	Pt [GeV]	φ	θ
Tracks 3	-	218.85	51.64	1.620	0.238
Tracks 5	+	91.69	80.38	-1.286	2.073
Tracks 7	+	82.65	38.48	-2.922	0.484
Tracks 46	-	47.72	12.31	1.954	2.881
Tracks 64	-	35.22	28.96	0.817	2.176
Tracks 500	+	1749.34	1181.03	-1.050	0.741
Tracks 501	+	119.01	76.12	0.452	0.694
Tracks 508	+	37.66	20.69	-0.597	2.560
Tracks 517	-	24.91	16.77	1.536	2.403
Tracks 522	-	22.39	10.03	1.264	2.677

HYPATIA - Control Window

Parameter Control | Interaction and Window Control | Output Display

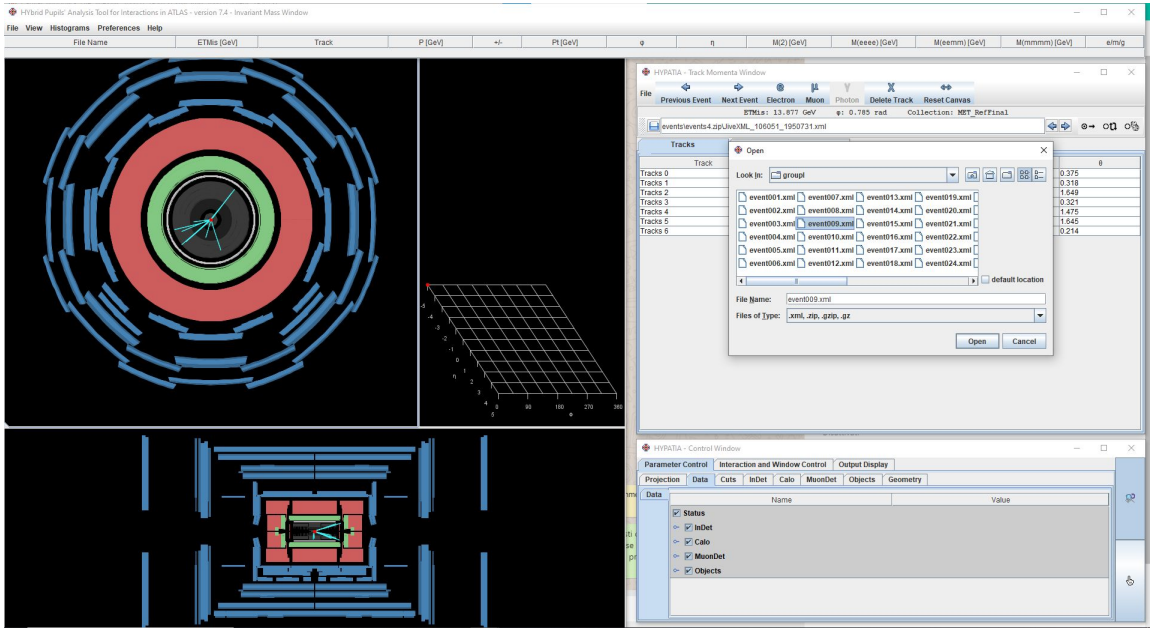
Projection | Data | Cuts | InDet | Calo | MuonDet | Objects | Geometry

InDet | Calo | MuonDet | Objects | ATLAS

Name		Value
☑ |Pt|	>	10.0 GeV
☐ |Pt2|	<	700.0 MeV
☑ |d0|	<	2.5 mm
☑ |z0|	<	20.0 cm
☐ |d0 Loose|	<	2.0 cm
☐ |z0-zVtx|	<	2.5 mm
☐ Layer	>	0

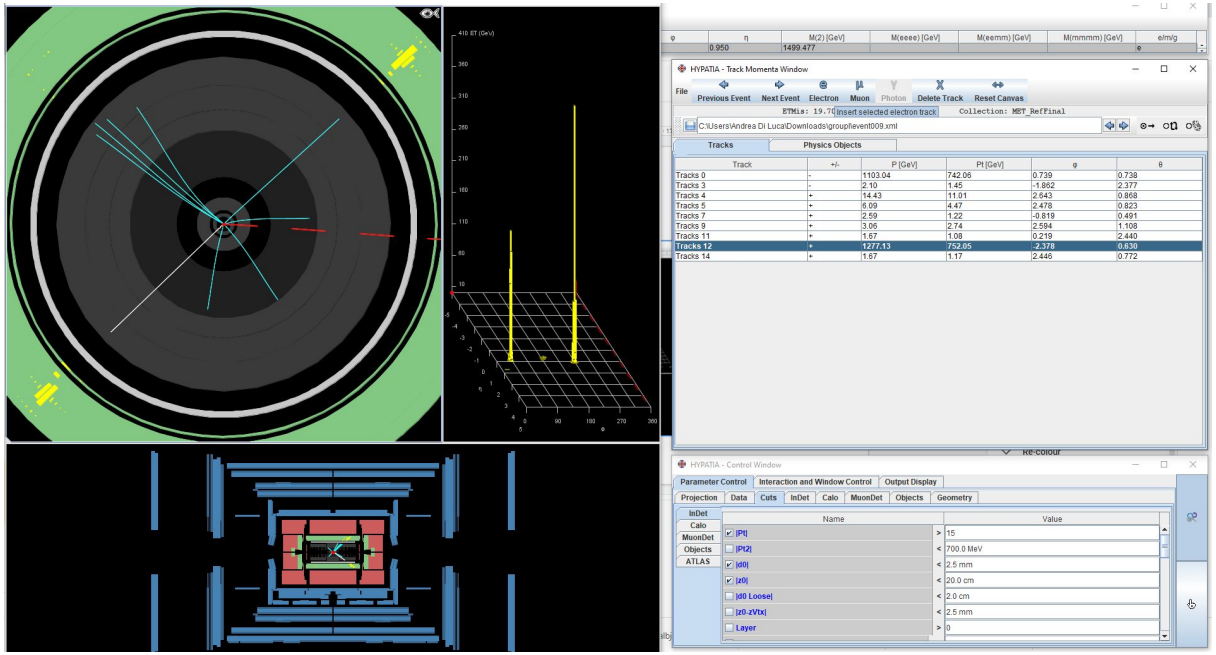
Apriamo Hypatia e selezioniamo un set di eventi

1. Clicca su *File*
2. Clicca *Read Event Locally*
3. Seleziona la cartella contenete gli eventi



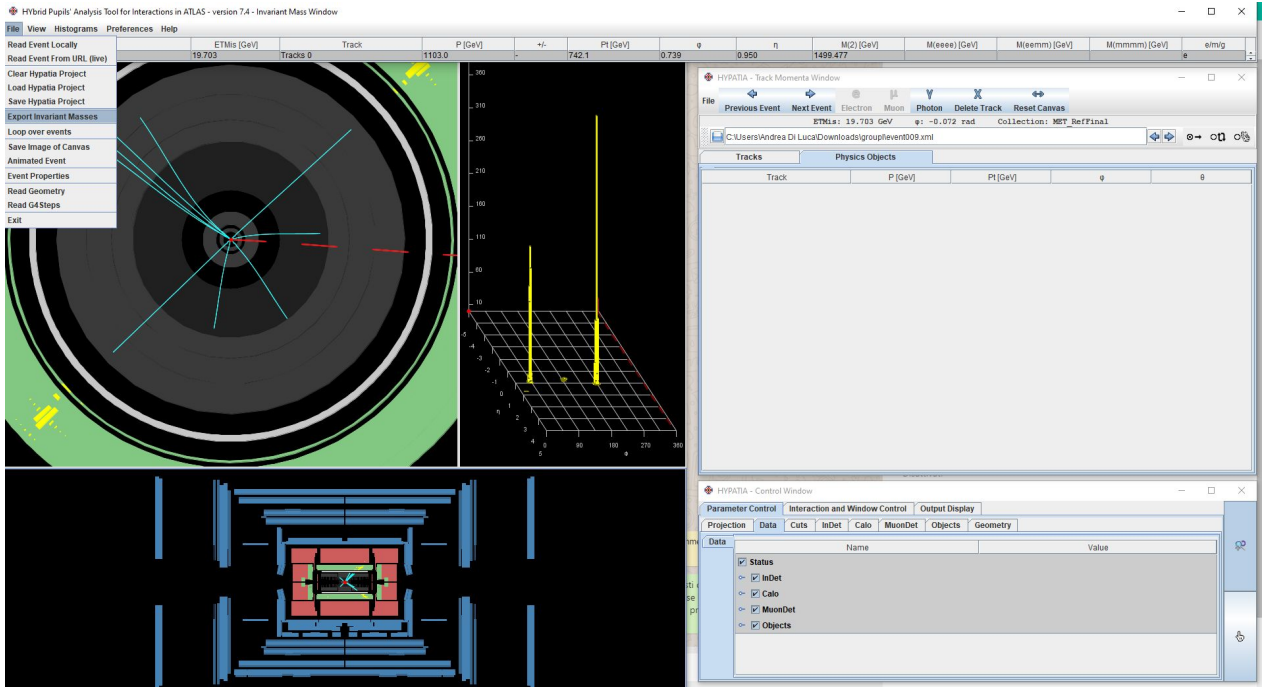
Analizza l’evento

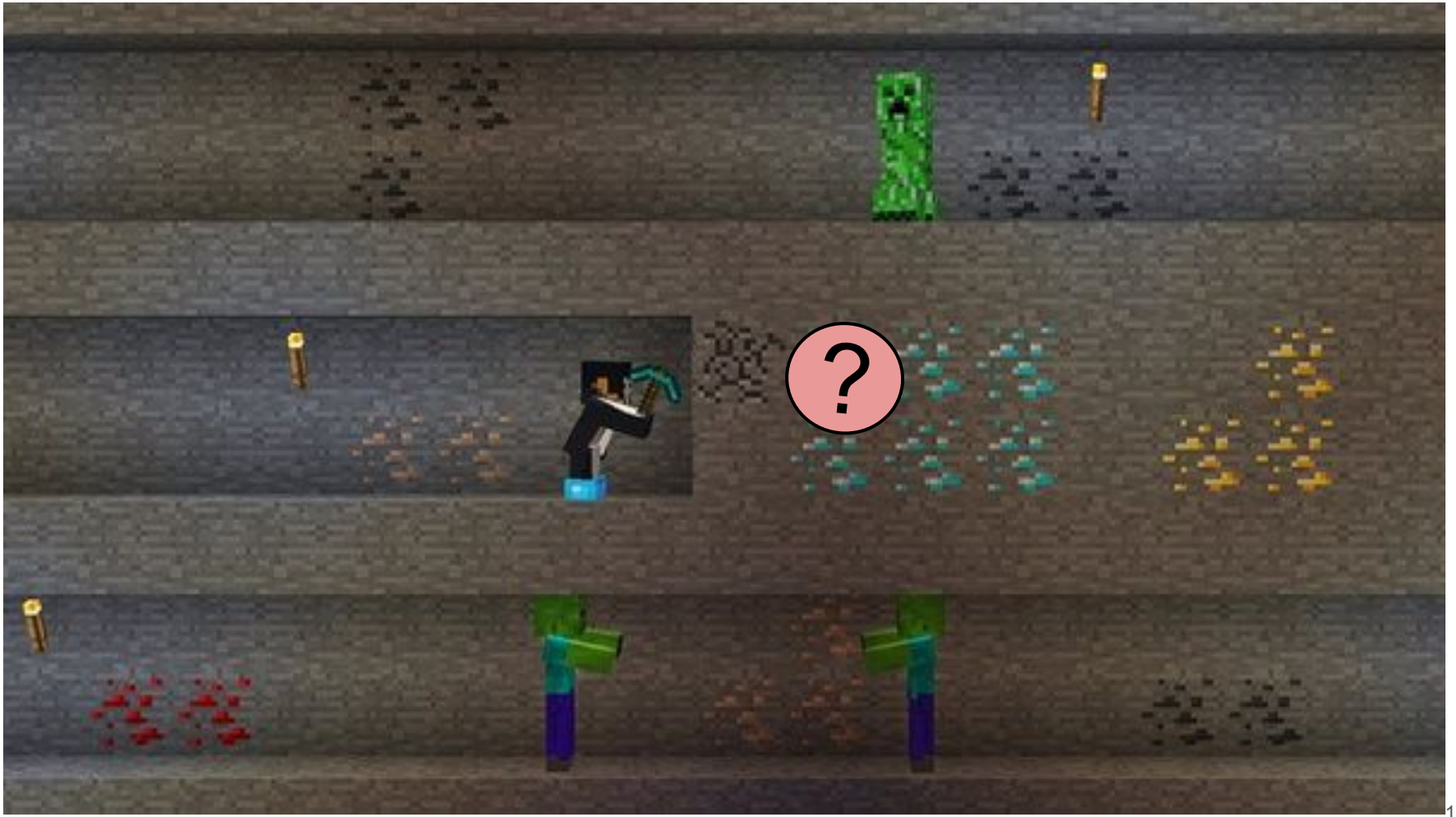
1. Applica le selezioni che ritieni utili per classificare il tuo evento
2. Seleziona le tracce in Tracks ed assegna il tipo di particella



Esporta i risultati della tua analisi

1. Una volta terminato, clicca su *File*, poi su *Export invariant masses*
2. Salve il file che poi potrai sottomettere.





ARE
YOU READY
TO CATCH
SOME
PARTICLES?
LET'S SEE.

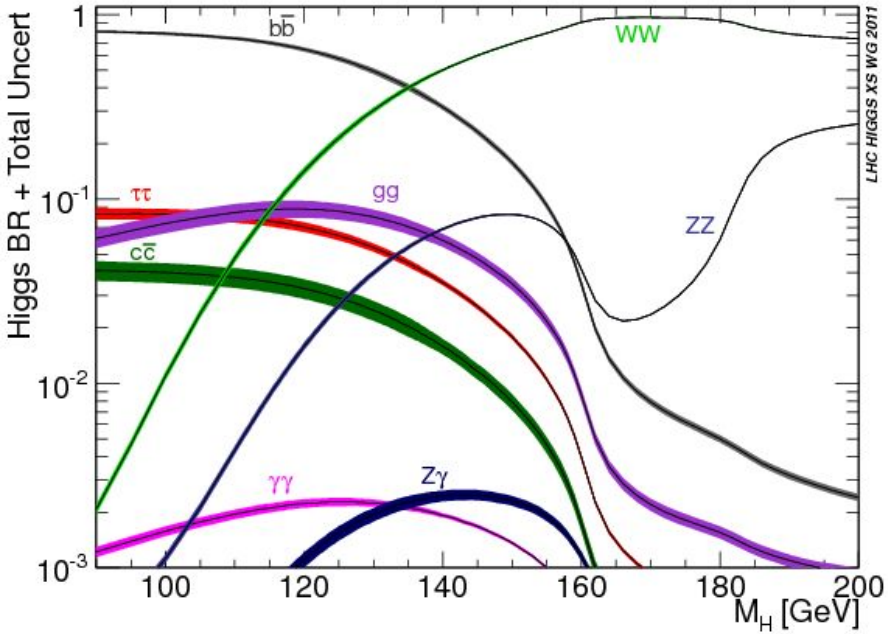
Reach the quiz page:
kahoot.it

powered by:
Kahoot!

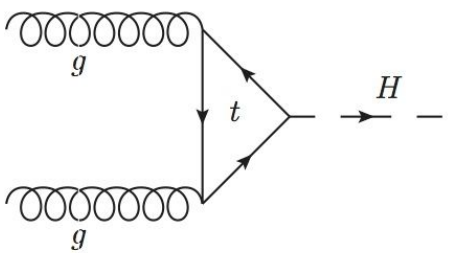
Backup

Come decade il bosone di Higgs?

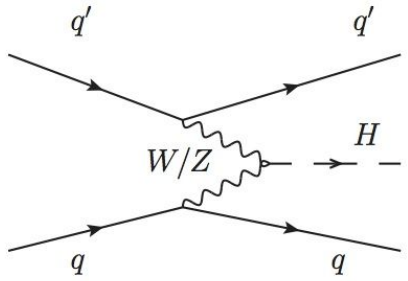
Decay channel	Branching ratio	Rel. uncertainty
$H \to \gamma\gamma$	2.28×10^{-3}	$^{+5.0\%}_{-4.9\%}$
$H \to ZZ$	2.64×10^{-2}	$^{+4.3\%}_{-4.1\%}$
$H \to W^+W^-$	2.15×10^{-1}	$^{+4.3\%}_{-4.2\%}$
$H \to \tau^+\tau^-$	6.32×10^{-2}	$^{+5.7\%}_{-5.7\%}$
$H \to b\bar{b}$	5.77×10^{-1}	$^{+3.2\%}_{-3.3\%}$
$H \to Z\gamma$	1.54×10^{-3}	$^{+9.0\%}_{-8.9\%}$
$H \to \mu^+\mu^-$	2.19×10^{-4}	$^{+6.0\%}_{-5.9\%}$



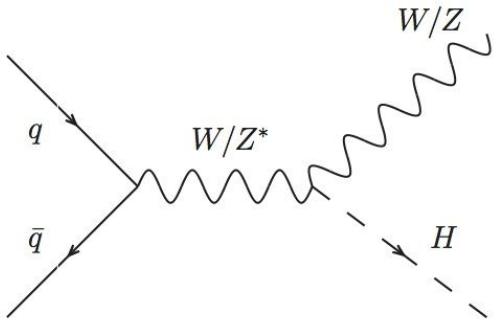
http://opendata.atlas.cern/books/current/get-started/_book/the-higgs-boson.html



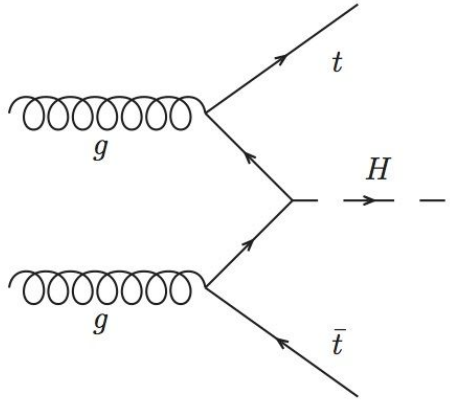
a)



b)



c)



d)