Identify the decaying particles through ATLAS data analysis

—— leptons and photons in Z path

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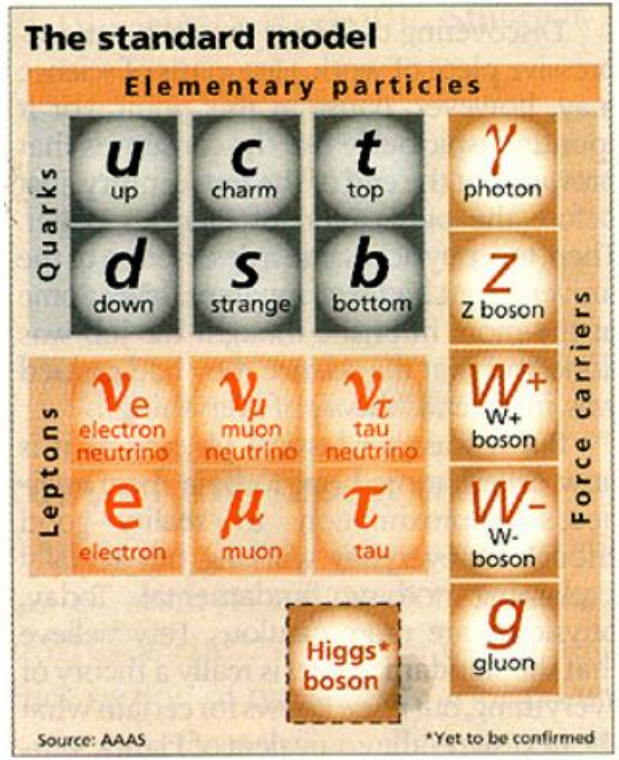
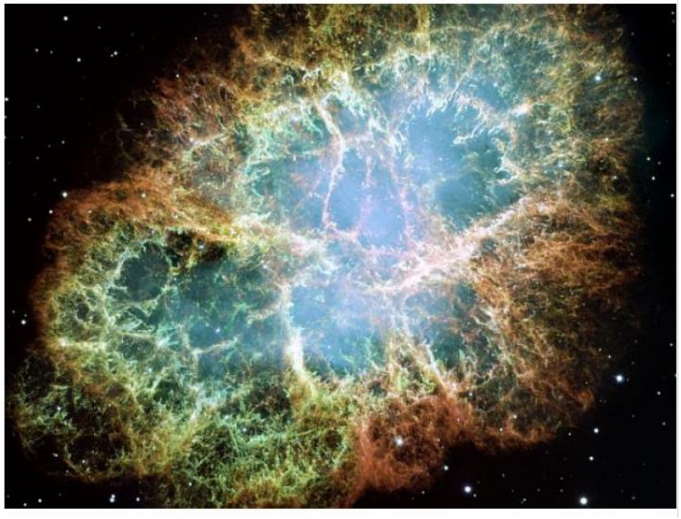
Outline

1. The standard model of particle physics
2. ATLAS detector
3. Identification of particles
4. Result
5. Summary and outlook

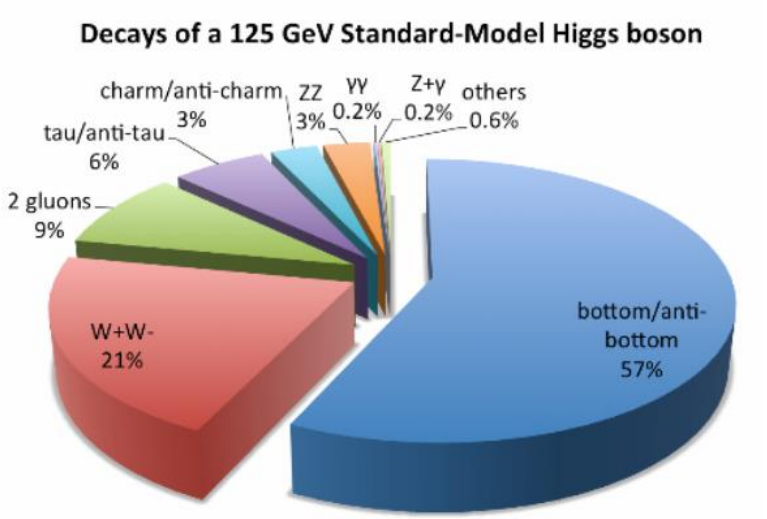
1. The standard model of particle physics



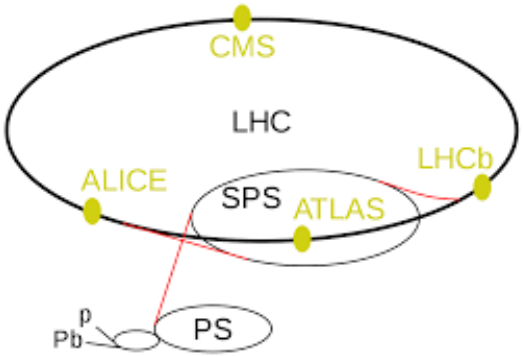
The standard model

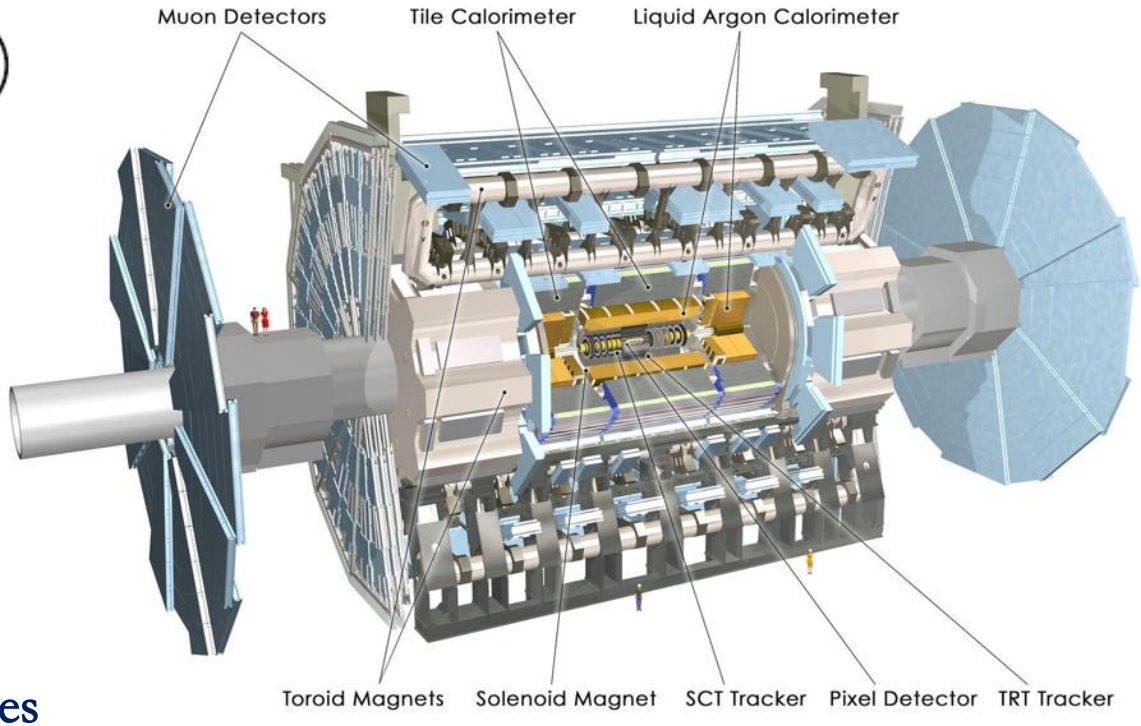


In such extreme conditions as a supernova explosion, Z bosons are produced as an "everyday" particle



2. ATLAS detector

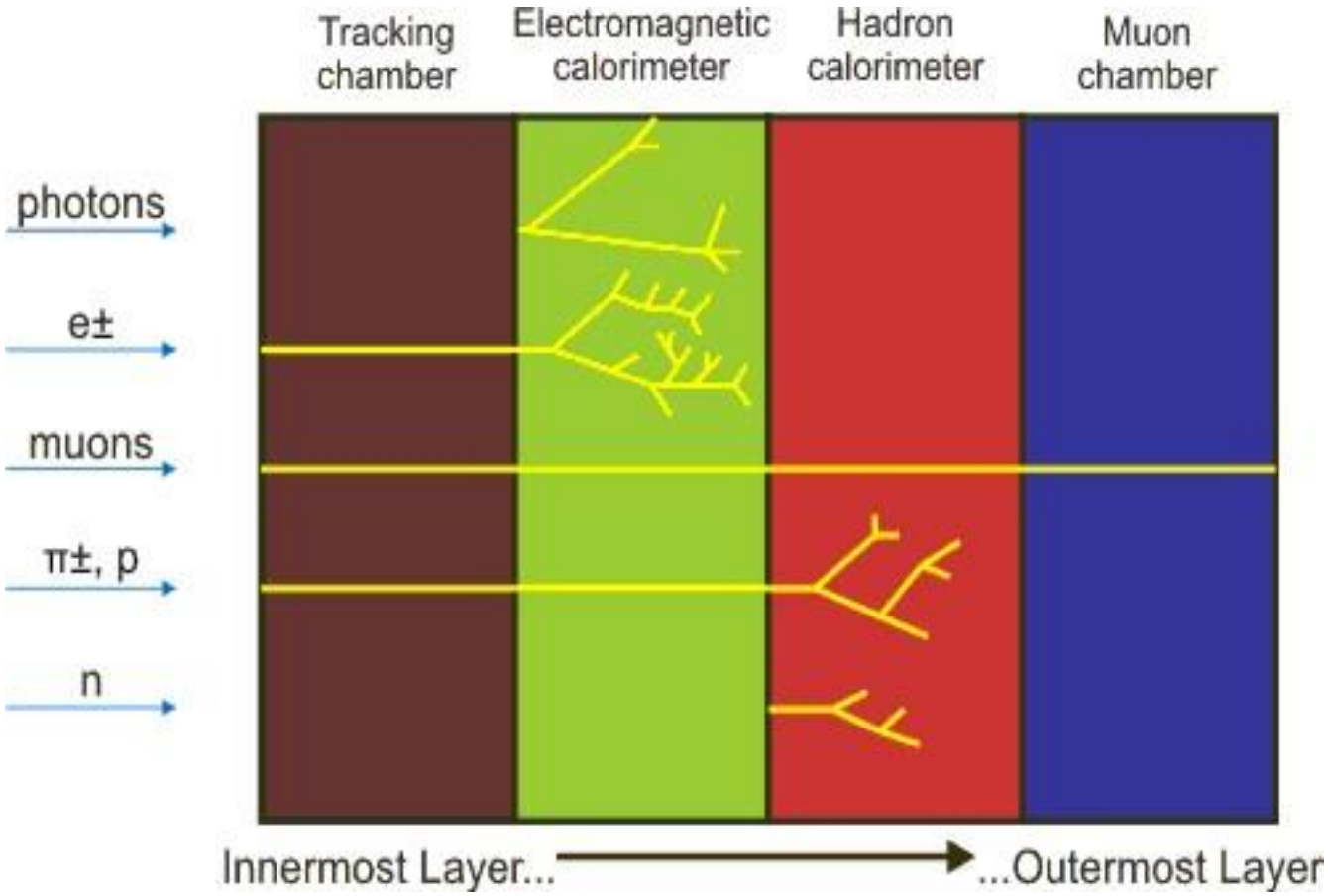




- 7000 tons
- 46 m long
- 25 m height
- 3000 km of cables
- 100M of readout channels

2.1 The principle of identifying particles

According to different kinds of particles have different kinds of interactions with the mediums in the detectors.



3. Identification of particles

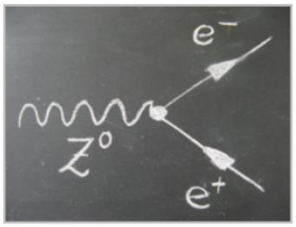
A Data sample: the data sample of many thousand events is divided into smaller packages with 50 events each.

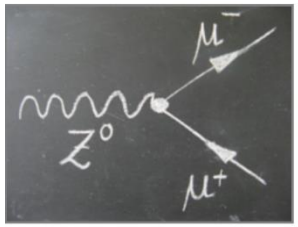
Tool: HYPATIA

Download Data Samples for INTERNATIONAL MASTERCLASSES hands on particle physics

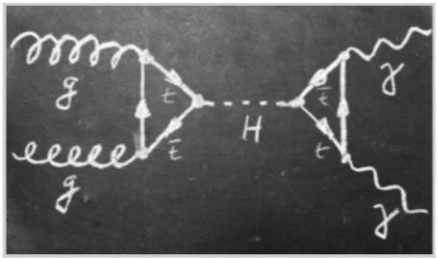
Purposes:

- Z boson, by hunting for an electron-positron pair or a muon-antimuon pair ($Z \rightarrow l^+l^-$)

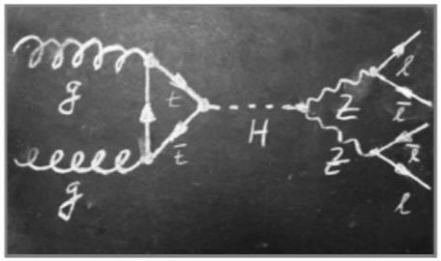




- Higgs boson by hunting for a photon-photon pair($H \rightarrow \gamma\ \gamma$)



- Higgs boson by hunting for 2 lepton-pairs ($H \rightarrow l^+l^-\ l^+l^-$)

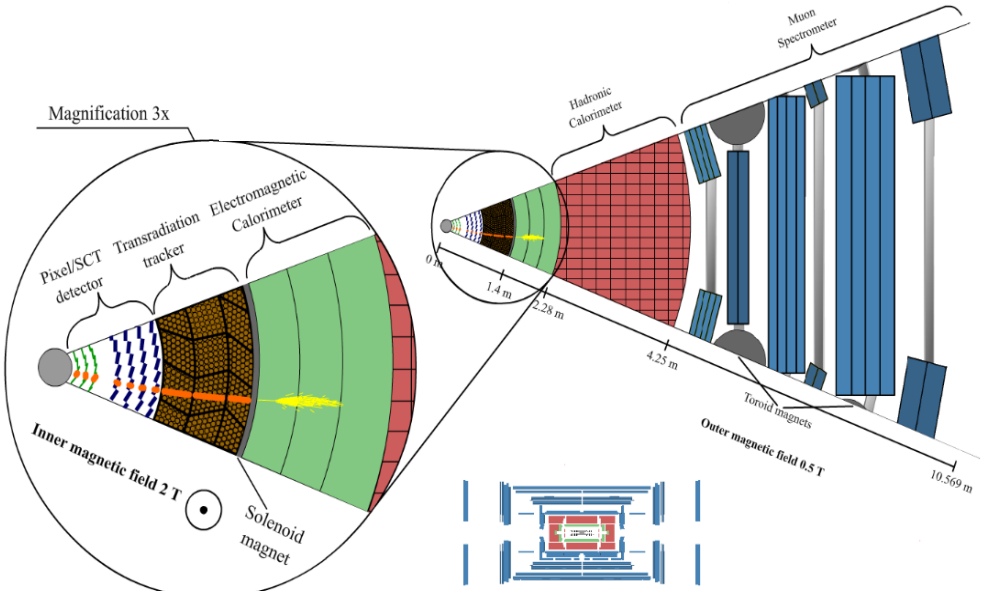


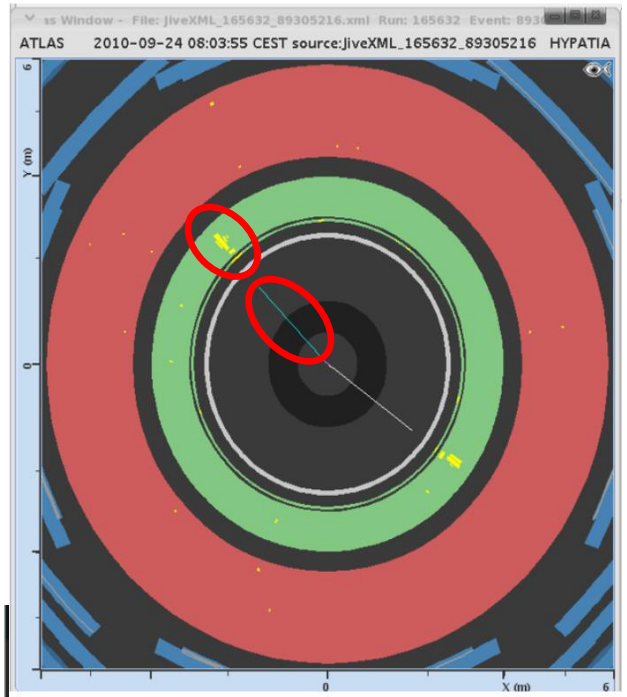
3.1 case1: $Z \rightarrow e^+e^-$

$Z \rightarrow e^+e^-$

Steps to identify

- Two footprints in innermost detector from the vertex detector
- Two clusters in the electromagnetic calorimeter
- Sum of electrical charge is 0





Reconstructed Tracks

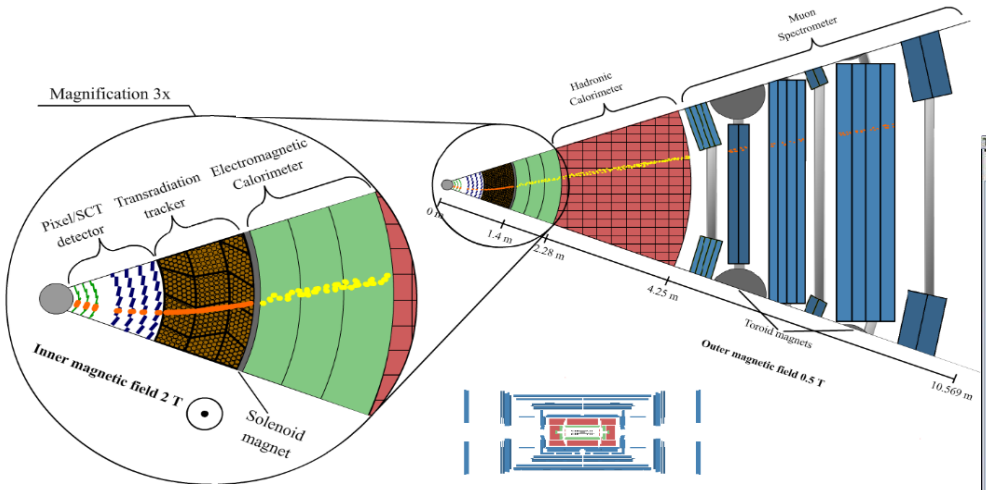
Track	+/-	P [GeV]	Pt [GeV]	φ	θ
Tracks 1	+	61.94	46.66	2.336	2.288
Tracks 72	-	33.25	31.18	-0.642	1.216

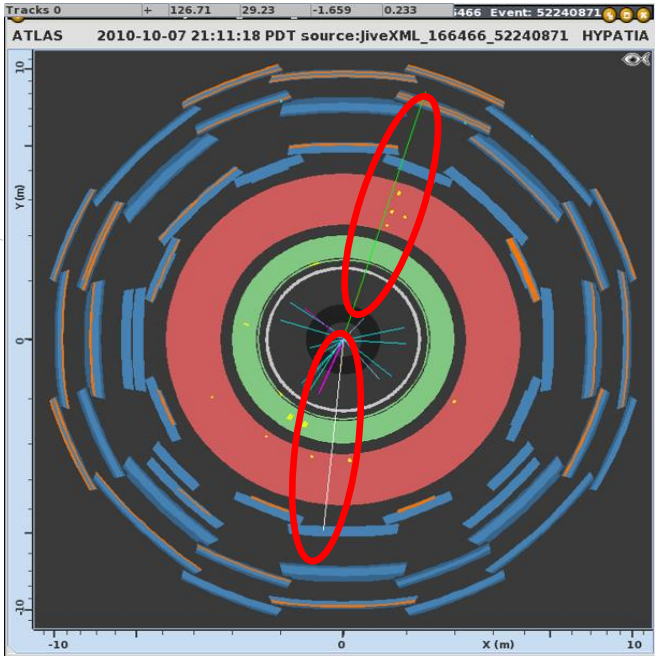
3.2 case 2: $Z \rightarrow \mu^+\mu^-$

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

Steps to identify

- Two footprints from the vertex detector to muon spectrometer
- Sum of electrical charge is 0





Reconstructed Tracks

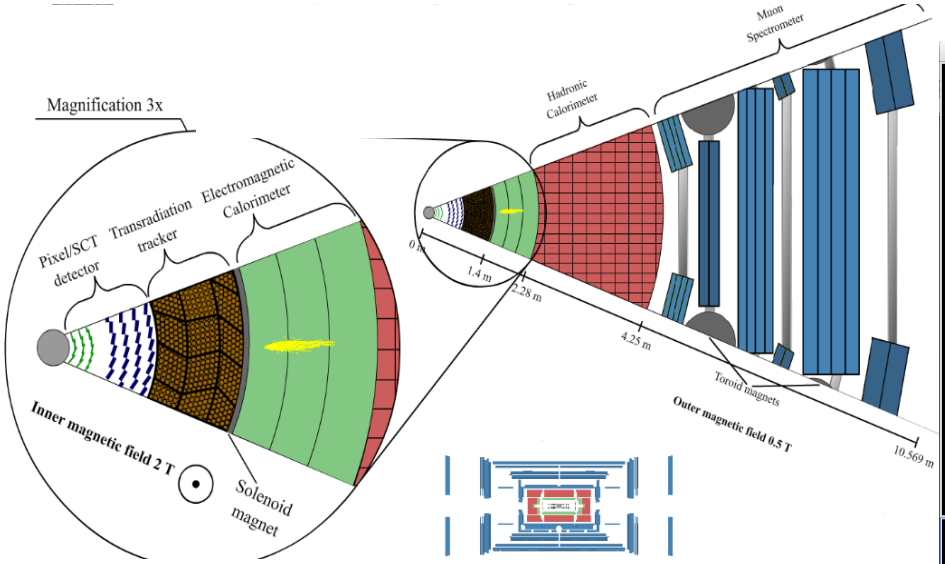
Track	+/-	P [GeV]	Pt [GeV]	φ	θ
Tracks 0	+	**126.71**	**29.23**	**-1.659**	**0.233**
Tracks 3	+	7.78	4.24	-1.928	0.577
Tracks 5	-	**120.76**	**61.66**	**1.257**	**0.536**
Tracks 6	+	2.97	1.31	-0.477	2.686
Tracks 7	-	2.83	1.06	-0.062	2.757
Tracks 9	-	2.99	1.20	-2.356	0.415
Tracks 10	+	8.03	1.47	-2.472	2.958
Tracks 11	+	5.87	1.19	-2.757	0.204
Tracks 15	+	6.06	2.69	-0.771	2.681
Tracks 17	-	8.08	4.16	-2.043	0.540
Tracks 24	-	1.50	1.36	2.582	2.002

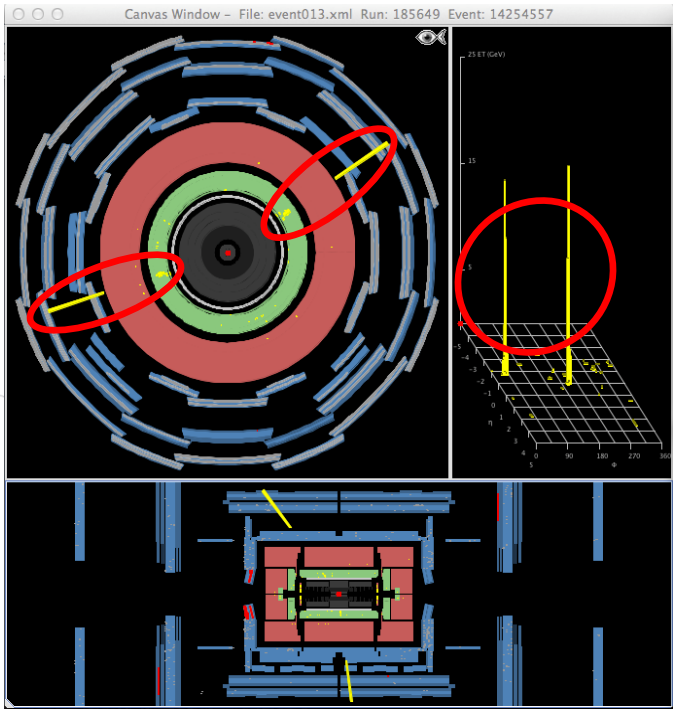
3.3 case 3: H→ γ γ

H→ γ γ

Steps to identify

- Two clusters in the electromagnetic calorimeter
- Two tracks in the muon spectrometer
- Two peaks





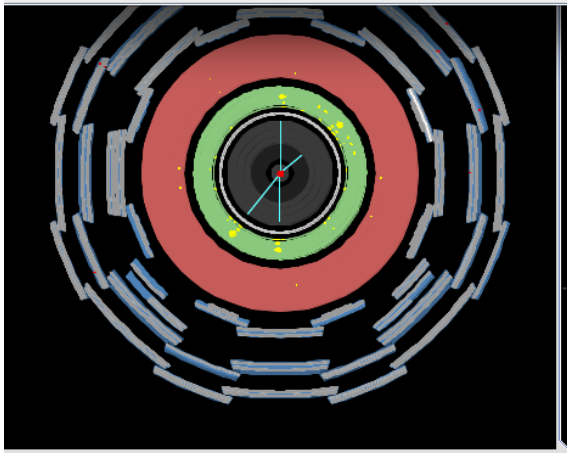
Tracks | Physics Objects

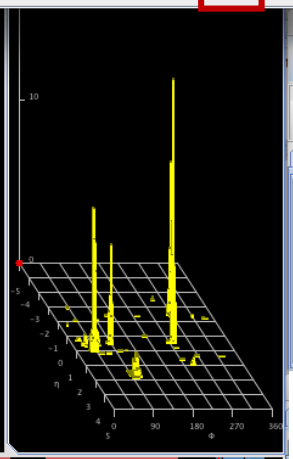
Track	P [GeV]	Pt [GeV]	φ	θ
Object 0	49.03	48.71	-2.834	1.456
Object 1	67.27	54.15	0.588	2.206

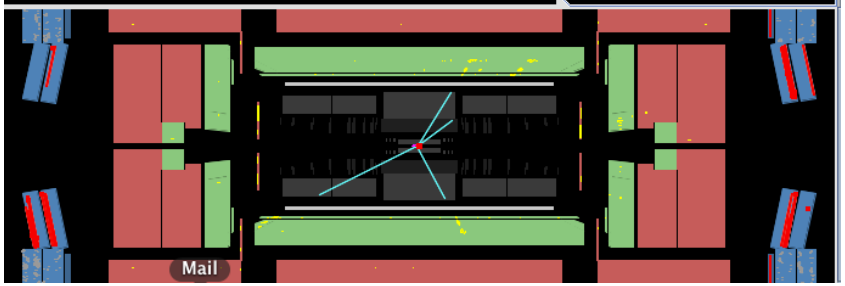
H→ $e^+e^-e^+e^-$

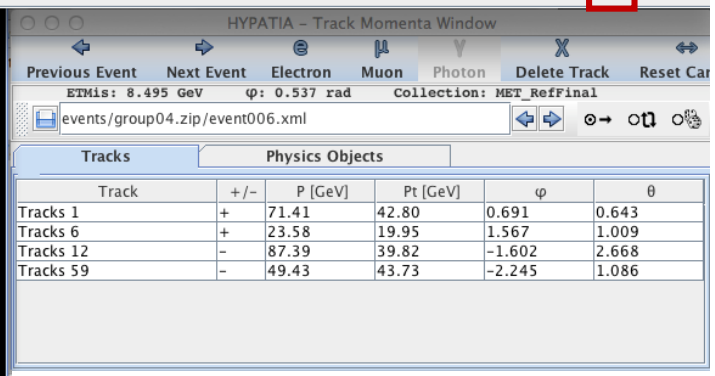
File View Histograms Preferences Help

File Name	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	φ	η	M(2) [GeV]	M(4) [GeV]		e/m/g
event006.xml	8.495	Tracks 1	71.4	+	42.8	0.691	1.100	89.939	229.736		e
		Tracks 59	49.4	-	43.7	-2.245	0.505				e
		Tracks 6	23.6	+	20.0	1.567	0.594	87.551			e
		Tracks 12	87.4	-	39.8	-1.602	-1.423				e









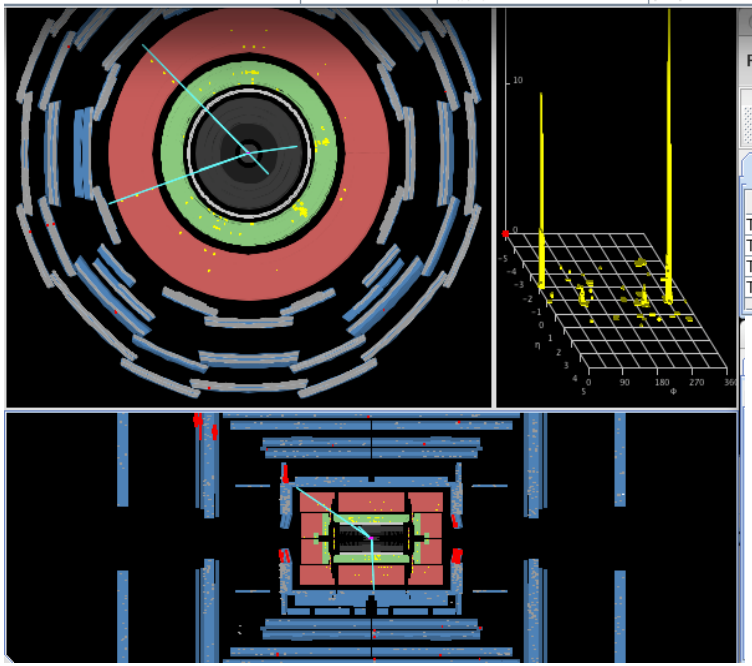
Track	+/-	P [GeV]	Pt [GeV]	φ	θ
Tracks 1	+	71.41	42.80	0.691	0.643
Tracks 6	+	23.58	19.95	1.567	1.009
Tracks 12	-	87.39	39.82	-1.602	2.668
Tracks 59	-	49.43	43.73	-2.245	1.086

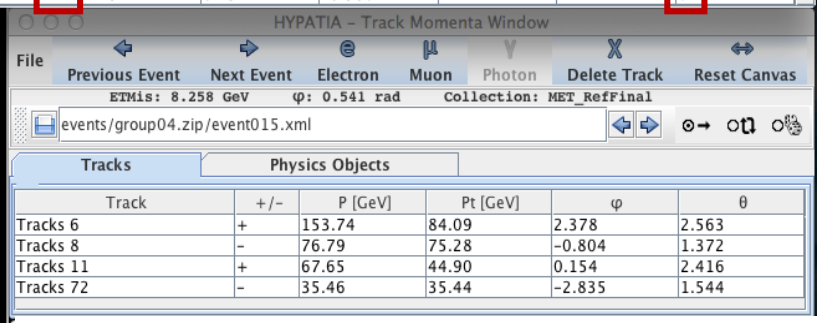
Steps to identify

- Four tracks in the tracking chamber
- Four clusters in the electromagnetic calorimeter
- Sum of electrical charge is 0

H→ $e^+e^-\mu^+\mu^-$

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



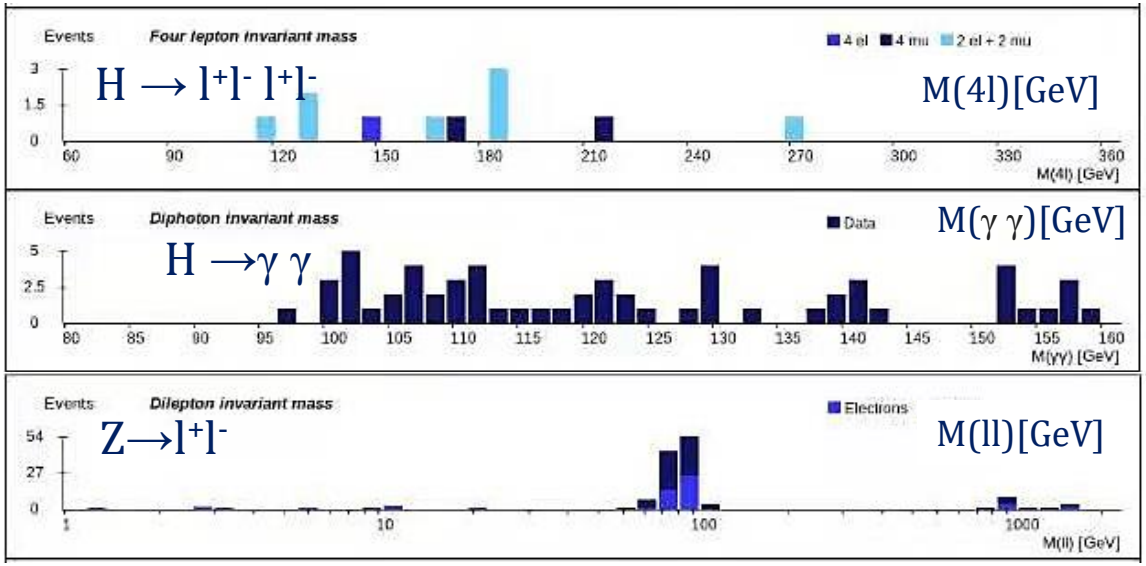


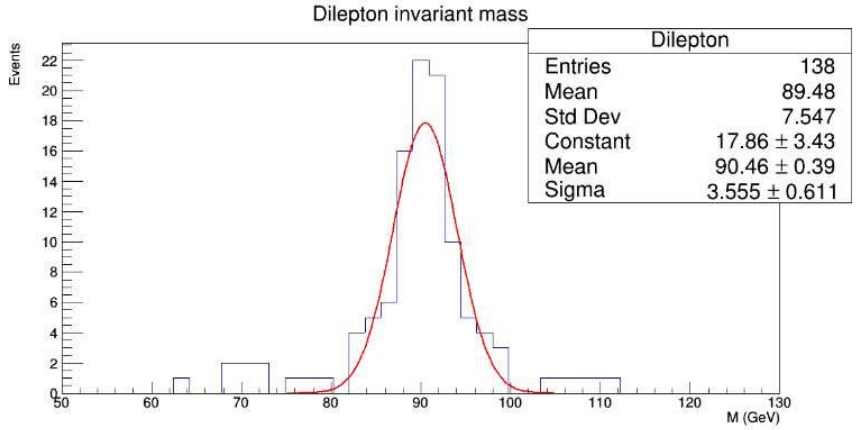
Track	+/-	P [GeV]	Pt [GeV]	φ	θ
Tracks 6	+	153.74	84.09	2.378	2.563
Tracks 8	-	76.79	75.28	-0.804	1.372
Tracks 11	+	67.65	44.90	0.154	2.416
Tracks 72	-	35.46	35.44	-2.835	1.544

Steps to identify

- Two tracks in the tracking chamber
- Two clusters in the electromagnetic calorimeter
- Two tracks in the muon spectrometer
- Sum of electrical charge is 0

4. Result





- Not see the Higgs boson (lack of data)
- See Z boson (Gaussian)
  Mean of mass is 90.46 ± 0.39 GeV
  Sigma is 3.555 ± 0.611 GeV

5. Summary and outlook

•Learn more details about the SM, Higgs boson, Z boson and particle physics

•Study ATLAS detector and the principle to identify particles

•Learn about how to use the HYPATIA to identify particles

•Plan to identify particles in batch mode

Thank You!

Merci !

谢谢!