

# GET STARTED ON THE WEB WITH HYPATIA AND OPLOT

You will now analyze up to 50 particle collisions (events) by using the visualization application HYPATIA.

From these collisions, you shall try to find the footprints from heavy neutral particles, like for instance the Z-boson or the Higgs boson.

## All you need can be found at

[http://atlas.physicsmasterclasses.org/en/zpath\\_measurement.htm](http://atlas.physicsmasterclasses.org/en/zpath_measurement.htm) (replace /en/ with your language)

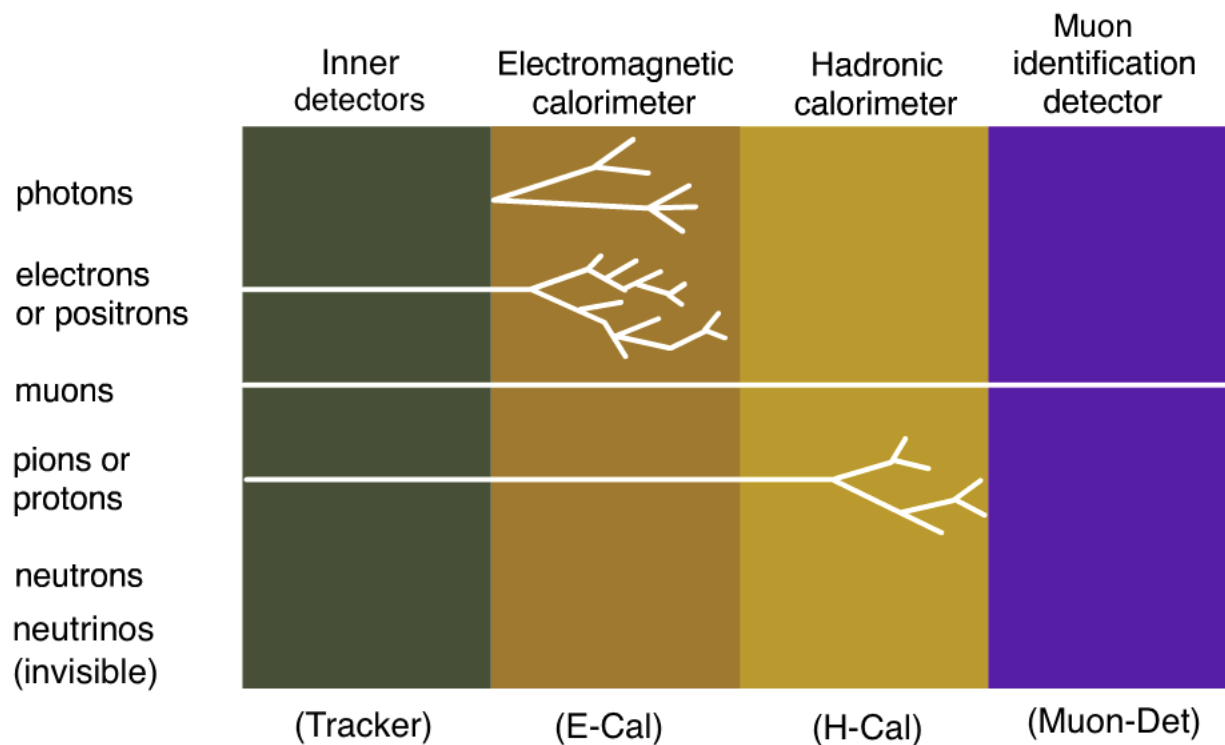
This is:

1. The HYPATIA application and instructions
2. Your unique dataset - ask your tutor if you need help
3. The web result upload page OPLOT: <http://cernmasterclass.uio.no/OPLOT/>
  - username: ippog
  - password: mc13

## Do the following:

Go to the Z-Path: [http://atlas.physicsmasterclasses.org/en/zpath\\_measurement.htm](http://atlas.physicsmasterclasses.org/en/zpath_measurement.htm)

1. Instructions of what to do can be found under the sub menu items of **“Get to work”**:
  - Get to work→Data samples and tools
  - Get to work→Do it!
  - Get to work→Analyze your result (together with rest of students and tutors)
2. Find and download your data sample - follow instructions found at **“Data samples and tools”**.
  - Open HYPATIA
  - Unzip data sample
  - Load events in HYPATIA with File→Read Events Locally - Navigate to your downloaded and unzipped data sample
3. If you need hints on how to use HYPATIA, and how to identify particles and events go to
  - How to use HYPATIA: Identifying Particles→Visualization with HYPATIA
  - How to identify particles: Identifying Particles→Particle footprint Visualization
  - How to identify events: Identifying Events→Visualization
4. After you are done analysing your events, export the Invariant Mass Table
  - File→Export Invariant Masses
  - Place it in the default area, or on the Desktop. Remember where you put it!
5. Upload the file just produced (Invariant\_Masses.txt) to OPLOT
  - <http://cernmasterclass.uio.no/OPLOT/>
  - Choose: Student → Year(2013) → Month → Date → Institute
  - Chose the correct group according to the description on OPLOT
  - Upload your file Invariant\_Masses.txt.
6. Congratulations you have delivered your results!



#### Electrons and photons:

- Leave energy deposit in E-Cal
- Stop in E-Cal

#### Electrons:

- Leave track in Tracker

#### Photons:

- Leave **no** track in Tracker

#### Protons and neutrons:

- Leave energy-deposit in H-Cal (and possibly a little in the E-Cal)
- Stop in H-Cal

#### Protons:

- Leave track in Tracker

#### Neutrons:

- Leave **no** track in Tracker

#### Muons:

- Leave a track in Tracker
- Reach all the way out to the Muon-Det
- Leave little energy-deposit in E-Cal and H-Cal

#### Neutrinos:

- Leave the whole detector without a trace
- Can only be inferred by the missing energy (ETMis) in the energy-balance of the collision
- Indicated with red dashed line in HYPATIA

#### Jets (not shown here)

- Are showers of particles, for instance a shower of neutrons, protons and other hadrons
- Leave many tracks in Tracker
- Leave energy-deposit in H-Cal (and possibly some in E-Cal)
- Stop in H-Cal

## TYPICAL electron-positron event

- Energy deposit in electromagnetic calorimeters (E-Cal) marked with red circles
- Stops in E-Cal
- One particle should be positive, the other negative
- NB! Remember to also investigate the longitudinal display, not just transverse as shown here!

HYPATIA - Track Momenta Window

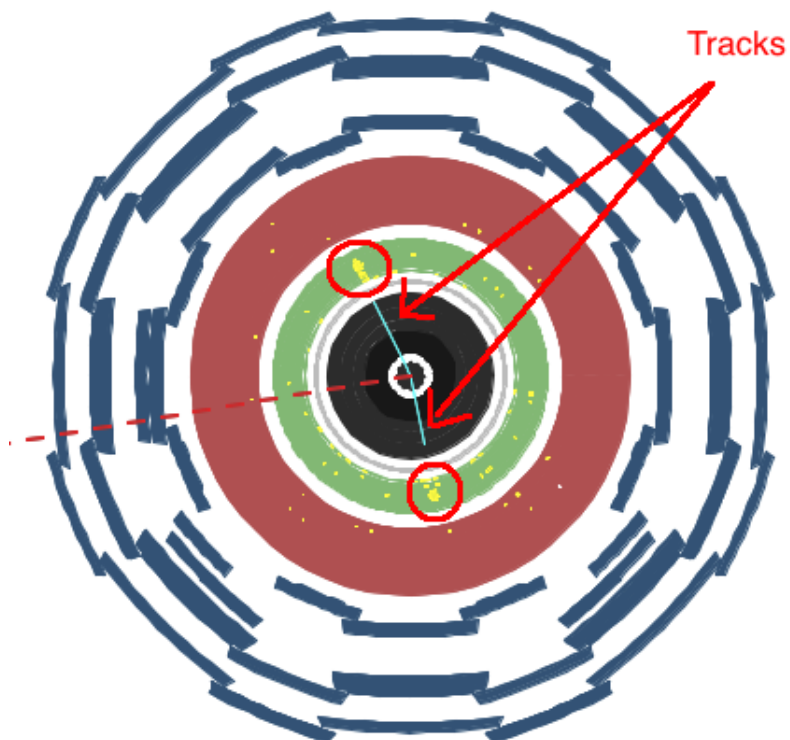
Previous Event Next Event Electron Muon Photon Delete Track Reset Canvas

ETMis: 16.187 GeV  $\varphi$ : -2.974 rad Collection: MET\_Reffinal

iaikenp/Desktop/Hypatia\_7-1-2/Hypatia\_7-1/group1/event013.xml

Tracks Physics Objects

Track	+/-	P [GeV]	Pt [GeV]	$\varphi$	$\theta$
Tracks 2	+	40.57	33.41	-1.366	0.968
Tracks 141	-	51.42	43.19	2.018	2.144



## TYPICAL muon-antimuon event

- Tracks all the way through the detector and into muon detector
- One particle should be positive, the other negative
- NB! Remember to also investigate the longitudinal display, not just transverse as shown here!

HYPATIA - Track Momenta Window

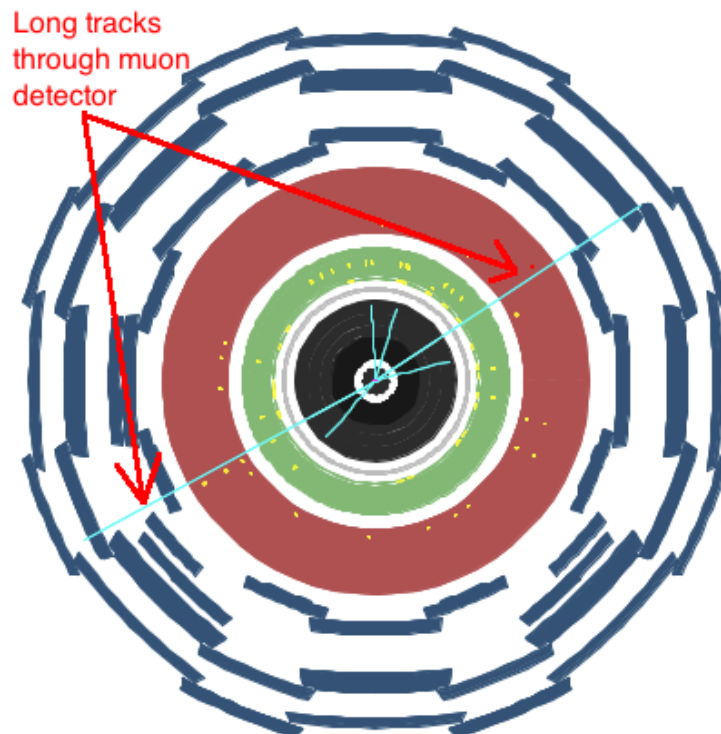
Previous Event   Next Event   Electron   Muon   Photon   Delete Track   Reset Canvas

ETMis: 7.369 GeV    $\varphi$ : 2.796 rad   Collection: MET\_Reffinal

iaikenp/Desktop/Hypatia\_7-1-2/Hypatia\_7-1/group1/event011.xml

**Tracks**   Physics Objects

Track	+/-	P [GeV]	Pt [GeV]	$\varphi$	$\theta$
Tracks 22	-	139.51	47.69	0.576	0.349
Tracks 139	+	73.73	37.69	-2.627	0.537
Tracks 198	+	11.60	7.60	1.318	2.427
Tracks 238	+	19.76	10.90	0.291	0.584
Tracks 239	-	105.93	54.03	1.630	0.535
Tracks 242	-	19.90	8.98	-2.321	0.468

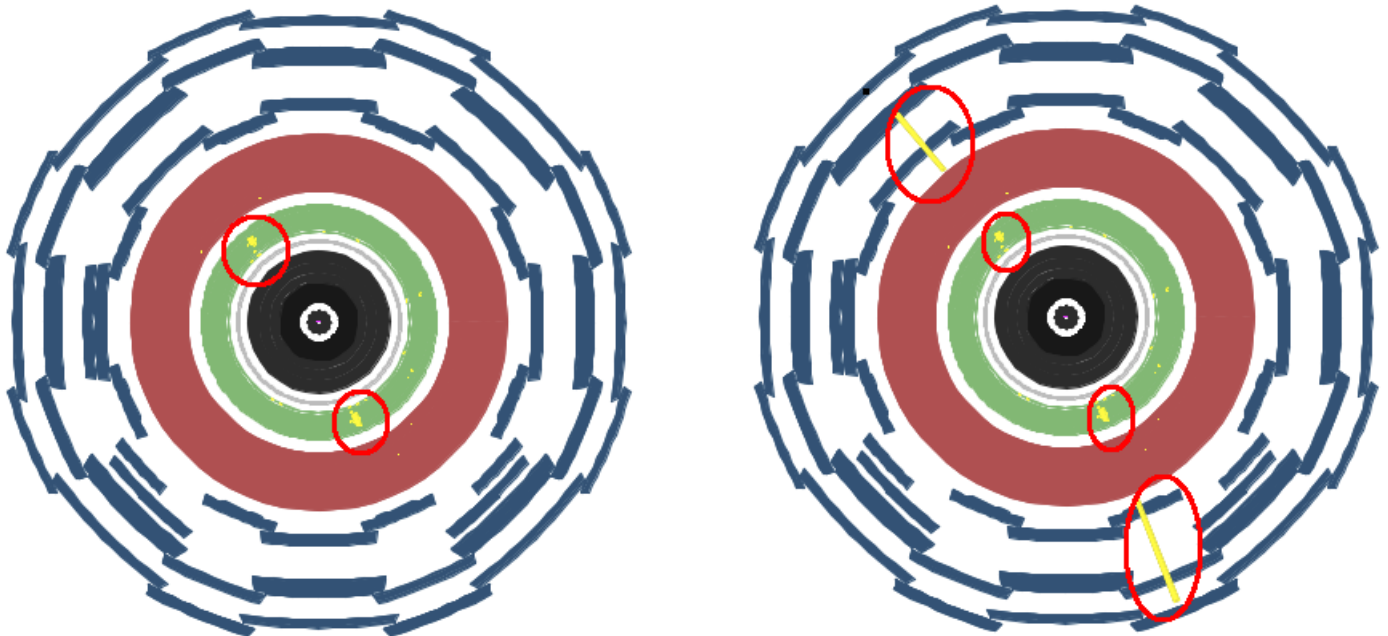


## EXAMPLE of unconverted di-photon event

- Energy deposit in the E-Cal (red circles)
- Objects in the Objects Tab, and marked with yellow “towers” (red ellipse in figure)
- No tracks in inner-detector
- NB! Remember to also investigate the longitudinal display, not just transverse as shown here!

NB! Photons can also be converted, and there will then be tracks in the inner detector. Needs your further analysis!

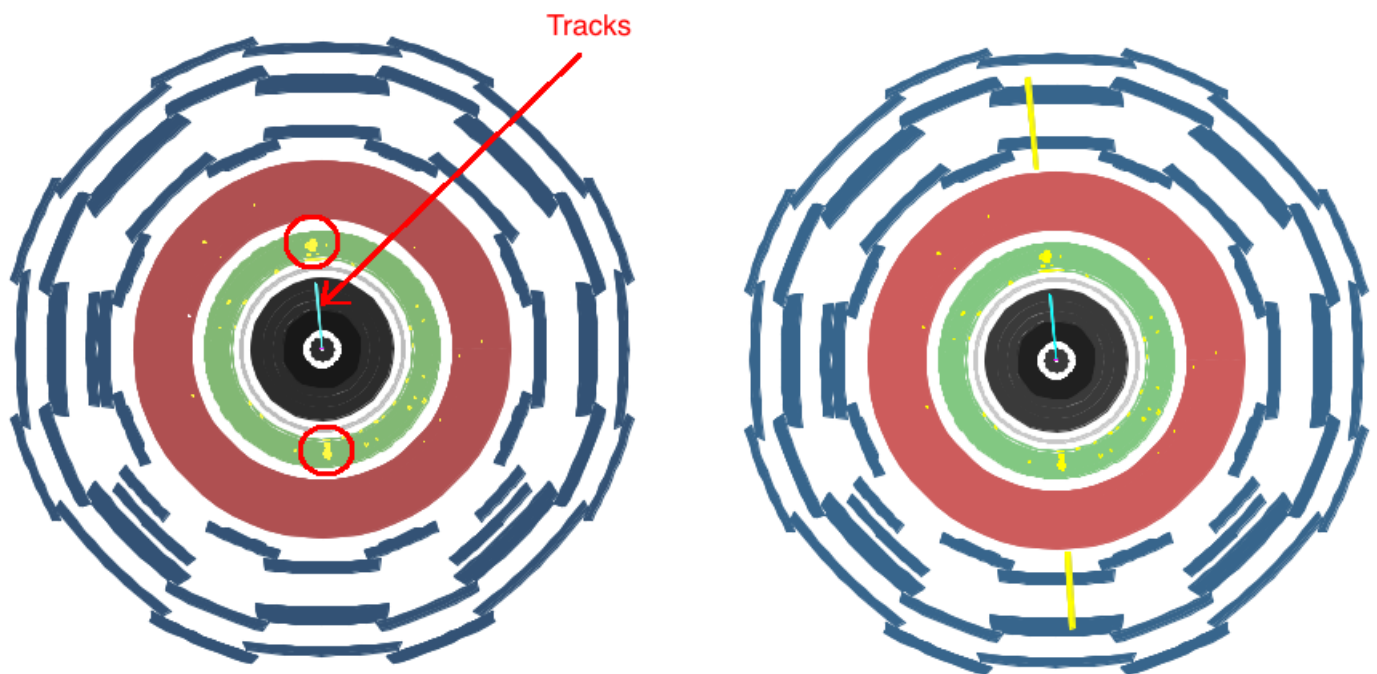
Track	P [GeV]	Pt [GeV]	$\varphi$	$\theta$
Object 0	98.35	71.73	-1.199	2.324
Object 1	50.96	38.60	2.265	0.859



## EXAMPLE of converted di-photon event

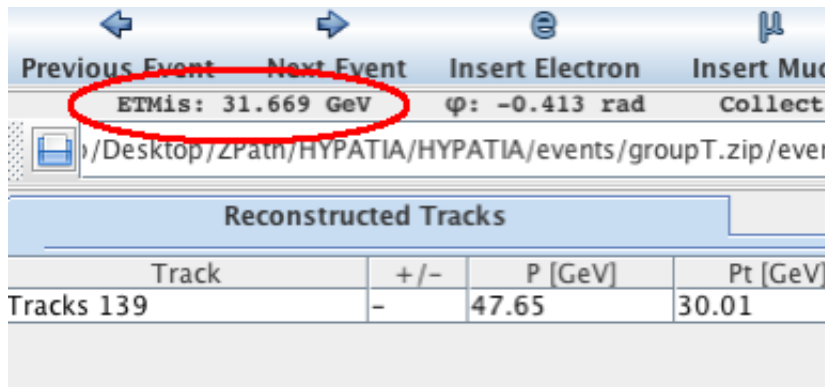
- Energy deposit in the E-Cal (red circles)
- Objects in the Objects Tab, and marked with yellow “towers” (red ellipse in figure)
- Tracks in inner-detector
- NB! Remember to also investigate the longitudinal display, not just transverse as shown here!

Track	P [GeV]	Pt [GeV]	$\phi$	$\theta$
Object 0	106.15	52.96	1.673	0.522
Object 1	53.31	41.32	-1.512	2.255



## EXAMPLE of background-event

- Large missing transverse energy (ETMis) (red ellipse)
- Only one electron (red circle)
- NB! Remember to also investigate the longitudinal display, not just transverse as shown here!
- NB! This is only 1 example of a background event. Other background events may contain muons and/or jets also.



Track	+/-	P [GeV]	Pt [GeV]
Tracks 139	-	47.65	30.01

