



International Particle
Physics Outreach Group

**International
Masterclasses**

Hands on Particle Physics

**Internationale
masterclass
deeltjesfysica voor
scholieren**



International Particle
Physics Outreach Group

International Masterclasses

Hands on Particle Physics

- 13.000 high school students from 60 countries every year
- hosted by 225 universities and research centres
- ends with discussion of results of other international groups (+CERN)
- free of charge for the participants!

Being a particle physicist for a day

Example programme at Nikhef

12:45 Arrival

13:00 Lecture

13:45 Break

14:00 Expostrip

14:15 Workshop introduction / instructions

14:30 Workshop

15:30 Evaluation and discussion of results

15:45 Break

16:00 Videoconference with CERN (and other groups)

17:00 Closing

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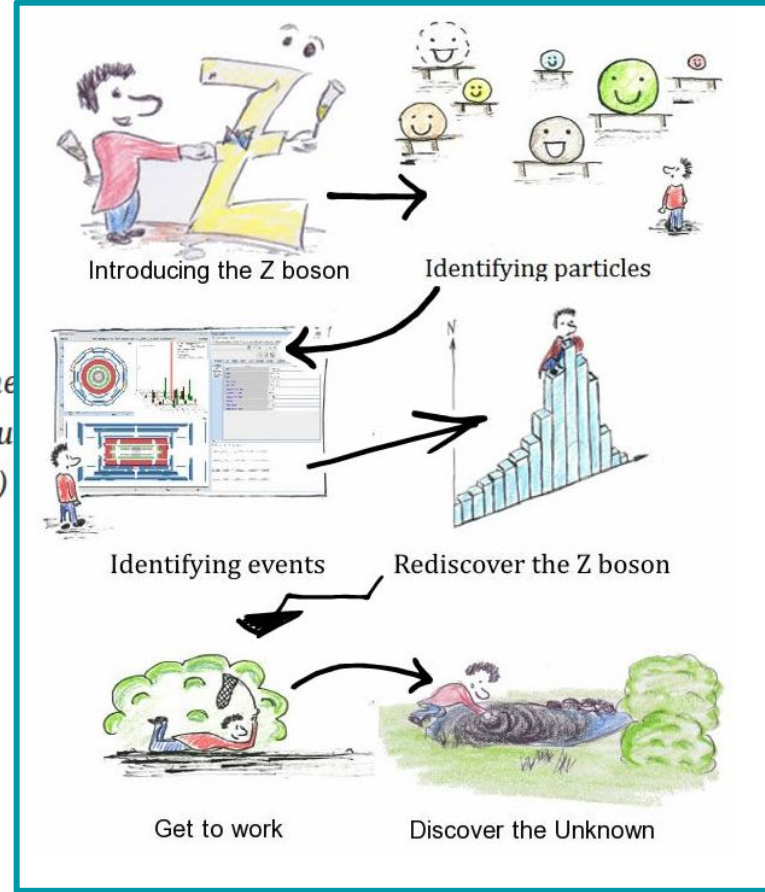


A measurement with actual ATLAS data

Z-Path

Welcome to the Z-path! Here you will learn about some particles, such as the Z boson and the Higgs boson, and their importance to our understanding of Nature. In this quest you will use real ATLAS data from the Large Hadron Collider (LHC) at CERN.

<https://atlas.physicsmasterclasses.org/en/zpath.htm>



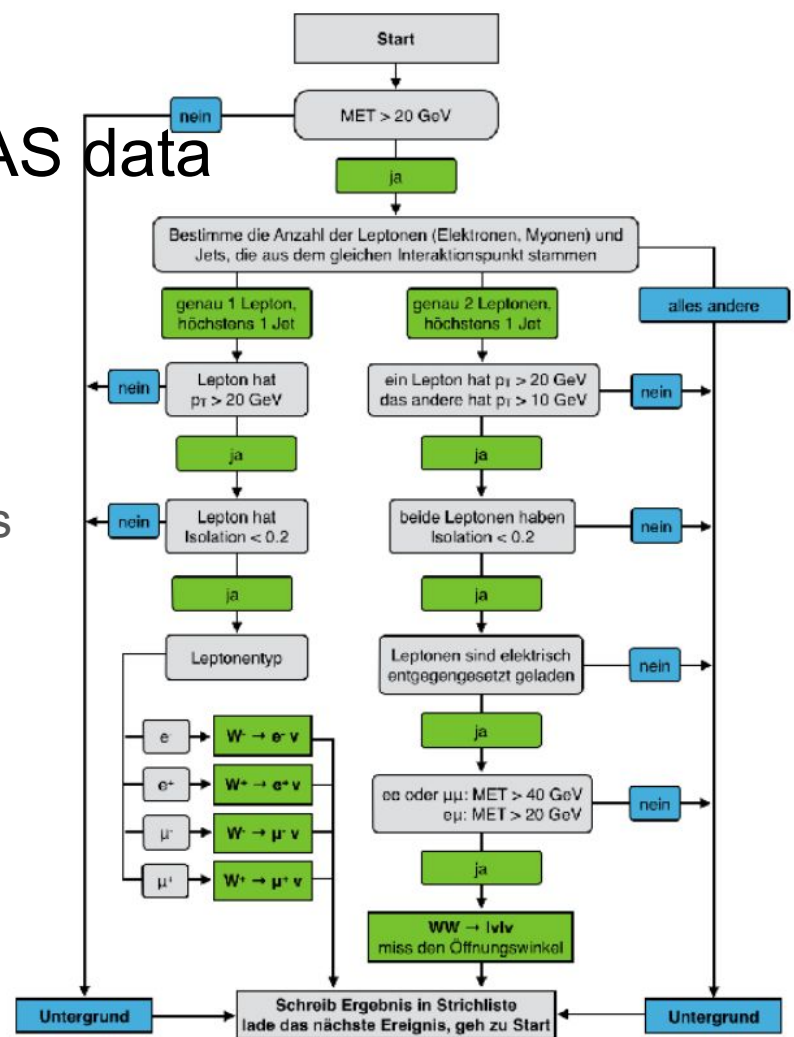
A measurement with actual ATLAS data

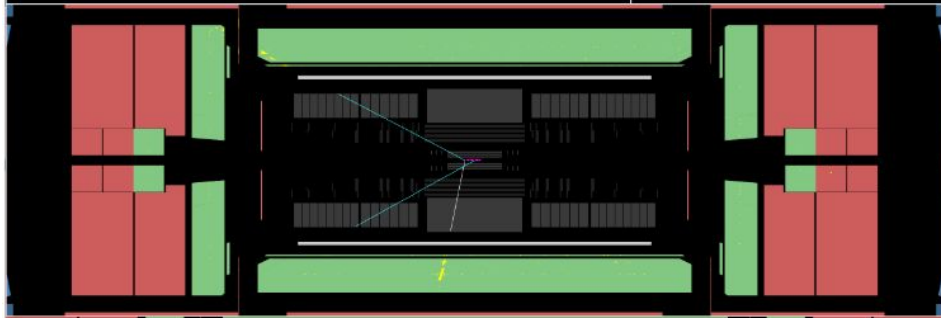
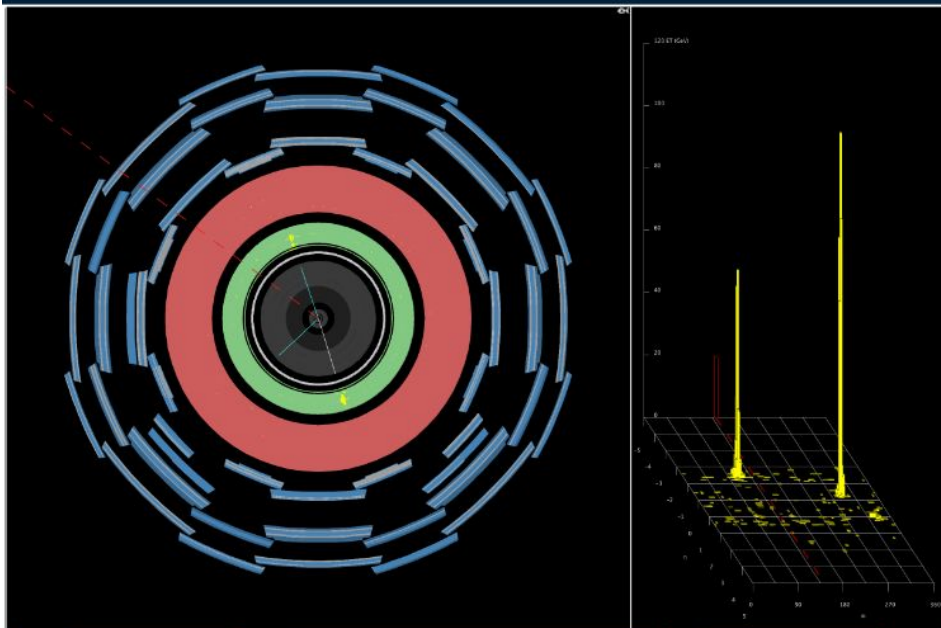
datasets:

ATLAS real pp-data from 2012 at 8 TeV

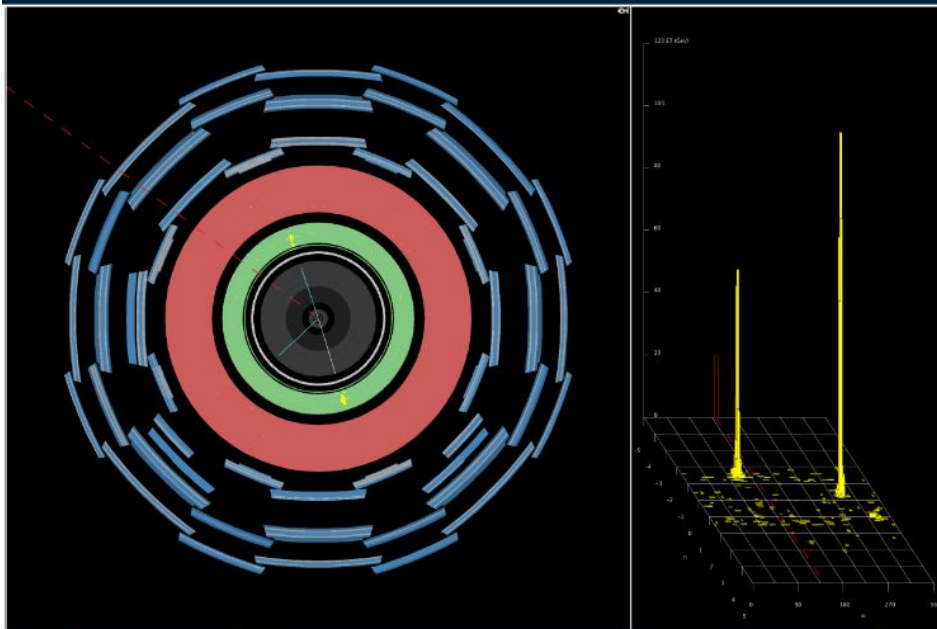
+ MC simulations of Z' and Graviton

kinematic selections like in an ATLAS analysis





File Name	ETMis [G...]	Track	P [GeV]	...	Pt [GeV]	ϕ	η	M(2) [GeV]	M(eeee) [...]	M(eemm)...	M(mmmm)...	e/...
event022.xml	19.156	Tracks 7	838.7	-	390.6	1.900	-1.398	956,389				e/...
		Tracks 22	425.5	+	417.1	-1.263	-0.200					e



Electron-positron event

- Typically two big towers on lego plot, and tracks pointing to the towers (both views)

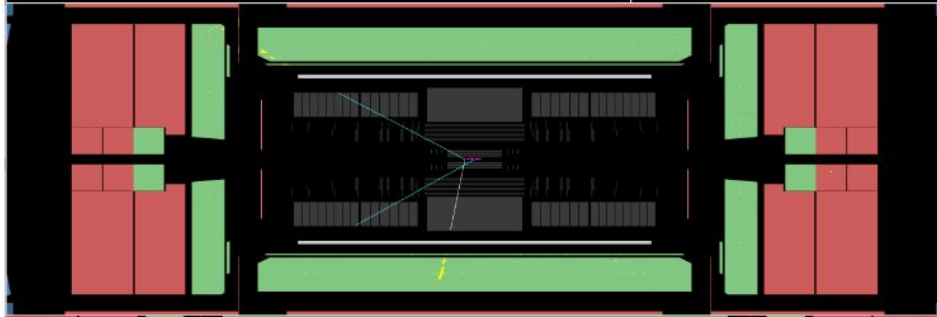
File Previous Event Next Event **Electron** Muon Photon Delete Track

ETMis: 19,156 GeV ϕ : 2,503 rad Collection: MET_Reffinal

ads/Hypatia_7.4_Masterclass (1)/groupT/event022.xml

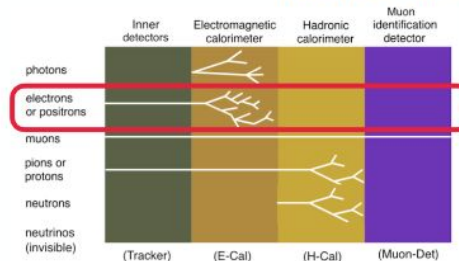
Tracks Physics Objects

Track	+/-	P [GeV]	Pt [GeV]	η	θ
Tracks 7	-	838,68	390,63	1,900	2,657
Tracks 22	+	425,52	417,12	-1,263	1,770
Tracks 245	+	181,58	88,56	-2,386	2,632



File Name	ETMis [GeV]	Track	P [GeV]	Pt [GeV]	η	θ	M[2] [GeV]	M(eeee) [GeV]	M(eemm) [GeV]	M(mmmm) [GeV]	e/...
event022.xml	19,156	Tracks 7	838,7	390,6	1,900	-1,398	956,389				e
		Tracks 22	425,5	417,1	-1,263	-0,200					e

From your cheat sheet



Electrons and photons:

- Leave energy-deposit in E-Cal
 - Stop in E-Cal
- Electron:
Leaves a track in Tracker
- Photon:
Leaves **no** track in Tracker

Adapt within fixed boundaries

Walking along the Nikhef Expo-Strip

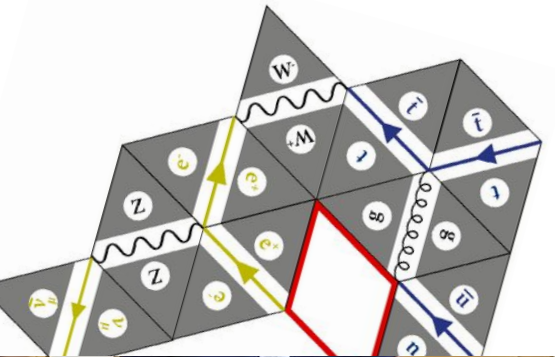
These questions are supposed to guide you while exploring the Expo-Strip. For some of these questions the answer will not be given in the texts accompanying the exposition. You might need to do some estimations yourself - be creative!

-
1. How many Photo-Multiplier-Tubes are on one KM3NeT DOM? Why so many?
 2. Estimate the daily rate of particles observed in the cloud chamber. How could you increase it?

Videoconferentie met CERN

Someone in the room falls asleep	"Order of magnitude"	Mention of any other detector than ATLAS	"You need more data"	Question that was already explained
Histogram is shown	Someone asks a way to complicated question	Unstable internet connection	One group discovered the Z' boson	"You don't need to know this (but...)"
You ask a question	Comic Sans on slides	You finally understand something confusing	"Basically, ..."	You summarize the measurement at Nikhef
Feynman diagram shown	"At the end of the day..."	Host says "good question"	mention of weak force	Higgs boson mentioned
FREE SPACE	"Statistically significant!"	Someone in the room asks a question	No-one volunteers to answer a question	You come up with a meme and share it afterwards

It does not need to be all digital!



P. Lindenau



Netzwerk Teilchenwelt



It does not need to be ATLAS data!

