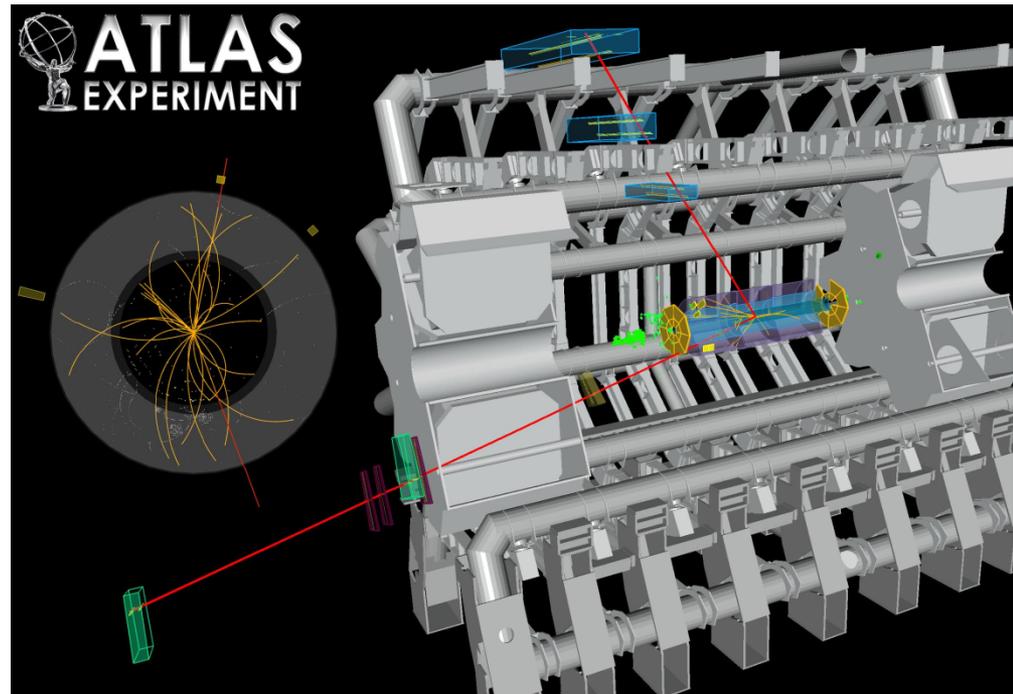
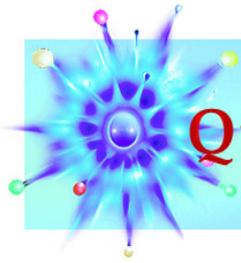




ATLAS Z-Path Masterclass 2016





Generic Design

Cylinders wrapped around the beam pipe

From inner to outer . . .

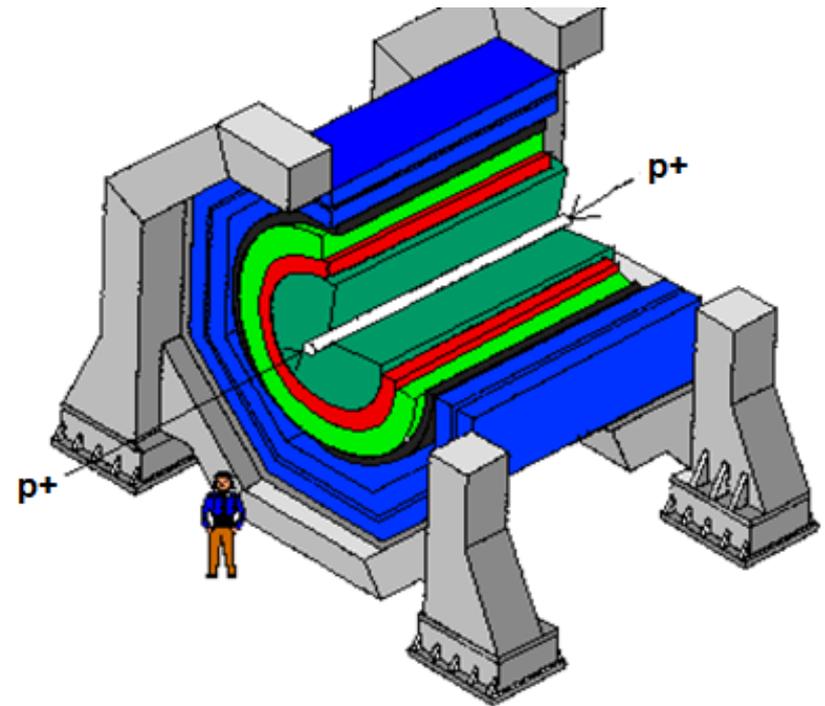
Tracking

Electromagnetic calorimeter

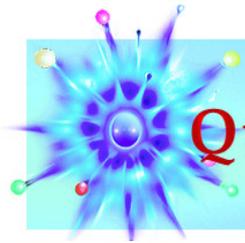
Hadronic calorimeter

Magnet*

Muon chamber



* *Location of magnet depends on specific detector design.*

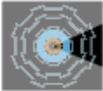


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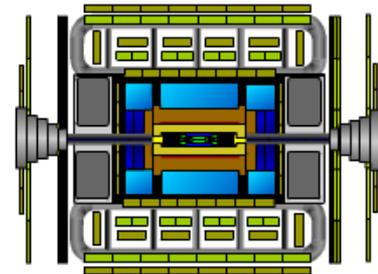
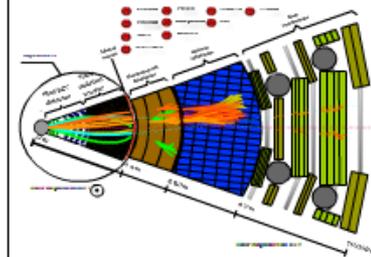
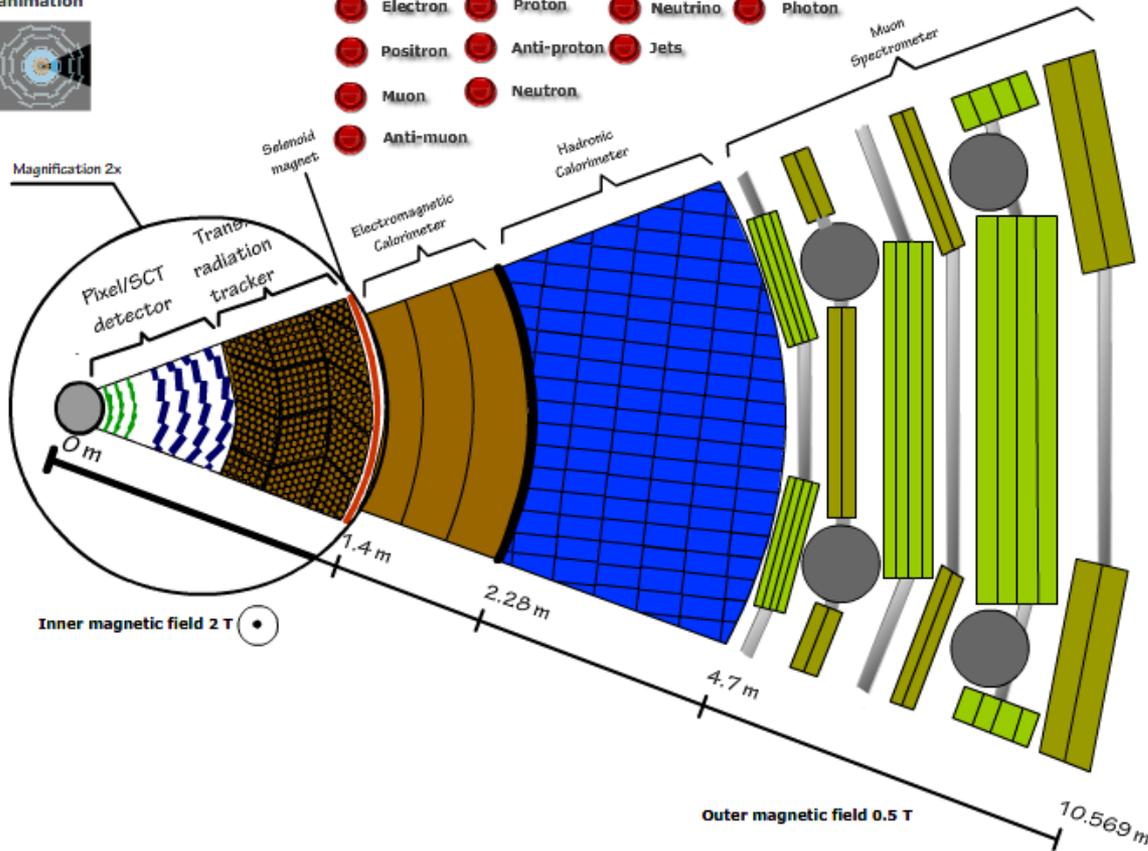
ATLAS Detector

ATLAS

animation

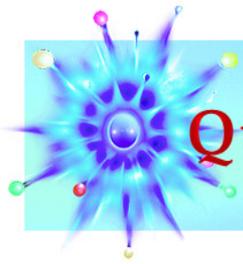


- Electron
- Positron
- Muon
- Anti-muon
- Proton
- Anti-proton
- Neutron
- Neutrino
- Photon
- Jets



Created by Jeřábek, Jende 2010

[Play with ATLAS online!](#)

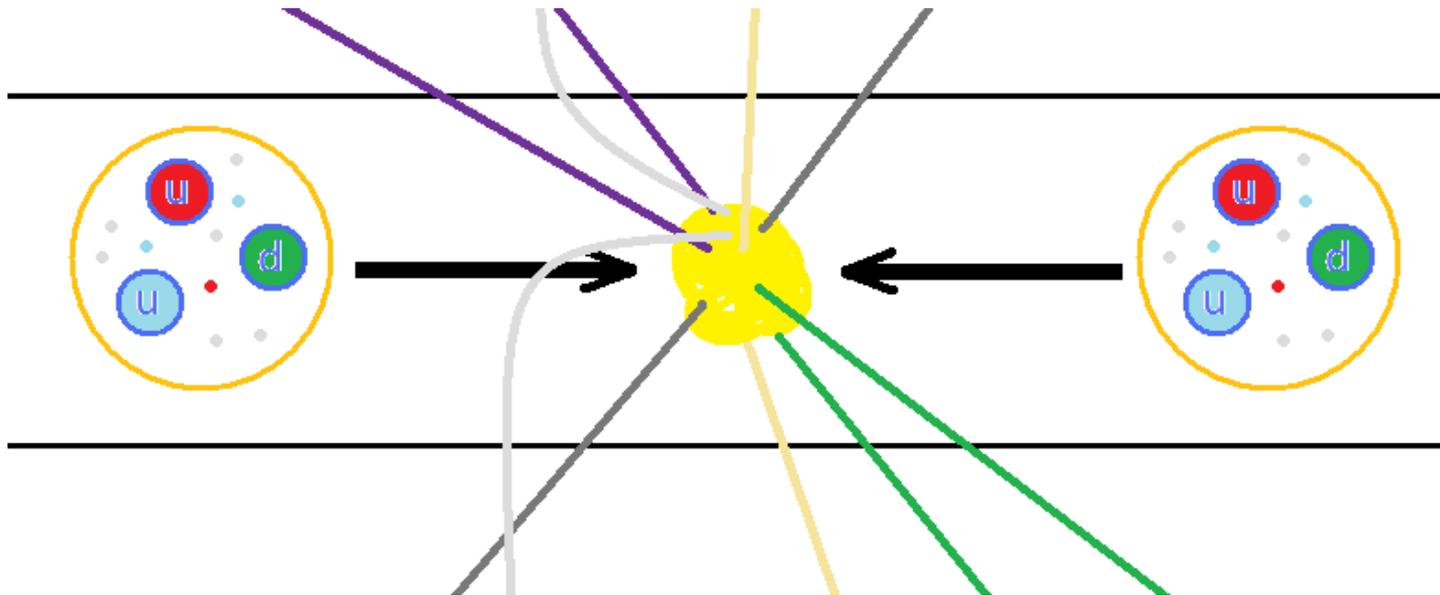


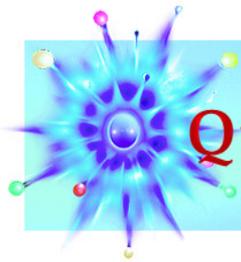
QuarkNet

Proton Interactions

If each beam proton has energy 4 TeV....

- The total collision energy is $2 \times 4 \text{ TeV} = 8 \text{ TeV}$.
- But each particle inside a proton shares only a portion.
- So a newly created particle's mass ***must be*** smaller than the total energy.



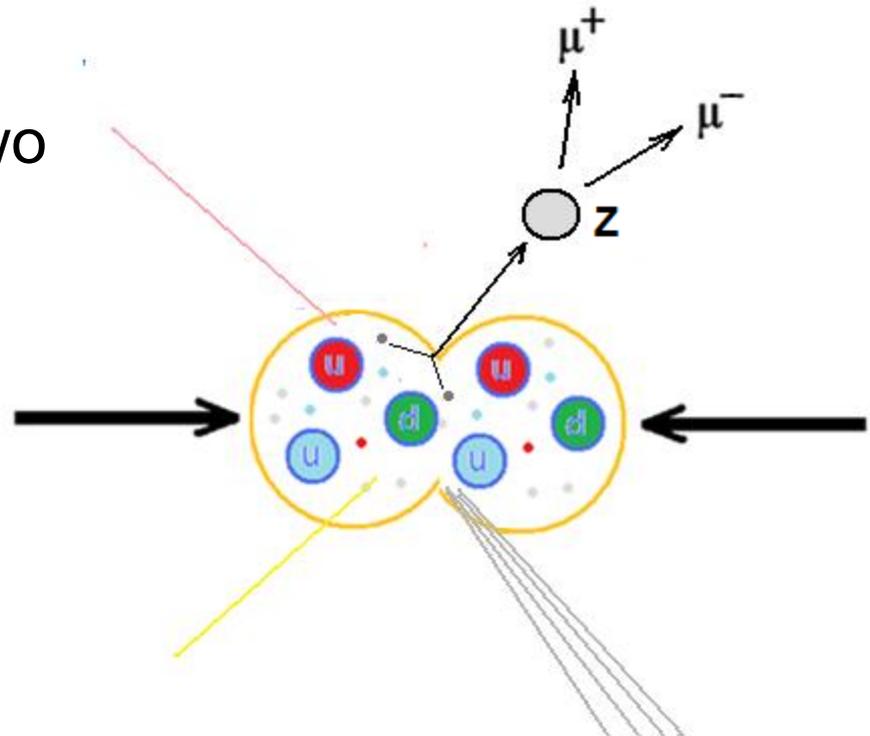


QuarkNet

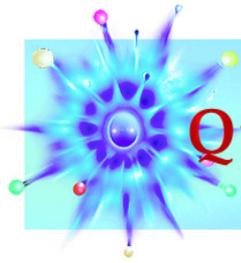
Particle Decays

We are looking for the Z boson, a particle with no charge that decays into two muons or two electrons.*

What do we know about the charges of the muons or electrons? What is the charge of the Z?



**The Z has other decays . . . but these are not what we are looking for.*

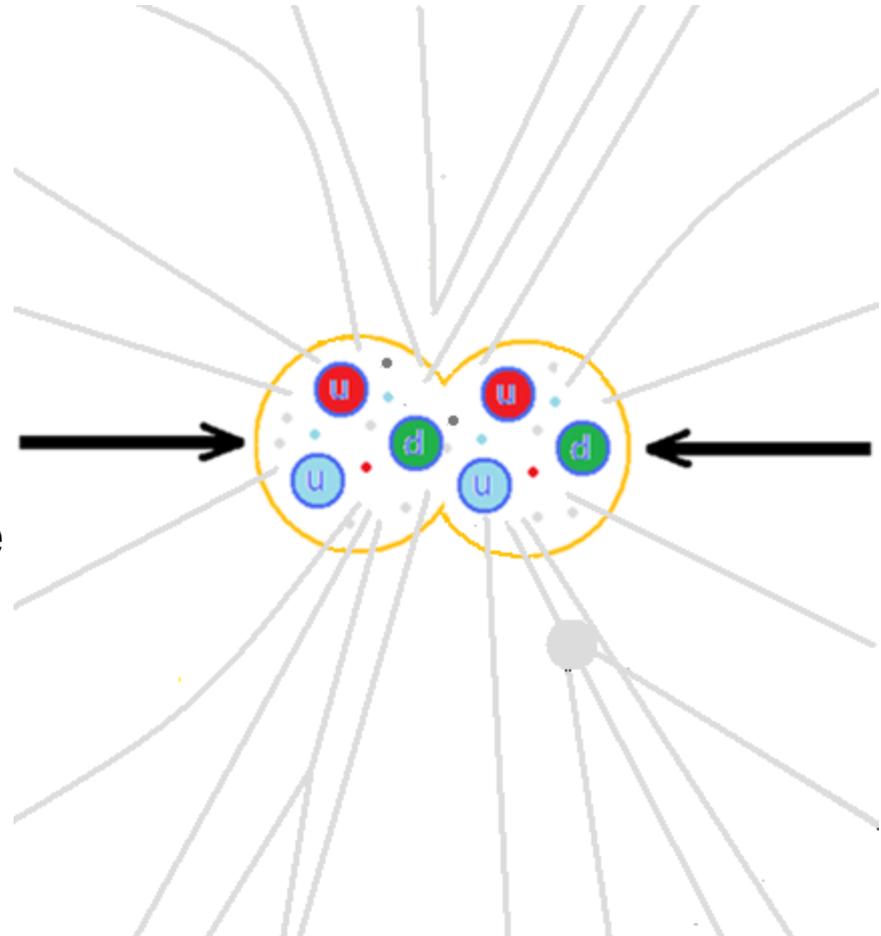


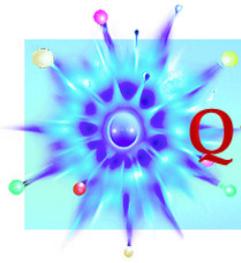
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Particle Decays

A “dimuon” or “dielectron” event *might* be a decay of the particle that we are interested in.

It may be hard to find the tracks we want unless we make a “cut” on low- energy tracks.



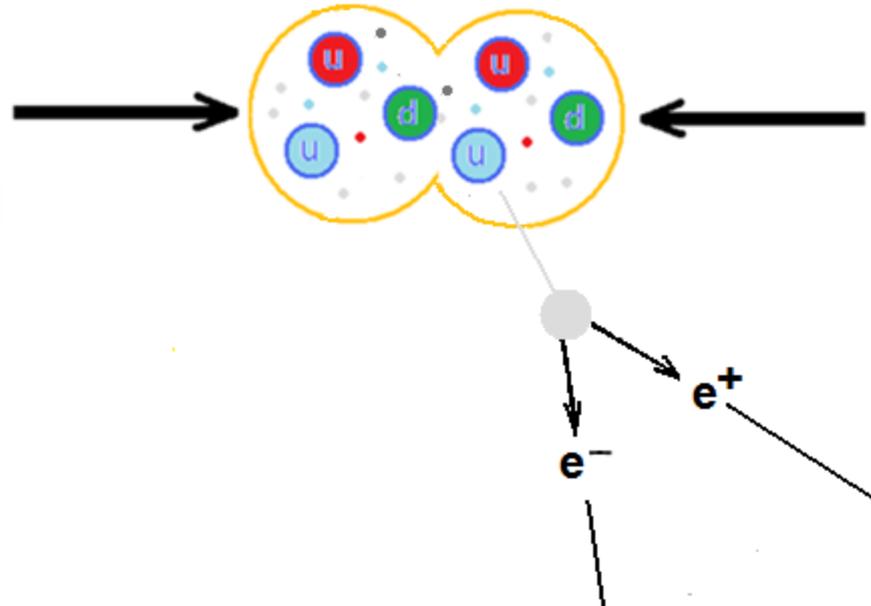


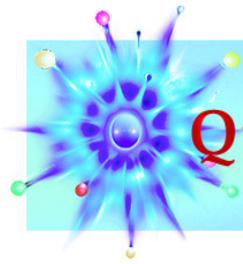
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Particle Decays

If we cut out all tracks below, say, 5 GeV momentum, the picture is clearer.

Today, we will filter many events to find $Z \rightarrow e^- e^+$ and $Z \rightarrow \mu^- \mu^+$ signals and use momentum information from these to find the mass of the Z boson.



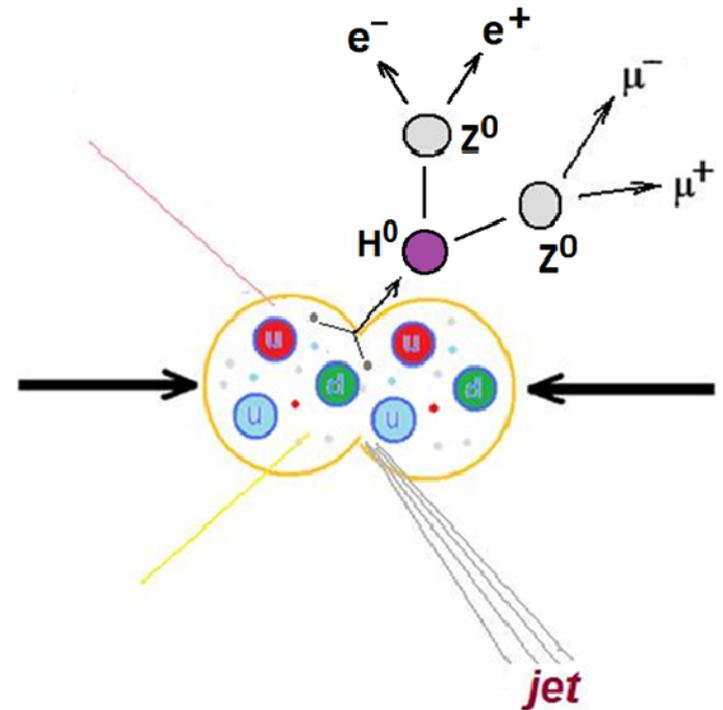


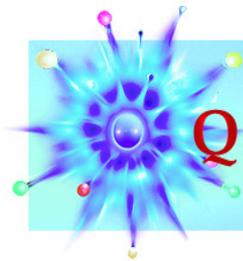
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Particle Decays

The Higgs boson was discovered by CMS and ATLAS and announced on July 4, 2012.

This long-sought particle is part of the “Higgs mechanism” that accounts for other particle having mass.





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Helping Develop America's Technological Workforce

HYPATIA Event Display

Hybrid pupils' analysis tool for interactions in ATLAS - version 6.0 - Invariant Mass Window

File View Histograms Preferences Help

File Name	ETMis [GeV]	Track	P [GeV]	+/-	Pt [GeV]	ϕ	η	M(Z _{ij}) [GeV]	M(4l) [GeV]	e/ μ
00036_JiveXML_166964_987982.xml	19.626	Tracks 3	112.6	+	49.4	1.441	-1.464	95.325		μ
		Tracks 69	96.8	-	45.9	-1.720	-1.378			μ

Canvas Window - File: 00036_JiveXML_166964_987982.xml Run: 166964 Event: ...

ATLAS 2010-10-18 04:39:34 CEST run:166964 ev:987982 HYPATIA

HYPATIA - Track Momenta Window

File Previous Event Next Event Insert Electron Insert Muon Delete Track Reset Canvas

ETMis: 20.808 GeV ϕ : -2.415 rad Collection: MET RefFinal

C:\installers\HYPATIA\groupAI\00036_JiveXML_166964_987982.xml

Reconstructed Tracks

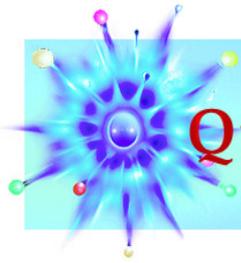
Track	+/-	P [GeV]	Pt [GeV]	ϕ	θ
Tracks 3	+	112.57	49.42	1.441	2.687
Tracks 69	-	96.83	45.88	-1.720	2.648
Tracks 127	-	37.93	30.81	1.803	0.948
Tracks 128	+	25.73	12.70	0.303	2.625
Tracks 134	+	121.30	89.22	-0.597	2.315
Tracks 136	-	34.18	8.63	-3.123	0.255
Tracks 154	+	14.19	8.35	-2.346	2.513
Tracks 176	-	13.53	12.74	0.259	1.915

HYPATIA - Control Window

Parameter Control Interaction and Window Control Output Display

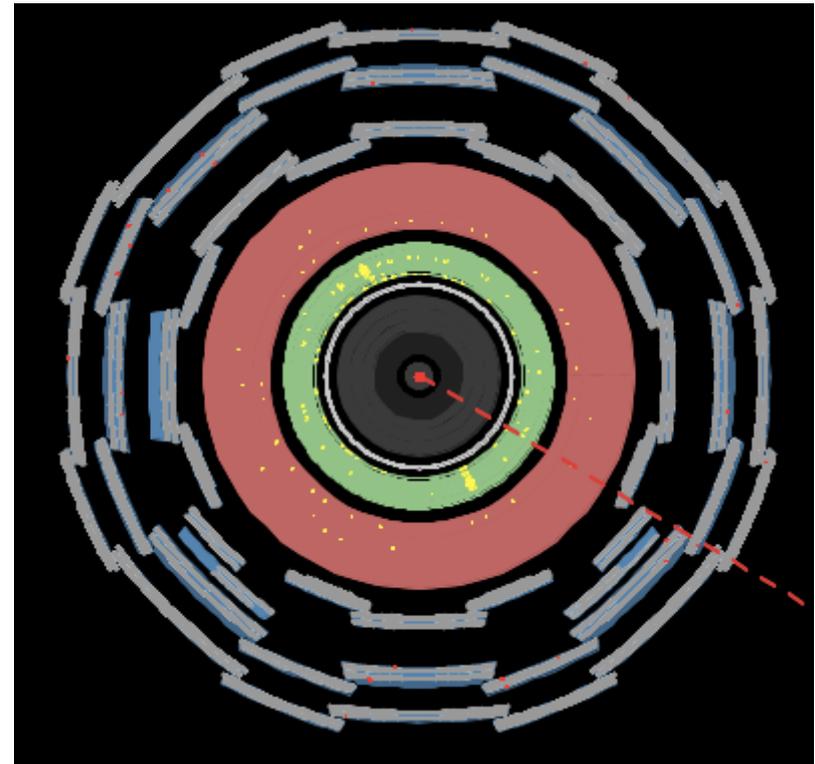
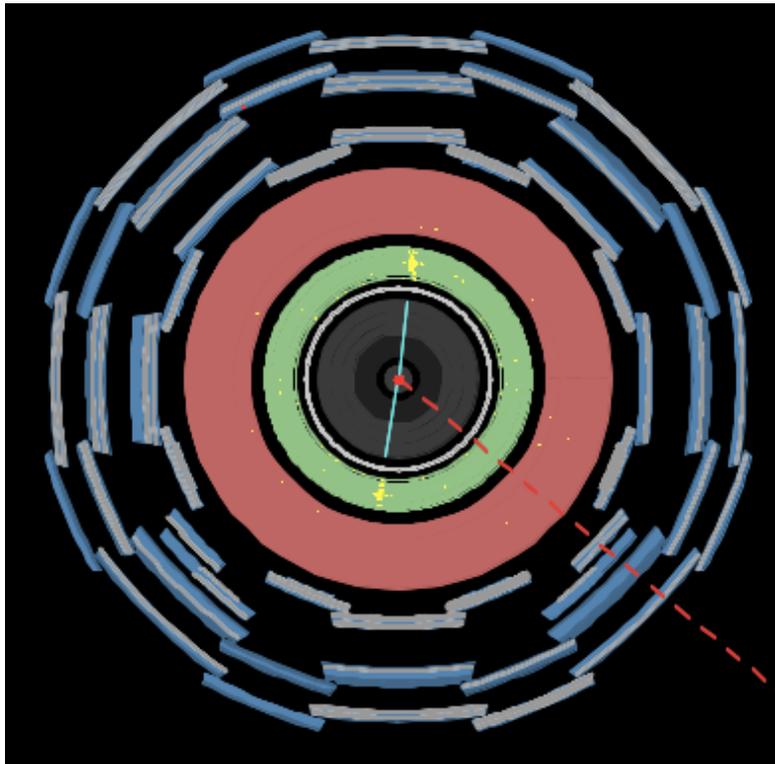
Projection Data Cuts InDet Calo MuonDet Objects Geometry

Category	Name	Value
InDet		
Calo	<input checked="" type="checkbox"/> Pt	> 5.0 GeV
MuonDet	<input type="checkbox"/> d0	< 2.5 mm
Objects	<input type="checkbox"/> z0	< 20.0 cm
ATLAS	<input type="checkbox"/> d0 Loose	< 2.0 cm
	<input type="checkbox"/> z0-zvtx	< 2.5 mm

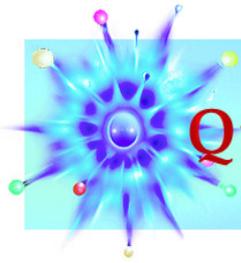


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HYPATIA Event Display

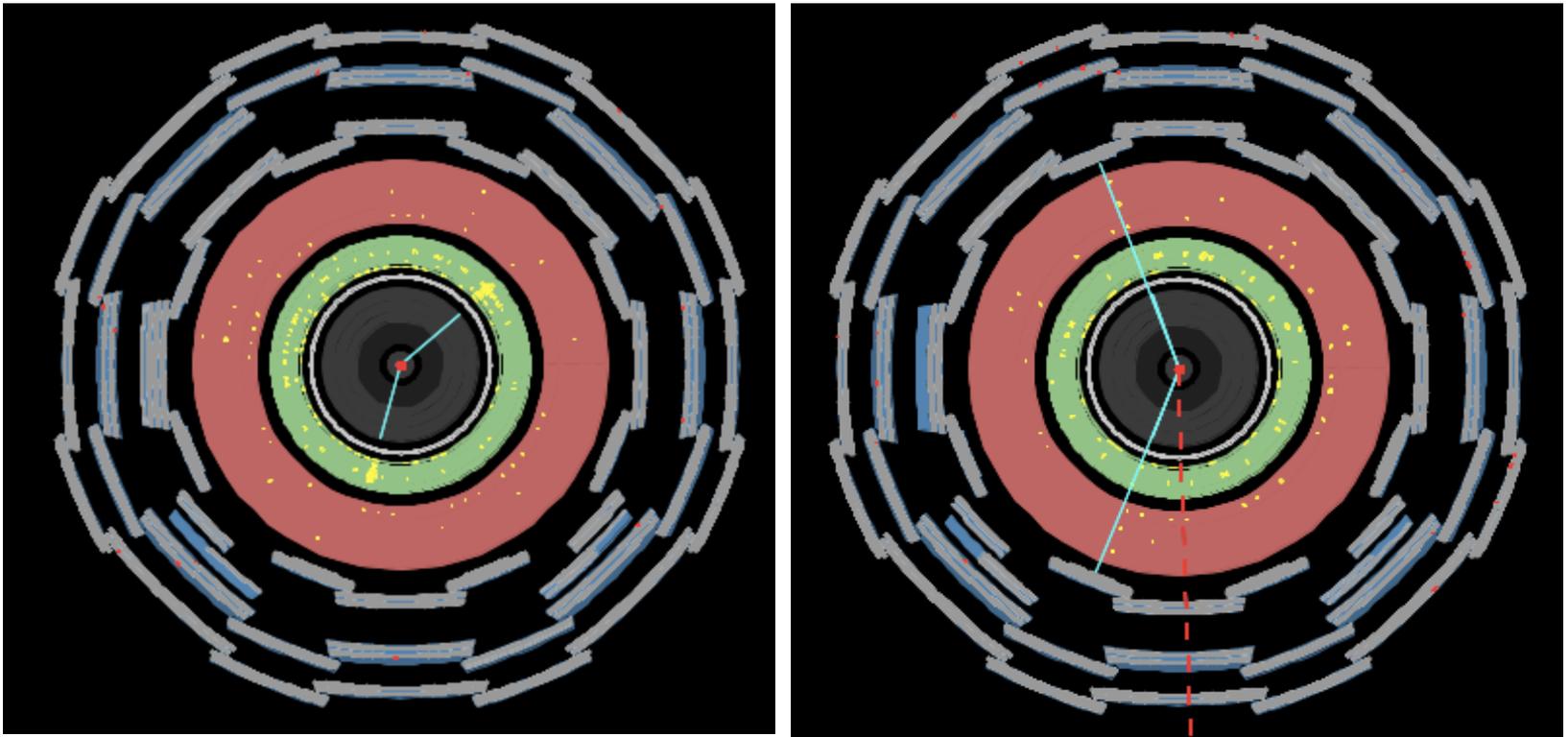


How are these events similar? Different? Why?

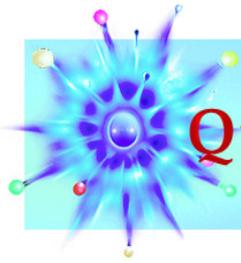


QuarkNet

HYPATIA Event Display

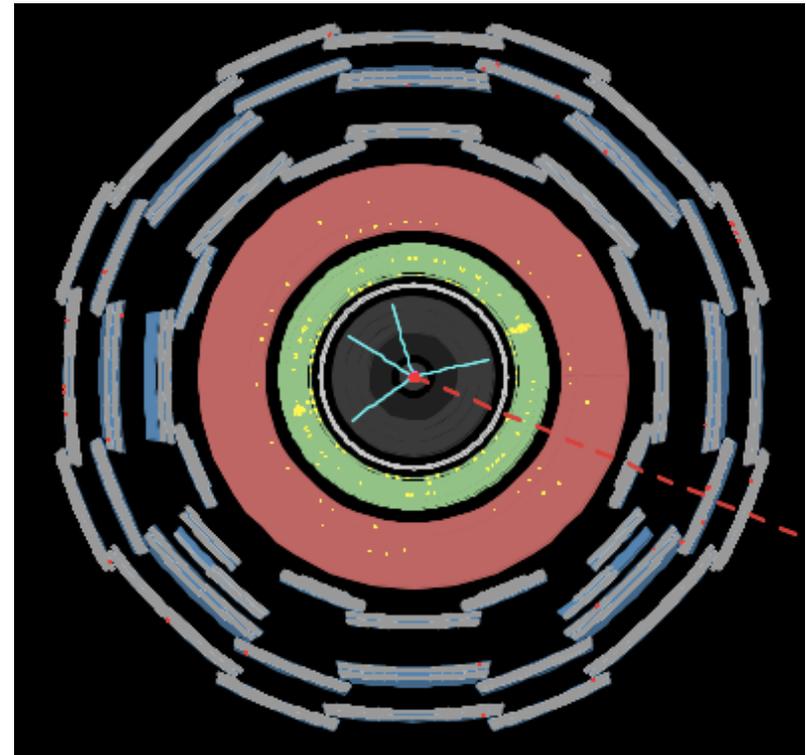
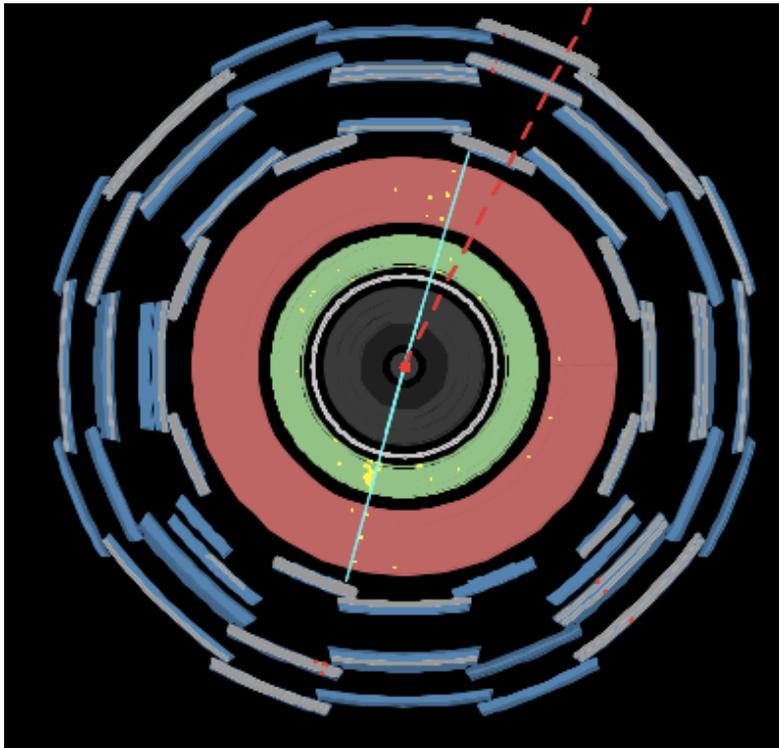


How are these events similar? Different? Why?



QuarkNet

HYPATIA Event Display



How are these events similar? Different? Why?