Measurement of exclusive $\gamma\gamma \to \mu^+\mu^-$ events in the ATLAS Experiment

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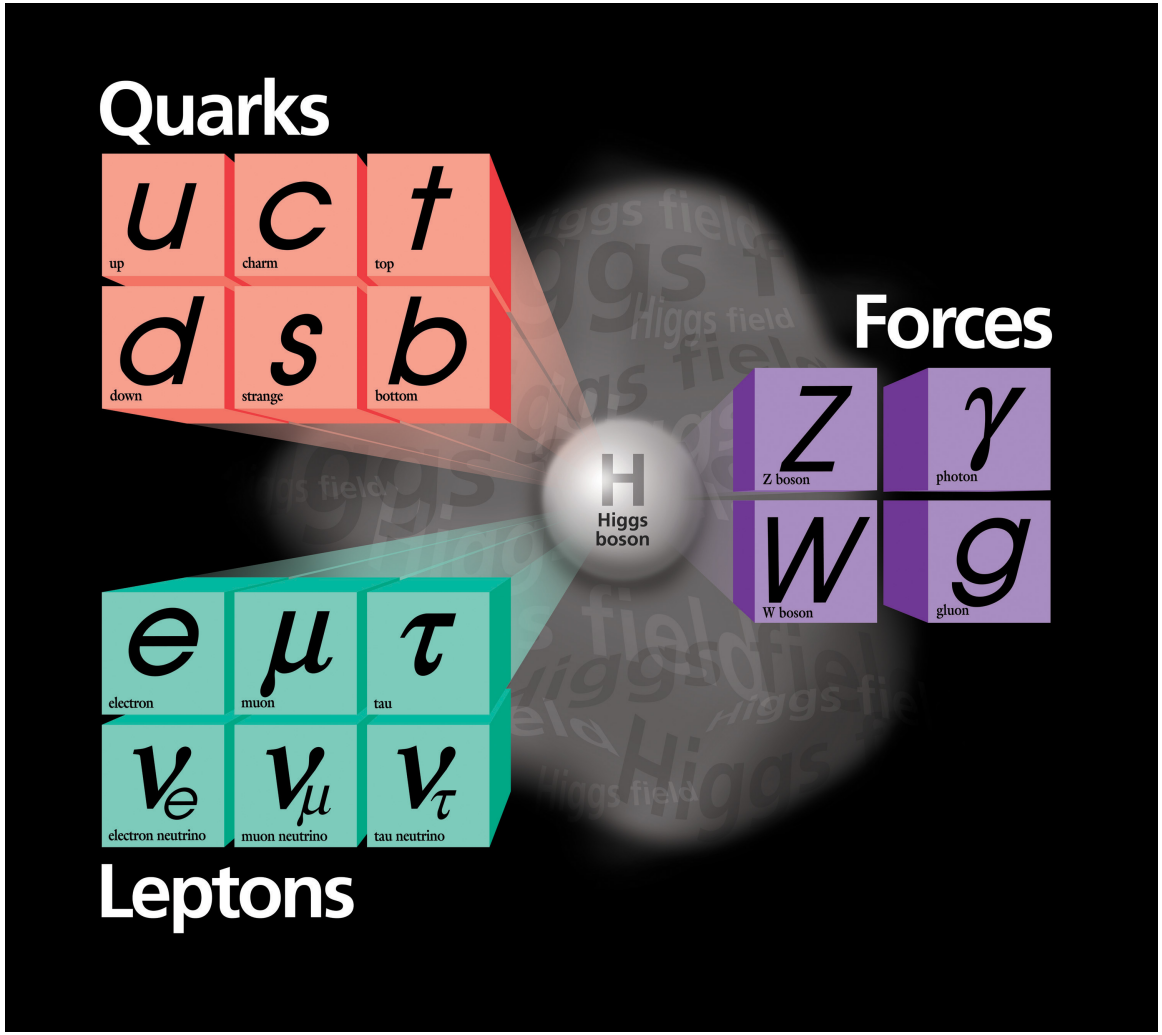
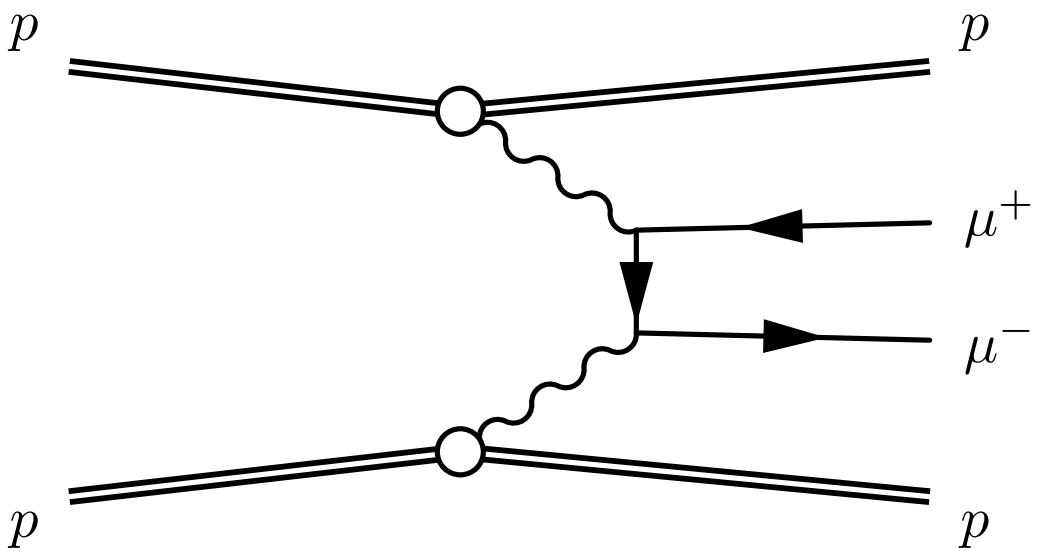
HEPP2015

The Standard Model - Particles



Defining Exclusive

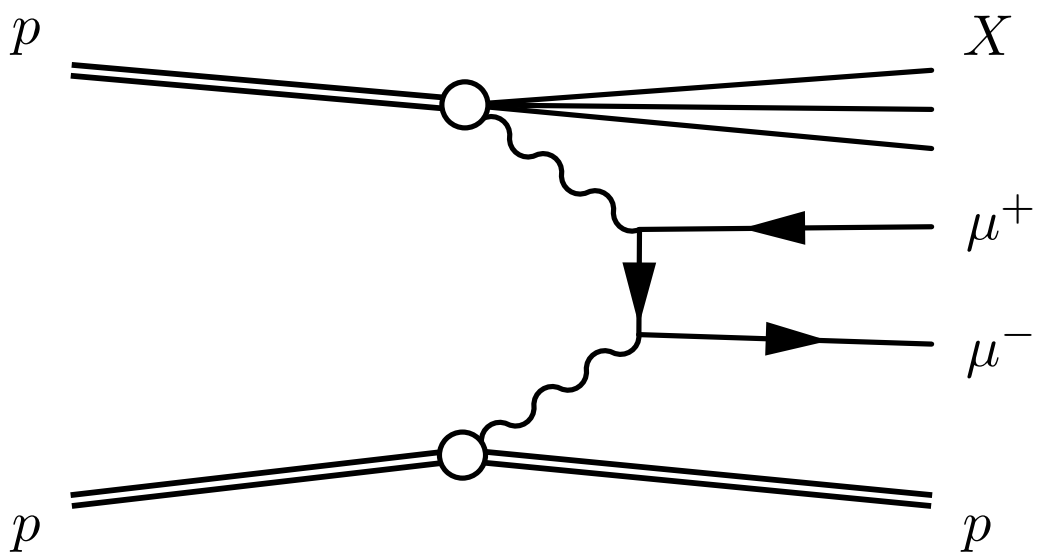
We define an exclusive interaction as a proton-proton interaction in which neither proton dissociates, e.g:



$$p + p \quad \to \quad p + \gamma\gamma + p \quad \to \quad p + \mu^+\mu^- + p$$

Single Dissociative

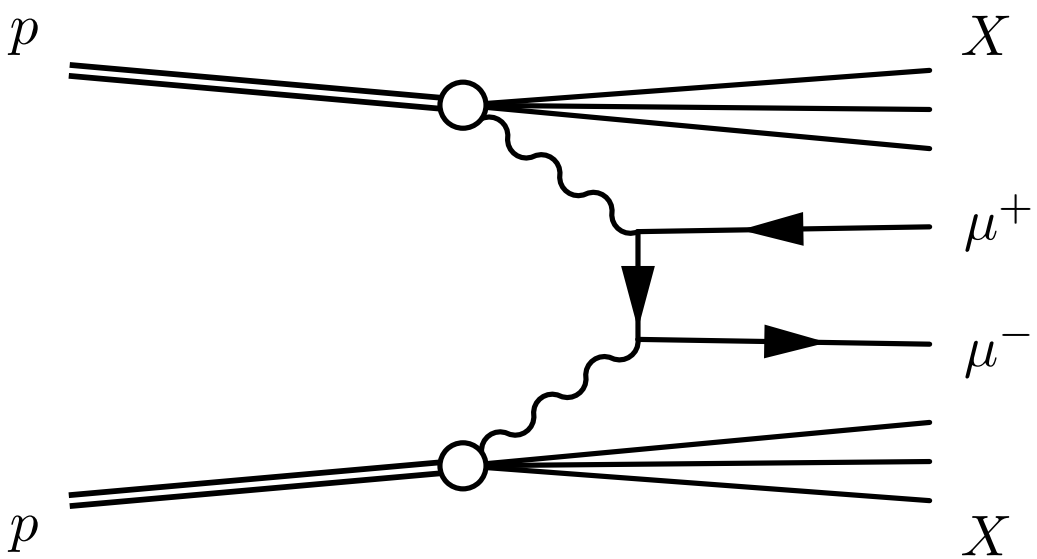
The case where a single proton dissociates is called single dissociative:



$$p + p \quad \rightarrow \quad p + \gamma\gamma + p* \quad \rightarrow \quad p + \mu^+\mu^- + p*$$

Double Dissociative

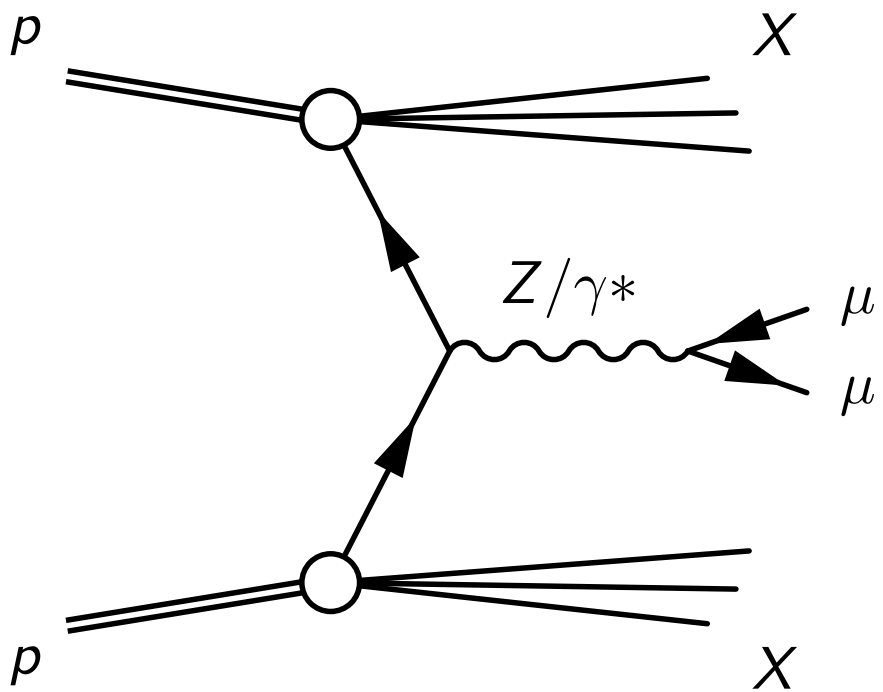
The case where both protons dissociate is called double dissociative:



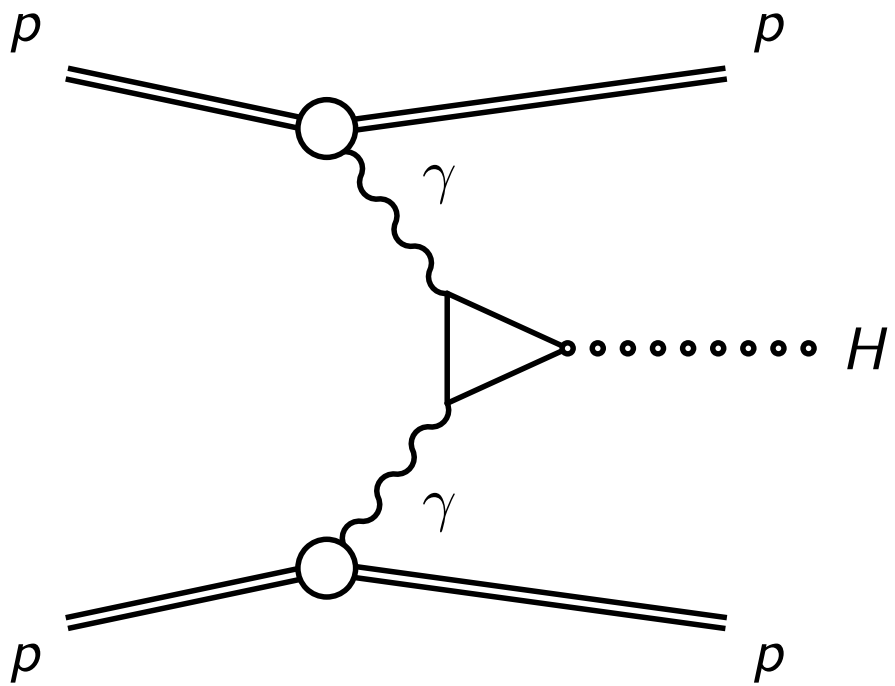
$$p + p \quad \rightarrow \quad p* + \gamma\gamma + p* \quad \rightarrow \quad p* + \mu^+\mu^- + p*$$

Background Process - Drell-Yan

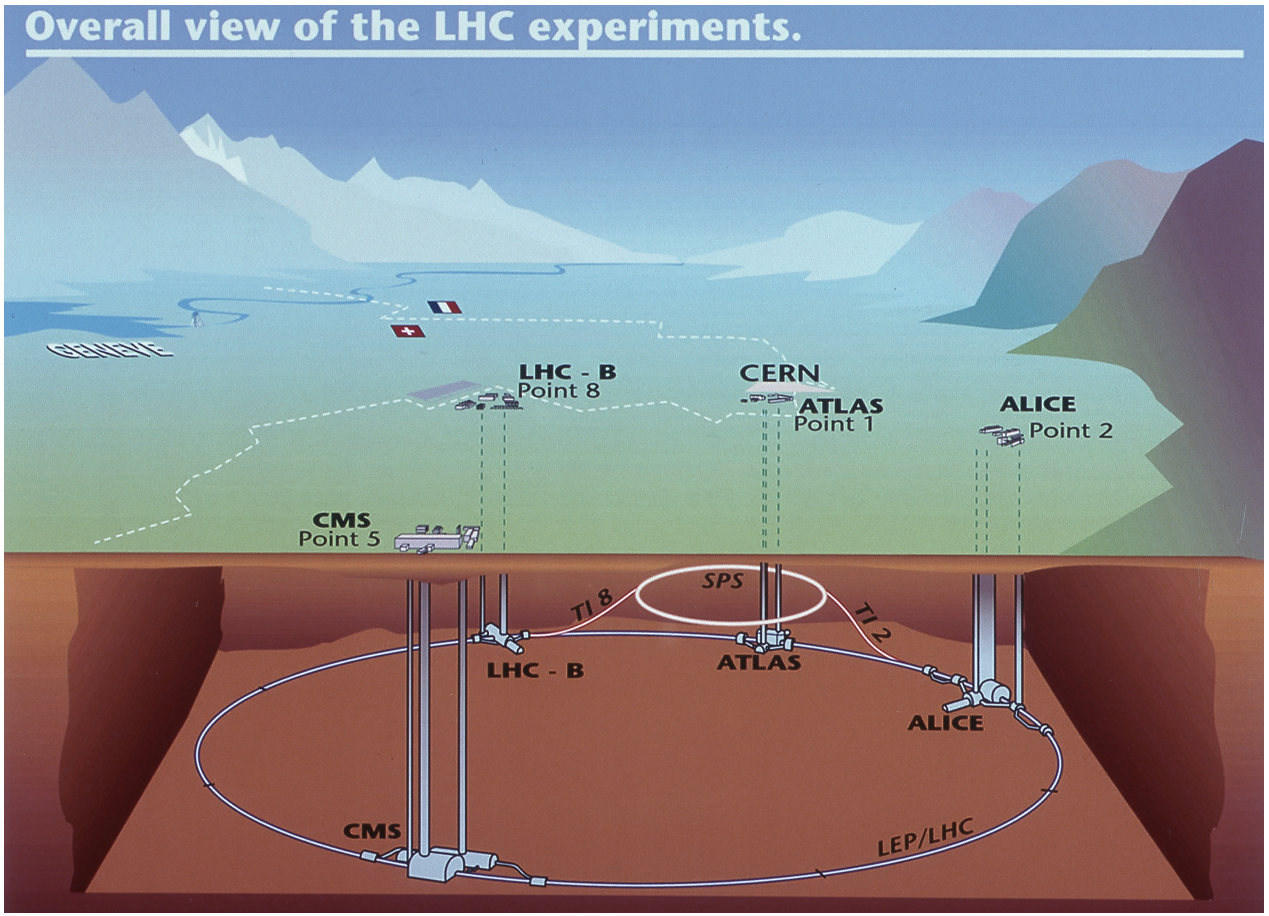
The main background process is Drell-Yan, i.e. quark-antiquark annihilation:



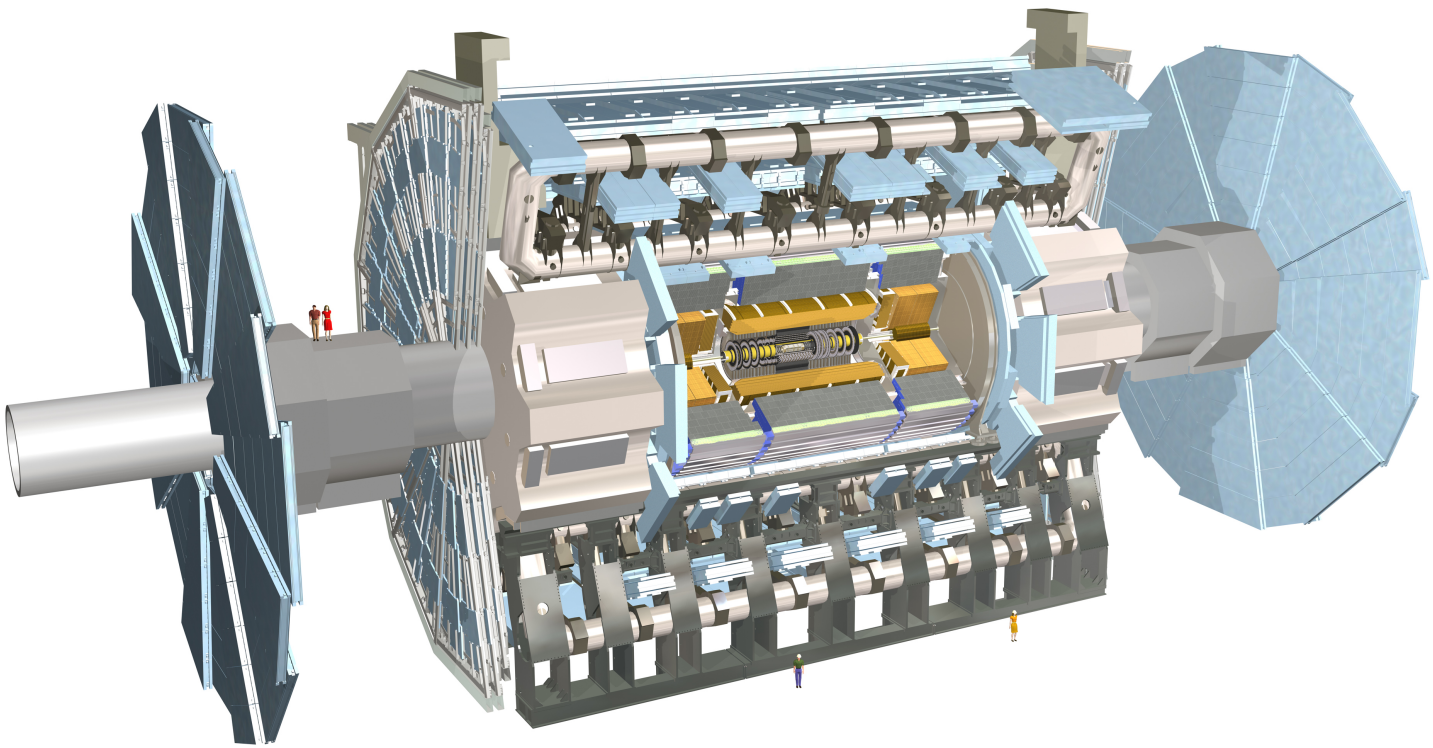
Another Possibility - Exclusive Higgs Production



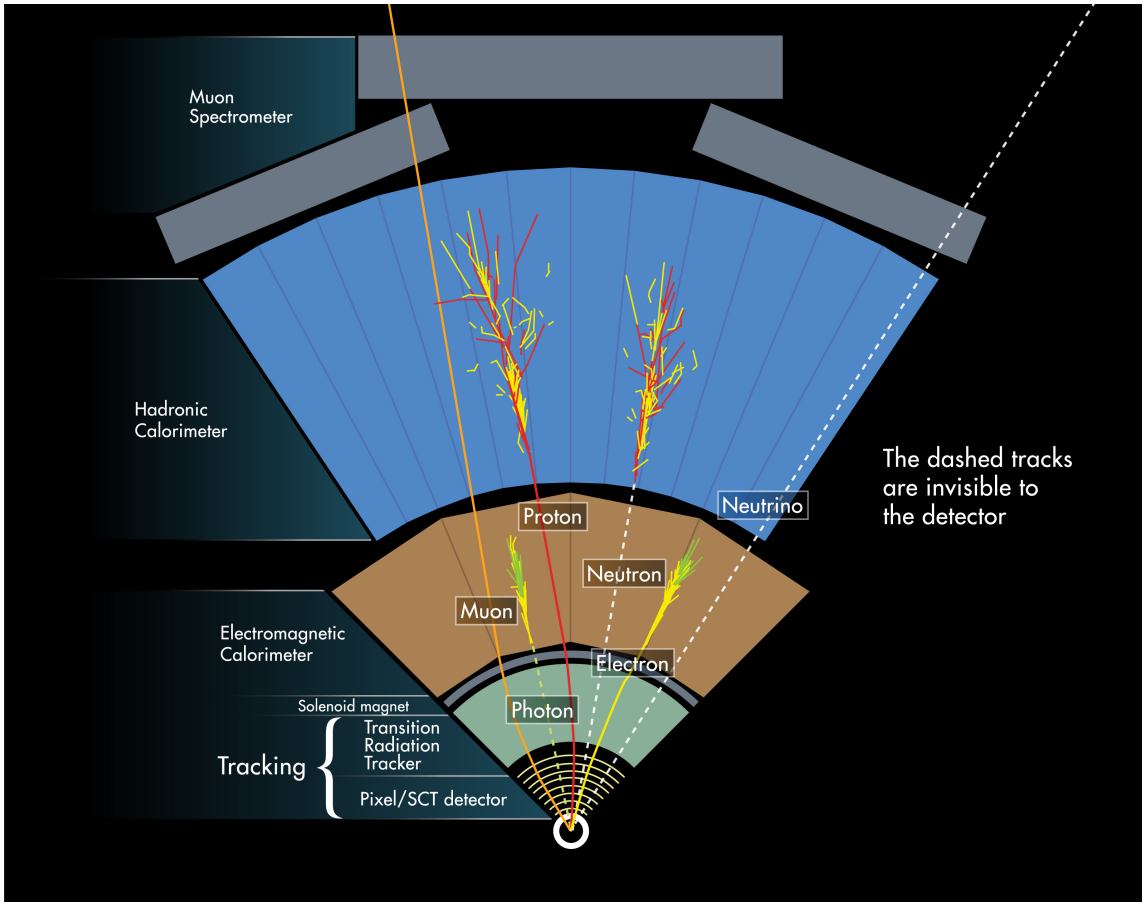
LHC


Overall view of the LHC experiments.
GENEVE
LHC - B
Point 8
CERN
ATLAS
Point 1
ALICE
Point 2
CMS
Point 5
SPS
TI 8
TI 2
LHC - B
ATLAS
ALICE
CMS
LEP/LHC

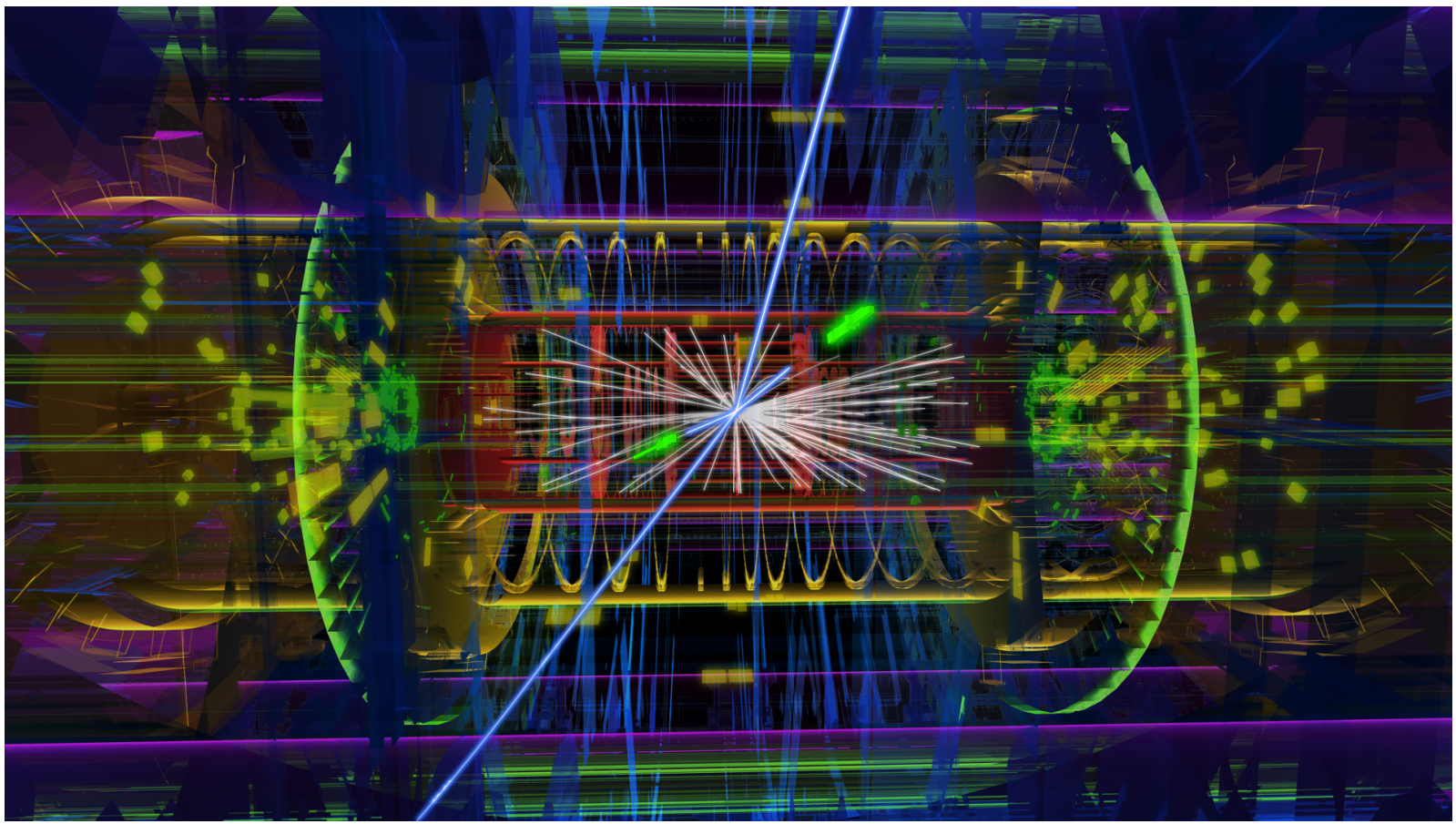
The ATLAS Detector



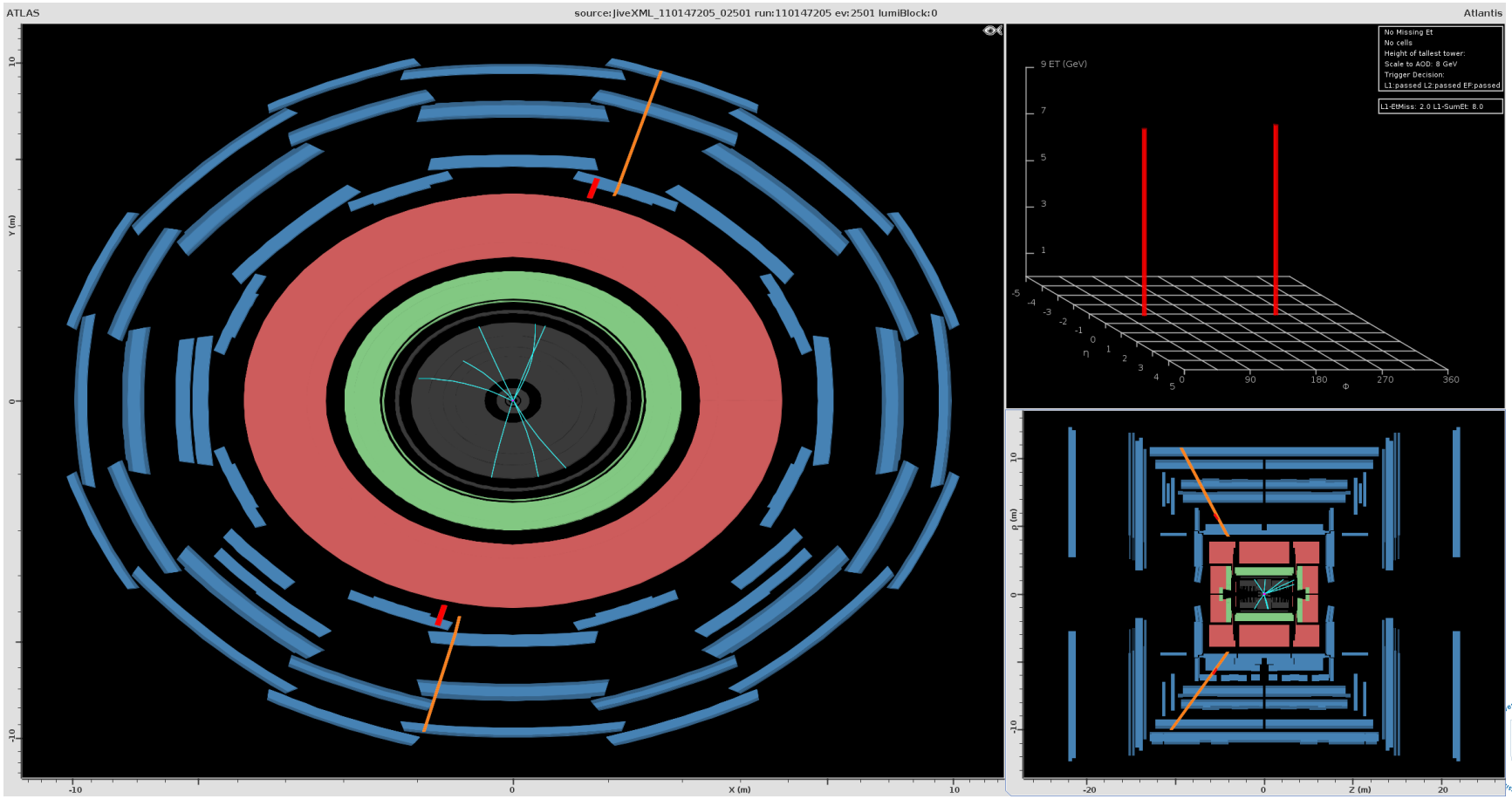
The ATLAS Detector



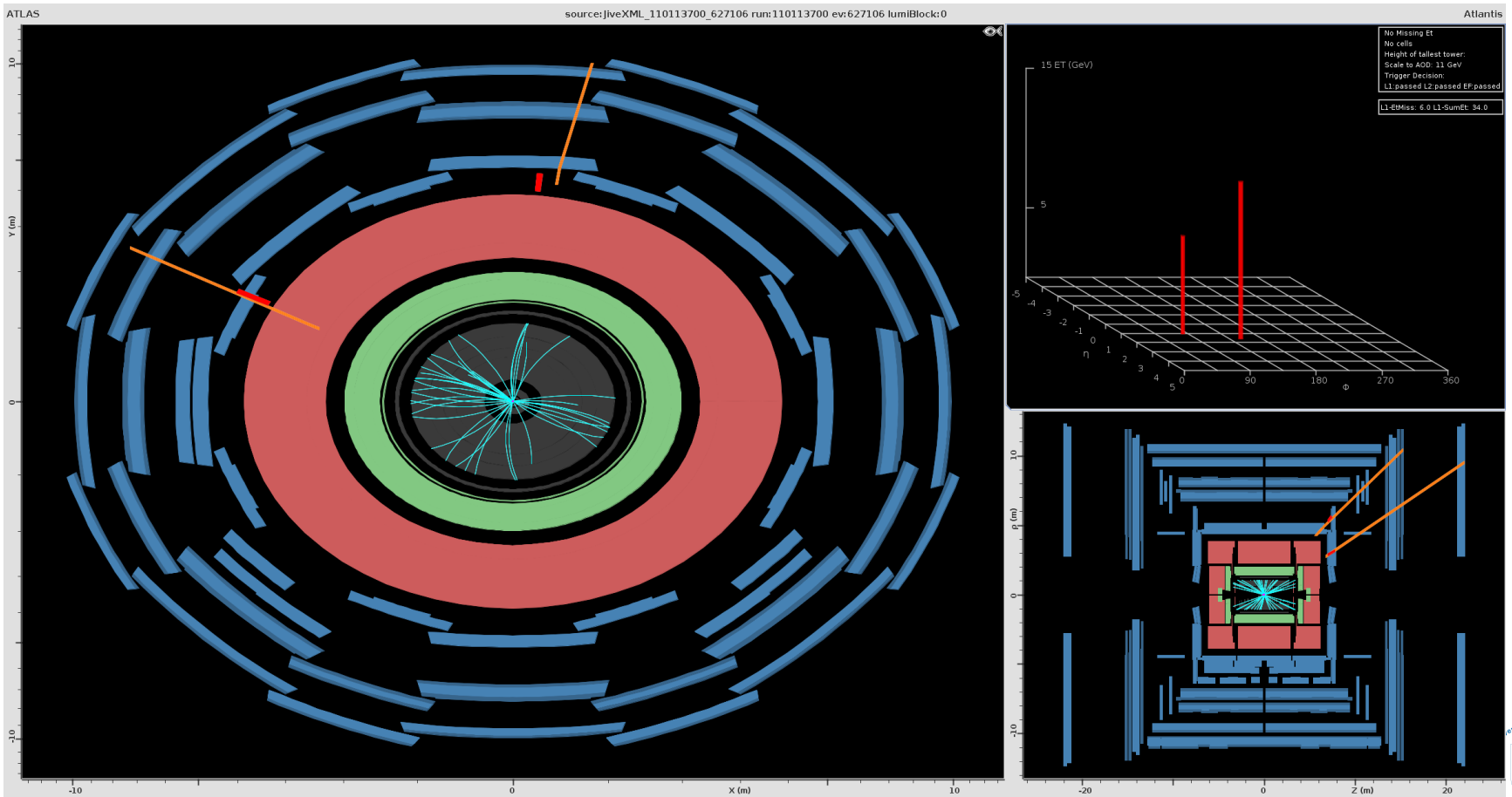
The ATLAS Detector



Signal Event Visualisation

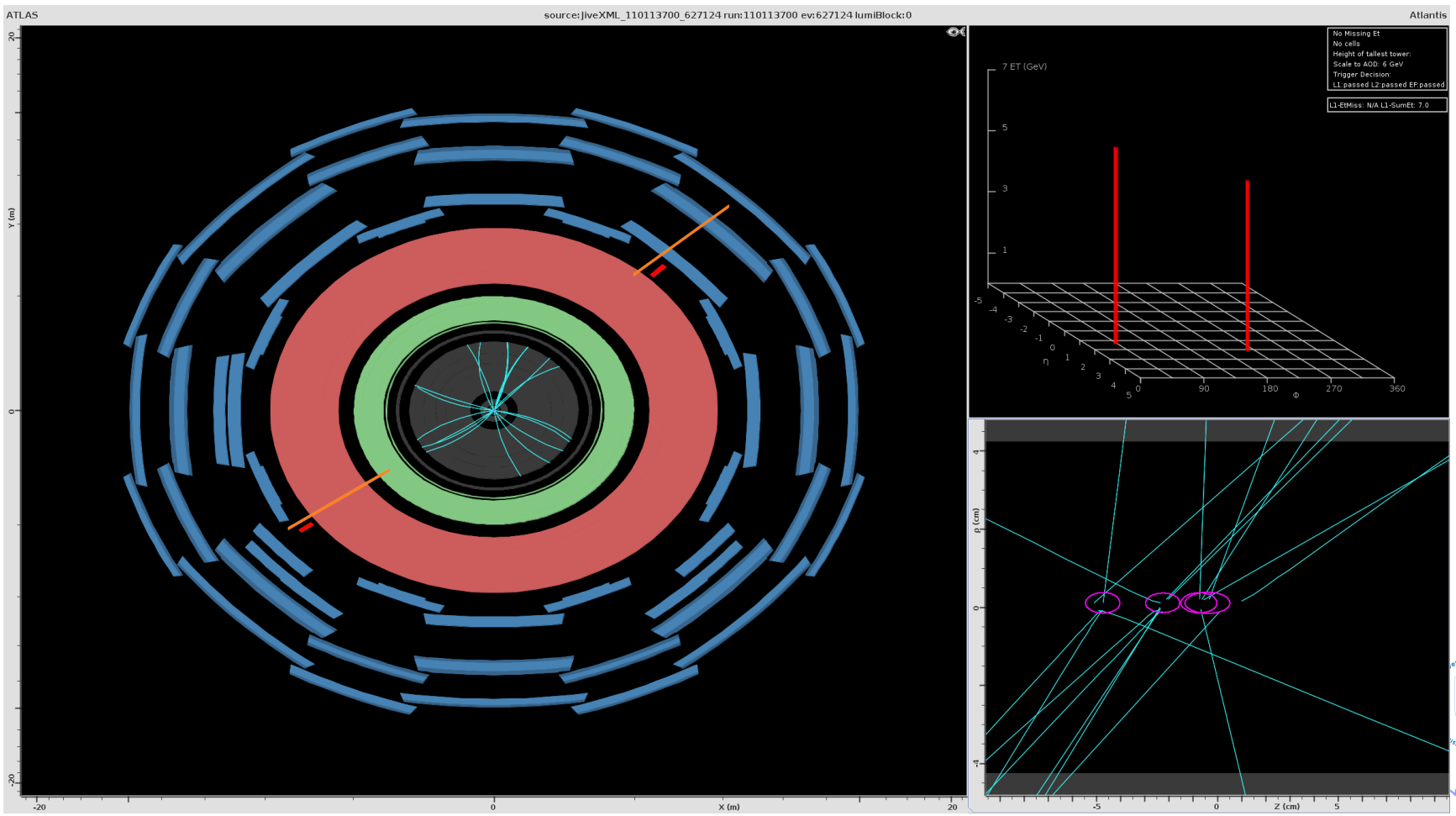


Background Event Visualisation



Sometimes it is easy to spot background events

Events Background – Harder Case



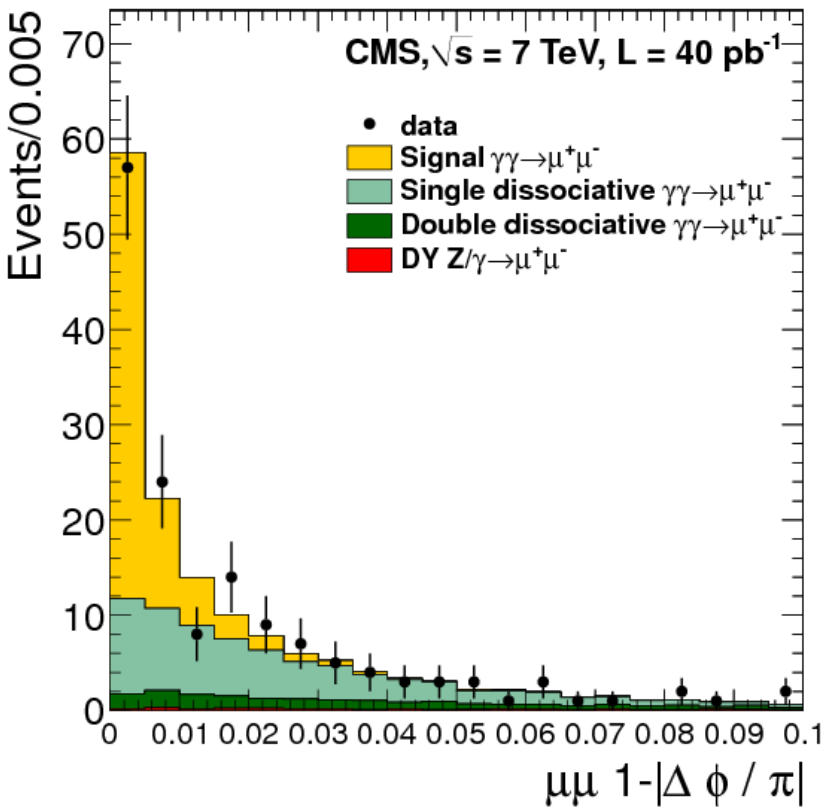
Selection criteria for muons/muon pairs

$\mid \eta \mid$	< 2.4
p_T	> 10 GeV
tracks per vertex	$= 2$
vertex exclusivity	$= 3$mm
$M_{\mu\mu}$	20-60 GeV
Δp_T	< 1.5 GeV
Acoplanarity	< 0.008

Acoplanarity

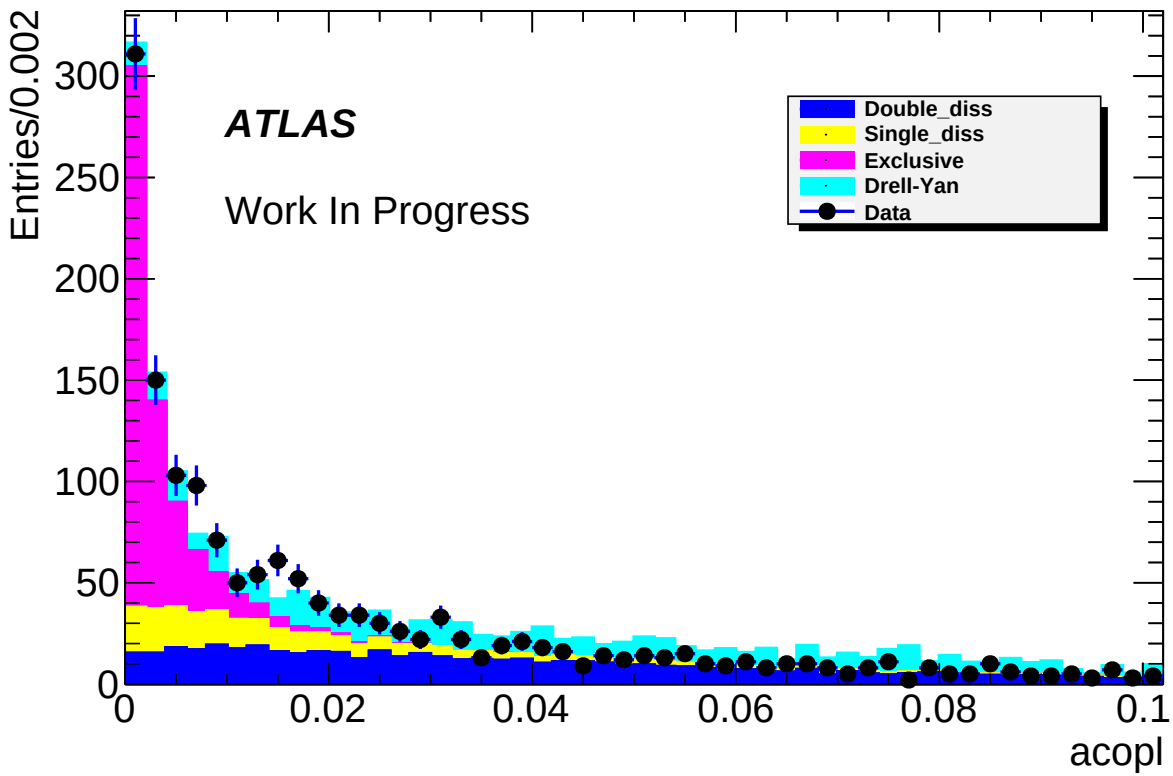
$$1 - \frac{|\Delta\phi_{\mu\mu}|}{\pi}$$

Previous Studies - CMS with 2010 data



CMS Collaboration **JHEP 1201 (2012) 052**

2011 Data


Entries/0.002
300
250
200
150
100
50
0
0
0.02
0.04
0.06
0.08
0.1
acopl
ATLAS
Work In Progress
Double_diss
Single_diss
Exclusive
Drell-Yan
Data

Thanks to:

Survival Factor Studies

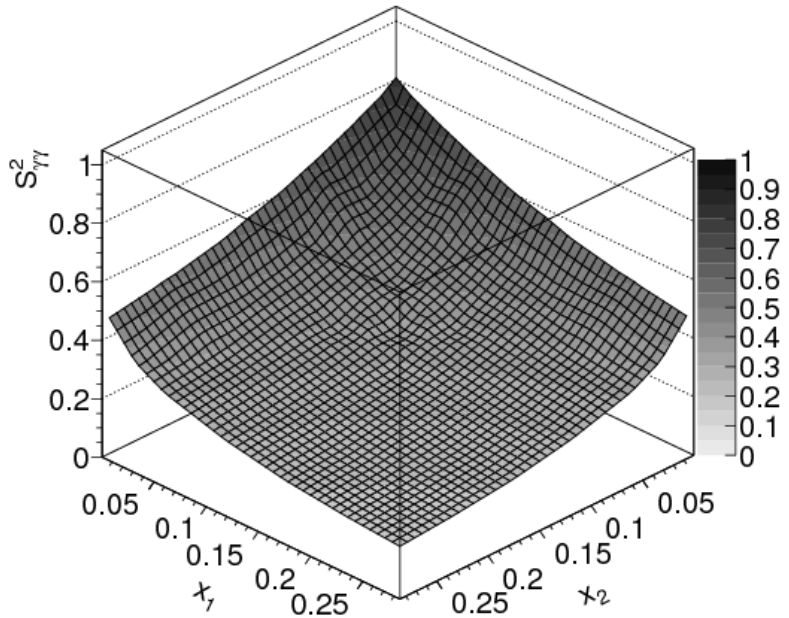


Figure: The survival factor as a function of the energy fractions of the protons carried by the interacting photons, x_1 and x_2

Mateusz Dyndal, Laurent Schoeffel **Phys.Lett. B741 (2015) 66-70**

Events Signal – Zoom