Z’ mumu
2013 data

A.M.

Summary from reports of Lanev, Rodogna Lepton etc

Z' working people Dimuon

Lanev
- MC and Data Comparison
- Trigger and Events Checks

I report /summary mainly from Lanev as example

- Introduction
- Run2015B with the tracker-only p_T used for the endcaps.
- First look on data from Run2015C
- Event Displays
- Conclusions

Rodogna Presentation
- pT studies and Checks
- Dimuon Spectra with MC

Marcellini Bologna :
- Trigger MC and Data checks

Federica Primavera and Neumeister Student
- MC and Data Dimuon spectra

Runs and LHC Fills for Run2015B (Week 2)

Run	Fill	Time, UTC		Lumi, pb^{-1}			JSONs	Comment
		Start	End	WBM	Delivered	Recorded		
251636	3992	13 07:33	13 07:34	1.07			D	
251638		13 07:38	13 08:17	2.62	3.263	2.501	D M	
251642		13 08:42	13 08:46	1.02	0.570269	0.138300		no DCSOnly, but $Z \to \mu^+\mu^-$ signal exists.
251643		13 08:50	13 12:50	14.93	14.937	14.325	D M G	
251717	3996	14 07:09	14 07:16	1.86			D	Stage1Test, Problem with pixels
251718		14 07:39	14 09:31	9.48			D	Stage1Test, Problem with pixels
251721		14 09:38	14 11:19	2.48	2.478	2.435	D M G	FSQ/HIN low PU at the end of the run (aft
251781	4001	15 01:40	15 02:15	0.10	0.069917	0.032374		
251883	4008	16 01:30	16 04:27	7.09	0.600418	0.520740	D M G	
252116	4019	20 01:35	20 02:32	1.91				$B = 0$ T
252126	4020	20 04:24	20 05:30	3.24				$B = 0$ T
Grand Total:		08 00:03	16 04:27	67.00	**58.732**	**50.129**		(without usage of JSON files!)

Integrated luminosities were calculated using the official tool `lcr2.py`

Integrated luminosity using JSON files:

FEVT+ MuonPhys = 46.184 pb^{-1} (currently)

AOD + DCSOnly = 52.795 pb^{-1}

AOD + MuonPhys = 46.068 pb^{-1} (today; 46.248 pb^{-1} yesterday)

AOD + Golden = 40.003 pb^{-1}

"DCSOnly" = `json_DCSONLY_Run2015B.txt` + `json_DCSONLY_Run2015B_2.8T.txt`

Used MC & Data

At 17/08/2015

- **MadGraph samples require using weights:**

  DY: σ =6025.2 pb /DYJetsToLL_M-50_TuneCUETP8M1_13TeV-amcatnloFXFX-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-

  WJets $\to l\nu$: σ =6.15e4 pb/WJetsToLNu_TuneCUETP8M1_13TeV-amcatnloFXFX-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-

  according to discussions at hypernews:

  https://hypernews.cern.ch/HyperNews/CMS/get/generators/2679/1/1/1/1/2.html

  POWHEG and Pythia samples have no weights:

  $t\bar{t}$: σ =815.96 pb /TT_TuneCUETP8M1_13TeV-powheg-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v4

  ZZ: σ =15.4 pb /ZZ_TuneCUETP8M1_13TeV-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v2

  WW: σ =118.7 pb/WW_TuneCUETP8M1_13TeV-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v1

  WZ: σ =66.1 pb /WZ_TuneCUETP8M1_13TeV-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v2

  tW: σ =35.6 pb /ST_tW_top_5f_inclusiveDecays_13TeV-powheg-pythia8_TuneCUETP8M1/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v1

  $\bar{t}W$: σ =35.6 pb /ST_tW_antitop_5f_inclusiveDecays_13TeV-powheg-pythia8_TuneCUETP8M1/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-

- Used Prompt Reco SingleMuon AOD dataset:
  /SingleMuon/Run2015B-PromptReco-v1/AOD
- PromptReco JSONs has been used: $\int \mathcal{L}\, dt = 1.04 \times 46.011 = 47.9\ \text{pb}^{-1}$
- HLT trigger used: HLT_Mu45_eta2p1_v1
  Offline cut $p_T > 48$ GeV

MC

Used MC datasets **RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A** to perform first Data / MC comparison.

Cross section were taken from CMS twiki page:

`https://twiki.cern.ch/twiki/bin/viewauth/CMS/StandardModelCrossSectionsat13TeV`

DY, $t\bar{t}$ — NNLO calculation; dibosons — NLO calculations.

DY: σ =6025.2 pb `/DYJetsToLL_M-50_TuneCUETP8M1_13TeV-amcatnloFXFX-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v2`

$t\bar{t}$: σ =815.96 pb `/TT_TuneCUETP8M1_13TeV-powheg-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v4`

ZZ: σ =15.4 pb `/ZZ_TuneCUETP8M1_13TeV-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v2`

WW: σ =118.7 pb `/WW_TuneCUETP8M1_13TeV-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v1`

WZ: σ =66.1 pb `/WZ_TuneCUETP8M1_13TeV-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v2`

WJets $\rightarrow l\nu$: σ =6.15e4 pb `/WJetsToLNu_TuneCUETP8M1_13TeV-amcatnloFXFX-pythia8/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v1`

tW: σ =35.6 pb `/ST_tW_top_5f_inclusiveDecays_13TeV-powheg-pythia8_TuneCUETP8M1/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v1`

$\bar{t}W$: σ =35.6 pb `/ST_tW_antitop_5f_inclusiveDecays_13TeV-powheg-pythia8_TuneCUETP8M1/RunIISpring15DR74-Asympt50ns_MCRUN2_74_V9A-v2`

List of Unprescaled Muon Triggers

These triggers have been unprescaled in Run2015B:

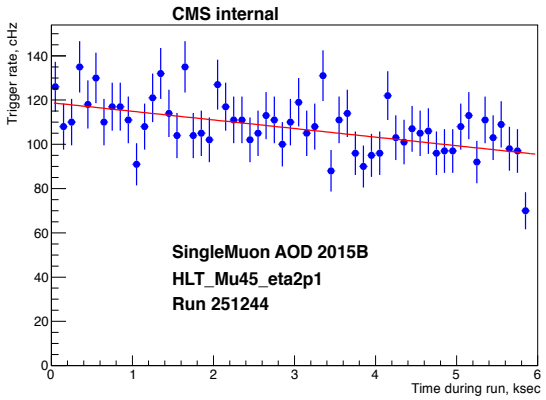
Single Muon triggers:

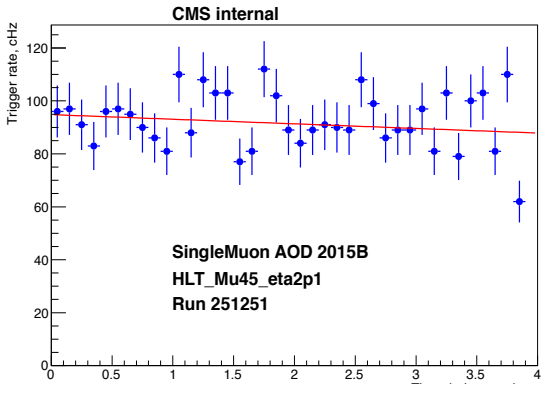
HLT_Mu45_eta2p1
HLT_Mu50
HLT_Mu50_eta2p1
HLT_Mu55
HLT_Mu300
HLT_Mu350

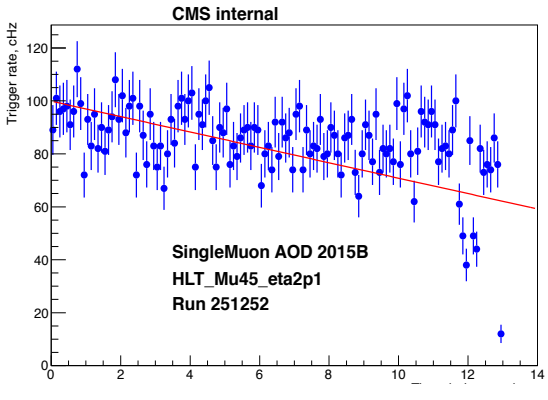
Double Muon triggers:

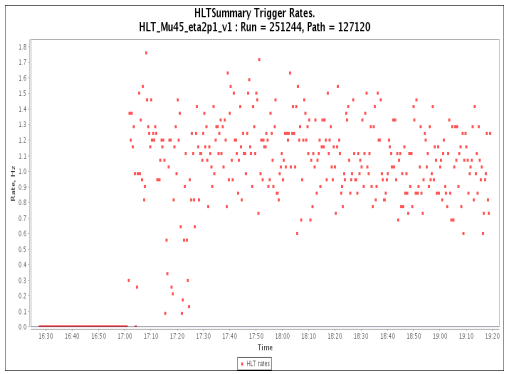
HLT_Mu17_TrkIsoVVL_Mu8_TrkIsoVVL_DZ
HLT_Mu17_TrkIsoVVL_TkMu8_TrkIsoVVL_DZ
HLT_Mu27_TkMu8
HLT_Mu30_TkMu11
HLT_Mu40_TkMu11

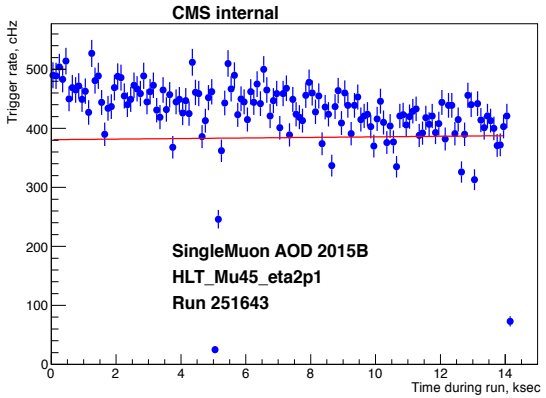
Trigger rates for several runs

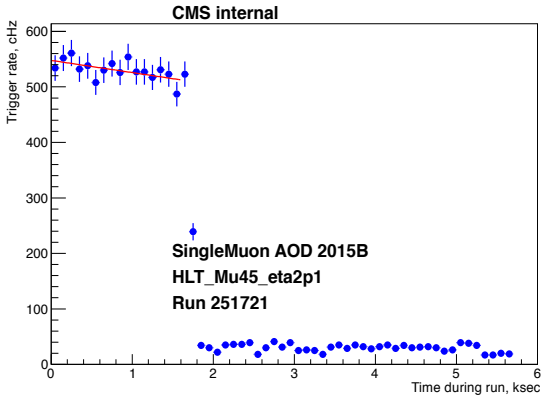








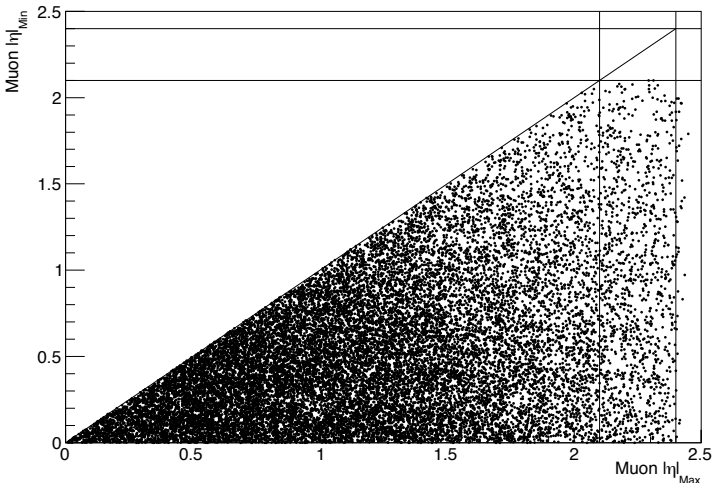


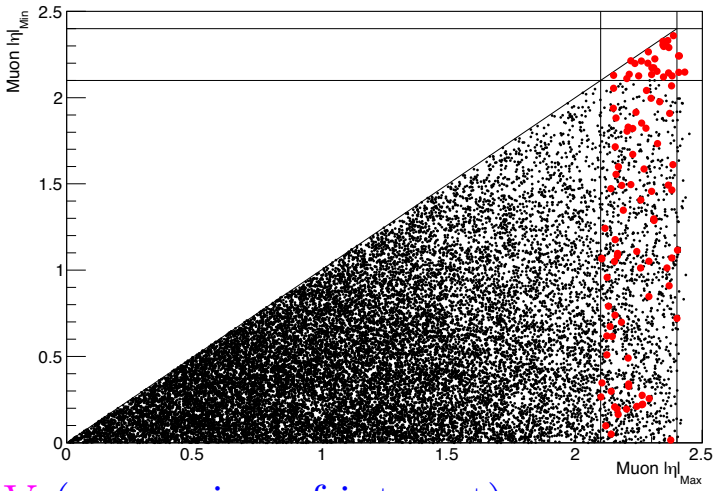


Rates of `HLT_Mu45_eta2p1` in runs 251244, 251251, 251252, 251643 are compatible with WBM values: 0.86, 0.93, 0.81, 4.26 Hz.

Difference arises since WBM averages trigger rates for all lumisections even without Physics declared.

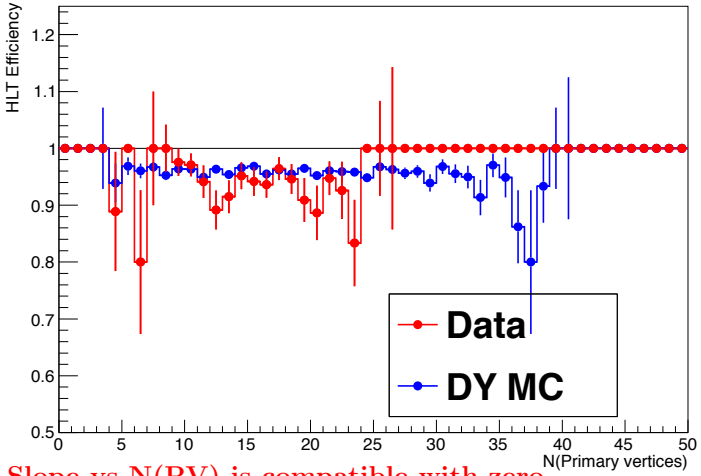
Statistics of triggers: Summary





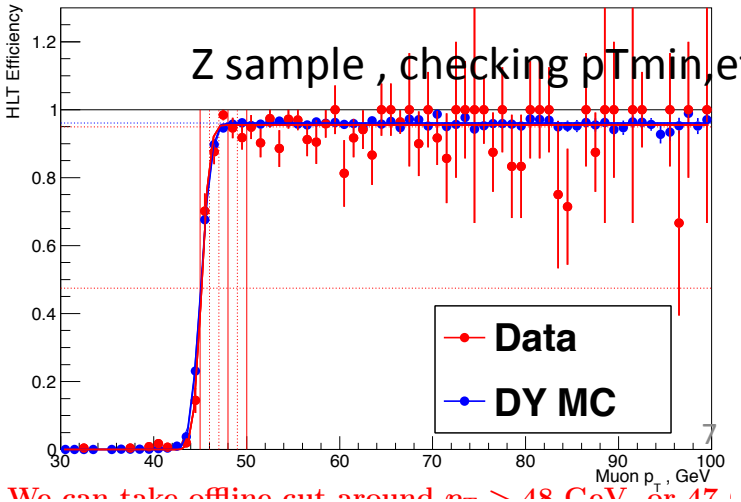
- Used Drell-Yan MC sample with $M \in [2, 3]$ TeV (our region of interest) and `HLT_Mu45_eta2p1` as baseline trigger.
- Adding `HLT_Mu50` increases statistics by $\sim 0.5\%$ — Not a large amount.

HLT Efficiency vs Number of Primary Vertices



Slope vs N(PV) is compatible with zero within statistical uncertainty.

Trigger Turn-on Curve



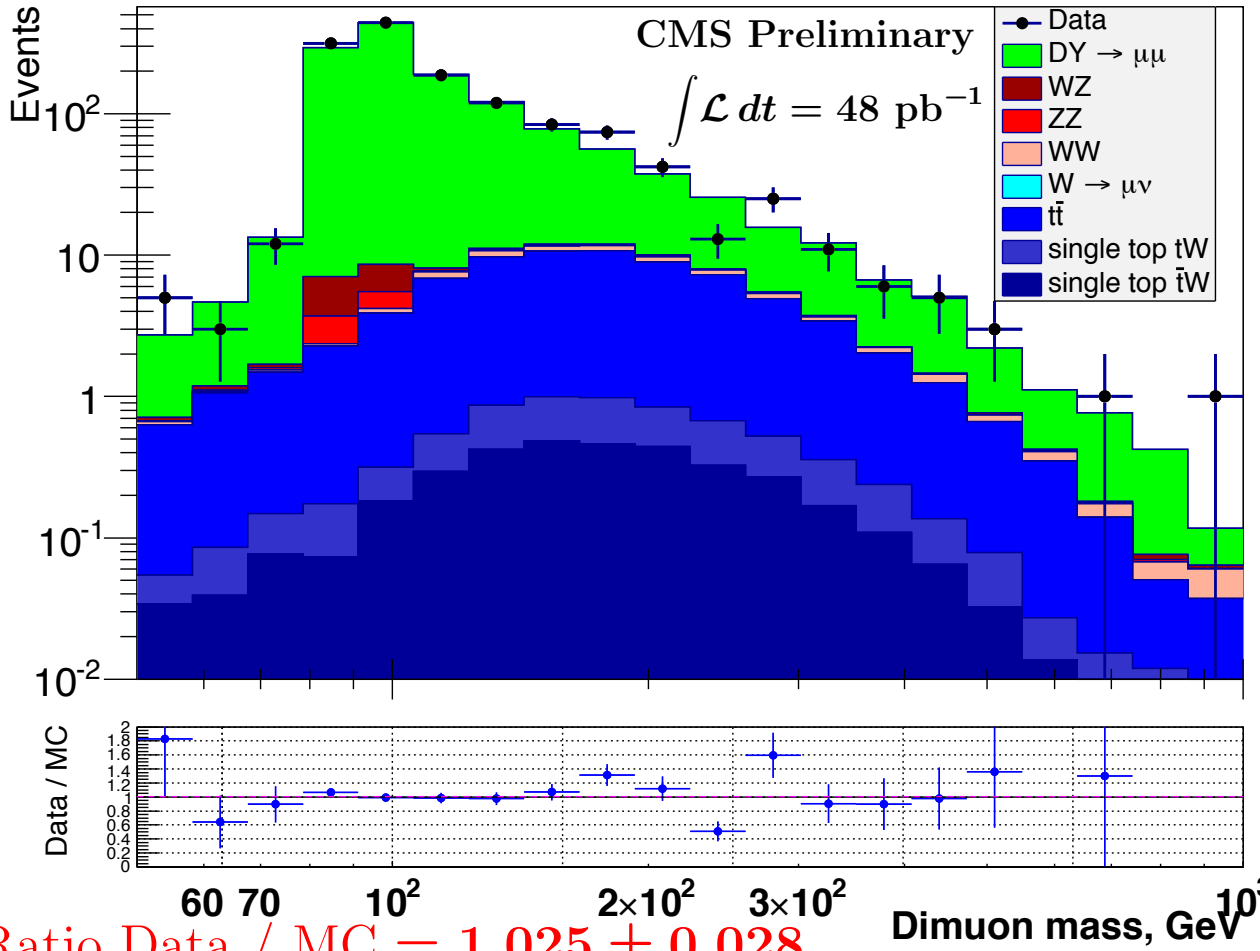
We can take offline cut around $p_T > 48$ GeV, or 47

- HLT trigger used: `HLT_Mu45_eta2p1_v1`
  Offline cut $p_T > 48$ GeV

- It is known that endcap alignment is not the best in Prompt reconstructi at Run2015B
  `https://indico.cern.ch/event/438183/contribution/1`
- For endcap muons ($|\eta| > 1.2$) momentum resolution is better for tracker-c muons than for Tune-P muons.
  `https://indico.cern.ch/event/437532/contribution/2`
- Therefore there was a proposal to do mass plots for LHCP
  using tracker-only p_T for the endcaps
- Also with tracker-only p_T used everywhere, both in barrel and in endcaps
- Our heaviest dimuon has muons with $\eta = 1.464$ and 0.584:
  $M = 835.783 \pm 32.930$ GeV for Tune-P
  $M = 921.042 \pm 51.685$ GeV for tracker muon in endcap
  $M = 953.783 \pm 72.078$ GeV for both tracker muons

tracker-only muon for endcaps ($|\eta| > 1.2$)

- HLT trigger used: `HLT_Mu45_eta2p1_v1`
  Offline cut $p_T > 48$ GeV



Ratio Data / MC $= 1.025 \pm 0.028$

→ Dimuon Mass Log scale

Runs and LHC Fills for Run2015C

Run	Fill	Time, UTC		Lumi, pb^{-1}			JSONs	
		Start	End	WBM	Delivered	Recorded		
254227	4201	08.13 03:29	08.13 04:47	0.24			DCS	
254229		08.13 04:53	08.13 04:56	0.02			DCS	
254231		08.13 05:14	08.13 05:39	0.09			DCS	
254232		08.13 05:43	08.13 06:23	0.10			DCS	
Grand Total:		08.13 03:29	08.13 06:23	0.45	0.476	**0.372**		(withou
Grand Total:		08.13 03:29	08.13 06:23		0.405	**0.347**		(using D

- HLT trigger used: `HLT_Mu45_eta2p1_v1`
  Offline cut $p_T > 48$ GeV

All other runs in Run2015C have been taken with $B = 0$ T so far

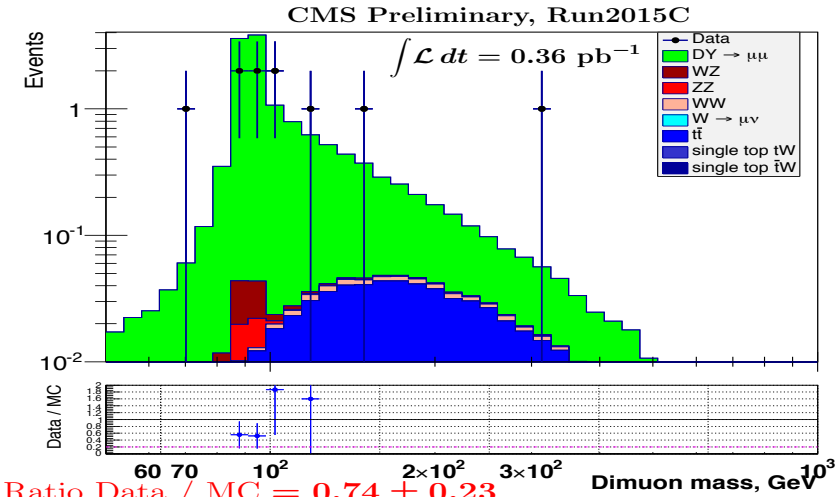
Integrated luminosities were calculated using the official tool `brilcalc`

Integrated luminosity using JSON file:
FEVT+ DCSOnly $= 1.04 \times 0.347 = 0.361$ pb^{-1}

Heaviest dimuon has mass 324 GeV

HLT Menu = Run2015/25ns14e33/v3.3/V2

Dimuon mass spectra for Run2015C



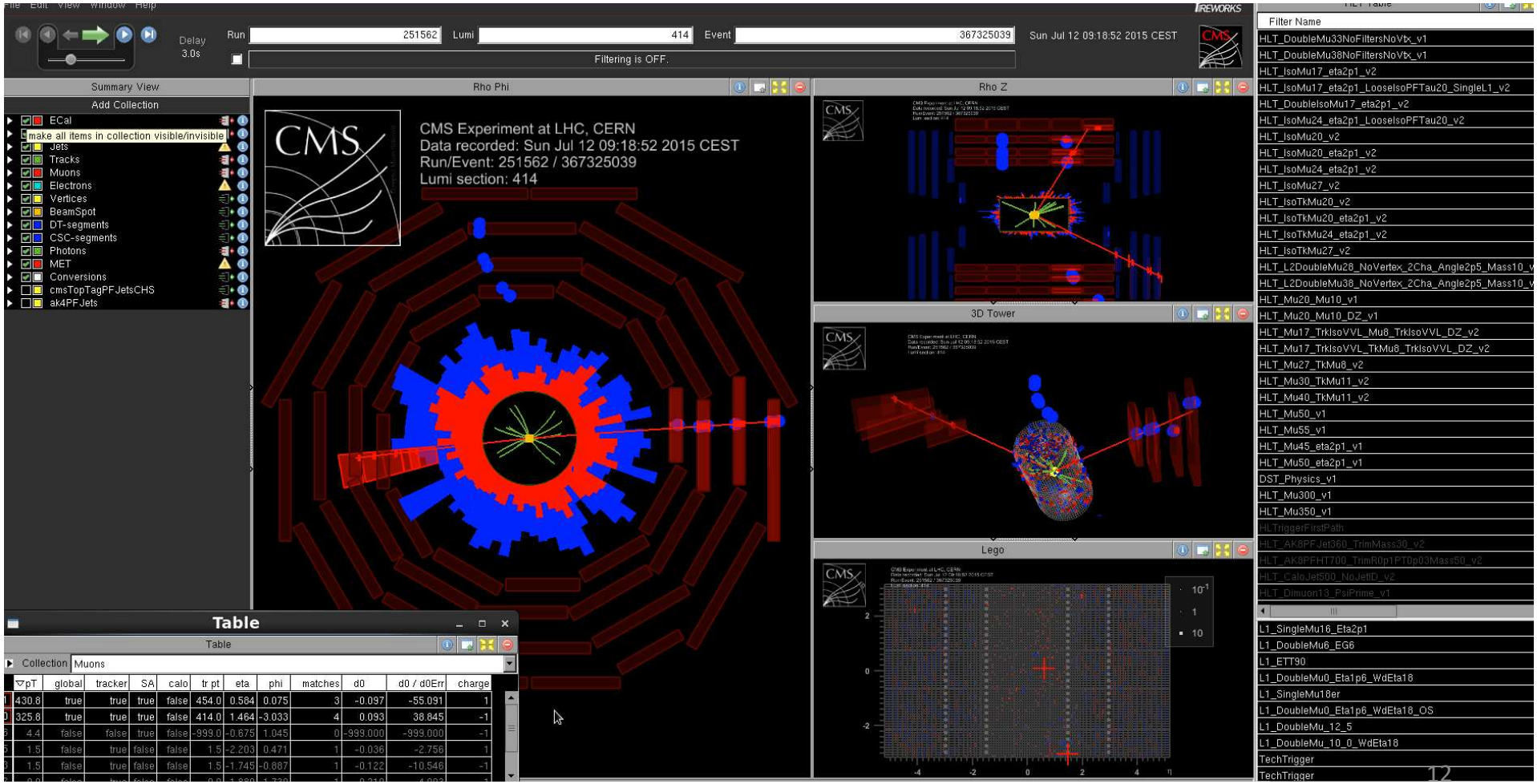
Ratio Data / MC = 0.74 + 0.23

→ Dimuon Mass Log scale

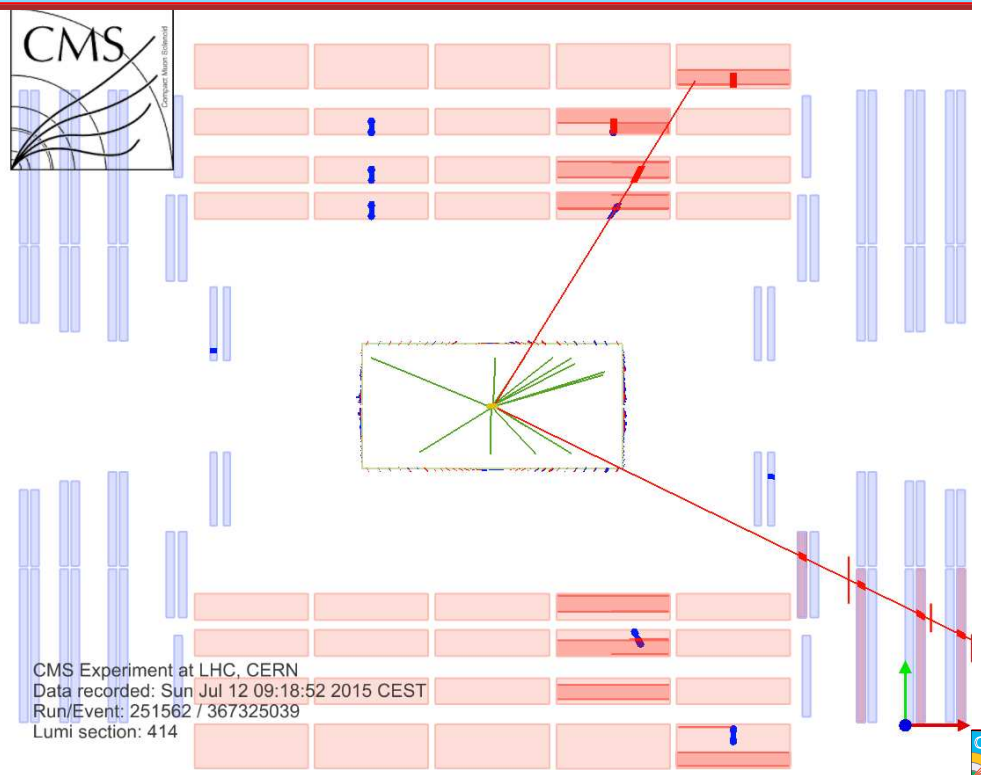
Event Display

Event with Dimuon $M = 836$ GeV

run : ls : evt = 251562 : 414 : 367325039



Event with Dimuon $M = 836$ GeV



Event with Dimuon $M = 836$ GeV