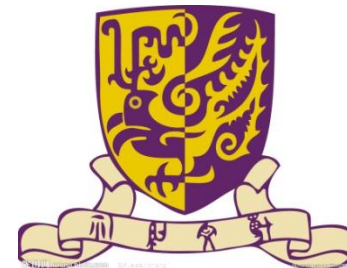CMSDas 2012@TaiPei

The Search for Exotica with Displaced Vertices

Lee Yun-Han (NTU)
Tsai Jui-Fa (NTU)
Leung Shing-Chau (CUHK)
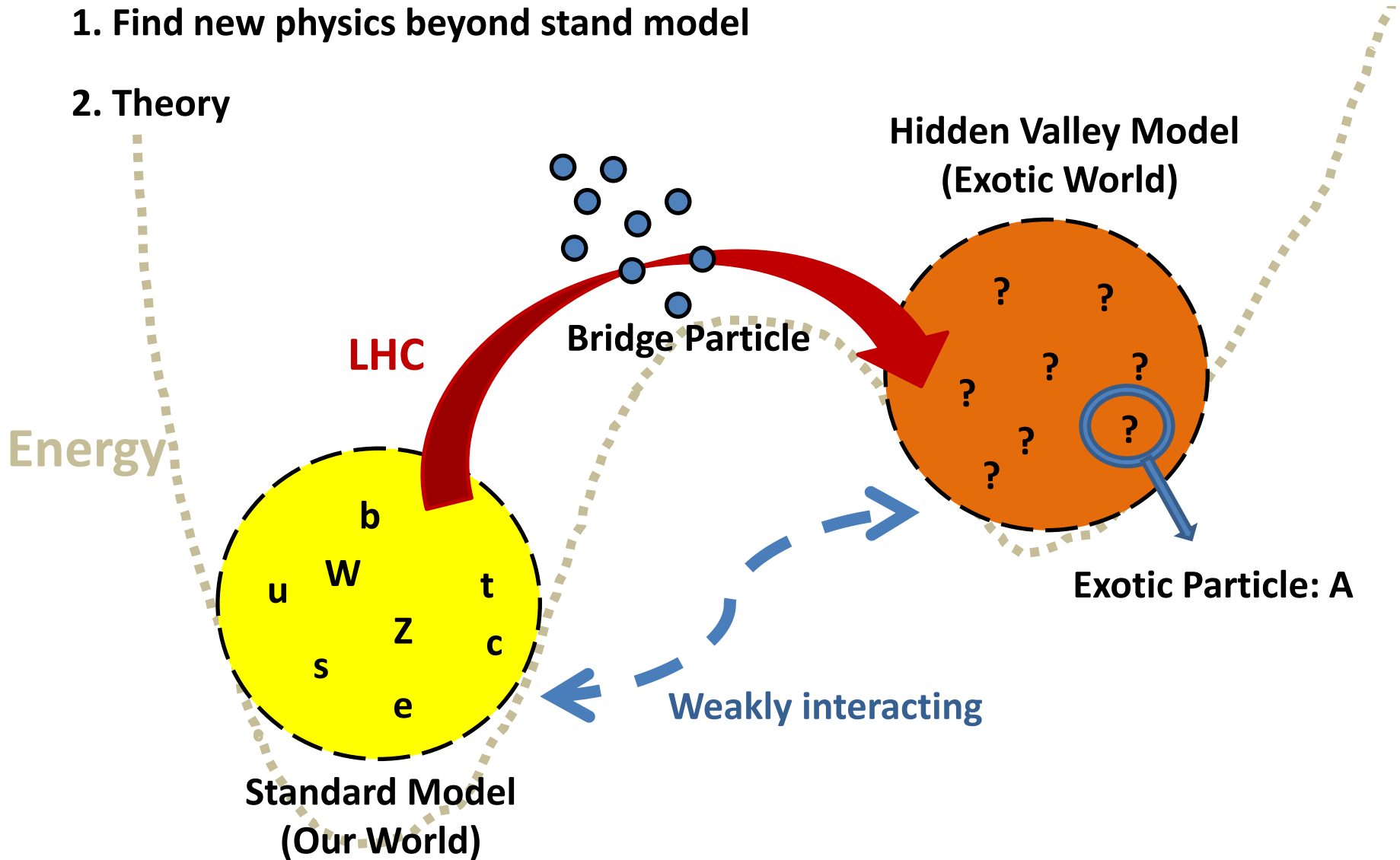Tao Chiao-Yu (NTU)

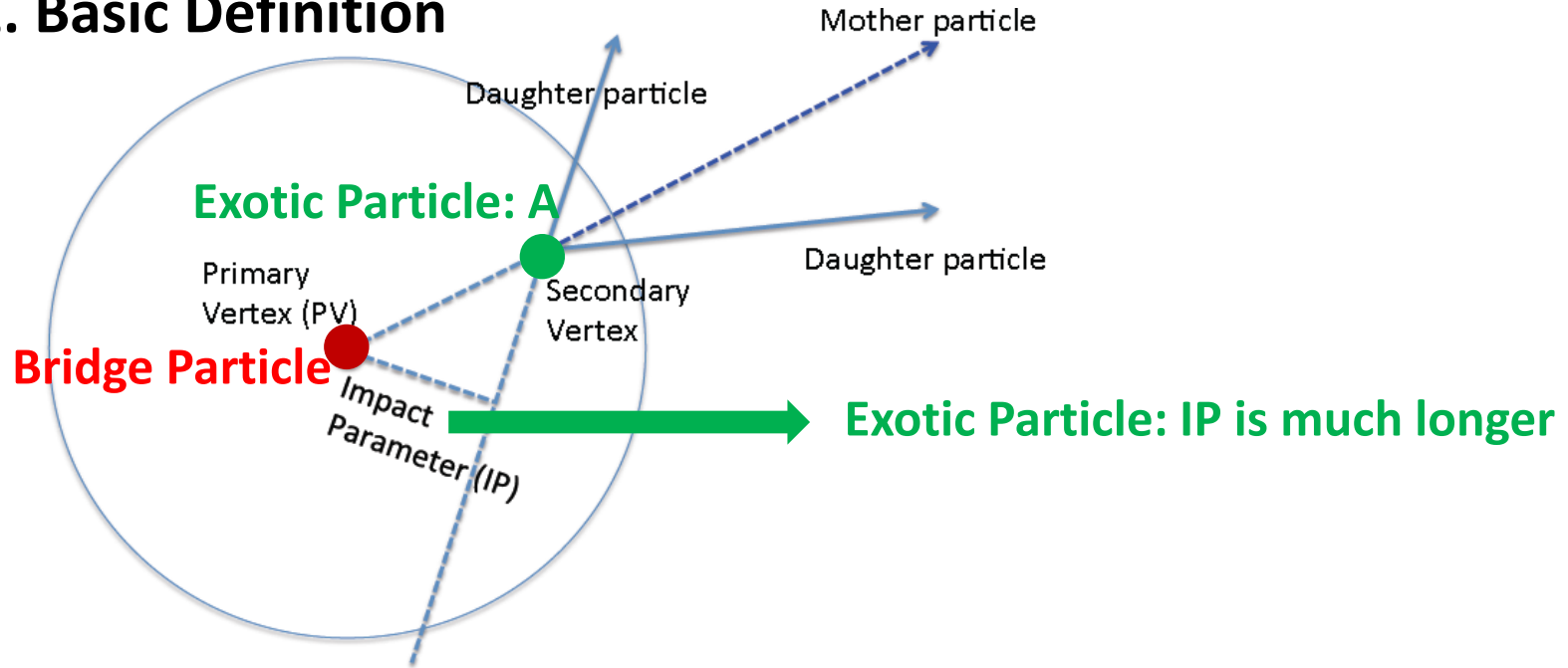# Motivation :

1. Find new physics beyond stand model

2. Theory

Energy

LHC

Bridge Particle

**Hidden Valley Model
(Exotic World)**

? ? ? ? ? ? ? ? ?

Exotic Particle: A

Weakly interacting

b

u   W   t

Z   c

s

e

**Standard Model
(Our World)**

Exotic Particle : It should be long-lived -> Long Decay Length

2. Basic Definition

Mother particle

Daughter particle

Exotic Particle: A

Primary
Vertex (PV)

Secondary
Vertex

Daughter particle

Bridge Particle

Impact
Parameter (IP)

Exotic Particle: IP is much longer

Analysis Strategy

- MC generation
  pp -> Higgs -> AA -> Leptons
- Apply all the selections on data
- Set limits or make a discovery!
- Systematic study: trigger efficiency & tracking efficiency

Selections

	Electrons	Muons
HLT	HLT_DoublePhoton33_v*	HLT_L2DoubleMu23_NoVertex_v*
d0Significance	>3	>2
dPhi	<0.8	<0.2
decayLength Significance	>8	>5

PV   SV

Momentum of X

Displacement

Selections

Cosmic muon · Real displaced lepton · Misreconstructed track
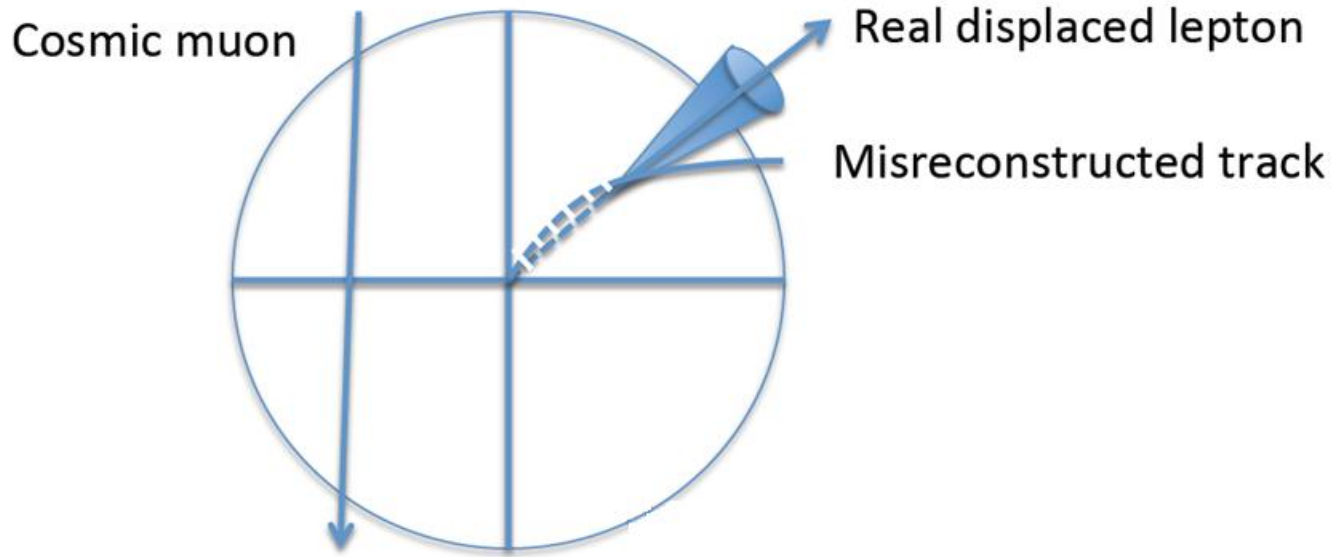
	Electrons	Muons
Hits before Secondary Vtx	**≤1**	**≤1**
Two Muon opening angle	N/A	**cosΘ > -0.95**

Result of 2011 Data

CMS Preliminary $\sqrt{s}=7$ TeV L=2.7 fb^{-1}

e^+e^-

H(1000) → XX(350), 1 pb
Z/γ^* → ee
QCD
Z/γ^* → $\tau\tau$
ZZ
WZ
WW
tt
data

CMS Preliminary $\sqrt{s}=7$ TeV L=3.4 fb^{-1}

$\mu^+\mu^-$

H(1000) → XX(350), 1 pb
Z/γ^* → $\mu\mu$
QCD
Z/γ^* → $\tau\tau$
ZZ
WZ
WW
tt
data

mass [GeV/c^2]
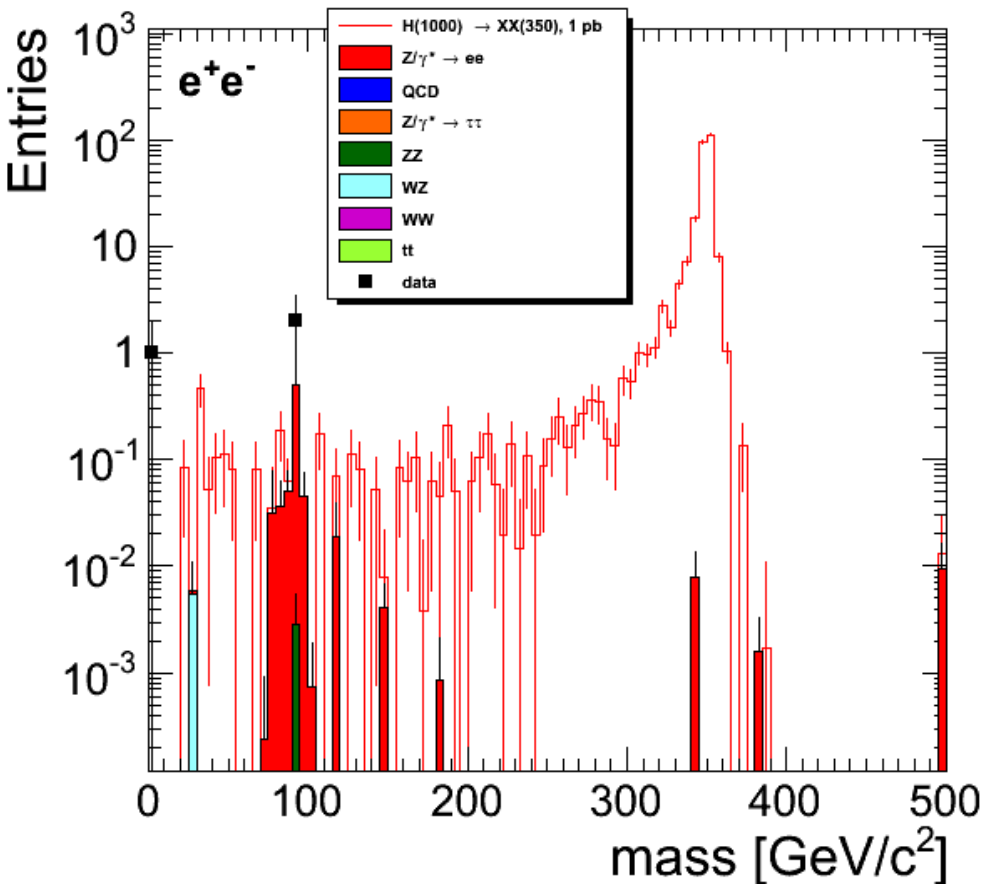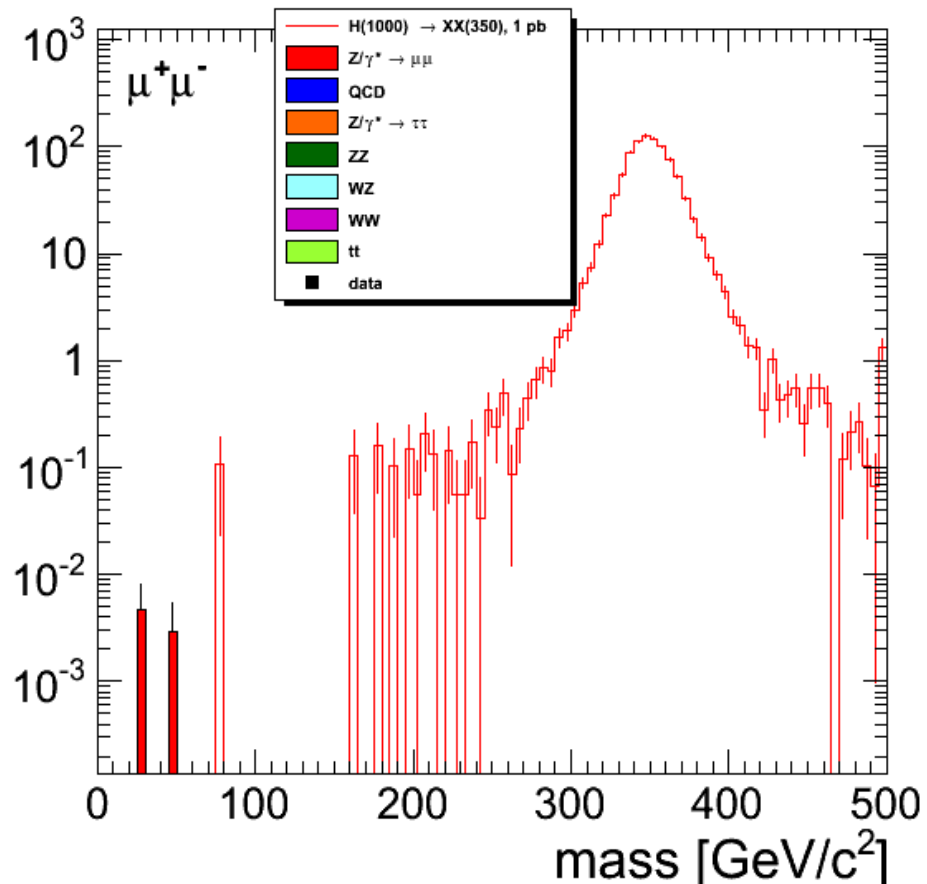
Measuring Tracking Efficiency with Cosmic Muon

- Major Systematic uncertainty in Exotica Search: Tracking Efficiency

- Exotica - Secondary Vertex at impact parameter > 10 cm:
  where tracking efficiency starts to drop…

- Using cosmic muons to measure efficiencies of large impact parameter events

- Have understanding of cosmic muons; and availablility

Efficiency v.s Longitudinal Impact Parameter
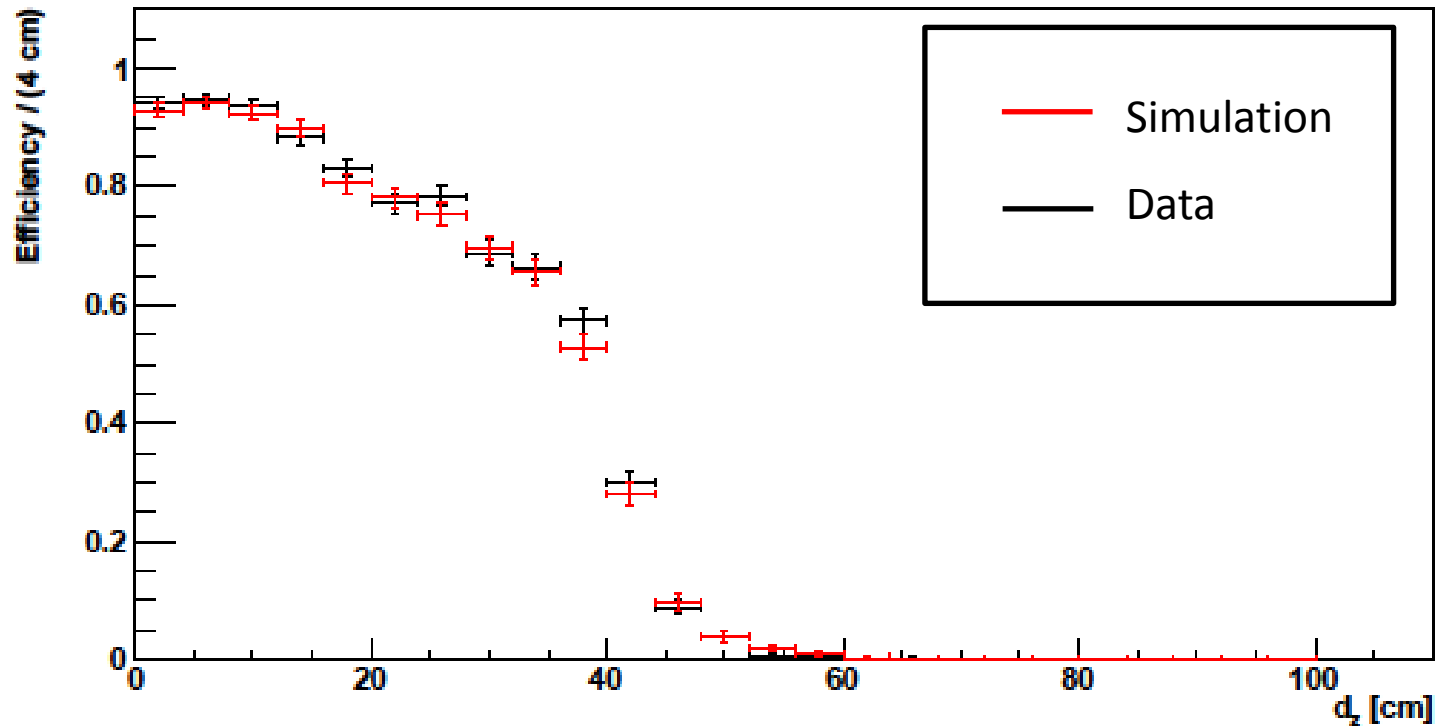
- < 50% Cosmic muon Track Efficieny up to d_z = 40 cm

- Good Simulation-Data agreement everywhere

Cosmic Tracker Muon Efficiency
Vs
Transverse Impact Parameter
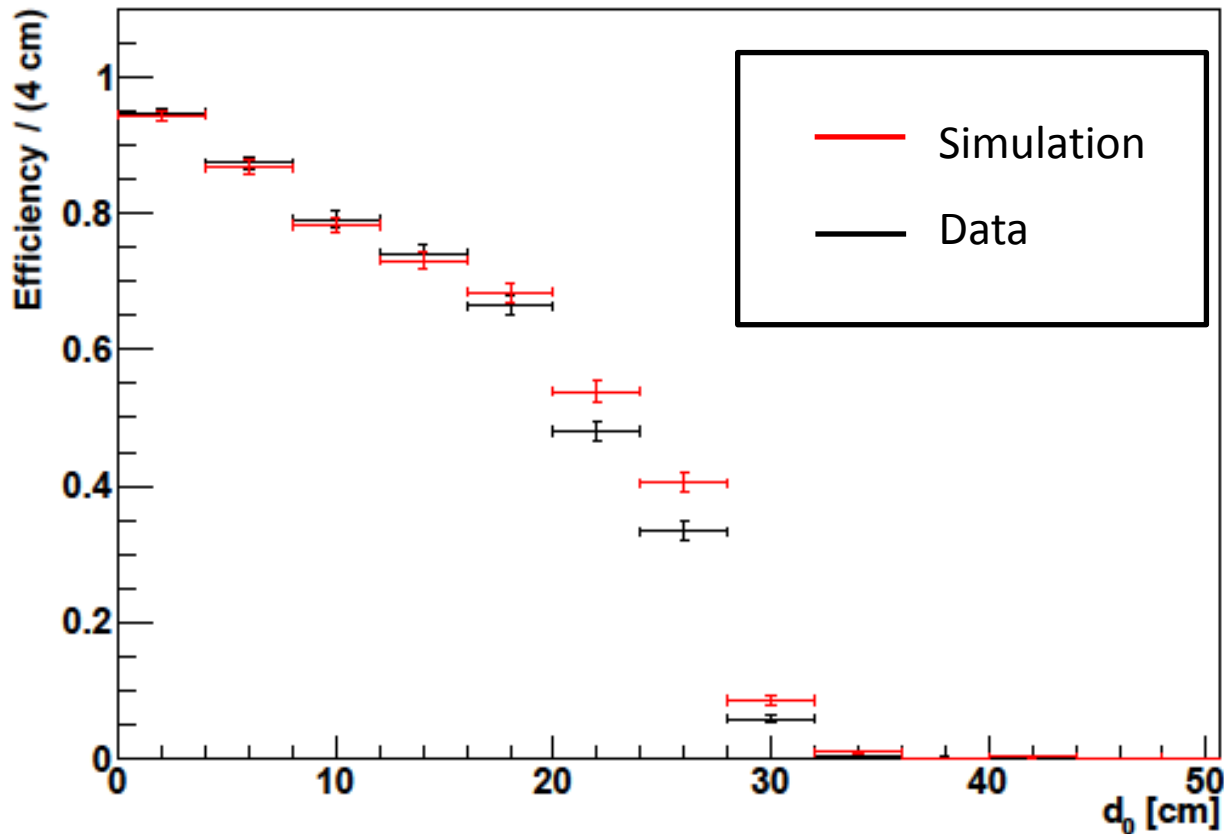
- < 50% Cosmic muon Track Efficieny up to d_0 = 20 cm

- Good Simulation-Data Agreement at that region

Simulation-Data Efficiency ratio against $|d_0|$
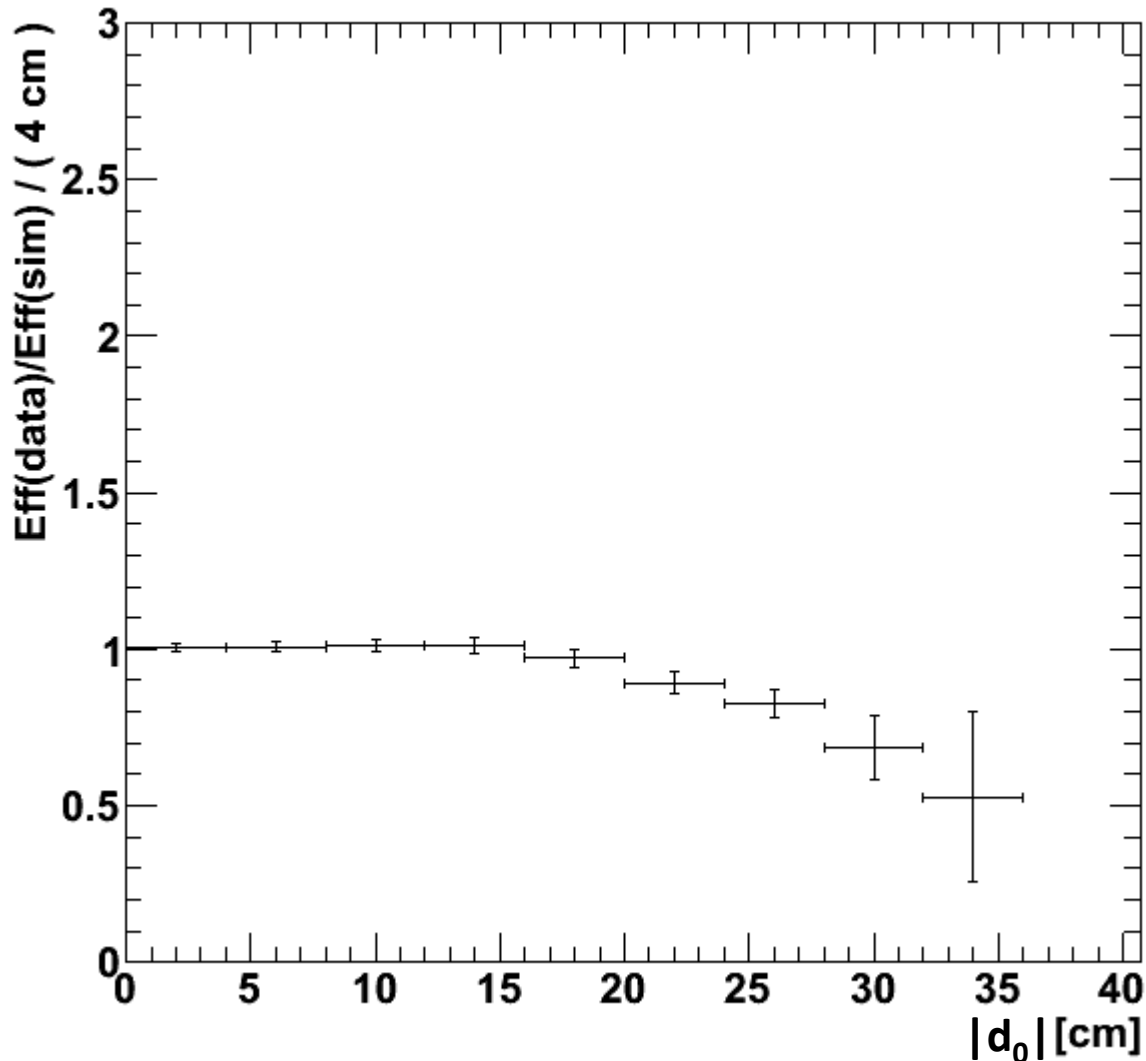
- Data Cosmic muon count is lower than simulation after d_0 = 15 cm

- Good understanding of muon systematic uncertainty in Trackers

Upper Limit for Electrons
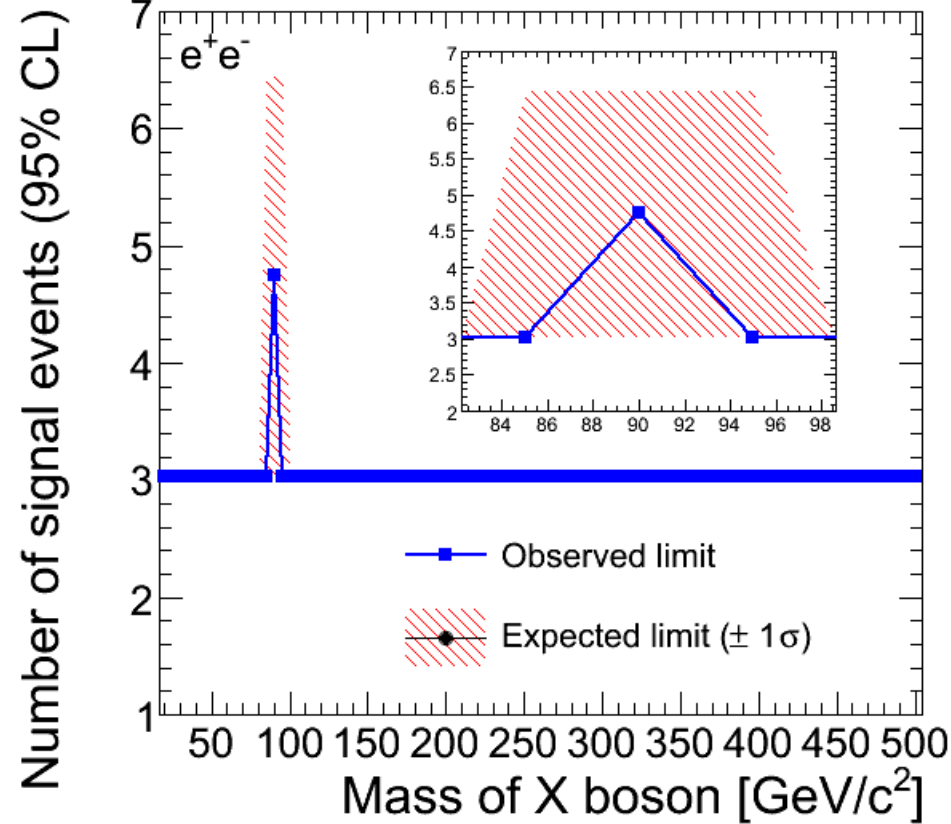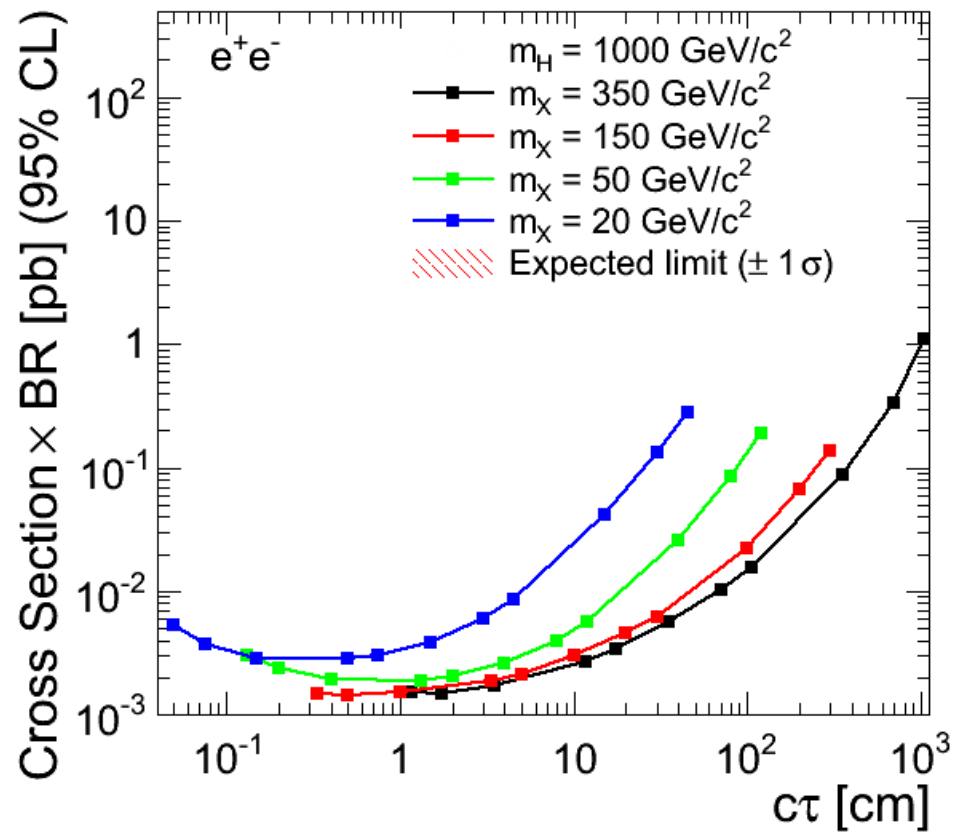
Upper Limit for Muons
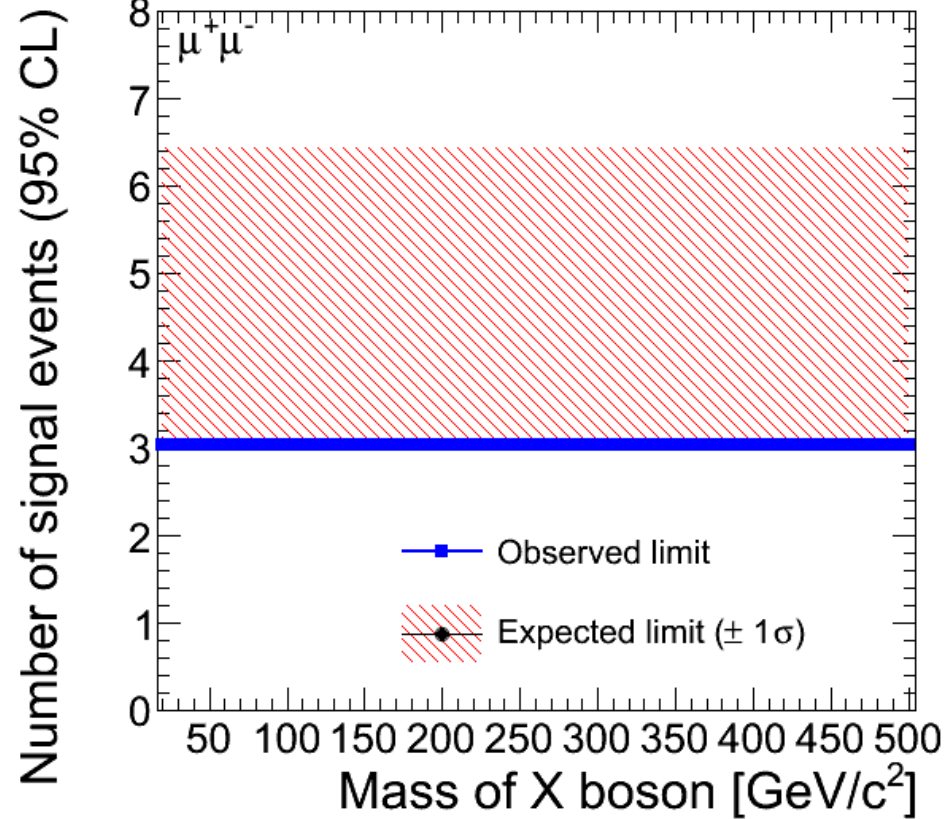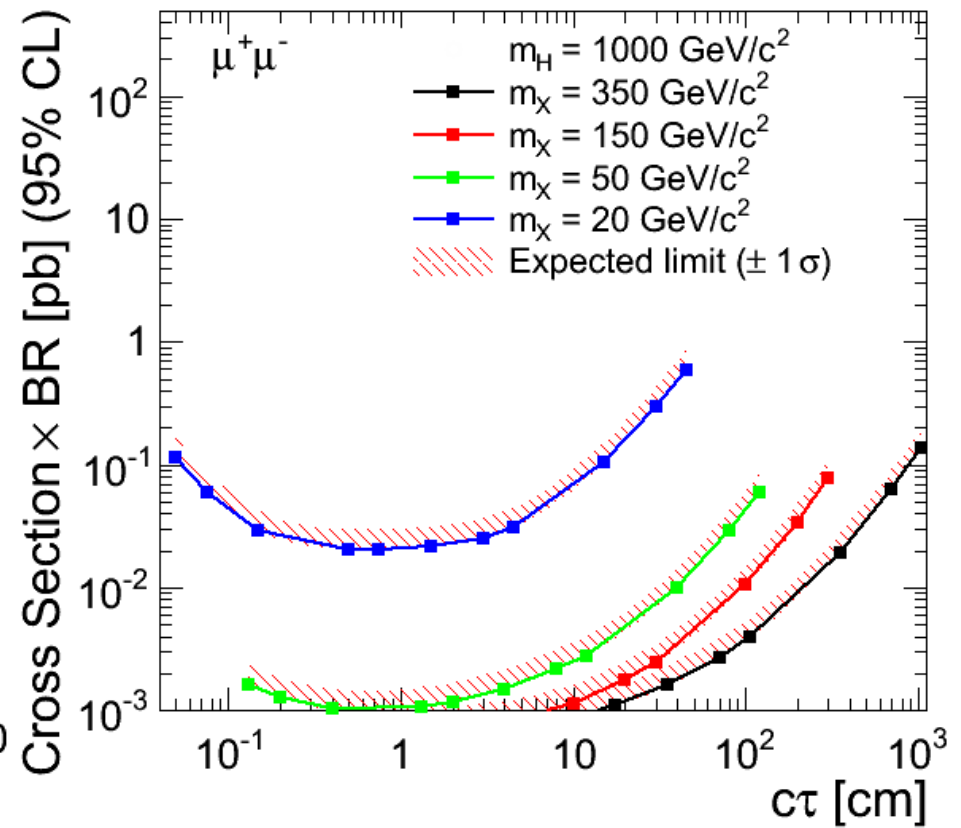
Quick Check on 2012 data

- Selection criteria
- Dimuon mass : [50, 250] GeV
  - Dimuon decayLength>10
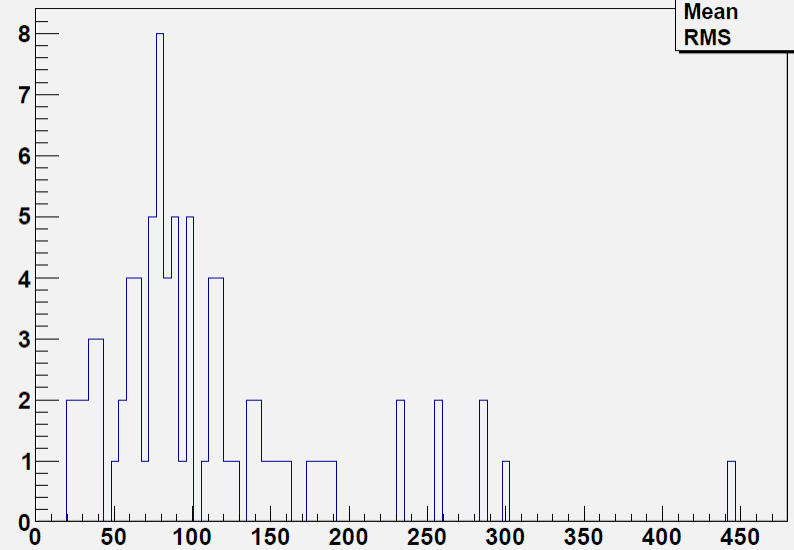 - Dimuon decayLengthSignificance >2
  - Dimuon vz<25
  - Dimuon vertexChi2 <5
  - Muon eta<2.2
  - Muon d0 >2

MC
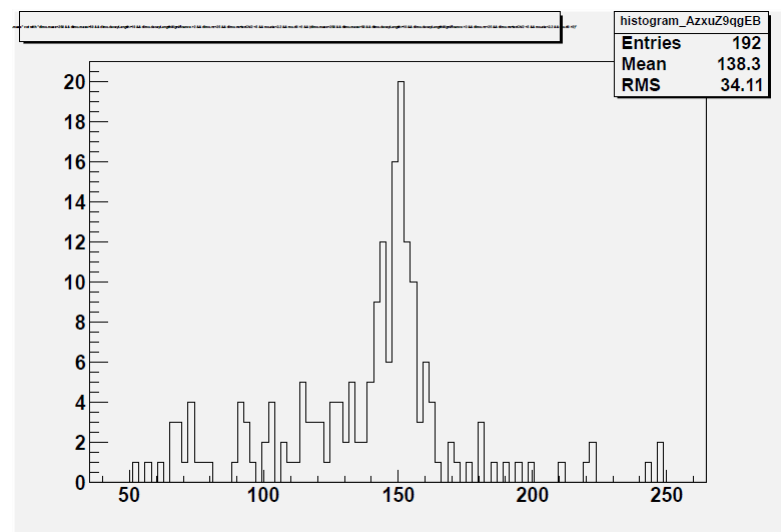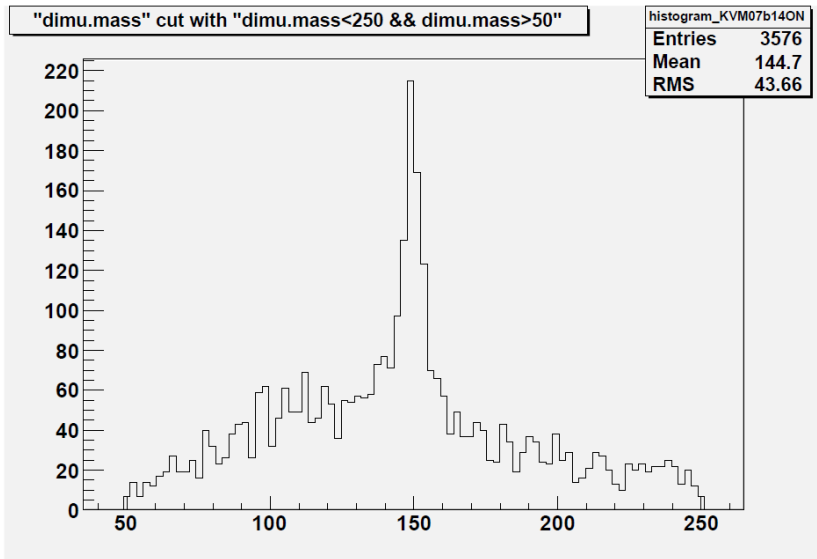
Data

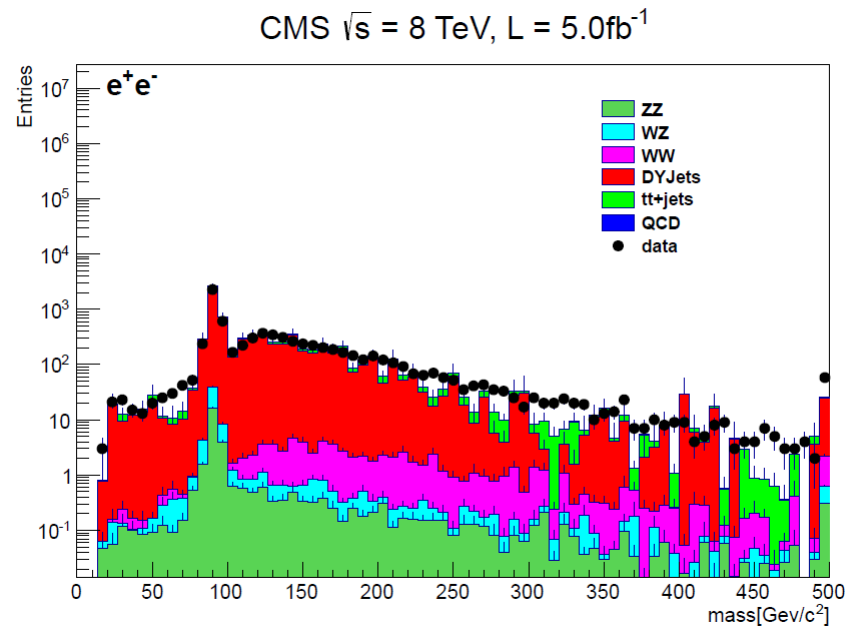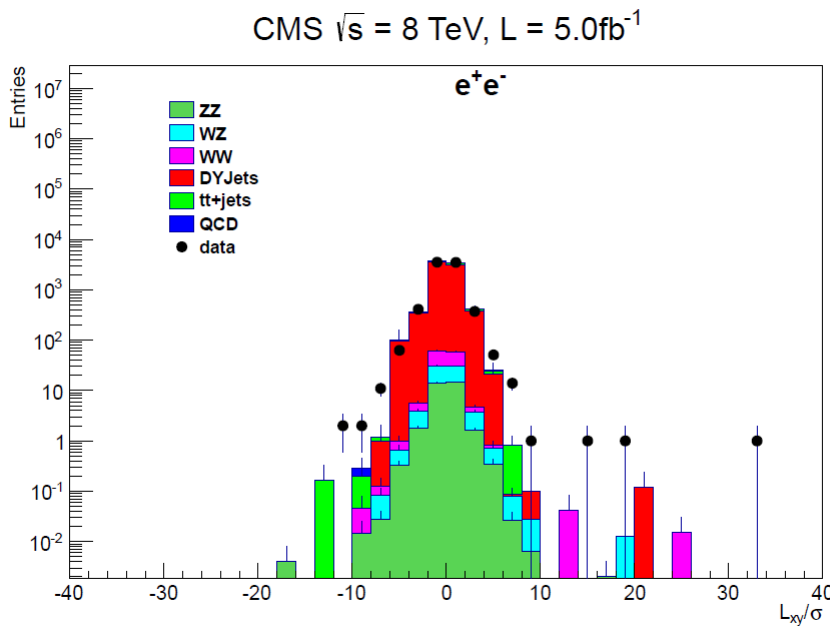"dimu.mass" cut with "dimu.mass<500 && dimu.mass>20 && dimu.decayLength>=0"
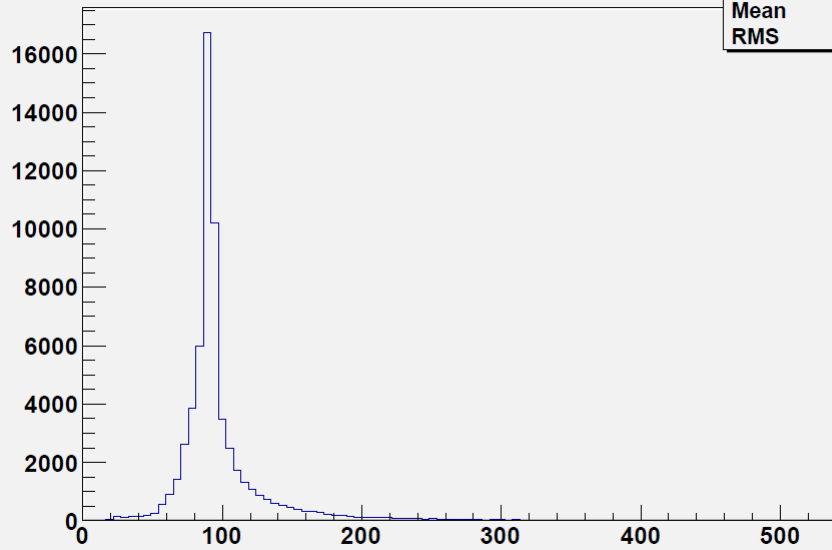
histogram_oWuHpCdqgE	
Entries	60879
Mean	100.7
RMS	41.84

"dimu.mass" cut with "dimu.decayLength>10 && dimu.decayLengthSignificance>2 && dimu.vz<26 && dimu.vertexChi2 <6 && mu.eta<2.2 && mu.d0 >2 && dimu.mass<500 && dimu.mass>20"

histogram_qNlzi8KJ07	
Entries	83
Mean	107.9
RMS	72.34

First Look on 2012 data

- Electron channel
- Before cut
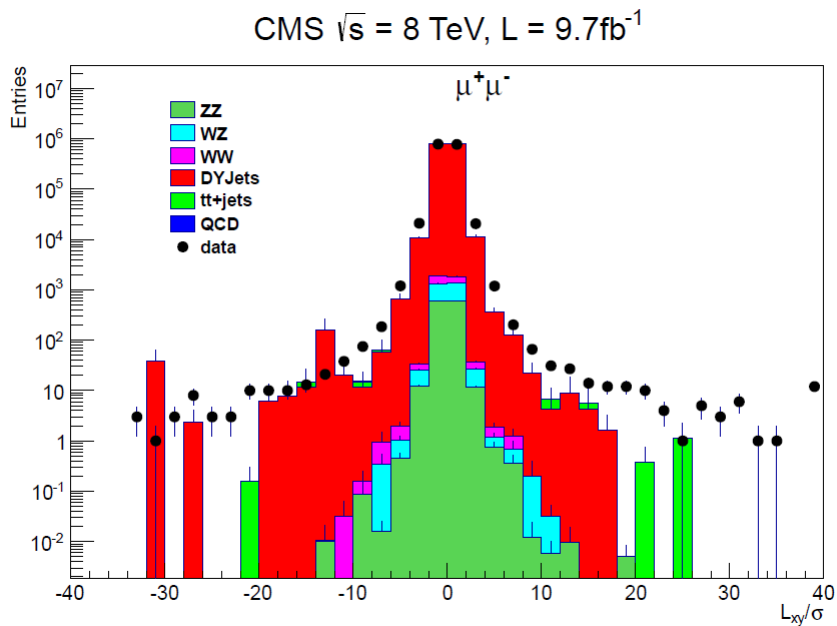
First Look on 2012 data

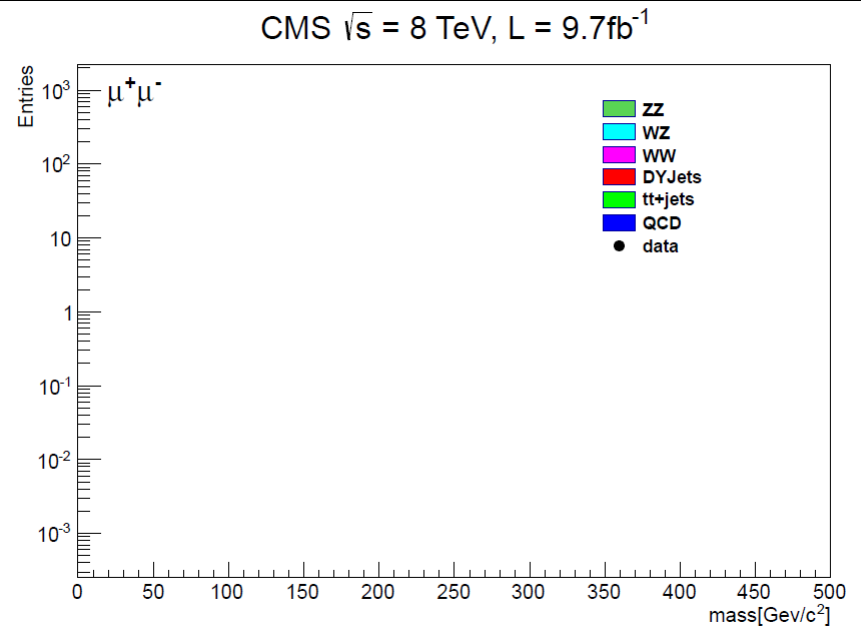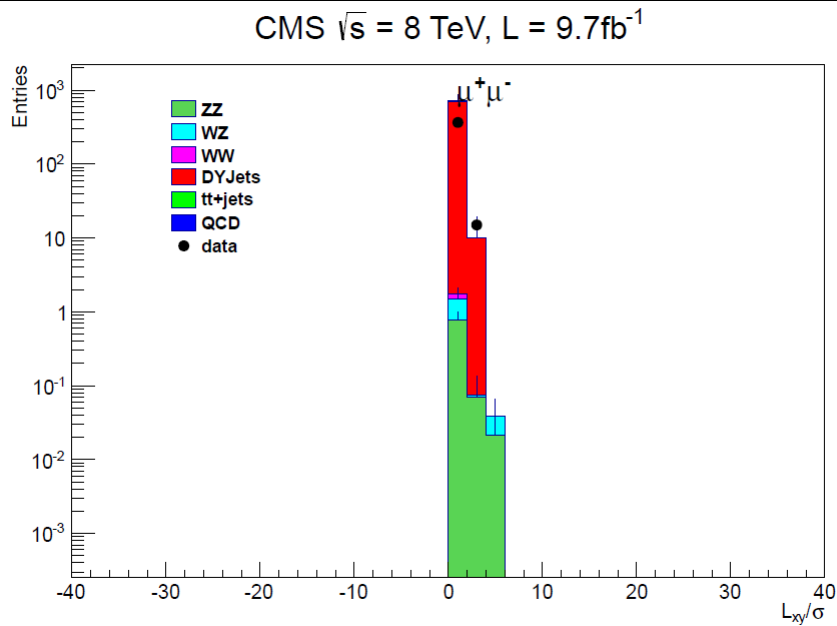- Electron channel
- After cut
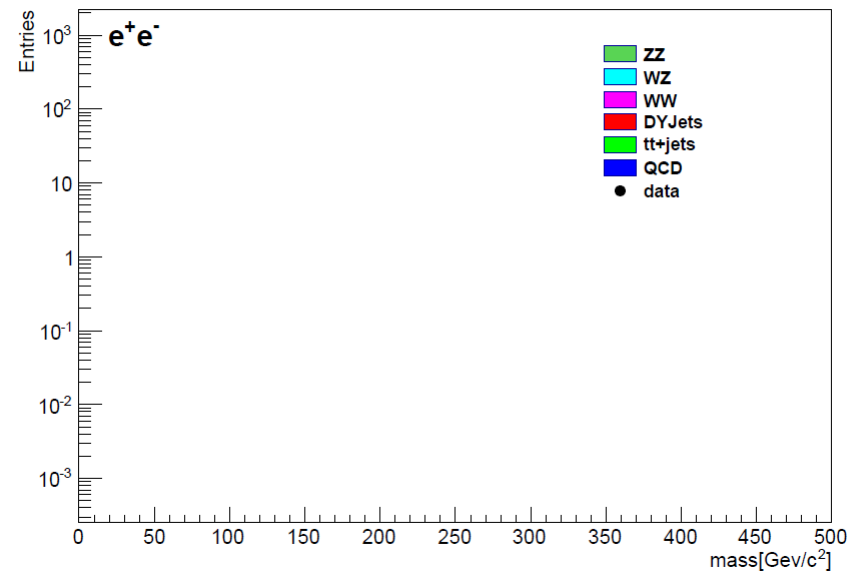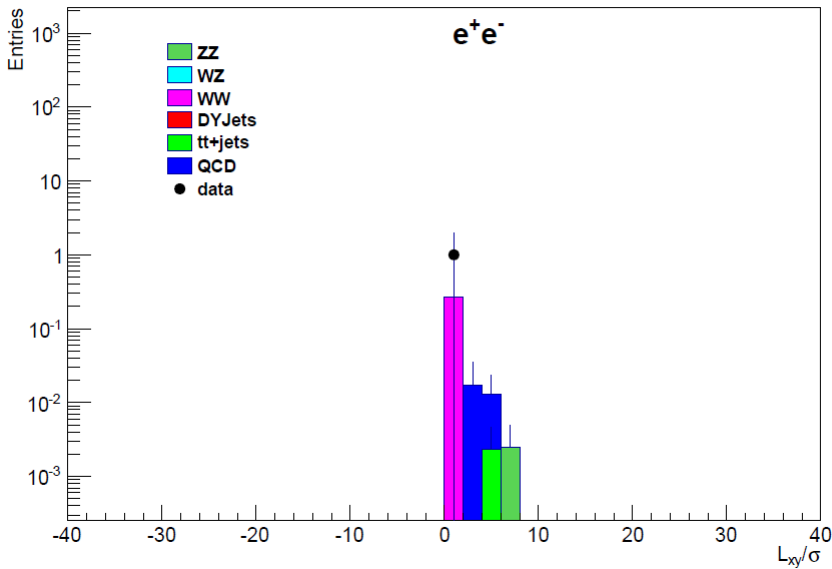
First Look on 2012 data
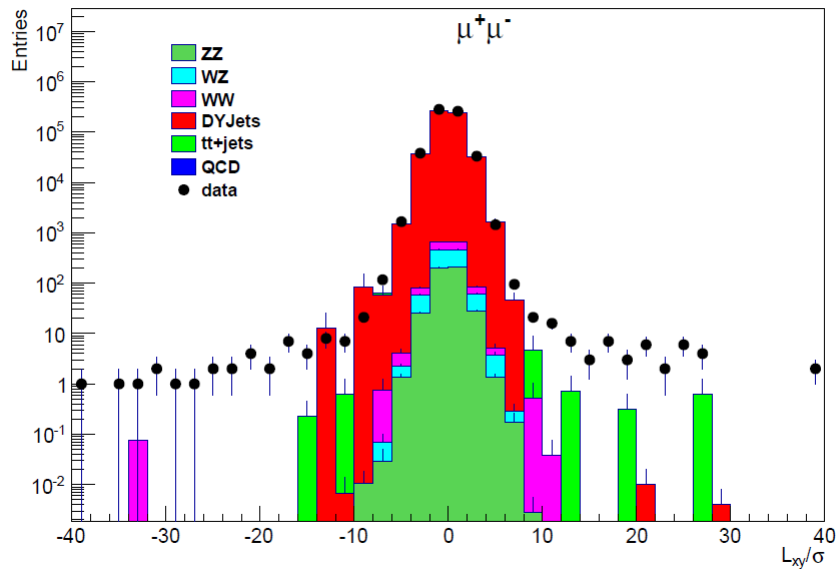
- Muon channel – track-based muon
- Before cut
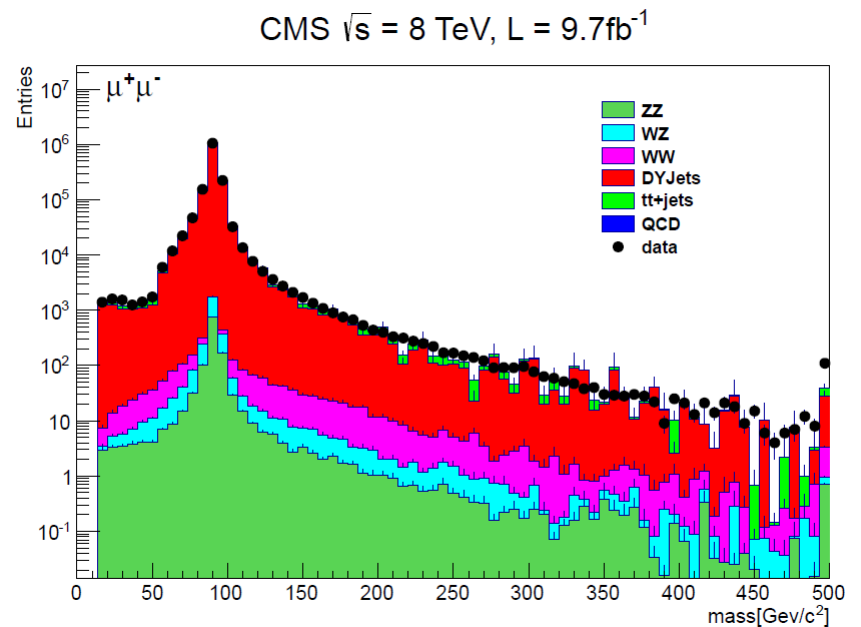
First Look on 2012 data
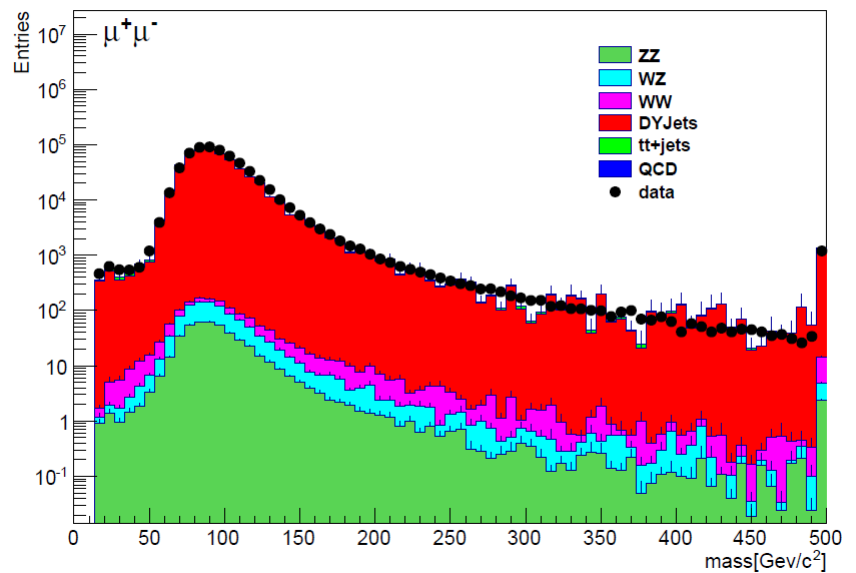
- Muon channel – track-based muon

- After cut

First Look on 2012 data

- Muon channel – standalone muon
- Before cut

First Look on 2012 data

- Muon channel – standalone muon
- Before cut
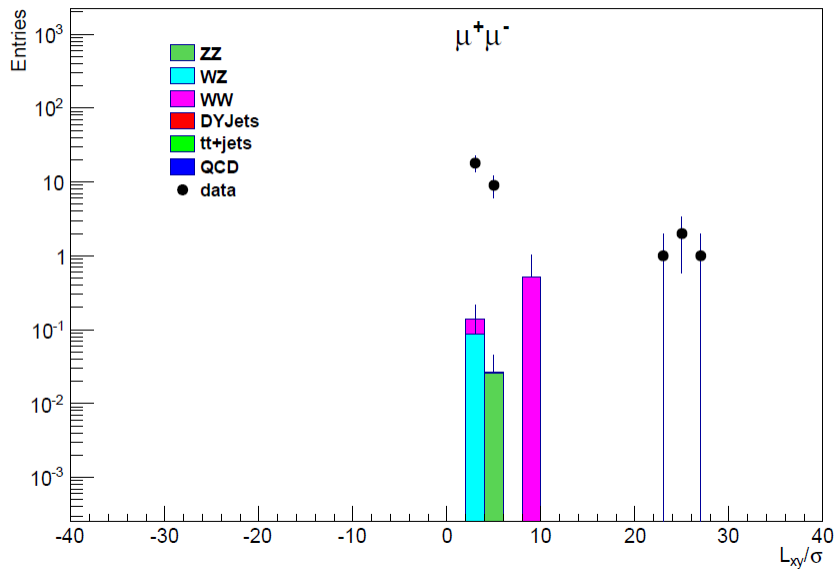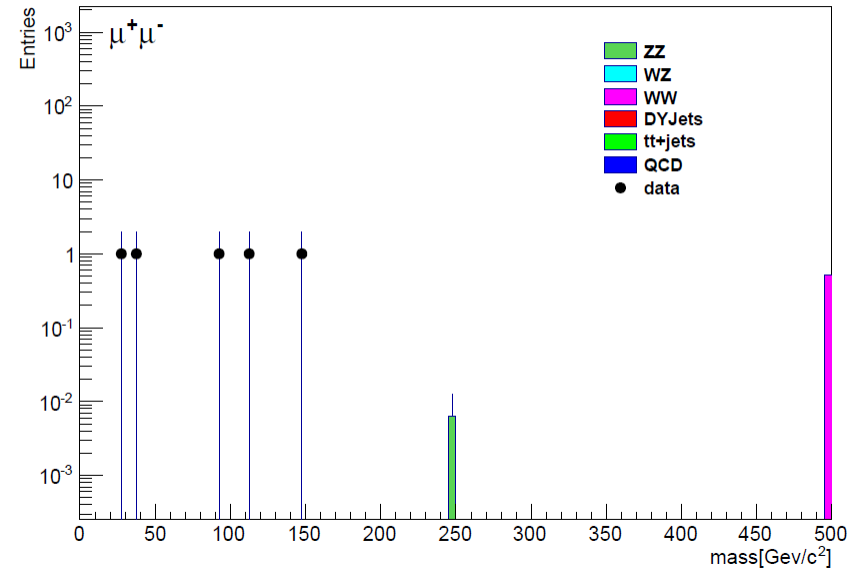
Conclusion

- We have sufficient tools to find out long-lived exotica – if there is one

- The upper limit for 2011 data is provided.

- We have yet to see an exotica in 2012 data.