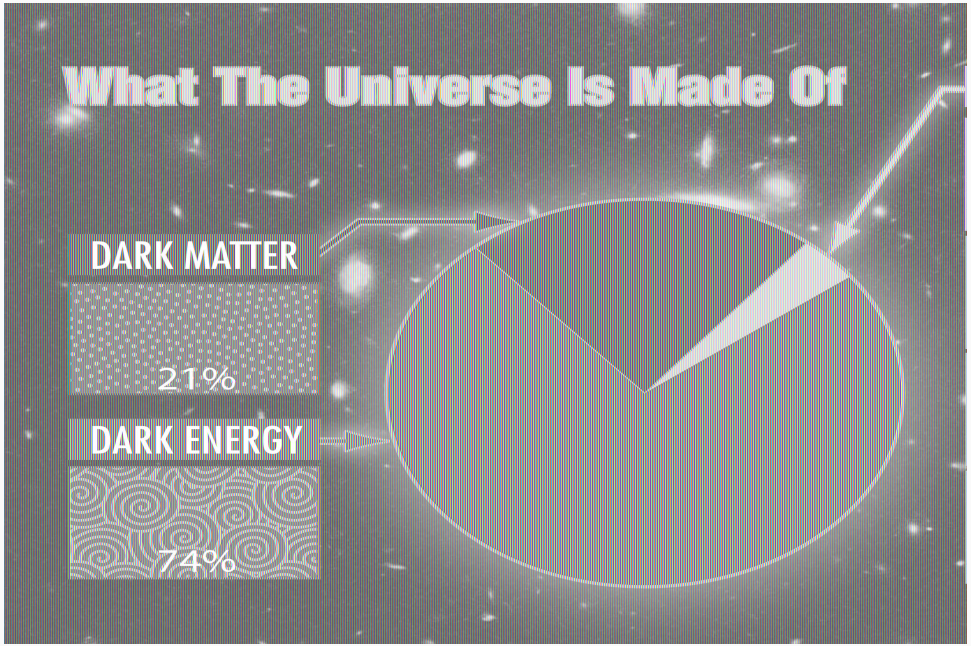
Dark Matter Mono-Photons

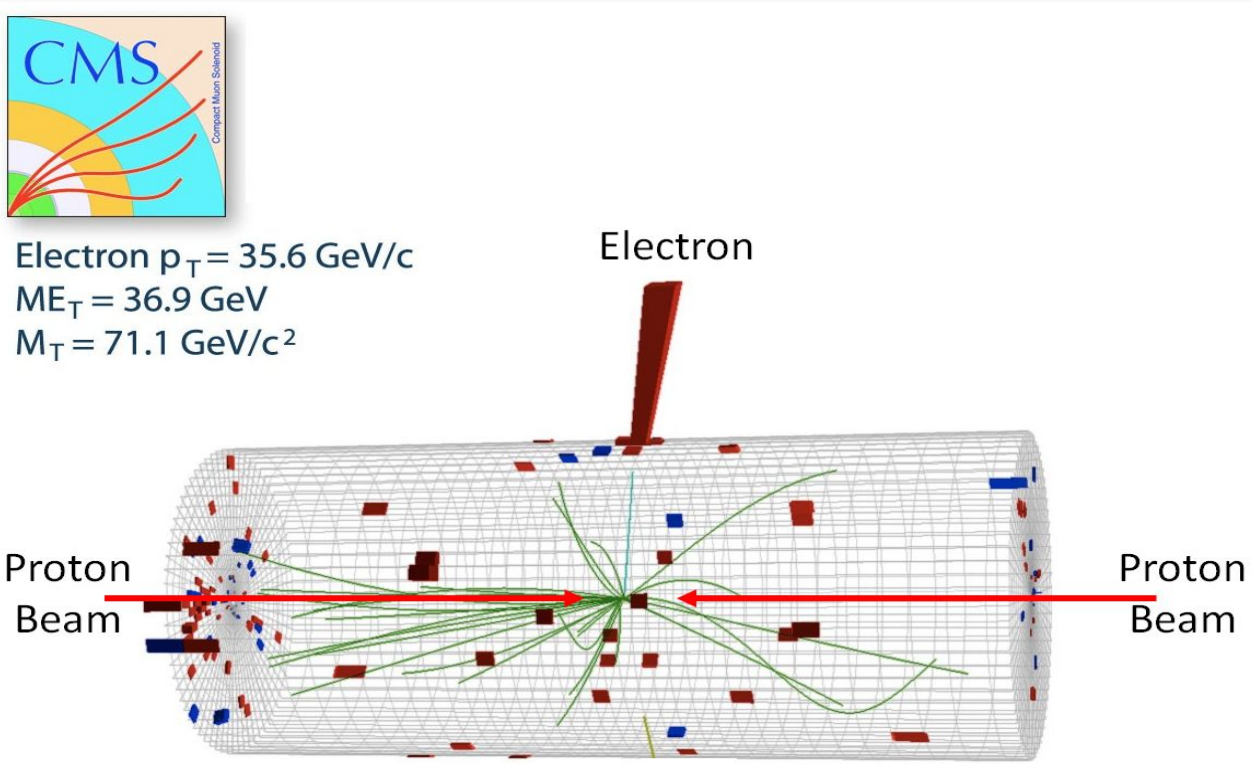
Preliminary Results from CMSDASia 2016

Overview

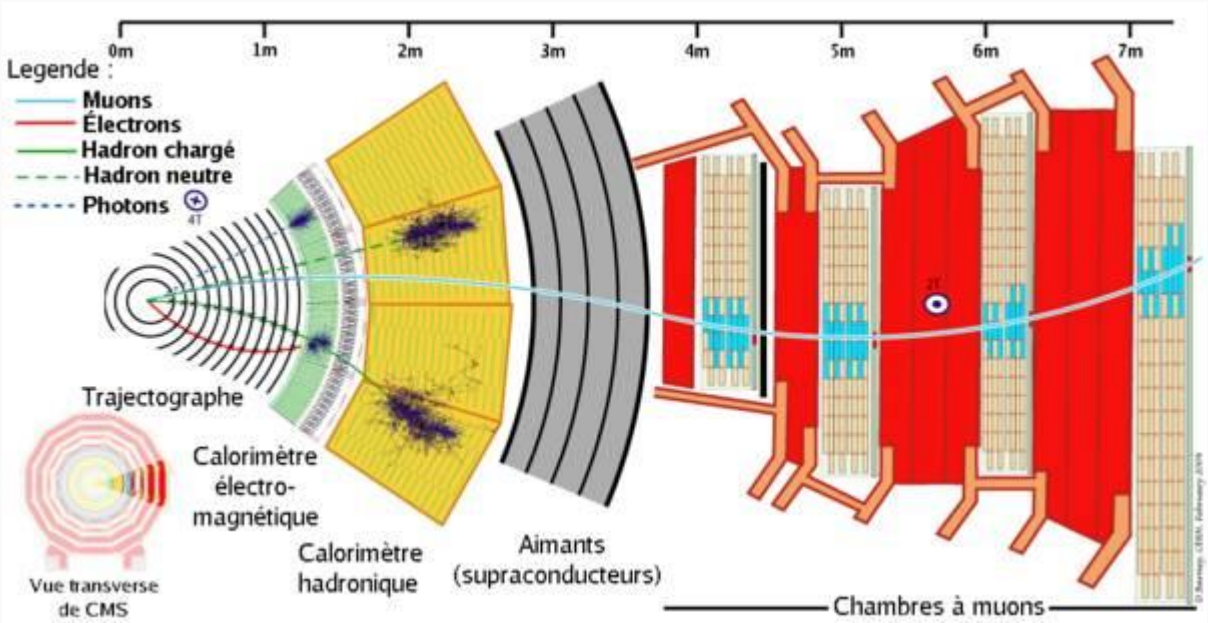
- Physics Motivation
- Analysis Strategy
- Event Selection (Trigger, Photon ID, Lepton Veto…)
- MC vs DATA vs Signal
- Systematics and Limits using Combine



Signature: Photon + MET



CMS Detector



Analysis Strategy and Workflow

1.) Determine the Trigger needed
2.) Apply Medium Photon ID developed by egamma group (maintains good signal efficiency)
3.) Apply Lepton Veto (reject events with muon or electron satisfying IDs)
4.) Other Cuts
5.) MC + Data + Signal Comparison
6.) Limits Signal

Trigger

-HLT_Photon175

-HLT_Photon165_HE10

Background Sample

Irreducible

Z+gamma

Reducible

W+jets
Z+jets
QCD multijets
W+gamma
QCDmultijets + gamma
Z+W
gamma + jets

Background Estimation

How to kill our enemy?

channel	method
Z+gamma	cannot reduce (Through MC study)
Z+jet	photon ID
W+jet	photon ID
QCD	photon ID
photon + jets	MET
W + gamma (e nu gamma, mu nu gamma)	lepton (electron/muon) veto

Background Estimation

- **Cuts**

  photon

  Photon ID

  - **PT > 175 GeV**
  - **Photon_SuperCluster_Eta**

Barrel	Endcap

Background Estimation

- **Cuts**

MET(Missing Transverse Energy)

- **pfMET > 140 GeV**
- **delta Phi (gamma, MET) > 2**

Background Estimation

- **Cuts**

Lepton Veto

- **pfMET > 140 GeV**
- **delta Phi (gamma, MET) > 2**

MC/Data Comparison - Background estimation

From these MC samples, we can estimate the background by stack events.

-Z Nu Nu G Jets-MonoPhoton

-W G Jets-MonoPhoton

-Z L L G Jets-MonoPhoton

-W To Tau Nu

-W To Mu Nu

-G jets

(G is gamma simbol here)

MC/Data Comparison - Background estimation

Estimate how many events passed conditions, for sum of MC

1) trigger
2) photon
3) MET
4) delta R
5) Lepton veto

Pileup Generation Mechanism

-start with chosen input distribution

Pileup reweighing

-Match the MC distribution to the data distribution

Pileup mitigation

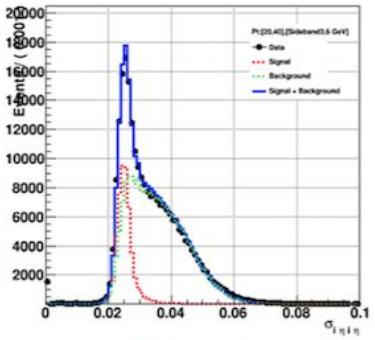
-remove the effect of pileup from physical analysis and object

In the end, stack the plots for comparison. using THStack.

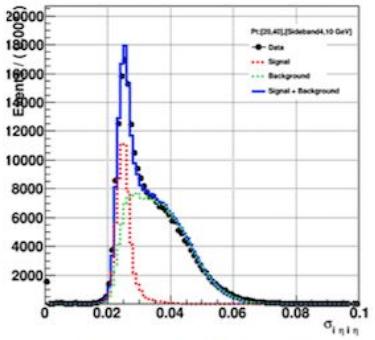
MC/Data Comparison - Background estimation

But!
MC cannot really describe the data for high pT.
-Irreducible background cannot be eliminated fro
We could however do something about the reduc

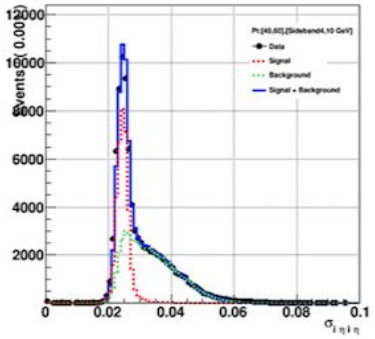
Example, we use the template method
to estimate the photon fake rate for both
the barrel and the end caps.



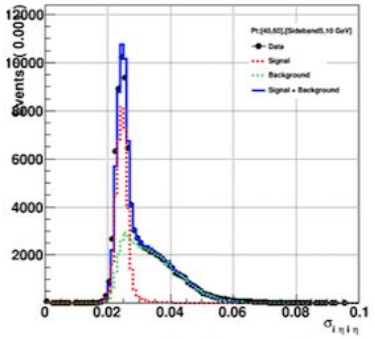
a) p_T *bin:* 20 – 40 *GeV, CHIso:*3 – 6 *GeV*



b) 20 – 40 *GeV, CHIso:*4 – 10 *GeV*



c) 40 – 60 *GeV, CHIso:*4 – 10 *GeV*



d) 40 – 60 *GeV, CHIso:*5 – 10 *GeV*

MC/Data Comparison - Background estimation

Signal template

good control sample: Z -> mumu + gamma (constrained to low pT from 10~30TeV)

For high pT: we trust MC signal template
(gamma in data = gamma MC x (e in data/e in MC))
(e in data/e in MC : using Z -> e + e)

Background template

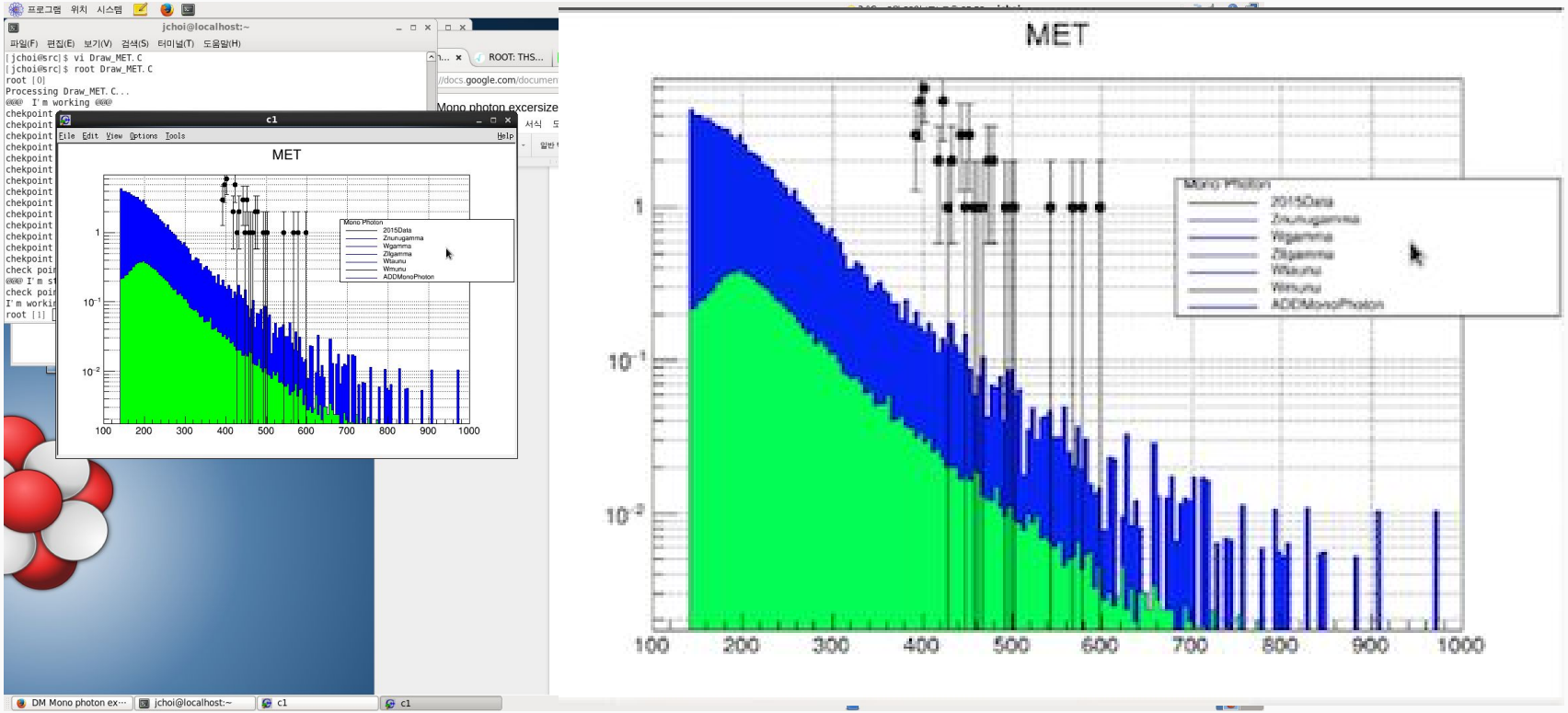
side band(SB) = background rich region

within the signal region: Find the sgnal/ background ratio

MC/Data Comparison - Systematics

- **Hardware**
- **Method uncertainties**

Preliminary Result



Future Work

***FIX LIMITS PLOT!!!**
***Systematic Uncertainty**
***e-gamma Fake Rate**
***gamma Fake Rate**
(MVA Template)