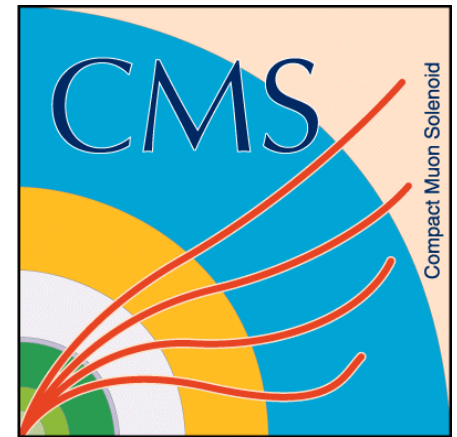


# Z boson production in PbPb collisions in CMS

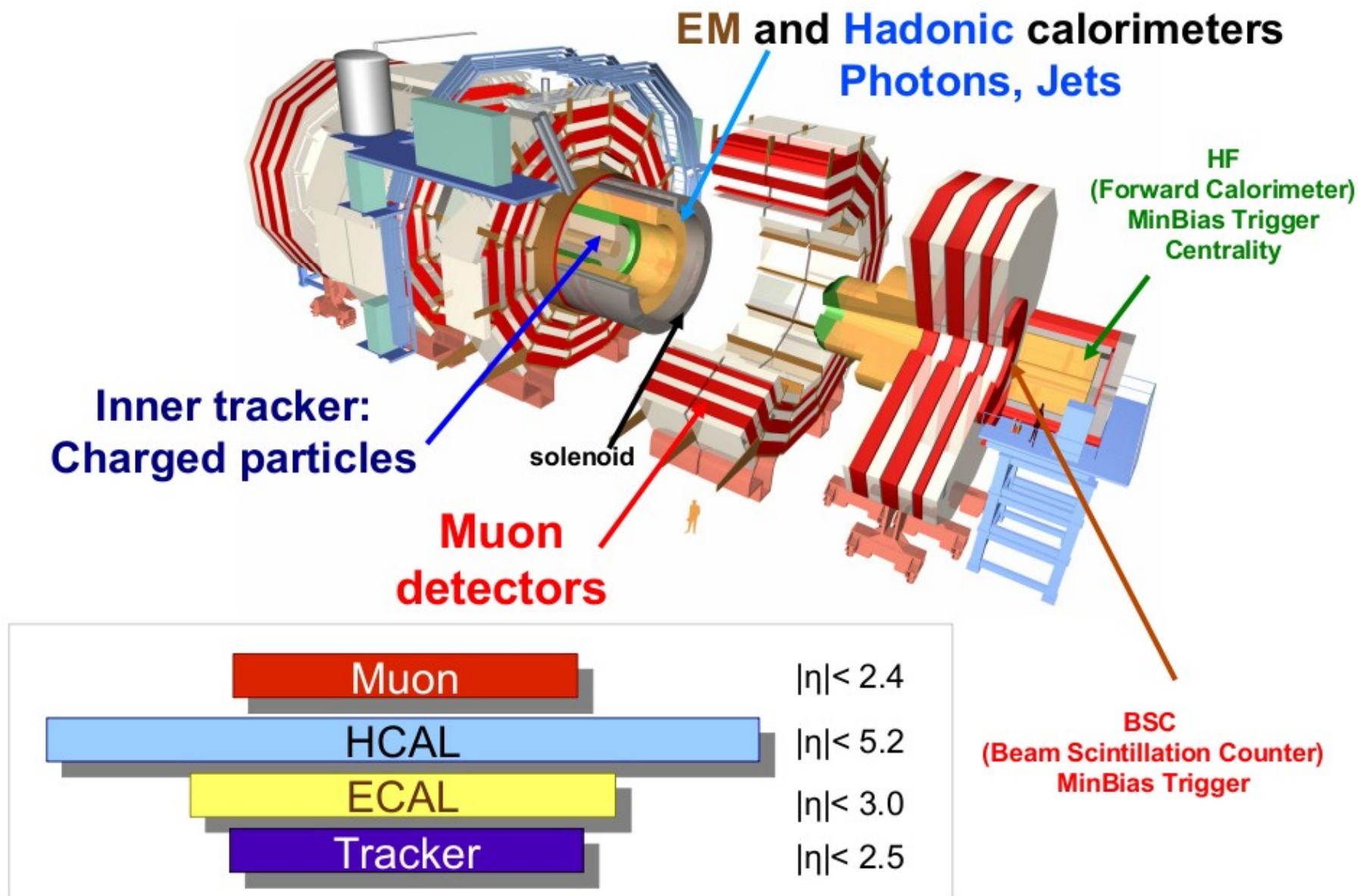
Anna Julia Zsigmond  
Wigner RCP

*for the CMS Collaboration*

25th Indian-Summer School, Prague  
2. September 2013

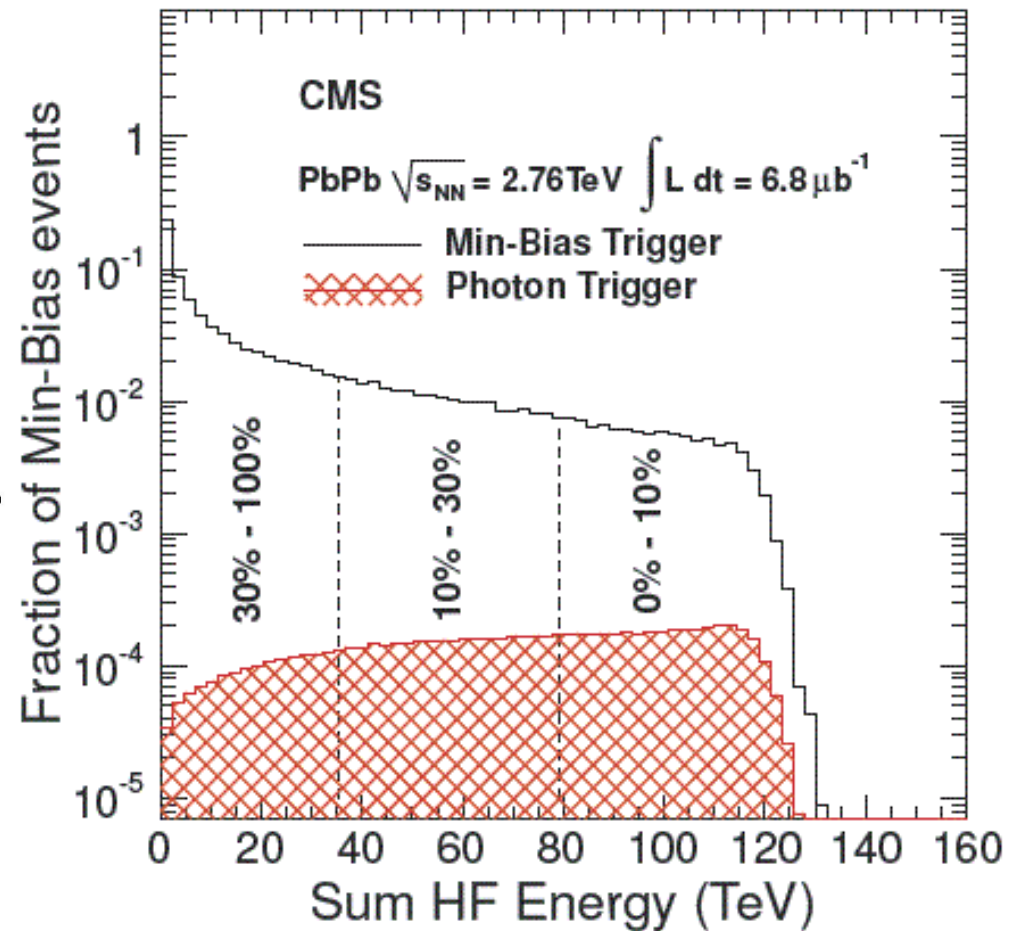
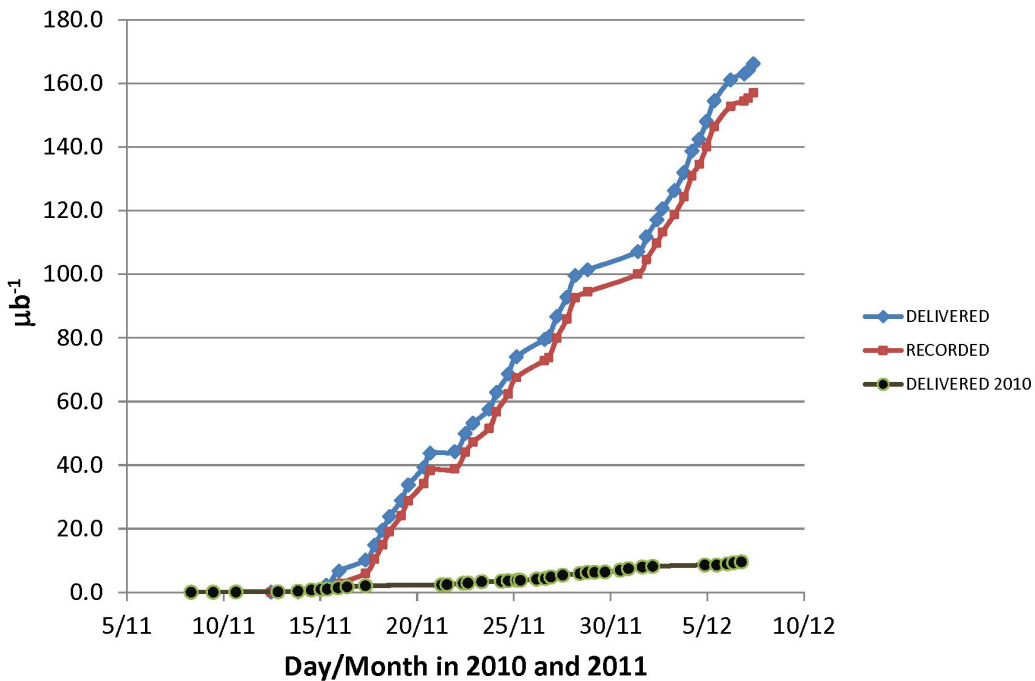


# CMS detector

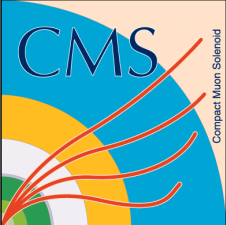


# PbPb collisions in CMS

CMS ION LUMINOSITY 2011 and 2010



- The total hadronic cross section is divided into centrality classes
- The corresponding impact parameter and number of binary collisions comes from Glauber model calculations

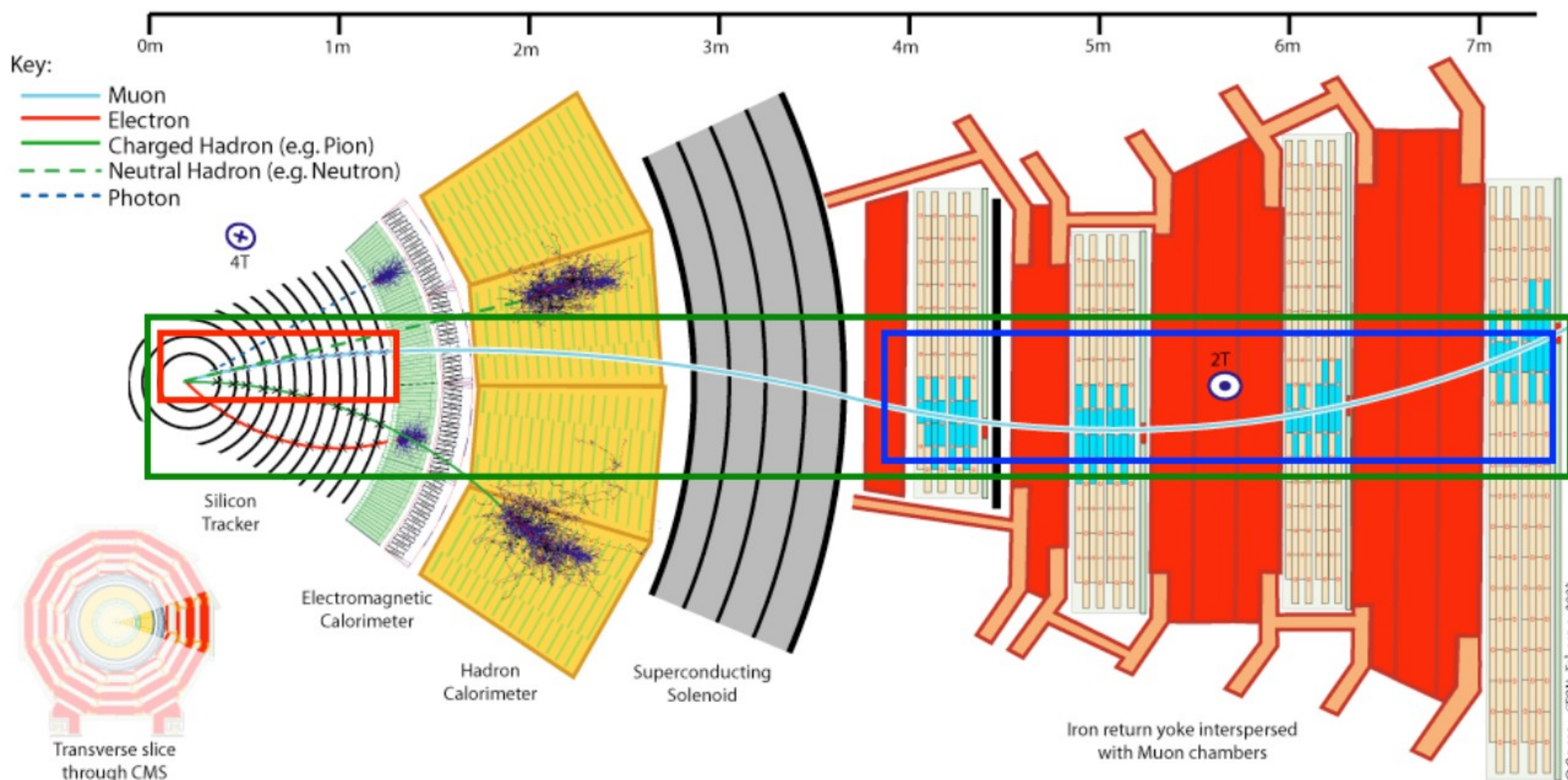


# Introduction to EWK bosons

- LHC energies allow for first measurements of Z and W bosons in heavy ion collisions
- Electroweak bosons are essentially not perturbed by the QCD medium
  - At first order, check the binary scaling hypothesis
  - Serve as a reference to modified processes (jets...)
  - Second order modifications ultimately constrain initial state (npdf)
- Isolated photons
  - From 2010: PLB 710 (2012) 256
  - From 2011: PLB 718 (2013) 773, photon+jet
- Z in muon and electron channel
  - From 2010: PRL 106 (2011) 212301
  - From 2011: CMS-PAS-HIN-12-008 and CMS-PAS-HIN-13-004
- W in muon channel
  - From 2010: PLB 715 (2012) 66

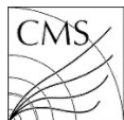
<https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsHIN>

# Muon reconstruction

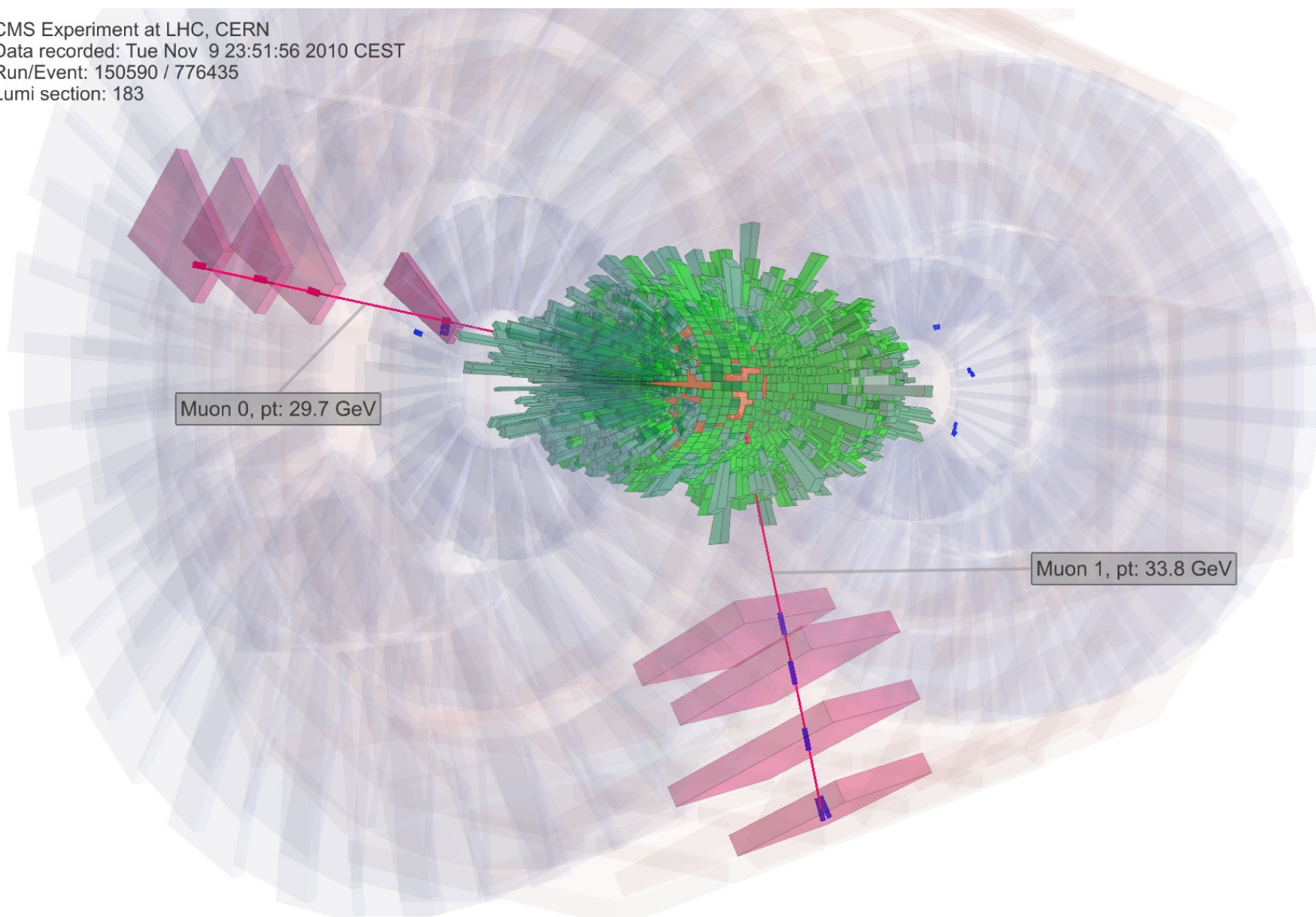


- Global muons reconstructed with information from inner tracker and muon stations
- Good resolution for high  $p_T$  muons

# First $Z \rightarrow \mu^+ \mu^-$ candidate in PbPb

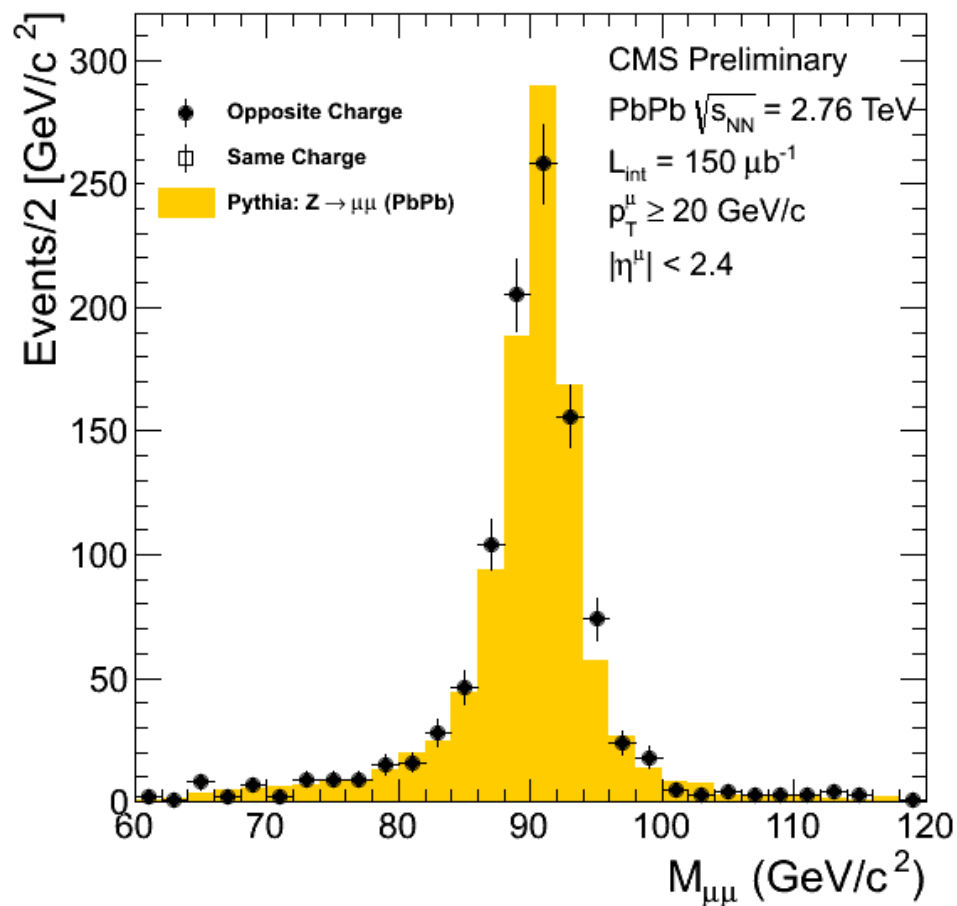
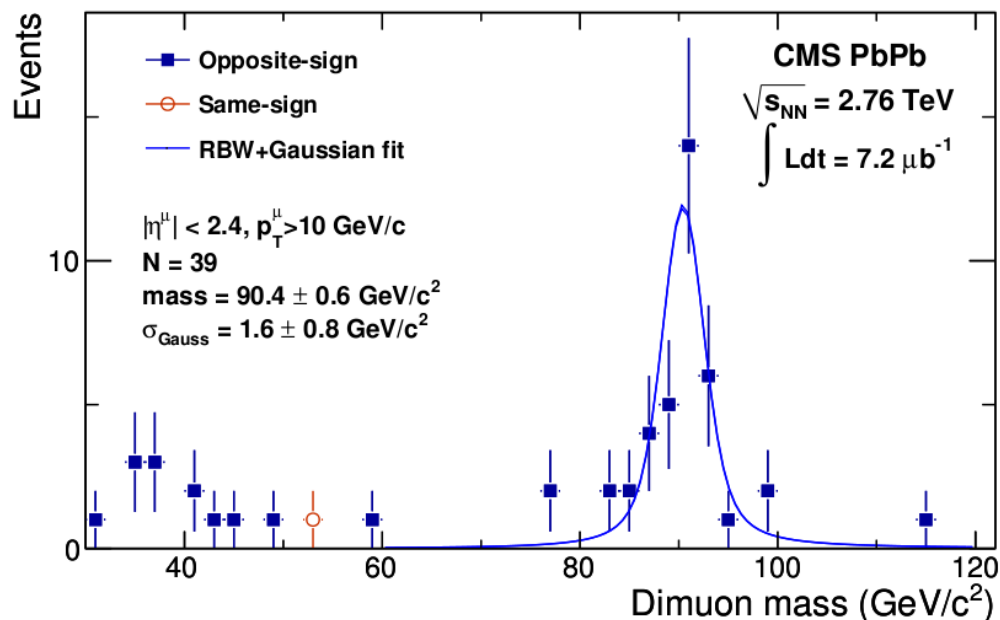


CMS Experiment at LHC, CERN  
Data recorded: Tue Nov 9 23:51:56 2010 CEST  
Run/Event: 150590 / 776435  
Lumi section: 183



# Z production in muon channel

PRL 106 (2011) 212301  
CMS-PAS-HIN-13-004

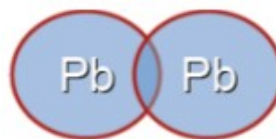
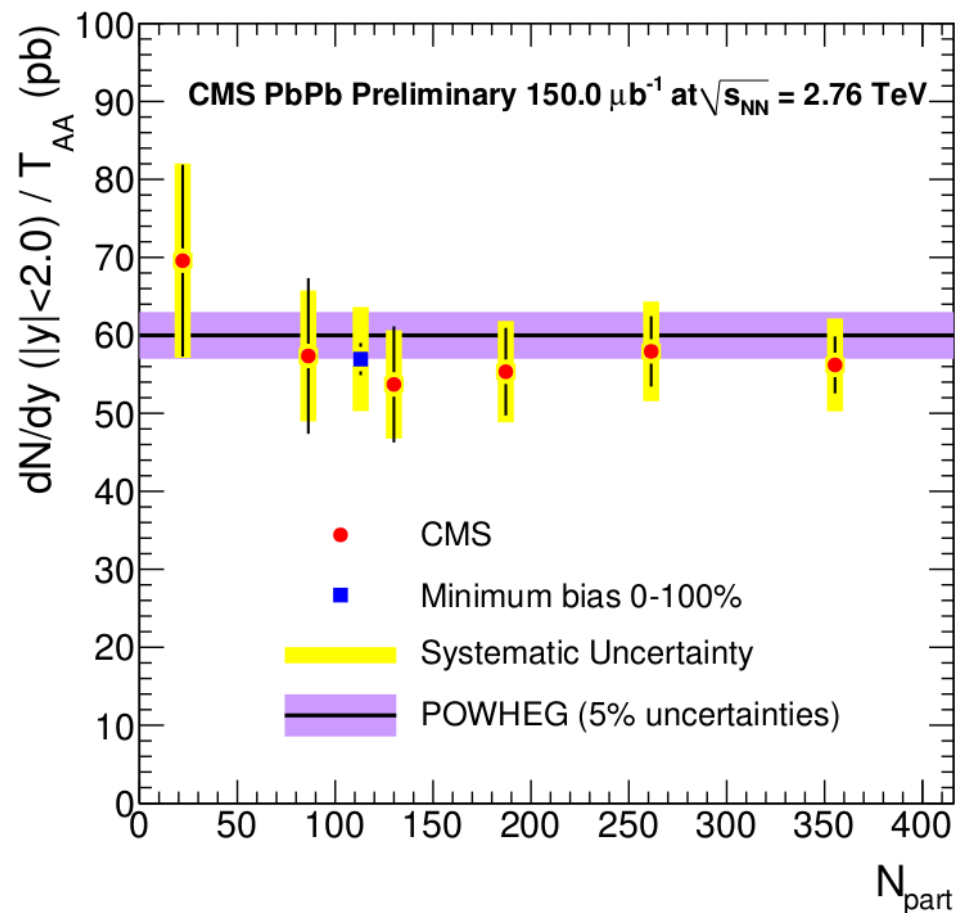


- 2010: 39 Z candidates  
 $\rightarrow p_T^\mu > 10 \text{ GeV}/c$
- 2011: 1022 Z candidates  
 $\rightarrow p_T^\mu > 20 \text{ GeV}/c$   
 $\rightarrow |\eta^\mu| < 2.4$

# Z production in muon channel

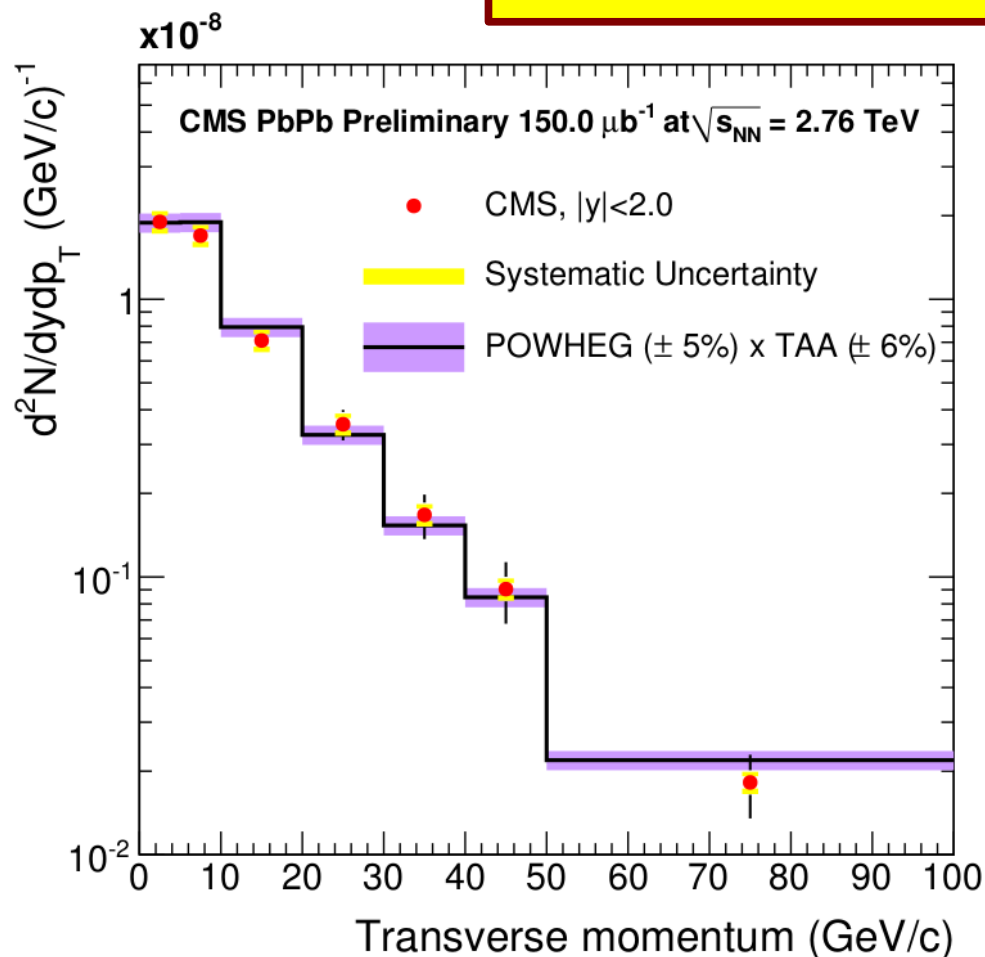
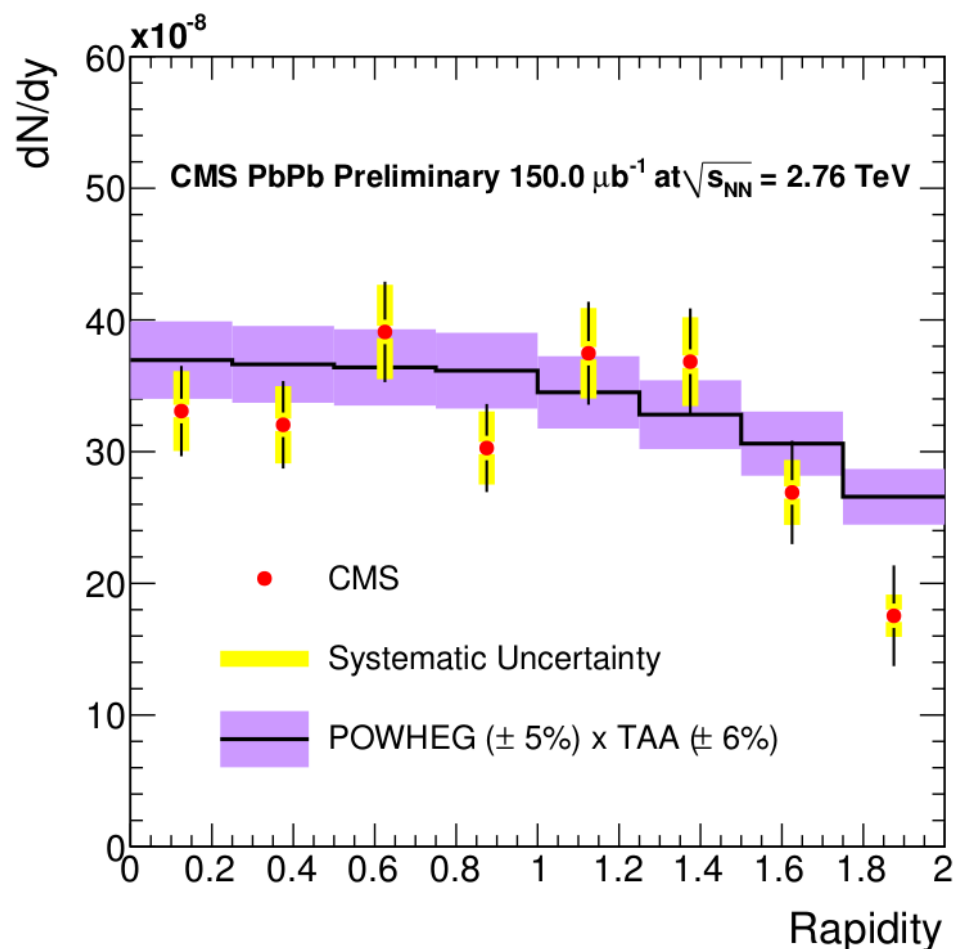
CMS-PAS-HIN-12-008

- Z production scales with number of binary nucleon-nucleon collisions
- Comparison with **POWHEG** NLO generator
- ➔ Good description of data at LHC and Tevatron energies



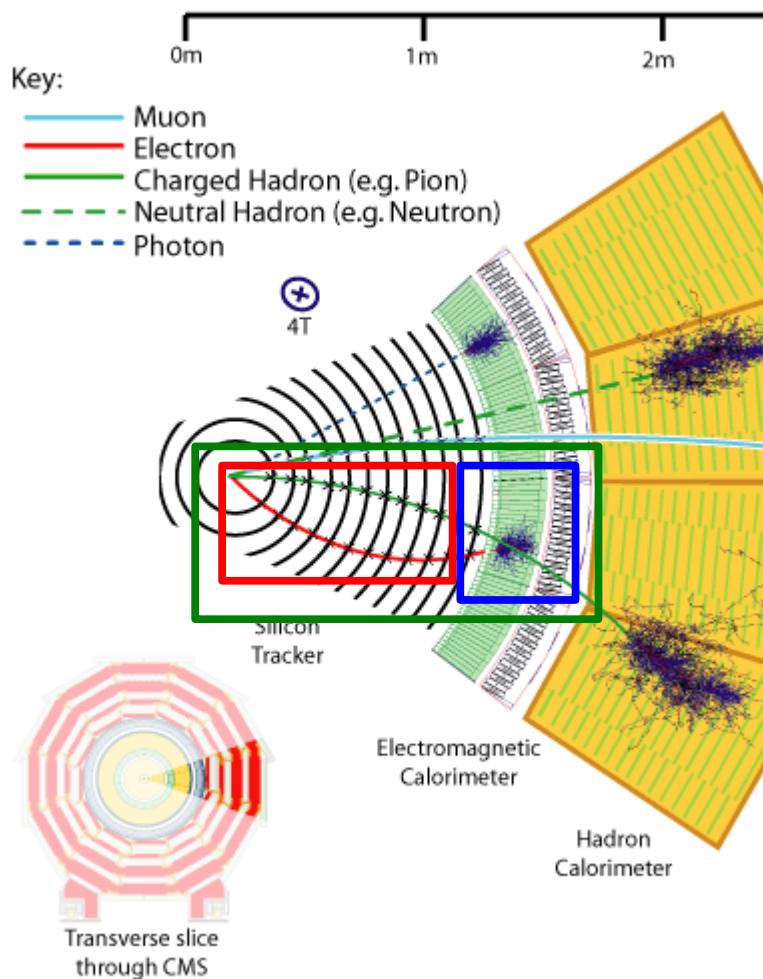
# Z production in muon channel

CMS-PAS-HIN-12-008



- Differential measurement with 2011 statistics
- No large deviations from the POWHEG reference

# Electron reconstruction

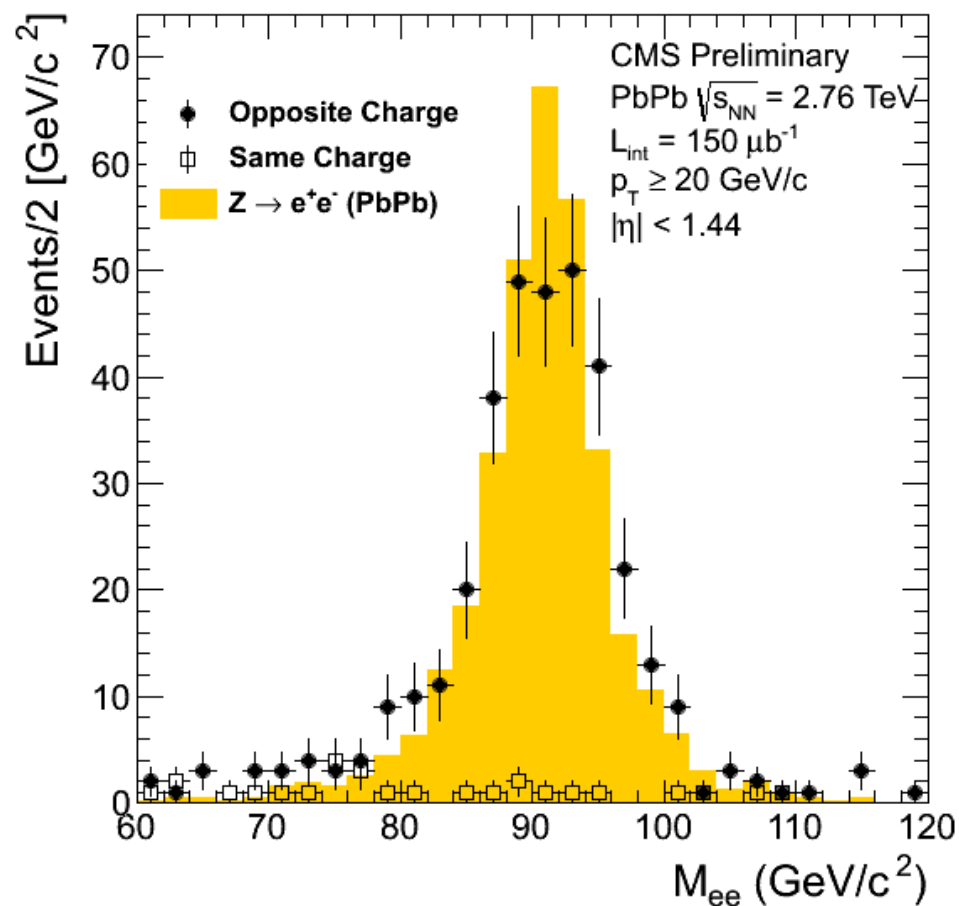


- Seeded by **supercluster** in ECAL
- **Inner track** reconstructed from the outside with radiation taken into account
- **Electron candidate** a supercluster matched to an inner track

# Z production in electron channel

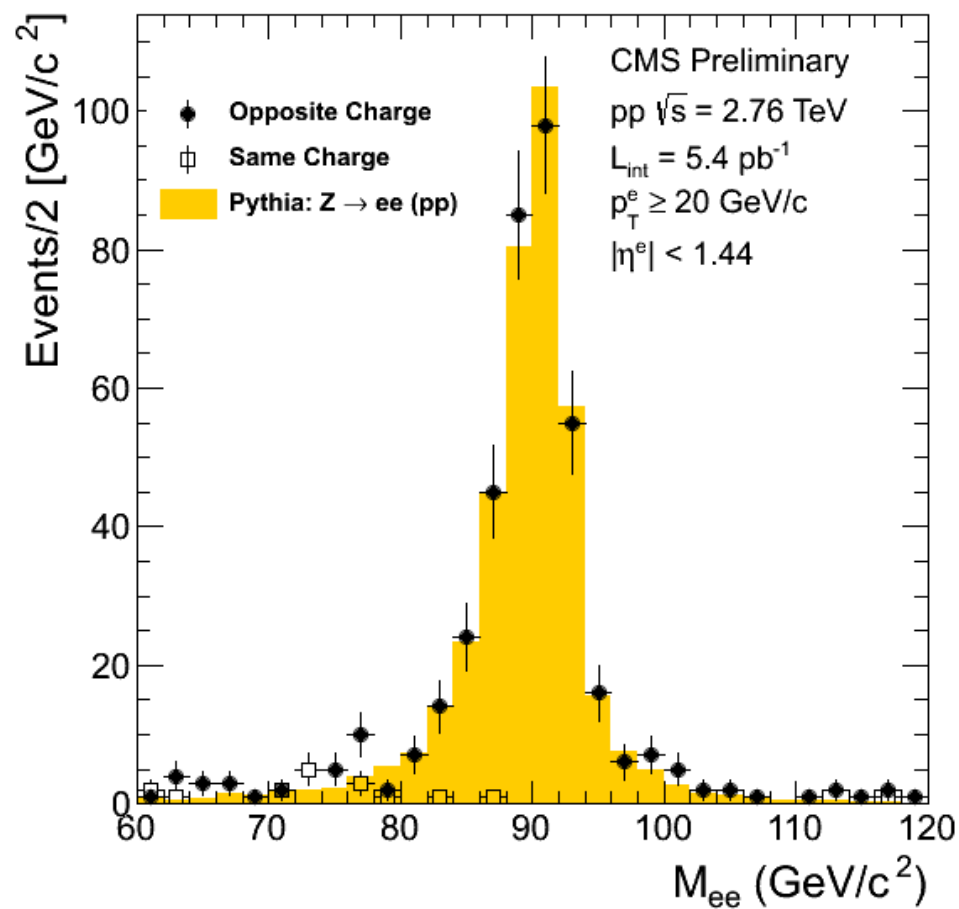
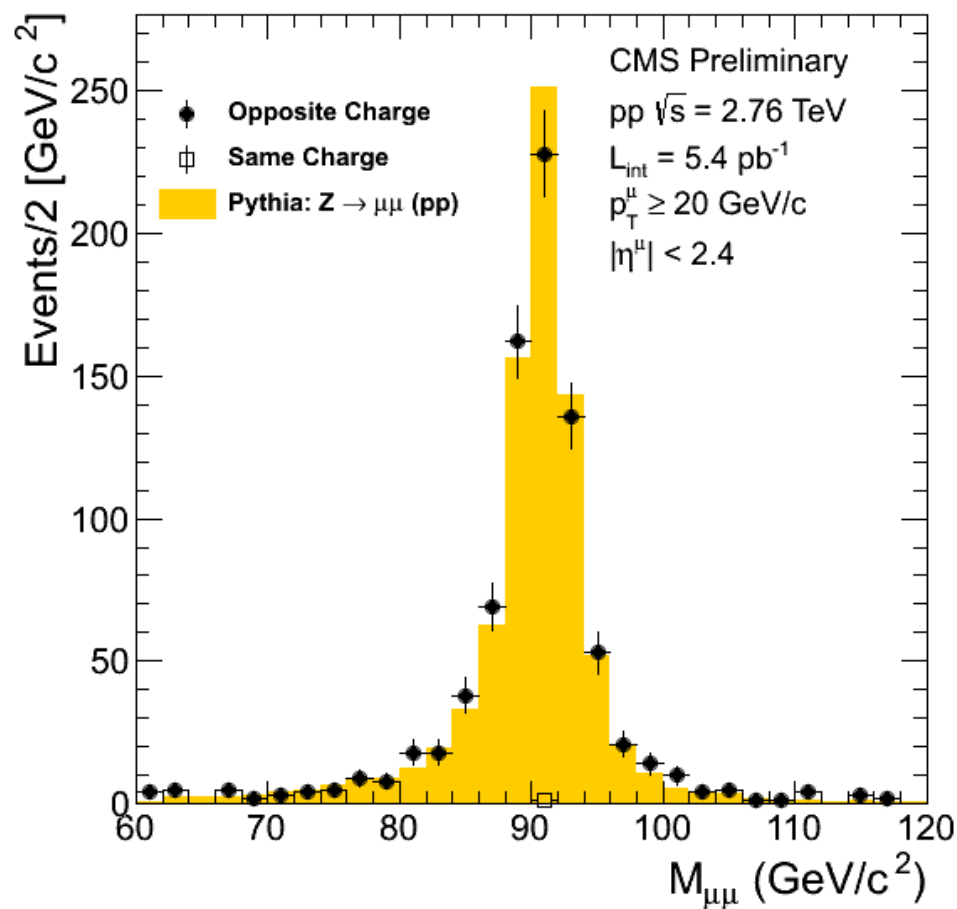
CMS-PAS-HIN-13-004

- Electron selection:
  - $p_T^e > 20 \text{ GeV}/c$
  - $|\eta^e| < 1.44$  only ECAL Barrel
  - Shower shape used to reject photons
  - HCAL used to reject QCD jet background
- Background well described by same sign pairs
- 328 Z candidates



# Z production in pp collisions

CMS-PAS-HIN-13-004

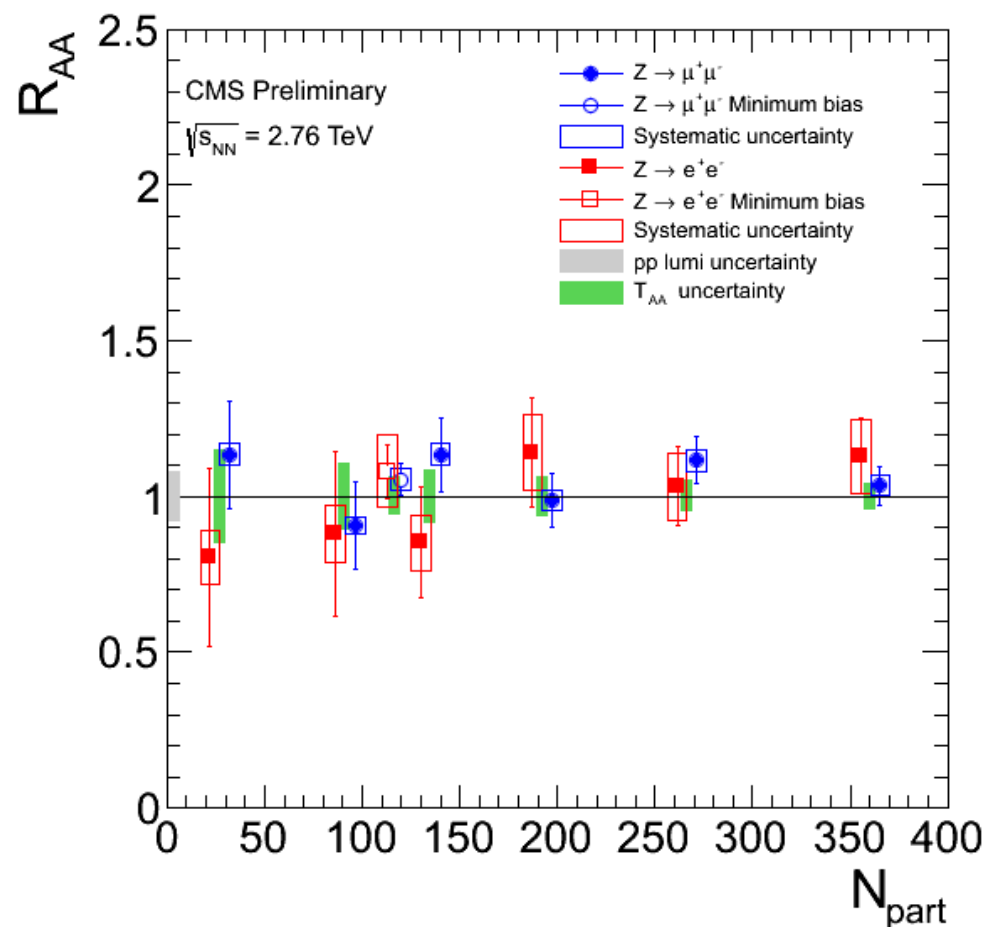


- Reference data from 2013 February  $L_{\text{int}} = 5.35 \text{ pb}^{-1}$
- Direct measurement of nuclear modification factor ( $R_{\text{AA}}$ ) possible

# Nuclear modification factor

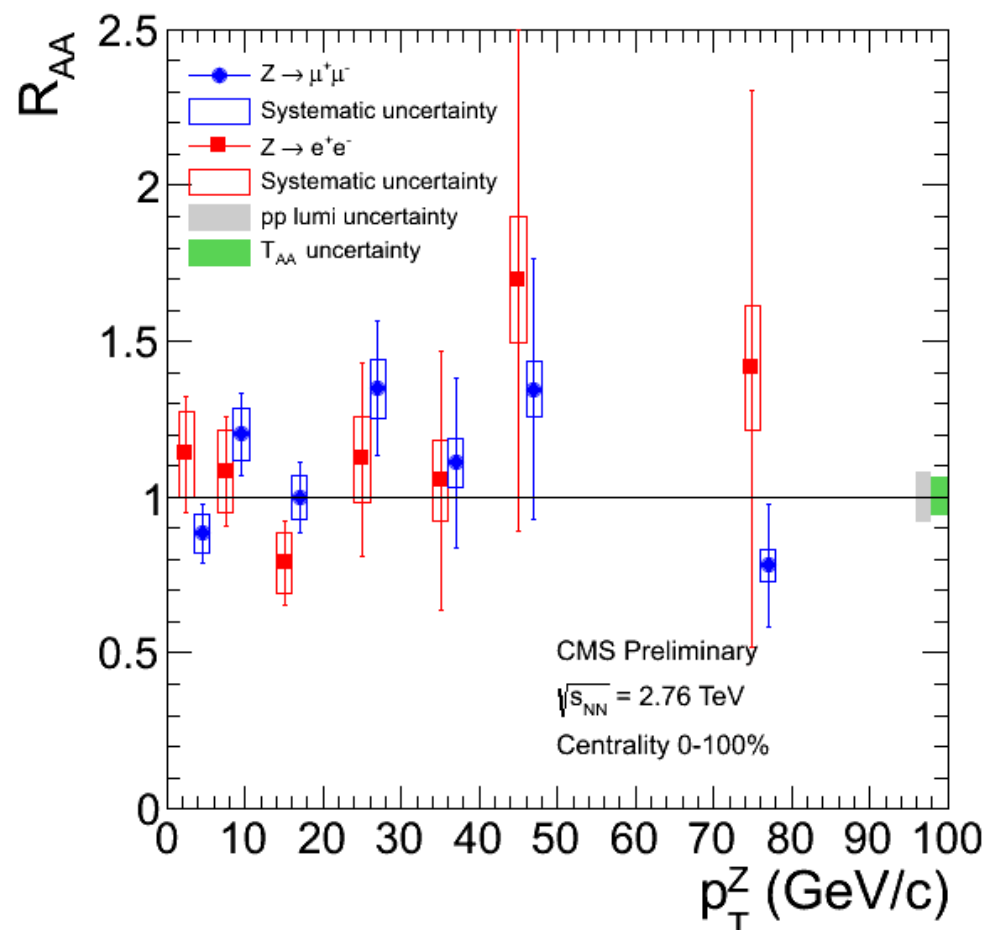
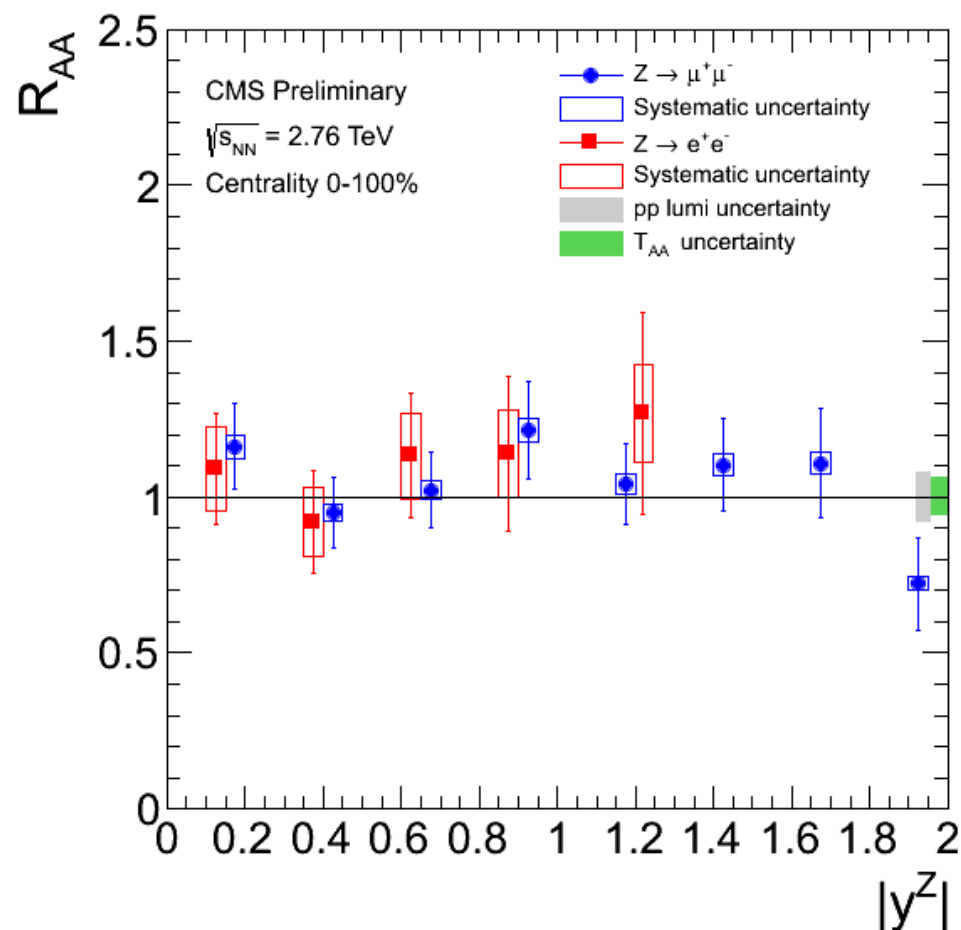
CMS-PAS-HIN-13-004

- $dN_{AA} / T_{AA} = d\sigma^{pp} \times R_{AA}$
- $T_{AA}$ : nuclear overlap function from Glauber-model calculations
- $R_{AA}(\text{muon}) = 1.06 \pm 0.05 \pm 0.11$
- $R_{AA}(\text{electron}) = 1.08 \pm 0.09 \pm 0.14$
- The two leptonic decay channels are in agreement
- Z production (as expected) scales with  $T_{AA}$



# Nuclear modification factor

CMS-PAS-HIN-13-004



- Split in rapidity and  $p_T$
- Possible nuclear effects are within the uncertainties of the measurements



# Summary & Outlook

- Z boson production is **unmodified** by the hot **QCD** medium
- Yield **scales** with the number of binary nucleon-nucleon collisions
- Measurement of **nuclear modification factor** of Z bosons in **muon** and **electron** channel doesn't show large deviations from 1
- Possible nuclear effects within the uncertainties

## Future

- **pPb collision data** taken in 2013
- Analysis of electroweak boson production ongoing
- Important input for **nuclear PDFs**
- **Z+jet** measurements in future PbPb and pPb data will give further insights to jet quenching and nuclear effects

# CMS Heavy-ion results

<https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsHIN>

