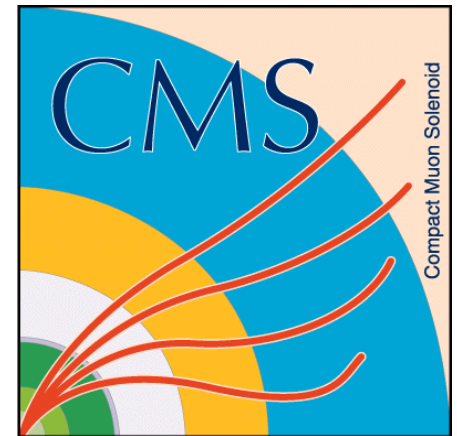


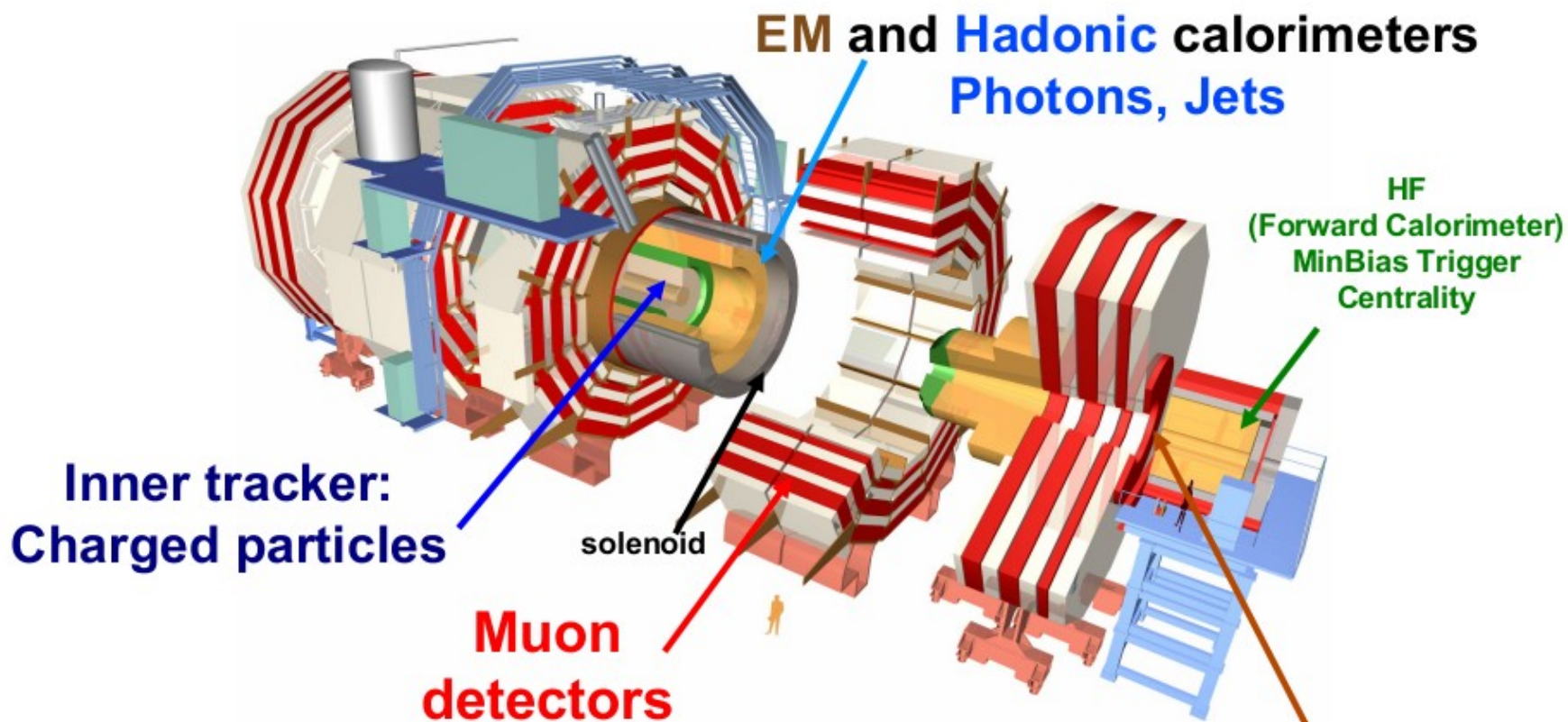
Study of Z boson production in PbPb collisions in CMS

Anna Julia Zsigmond
Wigner RCP, young researcher

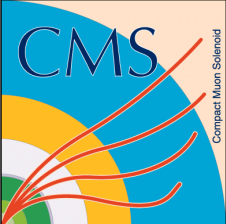
RECFA visit to Hungary, Budapest
4. October 2013



CMS detector

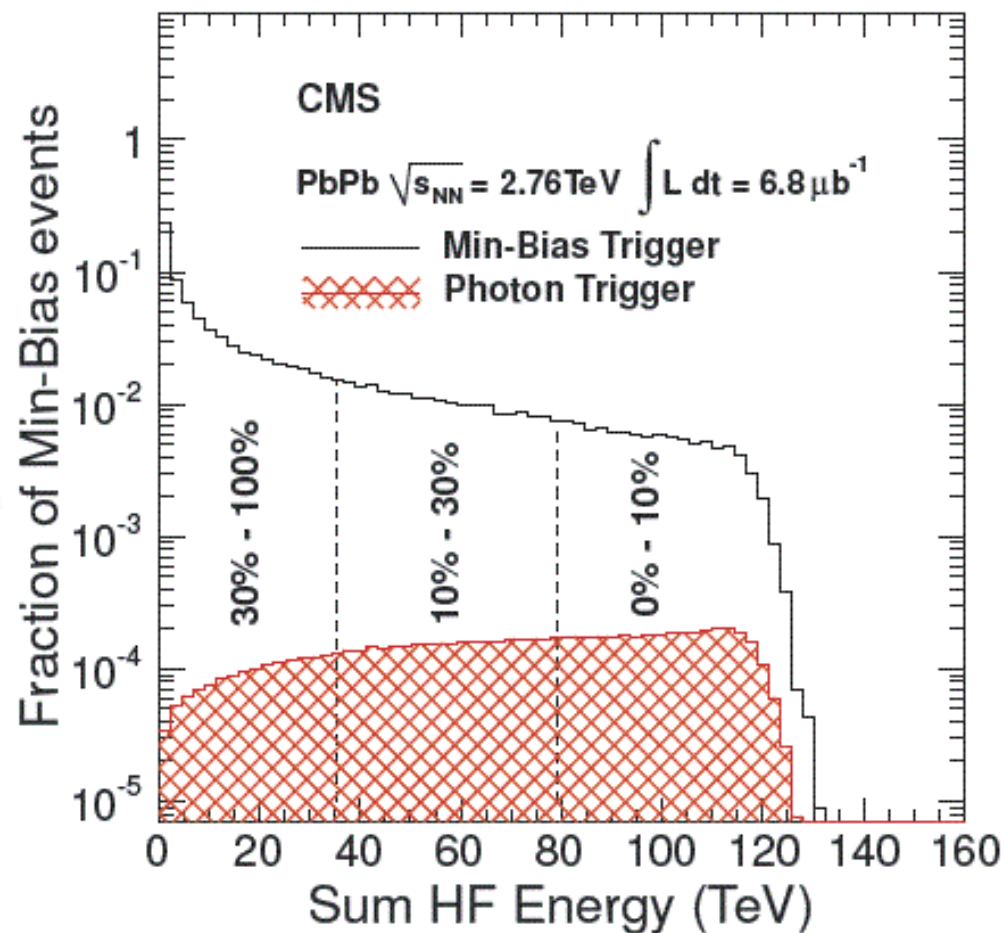
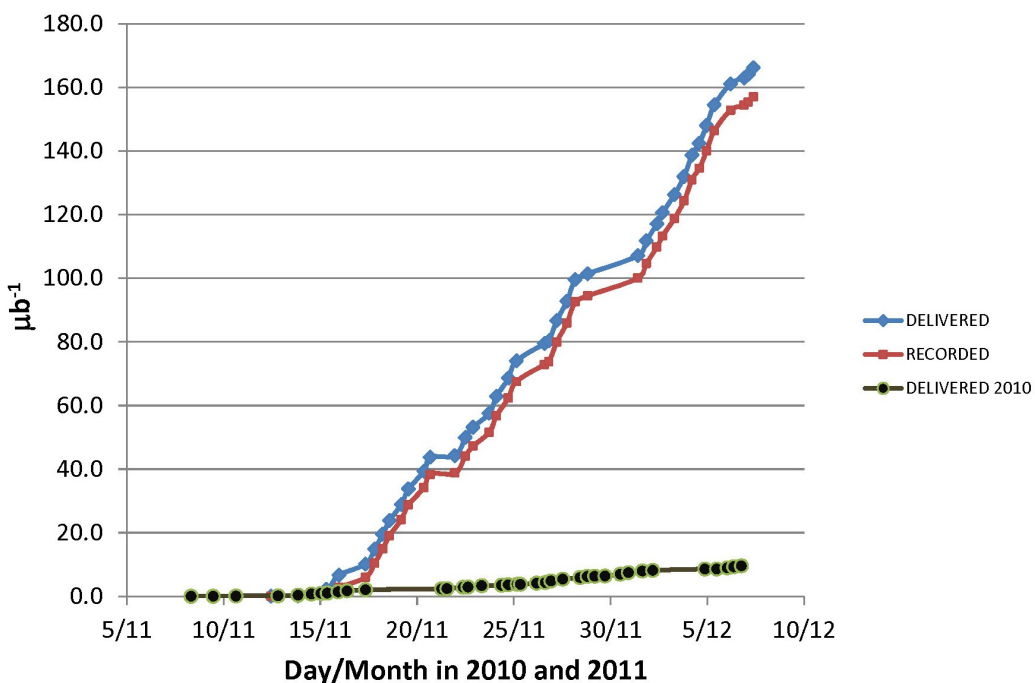


| | |
|---------|----------------|
| Muon | $ \eta < 2.4$ |
| HCAL | $ \eta < 5.2$ |
| ECAL | $ \eta < 3.0$ |
| Tracker | $ \eta < 2.5$ |



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

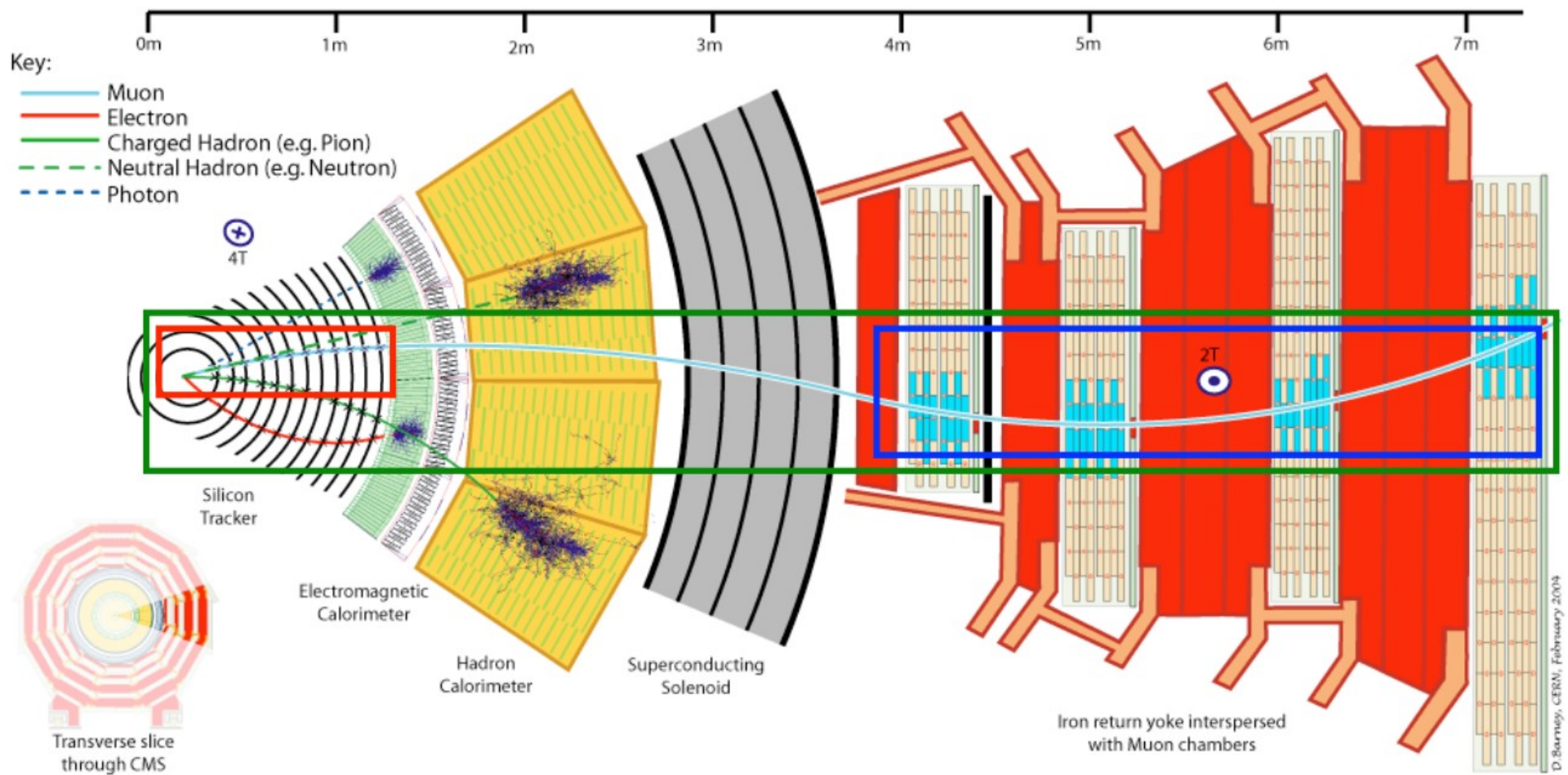


Introduction to electroweak bosons

- LHC energies allow for first measurements of Z and W bosons in heavy ion collisions
- Electroweak bosons are essentially not modified 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 (nuclear parton distribution functions)
- CMS results for 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

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

Muon reconstruction



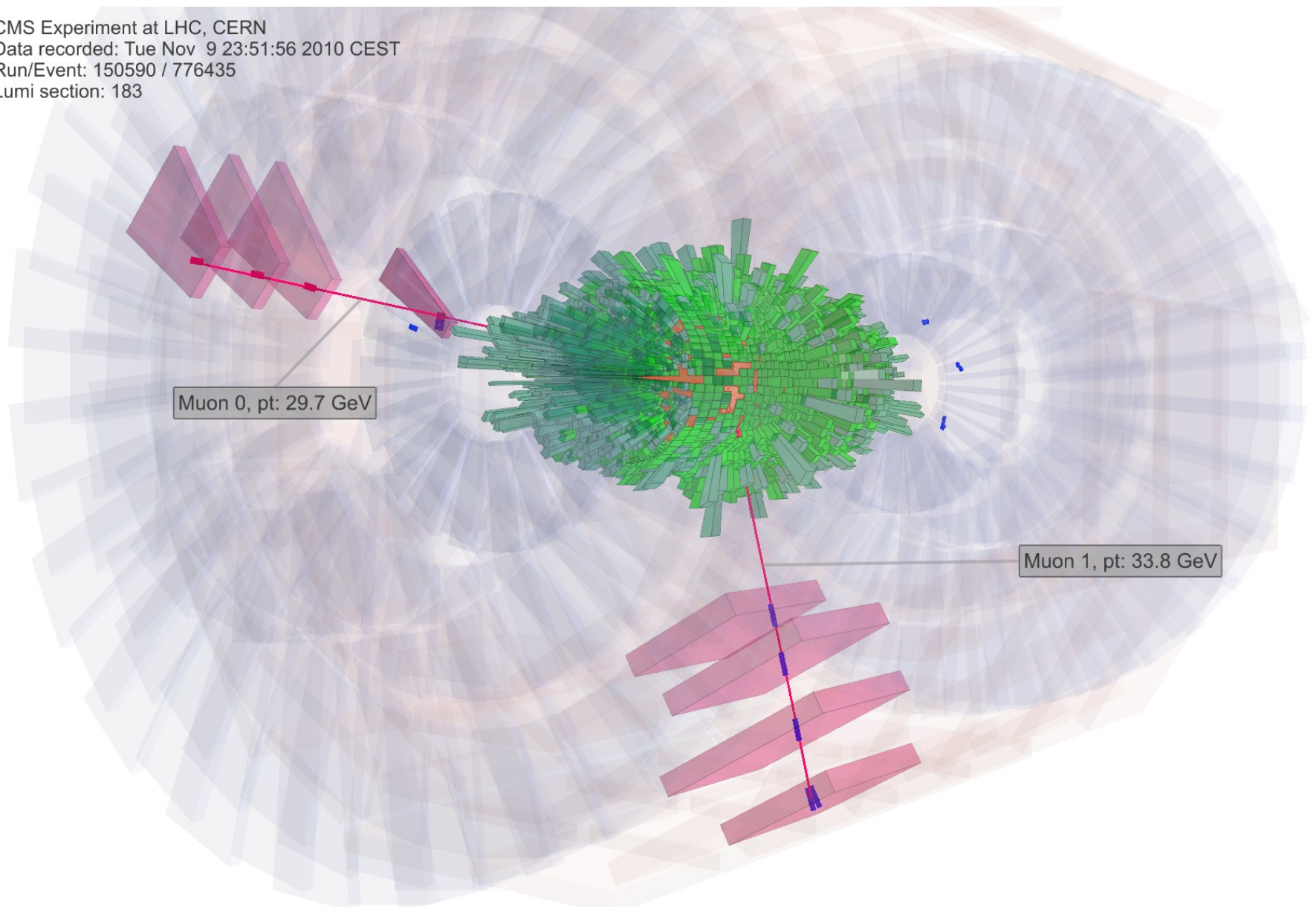
- **Global muons** reconstructed with information from **inner tracker** and **muon stations**
- Good resolution for high p_T muons



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

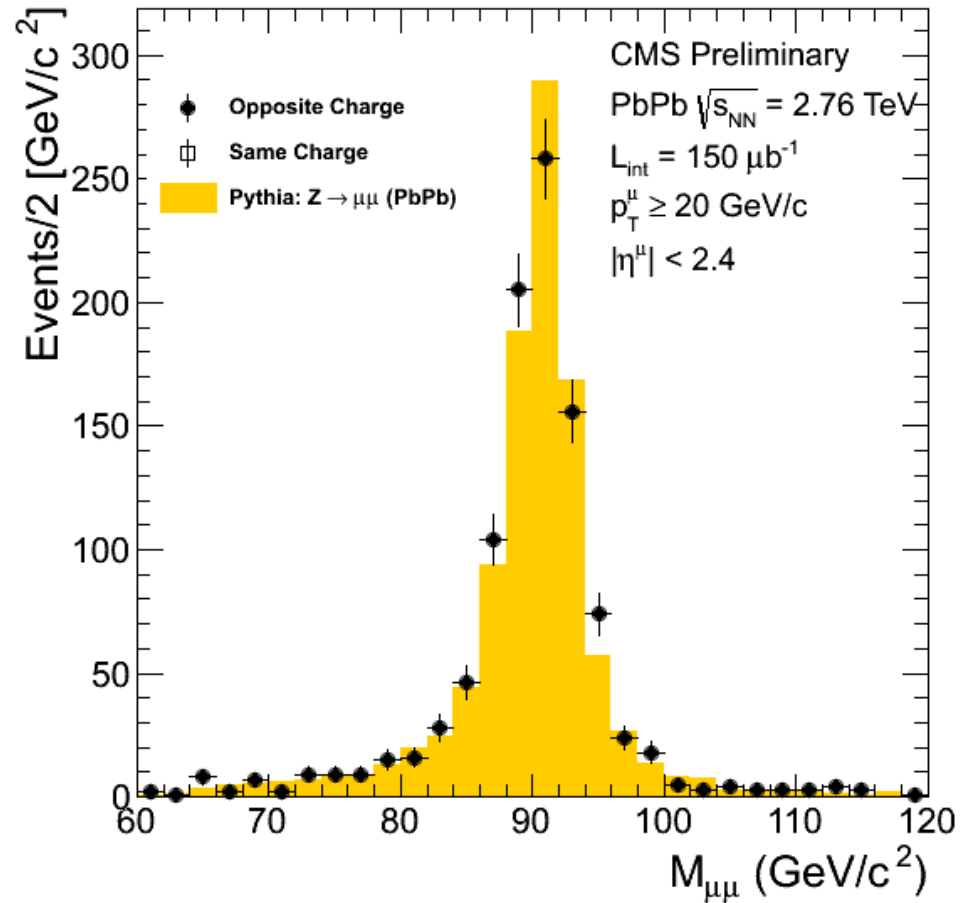
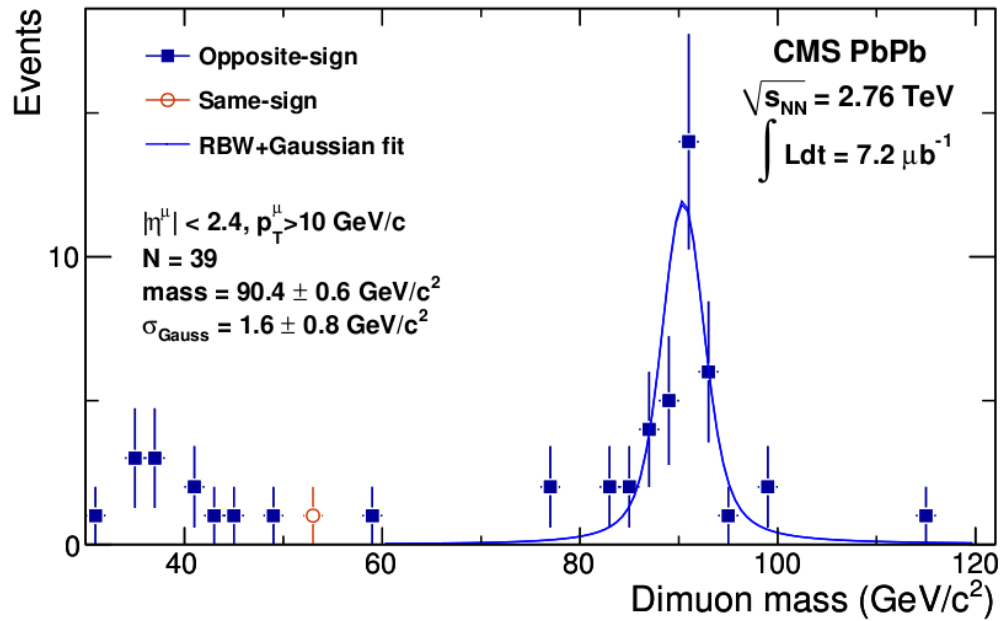


CMS Experiment at LHC, CERN
Data recorded: Tue Nov 9 23:51:56 2010 CEST
Run/Event: 150590 / 776435
Lumi section: 183



Z production in muon channel

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

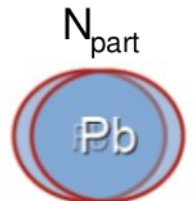
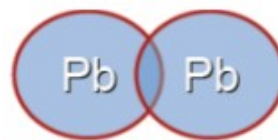
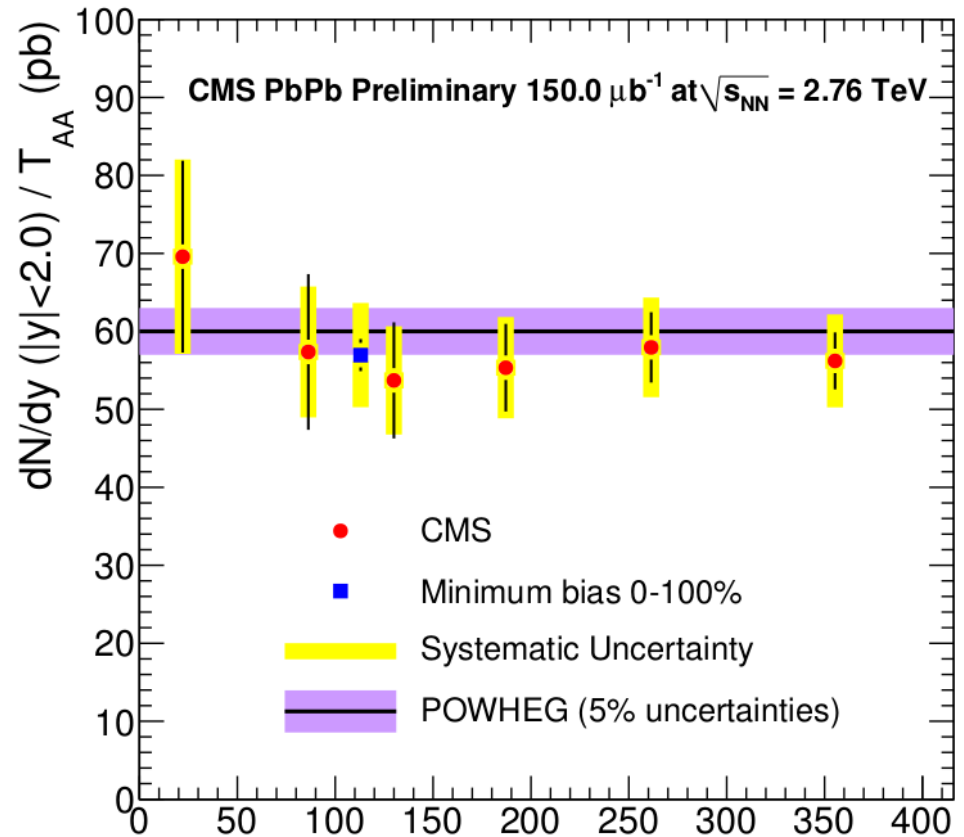


- 2010: 39 Z candidates
 - $p_T^\mu > 10 \text{ GeV}/c$
- 2011: 1022 Z candidates
 - $p_T^\mu > 20 \text{ GeV}/c$
 - $|\eta^\mu| < 2.4$

Z production in muon channel

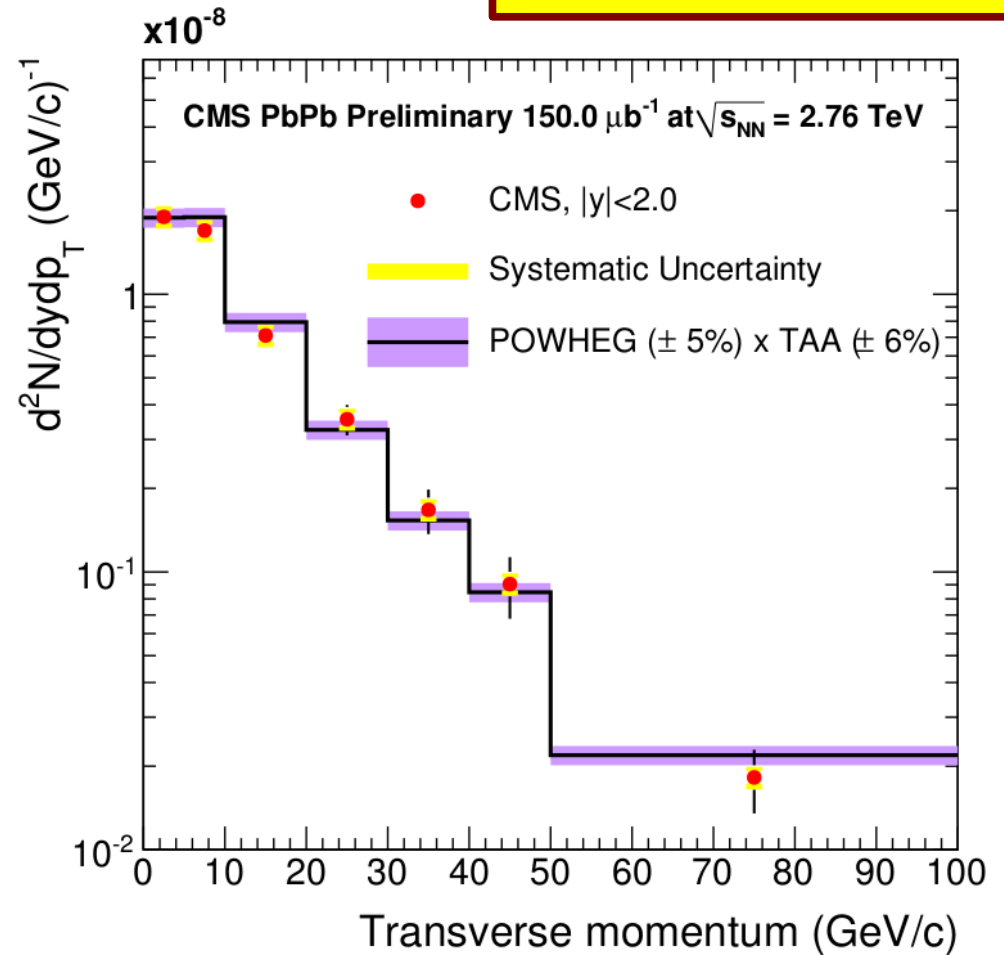
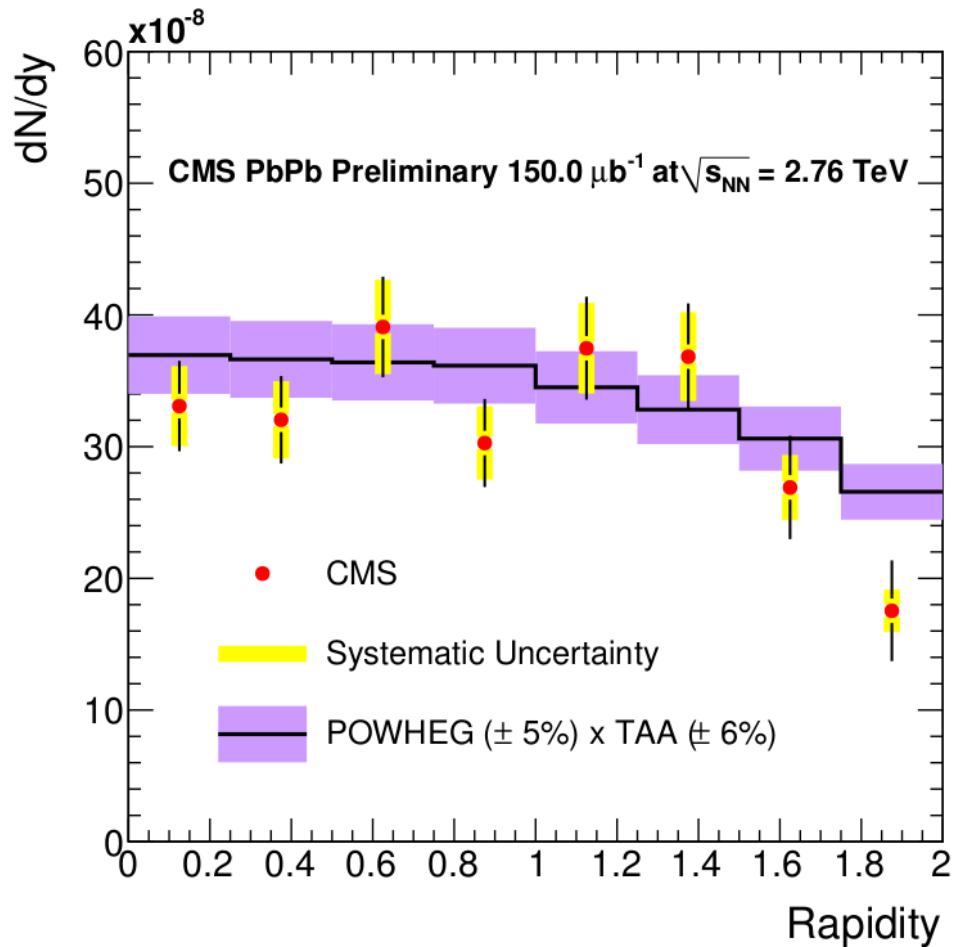
CMS-PAS-HIN-12-008

- Invariant yield results after
 - counting the selected muon pairs in 60-120 GeV mass region
 - correcting for acceptance and efficiency
- Z production scales with number of binary nucleon-nucleon collisions
- Comparison with **POWHEG** NLO generator
 - Good description of data at LHC and Tevatron energies



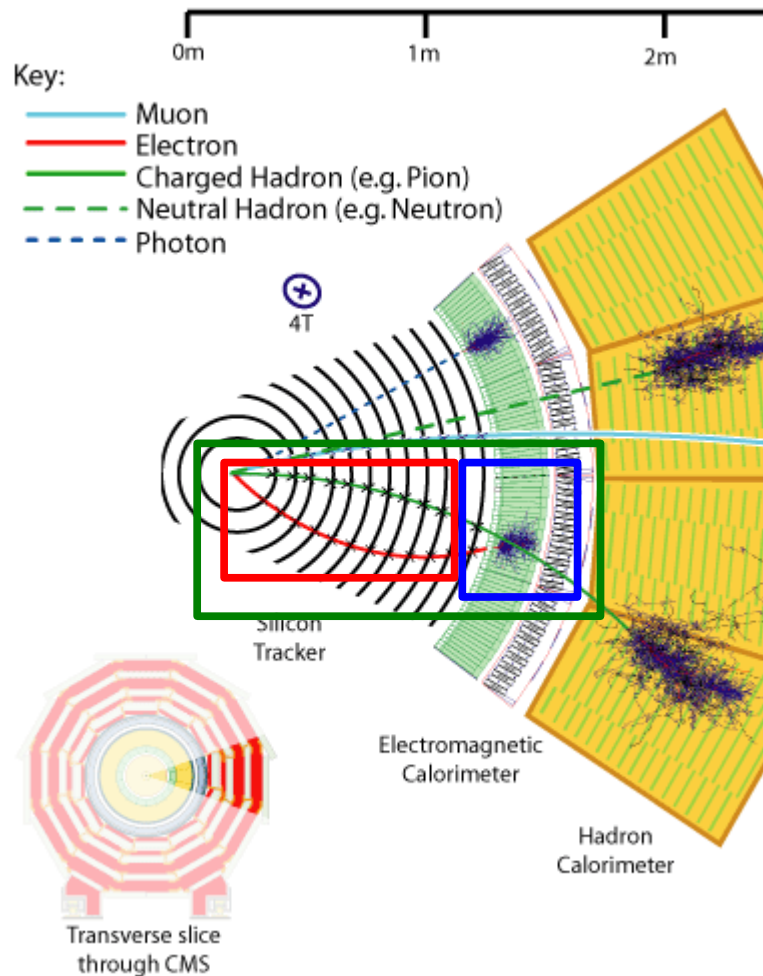
Z production in muon channel

CMS-PAS-HIN-12-008



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

Electron reconstruction

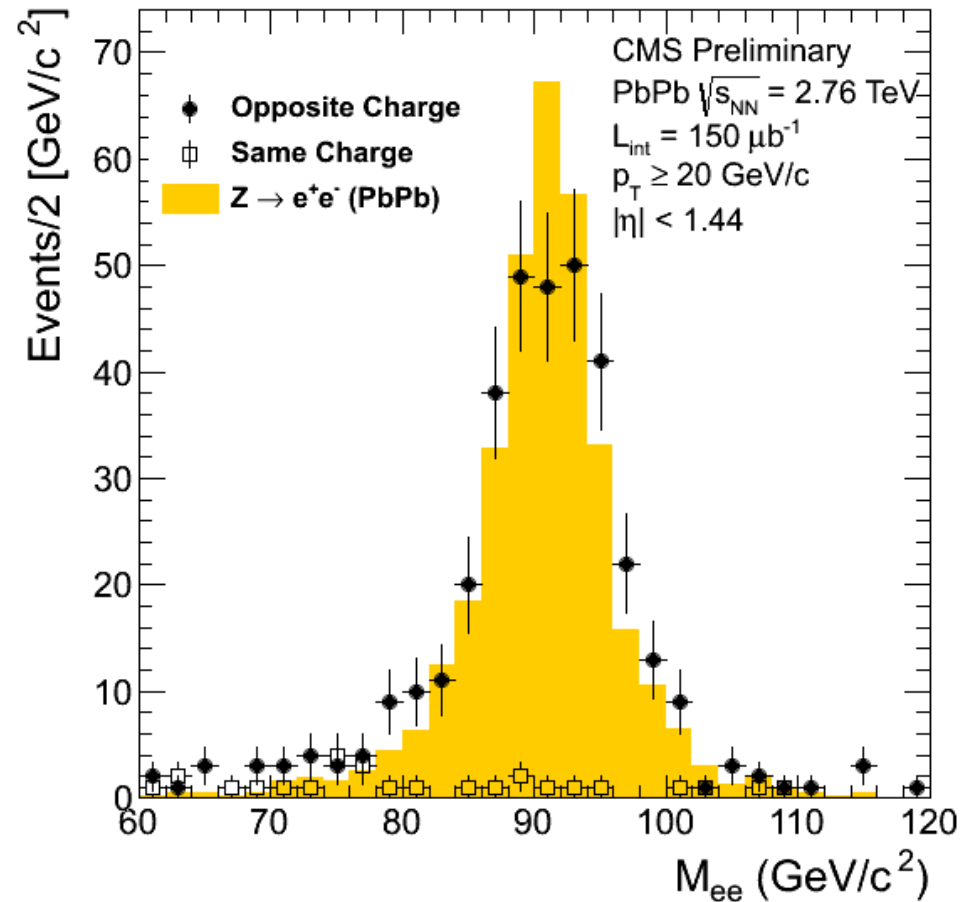


- Seeded by **supercluster** in ECAL
- **Inner track** reconstructed from the outside with radiation taken into account
- **Electron candidate** a supercluster matched to an inner track

Z production in electron channel

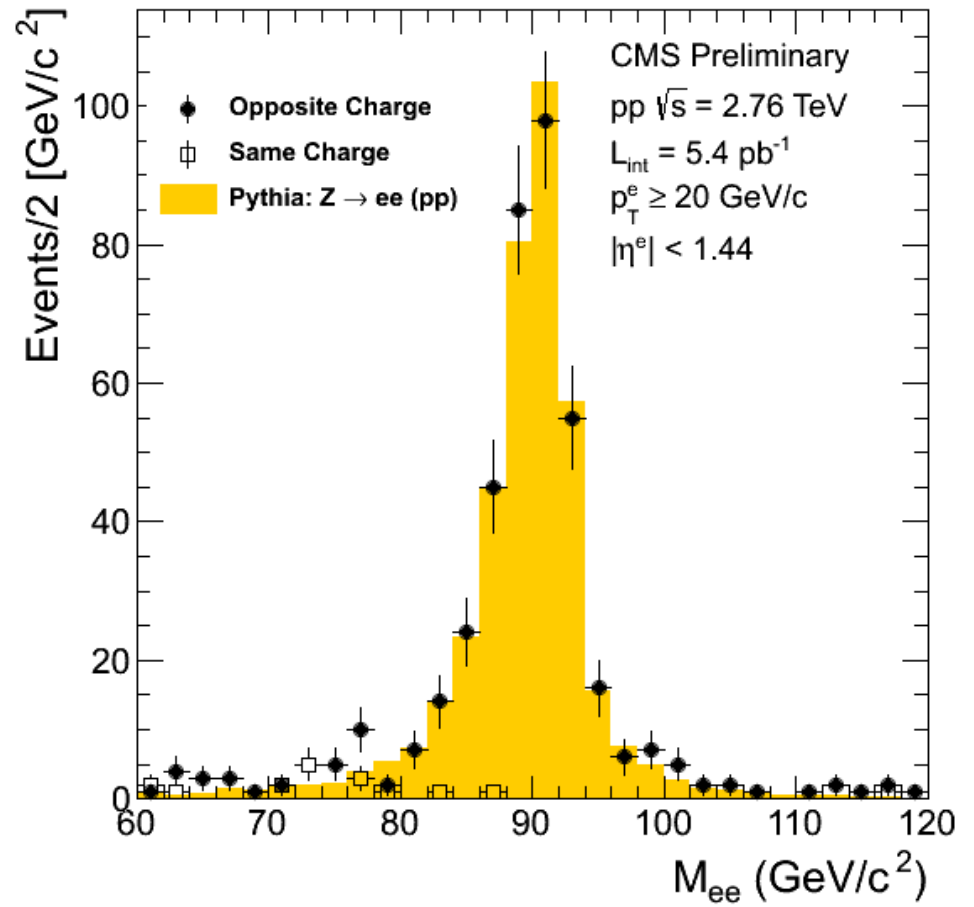
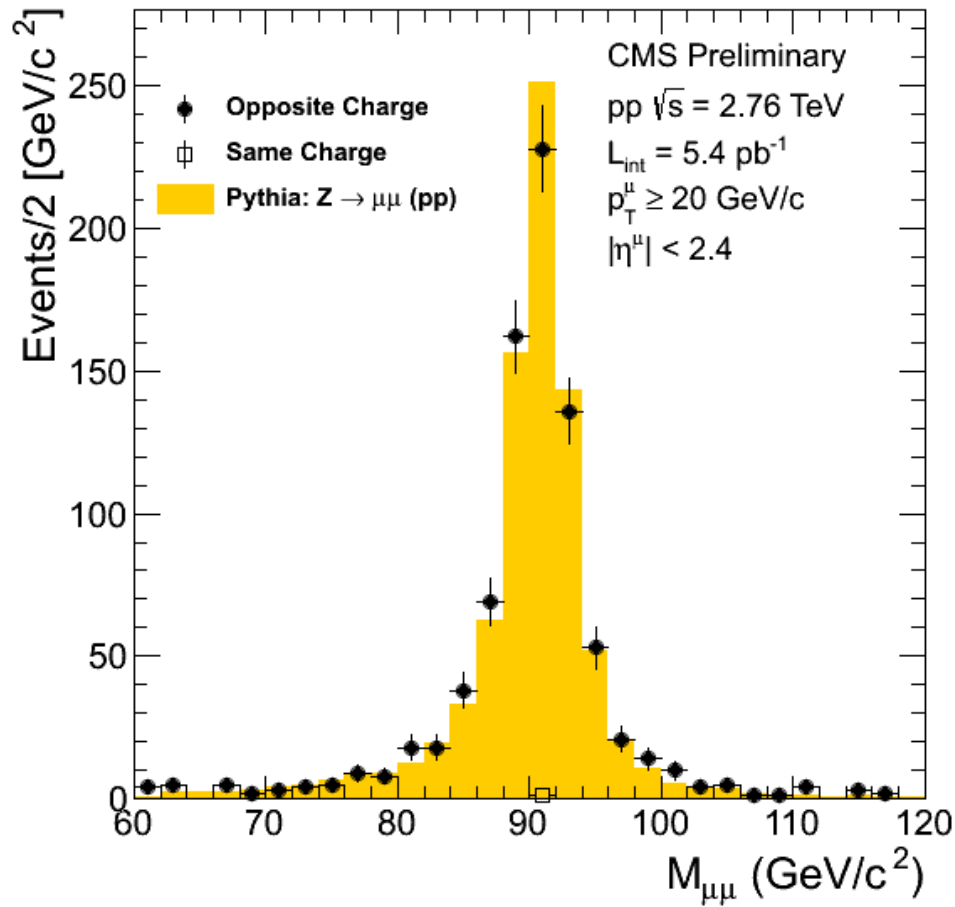
CMS-PAS-HIN-13-004

- 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



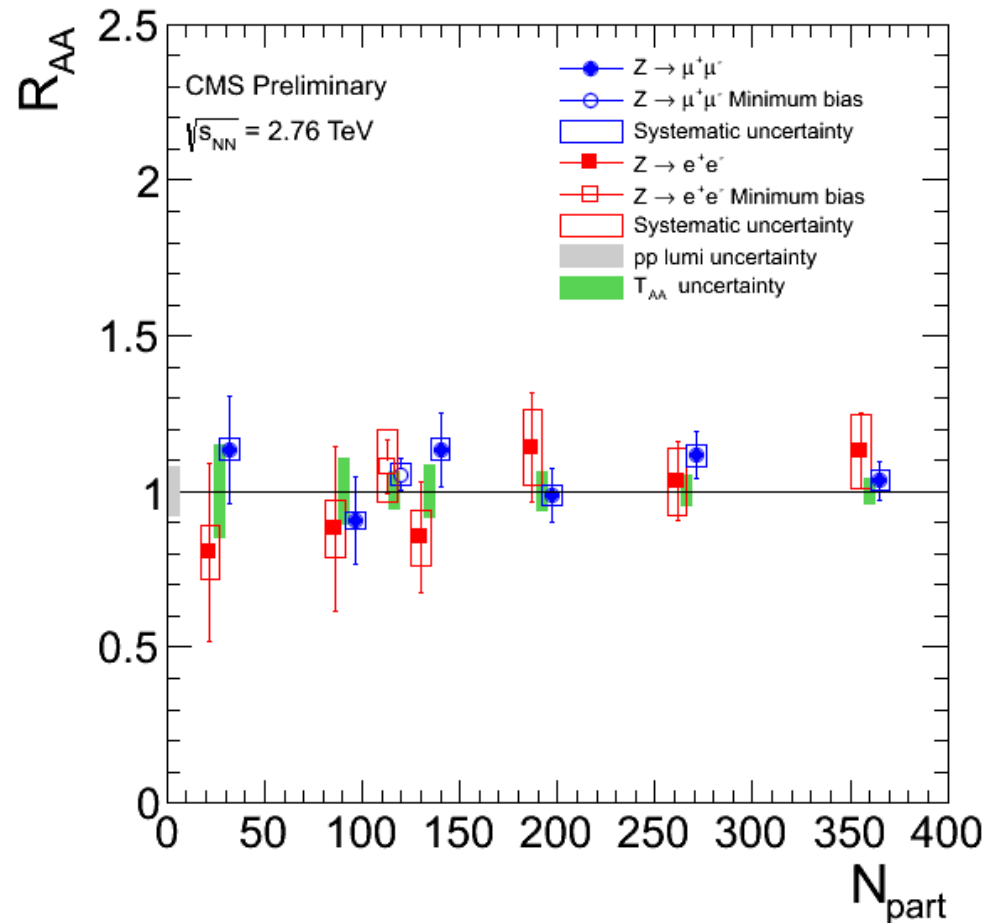
- Reference data from 2013 February $L_{int} = 5.35$ pb $^{-1}$
- Direct measurement of nuclear modification factor (R_{AA}) possible



Nuclear modification factor

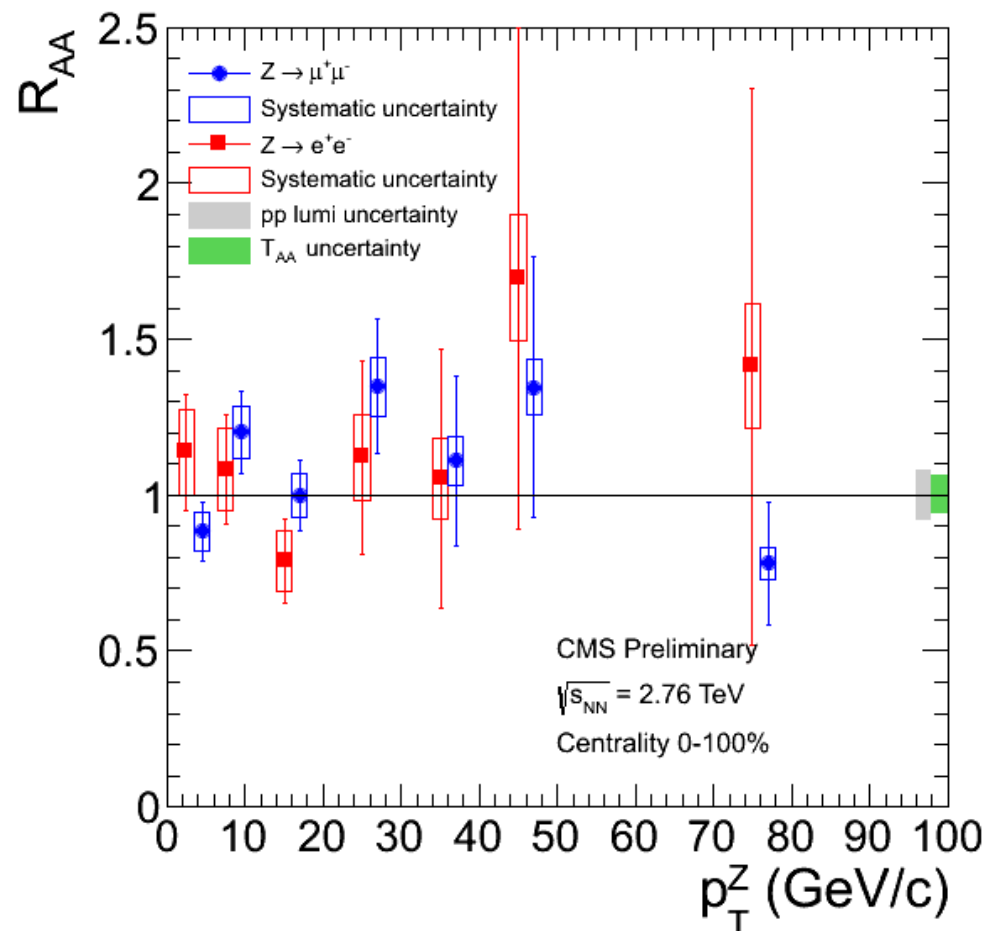
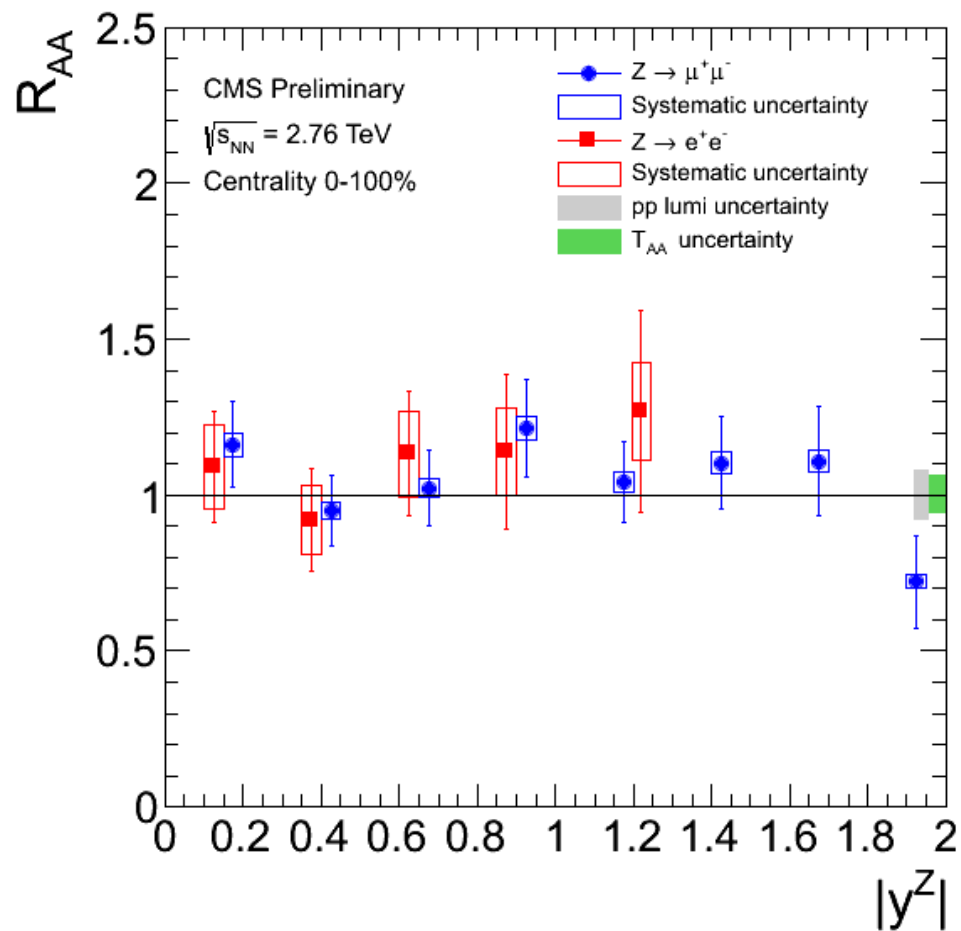
CMS-PAS-HIN-13-004

- $dN_{AA} / T_{AA} = d\sigma^{pp} \times R_{AA}$
- 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

