Search for new heavy neutral bosons decaying into a dilepton pair with the CMS detector at $\sqrt{s} = 8$ TeV

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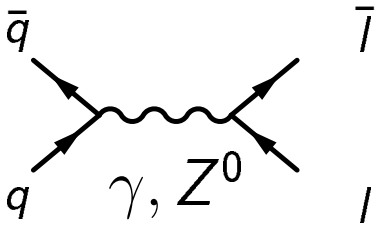
March 8, 2013

Motivation

- Search for narrow heavy ($\geq$ 1 TeV) resonances decaying into a dilepton pair.
- Generic search also motivated by several theories beyond the Standard Model : Grand Unified Theories (Z'), Large Extra Dimensions (RS gravitons),...
- Main background : Drell-Yan process. Irreducible, interfers with the signal.
- Signature : new peak in the dilepton mass spectrum.



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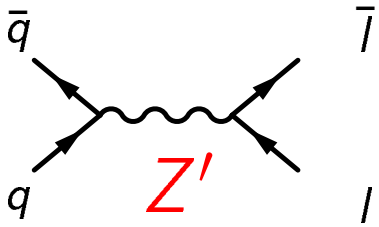
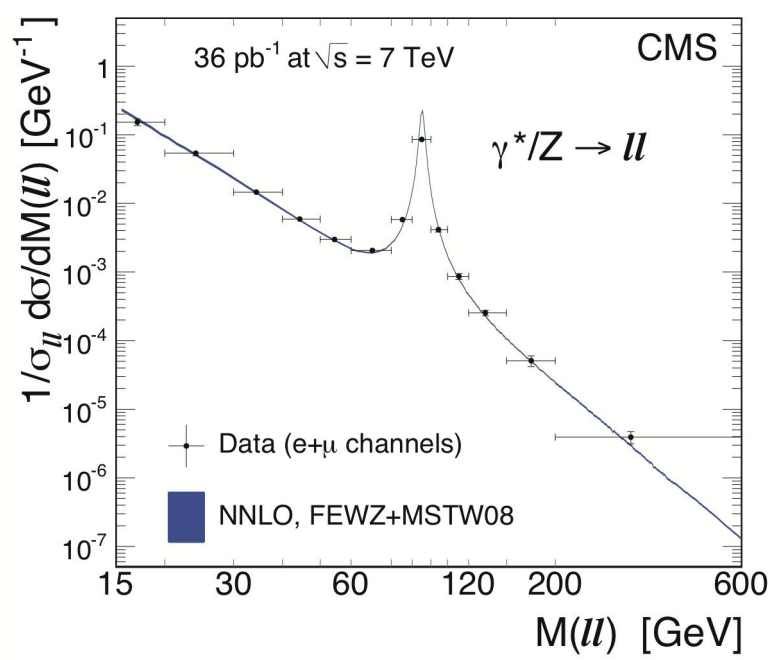
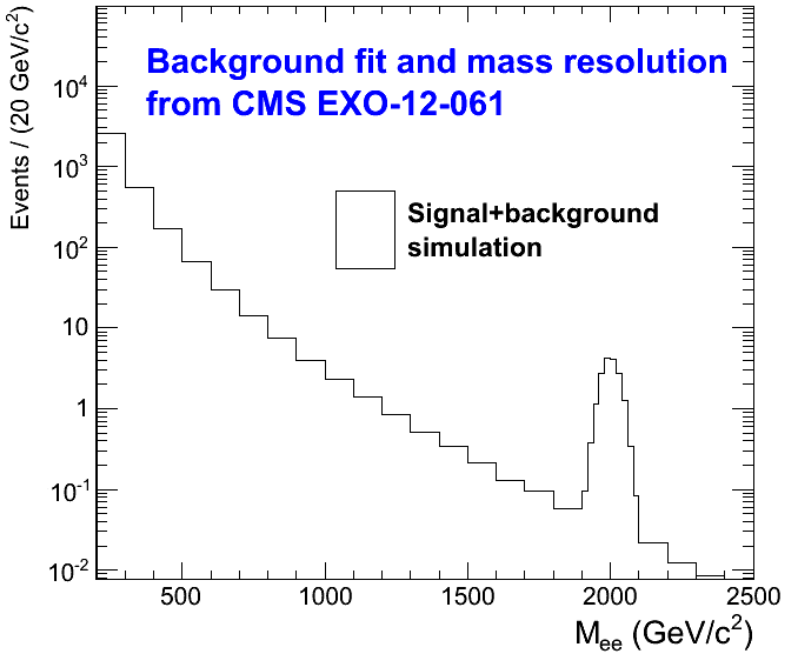


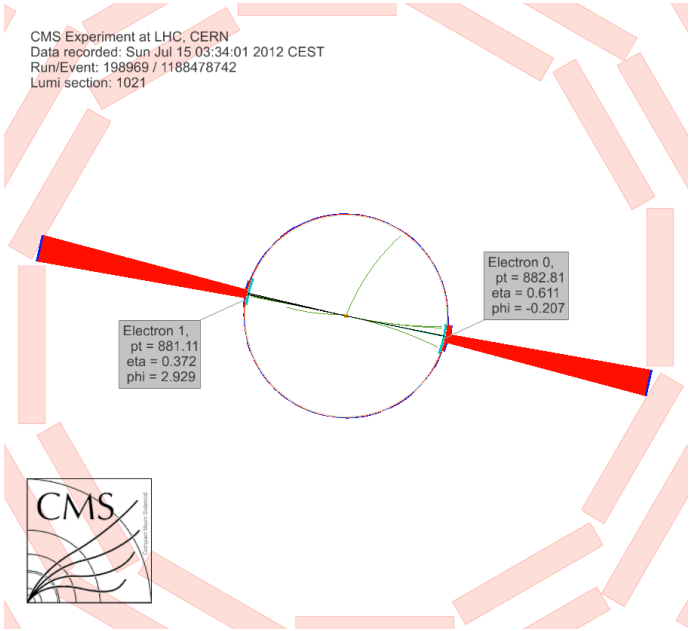


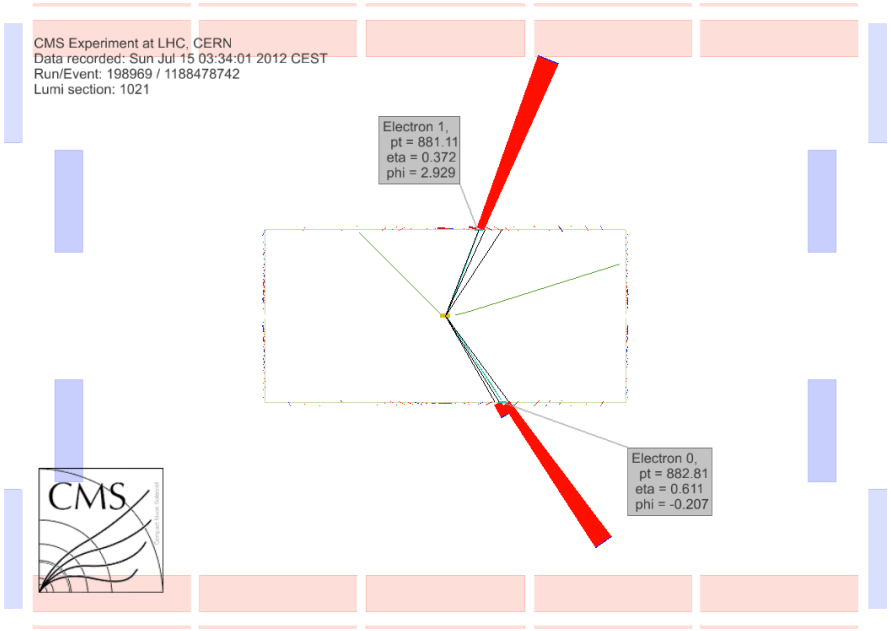


Event selection

This talk focuses on the electron channel.

- Selection : 2 isolated high energy electrons.
- Key detectors : tracker, electromagnetic calorimeter.
- Challenge : control electron reconstruction, identification at very high E_T.





M_{ee}=1776 GeV/c^2

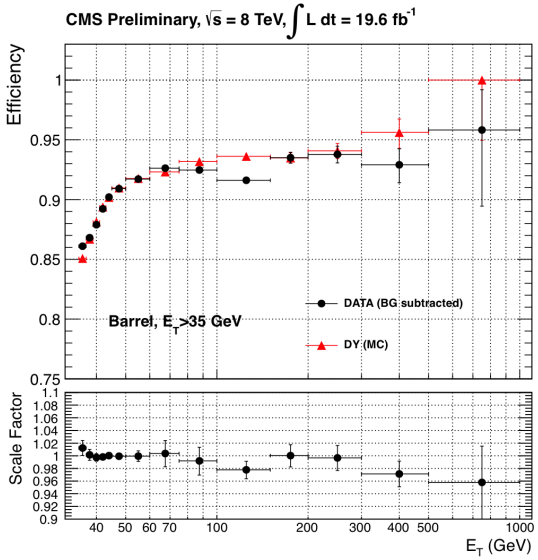
Analysis presented here uses the full 2012 dataset ($\sqrt{s}$ = **8 TeV**) corresponding to $\sim$ **20 fb**$^{-1}$.

Electron reconstruction

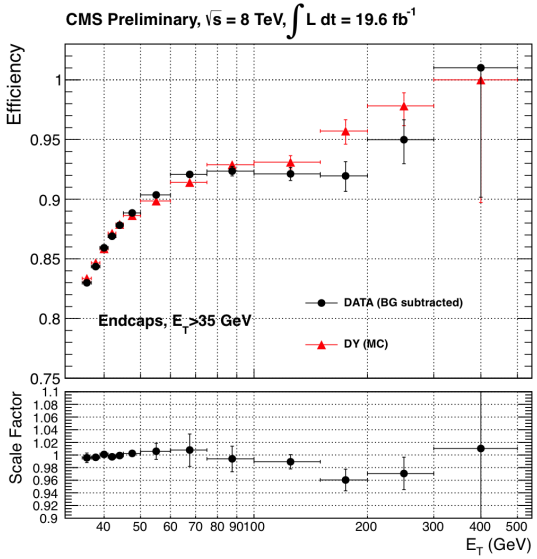
- Dedicated identification, optimized for high energy electrons.
- Needs to be very efficient on a large E_T range (35 GeV $\rightarrow$ 1 TeV).
- Efficiency in search region from simulations.
- Checked with the data using the Tag and Probe (T&P) method.

T&P method :

1. Build a pure dielectron sample by applying tight cuts on one electron (tag) and working at the Z peak.
2. Measure efficiency on the other loosely selected (probe).



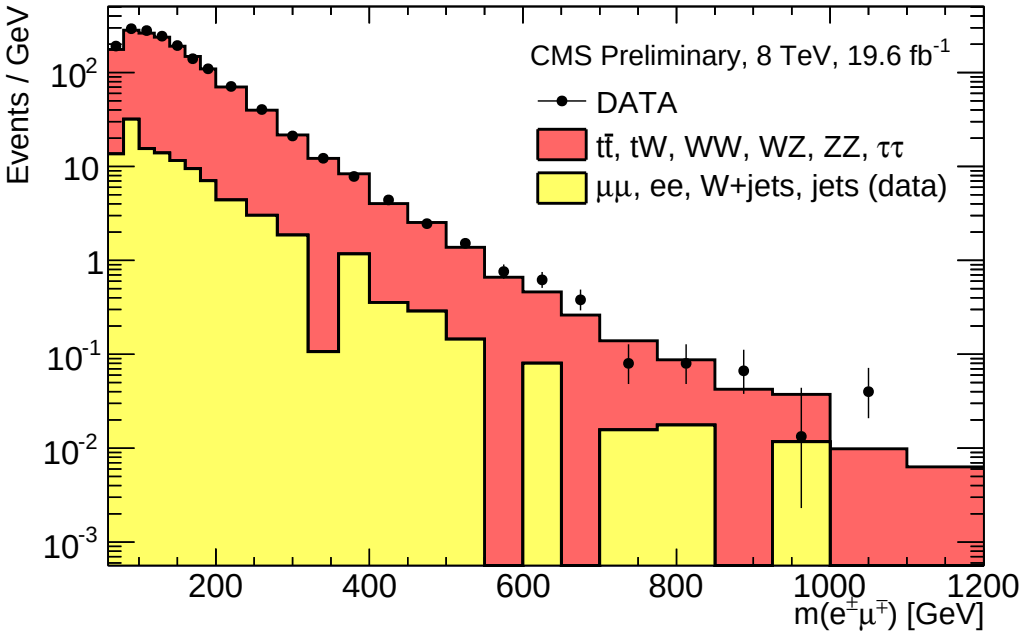
Identification efficiency vs E_T (central electrons)



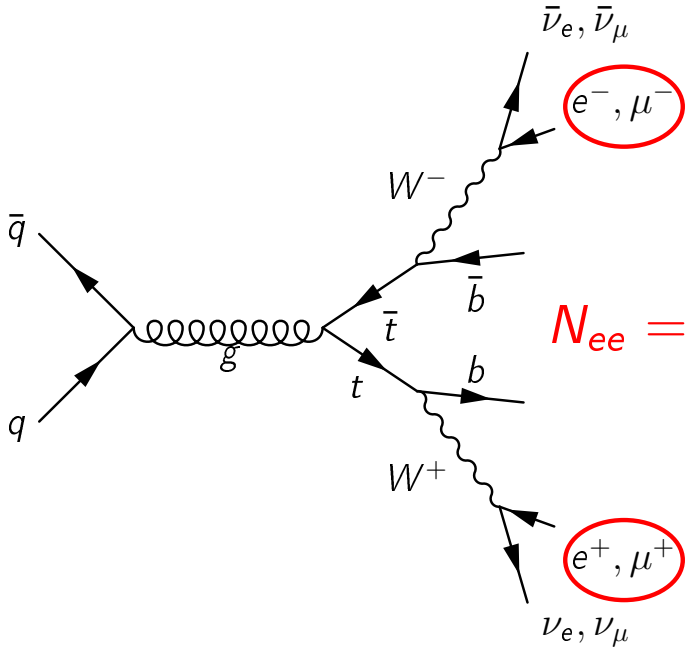
Identification efficiency vs E_T (forward electrons)

Reducible backgrounds

- Leptonic decay of $t\bar{t}$ or diboson pairs ($\sim 10\%$). Controlled using the $e\mu$ mass spectrum:



$M_{e\mu}$(GeV)

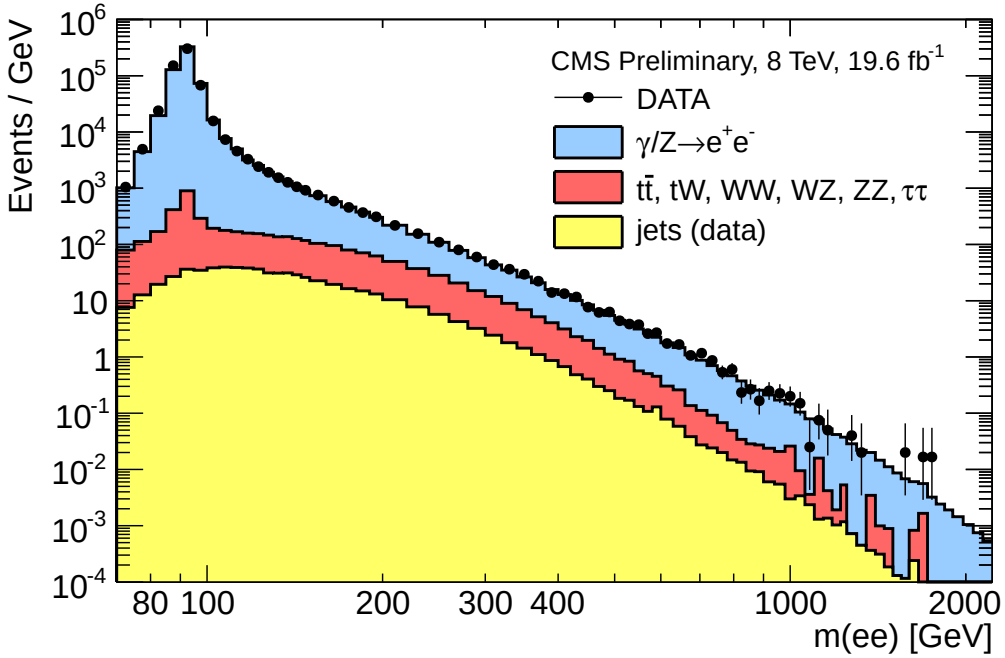


$$N_{ee} = \frac{N_{e\mu}}{2}$$

- Fake electrons from multijets events ($\sim 2/3\%$). Estimated from the data by measuring the fake rate and applying twice to jets-jets events.

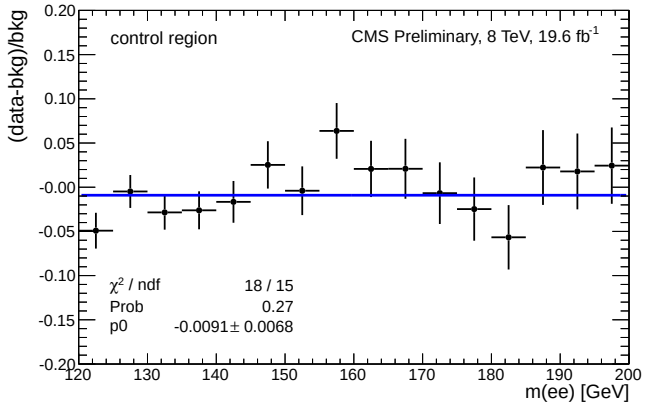
Mass spectrum

- Selection : two high energy isolated electrons ($E_T > 35$ GeV), at least one in the central region of the detector.
- Good agreement in the whole mass range.

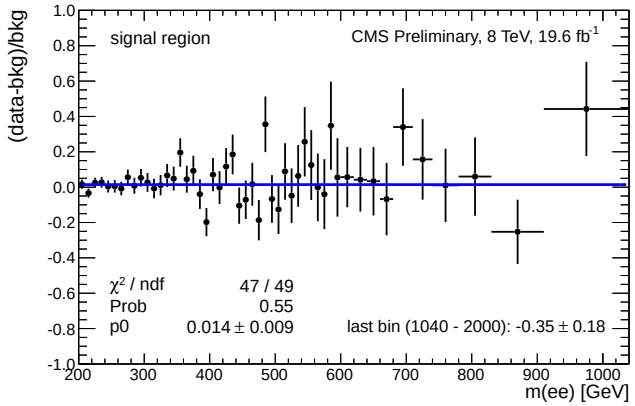


Dielectron mass spectrum

Control region (120-200 GeV)

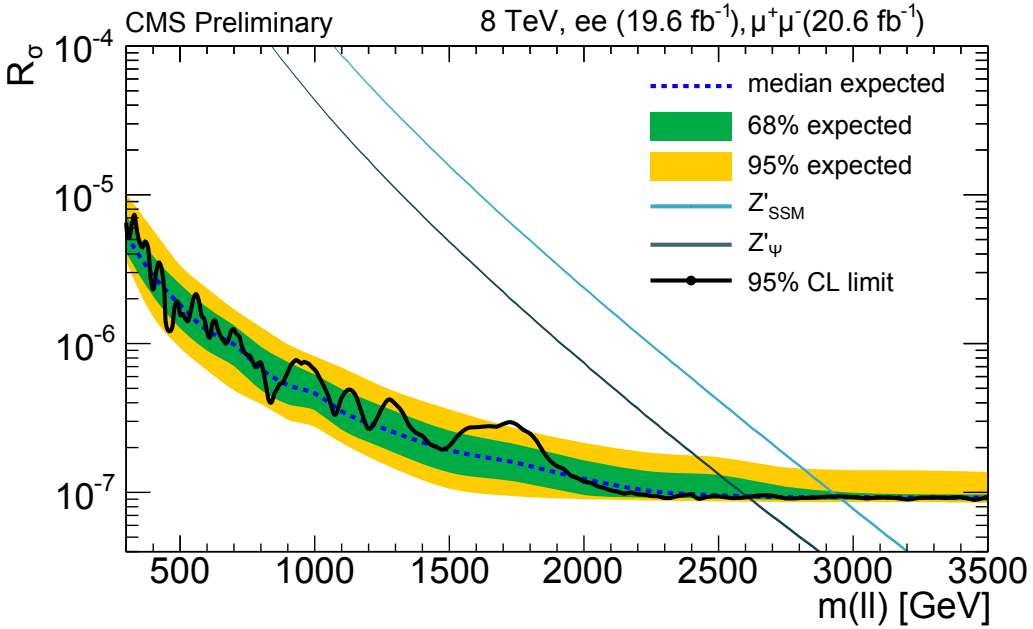


Signal region (>200 GeV)

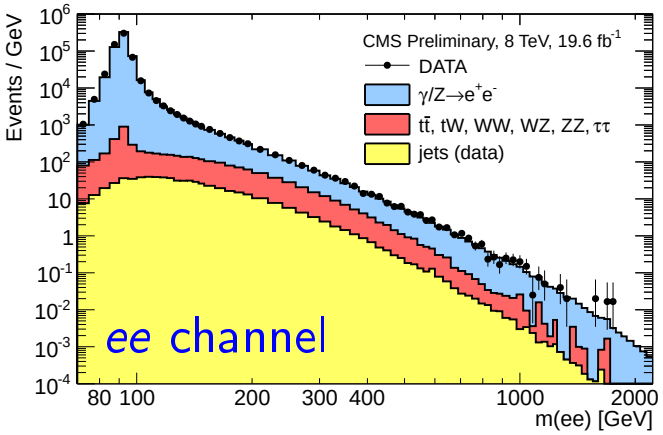


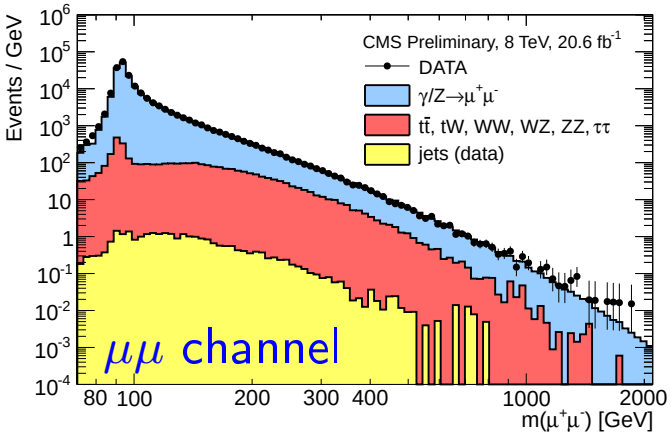
Results : limits

- Combination of ee and $\mu\mu$ channels, assuming lepton universality.
- Limits set on $R_\sigma = \frac{\sigma(pp \to Z' + X \to ll + X)}{\sigma(pp \to Z + X \to ll + X)}$ allowing to reduce several systematics uncertainties.
- Main systematics : acceptance $\times$ efficiency (3-6%), pdf (2-20%).



Model	95% C.L. lower mass limit
Z'_{SSM}	2960 GeV
Z'_ψ	2600 GeV





Conclusions

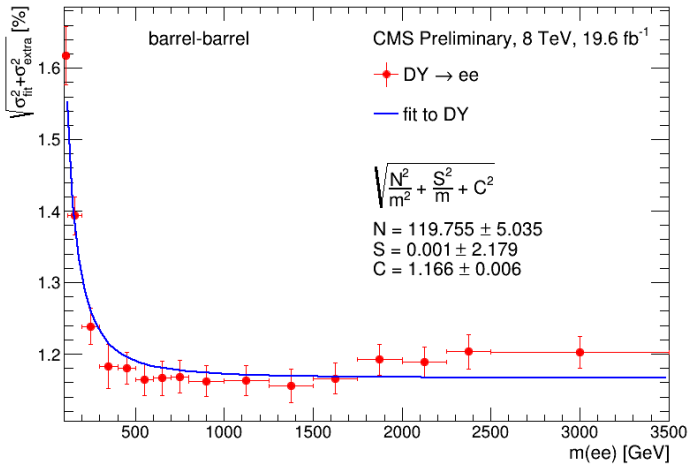
- No Z' found (yet!).
- Stringent limits on its cross section.
- Excluded well above 2 TeV for several models.

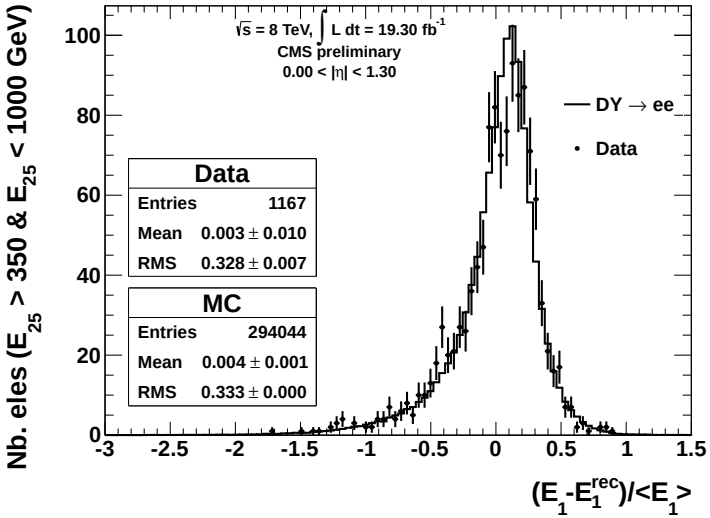
Thank you for your attention !

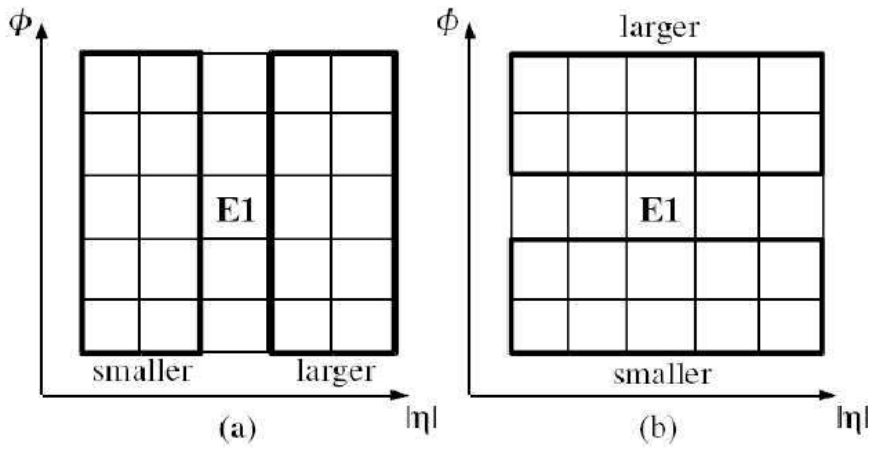
Bibliography :
CMS-EX0-12-061
https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsEXO12061

Back up : Mass resolution and checks of energy measurement at high energy

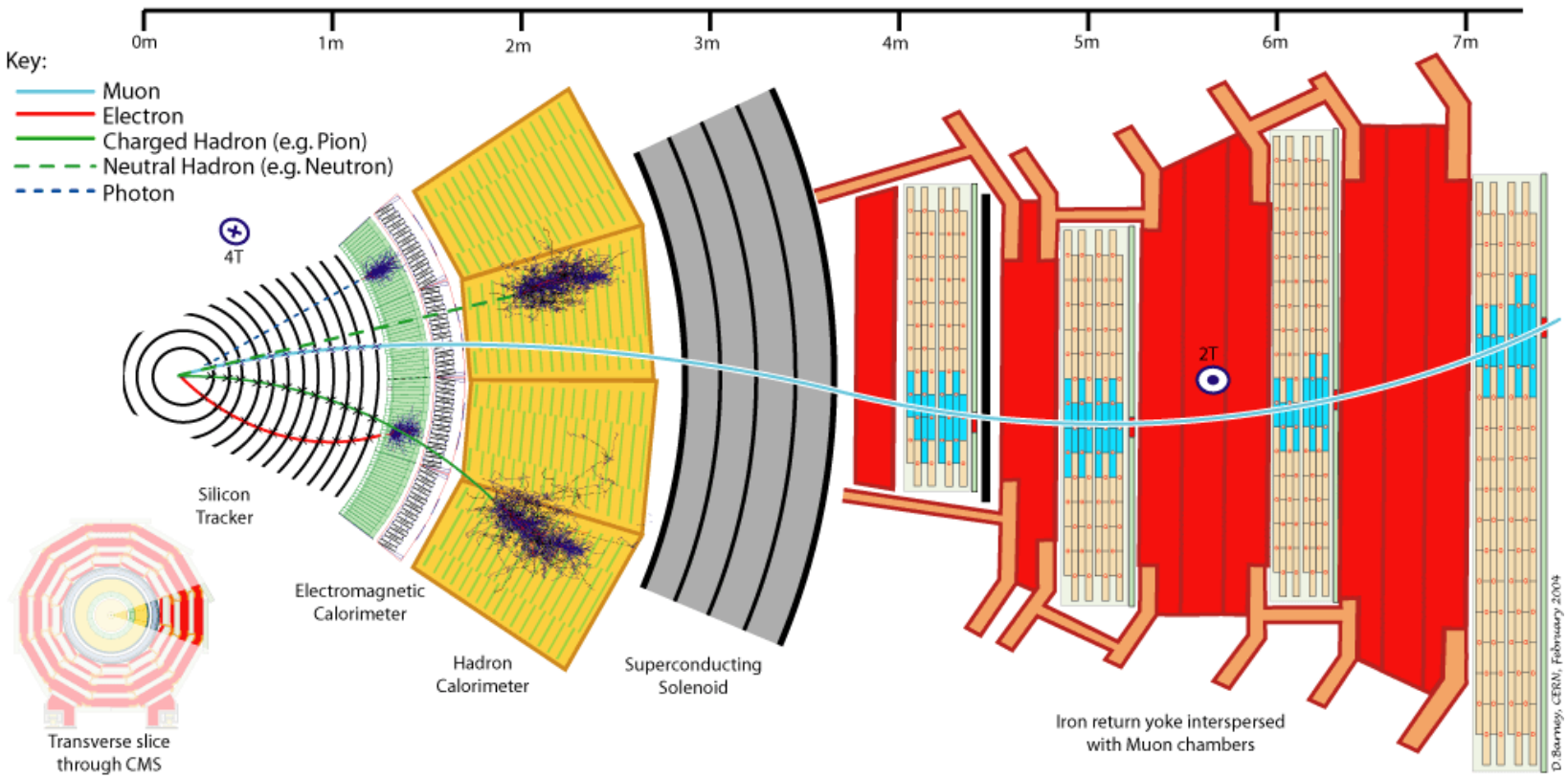
- Mass resolution σ_{fit} from a fit of $M_{reco} - M_{gen}$.
- Add a σ_{extra} term to model data extra width at the Z peak.
- Check calorimeter response by estimating the highest energetic cell energy (E_1) from the surrounding ones.



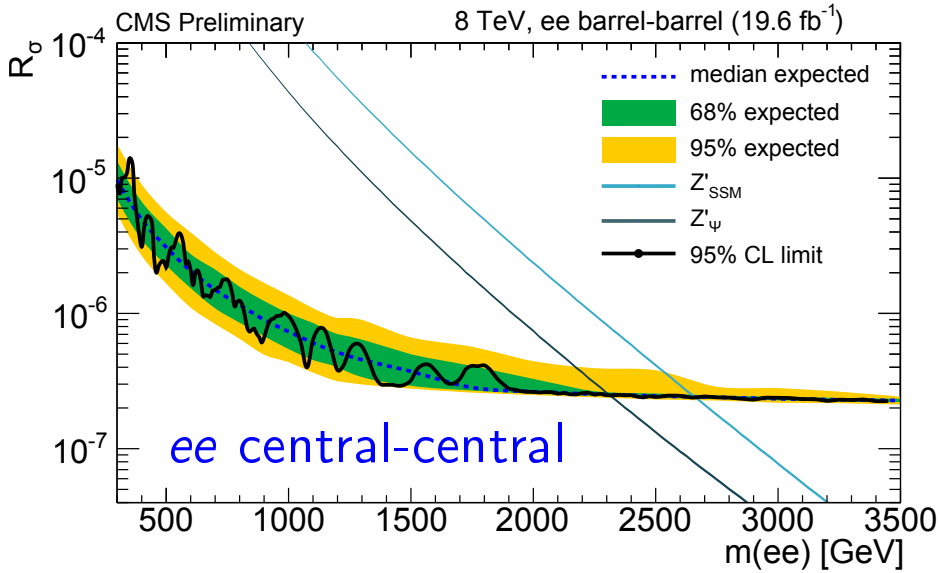


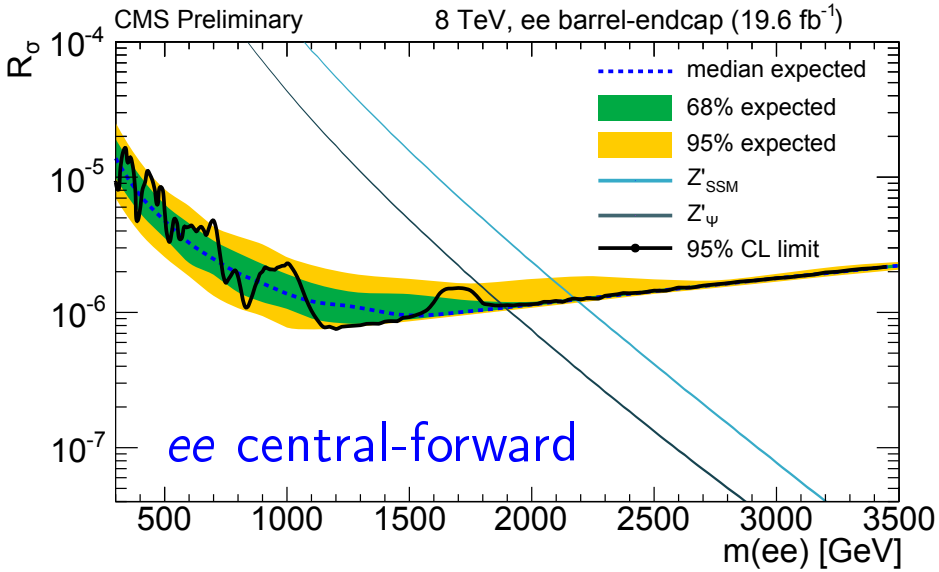


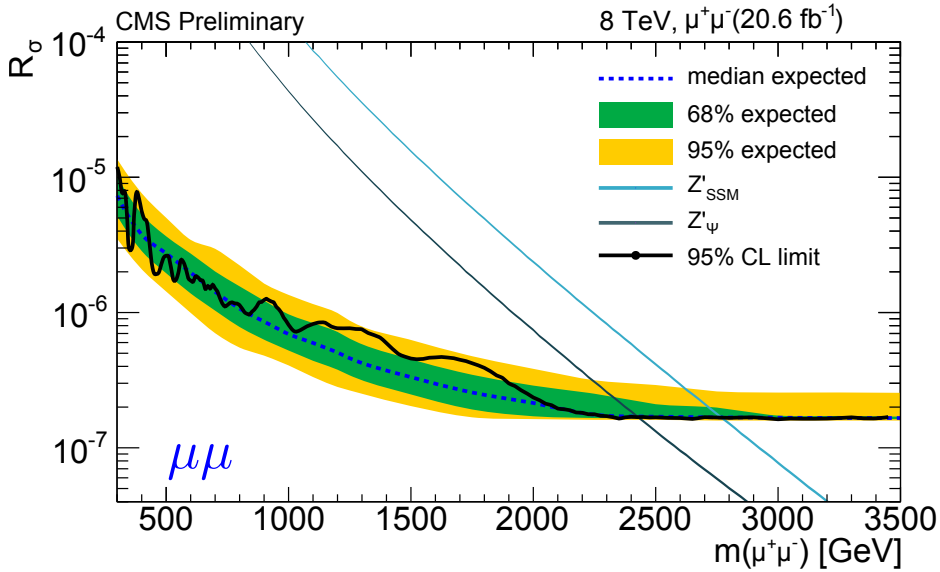
Back up : The CMS detector

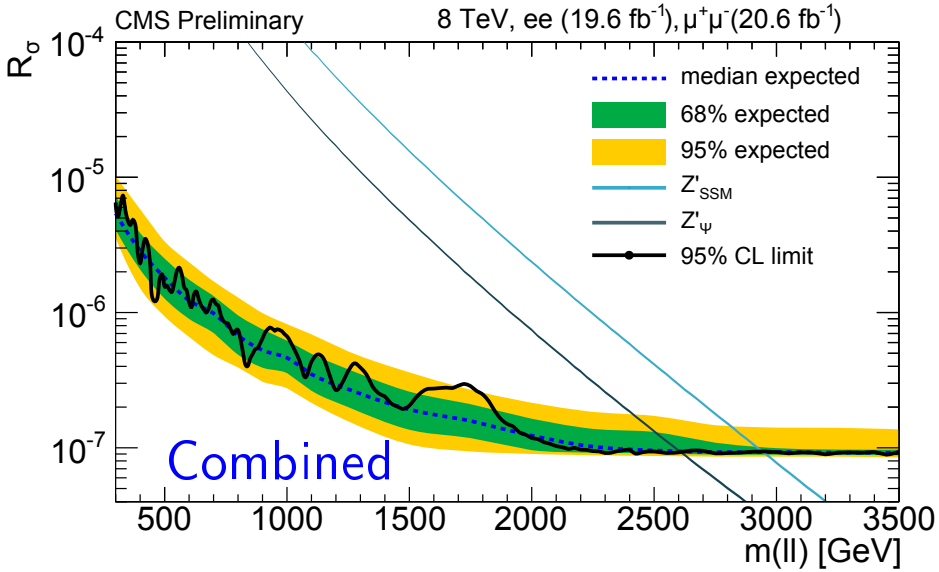


Back up : Single channel Limits

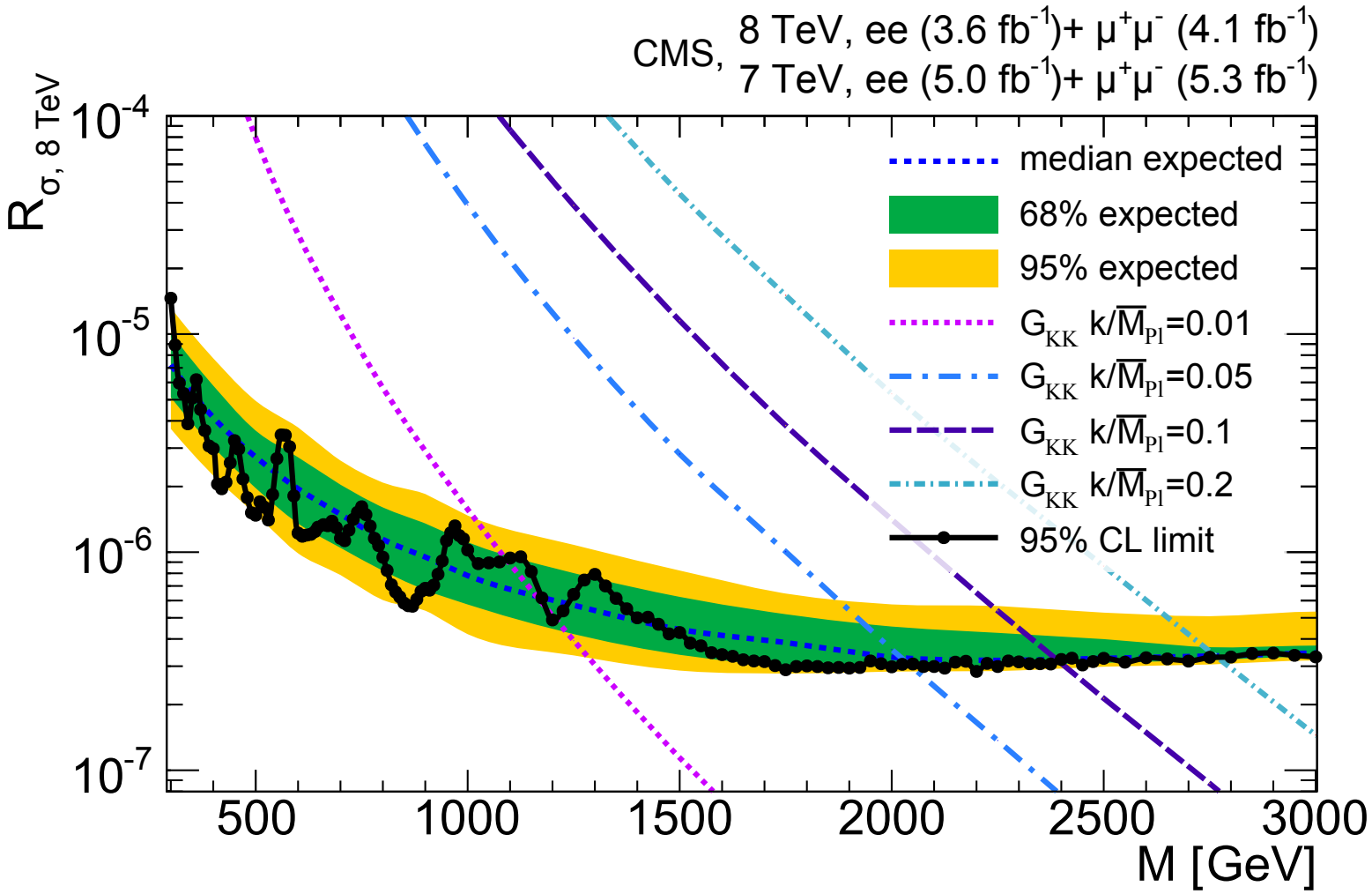








Back up : Limits for gravitons



Back up : Discovery potential at 14 TeV

From CMS TDR : integrated luminosity to reach a 5 σ significance versus mass.

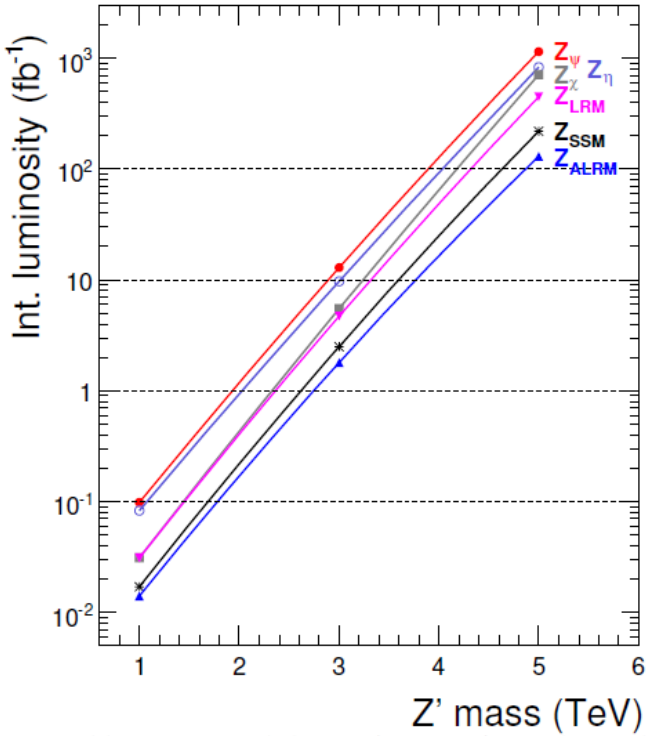
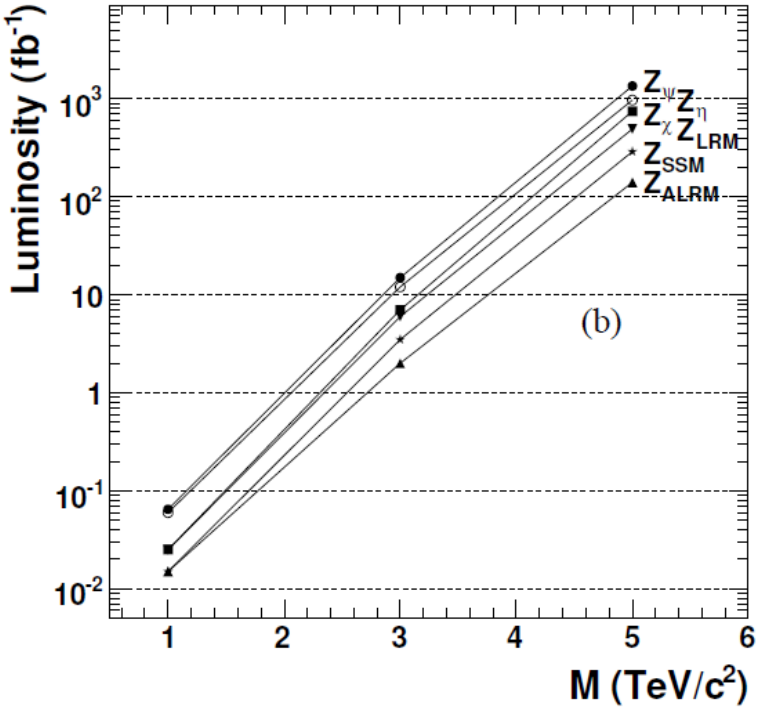


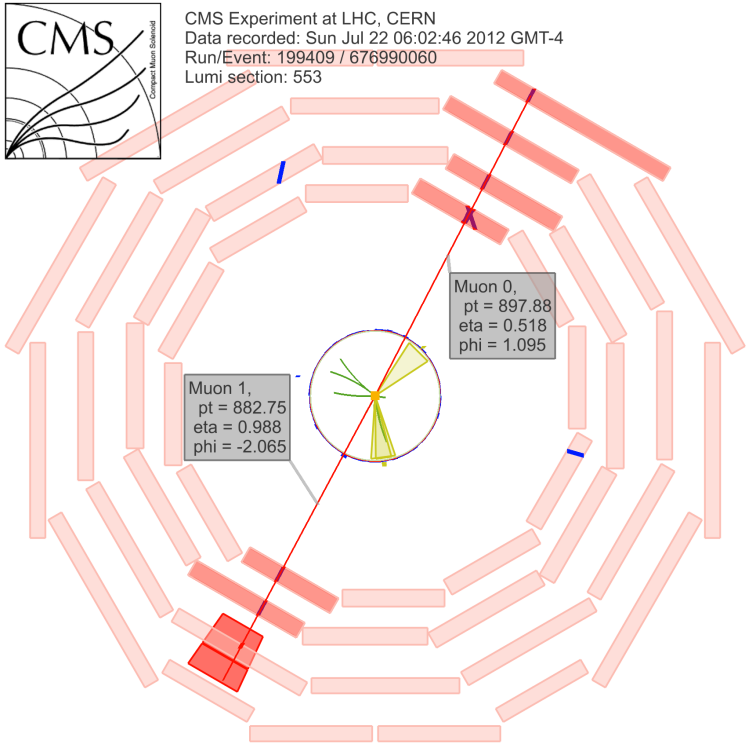
Figure 3.20: Integrated luminosity needed to reach 5σ significance ($S_{\mathcal{L}} = 5$) as a function of Z′ mass for (top to bottom) Z_ψ, Z_η, Z_χ, Z_{LRM}, Z_{SSM} and Z_{ALRM}. Symbols indicate fully-simulated mass-luminosity points, lines are the results of interpolations between the points.

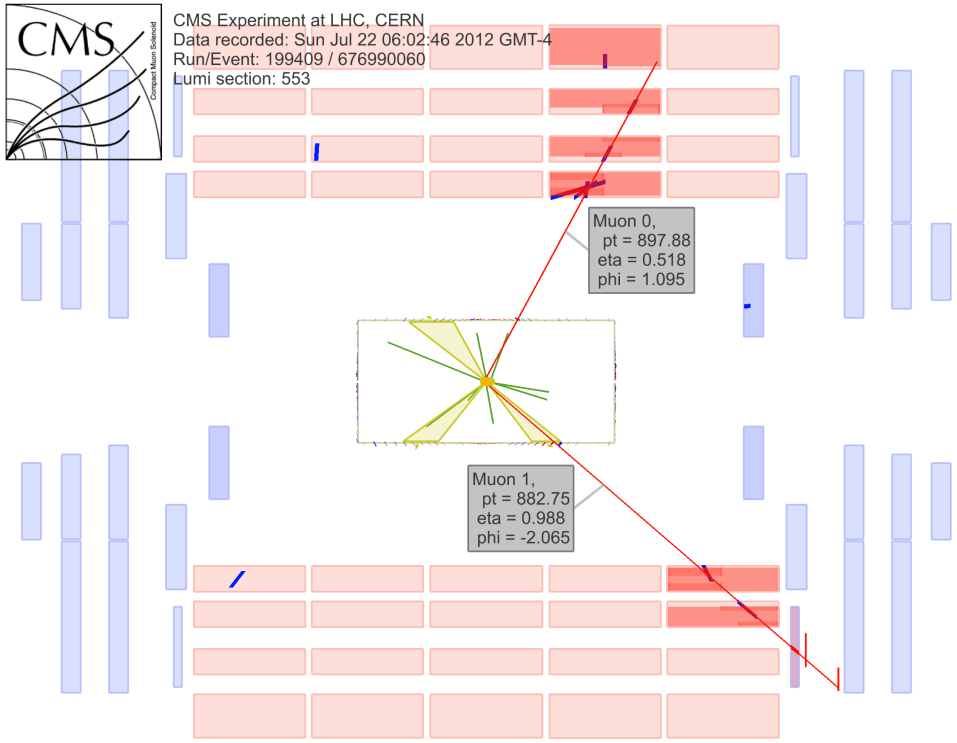


$\mu\mu$ channel

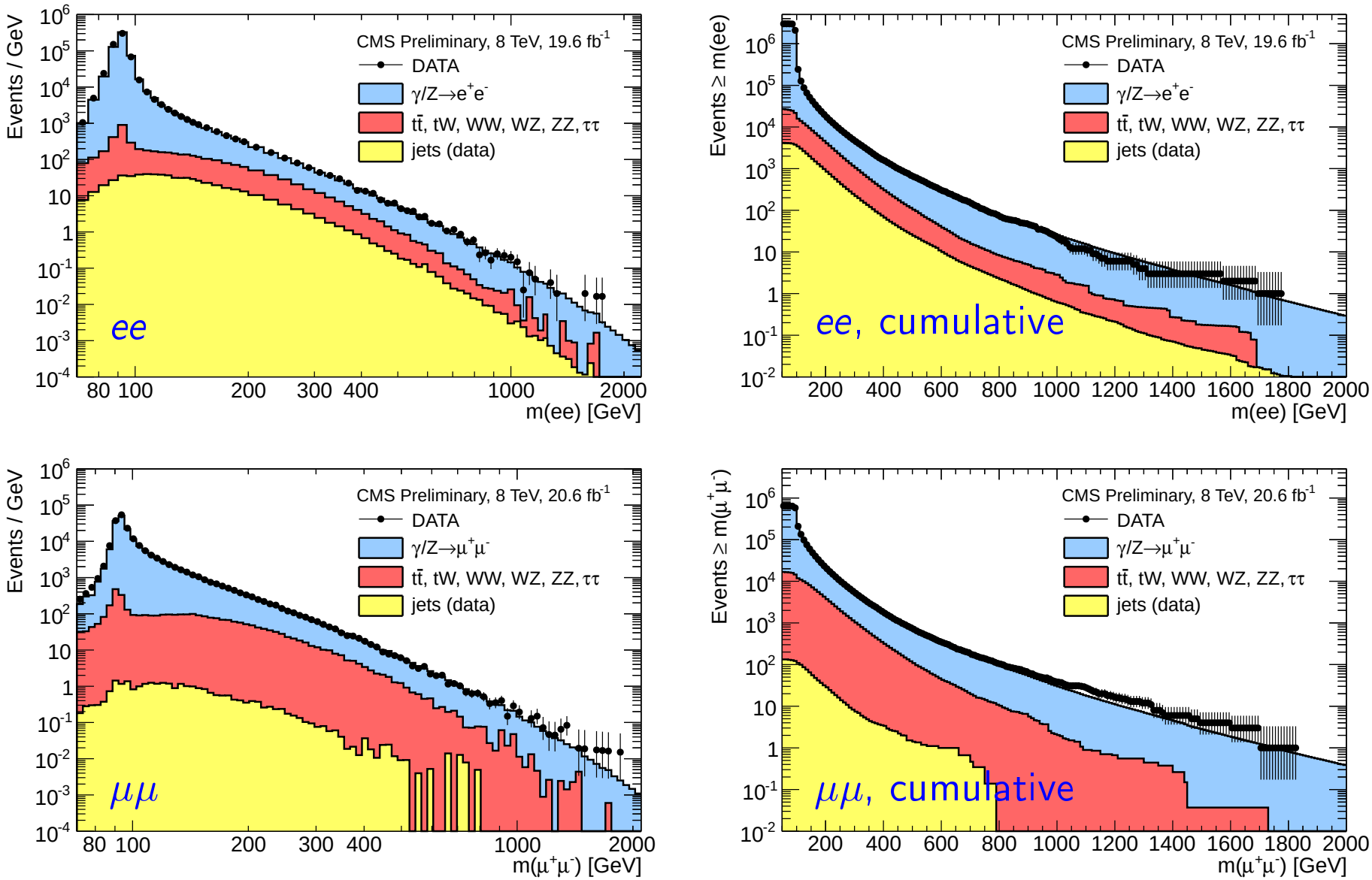
ee channel

Back up : Dimuon event display

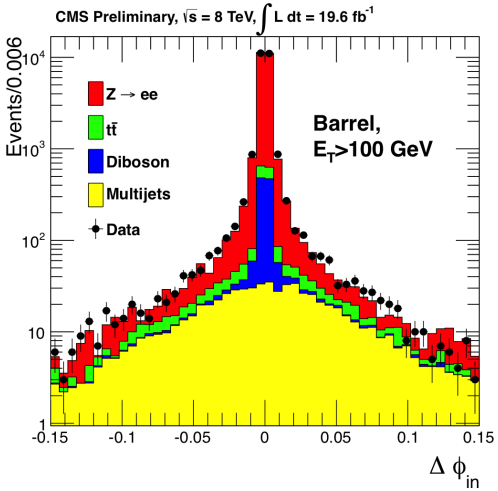




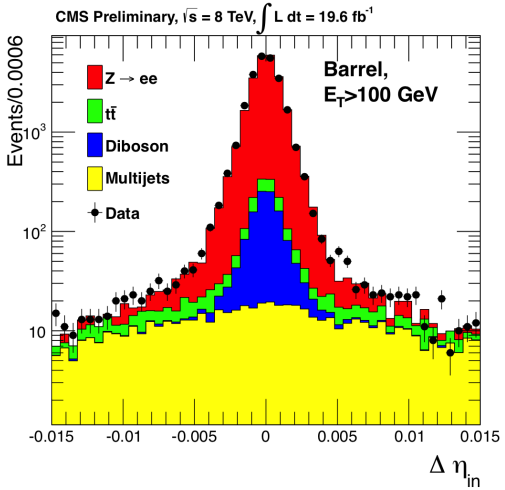
Back up : Cumulative mass plots



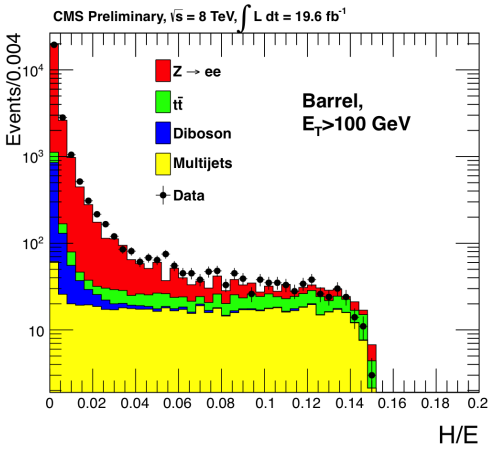
Electron selection variables at high E_T



$\phi_{track} - \phi_{calo}$



$\eta_{track} - \eta_{calo}$



hadronic energy / electromagnetic energy