Update on $Z \to e^+e^-$ analysis

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on behalf of ***Z Signal Extraction*** *team*:

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VBTF meeting

(Sept 17, 2010)

Overview

- ✦Update on comparison of results from "cut and count " and simultaneous fit
- ✦Update on electron energy scale
- ✦Update related to efficiency for WP80 in endcaps

$Z \rightarrow ee$ cross section from "cut & count"

CMS

$N_{Selected}$ = 993 ± 31.5
$N_{Background}$ = 9.9 ± 11.8
Electron offline efficiency: from tag & probe

ε_{Reco} = 1.000 ± 0.003 (stat) ± 0.006 (syst)
$\varepsilon_{Reco \rightarrow WP95}$ = 0.901 ± 0.012 (stat) ± 0.012 (syst)
$\varepsilon_{WP95 \rightarrow HLT}$ = 0.989 ± 0.003 (stat) ± 0.013 (syst)

Work ongoing

includes syst due to signal and bkg shape, and energy scale

Dilepton efficiency = 0.800 ± 0.016 (stat) ± 0.020 (syst)
Acceptance = 0.4606 ± 1.7% (theory) ± 1% (Energy scale) ← from MC

$\sigma_{\gamma^*/Z}$ x BR($Z \rightarrow ee$) = 910.5 ± 34.0 (stat) ± 31.0 (syst) ± 100.1 (lumi) pb

NLO prediction = 970 ± 20 pb, NNLO prediction = 972 ± 39 pb

Observed cross section is lower than prediction !

The only MC ingredient is acceptance.

Simultaneous fit: improvements over last week

✦In last week's simultaneous fit result, an isolation cut was (inadvertently) applied to the low purity samples:

- -this isolation cut wasn't 100% efficient
- -caused an increase in efficiency by ~2%
- -and decrease in cross section by similar amount
- -now remedied

✦The resolution of high purity (TT) sample in data is very close to the one in MC. Making this parameter float doesn't help the fit at all. Now fixed.

✦Increased the precision of the numerical computation and integration steps in the fit. This also helped somewhat in improving the fit quality.

Still some more improvements possible:
- Fit is not very sensitive to resolution parameters of TF samples: can fix them
- Can also fix the mass shift in all three samples to the value determined separately (discussed on a later slide)

Simultaneous fit results

	Floating Parameter	FinalValue	+/-	Error
1	bkg shape TF_BB	-2.6071e-02	+/-	8.51e-03
2	bkg shape TF_End	-1.4441e-02	+/-	5.14e-03
3	eff_B	8.9587e-01	+/-	2.04e-02
4	eff_E	8.7943e-01	+/-	4.61e-02
5	massShiftTF_BB	-4.7263e-01	+/-	3.54e-01
6	massShiftTF_End	-6.6227e-03	+/-	2.88e-01
7	massShiftTT	-4.4946e-01	+/-	1.44e-01
8	nBkgTF_BB	6.6760e+01	+/-	1.30e+01
9	nBkgTF_End	1.3950e+02	+/-	1.63e+01
10	resoTF_BB	7.5291e-02	+/-	1.08e-01
11	resoTF_End	3.1977e-02	+/-	4.19e-02
12	xsec	9.1220e+02	+/-	3.73e+01

- (1–2) Exponential bkg. shape for the two low purity samples
- (3–4) Electron offline efficiency in the barrel and endcaps
- (5–7) Mass shifts due to electron energy scale
- (7–8) # background events in low purity sample
- (9–11) Gaussian resolution widths
- (12) Z signal cross section (contains ~1% residual bkg.)

PARAMETER CORRELATION COEFFICIENTS

NO.	GLOBAL	1	2	3	4	5	6	7	8	9	10	11	12
1	0.12440	1.000	0.000	0.102	-0.036	0.046	0.000	-0.000	0.104	0.001	0.056	0.000	-0.055
2	0.05629	0.000	1.000	-0.002	0.014	0.000	-0.047	0.000	0.000	0.013	0.000	-0.031	-0.009
3	0.77035	0.102	-0.002	1.000	-0.460	0.122	-0.007	-0.000	0.582	-0.068	0.102	-0.004	-0.354
4	0.76303	-0.036	0.014	-0.460	1.000	-0.043	0.052	0.000	-0.207	0.527	-0.036	0.027	-0.321
5	0.74964	0.046	0.000	0.122	-0.043	1.000	0.000	-0.000	0.125	0.001	0.748	0.000	-0.066
6	0.14593	0.000	-0.047	-0.007	0.052	0.000	1.000	0.000	0.001	0.048	0.000	0.128	-0.034
7	0.00000	-0.000	0.000	-0.000	0.000	-0.000	0.000	1.000	-0.000	0.000	-0.000	0.000	-0.000
8	0.59760	0.104	0.000	0.582	-0.207	0.125	0.001	-0.000	1.000	0.007	0.104	0.000	-0.317
9	0.56881	0.001	0.013	-0.068	0.527	0.001	0.048	0.000	0.007	1.000	0.001	0.025	-0.342
10	0.74817	0.056	0.000	0.102	-0.036	0.748	0.000	-0.000	0.104	0.001	1.000	0.000	-0.055
11	0.13211	0.000	-0.031	-0.004	0.027	0.000	0.128	0.000	0.000	0.025	0.000	1.000	-0.018
12	0.66034	-0.055	-0.009	-0.354	-0.321	-0.066	-0.034	-0.000	-0.317	-0.342	-0.055	-0.018	1.000

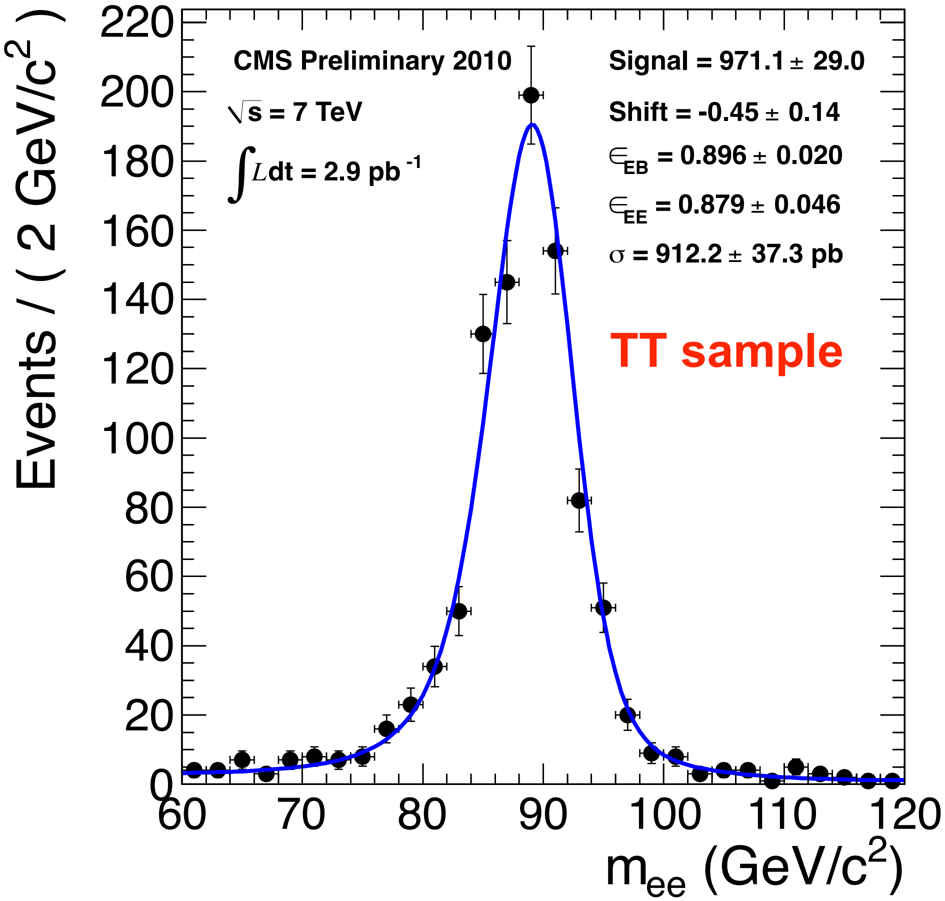
Parameter Correlation Coefficients

cross section after bkg subtraction

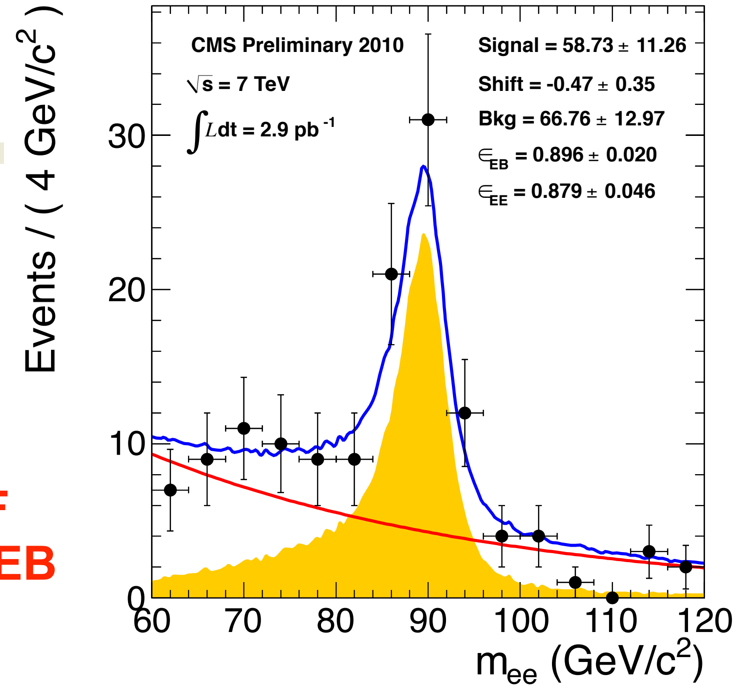
910.5 ± 34.0 ± 31.0 from simple counting

σ = 904.9 ± 37.3 (stat) ± 23.2 (syst) pb ➡Syst includes theory 1.9% ⊕ 1% EES ⊕ Bkg subtr.

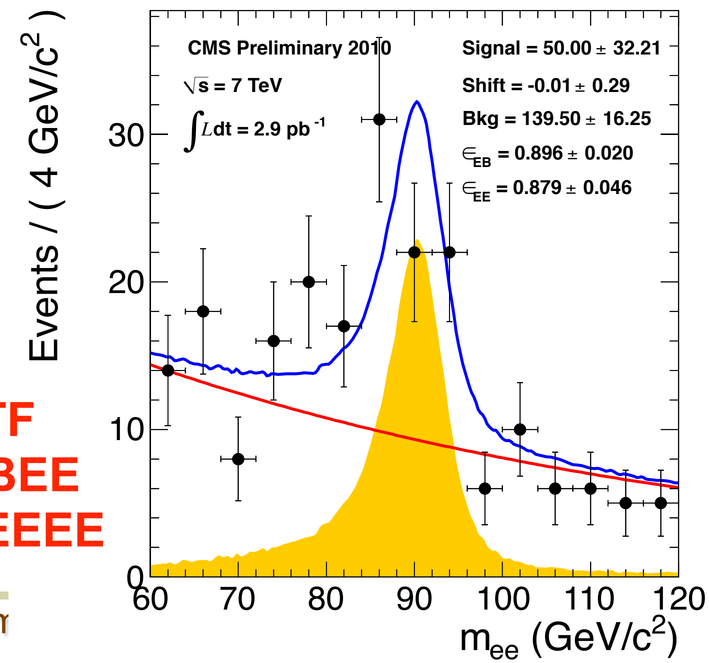
Simultaneous fit plots



TF EBEB



TF EBEE +EEEE



- Signal shapes from NLO ⊗ CMS simu.
- Convolve using Gaussian resolution.
- Let the energy scale float.

Cross check: fit after fixing nuisance params

Perform the same simultaneous fit with all parameters fixed (to the value written on last slide) except the two efficiencies and cross section.

	Floating Parameter	FinalValue +/- Error
1	eff_B	8.9587e-01 +/- 1.89e-02
2	eff_E	8.7943e-01 +/- 4.09e-02
3	xsec	9.1220e+02 +/- 2.93e+01

PARAMETER CORRELATION COEFFICIENTS

NO.	GLOBAL	1	2	3
1	0.66918	1.000	-0.515	-0.277
2	0.66570	-0.515	1.000	-0.263
3	0.54824	-0.277	-0.263	1.000

The errors are reduced now. The statistical uncertainty in cross section is smaller than the stat uncertainty from cut & count analysis.

Electron energy scale: How we compute it ?

We can write the relation between Zee mass in data and MC using the following equations:

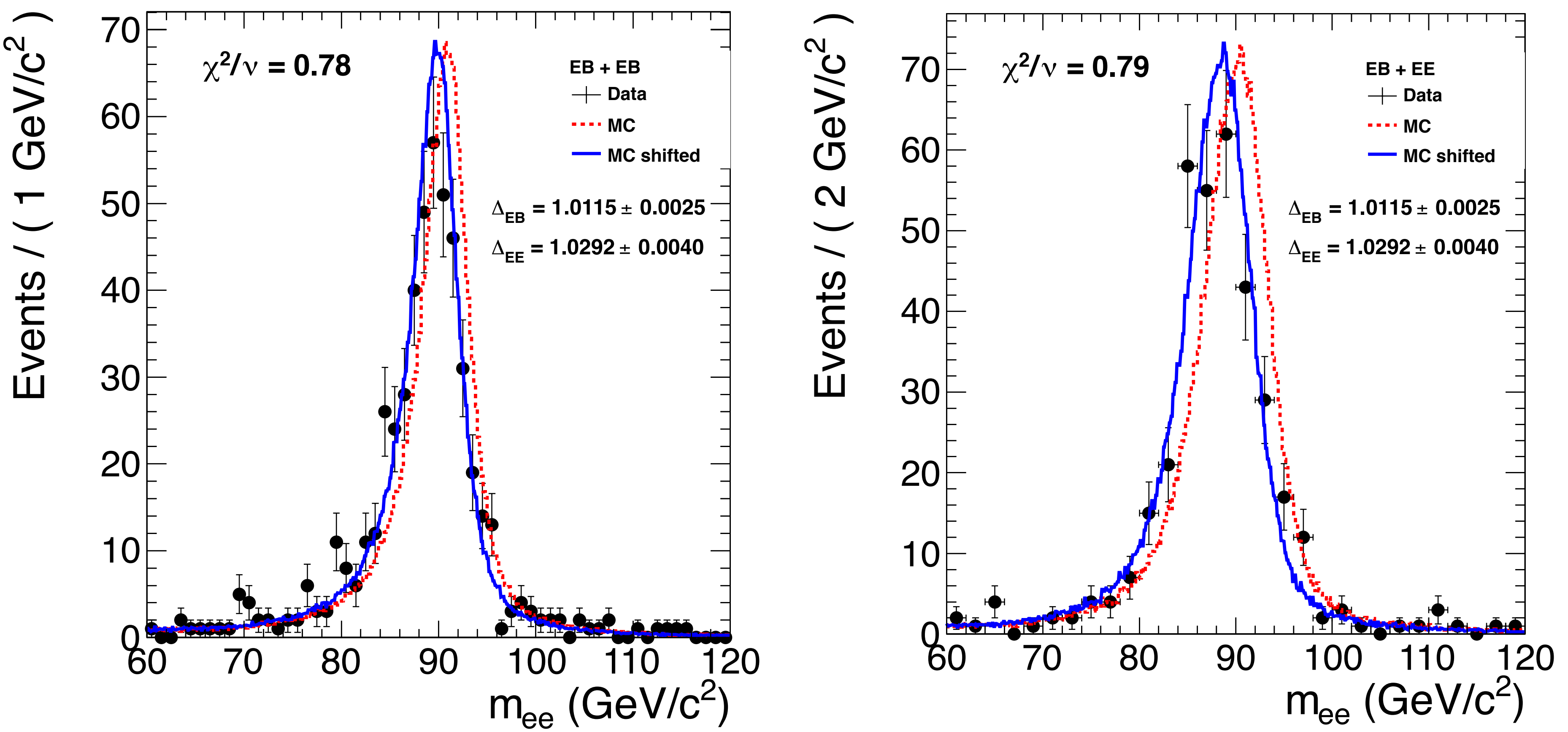
M_MC = a * M_data for EB,EB
M_MC = b* M_data for EE,EE
M_MC = sqrt(a*b) M_data for EB,EE

Here a,b are the energy scaling factors in the EB and EE respectively.

- Take the Zee events in data and rescale the electron energy such that we maximize the likelihood between the data Mee & MC Mee.
This gives us an energy scale correction factor A=xx +- yy

- Perform this fit simultaneously for both EBEB and EBEE samples.

Electron energy scale in data

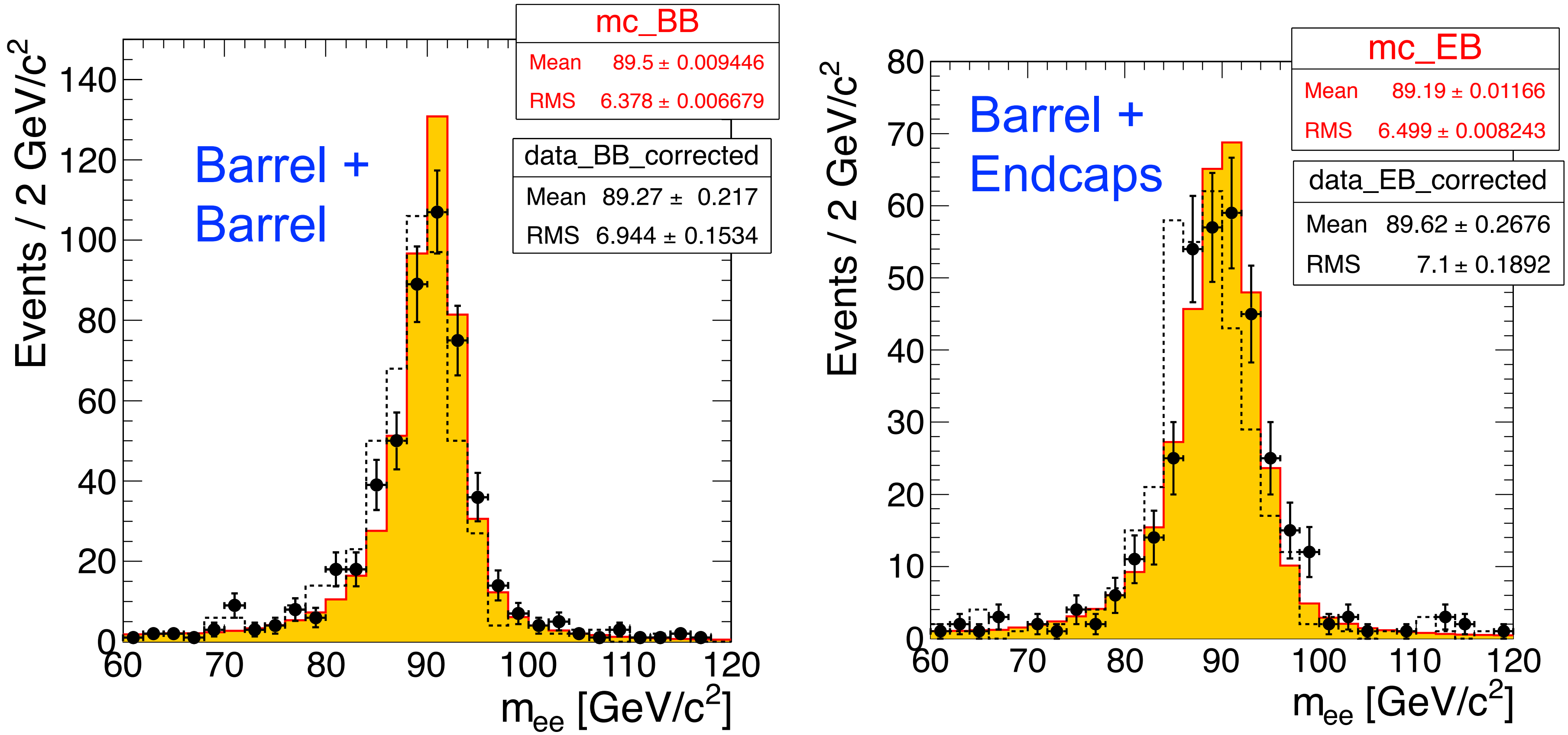


Electron energy scale (for WP95) is: 1.0115 ± 0.0025 (in EB)
1.0292 ± 0.0040 (in EE)

Practically the same for WP80

Electron energy scale: closure test

Apply the energy scale correction back to the Z→ee sample to see if data and MC agree now.



Conclusion: Closure test is successful and energy scale correction works.

Efficiency for WP80 in the endcaps

✦WP80 efficiency in the endcaps was a subject of puzzle until last week

- different groups were reporting different numbers which didn't agree with one another
- quoted efficiency was all over the place in the range 64−82%, with about 4% stat uncertainty

✦ Now the puzzle is resolved: it is about 70% ± 4%

- The Z tag & probe people were not applying conversion rejection cuts,
- because
  - this is not part of the Z selection
  - it is not yet implemented in the standard GsfElectron class (will be in 3.9.x)
  - someone needs to write a plugin for partner track rejection and put it in a standard package

✦The W people were applying conv. rej. cuts, but they had to deal with larger background. Measured a somewhat downward efficiency.