



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

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on behalf of Z Signal Extraction team:

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VBTF meeting
(Oct 1, 2010)

Overview



◆ Updates on electron efficiency

-Our efficiency measurements and methodologies were blessed by Egamma POG. Please see talks by Si and Jeremy for details. I will summarize the main results in this talk.

<http://indico.cern.ch/conferenceDisplay.py?confId=108938>

◆ Other updates

-updated acceptance numbers

-updated various systematics numbers related to efficiency

-additional study of the effect of energy scale on acceptance

◆ The golden Zee signal yield and publicity plots haven't changed

-Georgios will update the cross section value using the latest numbers for efficiency and acceptance.



Acceptance for $Z \rightarrow ee$ events

- ◆ Zee yield from $\int L dt = 2.88 \text{ pb}^{-1}$
 - By using the energy scale corrections from Zee (EB:1.0115 & EE:1.0292):
 - we have $994+7(\text{in}) - 1(\text{out}) = 1000$ events.

- ◆ Acceptance (generated \rightarrow gen level accepted)

$$\begin{aligned} A &= 0.4584 \\ A_{\text{EBEB}} &= 0.2380 \\ A_{\text{EBEE}} &= 0.1713 \\ A_{\text{EEEE}} &= 0.0490 \end{aligned}$$

- ◆ Acceptance: A^* (generated \rightarrow super clusters accepted)

$$\begin{aligned} A^* &= 0.4345 \pm 0.59 \% \text{ syst due to energy scale} \oplus \text{ theory syst} \\ A^*_{\text{EBEB}} &= 0.2257 \\ A^*_{\text{EBEE}} &= 0.1612 \\ A^*_{\text{EEEE}} &= 0.0476 \end{aligned}$$

Outline of the efficiency measurements



- ◆ Present efficiency measurements used for the $Z \rightarrow ee$, $W \rightarrow ev$ inclusive cross section measurements
 - Efficiency Factorization Scheme:
 - Supercluster \rightarrow ECAL driven GSF electron
 - ECAL Driven GSF electron \rightarrow WP95 (WP80)
 - WP95 (WP80) \rightarrow HLT

- ◆ Various cross checks performed and consistent results are obtained:
 - Different tag requirements
 - Different background subtraction methods

- ◆ Systematics are estimated:
 - Signal Shape: 1% for WP95, 2% for WP80
 - Bkg Shape: 0.3%
 - Energy Scale: 0.2%

Supercluster → GsfElectron efficiency



Probe (Photon with cleaning cuts) → matched to an ECAL Driven GSF electron : $\Delta R < 0.3$

WP95 Tag + Probe (Photon , cleaning cuts)

Total: $0.97 \pm 0.004 \pm 0.01$ (syst)
EB : 0.98 ± 0.005
EE : 0.96 ± 0.01

MC Tag and Probe Efficiency:

Total: 0.981 ± 0.0001
EB : 0.986 ± 0.0001
EE : 0.970 ± 0.0003

Supercluster Cleaning Cuts

- Reco Photon candidate
- H/E < 0.15 (0.07)
- Sigma lepton lepton < 0.01 (0.03) “caloID”
- Combined Isolation < 0.15 (0.1)

Cross check from other methods:

Template: 0.984 ± 0.012
WP60Tag + Photon: 0.976 ± 0.005
WP80Tag + Photon: 0.972 ± 0.004

**Consistent results obtained
from all methods**

Systematics to be discussed later...

GsfElectron → WP95 efficiency



- **Tag (WP80) + EcalDriven GSF electron probe**

| | |
|-----------|---------------------------------|
| Total: | $0.92 \pm 0.01 \pm 0.01$ (syst) |
| EB: | 0.92 ± 0.01 |
| EE: | 0.91 ± 0.02 |
| Plus EB: | 0.93 ± 0.02 |
| Plus EE: | 0.91 ± 0.02 |
| Minus EB: | 0.92 ± 0.02 |
| Minus EE: | 0.91 ± 0.03 |

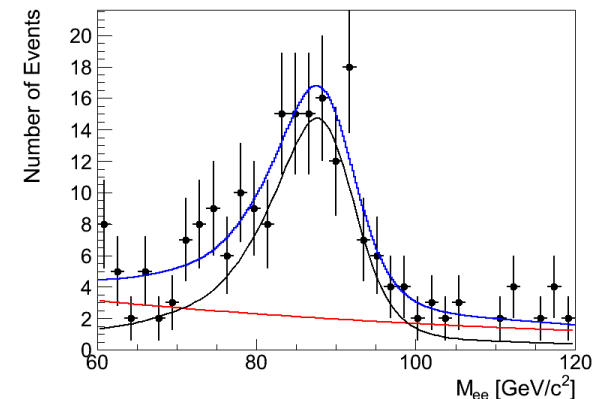
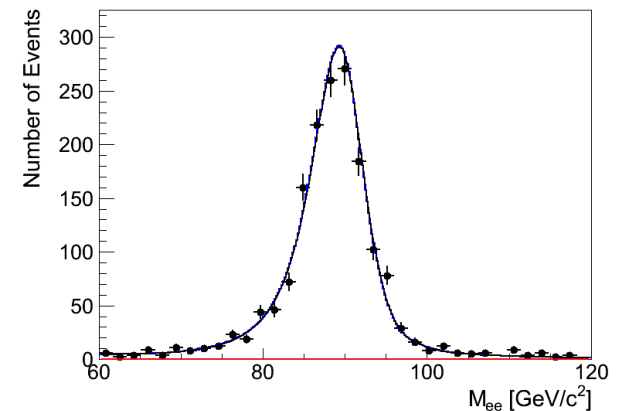
- **MC Tag and Probe Efficiency (WP80 Tag) :**

| | |
|------------|--------------------|
| Total: | 0.949 ± 0.0004 |
| EB: | 0.955 ± 0.0005 |
| EE: | 0.943 ± 0.0008 |
| Plus EB : | 0.954 ± 0.0006 |
| Plus EE : | 0.942 ± 0.0010 |
| Minus EB : | 0.955 ± 0.0007 |
| Minus EE : | 0.944 ± 0.0010 |

Cross check from other methods:

| | |
|---------------------|-----------------------------|
| SS/OS: | $0.923 \pm 0.006 \pm 0.007$ |
| Tag(WP95) + GsfEle: | 0.92 ± 0.01 |
| Tag(WP60) + GsfEle: | 0.92 ± 0.01 |

Consistent results from all methods



Data Efficiency is ~3% lower than MC

GsfElectron → WP80 efficiency



- **Tag (WP80) + EcalDriven GSF electron probe**

| | |
|------------|---------------------------------|
| Total: | $0.79 \pm 0.01 \pm 0.02$ (syst) |
| EB: | 0.83 ± 0.01 |
| EE: | 0.71 ± 0.02 |
| Plus EB : | 0.81 ± 0.02 |
| Plus EE : | 0.70 ± 0.03 |
| Minus EB : | 0.82 ± 0.02 |
| Minus EE : | 0.73 ± 0.03 |

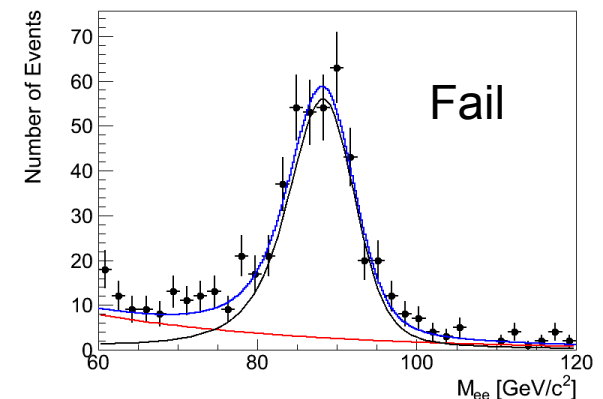
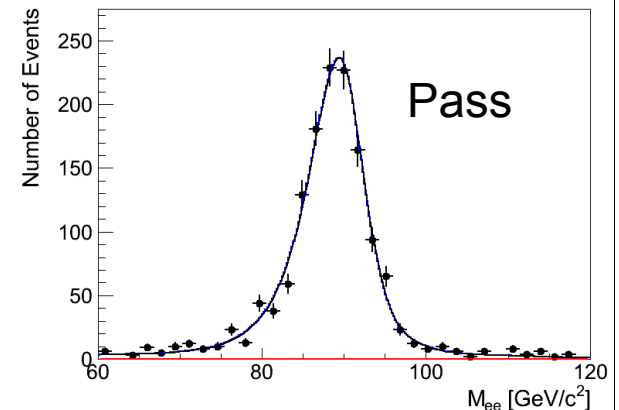
- **MC Tag and Probe Efficiency (WP80 Tag) :**

| | |
|------------|--------------------|
| Total: | 0.822 ± 0.0004 |
| EB: | 0.857 ± 0.0005 |
| EE: | 0.741 ± 0.0008 |
| Plus EB : | 0.858 ± 0.0006 |
| Plus EE : | 0.740 ± 0.0010 |
| Minus EB : | 0.857 ± 0.0007 |
| Minus EE : | 0.743 ± 0.0010 |

Cross check from other methods:

| | |
|---------------------|--------------------------|
| SS/OS: | $0.77 \pm 0.01 \pm 0.01$ |
| Template: | 0.75 ± 0.08 |
| Tag(WP60) + GsfEle: | 0.79 ± 0.01 |

Consistent results from all methods



Data Efficiency is ~4% lower than MC

WP95 → HLT efficiency



- **Tag (WP95)** + WP95 electron probe
- No bkg, simple counting

Total: $0.988 + 0.002 - 0.003 \pm 0.002$ (syst)
EB : $0.987 + 0.003 - 0.004$
EE : $0.990 + 0.004 - 0.006$
Plus EB: $0.991 + 0.003 - 0.005$
Plus EE: $0.987 + 0.006 - 0.010$
Minus EB: $0.986 + 0.004 - 0.006$
Minus EE: $0.990 + 0.004 - 0.009$

MC: WP95 → HLT_Ele15_LW_L1R (Note that it's a different trigger)

Total: 0.991 ± 0.0001
EB: 0.997 ± 0.0001
EE: 0.980 ± 0.0003
Plus EB: 0.997 ± 0.0001
Plus EE: 0.980 ± 0.0004
Minus EB: 0.997 ± 0.0001
Minus EE: 0.981 ± 0.0004

HLT Selection:

132440 – 137028: HLT_Photon10_L1R (Require
Trigger Photon Pt > 15GeV)

138564 – 140401: HLT_Photon15_Cleaned_L1R

141956 – 144114: HLT_Ele15_SW_CaloEleId_L1R

WP80 → HLT efficiency



- **Tag (WP80) + WP80 electron probe**
- No bkg, simple counting

Total: 0.988 + 0.002 - 0.003 ± 0.002 (syst)
EB : 0.987 + 0.003 - 0.004
EE : 0.990 + 0.004 - 0.006
Plus EB: 0.991 + 0.003 - 0.005
Plus EE: 0.987 + 0.006 - 0.010
Minus EB: 0.986 + 0.004 - 0.006
Minus EE: 0.990 + 0.004 - 0.009

MC: VBTF80 -> HLT_Ele15_LW_L1R (Note that it's a different trigger)

Total: 0.994 +/- 0.0001
EB: 0.997 +/- 0.0001
EE: 0.988 +/- 0.0003
Plus EE : 0.989 +/- 0.0004
Plus EB : 0.996 +/- 0.0001
Minus EE : 0.989 +/- 0.0004
Minus EB : 0.997 +/- 0.0001

Systematics: Bkg Shape & Energy Scale



Background shape systematics:

- Perform ToyMC pseudo experiments assuming a particular background parameterization ($1 / M^\alpha$) and performing the fit using the exponential background parameterization.
- Mean bias found to be at most 0.3%

Energy scale systematics:

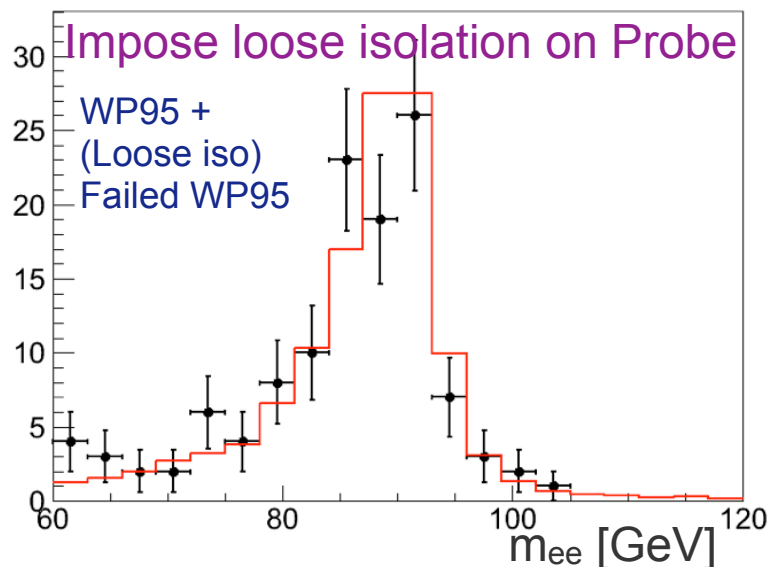
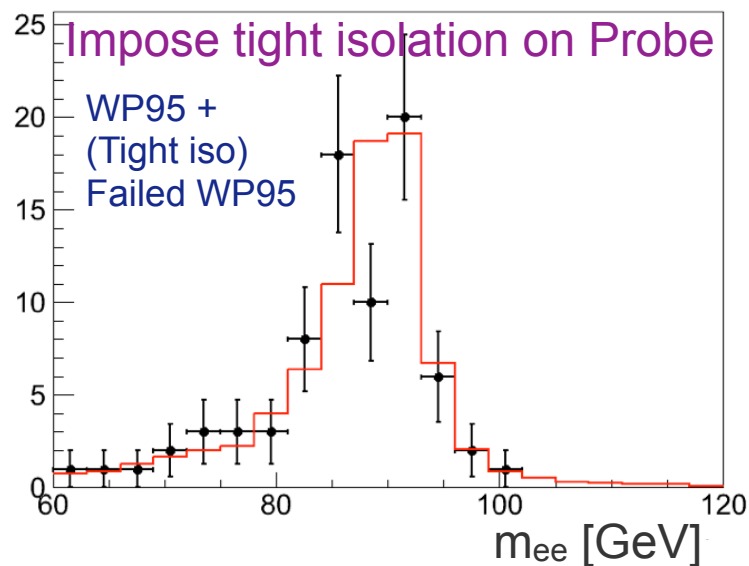
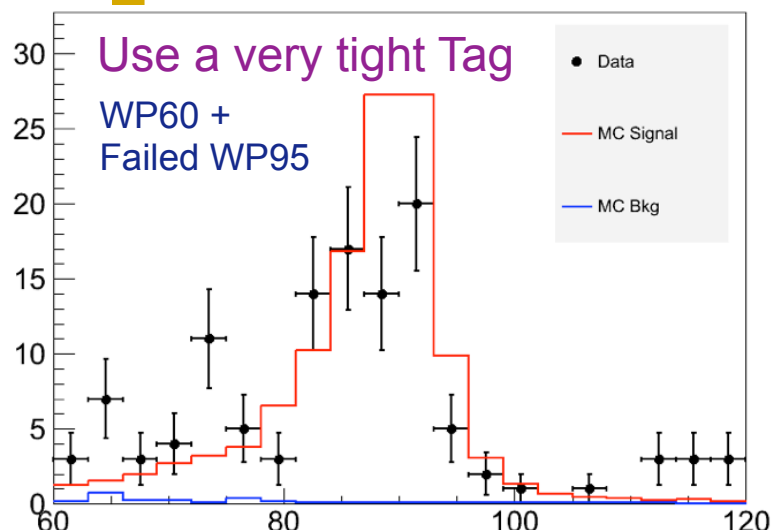
- Shift the electron energies in MC, by the uncertainties of the energy scale determination, and see how much the efficiency changes.
- Maximal differences are 0.2%

Systematics: Signal shape



- ◆ Signal shape for the Tag+Fail sample may not be well reproduced by the simulation.
- ◆ If no constraints are imposed on the size of the low side tail, then the uncertainty on the efficiency is potentially very large.
- ◆ We construct various signal shape templates by imposing tight cuts on the Tag + Fail sample.
- ◆ Systematics are determined by performing the efficiency fit using the fixed template from these data samples for the signal PDF.
- ◆ Use an extended mass range (50 – 120) to probe more of the low side tail.

Signal shape templates from data



- Tag+Probe sample has very low background.
- MC signal is shown in Red. MC bkg in Blue.
- Tails are reasonably reproduced by simulation.
- The MC shape hasn't been corrected by resolution smearing in these plots.
- There is good overall agreement between data and MC for the signal shape.

Signal shape systematics summary



• Maximum differences observed between the data-based template fits vs. standard signal parameterization:

- WP95 : EB 1.1% EE: 1.2%
- WP80 : EB 1.8% EE: 0.2%

Other changes



◆ Resolution systematics

-Electron energy resolution effects the signal yield in two ways

- in the ET cut of 20 GeV
- in the mass cut of [60,120] GeV

-The overall effect is 0.59%

-See backup slide for details.



Summary



- ◆ Measured the following electron efficiencies for the $Z \rightarrow ee$, $W \rightarrow ev$ inclusive cross section measurements:
 - Supercluster \rightarrow ECAL driven GSF electron
 - ECAL Driven GSF electron \rightarrow WP95 (WP80)
 - WP95 (WP80) \rightarrow HLT

- ◆ Systematics have been estimated:
 - Signal Shape: 1% for WP95, 2% for WP80
 - Bkg Shape: 0.3%
 - Energy Scale: 0.2%
 - Syst in acceptance due to resolution: 0.59%

- ◆ Acceptance numbers have been updated
- ◆ Several crosschecks performed and alternative methods/ templates studied.

Backup

Systematics: Bkg Shape & Energy Scale



| | energyScale (%) | bkgParameterization (%) |
|-------|-----------------|-------------------------|
| GSF | 0.1 | 0.06 |
| ID95 | 0.1 | 0.25 |
| ID80 | 0.2 | 0.24 |
| HLT95 | 0.0 | 0.01 |
| HLT80 | 0.1 | 0.00 |

Systematics: Electron Energy Resolution



syst uncertainty in acceptance = 0.59%

smearPass, defaultPass, smearPass/defaultPass
= 838136, 843096, 0.994117

defaultPass - smearPass = 4960

nDefaultPassSmearFail= 16522

nDefaultPassSmearFail_becauseEt= 14174

nDefaultPassSmearFail_becauseMass= 2348

nDefaultFailSmearPass= 11562

nDefaultFailSmearPass_becauseEt= 9355

nDefaultFailSmearPass_becauseMass= 2207