Measurement of the W mass and width in the $\mathrm{qq}\ell\nu$ channel at $\sqrt{s} = 189$ GeV using a convolution method

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- Introduction
- Standard Model Fit
- $M_{\mathrm{W}}/\Gamma_{\mathrm{W}}$ Fit

A copy of the transparencies can be found at
/afs/cern.ch/user/d/dubbj/public/ww/ww_060300.ps

Introduction

- **Kinematic fit** of events with energy/momentum conservation and equal-mass constraint
  $\Rightarrow \chi^2(m)$ function
  $\Rightarrow$ **Error density** $P(m)$

- **Physics function** $f(m; M_{\mathrm{W}}, \Gamma_{\mathrm{W}})$ takes into account **background shape** and **ISR** effects on kinematic fit

- Event **likelihood** given by **convolution** of **error density** $P(m)$ with **physics function** $f(m; M_{\mathrm{W}}, \Gamma_{\mathrm{W}})$

- **Unbinned maximum likelihood** fit yields M_{W} (and Γ_{W})

- For details see TN641

Standard Model Fit

- **Only M_{W} free parameter** in physics function
  Γ_{W} constrained to SM value: Γ_{W} (M_{W})
- Fit each channel separately
- **Combined** result is **weighted average**
  (stat. $\oplus$ sys. error as weight)

- **Changes** compared to Dec. 99 talk:
  - Trackless events included
  - Background shape for physics-function taken as histogram from MC (4-fermion and Z/γ)
  - Evil-τ background shape in $\mathrm{qq}\tau\nu$ fit

- **Expected stat. error** from ensemble test

Channel	Exp. error / GeV	Pull width
$\mathrm{qqe}\nu$	0.159 ± 0.005	1.00 ± 0.01
$\mathrm{qq}\mu\nu$	0.165 ± 0.005	0.99 ± 0.01
$\mathrm{qq}\tau\nu$	0.212 ± 0.004	0.99 ± 0.01
$\mathrm{qq}\ell\nu$	0.101 ± 0.003	

Standard Model Fit

- **Calibration function** given by **straight line** fit to $M_{Fit}(M_{True})$
  - Scale stat. errors with inverse slope
  - Bias correction with inverse calibration function

  Slope consistent with unity for all channels

  Only small bias ($<$ 50 MeV)

- **Systematic studies** use data sized **subsamples**, taking into account **correlations between samples and channels**

- **Results** (detailed in TN642)

Channel	M_{W} / GeV
$\mathrm{W^+W^-} \rightarrow \mathrm{q\bar{q}}e\nu$	$80.135 \pm 0.166_{\text{stat}} \pm 0.042_{\text{sys}}$
$\mathrm{W^+W^-} \rightarrow \mathrm{q\bar{q}}\mu\nu$	$80.469 \pm 0.176_{\text{stat}} \pm 0.039_{\text{sys}}$
$\mathrm{W^+W^-} \rightarrow \mathrm{q\bar{q}}\tau\nu$	$80.655 \pm 0.222_{\text{stat}} \pm 0.052_{\text{sys}}$
$\mathrm{W^+W^-} \rightarrow \mathrm{q\bar{q}}\ell\nu$ comb.	$80.382 \pm 0.106_{\text{stat}} \pm 0.029_{\text{sys}}$

Systematics

- **Beam energy**:

  25 MeV were added to beam energy, the results were scaled to the beam energy uncertainty of 20 MeV.

- **Bias correction**:

  The uncertainty of the calibration function was translated to an error on the bias correction.

- **Initial State Radiation**:

  Comparison of the results using events of run 9300 with ISR $\mathcal{O}(\alpha^3)$ and events reweighted to correspond to ISR $\mathcal{O}(\alpha^1)$.

- **Energy scale and errors for jets and leptons**:

  Based on the `WWFIX` routine

- **Hadronization**:

  Comparison of the results of KORALW/JETSET samples (run 8438 and 9865) with HERWIG samples (run 8442 and 9866).

- **4-fermion effects**

  Comparison of the results using events of run 9300 with `grc4f` matrix elements and events reweighted to correspond to EXCALIBUR matrix elements.

- **Fit Procedure**:

  The convolution range was changed from $\Delta\chi^2 = 25$ to $\Delta\chi^2 = 16$ ("$5\sigma \to 4\sigma$").

- **Background**:

  The mean number of Z/γ and four-fermion background events in each channel was increased according to the uncertainty in the accepted cross-section.

M_{W}/Γ_{W} Fit

- M_{W} **and** Γ_{W} **free parameters** in physics function
- Fit each channel separately
- **Combined** result is **weighted average**
  (stat. $\oplus$ sys. error as weight)

- **Calibration function for** M_{W} given by **straight line** fit to $M_{Fit}(M_{True})$
  - Scale stat. errors with inverse slope
  - Bias correction with inverse calibration function

  Slope consistent with unity for all channels
  Only small bias ($<$ 70 MeV)
- **Calibration function for** Γ_{W} given by **straight line** fit to $\Gamma_{Fit}(\Gamma_{True})$ with **slope constrained to 1**.

M_{W}/Γ_{W} Fit

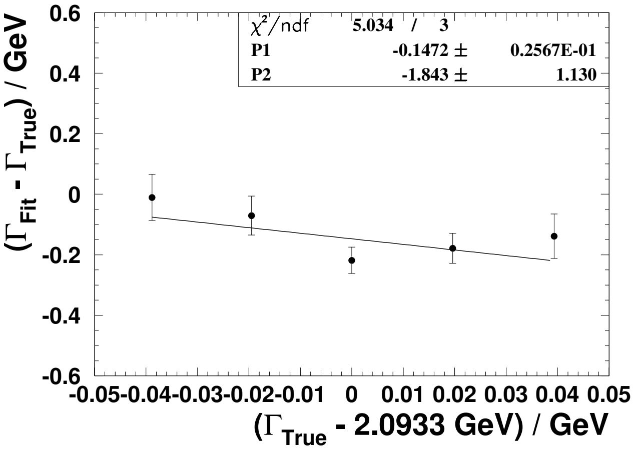
- **Expected stat. error** from ensemble test

Channel	Exp. error for M_{W} / GeV	Pull width for M_{W}
$\mathrm{qqe}\nu$	0.168 ± 0.005	1.04 ± 0.01
$\mathrm{qq}\mu\nu$	0.170 ± 0.005	1.05 ± 0.02
$\mathrm{qq}\tau\nu$	0.204 ± 0.002	0.97 ± 0.01
$\mathrm{qq}\ell\nu$	0.103 ± 0.002	

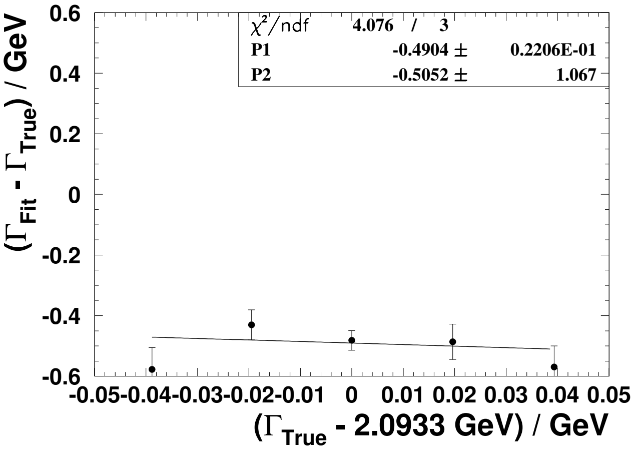
Channel	Exp. error for Γ_{W} / GeV	Pull width for Γ_{W}
$\mathrm{qqe}\nu$	0.308 ± 0.004	1.06 ± 0.02
$\mathrm{qq}\mu\nu$	0.290 ± 0.004	1.08 ± 0.02
$\mathrm{qq}\tau\nu$	0.471 ± 0.007	1.04 ± 0.01
$\mathrm{qq}\ell\nu$	0.193 ± 0.002	

- **Systematic studies** use data sized **subsamples**, taking into account **correlations between samples and channels**

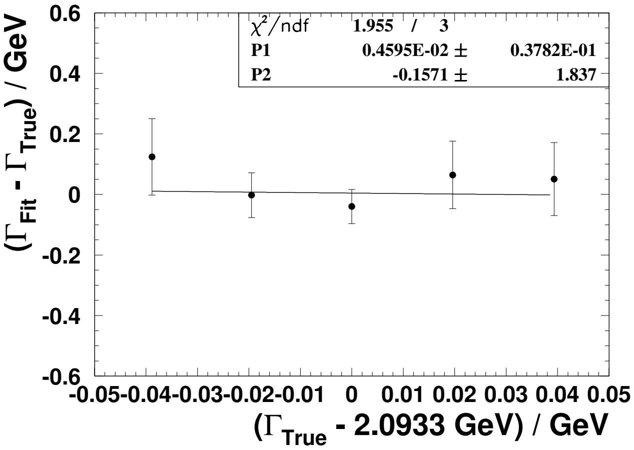
M_W/Γ_W Fit



qqeν



qq$\mu\nu$



qq$\tau\nu$

M_W/Γ_W Fit

- **Problems**
  - **Method** does **not** prove to be **sensitive** to changes in Γ_W of $\lesssim$ 40 MeV
    $\Rightarrow$ bias correction for width with slope constrained to 1
  - **Large bias correction** for Γ_W in the $qq\mu\nu$ channel (490 MeV)
  - **Pull widths** for M_W and Γ_W **a bit large**
    $\Rightarrow$ **scale stat. errors** with pull width

- **Results**

Channel	M_W / GeV
$W^+W^- \rightarrow q\bar{q}e\nu$	$80.128 \pm 0.173_{\text{stat}} \pm 0.043_{\text{sys}}$
$W^+W^- \rightarrow q\bar{q}\mu\nu$	$80.505 \pm 0.187_{\text{stat}} \pm 0.042_{\text{sys}}$
$W^+W^- \rightarrow q\bar{q}\tau\nu$	$80.660 \pm 0.224_{\text{stat}} \pm 0.058_{\text{sys}}$
$W^+W^- \rightarrow q\bar{q}\ell\nu$ comb.	$80.389 \pm 0.110_{\text{stat}} \pm 0.033_{\text{sys}}$

Channel	Γ_W / GeV
$W^+W^- \rightarrow q\bar{q}e\nu$	$1.997 \pm 0.326_{\text{stat}} \pm 0.067_{\text{sys}}$
$W^+W^- \rightarrow q\bar{q}\mu\nu$	$2.465 \pm 0.339_{\text{stat}} \pm 0.069_{\text{sys}}$
$W^+W^- \rightarrow q\bar{q}\tau\nu$	$2.333 \pm 0.510_{\text{stat}} \pm 0.115_{\text{sys}}$
$W^+W^- \rightarrow q\bar{q}\ell\nu$ comb.	$2.241 \pm 0.213_{\text{stat}} \pm 0.054_{\text{sys}}$

Summary

You get a result in the right range for Γ_{W}, but can you (do you want to) trust it?