

**Status report**

**W-mass determination for**

**$WW \rightarrow qq\bar{e}\nu, qq\bar{\mu}\nu$  events**

**using a Convolution method**

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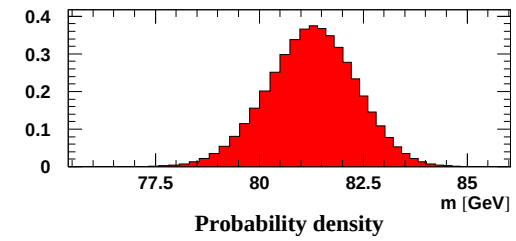
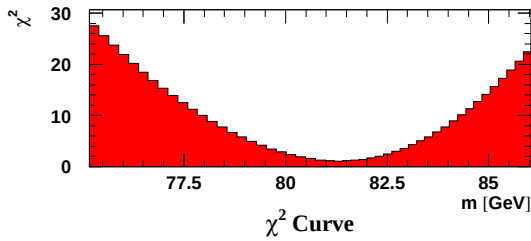
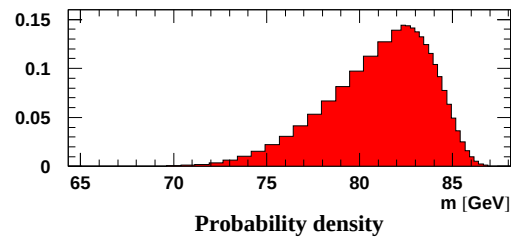
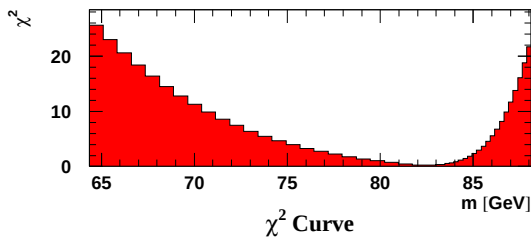
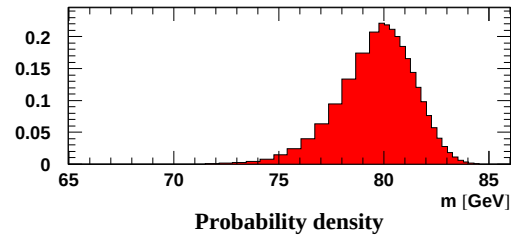
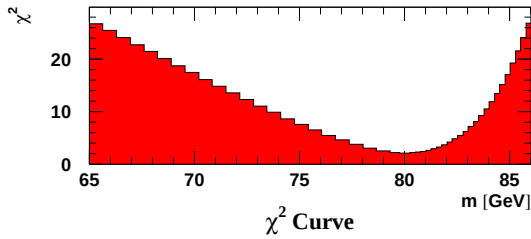
# Method

The Convolution method tries to use the full information of each WW-event in an Unbinned Maximum Likelihood Fit.

- For each event  $i$  construct  $\chi^2$ -function of the jet/lepton energies and momenta with energy/momentum conservation and equal-mass constraint ( $m_{W^-} = m_{W^+}$ )
- Instead of just minimizing the  $\chi^2$ -function, its shape is determined in a certain mass region around the minimum (fix  $m$ , minimize  $\chi^2$ -function  $\rightarrow \chi^2(m)$ )
- Convert  $\chi_i^2(m)$  into probability density  $P_i(m)$  ( $\rightarrow$  asymmetric errors)

$$P_i(m) \propto \exp \left( -\frac{\chi_i^2(m) - \chi_i^2(m_{min})}{2} \right)$$

# Method (cont.)



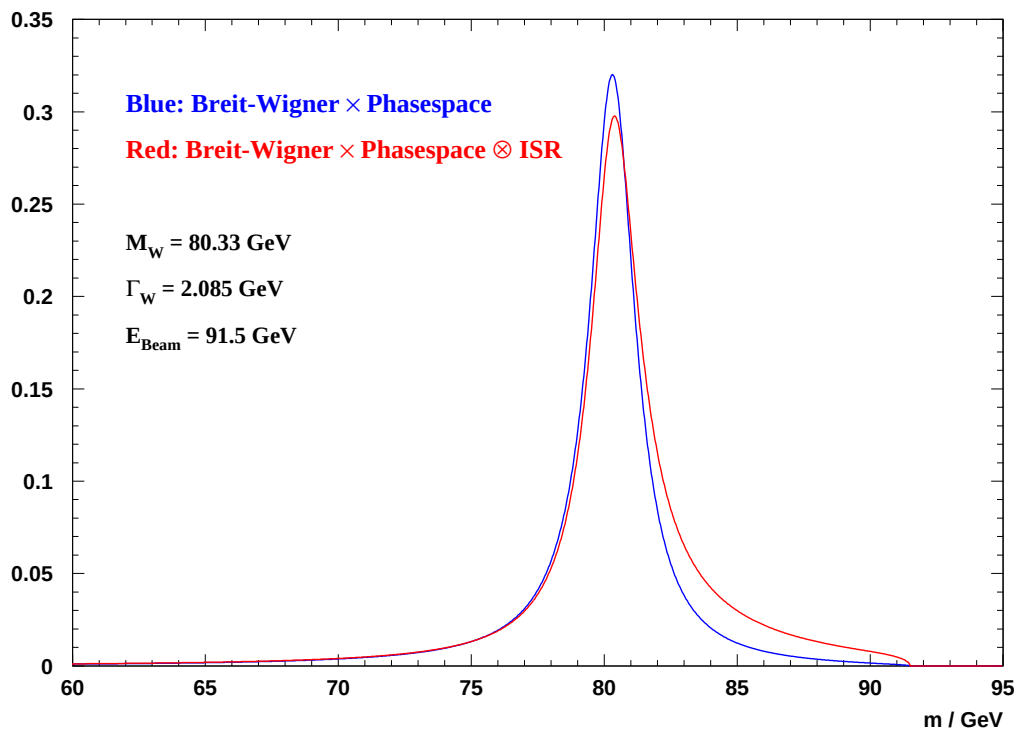
- The Event-Likelihood  $L_i(M_W, \Gamma_W)$  is given by the convolution of the physics-function  $f(m; M_W, \Gamma_W)$  with  $P_i(m)$ :

$$L_i(M_W, \Gamma_W) = \int f(m'; M_W, \Gamma_W) P_i(m') dm'$$

# Method (cont.)

- $f(m; M_W, \Gamma_W)$  is a superposition of relativistic Breit-Wigner functions (with phase-space factor) which are shifted by  $(\sqrt{s} - \sqrt{s'})/2$  and weighted by the probability  $P_{ISR}(s')$  that an ISR photon of energy  $E_{ISR} = (s - s')/2\sqrt{s}$  is emitted. This takes the effect of ISR on the  $\chi^2$ -function into account (in the statistic mean)

$$f(m; M_W, \Gamma_W) = \int bw(m, s', s; M_W, \Gamma_W)_{shifted} \times PS(s', m) \times P_{ISR}(s') ds'$$



Comparison of a relativistic Breit-Wigner function with phase-space factor and the physics-function  $f$

## Method (cont.)

- Minimize

$$-\log L(M_W, \Gamma_W) = -\log \prod_{i=1}^{N_{Sample}} L_i(m_i; M_W, \Gamma_W)$$

to get  $M_W$  and  $\Gamma_W$

# Results for OPAL 183 GeV data

Selected events: 237 (125  $qqe\nu$ , 112  $qq\mu\nu$ )

## Results:

$$M_W = 80.36 \pm 0.18 \pm 0.10 \pm 0.03 \text{ GeV}$$

$$\Gamma_W = 2.01^{+0.37}_{-0.32} \pm 0.26 \pm 0.02 \text{ GeV}$$

N.B. Systematic errors not complete

## Included Monte-Carlo correction:

$$M_W : +0.03 \text{ GeV}$$

$$\Gamma_W : +0.34 \text{ GeV}$$

## Expected stat. errors from Monte-Carlo Samples:

$$\delta M_W = 0.2 \text{ GeV (Pull: } 1.07 \pm 0.08)$$

$$\delta \Gamma_W = 0.36 \text{ GeV (Pull: } 1.09 \pm 0.08)$$

# Systematics

The main MC sample is run 7323 (KoralW at 183 GeV,  $M_W = 80.33$  GeV,  $\Gamma_W = 2.0933$  GeV)

- **Beam energy:** Add 30 MeV to beam energy
- **Detector effects:**
  - **Energy/momentum measurement:** Scale jet energy/lepton momentum by 0.99
  - **Energy/momentum errors:** Scale errors by 1.03
  - **Angular errors:** Scale errors by 1.05
  - **HCAL modeling:** Compare results of MC runs 5763 and 6900
- **MT:** Use new MT package instead of GCE
- **Hadronization:** Compare results with HERWIG sample (run 5033)
- **ISR:**
  - Redo fits with ISR coefficients taken from Pythia sample (run 5763)
  - Compare results from MC runs 7323 and 7667 (only 1. Order ISR effects)

# Systematics (cont.)

| Systematic                               | MC $\Delta M_W$ (MeV)        | Data $\Delta M_W$ (MeV) | MC $\Gamma_W$ (MeV)           | Data $\Gamma_W$ (MeV) |
|------------------------------------------|------------------------------|-------------------------|-------------------------------|-----------------------|
| Beam energy                              | <b>25</b>                    | $24 \pm 8$              | 2                             | $2 \pm 15$            |
| $E_{jet} \times 0.99$                    | -7                           | $-11 \pm 14$            | 2                             | $2 \pm 22$            |
| $p_{lep} \times 0.99$                    | 4                            | $-5 \pm 35$             | 9                             | $18 \pm 56$           |
| $\delta E_{jet} \times 1.03$             | -7                           | $3 \pm 14$              | -1                            | $-6 \pm 21$           |
| $\delta p_{lep} \times 1.03$             | 0                            | $3 \pm 9$               | 9                             | $18 \pm 56$           |
| $\delta(\theta, \phi)_{jet} \times 1.05$ | 5                            | $15 \pm 10$             | -12                           | $-7 \pm 20$           |
| $\delta(\theta, \phi)_{lep} \times 1.03$ | 0                            | $0 \pm 7$               | 1                             | $-2 \pm 11$           |
| HCAL model                               | $5 \pm 27$                   |                         | $20 \pm 42$                   |                       |
| MT                                       | <b>-105</b>                  | $-36 \pm 90$            | -10                           | $-74 \pm 169$         |
| Hadronization                            | <b>36</b> $\pm 32$           |                         | $-33 \pm 66$                  |                       |
| ISR Pythia coeff.                        | 171                          | $167 \pm 24$            | 145                           | $167 \pm 50$          |
| ISR 1.Order                              | <b>72</b> $\pm 39$           |                         | <b>231</b> $\pm 62$           |                       |
| Total                                    | <b>95</b> ( <b>142</b> ) MeV |                         | <b>259</b> ( <b>309</b> ) MeV |                       |

# Conclusions

- Nice cross-check for other methods
- Good agreement between MC and data
- But still some problems
  - $\Gamma_W$  too small
  - big effect of ISR modeling
- And much to do
  - 4f systematics
  - background systematics
  - $qq\tau\nu$  channel is missing
  - ...