Luminosity measurement at $\sqrt{s} = 4.19\,\mathrm{GeV}$ via Bhabha scattering

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Charmonium Meeting 17.1.17
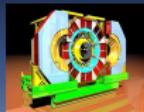
Event Selection

Good Tracks
- Cut on interaction region: $R_{xy} < 1\,\mathrm{cm}$, $R_z < 10\,\mathrm{cm}$.
- Cut on direction: $|\cos\vartheta| < 0.93$.
- For loose electron identification: $E/p > 0.7$.

Event Topology
- Number of positively charged particles: $n_+ = 1$.
- Number of positively charged particles: $n_- = 1$.
- No veto on photons.

Cuts similar to old BESII $\int \mathcal{L}\mathrm{d}t$ measurement (arXiv:1503.03408)
- $\alpha(e^+, e^-) > 175°$.
- $p_{\min} = 2 \cdot (\frac{1}{c}) \cdot \sqrt{s}/4.26 = 1.97\,\mathrm{GeV}/c$.
- $p_{\max} = 4\,\mathrm{GeV}/c$.
- $E_{\mathrm{shower}} = 1.55 \cdot \sqrt{s}/4.26 = 1.55\,\mathrm{GeV}$.
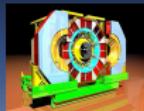
Bhabha Cross Section and Monte Carlo Generation

Calculation of σ_{Bhabha}

Numeric Monte Carlo Calculation with Babayaga3.5

Options of Babayaga3.5

- Despite energy: use joboptions file from $\sqrt{s} = 4180 \, \text{MeV}$ Monte Carlo

  /besfs/groups/psip/psipgroup/public/bes3gen/workarea702p01/TestRelease/
  TestRelease-00-00-84/4180MC/sim_ee.txt

- Also used for Monte Carlo generation.

- $E_{\text{beam}} = 2.095 \, \text{GeV}$
- $\theta_{\text{min}} = 20°$
- $\theta_{\text{max}} = 160°$
- $E_{\text{min}} = 1 \, \text{MeV}$

- maximum acollinearity: $180°$
- running alpha: **true**
- enable FSR: **true**

Result (with $5 \cdot 10^4$ events)

$\rightarrow$ unweighted $\sigma_{\text{Bhabha}} = (423.8 \pm 1.6) \, \text{nb}$

weighted $\sigma_{\text{Bhabha}} = (423.4 \pm 0.6) \, \text{nb}$

Comparison of Data and Monte Carlo
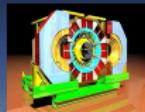
Polar Angle Distribution
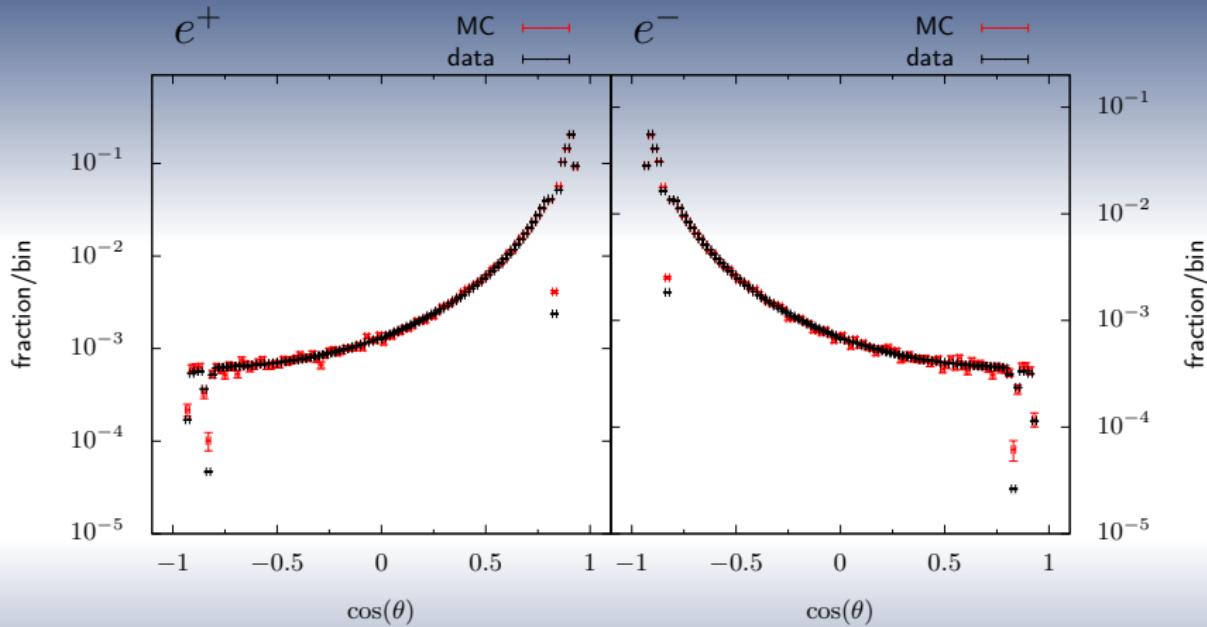
- $80\,\%$ of measured data at $\sqrt{s} = 4190\,\mathrm{MeV}$ (≈ 6600 from ≈ 8100 dst files).
- $3.1 \cdot 10^5$ Monte Carlo events.
- Both distributions are normalized.
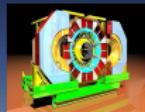
Invariant Mass (e^+e^-) and opening Angle
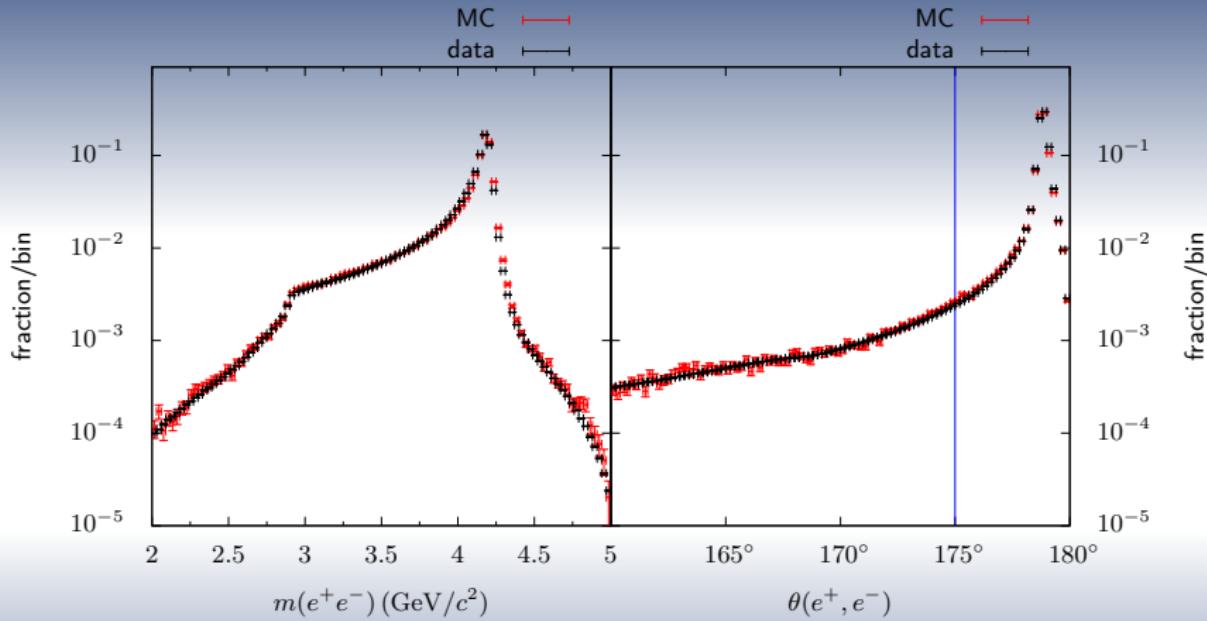
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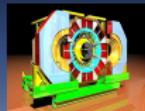
Momentum Distribution
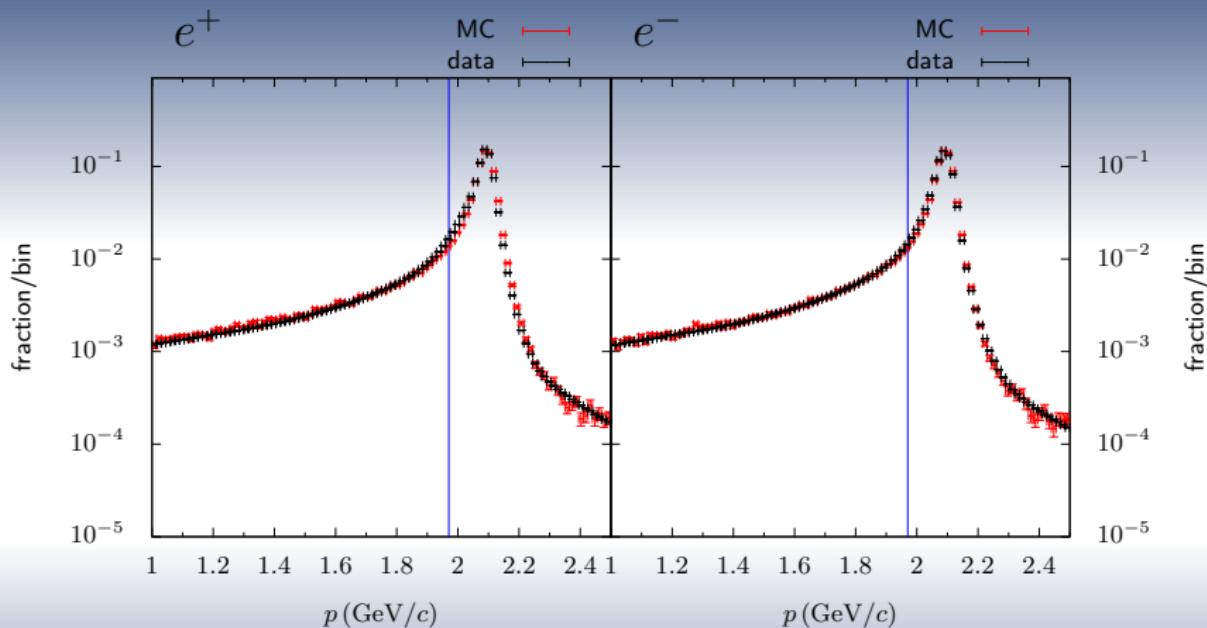
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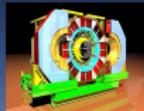
Shower Energy
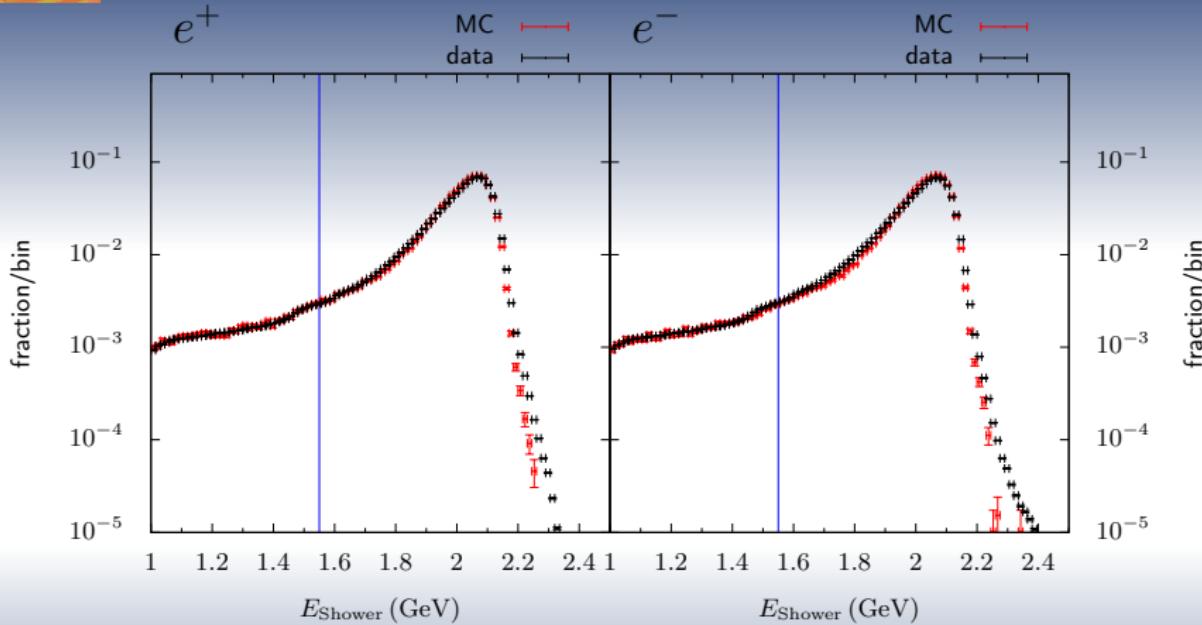
Integrated efficiency determined by $3.1 \cdot 10^5$ Monte Carlo events after all cuts
$\varepsilon = (40.2 \pm 0.2)\,\%$.
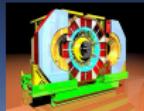
Result for integrated Luminosity

Integrated Luminosity

$$\int \mathcal{L} \mathrm{d}t = \frac{N_{\mathrm{rec}}}{\sigma_{\mathrm{Bhabha}} \cdot \varepsilon} = (395.0 \pm 1.3)\,\mathrm{pb}^{-1}$$

$$N_{\mathrm{rec}} = 6.7 \cdot 10^{7} \pm 2.7 \cdot 10^{3}$$

$$\sigma_{\mathrm{Bhabha}} = (423.8 \pm 1.6)\mathrm{nb}$$

$$\varepsilon = (40.2 \pm 0.2)\,\%$$

Only part of measured data used

- Status from 12th January.
- 6630 of currently 8129 dst files.
- $\approx 82\,\%$ of measured data.
- $\rightarrow$ Current status later today.