Compare MCGPJ and BabaYaga@NLO with experimental data

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The MCGPJ was compared with experimental data collected by BES-III when Alexey was visiting IHEP in March 2010.
Later on, in late August to September, Carlo Calame visited our institute, and made BabaYaga@NLO for BES-III. After he left, we compared BabaYaga@NLO with BES-III data too.
The work was done by Ping and a Ph.D student Mr. Boqun Wang.

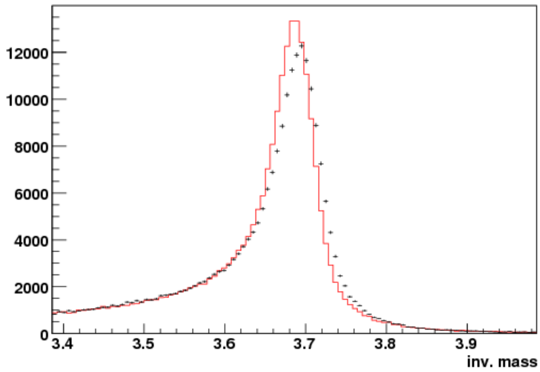
Selection criteria

The event selection criteria for Bhabha events are as follow:

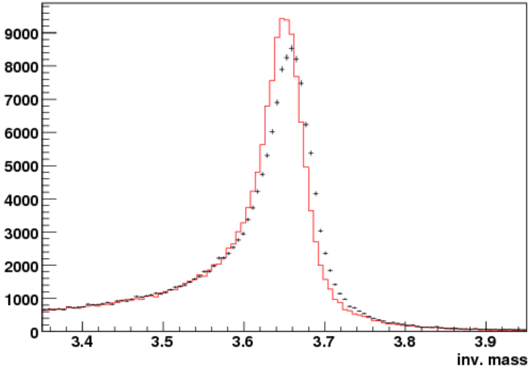
- The vertex of the charged tracks should satisfy $V_r < 1.0$ cm and $|V_z| < 5.0$ cm. The polar angle should satisfy $|cos\theta| < 0.93$.
- The number of good charged tracks is two with zero net charge.
- The angle between two charged tracks should greater than 170°.
- Define the scaled energy $X_h = M_{e^+e^-}/E_{cms}$ where $M_{e^+e^-}$ is the invariant mass of two electron. Then require $0.9 < X_h < 1.1$.
- The deposit energy of the charged tracks in EMC should larger than 1.5 GeV.
- The hit layer of the charged tracks in MUC should be zero.

Apply these cuts to 2 million MC events generated by Monte Carlo at 3.686 GeV and 3.65 GeV respective, and compare with the data of run 8093 and 8106 taken at 3.686 GeV, and run 9613 to 9779 taken at 3.65GeV respectively.

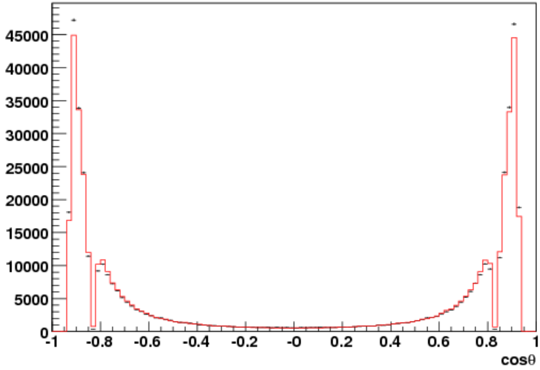
Bhabha Process: Invariant mass distribution@3.686GeV (MCGPJ)



Bhabha Process: Invariant mass distribution@3.65GeV (MCGPJ)



Bhabha Process: Angular distribution@3.686GeV (MCGPJ)



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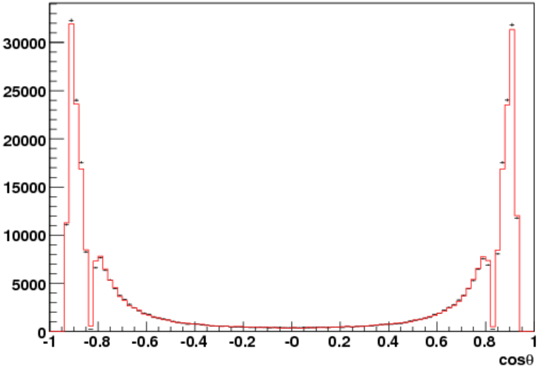
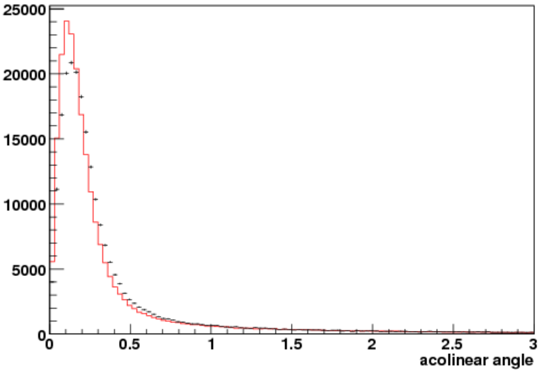


Bhabha Process: Accolinearity distribution@3.686GeV (MCGPJ)



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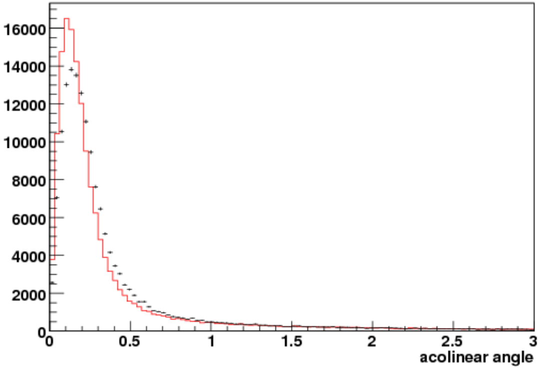
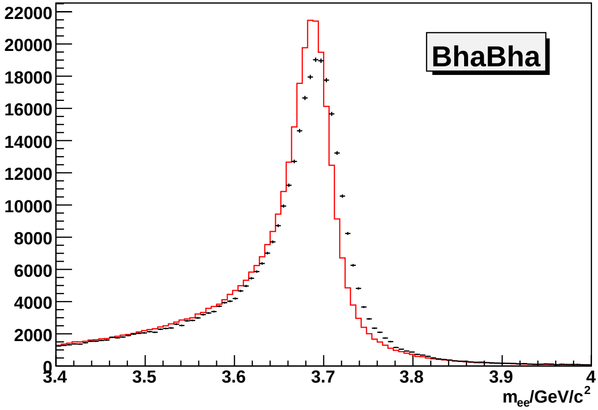


Bhabha: Invariant mass distribution@3.686GeV (BabaYaga@NLO)



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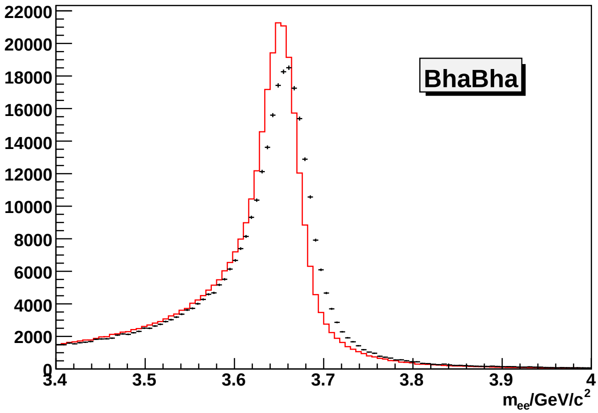

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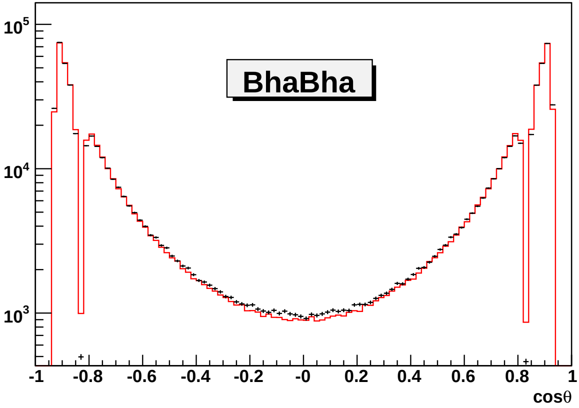
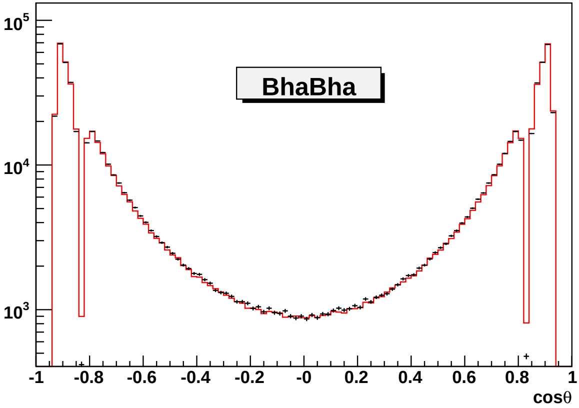
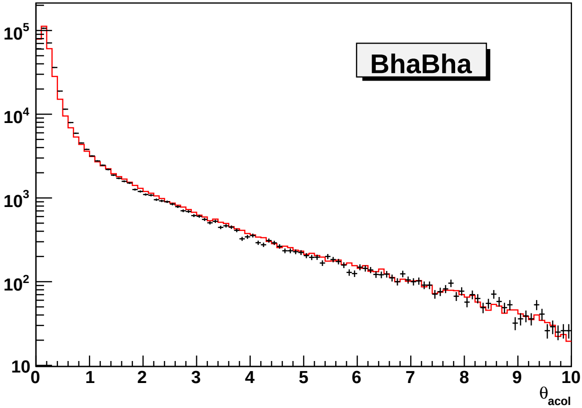


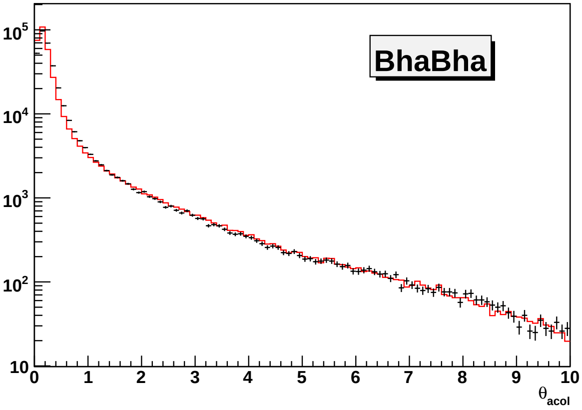
Bhabha Process: Angular distribution@3.65GeV (BabaYaga@NLO)



Bhabha Process: Accolinearity distribution@3.686GeV (BabaYaga@NLO)



Bhabha Process: Accolinearity distribution@3.65GeV (BabaYaga@NLO)



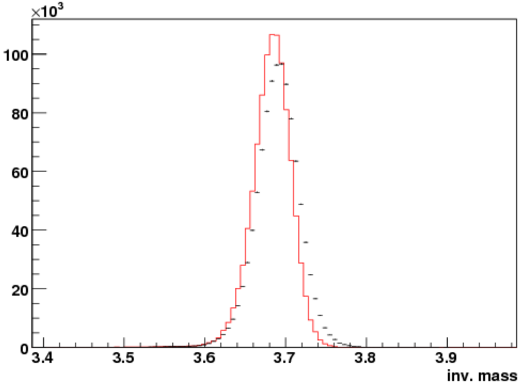
μ pair Events

The event selection criteria for μ events are as follow:

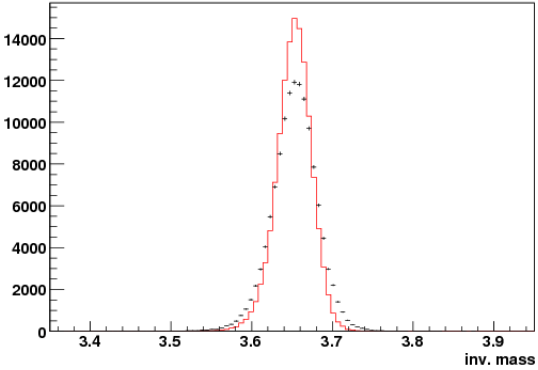
- The vertex of the charged tracks should satisfy $V_r < 1.0$ cm and $|V_z| < 5.0$ cm. The polar angle should satisfy $|cos\theta| < 0.8$.
- The number of good charged tracks is two with zero net charge.
- The angle between two charged tracks should greater than 170°.
- Define the scaled energy $X_h = M_{\mu^+\mu^-}/E_{cms}$ where $M_{\mu^+\mu^-}$ is the invariant mass of two muon. Then require $0.9 < X_h < 1.1$.
- The deposit energy of the charged tracks in EMC should less than 0.3 GeV.
- The TOF difference between two charged tracks $|\Delta tof|$ should less than 4 ns to suppress cosmic ray background.

Apply these cuts to 2 million MC events generated by Monte Carlo at 3.686 GeV and 3.65 GeV respective, and compare with the data of run 8093 to 9025 taken at 3.686 GeV, and run 9613 to 9779 taken at 3.65GeV respectively.

Mu pair: Invariant mass distribution@3.686GeV (MCGPJ)



Mu pair: Invariant mass distribution@3.65GeV (MCGPJ)



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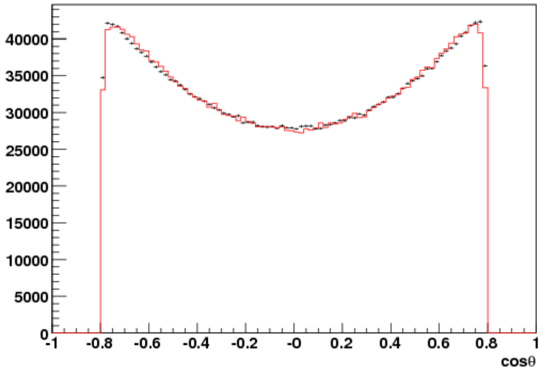

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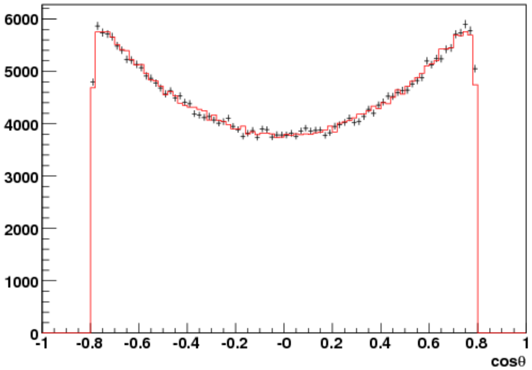

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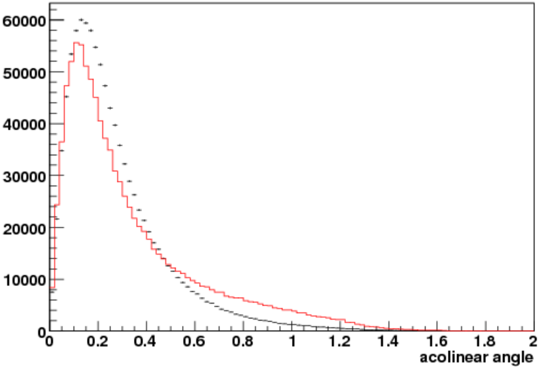

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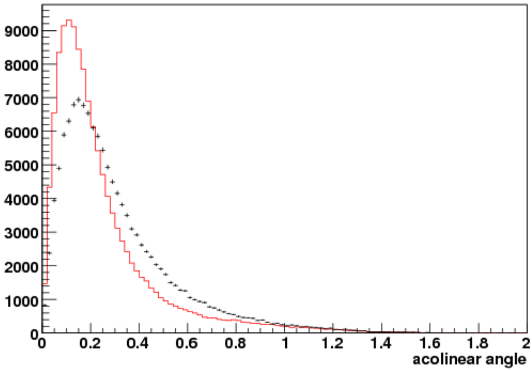
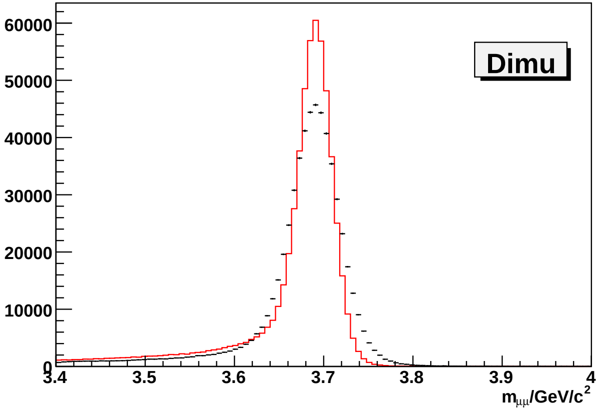


Mu pair: Invariant mass distribution@3.686GeV (BabaYaga@NLO)



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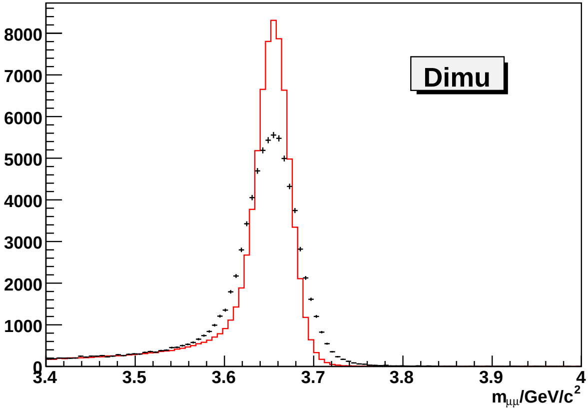

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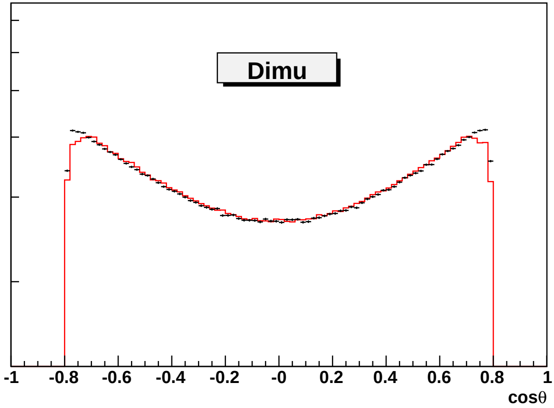

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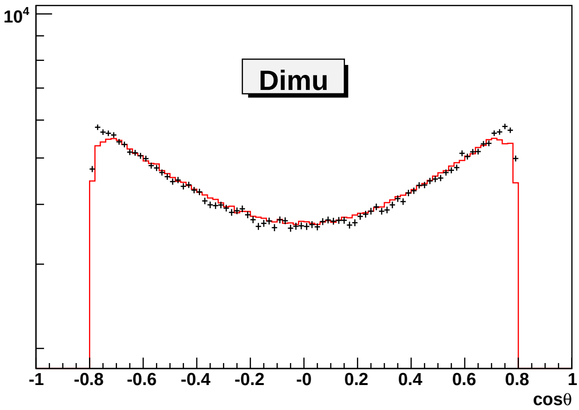

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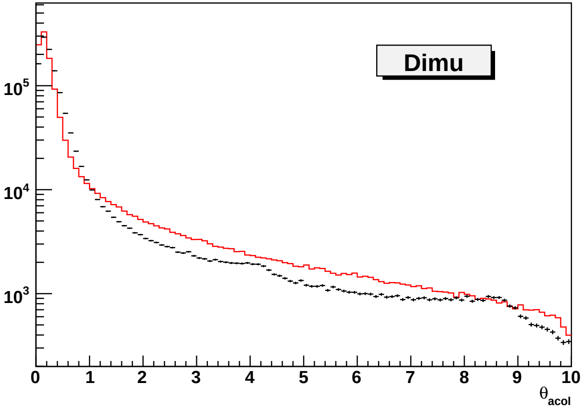

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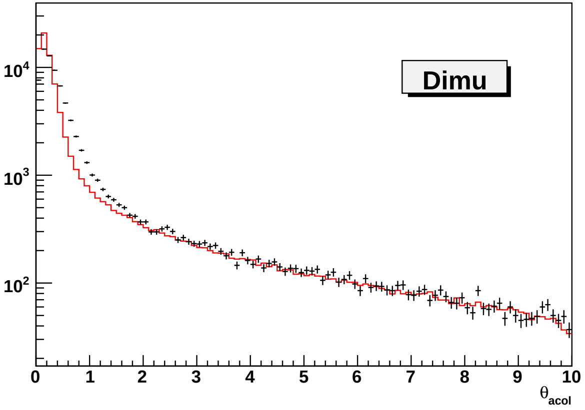


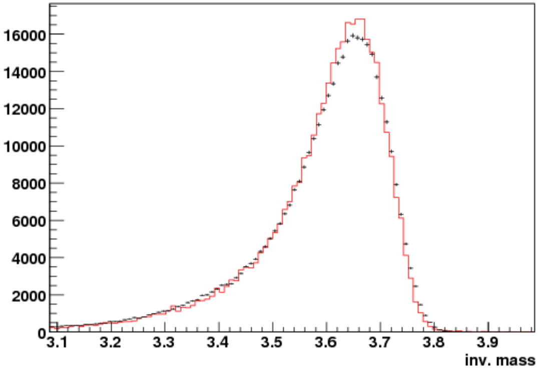
$\gamma\gamma$ events

The event selection rules for Two Gamma events are as follow:

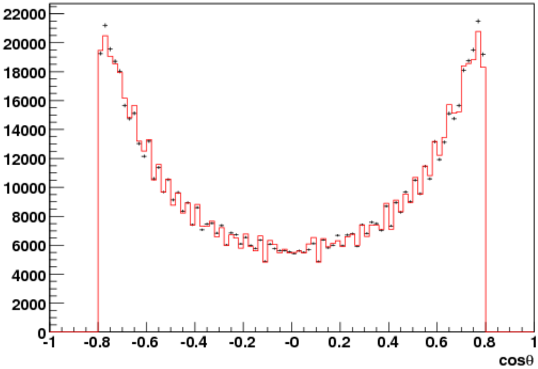
- The number of good charged tracks is zero.
- The number of good photon is 2. A neutral cluster is considered to be a good photon candidate if the following requirements are satisfied: the deposited energy is greater than 25 MeV in Barrel EMC ($|\cos\theta| < 0.8$), $>$ 50 MeV in the Endcap EMC ($0.84 < |\cos\theta| < 0.92$); and the angle between the cluster and the nearest charged track is required to be greater than 10°. We also require 0$<$t$<$14, here t in unit of 50 ns is the time information from the EMC to suppress electronic noise and energy deposits unrelated to the event.
- The polar angle of good photon should satisfy $|\cos\theta| <0.8$.
- The acollinear angle between two photon should be less than 5°.
- The energy of good photon shoud be greater than 1.5GeV.

Apply these cuts to 100k MC events generated by Monte Carlo at 3.686 GeV and the data from run 8093 to 9025.

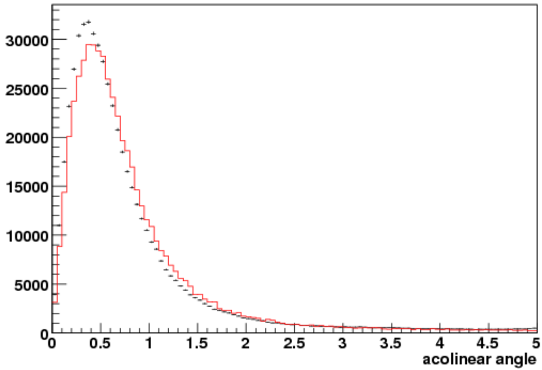
$\gamma\gamma$: Invariant mass distribution@3.686GeV (MCGPJ)



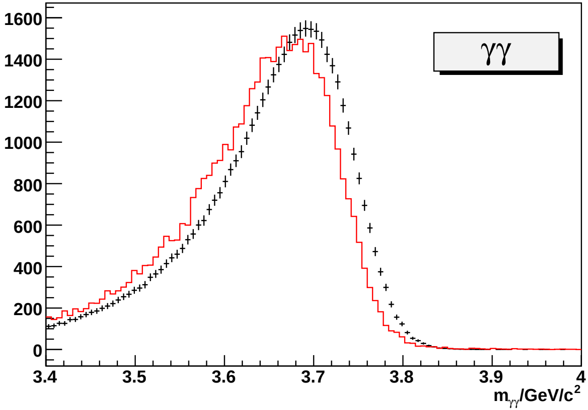
$\gamma\gamma$: Angular distribution@3.686GeV (MCGPJ)



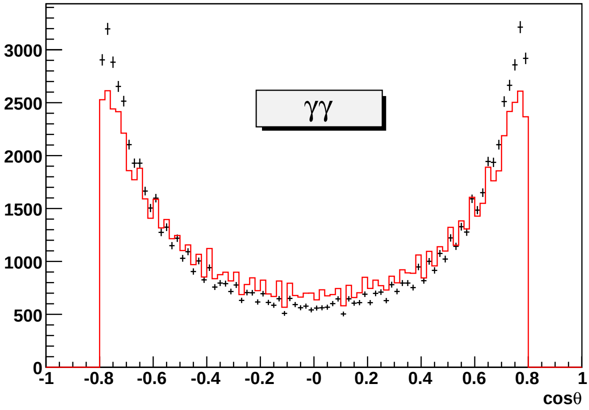
$\gamma\gamma$: Accolinearity distribution@3.686GeV (MCGPJ)



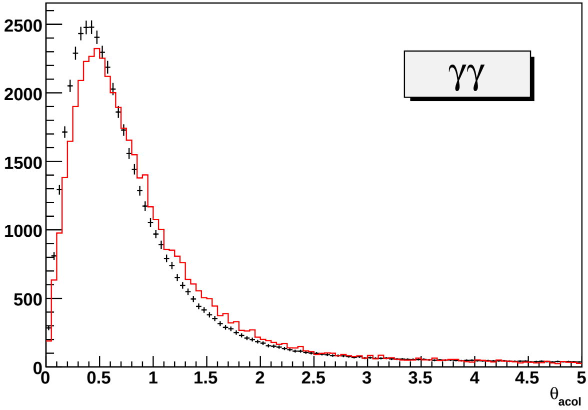
$\gamma\gamma$: Invariant mass distribution@3.686GeV (BabaYaga@NLO)



$\gamma\gamma$: Angular distribution@3.686GeV (BabaYaga@NLO)



$\gamma\gamma$: Accolinearity distribution@3.686GeV (BabaYaga@NLO)



Summary

- `MCGPJ` and `BabaYaga@NLO` are used at BES-III.
- The distributions are consistent with experimental data for the three proceses: bhabha, mu pair, and $\gamma\gamma$.
- `BabaYaga@NLO` will be used for high precision luminosity measurement at BES-III.
- `MCGPJ` and `BabaYaga@NLO` will be highly valuable for BES-III.

A question on PHOKARA

I have been asked to write a MC program based on PHOKHARA since 2008 on

$e^+e^- \to \gamma_{ISR} + \chi_c$

then

$\chi_c \to \gamma J/\psi$.

Question :

Do I need to symmetrize the γ decayed from χ_c with the γ_{ISR}?

Since the γ from χ_c decay, in principle, can be distingished from γ_{ISR}.