MCGPJ status

(MC Generator Photon Jets)

Fedor Ignatov
BINP, Novosibirsk

19th Radio MonteCarlo WG, Mainz

MC generators

High experimental precision relies on high theoretical precision of MC tools:

Several MC generators available with 0.1-0.5% precision.
Most recent e+e- -> e+e- (gamma) generators
include exact O(α) + some parts from High Order terms:

MCGPJ (VEPP-2000) – accuracy 0.2% for e+e-, π+π- etc
1 real photon (from any particle)
+ photon jets along all particles (collinear Structure function)

BabaYaga@NLO (KLOE,BaBar) - 0.1% for e+e-, μ+μ-
Parton shower approach: n photons with angle distribution
interference for 1 photon radiation

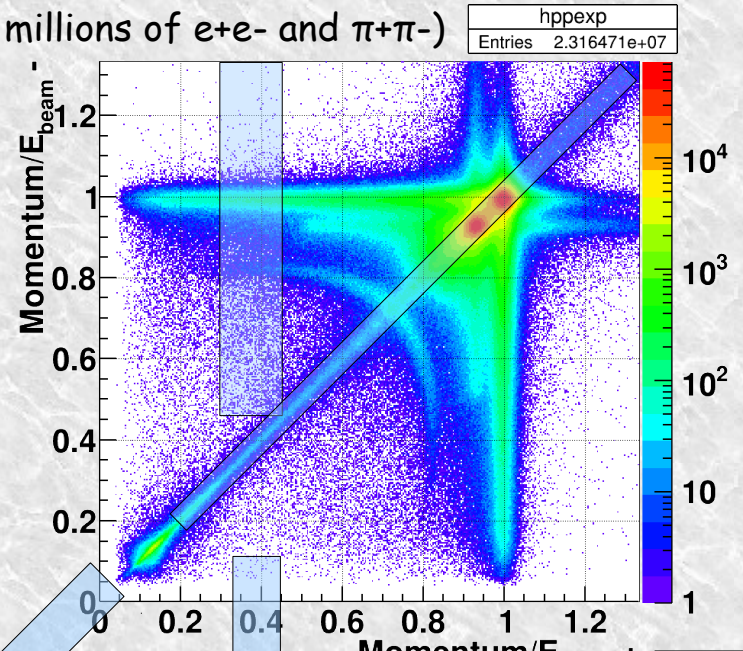
BHWIDE (LEP) – 0.5% (~0.1%?), e+e–
n real photons by Yennie-Frautschi-Suura (YFS) exponentiation method
interference on O(α) level

And there are other generators for different channels:
PHOKHARA (KLOE) μ+μ-, π+π- etc
KKMC (μ+μ-),
etc

MC generator, MCGPJ

High experimental precision relies on high theoretical precision of MC tools:

All events from RHO2013 scan
(~ 10 millions of e+e- and π+π-)



MCGPJ generator is used by Novosibirsk group

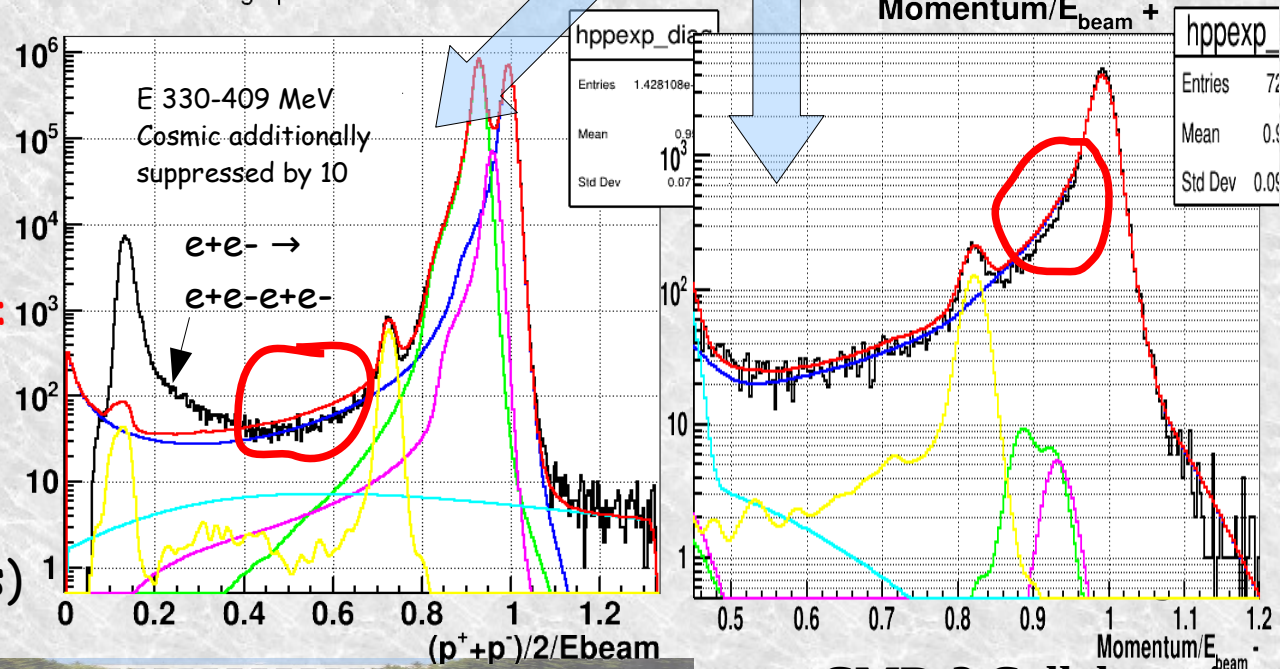
High statistics allowed us to observe
a discrepancy in momentum distribution
of experimental data vs theoretical spectra from MCGPJ

The source of the discrepancy is understood

Several steps for upgrading MCGPJ were done:

photon jet angular distribution,
rebalance of jet compensator,
Structure function for FSR,
…

some question still under inspection:
Matching between
exact Berends 1 photon vs
always 4 jet configuration
(Positive balance of Matrix elements)



MCGPJ modifications

Several steps for upgrading MCGPJ were done:

photon jets angular distribution with proper kinematic: $f(c=\cos(\theta), x=\omega/E) \sim \frac{1}{pk} - \frac{x(1-x)}{1+(1-x)^2}\frac{m^2}{(pk)^2}$

$$\sim \frac{1}{1-\beta c} - \frac{1-x}{1+(1-x)^2} * \frac{1-\beta^2}{(1-\beta c)^2}$$

Born cross-section boost shift rewritten with virtuality of lepton

? how well factorization is working now(|ISR|*|BornShift|*|FSR|)

In case jets along lepton → leptons was near real, but now it is not

Structure function for FSR: To be consistent with single photon behavior, it started to be used relative to energy of particle after radiation:

$$D(z,s) \sim \frac{1}{2} b (1-z)^{\frac{b}{2}-1} \ldots., b = \frac{2\alpha}{\pi}(L-1), L = \log\left(\frac{s}{m^2}\right), s \to s(1-x)^2$$

rebalance of jet compensator:

not necessary to keep minimal cone θ from which exact 1 photon Berends is used

some question still under inspection: (some effects of my(not theorist) not understanding at level ~ 0.05%)

1)? is it consistent definition of Berneds soft part versus Jets soft part….

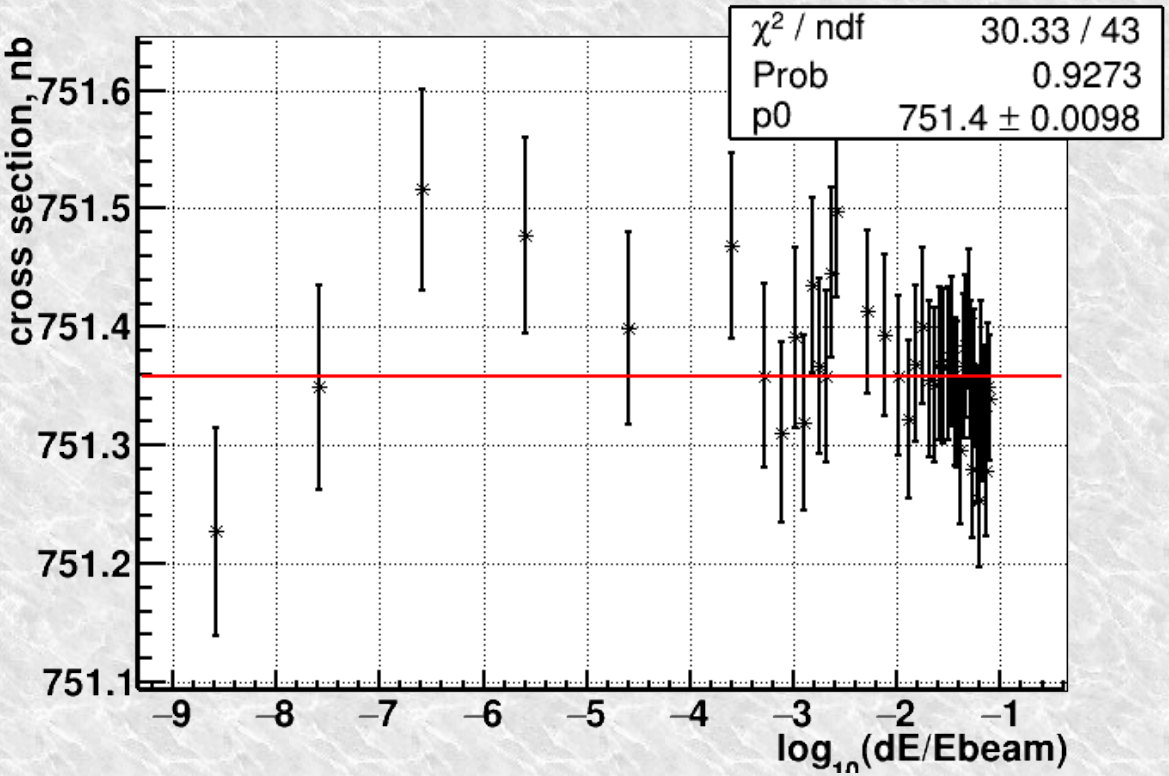
2) problem to construct generator…, now can be used in weighting mode

No positive balance of Matrix element between exact Berends 1 photon vs always 4 jet configuration: how to subtract only 1 photon from always 4 jet event…

Consistency checks

different cut on soft part

Very good test for consistency
(sensitive to everything…)



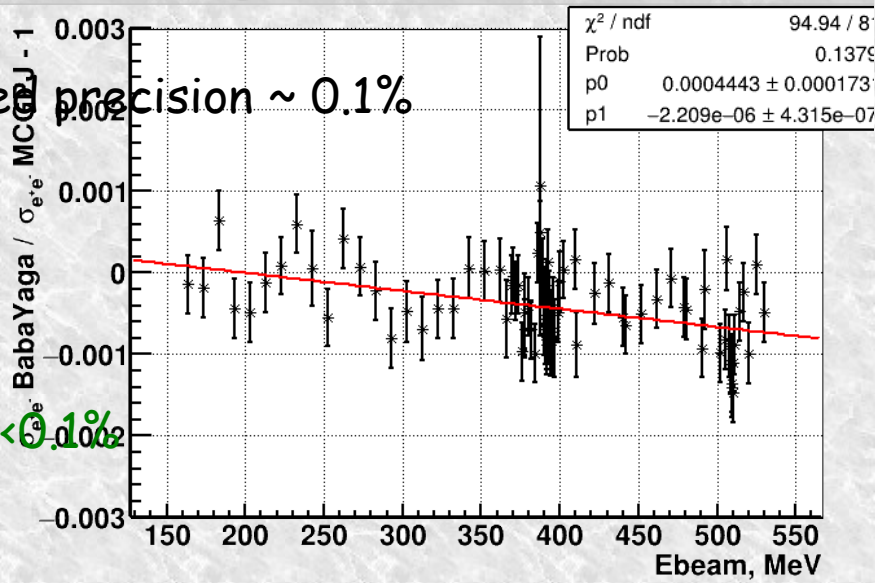
Original exact 1 photon Berends paper doesn't have exact soft part...
at level ~ $\alpha/\pi * \Delta$ (x2*(L-1))
If you have link to paper with exact 1-photon full formulas, please send me.

BabaYaga@NLO vs MCGPJ generators

Only two available e+e- → e+e- generators with claimed precision ~ 0.1%

BabaYaga@NLO used by KLOE, BaBar

MCGPJ used by Novosibirsk group



Integrated cross-section was consistent at the level <0.1%

(0.0-0.7% for 2E = 0.15-0.5 GeV)

In Selection cuts:

$|\Delta\varphi|<0.15$, $|\Delta\theta|<0.25$, $1< \theta_{average} <\pi -1$, $P^{+-} >0.45\ E_{beam}$

Calculated cross-section at E beam=391.48 MeV

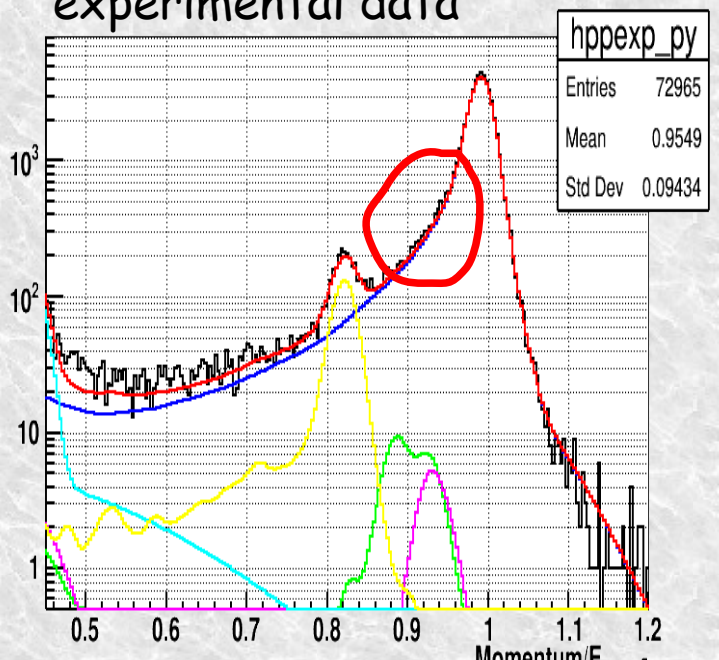
MCGPJ : 751.671 +- 0.034 nb

BabaYaga@NLO : 751.218 +- 0.059 nb

Δ ~ 0.06%

Recent MCGPJ modifications change cross-section: -0.06%

BabaYaga better describes momentum spectrum of experimental data



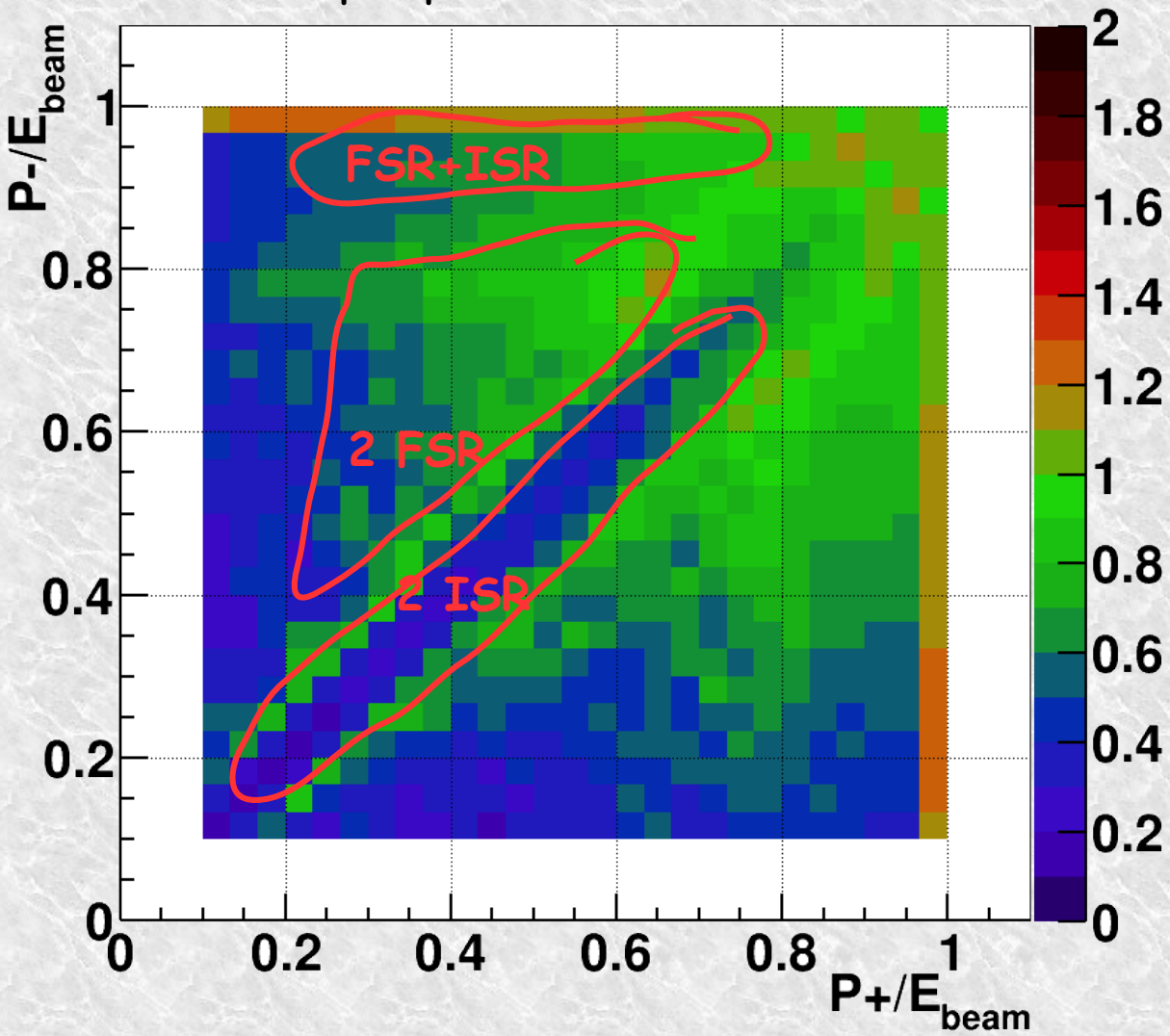
BabaYaga @ NLO vs MCGPJ

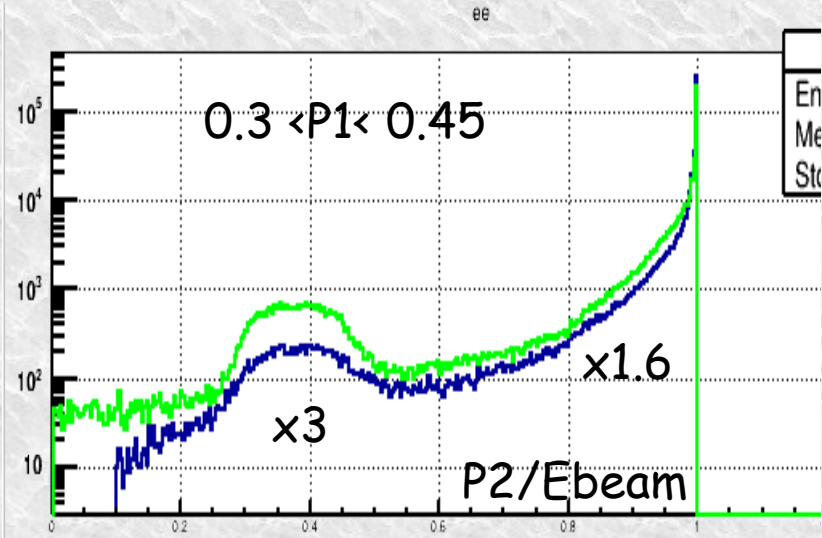
Ebeam = 391.48 MeV

Comparison of momentum spectra from generators

BabaYaga divided by MCGPJ

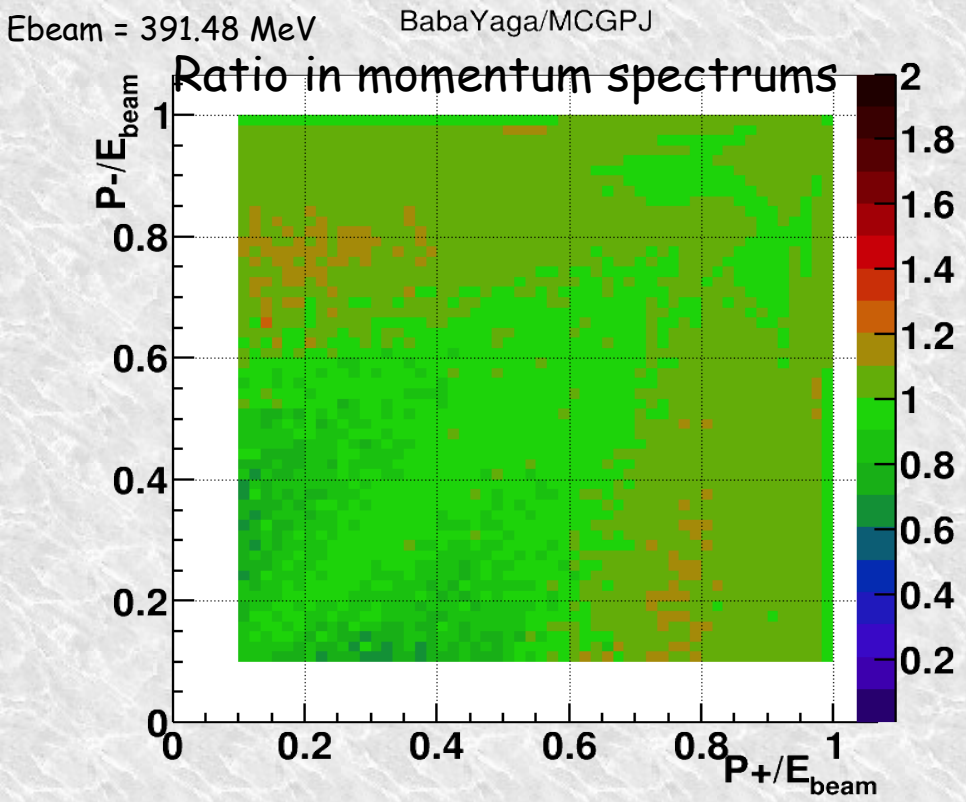
$$\frac{\partial^2\sigma}{\partial p^+ \partial p^-}\ \text{BabaYaga/MCGPJ}$$

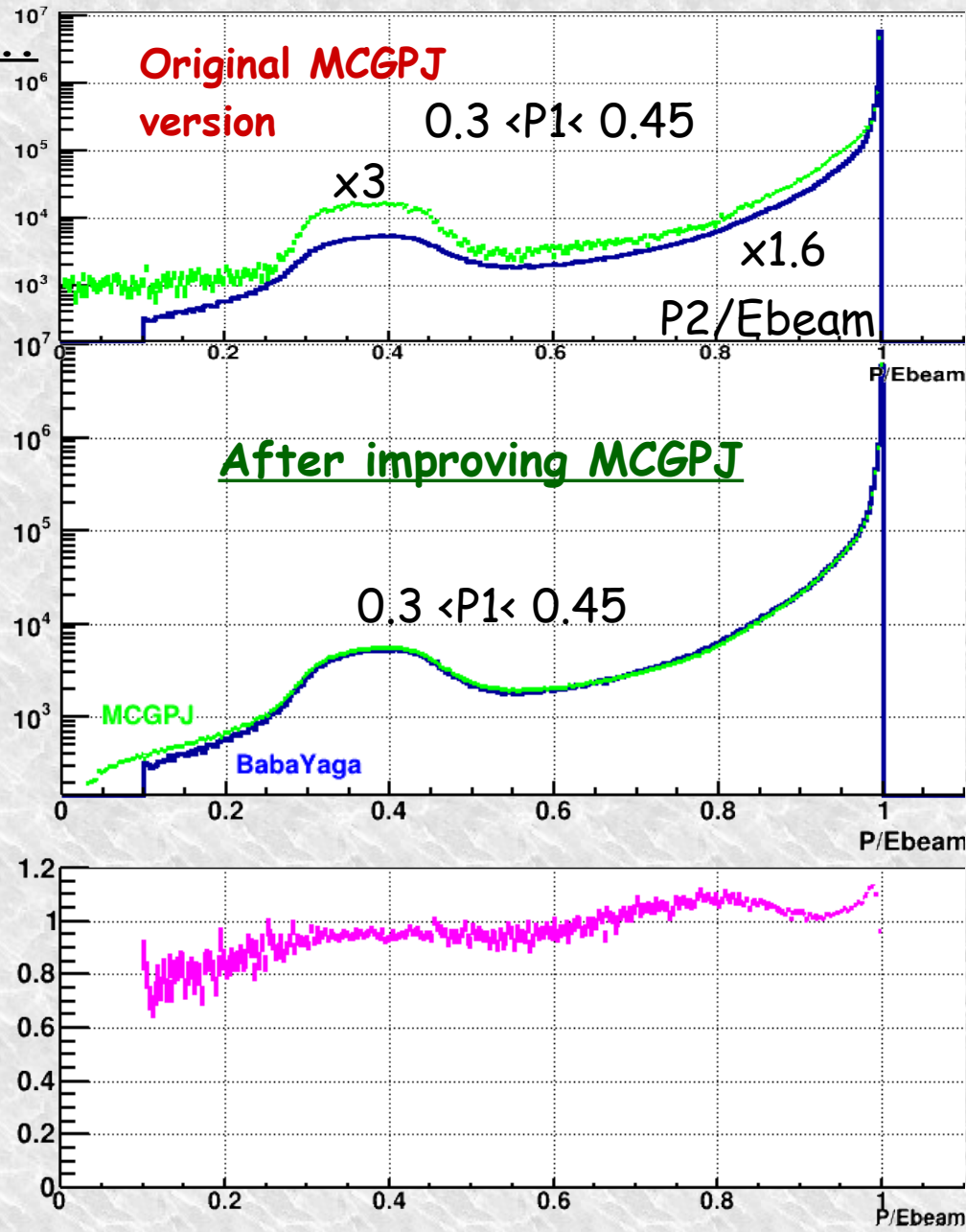




MCGPJ vs BabaYaga spectrums

After adding angle distribution for jets, etc ...





Momentum spectrum still disagree at level ~ 10%

Need more experimental data for cross-check

We need more theoretical help

Result in |Fπ| systematic by momentum

→ 0.0 - 0.4%

For precision ~<0.1% necessary to have exact e+e-→e+e-(γγ) NNLO generator

MCGPJ vs BabaYaga spectrums

After adding angle distribution for jets, etc ...

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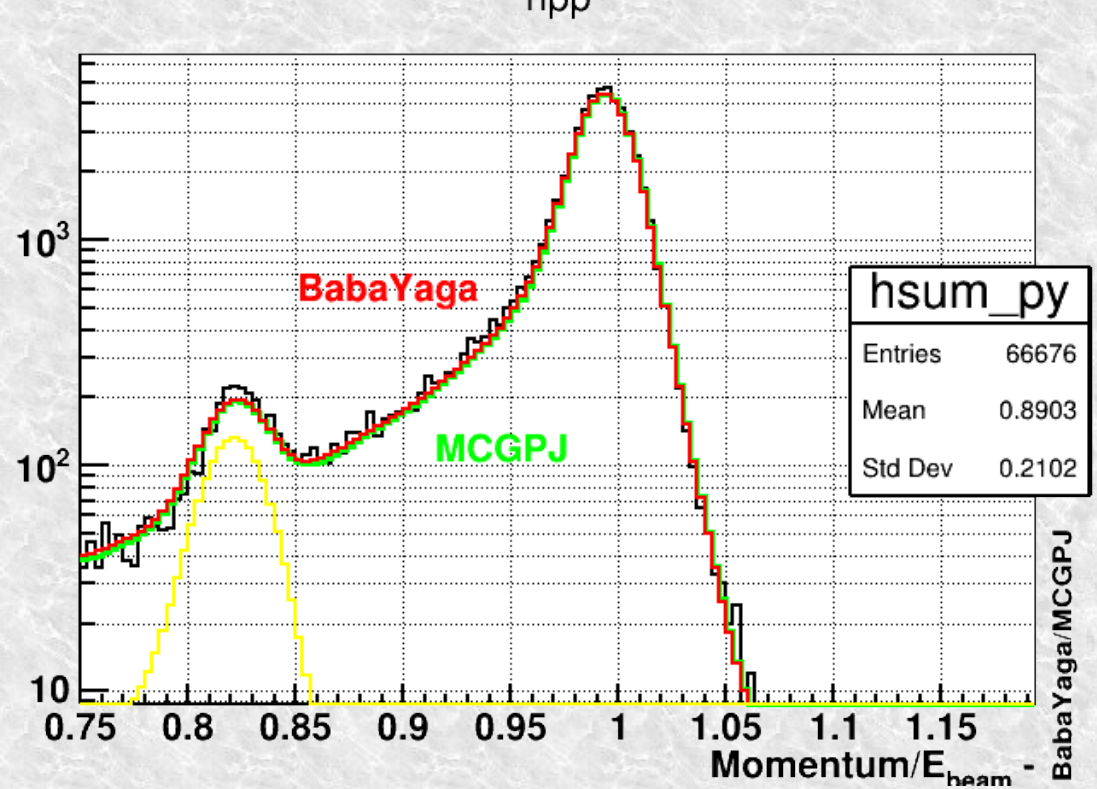
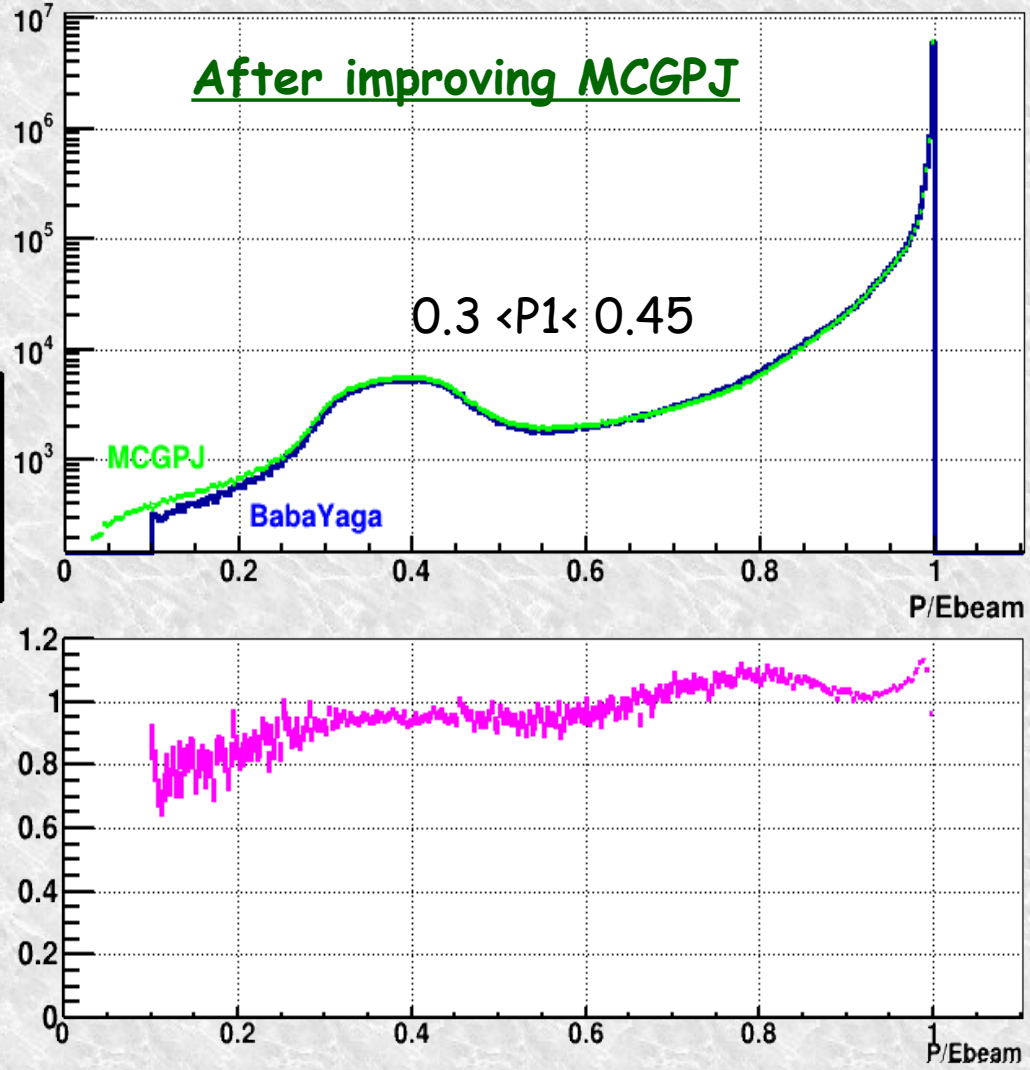




Can't separate models...

~half of trail from bremsstrahlung,

Biggest difference at 3π peak

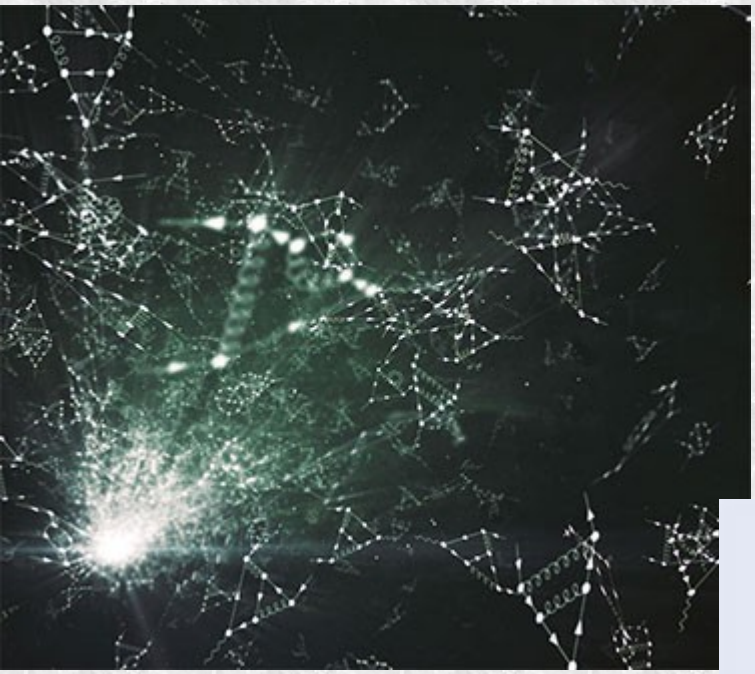
Summary

It is great that we have at least few independent MC generators

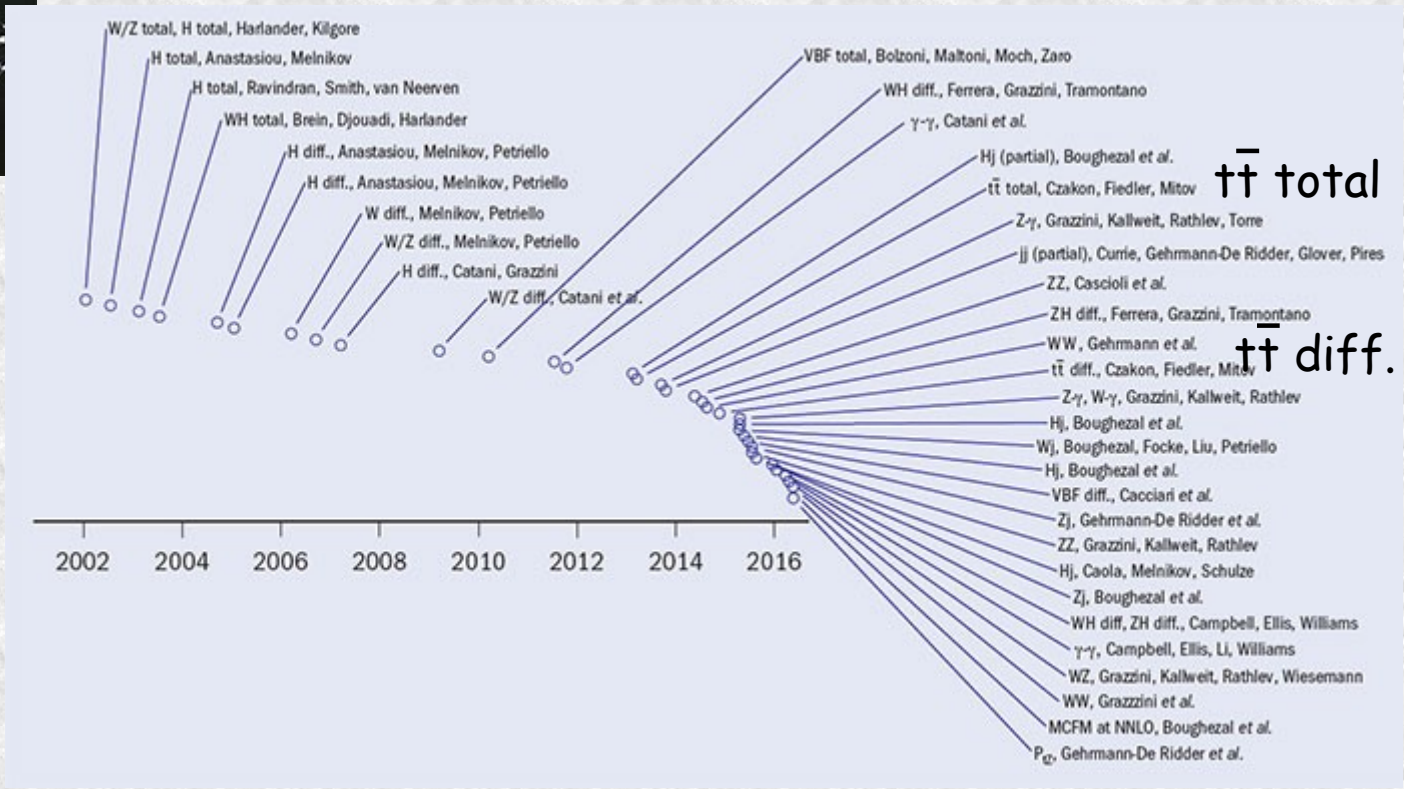
MCGPJ still is under improvements
Inconsistency in momentum spectra of MCGPJ vs BabaYaga@NLO at ~ 10%

To drop all doubts and If we want to go below **precision ~<0.1%:**
I think it is necessary to have exact e+e-→e+e-(γγ) NNLO generator
(better produced semi-automatically)

CERN Courier, Mar 17, 2017
“The two-loop explosion”

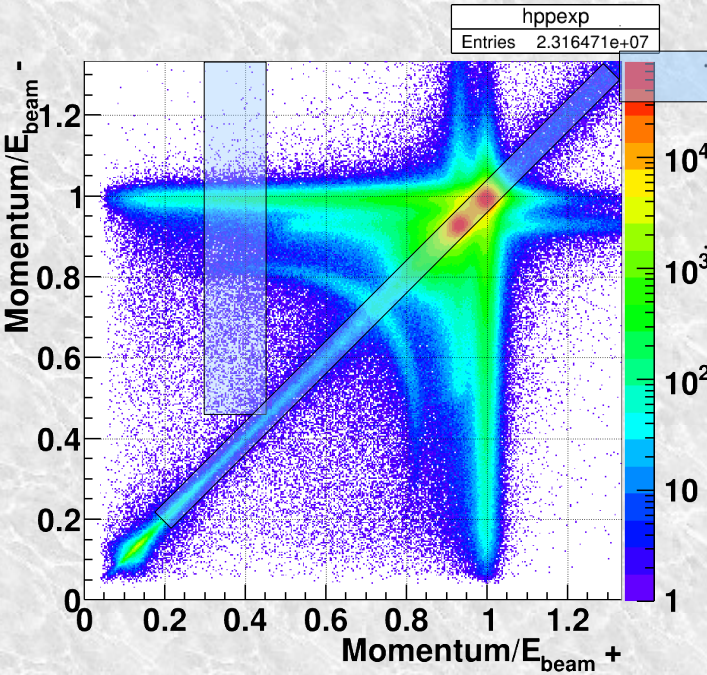


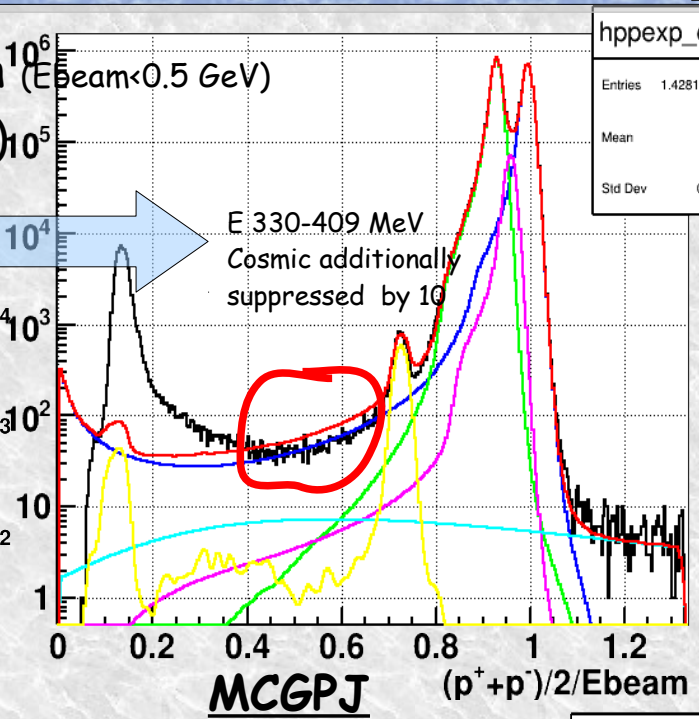
During last decade number of NNLO calculation in QCD is growing, probably QED is simpler

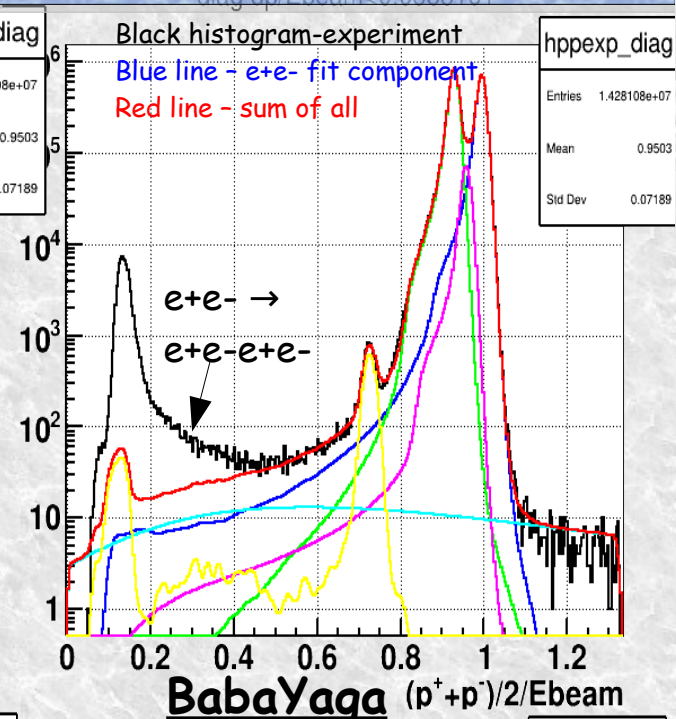


BabaYaga @ NLO vs MCGPJ vs experiment

All events from RHO2013 scan
(~ 10 millions of e+e- and π+π-)







BabaYaga better describe experimental data

MCGPJ modification was done with adding angular distribution to photon jets (some question still under inspection)