study of $\gamma \to e^+e^-$ conversion

Changchun Zhang

IHEP, Beijing

Dec 25, 2001

Outline

- **Introduction**
- **Software and environment**
- $\gamma \to e^+e^-$ **reconstruction**
- γ **Conversion rate**
- **Inclusive** γ **spectrum**
- **Summary**

1. Introduction

- $J\psi$ radiative decays
- diffculty caused by BSC E resolution, 21%
- much improved if using precise $e^{\pm}$ momentum
- First study by Dr Li HB (talk at BES2000)

2. Software and environment

Klamcorr.f is adapted to make γ reconstruction

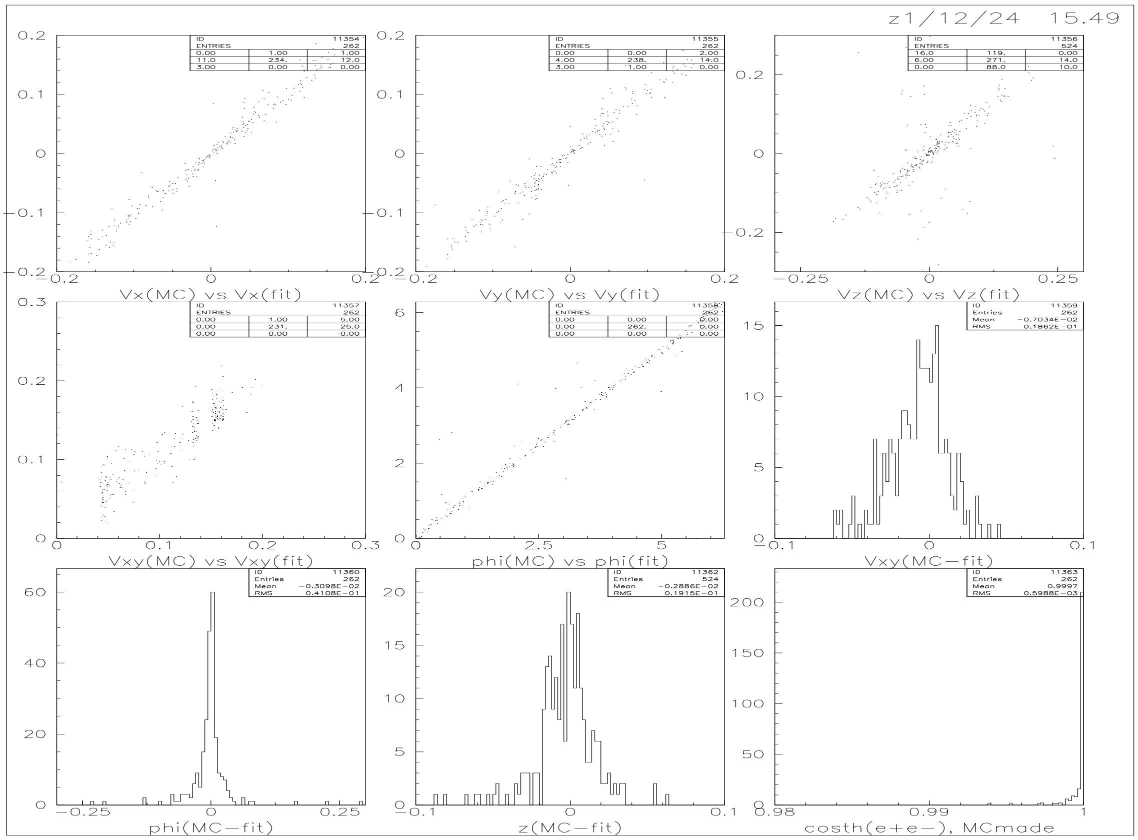
- **Klamcorr (K_s^0,Λ)**
  - **Klamcopy : RMAX = 40 cm, TMAX = 200 MeV for γ**
  - **e^+e^- go along same direction due to $M_\gamma = 0$**
  - **Two circles of e^+e^- should touch at a point**
  - **Take average, if two crossing points**

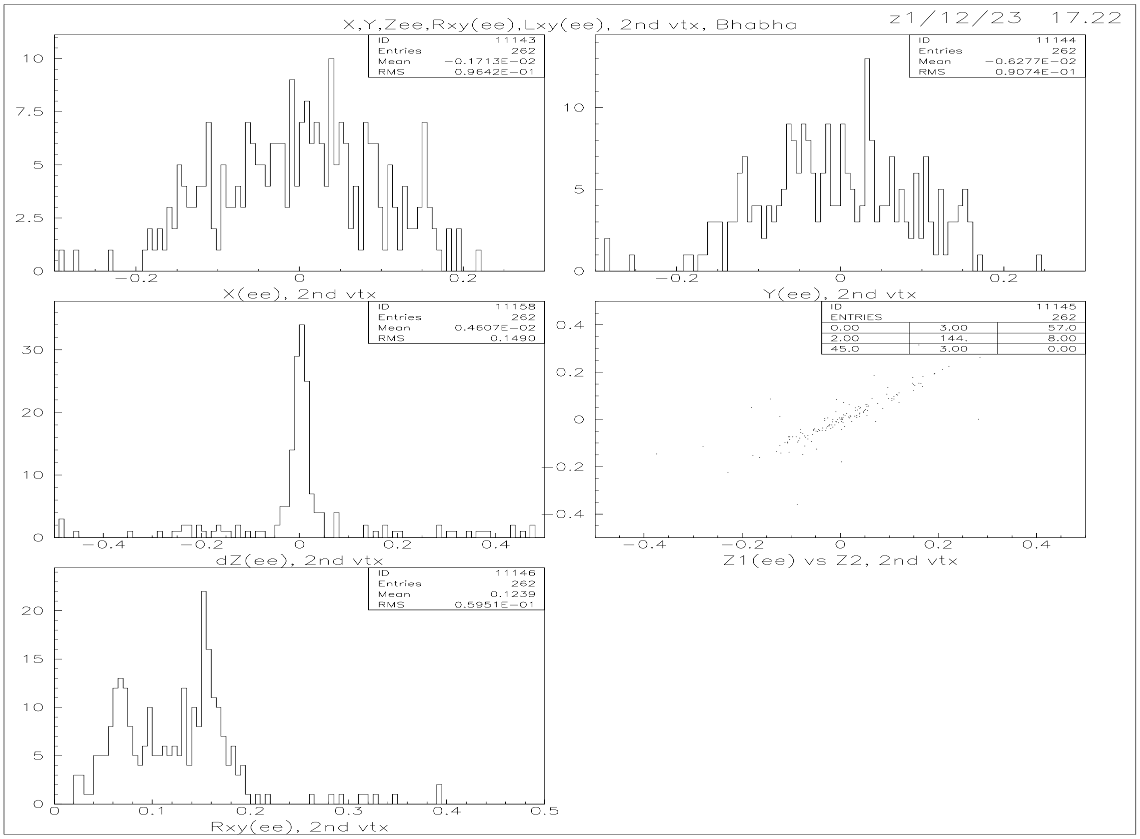
- **Events and environment**
  - **SIMBES 6-Dec-01 version (Chen JC)**
  - **SIMBES :** $3 \times 10^6 J\psi \to \mu\mu(\gamma)$ **events**
  - **Sober :** $3 \times 10^6 J\psi \to ee(\gamma)$ **events**
  - **BES-II 50M data**
  - **PC Linux 7.2**
  - **BES v103 library**

3. $\gamma \to e^+e^-$ reconstruction

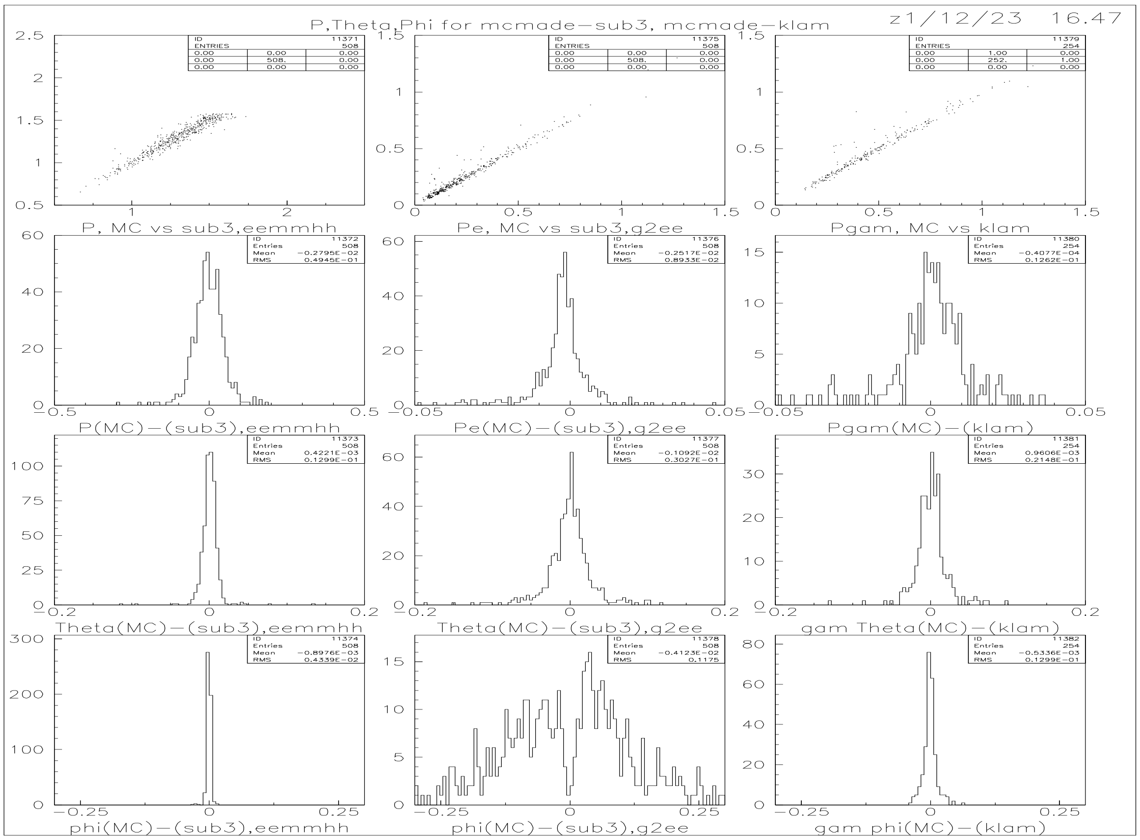
SIMBES MC events used for this study

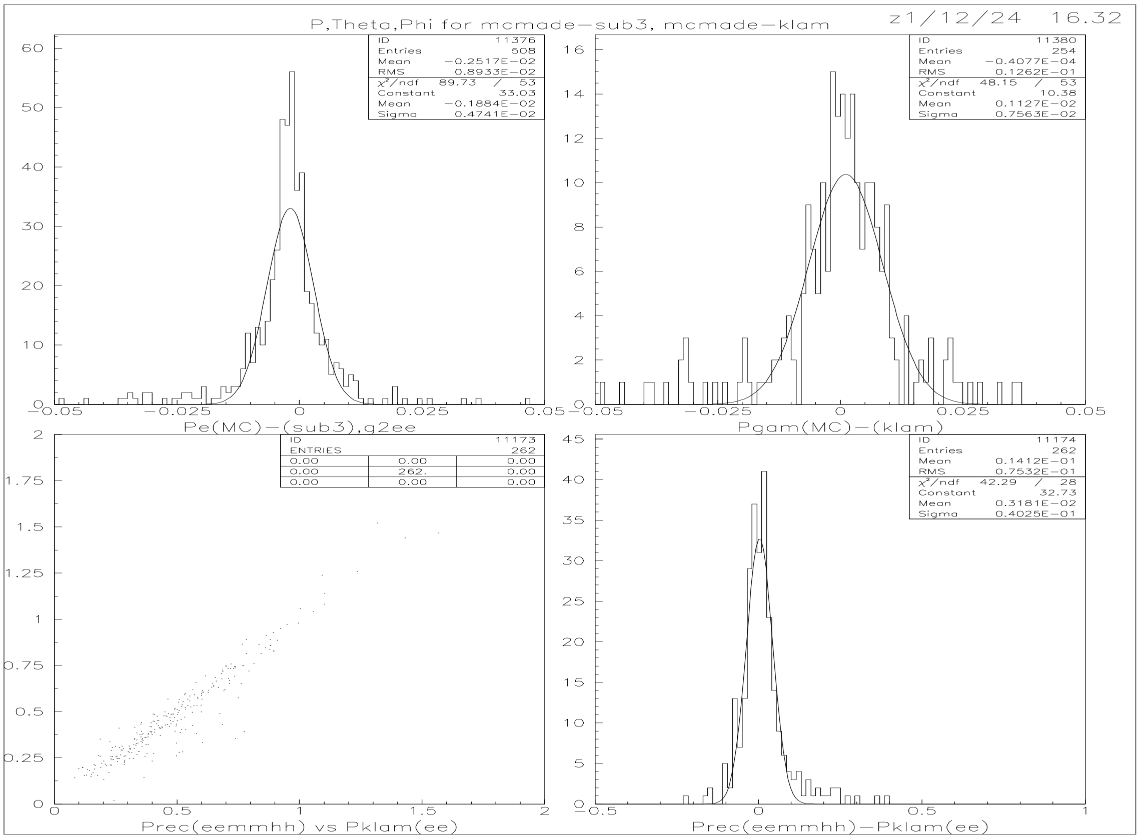
- **Crossing point and** R_{xy}
  - **SIMBES :** $\gamma\mu\mu$
  - **mcmade - klam rec**
  - σ_{xy} **= 1.9 cm,** σ_z **= 2 cm**
  - **Good resolution in** ϕ **:** σ_ϕ **= 2 deg**


z1/12/24 15.49
Vx(MC) vs Vx(fit)
Vy(MC) vs Vy(fit)
Vz(MC) vs Vz(fit)
Vxy(MC) vs Vxy(fit)
phi(MC) vs phi(fit)
Vxy(MC−fit)
phi(MC−fit)
z(MC−fit)
costh(e+e−), MCmade
ID 11359 Entries 262 Mean −0.7034E−02 RMS 0.1862E−01
ID 11360 Entries 262 Mean −0.3098E−02 RMS 0.4108E−01
ID 11362 Entries 524 Mean −0.2886E−02 RMS 0.1915E−01
ID 11363 Entries 262 Mean 0.9997 RMS 0.5988E−03

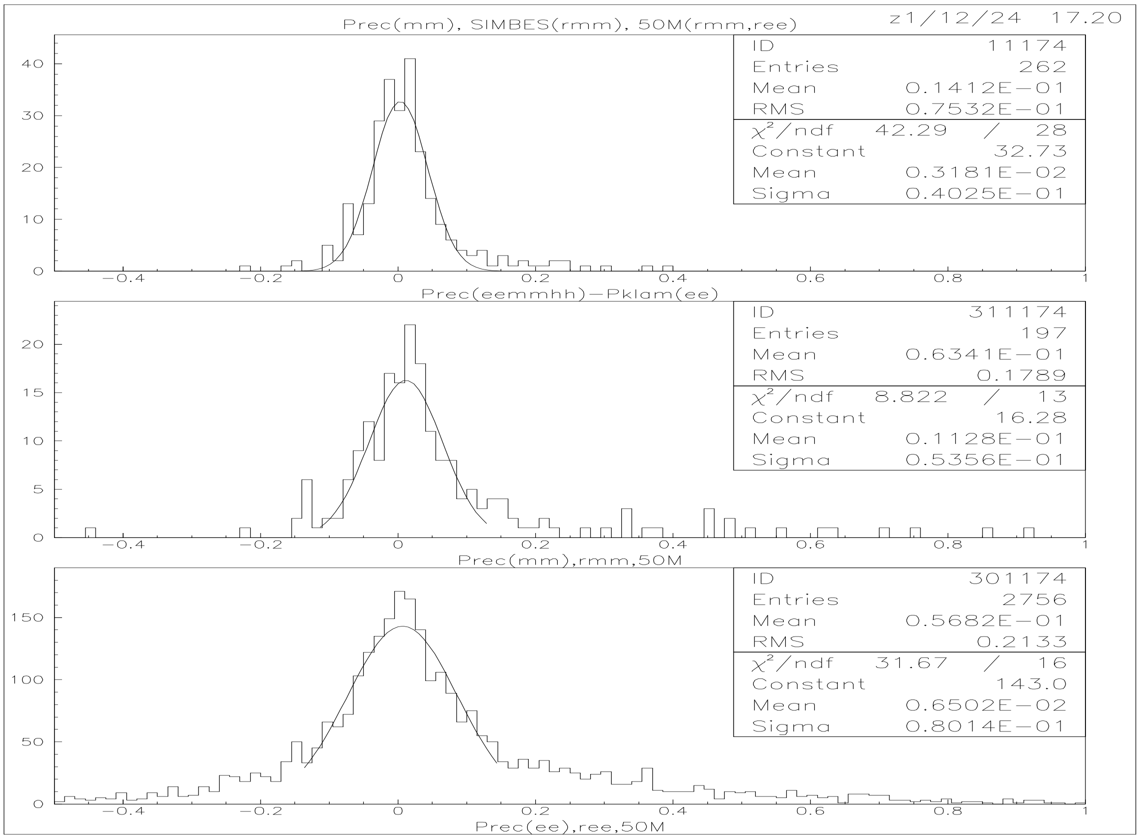

X,Y,Zee,Rxy(ee),Lxy(ee), 2nd vtx, Bhabha
z1/12/23 17.22
X(ee), 2nd vtx
Y(ee), 2nd vtx
dZ(ee), 2nd vtx
Z1(ee) vs Z2, 2nd vtx
Rxy(ee), 2nd vtx
ID 11143 Entries 262 Mean −0.1713E−02 RMS 0.9642E−01
ID 11144 Entries 262 Mean −0.6277E−02 RMS 0.9074E−01
ID 11158 Entries 262 Mean 0.4607E−02 RMS 0.1490
ID 11145 ENTRIES 262
ID 11146 Entries 262 Mean 0.1239 RMS 0.5951E−01

- γ energy at conversion point
  - P_μ = mcmdae vs trklst
  - P_e = mcmdae vs trklst
  - P_γ = mcmade vs klam rec
  - ϕ
    - big difference in ϕ_e
    - good resolution in ϕ_γ
  - γ energy resolution
    - $E_\gamma < 1$ GeV
    - σ_{E_γ} = 7.6 MeV from mcmade - klam rec
    - σ_{E_γ} = 40 MeV from mcmade - trklst (recoiling γ against $\mu\mu$)

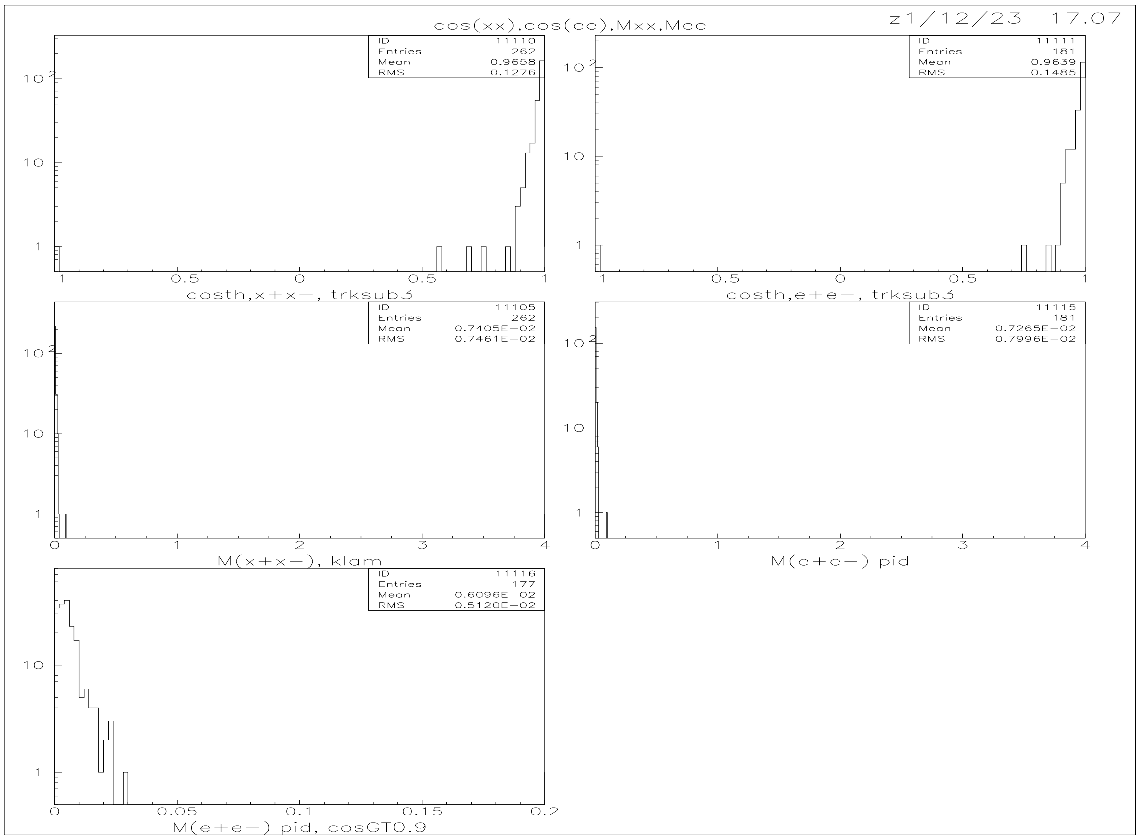

P,Theta,Phi for mcmade-sub3, mcmade-klam
z1/12/23 16.47
P, MC vs sub3,eemmhh
Pe, MC vs sub3,g2ee
Pgam, MC vs klam
P(MC)-(sub3),eemmhh
Pe(MC)-(sub3),g2ee
Pgam(MC)-(klam)
Theta(MC)-(sub3),eemmhh
Theta(MC)-(sub3),g2ee
gam Theta(MC)-(klam)
phi(MC)-(sub3),eemmhh
phi(MC)-(sub3),g2ee
gam phi(MC)-(klam)


P,Theta,Phi for mcmade-sub3, mcmade-klam
z1/12/24 16.32
ID 11376
Entries 508
Mean -0.2517E-02
RMS 0.8933E-02
χ^2/ndf 89.73 / 53
Constant 33.03
Mean -0.1884E-02
Sigma 0.4741E-02
ID 11380
Entries 254
Mean -0.4077E-04
RMS 0.1262E-01
χ^2/ndf 48.15 / 53
Constant 10.38
Mean 0.1127E-02
Sigma 0.7563E-02
Pe(MC)-(sub3),g2ee
Pgam(MC)-(klam)
ID 11173
ENTRIES 262
ID 11174
Entries 262
Mean 0.1412E-01
RMS 0.7532E-01
χ^2/ndf 42.29 / 28
Constant 32.73
Mean 0.3181E-02
Sigma 0.4025E-01
Prec(eemmhh) vs Pklam(ee)
Prec(eemmhh)-Pklam(ee)

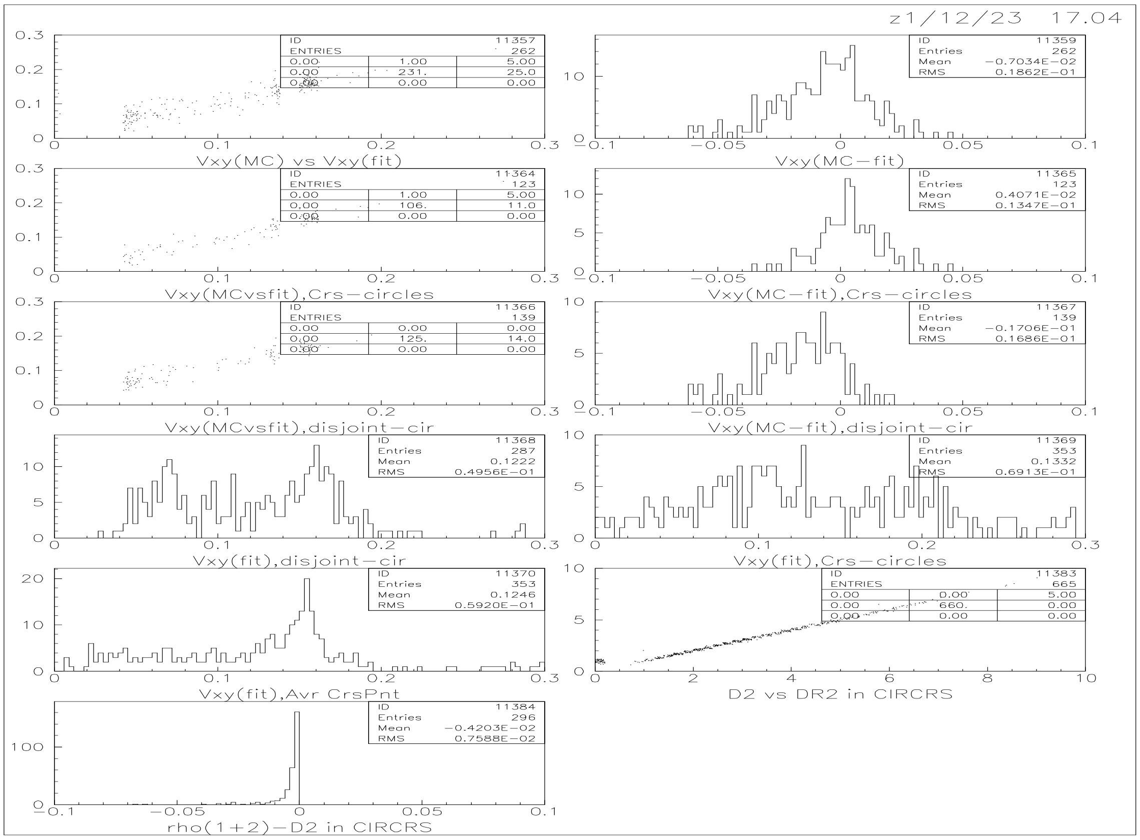
- Recoiling γ against $\mu\mu$ and ee
  - dE $= E_\gamma(klam)$ - $P_{rec}(\mu\mu$ or $ee)$
  - SIMBES : $\sigma_{E_\gamma} = 40$ MeV from $\gamma\mu\mu$
  - Data : $\sigma_{E_\gamma} = 54$ MeV from $\gamma\mu\mu$
  - Data : $\sigma_{E_\gamma} = 80$ MeV from γee



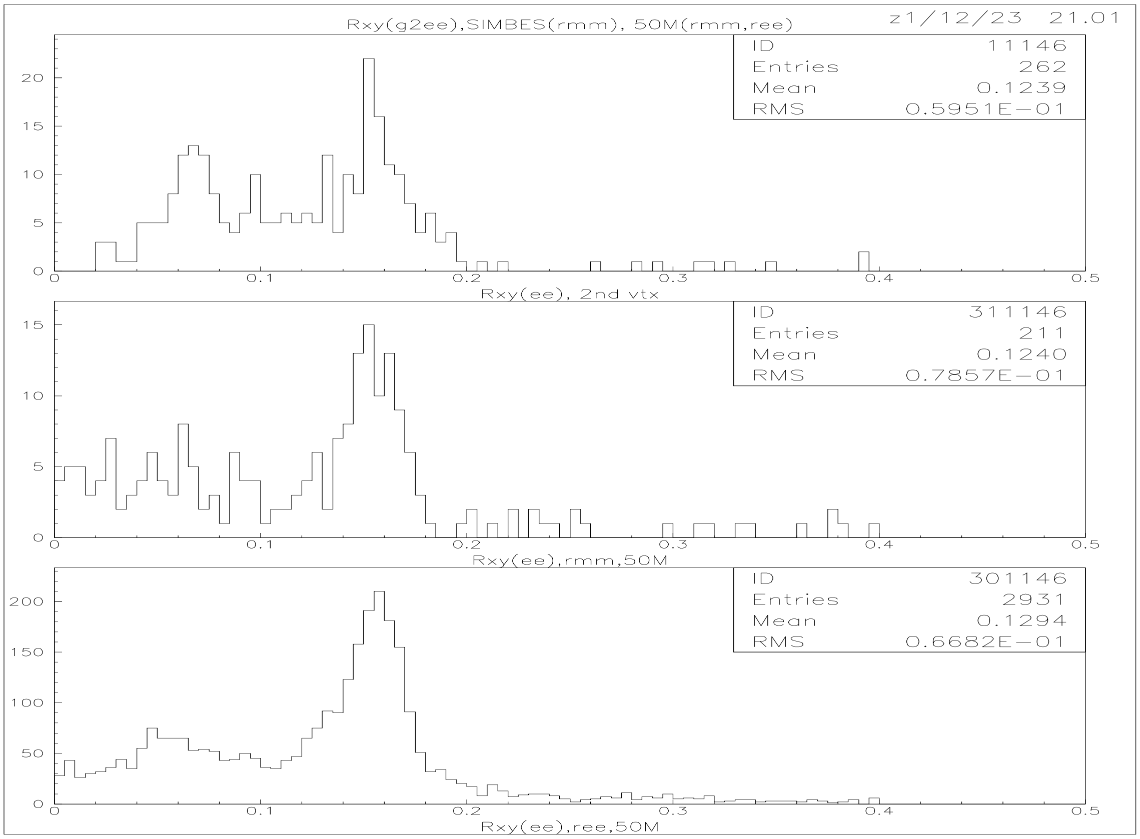
- $cos\theta_{ee}$ **and** M_{ee}
  - **SIMBES : trklst level**
  - **after klam selection**



- **Improvement in R_{xy} calculation**
  - **SIMBES : $\gamma\mu\mu$**
  - **VC/MDC wall is seen in R_{xy} for two disjoin circles**
  - **spread R_{xy} for two crossing circles**
  - **Much improved after average**
  - **Still room to study**



- Obeserved R_{xy}
  - SIMBES : $\gamma\mu\mu$
  - Data : $\gamma\mu\mu$
  - Data : γee
    - both initial and final radiative phtons
    - more geometry
  - VC/MDC wall is clearly seen in R_{xy}
    - VC inner/outer wall : 4.8/13.5 cm
    - MDC inner wall : 15.5 cm
    - Wall area for VC and MDC clearly seen



4. Conversion rate of $\gamma \to e^+e^-$

- **MC at mcmade level : $J\psi \to \mu\mu(\gamma)$ selected by E_γ and $cos\theta$ cuts**

Table 1a. γ conversion rate for $E_\gamma > 140MeV$ and $|cos\theta_\gamma| < 0.8$

mcmade	$N\gamma$	%
generated	83680	100
$E_e^\pm > 70MeV$ $\lvert cos\theta_e^\pm\rvert < 1$	2862	3.38
$E_e^\pm > 70MeV$ $\lvert cos\theta_e^\pm\rvert < 0.85$	2862	3.38
$E_e^\pm > 70MeV$ $\lvert cos\theta_e^\pm\rvert < 0.7$	1802	2.15
$E_e^\pm > 70MeV$ $\lvert cos\theta_e^\pm\rvert < 0.5$	1254	1.50

Table 1b. γ conversion rate for $E_\gamma > 200MeV$ and $|cos\theta_\gamma| < 0.5$

mcmade	$N\gamma$	%
generated	45642	100
$E_e^\pm > 70MeV$ $\lvert cos\theta_e^\pm\rvert < 1$	1226	2.69
$E_e^\pm > 70MeV$ $\lvert cos\theta_e^\pm\rvert < 0.85$	1226	2.69
$E_e^\pm > 70MeV$ $\lvert cos\theta_e^\pm\rvert < 0.7$	1226	2.69
$E_e^\pm > 70MeV$ $\lvert cos\theta_e^\pm\rvert < 0.5$	1219	2.67

- **MC at TRKLST level :γ defined from recoiling system of $\mu\mu$**
  - $E_{rec} = E_{CM} - (E_{\mu^+} + E_{\mu^-}) > 200MeV$
  - $|cos\theta_{rec}| < 0.5$ **(higher efficiency)**
  - $ee \rightarrow \mu\mu\gamma$ **with** $\gamma \rightarrow ee$ **selected by klamcorr**

Table 2 γ conversion rate at TRKLST level

(a) E_γ and $cso\theta_\gamma$ from mcmade

cut	$N\gamma$	%
$E_\gamma > 200MeV$ $\|cos\theta_\gamma\| < 0.5$	19727	100
$R_{xy} > 2cm$	139	0.70
$\&M_{ee} < 100MeV$	139	0.70
$\&\|cos\theta_{ee}\| < 0.9$	137	0.69

(b) E_γ and $cos\theta_\gamma$ from TRKLST

cut	$N\gamma$	%
$E_\gamma > 200MeV$ $\|cos\theta_\gamma\| < 0.5$	20964	100
$R_{xy} > 2cm$	132	0.63
$\&M_{ee} < 100MeV$	132	0.63
$\&\|cos\theta_{ee}\| < 0.9$	128	0.61

- It shows
  - The rate can be estimated at TRKLST level via recoiling γ against $\mu\mu$
  - The rate for real data is also estimated

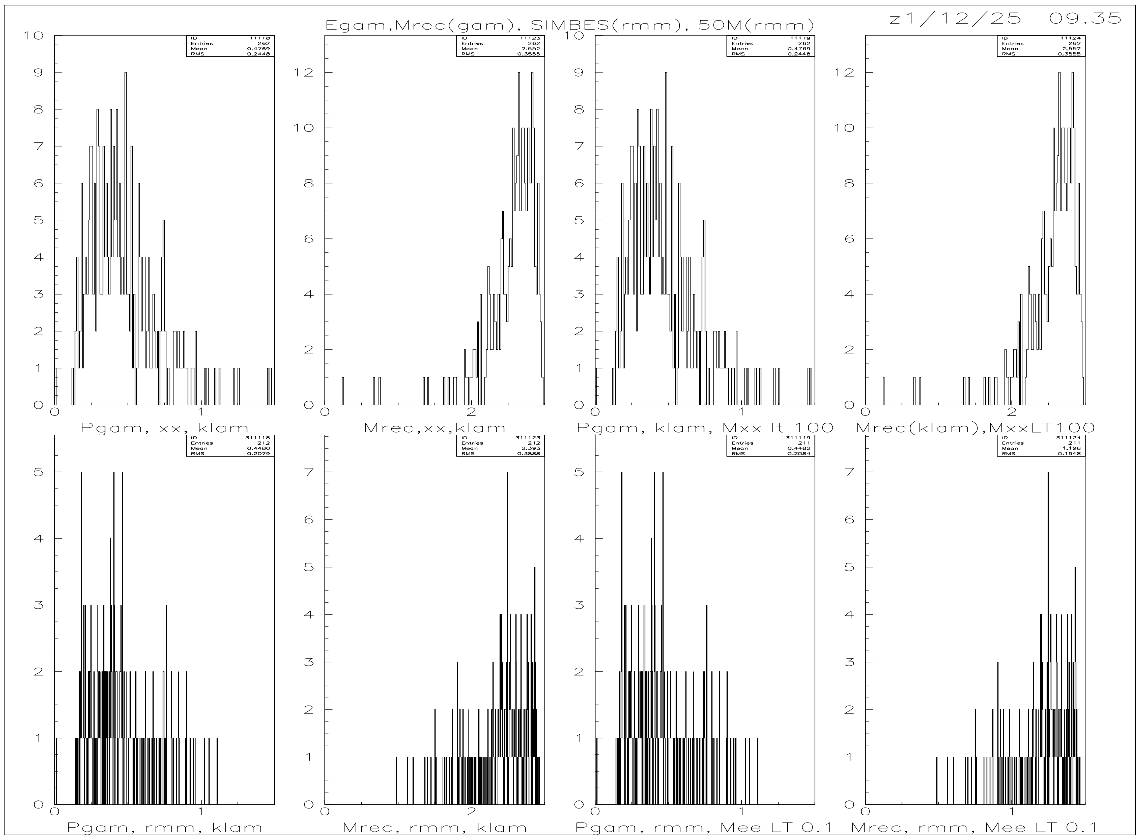
Table 3 γ conversion rate from Data 50M

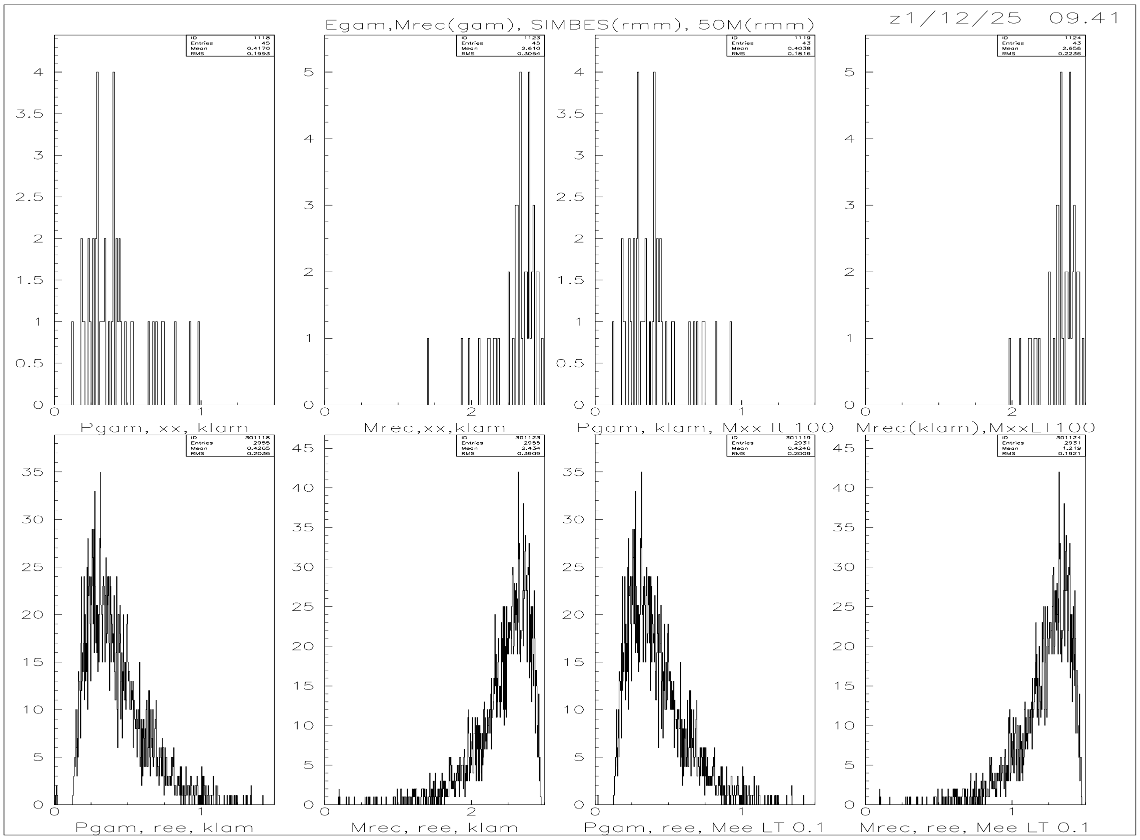
cut	$N\gamma$	%
$E_\gamma > 200MeV$ $\lvert cos\theta_\gamma\rvert < 0.5$	54122	100
$R_{xy} > 2cm$	100	0.19
$\&M_{ee} < 100MeV$	99	0.18
$\&\lvert cos\theta_{ee}\rvert < 0.9$	92	0.17

  - The rate for real data is lower than expected from MC
    - Inner wall of VC in SIMBES seems overestimated
    - Contamination from h^+h^- that punch through detector

5. Inclusive γ spectrum

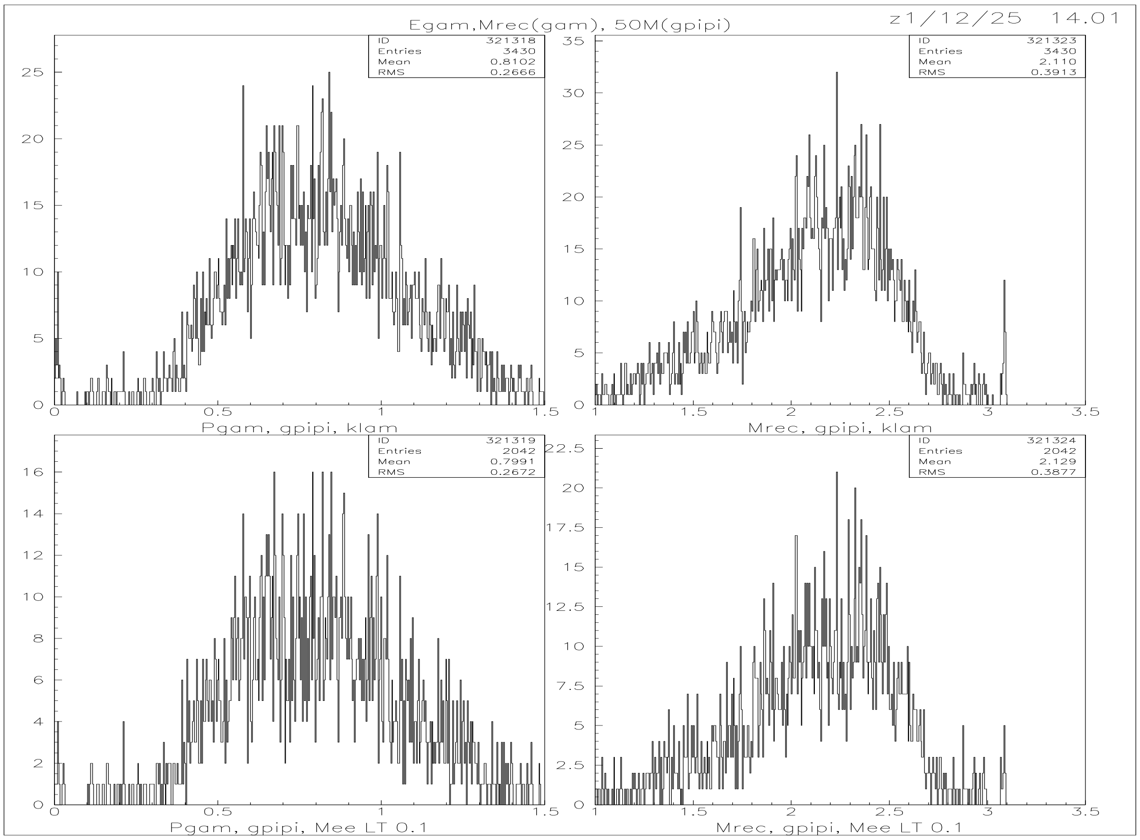
- **Recoiling γ against $\mu\mu$ and ee**
  - **SIMBES :** $\gamma\mu\mu$
  - **Sober :** γee
  - **Data :** $\gamma\mu\mu$, γee
  - E_γ, M_{rec} **after klam**
  - E_γ, M_{rec} **after** $Mee < 100MeV$

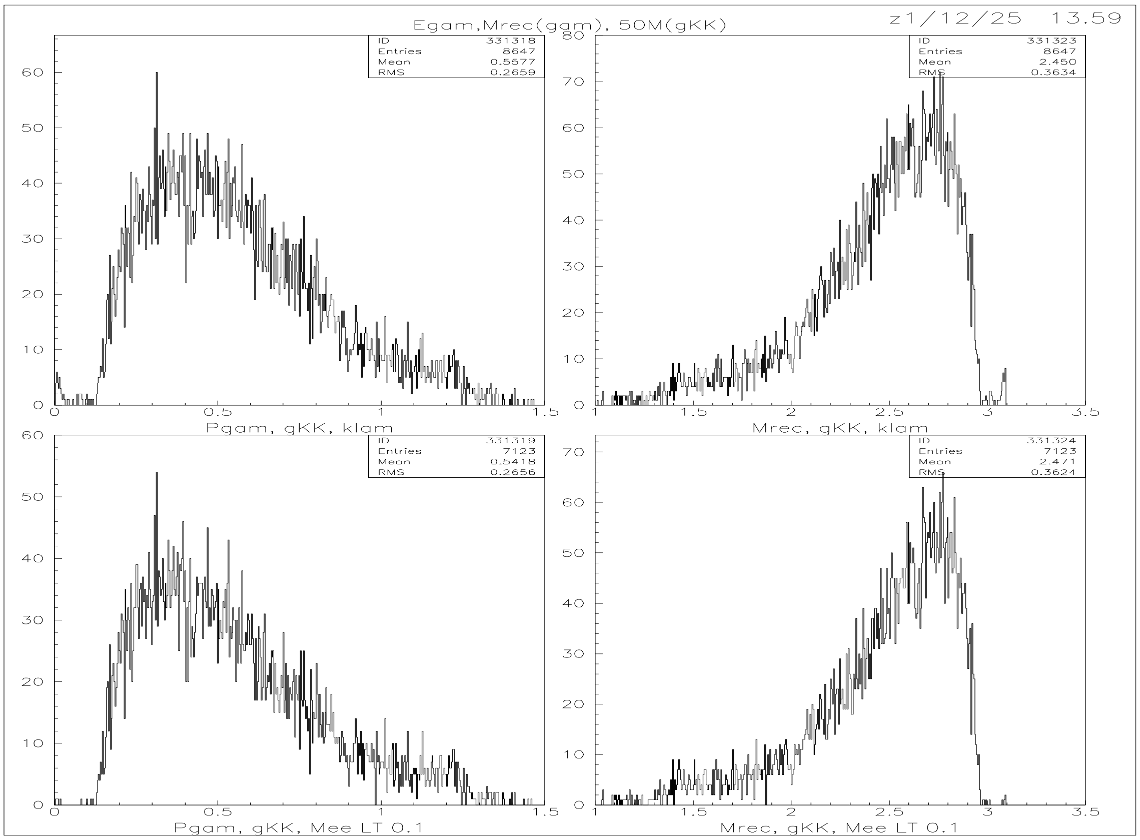


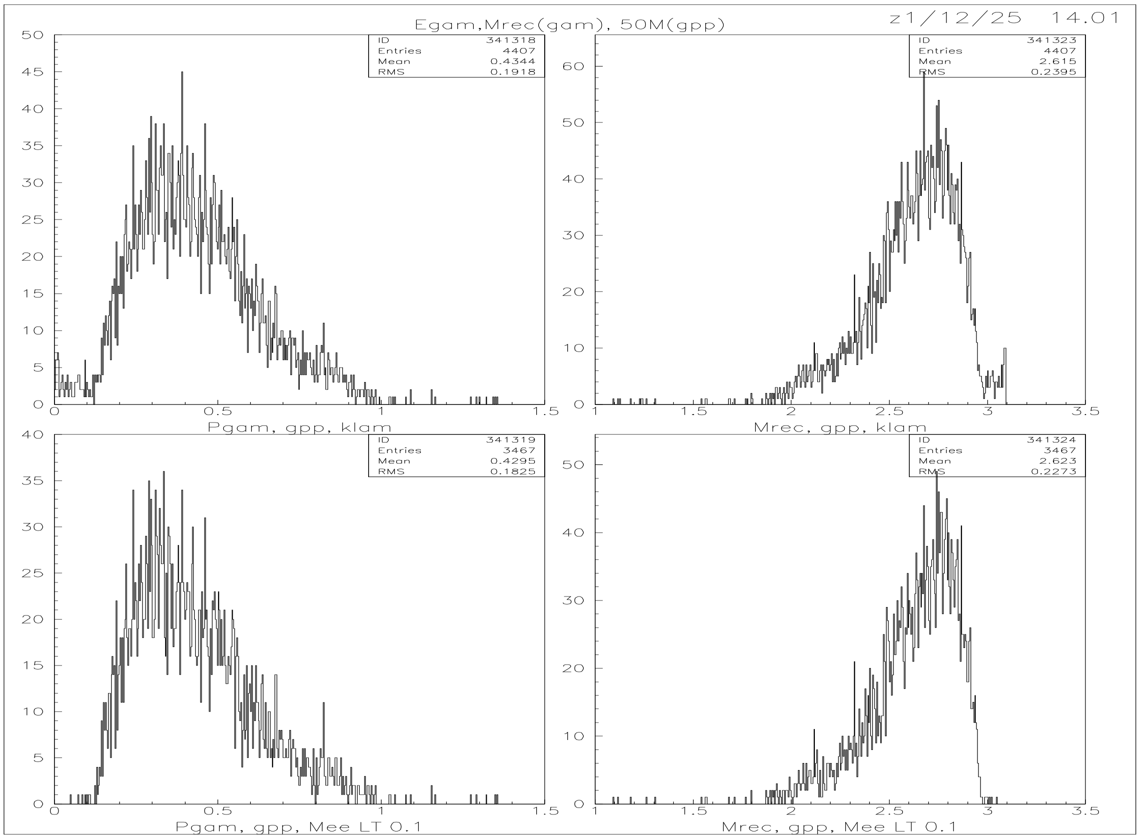


Egam,Mrec(gam), SIMBES(rmm), 50M(rmm)
z1/12/25 09.41
Pgam, xx, klam
Mrec,xx,klam
Pgam, klam, Mxx lt 100
Mrec(klam),MxxLT100
Pgam, ree, klam
Mrec, ree, klam
Pgam, ree, Mee LT 0.1
Mrec, ree, Mee LT 0.1

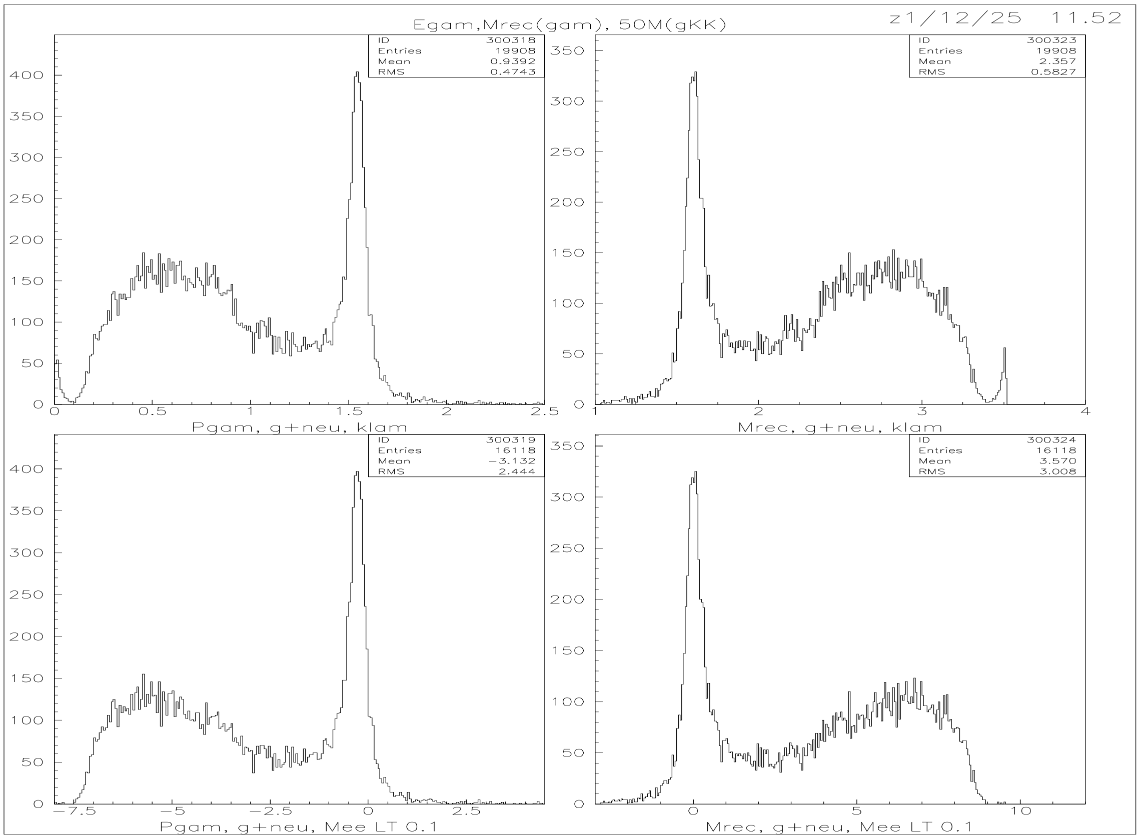
- Recoiling γ against $\pi\pi$, KK and pp
  - Data : $\gamma\pi\pi$, γKK and γpp
  - E_γ, M_{rec} after klam
  - E_γ, M_{rec} after $Mee < 100MeV$
  - excess at E_γ = 1.22 GeV and M_{rec} = 1.43 GeV in γKK is seen




Egam,Mrec(ggm), 50M(gKK)
z1/12/25 13.59
ID 331318
Entries 8647
Mean 0.5577
RMS 0.2659
Pgam, gKK, klam
ID 331323
Entries 8647
Mean 2.450
RMS 0.3634
Mrec, gKK, klam
ID 331319
Entries 7123
Mean 0.5418
RMS 0.2656
Pgam, gKK, Mee LT 0.1
ID 331324
Entries 7123
Mean 2.471
RMS 0.3624
Mrec, gKK, Mee LT 0.1


Egam,Mrec(gam), 50M(gpp)
z1/12/25 14.01
ID 341318
Entries 4407
Mean 0.4344
RMS 0.1918
Pgam, gpp, klam
ID 341323
Entries 4407
Mean 2.615
RMS 0.2395
Mrec, gpp, klam
ID 341319
Entries 3467
Mean 0.4295
RMS 0.1825
Pgam, gpp, Mee LT 0.1
ID 341324
Entries 3467
Mean 2.623
RMS 0.2273
Mrec, gpp, Mee LT 0.1

- **Recoiling γ against neutrals**
  - **Data :** $\gamma + treutrals$
  - E_γ, M_{rec} **after klam**
  - E_γ, M_{rec} **after** $Mee < 100MeV$



5. Summary

- Software for $\gamma \to e^+e^-$ reconstruction, adapted from klamcopy.f and circrs.f, works properly

- γ conversion point, R_{xy}, correctly calculated, and Its distribution after reconstruction of $\gamma \to e^+e^-$ shows clear effect of VC/MDC walls

- However further improvement of the software is possible

- Glance at inclusive γ plots from J/psi specific decay channels is interesting

- Fowlloing studies in future is planned
  - π^0 and η subtraction
  - Telesis fit should be added