Beam Losses from Radiative Bhabha and Beamstrahlung for FCC-ee

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Machine-Detector interface MDI meeting
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Thanks to:
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Outline:

→Planned schedule: Work to be done

→Preliminary results:

1- Radiative Bhabha between BBBREM and GuineaPIG++

2- SAD tracking:

a)Without synchrotron masks
b)With synchrotron masks

Work to be done:

→ Simulate beam losses overall the FCC ring due to **radiative Bhabha** and **Beamsstrahlung** :

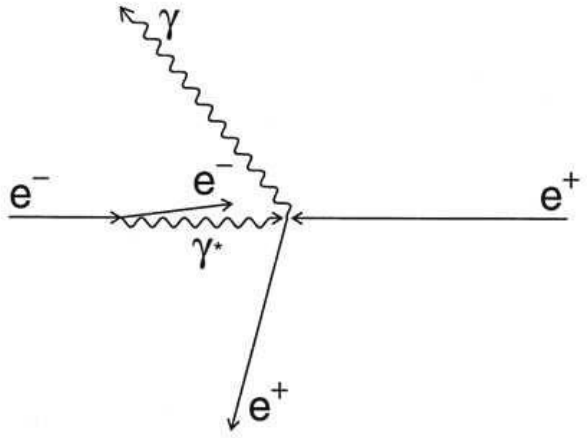
1) Event Generation: **GuineaPIG++** and **BBBREM**
2) Tracking with **SAD** (physical aperture insertion)

→ Simulation of losses from Touschek scattering (using code from KEK “Y. Ohnishi” and Frascati “M. Boscolo”)

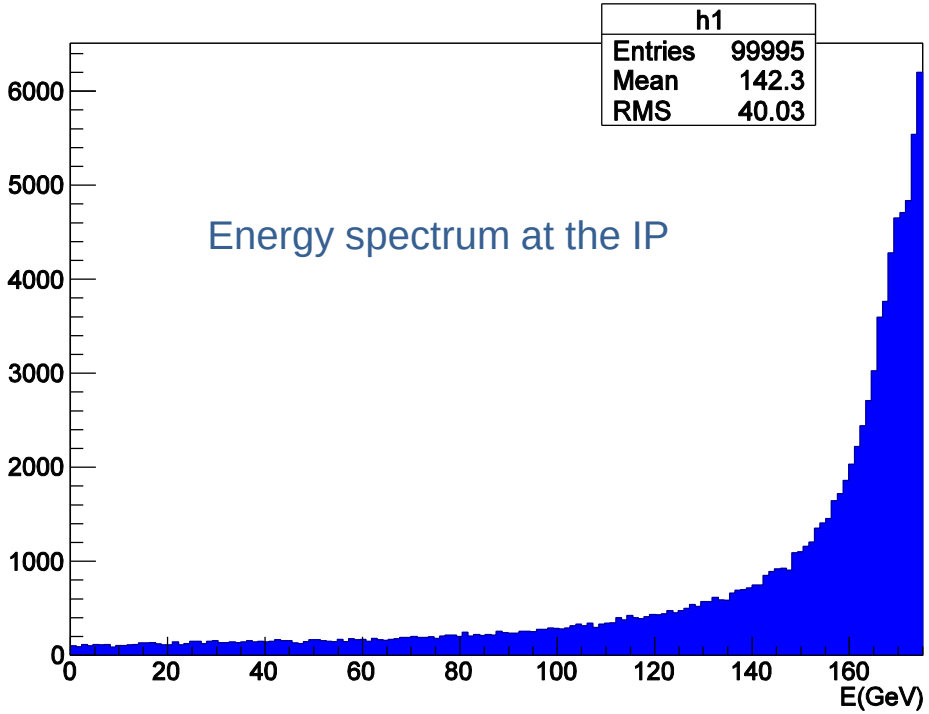
→ Study the main loss locations and mitigation methods (collimators, etc ..)

Tools: **SAD** and **GEANT4**

GuineaPIG++



Radiative Bhabha at zero photon scattering angle



Main points:

→ The maximum energy of the Bhabha charged particles is set to a default number of compt_emax= 100 GeV (change to beam energy 175 GeV)

→ Compt_xmin= 0.01, represents the energy cut on the photons (E=0.01*beam energy)

→ This number is set to this value in order to avoid using low energy virtual photons (Daniel)

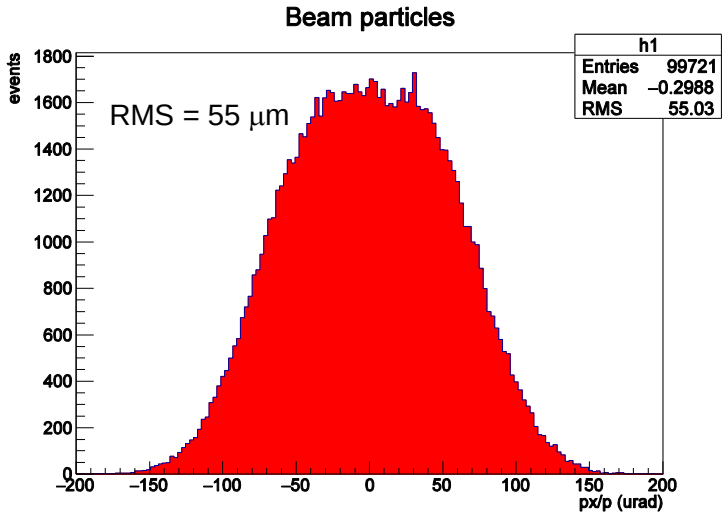
→ Beam size effect: b~ $\frac{\hbar}{q_\perp}$; $q_\perp = \text{trannsverse momentum of virtual photon}$, when $q_\perp$<<1 →
b >>σ_y ➔ reduction of the cross section (however no observed cut in the spectrum of the Bhabhas)

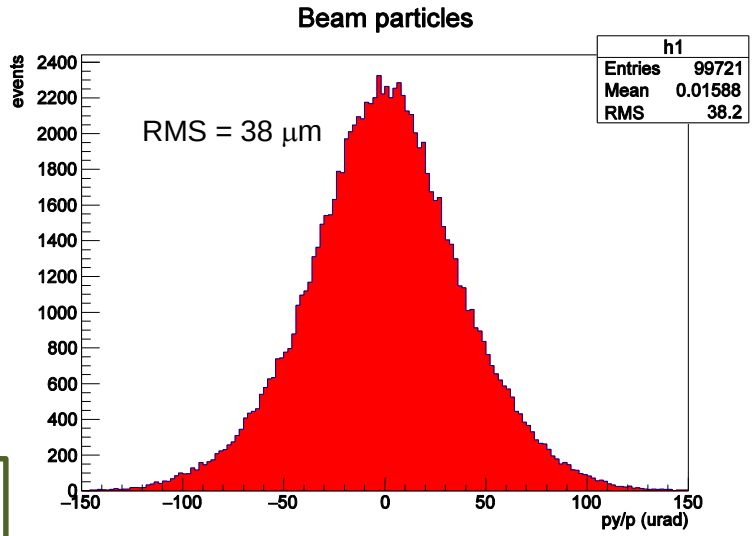
Compt_emax (GeV)	Beam size ON	Beam size OFF
Default: 100	89.5 mbarn	48 mbarn
Beam energy: 175	622 mbarn	294 mbarn

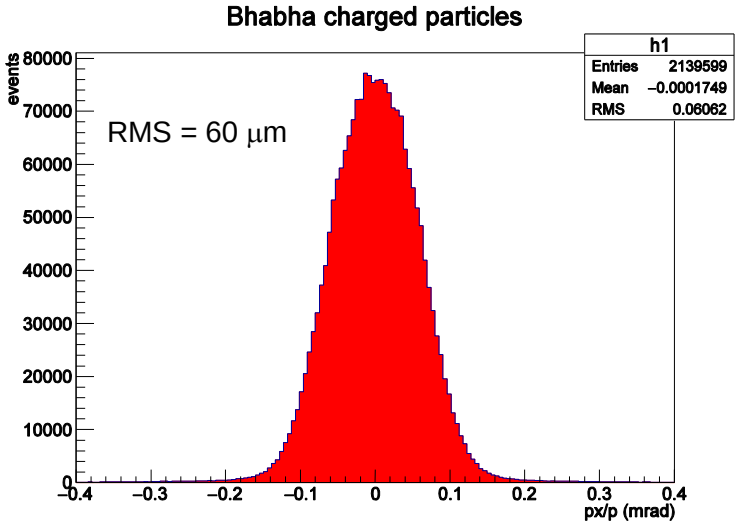
Dynamics

Beam : $\frac{p_x}{p} = \sqrt{\frac{\epsilon_x}{\beta_x}} = 35\ 10^{-6}\ \mathrm{rad};$

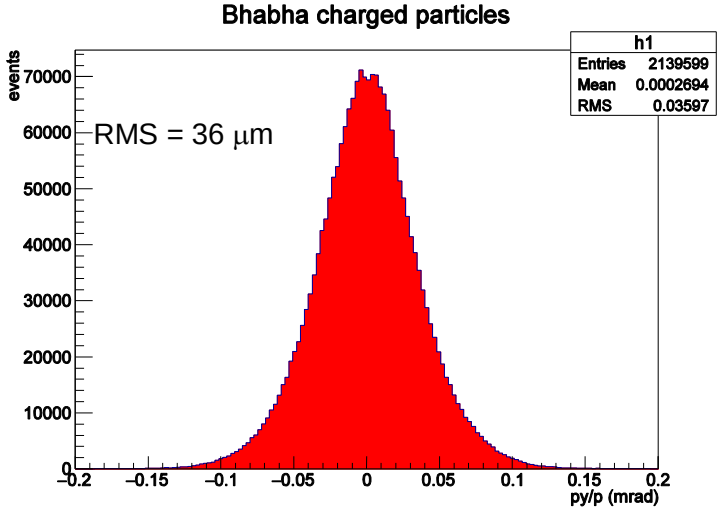
$\frac{p_y}{p} = \sqrt{\frac{\epsilon_y}{\beta_y}} = 12.6\ 10^{-6}\ rad$



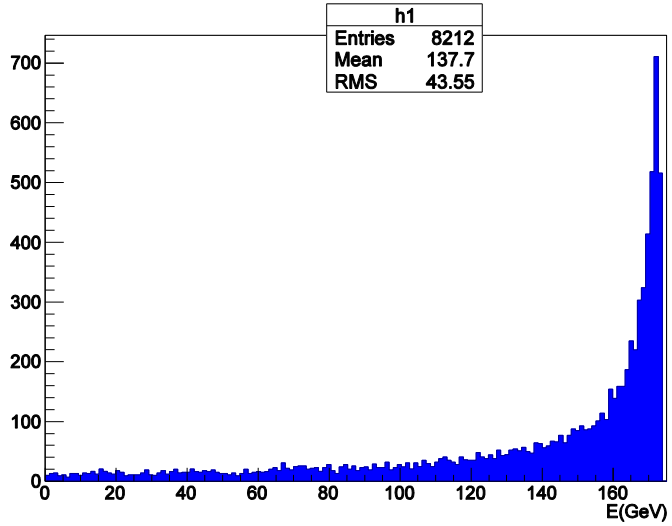


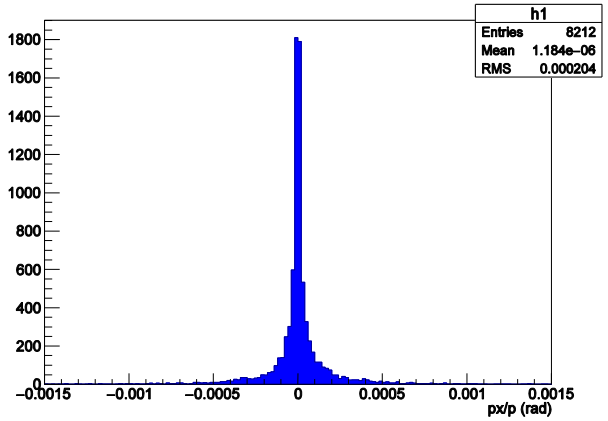


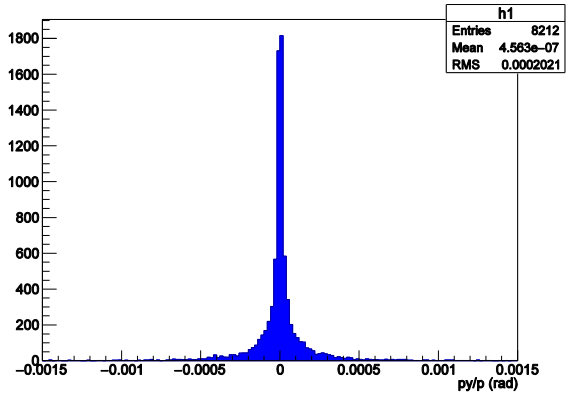
Bhabha dynamics are similar to the beam dynamics



BBBREM







No beam input parameters: *Angular distributions are very large compared to beam distributions*

- → Each event is assigned a weight
- → Cross-section is calculated considering these weights
- → Cutoff on the transverse momentum of the virtual photons could be added which is similar to the beam size on in GuineaPIG++
- → Cutoff: $q_{min} = \frac{\hbar c}{\sigma_y}$; σ_y= 70 nm ➔ q_{min}=3 $10^{-9} GeV$

BBBREM	No cutoff	With cutoff
Cross section (mbarn)	347	158.5

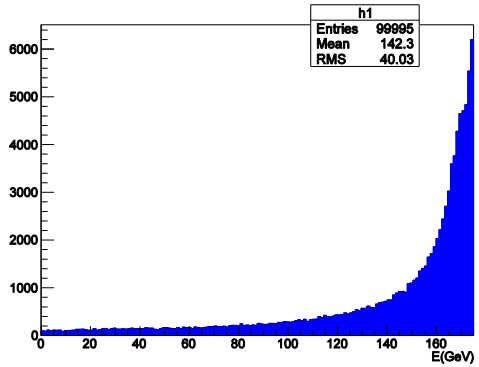
GuineaPIG++	622	294

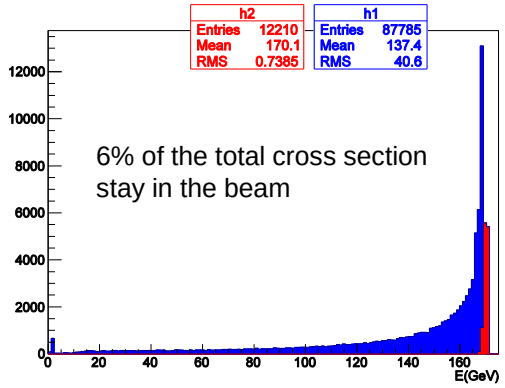
→ A factor of about 1.8 is obtained in the cross section calculations between GuineaPIG++ and BBBrem ??

Particle tracking in SAD

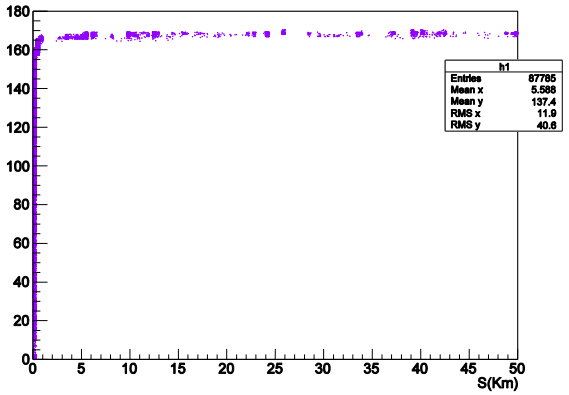
- → Physical apertures were inserted: */afs/cern.ch/user/d/delkhech/public/FCCee_t_by2_apertures.sad*
- → Apertures: r= 15 mm in the IR , r=35 mm elsewhere with a transition over a 2 m drift starting at ~ ± 10 meters
- → Particle distributions from GuineaPIG++ were considered (energy, positions and angles)
- → Tracking from IP.1 to IP.2: w/ synchrotron masks (masks closed) & w/o synchrotron masks (masks open)
- → Mask width in X is 20 mm (r=10 mm), no offset, placed before and after final focus quadrupoles
- → LOSSMAP function is used : Gives the position of loss in the ring
- → RAD (synchrotron radiation), FLUC (diffusion due to SR) and RFSW (enables acceleration with cavities)

Masks OPEN

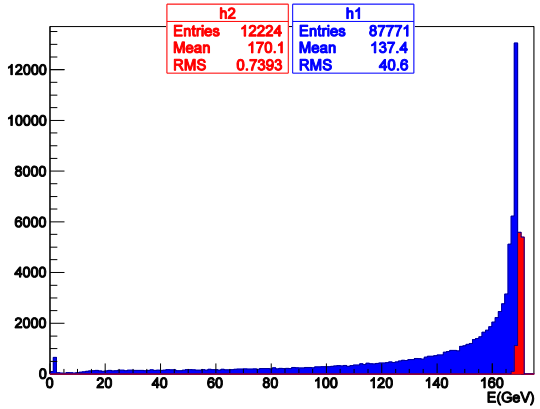




6% of the total cross section stay in the beam



Masks CLOSED



Only few particles ~ 14 particles are lost when masks are closed (almost no effect)

Conclusions and next plans

→ Bhabhas were generated by both simulation codes(GuineaPIG++ and BBBrem)

→ A factor of ~ 1.8 discrepancy in the cross section calculation is observed

→ Bhabhas were tracked w/ and w/o Synchrotron masks, no important effect of the masks on the losses

→ Bhabhas still can reach the second IR and should be stopped (collimated) before

Next Plans:

→ Study the Beamstrahlung losses using GuineaPIG++

→ Search for collimator positions and study the effect of collimators on the losses from both processes

→ Simulation of losses from Touschek overall the ring (mitigation studies)