Radiative Corrections in MCEEP and SIMC

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Hall A Data Analysis Workshop

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Write ups on radiative corrections

- SIMC
  - R. Ent et al PRC 64 , 054610 (2001)

- MCEEP
  - Explanation in MCEEP manual
  - Single photon exchange
    - L. W. Mo and Y. S. Tsai, Rev. Mod. Phys. 41, 205 (1969)
    - E. Borie and D. Drechsel, NPA 167, 369 (1971).
  - Multi-photon exchange
    - J.A. Templon et al, PRC 61, 014607 (2000)

MCEEP radiative corrections

- Peaking approximation for radiation along beam (pre) and scattered electron (post). Ignore radiation by proton
- Divide radiation in soft and hard parts with cutoff at E_γ = 1 MeV
- Soft radiation is the Schwinger correction which includes virtual and vacuum polarization contributions
- Hard radiation (radiative tail)
    - Every event radiate photon for pre and post radiation using 1/k distribution
    - Check in new kinematics pass acceptance cut. If both pass then randomly pick one (keep weight factor of 2)
    - Calculate cross section from Mo & Tsai for either pre or post
- Multi-photon correction applied to radiative tail

SIMC radiative corrections

- Extended Peaking approximation including radiation along proton direction. Account for angular distribution of photon radiation.
- Instead of radiated photon momentum use missing energy and missing momentum as kinematic variables to evaluate radiative effects
- Multi-photon effects included
- Use modified equivalent radiator method to combine internal and external radiation
- Randomly choose pre or post radiation event and randomly pick photon energy according to 1/k

Comparison between SIMC and MCEEP for elastic ep

- E_{beam} = 5.008 GeV and Q^2 = 3.5 GeV^2
- Set cuts
  - Electron: abs(ϕ_{tgt}) < 20mr , abs(θ_{tgt}) < 80mr and abs(δ) < 4%
  - Proton: abs(ϕ_{tgt}) < 20mr , abs(θ_{tgt}) < 80mr and abs(δ) < 4%

Condition	Ratio of MCEEP/SIMC yield
No external radiation No internal radiation	1.005
External radiation No internal radiation	1.006
External radiation Internal radiation	1.083
External radiation Internal radiation (SIMC includes proton radiation tail)	1.100

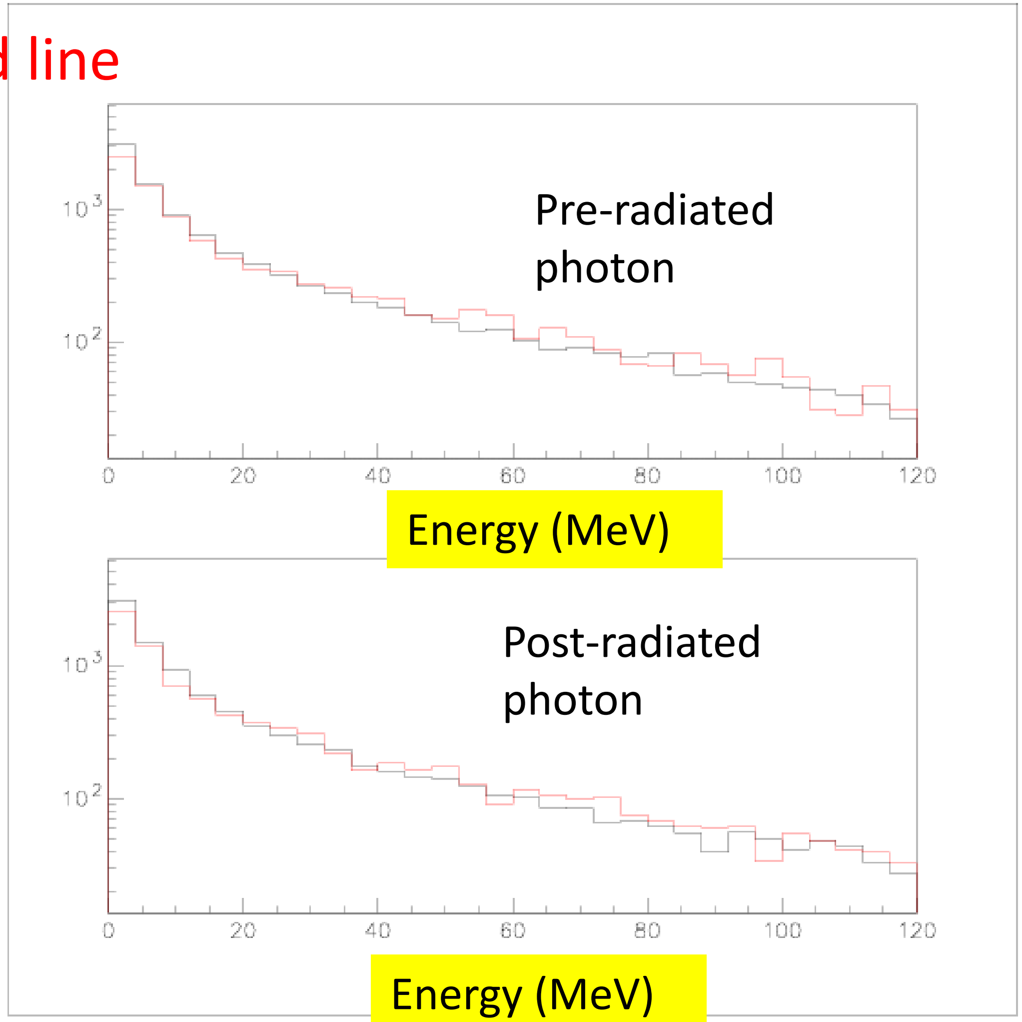
Comparison between SIMC and MCEEP

- External and internal radiation
- No proton radiation in SIMC
- Both have 70% of events with $E\gamma < 1$ MeV

Condition	Ratio of MCEEP/SIMC yield
$E\gamma < 1$ MeV	1.094
$E\gamma > 1$ MeV	1.055

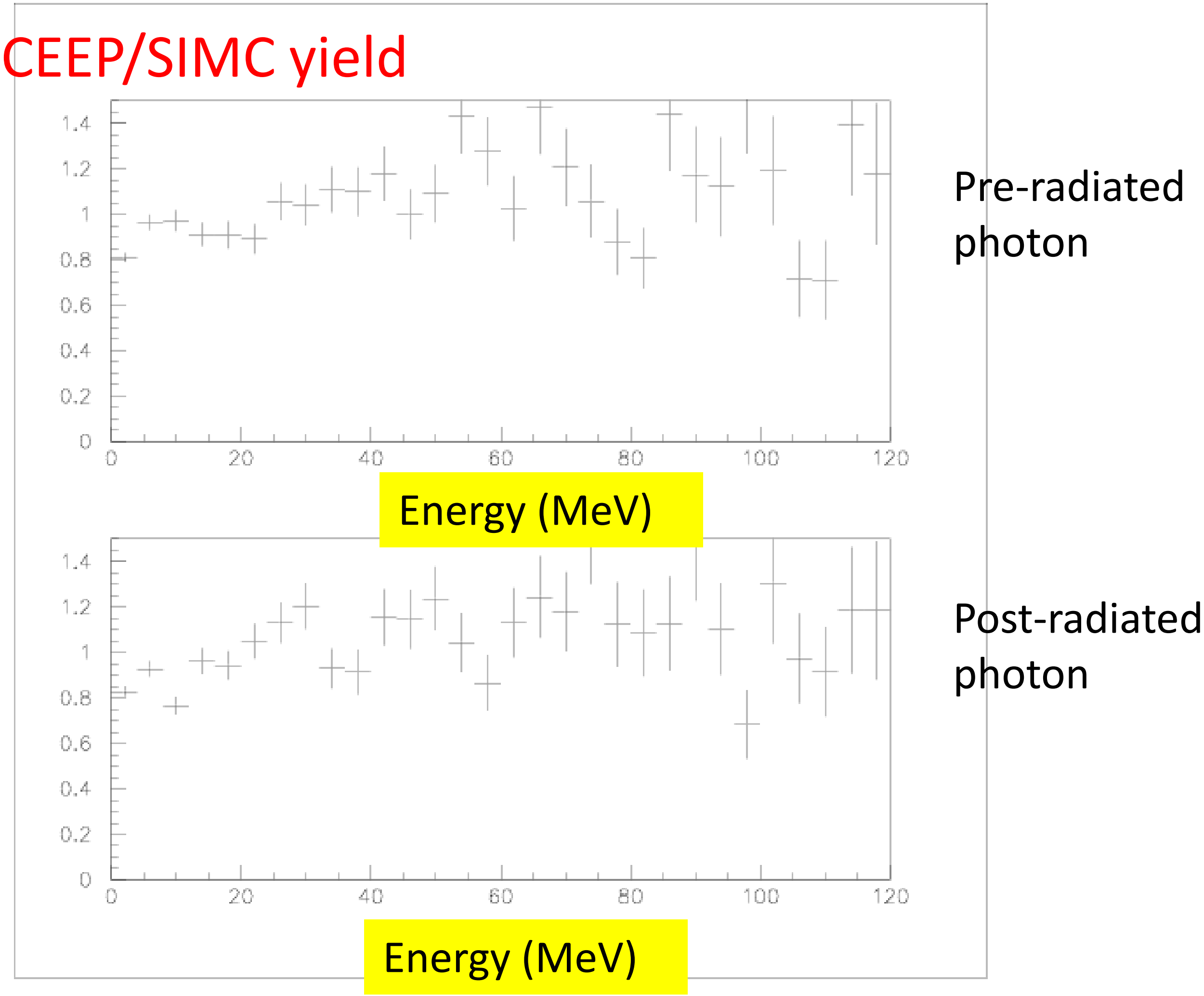
Comparing Photon energy distributions SIMC and MCEEP

- SIMC is red line



Comparing Photon energy distributions SIMC and MCEEP

- Ratio of MCEEP/SIMC yield



Conclusions

- Need to include proton radiation as Q^2 and beam energy increase
- Need to have consistency between radiative corrections used to extract present cross sections and past methods of radiative corrections used to extract the nucleon form factors.
- In E01020, using SIMC radiative corrections better agreement between ep elastic data and simulation
  - Makes smaller difference in d(e,ep) cross section since corrected the d(e,ep) data by normalization from p(e,ep)
- Personal opinion that one should use the radiative correction formalism developed in Ent et al PRC 64 , 054610 (2001)