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**VCS-E93050 Polarizability data at $Q^2 = 1$ and 2GeV^2 . Practical use of radiative correction to some measured cross sections
($e p$ to $e p \gamma$)**
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VCS-E93050

Polarizability data at $Q^2 = 1$ and 2 GeV^2 .

**Practical use of radiative corrections
to measured cross sections $d^5\sigma (ep \rightarrow ep\gamma)$**

This short note summarizes how in practice one applies radiative corrections to the measured cross sections $d^5\sigma(ep \rightarrow ep\gamma)$ for DA-1 and DA-2 data of VCS-E93050 (polarizabilities). It does not intend to explain what radiative corrections are. For this I refer to specialized litterature (see References).

1 Where to find the informations

Radiative corrections to Virtual Compton Scattering have been studied [1], [2] and outlined [3] in several Thesis works. The latest dedicated reference on the subject is ref. [4].

I have taken all basic informations from the thesis of Dominique Marchand and Julie Roche on VCS-MAMI. It is worth pointing out that the correction factor presented in this memo applies only when Luc Van Hoorebeke's simulation code VCSSIM [5] is used to compute the solid angle. This is because Luc's code already incorporates a well-defined part of the radiative corrections to Virtual Compton Scattering.

2 Some terminology

2.1 Real radiative corrections

VCSSIM includes all radiative effects that are sensitive to experimental cuts. It includes internal and external bremsstrahlung, so we don't have to bother with them. Extra-terms that need to be considered are:

- 1) a term due to real photon emission which is independent of experimental cuts (see [3] p.104). It is called T_{anal} (see [2] p.118).
- 2) a term introduced by continuity to elastic scattering, and still to be confirmed theoretically [6]. I name it δ_{cont} here. I guess it corresponds to the term $(\delta_1 + \delta_2^{(0)})$ in ref. [4] (Table 1).

2.2 Virtual radiative corrections

They are independent of experimental cuts. This term is called δ_V (see [2] p.118).

3 Practical use of radiative corrections for VCS

Once we have a measured value $d^5\sigma_{measured}$, we have to compute:

$$d^5\sigma_{corr} = d^5\sigma_{measured} \times F_{rad} \quad , \quad \text{where} \quad F_{rad} = \exp(-\delta_V - T_{anal} - \delta_{cont}).$$

F_{rad} is the global radiative correction factor not taken into account in VCSSIM. Table below gives the values for DA-1 and DA-2 settings of E93050. Kinematic points are taken from [2] p.118.

Numerical values differ slightly from [2] because they have been updated by Nicole d'Hose [6]. The correction factor F_{rad} depends mostly on Q^2 , and only very slightly on variables like q'_{cm} or $\cos\theta_{\gamma\gamma cm}$.

The (systematic) error bar on this correction factor is estimated to be $\pm 2\%$ [6], [4], i.e. inducing a $\pm 2\%$ relative error on the cross section. This error is reported in the last line of the table.

Conclusion: in practice for E93050 data analysis, the cross section after application of F_{rad} will be about 7 % lower than the measured cross section obtained with VCSSIM.

JLab-E93050 kinematics		
Kinematics	close to DA-1 : E=4.0 GeV, E'=3.33 GeV $\theta_e = 15.7^\circ$ $Q^2 = 1 \text{ GeV}^2$	close to DA-2 : E=4.4 GeV, E'=3.24 GeV $\theta_e = 21.5^\circ$ $Q^2 = 2 \text{ GeV}^2$
T_{anal}	+26.7 %	+29.2 %
δ_{cont}	-1.3 %	-1.5 %
δ_V	-18.3 %	-20.3 %
F_{rad}	(+93.1 \pm 2.0) %	(+92.9 \pm 2.0) %

Addendum 2007:

Values of radiative corrections for the first VCS experiment at MAMI.

MAMI VCS kinematics	
Kinematics	$q_{cm}=0.6 \text{ GeV}/c$, $\epsilon = 0.61$, $q'_{cm} = 111 \text{ MeV}/c$ E=0.843 GeV, E'=0.528 GeV, $\theta_e = 53.14^\circ$ $Q^2 = 0.356 \text{ GeV}^2$
T_{anal}	+22.0 %
δ_{cont}	-1.2 % (*)
δ_V	-15.6 %
F_{rad}	(+94.9 \pm 2.0) %

(*) = the value of $(\delta_1 + \delta_2^{(0)})$ averaged over the two MAMI kinematics of Table 1 in ref. [4].

Thanks to Luc Van Hoorebeke and Nicole d'Hose for their remarks.

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