差出人: **T. Tauchi** toshiaki.tauchi@kek.jp
件名: Re: CAIN lumi calculation with many low E photons
日付: 2021年3月11日 17:36
宛先: Barklow Timothy timb@slac.stanford.edu、 kaoru yokoya kaoru.yokoya@kek.jp
CC: yokoya yokoya@post.kek.jp

Dear Tim and Yokoya-san,

I modified the CAIN to generate the non-linear Compton scattering by using the z_n variable which works even with NY=20. Actually following three routines are modified, which are nlcpst0.f, nlcpgen00.f and nlcpcm.h. These routines are attached in this email.

I explain these modifications page by page in the appended file of non-linear-Compton-zn.pdf below.

page 1 : Non-linear Compton scattering process is expressed by an electron scattering with multiple photons and the cross sections is given by a sum of n from 1 to infinity in principle. The process is described in the electron rest frame, then the phisical varibles are Lorentz-transformed to the laboratory frame. I propose a simple correspondance between the linear Compton process in CAIN and non-linear Compton one based on z and z_n which are notmalized so that z, z_n = 0 ~ 1.
note : Definitions of F_1n and F_2n are slightly different from ones in CAIN.

page 2 : Comparison between the CAIN variables and the proposed ones in the non-linear Compton process.

page 3 : Event generation process is explained. 1. A unifor random number is given, which is equla to z_n, 2. Photon energy is calculated in the electron rest frame. 3. The scattering angle is calculated in the electron rest frame. 4. The photon energy y in the laboratory frame is calculated by the Lorentz transformation. Actually the y is a simple function of z_n with n, xisq and x with extremely good approximation. It is used in nlcpst0.f and nlcpgn00.f .

page 4 : Brief explanation of Compton scattering process in a strong laser field since it is used in CAIN to generate the non-linear Compton scattering. The laser strength is expressed by xi-parameter (or a_0) , which is calculated the laser power density. In order to see a relation with the cross section, the laser field amplitude "-a^2" can be expressed by inverse of the laser-photon energy (ref. Landau Lifshitz QED,Vol.4 second edition, p.449) The scattering amplitude can be expressed by the Lorentz invariant varibables which are calculated in the CM frame as well as the laboratory frame, e.g. u, u_n of maximum u and a usual x -parameter.

page 5 : The probability of n-th harmonic emission per unit volume and unit time is given with the Lorentz invariant amplitude and the phase space factor. The latter, i.e. I is calculated in the CM frame.

page 6 : With a variable u which is a function of scattering angle of electron with respect to the incident photon, the total probability of emission from unit volume in unit time is expressed. It should be the same as in CAIN, i.e. Eq.(5.111) in CAIN242 manual. Next, the cross section is calculated by the probability divided by the flux of incident particles, J_{inc}. Then, the usual cross section is obtained.

page 7 : It show 4 figures of photon energy distributions by CAIN with various variables of NY, NLAMBDA etc. . Left-top figure shows the CAIN result with NPH=3, NY=200,NXI=200 and NLAMBDA=200. As pointed out in previous emails, there is a fake bump around 50GeV. Right-top figure shows the modified CAIN result with the same parameters. The energy distribution is smooth as expected as shown in left-bottom figure of linear Compton scattering (NPH=0). Right-bottom figure shows the modified CAIN result with NY=20, NLAMBDA=20 . It is same as one with NY=200 and NLAMBDA=200 in the right-top fugure except for number of photons in the first bin.

page 8 : In order to see the fist bin photon number as a function of NLAMBDA, the total number of photons are calculated as a fucntion of NLAMBDA shown in right figure. In this case (x=1,000), NLAMBDA must be larger than 5,000. Left figure shows two cases with NLAMBDA=20 and 10,000 where the other parameters are same , i.e. NPH=3, NY=20, NXI=20. It shows that the photons in the first bin have to be generated with NLAMBDA>5,000. In nlcpcm.h, MMLM is changed to 10,000 .

page 9 : Finally, the photon photon luminosities are shown as a function of the CM energy around the sharp peak.

In conclusion, the three routines must be modified in order to generate properly non-linear Compton scattering process, especially for case of x=1,000 .

Your questions and comments are very welcome.

Best regards,
Toshiaki

nlcpgn00.f_zn