LOOKUP: An Interface Program to the Lookup Tables for Compton Scattering

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October 10, 1995

Abstract

This note describes an 'easy-to-use' interface program to the lookup tables for nonlinear Compton scattering. The program gives estimates for the total number of gammas and electrons scattered in one event, the number of electrons scattered by coherent absorption of n laser photons, the number of electrons hitting a row of ECAL at a certain position, as well as the electron energy spectrum in 0.4 GeV wide bins.

1 Introduction

The purpose of this program is to have an easy and fast way to estimate the linear and nonlinear electron and gamma yield from Compton scattering, either integrated over the energy spectrum or within a certain energy range. Hopefully, the program will be a useful tool in planing future runs. It should greatly faciliate getting reliable estimates of forward gamma rates as well as adequate Ecal positions.

The version of the program described here is intended as a first approach. It would be fairly straight forward to add a command processor which would allow the user to specify output formats, fix input parameters, lookup a series of configurations and much more. However, I will do this only if there is a real demand.

The program is installed in `c:\dev` on all E-144 DAQ PC's upgraded to the lastest version of the software. The source code is in `lookup.c` and the batch-file to compile the program is `lookup.bat`.

2 The Input Parameters

The input parameters necessary to run the program are listed in table 1, together with their range and default value in the lookup tables. Other parameters needed to calculate the rates are assumed to be fixed and cannot be changed. These are for example

- the f-number of the laser focusing optics (6.0),
- the ratio σ_x/σ_y of the laser pulse (1.0),
- the crossing angle between the laser and the electron beam (17.0 deg),
- the electron beam energy (46.6 GeV),
- the offset in x and y between the laser pulse and the electron bunch (0.0),
- the energy bin width of the output spectrum (0.4 GeV).

The input parameters can be specified in two ways. The first possibility is to pass them as command line arguments to the program with the following format:

```
lookup <color> <lene> <lare> <lwid> <elnr> <bsix> <bsiy> <bwid> <toff> <ecpo>,
```

where	`<color>`	: 'ir' or 'gr',	
	`<lene>`	: laser energy	[mJ],
	`<lare>`	: laser focal spot size	[μm^2],
	`<lwid>`	: laser pulse length (FWHM)	[psec],
	`<elnr>`	: nr of electrons in beam bunch,	
	`<bsix>`	: σ_x of electron beam	[μm],
	`<bsiy>`	: σ_y of electron beam	[μm],
	`<bwid>`	: beam bunch length (FWHM)	[psec],
	`<toff>`	: offset in time	[psec],
	`<ecpo>`	: Ecal position (PCS)	[mm].

If invalid arguments are specified, the program writes the proper format to the screen. Calling `lookup` without any arguments causes the program to prompt the user for each of the input parameters seperately.

The Ecal position `ecpo` refers to the y-coordinate of the upper edge of the first Ecal row in the coordinate system for which the KEK gamma line is at $y = 0.0$ (PCS). The transformation between the Ecal position given by V_{acc} on the SCP program and `ecpo` is the following:

$$\texttt{ecpo} = V_{acc} + \texttt{offset}, \qquad \text{with } \texttt{offset} = \text{-135.0 mm for Sept 94,}$$
$$= \text{-86.8 mm for March 95.}$$

Parameter	**Lower Limit**	**Upper Limit**	**Default Value**
Laser Color	'ir'	'gr'	
Laser Energy	—	—	140 (70) mJ
Laser Focal Area	30 (10) μm^2	150 (130) μm^2	70 (35) μm^2
Laser Pulse Length (FWHM)	0.8 (1.0) psec	4.8 (5.0) psec	2.0 (2.5) psec
Beam Electrons	—	—	1×10^9
Beam σ_x	30 μm	130 μm	60 μm
Beam σ_y	30 μm	130 μm	60 μm
Beam Bunch Length (FWHM)	4.0 psec	9.0 psec	6.8 psec
Timing Offset	0.0 psec	8.0 psec	0.0 psec
Ecal Position (PCS)	-351 mm	-85 mm	—

Table 1: The input parameters with their range and default value in the lookup tables. The laser energy is limited by the resulting η value, which has a valid range of 0.01 to 2 for IR and 0.005 to 1 for Green. If two values are quoted, the one in paranthesis refers to the Green laser, the other one to IR.

3 Output Format

The output of the program is printed to the screen as well as written to the log-file `c:\dev\lookup.log`. First the input parameters and some calculated properties are shown, e.g.

```
Input Parameters:
=================
Laser:  Wave Length         :        1.054 [um]
        Energy              :      100.000 [mJ]
        Focal Spot Area     :       70.000 [um^2]
        Pulse Width (FWHM)  :        2.000 [psec]
  ==>   A(eff)/A(diff lim)  :     2.749411
  ==>   Eta Value           :     0.170533
  ==>   Upsilon Value       :     0.071472
Beam :  Nr of Electrons     :   1.000E+009
        Sigma(x)            :       60.000 [um]
        Sigma(y)            :       60.000 [um]
        Bunch Length (FWHM):        6.800 [psec]
Offset: Timing              :        0.000 [psec]
Ecal Position (PCS)         :     -138.000 [mm]
--> hit any key to continue ...
```

The next page lists the total electron and gamma rates, e.g.

```
Total Rates:
============
Total N(gamma):  3.8558E+005
Total N(e-)   :  3.8470E+005
N(e-) for n=1 :  3.8423E+005
N(e-) for n=2 :  1.3235E+003
N(e-) for n=3 :  1.4099E+001
N(e-) for n=4 :  2.4467E-001
N(e-) for n=5 :  5.4699E-003
--> hit any key to continue ...
```

Then the total electron spectrum is listed, e.g.

```
Electron Spectrum: ( 0.000 to 28.000 GeV)
==================
E(e-)      N(e-) | E(e-)      N(e-) | E(e-)      N(e-) | E(e-)      N(e-)
[GeV]            | [GeV]            | [GeV]            | [GeV]
--------------------------------------------------------------------------
 0.20  0.000E+000 |  7.40  2.100E-010 | 14.60  1.710E-001 | 21.80  5.774E+001
 0.60  0.000E+000 |  7.80  1.829E-009 | 15.00  2.972E-001 | 22.20  5.923E+001
 1.00  0.000E+000 |  8.20  1.401E-008 | 15.40  4.240E-001 | 22.60  6.074E+001
 1.40  0.000E+000 |  8.60  7.055E-008 | 15.80  5.429E-001 | 23.00  6.234E+001
 1.80  0.000E+000 |  9.00  4.807E-007 | 16.20  6.502E-001 | 23.40  6.410E+001
 2.20  0.000E+000 |  9.40  1.784E-006 | 16.60  7.465E-001 | 23.80  6.605E+001
 2.60  0.000E+000 |  9.80  5.183E-006 | 17.00  8.345E-001 | 24.20  6.823E+001
 3.00  4.697E-040 | 10.20  2.293E-005 | 17.40  9.174E-001 | 24.60  7.066E+001
 3.40  8.785E-034 | 10.60  6.692E-005 | 17.80  1.382E+000 | 25.00  7.336E+001
 3.80  6.638E-029 | 11.00  1.433E-004 | 18.20  1.037E+001 | 25.40  7.632E+001
 4.20  3.385E-025 | 11.40  2.734E-004 | 18.60  2.332E+001 | 25.80  5.056E+003
 4.60  4.303E-022 | 11.80  1.003E-003 | 19.00  3.295E+001 | 26.20  1.118E+004
 5.00  1.849E-019 | 12.20  2.760E-003 | 19.40  4.006E+001 | 26.60  1.050E+004
```

```
 5.40  2.613E-017 | 12.60  5.332E-003 | 19.80  4.531E+001 | 27.00  9.868E+003
 5.80  1.667E-015 | 13.00  8.425E-003 | 20.20  4.918E+001 | 27.40  9.294E+003
 6.20  5.487E-014 | 13.40  1.157E-002 | 20.60  5.207E+001 | 27.80  8.776E+003
 6.60  1.333E-012 | 13.80  1.685E-002 | 21.00  5.433E+001 |
 7.00  1.995E-011 | 14.20  6.511E-002 | 21.40  5.615E+001 |
--> hit any key to continue ...
```

Finally, the expected rates for the top 6 Ecal rows are given, e.g.

```
ECAL Rates:
===========
Row   E-Top  E-Cent  E-Acce      Energy       N(e-)  1/Ng*dN/dE
      [GeV]    [GeV]  [GeV]       [GeV]                 [1/GeV]
---------------------------------------------------------------
  0  19.792  18.430   2.614  2.495E+003  1.308E+002  1.343E-004
  1  17.178  16.031   2.193  5.384E+001  3.312E+000  3.972E-006
  2  14.985  14.014   1.859  5.877E+000  4.036E-001  5.850E-007
  3  13.126  12.326   1.542  2.018E-001  1.597E-002  2.754E-008
  4  11.450  10.770   1.303  4.370E-003  3.957E-004  8.074E-010
  5  10.147   9.585   1.104  1.542E-004  1.558E-005  3.779E-011
```