3. EGS4 – A Code Greatly Influenced by Medical Physics

Since the introduction of EGS3 there has been a growing need to extend the lower limit of kinetic energy—*i.e.*, down to 1 and 10 keV for photons and electrons, respectively. Essentially, EGS3 has become more and more popular as a general low-energy electron-photon transport code that can be used for a variety of problems in addition to those normally associated with high-energy physics. While there was a collaborative effort being undertaken in 1982-1983 by Nelson (SLAC) and Hirayama (KEK) to extend the flexibility of EGS in general, particularly for use around high-energy accelerators, there was also an important low-energy benchmarking effort being done by Rogers, Bielajew, and colleagues at the NRC in Canada. The work of these three laboratories was pooled and the EGS4 Code System became the result.

Although EGS is still very heavily used in particle physics, it is interesting to note that of the 260 requests for EGS4 received by SLAC in 1986, well over half were from hospitals or organizations involved in medical physics and dosimetry research. The current strong interest by hospital physicists has led to a number of EGS courses, as well as to the publication of a more general book on the subject entitled *Monte Carlo Transport of Electrons and Photons*[5]

4. General Description (and the Role of PEGS4)

EGS is basically an *analog* Monte Carlo program. That is to say, each and every particle is followed until it reaches its final destiny, usually an energy limit (cutoff) or a discard boundary. Due to the statistical nature of the Monte Carlo method, the accuracy of the results will depend on the number of histories run. Generally, the statistical uncertainties are proportional to the inverse square root of the number of histories, so that to cut uncertainties in half it is necessary to run four times as many histories. Also, for given cutoff energies, the computer time for a high-energy shower history is slightly more than linear in the energy of the incident particle. The point to be made here is that analog Monte Carlo calculations can be very time consuming.

It is for this reason that the computational task of the EGS4 Code System is divided into two parts. First, a preprocessor code (PEGS4) uses theoretical (and sometimes empirical) formulas to compute the various physical quantities needed, and prepares them in a form for fast numerical evaluation. Then EGS4 uses these data, along with user supplied data and routines, to perform the actual simulation.