

## Geometry Design of an Electron Dump with Simple Geo

M Şekerci<sup>1</sup>, F Ç Öztürk<sup>2</sup>, N Hafızoğlu<sup>2</sup> and S Özkorucuklu<sup>2</sup>

<sup>1</sup> Süleyman Demirel University, Department of Physics, 32260, Isparta, Turkey

<sup>2</sup> Istanbul University, Department of Physics, 34134, Istanbul, Turkey

mertsekerci@sdu.edu.tr

**Abstract.** The goal of this study is to design a geometry of an electron dump with Simple Geo code which is a freeware product and provides the ability of designing complex geometric systems easily. Also, Simple Geo can output the designed geometry in many different formats. Desired design of the electron dump is to stop the 40 – 42 MeV electron beams. To reach this aim, requested geometric design with the possible material was done with Simple Geo and a FLUKA output format file created to run the simulations in FLUKA code.

In particle accelerators and research laboratories, the transportation of the high energetic charged particles done by the structures called beam lines. With the help of this structures high energetic charged particle beams could be transported in desired ways to perform the requested experiments and to observe the interactions. That kind of structures are also used in the areas of high energy physics experiments and related facilities such as particle colliders, synchrotron radiation devices for example to produce a synchrotron light source, particle therapy in where that energetic particle beams consisting of usually protons but also neutrons to be used for cancer treatment, astrophysics, military purposes and for increasing the industrial improvements. Used for all kind of desires, high energetic charged particle beams used in the beam lines must be neutralized and ended finally. This is a must property of a suitable beam line since without a neutralization that high energetic charged particle beams should harm even destroy the rest of the system, located after the beam line. Structures called “beam dumps” are used for this purpose [1].

Basically, dump systems are used to stop and neutralize the high energetic charged particle beams without any harm to their organic and inorganic surroundings including the beam line itself. The design studies completed in this study is done for an electron dump system which can be used in a beam line that houses 40 – 42 MeV electron beam produced from a thermionic electron gun and used to create a free electron laser light.

Electron dumps have been designed to have different geometric details and are made of different materials according to the characteristic specifications of the charged particle beams of the systems that they are going to be used [2]. For this study as is mentioned before, the studied design will be able to stop 40 – 42 MeV energetic electron beams. The energy of the charged particle beam is the most important value of that characteristic specifications.



Electron dump systems also requested to minimize the effects of the secondary particles which could be occurred due to the uncontrolled interactions of high energetic charged particle beams and matter inside the electron dump systems. Therefore, neutralization and extermination of high energetic charged particle beams and possible formed secondary particles are done by the absorption of the energies of the beam and secondary particles after hitting the beam to a structure that holds a conical space inside a cylindrical material. Most of the electron dumps which are used for high energetic electron beams like in this particular study, have the same shape which is a conical space inside a cylindrical structure. The reason of that conical space inside the cylindrical structure is to eliminate the possibility of the damage to the beam line which may occur due to the backscattering of the secondary particles and beam itself [3]. This shape will not let the secondary particles creation allowing to scatter directly on the opposite way of the incoming beam.

In Figure 1. mentioned conical space itself is shown inside a cylindrical structure. This figure was obtained during the designing with the Simple Geo [4].

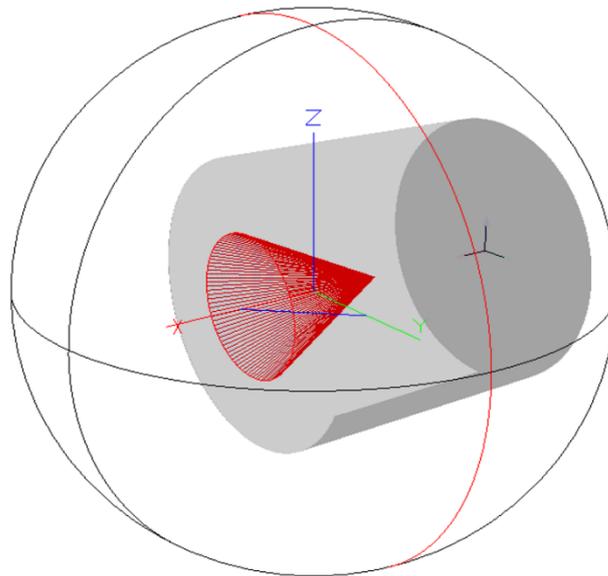


Figure 1. Conical space itself inside the cylindrical structure

Simple Geo is the code used in the overall design and used to create the geometric design. It is possible to create and design different complex geometries and structures with this freeware code. Besides, to create even more complex geometries, the code provides pre-defined geometries and mathematical logic based operators such as addition and subtraction to make the connections between different geometric objects to create the final object. Primary reason of using Simple Geo is its simplicity of geometric design and ability to provide different format output files that could be directly imported by other simulation or design codes. This property of Simple Geo, provides us the simplicity of testing the designed structure with some useful other codes like FLUKA.

In Figure 2. the conical space and the cylindrical structure is shown together. This figure was obtained with the Simple Geo's mentioned mathematical logic subtraction method. In order to create this shape, a cylinder defined first with specific properties. Continuously, the required conical space is created by defining the properties of that conical structure.

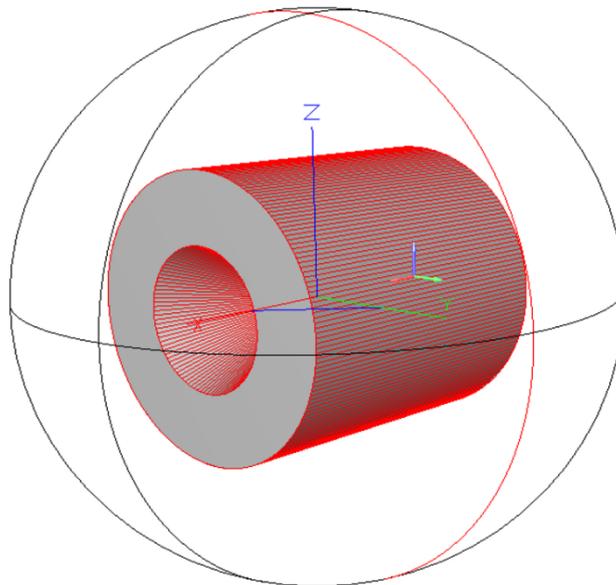


Figure 2. Conical space inside the cylindrical structure together

Cylindrical core of the electron dump system is designed as 24 cm long on the direction of the beam propagation way with a 6 cm radius to provide the requests and be used on a beam line that houses 40 – 42 MeV electron beam as mentioned before. The conical space on the cylindrical core has a 3 cm maximum radius and 0 cm minimum radius and the length of the core is determined as 4 cm. Those dimensions are selected since they are observed to be the most applicable and suitable ones. Some simulations of different dimensional geometries designed with Simple Geo were studied with FLUKA code before giving the final decision. Simulation studies covering this context still continues with the simulation code FLUKA [5].

One other important topic is about the material selection of the production of these kind of devices. The materials used in electron dump systems are usually carbon, aluminum, copper, beryllium, and lead. That diversity to produce an electron dump is due to the usage purposes of the dump system and to be able to produce it with low cost. Some of these materials are able to work with respectively lower energetic high energy charged particle beams.

Carbon – graphite was selected for the electron dump system designed in this study. Primary reason for this is the low neutron production rate of the carbon – graphite. Furthermore, carbon – graphite provides the best results for the mentioned energy range and price-performance rate.

An electron dump structure with these dimensions and with a lead cover has been observed to operate with high efficiency and also incarcerate the secondary particles inside itself.

**References**

- [1] McIntosh D H, 1994 *UCLA Technical Design Report* **3-12**
- [2] Colin Smith, Yun He, Charles Sinclair, 2005 *IPAC* **5 1-3**
- [3] Scientific Assessment of High-Power Free-Electron Laser Technology, 2009, Committee on a Scientific Assessment of Free-Electron Laser Technology for Naval Applications, Board on Physics and Astronomy, Division on Engineering and Physical Sciences, National Research Council
- [4] Theis C, Buchegger K.H, Brugger M, Forkel-Wirth D, Roesler S, Vincke H, *Nuclear Instruments and Methods in Physics Research A* **562**, 827-829
- [5] Ferrari A, Sala P R , Fasso A, Ranft J, 2008 **3-10**, 243-252