

## **2.6      *Understanding a sampling calorimeter***

### **2.6.1    Scenario: Optimizing detector design**

A team of physicists is assigned to prepare a design proposal for an electromagnetic calorimeter for a modern high-energy physics experiment. The task is quite challenging, as calorimetry offers a wide range of possible combinations, unlike tracking. The team must achieve good energy and spatial resolution, and yet take into account physics requirements, detector size and cost limitations. The team decides to use *Geant4* detector simulation toolkit in order to test calorimeter models of various geometry and material composition. It turns out that the compromise between all the requirements can be achieved by constructing a *sampling calorimeter* with lead as an absorber and liquid argon as the active material. The concept is accepted, especially since it is further proposed to use a similar setup, only with copper instead of lead, to serve as a hadron calorimeter.

### 2.6.2 Literature

1. C. Grupen, Particle Detectors (Cambridge University Press, 1996).
2. K. Kleinknecht, Detectors for Particle Radiation (Cambridge University Press, 1999).
3. D. Green, The Physics of Particle Detectors (Cambridge University Press, 2000).
4. R. Fruhwirth, M. Regler, R.K. Bock, H. Grote, D. Notz, Data Analysis Techniques for High Energy Physics, 2nd Edition (Cambridge University Press, 2000).
5. R. C. Fernow, Introduction to Experimental Particle Physics (Cambridge University Press, 1986).
6. R. Wigmans, Calorimetry, Energy Measurement in Particle Physics (Oxford Scientific Publications, 2000).
7. Geant4: A toolkit for the simulation of the passage of particles through matter.  
<http://cern.ch/geant4>

### 2.6.3 Aims of the material

The aim of this scenario is a closer study of one of the most important sub-systems of modern particle detectors, the sampling calorimeter. The other goal is to introduce the students to the Geant4 toolkit. More specifically, study subjects are:

- Geometrical description in Geant4
- Acceptance correction
- Response to electrons
- Factors affecting the resolution
- Response to charged pions

At this point, the group may already have knowledge of Geant4, and it is then conceivable to prepare an assignment involving simulation of a sampling calorimeter prototype. Otherwise, study of the reference literature and Geant4 usage manuals would be sufficient.