

Materials Selection. Exercice

Particle detector

Background. The study of particle structures and interactions in high energy physics requires the development new detectors.

The support of the detector should be stiff to enable the positioning of the silicon chip. The material must allow the precise machining of the allignment fixtures that are used for the silicon sensor. It has to provide enough flexural strength and exhibit a high thermal conductivity to carry the heat from the silicon sensor to the cooling element. In addition a high stiffness is required to avoid vibration from the circulating. It should be transparent to elementary particles, its radiation length should be as long as possible.

The Project is to investigate materials for supporting silicon chips in high energy physics detectors.

- Collect a range of possible existing materials.
- Create and discuss some possible composites alternatives (fibres or particle)
- Formulate a specification for selecting materials.
- Use CES level 1, 2 or 3 to explore the choice of materials for the detector supports.
- Present the case for your choice of material and process as a presentation, using data or charts from CES and from any other sources you have used to explain your reasoning.
- Make some consideration about the toxicity of the materials and its life time in humid atmosphere

Function	
Constraints	
Objective	
Free variables	

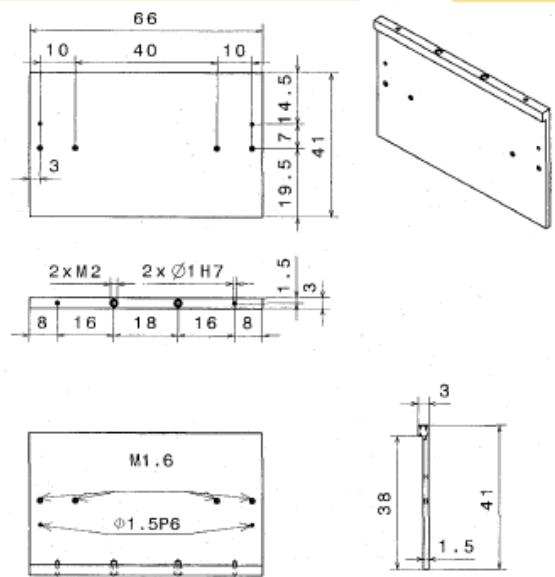
Hints: The radiation length can be expressed by

$$1/X_0 = \frac{4\alpha N_A Z(Z+1) r_e^2 \log(183 Z^{-1/3})}{A}$$

with

α = fine structure constant ($\approx 1/137$)
 N_A = Avogadro's number ($6.022 \cdot 10^{23}$ /mole)
 Z = atomic number of the traversed material
 A = atomic weight of the traversed material
 r_e = electron radius ($2.818 \cdot 10^{-13}$ cm).

- The dimensions (order of magnitude) of the support is shown in the picture. These plus the limit on service temperature and the need for low dielectric loss lead to the following specification:



plan of the silicon chip support (dimensions in mm)