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Contemporary Physics and Engineering Applications

Superconducting Accelerator Magnets: An Interdisciplinary Application

This interactive tutorial, on 2 CD-ROM disks for Windows 95/NT, presents a complete introduction to the physics and engineering concepts used in the design and construction of superconducting accelerator magnets. Development of this tutorial was funded by the U.S. Dept. of Energy, and is targeted to college level science and engineering students.

Subsets of this material can be used to create the study modules described below. These modules are suitable as supplementary resources to standard introductory science courses at the high school or college level.

Study Modules Based on “Superconducting Accelerator Magnets” Tutorial

1. Particles & Accelerators

This module provides general background on particle physics (as the reason for accelerators) and on the types of accelerators. It could be used in conjunction with WWW sites from major accelerator laboratories; several lab sites provide general educational material.

- Particles
- Accelerators

Possible student project:

Compile a table of size / energy/ beam/ field for world accelerators; use WWW for lab info. Relate those sizes to sites in your county.

2. Magnets & Superconductivity

This module provides the introduction to magnetic fields and superconductivity; it is a prerequisite to the later modules.

- Units and Lorentz Force
- Accelerator Magnet Fields
- Future Superconductor Applications
- Superconductivity and Magnets

Possible student project:

Compile a table of fields for typical magnet applications; use WWW for info from companies. Determine companies in your county that manufacture or use magnets.

3. Superconducting Magnet Design & Construction

This module summarizes key design features of several existing accelerator magnet designs; it discusses the factors that affect the design decisions, and shows the full construction process. It provides a good illustration that there is not just one right answer for science and engineering design.

- Magnet Designs
- Construction Steps (with videos)
- Design Issues

Possible student project:

Summarize major construction steps, and note which are required because of superconducting aspect of the magnet and which are required for any electromagnet.

4. Superconductor Fabrication

This module illustrates the technology of producing and testing superconductor for magnets. It includes an overview of the classes of superconductors and their applicability to magnets. It is an introduction to the work of materials scientists.

- Making Wire
- Parameters
- Making Cable
- Material Classes & Status

Possible student project:

Compile a table of typical SC wire available: use WWW for info from companies. Determine companies in your county that manufacture or use superconductor.

5. Magnetic Field Calculation

This module provides an interactive program that calculates and displays the magnetic field for a dipole or quadrupole magnet with specified geometry and superconductor properties. It includes a summary of the main features that can be varied in a magnet design, and an introduction to the concept of calculating fields from current lines.

It is an introduction to the role of mathematical physics and finding optimal parameter values.

- Design Issues
- Field from Current Lines
- Interactive Field Calculation Program

Possible student project:

Develop parameters for a magnet of specified aperture and field. (A list of feasible aperture and field specifications could be provided.)