NEW DOCUMENTATION FROM THE LOS ALAMOS ACCELERATOR CODE GROUP*

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Summary

Within the past two years, the Los Alamos Accelerator Code Group has produced four new documents for computer codes which are now available on request.

- MAFIA User Guide
- Reference Manual for the POISSON/SUPERFISH Group of Codes
- User's Guide for the POISSON/SUPERFISH Group of Codes
- A Compendium of Computer Codes Used in Particle Accelerator Design

Introduction

The MAFIA system [1] is a set of computer programs used for the computer-aided analysis and design of three-dimensional electromagnetic structures including electrostatic and magnetostatic devices, radio-frequency cavities, bellows, etc. The programs are the result of an ongoing collaboration between Deutsches Elektronen-Synchrotron, Los Alamos National Laboratory, and Kernforschungs Anlage-Jülich. MAFIA is an acronym for the solution of MAxwell's equations using the Finite Integration Algorithm [2]. This algorithm reduces the integral representation for each of Maxwell's equations to a fully generalized matrix equivalent which is convenient for use in large-scale computers. Solutions can be in the frequency-domain or the time-domain. The theory behind the MAFIA codes is well documented [3, 4, 5, 6].

The POISSON/SUPERFISH Group of Codes is used in the computer-aided design of magnets and radio-frequency structures. These codes provide the user with a choice between Cartesian (x, y) coordinates and cylindrical (r, z) coordinates. POISSON calculates magnetostatic and electrostatic fields while SUPERFISH computes the resonant frequencies and fields in radio-frequency cavities handling dielectric materials and linear magnetic materials. These codes use a variable triangular mesh that distorts to fit the problem geometry; they are the original nine programs written by Ronald Holsinger, supported by the Department of Energy as the standardized version for the accelerator community.

We are optimistic that this new documentation will prove useful; friendly users who have tested the manuals have reported favorable reactions to both the material covered and the organization.

These documents were prepared as input data for the TEX and LATEX programs which are in worldwide use and growing in popularity. These programs produce clean, professional results: pages that are easy to read and reproduce. As an example, this paper was produced using the program TEX. The documents can be sent as ASCII files over a computer network and reproduced, except for illustrations, anywhere the TEX and LATEX programs are supported.

MAFIA User Guide

The 100-page MAFIA User Guide [7] gives a simple tutorial example for which both time-domain and frequency-domain solutions are calculated. The input data requirements for each of the codes in the MAFIA group are given in detail.

POISSON/SUPERFISH Reference Manual

The POISSON/SUPERFISH Reference Manual [8] comprehensively reports on the complete POISSON/SUPERFISH Group of Codes. The manual is structured so that its three sections can be divided into two independent modules, one for POISSON and one for SUPERFISH. Each module describes the basic physics, extensively documents the theory behind the algorithms used in the programs, and addresses the convergence and accuracy of the programs. The 300-page POISSON module includes detailed examples for a quadrupole magnet, an electrostatic problem, and a permanent magnet solenoid. The 200-page

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SUPERFISH module provides detailed examples for a spherical cavity, a synchrotron cavity with ferrites, and an electron linac cavity.

While the expert user will need these reference manuals for in-depth information, the novice user needs something introductory. The User's Guide has been written for this purpose. This guide contains much of the essential detail included in the reference manuals, but is more tutorial in nature.

POISSON/SUPERFISH User's Guide

The 250-page User's Guide [9] emphasizes the mechanics of the codes. Sample input and output files are shown and explained. TEKPLOT's graphical output is used to illustrate the results. Although a tutorial approach is used, the guide is organized so that reference tables and information are easy to find.

The first chapter is a primer for the POISSON/SUPERFISH group of codes. The user is given a general introduction to the codes and then led through a simple magnetostatic example and a simple radio-frequency cavity calculation. Each of the following chapters concentrates on one of the programs in the group of codes and provides more detail.

The User's Guide features sections on warning and diagnostic error messages for each program. The messages are not only listed but provide information based on our experience about what to do or what to check when these messages are received.

A 58-page chapter of examples leads the user through the use of a large variety of options for the POISSON and PANDIRA programs. Both VAX and Cray command files to run these examples are given. The following is a list of the included examples followed by the options they illustrate.

H-Magnet with options

- calculate fields and gradients in a region on mesh points
- continue from previous POISSON dump number
- adjust current to produce a given field

Quadrupole magnet with a hyperbolic pole tip using both POISSON and PANDIRA

- quadrupole symmetry
- input of a permeability table
- output fields on specified lines

Cylindrical permanent magnet

- cylindrical coordinates
- variable mesh in both r and z directions
- input of B-H curve

Vector potential problem

- input file to LATTICE directly without using AUTOMESH
- input fixed vector potential on boundaries
- constant fixed permeability value

Electrostatic problem using POISSON

Septum magnet

- negative coordinates
- full geometry input
- off-center harmonic analysis

Dipole magnet, center field calculations

- front vertical cross-section geometry assuming infinite length

Dipole magnet, end field calculations

- side view cross-section geometry with a return yoke
- adjust the length of the magnet to generate the same fields
- put the return leg far enough so that this addition won't affect the fields at the area of interest

Compendium of Computer Codes

The Accelerator Code Group has assembled a compendium of over 140 codes used in the accelerator community for particle accelerator design. Complete copies of the compendium have been sent to the contributors so that the entries could be checked for accuracy. For each code listed in the compendium, the following information is available:

- Person-to-contact and their address
- Code classification according to design purpose
- Short description of capabilities, algorithms, and special features
- Publications that describe the code
- Documentation availability
- Access to the codes

- Source language
- Target computer(s)
- Type of files available
- Distribution media

We would like to keep the compendium up-to-date, and we solicit additional contributions from authors and users.

Access

Copies of this documentation may be obtained by writing to the following address.

Distribution
Los Alamos Accelerator Code Group
AT-6, Mail Stop H-829
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

References

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[2] T. Weiland, "On the Numerical Solution of Maxwell's Equations and Applications in the Field of Accelerator Physics," *Particle Accelerators* **15(4)**, 245-292 (1984).

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[4] T. Weiland, "On the Unique Numerical Solution of Maxwellian Eigenvalue Problems in Three Dimensions," *Particle Accelerators* **17(3-4)**, 227-242 (1985).

[5] T. Weiland, "Transverse Beam Cavity Interaction, Part I: Short Range Forces," *Nuclear Instruments and Methods (NIM)* **212**, 13-34 (1983).

[6] R. Klatt and T. Weiland, "Wake Field Calculations with Three-Dimensional BCI Code," in *Proceedings of the 1986 Linear Accelerator Conference*, Stanford Linear Accelerator Center report SLAC-303 (June 1986), pp. 282-285.

[7] The Mafia Collaboration, "MAFIA User Guide," Los Alamos National Laboratory (in process).

[8] Los Alamos Accelerator Code Group, "POISSON/SUPERFISH Reference Manual," Los Alamos National Laboratory report LA-UR-87-126 (January 1987).

[9] M.T. Menzel, H.K. Stokes, "User's Guide for the POISSON/SUPERFISH Group of Codes," Los Alamos National Laboratory report LA-UR-87-115 (January 1987).

[10] Los Alamos Accelerator Code Group, "Computer Codes Used in Particle Accelerator Design," Los Alamos National Laboratory report LA-UR-86-3320 (August 1986).