RECENT ADVANCES IN THE POISSON/SUPERFISH CODES*

R. Ryne, T. Barts†, K.C. D. Chan, R. Cooper, H. Deaven, J. Merson, G. Rodenz
Los Alamos Accelerator Code Group
Los Alamos National Laboratory
Los Alamos, NM 87545

Abstract

We report on advances in the POISSON/SUPERFISH family of codes used in the design and analysis of magnets and rf cavities. The codes include preprocessors for mesh generation and postprocessors for graphical display of output and calculation of auxiliary quantities. Release 3 became available in January 1992; it contains many code corrections and physics enhancements, and it also includes support for PostScript, DISSPLA, GKS and PLOT10 graphical output. Release 4 will be available in September 1992; it is free of all bit packing, making the codes more portable and able to treat very large numbers of mesh points. Release 4 includes the preprocessor FRONT and a new menu-driven graphical postprocessor that runs on workstations under X-Windows and that is capable of producing arrow plots. We will present examples that illustrate the new capabilities of the codes.

Introduction

The POISSON/SUPERFISH family of codes are widely used by the accelerator community for the design and analysis of magnets and rf cavities [1],[2]. Since the mid 1980's, official versions of the codes have been maintained and distributed by the Los Alamos Accelerator Code Group (LAACG). The most recent version of the POISSON/SUPERFISH family includes the following codes:

1. FRONT: pre-preprocessor
2. AUTOMESH: preprocessor for mesh generator LATTICE
3. LATTICE: mesh generator for POISSON, PANDIRA, SUPERFISH and PAN-T
4. POISSON: magnetostatic and electrostatic Poisson solver (based on successive over-relaxation)
5. PANDIRA: Poisson solver (based on Gaussian elimination) that can treat permanent magnet materials
6. MIRT: code for optimization using POISSON
7. FORCE: postprocessor to calculate forces on coils and bodies
8. SUPERFISH: rf cavity code (also able to treat waveguides at cutoff)
9. SFO1: postprocessor for calculation of Q, transit time factor, etc.
10. SHY: postprocessor for printing fields in selected regions
11. PAN-T: thermal analysis code using output from SUPERFISH
12. FIXPLT: used to generate source code for specific graphics libraries
13. PSFPLOT: graphics postprocessor
14. XPP3 and XPP4: X-Windows versions of PSFPLOT

The current distribution of these codes also includes online documentation, an extensive list of examples, a makefile (UNIX version) and information on compiling the codes (VAX version).

POISSON/SUPERFISH Release 3

Release 3.0 of POISSON/SUPERFISH was officially distributed in January of 1992 [3]. This release included a major reorganization of the codes. There were also a number of bug fixes and physics enhancements, including corrected stored energy calculations and changes to the built-in permeability tables. In addition, graphics support was expanded to include not only Tektronix PLOT10, but also DISSPLA, GKS and PostScript. (On an unofficial basis, a preliminary X-Windows implementation of the graphics postprocessor was made available to some users.) Release 3.0 was installed at the National Energy Research Supercomputer Center (NERSC) and the Florida State University Supercomputer Research Institute (FSU/SCRI). This release was the first to be ported to the UNICOS operating system.

POISSON/SUPERFISH Release 4

When the POISSON/SUPERFISH codes were originally developed in the 1960's and 1970's memory was scarce, and the authors went to great efforts to pack as much information as possible into each computer word. This packing and unpacking of data (which required shifting and masking operations) made the codes far from portable and has been a source of frustration for decades. Furthermore, details of the bit packing made it impossible to run problems with more that 32767 ($=2^{15}-1$) mesh points, which is too small for many users who want to simulate complicated structures. This situation has been remedied in POISSON/SUPERFISH Release 4; all bit packing has been removed. Now a user can change the maximum number of allowed mesh points simply by changing a parameter statement, and the upper limit to this depends only on one's available computing power. In addition to the removal of bit packing, Release 4 also the addresses the namelist input issue, for which there is no FORTRAN77 standard: the

* Work supported by the U.S. Dept. of Energy, Office of Energy Research: Office of High Energy and Nuclear Physics, Office of Basic Energy Sciences, Office of Fusion Energy, Office of Superconducting Super Collider, and Scientific Computing Staff
† Mail Stop 1042, Superconducting Super Collider Laboratory, Dallas, TX 95237

new release contains FORTRAN77 routines that encompass most implementations of namelist. Also, the FREE subroutine (which has been renamed FREEIN to avoid conflict with system routines on some platforms) has been rewritten to help minimize numerical roundoff. Release 4 has been compiled on Sun SPARC, IBM RISC/6000, HP 750, Silicon Graphics, Cray Y-MP, Cray 2 and VAX computers.

In addition to the above programming changes and minor bug fixes, Release 4 also contains some important additional features: the program FRONT, and arrow plotting in the PSFPLOT graphics postprocessor, and a new X-windows version of the postprocessor are all officially included in the family of codes.

Many versions of FRONT exist in the accelerator community. It provides an alternative method of generating an input file for AUTOMESH. FRONT also generates UNIX script files (or VAX command files) to help make running the sequence of codes a little easier.

Prior to Release 4, the graphical postprocessor allowed one to plot contours of constant rH_ϕ. This is shown in Figure 1 for a sample problem. With the distribution of Release 4, it is now possible to make arrow plots. This is shown in Figure 2 for the same sample problem.

Finally, Release 4 contains a new X-Windows version of the postprocessor written using XView (and soon to be available using MOTIF.) This provides the user with a menu-driven interface to the postprocessor. See Figure 3.

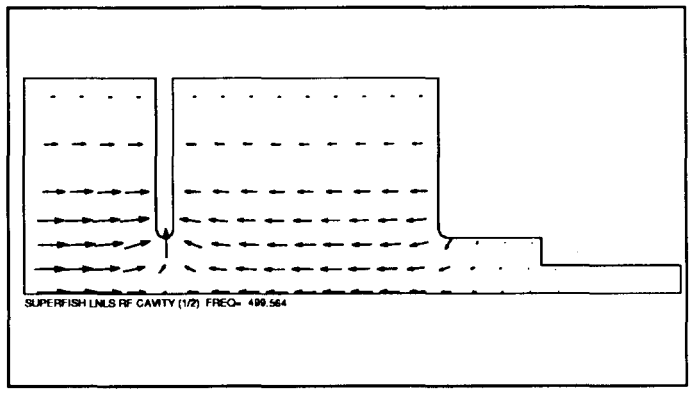

Figure 2 Graphical output with arrow plots

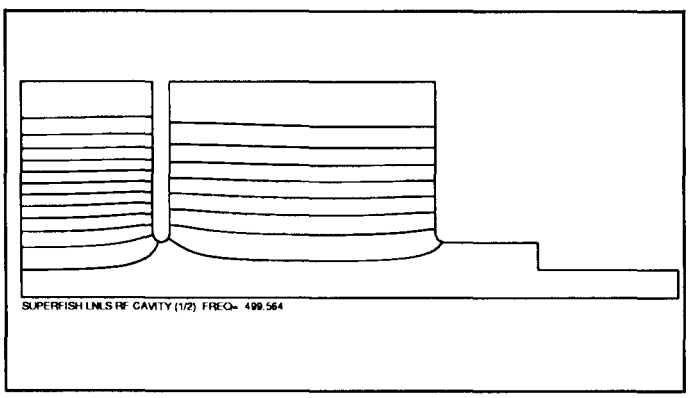

Figure 1 Graphical output showing contours of constant rH_ϕ for a sample problem

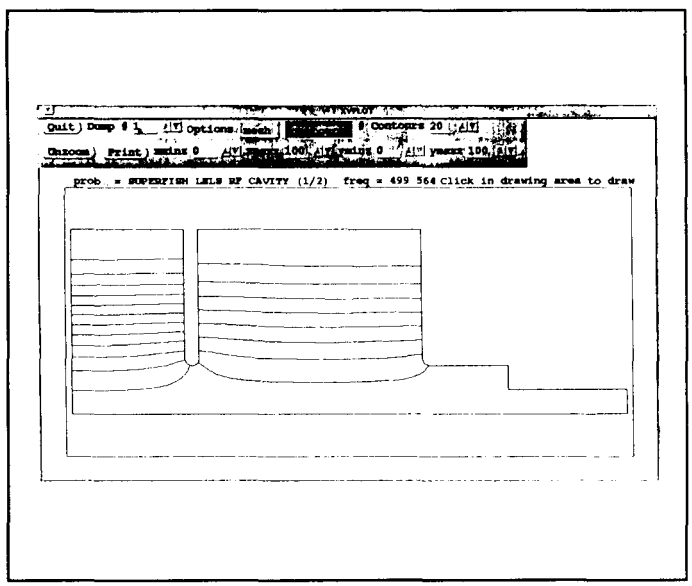

Figure 3 User interface to the X-Windows version of the graphics postprocessor

Other versions of POISSON/SUPERFISH

The LAACG maintains and distributes versions of POISSON/SUPERFISH for Cray's, VAX's and most UNIX workstations. The PC field has been addressed by others. PC versions of the codes have been available for several years, free of charge, from Brookhaven National Laboratory. (See the entry in the LAACG Compendium [4].) A commercial version of the codes is available from Acceleration Consultants; it includes extensive enhancements that make the codes more user friendly and useful [5]. Also, the Los Alamos AT-1 group maintains a PC version of the codes; they will supply executable code and documentation free of charge, but source code is not distributed [6].

References

[1] K. Halbach, "A Program for Inversion of System Analysis and Its Application to the Design of Magnets," Lawrence Berkeley Laboratory report UCRL-17436 (1967), CONF-670705–14.

[2] K. Halbach and R. F. Holsinger, "SUPERFISH," *Particle Accelerators* **7**, 213 (1976).

[3] T. Barts and J. Merson, "Users' Notes for POISSON/SUPERFISH Release 3.0," LA-UR-91–4140, February 21, 1992

[4] Los Alamos Accelerator Code Group, "Computer Codes for Particle Accelerator Design and Analysis: A Compendium," LA-UR-90–1766, May 1990.

[5] For information, contact Acceleration Consultants, 53 Rock Point Place NE, Albuquerque, NM 87122, phone (505)298–8446

[6] For information, contact Group AT-1, Mail Stop H817, Los Alamos National Laboratory, Los Alamos, NM 87545, phone (505)667–6627