

High Energy Facilities  
Accelerator Development Branch  
BROOKHAVEN NATIONAL LABORATORY  
Associated Universities, Inc.  
Upton, NY 11973

SSC Technical Note No. 36  
(SSC-N-46)

MODIFICATIONS IN THE POISSON GROUP CODES

Ramesh C. Gupta

October 4, 1985

The following short note is intended to outline some modifications in the POISSON group codes (either completed or underway) at the Accelerator Development Branch, Brookhaven National Laboratory. A more detailed and complete report will be written at a later date when the other improvements under consideration are incorporated. In writing this sketchy note, it is presumed that the reader has some familiarity with the POISSON Group codes.

In the program AUTOMESH, the modifications are made to allow the user to have a better control on the generation of the mesh. This allows one to define several complex structures at a number of places in a model. It is done by including few new variables in the NAMELIST. These variables (XSTR, XEND, KSTR, KEND, YSTR, YEND, LSTR, LEND) are (optionally) defined during \$REG for a region. The program computes, for this region, the other required variables (XMAX, YMAX, KMAX, LMAX, DX, DY, etc.) and the mesh is generated very conveniently. To increase the

power further, a region can be divided in a number of subregions and the size of the grid (DX and DY) may be different in these subregions. The above is important if the mesh density is to be varied within a region. Finally, to have a full control on the generation of the mesh, along with the physical coordinates one can also provide the logical coordinates of a point in the NAMELIST \$PO. For example: \$PO X=10., Y=5., IK=25, IL=20 will override the logical coordinates computed by AUTOMESH and if the two (computed and user assigned) are different, a warning is issued.

A mesh generated with these means of the magnet model of Fig 1 is shown in Fig 2. It is a 2-in-1 magnet and the magnitude of the current in the coils in the two apertures may, in general, be different. The mesh of the coil structure is shown in Fig 4 in an expanded scale. The mesh in the coil regions is so dense that it could not be resolved in Fig 2. The coil itself is shown in Fig 3.

Along with these, a parallel approach is being developed in which a user can input a number of pairs of physical and logical coordinates - (X,K) and (Y,L). Then the whole space will be divided in number of rectangular boxes having different mesh densities, in general. These rectangular boxes are used only internally to assign appropriate physical and logical coordinates and will not be visible in an actual mesh. To explain it let us consider the following example :

```
$XK PAIR=4$  
0.,1, 10.,21, 12.,23, 15.,25  
$YL PAIR=3$  
0.,1, 10.,21, 15.,26
```

and then

```
$REG IREG=11,NPOINT=2$
```

```
$PO X=0.,Y=0.$
```

```
$PO X=15.,Y=15.$
```

The line will get the following DX and DY :

(a) From (0.0, 0.0) to (10., 10.) : DX=.5, DY=.5

(b) From (10., 10.) to (12., 12.) : DX=1., DY=1.

(c) From (12., 12.) to (15., 15.) : DX=1.5, DY=1.

The above simple example illustrates how a region will have a varying grid-size. However, in practice, one might prefer to put each of those regions in a separate Box which are not to be overlaid by new regions within them. This approach has been successfully tested in the complex geometry such as of Fig 2, but some work still remains to be done in terms of cleaning out the source code and providing a better input specifications.

In the program POISSON, the modifications have been made to improve the convergence and to allow the users to have access to the intermediate results while the program execution is still under progress. These modifications are important for those problems which need several thousands of iterations to reach the required convergence. In the old version of POISSON, the overrelaxtion factor, CON(75), is optimized periodically upto iteration No. 1600. In many cases it has been seen that it is too high for the later stage of the solution. In many of those cases, a reduction in the value of overrelaxtion factor seemed to speed up the convergence. In some cases this reduction was found even essential to stop the solution from diverging. To partly overcome this problem a check has been introduced to

"watch" and to try to improve the path to the required convergence. The watch becomes effective after iteration No. 2000 and performs the following operations :

(a) Compares the present value of convergence to that at 100 iterations before and if the solution is relatively diverging by over 10% it reduces the value of overrelaxation factor by 10 to 20%. This watch is turned on at iteration No. 2000, 2100, 2200, etc.

(b) Compares the present value of convergence to that at 1000 iteration before and if the solution is relatively diverging it switches off the overrelaxation by making  $CON(75) = 1$ . This watch is turned on at iteration No. 3000, 4000, 5000, etc.

A better prescription for computing  $CON(75)$  may be developed later, together with a value of overrelaxation factor for iron points in the initial stages of the solution.

In the code POISSON, a facility has been introduced which allows a user to have an access to the intermediate results while the run (either in interactive mode or in batch mode) is in progress for a better convergence. The program now opens a new file, INTER.SAV, after every 1000 iterations and writes DUMP No. 0 and DUMP No. 1 on that. The file INTER.SAV is identical in structure to TAPE35.DAT and, therefore, can be used just for any purpose for which TAPE35.DAT is used. The file INTER.SAV is closed after DUMP No. 1 is written - always DUMP No. 1 is the latest solution and DUMP No. 0 the original DUMP No. 0 of TAPE35.DAT. This facility is also useful in the events of computer breakdown; since instead of starting the POISSON execution from the beginning one can now start from DUMP No. 1

of INTER.SAV. An additional facility will soon be introduced through which one will be able to change the values of CON()'s during the run in progress. It will be done through a new file INTER.INT which will be read and discarded after every 1000 iterations. It will be useful to those who are watching the progress of solution and might like to change the course of the run by changing the problem constants. The file INTER.INT will be similar in structure to the input file used to initiate a normal POISSON execution.

Apart from those described above, several other modifications have been incorporated, both in POISSON and in AUTOMESH. They will be described in the complete report on a later date. Some of these changes are the following:

1. New B-H tables for material 2 and 3 have been put in. These tables are those which are commonly used at BNL.

2. Revision of a B-H tables now actually replaces the old table and releases the space for a new table to be put in. In the old version an old table would still occupy a space even when it has been redefined.

3. Now one can compute the field harmonics at any point, not just at the origin. These harmonics are now computed in prime units together with the units used in the old POISSON.

4. One can specify a hyperbolic arc in any quadrant to construct a boundary of a region.

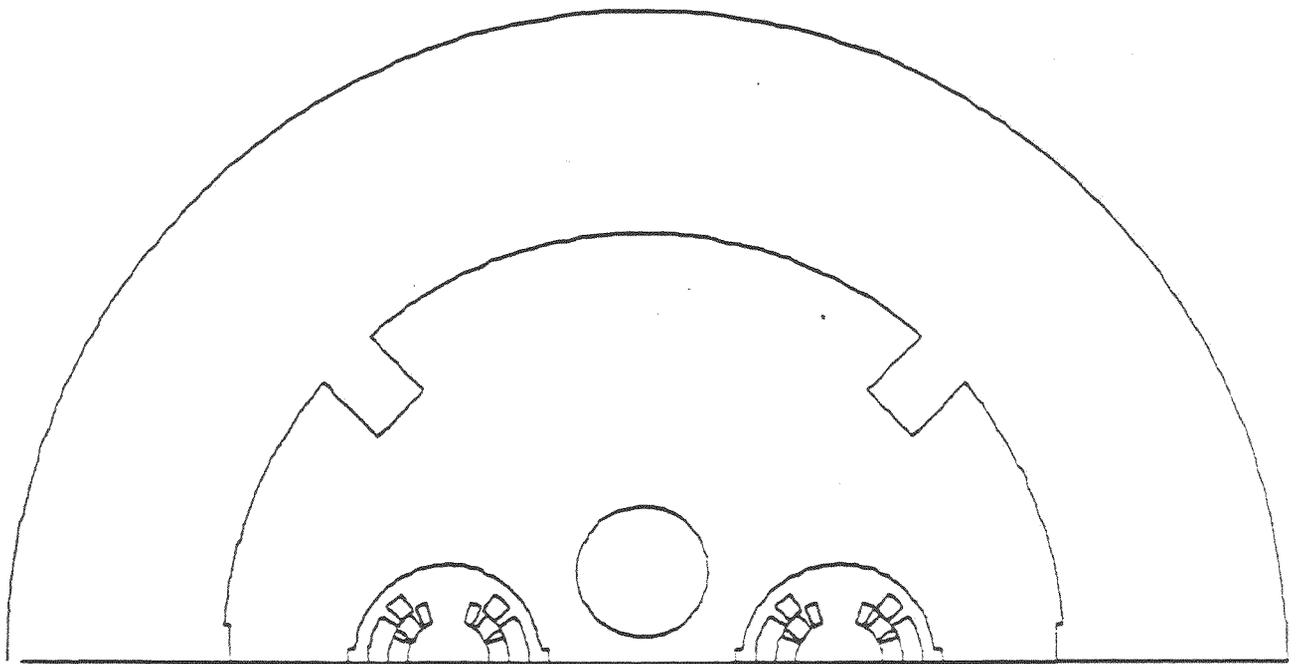


Fig 1. The upper half of the magnet. This geometry should be as close to the real structure as possible if a good solution is to be expected from POISSON. It is particularly important for the coil region.

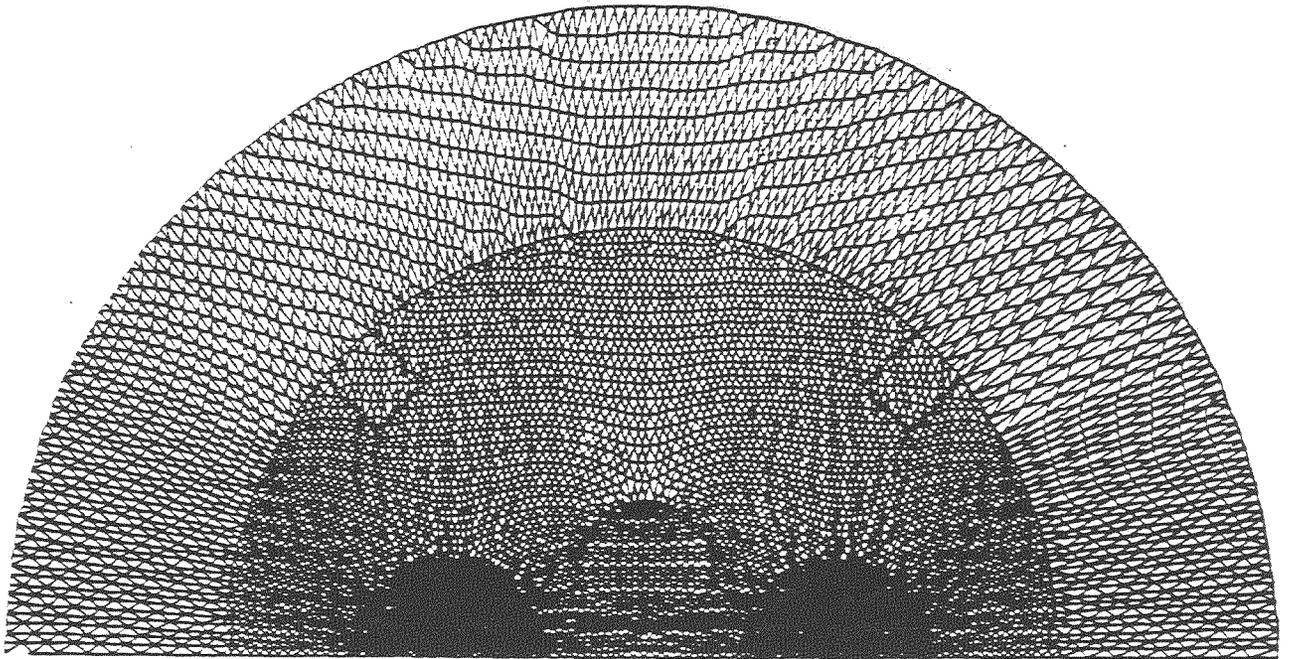


Fig 2. The mesh generated by the AUTOMESH (plus LATTICE). A high mesh density in the coil region helps defining the coil geometry precisely. The mesh in the coil region is given separately in Fig 4.

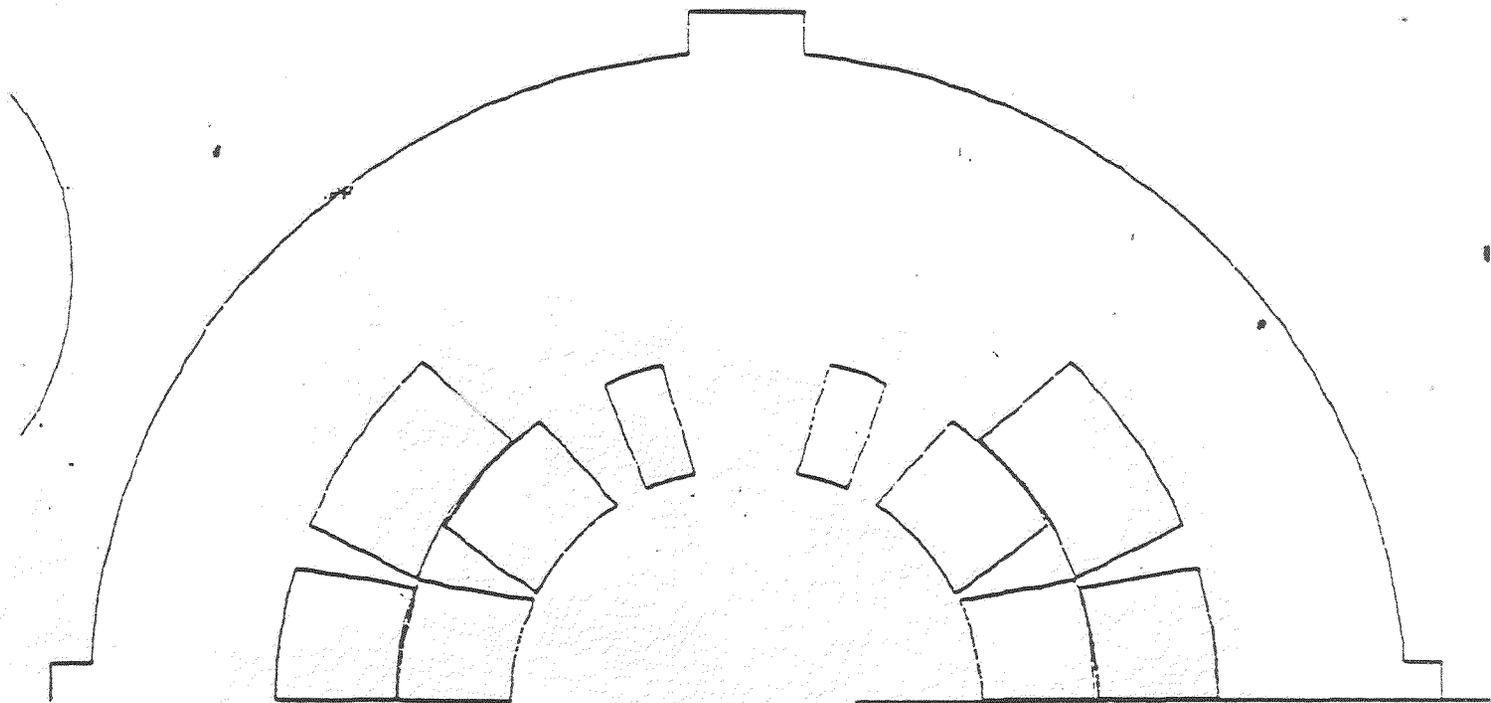


Fig 3. The coil geometry. The same coil geometry is used in both apertures, however, the magnitude of the current in the coils in the two apertures may be different.

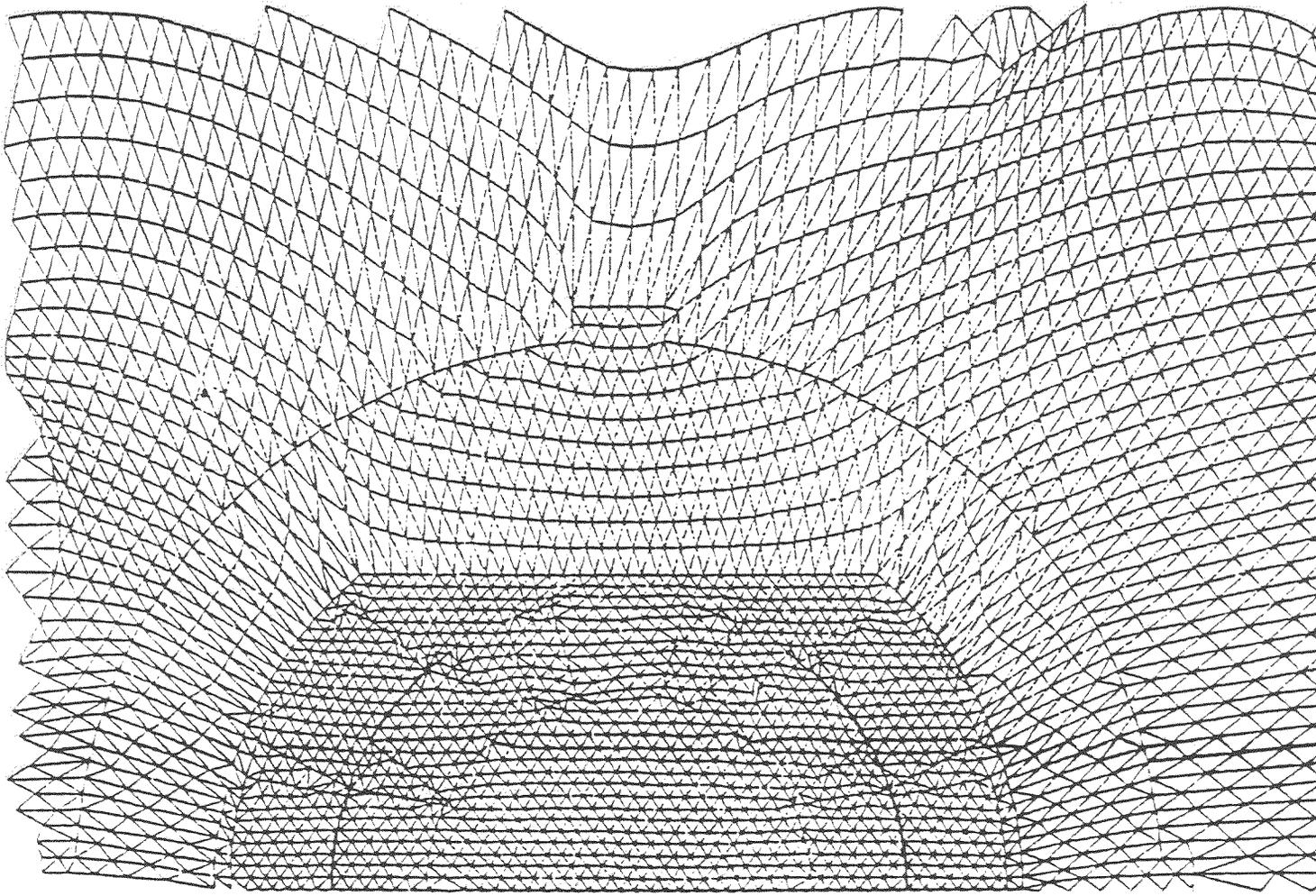


Fig 4. The mesh of the coil geometry. It is given separately here because it is so dense in Fig 2 that it can not be seen clearly there.

DISTRIBUTION

BLDG. 911

AD Library  
(H. Martin)  
G. Bunce  
H. Foelsche  
J. Grisoli  
P. Hughes (1) + 1  
for each author  
D. Lazarus  
D. Lowenstein  
T. Sluyters

FOR SSC PAPERS

FNAL

C. Rode  
W. Fowler  
Les Oleksuik

LBL

Shlomo Caspi  
R. Donaldson (2 copies)  
K. Halbach  
P. Limon  
C. Taylor  
M. Tigner  
R. Wolgast

SLAC

R. Early  
H. Shoaee

Bruce G. Chidley  
Chalk River Nuclear Laboratories

Philip H. Debenham  
National Bureau of Standards

BLDG. 902

D. Brown  
J. Claus  
J.G. Cottingham  
E. Courant  
P. Dahl  
F. Dell  
A. Flood  
M. Garber  
C. Goodzeit  
A. Greene  
R. Gupta  
H. Hahn  
H. Halama  
K. Jellett  
E. Kelly  
S.Y. Lee  
R. Louttit  
G. Parzen  
A. Prodell  
P. Reardon  
W. Sampson  
R. Shutt  
J. Sondericker  
S. Tepekian  
P. Wanderer  
E. Willen

BLDG. 460

N. Samios

BLDG. 510

H. Gordon  
T. Kycia  
L. Leipuner  
S. Lindenbaum  
R. Palmer  
M. Sakitt  
M. Tannenbaum  
L. Trueman  
D. White

BLDG. 535

W. Casey

BLDG. 725

M. Barton

S&P in Magnet Division for all MD papers

S&P in Cryogenic Division for all Cryo Papers  
(and J. Briggs, R. Dagradi, H. Hildebrand  
W. Kollmer)