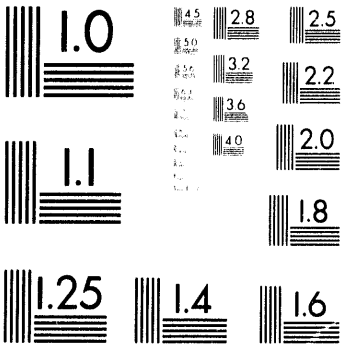
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

1 of 1

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UCRL-ID-115227

Using the TSAR Electromagnetic Modeling System

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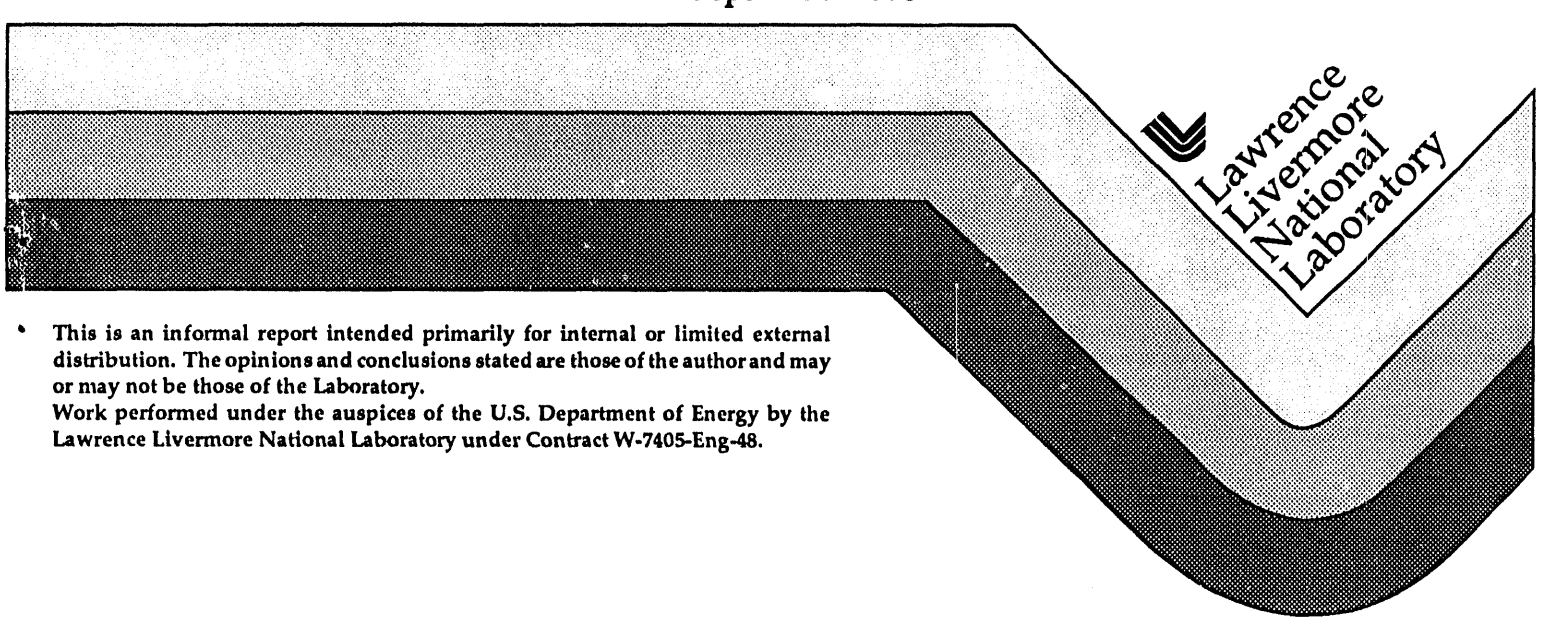
September 1993



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Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

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Using the TSAR Electromagnetic Modeling System

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Chapter 1

INTRODUCTION

A new user, upon receipt of the TSAR EM modeling system, may be overwhelmed by the number of software packages to learn and the number of manuals associated with those packages. This is a document to describe the creation of a simple TSAR model, beginning with an MGED solid and continuing the process through final results from TSAR. It is not intended to be a complete description of all the parts of the TSAR package. Rather, it is intended simply to touch on all the steps in the modeling process and to take a new user through the system from start to finish.

There are six basic parts to the TSAR package. The first, MGED, is part of the BRL-CAD package and is used to create a solid model. The second part, ANASTASIA, is the program used to sample the solid model and create a finite--difference mesh. The third program, IMAGE, lets the user view the mesh itself and verify its accuracy. If everything about the mesh is correct, the process continues to the fourth step, SETUP_TSAR, which creates the parameter files for compiling TSAR and the input file for running a particular simulation. The fifth step is actually running TSAR, the field modeling program. Finally, the output from TSAR is placed into SIG, B2RAS or another program for post-processing and plotting. Each of these steps will be described below.

The best way to learn to use the TSAR software is to actually create and run a simple test problem. As an example of how to use the TSAR package, let's create a sphere with a rectangular internal cavity, with conical and cylindrical penetrations connecting the outside to the inside, and find the electric field inside the cavity when the object is exposed to a Gaussian plane wave. We will begin with the solid modeling software, MGED, a part of the BRL-CAD modeling release.

Chapter 2

CREATING A SOLID MODEL

If the BRL package has been installed properly, (installation instructions are included with the BRL-CAD software), one begins by typing:

mged hollow_sphere.g,

where hollow_sphere.g is the filename chosen for the MGED database. Below is an example MGED session, with responses to prompts in bold face.

```
BRL-CAD Release 4.0  Graphics Editor (MGED)
        Wed Nov 13 15:58:13 PST 1991, Compilation 11
        laguna@wichita.llnl.gov:/public1/BRL4.0/BRL4.0/.mged.ibm

hollow_sphere.g: A  file or directory in the path name does not exist.
Create new database (y|n) [n]? y
attach (nu|tek|tek4109|ps|plot|sgi|X) [nu]? sgi
```

(Choose the appropriate device driver for your workstation.)

```
ATTACHING sgi (SGI 4d)
Untitled MGED Database (units=mm)
```

Begin by building a sphere with a one meter radius, located at the origin. Units are in millimeters, although they could be in meters, centimeters, feet or inches. The command to change the default units is units ab, where ab is **mm, cm, m, in** or **ft.** We will name the primitive sphere.s. The naming convention calls for solids to end with a .s extension and regions, (to be introduced later), with an .r extension, for easy identification.

```
mged> in sphere.s sph
Enter X, Y, Z of vertex: 0 0 0
Enter radius:  1000
51 vectors in 0 sec
```

Now enter a rectangular solid inside the sphere.

```
mged> in box1.s arb8
Enter X, Y, Z for point 1: -350  -150   400
Enter X, Y, Z for point 2:  350   150  -400
Enter X, Y, Z for point 3:  350   350  -400
Enter X, Y, Z for point 4: -350  350  -400
Enter X, Y, Z for point 5: -350 -150   200
Enter X, Y, Z for point 6:  350 -150   200
Enter X, Y, Z for point 7:  350  350   200
Enter X, Y, Z for point 8: -350  350   200
16 vectors in 0 sec
```

The arb8 command is for an eight-sided solid of arbitrary shape. An easier method for a rectangular solid is the box command. Another possibility would be to enter a simple box of arbitrary size using the make command, then adjust the box using the solid editor.

mged> **in box2.s box**
Enter X, Y, Z of vertex: **-740 -530 -640**
Enter X, Y, Z of vector H: **0 0 1240**
Enter X, Y, Z of vector W: **0 1030 0**
Enter X, Y, Z of vector D: **1440 0 0**
16 vectors in 0 sec

Now enter a cylinder at an angle to the box.

mged> **in cyl1.s rcc**
Enter X, Y, Z of vertex: **0 -515 -1060**
Enter X, Y, Z of height (H) vector: **0 1160 2000**
Enter radius: **100**
42 vectors in 0 sec

Finally, enter an elliptical cone through the sphere and box.

mged> **in cone1.s tgc**
Enter X, Y, Z of vertex: **-1300 102 -93**
Enter X, Y, Z of height (H) vector: **2600 0 0**
Enter X, Y, Z of vector A: **0 230 0**
Enter X, Y, Z of vector B: **0 0 128**
Enter scalar c: **132.5**
Enter scalar d: **69.5**
42 vectors in 1 sec

Use the command **tops** to look at what objects exist at the top level.

mged> **tops**

box1.s cone1.s sphere.s
box2.s cyl1.s

Currently there are five primitive solids, two of which are boxes, and all are located in the same spatial region. (As noted earlier, the .s extension signifies a solid). To get rid of one box, use the kill command. We will eliminate the smaller box so that more of the sphere will be hollow. This will mean fewer nodes to be displayed when we look at the mesh.

mged> **kill box1.s**

Now the relationship between the solids must be defined by creating a region. This consists of a name for the region and the boolean operations that must be performed between solids to create the region. MGED allows no explicit grouping of Boolean operators nor is there an operator precedence. Instead, there is an implicit grouping of operations between union operators. See appendix B of the Anastasia manual for further details.

MGED allows unions (u), subtractions (-), and intersections (+) to be performed. In this case, one would simply subtract the box, cone and cylinder from the sphere to obtain the hollow sphere with penetrations.. We will call this region carved_sphere.r.

mged> **r carved_sphere.r u sphere.s - box2.s - cone1.s - cyl1.s**
Defaulting item number to 1001

Creating region id=1000, air=0, los=100, GIFTmaterial=1

To make things more interesting, let's also create a simple solid that just consists of the cylinder. This will allow us to assign a different dielectric constant to this region.

mged> **r cylinder.r u cyl1.s**
Defaulting item number to 1002
Creating region id=1001, air=0, los=100, GIFTmaterial=1

It is very useful in MGED to be able to display regions using different colors. A default color table can be created, then regions can be assigned item numbers to correspond to certain colors. We will create a simple two-color table and assign one color to each of our regions. Each line of the color table contains the lowest and highest item numbers for each color, then the red, green and blue values for that color, then finally a short descriptive string for each color.

mged> **color 100 125 0 255 0 green**
mged> **color 126 150 255 0 0 red**

Now assign each of our regions to a particular color using the item command.

mged> **item carved_sphere.r 105**
mged> **item cylinder.r 130**

Clearing the display with the Z command, then displaying the regions should reflect the changes made to the colors.

mged> **Z**
mged> **E carved_sphere.r cylinder.r**

One final step must be done in MGED before proceeding to build a mesh. We need to assign a finite-difference material to each of the regions. Later we will assign constituitive parameters to each of these materials. The finite-difference materials are entered after the Parameter String prompt, and have the form fd_mat=num, where num is number between 1 and 16. The Material prompt is asking for a material definition for the ray tracer, and seems to recognize plastic, mirror and glass. The color prompt allows rgb values to be entered, and the color will show up in any ray traces done with this database.

We generally reserve finite-difference material number 1 for the background material, which by default is free space. You might want to follow the same practice and only change the background material parameters if the object sits in a material other than vacuum. (Use care if the background material is changed. The velocity of propagation and the boundary conditions are only two things that might need to be changed). Use numbers 2 through 16 for the model's materials.

mged> **mater carved_sphere.r**
Material =
Material? ('del' to delete, CR to skip) **plastic**
Param =
Parameter string? ('del' to delete, CR to skip) **fd_mat=8**
Color = (No color specified)
Color R G B (0..255)? ('del' to delete, CR to skip) **0 255 0**
Inherit = 0: lower nodes (towards leaves) override
Inheritance (0|1)? (CR to skip) [**CR**]

mged>
mged> **mater cylinder.r**
Material =
Material? ('del' to delete, CR to skip) **plastic**
Param =
Parameter string? ('del' to delete, CR to skip) **fd_mat=3**
Color = (No color specified)
Color R G B (0..255)? ('del' to delete, CR to skip) **255 0 0**
Inherit = 0: lower nodes (towards leaves) override
Inheritance (0|1)? (CR to skip) [**CR**]

At this point, if we are satisfied by the way the solid model looks, we can leave mged. Before we do, though, we might want to use the saveview command to create a file which will raytrace the object.

To use the saveview command, first display the model on the screen exactly as you would like it to appear in the raytrace. You can use the sliders to rotate the model to the desired position, or use the vrot command. Once you have the model in the position you would like, type:

saveview filename -s m -C#/#/#

This will create an executable named 'filename' which can be run to generate a ray-traced view of the object. The argument -s m will produce a picture m pixels by m pixels. The argument -C#/#/# will set the background color to the RGB value #/#/#, where each # is a number in the range of 0 to 255. For example, entering:

saveview picture1 -s 256 -C140/190/140

would create an executable file picture1. Leave MGED by typing 'q' after the prompt:

mged> q

To produce a ray-traced view of the solid model, simply type the name of the saveview file. Since ray-tracing may take a very long time, it is best to lower the priority with the nice command and run it in the background:

nice picture1 &

This command will produce a ray-traced picture, picture1.pix, which will have a resolution of 256 pixels by 256 pixels and a pale green background.

To display the picture, first convert to ras format with the command:

pix2ras -s 256 picture1.pix picture1.ras

then display the picture created by typing:

xtras picture1.ras.

To close the display, place the pointer inside the display window and type q for quit.

Chapter 3

MAKING A FINITE DIFFERENCE MESH

Once we have left MGED, the next step is to use ANA to create a finite difference mesh, based on the solid model just created. To do this, type:
ana hollow_sphere.g

Anastasia offers the choice of either a graphical button menu for command entry, or keyboard entry using the teletype mode. The following is a session using teletype mode. In graphical mode, mouse clicks would be used for selecting, and keyboard entry would only occur when prompted for specific input.

Select Display Type (graphics | tty) **tty**

Anastasia Version 1.13 -- April 1992

========== REGIONS IN hollow_sphere.g ==========

cylinder.r carved_sphere.r cr

SELECT AND GROUP REGIONS TO BE MESHED

Each region of the solid model that is to be meshed must be assigned to a group. Each group has its own set of mesh parameters and is meshed separately. After a group is meshed, that mesh will be merged with the mesh(es) of previous groups. Group 1 has been created for you.

Regions are added to groups by using the commands below.

a --- add or delete regions for group [1]
c --- create new group
g --- list all group assignments
r --- list all regions
s --- select alternative group
x --- accept group assignments

Enter command: **a**

ADD REGIONS TO GROUP NUMBER [1]

Enter names of regions to be added, one region per line. Regular expressions are acceptable. Terminate with a '.' on a line by itself.

For this simple model, add all the regions to one group. More complicated models may require more than one group.

cylinder.r
adding [cylinder.r]
carved_sphere.r
adding [carved_sphere.r]

========== GROUP 1 ============
cylinder.r carved_sphere.r

a - add or delete regions for group [1]
c - create new group
g - list all group assignments
r - list all regions
s - select alternative group
x - accept group assignments

Enter command: x

Accept the group assignments and move to the next step, selecting parameters for this particular mesh.

========== GROUP 1 ============ ====================

cylinder.r carved_sphere.r

EXTENT OF BOUNDING RPP IN MILLIMETERS

	MIN	MAX
X	-1000.00	1000.00
Y	-1000.00	1000.00
Z	-1110.17	1000.00

==========
========== Bounding RPP==========

X MIN =	[-1000.0000]	X MAX =	[1000.0000]
Y MIN =	[-1000.0000]	Y MAX =	[1000.0000]
Z MIN =	[-1110.1718]	Z MAX =	[1000.0000]

========== SET MESH PARAMETERS==========

a - Select Grid Alignment	[0.00][0.00][0.00]
b - Select Number of Boundary Pad Cells	[0]
c - Set Cell Size	[0.00]
d - Set Ray Distribution	[REGULAR]
e - Set Extent of Bounding RPP	
f - Select Output Fields	[ELECTRIC]
j - Job to be run in	[FOREGROUND]
m - Select Mesh Format	[CELL_ASC]
n - Select Mesh File Name	[hollow_sphere]
p - Generate Full or Partial Mesh	[FULL_MESH]
r - Set Max Rays Per Cell	[4][4][4]
s - Cast Rays on Solid Centers	[OFF]
x - Accept Mesh Parameters	

Enter Command: **b**

SELECT THE NUMBER OF BOUNDARY PAD CELLS

Determines the number of empty cells that are to be added to the boundaries of the model.

We need to surround the model with some free space cells, so that the radiation boundary conditions and near/far-field interface operate correctly. Standard practice is to allow 8 cells from the problem space boundary to the model. More may be necessary to avoid reflections from the corners of the problem space.

Enter integer number of pad cells: **8**

Number of pad cells set to [8]

```
=========================================================
====================Bounding RPP =======================
      X MIN = [-1000.0000]          X MAX = [ 1000.0000]
      Y MIN = [-1000.0000]          Y MAX = [ 1000.0000]
      Z MIN = [-1110.1718]          Z MAX = [ 1000.0000]
=================== SET MESH PARAMETERS ============
      a --- Select Grid Alignment                    [0.00][0.00][0.00]
      b --- Select Number of Boundary Pad Cells      [8]
      c --- Set Cell Size                            [ 0.00]
      d --- Set Ray Distribution                     [REGULAR]
      e --- Set Extent of Bounding RPP
      f --- Select Output Fields                     [ELECTRIC]
      j --- Job to be run in                         FOREGROUND]
      m --- Select Mesh Format                       [CELL_ASC]
      n --- Select Mesh File Name                    [hollow_sphere]
      p --- Generate Full or Partial Mesh            FULL_MESH]
      r --- Set Max Rays Per Cell                    [4][4][4]
      s --- Cast Rays on Solid Centers               [OFF]
      x --- Accept Mesh Parameters
```

Enter Command: **c**

SET GRID CELL SIZE

Select cell size for the mesh in millimeters

Set the cell size based on the highest frequency of interest. 10 cells per wavelength is the standard value.

Enter Cell Size [mm] : **50**

Cell size set to [50.00] mm

```
=========================================================
=================== Bounding RPP ======================
            X MIN = [-1000.0000]          X MAX = [ 1000.0000]
            Y MIN = [-1000.0000]          Y MAX = [ 1000.0000]
            Z MIN = [-1110.1718]          Z MAX = [ 1000.0000]
```

==========SET MESH PARAMETERS ==========

a --- Select Number of Boundary Pad Cells	[0.00][0.00][0.00]
b --- Select Number of Boundary Pad Cells	[8]
c --- Set Cell Size	[50.00]
d --- Set Ray Distribution	[REGULAR]
e --- Set Extent of Bounding RPP	
f --- Select Output Fields	[ELECTRIC]
j --- Job to be run in	[FOREGROUND]
m --- Select Mesh Format	[CELL_ASC]
n --- Select Mesh File Name	[hollow_sphere]
p --- Generate Full or Partial Mesh	[FULL_MESH]
r --- Set Max Rays Per Cell	[4][4][4]
s --- Cast Rays on Solid Centers	[OFF]
x --- Accept Mesh Parameters	

Change the ray distribution from regular to random. This isn't really necessary, it is just included as an example of a parameter that can be toggled between values.

Enter Command: **d**

==========
========== Bounding RPP==========
X MIN = [-1000.0000] X MAX = [1000.0000]
Y MIN = [-1000.0000] Y MAX = [1000.0000]
Z MIN = [-1110.1718] Z MAX = [1000.0000]
========== SET MESH PARAMETERS==========

a --- Select Grid Alignment	[0.00] [0.00] [0.00]
b --- Select Number of Boundary Pad Cells	[8]
c --- Set Cell Size	[0.00]
d --- Set Ray Distribution	[RANDOM]
e --- Set Extent of Bounding RPP	
f --- Select Output Fields	[ELECTRIC]
j --- Job to be run in	[FOREGROUND]
m --- Select Mesh Format	CELL_ASC]
n --- Select Mesh File Name	[hollow_sphere]
p --- Generate Full or Partial Mesh	[FULL_MESH]
r --- Set Max Rays Per Cell	[4][4][4]
s --- Cast Rays on Solid Centers	[OFF]
x --- Accept Mesh Parameters	

Enter Command: **n**

Shorten the output file name, as ANA will append 6 characters to the specified name.

SELECT A BASE FILE NAME FOR THE GENERATED MESHES

Enter a name for the output mesh file: **sphere**

```
==========================================================
=================== Bounding RPP==========================
          X MIN = [-1000.0000]          X MAX = [ 1000.0000]
          Y MIN = [-1000.0000]          Y MAX = [ 1000.0000]
          Z MIN = [-1110.1718]          Z MAX = [ 1000.0000]
=================== SET MESH PARAMETERS=================

    a --- Select Grid Alignment                  [0.00][0.00][0.00]
    b --- Select Number of Boundary Pad Cells     [8]
    c --- Set Cell Size                          [ 0.00]
    d --- Set Ray Distribution                   [REGULAR
    e --- Set Extent of Bounding RPP
    f --- Select Output Fields                   [ELECTRIC]
    j --- Job to be run in                       [FOREGROUND]
    m --- Select Mesh Format                     [CELL_ASC]
    n --- Select Mesh File Name                  [sphere]
    p --- Generate Full or Partial Mesh          [FULL_MESH]
    r --- Set Max Rays Per Cell                  [4][4][4]
    s --- Cast Rays on Solid Centers             [OFF]
    x --- Accept Mesh Parameters
```

Enter Command: **r**

SET THE MAXIMUM NUMBER OF RAYS PER OCTANT

Sets the maximum number of rays that will be generated for any octant to determine whether that octant is in or out of the solid. Fewer rays will generally result in certain octants being incorrectly classified whereas more rays require more computer time.

Set the maximum number of rays cast in each direction based on the model being sampled. Parts which are thin in the y-direction may require y-rays to be cast in order to be found. Y-rays are the most time-consuming, though, so should be used only when necessary.

Enter the maximum number of rays per octant in each direction (x,y,z): **4 0 4**
Maximum rays per octant set to [4][0][4]

```
==========================================================
=================== Bounding RPP==========================
          X MIN = [-1000.0000]          X MAX = [ 1000.0000]
          Y MIN = [-1000.0000]          Y MAX = [ 1000.0000]
          Z MIN = [-1110.1718]          Z MAX = [ 1000.0000]
=================== SET MESH PARAMETERS=================

    a --- Select Grid Alignment                  [0.00][0.00][0.00]
    b --- Select Number of Boundary Pad Cells     [8]
    c --- Set Cell Size                          [ 0.00]
    d --- Set Ray Distribution                   [REGULAR]
    e --- Set Extent of Bounding RPP
    f --- Select Output Fields                   [ELECTRIC]
    j--- Job to be run in                        [FOREGROUND]
    m --- Select Mesh Format                     [CELL_ASC]
    n --- Select Mesh File Name                  [hollow_sphere]
```

```
p --- Generate Full or Partial Mesh                [FULL_MESH]
r --- Set Max Rays Per Cell                       [4][0][4]
s --- Cast Rays on Solid Centers                  [OFF]
x --- Accept Mesh Parameters
```

At this point, we are ready to let ANA begin building the mesh, so enter 'x' to proceed. See the ANA manual for other possible options.

Enter Command: **x**

NON_PAD GRID DIMENSIONS CALCULATED TO BE

I = 40
J = 40
K= 44

EXTENT OF BOUNDING RPP IN MILLIMETERS

	MIN	MAX
X	-1000.00	1000.00
Y	-1000.00	1000.00
Z	-1150.00	1000.00

--------- Mesh Parameters for Group [1] ----------

```
Grid Alignment                          [0.00][0.00][0.00]
Number of Boundary Pad Cells            [8]
Set Cell Size                           [50.00]
Set Ray Distribution                    [RANDOM]
Output Fields                           [ELECTRIC]
Mesh Format                             [CELL_ASC]
Mesh File Name                          [sphere]
Max Rays Per Cell                       [4][0][4]
Cast Rays on Solid Centers              [OFF
```

========== Meshing group 1 ==========

cylinder.r carved_sphere.r

==========

Max Rays = [4][0][4]

[0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16]
[17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30] [31]
[32] [33] [34] [35] [36] [37] [38] [39]

Group 1 Meshed in 56.800000 CPU seconds

When Ana is finished, three new files should exist: ana_ERR,hollow_s_LOG and sphere_a_cla. The file ana_ERR will contain any error messages written during the meshing procedure, hollow_s_LOG will contain a record of the meshing session, and

sphere_a_cla will contain the mesh itself. Standard procedure is to rename the mesh file, replacing the _a_cla string with a .grd extension. This practice will ensure that a grid created at one cell size will not be inadvertantly overwritten if the model is re-meshed at a different cell size or for some other reason. Also, it is good practice to include some mention of the cell size as part of the file name, in the event that more than one mesh is created. In the case of this example, the file will be renamed from sphere_a_cla to sphere_50.grd.

mv sphere_a_cla sphere_50.grd

Chapter 4

EXAMINING THE FINITE DIFFERENCE MESH

At this point, a finite-difference mesh exists which could be used as input to TSAR. However, we don't know if the mesh really is a good approximation to the solid model, or whether there are problems with the mesh. This can only be determined by examining the mesh itself, by using the program IMAGE. Invoke IMAGE by typing:

image sphere_50.grd

The program will open a window and read in the mesh. Once the mesh is completely read in, the user can manipulate what is displayed by using the various buttons arrayed on the screen. As described in the IMAGE manual, the full mesh can be displayed, or the user may display only a portion by changing the bounding box or selecting a single plane for display.

To display the full mesh, click on 'Fields' with the left mouse button (all IMAGE commands use the left mouse button). This will cause the full mesh to be displayed. At 50 mm resolution, the example model is a particularly dense mesh, and trying to work with the full model will be extremely slow. Instead, click on the 'Bbox only' button to turn off the display, then click on 'Yrot', move the pointer over the slide bar along the right hand side of the display window, hold down the left mouse button and move the mouse up and down until the y rotation is approximately 90 degrees.

Now try looking at the mesh a single plane at a time, by clicking on the 'i slice' button, then the 'Fields' button. The display should show a single plane through the middle of the mesh, and the dielectric cylinder should be visible. Try out some of the other buttons, referring to the IMAGE manual as necessary. When you are finished, click on the 'exit' button along the top to leave IMAGE.

The idea is to look for gaps where there should be no aperture, materials where there should be none, dangling edges, lack of symmetry, etc. Look carefully at the apertures and at the cylinder piercing the sphere. If the result doesn't look correct, it may be necessary to return to ANA and try re-gridding with some different parameters. You may need to try adjusting mesh alignment, or changing the cell size slightly, reordering material numbers, (higher numbered materials take precedence), or meshing some parts in different groups. This is an extremely important step in the modeling process, and several iterations may be necessary before a satisfactory mesh is obtained.

An important point is the material precedence scheme used by ANA. Look carefully at the cylinder piercing the sphere. Notice how the cylinder appears to shrink in diameter where it enters the sphere. This is because where there is a material conflict, ANA will choose the higher-numbered material. Since the cylinder in this case is number three and the sphere is number eight, the sphere will be given precedence, which results in a slightly smaller cylinder. A better choice might have been to give the cylinder a higher material number. This would require returning to MGED and re-doing the mater command for the sphere and the cylinder, then re-running ANA. For the purpose of this tutorial, we will just keep the current model.

Because the mesh is just an approximation to the solid model, it will be impossible to obtain a perfect mesh. Only the user can decide if a particular mesh is a good electromagnetic representation of the object to be simulated, and this must be based on a knowledge of EM, experience in running TSAR, and on a certain amount of intuition.

Don't overlook the importance of this step. Usually ANA will provide a reasonably good mesh, but if any errors or anomalies do exist, the answers that TSAR provides will not accurately reflect what happens to the real object which you are trying to simulate.

Chapter 5

SETTING TSAR PARAMETERS

Once an acceptable finite-difference mesh has been obtained, the preliminary work has been completed, and it is now time to begin to work with TSAR itself. A program called SETUP_TSAR, (formerly called SHELL), exists to help set up both the parameters necessary to compile TSAR and the input file used to actually run TSAR. To run the program, simply type:

setup_tsar

The following is the session used to set up the parameter files necessary to compile TSAR.

SETUP_TSAR - an interactive utility for setting up TSAR input files
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SETUP_TSAR

1. Enter/Modify basic compile-time parameters.
2. Enter/Modify far-field compile-time parameters.
3. Enter/Modify thin slot compile-time parameters.
4. Enter/Modify run-time namelist file.
5. Exit.

(* indicates that an item of this type exists.)

Please select an option >>
1
Selecting 1 calls up a menu which will allow arrays within TSAR to be specified for compilation.

#	Description	Current value
1.	Number of cells in the I direction	20
2.	Number of cells in the J direction	20
3.	Number of cells in the K direction	20
4.	J planes in core memory	20
5.	Maximum # of point field sensors	10
6.	Maximum # of internal radiators	10
7.	Maximum # of slice sensors	4
8.	Maximum length of user-supplied pulses	200
9.	Maximum # of user-supplied pulses	4
10.	Maximum # of volumee sensors	1
11.	Number of bits for each material index	3
12.	Name of NAMELIST user input file	tsarin
13.	Exit	

Numbers 1, 2 and 3 need to be changed to match the values found in the header of the mesh file. In this case, I=56, J=56 and K=60.

What item would you like to change? >>
1

Item to change : MaxI
Type : Integer
Lower Limit : 0
Current Value : 20

New value >>
56

#	Description	Current value
*1.	Number of cells in the I direction	56
2.	Number of cells in the J direction	20
3.	Number of cells in the K direction	20
4.	J planes in core memory	20
5.	Maximum # of point field sensors	10
6.	Maximum # of internal radiators	10
7.	Maximum # of slice sensors	4
8.	Maximum length of user-supplied pulses	200
9.	Maximum # of user-supplied pulses	4
10.	Maximum # of volumee sensors	1
11.	Number of bits for each material index	3
12.	Name of NAMELIST user input file	tsarin
13.	Exit	

What item would you like to change? >>
2

Item to change : MaxJ
Type : Integer
Lower Limit : 0
Current Value : 20

New value >>
56

#	Description	Current value
*1.	Number of cells in the I direction	56
*2.	Number of cells in the J direction	56
3.	Number of cells in the K direction	20
4.	J planes in core memory	20
5.	Maximum # of point field sensors	10
6.	Maximum # of internal radiators	10
7.	Maximum # of slice sensors	4
8.	Maximum length of user-supplied pulses	200
9.	Maximum # of user-supplied pulses	4

```
10.  Maximum # of volume sensors                    1
11.  Number of bits for each material index         3
12.  Name of NAMELIST user input file               tsarin
13.  Exit

What item would you like to change? >>
3

Item to change      : MaxK
Type                : Integer
Lower Limit         :  0
Current Value       :  20

New value >>
60

#  Description                                      Current value
-------------------------------------------------------------------------------

* 1.   Number of cells in the I direction          56
* 2.   Number of cells in the J direction          56
* 3.   Number of cells in the K direction          60
  4.   J planes in core memory                     20
  5.   Maximum # of point field sensors            10
  6.   Maximum # of internal radiators             10
  7.   Maximum # of slice sensors                  4
  8.   Maximum length of user-supplied pulses     200
  9.   Maximum # of user-supplied pulses           4
 10.   Maximum # of volumee sensors                1
 11.   Number of bits for each material index      3
 12.   Name of NAMELIST user input file            tsarin
 13.   Exit
```

All the J planes should fit into memory, so set number 4 equal to the number of J planes.

```
What item would you like to change? >>
 4

Item to change      : JBufSize
Type                : Integer
Lower Limit         :  0
Current Value       :  20

New value >>
56

#  Description                                      Current value
-------------------------------------------------------------------------------

* 1.   Number of cells in the I direction          56
* 2.   Number of cells in the J direction          56
* 3.   Number of cells in the K direction          60
```

* 4.	J planes in core memory	56
5.	Maximum # of point field sensors	10
6.	Maximum# of internal radiators	10
7.	Maximum # of slice sensors	4
8.	Maximum length of user-supplied pulses	200
9.	Maximum # of user-supplied pulses	4
10.	Maximum # of volume sensors	1
11.	Number of bits for each material index	3
12.	Name of NAMELIST user input file	tsarin
13.	Exit	

For this example problem, we may keep the default values for the rest of the parameters. See the TSAR manual for an explanation of these parameters.

To exit this menu, choose number 13.

What item would you like to change? >>
13

SETUP_TSAR

*1. Enter/Modify basic compile-time parameters.
2. Enter/Modify far-field compile-time parameters.
3. Enter/Modify thin slot compile-time parameters.
4. Enter/Modify run-time namelist file.
5. Exit.

(* indicates that an item of this type exists.)

Please select an option >>

At this point, we have created the file params.inc, which contains some of the parameters necessary to compile the tsar code for this size problem. The next step is to set the far-field projection parameters.

In this problem, we don't intend to perform any far-field calculations, so the default values will be fine. However, on some machines, in order to get the file projprms.inc written to the current directory, it is necessary to enter at least one value, even if it is the same as the default. (An alternative would be to copy projprms.ctp from the tsar source file, edit it as necessary and rename it projprms.inc.) Choose item 2 from the menu to select the far-field parameters, then enter one for the maximum number of frequency-domain far-field points per pattern.

Please select an option >>

2

#	Description	Current value
1.	Max # of freq-domain far-field patterns	1
2.	Max # of freq-domain far-field points per pattern	1
3.	Max # of time-domain far-field observation points	1
4.	Max # of time-domain far-field timesteps per point	1
5.	Max # of time-domain near-field observation points	1

```
6.  Max # of space points in near-field sampling surface          1
7.  Max # of time-domain near-field timesteps per point           1
8.  Exit

What item would you like to change? >>
```

2

```
Item to change      : MaxFFPts
Type                : Integer
Lower Limit         :  0
Current Value       :  1

New value >>
```

1

Selecting a menu item, even if the entry is the same as the default, is sufficient to cause the include file to be created.

```
#  Description                                                    Current value
-------------------------------------------------------------------------------
  1. Max# of freq-domain far-field patterns                       1
* 2. Max # of freq-domain far-field points per pattern           1
  3. Max # of time-domain far-field observation points           1
  4. Max # of time-domain far-field timesteps per point          1
  5. Max # of time-domain near-field observation points          1
  6. Max # of space points in near-field sampling surface        1
  7. Max # of time-domain near-field timesteps per point         1
  8. Exit

What item would you like to change? >>
```

8

```
                    SETUP_TSAR

* 1. Enter/Modify basic compile-time parameters.
* 2. Enter/Modify far-field compile-time parameters.
  3. Enter/Modify thin slot compile-time parameters.
  4. Enter/Modify run-time namelist file.
  5. Exit.

 (* indicates that an item of this type exists.)

 Please select an option >>
```

Having completed item 2 on the menu, we have now dimensioned the problem and have created two files, params.inc and projprms.inc. We next need to create the file slotprms.inc, but we don't need to modify the parameters since there are no thin slots (less

than a cell dimension) in this example problem. Entering, touching one value, then exiting the menu will create the necessary file.

3

```
#  Description                                          Current value
-------------------------------------------------------------------------------
 1.     Max # of thin slots allowed                          1
 2.     Max # of cells with thin slots                       1
 3.     Max # of basis functions per slot                    1
 4.     Max # of time steps saved in HTSA                    1
 5.     Max # of HTSA probes                                 1
 6.     Exit

What item would you like to change? >>
```

1

```
Item to change      :MaxSlots
Type                :Integer
Lower Limit         :  1
Current Value       :  1

New value >>
```
1

```
#  Description                                          Current value
-------------------------------------------------------------------------------
* 1.  Max # of thin slots allowed                          1
  2.  Max # of cells with thin slots                       1
  3.  Max # of basis functions per slot                    1
  4.  Max # of time steps saved in HTSA                    1
  5.  Max # of HTSA probes                                 1
  6.  Exit

What item would you like to change? >>
```

6

```
                    SETUP_TSAR

* 1.  Enter/Modify basic compile-time parameters.
* 2.  Enter/Modify far-field compile-time parameters.
* 3.  Enter/Modify thin slot compile-time parameters.
  4.  Enter/Modify run-time namelist file.
  5.  Exit.

 (* indicates that an item of this type exists.)

 Please select an option >>
```

Next, before leaving setup_tsar, we need to create an input file for a particular tsar run, which will include such things as which boundary conditions to use, how many time steps

to run, etc. To create the input file, usually called tsarin, select number four from the menu.

Please select an option >

4

SIMULATION PARAMETERS

1. General problem set-up
2. Materials
3. Incident wave shape
4. Point radiation sources
5. External plane wave sources
6. Point sensors
7. Input verification
8. Near-field sampling
9. Far-field projections
10. Thin Slots
11. Slice sensors
12. Volume sensors
13. Finished

Select an option >>

1

#	Description	Current value
1.	Comment title of problem	TSAR Finite Difference Software
2.	Size of single grid cell	1.000E-02
3.	Total number of time steps to execute	16
4	Use explicit virtual memory?	NO
5.	Name of object grid file	grid
6.	Use real, not grid coordinates?	NO
7.	I location of real origin	0.000E+00
8.	J location of real origin	0.000E+00
9.	K location of real origin	0.000E+00
10.	Boundary condition of XMin face	None
11.	Boundary condition of XMax face	None
12.	Boundary condition of YMin face	None
13.	Boundary condition of YMax face	None
14.	Boundary condition of ZMin face	None
15.	Boundary condition of ZMax face	None
16.	Exit	

What item would you like to change? >>

1

Item to change : Title
Type :String

Current Value : TSAR Finite Difference Software

Enter new value >>

Hollow_sphere,dx=50mm,9/1/93

#	Description	Current value
*1.	Comment title of problem	Hollow_sphere,dx=50mm,9/1/93
2.	Size of single grid cell	1.000E-02
3.	Total number of time steps to execute	16
4.	Use explicit virtual memory?	NO
5.	Name of object grid file	grid
6.	Use real, not grid coordinates?	NO
7.	I location of real origin	0.000E+00
8.	J location of real origin	0.000E+00
9.	K location of real origin	0.000E+00
10.	Boundary condition of XMin face	None
11.	Boundary condition of XMax face	None
12.	Boundary condition of YMin face	None
13.	Boundary condition of YMax face	None
14.	Boundary condition of ZMin face	None
15.	Boundary condition of ZMax face	None
16.	Exit	

What item would you like to change? >>

1

Select number two to set the proper cell size.

Item to change : Dx
Type : Real
Lower Limit : 0.
Current Value : 1.000E-02

New value >>

5.0e-2

#	Description	Current value
*1.	Comment title of problem	Hollow_sphere,dx=50mm,9/1/93
*2.	Size of single grid cell	5.000E-02
3.	Total number of time steps to execute	16
4.	Use explicit virtual memory?	NO
5.	Name of object grid file	grid
6.	Use real, not grid coordinates?	NO
7.	I location of real origin	0.000E+00
8.	J location of real origin	0.000E+00
9.	K location of real origin	0.000E+00
10.	Boundary condition of XMin face	None
11.	Boundary condition of XMax face	None
12.	Boundary condition of YMin face	None

13.	Boundary condition of YMax face	None
14.	Boundary condition of ZMin face	None
15.	Boundary condition of ZMax face	None
16.	Exit	

What item would you like to change? >>

Set the number of time steps for the problem to run by selecting number three. We will run the problem for 128 time steps.

What item would you like to change? >>

3

Item to change : NSteps
Type : Integer
Lower Limit : 0
Current Value : 16

New value >>

128

#	Description	Current value
*1.	Comment title of problem	Hollow_sphere,dx=50mm,9/1/93
*2.	Size of single grid cell	5.000E-02
*3.	Total number of time steps to execute	128
4.	Use explicit virtual memory?	NO
5	Name of object grid file	grid
6.	Use real, not grid coordinates?	NO
7.	I location of real origin	.000E+00
8.	J location of real origin	0.000E+00
9	K location of real origin	0.000E+00
10.	Boundary condition of XMin face	None
11.	Boundary condition of XMax face	None
12.	Boundary condition of YMin face	None
13.	Boundary condition of YMax face	None
14.	Boundary condition of ZMin face	None
15.	Boundary condition of ZMax face	None
16.	Exit	

What item would you like to change? >>

5

Item to change : GridFile
Type : String
Current Value : grid

Enter new value >>

sphere_50.grd

#	Description	Current value
*1.	Comment title of problem	Hollow_sphere,dx=50mm,9/1/93
*2.	Size of single grid cell	5.000E-02
*3.	Total number of time steps to execute	128
4.	Use explicit virtual memory?	NO
*5.	Name of object grid file	sphere_50.grd
6.	Use real, not grid coordinates?	NO
7.	I location of real origin	0.000E+00
8.	J location of real origin	0.000E+00
9.	K location of real origin	0.000E+00
10.	Boundary condition of XMin face	None
11.	Boundary condition of XMax face	None
12.	Boundary condition of YMin face	None
13.	Boundary condition of YMax face	None
14.	Boundary condition of ZMin face	None
15.	Boundary condition of ZMax face	None
16.	Exit	

What item would you like to change? >>

10

Item to change : BCXMin
Type : String
Possible values :NONE
MAGNETIC PERFECT CONDUCTOR
ELECTRIC PERFECT CONDUCTOR
2ND ORDER MUR RADIATION
1ST ORDER MUR RADIATION

Current Value : None

Enter new value >>

2nd

#	Description	Current value
*1.	Comment title of problem	Hollow_sphere,dx=50mm,9/1/93
*2.	Size of single grid cell	5.000E-02
*3.	Total number of time steps to execute	128
4.	Use explicit virtual memory?	NO
*5.	Name of object grid file	sphere50.grd
6.	Use real, not grid coordinates?	NO
7.	I location of real origin	0.000E+00
8.	J location of real origin	0.000E+00
9.	K location of real origin	0.000E+00
*10.	Boundary condition of XMin face	2ND ORDER MUR RADIATION
11.	Boundary condition of XMax face	None
12.	Boundary condition of YMin face	None
13.	Boundary condition of YMax face	None

14.	Boundary condition of ZMin face	None
15.	Boundary condition of ZMax face	None
16.	Exit	

What item would you like to change? >>

11

Item to change : BCXMax
Type : String
Possible values : NONE
MAGNETIC PERFECT CONDUCTOR
ELECTRIC PERFECT CONDUCTOR
2ND ORDER MUR RADIATION
1ST ORDER MUR RADIATION

Current Value : None

Enter new value >>

2nd

#	Description	Current value
*1.	Comment title of problem	Hollow_sphere,dx=50mm,9/1/93
*2.	Size of single grid cell	5.000E-02
*3.	Total number of time steps to execute	128
4.	Use explicit virtual memory?	NO
*5.	Name of object grid file	sphere_50.grd
6.	Use real, not grid coordinates?	NO
7.	I location of real origin	0.000E+00
8.	J location of real origin	0.000E+00
9.	K location of real origin	0.000E+00
*10.	Boundary condition of XMin face	2ND ORDER MUR RADIATION
*11.	Boundary condition of XMax face	2ND ORDER MUR RADIATION
12.	Boundary condition of YMin face	None
13.	Boundary condition of YMax face	None
14.	Boundary condition of ZMin face	None
15.	Boundary condition of ZMax face	None
16.	Exit	

What item would you like to change? >>

Continue through the boundary conditions, setting each one to 2nd order Mur, until all six faces have been set, then enter 16 to leave this menu.

#	Description	Current value
*1.	Comment title of problem	Hollow_sphere,dx=50mm,9/1/93
*2.	Size of single grid cell	5.000E-02
*3.	Total number of time steps to execute	128
4.	Use explicit virtual memory?	NO

*5.	Name of object grid file	sphere_50.grd
6.	Use real, not grid coordinates?	NO
7.	I location of real origin	0.000E+00
8.	J location of real origin	0.000E+00
9.	K location of real origin	0.000E+00
*10.	Boundary condition of XMin face	2ND ORDER MUR RADIATION
*11.	Boundary condition of XMax face	2ND ORDER MUR RADIATION
*12.	Boundary condition of YMin face	2ND ORDER MUR RADIATION
*13.	Boundary condition of YMax face	2ND ORDER MUR RADIATION
*14.	Boundary condition of ZMin face	2ND ORDER MUR RADIATION
*15.	Boundary condition of ZMax face	2ND ORDER MUR RADIATION
16.	Exit	

What item would you like to change? >>

16

SIMULATION PARAMETERS

*1. General problem set-up
2. Materials
3. Incident wave shape
4. Point radiation sources
5. External plane wave sources
6. Point sensors
7. Input verification
8. Near-field sampling
9. Far-field projections
10. Thin Slots
11. Slice sensors
12. Volume sensors
13. Finished

Select an option >>

2

Next, the material constituitive parameters need to be set. Enter 2 to select the materials menu.

#	Description	Current value
1.	Relative material permittivity, epsilon	(Array)
2.	Relative material permeability, mu	(Array)
3.	Electrical conductivity	(Array)
4.	Magnetic conductivity	(Array)
5.	Trim calcs outside closed shell?	NO
6.	Exit	

What item would you like to change? >>

1

Start by setting any relative dielectric constants different than free space.

```
Item to change       : EpsR
Type                 : Real Array
Lower Limit          : 1.
Current Value ( 1) : 1.00
Current Value ( 2) : 1.00
Current Value ( 3) : 1.00
Current Value ( 4) : 1.00
Current Value ( 5) : 1.00

Item to change, new value (0,0 to end) >>
```

To make the cylinder a dielectric, choose material 3 and enter a relative dielectric constant. Enter the material and constant as a pair separated by a comma.

3,1.7

```
Item to change       : EpsR
Type                 : Real Array
Lower Limit          : 1.
Current Value ( 1) : 1.00
Current Value ( 2) : 1.00
Current Value ( 3) : 1.70
Current Value ( 4) : 1.00
Current Value ( 5) : 1.00

Item to change, new value (0,0 to end) >>
```

To exit this menu, enter 0,0.
0,0

```
#  Description                                                    Current value
-------------------------------------------------------------------------------
*1.  Relative material permittivity, epsilon                     (Array)
 2.  Relative material permeability, mu                          (Array)
 3.  Electrical conductivity                                     (Array)
 4.  Magnetic conductivity                                       Array)
 5.  Trim calcs outside closed shell?                            NO
 6.  Exit

What item would you like to change? >>
```

Make the sphere metallic by choosing an electrical conductivity value.

3

```
Item to change       : ConductE
Type                 : Real Array
Lower Limit  :         0.
Current Value ( 1) : 0.000E+00
Current Value ( 2) : 0.000E+00
Current Value ( 3) : 0.000E+00
Current Value ( 4) : 0.000E+00
Current Value ( 5) : 0.000E+00
```

Item to change, new value (0,0 to end) >>

The sphere is material 8. Even though 8 is not displayed, it can still be entered as a material value. The menu will change to display 5 values centered at the chosen material number.

8,3.0e

```
Item to change       : ConductE
Type                 : Real Array
Lower Limit          : 0.
Current Value ( 4) : 0.000E+00
Current Value ( 5) : 0.000E+00
Current Value ( 6) : 0.000E+00
Current Value ( 7) : 0.000E+00
Current Value ( 8) : 3.000E+07
```

Item to change, new value (0,0 to end) >>

Exit this menu by entering 0,0.

0,0

#	Description	Current value
*1.	Relative material permittivity, epsilon	(Array)
2.	Relative material permeability, mu	(Array)
*3.	Electrical conductivity	(Array)
4.	Magnetic conductivity	(Array)
5.	Trim calcs outside closed shell?	NO
6.	Exit	

What item would you like to change? >>

Having defined values for all the regions in our model, we can exit.

6

SIMULATION PARAMETERS

```
*1.  General problem set-up
*2.  Materials
 3.  Incident wave shape
 4.  Point radiation sources
 5.  External plane wave sources
 6.  Point sensors
 7.  Input verification
 8.  Near-field sampling
 9.  Far-field projections
10.  Thin Slots
11.  Slice sensors
12.  Volume sensors
```

13. Finished

Select an option >>

3

The time history of the incident field now needs to be specified. Choose three from the menu.

#	Description	Current value
1.	Shape of incident pulse	2
2.	Frequency of sinusoidal waves	1.000E+09
3.	Time delay of Gaussian peak	40.0
4.	Full width half-max of Gaussian	25.0
5.	Rise time of exponential pulses	16.0
6.	Fall time of exponential pulses	10.0
7.	Peak amplitude of incident fields	1.00
8.	Enter source params. in units of Dt?	YES
9.	File name of user-supplied pulses	(Array)
10.	Exit	

What item would you like to change? >>

These menu items define the type of pulse and its particular shape. We'll keep the default parameters for this example. See the TSAR manual for an explanation.

10

SIMULATION PARAMETERS

*1. General problem set-up
*2. Materials
*3. Incident wave shape
4. Point radiation sources
5. External plane wave sources
6. Point sensors
7. Input verification
8. Near-field sampling
9. Far-field projections
10. Thin Slots
11. Slice sensors
12. Volume sensors
13. Finished

Select an option >>

We want to excite our model externally, so we don't want to set any radiation sources. Our next choice should be number five.

5

#	Description	Current value
1.	Apply external plane wave?	NO
2.	Run TSAR in scattered field mode?	NO
3.	Elevation angle of incident plane wave	90.0
4.	Azimuthal angle of incident plane wave	90.0
5.	Polarization of incident plane wave	90.0
6.	Material index of surrounding medium	1
7.	User pulse shape for external waves	0
8.	XMin boundary of total field zone	4
9.	XMax boundary of total field zone	52
10.	YMin boundary of total field zone	4
11.	YMax boundary of total field zone	52
12.	ZMin boundary of total field zone	4
13.	ZMax boundary of total field zone	56
14.	Exit	

What item would you like to change? >>

1

Changing one will excite the problem with a plane wave. Numbers three through five dictate the direction and polarization of the wave. Match the numbers below to set up a plane wave propagating in the x-direction, polarized in the y-direction.

#	Description	Current value
*1.	Apply external plane wave?	YES
2.	Run TSAR in scattered field mode?	NO
3.	Elevation angle of incident plane wave	90.0
*4.	Azimuthal angle of incident plane wave	0.000E+00
*5.	Polarization of incident plane wave	0.000E+00
6.	Material index of surrounding medium	1
7.	User pulse shape for external waves	0
8.	XMin boundary of total field zone	4
9.	XMax boundary of total field zone	52
10.	YMin boundary of total field zone	4
11.	YMax boundary of total field zone	52
12.	ZMin boundary of total field zone	4
13.	ZMax boundary of total field zone	56
14.	Exit	

What item would you like to change? >>

14

SIMULATION PARAMETERS

*1. General problem set-up
*2. Materials
*3. Incident wave shape
4. Point radiation sources
*5. External plane wave sources
6. Point sensors

```
 7.   Input verification
 8.   Near-field sampling
 9.   Far-field projections
10.   Thin Slots
11.   Slice sensors
12.   Volume sensors
13.   Finished

Select an option >>
```

We now have the simulation itself defined. We next need to choose the output from TSAR. Let's select two point sensors from menu number 6 and a slice sensor from menu 11.

6

```
#  Description                                          Current value
-------------------------------------------------------------------------
 1.  X location of point sensors                        (Array)
 2.  Y location of point sensors                        (Array)
 3.  Z location of point sensors                        (Array)
 4.  X component of point direction                     (Array)
 5.  Y component of point direction                     (Array)
 6.  Z component of point direction                     (Array)
 7.  Type of point sensors                              (Array)
 8   Turn-on time of point sensors                      (Array)
 9.  Turn-off time of point sensors                     (Array)
10.  Prefix name of point sensor data files             point
11   Print point data in binary (vs ASCII) ?            NO
12.  Exit

What item would you like to change? >>
```

First set the location of the sensors, in grid (I,J,K) co-ordinates.

1

```
Item to change        : PntX
Type                  : Real Array
Current Value ( 1) : (Not Assigned)
Current Value ( 2) : (Not Assigned)
Current Value ( 3) : (Not Assigned)
Current Value ( 4) : (Not Assigned)
Current Value ( 5) : (Not Assigned)

Item to change, new value (0,0 to end) >>
```

1,28

```
Item to change        : PntX
Type                  : Real Array
Current Value ( 1) :    28.0
Current Value ( 2) : (Not Assigned)
Current Value ( 3) : (Not Assigned)
```

```
Current Value ( 4) : (Not Assigned)
Current Value ( 5) : (Not Assigned)

Item to change, new value (0,0 to end) >>
```

2,20

```
Item to change       : PntX
Type                 : Real Array
Current Value ( 1) :   28.0
Current Value ( 2) :   20.0
Current Value ( 3) : (Not Assigned)
Current Value ( 4) : (Not Assigned)
Current Value ( 5) : (Not Assigned)

Item to change, new value (0,0 to end) >>
```

0,0

#	Description	Current value
*1.	X location of point sensors	(Array)
2.	Y location of point sensors	(Array)
3.	Z location of point sensors	(Array)
4.	X component of point direction	(Array)
5.	Y component of point direction	(Array)
6.	Z component of point direction	(Array)
7.	Type of point sensors	(Array)
8.	Turn-on time of point sensors	(Array)
9.	Turn-off time of point sensors	(Array)
10.	Prefix name of point sensor data files	point
11.	Print point data in binary (vs ASCII) ?	NO
12.	Exit	

What item would you like to change? >>

Proceed through the menu, setting y and z locations for probes 1 and 2. Use IMAGE to assure that the probes are located in the appropriate locations. Also specify a probe direction for probes 1 and 2 by setting a value for each of the component directions. The default setting is z=1.0. The total length must not exceed 1, so if another component is selected, reduce the z component appropriately. In this case, the incident field is polarized in the y direction, so a good choice might be to set the y-components to 1 and reduce the z-components to 0.

Finally, choose a probe type, such as EFIELD. Refer to the TSAR manual for the choices.

#	Description	Current value
*1.	X location of point sensors	(Array)
*2.	Y location of point sensors	(Array)
*3.	Z location of point sensors	(Array)
4.	X component of point direction	(Array)

*5.	Y component of point direction	(Array)
*6.	Z component of point direction	(Array)
*7.	Type of point sensors	(Array)
8.	Turn-on time of point sensors	(Array)
9.	Turn-off time of point sensors	(Array)
10.	Prefix name of point sensor data files	point
11.	Print point data in binary (vs ASCII) ?	NO
12.	Exit	

What item would you like to change? >>

12

SIMULATION PARAMETERS

*1. General problem set-up
*2. Materials
*3. Incident wave shape
4. Point radiation sources
*5. External plane wave sources
*6. Point sensors
7. Input verification
8. Near-field sampling
9. Far-field projections
10. Thin Slots
11. Slice sensors
12. Volume sensors
13. Finished

Select an option >>

11

#	Description	Current value
1.	Prefix name of slice output data files	slice
2.	Type of slice sensor	Array)
3.	Switch to turn slice sensors on and off	(Array)
4.	Turn-on time of slice sensors	(Array)
5.	Turn-off time of slice sensors	(Array)
6.	Time step increment for slice sensors	(Array)
7.	Lower I limit for slice sensors	(Array)
8.	Upper I limit for slice sensors	(Array)
9.	I increment for slice sensors	(Array)
10.	Lower J limit for slice sensors	(Array)
11.	Upper J limit for slice sensors	(Array)
12.	J increment for slice sensors	(Array)
13.	Lower K limit for slice sensors	(Array)
14.	Upper K limit for slice sensors	(Array)
15.	K increment for slice sensors	(Array)
16.	Exit	

What item would you like to change? >>

2

Item to change : CSlcKind
Type : String Array
Possible values : EX
EY
EZ
HX
HY
HZ
Current Value (1) :
Current Value (2) :
Current Value (3) :
Current Value (4) :

Item to change (0 to end) >>

1

Enter new value >>

EY

Item to change : CSlcKind
Type : String Array
Possible values : EX
EY
EZ
HX
HY
HZ

Current Value (1) : EY
Current Value (2) :
Current Value (3) :
Current Value (4) :

Item to change (0 to end) >>

0

#	Description	Current value
1.	Prefix name of slice output data files	slice
*2.	Type of slice sensor	(Array)
3.	Switch to turn slice sensors on and off	(Array)
4.	Turn-on time of slice sensors	(Array)
5.	Turn-off time of slice sensors	(Array)
6.	Time step increment for slice sensors	(Array)
7.	Lower I limit for slice sensors	(Array)

8. Upper I limit for slice sensors (Array)
9. I increment for slice sensors (Array)
10. Lower J limit for slice sensors (Array)
11. Upper J limit for slice sensors (Array)
12. J increment for slice sensors (Array)
13. Lower K limit for slice sensors (Array)
14. Upper K limit for slice sensors (Array)
15. K increment for slice sensors (Array)
16. Exit

What item would you like to change? >>

Proceed through the items in this menu, giving a value to the first it element of each item. For at least one of the co-ordinates, the upper and lower limits must be equal, so that a single plane is defined. (Volume sensors are available if desired).

16

SIMULATION PARAMETERS

*1. General problem set-up
*2. Materials
*3. Incident wave shape
4. Point radiation sources
*5. External plane wave sources
*6. Point sensors
7. Input verification
8. Near-field sampling
9. Far-field projections
10. Thin Slots
*11. Slice sensors
12. Volume sensors
13. Finished

Select an option >>

13

SETUP_TSAR

* 1. Enter/Modify basic compile-time parameters.
* 2. Enter/Modify far-field compile-time parameters.
* 3. Enter/Modify thin slot compile-time parameters.
* 4. Enter/Modify run-time namelist file.
5. Exit.

(* indicates that an item of this type exists.)

Please select an option >>

5

Call again!
STOP

At this point, there are three include files, to be used for compiling TSAR, and one tsarin file, to run a particular simulation. If any of these files need to be changed, either SETUP_TSAR or your favorite editor may be used at this stage.

The next step in the process is to compile an executable TSAR. If the installation instructions were followed, and your environment variables are properly set, it should only be necessary to type:

maketsar

This command will find the source code, compile and link TSAR, and leave an executable called tsar in the local directory. It will also leave a host of object files, *.o, in the local directory. Once a good executable has been built, these object files can be deleted if desired.

It is a good idea to try TSAR for just a couple of time steps the first time a new executable is ready to run. This checks the settings in the tsarin file and will quickly let you know if something is not correctly set. Once it runs for a couple of time steps and creates the right output files, etc., one can edit the tsarin file for the desired number of time steps. Since for any realistic job, TSAR can run for long periods of time, it is almost always submitted as a background job:

tsar >& tsar.log&

Chapter 6

POST- PROCESSING

When TSAR finishes running, we should have three output files: point01, point02 and slice01. The point files are in SIG external format, that is, they contain several lines of header information followed by just Y values (implied X values). These files can be read into SIG through the TSREAD command.

If a processing package other than SIG is to be used, a simple filter can be written to read the header, extract the initial time (T0) and the time between Y values (DT), then rewrite the file with explicit X values (XY pairs). By only storing Y values the data files are greatly reduced in size. However, if your post-processor always requires XY pairs, it might be worthwhile to alter the output routines within TSAR.

The slice file output can be converted into a ras file with the program B2RAS, for display with XTRAS. To run B2RAS, type b2ras, followed by an input file and an output file:

b2ras slice01 slice01.ras

Once again, this program can be run graphically, with mouse interaction, or in teletype mode, with a command line interface. The following is an example of TTY mode.

Select Mode for Option Selection (graphics - tty): **tty**

```
=============== CURRENT OPTION SETTINGS =============
DATA OPTIONS ------------------------------------------------------------
      Merge geometry with processed data
      Fill artifacts in the mesh
      Data is cell centered
      Average pixels between data points
      Process all frames in the input file
      Do not bevel geometry edges
      Data is not symettric about 0
      Use linear data scaling
ORIENTATION OPTIONS -----------------------------------------------------
      Do not rotate image
      Do not flip image horizontally
      Do not flip image vertically
COLOR TABLE -------------------------------------------------------------
      Selected color table is [Multicolor 1]

============= B2RAS MAIN PARAMETER MENU =============

Make changes to B2RAS parameters by selecting the appropriate sub-menu.

      c - change Color table
      d - change Data options
      o - change Orientation options
      x - accept current options settings and proceed
```

Enter desired option: **c**

COLOR TABLE MENU ----------
Current Color Table is [Multicolor 1]

1 --- Multicolor 1
2 --- Multicolor 2
3 --- Multicolor 3
4 --- Multicolor 4
5 --- Multicolor 5
6 --- Multicolor 6
7 --- Multicolor 7
8 --- Multicolor 8
9 --- Multicolor 9
10 --- Grayscale

Enter Color Table Number (1-10): **6**

Color table 6 is a good choice for time domain values that are both positive and negative.

========== CURRENT OPTION SETTINGS ==========
DATA OPTIONS ----------
Merge geometry with processed data
Fill artifacts in the mesh
Data is cell centered
Average pixels between data points
Process all frames in the input file
Do not bevel geometry edges
Data is not symettric about 0
Use linear data scaling
ORIENTATION OPTIONS ----------
Do not rotate image
Do not flip image horizontally
Do not flip image vertically
COLOR TABLE ----------
Selected color table is [Multicolor 6]

========== ===B2RAS MAIN PARAMETER MENU ==========
Make changes to B2RAS parameters by selecting the appropriate sub-menu.

c --- change Color table
d --- change Data options
o --- change Orientation options
x --- accept current options settings and proceed

Enter desired option: **d**

DATA OPTIONS MENU ----------

d - Data	[Data and Geometry]
f - Fill Mesh	[Fill]
o - Data Orientation	[Cell Centered]
a - Average between data values	[Average]

n - Process Frames [All Frames]
b - Bevel Mesh Edges [No]
m - Data Is Symmetric About 0 [No]
s - Data Scaling [Linear]
x - Accept Current Data Option Values

Enter character option: **o**

Data Orientation Can Be One of the Following:

c - Cell Centered
x - Along Ex
y - Along Ey
z - Along Ez

Enter character: **y**

Since we wrote Ey values, the natural choice is y.

DATA OPTIONS MENU ----------

d - Data [Data and Geometry]
f - Fill Mesh [Fill]
o - Data Orientation [Ey]
a - Average between data values [Average]
n - Process Frames [All Frames]
b - Bevel Mesh Edges [No]
m - Data Is Symmetric About 0 [No]
s - Data Scaling [Linear]
x - Accept Current Data Option Values

Enter character option: **m**
Since these are time domain values, they vary about zero.

DATA OPTIONS MENU ----------

d - Data [Data and Geometry]
f - Fill Mesh [Fill]
o - Data Orientation [Ey]
a - Average between data values [Average]
n - Process Frames [All Frames]
b - Bevel Mesh Edges [No]
m - Data Is Symmetric About 0 [Yes]
s - Data Scaling [Linear]
x - Accept Current Data Option Values

Enter character option: **s**

Enter number of cycles for log scaling: **2**

B2ras normalizes all values to the largest magnitude number found in the file. By choosing a 2-cycle log scale, the largest value in the output will be 1 and the smallest will be 0.01.

DATA OPTIONS MENU ----------

d - Data	[Data and Geometry]
f - Fill Mesh	[Fill]
o - Data Orientation	[Ey]
a - Average between data values	[Average]
n - Process Frames	[All Frames]
b - Bevel Mesh Edges	[No]
m - Data Is Symmetric About 0	[Yes]
s - Data Scaling	[Log (2 cycles)]
x - Accept Current Data Option Values	

Enter character option: **x**
Accept the current data option settings and return to the main menu.

========== CURRENT OPTION SETTINGS ==========
DATA OPTIONS ----------
Merge geometry with processed data
Fill artifacts in the mesh
Data is oriented along Ey
Average pixels between data points
Process all frames in the input file
Do not bevel geometry edges
Data is symmetric about 0
Use log data scaling [2 cycles]
ORIENTATION OPTIONS ----------
Do not rotate image
Do not flip image horizontally
Do not flip image vertically
COLOR TABLE ----------
Selected color table is [Multicolor 6]

==========B2RAS MAIN PARAMETER MENU ==========
Make changes to B2RAS parameters by selecting the appropriate sub-menu.

c - change Color table
d - change Data options
o - change Orientation options
x - accept current options settings and proceed

Enter desired option: **x**
Accept all the current settings and let b2ras begin to process the data.

========== CURRENT OPTION SETTINGS ==========
DATA OPTIONS ----------
Merge geometry with processed data
Fill artifacts in the mesh
Data is oriented along Ey
Average pixels between data points
Process all frames in the input file

```
        Do not bevel geometry edges
        Data is symmetric about 0
        Use log data scaling [2 cycles]
ORIENTATION OPTIONS ----------------------------------------------------
        Do not rotate image
        Do not flip image horizontally
        Do not flip image vertically
COLOR TABLE ------------------------------------------------------------
        Selected color table is [Multicolor 7]

****************** Begin Processing ******************************
 xres [1]  yres[41]  zres[45]
 Reading Mesh File
   Filter Mesh Data [Filter 1]
   Reading frame : 25
   Processing frame : 25
   Writing frame : 25
```

We now have the file slice01.ras, which may be displayed with xtras:

xtras slice01.ras

This concludes our example of the TSAR EM modeling package. There are many other options available, but it is hoped that this will allow a new user to get started. Experimenting with other selections should be less daunting now that the user has set up and run at least one TSAR problem.

DATE
FILMED
12/28/93
END