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Abstract

The program EFDRAW plots the geometrical elements of the EFFI Coils in a central perspective. The coils can be scaled, rotated and translated. An option allows the user to remove the 'hidden' lines.

EFDRAW: Ein Programm, das EFFI-Spulen in einer Zentralperspektive zeichnet

Zusammenfassung

Das Programm EFDRAW zeichnet die geometrischen Elemente der EFFI-Spulen in einer Zentralperspektive. Die Spulen können skaliert, gedreht und verschoben werden. Eine Option erlaubt dem Benutzer, "versteckte" Linien wegzunehmen.

1. Introduction

The EFFI computer code calculates the Electromagnetic Field, Force and Inductance in coil systems of arbitrary geometry /1/. As for all codes reading in complex data, it is well possible for its user to fall into formal as well as substantial errors when providing the input. EFDRAW proposes to check aforehand: 1) the formal correctness of the EFFI input (e.g., that no coil has a radius less than or equal to zero); 2) the substantial correctness of the geometrical disposition of the coils, by drawing them in central perspective.

2. Check of the formal correctness

Since the EFFI code is already able of performing the check of the formal correctness of its input, the same algorithms used by it have been detached, translated in standard FORTRAN and incorporated in EFDRAW.

Sets of data having formal errors are discarded without the further checking for their substantial correctness: in case of an error, the program stops with an error message in order to allow the user to put in formal correct data.

3. Check of the substantial correctness

The best possibility of checking the substantial correctness of the coil´s positioning is to visualize them. We chose as visualization method a drawing of the whole structure in a central perspective.

3.1 Transformation of the Coils Elements in Finite Elements

The best method of drawing a structure using the facility of a digital computer is to have it represented in the form of Finite

Elements. Since EFFI does not use them, the first step is to transform its geometrical elements (LOOP´s, ARC´s, and GCE´s) into Finite Elements.

LOOP´s (which are substantially ARC´s of 360^{o}) and ARC´s are thus divided into subarcs of 10^{o}; this angle is slightly adjusted, in order to obtain equal subarcs corresponding to the same arc. The subarcs are then transformed into "bricks" (cuboids) and the coordinates of their vertices are calculated (Fig. 1, 2).

GCE´s are already in the form of bricks, isolated or following each other; they are not transformed and only the coordinates of their vertices are calculated.

GCE-´s are not put into the picture at all, since they are coincident with other conductor elements and are only used in the calculation of Forces and Inductances.

3.2 Projection in a central perspective

As basic element for the projection in a central perspective we chose a planar quadrilateral: the lateral faces of the Finite Elements obtained from the geometry of the EFFI coils are projected onto a window having the logical dimensions 2. x 1.442 (Fig. 3).

The distance d between the view-point and the window plane may be chosen by the user. Since it is not very easy to choose a reasonable value for this parameter, we prefer the most traditional concept of the projection angle: α is the angle from which one half of the horizontal window frame is seen (Fig. 3). Since this half has the length of 1, we have:

$$d = 1/tg\alpha$$

The projection algorithm used is:

$y_{proj} = y_{str}\, d/(x_{str}+d)$ $\qquad$ $z_{proj} = z_{str}\, d/(x_{xtr}+d)$

(str = structure, proj = projected)

Choosing a very small α, and thus a very large d, the user can obtain an orthogonal projection. Angles which are very small or negative are transformed automatically in an angle of $1.x10^{-20}$ degrees. Fig. 4 shows a quadrilateral projected on the window.

Points to the left of the window plane ($x < 0$) or outside of the window frame are erased and do not appear on the plot. The lines connecting erased points with not erased points are properly clipped.

The user must be warned here that a bad positioning or scaling of the structure can be rather frustrating: the whole object may disappear from the window and the plot will contain therefore only the frame. The option 'Print' (see 4) can be very useful when looking for a positioning error.

The program offers two possibilities: 1) the lines hidden by the quadrilaterals lying between them and the window are not removed, with the exception of the quadrilaterals belonging to the same brick; we defined this possibility as "not hidden"; 2) the lines hidden are removed from the plot; we defined this possibility as "hidden". In the first case the plot is rather confusing, but its execution is very rapid. In the second case one obtaines nice plots, but the drawing of a complicated structure is highly time-consuming. We recommend therefore to use "not hidden" when positioning the structure, going to "hidden" for the final plots. With the option "not hidden" the user obtains also more information on the written output.

Small problems may arise when the structure is clipped by the window plane and the option "hidden" is used, because the bricks are not cut in a clean way. An example can be seen in Fig. 8.

4. Input options

Each input card for the options consists of a two-characters command (in inverted commas), followed by its parameters.

'CO' par_1 par_2 ...

The cards are read consecutively and each command acts on the set of data that is obtained from the preceding transformation. The commands are:

'DH' α [Draw Hidden]

The structure is projected with the angle α, with the hidden lines removed.

'DN' α [Draw Not-hidden]

The structure is projected with the angle α, without removing the hidden lines.

'PR' n_1 n_2 [Print]

The coordinates of the points n_1 through n_2 are printed.

'TR' dx dy dz [Translate]

The structure is translated by dx in the x-direction, by dy in the y-direction and by dz in the z-direction.

'XR' α [X-Rotation]

The structure is rotated by the angle α around the x-axis.

'YR' β [Y-Rotation]

The structure is rotated by the angle β around the y-axis.

'ZR' γ [Z-Rotation]

The structure is rotated by the angle γ around the z-axis.

'SC' f [Scale]

The structure is scaled by the factor f. This command scales also the translations, which must be always given in the original length units.

'RE' [Restart]

This command cancels the effect of all preceeding commands, so that the following command acts on the original set of data. This command has no parameters.

5. Acknowledgment

I wish to thank Dr. J. Kißlinger (IPP, Garching) for having kindly supplied some of the algorithms used in EFDRAW.

Appendix A

EFDRAW is a program of about 2800 cards, written in FORTRAN-77 /2/ and IBM Assembler /3/. The program structure is represented in Fig. 5.

Fig. 6, 7, 8 and 9 are examples of the EFDRAW performance, with the EFFI data for a Tokamak reactor; the data are listed in Appendix B.

The used input/output units are:

5 For the Commands input
6 For the normal output
1 For the EFFI input
2 Temporary I/O unit (record length = 96 Bytes)

The content of each program section is summarized here:

MAIN: allocates dynamically the storage for the fields (s. also the subroutine GETSTO).

ASSIGN: transforms the free input of EFFI either in literals or in numerics.

CLIP: eliminates null vectors and clips vectors at the window frame.

COILS: reads in the geometrical data of EFFI.

COVER: finds if a vector or a part of it is covered by a quadrilateral.

DRAW: reads the options of EFDRAW, performs transformations and prints the data. It allocates also storage for 'hidden' pictures.

EFERME: prints messages for errors occuring in the EFFI coils.

EFFIC: reads in the EFFI input.

FREAD: handles the particular form of the EFFI input.

HIDDEN: calculates the data for the picture in the 'hidden' mode.

INITPL: initializes the plotter. The positioning of the plots is calculated for the output devices Versatec-Model 8224, Versatec-Model 1200 and Xynetics only. For other output devices, the user must alter this routine, and possibly the routine PICT.

INTPLA: finds the intersection between a vector and a quadrilateral plane.

INTSID: finds the intersection between a vector and a quadrilateral side.

NOHID: calculates the data for the picture in the 'no hidden' mode.

PICT: draws the picture.

POIGC: calculates the vertices of a brick represented by a GCE.

ROT: applies the Euler's angles to a GCE.

SETARC: transforms LOOP's and ARC's into bricks.

SETGCE: transforms GCE's into bricks.

TESTC: prereads the EFFI data and checks the formal correctness of the geometrical input.

UNITS: sets the EFFI units (EFFI User's Manual 3.2).

VERTEX: reads the quadrilaterals' data from a temporary file.

WRDATA: writes the quadrilaterals' data on a temporary file.

GETSTO: (IBM Assembler) supplies storage for the dynamical allocation of arrays.

For the plotting, the following CalComp routines have been used (all coordinates are in inches):

AROHD: draws a segment ending with an arrow. The first two arguments are the coordinates of the beginning point of the segment. The third and fourth argument are the coordinates of the ending point of the arrow. The fifth argument is the width of the point of the arrow. The sixth argument defines the form of the arrow end.

DASHP: draws a dashed line. The first and second argument are the coordinates of the point to which the pen is to be moved. The third argument is the length of the dash and of the interval between dashes.

FACTOR: allows the programmer to enlarge or reduce the size of the plot. The argument is the ratio of the desired size to the normal size.

MESAGE: this special Xynetics routine enables the user to communicate with the operator.

NEW PEN: is used to select a different line width. The method to modify the line width depends strongly on the physical output device.

PLOT: is used to move the pen in a straight line to a new position. The first and the second argument are the x, y coordinates of the position to which the pen is to be moved. The third argu-

ment has the following meaning: 1) = 2: the pen is down during the movement, thus drawing a visible line; 2) = 3: the pen is up during the movement; 3) = 999: this call is used to close the plotting process and can be used only once in a program. A negative value of the third argument defines a new origin of the coordinates system after the movement is completed.

PLOTS: is used to initialize the plot subroutines and may be called only once.

SYMBOL: is used to draw texts. The first two arguments are the coordinates of the lower left-hand corner of the first character to be produced. The third argument is the height of the character(s) to be plotted. The fourth argument contains the text to be plotted. The fifth argument is the angle, in degrees from the x-axis, at which the text is to be plotted. The sixth argument is the number of characters in the text.

In addition to that, the user must supply following subroutines:

JOBINF: is called by a CHARACTER x 64 variable.
This variable contains:

in characters	9 - 16	the job name;
in characters	3 - 6	the JES 3 job number;
in characters	10 - 27	the date (European notation);
in characters	43 - 44	the hour of the day;
in characters	49 - 50	the minute;
in characters	56 - 57	the second.

PAPIER: defines the physical output device. The argument is an array dimensioned 3: the first element contains the width of the paper, the second element contains the length of the paper, the third argument contains an abbreviation of the name of the plotter.

TIMED: provides the time which is elapsed between two calls.

TIMEL: provides the time remaining till the end of the requested time. It is used to interrupt the plotting in a clean way if the requested time is not sufficient.

Appendix B

Input on unit 5

```
'SC'  .1
'ZR' -140.
'YR' -30.
'TR'    9.   0.   0.
'DN'   20.
'DH'   20.
'RE'
'SC'  .08
'YR' -90.
'TR'    5.   0.   0.
'DH'   20.
'TR'    4.   0.   0.
'DH'   1.E-6
```

Output on unit 6

```
          A TOKAMAK REACTOR PLOTTED BY THE PROGRAM EFDRAW

         2236 QUADRILATERALS       3032 POINTS

 PICTURE    1  NO-HIDDEN
  2236 QUADRILATERALS BEHIND THE WINDOW PLANE
 ELAPSED CPU TIME =   0.37 SEC.    REMAINING CPU TIME =1790.95 SEC.

 PICTURE    2  HIDDEN
 ELAPSED CPU TIME =  99.86 SEC.    REMAINING CPU TIME =1691.09 SEC.
     4 VECTORS HAVE BEEN ERASED TO AVOID LOOPING

 PICTURE    3  HIDDEN
 ELAPSED CPU TIME =  35.79 SEC.    REMAINING CPU TIME =1655.30 SEC.

 PICTURE    4  HIDDEN
 ELAPSED CPU TIME =  63.18 SEC.    REMAINING CPU TIME =1592.12 SEC.
     6 VECTORS HAVE BEEN ERASED TO AVOID LOOPING
```

Input on unit 1

```
A TOKAMAK REACTOR PLOTTED BY THE PROGRAM EFDRAW
 ANGLE=DEGREE
 CURRENT=A/CM**2
 LENGTH=M
$
COIL=TOK01      $
ARC
```

```
  3.4771E+00  0.0          0.0
  5.1257E+00
  0.0         9.0000E+01   0.0          3.6380E+01
  6.3000E-01  6.3000E-01   0.0           $
ARC
  4.1944E+00  0.0          5.2893E-01
  4.2350E+00
  0.0         9.0000E+01   3.6380E+01   7.2030E+01
  6.3000E-01  6.3000E-01   0.0           $
ARC
  4.5489E+00  0.0          1.6204E+00
  3.0870E+00
  0.0         9.0000E+01   7.2030E+01   1.0787E+02
  6.3000E-01  6.3000E-01   0.0           $
ARC
  4.2672E+00  0.0          2.4931E+00
  2.1700E+00
  0.0         9.0000E+01   1.0787E+02   1.4429E+02
  6.3000E-01  6.3000E-01   0.0           $
ARC
  3.9100E+00  0.0          2.7500E+00
  1.7300E+00
  0.0         9.0000E+01   1.4429E+02   1.8000E+02
  6.3000E-01  6.3000E-01   0.0           $
ARC
  3.9100E+00  0.0         -2.7500E+00
  1.7300E+00
  0.0         9.0000E+01   1.8000E+02   2.1571E+02
  6.3000E-01  6.3000E-01   0.0           $
ARC
  4.2672E+00  0.0         -2.4931E+00
  2.1700E+00
  0.0         9.0000E+01   2.1571E+02   2.5213E+02
  6.3000E-01  6.3000E-01   0.0           $
ARC
  4.5489E+00  0.0         -1.6204E+00
  3.0870E+00
  0.0         9.0000E+01   2.5213E+02   2.8797E+02
  6.3000E-01  6.3000E-01   0.0           $
ARC
  4.1944E+00  0.0         -5.2893E-01
  4.2350E+00
  0.0         9.0000E+01   2.8797E+02   3.2362E+02
  6.3000E-01  6.3000E-01   0.0           $
ARC
  3.4771E+00  0.0          0.0
  5.1257E+00
  0.0         9.0000E+01   3.2362E+02   3.6000E+02
  6.3000E-01  6.3000E-01   0.0           $
GCE
  2.1800E+00  0.0          2.7500E+00
  2.1800E+00 -3.1500E-01   2.7500E+00
  1.8650E+00  0.0          2.7500E+00
  0.0
```

```
  2.1800E+00  0.0         -2.7500E+00
  2.1800E+00 -3.1500E-01 -2.7500E+00
  1.8650E+00  0.0         -2.7500E+00   $
COIL=TOK02      $
ARC
  3.0113E+00  1.7386E+00  0.0
  5.1257E+00
  3.0000E+01  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.6324E+00  2.0972E+00  5.2893E-01
  4.2350E+00
  3.0000E+01  9.0000E+01  3.6380E+01   7.2030E+01
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.9395E+00  2.2745E+00  1.6204E+00
  3.0870E+00
  3.0000E+01  9.0000E+01  7.2030E+01   1.0787E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.6955E+00  2.1336E+00  2.4931E+00
  2.1700E+00
  3.0000E+01  9.0000E+01  1.0787E+02   1.4429E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.3862E+00  1.9550E+00  2.7500E+00
  1.7300E+00
  3.0000E+01  9.0000E+01  1.4429E+02   1.8000E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.3862E+00  1.9550E+00 -2.7500E+00
  1.7300E+00
  3.0000E+01  9.0000E+01  1.8000E+02   2.1571E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.6955E+00  2.1336E+00 -2.4931E+00
  2.1700E+00
  3.0000E+01  9.0000E+01  2.1571E+02   2.5213E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.9395E+00  2.2745E+00 -1.6204E+00
  3.0870E+00
  3.0000E+01  9.0000E+01  2.5213E+02   2.8797E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.6324E+00  2.0972E+00 -5.2893E-01
  4.2350E+00
  3.0000E+01  9.0000E+01  2.8797E+02   3.2362E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.0113E+00  1.7386E+00  0.0
  5.1257E+00
  3.0000E+01  9.0000E+01  3.2362E+02   3.6000E+02
  6.3000E-01  6.3000E-01  0.0           $
GCE
```

```
  1.8879E+00  1.0900E+00  2.7500E+00
  2.0454E+00  8.1721E-01  2.7500E+00
  1.6151E+00  9.3251E-01  2.7500E+00
  0.0
  1.8879E+00  1.0900E+00 -2.7500E+00
  2.0454E+00  8.1721E-01 -2.7500E+00
  1.6151E+00  9.3251E-01 -2.7500E+00   $
COIL=TOK03      $
ARC
  1.7386E+00  3.0113E+00  0.0
  5.1257E+00
  6.0000E+01  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0           $
ARC
  2.0972E+00  3.6324E+00  5.2893E-01
  4.2350E+00
  6.0000E+01  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0           $
ARC
  2.2745E+00  3.9395E+00  1.6204E+00
  3.0870E+00
  6.0000E+01  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  2.1336E+00  3.6955E+00  2.4931E+00
  2.1700E+00
  6.0000E+01  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  1.9550E+00  3.3862E+00  2.7500E+00
  1.7300E+00
  6.0000E+01  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  1.9550E+00  3.3862E+00 -2.7500E+00
  1.7300E+00
  6.0000E+01  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  2.1336E+00  3.6955E+00 -2.4931E+00
  2.1700E+00
  6.0000E+01  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  2.2745E+00  3.9395E+00 -1.6204E+00
  3.0870E+00
  6.0000E+01  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  2.0972E+00  3.6324E+00 -5.2893E-01
  4.2350E+00
  6.0000E+01  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
```

```
  1.7386E+00  3.0113E+00  0.0
  5.1257E+00
  6.0000E+01  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0          $
GCE
  1.0900E+00  1.8879E+00  2.7500E+00
  1.3628E+00  1.7304E+00  2.7500E+00
  9.3251E-01  1.6151E+00  2.7500E+00
  0.0
  1.0900E+00  1.8879E+00 -2.7500E+00
  1.3628E+00  1.7304E+00 -2.7500E+00
  9.3251E-01  1.6151E+00 -2.7500E+00   $
COIL=TOK04      $
ARC
  1.0917E-06  3.4771E+00  0.0
  5.1257E+00
  9.0000E+01  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.3169E-06  4.1944E+00  5.2893E-01
  4.2350E+00
  9.0000E+01  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.4283E-06  4.5489E+00  1.6204E+00
  3.0870E+00
  9.0000E+01  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.3398E-06  4.2672E+00  2.4931E+00
  2.1700E+00
  9.0000E+01  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.2277E-06  3.9100E+00  2.7500E+00
  1.7300E+00
  9.0000E+01  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.2277E-06  3.9100E+00 -2.7500E+00
  1.7300E+00
  9.0000E+01  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.3398E-06  4.2672E+00 -2.4931E+00
  2.1700E+00
  9.0000E+01  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.4283E-06  4.5489E+00 -1.6204E+00
  3.0870E+00
  9.0000E+01  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
```

```
  1.3169E-06  4.1944E+00 -5.2893E-01
  4.2350E+00
  9.0000E+01  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.0917E-06  3.4771E+00  0.0
  5.1257E+00
  9.0000E+01  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0          $
GCE
  6.8448E-07  2.1800E+00  2.7500E+00
  3.1500E-01  2.1800E+00  2.7500E+00
  5.8557E-07  1.8650E+00  2.7500E+00
  0.0
  6.8448E-07  2.1800E+00 -2.7500E+00
  3.1500E-01  2.1800E+00 -2.7500E+00
  5.8557E-07  1.8650E+00 -2.7500E+00   $
COIL=TOK05      $
ARC
 -1.7386E+00  3.0113E+00  0.0
  5.1257E+00
  1.2000E+02  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.0972E+00  3.6324E+00  5.2893E-01
  4.2350E+00
  1.2000E+02  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.2745E+00  3.9395E+00  1.6204E+00
  3.0870E+00
  1.2000E+02  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.1336E+00  3.6955E+00  2.4931E+00
  2.1700E+00
  1.2000E+02  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -1.9550E+00  3.3862E+00  2.7500E+00
  1.7300E+00
  1.2000E+02  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -1.9550E+00  3.3862E+00 -2.7500E+00
  1.7300E+00
  1.2000E+02  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.1336E+00  3.6955E+00 -2.4931E+00
  2.1700E+00
  1.2000E+02  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
```

```
 -2.2745E+00  3.9395E+00 -1.6204E+00
  3.0870E+00
  1.2000E+02  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.0972E+00  3.6324E+00 -5.2893E-01
  4.2350E+00
  1.2000E+02  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -1.7386E+00  3.0113E+00  0.0
  5.1257E+00
  1.2000E+02  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0          $
GCE
 -1.0900E+00  1.8879E+00  2.7500E+00
 -8.1721E-01  2.0454E+00  2.7500E+00
 -9.3250E-01  1.6151E+00  2.7500E+00
  0.0
 -1.0900E+00  1.8879E+00 -2.7500E+00
 -8.1721E-01  2.0454E+00 -2.7500E+00
 -9.3250E-01  1.6151E+00 -2.7500E+00   $
COIL=TOK06      $
ARC
 -3.0113E+00  1.7386E+00  0.0
  5.1257E+00
  1.5000E+02  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.6324E+00  2.0972E+00  5.2893E-01
  4.2350E+00
  1.5000E+02  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.9395E+00  2.2745E+00  1.6204E+00
  3.0870E+00
  1.5000E+02  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.6955E+00  2.1336E+00  2.4931E+00
  2.1700E+00
  1.5000E+02  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.3862E+00  1.9550E+00  2.7500E+00
  1.7300E+00
  1.5000E+02  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.3862E+00  1.9550E+00 -2.7500E+00
  1.7300E+00
  1.5000E+02  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
```

```
 -3.6955E+00  2.1336E+00 -2.4931E+00
  2.1700E+00
  1.5000E+02  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.9395E+00  2.2745E+00 -1.6204E+00
  3.0870E+00
  1.5000E+02  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.6324E+00  2.0972E+00 -5.2893E-01
  4.2350E+00
  1.5000E+02  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.0113E+00  1.7386E+00  0.0
  5.1257E+00
  1.5000E+02  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0          $
GCE
 -1.8879E+00  1.0900E+00  2.7500E+00
 -1.7304E+00  1.3628E+00  2.7500E+00
 -1.6151E+00  9.3251E-01  2.7500E+00
  0.0
 -1.8879E+00  1.0900E+00 -2.7500E+00
 -1.7304E+00  1.3628E+00 -2.7500E+00
 -1.6151E+00  9.3251E-01 -2.7500E+00   $
COIL=TOK07      $
ARC
 -3.4771E+00  2.1835E-06  0.0
  5.1257E+00
  1.8000E+02  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -4.1944E+00  2.6339E-06  5.2893E-01
  4.2350E+00
  1.8000E+02  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -4.5489E+00  2.8565E-06  1.6204E+00
  3.0870E+00
  1.8000E+02  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -4.2672E+00  2.6797E-06  2.4931E+00
  2.1700E+00
  1.8000E+02  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.9100E+00  2.4553E-06  2.7500E+00
  1.7300E+00
  1.8000E+02  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
```

```
 -3.9100E+00  2.4553E-06 -2.7500E+00
  1.7300E+00
  1.8000E+02  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -4.2672E+00  2.6797E-06 -2.4931E+00
  2.1700E+00
  1.8000E+02  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -4.5489E+00  2.8565E-06 -1.6204E+00
  3.0870E+00
  1.8000E+02  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -4.1944E+00  2.6339E-06 -5.2893E-01
  4.2350E+00
  1.8000E+02  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.4771E+00  2.1835E-06  0.0
  5.1257E+00
  1.8000E+02  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0          $
GCE
 -2.1800E+00  1.3690E-06  2.7500E+00
 -2.1800E+00  3.1500E-01  2.7500E+00
 -1.8650E+00  1.1711E-06  2.7500E+00
  0.0
 -2.1800E+00  1.3690E-06 -2.7500E+00
 -2.1800E+00  3.1500E-01 -2.7500E+00
 -1.8650E+00  1.1711E-06 -2.7500E+00   $
COIL=TOK08      $
ARC
 -3.0113E+00 -1.7386E+00  0.0
  5.1257E+00
  2.1000E+02  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.6324E+00 -2.0972E+00  5.2893E-01
  4.2350E+00
  2.1000E+02  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.9395E+00 -2.2745E+00  1.6204E+00
  3.0870E+00
  2.1000E+02  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.6955E+00 -2.1336E+00  2.4931E+00
  2.1700E+00
  2.1000E+02  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
```

```
 -3.3862E+00 -1.9550E+00  2.7500E+00
  1.7300E+00
  2.1000E+02  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.3862E+00 -1.9550E+00 -2.7500E+00
  1.7300E+00
  2.1000E+02  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.6955E+00 -2.1336E+00 -2.4931E+00
  2.1700E+00
  2.1000E+02  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.9395E+00 -2.2745E+00 -1.6204E+00
  3.0870E+00
  2.1000E+02  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.6324E+00 -2.0972E+00 -5.2893E-01
  4.2350E+00
  2.1000E+02  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.0113E+00 -1.7386E+00  0.0
  5.1257E+00
  2.1000E+02  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0          $
GCE
 -1.8879E+00 -1.0900E+00  2.7500E+00
 -2.0454E+00 -8.1721E-01  2.7500E+00
 -1.6151E+00 -9.3250E-01  2.7500E+00
  0.0
 -1.8879E+00 -1.0900E+00 -2.7500E+00
 -2.0454E+00 -8.1721E-01 -2.7500E+00
 -1.6151E+00 -9.3250E-01 -2.7500E+00   $
COIL=TOK09      $
ARC
 -1.7386E+00 -3.0113E+00  0.0
  5.1257E+00
  2.4000E+02  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.0972E+00 -3.6324E+00  5.2893E-01
  4.2350E+00
  2.4000E+02  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.2745E+00 -3.9395E+00  1.6204E+00
  3.0870E+00
  2.4000E+02  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
```

```
 -2.1336E+00 -3.6955E+00  2.4931E+00
  2.1700E+00
  2.4000E+02  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -1.9550E+00 -3.3862E+00  2.7500E+00
  1.7300E+00
  2.4000E+02  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -1.9550E+00 -3.3862E+00 -2.7500E+00
  1.7300E+00
  2.4000E+02  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.1336E+00 -3.6955E+00 -2.4931E+00
  2.1700E+00
  2.4000E+02  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.2745E+00 -3.9395E+00 -1.6204E+00
  3.0870E+00
  2.4000E+02  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -2.0972E+00 -3.6324E+00 -5.2893E-01
  4.2350E+00
  2.4000E+02  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -1.7386E+00 -3.0113E+00  0.0
  5.1257E+00
  2.4000E+02  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0          $
GCE
 -1.0900E+00 -1.8879E+00  2.7500E+00
 -1.3628E+00 -1.7304E+00  2.7500E+00
 -9.3251E-01 -1.6151E+00  2.7500E+00
  0.0
 -1.0900E+00 -1.8879E+00 -2.7500E+00
 -1.3628E+00 -1.7304E+00 -2.7500E+00
 -9.3251E-01 -1.6151E+00 -2.7500E+00   $
COIL=TOK10       $
ARC
 -3.2746E-06 -3.4771E+00  0.0
  5.1257E+00
  2.7000E+02  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.9501E-06 -4.1944E+00  5.2893E-01
  4.2350E+00
  2.7000E+02  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
```

```
 -4.2840E-06 -4.5489E+00  1.6204E+00
  3.0870E+00
  2.7000E+02  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -4.0187E-06 -4.2672E+00  2.4931E+00
  2.1700E+00
  2.7000E+02  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.6823E-06 -3.9100E+00  2.7500E+00
  1.7300E+00
  2.7000E+02  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.6823E-06 -3.9100E+00 -2.7500E+00
  1.7300E+00
  2.7000E+02  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -4.0187E-06 -4.2672E+00 -2.4931E+00
  2.1700E+00
  2.7000E+02  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -4.2840E-06 -4.5489E+00 -1.6204E+00
  3.0870E+00
  2.7000E+02  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.9501E-06 -4.1944E+00 -5.2893E-01
  4.2350E+00
  2.7000E+02  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
 -3.2746E-06 -3.4771E+00  0.0
  5.1257E+00
  2.7000E+02  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0          $
GCE
 -2.0530E-06 -2.1800E+00  2.7500E+00
 -3.1500E-01 -2.1800E+00  2.7500E+00
 -1.7564E-06 -1.8650E+00  2.7500E+00
  0.0
 -2.0530E-06 -2.1800E+00 -2.7500E+00
 -3.1500E-01 -2.1800E+00 -2.7500E+00
 -1.7564E-06 -1.8650E+00 -2.7500E+00   $
COIL=TOK11       $
ARC
  1.7386E+00 -3.0113E+00  0.0
  5.1257E+00
  3.0000E+02  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
```

```
  2.0972E+00 -3.6324E+00  5.2893E-01
  4.2350E+00
  3.0000E+02  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0          $
ARC
  2.2745E+00 -3.9395E+00  1.6204E+00
  3.0870E+00
  3.0000E+02  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  2.1336E+00 -3.6955E+00  2.4931E+00
  2.1700E+00
  3.0000E+02  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.9550E+00 -3.3862E+00  2.7500E+00
  1.7300E+00
  3.0000E+02  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.9550E+00 -3.3862E+00 -2.7500E+00
  1.7300E+00
  3.0000E+02  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  2.1336E+00 -3.6955E+00 -2.4931E+00
  2.1700E+00
  3.0000E+02  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  2.2745E+00 -3.9395E+00 -1.6204E+00
  3.0870E+00
  3.0000E+02  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  2.0972E+00 -3.6324E+00 -5.2893E-01
  4.2350E+00
  3.0000E+02  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0          $
ARC
  1.7386E+00 -3.0113E+00  0.0
  5.1257E+00
  3.0000E+02  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0          $
GCE
  1.0900E+00 -1.8879E+00  2.7500E+00
  8.1721E-01 -2.0454E+00  2.7500E+00
  9.3250E-01 -1.6151E+00  2.7500E+00
  0.0
  1.0900E+00 -1.8879E+00 -2.7500E+00
  8.1721E-01 -2.0454E+00 -2.7500E+00
  9.3250E-01 -1.6151E+00 -2.7500E+00   $
COIL=TOK12      $
ARC
```

```
  3.0113E+00 -1.7386E+00  0.0
  5.1257E+00
  3.3000E+02  9.0000E+01  0.0          3.6380E+01
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.6324E+00 -2.0972E+00  5.2893E-01
  4.2350E+00
  3.3000E+02  9.0000E+01  3.6380E+01  7.2030E+01
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.9395E+00 -2.2745E+00  1.6204E+00
  3.0870E+00
  3.3000E+02  9.0000E+01  7.2030E+01  1.0787E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.6955E+00 -2.1336E+00  2.4931E+00
  2.1700E+00
  3.3000E+02  9.0000E+01  1.0787E+02  1.4429E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.3862E+00 -1.9550E+00  2.7500E+00
  1.7300E+00
  3.3000E+02  9.0000E+01  1.4429E+02  1.8000E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.3862E+00 -1.9550E+00 -2.7500E+00
  1.7300E+00
  3.3000E+02  9.0000E+01  1.8000E+02  2.1571E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.6955E+00 -2.1336E+00 -2.4931E+00
  2.1700E+00
  3.3000E+02  9.0000E+01  2.1571E+02  2.5213E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.9395E+00 -2.2745E+00 -1.6204E+00
  3.0870E+00
  3.3000E+02  9.0000E+01  2.5213E+02  2.8797E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.6324E+00 -2.0972E+00 -5.2893E-01
  4.2350E+00
  3.3000E+02  9.0000E+01  2.8797E+02  3.2362E+02
  6.3000E-01  6.3000E-01  0.0           $
ARC
  3.0113E+00 -1.7386E+00  0.0
  5.1257E+00
  3.3000E+02  9.0000E+01  3.2362E+02  3.6000E+02
  6.3000E-01  6.3000E-01  0.0           $
GCE
  1.8879E+00 -1.0900E+00  2.7500E+00
  1.7304E+00 -1.3628E+00  2.7500E+00
  1.6151E+00 -9.3251E-01  2.7500E+00
  0.0
```

```
  1.8879E+00 -1.0900E+00 -2.7500E+00
  1.7304E+00 -1.3628E+00 -2.7500E+00
  1.6151E+00 -9.3251E-01 -2.7500E+00    $
  COIL=XAX   $
(GCE'S TO SIMULATE THE X-AXIS)
  GCE   -0.5    0.   0.  90.  90.  0.
  .01  .01    1.  0.   $
  GCE   -1.5    0.   0.  90.  90.  0.
  .01  .01    1.   0.   $
  GCE  -2.5    0.   0.  90.  90.  0.
  .01  .01    1.   0.   $
  GCE  -3.5    0.   0.  90.  90.  0.
  .01  .01    1.   0.   $
  GCE  -4.5    0.   0.  90.  90.  0.
  .01  .01    1.    0.   $
  GCE  -5.5    0.   0.  90.  90.  0.
  .01  .01    1.   .   $
  GCE  -6.5    0.   0.  90.  90.  0.
  .01  .01    1.   0.   $
  GCE  -7.5    0.   0.    90.  90.  0.
  .01  .01    1.   0.   $
  GCE  -8.5    0.   0.  90.  90.  0.
  .01  .01    1.  0.   $
  GCE  -9.5    0.   0.   90.  90.  0.
  .01  .01    1.   0.   $
  GCE -10.5    0.   0.   90.  90.  0.
  .01  .01    1.    0.   $
  GCE -11.5    0.   0.  90.  90.  0.
  .01  .01    1.   0.   $
  GCE -12.5    0.   0.   90.  90.  0.
  .01  .01    1.   0.   $
  GCE -13.5    0.   0.   90.  90.  0.
  .01  .01    1.   0.   $
  GCE  0.5    0.   0.    90.  90.  0.
  .01  .01    1.   0.   $
  GCE  1.5    0.   0.  90.  90.  0.
  .01  .01    1.    0.   $
  GCE  2.5    0.   0.   90.  90.  0.
  .01  .01    1.   0.   $
  GCE  3.5    0.   0.  90.  90.  0.
  .01  .01    1.   0.   $
  GCE  4.5    0.   0.  90.  90.  0.
  .01  .01    1.   0.   $
  GCE  5.5    0.   0.   90.  90.  0.
  .01  .01    1.   0.   $
  GCE   6.5    0.   0.   90.  90.  0.
  .01  .01    1.    0.   $
  GCE  7.5    0.   0.   90.  90.  0.
  .01  .01    1.    0.   $
  GCE  8.5    0.   0.  90.  90.  0.
  .01  .01    1.   0.   $
  GCE  9.5    0.   0.  90.  90.  0.
  .01  .01    1.  0.   $
  GCE  10.5    0.   0.  90.  90.  0.
```

```
  .01  .01    1.  0.   $
  GCE  11.5    0.   0.  90.  90.  0.
  .01  .01    1.   0.   $
COIL=YAX    $
(GCE'S TO SIMULATE THE Y-AXIS)
  GCE  0. -10.5  0.    0.  90.  0.
  .01  .01    1.  0.   $
  GCE 0.  -9.5  0.   0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.  -8.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE 0.  -7.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE 0.  -6.5  0.   0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.  -5.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE  0.  -4.5  0.  0.  90.  0.
  .01  .01    1.    0.   $
  GCE  0.  -3.5  0.  0.  90.  0.
  .01  .01    1.    0.   $
  GCE  0.  -2.5  0.  0.  90.  0.
  .01  .01    1.    0.   $
  GCE  0.  -1.5  0.  0.  90.  0.
  .01  .01    1.    0.   $
  GCE  0.  -0.5  0.  0.  90.  0.
  .01  .01    1.    0.   $
  GCE   0.  12.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.  11.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.  10.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   9.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   8.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   7.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   6.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   5.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   4.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   3.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   2.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   1.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
  GCE   0.   0.5  0.  0.  90.  0.
  .01  .01    1.   0.   $
COIL=ZAX    $
(GCE'S TO SIMULATE THE Z-AXIS)
```

```
GCE    0.    0.   -8.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.   -7.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.   -6.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.   -5.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.   -4.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.   -3.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.   -2.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.   -1.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.   -0.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.    0.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.    1.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.    2.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.    3.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.    4.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.    5.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.    6.5     0.   0.   0.
.01   .01    1.     0.    $
GCE    0.    0.    7.5     0.   0.   0.
.01   .01    1.     0.    $
$
$
```

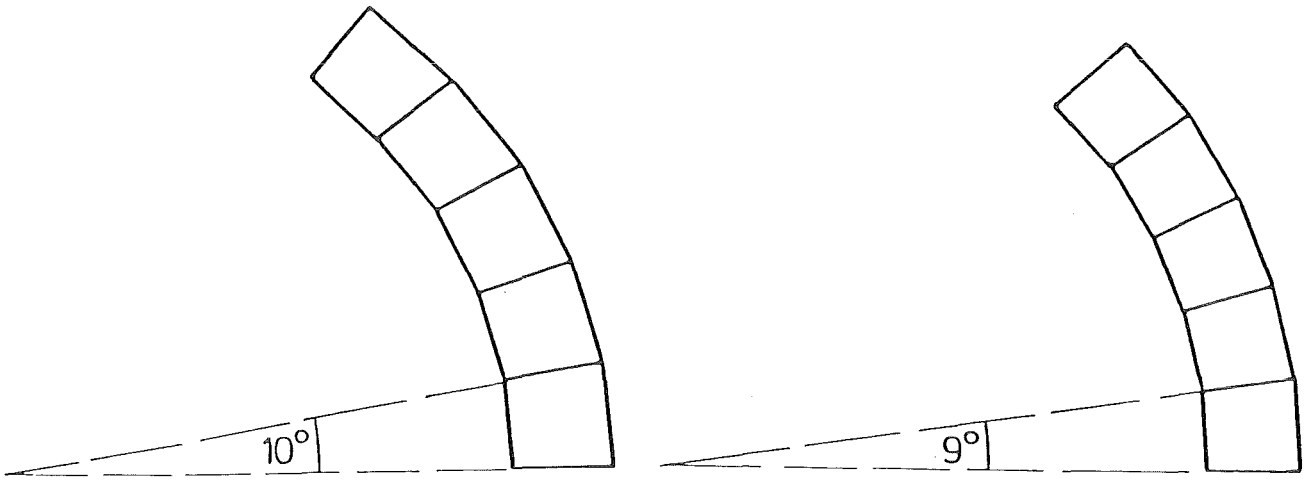

Fig. 1 a) an arc divided in subarcs of exactly 10^{o},
b) an arc divided in subarcs of 9^{o} (the angle has been adjusted).

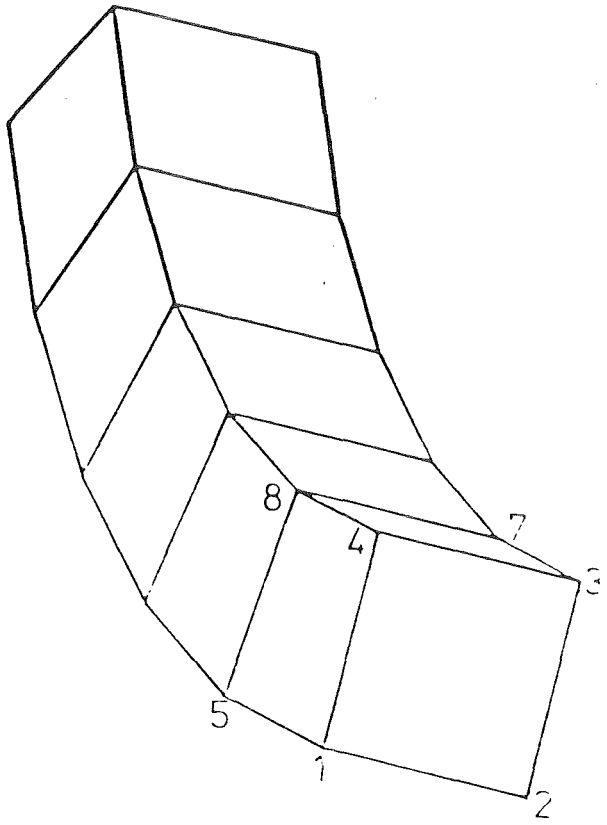

Fig. 2 A subarc transformed into the Finite Element 'Brick'.

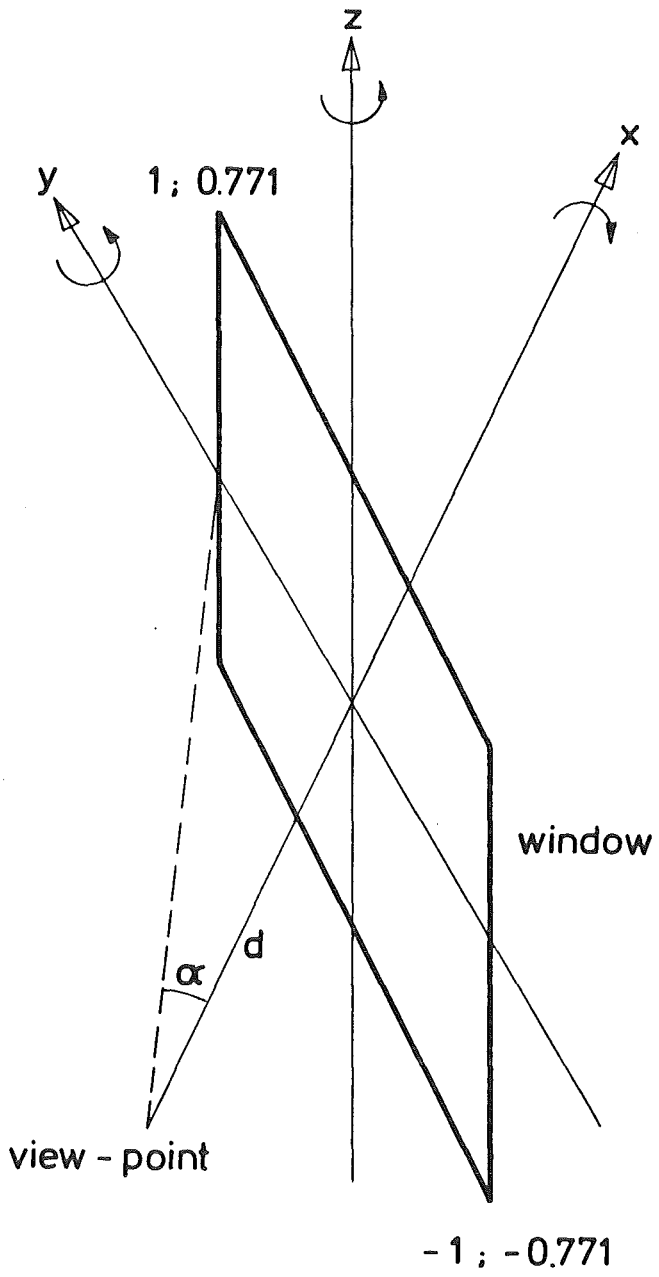

Fig. 3 The window plane, the view-point and the global axis with their rotations.

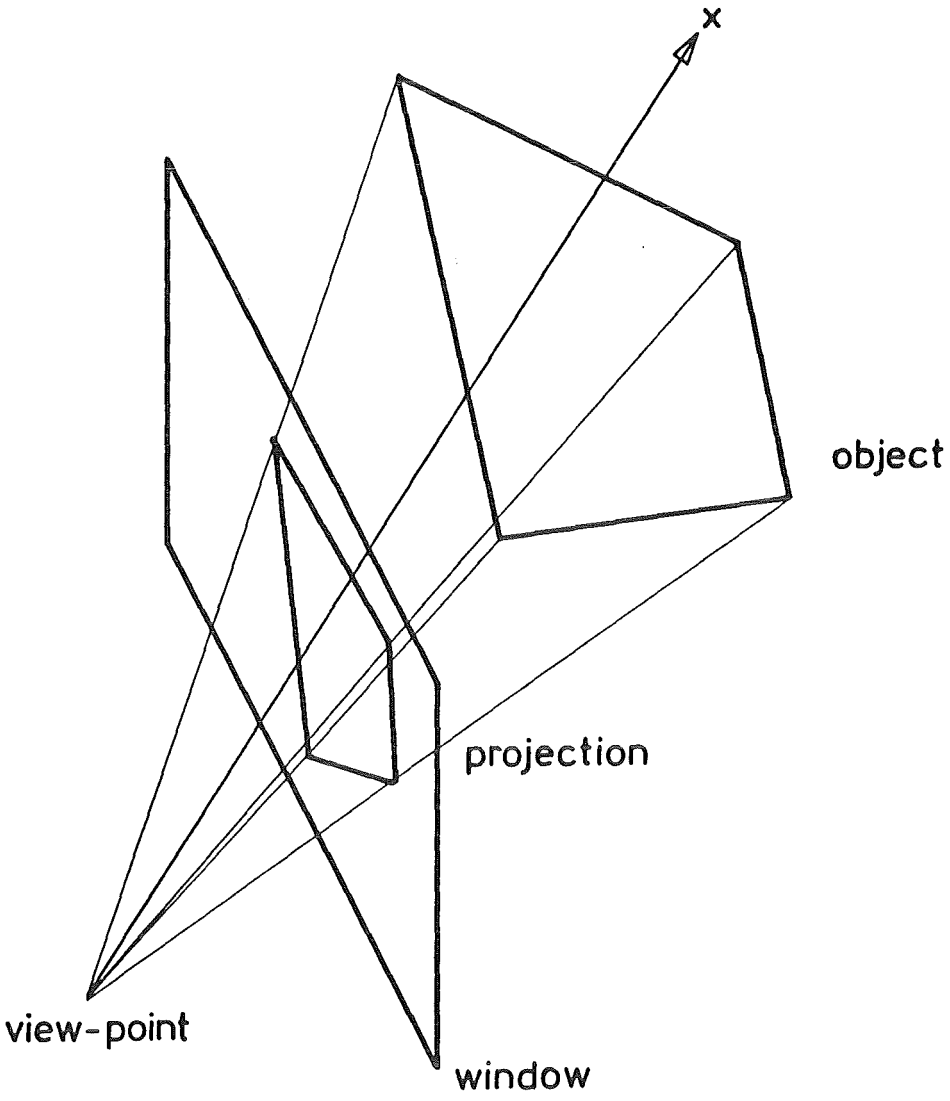

Fig. 4 A quadrilateral projected on the window plane.

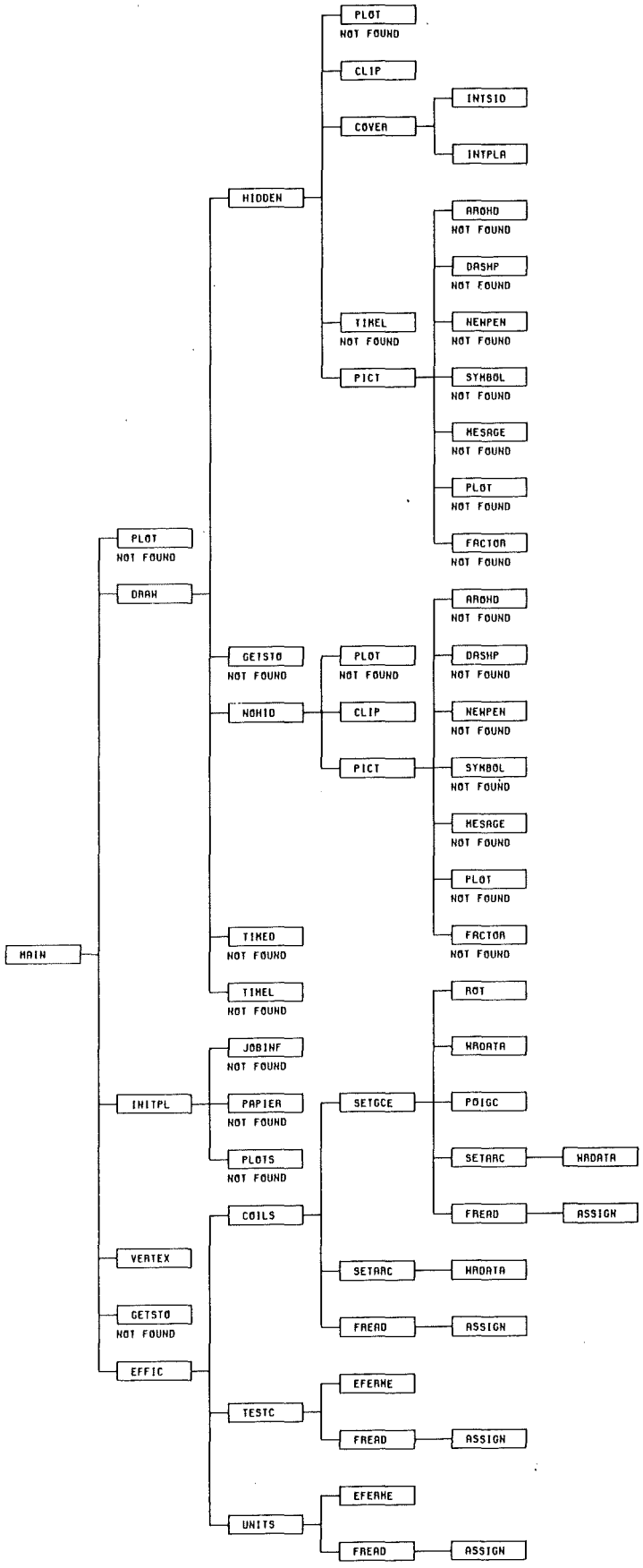

Fig. 5 Structure tree of the program EFDRAW.

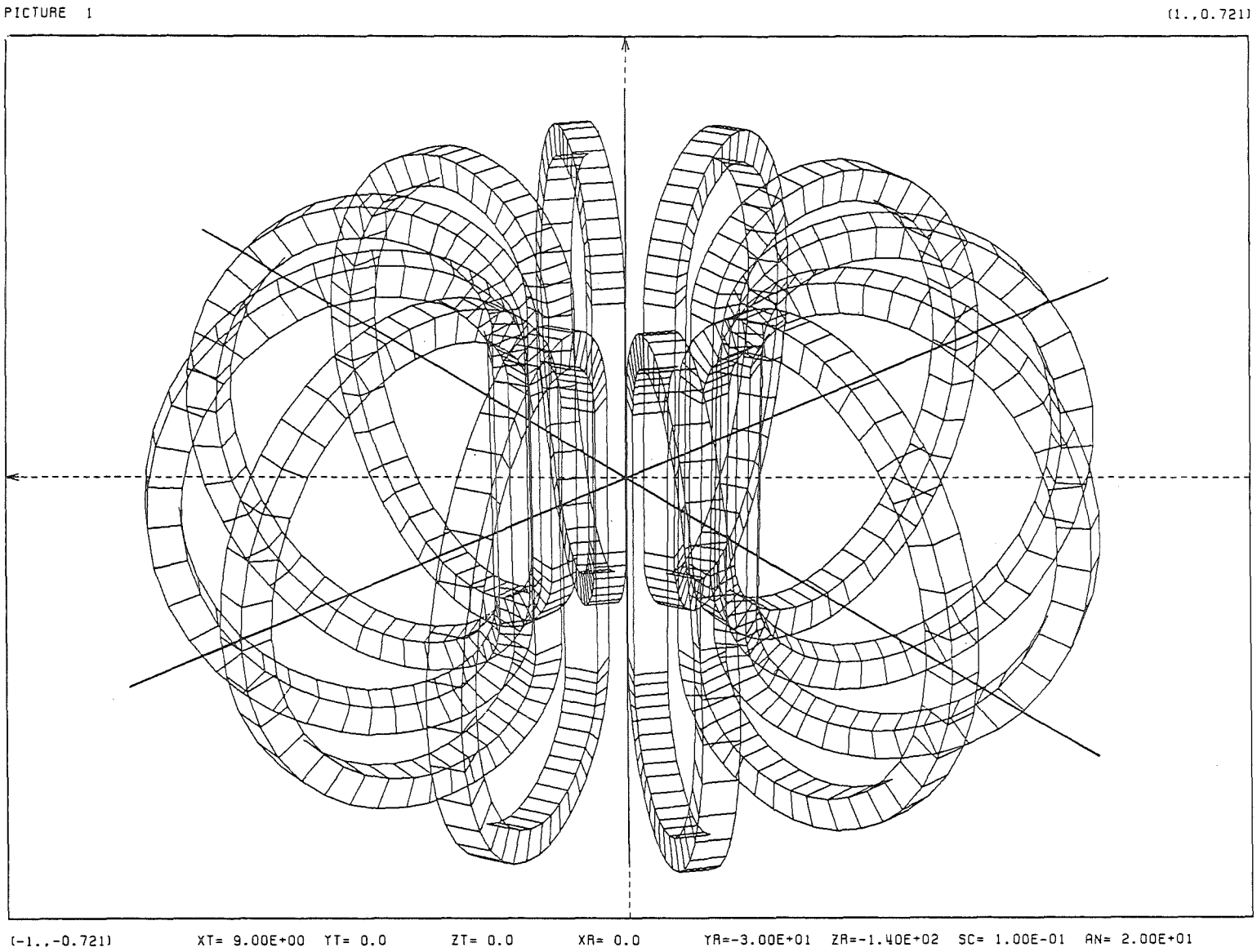

Fig. 6 A drawing with the option 'not-hidden'.

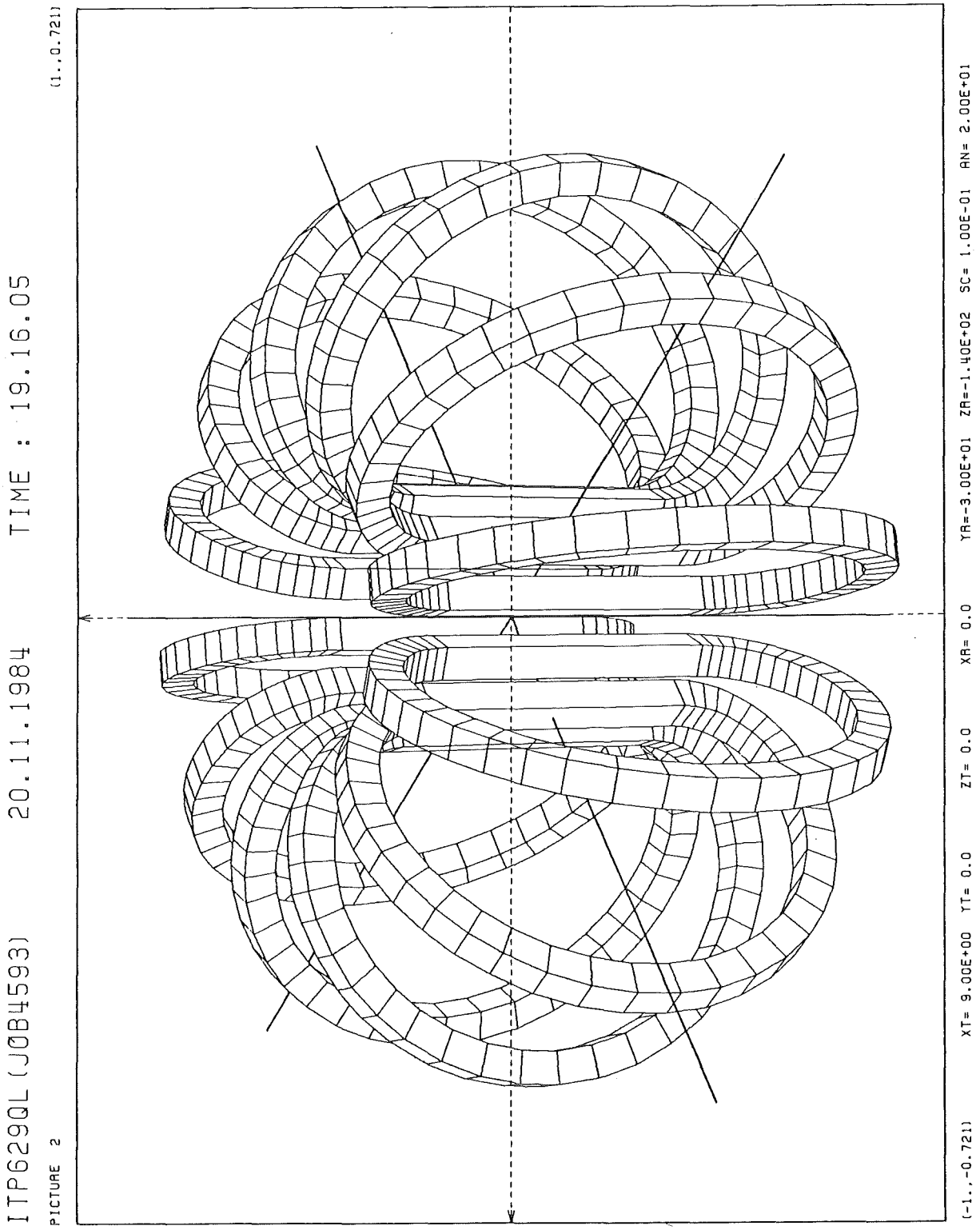

Fig. 7 The same structure as in Fig. 6, plotted with the option 'hidden'.

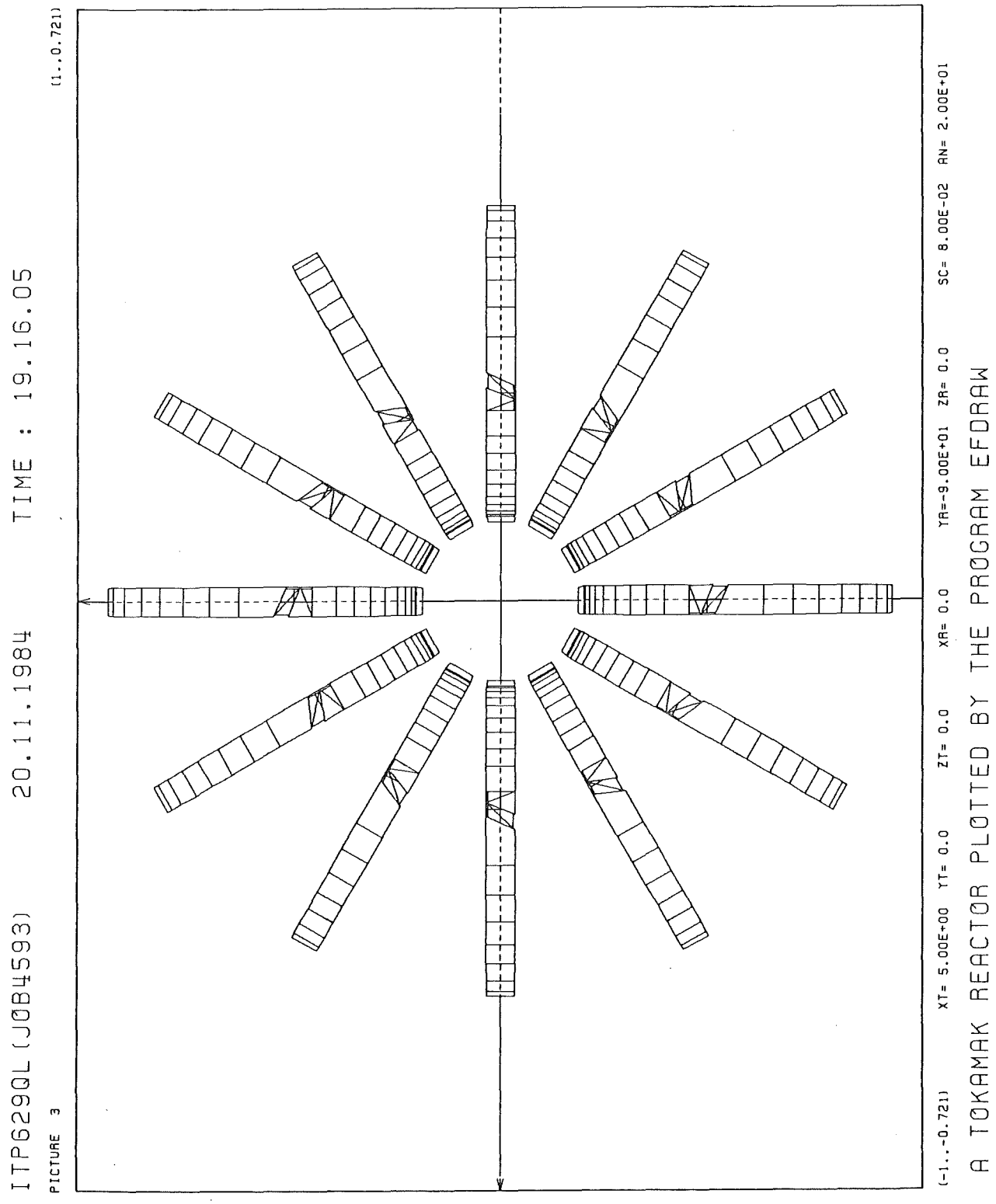

Fig. 8 A structure clipped by the window plane.

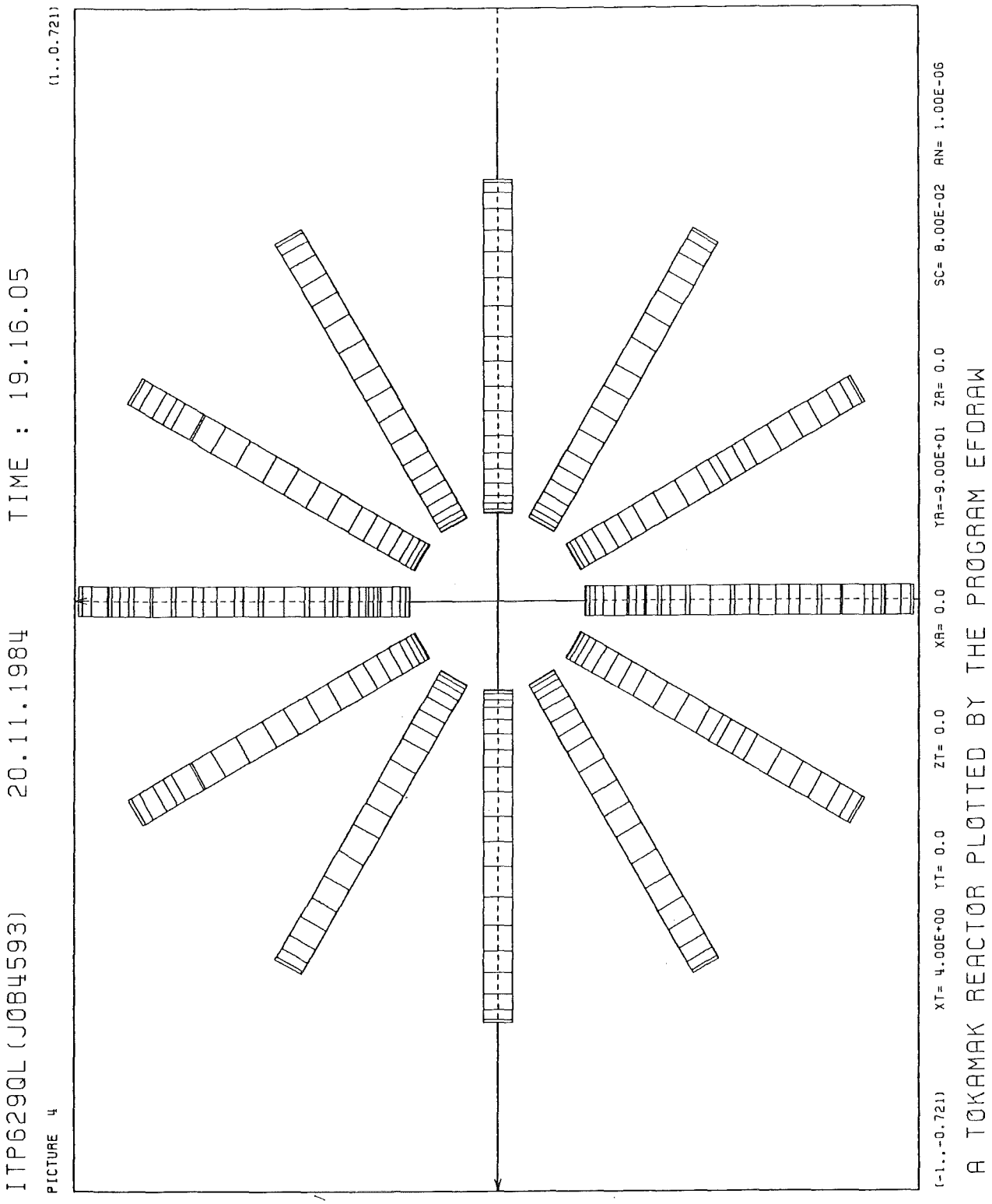

Fig. 9 The same structure as in Fig. 8, not clipped by the window plane.

References

/1/ S. J. Sacket: UCID 17621 "EFFI - a code for calculating the electromagnetic field, force and inductance in coil systems of arbitrary geometry", 1977.

/2/ Operating System BS 3000 - FORTRAN 77 - Reference Manual.

/3/ OS/VS - DOS/VSE - VM/370 - Assembler Language - IBM: GC 33-4010-5.