- TRIA -

A generator for a locally refined triangular mesh

B. Küppers, P. Börner, D. Reiter

Institut für Energieforschung - Plasmaphysik,

Forschungszentrum Jülich GmbH, Association EURATOM-KFA

D-52425 Jülich, Germany

Table of contents

1 Abstract

The effects of neutral particles on the edge plasma conditions play a key role in fusion research. New options to obtain non-linear Monte Carlo solutions of model kinetic equations in the transition flow regime with the EIRENE neutral particle transport code have become available recently. These require a triangular mesh generator for multiply connected 2D domains. To resolve steep spatial gradients, e.g., in the ionization-recombination front in detached divertor plasmas, or to study shock structures, local mesh refinement is also mandatory.

A new mesh generator with these capabilities has been developed and is described in this report. The algorithm, the usage of the code and examples relevant for magnetic confinement fusion configurations are given.

2 Introduction

Monte Carlo solution for non-linear neutral gas transport problems (i.e., including neutral-neutral interactions photon-gas interactions, etc.) have become available in the EIRENE Code (ref /1/).
The method is based on an iterative procedure solving successively linearized kinetic Boltzmann-equations in BGK-approximation on a discretised two or three dimensional but otherwise arbitrarily complex bounded domain. The choice of an approximate "BGK-model"-collision term permits to avoid discretisation in velocity space, while still retaining the main features of the Boltzmann collision integral (collisional invariants, conservation of particles, momentum and energy, H-theorem). See figure 1 for a typical configuration of interest in controlled fusion research. Here both the SOL-plasma and the vacuum region between the plasma and the furnace chamber are discretised, permitting, e.g., computation of momentum and heat transport from the divertor plasma, through the gas (viscous effects), to the pump and divertor structures.

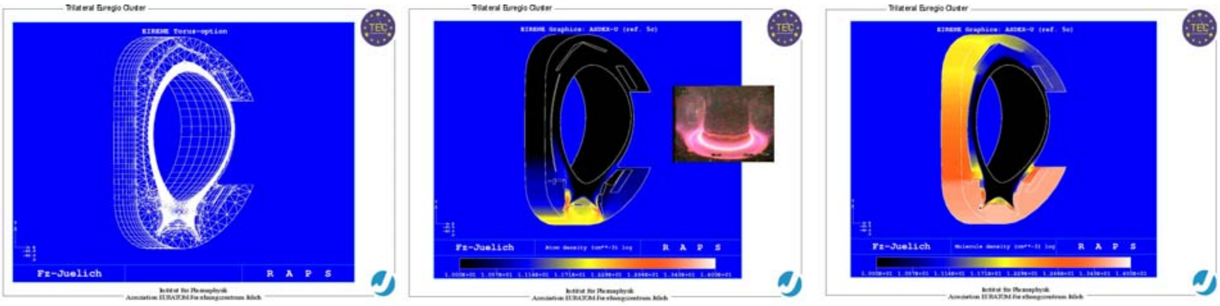


Figure 1: typical toroidal section of 2D divertor configuration, a) triangular grid, b) H atom density (cm^{-3}), c) H2 molecule density (cm^{-3})

Spatial discretisation of multiply connected domains with a high degree of flexibility is a crucial ingredient of this method, but, of course, has applications in many other areas of computational physics and engineering as well.
Finite element (triangular) discretisation schemes appear to be most adequate for two dimensional problems, although the Monte Carlo procedure mentioned above is independent from the particular underlying discretisation scheme.
A finite element mesh generator has been developed and is described here, which permits discretisation of general multiply connected two dimensional bounded domains, with the boundaries, internal and external, specified by a set of closed polygons.
The resulting triangulation is no Delaunay-triangulation, but it can easily be converted to a Delaunay-triangulation. As it is not necessary for our needs we spared the expense.
Our method is based on earlier work by H.Greza, RWTH Aachen (ref /2/) Since this work appears to be available neither in accessible literature nor in english language, we describe here, for reference purposes, the algorithm, our code and its usage.
In order to resolve steep spatial gradients, locally refined meshes are required in most practical applications. Adaptive mesh refinement options would be a further useful tool, but are not described in this report, as they can easily be added to a post-processor for the code described here. We have, however, generalised the algorithm of ref /2/ insofar, as we permit a spatially continuously varying grid size, defined by an external, user supplied (hence:

problem specific) spatial function g(x,y). Here g is the characteristic side length of a triangle near the point (x,y).

The numerical method, as well as the required input information and the output of the code are described in the next section.
Thereafter we give a program description in technical terms. The next section, then, is the user manual detailing the usage of the code. The interface to the EIRENE code, for the specific application to non-linear neutral gas (more generally: Boltzmann-equation for transition flow regime) problems in BGK-approximation is described in the next section. Reference is made there to the EIRENE code user manual /3/. Any reader not interested in this particular application may skip that section.
Finally a few examples, together with the corresponding input information, are given.

3 Solution, Constants and Variables

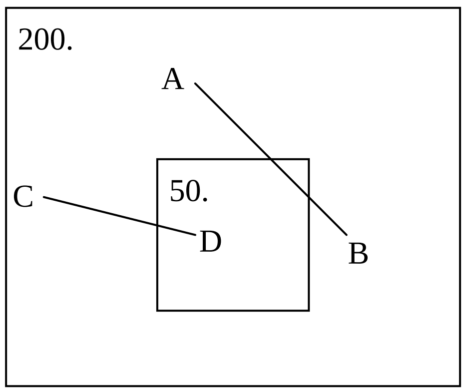
3.1 Solution Method

For the generation of a triangular mesh for a general two dimensional bounded domain G one has to provide information about both the boundaries of the region to be “triangulated” and the desired size of triangles. The boundary δG of the working region G is specified by a number of closed oriented polygons. The size of the triangles is determined by a characteristic side length. Calculation of equilateral triangles with that side length is attempted, where possible (for details see section 5.1).

The desired side length DELPOIN for triangles is read in first. As pointed out already in the introduction, our code permits an arbitrary spatially dependent mesh size. The spatial function g(x,y) mentioned there is a characteristic side length. The algorithm requires knowledge of the minimum of g along any straight line segment $(x,y)_1$--$(x,y)_2$ inside the closed domain $\overline{G}=G+\delta G$ (i.e., including the boundary).

If no such function DELPOIN_G(X_1,Y_1,X_2,Y_2) is specified, then either g=DELPOIN (=constant) or, optionally, specific rectangular regions may by specified with different values of DELPOIN. For any point (x,y) in the domain not covered by one of these extra regions the default g(x,y)=DELPOIN is used.

Next, boundaries of the region to be triangulated have to be specified. The outmost boundary is a closed polygon defined by points (x_i,y_i), i=1,n. The orientation along the polygon is determined by the increasing label i. The domain is on the left of the polygon. Internal regions to be excluded from triangulation are simply specified by further closed polygons with opposite orientation. If any of these boundary segments are longer than the desired side length of the triangles, these segments are split into two equal pieces. This is repeated until there is no boundary part longer than (the local) DELPOIN. If a particular segment of a polygon belongs to two or more regions with different values of desired side lengths, then its assigned value of DELPOIN is calculated as the minimum of the desired side lengths of the regions containing the starting point and the end point of the boundary part (see Figure 2).



DELPOIN = 200. for $\overline{AB}$
DELPOIN = 50. for $\overline{CD}$

Figure 2: Calculation of DELPOIN

Now grid generation is started, using a frontier of grid sides which gradually moves into the domain. At the beginning the frontier consists of all boundaries. If a triangle is build up, the frontier changes. At any time the frontier completely surrounds the regions still to be triangulated. Each frontier part becomes a triangle side in the final grid.
To prevent the overlapping of regions with small triangles by bigger triangles, it is necessary to start the triangulation with small triangles. A frontier list consisting of all boundary polygon segments is created.
Then the shortest frontier-part of the frontier-list is used and becomes the base-side of the triangle to be generated.
The construction of the new triangle is done as described below:
First the optimal position of the 3rd vertex C of the triangle is calculated. Calculation of equilateral triangles is attempted. However, this can not always be realised, e.g. if the difference between base-length (DELBAS) and desired side-length (DELPOIN) is too big. Therefore only isosceles triangles are computed. In this case the length of the leg is calculated by:

$$DELTA2 = \begin{cases} DELPOIN & for\ 0.55 \cdot DELBAS \leq DELPOIN \leq 1.5 \cdot DELBAS \\ 0.55 \cdot DELBAS & for\ 0.55 \cdot DELBAS > DELPOIN \\ 1.5 \cdot DELBAS & for\ 1.5 \cdot DELBAS < DELPOIN \end{cases}$$

Vertex C is always left of vertices A and B if the base is considered to run from A to B. It can be suggestive (if an already existing grid point is nearby C) or necessary to use an already existing grid-point X as 3rd vertex instead of C. To prevent overlapping only points X from the frontier are considered. Therefore a candidate-list is generated.
The conditions for inserting a point into the list are:

- The distance between the candidate and C must be within a certain search-radius, which is 3 x DELBAS initially. If no grid point lies within this radius and if C is outside the region to be triangulated, the search radius is enhanced in steps of 0.5 x DELBAS.
- The candidate must lie left of the base-side of the triangle.

If the candidate-list remains empty or if the candidate points are unsuitable, C is added to the list. A candidate-point is suitable, if the distances between A and C and between A and B are smaller than 1.5 x DELTA2 and the distance between C and the candidate is smaller than DELTA2.
The candidates are sorted by increasing distances to C. Then the first point fulfilling the following conditions is selected:

- To prevent overlapping no other grid point should be positioned inside the triangle. To this end only the frontier parts must be tested.
- No frontier part (except the base line of the triangle) is allowed to cross the median starting from the tested vertex.

If no vertex is found, the search-radius is increased and the search repeated.

After successful searching for the 3rd vertex of the new triangle the node-list (labelled list of co-ordinates of the triangles) and element-list (labelled list of triangles) are updated. If C was selected, its co-ordinates are added to the node-list. For each new triangle the indices of the vertices are stored counter clockwise in the element-list.
The frontier-list is updated as follows:

- The previously considered frontier-part is eliminated.

- If C was selected, two frontier-parts ($\overline{AC}$ from the starting point A of the previously considered frontier-part to C and $\overline{CB}$ from C to the end point B of the previously considered part) are added.
- If an existing grid point X was selected instead of C, it is necessary to test if a frontier-part with reverse direction is already part of the frontier. In this case this frontier part $\overline{XA}$ or $\overline{BX}$ must be deleted, otherwise the triangle-side is added to the frontier-part. Under consideration of the direction this is valid for both new triangle-sides.

Then a new triangle is generated with the next frontier-part.

After processing all frontier-parts, the complete grid of triangles is generated.

Subsequently, characteristics for neighbouring triangles are tested. To this end the element-list is considered. For each triangle side one looks for a triangle in the element-list containing a side with the same vertex-numbers but in reverse order. The element number and the side number of the adjacent triangle are stored. If no adjacent triangle can be found the triangle-side is part of a boundary $\partial G = \bigcup_i P_i$. (This is checked.) The boundary number i.e., the number i of the polygon P_i is then saved.

Finally, the results are plotted and an element and co-ordinate dataset is generated.

3.2 Defined Variables

The most important variables are defined in modules

Module **CCANDI**

icandi(:)	:	INTEGER List of possible points (candidate list)
ncandi	:	INTEGER Total number of possible points

Module **CDELTA**

delta0	:	DOUBLE PRECISION Size of triangle, constant, input variable
delta2	:	DOUBLE PRECISION Length of triangle sides, calculated from DELPOIN and DELBAS
delbas	:	DOUBLE PRECISION Base length of a triangle

Module **CELM**

ielm(3,:)	:	INTEGER Definition of triangles by node-numbers ielm(i,j): co-ordinate number of vertex i for triangle j
nelm	:	INTEGER Total number of triangles
iadja(3,:)	:	INTEGER Matrix contains indices of neighbouring triangles
iside(3,:)	:	INTEGER Adjacent side of neighbouring triangle
iprop(3,:)	:	INTEGER 0 if there is an adjacent triangle, otherwise value depends on index of boundary

Module **CFRONT**

delfro(:)	:	DOUBLE PRECISION Length of frontier parts
ifront(2,:)	:	INTEGER List of frontier parts ifront(1,*) : starting point of frontier part ifront(2,*) : end point of frontier part
npartfr	:	INTEGER Total number of frontier parts

Module **CPOIN**

x(:)	:	DOUBLE PRECISION x-co-ordinates of boundaries
y(:)	:	DOUBLE PRECISION y-co-ordinates of boundaries
xa(2), xb(2), xc(2)	:	DOUBLE PRECISION x- and y-co-ordinates of triangle vertices
nodcon(2)	:	DOUBLE PRECISION co-ordinates of 3rd vertex
npoin	:	INTEGER Total number of points
ia, ib, ic	:	INTEGER Indices of points

inodcon	:	INTEGER Index of 3rd vertex
nfront	:	INTEGER Total number of frontiers
ikont(:)	:	INTEGER Total number of points for each frontier

Module **CREG**

xadel, yadel	:	DOUBLE PRECISION co-ordinates of starting point of a frontier part
xedel, yedel	:	DOUBLE PRECISION co-ordinates of end point of a frontier part
delpoin	:	DOUBLE PRECISION Maximal length of a frontier part (can be changed by region)
delx	:	DOUBLE PRECISION width of a region
dely	:	DOUBLE PRECISION height of a region
ireg	:	INTEGER Loop index over regions
nreg	:	INTEGER Total number of regions

4 Structure of Program and Dependency of Modules

4.1 Hierarchy of Subroutine and Function calls

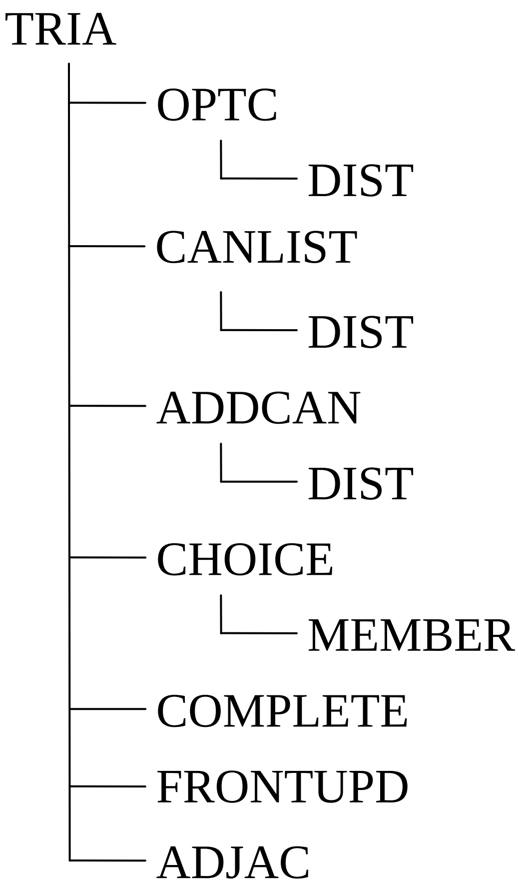


Figure 3: Hierarchy of Subroutines

4.2 List of Program Units

4.2.1 Main Program TRIA

First the main program TRIA reads the input data for the desired side lengths of the triangles. Then the boundaries are read in and refined if necessary. The frontier is constructed from all boundaries. In a next step the frontier parts are treated in a loop. To this end in each cycle the shortest frontier part is searched. Calculation of the optimal vertex C, creation of the candidate list, eventually adding point C to the candidate list, searching for the third vertex of the triangle and update of the element-, node- and frontier part list is done for this frontier part.
After all frontier parts are worked out a grid is constructed from the calculated triangles, i.e. the neighbouring triangles are searched for. Finally the calculated grid is plotted and printed out.

Needed Modules

CPOIN
CFRONT
CCANDI
CELM
CDELTA
CREG

Called Procedures

OPTC
CANLIST
ADDCAN
CHOICE
COMPLETE
FRONTUPD
ADJAC

- input of global triangle side length and regions with locally defined side lengths
- input of total number of boundaries
- for all boundaries
  - input of co-ordinates of the actual boundary (first and last point must be equal)
  - add actual boundary to frontier, calculation of length of frontier parts, computation of desired length of frontier parts, split frontier part if it is longer
- (loop)
  - sort of the frontier parts from longest to shortest
  - actual frontier part is last frontier part in the list (i. e. shortest frontier part)
  - compute the best third vertex C of the triangle with the actual frontier part as base line (OPTC)
  - create a list with existing grid points as possible third vertex of the triangle (CANLIST)
  - add point C to candidate list if necessary and possible (ADDCAN)
  - select the triangle vertex from candidate list (CHOICE)
  - update the element- and node list (COMPLETE)
  - update the list of frontier parts
- repeat until no frontier parts are left
- construct the grid from calculated triangles (ADJAC)
- graphical output of the grid
- output of co-ordinate dataset
- output of element and neighbor dataset

Figure 4: Nassi-Shneiderman-diagram of main program TRIA

4.2.2 Function DIST

This function calculates the distance between points x and y.

Input-Variables

x1	:	DOUBLE PRECISION x-co-ordinate of point x
x2	:	DOUBLE PRECISION y-co-ordinate of point x
y1	:	DOUBLE PRECISION x-co-ordinate of point y
y2	:	DOUBLE PRECISION y-co-ordinate of point y

Output-Variables

DIST	:	DOUBLE PRECISION Distance between point x and point y

Called Procedures

none

4.2.3 Function MEMBER

This function tests if point xp is inside the triangle limited by vertices xk1, xk2 and xk3.

Input-Variables

xp(2)	:	DOUBLE PRECISION co-ordinate of the point to be tested
xk1(2), xk2(2), xk3(2)	:	DOUBLE PRECISION co-ordinates of the vertices of the triangle

Output-Variables

MEMBER	:	LOGICAL indicates if xp is inside the triangle

Called Procedures

none

4.2.4 Subroutine OPTC

This subroutine calculates the optimal position for a new grid point starting from a frontier part (base line of the new triangle).

Needed Modules

CPOIN
CDELTA
CREG

Called Procedures

DIST

4.2.5 Subroutine CANLIST

This subroutine searches grid points near point C and adds these points to the candidate list.

Input-Variables

FRAD	:	DOUBLE PRECISION search radius
EPSANG	:	DOUBLE PRECISION minimal inner angle to avoid triangles degenerate to a line

Needed Modules

CPOIN
CFRONT
CCANDI
CDELTA

Called Procedures

DIST

4.2.6 Subroutine ADDCAN

If no suitable candidate was found in subroutine CANLIST point C is added to the candidate list.

Needed Modules

CPOIN
CCANDI
CDELTA

Called Procedures

DIST

4.2.7 Subroutine CHOICE

This subroutine selects the third vertex from the candidate list if possible.

Output-Variables

FOUND	:	LOGICAL indicates if the third triangle point was found

Needed Modules

CPOIN
CFRONT
CCANDI

Called Procedures

MEMBER

4.2.8 Subroutine COMPLETE

This subroutine updates the node-list and the element-list.

Needed Modules

CPOIN
CELM
CFRONT

Called Procedures

none

4.2.9 Subroutine FRONTUPD

This subroutine updates the frontier.

Needed Modules

CPOIN
CFRONT
CDELTA
CELM
CREG

Called procedures

DIST

4.2.10 Subroutine ADJAC

This subroutine constructs the grid from the calculated triangles.

Needed Modules

CPOIN
CELM

Called procedures

none

5 How to use the program

5.1 Description of Input Data

Program TRIA reads input-data from a dataset with unit-number 2. This dataset must have the following form:
In the first line a real number indicates the desired side-length of the triangles. It is possible to define rectangular regions of the grid where other side lengths can be used in the following lines. Each region is defined in one line and is given by a rectangle defined by minimal and maximal co-ordinates. Five real numbers separated by at least one blank are needed for this definition. The meaning of the real numbers is respectively:

- minimum x-value
- minimum y-value
- maximal x-value
- maximal y-value
- desired side-length

A blank line at the end is used to end the input of different regions.

Afterwards the boundaries of the region to be triangulated are specified. The input for each boundary is defined in an input-block with the following sequence of lines:
In the first line the number of points (n) of this boundary is given. Each of the following n lines contains one point of the boundary, x- and y-value separated by at least one blank. The first and last co-ordinate must be equal to describe a closed boundary.
The direction of the boundary has to be obeyed, outer boundaries must be given counter-clockwise, inner boundaries (holes in the region to be triangulated) clockwise, because the triangulation is performed left of the boundary.
The input-blocks for the different boundaries are **not** separated by blank lines.

Example:

```
1.5
1.5 8. 3.5 10. 0.5

18
0.   3.
0.3  1.7
1.5  1.1
3.   0.9
4.8  1.3
6.1  2.1
7.1  3.2
7.6  4.8
7.3  6.
4.7  8.
4.8  9.2
4.6  9.7
4.   9.8
2.   9.3
0.7  8.
0.7  7.3
1.2  6.
```

0. 15	3.
1.6	3.2
2.	4.5
3.	5.7
3.6	5.7
4.2	5.4
5.3	5.3
5.7	4.9
6.	4.2
5.9	3.5
5.4	2.9
4.5	2.8
3.9	3.1
3.	2.8
2.	2.6
1.6	3.2

5.2 Description of Output Data

If the input data are correct the program TRIA creates three datasets, the first one containing the co-ordinates of the grid points, the second one defining the elements (triangles) of the grid and the third specifying the neighbourhood relationships. Furthermore a plot of the grid is created by the program.
If an error occurs in program TRIA the program ends with the message 'stop error'. In this case an error-message will be written to standard-output (unit-number 6).

5.2.1 Graphic Output

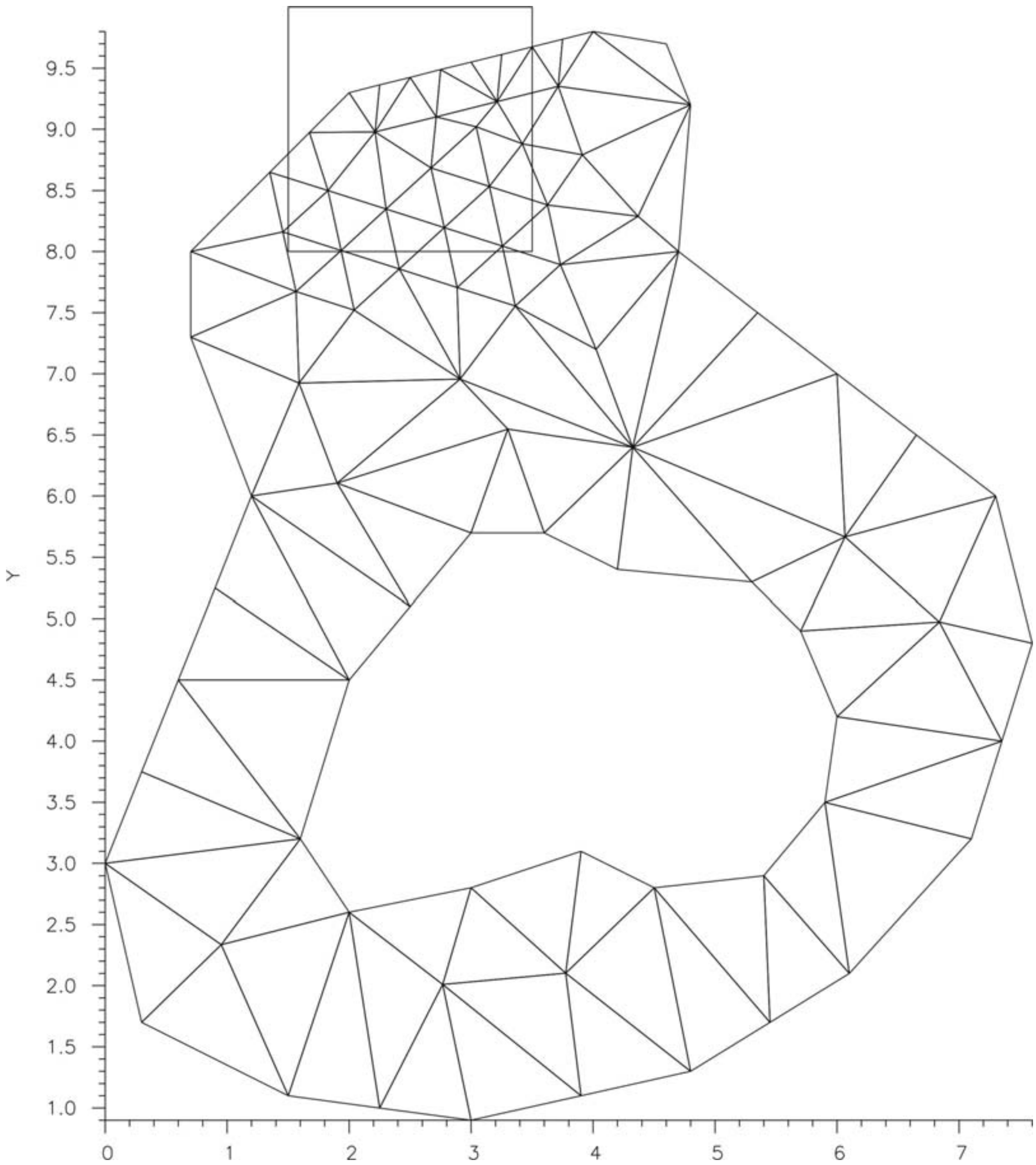


Figure 5: Graphical output

5.2.2 Co-ordinate dataset

The co-ordinates of the grid points are contained in the dataset with the unit-number 23. First the total number of grid points is given. In the following all x co-ordinates and then all y co-ordinates of the grid points are written.

Example:

```
 85
  0.000000000E+00  3.000000000E-01  1.500000000E+00  3.000000000E+00
  4.800000000E+00  6.100000000E+00  7.100000000E+00  7.600000000E+00
  7.300000000E+00  4.700000000E+00  4.800000000E+00  4.600000000E+00
  4.000000000E+00  2.000000000E+00  7.000000000E-01  7.000000000E-01
  1.200000000E+00  2.250000000E+00  3.900000000E+00  5.450000000E+00
  7.350000000E+00  6.000000000E+00  6.650000000E+00  3.000000000E+00
  3.500000000E+00  3.750000000E+00  1.350000000E+00  1.675000000E+00
  6.000000000E-01  9.000000000E-01  5.350000000E+00  2.500000000E+00
  2.750000000E+00  3.250000000E+00  3.000000000E-01  2.250000000E+00
  1.600000000E+00  2.000000000E+00  3.000000000E+00  3.600000000E+00
  4.200000000E+00  5.300000000E+00  5.700000000E+00  6.000000000E+00
  5.900000000E+00  5.400000000E+00  4.500000000E+00  3.900000000E+00
  3.000000000E+00  2.000000000E+00  2.500000000E+00  2.213388348E+00
  3.213388348E+00  2.713388348E+00  3.713388348E+00  1.826496417E+00
  1.457048463E+00  1.933544880E+00  1.564096925E+00  2.040593343E+00
  2.410041297E+00  2.302992834E+00  2.779489252E+00  2.672440789E+00
  3.148937206E+00  3.255985669E+00  3.041888743E+00  1.588096846E+00
  2.886537714E+00  3.363034131E+00  2.910537635E+00  3.732482086E+00
  4.024220508E+00  3.625433623E+00  3.420196703E+00  4.369668542E+00
  3.911852271E+00  6.065685425E+00  3.300000000E+00  4.324264069E+00
  3.775735931E+00  9.514718626E-01  2.766421356E+00  6.839949494E+00
  1.901471863E+00
  3.000000000E+00  1.700000000E+00  1.100000000E+00  9.000000000E-01
  1.300000000E+00  2.100000000E+00  3.200000000E+00  4.800000000E+00
  6.000000000E+00  8.000000000E+00  9.200000000E+00  9.700000000E+00
  9.800000000E+00  9.300000000E+00  8.000000000E+00  7.300000000E+00
  6.000000000E+00  1.000000000E+00  1.100000000E+00  1.700000000E+00
  4.000000000E+00  7.000000000E+00  6.500000000E+00  9.550000000E+00
  9.675000000E+00  9.737500000E+00  8.650000000E+00  8.975000000E+00
  4.500000000E+00  5.250000000E+00  7.500000000E+00  9.425000000E+00
  9.487500000E+00  9.612500000E+00  3.750000000E+00  9.362500000E+00
  3.200000000E+00  4.500000000E+00  5.700000000E+00  5.700000000E+00
  5.400000000E+00  5.300000000E+00  4.900000000E+00  4.200000000E+00
  3.500000000E+00  2.900000000E+00  2.800000000E+00  3.100000000E+00
  2.800000000E+00  2.600000000E+00  5.100000000E+00  8.977696609E+00
  9.227696609E+00  9.102696609E+00  9.352696609E+00  8.498503583E+00
  8.161593789E+00  8.010097372E+00  7.673187579E+00  7.521691161E+00
  7.858600955E+00  8.347007166E+00  8.195510748E+00  8.683916959E+00
  8.532420542E+00  8.044014331E+00  9.020826753E+00  6.923571674E+00
  7.707104538E+00  7.555608121E+00  6.957488634E+00  7.892517914E+00
  7.201584710E+00  8.380924125E+00  8.881724615E+00  8.288110407E+00
  8.790758675E+00  5.665685425E+00  6.548528137E+00  6.398528137E+00
  2.101471863E+00  2.334314575E+00  2.010660172E+00  4.974264069E+00
  6.107106781E+00
```

5.2.3 Element dataset

In the first line in unit 24 (element dataset) the total number of triangles is given. Then one line with 4 integer values for each triangle is written.

Column	**Description**
1	index of triangle
2	co-ordinate number of first vertex of triangle
3	co-ordinate number of second vertex of triangle
4	co-ordinate number of third vertex of triangle

Example:

```
 119
    1       36      14      52
    2       34      24      53
    3       33      32      54
    4       32      36      52
    5       26      25      55
    6       25      34      53
    7       24      33      53
    8       13      26      55
    9       55      25      53
   10       54      32      52
   11       33      54      53
   12       52      14      28
   13       28      27      56
   14       56      27      57
   15       28      56      52
   16       56      57      58
   17       58      57      59
   18       59      57      15
   19       58      59      60
   20       58      60      61
   21       58      61      62
   22       58      62      56
   23       56      62      52
   24       62      61      63
   25       62      63      64
   26       64      63      65
   27       65      63      66
   28       62      64      52
   29       64      65      67
   30       60      59      68
   31       66      63      69
   32       66      69      70
   33       70      69      71
   34       66      70      72
   35       69      63      61
   36       69      61      71
   37       72      70      73
   38       66      72      74
   39       66      74      65
   40       64      67      54
   41       54      67      53
   42       53      67      75
   43       75      67      65
```

44	53	75	55
45	64	54	52
46	75	65	74
47	74	72	76
48	61	60	71
49	57	27	15
50	13	55	11
51	11	12	13
52	75	74	77
53	75	77	55
54	77	74	76
55	42	43	78
56	55	77	11
57	39	40	79
58	40	41	80
59	47	48	81
60	77	76	11
61	15	16	59
62	44	45	21
63	50	37	82
64	72	73	10
65	70	71	80
66	73	70	80
67	68	59	16
68	60	68	71
69	76	72	10
70	76	10	11
71	18	4	83
72	3	18	50
73	43	44	84
74	20	6	46
75	5	20	47
76	51	39	85
77	45	46	6
78	38	51	17
79	35	1	37
80	30	29	38
81	29	35	37
82	17	30	38
83	31	10	80
84	23	22	78
85	22	31	80
86	9	23	78
87	21	8	84
88	84	8	9
89	7	21	45
90	42	78	80
91	78	43	84
92	73	80	10
93	39	79	85
94	79	40	80
95	46	47	20
96	19	5	81
97	4	19	83
98	48	49	81
99	68	16	17
100	68	17	85
101	85	17	51
102	68	85	71
103	47	81	5
104	80	41	42
105	19	81	83
106	83	81	49
107	83	49	50
108	83	50	18

```
  109        79     80     71
  110        79     71     85
  111        78     84      9
  112        82     37      1
  113        50     82      3
  114        21     84     44
  115        82      1      2
  116        82      2      3
  117         7     45      6
  118        78     22     80
  119        37     38     29
```

5.2.4 Neighbour dataset

In the first line in unit 25 (neighbour dataset) the total number of triangles is given. Then one line with 10 integer values for each triangle is written.

Column	Description
1	index of triangle
2	index of triangle adjacent to the first triangle side
3	number of the side of adjacent triangle to the first triangle side
4	0 if an adjacent triangle to the first triangle side exists, otherwise number of boundary
5	index of triangle adjacent to the second triangle side
6	number of the side of adjacent triangle to the second triangle side
7	0 if an adjacent triangle to the second triangle side exists, otherwise number of boundary
8	index of triangle adjacent to the third triangle side
9	number of the side of adjacent triangle to the third triangle side
10	0 if an adjacent triangle to the third triangle side exists, otherwise number of boundary

Example:

```
119
    1         0  0 -1      12  1  0       4  2  0
    2         0  0 -1       7  3  0       6  2  0
    3         0  0 -1      10  1  0      11  1  0
    4         0  0 -1       1  3  0      10  2  0
    5         0  0 -1       9  1  0       8  2  0
    6         0  0 -1       2  3  0       9  2  0
    7         0  0 -1      11  3  0       2  2  0
    8         0  0 -1       5  3  0      50  1  0
    9         5  2  0       6  3  0      44  3  0
   10         3  2  0       4  3  0      45  2  0
   11         3  3  0      41  3  0       7  2  0
   12         1  2  0       0  0 -1      15  3  0
   13         0  0 -1      14  1  0      15  1  0
   14        13  2  0      49  1  0      16  1  0
   15        13  3  0      23  3  0      12  3  0
   16        14  3  0      17  1  0      22  3  0
   17        16  2  0      18  1  0      19  1  0
```

18	17	2	0	49	3	0	61	3	0
19	17	3	0	30	1	0	20	1	0
20	19	3	0	48	1	0	21	1	0
21	20	3	0	24	1	0	22	1	0
22	21	3	0	23	1	0	16	3	0
23	22	2	0	28	3	0	15	2	0
24	21	2	0	35	2	0	25	1	0
25	24	3	0	26	1	0	28	1	0
26	25	2	0	27	1	0	29	1	0
27	26	2	0	31	1	0	39	3	0
28	25	3	0	45	3	0	23	2	0
29	26	3	0	43	2	0	40	1	0
30	19	2	0	67	1	0	68	1	0
31	27	2	0	35	1	0	32	1	0
32	31	3	0	33	1	0	34	1	0
33	32	2	0	36	3	0	65	1	0
34	32	3	0	37	1	0	38	1	0
35	31	2	0	24	2	0	36	1	0
36	35	3	0	48	3	0	33	2	0
37	34	2	0	66	1	0	64	1	0
38	34	3	0	47	1	0	39	1	0
39	38	3	0	46	2	0	27	3	0
40	29	3	0	41	1	0	45	1	0
41	40	2	0	42	1	0	11	2	0
42	41	2	0	43	1	0	44	1	0
43	42	2	0	29	2	0	46	1	0
44	42	3	0	53	3	0	9	3	0
45	40	3	0	10	3	0	28	2	0
46	43	3	0	39	2	0	52	1	0
47	38	2	0	69	1	0	54	2	0
48	20	2	0	68	3	0	36	2	0
49	14	2	0	0	0	-1	18	2	0
50	8	3	0	56	3	0	51	3	0
51	0	0	-1	0	0	-1	50	3	0
52	46	3	0	54	1	0	53	1	0
53	52	3	0	56	1	0	44	2	0
54	52	2	0	47	3	0	60	1	0
55	0	0	-2	91	1	0	90	1	0
56	53	2	0	60	3	0	50	2	0
57	0	0	-2	94	1	0	93	1	0
58	0	0	-2	104	1	0	94	2	0
59	0	0	-2	98	3	0	103	1	0
60	54	3	0	70	3	0	56	2	0
61	0	0	-1	67	2	0	18	3	0
62	0	0	-2	89	2	0	114	3	0
63	0	0	-2	112	1	0	113	1	0
64	37	3	0	92	3	0	69	2	0
65	33	3	0	109	2	0	66	2	0
66	37	2	0	65	3	0	92	1	0
67	30	2	0	61	2	0	99	1	0
68	30	3	0	102	3	0	48	2	0
69	47	2	0	64	3	0	70	1	0
70	69	3	0	0	0	-1	60	2	0
71	0	0	-1	97	3	0	108	3	0
72	0	0	-1	108	2	0	113	3	0
73	0	0	-2	114	2	0	91	2	0
74	0	0	-1	77	2	0	95	3	0
75	0	0	-1	95	2	0	103	3	0
76	0	0	-2	93	3	0	101	3	0
77	0	0	-2	74	2	0	117	2	0
78	0	0	-2	101	2	0	82	3	0
79	0	0	-1	112	2	0	81	2	0
80	0	0	-1	119	2	0	82	2	0
81	0	0	-1	79	3	0	119	3	0
82	0	0	-1	80	3	0	78	3	0

83	0	0	-1	92	2	0	85	2	0
84	0	0	-1	118	1	0	86	2	0
85	0	0	-1	83	3	0	118	2	0
86	0	0	-1	84	3	0	111	3	0
87	0	0	-1	88	1	0	114	1	0
88	87	2	0	0	0	-1	111	2	0
89	0	0	-1	62	2	0	117	1	0
90	55	3	0	118	3	0	104	3	0
91	55	2	0	73	3	0	111	1	0
92	66	3	0	83	2	0	64	2	0
93	57	3	0	110	3	0	76	2	0
94	57	2	0	58	3	0	109	1	0
95	0	0	-2	75	2	0	74	3	0
96	0	0	-1	103	2	0	105	1	0
97	0	0	-1	105	3	0	71	2	0
98	0	0	-2	106	2	0	59	2	0
99	67	3	0	0	0	-1	100	1	0
100	99	3	0	101	1	0	102	1	0
101	100	2	0	78	2	0	76	3	0
102	100	3	0	110	2	0	68	2	0
103	59	3	0	96	2	0	75	3	0
104	58	2	0	0	0	-2	90	3	0
105	96	3	0	106	1	0	97	2	0
106	105	2	0	98	2	0	107	1	0
107	106	3	0	0	0	-2	108	1	0
108	107	3	0	72	2	0	71	3	0
109	94	3	0	65	2	0	110	1	0
110	109	3	0	102	2	0	93	2	0
111	91	3	0	88	3	0	86	3	0
112	63	2	0	79	2	0	115	1	0
113	63	3	0	116	3	0	72	3	0
114	87	3	0	73	2	0	62	3	0
115	112	3	0	0	0	-1	116	1	0
116	115	3	0	0	0	-1	113	2	0
117	89	3	0	77	3	0	0	0	-1
118	84	2	0	85	3	0	90	2	0
119	0	0	-2	80	2	0	81	3	0

Part of the Example:

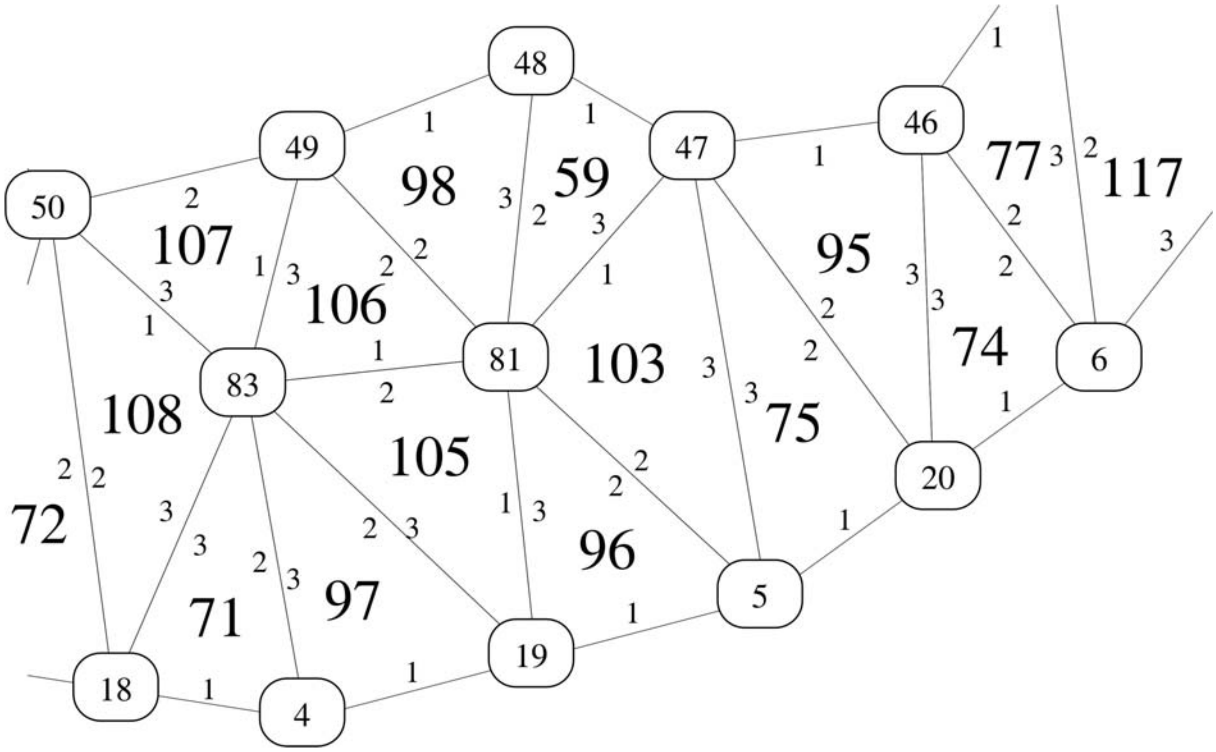


Figure 6: Part of example

5.3 Program Environment and Shell-Scripts

System Environment

Computer	IBM RS/6000	
Operating System	AIX 4.1	
Programming Language	FORTRAN	
Compiler	AIX XL FORTRAN	
Libraries	Graphic-library GR	(developed at KFA-Jülich, public domain)
	Graphic-library GLI-GKS	(developed at KFA-Jülich, public domain)

Compilation

```
xlf -g -q check -q flttrap=ov:zero:inv:en -qextchk
    -bloadmap:log.out -q sigtrap -l gr -l gks -lX11 -lXt
    -o tria
```

Program-Call

```
ln -s textor.input fort.2
./tria
mv fort.23 textor.npco_chr
mv fort.24 textor.elemente
mv fort.25 textor.neighbor
mv gli.eps textor.eps
rm fort.2
```

6 EIRENE-Interface

6.1 Producing an input-dataset for TRIA using EIRENE

It is possible to produce a TRIA-input-dataset for a 2-D geometry using EIRENE. Therefore each surface belonging to a frontier in TRIA has to be marked by flag 'ILPLG' in EIRENE-input. Only EIRENE surfaces described as straight lines can become part of TRIA-frontier. These lines may be part of the regular grid or additionally defined structures.
'ILPLG' has to be defined as a positive or negative number specifying the direction and the number of the boundary. A positive number indicates that the contour has clockwise direction, a negative number that the contour has counter clockwise direction. All parts of one boundary must have the same number.
Eirene writes the average length of boundary parts as desired side-length of the triangles. Then for each frontier the number of points and the co-ordinates are written by EIRENE to unit 78 thus defining an input-dataset for TRIA.

6.2 Using a TRIA-Output as input for EIRENE

Besides providing a TRIA output as grid definition for EIRENE several changes to the EIRENE input-file have to be made. Additionally a subroutine called 'infcop' is needed for reading the grid-input and setting the appropriate EIRENE arrays.

In input-block 2a

Variable	Value	Comment
'NLFEM'	.true.	triangle mesh
'INDGRD(1)'	6	input of grid in 'infcop' 'infcop' is a user-defined subroutine
'NR1ST'	total number of triangles	
'NRKNOT'	total number of co-ordinates	
'NRTRI'	total number of triangles	

In input-block 3

Cases	Action	Comment
if grid is only tria-output	delete all surfaces with 'ILPLG' ≠ 0	all surfaces with 'ILPLG' ≠ 0 are part of the triangulated mesh
if grid is combination of tria-output and triangulated braams grid	delete cuts	inside a triangular mesh there are no cuts
	surfaces with 'ILPLG' ≠ 0 have to remain unchanged	they are used to specify the reflection model for the appropriate triangle sides

In input-block 5

Cases	Action		Comment
if grid is only tria-output	2 possibilities	1) 'INDPRO' = 3 set values for plasma profiles	constant plasma profiles
		2) 'INDPRO' = 5 set values	plasma profiles via user defined subroutine
if grid is combination of tria-output and triangulated braams grid	'INDPRO' = 6		plasma file written by braams is read in

In input-block 7

Cases	Action	Comment
if grid is only tria-output	define sources	only point sources are available
if grid is combination of tria-output and triangulated braams grid	no changes have to be made	

7 Examples

7.1 ITERG

Input Dataset

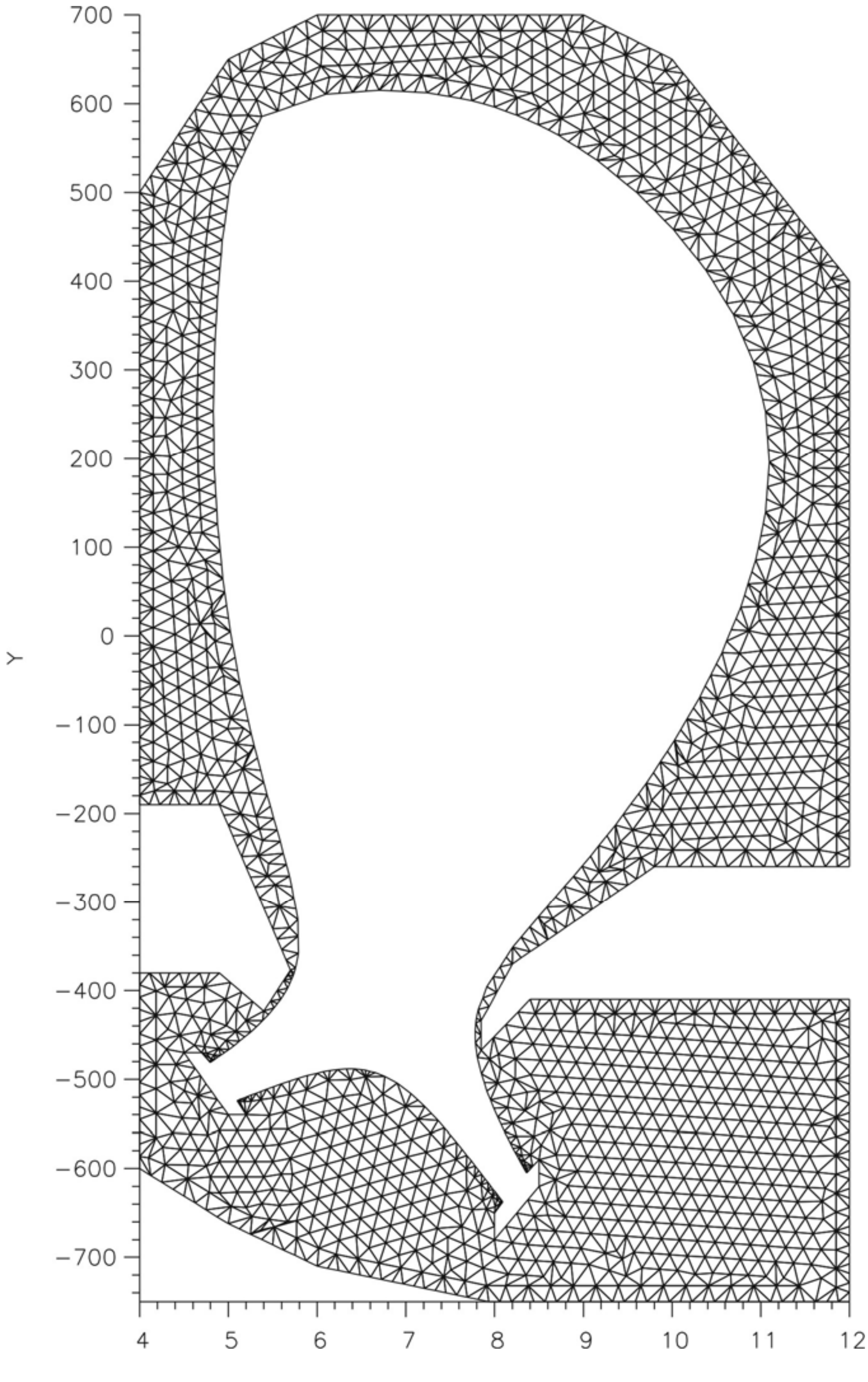
```
 10.
 800. 0.    1200. 750. 10.

 26
    4.0000E+02   -6.0000E+02
    5.0000E+02   -6.6209E+02
    6.0000E+02   -7.0980E+02
    7.9344E+02   -7.5000E+02
    1.2000E+03   -7.5000E+02
    1.2000E+03   -4.1000E+02
    8.4000E+02   -4.1000E+02
    7.8500E+02   -4.6700E+02
    7.8500E+02   -4.3400E+02
    8.2000E+02   -3.7000E+02
    9.8000E+02   -2.6000E+02
    1.2000E+03   -2.6000E+02
    1.2000E+03    4.0000E+02
    1.0000E+03    6.5000E+02
    9.0000E+02    7.0000E+02
    8.0000E+02    7.0000E+02
    6.0000E+02    7.0000E+02
    5.0000E+02    6.5000E+02
    4.0000E+02    5.0000E+02
    4.0000E+02   -1.9000E+02
    4.9000E+02   -1.9000E+02
    5.7000E+02   -3.7700E+02
    5.4000E+02   -4.2300E+02
    4.9000E+02   -3.8000E+02
    4.0000E+02   -3.8000E+02
    4.0000E+02   -6.0000E+02
 155
    5.2000E+02   -5.4000E+02
    5.0000E+02   -5.4000E+02
    4.5000E+02   -4.7000E+02
    4.7000E+02   -4.7000E+02
    4.7943E+02   -4.8119E+02
    4.8013E+02   -4.8073E+02
    4.8116E+02   -4.8003E+02
    4.8270E+02   -4.7898E+02
    4.8486E+02   -4.7750E+02
    4.8771E+02   -4.7552E+02
    4.9127E+02   -4.7302E+02
    4.9555E+02   -4.6996E+02
    5.0054E+02   -4.6631E+02
    5.0618E+02   -4.6206E+02
    5.1245E+02   -4.5717E+02
    5.1862E+02   -4.5215E+02
    5.2515E+02   -4.4659E+02
    5.3189E+02   -4.4050E+02
    5.3869E+02   -4.3393E+02
    5.4534E+02   -4.2693E+02
```

5.5163E+02	-4.1963E+02
5.5554E+02	-4.1464E+02
5.5909E+02	-4.0970E+02
5.6293E+02	-4.0380E+02
5.6669E+02	-3.9722E+02
5.6950E+02	-3.9157E+02
5.7160E+02	-3.8672E+02
5.7294E+02	-3.8327E+02
5.7408E+02	-3.7998E+02
5.7576E+02	-3.7439E+02
5.7892E+02	-3.5801E+02
5.7845E+02	-3.1952E+02
5.6899E+02	-2.7072E+02
5.5492E+02	-2.1872E+02
5.3987E+02	-1.6508E+02
5.2561E+02	-1.1001E+02
5.1294E+02	-5.3307E+01
5.0236E+02	4.6675E+00
4.9396E+02	6.4519E+01
4.8789E+02	1.2613E+02
4.8425E+02	1.8930E+02
4.8308E+02	2.5357E+02
4.8434E+02	3.1825E+02
4.8780E+02	3.8253E+02
4.9326E+02	4.4606E+02
5.0199E+02	5.1077E+02
5.3752E+02	5.8540E+02
6.0997E+02	6.1050E+02
6.6985E+02	6.1516E+02
7.2366E+02	6.1254E+02
7.7439E+02	6.0354E+02
8.0009E+02	5.9621E+02
8.2509E+02	5.8712E+02
8.4929E+02	5.7637E+02
8.7215E+02	5.6438E+02
9.1596E+02	5.3615E+02
9.6048E+02	4.9988E+02
1.0018E+03	4.5817E+02
1.0385E+03	4.1222E+02
1.0690E+03	3.6236E+02
1.0918E+03	3.0890E+02
1.1055E+03	2.5292E+02
1.1098E+03	1.9609E+02
1.1055E+03	1.3992E+02
1.0942E+03	8.5274E+01
1.0774E+03	3.2400E+01
1.0561E+03	-1.8876E+01
1.0311E+03	-6.8835E+01
1.0027E+03	-1.1776E+02
9.7104E+02	-1.6582E+02
9.3618E+02	-2.1309E+02
8.9847E+02	-2.5961E+02
8.5894E+02	-3.0550E+02
8.2050E+02	-3.5125E+02
7.9138E+02	-3.9560E+02
7.8174E+02	-4.2115E+02
7.7962E+02	-4.3138E+02
7.7893E+02	-4.3646E+02
7.7826E+02	-4.4565E+02
7.7854E+02	-4.5885E+02
7.8070E+02	-4.7540E+02
7.8511E+02	-4.9398E+02
7.9148E+02	-5.1338E+02
7.9926E+02	-5.3278E+02
8.0344E+02	-5.4221E+02

8.0741E+02	-5.5072E+02
8.1114E+02	-5.5840E+02
8.1461E+02	-5.6534E+02
8.1783E+02	-5.7160E+02
8.2079E+02	-5.7725E+02
8.2352E+02	-5.8235E+02
8.2539E+02	-5.8582E+02
8.2711E+02	-5.8896E+02
8.2867E+02	-5.9179E+02
8.3009E+02	-5.9435E+02
8.3138E+02	-5.9666E+02
8.3255E+02	-5.9875E+02
8.3362E+02	-6.0064E+02
8.3458E+02	-6.0235E+02
8.3546E+02	-6.0389E+02
8.3597E+02	-6.0479E+02
8.5000E+02	-5.9000E+02
8.5000E+02	-6.2000E+02
8.0000E+02	-6.8000E+02
8.0000E+02	-6.5000E+02
8.0910E+02	-6.3745E+02
8.0817E+02	-6.3621E+02
8.0656E+02	-6.3408E+02
8.0478E+02	-6.3173E+02
8.0282E+02	-6.2914E+02
8.0064E+02	-6.2627E+02
7.9824E+02	-6.2310E+02
7.9557E+02	-6.1961E+02
7.9263E+02	-6.1575E+02
7.8936E+02	-6.1148E+02
7.8574E+02	-6.0678E+02
7.8214E+02	-6.0213E+02
7.7815E+02	-5.9700E+02
7.7373E+02	-5.9136E+02
7.6881E+02	-5.8514E+02
7.6334E+02	-5.7832E+02
7.5725E+02	-5.7084E+02
7.5045E+02	-5.6266E+02
7.3616E+02	-5.4621E+02
7.2122E+02	-5.3043E+02
7.0576E+02	-5.1614E+02
6.9035E+02	-5.0454E+02
6.7641E+02	-4.9671E+02
6.6576E+02	-4.9251E+02
6.5946E+02	-4.9114E+02
6.5457E+02	-4.8969E+02
6.4921E+02	-4.8888E+02
6.4175E+02	-4.8826E+02
6.3307E+02	-4.8823E+02
6.2312E+02	-4.8896E+02
6.1433E+02	-4.9018E+02
6.0706E+02	-4.9153E+02
5.9974E+02	-4.9315E+02
5.8902E+02	-4.9592E+02
5.7867E+02	-4.9895E+02
5.6882E+02	-5.0210E+02
5.5956E+02	-5.0525E+02
5.5096E+02	-5.0831E+02
5.4307E+02	-5.1121E+02
5.3662E+02	-5.1363E+02
5.3089E+02	-5.1582E+02
5.2589E+02	-5.1776E+02
5.2163E+02	-5.1942E+02
5.1811E+02	-5.2080E+02
5.1532E+02	-5.2191E+02

```
5.1320E+02   -5.2275E+02
5.1170E+02   -5.2335E+02
5.1069E+02   -5.2374E+02
5.1002E+02   -5.2401E+02
5.2000E+02   -5.4000E+02
```

Graphical Output



7.2 ITERV

Input Dataset

```
 50.
 500. -750. 700. -600. 100.
 600. -700. 650. -500. 20.

 56
    4.0000E+02   -6.0000E+02
    5.0000E+02   -6.6209E+02
    6.0000E+02   -7.0980E+02
    7.9344E+02   -7.5000E+02
    7.9344E+02   -6.1961E+02
    8.0493E+02   -6.3192E+02
    8.0429E+02   -6.3109E+02
    8.0321E+02   -6.2965E+02
    8.0201E+02   -6.2807E+02
    8.0068E+02   -6.2632E+02
    7.9922E+02   -6.2439E+02
    7.9760E+02   -6.2226E+02
    7.9580E+02   -6.1990E+02
    7.9381E+02   -6.1730E+02
    7.9162E+02   -6.1443E+02
    7.8919E+02   -6.1126E+02
    7.8649E+02   -6.0775E+02
    7.8351E+02   -6.0389E+02
    7.8020E+02   -5.9963E+02
    7.7653E+02   -5.9493E+02
    7.7245E+02   -5.8975E+02
    7.6793E+02   -5.8404E+02
    7.6289E+02   -5.7776E+02
    7.5236E+02   -5.6494E+02
    7.4144E+02   -5.5216E+02
    7.3016E+02   -5.3967E+02
    7.0953E+02   -5.1939E+02
    6.8890E+02   -5.0360E+02
    6.7088E+02   -4.9433E+02
    6.5946E+02   -4.9114E+02
    6.4928E+02   -4.8888E+02
    6.3866E+02   -4.8817E+02
    6.2456E+02   -4.8881E+02
    6.0940E+02   -4.9106E+02
    5.9824E+02   -4.9351E+02
    5.8911E+02   -4.9589E+02
    5.8187E+02   -4.9798E+02
    5.7476E+02   -5.0017E+02
    5.6456E+02   -5.0353E+02
    5.5485E+02   -5.0691E+02
    5.4568E+02   -5.1024E+02
    5.3711E+02   -5.1345E+02
    5.2918E+02   -5.1648E+02
    5.2191E+02   -5.1931E+02
    5.1535E+02   -5.2189E+02
    5.0952E+02   -5.2421E+02
    5.0443E+02   -5.2625E+02
    5.0009E+02   -5.2800E+02
    4.9651E+02   -5.2944E+02
    4.9365E+02   -5.3060E+02
    4.9149E+02   -5.3147E+02
```

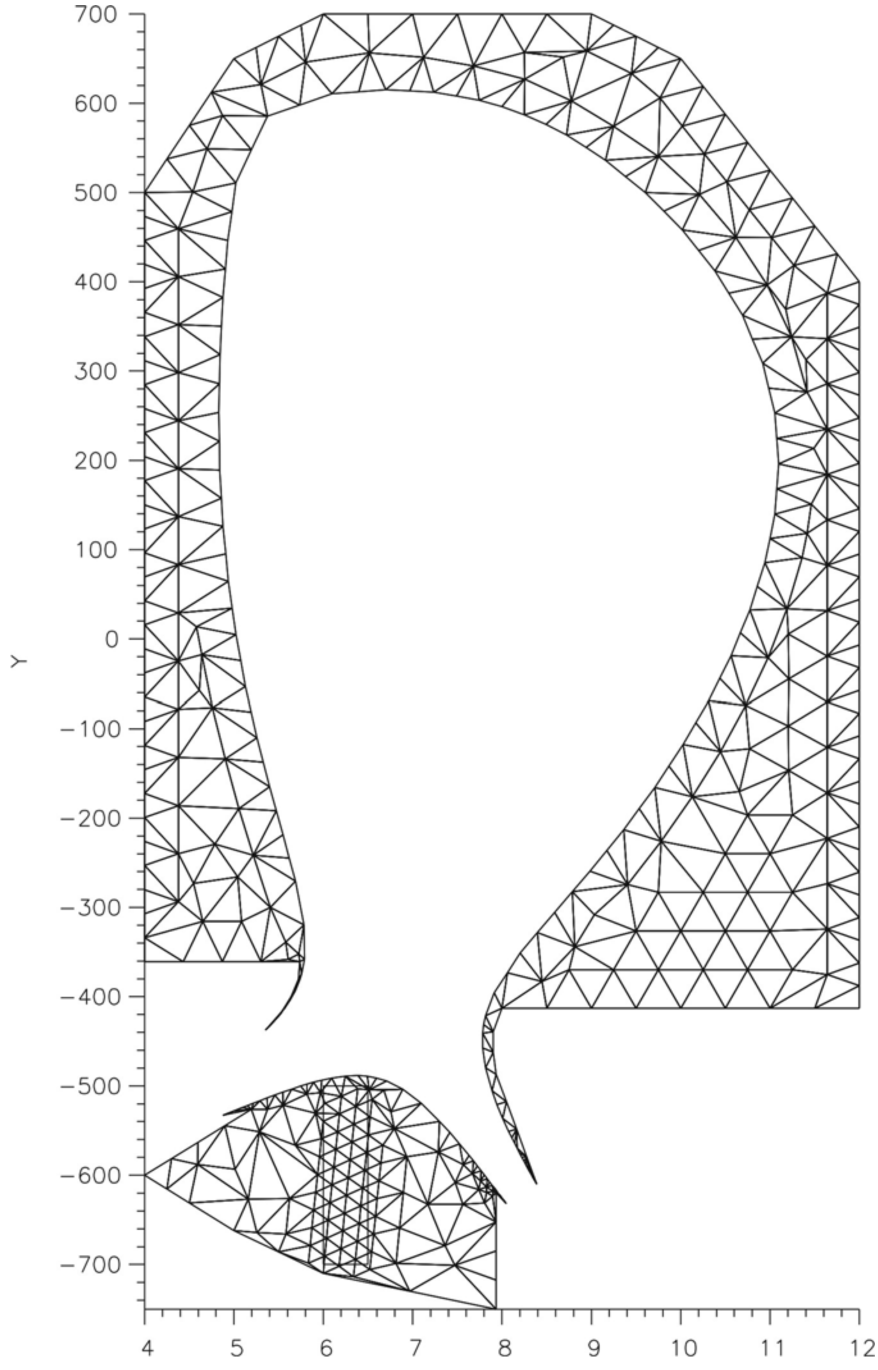
4.8996E+02	-5.3209E+02
4.8894E+02	-5.3251E+02
4.8825E+02	-5.3279E+02
5.1967E+02	-5.2614E+02
4.0000E+02	-6.0000E+02

115

4.0000E+02	-3.6078E+02
5.7377E+02	-3.6078E+02
5.7213E+02	-3.8039E+02
5.6393E+02	-4.0000E+02
5.5410E+02	-4.1634E+02
5.3553E+02	-4.3704E+02
5.3566E+02	-4.3691E+02
5.3586E+02	-4.3672E+02
5.3616E+02	-4.3643E+02
5.3657E+02	-4.3602E+02
5.3712E+02	-4.3548E+02
5.3781E+02	-4.3480E+02
5.3863E+02	-4.3398E+02
5.3960E+02	-4.3301E+02
5.4069E+02	-4.3188E+02
5.4191E+02	-4.3061E+02
5.4325E+02	-4.2920E+02
5.4469E+02	-4.2764E+02
5.4622E+02	-4.2595E+02
5.4784E+02	-4.2412E+02
5.4951E+02	-4.2218E+02
5.5123E+02	-4.2012E+02
5.5240E+02	-4.1867E+02
5.5357E+02	-4.1720E+02
5.5501E+02	-4.1533E+02
5.5672E+02	-4.1305E+02
5.6351E+02	-4.0284E+02
5.6855E+02	-3.9356E+02
5.7162E+02	-3.8668E+02
5.7408E+02	-3.7998E+02
5.7576E+02	-3.7439E+02
5.7892E+02	-3.5801E+02
5.7845E+02	-3.1952E+02
5.6899E+02	-2.7072E+02
5.5492E+02	-2.1872E+02
5.3987E+02	-1.6508E+02
5.2561E+02	-1.1001E+02
5.1294E+02	-5.3307E+01
5.0236E+02	4.6675E+00
4.9396E+02	6.4519E+01
4.8789E+02	1.2613E+02
4.8425E+02	1.8930E+02
4.8308E+02	2.5357E+02
4.8434E+02	3.1825E+02
4.8780E+02	3.8253E+02
4.9326E+02	4.4606E+02
5.0199E+02	5.1077E+02
5.3752E+02	5.8540E+02
6.0997E+02	6.1050E+02
6.6985E+02	6.1516E+02
7.2366E+02	6.1254E+02
7.7439E+02	6.0354E+02
8.0009E+02	5.9621E+02
8.2509E+02	5.8712E+02
8.4929E+02	5.7637E+02
8.7215E+02	5.6438E+02
9.1596E+02	5.3615E+02
9.6048E+02	4.9988E+02
1.0018E+03	4.5817E+02

1.0385E+03	4.1222E+02
1.0690E+03	3.6236E+02
1.0918E+03	3.0890E+02
1.1055E+03	2.5292E+02
1.1098E+03	1.9609E+02
1.1055E+03	1.3992E+02
1.0942E+03	8.5274E+01
1.0774E+03	3.2400E+01
1.0561E+03	-1.8876E+01
1.0311E+03	-6.8835E+01
1.0027E+03	-1.1776E+02
9.7104E+02	-1.6582E+02
9.3618E+02	-2.1309E+02
8.9847E+02	-2.5961E+02
8.5894E+02	-3.0550E+02
8.2050E+02	-3.5125E+02
7.9138E+02	-3.9560E+02
7.8174E+02	-4.2115E+02
7.7962E+02	-4.3138E+02
7.7852E+02	-4.4083E+02
7.7844E+02	-4.5739E+02
7.8156E+02	-4.7975E+02
7.8868E+02	-5.0545E+02
7.9435E+02	-5.2091E+02
8.0069E+02	-5.3608E+02
8.0747E+02	-5.5084E+02
8.1091E+02	-5.5793E+02
8.1409E+02	-5.6431E+02
8.1703E+02	-5.7005E+02
8.1973E+02	-5.7522E+02
8.2220E+02	-5.7989E+02
8.2446E+02	-5.8410E+02
8.2653E+02	-5.8790E+02
8.2841E+02	-5.9133E+02
8.3013E+02	-5.9442E+02
8.3169E+02	-5.9722E+02
8.3311E+02	-5.9974E+02
8.3440E+02	-6.0203E+02
8.3557E+02	-6.0409E+02
8.3664E+02	-6.0595E+02
8.3761E+02	-6.0764E+02
8.3849E+02	-6.0916E+02
8.3900E+02	-6.1005E+02
7.9344E+02	-4.8693E+02
7.9016E+02	-4.6209E+02
7.9016E+02	-4.3922E+02
8.0000E+02	-4.1310E+02
1.2000E+03	-4.1310E+02
1.2000E+03	4.0000E+02
1.0000E+03	6.5000E+02
9.0000E+02	7.0000E+02
8.0000E+02	7.0000E+02
6.0000E+02	7.0000E+02
5.0000E+02	6.5000E+02
4.0000E+02	5.0000E+02
4.0000E+02	-3.6078E+02

Graphical Output



7.3 TEXTOR

Input Dataset

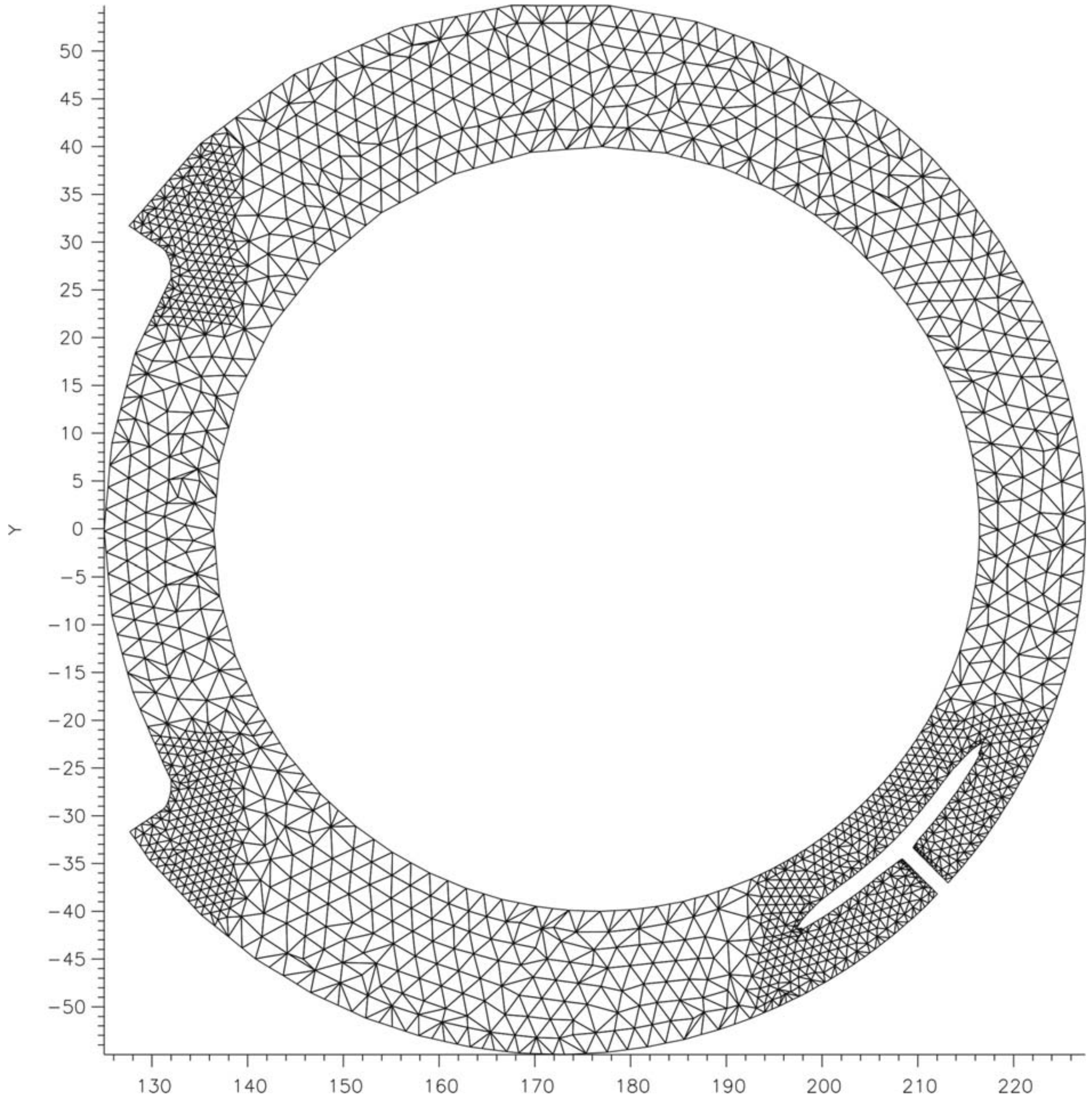
```
 2.38954843787696358
 128. -40. 138. -22. 1.
 128. 22. 138. 40. 1.
 194. -50. 222. -20. 1.

 173
   1.31072306630000E+02  -2.42685079570000E+01
   1.31990349290000E+02  -2.62327879670000E+01
   1.32028889660000E+02  -2.69066691400000E+01
   1.31980443000000E+02  -2.74822682140000E+01
   1.31869864460000E+02  -2.80005425210000E+01
   1.31709516050000E+02  -2.84839004280000E+01
   1.31500685210000E+02  -2.89386242630000E+01
   1.31203925610000E+02  -2.93110936880000E+01
   1.30801248550000E+02  -2.95804440980000E+01
   1.30371034150000E+02  -2.98682183030000E+01
   1.29910504820000E+02  -3.01762700080000E+01
   1.29416608810000E+02  -3.05066436530000E+01
   1.28886008260000E+02  -3.08615773920000E+01
   1.28314983840000E+02  -3.12435358760000E+01
   1.27699494360000E+02  -3.16552490000000E+01
   1.29782366750000E+02  -3.46645742650000E+01
   1.35139906410000E+02  -4.03791129590000E+01
   1.40809535980000E+02  -4.49641406540000E+01
   1.46585547920000E+02  -4.85212087630000E+01
   1.52314925190000E+02  -5.11687159540000E+01
   1.57889306550000E+02  -5.30284464360000E+01
   1.63236176970000E+02  -5.42170763020000E+01
   1.68310618400000E+02  -5.48414886000000E+01
   1.73088216780000E+02  -5.49966752530000E+01
   1.77559363840000E+02  -5.47652542590000E+01
   1.81724774840000E+02  -5.42180299760000E+01
   1.85592091080000E+02  -5.34149706360000E+01
   1.89173412320000E+02  -5.24064779280000E+01
   1.92483508590000E+02  -5.12346625330000E+01
   1.95538496970000E+02  -4.99345213170000E+01
   1.98355019090000E+02  -4.85350638630000E+01
   2.00949597360000E+02  -4.70602631570000E+01
   2.03338265420000E+02  -4.55298721790000E+01
   2.05536317830000E+02  -4.39601570370000E+01
   2.07558226590000E+02  -4.23644602300000E+01
   2.09417462350000E+02  -4.07537221910000E+01
   2.11126589780000E+02  -3.91368746760000E+01
   2.12048506740000E+02  -3.81885021920000E+01
   2.11718058590000E+02  -3.78580540420000E+01
   2.11409997940000E+02  -3.75499993560000E+01
   2.11122441290000E+02  -3.72624456880000E+01
   2.10853648190000E+02  -3.69936585430000E+01
   2.10602045060000E+02  -3.67420464750000E+01
   2.10366129880000E+02  -3.65061312910000E+01
   2.10144567490000E+02  -3.62845569850000E+01
   2.09936070440000E+02  -3.60760748390000E+01
   2.09739518170000E+02  -3.58795285220000E+01
   2.09553861620000E+02  -3.56938540940000E+01
   2.09378075600000E+02  -3.55180799960000E+01
   2.09211301800000E+02  -3.53513091800000E+01
```

2.09052729610000E+02	-3.51927220820000E+01
2.08901572230000E+02	-3.50415736440000E+01
2.08757185940000E+02	-3.48971843720000E+01
2.08618950840000E+02	-3.47589463000000E+01
2.08486294750000E+02	-3.46263051030000E+01
2.08358764650000E+02	-3.44987690450000E+01
2.07366275790000E+02	-3.52244257930000E+01
2.05678653720000E+02	-3.65063637500000E+01
2.03972506520000E+02	-3.78985583780000E+01
2.02122235300000E+02	-3.92690151930000E+01
2.00116848950000E+02	-4.06072080140000E+01
1.97944712640000E+02	-4.19004648920000E+01
1.97860026360000E+02	-4.17491525410000E+01
1.97338259220000E+02	-4.18322891000000E+01
1.97451591490000E+02	-4.15894478560000E+01
1.97622382640000E+02	-4.13226753470000E+01
1.97791528700000E+02	-4.10452783110000E+01
1.98034048080000E+02	-4.07303482290000E+01
1.98330724240000E+02	-4.03891652820000E+01
1.98652911190000E+02	-4.00384962560000E+01
1.99041593070000E+02	-3.96542817350000E+01
1.99322652820000E+02	-3.93382996320000E+01
2.00004553790000E+02	-3.87400537730000E+01
2.01135611530000E+02	-3.78540664910000E+01
2.02921175960000E+02	-3.65354359150000E+01
2.04584121700000E+02	-3.52147907020000E+01
2.06117725370000E+02	-3.38775277140000E+01
2.07526922230000E+02	-3.25269132850000E+01
2.08865213390000E+02	-3.11311185360000E+01
2.10166573520000E+02	-2.96416401860000E+01
2.11429834370000E+02	-2.80600279570000E+01
2.12670969960000E+02	-2.63988256450000E+01
2.13722372060000E+02	-2.50236421820000E+01
2.14041996000000E+02	-2.47512206440000E+01
2.14526081090000E+02	-2.41739228370000E+01
2.14879035950000E+02	-2.38209649920000E+01
2.15230274200000E+02	-2.34768182040000E+01
2.15596580510000E+02	-2.31135264040000E+01
2.15838003160000E+02	-2.29405850170000E+01
2.16086220740000E+02	-2.27624997500000E+01
2.16339492800000E+02	-2.25829109550000E+01
2.16565656660000E+02	-2.24626928570000E+01
2.16787934300000E+02	-2.23589628930000E+01
2.16338014600000E+02	-2.35317021610000E+01
2.16476011280000E+02	-2.36092135310000E+01
2.15322303770000E+02	-2.55561888220000E+01
2.14110803600000E+02	-2.74002224210000E+01
2.12848567960000E+02	-2.91443705560000E+01
2.11541962620000E+02	-3.07916373010000E+01
2.10196876530000E+02	-3.23449879880000E+01
2.09488224980000E+02	-3.33482265470000E+01
2.09614825250000E+02	-3.34748268130000E+01
2.09746503830000E+02	-3.36065024140000E+01
2.09883737560000E+02	-3.37437391280000E+01
2.10027098660000E+02	-3.38870882990000E+01
2.10177159310000E+02	-3.40371519330000E+01
2.10334610940000E+02	-3.41946095230000E+01
2.10500192640000E+02	-3.43602001670000E+01
2.10674738880000E+02	-3.45347374680000E+01
2.10859107970000E+02	-3.47191125150000E+01
2.11054301260000E+02	-3.49142968650000E+01
2.11261343960000E+02	-3.51213425400000E+01
2.11481404300000E+02	-3.53414058690000E+01
2.11715722080000E+02	-3.55757236480000E+01
2.11965656280000E+02	-3.58256518840000E+01

2.12232661250000E+02	-3.60926538710000E+01
2.12518310550000E+02	-3.63783210520000E+01
2.12824392320000E+02	-3.66843819620000E+01
2.13152718540000E+02	-3.70127141480000E+01
2.14184546470000E+02	-3.58608961110000E+01
2.15633130070000E+02	-3.41040998700000E+01
2.17037439350000E+02	-3.22478801010000E+01
2.18391466140000E+02	-3.02892297510000E+01
2.19688630100000E+02	-2.82250523570000E+01
2.20921731000000E+02	-2.60521709920000E+01
2.22082805630000E+02	-2.37673312430000E+01
2.23163080220000E+02	-2.13671982290000E+01
2.24152779580000E+02	-1.88483789560000E+01
2.25041031840000E+02	-1.62074387070000E+01
2.25815629960000E+02	-1.34409412740000E+01
2.26462817190000E+02	-1.05454988780000E+01
2.26967048650000E+02	-7.51785561440000E+00
2.27310585980000E+02	-4.35500293970000E+00
2.27473163600000E+02	-1.05435149740000E+00
2.27431488040000E+02	2.38602217290000E+00
2.27158617970000E+02	5.96702620390000E+00
2.26623296740000E+02	9.68805029990000E+00
2.25788998600000E+02	1.35462492700000E+01
2.24612975120000E+02	1.75355225800000E+01
2.23045039180000E+02	2.16450423000000E+01
2.21026110650000E+02	2.58571684360000E+01
2.18486690520000E+02	3.01444262270000E+01
2.15345263480000E+02	3.44651907680000E+01
2.11507081990000E+02	3.87574851510000E+01
2.06863546370000E+02	4.29301440720000E+01
2.01293849950000E+02	4.68503028150000E+01
1.94670581820000E+02	5.03261685370000E+01
1.86873376370000E+02	5.30841290950000E+01
1.77817153930000E+02	5.47407507900000E+01
1.67505037780000E+02	5.47742366790000E+01
1.56119573120000E+02	5.25093257430000E+01
1.44866573810000E+02	4.75638300180000E+01
1.35083246230000E+02	4.03266370300000E+01
1.27615249160000E+02	3.17115962510000E+01
1.28233778480000E+02	3.12978595500000E+01
1.28807473180000E+02	3.09141069650000E+01
1.29340457920000E+02	3.05575847630000E+01
1.29836475850000E+02	3.02257955070000E+01
1.30298888680000E+02	2.99164772030000E+01
1.30730795860000E+02	2.96275675300000E+01
1.31134998800000E+02	2.93571978810000E+01
1.31453847890000E+02	2.90323108430000E+01
1.31657183170000E+02	2.86121994260000E+01
1.31822991370000E+02	2.81850606200000E+01
1.31956481930000E+02	2.76261746880000E+01
1.32025516030000E+02	2.69875884060000E+01
1.31983268260000E+02	2.61761486530000E+01
1.28258645530000E+02	1.84098392720000E+01
1.25812780860000E+02	8.97118076680000E+00
1.25002634530000E+02	-2.71503767000000E-01
1.25824332240000E+02	-9.03595760460000E+00
1.27999031540000E+02	-1.70586958530000E+01
1.31072306630000E+02	-2.42685079570000E+01
65	
2.04040741920000E+02	-2.89559274910000E+01
2.02757835390000E+02	-3.01265150310000E+01
2.01369142530000E+02	-3.12851607800000E+01
1.99867081640000E+02	-3.24250161650000E+01
1.98243713380000E+02	-3.35379391910000E+01
1.96490728860000E+02	-3.46142739060000E+01

1.94599545000000E+02	-3.56425791980000E+01
1.92561471460000E+02	-3.66093218330000E+01
1.90367841720000E+02	-3.74985337260000E+01
1.88010275360000E+02	-3.82914155720000E+01
1.85481083390000E+02	-3.89658778910000E+01
1.82773780820000E+02	-3.94960731270000E+01
1.79883718490000E+02	-3.98518711330000E+01
1.76809024810000E+02	-3.99983376260000E+01
1.73551821710000E+02	-3.98952692750000E+01
1.70119798180000E+02	-3.94968152050000E+01
1.66528153420000E+02	-3.87513428930000E+01
1.62802076340000E+02	-3.76016616820000E+01
1.58979773520000E+02	-3.59858870510000E+01
1.55115866660000E+02	-3.38391870260000E+01
1.51285254960000E+02	-3.10968369250000E+01
1.47586834430000E+02	-2.76990383860000E+01
1.44146800040000E+02	-2.35978856680000E+01
1.41120183470000E+02	-1.87668472530000E+01
1.38689661030000E+02	-1.32126510140000E+01
1.37059772010000E+02	-6.98892995720000E+00
1.36445033550000E+02	-2.09886254740000E-01
1.37050914760000E+02	6.93881735210000E+00
1.39048218730000E+02	1.41957789660000E+01
1.42543411250000E+02	2.12301090360000E+01
1.47550177570000E+02	2.76607960460000E+01
1.53969144820000E+02	3.30886572600000E+01
1.61581766610000E+02	3.71362328530000E+01
1.69545972350000E+02	3.94006401300000E+01
1.76998174190000E+02	3.99961680170000E+01
1.83738934990000E+02	3.93292635680000E+01
1.89695763590000E+02	3.77412706610000E+01
1.94871222970000E+02	3.55028927330000E+01
1.99308145050000E+02	3.28215330840000E+01
2.03068041800000E+02	2.98527359960000E+01
2.06218528750000E+02	2.67115414140000E+01
2.08826351170000E+02	2.34822243450000E+01
2.10953998570000E+02	2.02260524030000E+01
2.12658190730000E+02	1.69872626660000E+01
2.13989496230000E+02	1.37975245710000E+01
2.14992547040000E+02	1.06792725620000E+01
2.15706491470000E+02	7.64814242720000E+00
2.16165637970000E+02	4.71477545800000E+00
2.16399979590000E+02	1.88613664360000E+00
2.16435790060000E+02	-8.33516009150000E-01
2.16296124460000E+02	-3.44191715120000E+00
2.16001224520000E+02	-5.93826770780000E+00
2.15569019320000E+02	-8.32284539940000E+00
2.15015316010000E+02	-1.05967171490000E+01
2.14354157450000E+02	-1.27615228300000E+01
2.13598060610000E+02	-1.48193180560000E+01
2.12758183480000E+02	-1.67724519970000E+01
2.11844563480000E+02	-1.86234861610000E+01
2.10866189000000E+02	-2.03751146790000E+01
2.09831213950000E+02	-2.20301285390000E+01
2.08746910100000E+02	-2.35913693900000E+01
2.07619953160000E+02	-2.50617057090000E+01
2.06456375120000E+02	-2.64440089460000E+01
2.05261659620000E+02	-2.77411371470000E+01
2.04040741920000E+02	-2.89559274910000E+01

Graphical Output



8 Appendix

8.1 References

[1] D. Reiter, C. May, M. Baelmans, P. Boerner, "Non-linear effects on neutral gas transport in divertors", J. Nucl. Materials, 241-243, (1997), 342

[2] H. Greza, "Automatische Neugenerierung lösungsadaptierter unstrukturierter Rechennetze zur numerischen Strömungssimulation nach der Methode der Finiten Elemente", DGLR Jahrbuch 1991, Bd. I, pp. 389-399 (1991)

[3] D. Reiter, "The EIRENE Code, Version: Jan. 92 Users Manual", Bericht der KFA Jülich Jül-2599, März 1992 oder www.eirene.de