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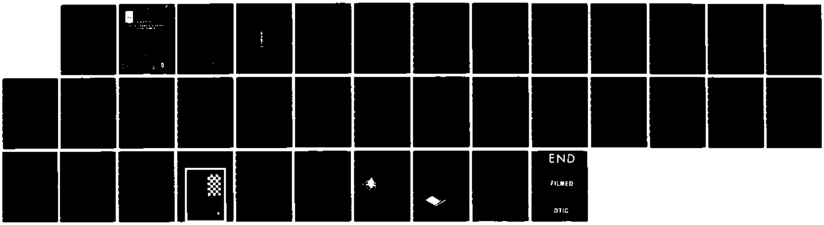

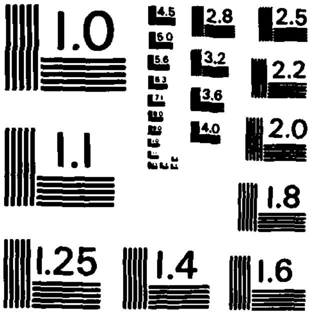

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ROYAL SIGNALS & RADAR ESTABLISHMENT

AD-A148 489

A FORTRAN PLOTTING PACKAGE FOR GRAPHIC VDUs

Authors: V J Mifsud and
C Broughton

RSRE MEMORANDUM No. 3739

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ROYAL SIGNALS AND RADAR ESTABLISHMENT

Memorandum 3739

Title: A FORTRAN PLOTTING PACKAGE FOR GRAPHIC VDUs

Authors: V J Mifsud, C Broughton

Date: August 1984

Summary

A set of plotting routines have been implemented in FORTRAN on DEC LSI-11, PDP-11 and VAX-11 computers to provide a transportable graphics capability to improve data presentation and machine control on vector scan particle beam lithography machines. The routines are general in nature and have already proved to be of use in many scientific applications requiring compact and tailored graphics capabilities within specific programs. This document is designed to act as a User's Guide for the suite. Versions of the routines are available for ReGIS, Tektronics 4010/4014 and SIGMA native-mode graphics terminals.

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A FORTRAN PLOTTING PACKAGE FOR GRAPHIC VDUs USERS GUIDE

RSRE
SP1 DIV

LITHOGRAPHY
SECTION

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1. Introduction

The specific requirements of pattern verification and wafer layout control in lithographic applications requires a limited set of graphics routines to improve data presentation and to ease machine operation. The specific requirements have been defined and a suite of subroutines written to satisfy this need. The suite is highly modular and is written in a high-level language to ease its adaptation to suit a variety of tasks.

This package is intended to be used in conjunction with both monochrome and colour terminals. The former include the DEC VT125, VT24X and Tektronics 4014-compatible graphics terminals (including the Pericom series, the VT24X and VT100 type terminals upgraded with the Selanar graphics option), the latter include the SIGMA range of compatible terminals and the VT241. It is coded mainly in FORTRAN-77 with MACRO-11 used where required for speed. The suite of subroutines is designed to run on RSX-11M systems on PDP-11 or LSI-11 computers. A VAX VMS version is also available. Conversion to run on other terminals or operating systems should be easily achievable due to the use of high level routines and a modular structure.

2. Overview

The package is designed to present a set of subroutines that include a one to one correspondence with the DEC supplied routines for the Servogor 281 plotter (also marketed by Philips and Calcomp). The intention is to permit programs requiring graphic output to have direct access to the Servogor plotter, a ReGIS terminal or a Tektronics PLOT-10 compatible terminal. Identical calls are provided as appropriate, requiring only that a graphics program be task built with the appropriate libraries to suit the specific terminal type. In addition, further routines provide a broader range of functions, though compatibility with the plotter is then not available.

The package expects its coordinates (either: user's or the terminal's) in 0.1 mm units (integers) and does not accepts real numbers denoting cm. Two types of routines are provided, those that correspond to an A4 page (30 by 21 cm), and those that use the coordinates of the terminal directly.

The package can be used in FORTRAN-77 under IAS , all RSX11M/M+ systems, RT11 and VMS. It is possible to modify the suite to run under FORTRAN-IV and IV PLUS if required. This description refers specifically to RSX-11M operating systems.

Implementation of these FORTRAN routines in an operational environment is a prerequisite for usage of the any of the higher software level (written normally in FORTRAN), e.g.: the HCFS-Package (Hardware Compatible Fortran Software) and 2-D and 3-D plotting packages already available. Mixed usage of subroutines from different software levels, in the same application program is also possible but should be checked thoroughly.

2.1. Index of subroutines

The package subroutines can logically be divided into functional groups, as follows.

2.1.1. GROUP 1 : Vectors

RMOVE,JMOVE	relative move, A4 coords option
XRMOVE,XJMOVE	relative move, graphic terminal coords option
RPLOT,JPLOT	relative plot, A4 coords option
XRPLOT,XJPLOT	relative plot, graphic terminal coords option
AMOVE,KMOVE	absolute move,

A4 coords option

XAMOVE,XKMOVE absolute move, graphic terminal coords option

APLOT,KPLOT absolute plot, A4 coords option

APLOT,KPLOT absolute plot, graphic terminal coords option

2.1.2. GROUP 2 : Pen and line type

PENUP dummy in monochrome terminals, for compatibility

NEWPEN dummy in monochrome terminals, change colour in colour terminals

PLUMA dummy in monochrome terminals, change colour in colour terminals

LINTYP select line type

2.1.3. GROUP 3 : Text plotting

SETCHR select character size and angle

NEWCHR select character set

SETSLN select character slant

POINT plot a point mark

TEXT plot text

2.1.4. GROUP 4 : Circle, sector and axes

CIRC plot circle

SECT plot sector

AXEL plot axis

2.1.5. GROUP 5 : Digitising and window

LOCAT get coordinates without user intervention

DIGTZE digitize interactively (not available on VT125)

OFFSET select offset coordinates

WINDOW select plotting window

PLTWND verify the current plotting window

2.1.6. GROUP 6 : Miscellaneous

CHART dummy, for compatibility

PLTON open output channel and ini-

tialize graphic terminal
PLTOFF close O/P channel and logically disconnect
OFFBUF dummy, graphic terminal used in real time
ONBUF dummy, graphic terminal used in real time
PLTNAM change default names (O/P device and file)
PLTERR transfer ERROR condittion to user program

2.1.7. GROUP 7 : Extensions

ARECT Rectangle drawing routine, A4 coordinates
XARECT Rectangle drawing routine, plotter coords
FILSEL Sets to filled or edged rectangle drawing

CURSOR Returns cursor coordinates and key code

ERALN Erases a previously drawn line (A4 coords)
XERALN Erases a previously drawn line (Terminal units)
ERART Erases a previously drawn rectangle (A4 coords)
XERART Erases a previously drawn rectangle (Term units)
ERASE Selects normal or erase writing for subsequent features

2.2. Notes on usage

This package, with the exception of the routines LOCAT, CURSOR, and DIGTZE, can also be used with the graphic terminal offline instead of on-line, since all the other routines are output only. This makes it possible to store pictures (plots) in files for later plotting. In this memorandum, online plotting is defined as plotting with the graphic terminal directly connected to a dedicated line, with the plotting program outputting the graphic commands to the terminal which immediately begins executing them. Offline plotting is considered to be plotting into a file, which later on is output to the graphic terminal by using the appropriate file transfer utility program: PLTPER or PLTVT.

3. Detailed description of the package subroutines

These subroutines will be described complete with variable usage, call and ,if possible, examples. The order will be the same as in 2.1.

Equivalent subroutine names are mentioned in parenthesis.

RMOVE (JMOVE)

This subroutine moves the cursor with relative coordinates, within the limits of an A4 page (30cm X 21cm or 3000 X 2100 graphic units).

```
Use : CALL RMOVE  (IX,IY)

        IX      = x-coordinate
        IY      = y-coordinate
```

XRMOVE (XJMOVE)

This subroutine moves the cursor with relative coordinates, within the limits of the particular graphic terminal.

For a VT125/24X, this is 680 X 480 units.
For a Pericom or Tektronics equivalent,
this is 1024 X 780 units.
For a SIGMA colour terminal,
this is 768 X 512 units.

```
Use : CALL XRMOVE  (IX,IY)

        IX      = x-coordinate
        IY      = y-coordinate
```

RPLOT (JPLOT)

This subroutine plots a line with relative coordinates, within the limits of an A4 page (30cm X 21cm or 3000 X 2100 graphic units).

```
Use : CALL RPLOT  (IX,IY)

        IX      = x-coordinate
        IY      = y-coordinate
```

XRPLOT (XJPLOT)

This subroutine plots a line with relative coordinates, within the limits of the particular graphic terminal.

For a VT125/24X, this is 680 X 480 units.
For a Pericom or Tektronics equivalent,
this is 1024 X 780 units.
For a SIGMA colour terminal,
this is 768 X 512 units.

Use : CALL XRPLOT (IX,IY)

IX	= x-coordinate
IY	= y-coordinate

AMOVE (KMOVE)

This subroutine moves the pen with absolute coordinates, within the limits of an A4 page (30cm X 21cm or 3000 X 2100 graphic units).

Use : CALL AMOVE(IX,IY)

IX	= x-coordinate
IY	= y-coordinate

XAMOVE (XKMOVE)

This subroutine moves the pen with absolute coordinates, within the limits of the particular graphic terminal.

For a VT125/24X, this is 680 X 480 units.
For a Pericom or Tektronics equivalent,
this is 1024 X 780 units.
For a SIGMA colour terminal,
this is 768 X 512 units.

Use : CALL XAMOVE(IX,IY)

IX	= x-coordinate
IY	= y-coordinate

APLOT (KPLOT)

This subroutine plots a line with absolute coordinates, within the limits of an A4 page (30cm X 21cm or 3000 X 2100 graphic units).

Use : CALL APLOT(IX,IY)

```
        IX      = x-coordinate
        IY      = y-coordinate
```

XAPLOT (XKPLOT)

This subroutine plots a line with absolute coordinates, within the limits of the particular graphic terminal.

For a VT125/24X, this is 680 X 480 units.
For a Pericom or Tektronics equivalent,
this is 1024 X 780 units.
For a SIGMA colour terminal,
this is 768 X 512 units.

Use : CALL XAPLOT(IX,IY)

```
        IX      = x-coordinate
        IY      = y-coordinate
```

PENUP

This subroutine is a dummy, to match the plotter routine that raises or lowers the pen

Use : CALL PENUP(IM)

```
        IM      = 0 : pen up
        IM      = 1 : pen down
```

NEWPEN

In the plotter suite, this subroutine selects one of the 8 pens on the plotter. It is also possible to park the current pen without selecting a new pen.
In this suite, it is a dummy routine for monochrome terminals. For colour terminals, the subroutine provides colour selection. The colour selection depends on the type of terminal used.

Use : CALL NEWPEN(IP)

```
     IP      = 0    : parks current pen (plotter only)
               1..8 : select pen, return to location
                    : or select colour, remain at loc-
ation
```

PLUMA

In the plotter package, this subroutine selects one of the 8 pens on the plotter. It is also possible to park the current pen without selecting a new one.
In this suite, it is a dummy routine for monochrome terminals. For colour terminals, the subroutine provides colour selection. The colour selected depends on the type of terminal used.

Use : CALL PLUMA(IP)

```
     IP      = -1     :  parks  current  pen  (plotter
only)
                0...7 : select pen, return to location
                      : or select  colour,  remain  at
location
```

LINTYP

This subroutine selects the line type and length of elements if dashed.

Use : CALL LINTYP(IN,IL)

```
        IN      = 0 : continous line
                  1 : dotted line
                  2 : dashed line
                  3 : dashed dashed
                  4 : dashed dotted
        IL      = dummy, included for compatibility
```

SETCHR

This subroutine is used to set text and plot mark characteristics, the detail of which depends on the graphic terminal.

Use : CALL SETCHR(IH,ID,IW)

```
      On a VT125,
        IH       = character height
        ID       = character direction in degrees
        IW       = character width

      On a Pericom,
        IH       = character height
        ID       = character direction in degrees
                      (not implemented)
        IW       = character width (not used)

      On a SIGMA,
       IH       = character height
       ID       = character direction in degrees
                     (0,90,180,270 available)
       IW       = character width (not used)
```

NEWCHR

This subroutine selects one of five character sets of the graphic terminal. The detail depends on the actual terminal type.

Use : CALL NEWCHR(IN)

```
        IN       = 0 : standard ASCII set
                   1 : German set
                   2 : Spanish set
                   3 : Swedish-Finnish set
                   4 : Danish-Norwegian set
```

SIGMA terminals do not offer this facility.

SETSLN

This subroutine is used to set the character slant.

Use : CALL SETSLN(IN)

```
        IN       = 0 : 90 degrees (straight)
                   1 : 75 degrees (forward slant)
                -90<IN<90 slant angle (forward or back)
```

POINT

This subroutine is used to plot a point mark

Use : CALL POINT(IN)

```
IN      = 0...4 : plot point mark
                   (see figure 1 for marks)
```

TEXT

This subroutine plots text with a given number of characters.

Use : CALL TEXT(STRING ,IN)

```
STRING  = string to be plotted (BYTE array)
IN      = number of characters in STRING.
```

N.B. This routine requires the number of characters to be explicitly stated. The option to leave out the number of characters is not presently available.

CIRC

This subroutine plots a circle.

Use : CALL CIRC(IR)

```
IR      = radius of circle.
           Will plot the circle from the
           perimeter point corresponding
          to 0 degrees
           if > 0 : counterclockwise plot
           if < 0 : clockwise plot
```

SECT

This subroutine will plot sectors of a circle.

Use : CALL SECT(IR,IA,IB)

```
        IR      = radius of circle of which the
                  sector is a part
                   if > 0 : counterclockwise plot
                   if < 0 : clockwise plot
        IA      = start angle (degrees)
        IB      = end angle (degrees)
```

AXEL

This subroutine plots a x- or y-axis with tic-marks.

Use : CALL AXEL(IM,IL,ID,IT1,IT2)

```
        IM      = select axis :
                   if 0 : x-axis
                   if 1 : y-axis
        IL      = absolute length of axis
        ID      = distance between tic-marks
                   if > 0 : right
                   if < 0 : left
        IT1     = length of first tic-mark
                   if > 0 : up
                   if < 0 : down
        IT2     = length of second tic-mark
                   if > 0 : up
                   if < 0 : down
```

(See Figure 2 for illustration)

LOCAT

This subroutine is used to get the user's plotting coordinates from the plotter. Note that it can only be used with online plotting.

Use : CALL LOCAT(IX,IY)

```
  IX = integer variable to receive the x-coordinate
  IY = integer variable to receive the y-coordinate
```

DIGTZE

Subroutine to digitize interactively with the graphic terminal, if this supports the feature (VT125 type terminals do not). To use on the Pericom, either depress the optional light pen at the desired location, or use the cursor positioning arrows to set the cursor hairs onto the desired location and then depress the space bar. This can only be used for online work. On SIGMA terminals, the optional joystick is supported.

Use : CALL DIGTZE(IX,IY)

```
  IX = integer variable to receive the x-coordinate
  IY = integer variable to receive the y-coordinate
```

OFFSET

This subroutine is used to set a fixed x and/or y offset for all subsequent graphical display.

Use : CALL OFFSET(IX,IY)

```
        IX      = x offset
        IY      = y offset
```

WINDOW

Subroutine to set the display window. All subsequent plotting will only be recognized and plotted inside this window. Note that this does not scale the coordinates in any way.

Use : CALL WINDOW(IXMIN,IXMAX,IYMIN,IYMAX)

```
        IXMIN   = x-coordinate of lower left corner
        IXMAX   = x-coordinate of upper right corner
        IYMIN   = y-coordinate of lower left corner
        IYMAX   = y-coordinate of upper right corner
```

PLTWND

Subroutine to display the current window.

Use : CALL PLTWND

```
        no arguments
```

CHART

This routine is a null operation in the graphic terminals.

use : CALL CHART(ICM)

```
        ICM    = advance paper ICM cm. Range : 1...64
```

PLTON

This subroutine opens the output channel (disc file or terminal line), verifies the output buffer and sends a string initialising the plotter.

Only subroutines PLTNAM and PLTERR can be called before PLTON is called.

Use : CALL PLTON (IBUF,LBUF [,LUN])

```
      IBUF = name of array reserved in user program
                  and used as output buffer
      LBUF = length of array IBUF in words
                 in range 42...512, if IBUF has length
                 >512, space over 512 words is unused;
                 optimal LBUF for disc access = 512
                  words
      LUN  = optional channel number used for ouput
                channel; default LUN=1 (hint: most
                users may prefer automatic channel
                allocation by system subroutine
                 GTCHN to get a free channel number)
```

PLTOFF

This subroutine switches the graphic processor to logically off. The terminal will exit graphics mode after this call.

Use : CALL PLTOFF

no arguments

OFFBUF

This subroutine switches buffering OFF, that means, every cal] to another subroutine causes immediate output of a string to the plotter. Initial software mode is BUFFERED. This call has no effect when writing to disc file.

use : CALL OFFBUF

no arguments

ONBUF

This subroutine switches buffering ON, that means, every call to another subroutine causes buffered output of a string to the plotter.

use : CALL ONBUF

no arguments

PLTNAM

This subroutine changes default names for output file and device and can be called only once and only before CALL START.

use : CALL PLTNAM (FNAM,LFNAM,DNAM,LDNAM)

```
   FNAM  = Array containing ASCII string
              of new file name
   LFNAM = length of new file name string
   DNAM  = array containing ASCII string of new device
                   name
   LDNAM = length of device name
```

PLTERR

This subroutine establishes decoding of possible errors, when using this software package. Once called, it allows one to determine the nature of the fault. (Not fully implemented as not needed in this case).

Use : CALL PLTERR (IER)

IER = array of two words reserved for error information; lower word contains error number from plotter control processor; high word contains status information from file control processor; in both cases value equal zero mean success.

Possible error number are:
0 = no errors detected

ARECT

This routine draws the border or fills a rectangle, given the bottom left and top right coordinates in A4 units.

Use : CALL ARECT(IX1,IY1,IX2,IY2)

IX1	= x coordinate of lower left corner
IY1	= y coordinate of lower left corner
IX2	= x coordinate of top right corner
IY2	= y coordinate of top right corner

XARECT

This routine draws the border or fills a rectangle, given the bottom left and top right coordinates in terminal units.

Use : CALL XARECT(IX1,IY1,IX2,IY2)

IX1	= x coordinate of lower left corner
IY1	= y coordinate of lower left corner
IX2	= x coordinate of top right corner
IY2	= y coordinate of top right corner

FILSEL

This subroutine selects the drawing mode for rectangle plotting. If set, the rectangles are filled, if cleared, only the edges are drawn.

Use : CALL FILSEL(ILOG)

```
        ILOG  = BYTE variable. If set, block drawing
                       is selected until changed.
                       If cleared, edge drawing is
                       selected until changed.
```

CURSOR

Operates as for DIGTZE, but it also returns the ASCII code for the key depressed to transmit the current cursor coordinates, as well as the coordinates themselves.

Use : CALL CURSOR(IX,IY,CHAR)

```
        IX    = X cursor coordinate
        IY    = Y cursor coordinate
        CHAR  = BYTE variable, containing the
                       ASCII code of the key
```

ERALN

This routine allows the erasure of a previously drawn line, that has been defined using A4 units. It is necessary to select the same line characteristics (ie solid, dotted etc) as those used to draw the line before calling this routine.

Use : CALL ERALN (IX,IY)

```
        IX  = X-coordinate (absolute)
        IY  = Y-coordinate (absolute)
```

A complement or erase line is drawn from the current position to that defined by the subroutine arguments.

XERALN

This routine allows the erasure of a previously drawn line that has been defined using graphic terminal units. It is necessary to select the same line characteristics (ie solid, dotted etc) as those used to draw the line before calling this routine.

Use : CALL XERALN (IX,IY)

```
        IX  = X-coordinate (absolute)
        IY  = Y-coordinate (absolute)
```

A complement or erase line is drawn from the current position to that defined by the subroutine arguments.

ERART

This subroutine provides a means of erasing a previously drawn rectangle, be it in border or filled-in state. This routine accepts A4 coordinates, and is complemented by the following routine that uses terminal coordinates.

Use : CALL ERART (IX1,IY1,IX2,IY2)

```
 IX1  = X-coordinate of lower left corner (absolute)
 IY1  = Y-coordinate of lower left corner (absolute)
 IX2  = X-coordinate of top right corner (absolute)
 IY2  = Y-coordinate of top right corner (absolute)
```

This routine uses complement drawing to erase the figure. Consequently, it is necessary to choose the same line or fill characteristics as were used to draw the figure before calling this routine.

XERART

This subroutine provides a means of erasing a previously drawn rectangle, be it in border or filled-in state. This routine accepts terminal coordinates, and is complemented by the previous routine that uses A4 coordinates.

Use : CALL XERART (IX1,IY1,IX2,IY2)

```
IX1  = X-coordinate of lower left corner (absolute)
IY1  = Y-coordinate of lower left corner (absolute)
IX2  = X-coordinate of top right corner (absolute)
IY2  = Y-coordinate of top right corner (absolute)
```

This routine uses complement drawing to erase the figure. Consequently, it is necessary to choose the same line or fill characteristics as were used to draw the figure before calling this routine.

ERASE

This subroutine switches the terminal from normal to complement writing (and vice versa). It can be used to erase a block of lines or rectangles before returning to normal writing.

Use : CALL ERASE (ILOG)

```
ILOG  = BYTE variable. If true, erase writing
           is selected until ERASE is called
           with ILOG set to false.
           If false, normal writing is resumed.
```

4. An example using the package calls

```
C***  This is a program  in  FORTRAN-77  to  test  the
package calls
C
C*  Allocate 512 words buffer for output
C
      INTEGER IBUF(512)
C
C*  Create two logical variables
C
      LOGICAL LOG1,LOG2
      DATA ILOG1,ILOG2/.TRUE.,.FALSE./
C
C*  Initialize plotter
C
      CALL PLTON(IBUF,512,3)
C
C*  Create a border by filling the screen then erasing
the drawing zone
C
      CALL FILSEL(ILOG1)
      CALL XARECT(0,0,1023,779)
      CALL XERART(40,40,984,740)
      CALL FILSEL(ILOG2)
C
C*  Write in a title
C
      CALL SETCHR(80,10,10)
      CALL XAMOVE(250,675)
      CALL TEXT('TEST PROGRAMME FOR  FORTRAN  GRAPHICS
PACKAGE',43)
C
C*  Draw some nested circles
C
      DO 10 I=1,5
      CALL XAMOVE(100,500)
      CALL CIRC(I*-100)
10    CONTINUE
C
C*  Draw a rectangular pattern
C
      CALL XARECT(100,100,240,200)
      CALL XAMOVE(100,100)
      CALL XRPLOT(140,100)
      CALL XRMOVE(-140,0)
      CALL XRPLOT(140,-100)
      CALL FILSEL(ILOG1)
      CALL XERART(150,130,190,170)
```

```
C
C*  Demonstrate the various text sizes
C
   CALL SETCHR(5,10,10)
   CALL XAMOVE(500,550)
   CALL TEXT('THIS IS THE SMALLEST WRITING',28)
   CALL SETCHR(30,10,10)
   CALL XAMOVE(500,525)
   CALL TEXT('THIS IS THE NEXT SIZE UP',24)
   CALL SETCHR(55,10,10)
   CALL XAMOVE(500,500)
   CALL TEXT('THIS IS THE NEXT SIZE UP',24)
   CALL SETCHR(80,10,10)
   CALL XAMOVE(425,450)
   CALL SETSLN(1)
   CALL  TEXT('THIS  IS  THE  LARGEST   SIZE   WITH
SLANT',35)
C
C*  Draw a chequer pattern
C
   DO 30 J=1,5
   DO 30 I=1,4
   K=0
   IF(J.EQ.2.OR.J.EQ.4)K=50
   IX1=400+I*100+K
   IY1=50+J*50
   CALL XARECT(IX1,IY1,IX1+50,IY1+50)
30 CONTINUE
C
C*  End of plot. Sign off
C
   CALL PLTOFF
   STOP
   END
```

A screen dump of the graphical output of this program is included as Figure 3.

Other typical examples of graphical output produced using these routines are included as Figures 4,5,6 and 7.

Figure 1 : Point plot markers

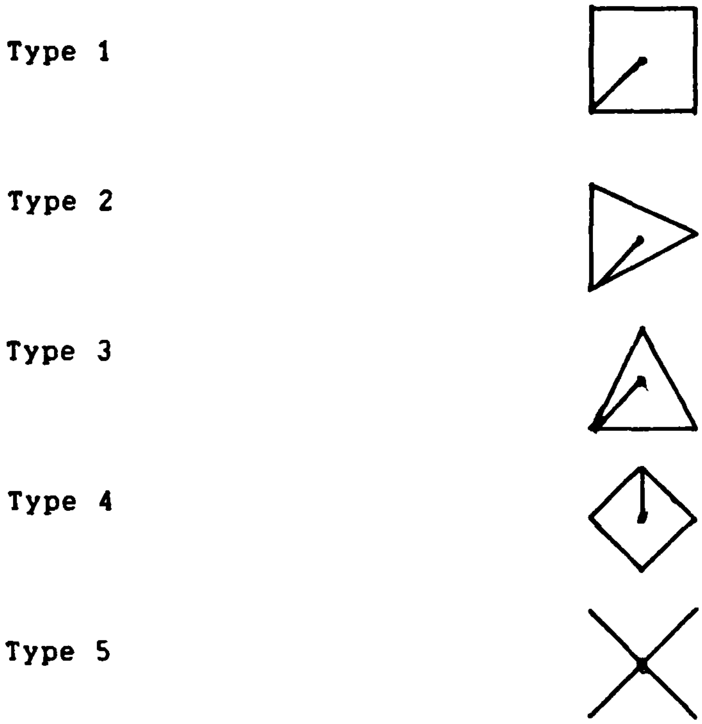
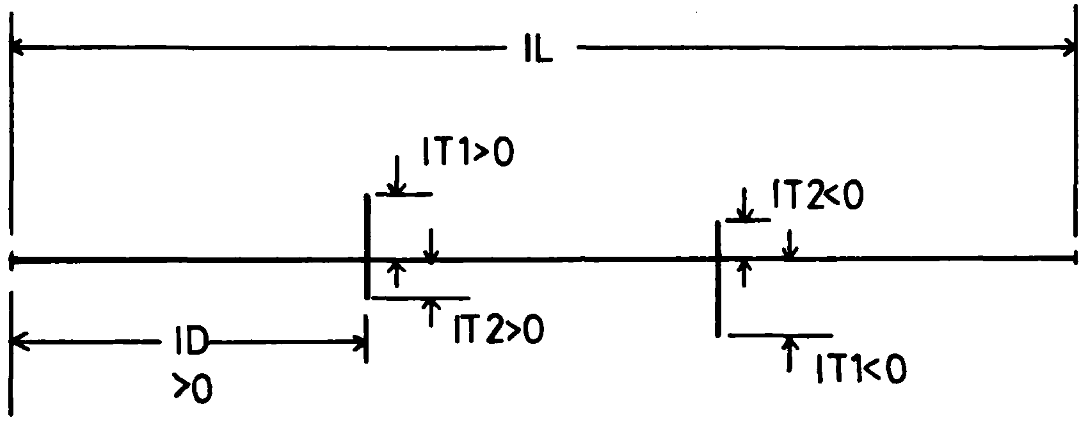
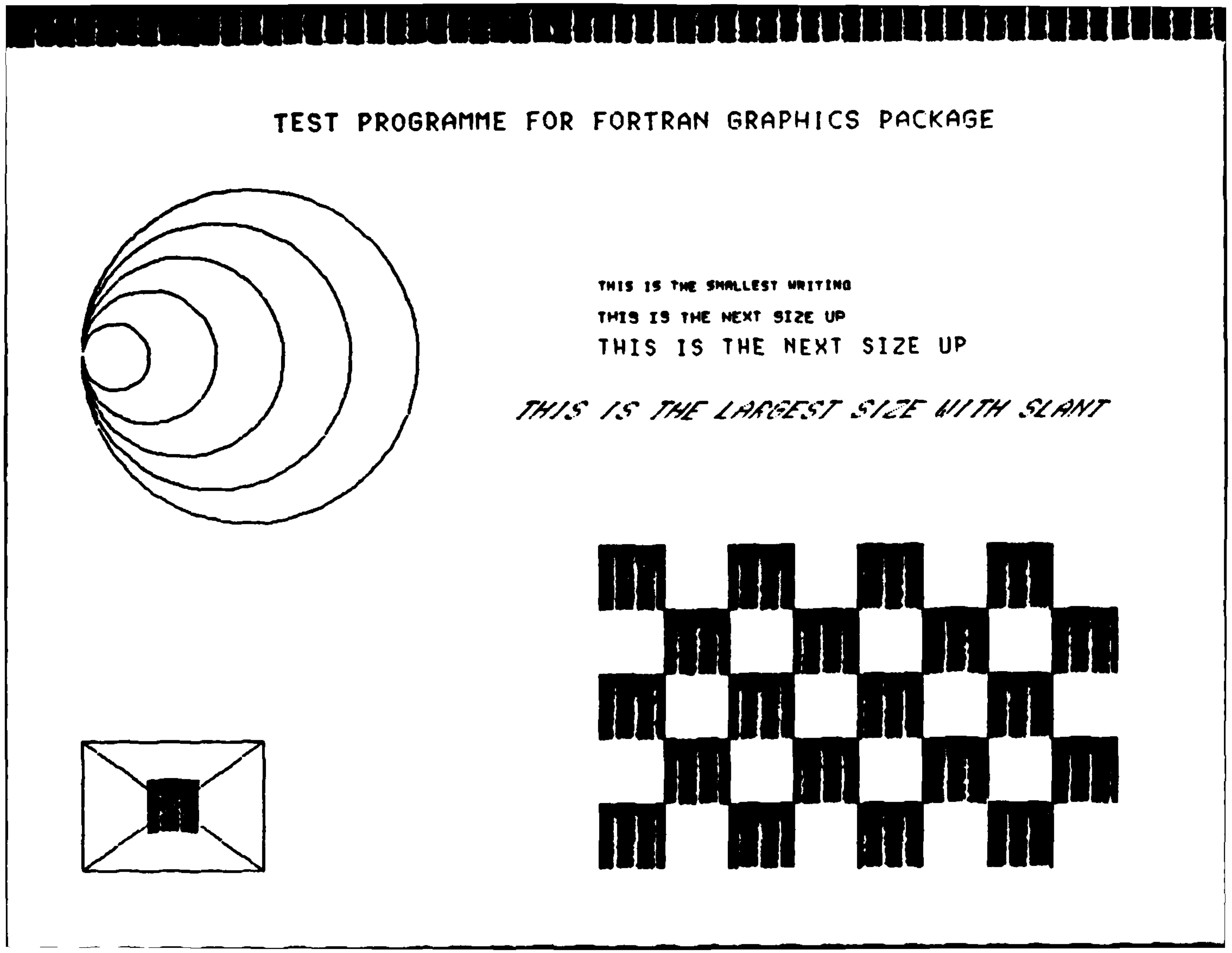


Figure 2: Schematic of parameters in AXEL





TEST PROGRAMME FOR FORTRAN GRAPHICS PACKAGE

THIS IS THE SMALLEST WRITING

THIS IS THE NEXT SIZE UP

THIS IS THE NEXT SIZE UP

THIS IS THE LARGEST SIZE WITH SLANT

Figure 4 : Plot of small feature cross-section

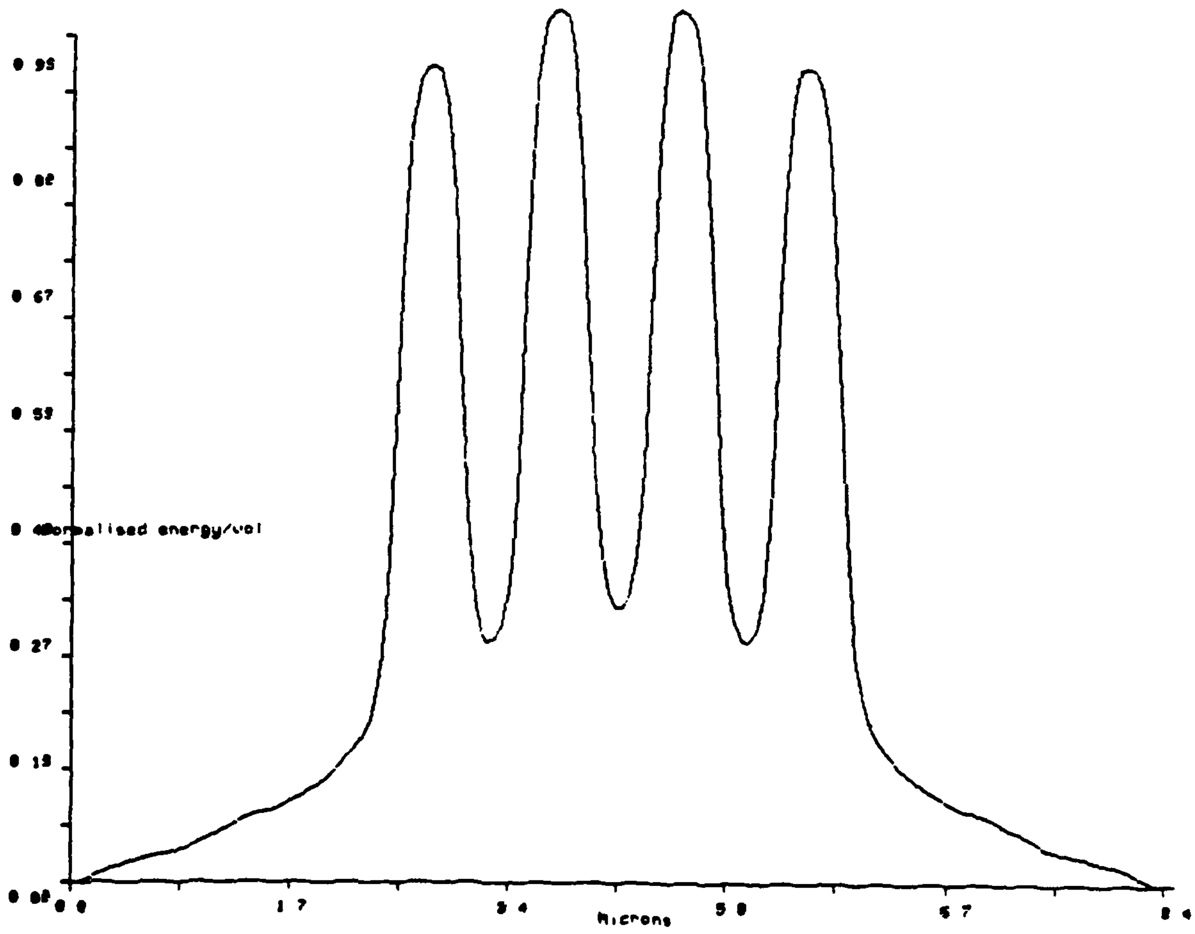
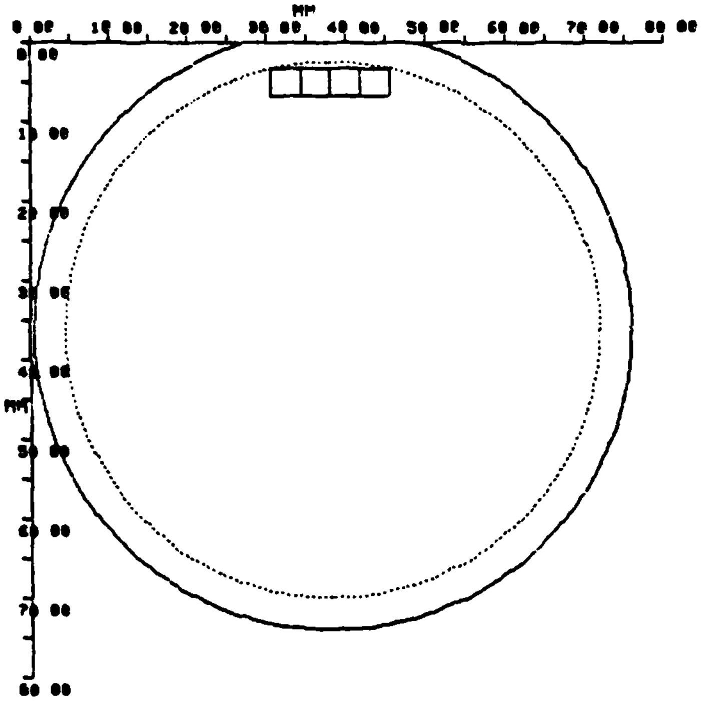


Figure 5 : Example Slice Plot

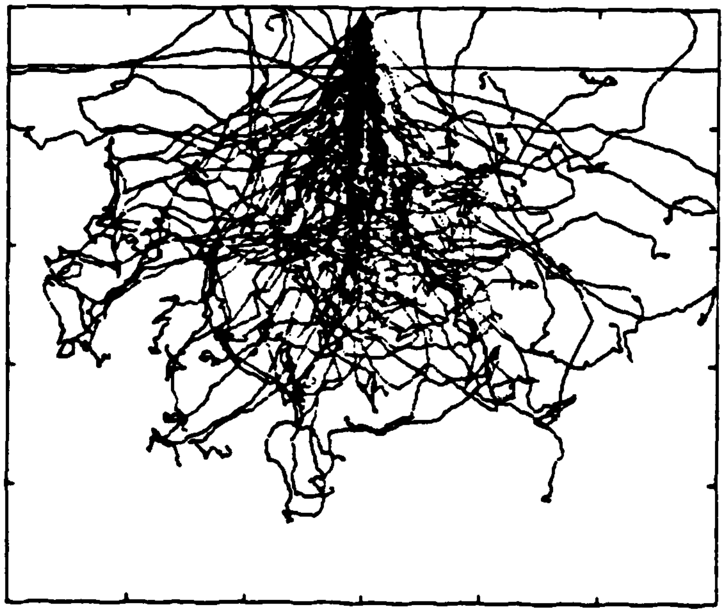
```
EBMF2 EXPOSURE FILE NAME =
ON 21-AUG-84
CHIP SIZE =  3 7500      2 4000
REPEAT DISTANCES =  3 7500      3500 0000
```



```
TOTAL NUMBER OF CHIPS       4
```

Figure 6 : Example Plot of Monte-Carlo Simulation

MONTE CARLO SIMULATION OF ELECTRON TRAJECTORIES



100ELECTRONS at 20.0 keV

0.50 Microns of PMMA on SILICON

14.0 Percent BACKSCATTERED

11.0 Percent REEMERGED

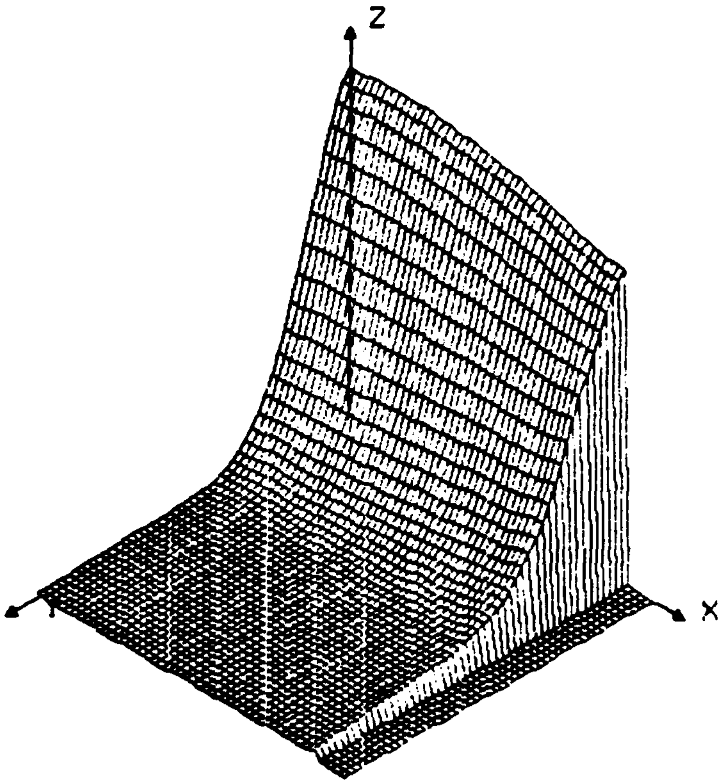
1.00 Micron x grid spacings

1.00 Micron y grid spacings

Figure 7 : Example 3-D plot

DIAW3D -- STOP END OF PLOT

ENERGY DEPOSITION SURFACE FOR 20 keV ELECTRONS



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Abstract A set of plotting routines have been implemented in FORTRAN on DEC LSI-11, PDP-11 and VAX-11 computers to provide a transportable graphics capability to improve data presentation and machine control on vector scan particle beam lithography machines. The routines are general in nature and have already proved to be of use in many scientific applications requiring compact and tailored graphics capabilities within specific programs. This document is designed to act as a User's Guide for the suite. Versions of the routines are available for ReGIS, Tektronics 4010/4014 and SIGMA native-mode graphics terminals.

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