```
/*************************************************************
*   Notes to   CAT3D   updates and development                *
*   CAT3D is a TPS  (Therapy planning System for Radiotherapy)  *
*   © MEVIS Informática Médica Ltda.                          *
*   Chief software developer:  Armando Alaminos Bouza         *
*   Ave. Brigadeiro Luis Antonio 2050,  Cj. 35  CEP 01318-002   *
*   São Paulo. BRASIL - (+55 11) 3148 0267 - www.mevis.com.br   *
*************************************************************/
```

```
 _____________________________________________________________________
|                                                                     |
| IMPORTANT:  Do not overwrite the old version.  Save the old version |
|             before unpacking the new one.                           |
|_____________________________________________________________________|
```

15/01/2001
Bug removed in ROIs projection to DRR-BEV. Evident when gantry angle was close to 45 degrees and ROIs were far from field's isocenter. Bug reported by Dr. Danyel Sobol (Curitiba).

Updated to version 3.61.

01/02/2001
Plateau profile included as an optional parameter.

move to version 3.65

22/02/2001
Multimodality image fusion included. Fusion is an optional module.

move to version 4.00

24/03/2001
Virtual SourceDiameter can be as wide as 300mm
(for internal reflections)

Field Weight now has +-0.001 precision.

Several temporary variables in RADPDD changed from float to double.
Search for SSD (skin location) now with +-0.1mm precision.

F1 now shows info about F5 , ^F5 and Alt-F5. (image fusion)

TMR table computation and display for user analysis.

Bug removed: after F11, while in RSD selection if you pressed ESC, CAT3D tried to compute dose, without dosimetry data base, so an NAN or 0 result was shown.

move to version 4.01.

01/04/2001
Bug removed in pencil beam generation (two calls for Dia2Side() when only one was right) which result in a lack of scattered radiation after integration, -1.6% .
With this correction the difference between FAST and BEST method, for open fields along the main axis, dropped to 0.3%

New: Field entry representation at central axis interception with skin. If the field does not use wedge filter, the entry line color is green. For fields using wedge filters, the color is blue and a triangle is shown if appropriate. The size of the line is equivalent to the field projection at skin level.

version 4.02

05/04/2001

Density Cube:
New pixel density search via: GetDensity3DFast() in module RadDen3F.C. With this search a shorter time is needed for Pencil Beam. See the sample case

	Old		New
Pencil Beam (1, 100x100 mm field)	65s	->	40.5s
DRR beam eye view	105s	->	23 s

PC's RAM size became a main issue, because increasing the amount of memory allocated for the density cube, several results will be even better such as DRR-BEV and pencil beam calculations. Other algorithms, in the near future, could become clients of the density cube: 3D rendering, e-density correction, SSD search, etc.

New: The ray tracing step could be changed for faster DRR processing. Default step is 1.5mm (it was 1.0), and can be set from 0.1mm to 8mm. The greater the ray tracing step, the faster DRR computation. But smaller steps produces sharper DRR images. Ray tracing step smaller than the resolution of density cube do not produces further improvement in DRR images.

move to version 4.03

09/04/2001

Pencil Beam algorithm with two pencil size 4x4mm (the old one) and 8x8mm. The greater pencil size is the faster alternative, the 4x4mm should be use to generate the definitive dose distribution. Dose differences between them are more evident at very low dose levels or close to regions without lateral electronic equilibrium.

The present "Dose Computation Method" are:

```
FAST     (PDD look-up table)
NORMAL   (pencil beam 8x8mm)
BEST     (pencil beam 4x4mm)
```

move to version 4.04

15/04/2001

New: optional information about in air penumbra:

AIR_COLLIMATOR
SourceDiameter alfa1 alfa2 CollimatorTransmision.

The mandatory set of similar parameters inside your data base will be used for modeling water penumbra for fast table look-up and the AIR_COLLIMATOR set will be used for pencil beam processing. If AIR_ COLLIMATOR is not present, both methods use the set in the mandatory block.

For more information concerning this model see: Johns and Cunningham, "The Physics of Radiology", fourth edition, chapter 10, pages 369-371. A deeper approach could be found in: "Radiation Therapy Physics", by William R. Hendee y Geoffrey S. Ibbott, pages 347-350.

move to version 4.05

06/05/2001

Printing services using MS-Windows drivers. All printing process generate binary archives that are read and send to windows' printers by WPRINT.EXE . WPRINT is the printing tool for MSPS and CAT3D, it is called as a new process from CAT3D which goes to background while WPRINT is working. Please, do not return to CAT3D until your printer's driver stop (some printer's driver can't work in background while a 32 bits DOS-extended application is running).

New: Asymmetric fields for CAT3D.
In addition to INPLANE and CROSSPLANE four other parameters have been introduced to set individual positions of each collimator jaw.

```
Inplane head-jaw
Inplane feet-jaw
Crossplane right-jaw
Crossplane  left-jaw
```

Head, feet, right and left are defined according to the jaw direction when the collimator angle is set to zero (0.0) .
When both jaws are set to zero a symmetric aperture is assumed.
No negative values are allowed for jaw positions. If CAT3D finds an asymmetric aperture it checks that

```
Inplane = Inplane_Head + Inplane_Feet
```

or

```
Crossplane = Crossplane_Right + Crossplane_Left.
```

If these conditions are not satisfied, CAT3D assumes symmetric field and set to zero each individual jaw.

move to version 4.50 .

10/05/2001

New: Dosimetry data files (*.RSD) could be set to READ-ONLY mode at operating system level. Versions of CAT3D prior to 4.51 could not work with .RSD files in READ-ONLY mode. For safety reasons, it is better to keep your RSD files in read only mode to avoid accidental errors. (Dr. Jose Renato -Casa de Saude de Campinas, SP- request).

move to version 4.51.

15/05/2001
Several calls to RestoreMouseWindow() inside program loops to avoid problems with mouse when Windows'screen saver enter. I don not know whether this will be enough to avoid the problem.

bug removed in F1-Menu when you try to access F6.

move to version 4.52

30/05/2001
Brachytherapy module:
More lines for the source info window, because planning with more than 10 sources did not fit into window. (Dr. Danyel Sobol reported).

Density cube generates a default 400x400x400 mm phantom so that brachytherapy plannings without CT/MR could be restored. (Dr. Danyel Sobol reported this bug).

X-ray pair: implementation of "goto POI" (CTRL G)

In 3D-Roi: six differents colors when solid Roi rendering is used (Dra. Elisa Singer request - Mevaterapia, Buenos Aires, AR -)

move to version 4.53

18/06/2001
SSD report in Protocol: for dynamic fields the average SSD is computed an reported (Dra. Elisa Singer request - Buenos Aires , AR -)

move to version 4.54

19/07/2001
Improved entry representation when wedge filter is used
move to version 4.55

WDCALC : now computes TMR from the PDD table.
Move to version 2.55

23/07/2001
Faster rendering of wedge filter representation.
move to version 4.56

27/07/2001
Save Plan: some additional parameters are now saved:

- normalization dose
- normalization depth
- target dose
- target percent selected
- active isodose curves, including colors

(Dr. Marcio Tokarski request)
Now "Save Plan" is also available from the Planning Window (^S)
(Dr. Marcio Tokarski request - Campinas, SP, Brasil -)

Bug removed: memory leakage (lack of a free()) when
closing EditGenData()

New: circular cursor, with variable radius for drawing
ROIs/shields with margins. Available inside
"Draw ROI". The cursor radius can be changed
in the middle of the segment so that the margin may
be different for different parts of the target-volume.
Inside "Draw Roi" use the keys " + " or " - " to
modify cursor radius. See cursor radius in mm at the
bottom of the info windows for DRAW ROI.
(suggestion by Dra. Fernanda Martins Souza -Campinas-)

move to version 4.57

28/07/2001
New: DVH (Dose Volume Histogram) for up to three ROIs
simultaneously. Printing available for DVH using
< ^P > .
(Dr. Marcio Tokarski request)
move to version 4.58

05/07/2001
"Draw ROI" remember the last used cursor.
improved interface for "Delete ROI"
Larger windows for "Edit ROI names".

move to version 4.59

16/08/2001
NEW: Planning with different photon energies.
The parameter DEVICE was added to the field settings.
The default device is 0 (zero), it means that the
field is using the equipment selected when you opened
the teletherapy planning. A non zero device means a
field applied with a different equipment or energy.
Legal devices should be registered in the RSD file
which will allow foreign fields.

Example of an RSD file

```
DEVICE  1 = mogi.rsd
device  2 = mv10.rsd
```

Up to 7 device can be registered, from 1 to 7.

move to version 4.60

21/08/2001
Protocol printing shows the device associated with each
field and, at the end, the name of each used device.

ROI services:
the "ROI Info" now shows the name of the ROI, and
the output window is greater to accommodate more
segments.

the "ROI status" now shows if ROI are ON or OFF. Being off that not means that there is no ROIs, it means that they are not shown. "ROI status" commute between On and OFF.

move to version 4.61

30/08/2001
Bug removed: when a Shield File Name was entered followed by one or more "SPACE" chars.
(reported by Dr. Danyel Sobol, Curitiba)
move to version 4.62

16/09/2001
New: Dose Matrix Cache - It saves the computed dose distribution for the last 150 rendered planes. If any field parameter is changed the existing data in dose matrix cache is discharge. Changes in Electron Density Correction, Dose Computation Method, Normalization Depth and the number of static fields for a 360 degrees dynamic field modeling also reset the cache.

The improved performance due to Dose Matrix Cache mechanism is more evident when working with Pencil Beam methods. DVH computation is also very sensitive to cache.

If you want to disable the cache, go to the main menu and select "Options".

01/10/2001
Protocol: now printing:
- Dose Computation Method
- Normalization Depth
- Density correction status (ON or OFF)
(Dr. Marcio Tokarski request)

Mevis' VESA library is VBE 3.0 aware.

Improved isodose drawing close to build-up regions. New checks were introduced to avoid isodose drawing in air close to skin borders.
(Dr. Andrés Bruna request)

3D rendering: <ESC> key available while processing isodose surfaces in 3D. This could be useful when you inadvertently enter a number of net nodes too big. Without the <ESC> command for abort, you had to wait a long time or reboot the PC.
(Dr. Marcio Tokarski, request - Campinas, SP -)

07/10/2001
Improved <ALT-C>: When using the screen capture utility the actual size in mm of the region is reported. A label reporting the width in mm of the capture

rectangle is shown at the lower right corner (W:xxxmm) and the height is presented at the lower left corner (H:xxx.xmm). The size report is active only when the footer option is also active. So, if you want to hide both labels, press <F> or <f>. The <F> key sets the footer option into ON or OFF state.
(Dr. André Bruna, requested to be used in conjunction with a DICOM Printer Server he is using to output films on their CT laser).

Long file name support for <ALT-C>. The BMP files generated using <ALT-C> have a prefix containing the registered patient name. The new functionality is available trough a Win32 executable named "LongFN.exe" .

NEW: Normalization Depth to a user selected POI. It is very useful when the isocenter of any field is covered by the shadow of a protection. Remember not to use any POI without primary photons from any active radiation field. Do not use any POI located in build-up region.

Improved DVH(Dose Volume Histogram), for up to five ROIs simultaneously. The coordinates of the hottest point found are now reported.

move to version 4.66

09/10/2001
Improved DVH (Dose Volume Histogram), with a cursor to reveal detailed information concerning any ROI in the histogram.

Bug removed: The projection of collimator setting into Beam Eye View images (BEV) (function BEV_DrawCollimator()) did not consider asymmetric positioning. Now it is fixed. (reported by Dr. Marcio Tokarski, Campinas - SP)

03/11/2001
Bug removed: Erratic behavior when printing protocols including 8, 16, 24 or 32 fields.

Improved Zoom: When using a zoom (F4) in axial view, if you enter PageUp or PageDown and the next image is also axial view, CAT3D will keep the magnification factor and field of view position, as well as cursors position. (Dr. Juan Romero Acuña, requested - COL, AR -)

move to version 4.68

06/11/2001
Bug removed: Wrong protocol report when using asymmetric collimation on cross-plane.
(reported by Dr. Andres Bruna & Dra. Laura Muchiutti, COL, AR.)
move to version 4.69

11/11/2001

CONTOUR.EXE : New version of Contour supports JPEG input. The old version only accepted TIFF images, but popularization of digital cameras push JPEG as a very important format. Cameras are useful even for those with scanners because big contours over paper are easily digitalized with conventional cameras, on the other hand big flat-bed scanners are very expensive.
Contour now includes an option for ZLevel edition. If you are going to use only 1 plane, left ZLevel unchanged (with 0). For those trying to create a 3D patient using contour drawing, ZLevel must be entered for each plane. In the last case, remember to keep the same patient name (it is case sensitive) and image scale. For 3D processing CAT3D needs 3 planes or more at different ZLevels. Each plane should be supplied with a different file name.
(Updated by Eng. Elga Mellado to version 3.0)

SHIELD.EXE : SHIELD also supports JPEG images as input.
Shield now generates "FULL ATTENUATION REGION" and "PARTIAL ATTENUATION REGION". The old version only included "FULL ATTENUATION" (Shield = 1) or "OPEN REGION" (Shield = 0). A region with attenuation 0.8 means that 80% of the incident primary photons is absorbed inside the shield, and only 20% leaves the shield and reach the skin of the patient.
(Updated by Eng. Elga Mellado to version 3.0)

CAT3D now supports "PARTIAL ATTENUATION REGION" .

CAT3D: Improved algorithm of asymmetric fields penumbra to solve improper results when a collimating jaw was very close to zero or zero.
With the new method, negative jaw positioning is now legal.

(Dr. Marcio Tokarski, detected an improper result when using jaw position of zero, for two adjacent fields).

Maximum number of segments for ROIs drawing grows from 256 to 512. (Dr. Danyel Sobol, requested)

move to version 4.70

29/11/2001

NEW: Movie 3D. In the 3D rendering window the command <M> opens a menu with two entries: <I> for movie initialization and <P> to play the sequence of frames associated with the movie. Prior to movie Initialization configure the 3D rendering in the way you wish to see the movie.
At the moment of this writing, a whole scene generates 20 frames the latitude is constant while the longitude increase in 18 degrees from frame to frame. In the near future more degree of freedom will be available to the user.

move to version 4.72 14/12/2001

In "Resume a Patient", improved plan selection menu with additional information about the treatment and patient.

Variable number of frames to generate a 3D movies.

move to version 4.73

20/01/2002
In "Print used Shields" CAT3D draws the outline of the collimator for the associated field.
(requested by Dr. Renato Ros - CLINRAD/CEPRO + ICAVC)
move to version 4.74

08/02/2002
In the 3D rendering window, new control for dose renderization. Using the command < I > the user is allowed to hide or show the isodose surface and select other dose threshold. If the dose threshold is changed, a few seconds are needed to run the marching cubes routine with the new dose.
(requested by Dr. Renato Ros - CLINRAD/CEPRO + ICAVC)
move to version 4.75

23/03/2002
New: isodose color reference output in the planning window. the color reference also goes to printer outputs. Suggestion by Dr. Eugenio DelVigna.

"Screen Hard Copy" including registered institution name at the top of the page. Suggestion by Dr.Eugenio DelVigna.

"Three Plane View" now available while drawing ROIs. You can switch it on or off using <3> while drawing a ROI. The "Three Plane View" option generates a great demand of CPU time with any mouse movement, so the mouse pointer becomes heavier. The faster the CPU the lighter the mouse movement. If you do not feel comfortable with the mouse in "Three Plane View" mode, switch the mode off with < 3 >. If you need anatomical references in coronal and sagittal view use < 3 > to switch on the auxiliary planes.

Bug removed for Normalization Depth (At a POI). Reported by Dra. Ieda Horst - CLINIRAD - Hospital Angelina Caron.

move to version 4.76

09/04/2002
Faster 3D rendering. Improved algorithm for polygon filling used when rendering solid 3D surfaces.

Better selection of cursor color and box color used in screen capture <ALT-C> .

Bug removed in Gray Level management for images with very few tones (less than 3 levels). Bug reported by

Dr. Danyel Sobol - CLINIRAD - Hospital Angelina Caron.

move to version 4.77

Bug removed: Projection error for ROIs and POIs in Beam Eye View (bev) for various sets of gantry/couch/ collimator angles. Bug reported by Dr. Danyel Sobol, CLINIRAD - Hospital Angelina Caron - Curitiba.

move to version 4.78

/***/

CAT3D - New version running on WIN32. Graphics output via DirectX 5 or newer.

The recommended platform for this new version has changed:

Pentium III 800 MHz or better
RAM 256 MBytes

Windows 2000 Pro (also runs on Windows ME and XP)
DirectX 7.0

Long file names supported. The inclusion of long file names makes impossible to open new plans with versions of CAT3D prior to 5.00 (old DOS32 code).

Customizable labels for Inplane, Crossplane, etc. This capability allows better interpretation of field parameters and protocols. The appropriated labels can be entered via configuration file "CAT3D.INI". Example:

```
Crossplane = X
Inplane    = Y
RightJaw   = X1
LeftJaw    = X2
HeadJaw    = Y1
FeetJaw    = Y2
```

CAT3D now supports:
Up to 256 axial images (the previous versions allowed only 128).
Maximum number of ROI segments is 1024 (previous version allowed only 512 segments).

CAT3D now saves the number of fields used to simulate a dynamic 360 degrees field.

CAT3D now checks for any modification in the active plan, and warn the user if any data could be lost before leaving the plan.

Version 5.00 could connect to remote data disks by using mapped drives.

CLEAN - Skin Contour edition tool now includes other method,

in addition to the old threshold procedure. Some images imported via scanner has a very slight interface air-skin, it was notorious in regions of the orbits. In that case the old threshold method removes tissue from the patient and the user had to use the "Retouch" tool in a rather subjective way. Now the user could take another approach for fussy contours: draw the skin border. The old method is the fast way and should be the right choice for most tomograms but the skin drawing tool will provide a complementary approach for some cases.

Mouse Right Click : Use to control Gray level window. It mimics a wide spread function found on CT and MR workstations.

```
   In the planning window : open the Gray Level Control.
   In the Mosaic window   : open the Gray Level Control.
   Inside the Gray Level Control: Keep the right button
                                  pressed and move up and
                                  down for contrast and lateral
                                  for center.
```

Improved 3D surface rendering. It is 10% faster than previous version.

New 2D isodose level contouring algorithm more stable on several field topographies.

NEW : Tray factors can be included in radioterapy data files (.RSD) The best place is at the end of file. Follows an example:

```
  TRAY   0.978  =  BANDEIXA 1
  TRAY   0.982  =  BANDEIXA 2
  TRAY   0.965  =  BANDEIXA maior
```

This is for a system with 3 trays. Line starts with key word "TRAY" followed for the transmission factor (as a float number) and ends with the name of the tray. The syntax is

```
   <TRAY>  [ [FloatNum] =  [CharString] ]
```

Each .RSD file can define up to 32 trays. The maximum length for tray names is 26 characters. Transmission factors are valid from 0.01 to 0.9999 .

move to version 5.00

NEW: CAT3D now exports shield shapes to VARIAN MLC, 52 leaves, format (IEC scale is assumed).

move to version 5.01

CAT3D exports shield SHAPE in addition to MLC settings in VARIAN MLC 52 leaves format.

move to version 5.02

Dose integration for teletherapy and brachytherapy treatment.

If you need to do the integration, a protocol must be entered for teletherapy so that the total dose of the teletherapy case could be added to the brachytherapy dose.

Bug removed with thick isodose lines, more evident in zoomed views. (bug reported by Dr.Renato Ross, CLINRAD/CEPRO, Sao Paulo).

Bug removed in monitor unit calculations for dynamic fields. It was more evident in arcs with very different SSD at different gantry angles. (bug reported by Dr.Renato Ross, CLINRAD/CEPRO, Sao Paulo).

Default number of fields to simulate a 360 degrees gantry rotation moves to 45 (8 degrees step).

move to version 5.05

The ROI service menu changed:
"Print Segment" changed to "ROI to Shield layout file"

Larger "Shield File Name", now 15 characters long (not including ".PB").

Enhanced tools bar treatment (internal optimization).

move to version 5.06

Bug removed: Device number other than 0 (zero) did not changed the selection list for wedge filters and trays. (bug reported by Lic Andres Bruna - AR).

Radiation Field Editor now saves the edition position so you can navigate trough the radiation fields with the edition cursor over the same parameter.

New data added to treatment plan registration.

```
CLINIC    -> Name of the clinic
PHYSICIAN -> Name of the responsible for the treatment
PHYSICIST -> Name of the physicist in charge fot the plan.
```

For a CAT3D planning workstation which is mainly used by one doctor and one physicist, include this data in the initialization file (CAT3D.INI), so that any new patient start with these setting. Example:

```
CLINIC    = Radioterapia XYZ
PHYSICIAN = John   de Tal
PHYSICIST = Robert Perez
```

The name of the physician and physicist can hold up to 23 characters. The name of the clinic supports up to 31 characters.

NEW: Mouse drag allowed while DRAWING ROIs. Mouse drag capability is mandatory for user of "pen devices" (tested with Genius' "Cordless Natural Pen Device", WizardPen 5x4, USB).

Protocol page format changed. With the new support for Shield file names 15 characters long, a larger field was necessary to accommodate the shield names. So each protocol page now accommodates 6 radiation

fields. Several pages will be printed when the plan contains more than 6 active fields.

move to version 5.07 (January 2003)

New: support for images with more than 12 bits per pixel.
This is not a common scenario but some MR equipment saves 15 bits per pixel generating an overflow condition in CAT3D gray level manager. Our gray level manager works with up to 12 bits per pixel which is enough for most CT and MR images. So, we introduced a pixel depth reduction tool to accomodate 16 bits images into 12 bits per pixels. You will find the image reduction tool in the "Option" entry of the main menu. (bug reported by Lic Andres Bruna - Santa Fe - AR).

move to version 5.08

Bug removed: in function CreateFileListByMask(char *, char *, char **).
module RADTELE2.C
move to version 5.09

BeV dialogue now includes OK and CANCEL buttons. The old <F10> and <ESC> keys are also allowed.
move to version 5.10

Bug removed: When "Dose Computation Mode" was changed without an active plan, CAT3D crashed. Now "Teletherapy Menu" is not available without an active plan (bug reported by Dr. Renato Ros - IAVC / CEPRO)

move to version 5.11 (12/02/2003)

Internal optimization: Temporary files such as *.M1D and *.PBS are deleted before exiting CAT3D, because they allocated several mega-bytes of hard disk space.

Bug removed: If the Shield Selection Window was opened in a new directory, without any .PB file.

Enhanced generation of MLC files (Varian Medical System' multileaf collimator). MLC file format (revisions G / H) supports up to 250 vertex for a shape description. CAT3D now reduces the number of vertex to the limit defined by the "MLC File Format Description" revision G / H (P/N 1106064-03, June 2001).

move to version 5.12 (20/02/2003)

NEW: Automatic ROI search based on Houndsfield Units (HU).
It is a Beta version.
It is a new entry at the level of ROI Menu. You should set a HU Window so that the structure you are trying to draw gets highlighted in red. The HU Window limits are control through the use of arrow keys or the mouse when right clicked. When you are satisfied with the red coverage, point the mouse to a border of

the structure and left-click. An automatic search will be successful if a closed region can be defined otherwise it fails. You can point other border point if needed. When the desired structure is properly outlined in blue you can press <F10> to save the contour in memory.
Use <ESC> to abort Automatic ROI without any modification of the previous ROI data base.

Improved mouse library for SelectRegion() used in ALT_C and Zoom.

move to version 5.13 (beta)(05/03/2003)

NEW: Manual retouch to improve Automatic ROI search capabilities. Some times the Houndsfield Units (HU) algorithm finds a contour that joins two neighbor structures with very close HU. With manual retouch, the user is able to cut the path between both structures. To open the retouch tool, press <INSERT> in the Auto ROI window. Use the mouse, left-clicking, and draw a border to isolate the undesired region. After each left-click, a green dot will be displayed. You can delete the green dots, from last to first (DEL key). Pressing <F10> you close the retouch tool and return to Auto ROI window. (suggested by Dr.Renato Ros, IAVC/CEPRO).

move to version 5.14 (11/03/2003)

NEW: Concerning the Manual Retouch for Automatic ROI search, the use of mouse dragging is now available.
(suggested by Dr.Renato Ros, IAVC/CEPRO).

move to version 5.15 (20/03/2003)

Bug removed: Error in format for "ROI Status". The state of the ROIs was printed overlaying the text "ROI Status" . Fixed

move to version 5.16 (26/03/2003)

Bug removed: The Screen Capture Tool <ALT - C> had an abnormal behavior when used in a context with active Region Clipping for primitive drawing. The problem was evident when you try to use <ALT - C> inside the Dose-Volume Histogram (DVH) window, parts of the selection rectangle were not shown. The problem was fixed by fixing the underlying drawing library. (bug reported by Dra. Fatima Regina Oliveira Dias - CORSB - Blumenau)

The cross line cursor in the DVH window, now shows a vertical line on the Differential Histogram region (dose line).
(suggested by Dra. Fatima Regina Oliveira Dias - CORSB - Blumenau)

NEW: Wedge Position now includes "IN" and "OUT" . Previous versions had support only for "Clockwise" and "Counter Clockwise".

move to version 5.17 (29/03/2003)

Internal change concerning security.

move to version 5.18

Bug removed in CatShell.EXE for water phantom generation (move to version 11.2 of catshell)

update in the brachytherapy module:
   .bug removed for Cs sources isodoses in X-ray pair images.
   .better support for long file names (x-ray pairs).
   .better CT slave reconstructions showing the cursor position in CT space (coronal and sagital views).

move to version 5.20   (2/05/2003)

Internal optimizations:
   -function round() was translated from C to pentium assembly, as a result round() became 50% faster.
   -faster GetPencil() for pencil beam convolution, some code was translated into assembly.
   -faster GetDensity3DFast() with some code translated to pentium assembly.
   -faster GetFastProfile() translated into Pentium assembler as inline code.
   -new version of GetPrimaryBeam, now returning float in the range [0..1] (GetPrimaryBeam_f) .

   As a result, the pencil beam convolution became faster:

         Pentium 2 400MHz   - 62% faster
         Pentium 3 1.0GHz   - 60% faster
         Pentium 4 1.8GHz   - 50% faster

New parameter for CAT3D.INI : The parameter EXPORT in the file CAT3D.INI, sets the path used to save .BMP images taken with the capture utility <ALT - C> . Previous versions of CAT3D saved the BMPs in the same path of the program (usually c:\cat3d). The new approach promotes a separated directory for saving .BMP images, which is easer an safer. Example:

         EXPORT = C:\CAT3D_EXPORT

If the item EXPORT is not found in CAT3D.INI, the BMP images are saved in the CAT3D directory (old fashion behavior).

move to version 5.22 (21/05/2003)

"Path Selection" now includes entries to change all the useful path: Working Path, Fusion Path and Export Path.

Now CAT3D sorts the wedge control points by its offset from the main axis. Prior to this version the user had to enter the control point from negative offsets to positive, and sorted. The only relevant detail is that negative offset corresponds to greater transmission factors in order to obtain a coherent clock-wise position

move to 5.23 (15/06/2003)

NEW: Gantry angle customization. For equipments with non SI gantry angle scale, two new configurations parameters were included in CAT3D.INI: GANTRYZERO and GANTRYROTATION .

Standing in front of the gantry the SI scale looks like:

```
          0

   270         90

          180
```

If your gantry scale looks like the previous one, do not use GANTRYZERO of GANTRYROTATION. If the gantry scale differs you could use the new parameters.
Example of non SI gantry scale:

```
          180

   270         90

          0
```

for the previous gantry scale include the following two lines in CAT3D.INI

```
GantryZero = 180
GantryRotation = -1
```

(requested by: Lic. Leopoldo Mazzucco - Rio Cuarto - and
Lic. Andres Bruna - Santa Fe -)
move to version 5.24 (03/07/2003).

NEW: Image alignment process is now optional when starting a new planning. Alignment is needed for images imported via film scanner. If your tomograph were imported via DICOM, or any other proprietary CT/MR file format, alignment is not necessary.
Alignment is only useful if you have two well defined reference markers in each tomograph. Such references could be two parallel thin copper wires along the CT couch. A distance of 200 mm between the wire is a good choice. The wires also provide an internal calibration to check the image scale supplied by the CT/MR file.
(requested by: Eng.Carlos Caballero - Valley Radiation Oncology -Phoenix. AZ. USA).

move to version 5.25 (10/07/2003)

Pencil beam calculations now goes to a depth of 600 mm. Previous versions only reached 400 mm depth. Any depth beyond the measured PDD is generated by extrapolating the tail of PDD as an exponential function. This modification only affects patients with big cross sections (diameter > 400mm).
(the report of limitation in Pencil Beam calculation depth came from Dr. Marcio Tokarski - Casa de Saude de Campinas + Fornecedores de Cana de Piracicaba).
move to version 5.26 (11/07/2003).

Bug removed: File name edition in "Roi to Shield File" allowed an empty file name. Now a file name with more than 1 character is mandatory.
(detected by Dr. José Galdino Ulysses. ASCOMCER - Juiz de Fora, MG.)

move to version 5.27 (17/07/2003)

NEW: The number of slices for image fusion move to 256 per series (previous version was 128).

move to version 5.28 (23/07/2003)

Faster 3D surface rendering. The performance gain depends on the CPU type. Some test shows that surface rendering became 70% faster. Functions GetXPort() and GetYPort() were translated into assembler, and several calls to malloc() and free() were removed from FillPoly3D() which is the most important graphics function for 3D surface rendering. A minor gain came from the use of Windows' Memory Mapped File technology.

Faster projection of slices into de 3D windows.

NEW: axial, sagital and coronal slices can be projected in the same 3D view. <F7>, <CTRL-F7>, and <SHIFT-F7> became ON/OFF controls.

NEW: Light diffusion control for 3D surface rendering.

NEW: The Movie service inside the 3D Rendering Window now export the whole series, frame by frame to Windows Bitmap files (.BMP), so that you can create and edit AVI files. AVI files are one of the video formats widely supported in the Windows environment. You can use the .BMPs to create AVI clips with the help of any video clip edition tool, such as AviEdit. You can download AVIEdit from the site of its author, Alexander Milukov at:

www.am-soft.ru/aviedit.html

NEW: Mouse control improved inside form-editor. The most important use of the form-editor inside CAT3D is the Field Editor (activated with <F11>). Now you no longer need to move the edition parameter with TAB or CR or Up/ Down Arrow, use a mouse click to skip from one parameter to the other.

move to version 5.29 (07/08/2003)

NEW: Several factors for each wedge filter. The original sintax for wedge filter definition was:

```
NumberOfControlPoints     WedgeName
offset1       offset2..   0  offseti ... ofset_NumberOfControlPoints
val1          val2..   wedgefactor    val_i.. val_NumberOfControlPoints
```

where offset were distances to central axis in mm, projected to the Source Isocenter Distance (sid) of the machine. Only one wedge factor was allowed, the one at the offset zero (central axis).

The new sintax has optional parameters:

```
NumberOfControlPoints   WedgeName   WOF     NumberOfFieldSize
offset1     offset2..   0  offseti ...  ofset_NumberOfControlPoints
val1        val2..      wedgefactor val_i.. val_NumberOfControlPoints
FieldSize1  FieldSize2...     FieldSize_NumberOfFieldSize
wedge_fac1  wedge_fac2...   wedge_fac_NumberOfFieldSize
```

The word "WOF" if like a flag, telling CAT3D that the values (val_i) are not normalized to any wedge factor so that they form a relative wedge profile. The actual wedge factors are defined in the last line. Wedge factors for up to 16 field size are allowed.

move to version 5.30 (11/08/2003)

Improved selection frame inside Image Fusion. The new selection frame is mouse oriented.

BUG removed: Printing shield files when the image directory (working directory) contains white spaces in the middle of the path, for example:

c:\CAT3D\RTPIMG\Pedro Perez Martines\

Some changes were done in CAT3D itself and some others in WPRINT.EXE, the new version of WPRINT.EXE moved to 1.50. (bug reported by Dr. Marcio Tokarski - Casa de Saude de Campinas)

move to version 5.31 (19/08/2003)

NEW: SSE optimization ! . Now CAT3D check the availability of SSE support at startup. If SSE support is present, some procedures have been optimized for SSE technology. SSE is a new technology introduced by INTEL in the Pentium 3, which allows 4 floating point operations (single precision) to be executed with a single CPU instruction, in parallel. They were introduced to improve floating point processing with Pentiums (IA-32).

Bug removed: In 3D surface rendering with very big magnification.

move to version 5.32 (02/09/2003)

NEW: Check for file overwrite when exporting a ROI to Shield Definition File. This avoid the inadvertently destruction of a previous .PB file, sometimes from other patient's treatment. (sudgested by Dr. Renato Ros. CEPRO and ICAVC).

move to version 5.33 (05/10/2003)

NEW: Copy/Paste radiation fields. Inside the fields editor, <CTRL C> copies to a clipboard the field parameters. Then you move to other field position and press <CRTL V> which will paste the content of the clipboard to the present field. The paste command ask for instructions regarding field orientation in relation to the original field. If you are copying to a parallel opposed field, the gantry angle will change in 180 degrees, the shield will be mirrored and the wedge position will be rotated in 180 degrees. Every <CTRL C> replace the content of the clipboard. If the <CTRL C> command is entered over a non used field, the clipboard will be

empty of its content.

move to version 5.34 (10/10/2003).

Bug Removed: In the window for wedge filter selection, the was a label showing a wrong value for the wedge factor. Now the label shows the name of the filter followed by the wedge factor for field size 100x100mm .

move to version 5.35 (19/10/2003)

NEW : The DICOM.EXE (Dicom Filter) now opens native images from Toshiba Asteion CT.

The Dicom filter can open a images passed as command line parameter. With this addition you can "drag and drop" dicom images into the Dicom filter's icon in the desktop. Also, you can associate the widely accepted dicom extension, "*.DCM", with the program DICOM.EXE to open. When you call Dicom.exe with an image file as parameter, it looks into the file for the patient, study and series information in order to process the whole series.

Dicom.exe move to version 3.46 (03/12/2003)

Minor improvement for CAT3D : The validation check after POI table edition used to limit the Z range from -400 to 400. The present version goes from -400 to 1200 mm. I got into troubles with patient scanned from the pelvic region to the neck so the top Z was close to 600. (limitation reported by Armando Alaminos).

move to version 5.36 (09/12/2003).

NEW: Penumbra model in water. The penumbra model in water now support direct measure data in addition to the equation model (see, Johns and Cunningham, "The Physics of Radiology", fourth edition, chapter 10, pages 369-371. A deeper approach could be found in: "Radiation Therapy Physics", by William R. Hendee y Geoffrey S. Ibbott, pages 347-350). The water penumbra description goes into the radiotherapy system data file (.RSD) and the sintax is as follows:

```
WATER_PENUMBRA
number_of_penumbras

FieldSize_at_isocenter_level     ssd     depth   numbre_of_control_points
x0     x1    x2 .....   xnumber_of_control_points
r0     r1    r2 .....   xnumber_of_control_points


FieldSize_at_isocenter_level     ssd     depth   numbre_of_control_points
x0     x1    x2 .....   xnumber_of_control_points
r0     r1    r2 .....   xnumber_of_control_points

.
.
.
until number_of_penumbras
```

x0, x1, ... are distance from the central axis at the depth of measurements
r0, r1, ... are ionizations reading for the corresponding x0, x1,...

The control points in one penumbra must be ordered, so that:

x0 < x1 < x2 < .... xn

Lets see one example :

```
WATER_PENUMBRA
4

50      1000    50      12          (FieldSize=50mm    SSD=1000mm   Depth=50mm No.Points=12)
10      15      20      25      30      35      40      45      50      60      100     200
82.1    81.6    78.8    55.9    15.5    4.3     2.9     2.0     1.5     1.0     0.3     0.1

50      1000    200     11
5       15      20      25      30      35      40      50      75      105     200
32.4    32.1    31.7    29.5    19.4    6.5     3.2     2.1     1.0     0.5     0.04

300     1000    50      16
125     130     135     140  145   150  155  160  165   170 175  180 185   190 195  200 225
93.9    93.6    93.4    92.8 91.8 88.5 64.0 22.3 11.4  9.5 8.2  7.3 8.4   5.8 5.4  4.8 3.1

300     1000    200     19  (FieldSize=300mm SSD=1000mm  Depth=200mm No.Points=19)
65      90      100  110  120  130  140  150  160  165  170  175  180   185   190   195  200  210  225
45      44.7    44.3 44.1 43.8 43.2 42.5 41.8 40.5 39.7 38.7 35.5 22.9  12.2  9.7   8.7  7.8  6.5  5.2
```

The limitations of the model are:

maximum numbre of penumbras	:	256
maximum numbre of points in one penumbra	:	128
maximum numbre of depth for one field size	:	32
maximum numbre of different field size	:	64
minimum difference between different field size	:	0.1 mm

Bug removed: In the radiation field editor due to an error in the library (grtext.lib) .

move to version 5.37 (04 /01 / 2003)

Bug removed: When using "New isodose surface" inside de 3D rendering windows, the number of node was modified by the number of nodes used for anatomy rendering. Now the number of nodes for isodose surface remains constant

Bug removed: Problem when printing a protocol if CAT3D is installed inside a directory with path including white spaces. For example, if you install CAT3D in one of the following directories:

c:\arquivo de programas\cat3d
c:\program files\cat3d

This bug was removed, but it is not recommended install CAT3D

in those complex path. The author recommends the following directory:

c:\cat3d

NEW : Hide or Show Isodoses with "Ctrl I" (^I). In previous version the user had to use a big normalization number when isodose curves were not necessary, for example drawing roi-shields in beam eye views. (suggested by Renato Ross, Marcio Tokarski and others).

NEW: Support for ELECTRON Beams

Dose computation algorithms for electron beams:

FAST : PDD table look up and profile look up. Correction for output factor dependace with SSD, using de air gap factor method (AAPM Task Group 25 Repor). The introduction of WATER_PENUMBRA data is mandatory for electrons. The FAST method gives poor result with protection, oblique incidence or tissue heterogeneities.

Pencil Beam 4x4 : Convolution of a pencil beam generated from the PDD table. The PDD for zero area field must be present in the user supplied table. The PDD for zero area can be generated from a exponential function like:

$$PDD(0,z) = 100.0 * \exp(- A * z)$$

and the constant A can be derived from the (PDDbk) background level and the (Rp) practical range.

$$A = - \frac{1}{Rp} \ln \left(\frac{PDDbk}{100.0} \right)$$

Corrections for irregular fields or protections are satifactory. For oblique incidence there is a limited correction, which is not enough for electrons. It only computes changes in SSD for voxels in the main axis of the pencil beam. Correction for output factor dependace with SSD, using de air gap factor method.

Maximum Precision Convolution. Pencil Beam 4x4mm :
This is the most rigorous convolution, taking into account changes in SSD for pencil beams far from the deposition point. It is also the most time consuming method. Correction for output factor dependace with SSD, using de air gap factor method. This is the method of choice when using electrons.

The user must supplied data regarding output factor versus SSD, which is used by the air gap factor method.
The sintaxis of this data is as follows:

```
OUTPUT_FACTOR_VERSUS_SSD
N_Number_of_Fields       M_Number_of_SSDs
Field_1    Field_2...    Field_N
SSD_1      SSD2 ...      SSD_M
D_f1_ssd1  D_f2_ssd1 ...   D_fN_ssd1
D_f1_ssd2   D_f2_ssd2 ...  D_fN_ssd2
.
.
D_f1_ssdM ..............  D_fN_ssdM
```

follows and example :

```
OUTPUT_FACTOR_VERSUS_SSD
10    5             (Number_of_Fields    Number_of_SSD - field of 100x100mm ssd=1000mm must
be present)
20     40     60     80     100    120    150    180    200    250    (Field sizes)
950    1000   1050   1100   1150                                       (SSDs)

46.20   68.26 78.09   83.80      87.85  90.75   93.91 96.37  97.60 100.15
33.72   59.34 70.08   75.96      79.54  81.77   84.08 85.75  86.62  88.85
29.81   51.50 61.03   66.76      70.64  73.54   76.65 79.12  80.32  82.72
23.31   44.65 54.84   61.08      63.69  66.37   69.49 71.72  72.99  75.48
18.54   37.67 47.71   53.63      57.42  60.35   63.22 65.29  66.32  68.21
```

You can mix photons and electron beams in a planning. I sudjest to register electron data files as known devices inside photon data files. Using the device sintax previously defined. Follows an example:

Device 1 = Elec_07MeV.rsd

The electron beam support is part of an optional module.

move to version 5.50 beta (it is consider a beta version)

NEW: In "Draw ROI Segment" and "Auto ROI" :

<Page UP> and <Page Down> can be use to close a ROI segment and continue drawing in the neighbor slice. This is a shortcut for the following set of commands:

F10 , PageUp, ^F3, CR, CR

When PageUp or PageDown are used, CAT3D keeps the same ROI number for the next segment. For the last segment of the ROI, use F10.

move to version 5.52 beta

NEW: In Draw ROI - When using the circular cursor the Windows' mouse cursor is now followed by a satellite circular cursor with the same diameter as requested by the user in mm. With this addition shield drawing can be accomplished using the mouse, taking into account the safety margin.

move to version 5.53 beta

NEW: For electron fields. Any electron field is normalized at skin (depth of the maximum dose). If you have a mixed plan with photons and electrons and you set the Normalization Depth to isocenter, that will be the method for photon fields, but electron fields will be normalized at skin.

NEW: Different dialog for image scale calibration <F9> . The program ask more questions to avoid inadvertently use of F9. Some user accidentally press F9 when they were trying to press F10, as a result pixel size of each image was modified the wrong way. We hope that the new verbose dialog will help to prevent this mistake.

Some improvements regarding incompativility issues with old DOS file names in old plans

move to version 5.54

NEW: Equipment name printed at the footer of printouts

Improved algorithm for maximum precision convolution (important for e-)

move to version 5.55

NEW: Optimization for INTEL Pentium 4 with Hyper-Threading (HT) Technology.

The new generation of INTEL processors support hyper-threading, which allows one (1) physical CPU to execute two (2) threads concurrently. The HT physical CPU is presented to the operating system as two (2) logical processors (or more logical processors in the future).

With this new version of CAT3D and its supporting library (WinLib) we start a process toward multi-threading migration. The first visible change is the new ability of CAT3D to compute in the background (for example, start a long dose-volume histogram calculation and switch to your text processor or any other application while CAT3D works).

move to version 5.56, 02/02/2004

NEW: Mouse control for the Dose-Volume Histogram cursor: click on the cumulative curve of your choice.

NEW: Integral Dose computation. Goto to the "Teletherapy Menu" (of the fx icon in the icon bar) and select "Integral Dose". Integral Dose is shown in cGy * cm3 (cm3 = cubic centimeter). The user should enter target percent selected and the target dose at that isodose. The previous two parameters are shared with the Protocol, so the values you enter for Protocol is used for integral dose and vice-versa. Two levels of precision can be used, voxels of 1 cm3 or voxels with 0.125 cm3. The smaller the voxel, the higher the precision and longer computation time. The computation time also depends on the dose computation method.

The supporting library (WinLib) now checks for Hyper-Threading capability in the CPU. WinLib move to version 3.04.

move to version 5.57 (06 / 03 /2004)

Improvement : Mouse control for Retouch (inside Clean Image). Move cursor using either keyboard or mouse and paint using either <CR> or mouse click.

In "Clean Images" , inclusion of PageUp and PageDown, for moving backward or forward between de images.

move to version 5.58 (15/ 03/ 2004)

NEW : CAT3D respond to mouse wheel. Mouse wheel is available for file selection, menu navigation, etc. The Cross Section Anatomy and some image filters also became mouse wheel aware.

move to version 5.59 (20 / 03 / 2004)

NEW : Clean Image now has a table (couch) top level control , to help image cleaning. (requested by Dr. Lucia Helena Bardella and Dr. Delano Batista)
move to version 5.60

Bug Removed: A red vertical line was left at the right limit of the table level indicator. Now it is OK. (reported by Lic. Andrés Bruna).

move to version 5.61

Bug removed: DVH tried to work with ROI Status in OFF, so it failed. Now the DVH routine check for ROI Status and reject the task if ROI Status is OFF. (reported by Dr. Márcio Tokarski).

NEW: In "ROI to Shield layout file", the questions about magnification and mirror were removed, because they are no longer needed.
move to version 5.62 (10/04/2004)

Optimization: Faster implementation of function GetPencil(radius, depth). This function is the foundation of all the convolution methods. I wrote two codes, both in assembler, one that is common to all the Pentium family and is the new used code, it is 7% faster. I wrote a Pentium 4 only solution using SSE2 instructions which is 12% faster but only executes on Pentium 4, so I will wait until more CAT3D users updates their CPUs to Pentium 4.

Bug removed: DVH opened the dialog when there was no ROI defined. Now it checks and abort if no ROI was entered.

NEW: <ESC> added to abort Dose Volume Histogram computation.

NEW: Security issue: if you had an opened plan and changed the working path there was the risk of saving the plan in a path different from the patient images. Now it ask to save the plan just before the working path is changed.
move to version 5.63 (14/04/2004)

NEW: Transparency control for fusion. The foreign pixel (from MR, SPECT or PET) is transparent if it is

pixel value <= Tr Low
pixel value >= Tr High

The user can change the TrLo and TrHi inside the Bright/Contrast window, using

<T> or <^T> respectively.

(suggested by Dr. Jorge Nagel - Instituto Gamma, Rosario - AR).

Some bugs removed from the fusion module.
move to version 5.64 (20/04/2004)

NEW: Patient Position Setup. There was inconsistency when the patient was in ventral decubitus, regarding the text information to the left side of the planning window. Now, the user can setup the actual patient position when in the Mosaic window, using <ALT - F9>. CAT3D must use a caudal view of the patient (form feet to head). Legal patient positions are:

Dorsal Decubitus :

ANTERIOR

R L
I E
G F
H T
T

POSTERIOR

Ventral Decubitus :

POSTERIOR

L R
E I
F G
T H
T

ANTERIOR

For any other position CAT3D will make a "mirror" operation on all the images which is equivalent to a reversion of the point of view. If Patient Position is changed after POIs and ROIs were entered, CAT3D will try to fix all POIs and ROIS to the new position. Radiation fields are not fixed by

CAT3D, so check all of them. HINT: Set the patient position at the very beginning of the planning.

Improvement: CAT3D will try to fix all POIs and ROIS, after Z inversion. Radiation fields are not fixed by CAT3D, so check all of them.

HINT: Set the patient position at the very beginning of the planning.

move to version 5.65 (15/05/2004)

NEW : A shortcut to draw protection shields. Now you can draw a ROI to be used as SHIELD, so CAT3D linkes the operation of "Draw ROI" and "ROI to Shield Layout file" . It is a faster way for drawing conformal protections in DRR beam eye views. (suggested by Dr. Pedro Paulo Pereira – Radioterapia Botafogo - Rio de Janeiro).

In Mosaic: control via mouse double click.

move to version 5.66

NEW: No need to type patient name and plan file when you start a new planning. Now CAT3D ask you to select the CT/MR image set and look for the registered name inside the image header. Of course, you can modify than names, but most of the times you will save 40 key strokes.

move to version 5.67

NEW: Some additional monitor units styles for Co-60 machines. If you need monitor units such as MINUTES : CENTI_MIN, there is a new configuration parameter for RSD files:

MONITOR =

possible case are:

MONITOR = MU (used for LINAC and Co in centi-minutes)

MONITOR = MIN:CENTI (minutes : centi_minutes)

MONITOR = MIN:SEC (minutes : seconds)

MONITOR = SECONDS (seconds)

For Linacs the only valid format is MU

(suggested by Lic. Angel Meneses, Liga Dominicana Contra el Cancer, INC.)
move to version 5.68

Bug Removed: In "Set Isodoses" if the user entered the same isodose twice, CAT3D behavior was unpredictable. The problem was fixed. (Reported by Dr. Alvaro and Dra. Daniela from Centro Oncologiaco de Mogi - SP).

NEW : Better modeling for the air collimator penumbra. Several sets of air collimator parameters for different field sizes are allowed. It was noted that optimum parameters for air penumbra representation depends on field size. For that reason the new model allows for the use of up to 32 field

size. The new syntaxis is an extension of the previous syntaxis.

The old syntaxis was:

```
AIR_COLLIMATOR
SourceDiameter  alfa1  alfa2   CollimatorTransmision.
```

The new syntaxis is

```
AIR_COLLIMATOR   N
FieldSize1   SourceDiameter1  alfa11  alfa21   CollimatorTransmision1
FieldSize2   SourceDiameter2  alfa12  alfa22   CollimatorTransmision2
   .
   .
   .
FieldSizeN   SourceDiameterN  alfa1N  alfa2N   CollimatorTransmisionN
```

A good approach is to optimize a set of parameters for the minimum used field size, may be 40x40mm, another set for a 100x100mm field and a last set for a big field, such as 300x300mm. More sets are allowed (up to 32) but this 3 should be reasonable minimum.

This information is used when Convolution of Pencil Beams is used.

move to version 5.69 (01/07/2004)

Interface modification: The selection of possible normalization depth has changed. The text "Normalize at Skin" was changed to "Normalize at depth of maximum dose". (suggested by Lic. Angel Meneses, Liga Dominicana Contra el Cancer, INC.)

New: Planning is open with the 3 planes view active.

move to version 5.70 (07/07/2004)

Improvement : When a ROI segment, very big and complex, was drawn by dragging the mouse, the number of vertex overflowed the capacity (9000-1). The new capacity was set to (16k - 1 = 16383) vertex. In the improbable case of reaching the limit, the segment will not grow any more and the user have to close with F10, or delete some vertex with DEL and finish with mouse clicks not by mouse drag any more. Improved limit check. (limitation reported by Renato Ros, IAVC & CEPRO)

NEW: Command line parameter for CAT3D. Now CAT3D accept two type of files as parameter: .HIS and .RTP . With this option you can open saved plans by passing the .HIS or .RTP file to CAT3D. The working path will be set to the path containing the parameter. If you try to pass a .HIS form MNPS or MSPS, CAT3D will not open the plan, only plans saved with CAT3D. All versions of Microsoft Windows allows to link the mentioned file extensions with CAT3D. If you want to make the link, use the Explorer and right-click any RTP or HIS file, select "Open With" and look for CAT3D.EXE.

Improvement : CAT3D now checks if any previous plan exist for the same image set. If there is a plan, CAT3D generates a warning message to help the user avoid duplicated processing. If a new plan is started using images already in use by a previous plan, CAT3D will propose a different "Plan File Name" for the new plan. This avoids overwriting the previous plan. (suggested by Renato Ros,

IAVC & CEPRO)

move to version 5.71 (02/08/2004)

New: Windows with vertical scroll bar now responds to mouse click bellow de thump or above the thump, it is equivalent to PageDown or PageUp.

New: Better interface for "Set Isodoses" . Graphic selection of colors. Only one Window (dialog box) for setting up the color of each isodose, the labels and the width of the isodoses. The same procedure is shared with brachitherapy.

New: Brachitherapy isodoses with color reference and two line widths.
Cat3D now saves brachitherapy isodoses and colors, and implant time.

WinLib move to version 3.06
move to version 5.72

New: The colors of the field entry and wedge are better change for background white or black. The wedge filter is now light blue or dark blue depending on the active background. Yellow is not used any more due to problems with white background.

NEW: CAT3D now saves the last color set used and loads that set when it starts. This allows the user to keep a choice of colors of his/her preference.

Bug Removed : WPRINT did not print several copies of a protocol. Now it is OK. Correction by Eng. Elga Elena Mellado, WPRINT move to version 1.06. (05/08/2004)
(bug reported by Eng. Cesar Picon, Lima , Peru.)

Bug Removed : When using "Resume a Patient" from inside CatShell, the operation failed if the path to the plan had blank spaces. Corrected by Eng. Elga Mellado Quinones (bug reported by Eng. Cesar Picon, Lima , Peru.)

move to version 5.73

NEW : In WATER_PENUMBRA the maximum number of data points for a penumbra increased from 128 to 256.

maximum number of points in one penumbra : 256

Bug Removed: The parser that process .INI and .RSD files failed if there were very long lines (500 columns or more). Corrected.

Bug Removed : When CAT3D was launched by a double click over an RTP file, it generated an error loading the RSD file. Corrected.

Select segment was improved (it now select segments that are not hidden);

The number of vertex allowed for a Shield definition file was limited to 1024. Now it changed to 4096 vertex for region. If the ROI used to generate a shield has more than 4096, CAT3D will try to reduce the number of vertex. It will remove redundant vertex or vertex lying over a line. The wprintf was also corrected to accept 4096 vertex, ver 1.07. (reported Lic. Silvia Adamo - Mevaterapia - Buenos Aires - AR).

move to version 5.74
17/09/2004

Optimization: Faster algorithm for the circular cursor used to draw shields. Removal of unnecessary calling of function GetTrans23(). It is possible that these optimizations improve the movement of the mouse for those users using continues mouse drag.

NEW: CAT3D now supports a command line parameter to request for its version number: /V .

move to version 5.75
08/10/2004

NEW: The icon bar for "Draw ROI" now includes next and previous image, which is equivalent to PageUp and PageDown.

NEW: "Resume a Patient" now shows three additional fields: Diagnosis, if the plan is open and who is working or who was the last computer to open the plan. If the plan is open by other computer, CAT3D will not open such plan until it is closed by the other user. This is useful for those using a central patient data base with several CAT3Ds or simulator accessing from a network. The CATShell program also has this behavior.

NEW: Shadowed isodoses. CAT3D now renders shadowed isodoses if the user set the shadow parameter to a number between 1 and 5. If shadow is set to 0, the default isodose lines will be displayed. The shadow parameter is accessible in the "Set Isodoses" menu.

NEW: CAT3D generates animated gif files when the export option is used for 3D animation. Previous versions of CAT3D exported a sequence of frames as BMP files and the user had to create and edit an AVI. Now the process is strait forward: CAT3D do it all. The resulting gif files are saved in the "Export" directory and they can be used in presentations (PowerPoint, OpenOffice, etc), HTML files and web pages. (Dr. Marcos Antonio da Silva suggested to use animated gif – From Maringá - PR - Brasil).

BUG Removed : POIs projection on DRR/BEV did not take into account the divergence of the beam. The error was zero for POIs in the plane of the isocenter and grew for POIs far from that plane. (reported by Lic. Leopoldo Mazzucco - Rio Cuarto - AR)

move to version 5.76 (03/11/2004)

NEW: CAT3D updates its windows caption so that you have information about the plan file loaded for each instance of CAT3D. This is useful when several instances of CAT3D are running, now you know which plan is active in each instance.

Better isolation of dose data cache for several instance of CAT3D running simultaneously. This is a safer approach, it can prevent some errors reported from users that run several CAT3D simultaneously.

Better treatment of protocol when using mixed energies.

NEW: Brachytherapy the range check of activity or kerma was modify to support I6702 seed with low activity.

NEW: DVH for Brachytherapy.

Various geometry parameters can be included in RSD file, so that different machines can use its own angle definitions:

GRANTRYZERO, GANTRYROTATION, COUCHZERO, COUCHROTATION

Previous versions of CAT3D read these parameters only once from CAT3D.INI. Now CAT3D looks for these parameter in each RSD, if not found the setting in CAT3D.INI is used.

move to version 5.77 beta

Check and emit a warning if the maximum image capacity if reached.

NEW : Improved monitor unit calculation with Head Scatter Factors. Previous versions of CAT3D consider that head scatter factors were constant for conmutations of jaws. The previous model is not good in general, mainly for elongated fields. That is, for a rectangular field , (a x b) :

Sc(a,b) != Sc(b,a)

To support the new model you can introduce the clause :

AIR_OUTPUT_FACTORS

The sintax is:

AIR_OUTPUT_FACTORS

n (Number_of_diff_fields_size_that_follows)

inplane1 crossplane1 factor1
inplane2 crossplane2 factor2
.
.
.
inplane_n crossplane_n factor_n

Limits of the model:
Maximum Number of different square fields = 64
Maximum number of different fields in general = 128

The following is an example from a real Linac, Primus with 15 MV X-rays.

```
AIR_OUTPUT_FACTORS
30        (number of different field sizes)

30         30     0.860              (inplane   crossplane   OF)
40         40     0.918
50         50     0.945
60         60     0.962
70         70     0.975
80         80     0.985
90         90     0.993
100        100    1.000
120        120    1.011
150        150    1.022
180        180    1.029
200        200    1.032
250        250    1.037
300        300    1.040
350        350    1.042
400        400    1.046
400        30     0.937
400        50     0.991
400        80     1.017
400        100    1.025
400        150    1.034
400        200    1.039
400        300    1.041
30         400    0.907
50         400    0.969
80         400    1.001
100        400    1.012
150        400    1.029
200        400    1.038
300        400    1.044
```

For reference on the underlying model and how to measure the relative air output factors see: "Monitor Unit Calculations with Head Scatter Factors" by Kwok Leung Lam and Randall K. Ten Haken, in : "Monitor Unit Calculations for Photons and Electron Beams" edited by John P. Gibbons. A.M.P., Inc. 2000 .

- The order of protocol page was set as the field editor (first INPLANE followed by CROSSPLANE) .

- CAT3D generates a text file with every situation of the profile tool. This could be useful for commissioning. The text file is named :

"Profile_Data.txt"

and stored inside CAT3D directory. There are two columns, the first is offset from the origin of the profile and the second is the value of the function being scanned. Possible values are teletherapy dose, brachytherapy dose, Tele+Brachy dose or pixel values. The file "Profile_Data.txt" is continuously overwritten, so if you want to save a position: stop the cursor movement, switch Windows file manager, and copy/rename the file to other name.
(suggested by Lic. Andres Bruna).

move to version 5.77.2 beta

The step of the profile can be changed via CAT3D.INI, using the key word:

    PROFILE_OUTPUT_STEP

The valid range for this parameter if [0.5 .. 10] mm. If the value is outside the valid range, the default is preserved , 1.0 mm.
Follows an example that sets the step to 2 mm :

    PROFILE_OUTPUT_STEP = 2.0

move to version 5.77.4 beta (21/12/2004)
move to version 5.77 (release version)

NEW : For the multi modality image fusion, "Import ROI" was introduced
Use <ALT - F5> to import ROIs that were previously drawn in the other modality.
That option was already available in MNPS (c)MEVIS, for radiosurgery planning.
Be careful, the imported ROIs overwrite all the previous ROIs drawn, so if you plan to import ROIs, do it first and after that draw the additional ROIs.

move to version 5.78.1 beta (31/01/2005).

After "Delete ROI" the name of the deleted roi remained in the "Edit ROI Name" window. Now the name of the old ROI is also deleted.

CAT3D now stores the color of the POIs, as set in "Options" at the main menu level. It also stores the size of the font used for POIs labels

Field #1 is the default field number when CAT3D starts, instead of field #0.

Correction for the scatter contribution from a pencil with non unit density.

move to version 5.78.2 beta (09/02/2005).

Better selection of ROI segment when trying to delete a segment. A bug was found in the algorithm to measure the distance between a point and a line segment in 3D. A new algorithm was implemented, slower but safer.

move to version 5.80 (11/02/2005)

A bug was found when moving the working path from a directory with shield files to a directory without shield files. The bug crashed CAT3D when you closed the Field Editor after using <F10> . Reported by Leopoldo Mazzuco.

move to version 5.80.1 (17/02/2005)

BUG Removed: A bug was found in "Set Isodose" . If the user enter an isodose value of 0 (zero) set it ON, CAT3D aborted. Reported by Rosangela Novaes and Renato Ros. (23/02/2005)

NEW : Collimator angle customization. Similar to Gantry and Couch customization, the collimator angle can be set using the keywords :

   COLLIMATORROTATION

COLLIMATORZERO

These keywords can be used in CAT3D.INI or the RSD file for the Linac. (suggested by Lic. Erick Hernandez, Guatemala) (03/03/2005)

BUG Removed : in routine IsoFloat(..) (the function used to plot the isodoses) there was a counter that remained uninitialized if an isodose of zero (0) was set by the user. This was the source of the bug removed in 23/02/2005. The curious image set and plan that gave the hint into the problem was provided by Rogerio Sanchez(Hosp. A.C Camargo)(04/03/2005).

Improved GIF annimated: the default mode of the exported gif was changed to make infinite loops inside any internet navigator (we tested Microsoft IE and Mozilla Firefox).
(suggested by Ing. Elga Mellado Quinones - MEVIS) (11/03/2005).

Improved copy protection. (15/03/2005).

NEW: Protocol information exported to an external file. The file name has extension PPF and its name is same as plan name. The file is useful for those writting software for interfacing CAT3D with any device of program, such as service daba base. (Ing. Elga Mellado - 16/03/2005)

NEW: ROI interpolation. If the anatomic structure being delineated shows little changes in successive slices, the user can draw one slice and jump other. After closing the whole ROI, the interpolation creates new ROI segments for the slices previously ignored. Use interpolation with caution, it is a linear interpolation between the drawn slices, it is not a border hunter for segmentation like the "Auto ROI" .

NEW : Creation of a POI centered in the ROI for the three main axis (x,y,z). Can be useful to locate a possible isocenter for the ROI.
(suggested by Lic. Erick Hernandez - Guatemala).

NEW: Mutual Information Based multimodality image matching. The image fusion module now has an additional method for image matching: mutual information maximization (relative entropy minimization). Any new fusion starts with the traditional point based method (4 or more reference points) but the user can ask CAT3D for an additional optimization using statistic criteria. See the new fusion menu with <ALT - F5>. <ALT - F5> will be available after the initial fusion with <F5> .

move to version 5.81 (21/03/2005)

Number of maximum control points for wedge filter was changed to 64.
(21/03/2005)

The <ALT-F5> information was set to "Fusion Menu".

Bug removed: BMP and animated GIF exported, using the same file name prefix.

Bug removed: CAT3D try to read an additional image when "Resume a Patient", fixed.

move to version 5.82 (08/04/2005)

Bug removed: The "FillPolygon" routine in the graphics library failed when a zero area polygon was processed. The routine was corrected and CAT3D re-linked with the new library. The bug was found by Lic. Erick Hernandez from "Clinica de Radioterapia la Asunción" in Guatemala.

move to version 5.82.1 (20/05/2005).

Bug removed: Again the "FillPolygon". An issue regarding the sign of the polygon area was reported by Dra. Fatima Regina Oliveira Dias, from CORSB, Blumenau. The routine was corrected and CAT3D re-linked with the new library.
move to version 5.82.2 (16/06/2005).

Improved "Clean Image" or automatic skin contouring: Some images with high radiological density in the CT table and going from side to side of the field of view, created problems for the virtual table limit (the red line). The new version of "Clean Image" remove this limitation for the automatic skin search. The problem was reported by Dr.Petrus Paulus and the test images were supplied by him. (30/06/2005) .

New: Patient name now displayed in the protocol screen output. Suggested by Dr. Marcos Silva (04/06/2005)

move to version 5.82.3 (05/06/2005)

New: Option "Reference to Isocenter POI" added to functions menu (Ctrl+F11) This option allows to identify the isocenter and the original reference marked on the patient, and calculates the correction needed to adjust the markers position to the planning isocenter. Corrections can be printed.
(Suggested by Dr. Pedro Paulo Pereira - Radioterapia Botafogo - Rio de Janeiro).

Improved PPF file layout to include more complete information about the planning. (suggested by Dr. Marcos Antonio da Silva. Maringá - PR - Brasil).

move to version 5.82.4 (16/08/2005)

NEW: Virtual simulator can compute and display dose distributions. Some tools are not available, such as: Protocol, Normalization Dose, Normalization Depth, etc. The simulator can not modify or create new fields.

NEW: IMRT module.

NEW: Source Compensator Distance should be defined in each RSD file if the equipment were used for IMRT with compensator. Example:

SourceCompensatorDistance = 605

the source compensator distance is expressed in mm.

NEW:
The maximum thickness of the compensator must be defines in the RSD file.
Example :

CompensatorMaxThickness = 80

the maximum thickness depends on the LINAC available space and the CNC capability.

NEW:

The attenuation properties of the compensator material must be defined in the RSD file for each energy. The attenuation equation is as follows:

$$I = I0 * \exp(- u * t) \qquad \text{(equ. 2005.1)}$$

where

$$u = u0 + c1 * t + c2 * r \qquad \text{(equ. 2005.2)}$$

The second term in the equation 2005.2 represent "beam hardening" of the pencil beam traveling through the compensator material. r represent the off-axis distance at the plane of the bottom of the compensator. The third term is related to the possible beam energy variation at different off-axis distances.

To enter u0, c1, c2 in the RSD file, use the keyword CompensatorCoeff. Example :

CompensatorCoeff = 0.0435 -0.0001 0.000012

The values of u0, c1 and c2 must be stablished for each energy and material.

NEW: More mouse control for the 3D window. With the left mouse buttom pressed, rotate de camera around the projection center. With the right mouse buttom pressed, translate the projection center in the X and Z axis. With the right mouse buttom pressed and the CTRL key, translate the projection center in the Y and Z axis. With the mouse wheel move the camera in or out (Zoom IN and OUT).

NEW: Shield factor for your blocking system: You can measure the factor of your shields and enter the factor into the corresponding RSD file. A shield with factor 1.00 means a perfect blocking effect and shield factor equal to 0.0 means no shield at all. Thus, if your shields block 97% of the primary flux enter this data into the RSD as:

ShieldFactor = 0.97

"ShieldFactor" is a new keyword, should be present at the very beginning of the line and followed by the sign "=" .

NEW: Extended sintax for wedge filter definition. With the new sintax the "beam hardening" factors and maximum field size can be defined. Beam hardening factors are defined as: ratio of PDDs measured with a wedge to that measured with a wedge, at standard SSD and for a 100x100 mm field. Normalized to 1.00 at the depth of maximum dose. The keyword "BHF" followed the number of measured depths is the sintax.

See the following example:

```
49      W45     WOF    5     BHF   6    LIMITS  200    400
190.4     150      140      130      120      110      100      90       80       75       70       65       60
 55       50       45       40       35       30       25       20       15       10       5        0        -5
 -10      -15      -20      -25      -30      -35      -40      -45      -50      -55      -60      -65      -70
 -75      -80      -90      -100     -110     -120     -130     -140     -150     -190.4
0 0.03    0.029    0.028    0.042    0.071    0.332    0.572    0.651    0.673    0.696    0.728    0.74     0.761
 0.782    0.803    0.823    0.844    0.864    0.885    0.906    0.928    0.951    0.975    1        1.028    1.056
 1.088    1.119    1.154    1.189    1.228    1.268    1.31     1.356    1.403    1.453    1.505    1.559    1.616
 1.677    1.752    1.04     0.211    0.118    0.09     0.07     0.066    0
50        80       100      120      150              (field size)
0.3102    0.3098   0.3090   0.3138   0.3160           (output factor for the upper field size)
15      50      100     150     200     250       (depth de beam hardening factor)
1.0     1.006   1.023   1.038   1.058   1.065     (beam hardening factors)
```

The beam hardening was measured at 15, 50, 100, 150, 200 and 250 mm of depth (6 depths). In the previous example the maximum field size with the wedge is 200 mm in the wedge direction and 400 mm in the other axis.

NEW: In the BEV, a label is printed at the right lower corner of the image with the number of the corresponding field for the DRR/BEV. (suggested by Lic. Erick Hernández, Guatemala).

move to version 5.90

Increased resolution for DRR/BEV, that is greater image matrix.

Improved Dose-Volume Histogram for brachytherapy. It now support dose from 0 to 49999 cGy.

Detailed report for any ROI inside the DVH. In the DVH press letter <I> or <Ctrl-I> The new report will compute for you the following parameters: D90, D50, D30, D10, D1, V200, V150, V90 and V50. The information can be printed.

Higher floating point precision for brachytherapy dose computation.

Faster assembler implementation for converting double/float into integer (int). The new implementation has two methods , one for Pentium 3 or 4 that uses SSE assembler instructions and other for Pentium 2 or earliers. The new method improves the performance of all interpolations.

Increased number of brachytherapy sources supported. The previous version supported 64, from now on CAT3D supports 511 sources in a plan. Keep in mind that each source is represented by a POI, so the limitation of 512 POIs is the actual limit for the number of sources per plan.

Printed Protocol centered into page to support the use of pages with header and footer.

Bug removed: If you start to draw a ROI that is hidden, CAT3D automaticaly makes it visible. The previous version lets you draw on hidden ROIs. (reported by Dr. Marcos Antonio da Silva, Maringa and Londrina).

Beam Eye View is recalculated if you change the isocenter, gantry, couch or collimator angle. (suggested by Lic. Andres Bruna, CABIN - Argentina).

move to version 5.91.beta

Support for higher display resolutions. The previous version always used 1024x768 pixels. This version checks for Windows display mode and the following modes are kept if found:

1152x864
1280x960
1280x800 (frequently used in wide screen displays)

move to versio 5.92

NEW : Volume (ROI) expansion in 3D, including aniostropic and isotropic expansion. The user draws the GTV manually and the expansion tool creates the PTV using a GTV expansion. In the isotropic case the margin is the same in all directions. For the anisotropic expansion the user has to set the margins for anterior, posterior, right, left, cranial and caudal directions. The legal margin value is from 0.5 to 50 mm .

Bug removed: Better renderization of solid 3D ROIs when they are small. The previous implementation creates some holes inside small ROIs in 3D rendering.

move to version 5.93 beta. 09/11/2005

Bug removed: Sparce crashes of solid 3D rendering, not frequently. It was generated by the MOVUPS instruction (SSE) reading a last float from a memory mapped file, trying to read in a not legal region.

move to version 5.93.2 beta 21/11/2005.

Bug removed: Definition of the modulation limits when attenuation coefficients were dependent on off-axis was wrong. (reported by Leopoldo Mazzuco)

Bug removed: Density correction menu remained active when you changed a plan, without closing CAT3D. If the first plan used CT images and the second contour images, the electron density table for the second plan was wrong, because it keeps the first table. Now, every time you close or change a plan, the electron density correction is switched off. (reported by Instituto de Terapia Radiante, La Plata, AR)

move to version 5.93.3 beta. (28/11/2005).

Improved implementation of the contouring routine for isodose drawing, with better responses in singularities.

Higher resolution of the dose matrix for 2D isodose rendering.

move to version 5.93.4 beta. (29/11/2005).

NEW: Import a plan (field set) from an existing plan. Can be used as a template for a new plan or for QA in IMRT. Start a new plan and after setting the POIs and ROIs go to the main menu (most external menu), select "Options" and select "Import Field Set". Please, remember than the imported plan overwrites any field you had set before.

move to version 5.93.5 beta (02/12/2005).

Bug removed: a problem was detected when unused lines in the RSD file had several TAB characters. Detected by Armando - Mevis.

NEW: Saving the optimizations conditions used for IMRT.

move to version 5.93.6 beta (08/12/2005).
move to version 5.93.7 (18/12/2005).

Bug removed : Another condition of sparce crashes of solid 3D rendering, not frequently. It was generated by the MOVUPS instruction (SSE) reading a last float from a memory mapped file, trying to read in a not legal region. (reported by Lic. Erick Hernandez, La Asunción, Guatemala). (05/01/2006)

NEW: Penumbra model for shields. With the new penumbra model CAT3D accepts a parameter in the RSD file to adjust the width of shield's penumbra at the level of the isocenter. The parameter is "ShieldPenumbra" and it is the width of the penumbra, considering width the distance between 80 and 20% decrement lines. See the following example:

ShieldPenumbra = 5.6 (distance from 80% to 20% in mm, at isocenter level.)

The valid range for field penumbra is : 2.0 to 12.4 mm .
Note: The penumbra region for shields is very narrow, because they are closer to isocenter than LINAC collimation system, so if you want to measure that penumbra use a micro-chamber, a diode or film dosimetry. Regular ionization chambers are to big for that narrow penumbra and they magnify the penumbra.
(collaborator: Lic. Andres Bruna).

NEW: If the active RSD file is modified with an open plan and the user close and open the teletherapy planning, CAT3D checks for modifications and flushes the dosimetry cache. This is useful for RSD edition and beam modeling. The check for modification is made using the CRC-CCITT, with 32 bits (cyclic redundancy check with 32 bits, from the Consultative Committee for Telephone and Telegraph (CCITT)).

move to version 5.94.1beta (17/01/2006)

Optimized algorithm for shield's penumbra generation. CAT3D generates the appropriated penumbra using the mathematical model only ones and save the result to a temporary file, any future call to the shield uses the stored penumbra.

move to version 5.94.2beta (23/01/2006)

Interface Library: bug removed in SelectPath() , very sparse, only critical for the filter "Gif2Img". A local variable was not properly inicialized .
move to version 5.94 (08/02/2006)

Security issue: when the user changes the "Dose Computation Mode", CAT3D now forces a new computation of dose distribution.

Conformal Shield (apertures) exported to MultiCut (is a computer-controlled hardware unit that creates Styrofoam molds for the purposes of beam modification), manufactured by Multidata Systems International Corporation.

move to version 5.95.1beta (08/03/2006)

New affordable version: A new version of CAT3D which only supports Co-60 teletheraphy units was created for clinics without LINACs. The restricted version is not able to work with high energy photons or electrons.

Clean Image was modified to preserve the values of pixels if they are not zero.

move to version 5.95.2beta (17/03/2006).

The internal gray table for CT pixel (or RM or PET, etc) translation in screen rendering was grown from 4096 to 16384 intensity levels. The results is that pixels with intensities above 4096 are rendered in white , because there is no saturation, as it happened in previous versions.

Screen mode of 1280x1024 is also accepted by CAT3D. This is the optimum resolution for 19" LCD monitors. If you use a resolution above 1024x768, consider using

PLATES = 512 in CAT3D.INI .

Shield exported to Multicut now with the external border of the shield. A scale problem was also fixed (thanks to the advice and collaboration of Lic. Gustavo Sánchez and Eng. Marcelo Martínez, from ITR de La Plata - Argentina).

move to version 5.95.3beta (27/03/2006)

Shield exported to Multicut in normal or mirror condition. Bug removed that generated a wrong vertex in the main axis of the field. (thanks to the advice and collaboration of Lic. Gustavo Sánchez, from ITR de La Plata - Argentina).

move to version 5.95.4beta (17/04/2006)

NEW : Improved management of conformal shields: Following the kind advices of some users (Lic. Graciela Vélez, Lic. Gustavo Sánchez and Lic. Andrés Bruna), the following modifications were introduced :

a) Shields must be drawn over Beam Eye View (BEV) images.
b) CAT3D automatically sets the beam axis of the shield from BEV data.
c) CAT3D automatically generates an optional comment string with the field number and gantry angle. The user can edit the proposed comment.
d) CAT3D generates a shield file name proposition. The user press ENTER to accept the proposition. The user can edit the proposed file name.
e) CAT3D automatically links the shield file with the proper field that generated the BEV.

Improved ROI volume calculation: The volume calculation could go wrong if there are repeated CT slices (same Z) and the ROI interpolation generates the same ROI for each one of the redundant slices. It was fixed.
NOTE: It is not advised the use of redundant slices in a plan !

move to version 5.95.6beta (24/04/2006)

NEW: The Dicom filter emits a warning for repeated slices (slices with same Z , if axial, or X if sagittal, or Y if coronal) and mark those slices with a red cross, to assist the user in the appropriate slice

selection. Please select only one slice for each value of Z in axial views. Dicom move to version 3.66 (24/04/2006).

Improved attenuation model for IMRT compensators :
The attenuation properties of the compensator material must be defined in the RSD file for each energy. The attenuation equation is as follows:

$$I = I0 * \exp(- u * t) \qquad \text{(equ. 2006.1)}$$

where

$$u = u0 + c1 * t + c2 * r + c3 * S \qquad \text{(equ. 2006.2)}$$

The second term in the equation 2006.2 represent "beam hardening" of the pencil beam traveling through the compensator material. r represent the off-axis distance at the plane of the isocenter. The fourth term depends on scattered radiation inside the modulator material and S is equivalent square for the field size, at isocenter level.

To enter u0, c1, c2 and c3 in the RSD file, use the keyword CompensatorCoeff. Example :

```
CompensatorCoeff = 0.0435   -0.0001    0.000012  -0.00000031
```

The values of u0, c1, c2 and c3 must be stablished for each energy and material.

The extended model was due to experimental result from Lic. Leopoldo Mazzucco, Rio Cuarto, Argentina.

CAT3D move to version 5.96 (16/05/2006)

Bug removed: In the option "Reference to Isocenter". In some conditions the selected POIs were scrambled by CAT3D. It was an improper access to the index of POIs. (Reported by Bioing. Victor Bahamonde, from CABIN, Argentina).

The internal gray table for CT pixel (or RM or PET, etc) translation in screen rendering was grown from 16384 to 32768 intensity levels. PET images have pixels with internal values as high as 2^15, so we increased the pixel range to accomodate such values.

New: Dose Prescription in brachytherapy planning. Now you can select a POI and ask CAT3D for the necessary implant time to achieve a desired prescribed dose to that point. Source decay is taken into consideration.

New: Dose to POIs report in brachytherapy plans. If there was a previous dose prescription to a POI, a report of the volume inside several isodoses will be presented.

New: Use of mouse to move the cursor in X-Ray views. Mouse left click is used and you have to click over the same point in both views.
IMPORTANT : one click is not enough, you have to click both X-Ray views !

New: Distance tool for X-ray view. Using double-click or enter you fix one end point, the other is the position of the red cursor. Ctrl-D also works in X-ray views.

Improved Table Editor : The table editor is the editor used to open and modify the POI table, electrons density table, ROI hiding, etc. Now you can select a cell by clicking with the left button of the mouse, move through a column with the mouse wheel. From the keyboard the new valid keys are:

```
TAB       - move to next cell
HOME      - move to first column, first row
PAGE UP   - move several rows up in the table
PAGE DOWN - move several rows down in the table
```

As usual , F10 and ESC close the table editor, the first accepting the changes the later discarding any change. The buttons <OK> and <CANCEL> can be clicked with the mouse giving the same results of <F10> and <CANCEL> respectively.

move to version 5.97.1 beta (24/06/2006)

NEW: Non axial ROIs are suitable for DVH computation. Non axial ROIs are frequently found when they are imported from image fusion.

move to version 5.97.2 beta (28/06/2006)

Better computation of ROI volumes when several segments of one ROI have overlapped areas and for non axial ROIs. For some complex ROIs with lot of vertex it is a time consuming task. In case of several segments in one plane, CAT3D checks for each point of the domain if it is inside or outside each segment (closed polygon) using the Jordan Curve Theorem as criterion (Haines, Eric, "Point in Polygon Strategies," Graphics Gems IV, ed. Paul Heckbert, Academic Press, p. 24-46, 1994).

Implant time was included in the brachytherapy dose to POIs report. A brief dose-volume report was also included (only if there is a dose prescription to a given POI).

move to version 5.97.3 beta (28/06/2006)

NEW: ROI segment retouch. When in "Draw ROI", at the very beginning of a new plane, if a previous segment of the ROI exist, you can retouch by pressing the INSERT key . The retouch was aimed to add or remove small areas of an existing segment, it creates a bypass between two points in the previous segment, so the retouch segment is an open polygon.
(suggestion by Lic. Andres Bruna)

move to version 5.97.4 beta (8/07/2006)

some minor bugs removed.

move to version 5.97 (31/07/2006)

NEW: DVH with absolute total dose. Use <^D> or < % > to switch between absolute or relative dose.
Better scale in the DVH dose axis.

Improved IMRT :
  a) Dose transmission is equal to maximum modulation limit for far beamlets.
  b) Render Modulator now shows field limits.

move to version 5.98.1 beta

Improved ROI selection dialog for "Draw ROI" .
move to version 5.98.2 beta (17/09/2006)

NEW: CAT3D exports the dose distribution of the active image plane when the user activates the profile (F8). The dose distribution goes to a file inside CAT3D directory :

     Plane_TeleDose.txt

It is an ASCII file. Each line ends with two characters: CR LF   (0x0D 0x0A).

The structure of the file is:

```
Line 1:  string comment
Line 2:  string , planfile name
Line 3:  reserved, it is empty so far
Line 4:  x1   y1   z1 (coordinates of the upper left corner of plane/screen)
Line 5:  x2   y2   z2 (coordinates of the upper right corner of plane/screen)
Line 6:  x3   y3   z3 (coordinates of the lower left corner of plane/screen)
Line 7:  x4   y4   z4 (coordinates of the lower right corner of plane/screen)
Line 8:  v11  v12  v13....v1n
.
 .
 .
Line 8:  vm1  vm2  vm3... vmn
```

This is for a matrix with n columns and m rows. Each dose value (vij) is represented by a float. Each row ends with the end of line marker (CR LF).

In <ALT-C> the frame selection now has red border.

move to version 5.98.3 beta (05/10/2006)

Correction: the solid model of the modulator is exported with the same orientation of the beam eye view (the XYZ file).

Better ray tracing algorimth supporting a tissue volume that do not form a simply connected space (volume). The algorimth is slower but safer for some exotic conditions. The test case probing the previous method was kindly sent by Lic. Gustavo Sanchez, from ITR de La Plata, Argentina.

Open Watcom C/C++ compiler upgrade to version 1.6 release 1. The generated code is smaller and slightly more efficient for floating point computation because the generation of FWAIT instruction was removed.

move to version 5.98.4 beta (09/10/2006)

Open Watcom C/C++ 1.6 release 1 had a bug in code generation, so we had to return to version 1.5.

NEW: In the "Integral Dose" option, a report of the volume inside several isodoses was included.

Bug removed: 2D isodose level contouring algorithm more stable on several field topographies, in this case for constant dose regions. A new check against zero division was introduced. The rare cases showing the bug were sent by Dr. Wagner Hideo Yaegashi from "Clinica Memorial".

move to version 5.98 (26/10/2006)

In 3D, when you enter de number of nodes in the X axis, CAT3D makes a proposition for the number of nodes in Y and Z. It computes ny and nz in such a way that the resulting voxels are cubes (have same size in each axis or close to that).

NEW: CAT3D shows the borders of each field in any axial, coronal or sagittal plane.

Bug removed in some DVH (new FillPloy() with window clipping).

NEW: when drawing a shield inside CAT3D, there is no more need to enter roi number or roi name.

move to version 5.99 (24/11/2006)

Bug removed in MLC and Shape export to Varian Shaper (29/11/2006)

Better polygon clipping using Vatti's method (Bala R. Vatti, "A generic solution to polygon clipping", Communications of the ACM, v.35 n.7, p.56-63, July 1992). This is used in FillPoly and is of importance to DVH computation.

ROIs used for shield drawing (32 to 63) are not rendered in 3D any more.

ROI information now shows the perimeter of each segment including segments used for shield. Using the area and perimeter of a shield the user could compute an approximated equivalent square side for independent hand check. (10/01/2007)

Bug removed: When the electron density correction (EDC) table was changed, the old dose cache was not invalidated. Now a change in EDC force CAT3D to re-compute all dose distributions. (bug reported by : Lic. Andrés Bruna and Bio Eng. Victor Bahamonde, from CABIN, Argentina). (12/01/2007)

NEW: Pixel range for electron density correction now goes up to 8192. Previous version was limited to 4096. The new range can be useful for some prosthetic material. (12/01/2007)

Improved ROI rendering over non axial images. Most ROIs are drawn on axial views but could be observed in sagital, coronal or oblique view. The new algorithm presents a better picture of a ROI when it is cut by any reformatted image plane (14/01/2007).

move to version 5.99.1 (15/01/2007)

NEW: <CTRL I> has three states:
- with isodoses and field borders
- with field border and no isodoses
- with isodoses and no field borders

NEW: When a radiation field is copied using <CTRL C> and <CTRL V> a new shield is created for the new field. The new ROI has a better comment showing the gantry angle of the new field. This has other beneficial side effects and avoid inconsistencies.

NEW: Axis and scale are rendered over Beam Eye Views. <CTRL I> also hide this axis. (recommended by Dr. Renato Ros, Edilson Pelosi and the staff of IAVC).

NEW: The shield (PB) is projected into the BEV, not only the original ROI. With this solution, PBs created by Shield.exe are rendered into BEV. Previous versions of CAT3D did not show PB's files generated by the program Shield.exe.

move to version 5.99.2 (19/01/2007)

NEW: When the three planes view is active, ROIs are rendered in all of them, the main windows and the auxiliary views.

Default state for ROI drawing was changed to three planes view. (recommended by Lic. Andrés Bruna - Argentina and Dr. Marcos A. Silva - Maringá e Londrina, Paraná, BR).

NEW: Two levels of quality for Beam Eye View (BEV). The default level is the faster, with lower quality. The BEV dialog window allows the user to select a high quality BEV . (recommended by Lic. Andrés Bruna - Argentina). (21/01/2007)

NEW icons in the tool bar. In non BEV images : show or hide ROIs and background color. In BEV images : show or hide ROIs, show or hide isodoses and show or hide the axis scale. (21/01/2007)

move to version 5.99.3 (22/01/2007)

NEW: Tooltips : The user hovers the cursor over an item in a tool bar, without clicking it, and a small box appears with supplementary information regarding the item being hovered over.

NEW: Grays window control while drawing a ROI, using the right mouse button over the image.

NEW: Show or hide isodoses while drawing a ROI, using <CTRL I> .

move to version 5.99.4 (26/01/2007)

NEW: Dynamic actualization of the screen image when gray window levels are moved with mouse o arrow keys (recommended by Lic. Andrés Bruna - Argentina). The user does not need to press ENTER to see the change in image bright and contrast.

move to version 5.99.5 (28/01/2007)

NEW: Predefined gray windows to assist bright and contrast adjust. Predefined combinations are stored in CAT3D.INI. The syntax is as follow

```
GRAY_XXXX   =   lowpixelvalue   highpixelvalue  comment_for_help
```

where GRAY_XXXX is one of the keywords representing entries for different type of tissues. See the following example, that you can copy and paste into your CAT3D.INI :

```
GRAY_BRAIN  =  1000   1090   CT Brain soft tissue
GRAY_SKULL  =  1050   1800   CT Skull soft window
GRAY_ABDOMEN = 886    1132   CT abdomen
GRAY_LUNGS   = 200    1100   CT lungs
GRAY_BONES   = 1050   2500   CT bones
GRAY_BEV     = 200    3500   DRR BEV
GRAY_BEV_DARK = 500   4094   DRR BEV Dark
GRAY_USER1   =  40    1100   CT user lung
GRAY_USER2   =  900   3000   CT user bone
GRAY_USER3   =  40    1200   not used
GRAY_USER4   =  50    1300   not used
GRAY_USER5   =  60    1400   not used
GRAY_USER6   =  70    1500   not used
GRAY_USER7   =  80    1600   not used
GRAY_USER8   =  90    1700   not used
GRAY_USER9   =  4     200    Atlas and Contours
```

Remember that good setting for a CT scanner are not necessary good for other machine. (recommended by Lic. Andrés Bruna - Argentina).

move to version 5.99.6 (28/01/2007)

Minor adjustments :
- DrawROI starts with 3 planes views, DrawShield only with the main view, because most of the time shield need to use cursor's radius information. (recommended by Dr. Renato Ros).

NEW: Support for 3 planes view for 512x512 pixels images while in 1024x768 Windows resolution. Now CAT3D resize on the fly the lateral images to 360x360 if the screen resolution is 1024x768 and to 512x512 if screen resolution is higher.

move to version 5.99.7 (30/01/2007)

Better interaction between the Proteq hard lock and the Windows printing services. Dr. Renato Ros reported an error condition when Windows is printing and CAT3D try to access the proteq hard lock. We hope that the problem has being avoided (03/02/2007)

move to version 5.99.8 (03/02/2007)

Security issue: if you had a BEV and the coordinates of the active isocenter were changed using <CTRL END> or <HOME> or <END> the BEV was not re-computed and any shield drawn in that obsolete BEV were shifted. Now, any change in the coordinates of the active isocenter (isocenter supporting the BEV) will force a refresh of the BEV.

(reported by Lic. Diego Dodat, ITR - La Plata, Argentina).

move to version 5.99.9 (06/02/2007)

NEW: The machine or energy of a saved plan can only be changed explicitly via <CTRL F11> and "Select a machine or energy".

move to version 5.99.9b (14/02/2007)

Better check for the SSE2 and SSE3 capabilities and the number of threads supported by the CPU.

move to version 6.00 (19/02/2007)

- **DirectDraw** is no longer the supporting platform or hardware abstraction layer. Cat3D 7.00 move to **SDL** (**Simple DirectMedia Layer** from http://www.libsdl.org/). All previous versions of CAT3D were full screen non cooperative, from now on CAT3D is a windowed application. CAT3D 7.00 is optimized for 32 bits per pixels screen modes, if the Windows desktop is not in 32 bits/pixel, SDL will emulate the mode but this is not optimum. CAT3D 7.00 should be executed in screen resolutions above 1024x768; a very good choice is 1280x1024, 32 bits/pixel. CAT3D 7.0X needs more system and video memory now, each window allocates four times the memory of an equivalent window in version 6.xx .

- NEW: Dose to POIs information.

- Bug removed: ray tracing returning depth with negative value in the range of ±Voxel size. It created a problem with the Maximum Precision Convolution method.

- better evaluation o maximum attenuation constrains for IMRT with solid modulators.

- The Beam Hardening Factor model (BHF) was modified to allows variations along different wedge thickness, following a model proposed by Lic. Andres Bruna.

- New isodose shading in 2D and 3D using "alpha blending". The alpha blending control is inside "Set isodose" window with a valid range between 0 and 10.

- Solid IMRT modulator can be exported to Autodesk DXF directly. Two additional files are needed: "xyz_2_dxf.exe" and "at3dx.dll", so if you plan to do this, check if both files are inside CAT3D's directory.

`move to version 7.0X.1 (beta)  (09/07/2007).`

- Access to teletherapy Field Editor from inside 3D window.

- Options to change density and teletherapy 3D reconstructions from inside 3D window. Use < ^D > and < ^I > .

- Default 3D rendering mode changed to SOLID .

- Each instance of CAT3D creates unique files por 3D volumes. Previous versions of CAT3D had problems with more than one CAT3D using 3D rendering. Now 3D rendering supports up to 20 CAT3D running simultaneously in the same working path.

- The printer server "WPRINT.EXE" move to version 1.09. Now, there is no need to enter <OK> at the end of WPRINT .

- Faster representation of wedge filters .

- Bug removed in the treatment of ROIs that includes complex polygons (self intersecting

contours) as segments. Reported by Dr. Edilson Pelosi – IAVC – São Paulo.

- The maximum number of ROIs (volumes) used as conditions for IMRT optimization increased from 5 to 8.

- The concept of priority was incorporated to the ROIs (volumes) used as optimization conditions in IMRT. The priority should be used when volumes are overlaped. The region of overlap is considered as optimization condition only with the volume of higher priority. Priority is an integral number, the greater the number the higher the priority.

- The user can change the margin of compensator material exceeding the field size in IMRT plans. Use the new RSD keyword: "CompensatorMargin" . This parameter is used by CAT3D to export compensator's geometry in XYZ or DXF files. The default value is 15 mm. The valid range for the parameter is [5..50] mm. Example of use :
  CompensatorMargin = 12

- New: DVH now computes and displays mean dose (or mean pdd) to each ROI . Previous versions of CAT3D computes minimum, maximum and most frequent dose (also known as "mode" in statistics).

- NEW: Automatic Shield generation. Being in a BEV window the ROI menu now shows a new option "Auto Shield" . The shield need some margin in the range [0.5 .. 50] mm. The margin can be isotropic or not. A shield can be generated from one or two ROIs . Two ROIs can be used if they are overlapped or in close contact.

- New: Transparency for 3D volumes .

- New: Bolus . The user can create up to 4 ROIs that allows the modification of the pixel values of the images (CT, RM, contours). These ROIs have reserved names:
  bolus-1 , bolus-2 , bolus-3 and **bolus-4**
  The names are not case sencitive. Bolus ROIs have two properties: pixel value and priority. The pixel value is the value than CAT3D dosimetry is going to receive if the voxel/pixel under consideration is bolus. Priority is use to tell CAT3D that the bolus is more important than the image pixel even if the pixel under consideration is not air. In regions with air, the bolus is always more important. If you want to add bolus outside patient skin use priority OFF (default). Use priority ON if you want a ROI that overwrite the pixel value (density) of the image for heterogeneities correction. To add bolus you only have to draw a ROI which one of the four reserved names. To edit the bolus properties open the Roi Menu and select "Edit Bolus Properties" .

move to 7.0X.11beta

- When typing a float value the ',' is translated to '.' . On the brasilian ABNT2 numeric keypad the ',' is now accepted.
- The blinking rate on the edition cursor was set to 0.7 seconds.

move to 7.0X.12beta

- New main menu style with some buttons for fast access.

- Automatic grays optimization: use the first button in the grays tool bar. Any other gray buttom remove automatic gray level optimization. Automatic gray level optimization is based in histogram equalization which is a non linear map between pixel values and available gray levels.

Move to version 7.0X.15beta

- Faster 3D rendering using “back-fase culling” .

- Main menu responds to <ALT – F4> .

Move to version 7.0X.16 beta (16/09/2007)

Move to release version 7.00 (26/09/2007)

- If image fusion is active, the 2D planes projected into the 3D window are taken from the external (floating) image set.
- In the 3D window the density surface has a new parameter: Smooth.
- Bug removed: alt-c followed by alt-c aborted CAT3D.
- New interface for CTRL-D in the 3D window.
- About now shows license limit and CAT3D configuration (if IMRT is included, if Virtual Simulator, etc).
- In DVH, if the user includes a hidden ROI for computation, CAT3D will remove the hidden attribute to that ROI .
- Bug removed in cursor movement while working with orthogonal x-rays
- CTRL-S now save inside orthogonal x-rays mode.
- default isodose shading was set to 1.
- Two quality index are shown when the TMR table is generated: TPR20/10 and D10.

Move to version 7.01 (01/12/2007)

- IMRT matrix generation can be aborted with <ESC>.
- The maximum number of control voxels was increased for better optimization of PTVs up to 2000 ml.
- The orientation mark on the modulator 3D model (XYZ or DXF) is deeper toward the gantry in the inplane axis.
- A field with modulator in OFF state keeps it modulation data.
- Image matching without POIs : CAT3D will try to make an automatic image matching if there are less than four common POIs between the fixed and floating image set. The automatic matching is based on Mutual Information Maximization and the optimization algorithm is a Simulated annealing. The optimization stops when the user press <ESC> . CAT3D shows a split image at the left of the screen to follow the evolution of matching improvement.
- New options and render capabilities to image fusion. In the fusion menu you can select

"Render as Reference image" and "Recon. As floating view" .

- Faster mutual information maximization on multicore processors like Pentium D, Core 2 Duo and Core 2 Quad, using 2 threads for MI computation.
- Add dose distributions from up to 5 plans. Each time you compute the integral dose of a plan, the 3D dose distribution is saved with extension ".DOSE3D". After DOSE3D is computed you should close the plan because if any change is made, the DOSE3D file is removed. Open a second plan that use the same image set. Select "Add dose from external Plans" in the teletherapy menu. You can add up to 4 external plans with the active plan.
- CAT3D checks screen resolution at start time and stop running if resolution is too low. CAT3D needs a Windows screen mode of 1024x768 or higher. Consider using 1152x864 for better rendering.

move to version 7.02 (06/02/2008)

Several CAT3D's algorithms were parallelized: Due to the multicore trend in the CPU market, parallelization strategy seems very promissory for math intensive tasks. Some time-consuming functions were recoded to allow a multi-thread approach :

- Dose computation.
- DRR / BEV generation.
- Mutual information computation for image matching.

In all cases the improvement were impressive, mainly if a Core 2 Quad is used to run CAT3D. The future CAT3D strategy for optimization should be based in parallelization, so users are encourage to upgrade their workstations with multi-cores CPU.

- Collimator angle is properly set when a field is copied to parallel opposed position.
- Asymmetry is properly set when a field is copied to parallel opposed position.
- DRR / BEV do not rotate with collimator angle.
- Bug removed in Auto Shield : affecting fields number 5 or above when no volume recalculation was needed (when volume was in cache). It was a hard to find bug, because it mainly showed in systems with low memory or field number above 14 (pointed out by Dra. Monica Brunetto, Dra. Marcela Setti and Dr. Anderson Cruz).
- Better treatment of ROI (volume) expansion with concave surface. In particular for ROIs with more than one polygon in an axial plane. For example, the top planes with seminal vesicles. (problem pointed out by Dr. Gustavo Sanchez and Lic. Diego Dodad, from ITR – La Plata).
- Faster representation of field entries and wedges.
- 3D representation of field entries. It is a transparent surface few mm above the skin. To hide/show the entries press CTRL-A.
- Brighter color for DRR/BEV axis and scale.
- Bug removed: ROI names were not cleaned when the plan was changed, only evident when the new plan had less ROIs than the old and you enter the DVH dialog (reported by Dr. Renato Ros)
- When a ROI is being drawn the pen color is the the same of the ROI color (recommended by Dr. Carlos Pereira , CLINIRAD , Hosp. Angelina Caron).
- Images produced by image matching (fusion) can be exported as a secondary image set in

IMG format. The secondary image set can be use by CAT3D or MNPS as a primary image set. To export the secondary image set, go to Fusion Menu (via ALT-F5) and select "Export as Secondary IMGs" .

move to version 7.03 (20/04/2008)

- Correction to 7.03: when a saved plan was opened the volumes of ROIs were not re-calculated . (reported by Dra. Raquel - Pelotas, RS - and Dr. Renato Ros - CEPRO).
- Better initial setting for the first window-resize.

move to version 7.03a (02/05/2008)

- improved kinematic for Orion Linacs or any other with CollimatorZero = 90 or CollimatorZero = 270. problem reported by Cr. Márcio Tokarski – Campinas SP .
- CAT3D supports a new command line parameter: -N . It is used to create a new plan for a set of images (.IMG) . The sintax is:
  CAT3D.exe -N image_file_name.img
- DICOM filter now can call MNPS or CAT3D after exporting the IMGs.
- Improved floating image renderization in 3D perspective.

Move to version 7.04.1beta (14/05/2008)

- Clean-Image now shows a gray representation of the anatomy while adjusting the cutting level. (subjested by Dr. Rogerio Sanchez, Radioterapia Santana , São Paulo).
- Better mouse control for 3D orientation (in the 3D window).
- The auxiliar reconstructed images now rendered in the 3D window. The center of the reconstructed images is driven with CTRL-G (Goto POI).
- Better blinking cursor for edition.

Move to version 7.04.4beta (2/06/2008)

- Cat3d menus now respond to one mouse click.
- Default Beam Eye View quality is High.
- Drag a POI with mouse. Move the mouse cursor to the POI you want to drag. When the shape of the cursor turns into a white cross, pressing the CTRL key, Click and held the left button and drag de POI to the desired place over the image, the release the mouse buttom. *Be careful not moving an isocenter POI to open air outside patient tissue because the ray tracer could get lost finding the entry point in skin !*.
- Default dose computation mode changed to “Pencil Beam 8x8” . Due to the availability of very fast CPUs like Pentium D, Core 2 Duo, Core 2 Quad and the new algorithms for multi-thread dose computation this method became very efficient and it is a much better model than “Fast”.

Move to version 7.04.5beta (24/06/2008)

- New buttons for the X-ray window. Most of the buttons are known for CAT3D users but the symbols with numbers from 1 to 4. They represent the first brachytherapy source data in CAT3D.INI file. These four sources are consider frequently used and as such have a shortcut to put them in the plan. The number of the source is automatically generated by CAT3D as a counter. All the buttons have associated tooltips.

move to version 7.04.7beta (01/07/2008)

- Automatic ROI expansion and Automatic Shield generation can avoid growing outside patient skin. When the expansion is limited into the patient tissue the process takes longer time because more conditions have to be checked.
- Better dialog for ROI expansion and Automatic Shield.
- New toolbar for the 3D window.

move to version 7.04 (03/09/2008)

- CAT3D reads new IMG format for sub-mm images. The support for sub-mm images started with Dicom filter 5.10.
- Maximum number of original images increased to 1022 (was 256).
- Maximum number of floating images for fusion increased to 1024 (was 256).
- Maximum number of roi segments increased to 2048 (was 1024).
- A linear model for Beam Hardening Factor (BHF) with field size at any fixed depth was introduced. The model was created by Lic. Andrés Bruna. There is a paramter to adjust in the RSD : BHFvsFieldSize . A frequently found value is 0.005 . The valid range for the parameter is 0.0...0.009 . Example of use:

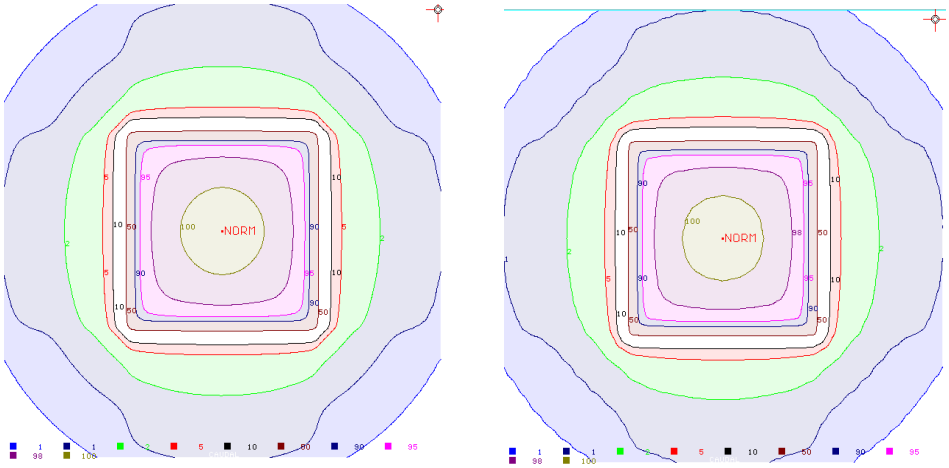
  BHFvsFieldSize = 0.004

  If the RSD does not have the parameter CAT3D assumes 0.0 which is equivalent to previous versions of CAT3D.

- New solid IMRT modulators can be exported in .decimal format.
- Improved monitor unit calculation for electron beams with pencil beam models.
- NEW: DVHs are saved to files . Each time a DVH is computed a file is generated with the same name of the plan file followed by the number of the ROIs. The file extension is .DVH . This file is ASCII, delimited by tabs and character strings are delimited with " " . The decimal separator is the point (.) . Is is very ease to import these files into Excel or OpenOffice, other external tools can be used also.

  Move to version 7.05 (23/12/2008)

- Better penumbra model in the corners of the fields. This improvement is only evident for low value isodoses (10.. 1%) close to the corners or diagonals of fields. The need for penumbra model modification at the corners was noted comparing the dose distribution of CAT3D´ BEV with measured distributions using MatriXX OmniPro I´mRT in CEPRO. The left image presents the result with the previous cat3d and the right shows the new result :



- Bug removed in CleanImage with contour drawing. The bug was generated in version 7.05 due to changes in internal polygon representation (it was int and move to float). CleanImage is now compatible with the new polygon representation.
- New: In the shield file (.PB) the comment field now includes the machine name for the plan. This is safer for institutions with more than one LINAC. (recommended by Dr. Renato Ros).
- POI and POI´s name are shown in the auxiliary reconstructed images.
- New keyword in CAT3D.INI: *LANTIS* . This keyword enables the export option for LANTIS RTP Link file format. The Lantis keyword also sets the path to export/save the .RTP files. The path.
- New: Export plan to LANTIS RTP Link file format. If the Lantis path is valid, the option will be available in Teletherapy menu (open the menu with CTRL-F11).
- Bug removed in function GetDensity( ) .
- NEW: when an image fusion is active, the keys <M> and <CTRL-M> change the mixture of pixels from both image sets either in “Render as Reference” or “Render as Floating” modes. This functionality is available also while drawing ROIs.
- In fusion mode, if you use “Render as Reference” the zoom is available and ROIs drawn in this mode are parallel to internal image planes (usually CT).
- CatShell now supports drag-and-drop of files. You can drag to CatShell Dicom, Elscint, Somatom-IMA, HIS and RTP files. Drop the files into the CatShell icon in the Windows´ desktop.
- Tissue setting for BEV are now saved as user preferences.
- NEW: while drawing a ROI, a segment can be deleted using <CTRL-DEL > . CTRL-DEL can be used when you get into an image plane, but before any drawing in that image plane. The target of delete are segments of the ROI you are drawing that lay on the present image plane.
- NEW: Floating toolbar controls which ROIs are shown or hidden. This toolbar is available in

the planning window, draw ROI, DVH and 3D window. With this tool, the 3D window can hide or show individuals ROIs, which is a new capability for 3D. The toolbar is implemented via and external process : RoiSelect.exe .

- Improved DVH: capacity for 8 ROIs. The ROIs can be individualy hidden using the floating ROI´s toolbar.
- DVH can switch background color between Black and White using < B > .
- DVH now searches for the point of highest dose in anatomy and creates a POI : "HOT_POI". After closing the DVH window the user can go (Goto POI , with ^G or the Goto button) to HOT_POI to investigate where the hot spot is in anatomy.
- Better check for coplanar condition for ROIs processing on DVHs.
- CAT3D removes ROI segments with area zero and perimeter below 1 mm.
- At the end of *Draw Shield* or *Auto Shield* the system ask the user to select a tray factor. (suggested by Dr. Wagner Hideo Yaegashi).
- When using copy and paste of fields, the shield definition file is only copied in case of parallel-opposed fields. This avoid the creation of not necessary and improper .PB files (suggested by Dr. Wagner Hideo Yaegashi).
- NEW: Add two ROIs and create a new one.
- NEW: Remove unused shield files. Available in the Options menu. Do not remove shield files if any other instance of CAT3D is running. This option is available when no plan is open.
- The ROI selection window now displays a color reference to each ROI.
- Support for Enhanced Dynamic Wedges manufactured by Varian. The RSD data file must contain one entry for each available wedge angle, like physical wedges. The valid names for EDW are: EDW10, EDW15, EDW20, EDW25, EDW30, EDW45, EDW60 . The wedge output factor (WOF) information use the position of the fixed jaw, either Y1 or Y2, not the field size like in physical wedges. EDW wedges can only be used in IN and OUT position, not in CW or CCW.

Move to version 7.06 .

- If the HOT_POI exist, CAT3D will search for the HOT_POI every time the plan is modified. Note that this search is non-lineal in a concave domine with multiple local maximum, so the HOT_POI found is not necessarily the absolute hot point. On the other hand, the only way to be sure that the hot point is the absolute maximum is to use a very small calculation grid which could take too much CPU time. HOT_POI is first created by the DVH. If the hot_poi is taking to much time , remove the HOT_POI .
- NEW: Shields can be exported to XYZ format. Two new parameters in the RSD file must be configured: SHIELDDISTANCE and SHIELDTHICKNESS, both in mm. SHIELDDISTANCE is the distance in mm between the source and the farthest side of the shield.
- Protocol information now include the number of fractions, so that total dose for the plan is computed and reported.
- Bug removed in the field editor page. It was a wrong initialization of float fields for edition. Not frequent.
- The isodose shadows now use a color wash style. If color wash effect is desired set the shadows to 3 or more in the isodose dialog.
- Longer edition line for the ROIs in a DVH.

- NPSF model was changed to X. Allen Li empirical formula. See: "Peak Scatter Factors for High Energy Photon Beams" , Med. Phys. June 1999. It is better that BJR supplement 25 because it takes into account the dependency on energy from Co-60 to 24 MV.
- Polygon plane equation (normal to polygons) is computed using Newell's method. It solved some problems with concave polygon interpolations and polygon sorting.
- Remove a POI using CTRL + RightClick with mouse on the poi.
- NEW: In IMRT there is a 3D visualization for Render Modulators.
- If you prefer to copy shields with CTRL_V always, not only for parallel opposed fields, include the following line in CAT3D.INI :

  CopyShieldAlways = 1;

- New module: brachytherapy templates for prostate planning.
- Better treament of some polygons while in DVH using Newell´s method.
- Render modulator with color representation intensity/flux map.
- In Render Modulator window use <PageUp> or <PageDown> to change field.

Move to version 7.07

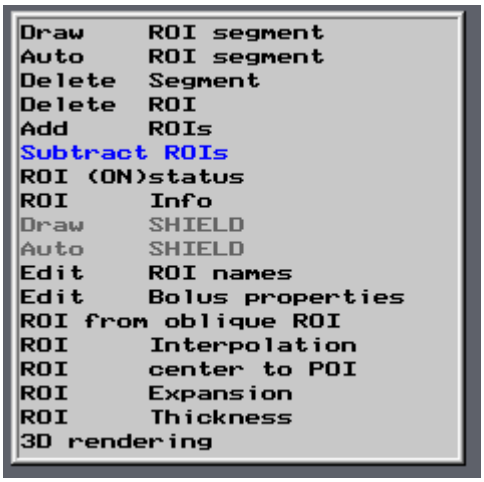
- NEW dialog for IMRT constrains. The maximum number of constrains now is 10.
- NEW parameter for IMRT optimization : Tolerance. Tolenrance is only checked for PTVs (equal condition).
- Bug removed when several instances of CAT3D runs 3D windows (reported by Dr. Marcos Silva).
- The maximum window size of CAT3D is limited to 1200x1000 pixels, avoiding problems with higher resolutions in new high definition monitors.
- New parameter for RSD: MLC_MODEL . If no MLC_MODEL is defined, the BEV will not show the leaves. Example of use :

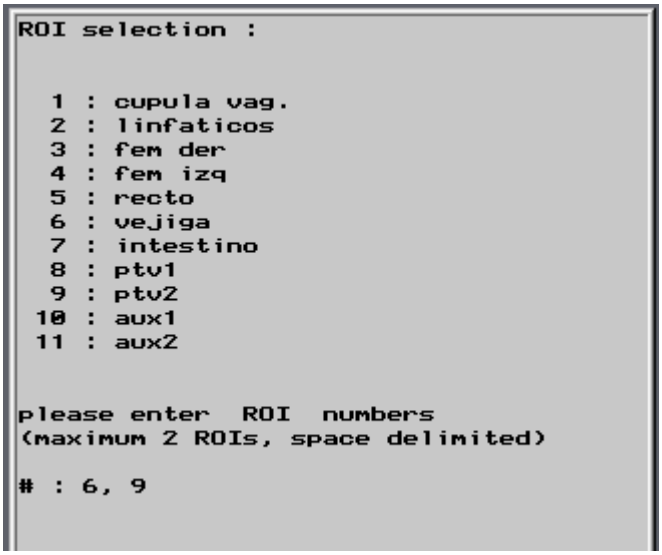
  MLC_MODEL = MLC_V120

  Valid models are: MLC_V52, MLC_V80, MLC_V120, MLC_V120H,
  MLC_S58, MLC_S82,
  MLC_E80 .

- Improved rendering of PET images in fusion. Now supporting PET pixels in the range of : [0..32536].
- The fusion transparency (low and high filters) is obeyed in 3D projections.
- NEW: Draw ROI now has a circular segments mode. In Draw ROI press CTRL-C to enter or exit circle mode. When in circle mode the ring around the mouse pointer is salmon color. Circle mode is not available in Retouch mode. Use + or – to adjust the mouse radius to fit your needs.

- NEW: Subtract two ROI. In the example below , select “Subtract ROIs” and after that tell CAT3D to create a ROI by subtracting roi 6 minus roi 9. The new roi wil be the volume of roi 6 not overlaped by roi 9.





- NEW: CAT3D now detects if a Protocol is invoked before the CleanImage and emits a warning message. Remember that CleanImage (in mosaic) sets the border of the skin, so it is very important for source-skin-distance (SSD) computation.
- Better treatment of very elongated ROIs in IMRT, for example in some cases involving spinal cord.
- Bug removed in some cases of 3D surface smooth. This change was in i_math.dll .
- Bug removed in Mosaic, it was not showing de Z level of each frame. Now it is working properly.
- Bug removed in DVH for very complex ROIs with several polygons for axial plane. It created false HotPOIs with very high dose.
- CAT3D now updates the Window's Recent Items list with plan names. In Windows XP look in “My Recent Documents” and using Windows Vista or later look in “Recent Items”.
- Improved compatibility with Windows Vista and Windows 7.
- For MLC model MLC_E80 (Elekta 80 leaves), CAT3D saves a plan in DicomRT for Elekta WorkStation 5.0. The Plan File for this case is limited to 16 characters . The settings of backup collimators is set to the border of de MLC.
- NEW : New tool for film densitometry. Use CTRL-F8 to switch between original pixel value, hounsfield units or some options for densitometry. The film calibration file must be in a file with the name: DENSITOMETRY.TXT . CAT3D looks for the the film calibration file in the patient's folder, if it is not found it tries in CAT3D own folder. See the next example:

```
rem       DOSE     PIXEL_VALUE_FROM_SCANNER
rem
POINT =   0.0      254
POINT =   1.0      220
```

```
POINT =  25.0    88
POINT =  50.0    54.5
POINT =  75.0    38.5
POINT =  100.0   28.5
POINT =  125.0   20.5
POINT =  150.0   15.5
rem  maximum number of points 64.
rem  end of file
```

- Do not use auto-contrast when scanning the film. The first column is dose or monitor units, the second is light intensity (not density).
- Gif2Img was updated, now support TIFF files with up to 16 gray levels, this is the best choice for dosimetry.
- CAT3D now exports Varian MLC files in revision H, previous versions only created revision G of Varian specification. Starting from Varian MLC WorkStation 7.0 revision H is mandatory.
- Dose to POIs now shows dose per fraction and Total Dose. Also, Dose to POIs is available in Add Dose Mode.
- New parameter for CAT3D.INI : VARIANMLC . Defines the path to copy each .MLC file exported by CAT3D. This option can be used to copy MLC file into a folder in the Varian MLC WorkStation or on a Shaper station.
- Bug removed in integral dose and 3D dose computation that affects PCs with I7 processors.

Move to version 7.08.20

- Support to export MLC files for Varian LINACs using Varian angle scale.
- CAT3D now detects Siemens virtual wedges and prevents computing Beam Hardening on them.
- Support for Step & Shoot delivery in IMRT.
- Bug removed in the Select Color dialog of isodose curves.
- CAT3D now prevents importing a plan into itself. Of course this was a user mistake but it destroyed the plan.
- RoiSelect.exe now follows the movement of the CAT3D window. This is specially useful in double monitor systems.
- RoiSelect : Use Right-click in a roi to go directly to Draw ROI.
- RoiSelect : Use SHIFT + Click to change the background color of RoiSelect window, this is useful for better visibility of dark colored rois .

Move to version 7.09.6

- The main C/C++ compiler to build CAT3D was changed to INTEL ICL.
- New capabilities for the Mosaic window: rendering of ROIs and isodoses.
- The number of frames in the Mosaic can change.
- In the case of using a LINAC with MLC, there is no more warning for lack of trays.
- New matrix model for IMRT optimization allowing bigger treatment volumes in the same memory space.
- CAT3D selects the window area depending on the actual Windows resolution. Better use of the

screen for 1980x1080 and 1600x900 modes.

- New parameters for RSD :

  MLC_FACTOR
  MLC_LEAKFRONT
  MLC_LEAKLAT
  MLC_RAD_OFFSET

  All of them are parameters for MLC modeling.

- Dicom filter now opens Lossy JPEG compressed images in 12 bits, volumetric multi-frame images and lossless JPEG digital X-Rays from Fuji.
- ROIExpansion now includes a parameter to keep a minimum distance to skin.
- Support to export for Varian MLC 52 leaves in revision H.
- Add Dose from External Plans allows up to 8 externals plus the active plan.
- NEW: Pencil Beam model now includes Offaxis Beam Softening. The lateral quality follows the formalism of Taylor et. al., in "A generic off-axis energy correction for linac photon beam dosimetry", Med. Phys. (25) May 1998. To activate de softening computation a new keyword is added to the RSD :
  OffAxisSoftening = 1
  Note that the softening is considered only in PencilBeam modes.

Move to version 7.09.10

- NEW: Information regarding voxel density in ROIs . At the end of "ROI Info", the new version, shows the mean and standard deviation of of the raw voxel values. If the electron density correction is active the mean and standard deviation are also shown.
- Bug removed interpolating dose planes at the right border of the main window. That bug created small negative dose values at the border of DicomRT-Dose planes.
- The DosePlane2dcm.exe service now reads CAT3D.INI to set the axis orientation. If MatriXX = 1 is found the dicom RT-Dose file uses the MatriXX convention. The new DosePlane2dcm.exe does not open a console, so there is no more window blink.
- NEW: In the "Draw Shield" the user can edit (retouch) a previous shield. As the first command in the Draw Shield, press <INSERT> to enter retouch mode.
- NEW: At the end of Draw Shield the optimum collimator settings are fixed for the field. To do this two new parameters are read from the RSD : Collimator2Shield and CollimatorAsymmetric. Collimator2Shield is the distance from shield border to collimator jaws in mm [1..16]. CollimatorAsymmetric tells CAT3D if the optimum setting are for an Asymmetric collimator or not, the default is asymmetric For a symmetric collimator set zero (0) othewise set it to 1. If you want different margins in cross-plane and inplane use Collimator2ShieldInplane and Collimator2ShieldCrossplane. If you want field size rounded to 5 or 10 mm use CollimatorRoundedTo. Example of use for a symmetric collimator:

  Collimator2Shield = 5.0
  CollimatorAsymmetric = 0
  CollimatorRoundedTo = 10

Other Example in an asymmetric collimator:

Collimator2ShieldInplane = 2
Collimator2ShieldCrossplane = 5
CollimatorAsymmetric = 1

- Use AutoFieldSize in the .INI to set your preferences . The valid values are : YES, NO and ASK . In the case on NO, CAT3D is not going to fit the collimator to the shields. In the case of ASK CAT3D will ask if you want to fit the collimator at the end of each shield.
- To set the behavior of CAT3D Auto Field Size while using CAT3D, go to the main menu, select Options and Auto Field Settings.
- the DicomRT-Dose exported by CAT3D is generated with 1mm/pixel, approximately.
- Better rendering of 8 bits image reconstructions.
- NEW: CAT3D now is sensitive to mouse click over the auxiliary reconstructed images at the right side of the screen. This can be used in the 2D and 3D windows.
- Isodose rendering over the auxiliary reconstructed images at the right side of the screen. This feature can be set to OFF or ON in the main menu, Options and "Show Isodoses in Auxiliary".
- For better agreement with experimental data the OffAxisSoftening can be set between 0.0 and 2.0 . 0.0 means no softening, 1.0 is the standard softening as published by Taylor et. al. 0.5 means ½ of the Taylor softening, etc.
- InOutTime for Cobalt-60 machines. It is a constant of time in centi-minutes that should be added to some Cobalt-60 machines. For example InOutTime = 5.5 , in the RSD .
- Brachytherapy isodose rendering over the auxiliary reconstructed images at the right side of the screen.
- Faster gamma error analysis in densitometry, now using multithreads.

Move to version 7.09.15

- Magnifying Lense : Press the key + to open a magnifying lense. While using the magnifying lense no other function is available. Use mouse wheel to modify magnification. Use a mouse Click to close the magnification lense. The lense is available in the planning window, in 3D window and in mosaic window.
- Fusion Lense: On the keyboard press <SHIFT-F5> to open the fusion lense. The fusion lense presents a square area with pixels from the floating or reference image. Use a Right-click of the mouse to toggle between pixels from floating or reference image. While using the fusion lense no other function is available. Use a mouse Click to close the Fusion Lense. The fusion lense can be used only when fusion is active.
- Bug removed in IMRT optimization if a ROI with zero (0.0) volume was used as OAR or PTV. ROIs with zero volume are not allowed but now the invalid ROI is identified and removed from IMRT optimization.

Move to version 7.09.16

- Bug removed that prevent some ROI segments to be retouched.

Move to version 7.09.17

- Internal data check to avoid IMRT optimization using RSD files without modulator or MLC information.

Move to version 7.09.18

- Zoom In and Zoom Out for BEV. Use F4 for zoom in and CTRL-F4 for zoom out.
- New dialog for ROI-Properties edition. Now it allows ROI' color edition.
- New method for ROI drawing with a circular brush. There are two brushes, one to add roi area an other to remove area. A button is used to switch between brushes.
- The path definition in CAT3D.INI now allows relative path. For example, instead of using IMAGE=c:\cat3d\rtpimg use IMAGE=rtpimg . This extension helps if you need to install CAT3D in a directory (folder) with different name, such as c:\CAT3D_718\ . If you use relative path the CAT3D.INI do not need modification after a change in the name of the instalation folder.