

# Varian BrachyTherapy

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*IFMP MedPhys Workshop*

*Elbasan, July 7, 2016*

# Varian Commitment to Brachytherapy

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Teaching courses (Varian & with ASTRO/GEC-ESTRO)

Classroom Training Centers

Support Toll Free Number

Support email: [support@varian.com](mailto:support@varian.com)

Ongoing applicator & software development

# Webinars on MyVarian

Over 130 webinar events available on a variety of subjects & treatment sites in 6 languages

Click on RESOURCE CENTRAL. Click on WEBINARS.

Webinars Brachytherapy

The Varian Webinar program consists of live online presentations delivered by Varian customers on various topics. Given the webinar MyVarian for your convenience.

Note: You do not need a MyVarian account to view webinars. To view a webinar, click on a webinar title and register now.

Filter on a BRACHYTHERAPY topic

Date	Title
Mar 2011	Brachytherapy[Measure Twice, Treat Once – HDR Afterloader QA]
Feb 2011	Brachytherapy[Interesting & Exciting; An Introduction to the iX Console]
Feb 2011	Brachytherapy[Right the First Time, Every Time – Brachytherapy Treatment Planning QA]

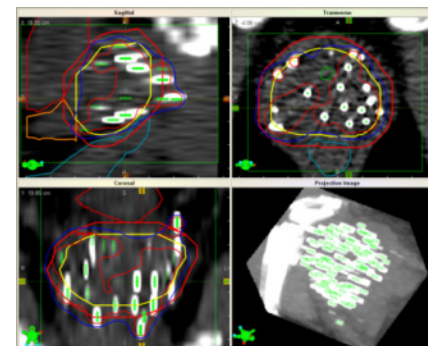
3 | VARIAN ONCOLOGY

http://my.varian.com/ Local intranet | Protected Mode: Off

# Varian BrachyTherapy Products

## High Dose Rate Delivery Systems Treatment Planning

- ✓ BrachyVision  
*HDR brachytherapy planning*
- ✓ Acuros BV  
*Advanced dose algorithm*
- ✓ Vitesse  
*Real-time HDR prostate planning*
- ✓ VariSeed  
*LDR seed planning*



# GammaMed*plus*™ iX HDR/PDR afterloader



# GammaMed Product Features

## GammaMed*Plus* 3/24 iX

- 3 channels
- Easy & cost effective introduction to HDR
- Field upgradeable to 24 channel system



## GammaMed*Plus* iX

- 24 channels
- Full functionality



# GammaMed Product Features

## GMPlus 3/24 iX



## Features

- Source
  - 0.9 mm capsule diameter
  - 3.5 mm active length
  - Ir-192 (370 GBq)

## GM iX



# GammaMed Product Features

## GMPlus 3/24 iX



## Features

- Wire speed ~60 cm/second
- Distal to proximal movement
- 60 programmable dwell positions per channel
- Selectable step size (1-10mm in 1 mm increments)
- Adjustable height

## GM iX





# GammaMed Product Features

## GMPlus 3/24 iX



## Features

- Fixed-length treatment distance
- Applicator end-test
- Bases treatment times on nominal 10 Ci source activity
- Built-in Geiger-Muller radiation detector

## GM iX

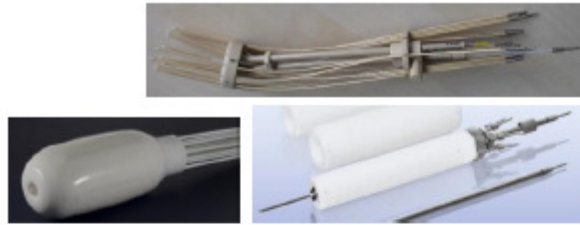


# GammaMed Safety



- Source safe key-lock
- Dummy source positioning control
- Radiation warning light
- Emergency source-retract button
- Emergency source hand crank
- Backup UPS in case of power failure

# Applicators



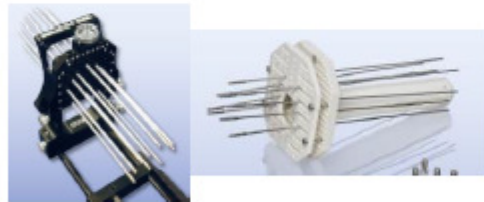
## Intracavitary

For treatments in a natural body cavity



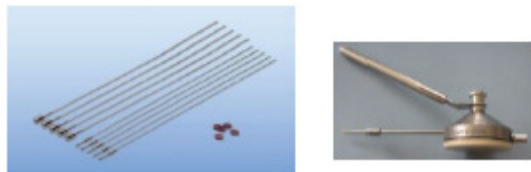
## Intraluminal

For treatments in a body lumen



## Interstitial

For treatments inside body tissue



## Intraoperative & Surface

For treatment involving implantation of a flap or tubes during surgery

# Brachytherapy Planning System

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## Treatment Planning

### BrachyVision™

- HDR brachytherapy planning

### Acuros® BV

- Advanced dose algorithm

### Vitesse™

- Real-time HDR solution

### VariSeed™

- LDR seed planning

# CT Sliding Gantry (CTSG)

- 80 cm wide bore
- All functionality of RT Pro
- 2 m scan range
- Up to 10 m rail length
- User choice of fixed or mobile couch



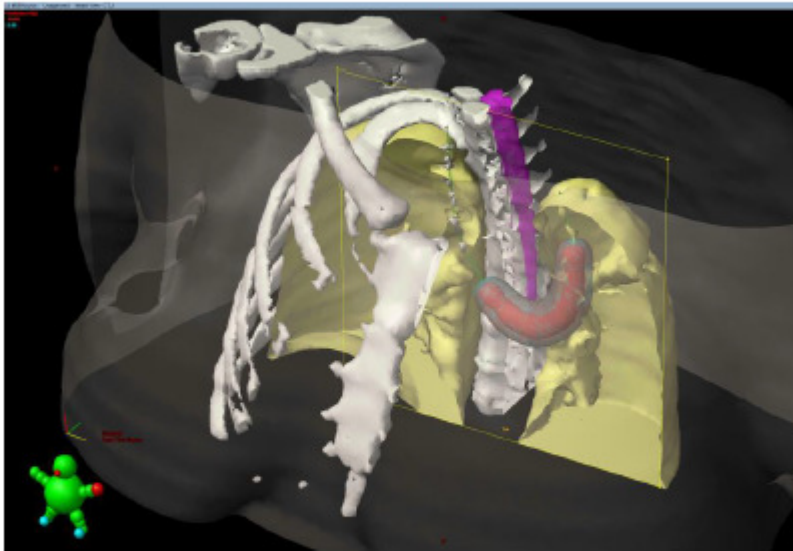
# MRI

- Excellent soft tissue definition
- Dockable couch



Siemens MAGNETOM<sup>®</sup> Aera (1.5T)  
Siemens MAGNETOM<sup>®</sup> Skyra (3T)  
Both available with dockable  
couches

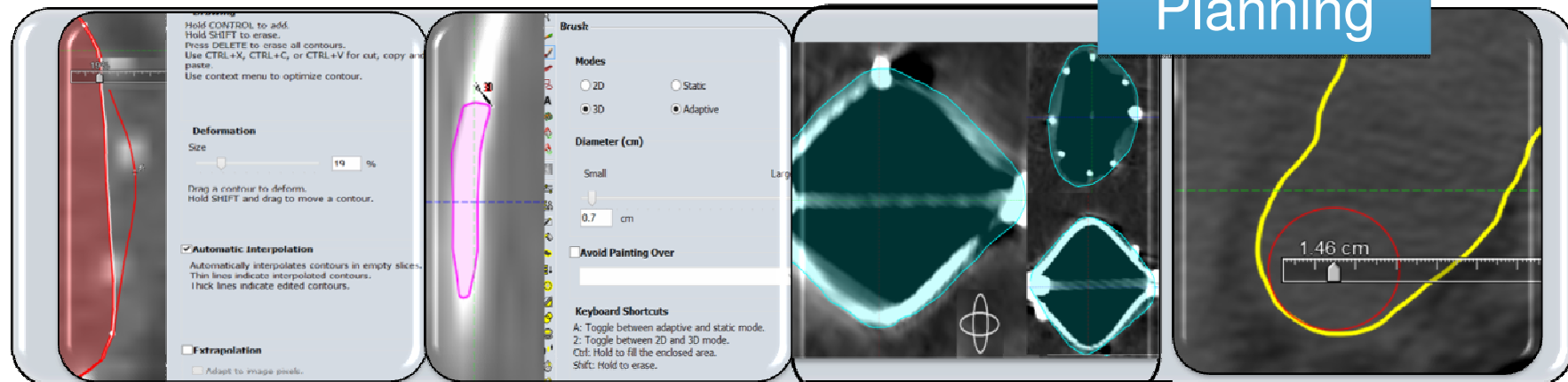
# BrachyVision 13.7



- Comprehensive brachytherapy planning system
- HDR, PDR and LDR supported
- Plan summation for both brachytherapy and external beam plans
- Film and 3-D image based planning
- Full 3D capability using Eclipse™ contouring, registration and plan evaluation
- Contour structures on any plane
- Fully integrated with ARIA® and Eclipse™

# Eclipse™ Contouring - new

Freehand  
also  
available in  
Planning



## Freehand

Draw, edit,  
move, adjust  
copy,  
interpolate  
without  
switching  
tools

## Smartbrush

Contour on  
any view  
including  
rotated. Static  
and Adaptive.

## Volume Contour

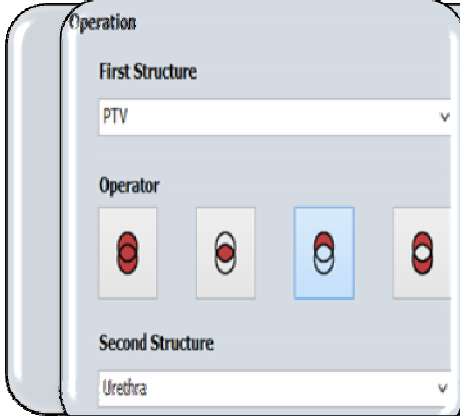
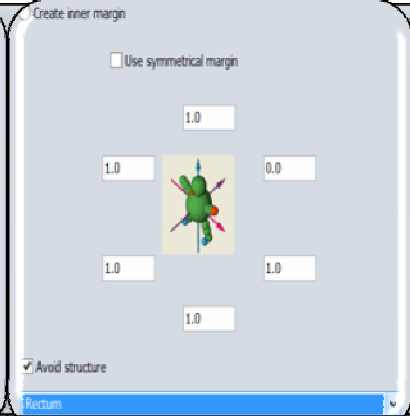

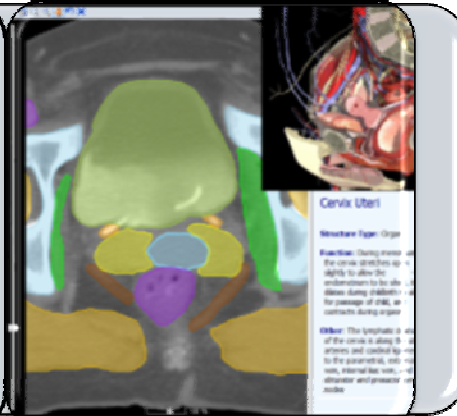
Draw a  
contour in  
each rotated  
view to create  
structure

## Deform Structure

Selected  
structure. Set  
region of  
influence



# Eclipse™ Contouring - new

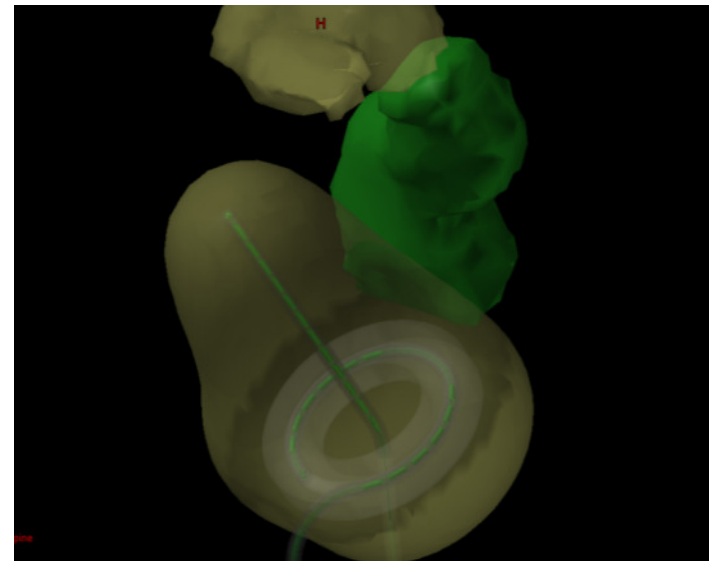
			
<p><b>Boolean Logic</b></p> <ul style="list-style-type: none"> <li>• Advanced</li> <li>• Simple</li> </ul>	<p><b>Margin</b></p> <ul style="list-style-type: none"> <li>• Symmetrical</li> <li>• Asymmetrical</li> <li>• Avoid Structures</li> </ul>	<p><b>Crop</b></p> <ul style="list-style-type: none"> <li>• Inside or outside another structure</li> <li>• Include Margin</li> </ul>	<p><b>Anatomy Atlas</b></p> <ul style="list-style-type: none"> <li>• Several areas included</li> <li>• Detailed view of selected structure</li> </ul>

# Applicator Placement

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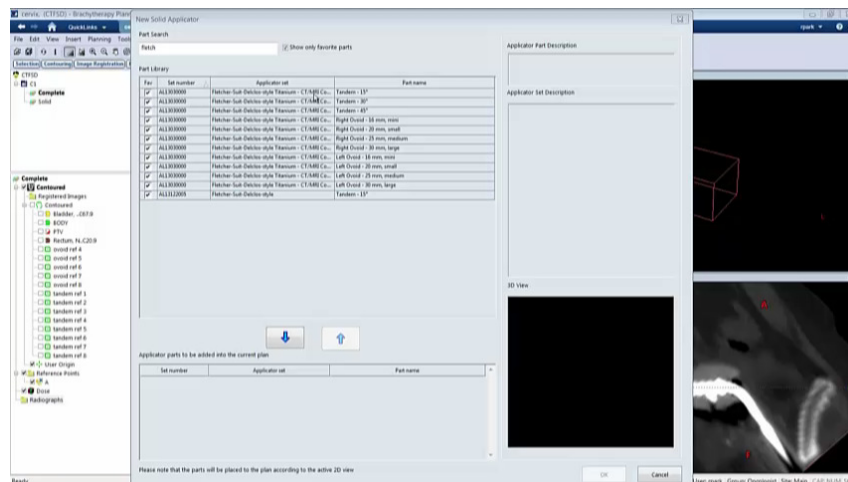
## Various techniques

- Manually
- Automatic detect
- Solid applicators
- Template plans



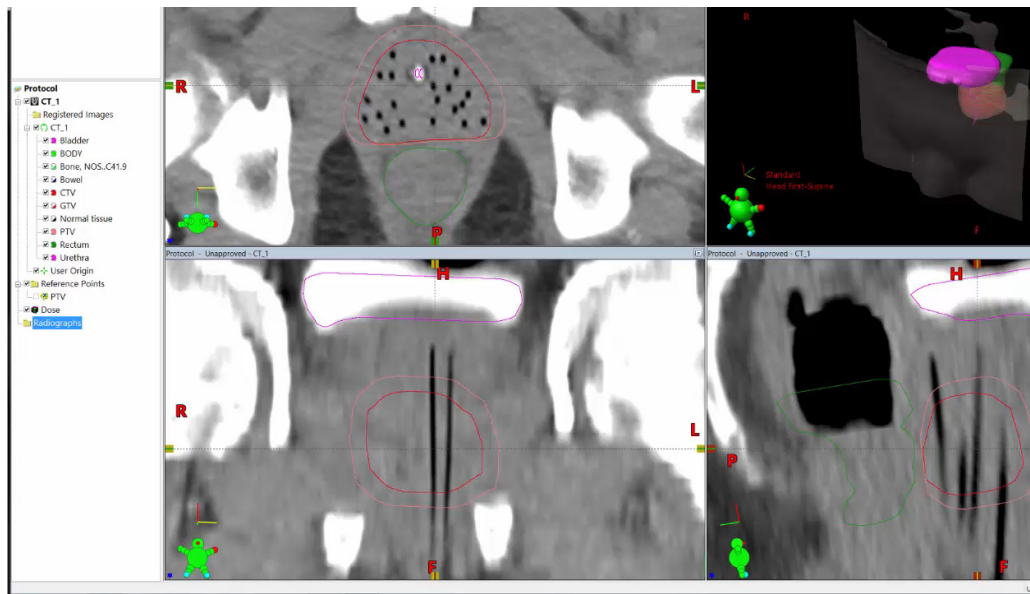


# Automatic Applicator Placement

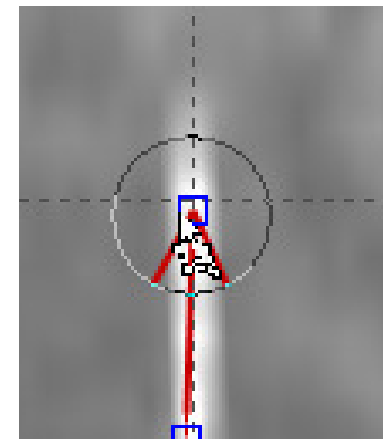


- Place rigid or library applicators with a click
  - High density applicators / solid markers
  - Move the applicator using arrow keys

# Automatic Catheter detection



- Works with metal or plastic applicators.
- Review and refine tip location:
  - Move planes to tip tool
  - Circle Cursor



# Dose Planning

## AUTOMATED OPTIMIZATION

- Adaptive Volumetric
- Geometric

## MANUAL OPTIMIZATION

- Dose shaper
- Dwell time control
- Point dose source contribution



# Adaptive Volumetric Optimization (AVOL)

The screenshot shows the 'Volume Optimization' window with several key features highlighted by callouts:

- Upper and lower limits to any structures and/or lines:** A callout points to the 'Structures and reference lines' table.
- Available for both TG43 and Acuros<sup>®</sup> BV\* dose:** A callout points to the 'Dose Histogram for All Objectives' graph.
- Dwell constraints including smoothing:** A callout points to the 'Dwell time objective' section.
- Basal dose limit to reduce hotspots:** A callout points to the 'Basal dose objective' section.

**Structures and reference lines table:**

ID	Resolu...	Points	Surf
CTV	0.0	0	
PTV	3.5	1654	
Rectum	2.5	1744	

**Dose Histogram for All Objectives:** A graph showing dose distribution for various objectives. The x-axis is 'Dose [Gy]' (0 to 16) and the y-axis is 'Dose [%]' (0 to 100). The graph shows a green curve for the target and red curves for organs at risk (OARs). A vertical line indicates the basal dose limit.

**Dwell time objective:**

Max [s]	Min [s]	Smooth	Priority
14.0	0.0	<input type="checkbox"/>	100

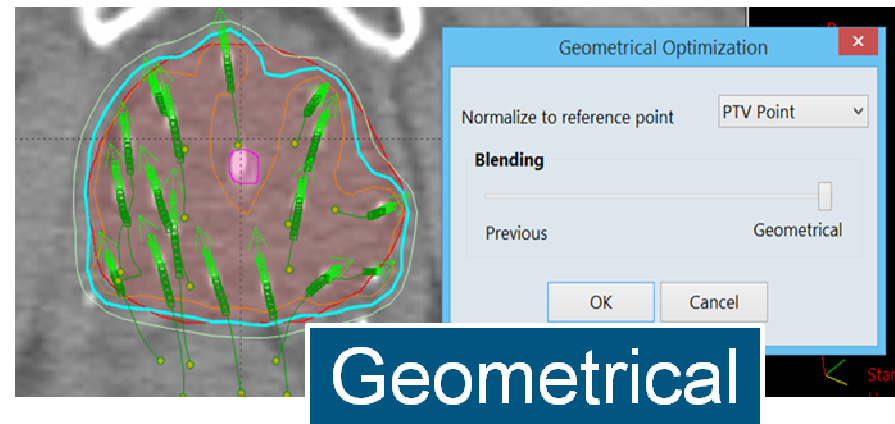
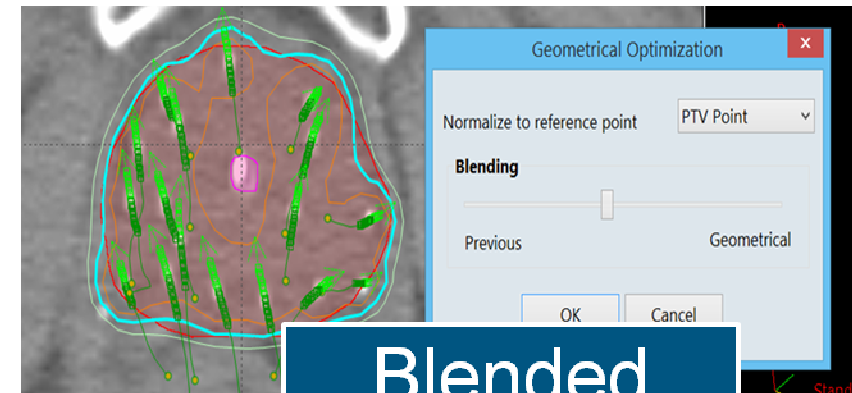
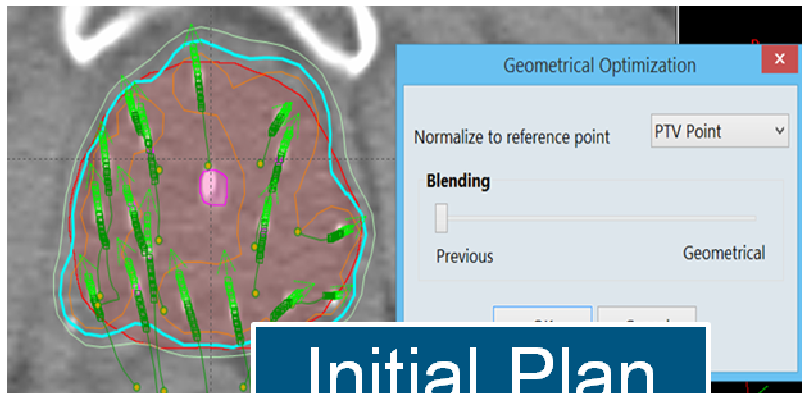
**Basal dose objective:**

Enable	Max basal dose [Gy]	Priority	Coarse mode
<input checked="" type="checkbox"/>	10.00	30	<input type="checkbox"/>

**Optimization progress:** A progress bar at the bottom of the window shows the optimization status. The 'Penalty contributions' section at the bottom indicates: Time 0%, basal dose 87%, Max time: 13.6 [s], Total penalty: 0.6.

\*Available from v13.7.  
Requires Acuros<sup>®</sup> BV license

# Geometrical Optimization

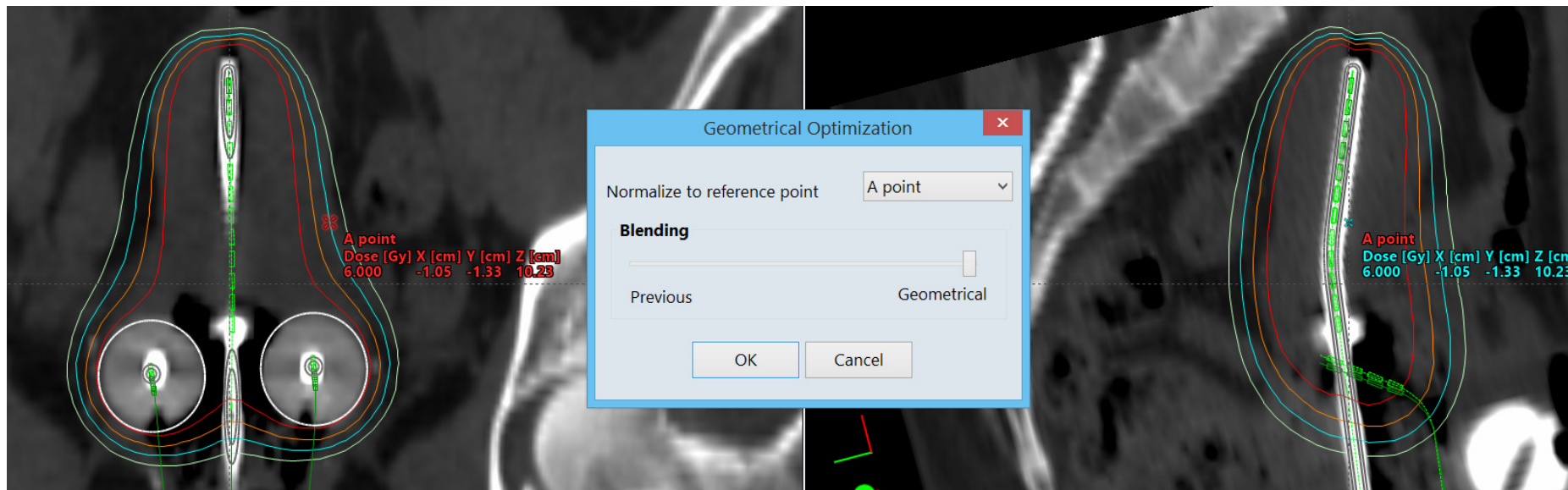




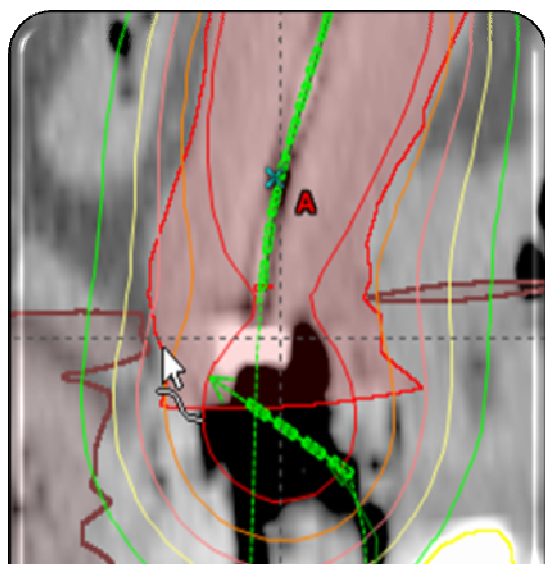
# Geometrical Optimization

## UNIFORM DOSE DISTRIBUTION

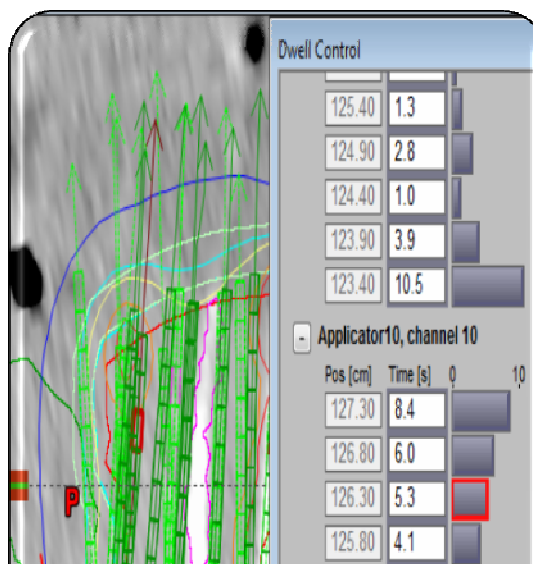
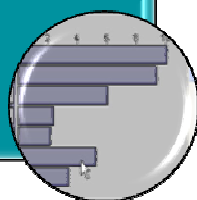
Good starting point



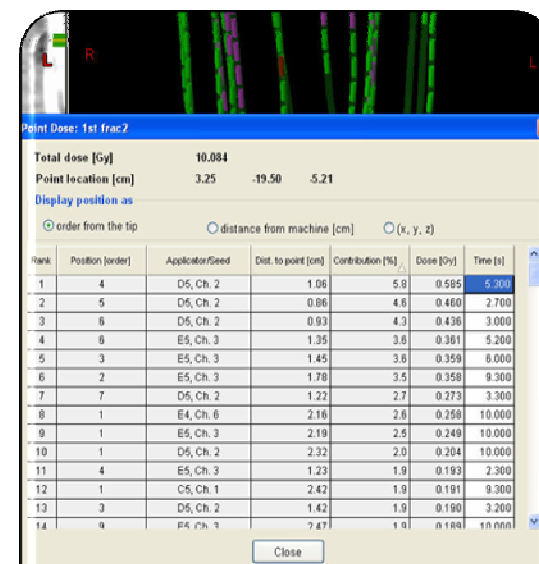
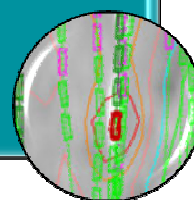
# Tools You Need



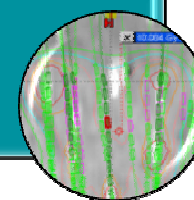
**Shaper**



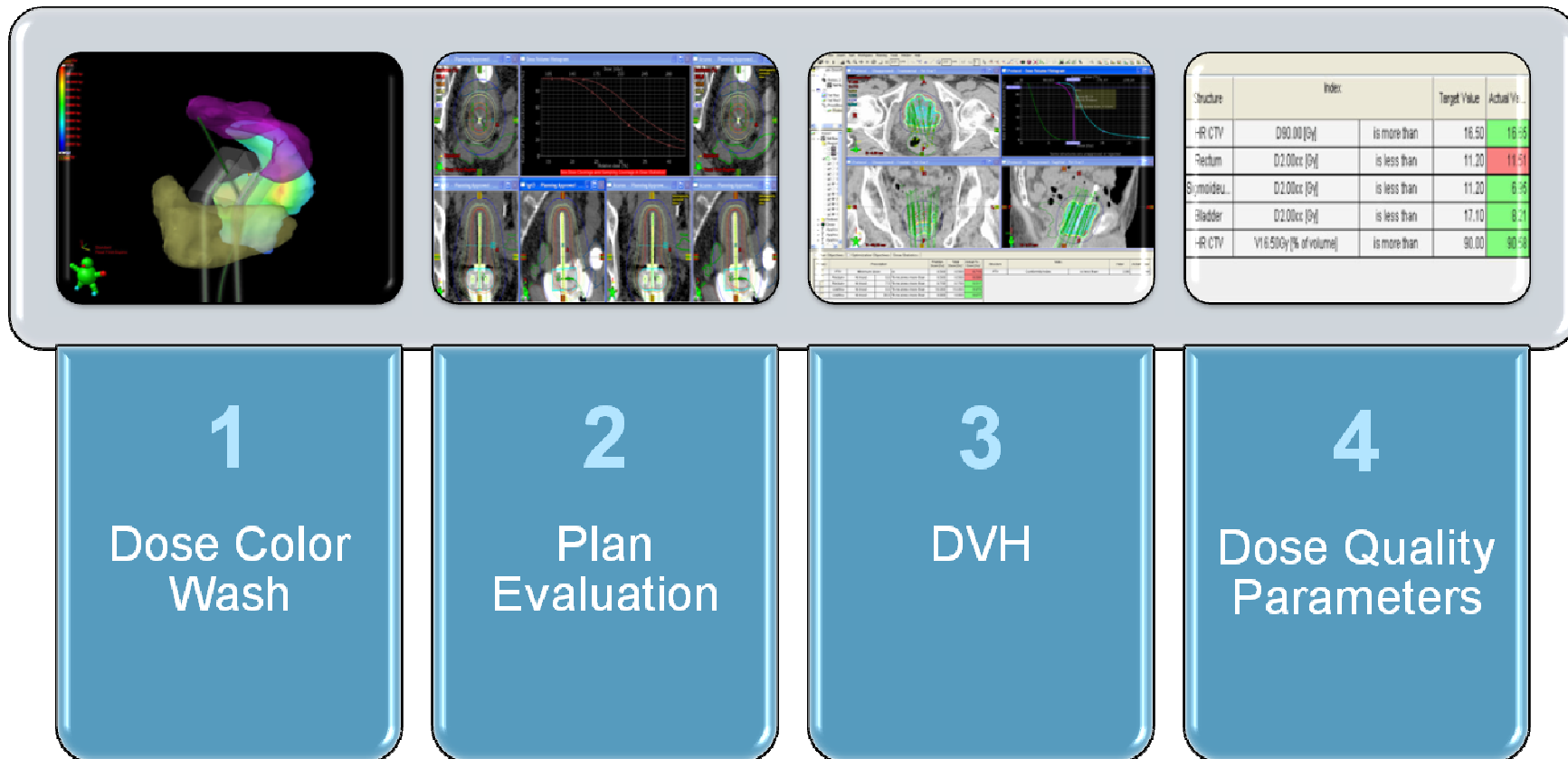
**Dwell control**  
*Source highlight*



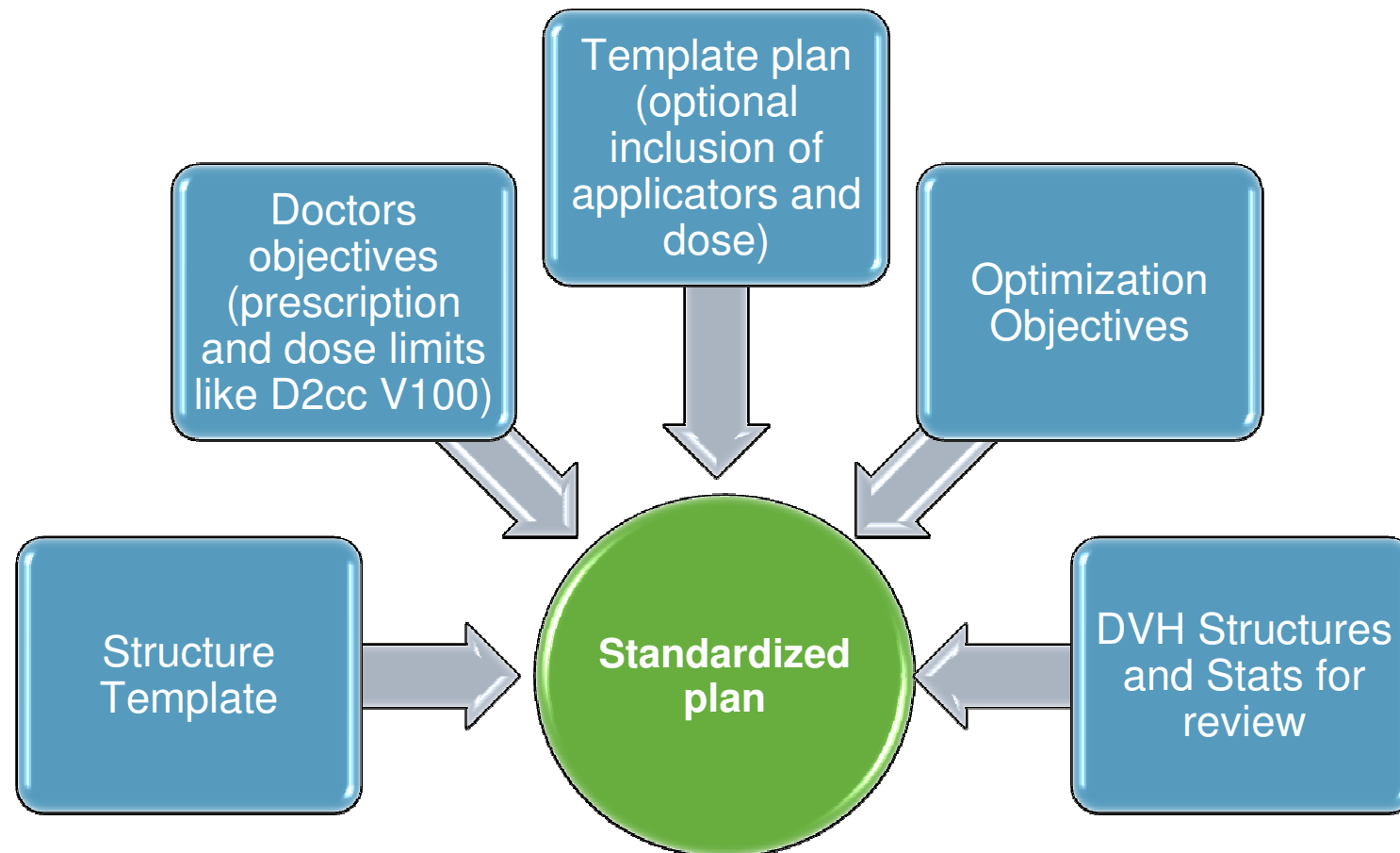
**Source contribution**  
*Source highlight*



# Plan Evaluation

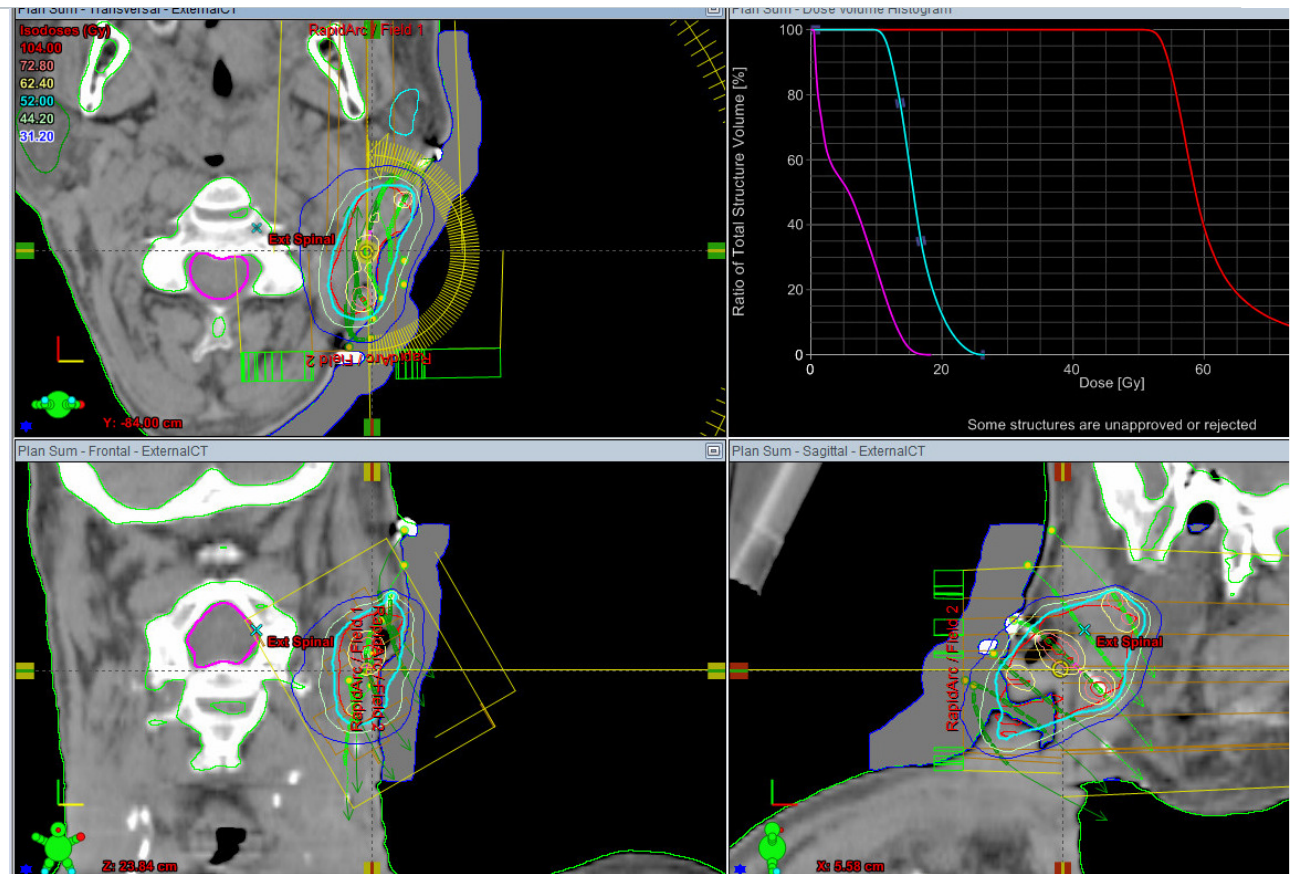


# Clinical Protocols



# Plan Summation of Multiple Plans

- View dose distribution and DVH when images are registered
- Useful for
  - Multiple brachytherapy fractions
  - External beam with Brachytherapy boost
- Weighting factors available
- Possible to create Structures of isodose levels for optimization constraints



# Plan Summation

- View the plans side by side

The screenshot displays a medical software interface for treatment plan summation. The interface is divided into several sections:

- Left Panel (Tree View):** Shows a hierarchical list of objects including 'Series 2', 'Study1', 'Series 4', 'C1', '3D Conformal', 'IMRT', 'Plan1', and 'RapidArc'. Under 'RapidArc', there are sub-panels for 'ExternalCT', 'Registered Images', 'Reference Points', 'Dose', 'Fields', and 'MLC'.
- Top Panel (Navigation):** Includes 'Contouring', 'Registration', 'External Beam Planning', 'Brachytherapy Planning', 'Brachytherapy 2D Entry', and 'Plan Evaluation' tabs.
- Central Grid (Views):**
  - Top-Left:** 'RapidArc - Unapproved - Transversal - ExternalCT'. Shows a 3D dose distribution with '3D Dose MAX: 45.758 Gy'. Includes a DVH plot with 'Ratio of Total Structure Volume [%]' on the y-axis and 'Dose [Gy]' on the x-axis.
  - Top-Right:** 'Plan1 - Unapproved - Transversal - CT\_1'. Shows a 3D dose distribution with '3D MIN for PTV: 7.274 Gy' and '3D MEAN for PTV: 17.822 Gy'.
  - Bottom-Left:** 'RapidArc - Unapproved - Frontal - ExternalCT'. Shows a frontal view of the dose distribution.
  - Bottom-Middle-Left:** 'RapidArc - Unapproved - Sagittal - ExternalCT'. Shows a sagittal view of the dose distribution.
  - Bottom-Middle-Right:** 'Plan1 - Unapproved - Frontal - CT\_1'. Shows a frontal view of the dose distribution.
  - Bottom-Right:** 'Plan1 - Unapproved - Sagittal - CT\_1'. Shows a sagittal view of the dose distribution.
- Bottom Panel (Table):** A table with columns: 'View', 'DVH Line', 'Structure', 'Approval Status', 'Plan', 'Course', 'Volume [cm³]', 'Dose Cover[%]', 'Sampling Cover[%]', 'Min Dose [Gy]', 'Max Dose [Gy]', and 'Mean Dose [Gy]'.
 

View	DVH Line	Structure	Approval Status	Plan	Course	Volume [cm³]	Dose Cover[%]	Sampling Cover[%]	Min Dose [Gy]	Max Dose [Gy]	Mean Dose [Gy]
<input type="checkbox"/>	—	Normal tissue	Unapproved	Plan1	C1						
<input type="checkbox"/>	—	BODY	Unapproved	RapidArc	C1						
<input checked="" type="checkbox"/>	—	Spinal co..C72.0	Unapproved	RapidArc	C1	27.5	100.0	100.1	0.119	16.562	5.131
<input checked="" type="checkbox"/>	—	PTV	Unapproved	RapidArc	C1	24.5	100.0	100.1	41.739	45.758	44.267
<input type="checkbox"/>	—	Bone, NOS..C41.9	Unapproved	RapidArc	C1						
<input type="checkbox"/>	—	Lt Parotid	Unapproved	RapidArc	C1						
<input type="checkbox"/>	—	Rt Parotid	Unapproved	RapidArc	C1						
<input type="checkbox"/>	—	Brain Stem	Unapproved	RapidArc	C1						

# Plan Summation

- View the Summed doses in 2D and 3D

The screenshot displays a medical planning software interface with the following components:

- Toolbar:** Includes navigation and tool icons, a scale of 2.0 cm, and a zoom level of 1.
- Tree View (Left):** Shows a hierarchy of data including Series 2 (CT\_4), Study1, Series 4 (CT\_1), C1, 3D Conformal, IMRT, Plan1, RapidArc, and Plan Sum.
- Plan Sum List (Left):** A detailed list of anatomical structures and plans, including ExternalCT, Registered Images (CT\_1, CT\_2, CT\_4), CT\_1, BODY, Bone, NOS..C41.9, Brain Stem, CouchInterior, CouchSurface, Lt Eye, Lt Optic Nerve, Lt Parotid, PTV, Rt Eye, Rt Optic Nerve, Rt Parotid, Spinal co...C72.0, Bolus, User Origin, Reference Points, Brachy+External, brachySpinal, BRCHY PTVPrimary, Ext PTV Primary, Ext Spinal, ref, Dose, Plan1, Fields, and RapidArc.
- View Windows:**
  - Plan Sum - Transversal - ExternalCT:** Shows a cross-sectional view of the neck with isodose lines and target volumes. A legend on the left lists isodose levels: 104.00, 72.80, 62.40, 52.00, 44.20, and 30.20.
  - Plan Sum - Model View - ExternalCT:** Shows a 3D model of the head and neck with isodose surfaces. A legend on the left lists isodose levels: 104.00, 72.80, 62.40, 52.00, 44.20, and 30.20. A text box on the right provides 3D dose statistics: 3D Dose MAX: 208.072 Gy, 3D MAX for PTV: 242.453 Gy, 3D MIN for PTV: 60.043 Gy, and 3D MEAN for PTV: 61.978 Gy.
  - Plan Sum - Frontal - ExternalCT:** Shows a frontal view of the neck with isodose lines and target volumes. A legend on the left lists isodose levels: 104.00, 72.80, 62.40, 52.00, 44.20, and 30.20.
  - Plan Sum - Sagittal - ExternalCT:** Shows a sagittal view of the neck with isodose lines and target volumes. A legend on the left lists isodose levels: 104.00, 72.80, 62.40, 52.00, 44.20, and 30.20.
- Table (Bottom):** A table summarizing the fields and doses.

In Total	Plan ID	Course ID	Operation	Plan Weight	Target Volume	Primary Reference Point [Volume]	Prescribed Percentage [%]	Dose / Fraction [Gy]	Number of Fractions	Total Prescribed Dose [Gy]	Plan Normalization Mode	Field ID	MU	Field Weight
<input checked="" type="checkbox"/>	Plan1	C1	+	1.00	PTV	BRCHY PTVPrimary [PTV]	100.0	3.000	3	9.000	No plan normalization			
<input checked="" type="checkbox"/>	RapidArc	C1	+	1.00		Ext PTV Primary [PTV]	100.0	2.150	20	43.000	Plan Normalization Value: 100.00	Field 1		1.000
											Plan Normalization Value: 100.00	Field 2		1.000

# Plan Summation ○ View the DVH of the summed plans

The screenshot displays a medical planning software interface for a neck patient. The main window is divided into four panels:

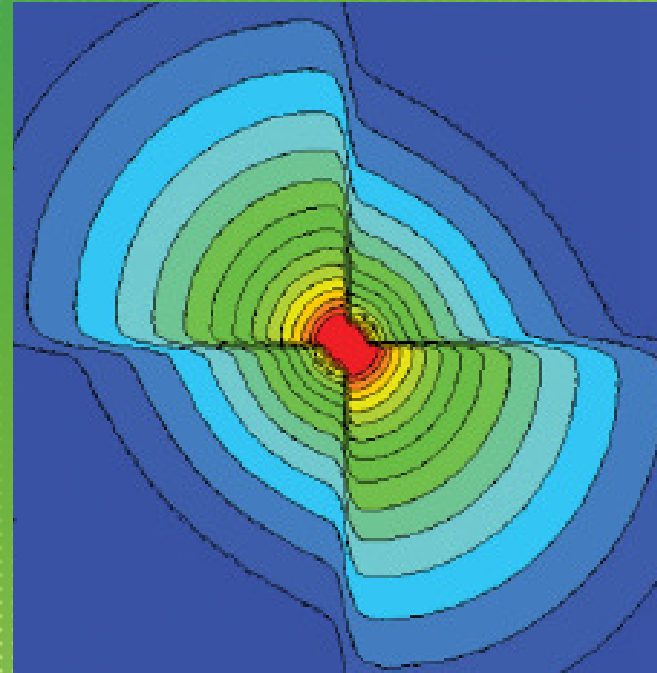
- Plan Sum - Transversal - ExternalCT:** Shows a cross-sectional view of the neck with various contours and dose distributions. A legend on the left lists structures like BODY, Bone, Brain Stem, and PTV.
- Plan Sum - Dose Volume Histogram:** A graph showing the Ratio of Total Structure Volume [%] versus Dose [Gy]. The x-axis ranges from 0 to 80 Gy, and the y-axis ranges from 0 to 100%. Multiple colored curves represent different structures.
- Plan Sum - Frontal - ExternalCT:** Shows a frontal view of the neck with contours and dose distributions.
- Plan Sum - Sagittal - ExternalCT:** Shows a sagittal view of the neck with contours and dose distributions.

At the bottom, a table provides detailed data for the summed plans:

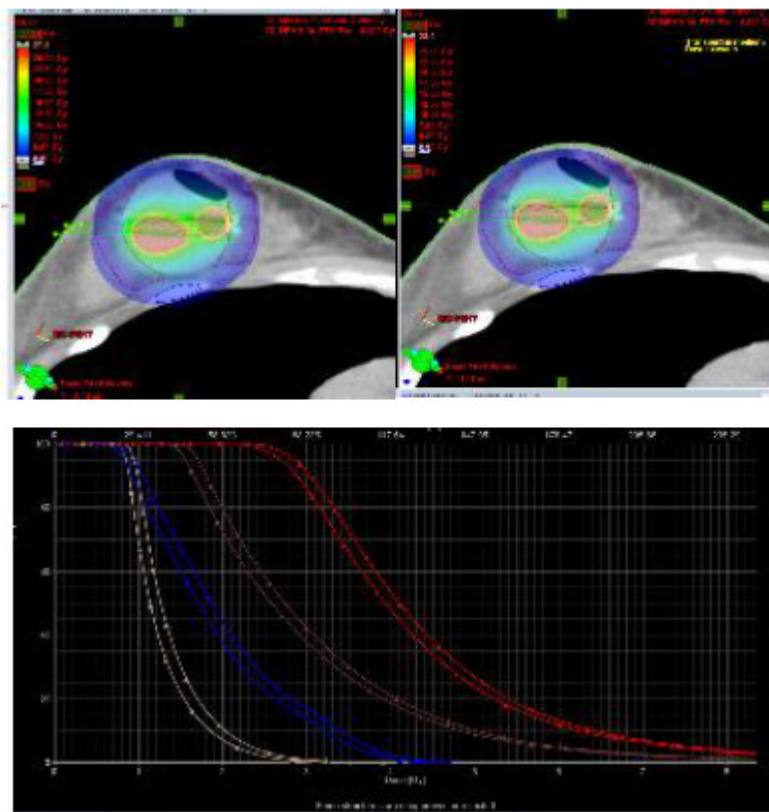
View	DVH Line	Structure	Approval Status	Plan	Course	Volume [cm <sup>3</sup> ]	Dose Cover[%]	Sampling Cover[%]	Min Dose [Gy]	Max Dose [Gy]	Mean Dose [Gy]
<input type="checkbox"/>		BODY	Unapproved	Plan Sum	C1						
<input checked="" type="checkbox"/>		Spinal co..C72.0	Unapproved	Plan Sum	C1	27.5	100.0	100.1	0.425	18.511	6.099
<input checked="" type="checkbox"/>		PTV	Unapproved	Plan Sum	C1	24.5	100.0	100.1	50.018	242.353	61.932
<input type="checkbox"/>		Bone, NOS..C41.9	Unapproved	Plan Sum	C1						
<input checked="" type="checkbox"/>		Lt Parotid	Unapproved	Plan Sum	C1	4.0	100.0	100.0	9.604	26.679	16.066
<input type="checkbox"/>		Rt Parotid	Unapproved	Plan Sum	C1						



Acuros<sup>®</sup> BV  
advanced dose calculation  
for brachytherapy



# ACUROS BT (for use with BrachyVision)



- Advanced dose calculation module of BrachyVision™
- Exclusive to Varian
- Inhomogeneity correction accounts for effects of applicator material, air and patient
- Optimize with Acuros BV dose†
- View as dose to material or dose to water
- Provides Monte Carlo-like accuracy dose calculations with speed and ease
- TG186 compliant for Varian sources

† Minimum requirement version 13.7

# Ideally a brachytherapy treatment planning system should...

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- Account for the effect of applicators
- Account for different patient tissues
- Account for the effects of the patient boundaries
- Give superb dose accuracy
- All with speed and ease

# In the real world, brachytherapy treatment planning systems...

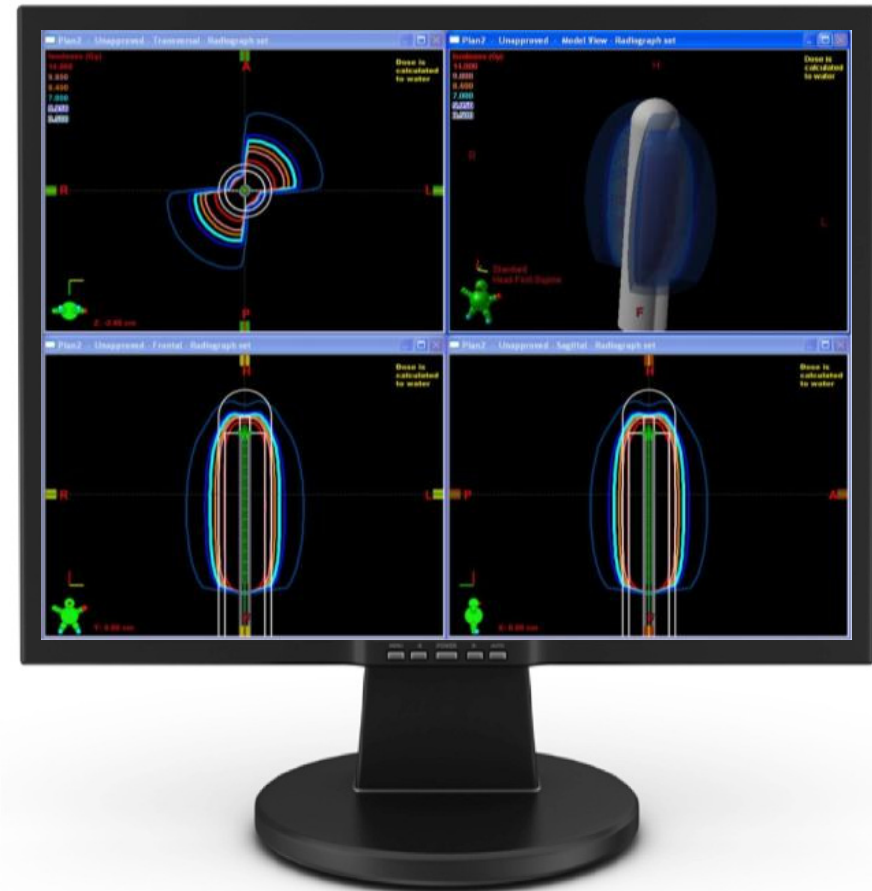
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- Based on TG43
- Assume source in an infinite volume of water
- No inhomogeneity correction
- No applicator attenuation correction
- No allowance for tissue/air interface

Other techniques have been too slow or inaccurate.

# Acuros BV accounts for...

- Effect of applicators
- Different patient tissues
- Effects of the patient boundaries
- Provides Monte Carlo-like accuracy dose calculations with speed and ease
- View inhomogeneity corrected dose for plan



# Acuros BV

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- Exclusive to Varian
- Developed by Transpire Inc, a well respected company in radiation transport methods & developer of Attila
- Licensable module\*

*\*Minimum requirement version 8.9*

# How does Acuros BV work?

## Acuros BV is a Grid-Based Boltzmann Solver (GBBS) code

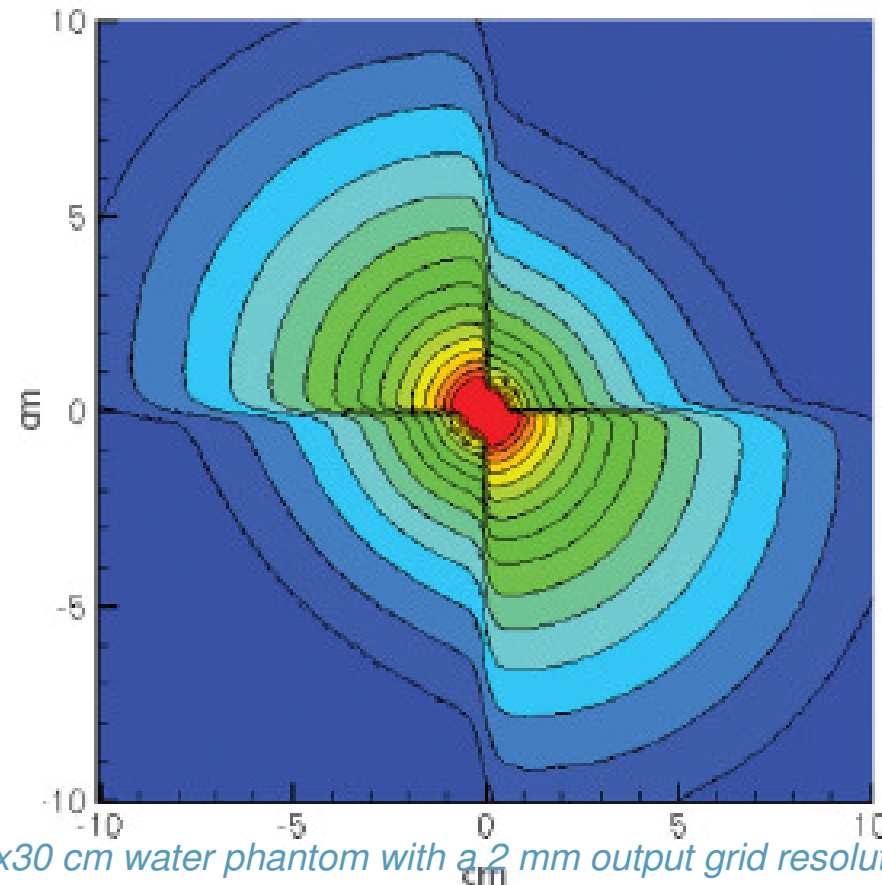
- GBBS codes solve the linear Boltzmann Transport Equation (LBTE) on a computational grid
- LBTE is the governing equation for radiation transport
- Solves the LBTE by discretizing in space, angle, and energy
- Built on a technology originally developed at Los Alamos

$$\hat{\Omega} \cdot \vec{\nabla} \psi + \sigma_t \psi = Q^{scat} + Q^{ext} \quad \text{where,} \quad Q^{scat} = \int_0^\infty dE' \int_{4\pi} d\hat{\Omega}' \sigma_s(\vec{r}, E' \rightarrow E, \hat{\Omega}' \cdot \hat{\Omega}) \psi$$

streaming      collision      sources

# How accurate is Acuros BV?

Comparison of the dose distribution generated with Acuros (solid line) vs. Monte Carlo MCNPX (dashed line)\*



*\*using a shielded cylinder applicator in a 30x30x30 cm water phantom with a 2 mm output grid resolution. The root mean square difference (0.5 to 10 cm) is 1.18%. 2%/2 mm Distance to Agreement (DTA) criteria (0.5 to 10 cm) passed for 100% of voxels.*



# How fast is Acuros BV?

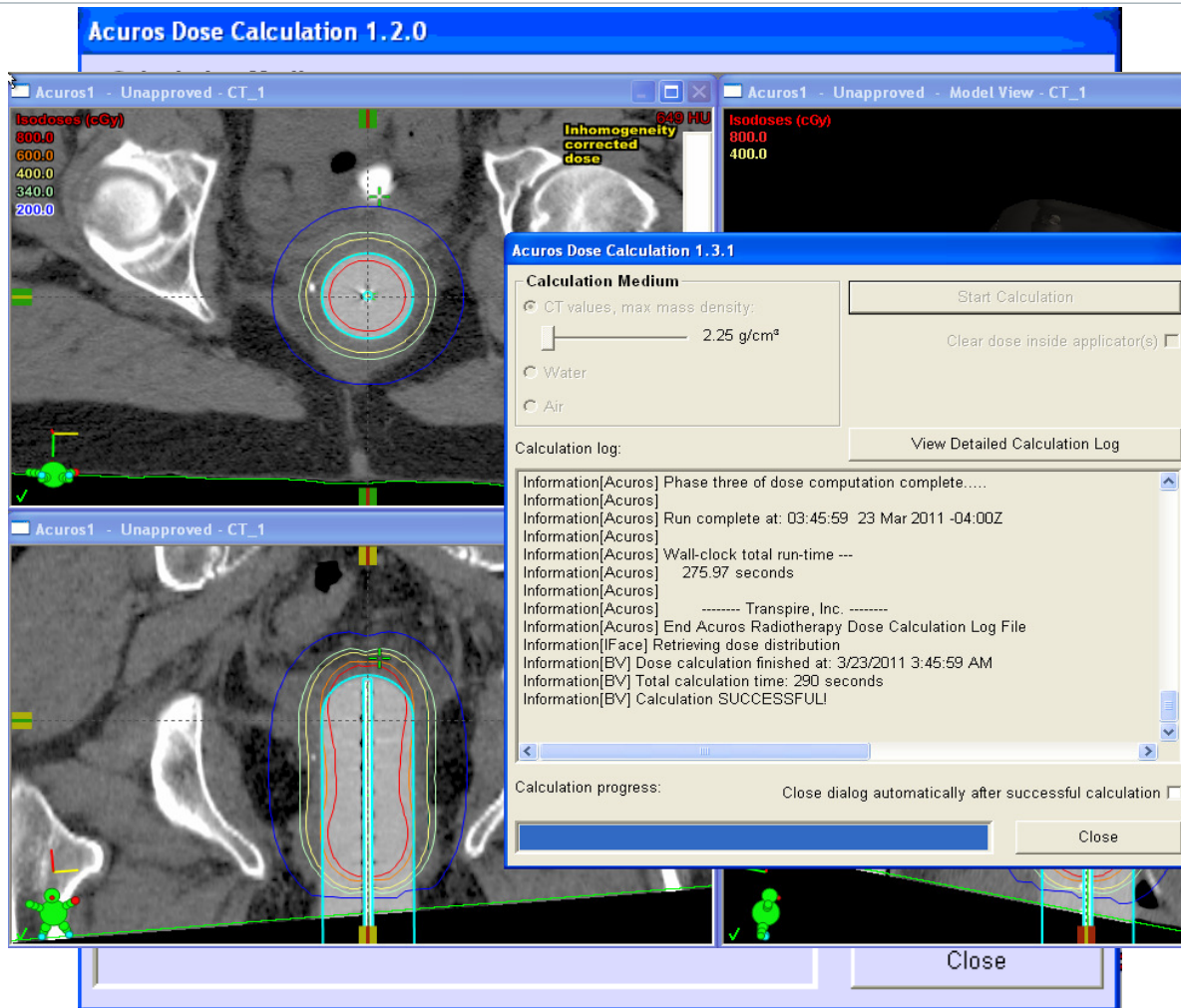
- Calculation times are generally less than a minute\*
- Comparatively, the same calculations in Monte Carlo could take hours or days



\* Time calculation based on using a DELL Precision T5500 with 24G RAM 10x10x10cm 3mm grid.

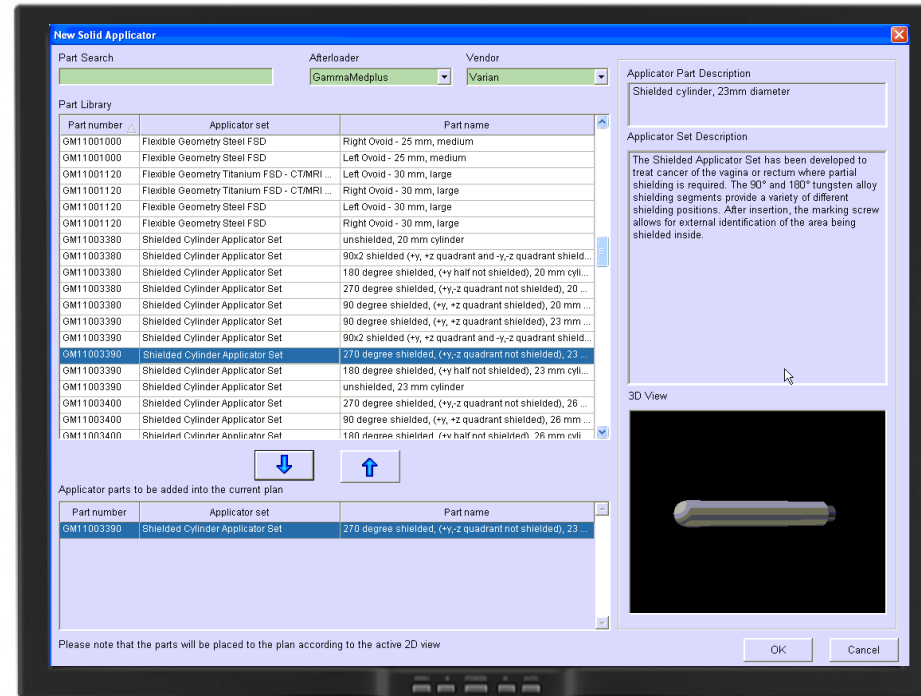
# How To Use Acuros BV

- Generate plan using TG43
- Select 'Calculate Inhomogeneity corrected dose'
- Select 'Use CT data, calculate in water, or calculate in air'
- Calculation performed and dose returned



# Solid Applicator Library

Models most  
Varian applicators\*



\*Minimum requirement version 8.9

# Clinical Use of Acuros BV for APBI

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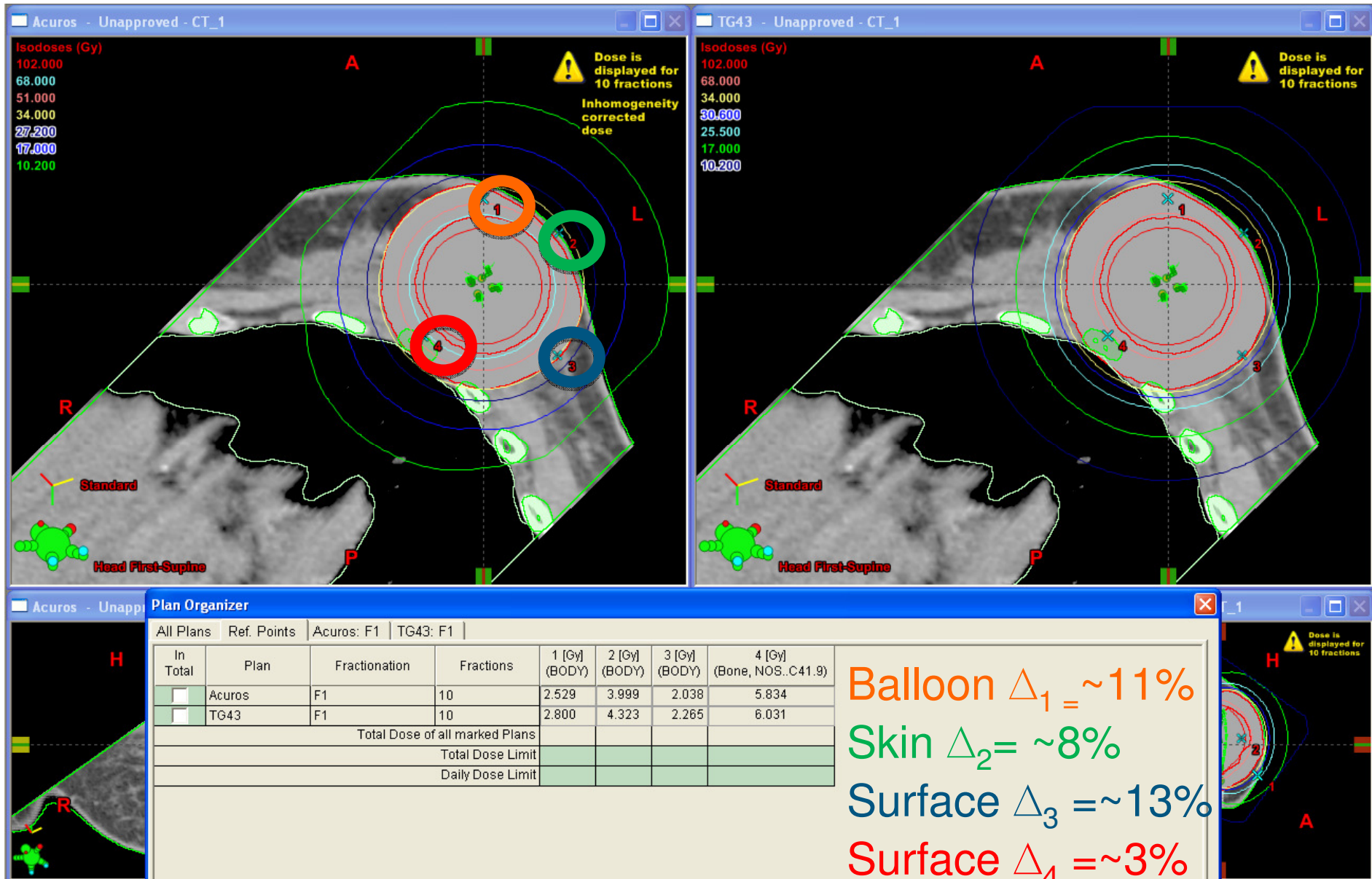
## Influential factors

- Proximity to tissue air interface → lack of scatter
- Presence of contrast media

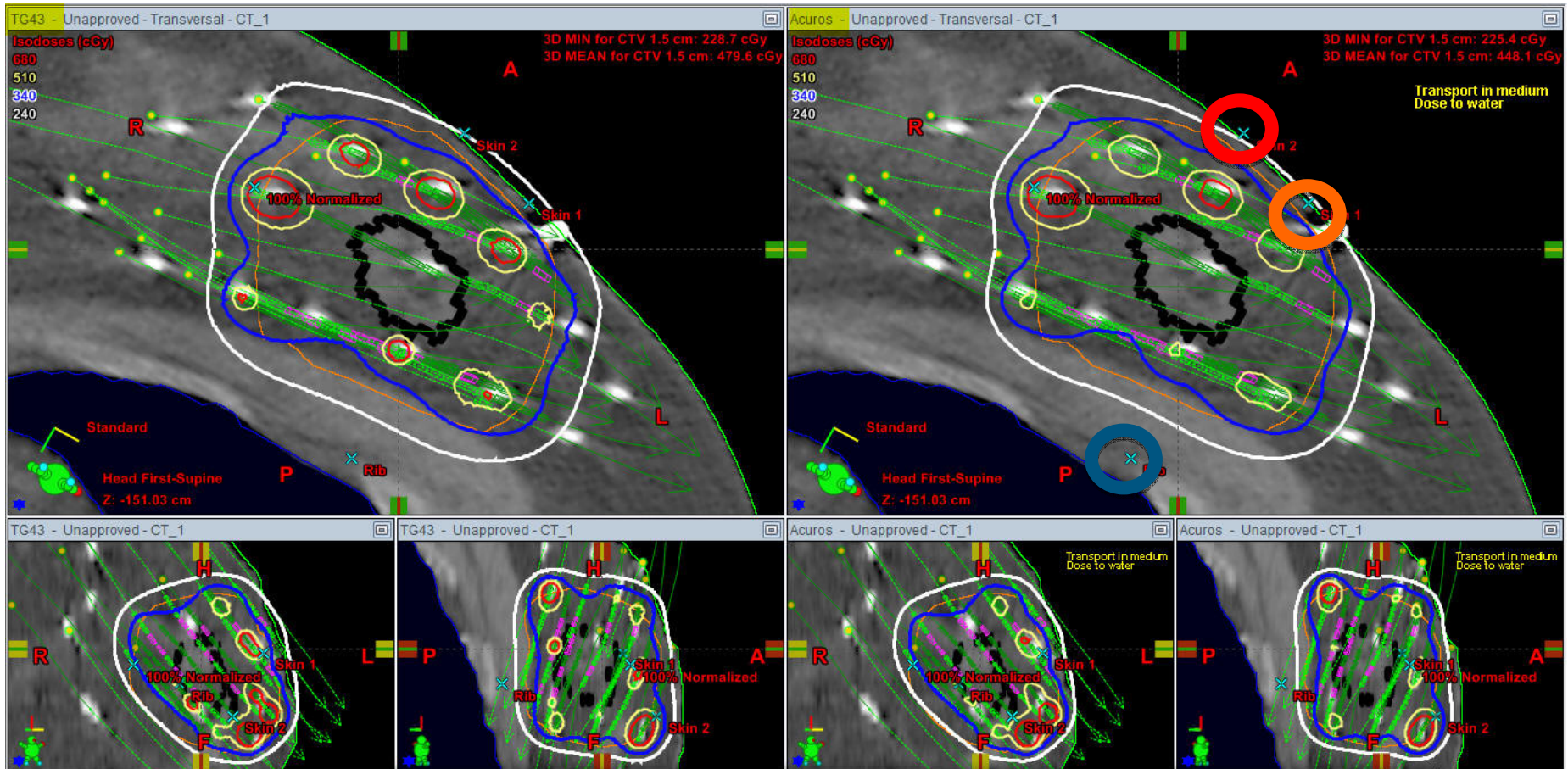
## Consequences

- Decreased skin dose
- Decreased dose to bone

# Contura: Acuros BV vs TG43



# Free-Hand Implant: Acuros BV vs. TG43

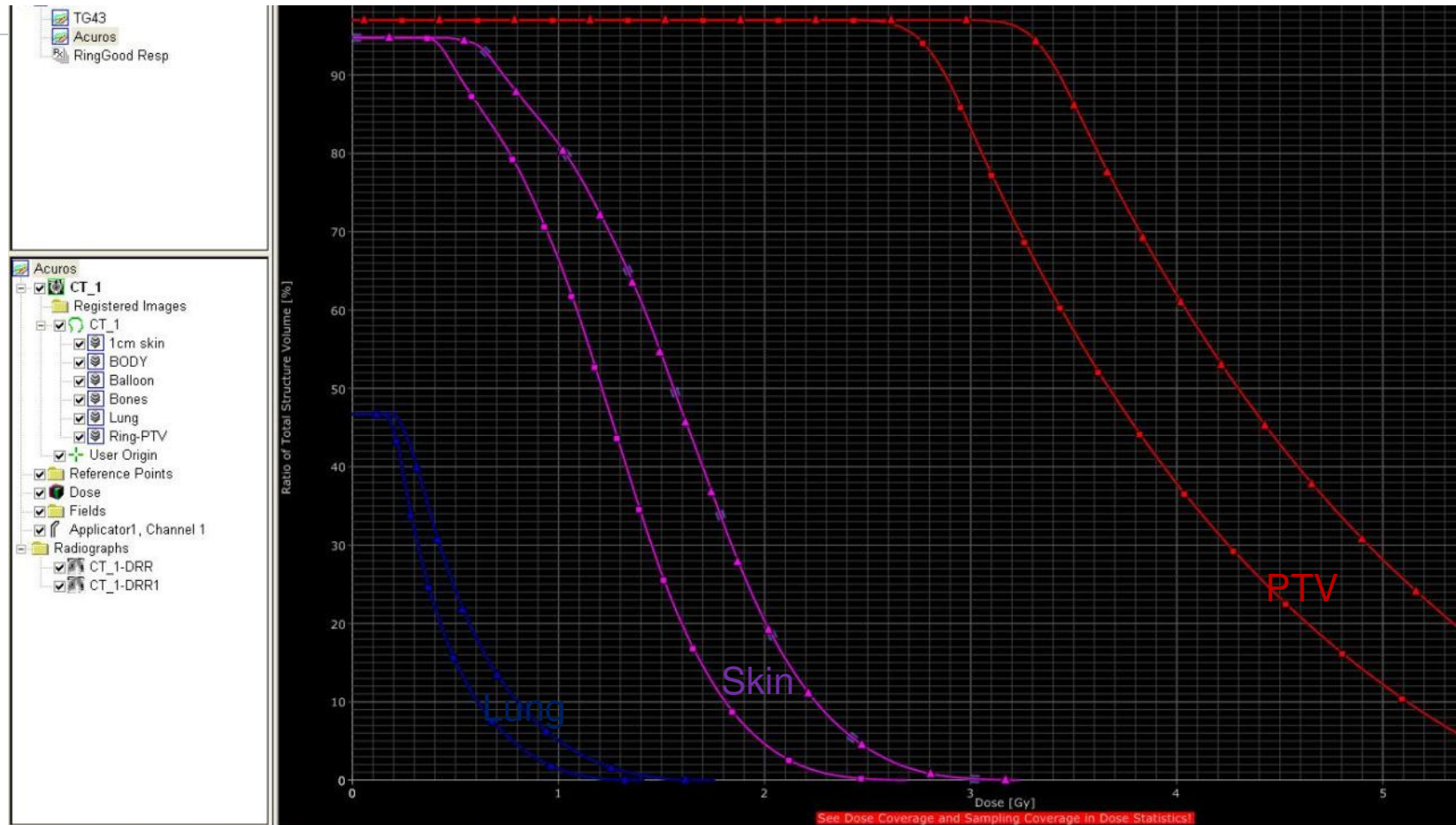


Number of Fractions	Total Dose [cGy]
1	340.0

All Plans		Ref. Points	TG43: F1	Acuros: F1					
In Total	Plan	Fractionation	Fractions	100% Normalized [cGy] (CTV 1.5 cm)	CTV 1 cm [cGy] (CTV 1 cm)	Rib [cGy] (Body)	Skin 1 [cGy] (Body)	Skin 2 [cGy] (Body)	
<input type="checkbox"/>	TG43	F1	1	340.0	340.0	167.1	280.8	240.7	
<input type="checkbox"/>	Acuros	F1	1	331.4	340.0	157.9	261.7	224.2	
Total Dose of all marked Plans									
Total Dose Limit									
Daily Dose Limit									

Skin 1  $\Delta_1 \approx \sim 19\%$   
 Rib  $\Delta_2 \approx \sim 10\%$   
 Skin 2  $\Delta_3$

# MammoSite TG43 vs. Acuros DVH

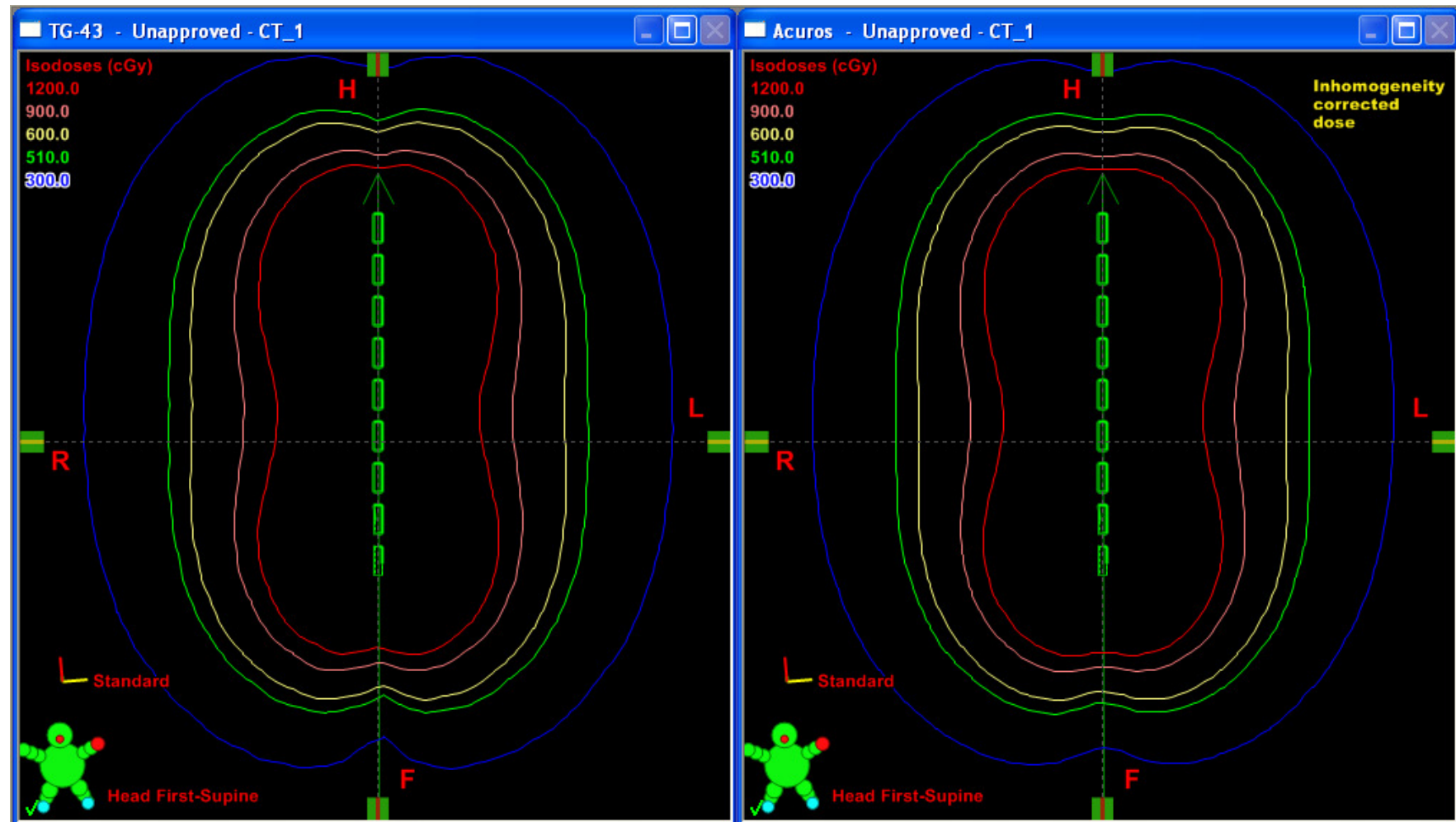


Selection Entry Registration Contouring Planning Plan Evaluation

View	DVH Line	Structure	Approval Status	Plan	Course	Volume [cm <sup>3</sup> ]	Dose Cover. [%]	Sampling Cover. [%]	Min Dose [Gy]	Max Dose [Gy]
<input checked="" type="checkbox"/>		1 cm skin	Approved	Acuros	C1	127.5	94.8	99.7	0.328	2.693
<input type="checkbox"/>		BODY	Approved	Acuros	C1					
<input type="checkbox"/>		Balloon	Approved	Acuros	C1					
<input type="checkbox"/>		Bones	Approved	Acuros	C1					
<input checked="" type="checkbox"/>		Lung	Approved	Acuros	C1	432.7	46.7	99.1	0.121	1.419
<input checked="" type="checkbox"/>		Ring-PTV	Approved	Acuros	C1	114.7	97.0	99.2	2.404	6.789
<input type="checkbox"/>		Whole dose matrix	Unapproved	Acuros	C1					
<input checked="" type="checkbox"/>		1 cm skin	Approved	TG43	C1	127.5	94.8	99.7	0.444	3.237

Ready User: Physicist Group: Physicist

# Simple Cylinder: Acuros BV vs TG 43





# Other Clinical Examples

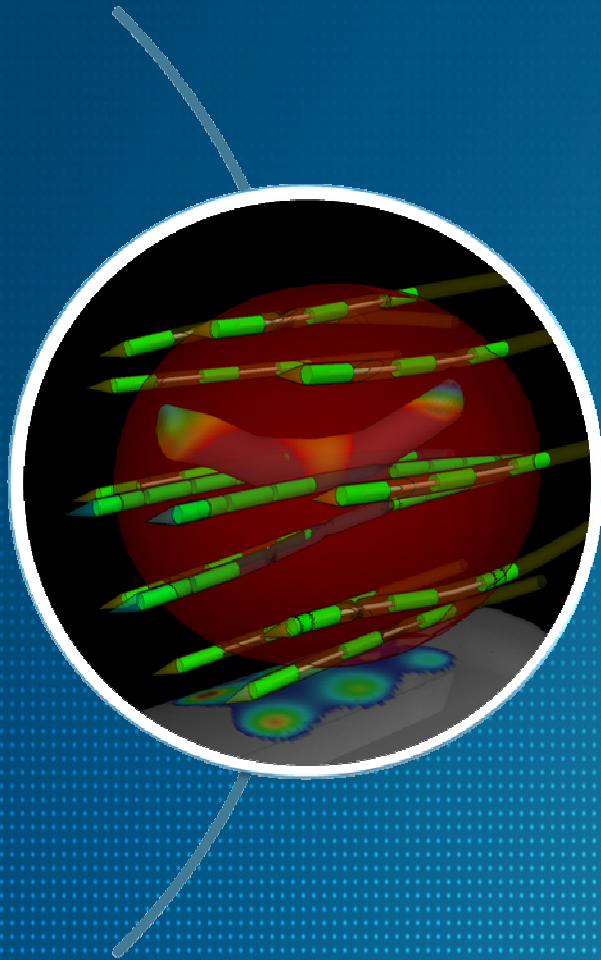
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- Bronchus/esophagus
- Shielded applicators
- Skin applicators

# Acuros BV does what you desire from a brachytherapy treatment planning system...

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- Account for the effect of applicators
- Account for the different patient tissues
- Account for the effects of the patient boundaries
- Improve dose accuracy
- All with speed and ease
- ‘Real’ dose distribution for a better understanding of treatment



# VariSeed 9.0

LDR Treatment Planning System

# VariSeed 9.0 New Features

## Varipath

- Prostate Transperineal Targeted Biopsies

## Volume optimization

- Supports varying packaging
- Lock needles
- Re-optimize during implant

## Image Reformatting

- Allows MR pre-planning

## Image Fusion

- Fuse up to 7 images sets
- Copy primary Image
- MR Pre-Plan transfer

# VariSeed 9.0 New Features

## General

- Alternative treatment sites
- 3D View with presets
- Dose color wash
- File Access Log accessible from the Help Menu
- Plan approval

## Import

- DICOM RT structure import

## Contouring

- Regions defined as list of structures to include (or exclude)

# VariSeed 9.0 New Features

## Source Placement

- Plan on orthogonal planes
- Angled and curved needles
- Needle placement
- 10 DQAs with new metrics
- View source data in planning (Study – View source details)

## Implant View™ seed planning module

- Strands and links supported
- Angled and curved needles

## Post Planning

- Seed orientation

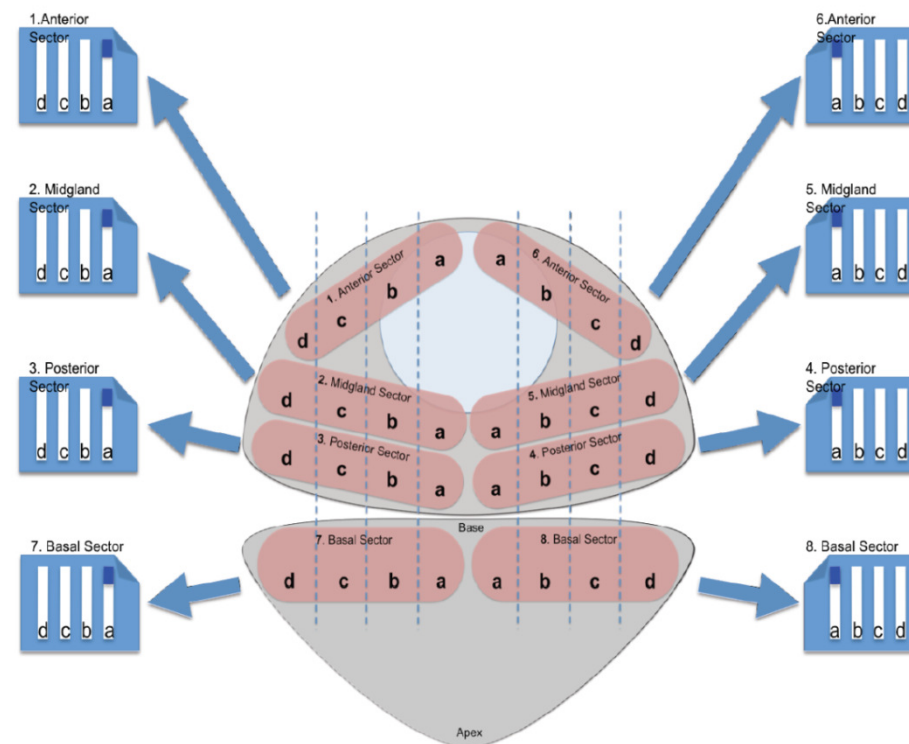
# VARIPATH™ BIOPSY MODULE

Purchasable Option Module in VariSeed 9.0

Separate VariPath presentation available for a more detailed understanding of the workflow.

# VariPath Targeted Transperineal Biopsy

- Straight forward system that allows urologists to plan, track, and localise biopsies, then move that data on to the patients next treatment modality
- Guy's estimates that approx. 30% of their biopsies require some form of treatment
- Can be Sold as standalone system



Courtesy of

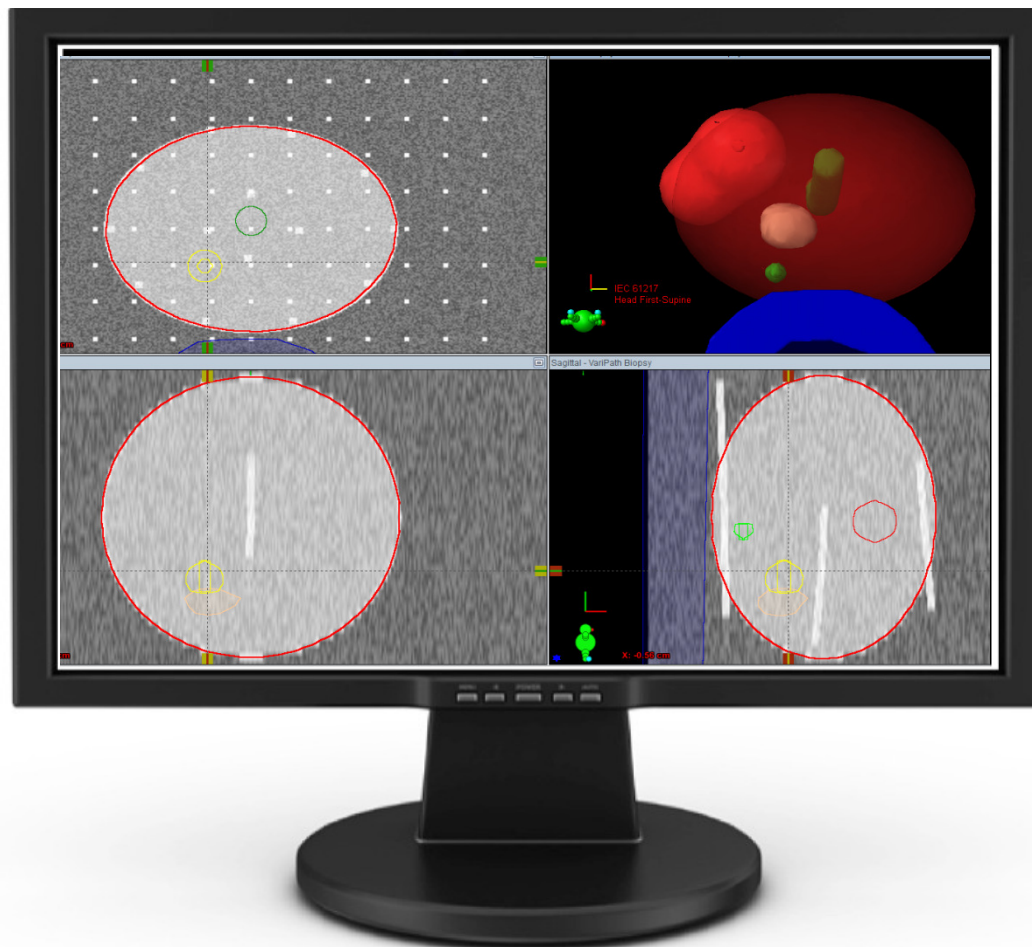


UROLOGY DEPARTMENT – GUY'S HOSPITAL



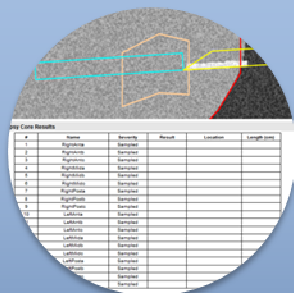
# VariPath Clinical Impact

- Mapping the tumor in 3D helps clinicians' decision making for future treatment
  - Active surveillance
  - Surgery
  - HIFU (High Intensity Focused Ultrasound)
  - LDR brachytherapy
  - HDR brachytherapy
  - External beam radiotherapy
  - Protons
- Data can be used for dose escalation in planned treatments



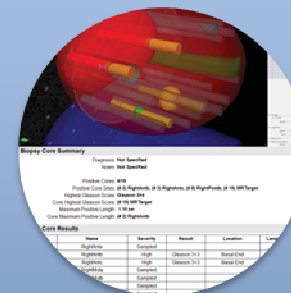
# VariPath Workflow

## Day 1 : Biopsies Sampled



- Image Fusion\* allows to access target region contours from MR images\*\*
- Plan the biopsy cores if required:
  - Freehand
  - Template
- Track cores on real-time US
  - Tilt the planned needle to align with the biopsy needle
  - Mark as sampled
- Report available for results

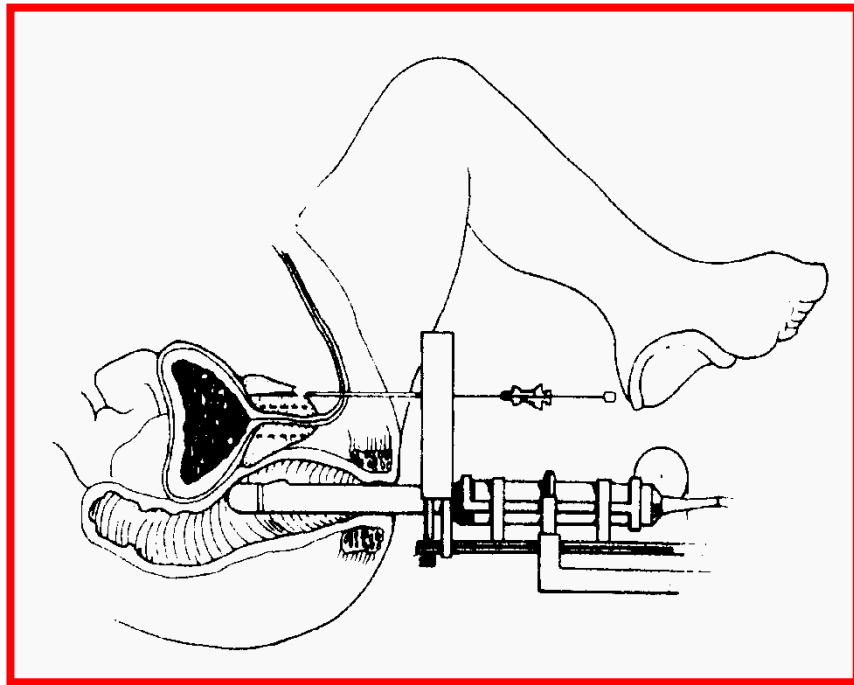
## Day 1 + : Biopsies Results



- Enter the results as:
  - Sectors
  - Percentages
- System can create tumour structures from abnormal results
- View results in 2D or 3D and Biopsy Report
- Export the tumour volumes and/or cores in DICOM RT as structures along with the image and patient structures to use for planning purposes

# TREATMENT PLANNING VITESSE™ 4.0

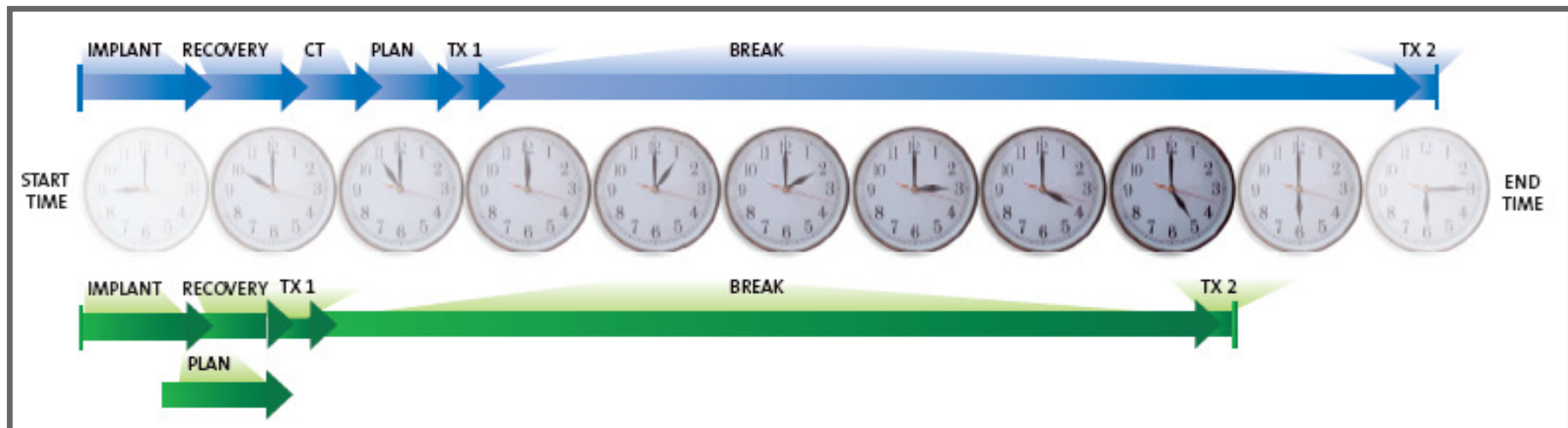
# True Image Guided Brachytherapy



# Intra-Operative HDR Planning

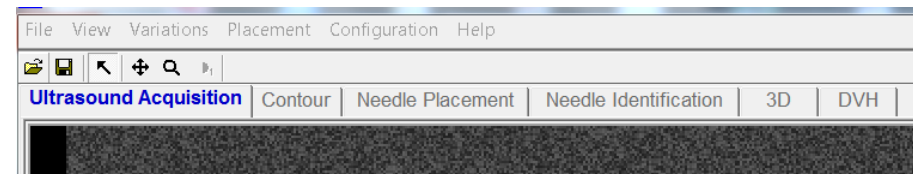
Simplifying process may save 1.5-2 hours to first treatment

- Eliminates the CT scanner step
- Generate the plan during the implant
- Fewer patient moves



# Key Feature

**WORKFLOW DRIVEN**  
Straight forward and  
structured workflow guides  
the user



# Key Feature

## IMPROVED WORKFLOW WITH BK SUPPORT

Network transfer of images,  
contours and calibration  
info from the ultrasound



\* License required on the BK  
scanner *Contact BK to obtain a license*

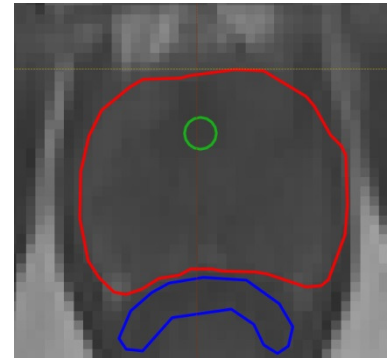
# Key Feature

## CONTOURING

Shape stamper for fast outlining of the urethra

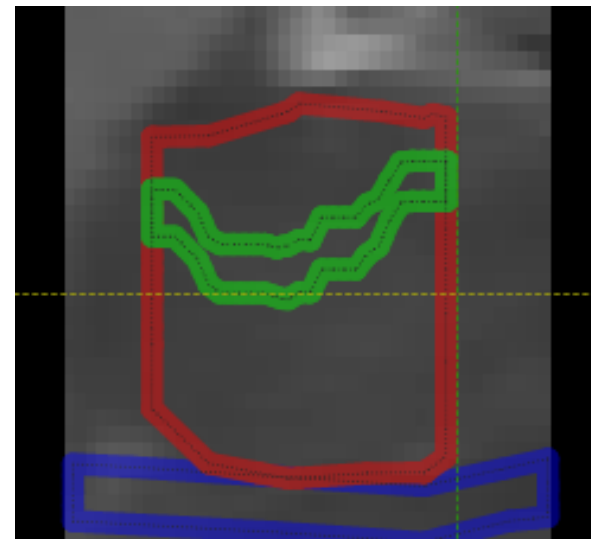
Regions allow Boolean logic for dose calculation

Sagittal & coronal contour review



Region List

- Prostate
  - Include
    - Prostate
    - Urethra
  - Ignore
- Urethra
- Rectum
- Bladder
- Seminal Vesicles





# Key Feature

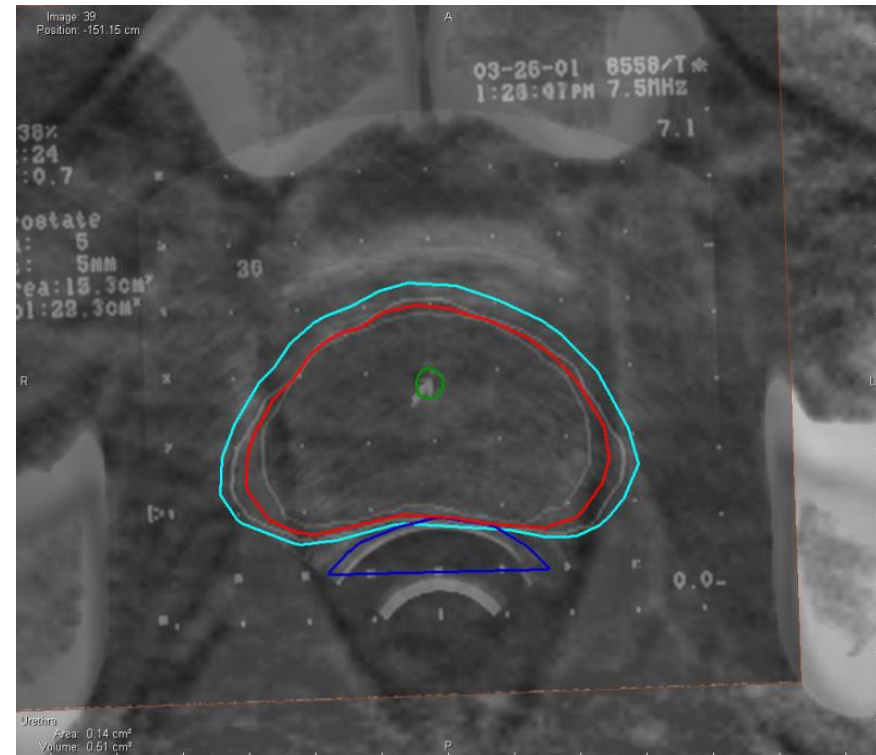
## IMAGE FUSION\*

Fuse up to 4 image sets

Point-based and  
manual match

Choose which image sets  
to display & interactively  
control blending

Available for CT, MR & US



*\*Requires Image Fusion option*

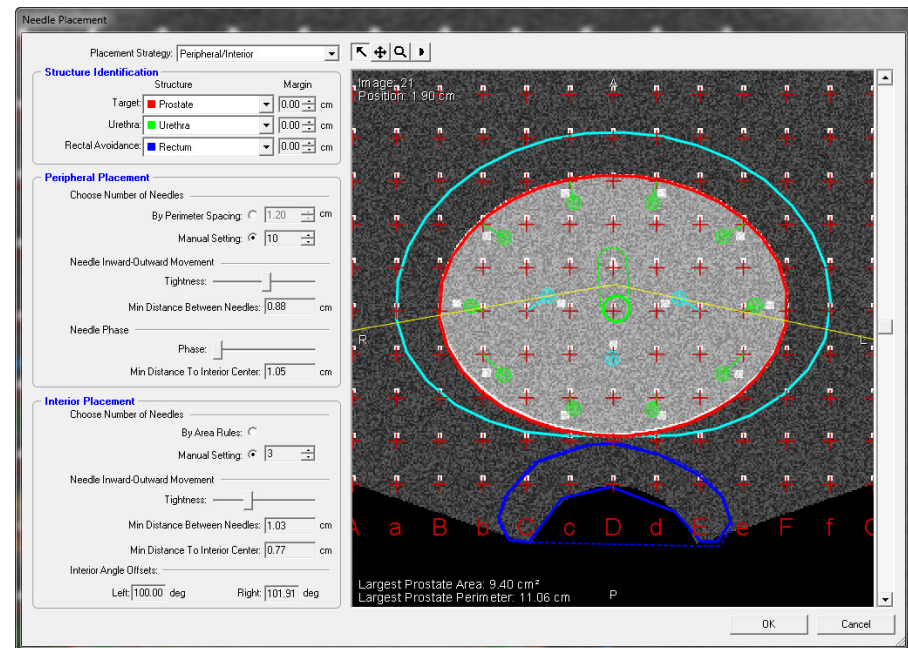
# Key Feature

## MULTIPLE NEEDLE PLACEMENT

Automatic placement based on volume

Needle position template

Manual placement with a single click



# Key Feature

## VOLUMETRIC OPTIMIZATION

Fast plan generation

View DVH and dose

Volume Optimization

Save As... Remove Defaults Dose Histogram Images

Region	Coverage	Priority	Portion	<>=	Dose
<input checked="" type="checkbox"/> Prostate	Volume	1.00	90.00 %	>	100.00 %
<input checked="" type="checkbox"/> Urethra	Volume	0.50	1.00 cm <sup>3</sup>	<	125.00 %
<input checked="" type="checkbox"/> Urethra	Volume	1.00	0.00 %	<	115.00 %
<input checked="" type="checkbox"/> Rectum	Volume	1.00	1.00 cm <sup>3</sup>	<	75.00 %

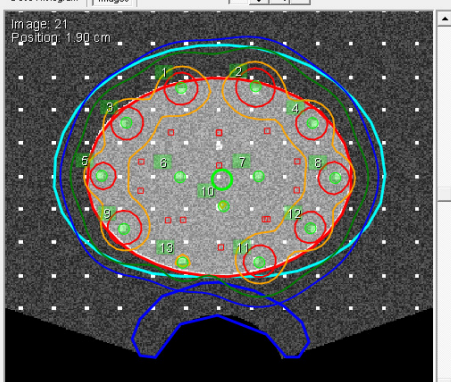
Add New Constraint Delete Unused Constraints

Dwell time objectives: Max Time  10.00 s, Min Time  0.00 s, Manual Smoothing  0

Basal Dose objective: Enable , Max Basal Dose 140.00 %, Priority 1.00

Total Penalty 0.00  
Max Time 6.26 Seconds  
DVH 0.00 ( 0.00%)  
Basal Dose 0.00 ( 0.00%)

Image: 21, Position: 1.91 cm



Time (s) vs Dwell Positions (0-64) graph showing a sawtooth pattern of dwell times.

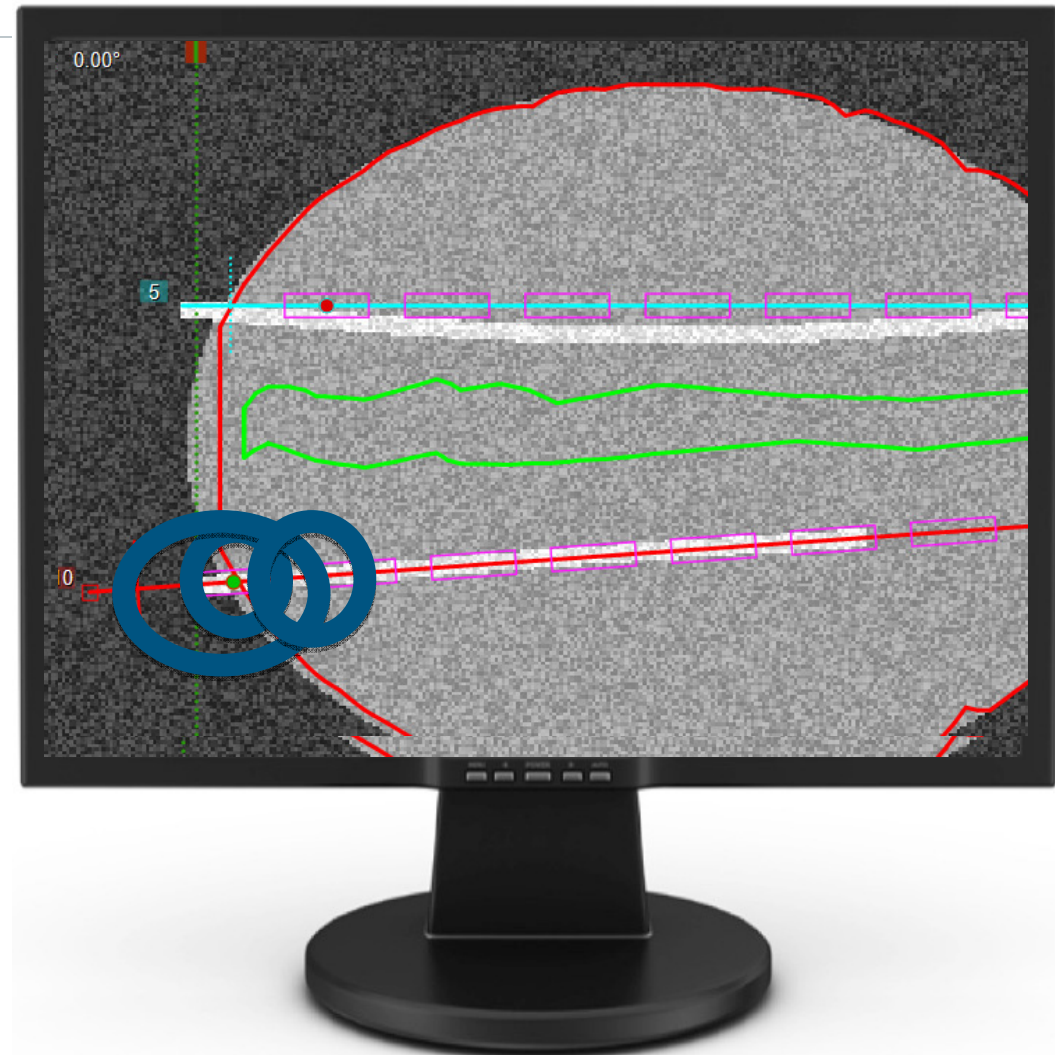
Optimizer idle.

Plan: Current Plan, Stop, Show Dwells, OK, Cancel

# Improve Needle Placement Coverage

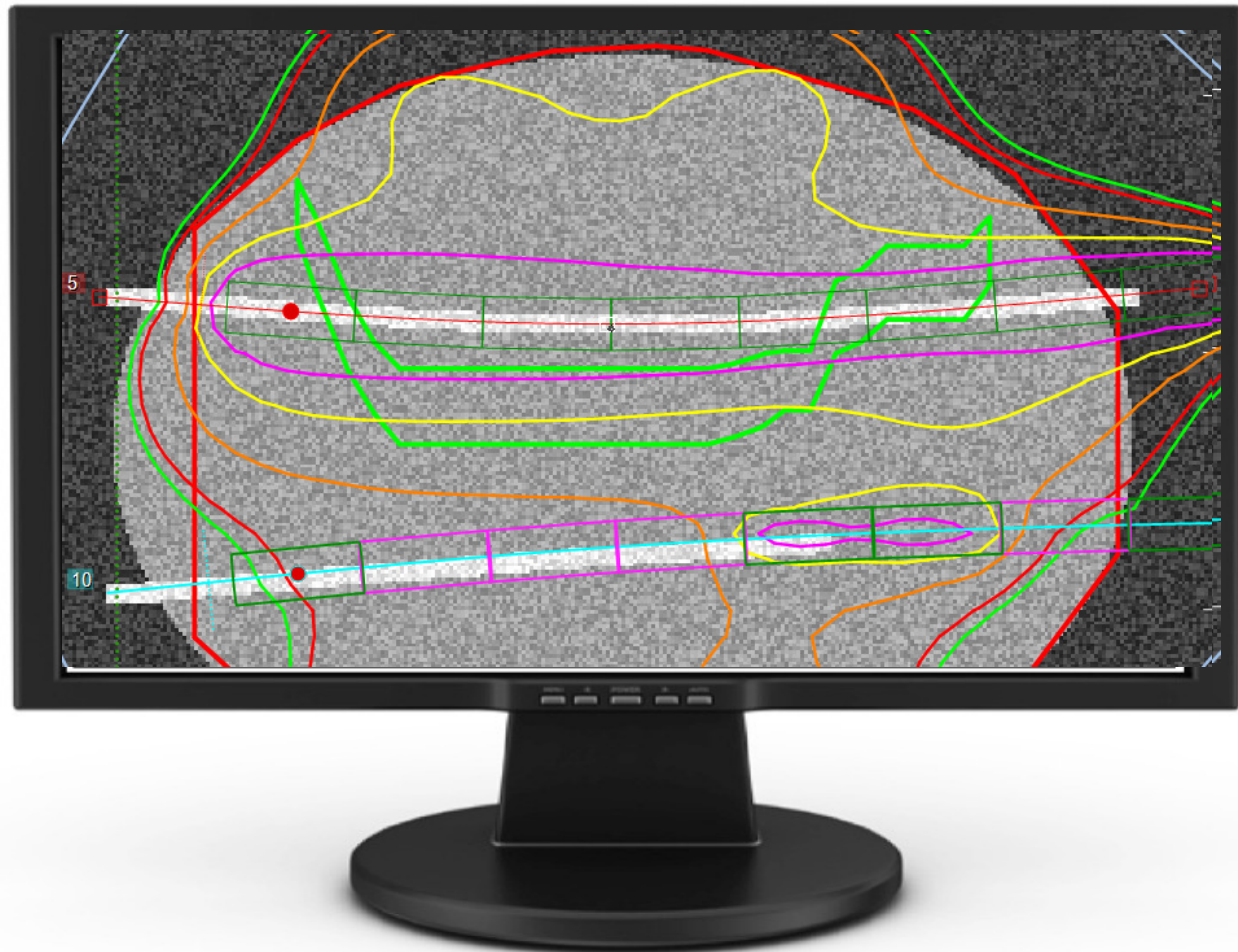
- Place or move needles from their planned positions to align with the implanted needles in the live ultrasound
- Move the tip of your planned needle to the tip of your implanted needle

**'Go'/'No go' indicator  
indicating the ability to  
achieve sufficient coverage  
based on the possible  
dwell positions**



# Needle Placement

Easily bend the needle paths to align with the real needle path in the live image.



# Needle Tip Adjustment Tool

Assists in correctly aligning needle tips

- Select reference needle(s) based on confidence of defined tip position
- Enter exposed length of the reference needle(s) from the template
- Select needle of concern
- Enter exposed length of selected needle
- Tool displays the determined offset of selected needle and allows adjustment
- Live image of the needle and offset applied can be viewed before accepting the change

Adjust Needle Tips

Reference	Number	Name	Internal path length (cm)	Exposed length (cm)	Delta (cm)	Visual Delta	Adjust
<input checked="" type="checkbox"/>	1	c+4.5	4.26	4.00	-0.04		Adjust
<input checked="" type="checkbox"/>	2	d+4.5	4.29	3.90	0.04		Adjust
<input type="checkbox"/>	3	b+4.0	4.27				Adjust
<input type="checkbox"/>	4	e+4.0	4.26				Adjust
<input type="checkbox"/>	5	B 3.0	4.24				Adjust
<input type="checkbox"/>	6	c+3.0	4.74				Adjust
<input type="checkbox"/>	7	d+3.0	4.61				Adjust
<input type="checkbox"/>	8	F 3.0	4.78				Adjust
<input type="checkbox"/>	9	b+2.5	4.24				Adjust
<input type="checkbox"/>	10	D 2.5	4.71				Adjust
<input checked="" type="checkbox"/>	11	d+2.0	4.38	3.85	0.00		Adjust
<input type="checkbox"/>	12	e+2.0	4.24				Adjust
<input type="checkbox"/>	13	c+1.5	4.25				Adjust

Transverse

Identify the reference needles and enter the length of the part of each needle that is protruding from the template

Path Image 1 - Needle 11 (d+2.0)

Real-time - Needle 11 (d+2.0)

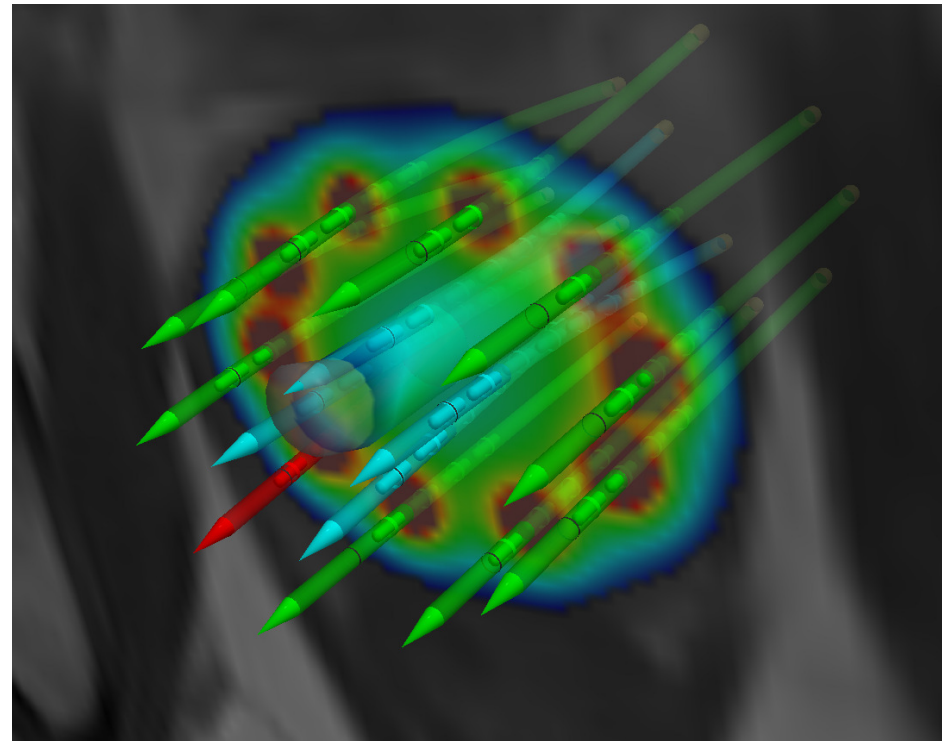
20.00°

OK Cancel

# Vitesse 4.0

The main aims of this release are:

- Increase support for focal therapy including support for VariPath and a pre-planning workflow.
- Improve contouring tools and minimize the need to switch tools
- Improve the Real time experience based on customer feedback focusing on needle position management and contour adjustment in the live view.
- Improved planning tools



# Vitesse 4.0

- DICOM RT Import
  - Contours from another system
  - VariPath Import
- Preplanning Capability
  - Ability to load a preplan, images and structures into the US study\*
  - Support for reformatting images along a new axis.

Study Information

Type

Ultrasound Video Acquisition

Image Import

Treatment Date: 11/03/2016

Planning Air kerma: 27944.01 U

Afterloader: VSiX

Source Calibration Date: 01/02/2016

Prescription Dose/Isodose Levels: <None> 10.00 Gy

Structure/Region Configuration: <None>

Template: B-K Standard

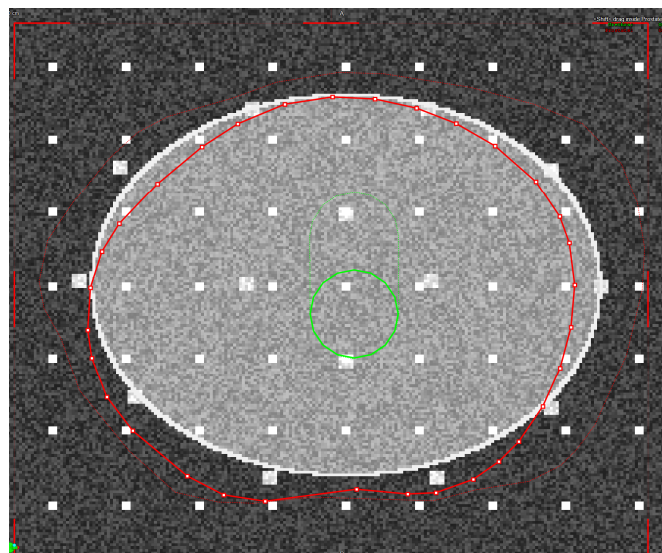
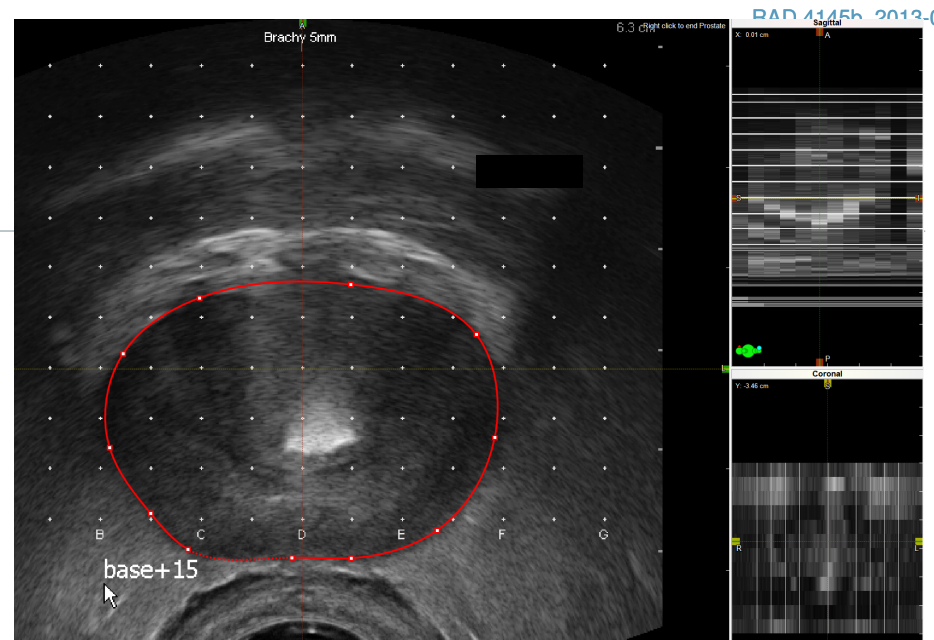
OK Cancel

\*Requires the fusion module



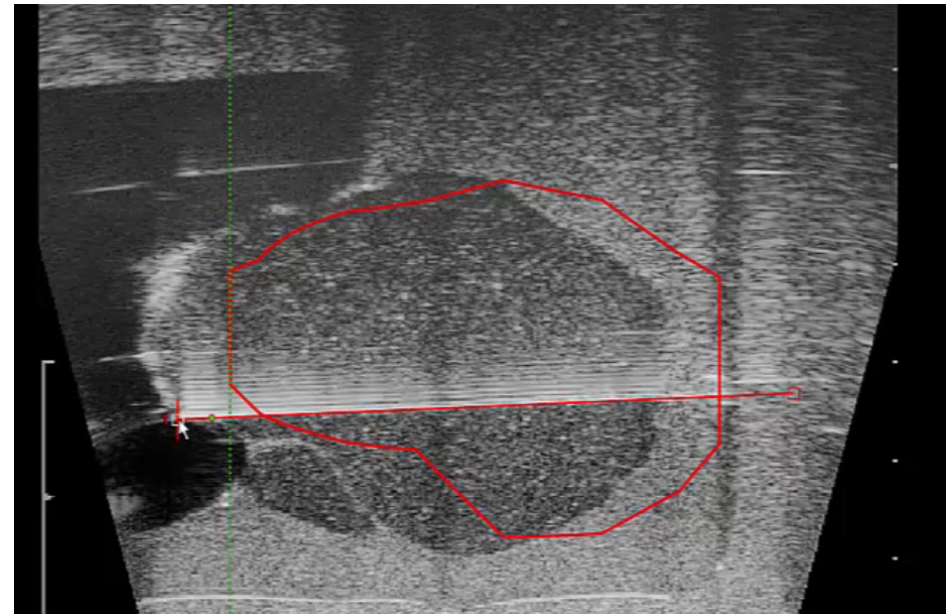
# Vitesse 4.0

- Improved contouring tools
  - Define the default layout
  - Visualize regions
  - Sweep Structure
  - New Spline based contouring tool.
  - View Contour and needle path projections
  - The ability to adjust drawn contours in the transverse view on real-time images in the OR.



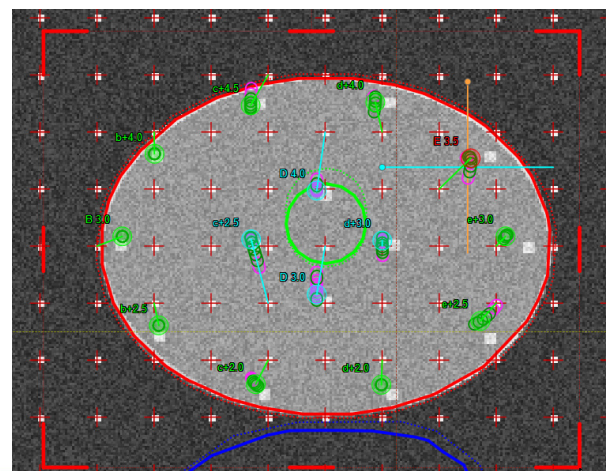
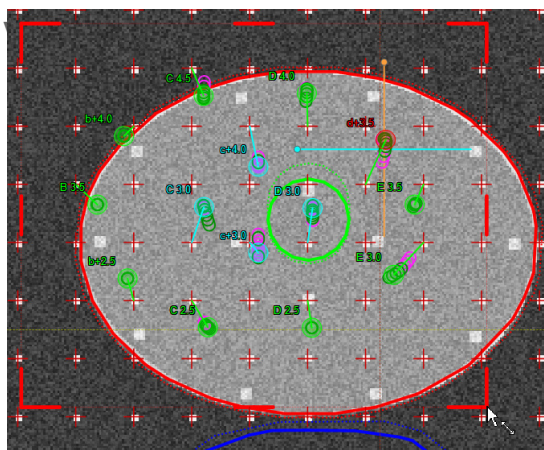
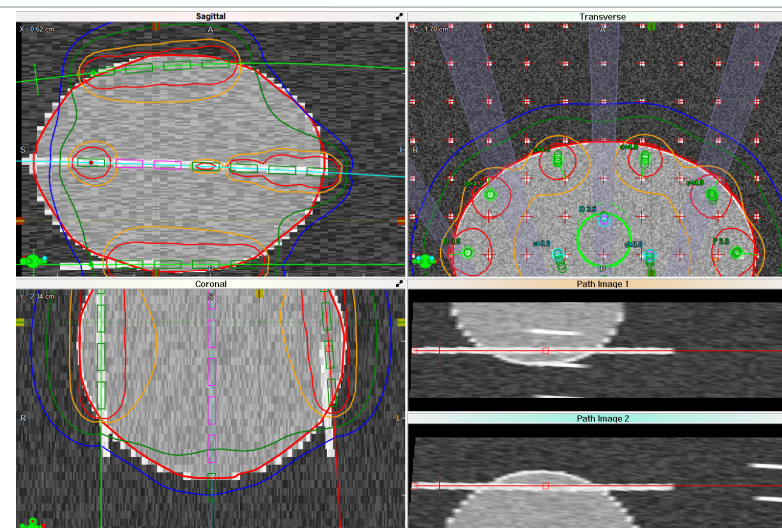
# Vitesse 4.0

- Needle position management
  - Frustration with needle tip movement when aligning contours
  - Needle tip will now remain consistent with the image not the contour
  - During re-capture the system will be aware of and base plane shift and will align the tips with the old base plane



# Vitesse 4.0

- Needle Identification view
  - Maximize image on Needle Identification View
  - Show needle tip dead-space in path images
- Template move and hole assignment tool in Needle ID



# Vitesse 4.0

- Needle shadowing indicator
  - Allows the user to determine needles that cause issues with shadowing
- Needle Labels configurable
- New layout with Needle list

Transverse Needle ID:

Sagittal/Coronal Needle ID:

Needle List			
#	Name	Length	Unit
1	b-2.0	130.00	cm
2	B 3.0	130.00	cm
3	B-4.0	130.00	cm
4	c-4.0	130.00	cm
5	d-4.0	130.00	cm
6	e-4.0	130.00	cm
7	F 3.0	130.00	cm
8	g-2.0	130.00	cm
9	h-1.5	130.00	cm
10	i-1.5	130.00	cm
11	D 3.5	130.00	cm
12	d-3.0	130.00	cm
13	D 2.5	130.00	cm
14	e-3.0	130.00	cm

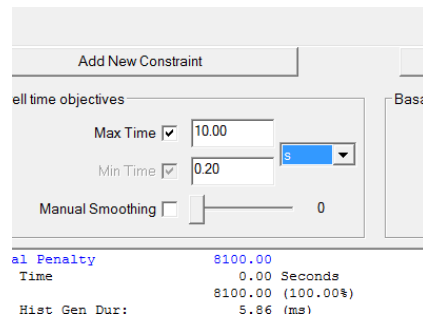
Prescription Dose/Isodose Levels			Modify
Dose (Gy)	Dose (%)	Color	
20.00	200.0%		
15.00	150.0%		
10.00	100.0%		
5.00	50.0%		

Treatment Date: 09/05/2012    Planning Air kerma: 40700.00

Longitudinal Transverse | 1.40 cm    Zero Probe Dep

# Vitesse 4.0

- Lots of other changes based on customer feedback
  - Needle placement with a <Ctrl> or <Shift> left click
  - 10 DQA's and new metrics
  - Ability to edit DQA's
  - Direct numeric entry of dose point positions
  - Volume Optimizer
    - Min/Max in Ci-s and s



**Needle List**

#	Name	Dose (Gy)	Depth (cm)	Lock
1	b+2.0	130.00	cm	<input type="checkbox"/>
2	B 3.0	130.00	cm	<input type="checkbox"/>
3	b+4.0	130.00	cm	<input type="checkbox"/>
4	c+4.0	130.00	cm	<input type="checkbox"/>
5	d+4.0	130.00	cm	<input type="checkbox"/>
6	e+4.0	130.00	cm	<input type="checkbox"/>
7	F 3.0	130.00	cm	<input type="checkbox"/>
8	e+2.0	130.00	cm	<input type="checkbox"/>
9	d+1.5	130.00	cm	<input type="checkbox"/>
10	c+1.5	130.00	cm	<input type="checkbox"/>
11	D 3.5	130.00	cm	<input type="checkbox"/>
12	d+3.0	130.00	cm	<input type="checkbox"/>
13	D 2.5	130.00	cm	<input type="checkbox"/>
14	c+3.0	130.00	cm	<input type="checkbox"/>

**Prescription Dose/Isodose Levels**

10.00 Gy Modify...

Dose (Gy)	Dose (%)	Color
<input checked="" type="checkbox"/> 20.00	200.0 %	Red
<input checked="" type="checkbox"/> 15.00	150.0 %	Yellow
<input checked="" type="checkbox"/> 10.00	100.0 %	Green
<input checked="" type="checkbox"/> 8.00	80.0 %	Blue

Prostate	D90%	98.92%
Urethra	D30%	117.16%
Rectum	D2cm²	71.82%

Treatment Date: 09/05/2012      Planning Air kerma: 40700.00 U

**Set Dosimetric Quality Alerts**

Dosimetric Quality Alert Sets: [Dropdown]

Current Dosimetric Quality Alert Set:

Region: Urethra

D: 30.00 % is less than or equal to 120.00 %

Buttons: Add Alert, Replace Selected, Delete Selected, Delete Unused, Delete All

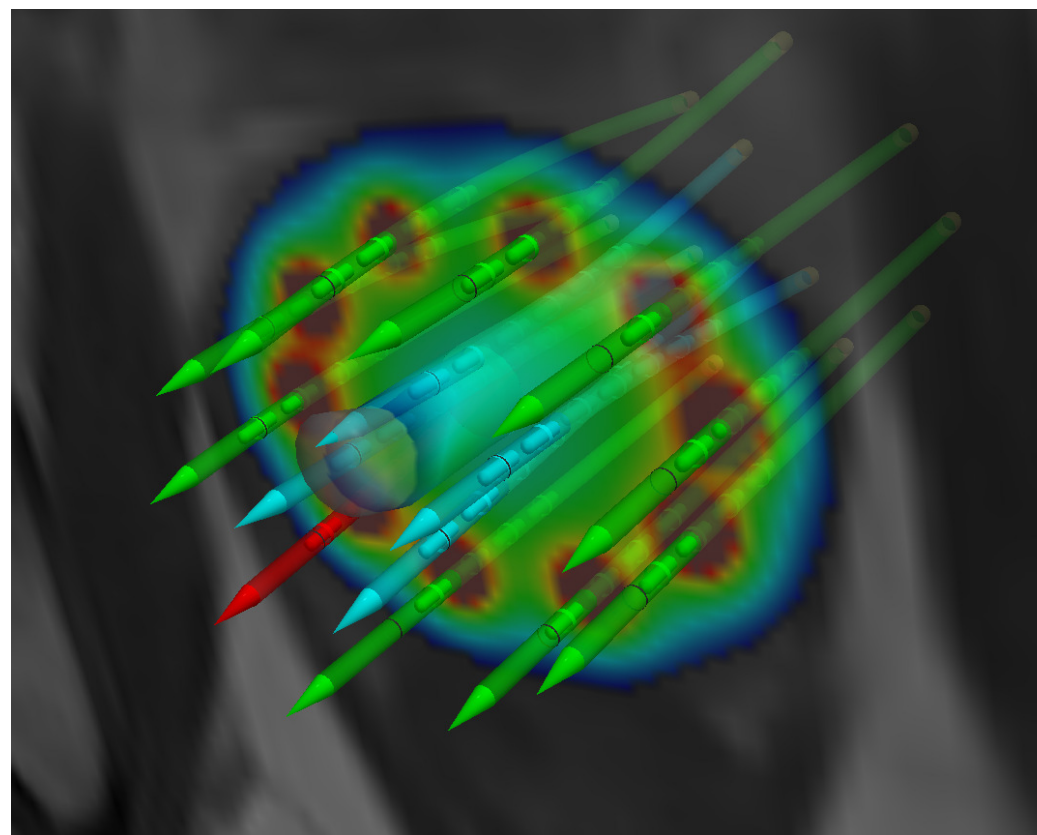
Dosimetric Quality Alerts:

- Prostate - D90% is between 95.00% and 115.00%
- Urethra - D30% is less than or equal to 120.00%
- Rectum - D2cm² is less than or equal to 90.00%

Buttons: OK, Cancel

# Vitesse 4.0

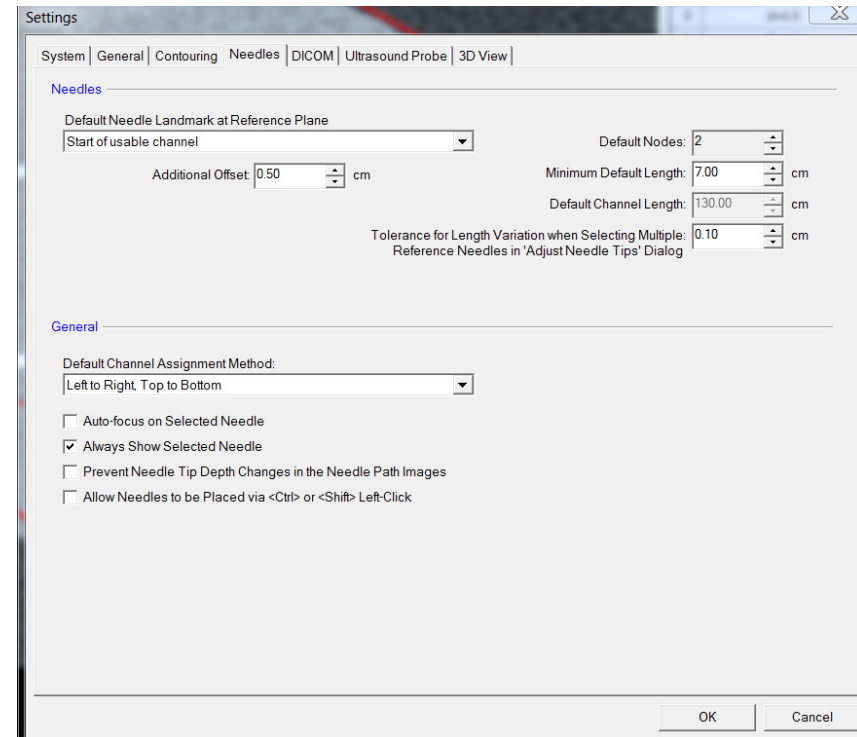
- Fusion\*
- Fused image visible in 3D View
- Allow 6 Fused volumes



\*Requires the fusion module

# Vitesse 4.0

- Other changes:
  - Check during DICOM export as to whether the sort order is the default and notifying the user if not.
  - Structure is defined according to regions on the Summary Report
  - Updated source data (marked 2012)
- Integration with BrachyVision
  - Update dwell range limitations to match BrachyVision
  - Update calibration time to be midnight



## Dose Information

### Prostate:

	[Include: Prostate]	[Exclude: Urethra]
Total Volume:	22.10 cm <sup>3</sup>	
V200%:	0.00 cm <sup>3</sup>	[ 0.00 %]
V150%:	0.00 cm <sup>3</sup>	[ 0.00 %]



Thank You for listening!