

A radiobiological modelling and evaluation system for radiation oncology treatment planning

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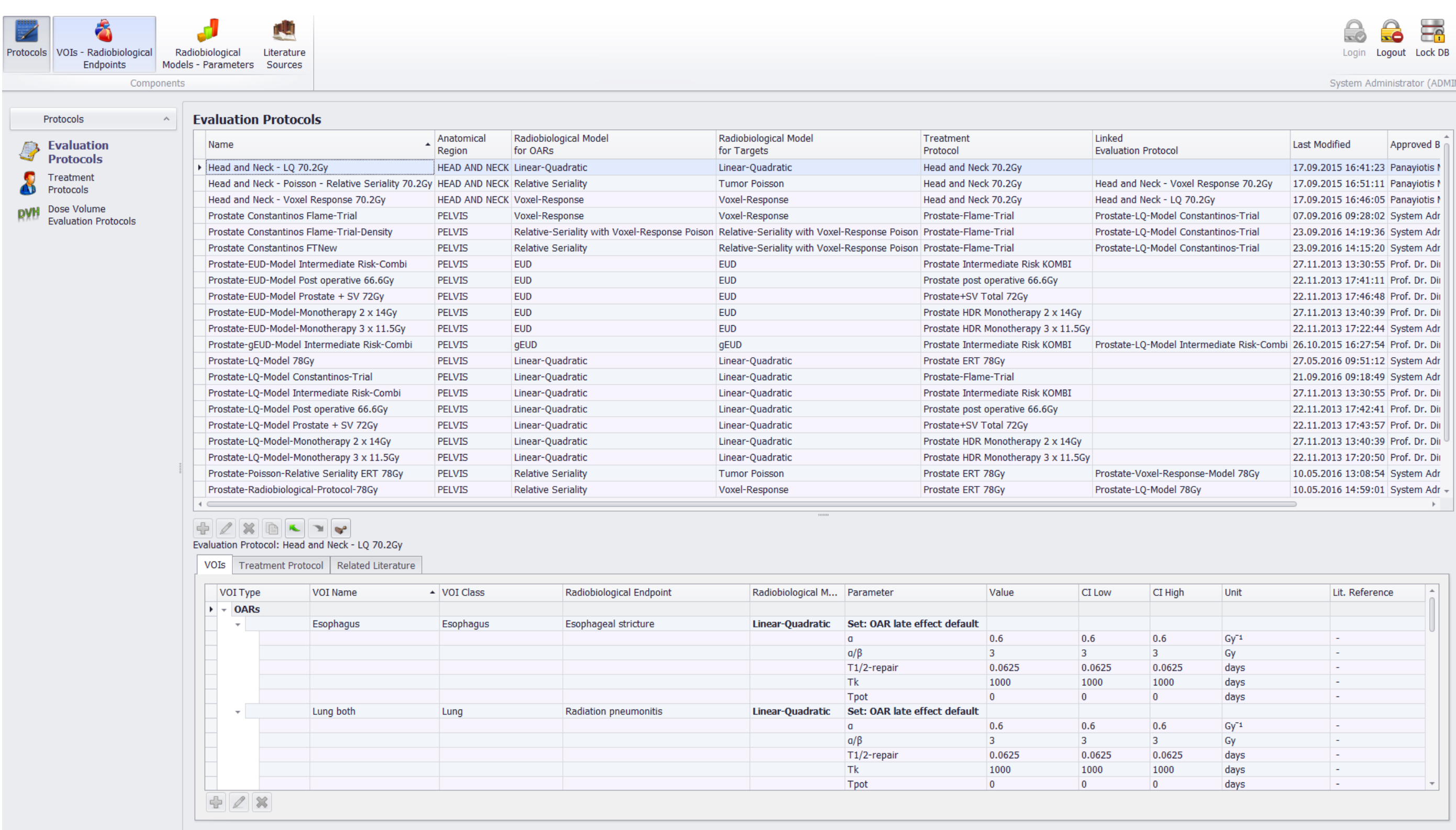
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BIOTOP is an expert, network based database system where the users can define models' parameter set along with anatomical information.

The users are able to build their evaluation protocols by selecting appropriate models and specifying related model parameters for well-defined endpoints. In addition, a literature database is available and all user-defined and predefined model parameters are linked to specific literature. In this way, the user has immediately access to the referenced literature for further consultation. Furthermore, an evaluation protocol is linked to one or more treatment protocols.



Treatment protocols may be composed of several treatment series utilizing different treatment techniques and fractionation schemes:

Treatment Protocols																	
Series		Groups															
Name	Series	Groups	Anatomical Region	Treatment Method	ERT Treatment	RT Treatment	Source Isotope	Decay half life (days)	Fractionation Type	Total Prescribed Dose (Gy)	Total Number Of Fractions	Dose per Fraction (Gy)	Fractions Equivalent	Number of Fractions	Time Interval between Fractions in a day	Fractionation Pattern	Total Treatment Time (days)
ERT Breast 25Gy	THORAX	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	50	25	2	YES	1	1	1111100	32			
ERT Breast Boost 24Gy	THORAX	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	14	7	2	YES	1	1	1111100	8			
Prostate LDR 144Gy	PELVIS	BRACHYTHERAPY (BRT)	PHOTON		1:125	59.81	BRT PERMANENT	144					1111100	8			
Accelerated Partial Breast Irradiation (APBI) 84Gy	THORAX	BRACHYTHERAPY (BRT)	HR		1:125	73.81	FRACTIONATED	32	8	4	YES	2	8	111111111111000	3		
Head and Neck 70.2Gy	HEAD AND NECK	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	70.2	39	1.8	YES	1	1	1111100	52			
Head and Neck 70.2Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	70.2	39	1.8	YES	1	1	1111100	52			
Prostate ERT 78Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	78	39	2	YES	1	1	1111100	52			
Prostate ERT 78.2Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	78.2	44	1.8	YES	1	1	1111100	59			
ERT Breast with 4Gy of the Prostate Comb-Treatment	THORAX	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	45	5	1.8	YES	1	1	1111100	4			
BRT Prostate 1cm Margin 54Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	9	5	1.8	YES	1	1	1111100	4			
BRT Prostate asymmetric Margins 28Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	12.6	7	1.8	YES	1	1	1111100	8			
BRT Prostate+50% 1cm Margin 28Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	58.4	28	1.8	YES	1	1	1111100	37			
Prostate post op 30 x 1.8Gy and 1cm margin	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	54	30	1.8	YES	1	1	1111100	39			
Prostate post op 7 x 1.8Gy and asymmetric margin	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	12.6	7	1.8	YES	1	1	1111100	8			
Lung 1 x 2.6Gy 1.5 peripheral localisation	THORAX	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	26	1	26	YES	1	0	1111100	0			
Lung 1 x 1.8Gy 1.5 peripheral localisation	THORAX	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	18	1	18	YES	1	0	1111100	0			
SIRT Lung 5 x 11Gy 1.5 thoracic wall, T2 peripheral	THORAX	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	55	5	11	YES	1	1	1111100	4			
SIRT Lung 8 x 7.5Gy central localisation	THORAX	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	60	8	7.5	YES	1	1	1111100	9			
HS 1.8Gy for GTV 3-2cm	HEAD AND NECK	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	18	1	18	YES	1	0	1111100	0			
HS 1.8Gy for GTV 2-3cm	HEAD	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	18	1	18	YES	1	0	1111100	0			
HR - Monotherapy single fraction 1.15Gy	PELVIS	BRACHYTHERAPY (BRT)	HR		1:192	73.81	FRACTIONATED	11.5	1	11.5	YES	1	1000000	0			
HR - Monotherapy single fraction 14Gy	PELVIS	BRACHYTHERAPY (BRT)	HR		1:192	73.81	FRACTIONATED	14	1	14	YES	1	1000000	0			
HR - single fraction 15.5Gy of the Prostate Comb-Treatment	PELVIS	BRACHYTHERAPY (BRT)	HR		1:192	73.81	FRACTIONATED	15.5	1	15.5	YES	1	1000000	0			
Prostate-Frame Series 1 P1 and P3	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	52.8	24	2.2	YES	1	1	1111100	31			
Prostate-Frame Series 2 P2 and P3	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	24.2	11	2.2	YES	1	1	1111100	14			
Prostate-Frame Series 1 P1 12.5 Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	52.8	24	2.2	YES	1	1	1111100	31			
Prostate-Frame Series 2 P2 24.2 Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY	PHOTON			FRACTIONATED	24.2	11	2.2	YES	1	1	1111100	14			

edit Treatment Series ✕

Name

Anatomical Region

Treatment Method ☒ External Beam Radiotherapy ☐ Brachytherapy

ERT - Treatment Type

Fractionation Type ☒ Fractionated ☐ Protracted ☐ Permanent

Fractionated Treatment Record

Total Prescription Dose D Gy

Total Number of Fractions N

Dose per Fraction d Gy

Fractions equidistant ? ☒ Yes ☐ No

Number of Fractions per Treatment Day n fractions/day

Time Interval between fractions in a day Δt hours

Fractionation Pattern

Total Treatment Time T days

Average Time Interval between Fractions $\bar{\Delta t}$ days

Edit Treatment Series ✕

Name

Anatomical Region

Treatment Method ☒ External Beam Radiotherapy ☐ Brachytherapy

ERT - Treatment Type

Fractionation Type ☒ Fractionated ☐ Protracted ☐ Permanent

Fractionated Treatment Record

Total Prescription Dose D 24.2 Gy

Total Number of Fractions N 11

Dose per Fraction d 2.2 Gy

Fractions equidistant ? ☒ Yes ☐ No

Number of Fractions per Treatment Day n 1 fractions/day

Time Interval between fractions in a day δt hours

Fractionation Pattern 11111100

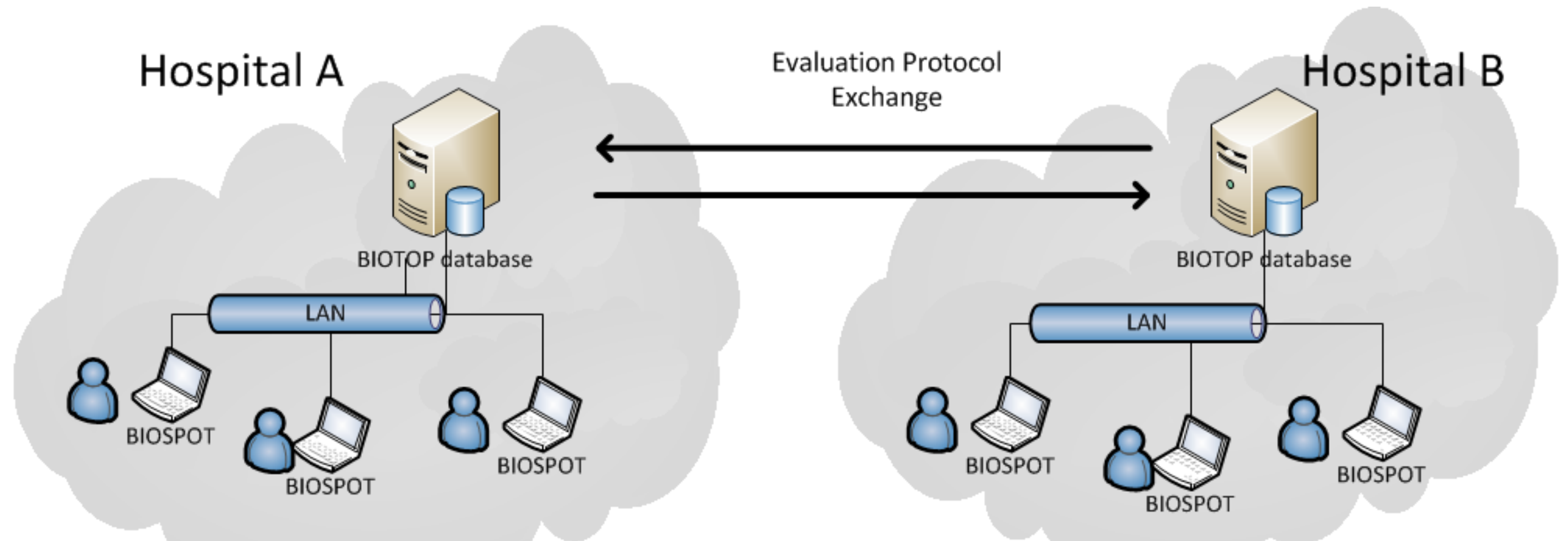
Total Treatment Time T 14 days

Average Time Interval between Fractions δt_a days

An evaluation protocol might also be composed of a group of treatment protocols. For instance, we might have a combination of treatments of external and brachytherapy.

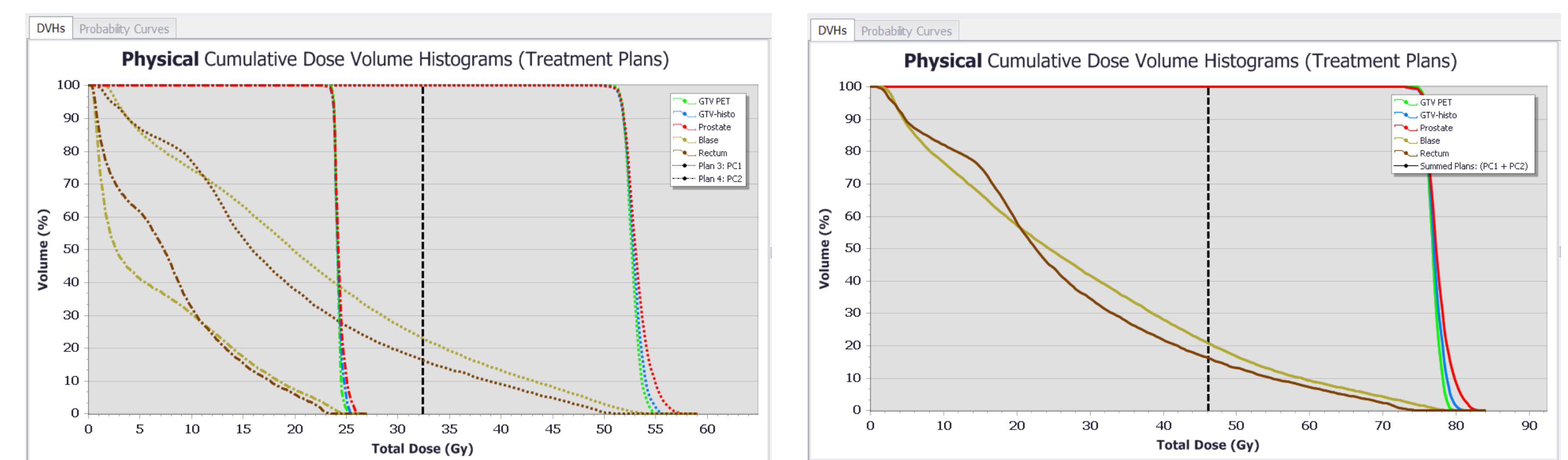
Treatment Protocols												
Series		Groups										
	Name	Anatomical Region	Treatment Method	ERT / BRT Treatment Type	Source Isotope	Decay Half Life (days)	Fractionation Type	Total Prescribed Dose (Gy)	Total Number of Fractions	Dose per Fraction (Gy)	Fractionation Equivalents	Number of Fractions per Treatment Day
A	Breast ERT 640y		THORAX									
	Series 1: Breast ERT 25x20y	THORAX	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	50	25	2	YES	1		
	Series 2: Breast Boost 70x20y	THORAX	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	14	7	2	YES	1		
	Prostate HDR Monotherapy 2 x 140y		PELVIS									
	Series 1: HDR - Monotherapy single fraction 140y	PELVIS	BRACHYTHERAPY (BRT)	HDR	Ir-192	73.81	FRACTIONATED	14	1	14	YES	1
	Series 2: HDR - Monotherapy single fraction 140y	PELVIS	BRACHYTHERAPY (BRT)	HDR	Ir-192	73.81	FRACTIONATED	14	1	14	YES	1
	Prostate HDR Monotherapy 3 x 11.50y		PELVIS									
	Series 1: HDR - Monotherapy single fraction 11.50y	PELVIS	BRACHYTHERAPY (BRT)	HDR	Ir-192	73.81	FRACTIONATED	11.5	1	11.5	YES	1
	Series 2: HDR - Monotherapy single fraction 11.50y	PELVIS	BRACHYTHERAPY (BRT)	HDR	Ir-192	73.81	FRACTIONATED	11.5	1	11.5	YES	1
	Series 3: HDR - Monotherapy single fraction 11.50y	PELVIS	BRACHYTHERAPY (BRT)	HDR	Ir-192	73.81	FRACTIONATED	11.5	1	11.5	YES	1
	Prostate Intermediate Risk R0HBI		PELVIS									
	Series 1: HDR - single fraction 10.50y of the Prostate Comb+Treatment	PELVIS	BRACHYTHERAPY (BRT)	HDR	Ir-192	73.81	FRACTIONATED	10.5	1	10.5	YES	1
	Series 2: HDR - single fraction 10.50y of the Prostate Comb+Treatment	PELVIS	BRACHYTHERAPY (BRT)	HDR	Ir-192	73.81	FRACTIONATED	10.5	1	10.5	YES	1
	Series 3: ERT-Part with 450y of the Prostate Comb+Treatment	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	45	25	1.8	YES	1		
	Prostate post-operative		PELVIS									
	Series 1: Prostate post-op 30 x 1.80y incl local margin	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	54	30	1.8	YES	1		
	Series 2: Prostate post-op 30 x 1.8-1.80y incl asymmetric margin	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	12.6	7	1.8	YES	1		
	Prostate 50V Total 70y		PELVIS									
Series 1: BMR7 Prostate+50V 1cm Margin 28x1.80y	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	50.4	28	1.8	YES	1			
Series 2: BMR7 Prostate 1cm Margin 30x1.80y	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	24.2	14	1.8	YES	1			
Series 3: BMR7 Prostate asymmetric Margins 7x1.80y	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	12.6	7	1.8	YES	1			
Prostate 70y		PELVIS										
Series 1: Prostate-Series 1 PC1 52.8 Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	52.8	24	2.2	YES	1			
Series 2: Prostate-Series 2 PC2 24.2 Gy	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	24.2	11	2.2	YES	1			
Prostate Flame-Trial		PELVIS										
Series 1: Prostate-Flame-Series 1 PC1 and PC3	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	52.8	24	2.2	YES	1			
Series 2: Prostate-Flame-Series 2 PC2 and PC3	PELVIS	EXTERNAL BEAM RADIOTHERAPY (ERT)	PHOTON	FRACTIONATED	24.2	11	2.2	YES	1			

Users can export/import evaluations treatment protocols and share them with other users located to remote locations.



BIOSPOT is a treatment plan evaluation system of radiation plans based on both predefined and user-defined evaluation protocols. The evaluation parameters are stored in BIOTOP rational database.

DICOM RT data are imported and linked to a selected evaluation protocol. BIOSPOT computes the dose volume histogram for each structure and each plan. Summation of the plans can also be performed.

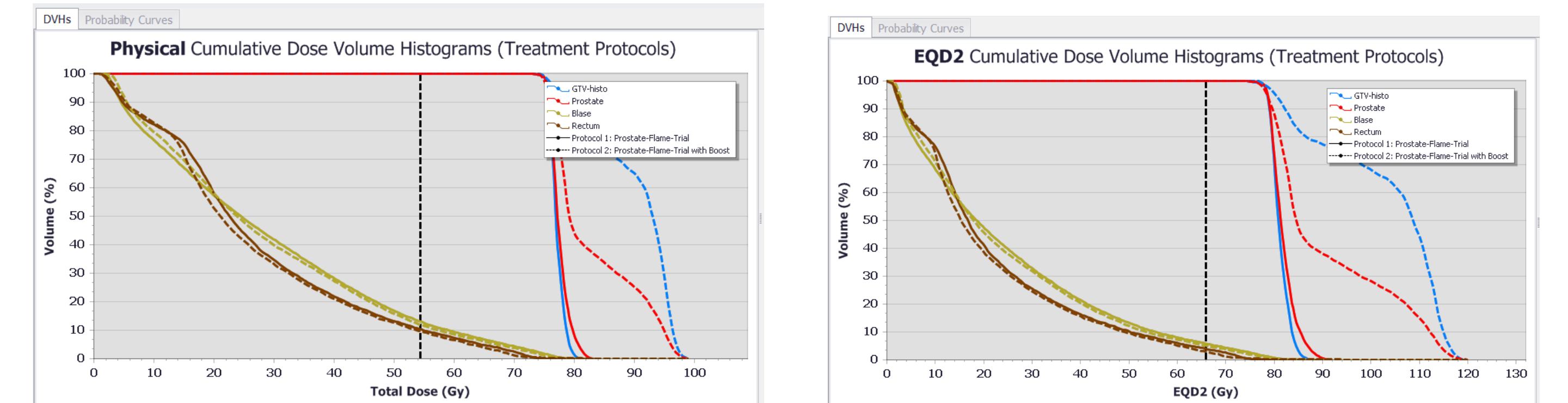


Treatment protocols defined in the evaluation protocol can be assigned to patient plans. Additionally, treatment protocols can be copied and the user is able to assign different plans or even to change the number of fraction or the dose per fraction.

The screenshot shows the 'Treatment Protocols' window. The left pane displays a tree view of protocols. The right pane shows a table with columns: Data Type, Dose per..., Total Prescrip..., and Total Treatme... The table contains data for various protocols, including 'Prostate-Flame-Trial' and 'Prostate-Flame-Trial with Boost'. A context menu is open over the 'Dose per...' column, showing options like 'Deactivate', 'Link Plan', and 'Reports'.

Data Type	Dose per...	Total Prescrip...	Total Treatme...
	(Gy)	(Gy)	(days)
Protocol #1: Prostate-Flame-Trial			48.04
Series #1 - Prostate-Flame-Series 1 PC1 and PC3	2.20	52.80	33.04
Plan #1: PC1	2.20	52.80	-
Series #2 - Prostate-Flame-Series 2 PC2 and PC3	11	24.20	14.04
Plan #4: PC2			
Protocol #2: Prostate-Flame-Trial with Boost			
Series #1 - Prostate-Flame-Series 1 PC1 and PC3			
Plan #1: PC1+SB			
Series #2 - Prostate-Flame-Series 2 PC2 and PC3			
Plan #2: PC2+SB			

As soon as a radiobiological evaluation protocol is selected BIOSPOT calculates voxel based equieffective doses (BED/EQD0 or EQD2) as 3D dose distribution and extracts the corresponding DVHs.



In addition, BIOTOP and BIOSPOT support EUD and gEUD, TCP and NTCP, and the overall uncomplicated tumour control probabilities P_+ calculations. Several models for effect probability such as Voxel-Poisson response model, Relative seriality model, Lyman-Kutcher-Burman model and Parallel architecture model are supported.

