

# Eclipse Scripting in Focus: Applications in Radiation Oncology

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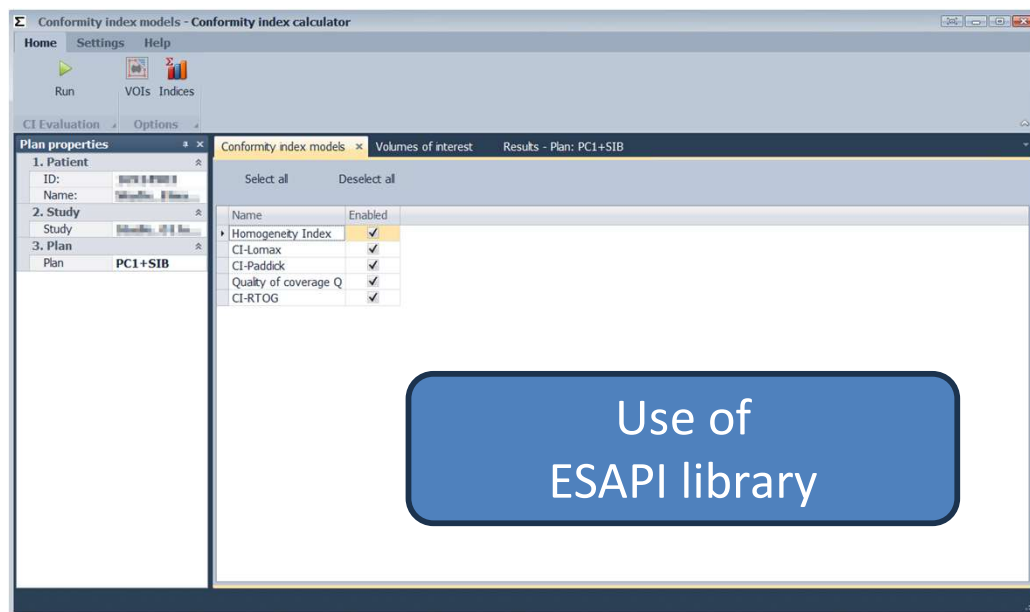
Med. Physik Abteilung, Straheilkunde, Universität Freiburg

# Outline

- What is Eclipse Scripting?
- ESAPI Features / Functionalities
- In-house applications for Med. Physics / Radiation Oncology
- Elements on best practises for code development
- Conclusion

# What is Eclipse Scripting?

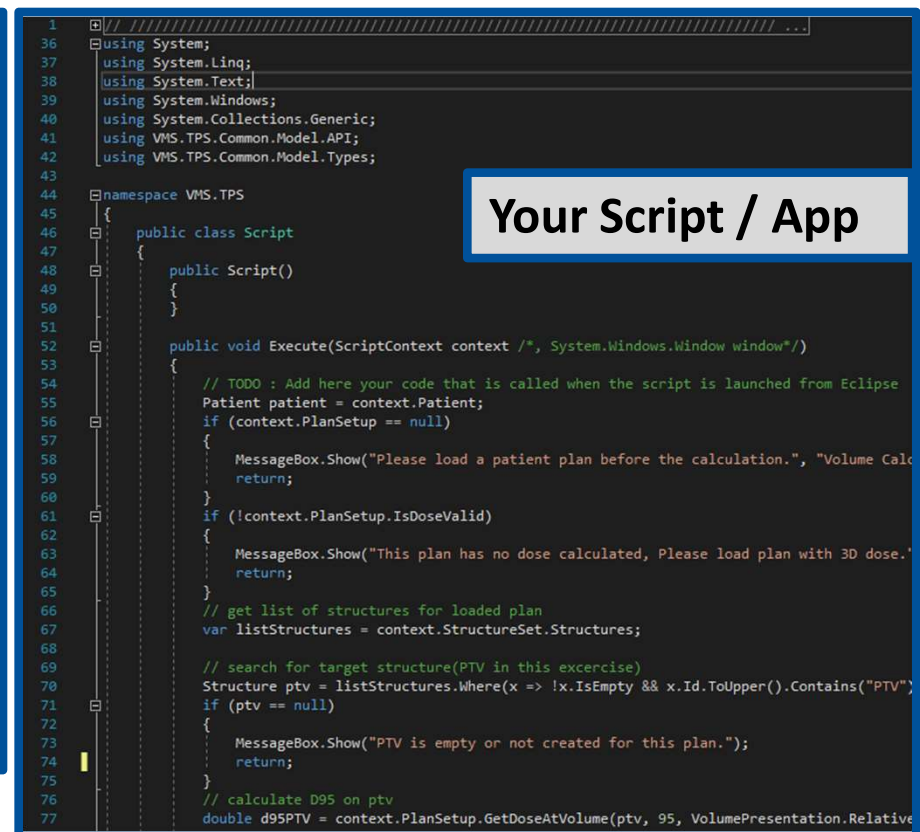
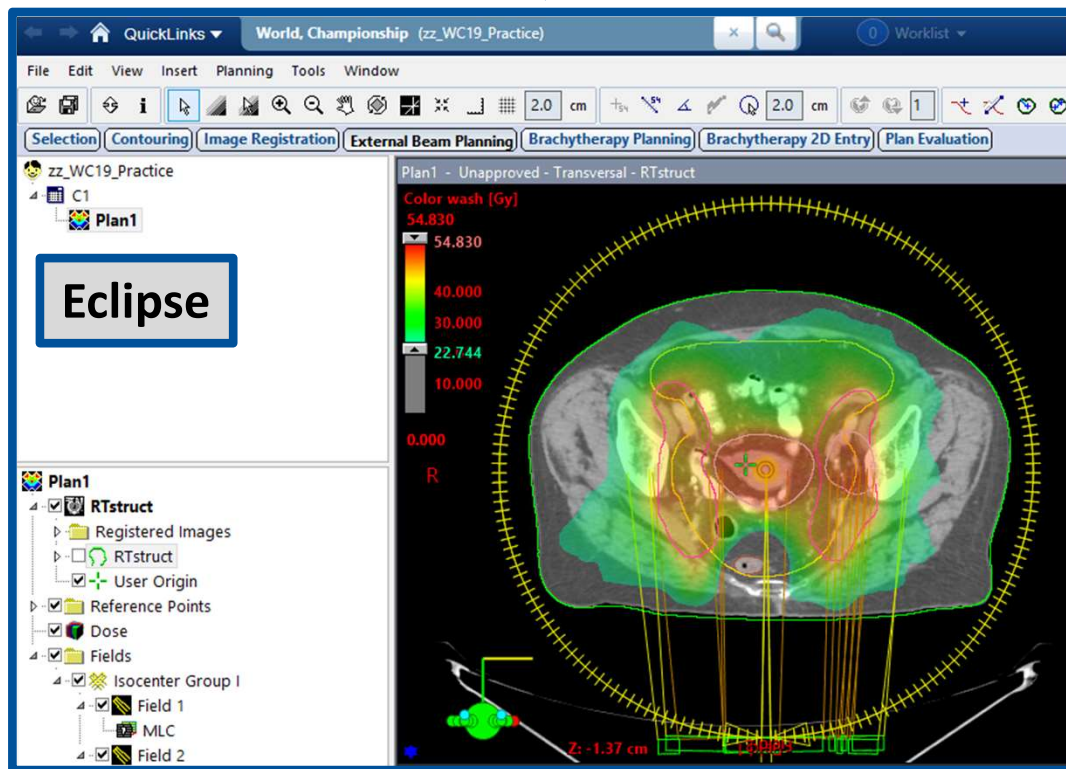
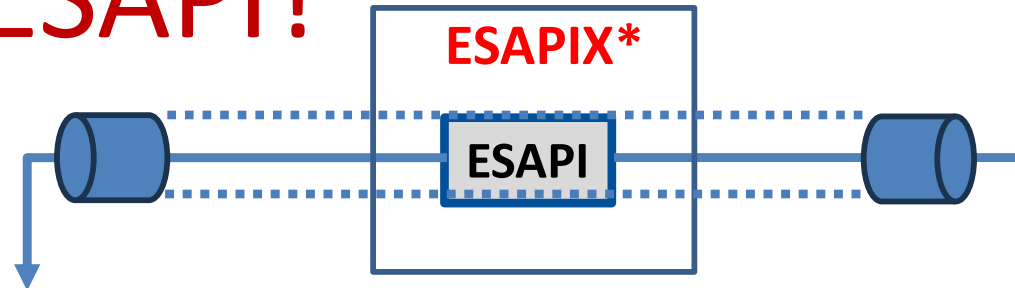
- Software application
- **ESAPI** => **E**clipse **S**cripting **A**pplication **P**rogramming **I**nterface



# What is ESAPI?

- Collection of .NET (software development framework by Microsoft) libraries
- Enables developers to build .NET scripts, DLLs, or application with .NET enabled languages (**C#**, Visual Basic, C++, F#)
- Operates on patient data loaded into Eclipse and/or all patients available in Eclipse database (ARIA DB)

# What is ESAPI?



(\*) <https://github.com/rexcardan/ESAPIX>



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dkfz.

German Cancer Consortium  
Partner site Freiburg

# VARIAN ecosystem - APIs

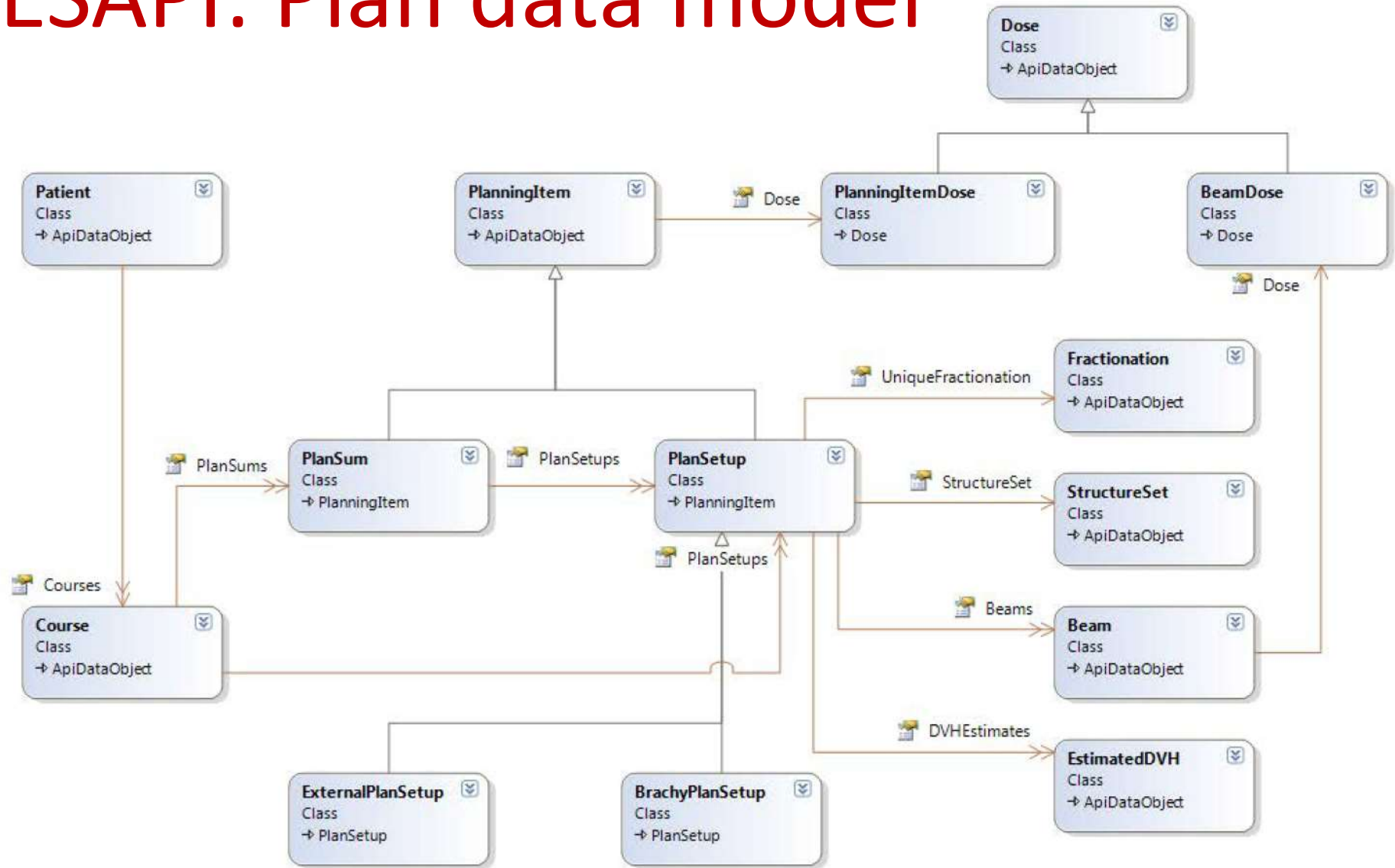
- Image Registration and Segmentation Scripting API
  - structures and structure sets
  - rigid and non-rigid registrations
- ARIA Portal Dosimetry Scripting API
  - portal dose images, predicted dose images and composite images
  - portal Dosimetry Analysis, including tests and gamma analysis
  - portal Dosimetry analysis templates
- Eclipse Scripting API

=> Microsoft .NET Framework library v4.6.2 (ESAPI 15.6)

# ESAPI v15.5 (or newer)

- ESAPI Access (read) to External Beam Planning Information: Patient, Course, Plan, Beams, Structures, DVHs, Doses, Images, Imaging Registration
- Access (read) to Eclipse Brachytherapy and Proton Data
- Eclipse Automation for External Beam Planning (read/write): Create Courses, Plans, Beams, Optimization, Dose calculation

# ESAPI: Plan data model



Source: Eclipse Scripting API Reference Guide, VARIAN



# Scripting running modes

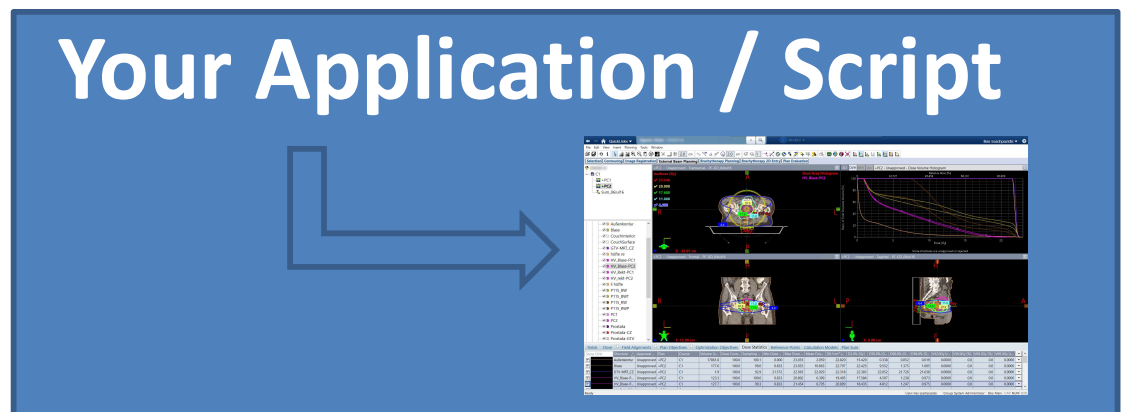
## Plugin Script



The screenshot shows a radiotherapy planning software interface. A blue box with the text "Your App Script" is overlaid on the central part of the screen, with a blue arrow pointing from the text to the software's menu bar. The software interface includes a menu bar at the top with options like "File", "Edit", "View", "Insert", "Planning", and "Tools". Below the menu bar is a toolbar with various icons. The main workspace displays a 3D anatomical model of a patient's pelvis with various structures and dose distributions. A "Dose Area Histogram" window is open on the right side, showing a graph of relative dose versus volume. At the bottom of the interface, there is a table with columns for "Fields", "Dose", "Field Alignments", "Plan Objectives", "Optimization Objectives", "Dose Statistics", "Reference Points", "Calculation Models", and "Plan Sum".

Fields	Dose	Field Alignments	Plan Objectives	Optimization Objectives	Dose Statistics	Reference Points	Calculation Models	Plan Sum													
Show	Hide	Structure	Approval	Plan	Course	Volume (cc)	Dose (Gy)	Sampling	Min Dose	Max Dose	Mean Dose	D0 1cm <sup>3</sup> (L)	D2.0% (Gy)	D30.0% (Gy)	D50.0% (Gy)	D98.0% (Gy)	V42.0Gy (%)	V30.0Gy (%)	V69.3Gy (%)	V69.3Gy (cc)	
[x]	[x]	Außenkontur	Unapproved	+PC2	C1	17861.0	100.0	100.1	0.000	23.035	2.059	22.820	15.420	0.338	0.052	0.019	0.0000	0.0	0.0	0.0000	+
[x]	[x]	Blase	Unapproved	+PC2	C1	177.6	100.0	99.0	0.833	23.035	10.663	22.797	22.425	9.352	1.375	1.005	0.0000	0.0	0.0	0.0000	+
[x]	[x]	GTV-MRT_CZ	Unapproved	+PC2	C1	1.9	100.0	92.9	21.572	22.565	22.029	22.318	22.383	2.052	21.726	21.638	0.0000	0.0	0.0	0.0000	+
[x]	[x]	HV_Blase-PC1	Unapproved	+PC2	C1	123.3	100.0	100.0	0.833	20.892	6.399	19.495	17.584	4.507	1.238	0.973	0.0000	0.0	0.0	0.0000	+
[x]	[x]	HV_Blase-PC2	Unapproved	+PC2	C1	127.7	100.0	99.3	0.833	21.454	6.705	20.899	18.435	4.812	1.247	0.975	0.0000	0.0	0.0	0.0000	+

## Standalone Application



The screenshot shows a radiotherapy planning software interface. A blue box with the text "Your Application / Script" is overlaid on the central part of the screen, with a blue arrow pointing from the text to the software's menu bar. The software interface includes a menu bar at the top with options like "File", "Edit", "View", "Insert", "Planning", and "Tools". Below the menu bar is a toolbar with various icons. The main workspace displays a 3D anatomical model of a patient's pelvis with various structures and dose distributions. A "Dose Area Histogram" window is open on the right side, showing a graph of relative dose versus volume. At the bottom of the interface, there is a table with columns for "Fields", "Dose", "Field Alignments", "Plan Objectives", "Optimization Objectives", "Dose Statistics", "Reference Points", "Calculation Models", and "Plan Sum".

Fields	Dose	Field Alignments	Plan Objectives	Optimization Objectives	Dose Statistics	Reference Points	Calculation Models	Plan Sum													
Show	Hide	Structure	Approval	Plan	Course	Volume (cc)	Dose (Gy)	Sampling	Min Dose	Max Dose	Mean Dose	D0 1cm <sup>3</sup> (L)	D2.0% (Gy)	D30.0% (Gy)	D50.0% (Gy)	D98.0% (Gy)	V42.0Gy (%)	V30.0Gy (%)	V69.3Gy (%)	V69.3Gy (cc)	
[x]	[x]	Außenkontur	Unapproved	+PC2	C1	17861.0	100.0	100.1	0.000	23.035	2.059	22.820	15.420	0.338	0.052	0.019	0.0000	0.0	0.0	0.0000	+
[x]	[x]	Blase	Unapproved	+PC2	C1	177.6	100.0	99.0	0.833	23.035	10.663	22.797	22.425	9.352	1.375	1.005	0.0000	0.0	0.0	0.0000	+
[x]	[x]	GTV-MRT_CZ	Unapproved	+PC2	C1	1.9	100.0	92.9	21.572	22.565	22.029	22.318	22.383	2.052	21.726	21.638	0.0000	0.0	0.0	0.0000	+
[x]	[x]	HV_Blase-PC1	Unapproved	+PC2	C1	123.3	100.0	100.0	0.833	20.892	6.399	19.495	17.584	4.507	1.238	0.973	0.0000	0.0	0.0	0.0000	+
[x]	[x]	HV_Blase-PC2	Unapproved	+PC2	C1	127.7	100.0	99.3	0.833	21.454	6.705	20.899	18.435	4.812	1.247	0.975	0.0000	0.0	0.0	0.0000	+

# General ESAPI Applications

- Contouring of help structures
  - Boolean operations,
  - a/symmetric margins
- Treatment planning
  - Automatic plan generation and optimization
  - Creation and calculation of verification plans
  - DVH-Analyser Documentation (Standard Treatment Plan Report, Dose Metric Report)
- Data extraction
  - Patient filtering with specific plan parameters
  - Extraction of DVH, structure 3D meshes, plan parameters, etc...

# In-house ESAPI applications

## R&D:

- Export of 3D meshes of structures => Radiomics
- Exporting Dose-Volume indices (Dxx, Vxx) for single and summation plans => DVHs in EQD2
- Plan Optimization / Prescription free optimization
- Monte carlo simulation => EGS dose => Eclipse import

## Clinical:

- Conformity Index Calculator
- Dosimetric Plan Evaluation
- Plan Dose Control (Secondary Independent Dose Verification)

# Dose-Volume Indices - Input

DVH\_data\_collection.csv

	A	B	C	D	E	F	G	
1	PIZ	Course	Plan	StructureClass	Structure	DoseMetrics	VolumeMetrics	
2		Scha	17	+rGBM_PET	GTV_PET	GTV_PET	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
3		Scha	17	+rGBM_PET	GTV_MRT	GTV_MRT	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
4		Scha	17	+rGBM_PET	PTV_MRT	rGBM_MRT	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	V95%[%], V90%[%], V
5		Scha	17	+rGBM_PET	PTV_PET	rGBM_PET	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	V95%[%], V90%[%], V
6		Scha	17	+rGBM_PET	Optic Chiasm	Chiasm	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
7		Scha	17	+rGBM_PET	Right optic nerve	Optic Nerve, Rig	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
8		Scha	17	+rGBM_PET	Left optic nerve	Optic Nerve, Lef	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
9		Scha	17	+rGBM_PET	Brainstem	Brainstem	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
10		Scha	17	+rGBM_PET	Left Retina	Left Retina	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
11		Scha	17	+rGBM_PET	Right Retina	Right Retina	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
12		Scha	r18	+rGBM-PET	GTV_PET	GTV-PET	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
13		Scha	r18	+rGBM-PET	GTV_MRT	GTV-MRT	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]
14		Scha	r18	+rGBM-PET	PTV_MRT	rGBM-MRT	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	V95%[%], V90%[%], V
15		Scha	r18	+rGBM-PET	PTV_PET	rGBM-PET	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	V95%[%], V90%[%], V
16		Scha	r18	+rGBM-PET	Optic Chiasm	Chiasm	Min[Gy], Max[Gy], Mean[Gy], D50%[Gy], D50%[EQD2Gy(8.0)]	Volume[cc]

# Dose-Volume Indices - Output

A	B	C	D	E	F	G	H
Piz	Course	Plan	GTV_PET_Min[Gy]	GTV_PET_Max[Gy]	GTV_PET_Mean[Gy]	GTV_PET_Volume[cc]	GTV_MRT_M
		+rGBM_PET	36.924	40.083	38.989	2.7938	
		+rGBM-PET	37.272	41.216	38.742	17.2615	
		Sum_14Aug19	21.882	40.808	39.132	36.016	
		+rGBM-PET	27.894	41.672	39.738	44.7287	
		+rGBM_PET	36.796	41.226	38.764	16.0789	
		+rGBM-MRT	34.546	41.974	39.272	12.5642	
		+rGBM-PET	37	40.918	39.509	23.7267	
		+rGBM-PET	38.108	40.899	39.915	5.4064	
		+rGBM-PET	38.788	40.795	40.181	1.342	
		+rGBM-MRT	24.253	40.953	38.893	28.8776	
		+rGBM-PET	38.237	40.589	39.695	0.5748	
		+rGBM-MRT	14.173	41.6	39.08	21.0325	
		+rGBM-MRT	26.424	41.343	39.581	16.2244	
		+rGBM-PET	38.395	41.184	39.897	6.6692	
		+rGBM-MRT	17.274	41.24	39.499	17.0338	
		+rGBM_MRT mod	39.582	40.409	40.088	0.2687	
		Sum_29Jun20 v1	39.063	40.906	39.895	4.5564	
		+rGBM-MRT	9.621	40.78	34.548	9.7951	
		+rGBM-PETmod2	18.581	42.026	39.082	2.3765	

# Conformity Index Calculator

Conformity index models - Conformity index calculator

Home Settings Help

Run VOIs Indices

CI Evaluation Options

Plan properties

1. Patient

ID: [text]  
Name: [text]

2. Study

Study: [text]

3. Plan

Plan: **PC1+SIB**

Conformity index models x Volumes of interest Results - Plan: PC1+SIB

Select all Deselect all

Name	Enabled
Homogeneity Index	<input checked="" type="checkbox"/>
CI-Lomax	<input checked="" type="checkbox"/>
CI-Paddick	<input checked="" type="checkbox"/>
Quality of coverage Q	<input checked="" type="checkbox"/>
CI-RTOG	<input checked="" type="checkbox"/>

# Conformity Index Calculator

Plan properties

- 1. Patient
  - ID: [REDACTED]
  - Name: [REDACTED]
- 2. Study
  - Study: [REDACTED]
- 3. Plan
  - Plan: **PC1+SIB**

Conformity index models | Volumes of interest | Results - Plan: PC1+SIB

Select all | Deselect all

VOI name	Target	Color
PC2-SIB	<input checked="" type="checkbox"/>	255; 0; 0
PC1-SIB	<input checked="" type="checkbox"/>	255; 0; 0
SB	<input type="checkbox"/>	255; 0; 0
Prostate	<input checked="" type="checkbox"/>	255; 0; 0
Prostata+SB-Basi	<input type="checkbox"/>	255; 0; 0
Prostata+SB	<input type="checkbox"/>	255; 0; 0
PC3_SiB	<input checked="" type="checkbox"/>	255; 0; 128
PC2	<input checked="" type="checkbox"/>	255; 0; 255
PC1	<input checked="" type="checkbox"/>	255; 128; 255

# Conformity Index Calculator

Results - Plan: PC2+SIB - Conformity index calculator

Home Settings Help

Run VOIs Indices Save to pdf Save to excel Copy to clipboard

CI Evaluation Options Results

Plan properties

1. Patient  
ID: [redacted]  
Name: [redacted]

2. Study  
Study: [redacted]

3. Plan  
Plan: PC2+SIB

Conformity index models Volumes of interest Results - Plan: PC1+SIB Results - Plan: PC2+SIB

	A	B	C	D	E	F
1	Patient:	[redacted]				
2	ID:	[redacted]				
3	Study:	[redacted]				
4	Plan:	PC2+SIB				
5	Date / Time	[redacted]				
6	Application Version:	[redacted]				
7						
8		<b>Conformity Indices</b>				
9	VOI	CI-RTOG	Q (Quality of Coverage)	HI (Homogeneity Index)	CI-Paddick / COIN	CI-Lomax
10	PC2-SIB	0.813	0.839	1.214	0.631	0.717
11	PC1-SIB	0.566	0.030	1.214	0.440	0.499
12	Prostate	1.503	0.925	1.324	0.529	0.892
13	PC3_SiB	10.126	1.020	1.324	0.099	1.000
14	PC2	0.751	0.835	1.324	0.724	0.738
15	PC1	0.536	0.030	1.324	0.516	0.526
16						
17						
18						
19						
20						
21						
22						
23						
24						

Sheet1



# EGS Dose Import

EgsImport v1.0 - Import .3ddose into Eclipse

Patient :

PIZ :

Course : pmma\_res\_in\_egs

Plan : Plan1\_3

**Select file ...**

C:\Users\ssachpazi.ONCOLOGY\Desktop\new\_EGS\_import\_files\PMMA\_CBCT\_1.3ddose

**Structure Set :**

**Dose Evaluation Plan Name :** Plan1\_3

**Conversion parameters**

**Monitor units :** 1000

**Gy per monitor unit :** 0.01

**Normalization Factor (Gy/Particle) :** 1.95E-12

**Start importing...**

**For research purposes only! Contact info: [ilias.sachpazidis@uniklinik-freiburg.de](mailto:ilias.sachpazidis@uniklinik-freiburg.de)**

# EGS Dose Import



# Dosimetric Plan Evaluation

The screenshot displays a radiotherapy planning software interface. The main window shows a transverse CT scan of a prostate with several dose contours overlaid. The contours are labeled with their respective dose values: 44.000 Gy (red), 40.000 Gy (orange), 33.250 Gy (green), 21.000 Gy (blue), and 15.000 Gy (purple). A specific point on the 33.250 Gy contour is labeled '33.034 Gy'. The interface includes a menu bar (File, Edit, View, Insert, Planning, Tools, Window), a toolbar, and a status bar at the bottom with tabs for Fields, Dose, Field Alignments, Plan Objectives, Optimization Objectives, Dose Statistics, Reference Points, Calculation Models, and Plan Sum.

On the left side, there is a tree view showing the plan structure:

- Prostata\_2-IntraObserver
  - HypoFocal\_SBRT
    - PTV1-3-SBRT
    - xPlan2
- PTV1-3-SBRT
  - HypoFocal\_SBRT1
    - Registered Images
      - HypoFocal\_SBRT
        - Blase
        - BODY
        - BP
        - CTV1\_MHRT\_ArmB
        - CTV1\_SBRT
        - CTV2\_SBRT
        - Dünndarm
        - GTV\_MRI
        - GTV-Histo\_all
        - GTV-PET
        - GTV-union
        - Hüftkopf li
        - Hüftkopf re
        - Prostate
        - Prostate1
        - PRV\_Urethra
        - PRV-Rektum
        - PTV1\_MHRT\_ArmB
        - PTV1\_SRRT

At the bottom left, a small 3D model of the prostate is shown with a 'Standard' label and 'Head First-Supine Z: 30.40 cm'.

On the right side, there is a 'Scripts' panel with a list of scripts:

- CIScriptLib.esapi.dll
- PlanControlling\_v1\_0\_0.cs
- PlanControlling\_v1\_2\_2.cs
- PlanControlling\_v1\_2\_4.cs
- PlanControlling\_v1\_2\_5.cs
- PlanControlling\_v1\_2\_6.cs
- PlanControlling\_v1\_2\_7.cs
- RTPlanEvaluator.esapi.dll

Below the script list, there is a 'Favorites' section with an 'Add or Remove Script from Favorites:' button and an 'Add...' button. The 'Location' section shows 'System Scripts' selected and a folder path: '\\Client\X\$\sachpazi\Debug\_C\'. A 'Run' button is located at the bottom right of the script panel.

In the top right corner of the main window, the following text is displayed:

3D Dose MAX: 44.211 Gy  
3D MAX for PTV1\_SBRT: 44.

# Dosimetric Plan Evaluation

RT Plan Evaluator v1.3 - Patient: 02\_IntraObserver, 02\_Prostata2 PIZ: Prostata\_2-IntraObs

**Run evaluation** **Print report** **About**

**Selected treatment region:** Prostate

**Selected metrics template:** HypoFocal\_SBRT\_40Gy

**Selected plan in scope:** PTV1-3-SBRT

**Plan details**

Parameter	Value
Selected plan in scope	PTV1-3-SBRT
Number of summed plans	0
Summed plans	

**Organs at risk**

Structures in plan	OAR class	Enabled
Blase	Bladder	<input checked="" type="checkbox"/>
BODY		<input type="checkbox"/>
BP		<input type="checkbox"/>
Dünndarm	Small Bowel	<input checked="" type="checkbox"/>
Hüftkopf li	Femoral Head Left	<input checked="" type="checkbox"/>
Hüftkopf re	Femoral Head Right	<input checked="" type="checkbox"/>
Prostate		<input type="checkbox"/>
Prostate1		<input type="checkbox"/>
PRV_Urethra	PRV Urethra	<input checked="" type="checkbox"/>
PRV-Rektum	PRV Rectum	<input checked="" type="checkbox"/>
Rectum2	Rectum	<input checked="" type="checkbox"/>
Rectum	Rectum	<input checked="" type="checkbox"/>
SB	Small Bowel	<input checked="" type="checkbox"/>

**Quality metric results**

Structures in plan	VOI class	Quality metric condition	Calculated value	Result	Quality metric desc
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Calculating DVH

Calculating DVH...

Abort

# Dosimetric Plan Evaluation

RT Plan Evaluator v1.3 - Patient: 02\_IntraObserver, 02\_Prostata2 PIZ: Prostata\_2-IntraObserver Birthday:

Run evaluation Print report About

## Selected treatment region:

Prostate

## Selected metrics template

HypoFocal\_SBRT\_40Gy

## Selected plan in scope:

PTV1-3-SBRT

## Plan details

Parameter	Value
Selected plan in scope	PTV1-3-SBRT
Number of summed plans	0
Summed plans	

## Organs at risk

Structures in plan	OAR class	Enabled
Blase	Bladder	<input checked="" type="checkbox"/>
BODY		<input type="checkbox"/>
BP		<input type="checkbox"/>
Dünndarm	Small Bowel	<input checked="" type="checkbox"/>
Hüftkopf li	Femoral Head Left	<input checked="" type="checkbox"/>
Hüftkopf re	Femoral Head Right	<input checked="" type="checkbox"/>
Prostate		<input type="checkbox"/>
Prostate1		<input type="checkbox"/>
PRV_Urethra	PRV Urethra	<input checked="" type="checkbox"/>
PRV-Rektum	PRV Rectum	<input checked="" type="checkbox"/>
Rectum2	Rectum	<input checked="" type="checkbox"/>
Rektum	Rectum	<input checked="" type="checkbox"/>
SB	Small Bowel	<input checked="" type="checkbox"/>
SB+8mm		<input type="checkbox"/>

## Quality metric results

Structures in plan	VOI class	Quality metric condition	Calculated value	Result	Quality metric descriptio
Blase	Bladder	D0.03cc < 38.060 Gy	36.2159 Gy	OK	Bladder D0.03cc
Blase	Bladder	D5.00cc < 37.000 Gy	26.7452 Gy	OK	Bladder D5.00cc
Blase	Bladder	D15.00cc < 32.000 Gy	18.5976 Gy	OK	Bladder D15.00cc
Blase	Bladder	D20.00cc < 28.000 Gy	16.2951 Gy	OK	Bladder D20.00cc
Blase	Bladder	D50.00cc < 18.120 Gy	8.7874 Gy	OK	Bladder D50.00cc
Dünndarm	Small Bowe	D0.01cc < 30.000 Gy	2.4087 Gy	OK	Small Bowel D0.01cc
Dünndarm	Small Bowe	D5.00cc < 18.100 Gy	0.8982 Gy	OK	Small Bowel D5.00cc
Hüftkopf li	Femoral He	D5.00cc < 28.000 Gy	11.8826 Gy	OK	Femoral Head Left D5.0
Hüftkopf re	Femoral He	D5.00cc < 28.000 Gy	9.1768 Gy	OK	Femoral Head Right D5.
PRV_Urethra	PRV Urethr	D0.01cc < 40.000 Gy	39.9875 Gy	OK	PRV Urethra D0.01cc
PRV-Rektum	PRV Rectur	D0.03cc < 38.000 Gy	36.5745 Gy	OK	PRV Rectum D0.03cc
Rectum2	Rectum	D1.00cc < 36.000 Gy	31.8204 Gy	OK	Rectum D1.00cc
Rectum2	Rectum	D2.00cc < 35.000 Gy	29.0424 Gy	OK	Rectum D2.00cc
Rectum2	Rectum	D20.00cc < 28.000 Gy	27.1813 Gy	OK	Rectum D20.00cc
Rektum	Rectum	D1.00cc < 36.000 Gy	33.9600 Gy	OK	Rectum D1.00cc
Rektum	Rectum	D2.00cc < 35.000 Gy	31.6686 Gy	OK	Rectum D2.00cc
Rektum	Rectum	D20.00cc < 28.000 Gy	22.1135 Gy	OK	Rectum D20.00cc
SB	Small Bowe	D0.01cc < 30.000 Gy	43.6785 Gy	NOK	Small Bowel D0.01cc
SB	Small Bowe	D5.00cc < 18.100 Gy	33.1467 Gy	NOK	Small Bowel D5.00cc
Urethra	Urethra	D50.00cc < 36.000 Gy	35.5347 Gy	OK	Urethra D50.00cc
z_Blase-PTV	Bladder	D0.03cc < 38.060 Gy	34.2969 Gy	OK	Bladder D0.03cc
z_Blase-PTV	Bladder	D5.00cc < 37.000 Gy	25.0549 Gy	OK	Bladder D5.00cc
z_Blase-PTV	Bladder	D15.00cc < 32.000 Gy	17.9217 Gy	OK	Bladder D15.00cc
z_Blase-PTV	Bladder	D20.00cc < 28.000 Gy	15.7868 Gy	OK	Bladder D20.00cc

# Dosimetric Plan Evaluation

ntaObserver\_PTV1-3-SBRT.pdf - Adobe Acrobat Reader (32-bit)

ge Unterschreiben Fenster Hilfe

QM\_Report\_Prostat... x



02\_IntraObserver, 02\_Prostata2 (ID: Prostata\_2-IntraObserver)  
Course: , Plan: PTV1-3-SBRT, StructureSet:

Generated: 23.01.2023 08:37:52

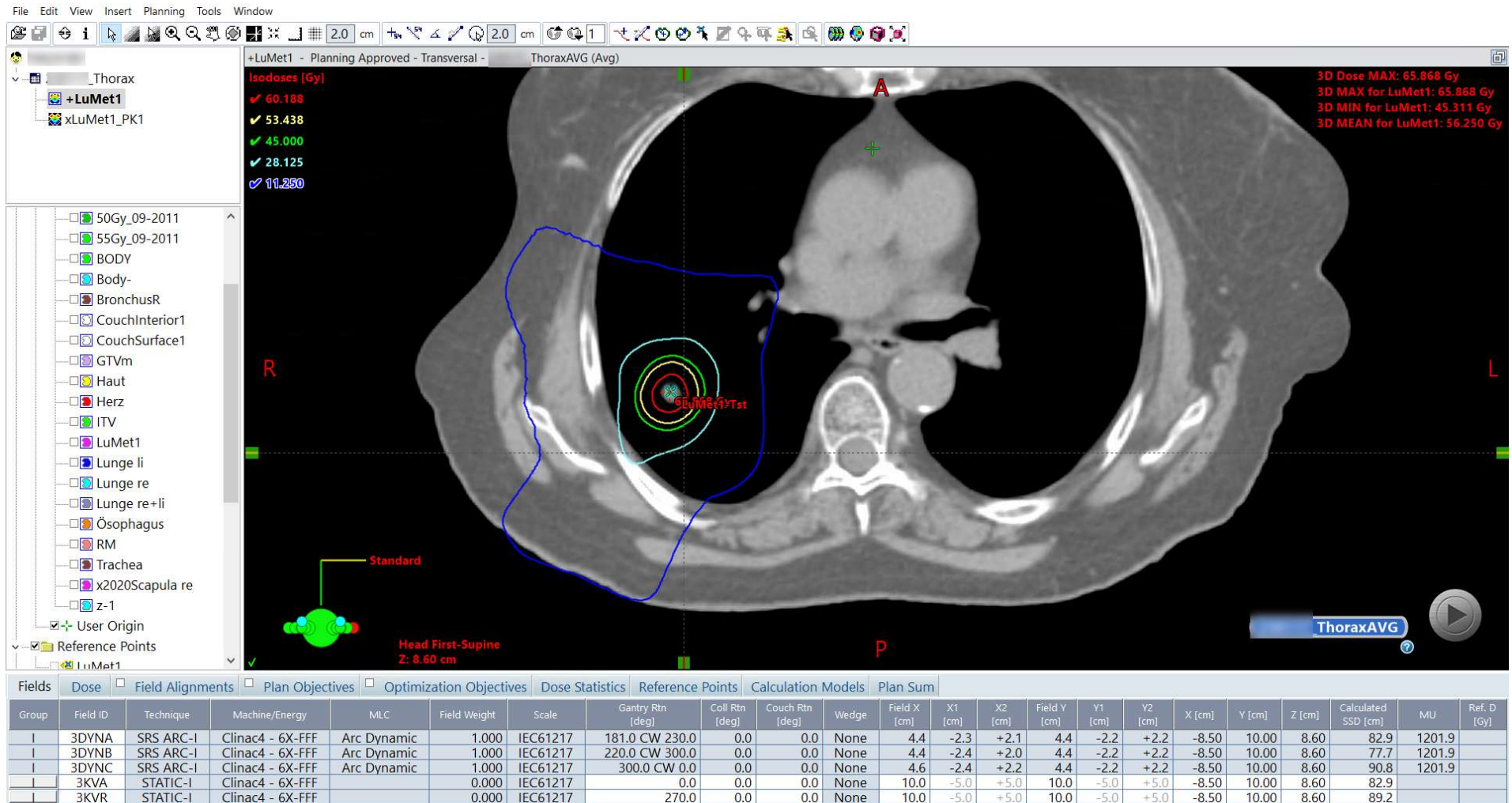
**02\_IntraObserver, 02\_Prostata2**  
PIZ: Prostata\_2-IntraObserver

## Plan quality metrics

**Metric template: HypoFocal\_SBRT\_40Gy**

Structures in plan	VOI class	QM condition	Calculated value	Result	QM description
Blase	Bladder	D0.03cc < 38.060 Gy	36.2159 Gy	OK	Bladder D0.03cc
Blase	Bladder	D5.00cc < 37.000 Gy	26.7452 Gy	OK	Bladder D5.00cc
Blase	Bladder	D15.00cc < 32.000 Gy	18.5976 Gy	OK	Bladder D15.00cc
Blase	Bladder	D20.00cc < 28.000 Gy	16.2951 Gy	OK	Bladder D20.00cc
Blase	Bladder	D50.00cc < 18.120 Gy	8.7874 Gy	OK	Bladder D50.00cc
Dünndarm	Small Bowel	D0.01cc < 30.000 Gy	2.4087 Gy	OK	Small Bowel D0.01cc

# Independent Dose Control: 3D and Dynamic Arcs Plans



# Independent Dose Control: 3D and Dynamic Arcs Plans

Abteilung Medizinische Physik, Klinik für Strahlenheilkunde Version 2022-07-12									
Patientenname: _____									
PIZ: _____									
Planne: _____									
Anzahl Fraktionen: _____									
Dosis (Gy) in MOSAIQ: _____									
Gesamtdosis (Gy) im Kontrollpunkt: _____									
Dosis/Frakt. (Gy) im Kontrollpunkt: _____									
Gerät: Varian_Truebeam									
Feld	Energie (MeV)	X (cm)	Y (cm)	MLC-Faktor	Dyn. Keil (Grad)	Exz. (cm)	MU	Tiefe (cm)	Gew. D/Frakt. (Gy)
1	X6			1.00					1.00
2	X6			1.00					1.00
3	X6			1.00					1.00
4	X6			1.00					1.00
5	X6			1.00					1.00
6	X6			1.00					1.00
7	X6			1.00					1.00
8	X6			1.00					1.00
9	X6			1.00					1.00
10	X6			1.00					1.00

Relative Maximumdosis	
Dmax (Gy)	<input type="text"/>
Dmax rel.	<input type="text"/>
MW-MU-Faktor	
MU IN (wedged)	<input type="text"/>
MU OUT (open)	<input type="text"/>

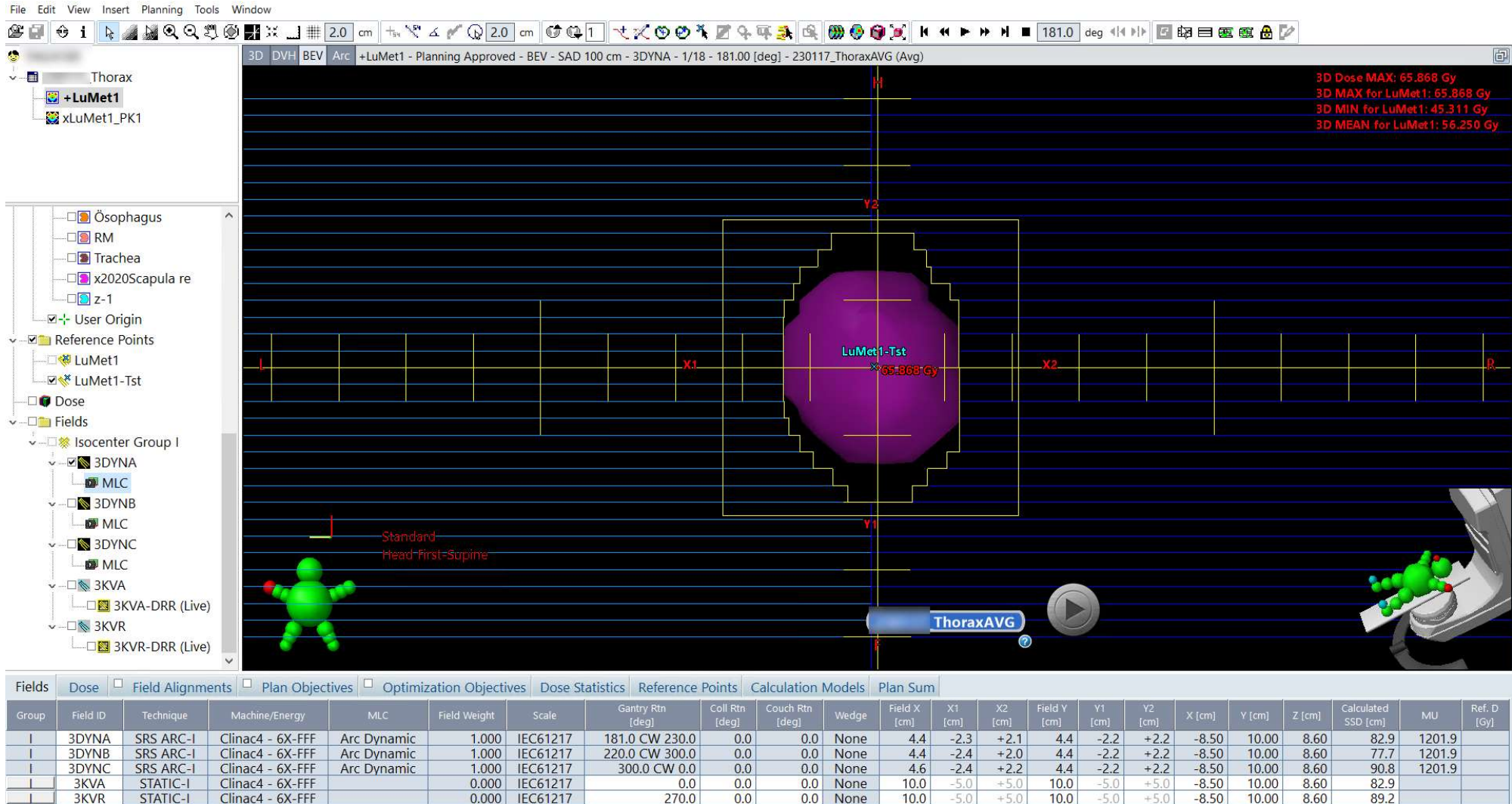
D<sub>max</sub> (PTV): \_\_\_\_\_ %  
D<sub>50</sub> (PTV): \_\_\_\_\_ Gy

KONTROLLBLATT | Calculation | Clin\_OF\_X6 | Clin\_OF\_X6-FFF | Clin\_OF\_X15 | Clin\_OF\_X10-FFF | Clin\_TPR\_X6 | Clin\_TPR\_X6-FFF | Clin\_TPR\_X15 | Clin\_TPR\_X10-FFF | Clin\_WF\_X6 | Clin\_WF\_... (+) |





# Independent Dose Control: 3D and Dynamic Arcs Plans



# Independent Dose Control: 3D and Dynamic Arcs Plans

DOSE CONTROL APPLICATION FOR 3D/IMRT PLANS / (V1.2.7) - CONTACT EMAIL: ILIAS.SACHPAZIDIS@UNIKLINIK-FREIBURG.DE

PATIENT INFORMATION

Patient name:

PIZ:

PLAN / REFERENCE POINT SELECTION

Plan ID: xLuMet1

Reference Point: xPK1\_LuMet1

Machine (ID): Clinac4 (VarianTruebeam)

Number of fractions: 3

Prescription dose (Gy): 56.250

Total dose @ reference point (Gy):

**RUN EVALUATION**

**SAVE TO XLSM**

**SAVE TO PDF**

FELD	ENERGIE(MEV)	X(CM)	Y(CM)	MLC-FAKTOR	DYN.KEIL	EXZ.(CM)	MU	TIEFE(CM)	GEW.	ECLIPSE: D/FRAKT.(GY)	UNABHÄNGIG: D/FRAKT.(GY)	RELATIVE AB. (%)
3DYNA	X6-FFF	4.4	4.4	0.45	None	None	1201.88	9.6	1	7.626	7.727	1.32
3DYNB	X6-FFF	4.4	4.4	0.46	None	None	1201.88	8.8	1	7.893	8.093	2.53
3DYNC	X6-FFF	4.6	4.4	0.43	None	None	1201.87	7.9	1	8.229	8.439	2.55

**Ergebnis der Kontrollrechnung**

Unabhängige Gesamtdosis (Gy) : 71.244

Eclipse Gesamtdosis (Gy) : 71.244

Relative Abweichung (%) : 2.150

# Independent Dose Control: 3D and Dynamic Arcs Plans



Gerät:		Varian_Truebeam									
Feld	Energie (MeV)	X (cm)	Y (cm)	MLC-Faktor	Dyn. Keil (Grad)	Exz. (cm)	MU	Tiefe (cm)	Gew.	D/Frakt. (Gy)	
1	3DYNA	X6-FFF	4.4	4.4	0.45		1201.9	9.6	1.00	7.727	
2	3DYNB	X6-FFF	4.4	4.4	0.46		1201.9	8.8	1.00	8.093	
3	3DYNC	X6-FFF	4.6	4.4	0.43		1201.9	7.9	1.00	8.440	
4		X6			1.00				1.00		
5		X6			1.00				1.00		
6		X6			1.00				1.00		
7		X6			1.00				1.00		
8		X6			1.00				1.00		
9		X6			1.00				1.00		
10		X6			1.00				1.00		

D <sub>max</sub> (PTV):	127.1	%
D <sub>max</sub> (PTV):	71.51	Gy
D <sub>max</sub> /Fraktion (PTV):	23.84	Gy

Ergebnis der Kontrollrechnung:			
Dosis pro Fraktion:	24.26	Gy	Datum: 23.01.2023
Relative Abweichung:	2.2	%	Med. Physik:

Kommentar/Notiz:	
Kontrollpunkt: xPK1_LuMet1 , Software Version: 1.2.7	

## Dosiskontrolle für 3D-Pläne

Abteilung Medizinische Physik, Klinik für Strahlenheilkunde  
Version 2022-07-12

Patientenname:   
 PIZ:

Planname: xLuMet1\_PK1  
Anzahl Fraktionen: 3  
Dosis (Gy) in MOSAIQ: 56.250  
Gesamtdosis (Gy) im Kontrollpunkt: 71.244  
Dosis/Frakt. (Gy) im Kontrollpunkt: 23.748

Gerät: Varian\_Truebeam

Feld	Energie (MeV)	X (cm)	Y (cm)	MLC-Faktor	Dyn. Keil (Grad)	Exz. (cm)	MU	Tiefe (cm)	Gew.	D/Frakt. (Gy)
1	3DYNA	X6-FFF	4.4	4.4	0.45		1201.9	9.6	1.00	7.727
2	3DYNB	X6-FFF	4.4	4.4	0.46		1201.9	8.8	1.00	8.093
3	3DYNC	X6-FFF	4.6	4.4	0.43		1201.9	7.9	1.00	8.440
4		X6			1.00				1.00	
5		X6			1.00				1.00	
6		X6			1.00				1.00	
7		X6			1.00				1.00	
8		X6			1.00				1.00	
9		X6			1.00				1.00	
10		X6			1.00				1.00	

D<sub>max</sub> (PTV): 127.1 %  
D<sub>max</sub> (PTV): 71.51 Gy  
D<sub>max</sub>/Fraktion (PTV): 23.84 Gy

Ergebnis der Kontrollrechnung:  
Dosis pro Fraktion: 24.26 Gy Datum: 23.01.2023  
Relative Abweichung: 2.2 % Med. Physik:

Kommentar/Notiz:  
Kontrollpunkt: xPK1\_LuMet1 , Software Version: 1.2.7

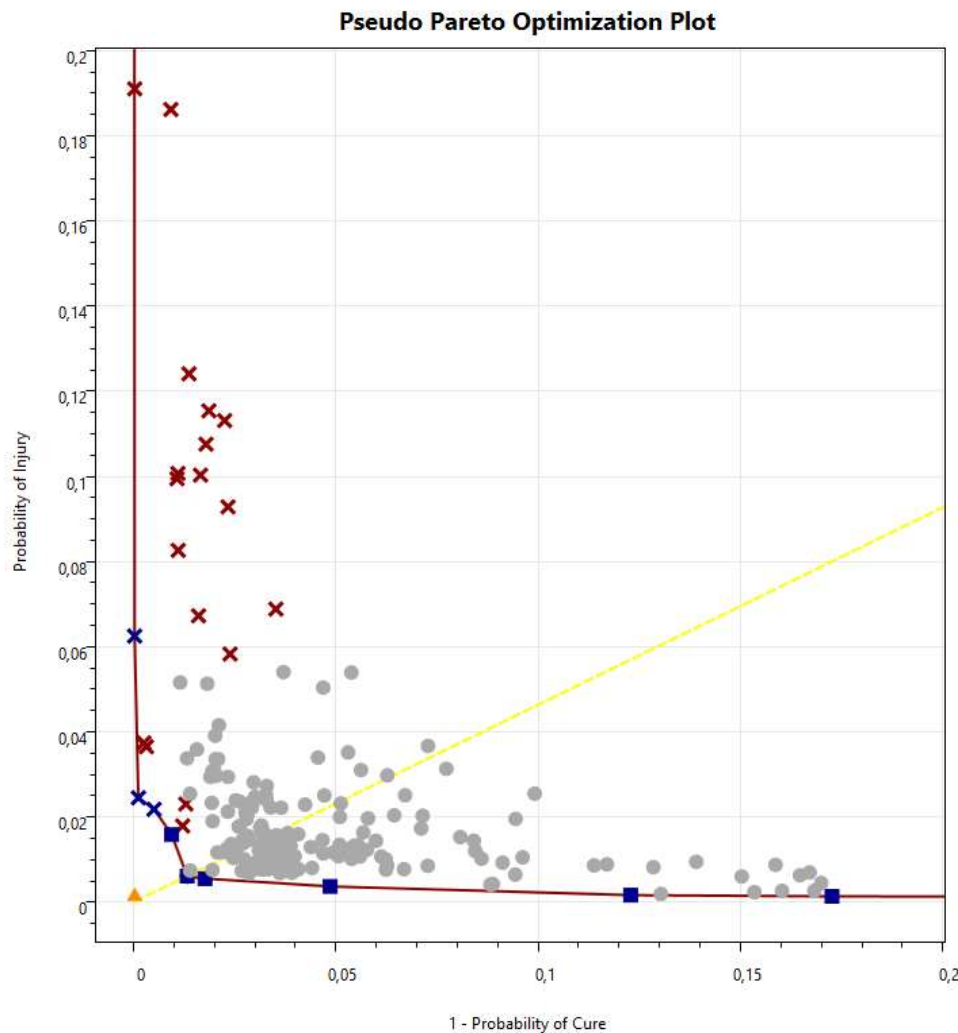
# Independent Dose Control: 3D and Dynamic Arcs Plans

- Ca. 5-10 Plans / Day
- Before (manual):  
 $(5 \text{ to } 10) * 10 \text{ min} = 50 \text{ to } 100 \text{ min}$   
(average. 1 h)
- After (in automated way):  
 $10 * 1 \text{ min} = 10 \text{ min}$

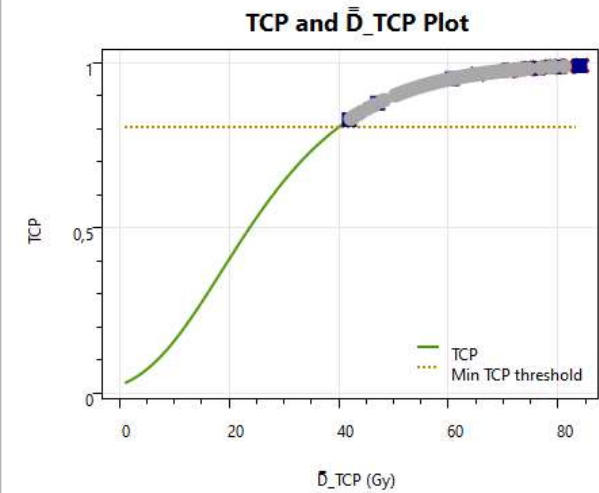
# Prescription free plan optimization

Optimization DVH Objectives

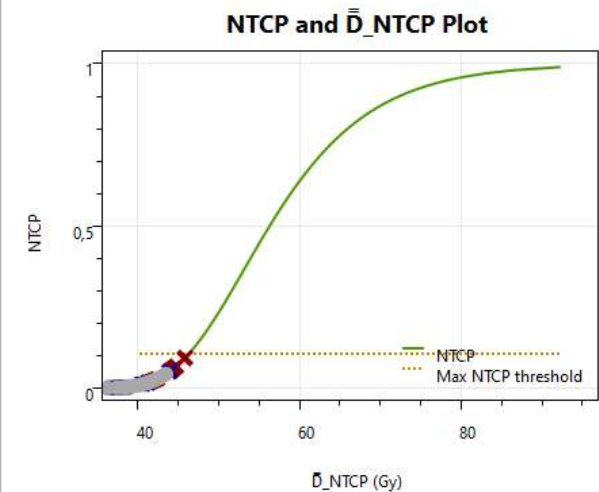
- Pareto properties
- Pareto front line
  - Diagonal line
  - ◆ Global optimum point
  - ▲ Illusion point
- Calculated Plans
- ✗ Invalid wrt. clin. protocol
  - ✗ Invalid + non-dominated
  - Pareto non-dominated
  - Pareto dominated



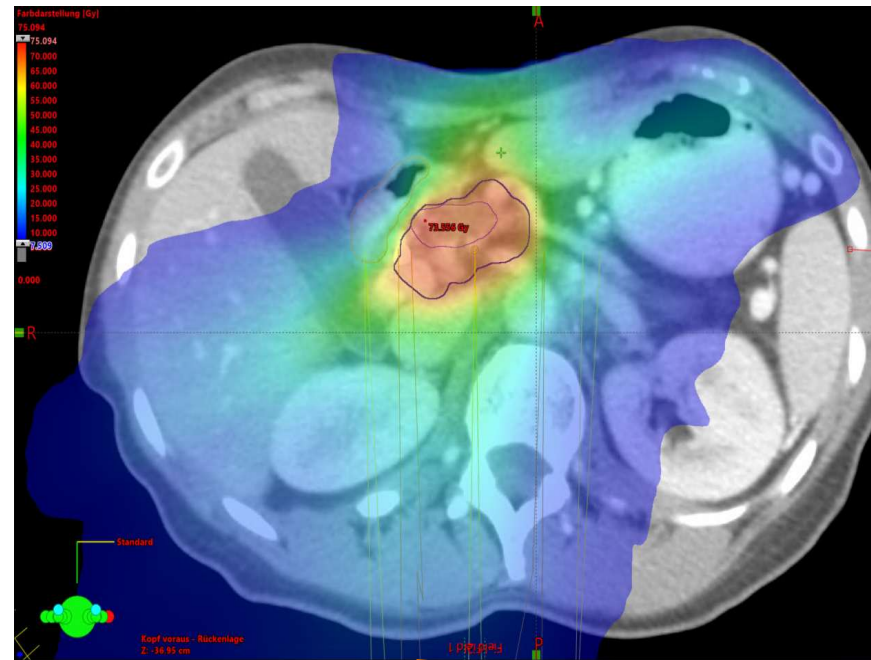
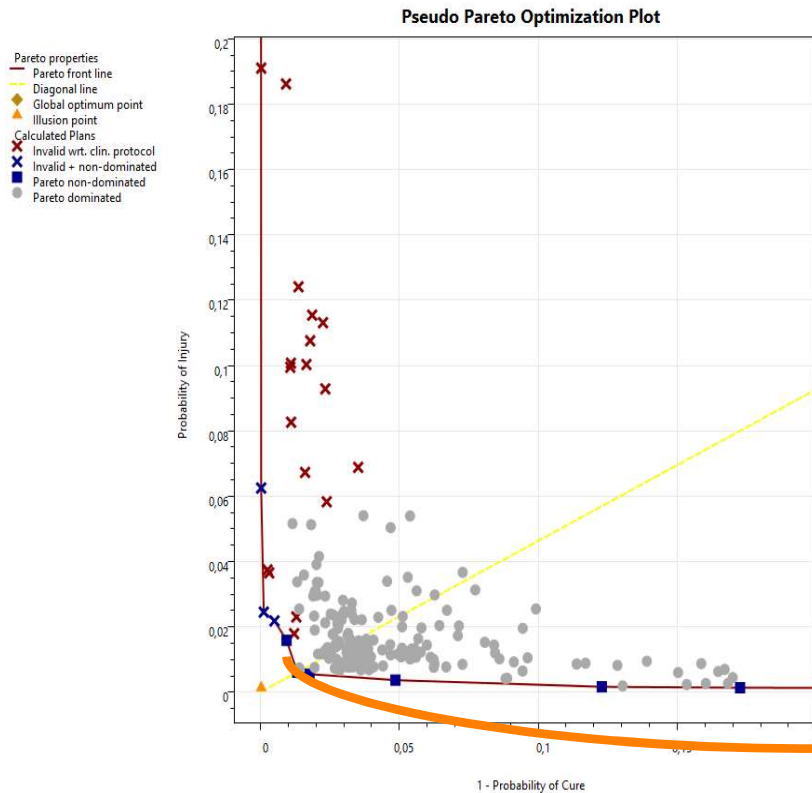
Select structure by ID



Select structure by ID



# Prescription free plan optimization



Course x20230120pp1, Plan Setup 152

# Best practises for code development

- Clean and Concise Code:
  - Principles: DRY, KISS, SOLID
  - Object oriented programming (OOP), functional programming
- Meaningful Variable and Function Names
- Consistent Coding Style
- Version Control (e.g. Gitlab)
- **Testing and Test-Driven Development (TDD)**
- NOT comment your code, just produce clean code

# Conclusion

- ESAPI empowers us with access to planning information, including patient data, treatment courses, plan parameters, and imaging modalities.
- Automations minimize errors, increase efficiency, and improve quality.
- The learning curve is steep
- Improving your programming skills requires patience and dedicated effort to achieve a high level of proficiency.



# Thank you for your attention

Email: [ilias.sachpazidis@uniklinik-freiburg.de](mailto:ilias.sachpazidis@uniklinik-freiburg.de)



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