

Bestrahlungsplanung der STX beim **Pankreas CA**

Priv.-Doz. Dr. Christos Moustakis

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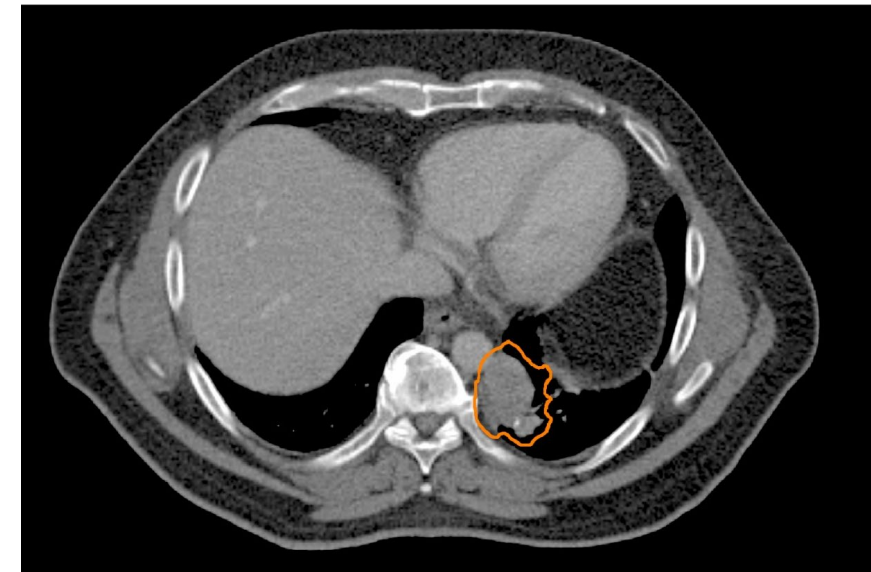
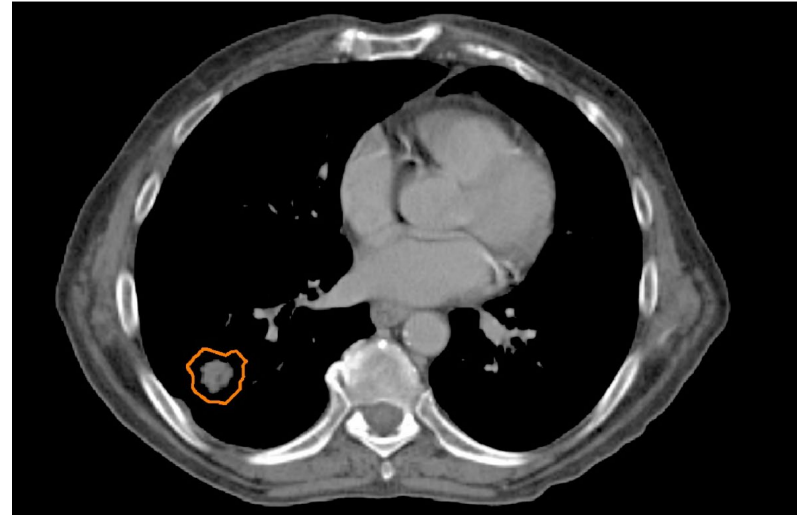
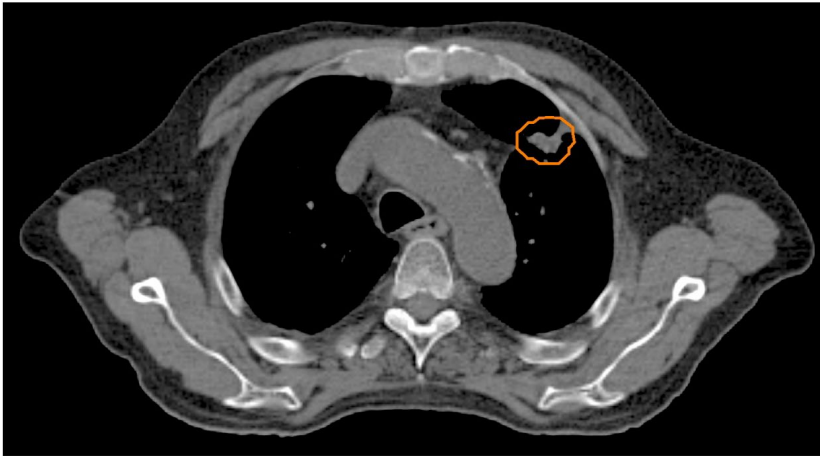
Lunge-Studie

ORIGINAL ARTICLE

Planning benchmark study for SBRT of early stage NSCLC

Results of the DEGRO Working Group Stereotactic Radiotherapy

Christos Moustakis^{1,2} · Oliver Blanck^{3,4} · Fatemeh Ebrahimi Tazehmahalleh^{1,5} · Mark ka heng Chan³ · Iris Ernst^{1,2} · Thomas Krieger⁶ · Marciana-Nona Duma⁷ · Markus Oechsner⁷ · Ute Ganswindt⁸ · Christian Heinz⁸ · Horst Alheit⁹ · Hilbert Blank⁹ · Ursula Nestle¹⁰ · Rolf Wiehle¹⁰ · Christine Kornhuber¹¹ · Christian Ostheimer¹¹ · Cordula Petersen¹² · Gerhard Pollul¹³ · Wolfgang Baus¹⁴ · Georg Altenstein¹⁴ · Eric Beckers¹⁵ · Katrin Jurianz¹⁵ · Florian Sterzing¹⁶ · Matthias Kretschmer¹⁷ · Heinrich Seegenschmiedt¹⁸ · Torsten Maass¹⁸ · Stefan Droege¹⁹ · Ulrich Wolf²⁰ · Juergen Schoeffler²¹ · Uwe Haverkamp^{1,2} · Hans Theodor Eich^{1,2} · Matthias Guckenberger²²

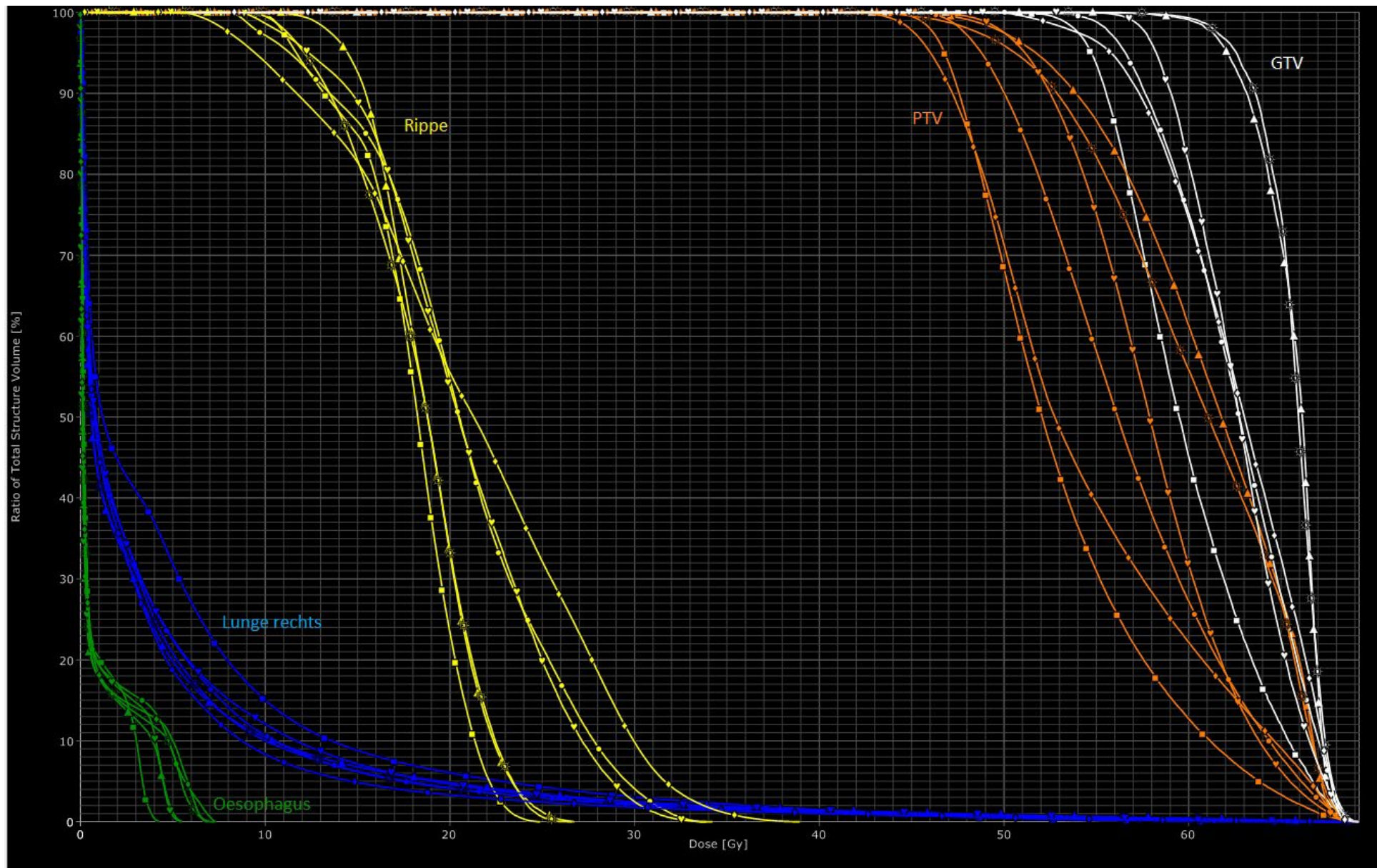


3 x 15Gy auf die

PTV-umschließende 65%-Isodose

22 Inst., 87 Pläne

36 IMAT, 21 3DCRT, 15 CK, 9 TT und 6 SF-IMR

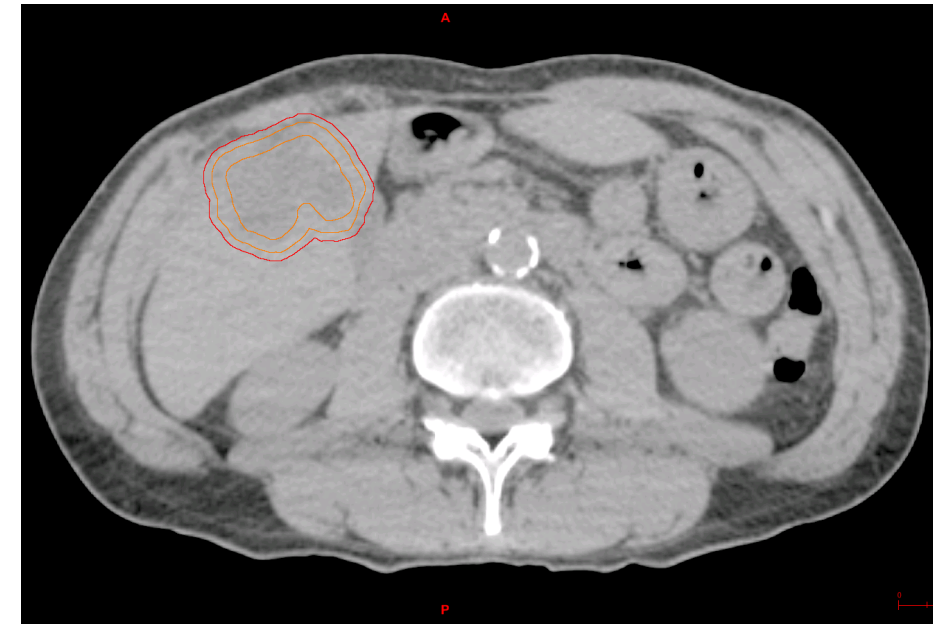
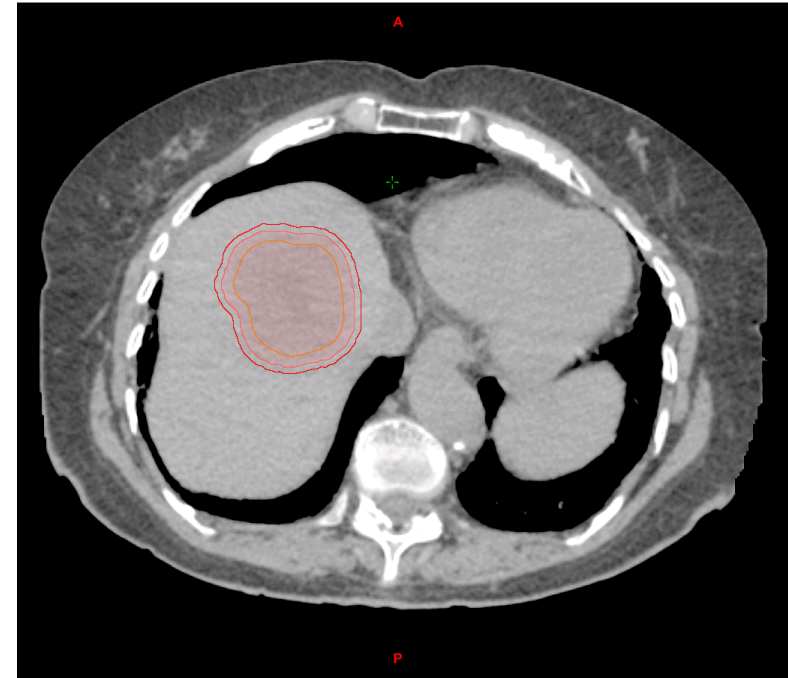
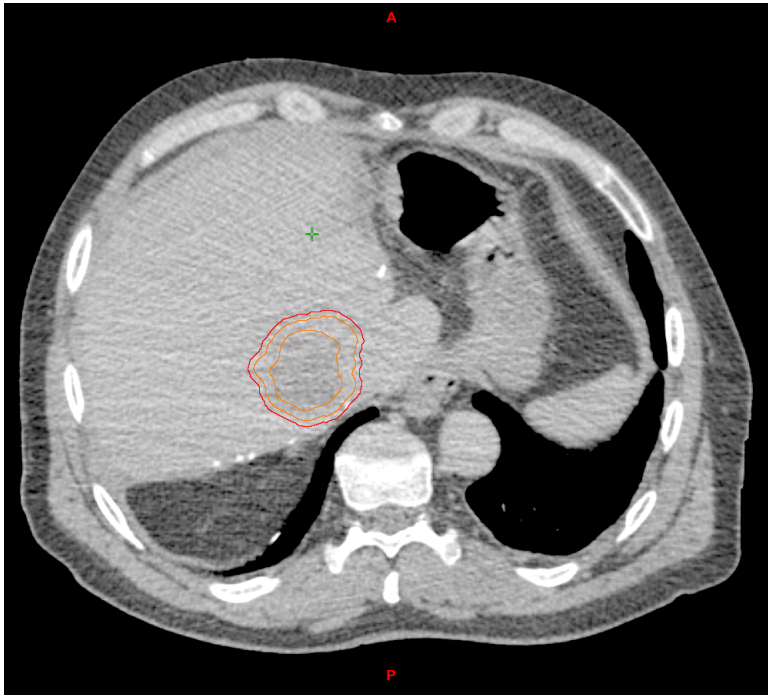


- Unterschiede zwischen den Anwender
- Homogenität in PTV (0,3-0,4)
- Art der Optimierung!
- Dosis Vorgaben für die Risiko Organe!
- Verschreibung?
- Planvergleich wichtig um die SBRT-Planung auf nationaler Ebene zu harmonisieren.

Leber-Studie

Planning Benchmark Study for Stereotactic Body Radiation Therapy of Liver Metastases: Results of the DEGRO/DGMP Working Group on Stereotactic Radiation Therapy and Radiosurgery

Christos Moustakis, PhD,¹ Oliver Blanck, PhD,^{2,3} Mark ka heng Chan, PhD,² Judit Boda-Heggemann, MD, PhD,⁴ Nicolaus Andrasczke, MD,⁵ Marciana-Nona Duma, MD,^{6,7} Dirk Albers, MSc,⁸ Christian Bäumer, PhD,⁹ Roman Fehr, PhD,¹⁰ Stefan A. Körber, MD,¹¹ Daniel Schmidhalter, MSc,¹² Manfred Alraun, PhD,¹³ Wolfgang W. Baus, PhD,¹⁴ Eric Beckers, MSc,¹⁵ Mathias Dierl, PhD,¹⁶ Stephan Droege, PhD,¹⁷ Fatemeh Ebrahimi Tazehmahalleh, PhD,^{1,14} Jens Fleckenstein, PhD,⁴ Matthias Guckenberger, MD,⁵ Christian Heinz, PhD,¹⁸ Christoph Henkenberens, MD,¹⁹ Andreas Hennig, MSc,²⁰ Janett Köhn, PhD,^{3,21} Christine Kornhuber, PhD,²² Thomas Krieger, PhD,²³ Britta Loutfi-Krauss, MSc,^{3,21} Manfred Mayr, MSc,²⁴ Markus Oechsner, PhD,⁶ Tina Pfeiler, PhD,⁹ Gerhard Pollul, MSc,²⁵ Jürgen Schöffler, MSc,²⁶ Heiko Tümmler, PhD,²⁷ Claudia Ullm, MSc,²⁸ Mathias Walke, PhD,²⁹ Rocco Weigel, MSc,³⁰ Martin Wertman, MSc,^{10,31} Rolf Wiehle, PhD,³² Tilo Wiezorek, PhD,⁷ Lotte Wilke, PhD,⁵ Ulrich Wolf, PhD,³³ Hans Theodor Eich, MD,¹ and Daniela Schmitt, PhD^{11,34}



Verschreibung auf
GTV D50 = 3x20Gy = 100%

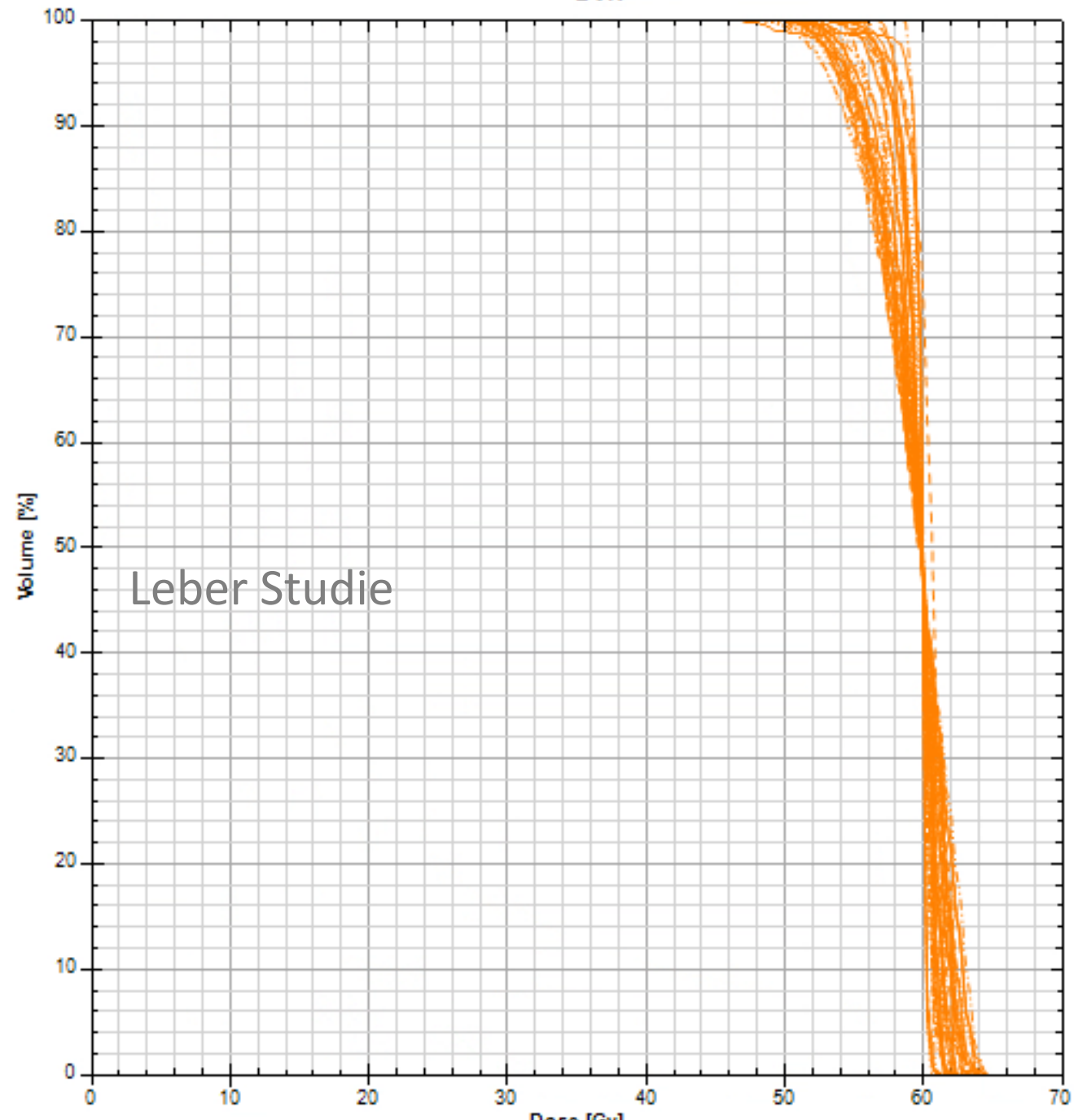
35 Inst., 660 Pläne (132 x 5 Verschreibungen)

GTVD50%, PTVDmin, PTVD98%, PTVD2%, PTVDmax

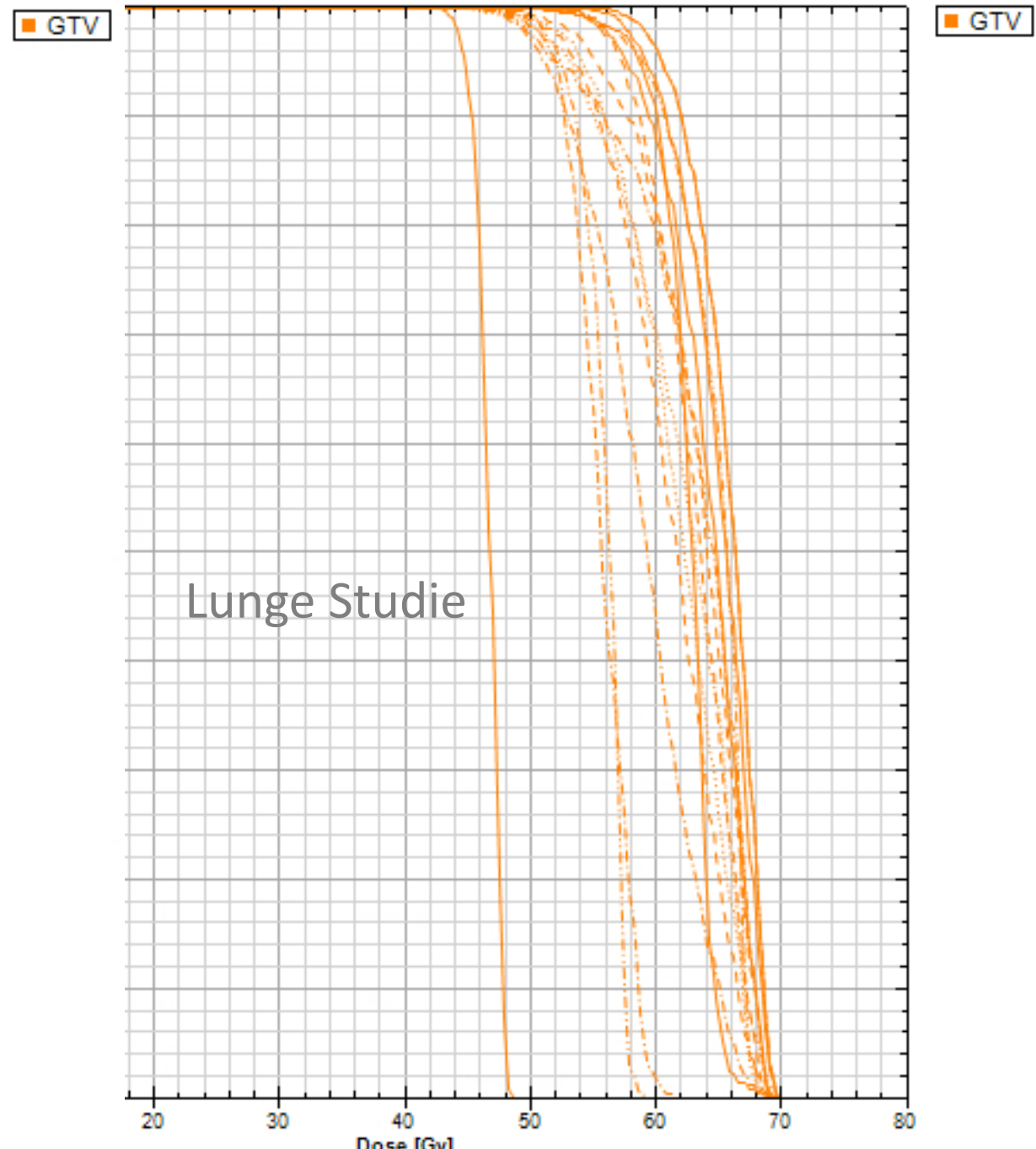
Planungsvorgaben

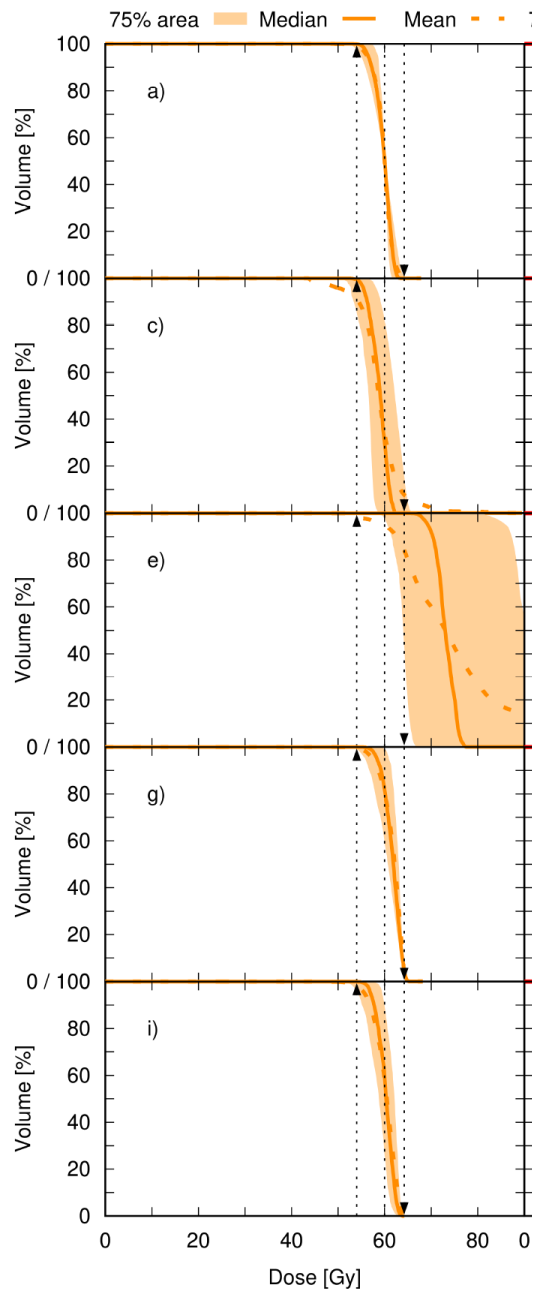
- Verschreibung auf **mediane GTV Dosis D50 = 3x20Gy = 100%**
- GTV (0.1 cm³) < 107% (110%)
- GTV V90% (V54Gy) > 98% (95%)
- PTV V70% (V42Gy) > 98% (95%)
- Konformalitäts-Index definiert als (V70% / PTV) < 1.2 (1.25)
- OARs:
 - Gesamt Leber minus V_Leber_15Gy (17Gy) > 700 cc,
 - Niere D33 < 15 Gy (17 Gy),
 - Herz DMax (1cc) < 30 Gy , Herz V24Gy < 10 cc (15 cc)
 - Darm, Duodenum, Jejunum (je einzeln)
 - DMax (0.1cc) < 24 Gy, V15Gy < 4cc (5cc), V18Gy < 1cc (1.5cc)
 - ALARA (!)

DVH

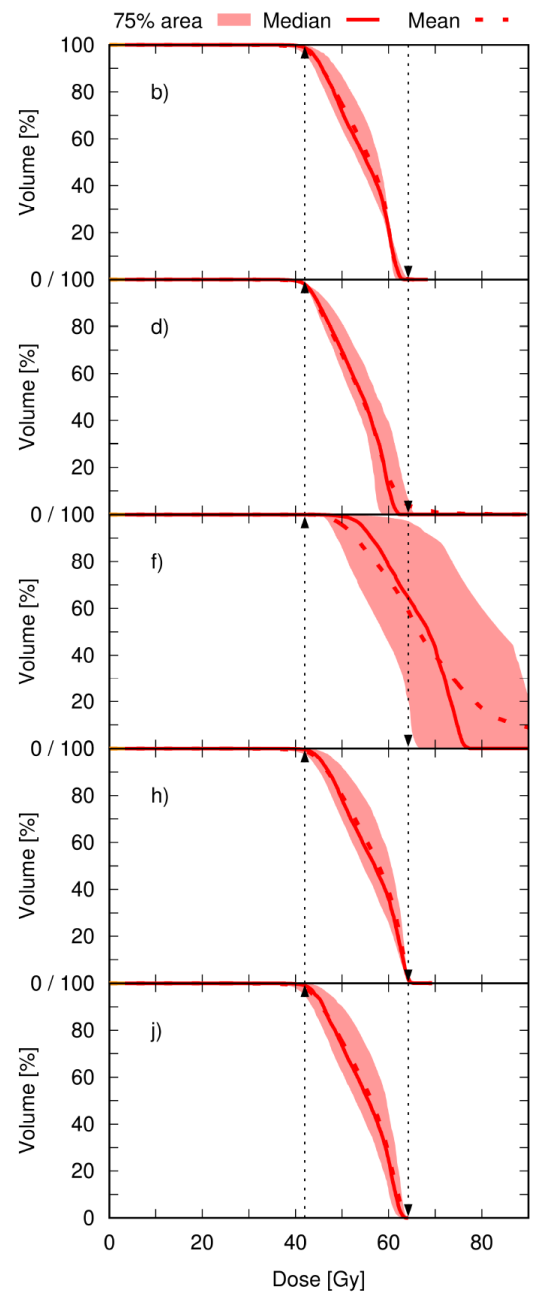


DVH





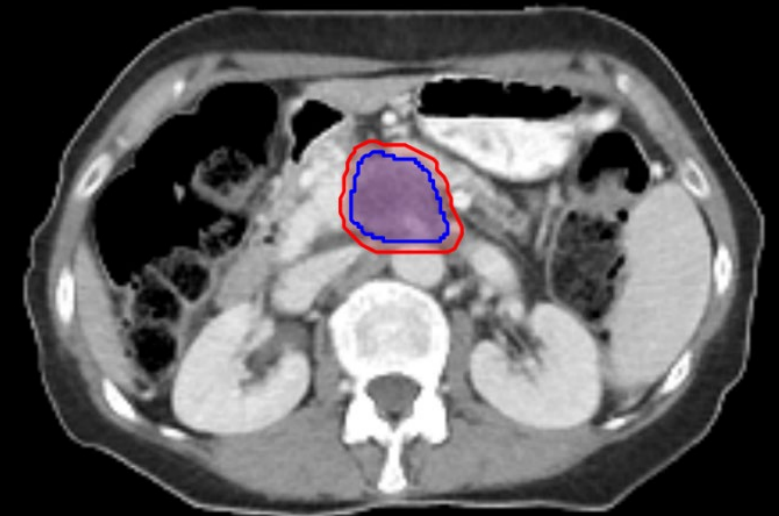
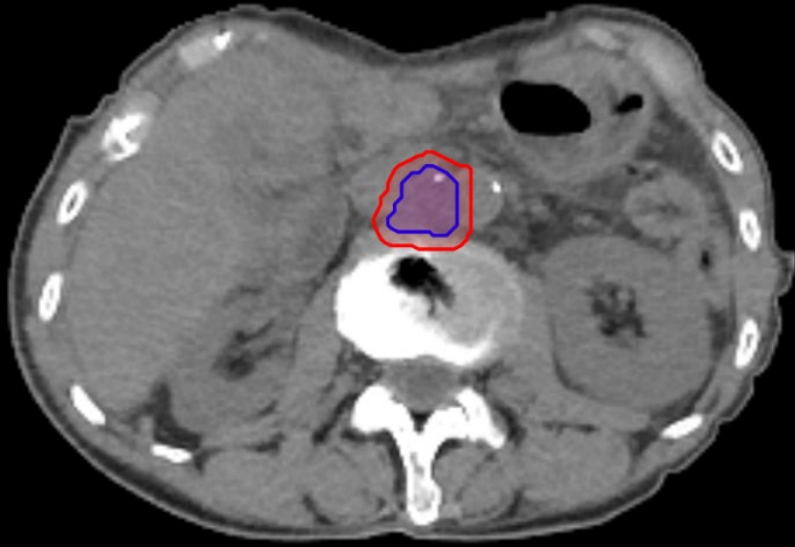
Prescription:
 60 Gy to GTV D50%
 42 Gy to PTV D98%
 42 Gy to PTV Dmin
 64,2 Gy to PTV D2%
 64,2 Gy to PTV Dmax



DVHs for different prescription methods for all plans of all cases. Clinical goals are marked with arrows.
 For GTV (orange) and PTV (red) the median and mean curve and the area of the central 75% of data is shown.

PACA-Studie

DGMP/DEGRO Working Group Stereotactic Radiotherapy and Radiosurgery
Associazione Italiana di Fisica Medica (AIFM) working group on physics aspects of SBRT (Participation)



42 Inst., 292 Plans

Phase 1 & 2 (Replanning)

Prescription A (5 fractions): $D_{50\%}(GTV) = 5 \times 9.2 \text{ Gy} = 46 \text{ Gy} (100\%)$

Prescription B (8 fractions): $D_{50\%}(GTV) = 8 \times 8.25 \text{ Gy} = 66 \text{ Gy} (100\%)$

Prescription A (5 fractions):

- $D_{50\%}(\text{GTV}) = 5 \times 9.2 \text{ Gy} = \underline{46 \text{ Gy (100%)}}$
- $D_{99\%}(\text{PTV}) = 33 \text{ Gy}$
- $D_{50\%}(\text{PTV}) = 44 \text{ Gy}$
- $D_{0.5\text{cm}^3}(\text{PTV}) = D_{0.5\text{cm}^3}(\text{GTV}) = 49.2 \text{ Gy}$
- $D_{0.5\text{cm}^3} = D_{\text{near max}}$
- $[D_{95\%}(\text{PTV}) = 40 \text{ Gy}]$
- $D_{99\%}(\text{GTV}) = 44.5 \text{ Gy}$
- $D_{\text{max}}(\text{Global}) = D_{\text{max}}(\text{GTV})$

Prescription B (8 fractions):

- $D_{50\%}(\text{GTV}) = 8 \times 8.25 \text{ Gy} = \underline{66 \text{ Gy (100%)}}$
- $D_{99\%}(\text{PTV}) = 54 \text{ Gy}$
- $D_{50\%}(\text{PTV}) = 64 \text{ Gy}$
- $D_{0.5\text{cm}^3}(\text{PTV}) = D_{0.5\text{cm}^3}(\text{GTV}) = 72 \text{ Gy}$
- $D_{95\%}(\text{PTV}) = 60 \text{ Gy}$
- $D_{99\%}(\text{GTV}) = 61.2 \text{ Gy}$
- $D_{\text{max}}(\text{Global}) = D_{\text{max}}(\text{GTV})$

Description	Constraint	5 fractions	8 fractions
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Aorta

Colon

Duodenum

Esophagus

Heart

Jejunum

Kidneys (individual and combined)

If solitary kidney or if one

kidney mean dose >10 Gy

Normal liver

Spinal Canal

Stomach

Vena Cava

Table 6 Timmerman tables, 5 fractions—Timmerman, 8-2021

Serial tissue	Volume	Volume max (Gy)	Max point dose (Gy)*	Endpoint (grade ≥3)
Optic pathway	<0.2 cm ³	23	25	Neuritis

Table 7 Timmerman tables, 8 fractions—Timmerman, 8-2021

Serial tissue	Volume	Volume max (Gy)	Max point dose (Gy)*	Endpoint (grade ≥3)
Optic pathway	<0.2 cm ³	27.2	29.6	Neuritis
Cochlea			26.4	Hearing loss
Brain stem (not medulla)	<0.5 cm ³	27.2	37.6	Cranial neuropathy
Spinal cord and medulla	<0.35 cm ³	26.4	33.6	Myelitis
Cauda equina	<5 cm ³	34	38.4	Neuritis
Sacral plexus	<5 cm ³	34	38.4	Neuropathy
Esophagus [†]	<5 cm ³	36.8	43.2	Esophagitis
Brachial plexus	<3 cm ³	32.8	39.2	Neuropathy
Peripheral (named) nerve	<2 cm length	37	43	Neuropathy
Heart/pericardium	<15 cm ³	34.4	40	Pericarditis
Great vessels	<10 cm ³	55.2	62	Aneurysm
Trachea and large bronchus [†]	<5 cm ³	50	56	Impairment of pulmonary toilet
Bronchus, smaller airways	<0.5 cm ³	38.4	48.8	Stenosis with atelectasis
Rib	<5 cm ³	50	63	Pain or fracture
Skin	<10 cm ³	43.2	45.6	Ulceration
Stomach	<5 cm ³	31.2	42	Ulceration/fistula
Bile duct			48	Stenosis
Duodenum [†]	<5 cm ³	31.2	42	Ulceration
Jejunum/ileum [†]	<30 cm ³	28.8	40	Enteritis/obstruction
Colon [†]	<20 cm ³	35.2	57.5	Colitis/fistula
Rectum [†]	<3.5 cm ³	56	61.5	Proctitis/fistula
Ureter	<20 cm ³	45		
Ureter			53	Stenosis
Bladder wall	<15 cm ³	22.4	44.8	Cystitis/fistula
Penile bulb	<3 cm ³	35		Erectile dysfunction
Femoral heads	<10 cm ³	35		Necrosis
Renal hilum/vascular trunk	15 cm ³	28		Malignant hypertension
Parallel tissue	Critical volume (cm³)	Critical volume dose max (Gy)		Endpoint (grade ≥3)
Lung (right and left)	1500 for males and 950 for females [‡]	14.4		Basic lung function
Lung (right and left)			V-15.2 Gy <37%	Pneumonitis
Liver	700 [‡]	24.8		Basic liver function
Renal cortex (right and left)	200 [‡]	20		Basic renal function

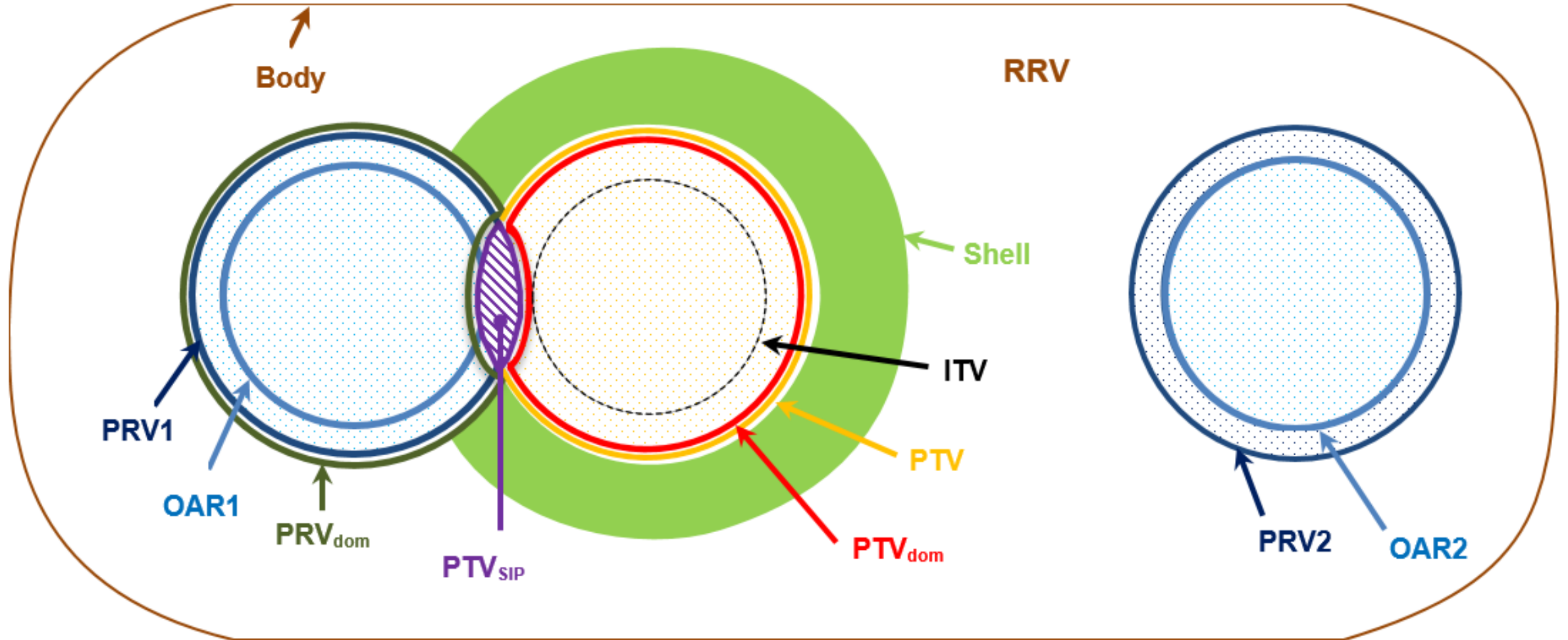
* "Point" defined as ≤0.035 cm³.

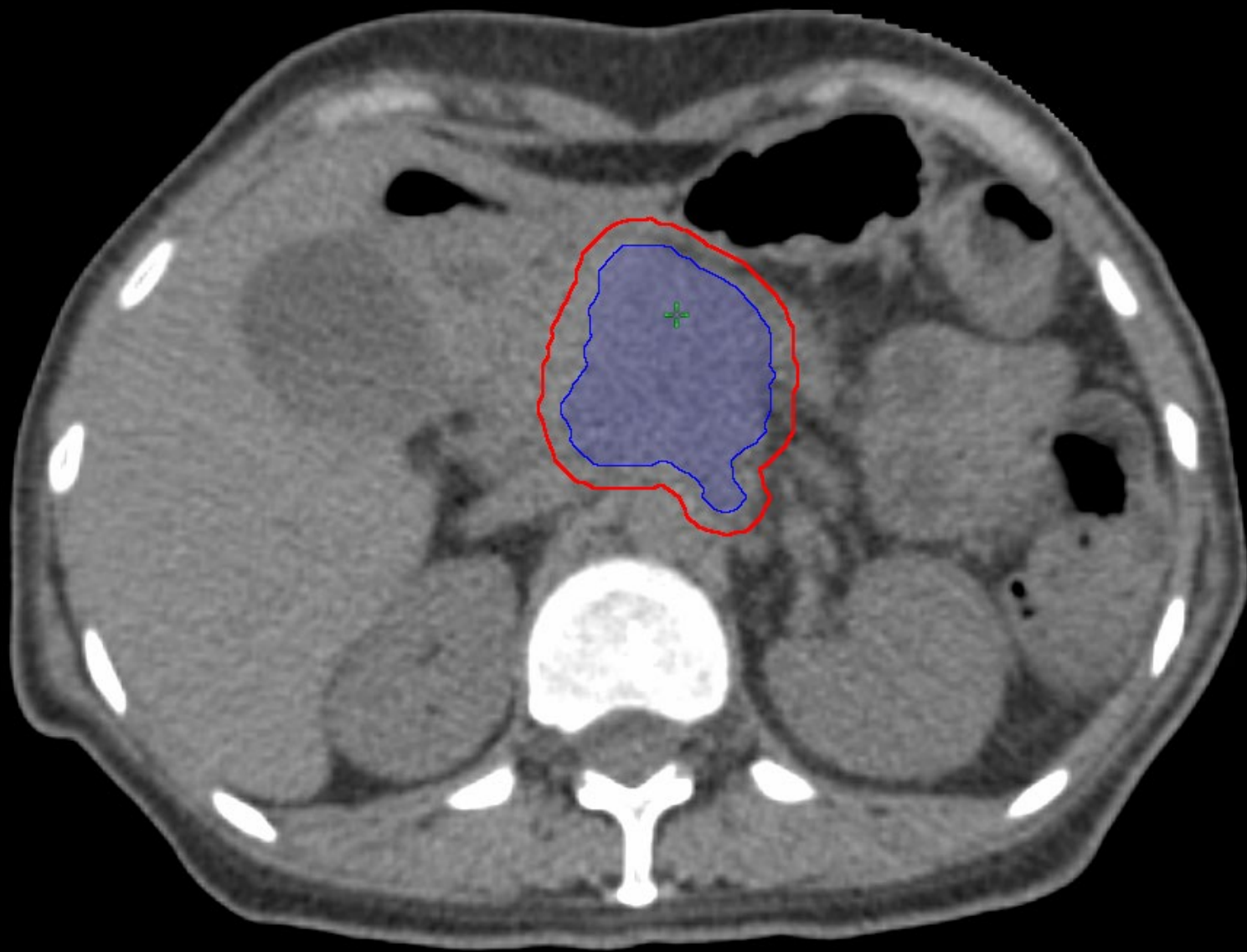
† Avoid circumferential irradiation.

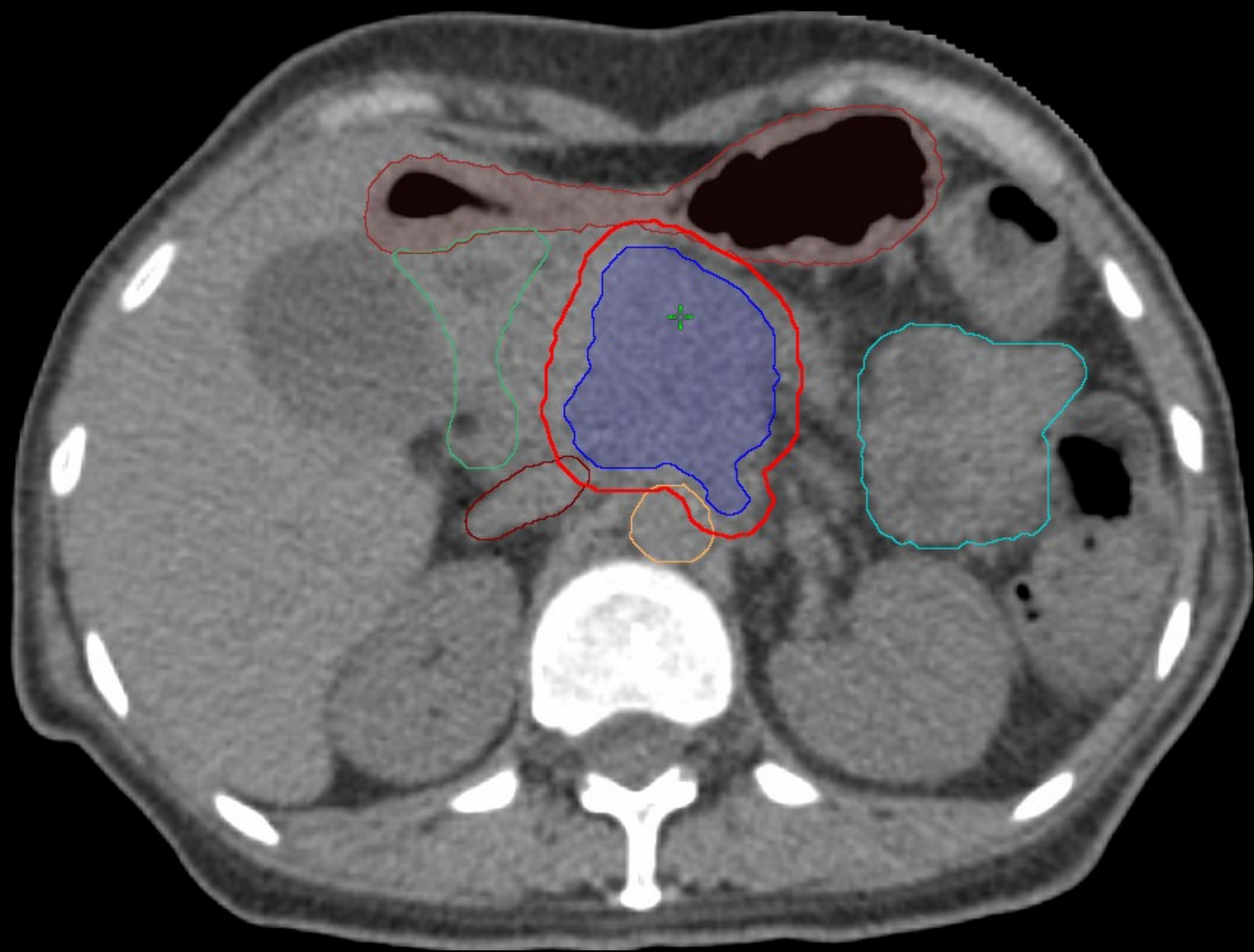
‡ One-third of the "native" total organ volume (before any resection or volume reducing disease), whichever is greater.

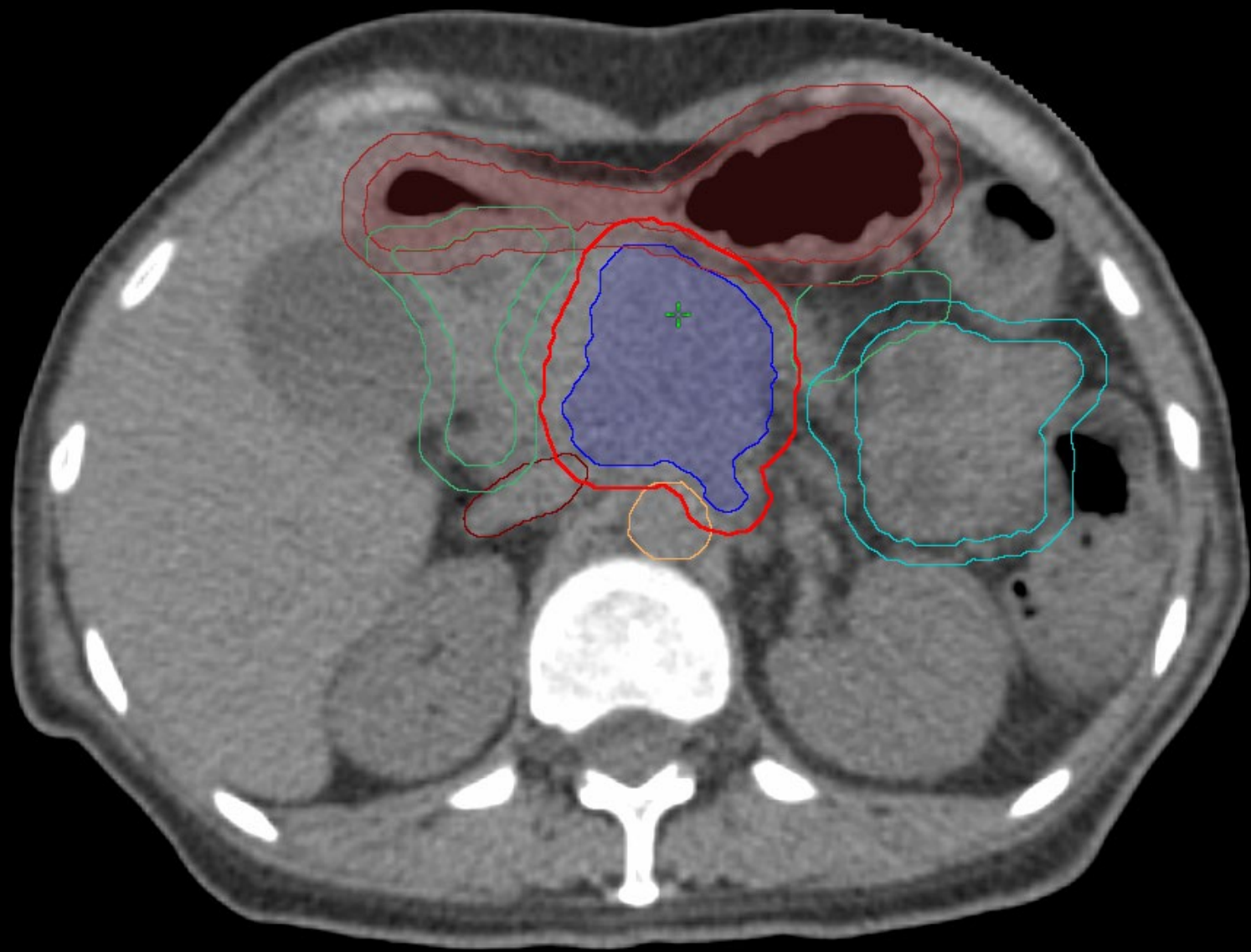
SIP (Simultaneously Integrated Protection) concept

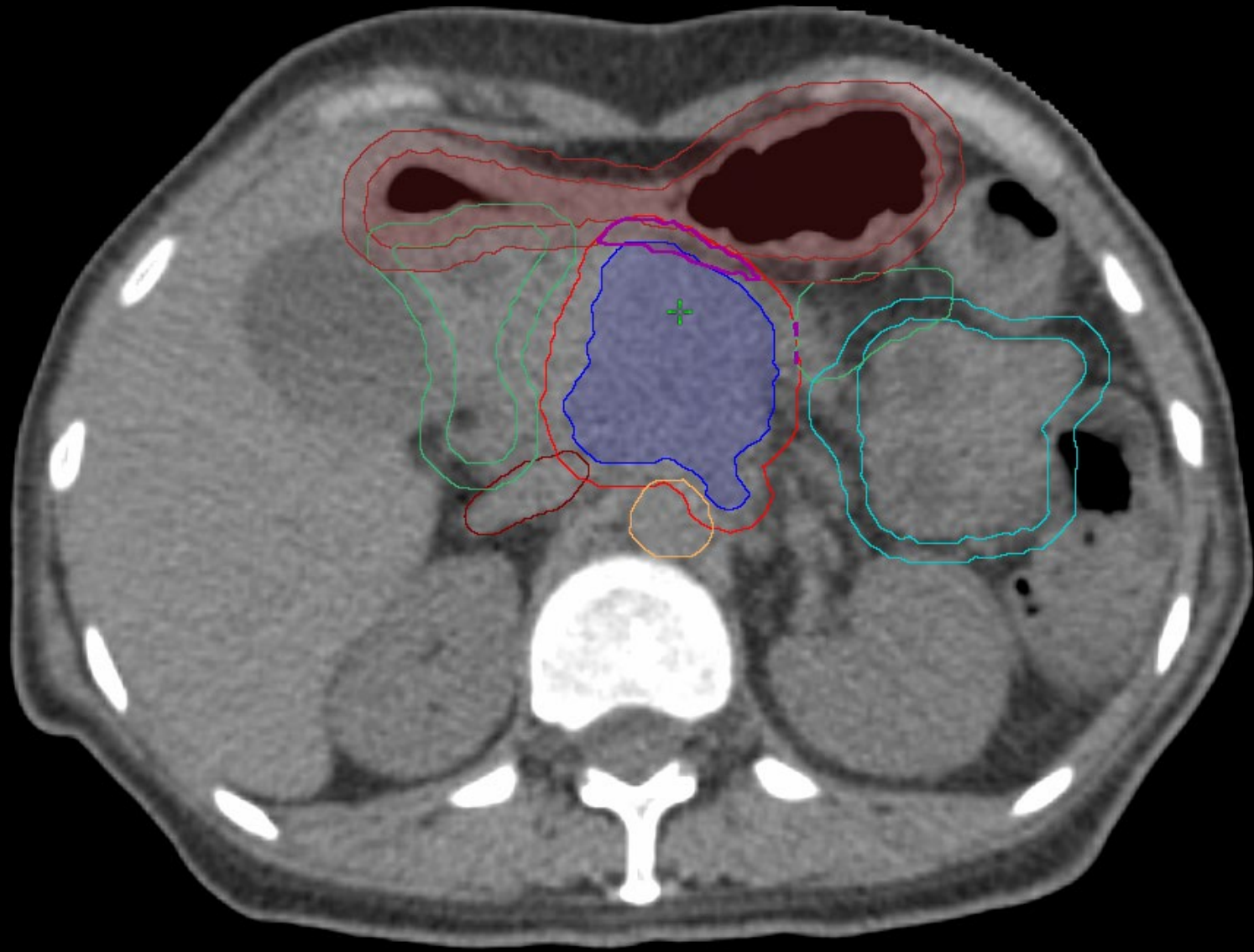
...Phase 2

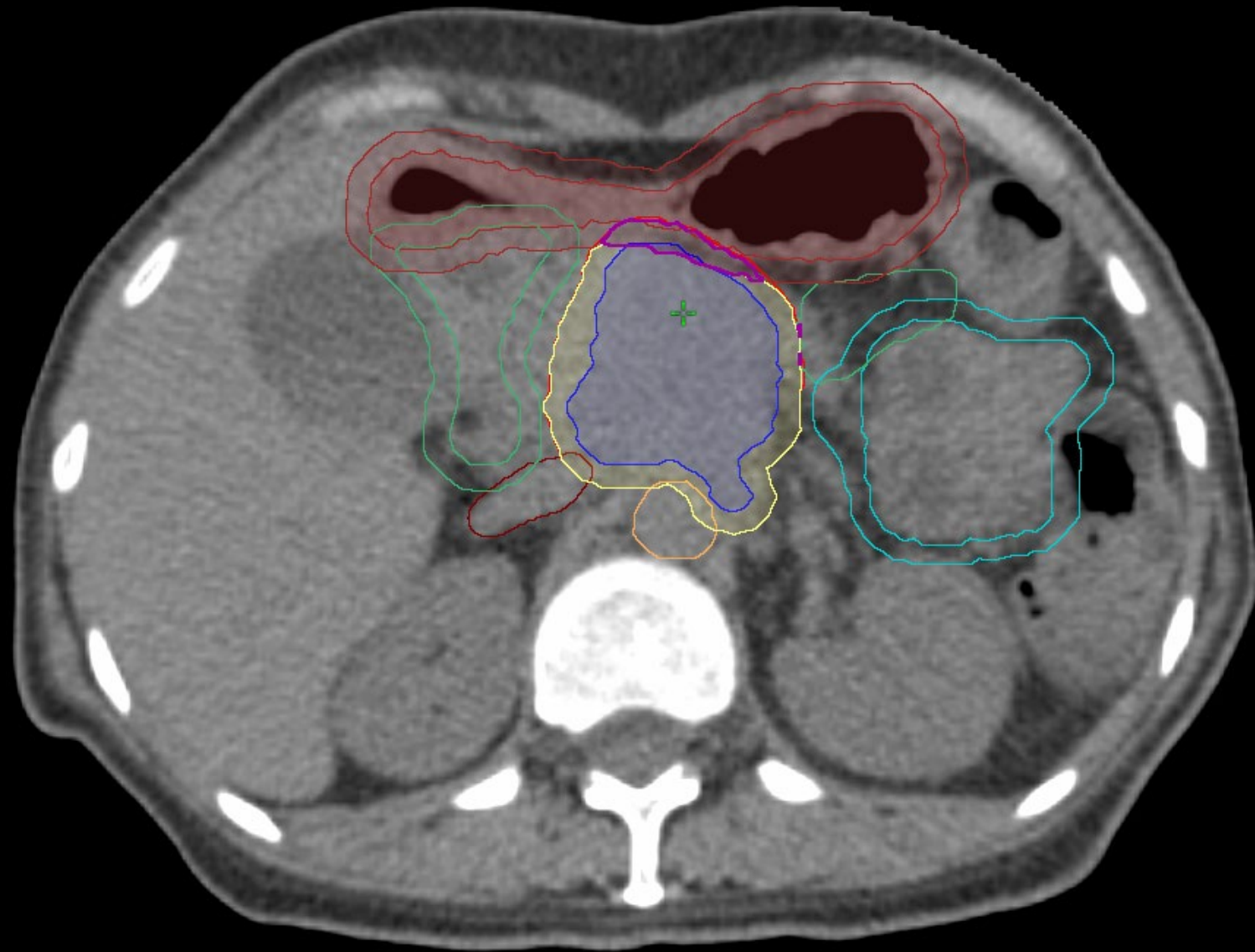


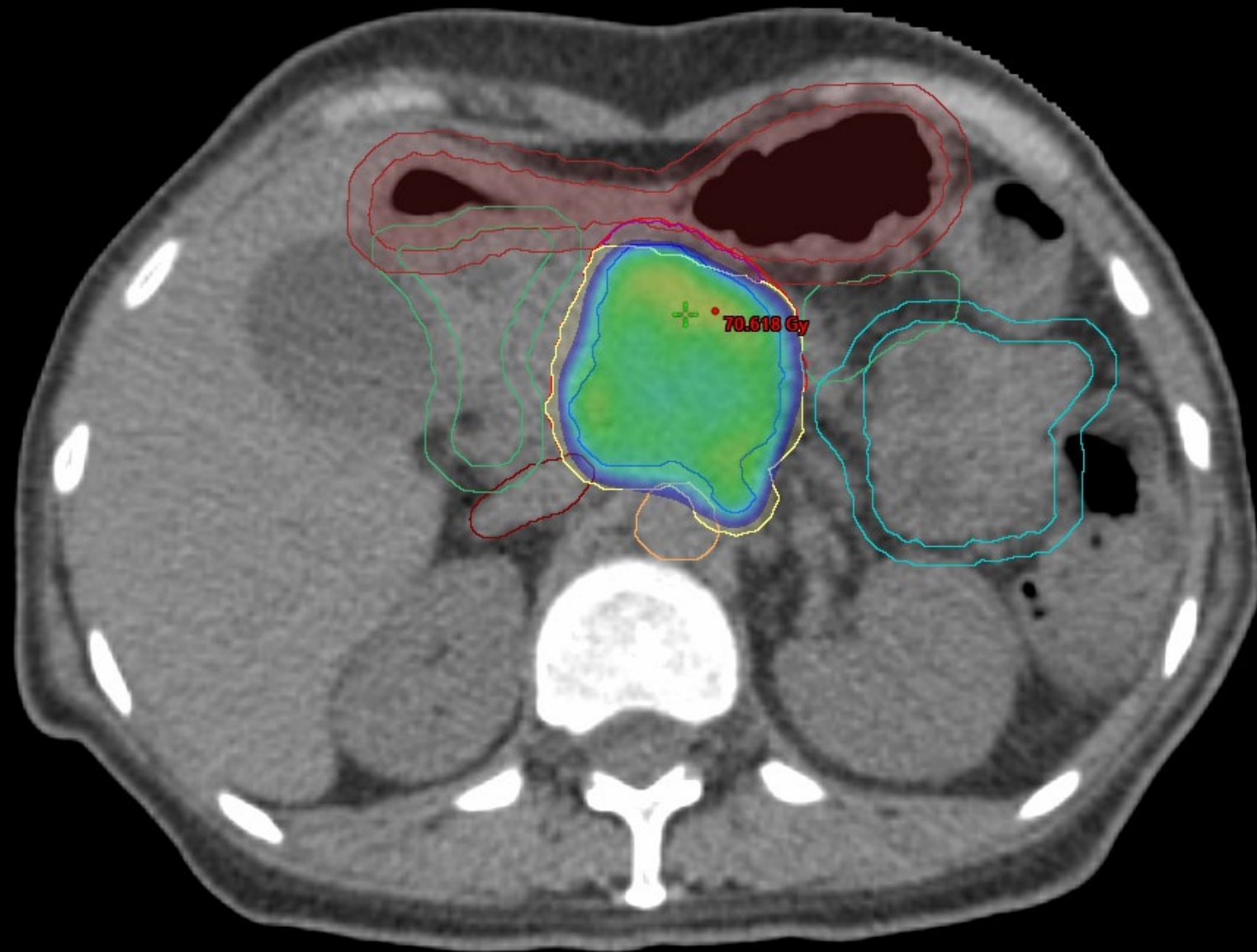


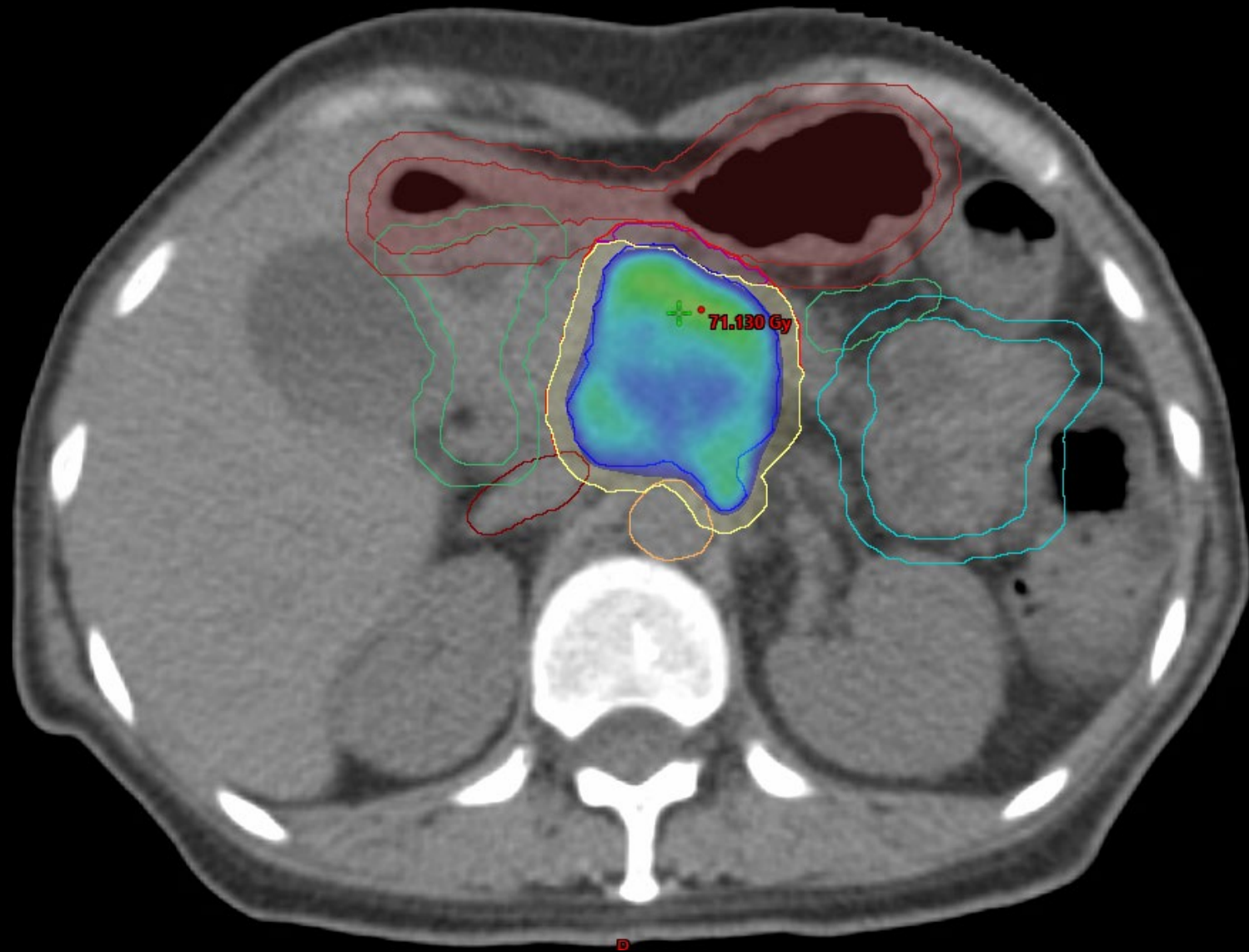


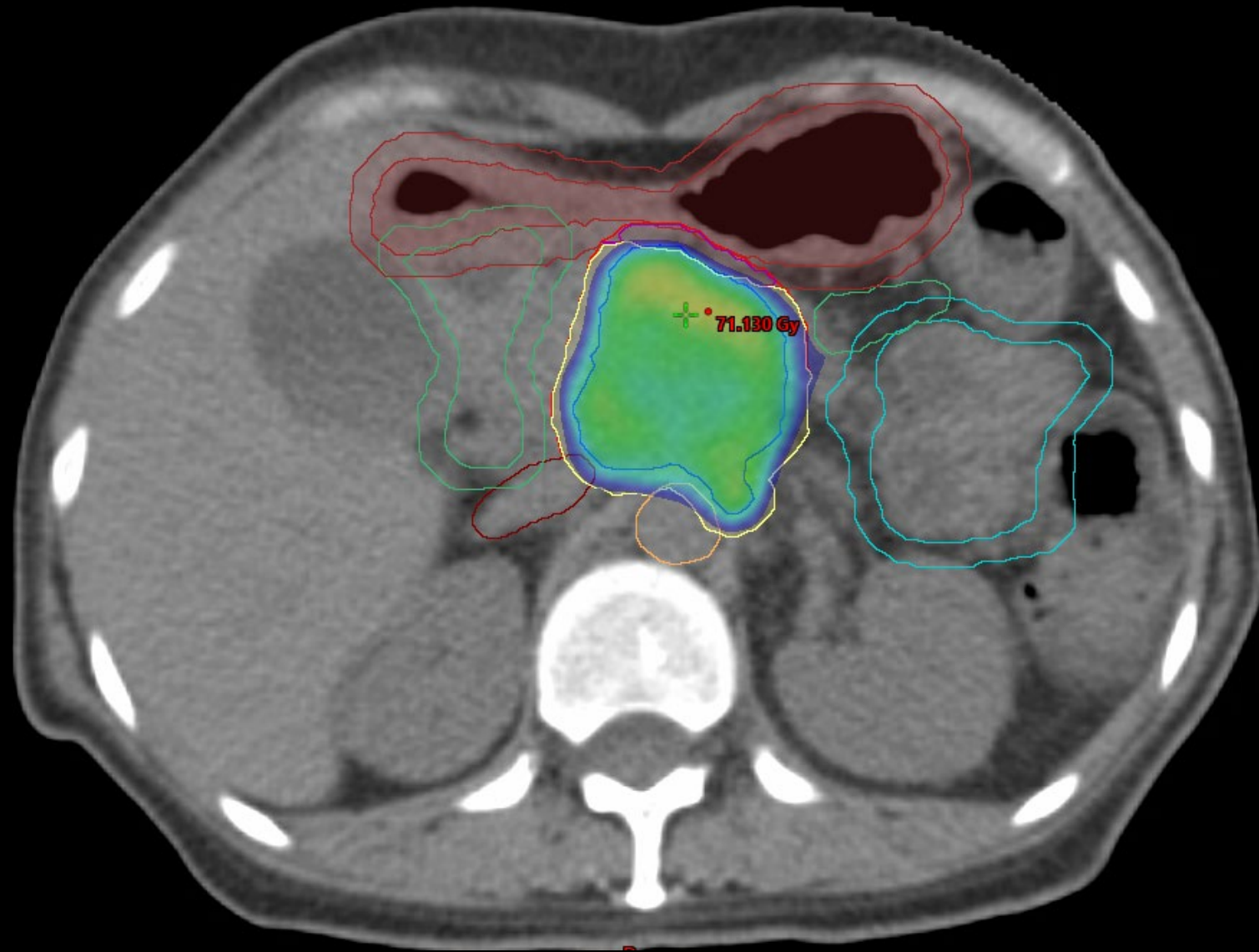




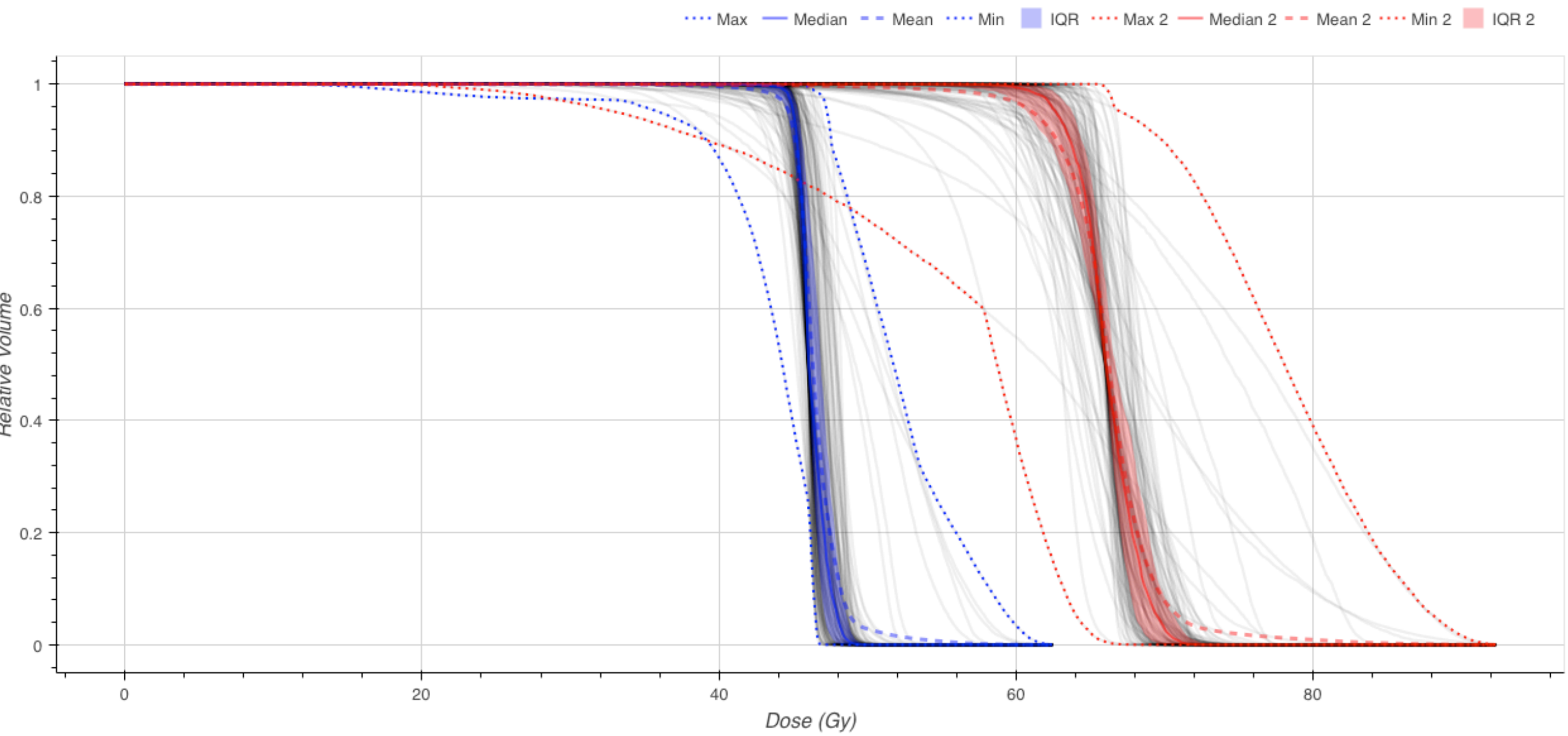




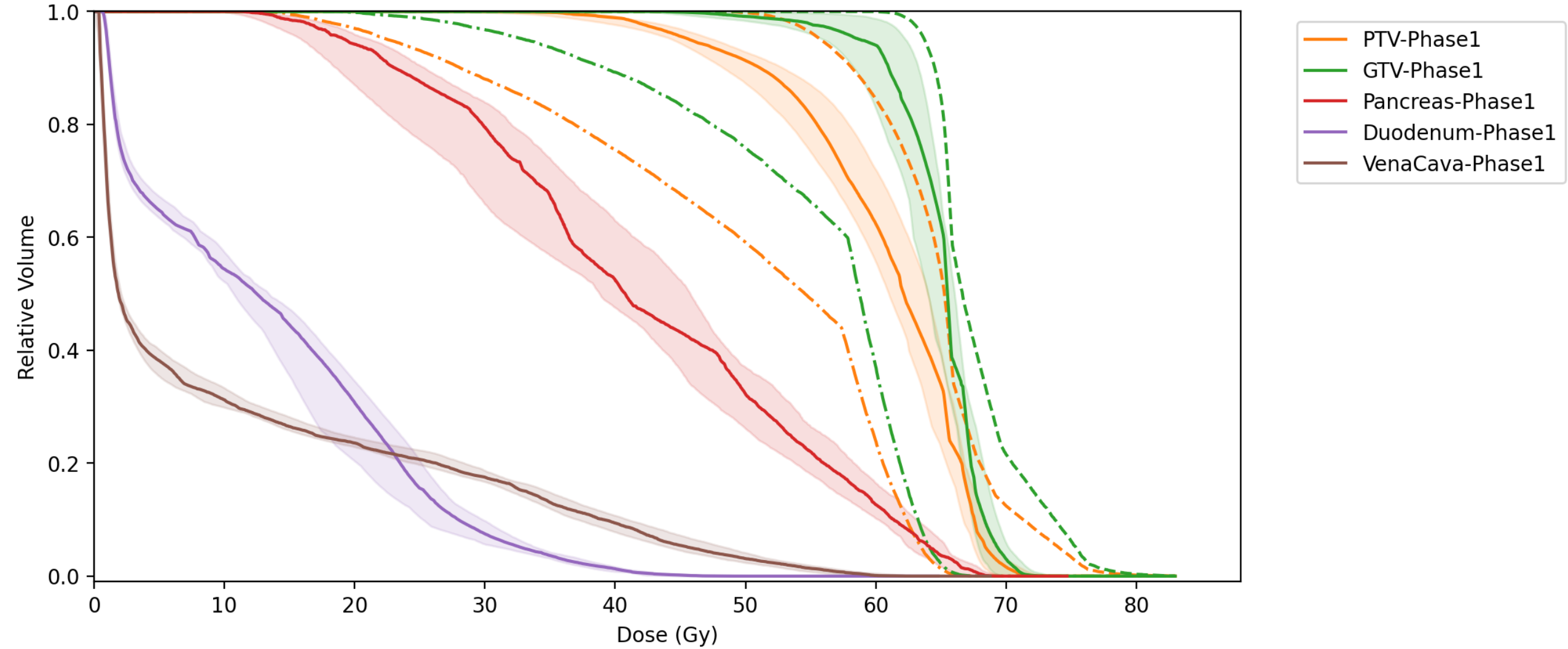




DVH for GTV, Blue lines: Prescription A, Red: Prescription B



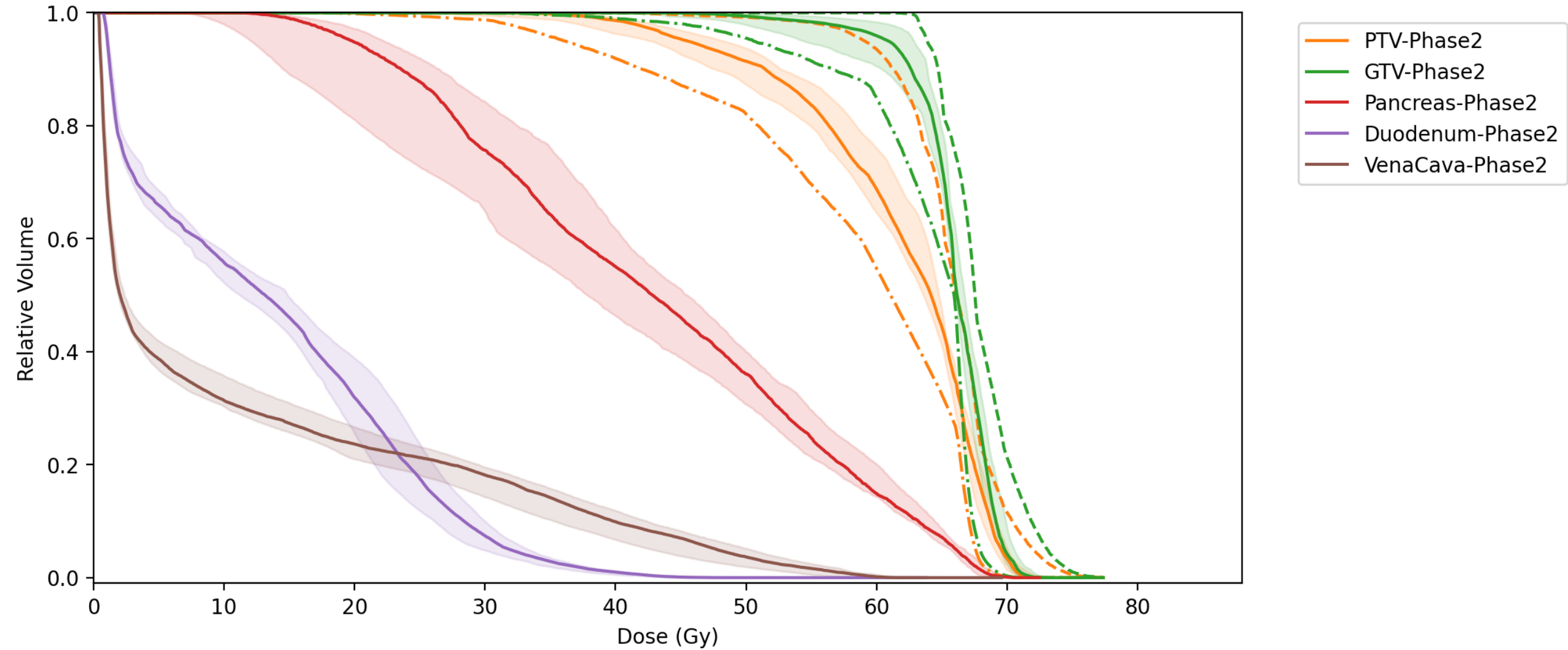
Phase 1



Die durchgezogene Linien sind der Median der 18 Phase2 Kliniken, der schattierter Bereich ist der +/-25% Percentile

“Minimum ‘-.’ und Maximum ‘--’ von PTV und GTV

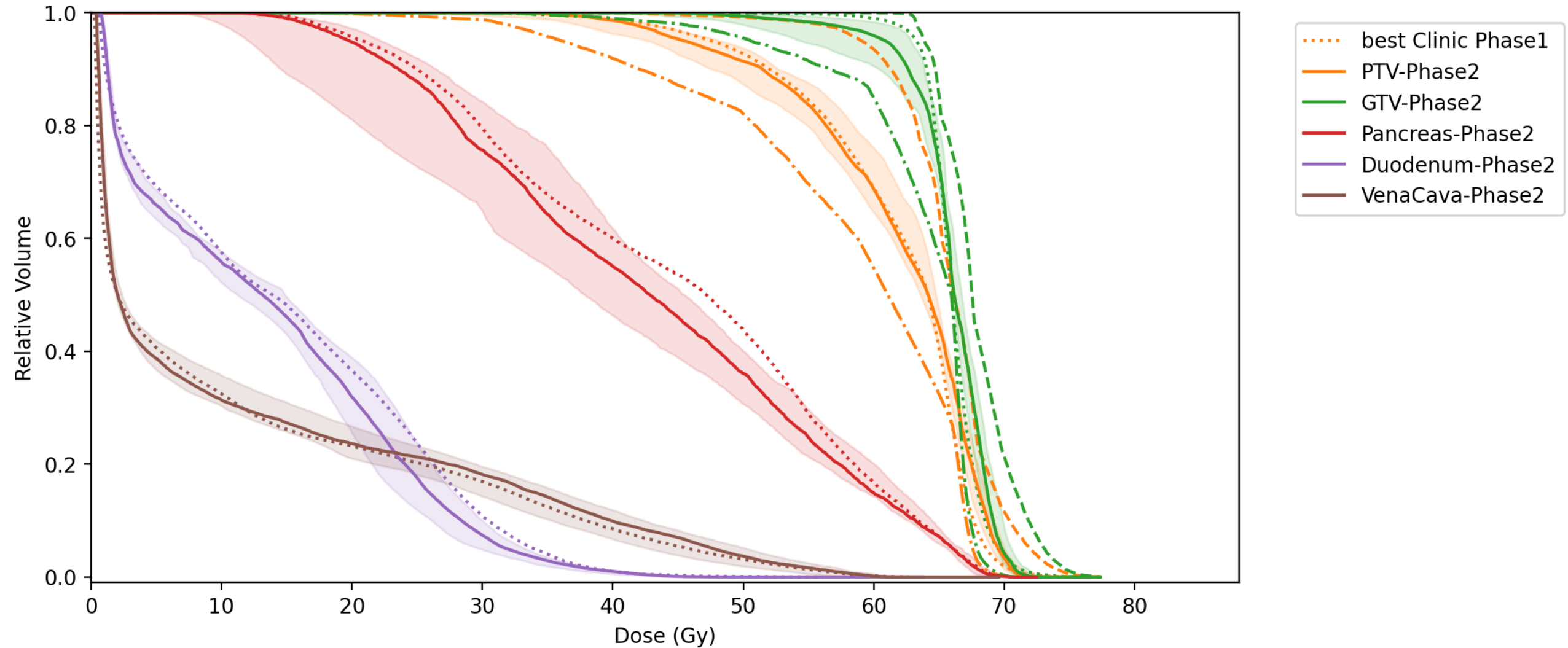
Phase 2



Die durchgezogene Linien sind der Median der 18 Phase2 Kliniken, der schattierter Bereich ist der $\pm 25\%$ Percentile

“Minimum ‘-.’ und Maximum ‘--’ von PTV und GTV

Phase 1 vs. 2



Die durchgezogene Linien sind der Median der 18 Phase2 Kliniken, der schattierter Bereich ist der +/-25% Percentile

“Minimum ‘-.’ und Maximum ‘--’ von PTV und GTV

Phase 1 vs. 2

SIP		Plan quality		Score Sum		Score final	
Phase 1		Phase 1		Phase 1		Phase 1	
na		3		12		2	
na		4		17		4	
na		4		18		4	
na		4		21		4	
na		4		13		3	
na		5		13		3	
na		5		14		3	

Planungsstudien...

- Verschreibung: **GTVD_{50%}**, $\text{GTV/PTVD}_{\text{near min}}$, $\text{GTV/PTVD}_{\text{near max}}$, $D_{\text{max}} = \text{GTVD}_{\text{max}}$
- Klinische Zielvorgaben für die Risikoorgane (Timmermann Tables)
- SIP-Konzept (ev. Kompromisse)

Verbesserung der Planqualität, Harmonisierung möglich

„...Innovative Radioonkologie im Team, präzise, **personalisiert**, menschlich...“
(personalisiert ... Patient... nicht Planer...)

Klinik für Strahlentherapie – Radioonkologie
Direktor: Univ.- Prof. Dr. H.T. Eich



Vielen Dank!

Christos Moustakis