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Planungsaspekte bei der SBRT der Prostata in der HypoFocal-SBRT-Studie

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Outline

- Background

- Dose concept

- HypoFocal-SBRT workflow

- Summary

- Outlook

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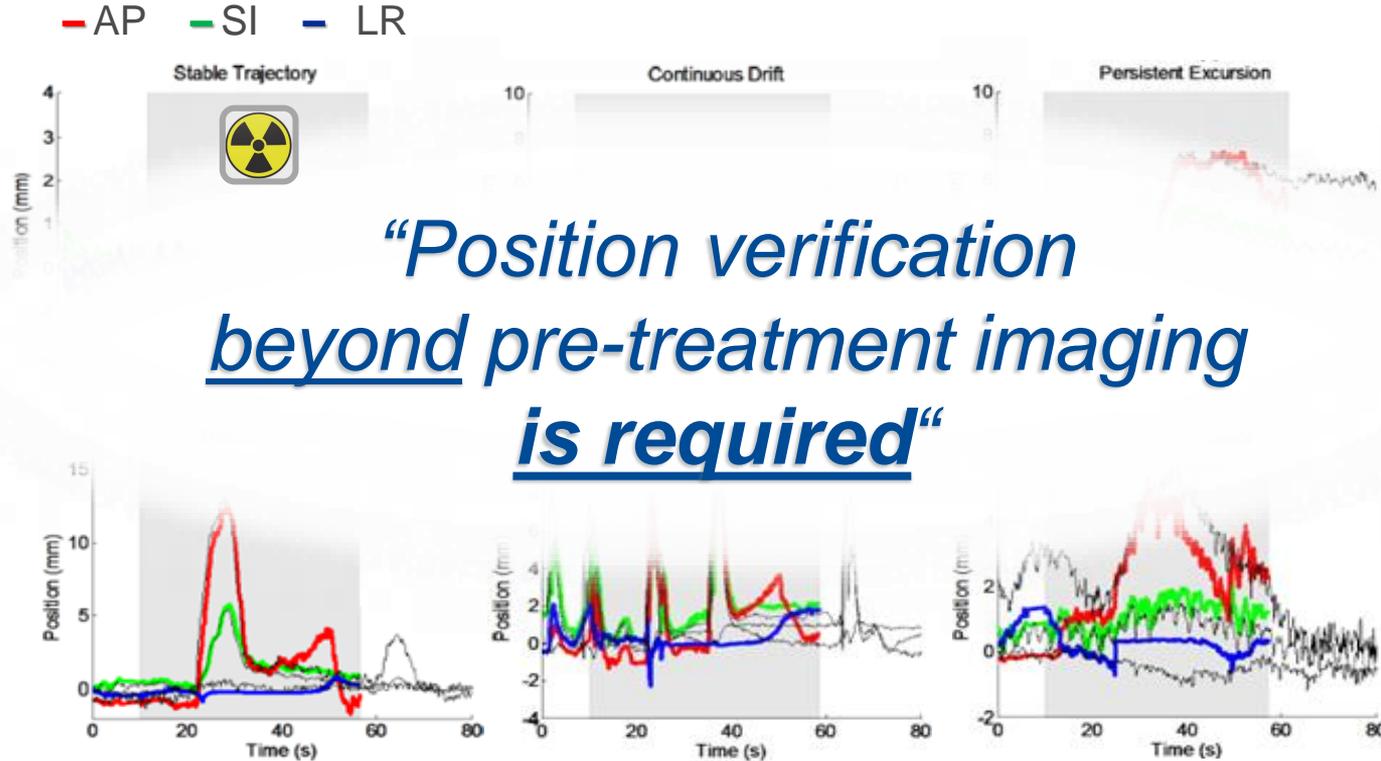
HypoFocal-SBRT trial

- Phase III Trial

- Multicentric

- Focal dose escalation

- Randomized
  - Arm A: 5 Fx, 30 Gy / 35 Gy / 40-42 Gy   *SBRT*
  - Arm B: 20 Fx, 46.4 Gy / 60-62 Gy

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HypoFocal-SBRT: Clinical Implementation

What is the
TASK?

Bladder
HIT

Bladder

SBRT +
Focal Boost

Rectum

Prostate

Urethra

Boost
MISSED

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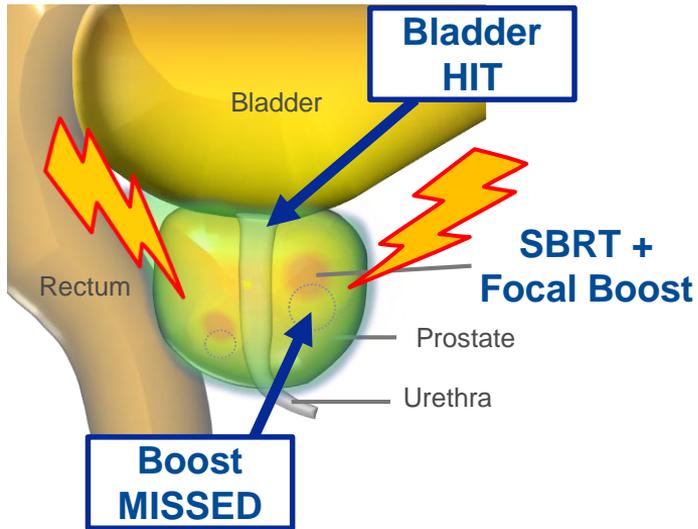
Intrafraction prostate motion types

— AP — SI — LR

Stable Trajectory   Continuous Drift   Persistent Excursion

"Position verification
<u>beyond</u> pre-treatment imaging
<u>is required</u>"

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HypoFocal-SBRT: Planning

Enable *efficient* dose application,
robust dose calculation,
considering *in-treatment imaging*
strategy.

At plan optimization phase
- ✓ Delivery efficiency
- ✓ Plan quality
- ✓ Organ motion

Delivery efficiency

MU/Gy

Dose objectives

Modulation

Plan quality

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Planning

Complexity reduction

- MU/Gy
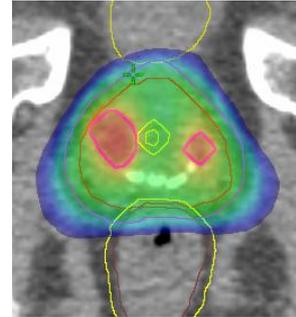- Aperture optimization

Fast dose application

- Dual-arc VMAT
- 10XFFF
- 2400 MU/min

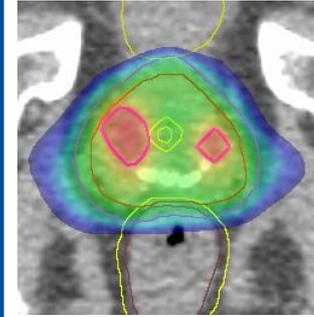Intra-treatment imaging

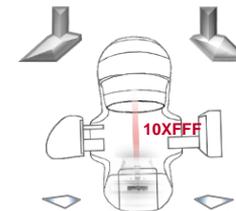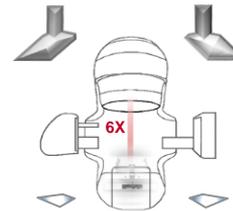- Imaging control points (ICP) per beam-on-time (BOT)

6X VMAT

MU: 2345
BOT: ~3.8 min

10XFFF VMAT

MU: ~ 2000
BOT: ~2 min

Max. gantry speed reached: ~1 RPM

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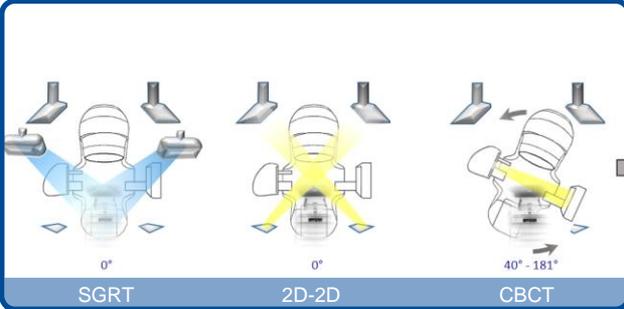
HypoFocal-SBRT: Delivery

- Development of an image-guided strategy for intra-fraction target position verification

- Establishment of action thresholds for interventions/corrections in 6DOF

- Fiducial marker (FM)-based
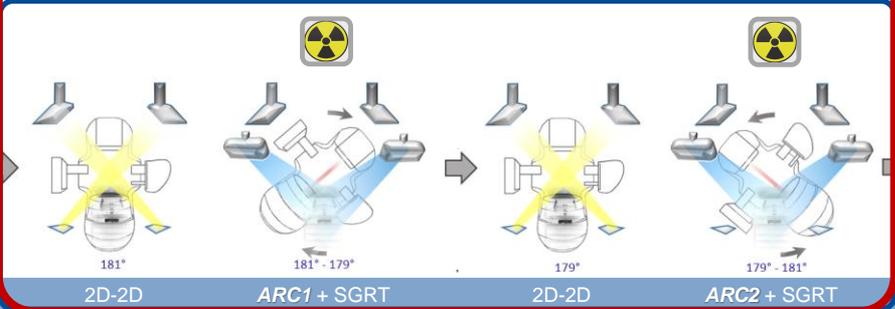

SGRT
(BrainLab ExacTrac)

FFF
(VMAT)
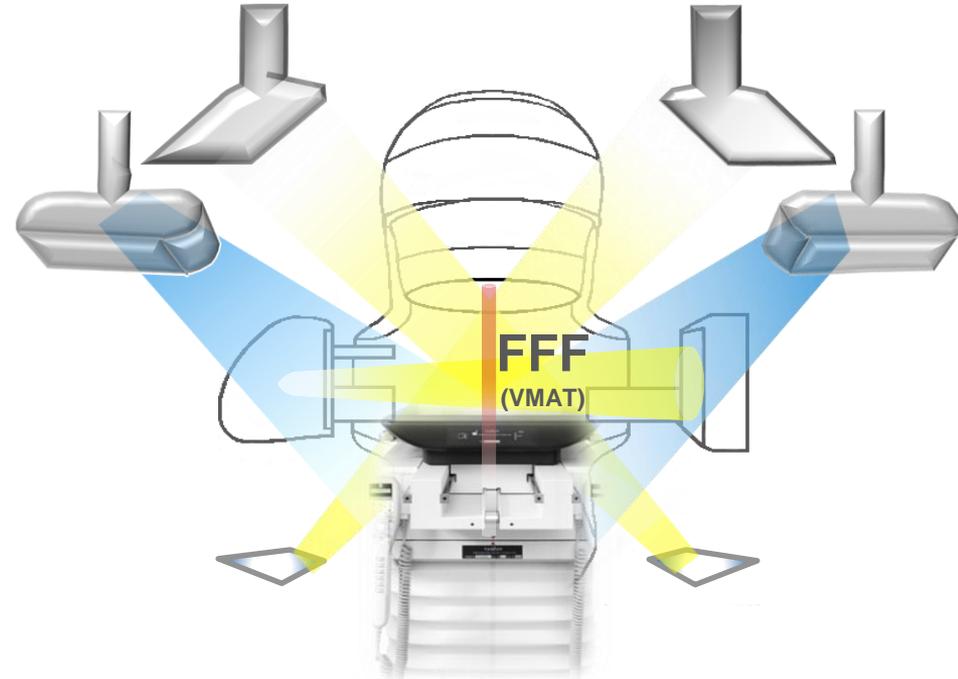
Perfect Pitch 6DOF

Delivery

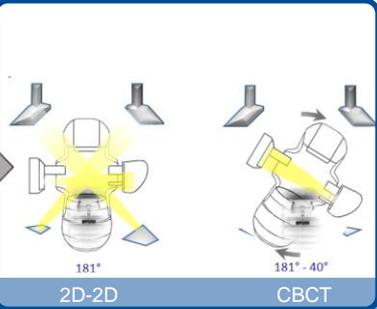| SGRT | 2D-2D | CBCT | 2D-2D | *ARC1* + SGRT | 2D-2D | *ARC2* + SGRT | 2D-2D | CBCT |

Pre-treatment　　　　　　Intra-treatment　　　　　　Post-treatment

Preliminary accuracy evaluation
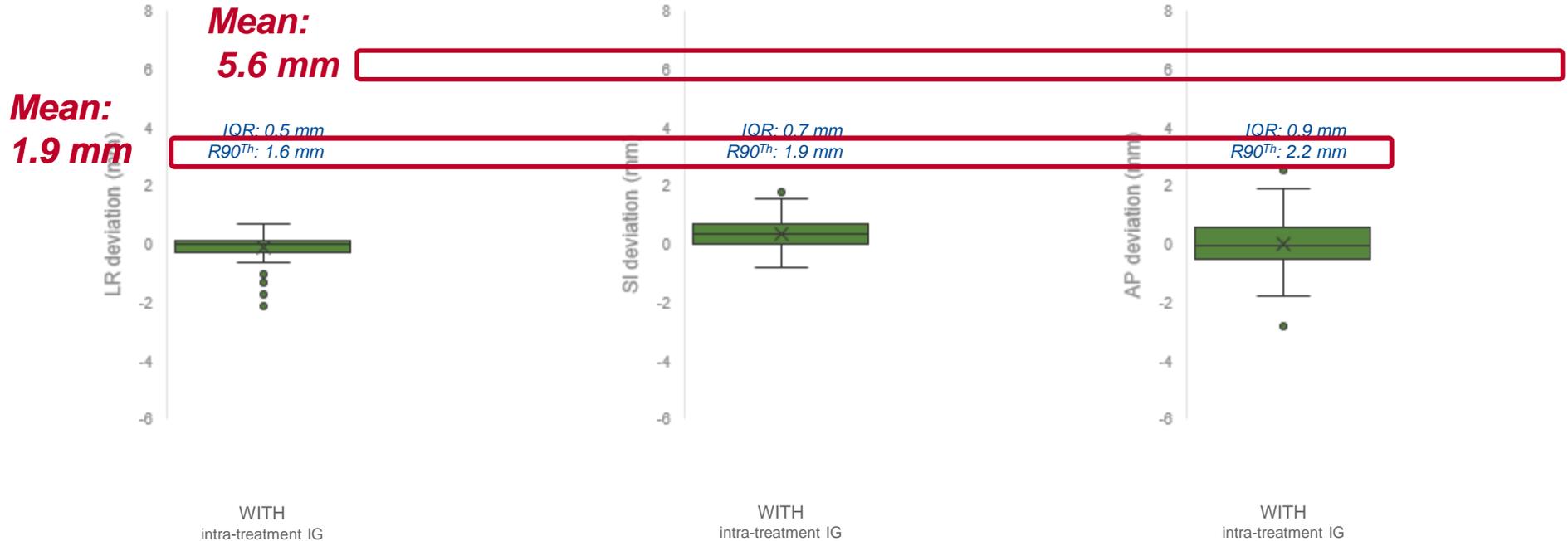
Retrospective

- Based on acquired imaging data (during dose application) using ExacTrac[1] system

Objective

- Quantify improvement in:
  - Beam-target geometric alignment
  - Delivered dose

Parameter	Value	
# Patients	10	
# Fractions	50	
Prescribed dose	30 Gy/35 Gy/40-42 Gy 5 Fx	
Recruitment	Jan 23 – Aug 23	
Age (median)	73	(62 – 82)
Initial PSA (median)	6.3 ng/ml	(4.4 – 19.2)
NCCN High risk	3	
Unfavorable intermediate risk	7	
CTV (cm^3)	35.1	(20 - 55.6)
PTV (cm^3)	63.6	(42.4 - 95.7)

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Positional uncertainty with & without intra-treatment image guidance (IG)

Mean: 5.6 mm

Mean: 1.9 mm

IQR: 0.5 mm
$R90^{Th}$: 1.6 mm

IQR: 0.7 mm
$R90^{Th}$: 1.9 mm

IQR: 0.9 mm
$R90^{Th}$: 2.2 mm

LR deviation (mm)

SI deviation (mm)

AP deviation (mm)

WITH
intra-treatment IG

WITH
intra-treatment IG

WITH
intra-treatment IG

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Isodose distributions for planned and (estimated) delivered doses with/without intra-treatment IG

Planned

No intrafract. IGRT

Target missed

Plan

Fx.3

PTV2

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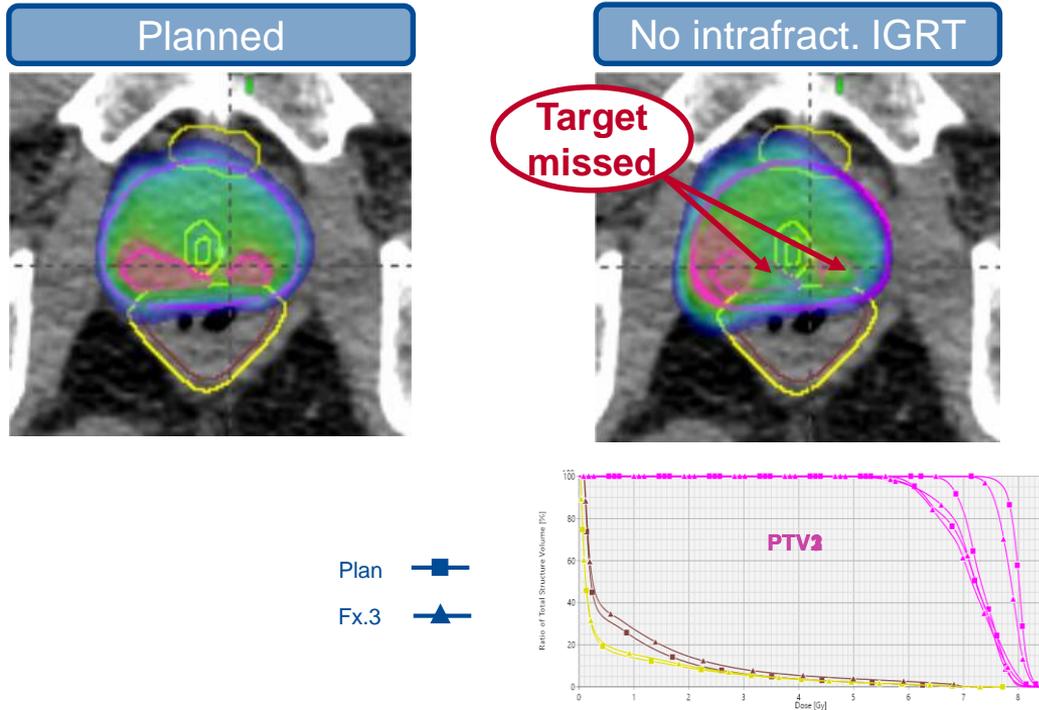
Treatment session time efficiency

Group: (Ave.)

		16.6 min	19.1 min	12.6 min
Treatment Session Time		(2023)	(2021-2)	(2024)
Laser + SGRT	3.6	8.6	10.8	6.2
2D-2D + CBCT	5.0			
Beam-ON + 2D-2D	5.6	5.6	5.8	4.1
2D-2D + CBCT	2.4	2.4	2.5	2.4

Time (min)
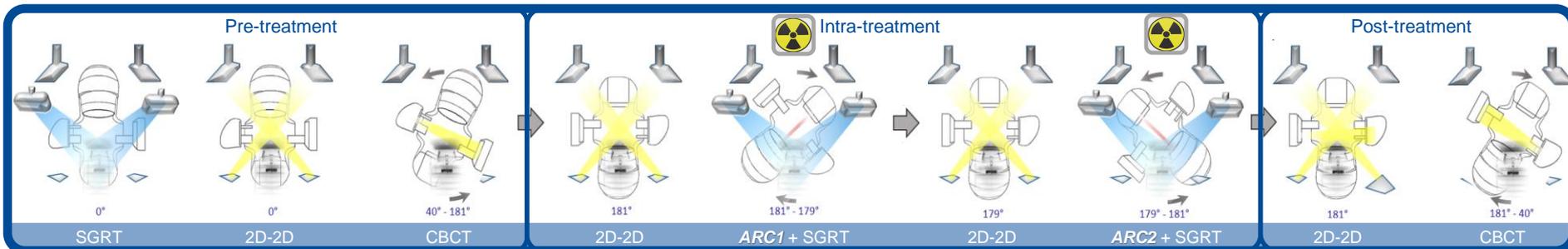
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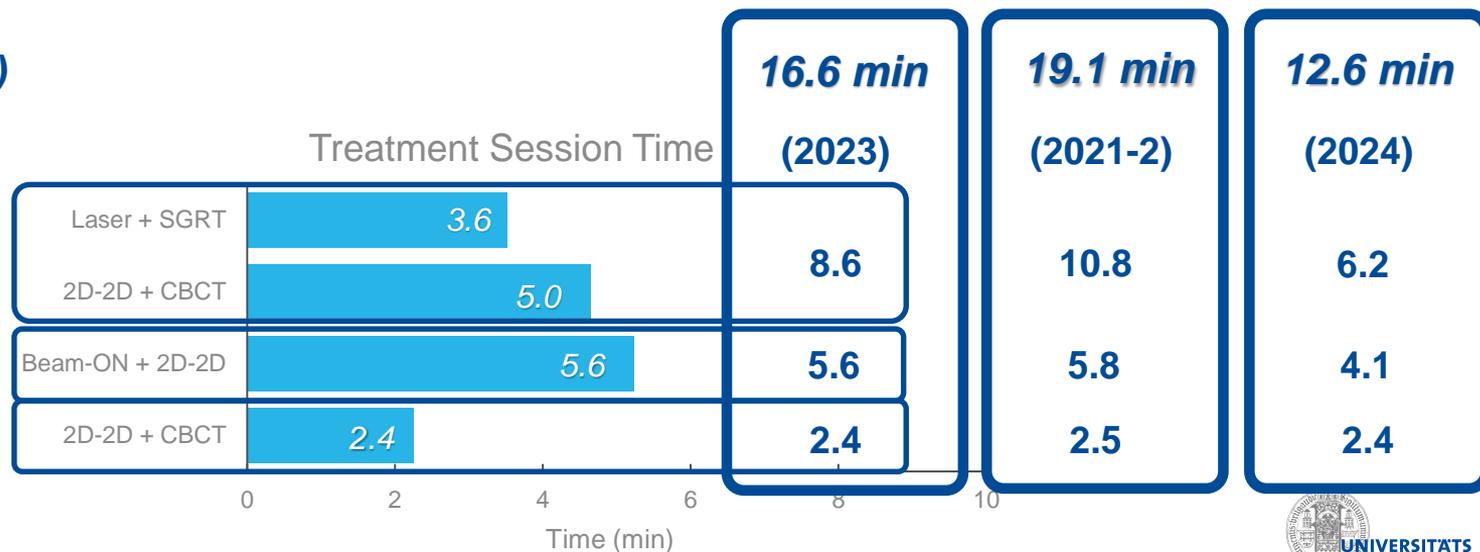
Why complexity reduction at planning process?

- Improved plan robustness

Static	Dynamic	Dose error

Low modulation

[204 MU/Gy]

1.8%
(2mm/2%)

High modulation

[298 MU/Gy]

5.5%
(2mm/2%)
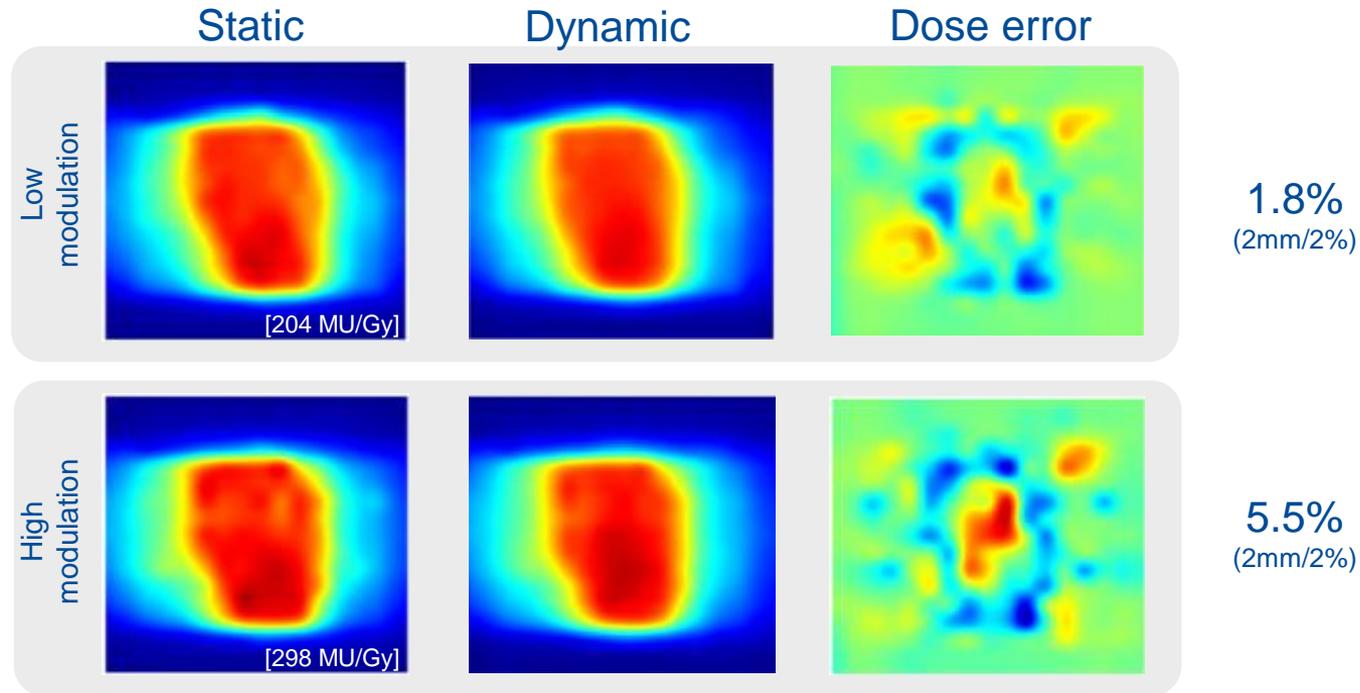
Interplay between *plan complexity* and *motion* [1]

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Why complexity reduction at planning process?

- Reduces marker blockages by the MLCs

BEV (TPS)

MV image (raw)

Marker 1

Marker 2

Marker 3

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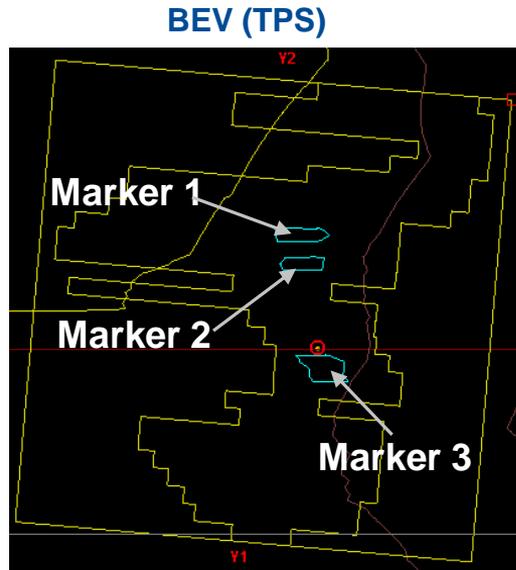
Why complexity reduction at planning process?

- Potential monitoring of target (GM) via MV BEV imaging

BEV (TPS)   MV image (raw)   MV image (processed)
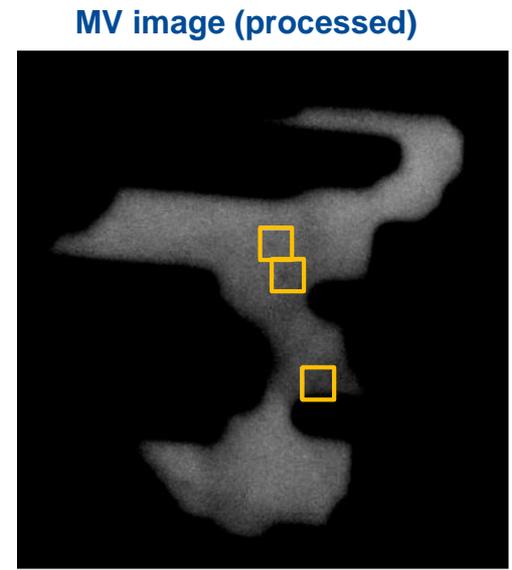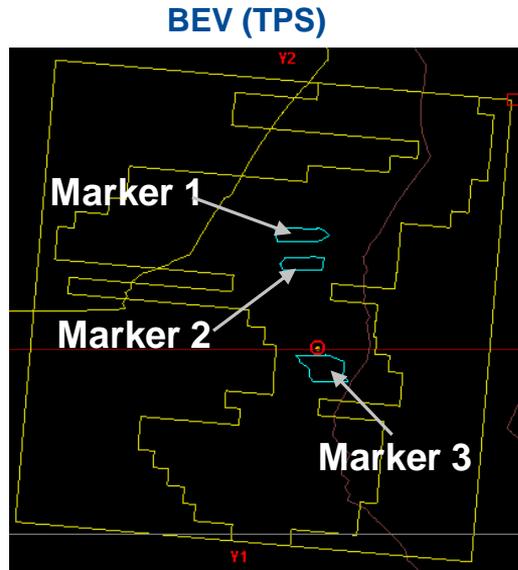
Summary

- Treatment ***solely*** based on pre-treatment IG is ***not sufficient***

- Complexity reduction ***maximized*** delivery efficiency and plan robustness.

- Intra-treatment IG direct prior/after each arc using the ExacTrac ***improved*** the positional & dosimetric accuracy

Limitations

- Method deals with the ***geometric*** adaptation ***only***.

- Volumetric changes and adaptation (i.e., adaptive RT) are not accounted for.

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Outlook

- ExacTrac Dynamic at UKFR
  - Integrated SGRT and IGRT
  - Pre-positioning, positioning and in-treatment patient monitoring

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Vielen Dank für Ihre Aufmerksamkeit

Fragen?

www.uniklinik-freiburg.de/hypofocal-sbrt-studie.html

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