

# Clinical Value of Motion Synchronization for Prostate SBRT

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# Prostate SBRT: Exciting, High Stakes

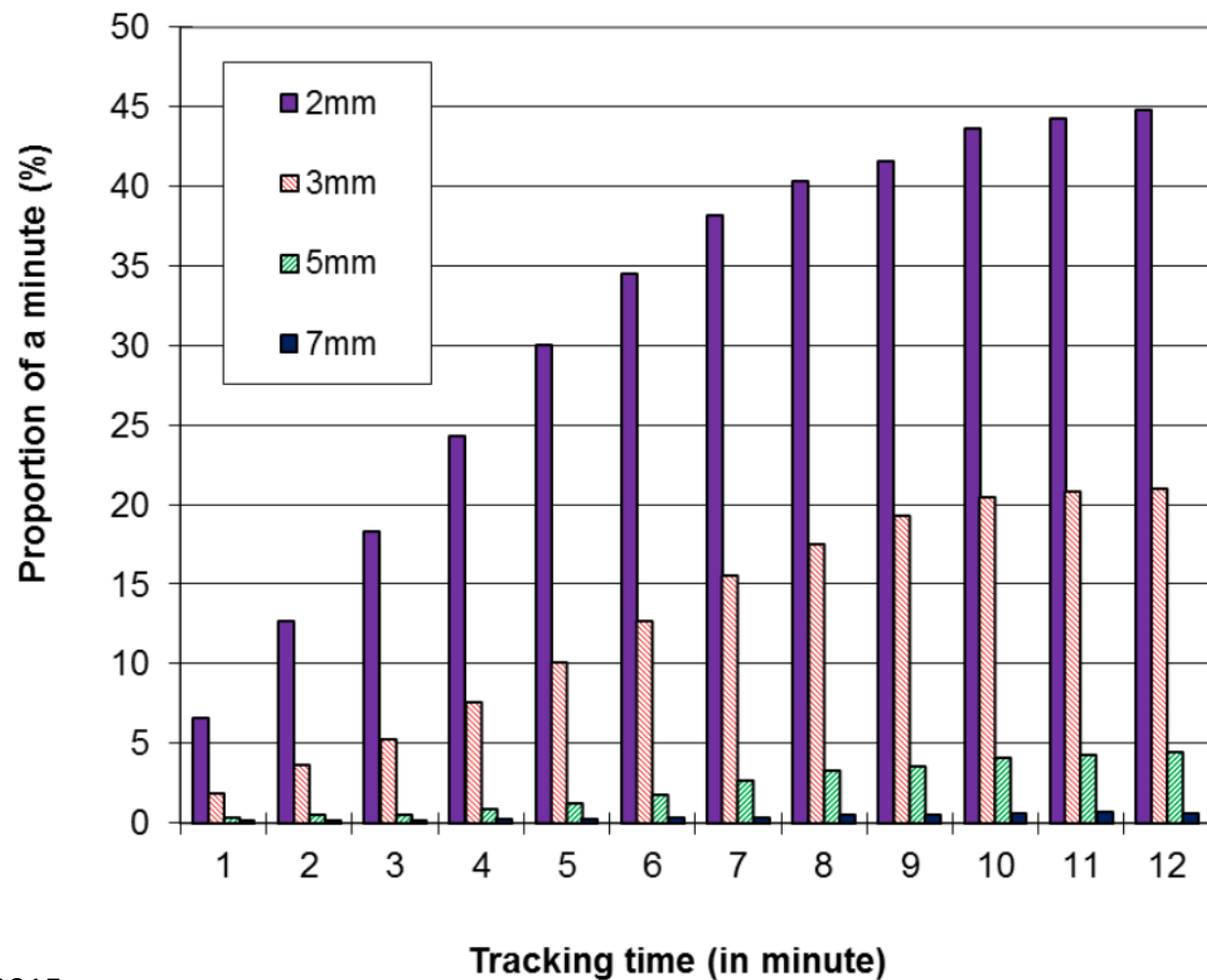
- Prostate SBRT is an exciting treatment paradigm
  - Shortens radiation treatment from 9 weeks to 1 week
    - Patient convenience, less disruption to patient daily life
  - More biologically active dose/fractionation ( $\alpha/\beta$  ratio)
- High dose/fraction = high stakes
  - Dose-volume relationship with toxicity not yet fully elucidated
  - Tight PTV margins  $\rightarrow$  target coverage more sensitive to intrafraction motion

# Quantifying Prostate Motion (Intrafraction)

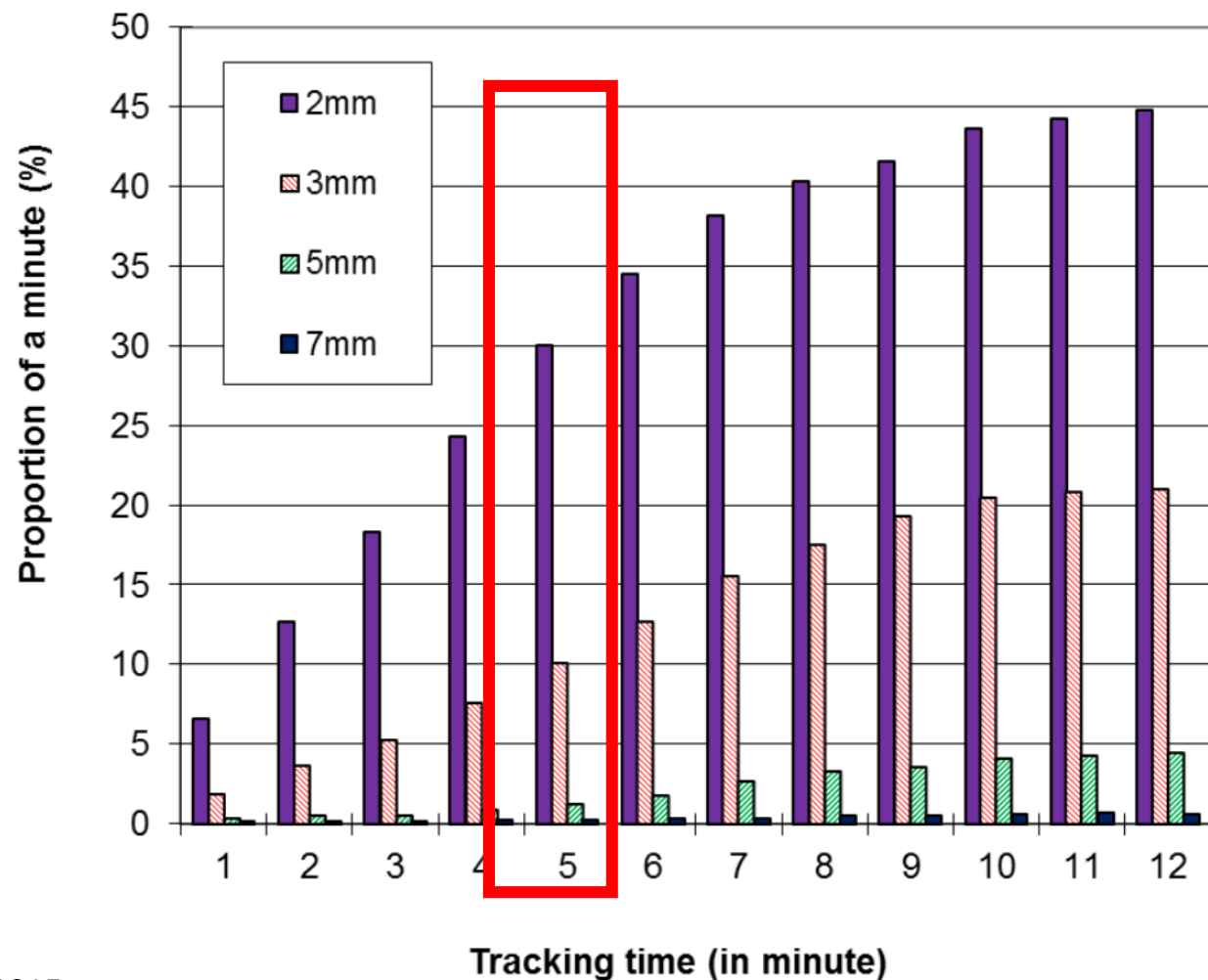
- Percent of treatment delivery time:

<b>≥3 mm</b>	<b>Fractions</b>	<b>Ant-Post</b>	<b>Sup-Inf</b>	<b>Right-Left</b>
Langen et al	550	5.9	5.1	0.1
Bittner et al	751	3.0	4.7	0.4
Shelton et al	1320	6.0	3.0	2.0
<b>≥5 mm</b>	<b>Fractions</b>	<b>AP</b>	<b>SI</b>	<b>RL</b>
Langen et al	550	1.1	1.0	0.0
Bittner et al	751	0.1	0.5	0.0

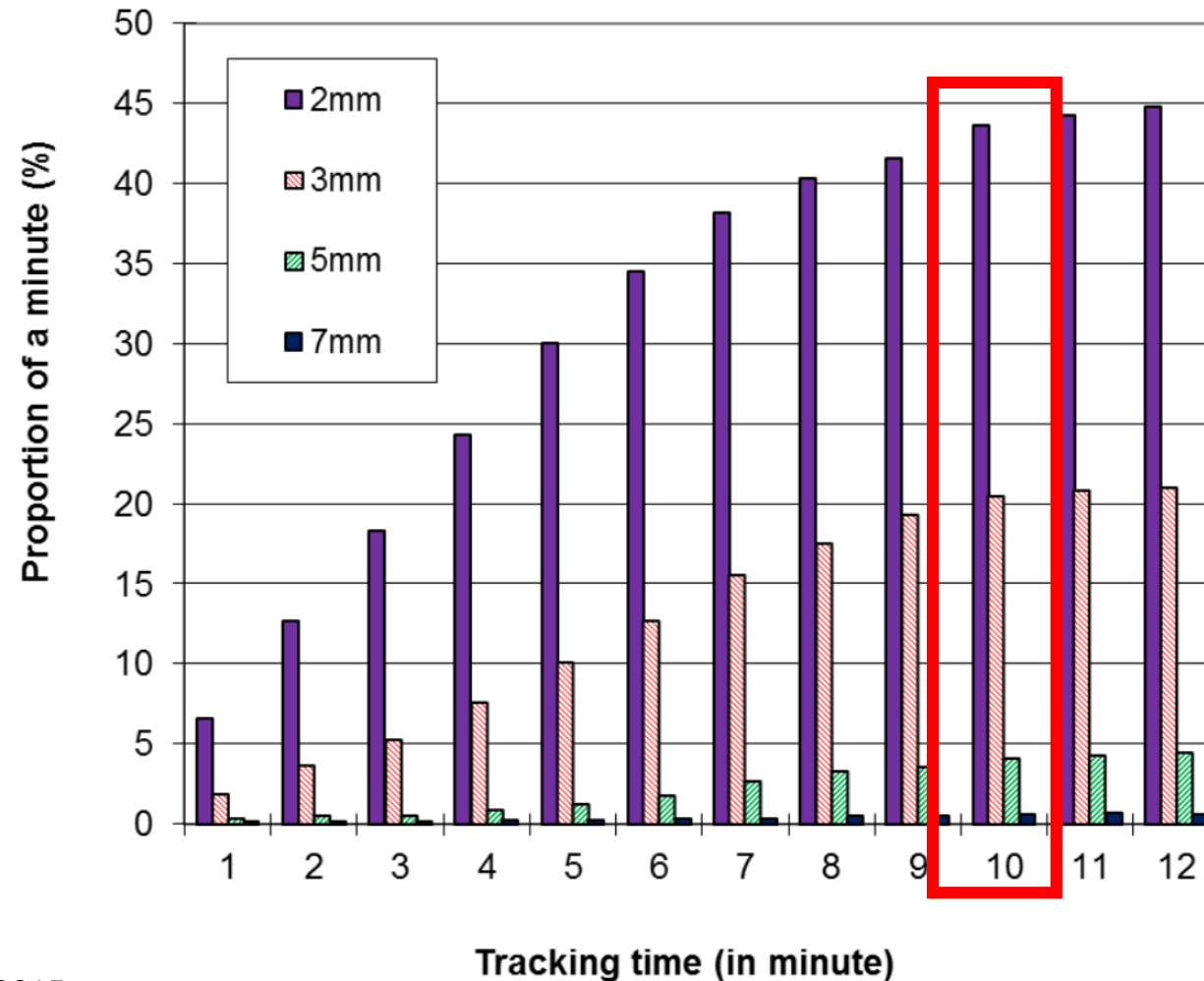
# Quantifying Prostate Motion (Intrafraction)



# Quantifying Prostate Motion (Intrafraction)



# Quantifying Prostate Motion (Intrafraction)



# Dosimetric Impact of Intrafraction Motion

- Tracked prostate motion during 548 treatment fractions
  - Estimate translations and rotations of the prostate during treatment (average 10 minutes)
- Simulated actual CTV coverage
  - No intrafraction correction
  - Translational correction only
  - Translational and rotation corrections



# Dosimetric Impact of Intrafraction Motion

- Percentage of treatments with at least 98% CTV coverage

	No Correction	Translational Only	Translational + Rotational
3 mm PTV margin	61%	96.6%	100%

# Dosimetric Impact of Intrafraction Motion

- Percentage of treatments with at least 98% CTV coverage

	No Correction	Translational Only	Translational + Rotational
0 mm PTV margin	11%	70.1%	99.5%
3 mm PTV margin	61%	96.6%	100%

# Intrafraction Motion: Summary

- Studies have consistently shown that intrafraction prostate motion occurs, even for treatments as short as 5 minutes
- Without intrafraction motion correction, CTV coverage can be negatively impacted even with 3 mm PTV expansion
- Clinical value of motion synchronization for SBRT:
  - Ensure/maximize CTV coverage = important for cancer control
  - Allow safe reduction of PTV margin = important for reducing toxicity

# Impact of Motion on Intraprostatic Boost

- Advances in imaging → better visualization of intraprostatic lesions
  - Increasing interest in delivering SIB to visible tumors to higher dose
- High stakes: even higher dose per fraction
  - Lesions are often close to urethra
  - PTV margin undesirable
- No motion correction, 0 mm PTV margin:  $D_{98\%}$  of boost region decreased from 45.6 Gy planned dose to 37.7 Gy delivered

# Is 0 mm PTV Expansion Possible?

- Phase II trial
  - 259 patients
  - Low- to intermediate-risk prostate cancer
  - 38 Gy in 4 fractions (daily)
- Contoured: prostate and seminal vesicles
- Total expansion (CTV and PTV):
  - Gleason 6: 2 mm (0 mm posteriorly)
  - Gleason 7: 5 mm (0 mm posteriorly)

# Trial Results

- 5 year freedom from biochemical recurrence:
  - Low-risk: 100%
  - Intermediate-risk: 88.5%
- 5-year toxicity: (without hydrogel spacer)
  - Cumulative incidence of grade 2 GI toxicity: 3.4%
  - Grade 3 GI toxicity: 0

# Conclusions

- In the high stakes treatment of prostate SBRT, intrafraction motion is important
- Radiation oncologists should use available technology to safely reduce PTV margin
  - Minimize toxicity, without compromising CTV coverage
- As the field continues to explore the treatment of intraprostatic lesions, the issue of motion synchronization and PTV margin becomes even more important