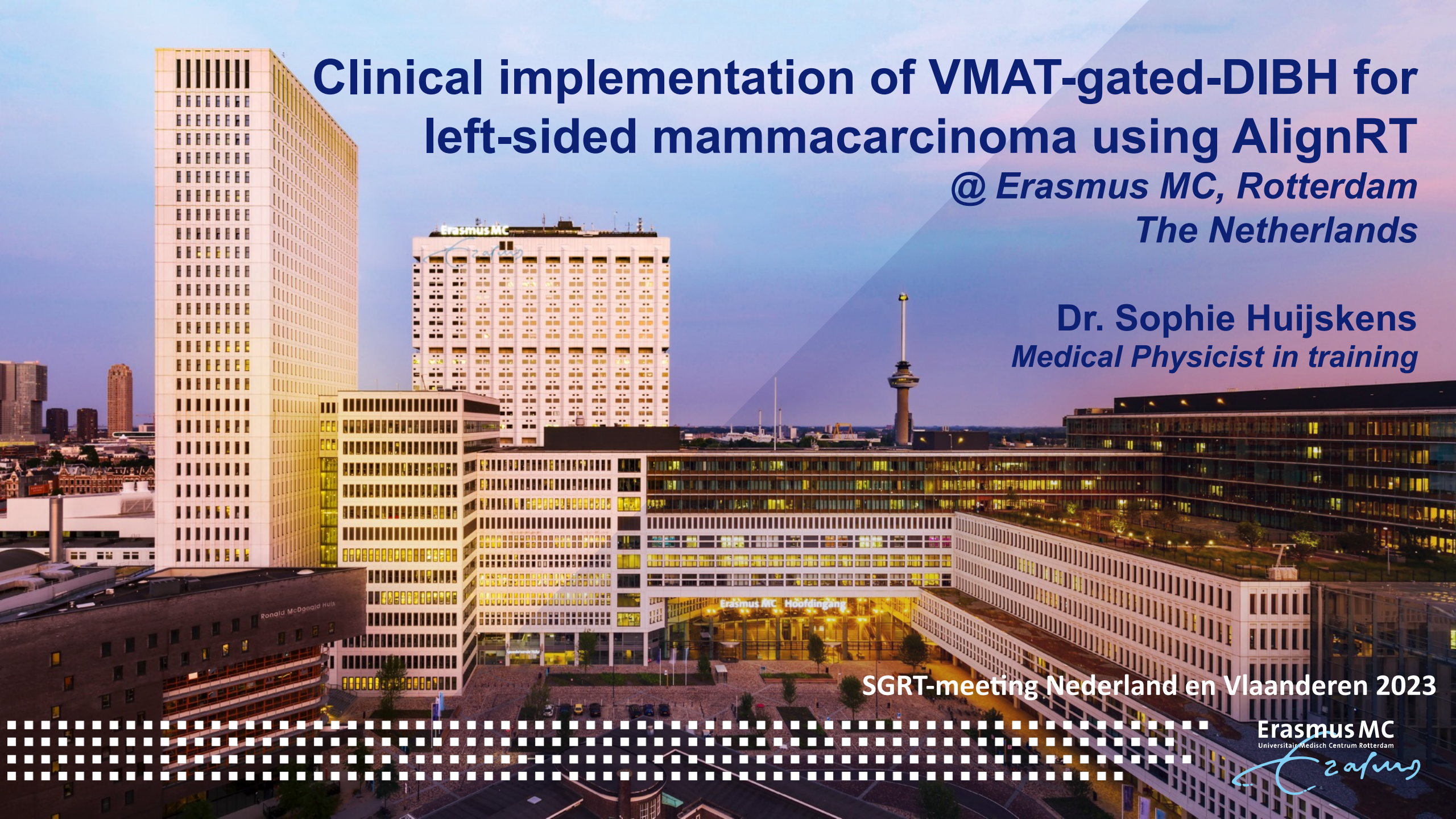
Clinical implementation of VMAT-gated-DIBH for left-sided mammacarcinoma using AlignRT

@ Erasmus MC, Rotterdam
The Netherlands

Dr. Sophie Huijskens
Medical Physicist in training



SGRT-meeting Nederland en Vlaanderen 2023

Erasmus MC
Universitair Medisch Centrum Rotterdam

Information

Erasmus MC
University Medical Center Rotterdam
Cancer Institute

Department of Radiotherapy

Rotterdam and Dordrecht, the Netherlands

Elekta Versa HD, Ethos, Cyberknife, Hyperthermia, Brachytherapy

6 AlignRT systems + Elekta Versa HD

Annually 1000 breast cancer patients

Left-sided → DIBH <70 yrs

40 sec training → CBCT acquisition

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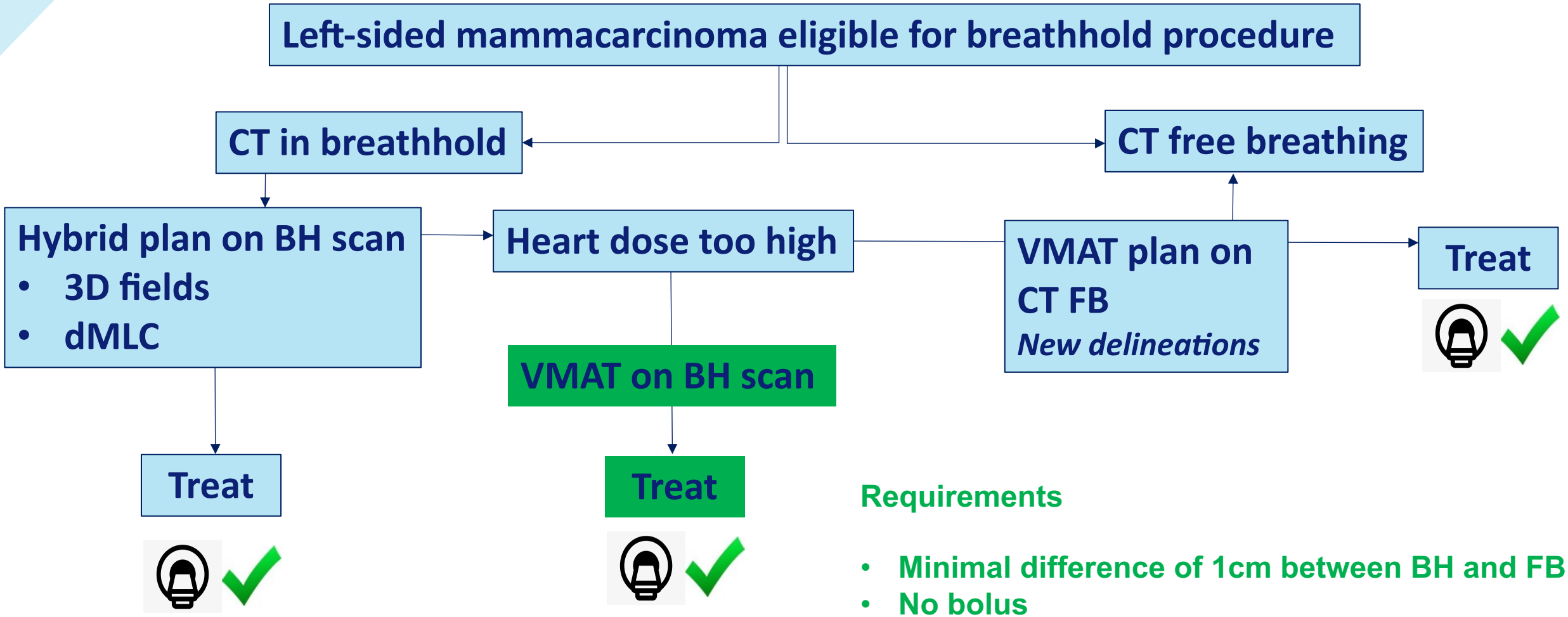
Planning Workflow



Requirements

- Minimal difference of 1cm between BH and FB
- No bolus
- Single side

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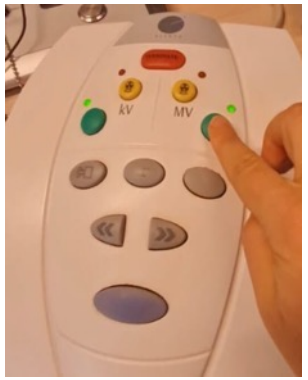
Goals

- Introduce VMAT-gated-DIBH for left-sided mammacarcinoma
- Test for an automation and safe procedure
- Evaluate BH parameters

Hybrid workflow

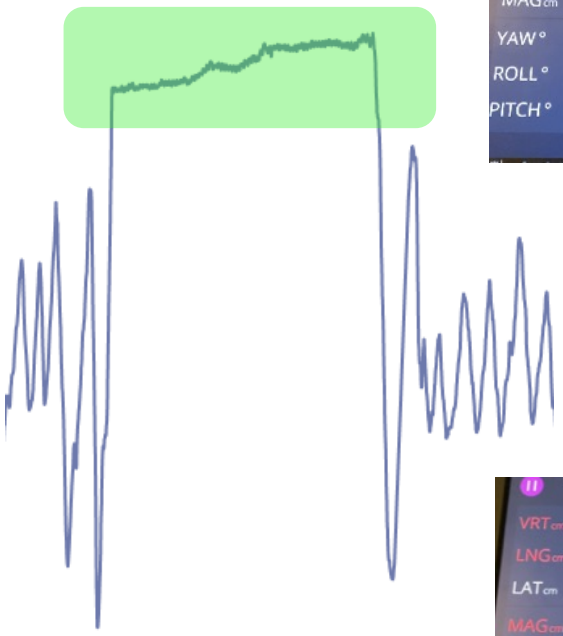
Manual



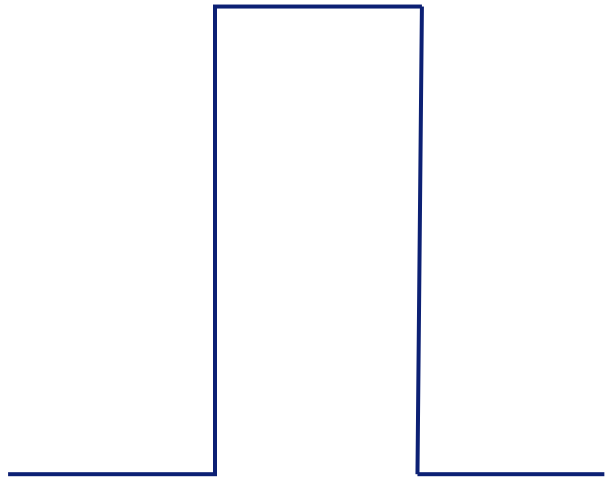
Breathhold

+ - 3mm

3 °



Beam on



Beam off

Patient positioning
Define ROI
Reference surface scan

Free breathing

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VMAT gating

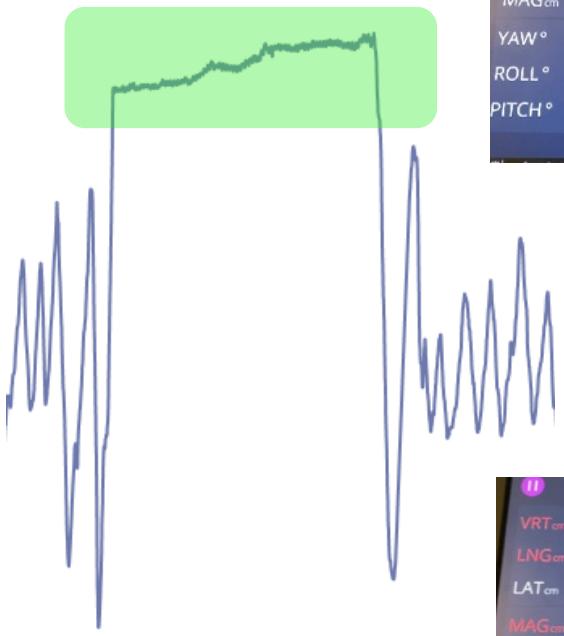
Automatic

Elekta Response Module

Breathhold

+ - 3mm

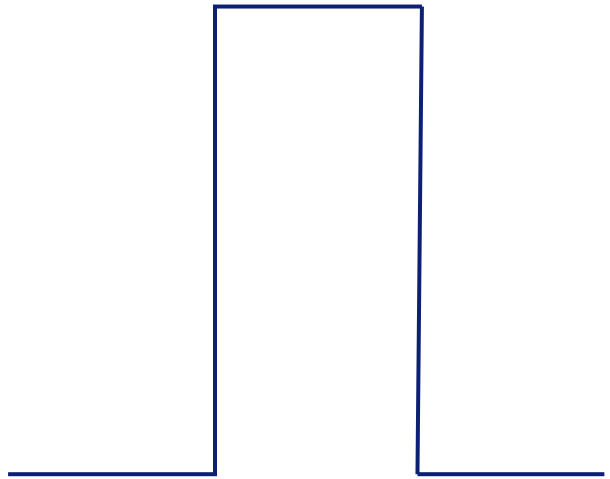
3 °



Patient positioning
Define ROI
Reference surface scan

Free breathing

Beam on



Beam off

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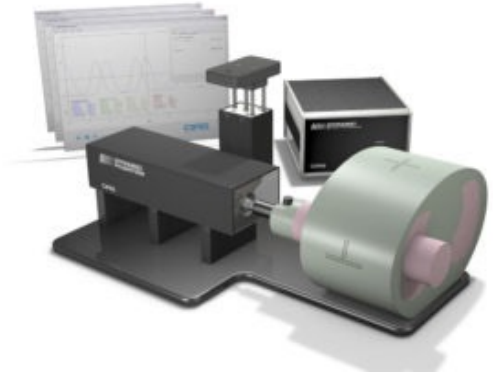
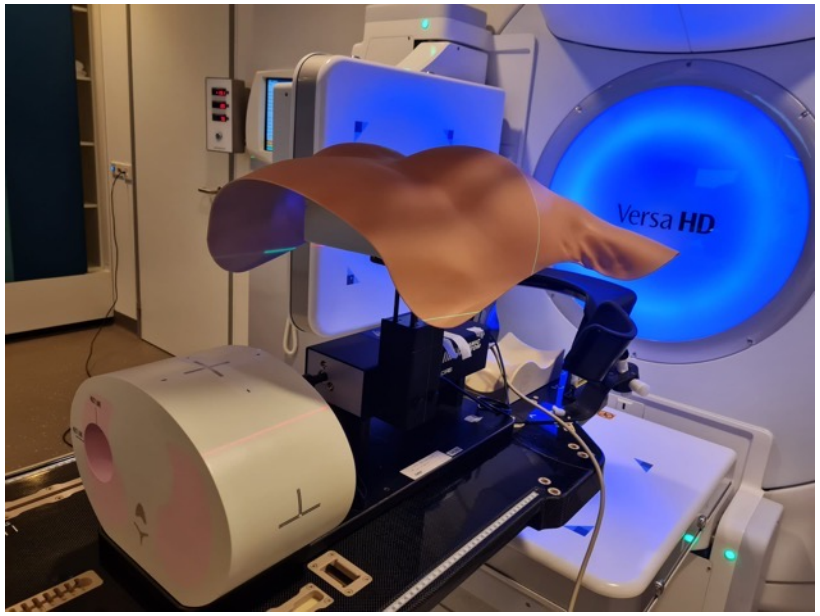
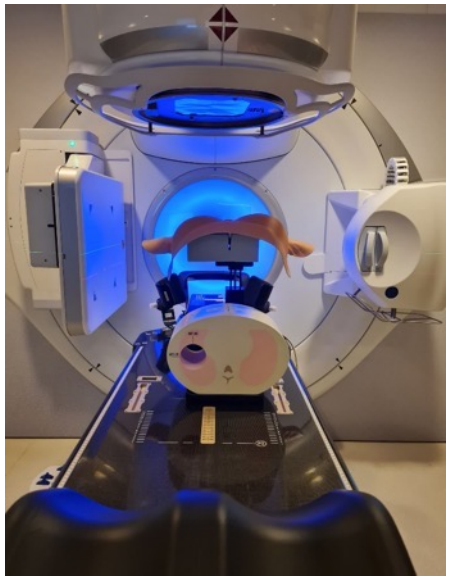
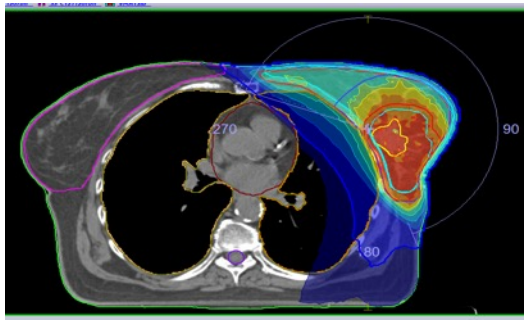
Testing







Connection AlignRT – Elekta response system – Linac



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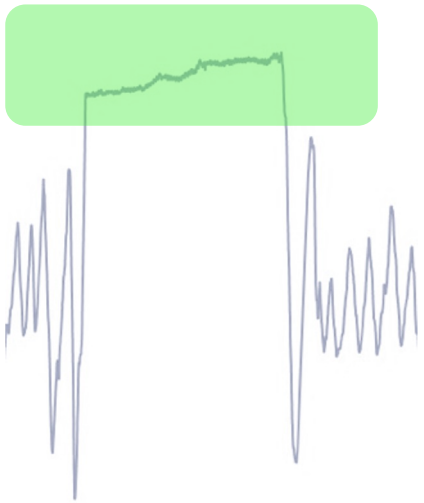
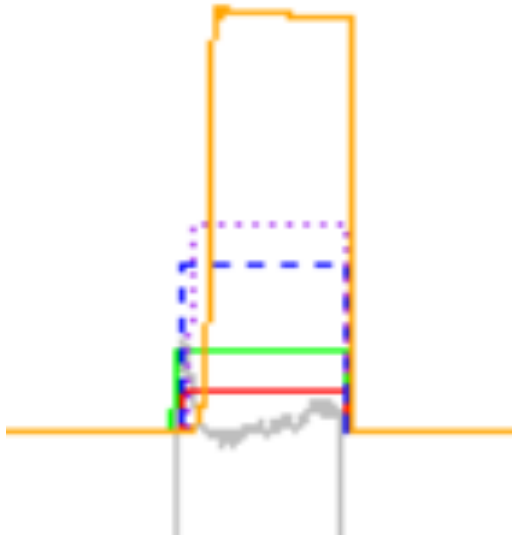
Testing Time-delay

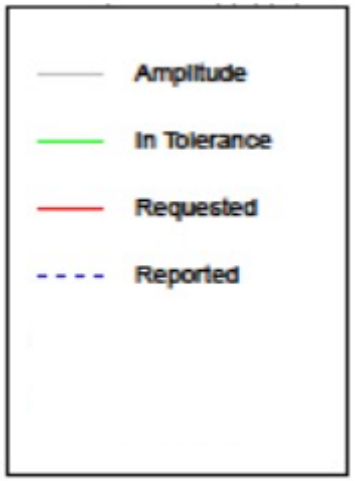
Breathhold

+ - 3mm

3 °







AlignRT

△ ON
Reported Beam – In tolerance = 0.82 s

△ OFF
Reported Beam – Out tolerance = 0.25 s

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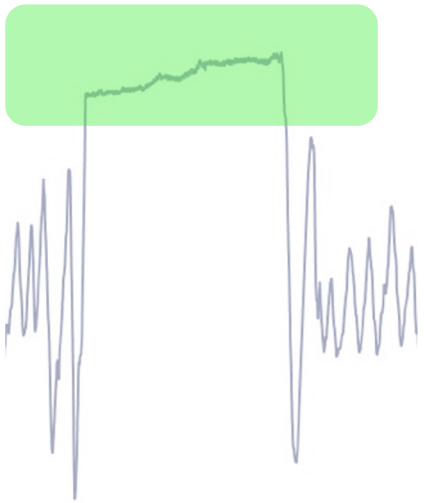
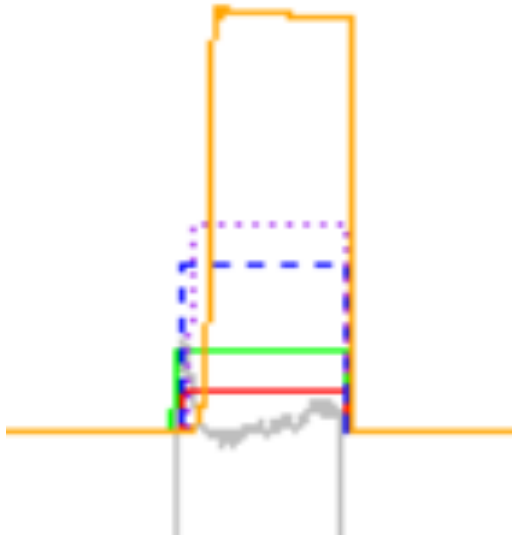
Testing Time-delay

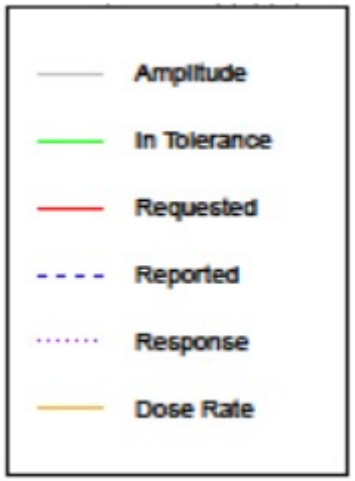
Breathhold

+ - 3mm

3 °







AlignRT

Δ **ON**
Reported Beam – In tolerance = 0.82 s

Δ **OFF**
Reported Beam – Out tolerance = 0.25 s

Elekta

Δ **ON**
Dose Rate – Reported Beam = 1.47 s

Δ **OFF**
Reported Beam – Dose Rate = 0 s

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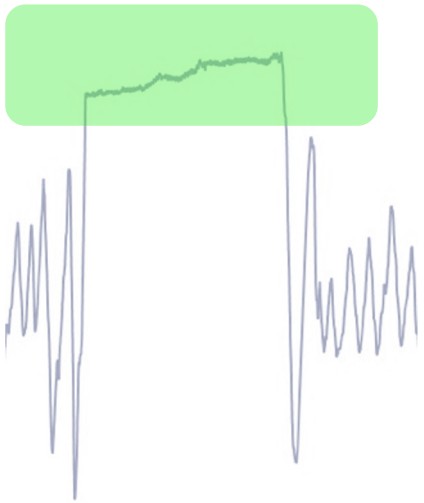
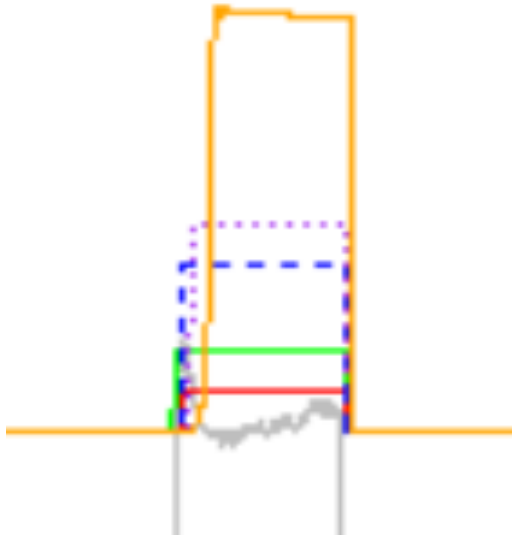
Testing Time-delay

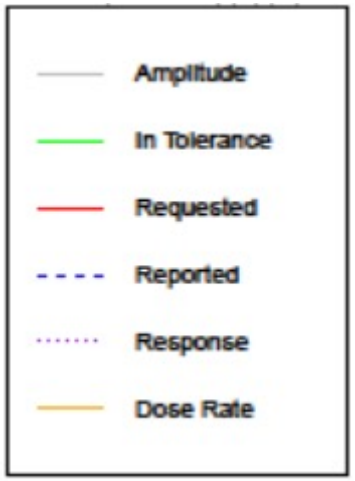
Δ ON
0.82 + 1.47 = 2.29 s

Breathhold

+ - 3mm
3 °







AlignRT

Δ ON
Reported Beam – In tolerance = 0.82 s

Δ OFF
Reported Beam – Out tolerance = 0.25 s

Elekta

Δ ON
Dose Rate – Reported Beam = 1.47 s

Δ OFF
Reported Beam – Dose Rate = 0 s

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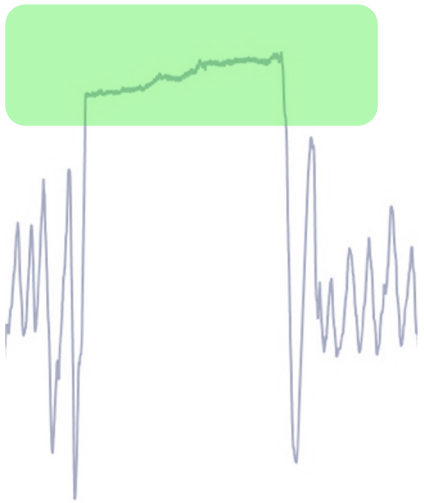
Testing Time-delay

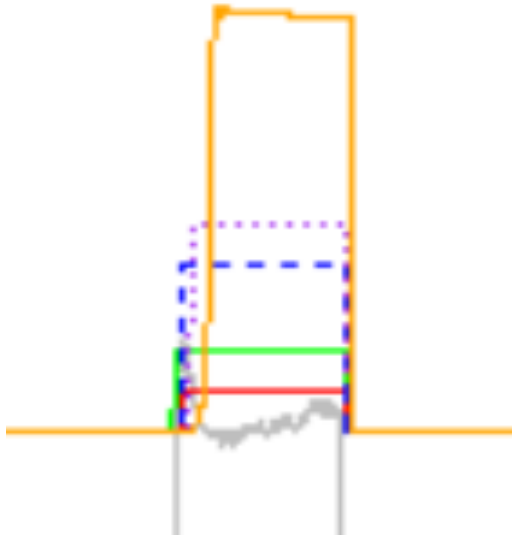
Δ ON
0.82 + 1.47 = 2.29 s

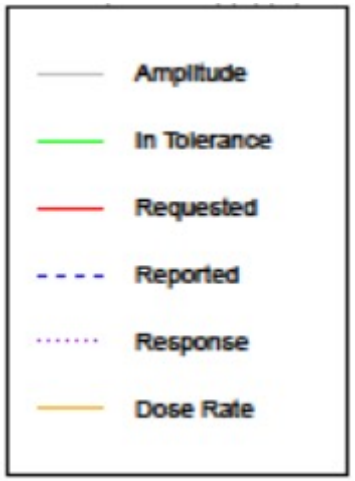
Δ OFF
0.25 + 0 = 0.25 s

Breathhold

+ - 3mm
3 °







AlignRT

Δ ON
Reported Beam – In tolerance = 0.82 s

Δ OFF
Reported Beam – Out tolerance = 0.25 s

Elekta

Δ ON
Dose Rate – Reported Beam = 1.47 s

Δ OFF
Reported Beam – Dose Rate = 0 s

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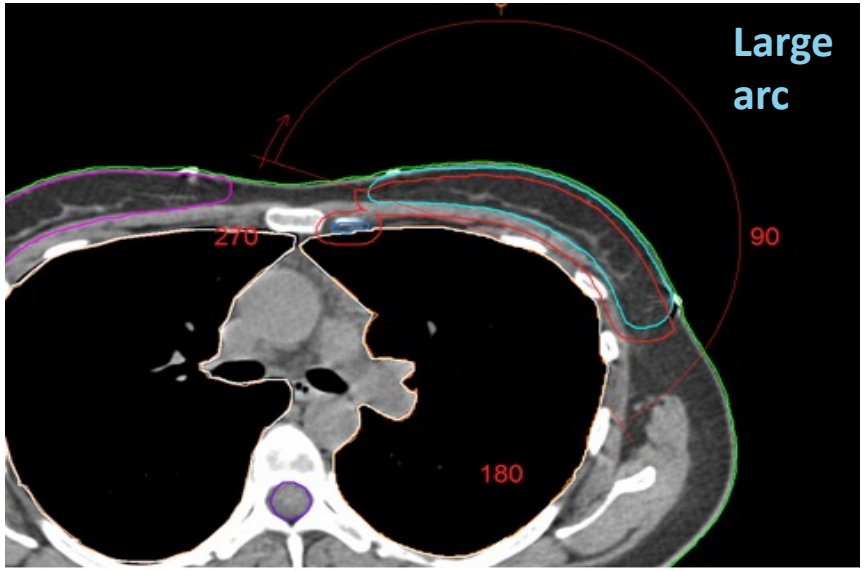
Planning



Requirements

- 1 VMAT bundle
- Large dual arc, approx. 200 degrees
- Control delivery time in TPS < 200 seconds

Dosimetry

VMAT delivery with/without interrupts showed no dosimetric effects
(1.0%/0.1mm,Gamma >99%)

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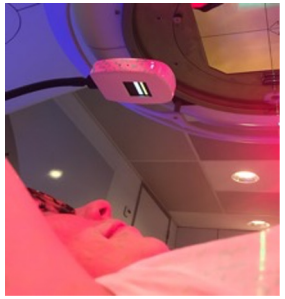
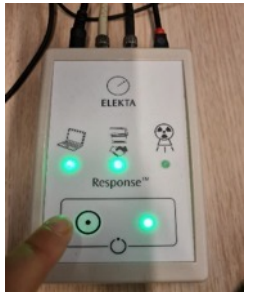
Workflow

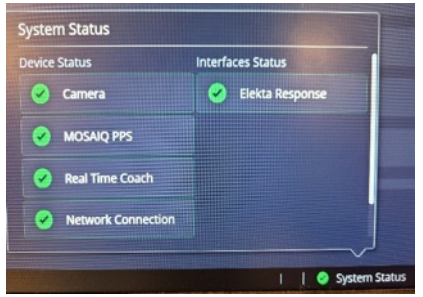
Real Time Coach



Planning VMAT in BH scan

Response module ON





Positioning patient is done FB CT; CBCT & ref scan in BH

AlignRT Beam Control ON

Breathhold instructions

Manual Console MV VMAT bundel ON

Beam is automatically enabled when BH is in tolerance

until all MU are delivered

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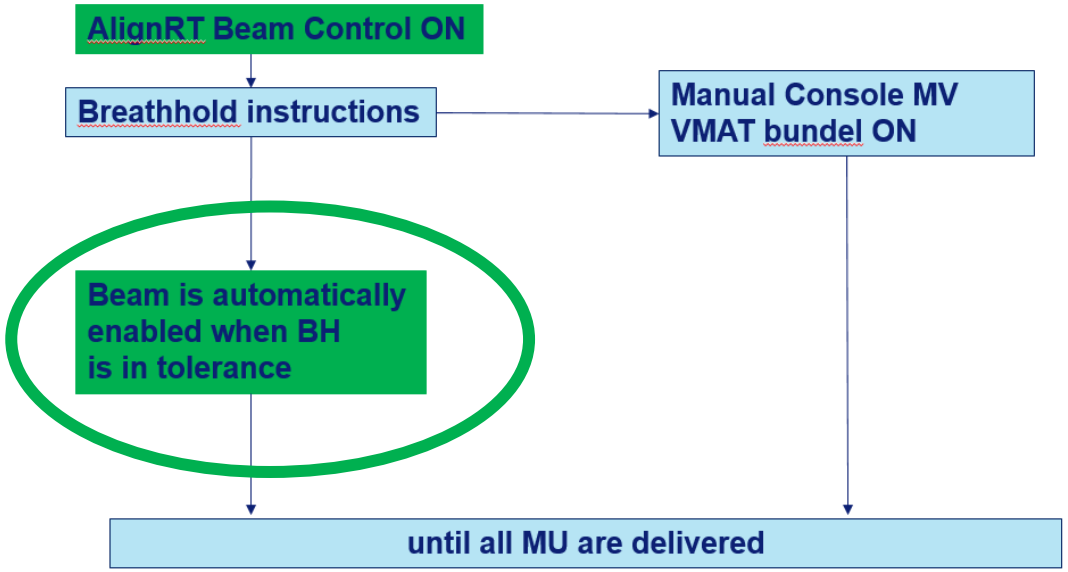
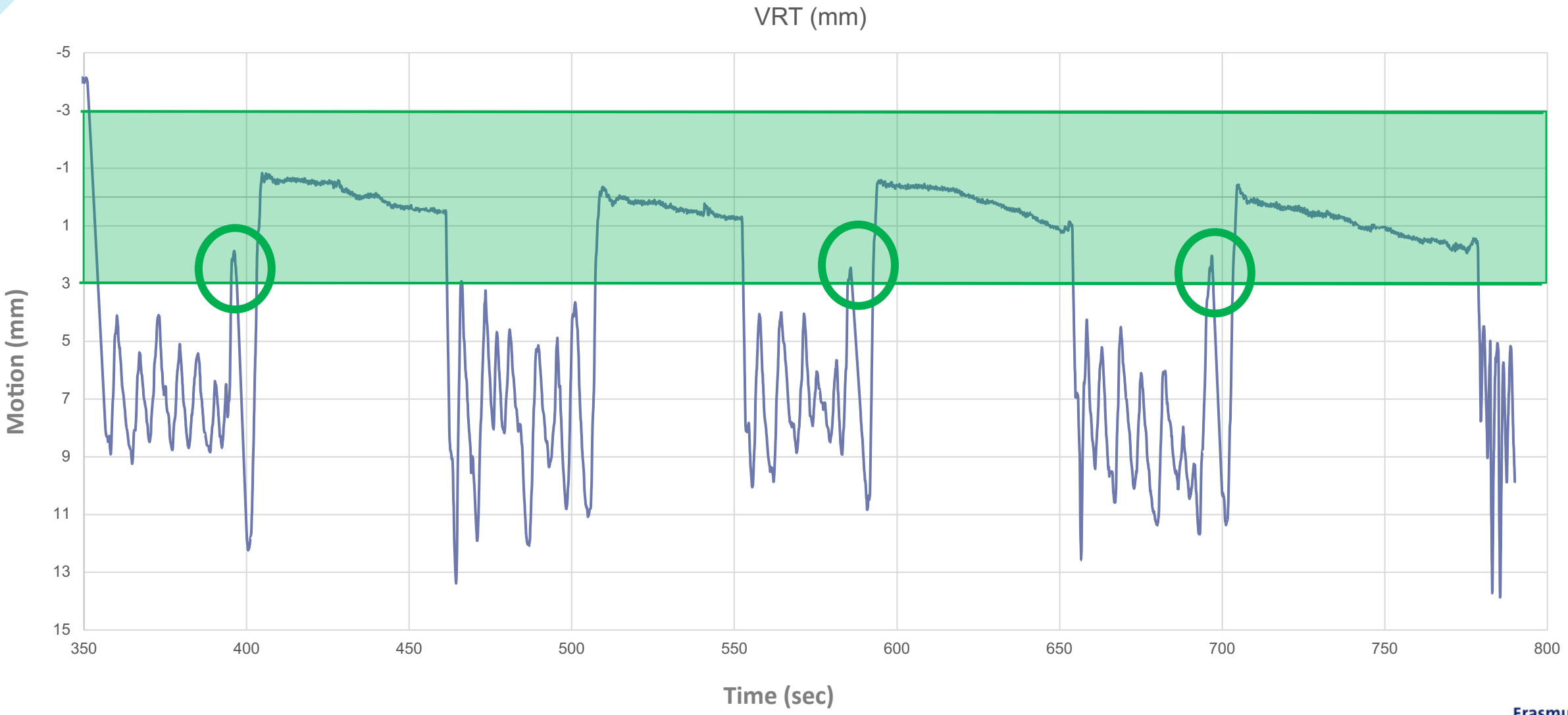
Workflow


AlignRT Beam Control ON
Breathhold instructions
Manual Console MV
VMAT bundel ON
Beam is automatically
enabled when BH
is in tolerance
until all MU are delivered


01_AMamLKLBH0t40 ISO 1
SGRT Patient
monitoring
VRT cm 0.81
LNG cm 0.53
LAT cm -0.10
MAG cm 0.98
YAW ° 0.0
ROLL ° 0.2
PITCH ° -1.8
Surface
Deformation
Video
PHILIPS

BH instructions



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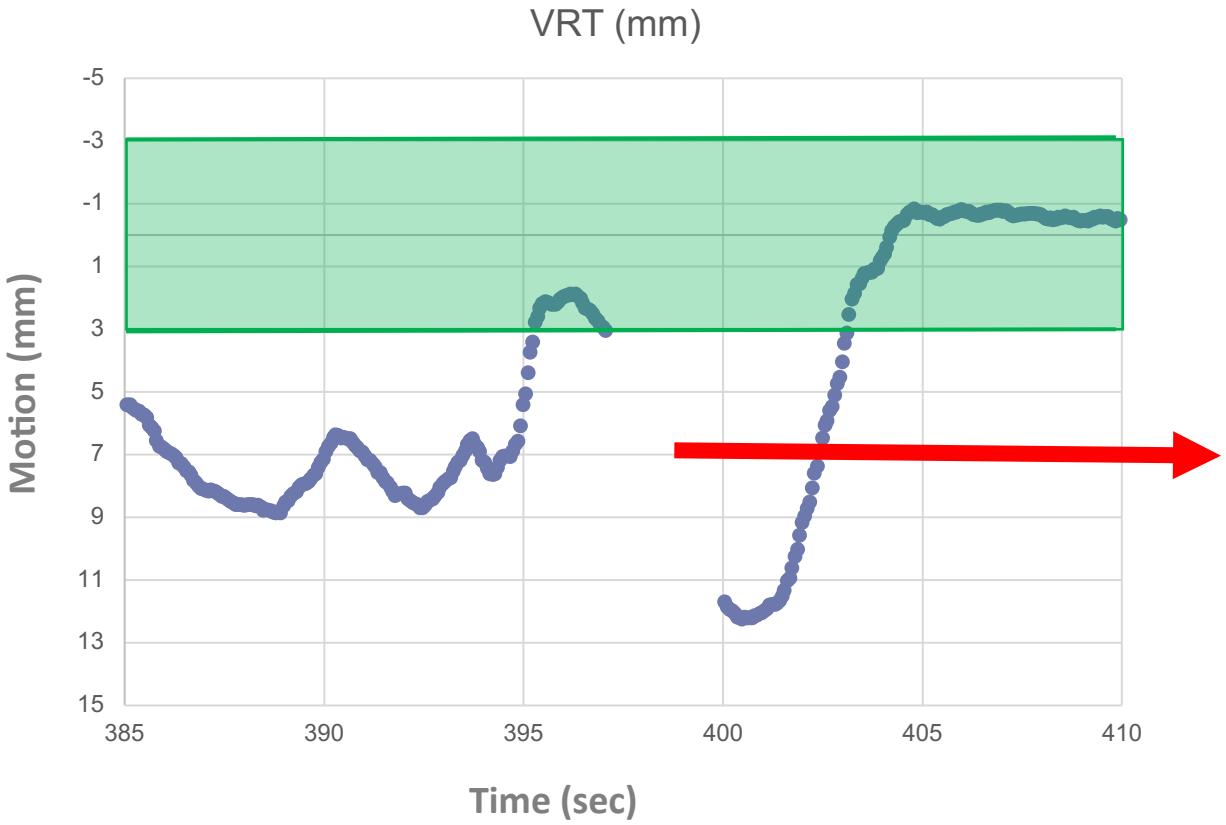
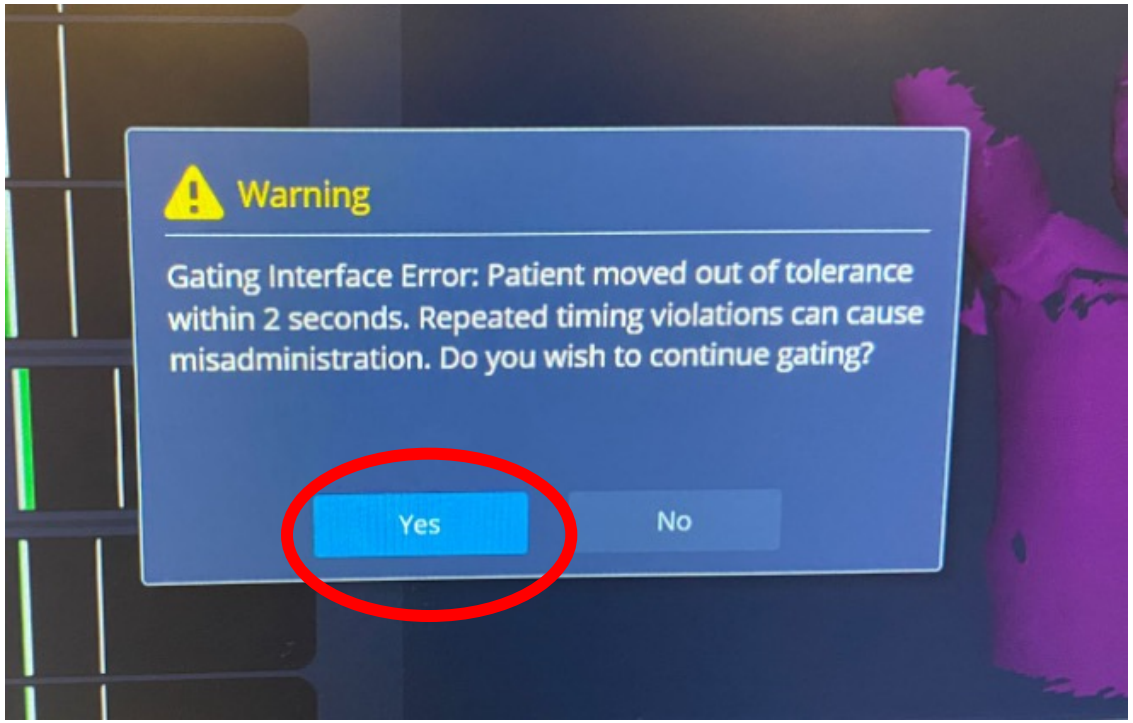
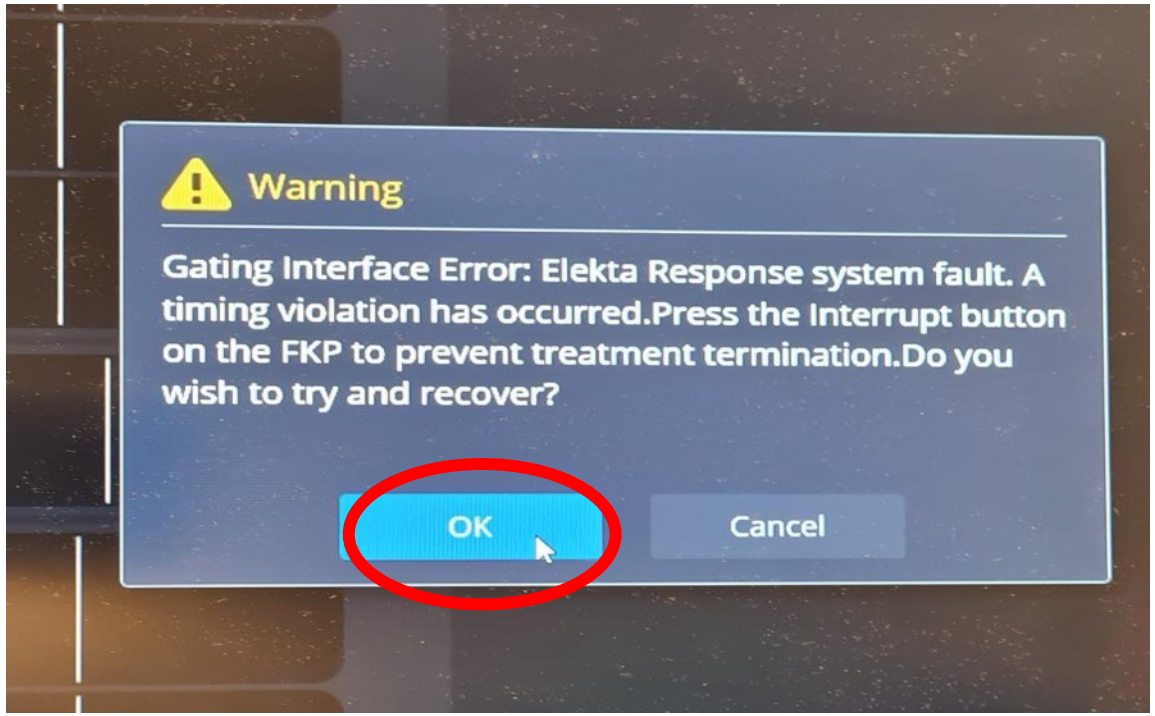
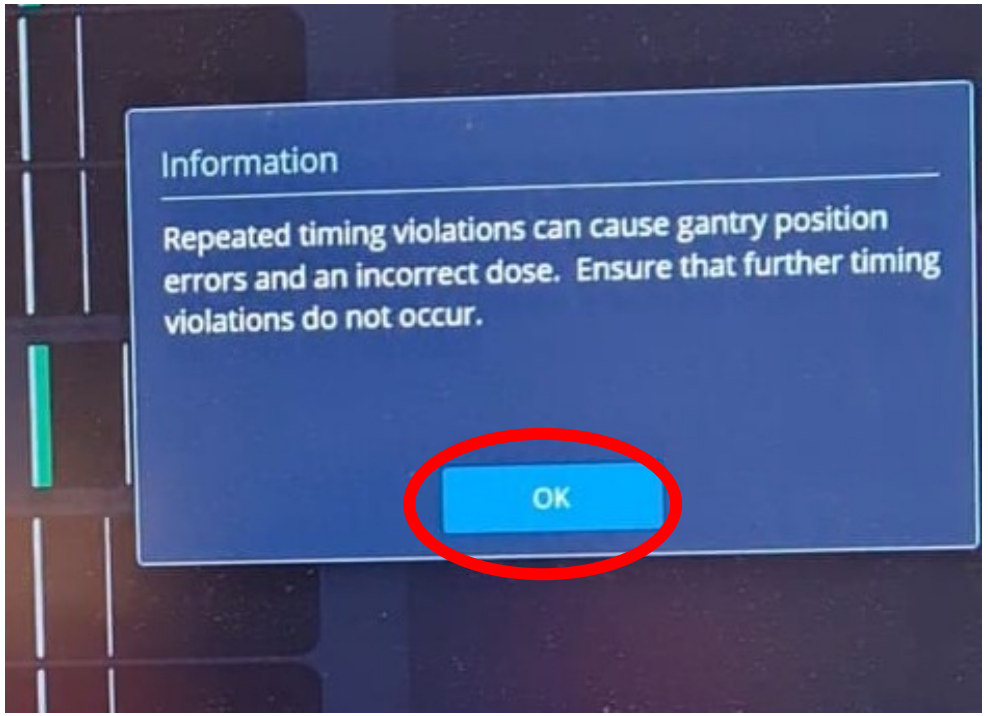
If 1st deep inspiration moves out of tolerance within 2 sec





After 4 times short Warning →





During a Warning

- No data collection
- Beam is not enabled

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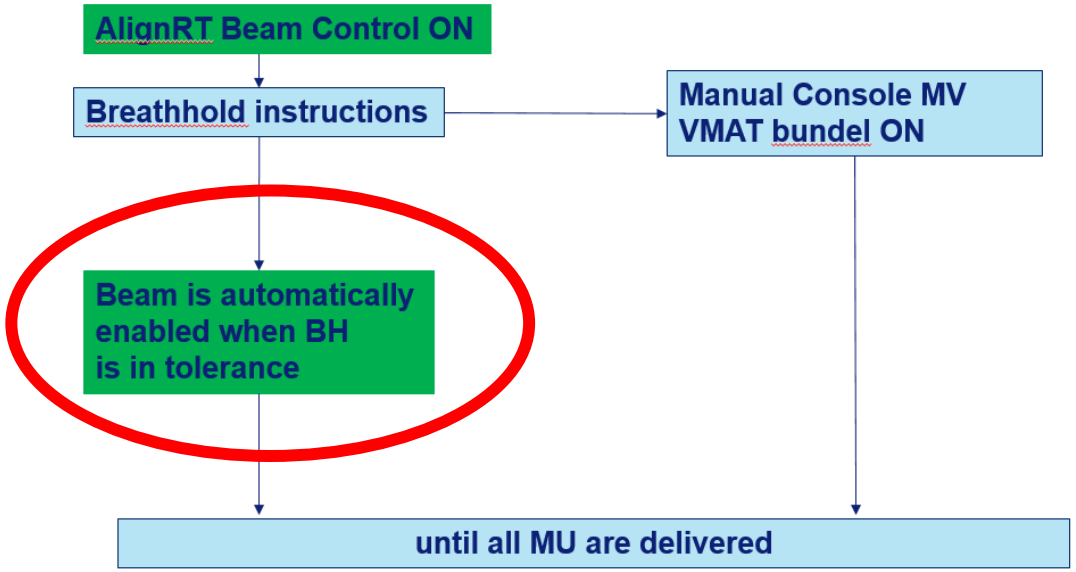
Workflow



With Warning

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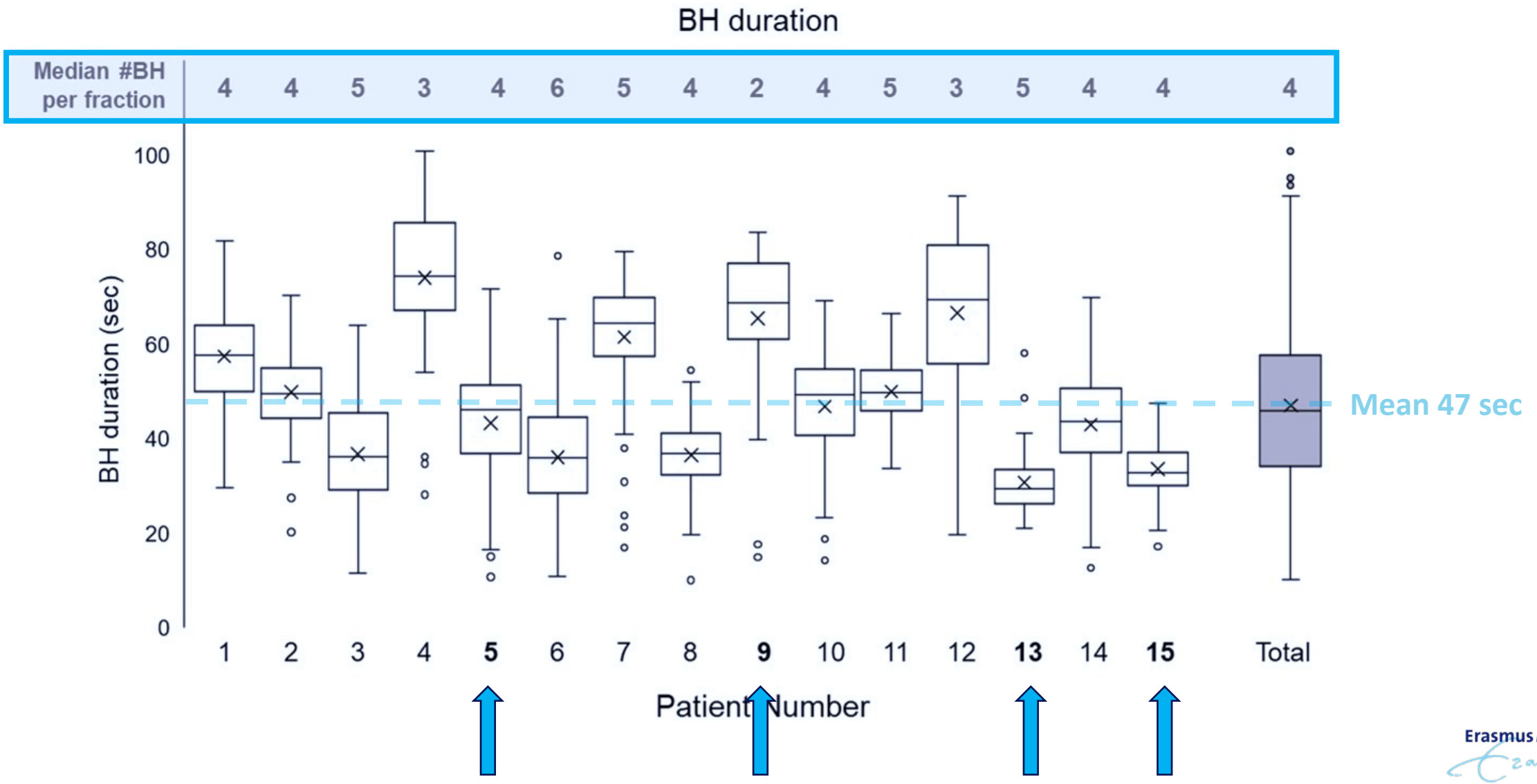
Results – BH analysis



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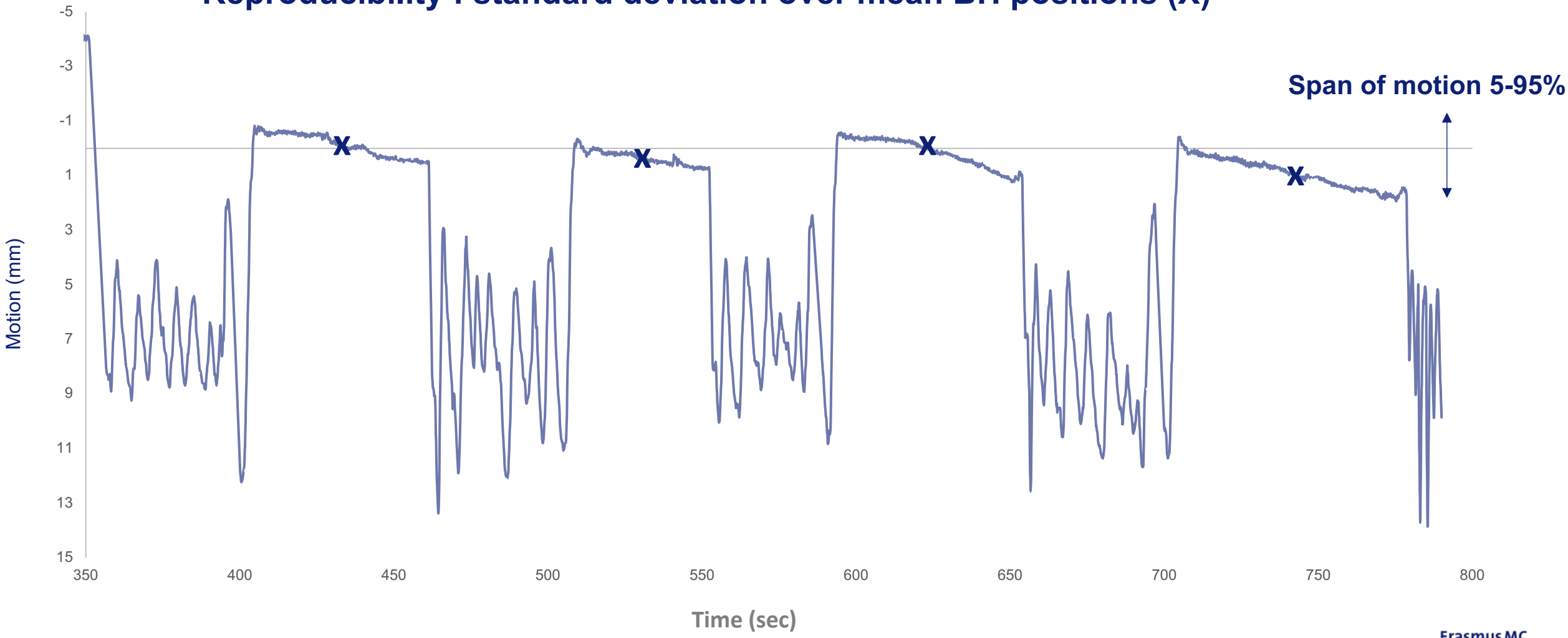
Results – BH analysis

- Stability: Span of motion 5-95% within one BH
- Reproducibility : standard deviation over mean BH positions (X)



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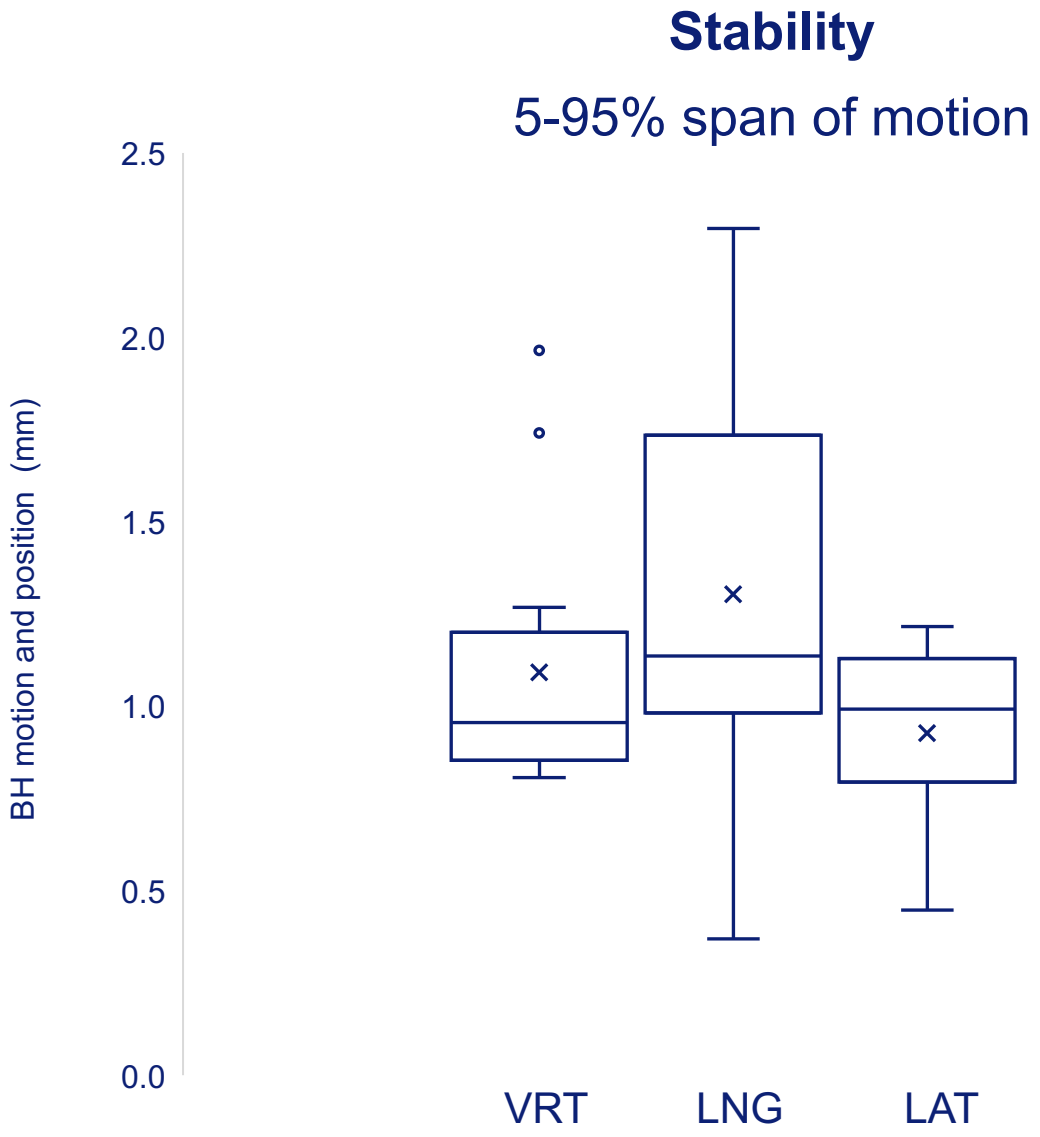
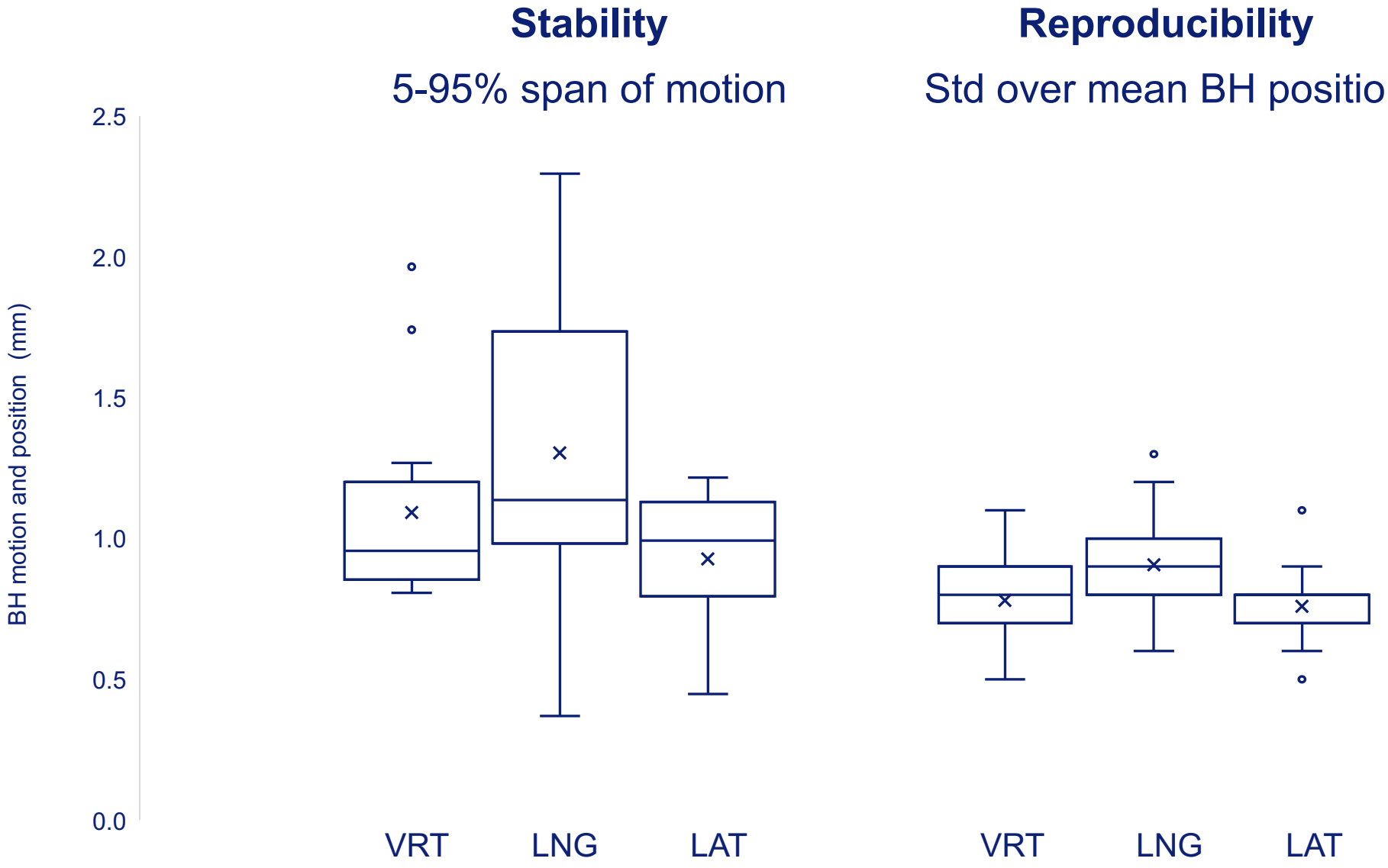
Results – BH analysis



Results – BH analysis



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Discussion

- ‘Belly breathers’ ➔ manually perform procedure
- BH instructions patient dependent
- Also without 1st inspiration → stable BH

Conclusions

- ✓ Safely introduced combined VMAT-gated-DIBH for left-sided breast
- ✓ Patients accomplished prolonged BHs (mean 47 sec)
- ✓ Prolonged BHs were stable and reproducible (both with/without instructions)

- Time warnings require manual action

Future work: Reconstruct dosimetric effects based on BH position

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Wesley Bernaards
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Marjolein Verstraate
Patrick Granton
Carly van Aartrijk-Noordermeer
Kay van Nielen
Joan Penninkhof

VisionRT
Kim Anema
Martijn Oosterveen
Martin Allen

Questions?

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