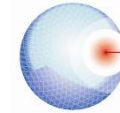




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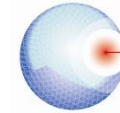


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# *Patient movement and millimetre accurate positioning*

SZHH markerless RT since 2021

Rayk Nachtigall, medical physicist

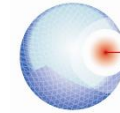


- „Strahlenzentrum Hamburg MVZ“
- Implementation and experience
- Patient movement
  - Thorax
  - Abdomen/Pelvis
  - Head & Neck

# Strahlenzentrum Hamburg MVZ



Strahlenzentrum Hamburg MVZ



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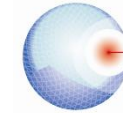
- Founded in 2007 (PD Dr. med. F. Fehlauser)
- 2007 paper- and filmless
- 2008 IMRT/SBRT
- 2011 Cyberknife



# Strahlenzentrum Hamburg MVZ



Strahlenzentrum Hamburg MVZ



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- 2 sites with 50 employees
  - Site Hamburg
    - 2 Elekta linacs (Harmony Pro + Versa HD)
    - 1 Cyberknife
  - Site Elmshorn
    - 1 Varian Clinac DHX



# Implementation and experience

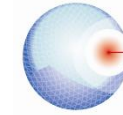


- 2008 introduction ABC gating Elekta
- 2019 decision to use SGRT
  - SGRT site visits (heads of RTT and physics)
  - result: AlignRT is more intuitive and understandable
- 1<sup>st</sup> March 2021 installation AlignRT and SafelD

# Implementation and experience



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- 30<sup>th</sup> April go live – all indications

## Thorax RT

- 30<sup>th</sup> June 2021 markerless

## Other malignant entities

- August 2021 markerless

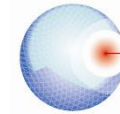
- 23<sup>rd</sup> November 2021 Markerless Award



# Implementation and experience

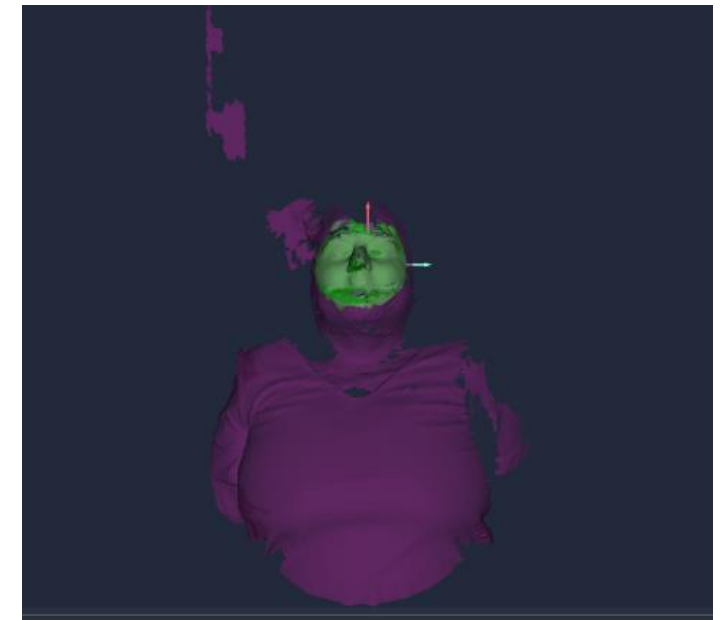


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- Since October 2022 head & neck
- Open mask
- Result of our experience,  
and gain confidence for maskless



# Patient movement Entities



- Thorax
  - Free breath 203 patients → 4000+ fractions
  - DIBH 76 patients → 1400+ fractions
- Abdomen/Pelvis
  - 40 patients → 920+ fractions
- Head & Neck (open mask)
  - 20 patients → 370+ fractions



# Patient movement Analysis

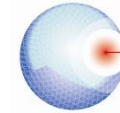


- Gaussian-Analysis
  - 6000+ data entries per dimension per fraction
  - Mean position  $\mu$ , deviation  $\sigma$
  - Spacial vector  $v$ , integrated patient movement margin  $m_{99\%}=2.5 \sigma_v$

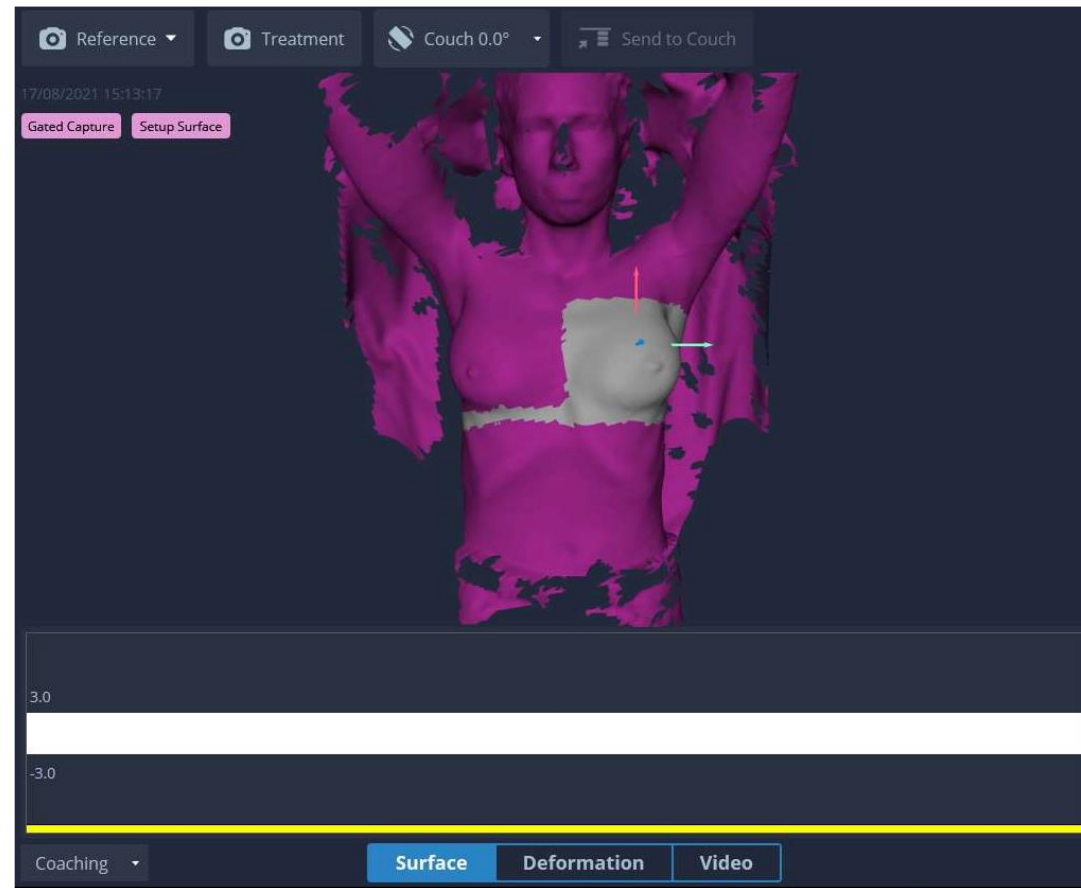
# Thorax



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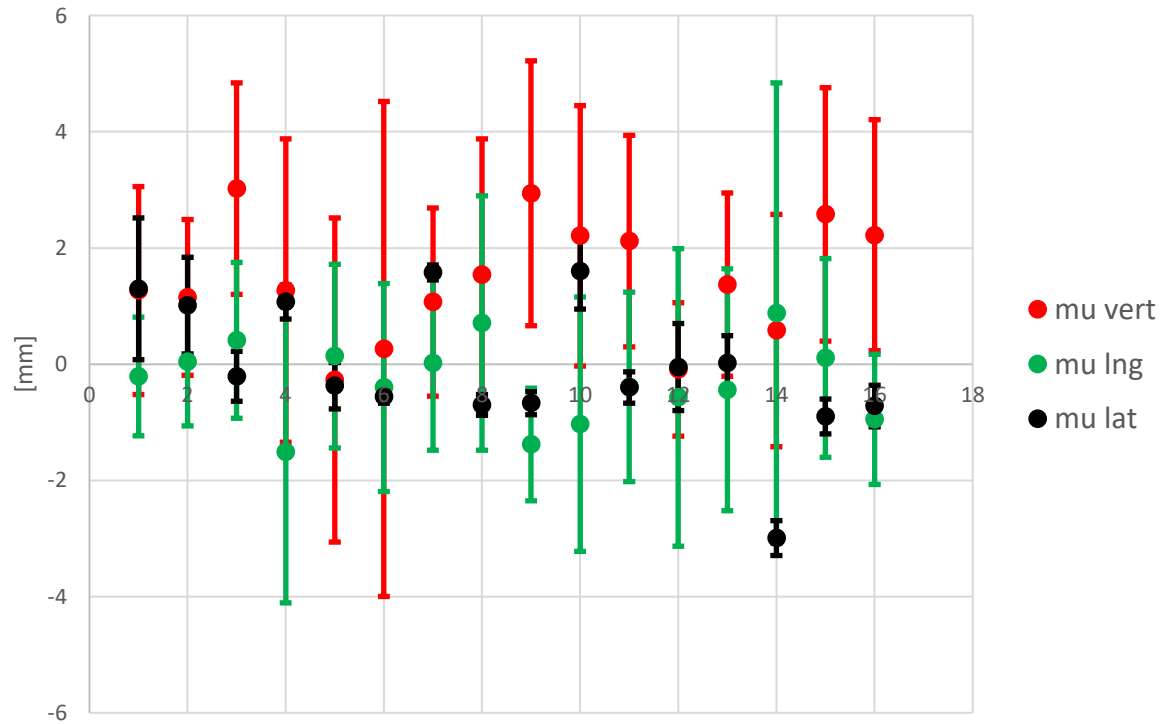
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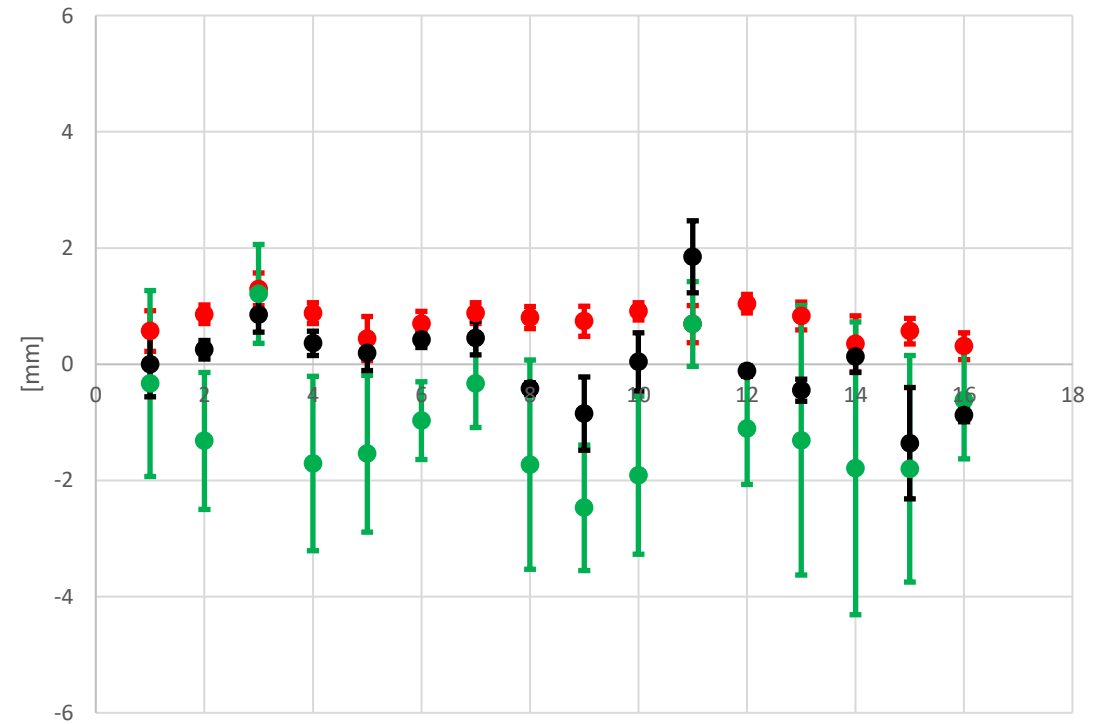
# Thorax

inter treatment example

### FB

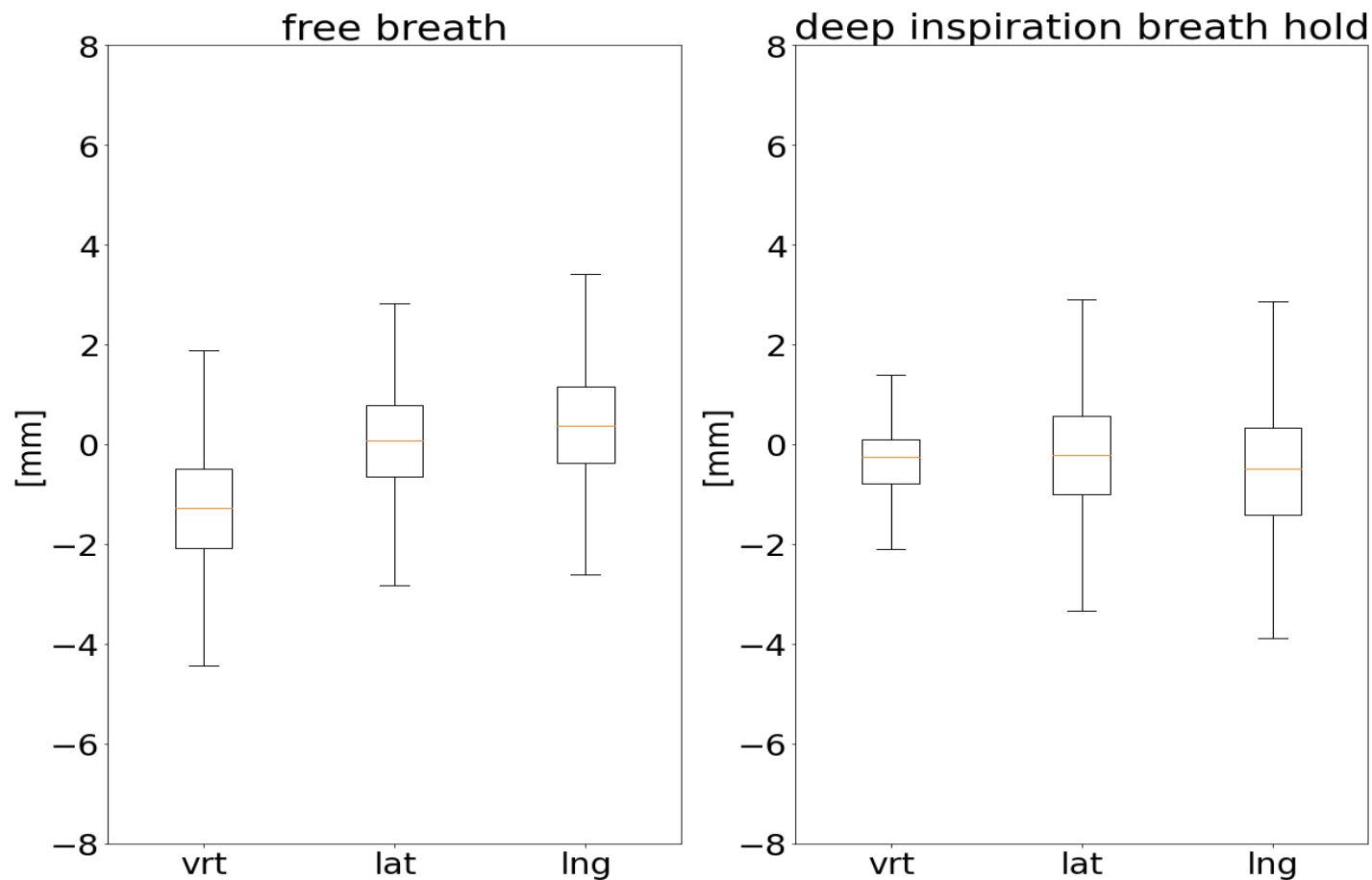


### DIBH



# Thorax

## mean patient position



$\mu \pm \sigma$  (FB)

-1.3  $\pm$  1.2 mm vrt

0.1  $\pm$  0.7 mm lat

0.4  $\pm$  1.1 mm lng

$\mu \pm \sigma$  (DIBH)

-0.3  $\pm$  0.7 mm vrt

-0.2  $\pm$  0.8 mm lat

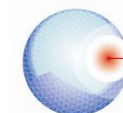
-0.5  $\pm$  1.3 mm lng

# Thorax

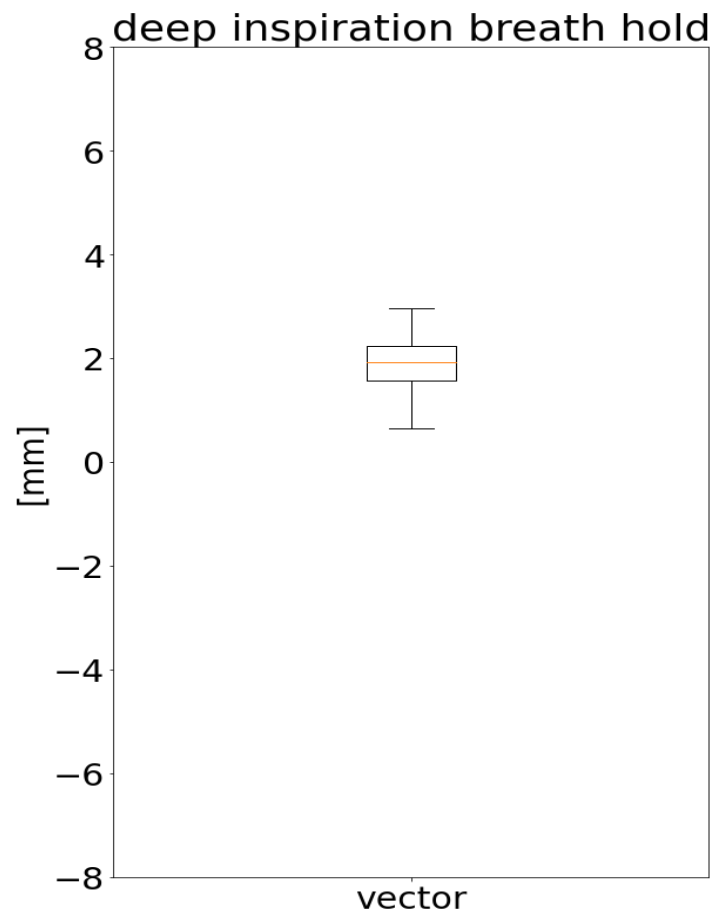
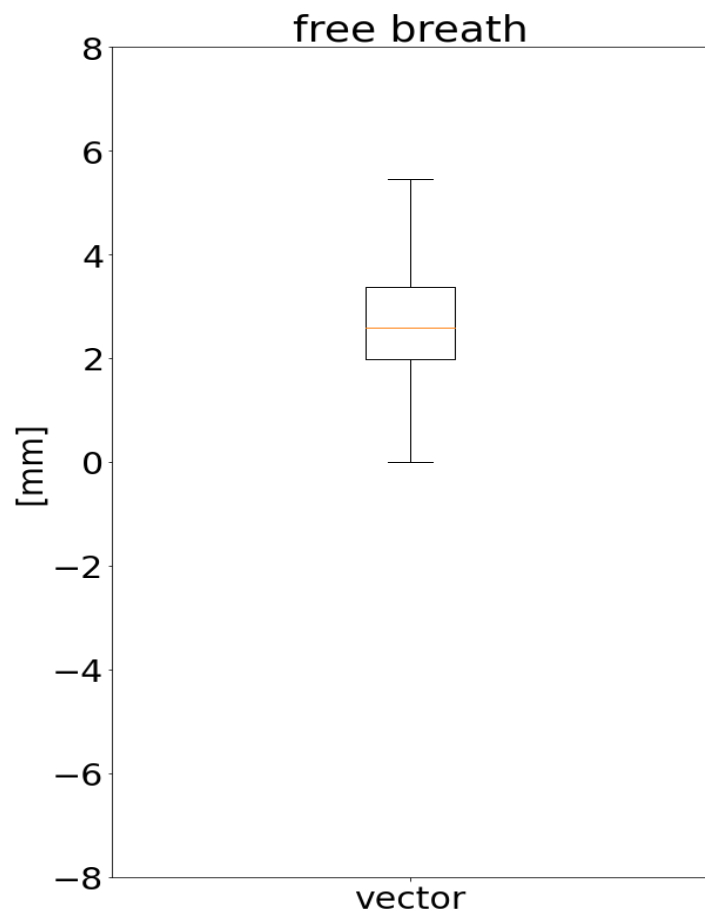
## patient position vector



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FB

$2.75 \pm 1.09$  mm  
 $m_{99\%} = 2.73$  mm

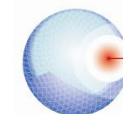
DIBH

$1.89 \pm 0.58$  mm  
 $m_{99\%} = 1.45$  mm

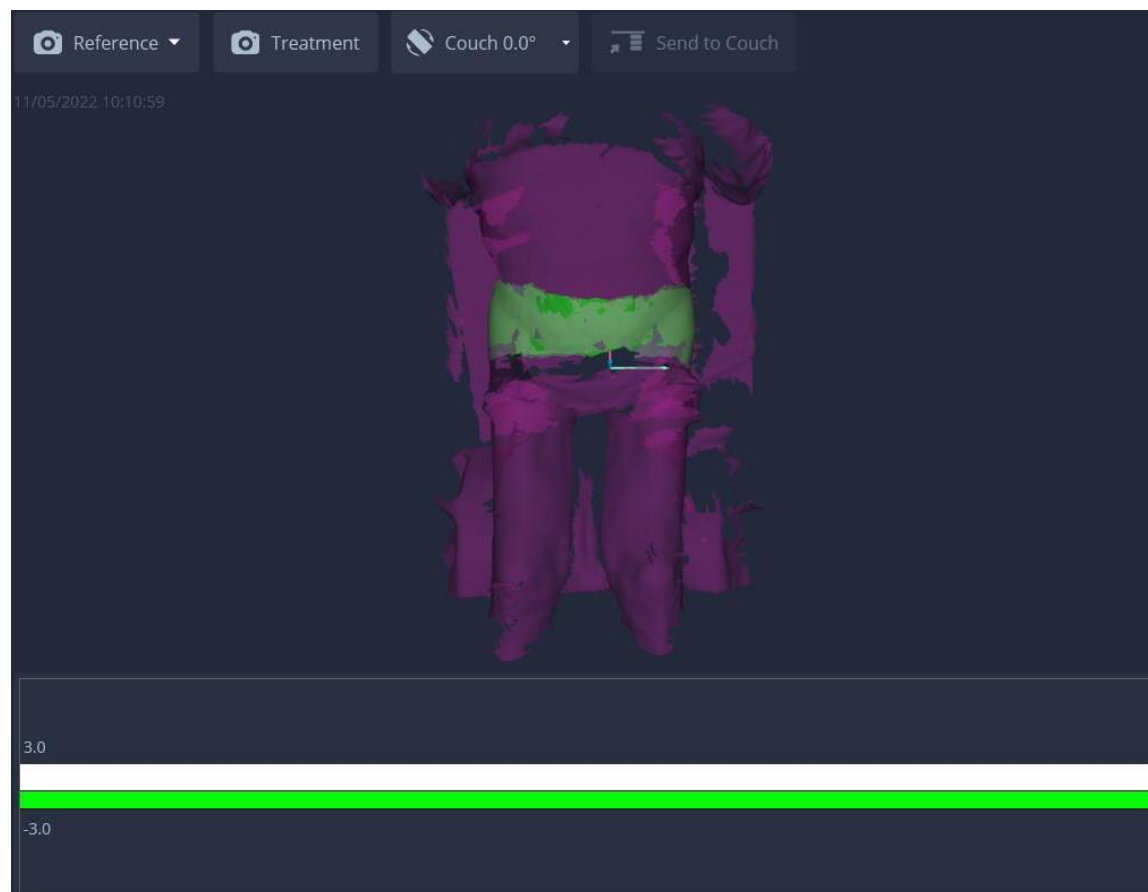
# Abdomen/Pelvis



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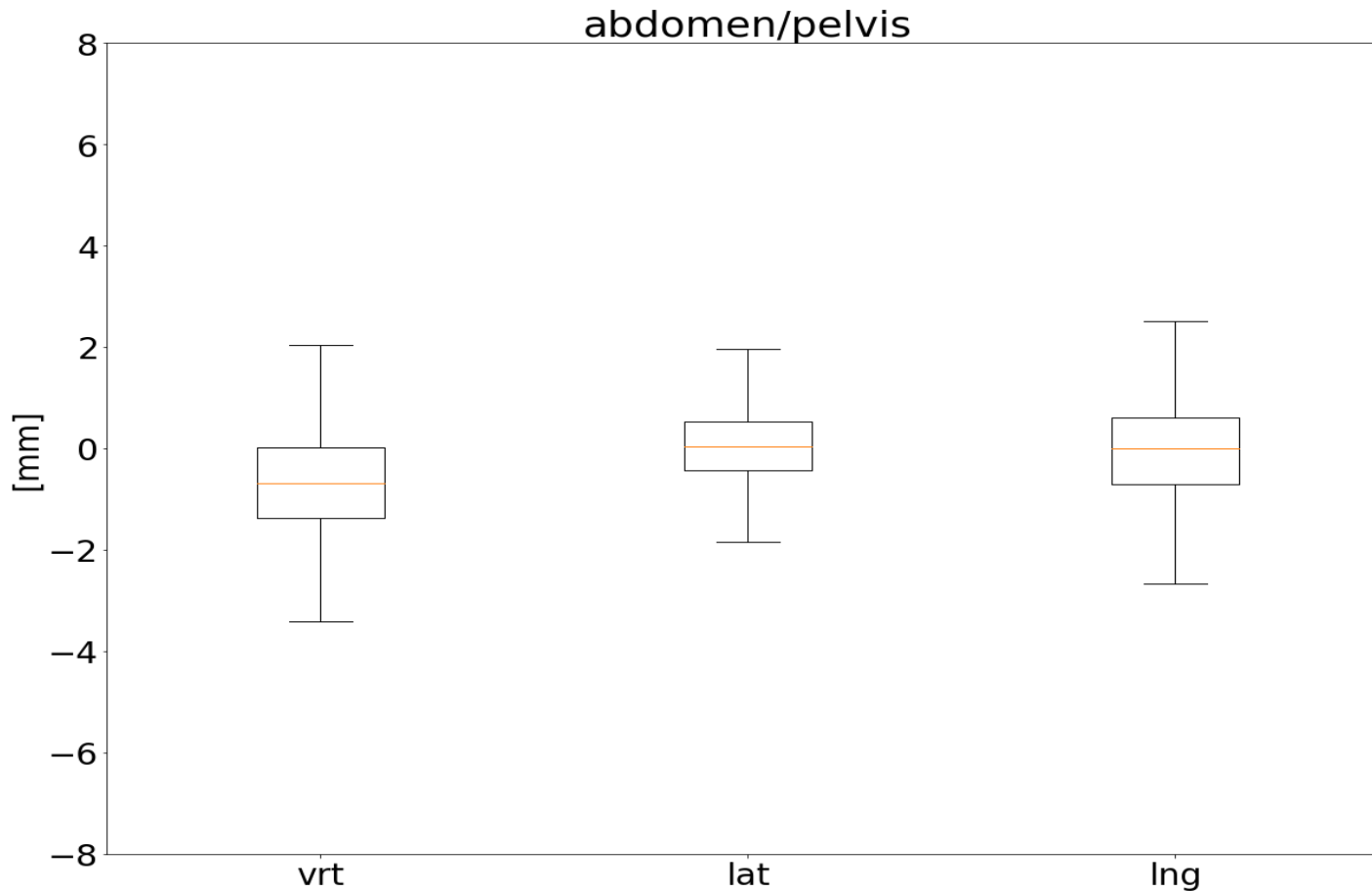


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# Abdomen/Pelvis

mean patient position



$\mu \pm \sigma$

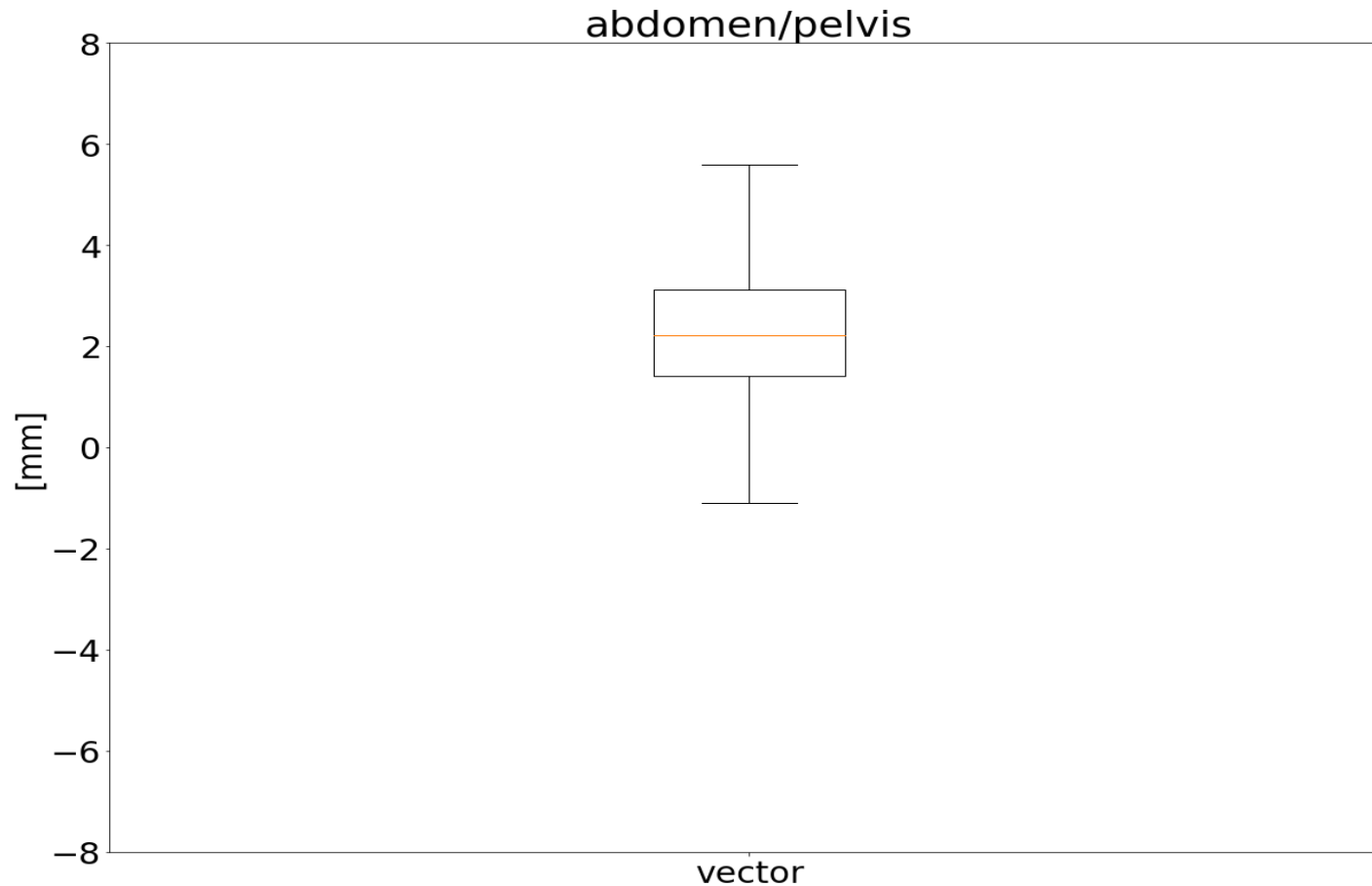
$-0.5 \pm 0.9$  mm vrt

$0.1 \pm 0.6$  mm lat

$0.0 \pm 1.3$  mm lng

# Abdomen/Pelvis

patient position vector



spacial vector

$2.22 \pm 1.10$  mm

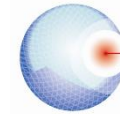
$m_{99\%} = 2.75$  mm



# Head & Neck



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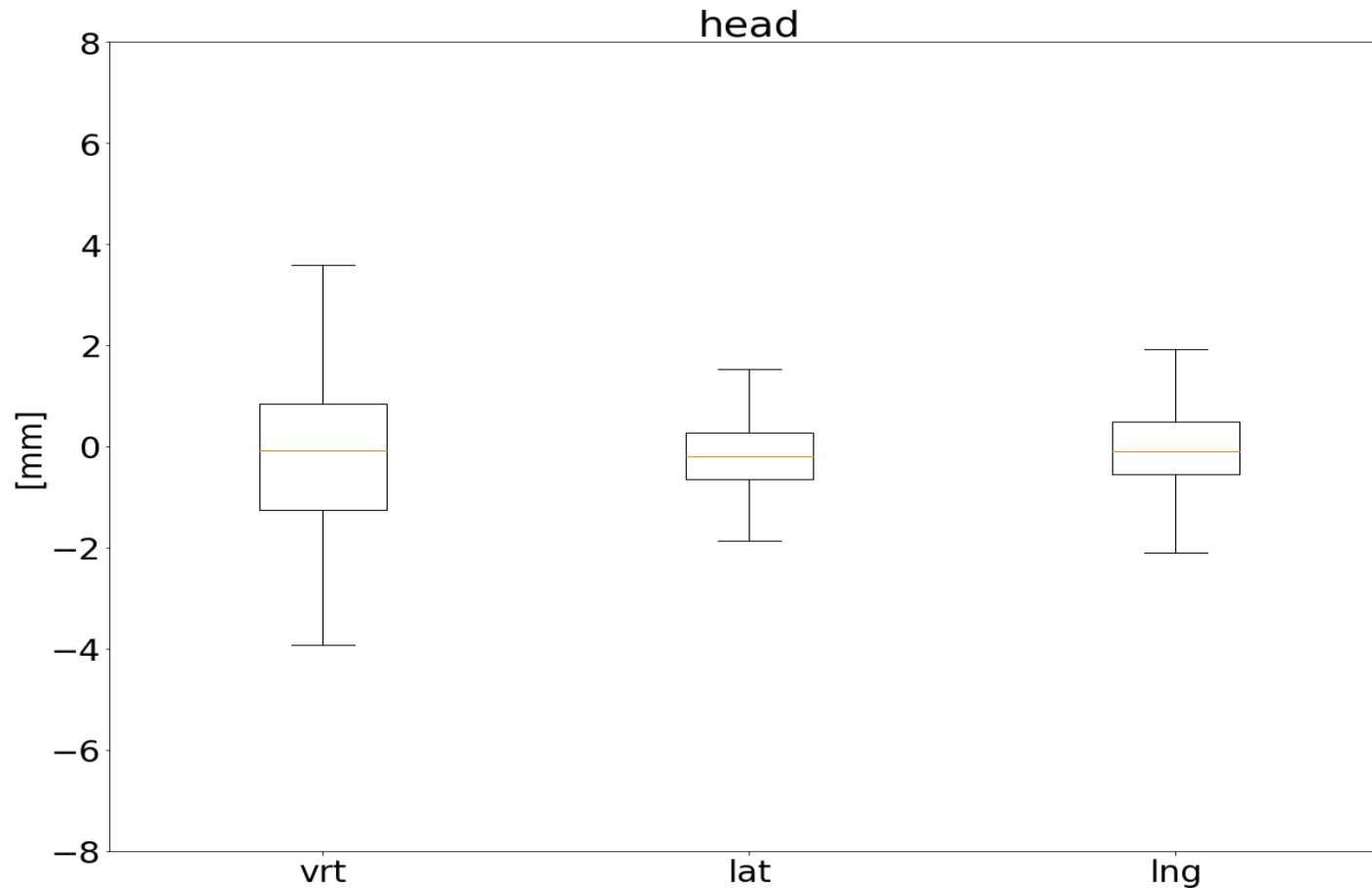


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# Head & Neck

mean patient position



$\mu \pm \sigma$

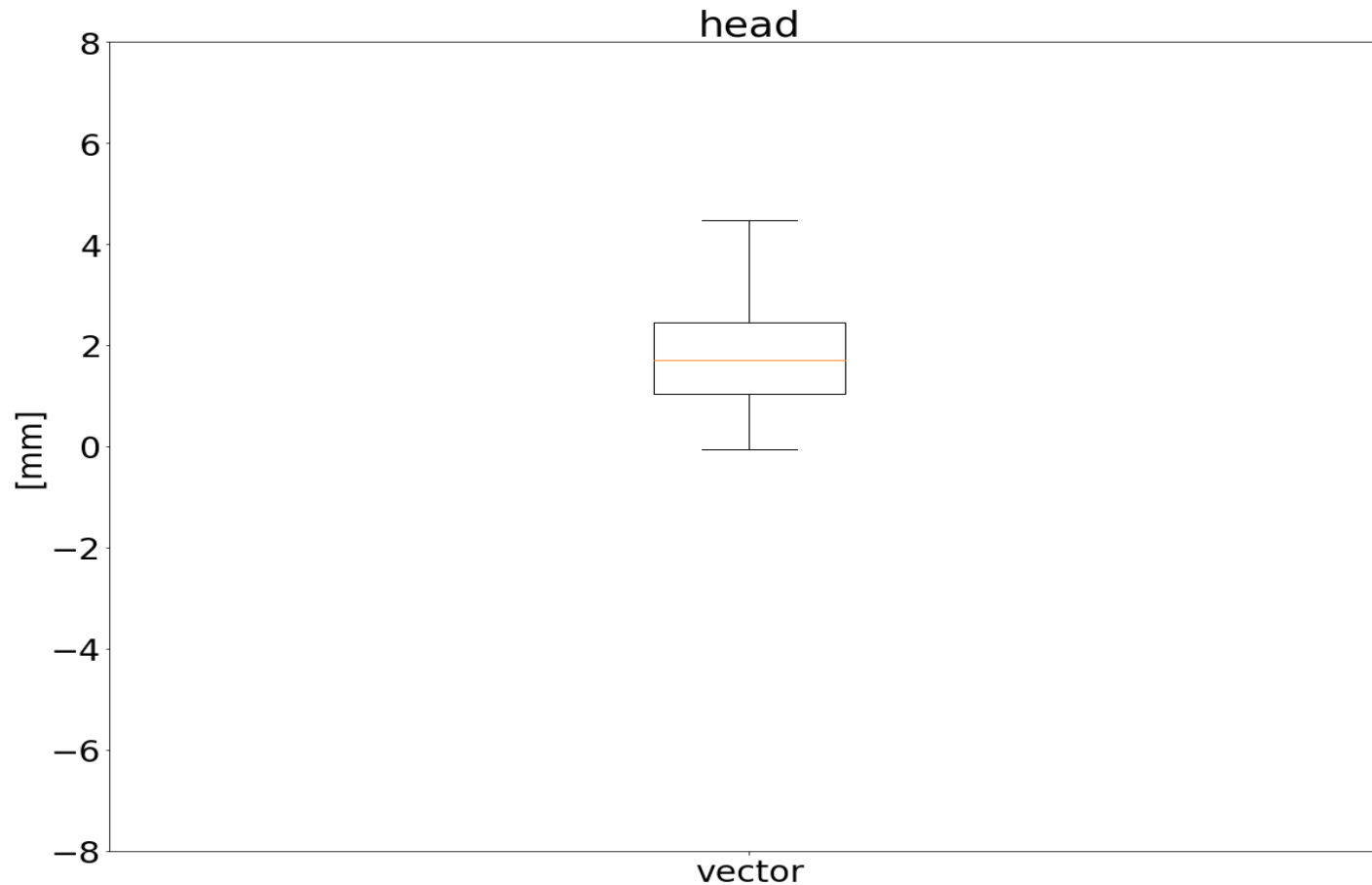
$-0.2 \pm 0.5$  mm vrt

$-0.2 \pm 0.5$  mm lat

$0.0 \pm 0.5$  mm lng

# Head & Neck

## patient position vector



spacial vector

$$1.80 \pm 0.38 \text{ mm}$$

$$m_{99\%} = 0.95 \text{ mm}$$

# Patient movement conclusion



Thorax

$m_{99\%}(\text{FB}) = 2.73 \text{ mm}$   
 $m_{99\%}(\text{DIBH}) = 1.45 \text{ mm}$

Abdomen/Pelvis

$m_{99\%} = 2.75 \text{ mm}$

Head & Neck

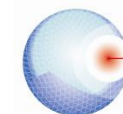
$m_{99\%} = 0.95 \text{ mm}$

- DIBH recommendation for all thoracic RT
- 2 mm safety margin is possible
- Open masks and SGRT more than sufficient

# Thank you!



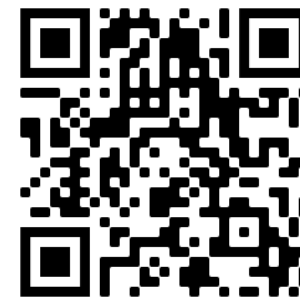
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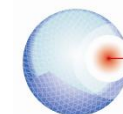
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# You're invited to visit us in Hamburg



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