The Robustness of Markerless Radiation Therapy in the Pelvis Region by Using SGRT with a Bore-based Linac

Yoshifumi Oku

Dept. of Radiology, Divi. of Medical Technology,
Kagoshima University Hospital, Japan

KAGOSHIMA UNIVERSITY

Disclosure of conflict of interest (COI)

- ✓ I have received sponsorship from Vision RT in order to attend this symposium.

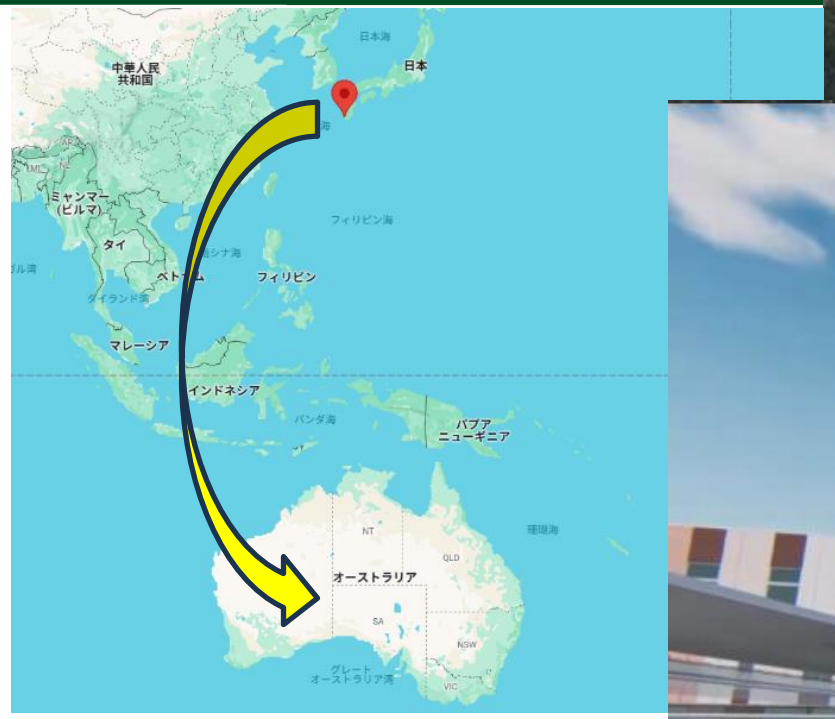
Outline

- Kagoshima University Hospital
- Characteristics of detection accuracy (Phantom and Clinical Study)

Outline

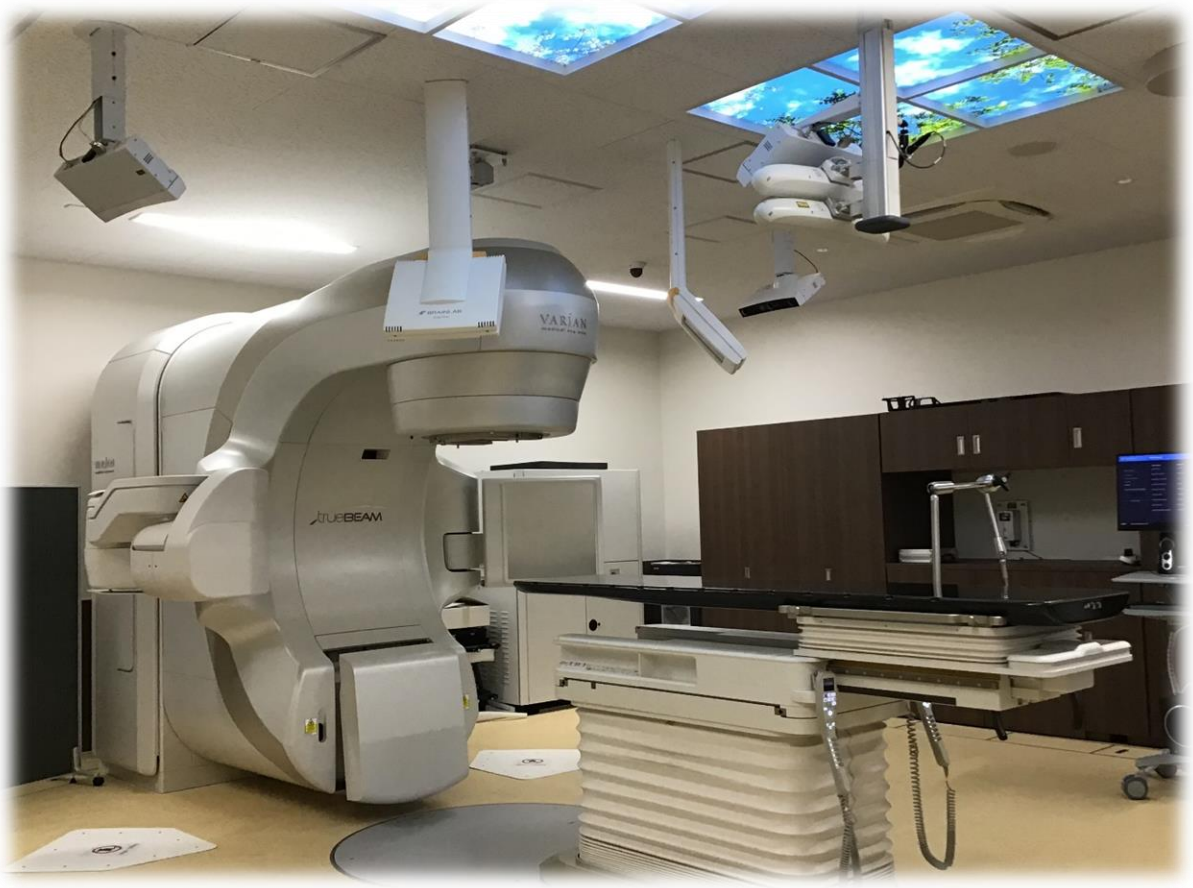
- Kagoshima University Hospital
- Characteristics of detection accuracy (Phantom and Clinical Study)

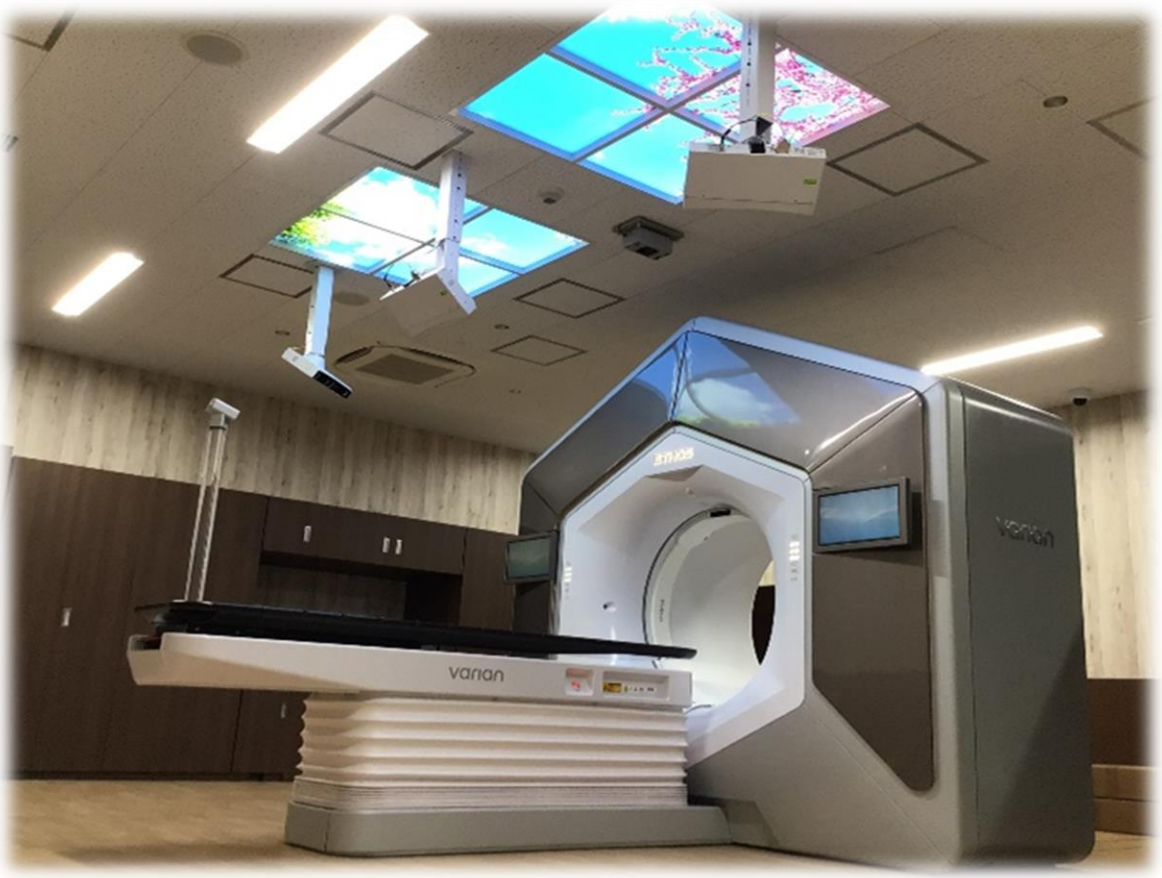
Kagoshima University Hospital



KAGOSHIMA UNIVERSITY

Radiation Oncology department

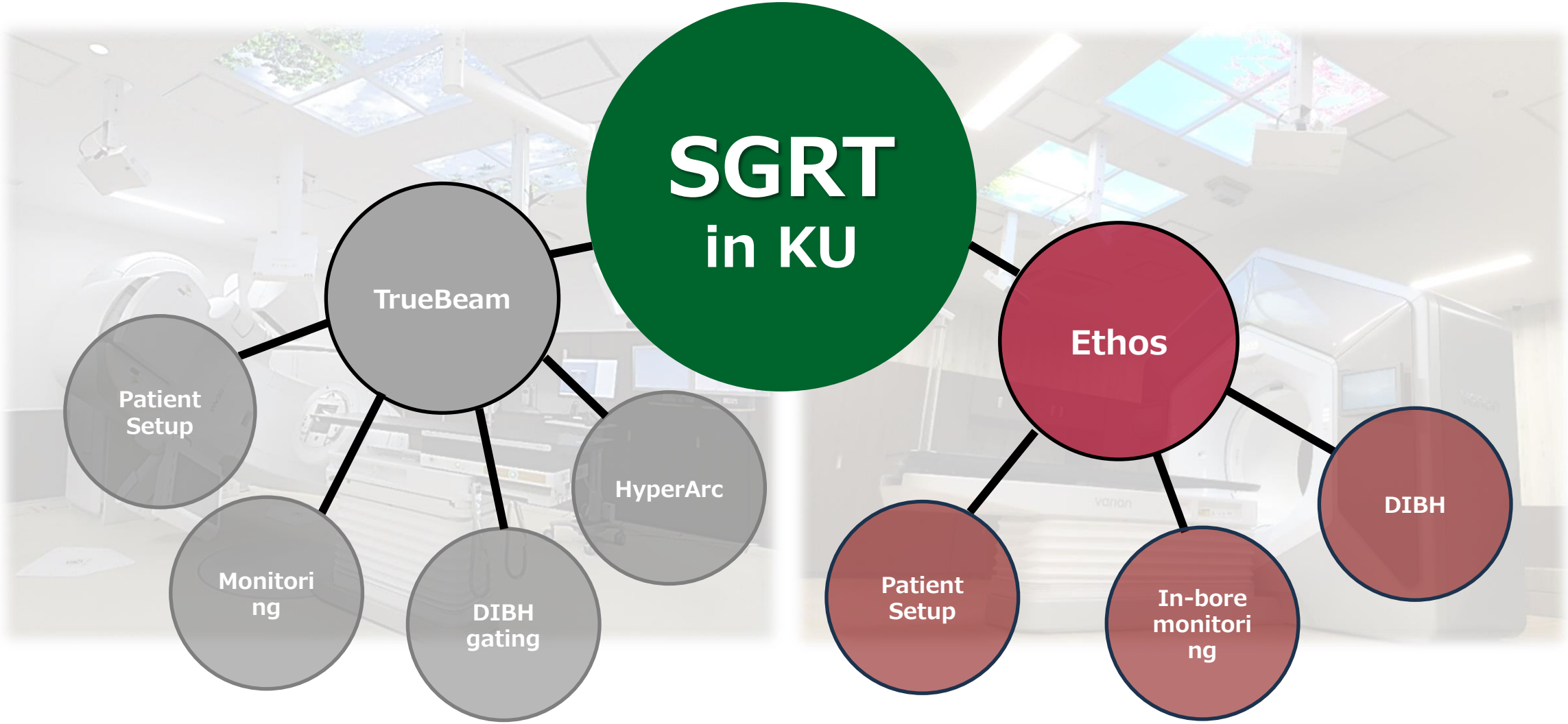




+ AlignRT (VisionRT Lt.)

+ AlignRT (VisionRT Lt.)
+ AlignRT-InBore (VisionRT Lt.)

Radiation Oncology department



History of SGRT in KU

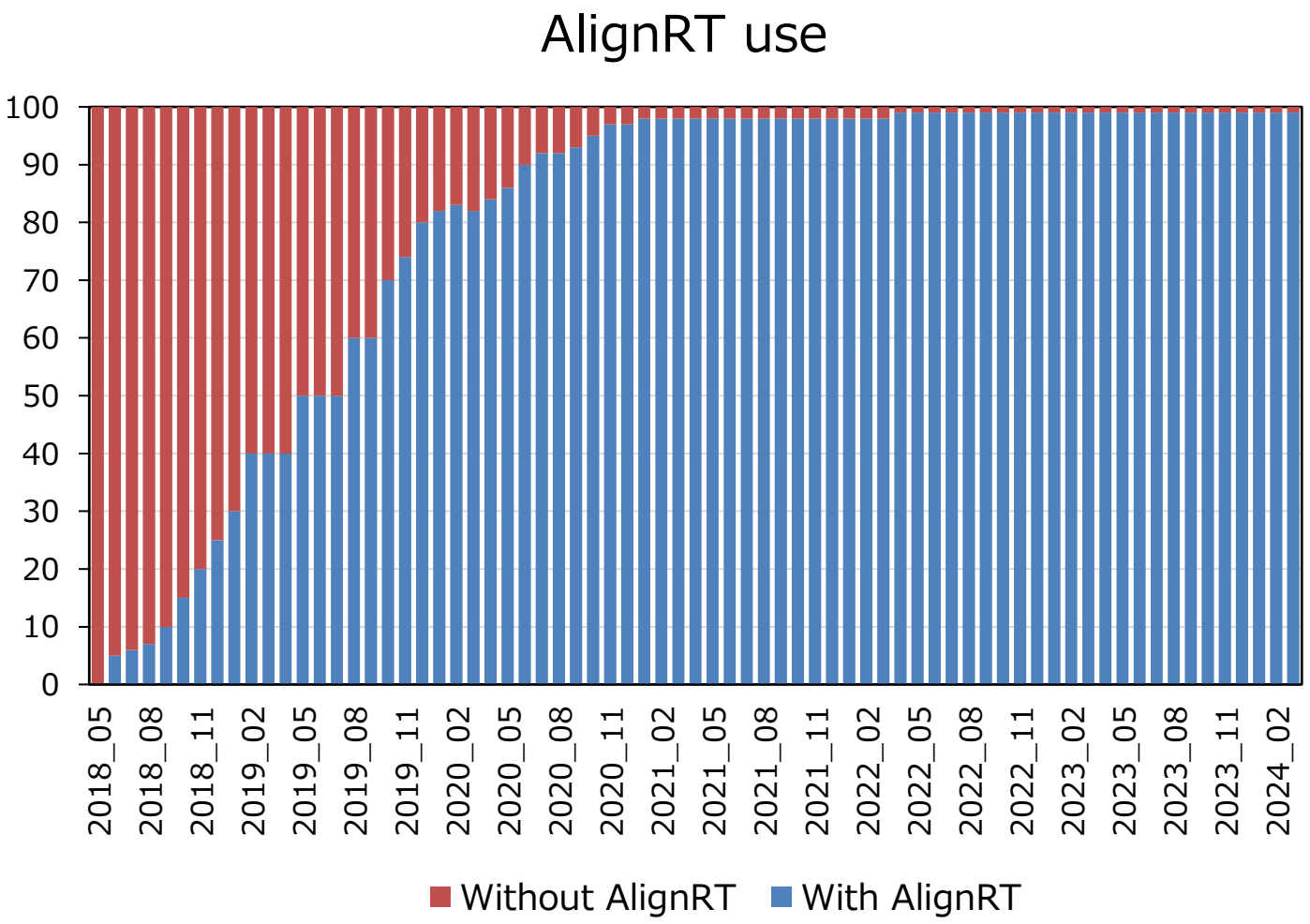
May 2018: 1st install on TrueBeam

June 2018: Setup of patient

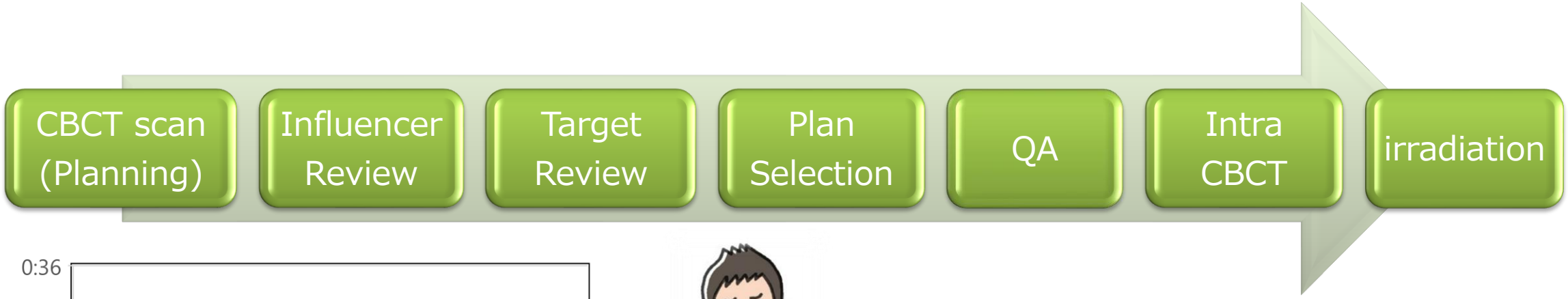
April 2019: DIBH (Breast, SBRT)

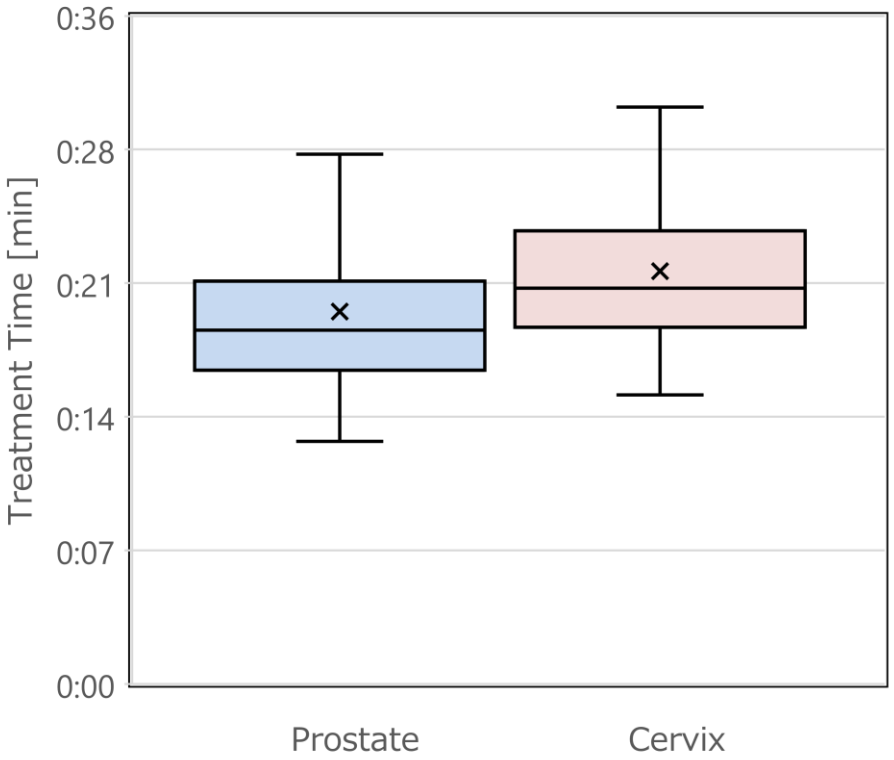
May 2022: 1st install on Ethos
AlignRT+AlignRT-InBore

June 2022: Setup of patient



On-line Adaptive in KU





- Important issue to be addressed during online adaptive radiation therapy.
- A precise assessment of the object detection accuracy is required.

SGRT for O-ring systems

From the view point of the spread of O-ring Radiotherapy System,

Problems were ...

① Optical line of sight limitations

② Difficult to correct for rotation errors

③ Intra-fractional motion during treatment

SGRT for O-ring systems

➢ Workflow

Step 1: Patient setup in front of the bore in Setup "isocenter" using SGRT with AlignRT

3-camera setup

Step 2: Shift into the bore + Delta Couch
(Shift between setup point and isocenter)

In-bore camera setup and monitoring

SGRT is helpful to localize the patient positioning accurately

Outline

- Kagoshima University Hospital

- Characteristics of detection accuracy (Phantom and Clinical Study)

Purpose

To assess the positioning accuracy of the patient setup with AlignRT-InBore system.

Methods / Equipment

Treatment system	
Radiotherapy machine	ETHOS Therapy (Varian)
Motion management system	AlignRT - InBore (VisionRT)
Motion device	QUASAR™ (Modus Medical Devices)
Female phantom	ERD Corporation

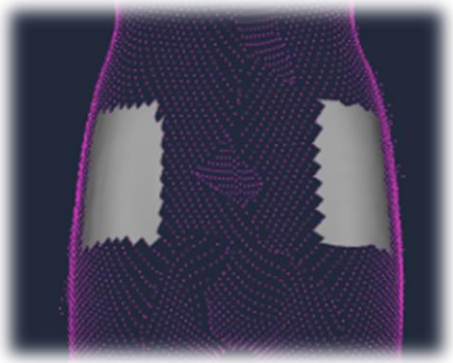
Patient characters		Total (n)
Patients		70
Age; median (range)	64 (24 - 82)	
Tumor location	Pelvis-male	45
	Pelvis-Female	25

Kagoshima University Institutional Review Board (Reference number: 220274).

Methods: workflow of setup

Obtain the image by In-bore → Set the ROI → Derive the displacement → Evaluation

Reference position,
Known displacement



Monitoring ROI was created on the pelvis region for all patient

Derive the phantom movement from Real time delta file (100ms) between static and dynamic.

Methods: workflow of setup

✓ Evaluation of displacement for three direction translation

Static

Systematic displacement

$$Mean = \frac{1}{n}\sum_{i=1}^{n}\overline{(x - x')}$$

n : number of data
x : phantom movement
x' : known displacement

Random displacement

$$SD = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Y_i - \bar{Y})^2}$$

$$Y_i = X_i - X'_i$$

Dynamic

Systematic displacement

$$Mean = \frac{1}{n}\sum_{i=1}^{n}\overline{(A_{target} - A_{reference})}$$

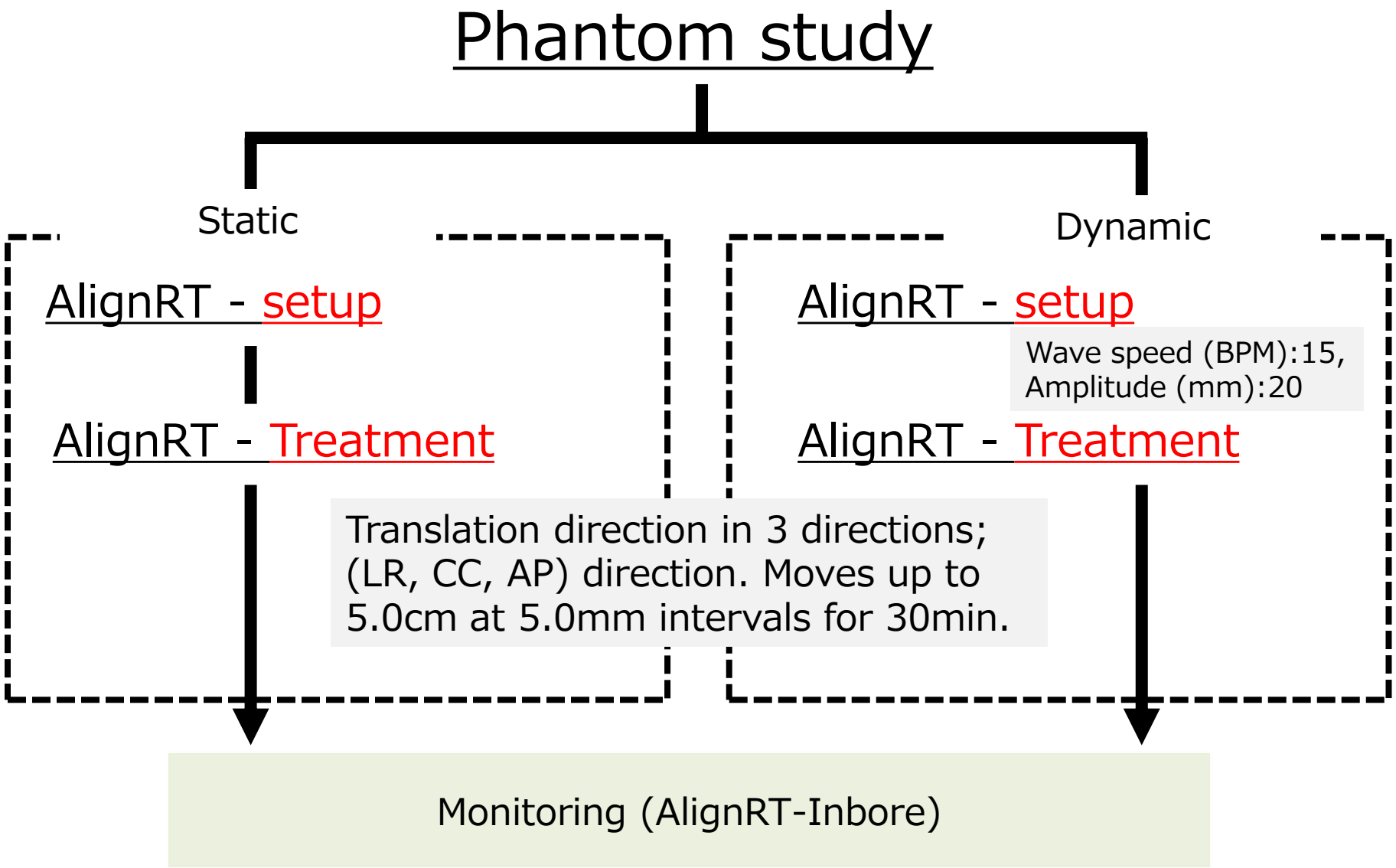
n : number of data
A : amplitude value

Random displacement

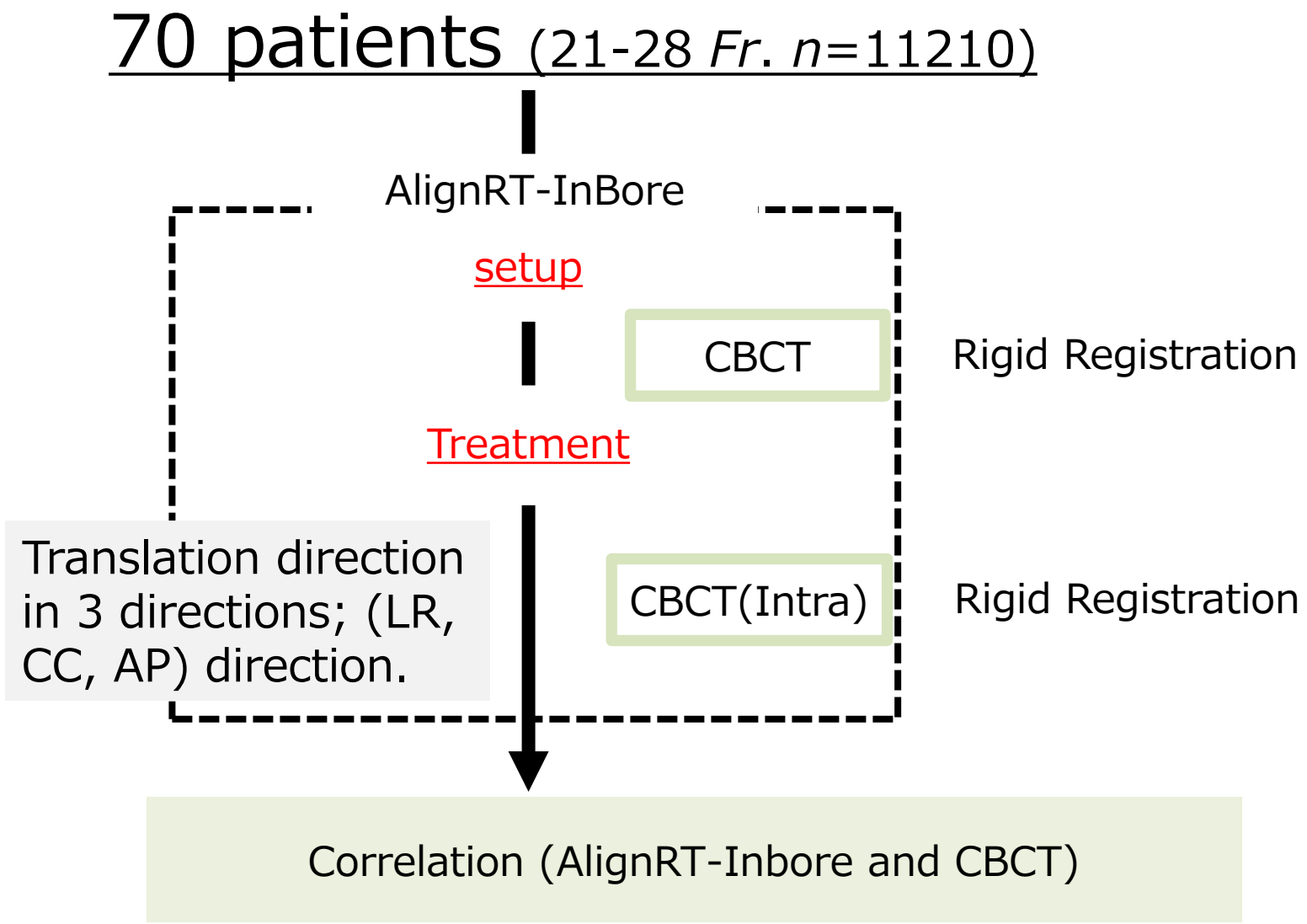
$$SD = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(B_i - \bar{B})^2}$$

$$B = |A_{target} - A_{reference}|$$

Methods: phantom study



Methods: clinical study



Methods: evaluation

(1) Phantom Positioning difference

Known displacement

(2) Phantom Positioning difference

Detectability of Static and Dynamic

(3) Positioning accuracy (during irradiation)

Reproducibility

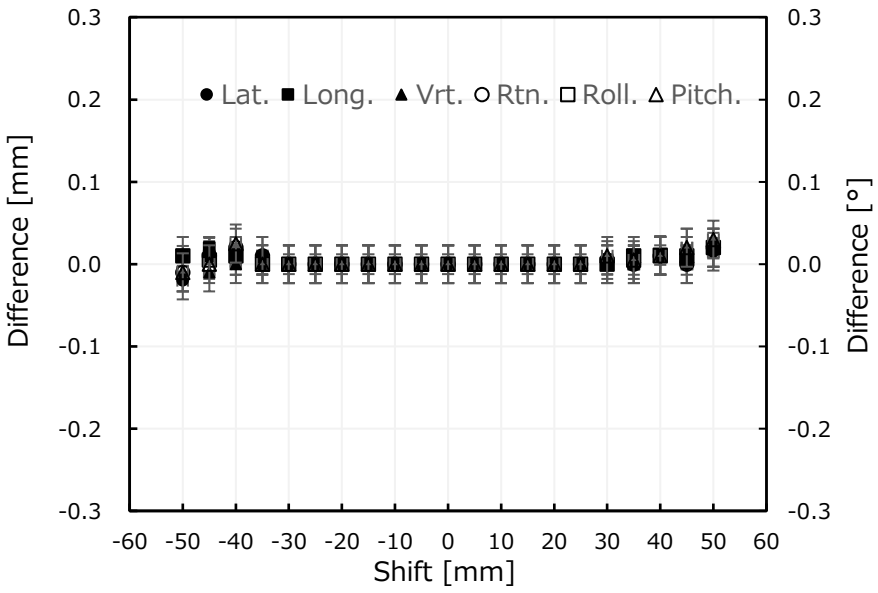
Evaluated with AlignRT-InBore

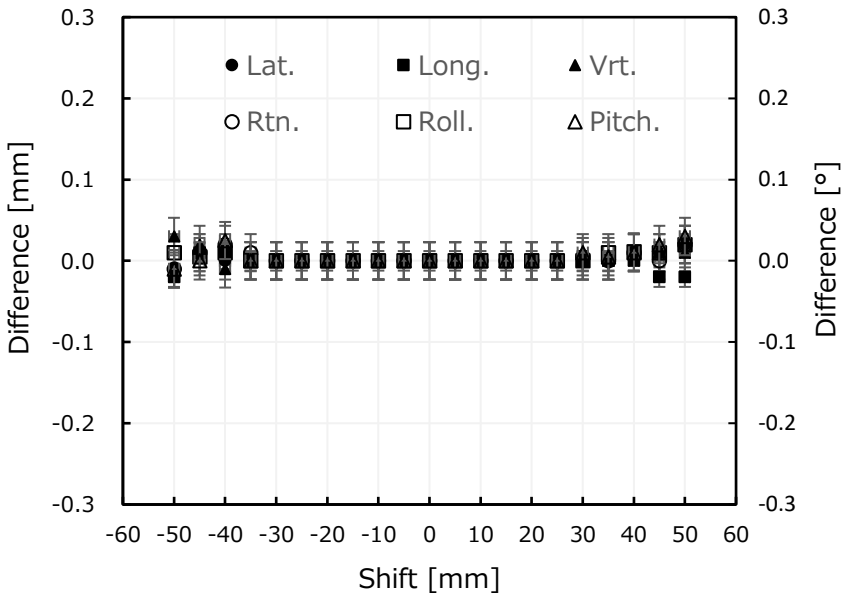
(4) Relations between the AlignRT- InBore and CBCT set-up errors

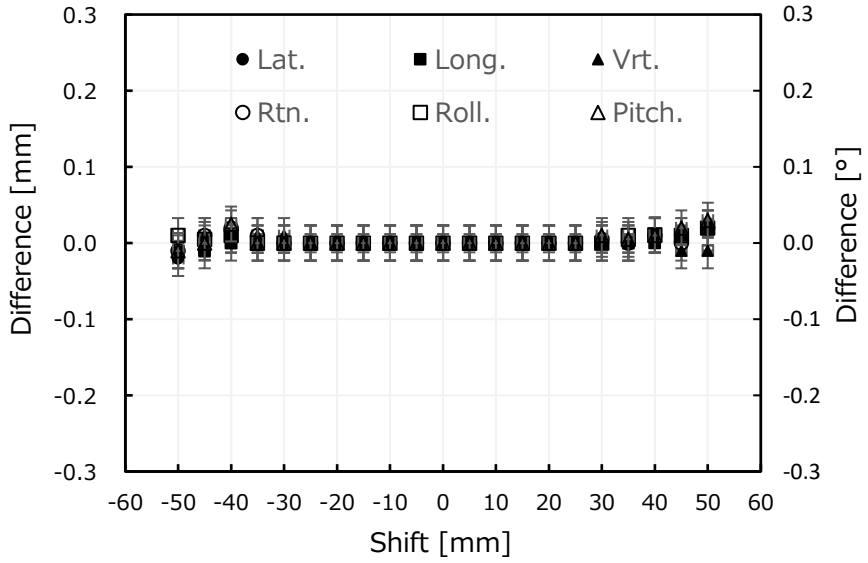
Peasons correlation coefficient test

Evaluated with AlignRT-InBore and CBCT

Results: known displacement





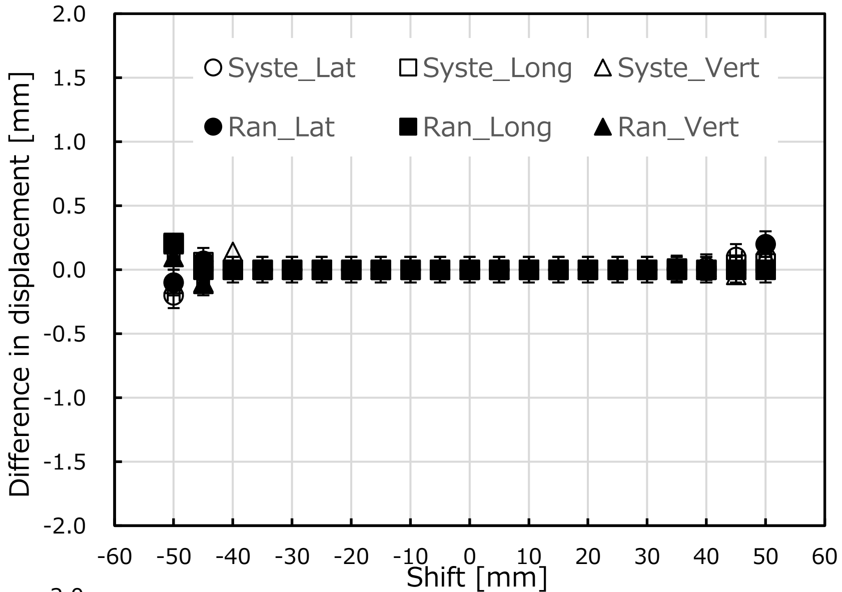


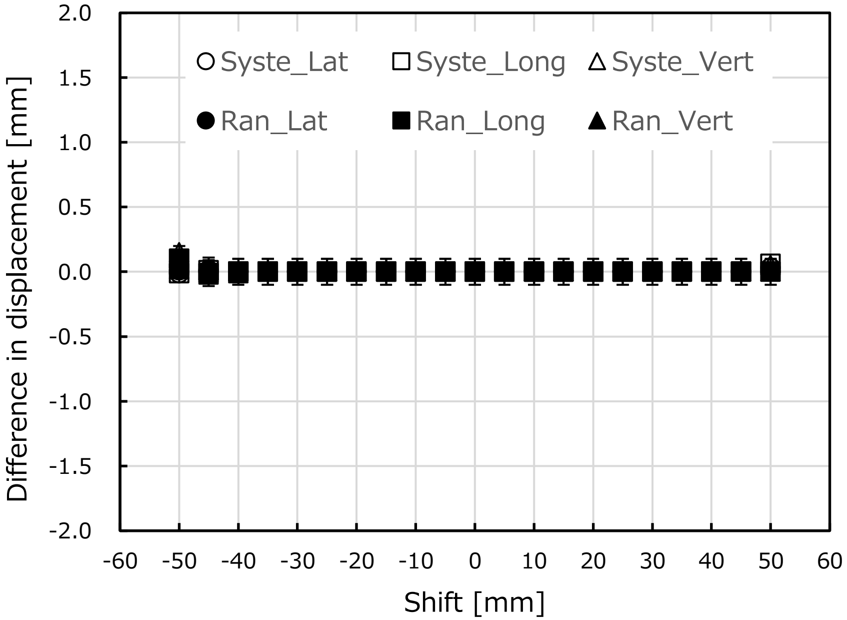
move direction (5.0mm interval)

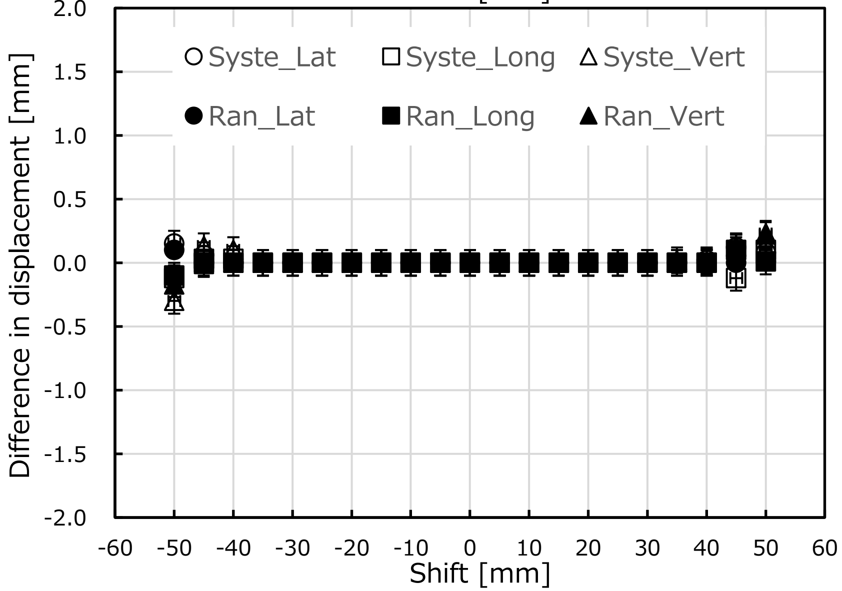
Lat	Long
Vert	

Agreed within 0.1mm, 0.1° for all directions.

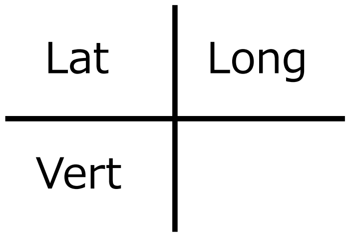
Results: detectability of static



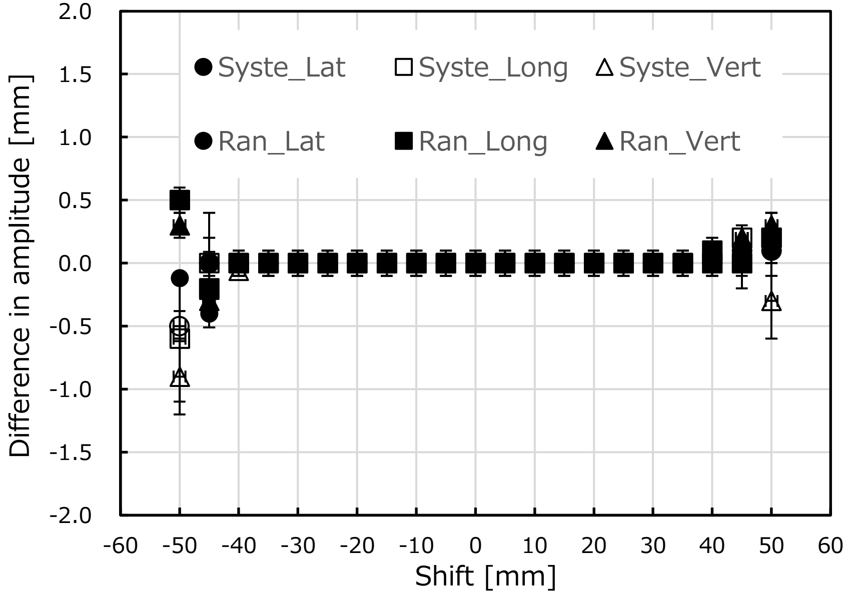


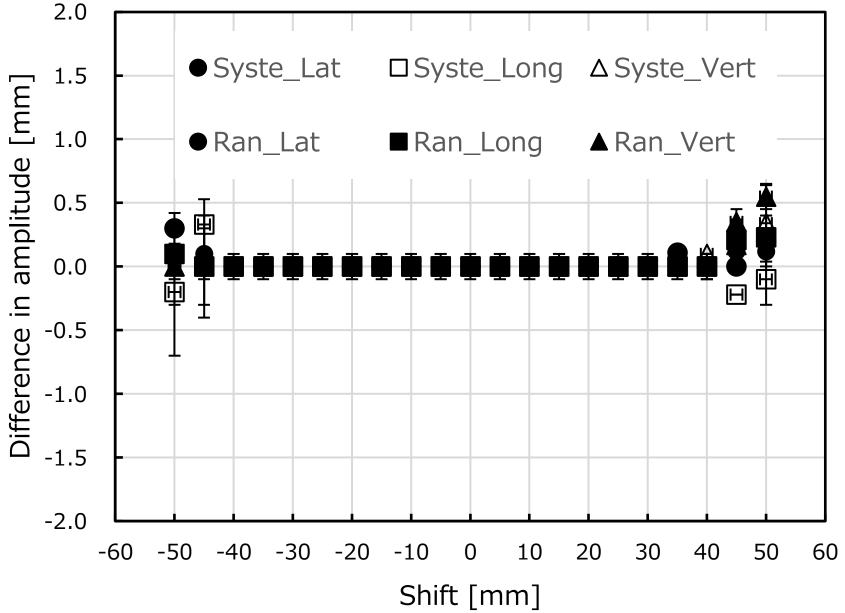


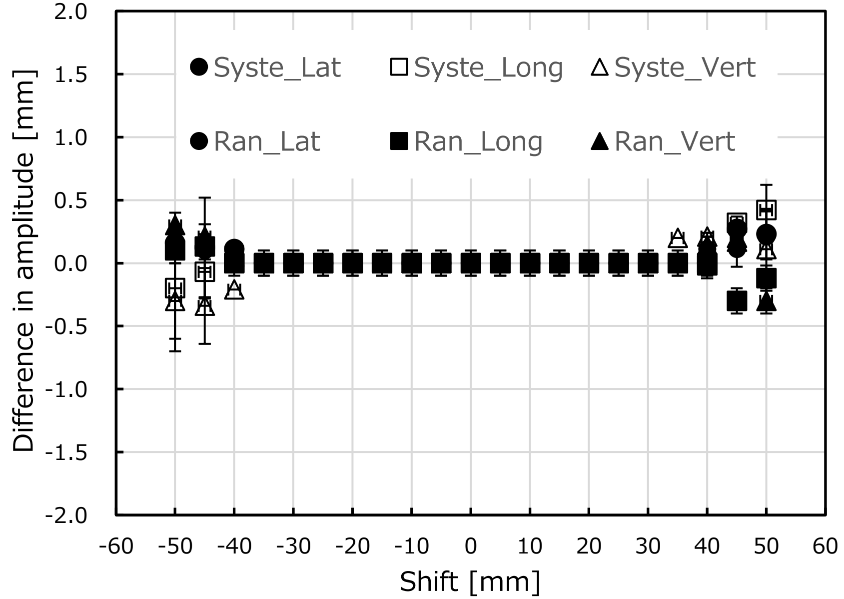
move direction (5.0mm interval)



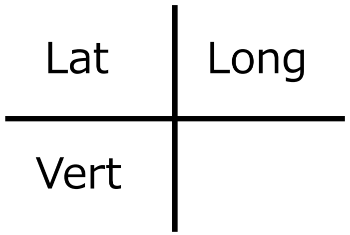
Results: detectability of dynamic



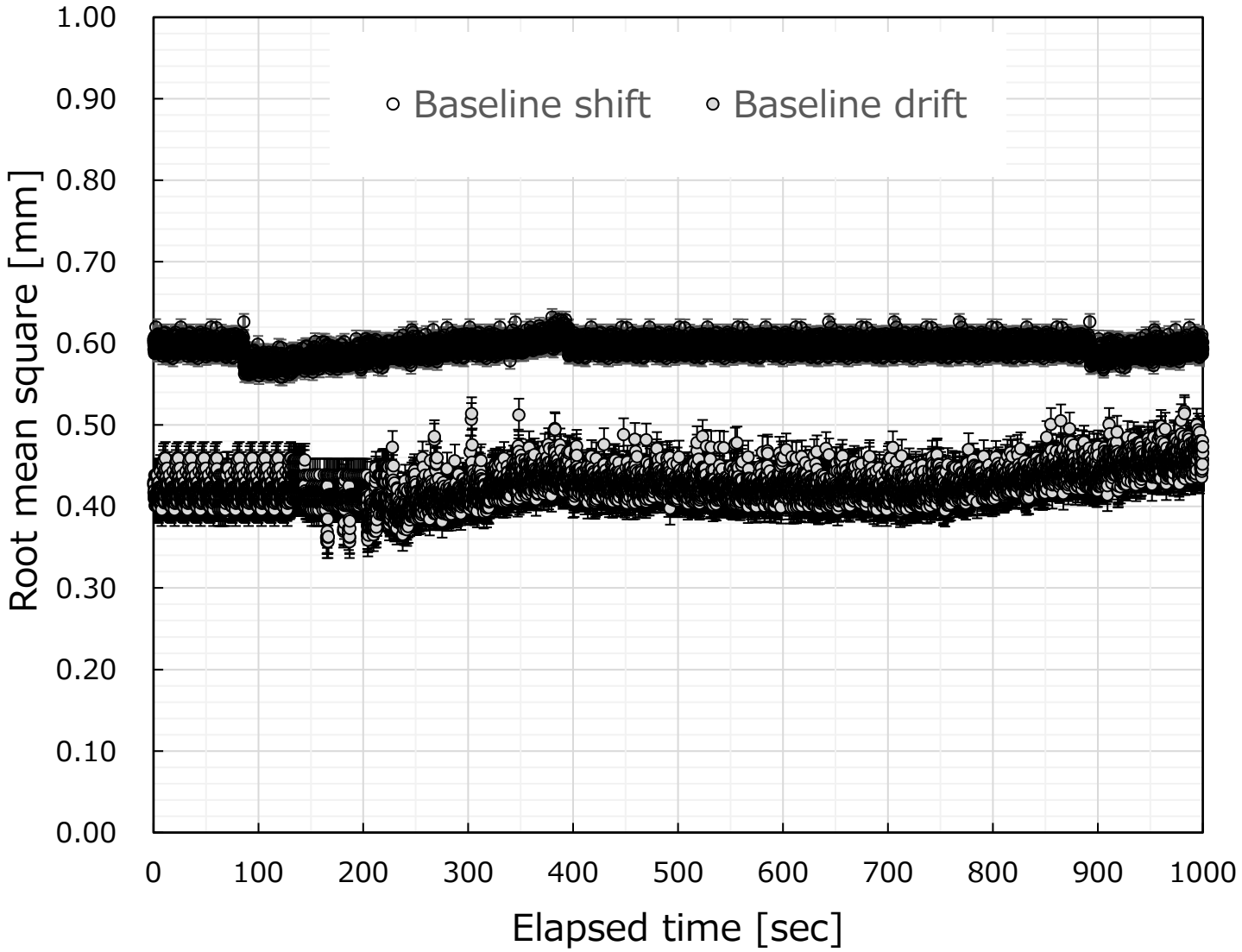




move direction (5.0mm interval)



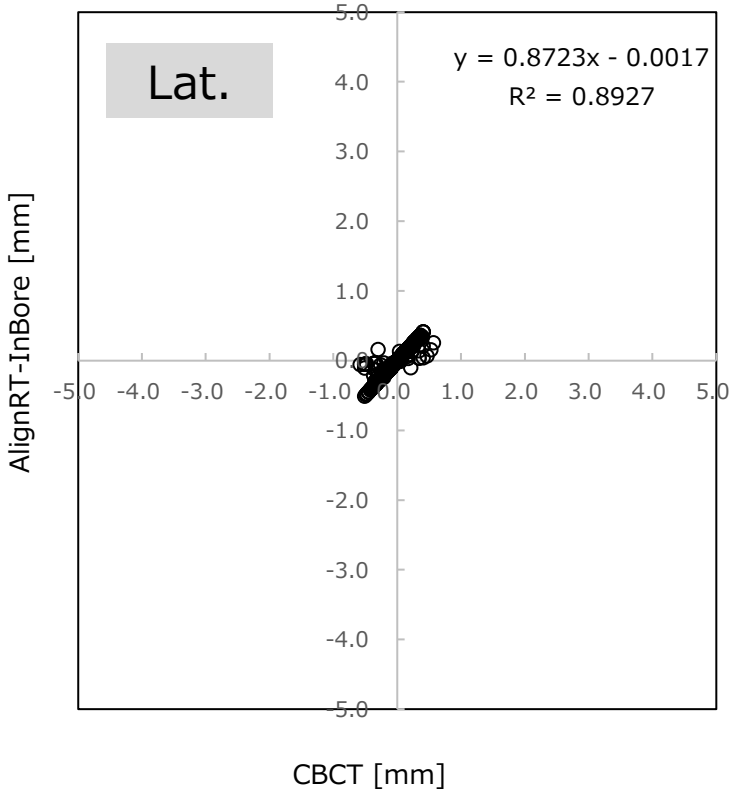
Results: reproducibility

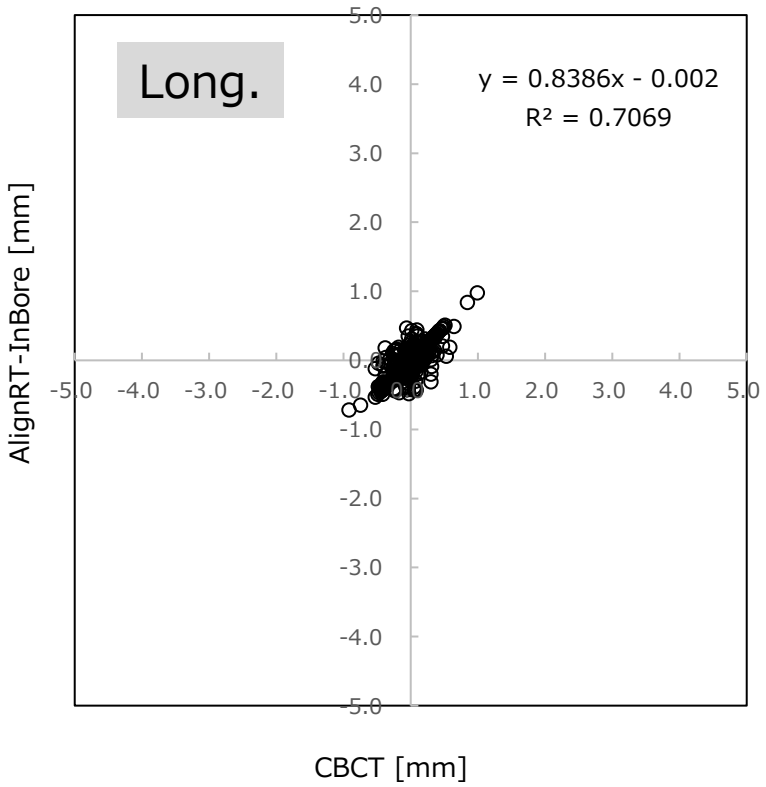


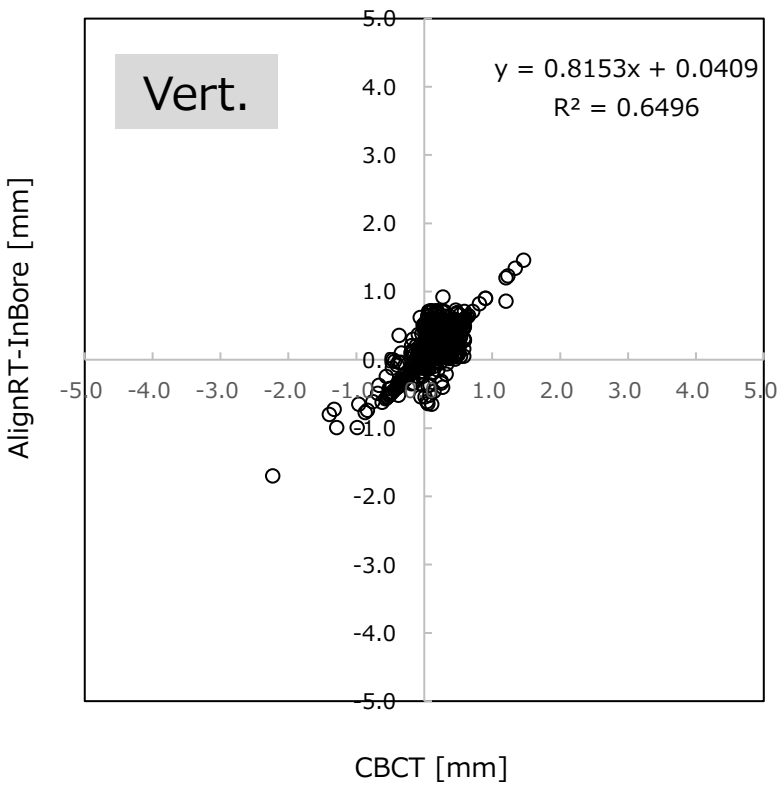
Variability	Stability
0.21 (±0.43)	**0.35 (±0.81)**
0.78 (±0.83)	**0.89 (±0.73)**

(Mean ± 1SD)

Results: correlation







A statistically significant ($P<0.01$) strong correlation was observed between AlignRT-InBore and CBCT in each directions.

Discussion (1)

Advantages:

- Markerless treatment
- Benefit for claustrophobic and infectious disease patients

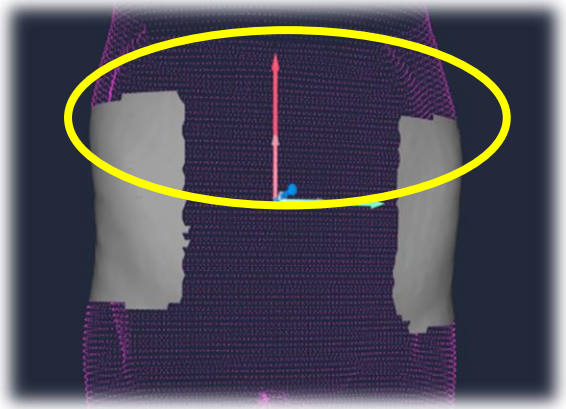
Patient first

Friendly for medical professions

Discussion (2)

Limitations:

- The detection accuracy and each displacement are in **a trade-off relationship**.



The cause is **to decrease the feature areas** by moving away from the isocenter.

- Cases that occurring in the vertically direction.

Rigid registration
Point to plane iterative closet point algorithm (ICP)*

The ICP recognize objects at the same height and reflection.

Conclusions

The accuracy of the patient setup and monitoring using the In-Bore optical positioning system is within 1.0 mm is available for the moving objects.

Thank you for your kind attention!