Implementing a breast workflow utilising 6DoF through AlignRT surface guided radiotherapy

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ICON CANCER CENTRE

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ALYA QADI

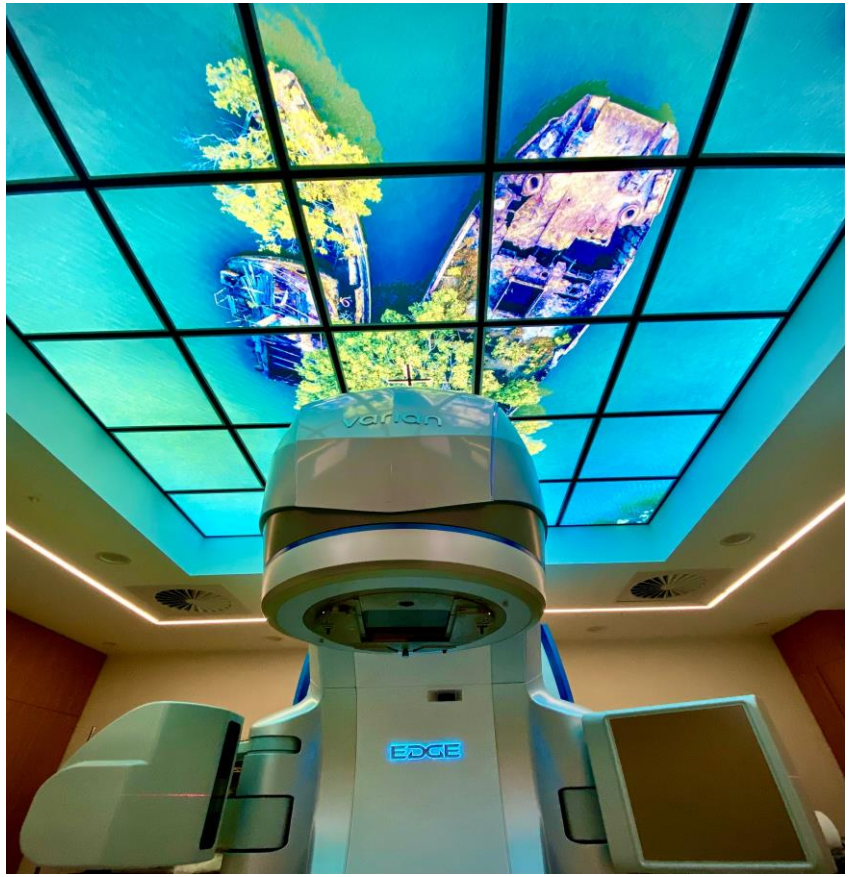
- Graduated from RMIT University in Melbourne, Australia
- 6 years as a radiation therapist
- Interest in patient care, stereotactic techniques & SGRT

Outline

- Background
- Aim and objectives
- Methods
- Results
- Discussion
- Challenges
- Conclusion

Department background

- Halcyon, 2 Truebeam (Stx and Edge) & one Superficial machine
- AlignRT for all patients set up
- 219+ breast patients per year ~3500 fractions
- Treatment techniques includes VMAT, SRS and Stereotactic



Aim and objectives

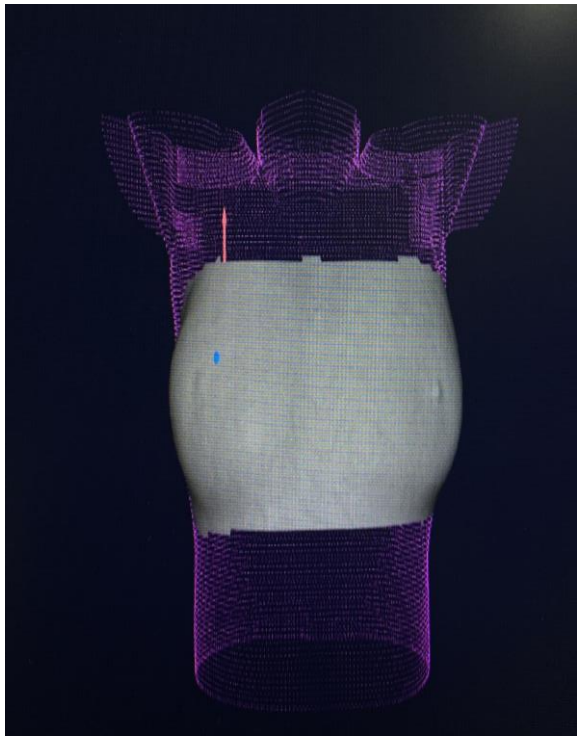
- **Aim:**
  - Implementing a positioning protocol for breast cancer patients using 6DoF through AlignRT and evaluate its effectiveness vs current practice

- **Objectives:**
  - To assess the accuracy of applying 6DoF in breast treatment setups.
  - To assess workflow efficiency and manual handling for radiation therapists.

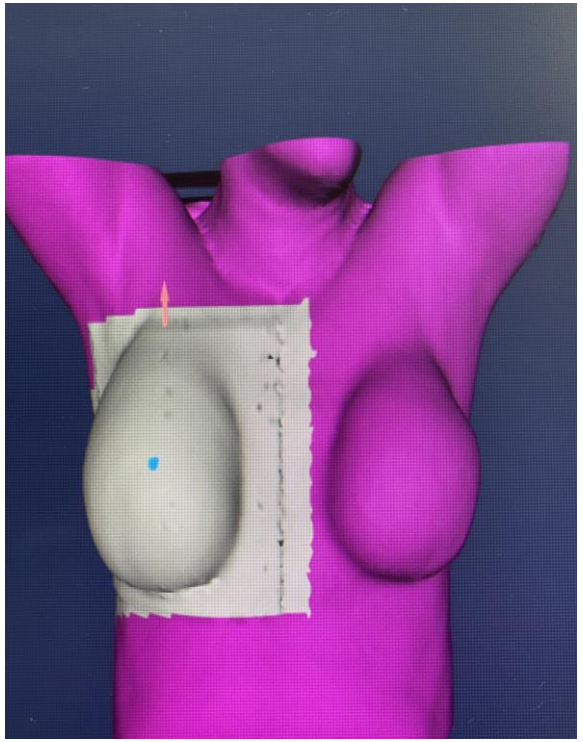
Breast treatment fractionation

Treatment Site + Laterality +Technique	Phase	Prescription PT/Isodose	Dose(Gy)	No. #	Dose(Gy)/#	Treat	Modality
Breast (Left) IMRT/VMAT	1	D95% > 95%	High: 48.0 Low: 40.05	15	High: 3.2 Low: 2.67	Daily	6MV
Breast (Right) IMRT/VMAT	1	D95% > 95%	High: 28.0 Low: 26.0	5	High: 5.6 Low: 5.2	Daily	6MV
Breast (Right) VMAT/IMRT	1	D95% > 95%	40.05	15	2.67	Daily	Photons
Breast + SCF + Axilla + IMC (Right) VMAT	1	D95% > 95%	High: 45.75 Low: 43.5	15	High: 3.05 Low: 2.9	Daily	Photons
Breast+Nodes (Right) VMAT	1	ICRU83	High: 57.0 Low: 50.0	25	High: 2.28 Low: 2.0	Daily	6MV

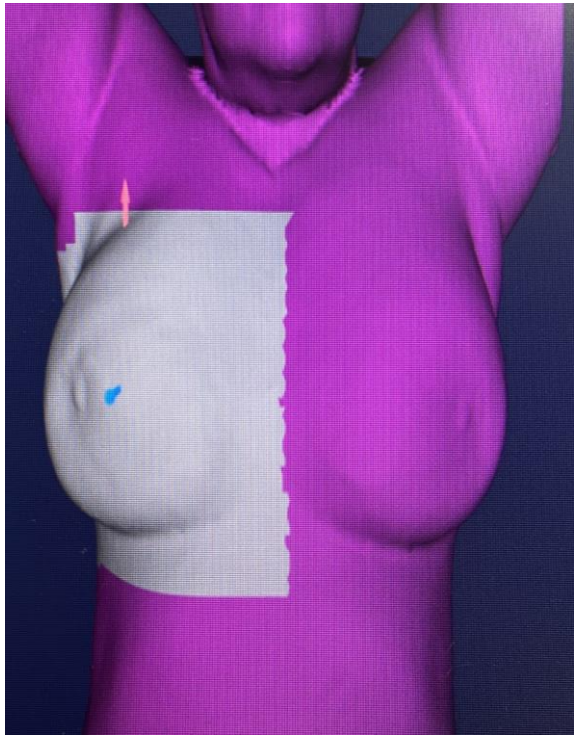
Region of Interest (ROI) Selection



Standard Breast

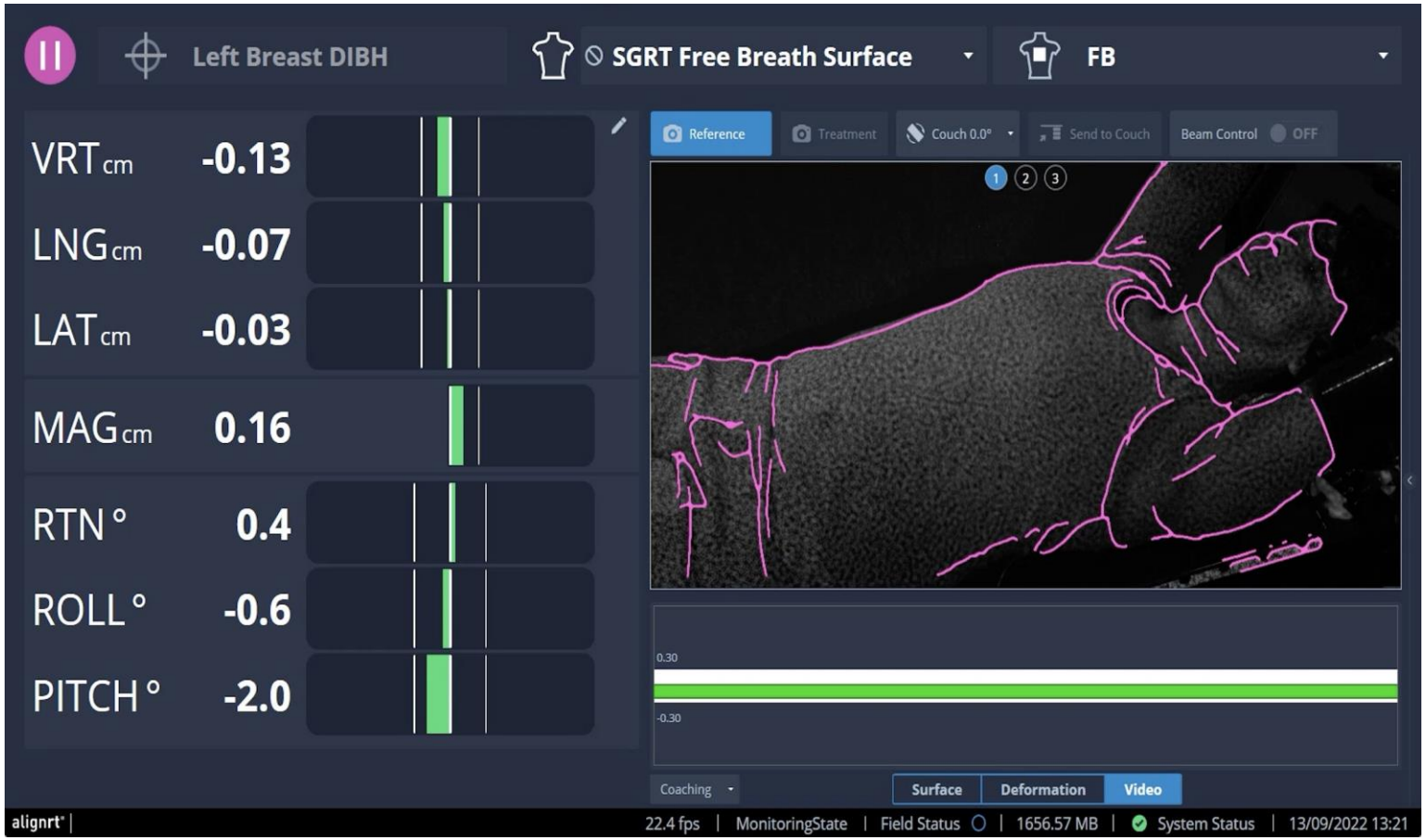


Bolus



Large Breast

Postural Alignment



Real time video and visualization of patient set up

Previous Set Up Protocol: 3DoF

Datasets used for set up:	
Free Breathing (FB)	**Deep inspiration Breath Hold (DIBH)**
• Patient is set to the acquired couch position. • AlignRT monitoring starts to set up patients on FB dataset. • Physical adjustment of RTN, PITCH & ROLL. • Manual adjustments of VRT, LNG &LAT.	• DIBH dataset. • Patient is instructed to breath in. • Physical adjustment of RTN, PITCH & ROLL in BH. • LNG & LAT manually adjusted, no VRT shifts applied.

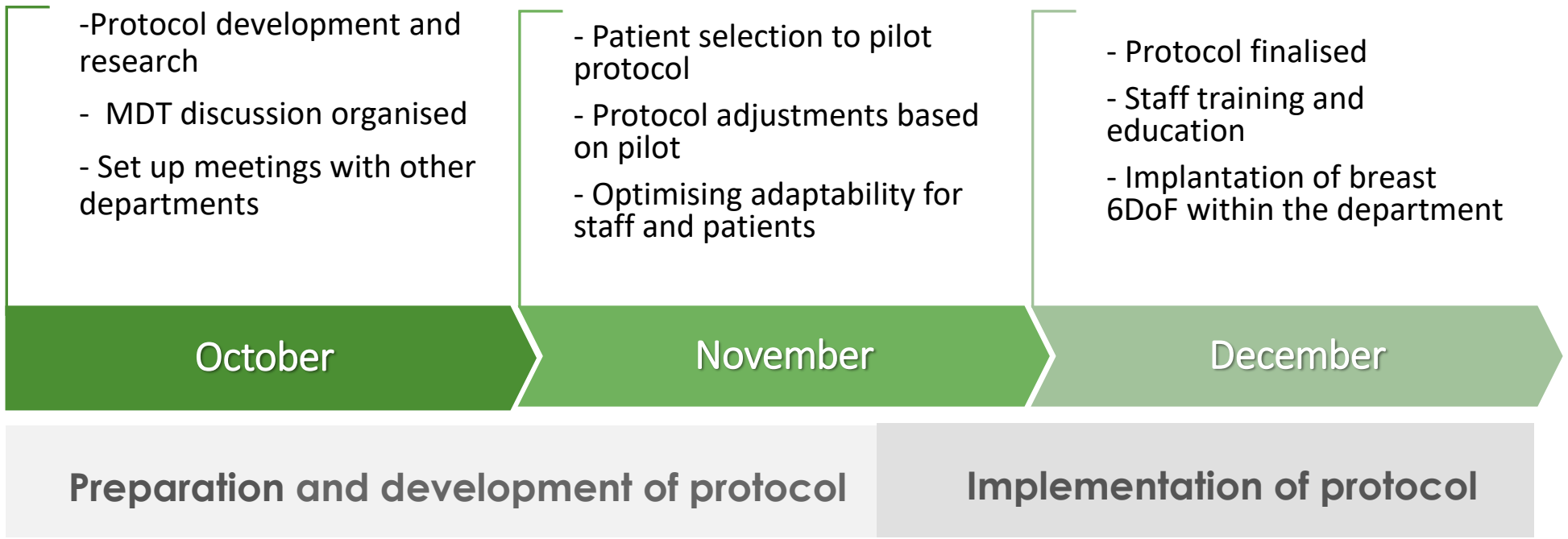
New Set Up Protocol: 6DoF

- Optimal patient position correction by achieving submillimeter accuracy
- Optimization of patients' rotations beyond physical abilities
- Reduces staff manual handling

Methods

Project timeline

2022



New breast treatment set up protocol (Datasets)

6DoF application using *"Send to Couch"* feature in AlignRT.

Deep Inspiration breath hold (DIBH)

FB dataset DIBH dataset

Free Breathing

FB dataset

Bolus

FB dataset DIBH dataset

DIBH Treatment Set Up Protocol

Inside the treatment room

Patient set up as per day one

Physical adjustment of RTN, PITCH & ROLL

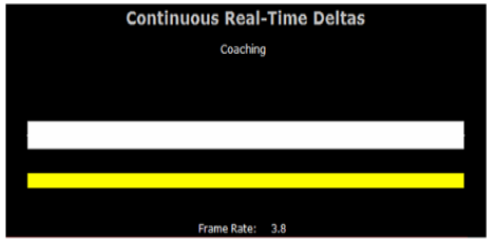
3DoF values are sent via AlignRT ***"send to Couch".***

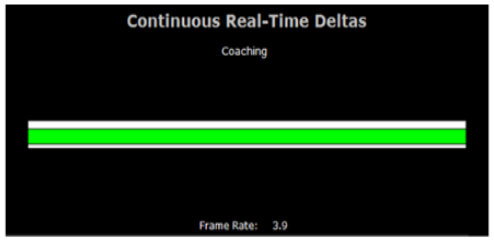
Inside the treatment room

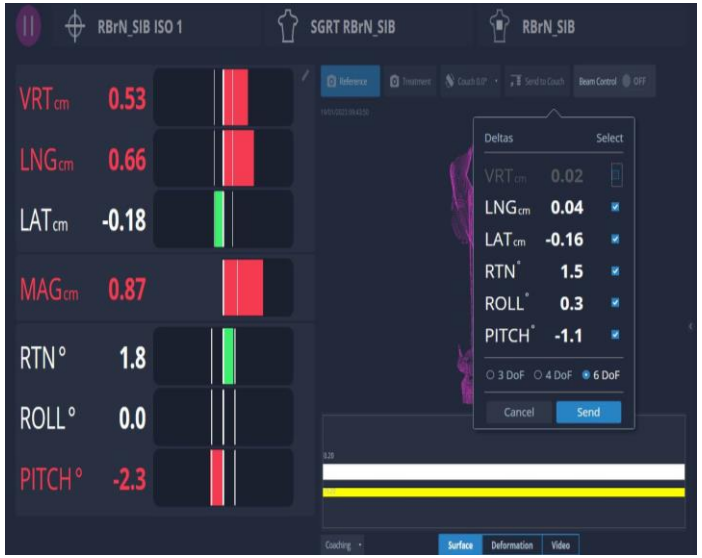
Patient in Breath hold (BH) *BH Dataset*. → Within tolerance → ***"send to Couch"*** 6DoF values.

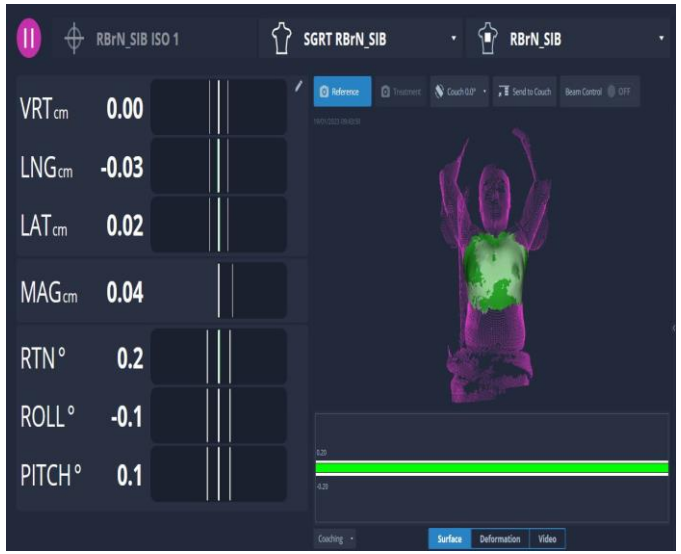
OR

Patient in Breath hold (BH) *BH Dataset*. → Over tolerance → ***Reassess FB .***









DIBH dataset

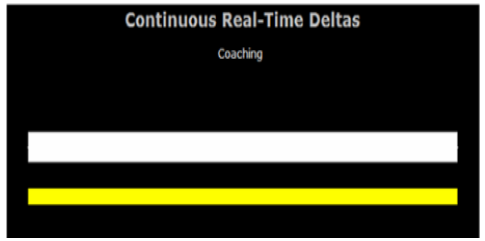
Treatment tolerances

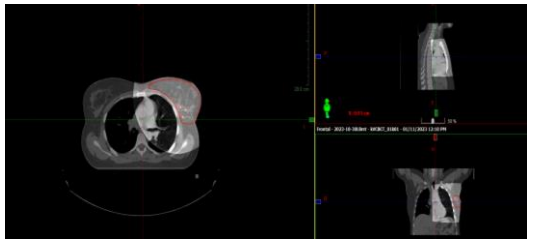
FB data set	
RTN, ROLL & PITCH (FB)	VRT, LNG & LAT (FB)
2Deg	1.5cm

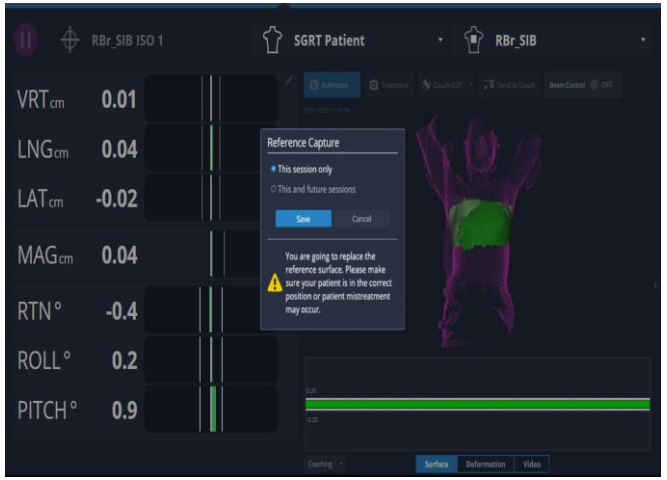
DIBH data set	
RTN, ROLL & PITCH (DIBH)	LNG & LAT (DIBH)
2.5Deg	1.0cm

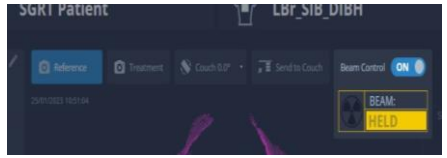
Outside the treatment room (Console)

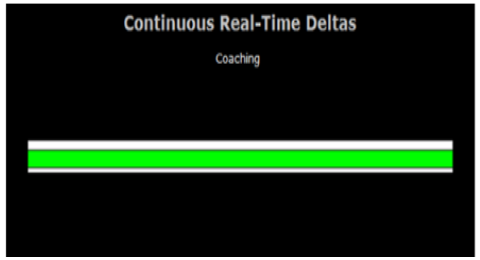
Patient in BH → Acquire (CBCT or KV/MV) + Image match → Patient in DIBH→ Apply shifts → Save reference capture in BH & gating

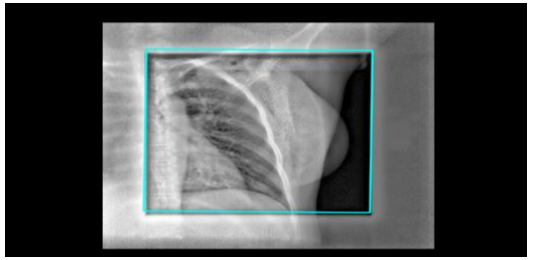












Patient in BH

Imaging

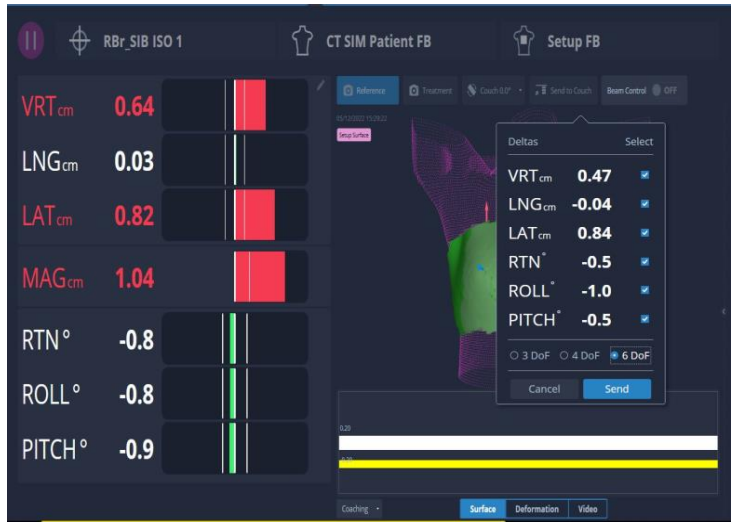
Reference Capture

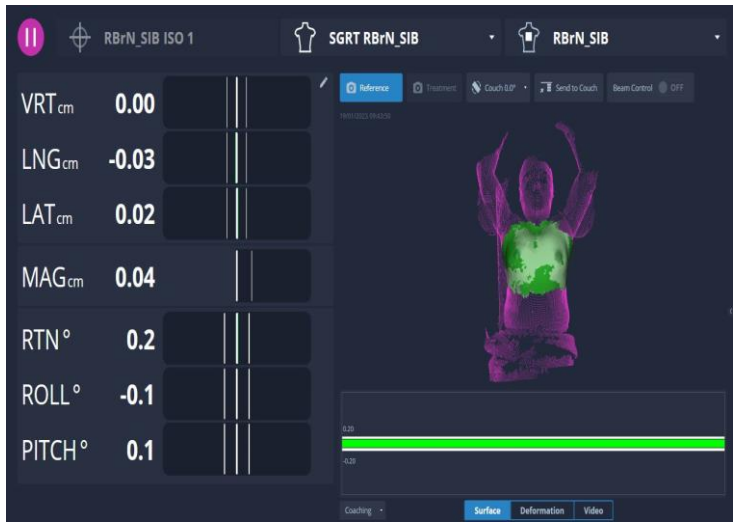
Beam Hold

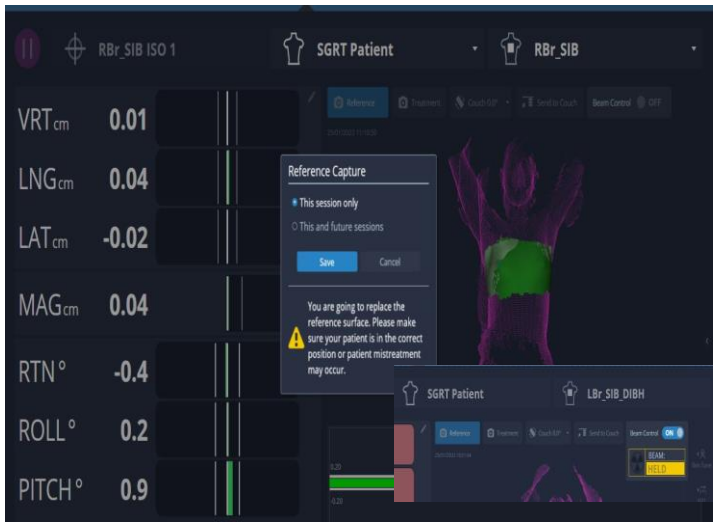
FB Treatment Set Up Protocol

FB Set Up

Patient in acquired couch position in FB → Apply 6DoF → Acquire (CBCT or KV/MV) +Image match → Apply shifts → Save reference capture & Beam control on



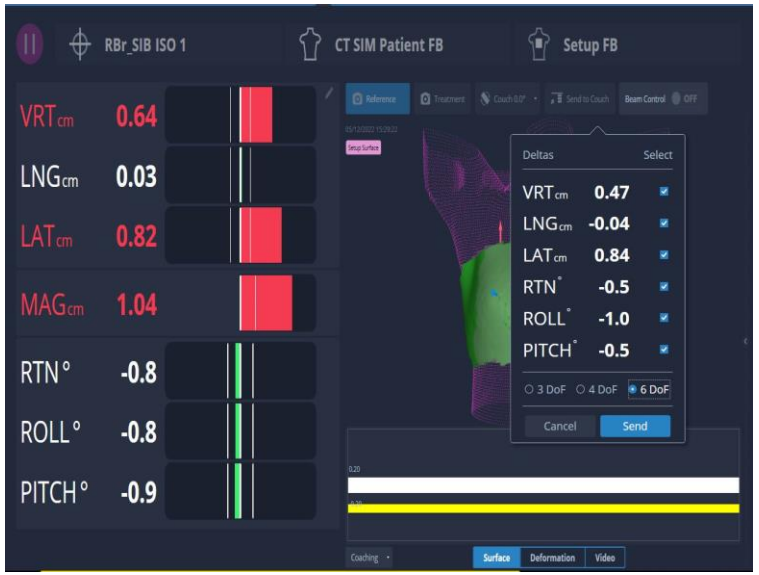


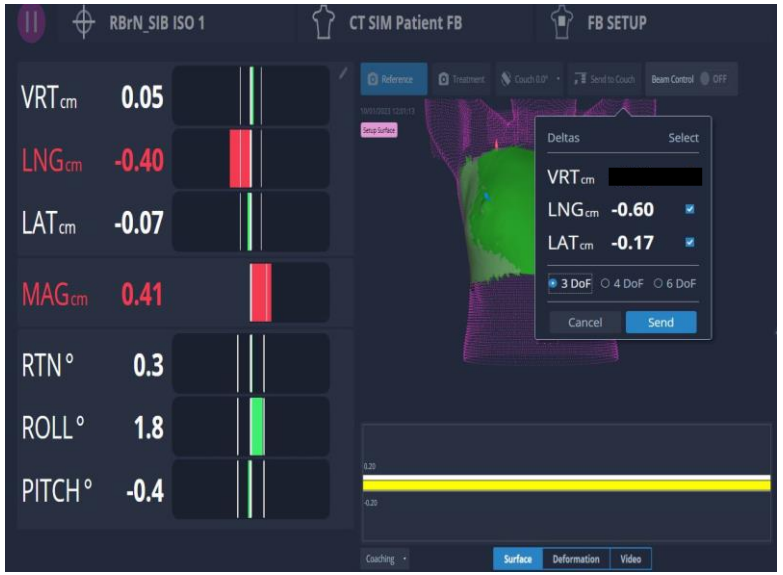


Bolus Treatment Set Up Protocol

BOLUS SET UP

Patient in acquired couch position in FB → Apply 6DoF → Acquire (CBCT or KV/MV) +Image match → Apply shifts → Save reference capture & Beam control on



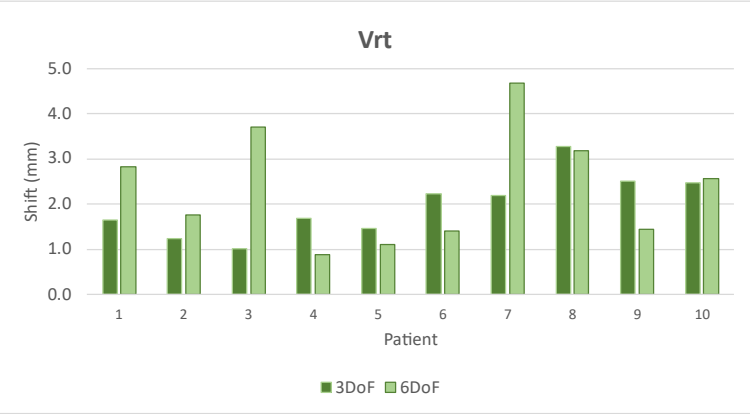


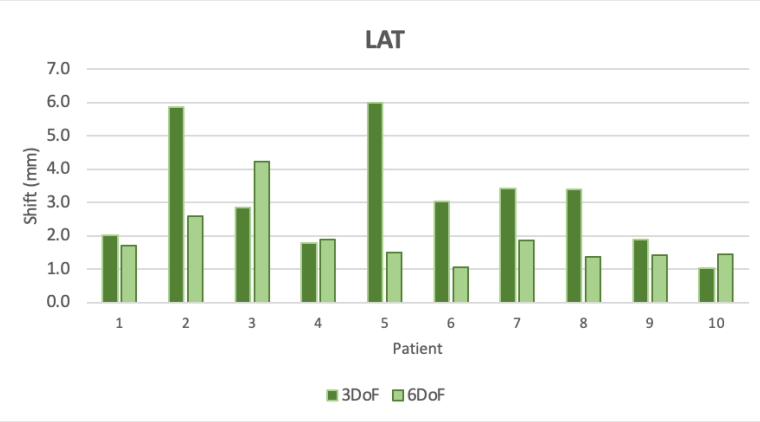
Inside treatment room

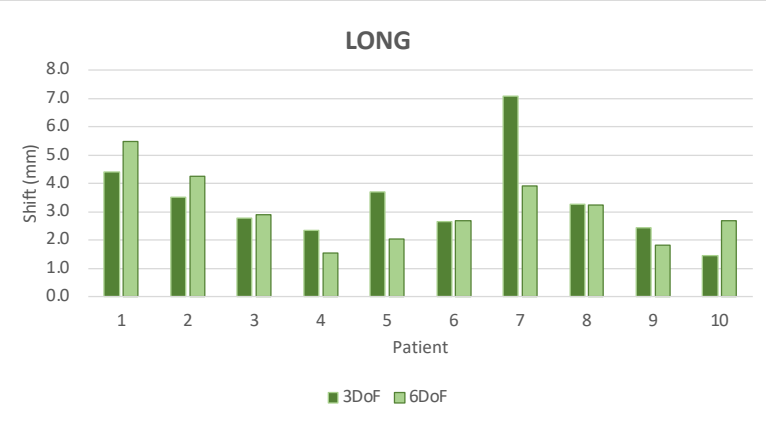
Treatment console

Results

Applied Translational Shift



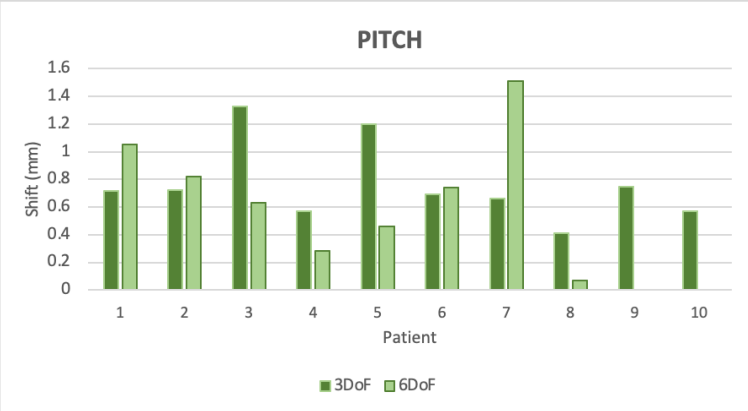


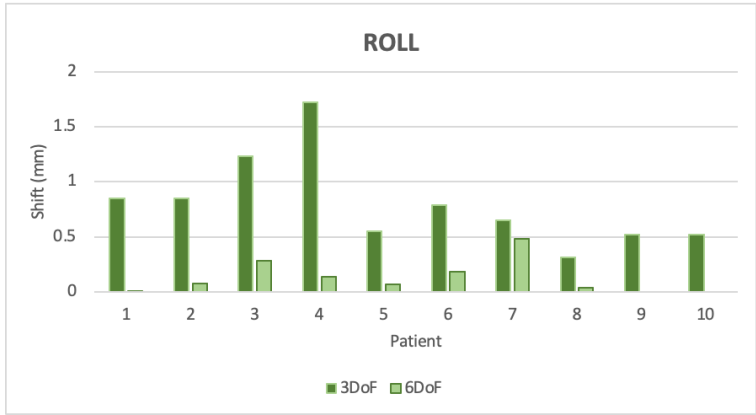


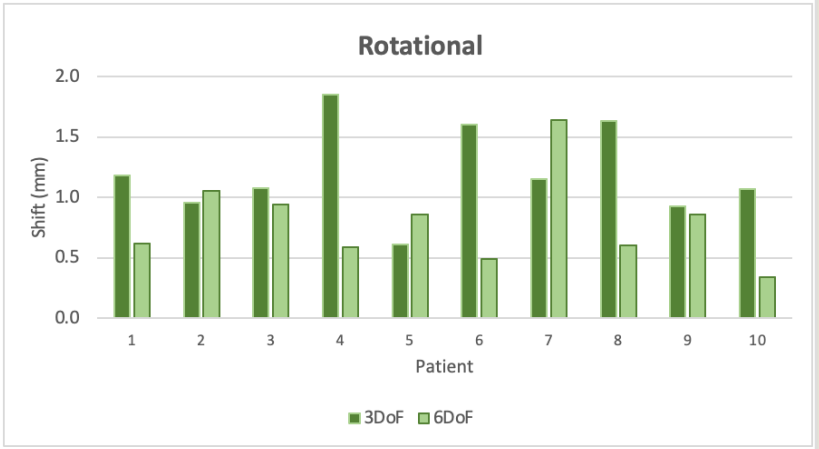
	VRT (mm)		LAT (mm)		LONG (mm)	
	6DoF	**3DoF**	**6DoF**	**3DoF**	**6DoF**	**3DoF**
Average ± SD	2.57 ± 2.17	1.87 ± 1.39	1.85 ± 1.62	2.99 ± 2.84	3.15 ± 2.70	3.35 ±3.38
Range	0 - 12.6	0 - 10	0 - 10.7	0 - 20.1	0 - 14.5	0 - 22.4
P-value	0.197		0.058		0.483	

*Larger range in the non 6dof

Applied Rotational Shifts







	Pitch(°)		Roll(°)		Rotation(°)	
	6DoF	**3DoF**	**6DoF**	**3DoF**	**6DoF**	**3DoF**
Average ± SD	0.56 ± 0.88	0.78 ± 0.69	0.14 ± 0.37	0.83 ± 0.73	0.82 ± 0.69	1.2 ± 0.92
Range	0 - 3.3	0 - 4.30	0 - 1.8	0 - 3.8	0 - 3.0	0 - 5.0
P-value	0.127		0.0003		0.033	

*Larger range in the non 6dof

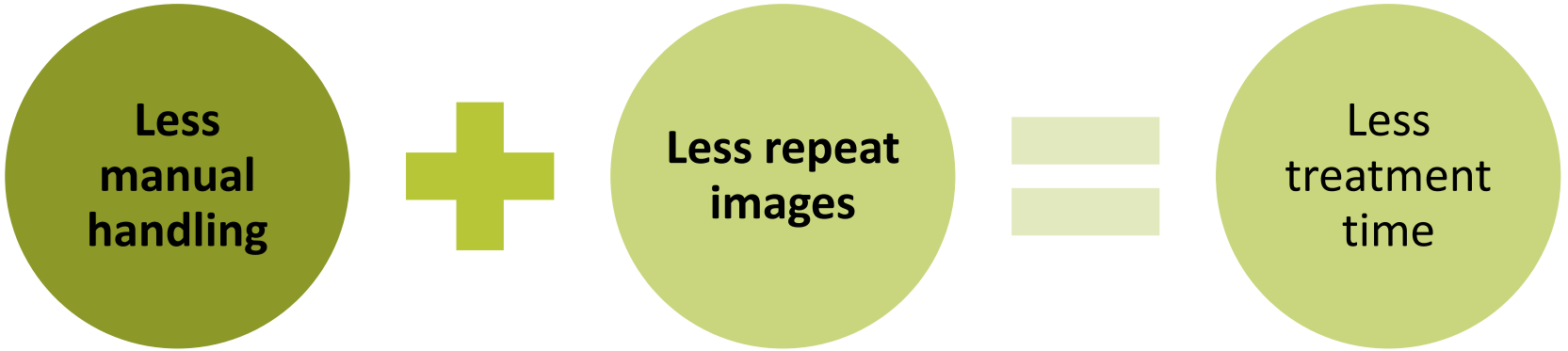
Time efficiency

	3DoF		6DoF	
	Breast only	**Breast/AX/CW/Nodes**	**Breast only**	**Breast/AX/CW/Nodes**
Time Range	18-20 minutes	20-25 minutes	12-16minutes	18-20 minutes

Average time reduction

26% for Standard Breast

15% for Breast Axilla, Chest wall & Nodes



~45minutes are saved per day

Workflow Enhancement

Increase in machine capacity

Cost effective

Reduced wait times

Increase in work health safety

Challenges

Inclined patients

- Larger patients set ups
- Impacts Pitch & Roll> 2.5

Bolus

- Superflab Impacts all 6DoF values
- 3D Bolus represent true values of rotations

Conclusion

Applying 6DoF for breast treatments proves to enhance workflow by reducing time, staff manual handling and increasing breast treatment accuracy and safety.

Acknowledgement

- Conversation with colleagues around Australia; esp.
  - Katie Davidson (Peter Mac), Louis Shu (Peter Mac)
  - Sue McKenna (VisionRT)
- **But most importantly**
  - Mark Wanklyn
  - Guneet Kaur
  - Abbey Adams
  - Siobhan Burke
  - Yeen Yeong
  - Rachel Gibbs

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Thank you !