Continuous development: How SGRT has enabled advancement of research-based clinical practice

University Hospitals Dorset
NHS Foundation Trust

*image credit: Phil Jackson

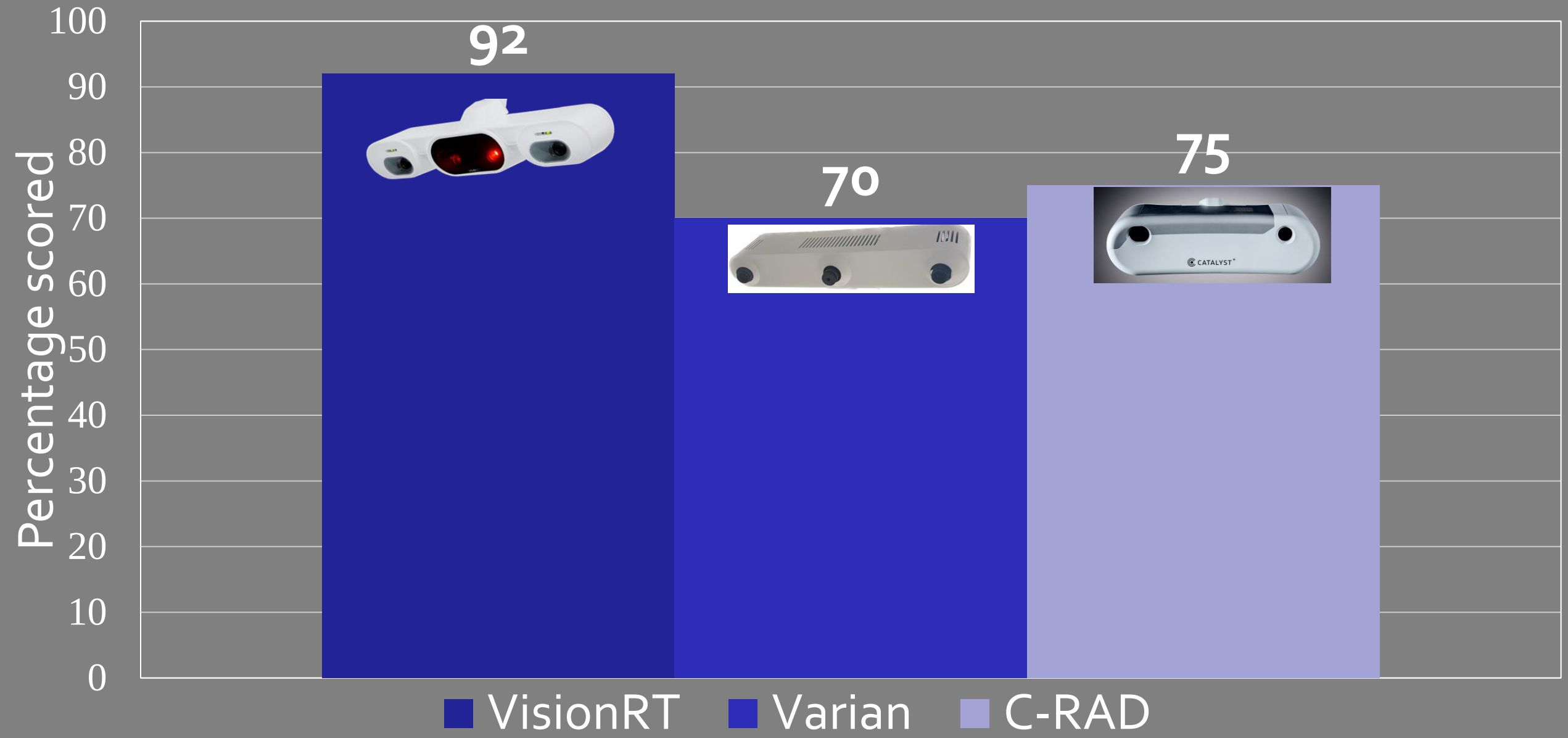
Joshua.Naylor@UHD.NHS.UK

Josh Naylor *(MPE / Principal Physicist)*


C-RAD
CATALY
IDENTIFY
varian
LAP
LAP
visionrt
BRAINLAB
ExactTrac Dynamic


JEU
Specification criteria
• Markerless
• Installation
• Maintenance
• Tech spec
• DIBH
• Safety
• Functionality
• Accuracy
• Patient interaction
• Support
• CT scanner gating
• Patient identification

Our decision (Sept 2019)



System (vendor)	Hardware	Camera Size	Camera Resolution	Frame Rate	Linac interface
AlignRT Horizon(VisionRT) 	3 Cameras	127x480x140 mm; 3.5kg	4096x2160 px (8MP)	15-45 fps	Auto Patient selection, beam-hold, couch shift
Catalyst+ HD (C-RAD) 	1-3 Cameras	625x230x200 mm; 9.5kg	1920x1200 px (2.3 MP)	15 fps	Auto Patient selection, beam-hold, couch shift
IDENTIFY (Varian) 	3 Cameras	500x500x400mm; 3.3kg	1280x1024 px (1.3 MP)	10 fps	Auto Patient selection, beam hold, treatment record push
ExacTrac Dynamic (Brainlab) 	1 Camera (+kV planar)	200x370x310mm; 9.7kg	640x512 px (0.3MP)	15-20 fps	Auto Patient selection, beam-hold

REFERENCE: TG302 / VISIONRT & C-RAD

Radiotherapy &Oncology

Articles Publish Topics About Contact

GUIDELINES | VOLUME 173, P188-196, AUGUST 2022 Download Full Issue

ESTRO-ACROP guideline on surface guided radiation therapy

P. Freislederer [1] • V. Batista • M. Öllers • ... D. Nguyen • C. Bert • J. Lehmann • Show all authors • Show footnotes

Open Access • Published: May 30, 2022 • DOI: https://doi.org/10.1016/j.radonc.2022.05.026 •

Check for updates

AAPM-TG302/ESTRO-ACROP SGRT GUIDELINES COMPLIANCE

alignrt®

AAPM-TG302/ESTRO-ACROP compliant ***motion monitoring accuracy*** *at all couch/gantry angles and skin tones.*

The most rigorous of the ESTRO-ACROP/AAPM-TG302 SGRT guidelines for SRS require a tracking accuracy of ≤0.5mm / ≤0.5° in phantoms, including consideration for potential camera occlusions.

AlignRT delivers a tracking accuracy of ≤0.5mm / ≤0.2° at all couch and gantry angles. AlignRT accuracy is not affected by skin tone.

TG302 Key Recommendations:	AlignRT Compliance:

TG302 Key Recommendations:	AlignRT Compliance:
Registration Algorithm: QA is **straightforward to implement and interpret for rigid registration algorithms.** Currently, **there are no known phantoms to enable rigorous testing of deformable algorithms.**	• AlignRT matches the ROI of live surface to reference surface, using rigid registration method (c.g. CBCT registrations). • When you capture a new reference surface in AlignRT, the ROI automatically propagates to the new reference surface

MEDICAL PHYSICS
The International Journal of Medical Physics Research and Practice

Volume 44, Issue 7
July 2017
Pages e43-e76

Task Group Report | Free Access

Use of image registration and fusion algorithms and techniques in radiotherapy: Report of the AAPM Radiation Therapy Committee Task Group No. 132

Kristy K. Brock, Sasa Mutic, Todd R. McNutt, Hua Li, Marc L. Kessler

First published: 04 April 2017 | https://doi.org/10.1002/mp.12256 | Citations: 473

AAPM TG132 – image reg/fusion

- “Even when deformable registration is available for use, limitations and challenges remain. Regardless of which algorithm is chosen, **deformable registration is ill-defined and over-constrained.**”
- There is **no comprehensive ground truth** when dealing with deformable image registration in patients.

DOI: 10.1002/mp.15532

AAPM SCIENTIFIC REPORT

AAPM task group report 302: Surface-guided radiotherapy

Hania A. Al-Hallaq[1] | Laura Cerviño[2] | Alonso N. Gutierrez[3] | Amanda Havnen-Smith[4] | Susan A. Higgins[5] | Malin Kügele[6,7] | Laura Padilla[8] | Todd Pawlicki[8] | Nicholas Remmes[9] | Koren Smith[10] | Xiaoli Tang[11] | Wolfgang A. Tomé[12]

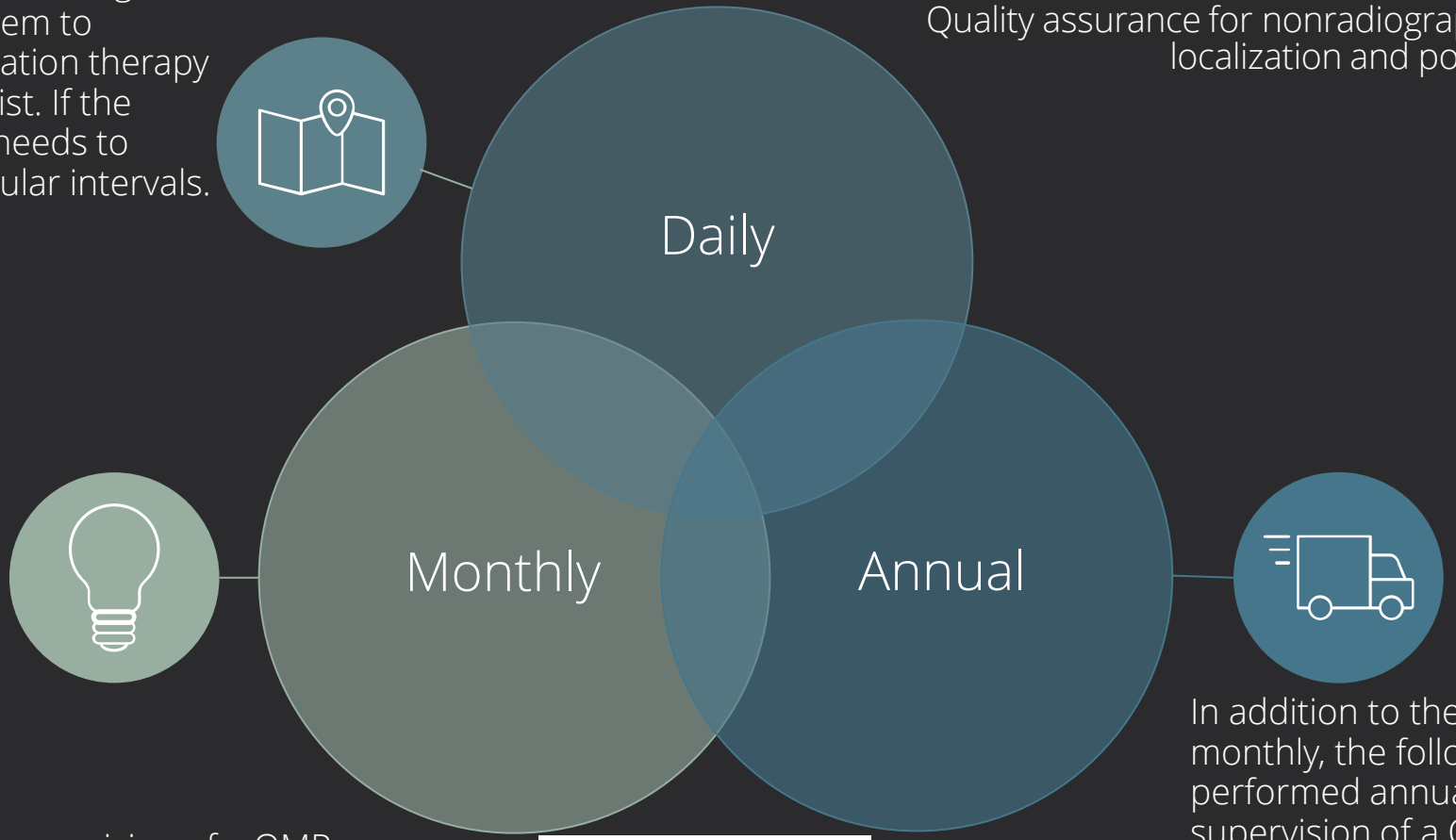
Slide credit: Mike Tallhamer
Chief of Radiation Physics – Advent Health Colorado

Task Group 147

Quality assurance for nonradiographic radiotherapy localization and positioning systems

A QMP should perform the following daily QA tests or delegate them to another member of the radiation therapy team, like a radiation therapist. If the tests are delegated, a QMP needs to review the test results in regular intervals.

- Safety
- Static Localization
- Documentation
- Vendor Recommended



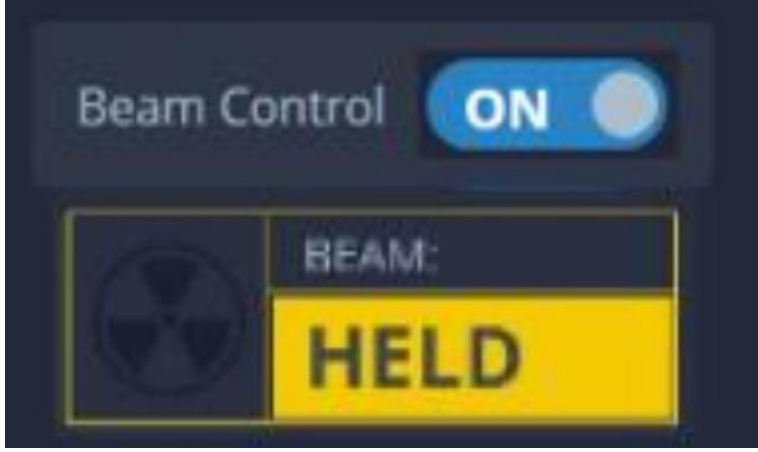
Monthly QA by or under the supervision of a QMP should include all tests performed daily with the addition of the following.

- Gating
- Static Localization (Hidden Target)
- Dynamic Localization
- Documentation
- Vendor Recommended

In addition to the tests performed daily and monthly, the following tests should be performed annually by or under the supervision of a QMP.

- System Stability
- System Integrity
- Extended System Performance
- Positioning Accuracy
- Extended Gating
- Data Transfer
- Documentation
- Vendor Recommended

3.3.2 | Implications of temporal accuracy/latency for dynamic radiation delivery



The temporal accuracy/latency for dynamic radiation delivery (i.e., beam hold) and integration with the treatment unit, when available, may affect dosimetric accuracy.[36] Per TG-142, the SGRT system delay should be evaluated for the specific application and deemed appropriate before treatment. While direct measurement of the latency time may be challenging,[37] SGRT latency time should be confirmed to be below a clinically appropriate threshold (e.g., <1 s for breast DIBH treatment). For free-breathing (FB) gated treatment, TG-76 recommends that the total time latency be as short as possible, and not to exceed 0.5 s in any case,

TG302

Software	Latency [ms]
Align RT 6.3	173
7.3 (resp mod)	82 (-53%)
Varian Identify	402 (+490%)

Publications

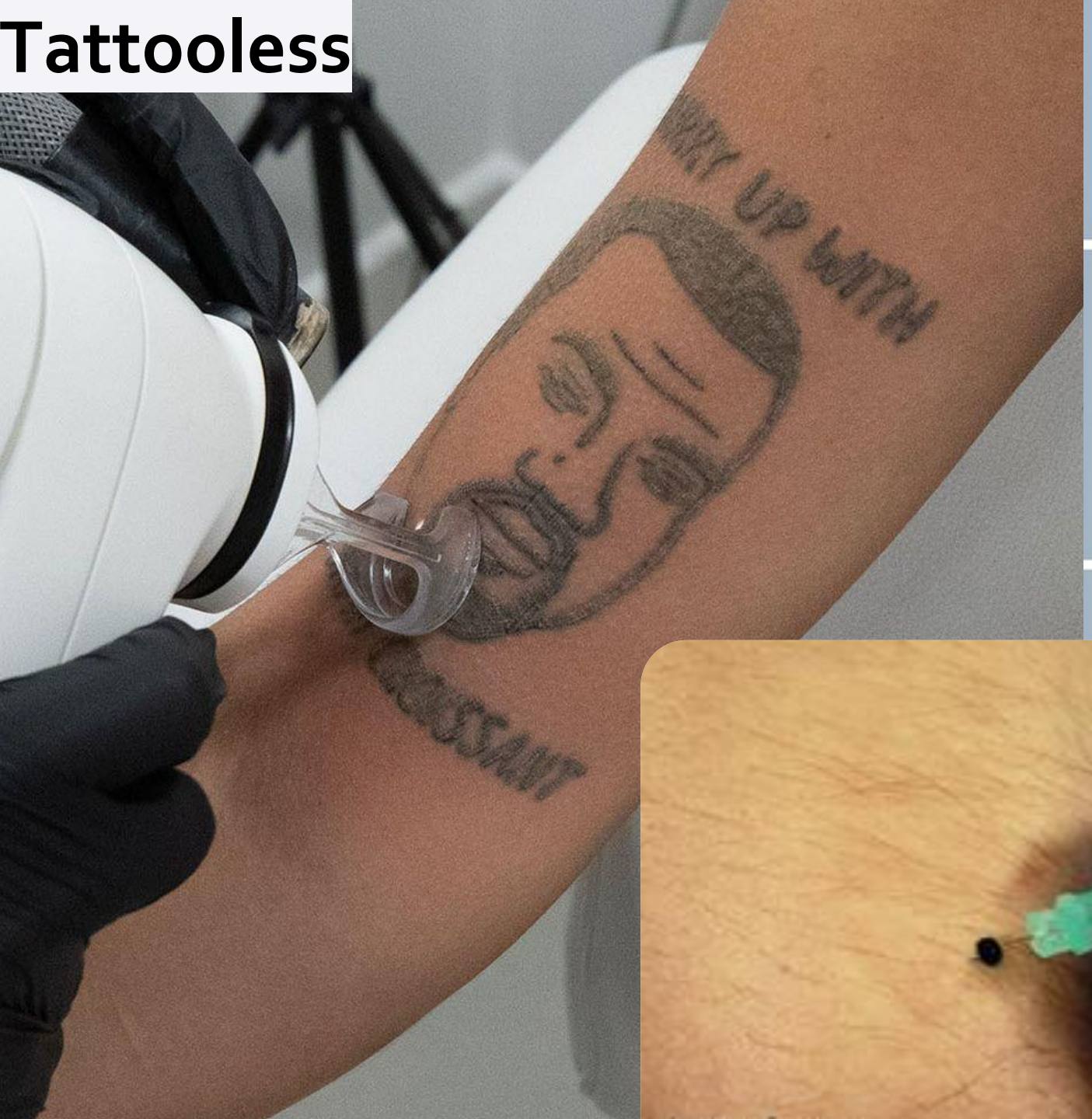
Accuracy	Breast (general)	DIBH - Left Breast	GateCT	InBore	Patient Safety	Pediatric	Pelvis	Proton
Sarcoma	SBRT / SABR	SRS	Other					

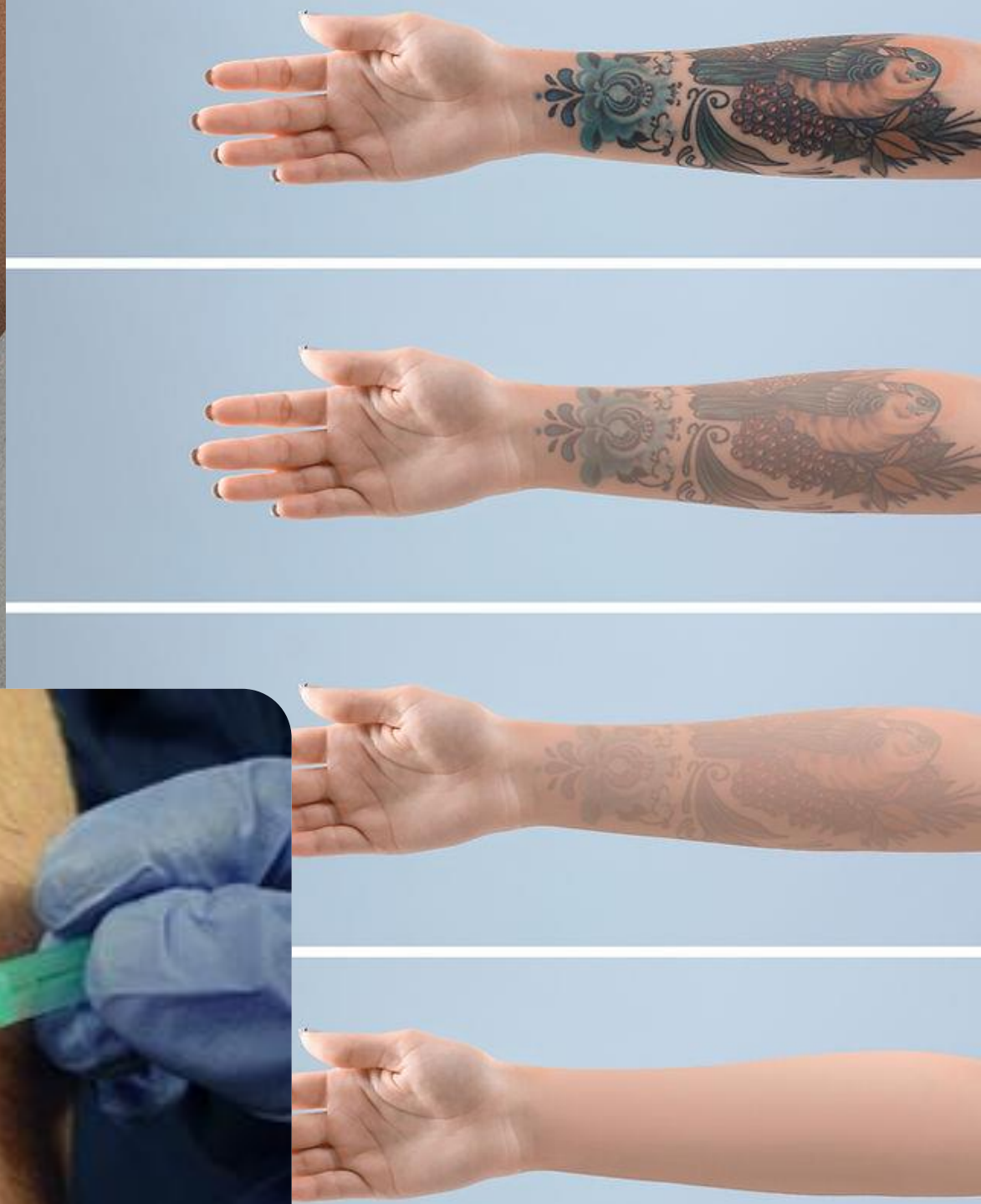
- Al-Hallaq, Hania; Batista, Vania; Kügele, Malin; Ford, Eric; Viscariello, Natalie; Meyer, Juergen: The Role of Surface-Guided Radiation Therapy for Improving Patient Safety. In Radiotherapy and Oncology. DOI: 10.1016/j.radonc.2021.08.008.
  ABSTRACT AVAILABLE

- Nicola Blake, et al. (2021). "Surface-guided radiotherapy for lung cancer can reduce the number of close patient contacts without compromising initial setup accuracy."
  ABSTRACT AVAILABLE

- Wiant, D. B., et al. (2016). "A novel method for radiotherapy patient identification using surface imaging."

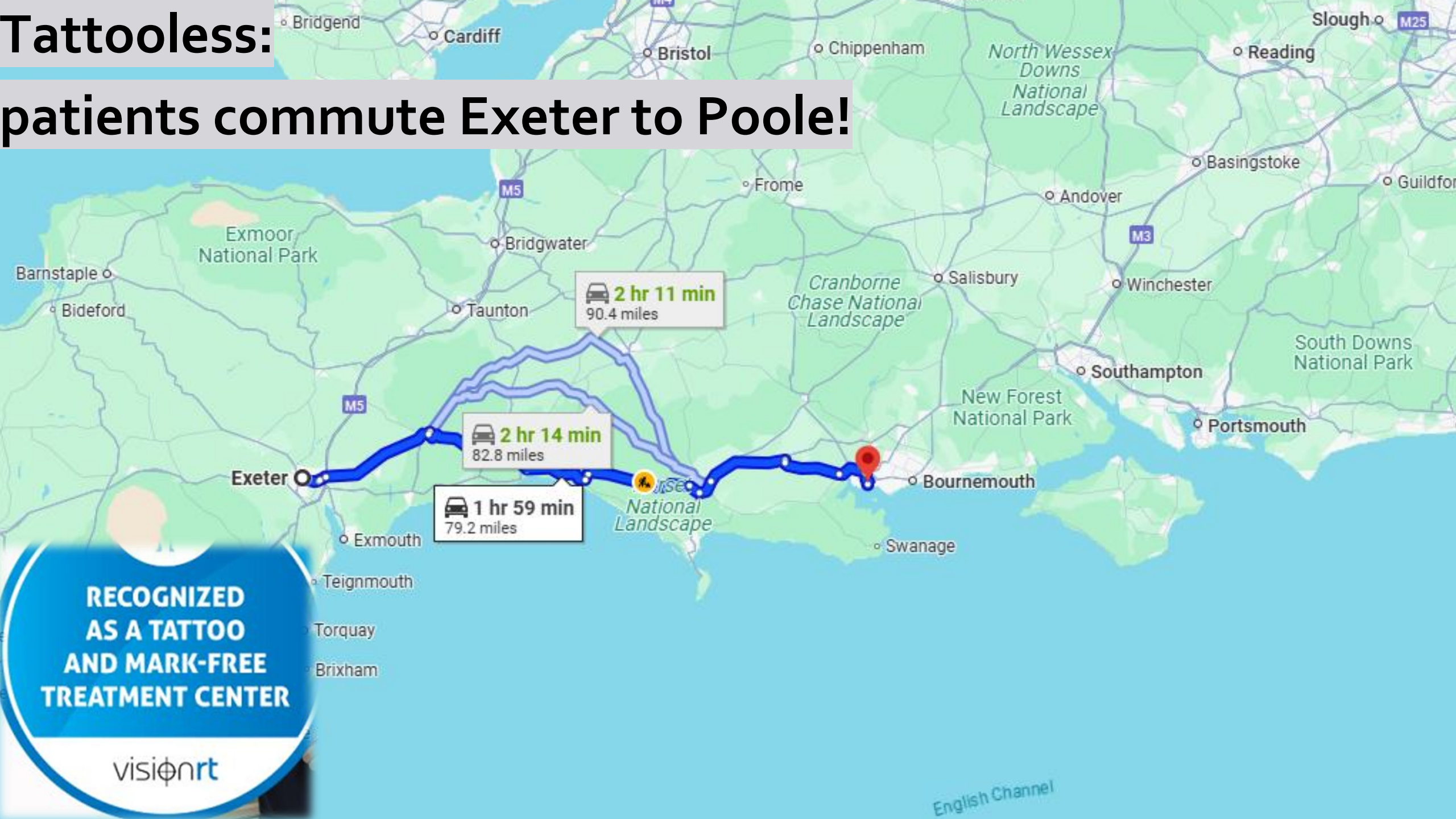
Tattooless





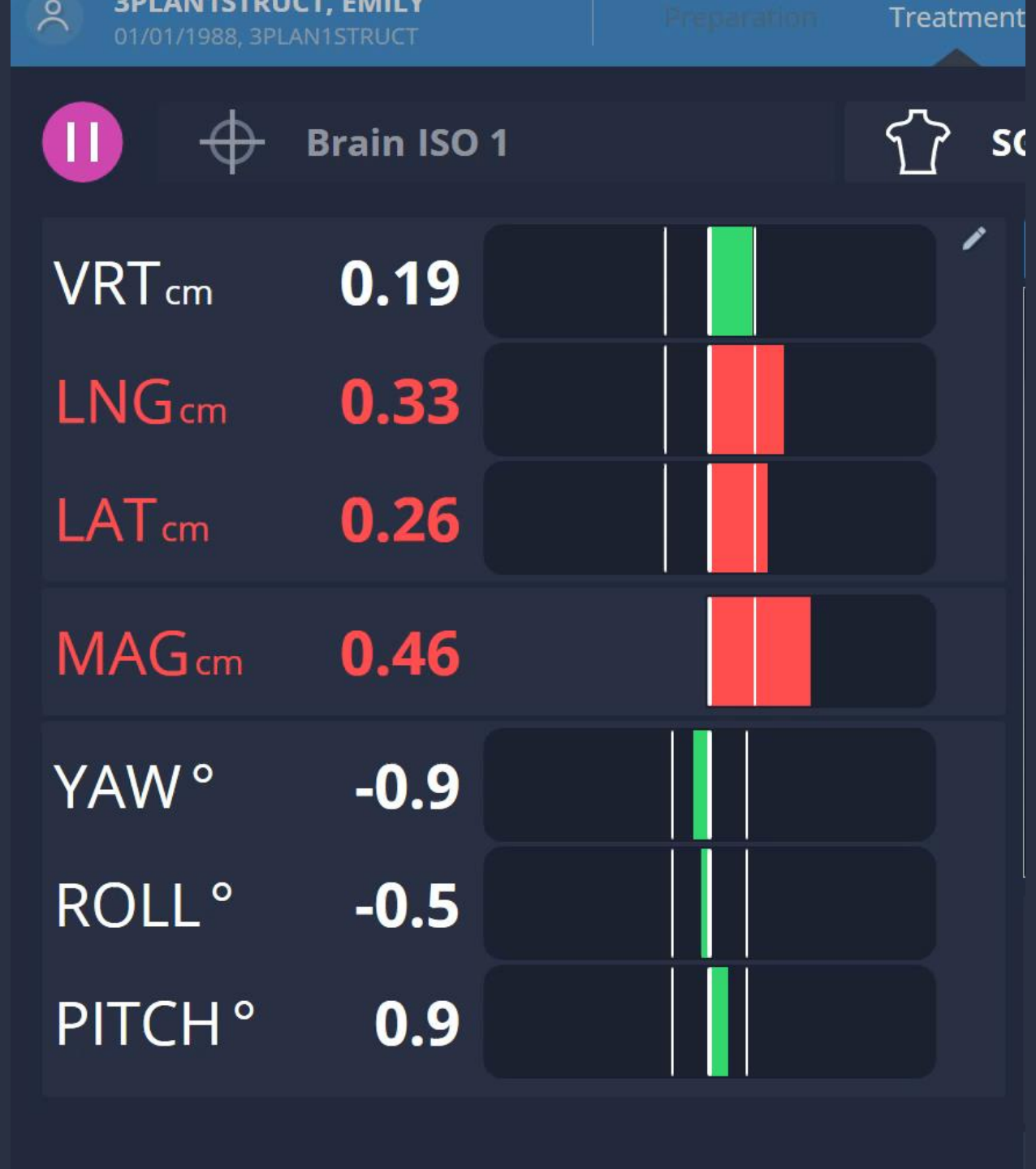
Tattooless:

patients commute Exeter to Poole!

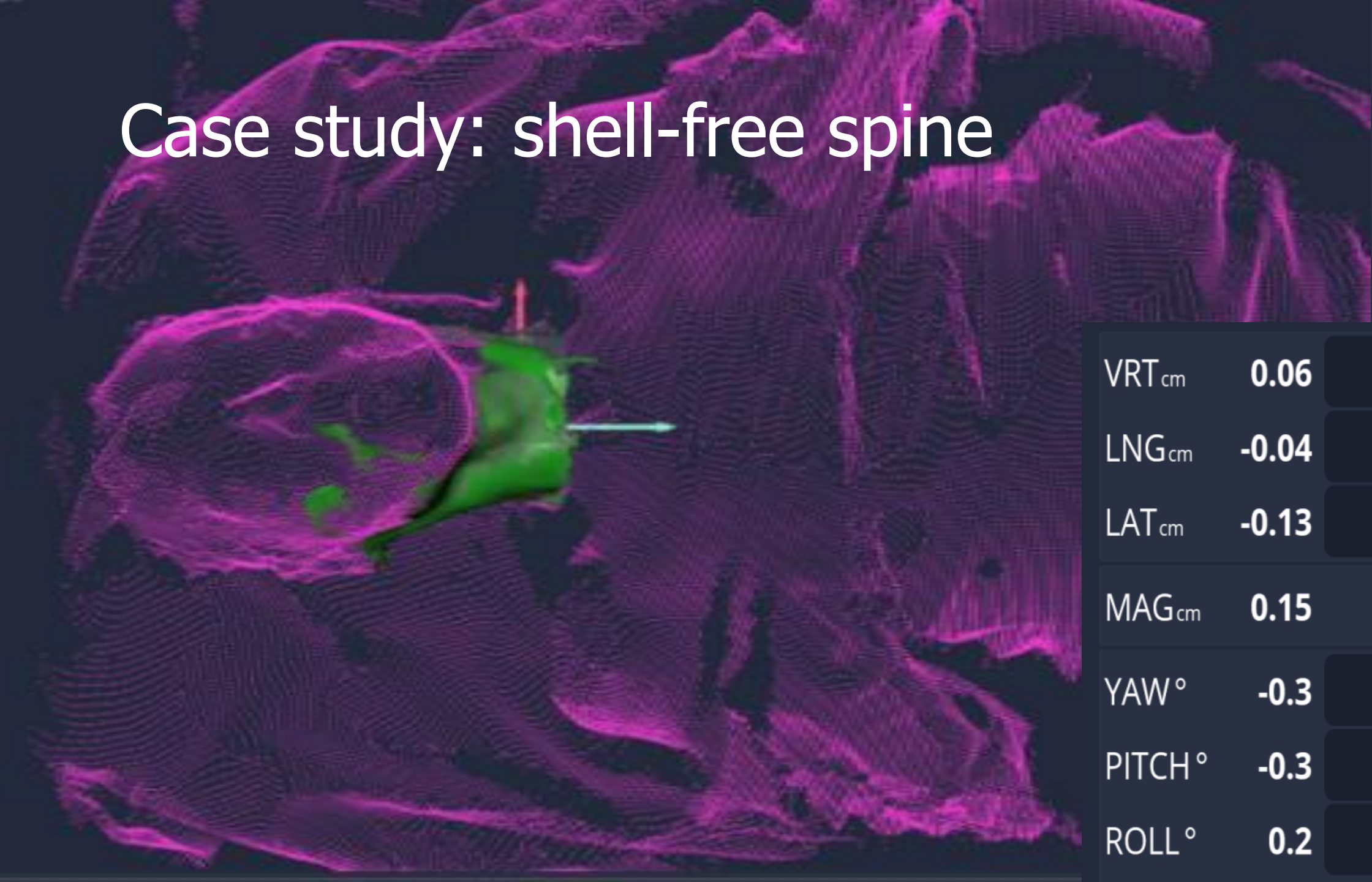



RECOGNIZED
AS A TATTOO
AND MARK-FREE
TREATMENT CENTER
visionrt

Real-time deltas (relaxing or tightening motion control)



Case study: shell-free spine



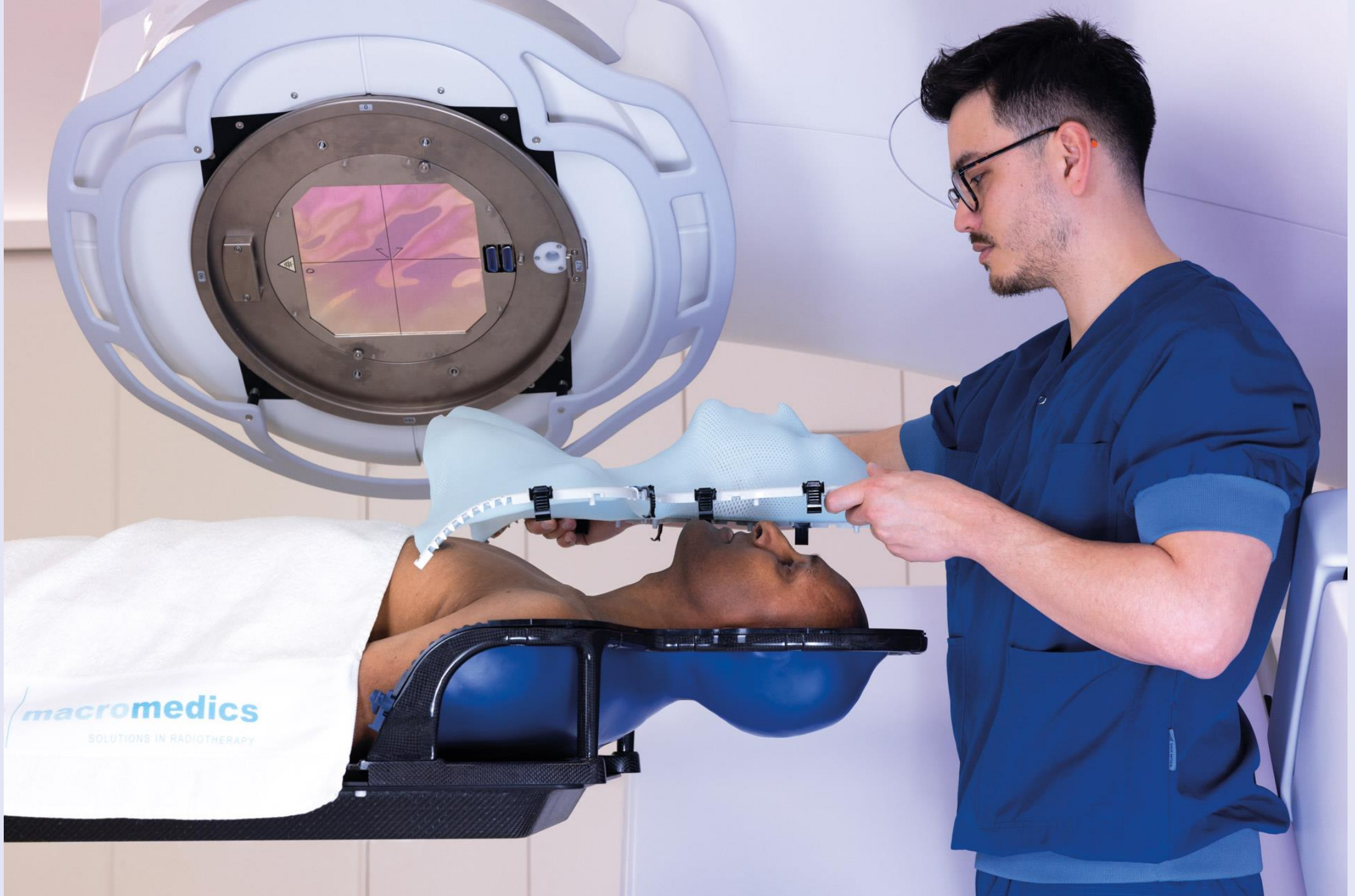
VRT cm	0.06
LNG cm	-0.04
LAT cm	-0.13
MAG cm	0.15
YAW °	-0.3
PITCH °	-0.3
ROLL °	0.2

Head and Neck Radiotherapy Treatment

Closed face shell

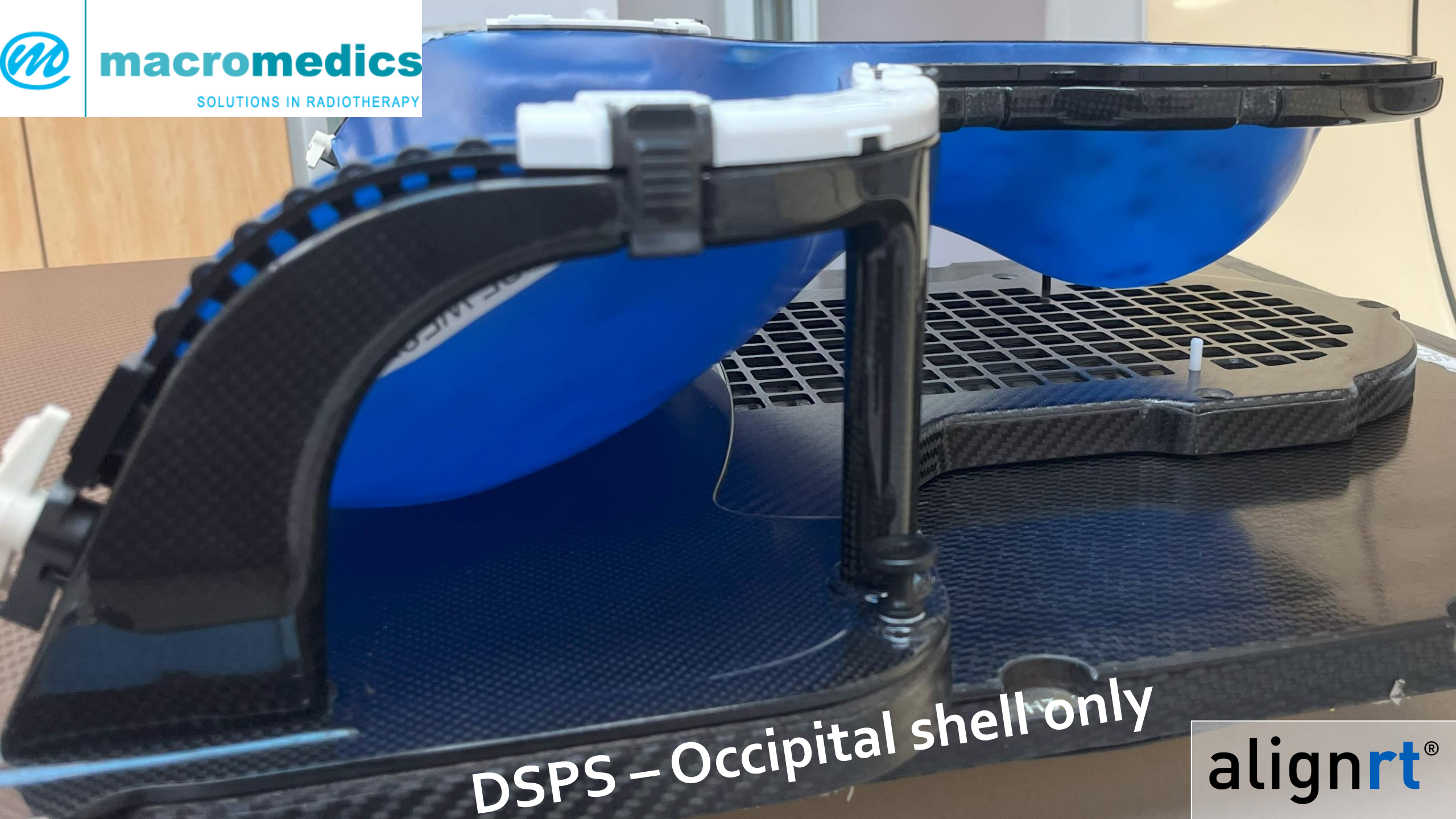
Open Face Mask

- Less claustrophobic
- Monitor the patient with SGRT
- Stronger materials


macromedics
SOLUTIONS IN RADIOTHERAPY

macromedics

SOLUTIONS IN RADIOTHERAPY



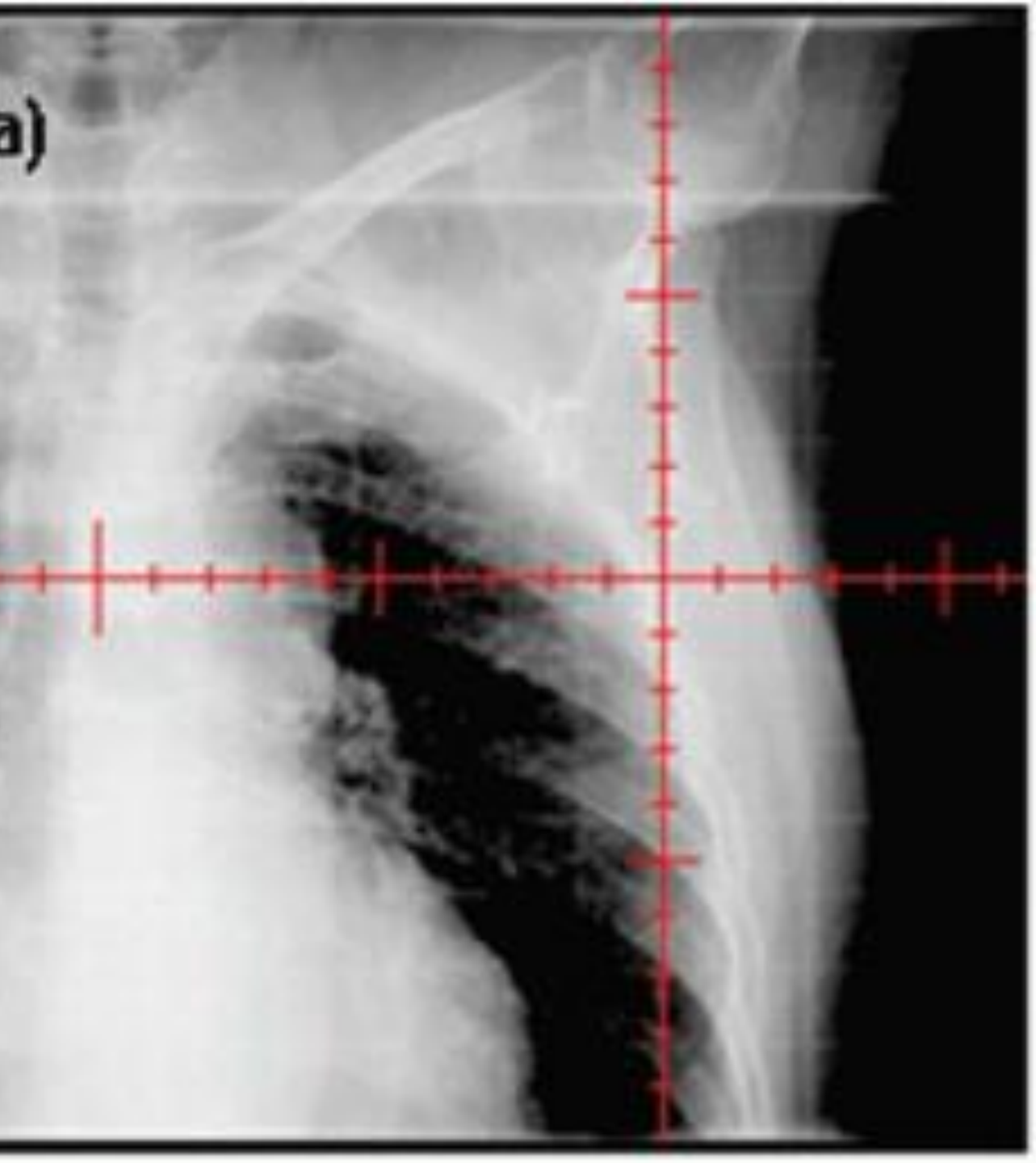
DSPS – Occipital shell only

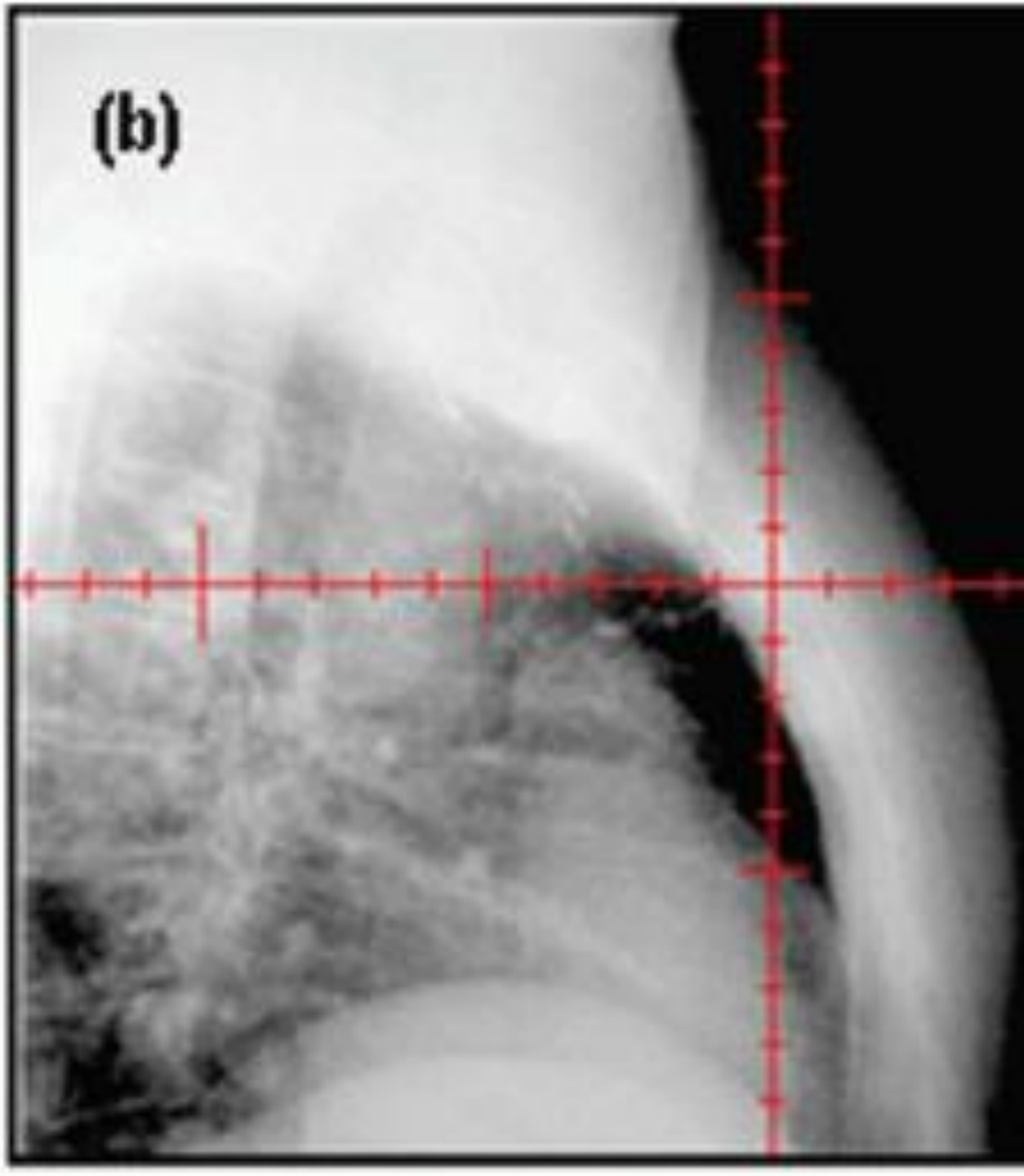
alignrt®

macromedics
SOLUTIONS IN RADIOTHERAPY

Weekly: before *and* after CBCT =inter- and intra- fraction motion for closed masks for comparison

alignrt®


a)


(b)

Original Article | Open Access | Published: 04 July 2022

Prerequisites for the clinical implementation of a markerless SGRT-only workflow for the treatmen breast cancer patients

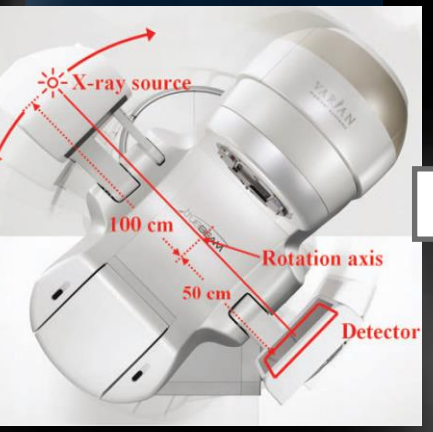
Tim-Oliver Sauer, Oliver J. Ott, Godehard Lahmer, Rainer Fietkau & Christoph Bert

Strahlentherapie und Onkologie **199**, 22–29 (2023) | Cite this article

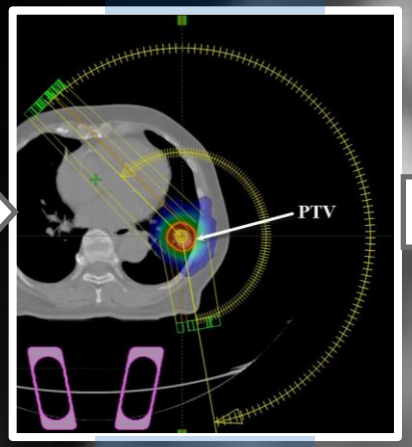
"For 40% of the patients, after five fractions with small CBCT corrections, the workflow could be changed to SGRT-only positioning with weekly CBCT."

SABR lung

Pre CBCT



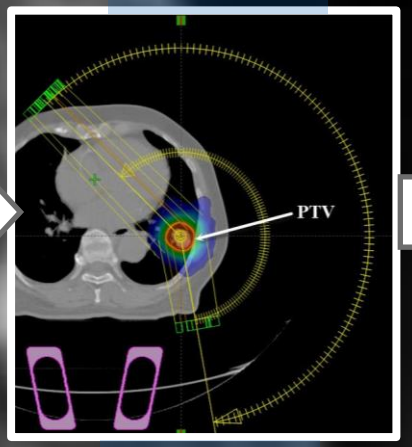
Arc 1



CFF

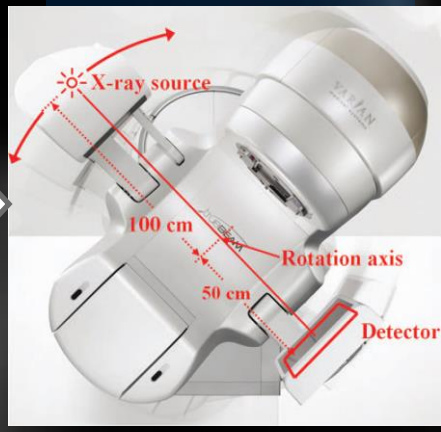
Mid CBCT

Arc 2

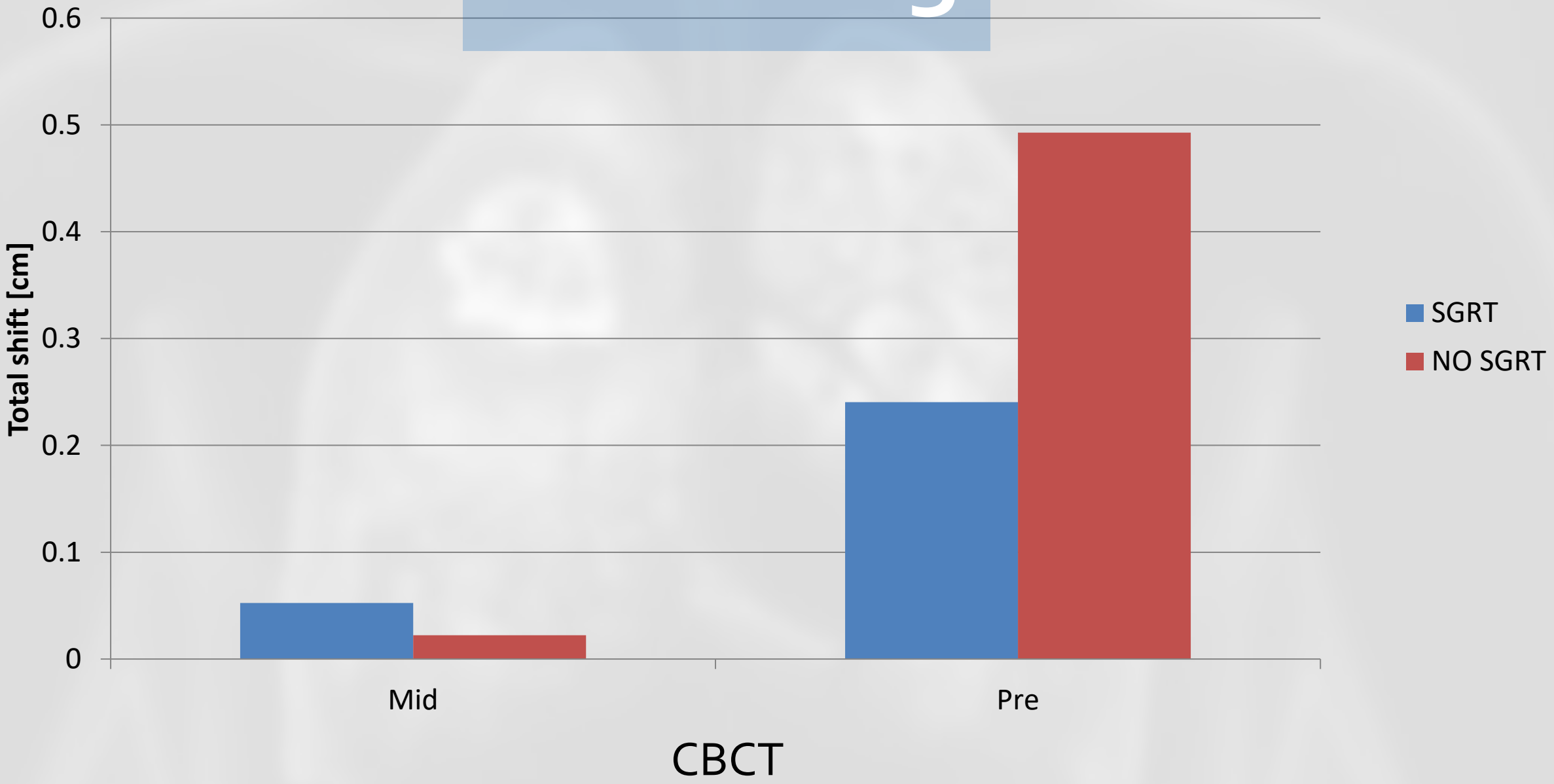


CFF

Post CBCT



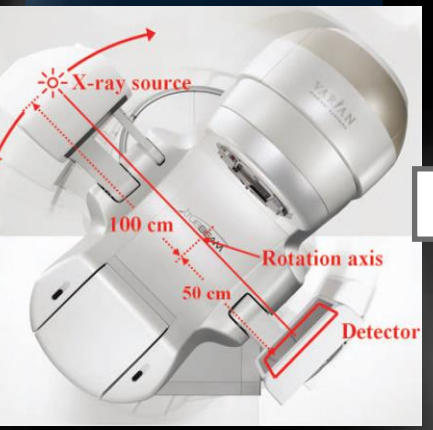
SABR lung



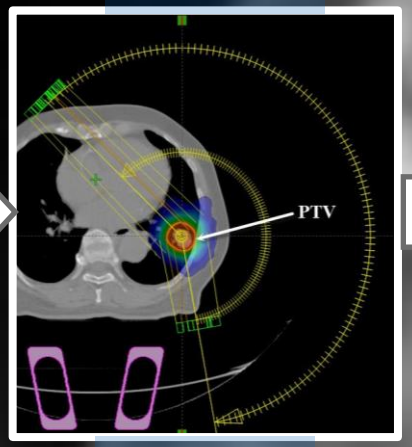
SABR lung



Pre CBCT

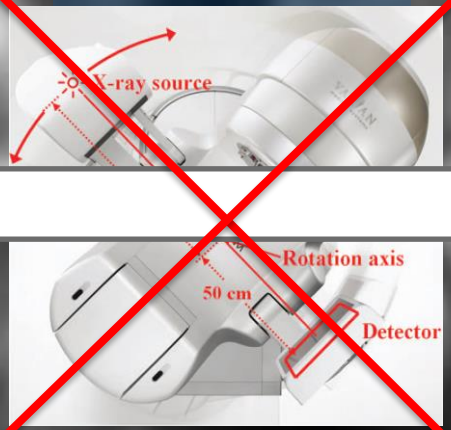


Arc 1

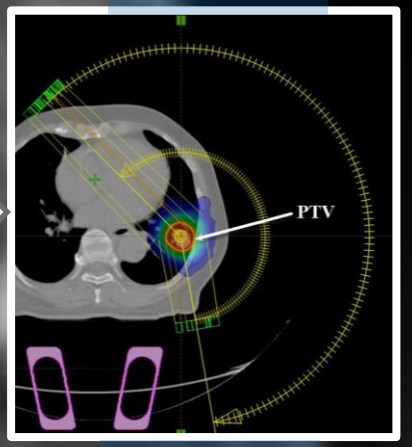


FFF

~~Mid CBCT~~

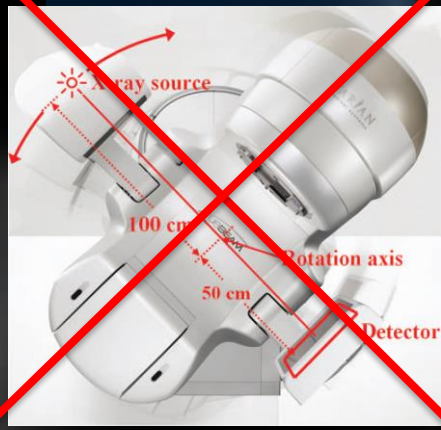


Arc 2



FFF

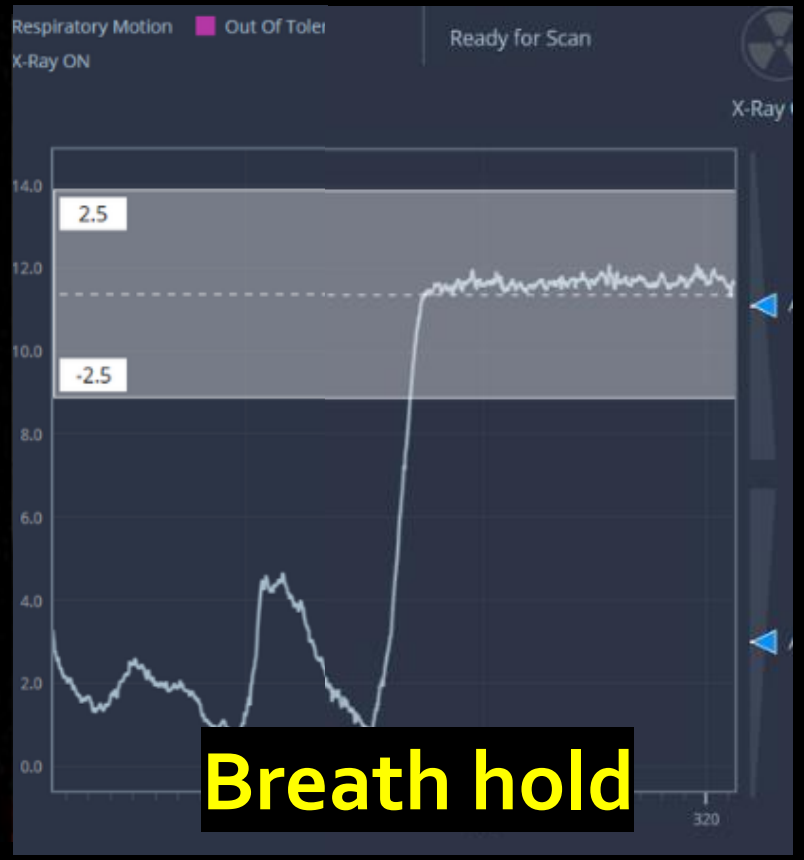
~~Post CBCT~~

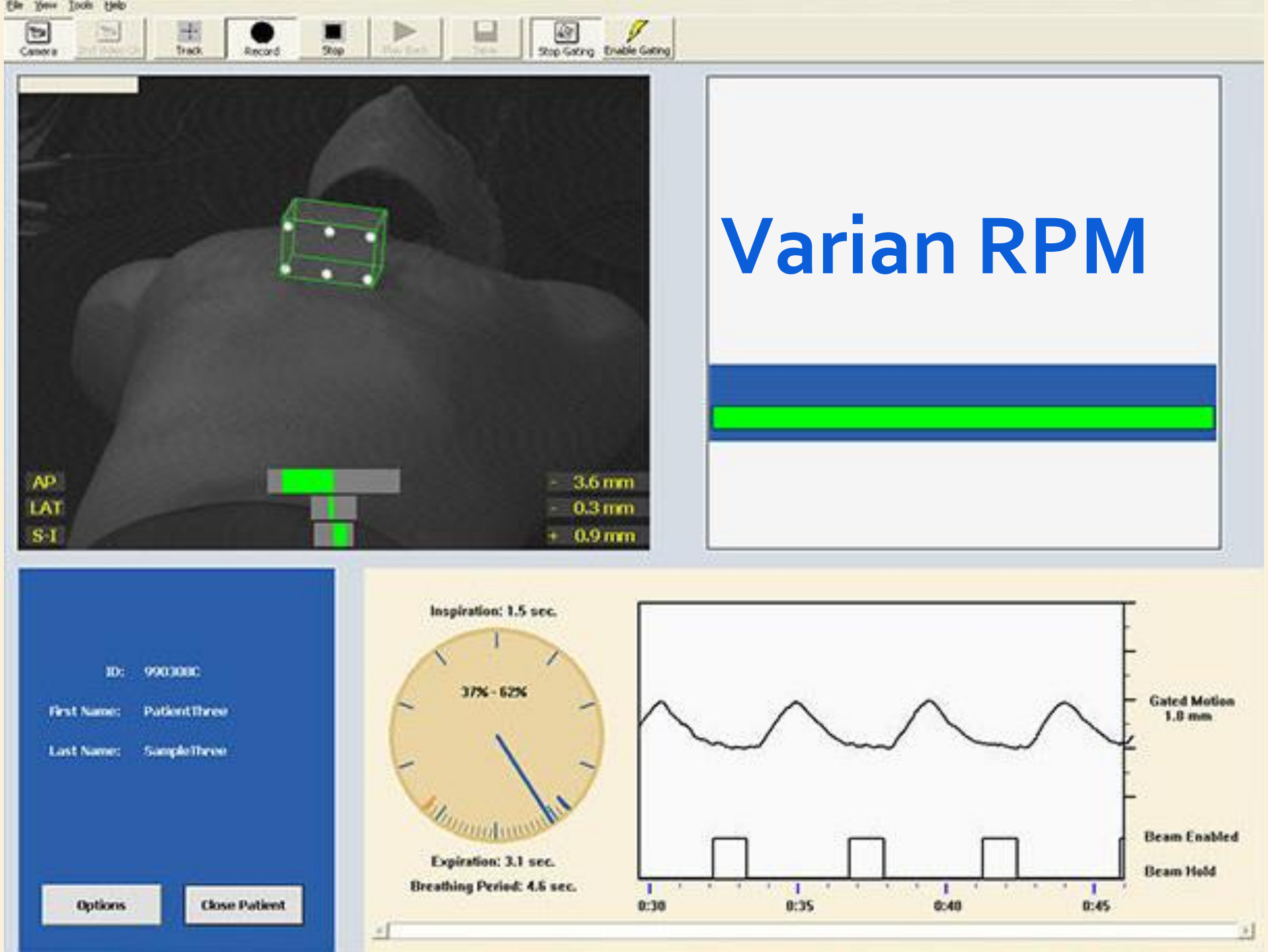


SGRT for tattoo-less set-up and real-time motion management
==large time saving, and radiation dose reduction

Lung treatment breathing motion mgmt

Lung treatment breathing motion mgmt




Camera
Track
Record
Stop
Stop Gating
Enable Gating
AP
LAT
S-I
3.6 mm
0.3 mm
0.9 mm
Varian RPM
ID:
First Name:
PatientThree
Last Name:
SampleThree
Options
Close Patient
Inspiration: 1.5 sec.
37% - 62%
Expiration: 3.1 sec.
Breathing Period: 4.6 sec.
Gated Motion
1.8 mm
Beam Enabled
Beam Hold
0:30
0:35
0:40
0:45

SMITH, JOAN
15/03/1959, V123456

Sim | Chart

senior

DIBH (3D Helical)

SGCT1 Surface

Capture | Couch Velocity | Edit Patch

04/10/2021 16:19:20

Review | Save Data... | Edit Range

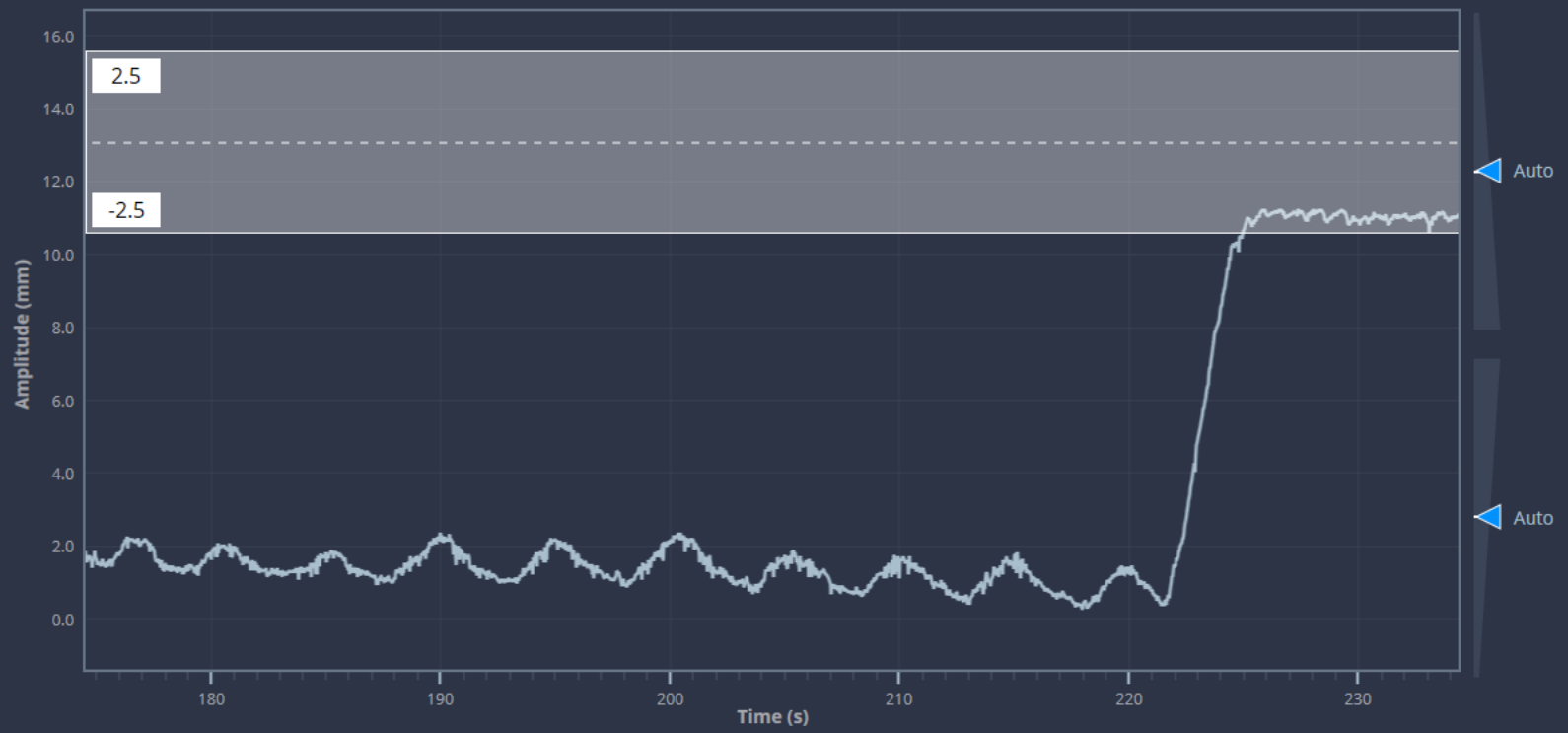
Monitoring

Respiratory Motion | Out Of Tolerance | X-Ray ON

1.3 s

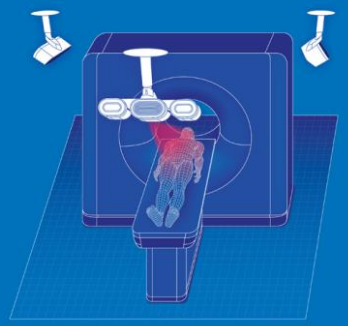
Ready for Scan

X-Ray OFF



simrt

SIM



4D AND BREATH HOLD CT

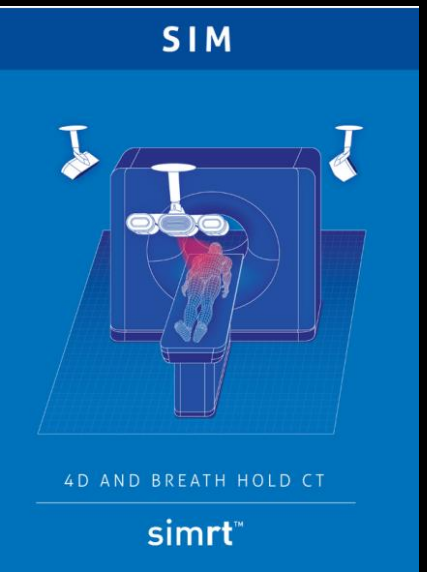
simrt™

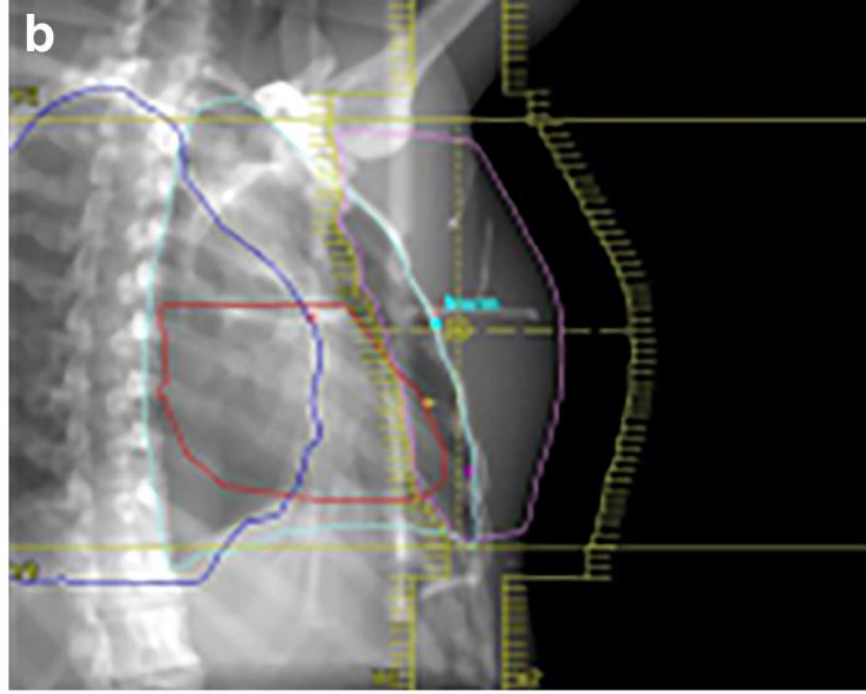
Respiratory

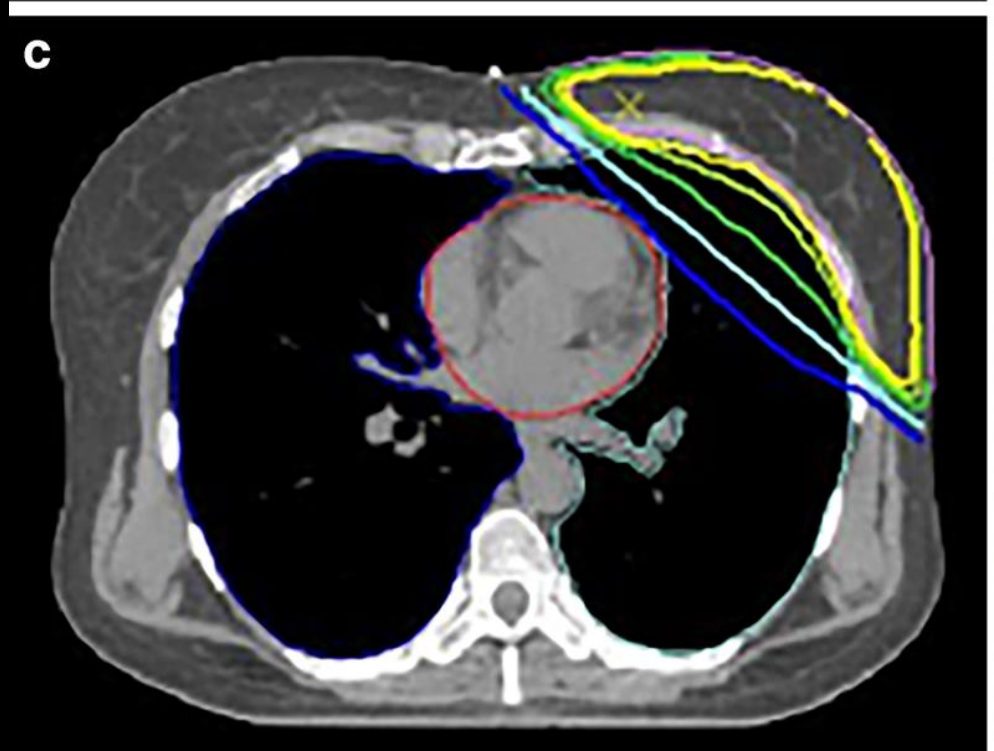
e softlock was unlocked

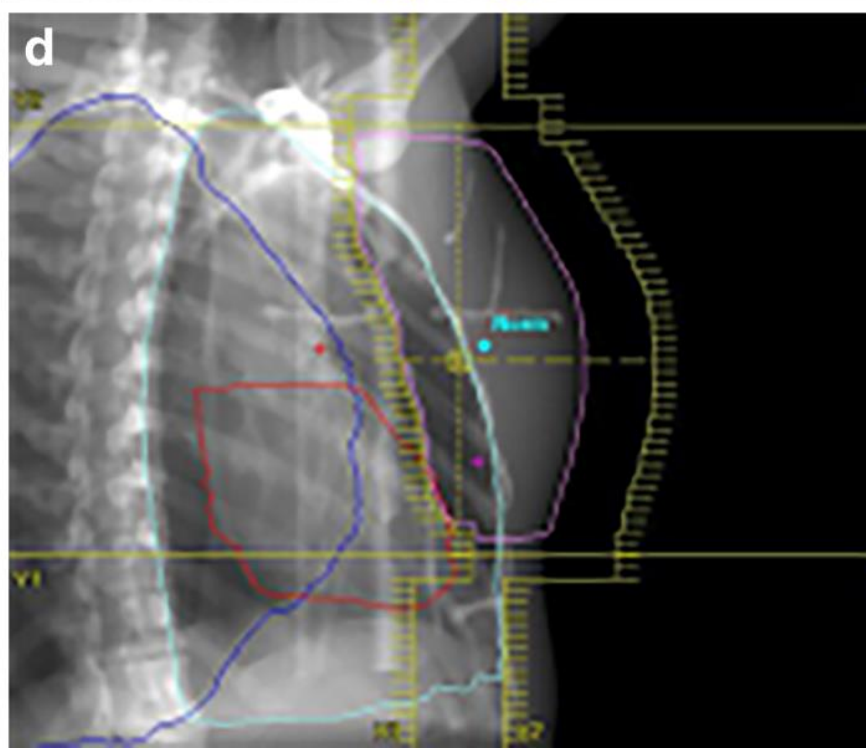
35.0 fps | System Status | 04/10/2021 16:29

simrt

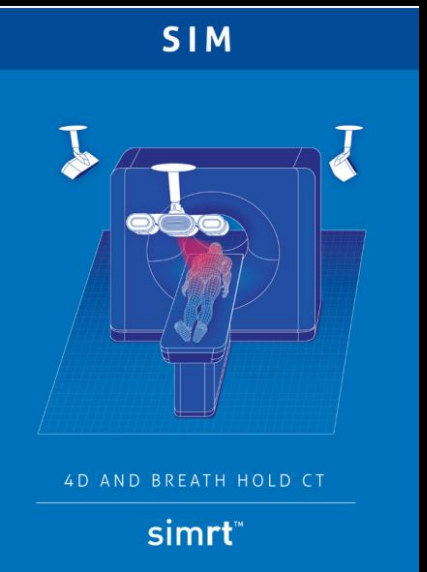








simrt



(not one of our patients)

SMITH, JOAN
15/03/1959, V123456

Sim | Chart

senior

DIBH (3D Helical)

SGCT1 Surface

Capture | Couch Velocity | Edit Patch

04/10/2021 16:19:20

Review | Save Data... | Edit Range

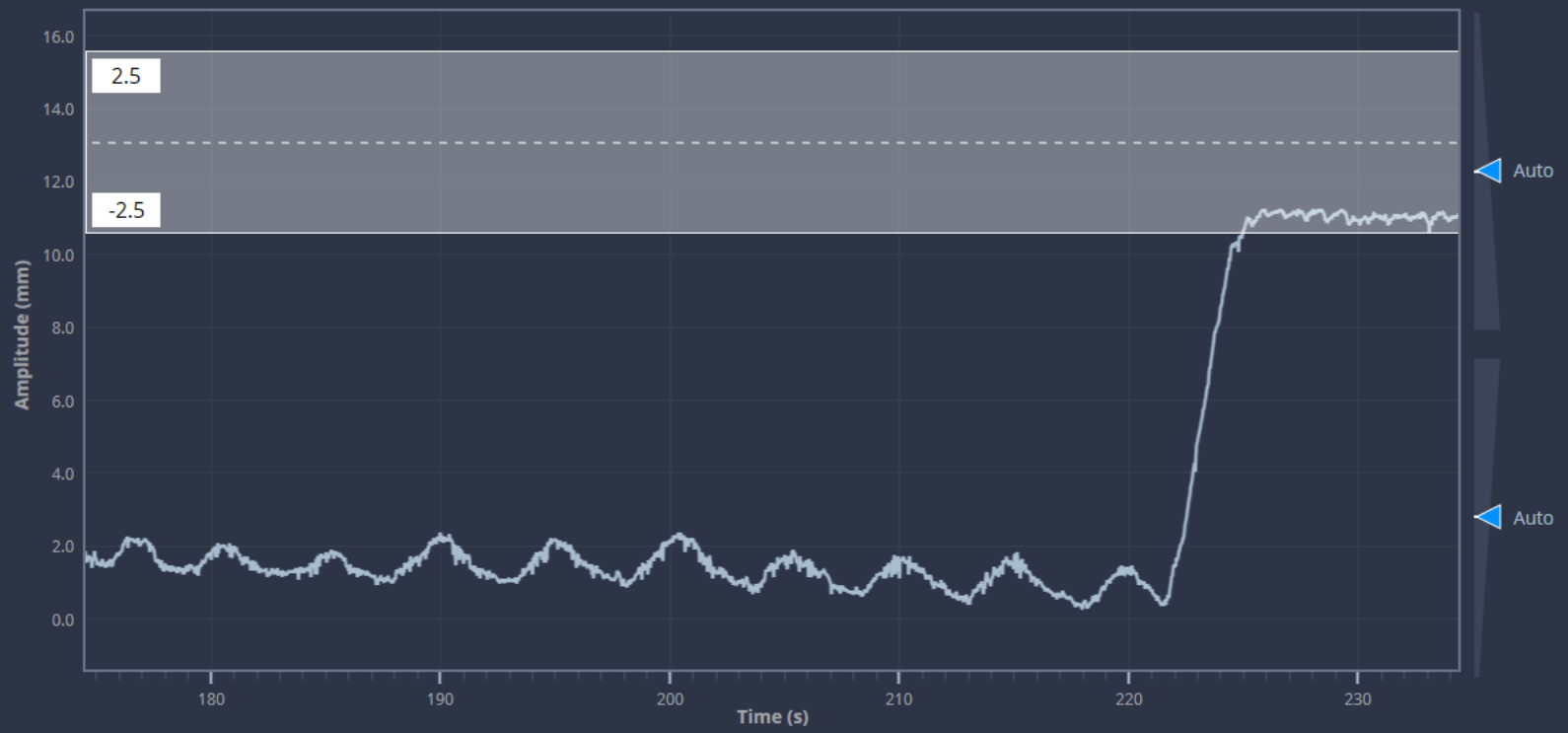
Monitoring

Respiratory Motion | Out Of Tolerance | X-Ray ON

1.3 s

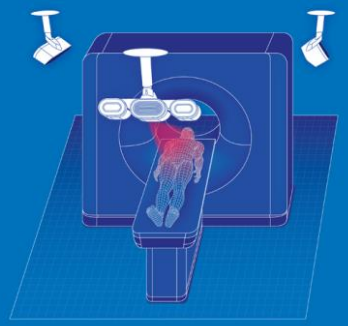
Ready for Scan

X-Ray OFF



simrt

SIM



4D AND BREATH HOLD CT

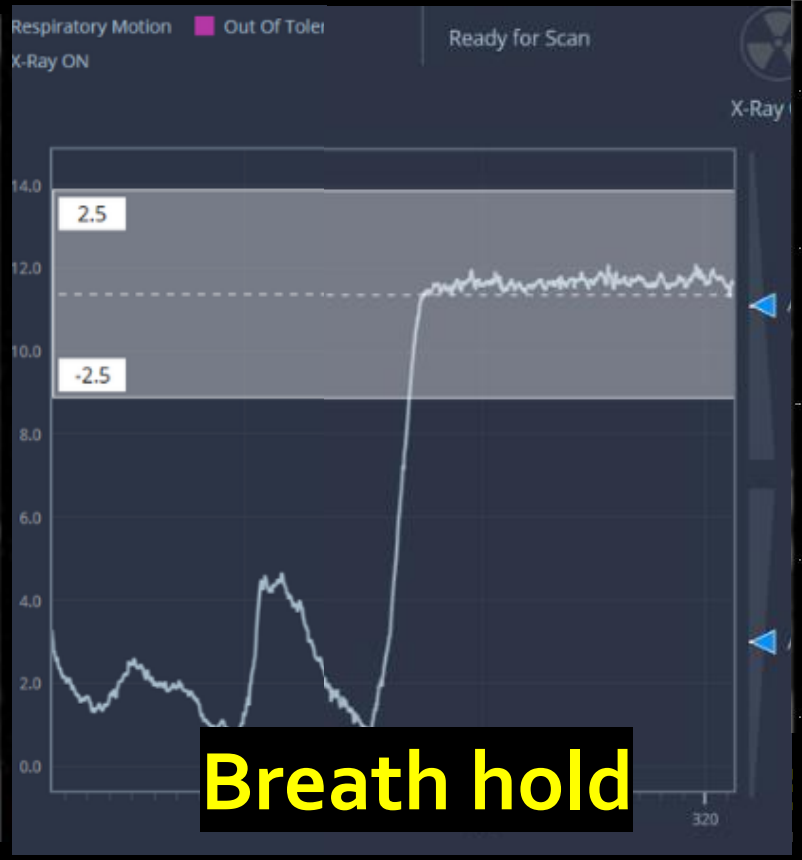
simrt™

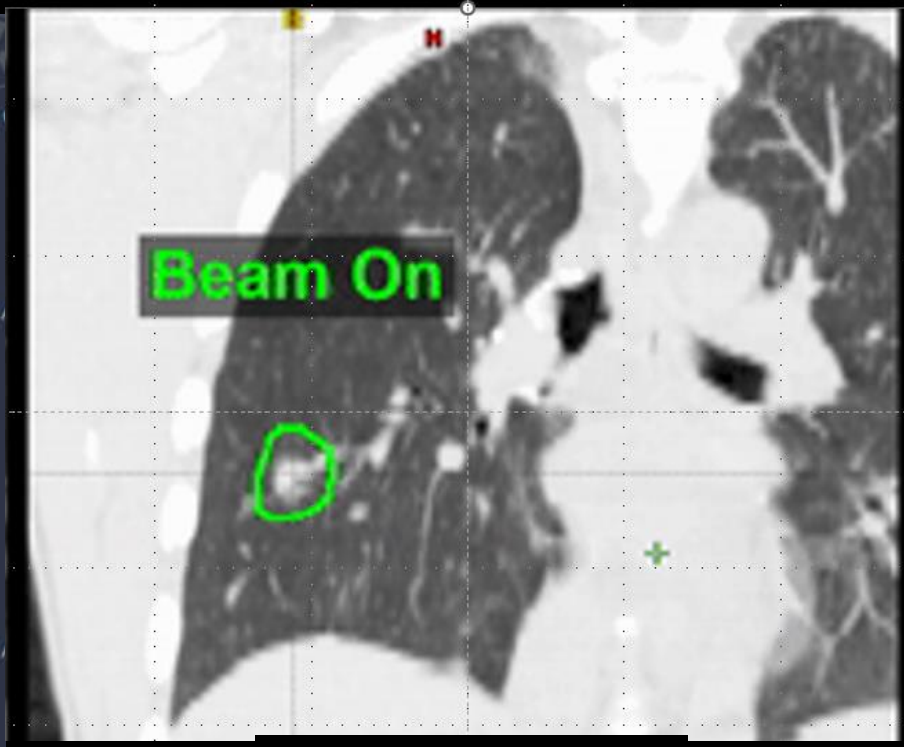
Respiratory

e softlock was unlocked

35.0 fps | System Status | 04/10/2021 16:29

Lung treatment breathing motion mgmt





Mediastinum initially, ad hoc –
now formalised for SABR lung

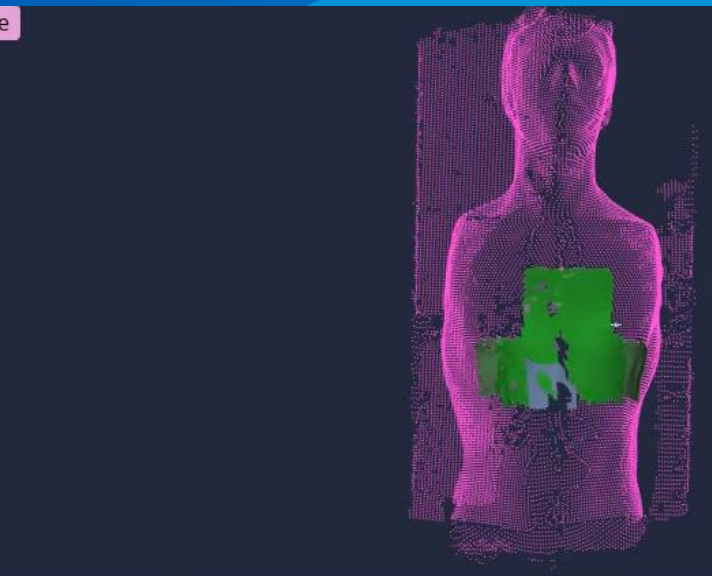
Lung treatment breathing motion mgmt

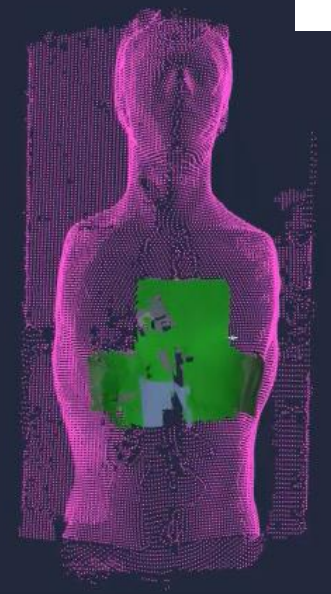
Lung treatment breathing motion mgmt

Respiratory Module

SIM PLAN TREAT DOSE

17 Jan 2024





Module® Patch Movement 120 BPM PHASE 75% Start 30% Stop 70%

10 20 30 40 50 60 70 80 90 100

Within Thresholds Time (s)

Activate Windows Go to Settings to activate Windows.

Surface Deformation Video Patch

5.4 fps | TreatmentMonitoringState | 1650.60 MB | System Status | 01/12/2022 11:58

NOT FOR CLINICAL USE

SGRT External ROI1

Reference Treatment Couch 0.0°

01/12/2022 11:05:00

Gated Capture

Respiratory Module® Patch Movement

Amplitude Based

120 BPM PHASE 88%

Amplitude (mm) 8.0 4.0 0.0

0 10 20 30 40 50 60 70 80 90

Beam On Within Thresholds Time (s)

Activate Windows Go to Settings to activate

Surface Deformation Video Patch

3.4 fps ROI 18.4 fps | TreatmentMonitoringState | 1025.38 MB | System Status | 01

visionrt | Guiding Radiation Therapy™

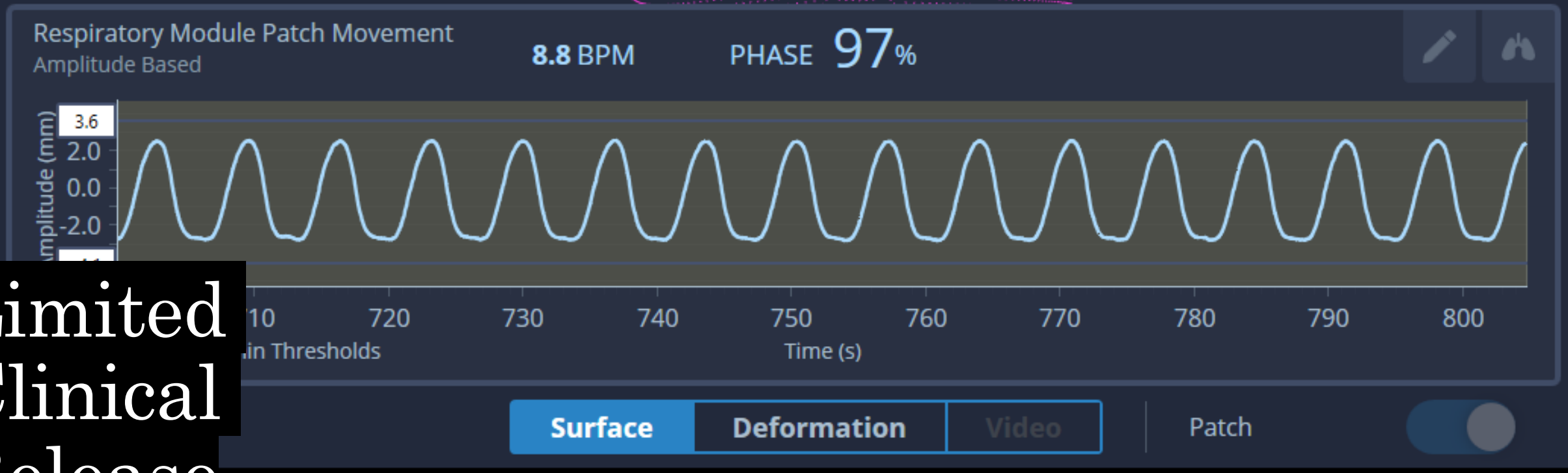
CE Mark Certifications for DoseRT, MapRT and Respiratory Module

News - 03 December 2024

Backup (aka safety) gating

1st patients… in the world!

24 Feb 2025



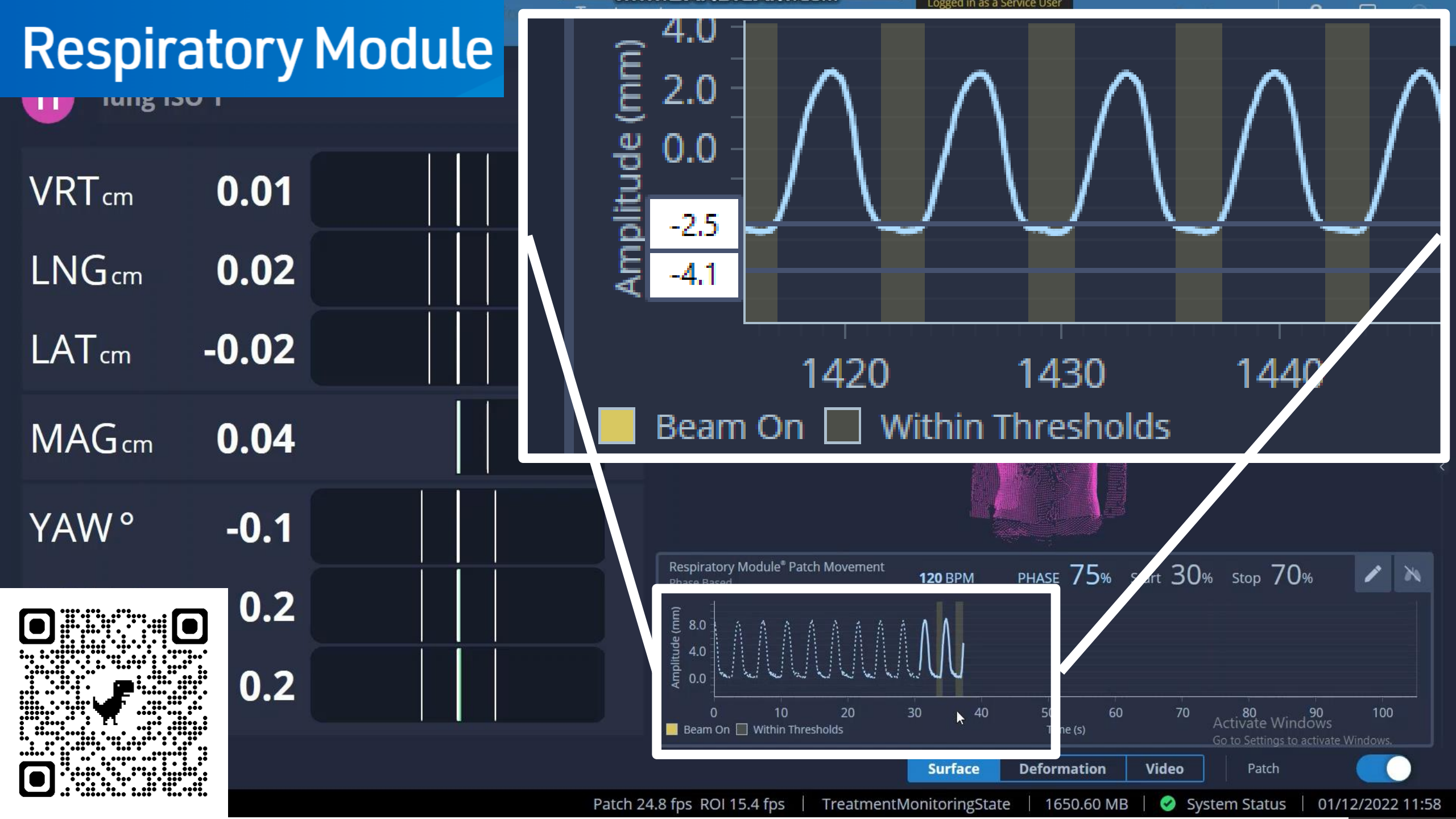
Limited Clinical Release

ROI 28.8 fps | System Status | 09/05/2024 18:27

Limited Clinical Release → V7 AlignRT upgrade, specialist training, collaboration

May ‘23 → Feb ’25… and beyond!

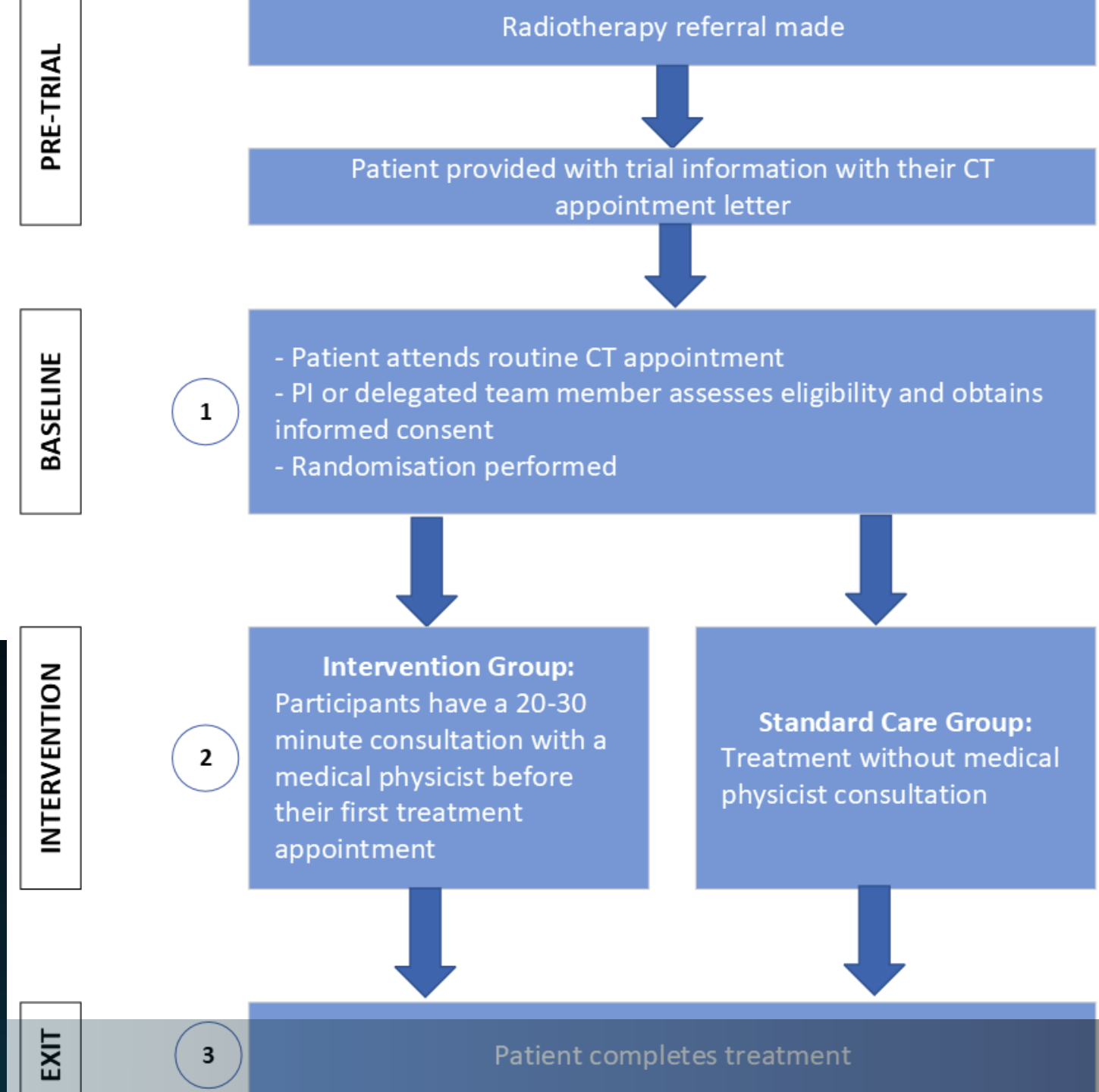
Respiratory Module



RAPPORT trial

Charlie.Martin@UHD.nhs.uk

Reduce **A**nxiety for **P**atients with **P**hysicist app**O**intments in **R**adio**T**herapy



Anxiety

What is it?

Procedural anxiety

Affects up to half of RT patients

Why is it bad?

Quality of life

RT side effects

Survival

Stress and the immune system

How can we manage it?

Medication

Psychosocial interventions

e.g. music therapy, reflexology, hypnosis, CBT

Slide credit / more info: Charlie.Martin@UHD.nhs.uk

Education & Information

Review Article | Open Access

Reduced patient anxiety as a result of radiation thera psychosocial support: a systematic review

Kelly Elsner BAppSc(MRT), Diana Naehrig Dr.Med, FMH Radioonkologie, Georgia K. B. Halkett BMedRad(Hons), FIR, PhD, Haryana M. Dhillon BSc, MA, PhD

First published: 03 February 2017 | https://doi.org/10.1002/jmrs.208 | Citations: 48

CLINICAL INVESTIGATION

An Investigation of the Effect of Virtual Reality on Alleviating Anxiety in Patients With Breast Cancer Undergoing Radiation Therapy: A Randomized Controlled Trial

Jaeyong Shin, MD, PhD,[*,†] Jee Suk Chang, MD, PhD,[‡] Jin Sung Kim, PhD,[‡] Ji-Yeon An, MS,[§] Seung Yeun Chung, MD, PhD,[‖] So-Yeon Yoon, PhD,[¶] and Yong Bae Kim, MD, PhD[‡]

The effect of timing of the provision of information on anxiety and satisfaction of cancer patients receiving radiotherapy

S D' haese [1], V Vinh-Hung, P Bijdekerke, M Spinnoy, M De Beukeleer, N Lochie, P De Roover, G Storme

RT Prepare: a radiation therapist-delivered intervention reduces psychological distress in women with breast cancer referred for radiotherapy

Georgia Halkett[1], Moira O'Connor[2], Michael Jefford[3,4], Sanchia Aranda[5,6], Susan Merchant[7], Nigel Spry[8,9], Robert Kane[2], Thérèse Shaw[10], David Youens[11], Rachael Moorin[11,12] and Penelope Schofield[3,4,13] on behalf of the RT Prepare project team

The Information Needs of New Radiotherapy Patients: How to Measure? Do They Want to Know Everything? And if Not, Why?

Maaike Zeguers, M.Sc. • Hanneke C.J.M. de Haes, Ph.D. • Linda C. Zandbelt, Ph.D. • ...
Debbie D. Geijsen, M.D. • Caro C.E. Koning, M.D., Ph.D. • Ellen M.A. Smets, Ph.D. • Show all authors

Published: November 15, 2010 • DOI: https://doi.org/10.1016/j.ijrobp.2010.09.032

Slide credit / more info: Charlie.Martin@UHD.nhs.uk

Physicists and education

PHYSICS CONTRIBUTION | VOLUME 115, ISSUE 1, P224-232, JANUARY 01, 2023

Examining the Effect of Direct Patient Care for Medical Physicists: A Randomized Prospective Phase III Trial

Todd F. Atwood, PhD • Derek W. Brown, PhD • James D. Murphy, MD • ... Ajay P. Sandhu, MD • Arno J. Mundt, MD • Todd Pawlicki, PhD • Show all authors

Published: October 23, 2022 • DOI: https://doi.org/10.1016/j.ijrobp.2022.05.014 • Check for updates

Objectives

1. Introduce yourself and describe the role of the medical physicist, compared to the radiation oncologist
2. Explain that you are the primary resource for all technical aspects related to their radiation therapy
3. Provide a basic overview of the entire radiation therapy process (from CT simulation to treatment delivery)
4. Discuss the purpose of the CT simulation appointment (the role it plays in treatment planning and treatment delivery)
5. Determine if the patient will have difficulty during the CT simulation (*e.g.* patient positioning, respiratory motion, etc.)
6. Assess the patient's comfort level with radiation therapy and answer any questions they have about the entire process
7. Explain the purpose of the next meeting (*i.e.* to review the patient's treatment plan and explain the treatment delivery)

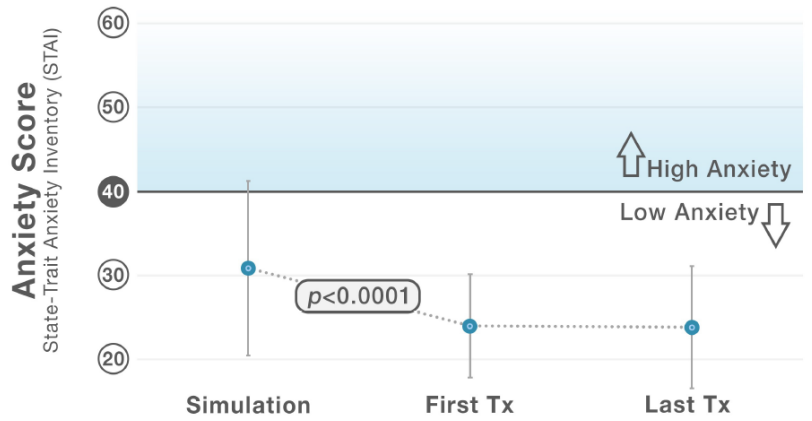
PHYSICS CONTRIBUTION

A Direct Patient-Provider Relationship With the Medical Physicist Reduces Anxiety in Patients Receiving Radiation Therapy

Jay Burmeister, PhD,[*,†] Michael M. Dominello, DO,[*] Roger Soulliere, MPH,[†] Geoff Baran, MS,[†] Kathryn Dess, MS,[‡] Brian Loughery, PhD,[§] Hyejeong Jang, MS,[*] Seongho Kim, PhD,[*] Mara Jelich, MS,[†] Pamela Laszewski, BSN, RN, OCN,[†] Cindy Zelko, RN,[†] and Lauren M. Hamel, PhD[*]

[*]*Department of Oncology, Karmanos Cancer Institute, Wayne State University School of Medicine, Detroit, Michigan;* [†]*Karmanos Cancer Center, Detroit, Michigan;* [‡]*University of Michigan, Ann Arbor, Michigan; and* [§]*William Beaumont Hospital, Dearborn, Michigan*

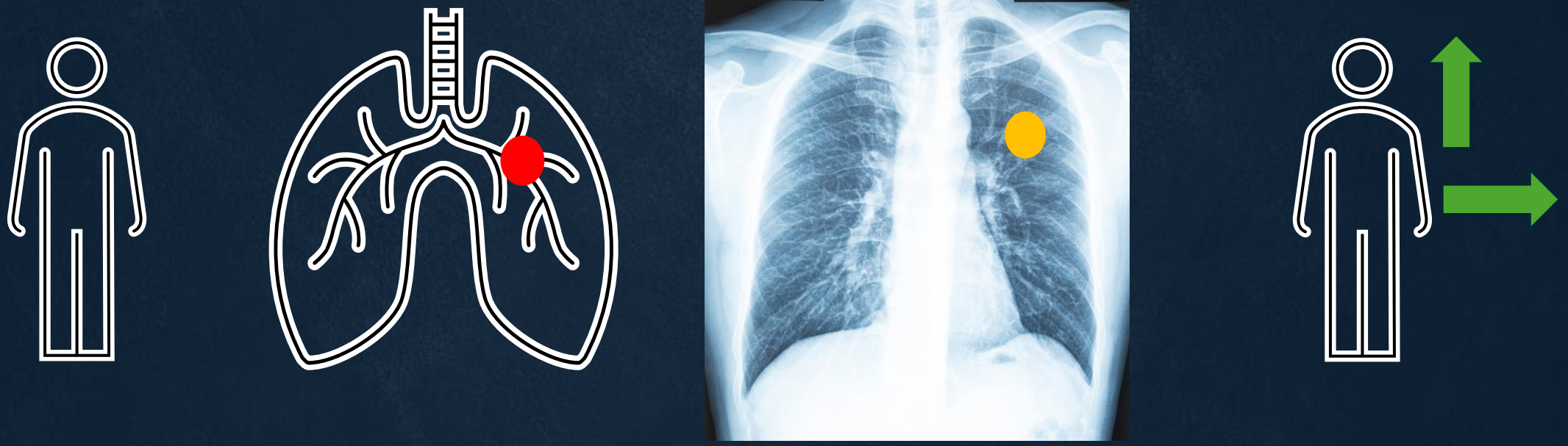
Received Apr 27, 2022; Accepted for publication Oct 1, 2022



Slide credit / more info: Charlie.Martin@UHD.nhs.uk

Images courtesy of San Diego

Does patient setup correlate with anxiety?



Slide credit / more info: Charlie.Martin@UHD.nhs.uk

… quantify this with SGRT

Slide credit / more info: Priscila.Paez@uhd.nhs.uk

Non-coplanar Radiation Therapy Survey

Preliminary results

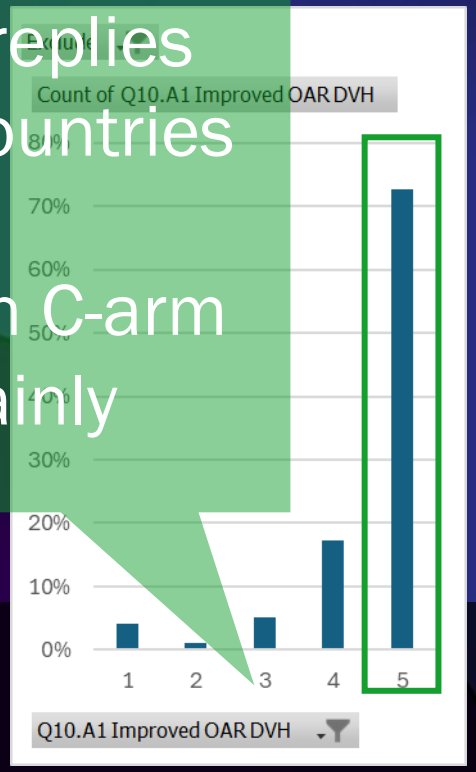
Priscila Páez, Thomas Carter

UH Dorset / Vision RT

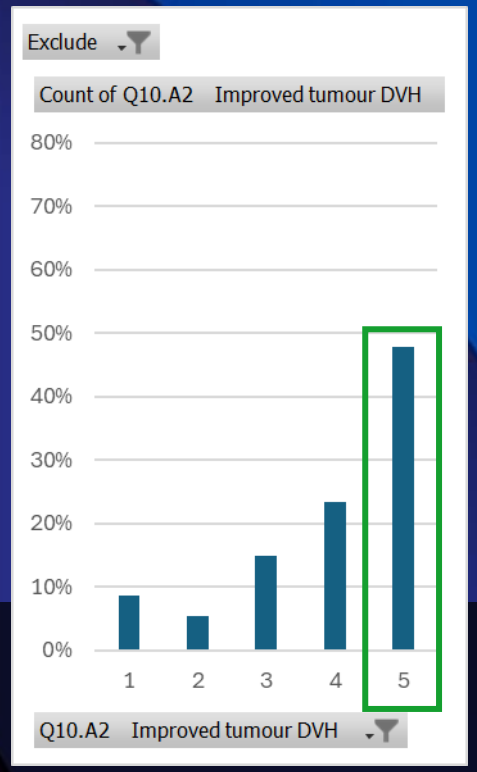
23/01/2025

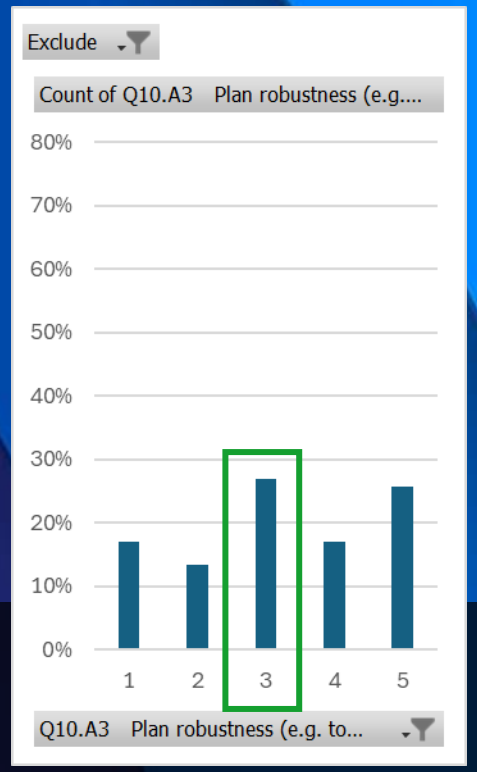
100 replies
+14 countries

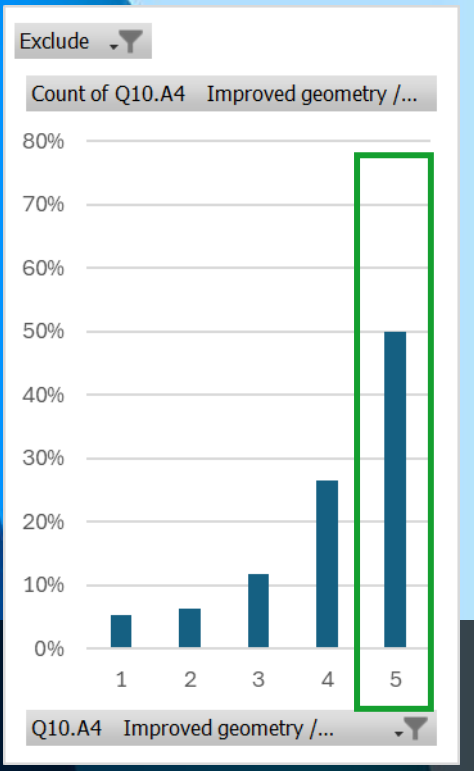
Photon C-arm mainly



Improved OAR DVH







Improved geometry / avoidance of dose overlap

- **Q10 When considering whether to create / assess a non-coplanar plan, how relevant do you consider these advantages of non-coplanar? More stars = more relevant**

Slide credit / more info: Priscila.Paez@uhd.nhs.uk

alignrt®

- ~~Markers~~ all
- ~~Mask~~ (H&N / palliative)
- ~~Radiation images~~ (breast/SABR)
- ~~Breathing(!)~~ (SABR)
- ~~Marker block~~ (lung – resp' mod')
- ~~Anxiety~~? (HSST research)
- ~~Collisions~~ (MapRT)
- >>10 000 SGRT patients treated – faster set up, no tattoos, real-time motion mgmt

Any questions?

Joshua.Naylor@UHD.nhs.uk

(MPE / Principal Physicist)