AlignRT InBore Clinical Summit:
Transforming Radiotherapy Workflows| Craiova, June 20th 2026

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Implementing Breast Treatment and DIBH with AlignRT InBore

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Overcoming Geometric Challenges, Optimizing Workflow, and Ensuring Cardiac Sparing in Ring-Gantry Environments

CENTRUL DE ONCOLOGIE SI RADIOTERAPIE SN SF. NECTARIE CRAIOVA

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- My comments and the accompanying slides reflect my own opinions and are not necessarily those of VisionRT or my institution.
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- No conflicts of interest to report

Introduction - Halcyon linac

Treatment delivery

- Ring gantry
- Photon energy 6MV FFF,
- Dose rate 800 MU/min
- CBCT: 4 RPM max gantry
- VMAT: 2 RPM max gantry

MLC

- MLC dual layer
- MLC leakage <0.1%
- MLC Velocity ±5cm/sec

Imaging

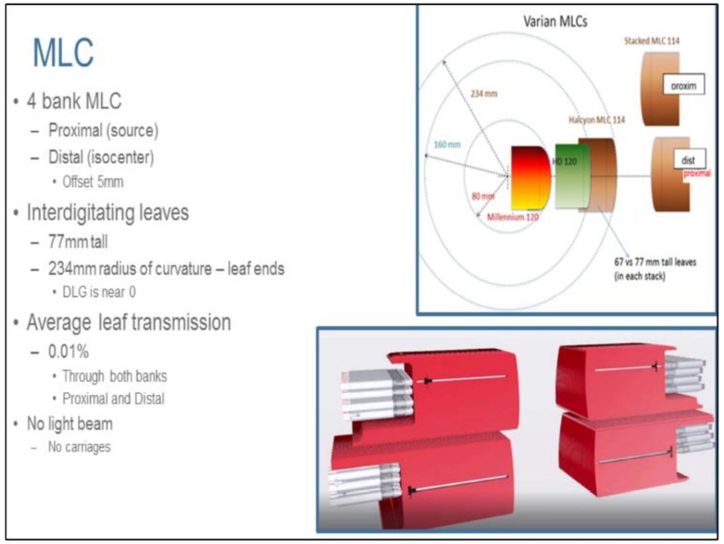
- KV CBCT;
- 100% IGRT

	Halcyon 6x-FFF	TrueBeam 6x-FFF	TrueBeam 6x (flattened)
Dmax	1.3	1.5	1.6
PDD(10)	63.0	64.3	67.2
Max. Dose Rate	800	1400	600

CT design but works like a linac

- 6x-Flattening Filter Free
- Dmax = 1.3
- $\text{PDD}(10)_{100} = 63.0\%$
- $\text{PDD}(10)_{80} = 61.5\%$
- Symmetry <2%
  - Maximum difference between any 2 points which are
  - Equidistant and symmetrical about the CAX
- OAI = 79.0 +/- 2
  - 28x28, 100SSD, d=10
  - 10cm off axis
  - Normalized to CAX
  - Replaces the flatness specification
- 800 MU/min = highest available dose rate
  - For 10x10, 100SSD, dmax

- Increased modulation
  - Higher leaf speed
  - 100 % interdigitation
  - 100% overtravel

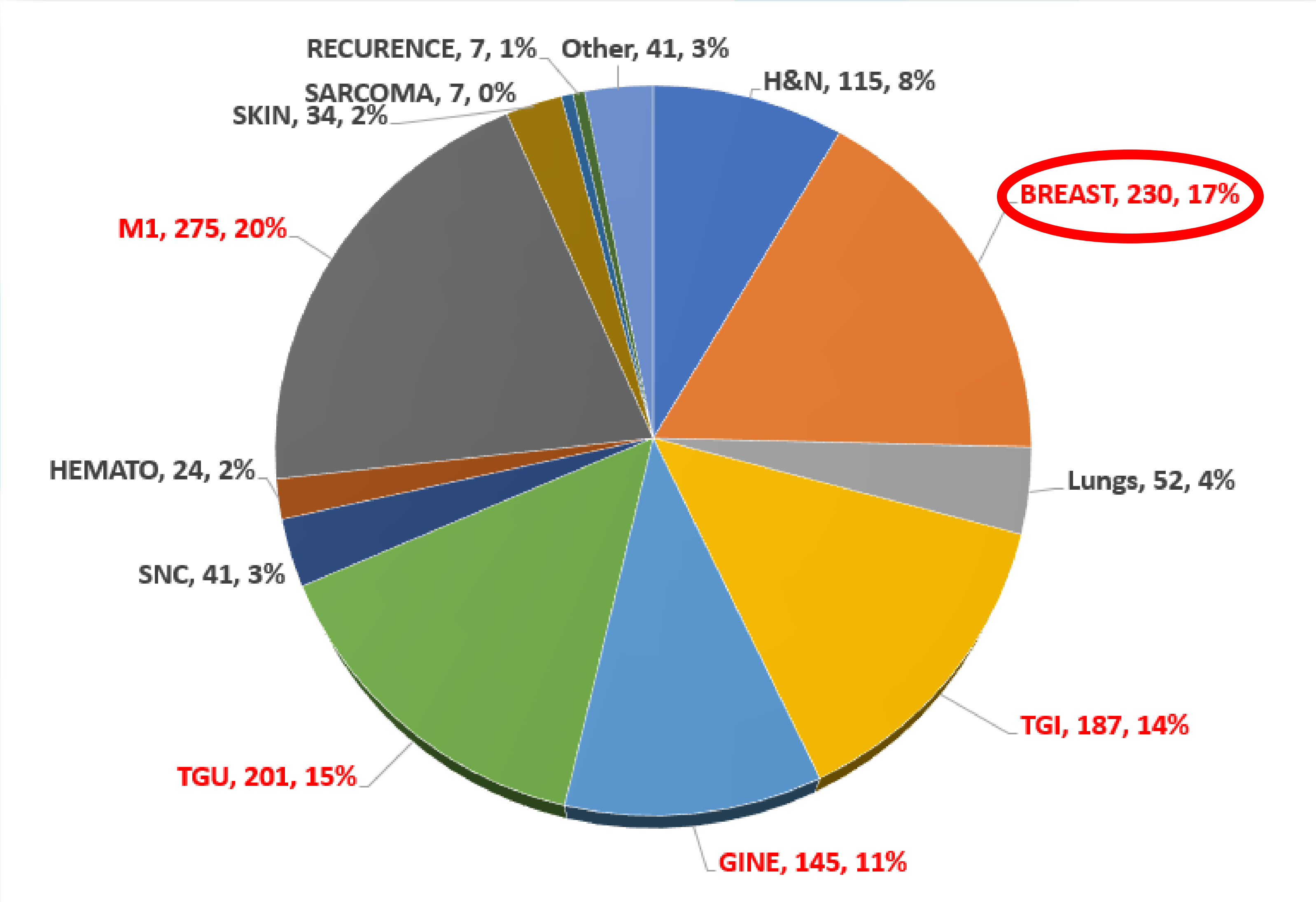


Introduction - General epidemiology data

More than 60% need radiotherapy treatments !

	Males	Females	Both sexes
Population	9 252 006	9 779 324	19 031 330
Incidence*			
Number of new cancer cases	57 311	47 350	104 661
Age-standardized incidence rate	330.8	238.1	276.5
Risk of developing cancer before 75yo	33.6	23.6	28.1
Top 3 cancers (ranked by cases)**	Prostate Lung Colorectum	Breast Colorectum Cervix uteri	Colorectum Breast **Lung**
Mortality*			
Number of cancer deaths	32 830	23 386	56 216
Age-standardized mortality rate	179.0	96.1	132.5
Risk of dying from cancer before 75yo	19.2	10.5	14.6
Top 3 cancers (rank by deaths)**	**Lung** Colorectum Prostate	Breast Colorectum Lung	**Lung** Colorectum Breast
Prevalence*			
5-year prevalent cases	156 580	145 290	301 870

Introduction - 2025 Split by Cancer Type



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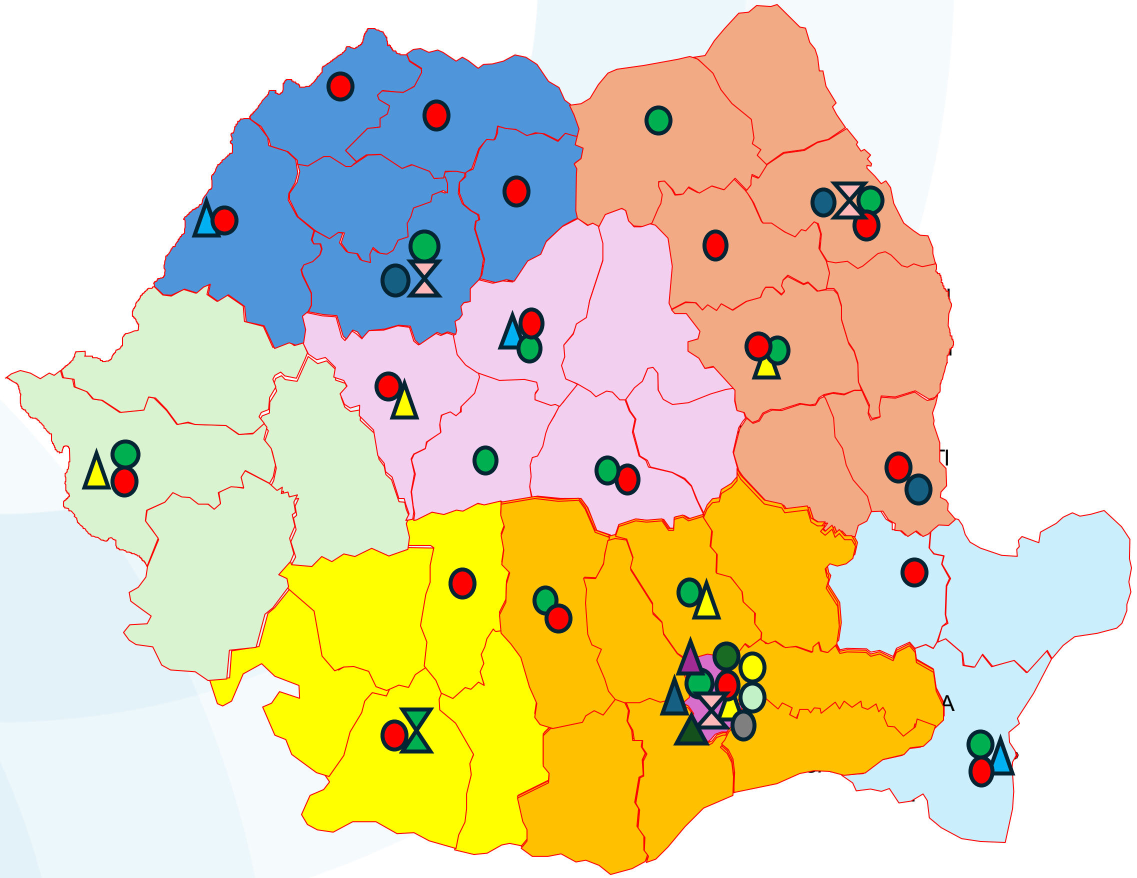
2010:
- 14 Cobalt 60 units
- 5 old Linac



End of 2026:
- ~ 115 new linacs

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Introduction - Why DIBH & Why SGRT?

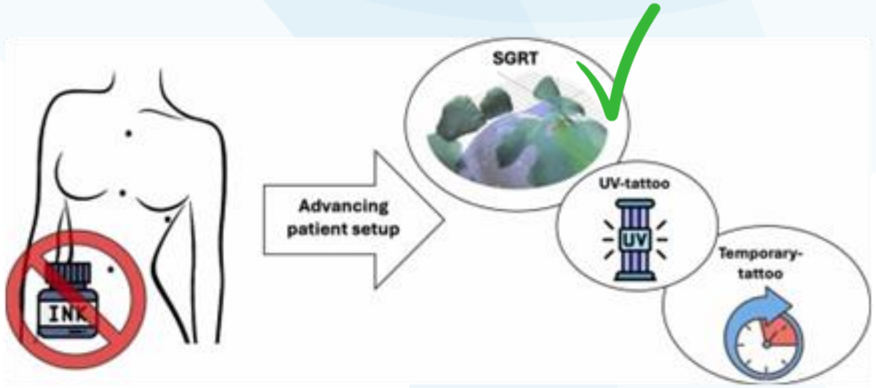
Imaging of the Acute and Chronic Cardiovascular Complications of Radiation Therapy

James Wilson, MBBS, Chong Jun Hua, MBBS, PhD, Nikoo Aziminia, BMBS, and Charlotte Manisty, MBBS, PhD AUTHOR INFO & AFFILIATIONS

Circulation: Cardiovascular Imaging • Volume 18, Number 3 • https://doi.org/10.1161/CIRCIMAGING.124.017454

- **Cardiac Sparing:** DIBH physically moves the heart away from the chest wall, drastically reducing the Left Anterior Descending (LAD) coronary artery dose.

- **The SGRT Advantage:** Traditional DIBH relies on spirometry or single-point markers. SGRT tracks thousands of points on the surface topology.



- Tatooless Workflow: Eliminates the physical and psychological burden of permanent skin markings for breast cancer patients.

The Challenge of the Bore (Ring Gantries)

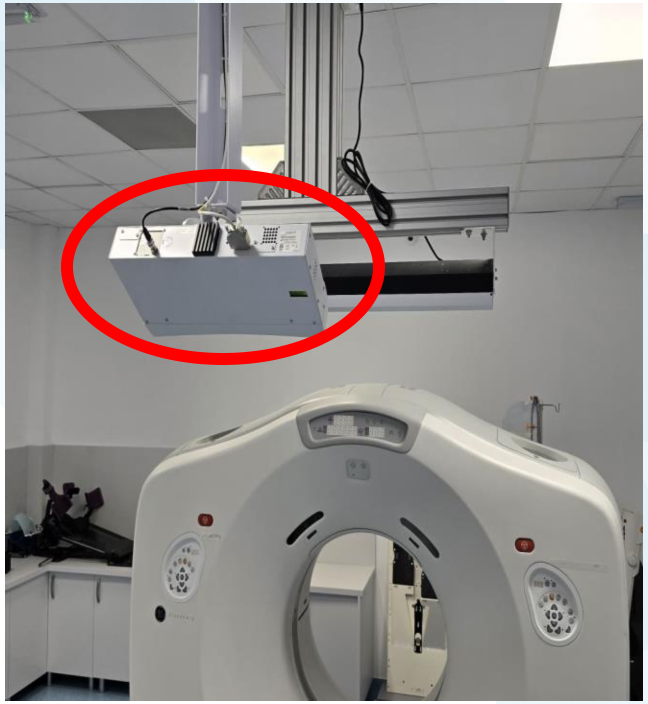
- **The Blind Spot:** Standard SGRT camera pods mounted on the ceiling lose their line of sight once the treatment couch moves deep inside a closed-bore LINAC (e.g., Halcyon, Ethos).

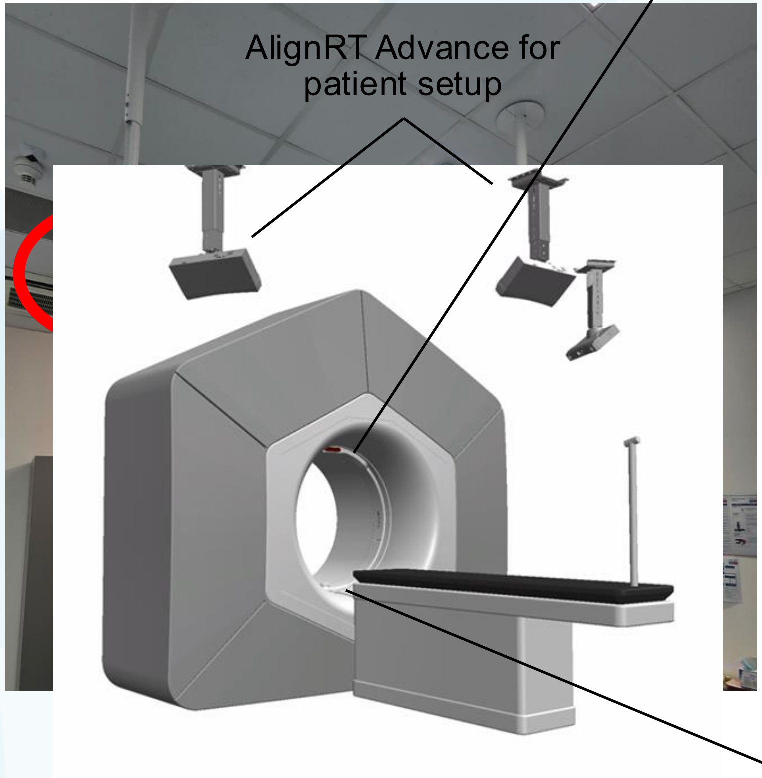
- **The In-Bore Solution:** Miniaturized, specialized camera units mounted directly inside the bore or at the bore opening.

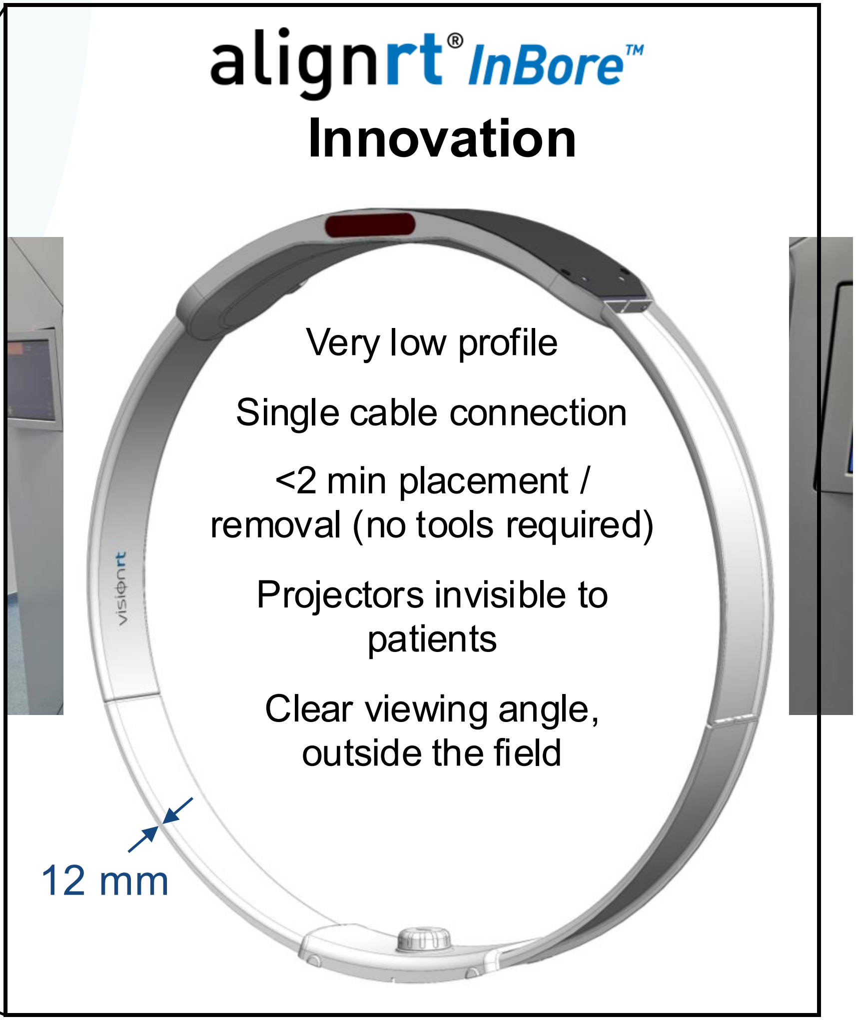
- **Continuous Tracking:** Seamless transition of surface tracking from the external room cameras to the internal bore cameras.

In Bore (Ring Gantries) - From SimRT to AlignRT

SimRT





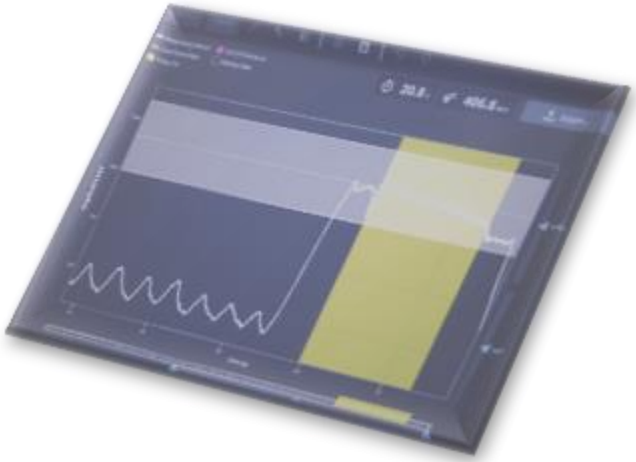


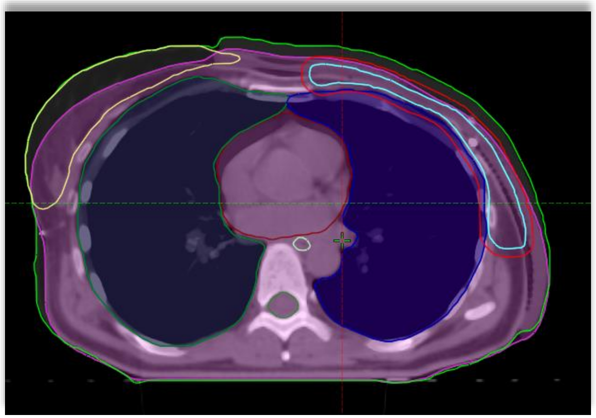
Simulation and Patient Selection (CT Workflow)

- **Patient Coaching:** Educating the patient during CT simulation to achieve a stable, reproducible breath-hold amplitude (typically 2–5 chest wall excursion).

- **Double CT Acquisition:** Obtaining a Free-Breathing (FB) scan for fallback plans and a stable DIBH CT scan for primary planning.

- **Surface Export:** Exporting the planned external contour (DICOM Structure Set) from the TPS to the SGRT database as the baseline reference.





Ring gantry Clinical Workflow - outside cameras

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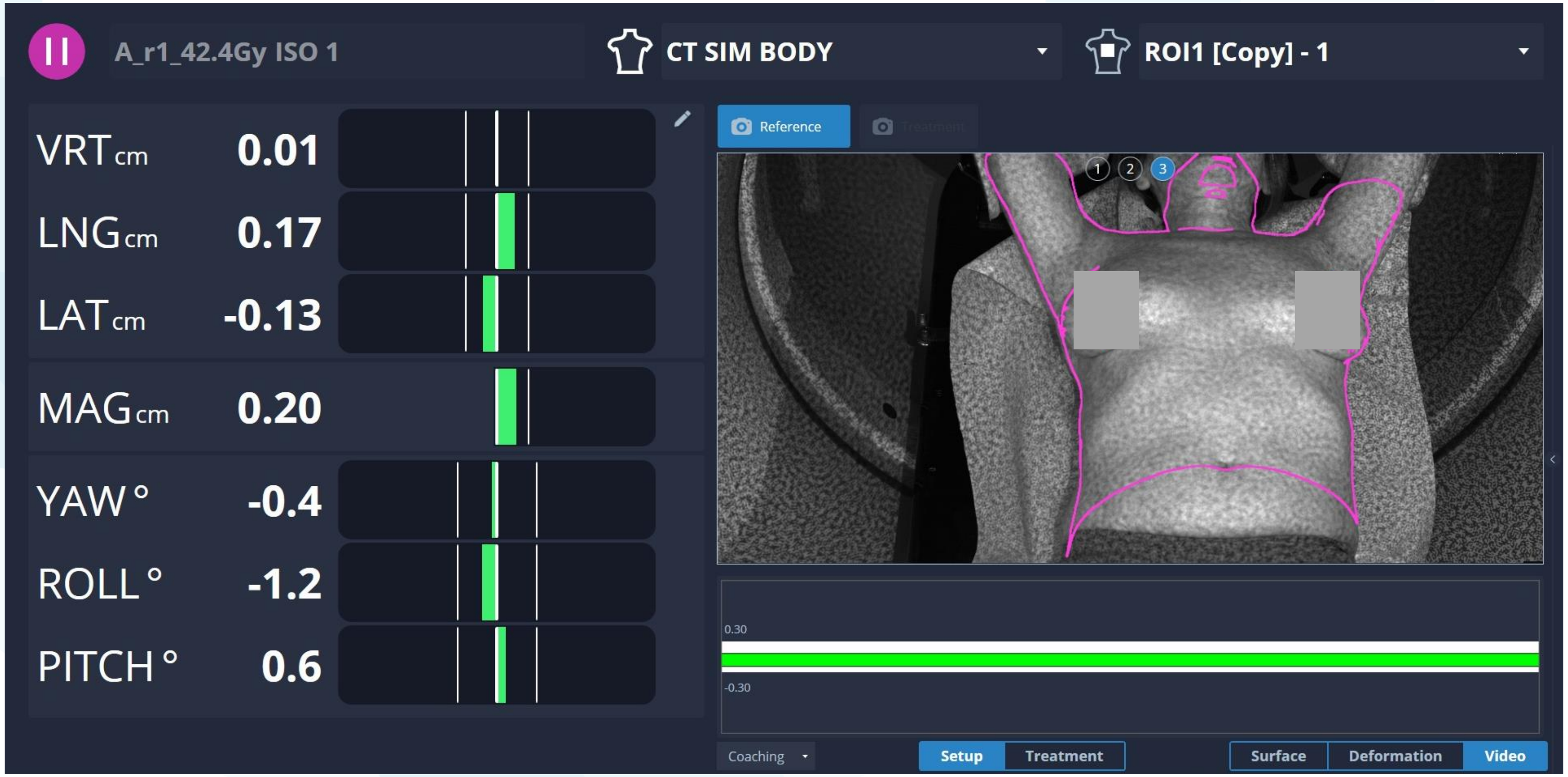

1
Free Breathing setup + Couch Adjustements

2
Swith to DIBH ref

3
Move to Isocenter (inside cameras)

Step 1: External Setup: Patient is aligned on the breast board outside the bore using external ceiling-mounted SGRT cameras (Free Breathing or DIBH check)

Step 2: Inside the Bore: Couch moves into the bore; software automatically hands over tracking to the In-Bore camera array.

Ring gantry Clinical Workflow - inside cameras

Free breathing: all RED – BEAM OFF

Breath Hold: all GREEN — Beam ON

5
BH (ref from planning): Aquire CBCT

6
BH (ref from planning): Shifts

7
New BH Ref

8
Treat and monitor in DIBH (using new ref)

Step 3: Verification: Patient takes a deep breath; once the surface matches the reference model within tolerance (e.g., ≤ 3 mm), an imaging check (CBCT/MV) is executed.

Step 4: Gated Treatment: Beam is turned on. Real-time monitoring keeps the beam active only if the patient stays inside the strict DIBH window

Defining the Region of Interest (ROI) for Breast

- **Anatomical Boundaries:** The ROI should span from the sternum to the mid-axillary line, and from the clavicle head down to the inframammary fold.

- **Excluding Non-Rigid Artifacts:** Must exclude the ipsilateral arm, throat (swallowing artifacts), and any loose clothing/immobilization accessories.

- **Contralateral Breast Inclusion:** Including a small portion of the stable contralateral chest wall helps the algorithm decouple true chest expansion from simple lateral rolling.

DIBH treatment experience - workflow recommendations TG302

CT Simulation:
- Create SGRT-friendly immobilization

Planning:
- Create accurate body contour (DICOM)
- Export plan and body contour to SGRT system

Prepare data in SGRT system:
- Import plan and body contour
- Select ROIs and settings including thresholds

Positioning for Treatment:
- Initial positioning using SGRT
- X-ray based target localization (e.g., kV/MV ports) at least once per week to confirm position and for troubleshooting as needed

Treatment:
- SGRT monitoring of DICOM FB surface
- If motion exceeds tolerance, go back to "Positioning for Treatment"

Workflow free-breathing

CT Simulation:
- Create SGRT-friendly immobilization
- Acquire scans at FB and DIBH

Planning:
- Create accurate FB & DIBH body contours (DICOM)
- Export plan and body contours (FB & DIBH) to SGRT system

Prepare data in SGRT system:
- Import plan and body contours (FB & DIBH)
- Select ROIs and settings including thresholds

Positioning for Treatment:
- Initial positioning with SGRT at FB
- Fine-tune positioning with SGRT at DIBH
- X-ray based target localization (e.g., kV/MV ports) to confirm DIBH position at least once per week and for troubleshooting as needed

Treatment:
- SGRT monitoring of DICOM DIBH surface
- If motion exceeds tolerance, coach patient to DIBH
- If motion continues to exceed tolerance, return to "Positioning for Treatment"

Workflow DIBH no bolus treatments

CT Simulation:
- Create SGRT-friendly immobilization
- Acquire scans at FB and DIBH

Planning:
- Create accurate FB & DIBH body contours (DICOM)
- Export plan and body contours (FB & DIBH) to SGRT system

Prepare data in SGRT system:
- Import plan and body contours (FB & DIBH)
- Select ROIs and settings including thresholds

Positioning for Treatment:
- Initial positioning with SGRT at FB
- Fine-tune positioning with SGRT at DIBH
- X-ray based target localization (e.g., kV/MV ports) to confirm DIBH position at least once per week and for troubleshooting as needed
- Acquire new reference surface *with bolus* at DIBH

Treatment:
- SGRT monitoring of DICOM DIBH surface during *non-bolus fields*
- SGRT monitoring of new reference surface during *bolus fields*
- If motion exceeds tolerance, coach patient to DIBH
- If motion continues to exceed tolerance, return to "Positioning for Treatment"

Workflow DIBH bolus treatments

Let’s see the results

Evaluation of Patient Setup Accuracy: Surface-Guided Radiation Therapy (AlignRT) vs. Conventional Tattoo-Based Positioning

Dosimetric Assessment of Deep Inspiration Breath Hold (DIBH) versus Free Breathing (FB) in Left and Right Breast Radiation Therapy

Evaluation of Patient Setup Accuracy: Surface-Guided Radiation Therapy (AlignRT) vs. Conventional Tattoo-Based Positioning

Evaluation of Patient Setup Accuracy: Surface-Guided Radiation Therapy (AlignRT) vs. Conventional Tattoo-Based Positioning

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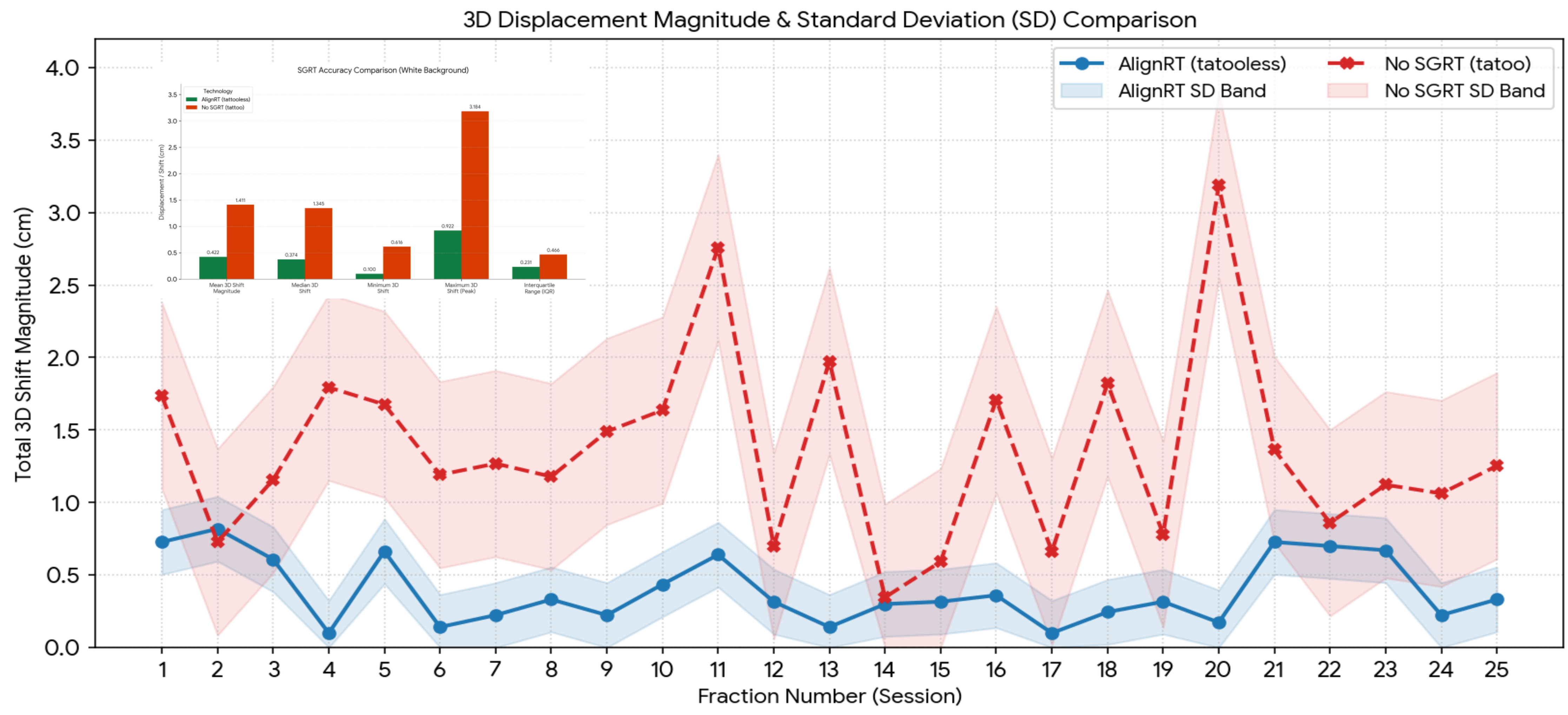
Start point - 25 fractions involved. Quantitatively compare the geometric setup reproducibility and daily variations between two distinct patient positioning workflows in radiation therapy: SGRT(**AlignRT - tatooless**) and conventional skin markings (**No SGRT - tattoo)**

Methodology. Daily translational setup errors along three orthogonal axes Vertical (Vrt), Longitudinal (Lng) and Lateral (Lat)—were extracted from daily localization logs. To capture the absolute spatial discrepancy for each treatment fraction, the **3D Vector Shift Magnitude** was computed using the Euclidean distance formula.

Statistical analysis. Statistical metrics including Mean, Standard Deviation (SD), Range (Minimum to Maximum), and Median absolute errors were analyzed. A two-tailed paired Student's t-test was performed on the 3D magnitude vectors to evaluate structural significance.

Evaluation of Patient Setup Accuracy: Surface-Guided Radiation Therapy (AlignRT) vs. Conventional Tattoo-Based Positioning – 25 fraction



Evaluation of Patient Setup Accuracy: Surface-Guided Radiation Therapy (AlignRT) vs. Conventional Tattoo-Based Positioning - increase analysis to more fraction

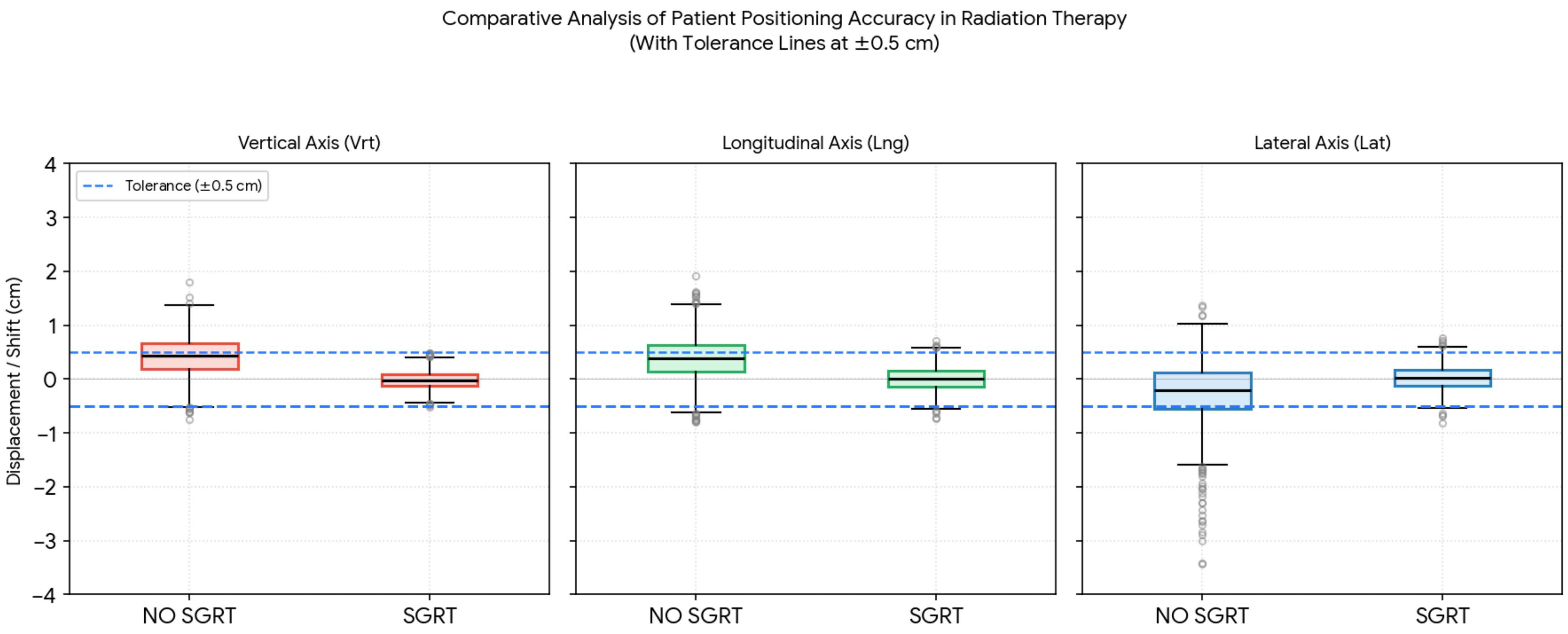
Table 1. Detailed statistics of shifts for 1580 fractions

	NO SGRT			SGRT - ALIGN RT		
	Vertical Axis (Vrt) [cm]	Longitudinal Axis (Lng) [cm]	Lateral Axis (Lat [cm]	Vertical Axis (Vrt) [cm]	Longitudinal Axis (Lng) [cm]	Lateral Axis (Lat) [cm]
Mean error	+0.41 *)	+0.32	-0.18 **)	+0.06	-0.05	-0.02
Standard Deviation (σ)	± 0.38	± 0.42	± 0.78 ***)	± 0.24	± 0.34	± 0.41
Maximum Displacement	+1.7	+2.1	+3.0	+1.0	+1.0	+1.1
Minimum Displacement	-1.5	-1.1	-3.7	-0.9	-1.0	-1.1

*) systematic tendency to position the patient slightly higher

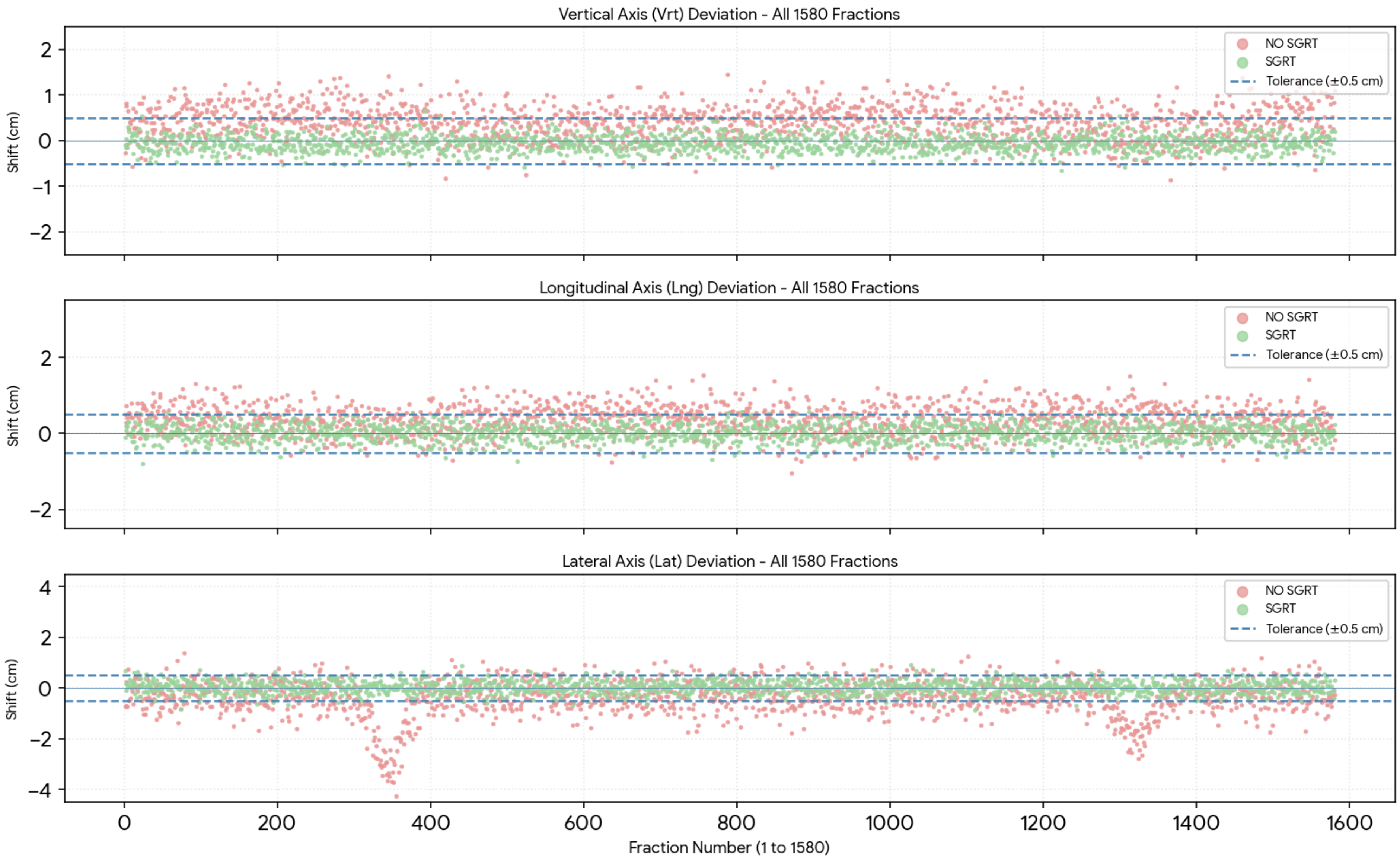
**) dendency to shift to the right/left of the patient

***) axis with the greatest variability and instability



A clear benefit of SGRT using AlignRT

Complete Big Data Trend Comparison (1580 Fractions): SGRT vs. NO SGRT



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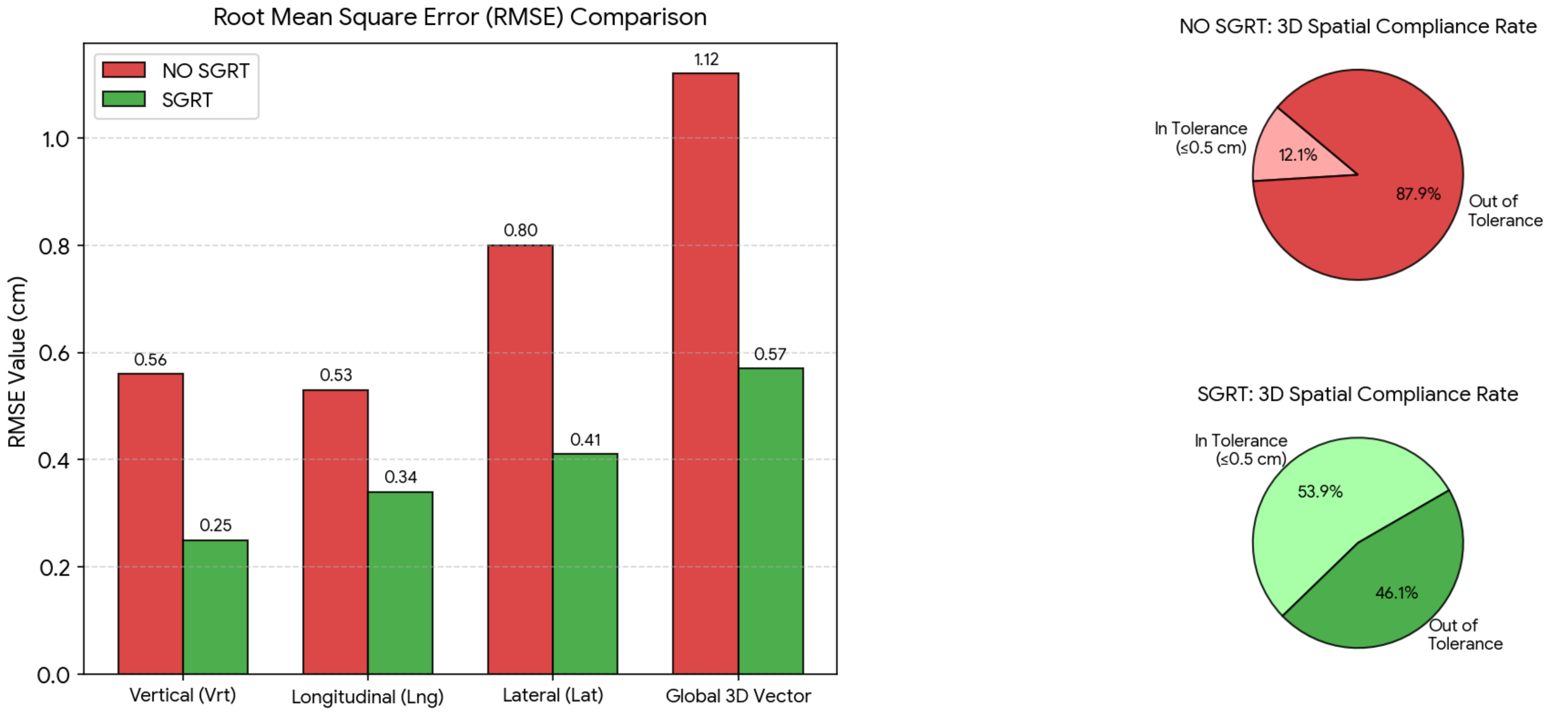
Statistical Breakdown of 1580 Fractions: Setup Error and Compliance Analysis



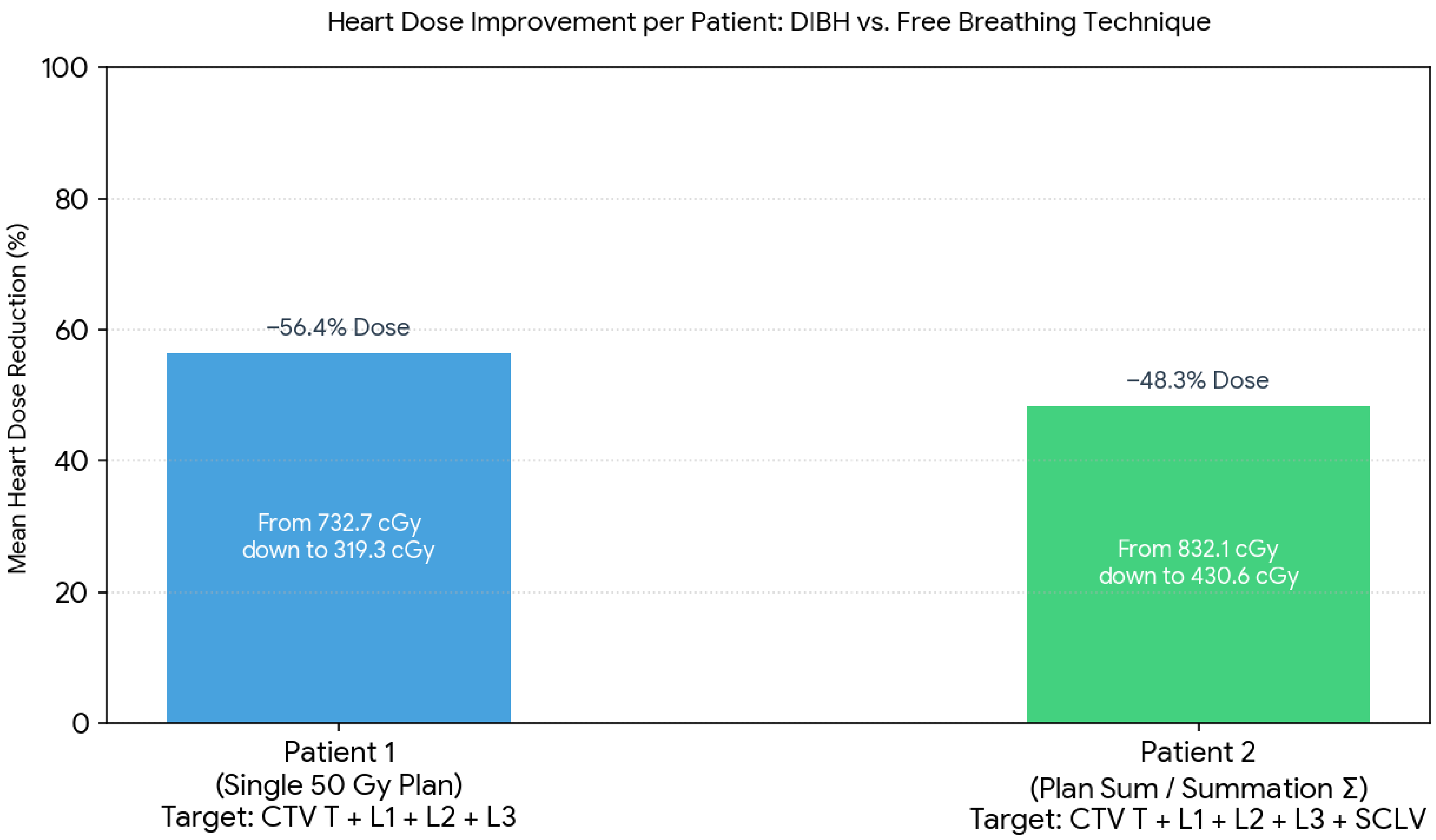
Coordinate / Vector	🔴 NO SGRT RMSE (cm)	🟢 SGRT RMSE (cm)	📉 Error Reduction (%)
Vertical Axis (Vrt)	0.56 cm	0.25 cm	**-55.36%**
Longitudinal Axis (Lng)	0.53 cm	0.34 cm	**-35.85%**
Lateral Axis (Lat)	0.80 cm	0.41 cm	**-48.75%**
💥 **Global 3D Vector**	**1.12 cm**	**0.57 cm**	**-49.11%**

Dosimetric Assessment of Deep Inspiration Breath Hold (DIBH) versus Free Breathing (FB) in Left and Right Breast Radiation Therapy

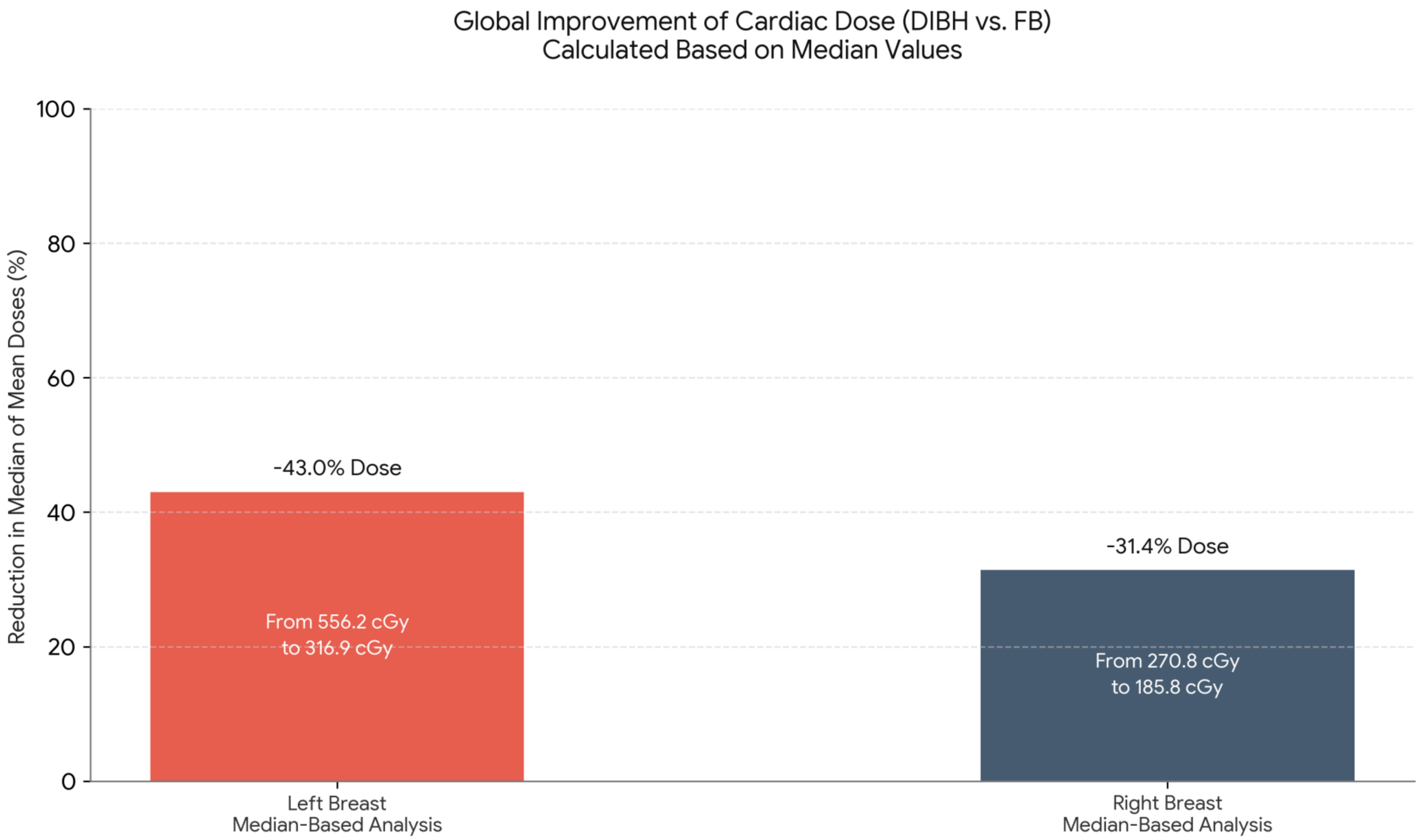
Dosimetric Assessment of Deep Inspiration Breath Hold (DIBH) versus Free Breathing (FB) in Left and Right Breast Radiation Therapy

Methodology. Evaluates the dosimetric benefits of DIBH versus **Free Breathing (FB)** across a cohort of **43 unique patients** (comprising 25 DIBH and 18 FB iterations), further stratified by target volume extensions: Clinical Target Volume Tumor (**CTV T**), complete axilla (**L1+L2+L3**), Supraclavicular Lymph Nodes (**SCLV**), and Internal Mammary Lymph Nodes (**MI**).

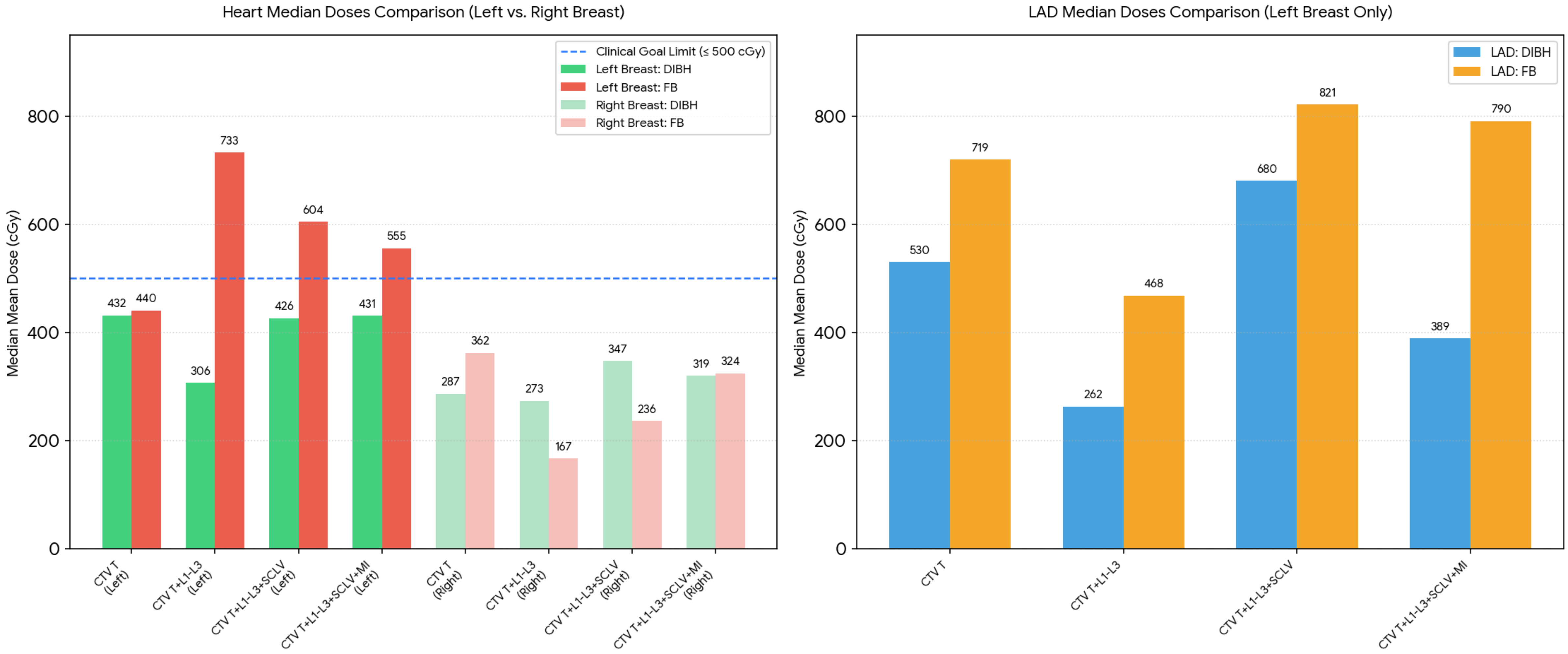
Statistical analysis. The core of the study section analyzes the global median values of the mean doses delivered to the Heart and the LAD coronary artery. Utilizing the median value prevents anatomical outliers from skewing the datasets, yielding a highly accurate representation of a standard patient profile.



Bar chart representation showing the net percentage of mean dose saved at the heart level for each clinical scenario



Global Improvement of Cardiac Dose (DIBH vs. FB) / Calculated Based on Median Values



Comparative Analysis of Medians (DIBH vs. FB)

Statistical Dispersion and Reproducibility (Standard Deviation (σ)

Region OAR Structure	Free Breathing (FB) (σ)	DIBH Technique (σ)	Clinical Implication
Left Breast Heart	119.87 cGy	64.19 cGy	DIBH cuts dose volatility by ~46.5%, standardizing cardiac safety.
Left Breast LAD	146.08 cGy	85.84 cGy	High FB variance leaves the coronary artery heavily exposed to random anatomical peaks.
Right Breast Heart	54.45 cGy	35.26 cGy	Low variance in both arms due to natural contralateral anatomical distance.

Results

Criterion 1: Laterality	Criterion 2: Target Volume Extent	OAR Structure	DIBH Technique (Median cGy)	FB Technique (Median cGy)	Net Dose Reduction (%)
LEFT BREAST	CTV T *(Breast only, no nodal stations)*	Heart LAD	431.57 530.10	440.14 719.41	-1.9% -26.3%
	CTV T + L1 + L2 + L3 *(Breast + Full Axilla)*	Heart LAD	306.36 262.50	732.65 467.93	-58.2% -43.9%
	CTV T + L1 + L2 + L3 + SCLV *(Breast + Axilla + Supraclavicular)*	Heart LAD	425.87 680.36	604.44 821.41	-29.5% -17.2%
	CTV T + L1 + L2 + L3 + SCLV + MI *(Breast + All Stations + Internal Mammary)*	Heart LAD	430.57 388.61	555.40 790.26	-22.5% -50.8%
RIGHT BREAST	CTV T *(Breast only, no nodal stations)*	Heart	362.17	286.14	-20.8%
	CTV T + L1 + L2 + L3 *(Breast + Full Axilla)*	Heart	273.25	256.12	-6.26%
	CTV T + L1 + L2 + L3 + SCLV *(Breast + Axilla + Supraclavicular)*	Heart	347.14	236.21	-46.9%
	CTV T + L1 + L2 + L3 + SCLV + MI *(Breast + All Stations + Internal Mammary)*	Heart	324.38	319.33	-1.6%

Discussion and Clinical Implications

- **The Critical Sparing Window (CTV T + L1 + L2 + L3)**

The most striking evidence of DIBH's efficacy is highlighted in the regional target extension involving the full axilla (CTV T + L1 + L2 + L3) on the Left Breast.

DIBH implemented with the Align RT inBore solution achieved a relative dose reduction of 58.2%.

- **LAD Gating and Internal Mammary Node Lymphadenopathy (+MI)**

The Left Anterior Descending (LAD) coronary artery is exceptionally susceptible to radiation injuries because it lies on the anterior surface of the heart. When the treatment scope is extended to encompass the Internal Mammary chain (+MI), the radiation fields are forced deeper medially near the sternum.

DIBH implemented with the Align RT inBore solution achieved a relative dose reduction of 50.8%.

This provides robust protection to the vascular system without forcing a compromise on the coverage of internal mammary lymph nodes.

- **Laterality Distinctions**

DIBH focuses primarily on reducing ipsilateral lung volume

Conclusions - AlignRT on Halcyon

- **Macro-Level Cardioprotection**: For left-sided breast treatments, DIBH reduces the global median mean heart dose yielding a 43.0% overall dose reduction.

- **Vascular Safeguarding**: DIBH lowers median LAD coronary artery exposures across all target variations, achieving its maximum relative benefit (50.8% reduction) during complex internal mammary chain field irradiations.

- **Clinical Success Rate Transformation**: When evaluating the entire left breast cohort against a rigid international constraint of 500 cGy for the heart mean dose, the success rate transitions from 30.95% under Free Breathing to an exceptional 99.62% under DIBH.

- **Geometric Stabilization**: The big data fraction profile proves that SGRT integration guarantees the physical maintenance of this dosimetric advantage, keeping (>97%) of all fractions within a strict 5 mm setup tolerance sphere, effectively eliminating large random positioning errors during delivery.

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Breast treatment (simulation, positioning, treatment control)

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Thank you for your attention!