

Postural Video to Assist with Reproducing Diagnostic CT Position in a Simulation-Free Palliative Workflow

SGRT APAC Meeting 2024 (Naarm/Melbourne)

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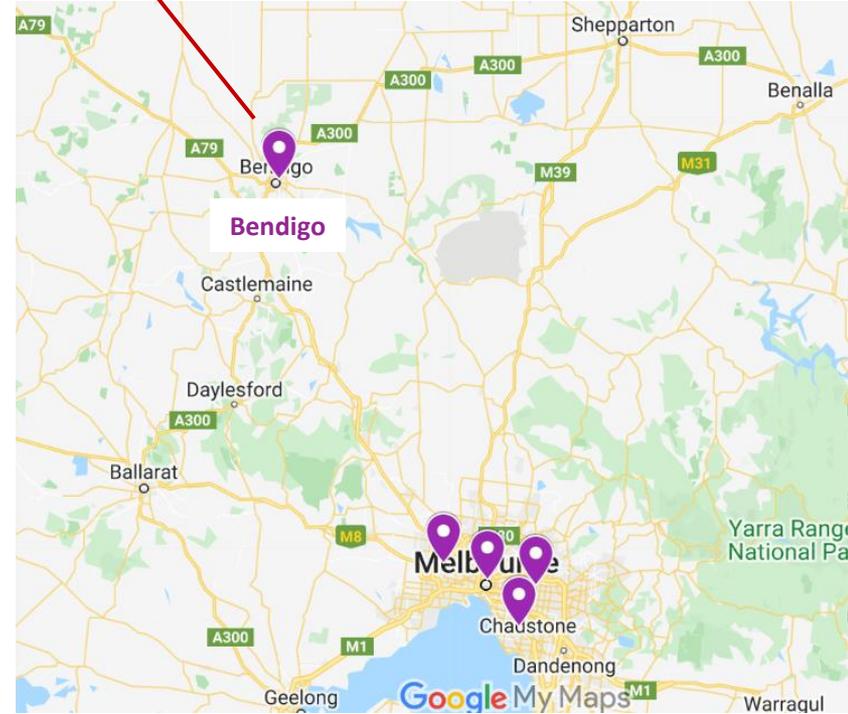


Peter Mac
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BACKGROUND

Mildura, Victoria 3500
via Calder Hwy/A79 4 hr 21 min
Fastest route now due to traffic conditions 400 km

- Patient benefits
 - Reduced no. of visits
 - Reduced time in the department
 - Reduced timeframe from referral to Tx
 - Comparable clinical outcomes
- Dept. benefit – pre-planning capacity



BACKGROUND - DOSIMETRY



Practical Radiation Oncology
Volume 11, Issue 2, March–April 2021, Pages e146–e153



Basic Original Report

Diagnostic Computed Tomography Enabled Planning for Palliative Radiation Therapy: Removing the Need for a Planning Computed Tomography Scan

Shelley Wong MRT^a, Stephanie Roderick MMedPhys^a, Alannah Kejda MSc^a, John Atyeo PhD^a,
Kylie Grimberg BAppSc^a, Brian Porter BAppSc^a, Jeremy Booth PhD^{a b},
George Hruby MBChB, FRANZCR^{a c}, Thomas Eade MBChB, FRANZCR^{a c}

Study	Measurement	Results
Wong, S. et al (2021)	HU comparison between dCT + pCT	Lung and bone: statistically insignificant Liver: $P=.004$ Overall impact on dosimetry: $\pm 2\%$

Physics and Imaging in Radiation Oncology 27 (2023) 100456



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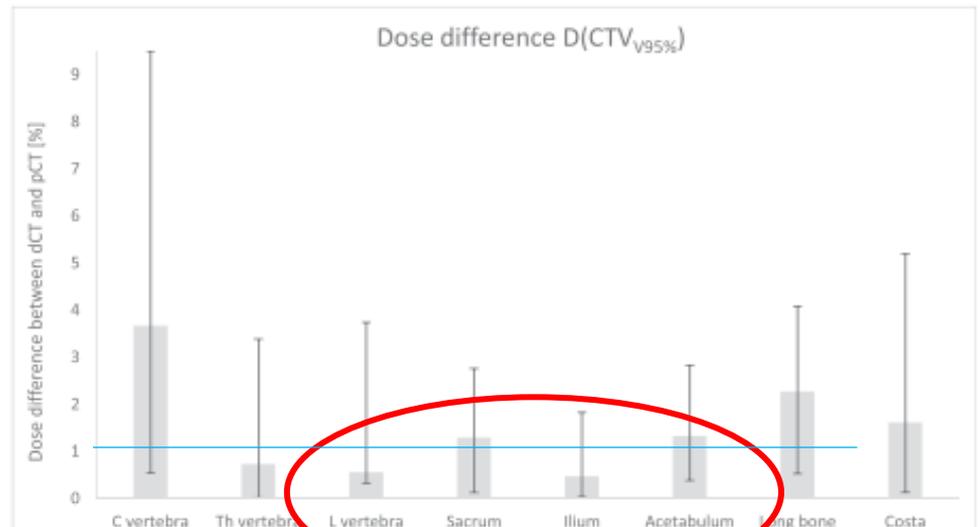


Original Research Article

Palliative intensity modulated radiotherapy of bone metastases based on diagnostic instead of planning computed tomography scans

Suvi Larjavaara^{*}, Satu Strengell, Tiina Seppälä, Mikko Tenhunen, Anu Anttonen

Comprehensive Cancer Center, Helsinki University Central Hospital, PL180, 00029 HUS, Finland



BACKGROUND - DOSIMETRY

Dosimetry on dCT

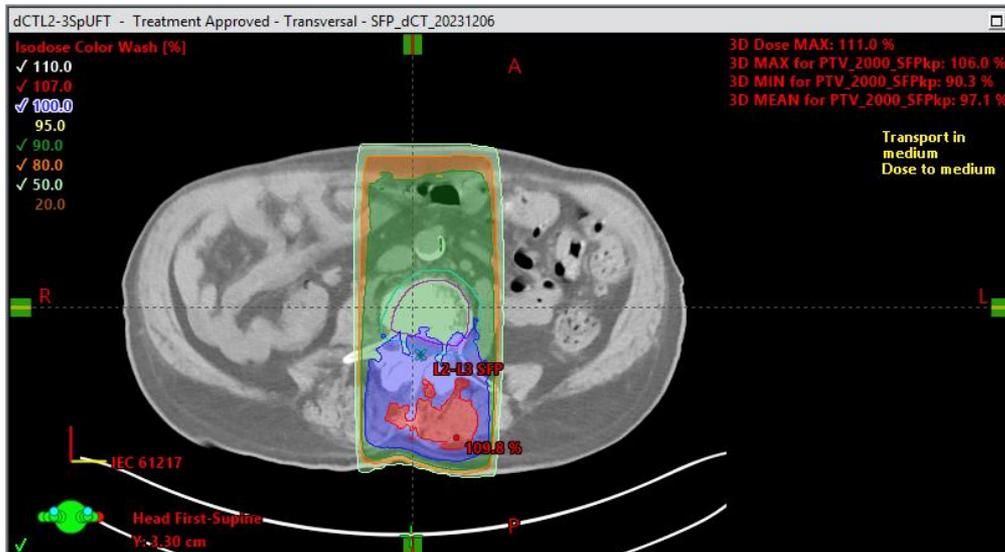
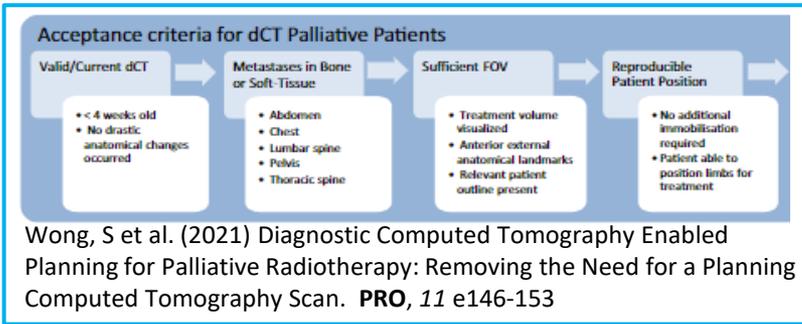


Image fusion and plan copy onto pCT (MUs forced)



BACKGROUND - WORKFLOW



O'Neil et al. *BMC Palliative Care* (2022) 21:220
<https://doi.org/10.1186/s12904-022-01115-y>

BMC Palliative Care

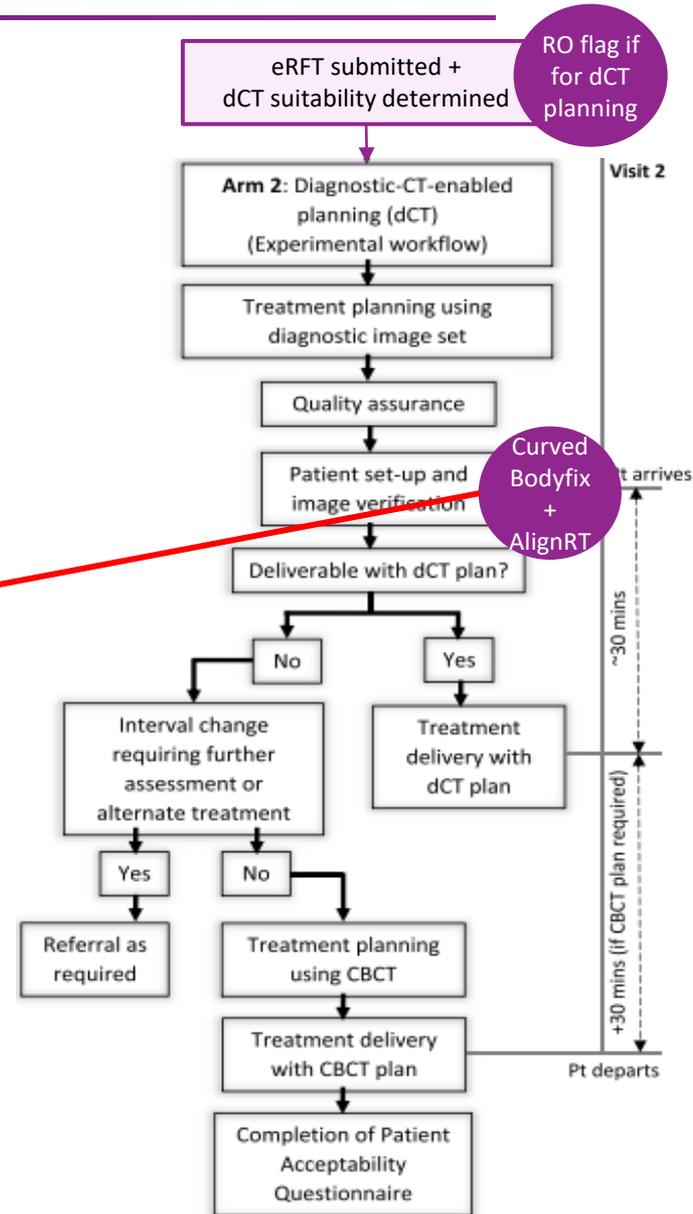
STUDY PROTOCOL

Open Access

DART: diagnostic-CT-enabled planning: a randomized trial in palliative radiation therapy (study protocol)

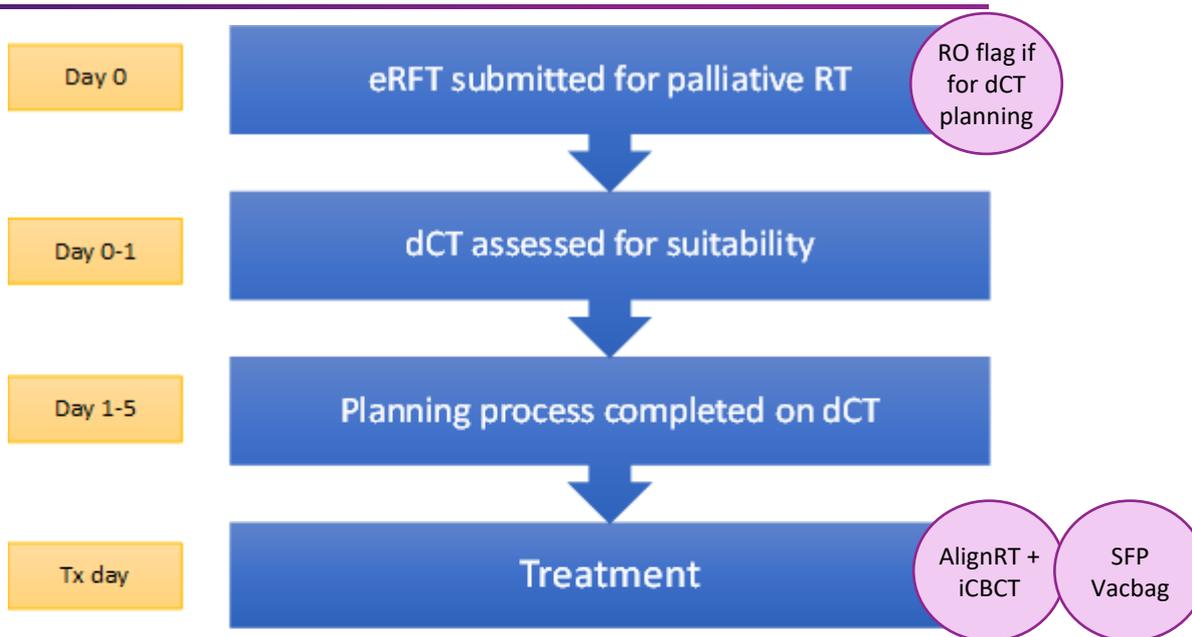


Melissa O'Neil, Timothy K. Nguyen, Joanna Laba, Robert Dinniwell, Andrew Warner and David A. Palma

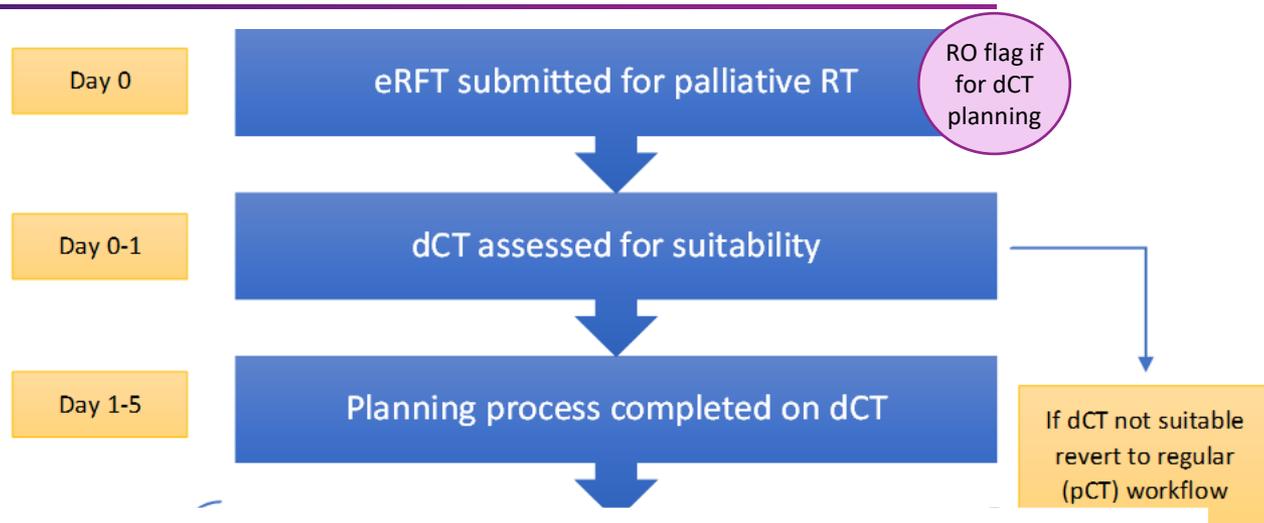


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WORKFLOW



PILOT WORKFLOW



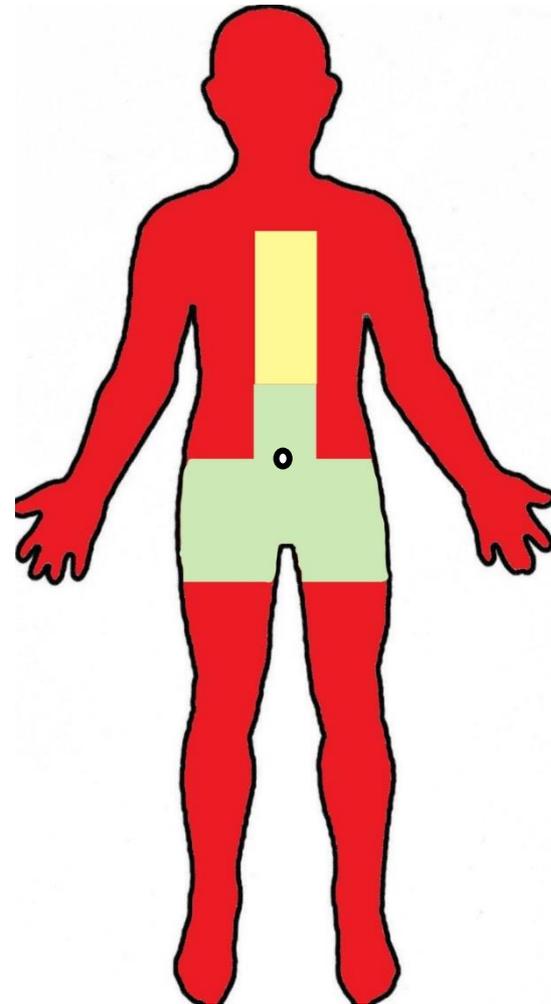
INCLUSION CRITERIA – PILOT PHASE

Keeping it simple

- Non-urgent palliative patients (7-14 days)
- dCT suitability criteria
- Bony lesions – T10 → pelvis

Next up

- Urgent patients eligible
- T4 → T10



SIM-FREE SET-UP: A CHANGE IN THINKING

	pCT pathway
CT	Optimise patient position/scan for Tx
	Document specific instructions/measurements – stabilisation equipment, RPs
Patient set-up	Set-up instructions – stabilisation, location RPs – locations, referenced Couch long – starting point
	Follow prescribed instructions (stabilisation equipment/location, RPs, couch long)
	Check against known parameters – couch long, isocentre measurements
Imaging	Match to known structures Certain degree of consistency is expected

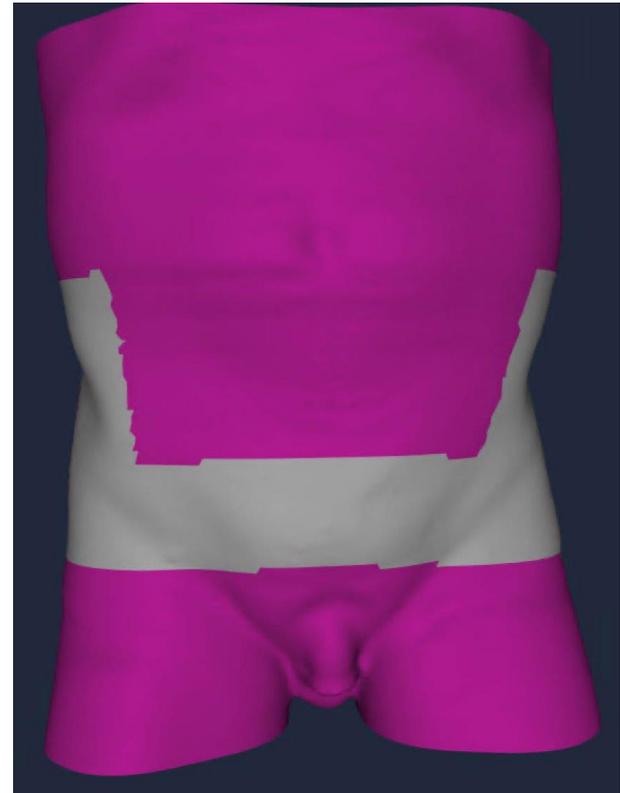
ROI SET-UP IN ALIGNRT

ROI1 (Set-up)



- Include as much of the visible surface as possible – beware of indentations/bulges from clothing etc
- Gives as much information as possible in AlignRT deltas

ROI2 (Treatment)



- For monitoring
- Reduce breathing artifact to prevent beam interruption

SIM-FREE SET-UP WORKFLOW

Task	Move...what?	Tools
Find approximate isocentre (Long, Lat, Vert)	The bed/couch	<ul style="list-style-type: none">• Postural video• Manual palpation (if required)
Correct rotational position (Pitch, Roll, Rotation)	The patient	<ul style="list-style-type: none">• Postural video• Deltas + deformation• Adjust stabilization equipment (if required – eg lift knees higher to correct pitch)



CASE STUDY

- Patient #6 for pilot phase
- 74 yo female
- Metastatic Breast Ca
- Tx: 20Gy/5Fx to Lt Sacrum
- Course: 6
- dCT → Fx1 = 30 days (recommended: 28 days)
 - 14/2/2024 → 15/3/2024
 - Leap year interference
 - Fx1 delayed by one day due to scheduling constraints
- Beam arrangement: AP-PA, 18MV



DATASET LENGTH

The screenshot displays a medical simulation software interface. At the top, the patient name is "dCT_LSacruUFT ISO 1" and the treatment plan is "CT SIM SGRT_Surface". The treatment table is set to "Tx".

On the left, a list of patient parameters is shown with input fields:

- VRT_{cm}
- LNG_{cm}
- LAT_{cm}
- MAG_{cm}
- RTN[°]
- PITCH[°]
- ROLL[°]

The main display area shows a 3D surface model of a patient's torso. The model is outlined in pink. Above the model are three numbered buttons: 1, 2, and 3. Below the model is a horizontal bar with a yellow segment at the top, and numerical values 0.30 and -0.30 are displayed below the bar.

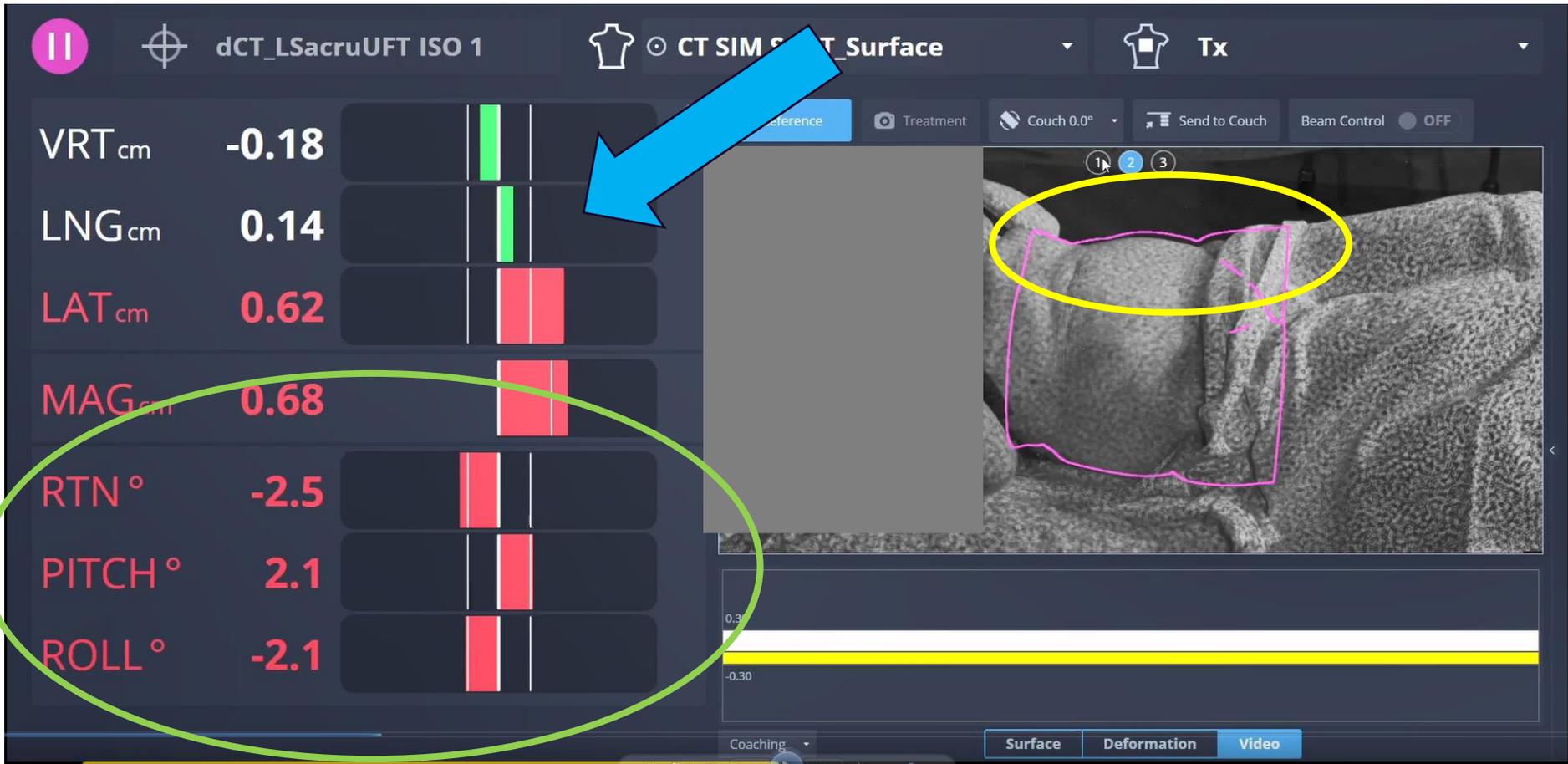
At the bottom, there are tabs for "Surface", "Deformation", and "Video", with "Video" currently selected. A "Coaching" dropdown menu is also visible.

FINDING ISOCENTRE

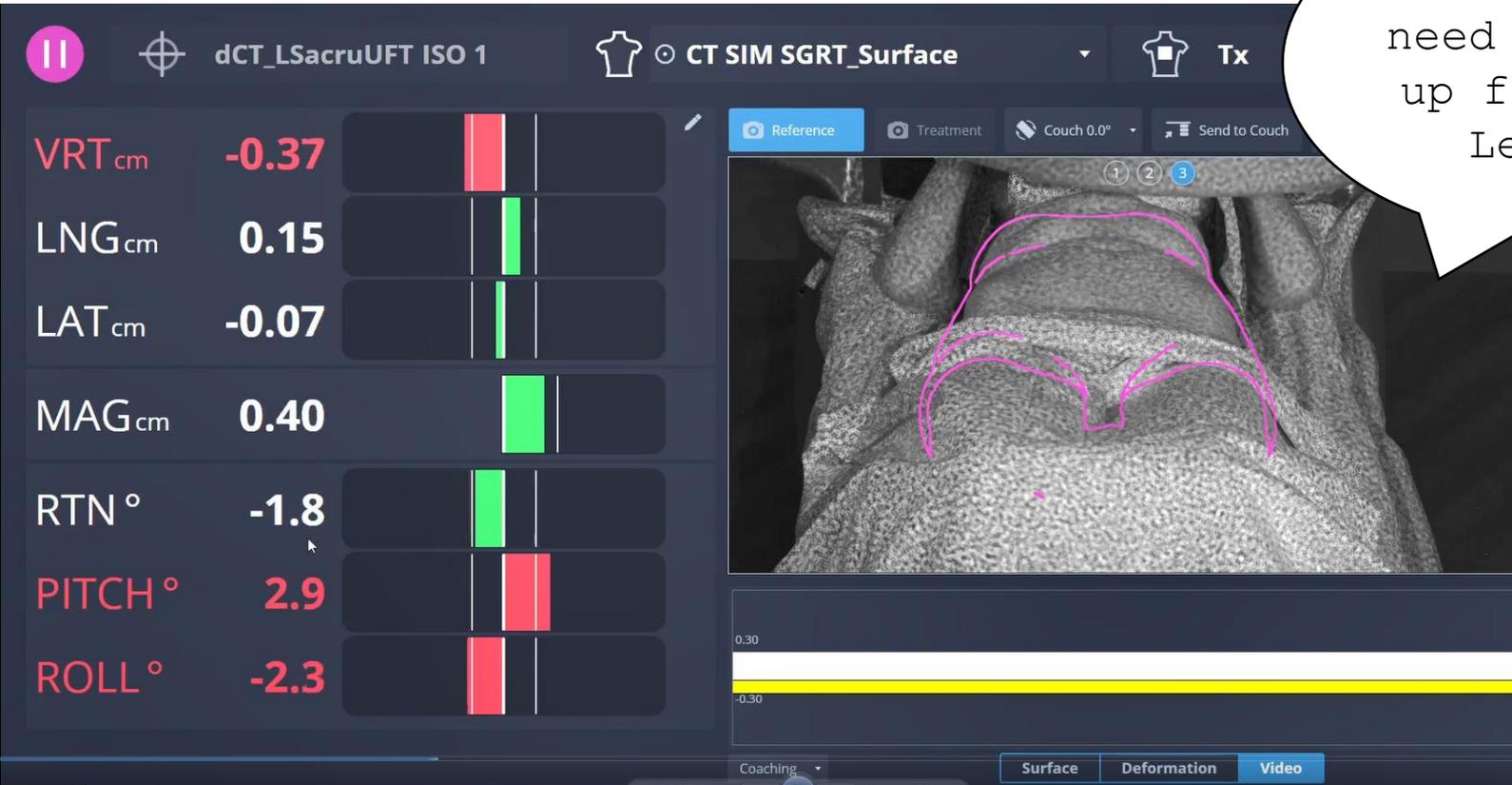
The screenshot displays a medical simulation software interface. On the left, a list of patient positioning parameters is shown, each with a numerical value and a corresponding bar chart. A blue circle highlights the first four parameters: VRT_{cm} (-0.99), LNG_{cm} (-2.03), LAT_{cm} (0.70), and MAG_{cm} (2.32). The right side of the interface shows a CT scan image of a patient's torso, with a pink outline indicating the isocentre. Two yellow circles highlight specific areas on the pink outline. Below the image, a vertical scale is visible, ranging from 0.30 to -0.30.

Parameter	Value
VRT _{cm}	-0.99
LNG _{cm}	-2.03
LAT _{cm}	0.70
MAG _{cm}	2.32
RTN [°]	-2.0
PITCH [°]	2.9
ROLL [°]	-2.0

ROTATIONAL CORRECTIONS

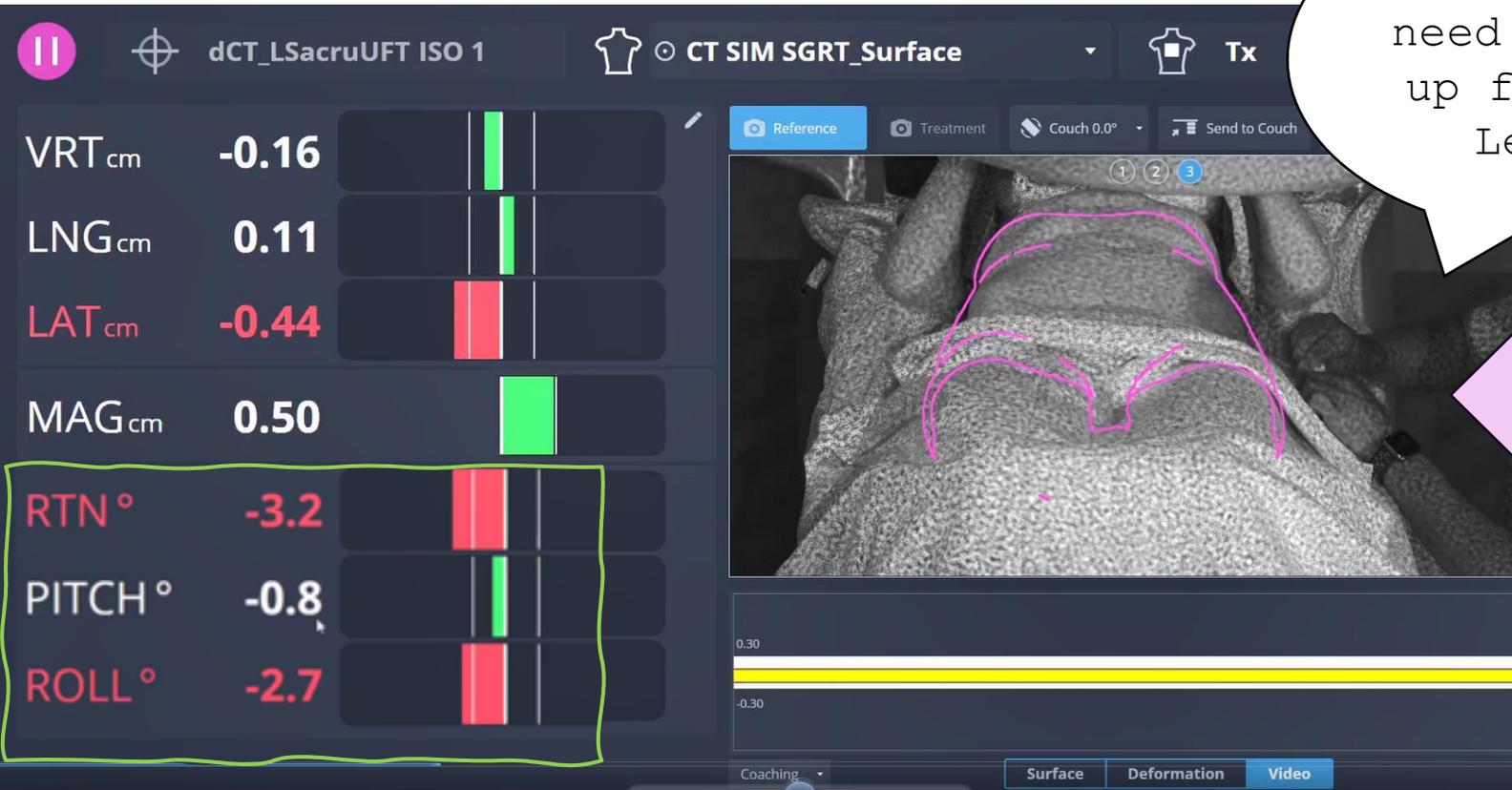


ROTATIONAL CORRECTIONS IN ACTION!



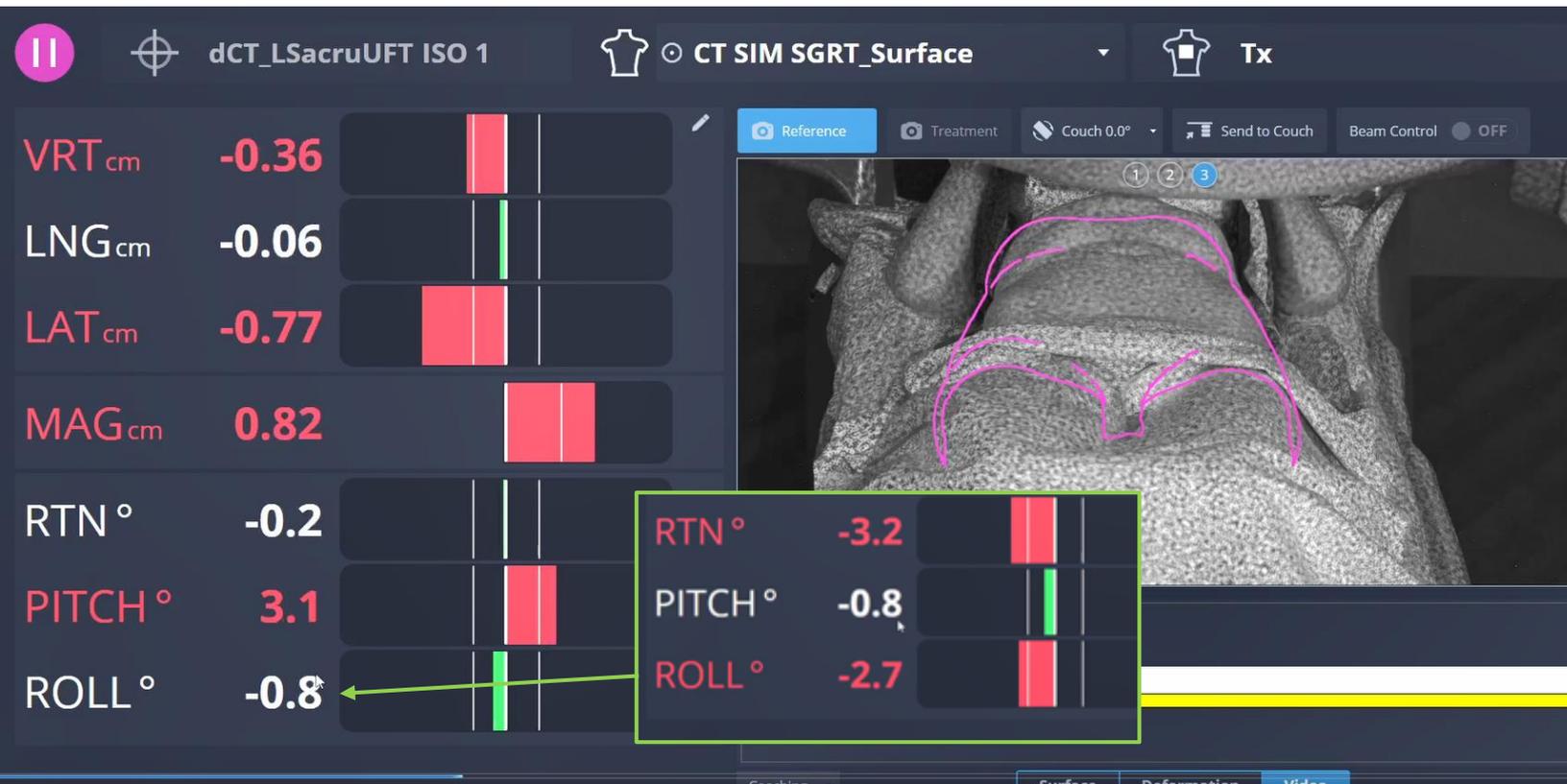
"I think we need to pull up from the Left..."

PATIENT REPOSITIONING



"I think we need to pull up from the Left..."

ROLL – CORRECTED



CORRECTING THE PITCH

The screenshot displays a medical simulation software interface for patient alignment. The top bar shows the patient ID 'dCT_LSacruUFT ISO 1' and the simulation type 'CT SIM SGRT_Surface'. The left panel lists alignment parameters with corresponding bar charts:

Parameter	Value
VRT _{cm}	-0.31
LNG _{cm}	-0.05
LAT _{cm}	-0.83
MAG _{cm}	0.90
RTN [°]	-0.6
PITCH[°]	3.0
ROLL [°]	-0.7

The 'PITCH[°]' parameter is highlighted with a green oval. The right panel shows a 3D model of a lumbar vertebra with a yellow circle and a pink outline. Below the model is a scale bar ranging from -0.30 to 0.30. The bottom bar includes 'Coaching' and view mode buttons for 'Surface', 'Deformation', and 'Video'.

PITCH – FLICKERING

II ⊕ dCT_LSacruUFT ISO 1 👤 CT SIM SGRT_Surface 📄 Tx

VRT_{cm} -0.48

LNG_{cm} -0.13

LAT_{cm} -0.70

MAG_{cm} 0.84

RTN° 0.0

PITCH° 0.0

ROLL° -1.3

Reference Treatment Couch 0.0° Send to Couch Beam Control OFF

1 2 3

0.30

-0.30

Coaching Surface Deformation Video

TAKING A PAUSE...

The screenshot displays a medical simulation software interface. On the left, a list of metrics is shown with corresponding bar charts:

Metric	Value
VRT _{cm}	-0.48
LNG _{cm}	-0.13
LAT _{cm}	-0.70
MAG _{cm}	0.84
RTN [°]	0.1
PITCH [°]	3.1
ROLL [°]	-0.9

The top of the interface shows the patient name "dCT_LSacruUFT ISO 1" and the simulation type "CT SIM SGRT_Surface". A toolbar includes buttons for "Reference", "Treatment", "Couch 0.0°", "Send to Couch", and "Beam Control OFF". The main display area shows a CT scan image of a patient's torso with a pink outline. Below the image is a vertical scale from -0.30 to 0.30. At the bottom, there are tabs for "Surface", "Deformation", and "Video".

... MAYBE THE SHEET IS IN THE WAY

The screenshot displays a medical simulation software interface. On the left, a list of patient positioning parameters is shown with corresponding bar charts:

Parameter	Value
VRT _{cm}	-0.48
LNG _{cm}	-0.13
LAT _{cm}	-0.70
MAG _{cm}	0.84
RTN [°]	0.1
PITCH [°]	3.1
ROLL [°]	-0.9

The top of the interface shows the patient name 'dCT_LSacruUFT ISO 1' and the simulation type 'CT SIM SGRT_Surface'. A toolbar includes buttons for 'Reference', 'Treatment', 'Couch 0.0°', 'Send to Couch', and 'Beam Control OFF'. The main view is a CT scan image of a patient's torso, with a pink outline and a yellow circle highlighting a specific area. A speech bubble points to this area with the text: 'I think the sheet is in the way...'. At the bottom, there are tabs for 'Surface', 'Deformation', and 'Video'.

MOVING THE SHEET AWAY

The screenshot displays a medical simulation software interface. On the left, a list of patient positioning parameters is shown with corresponding bar charts:

Parameter	Value
VRT _{cm}	-0.48
LNG _{cm}	-0.12
LAT _{cm}	-0.68
MAG _{cm}	0.87
RTN [°]	-0.2
PITCH [°]	1.2
ROLL [°]	-0.8

The main area shows a CT scan image of a patient's back. A pink outline highlights the patient's body. A large pink arrow points to the right side of the patient, indicating the direction to move the sheet away. The interface includes a top navigation bar with a pause button, a target icon, the patient ID 'dCT_LSacruUFT ISO 1', a shirt icon, the simulation name 'CT SIM SGRT_Surface', and a 'Tx' button. Below the navigation bar are buttons for 'Reference', 'Treatment', 'Couch 0.0°', 'Send to Couch', and 'Beam Control OFF'. At the bottom, there are tabs for 'Surface', 'Deformation', and 'Video', and a 'Coaching' dropdown menu.

IT WAS THE SHEET!

The screenshot displays a medical simulation software interface. On the left, a panel shows alignment data for a patient named 'dCT_LSacruUFT ISO 1'. The data is presented in a table with numerical values and corresponding bar charts. A blue circle highlights the first three rows (VRT, LNG, LAT), and a green checkmark is placed next to the PITCH row. The top right of the interface shows 'CT SIM SGRT_Surface' and 'Tx'. Below this, there are buttons for 'Reference', 'Treatment', 'Couch 0.0°', 'Send to Couch', and 'Beam Control OFF'. The main area features a CT scan image of a lumbar vertebra with a pink outline. At the bottom, there are tabs for 'Surface', 'Deformation', and 'Video', and a 'Coaching' dropdown menu.

Parameter	Value	Visual Indicator
VRT _{cm}	-0.53	Red bar chart
LNG _{cm}	0.06	Green bar chart
LAT _{cm}	-0.74	Red bar chart
MAG _{cm}	0.92	Red bar chart
RTN [°]	-0.2	Green bar chart
PITCH [°]	1.3	Green bar chart with checkmark
ROLL [°]	-1.0	Green bar chart

BINGO!

II ⊕ dCT_LSacruUFT ISO 1 👤 CT SIM SGRT_Surface 👤 Tx

Reference Treatment Couch 0.0° Send to Couch Beam Control OFF

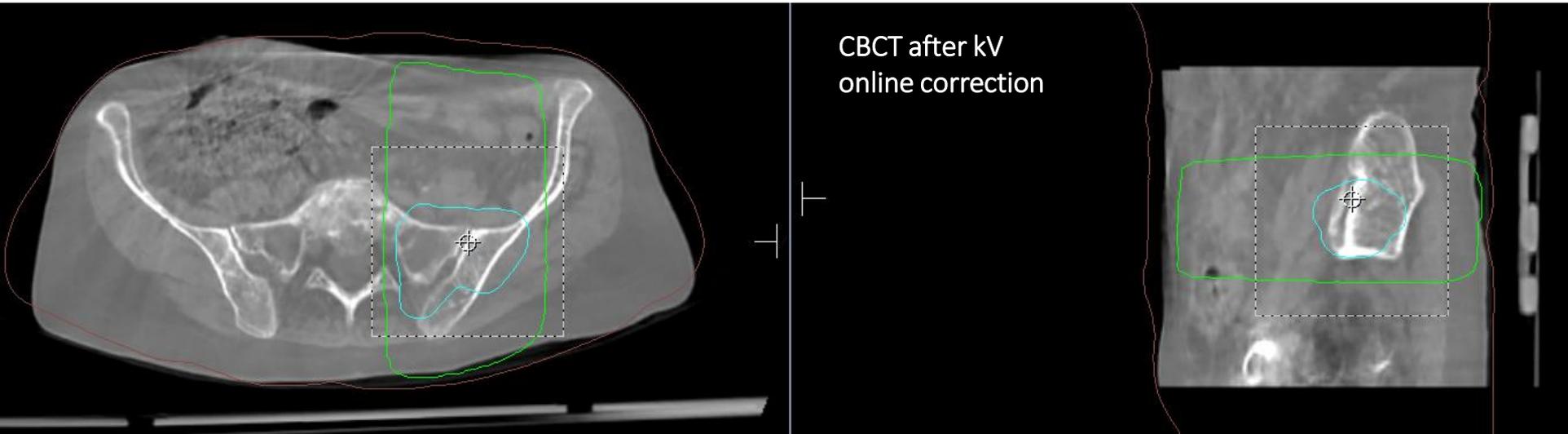
VRT _{cm}	-0.02	
LNG _{cm}	-0.02	
LAT _{cm}	0.09	
MAG _{cm}	0.11	
RTN°	0.0	
PITCH°	0.8	
ROLL°	-1.0	

0.30
-0.30

Coaching Surface Deformation Video

IMAGING

pre-kV pair → 2D/3D match + 6DOF correction → CBCT online review → 6DOF correction (if req'd)



Brown – patient/surface contour from dCT

Cyan – PTV

Green – Dose_90%

Contour looks GREAT!	Contour out of tol (multi Fx)	Contour out of tol (single Fx)
Reference capture for <u>this and future sessions</u> after CBCT for Fx2 →	Assess whether it may be due to position and can be corrected. Review for Fx2 →	If not positional: MU re-calc or re-plan ☹️

SUMMARY

- Successfully treated 7 out of 10 pilot patients. Impatiently waiting for the next 3!
- All imaging has been within tolerance (one r—setup required) and dCT-generated plans 100% deliverable
- Sim-free palliative RT offers significant benefits for both patients and our radiotherapy service
- AlignRT allows RTs to set-up patients from a reference surface generated from the dCT
 - Comparable set-up time vs. traditional set-up workflow
 - Increased accuracy over “free-positioning” or manual palpation
 - May allow more complex sim-free treatment techniques in the future



ACKNOWLEDGEMENTS

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- Dr Katrina Woodford (Research)
- Kenton Thompson (Clinical/Research)

Vacbag Insert Engineer

- Mr Woodford (Katrina's dad)

Moorabbin Team

- ROs: Dr Kathy Pope, Dr Mun Yee Tan, Dr Jennifer Tan, Dr Steven David
- Cara Anticevic & Karen McGoldrick (Education, Training & Supervision)
- RTs: Adrian, Jacinta, Duc, Jess N, Josh, Ngoc, Katherine, Henry, Freshta, Madu, Simone
- Admin/Appts: Be, Vy, Christie
- Physics: Trevor Ackerly, Derrick Wanigaratne

AlignRT Superstars

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- Katie Davidson (Parkville RT)

