// December 2023

Comparison of SGRT to MV isocentre position for two SGRT systems for use with SRS

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Disclaimer

⬈ GenesisCare has a reference site agreement with VisionRT

⬈ SGRT community are covering associated travel and accommodation costs

⬈ The views represented in the following presentation are my own and may not necessarily reflect those of GenesisCare and/or any vendors mentioned

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Today's Presenter

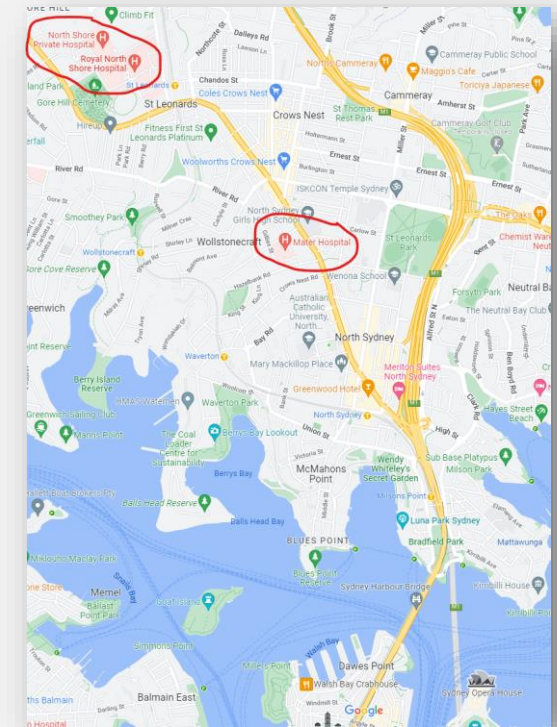**GenesisCare | NSW Physics**
Solution Driven | Patient Centred
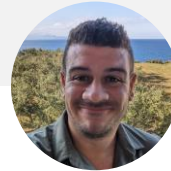
Mark Wanklyn

Senior Medical Physics Specialist

⊿ Trained in the UK

⊿ In Australia for last 6 years

⊿ Based at Mater Hospital & North Shore Health Hub in Sydney

⊿ SGRT SME for GC NSW

Today's Agenda

01 GenesisCare Australia

02 The GC Australia approach to SRS

03 SGRT & SRS

04 Our Study: Aims & Methods

05 Our Study: Results & Discussion

06 Conclusion and future directions

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01

GenesisCare Australia

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We Cover 5 of the 8 States and Territories

Australia oncology centres

WA
1. Bunbury
2. Fiona Stanley Hospital
3. Wembley
4. Shenton House
5. Mandurah
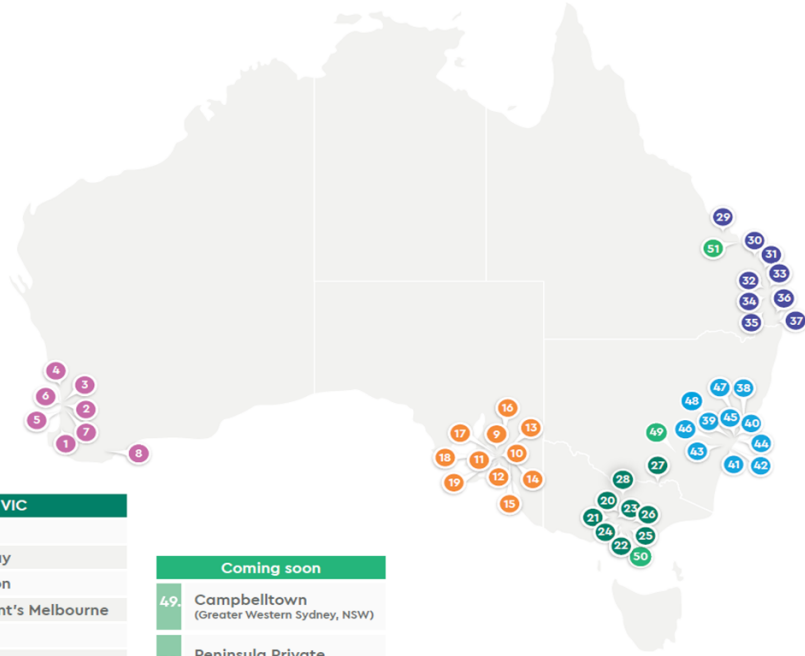6. Hollywood Private Hospital
7. Murdoch
8. Albany

SA
9. Calvary North Adelaide Hospital
10. St Andrew's 337 South Terrace
11. St Andrew's Medical Centre
12. Burnside Hospital
13. Western Hospital
14. Summit Health Care (consulting only)
15. Stirling Hospital (consulting only)
16. Hyde & Partners Medical Centre (consulting only)
17. Calvary Central Districts Hospital
18. Tennyson Centre Kurralta Park
19. Flinders Private Hospital

VIC
20. Epping
21. Footscray
22. Frankston
23. St Vincent's Melbourne
24. Cabrini
25. Berwick
26. Ringwood
27. Albury Wodonga
28. Shepparton

Coming soon
49. Campbelltown (Greater Western Sydney, NSW)
50. Peninsula Private (Mornington Peninsula, VIC)
51. Noosa (Sunshine Coast, QLD)

QLD
29. Rockhampton
30. Bundaberg
31. Fraser Coast
32. Nambour
33. Buderim
34. Chermside
35. Wesley Medical Centre
36. Southport
37. Tugun

NSW
38. Newcastle
39. Macquarie University Hospital
40. Mater Hospital Sydney
41. St Vincent's Sydney
42. Sacred Heart
43. Hurstville
44. Frenchs Forest
45. North Shore
46. Kingswood
47. Maitland
48. Norwest

To us, designing better care means being there when and where we're needed.
We have a network of more than 48 specialist treatment centres across Australia.

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AU_516_D_v22_09.2025

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6

And pretty much every technology is available somewhere

18 – Varian TrueBeam   **18**

3 – Varian Edge   **3**

2 – Varian Halcyon   **2**
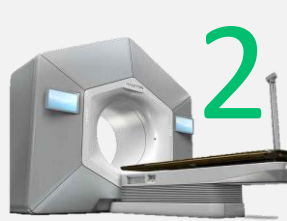
6 – Varian iX Series   **6**

13 – Elekta Synergy   **13**

27 – Elekta VersaHD   **27**

2 – Elekta Unity MR Linacs   **2**

16 – GE Optima / DiscoveryRT CTs   **16**

20 – Siemens Sensation / Definition   **20**

1 – Philips Brilliance   **1**

1 – Elekta GammKnife   **1**
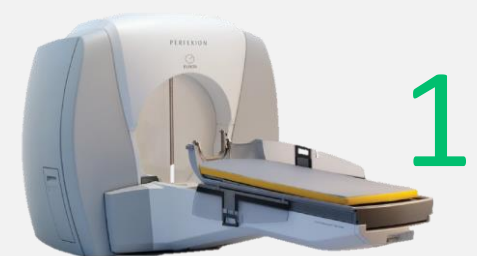
2 –ET Dynamic System   **2**

8 – ET Systems   **8**

11 –AlignRT & C-RAD Systems   **9**   **2**

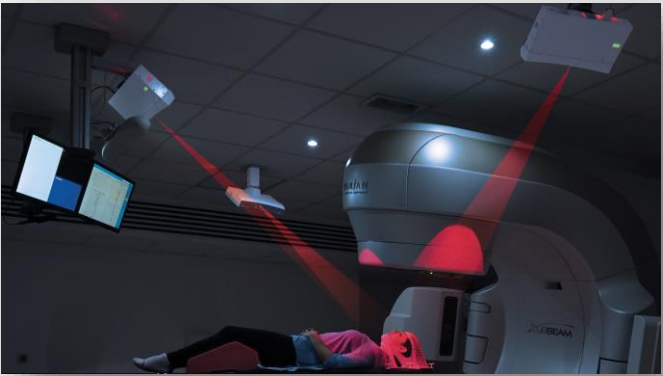**2**– Elekta FlexiTron HDR Systems   **2**

3 – xstrahl 200 or other Superficial X-ray unit   **3**

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We have a range of SGRT equipment available at GC Australia

Elekta VersaHD with C-RAD

Varian Truebeam with AlignRT system

ExacTrac Dynamic

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But what about NSW, where I work…

- ↗ 11 Centres in NSW

  - 2 regional centres in Newcastle and Maitland (2hrs North of Sydney)

  - 9 Metro centres

- ↗ Mix of Versa HD, Truebeam, Edge, Halcyon, AlignRT, Exactrac, Gamma Knife, Superficial, Brachy, MRI Linac, Monaco, Eclipse

- ↗ 20 Physicists ranging from Chief to Trainee

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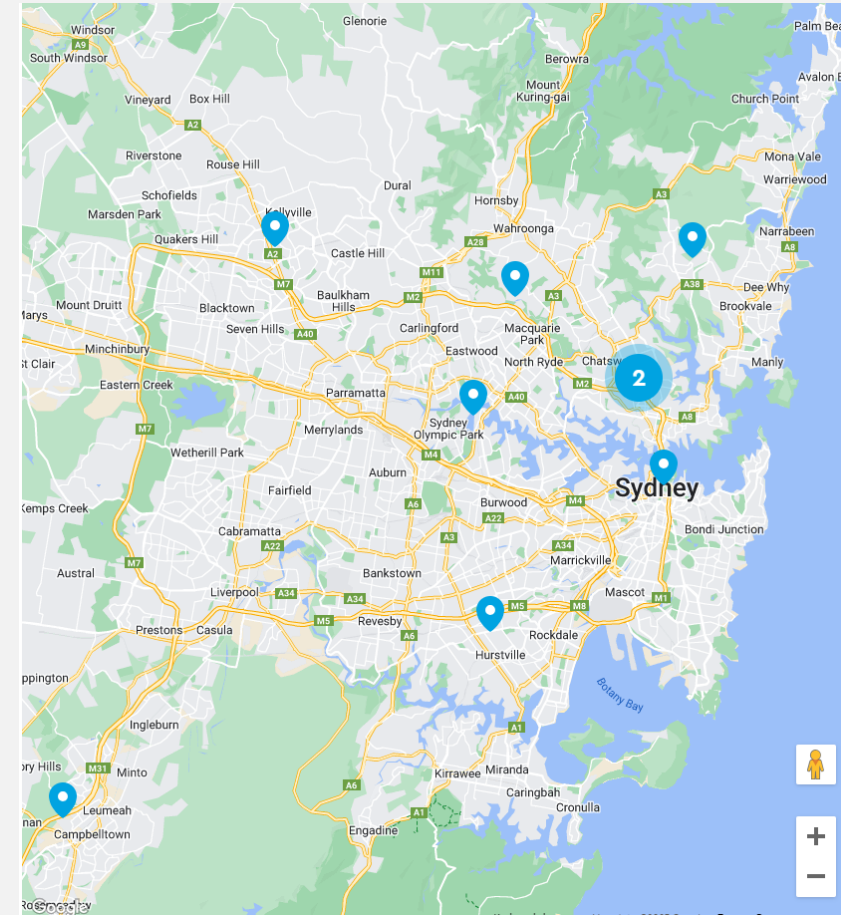
What we have at GC North Shore Group

Eclipse TPS

V16.1
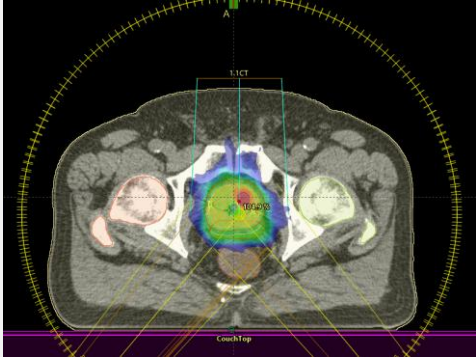
Truebeam & EDGE 3.0

With AlignRT
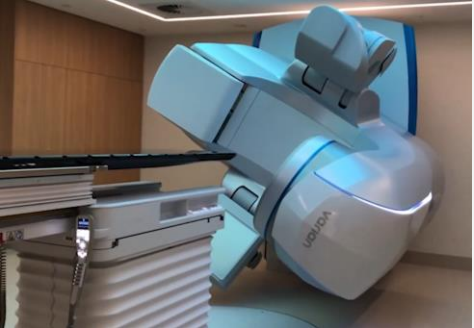
Halcyon

V4.0

Siemens and GE CT

With SimRT

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02
Approach to SRS at GC

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For our Varian sites -> HyperArc & Truebeam (Edge) & SGRT

Efficiency & Accuracy

- We use Varian's HyperArc solution for single isocentre treatments

- Single and multiple mets treated at non co planar angles

- We use the Encompass faceless masks for patient immobilization

- Patients are treated on a standard Truebeam and an Edge, both with 6DoF couches

- Workflow: AlignRT send to couch, CBCT for initial patient setup, AlignRT reference captured, MV imaging at each couch rotation, SGRT monitoring throughout

- We have treated over 440 fractions across 2 machines in NSW in 3 years

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For our Elekta sites -> Monaco & Versa HD & ExacTrac

Internal imaging

⬈ Monaco scripts have been developed to aid planning

⬈ Single and multiple mets treated at non co planar angles

⬈ Treatment delivery either MLC or Cones

⬈ Patient treated with Hexapod (6DoF)

⬈ Some patients treated with Faceless masks

⬈ Set up: SGRT pre-positioning, CBCT for initial patient setup, ETD SGRT reference captured, Stereoscopic Xray (ET) match, re-image with ET Stereoscopic at each cardinal angle and after each couch rotation and apply shifts as appropriate

⬈ Auto beam hold based on surface and X-Ray
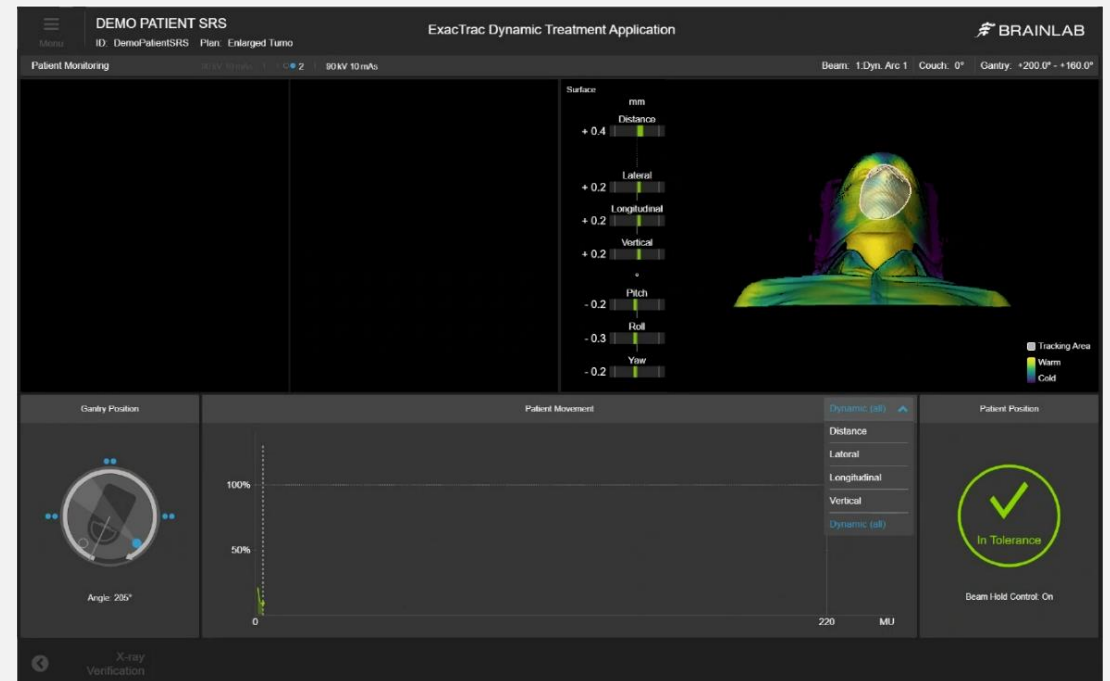
03
SGRT & SRS

Why would SRS patients benefit from SGRT

There are some obvious pros

- The faceless masks are more comfortable and less claustrophobic

- Allows intrafraction monitoring regardless of couch angle

- Brain lesions are well located, unlikely to move, and patients are immobilised appropriately

- Less dose to the patient from repeat MV imaging

- Reduction in overall treatment times due to reduced imaging

However…

- The question about internal and external motion correlation remains

- Important to quantify and understand the relationship between the SGRT isocentre and the treatment isocentre at non zero couch angles

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04

Our Study: Aims & Method

Our Study

Aims

1. Quantify the difference between the position of a hidden target phantom determined using MV imaging and SGRT for a range of couch angles

2. Compare the performance of AlignRT and ExacTrac Dynamic determining the position of a phantom at non-zero couch angles with respect to MV isocentre.

3. Determine whether SGRT, when used for SRS intrafraction monitoring, was a suitable alternative to internal imaging for position verification at non-zero couch angles.

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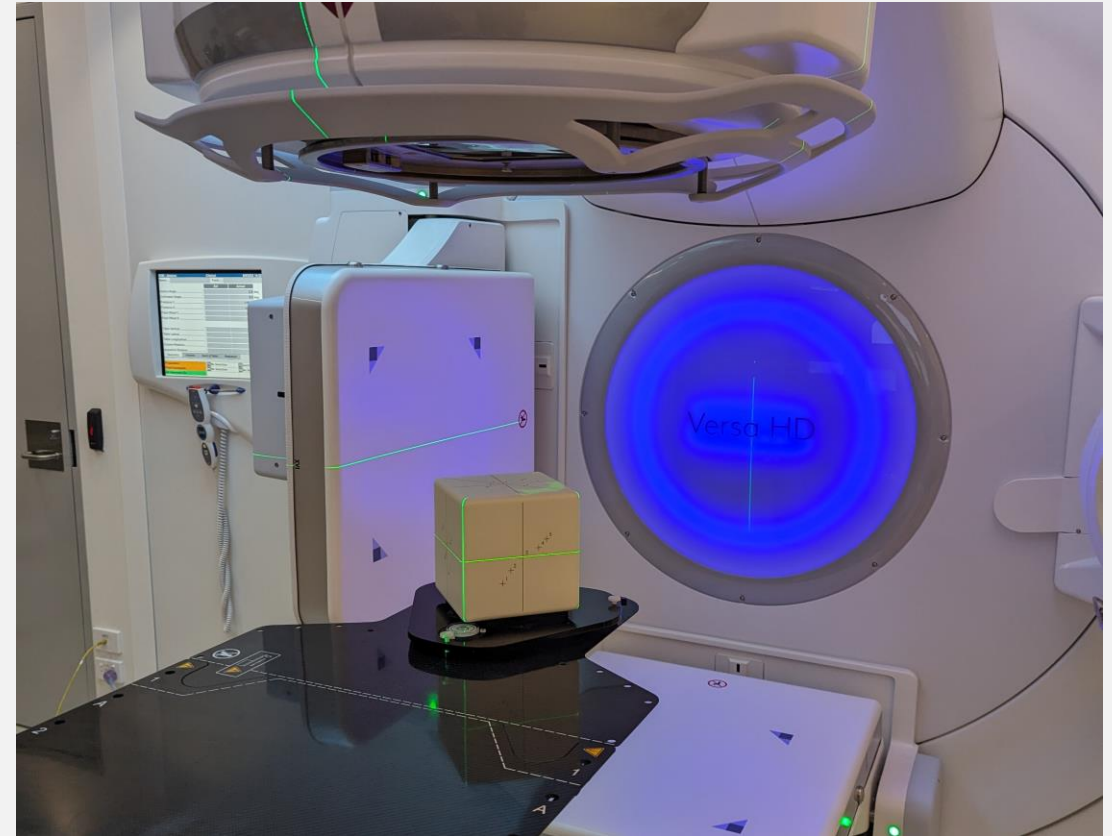
Method: Plan Setup
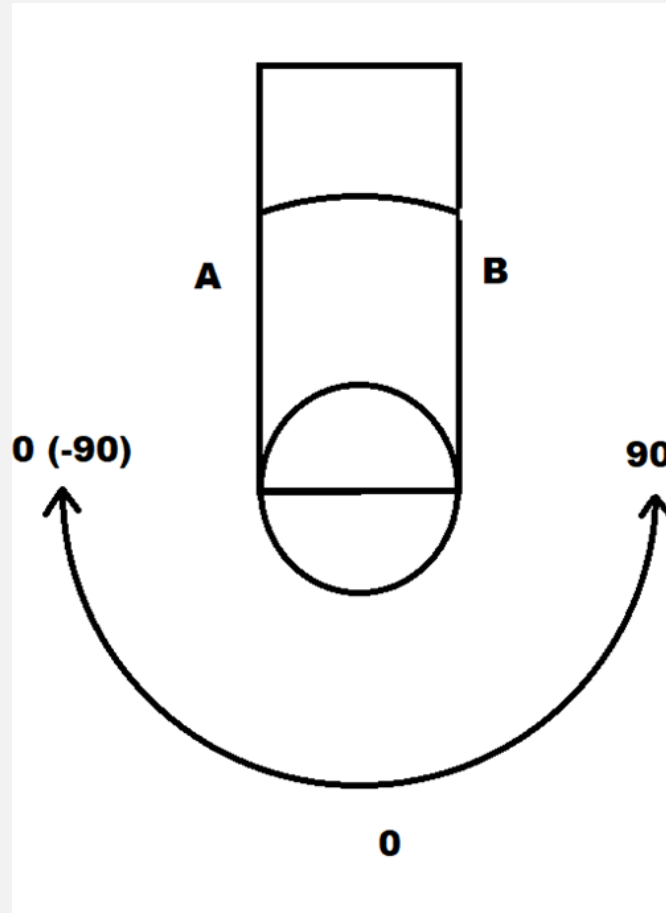
- ⬈ The AlignRT cube was used throughout this study

- ⬈ The Cube was scanned in the orientation shown

- ⬈ Pitch and Roll of the platform was set to 0 prior to scan

- ⬈ Scanned using the SRS protocol (Fine slice thickness)

- ⬈ Imported into TPS and imaging fields added at 15-degree couch angle increments from +90 degrees to -90 degrees

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Method: Data acquisition

↗ At couch 0 CBCT image acquired, and all shifts applied. SGRT reference captured.

↗ Couch rotated to -90

↗ Acquire MV image. Perform image match but do not apply shifts. Note suggested shifts in 6DoF

↗ Note suggested SGRT shifts in 6DoF

↗ Rotate couch to next gantry angle and repeat

↗ The difference between the suggested MV and SGRT shifts was calculated in 6DoF at each couch angle and plotted

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05

Our Study: Results & Discussion

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Results: Translational Axes

AlignRT

ExacTrac Dynamic

Difference between AlignRT and MV imaging in translational axes

Difference between ExacTrac and MV imaging in translational axes
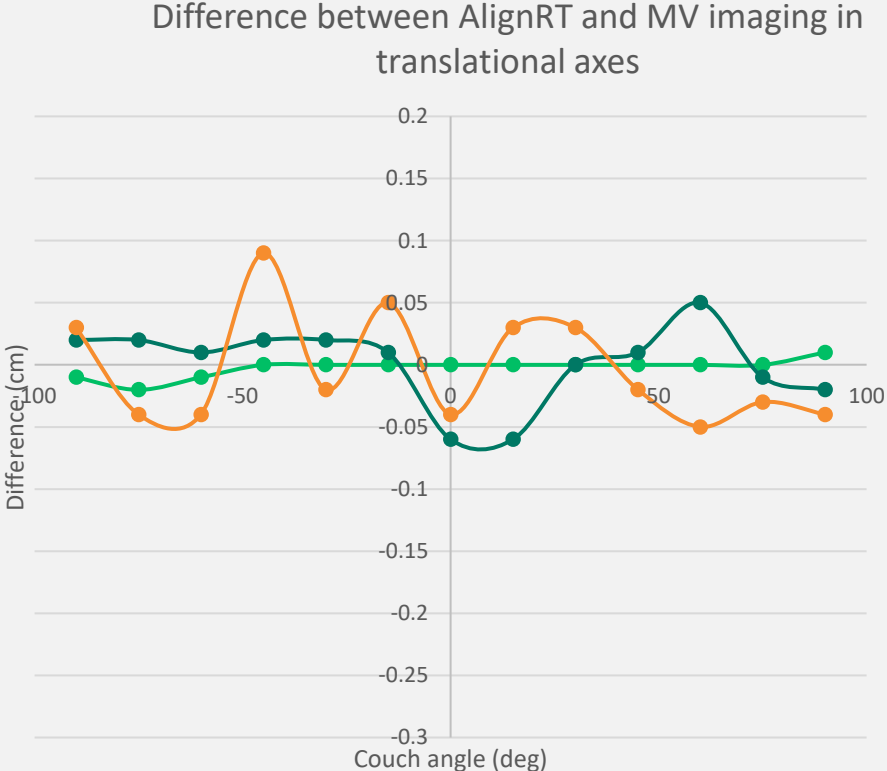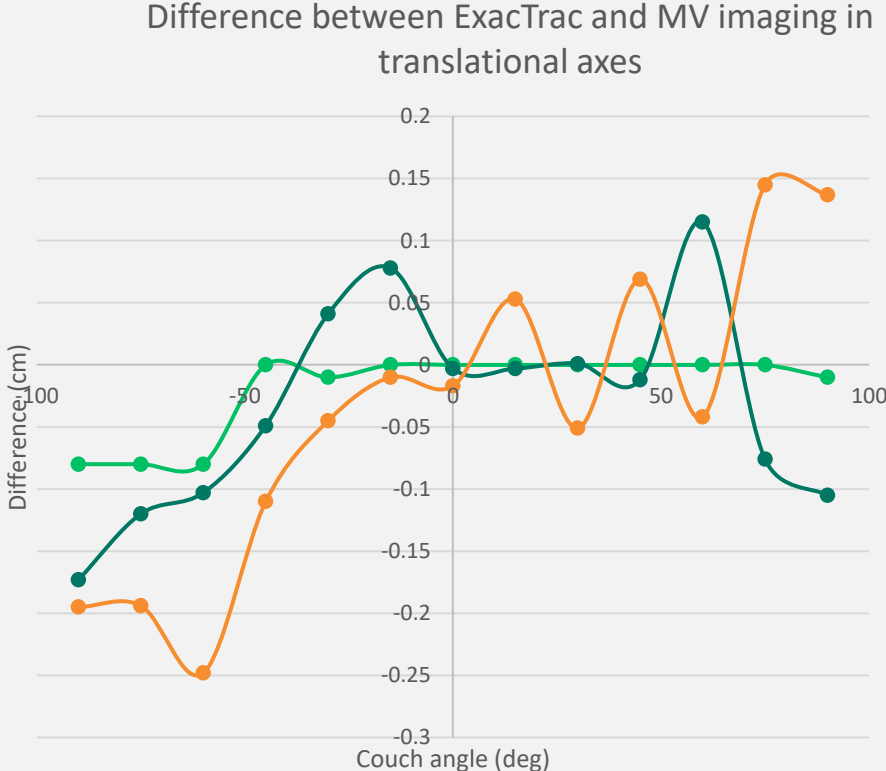
Results: Rotational Axes

AlignRT
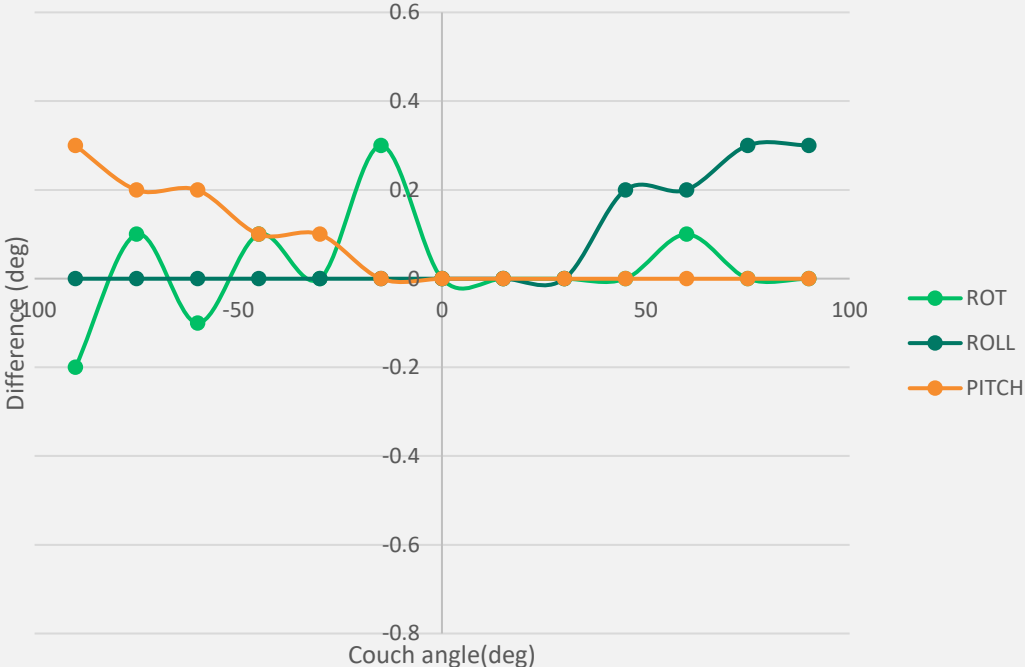
Difference between AlignRT and MV imaging in rotational axes

ExacTrac Dynamic

Difference between ExacTrac and MV imaging in rotational axes

Discussion: Translational Axes

AlignRT

Difference between AlignRT and MV imaging in translational axes
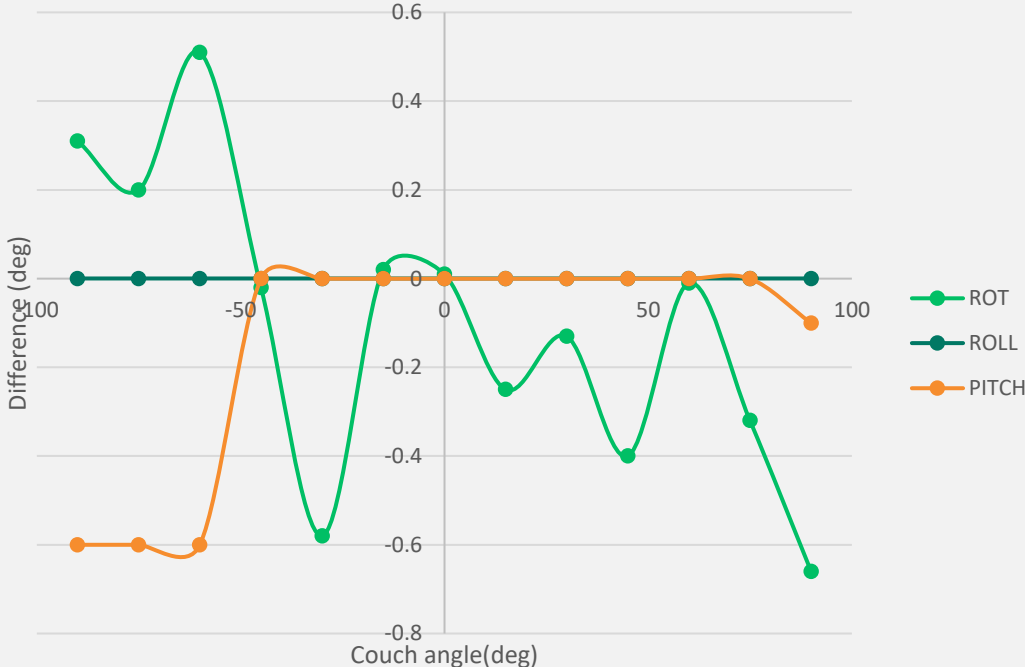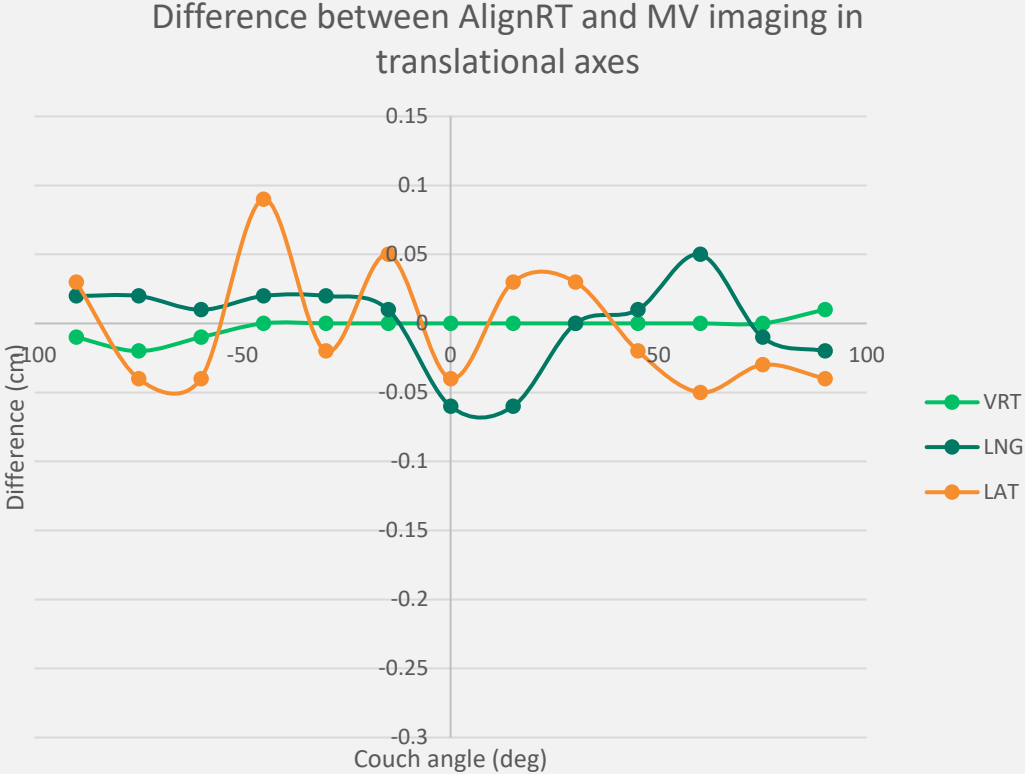
- ⬈ Agreement < 1mm at all couch angles
- ⬈ No observable relationship between agreement and couch position
- ⬈ VRT is difficult to assess on the MV planar image

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Discussion: Translational Axes

⬈ Due to the single camera nature of the system kept losing the surface of the cube

⬈ When you lose the surface of the cube you have to reacquire the SGRT surface which zeroes out any error making the difference between the MV imaging and SGRT no longer correlate

⬈ Not possible to disentangle the kV and SGRT portions of ETD

ExacTrac Dynamic

Difference between ExacTrac and MV imaging in translational axes

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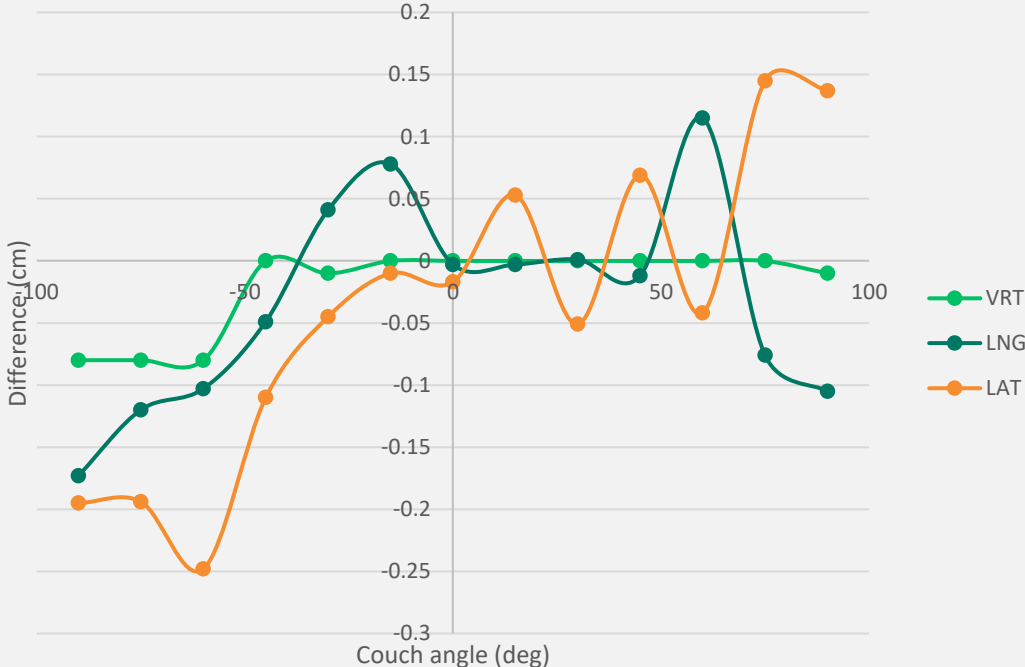
Discussion: Rotational Axes

AlignRT

Difference between AlignRT and MV imaging in rotational axes
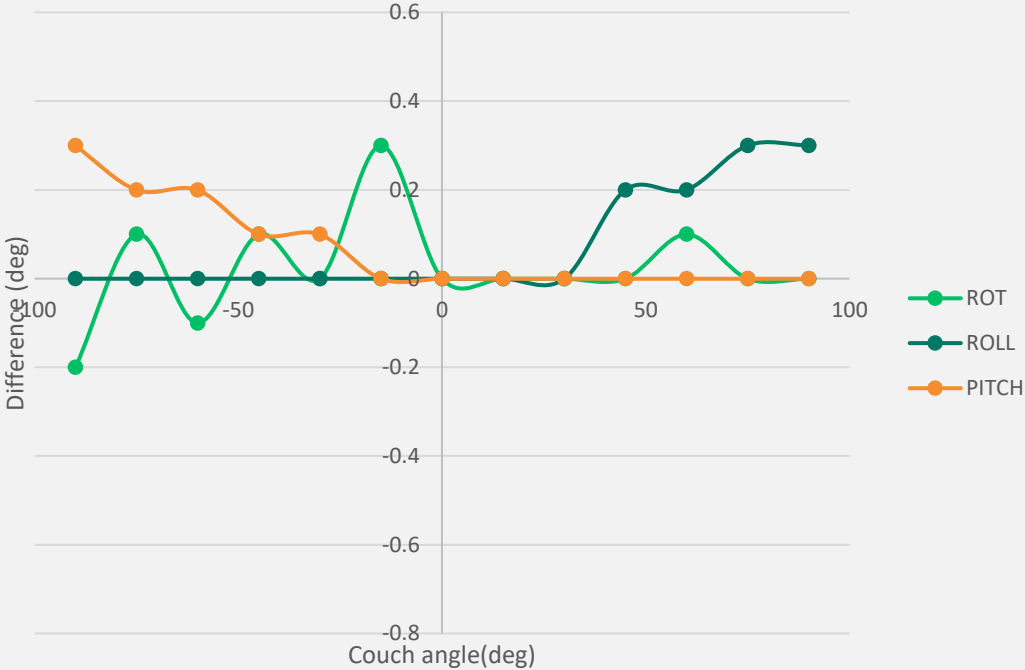
↗ Very good agreement <0.3 degrees

↗ Within local tolerances and wouldn't be cause for reimaging at any angle

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Discussion: Rotational Axes

⬈ Similar to the Translational axes

⬈ Had to keep re zeroing the SGRT component

⬈ Rotational axes performance not great

⬈ Perhaps due to single camera?

ExacTrac Dynamic

Difference between ExacTrac and MV imaging in rotational axes
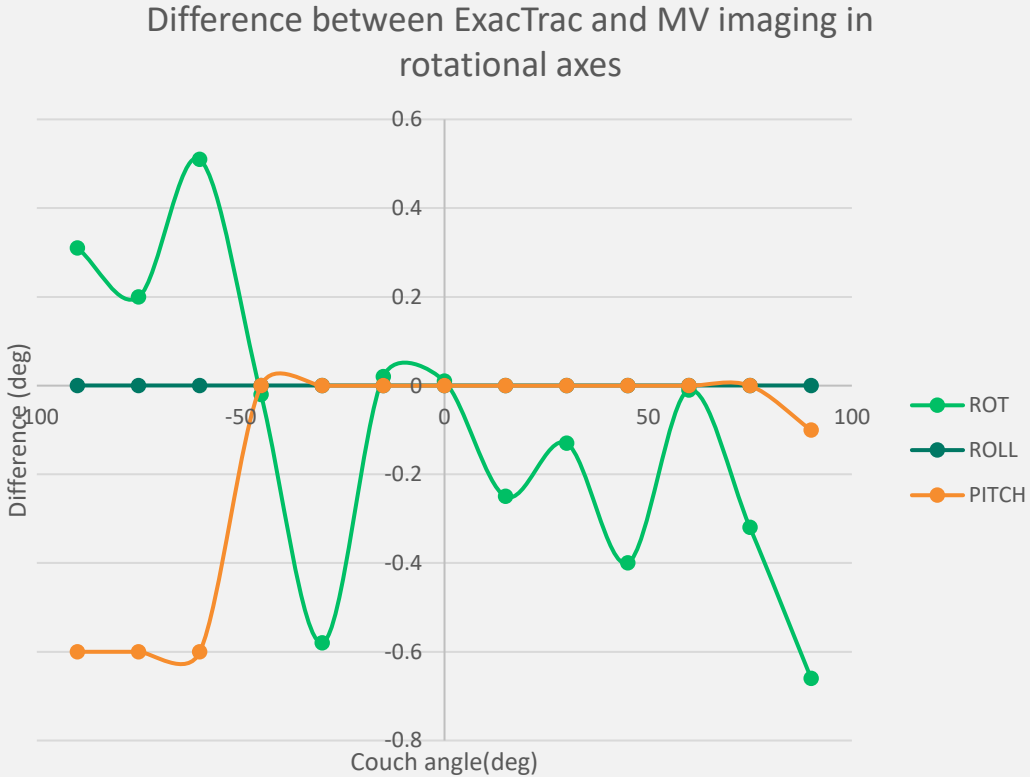
Discussion: Overall

AlignRT

⤢ Very good agreement between the MV planar imaging and SGRT for full range of couch motion

⤢ Easy to correlate the motion

⤢ No significant relationship in the size of agreement with couch position

⤢ The 3 camera set up allowed for consistent coverage of the cube

⤢ As an SGRT only system it was easy to correlate the SGRT component with the MV imaging

ExacTrac Dynamic

⤢ Due to the inability to use the system as an SGRT only system, very difficult to decouple the workflow and purely use the SGRT component

⤢ The data which we were able to capture did show larger deviations between the MV imaging and the SGRT readout

⤢ Single camera setup made it difficult to visualise monitor the cube when the couch was rotated

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06
Our Study: Conclusion & Future Work

Conclusion

Overall

⊘ It did seem that for the data acquired AlignRT provided greater agreement with the MV imaging than ETD

⊘ However, due to the workflow issues it was not possible to define this conclusively

⊘ AlignRT can effectively be used to monitor patient position at non zero couch angles

⊘ Using AlignRT for intrafraction monitoring during HyperArc (automated and non automated) deliveries can reduce patient verification imaging

⊘ AlignRT gives greater certainty that, in conjunction with a faceless immobilisation, the patient is in the correct position during SRS treatments

Personal thoughts

⊘ The AlignRT workflow was a lot simpler as didn't rely on any other system components

⊘ Varian linacs are much easier to operate than Elekta ones

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Future Work

- We will be repeating this work on our newly installed C-RAD system in Jan '24

- Results will be presented and can be circulated to any interested parties

- We are going to repeat the ETD work with a surrogate monitoring area to see if results can be obtained for all couch angles without recapturing SGRT baselines

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Acknowledgements

- ↗ Kankean Kandasamy

- ↗ Julie Bartley

- ↗ James Hellyer

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Thank you.

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Solution Driven | Patient Centred

AlignRT absolute shift values

Couch 0	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0.01	0	-0.01
LNG	-0.01	0	0.01
LAT	0	0.01	0.01
ROT	0	0.1	0.1
ROLL	0	0	0
PITCH	0	0	0

270	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0.01	0	-0.01
LNG	-0.01	0.01	0.02
LAT	0.05	0.08	0.03
ROT	0	-0.2	-0.2
ROLL	0	0	0
PITCH	-0.3	0	0.3

285	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0.02	0	-0.02
LNG	-0.01	0.01	0.02
LAT	0.01	-0.03	-0.04
ROT	0	0.1	0.1
ROLL	0	0	0
PITCH	-0.2	0	0.2

300	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0.01	0	-0.01
LNG	-0.01	0	0.01
LAT	0.04	0	-0.04
ROT	0.1	0	-0.1
ROLL	0	0	0
PITCH	-0.2	0	0.2

315	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	-0.01	0.01	0.02
LAT	0.01	0.1	0.09
ROT	0	0.1	0.1
ROLL	0	0	0
PITCH	-0.1	0	0.1

330	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	0.02	0.02
LAT	0.03	0.01	-0.02
ROT	0.1	0.1	0
ROLL	0	0	0
PITCH	-0.1	0	0.1

345	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	-0.01	0	0.01
LAT	-0.01	0.04	0.05
ROT	-0.1	0.2	0.3
ROLL	0	0	0
PITCH	0	0	0

Couch 0	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	-0.06	-0.06
LAT	0	-0.04	-0.04
ROT	0	0	0
ROLL	0	0	0
PITCH	0	0	0

15	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0.01	0.01	0
LAT	-0.01	0.02	0.03
ROT	-0.1	-0.1	0
ROLL	0	0	0
PITCH	0	0	0

30	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	0	0
LAT	0.02	0.05	0.03
ROT	0	0	0
ROLL	0	0	0
PITCH	0	0	0

45	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	-0.01	0	0.01
LAT	0.02	0	-0.02
ROT	0	0	0
ROLL	-0.2	0	0.2
PITCH	0	0	0

60	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	0.05	0.05
LAT	0.04	-0.01	-0.05
ROT	0	0.1	0.1
ROLL	-0.2	0	0.2
PITCH	0	0	0

75	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0.01	0	-0.01
LAT	0.03	0	-0.03
ROT	0	0	0
ROLL	-0.3	0	0.3
PITCH	0	0	0

90	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	-0.01	0	0.01
LNG	0.02	0	-0.02
LAT	0.03	-0.01	-0.04
ROT	-0.1	-0.1	0
ROLL	-0.3	0	0.3
PITCH	0	0	0

Couch 0	ART (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0.02	0.09	0.07
LAT	0.02	-0.01	-0.03
ROT	0	0.1	0.1
ROLL	-0.3	0	0.3
PITCH	0	0	0

ETD absolute shift values

Couch 0	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0.01	-0.017	-0.027
LAT	0	-0.012	-0.012
ROT	0	0.22	0.22
ROLL	0	0	0
PITCH	0	0	0

270	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0.08	0	-0.08
LNG	0.01	-0.163	-0.173
LAT	0.09	-0.105	-0.195
ROT	-0.3	0.01	0.31
ROLL	0	0	0
PITCH	0.6	0	-0.6

285	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0.08	0	-0.08
LNG	0.02	-0.1	-0.12
LAT	0.09	-0.104	-0.194
ROT	-0.8	-0.6	0.2
ROLL	0	0	0
PITCH	0.6	0	-0.6

300	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0.08	0	-0.08
LNG	0.02	-0.083	-0.103
LAT	0.12	-0.128	-0.248
ROT	-0.9	-0.39	0.51
ROLL	0	0	0
PITCH	0.6	0	-0.6

315	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	-0.049	-0.049
LAT	0	-0.11	-0.11
ROT	0	-0.02	-0.02
ROLL	0	0	0
PITCH	0	0	0

330	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0.01	0	-0.01
LNG	-0.07	-0.029	0.041
LAT	-0.06	-0.105	-0.045
ROT	0	-0.58	-0.58
ROLL	0	0	0
PITCH	0	0	0

345	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	-0.1	-0.022	0.078
LAT	-0.08	-0.09	-0.01
ROT	-0.5	-0.48	0.02
ROLL	0	0	0
PITCH	0	0	0

Couch 0	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	-0.003	-0.003
LAT	0	-0.017	-0.017
ROT	0	0.01	0.01
ROLL	0	0	0
PITCH	0	0	0

15	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	-0.02	-0.02
LAT	0	0.053	0.053
ROT	-0.1	-0.35	-0.25
ROLL	0	0	0
PITCH	0	0	0

30	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	-0.01	-0.009	0.001
LAT	0	-0.051	-0.051
ROT	-0.2	-0.33	-0.13
ROLL	0	0	0
PITCH	0	0	0

45	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	-0.012	-0.012
LAT	0	0.069	0.069
ROT	0	-0.4	-0.4
ROLL	0	0	0
PITCH	0	0	0

60	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	0.115	0.115
LAT	0	-0.042	-0.042
ROT	-0.1	-0.11	-0.01
ROLL	0	0	0
PITCH	0	0	0

75	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0	0	0
LNG	0	-0.076	-0.076
LAT	0	0.145	0.145
ROT	0	-0.32	-0.32
ROLL	0	0	0
PITCH	0	0	0

90	ETD (cm or Deg)	MV (cm or Deg)	Diff (cm or Deg)
VRT	0.01	0	-0.01
LNG	0	-0.105	-0.105
LAT	0.02	0.157	0.137
ROT	-0.3	-0.96	-0.66
ROLL	0	0	0
PITCH	0.1	0	-0.1