SGRT at Beacon Hospital – a success story

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Disclosure

- Consultant for Vision RT
- Consultant for Ferring
- Speaker for Astellas
- Consultant for Medisprof Cancer Centre and Daruieste Viata

Beacon Hospital experience

- opened Dec 2006
    - SRS/SABR since 2007

- 2 linacs, 4 Rad Oncs, 6 MPs, 14 RTT, 2 Nurses
- no patients/year: >700, >70% high technology
- techniques
    - 3D
    - IMRT- 2007
    - SRS- Dec 2007
    - SBRT- 2008
    - VMAT – 2019
    - SGRT - 2014
- respiratory management-all patients except pelvis/cranial
    - DIBH – all breast ca patients , if able to do it
    - abdominal tumors
    - lung tumors

Trilogy TX -HDMLC

Ed
ge

Beacon SGRT Experience

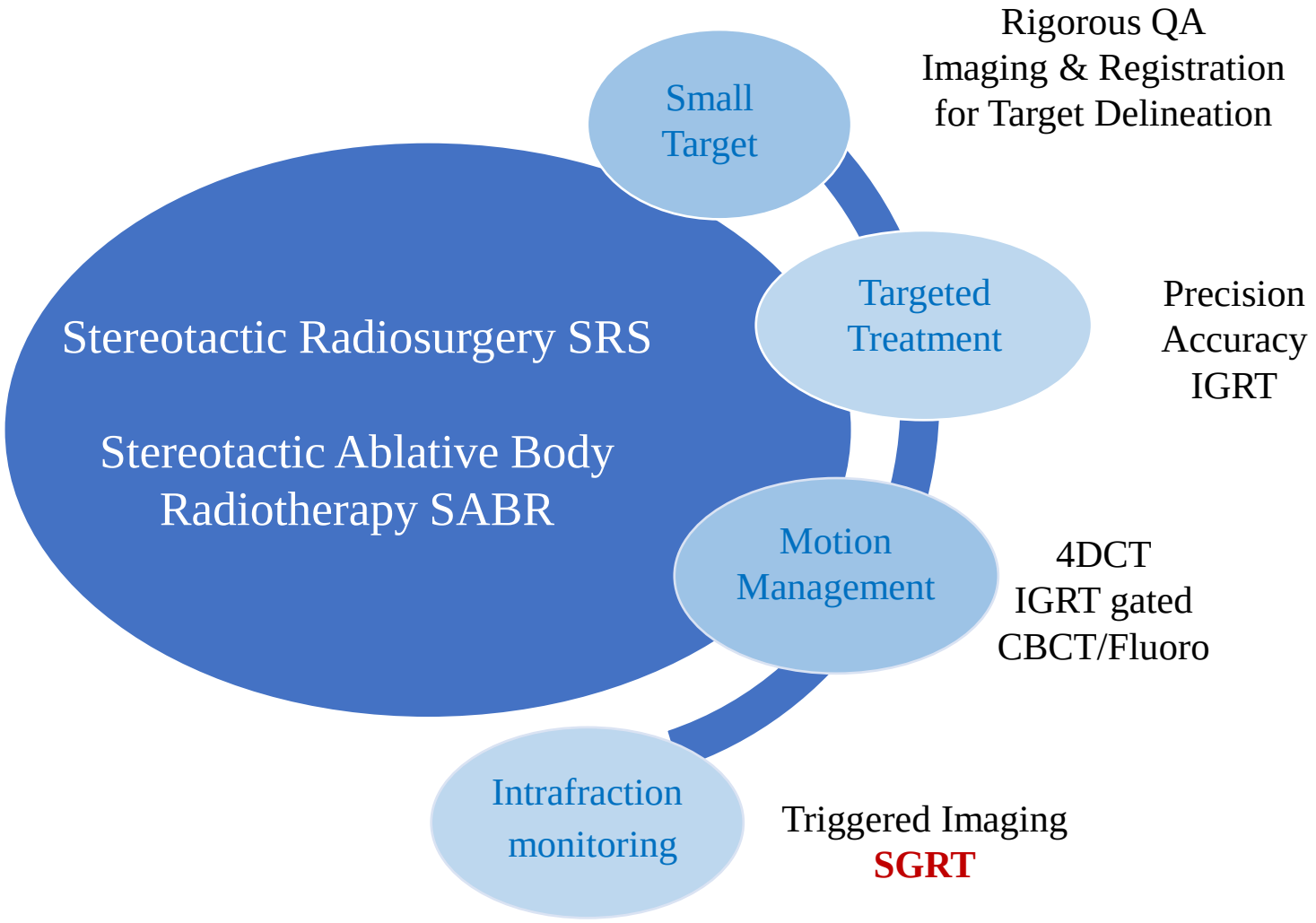
Varian EDGE

Varian Trilogy

Year	Site	Setup	Intrafraction Monitoring	No fractions treated since 2014
2014	**Intracranial SRS**	✓	✓	**>1000**
2017	Extremities/Thorax/Abdomen/Pelvis intrafraction monitoring		✓	
2018/ 2019	Breast tattooless (DIBH)	✓	✓	**356**
2019	Conventional RT- Most sites tattooless	✓	✓	
2019	**SABR Abdomen & Thorax**		✓	**3356 (fx)**

August 2021 Align RT Advance

Advances in Radiotherapy : SRS/SABR requirements



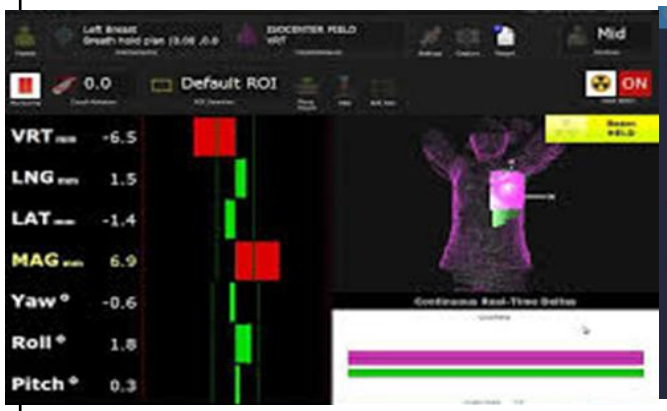
Imaging, planning, and treatment typically are performed in close temporal proximity. Treatment delivery should be accurate to within approximately 1 mm. This leaves little room for error in the overall process. Strict protocols

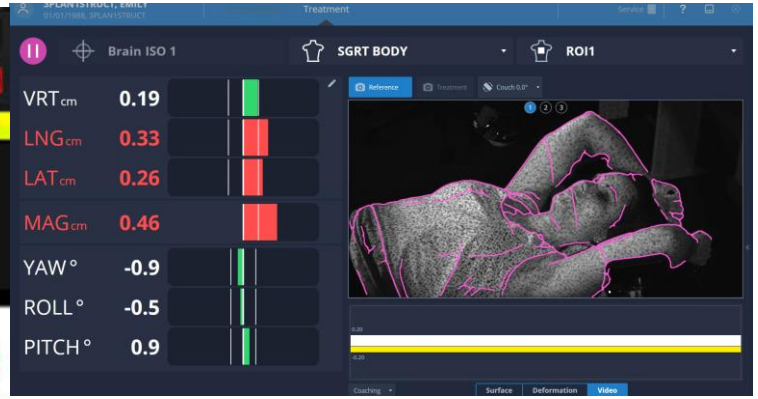
ACR/ASTRO Practise Guideline
2016

Advances in Radiotherapy- Surface guided radiotherapy

- Patient set-up
  - **Non-invasive, non-ionizing 3D real time**
  - Accurate isocentric set-up **(<= 3mm/0.2 degrees)**
- Intra-fraction monitoring
  - 6DOF motion monitoring in real time
  - Automatically switch off beam if motion> preset threshold
- Increased patient safety and comfort
- Improved clinical outcomes – better targeting and better sparing of OARs

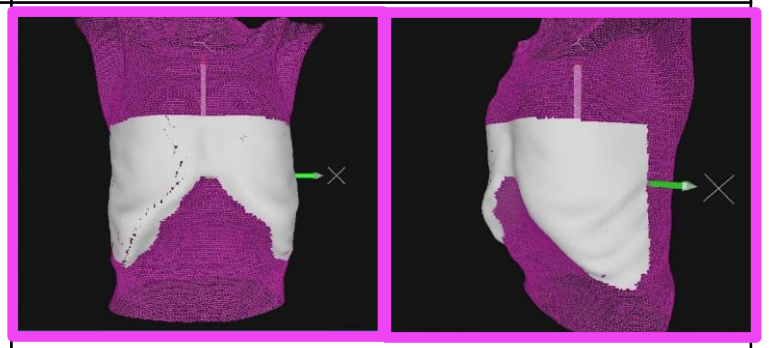
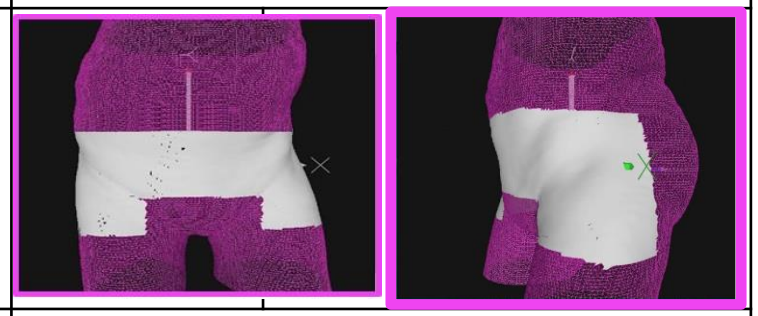
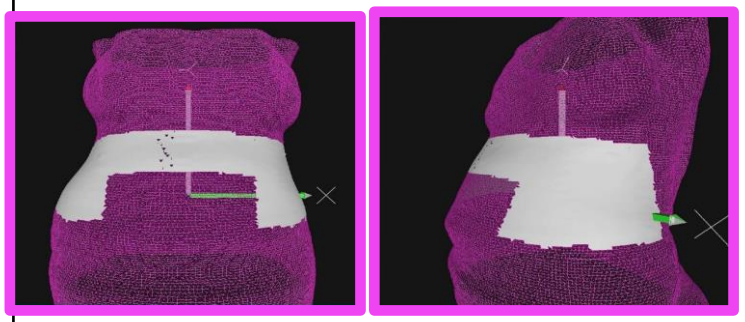
”3rd eye in the room” - easy monitoring



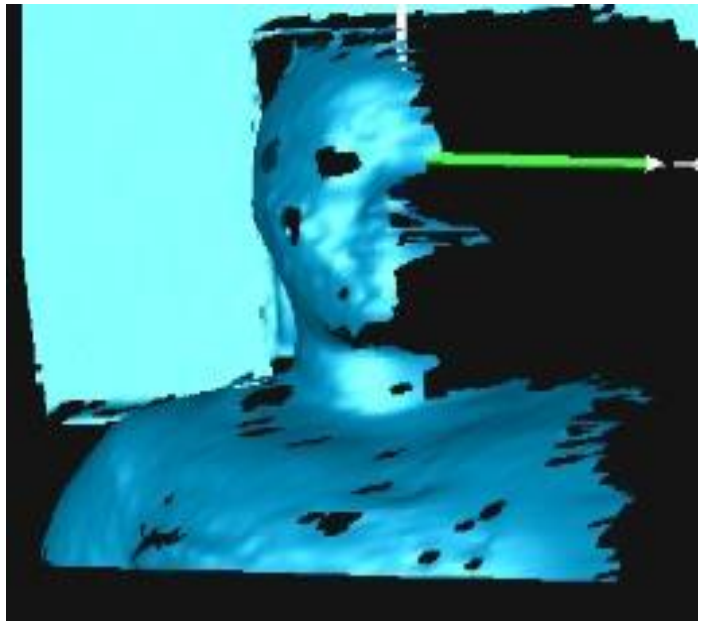


Monitors surfaces , NOT tumors
REIMAGE NECESSARY- CBCT after applying the shifts

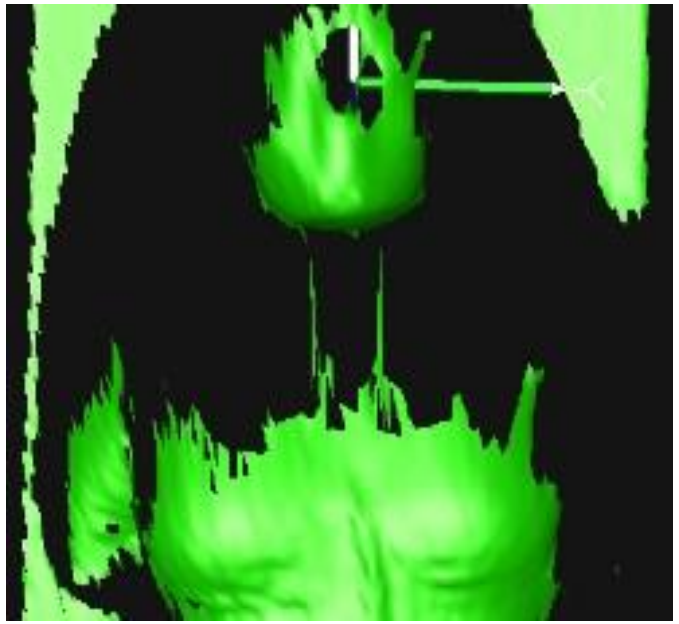
ROI selection -CRITICAL

Site	Include	Do not include	
Thorax	**Stable portion** of the skin surface Patient topography	Large unstable areas Anything not part of the patient such as gown or immobilization device Non-reproducible area due to breathing motion	
Pelvis	Anterior portion of hips Lateral portion of hips to the mid-coronal plane	Excessive adipose tissue Non-reproducible areas Anything not part of the patient	
Abdomen	Stable portion of the skin surface (ex. Ribs)	Large unstable areas Anything not part of the patient Non-reproducible area due to breathing motion	

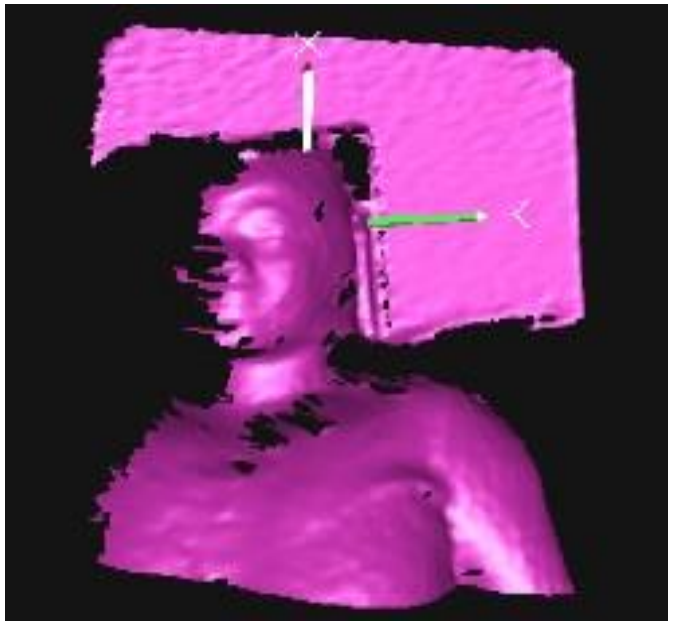
AlignRT Limitation: Camera blocked during gantry rotation



Left pod



Central pod



Right pod

- Two lateral cameras blocked for very short time during CBCT acquisition -will not capture any patient movement

- **Record patient position at the beginning and end of CBCT**

SRS/fSRS

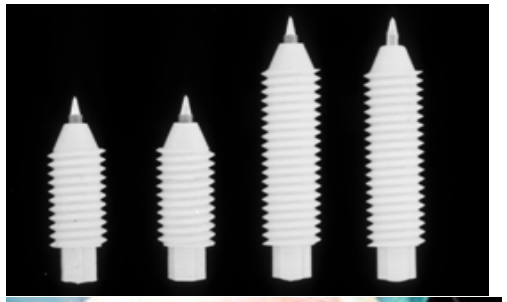
Beacon Experience SRS

- Indication- brain metastases/benign conditions
- 2500 treatments since 2007
- Largest experience with AlignRT outside USA
- Reference centre for VisionRT

SRS Programme	2007 – 2014	2014 – 2019	2019 - Present
Linac	Trilogy	Trilogy	Edge
Technique	Cones & arcs	Cones & arcs	Cones VMAT & HD-MLC
Verification	kV	CBCT	CBCT
Setup & Intrafraction Monitoring	Optical Guidance Platform (OGP)	Align RT	Align RT

Patient positioning and immobilization

Frame based

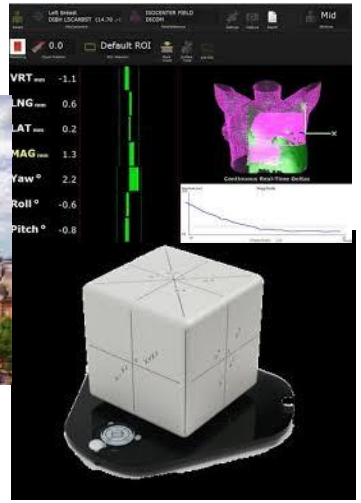


Frameless (Z med)

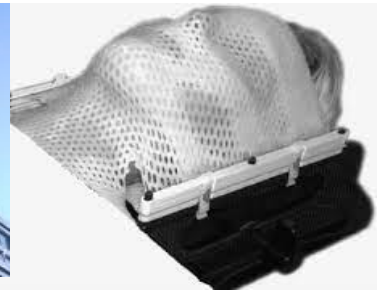
Surface guidance

Choosing a new solution- 2014

Vision RT



Brainlab -Munich



	Align RT	BrainLab Exactrac
Cost	Lower cost (factor of 3)	Higher Cost
Installation	little construction work	construction work required to install x- ray units
Downtime	½ day	2 weeks
Method of alignment	External contour of patient	Internal anatomy of patient
Non coplanar angles	Dependent on external anatomy	Non-coplanar verification of internal anatomy
6 Degrees of freedom	Achieved with head adjuster	6 degree couch included with package
Patient comfort	Open face mask	Closed face mask

Align RT Installation

- Vision RT room survey a month prior to install
- Beacon install mounting plates for cameras
- Cameras installed by Vision RT engineer over weekend
- Acceptance testing done on Monday
- **First patient treated that week**
- Integrated with Varian: MMI - Auto patient recall, couch control & beam hold

Questions we had:

- What is the accuracy of the system?
- ROI selection?
- How stable is the open mask?
- Does Align RT replace the need for CBCT?

Does SGRT meet these requirements? Beacon Results

MD Anderson audit of our cranial SRS treatments

The dosimetric precision of the TLD is ±3%, and the spatial precision of the film and densitometer system is ±1 mm.

Used for end to end evaluation

Film Plane	Gamma Index
Coronal	99%
Sagittal	99%
	Ratio
Dose to the center of the target	0.98

Beacon Hospital

Simulation and Immobilization

- Macromedics DSPS open face mask
- Ensure enough of face is outside mask for ROI
- Chin as down as possible

2 fingers between the mask and the plate

Cranial SRS ROI selection

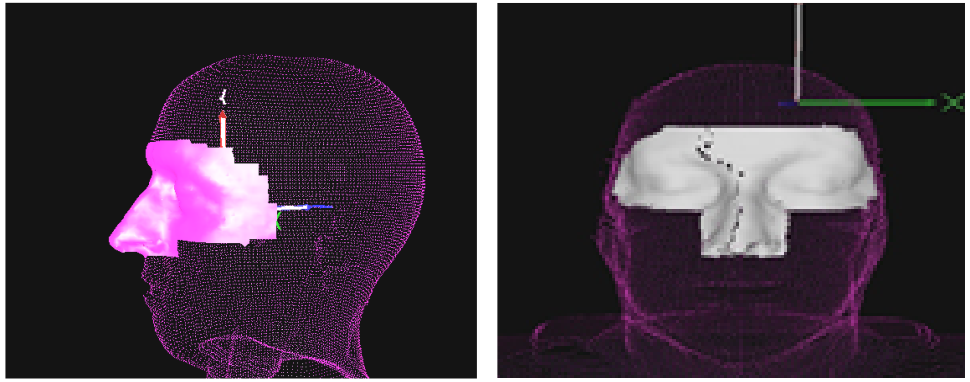
- Primary cause of poor setup

- ROI: rigid structures only

  - include frontal bones (=> chin down)
  - exclude cheeks, hairline, prominent eyebrows
  - exclude mask

- No make-up or false eyelashes

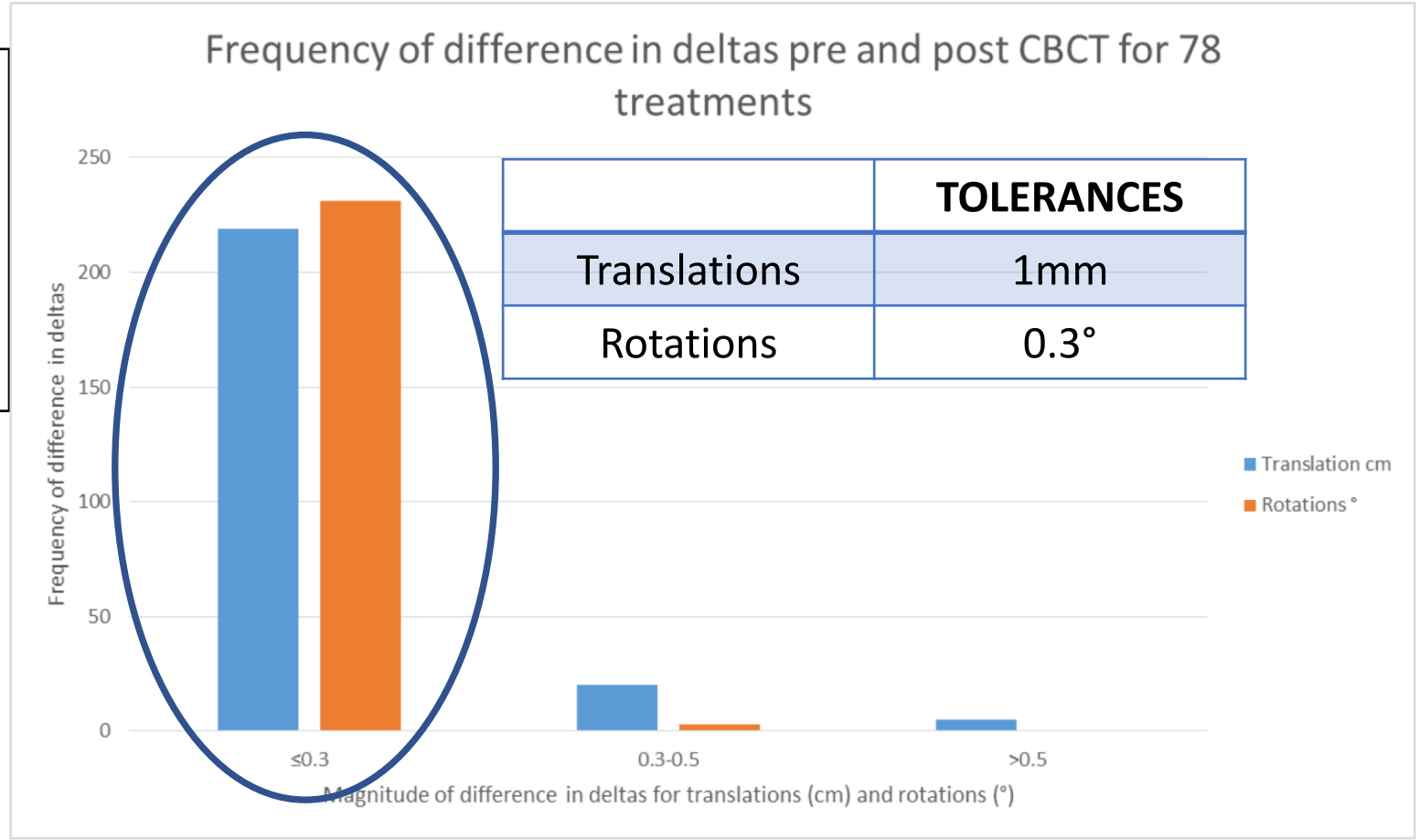
- Bushy eyebrows!



Open face mask stability

- 78 fractions
- Deltas before and after CBCT recorded

- Re-CBCT 5 patients due to motion during CBCT or matching
- Patients stable and comfortable



	TOLERANCES
Translations	1mm
Rotations	0.3°

Why stability is important - SRS for Multiple Intracranial Metastases (MIM)

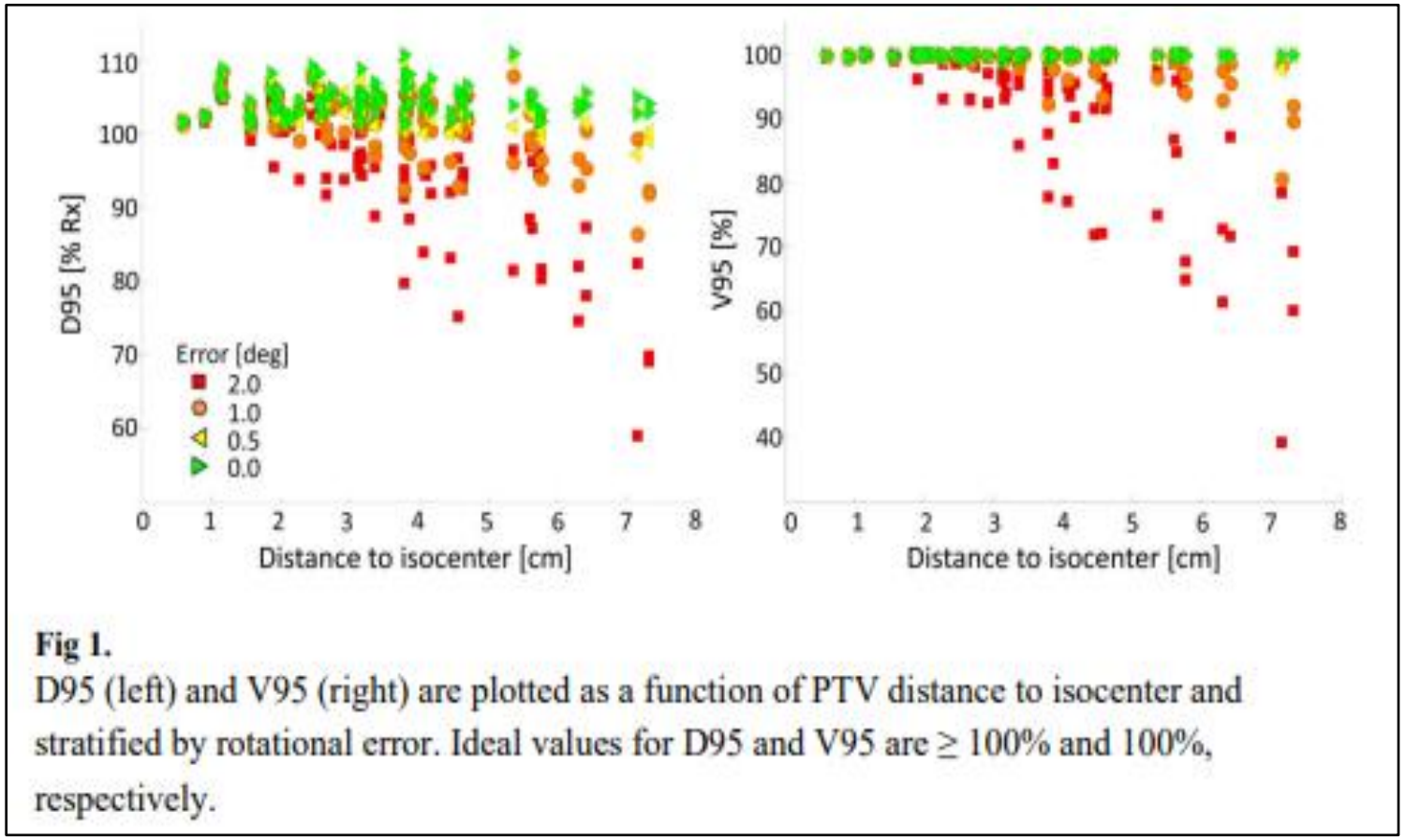
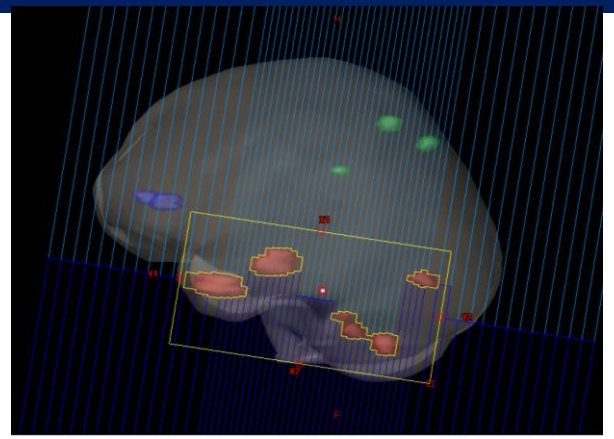
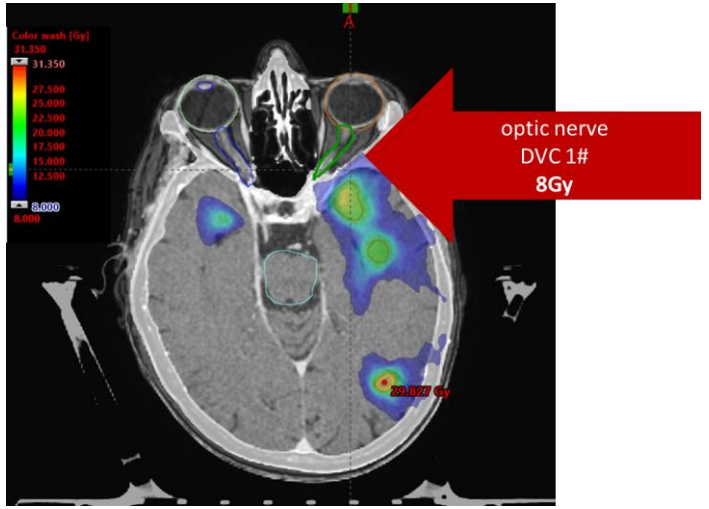


Fig 1.
D95 (left) and V95 (right) are plotted as a function of PTV distance to isocenter and stratified by rotational error. Ideal values for D95 and V95 are ≥ 100% and 100%, respectively.

Roper, Chanyavanich et al. 2015

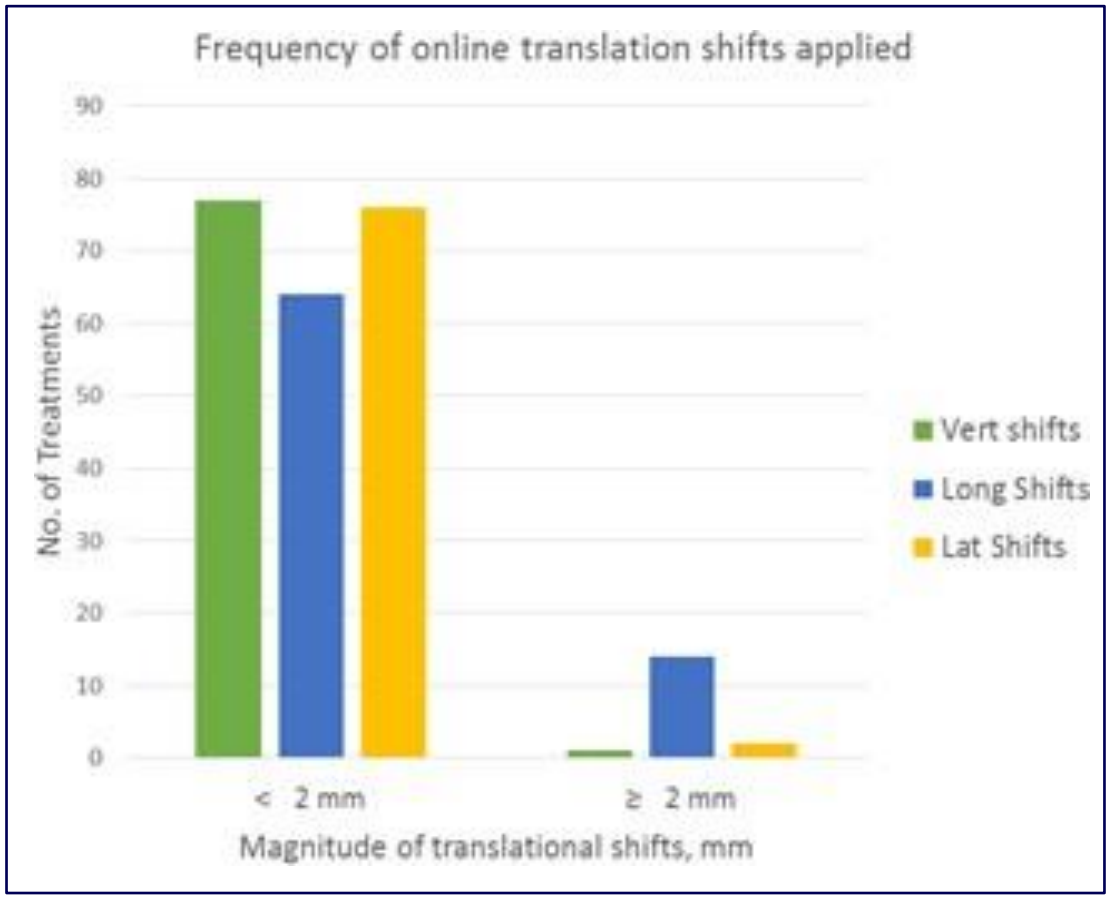


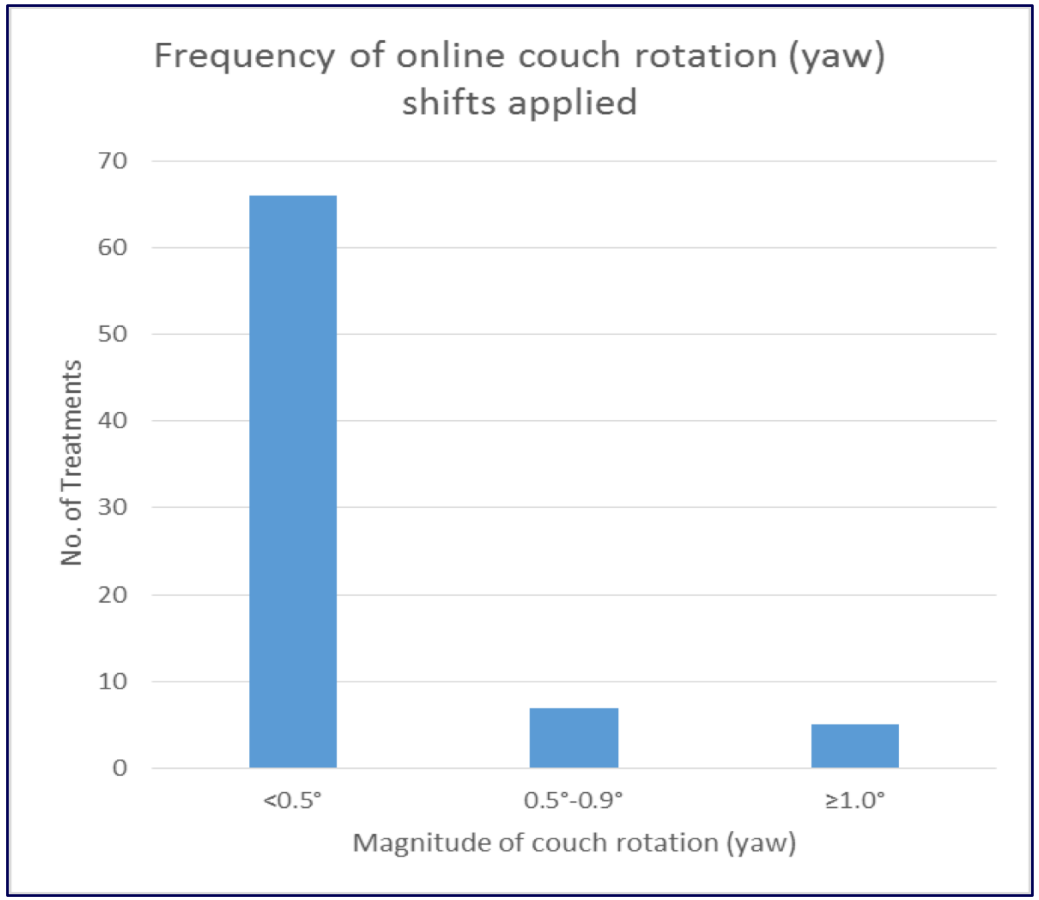
Iso is away from the treated area – monitor rotations



Align RT for couch rotations
OARs nearby – rotations ~0.5° could lead to a significant increase in D_{max} & $D_{0.02cc}$

Does Align RT replace CBCT?



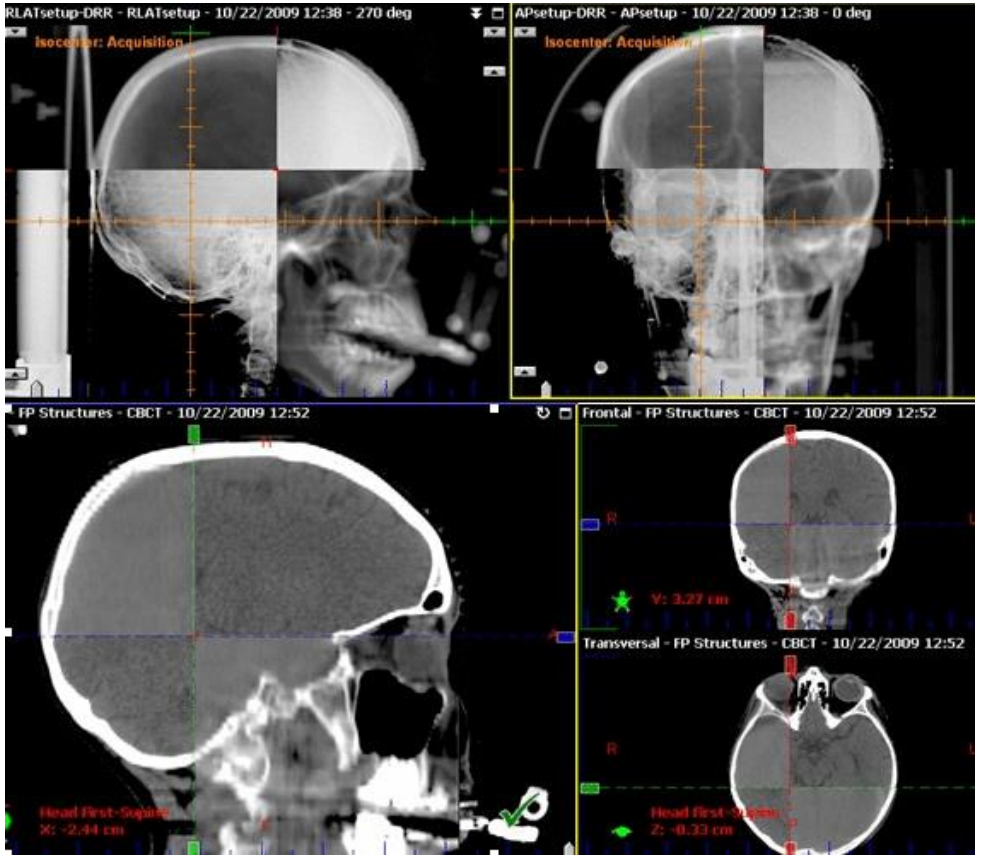


- Vert & Lat shifts: 98% < 2mm
- Long shifts: 82% < 2mm (correct for pitch)
- Couch rotation: 94% < 1°

Does AlignRT replaces CBCT?

- Volumetric imaging for soft tissue matching
    - **CBCT localisation remains the gold standard**

- SGRT **is complementary,** not alternative
    - patient positioning / initial setup
    - monitoring for intrafraction patient movement
    - reduced imaging dose
    - reduced anesthetic needs



AND….. ENHANCES CONFIDENCE IN OUR TREATMENT DELIVERY ACCURACY

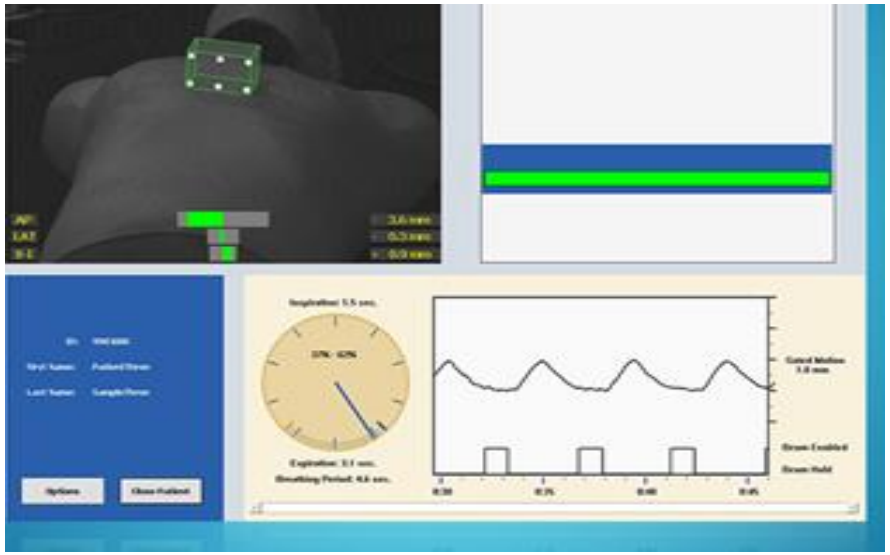
Beacon SRS Program Results

- Align RT installed Sept 2014
- **1000+ patients treated** (largest SRS series in Europe)
- Well tolerated – successfully treated over **98% of patients**
- Maintained similar tolerances to Varian OGP

Breast/chest wall irradiation- DIBH tattooless technique

SGRT for Breast, Chest wall, SCF

2007-2014



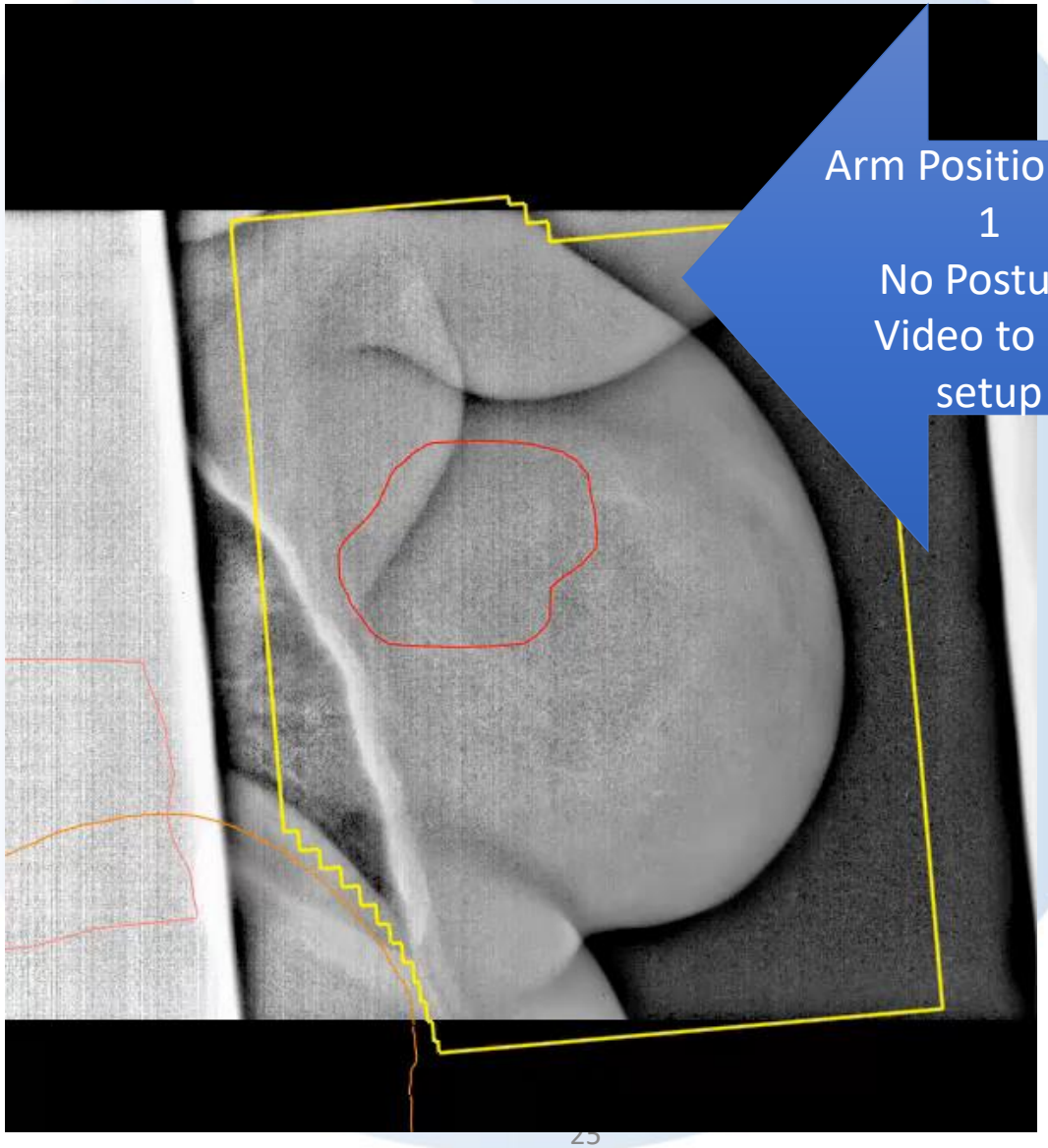
- Surrogate for lung filling
- Does not track patient motion
- Retrack block position

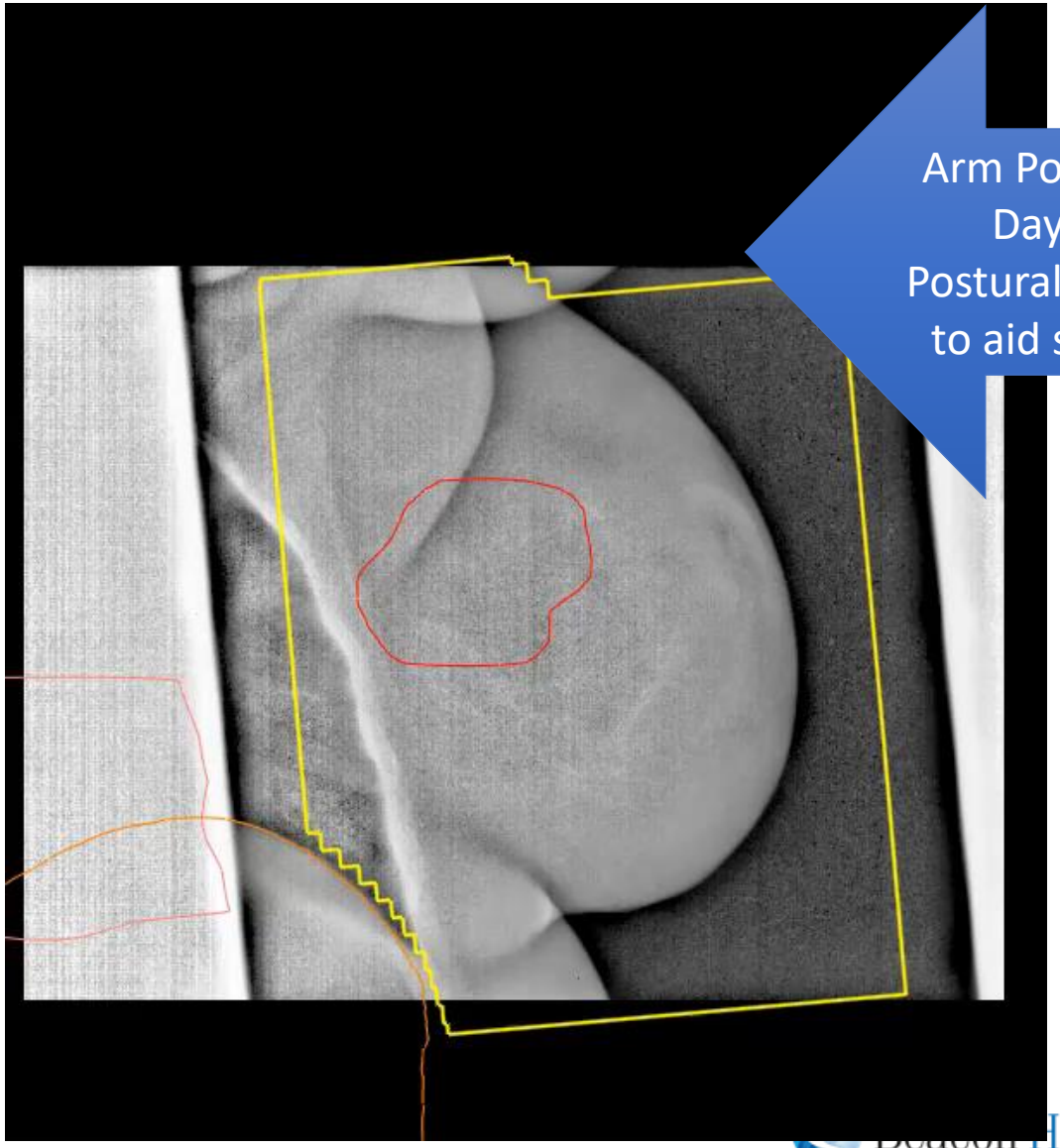
2018-2021

- Tracks actual breast tissue
- Highly accurate for FB and DIBH
- Able to identify bending back, rotations, etc

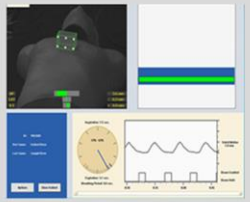
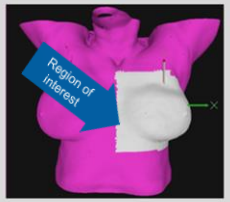
Since 2021- AlignRT Advance

Align RT Advance – Postural Video





Introduction of DIBH tatooless technique

marker block as surrogate for motion	patient skin surface
	
Tattoos	Tattooless
10 years experience 10 patients 2018	audit first 10 patients audit 10 patients at 1 year

Daily Imaging with RPM & SGRT

COMPARE
Magnitude of shifts
Total treatment time
Number of re-setups for 3 field

Repeated analysis 1 year later

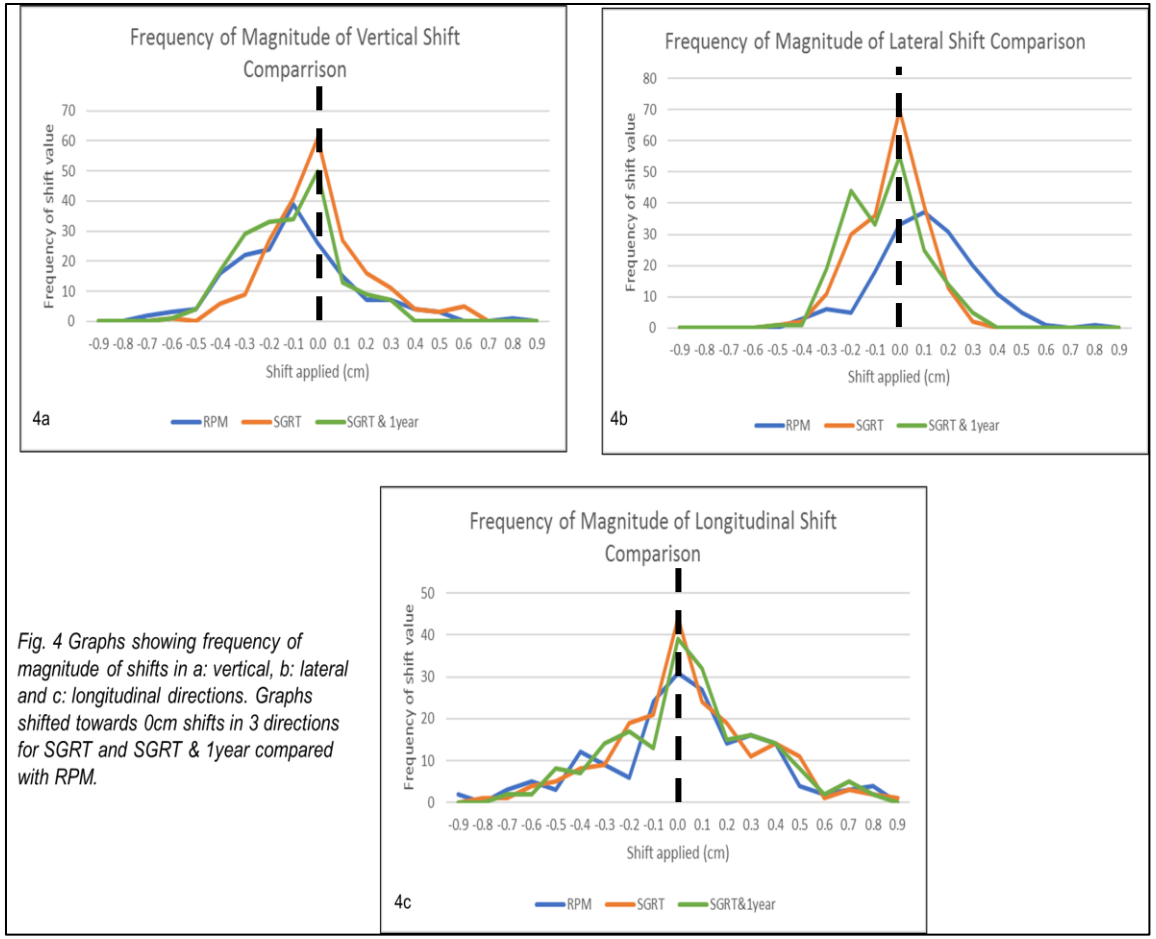
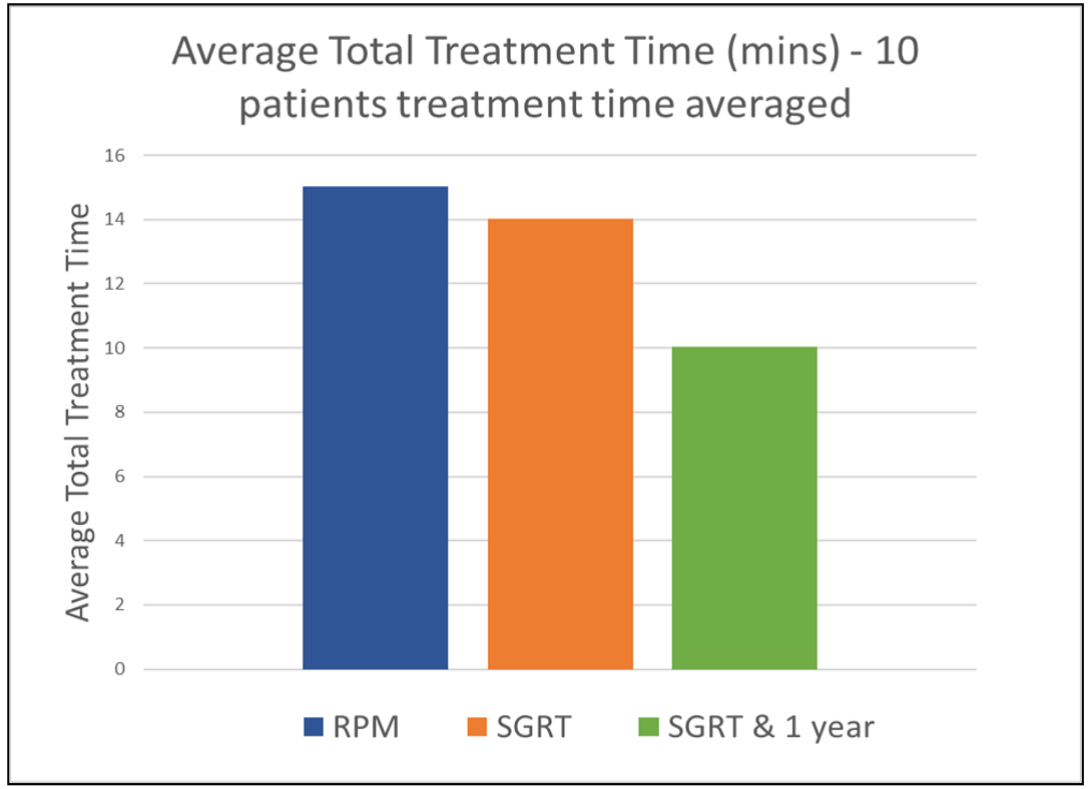


Fig. 4 Graphs showing frequency of magnitude of shifts in a: vertical, b: lateral and c: longitudinal directions. Graphs shifted towards 0cm shifts in 3 directions for SGRT and SGRT & 1year compared with RPM.

SGRT – more reliable for set-up than RPM
Importance of learning and experience

DIBH tatooless



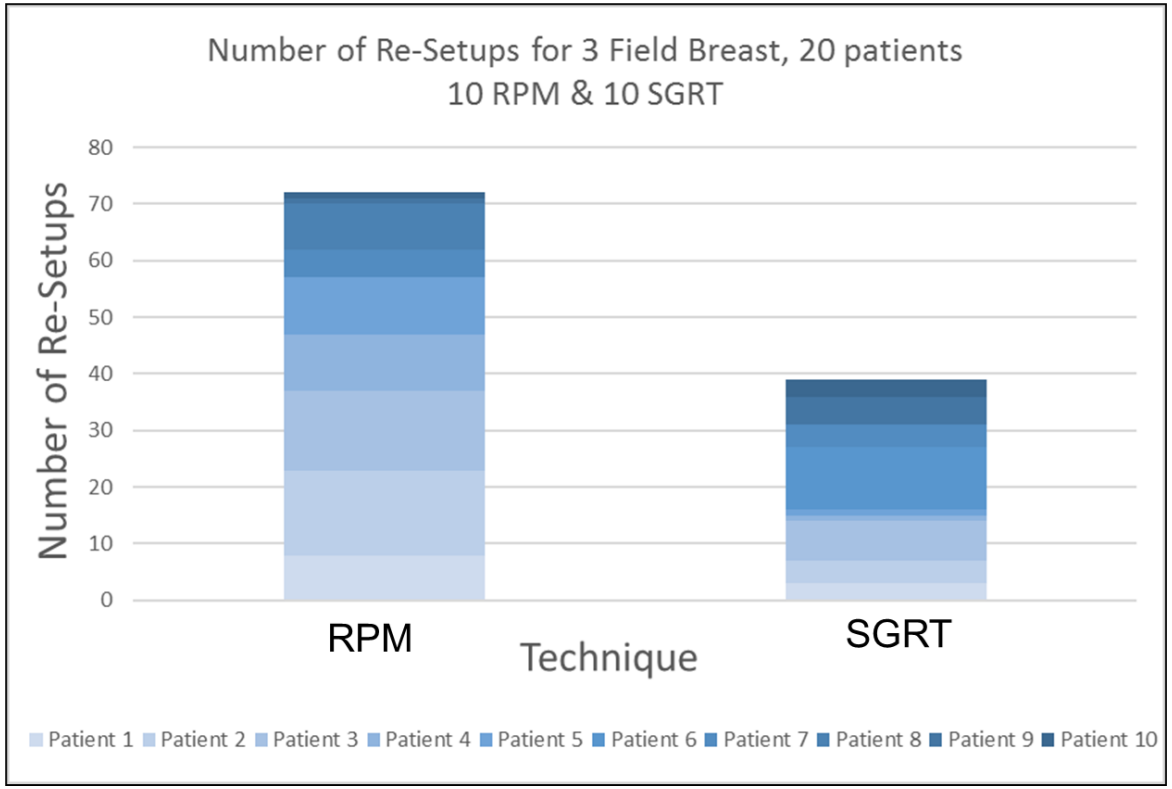
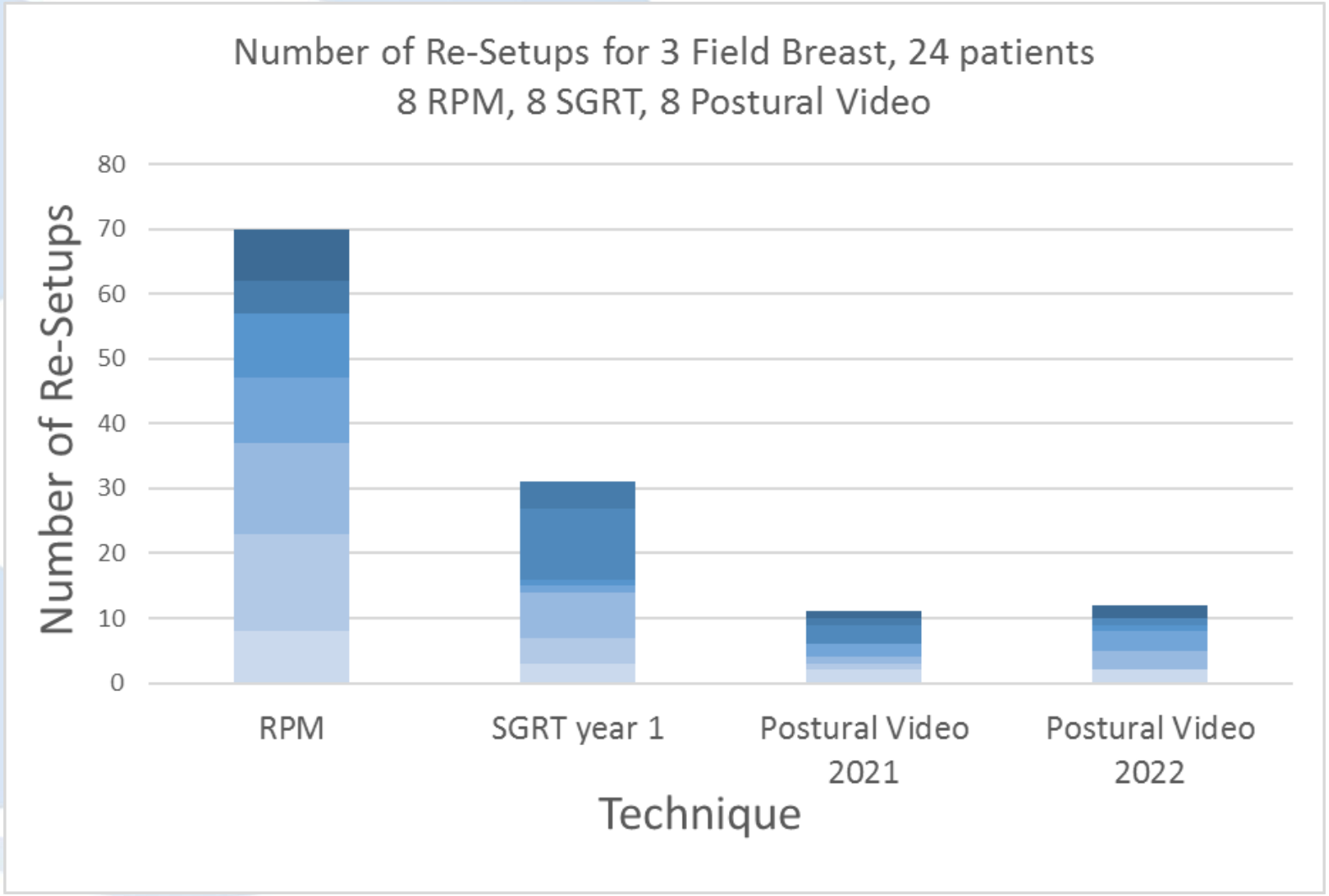


Fig. 5 Average total treatment time – reduced from 15 minutes with RPM to 10 minutes SGRT & 1 year

Results – Supraclav Setups with Postural Video

Graph shows a significant decrease in re-setups for 3 field treatments with Postural Video



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SGRT for SABR/ hypo-fractionated treatments and tattooless techniques

Beacon Hospital SABR Programme

Since 2008 – over 16 years… 2023 site Pancreas SABR
Varian RPM-RGSC for respiratory management
BodyFix immobilization (including body sheet before SGRT)
Mature programme
2019 – Integrate SGRT

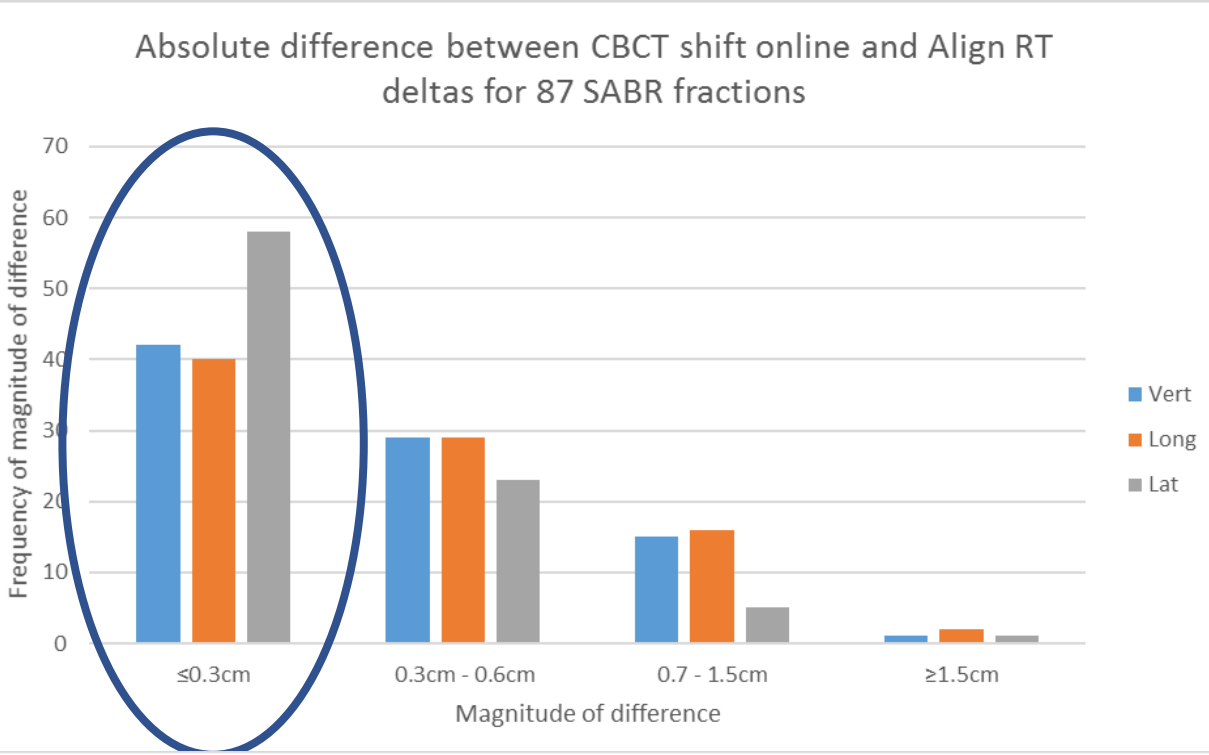
Integrating SGRT into SABR Programme.

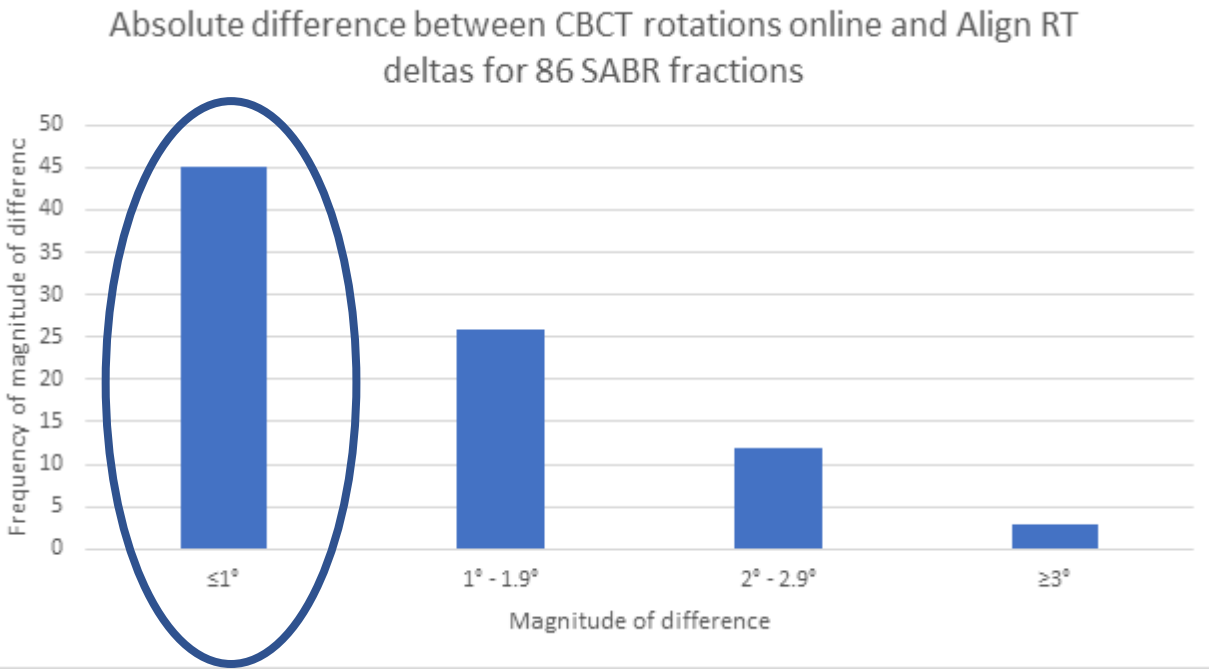
Advantages of SGRT for SABR
Tattooless setup
Intrafraction monitoring
“extra set of eyes on patient”
Minimize immobilization devices (remove body sheet)

SGRT for SABR

1. To assess effectivity of AlignRT surface guidance as a set up tool.
2. To use AlignRT to monitor patient intra-fraction motion, SABR treatment tolerance 0.3 cm, 3.0 degrees.
3. To increase safety when delivering SABR doses.

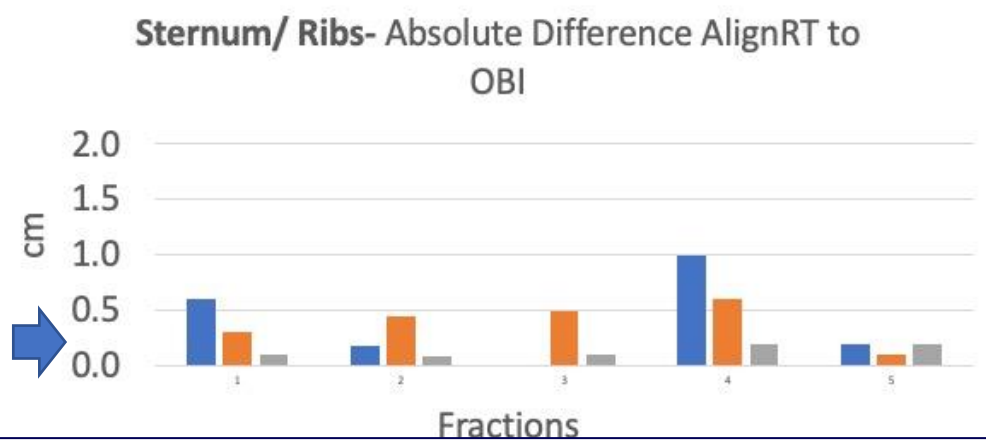
1. Record shifts indicated by AlignRT following set up
2. Record shifts indicated by OBI system following set up
3. Check for correlation (recorded shifts within 0.5cm and 2°)



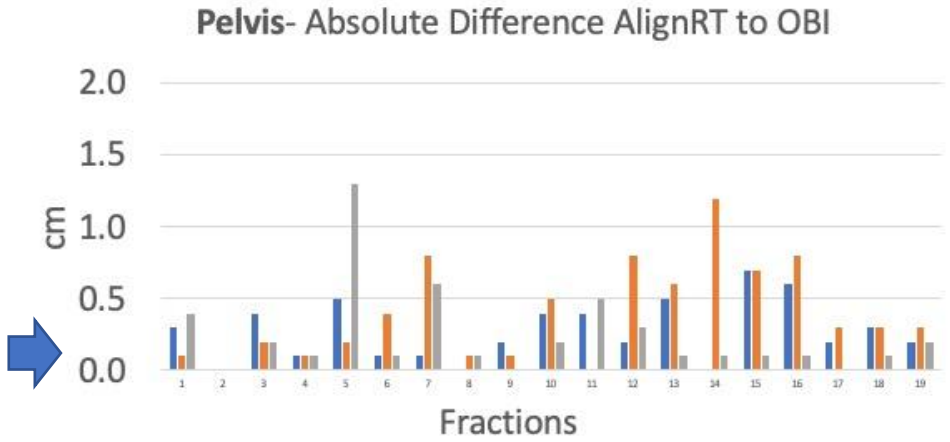


Absolute difference between AlignRT and OBI

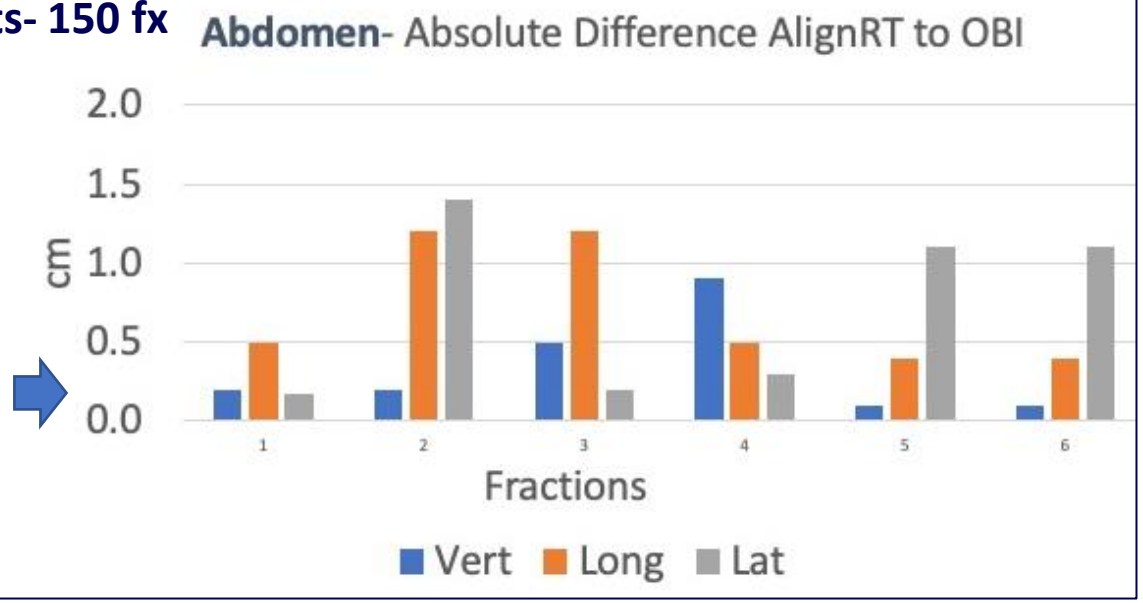
15 patients- 15fx



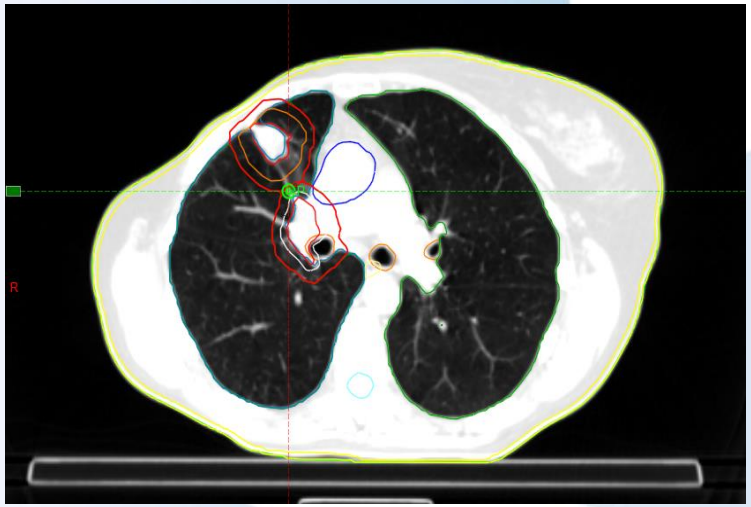
55 patients- 275fx



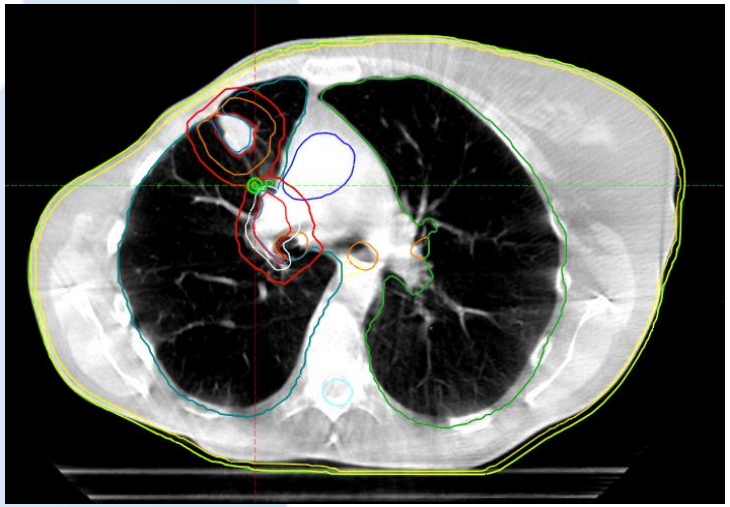
29 patients- 150 fx



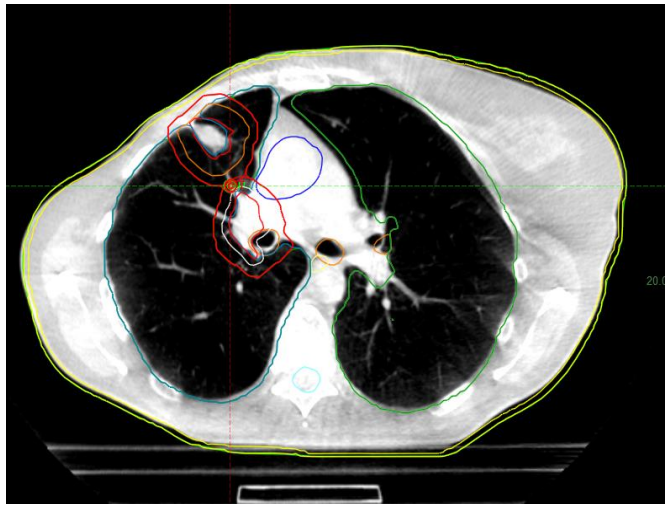
Integrating SGRT into SABR Programme : Respiratory Motion Management



Planning BH CT



CBCT SGRT only - airway blurring

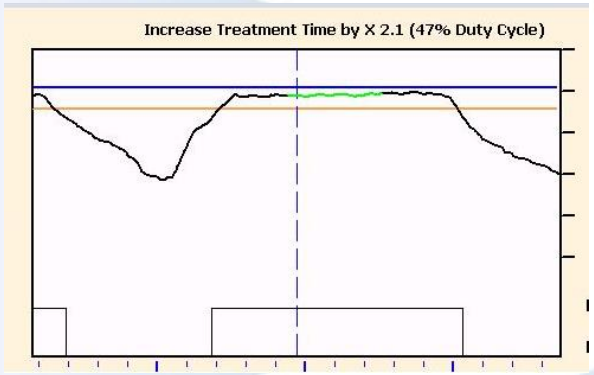


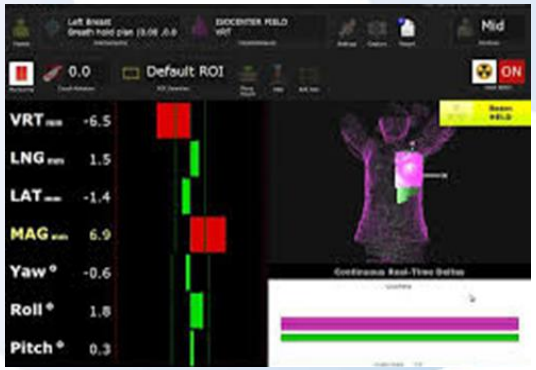
CBCT SGRT & RGSC airways improved

**Images for standard fractionation lung*

Beacon Hospital

Integrating SGRT into SABR Programme : Respiratory Motion Management





Limitations (SGRT alone)	Advantages of SGRT & Varian RGSC combined
Surface-target correlation not as good as SRS/Breast (3mm PTV)	Tattooless
CBCT blocking – noise during acquisition	Intrafraction motion & rotational correction
No respiratory phase gating	Full range of respiratory motion management

Intra-fraction monitoring

SABR / hypofractionation- SGRT becomes a necessity/mandatory

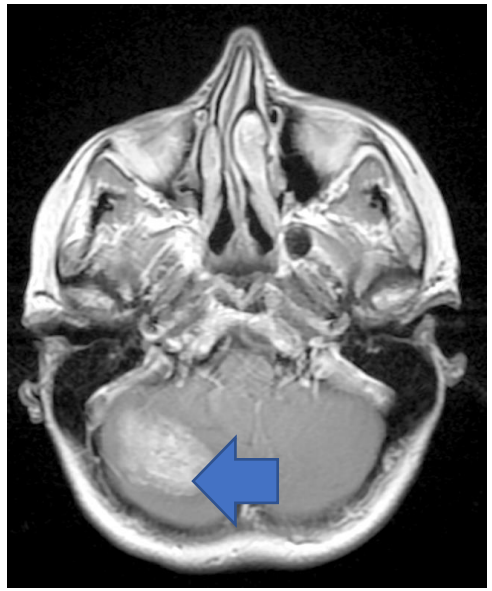
- High dose per fraction, very conformal – risk of geographic miss/significant toxicities
  - Longer treatments- potential for patient movements

- Rigorous image review time for SABR cases
  - time consuming process- longer than standard image review

- Factors provoking patient motion
  - sleeping, sneezing, coughing, arm/back pain,
  - hard couch top
  - unnatural position
  - room temperature
  - worry, watch check,
  - image review and treatment time

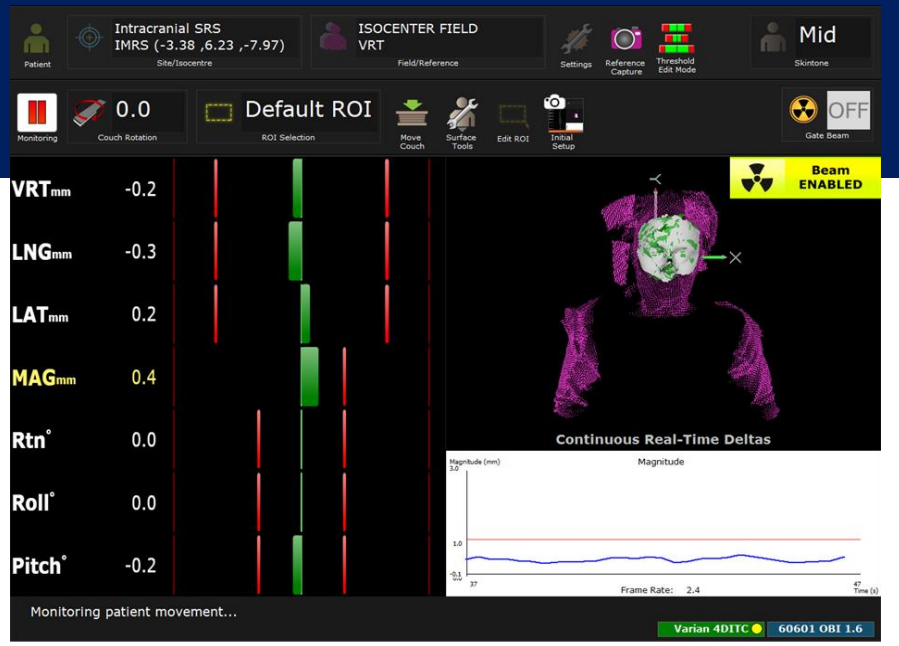
- RGSC does not have patient motion functionality (re-tracks based on block position)

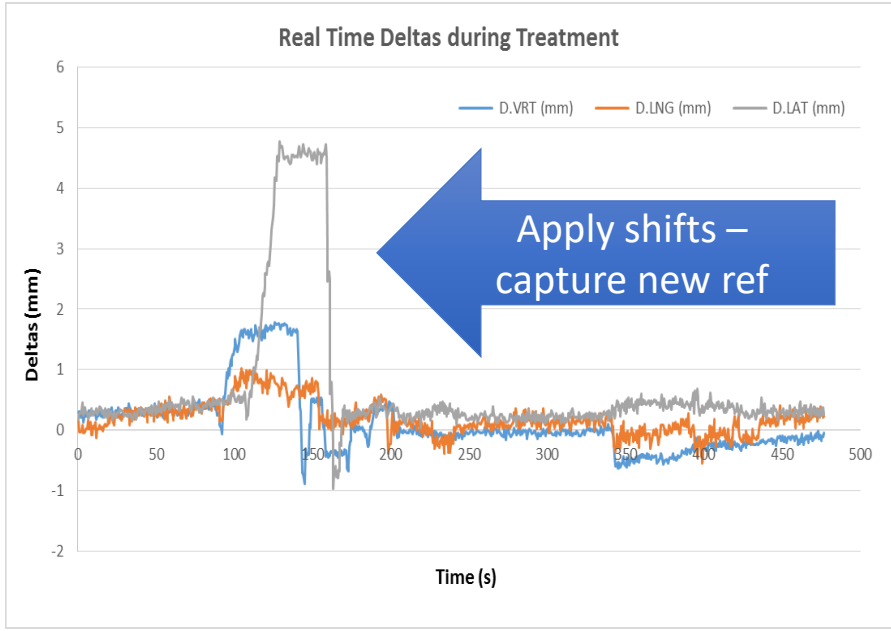
Align RT allows treatment delivery in the absence of full mask



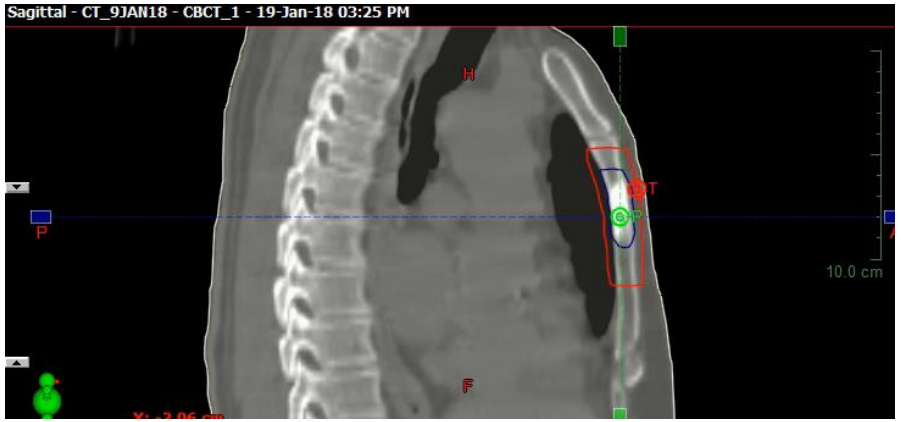
- 52 y.o. female, claustrophobic
- Met Breast Ca; Mar 2018
- for 24Gy in 3 fractions

- Unable to tolerate open face mask
- incomplete immobilization
- Increased PTV to 5mm and reverted to std fractionation (30Gy/10fx)
- Required real time monitoring of patient position

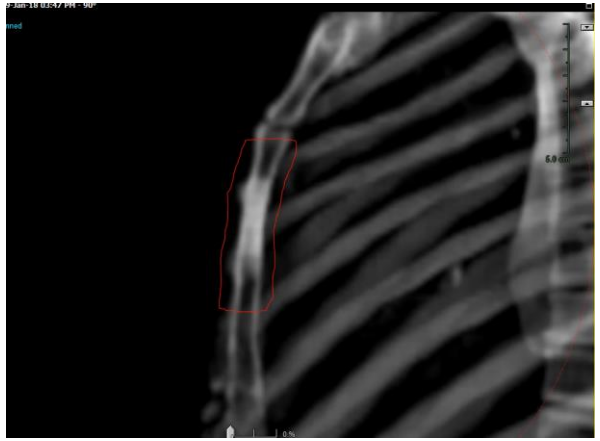




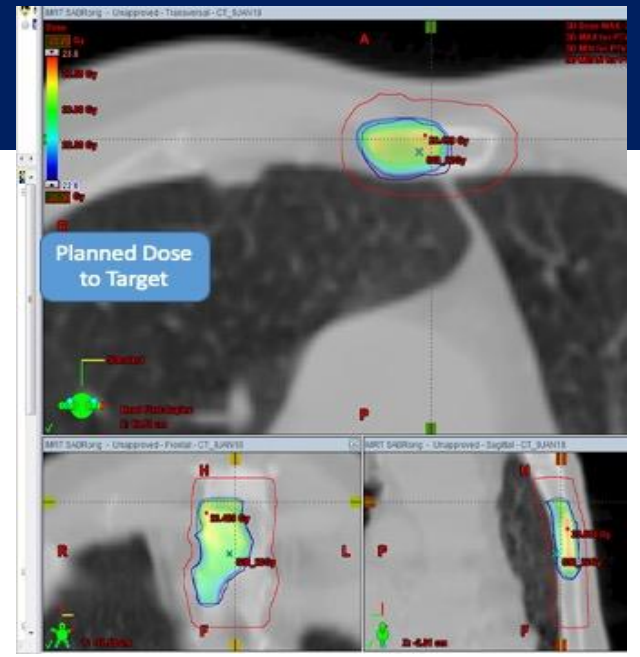
SGRT for SABR- retreat SABR 18Gy/1fx/SIB 22Gy

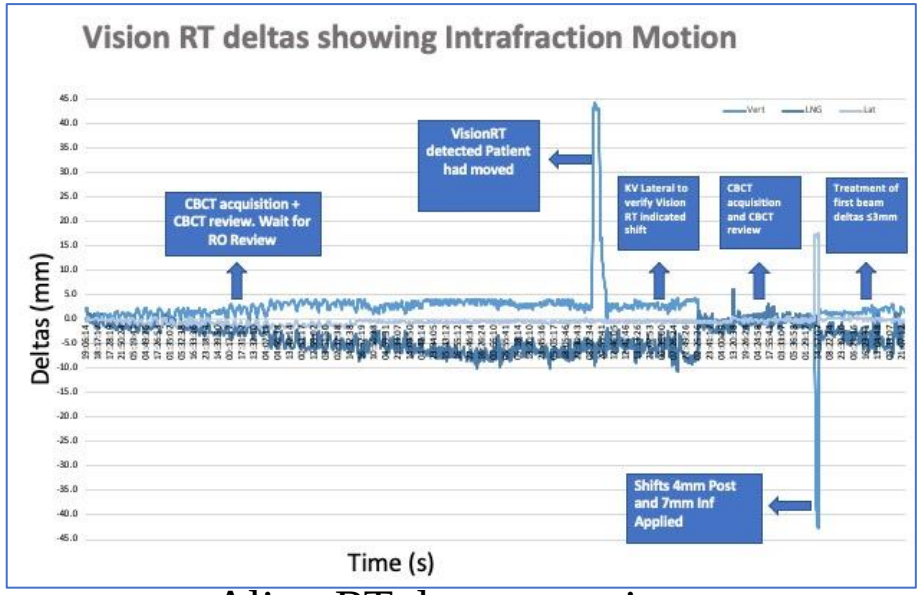


CBCT –Align RT

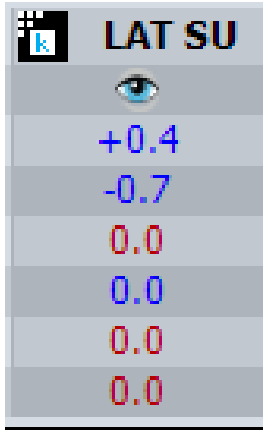


Kv imaging -

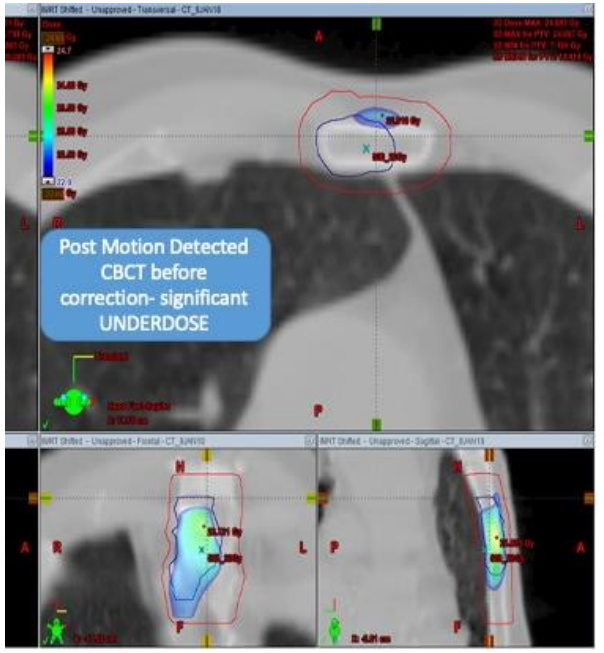




Align RT detects motion patient during image analysis



Applied shift and confirmatory CBCT



Intrafraction Motion – “Eyes on the Patient”

T12 metastasis August 2024 – 24Gy/2fx 2mm margin

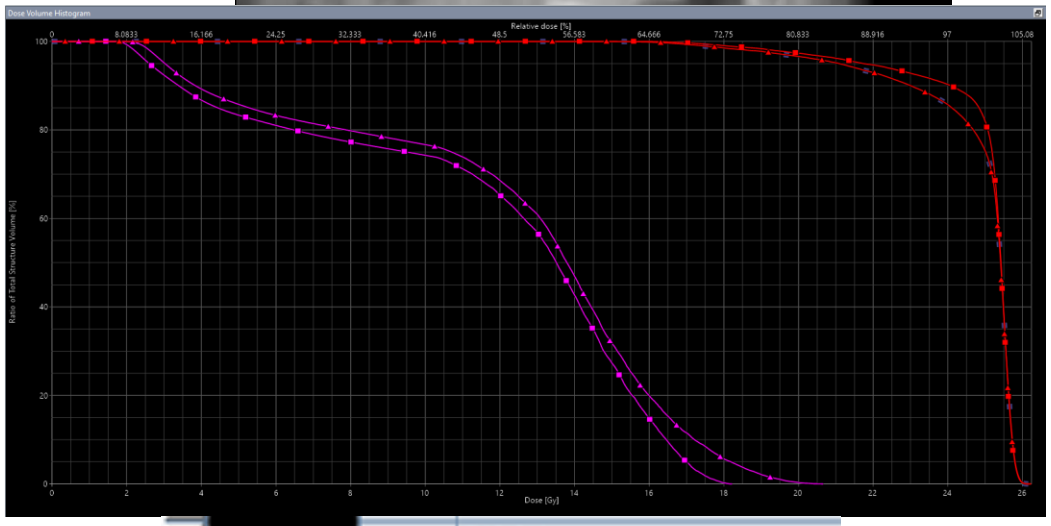
AlignRT motion monitoring - detected motion during fraction 1 delivery

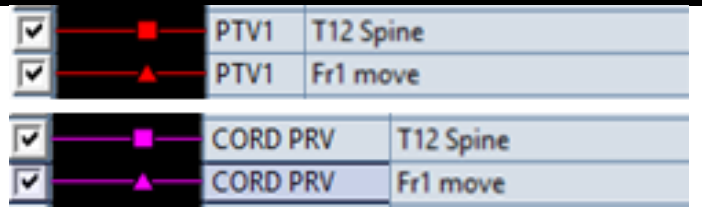
Beam off – kV/kV pair (long 0.16cm, lat 0.11cm)

kV/kV pair & CBCT OBI **imaging verified** same

Dose calc – 2fr – breach PRV for cord (D 0.035cc = 19.9Gy)

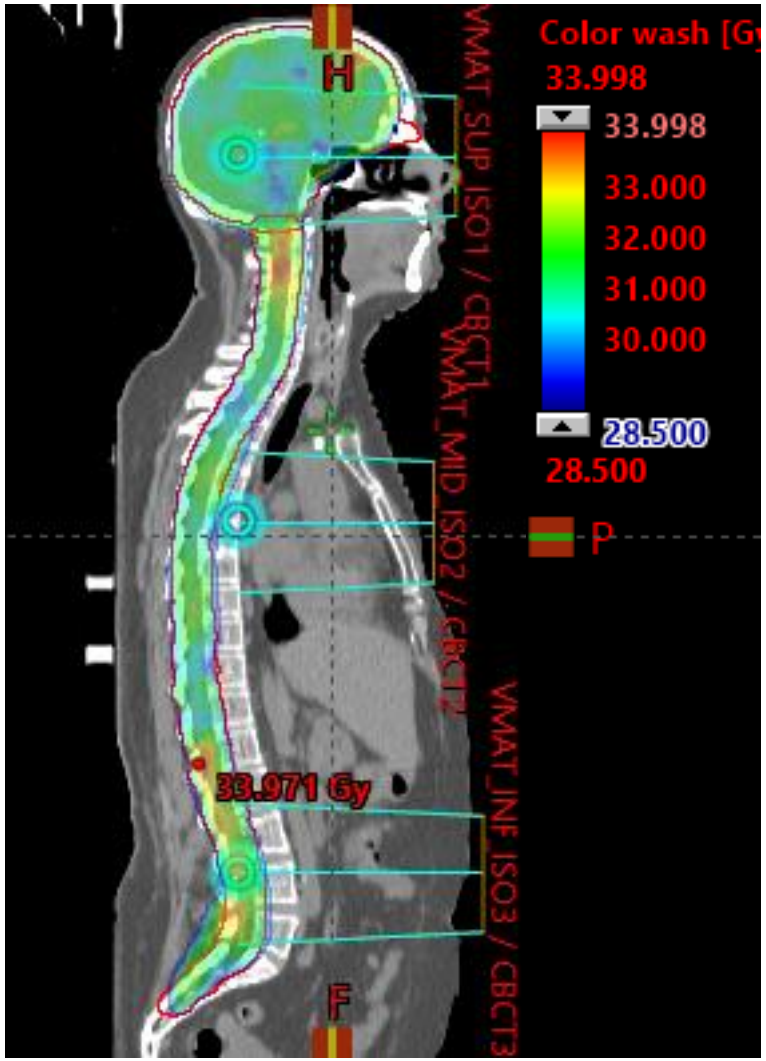
Status	
Vrt [cm]	0.00
Lng [cm]	+0.16
Lat [cm]	-0.11
Pitch [°]	+0.2
Roll [°]	-0.6
Rtn [°]	-1.1





Cranio-Spinal Irradiation - Case Study Nov 2022

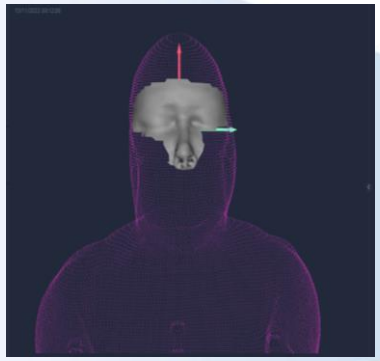
45yo female – Breast ca. June 2021
Secondary malignant neoplasm of brain and cerebral meninges
VMAT – 3 isocentres
30Gy in 10fr (7mm PTV)
Supine, H&N mask + knee lock
Imaging – extended CBCT, kVs
Required real time monitoring of patient position – ROIs



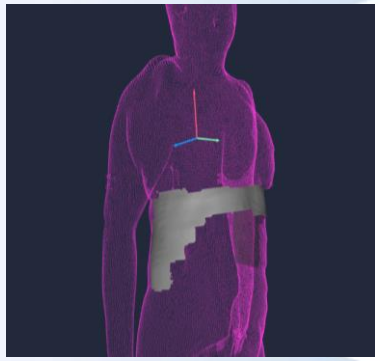
Beacon Hospital

Cranio-Spinal Irradiation - ROIs

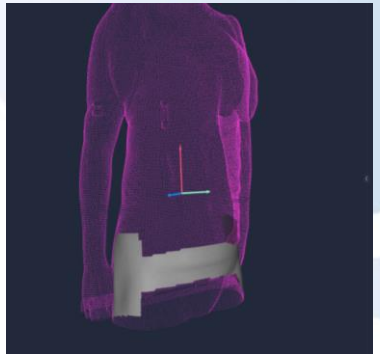
ROI definition



ROI 1
Cut out H&N mask

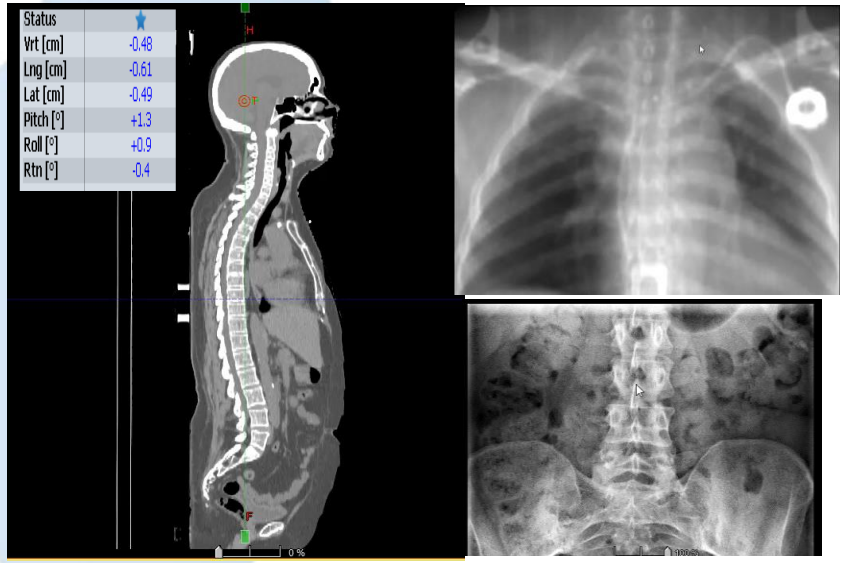


ROI 2
exclude abdomen

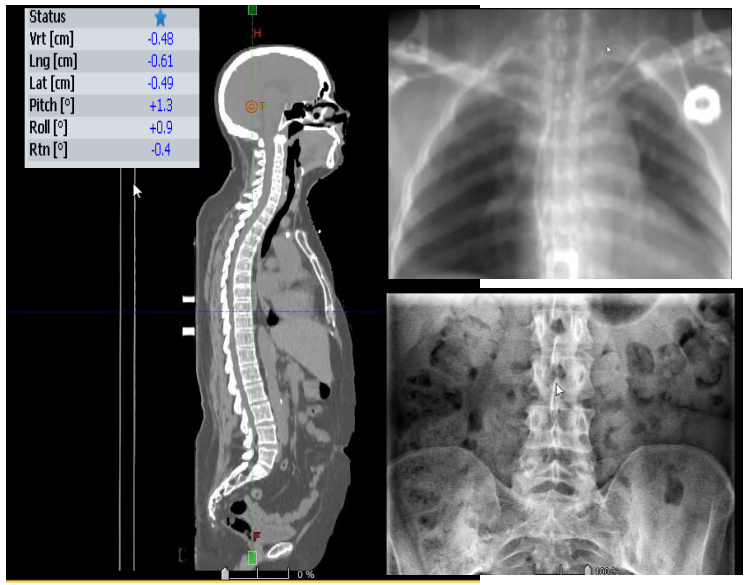


ROI 3
exclude abdomen

Image verification



Day 1



Day 3
Move to kVs for remaining fractions

Align RT tolerance:
Translations: 0.7cm
Rotations: 3°

Beacon Hospital

Intrafraction Motion – “Eyes on the Patient”

Patient Setup

Patient moved by the time the RTs left bunker

Beacon’s Top 5 Benefits from AlignRT

- Improved efficiency, reduction in patient localisation time
- Improved accuracy, reduction in shift magnitude, reduction gross error
- Improved consistency of breath-hold
- Improved safety standards using real-time intra-fraction monitoring
- Improved staff welfare:
  - reduction in patient manipulation
  - reduction in wrist and back pains

Conclusions

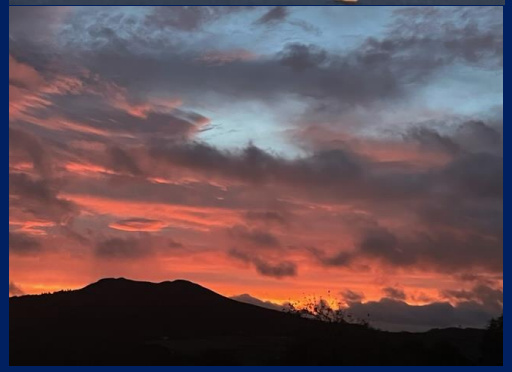
- Advantages of Integrating SGRT into all Daily Radiotherapy Treatments

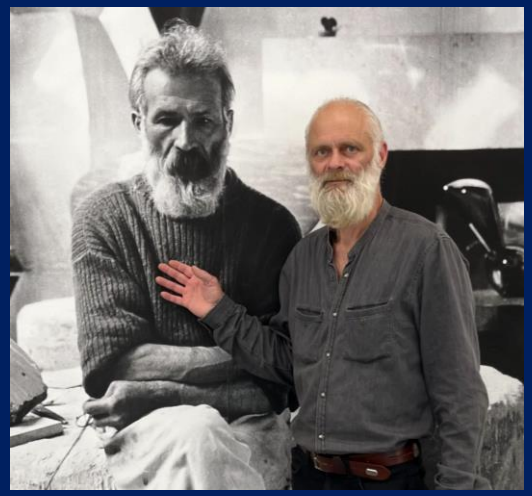
  - Faster, more accurate setup
  - Real time monitoring
  - Improves patient experience
  - Improved staff welfare

Enhanced confidence in our Treatment Delivery

Can't Imagine Treating a Patient without SGRT ever again!!!

Thank you





Special Thanks

Alex , Bogdan

Radiotherapy team Beacon Hospital, especially Darina, Marie, Katie