AdventHealth

SGRT for SRS Treatments: System Selection and Implementation

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Disclosures

- None

Outline

- Why SGRT?
  - Benefits
  - Potential
- Choosing an SGRT
  - System evaluation
  - What to look for
- SGRT system evaluation for SRS
  - Phantom selection
  - Setup and measurements
  - Results
- Conclusions

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AdventHealth Florida

- 15 Radiation Oncology Centers
- 19 Linacs (11 TrueBeam, 8 C-Series)
- 1 GammaKnife
- 3 HDRs (1 Flexitron, 2 Nucletron)
- 2 IORT (Xoft)
- 7 SGRT systems (5 AlignRT, 2 IDENTIFY)
- Single server Aria and Eclipse system

AdventHealth

Benefits of SGRT

- Improves patient setup
  - Consistent and reproducible interactional positioning
  - Setup patients to a surface not tattoos or markers
- Motion management during treatment
  - DIBH
  - SBRT/SRS
- No ionizing radiation to generate surface image.

Choosing an SGRT System

- What are we looking for in an SGRT system?
  - Precision and accuracy
  - Efficiency
  - Integration with linac and TPS
  - User and patient interface
- Will the SGRT system improve/help with my current workflows?

Available SGRT Systems

System (vendor)	Hardware	Camera Size	Camera Resolution	Frame Rate	Linac interface
AlignRT Horizon(VisionRT)	1-3 Cameras	127x480x140 mm; 3.5kg	4096x2160 px (8MP)	8-25 fps	Auto Patient selection, beam-hold, couch shift
Catalyst+ (C-RAD)	1-3 Cameras	620x390x280 mm; 16kg	640x480 px (0.3 MP)	8-24 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, treatment record push
ExacTrac Dynamic (Brainlab)	1 Camera	200x370x310mm; 9.7kg	640x512 px (0.3MP)	15-20 fps	Auto Patient selection, beam-hold,

System Evaluation

- Perform a literature review
  - Guidelines (TG, AAPM/ASTRO/ESTRO)
  - Publication search
  - SGRT community
- Site visit (virtual/in-person)
- Perform an internal study (if possible)
  - Focus on workflows that matter for your clinic

Our SGRT Journey

- First system installed in 2018 with a new TrueBeam.
- Started with DIBH breast but quickly evolved to all breast patients.
- SBRT with SGRT was introduced in 2021 and SRT in 2022.
- Some of our clinics is now using SGRT for every fraction and tattoo less.

Radiosurgery at AdventHealth

- Patients are split between the GammaKnife and Linacs
  - GK treats single fraction brain tumors and functional tumors
  - Linac treats fractionated brain tumors.

Our System Evaluation Process

- Equipment
- Literature and guidelines review
- Learn from other users
- Publications
- Internal study

Linac Based SRS Equipment

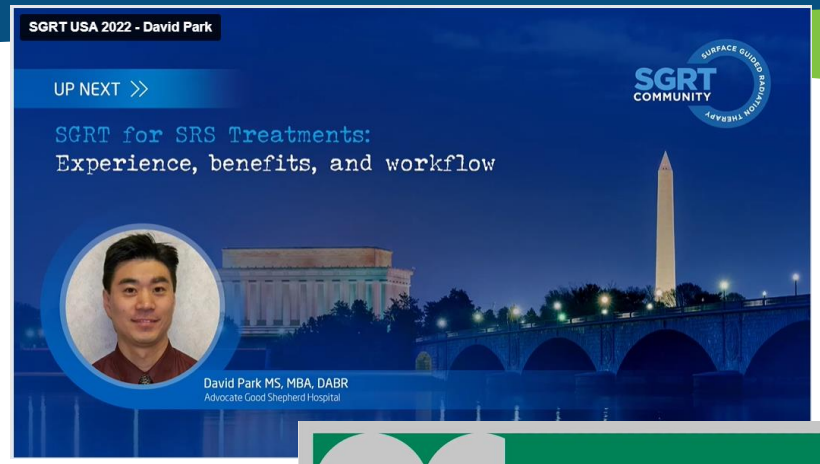
- Delivery System: Varian TrueBeam with HyperArc
- Patient Immobilization: Qfix Encompass System (table & mask)
- IGRT: Linac on board imaging (CBCT)
- SGRT: AlignRT/IDENTIFY for patient setup and motion monitoring

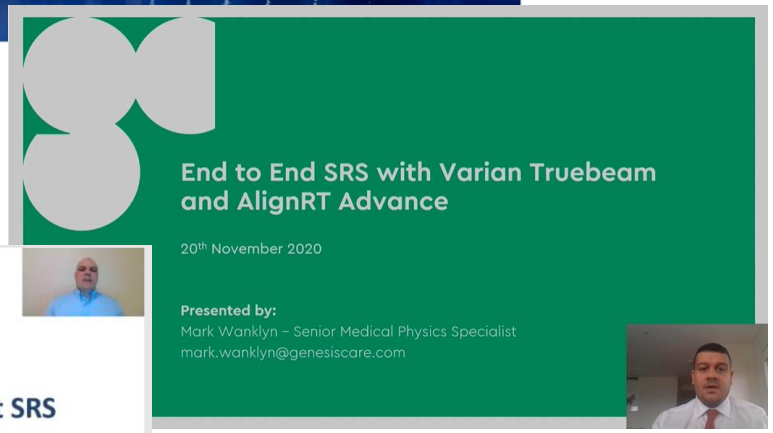
SGRT Resources: TG and Guidelines

- AAPM TG 302 and TG 147
  - Static localization accuracy of ≤2mm (≤1mm for SRS/SBRT)
  - Dynamic localization accuracy of 2mm or less per manufacturer spec.
- ESTRO-ACROP guidelines
  - Static accuracy of 1mm/1°
  - Dynamic accuracy 1mm/1° (0.5mm/0.5 ° for SRS)

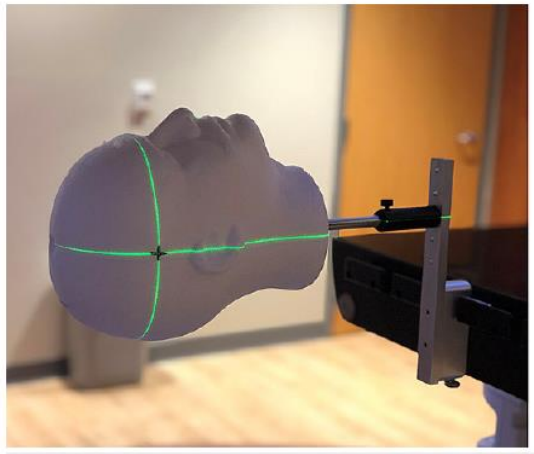
SGRT Community

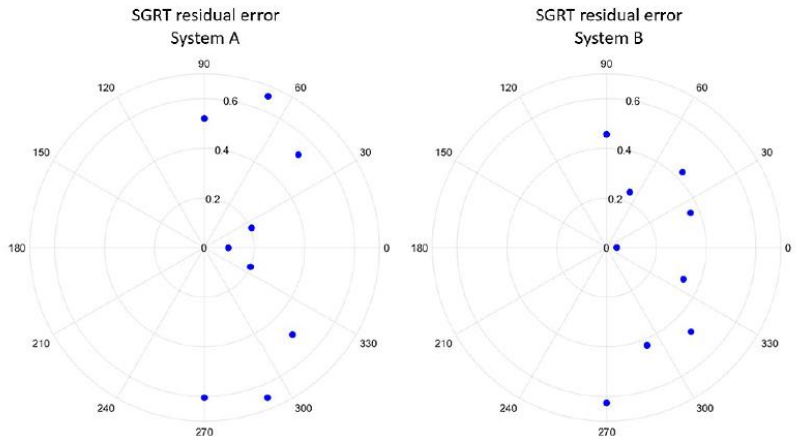
- Park: SGRT for SRS Treatments: Experience, Benefits and Workflow.
- Wanklyn: End to End SRS with Varian TrueBeam.
- Hecox: Ensuring Accuracy, Efficiency and Patient Comfort.





SGRT Publications





A Low-Cost Method to Assess the Performance of Surface Guidance Imaging Systems at Non-Zero Couch Angles

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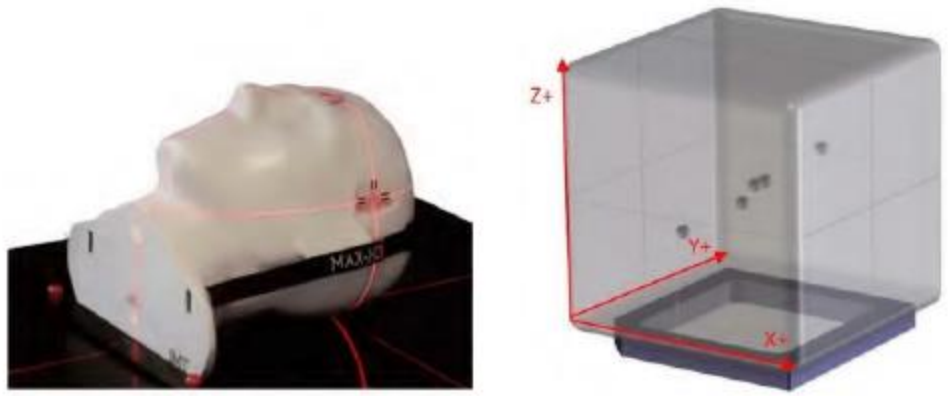
Abstract

A procedure is presented to assess performance at non-zero couch angles and perform routine quality assurance (QA) on surface-guided radiotherapy (SGRT) imaging systems used for stereotactic radiosurgery (SRS). A low-cost anthropomorphic phantom was used to assess the system under patient-like conditions. The phantom is embedded with a tungsten ball bearing (BB) to facilitate the use of surface imaging (SI) with concurrent megavoltage (MV) imaging to cross-compare and validate SI-reported offsets. Data analysis is done via in-house software that utilized the SGRT system's log files for automated analysis. This procedure enables users to assess and inter-compare MV-reported offsets with their SGRT system. The analysis provides SGRT system residual error so that users are aware of inherent offsets present in addition to increases in translational offsets due to couch walkout. The procedure was validated with two commercial SGRT systems. The procedure can be used with any surface imaging system and linear accelerator system.

SGRT Publications



Statistical evaluation of tolerances used in frameless cranial stereotactic radiosurgery using optical surface imaging and an anthropomorphic MAX-HD SRS phantom.

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Introduction: Intracranial stereotactic radiosurgery (SRS) has traditionally relied on rigorous forms of cranial immobilization in order to deliver an accurate conformal dose of radiation to the intracranial target(s) while maintaining a sharp precipitous falloff outside of the target in the surrounding healthy tissues. Traditionally this has been accomplished with conventional stereotactic headframes which employ a couch mounted frame secured to the skull with screws through 4 supporting posts. However, in recent years many frameless options have been investigated in conjunction with a variety of x-ray and video based imaging systems allowing for accurate localization of intracranial targets with a higher degree of comfort over the more traditional and invasive frames. These systems are less invasive but often require monitoring of the patient position relative to isocenter throughout the treatment to ensure the target localization remains within the TG-142 recommended mechanical tolerances of 1mm for SRS and/or the end-to-end tolerance of 0.95 listed in TG-135. Many of these frameless SRS systems use x-ray imaging to monitor the localization of the target throughout treatment using boney landmarks to periodically evaluate the quality of the localization over time. With the advent of optical surface monitoring systems, this monitoring can happen in near real-time using a video based tracking system instead of the more traditional "point in time" x-ray based systems. However, these optical monitoring systems are uniquely decoupled from the delivery system in ways that x-ray based correction systems are not and require special validation as noted in TG-147. A number of investigations have validated the accuracy, stability, and 6D tracking capabilities of these optical tracking systems for use in SRS cases using a variety of phantoms. However, these studies often focus on simple or limited geometries using either anthropomorphic or standard geometric based phantoms generalizing the results to all patient setups, and delivery techniques which is not always as straight forward for these optical systems when dealing with rotating couch geometries, camera obstructions during portions of the treatment, various relative isocenter locations, and a variety of patient setup complications. This white paper describes a variety of end-to-end tests used to evaluate these optical systems under a wide range of treatment conditions while seeking to isolate some of the confounding variables within the optical field of view of the treatment so that a statistically realistic view of the system can be obtained. All tests were completed using either the geometric isocenter calibration phantom provided by Vision RT with the AlignRT surface guided radiation therapy (SGRT) system and/or the anthropomorphic Integrated Medical Technologies (IMT) MAX-HD head phantom for comparison. Comparisons between the phantoms and conditions are made in order to isolate the variables being discussed and to glean insight from the measurement statistics as they relate to the TG-142 and TG-147 tolerances under those conditions.

Internal Evaluation

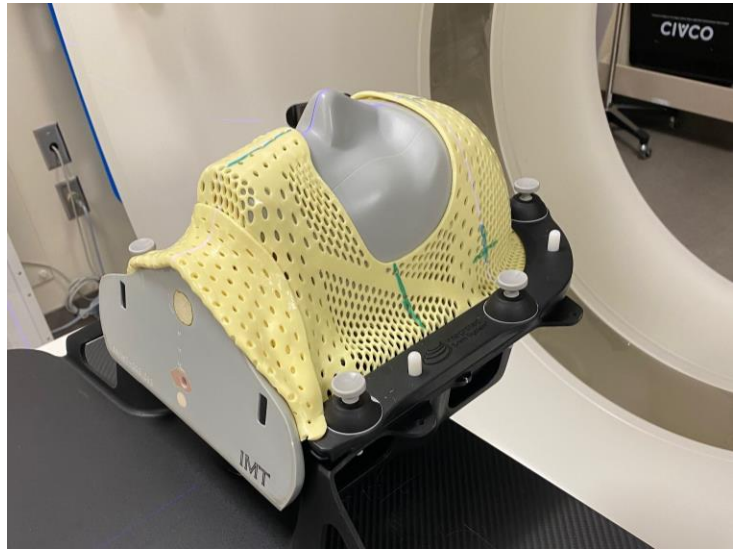
- Comparison of two SGRT systems using a phantom in an SRS workflow.

The Phantom

- MaxHD Phantom from IMT
- Anthropomorphic head phantom with various inserts.
- Phantom surface is SGRT compatible.

Setup and Calibration

- The phantom was simulated using an SRS protocol with a Qfix open face mask
- A treatment plan was created with none zero couch angles
- An ROI was drawn on the exposed area of the face in AlignRT



Setup and Calibration

- Prior to each measurements, IsoCal verification was performed to verify IGRT calibration
- SGRT calibration was performed according to manufacturer specificaions
- The Phantom was placed on the couch and a CBCT was taken to confirm positioning
- Winston-Lutz test was performed using the phantom central BB
- A reference surface was captured.

Measurements

- A treatment plan was created with 7 couch angles with gantry at zero
- MV images were taken at each couch angle and a shift was calculated from the reference image
- At the same time, the SGRT deltas were recorded for each angle

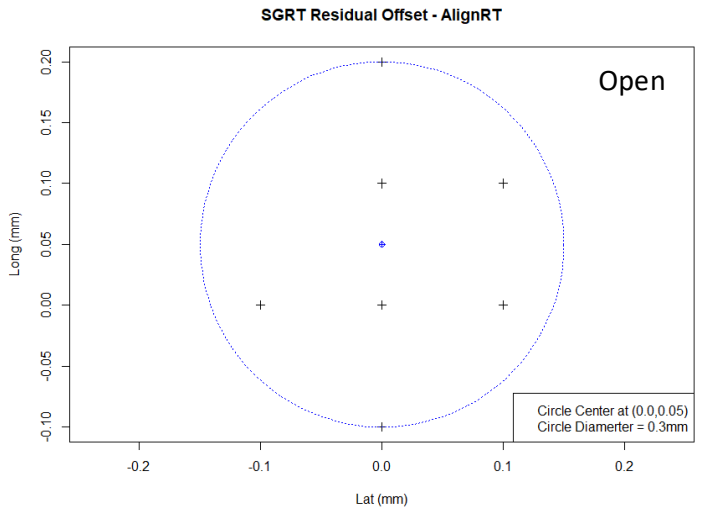
SGRT Error

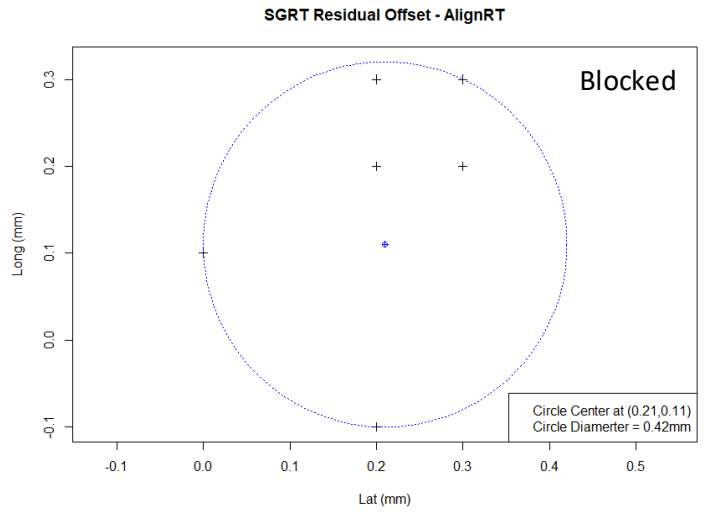
- The SGRT error can be calculated from the difference between the SGRT deltas and MV shifts.
- The residual error is the root mean square of the lateral and longitudinal difference.
- The SGRT error can be plotted in the lat (x) long (y) direction. As a result, the smallest enclosing circle can be calculated.
- The residual error can be plotted as a function of couch angle.

Results - AlignRT

SGRT Error

	Open			Blocked			Open - Blocked		
Table	Vert	Long	Lat	Vert	Long	Lat	Vert	Long	Lat
90	0.100	0.000	0.100	0.000	0.400	0.200	0.100	-0.400	-0.100
60	0.100	0.000	0.000	0.100	0.300	0.300	0.000	-0.300	-0.300
30	0.000	0.200	0.100	0.100	0.200	0.400	-0.100	0.000	-0.300
0	0.100	0.200	0.000	0.000	0.200	0.200	0.100	0.000	-0.200
330	0.100	0.100	0.200	0.000	-0.100	0.200	0.100	0.200	0.000
300	0.100	0.000	0.100	-0.100	-0.100	0.000	0.200	0.100	0.100
270	0.100	0.000	-0.100	0.000	-0.100	0.000	0.100	0.100	-0.100

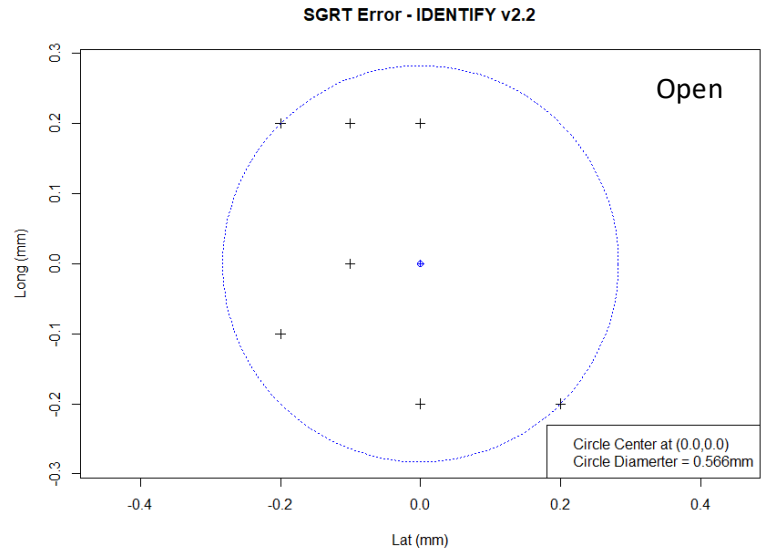


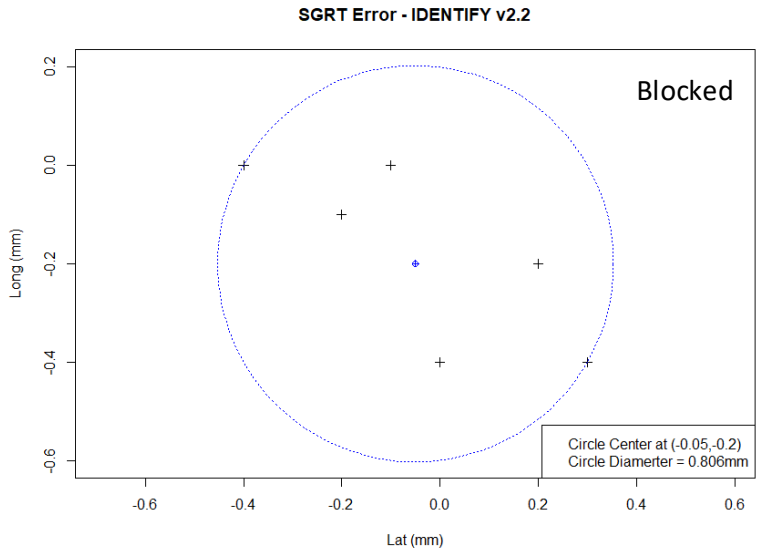


Results – IDENTIFY v2.2

SGRT Error

	Open			Blocked			Open-Blocked		
Table	Vert	Long	Lat	Vert	Long	Lat	Vert	Long	Lat
90	0.2	-0.1	0.2	0.4	-0.2	0.2	-0.2	0.1	0
60	0.2	-0.2	0	0.3	-0.4	0.3	-0.1	0.2	-0.3
30	0.2	-0.1	-0.2	0.3	-0.4	0	-0.1	0.3	-0.2
0	0.2	0	-0.1	0.3	-0.1	-0.2	-0.1	0.1	0.1
330	0.3	0.2	-0.2	0.3	0	-0.4	0	0.2	0.2
300	0.2	0.2	-0.1	0.3	0	-0.4	-0.1	0.2	0.3
270	0.1	0.2	0	0.3	0	-0.1	-0.2	0.2	0.1

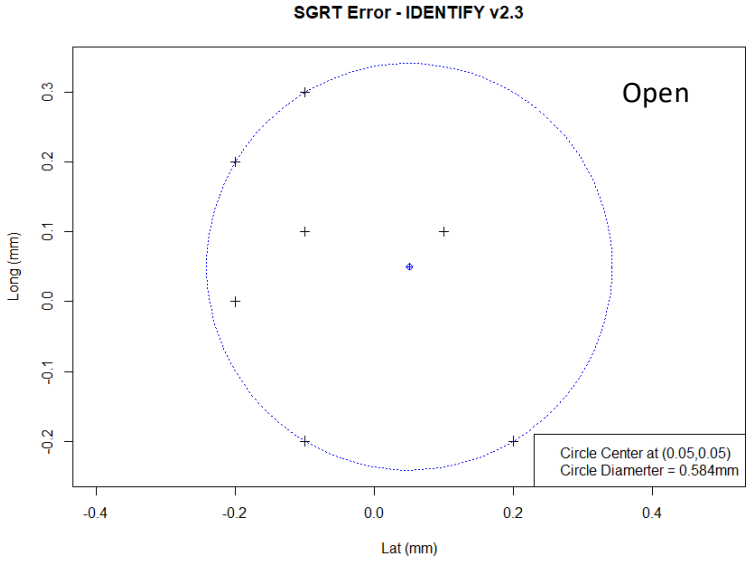


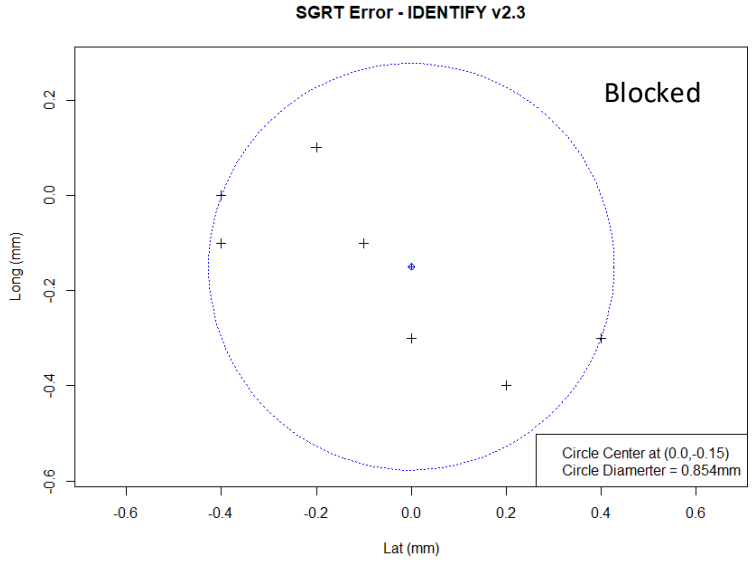


Results – IDENTIFY v2.3

SGRT Error

	Open			Blocked			Open - Blocked		
Table	Vert	Long	Lat	Vert	Long	Lat	Vert	Long	Lat
90	-0.1	-0.2	0.2	-0.2	-0.3	0.4	0.1	0.1	-0.2
60	-0.15	-0.2	-0.1	-0.15	-0.4	0.2	0	0.2	-0.3
30	-0.15	0	-0.2	-0.2	-0.3	0	0.05	0.3	-0.2
0	-0.1	0.1	0.1	-0.15	-0.1	-0.1	0.05	0.2	0.2
330	-0.2	0.2	-0.2	-0.1	0	-0.4	-0.1	0.2	0.2
300	-0.1	0.1	-0.1	-0.15	-0.1	-0.4	0.05	0.2	0.3
270	-0.1	0.3	-0.1	-0.15	0.1	-0.2	0.05	0.2	0.1

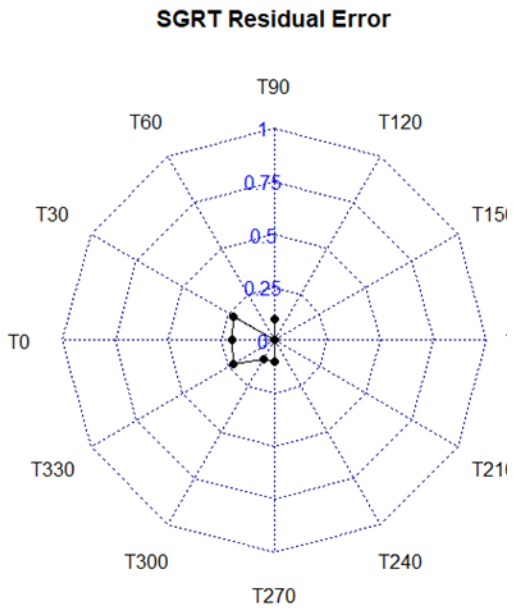




Results – AlignRT

Residual Error Magnitude

	Open		Blocked	
Table	XY	XYZ	XY	XYZ
90	0.100	0.141	0.447	0.447
60	0.000	0.100	0.424	0.436
30	0.224	0.224	0.447	0.458
0	0.200	0.224	0.283	0.283
330	0.224	0.245	0.224	0.224
300	0.100	0.141	0.100	0.141
270	0.100	0.141	0.100	0.100



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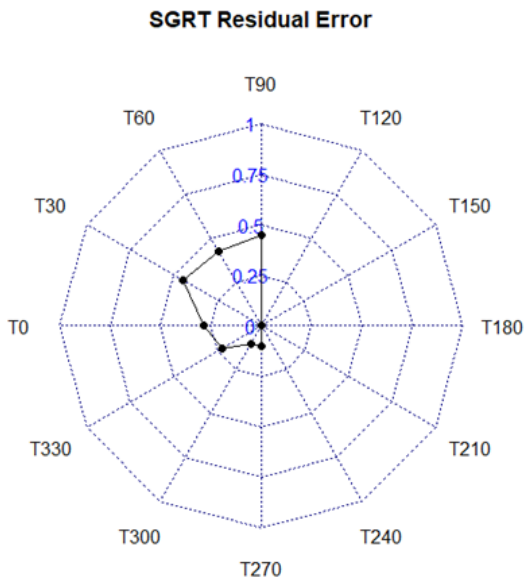

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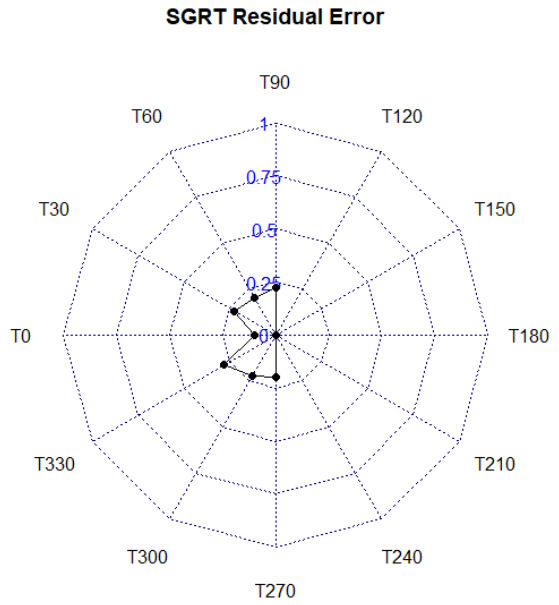
Results – IDENTIFY v2.2

Residual Error Magnitude

	Open		Blocked	
Table	X,Y	X,Y,Z	X,Y	X,Y,Z
90	0.224	0.300	0.283	0.490
60	0.200	0.283	0.500	0.583
30	0.224	0.300	0.400	0.500
0	0.100	0.224	0.224	0.374
330	0.283	0.412	0.400	0.500
300	0.224	0.300	0.400	0.500
270	0.200	0.224	0.100	0.316



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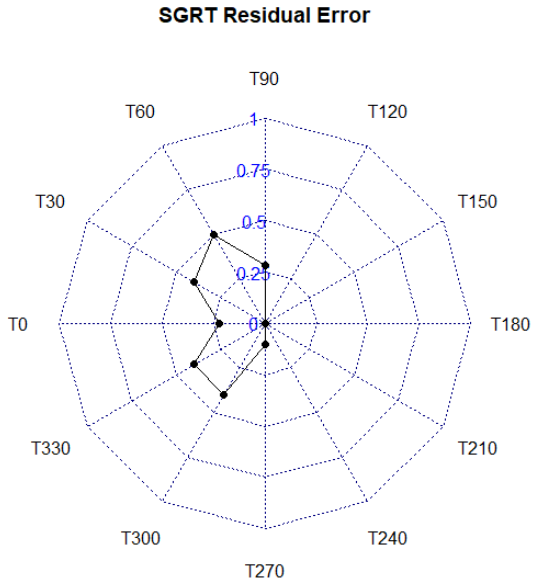

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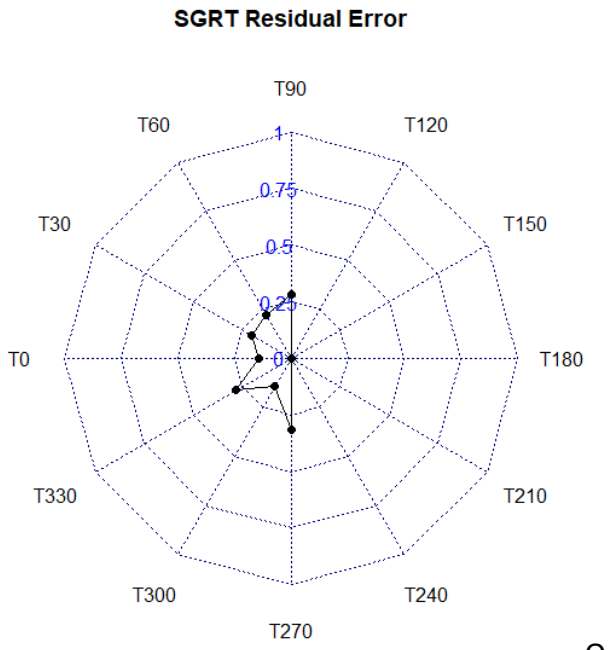
Results – IDENTIFY v2.3

Residual Error Magnitude

	Open		Blocked	
Table	X,Y	X,Y,Z	X,Y	X,Y,Z
90	0.283	0.300	0.500	0.539
60	0.224	0.269	0.447	0.472
30	0.200	0.250	0.300	0.361
0	0.141	0.173	0.141	0.206
330	0.283	0.346	0.400	0.412
300	0.141	0.173	0.412	0.439
270	0.316	0.332	0.224	0.269



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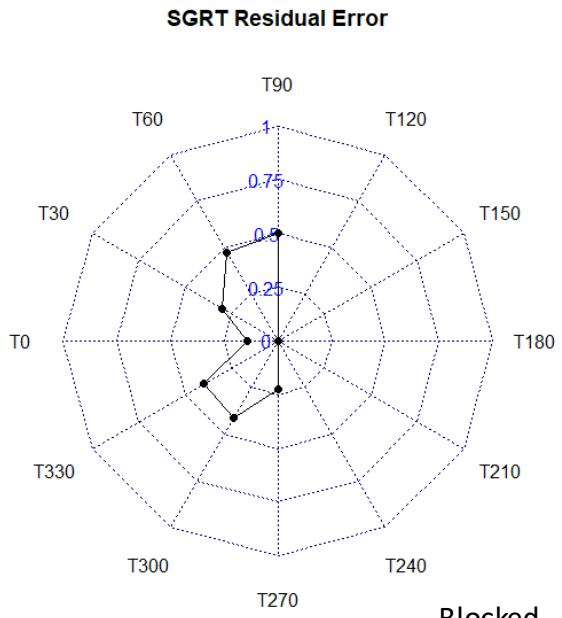

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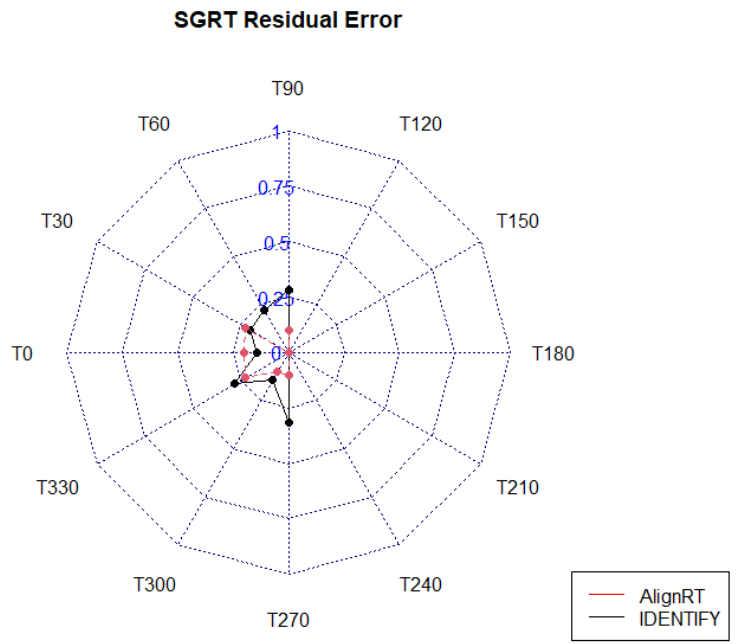
Results – Combined

Residual Error Magnitude



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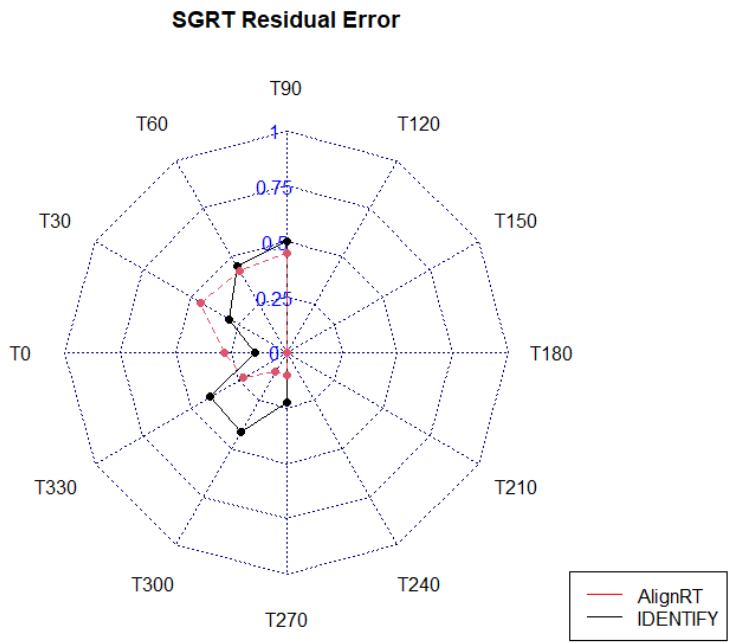

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Conclusions

- AlignRT was found to have smaller SGRT error and residual error with open and blocked camera pods
- AlignRT was compliant with both TG302 and ESTRO-ACROP guidelines, even with camera obstruction.
- IDENTIFY was compliant with TG302 but did not pass the more rigorous ESTRO-ACROP guidelines.

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- Adi.Robinson@adventhealth.com