Treatment Planning System Beam Modeling Parameters Exhibit High Variation Among Radiotherapy Institutions

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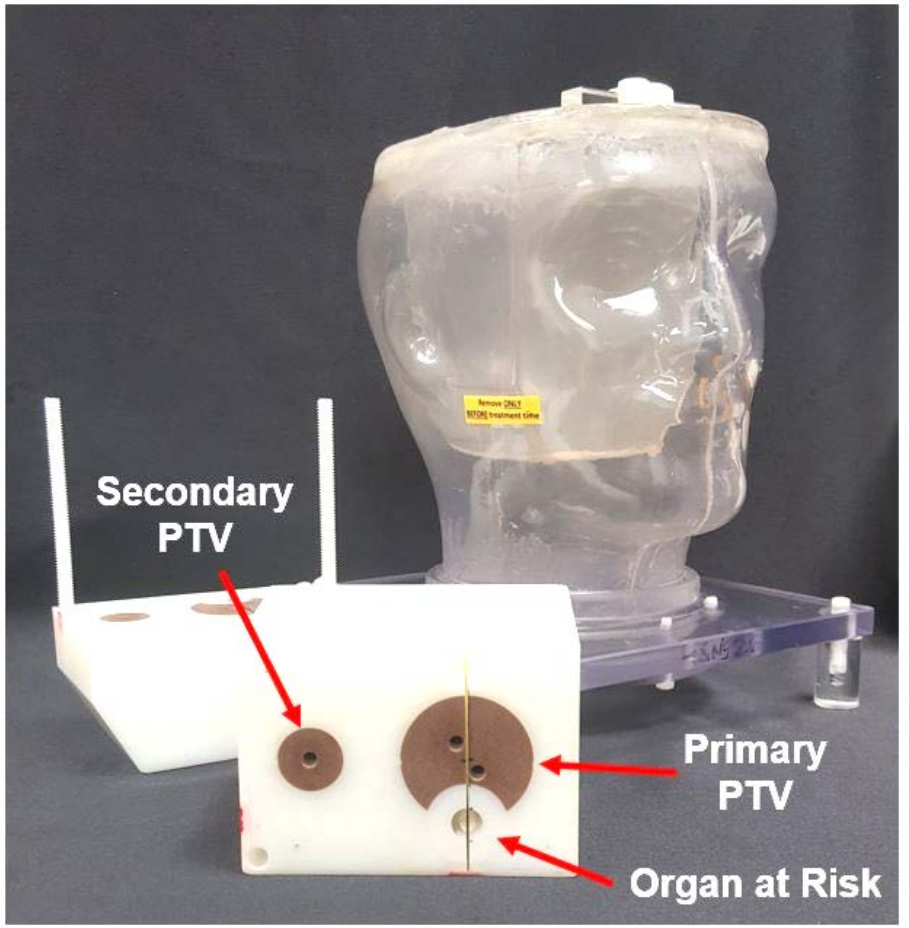
IROC™
IMAGING AND RADIATION ONCOLOGY CORE
Global Leaders in Clinical Trial Quality Assurance

THE UNIVERSITY OF TEXAS MD Anderson Cancer Center | UTHealth The University of Texas Health Science Center at Houston

Graduate School of Biomedical Sciences

IROC Houston Phantom Credentialing

- IROC mission is to provide quality control programs in support of the National Cancer Institute's National Clinical Trial Network
- Phantom credentialing is the first step to entering NCI-sponsored clinical trials using IMRT
- IROC phantom pass rate: **85-90%**[1]
  - Where do these errors come from?
  - How can this be improved?

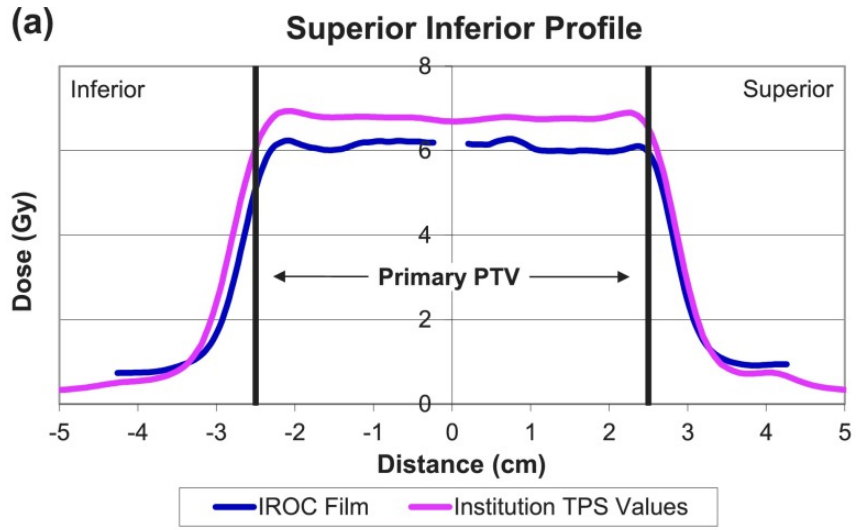


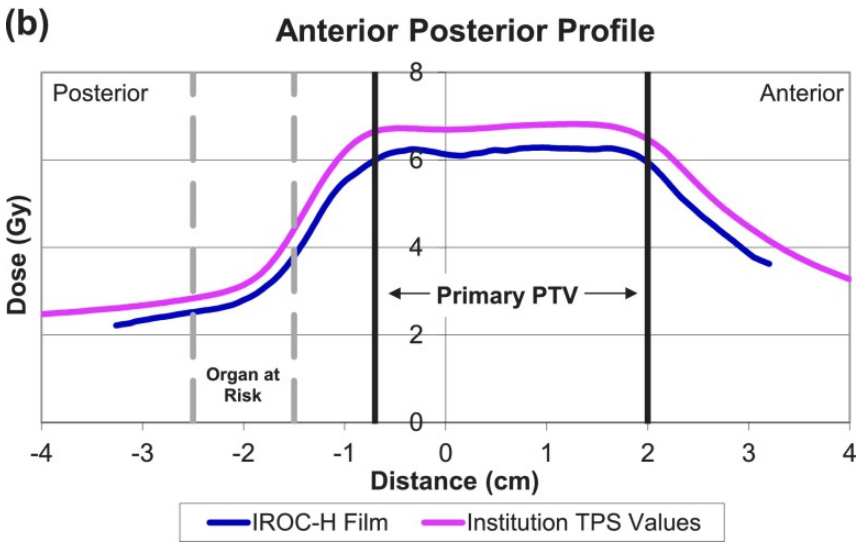
IROC H&N phantom and insert

[1] Carson, et al. *Med. Phys.* (2016)

Previous Work Indicates Dosimetric Issues

- **~70%** of failed irradiations due to systematic errors in dose calculation[1]
- **68%** of failing phantom associated with considerable calculation errors in TPS[2]
  - 56% overestimated dose when compared to TLD/film





[1] Carson, et al. *Med. Phys.* (2016)

[2] Kerns, et al. *Int. Jour. Rad. Onc. Biol. Phys.* (2017)

How Does the Beam Model Affect Phantom Outcomes?

- Previous work examining IROC site visit data shows that several different accelerator types exhibit comparable dosimetric characteristics (PDD, output factors, etc.)[3]

- If many accelerators behave the same, should they be modeled similarly?

- If not, can this be an indication of where errors arise in IMRT treatments?
  - What are the limitations of creating a model following a different method/variables? Small field dosimetry? Etc.

[3] Kerns, et al. *Med. Phys.* (2016)

Methods: Survey Creation

- Designed survey requesting beam modeling parameters for Eclipse, Pinnacle, and RayStation
  - Included detailed instructions on how to find parameters in respective TPS environment
- Implemented survey with individual phantom irradiations (August 2017) and annual online facility questionnaire (January 2018)
- Responses were broken down and analyzed separately according to:
  - Linear accelerator class
  - Beam energy
  - MLC configuration (in progress)

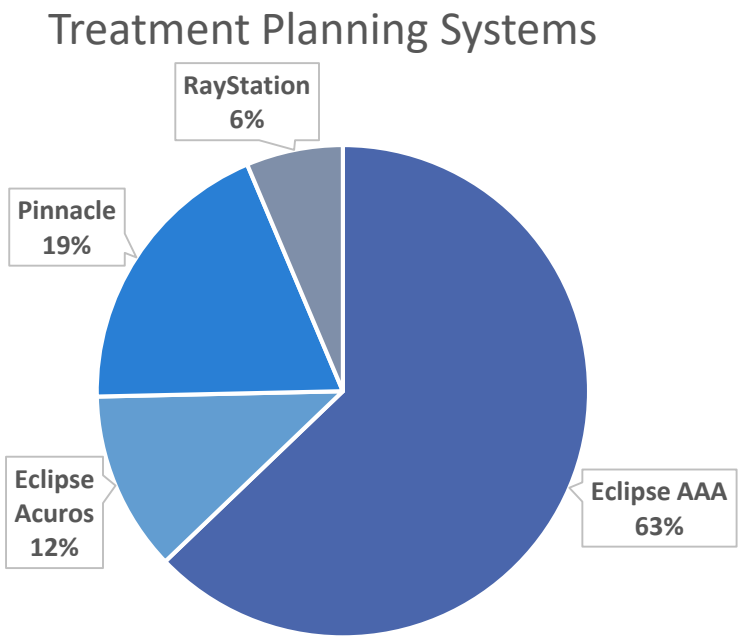
Methods: TPS Beam Modeling Parameters

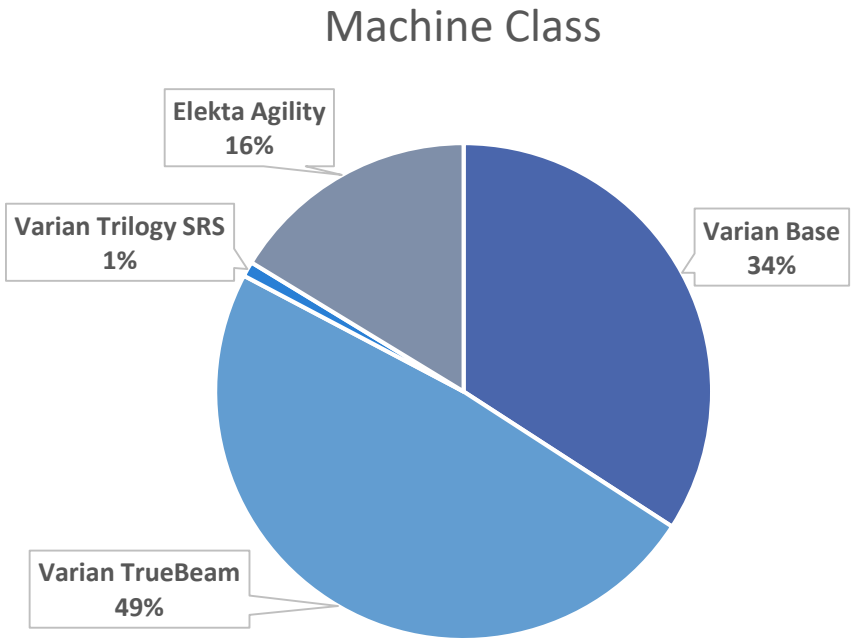
Eclipse*	Pinnacle[3]	RayStation
Effective Target Spot Size (X and Y)	Effective Source Size	Primary Source X/Y Width
MLC Transmission Factor	MLC Transmission	MLC Transmission
Dosimetric Leaf Gap	Tongue and Groove Width	Tongue and Groove
	Additional T&G Transmission	Leaf Tip Width
	Flattening Filter Gaussian Height/Width	
	Rounded Leaf Tip Radius	

* AAA and AcurosXB

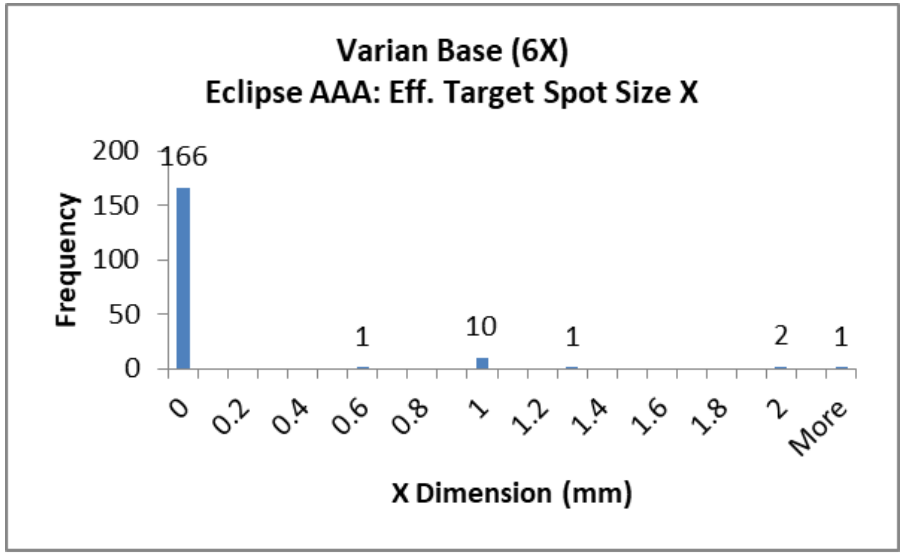
Results

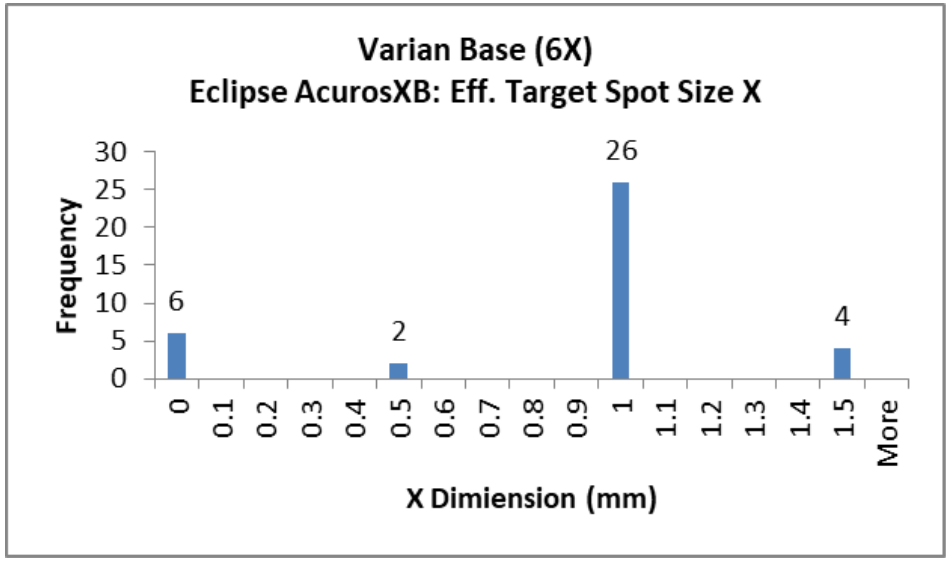
- 1,227 responses as of June 1st
- TPS versions: Eclipse (v8.6+), Pinnacle (v8.0+), RayStation (v3.1+)
- General TPS demographics:

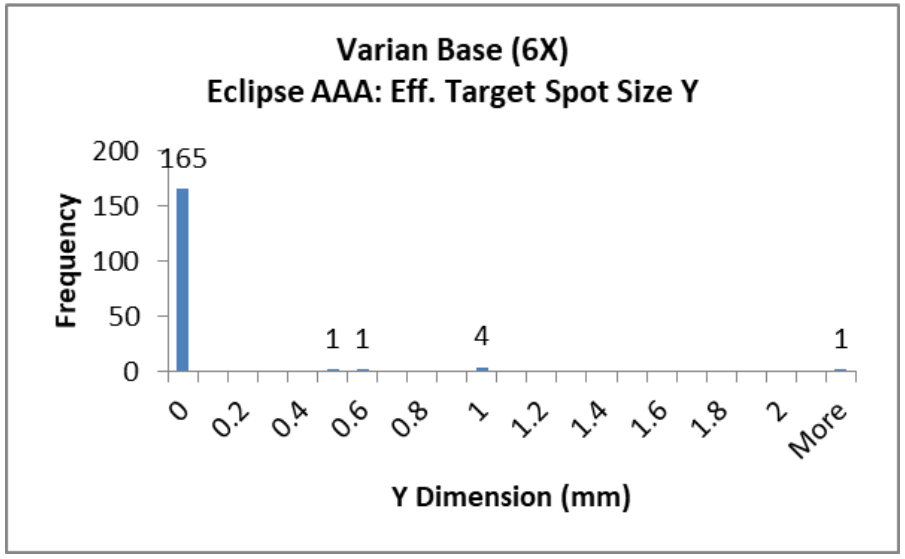


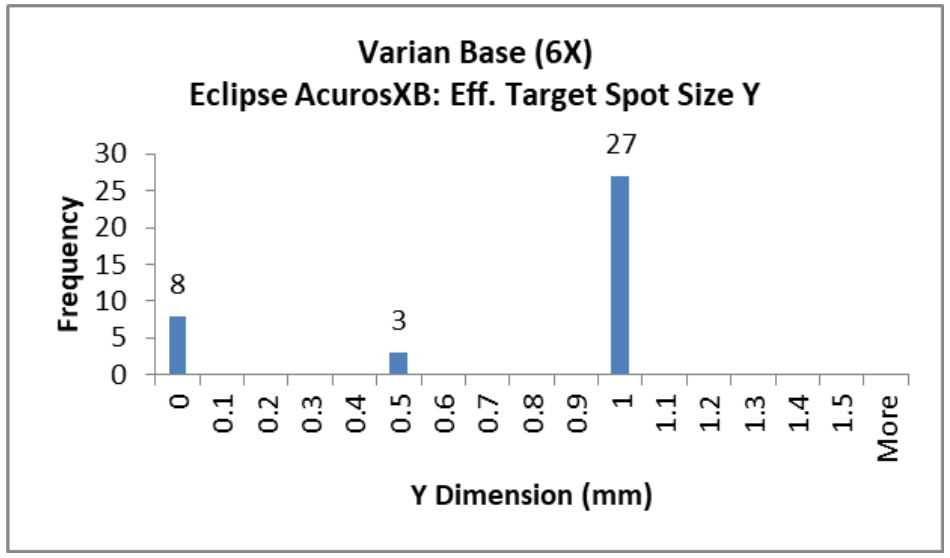


Histograms: Varian Base 6X/Eclipse Parameters





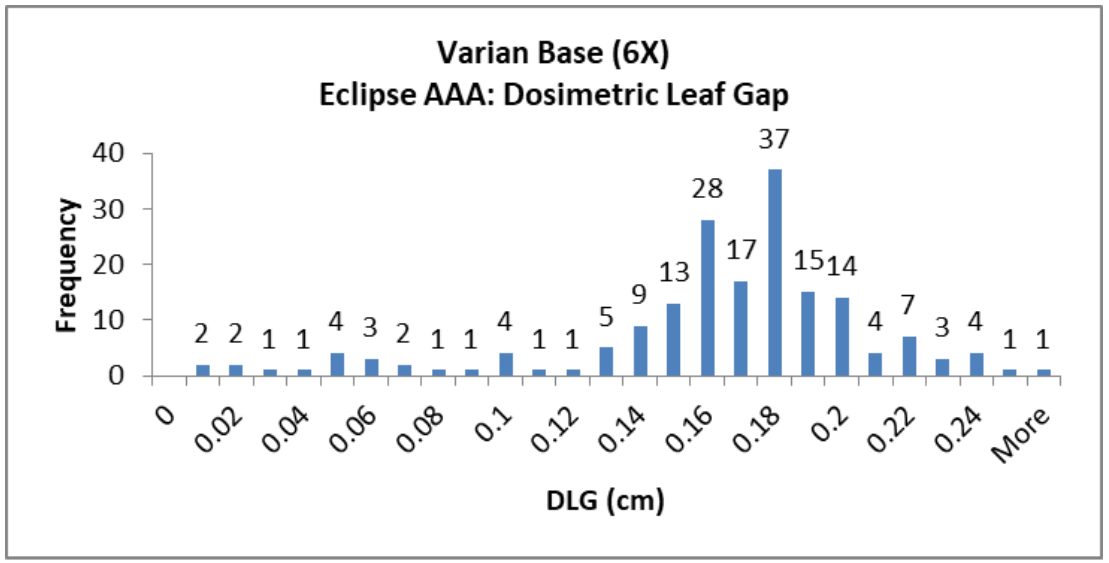


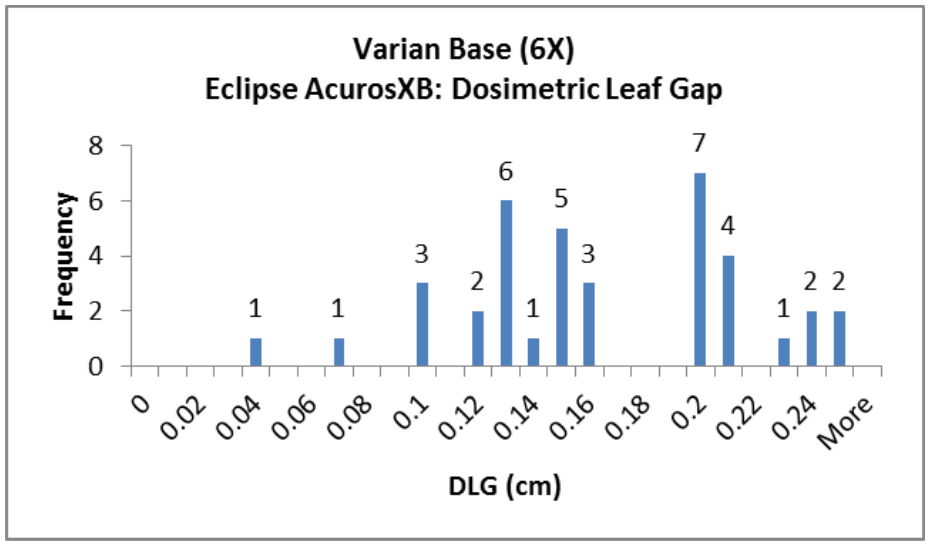


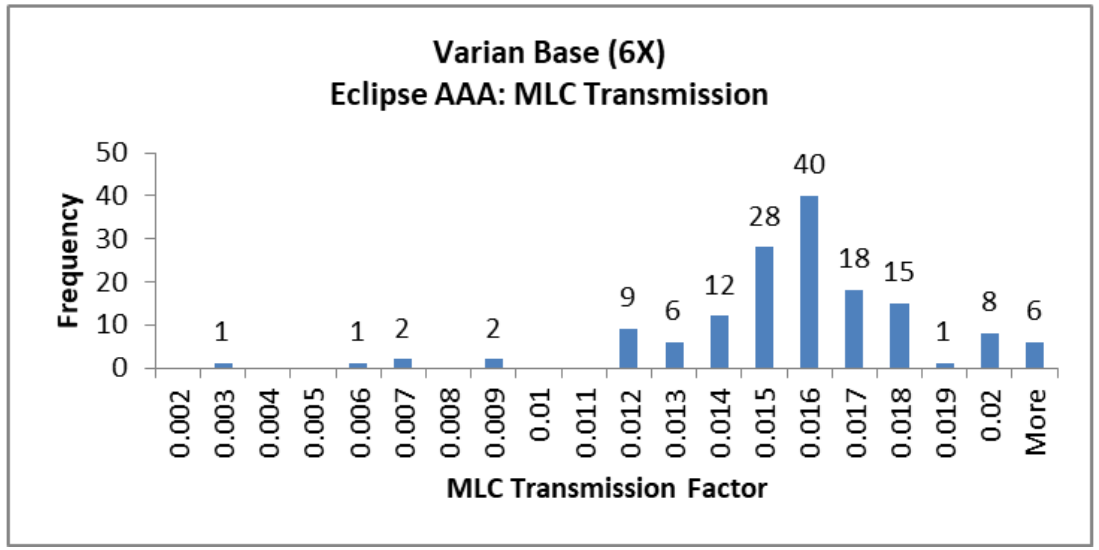
AAA Algorithm

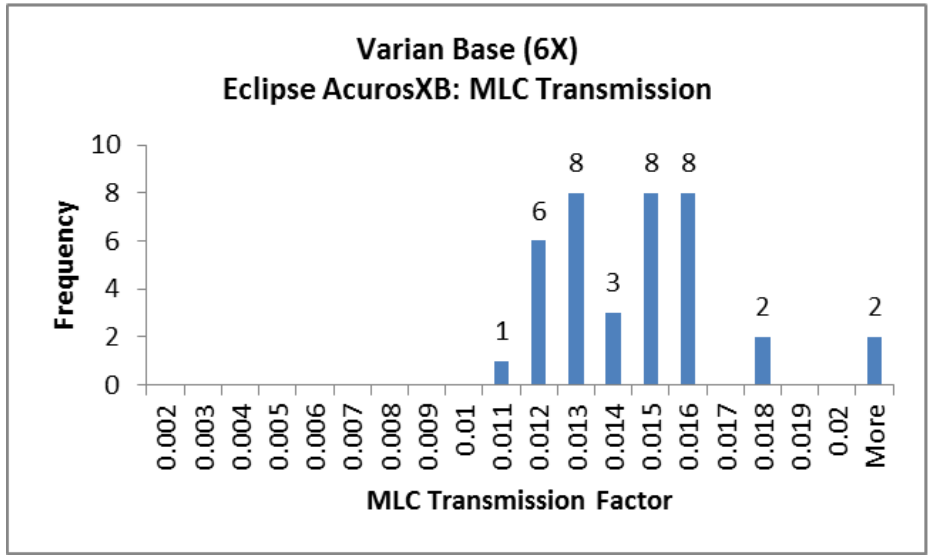
AcurosXB Algorithm

Histograms: Varian Base 6X/Eclipse Parameters









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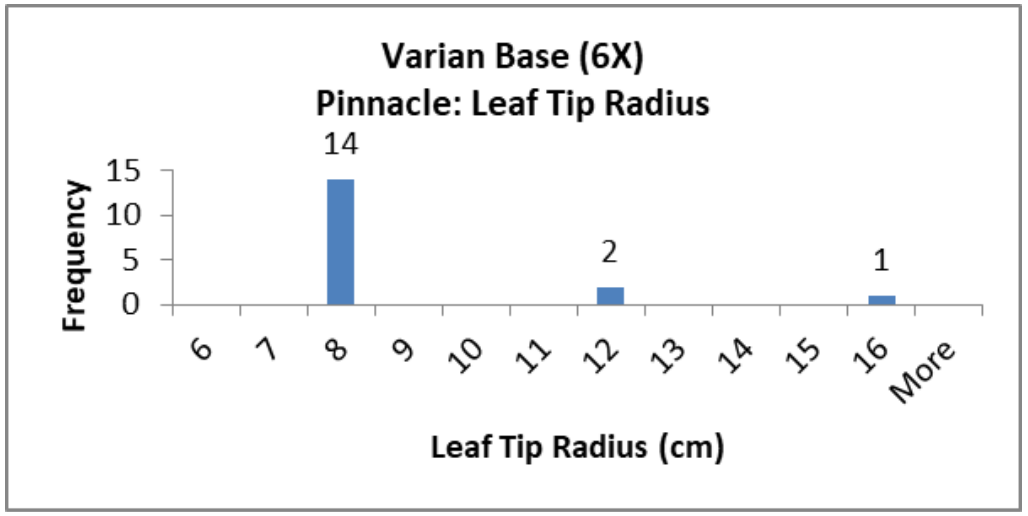
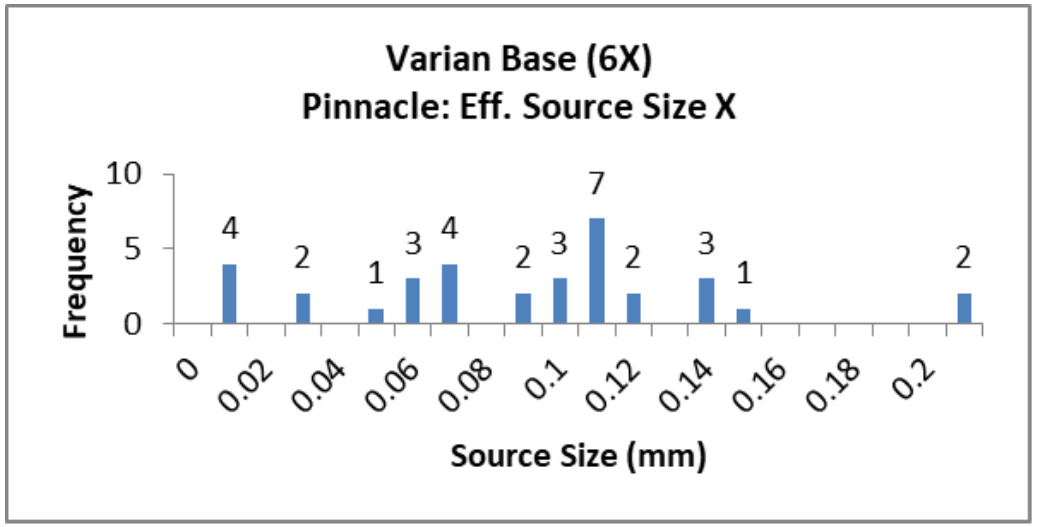
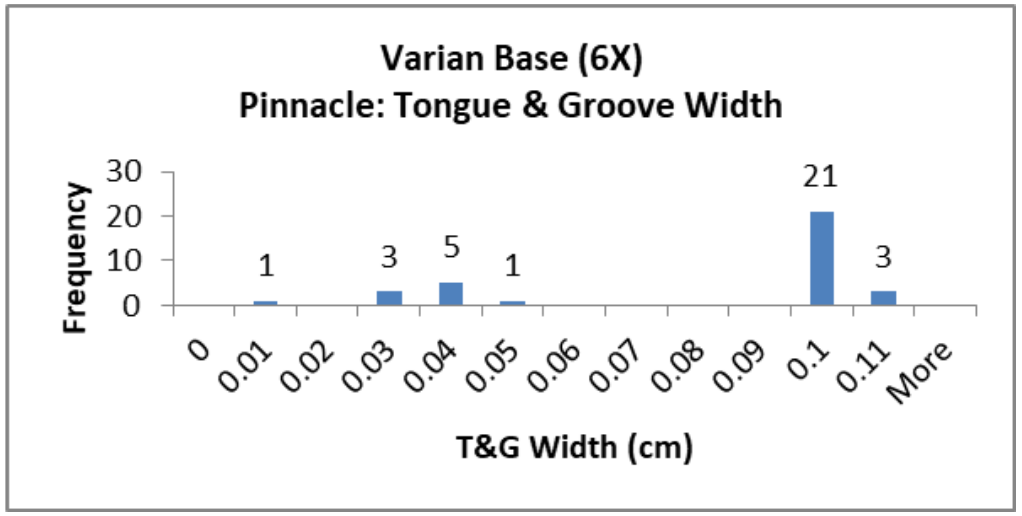
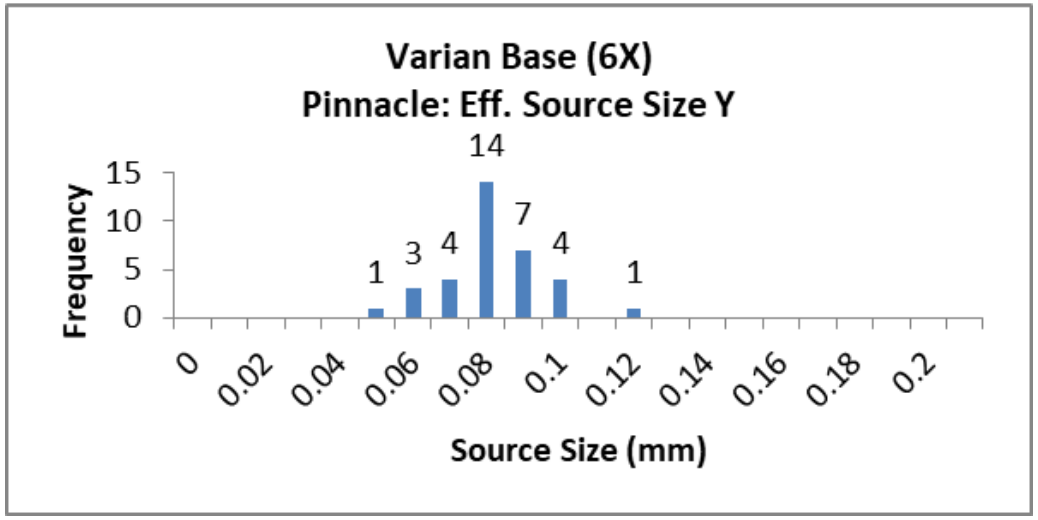
Histograms: Varian Base 6X/Pinnacle Parameters









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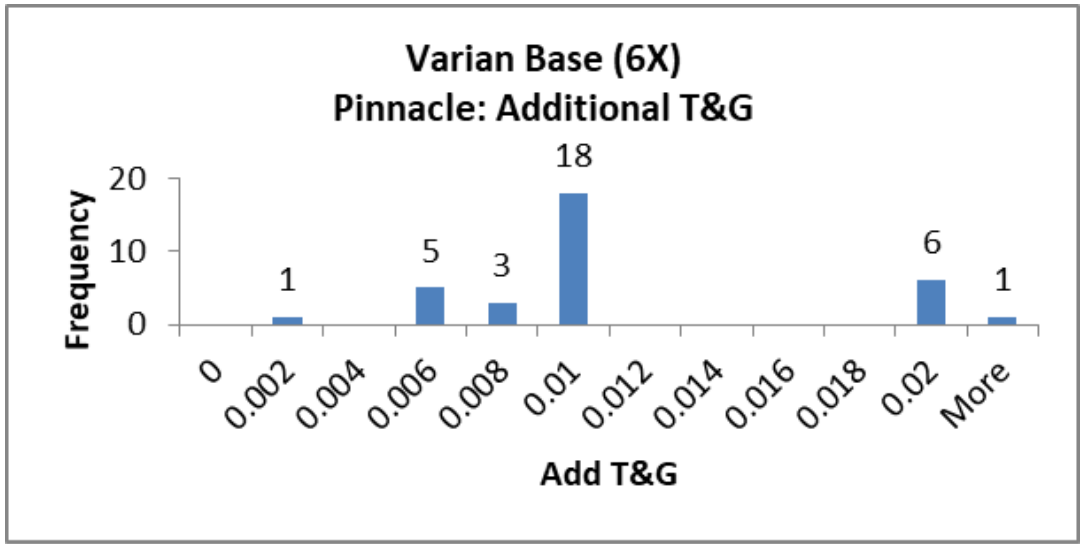

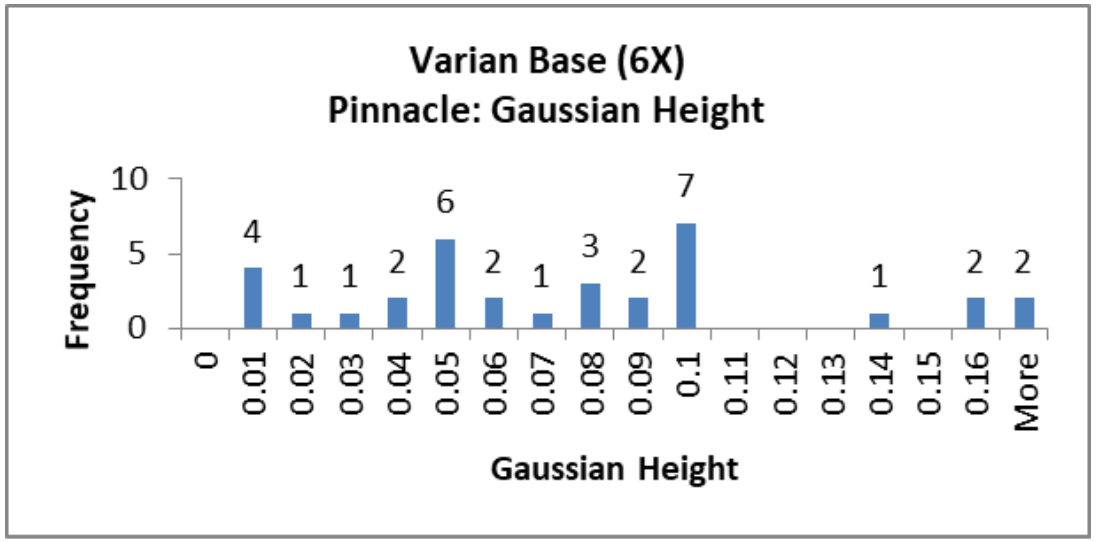

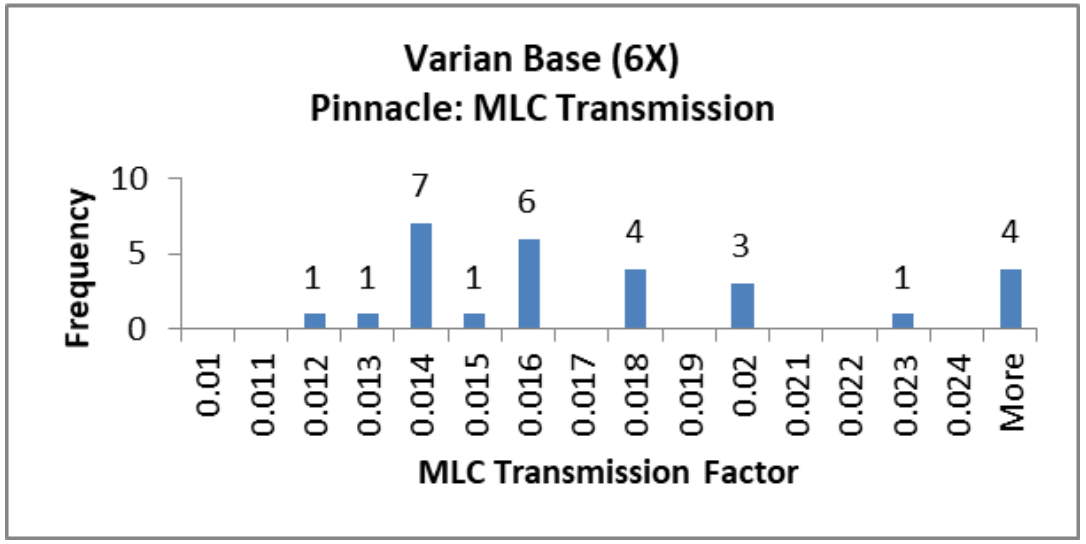

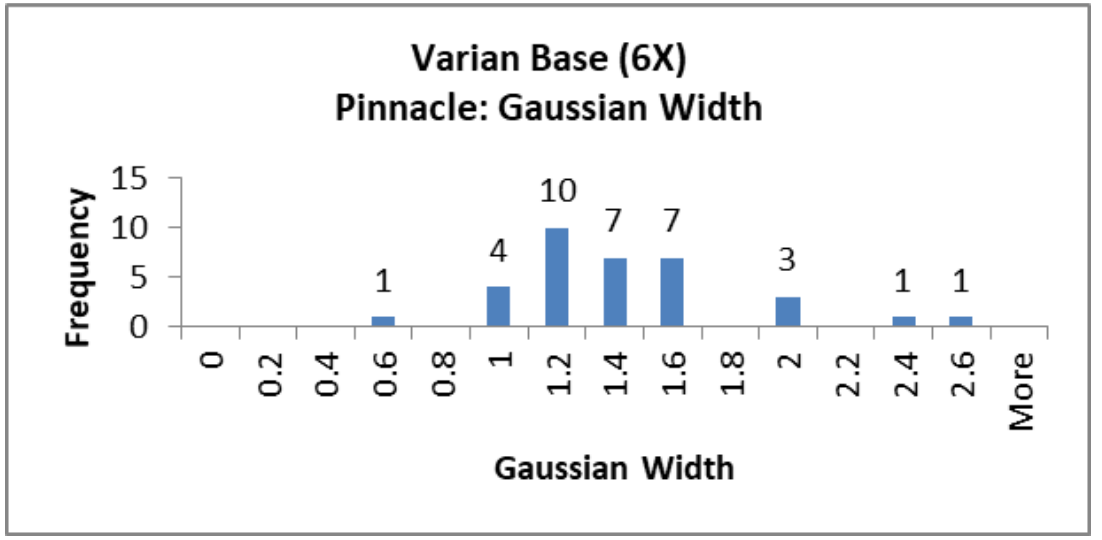

Implications & Future Work

- Disparate modeling may contribute to inaccuracies in IMRT dose calculation, small field calculations, etc.
- Determining reasonable ranges on modeling parameters can help institutions achieve more robust models and better accuracy
- Future work: determine expected changes in from these distributions of beam modeling parameters

Thank you for your attention!

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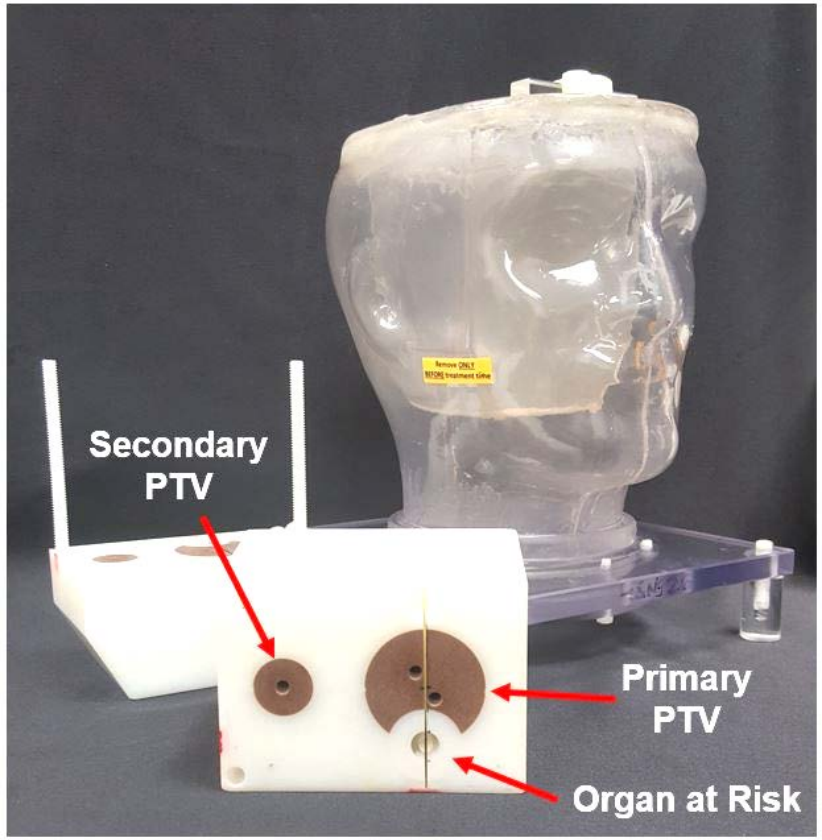

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