

Evaluation of the TomoTherapy Planning Station Heterogeneity Correction Algorithm Using an Anthropomorphic Phantom

David Followill, Ph.D.

Andrea Molineu, M.S.

John McGary, Ph.D.

Geoffrey Ibbott, Ph.D.



This investigation was supported by PHS grant CA10953 awarded by the NCI, DHHS.

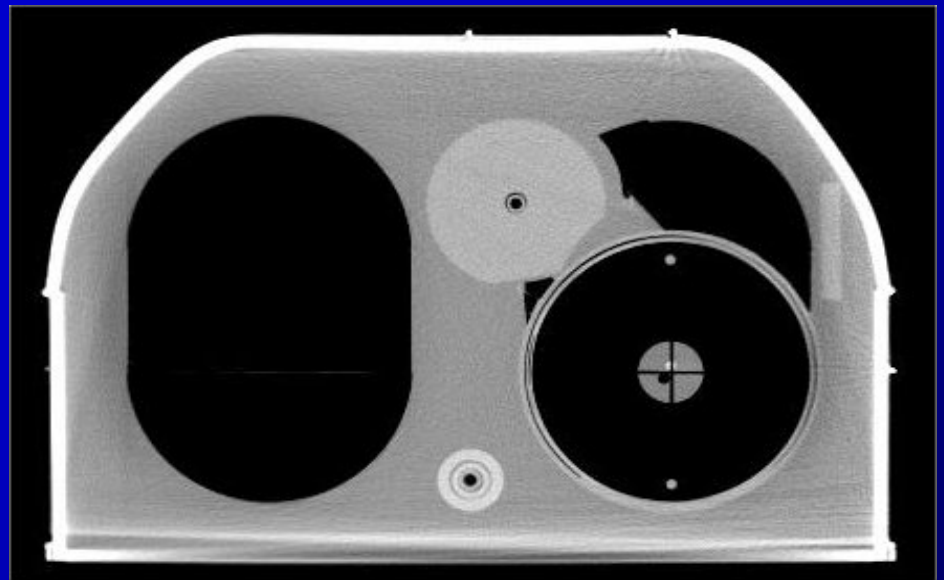
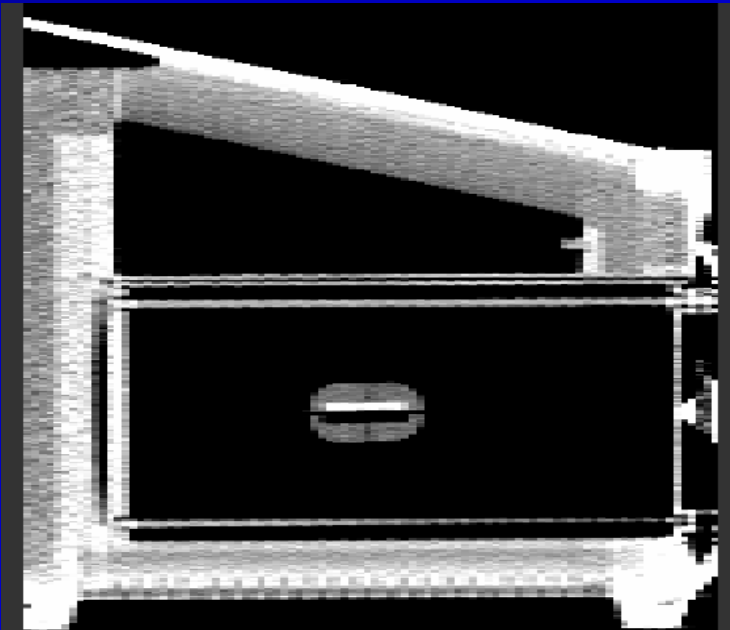
Introduction

- Previous studies of lung density corrections
 - based on slab phantoms
 - simple beam geometries
- Current generation convolution based algorithms should provide better dose estimates
- Limited data is available verifying the accuracy of treatment planning systems in an anthropomorphic phantom
- Differences between implementations of heterogeneity correction algorithms needs to be quantified before applying them in multi-institutional clinical trials

Objectives

- Evaluate the TomoTherapy Planning Station's heterogeneity dose calculation algorithm using the RPC's anthropomorphic lung phantom.
 - Develop a clinically conformal treatment plan for the lung insert with a centrally located tumor.
 - Measure delivered doses by these treatments using TLD and radiochromic film.
 - Compare measured and calculated dose distributions based on the TG-53 criteria of $\pm 5\%/5\text{mm}$.

- RPC's Anthropomorphic Thorax Phantom
 - Simulated heart, spine, lungs, and lung tumor heterogeneities
 - Tumor located centrally
 - TLD (Tumor, Heart, Cord)
 - Radiochromic film (Axial, Coronal, and Sagittal)

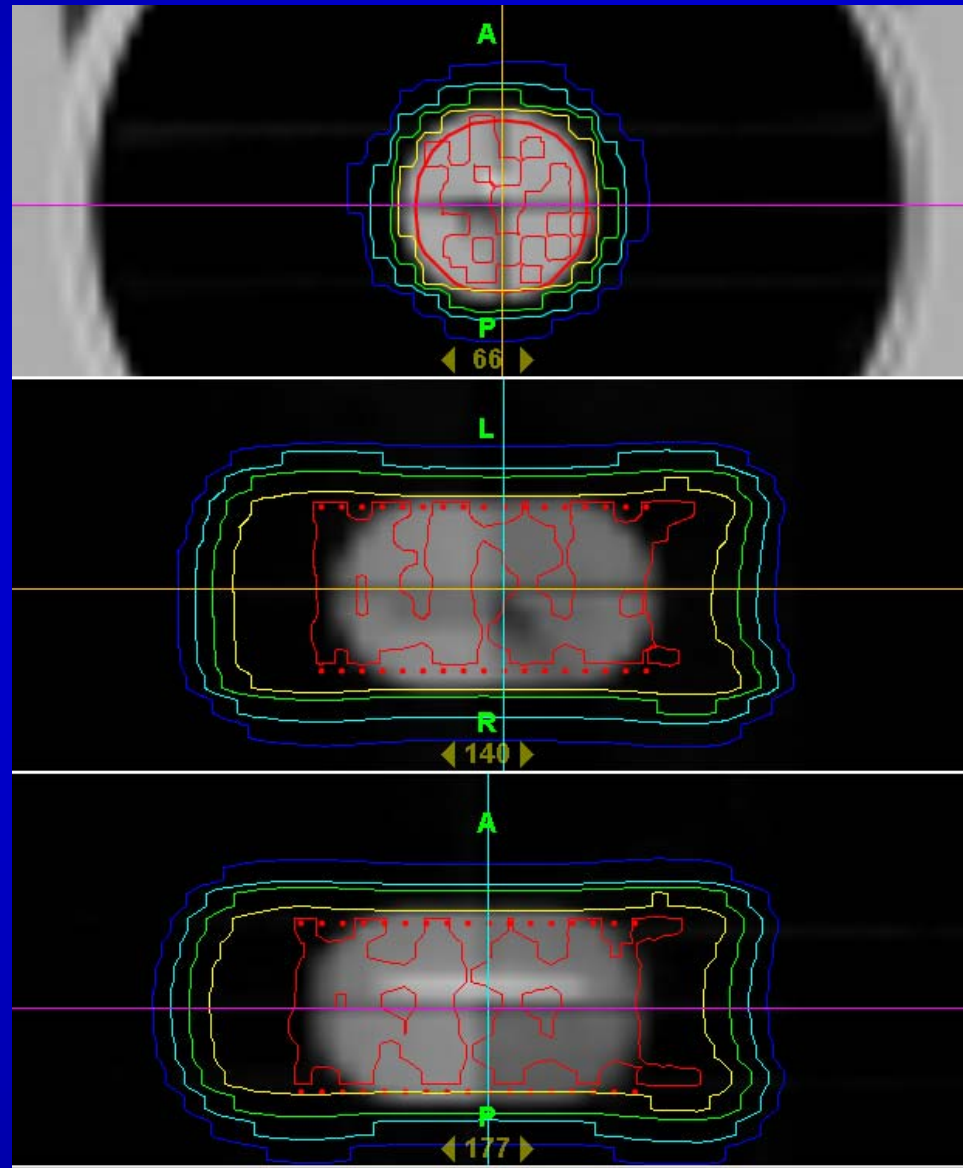


Doses per MV CT

MV CT Irradiation	PTV Sup (cGy)	PTV inf (cGy)	Cord (cGy)	Heart (cGy)
1	1.23	0.98	1.05	1.08
2	1.00	1.01	1.11	1.05
3	0.99	1.00	1.14	1.07
average	1.06			
std dev	0.07			

Methods and Materials

- Conformal Treatment Plans
 - Clinically constrained prescriptions
 - Helical delivery with 2.5 cm field length
 - 6 MV
 - 10 Gy to prescription point

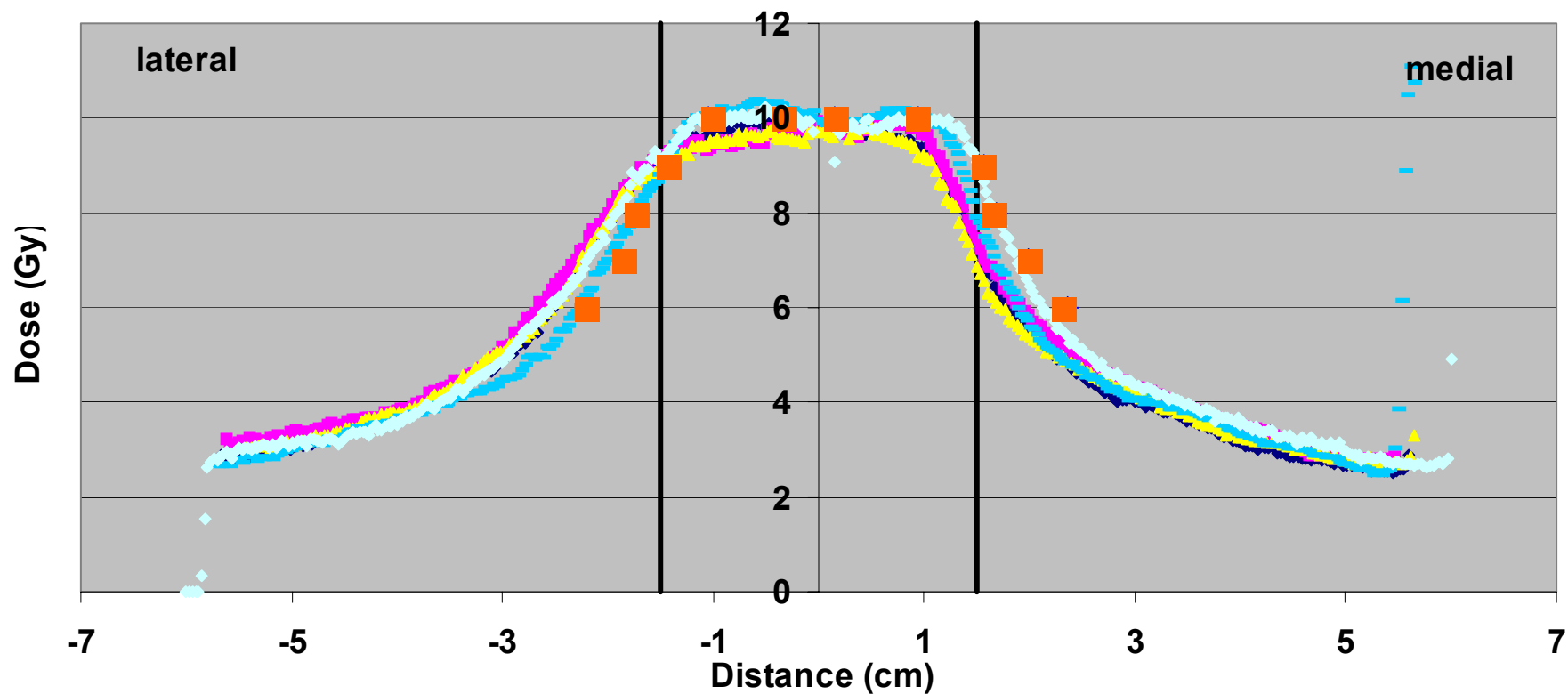


TLD Results

(Doses in Gy)

Irradiation	PTV Sup	PTV inf	Cord	Heart
1	9.85	9.93	1.11	1.35
2	10.06	9.93	1.07	1.30
3	9.85	10.00	1.05	1.29
4	9.92	9.84	1.06	1.26
5	9.79	9.85	1.06	1.27
average	9.90		1.07	1.30
std dev	0.08		0.03	0.03
Meas./Calc.	0.99			

Medial Lateral Profile



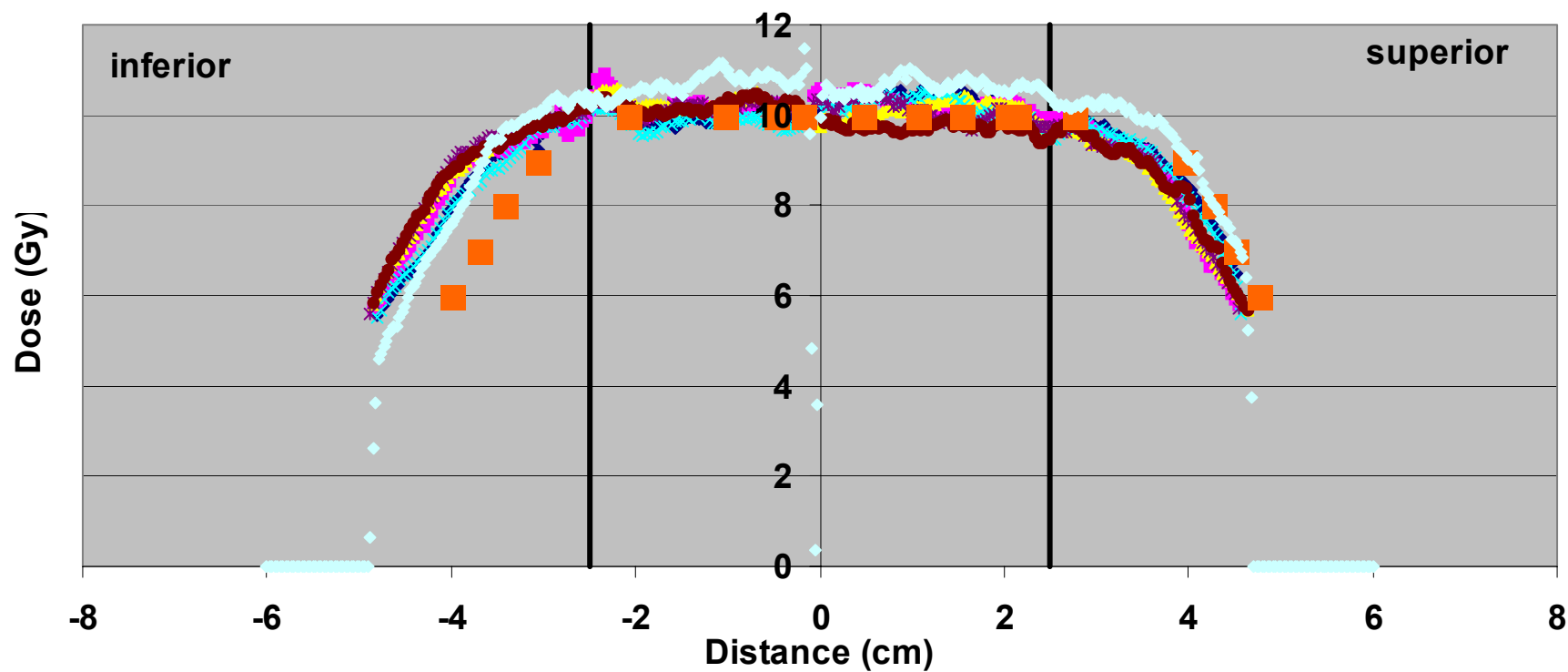
◆ Axial 1
+ new 2

■ Axial 2
- july axial

▲ Axial 3
◇ july coronal

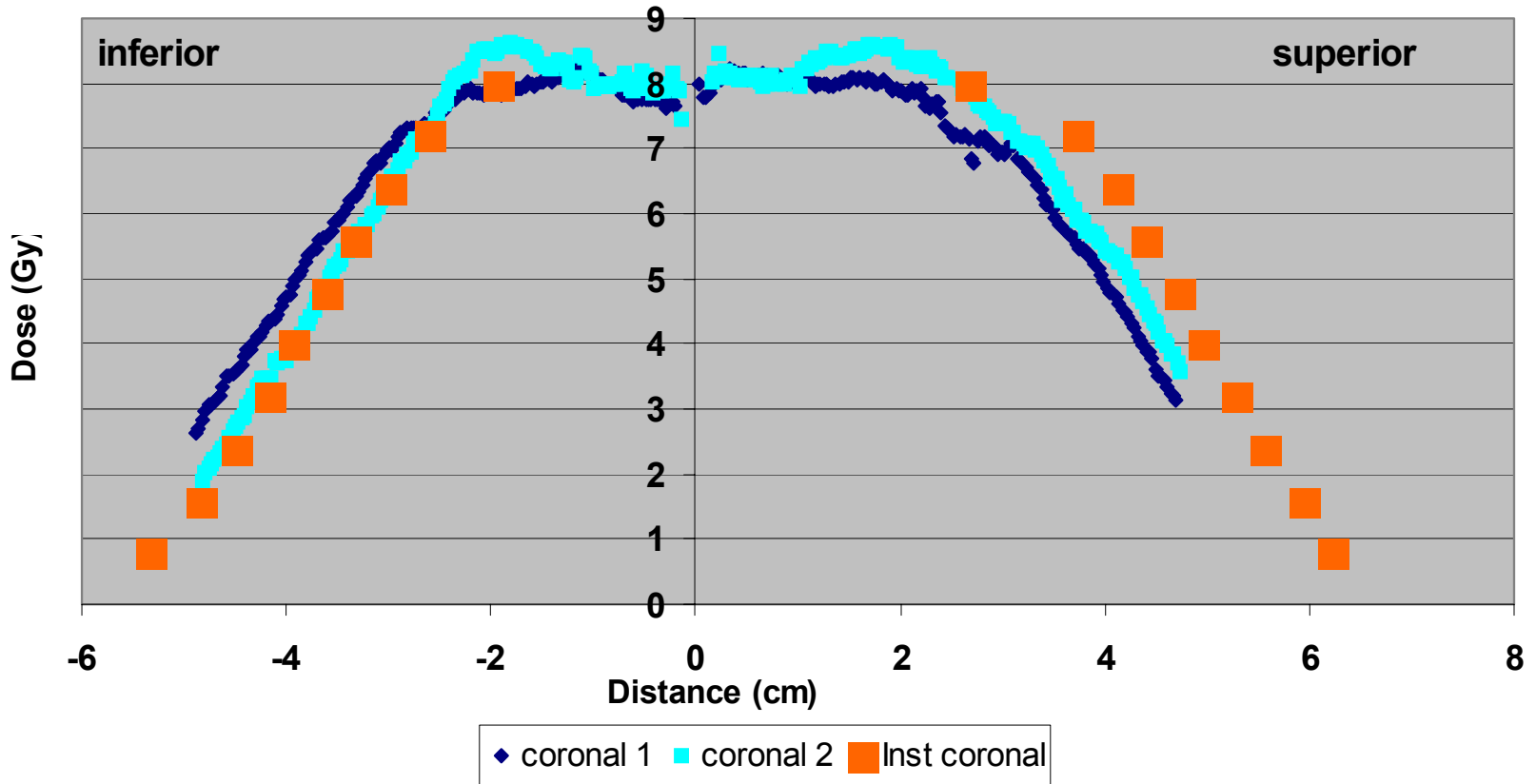
— Tumor
■ new inst values

Superior Inferior Profile

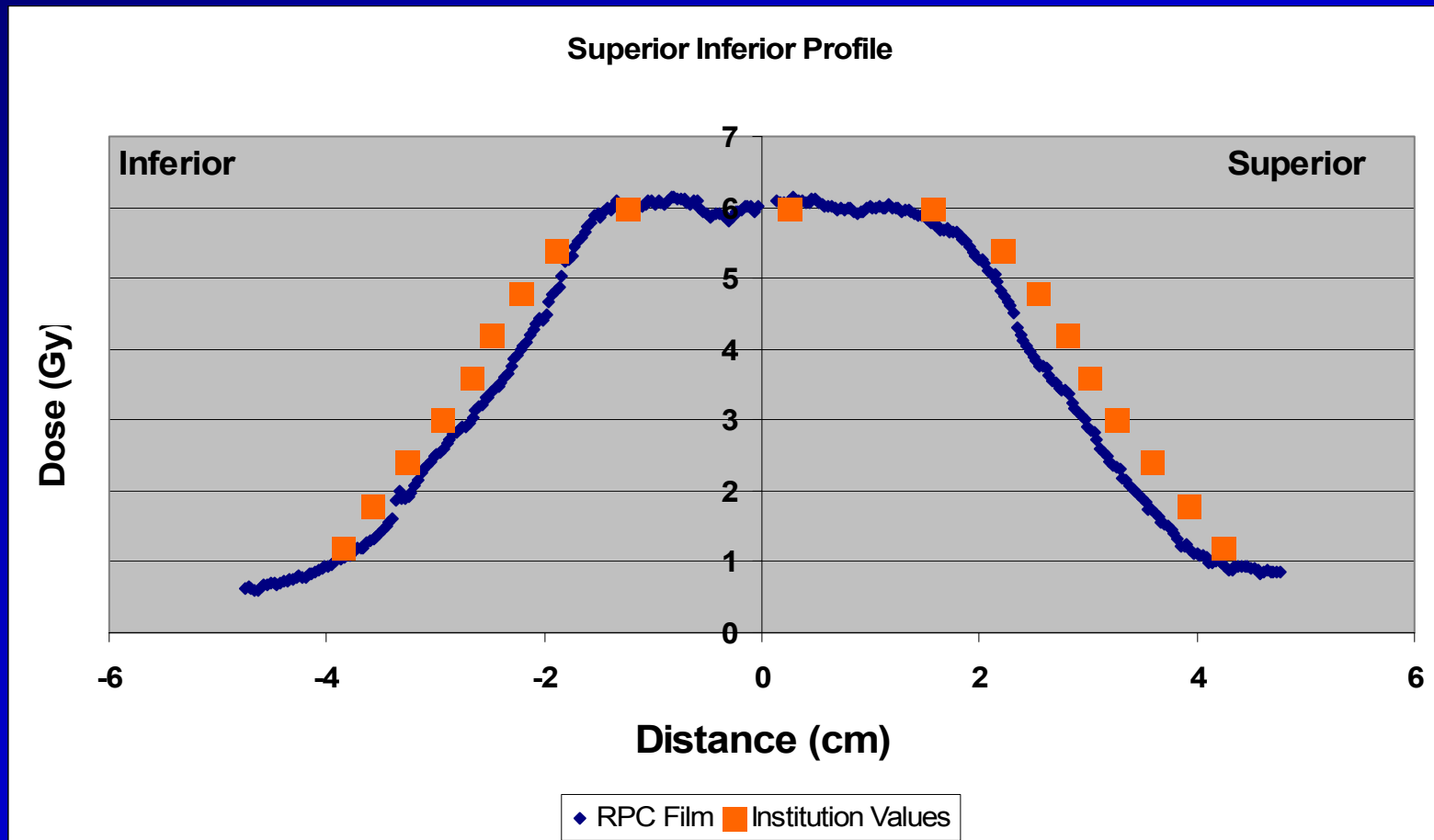


- ◆ Coronal 1 rt
- ◆ Coronal 2 rt
- ◆ Coronal 3 rt
- ◆ Coronal 1 lt
- ◆ Coronal 2 lt
- Coronal 3 lt
- Tumor
- new inst values
- ◆ july coronal

Superior Inferior Profile



With fiducials marking the center of the target



Conclusions

1. Patient doses from the MV CT are negligible compared to the total prescription dose delivered.
2. The TomoTherapy Planning Station heterogeneity correction algorithm calculates the tumor dose correctly in the presence of a lung heterogeneity.
3. Caution is warranted in the setup of patients using the MV CT, especially for symmetric tumors.