

# Linear Accelerator Quality Control Using Clinical Treatment Delivery: A Feasibility Study

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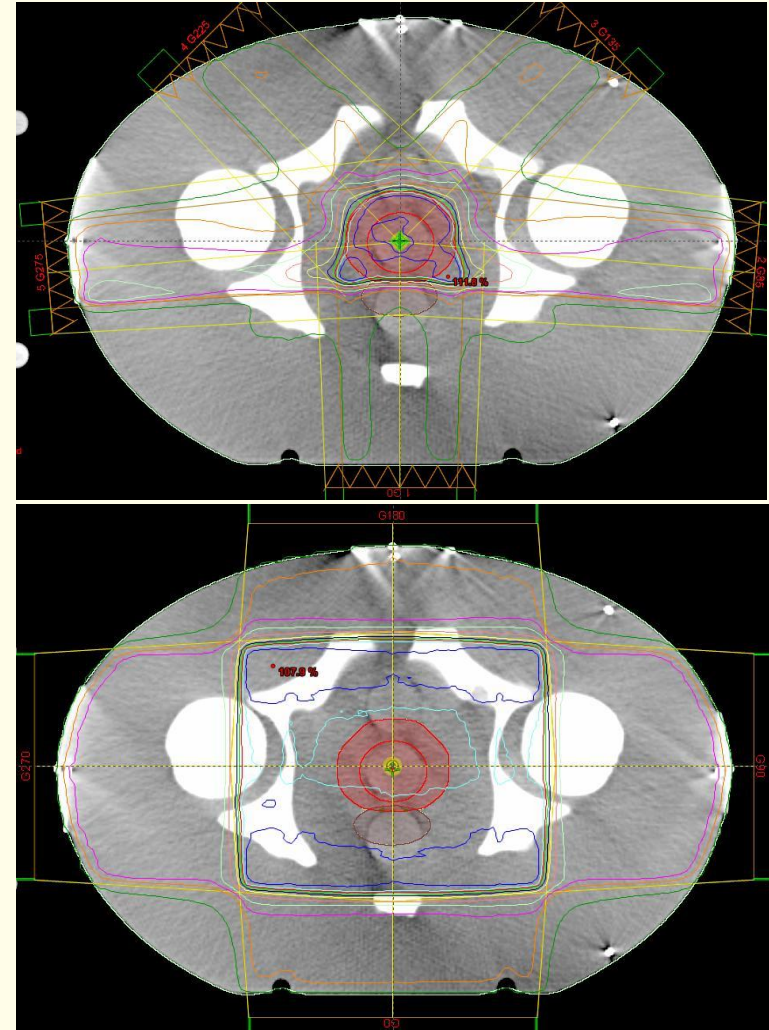
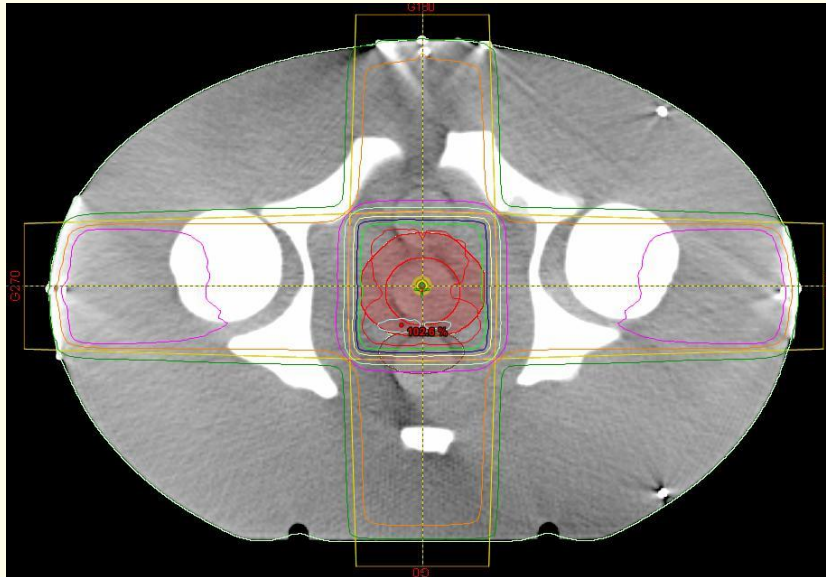
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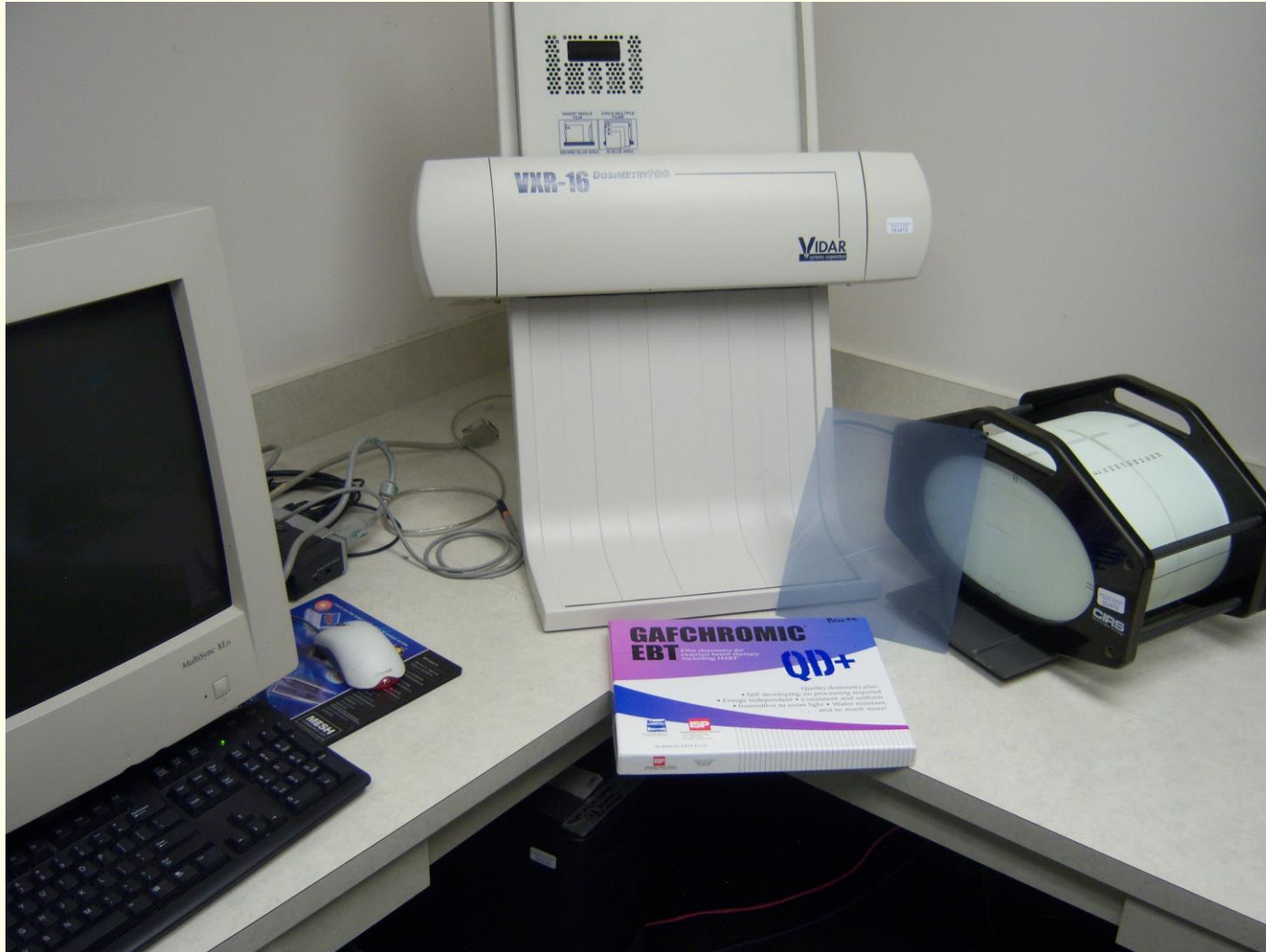
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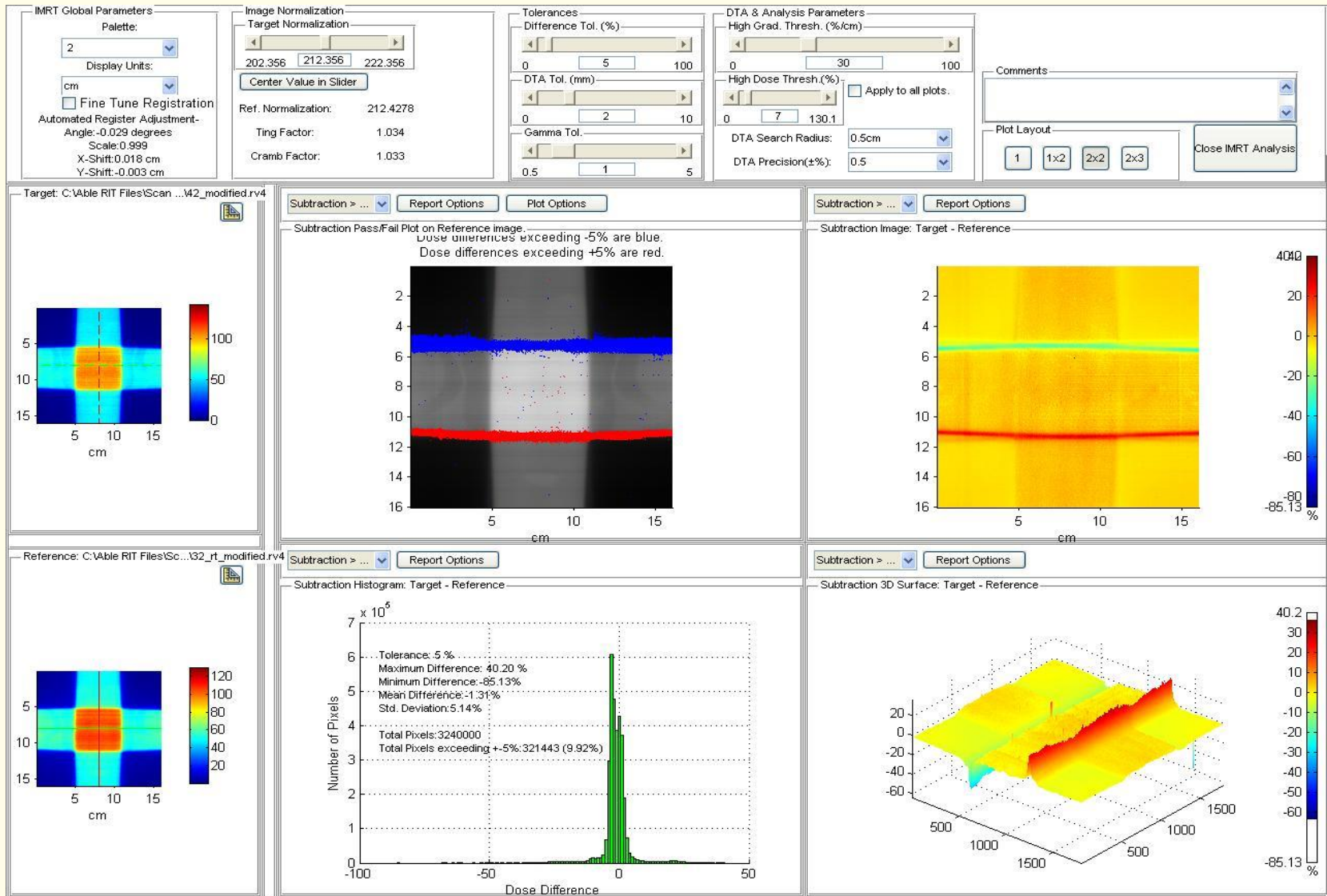
- **To determine if dose distributions resulting from clinical treatment delivery are sensitive enough to detect operational changes in mechanical parameters at the level specified by TG-40.**
  - **To evaluate if treatment delivery accuracy can be determined using process behavior charts developed from clinical treatment delivery dose distributions**
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- **Statistical Process Control (SPC)**
    - **W. A. Shewhart, Bell Labs, 1924**
    - **Application of probability and statistics to quality control of mass production**
    - **Introduced the control chart (or process behavior chart)**
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- **3 clinical treatment plans**
  - **Mechanical Parameters manipulated at 0.5, 1.0 & 1.5 times the TG-40 Tolerance**
  
  - **Gantry angle**
  - **Collimator angle**
  - **Table Height**
  - **Table Lateral**
  - **Field Size**
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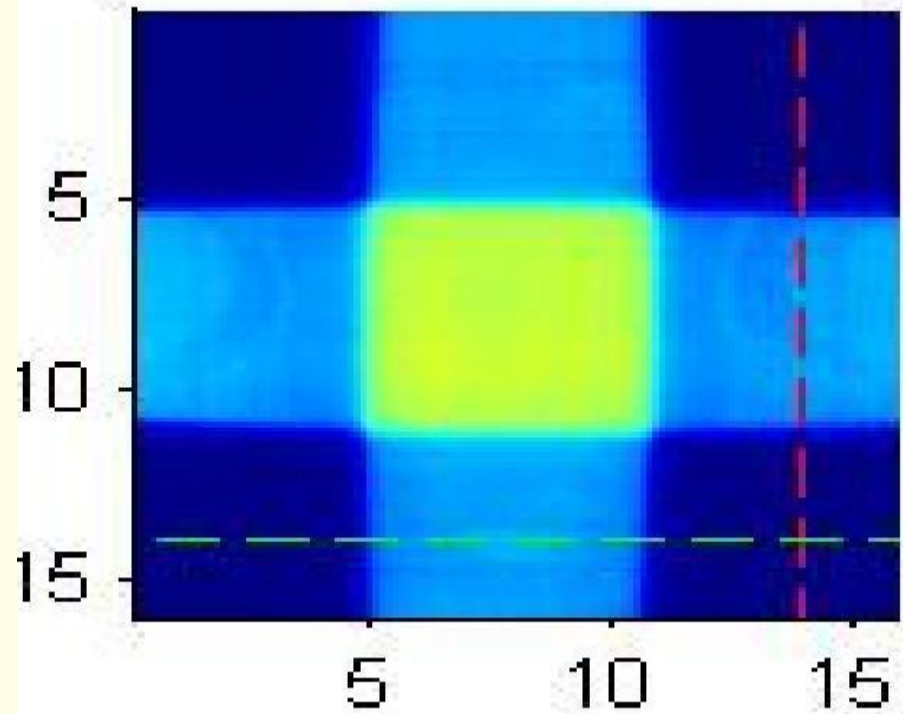
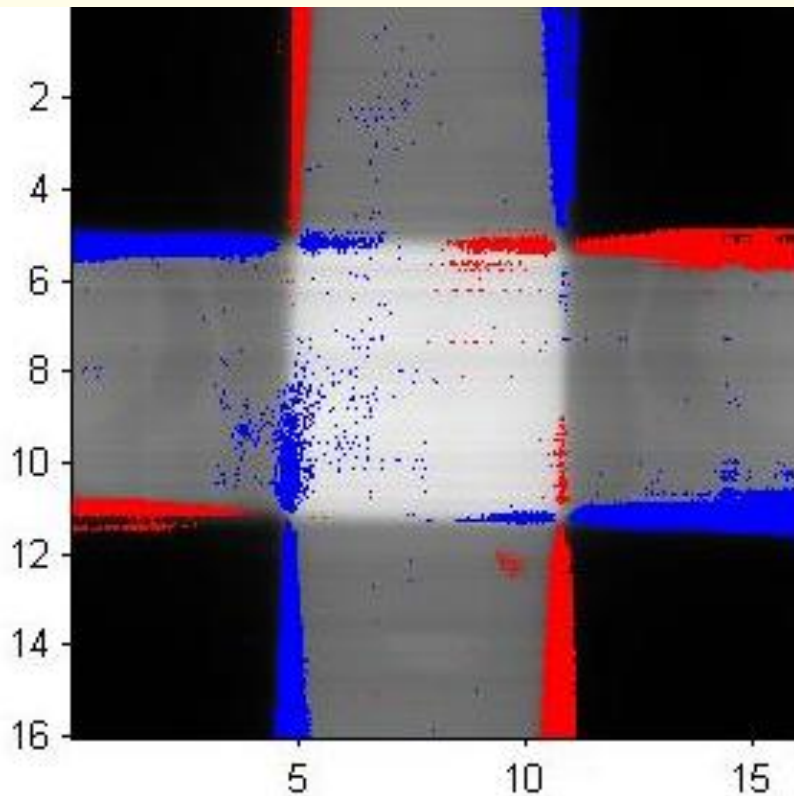


# F Test of Dose Difference Distribution

F Test @ 0.01 Significance Level-Dose Difference Distribution				
Modification	Magnitude	4 Field Box	Whole Pelvis	Prostate IMRT
none	none			
Gantry	0.5 deg			
Gantry	1.0 deg			
Gantry	1.5 deg			
Collimator	0.5 deg			
Collimator	1.0 deg			
Collimator	1.5 deg			
Table Height	1.0 mm			
Table Height	2.0 mm			
Table Height	3.0 mm			
Table Lateral	1.0 mm			
Table Lateral	2.0 mm			
Table Lateral	3.0 mm			
Field Size	1.0 mm			N/A
Field Size	2.0 mm			N/A
Field Size	3.0 mm			N/A
Color Key		Not Significant		Significant @0.01



- Vertical and Horizontal profiles across the penumbra were extracted and evaluated.



4 Field Box: Table Lateral  
Horizontal Profile



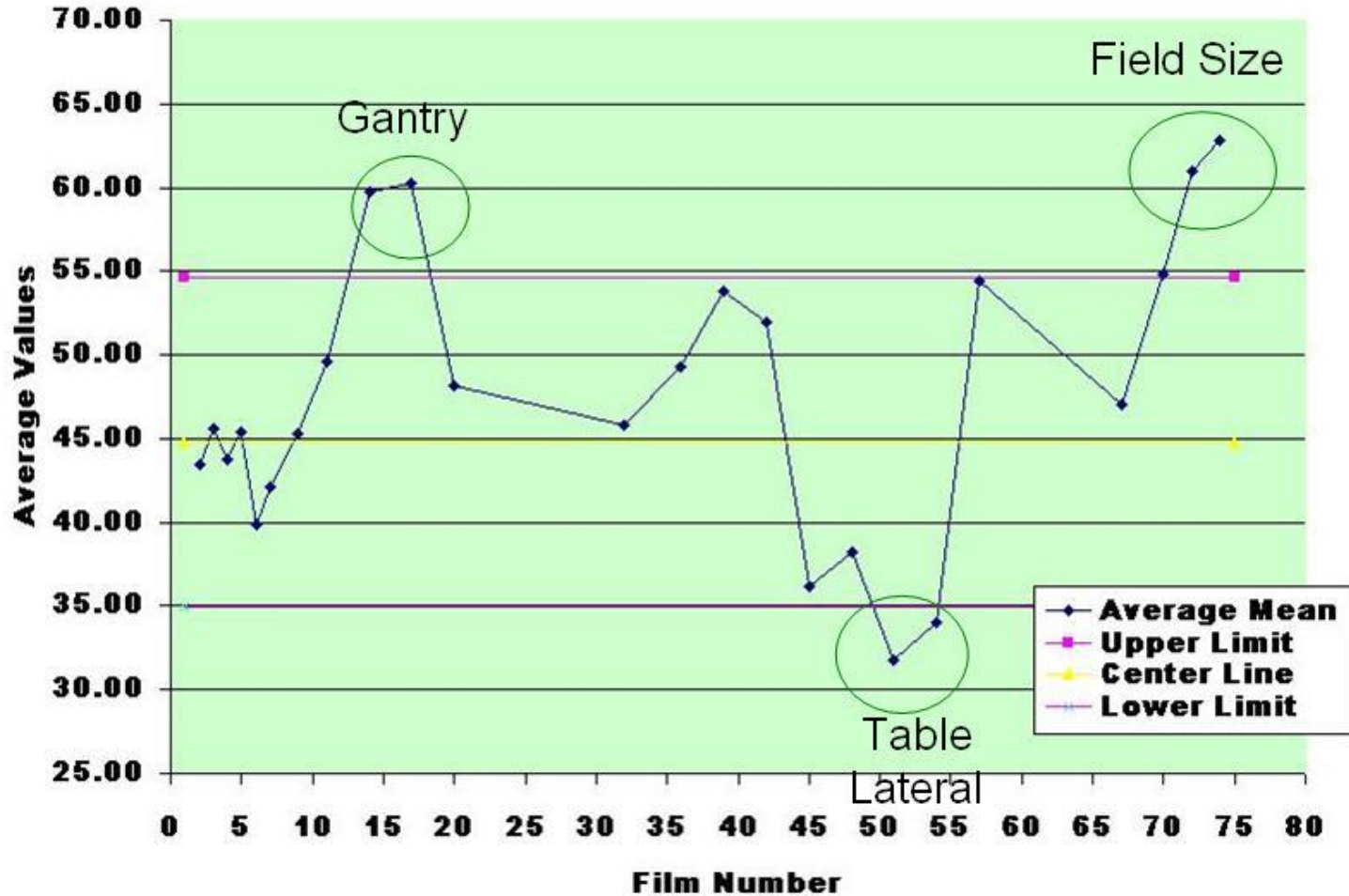
# Chi-Square Test Horizontal Profile

Chi-Square Test @ 0.05 Significance Level - Horizontal Profiles				
Modification	Magnitude	4 Field Box	Whole Pelvis	Prostate IMRT
none	none			
Gantry	0.5 deg			
Gantry	1.0 deg			
Gantry	1.5 deg			
Collimator	0.5 deg			
Collimator	1.0 deg			
Collimator	1.5 deg			
Table Height	1.0 mm			
Table Height	2.0 mm			
Table Height	3.0 mm			
Table Lateral	1.0 mm			
Table Lateral	2.0 mm			
Table Lateral	3.0 mm			
Field Size	1.0 mm			N/A
Field Size	2.0 mm			N/A
Field Size	3.0 mm			N/A
Color Key		Not Significant		Significant @ 0.05

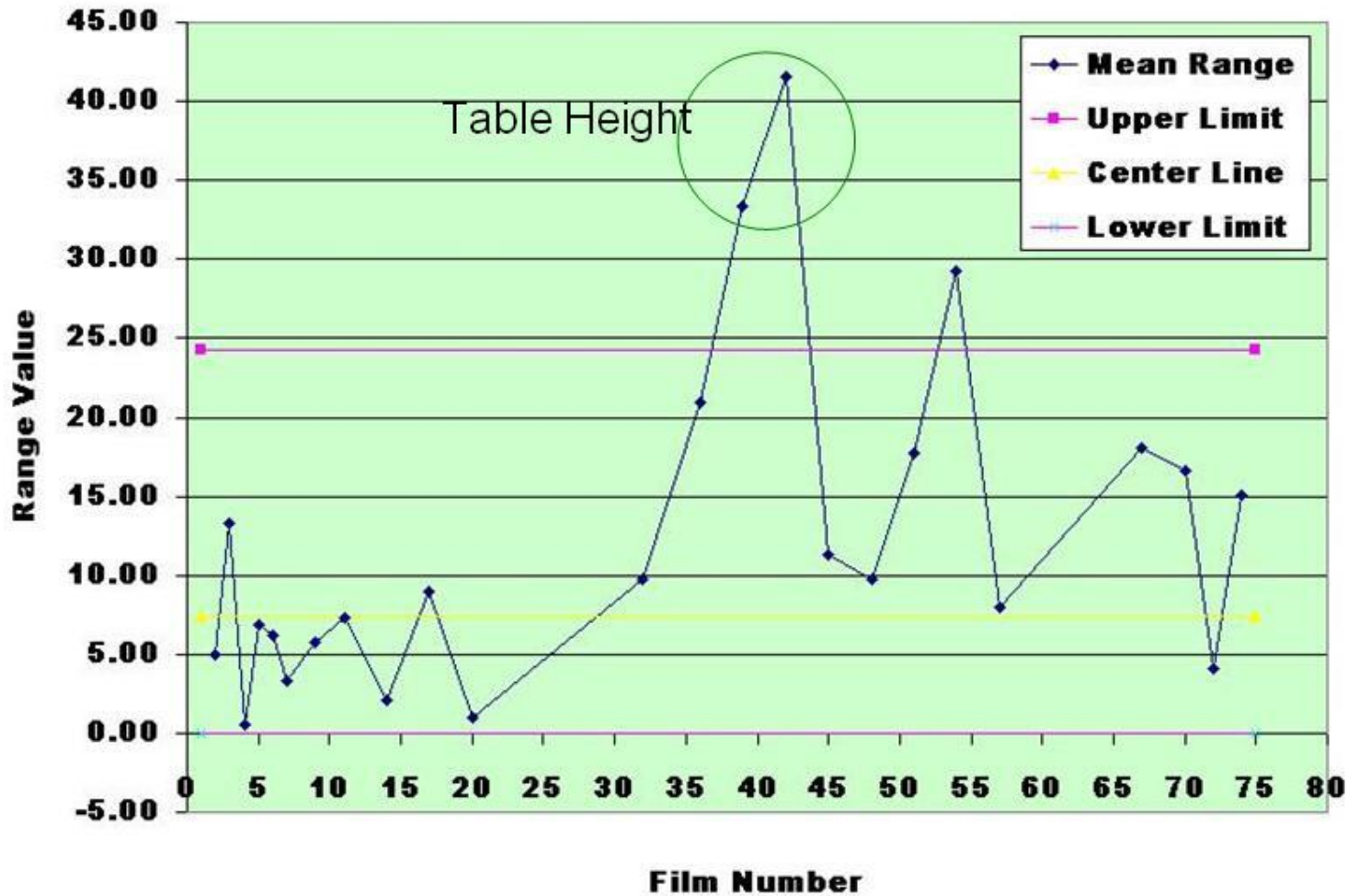
# Chi-Square Test-Vertical Profile

Chi-Square Test @ 0.05 Significance Level - Vertical Profile				
Modification	Magnitude	4 Field Box	Whole Pelvis	Prostate IMRT
none	none			
Gantry	0.5 deg			
Gantry	1.0 deg			
Gantry	1.5 deg			
Collimator	0.5 deg			
Collimator	1.0 deg			
Collimator	1.5 deg			
Table Height	1.0 mm			
Table Height	2.0 mm			
Table Height	3.0 mm			
Table Lateral	1.0 mm			
Table Lateral	2.0 mm			
Table Lateral	3.0 mm			
Field Size	1.0 mm			N/A
Field Size	2.0 mm			N/A
Field Size	3.0 mm			N/A
Color Key		Not Significant		Significant @ 0.05

**Process Behavior Chart: 4 Field Box ( Sample Average)**



**Process Behavior Chart: 4 Field Box (Sample Range)**



- **Clinical treatment delivery is sensitive enough to detect inaccuracies in mechanical parameters**
  - **Strategically sampled clinical treatment dose distributions can be used to provide quality control for mechanical parameters using statistical process control methodology.**
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## Thank You For Your Attention



- **Kutcher, G.J., Coia, L., Gillin, M., et al.**  
“Comprehensive QA for radiation oncology: Report of radiation therapy committee task group 40” *Med Phys* 21 (4) 581-618.
  - **Pawlicki, R., Whitaker, M., Boyer, A.L.** “Statistical process control for radiotherapy quality assurance” *Med Phys* 32 (9) 2777-2786.
  - **Pawlicki, R., Whitaker, M.** “Variation and control of process behavior” *Int. J. Radiat Oncol Biol Phys* 71(1) supl s210-s214.
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