# The Radiological Physics Center's Experience with IMRT

RSNA
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Geoffrey S. Ibbott, Ph.D.

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# Acknowledgements

- RPC Staff, especially Andrea Molineu, Paola Alvarez, Jessica Lowenstein, Joye Roll and David Followill

# Purposes of Credentialing for IMRT Clinical Trials

- Education

- Evaluate ability to deliver dose

- Improve understanding of protocol

- **Reduce deviation rate**
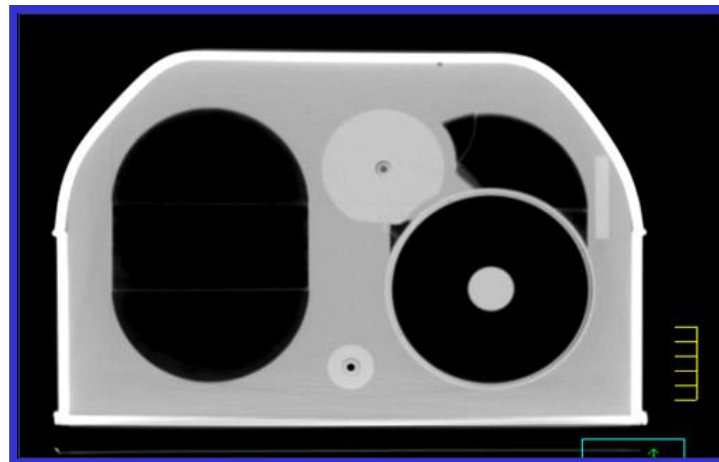
# General Credentialing Process

- Previous patients treated with technique
- Facility Questionnaire
- Knowledge Assessment Questionnaire
- Benchmark case or phantom
- Electronic data submission
- RPC QA & dosimetry review
- Clinical review by radiation oncologist

**Feedback to Institution**
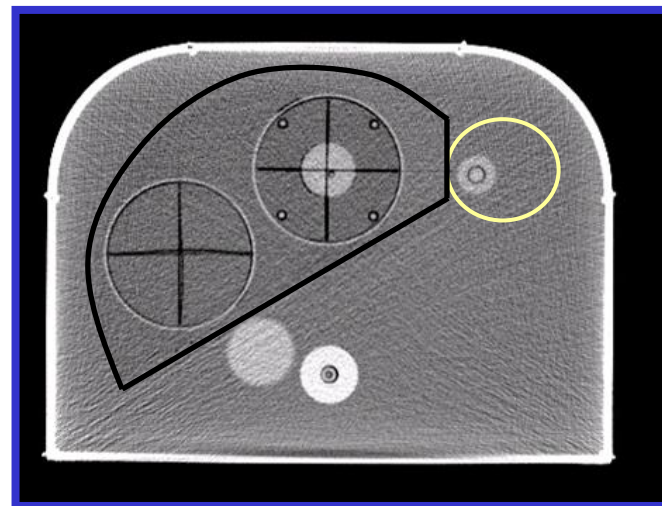
# RPC Phantoms
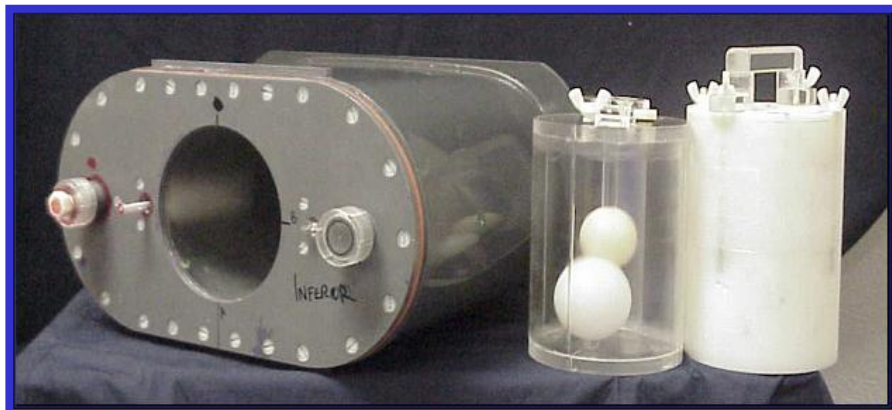


**Pelvis** (10)



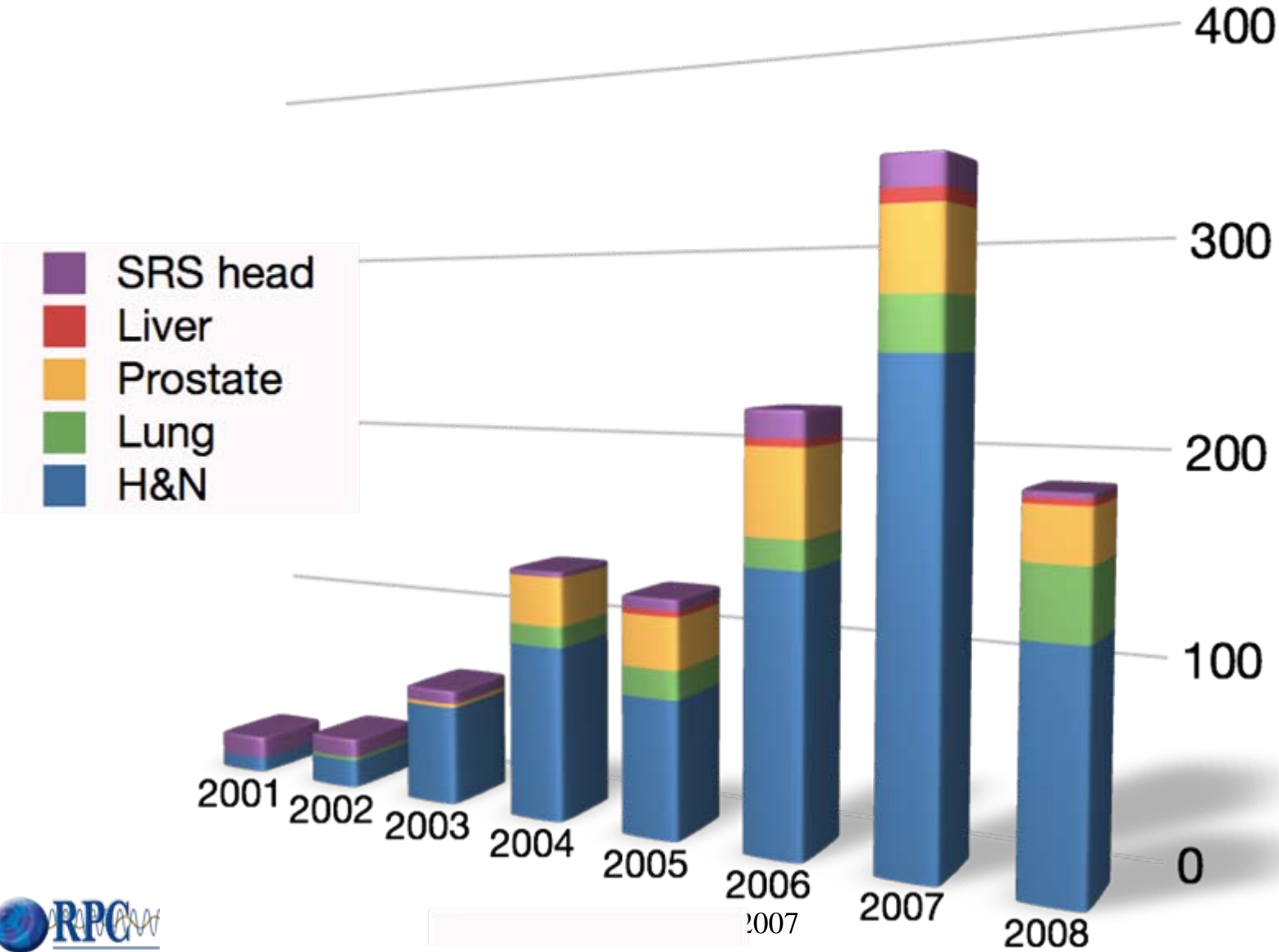**Thorax** (15)
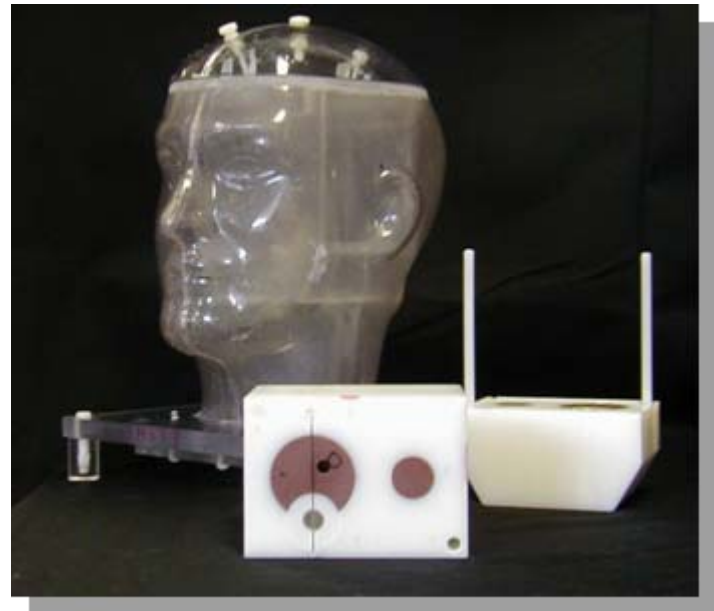


**H&N IMRT** (31)



**SRS Head** (4)



**Liver** (2)

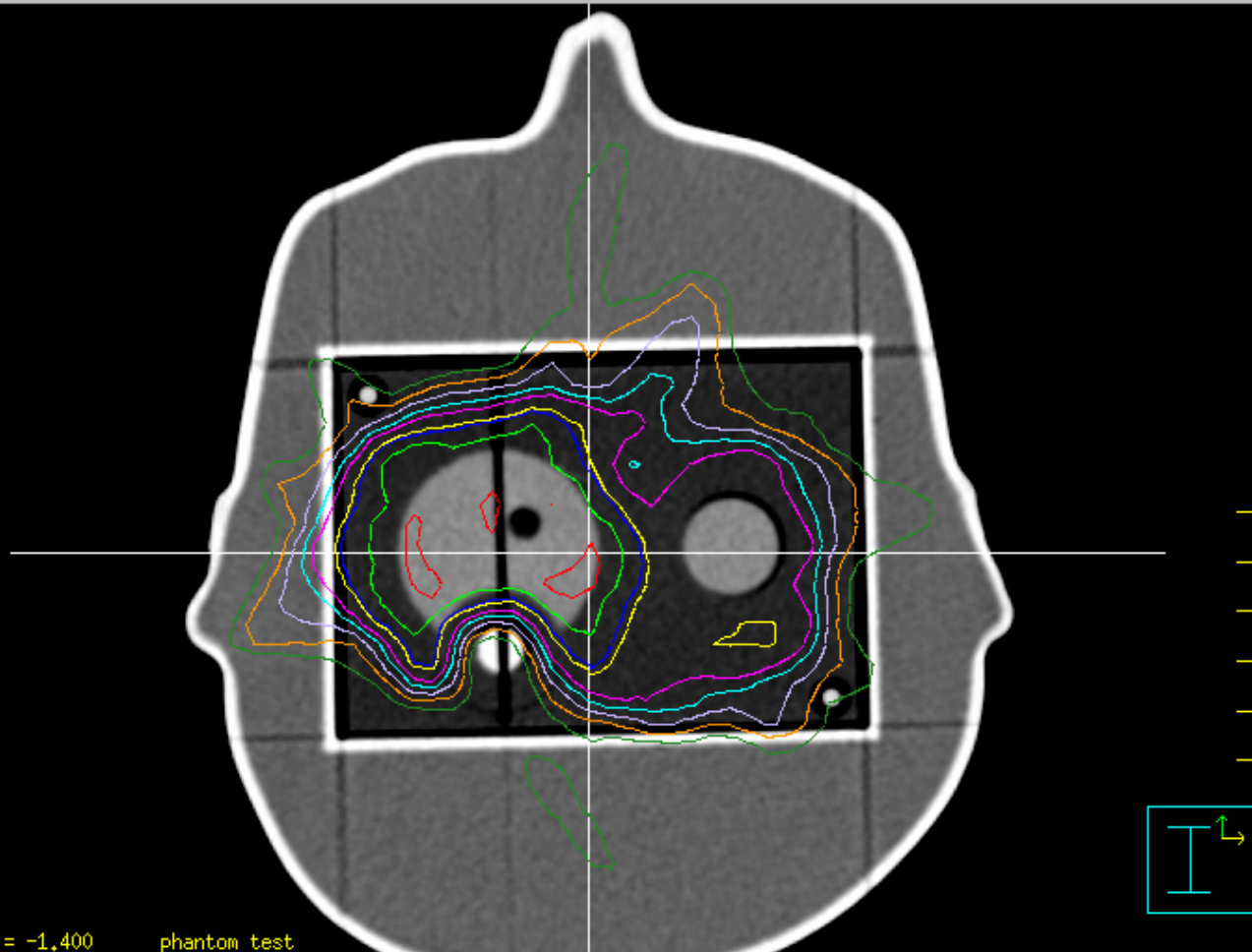# Number of phantom mailings

# IMRT Credentialing

### 600+ institutions have successfully irradiated an RPC phantom
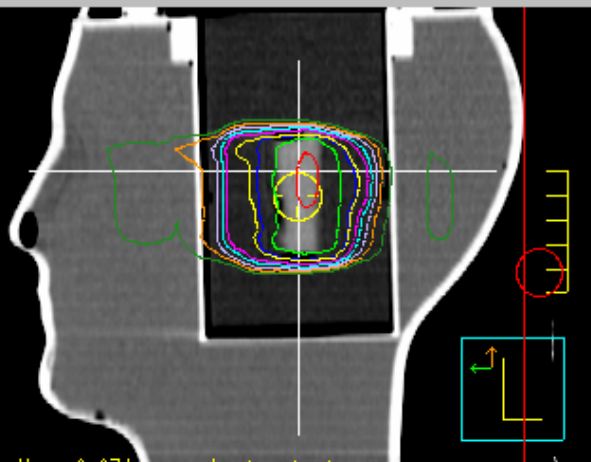
**Treat phantom as if it were a patient**

Absolute
700.0 cGy
660.0 cGy
614.0 cGy
600.0 cGy
540.0 cGy
502.0 cGy
450.0 cGy
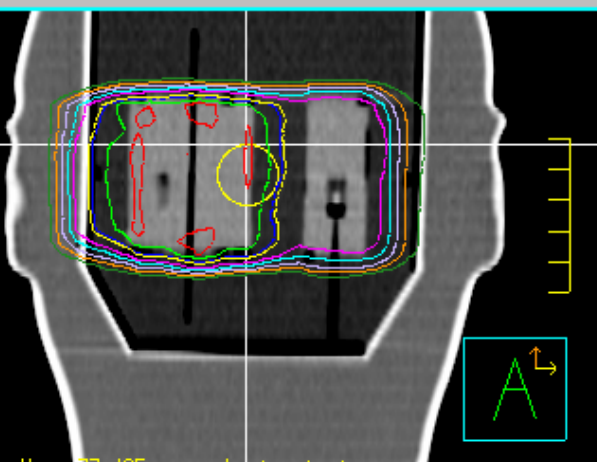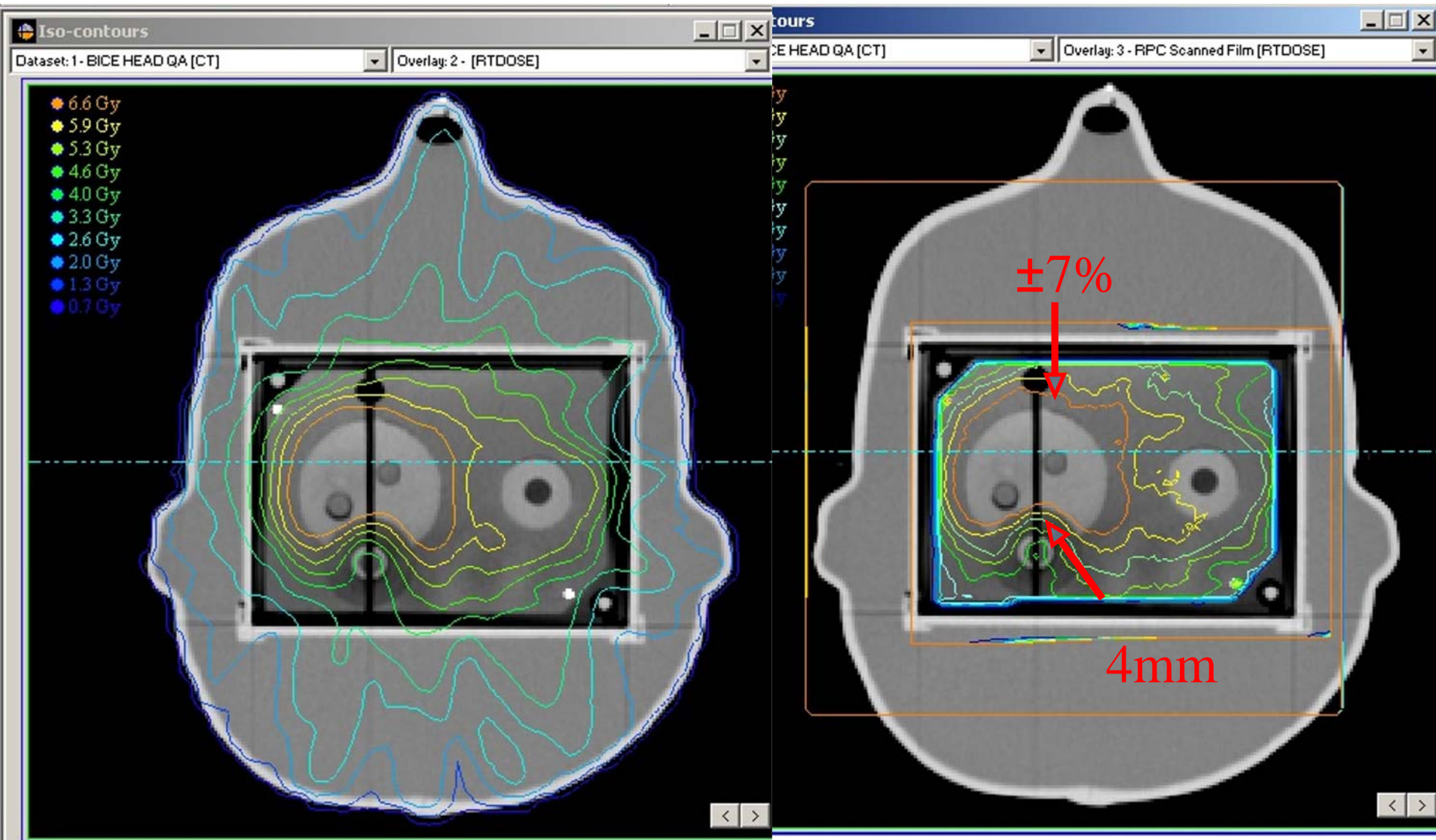400.0 cGy
350.0 cGy

Slice 83: Z = -1.400    phantom test

Absolute
700.0 cGy
660.0 cGy
614.0 cGy
600.0 cGy
540.0 cGy
502.0 cGy
450.0 cGy
400.0 cGy
350.0 cGy

Absolute
700.0 cGy
660.0 cGy
614.0 cGy
600.0 cGy
540.0 cGy
502.0 cGy
450.0 cGy
400.0 cGy
350.0 cGy

# Plan vs. Treatment

# IMRT H&N phantom results

- **558 irradiations were analyzed**

- **425 irradiations passed the criteria**

  - **70+ institutions irradiated multiple times**

- **133 irradiations did not pass the criteria**

- **377 institutions are represented**

**Only 76% of <u>institutions</u> passed the criteria on the first irradiation.**

# Plan vs. Treatment
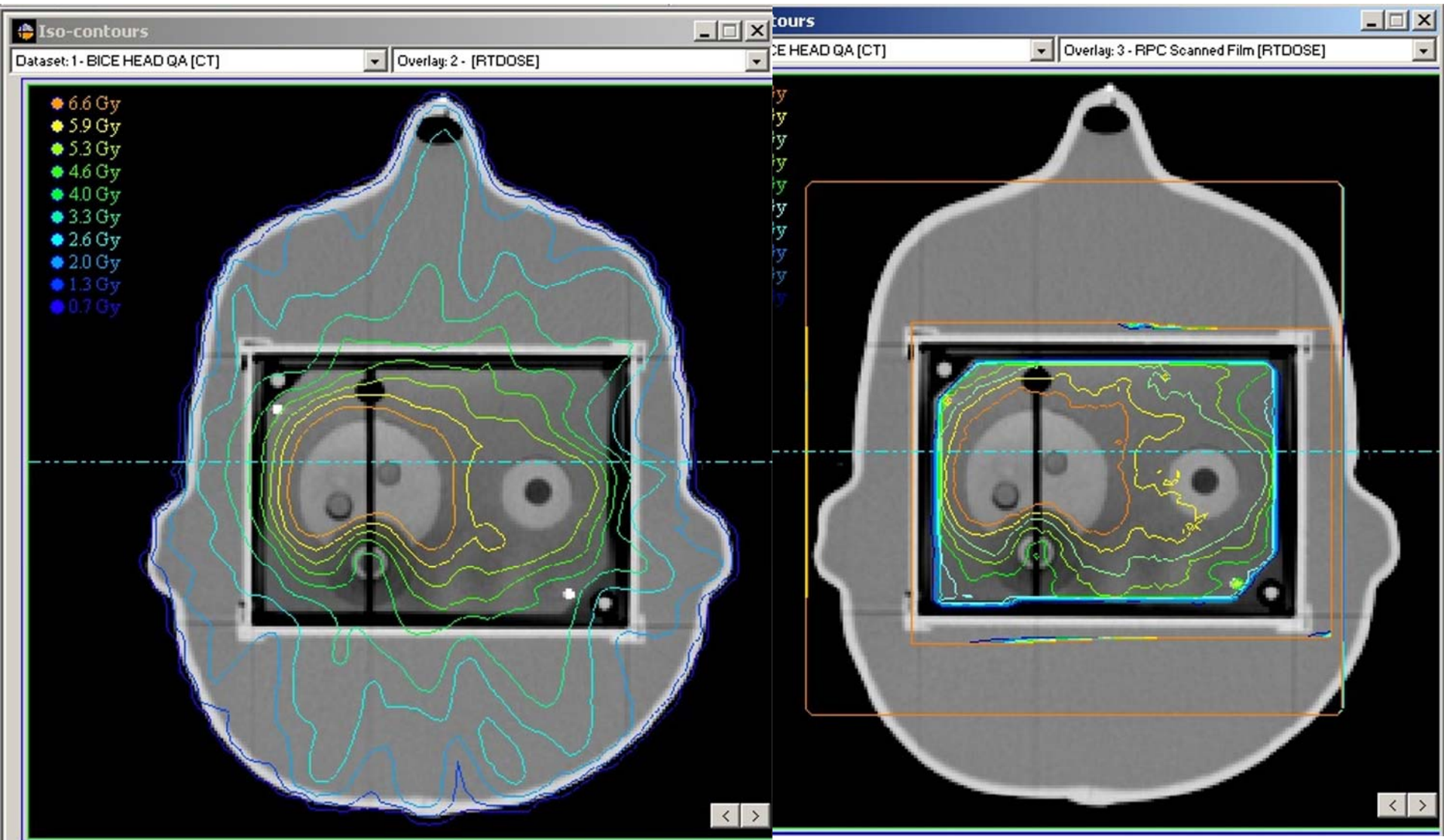
# Good HN profile



Right Left Profile
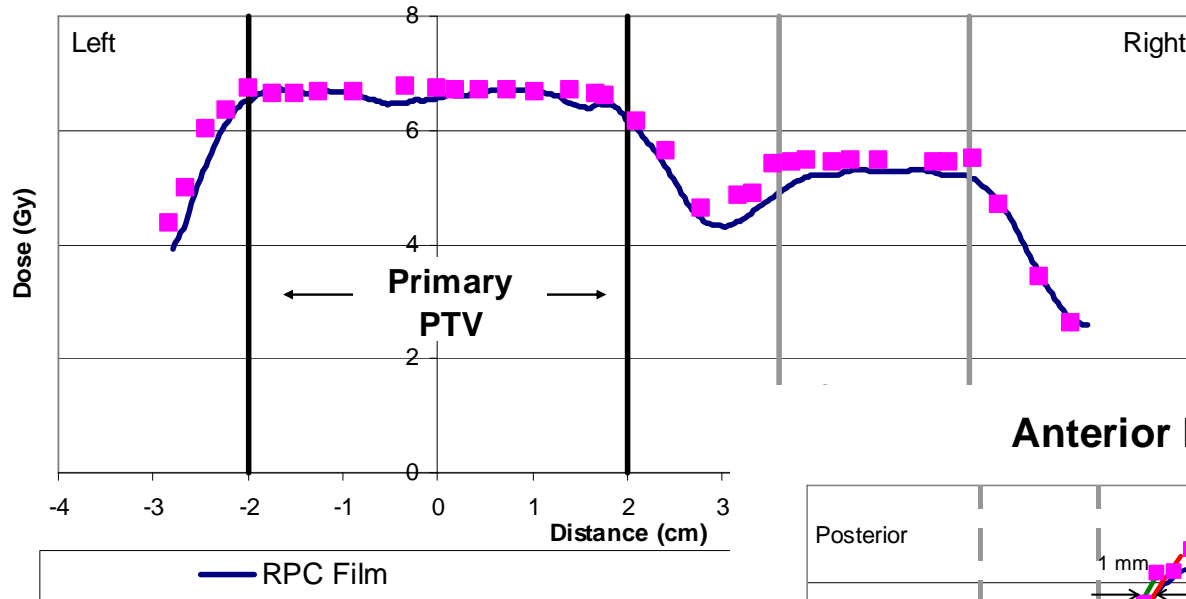
Anterior Posterior Profile

# Examples of failures
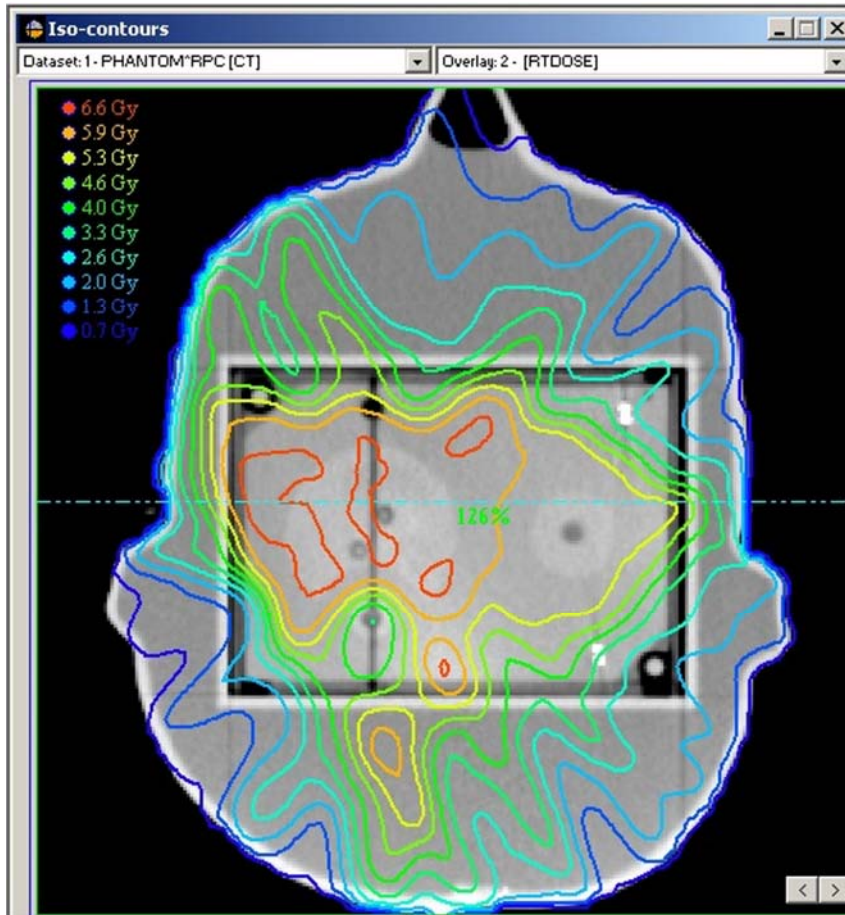
# Not so good HN profile

**Right Left Profile**
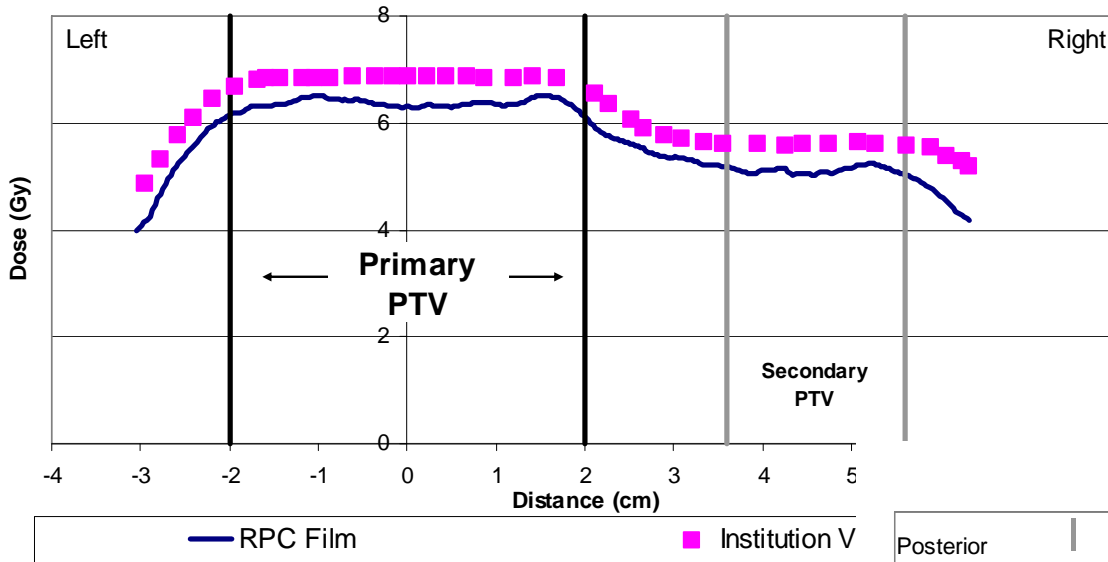


TLD 5-8% low

10 mm shift

**Anterior Posterior Profile**

# Not so good HN profile
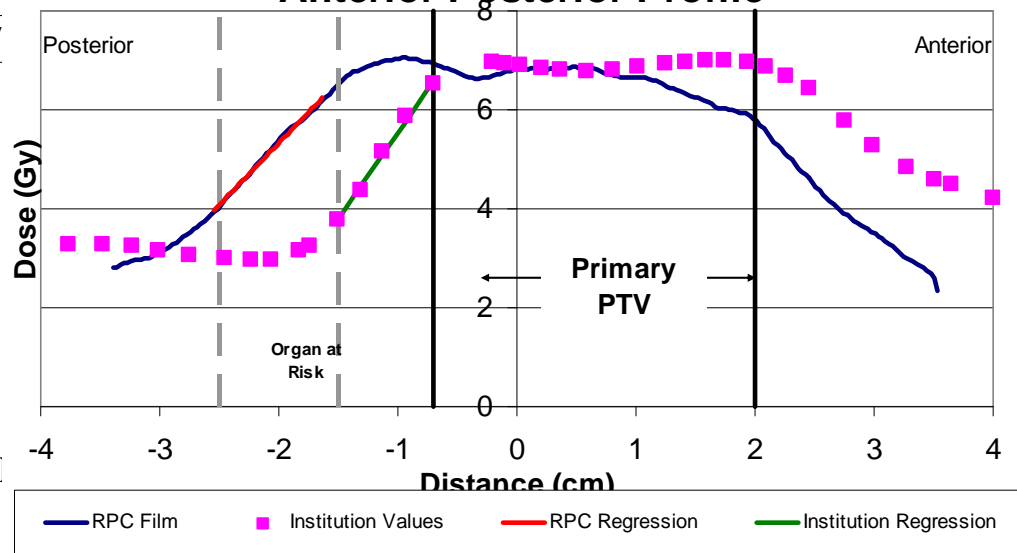


Anterior Posterior Profile
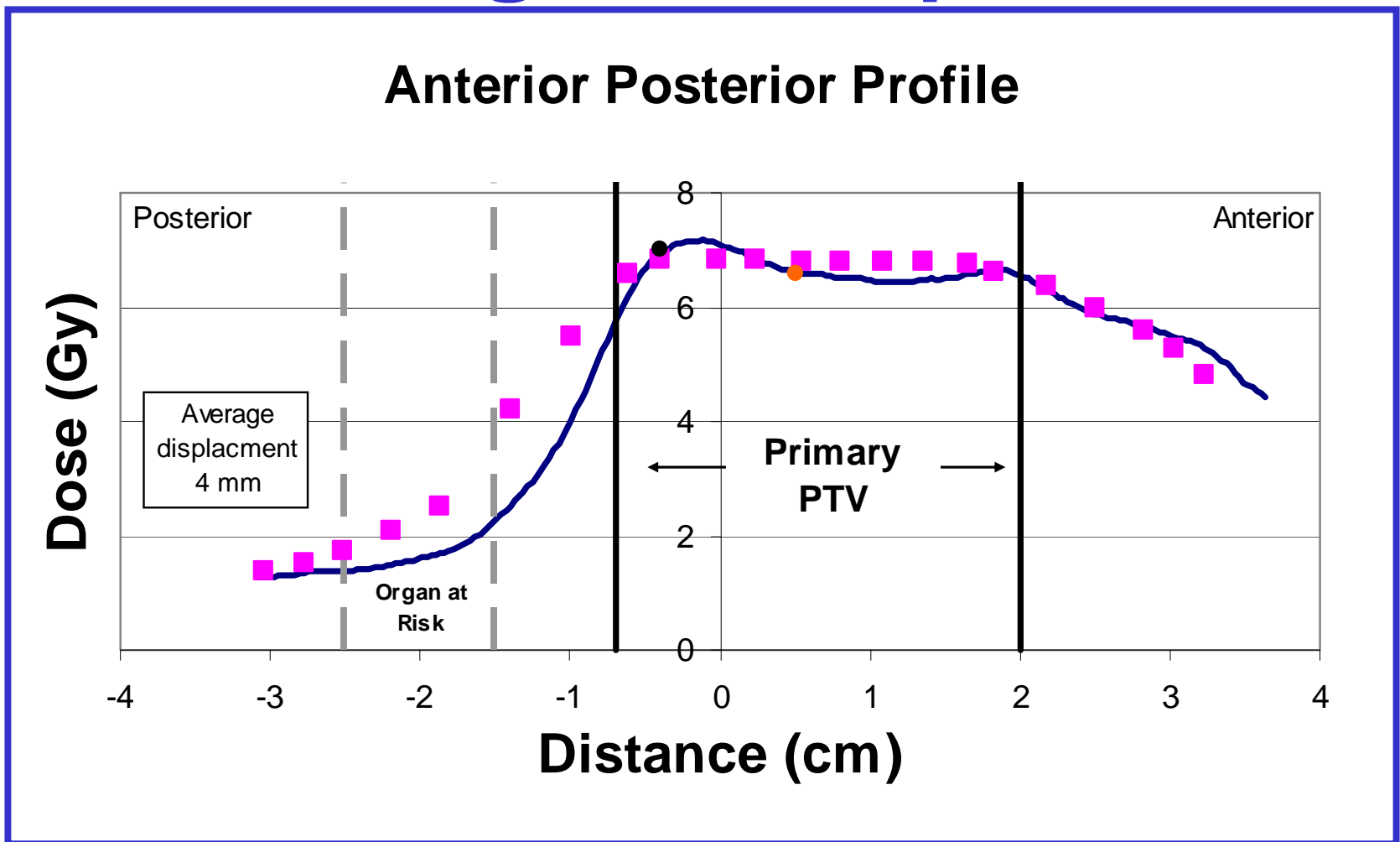
# Comparison: Planned vs. Delivered Distribution
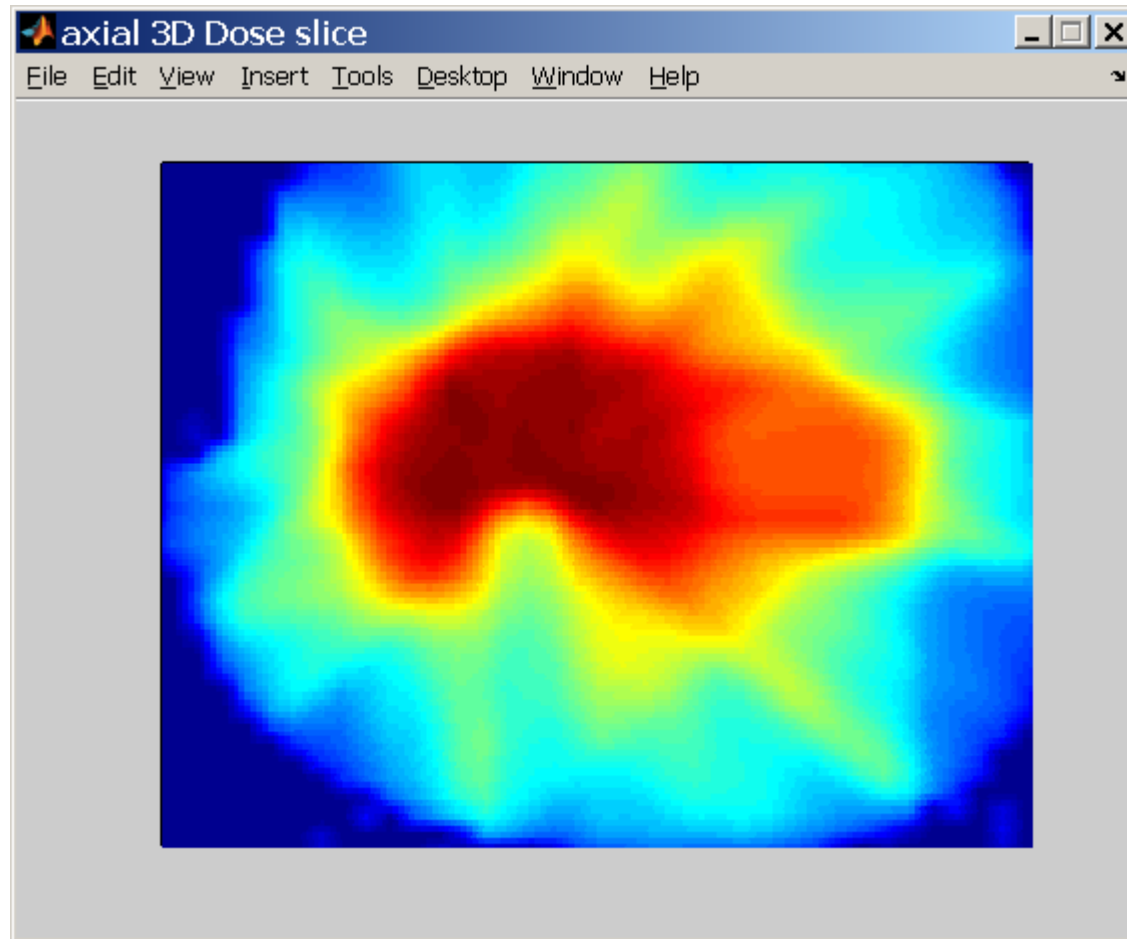
# Comparison: Planned vs. Delivered Distribution
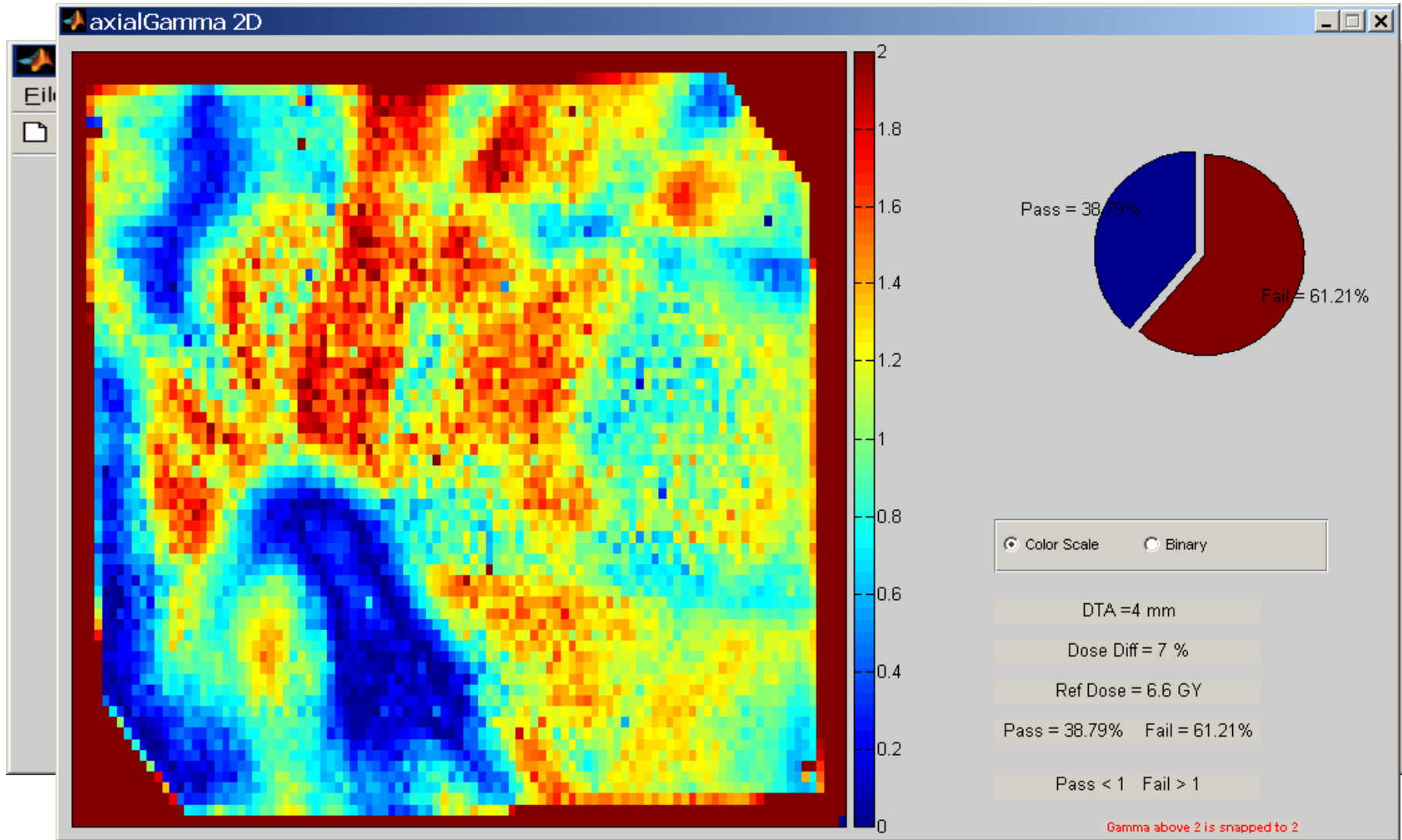
# HN results grouped by accelerator manufacturer

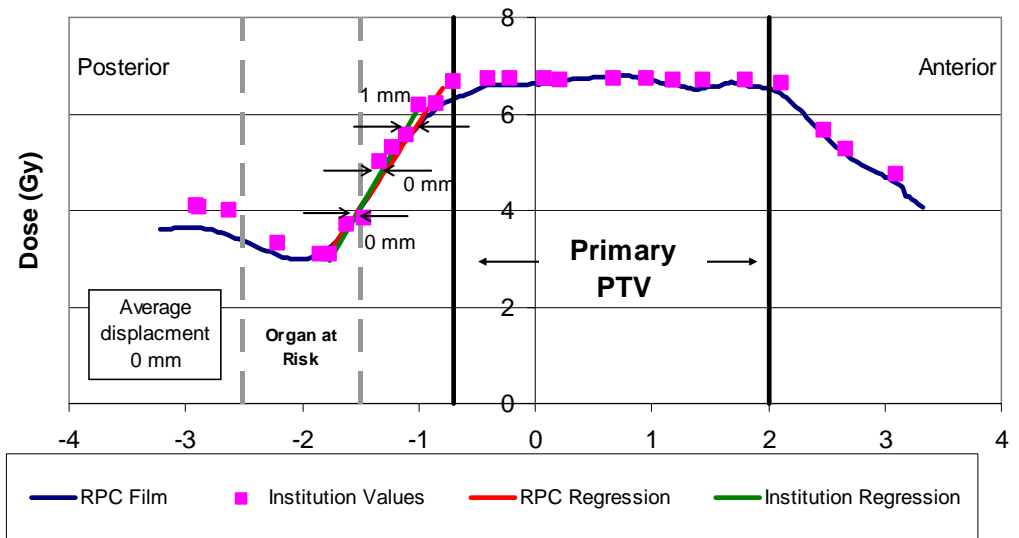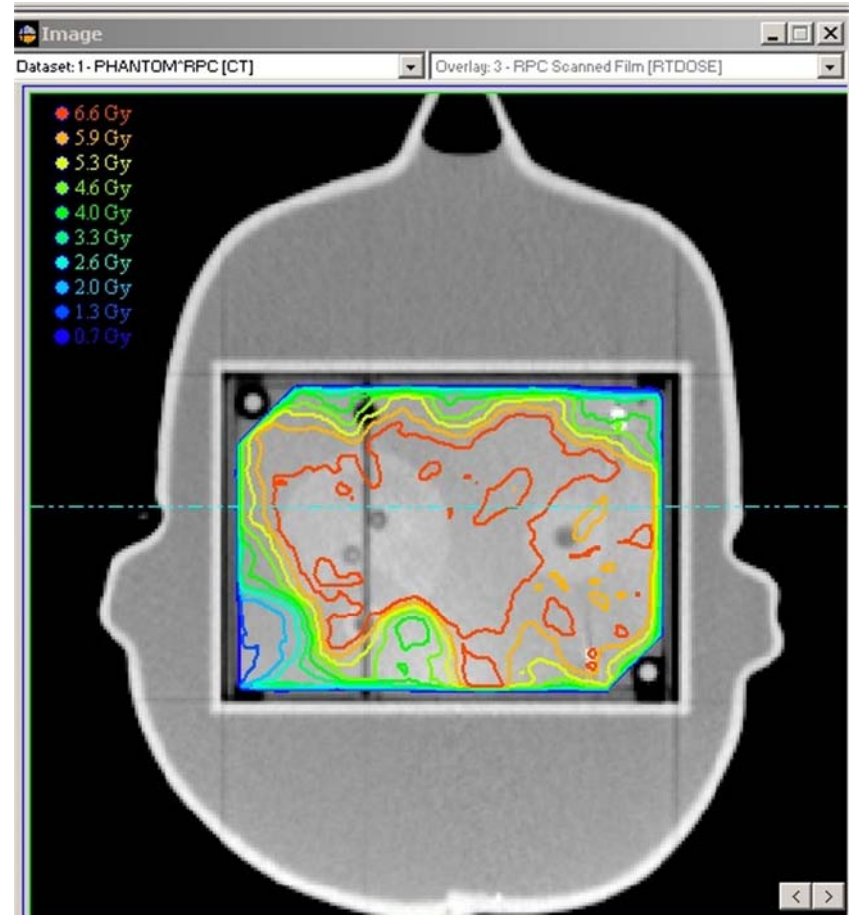| Linear Accelerator Manufacturer | Pass Rate (%) | Attempts | Criteria Failed | | |
|---|---|---|---|---|---|
| | | | Dose | DTA | Dose and DTA |
| BrainLab | 100 | 5 | 0 | 0 | 0 |
| Elekta | 60 | 35 | 11 | 2 | 1 |
| Siemens | 71 | 56 | 10 | 2 | 4 |
| TomoTherapy | 73 | 22 | 5 | 1 | 0 |
| Varian | 80 | 301 | 39 | 8 | 14 |
| total | | 419 | 65 | 13 | 19 |

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# HN results grouped by TPS

| Treatment planning system | Pass Rate (%) | Attempts | Criteria Failed | | |
|---|---|---|---|---|---|
| | | | Dose | DTA | Dose and DTA |
| Corvus | 75 | 32 | 7 | 0 | 1 |
| Eclipse | 85 | 114 | 10 | 4 | 3 |
| Pinnacle | 73 | 168 | 33 | 4 | 8 |
| TomoTherapy | 73 | 22 | 5 | 1 | 0 |
| XiO | 73 | 59 | 7 | 4 | 5 |
| Other | 79 | 24 | 3 | 0 | 2 |
| total | | 419 | 65 | 13 | 19 |

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# HN results grouped by machine/TPS

| Manufacturer/TPS Combination | Pass Rate (%) | Attempts | Criteria Failed | | |
|---|---|---|---|---|---|
| | | | Dose | DTA | Dose and DTA |
| Elekta/Corvus | 0 | 1 | 1 | 0 | 0 |
| Elekta/Pinnacle | 67 | 21 | 6 | 1 | 0 |
| Elekta/XiO | 56 | 9 | 2 | 1 | 1 |
| Elekta/Other | 50 | 4 | 2 | 0 | 0 |
| Siemens/Corvus | 88 | 8 | 1 | 0 | 0 |
| Siemens/Pinnacle | 70 | 27 | 5 | 0 | 3 |
| Siemens/XiO | 77 | 13 | 1 | 1 | 1 |
| Siemens/Other | 67 | 6 | 1 | 1 | 0 |
| Varian/Corvus | 73 | 22 | 5 | 0 | 1 |
| Varian/Eclipse | 86 | 110 | 9 | 3 | 3 |
| Varian/Pinnacle | 75 | 121 | 22 | 3 | 5 |
| Varian/XiO | 76 | 37 | 4 | 2 | 3 |
| Varian/Other | 77 | 13 | 1 | 0 | 2 |
| Other | 77 | 26 | 5 | 1 | 0 |
| total | | 418 | 65 | 13 | 19 |

# HN results grouped by technique

| IMRT technique | Pass Rate (%) | Attempts | Criteria Failed | | |
|---|---|---|---|---|---|
| | | | Dose | DTA | Dose and DTA |
| Dynamic MLC | 87 | 110 | 9 | 2 | 3 |
| IMAT | 50 | 12 | 5 | 0 | 1 |
| Segmental | 74 | 279 | 47 | 10 | 15 |
| TomoTherapy | 76 | 17 | 3 | 1 | 0 |
| Experimental | 0 | 1 | 1 | 0 | 0 |
| total | | 419 | 65 | 13 | 19 |

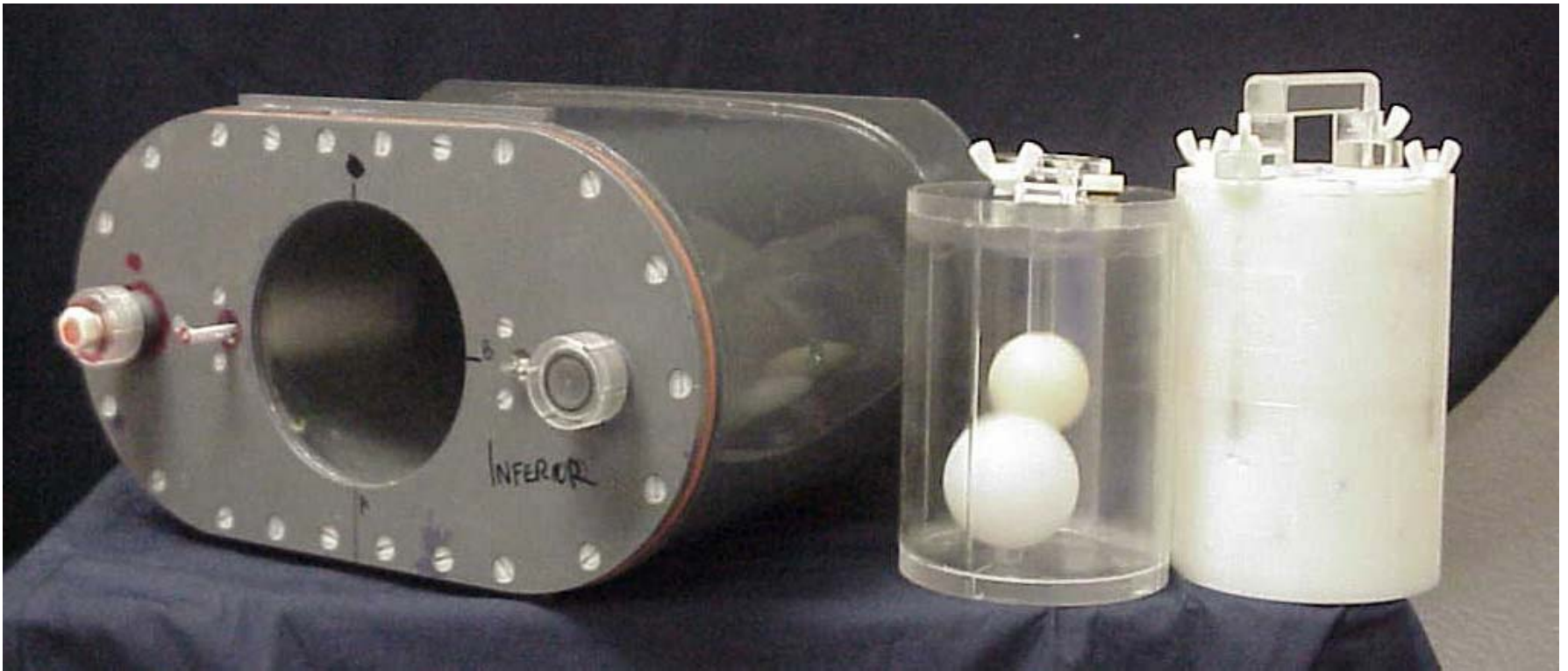# Pass Rate vs. Physicists

Number of Physicists per Machine
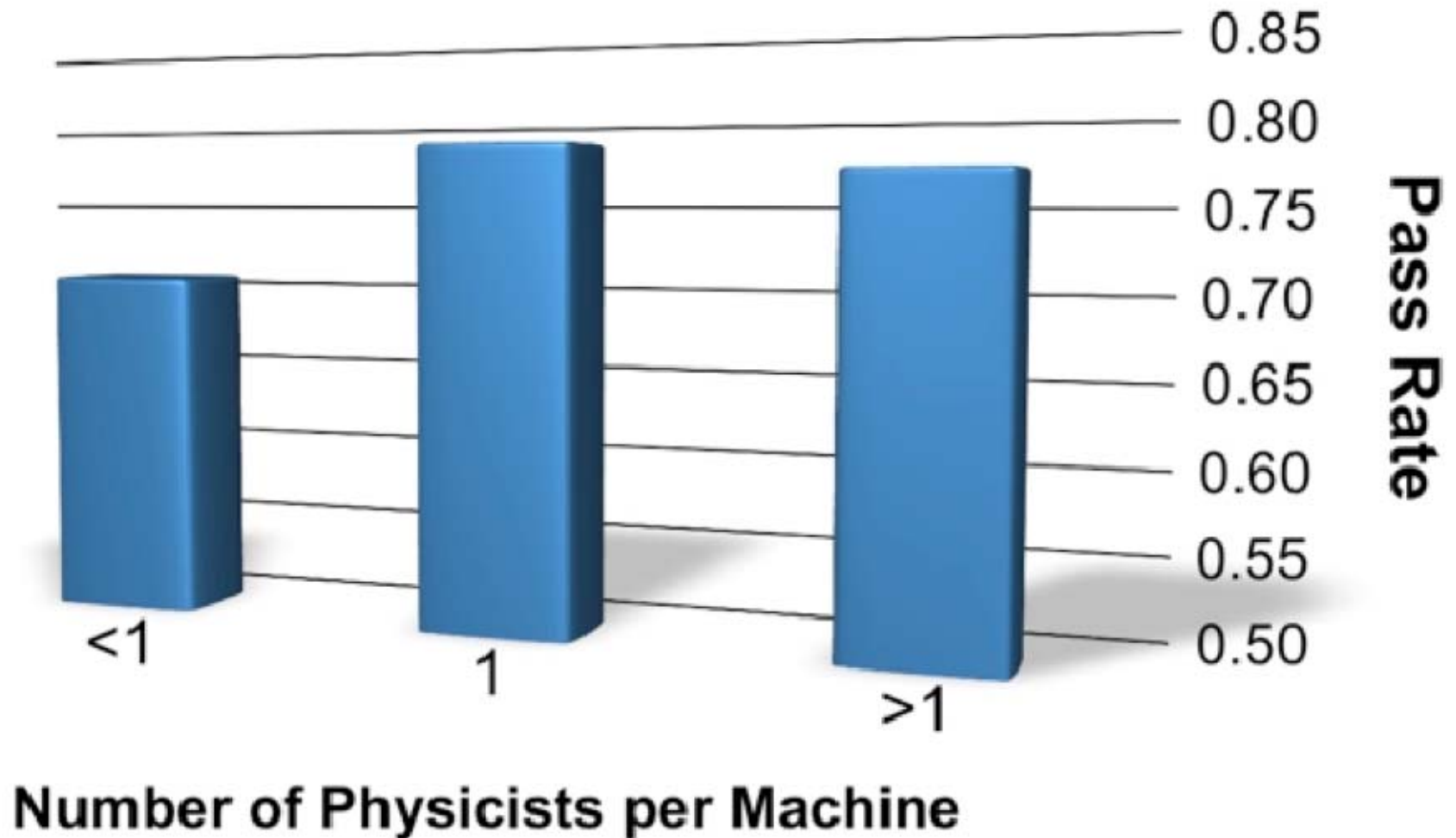
Pass Rate vs. Machines

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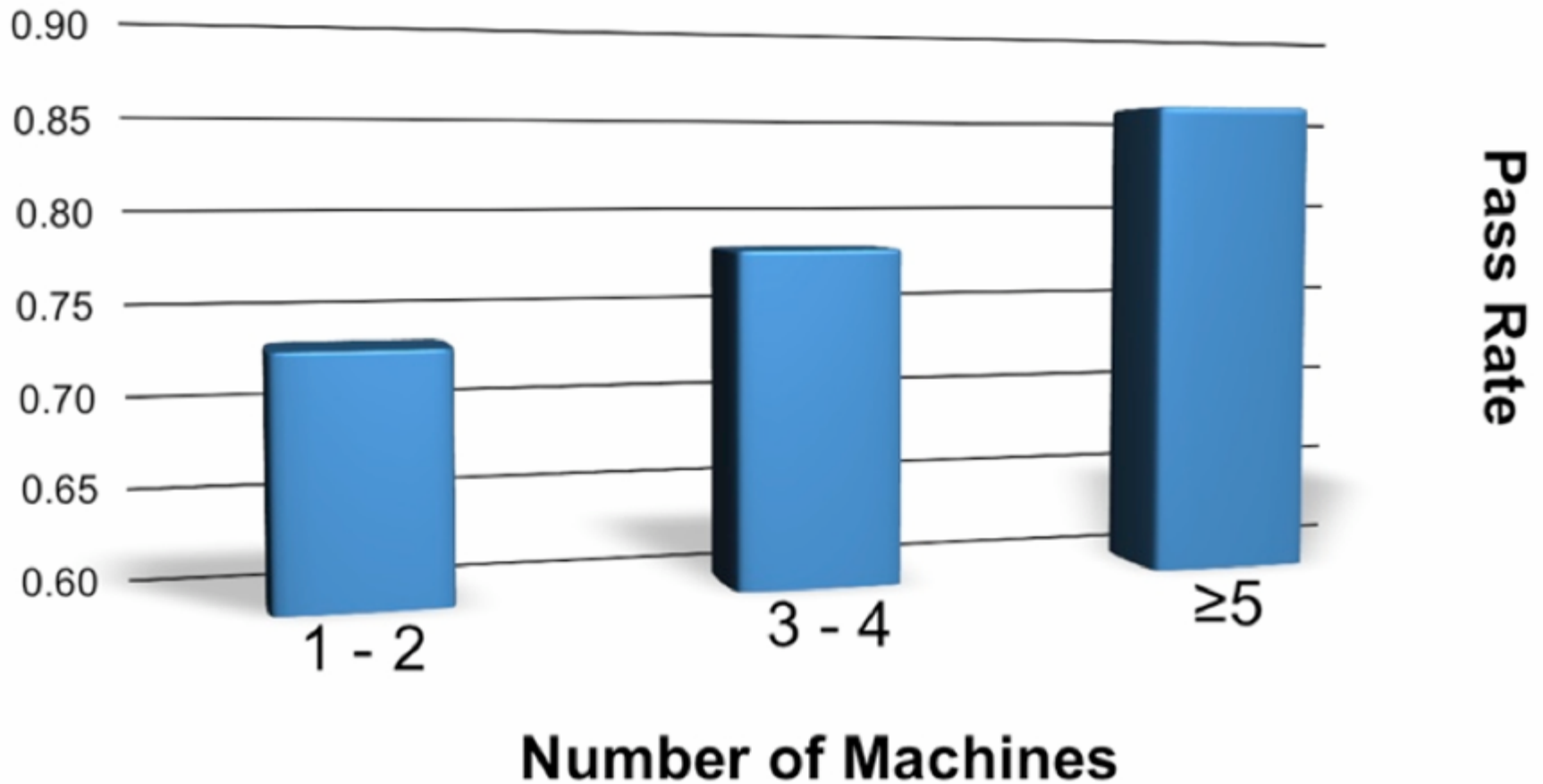
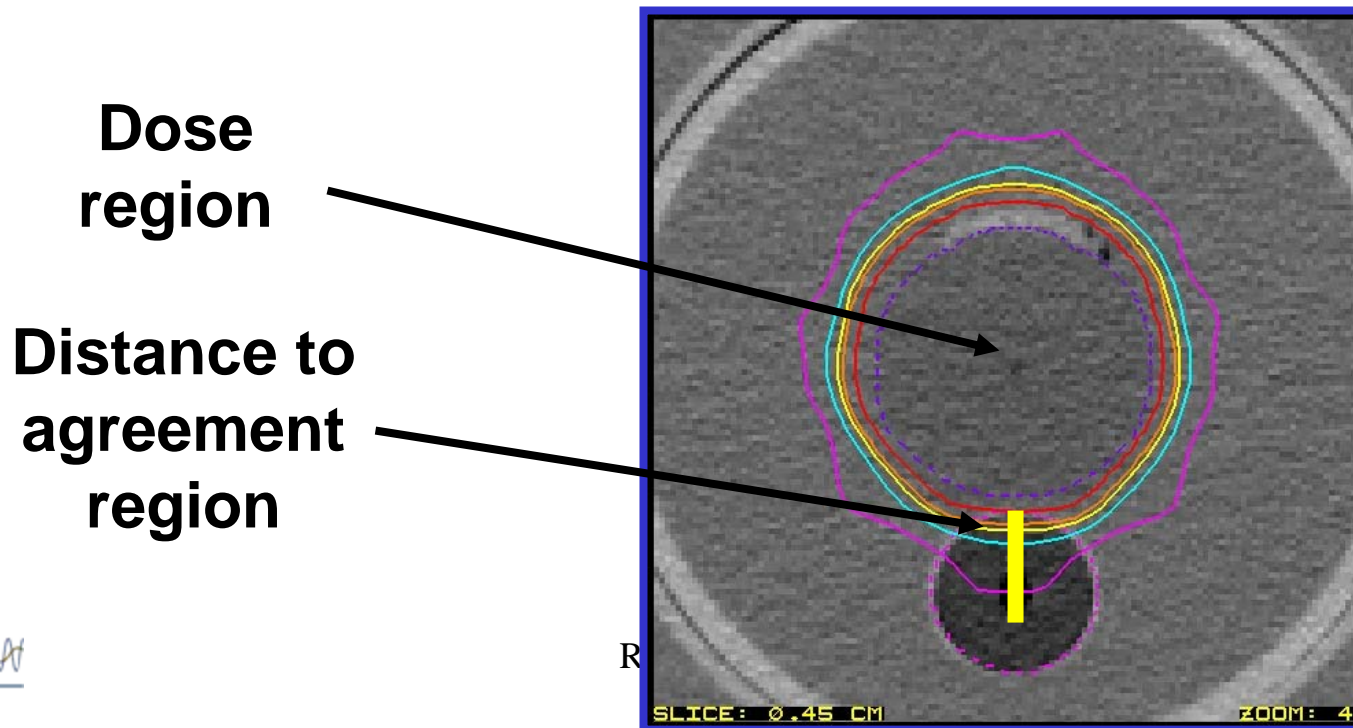# Prostate Phantom

# Criteria for credentialing

- **RPC/Inst dose in PTV:  0.93-1.07**

- **distance to agreement in high gradient regions near OARs: $\leq$ 4 mm**



**Dose region**

**Distance to agreement region**

# IMRT prostate phantom results
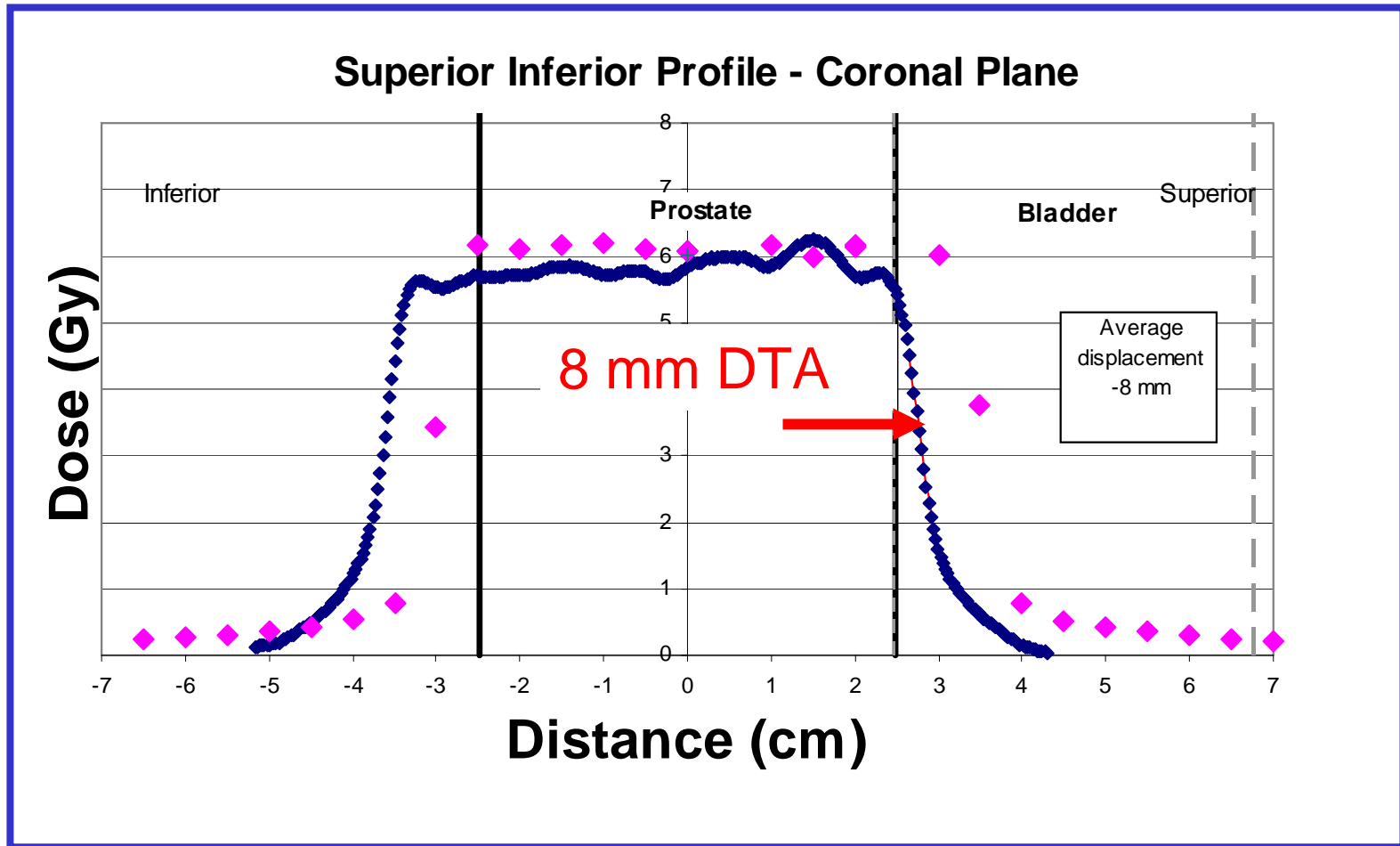
- **93 irradiations were analyzed**

- **76 irradiations passed the criteria**
  - **7 institutions irradiated multiple times**

- **17 irradiations did not pass the criteria**

- **85 institutions are represented**

**Only 79% of <u>institutions</u> passed the criteria on the first irradiation.**

# Good prostate profile



Anterior Posterior Profile- Sagittal Plane

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# Not so good prostate profile
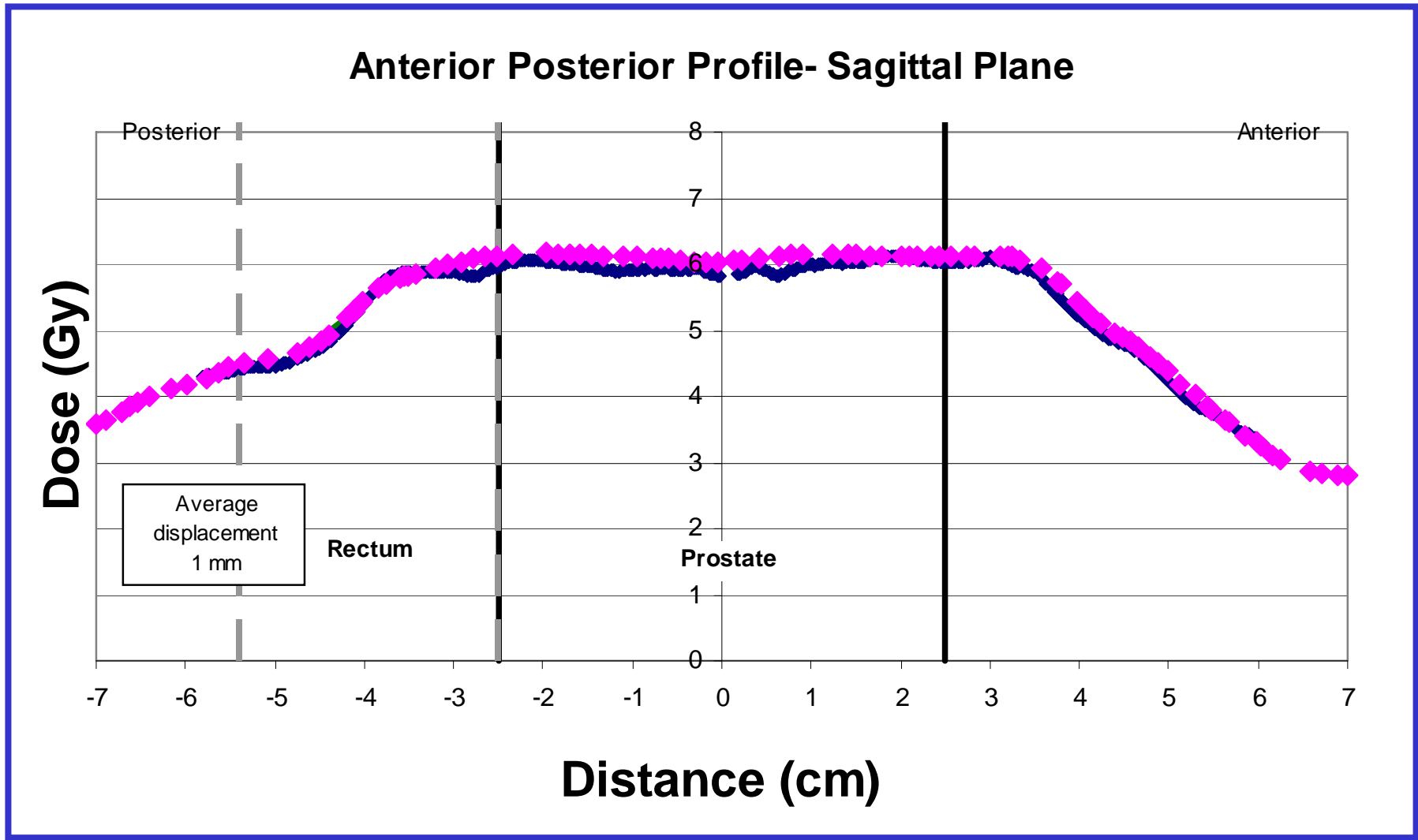


Superior Inferior Profile - Coronal Plane

# Explanations for Failures

| Explanation | Minimum # of occurrences |
| --- | --- |
| Incorrect output factors in TPS | 1 |
| Incorrect PDD in TPS | 1 |
| IMRT plan that exceeds accel capabilities | 3 |
| Software error | 1 |
| Inadequacies in beam modeling at leaf ends (Cadman, et al; PMB 2002) | 14 |
| QA technique | 3 |
| Errors in couch indexing with Peacock system | 3 |
| Equipment performance | 2 |
| Setup errors | 7 |

# Conclusions

- **The RPC's IMRT phantoms provide a comprehensive evaluation of IMRT for clinical trials**

- **QA of IMRT is important!**

http://rpc.mdanderson.org/rpc/

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Thank you!