The Radiological Physics Center's Experience with IMRT

RSNA

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Acknowledgements

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Purposes of Credentialing for IMRT Clinical Trials

- Education
- Evaluate ability to deliver dose
- Improve understanding of protocol
- **Reduce deviation rate**

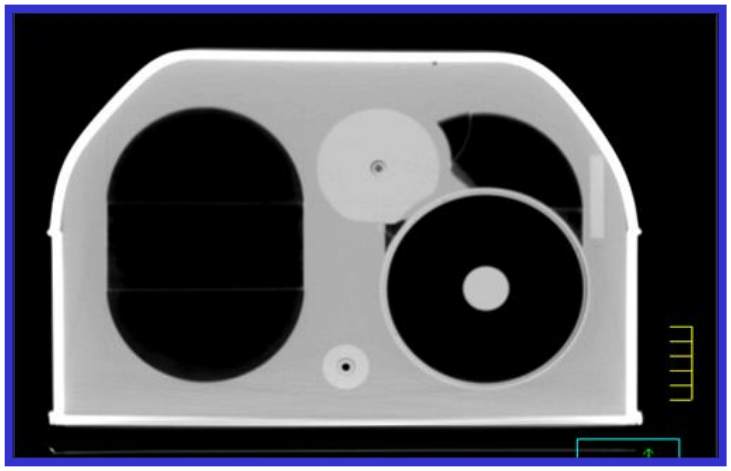
General Credentialing Process

- 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

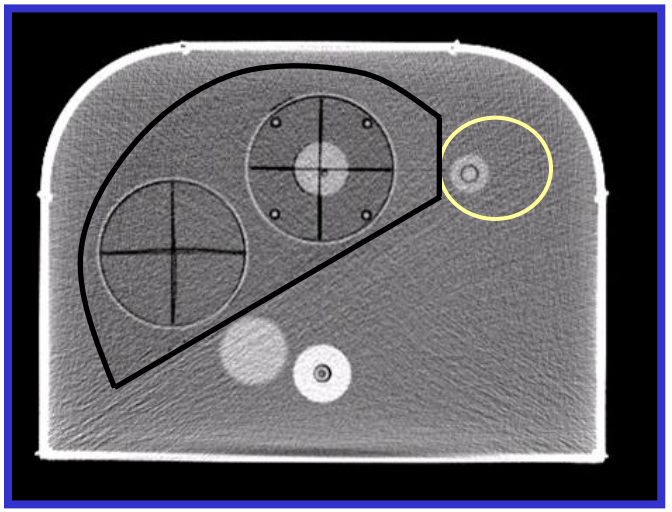
Pelvis (4)



Thorax (9)

H&N IMRT (25)

SRS Head (4)

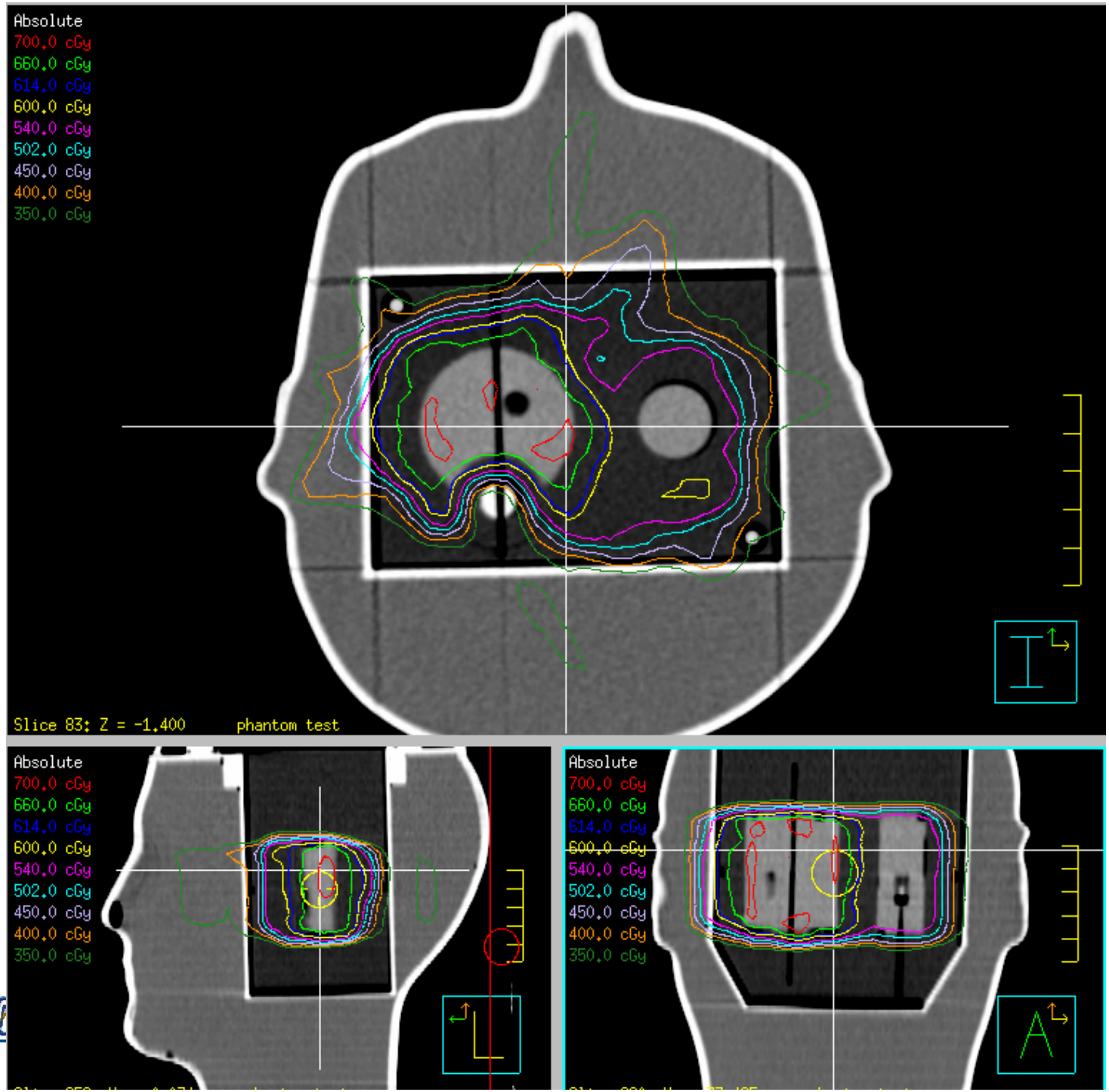


Liver (2)

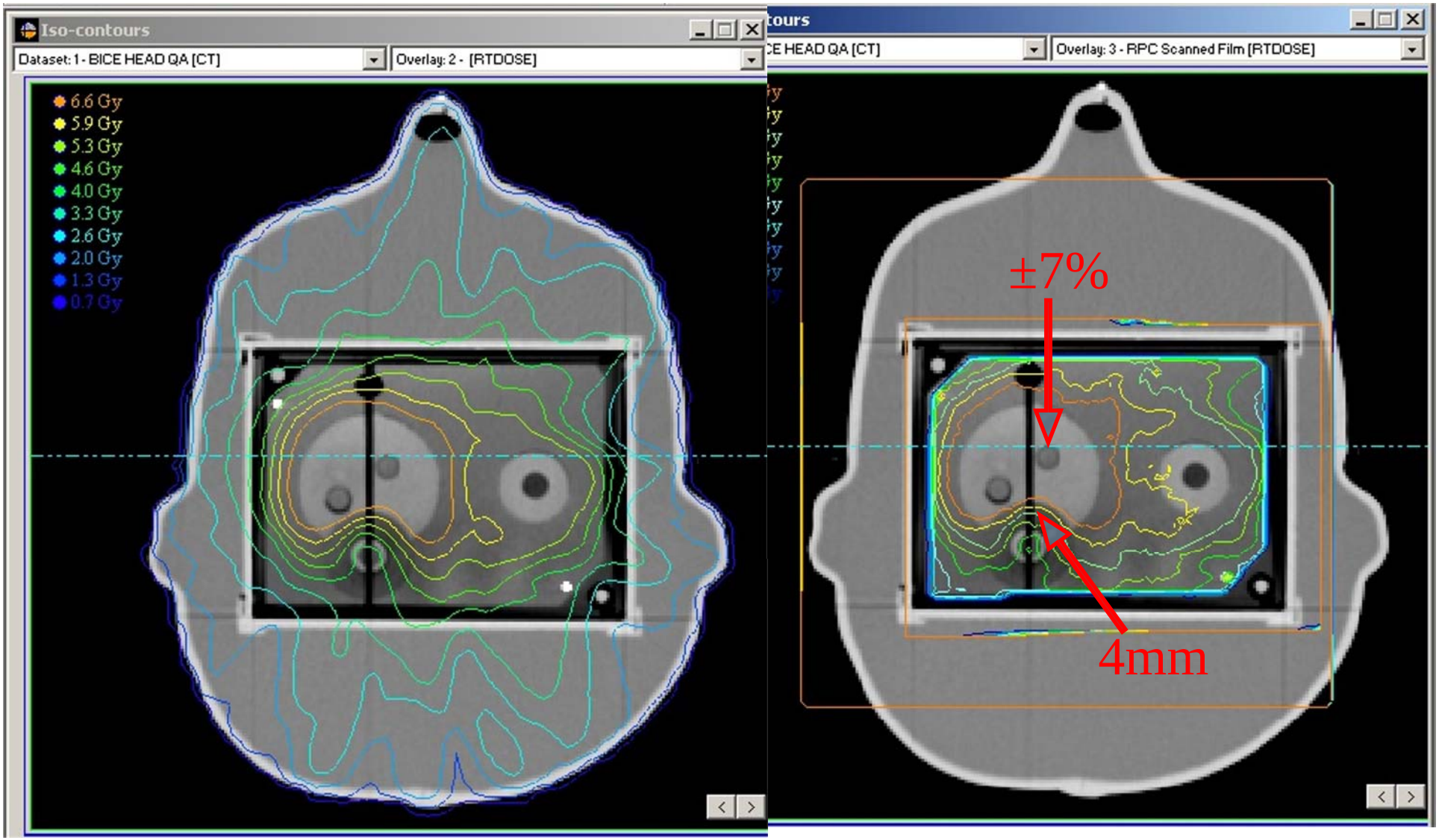
IMRT Credentialing

400+ institutions have successfully irradiated an RPC IMRT phantom

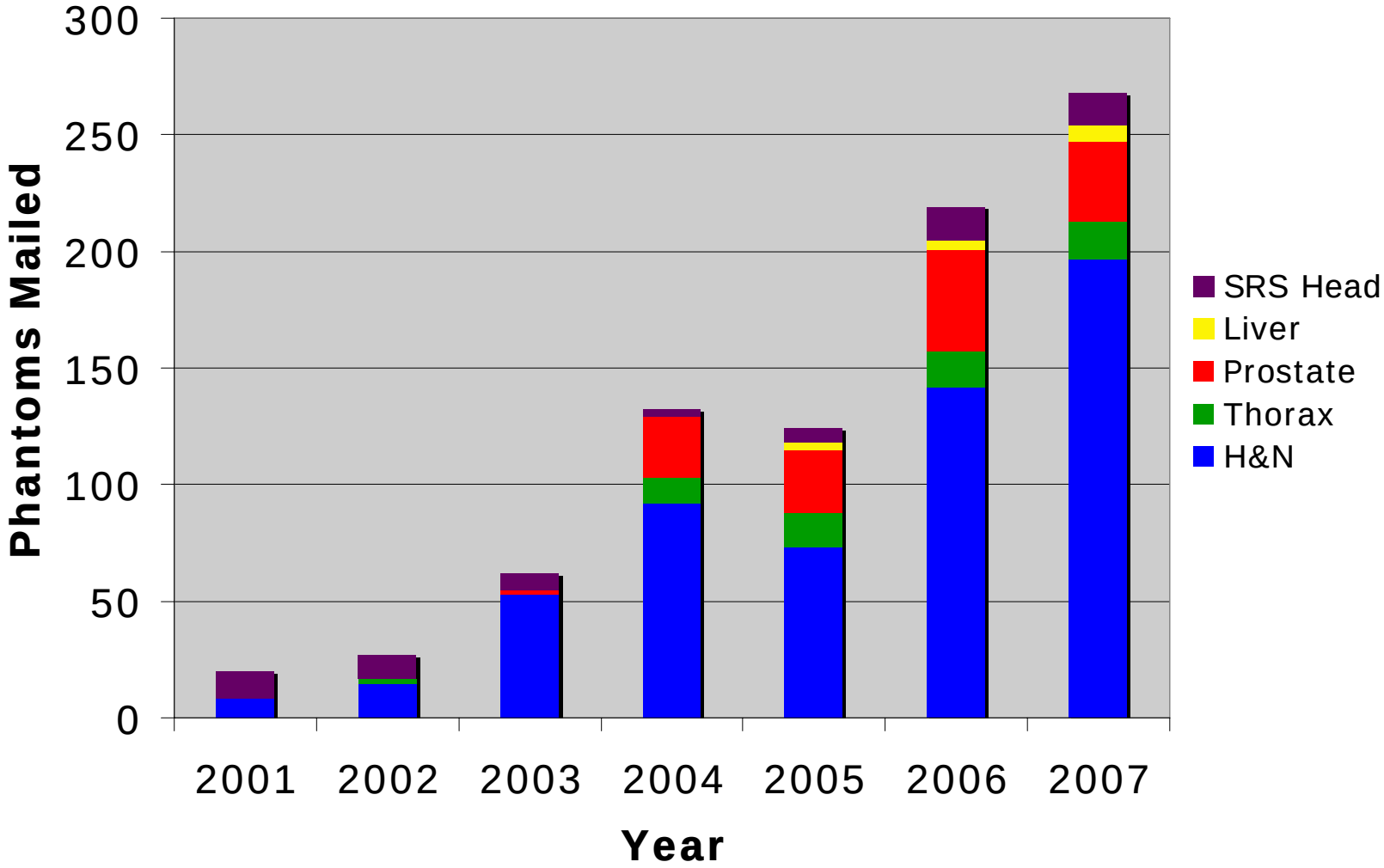
Scan, Plan, Treat a phantom


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



Number of phantom mailings

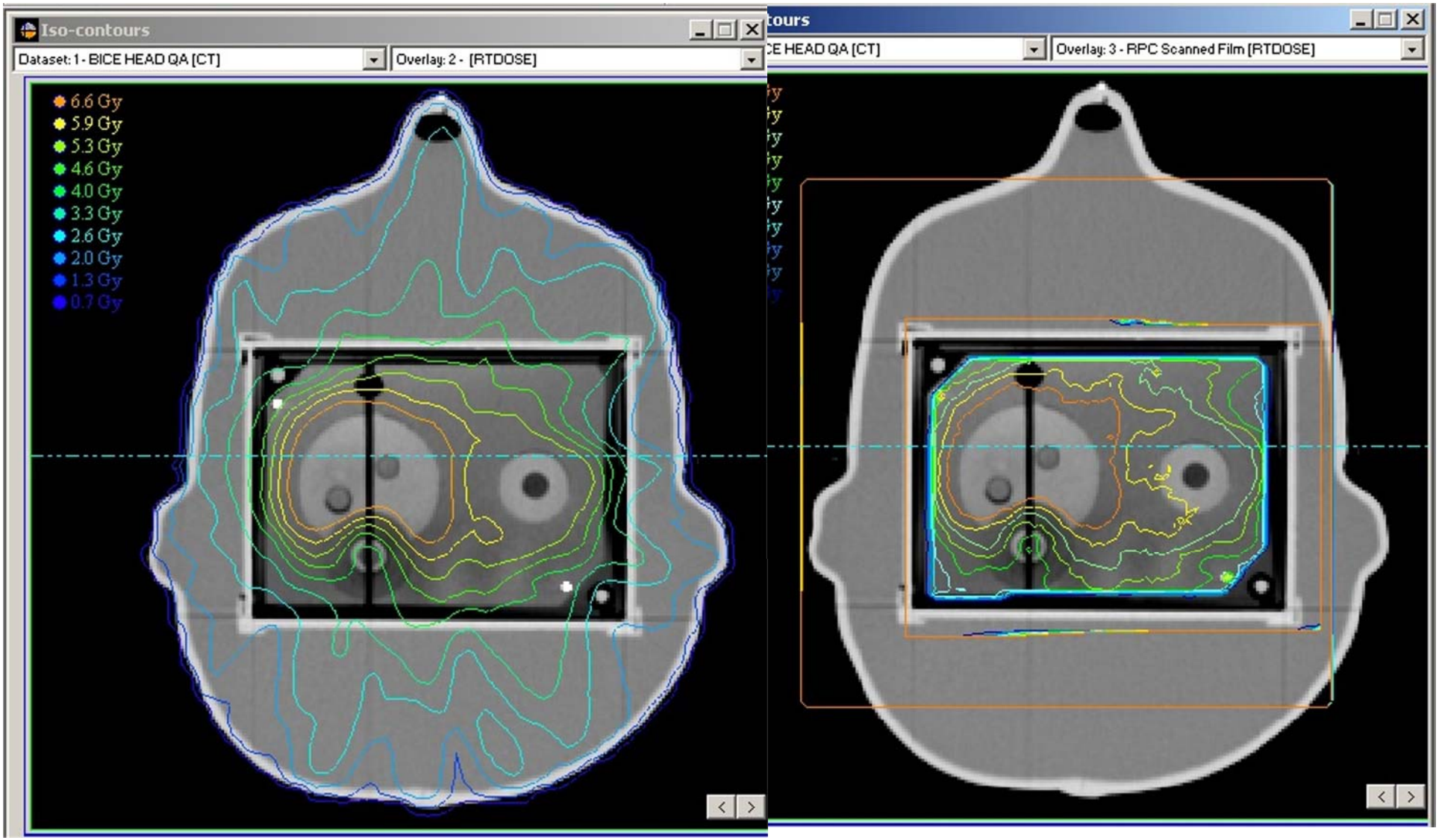


IMRT H&N phantom results

- 419 irradiations were analyzed
- 322 irradiations passed the criteria
  - 68 institutions irradiated multiple times
- 97 irradiations did not pass the criteria
- 322 institutions are represented

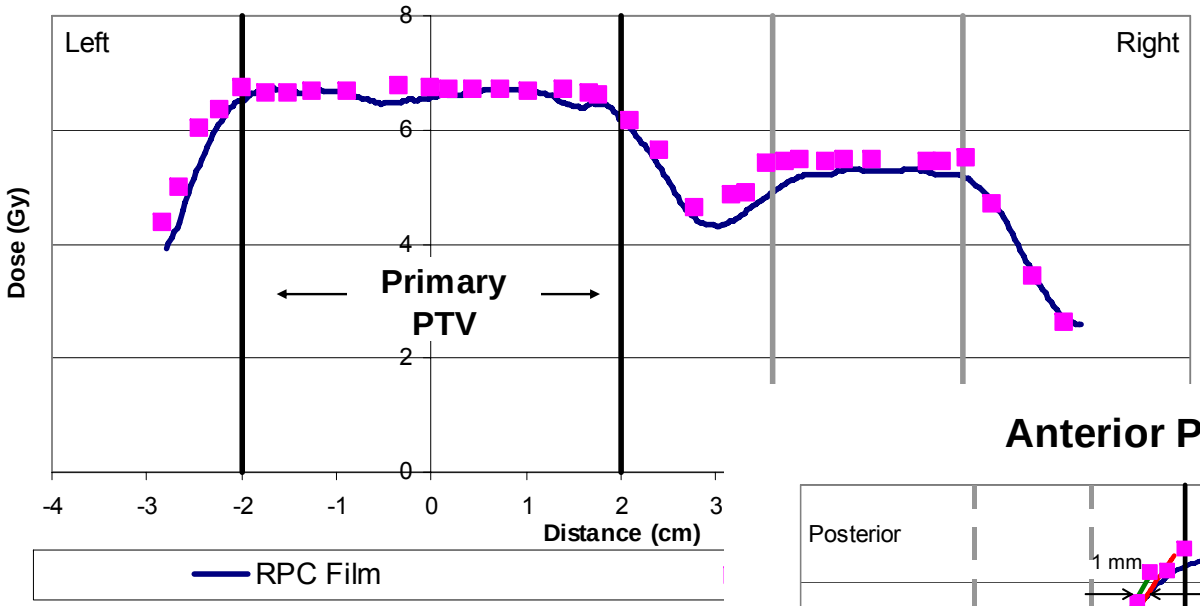
Only 76% of institutions passed the criteria on the first irradiation.

Plan vs. Treatment

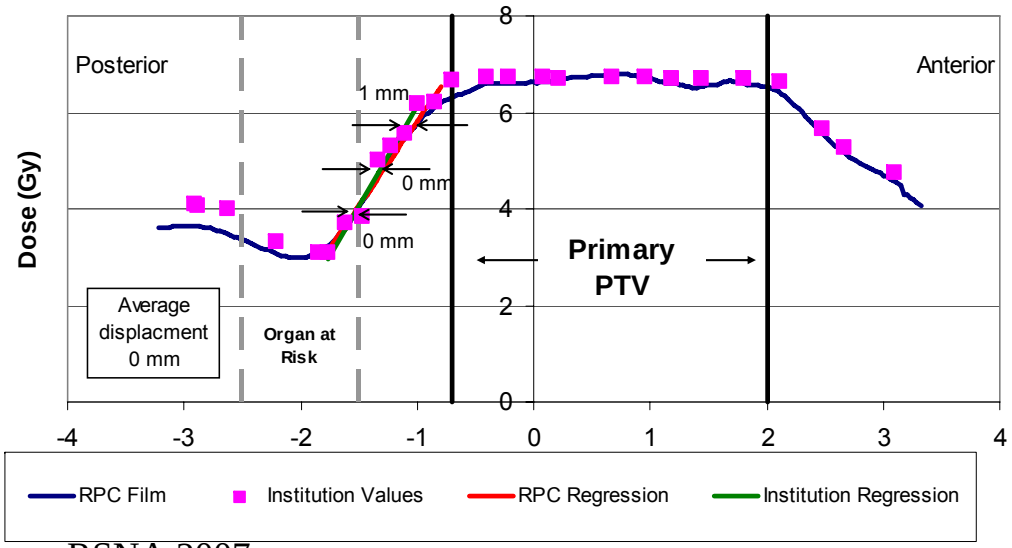


Good HN profile

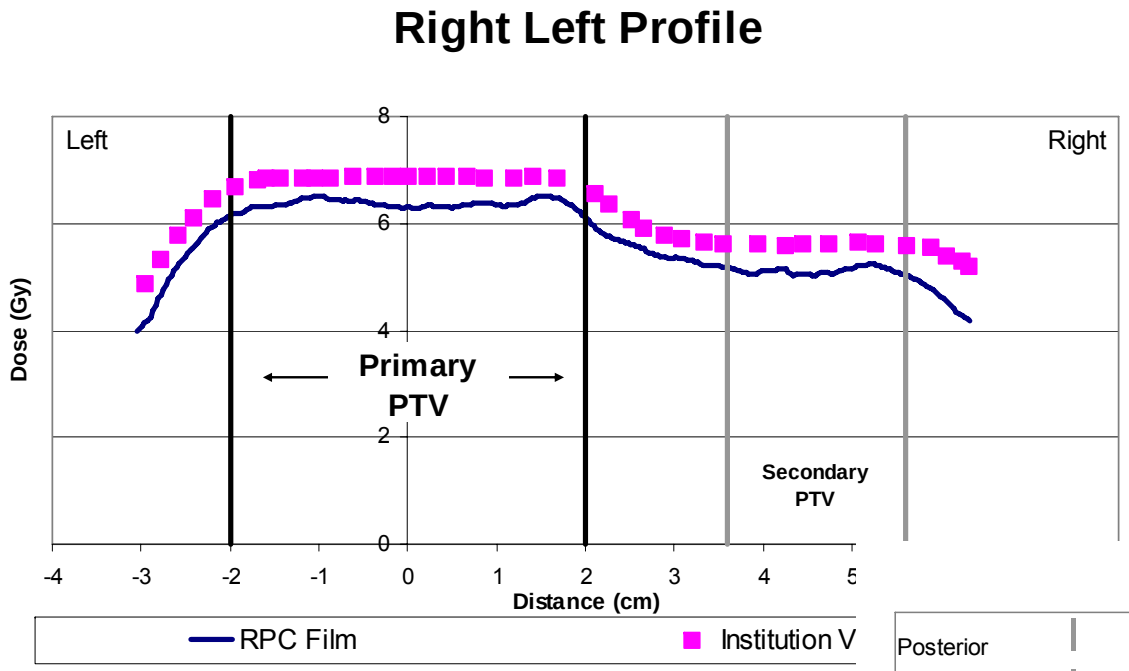
Right Left Profile



Anterior Posterior Profile

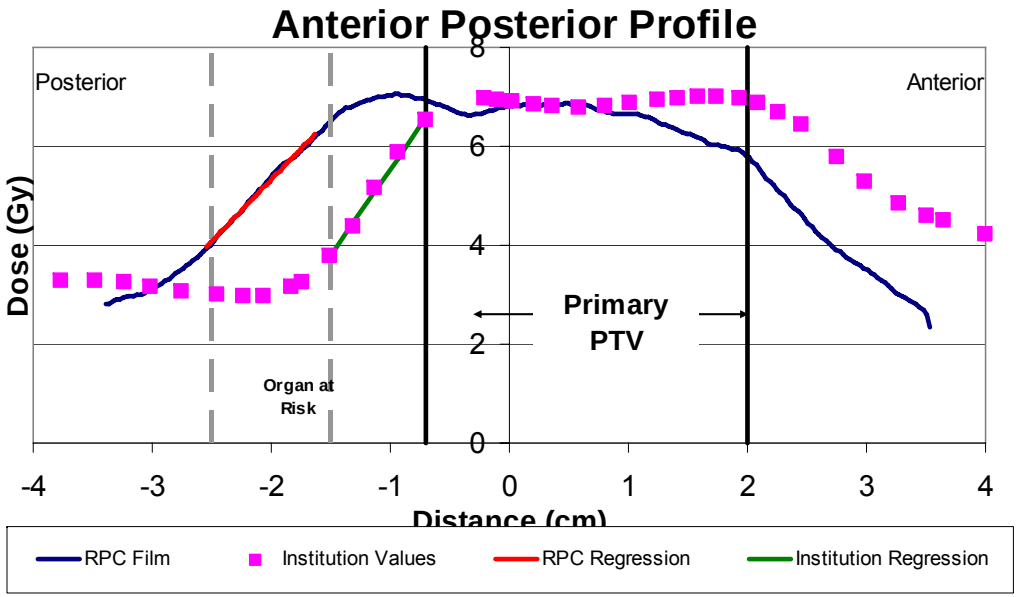


Not so good HN profile

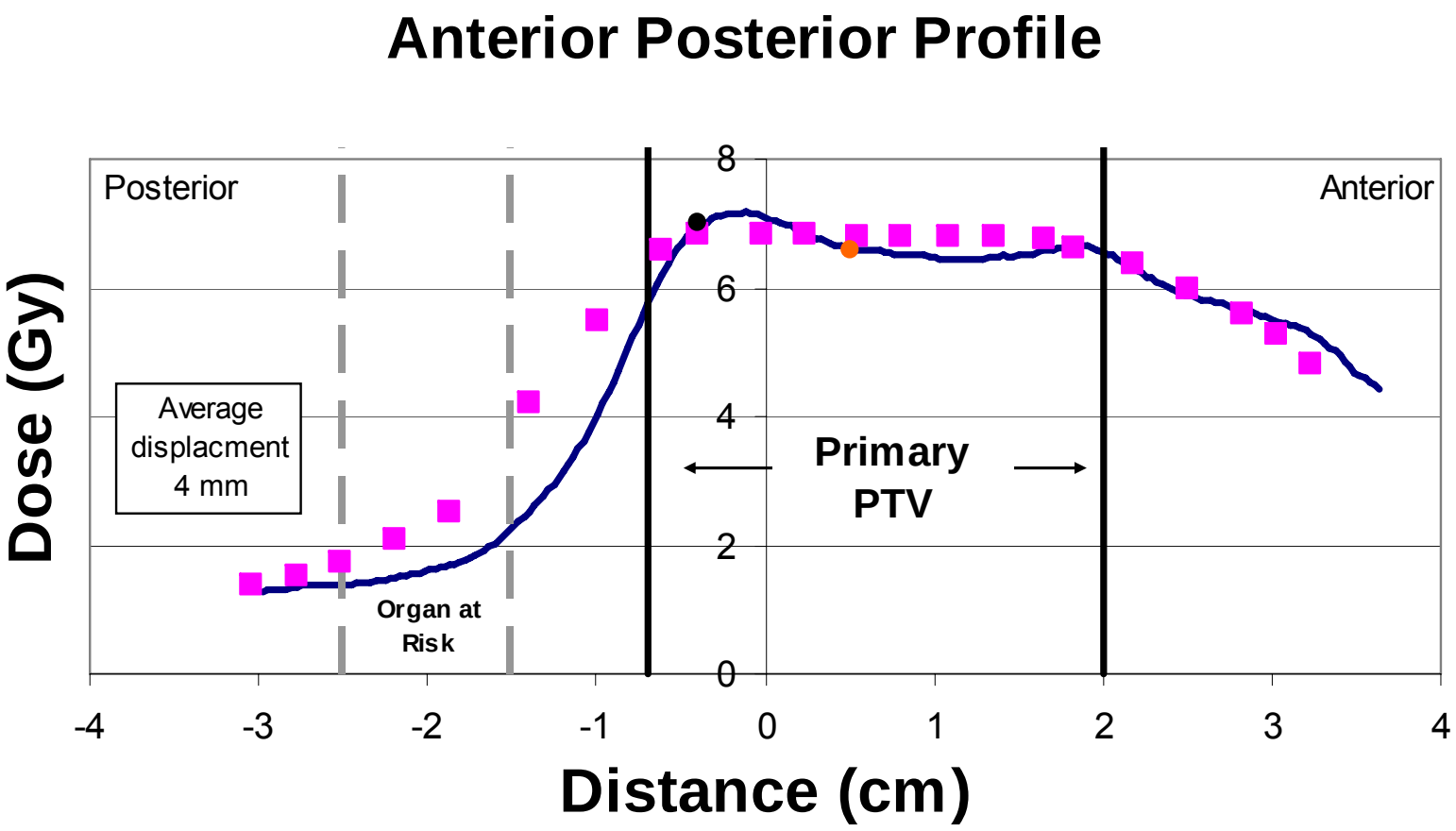


TLD 5-8% low

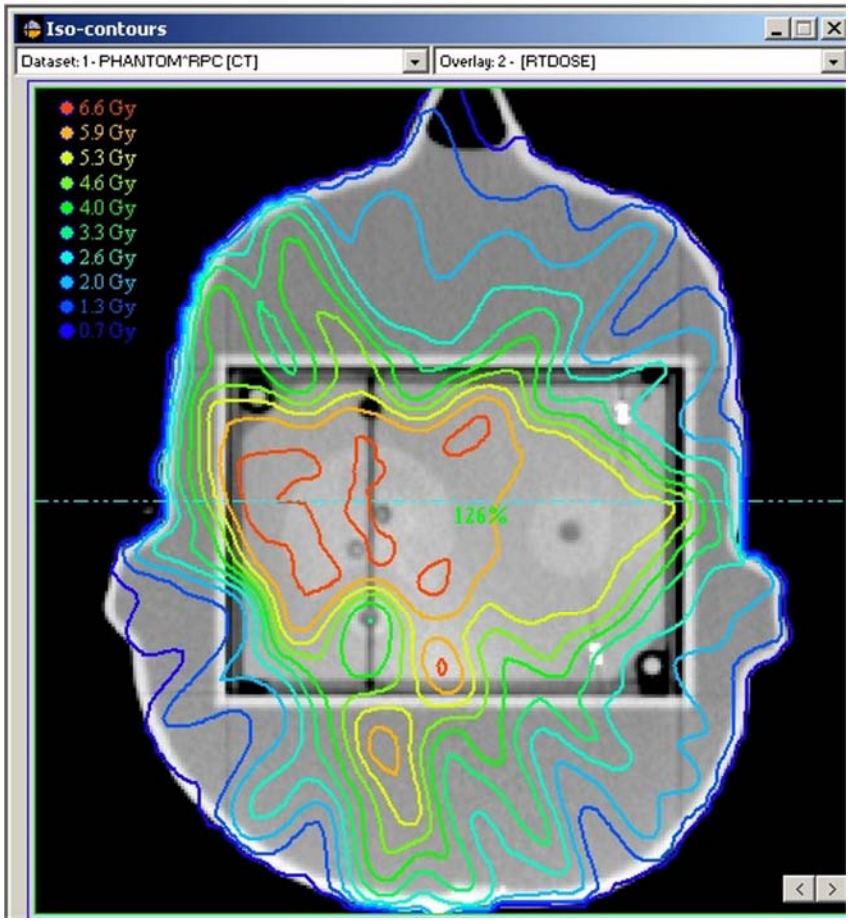
10 mm shift

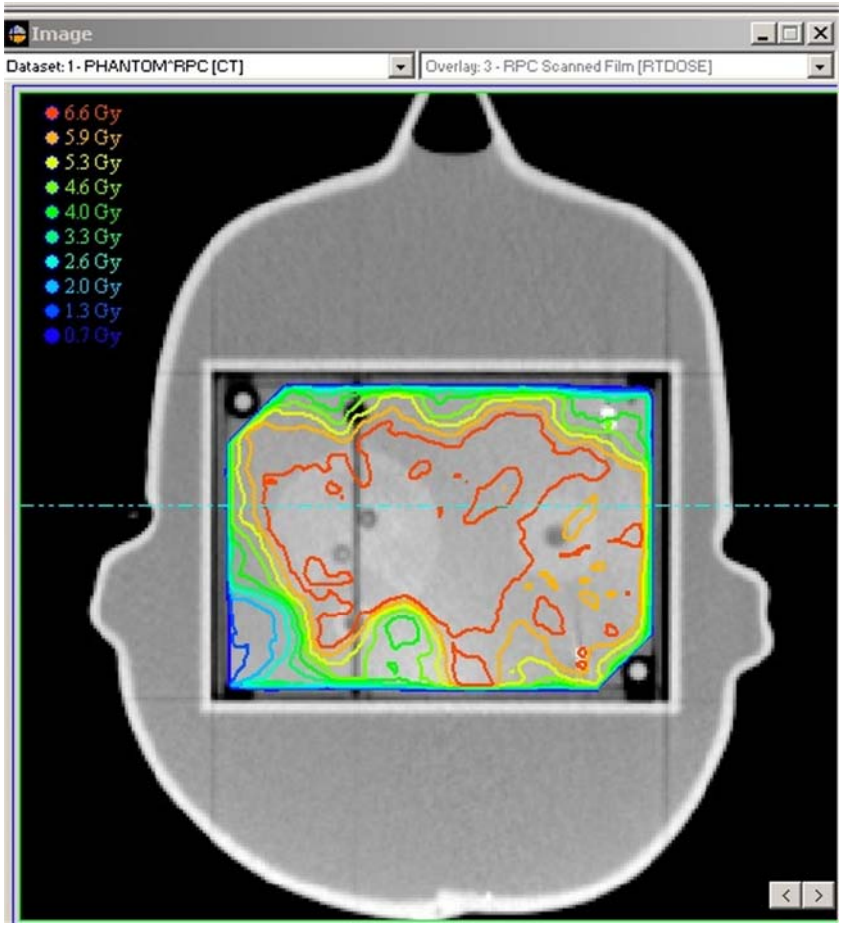


Not so good HN profile

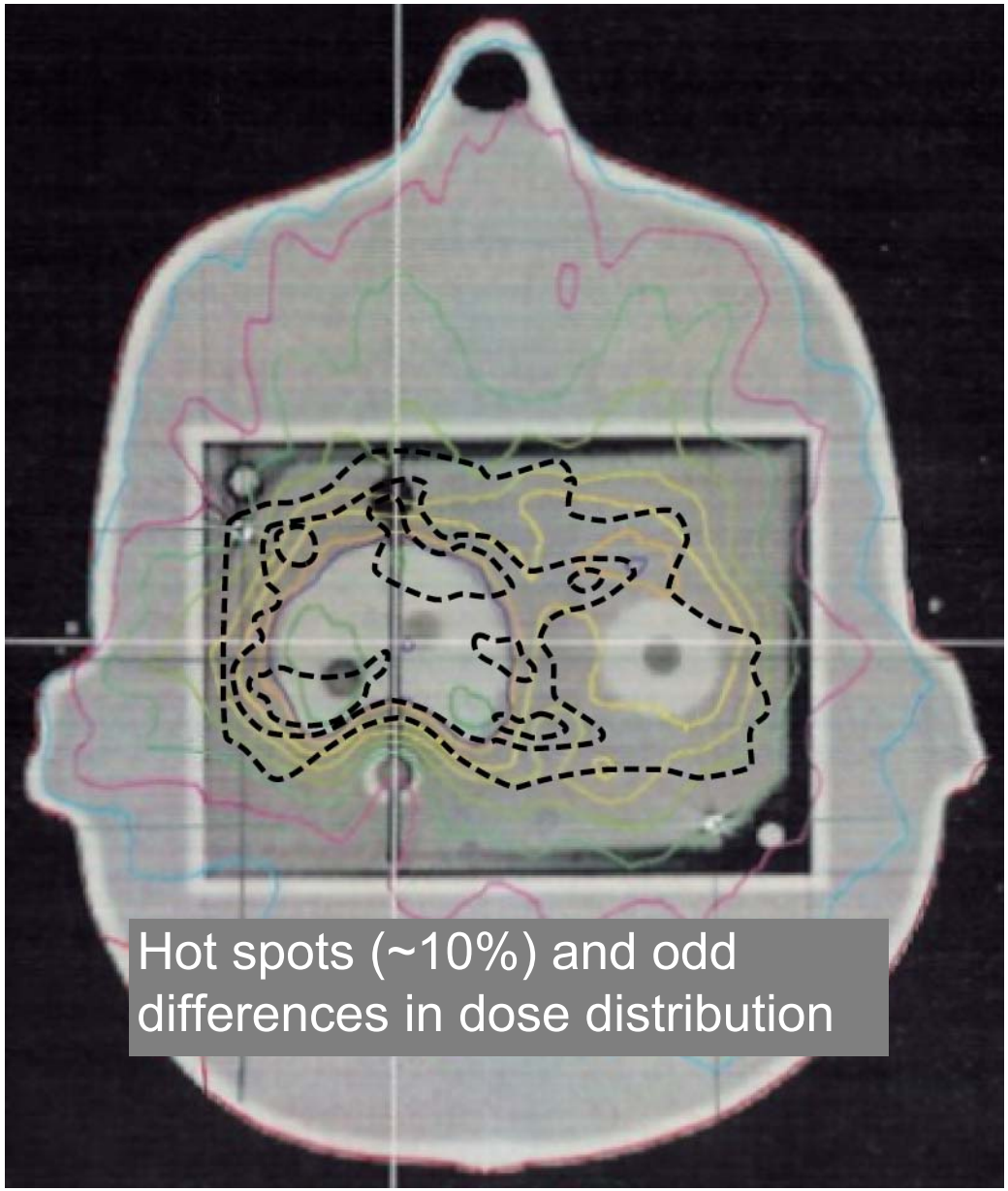


Examples of failures





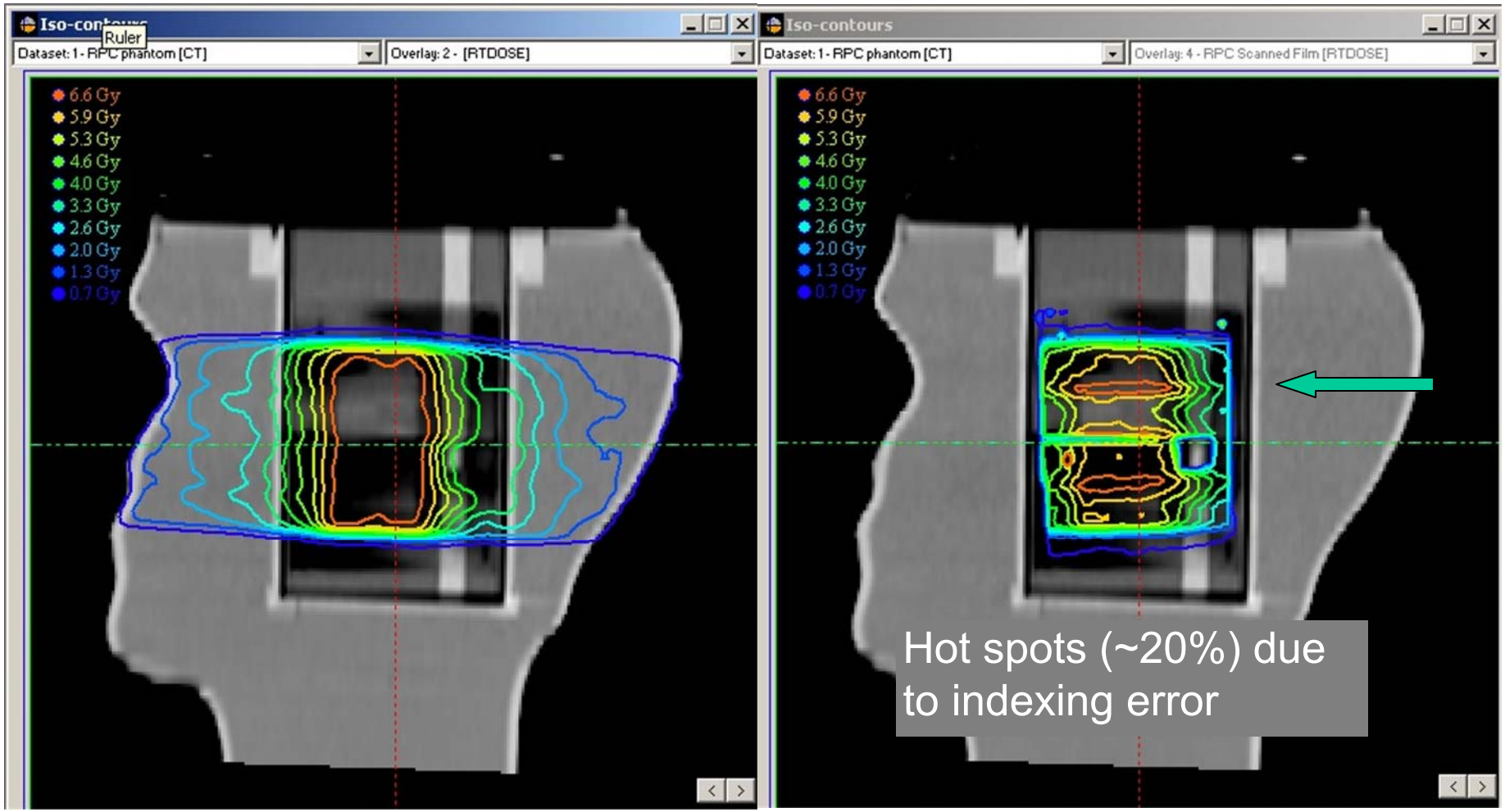
Comparison: planned vs. delivered distribution



Couch indexing error

Institution's Plan

Delivered Dose



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

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

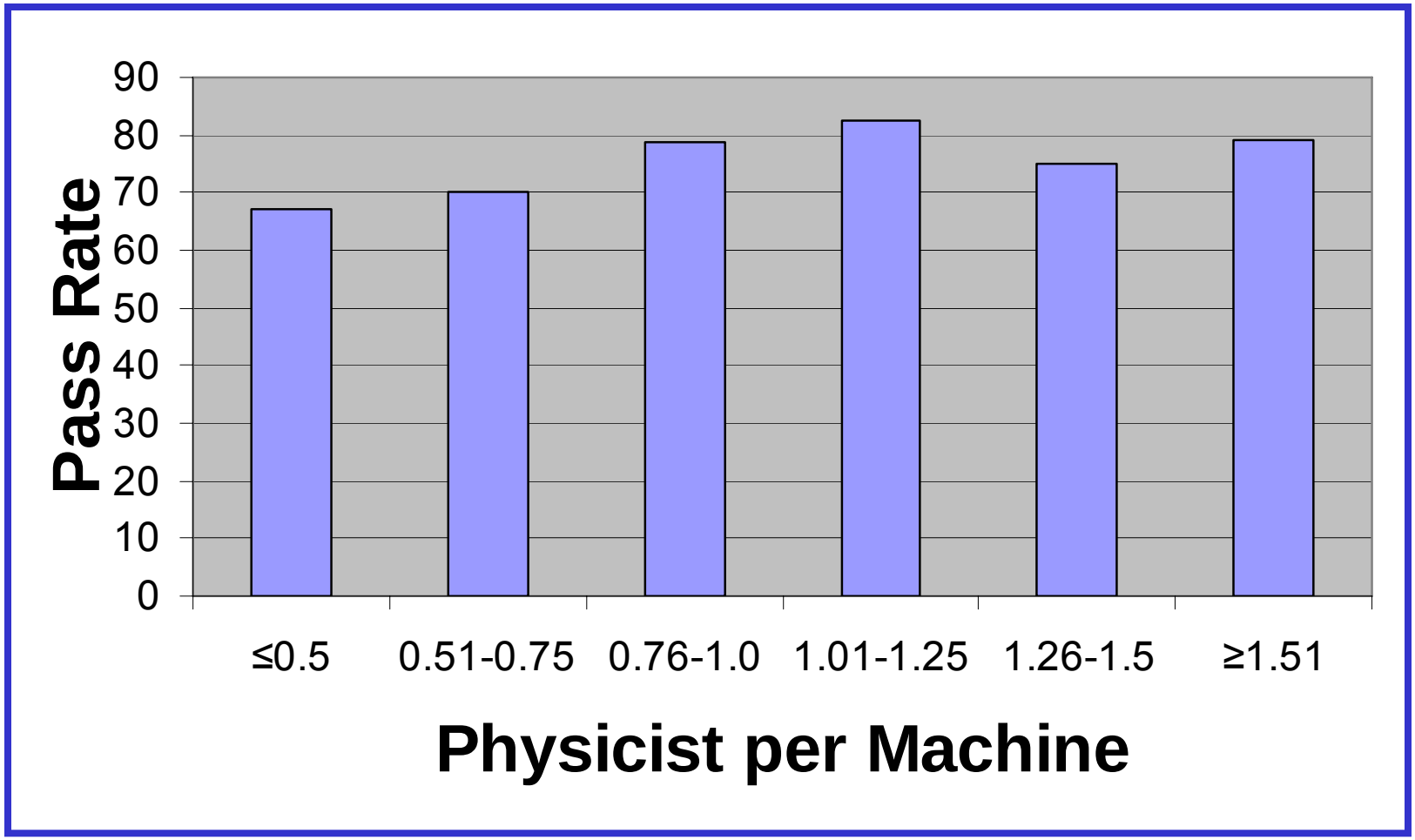
HN results grouped by machine/TPS

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

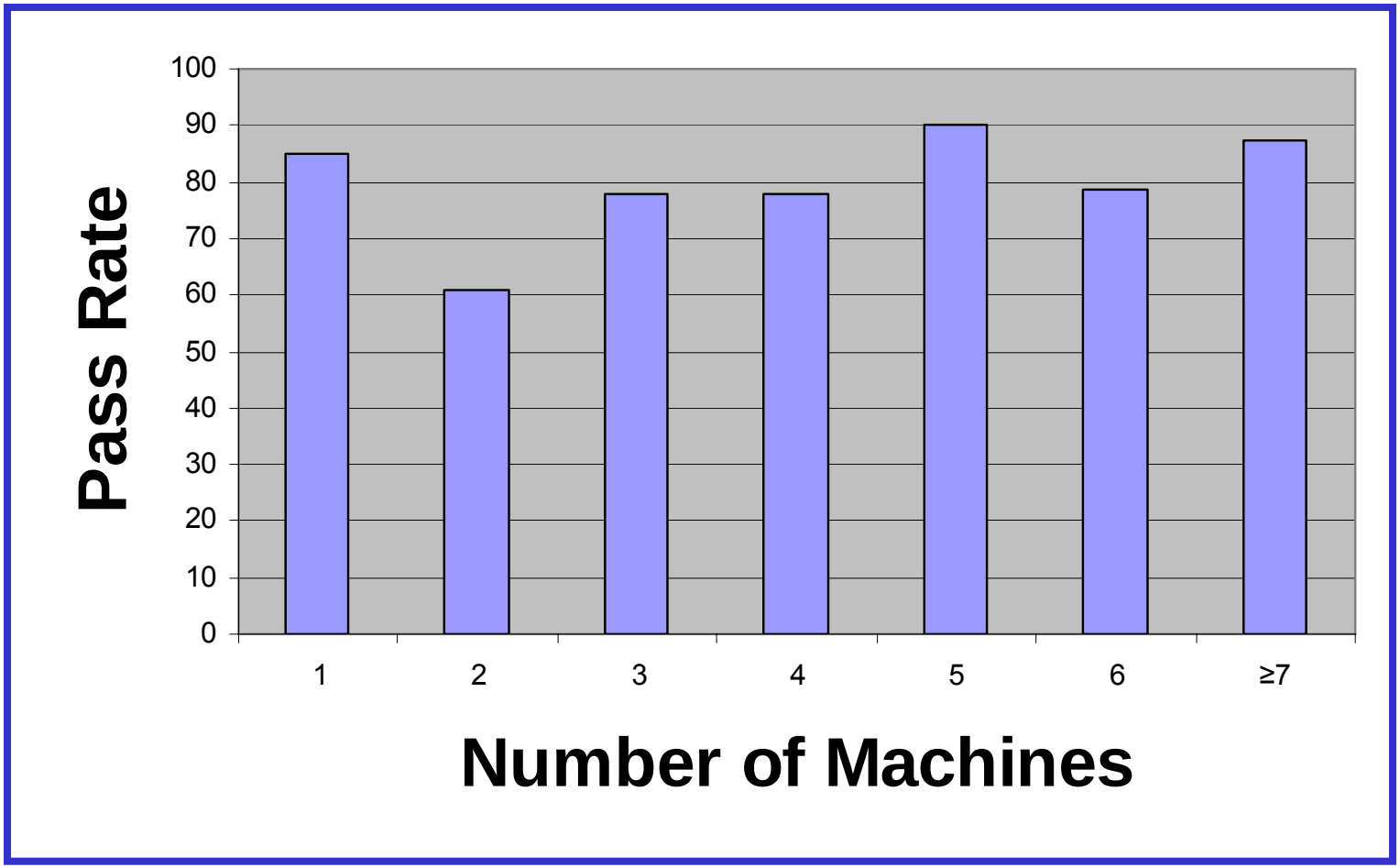
HN results grouped by technique

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

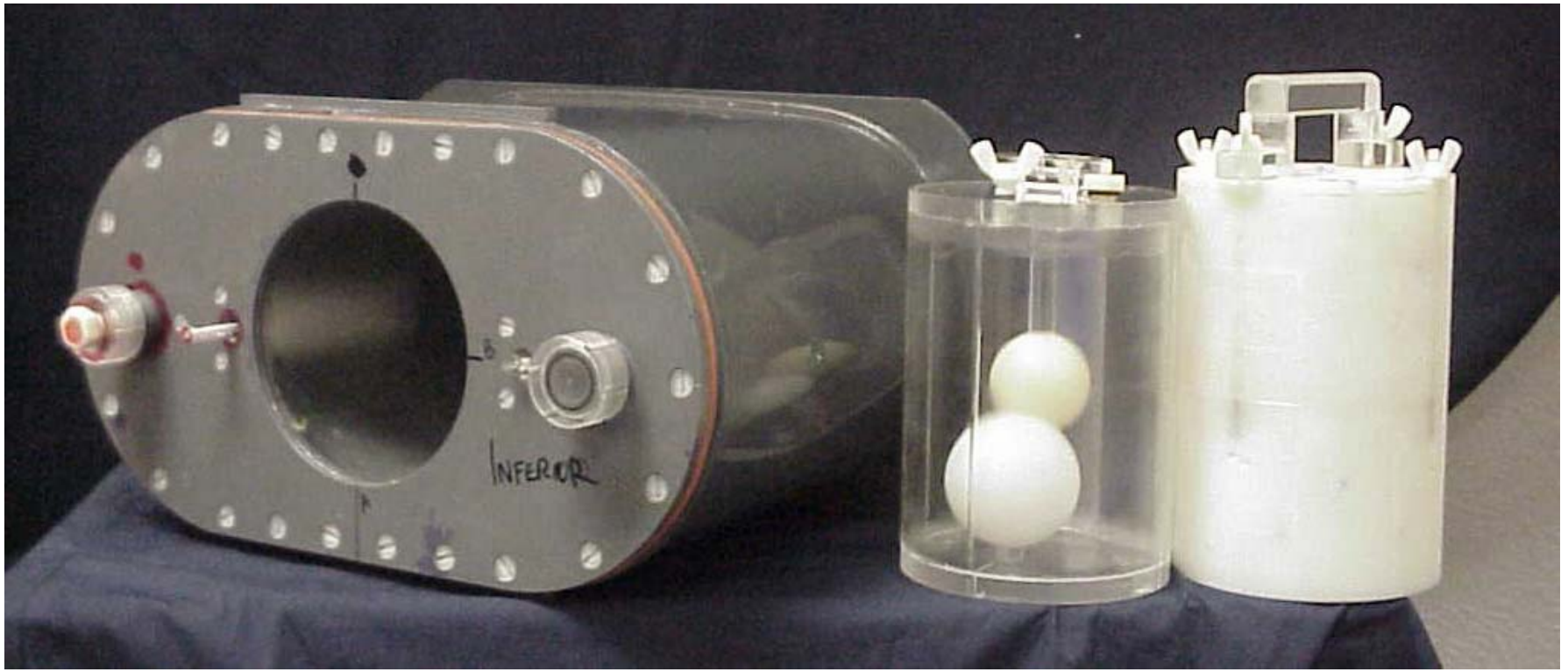
Physicist per machine



Number of machines



Prostate Phantom

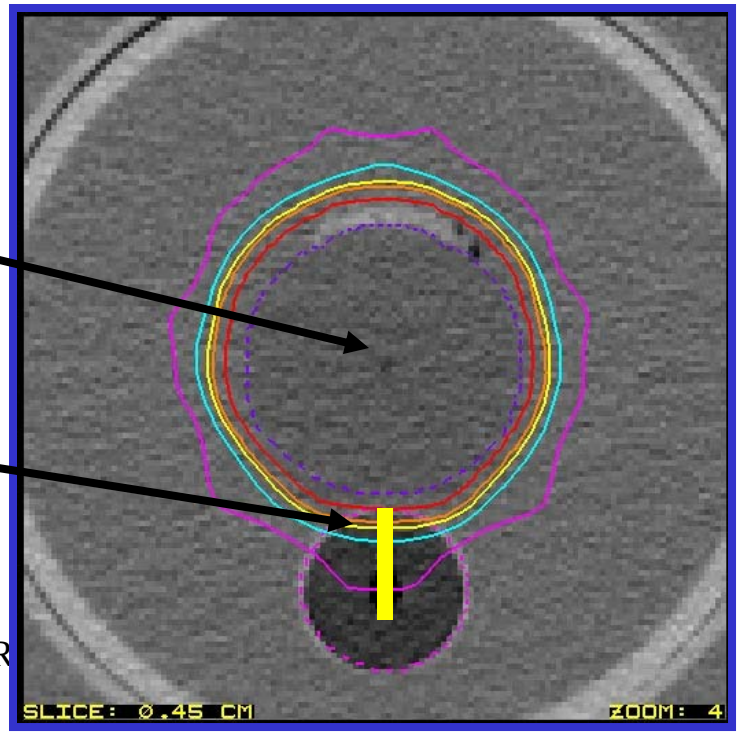


Criteria for credentialing

- **RPC/Inst dose in PTV: 0.93-1.07**
- **distance to agreement in high gradient regions near OARs: ≤ 4 mm**

Dose region

Distance to agreement region

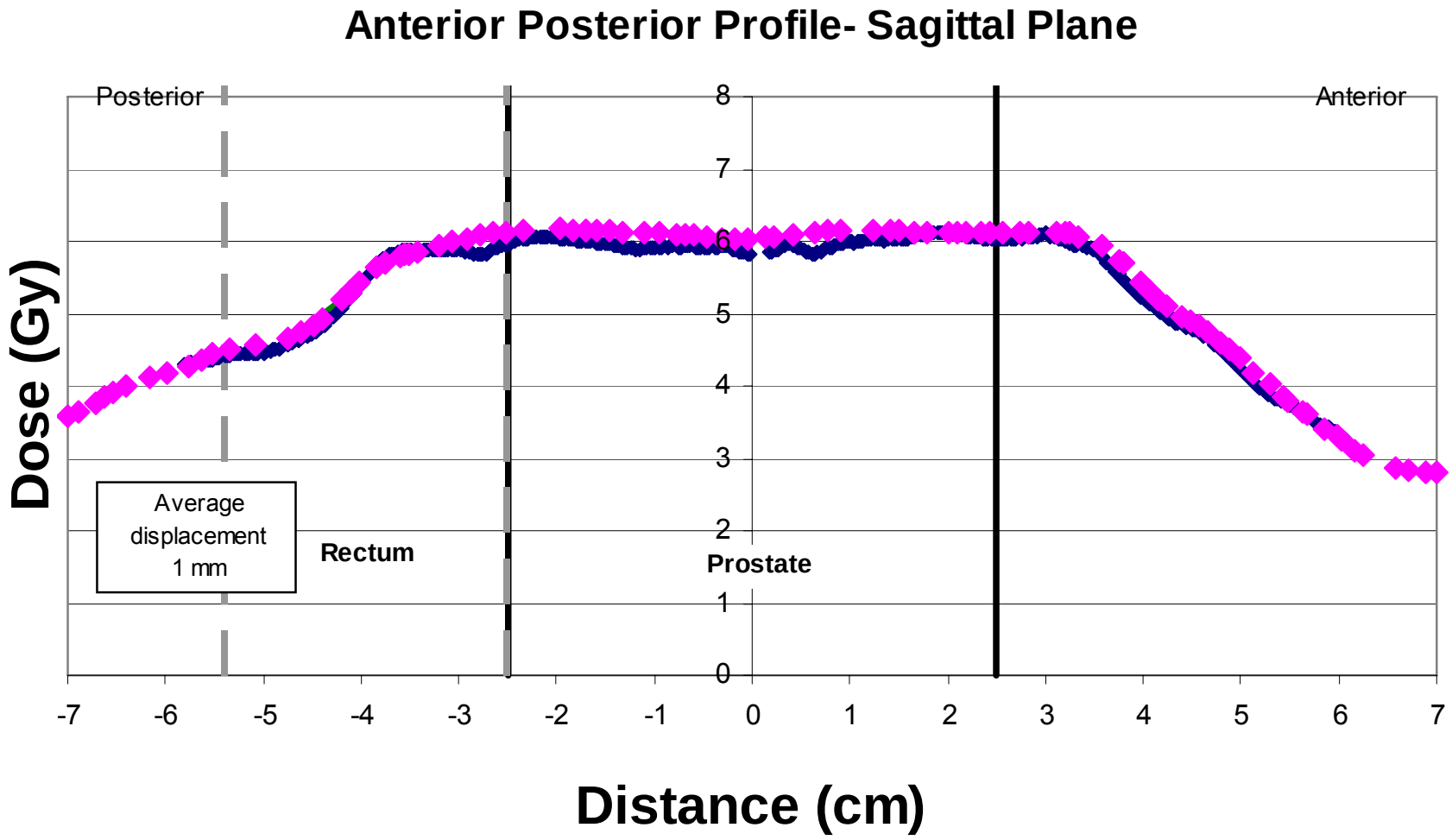


IMRT prostate phantom results

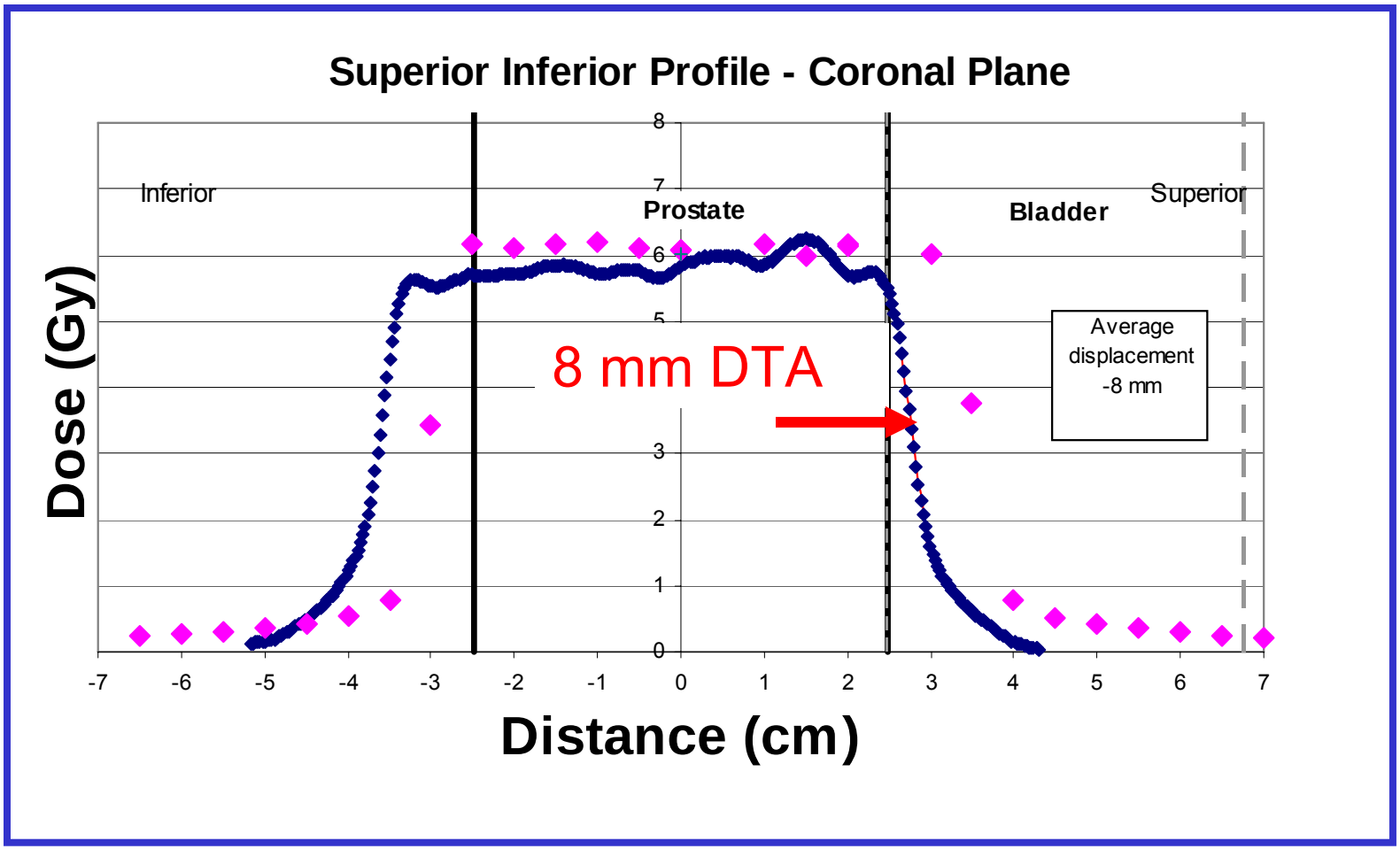
- 93 irradiations were analyzed
- 76 irradiations passed the criteria
  - 7 institutions irradiated multiple times
- 17 irradiations did not pass the criteria
- 85 institutions are represented

Only 79% of institutions passed the criteria on the first irradiation.

Good prostate profile



Not so good prostate profile



Explanations for Failures

Explanation	Minimum # of occurrences
incorrect output factors in TPS	1
incorrect PDD in TPS	1
Software error	1
inadequacies in beam modeling at leaf ends (Cadman, et al; PMB 2002)	14
not adjusting MU to account for dose differences measured with ion chamber	3
errors in couch indexing with Peacock system	3
2 mm tolerence on MLC leaf position	1
setup errors	7
target malfunction	1

Conclusions

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

The investigation was supported by PHS grants CA10953 and CA81647 awarded by the NCI, DHHS.

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

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Thank you!

RPC