Assessment and audit of charged particle beam therapy in clinical trials

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April14, 2009

Charged particle beams

- Presently 5 proton therapy centers
- At least 5 new centers expected to open in next 2 years
- No heavy particle beam centers anticipated today
  - RPC anticipates that by 5th year of next grant cycle, will need to prepare to audit carbon beam facilities

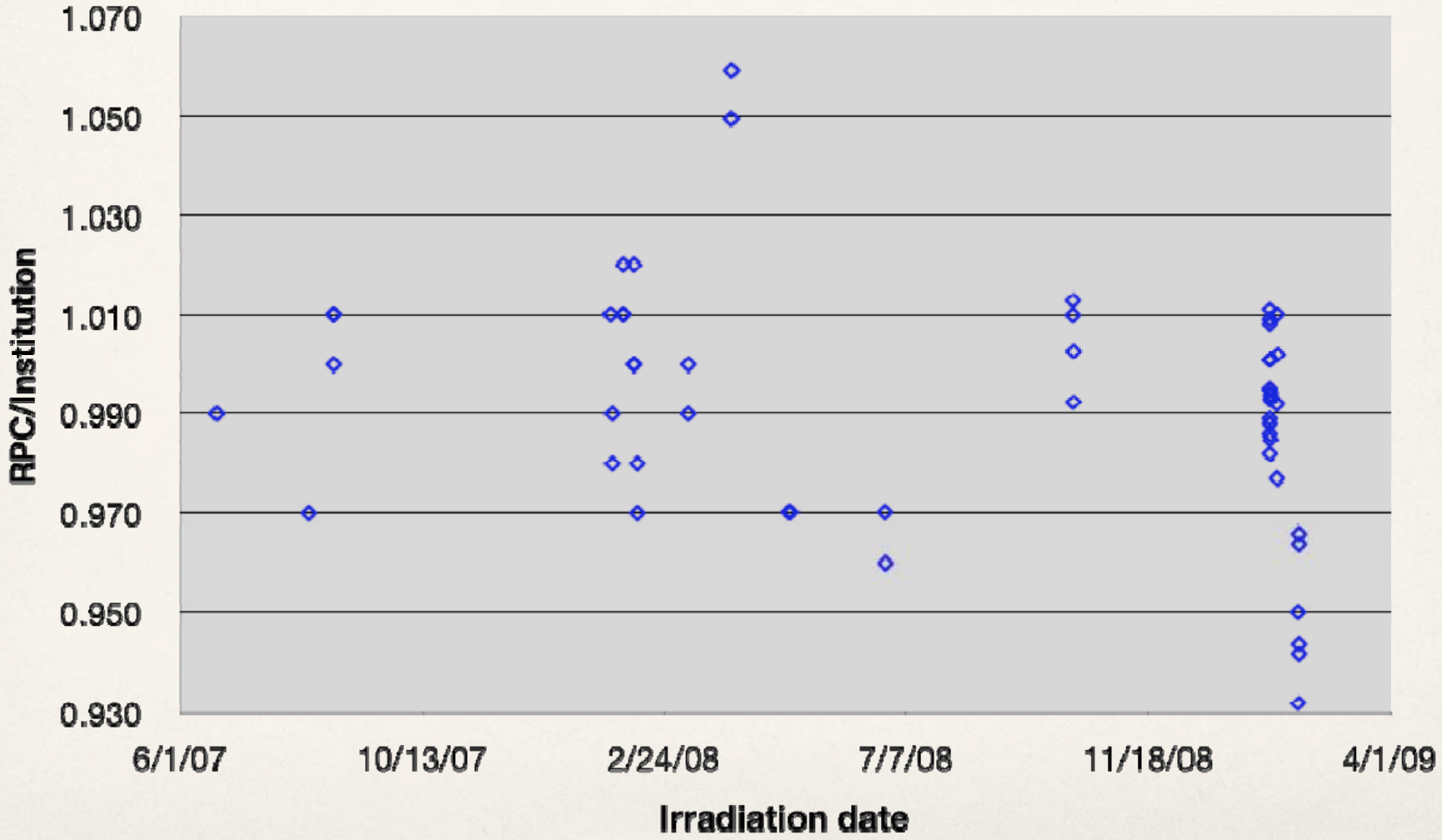
Proton Beam Monitoring

- Year 1:
  - Institute routine monitoring of proton beams
  - Institute program of dosimetry review visits to proton facilities
  - Complete evaluation of BANG® gels, Presage™ dosimeters
- Year 2:
  - Undertake redesign of H&N, thorax and pelvis phantoms for proton beams
  - Through AAPM, pursue adoption of uniform calibration protocol, traceability to NIST
- Years 3-5:
  - Accumulate database of representative beam data
  - Develop capabilities to independently recalculate patient plans

Proton Facility Credentialing

- NCI Guidelines mandate –
  - Questionnaire - sent to facilities by QARC
    - Completed by 4 of 5 centers
  - TLD monitoring
    - Mailed to all 5 centers
  - On-site dosimetry review visits
    - Purchased equipment, developing procedures
  - Anthropomorphic phantom
    - Modified existing pelvis phantom

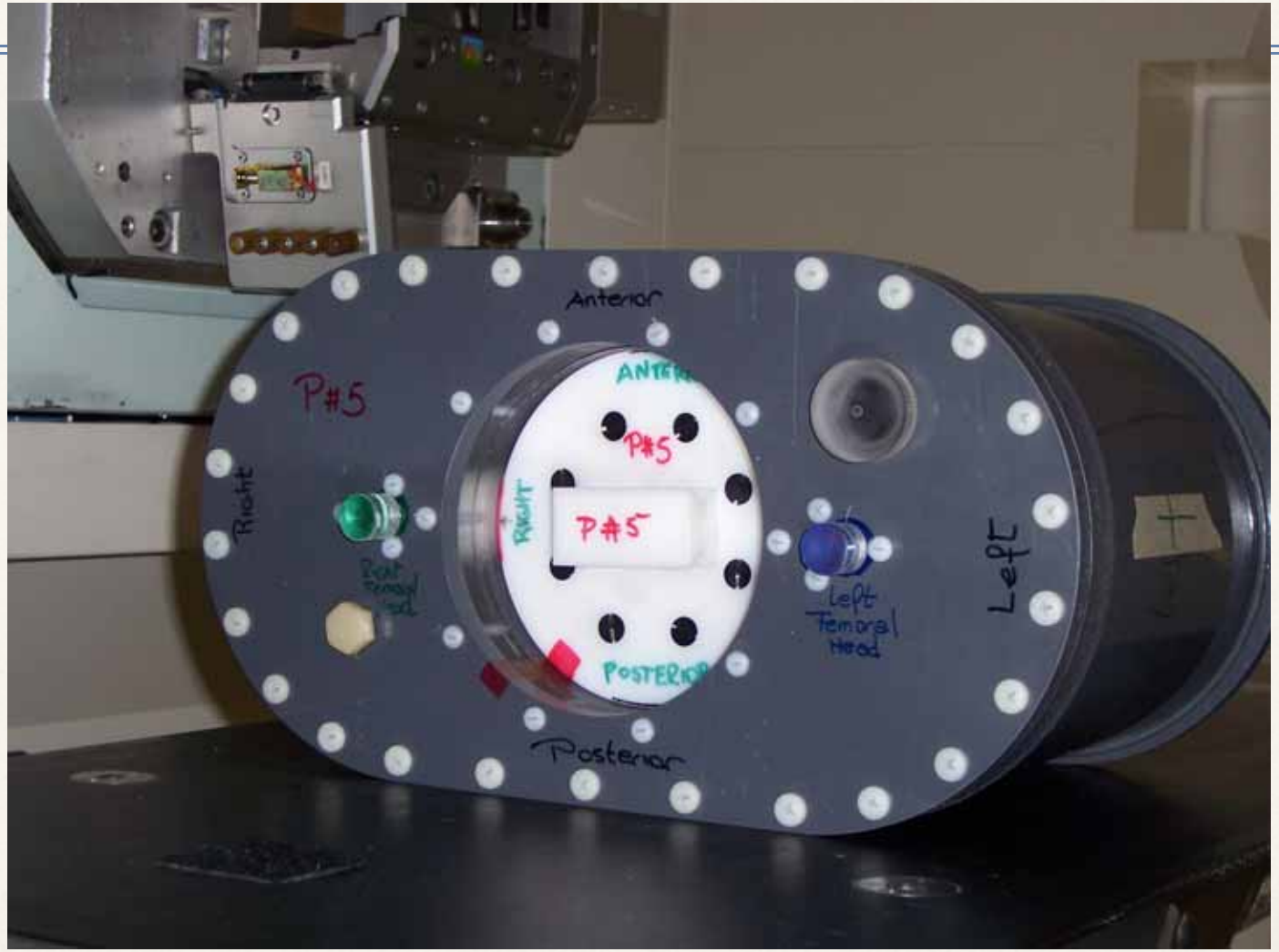
Proton Beam Monitoring



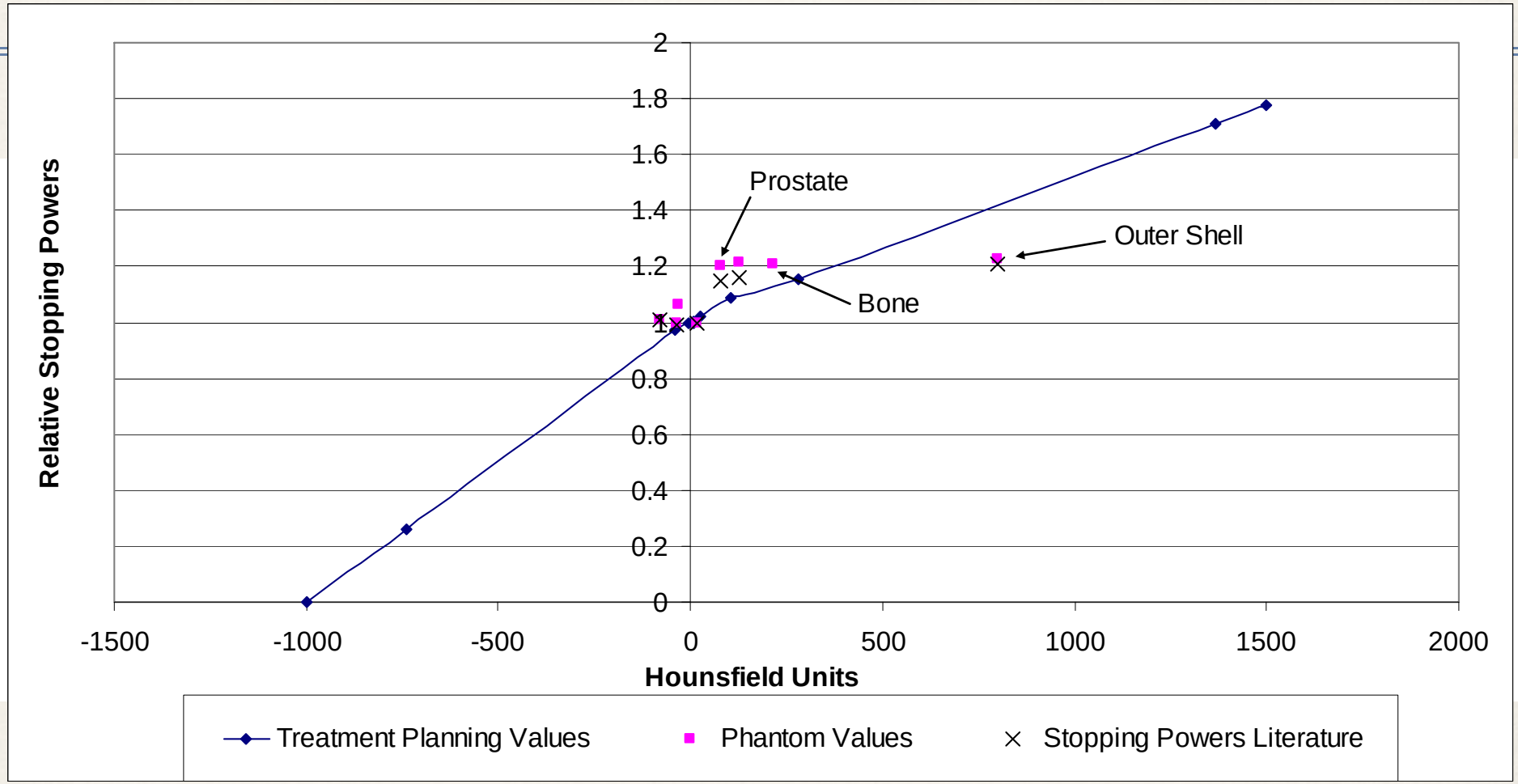
Audits

- Evaluation of OSL for audits of proton beams will begin this summer
- Program of evaluation likely to extend into next grant cycle

Proton Pelvis Phantom

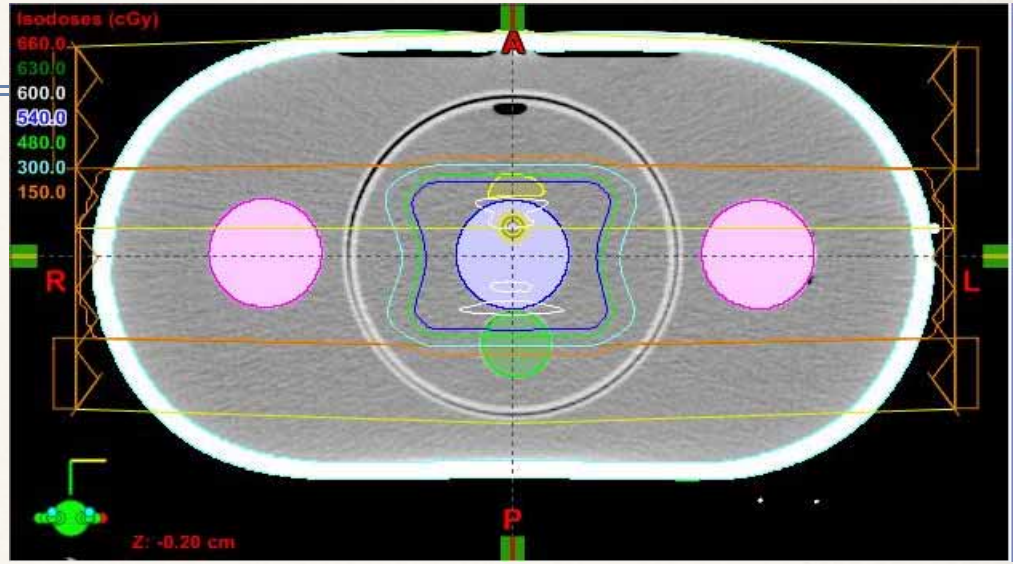


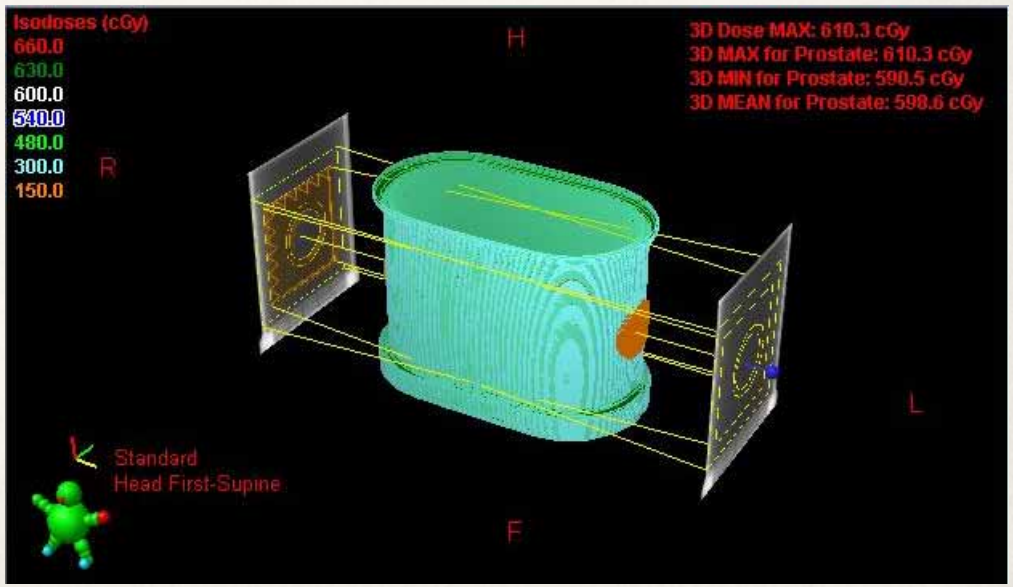
Material Stopping Powers



Phantom Treatment

- Treatment plan created with a prescription of 6 Gy to the prostate
- Plan delivered 3 times with film and TLD inserted in phantom
- Plan accounting for difference in patient and material SP to be delivered in near future





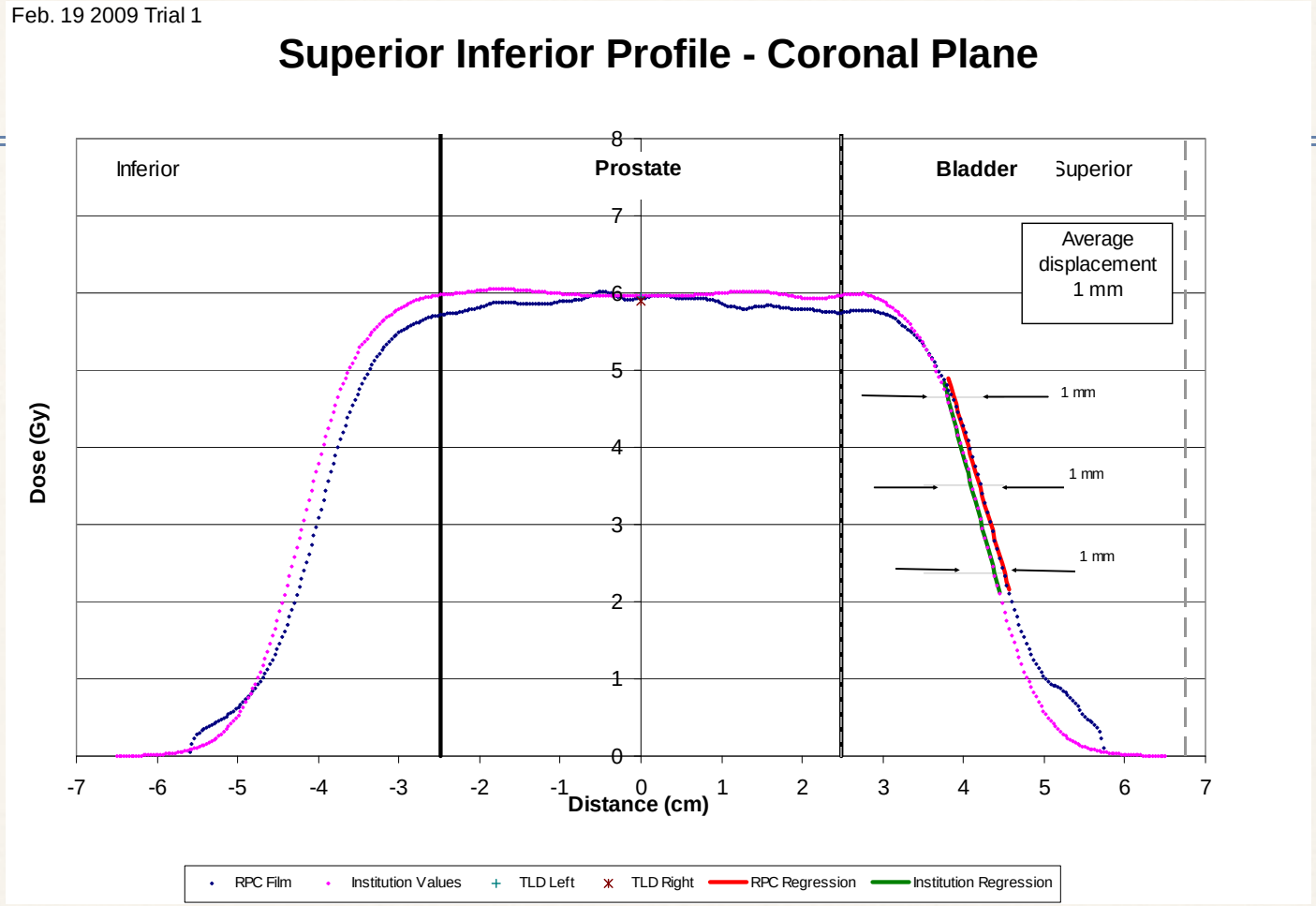
TLD results

	PTV Right	PTV Left	Femur Right	Femur Left
Institution Predicted Dose (cGy)	600.2	600.2	247.3	243.8
TLD Measured Dose (cGy)	589.8	595.1	242.1	240.4
Measured / Predicted Dose	**0.983**	**0.992**	**0.979**	**0.986**

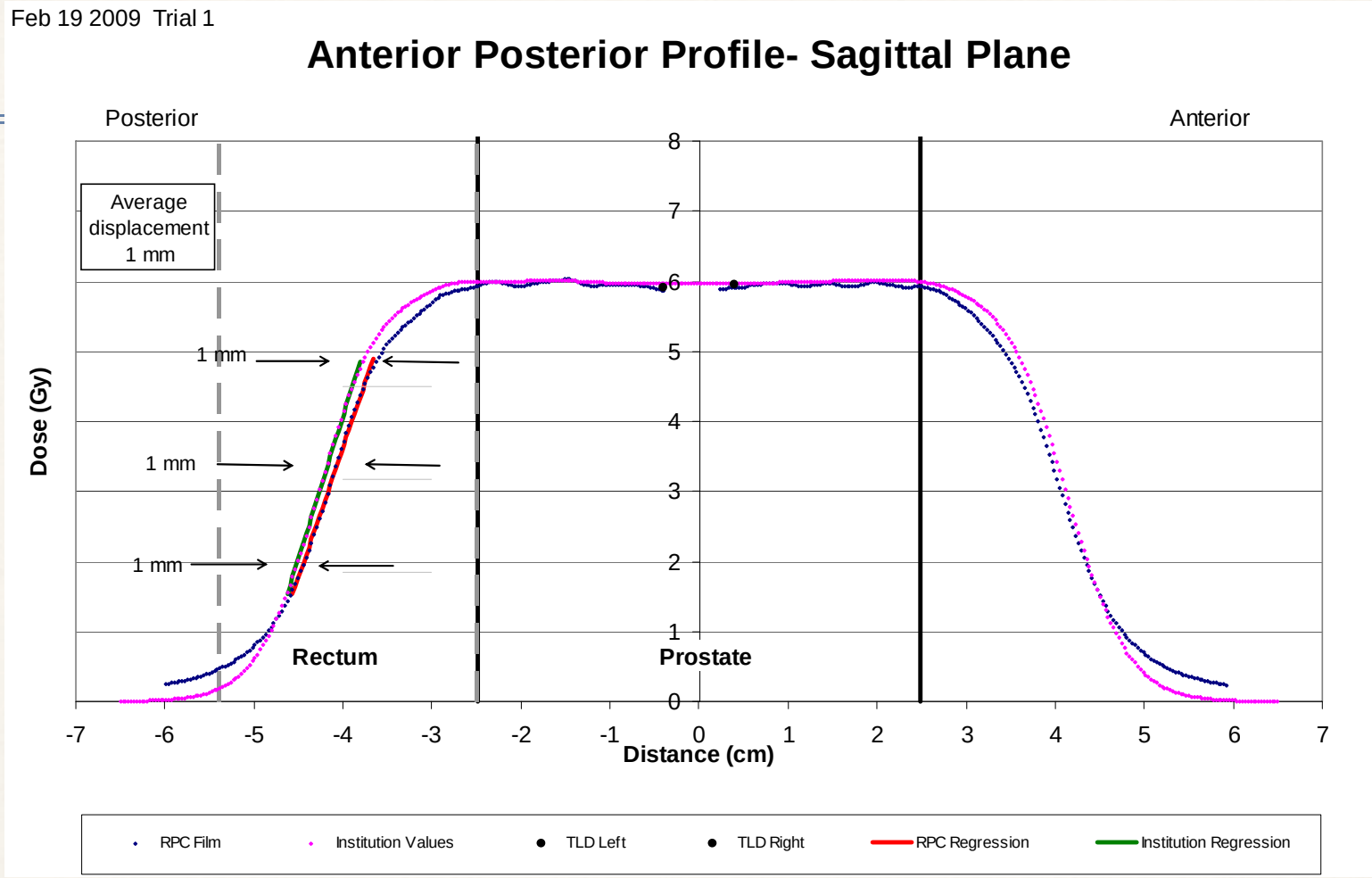
- PTV within 1.7% of predicted value
- Femur within 2.1% of predicted value

Film Results

Feb. 19 2009 Trial 1



Film Results



Reproducibility

PTV Right:	
Predicted Dose (cGy):	600.2
Measured Dose (cGy):	590.4
Std. Deviation	**0.202%**
Meas/Pred	0.984

PTV Left:	
Predicted Dose (cGy):	600.2
Measured Dose (cGy):	592.5
Std. Deviation	**0.463%**
Meas/Pred	0.987

- Measured Dose averaged over 3 trials
- Film profiles show at max a difference of 2 mm shift between trials

Phantoms

- Pelvis phantom has been developed
  - Evaluation is under way, will be completed this summer
- Lung phantom evaluation will begin this fall
  - Evaluation of materials will be considerably more complex
  - Likely to extend into next grant cycle

Visits

- Visit procedures have been developed at PTC-H
- First full visit planned for week of April 20
  - Northeast Proton Therapy Center
- Measurements to be made:
  - Mechanical tests, x-ray imaging, patient alignment
  - Output, depth dose, range (for variety of beam energies, modulation, field size, etc.)
  - Review of treatment planning procedures

Proposed measurements

Condition	Range	SSD	SOBP	Field size	Snout	Measurements
1	Reference	Reference	Reference	Reference	Reference	%dd, output, k_s, k_{pol}
2	Reference	Shorter	Reference	Reference	Reference	%dd, output
3	Greater	Shorter	Reference	Reference	Reference	%dd, output
4	Smaller	Shorter	Reference	Reference	Reference	%dd, output
5	Reference	Reference	Greater	Reference	Reference	%dd, output
6	Reference	Reference	Smaller	Reference	Reference	%dd, output
7	Reference	Reference	Reference	Smaller	Reference	%dd, output
8	Reference	Reference	Reference	Larger	Reference	%dd, output
9	Prostate case					%dd, output
10	Pediatric (e.g., spine) case					%dd, output
11	Reference	Reference	Reference	Reference	Reference	Profiles