# Evaluation Criteria for IROC's Proton Prostate Phantom

IROC™
IMAGING AND RADIATION ONCOLOGY CORE
*Global Leaders in Clinical Trial Quality Assurance*

ACR AMERICAN COLLEGE OF RADIOLOGY

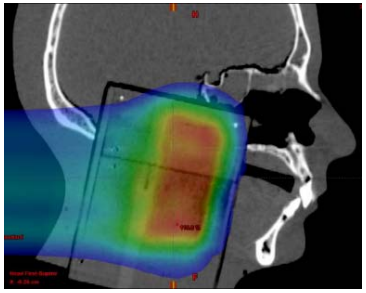
**Paige Taylor, M.S.**
**AAPM Annual Meeting**
**August 2, 2018**

# IROC's Mission

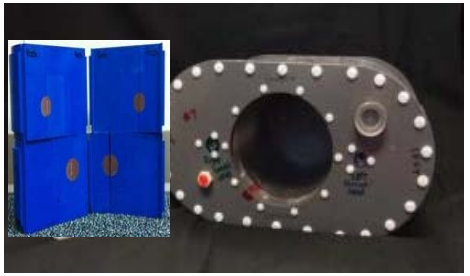
Provide quality control programs in support of the NCI's National Clinical Trial Network thereby assuring high quality data for clinical trials

# Proton Phantom Audits

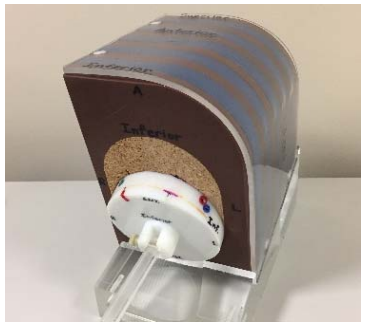
Brain



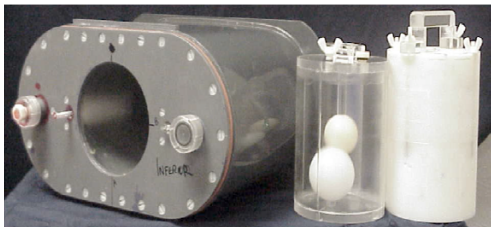
H&N



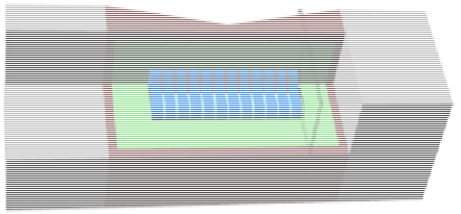
Liver



Lung/thorax



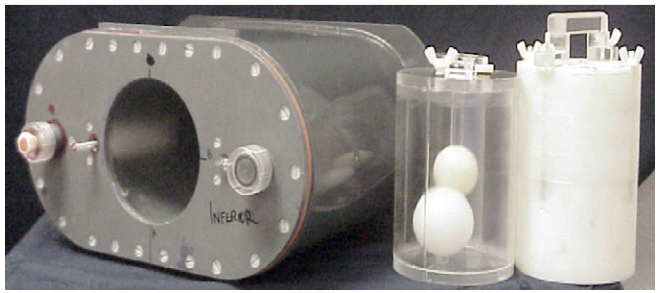
Prostate/pelvis

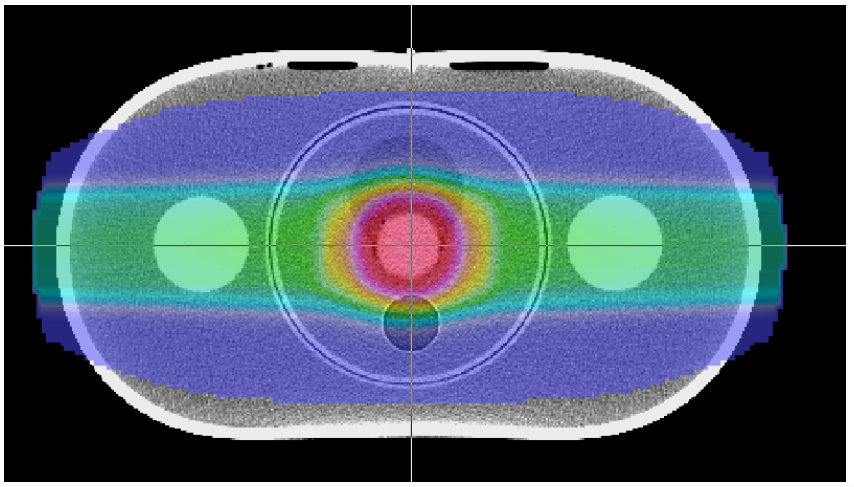


Spine

# Proton Prostate Phantom Design

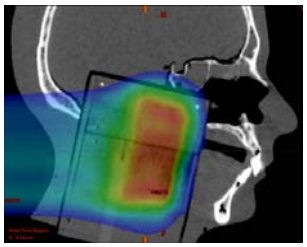
- Target: Prostate
- OARs: Bladder, rectum, and femoral heads
- Dosimetry insert contains TLD and radiochromic film for absolute and relative dose comparison with TPS

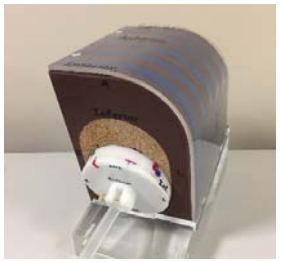
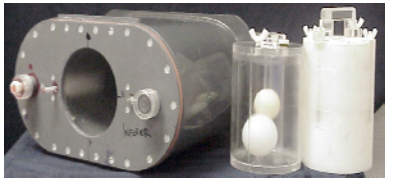
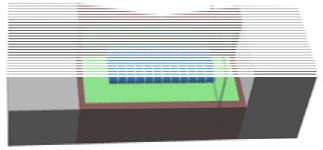




# Proton Phantom Audit Results

| | Brain | H&N | Liver | Lung | Prostate | Spine | TOTAL |
|---|---|---|---|---|---|---|---|
| Total Irradiations | 34 | 20 | 27 | 59 | 45 | 30 | 215 |
| # Passed | 33 | 18 | 10 | 40 | 37 | 23 | 161 |
| Pass Rate [%] | 97% | 90% | 37% | 68% | 82% | 77% | 75% |



# Phantom TLD vs. Proton TPS

International Journal of
Radiation Oncology
biology • physics

Technological Advances

**Results From t**
**Oncology Core**
**Phantoms Use**
**Credentialing**

**Paige A. Taylor, MS, Steph**
**Tyler Keith, BS, Carrie Luja**
**and David S. Followill, PhD**

***Department of Radiation Physics, University of Texas MD Anderson Cancer Center, Houston, Texas***

Received Sep 26, 2015, and in revised form Jan 25, 2016. Accepted for publication Jan 29, 2016.

pre-2015 data

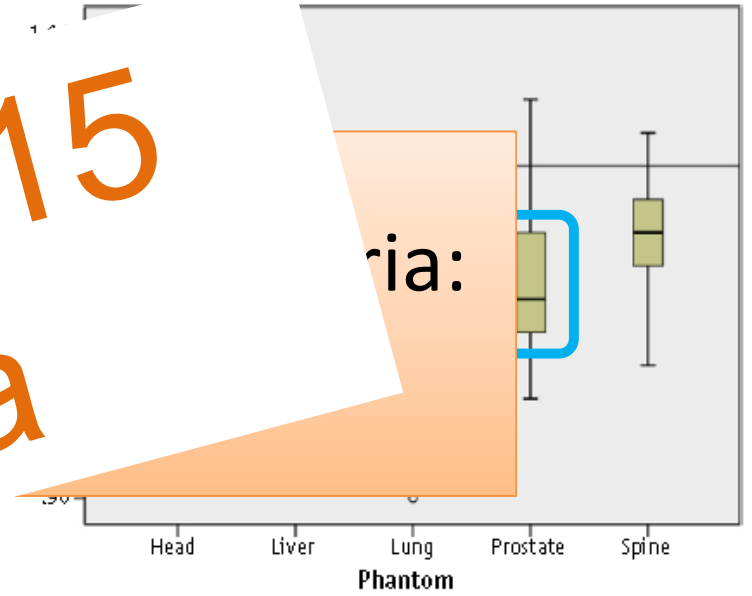
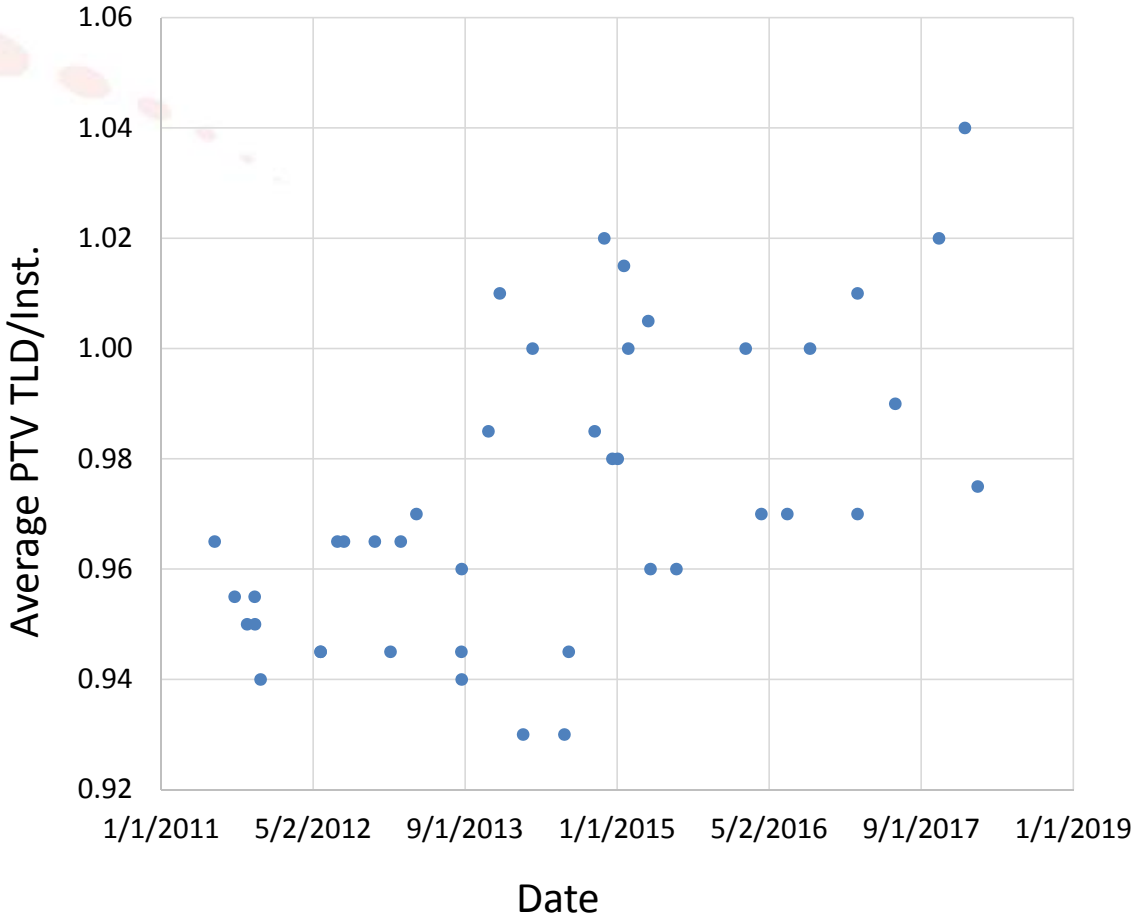



**Fig. 2.** Ratio of the TLD-measured dose to the dose predicted by the treatment planning system for each phantom type. *Abbreviation:* TLD = thermoluminescent dosimeters.

# Prostate PTV TLD

2015: Started to see an upward shift in TLD doses to target

Nothing changed in TLD system – we suspect a change in how dose is calculated in proton TPSs



# Proton Dose Calculations Evolving

| | 2009 - 2014 | 2015 - 2018 |
|---|---|---|
| mean | 0.961 | 0.992 |
| stdev | 0.024 | 0.024 |
| max | 1.03 | 1.05 |
| min | 0.93 | 0.95 |
| # phantoms | 27 | 16 |

- Eclipse aperture scatter for passive scattering
- Pinnacle's angular scattering: sequential piecewise modeling
- RayStation "19-fold multi tracing per spot and separate handling of the nuclear halo effect"*
- Monte Carlo more accurately modeling multiple coulomb scattering

*https://www.raysearchlabs.com/radiation-therapy-physics/

# PB Algorithms vs. MC in Proton Therapy

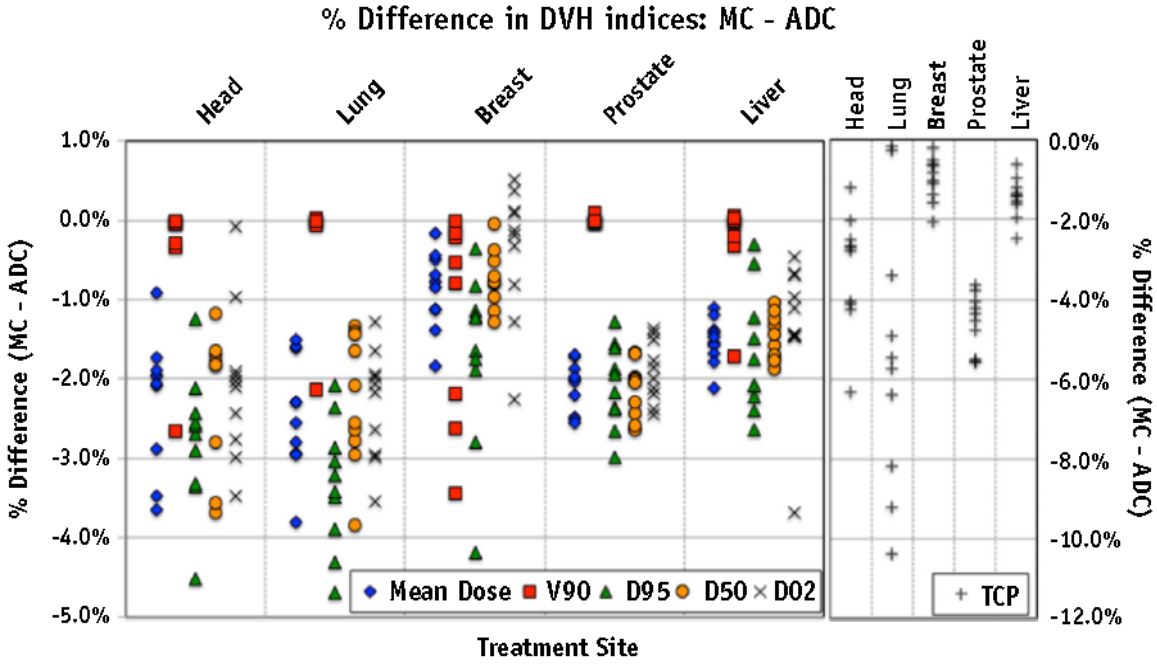
International Journal of Radiation Oncology biology • physics

www.redjournal.org

Physics Contribution

## Assessing the Clinical Impact of Approximations in Analytical Dose Calculations for Proton Therapy

Jan Schuemann, PhD, Drosoula Giantsoudi, PhD, Clemens Grassberger, PhD, Maryam Moteabbed, PhD, Chul Hee Min, PhD, and Harald Paganetti, PhD



# Proton Lung Phantom Dose Accuracy

- BIG improvements with Monte Carlo over pencil beam algorithms

**Pencil Beam Algorithms Are Unsuitable for Proton Dose Calculations in Lung**

**Paige A. Taylor, MS, Stephen F. Kry, PhD, and David S. Followill, PhD**

*The Imaging and Radiation Oncology Core Houston Quality Assurance Center, The University of Texas MD Anderson Cancer Center, Houston, Texas*

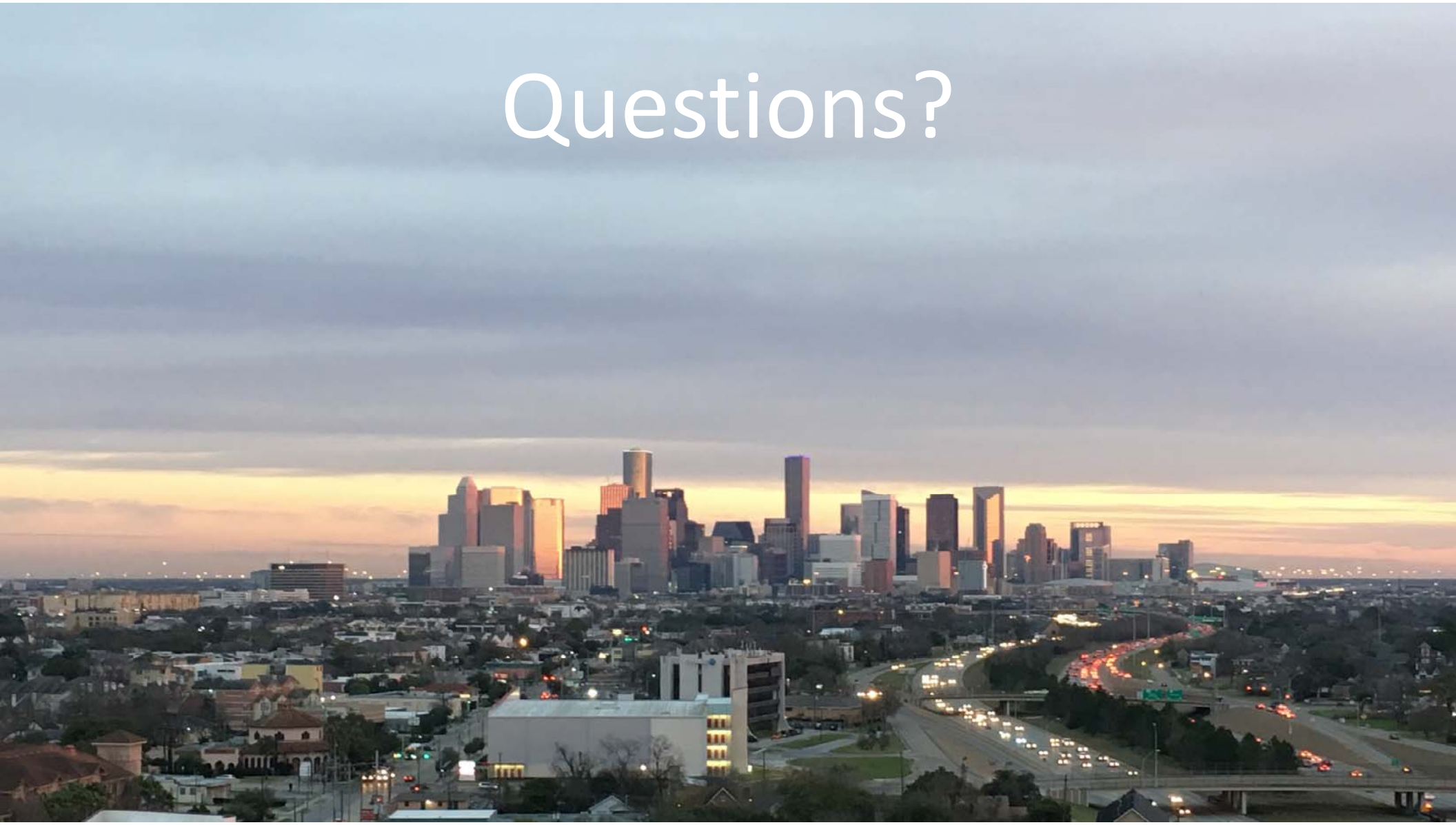
Received Jan 23, 2017, and in revised form May 16, 2017. Accepted for publication Jun 5, 2017.

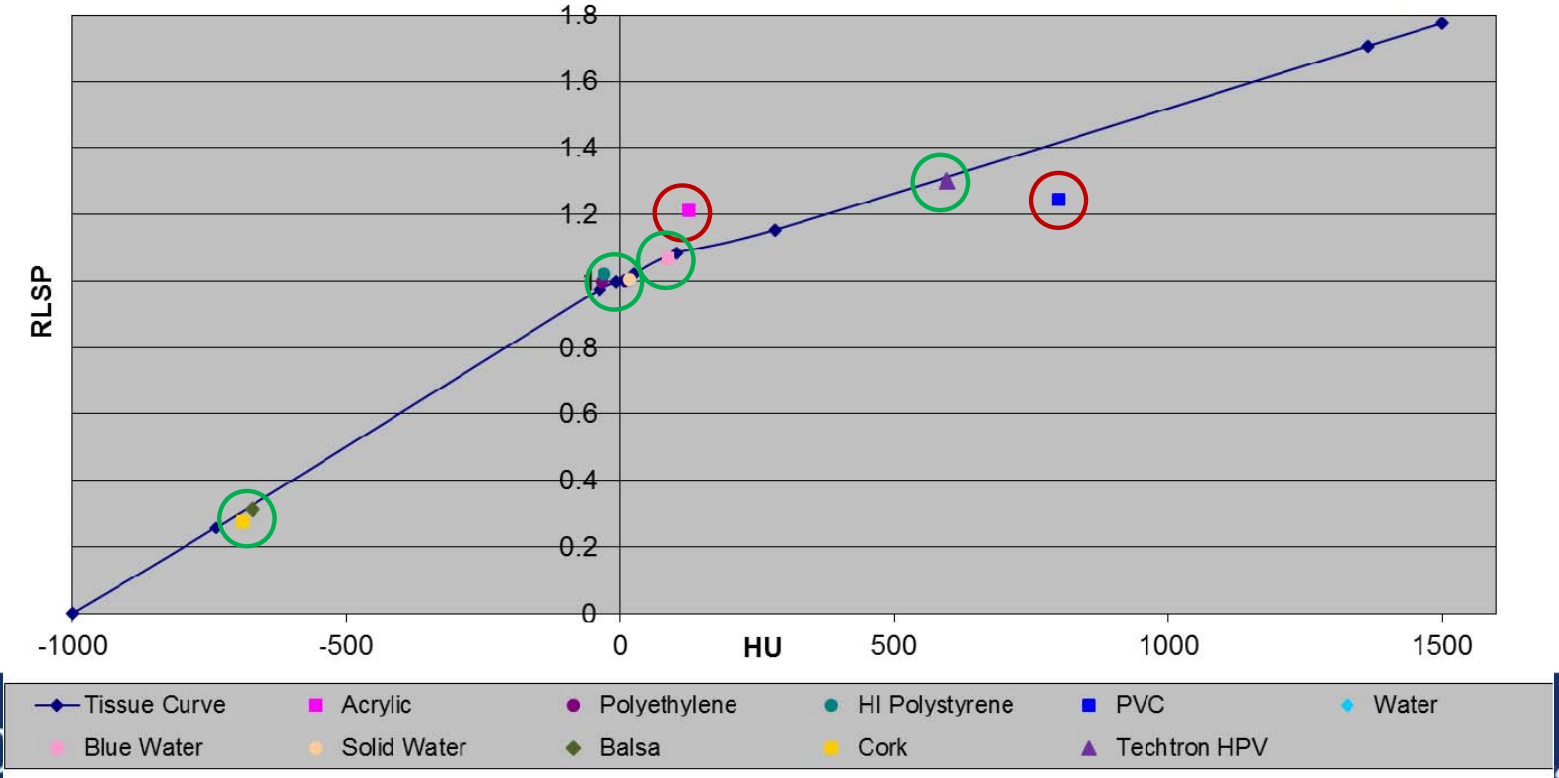
International Journal of Radiation Oncology biology • physics
Official Journal of the American Society for Radiation Oncology ASTRO

# What's Next?

- New prostate phantom criteria set: 1.00 ± 7%
- Big improvements seen with Monte Carlo *but* not all MC appears equal
  - Working with proton centers to look at different MC algorithms
    - RayStation, Eclipse AcurosPT, TOPAS, MCSquare
- Investigating proton algorithm accuracy in H&N and liver
  - H&N: High density (bone) and low density (nasal passages, oral cavity)
  - Liver: Low phantom pass rate, low average TLD/TPS
  - Will we see the same improvements over time?

# Questions?



# Phantom Audits

- Phantoms made from proton-equivalent plastics