

CIRP at the University of Wisconsin-Madison



Keith A. Kunugi

University of Wisconsin Medical Radiation Research Center

Department of Medical Physics

School of Medicine and Public Health

University of Wisconsin - Madison

2019 Council on Ionizing Radiation Measurements and Standards



UW-Madison Isotope Irradiators

Three Categories of Isotope Irradiator Use

- UW Hospitals and Clinics
 - Blood Irradiators
- University of Wisconsin – Madison
 - Radiation research across a number of disciplines
- UW Medical Radiation Research Center
 - NIST-traceable calibration of medical radiation measurement instrumentation
 - Ionizing radiation metrology research
 - Radiation research





Global Threat Reduction Initiative (GTRI)

- September 11, 2001
- Established in 2004
 - Initiated the Domestic Security Enhancement Program 2008.
 - Biometric access control devices
 - Door alarms
 - Motion sensors
 - Cameras
 - Duress buttons
 - Radiation sensors
 - Electronic tamper indicating seals
 - Remote monitoring systems





Cesium Irradiator Replacement Program (CIRP)

- Established 2014
- Replace current isotope-based irradiators with a non-isotope alternative.
 - ^{137}Cs ^{241}Am
 - ^{60}Co ^{192}Ir
- Removal of source - \$100k-\$200k per device
- Reimbursement of 50%-75% of purchase price of non-isotope irradiator.





UW-Madison Participation

(Part 1)

- 2015 - 2018
- Removed of two ^{137}Cs Irradiators from campus.
- Provide 75% of purchase price of a IGRT small animal irradiator.
- Installed in an AAALAC-certified animal facility.
- Delays in bringing system online
 - Remodeling of facility for irradiator
 - Delay-based irradiator start-up concerns
- Administrative infrastructure to manage facility





UW-Madison Participation

(Part 2)

- 2018 – present
- De-commissioning of:
 - One ^{137}Cs
 - One ^{60}Co teletherapy irradiator from the UWMRRC
- Acquisition of a 500kV X-ray system
 - Bid process underway
 - Remodeling in process to provide utilities for system
 - Design and fabrication of mounting system in process
- Timeline for removal... ?????





What Have We Gotten Ourselves Into?

- Wide range of ionization radiation dependent research at the UW
- Scope limited to basic research and pre-clinical studies
- Standard dose-response cell survival assays (2-8 Gy)
- Experimental evolutionary biology research (MGy)
- Everything in between





Problems? What Problems?

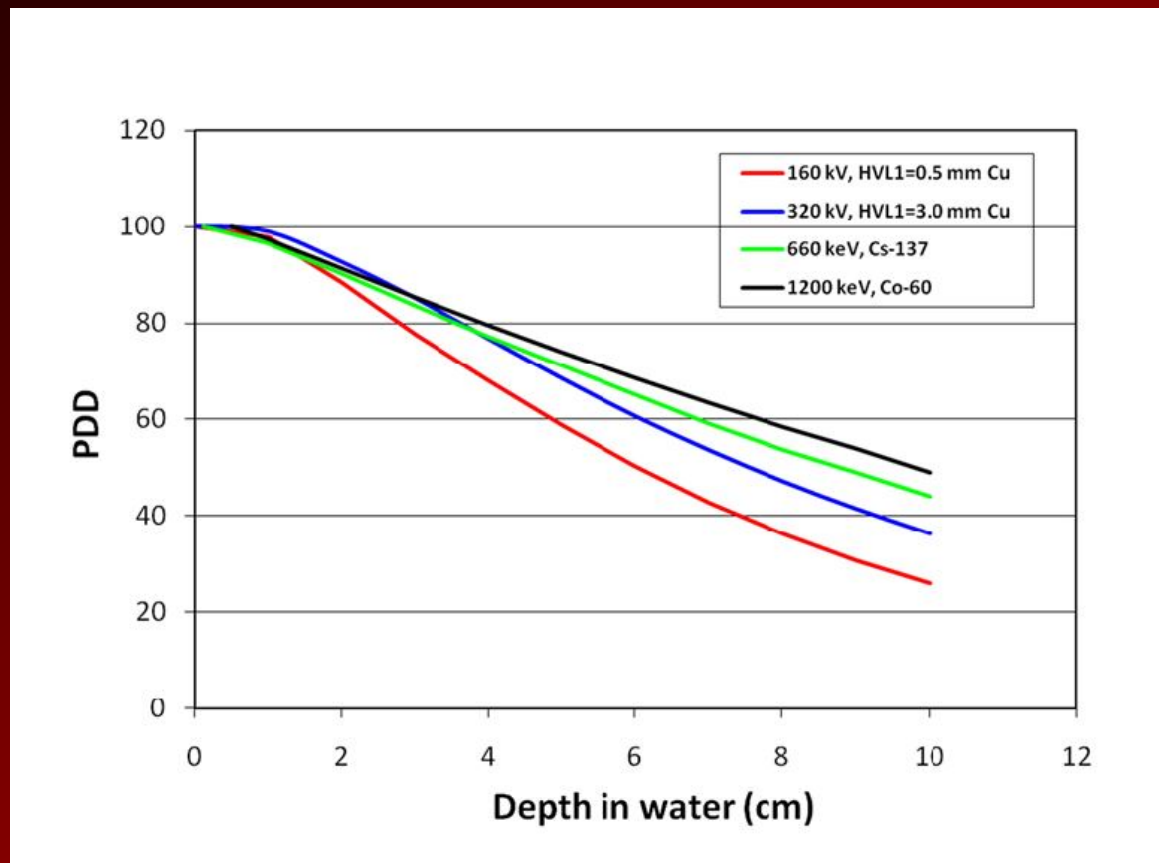
- A single radiation platform is not sufficient to cover the diverse research interests
 - Samples to be irradiated
 - Dose rate
 - Depth of target
 - Field size
 - Actual delivered dose
- Fundamental dose delivery





One Size Does Not Fit All

- Depth dose profiles are energy-dependent





Photon Quality Matters

- Dose range for blood irradiation is between 15-50 Gy to prevent TA-GvHD¹
- Clinically, a 7% to 10% change in dose significantly changes the tumor control probability²
 - Delivered dose should be within 5% of prescription dose
- Pre-clinical studies often involve steep dose-response relationships. Thus, accurate dose delivery is crucial for experimental success³



¹Del Lama et al, PLOS ONE, 8,6, e65334 (2013)

²ICRU Report 24 (1976)

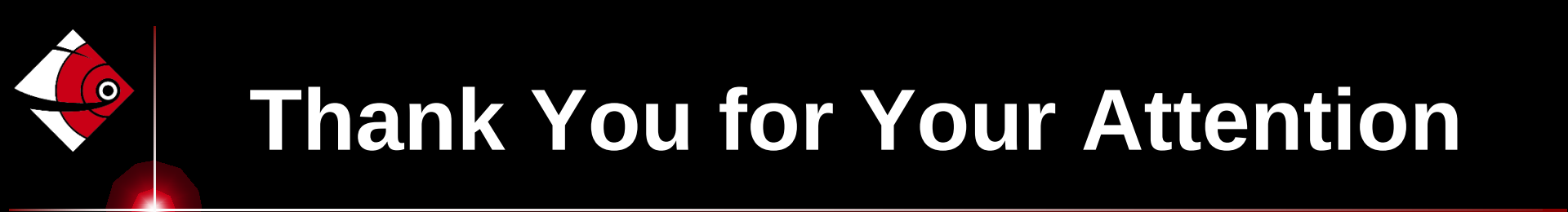
³Derosiers et al, (2013) J Res NIST, 118:403-417.



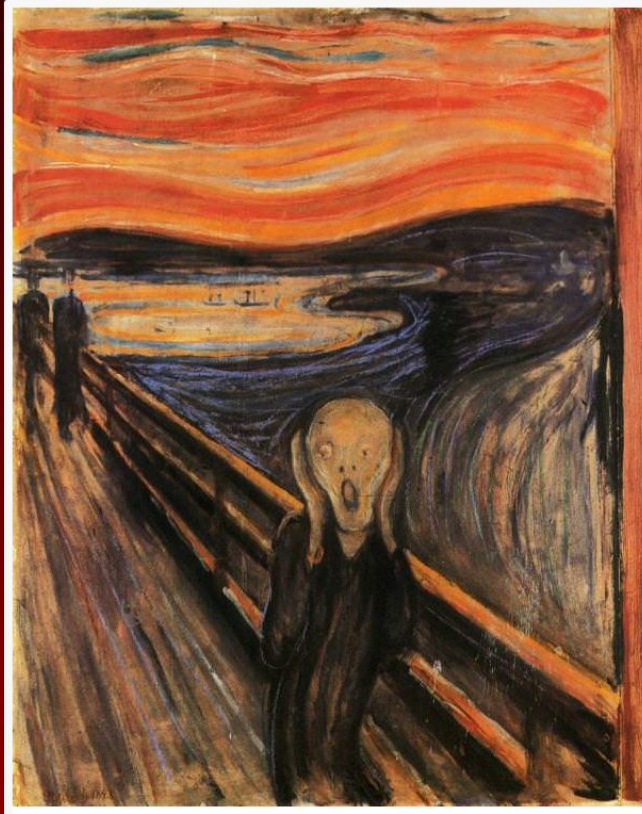
Next at the UW

- Decommission the two isotope irradiators.
- Install and commission the 500kV X-ray system
- Match the NIST beam qualities
- Investigate the characteristics of the beam qualities used in cabinet X-irradiators
- Develop dose verification protocols for cabinet X-irradiators





Thank You for Your Attention



My expected audience reaction



The Scream, Edvard Munch, 1893



Characterizing the Irradiator?

- AAPM Task Group 61 – X-rays to Absorbed Dose to Water (ADW)
- Standard measurement conditions
- Box irradiators do not replicate standard conditions.
- What next?



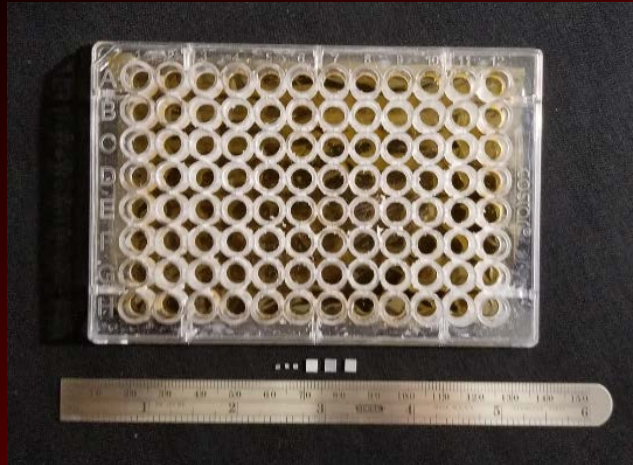


- **PXi X-Rad 320 – F2 Filter,** **HVL ~ 4mm Cu**
- **UWMRRC Attenuation Phantom F2 Filter,** **HVL = 3.98mm Cu**
- **Beam_nrc Simulation – 320 kV, F2 Filter,** **HVL = 3.70mm Cu**





Cell Culture Phantoms





Mouse Phantoms

