CIRP at the University of Wisconsin-Madison

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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

  - 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.
  - $^{137}\text{Cs}$
  - $^{241}\text{Am}$
  - $^{60}\text{Co}$
  - $^{192}\text{Ir}$
- 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
2018 – present

De-commissioning of:
- One $^{137}\text{Cs}$
- One $^{60}\text{Co}$ 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
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

![Diagram showing depth dose profiles for different energies.](chart.png)
Photon Quality Matters

- Dose range for blood irradiation is between 15-50 Gy to prevent TA-GvHD\(^1\)
- Clinically, a 7% to 10% change in dose significantly changes the tumor control probability\(^2\)
  - 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 success\(^3\)

\(^1\) Del Lama et al, PLOSONE, 8,6, e65334 (2013)
\(^2\) ICRU Report 24 (1976)
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

N Viscariello et al., AAPM, 2016
Cell Culture Phantoms
Mouse Phantoms