# Imaging and Radiation Oncology Core's development of a remote credentialling system for FLASH radiotherapy.

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

ACR American College of Radiology

Hayden Scott, MS
CIRMS Presentation

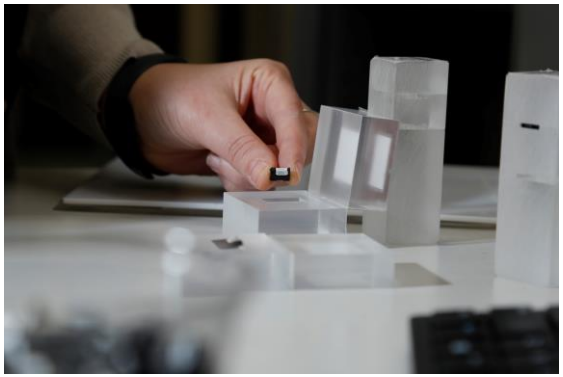
THE UNIVERSITY OF TEXAS
MD Anderson Cancer Center
Making Cancer History®

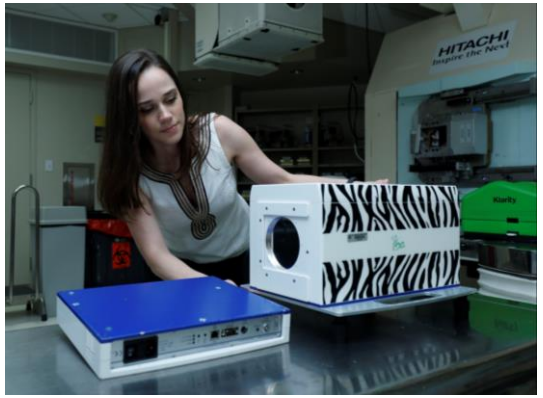
# Imaging and Radiation Oncology Core

Imaging and Radiation Oncology Core (IROC) QA Centers provide **quality assurance** for **clinical trials** in the US

# IROC Core Services

- Site qualification
- Trial Design Support
- Credentialing
- Data management
- Case review





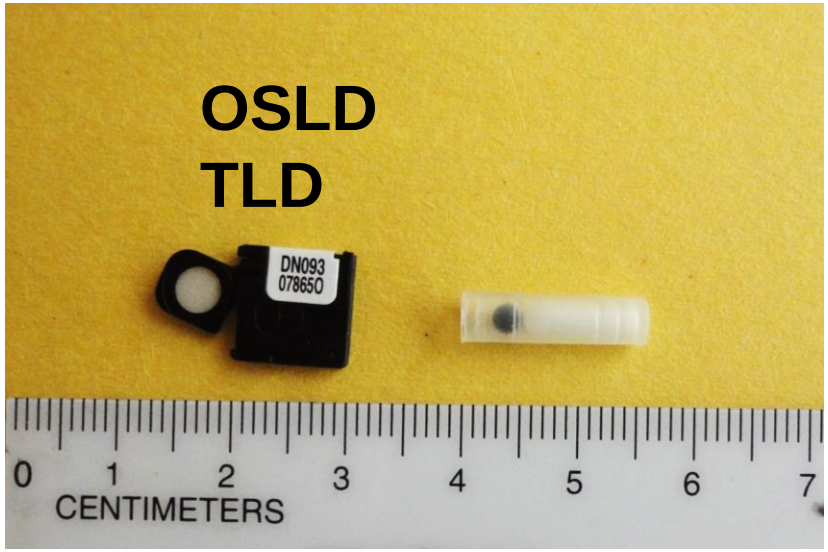
# Machine Output Audits

OSLD: Optically Stimulated Luminescent Dosimetry

- $Al_2O_3$ nanoDots (reusable)
- Used for photon and electron output checks

TLD: Thermoluminescent Dosimetry

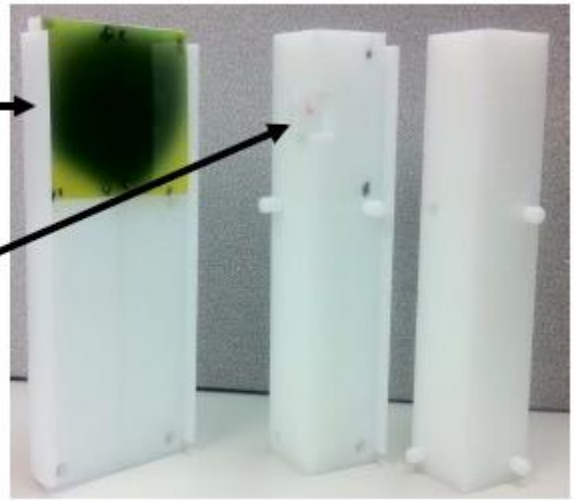
- LiF-100 powder in capsules (single use)
- Used for protons and unique photon machines (TomoTherapy, GammaKnife)



# End-to-End Audits: Phantoms

- End-to-end tests
- Phantoms are made of tissue-equivalent plastics
- Contain TLD and film for point dose and planar dosimetry
- Institution is instructed to treat the phantom like you would a patient: simulation, planning, IGRT, and delivery

Liver phantom insert




Head phantom insert

# End-to-End Audits: Photon Phantoms

Comparison between institution's plan and delivered dose.

| Phantom | H&N | Liver insert | Lung | Prostate | Spine |
|---|---|---|---|---|---|
| **Irradiations** | 2900 | 257 | 2085 | 671 | 449 |
| **Pass** | 2559 (88%) | 182 (71%) | 1787 (86%) | 570 (85%) | 353 (79%) |
| **Fail** | 341 | 75 | 298 | 101 | 96 |
| **Criteria** | 7%/4mm | 7%/4mm | 5%/5mm | 7%/4mm | 5%/3mm |

# End-to-End Audits: H&N Phantom

- IMRT credentialing phantom
  - H&N phantom
  - 6 Point dose (TLD) measurements
  - 2 Planar dose (radiochromic film)
- End-to-end test
  - Phantom treated like a patient
  - Imaging, Planning, Setup, Delivery
- Tests delivery in actual geometry
- Measures dose in target

# On-Site Dosimetry Audits


IROC physicist brings independent dosimetry equipment to radiotherapy clinic to perform spot-checks of machine output and performance

# Importance of Peer Review

- Peer review is very important in the context of new technologies in clinical trials
  - Proton therapy
  - MR-linacs
  - Ultra High Dose Rate Radiotherapy (FLASH)
- If our goal is comparability and consistency, peer review audits are a great way to verify that for new techniques

Image from https://www.pennmedicine.org/cancer/navigating-cancer-care/programs-and-centers/roberts-proton-therapy-center

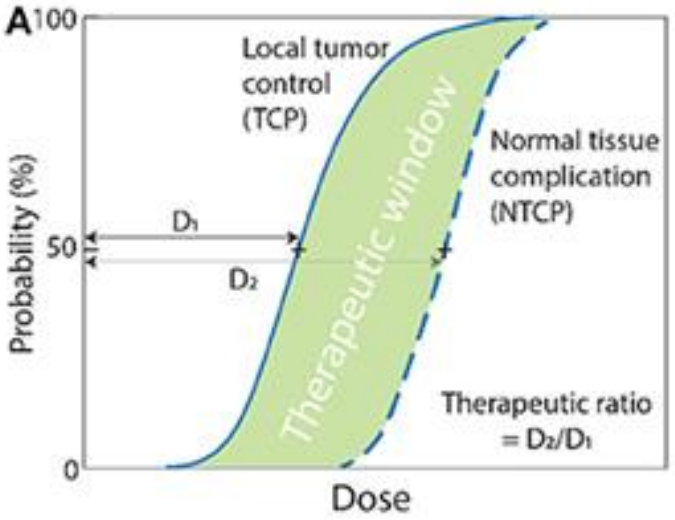
# Ultra-High Dose Rate Radiotherapy (FLASH): Very fast dose rate

- Delivers radiation at a rate orders of magnitude higher than conventional dose rates
- Defined as greater than 40 Gy/s
- Proton and electron FLASH beams are most common


https://intraop.com/mobetron-iort/

# Ultra-High Dose Rate Radiotherapy (FLASH): Less Radiation Toxicity

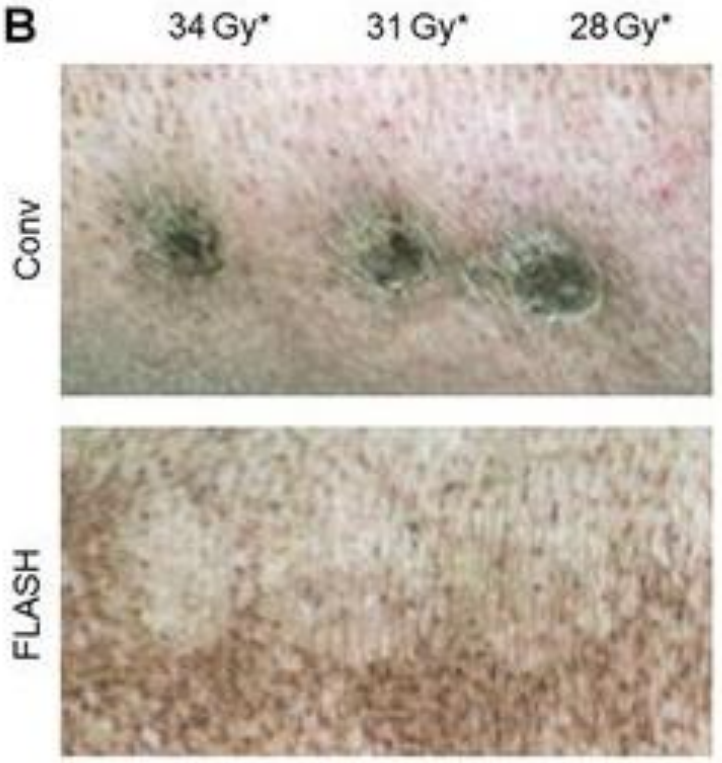
- FLASH has the potential to reduce dose to healthy tissue
- The fast dose delivery is what creates this effect




1. Ashraf MR, Rahman M, Zhang R, et al. Dosimetry for FLASH Radiotherapy: A Review of Tools and the Role of Radioluminescence and Cherenkov Emission. *Front Phys*. 2020;8. doi:10.3389/fphy.2020.00328

# IROC's future: moving into FLASH

- This effect can be seen and is already being implemented
- Varian Flash Forward Consortium
- Clinical Trials: FAST-01 (bone metastasis) and FAST-02 (thoracic bone metastasis)
- IROC needs to exist in this new space




1. Vozenin MC, De Fornel P, Petersson K, et al. The Advantage of FLASH Radiotherapy Confirmed in Mini-pig and Cat-cancer Patients. *Clin Cancer Res*. 2019;25(1):35-42. doi:10.1158/1078-0432.CCR-17-3375

# Challenges with FLASH

- Dose is delivered so fast that commonplace instruments encounter issues, e.g. ion chamber recombination
- Dose rate independent dosimeters need to be used
- Dose rate monitoring needed
- IROC has been using dose rate independent dosimeters for decades

https://www.flukebiomedical.com/products/radiation-measurement/phantoms-test-tools/farmer-type-ionization-chamber

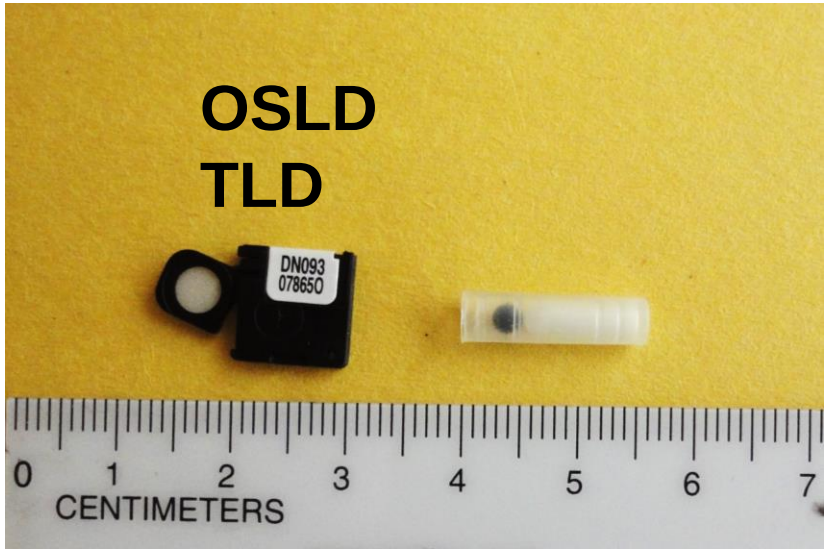
# Luminescence at IROC

OSLD: Optically Stimulated Luminescent Dosimetry

- $Al_2O_3$ nanoDots (reusable)
- Used for photon and electron output checks

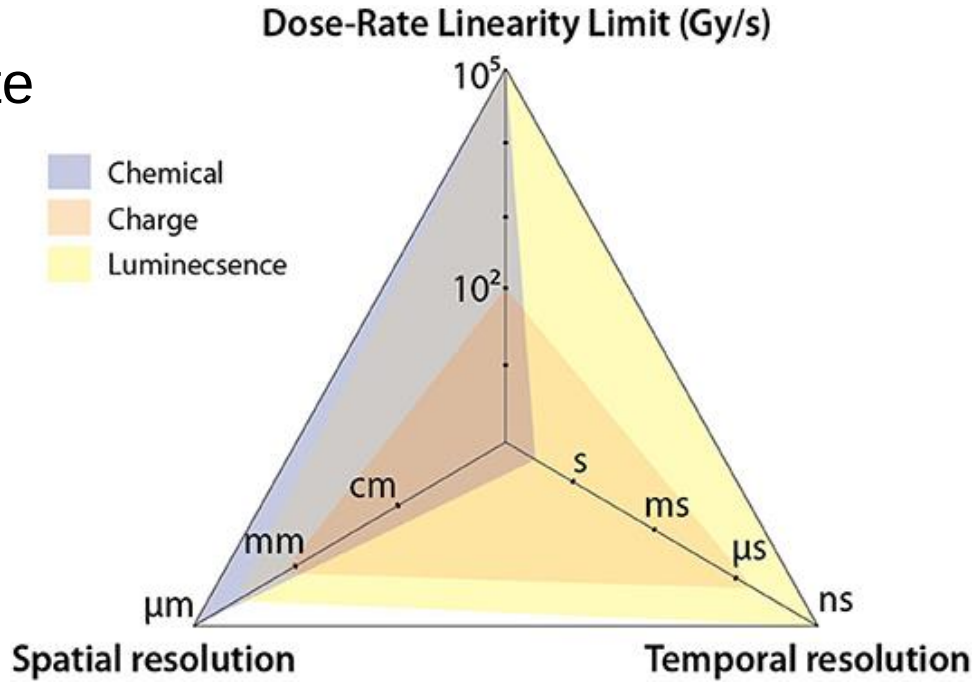
TLD: Thermoluminescent Dosimetry

- LiF-100 powder in capsules (single use)
- Used for protons and unique photon machines (TomoTherapy, GammaKnife)



# Luminescence and dose rate independence

- IROC has been using dose rate independent dosimeters for decades
- Passive Detectors that store signal after exposure to irradiation
- Ideal for IROC which mails Luminescence Dosimeters




1. Ashraf MR, Rahman M, Zhang R, et al. Dosimetry for FLASH Radiotherapy: A Review of Tools and the Role of Radioluminescence and Cherenkov Emission. *Front Phys*. 2020;8. doi:10.3389/fphy.2020.00328

# Time information: capturing this information

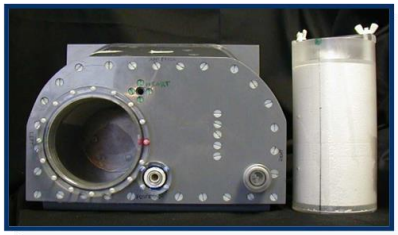
- Passive Luminescence dosimeters integrate dose
- Time information is needed to get dose rate
- Detectors with very high timing resolution are needed
- Clinics will need a way to record this information to send back to IROC

https://www.rpdinc.com/ptw-60023-microsilicon-dosimetry-diode-9353.html

# Integration into IROC FLASH phantoms

- Integrating dosimeters and timing instrument tools into a new anthropomorphic phantom
- Different phantoms need to be made for each treatment site

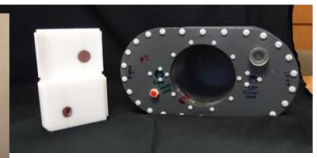

prostate phantoms


lung phantoms


Spine phantoms


H&N phantoms


SRS phantoms


liver inserts

# Future directions

- Passive detectors being tested
- Dose rate tools being developed
- Phantom design and testing in progress
- IROC FLASH phantom coming to a clinic near you

# Thank You! Contributors: Dr. Paige Taylor, Dr. Stephen Kry, Dr. Emil Schueler, and Paola Alvarez

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

ACR AMERICAN COLLEGE OF RADIOLOGY

Hayden Scott, MS
CIRMS Presentation

THE UNIVERSITY OF TEXAS
MD Anderson Cancer Center
Making Cancer History®