

Using TLDs for In-vivo Radiotherapy Dose Verification



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OSL Dosimetry Alternatives
Council on Ionizing Radiation Measurements & Standards
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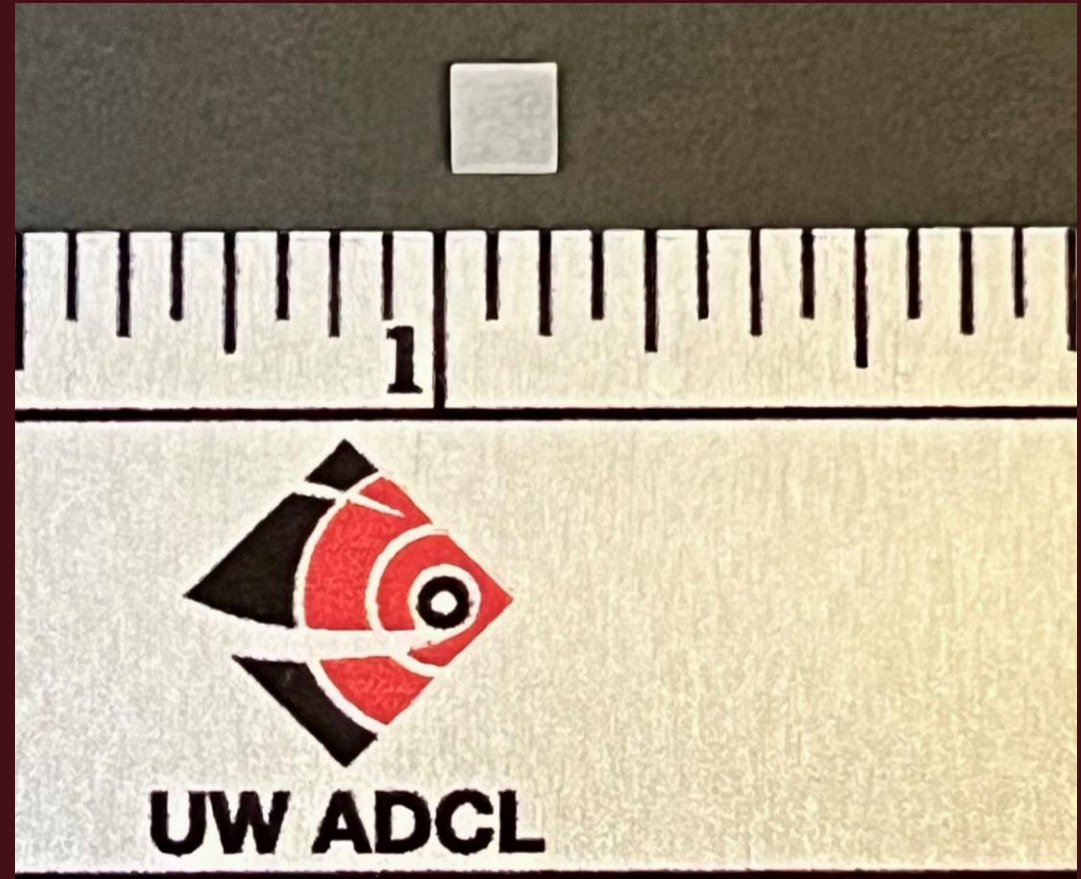
Outline

- TLD basics and readout
- Advantages and Disadvantages of using TLD
- Disadvantage (uncertainty) mitigation
- Overview of in-vivo dose verification service
- Overview of linac QA output verification service



TLD Basics

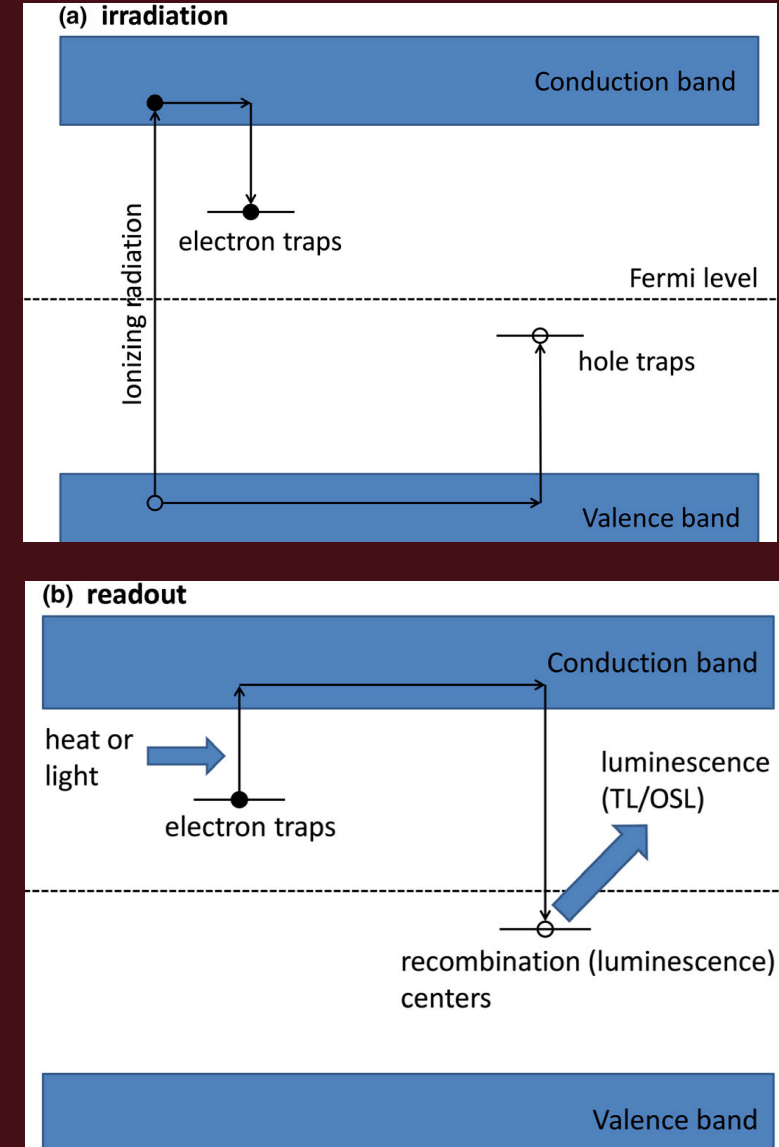
- Thermoluminescent Dosimeters
- Solid-state detectors (Insulators)
- LiF: Mg,Ti (TLD-100)





TLD Basics

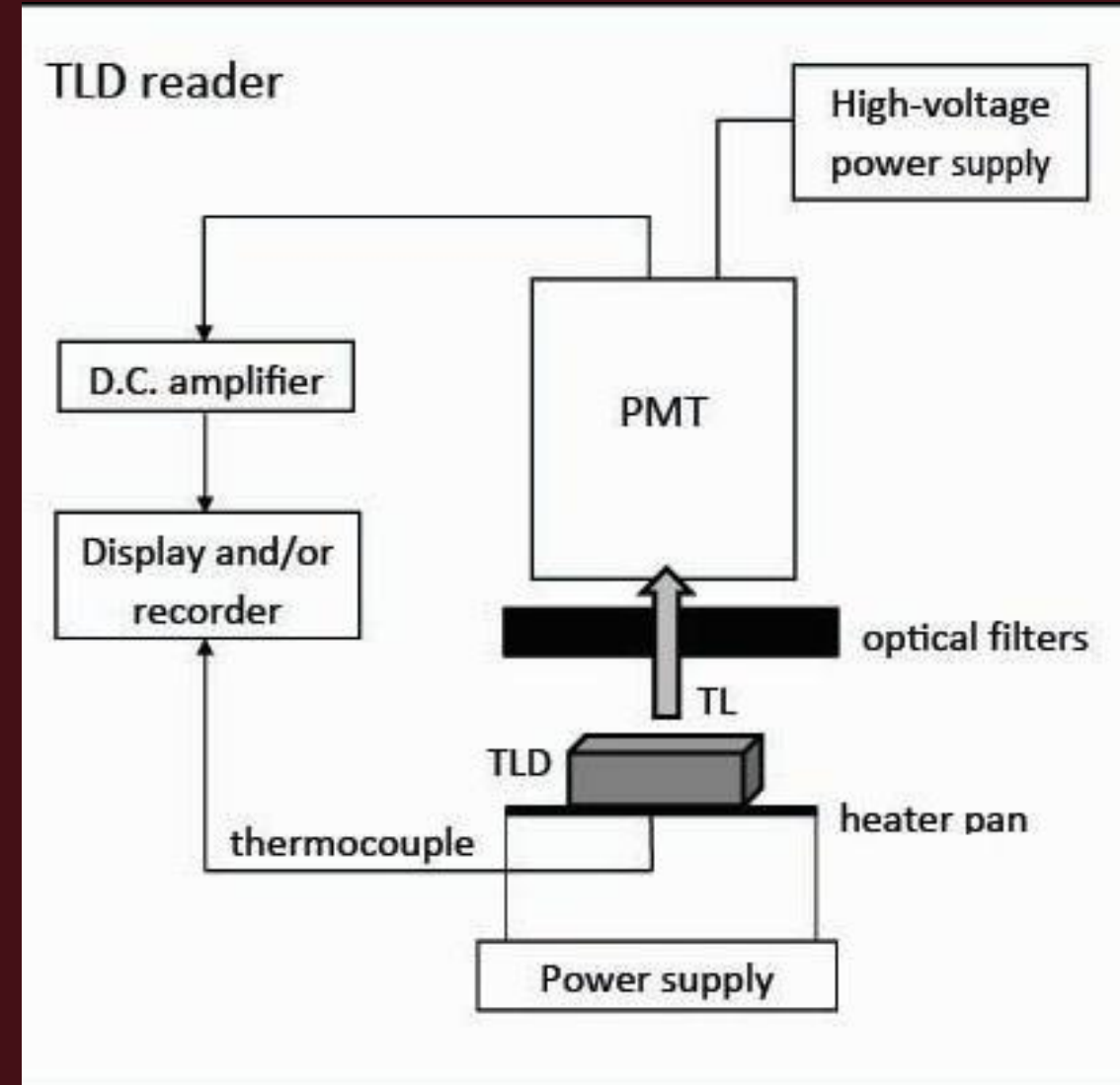
- Energy storage via electron trapping
- Heating = electron release and recombination (impurities)
- Light emitted while heating quantified





TLD Readout

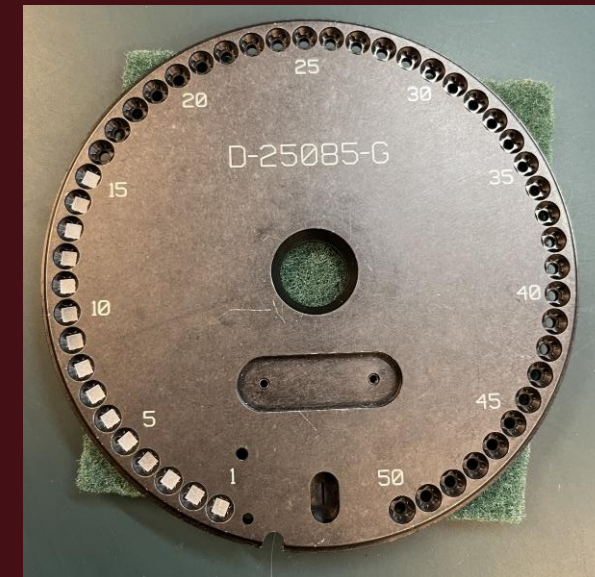
- Heated via planchet or nitrogen gas
- PMT collects emitted light
- Light converted to current
- Glow curve = integrated charge
- Relative vs Dose





TLD Readout

- Harshaw 5500 (Thermo Scientific™)
- 50 TLDs per carousel
- Vacuum Pick
- Nitrogen gas
 - For heating and cooling





Advantages of Using TLDs

- Good spatial resolution
- Inexpensive
- Passive
- Dose-rate independent
- Wide dose range
- Environment Resilient
- Highly tissue equivalent



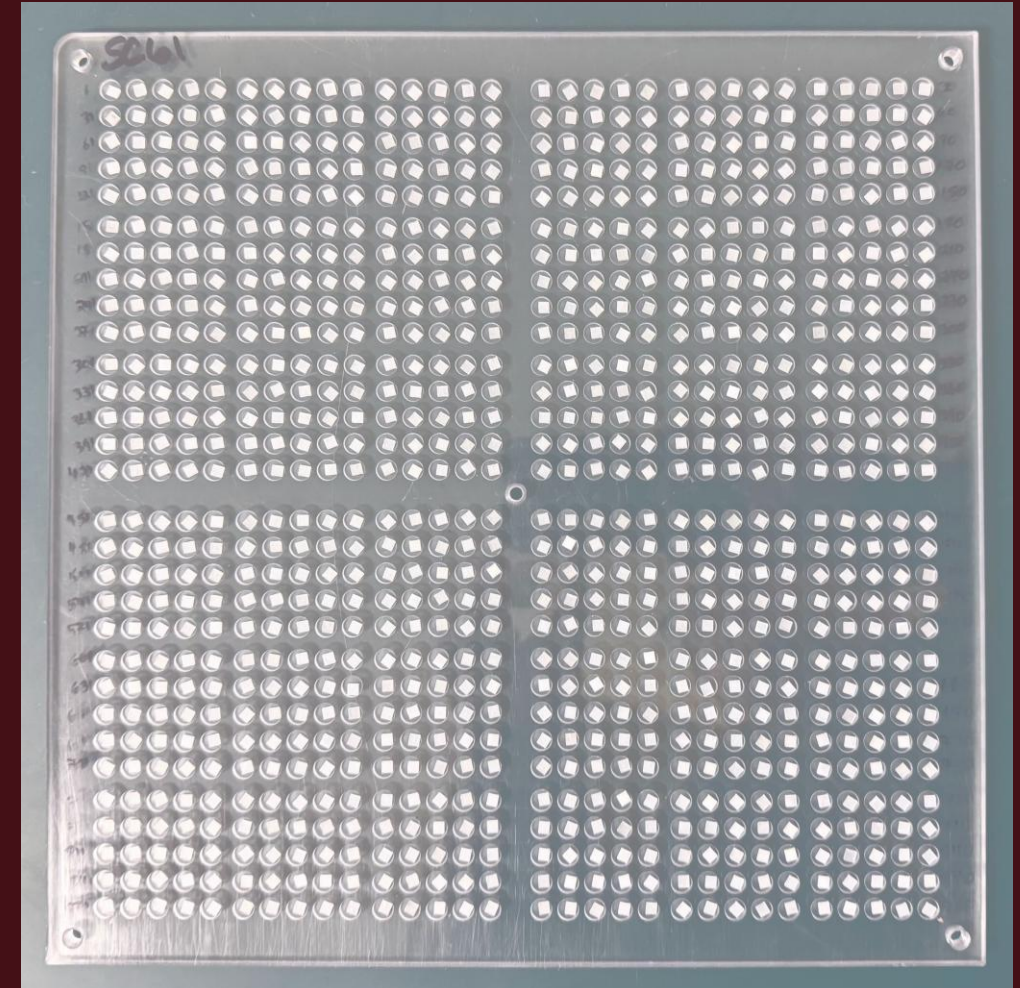
Disadvantages of Using TLDs

- Dose response (sensitivity)
- Non-linear response
- Unstable lower-energy traps
- Energy response
- Structural damage
- Destructive readout
- Delayed readout (24 hours)



Uncertainty Mitigation: Sorting

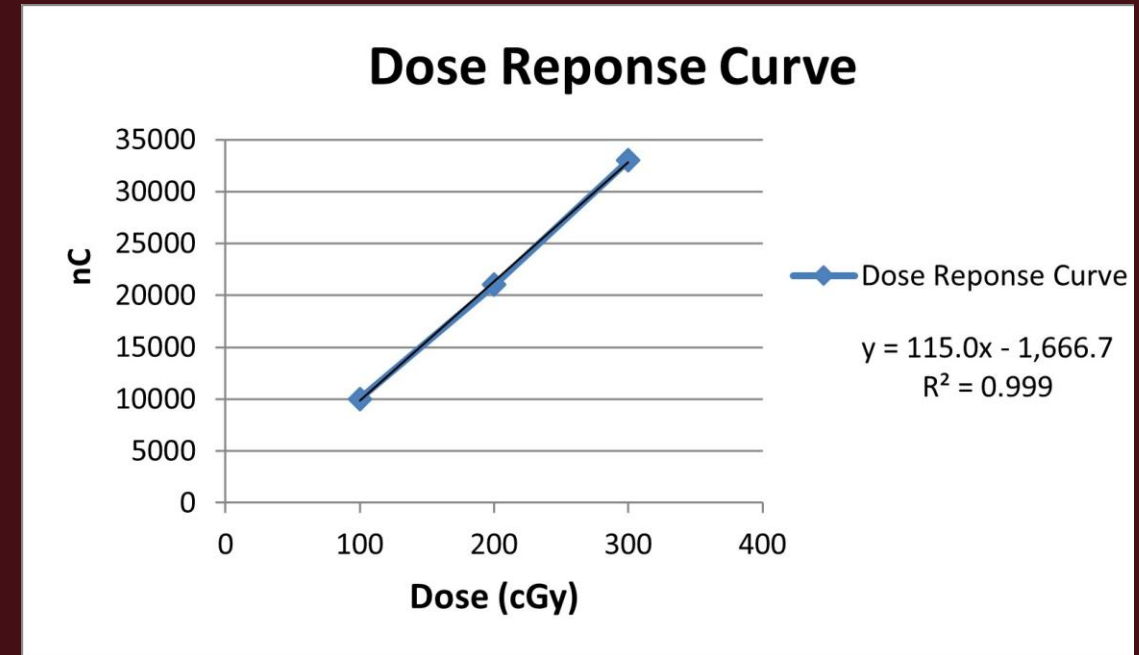
- Need:
 - Determine and account for individual TLD sensitivities
- Process:
 - Repeated irradiations
 - 900 TLDs per sort
 - Group into batches





Uncertainty Mitigation: Non-linearity

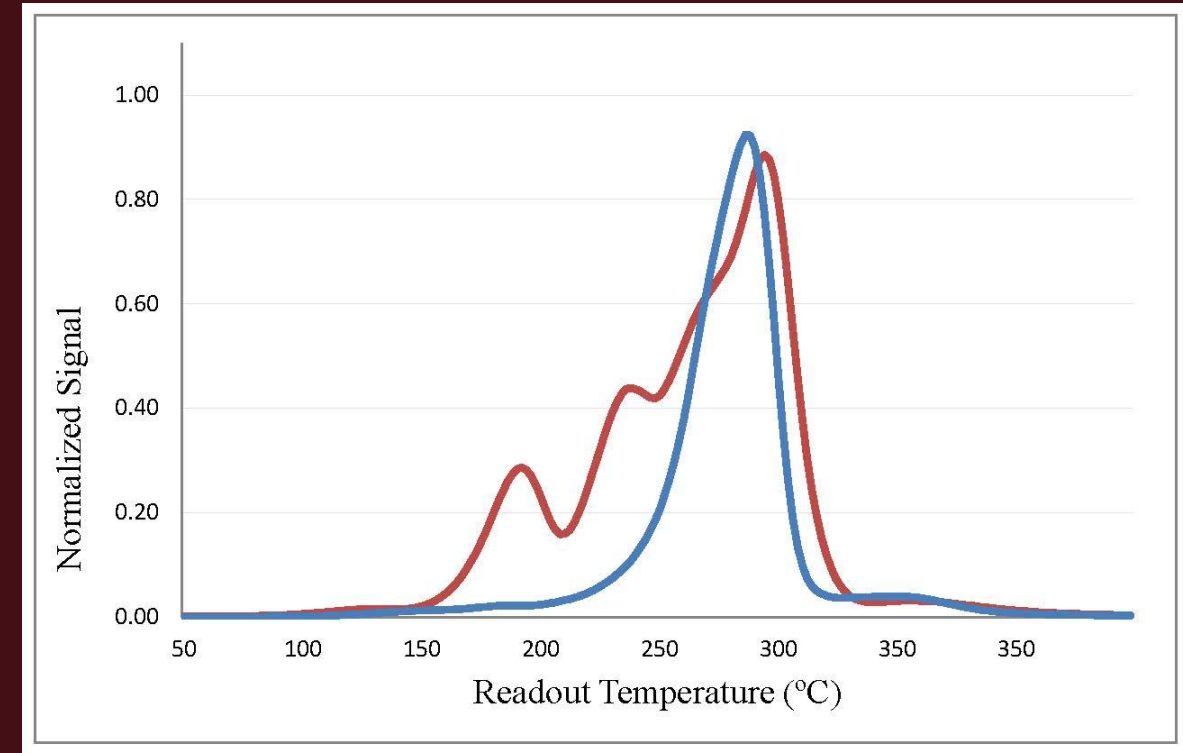
- Dose-response curve
 - 3 doses covering expected range
 - Patient TLD data fit onto curve
 - New curve for every set





Uncertainty Mitigation: Annealing

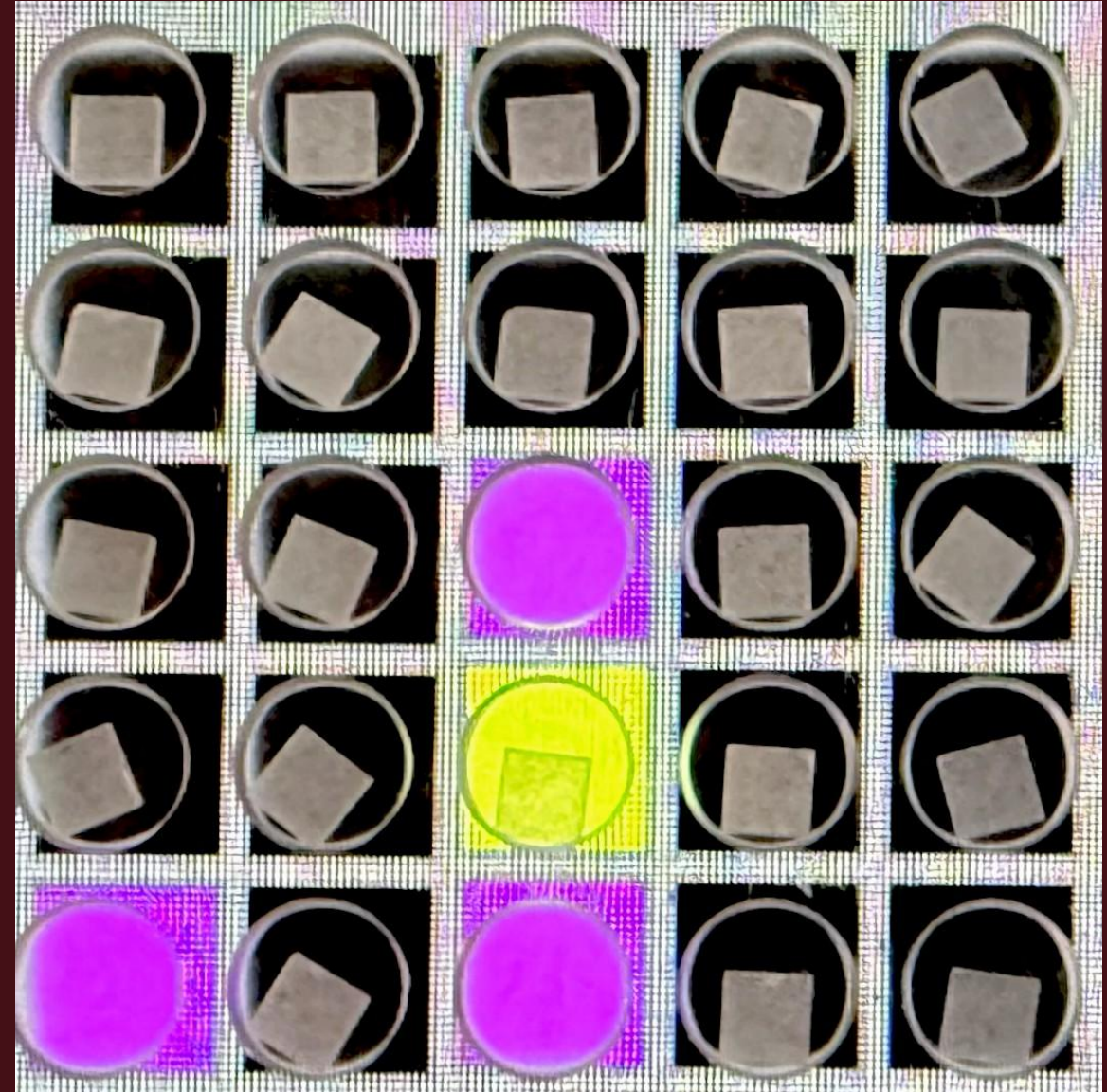
- Eliminate shallow-trap signal
- Cameron Annealing Method
 - 400°C for 1 hour
 - 80°C for 24 hours pre-irradiation
 - Quick cooldown
 - Stable until readout





Uncertainty Mitigation

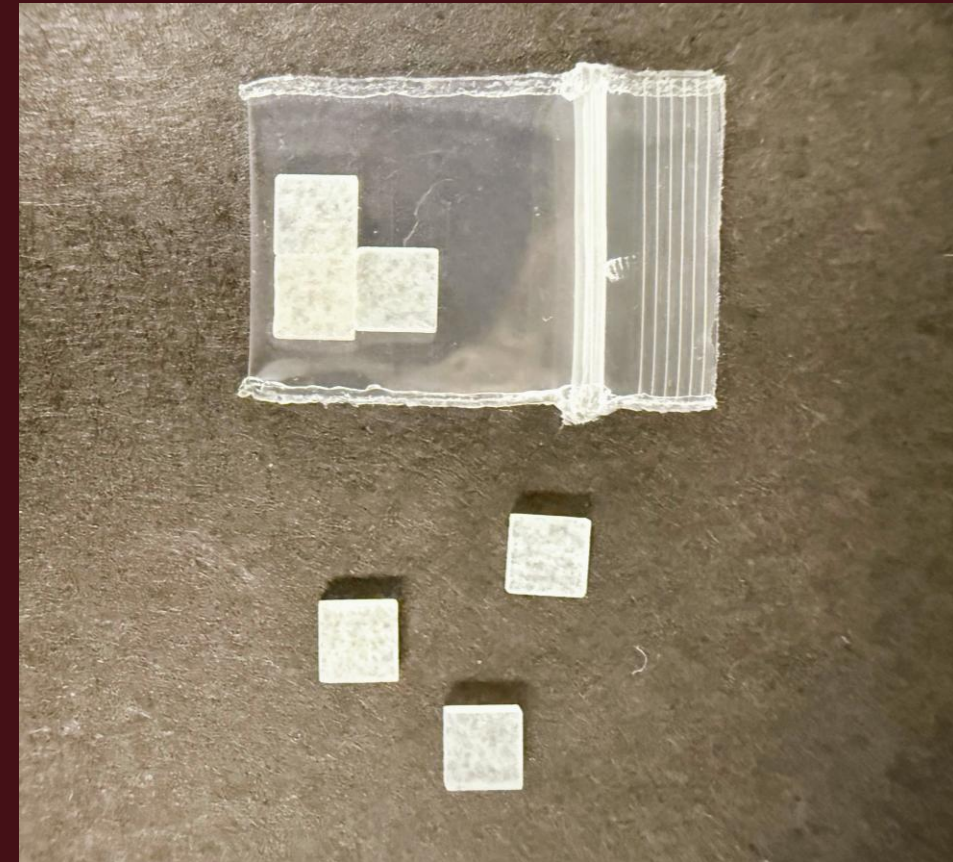
- Match energy for Patient and Calibration TLDs
- Vacuum tweezers, gloves, padded mailers
- Rigorous unloading and readout protocols





In-vivo Patient Dose Verification

- Control, Calibration and Patient TLDs
- Individual TLDs for patient
- 3 Calibrations for dose-response curve
- Same-day readout and analysis
- 2pm cutoff for orders





In-vivo Patient Dose Verification



- Separate calibrations for each set
- Recommended range: 0.5 – 1000 cGy
- Multiple TLDs per measurement point recommended (best uncertainty)
- Expanded uncertainty = 3.6%
- Report emailed (same day)





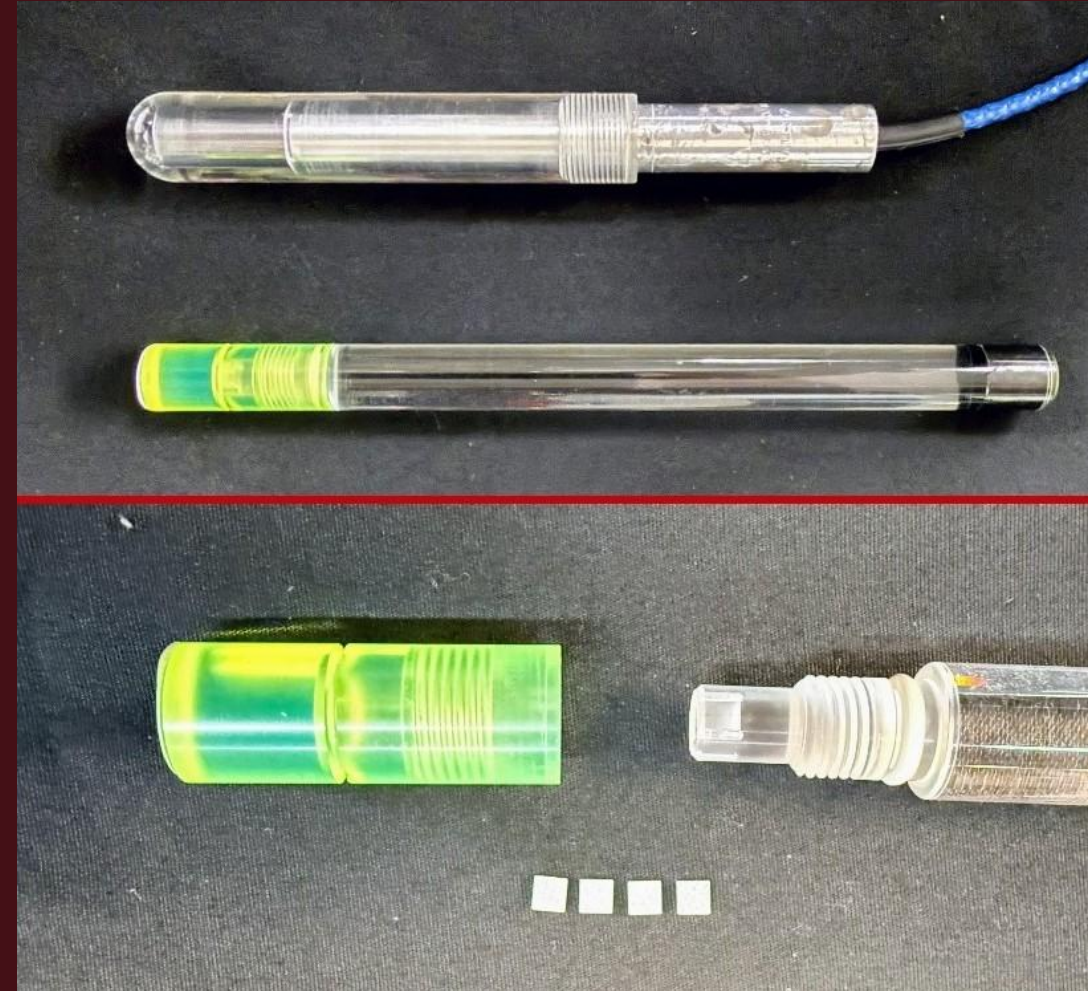
Common Applications

- Breast
- CIED
- IMRT
- Electron Treatments
- Small fields
- Steep dose gradient
- TBI
- Pregnancy



Linear Accelerator Output Verification Service

- TG-51 water tank
- Waterproof chamber surrogates
- One probe per beam
- UW calibration
- Expanded uncertainty = 5%
- Fast turnaround time



Thank you

- Scan for service info and order form
- uwmrrc.wisc.edu
- Questions?

