

# Review of Changes to the High Dose Program at NIST



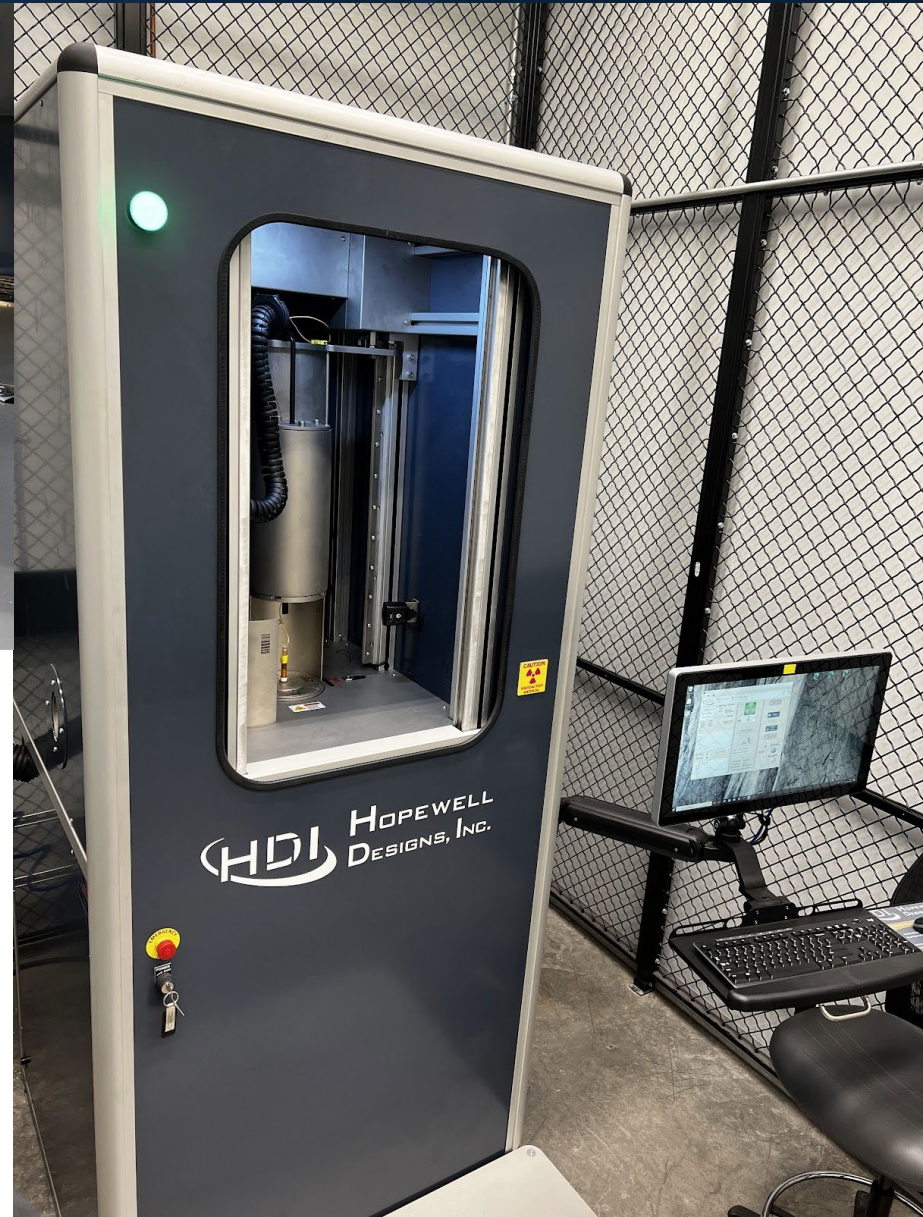
Ileana M. Pazos

[ileana.pazos@nist.gov](mailto:ileana.pazos@nist.gov)

April 18, 2023

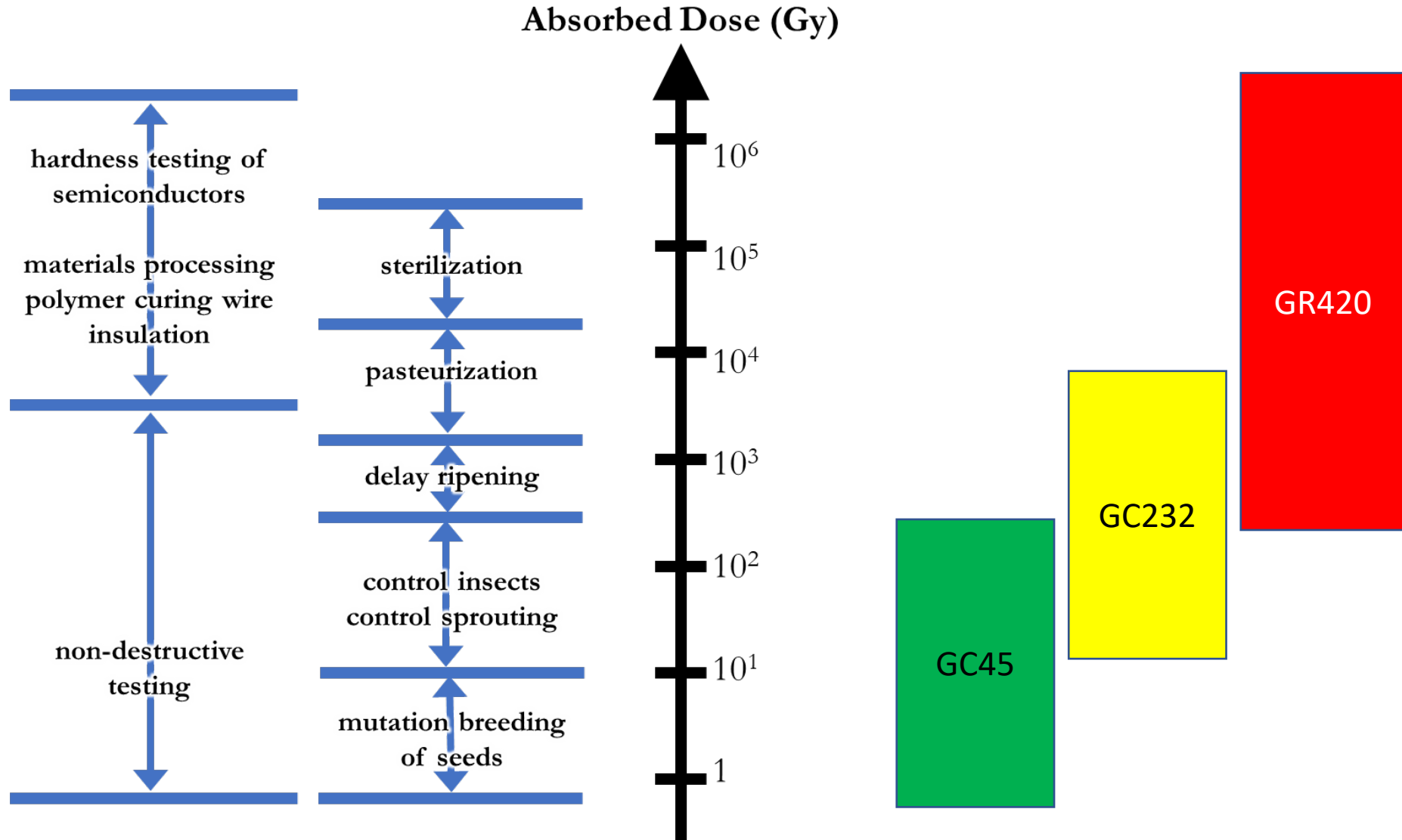


# Moves, new equipment, retired equipment NIST



*The mention of commercial products throughout this document does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the products identified are necessarily the best available for the purpose.*

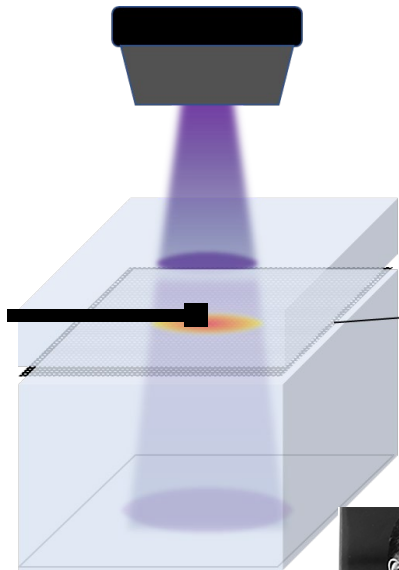
# Radiation processing dose range





# Irradiator Traceability

## Vertical Beam $^{60}\text{Co}$

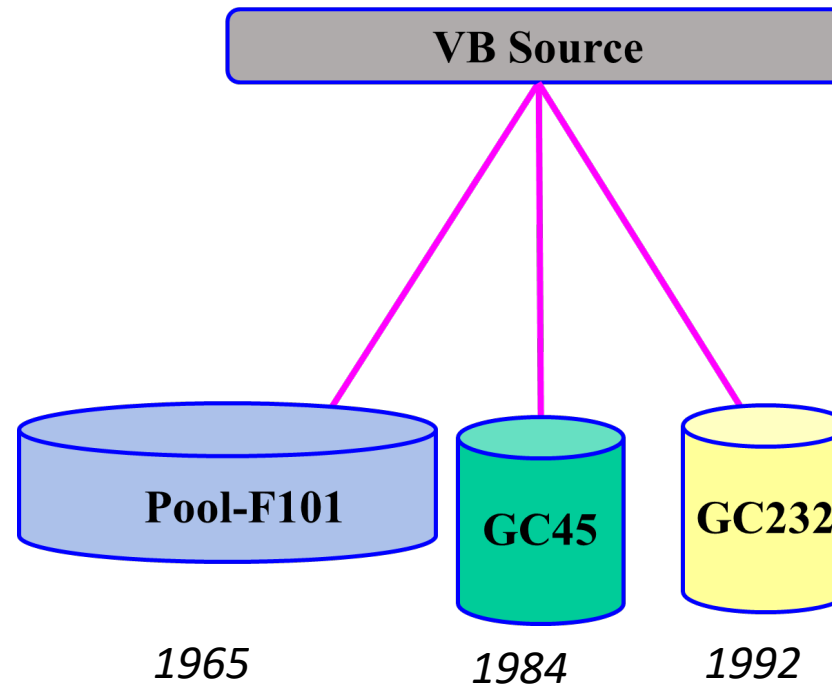


The Gy is realized through water calorimetry measurements



<https://www.nist.gov/history/radiation-physics-building/facilities/cobalt-60-pool-source>

## Traceability Pre – 2004

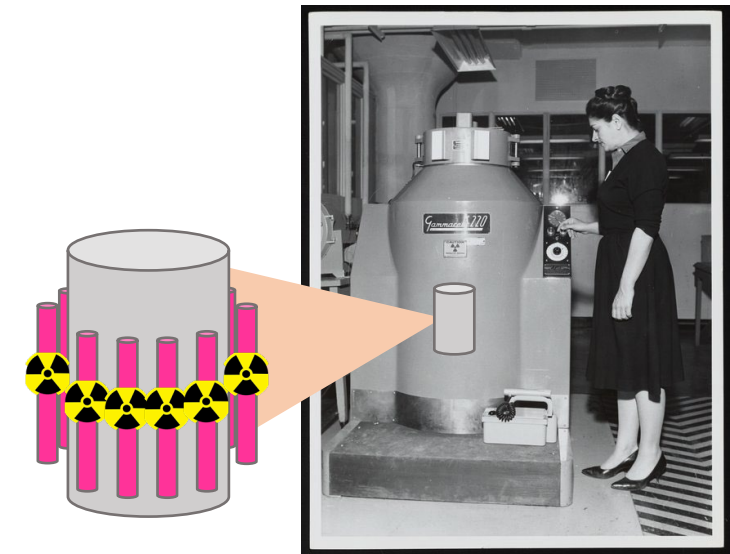


*The half-life of Cobalt-60 is 5.26 years*

## Gammacells 220

High-dose-rate sources perform customer calibrations

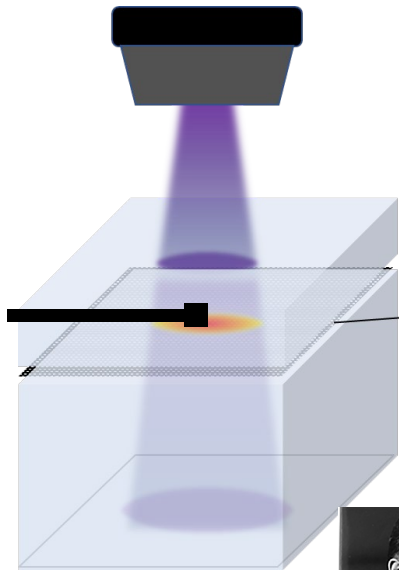
- Alanine dosimetry is used to transfer source-rate ratios
- GC provide uniform radiation doses throughout 8" x 6" chamber



<https://digital.sciencehistory.org/works/3n203z18c>

# Irradiator Traceability

## Vertical Beam $^{60}\text{Co}$

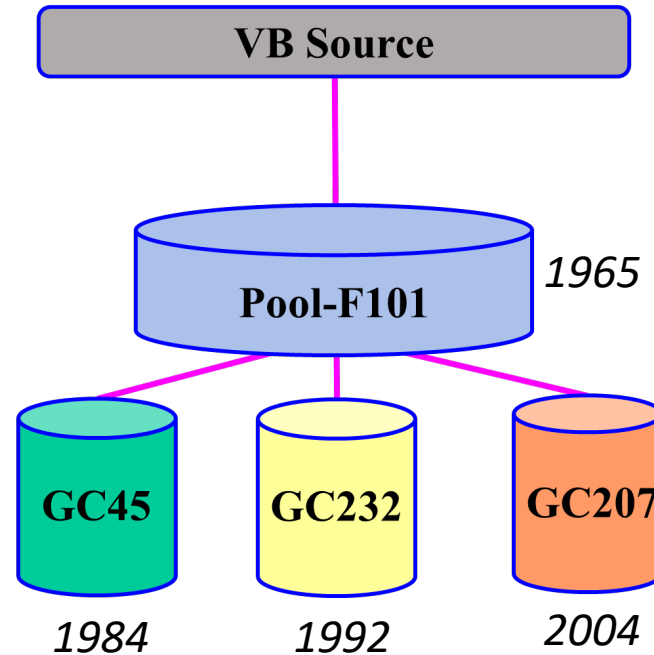


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## Traceability 2004 – 2018

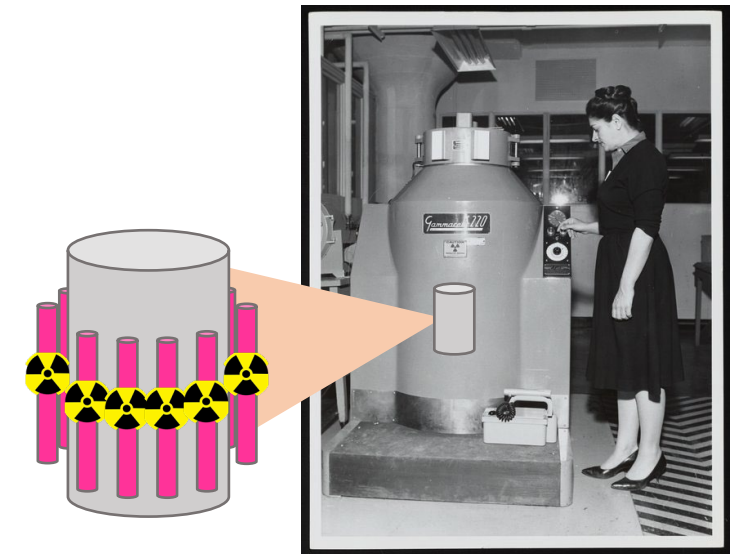


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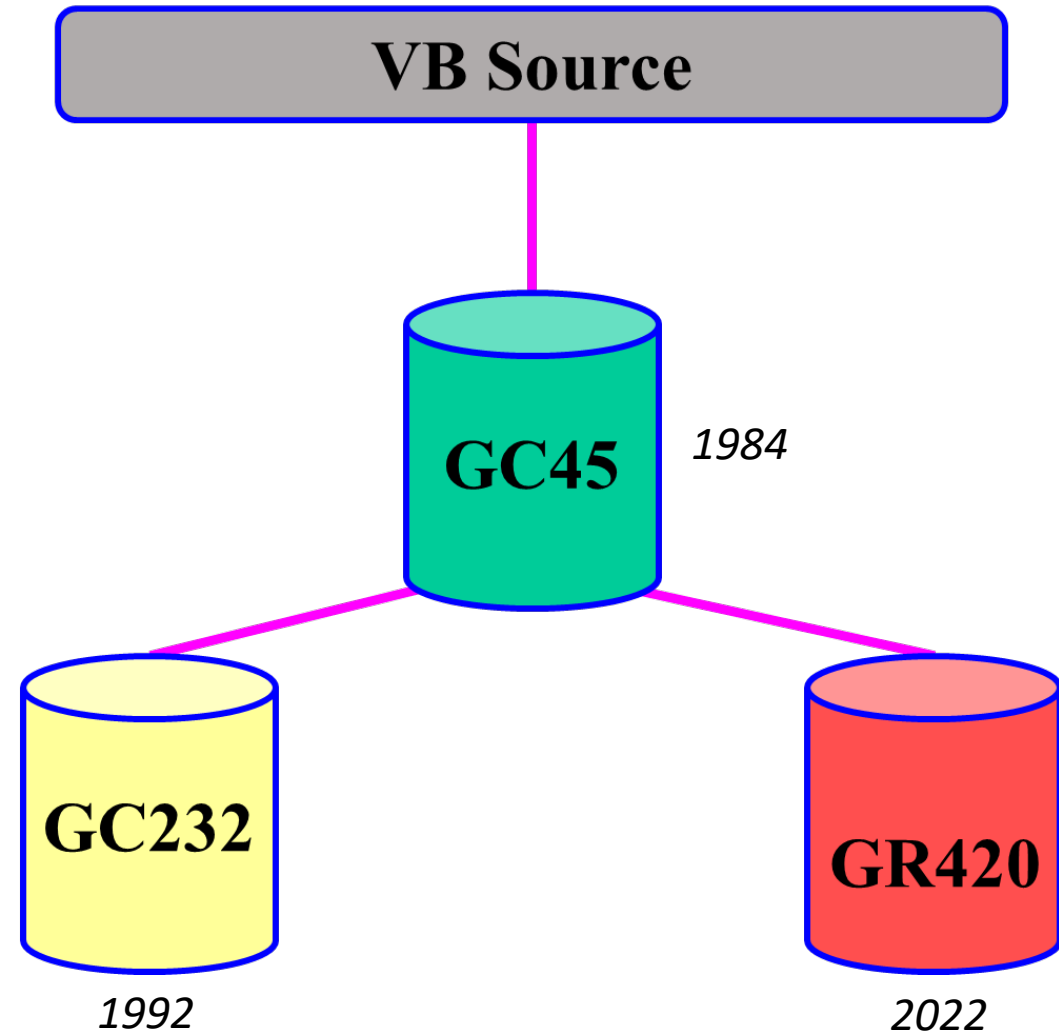
<https://digital.sciencehistory.org/works/3n203z18c>

# Current Traceability

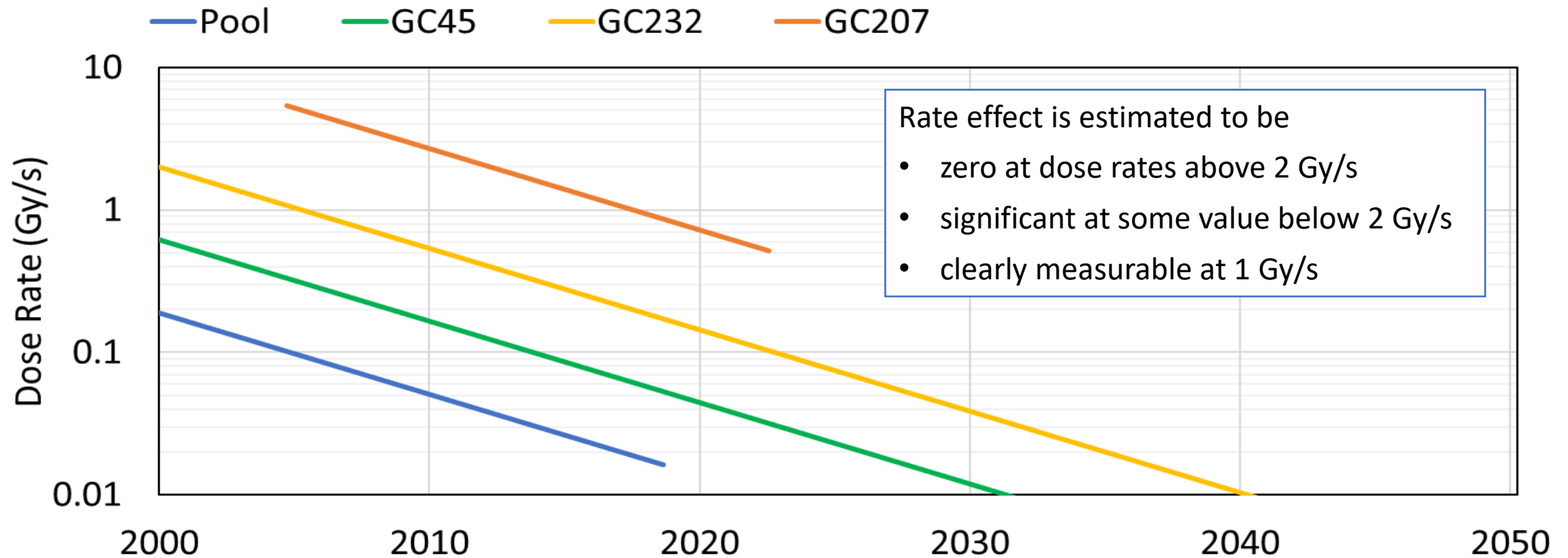
- “Pool source” was de-commissioned in 2018
- GC207 has been removed from service
- Acquired GR420 in 2022
- GC45 is now the intermediary source for traceability



<https://www.nist.gov/history/radiation-physics-building/facilities/cobalt-60-pool-source>

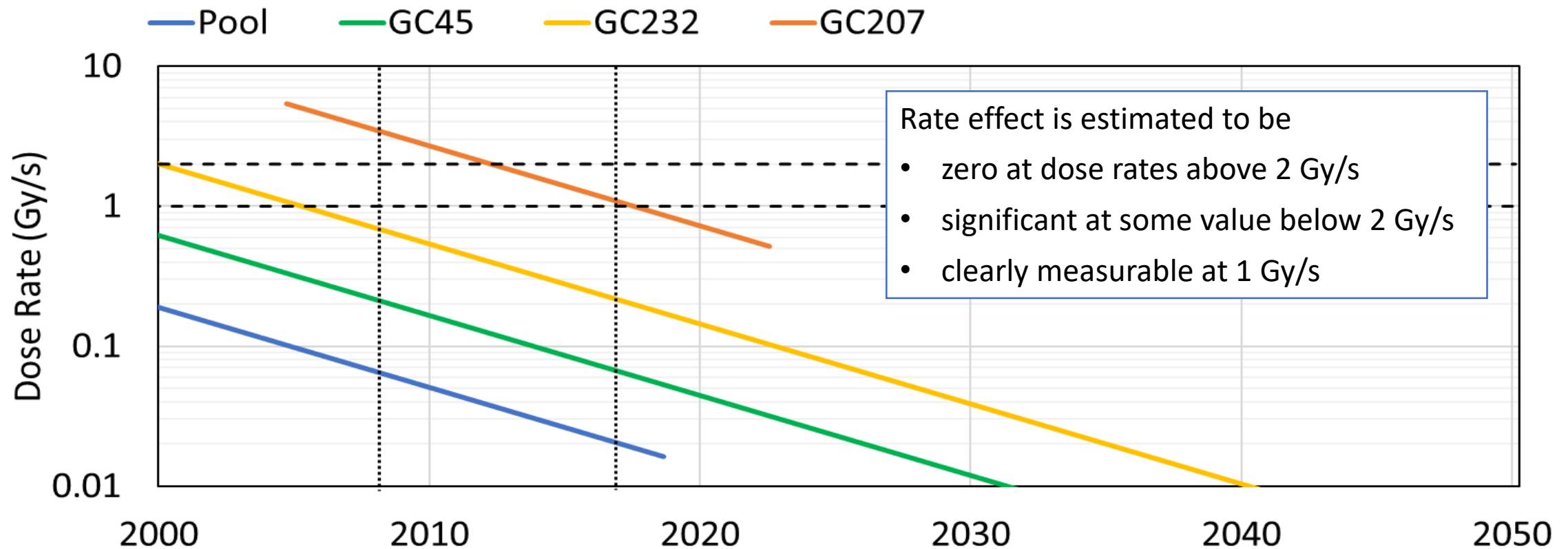


# Irradiator Dose Rates



- NIST developed the alanine dosimetry system in the early 1990s to replace radiochromic dye film dosimeters.

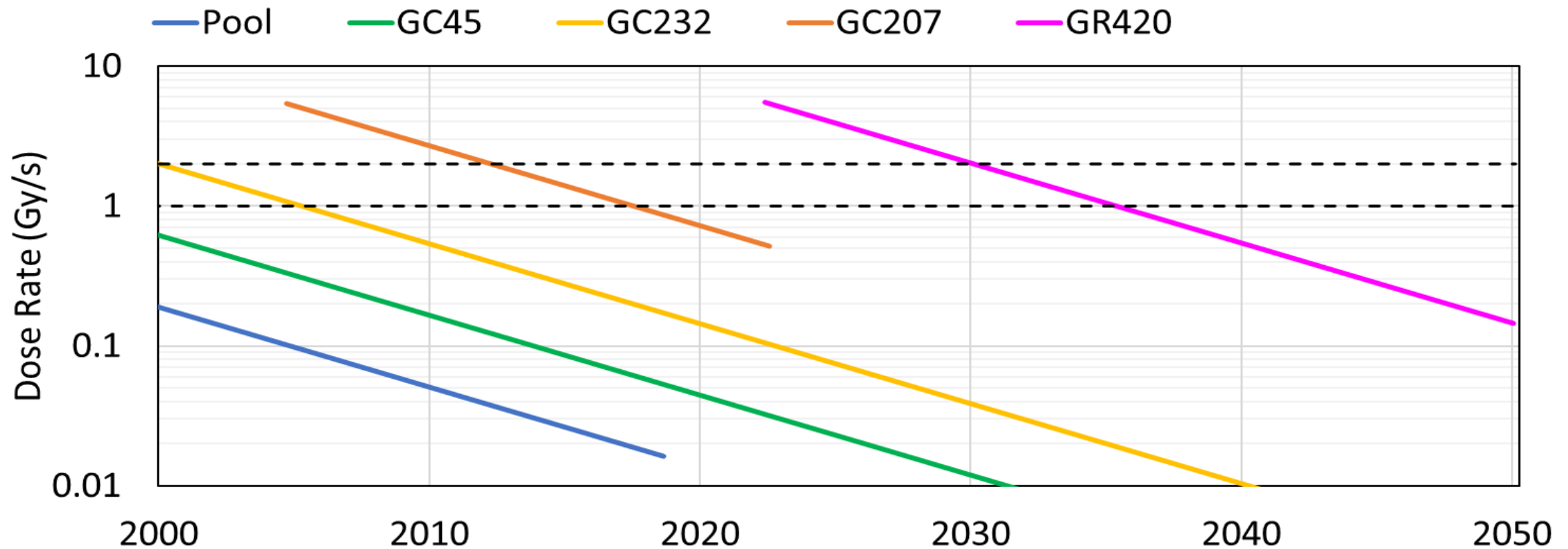
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- 2008: Nordion/Best Theratronics discontinued refurbishment of GC220.

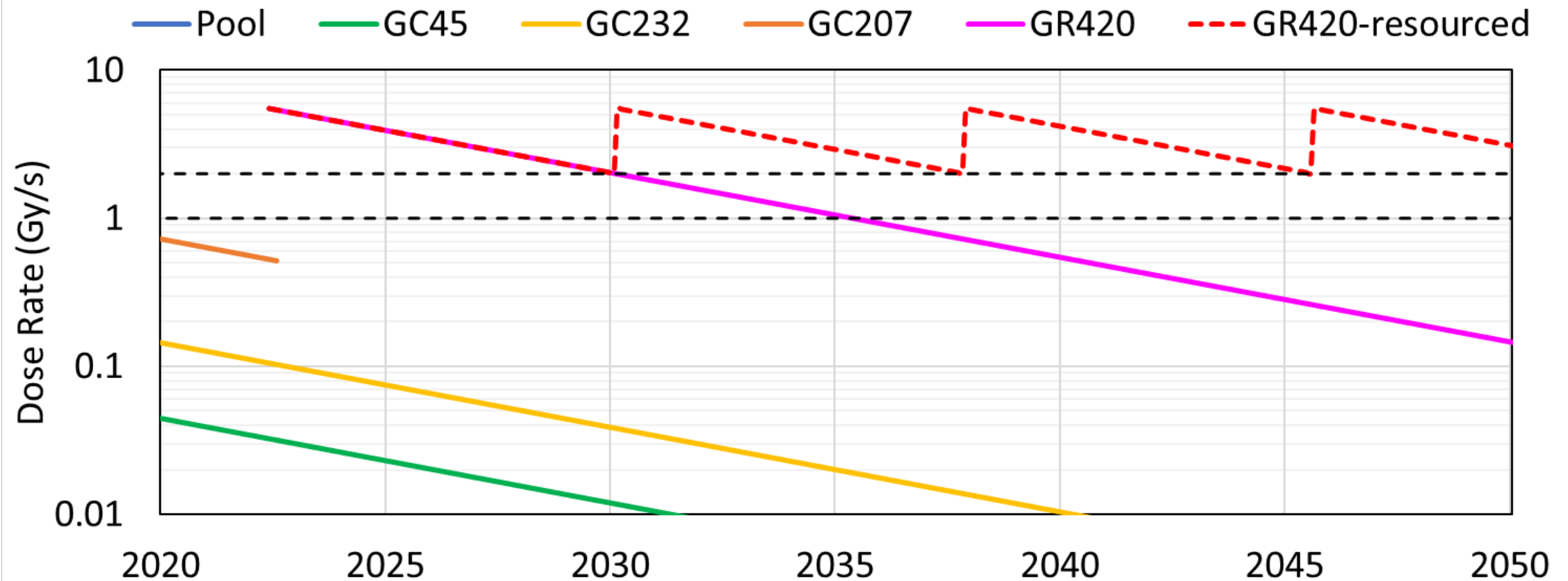


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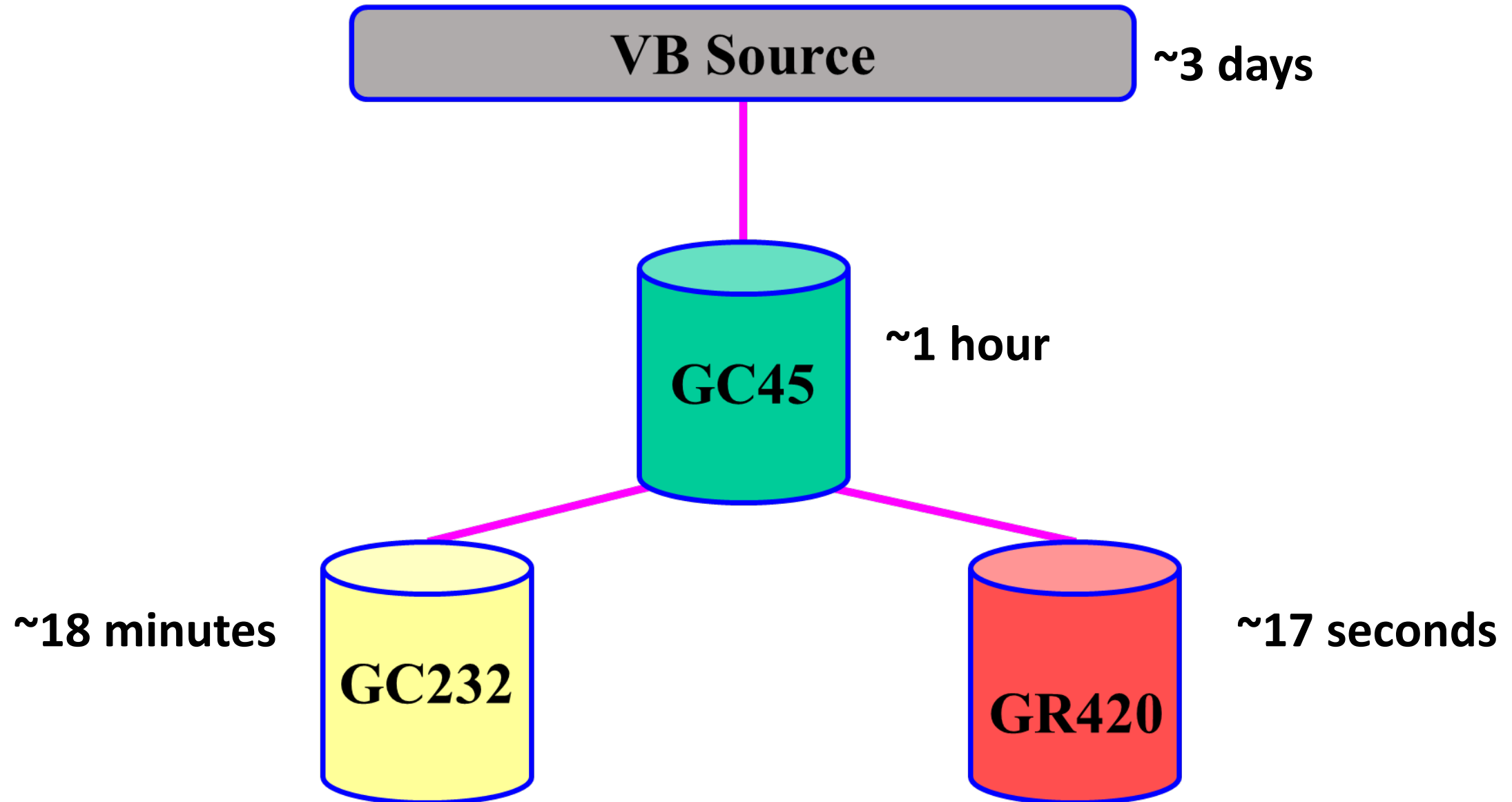
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# Duration to deliver 100 Gy





# HD Changes

NIST



EPR Lab



Irradiator Lab #1



Irradiator Lab #2

## Phase I:

March 2021  
–April 2022

Suspend HD  
Calibrations

**Move to  
renovated EPR  
lab**

Re-establish  
calibration curves  
< 5 kGy (via GC)

Revalidate  
< 5 kGy

## Phase II:

May–Sept  
2022

**Irradiator lab # 2  
receive GR420**

Safety and  
uniformity testing

Establish dose  
rate, traceability,  
geometries,  
comparisons

Validate and  
restart  
T&G < 100 kGy

## Phase III:

TBD

**Irradiator lab # 1  
renovation begins**

Partial operation

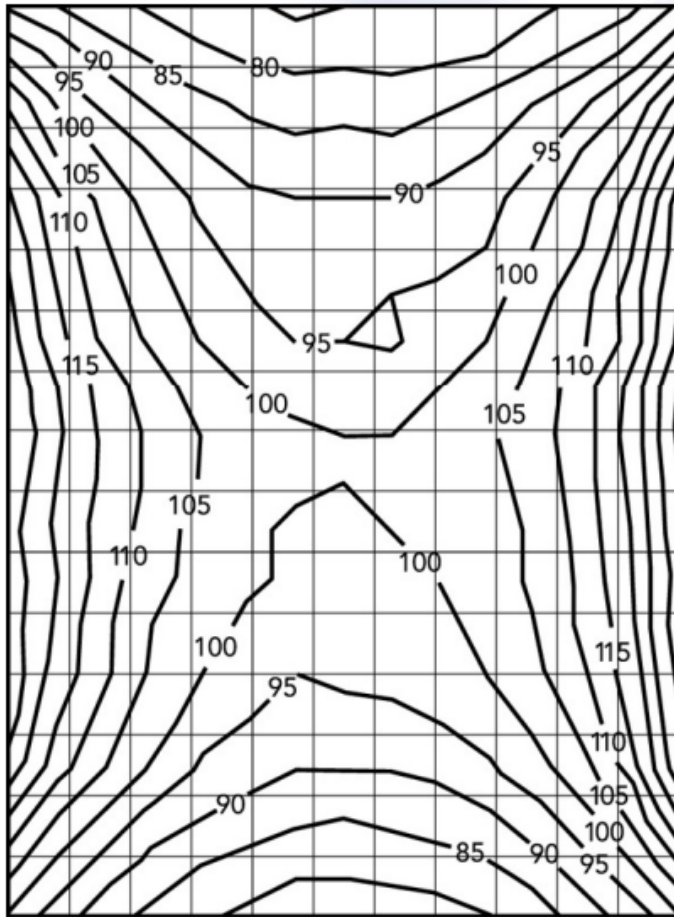
✓ G > 200 Gy \*

✗ G < 200 Gy

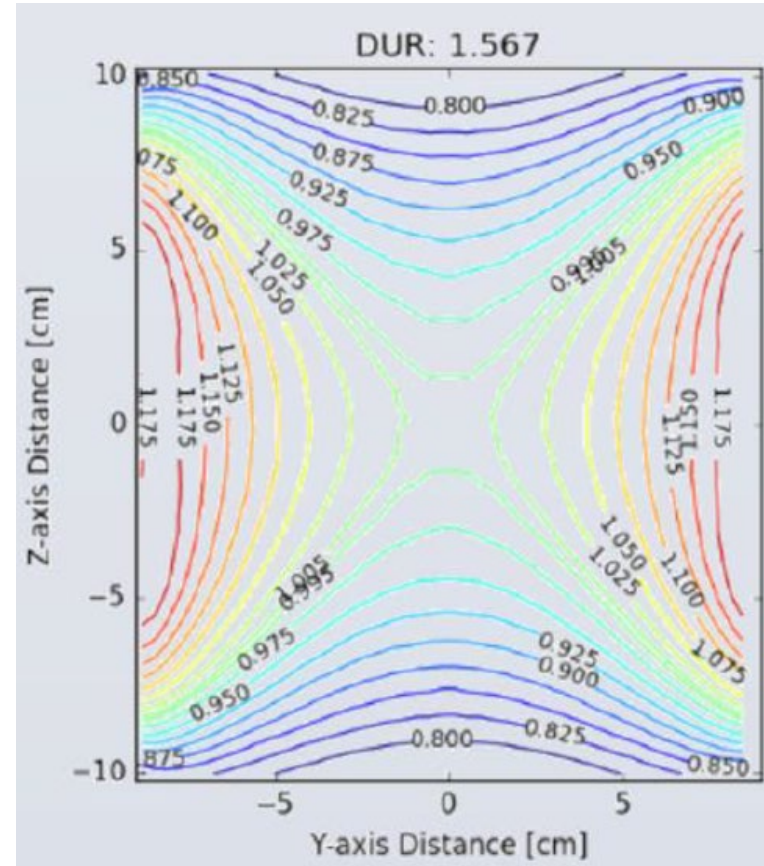
**Renovation  
complete, Fully  
operational**

# Characterizing GR420: uniformity

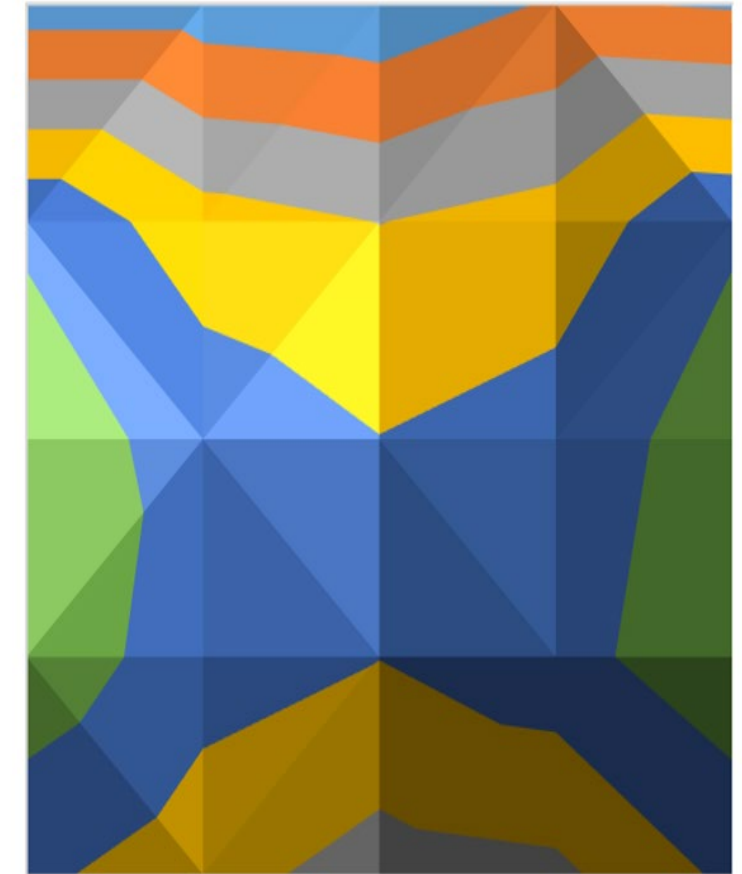
## GC220



## HDI model



## GR420

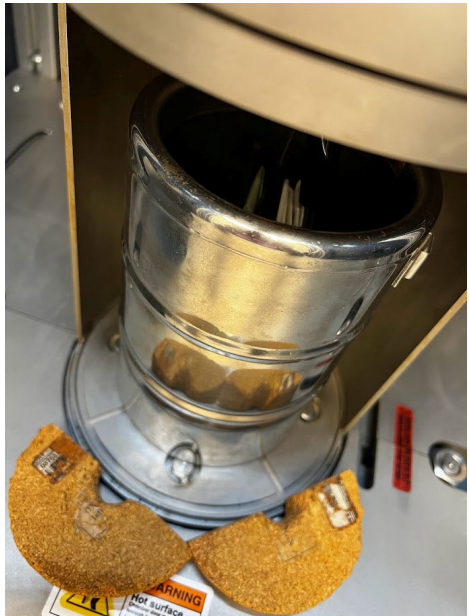
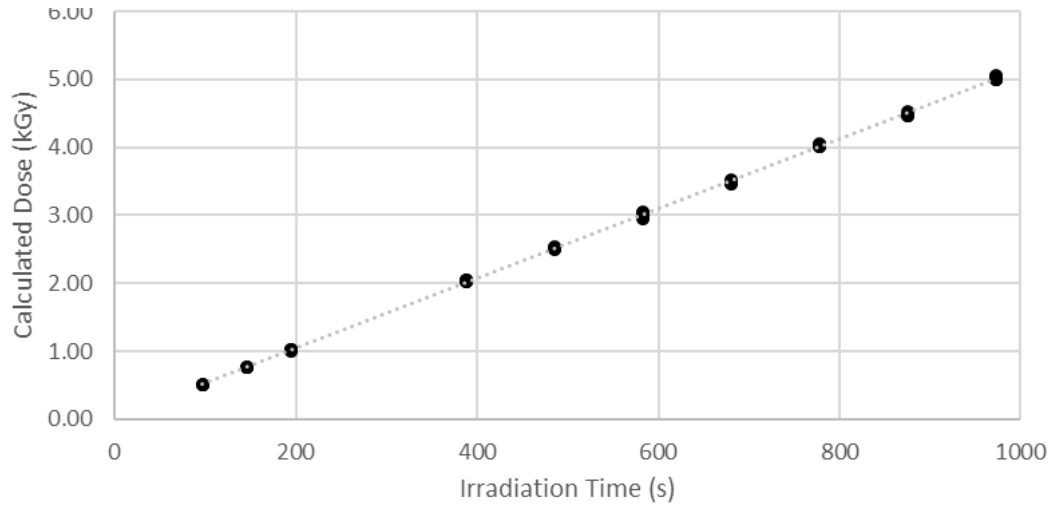
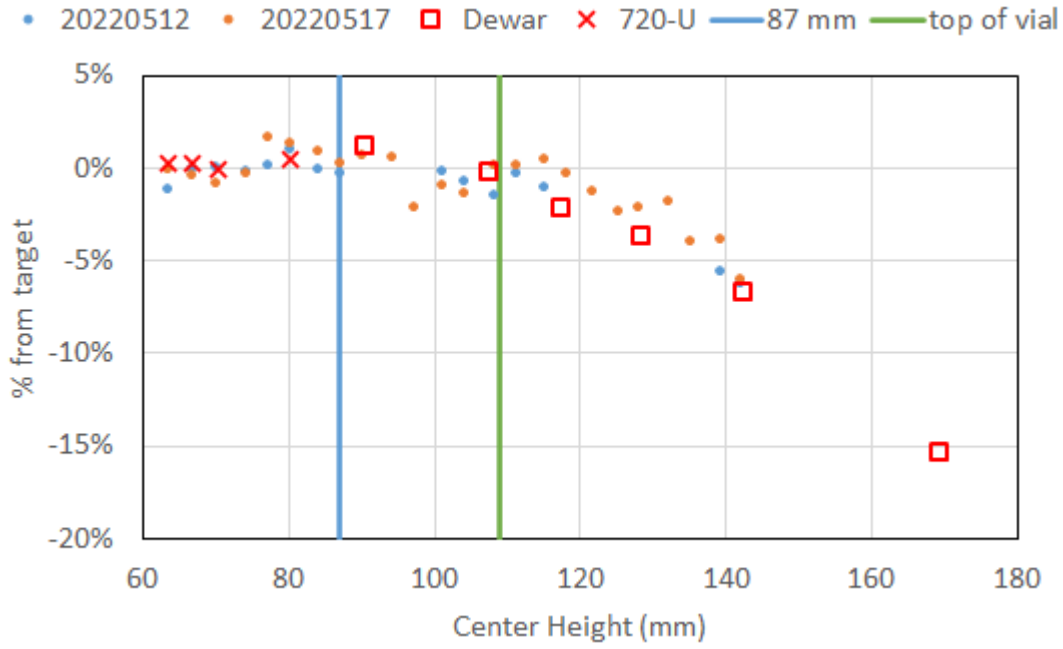


<https://www1.cgmh.org.tw/intr/intr2/c3s000/cor-elab/RadiationBiology/doc/%E9%8A%AB137%E7%85%A7%E5%B0%84%E5%84%80.pdf>

■ 0.8-0.85 ■ 0.85-0.9 ■ 0.9-0.95  
■ 0.95-1 ■ 1-1.05 ■ 1.05-1.1

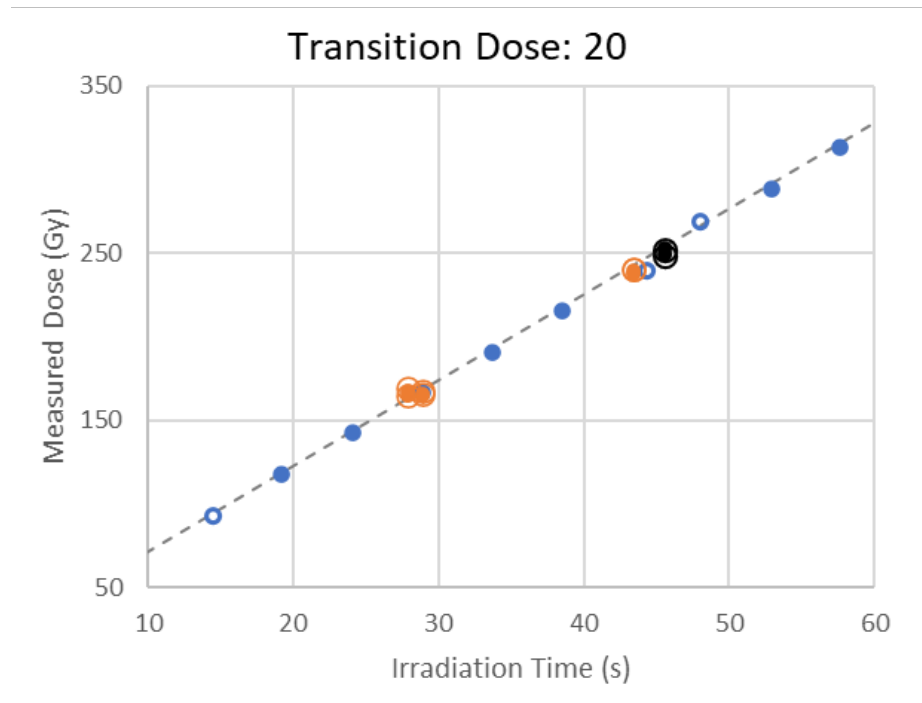
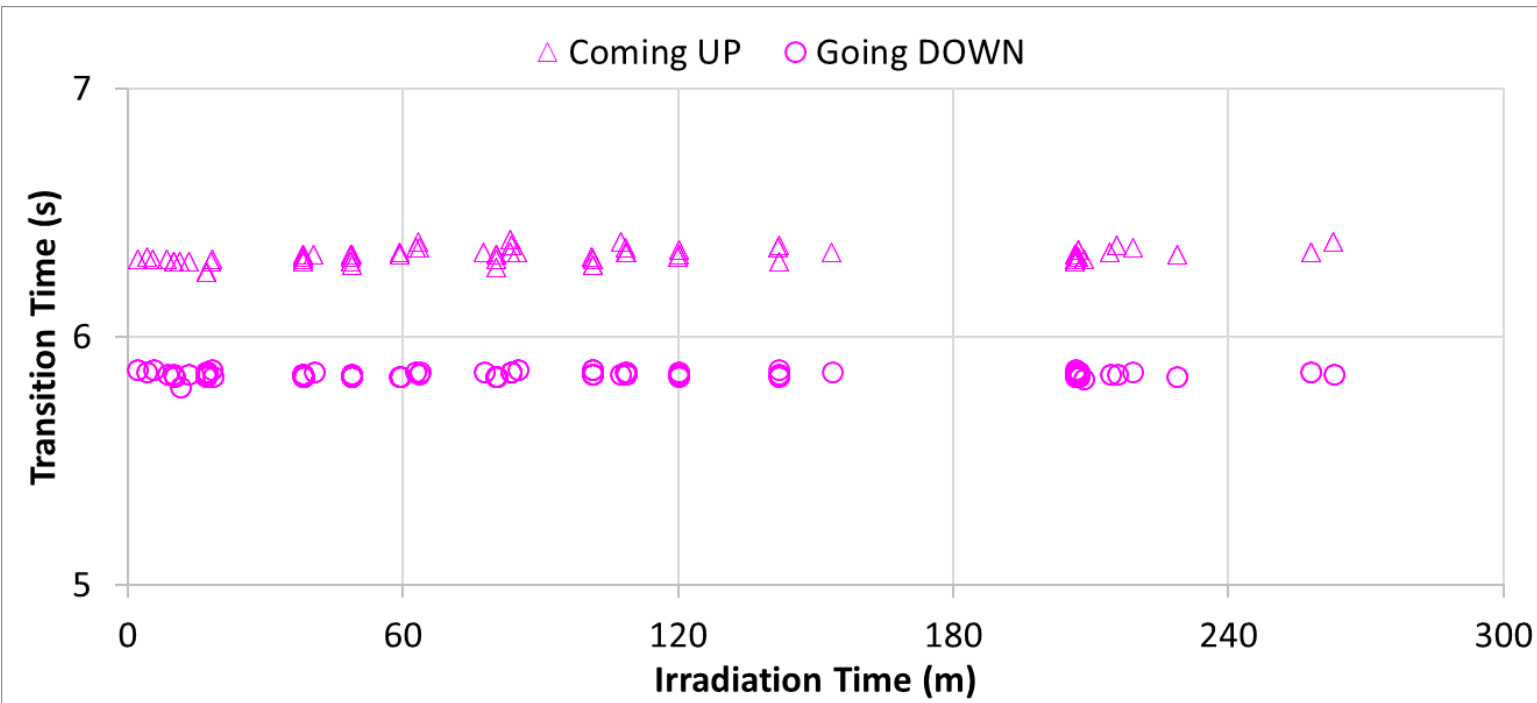


# z-axis, dose rate, and geometries





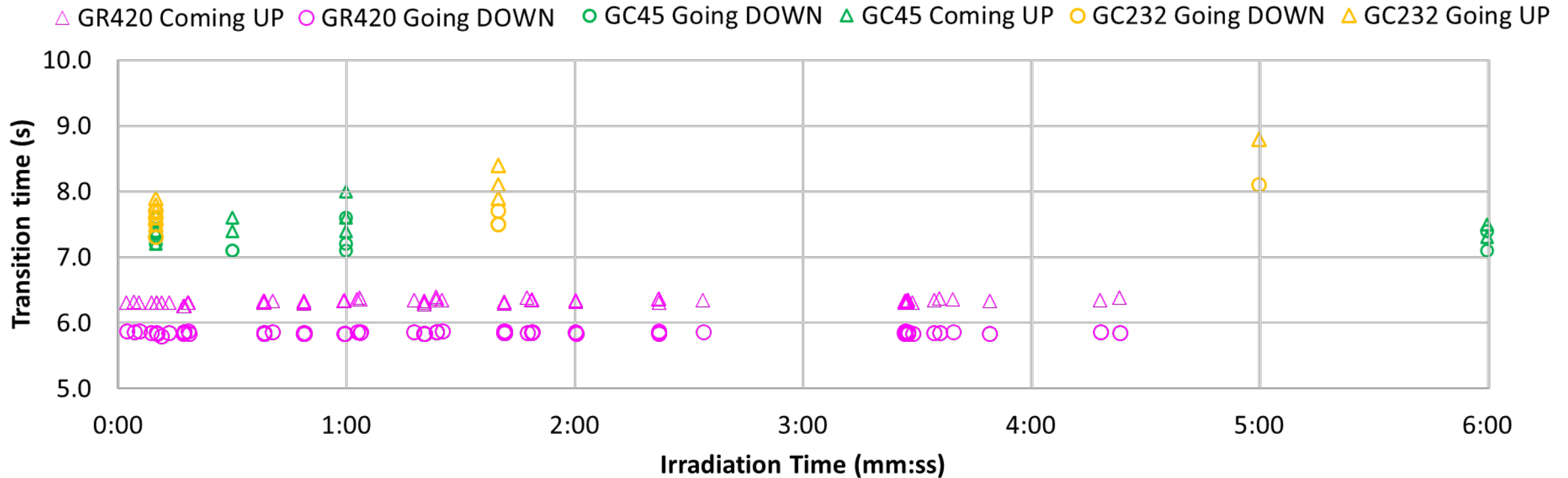
# Characterizing GR420: transit dose&time



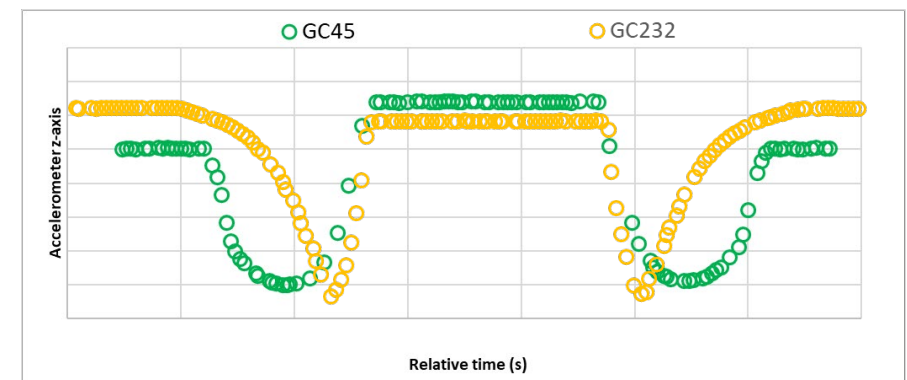
Equivalent transit time= the absorbed dose received by the dosimeters during the delivery of the dosimeters to and from the irradiation position.

Alanine dosimeters are irradiated for a series of very short times. The dosimeter response is measured and plotted versus irradiation time.

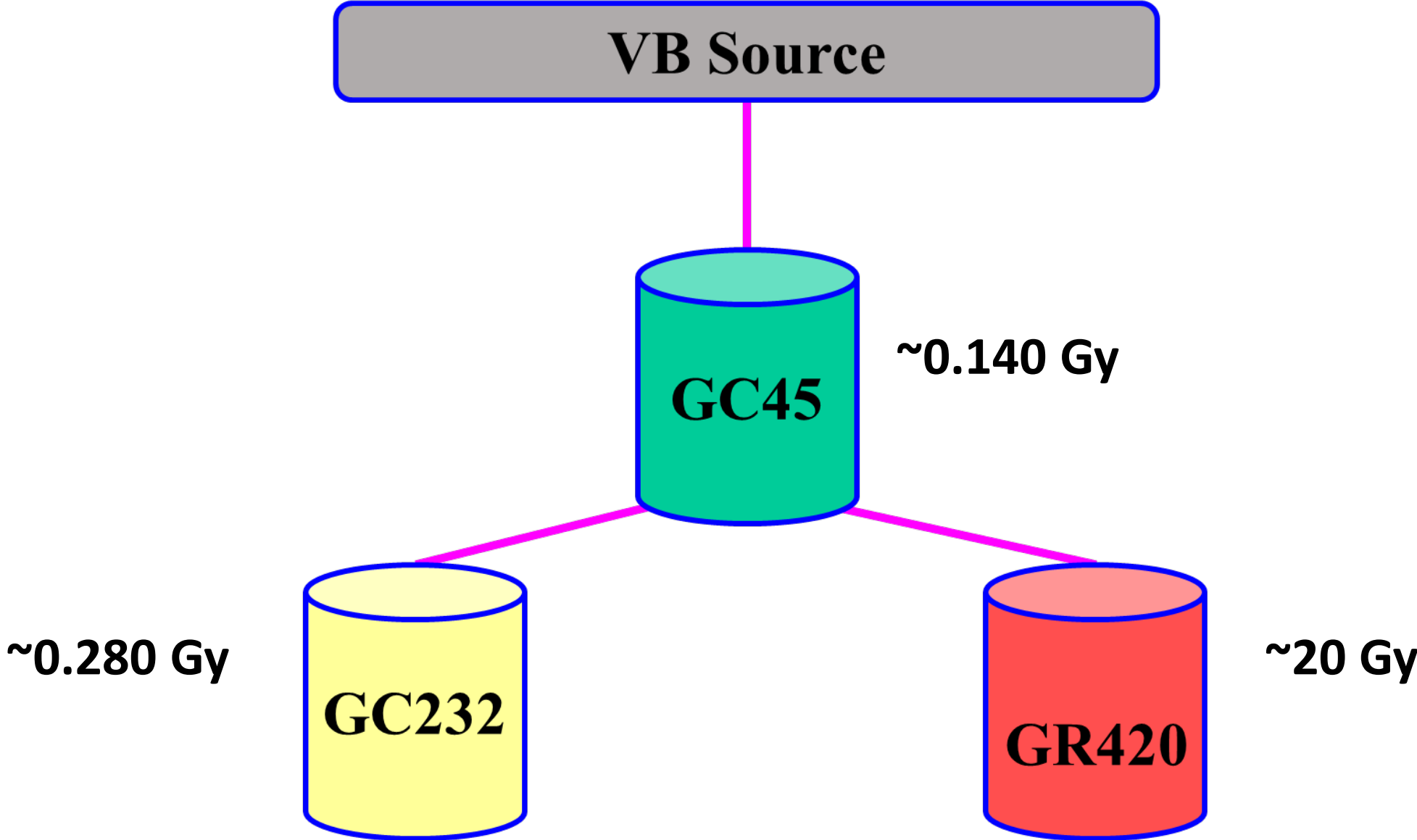
# Irradiation Transition Time



Transition dose and the equivalent transit time is the absorbed dose received by the dosimeters during the delivery of the dosimeters to and from the irradiation position.



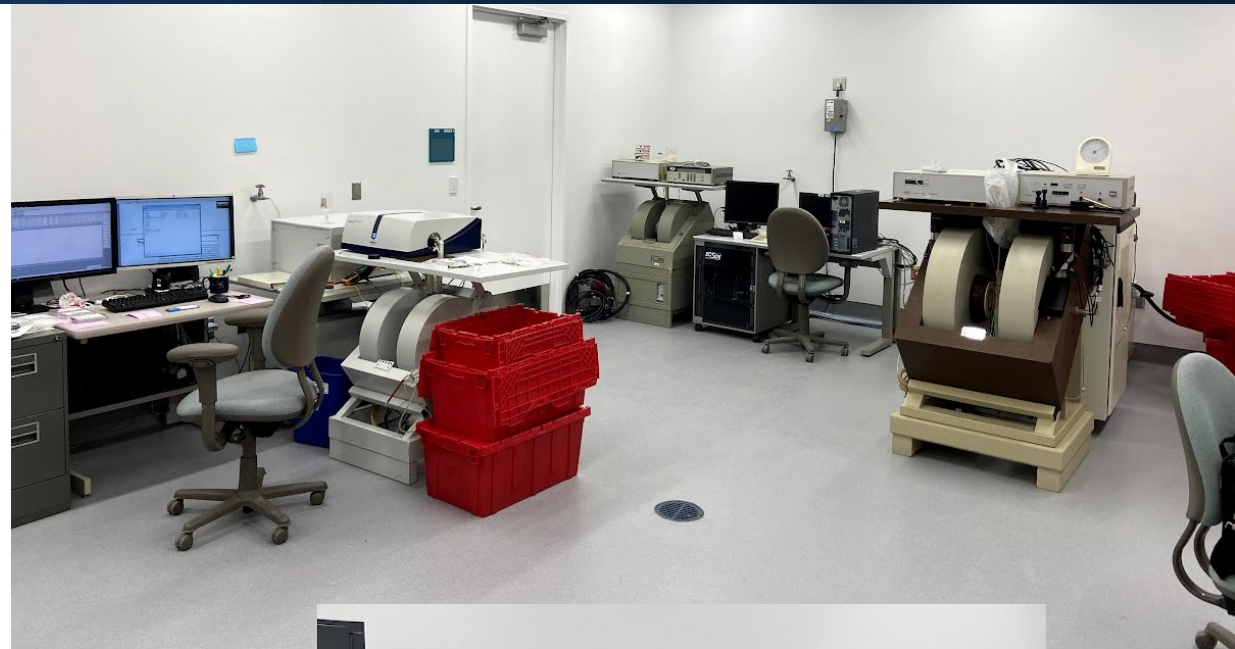
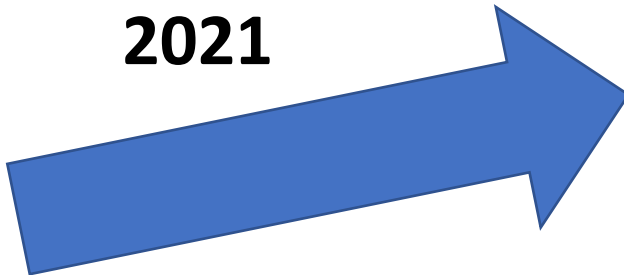
# Transition Dose

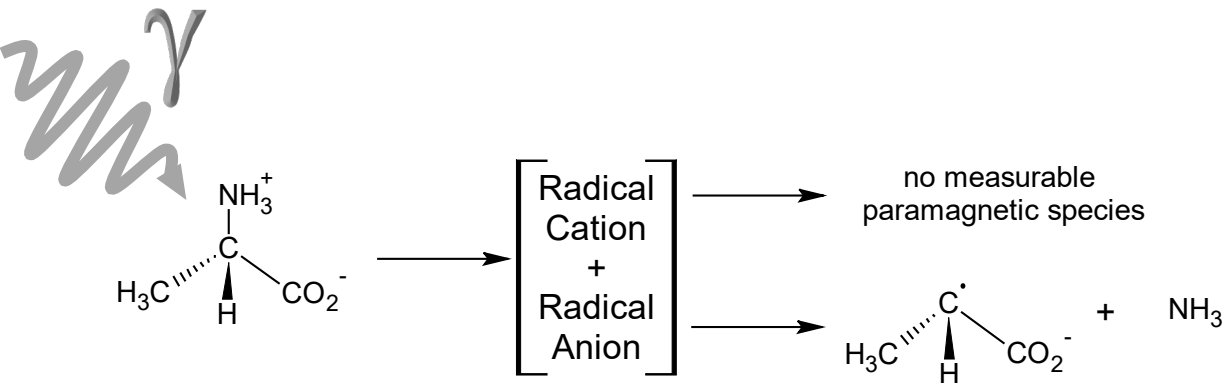




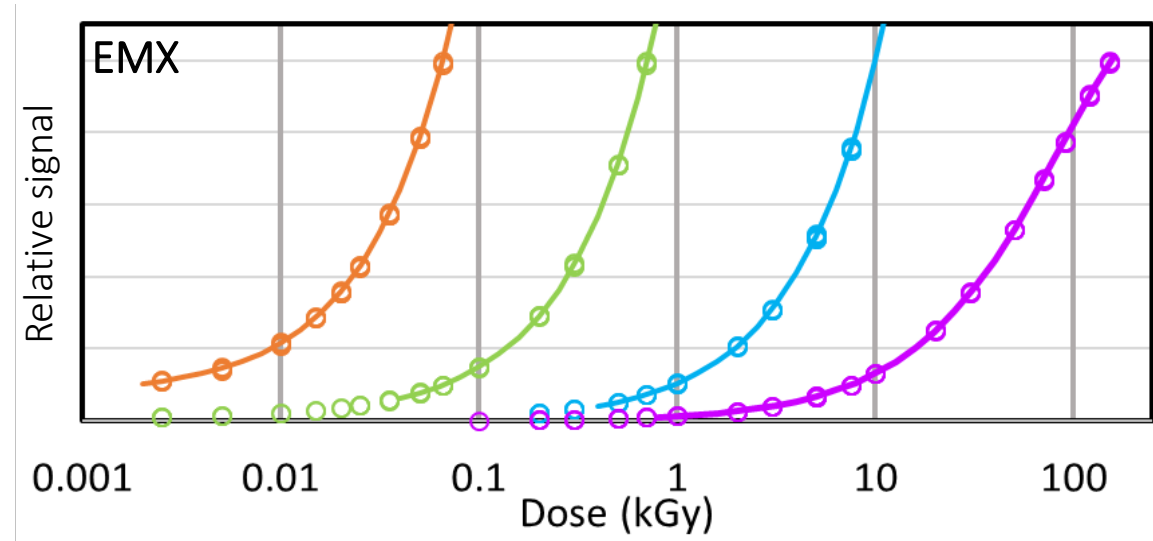
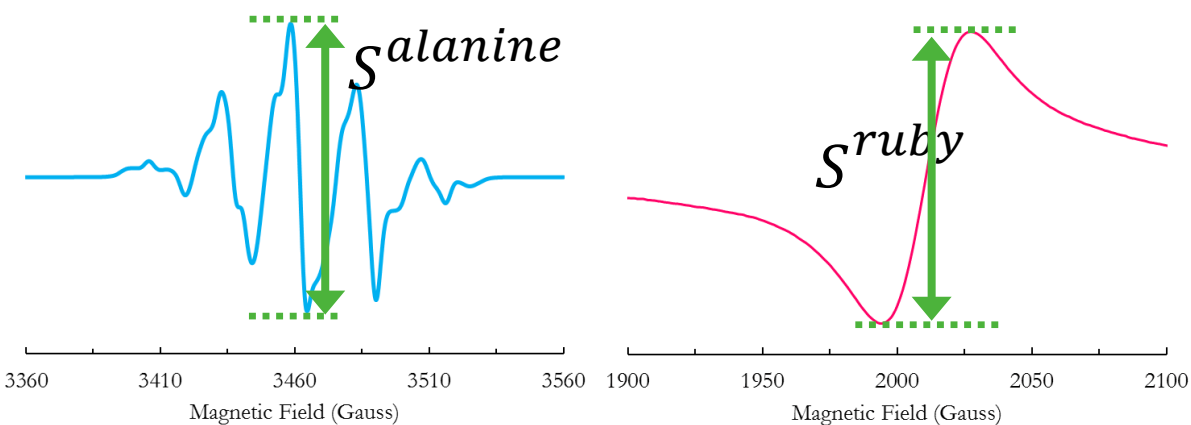
# EPR lab move to renovated space

NIST





The alanine-derived radical anion undergoes deamination producing a free-radical center that is exceptionally stable.<sup>1</sup>



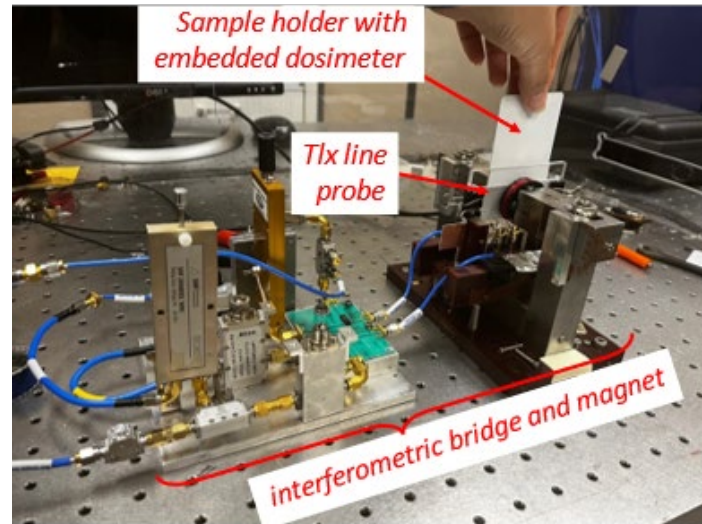


# Emergency Response Dosimetry System

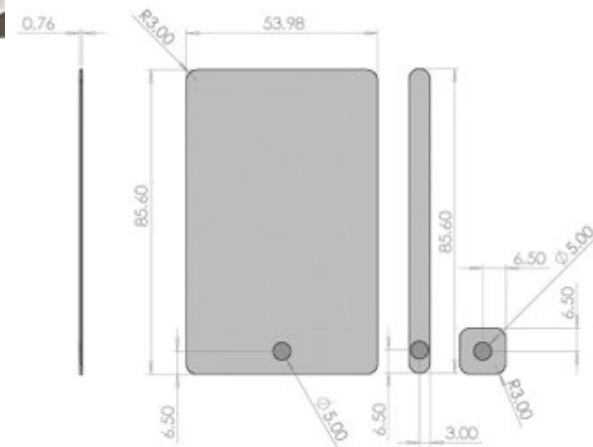


*Dosimeter  
embedded  
card*

*Automated Card Hopper*



*Experimental setup  
showing the magnet, the  
non-resonant  
interferometric bridge,  
transmission line probe,  
and sample holder with  
dosimeter*



*Rugged Automated  
Dosimetry Reader  
(rendering)*



*Automated Dosimetry  
Reader (rendering)*



# Thanks!