# So, what should we do with these check standards?

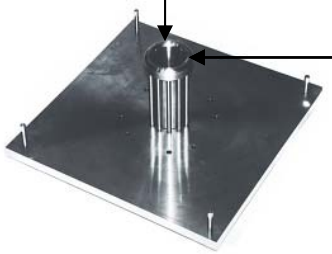
Marc F Desrosiers

NIST

# NIST Calibration Scheme

Vertical Beam, 1.3 kCi


alanine



Pool, 0.15 kCi

Transfer of dose rate made by alanine dosimeter ratios in terms of signal/second.

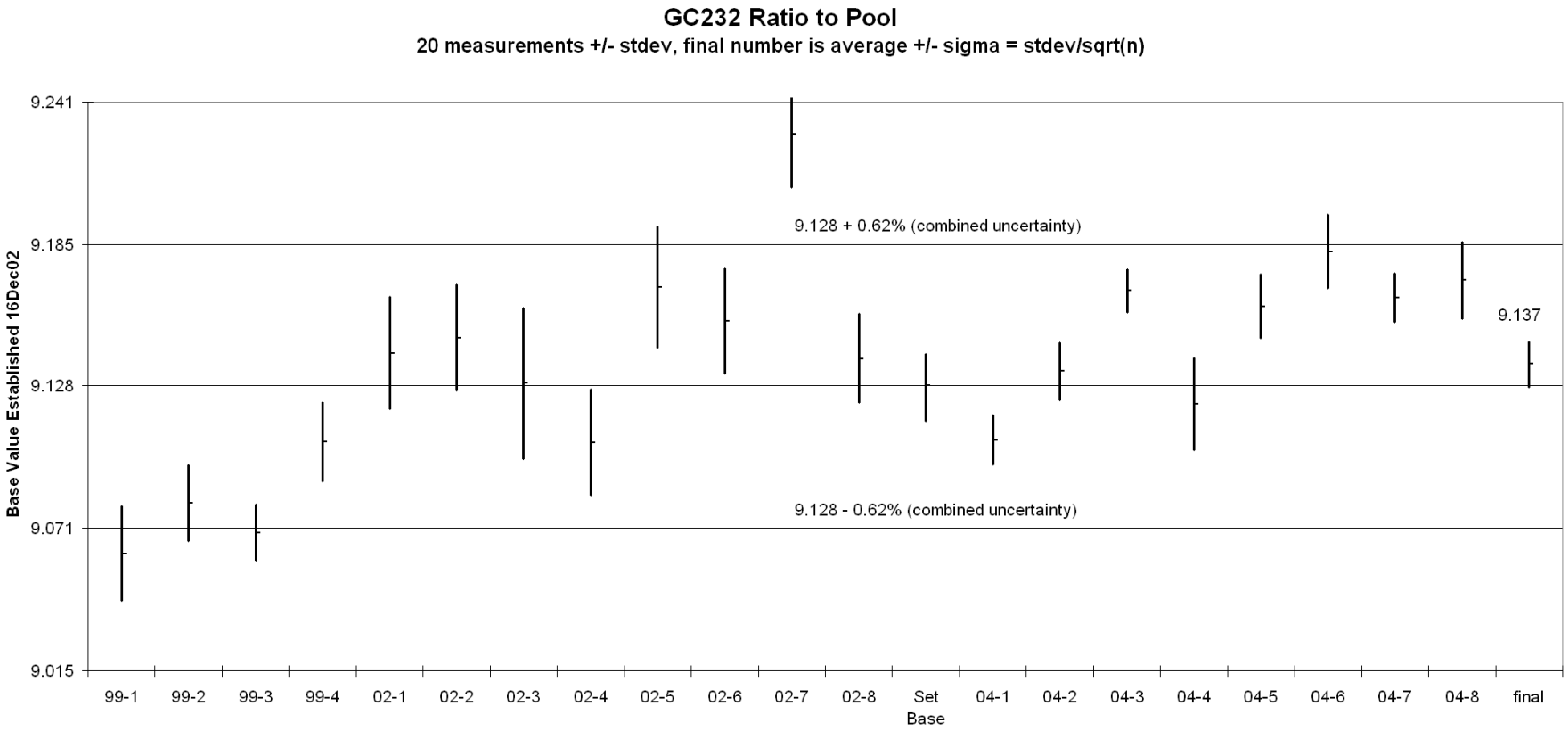
Long-term rate drift/error checked through international comparisons

alanine → GC207, 18 kCi

alanine → GC232, 3.7 kCi

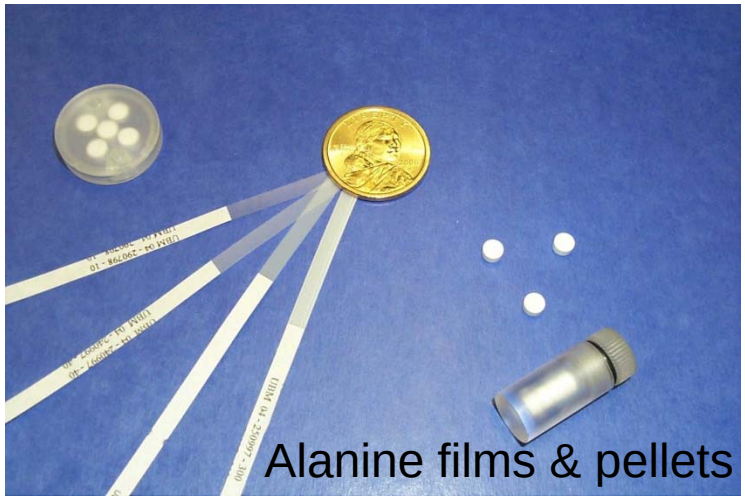
alanine → GC45, 1.0 kCi

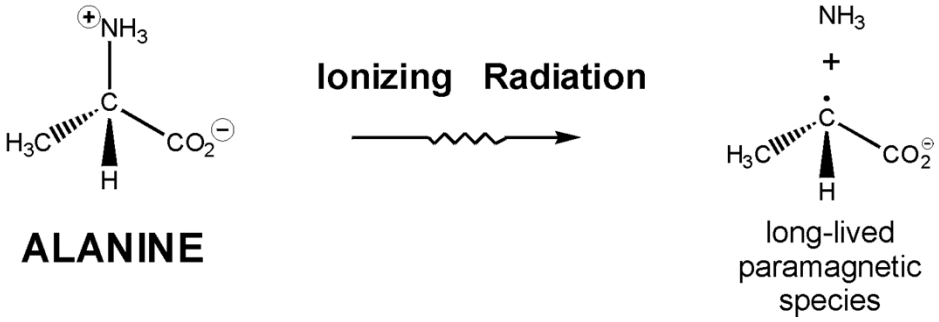
# Source Ratio Check Precision

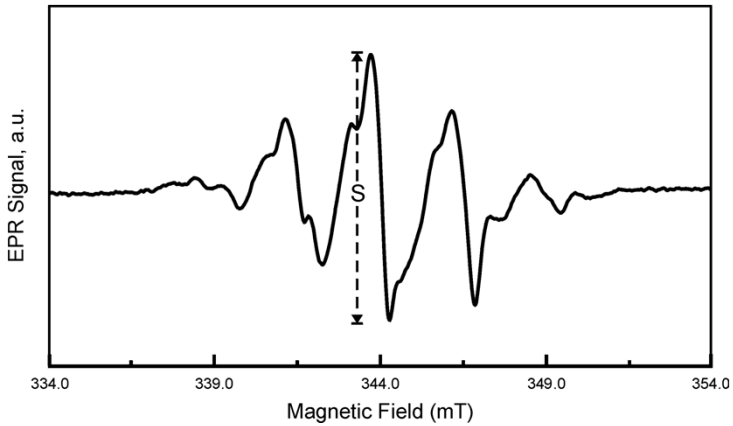


# Alanine Dosimetry

- Composed of alanine crystals dispersed in a polymer binder, these dosimeters are considered to be accurate, versatile and robust

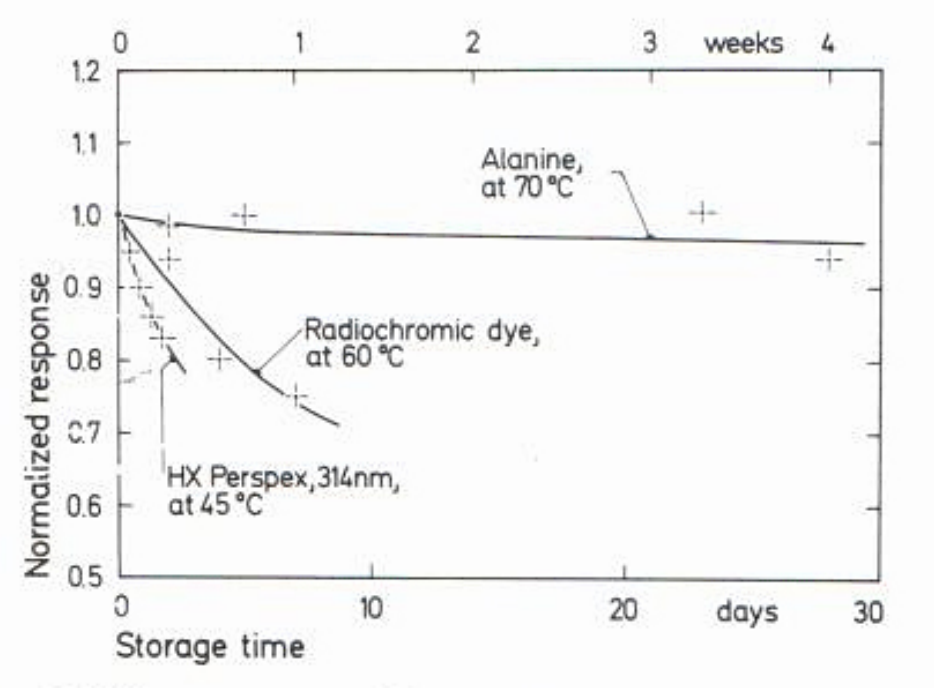


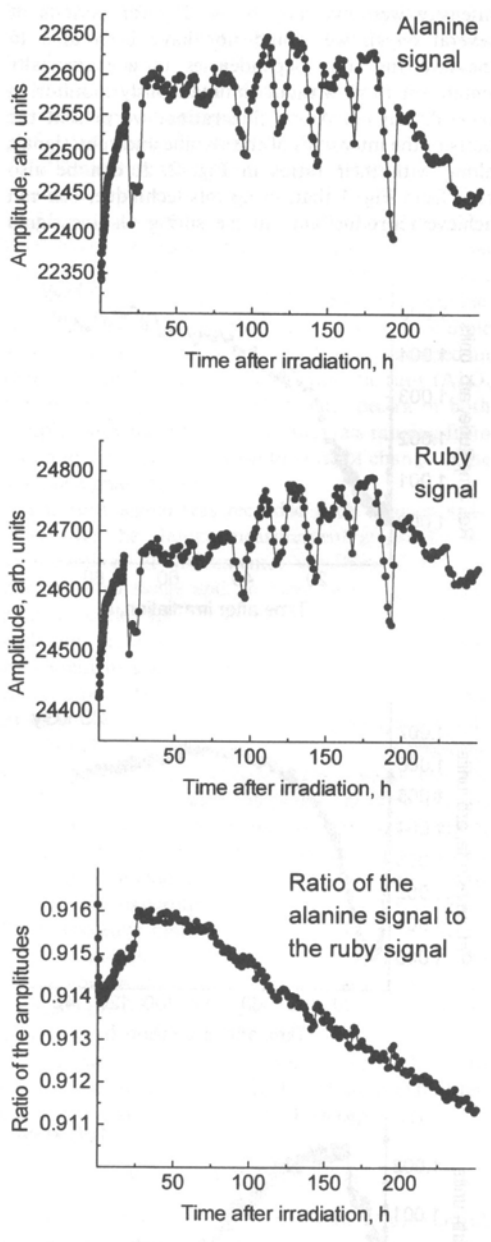



# Long-Term Stability

- Alanine, relative to other chemical dosimetry systems, is very stable with respect to time
- Data from 1982, Regulla & Deffner



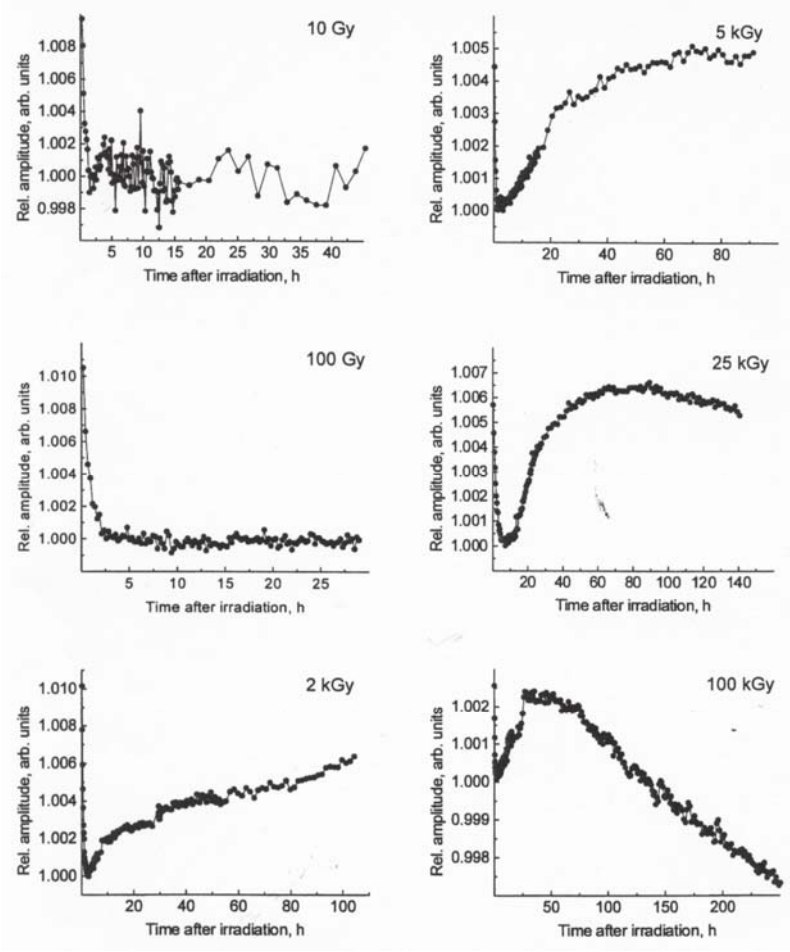



# Ruby

- Ruby reference device improves precision
- Since the ruby signal mimics the spectrometer sensitivity characteristics, measuring the alanine signal in tandem with the ruby allows us to “subtract out” spectrometer fluctuations by plotting the ratio of the two signals

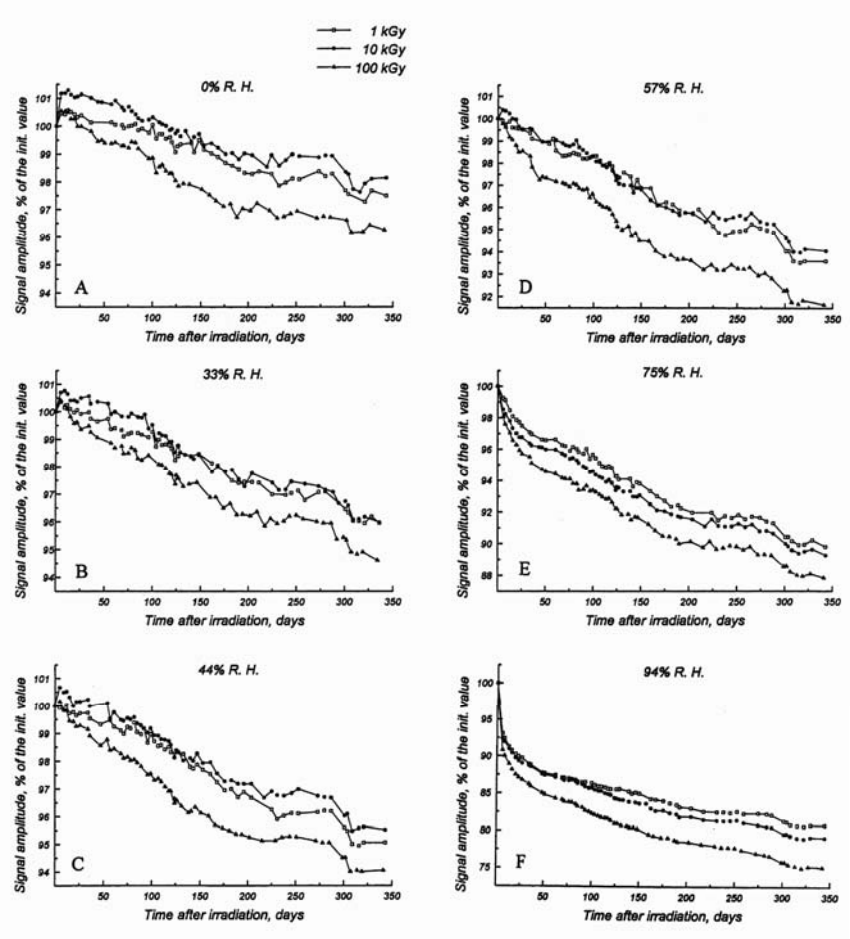
# Short-Term Studies

- NIST data from 1996
- Alanine temporal studies at several dose levels revealed variations with dose that were relatively minor



# One-Year Study

- NIST data from 2000
- One-year time studies as a function of dose and RH



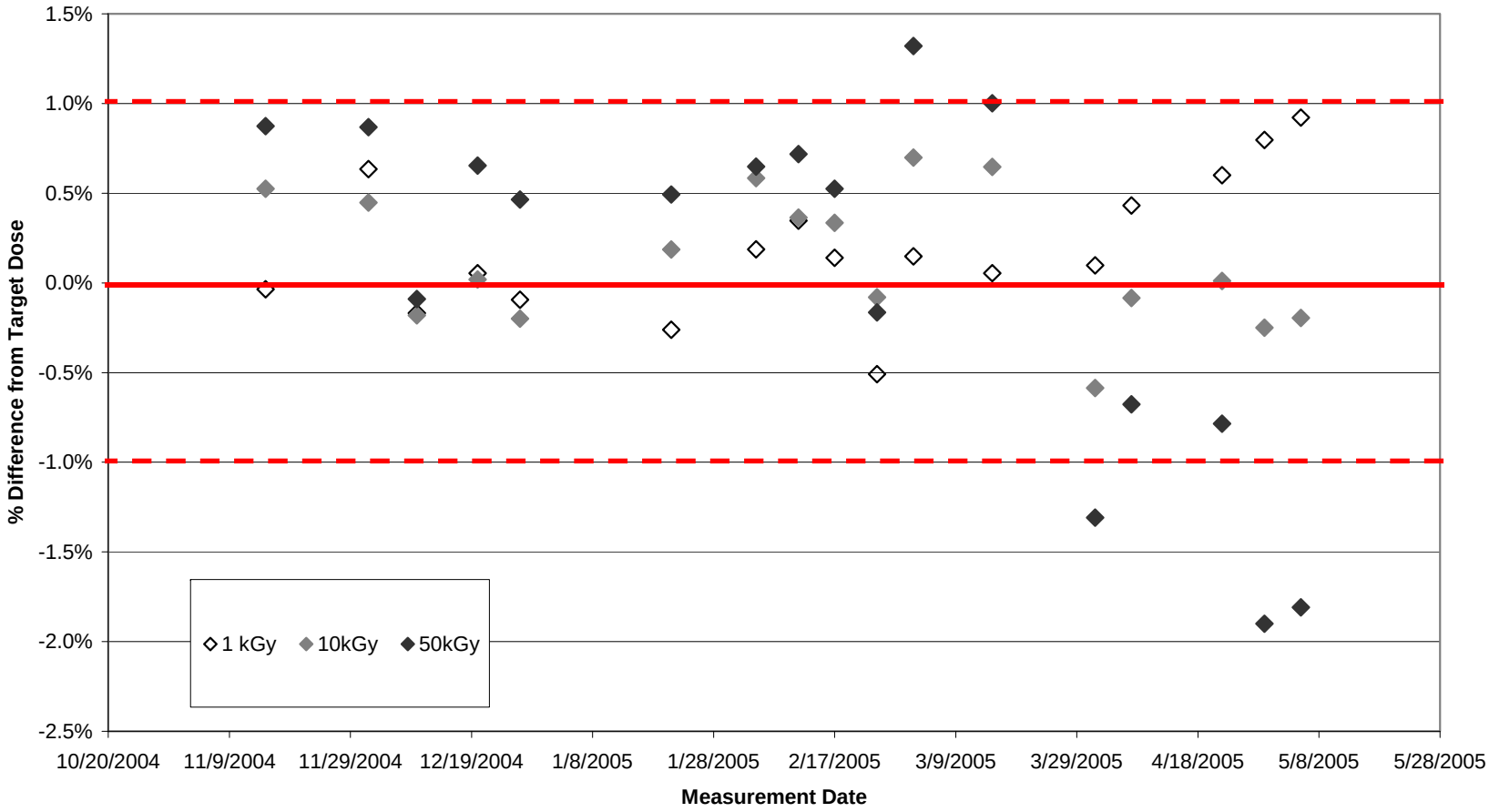
# To What Level Archival?

- If faced with wanting to remeasure dosimeters from several years ago, what correction factors?
- Difficulties in undertaking a multi-year study to determine this include:
  - Commitment of time & resources
  - Spectrometer & measurement configuration constant?
  - Would dosimeters chosen be representative?

# NIST High-Dose Calibration Services

- Dosimeter calibrations
  - Irradiation of customer-supplied dosimeters to customer-specified doses
- Transfer dosimetry
  - NIST-supplied dosimeters are irradiated by customers
  - NIST reads and certifies dosimeter doses
- Special measurements

# Check Standard Plot



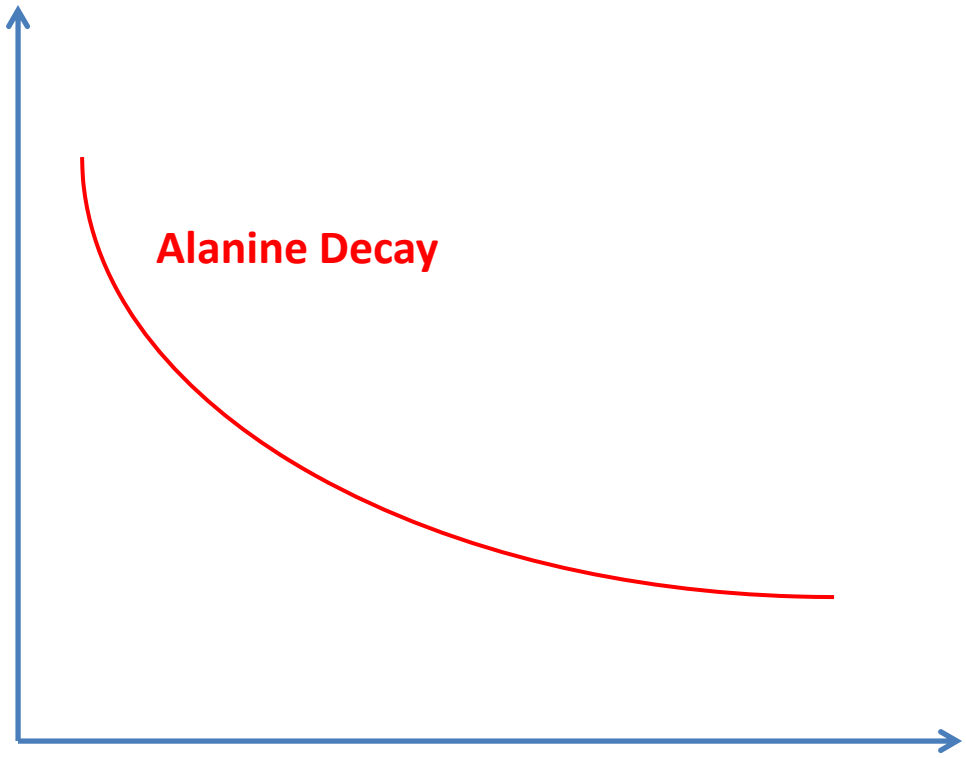
# Laboratory Small Talk

- 2005
  - Q: The check doses are piling up, what should I do with them?
  - A: Not sure, just toss them in the drawer for now.
- 2007
  - Q: We still saving these?
  - A: Sure, why not.
- 2009
  - Q: Why are we saving all these check doses?
  - A: Don’t know but if we throw them away I’ll think of a reason why to keep them the next day.
- 2011
  - Q: Any reasons yet?
  - A: Yes!

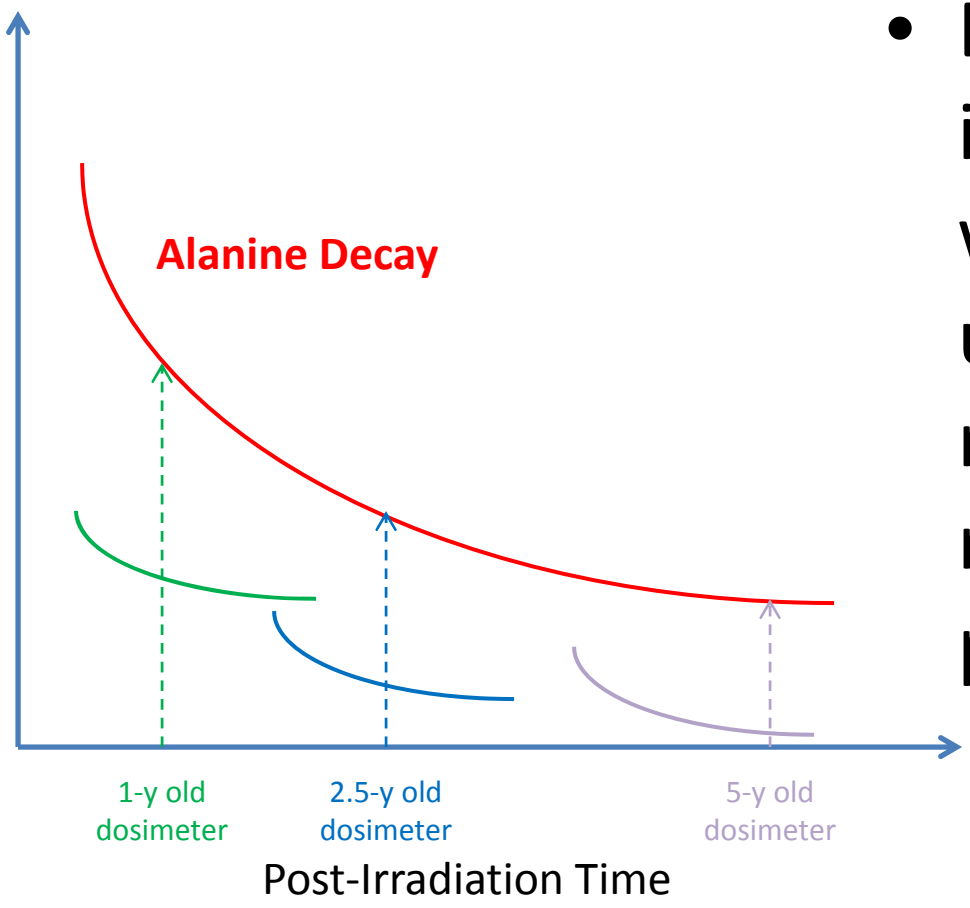
# Commonality?

- What do these check doses have in common?
  - Calibrated to the same standard
  - All irradiated in same geometry/holder
  - All from the same source/batch#
  - All stored identically

# Alanine Time Profile

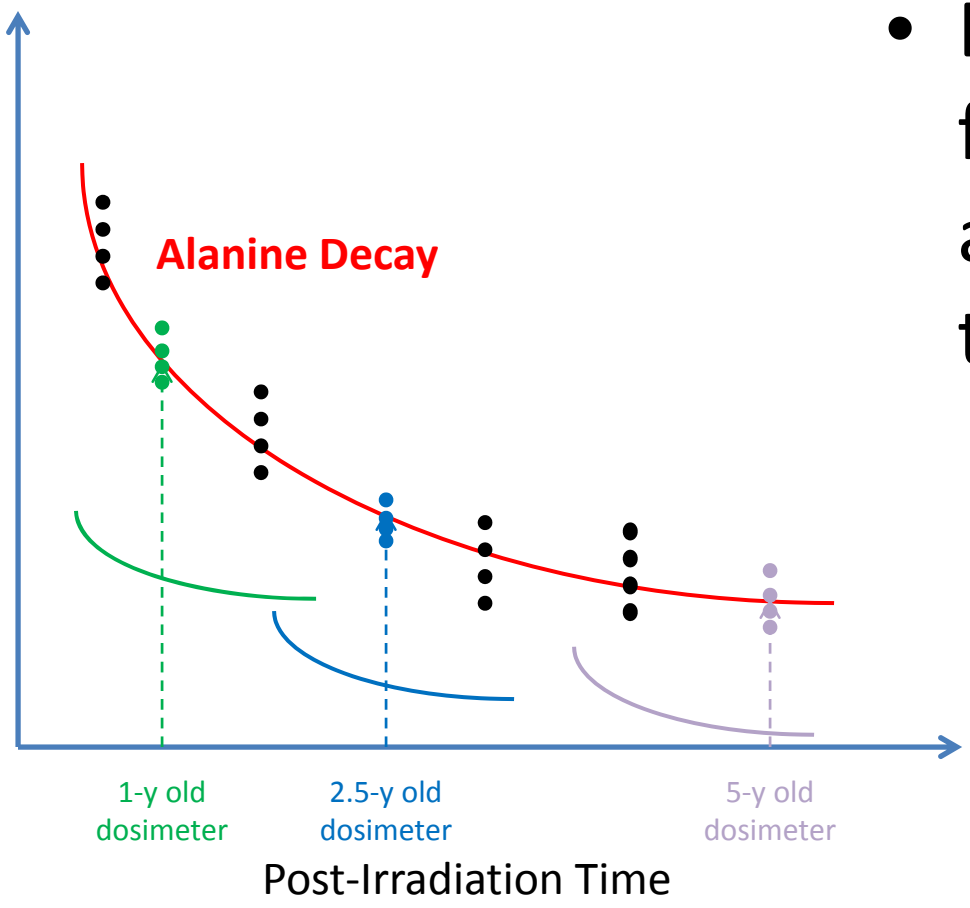


# Alanine Time Profile



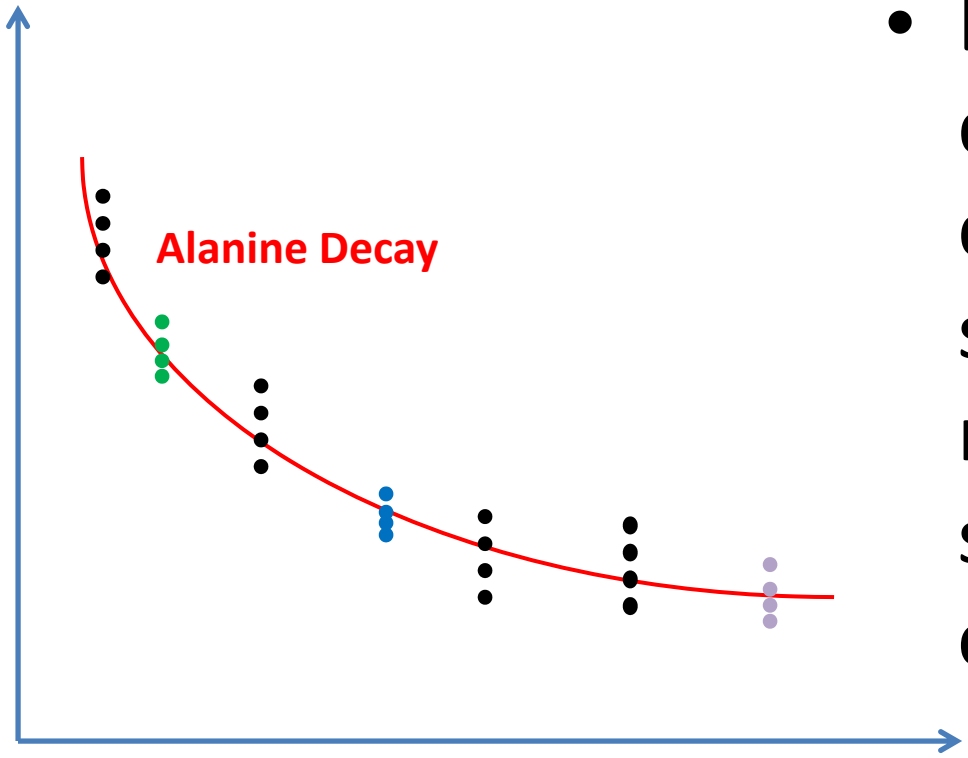

- Dosimeters irradiated in the past would have undergone their natural decay and represent different points in time.

# Alanine Time Profile



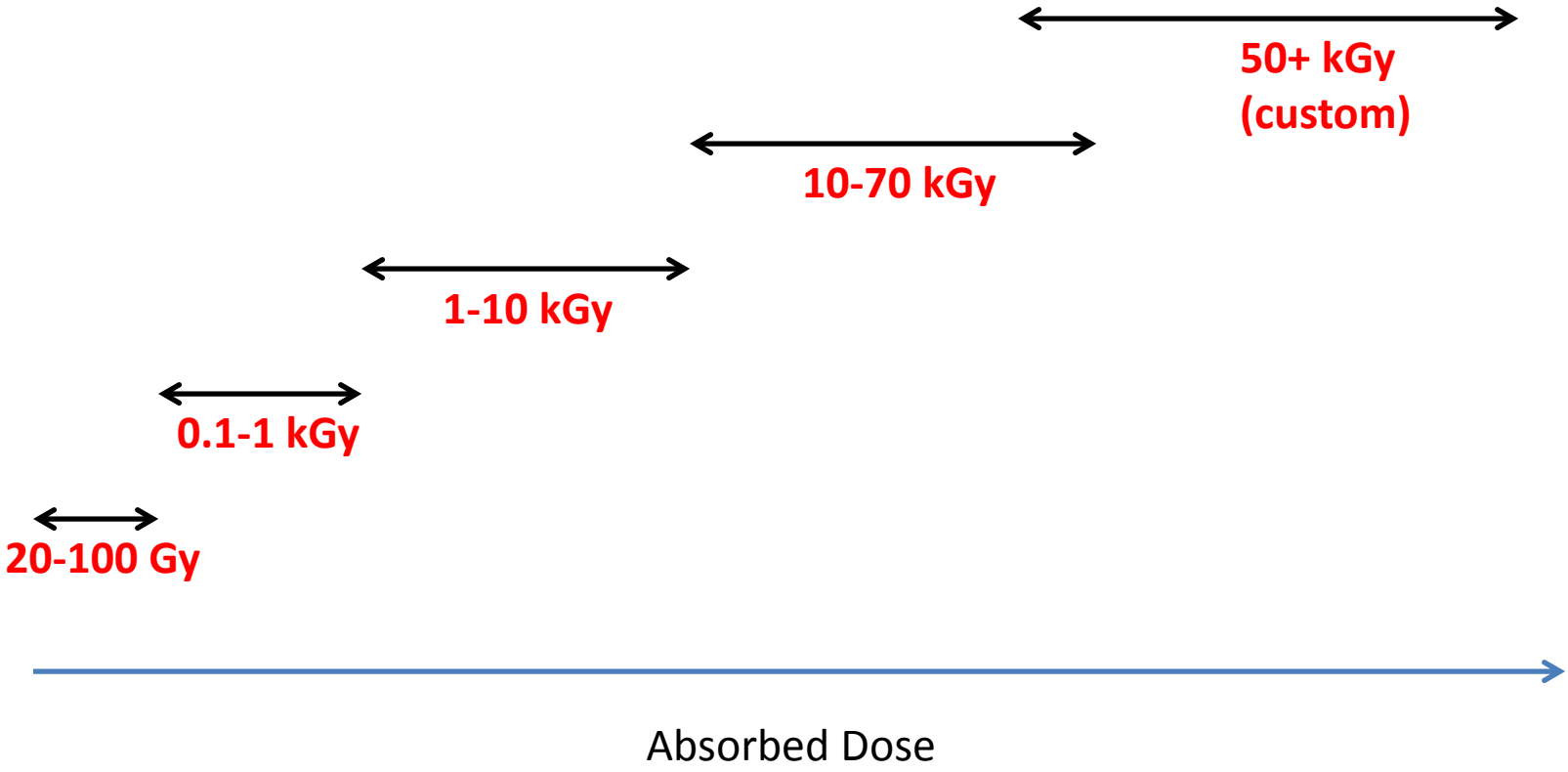

- Data can be acquired from measurements at different points in time.

# Alanine Time Profile

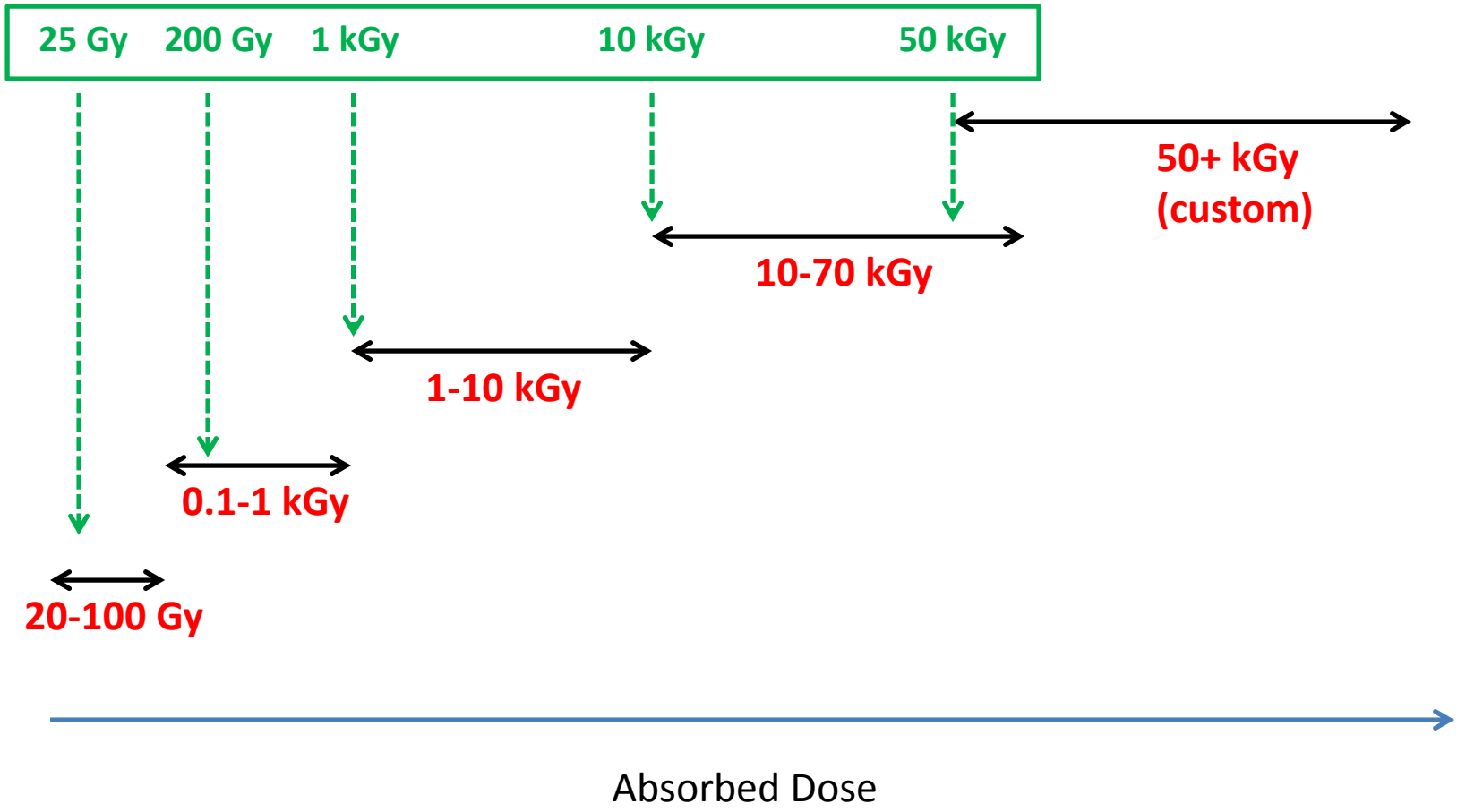



- By measuring dosimeters from different times in a single session a multi-year temporal study can be completed in a day.

# Calibrated Dose Ranges

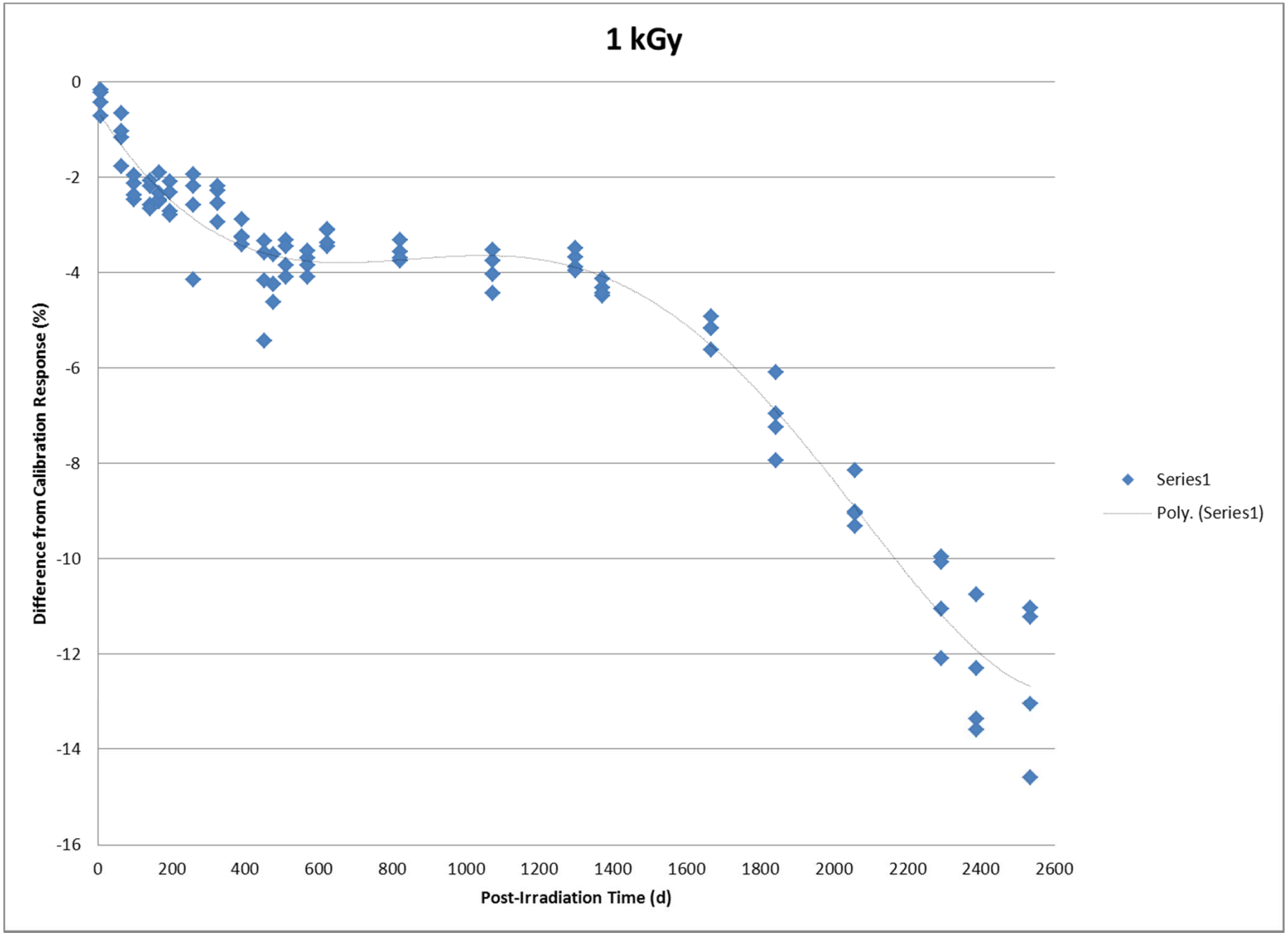


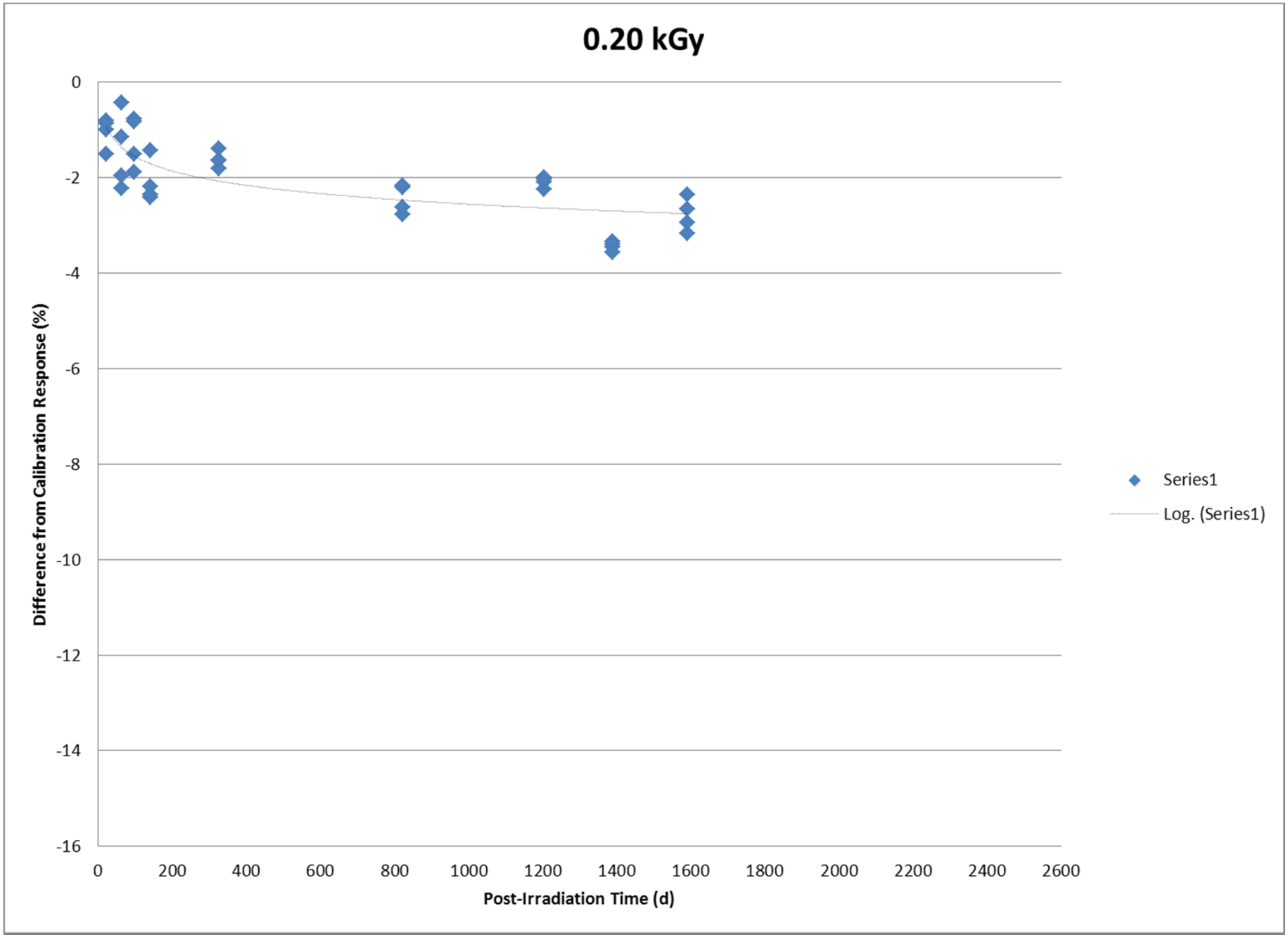
# Check Dose Levels

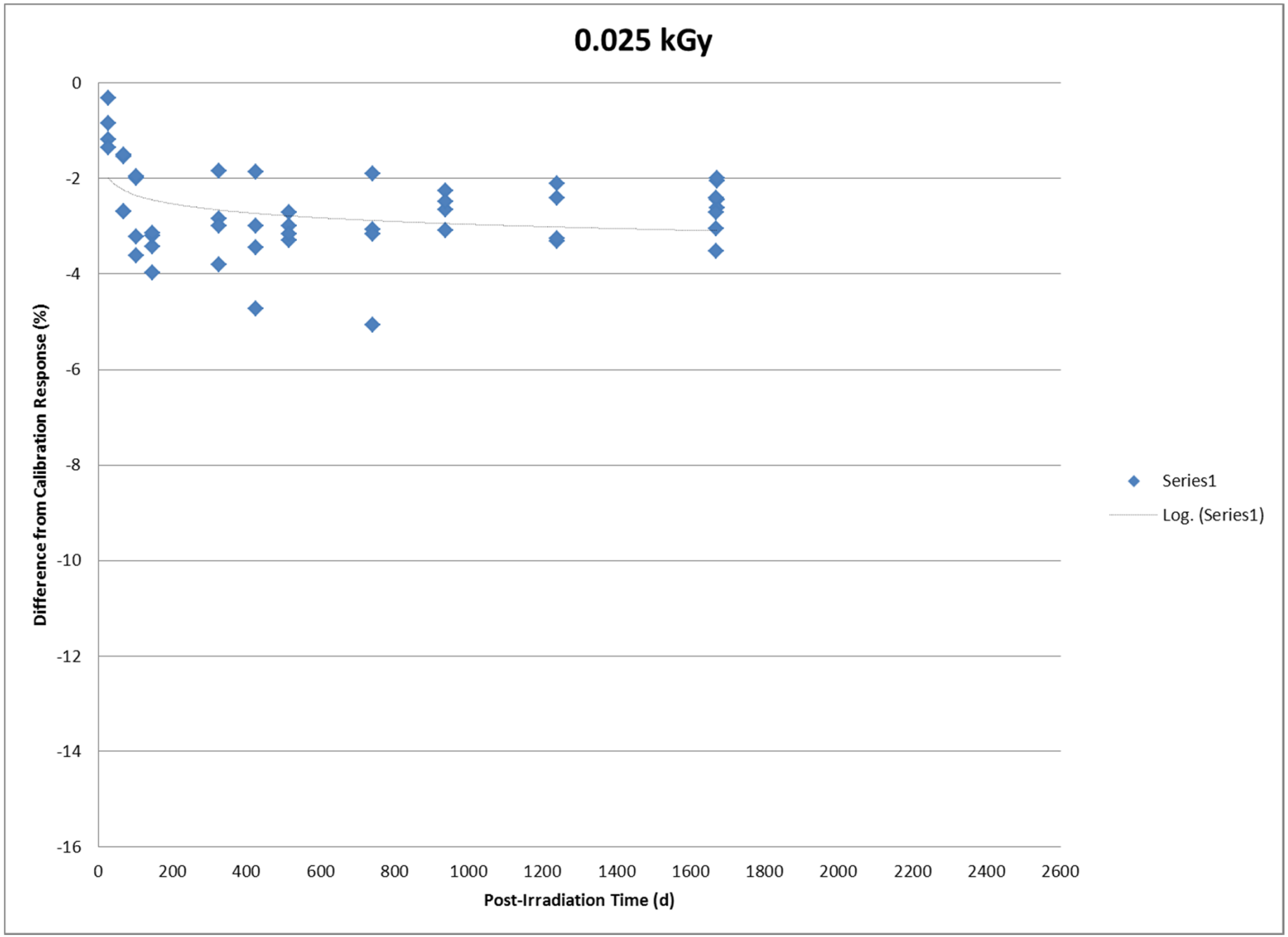


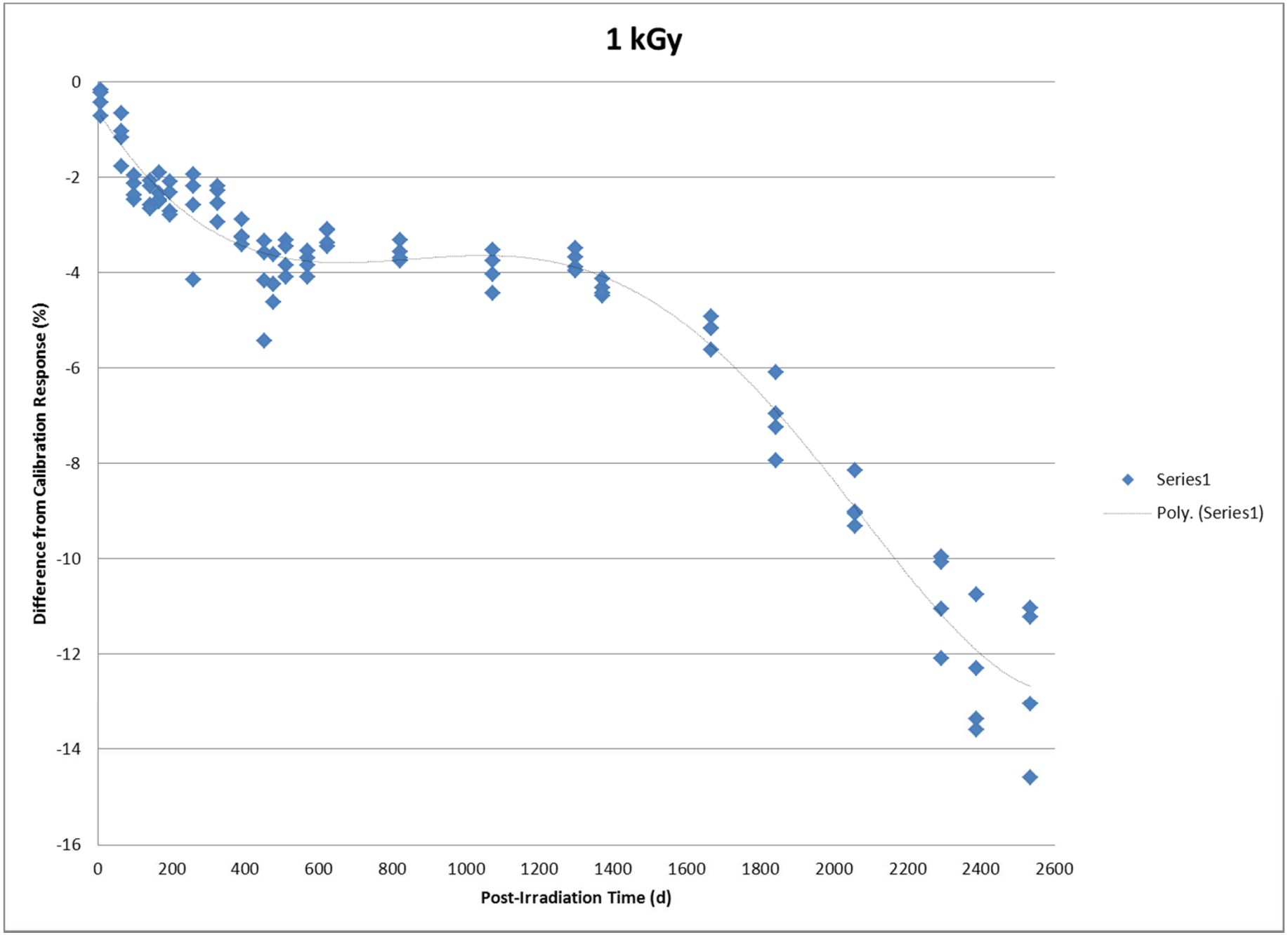
# Five Curves

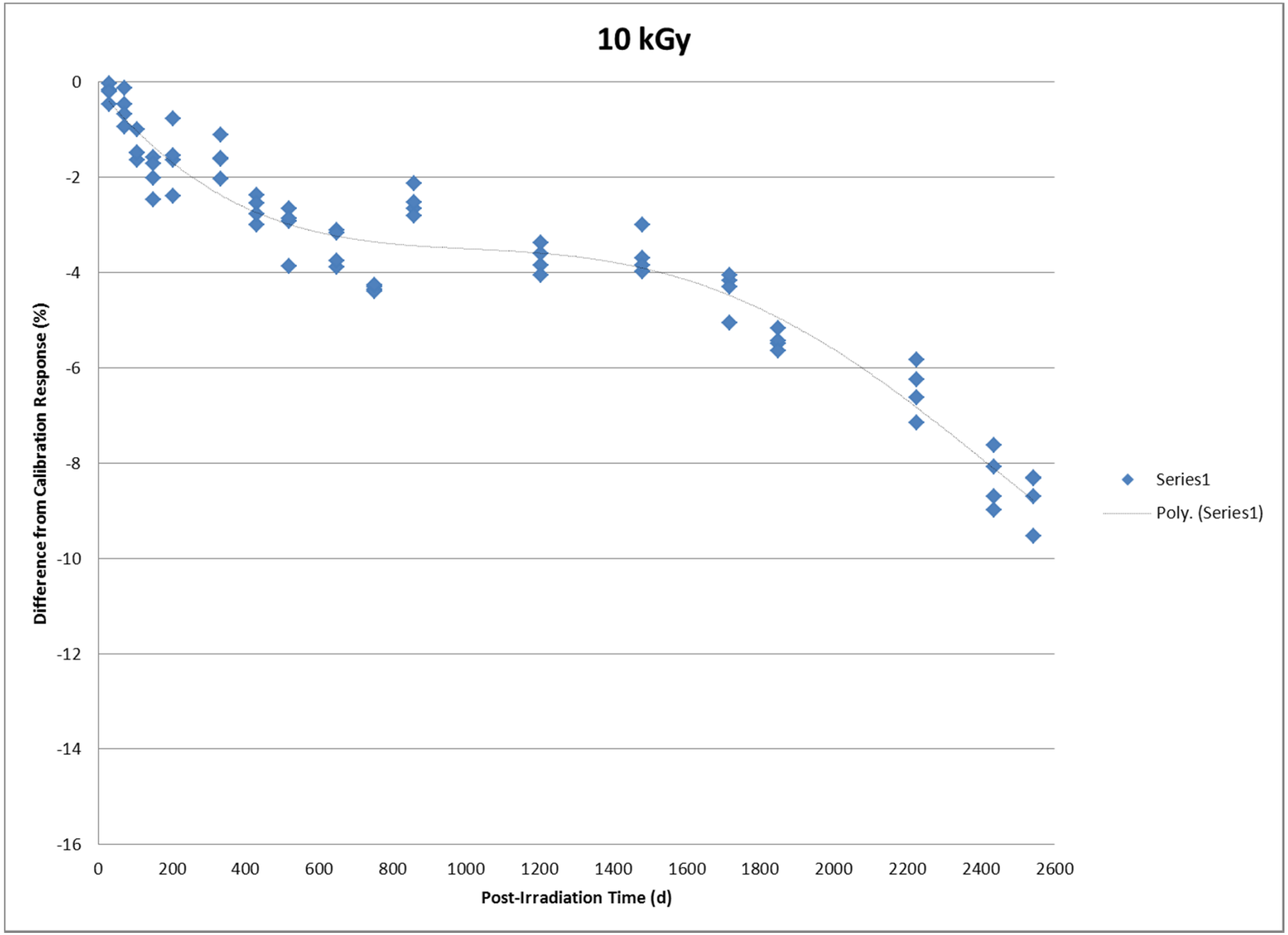
- We measured five different decay curves, one for each check dose level.
- For discussion, we will start with 1 kGy
  - Good signal strength
  - Linear response
  - Smallest effects from influence quantities

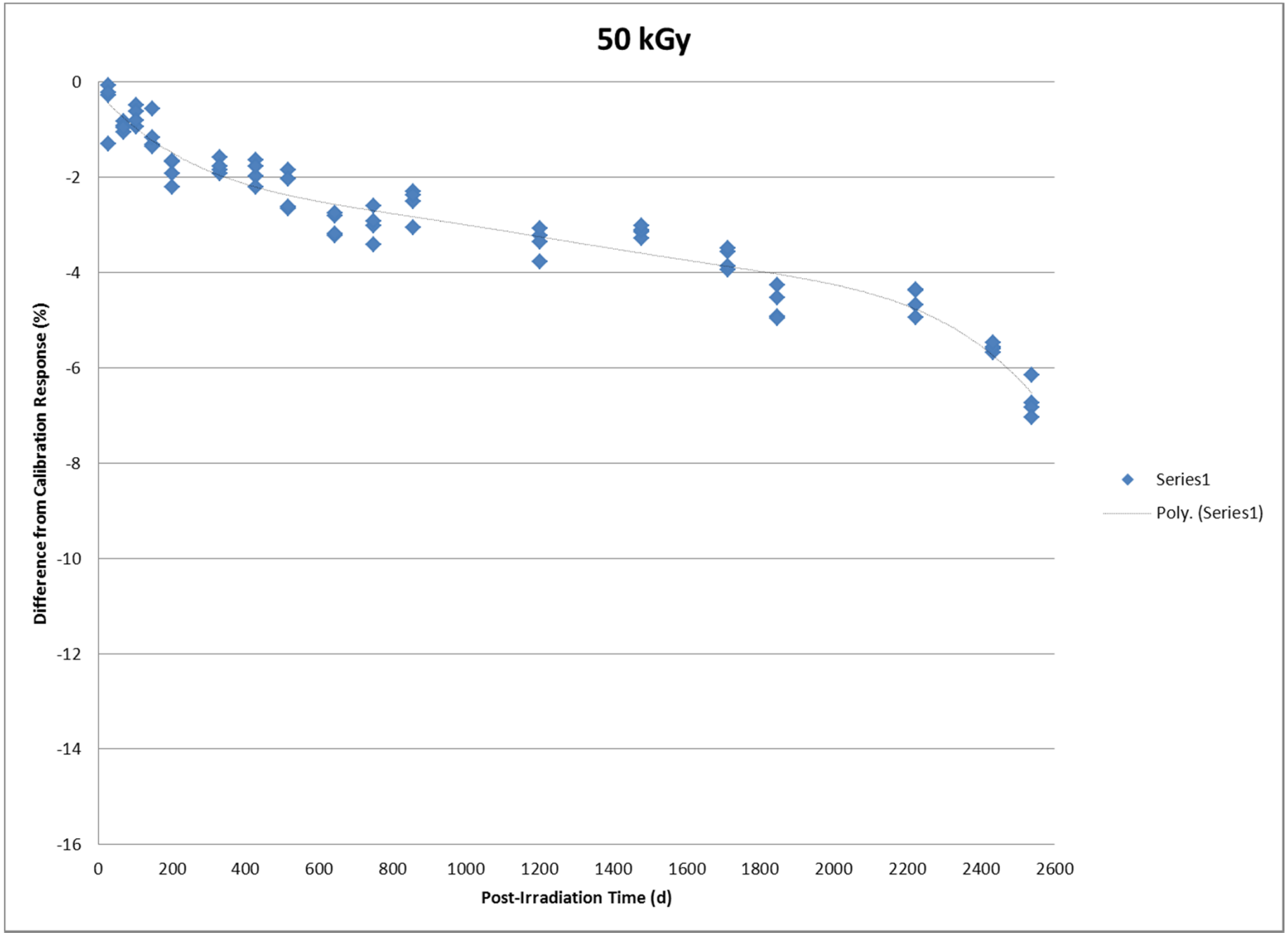

1 kGy
0
-2
-4
-6
-8
-10
-12
-14
-16
Difference from Calibration Response (%)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
Post-Irradiation Time (d)
Series1
Poly. (Series1)


0.20 kGy
0
-2
-4
-6
-8
-10
-12
-14
-16
Difference from Calibration Response (%)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
Post-Irradiation Time (d)
Series1
Log. (Series1)


0.025 kGy
0
-2
-4
-6
-8
-10
-12
-14
-16
Difference from Calibration Response (%)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
Post-Irradiation Time (d)
Series1
Log. (Series1)


1 kGy
0
-2
-4
-6
-8
-10
-12
-14
-16
Difference from Calibration Response (%)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
Post-Irradiation Time (d)
Series1
Poly. (Series1)


10 kGy
Difference from Calibration Response (%)
0
-2
-4
-6
-8
-10
-12
-14
-16
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
Post-Irradiation Time (d)
Series1
Poly. (Series1)

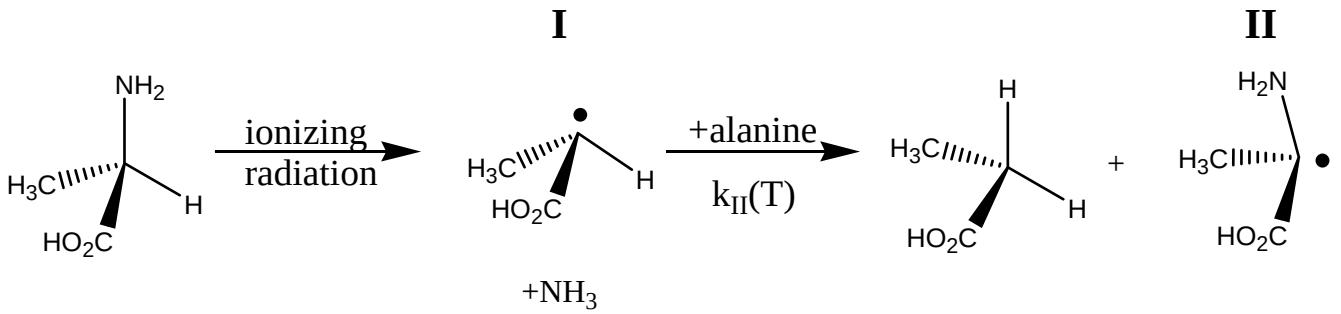

50 kGy
Difference from Calibration Response (%)
0
-2
-4
-6
-8
-10
-12
-14
-16
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
Post-Irradiation Time (d)
Series1
Poly. (Series1)

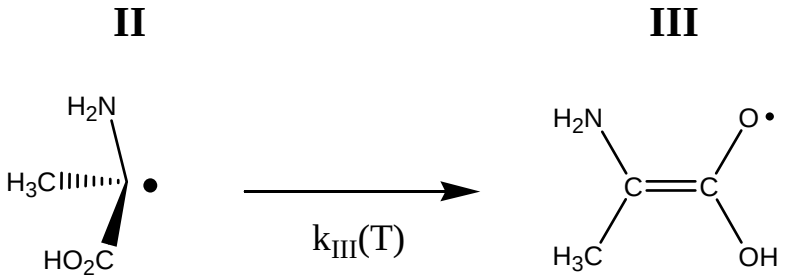
# Summary

- Year 1
  - Loss of 2-3% at all levels
- 400 to 1400 Days
  - Loss in 3-4% range at all levels
- 1500+ Days
  - Decay range of 7-12% varies with dose
  - Less definition in plateau regions with increasing dose
  - Decay level lower with increasing dose
    - Secondary radicals present at high dose are more stable?
  - Measurement scatter within single group of dosimeters increases with time (most evident at 1 kGy)

# Alanine Radical Chemistry

- Studies indicate that the alanine EPR spectrum may be a composite of three different radical spectra
- The relative concentration of these radicals is presumed to be dose dependent and most influential beginning at several kGy



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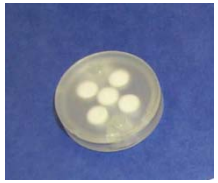
# Thank You!

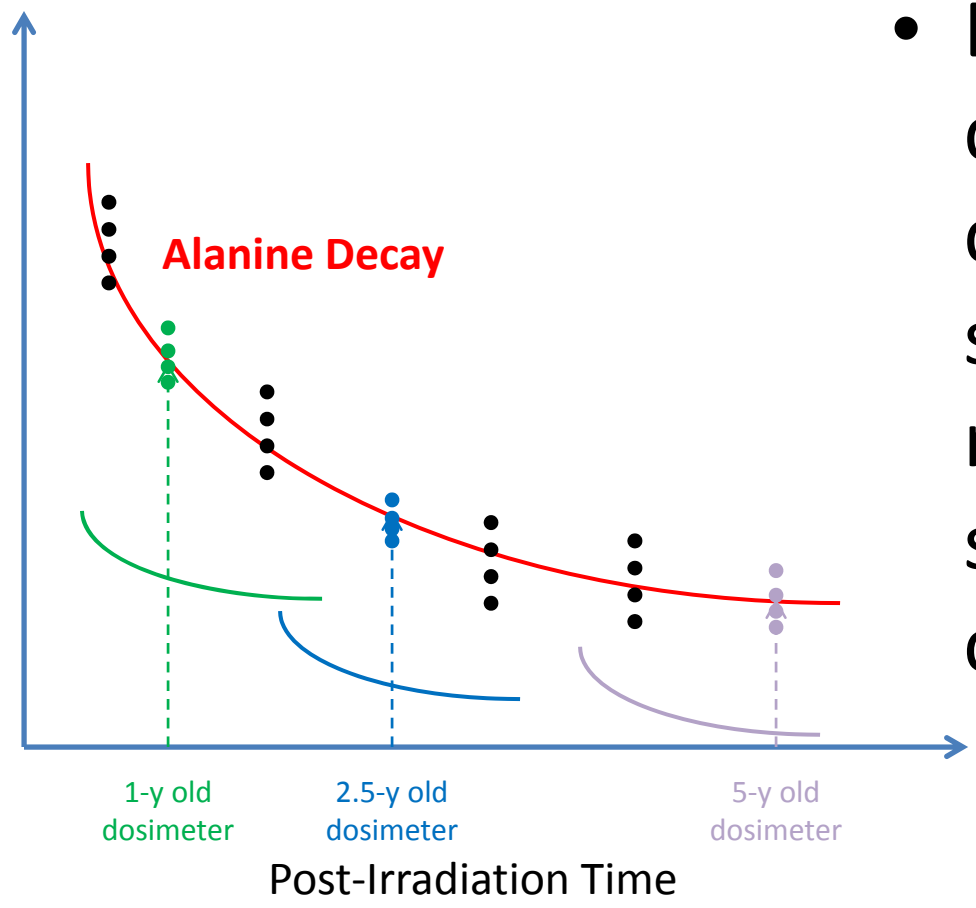
# Alanine Dosimetry

- High accuracy/precision
- Rugged / can be put in materials and shaped
- Commercially available
- Relatively insensitive to environmental influences
  - Time
  - Temperature
  - Humidity
  - Light
  - Energy/Quality
  - Rate

- Long lifetime
  - decays a few % / y
  - archival
- Broad dose range
  - 1 Gy to 200 kGy
- Tissue equivalent
- No readout treatment required
- ASTM/ISO standard



# Alanine Time Profile

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