

NIST High-Dose Program Calibration Services

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Ionizing Radiation Division

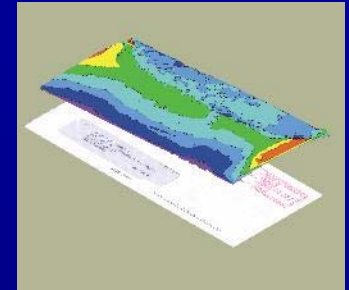
Physics Laboratory

National Institute of Standards and Technology

U. S. Department of Commerce

NIST High-Dose Program Calibration Services

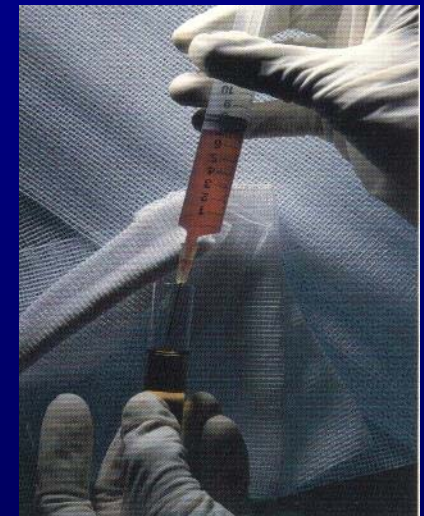
The Ionizing Radiation Division maintains the U.S. standard for high-dose dosimetry (20 - 100,000 Gy)



Food Irradiations
& many other areas



Vaccines



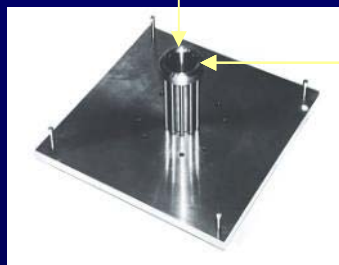
Medical
Product
Sterilization

NIST Internal Calibration Scheme

Vertical Beam



alanine



Pool Source

The gray is realized by a water calorimeter in the Vertical Beam gamma-ray field.

alanine

GC207

alanine

GC232

alanine

GC45



SI unit for dose:
Gray (Gy)

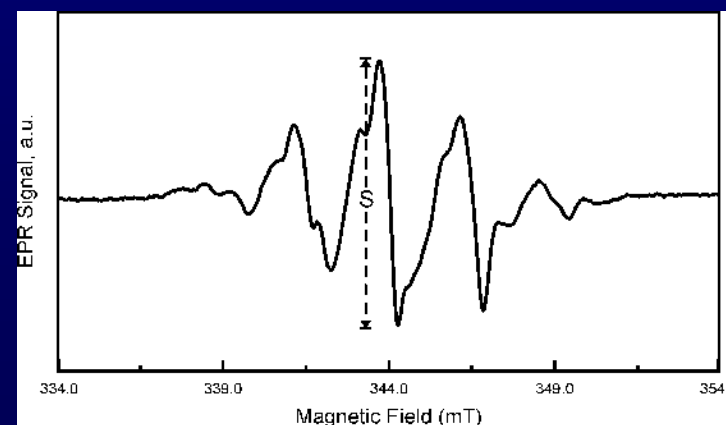
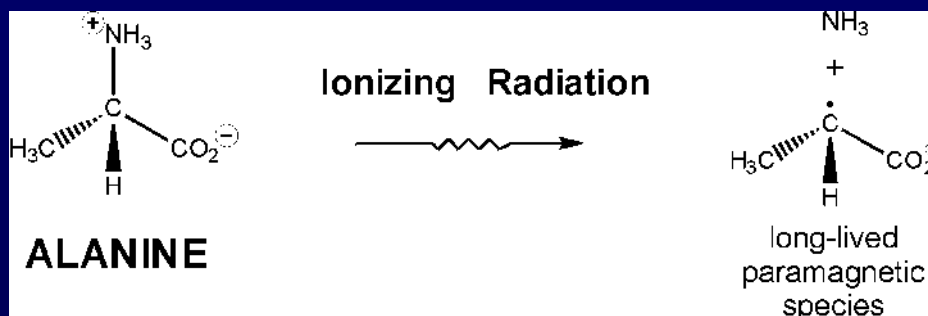
1 Gray = 1
Joule/kg

Alanine Dosimetry

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

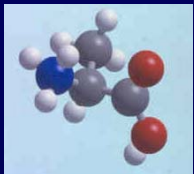


Alanine films & pellets

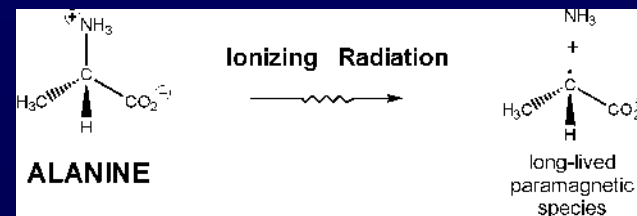
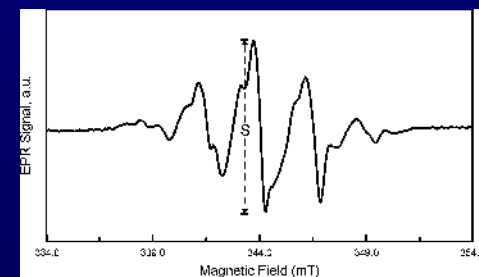


Alanine Dosimetry

- 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
 - 2 Gy to 200 kGy
- Tissue equivalent
- No readout treatment required
- ASTM/ISO standard

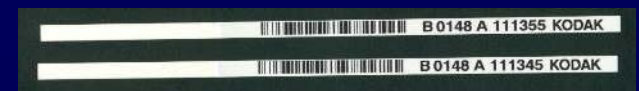
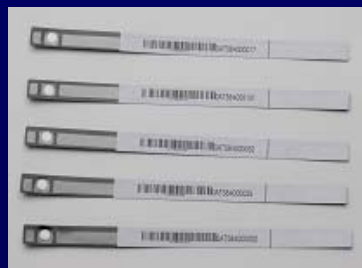


Alanine Dosimetry

- Alanine irradiation with ionizing radiation causes the production of radicals
 - # radicals $\propto$ dose absorbed over a wide dose range
 - Tissue equivalent
- The crystalline structure of the material counteracts the recombination of radicals

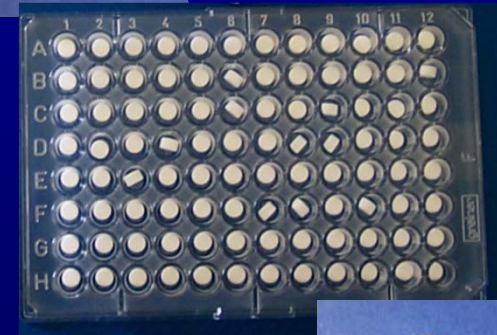


Diameter	4.8 mm
Height	3.0 mm



NIST High-Dose Program Calibration Services

- The alanine system is calibrated with NIST gamma sources
- The dosimeters are measured by Electron Paramagnetic Resonance (EPR) and referenced to an EPR standard
- The calibration curve is monitored with check standards



NIST High-Dose Program 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



NIST Irradiators



**Medium
Dose
Gammacell
("Huey")**



**Pool Source
("Dewey")**



**Low Dose
Gammacell
("Louie")**



**High Dose
Gammacell
("Daisy")**



Electron Paramagnetic Resonance (EPR)



Electron Paramagnetic Resonance (EPR) Standards

- EPR measurement precision is greatly improved by using EPR reference standards (ruby) to correct for spectrometer fluctuations and environmental influences
- Apply strong B-field to material
- Orients unpaired e⁻'s tend to spin parallel or antiparallel to B-field
- Creates distinct E levels for these e⁻'s
 - Net absorption of EM radiation (microwaves) to occur



Industrial Dose Certification

- Industrial radiation processors use NIST services for process validation and dosimetry certification

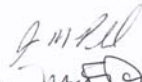
National Institute of Standards and Technology

REPORT OF CALIBRATION
OF

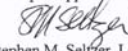
IBA Sterigenics' Irradiation Facility
in Bridgeport, NJ

FOR
IBA Sterigenics, Inc.
3125 Wichita Ct.
Fort Worth, TX 76140

ATTN: Cindy Robertson
Reference: PO# 35933

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For the Director
National Institute of Standards and Technology
by

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NIST High-Dose Program

Current Status and Future Prospects



His expertise will be missed,
but not forgotten.....

Retired after 27
years of service.



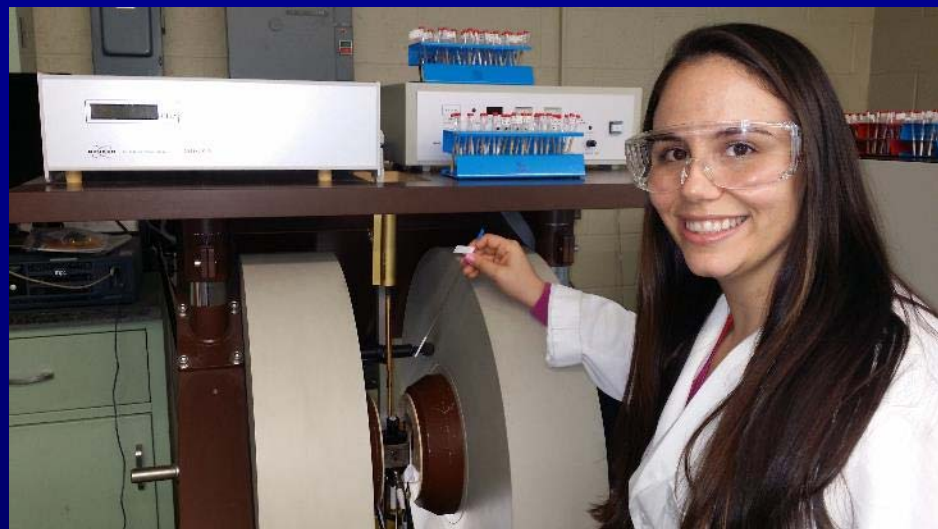
We wish Dr. Marc Desrosiers the
best success and a most enjoyable
retirement for many years to come



NIST High-Dose Program



Dr. Lonnie Cumberland



Dr. Ileana Pazos (New Staff)

The new “**NIST High-Dose Program**” integrates all of our Irradiation Calibration and Transfer Dosimetry services into a single comprehensive High-Dose program in which team members cross-trained to run all of the services which allow for multi-level service coverage redundancy to better support our customers.

NIST High-Dose Program

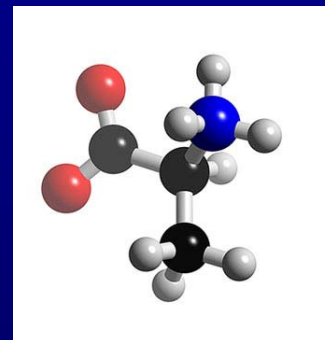
Thank You



Alanine Radical Chemistry

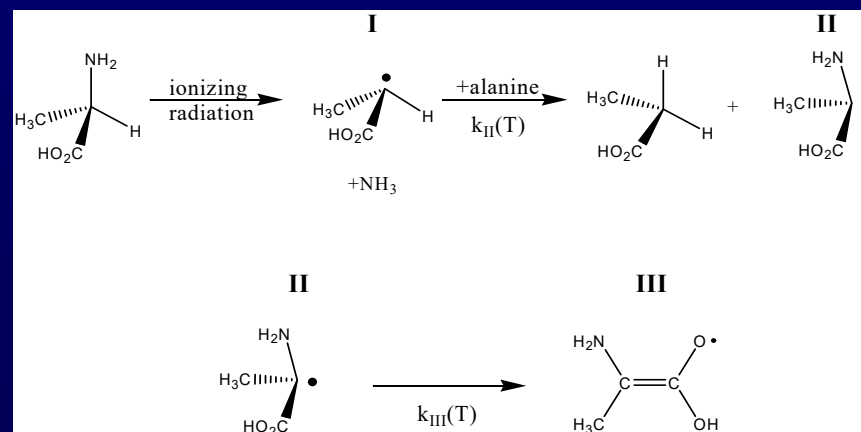
- Studies indicate that the alanine EPR spectrum may be a composite of mainly **three** different radical spectra
- The observed effects with dose rate may result from a change in the relative abundance of these radicals

Alanine is an amino acid
($\text{HO}_2\text{CCH}(\text{NH}_2)\text{CH}_3$)



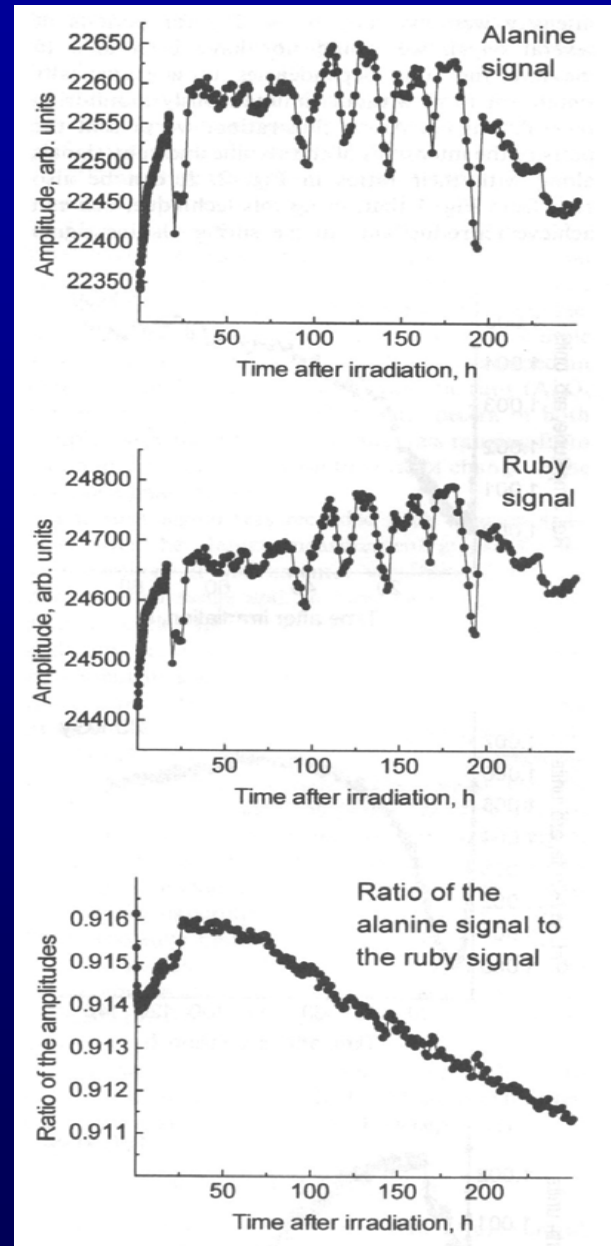
When exposed to ionizing radiation:

- Alanine becomes the free radical ($\text{CH}_3\text{C}\cdot\text{HCOO}^-$) and is stable
- Due to its stability, the yield of free radicals is measured and is proportional to the dose of radiation absorbed



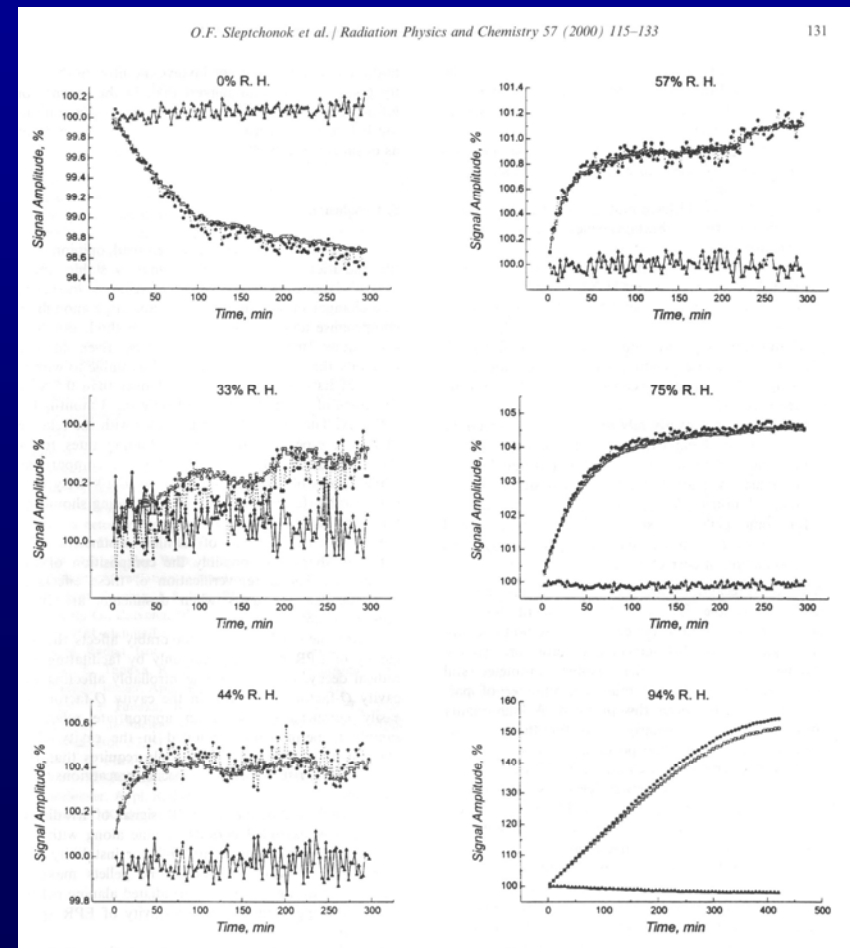
Time & Conditions

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



Compensating for Relative Humidity

- Although the RH, as well as the change in RH, has significant effects on the dosimeter response, there is no effect on the ala/ruby ratio



Temperature

- The change in alanine signal with temperature is linear and $\sim 0.1\%$ per degC
- The coefficient does change slightly with dose

