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A Novel Dosimetry System for Military Use in Response of Nuclear Emergencies

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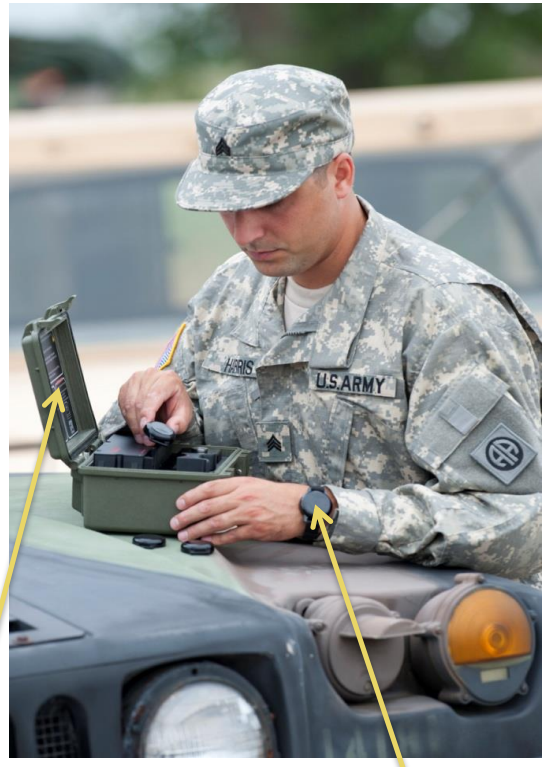
Purpose of the Study

- Create a Dosimetry System
  - Able to measure absorbed dose to tissue (cGy) arising from detonated tactical nuclear weapons
  - Able to measure dose equivalent for tracking occupational exposures
  - Able to withstand severe environmental and operational conditions
  - Reliable, light and easy to use
    - For details on how to use: http://www.youtube.com/watch?v=VqNEwQ18ISw or go to YouTube.com and type in “RadLight”
- Dosimetry System Includes
  - RadWatch® Dosimeter
  - RadLight ® Reader



RadLight ® Reader

RadWatch ® Dosimeter

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RadWatch® Dosimeter

- RadWatch® Dosimeter
  - Slide
    - 3 optically stimulated luminescence (OSL) radiation sensors-Al_2O_3:C
    - 1 radiofrequency identification (RFID) chip
      - RFID chips stores all pertinent information related to the dosimeter and can be interrogated by the RadLight reader
    - fluorescent nuclear track detector (FNTD) for low dose neutron measurements (optional)
  - Base– houses the slide and offers additional filtration
  - Cover-creates light tight and water resistant seal for the dosimeter

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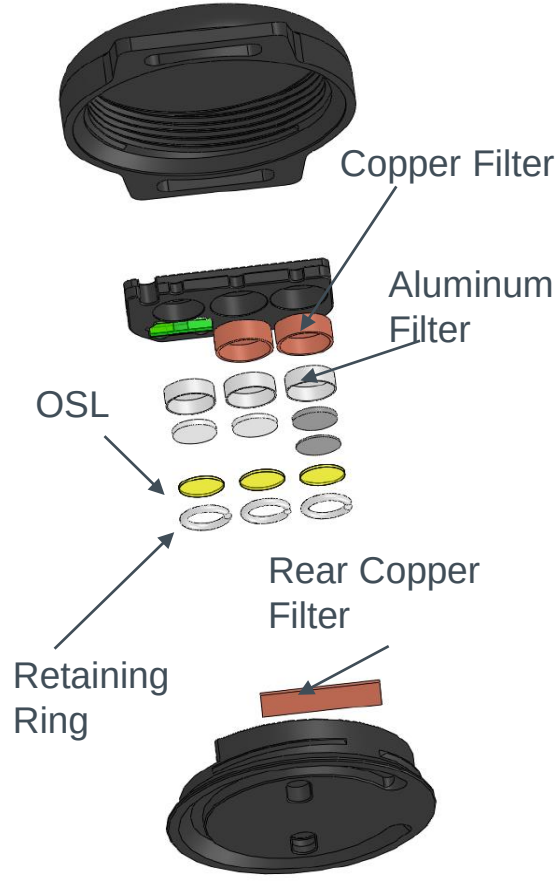
RadWatch® Slide

- RadWatch® Slide
  - Sensor 1 (E1)
    - Filtration-cylindrical shaped aluminum cup
    - Intended for photons detection and when used in conjunction with E2 provides energy information
  - Sensor 2 (E2)
    - Filtration-cylindrical shaped aluminum and copper cup
    - Intended for higher energy photons detection, also used as reference sensor
  - Sensor 3 (E3)
    - Filtration-cylindrical shaped aluminum and copper cup
    - Intended for neutron and photons detection. Neutron detection is done with the use of high density polyethylene (HDPE).



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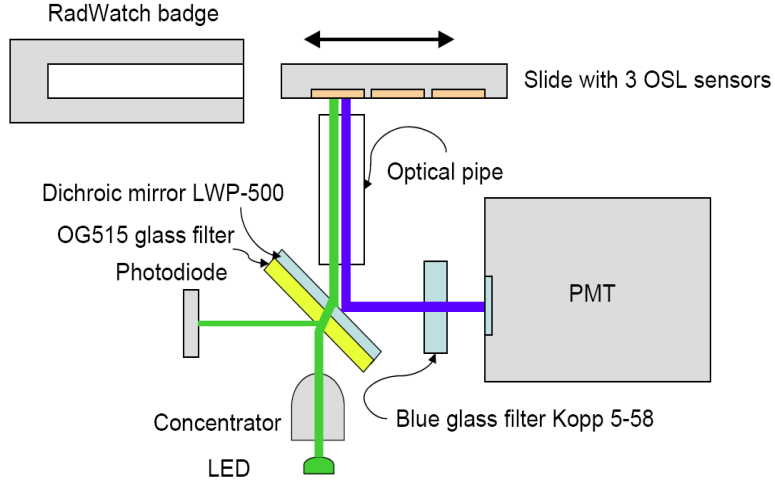
RadLight® Reader

- RadLight ® Reader
  - Portable reader that weight 2.2Kg
  - Operated using 4LR6 (AA) batteries
  - Analytical Method-Pulsed Optically Stimulated Luminescence (POSL) in reflection geometry
  - Stimulating light-green LED centered around 530nm
  - Emitted light- blue light centered around 420nm
  - Light photons counted using Photomultiplier Tube (PMT)
  - Reader interrogates RFID chip for dosimeter calibration data
  - Reader writes dose information on the RFID sensor



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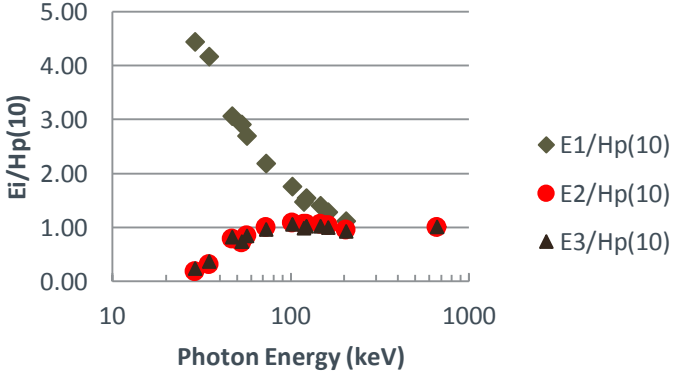
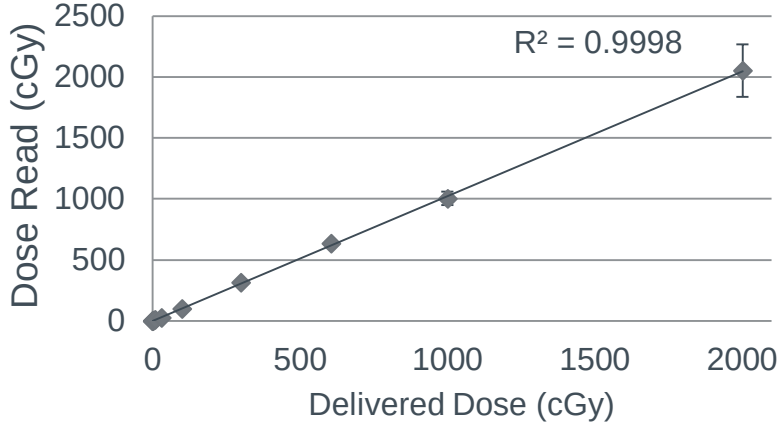
System Characteristics (I)

- Energy Response
  - Photon sources, energy from 29 keV to 1250 keV.
  - Response corrected for element sensitivity and reader calibration was normalized to delivered Hp(10)
  - Element 1 offers good energy discrimination at lower energies



- Linearity
  - Wide dose range (0.01cGy to 2000cGy)
  - Dosimeters exposed to Cs-137
  - Linear dose calculation based solely on element 2 and reader calibration factor
  - All doses within 5% of delivered dose
  - Coefficient of Variation (CV) <10% for all doses except for 0.01cGy where it is15%



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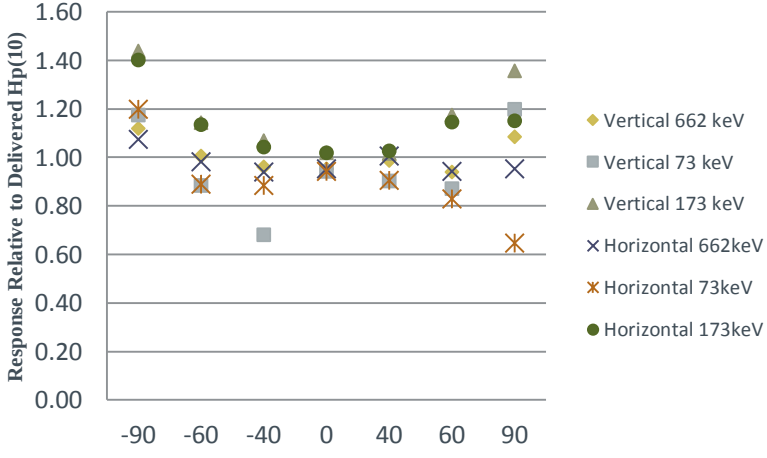
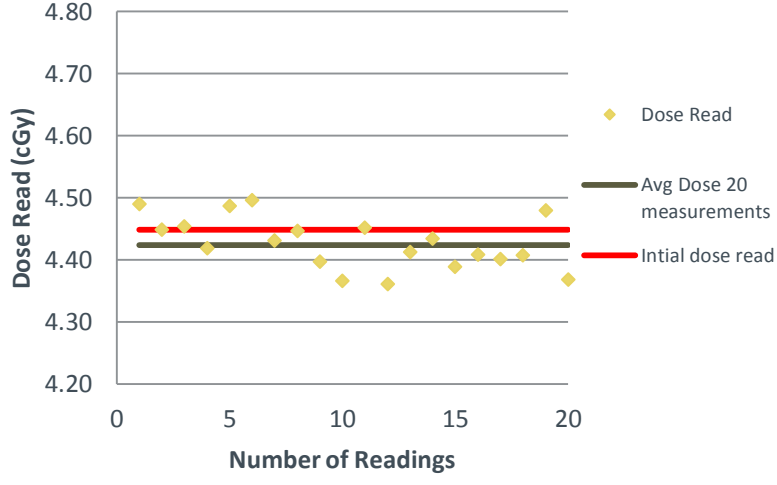
System Characteristics (II)

- Angular Response
  - Photons with energy of 73keV, 173keV, 662keV
  - Angles 0°, 40°, 60°, 90° vertical and horizontal directions
  - Response at each angle normalized to delivered dose
  - Response within 40%



- Re-readability
  - Dosimeter read 50 times to establish depletion equation
  - Depletion entered in the reader software
    =0.998*exp (-0.007*read number)
  - Dosimeter read 20 times, depletion correction applied
  - System precision = 1%



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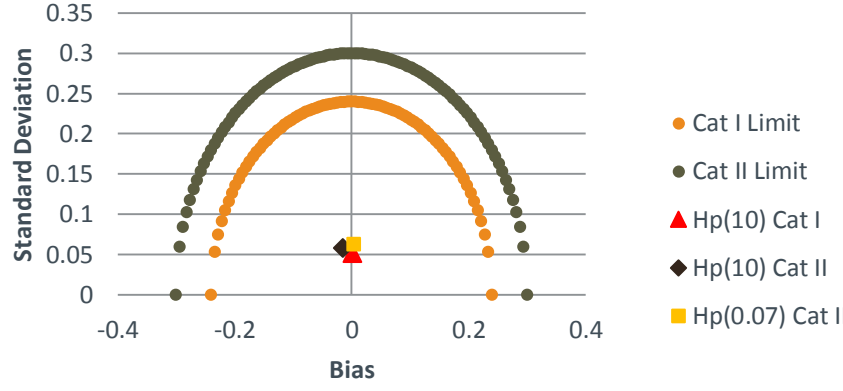
RadWatch® as Personnel Dosimeter Performance Results

- Dosimeter tested National Voluntary Laboratory Accreditation Program, ANSI N13.11-2009 Standard
- Testing categories:
  - Photons General –Accident Level
    - 15 dosimeters in the category
    - Dose range between 0.05Gy to 5Gy
    - No knowledge of the exposure field
  - Photons —Protection Level
    - 21 dosimeters in the category
    - Dose range between 0.5mSv to 5mSv
    - Energy from 70keV to 1250keV; Angles <=60°
    - No knowledge of the exposure field



	DDE			SDE		
	B	S	L^2	B	S	L^2
Cat 1A	0.0018	0.05	0.057	N/A	N/A	N/A
Cat 2C	-0.015	0.058	0.004	0.004	0.063	0.09

- Performance Evaluation
  - $B^2+S^2 \leq L^2$, Where B= bias, S = standard deviation, L= performance limit
  - L=0.24 for accident category, L=0.3 for protection category

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Conclusion

- RadWatch® –RadLight® System
  - Capable to be used as a tactical and as a personnel dosimeter
  - Desirable system for assessing dose in the field and in the laboratory conditions due to:
    - Simple dose calculation algorithm
    - Unique filter design that provides excellent angular response
    - Re-readability, offering the possibility of multiple readings without dose alteration, when depletion correction is applied
    - Wide dynamic range that offers the possibility of reading dosimeters exposed to very high doses without encountering saturation
    - Unique RFID identification capable of storing pertinent information related to the dosimeter
    - Reliability, easy to use, and lightness for the dosimeter and the reader