Experience in Satisfying HPS N13.11-2001

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HPS N13.11-2001

Personnel Dosimetry Performance - Criteria for Testing

- Approved July 31, 2001
- Effective date of change in fed register April 11, 2002
- Implemented for NVLAP third quarter 2002
- To be adopted by DOELAP in 2004
- Significant changes:
  - More photon fields
  - Mixtures – beta/photon and neutron/photon now allow low E photons
  - Angles – over half of category 2 non-perpendicular
  - 10% rule

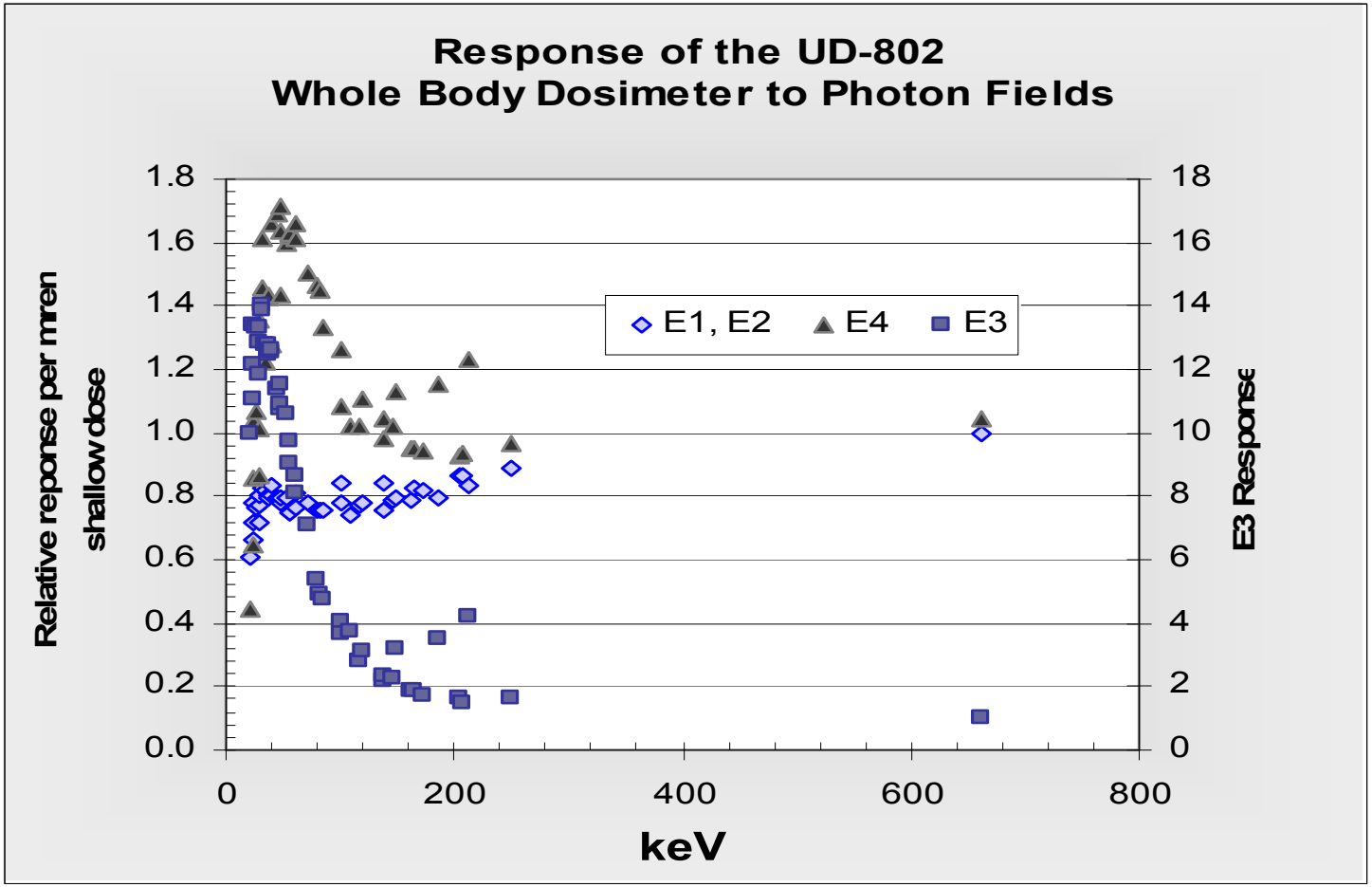
Photon fields

- New revision has increased the number of low energy photon fields from 6 to over 70
- Range is expanded at both ends
  - Was 30keV to 662 keV
  - Now 20 keV to 1250 keV
- Dose correction factors from NIST and ISO
- Excellent set of well-characterized fields for establishing dosimeter response curves

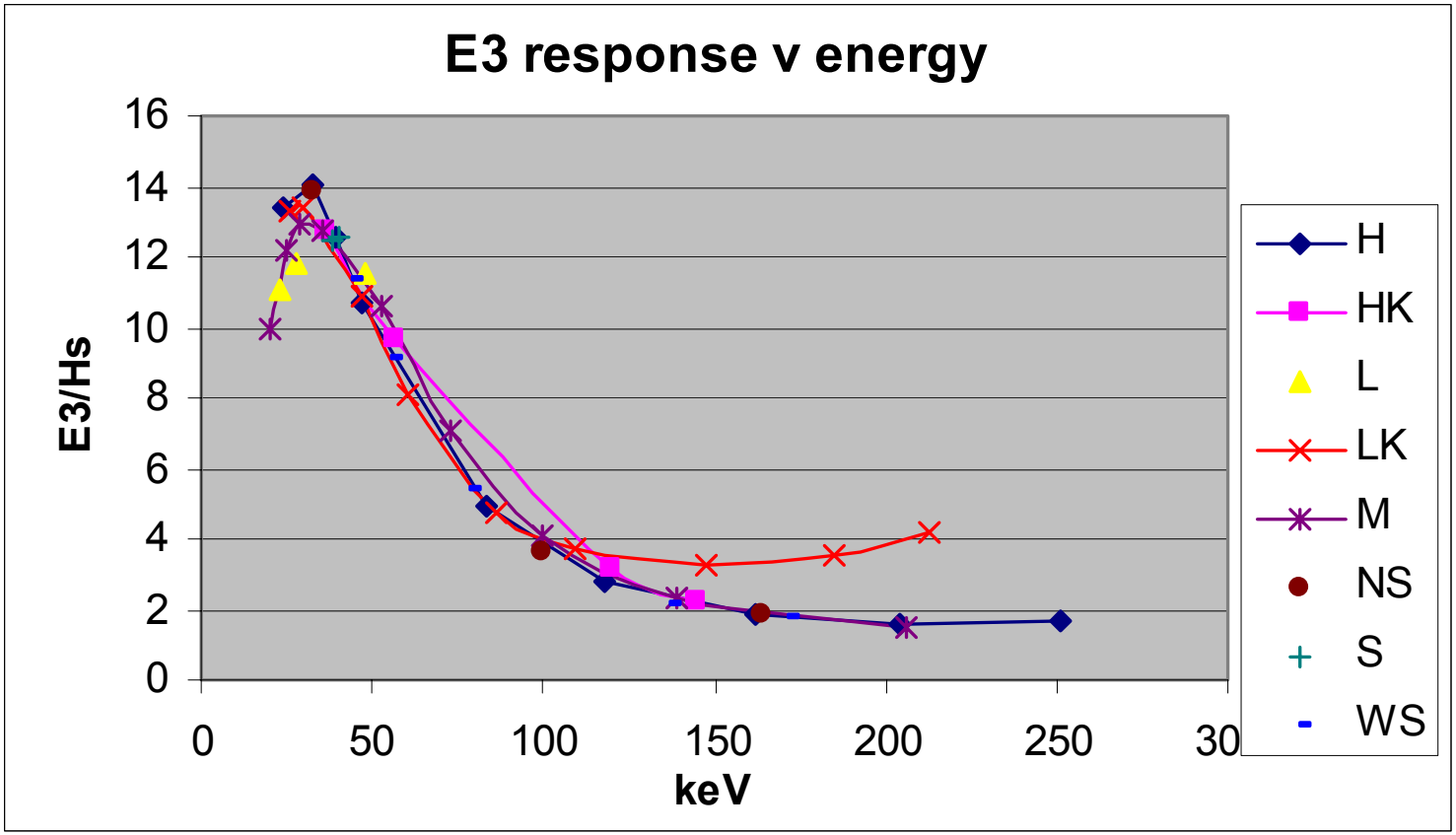
Photon fields - concerns

- How will the narrow and wide spectrum techniques compare?
- Is it necessary to “calibrate” to all of the fields?

Photon fields – response of Panasonic UD-802



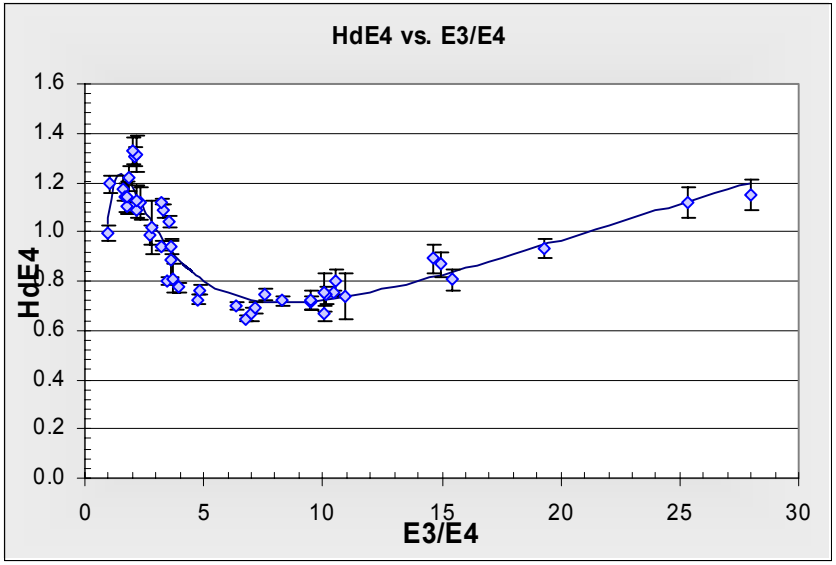
Photon fields – new LK technique



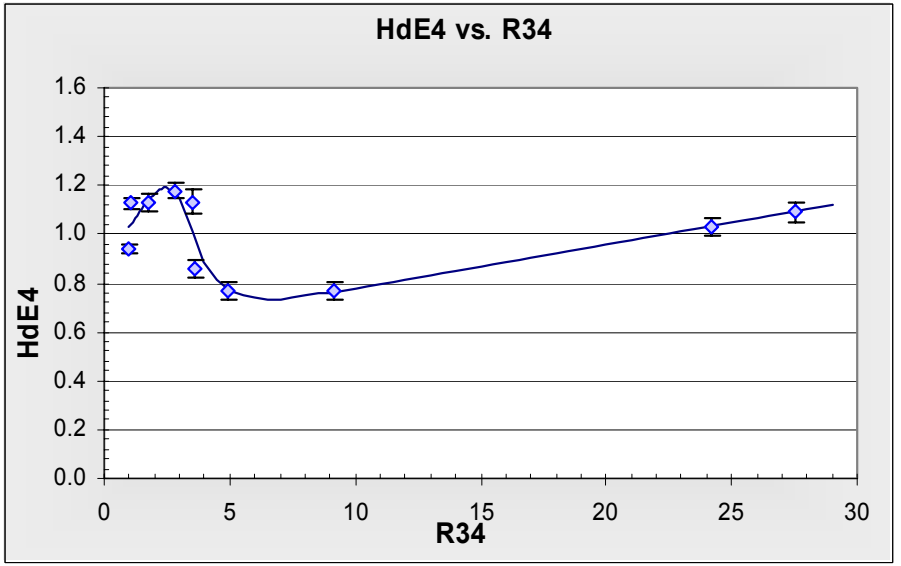
Photons - solution

- Using function-based photon correction factors accommodates the entire energy range
- How to model the response?
  1. Use all of the fields – expensive and time consuming
  2. Use subset, chosen to show inflections

Photon functions– two options



option 1: use all available data



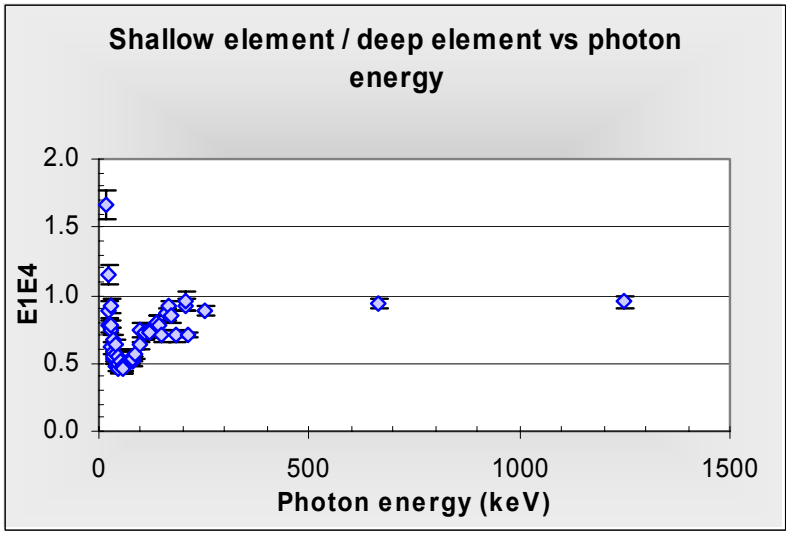
option 2: use select fields

Mixtures

- Past versions of N13.11 only used gammas (^{137}Cs) for mixtures with non-photon fields
- New standard includes low E photons
- **BUT**
  1. Only for hard betas or neutrons, not soft betas
  2. You can opt out, <u>regardless of your selection in category II</u>

Mixtures – concerns

- Photon response of shallow element ≠ photon response of deep element for low energy fields
- Old method of simple subtraction
  *beta = (shallow-deep)*cf*
  is no longer viable



Mixtures - solution

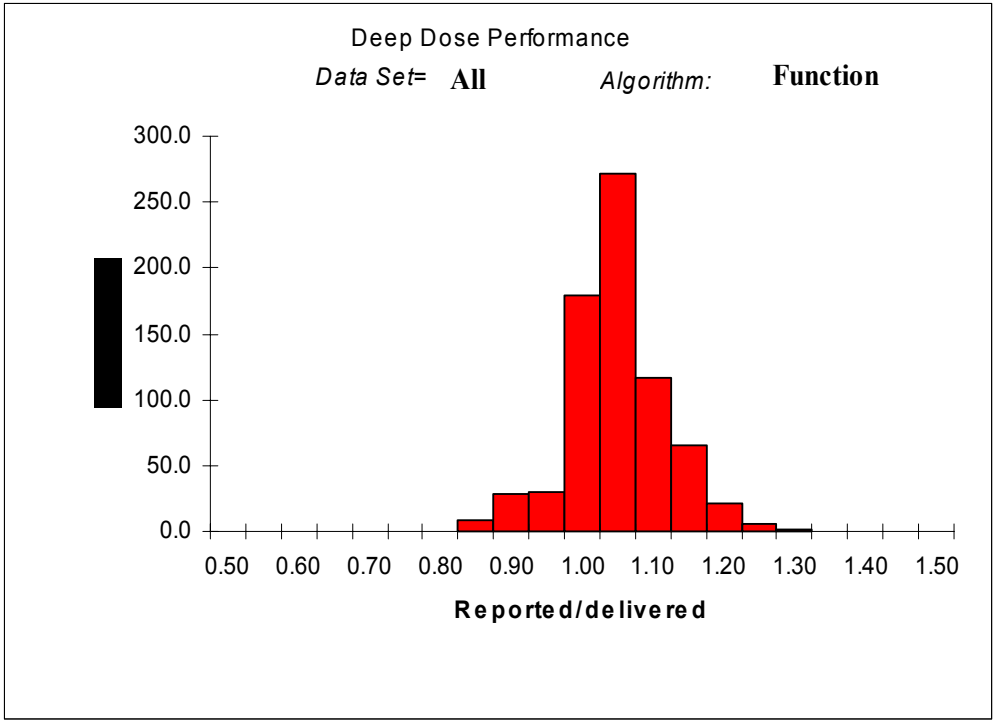
- Use **energy-dependent correction factors** to subtract the photon signal from the detectors used for beta or neutron
  - The amount of the photon signal subtracted depends on the ratio of element sensitivities for the particular photon field
  - The photon field is characterized using element responses
- $E1_{beta} = E1_{total} - E4*f(E3/E4)$
- This method works for full range of photon and beta energies
- Implemented at DOELAP and NVLAP facilities since 1989

Synthetic testing

- Compare the calculated to expected dose for over 700 mixtures of photons, photons with betas, photons with neutrons
  - Use the documented dosimeter relative response (reading/mrem) for each field multiplied by the desired dose to arrive at the simulated response
  - Sum any number of simulated responses to obtain mixed field responses
  - Compare the calculated dose from simulated responses to the sum of the input doses
- Allows an inexpensive and thorough test without the biases introduced by reader and dosimeters

Synthetic testing - results

Observed bias (calculated/expected) for 730 combinations of test responses (photons, photons + beta, photons + neutron)



	Shallow	Deep
n	730	728
Average	0.99	1.02
Low	0.76	0.83
High	1.22	1.25
+/- 10%=	87%	82%
+/- 20%=	98%	99%

Angularity testing

- Only implemented for category II (protection level pure photons)
- If E > 70 keV, angle chosen **randomly** from: -60h, -60v, -40h, -40v, ± 0, 40v, 40h, 60v, 60h
- For each of three facilities, 9 out of the 15 dosimeters were irradiated using a non-perpendicular geometry

Angularity testing-
first three NVLAP sessions

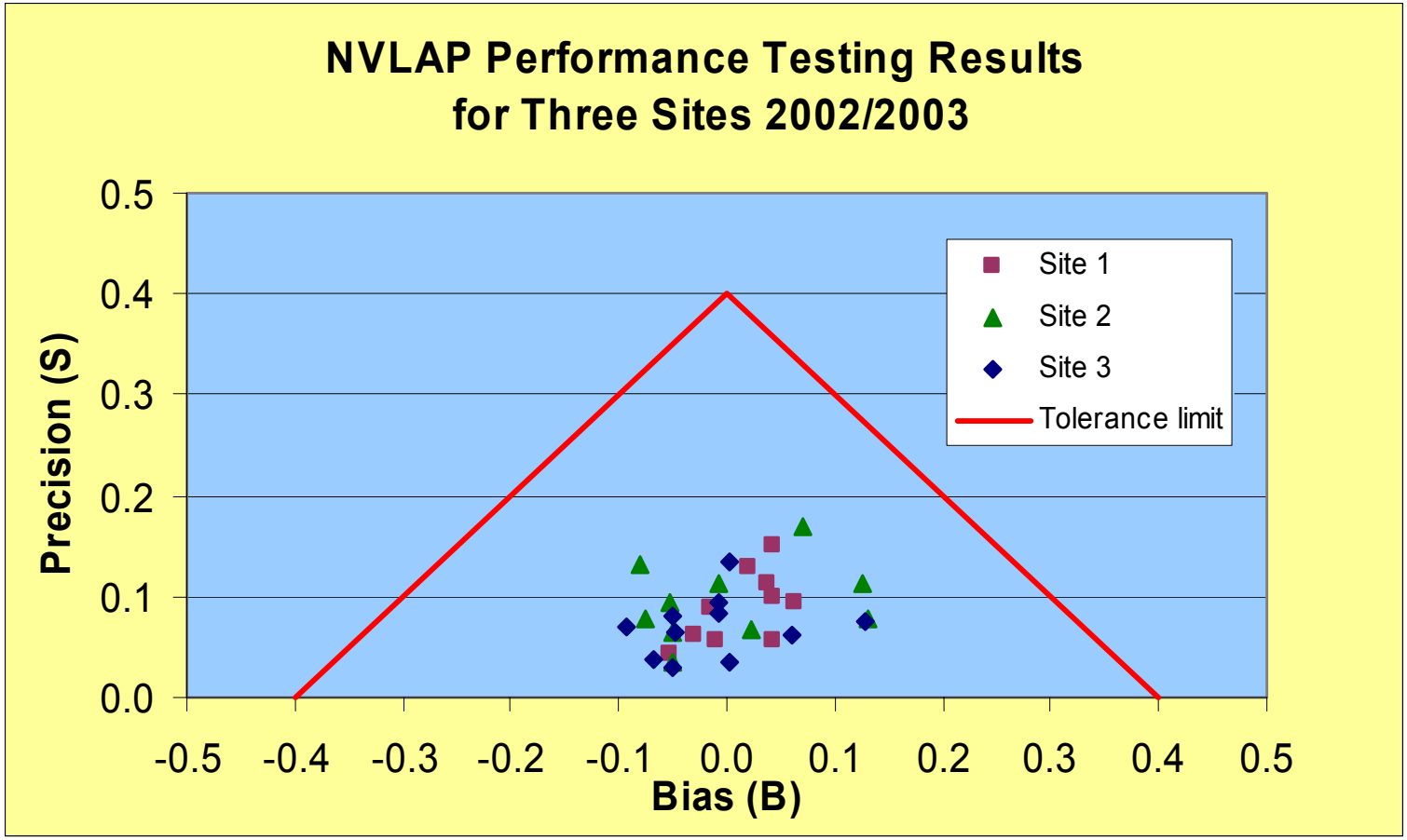
- Three facilities
- Three test sessions
- All tested to IIA
- All three passed but the 60V is a challenge for the Panasonic UD-802

Angle	Q3 '02	Q4 '02	Q1 '03
-60º v	x	x	x
-60º h	x		
-40º v	xx	x	x
-40º h	x	x	
0º	xxxx	xxx	xxx
40º h	x	xx	xxx
40º v	x	x	x
60º h	x	xx	x
60º v	x	x	xx
<70keV	xx	xxx	xxx

10% Rule

- Imposes a new ± 40% test on individual results
- Added in an attempt to get in line with ISO;
  - But the ISO (14146-2000) has no limits on the sum of average and standard deviation, just individual results.
  - ISO specifies an asymmetrical range, -34% to +50%, allowing more room for overestimates.
  - ISO uses factor to widen range for low doses.
- Together with angles, this is a significant new challenge

NVLAP testing - results



Conclusions

- New standard has some significant changes
- New photon fields are very manageable using a function-style algorithm based on select photon fields
- Mixture categories are also manageable and in any case can be avoided
- Angularity testing and the 10% rule combine to present a significant challenge

References

1. HPS ANSI N13.11 2001, Personnel Dosimetry Performance - Criteria for Testing
2. ANSI N13.11-1983, American National Standard for dosimetry - personnel dosimetry performance - criteria for testing
3. DOE EH-0027, "DOE Standard for Performance Testing of Personnel Dosimetry Systems“
4. ISO 14146, 2000, Radiation protection - Criteria and performance limits for the periodic evaluation of processors of personal dosemeters for X and gamma radiation

Presentation available at www.stanforddosimetry.com