Algorithm Development and Implementation

Neill Stanford, CHP

www.stanforddosimetry.com

Topics – *not algorithm specific*

- Performance goals
- N13.11-2001
- Response data
- Using Panasonic's new data
- Testing
- Documentation

Performance Goals

- The most accurate results for actual work environment conditions
- Be reasonable
  - Ask for what you need
  - Use specific algorithms for different conditions if possible
- Keep it as simple as possible
  - If you only need photons, for example, use E2/0.8. This is ± 24% *for all fields tested, even angles*.
  - Every additional capability comes at the expense of system uncertainty.

Performance goals (ctd)

- **Mixtures** - design it for the work environment
  - Betas and photons
  - Neutrons and photons
  - Betas and/or neutrons and photons (not with a single 802)
  - What photon energy?

HPS N13.11 2001

HPS N13.11-2001

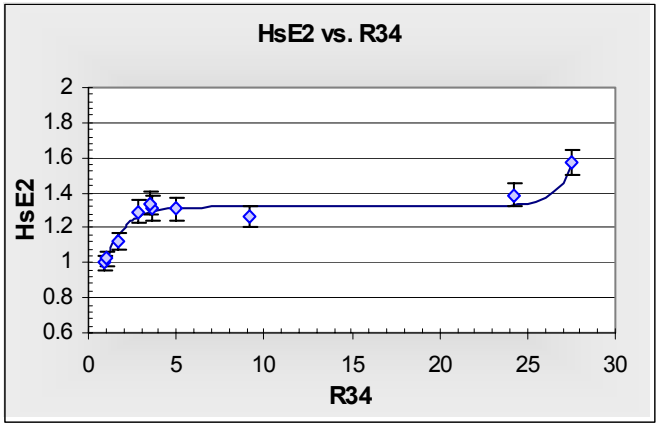
- NVLAP since 2002
- DOELAP in January 2004
- More photon fields, same range (plus ^{60}Co)
- Mixtures? – not if you don't want to
- Angles – over half of cat II
- 10% rule

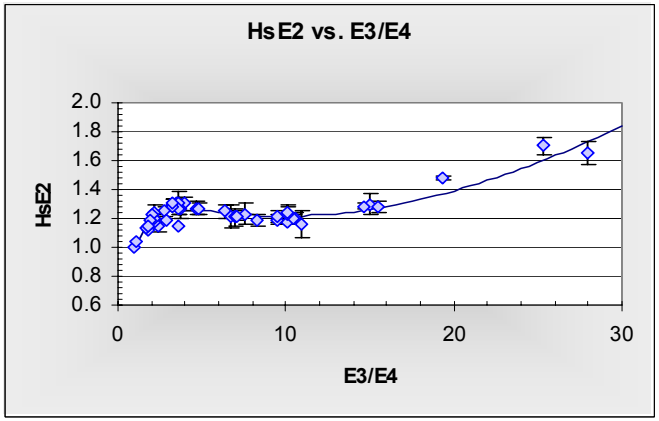
N13.11- New photon fields

- Many more fields
- More consistent with international correction factors
- You do not need to test to all of the new fields

N13.11- New photon fields

- Can pick the energies judiciously and let the function (or matrix solution) interpolate
- One fit to 10 points, the other to over 40





N13.11 - Mixtures

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

N13.11 - Angles

- Category II only (protection level pure photons)
- If E > 70 keV, angle chosen **randomly** from: -60h, -60v, -40h, -40v, 0, 40v, 40h, 60v, 60h

N13.11-Experience with category II

- Two facilities
- Both tested to IIA
- 3rd, 4th quarter 2002
- Both passed

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

N13.11 - 10% Rule

- Imposes a new ± 40% individual test
- Added in an attempt to get in line with ISO;
  - But the ISO (14146-2000) has no limits on 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.

Response data

Response data

- Establish a **standard response** set
  - Based on standard conditions
  - Free from bias – no reader cal bias, no fade
- Design the algorithm to the standard responses
- Ensure the responses are maintained for future applicability

Response data –normalize it

- Ensure the response data is standard with normalization to calibration elements.
  - "Calibrate the data" to show response of system perfectly calibrated with no fade
  - Phosphor specific corrections to data set using calibration elements and desired response for standard field (^{137}Cs for ex.)

Response data – normalize it

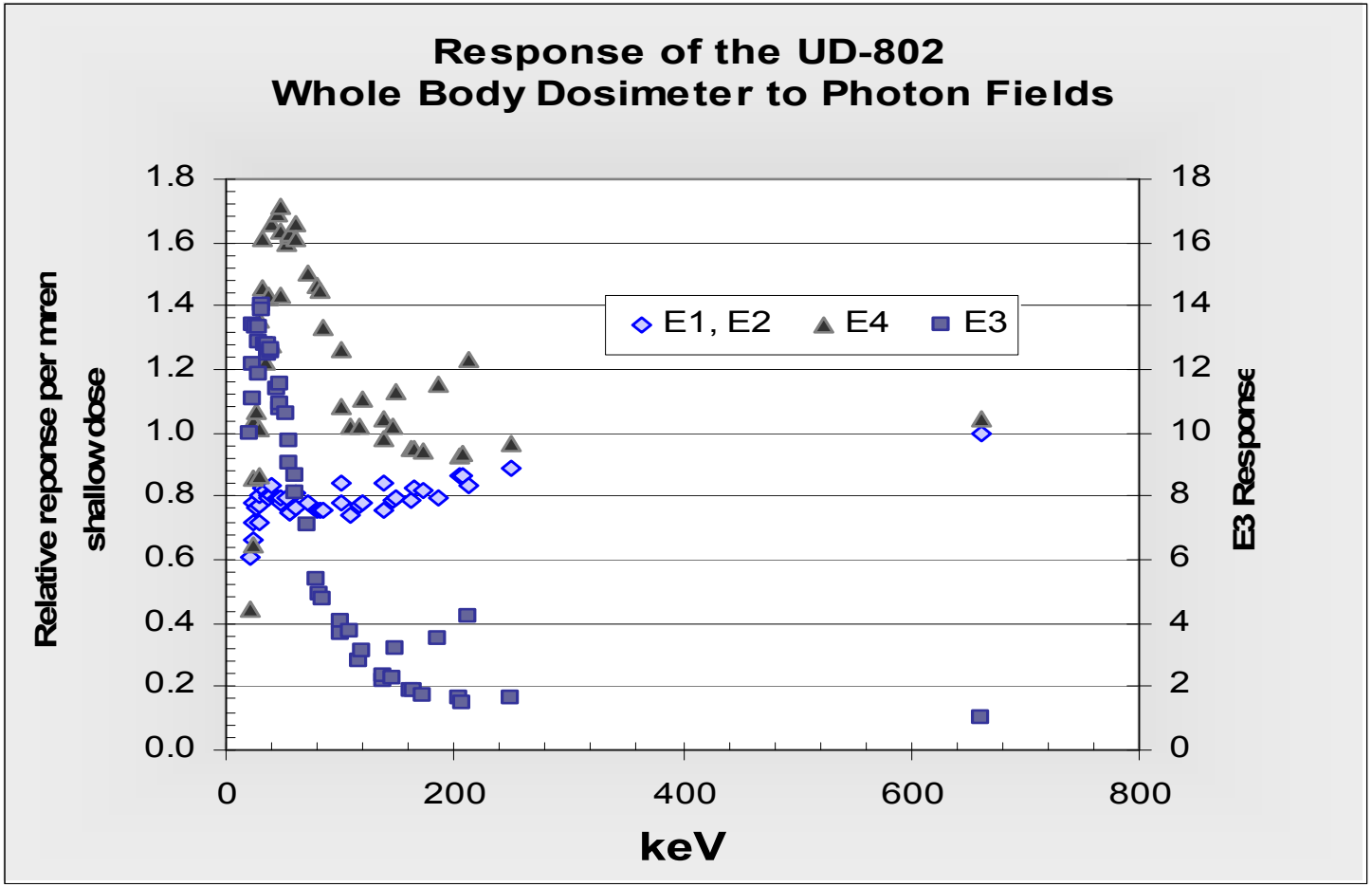
- Normalization factors are:
  - Phosphor specific
  - Fade interval specific
  - Reader and read time specific
- Use it to investigate QA performance
  - Always include standard field (^{137}Cs)
  - Allows the isolation of reader performance and fade from possible system shifts

Panasonic data

- Panasonic sponsored test data
  - 47 photon fields
    - All with 5 replicates at 0 degrees
    - 22 fields with 2 replicates at each of 8 angles (+/- 40ºv, +/-40ºh, +/-60ºv, +/-60ºh.)
  - Corrected for background and normalized for reader calibration and fade (E2 = E3=^{137}Cs dose)

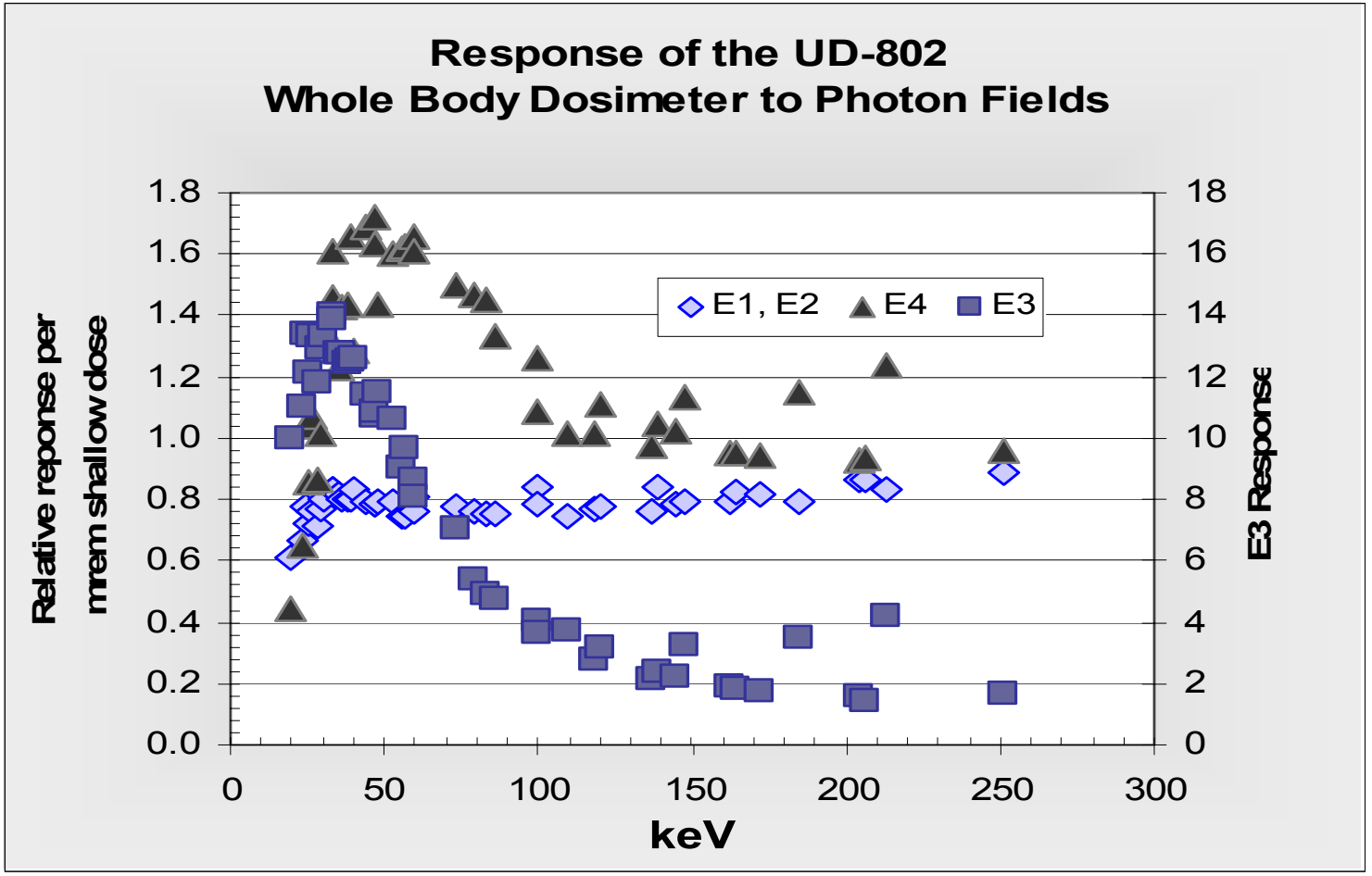
Panasonic data – perpendicular

20 – 662 keV

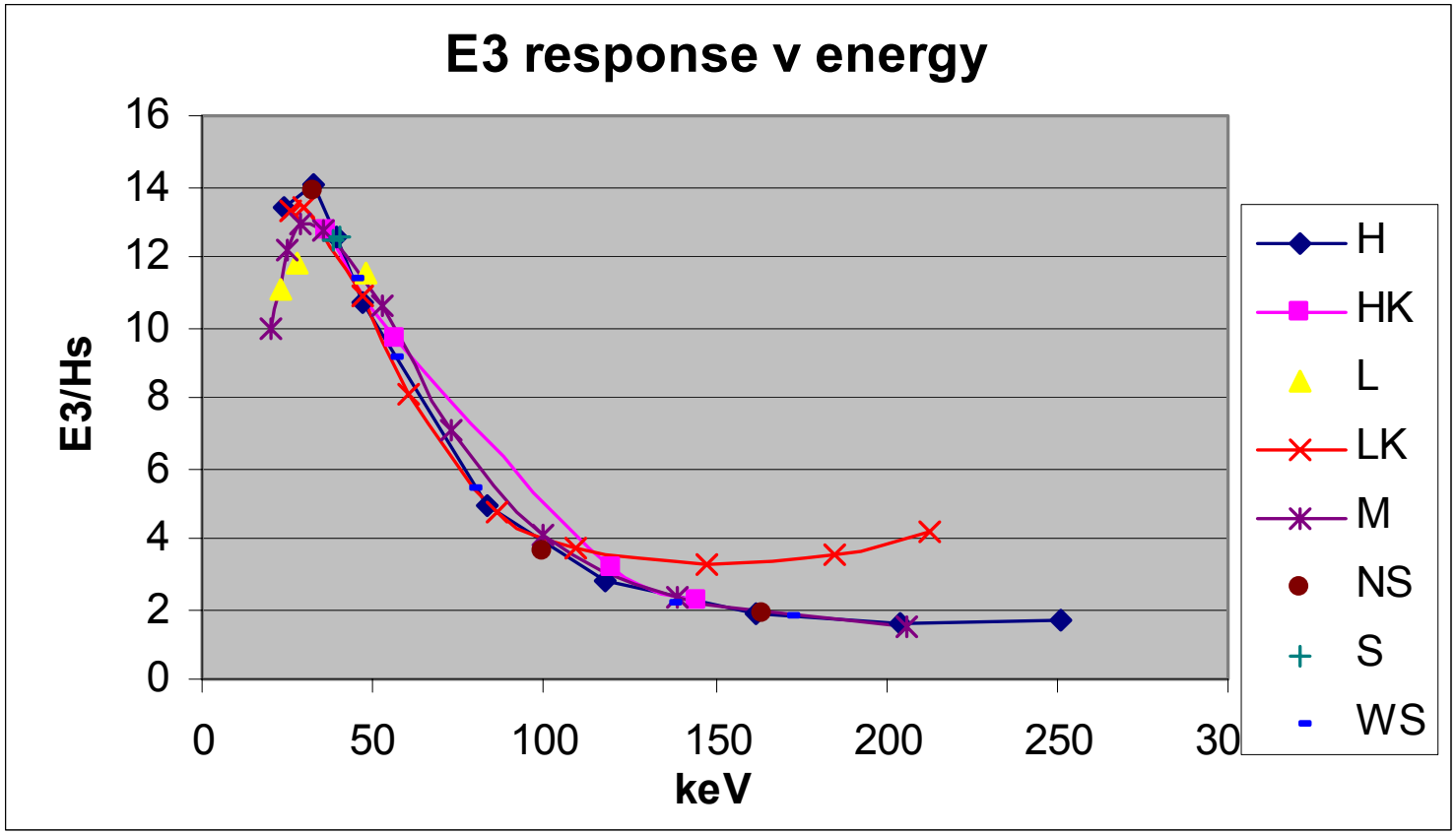


Panasonic data – perpendicular

20 - 250 keV



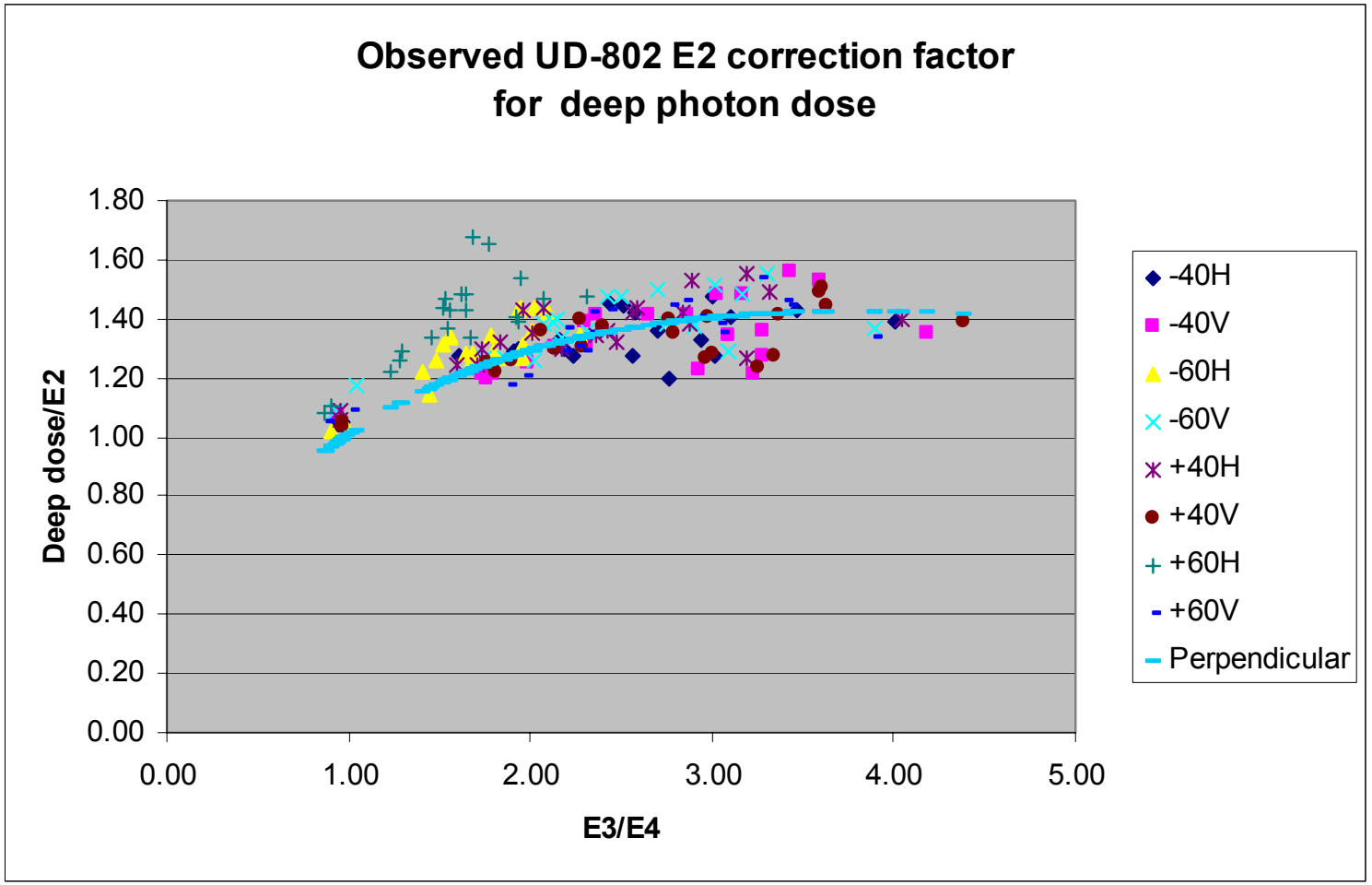
Panasonic data - LK fields?



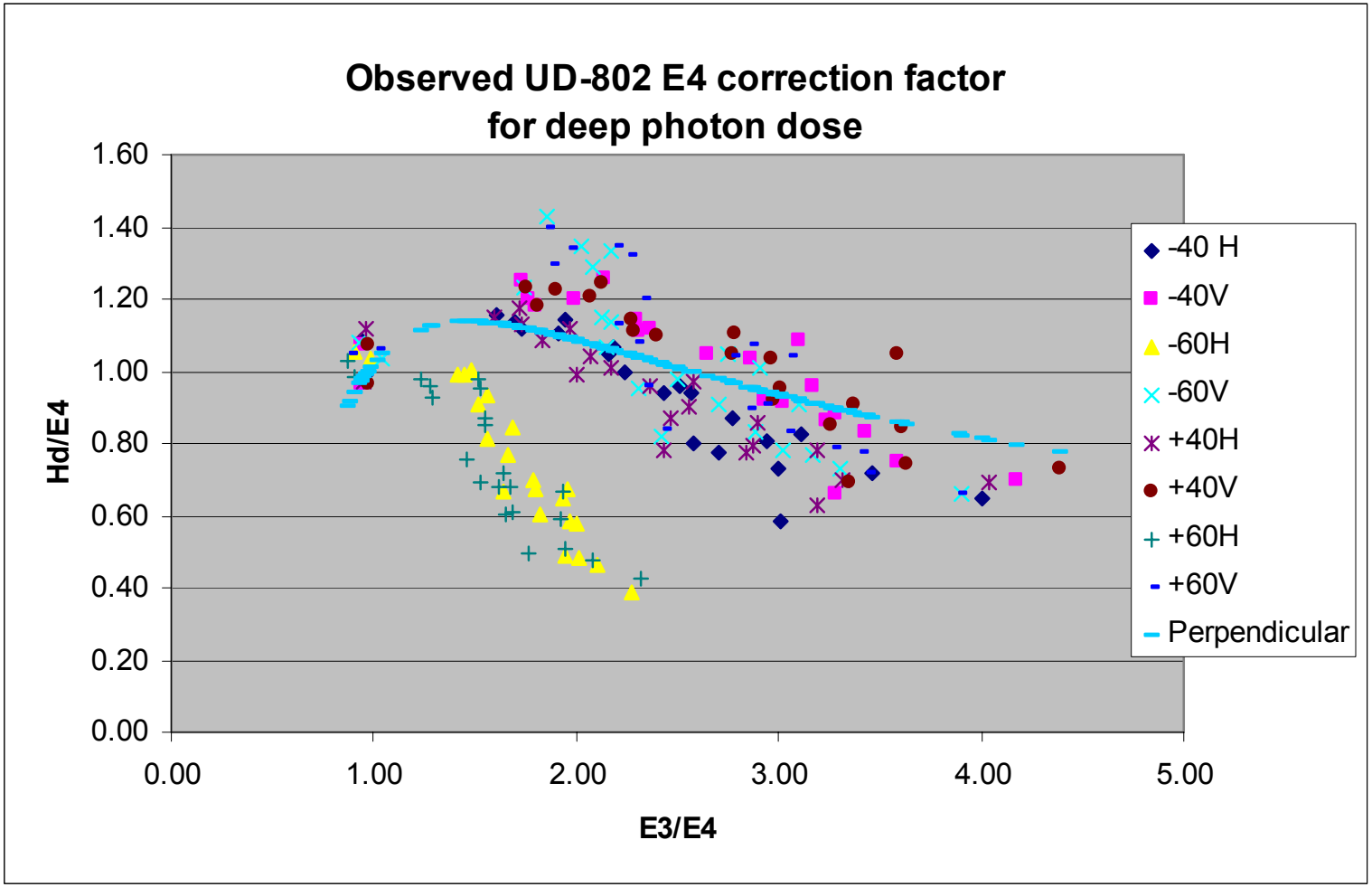
Panasonic data - ^{60}Co vs.^{137}Cs?

	E1	E2	E3	E4
Cs-137	0.977	1.000	1.000	1.046
Co-60	0.848	0.974	0.880	0.895
% diff	-13%	-3%	-12%	-14%

Panasonic data – angles



Panasonic data – angles



Panasonic data - uses

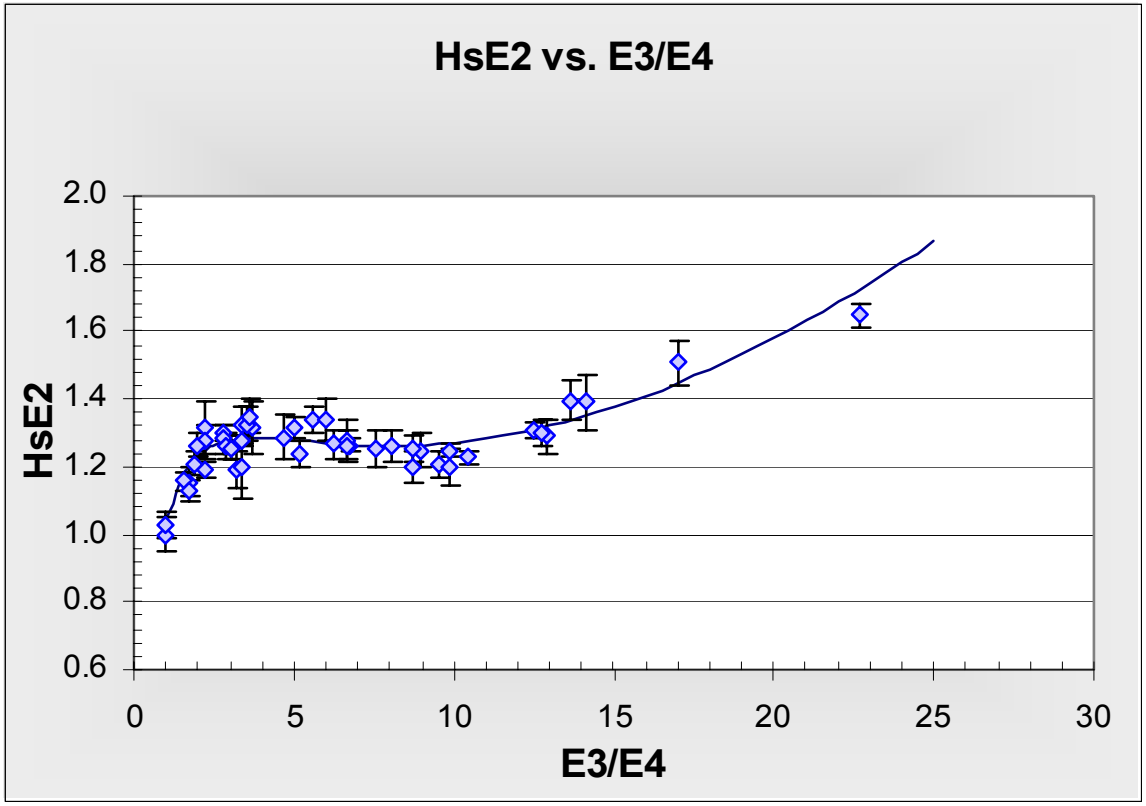
- Excellent for modeling general response
  - First cut at algorithm, general plan
  - Effect of angularity
- Should finalize algorithm with system specific data
  - Response functions or matrix
  - Site specific factors

Panasonic data -applicability

- Look at response of E2 for the Panasonic set compared to data collected for two other systems in 2002
  - Same dosimeter
  - Similar cases (hangers)
  - Same normalization procedure

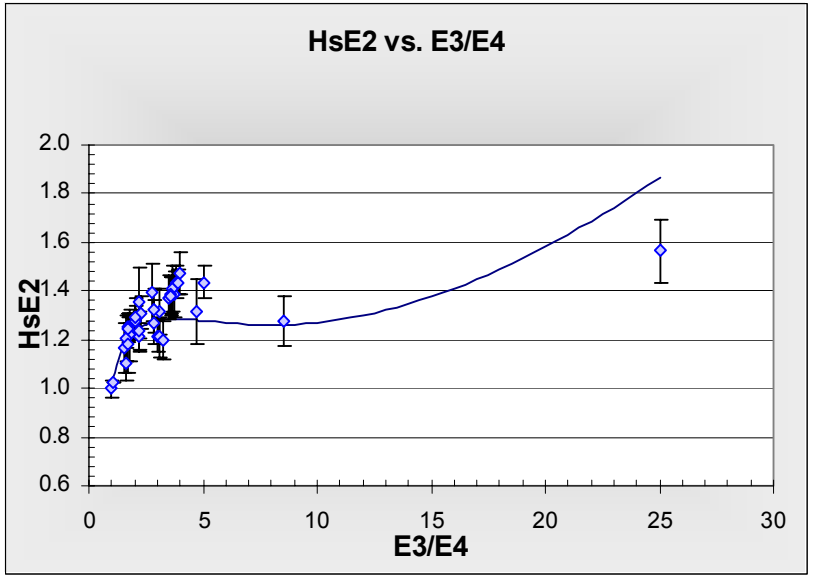
Panasonic data – applicability

- Hs/E2 for **Panasonic data**
- All points within range of -5% to +7% of the curve

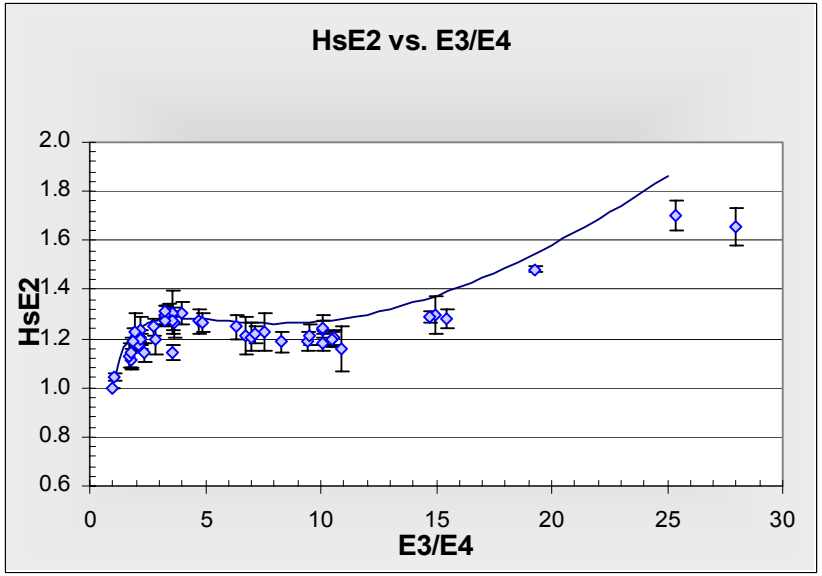


Panasonic data - applicability

- Two other facilities' data. The curve developed for the Panasonic data is superimposed.



- Curve is -13% to +19%



- Curve is -2% to +25%

Testing

- To test the system, shoot badges.
  - Tests reader cal, ECFs, fade, bkgd, handling
  - Shows routine performance for field badges
- To test the algorithm, use a spreadsheet.
  - Synthetic testing – arithmetically generate test responses
    - Total response for a mixed field = sum of responses to each component.
    - Component response = mR*/mrem * mrem
  - Compare algorithm results to sum of synthetic doses
  - Shows algorithm performance, isolated from other effects

Other issues

- Documentation
- Uncertainty calculations
- Keeping it current for slight system shifts

Documentation

- Must be sufficiently detailed to allow full verification. **Dose reconstruction.** Otherwise, future people are left with reinventing an algorithm to apply to the element readings.
- Design data set
- All calculations must be spelled out
- Test data