



# Algorithm Development and Implementation

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# 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  $\pm 24\%$  *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

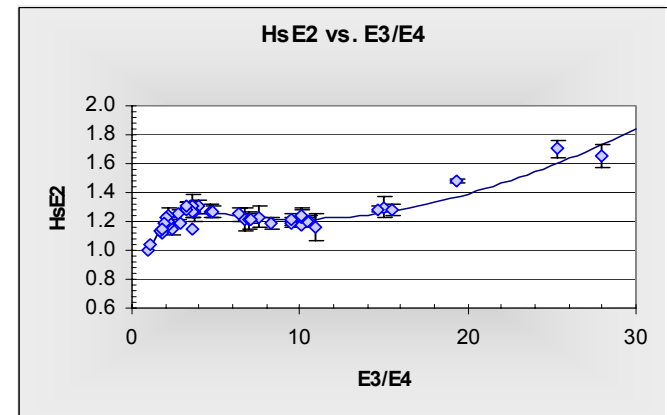
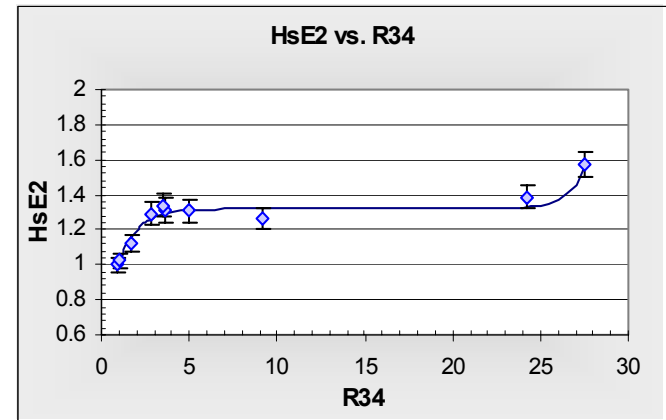
- NVLAP since 2002
- DOELAP in January 2004
- More photon fields, same range (plus  $^{60}\text{Co}$ )
- Mixtures? – not if you don't want to
- Angles – over half of cat II
- 10% rule

# 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 ( $^{137}\text{Cs}$ ) 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
- 3<sup>rd</sup>, 4<sup>th</sup> quarter 2002
- Both passed

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

# N13.11 - 10% Rule

- Imposes a new  $\pm 40\%$  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 ( $^{137}\text{Cs}$  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 ( $^{137}\text{Cs}$ )
  - Allows the isolation of reader performance and fade from possible system shifts

# Panasonic data

- Panasonic sponsored test data

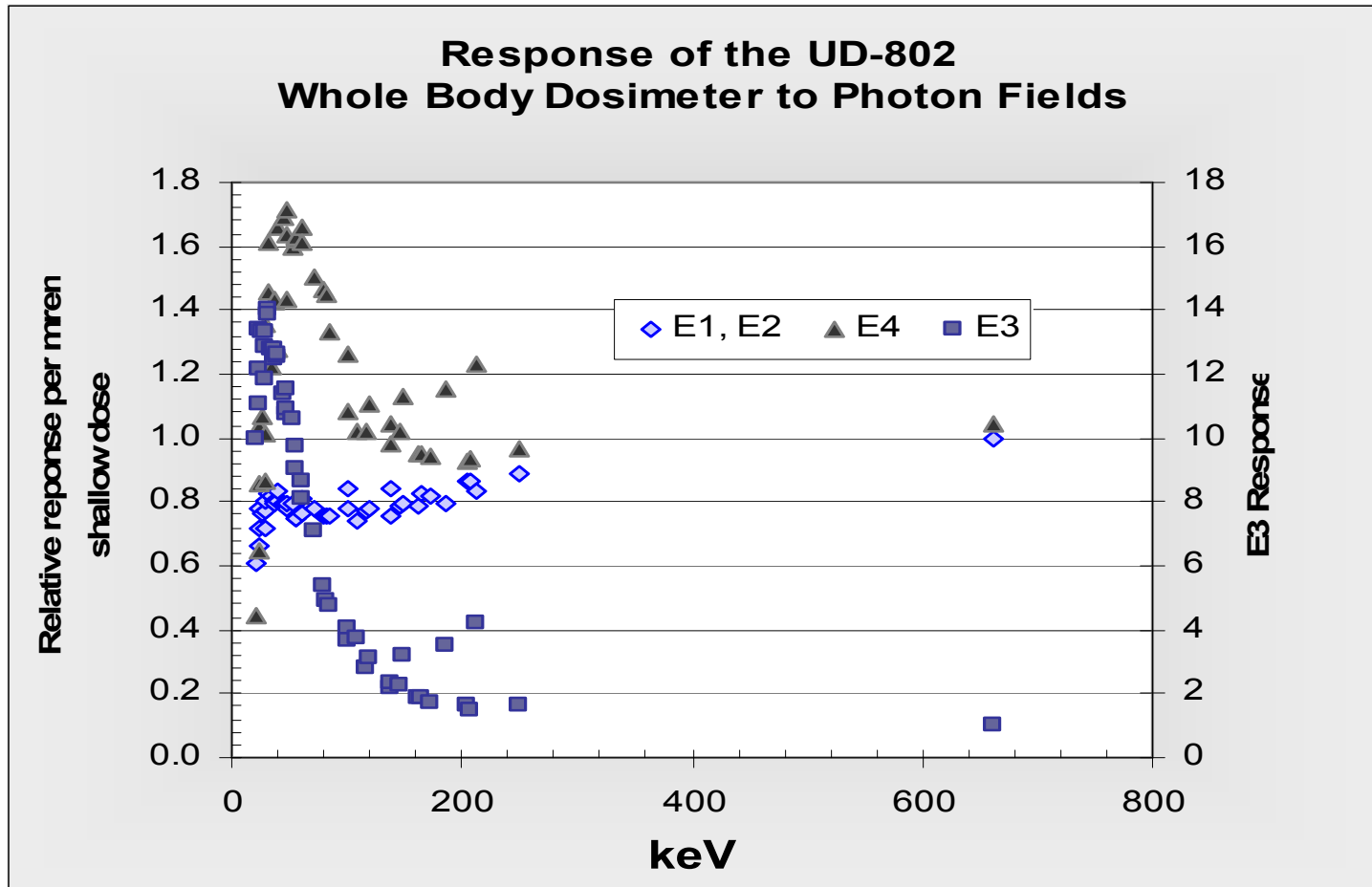
- 47 photon fields

- All with 5 replicates at 0 degrees

- 22 fields with 2 replicates at each of 8 angles (+/- 40°v, +/-40°h, +/-60°v, +/-60°h.)

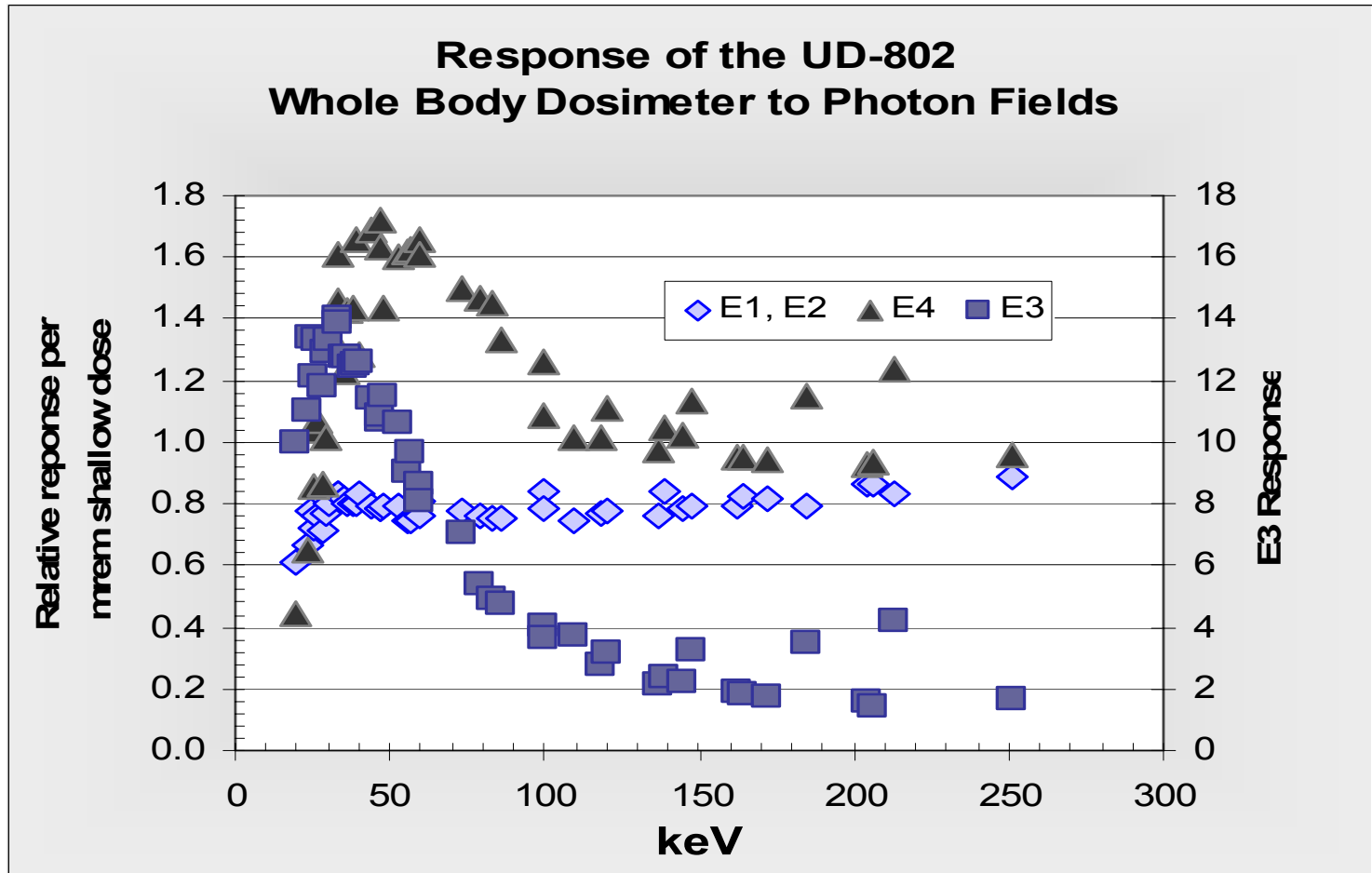
- Corrected for background and normalized for reader calibration and fade (E2 = E3=<sup>137</sup>Cs dose)

# Panasonic data – perpendicular 20 – 662 keV

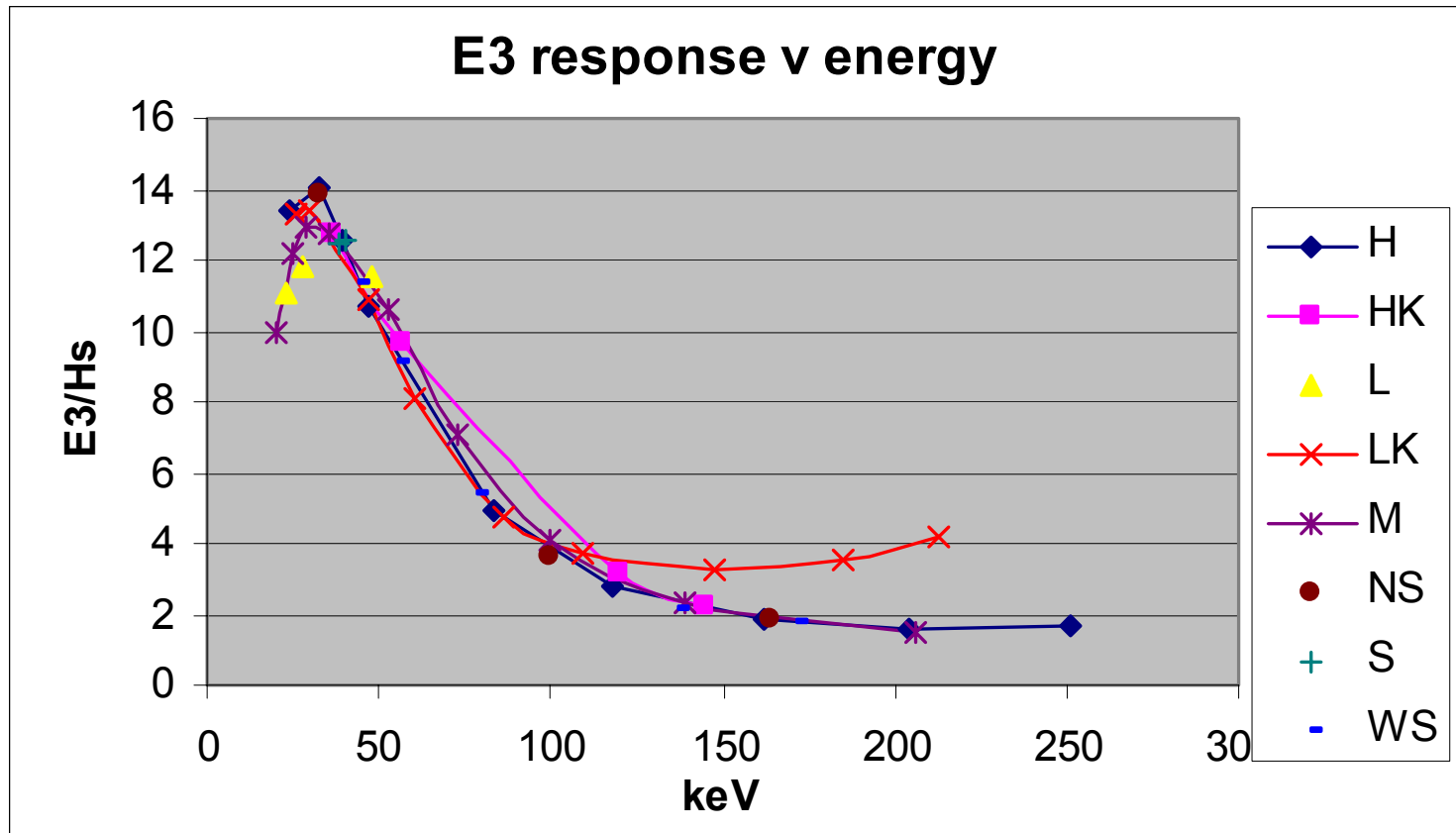


# Panasonic data – perpendicular

## 20 - 250 keV



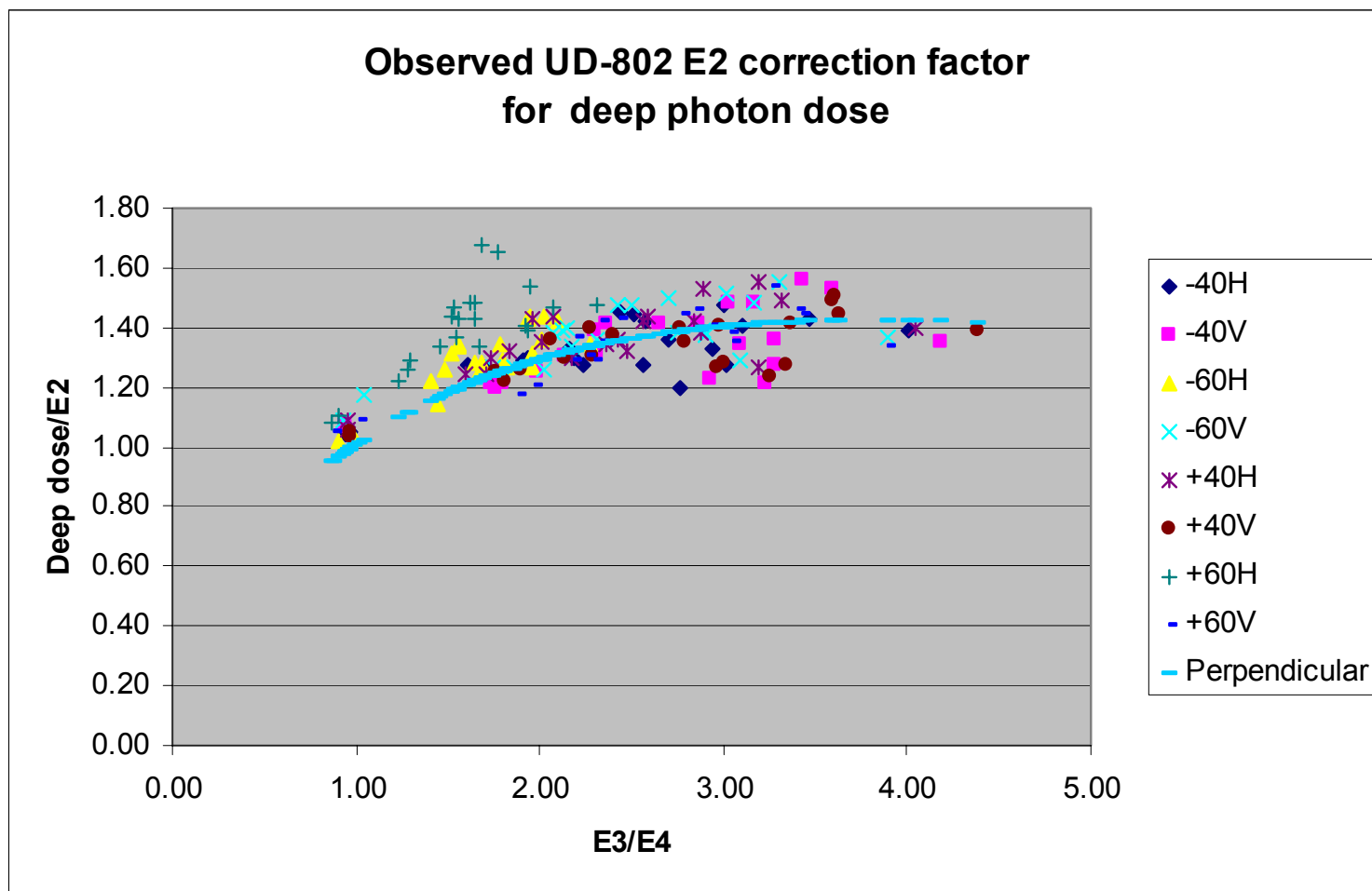
# Panasonic data - LK fields?



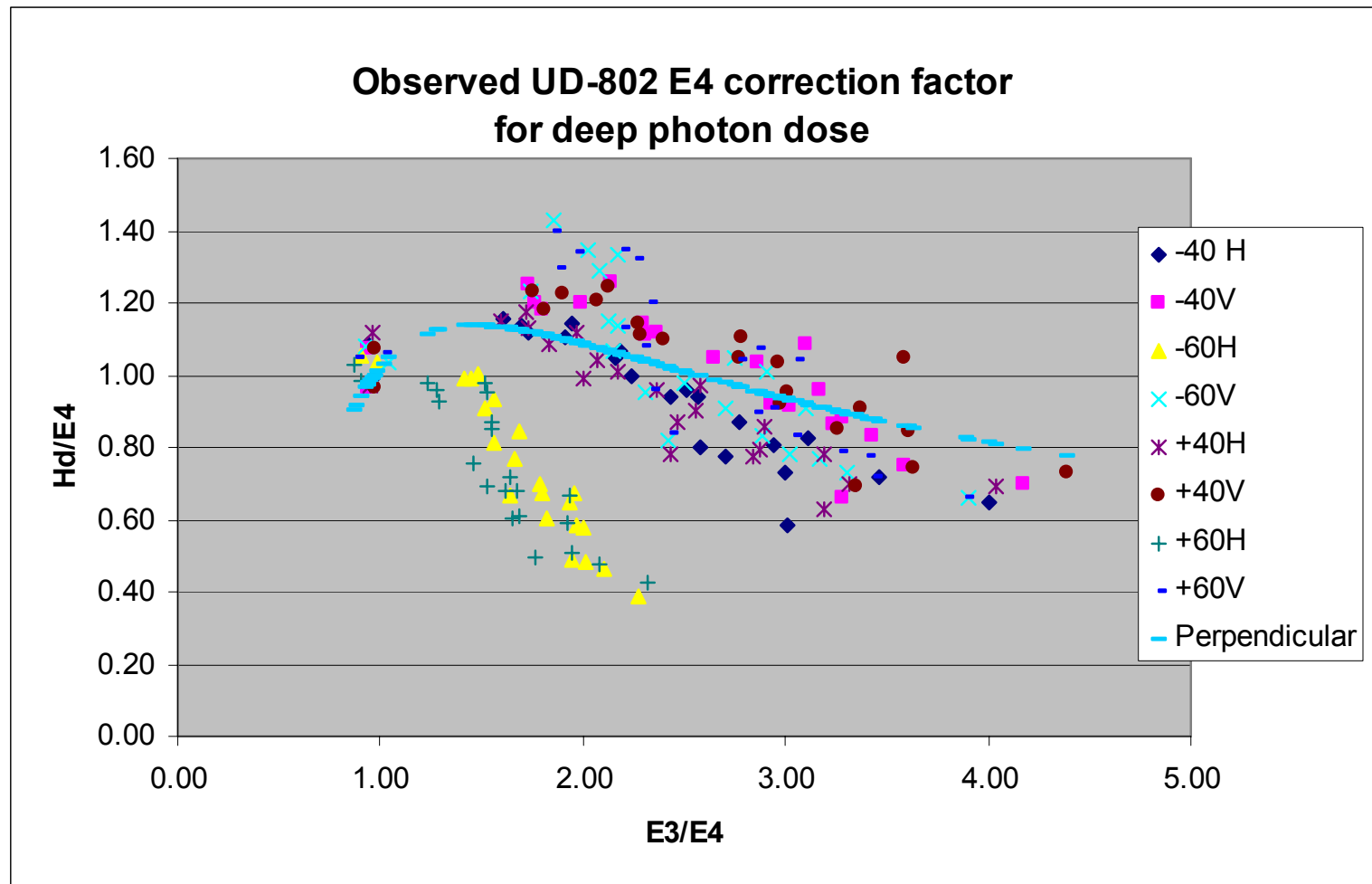
# Panasonic data - $^{60}\text{Co}$ vs. $^{137}\text{Cs}$ ?

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

# Panasonic data – angles



# Panasonic data – angles



# Panasonic data - uses

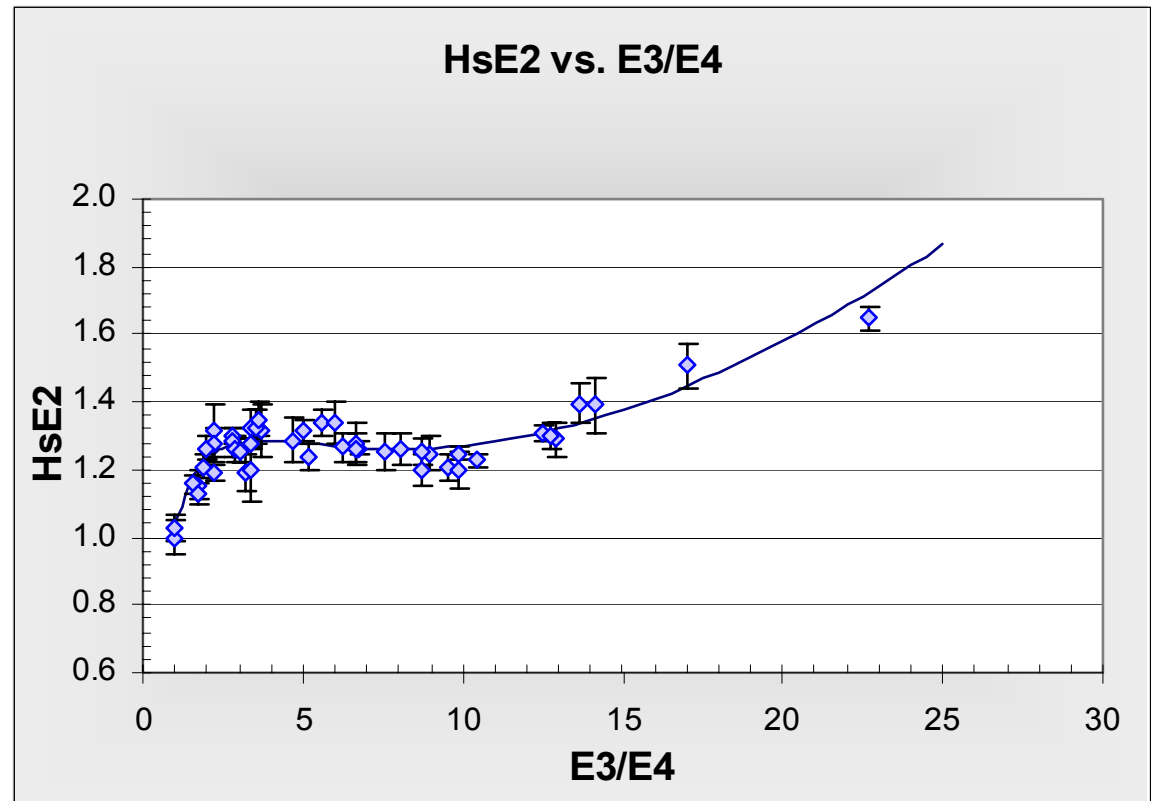
- Excellent for modeling general response
  - First cut at algorithm, general plan
  - Effect of angularity
- Should finalize algorithm with system specific data
  - Response functions or matrix
  - Site specific factors

# 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

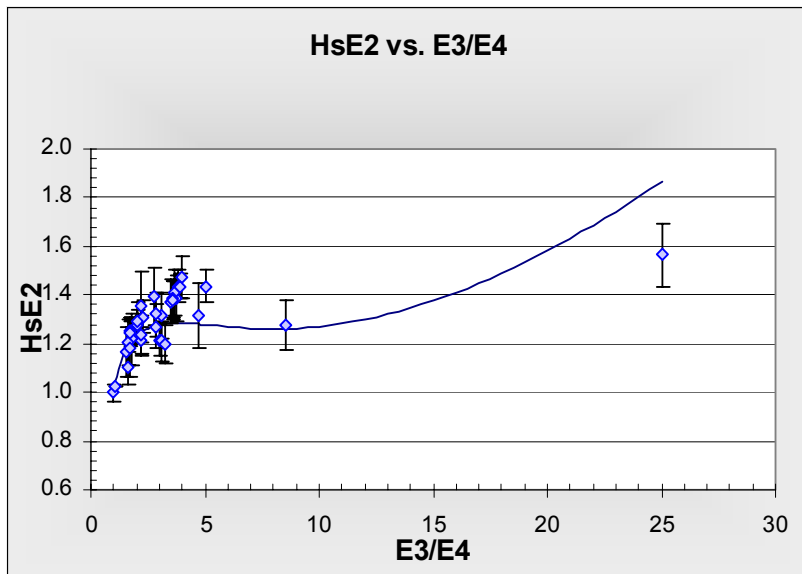
# Panasonic data – applicability

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

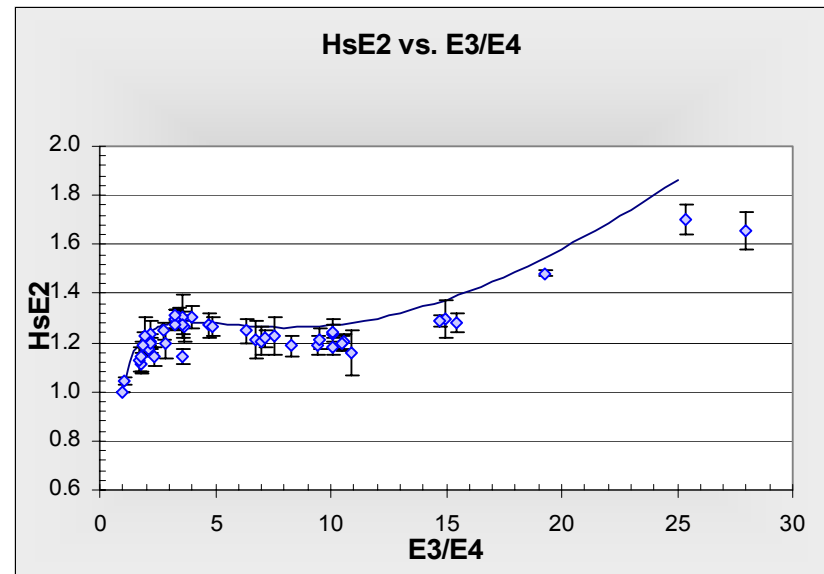


# Panasonic data - applicability

- 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