The Five Essentials for a Successful Dose Algorithm

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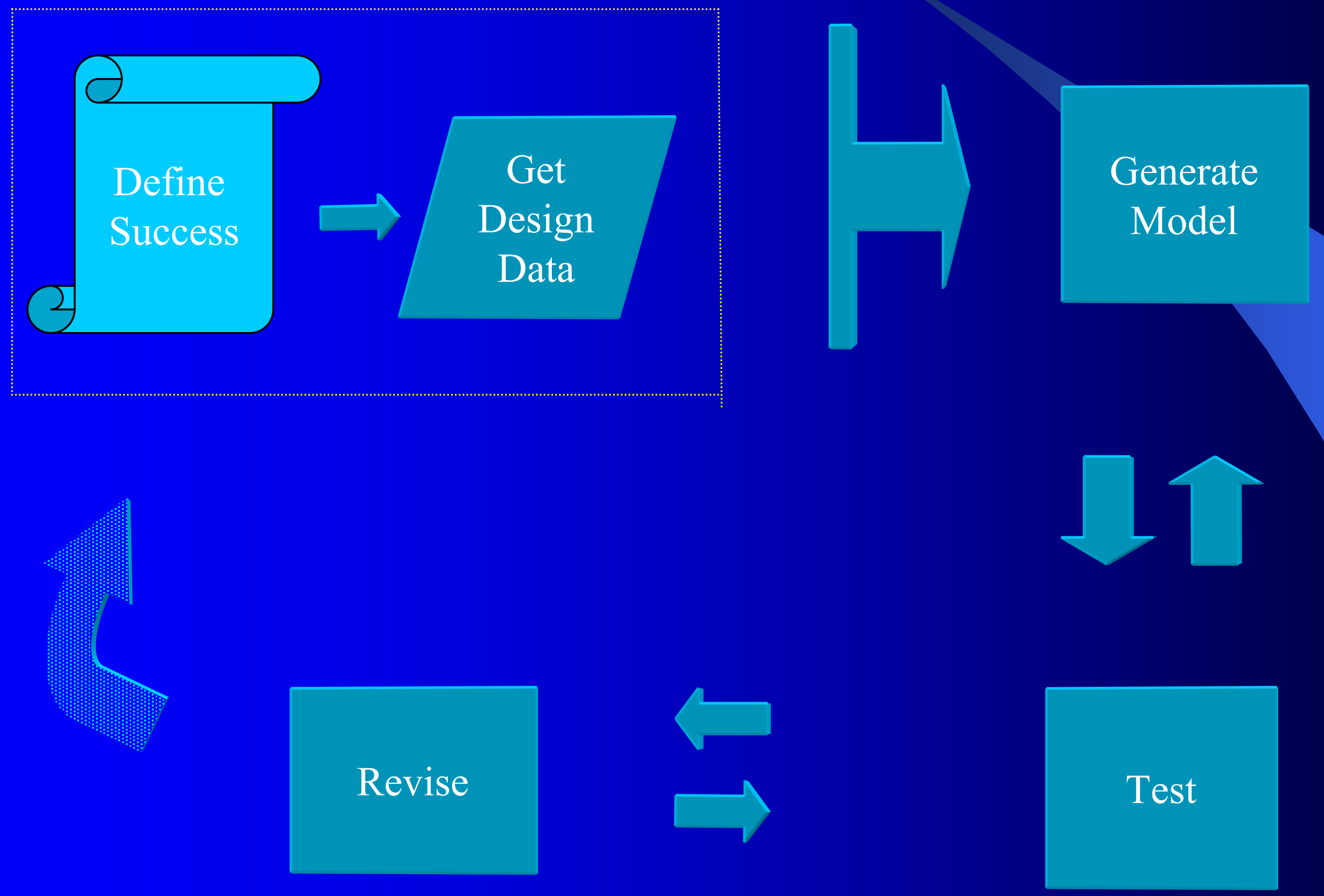
Abstract

The increase in sophistication of TLD dose algorithms has for the most part improved the capability of external dosimetry, but in some cases has created some problems. Some designs strive to meet goals that are not relevant to their situation; many base the algorithm on data not representative of the current conditions; algorithm designs are often too complex and difficult to maintain; insufficient testing leads to surprises in the field; and finally many programs fail to correct shortcomings with the algorithm once in place. Applicable to any algorithm design, this presentation provides tips on how to minimize these problems, outlining the five essential steps involved in creating and maintaining the most accurate and reliable TLD dose algorithm possible for a given situation.

TLD Dose Algorithm Life Cycle



1 Define successful

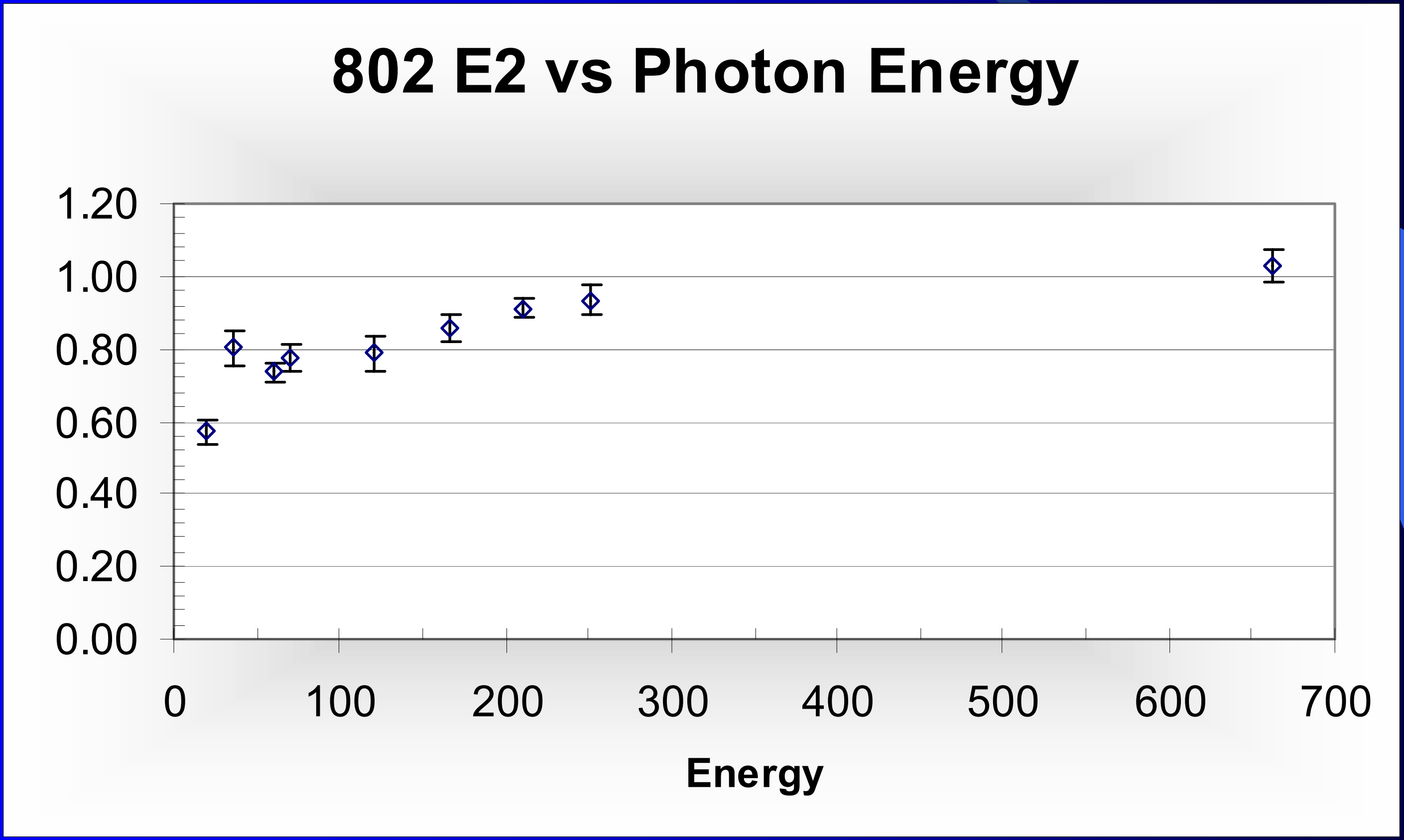
- What conditions need to be accommodated?
  - What types, what fields, what mixtures
  - What conditions (angularity for example.)
- Don't forget about real world dosimetry.
- Understand *routine* vs *special* dosimetry.

★ Complexity in an algorithm comes at the expense of precision.

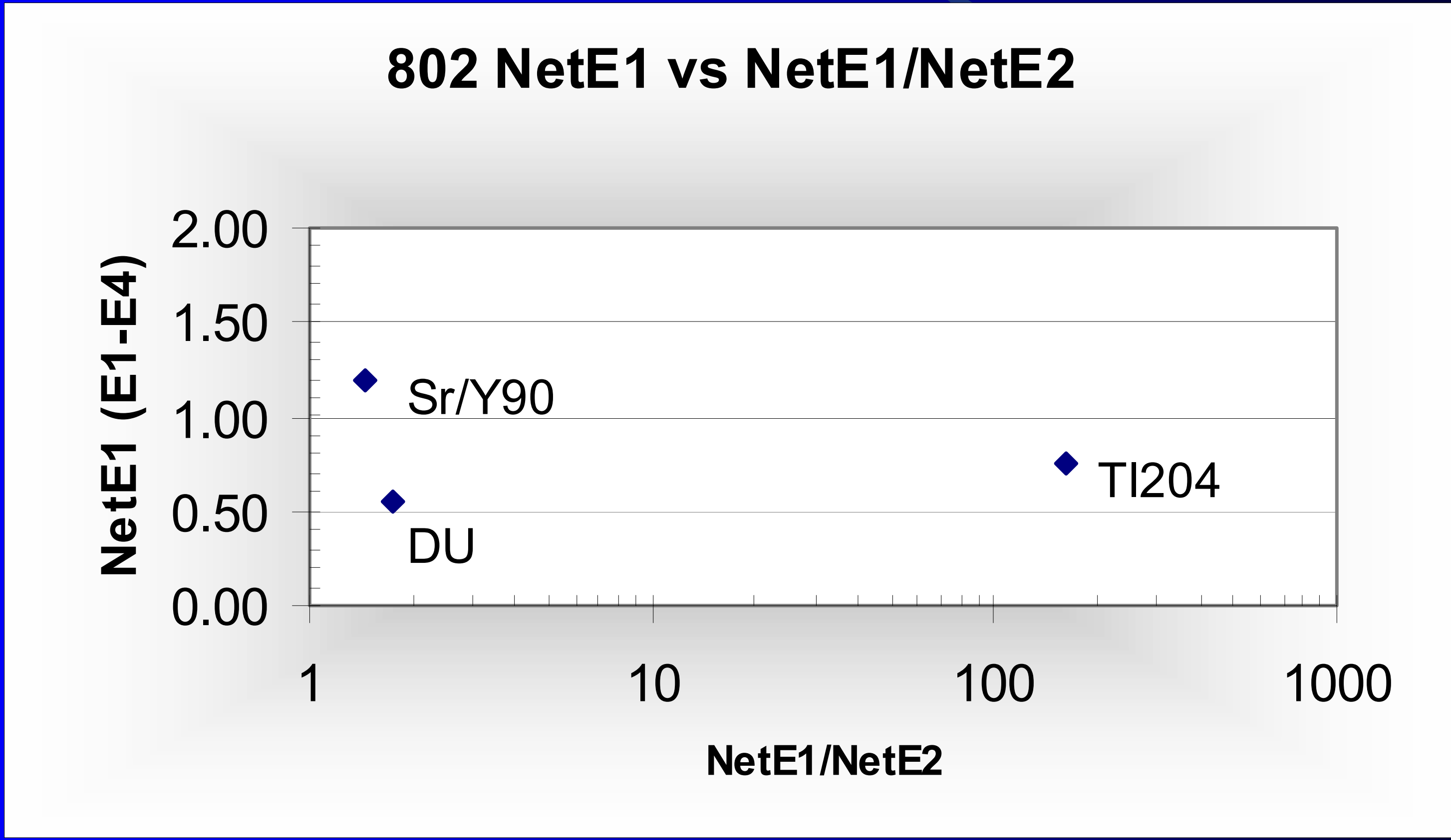
2 Appropriate design data

- Decide what range of fields the response data must cover, based on your goals.
- Pay attention to the statistics of the data.
- Normalize the data in a way that makes sense and that you can repeat with future data sets.
- Take advantage of the fields from the test standard(s) *when appropriate*.

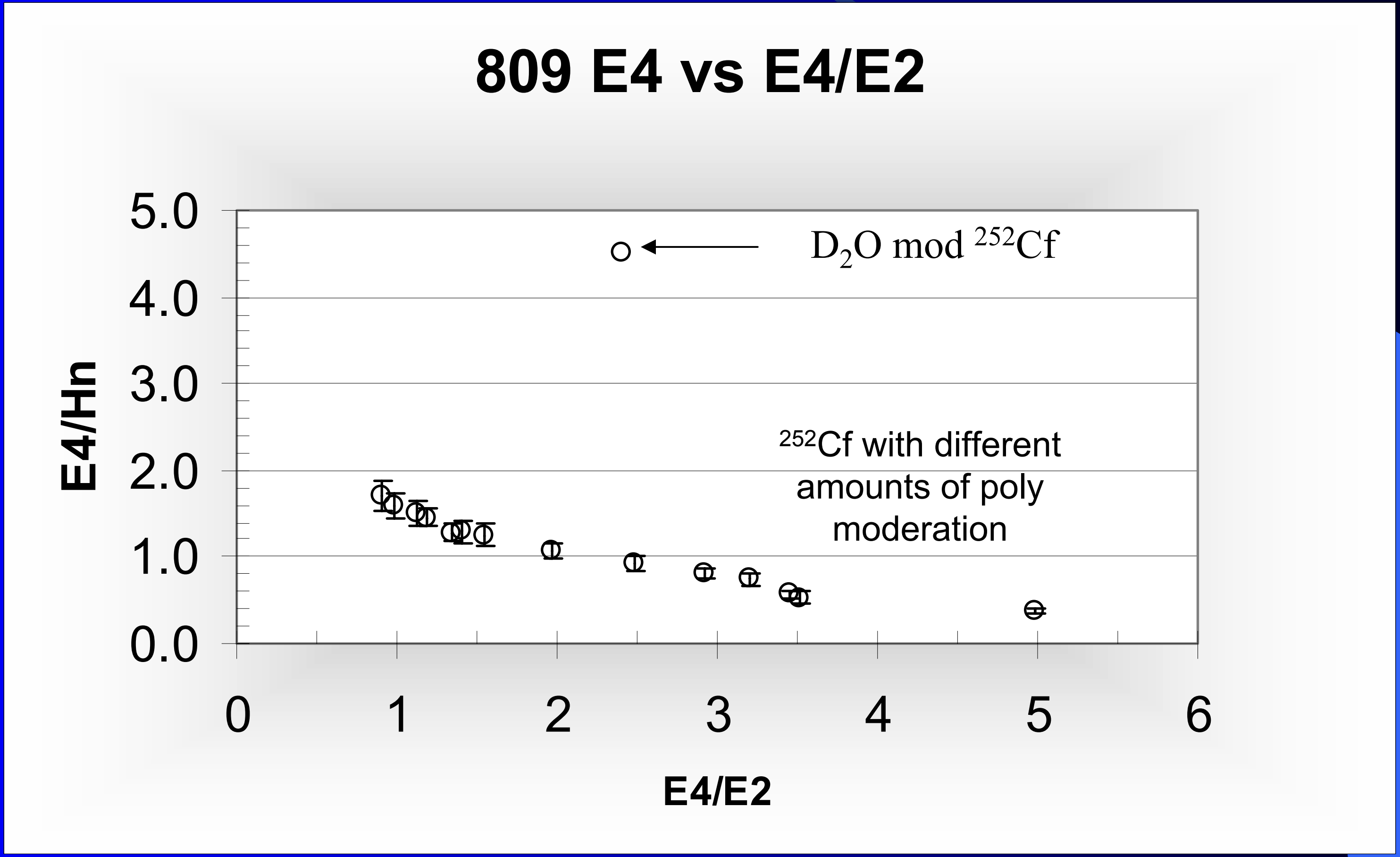
$Li_2B_4O_7$ response to DOELAP photon fields



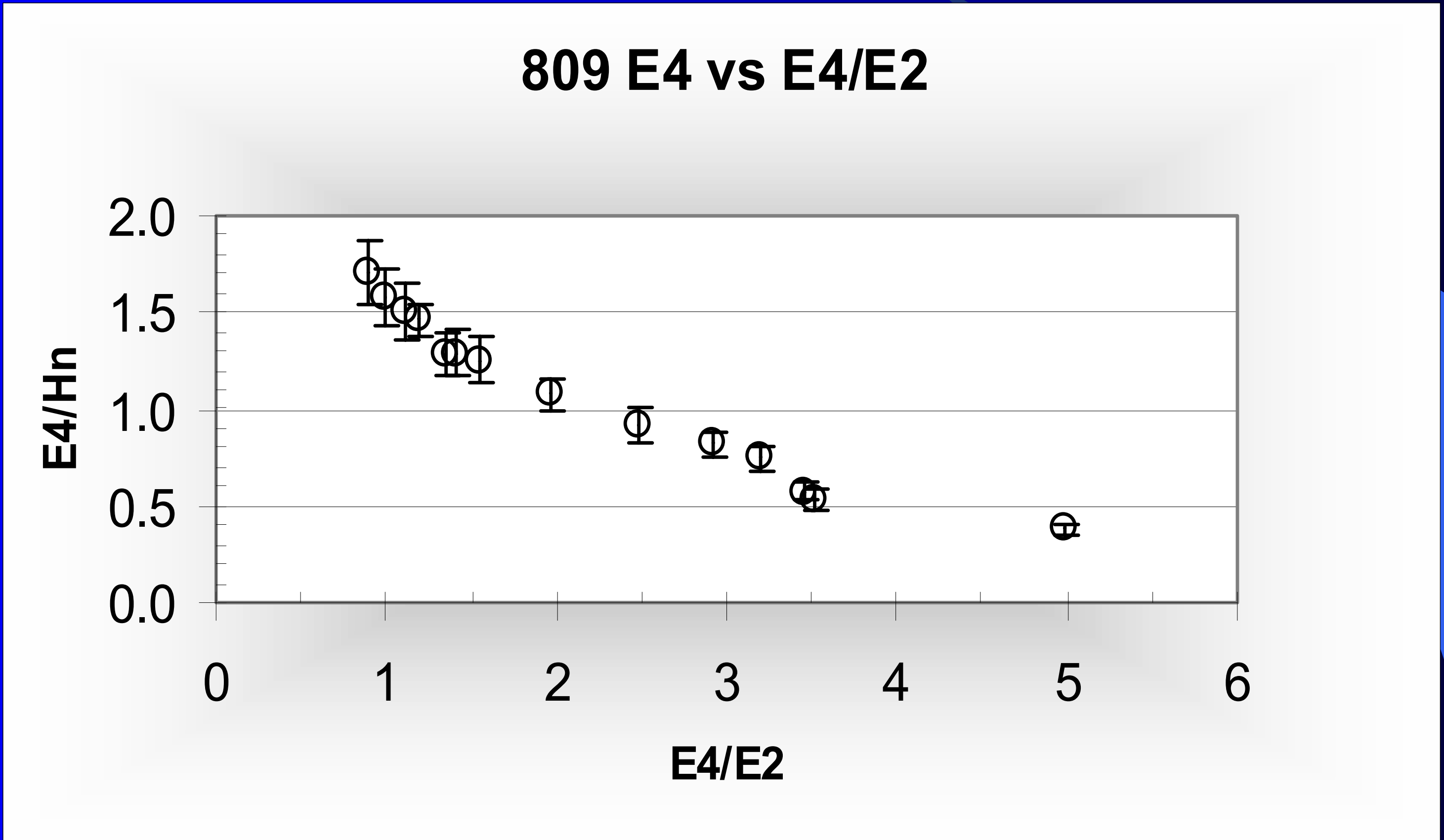
Shallow element response to three DOELAP beta fields



Response of the 809 TLD to various neutron fields



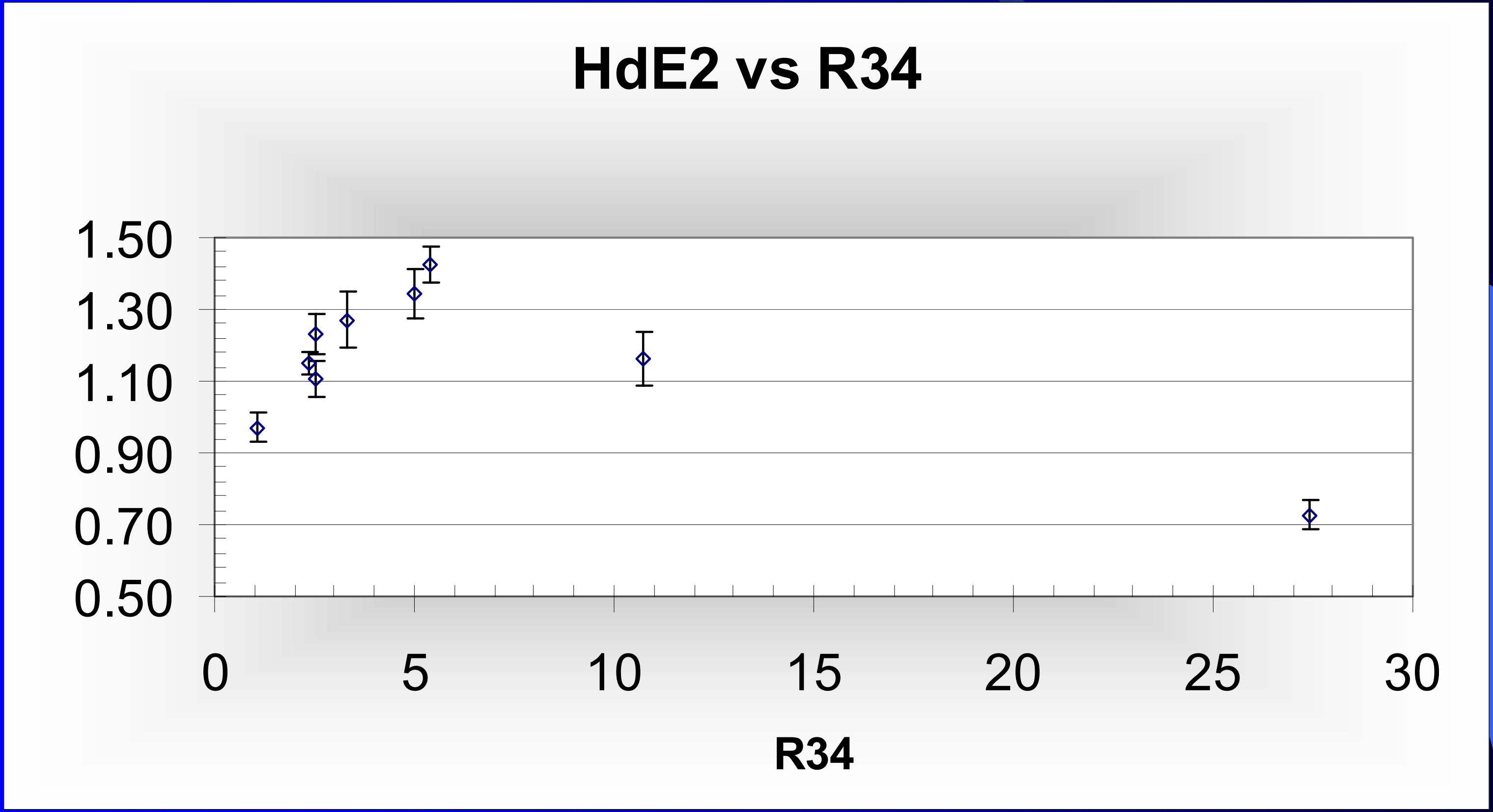
Without D_2O moderated ^{252}Cf



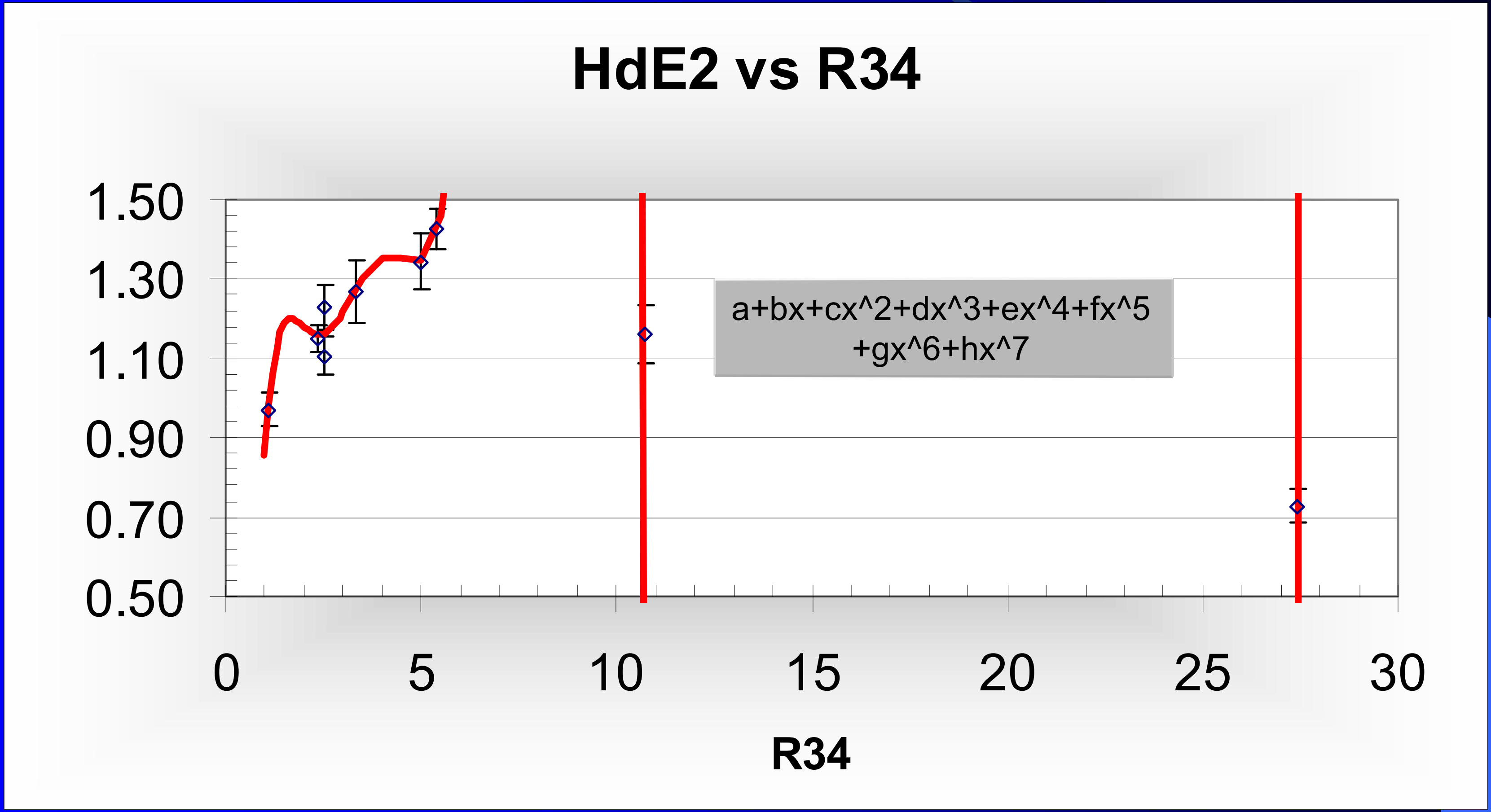
3 Practical model design

- Keep it as simple as possible - something you understand and trust
- Excess capability comes at a cost
- Minimize magnitude of corrections
- Use a flag routine
- Make sure it makes sense in the real world
  - Use well-behaved functions
  - Be careful extrapolating
  - Beware of curve fitting software

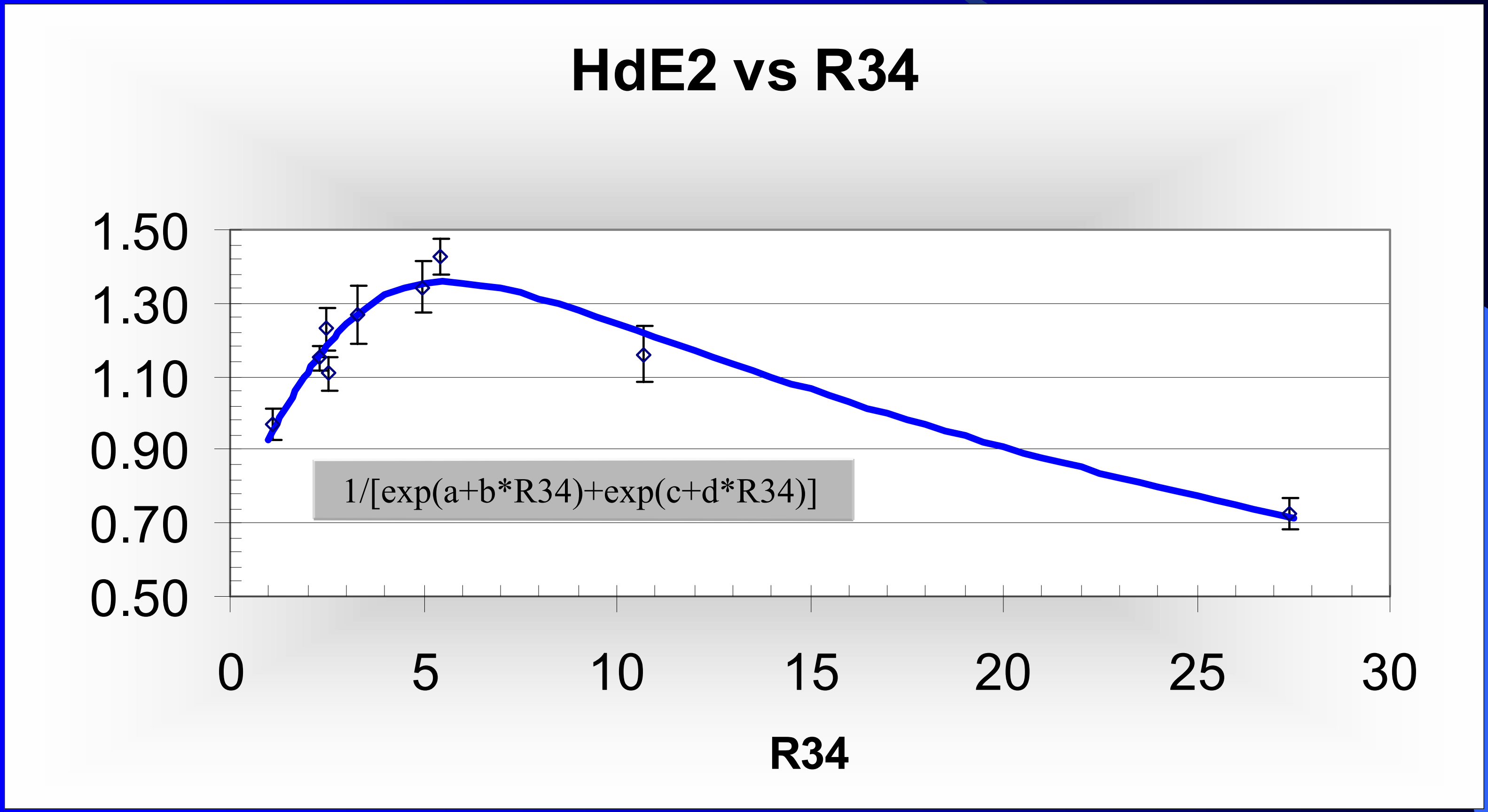
Example model data: $Li_2B_4O_7$ photon response vs CaSO ratio



Best fit! *(says the software)* - 7th order polynomial



More reasonable fit - two component exponential



Statistical comparison

These results came from Crystal Ball software. Input was standard element readings with standard deviations of 10%.

	----------M30 ----------		----------H150 ----------		----------Cs ----------	
	Exp	Poly7	Exp	Poly 7	Exp	Poly 7
Statistic						
Trials	500	500	500	500	500	500
Mean	41	5457698	99.9	99.8	98.3	97.4
Median	40.7	-134000	99.8	99.9	98.2	98.9
Mode	---	---	---	---	---	---
Standard Deviation	6.6	17705447	9.9	10.5	10.1	20.5
Variance	44.2	3.13E+14	97.9	110.1	101.5	419.2
Skewness	0.08	5.64	0.07	0.08	0	-0.75
Kurtosis	2.7	41.52	3.29	3.24	2.87	4.52
Coeff. of Variability	0.16	3.24	0.1	0.11	0.1	0.21
Range Minimum	23.2	-1074715	65.7	63.9	71.5	2.6
Range Maximum	59.5	1.64E+08	134.8	135.3	129	148.2
Range Width	36.3	1.65E+08	69.1	71.4	57.5	145.7
Mean Std. Error	0.3	791811.7	0.44	0.47	0.45	0.92

4 Comprehensive testing

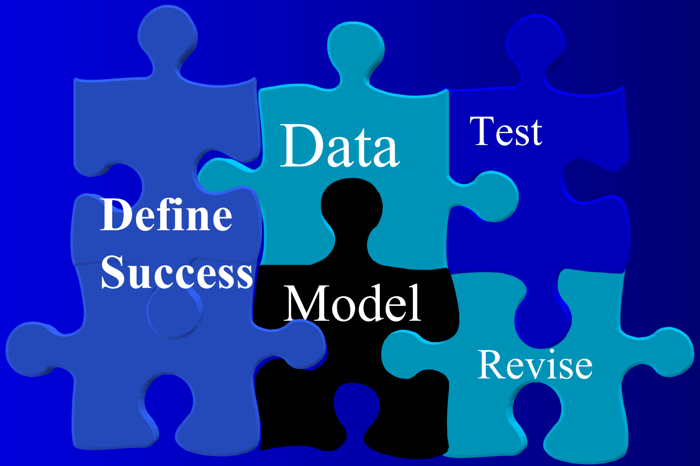
- Establish performance with design data-isolate the algorithm performance from other system variables
  - Pure field testing
  - Test with synthetic mixtures
  - Sensitivity testing; uncertainty analysis
- Check with field data, low doses
  - Make sure you agree with the results
  - Compare to the results of the past algorithm
  - Compare to any “known” field dose conditions

5 Routine evaluation and revision

- Pay attention to field results
  - Remove unnecessary capability and complexity
  - Improve areas of weakness
- Periodic response test
  - Evaluate current response data with respect to design data
  - Check the performance (last slide) using the new data set

Summary

- Decide what you want to do
- Start with good design data
- Make a practical model
- Test it extensively
- Keep testing it, revising as necessary



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