Efficiency Proficiency

Zsolt Révay

Institute of Isotopes

Budapest, Hungary

Why?

- Common
  - Log-log scale
  - One function: continuous, no break-point
- Different functions are being used
  - 2-3 regions, simple polynomial in each
  - 1 region: 5-6-order polynomial
  - 1 region: 6-8-order orthonormal polynomial
  - 1 region: constrained 6-order polynomial

Are these equally good?

Same quality data can be derived?

Polynomials

- n-th order polynomial in log-log scale:

$$\log \varepsilon = \Sigma\, a_i \log E^i$$

p^i – i-th order polynomial

op^i -- i-th order orthonormal polynomial

Difficult..., because

- If there are systematic errors in nuclear data,
- and everybody makes the
  - standardization (i.e. determination of k_0-s)
  - calibration, and
  - analysis

in the same way, using the same procedures,

- then the results are OK, and
- Mistakes will be never uncovered

Difficult..., because

- Old data based on old methods appear mixed with
- New data based on new methods

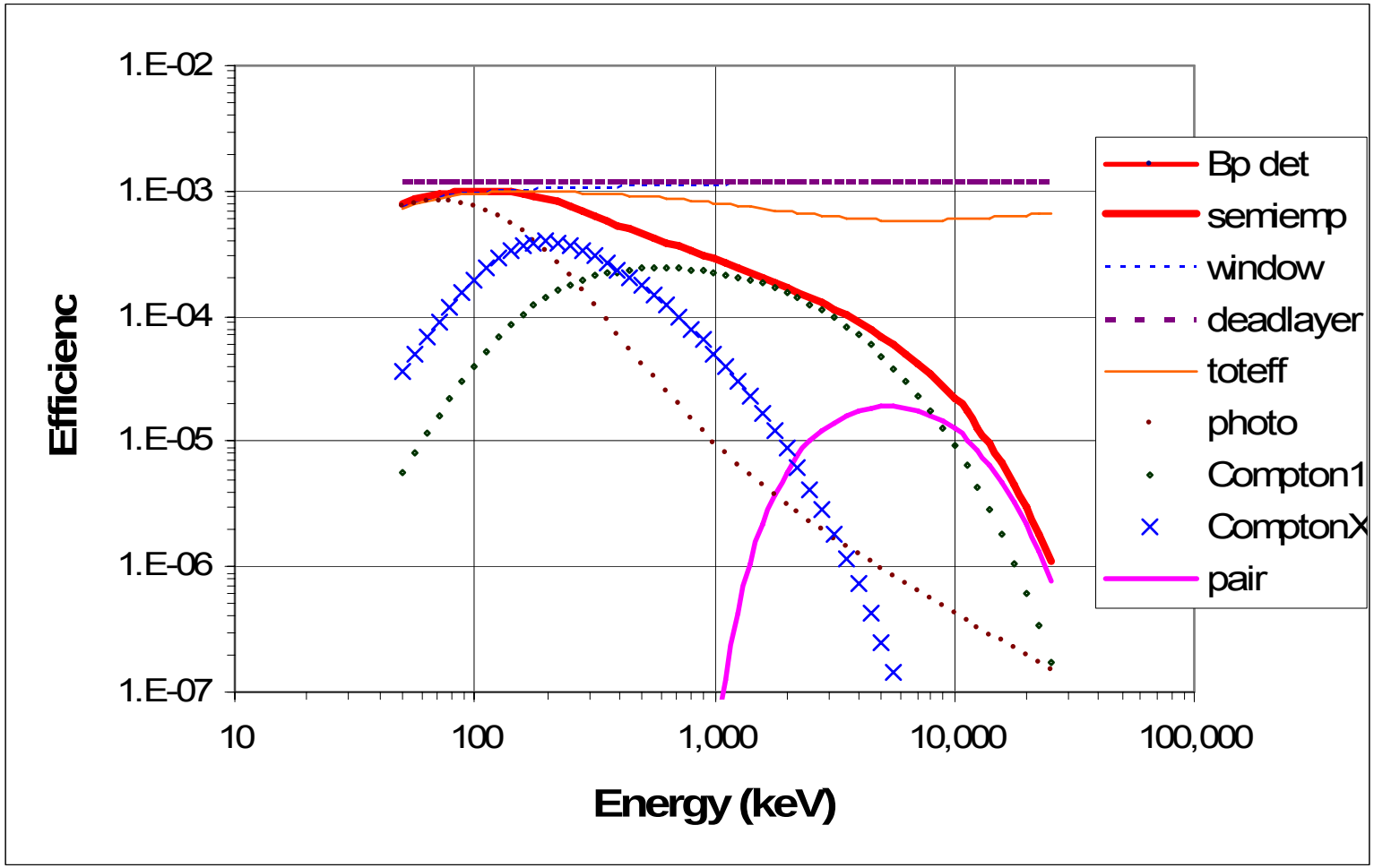
- Hard to follow the consistency

Semi-empirical approach

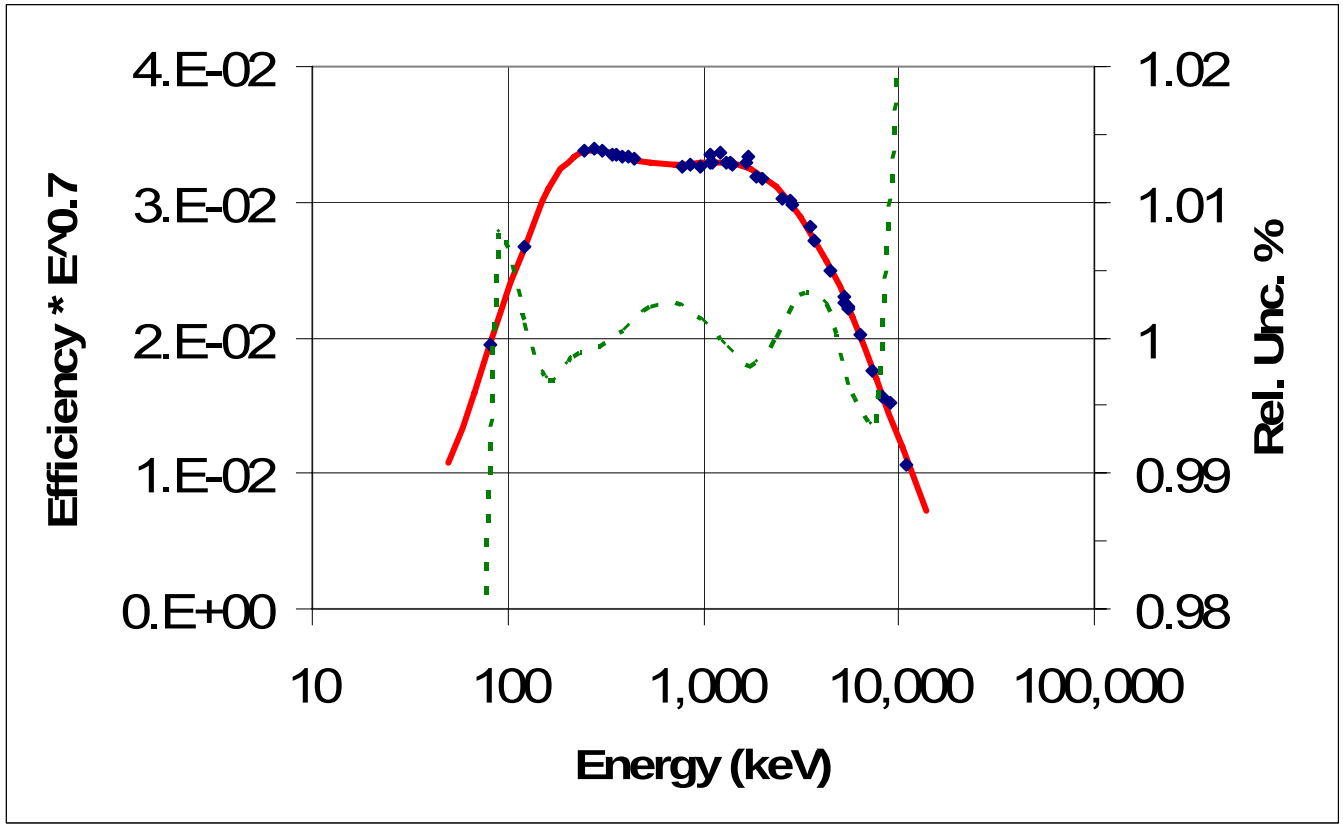
Calculate the contribution to full energy peaks

- Absorption in window, dead layer
- All physical effects considered in the active volume of the Ge crystal
  - Photoeffect
  - Single and multiple Compton scattering
  - Pair production

Semi-empirical efficiency for the 25% Budapest CS-HPGe detector



Fitted function to measured values

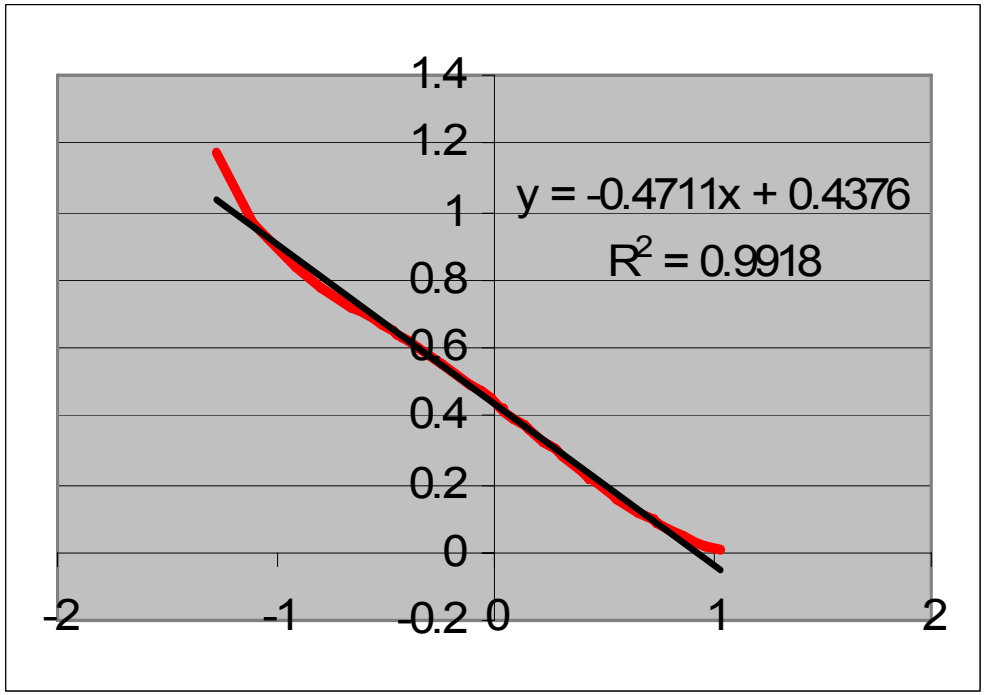


The middle region is not a straight line!

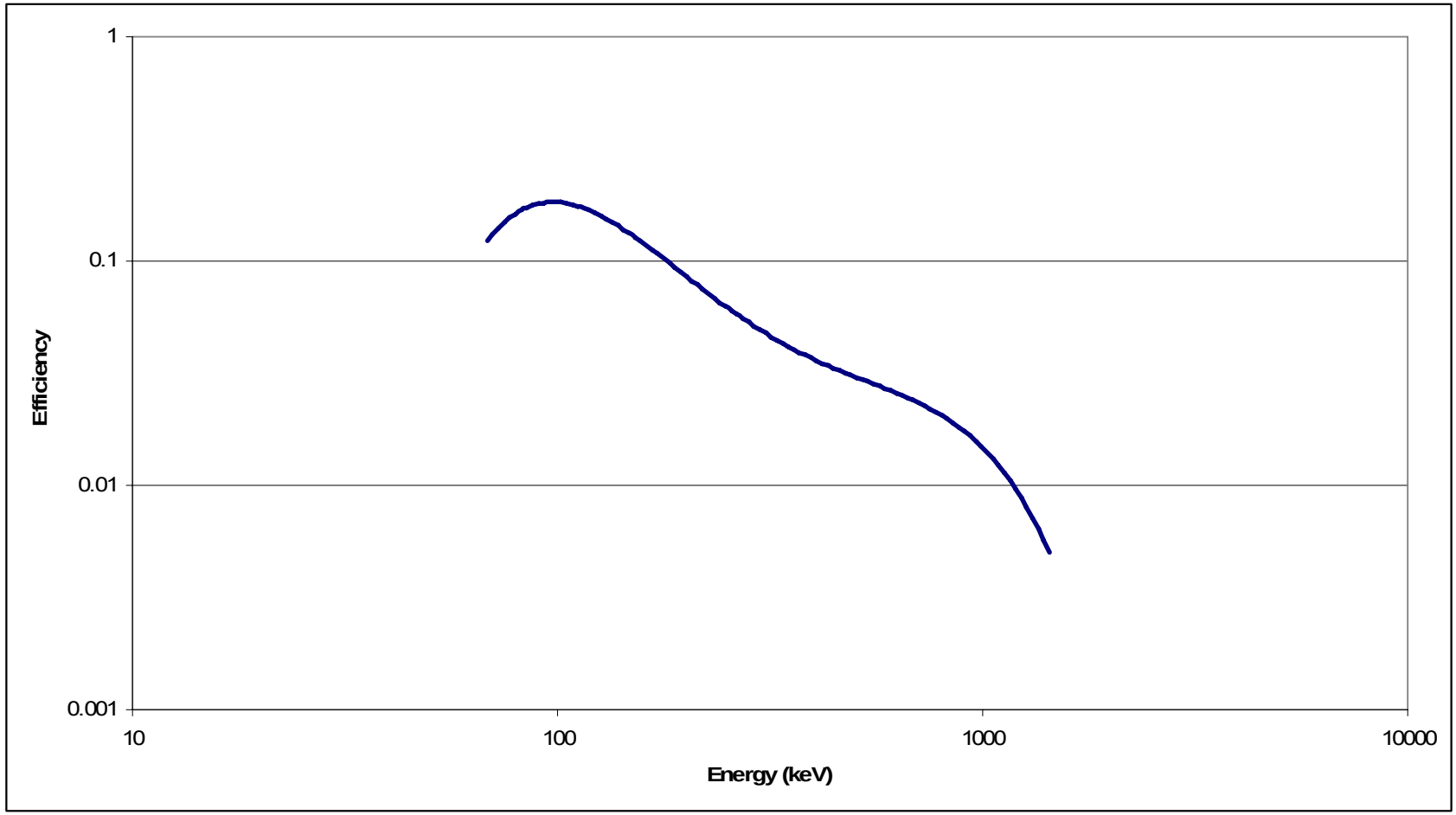
The fit of the middle region

It can be fitted acceptably with a straight line

- -1 → 100 keV
- 0 → 1000 keV
- 1 → 10000 keV



15-% HPGe contact counting



Efficiency proficiency test

- Two trials
  - 1st failed, because of using wrong lit data
  - 2nd test: lt. Data approved by R.B. Firestone
- Three sets: ^{133}Ba, ^{152}Eu, ^{226}Ra
- Data circulated:
  - Activity ± uncertainty
  - Energies
  - Emission probabilities ± uncertainty
  - Peak area ± uncertainty

Functions used

Number of points: 56 (except D)

A:
method: Hypermet
function: 8-order orthonormal polynomial

B:
method: Excel
Function: 50-250 3-order poly, 250- 1-order poly (straight line)

C:
method: Excel
function: 6-order poly

D:
method: k0-IAEA
function: ?
number of points: 21

E:
method: kayzero
function: 50-250: 3-order (?), 250- 1-order (?)

F:
method: Excel
function: 5-order poly

Results

- Most data arrived without uncertainties!!!
- Incompatibility problems

Results

	calc/meas	average Z-sc	st. dev	chi^2
A	1.0002	-0.0018	0.89	0.77
B	1.0042	0.41	1.36	2.0
C	1.0204	2.94	3.81	23
D	1.07	11	4.5	150
D^{mod}	1.02	4.61		
D^{m2}	0.995	-0.86		54
E	0.996	-0.55	1.21	1.7
F	1.0002	0.061	1.13	1.3

Conclusion

- There were methods with systematic errors
- For most methods $X^2<2$, i.e. acceptable

Recommendations

- Use uncertainties!!!
- Any function can be used
- Though the statistical tests were not very sensitive to this:

Avoid straight line for the middle region (2nd, or 3rd-order polynomial??)