SSDs – Good Idea, Bad Practice

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SSDs – Good idea, Bad Practice

Forbes & Callow (2002)

Q1 Do SSDs clarify or obscure the setting of ecological effects thresholds for risk assessment?

Q2 Do SSDs reduce or introduce uncertainty into risk assessment?

- *"If the SSD approach is to lead to better risk assessments, improvements are needed in how the theory is put into practice"*
- *"Since the species used for input into the sensitivity distributions generally are not derived from any known community, the ecological interpretation of the resulting risk probability is not obvious"*
- *"There is little reason to expect haphazard collections of literature data to accurately reflect the percentage of species at risk in actual communities in nature"*

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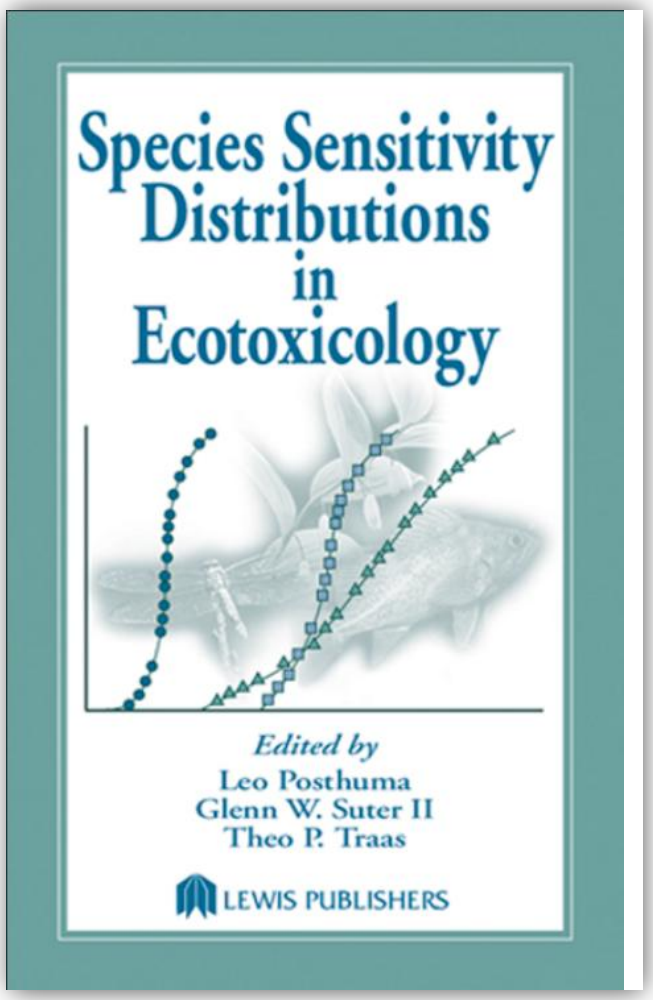

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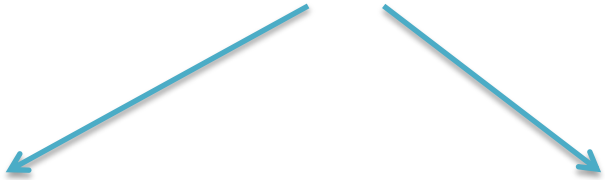
SSD SWoT Analysis



Strengths

- Puts (toxicity) calculations on more rational, transparent basis
- (Partially) overcomes arbitrariness of AF approach
- Has as objective protection of defined fraction of all species
- Provides a logical link between C-R modelling and inference based on model outputs

Weaknesses

- The list is long!

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Weaknesses / Issues

- Species selection
- End-point selection
- Which toxicity measure?
- Mixtures of toxicity measures
- Relevance to ecological / community function
    - Assumes that sensitivity of a community depends on sensitivity of individual species of which it is comprised
- Assumes no interaction between species
- No assessment of measurement error or uncertainties in input data
- No (explicit) relationship to ecosystem processes
- No accepted method of updating results (triggers, threshold concentrations etc.)
- Little or no validation
- Choice of *x* in HCx

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Weaknesses / Issues

- No *ecological* basis for the parametric form of the SSD, yet …
- Results of SSD modelling critically dependent on this choice
- Should all parts of the SSD (i.e. the fitted *cdf*) be treated as equally important?

SSD modelling represents an attempt to move away from the arbitrariness of AFs yet the identification of an SSD requires arbitrary decisions about:

- Choice of probability model
- Choice of species
- Choice of functional form for C-R model
- Choice of estimation strategy
- Choice of *x*
- Magnitude of ACRs

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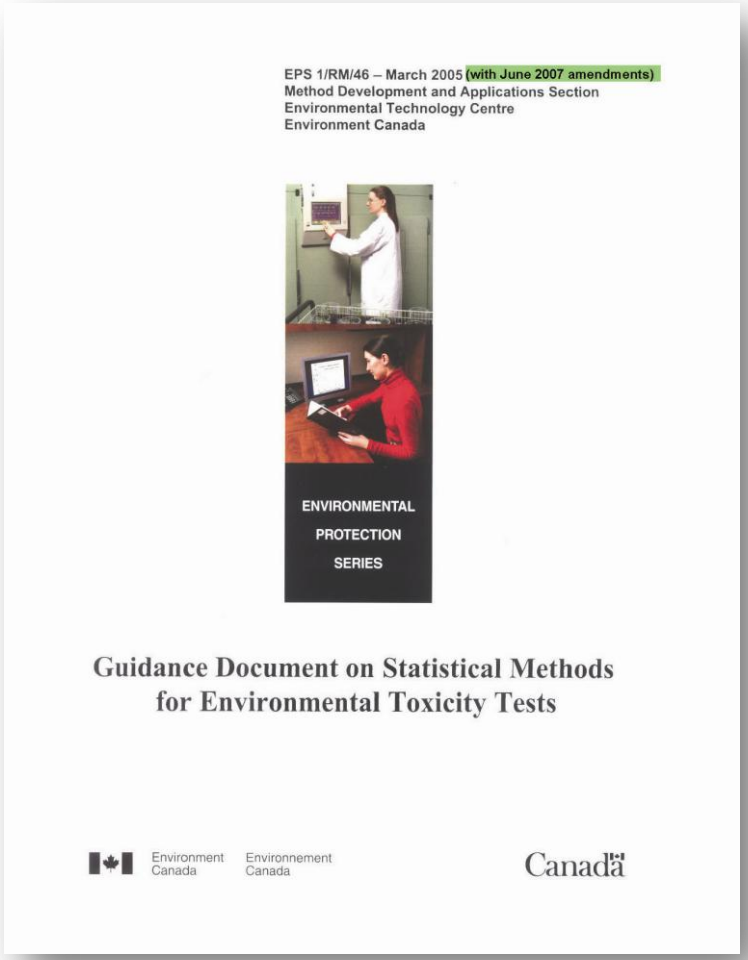
Issue: The design of C-R experiments



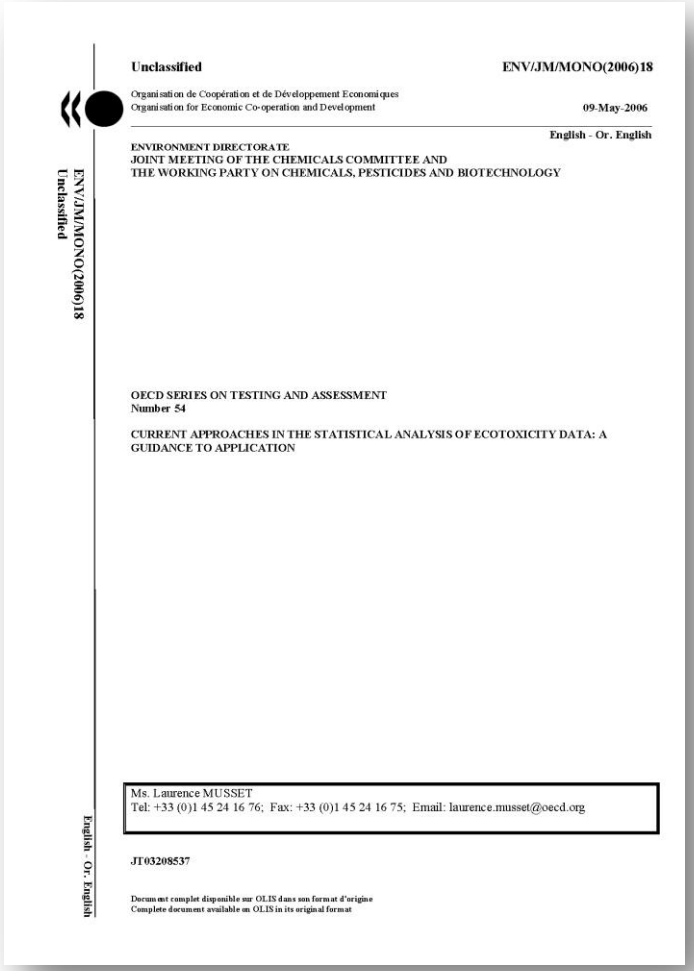
EPS 1/RM/46 – March 2005 (with June 2007 amendments)
Method Development and Applications Section
Environmental Technology Centre
Environment Canada

ENVIRONMENTAL PROTECTION SERIES

Guidance Document on Statistical Methods for Environmental Toxicity Tests

Environment Canada Environnement Canada

Canada



Unclassified ENV/JM/MONO(2006)18

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

09-May-2006

English - Or. English

ENVIRONMENT DIRECTORATE
JOINT MEETING OF THE CHEMICALS COMMITTEE AND
THE WORKING PARTY ON CHEMICALS, PESTICIDES AND BIOTECHNOLOGY

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OECD SERIES ON TESTING AND ASSESSMENT
Number 54

CURRENT APPROACHES IN THE STATISTICAL ANALYSIS OF ECOTOXICITY DATA: A GUIDANCE TO APPLICATION

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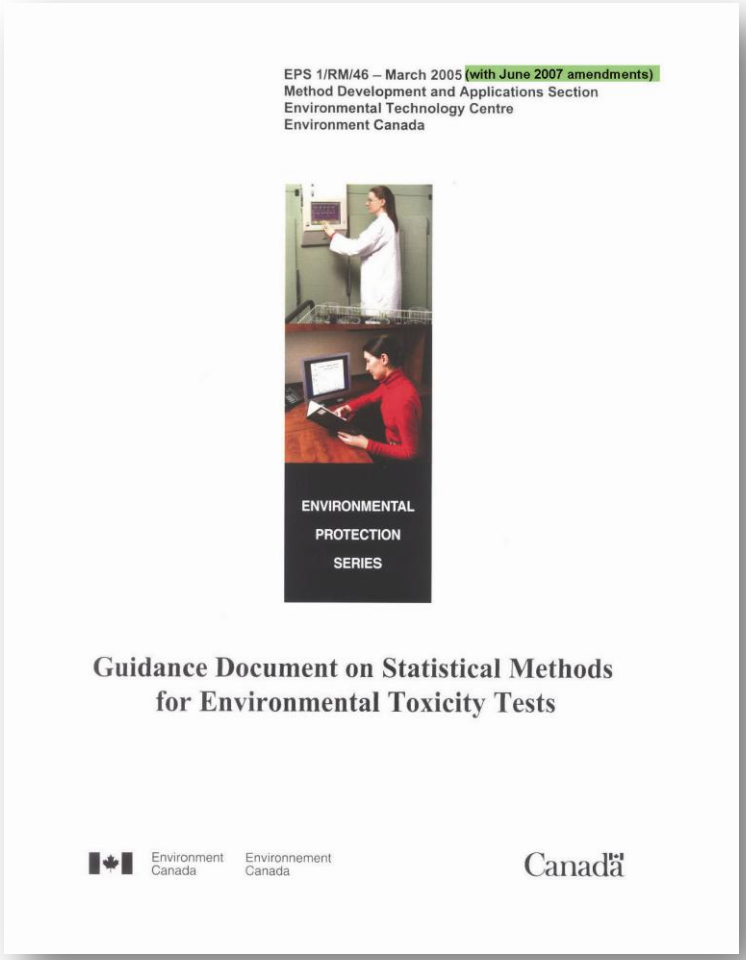
JT03208537

Document complet disponible sur OLIS dans son format d'origine
Complete document available on OLIS in its original format

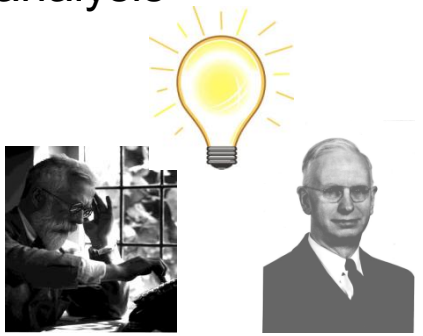
English - Or. English

Statistical Ecotoxicology – Burrs under the saddle

Issue: Getting good advice



"Canadian investigators …are often reluctant and sometimes actively hostile to the idea of continuing with logarithms for statistical analysis"



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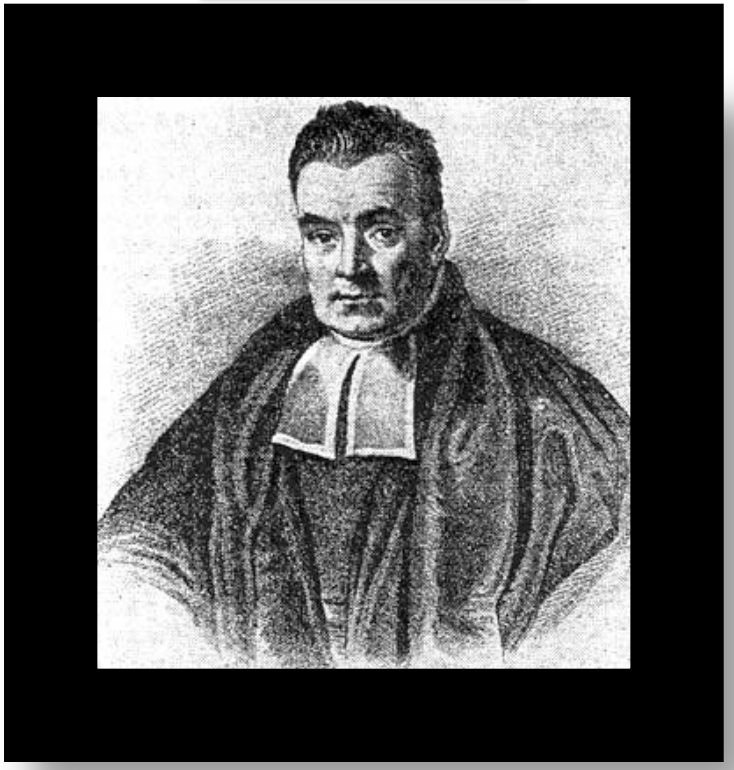
Issue: Statistical framework and metrics

Frequentist

Bayesian



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Issue: Modelling approaches

$$\text{data} = \text{model} + \text{error}$$

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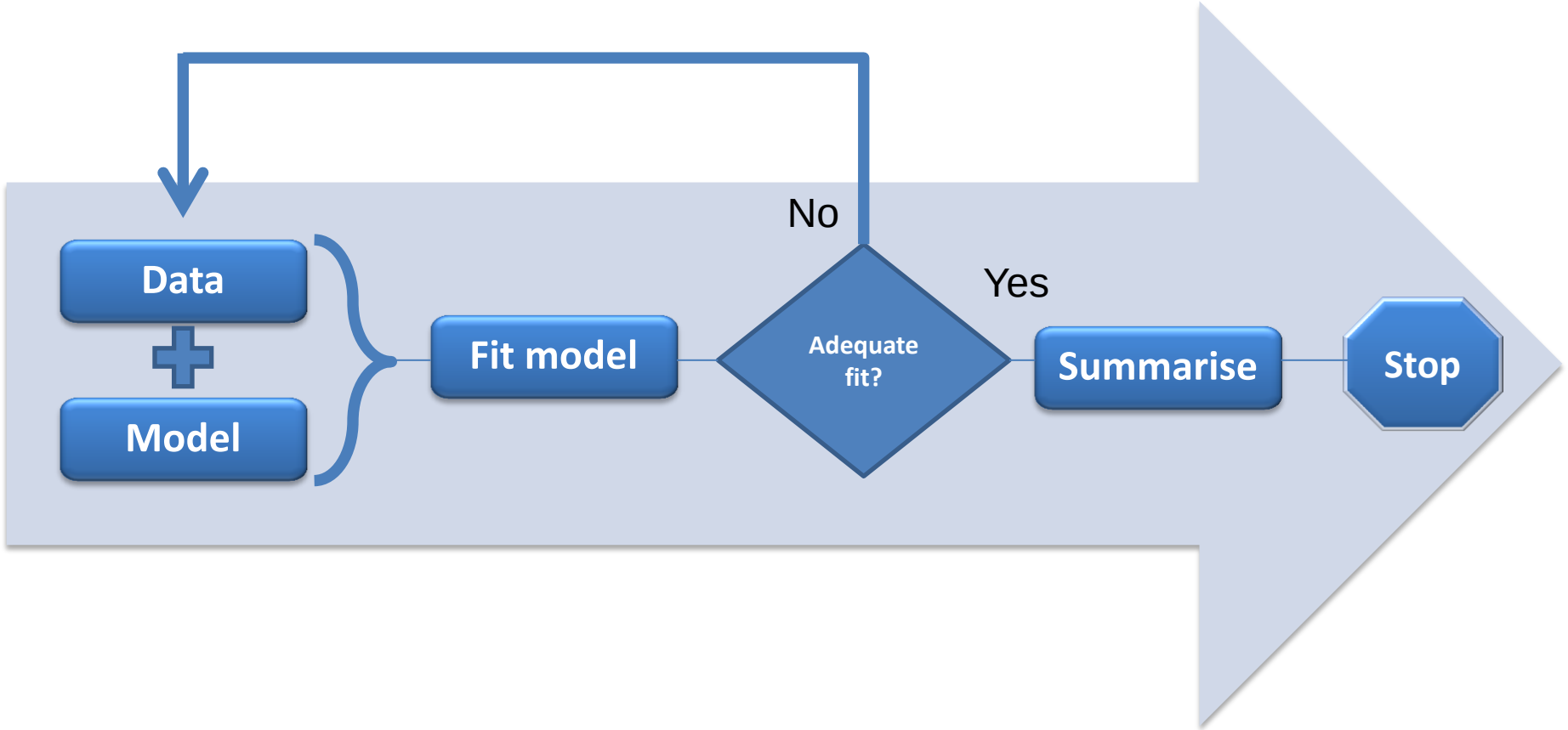
Issue: Modelling approaches



Adapted from Nelder, 1999

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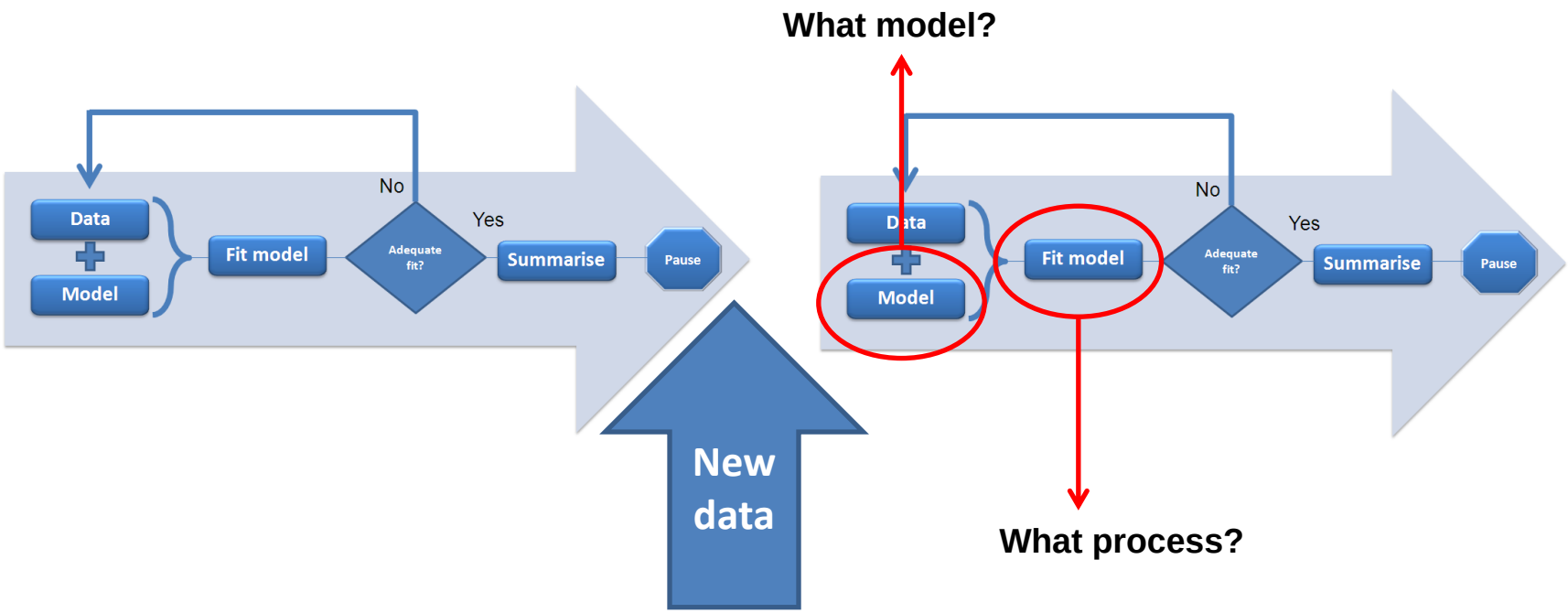
Issue: Modelling approaches



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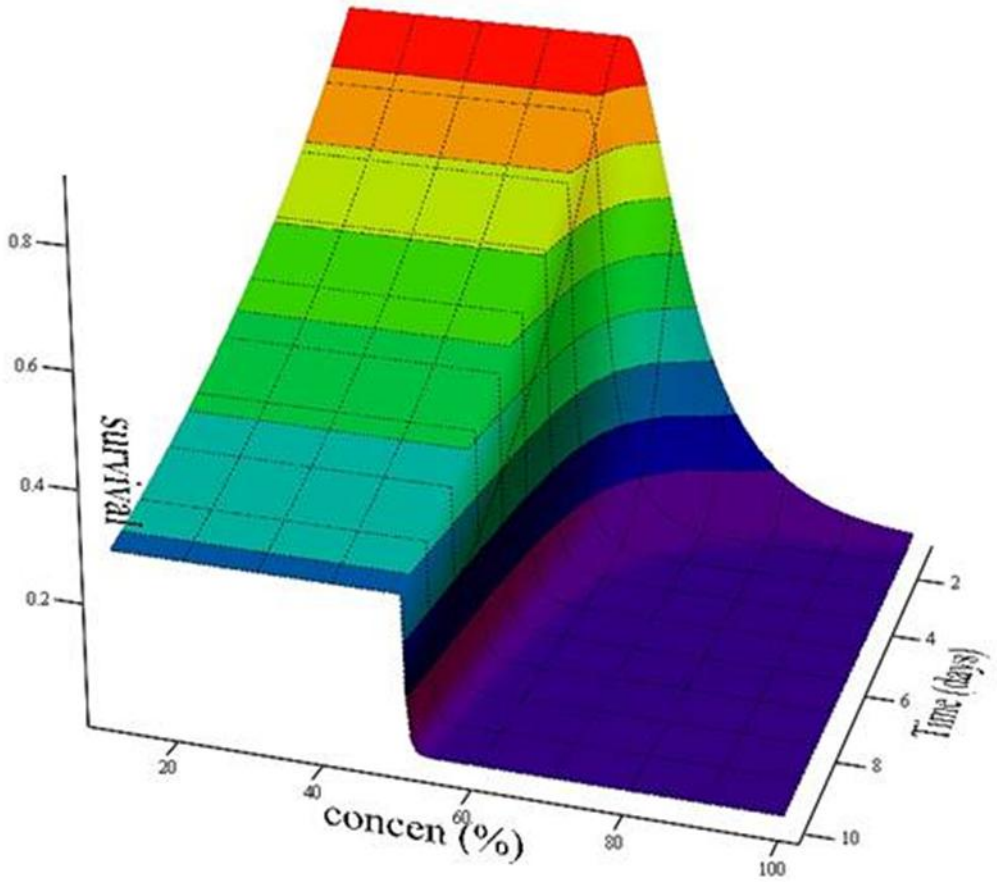
Issue: Challenging the assumptions



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Issue: Statistical driver or mute passenger?

"Automatically chooses the appropriate methods and data transforms"

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Issue: Wasteful models and wrong methods

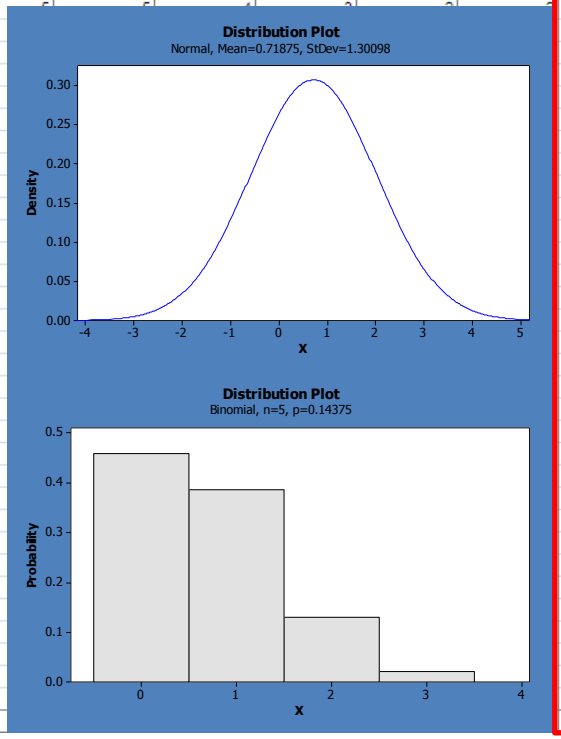
n(x)=5

Ignored!

r(x)

x

Pos	ID	Rep	Group	0 hrs	24 hrs	48 hrs	72 hrs	96 hrs	5 days	6 days	7 days
	1	1	FSW Control	5							2
	2	2	FSW Control	5							3
	3	3	FSW Control	5							3
	4	4	FSW Control	5							3
	5	1	Diluent Control	5							3
	6	2	Diluent Control	5							3
	7	3	Diluent Control	5							2
	8	4	Diluent Control	5							4
	9	1	3.1	5							0
	10	2	3.1	5							0
	11	3	3.1	5							0
	12	4	3.1	5							0
	13	1	6.3	5							0
	14	2	6.3	5							0
	15	3	6.3	5							0
	16	4	6.3	5							0
	17	1	12.5	5							0
	18	2	12.5	5							0
	19	3	12.5	5							0
	20	4	12.5	5							0
	21	1	25	5							0
	22	2	25	5							0
	23	3	25	5							0
	24	4	25	5							0
	25	1	50	5							0
	26	2	50	5							0
	27	3	50	5							0
	28	4	50	5							0
	29	1	100	5							0
	30	2	100	5							0
	31	3	100	5							0
	32	4	100	5							0



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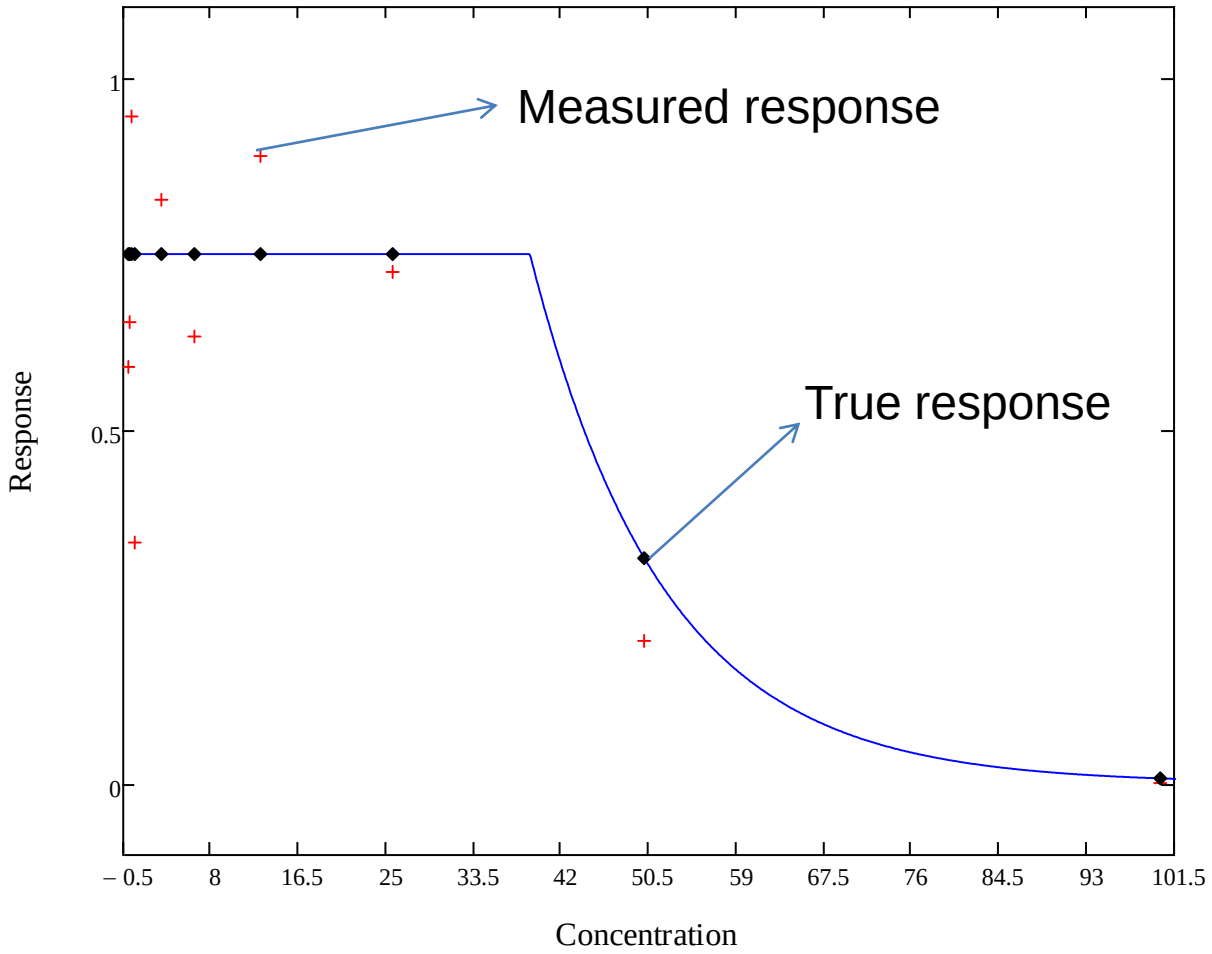
Issue: Small datasets



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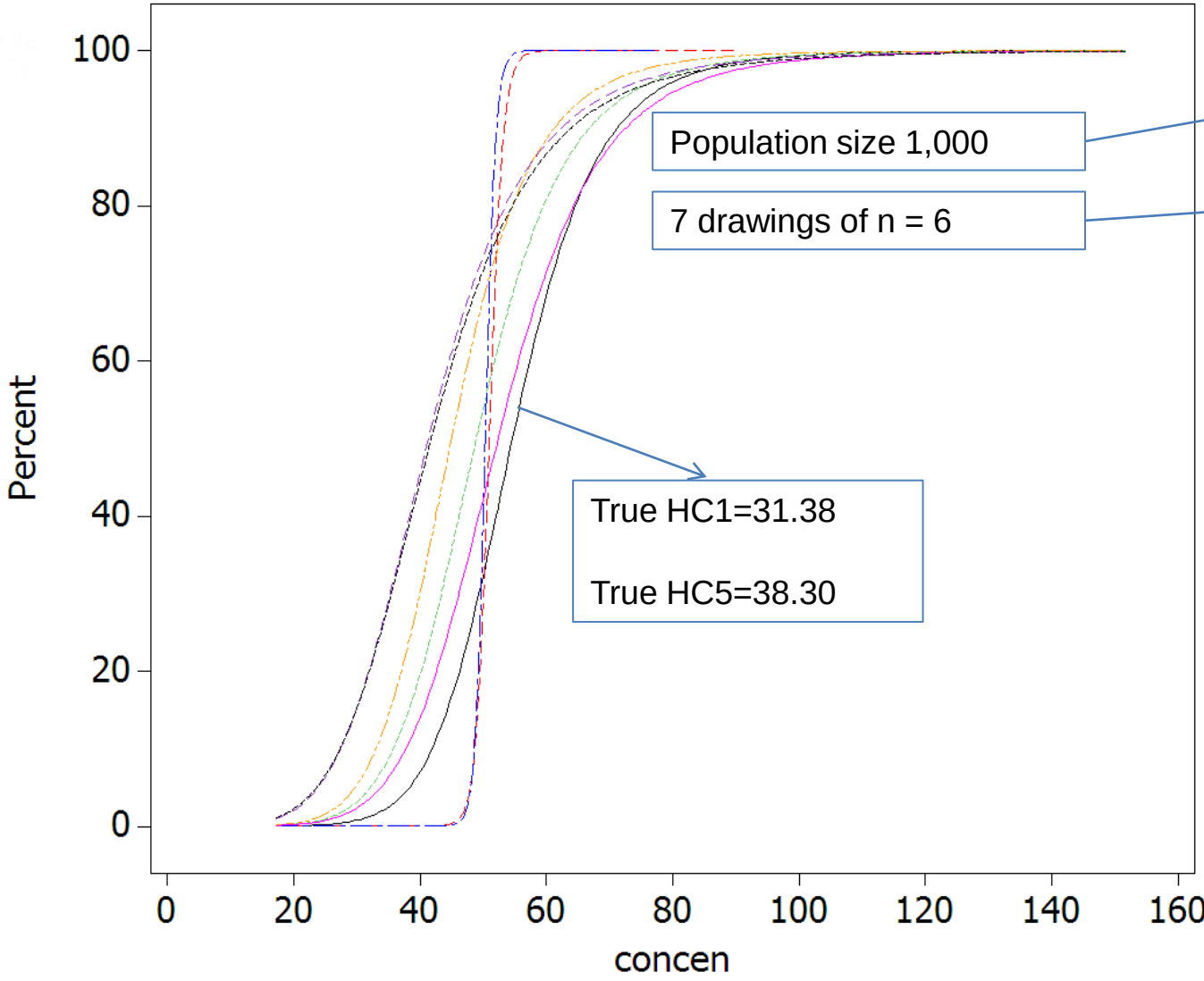

Loc	Scale	N
4.001	0.1207	1000
3.931	0.02075	6
3.890	0.1422	6
3.918	0.01587	6
3.806	0.1404	6
3.958	0.1486	6
3.721	0.1866	6
3.732	0.1935	6

Actual level of protection for HC1 {78% - 99.9999%} – mean = 94%

Actual level of protection for HC5 {75% - 99.9%} – mean = 92%

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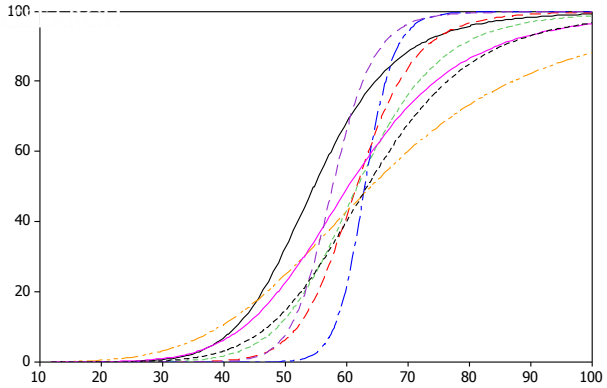
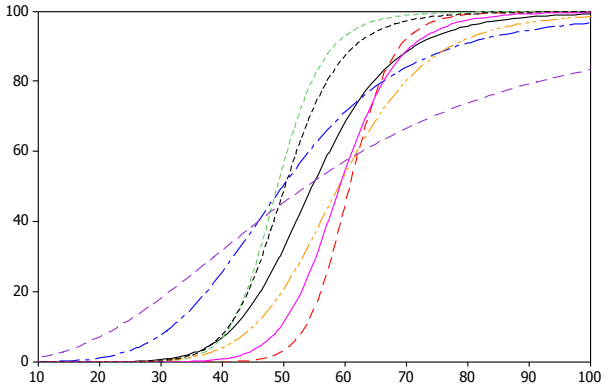
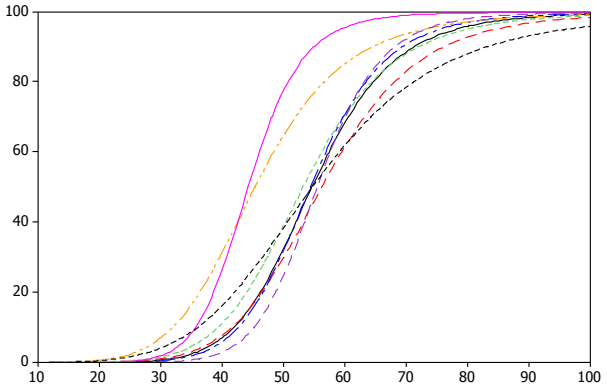


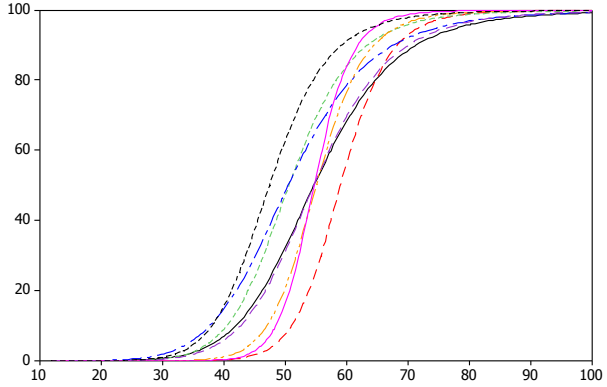
$\sigma = 0.5$



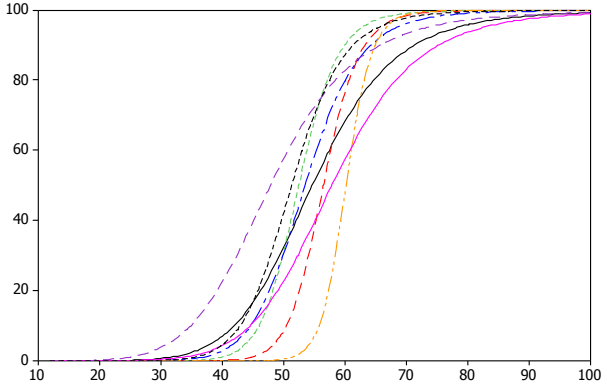
$\sigma = 0.2$



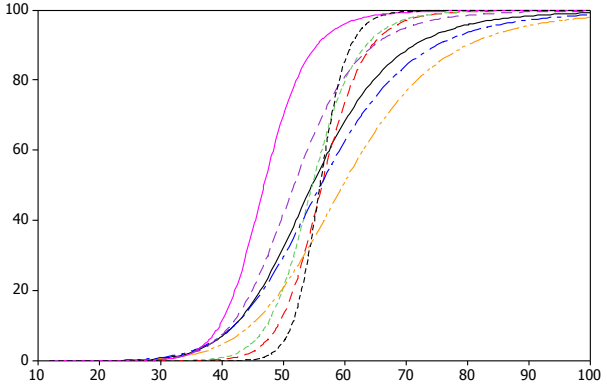
$\sigma = 0.1$



$\sigma = 0.05$



$\sigma = 0.01$



$\sigma = 0$

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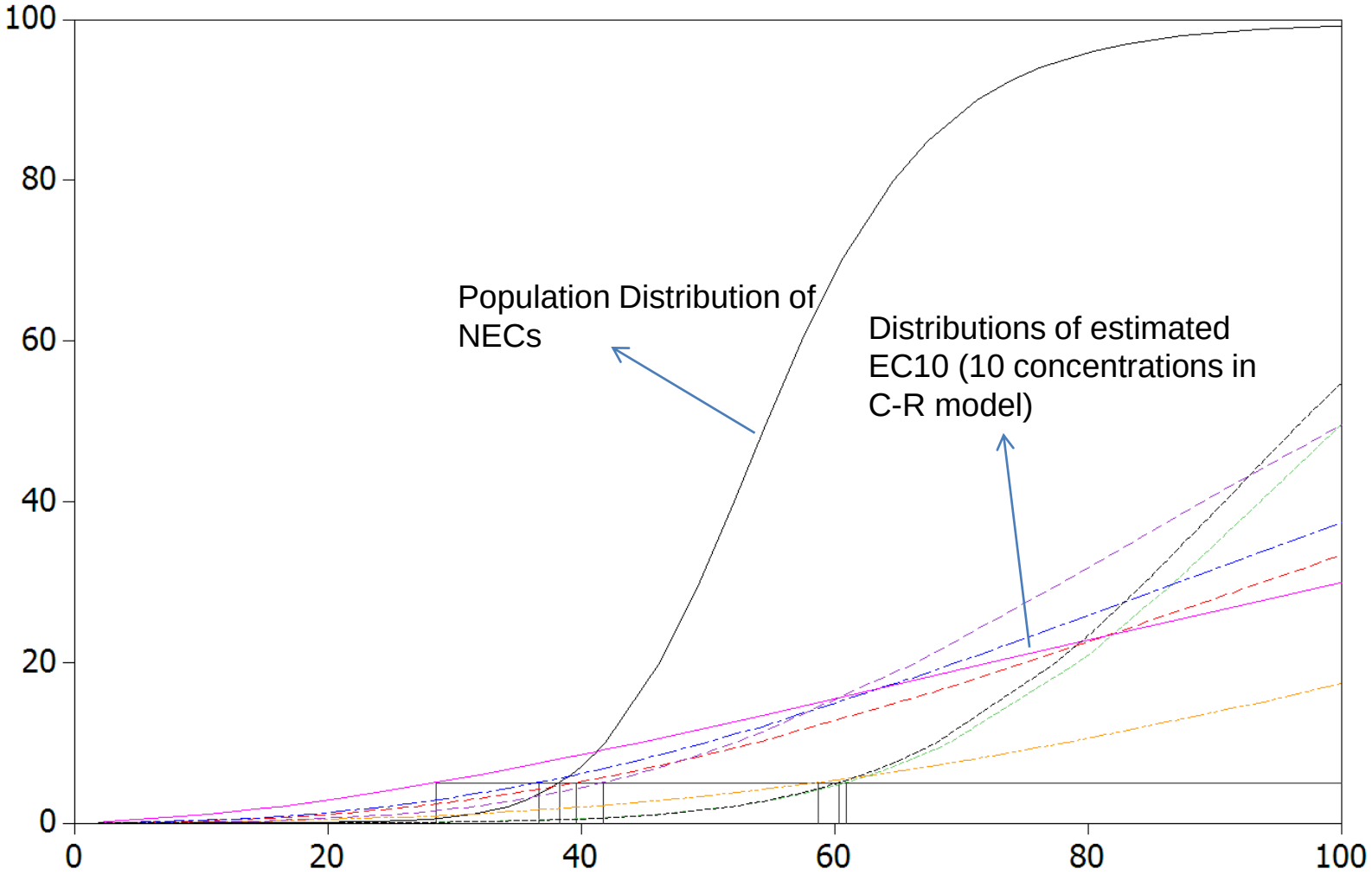
Issue: Mixtures of measures



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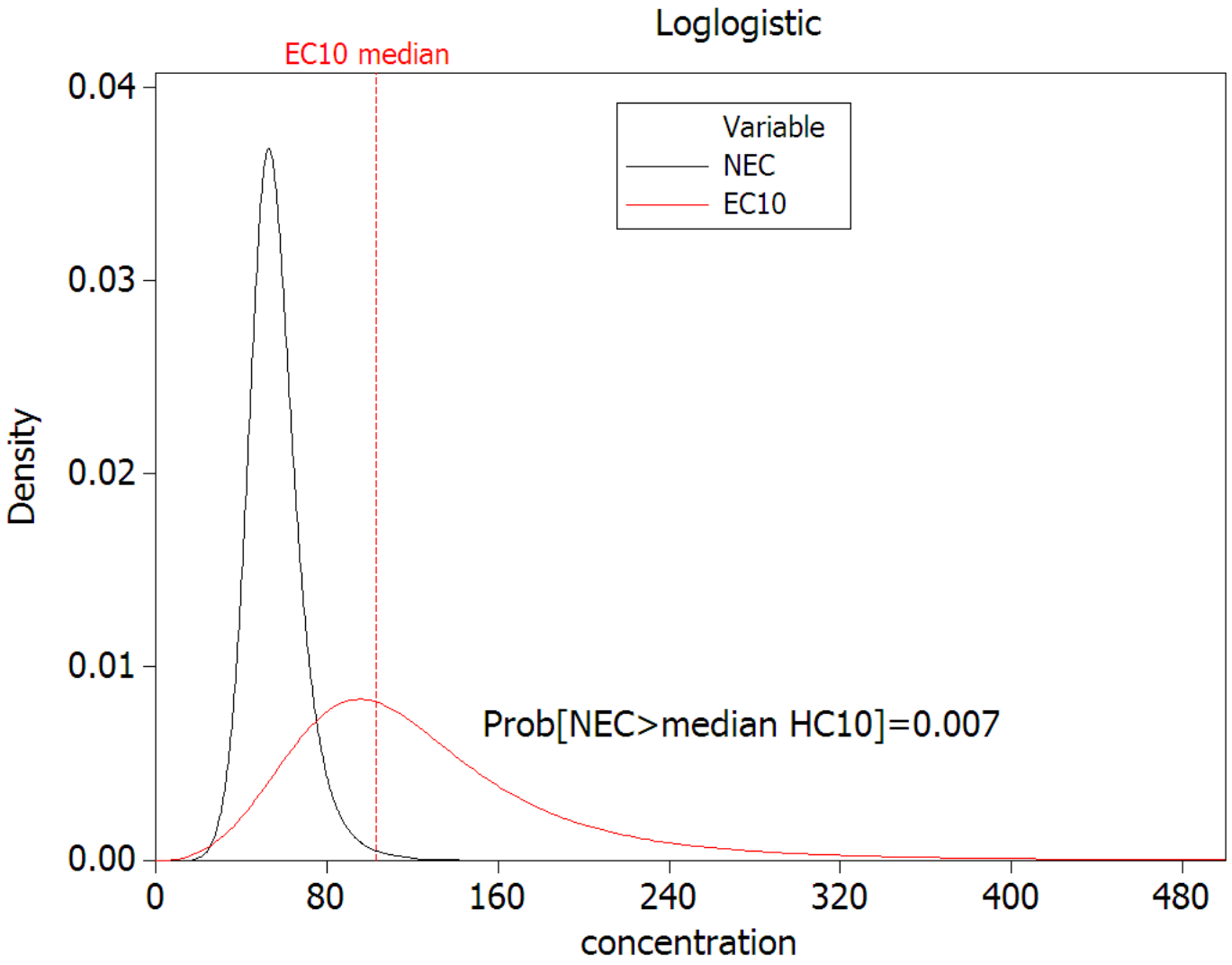

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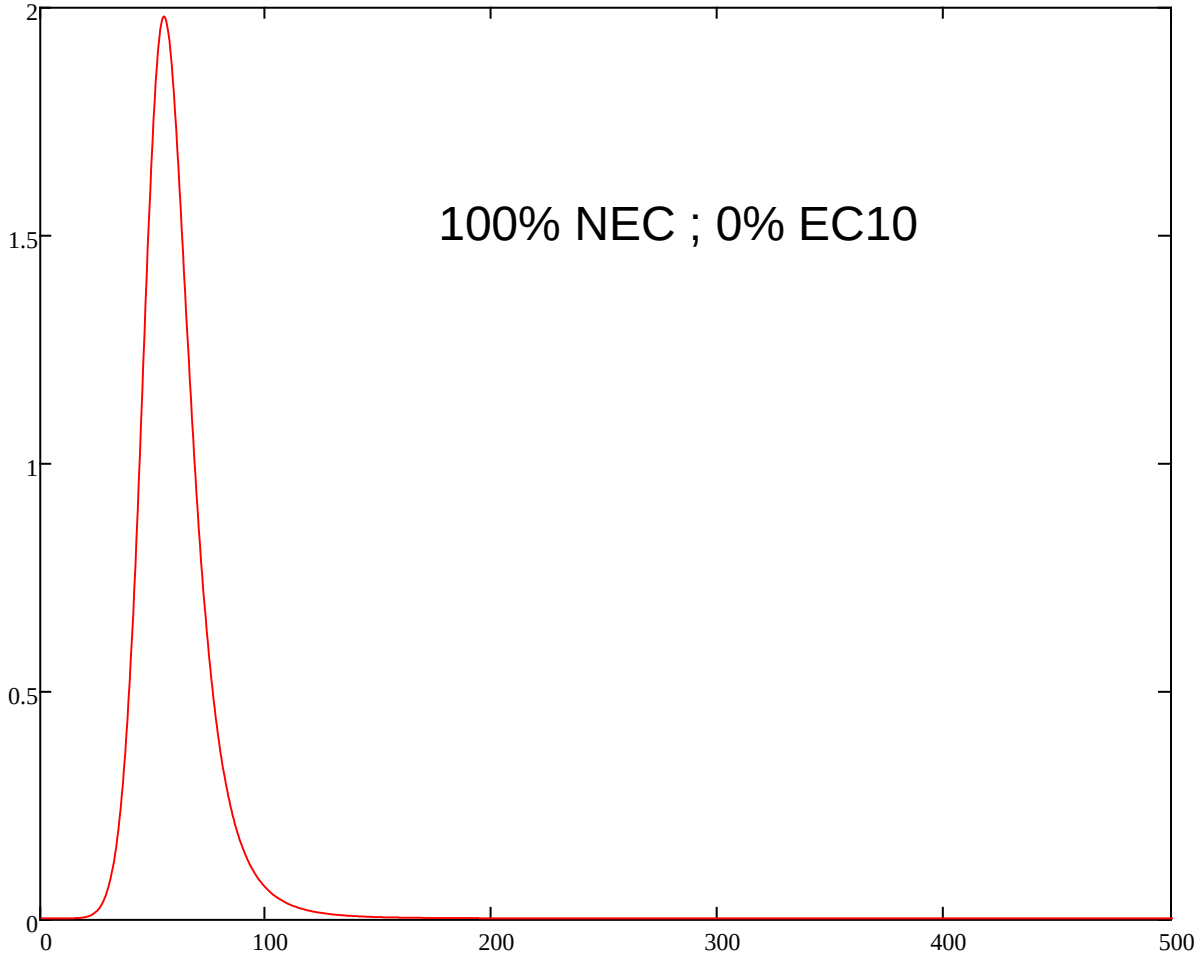

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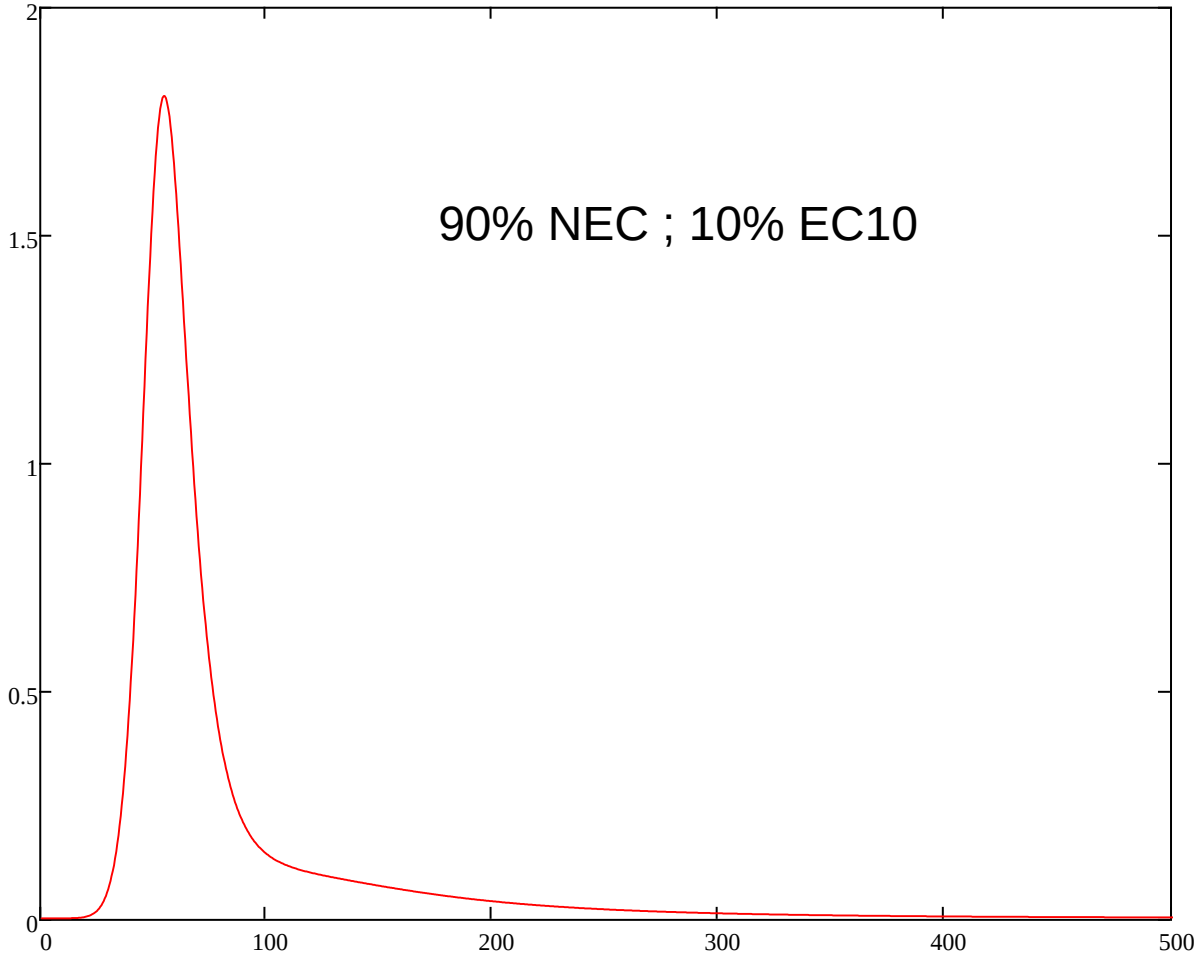

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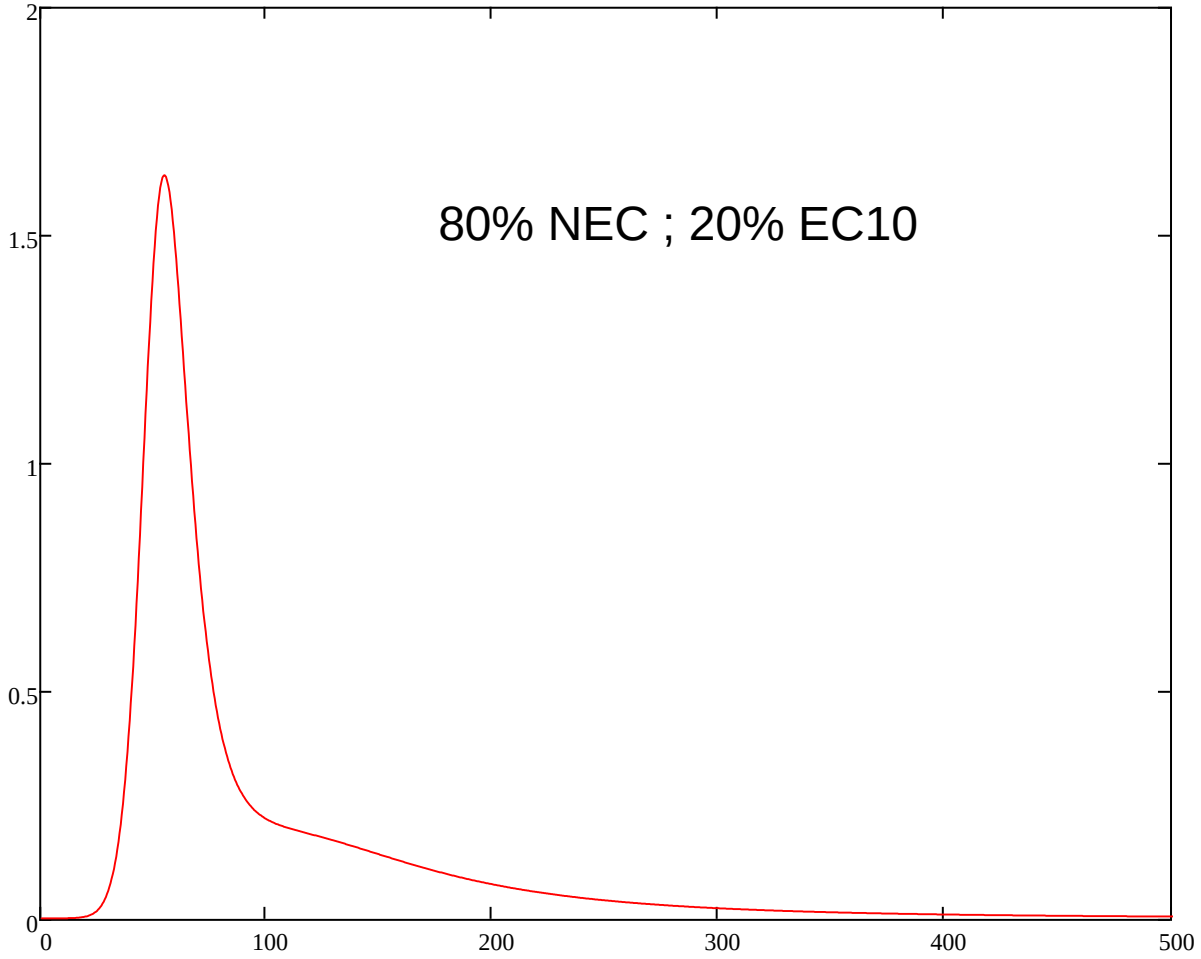

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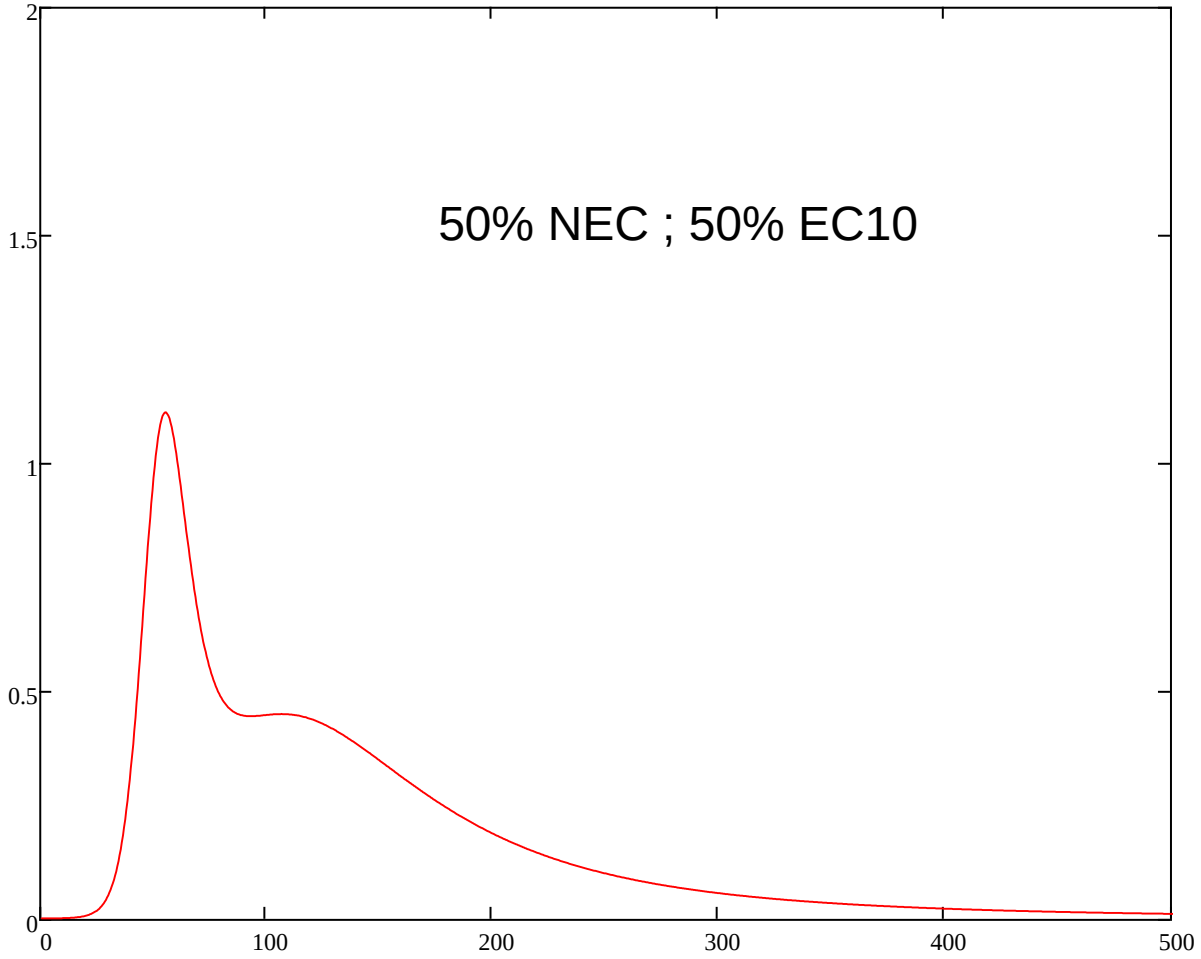

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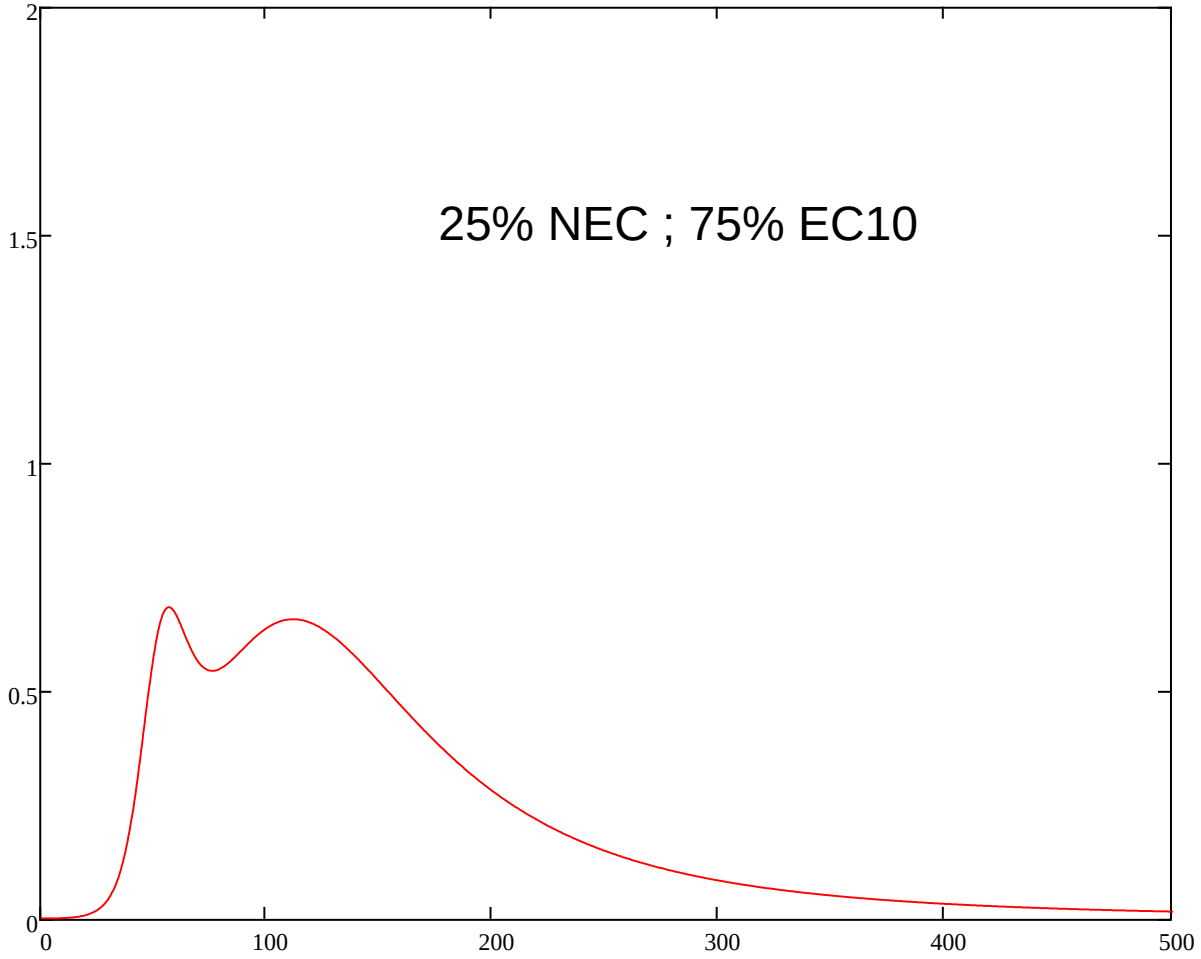

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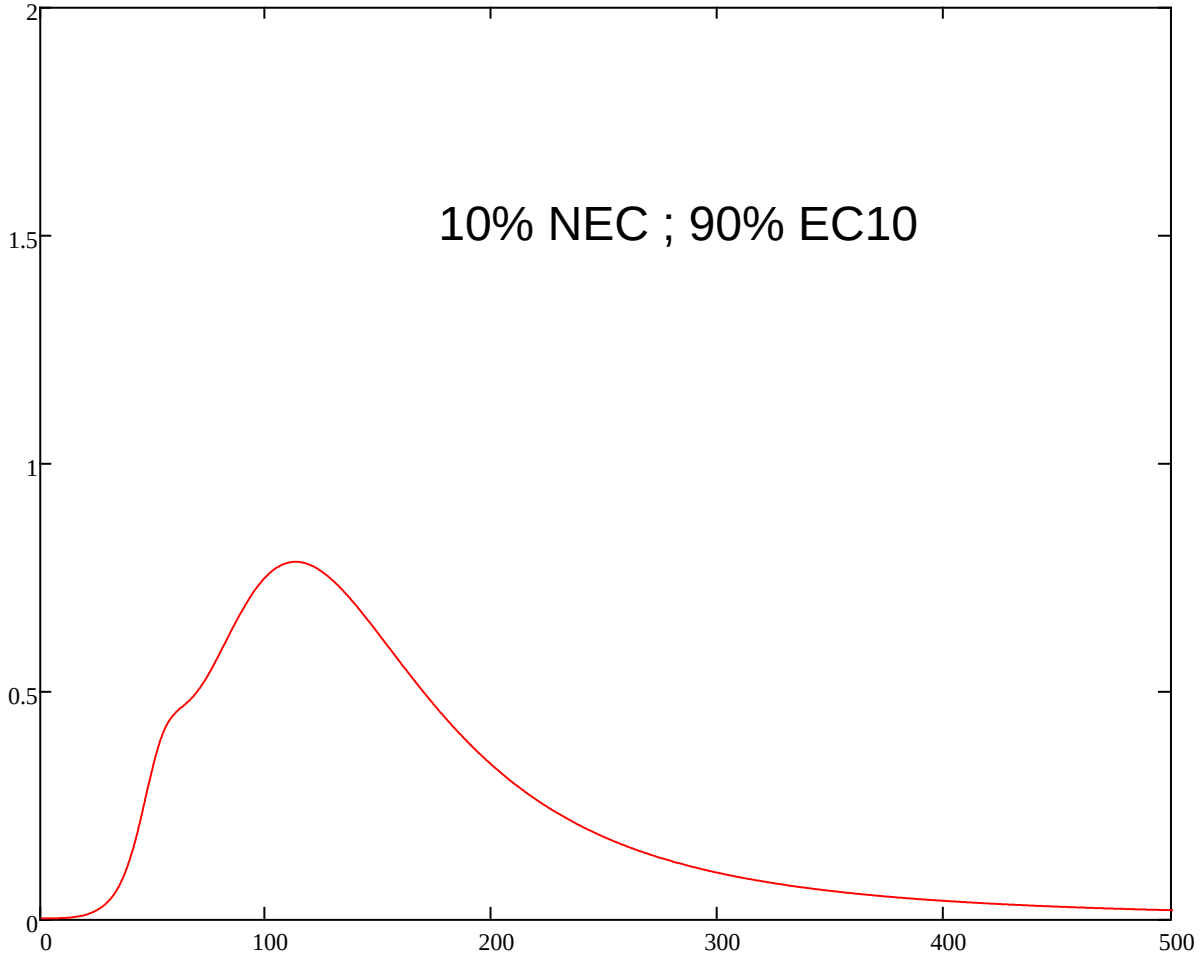

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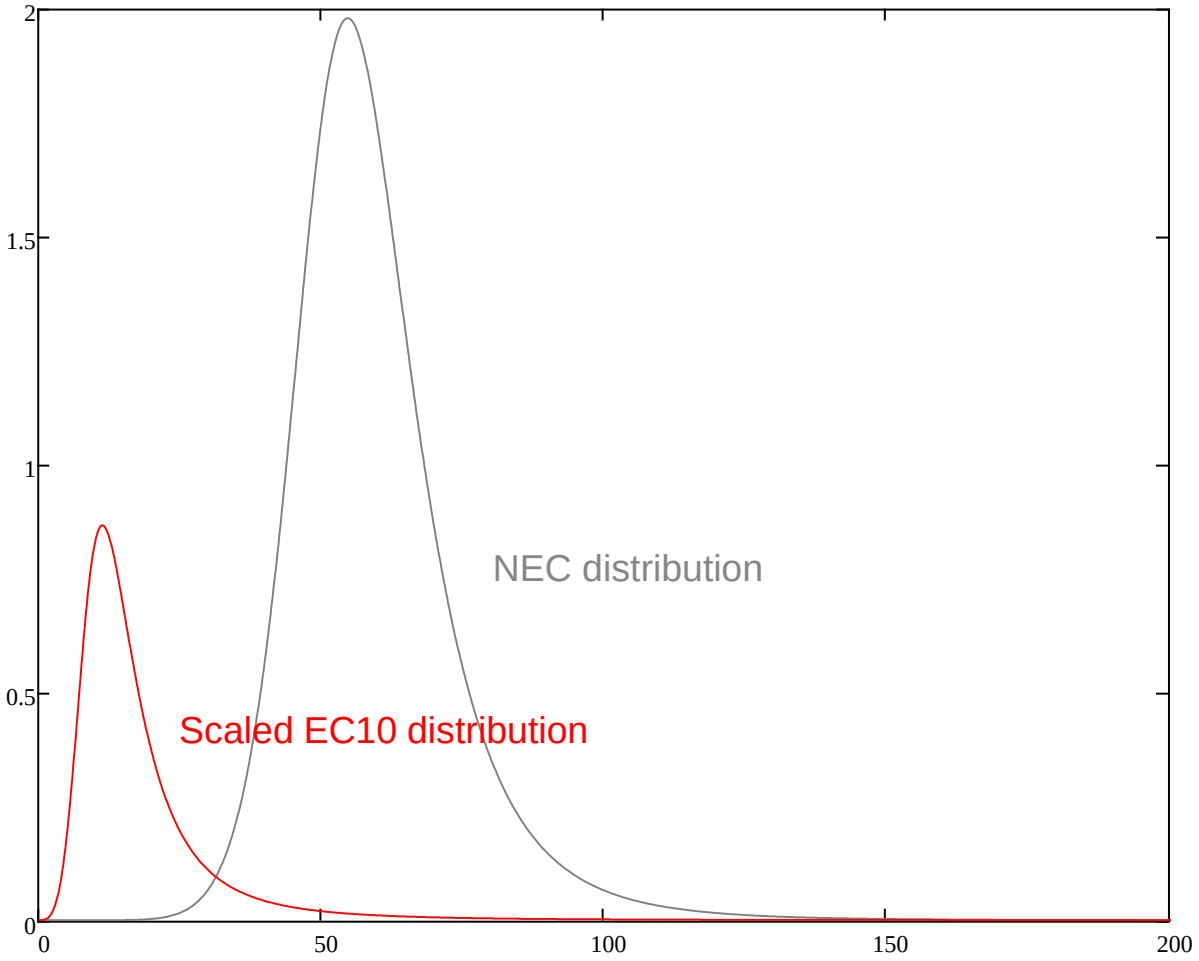
Arbitrary scaling of EC10 data: scale factor = 10



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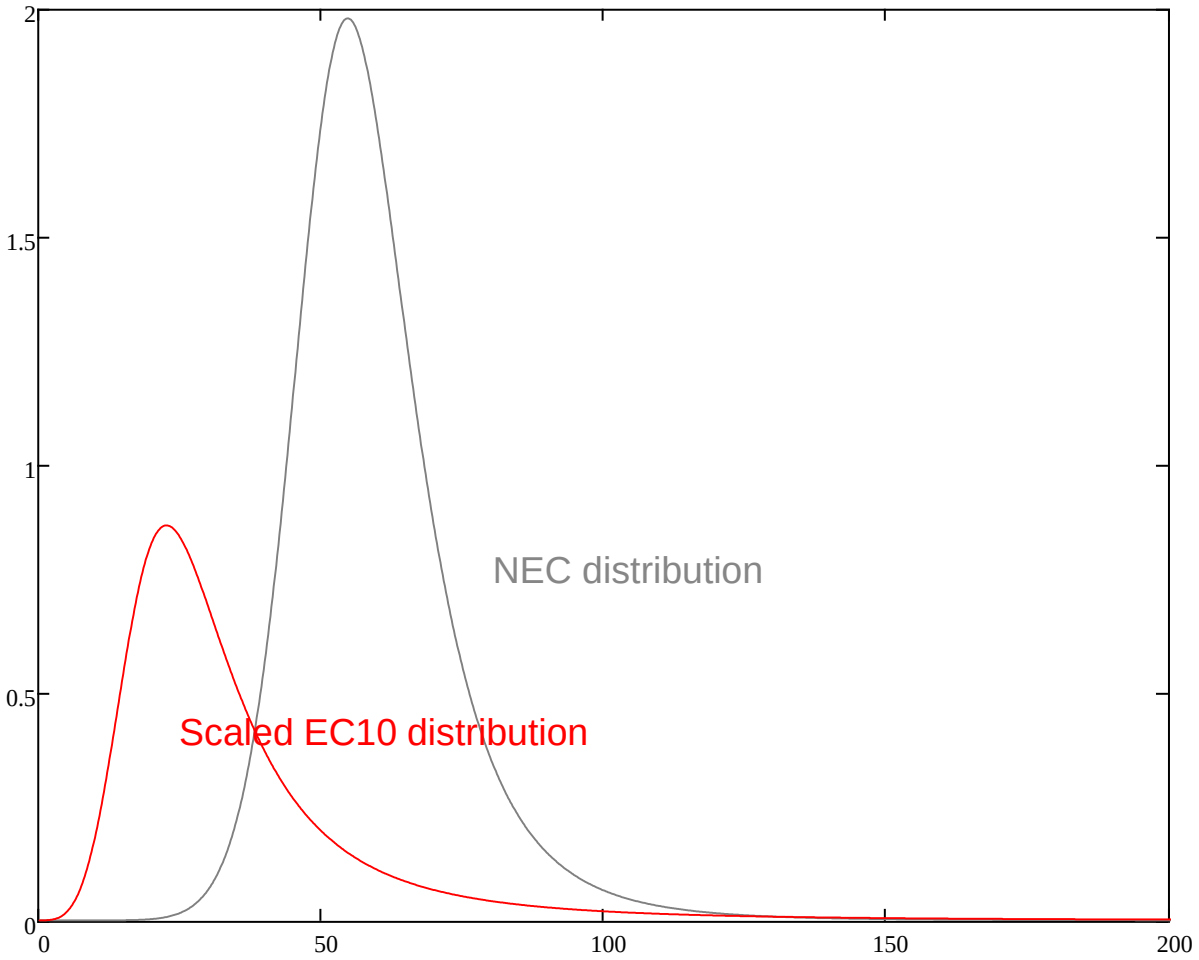
Arbitrary scaling of EC10 data: scale factor = 5



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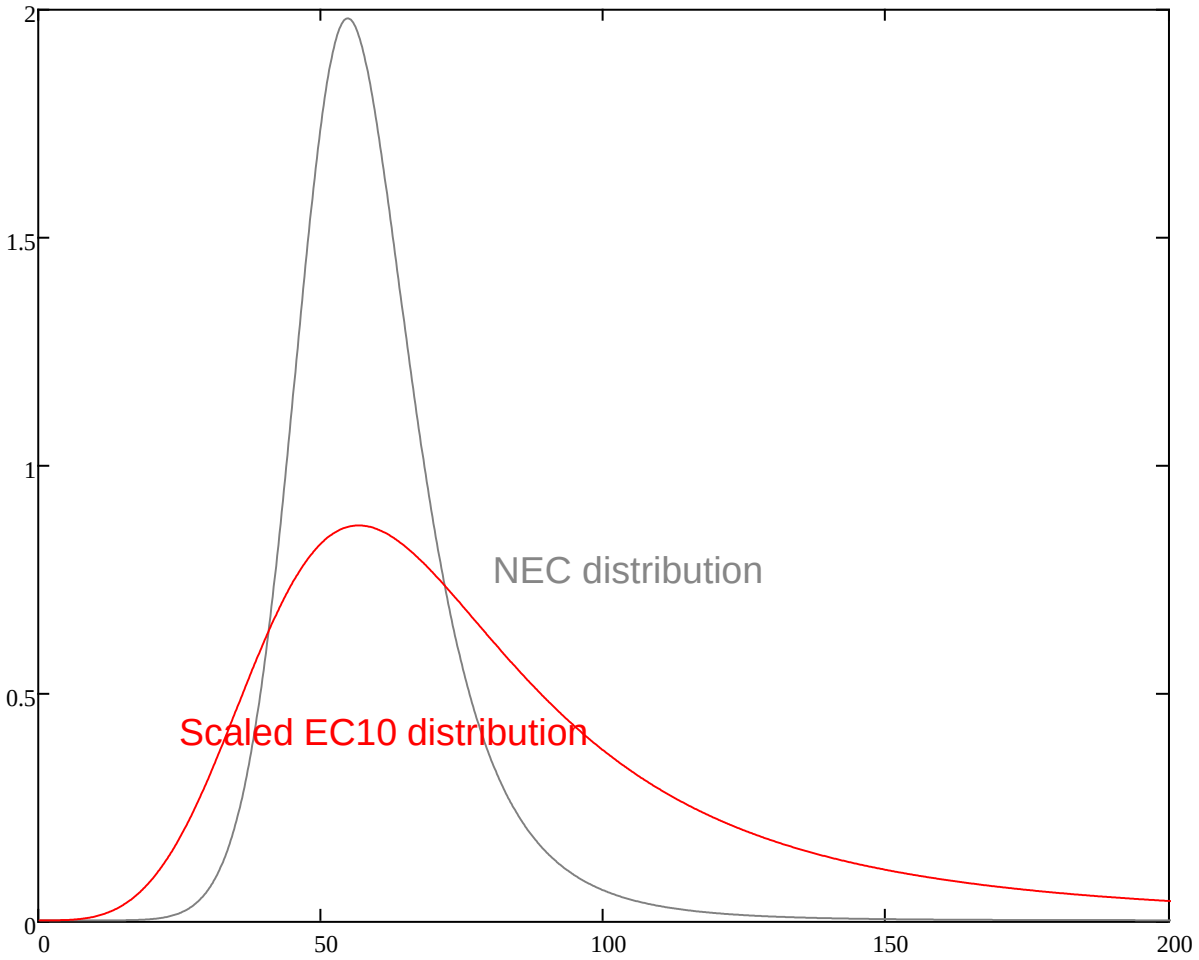
Arbitrary scaling of EC10 data: scale factor = 2



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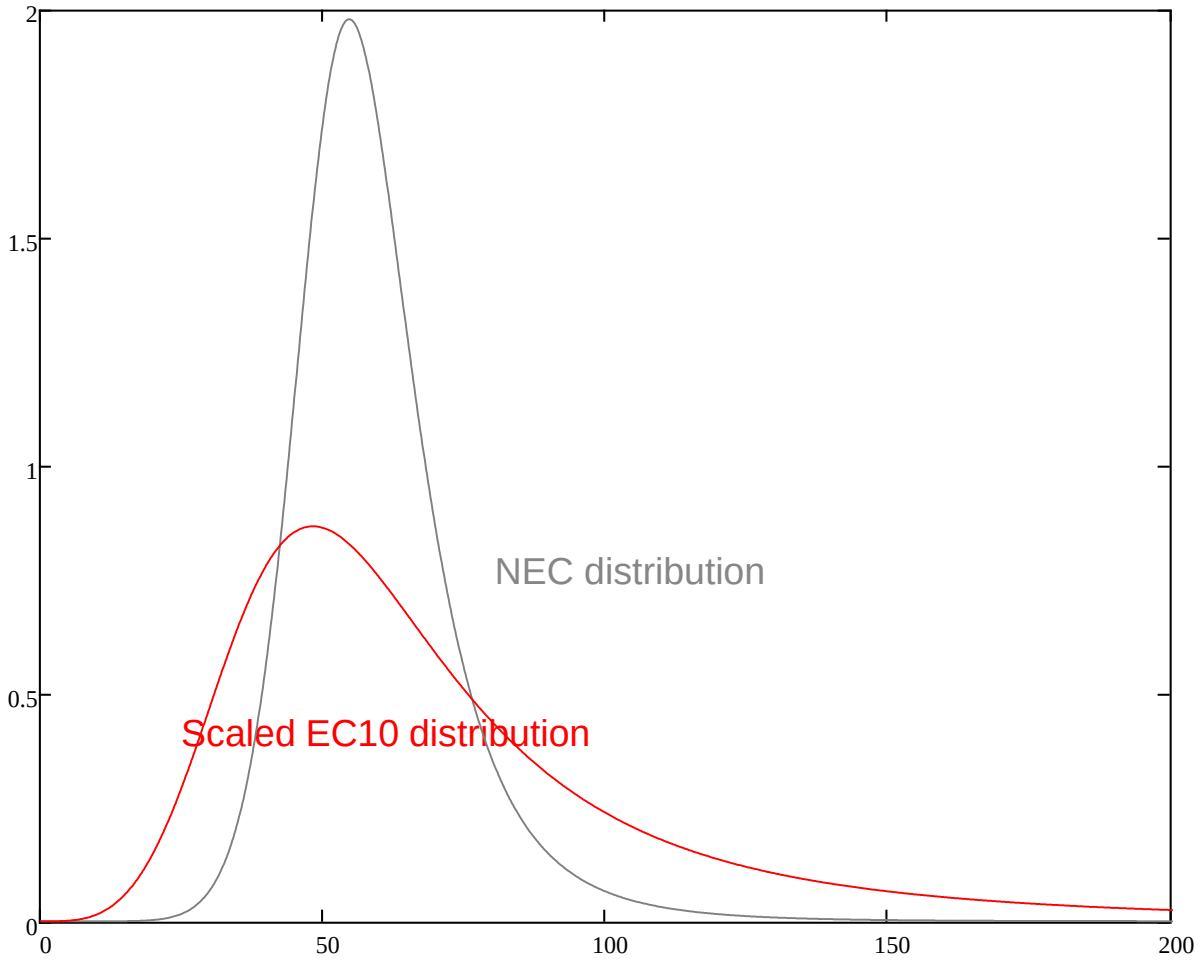
Arbitrary scaling of EC10 data: scale factor = 2.345 (‘optimal’)



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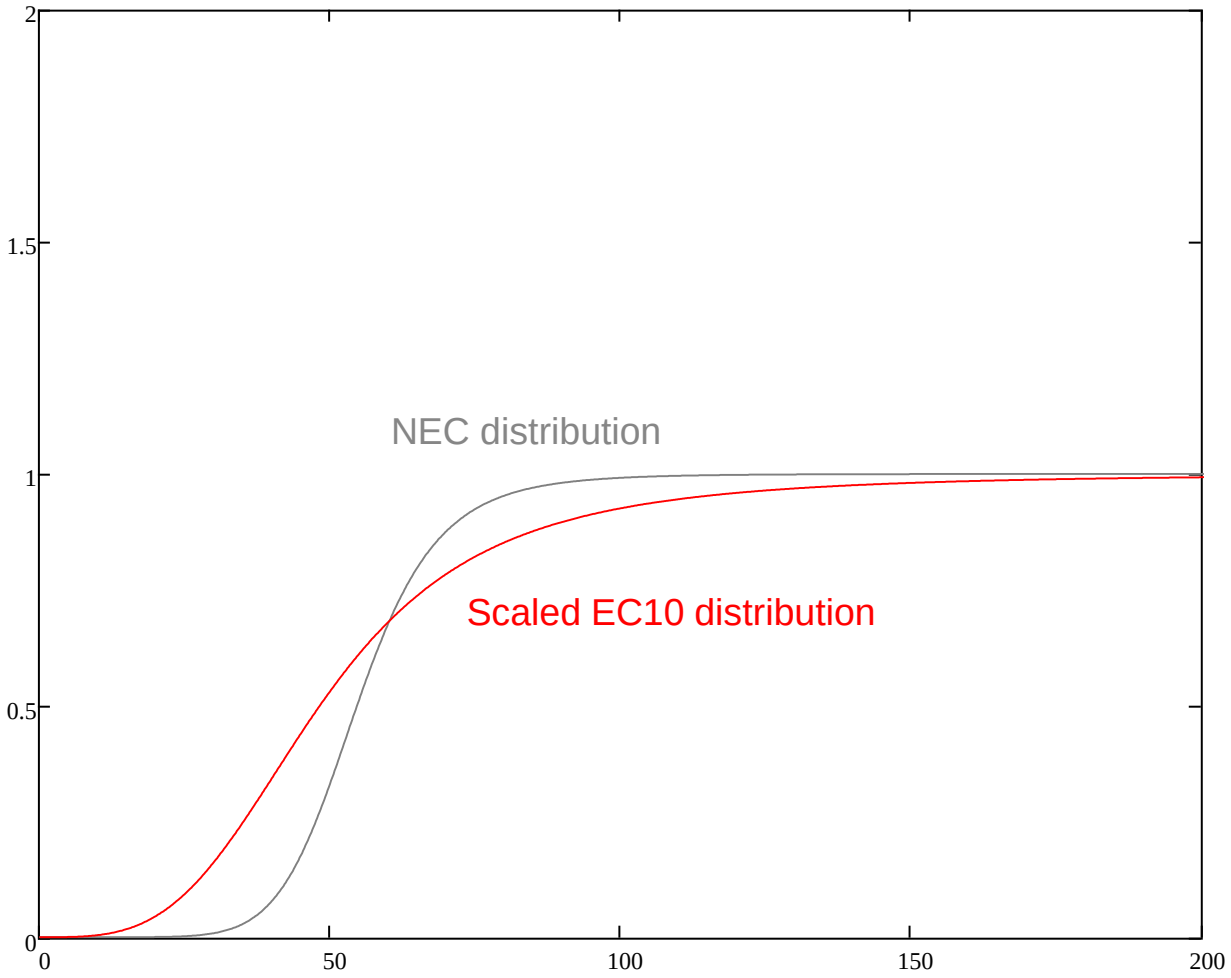

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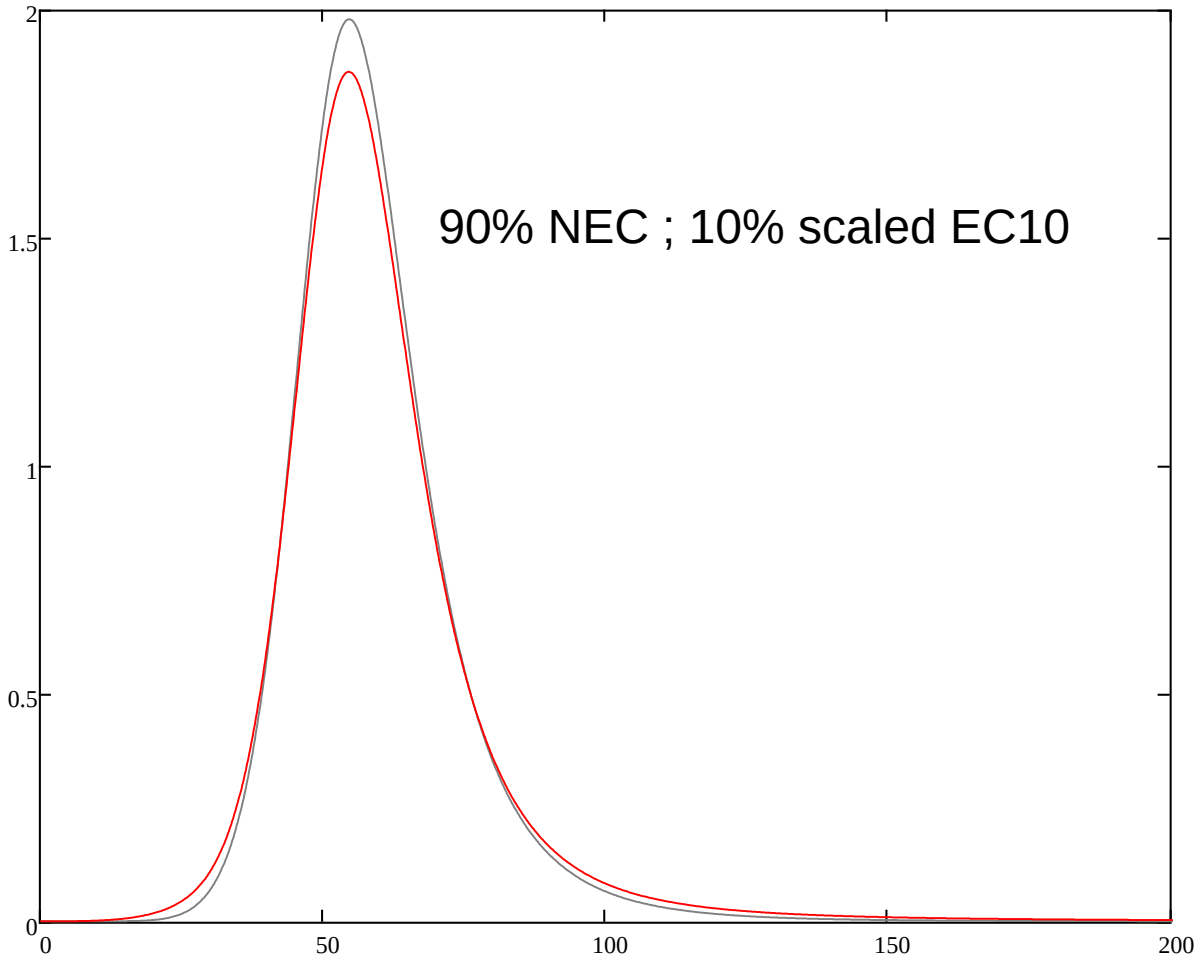

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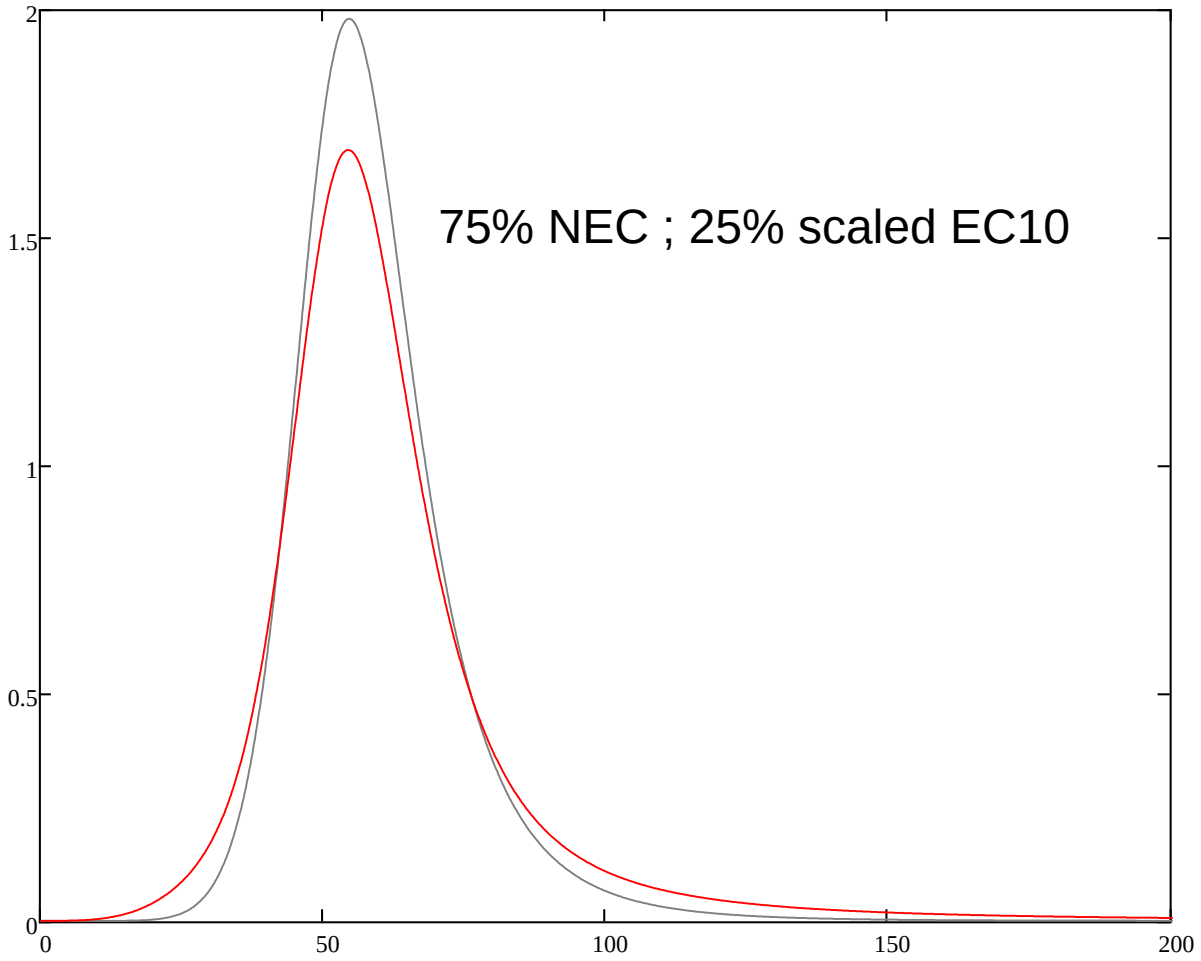

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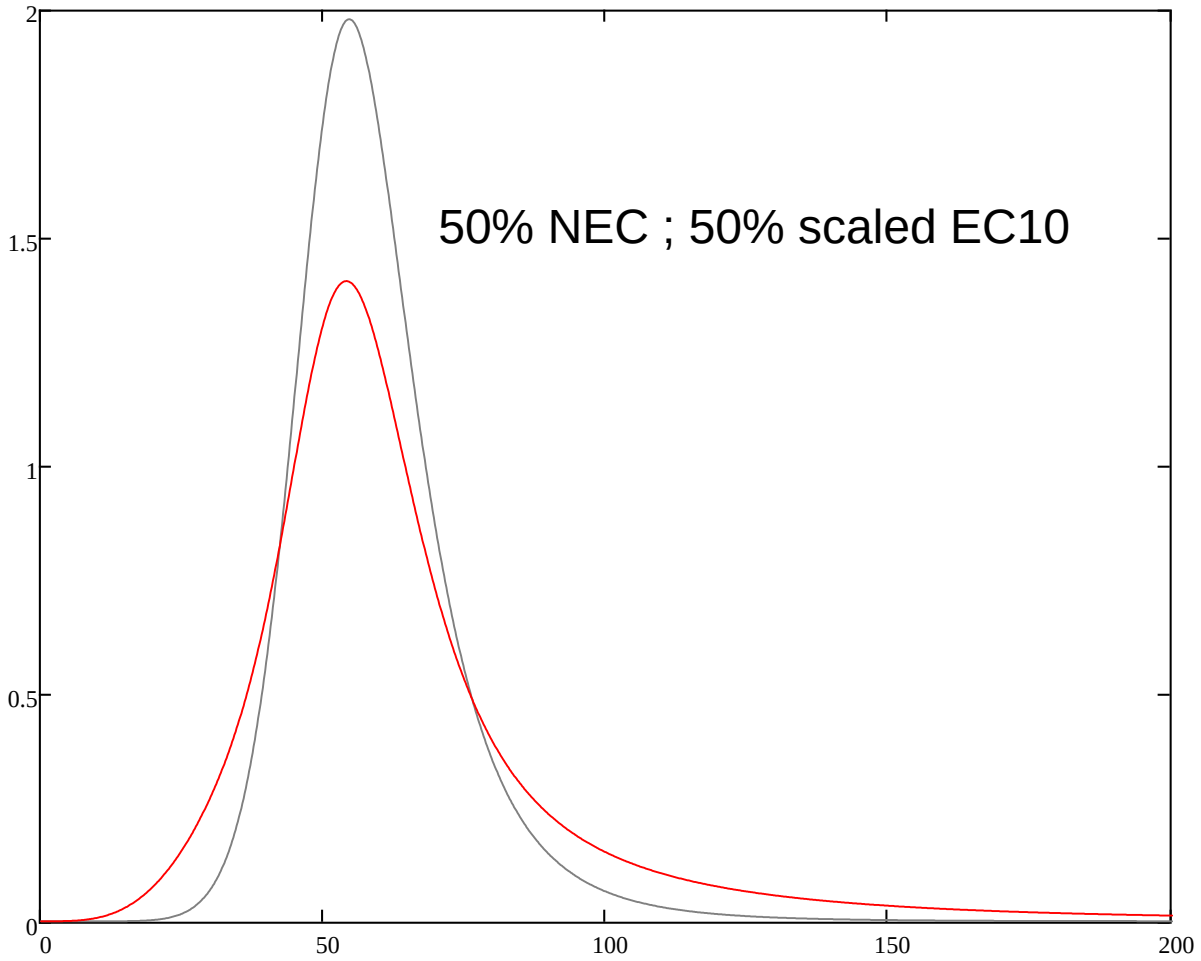

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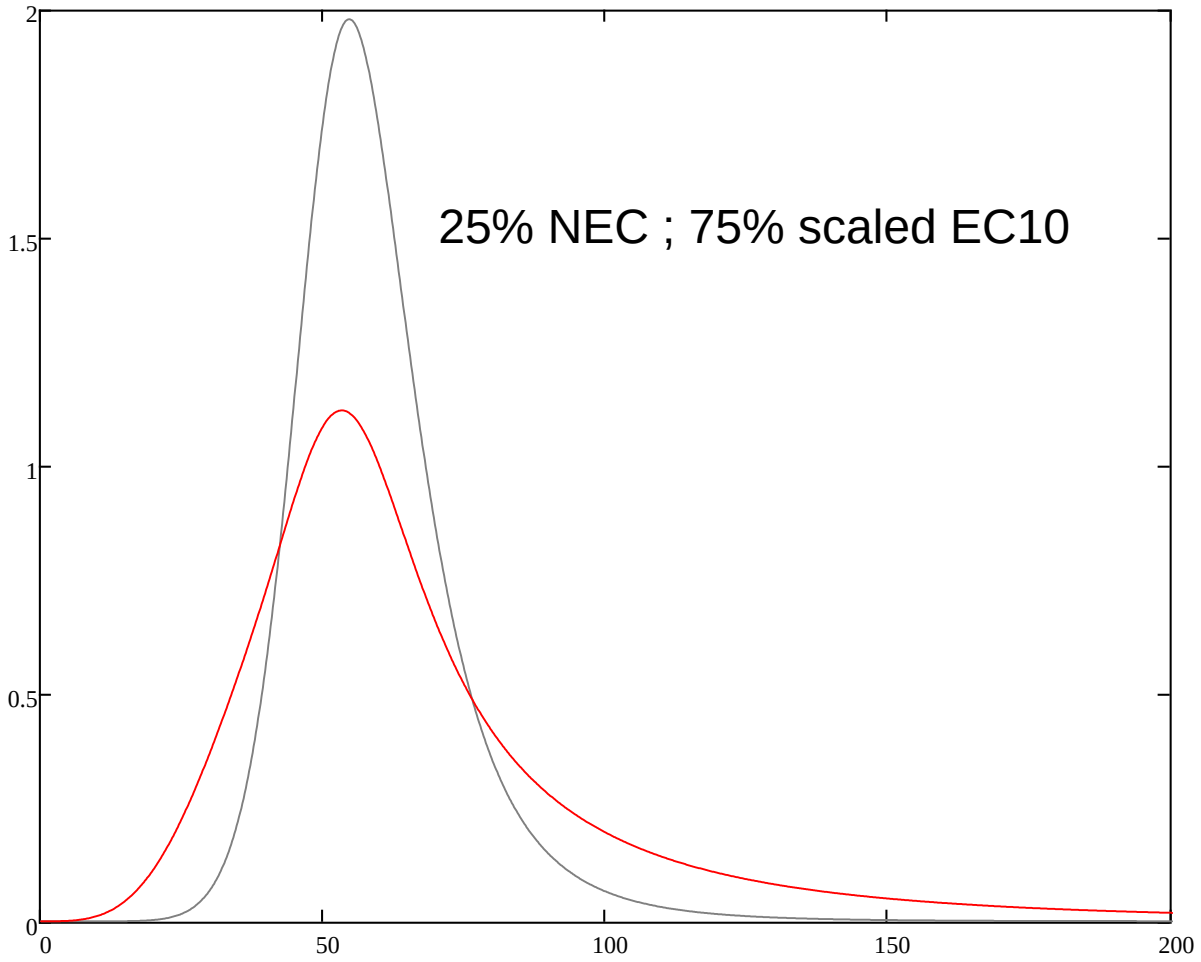

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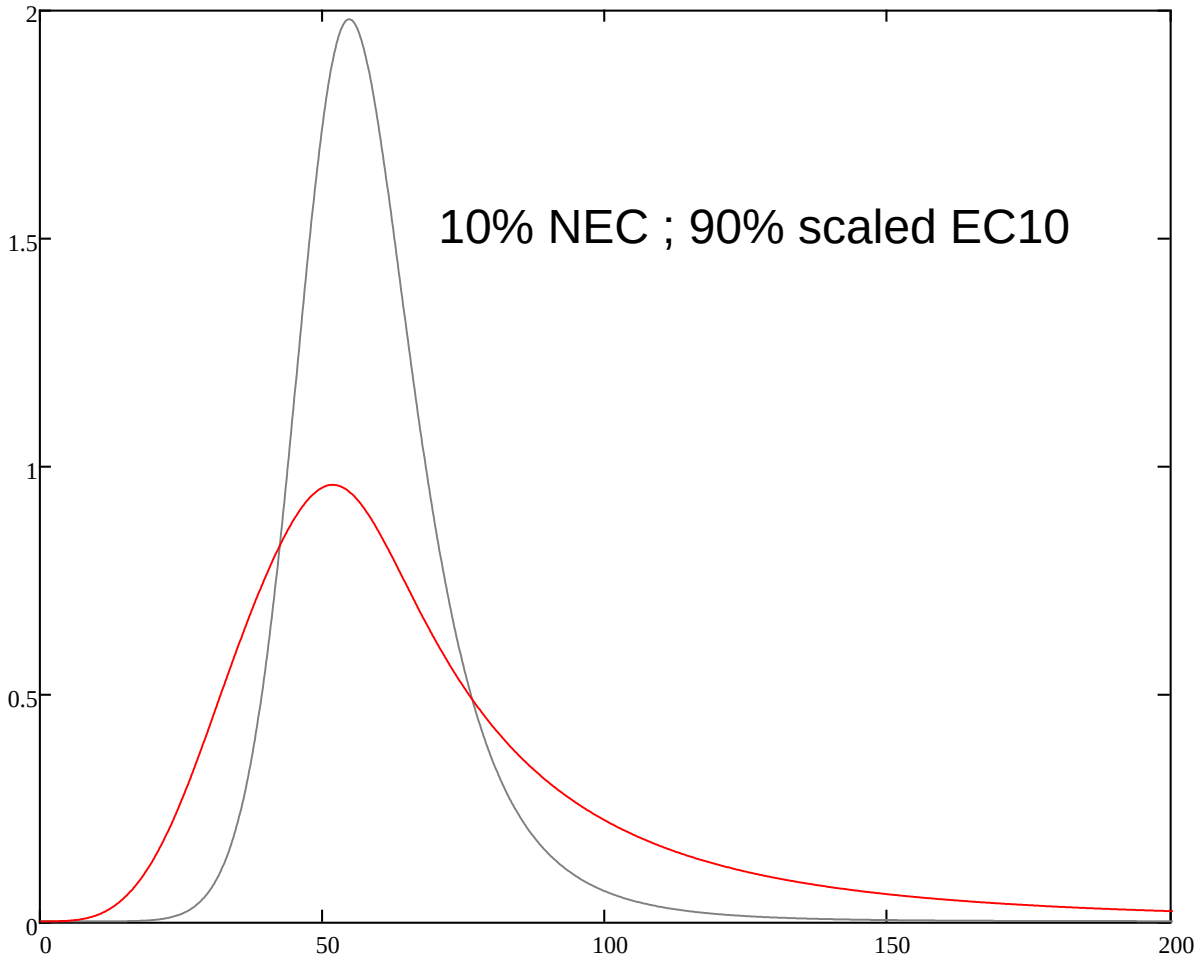

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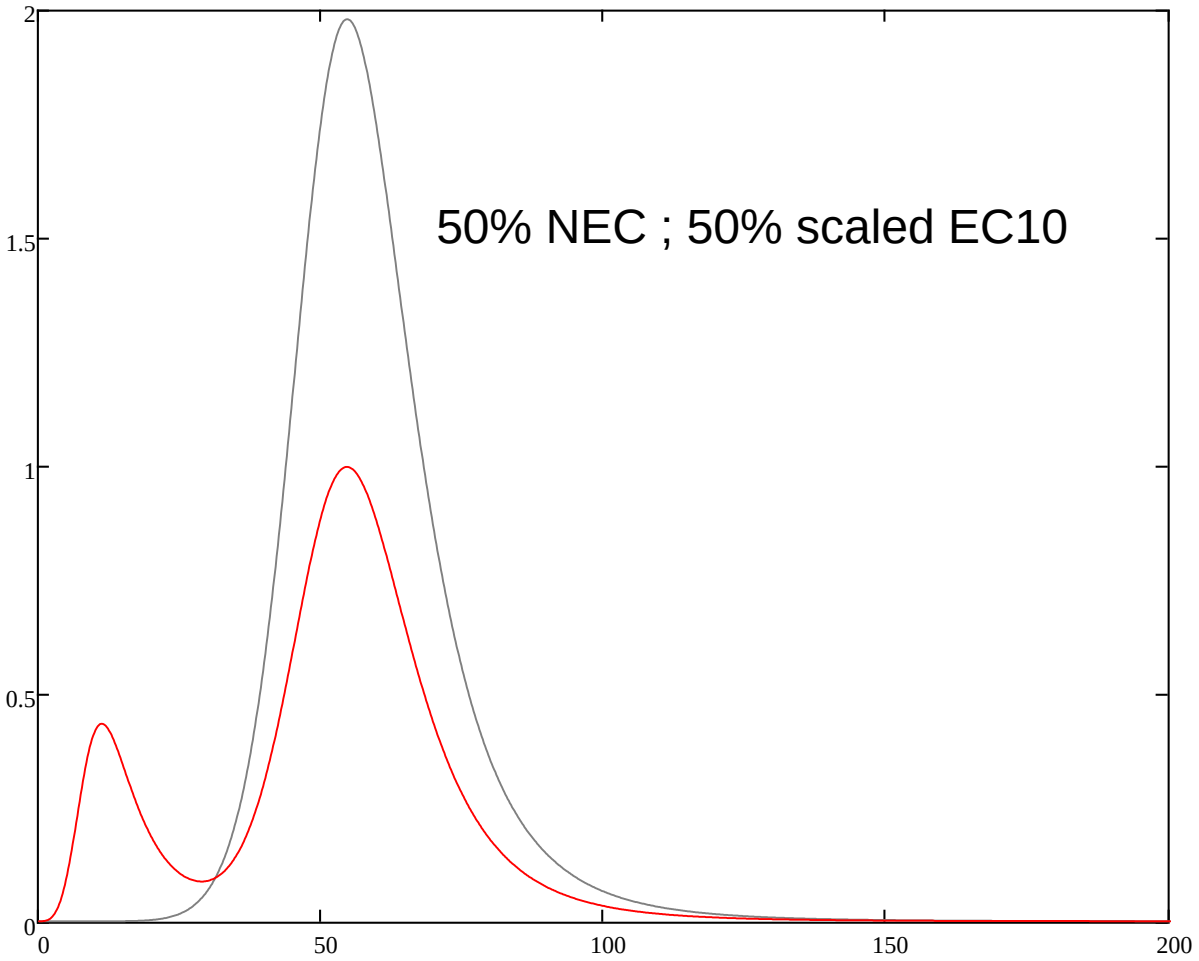

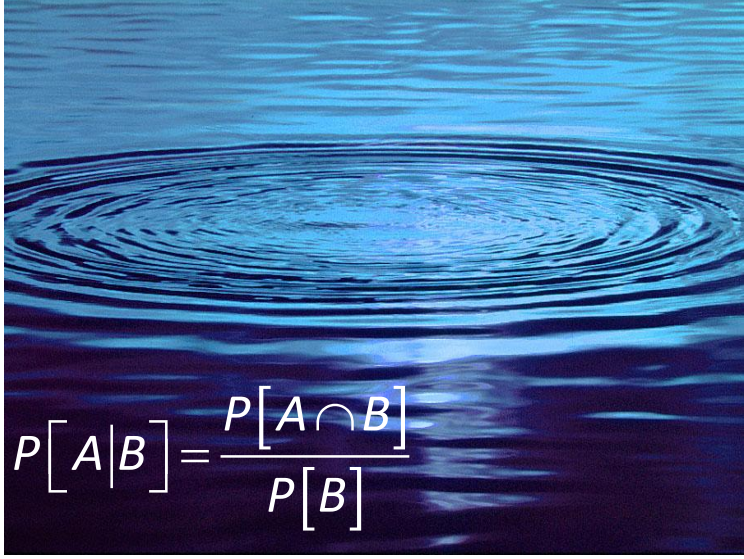

Thank You

Contact: Prof. David R. Fox

Email david.fox@unimelb.edu.au