Half-Life from Two Count-Rate Measurements

Decay constant, half-life and mean life from two background-corrected count rates taken some time apart, with the counting-statistics uncertainty.

Method: Exponential decay fitted to two net count rates with Poisson statistics

Input parameters

Unit system: SI

Parameter	Value	Unit
First gross count rate	72,000	1/min
Second gross count rate	27,300	1/min
Background count rate	1,200.0	1/min
Time between the measurements	5.0000	h
Counting time of each measurement	10.000	min

Calculated results

Parameter	Value	Unit
Decay constant	0.19958	1/h
Half-life	3.4729	h
Mean life	5.0104	h
Relative standard uncertainty of the half-life	0.23807	%

Notes for this case

• λ = ln[(C₁ − B)/(C₂ − B)]/Δt. Uncertainty from Poisson statistics with the background counted for the same time; dead-time losses at high rates and detector drift are not corrected. Measure over at least one half-life for a useful result.

Formula and method

$$\lambda = \frac{1}{\Delta t} \ln \frac{C_1 - B}{C_2 - B}, \quad T_{1/2} = \frac{\ln 2}{\lambda}$$

Variables

C_1	First gross count rate	1/s
C_2	Second gross count rate	1/s
B	Background count rate	1/s
Δt	Time between the measurements	s
t_c	Counting time of each measurement	s
λ	Decay constant	1/s
$T_{1/2}$	Half-life	s
τ	Mean life	s
$u_{T_{1/2}}/T_{1/2}$	Relative standard uncertainty of the half-life	-

Method and standards

Half-life measurement.

Assumptions and limits

- Single nuclide; no dead-time correction.

References

Exponential decay fitted to two net count rates with Poisson statistics

Report details

Report reference	FCC-GCGN-41M7 (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/nuclear-power/half-life-from-count-rates

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.