Definitions of yields

Problems and confusions

Sándor Takács

Institute for Nuclear Research

ATOMKI

Definitions of yield:

$$Y = \frac{N(reractions)}{N(incident)}$$

- **Target specific**
- **No dimension**
- **Time independent**

- **Different forms and different use**

Special cases

- Charged particle induced reactions
  - energy loss, changing energy along the path
  - short range, finite volume
  - energy dependence
- Thin and thick target yield
- Stable reaction products

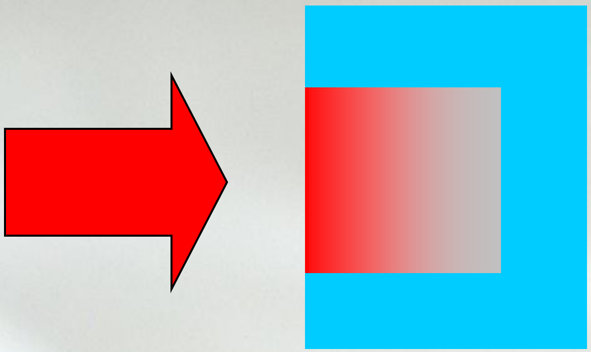
$$Y = \frac{N(reactions)}{N(incident)} \quad \left(\frac{N(reactions)}{C}\right) \quad \left(\frac{N(reactions)}{\mu Ah}\right) \quad \left(\frac{N(reactions)}{\mu A}\right)$$

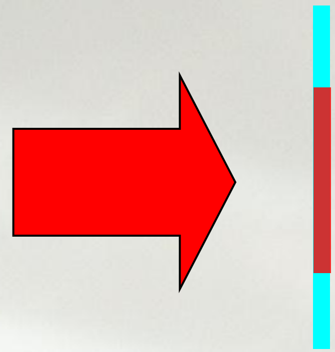
- Radioactive products

$$Y = \frac{N(reactions)}{N(incident)} \quad \left(\frac{MBq}{C}\right)\left(\frac{MBq}{\mu Ah}\right)\left(\frac{MBq}{\mu A}\right) \quad \left(\frac{MBq}{\mu A/h}\right)\left(\frac{MBq}{\mu A-h}\right)$$

Production rate

$$y(t) = N_t N_b(t)\sigma$$





$$y(t) = \frac{I(t)}{ze}\frac{N_A\rho}{M}\int_{E=0}^{E_b}\frac{\sigma(E)}{S(E)}dE$$

Number of nuclei produced in the target

$$N = \frac{tI_0}{ze}\frac{N_A\rho}{M}\int_{E_{out}}^{E_{in}}\frac{\sigma(E)}{S(E)}dE$$

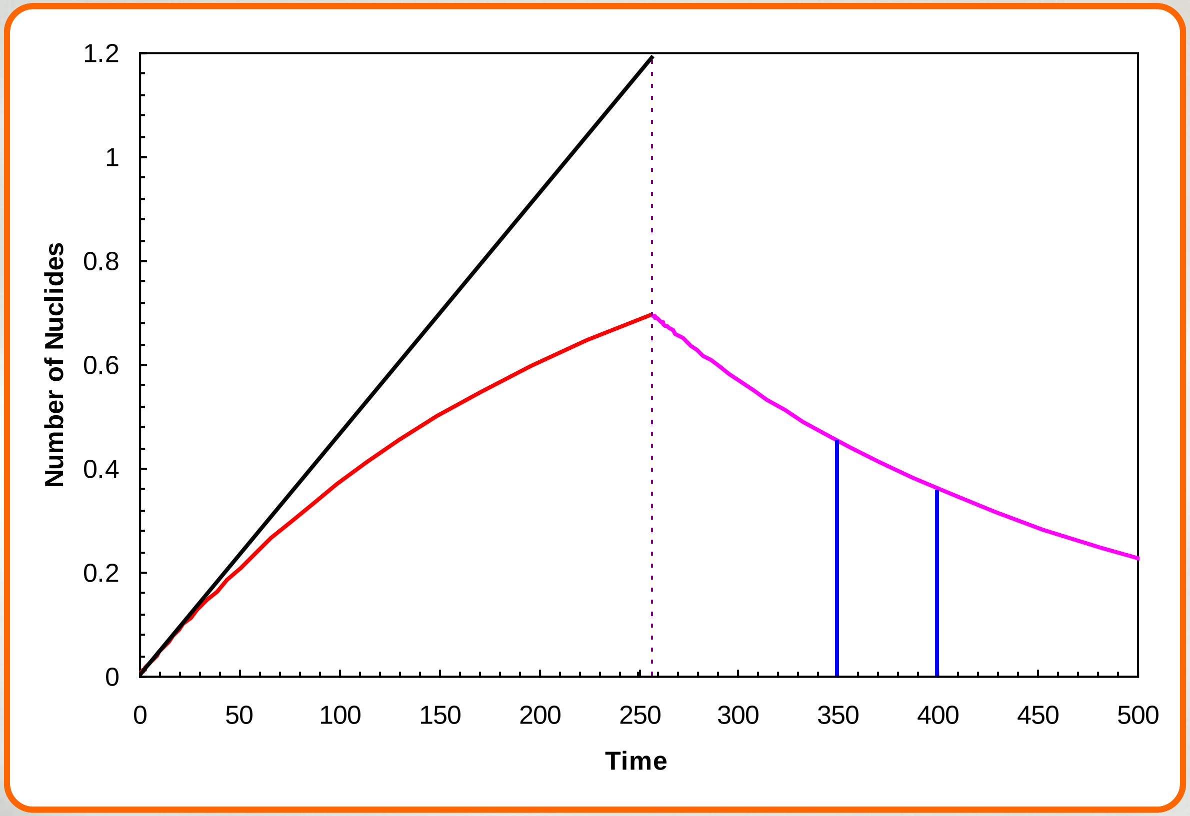
Number of nuclei present in the target

at EOB

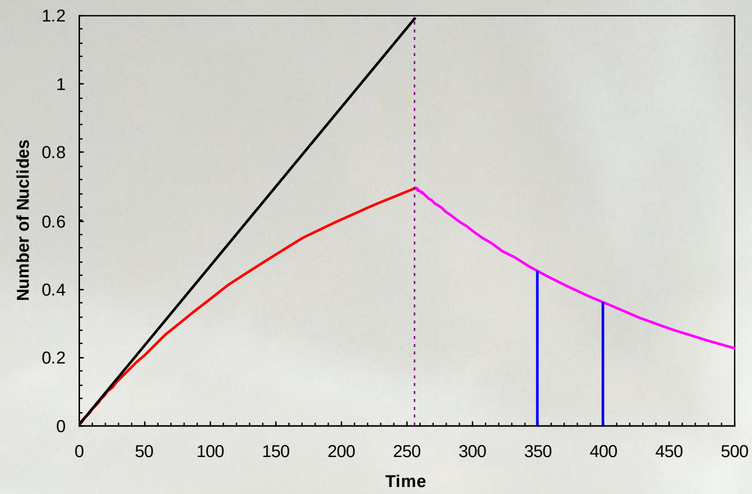
$$\frac{dN(t)}{dt} = I_0 y - \lambda N(t) \qquad N(t) = I_0 y \frac{1 - e^{-\lambda t}}{\lambda}$$

Number of produced nuclei in the target

Number of nuclei present in the target



$$A(t) = \lambda N(t)$$



$$N(t) = I_0 y \frac{1 - e^{-\lambda t}}{\lambda}$$

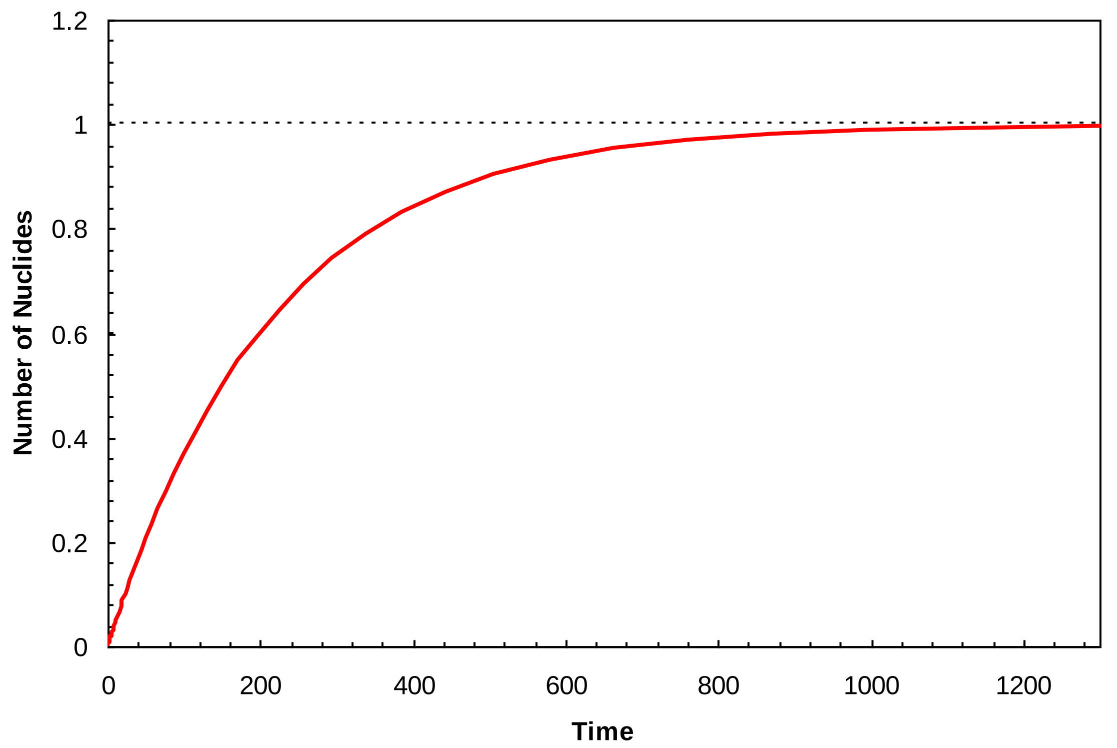
$$A(t) = \lambda N(t) = I_0 y \left(1 - e^{-\lambda t}\right)$$

$$y\left(1 - e^{-\lambda t}\right) \equiv a(t)$$

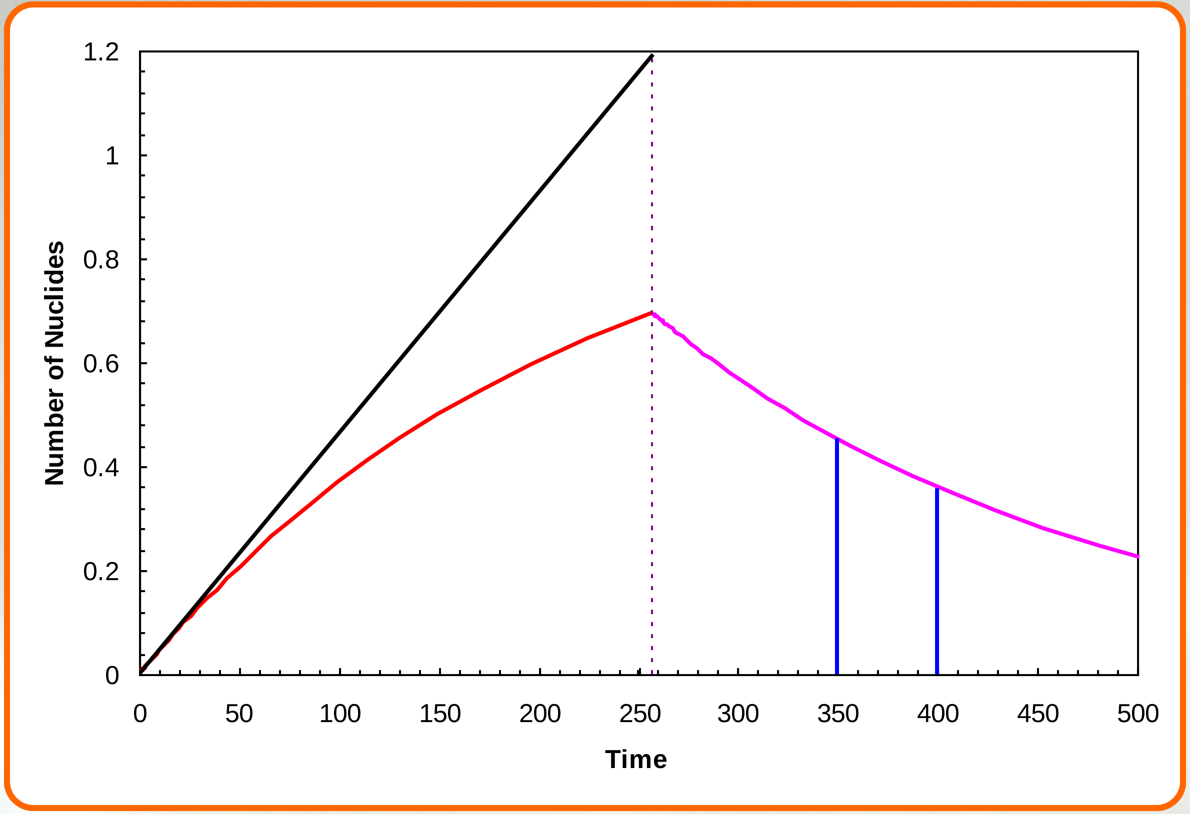
a(t) defined as the **decay rate** or **specific activity** per unit current *(Bq/μA)*

$$A(t \to \infty) = I_0 y \equiv I_0 a_{sat}$$

a_{sat} defined as the **saturation decay rate** or **saturation specific activity** per unit current *(Bq/mA)*



$$\frac{dA(t)}{dt} = I_0 \lambda y e^{-\lambda t} \equiv I_0 \alpha(t) \qquad \alpha(t = 0) = \lambda y$$



α(t) at *t=0* is the *production rate (y)* times *decay constant (λ)* which gives the **decay rate at *t = 0***.
This is time independent quantity with units of Bq/C and defined as the **physical yield**.

Yield quantities defined in EXFOR

Name	Symbol		Typical unit
thick target product yield	y	,PY„TT/CH	nuclei/μC, nuclei/μAh
end-of-bombardment thick target yield	a(t)	,TTY„EOB	MBq/μA
saturation thick target yield	a_{sat} $a(t \rightarrow \infty)$	,TTY„SAT	MBq/μA
physical thick target yield	α_{phys} a(t=0)	,TTY„PHY	MBq/C

Thank you for Your attention