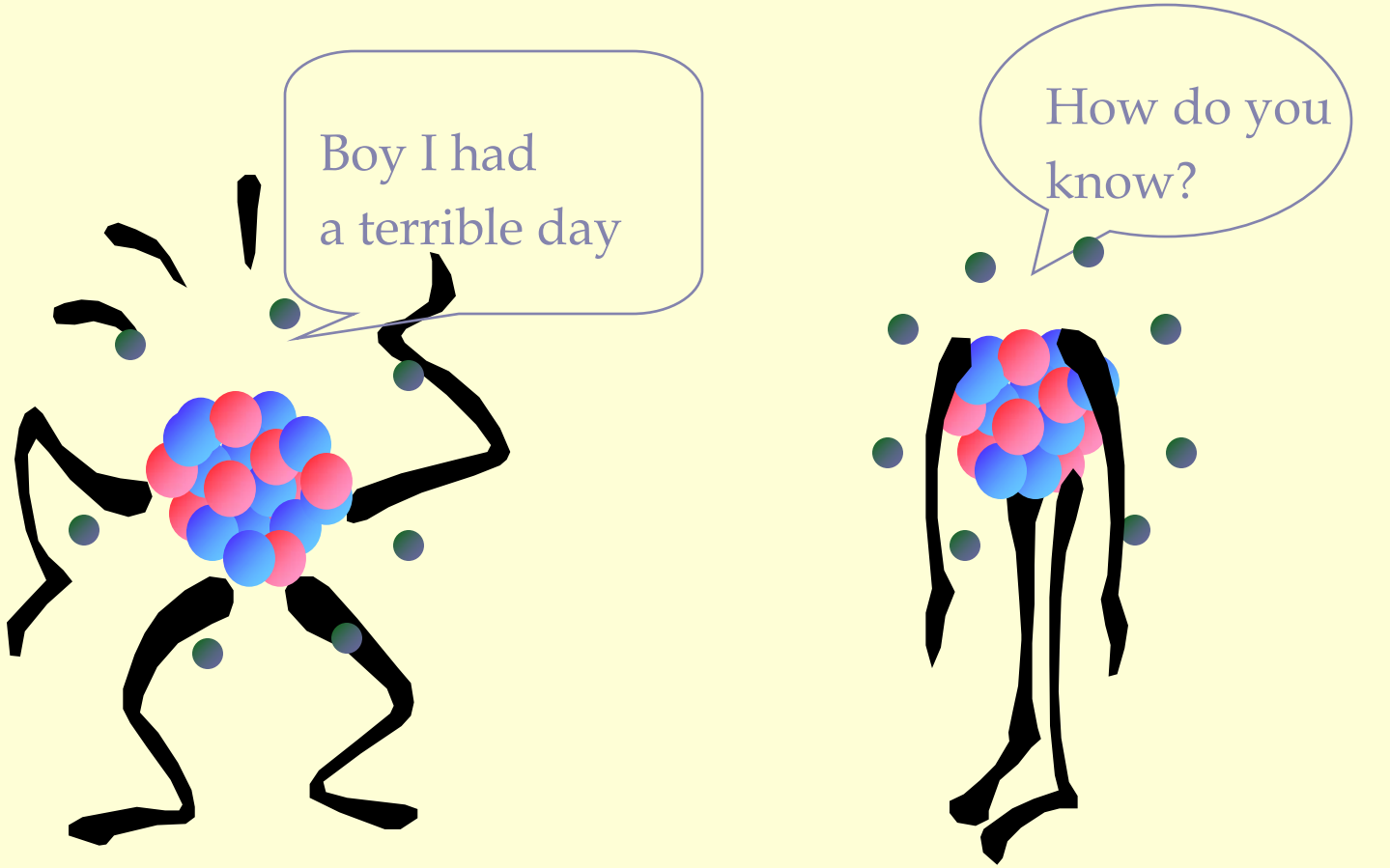
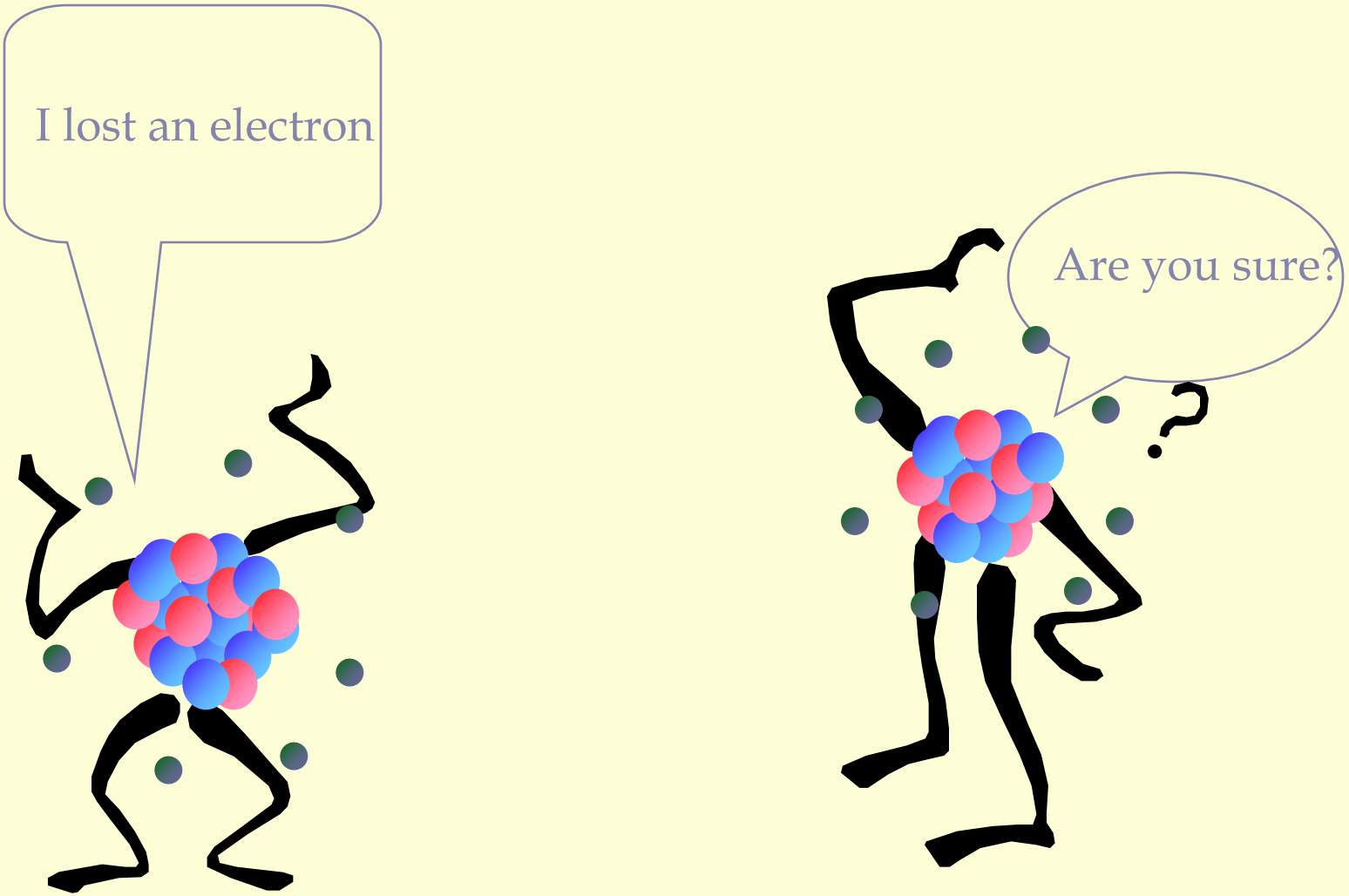
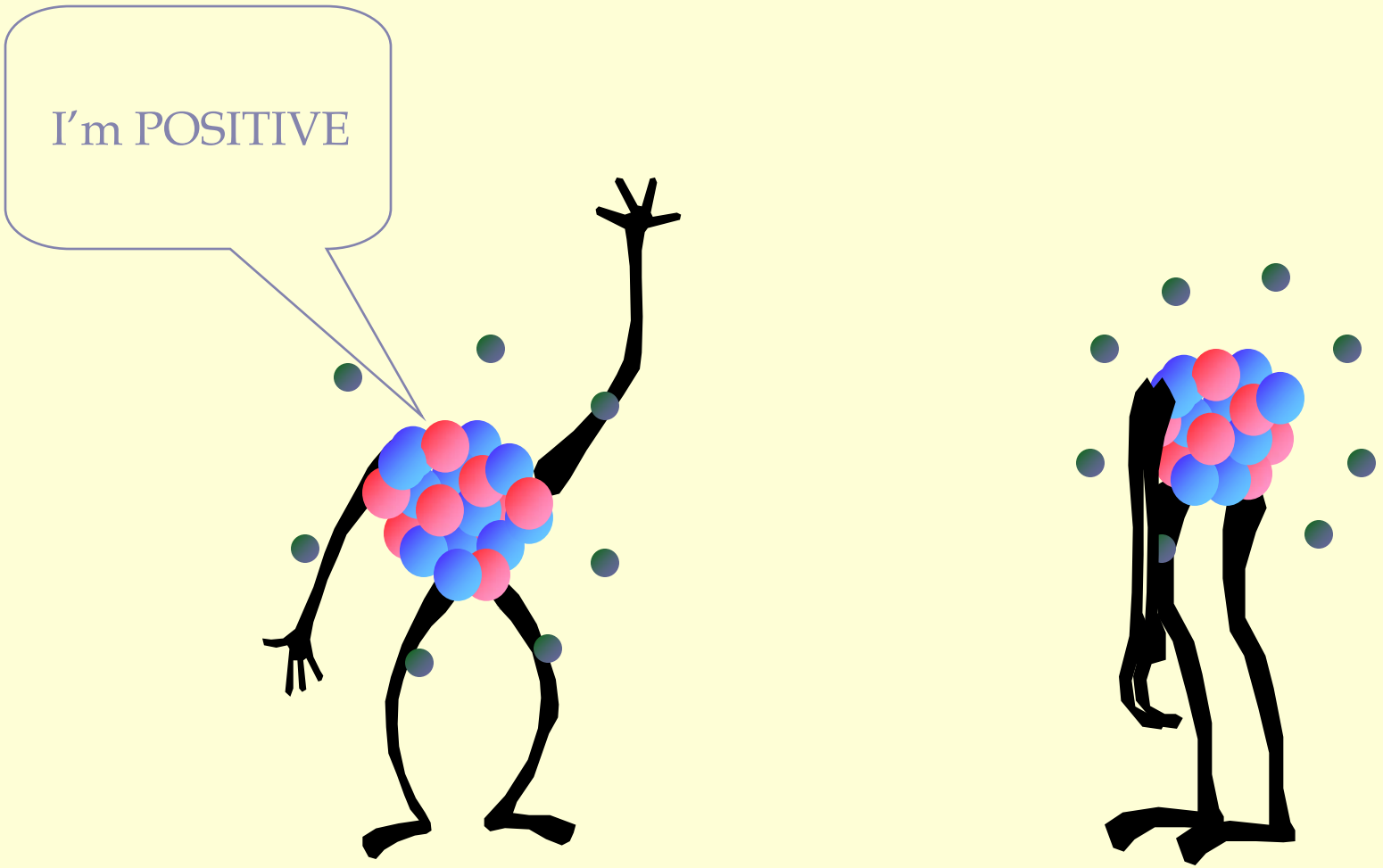
Criticality and Neutron Multiplication

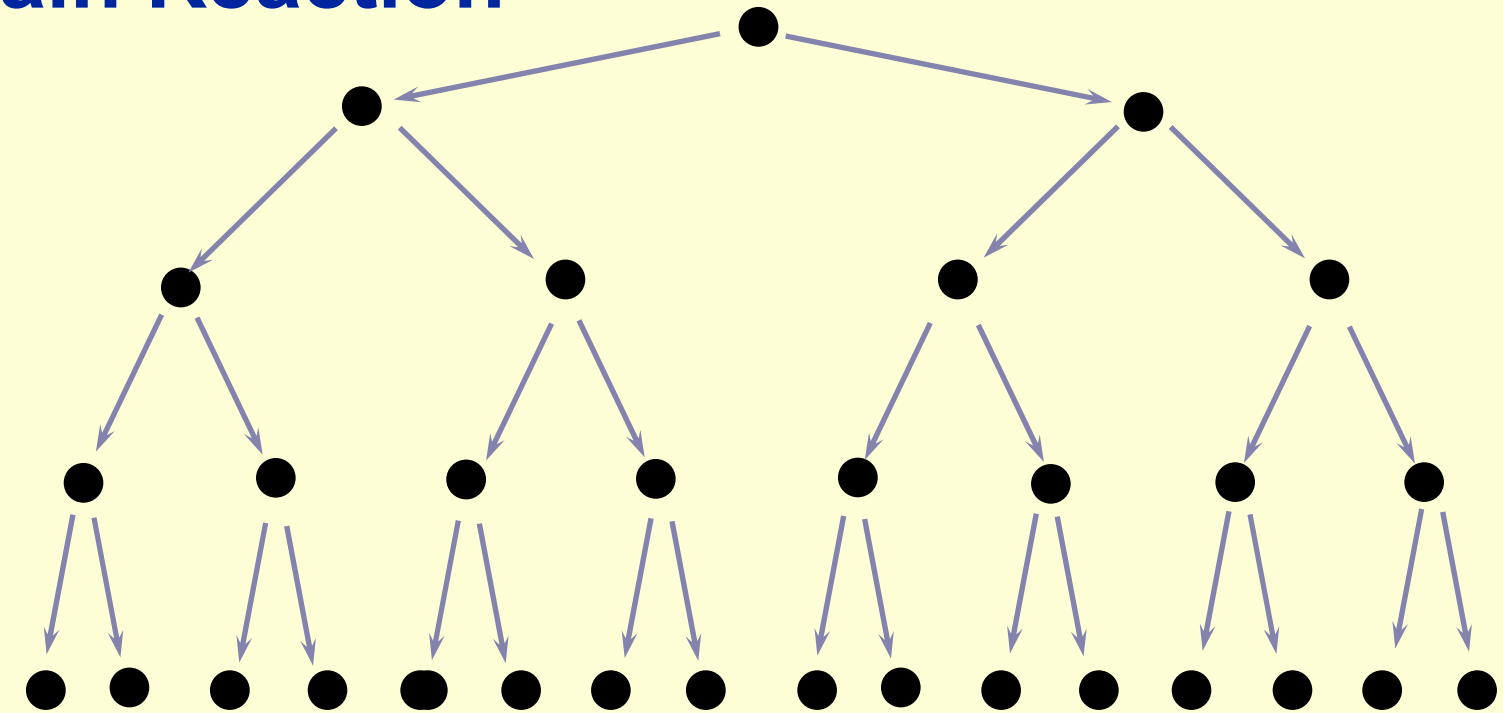
Two Atoms Walking Down the Street

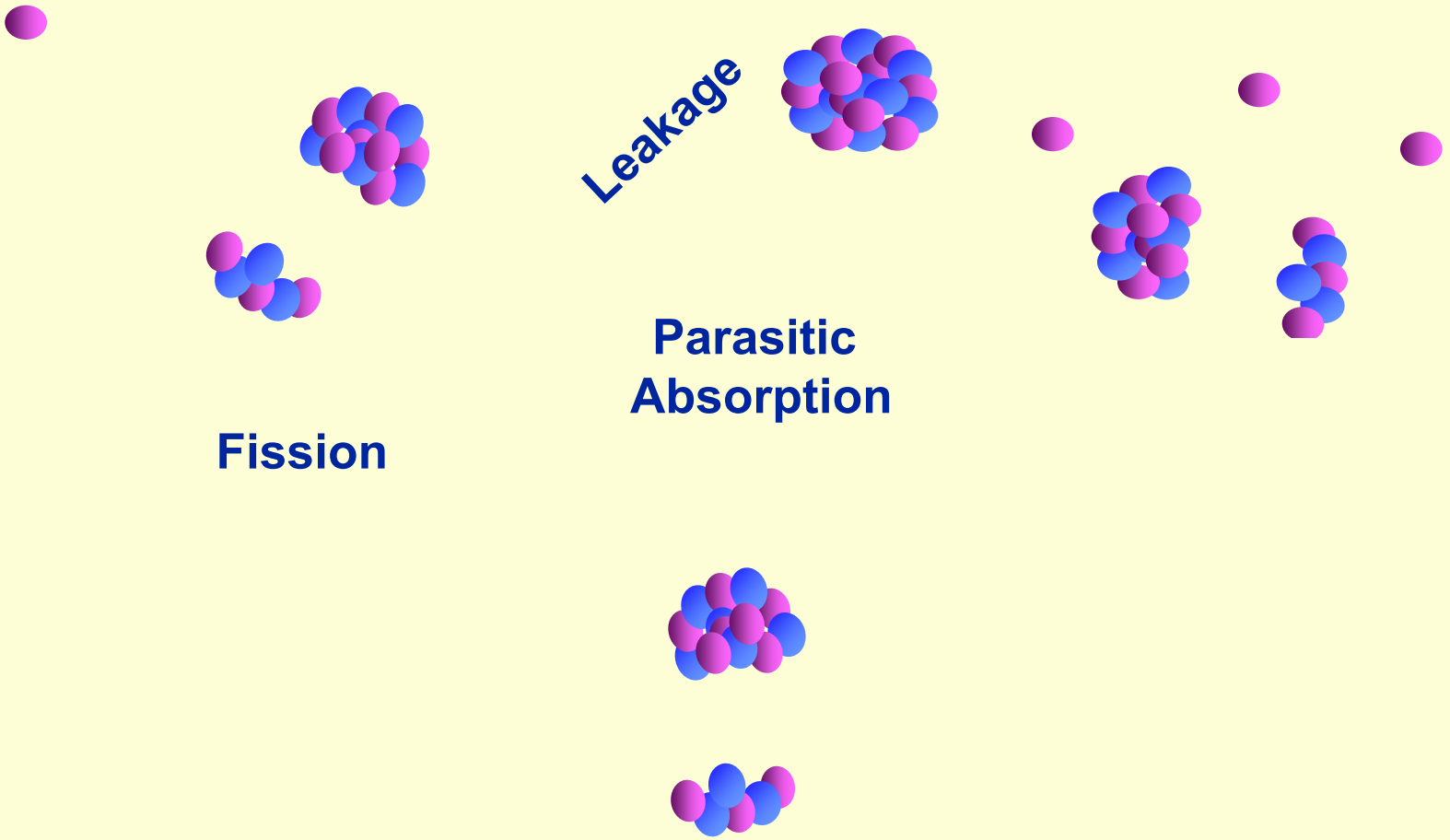



I lost an electron
Are you sure?


I’m POSITIVE

Chain Reaction





Controlled Chain Reaction

Neutron Multiplication Factor

$$k = \frac{\text{Number of neutrons in a generation}}{\text{Number of neutrons in the previous generation}}$$

Critical – the chain reaction is being maintained.

k=1

power output is constant

Reactivity

Critical	**Power Steady**
Sub-Critical	**Power Decreasing**
Super Critical	**Power Increasing**

$$\Delta k = \frac{\text{\# of neutrons change per generation}}{\text{neutrons in last generation}} \quad \text{(approx)}$$

More on Reactivity

$\Delta k = 0$	**Critical**
$\Delta k < 0$	**Sub-Critical**
$\Delta k > 0$	**Super Critical**

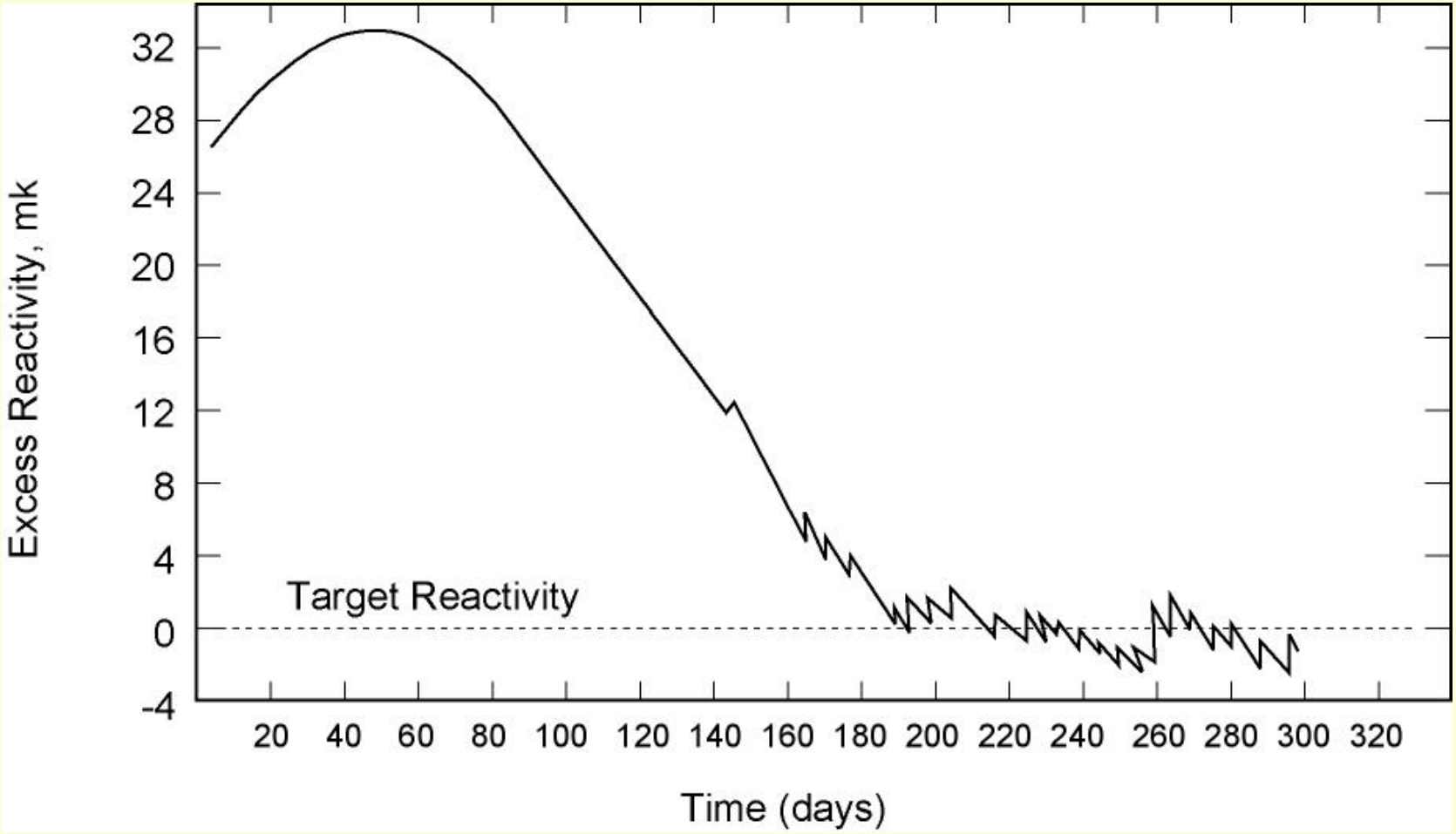
Practical units

$$mk = \frac{1}{1000} k$$

Reasons for Reactivity Control

- Maintain reactor critical at a steady power
- Increase of decrease power at a controlled rate
- Reduce power quickly

Excess Reactivity



Adjusting Reactivity

- Adjusting fissile material in core
  - Fuelling
- Adjusting the amount of absorption
  - Liquid zones, adjuster rods, absorber rods, shut off rods, liquid poison addition, liquid poison injection, moderator purification
- Adjusting leakage

Liquid Zone Control