Pb # 24.

Use the uncertainty principle $\Delta x \cdot \Delta p \geqslant \frac{\hbar}{2}$

$\lambda = 6000\ \text{Å}$ and $\frac{\Delta\lambda}{\lambda} = 10^{-6}$

$$\lambda = \frac{h}{p} \Rightarrow d\lambda = -\frac{h}{p^2}\,dp = -\frac{h\lambda^2}{h^2}\,dp$$

$$\Delta\lambda = \frac{\lambda^2}{h}\,\Delta p \Rightarrow \Delta = \frac{h}{\lambda^2}\,\Delta\lambda$$

$$\Rightarrow \Delta x \cdot \frac{h}{\lambda^2}\,\Delta\lambda = \frac{\hbar}{2} = \frac{h}{4\pi}$$

$$\Rightarrow \Delta x = \frac{\lambda^2}{4\pi\,\Delta\lambda} = \frac{\lambda}{4\pi\,\frac{\Delta\lambda}{\lambda}} = \frac{6000\ \text{Å}}{4\pi \times 10^{-6}} =$$

$$\Delta x = 4.78 \times 10^{8}\ \text{Å} = \boxed{0.0478\ m}$$

Pb # 29.

$\tau = 0.1$ ns for γ-rays of energy 2.00 MeV

Use the uncertainty principle $\Delta E \cdot \tau \geqslant \frac{\hbar}{2}$

$$\Delta E = \frac{\hbar}{2\tau} = \frac{h}{4\pi\tau} = \frac{6.63 \times 10^{-34}}{4\pi \times 0.1 \times 10^{-9}} = 5.27 \times 10^{-25}\ J$$

$$= 3.3 \times 10^{-6}\ eV$$

This is the natural width of the γ-emission line at 2.0 MeV energy.

This energy is much less than the experimental resolution of the detector (± 5 eV). The width cannot be measured.