The probability of scattering $p = \sigma/a_{\rm int}$, where σ is the scattering cross section and $a_{\rm int}$ is the "area of interaction" (which will cancel in the end). The number of scattering events $N = pN_bN_t$ where N_b is the number of beam particles on target and N_t is the number of target particles in the area of interaction. So

$$N = \frac{\sigma N_b N_t}{a_{\rm int}}$$

$N_t = V\rho_n$ where V is the volume of the target and ρ_n is the number density of target particles. $V = a_{\rm int}l$ where l is the length of the target. So $N_t = a_{\rm int}l\rho_n$. $\rho_n = \rho/m_t$ where ρ is the mass density of the target and m_t is the mass of a single target particle. So $N_t = a_{\rm int}l\rho/m_t$. If the target is a nucleus, $m_t = A/N_A$ where A is the atomic weight (in grams per mole usually) of the target particle and N_A is Avogadro's number. So $N_t = a_{\rm int}l\rho N_A/A$ and

$$N = \frac{\sigma N_b l \rho N_A}{A}$$

$$N_b = Rt$$

where R is the beam photon time rate and t is the time of running.