15.7 (a) Similar to Prob. 15.4, the final velocities of the particles are $\frac{A_2\beta}{A_1+A_2}$ and $\frac{-A_1\beta}{A_1+A_2}$,

and $$\vec{E} = Z_1 e \frac{A_2\vec{\beta}/(A_1+A_2)}{1-A_2\beta\cos\theta/(A_1+A_2)} + Z_2 e \frac{-A_1\vec{\beta}/(A_1+A_2)}{1+A_1\beta\cos\theta/(A_1+A_2)}$$

$$= e\vec{\beta}\left(\frac{Z_1A_2 - Z_2A_1}{A_1+A_2} + \frac{Z_1A_2^2 + Z_2A_1^2}{(A_1+A_2)^2}\beta\cos\theta + \cdots \right),$$

where we have assumed the fission takes place at $\vec{r}=0$, and we have only retained terms to second order of β. Following the same argument as in Prob. 15.4, we have

$$\frac{d^2I}{d(\hbar\omega)d\Omega} = \frac{e^2\beta^2\sin^2\theta}{4\pi^2\hbar c}\left(\frac{Z_1A_2-Z_2A_1}{A_1+A_2} + \frac{Z_2A_2^2+Z_2A_1^2}{(A_1+A_2)^2}\beta\cos\theta \right)^2$$

$$= \frac{\alpha\beta^2\sin^2\theta}{4\pi^2}\left| p + q\beta\cos\theta \right|^2,$$

with $\alpha = \frac{e^2}{\hbar c}$, $p = \frac{Z_1A_2 - Z_2A_1}{A_1+A_2}$, $q = \frac{Z_1A_2^2+Z_2A_1^2}{(A_1+A_2)^2}$.

Performing the angular integration,

$$\frac{dI}{d(\hbar\omega)} = \int \frac{d^2I}{d(\hbar\omega)d\Omega}d\Omega = \frac{\alpha\beta^2}{4\pi^2}2\pi\int_{-1}^{1}\sin^2\theta\left(p^2 + 2pq\beta\cos\theta + q^2\beta^2\cos^2\theta\right)d(\cos\theta)$$

$$= \frac{\alpha\beta^2}{2\pi}\left(\frac{4}{3}p^2 + \frac{4}{15}q^2\beta^2\right) = \frac{2\alpha\beta^2}{3\pi}\left(p^2 + \frac{q^2\beta^2}{5}\right).$$