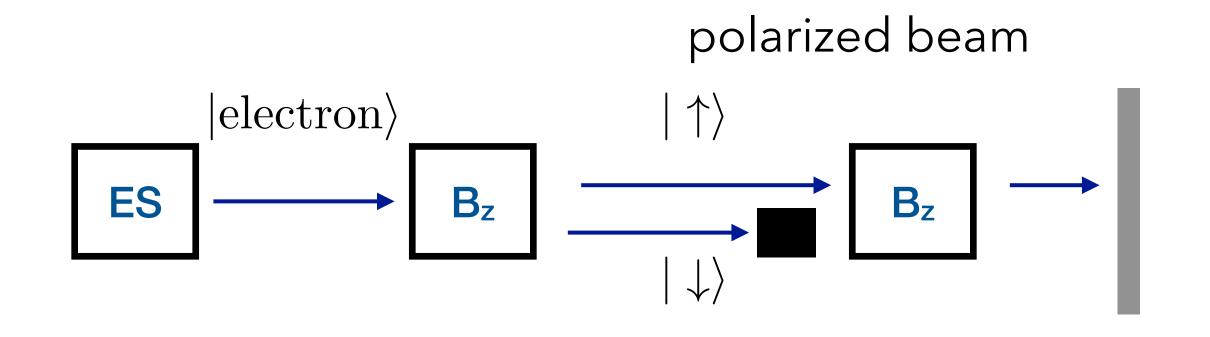


50% up / 50 % down

$$|\text{electron}\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle + \frac{1}{\sqrt{2}}|\downarrow\rangle = |+\rangle$$

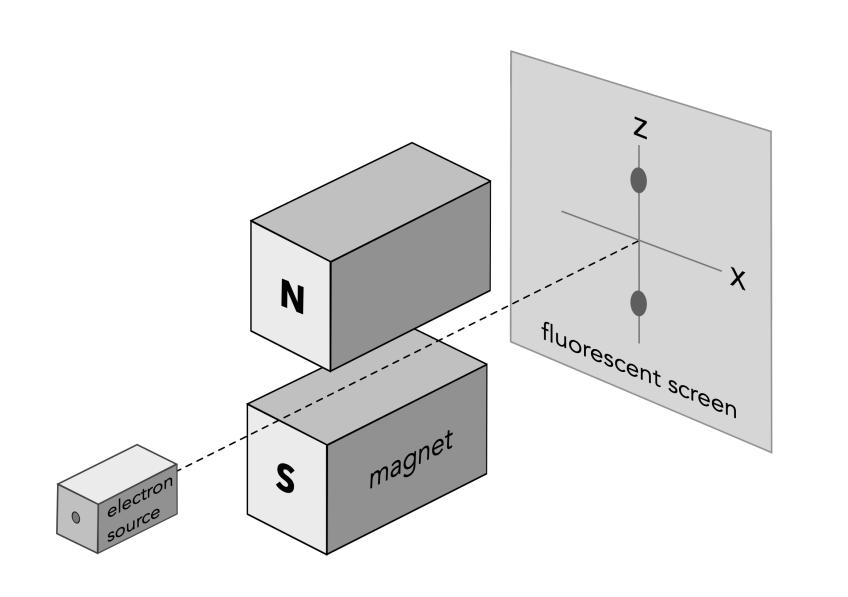
or

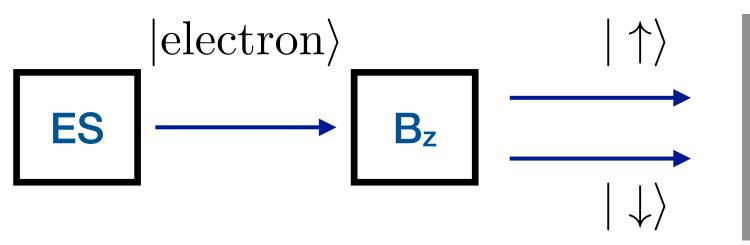
$$|\text{electron}\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle - \frac{1}{\sqrt{2}}|\downarrow\rangle = |-\rangle$$



100 % up

Spin moment in z:
$$+\frac{1}{2}\hbar$$





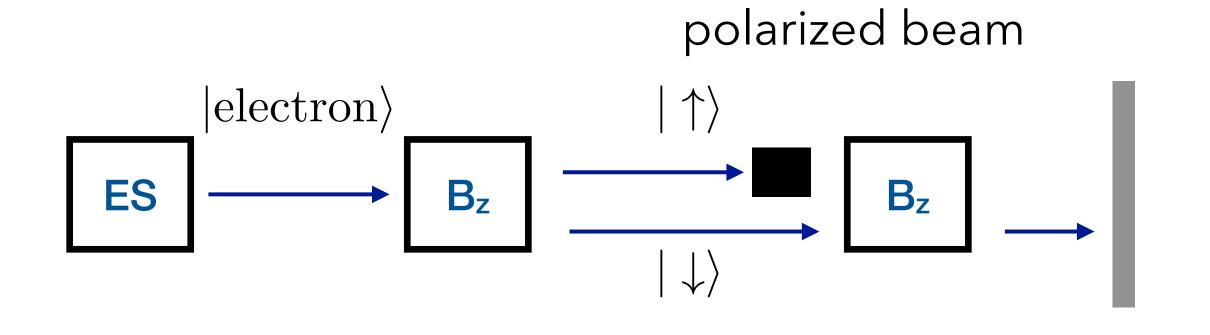
50% up / 50 % down

$$|\text{electron}\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle + \frac{1}{\sqrt{2}}|\downarrow\rangle = |+\rangle$$

or

$$|\text{electron}\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle - \frac{1}{\sqrt{2}}|\downarrow\rangle = |-\rangle$$

or



100 % down

Spin moment in z:
$$-\frac{1}{2}\hbar$$

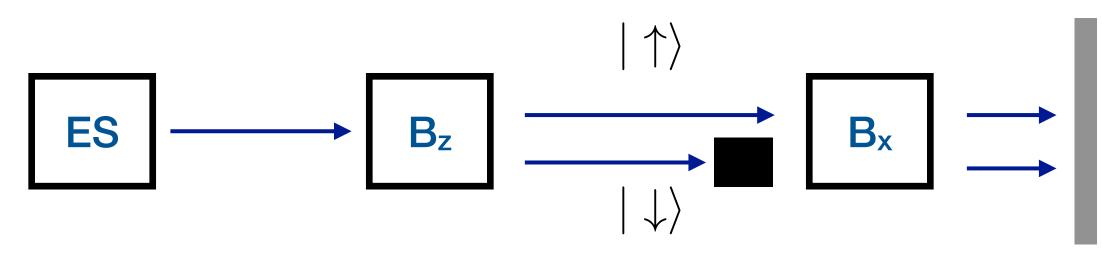
$$\begin{array}{c|c} & & & & & & & & \\ \hline \\ \hline \\ \hline \\ \hline \\ \end{array}$$

50% left / 50 % right

Spin moment in x:
$$\pm \frac{1}{2}\hbar$$

$$|\text{electron}\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle + \frac{1}{\sqrt{2}}|\downarrow\rangle$$

polarized beams



Random events

50% left / 50 % right

$$|\uparrow\rangle = \frac{1}{\sqrt{2}}|\rightarrow\rangle + \frac{1}{\sqrt{2}}|\leftarrow\rangle$$

$$|\downarrow\rangle = \frac{1}{\sqrt{2}}|\rightarrow\rangle - \frac{1}{\sqrt{2}}|\leftarrow\rangle$$

Random events

50% left / 50 % right

$$|\uparrow\rangle = \frac{1}{\sqrt{2}}|\rightarrow\rangle + \frac{1}{\sqrt{2}}|\leftarrow\rangle$$

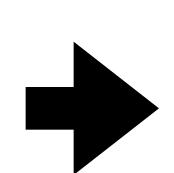
$$|\downarrow\rangle = \frac{1}{\sqrt{2}}|\rightarrow\rangle - \frac{1}{\sqrt{2}}|\leftarrow\rangle$$

$$|
ightarrow
ig$$

$$|+\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle + \frac{1}{\sqrt{2}}|\downarrow\rangle$$

but we also have:

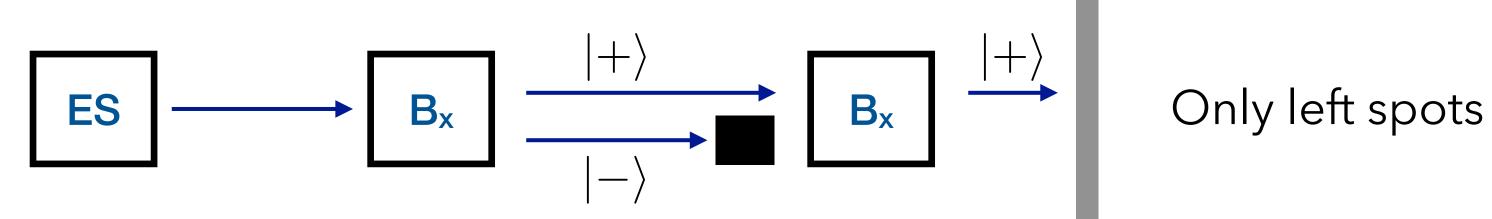
$$|-\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle - \frac{1}{\sqrt{2}}|\downarrow\rangle$$



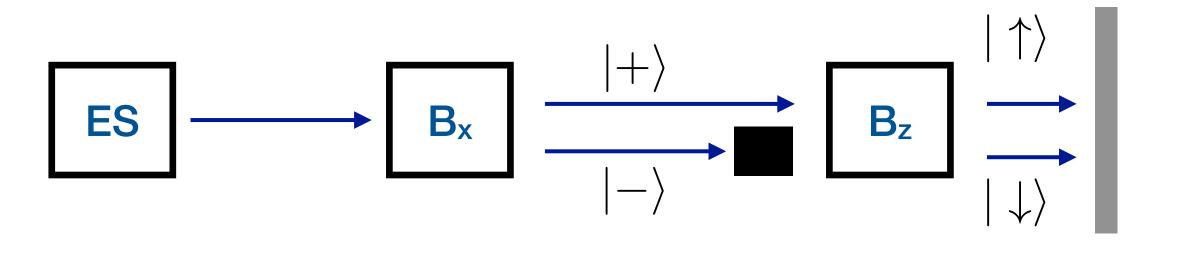
$$|\uparrow\rangle = \frac{1}{\sqrt{2}}|+\rangle + \frac{1}{\sqrt{2}}|-\rangle$$

$$|\downarrow\rangle = \frac{1}{\sqrt{2}}|+\rangle - \frac{1}{\sqrt{2}}|-\rangle$$

polarized beams



Only right spots



50% up / 50 % down

$$|+\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle + \frac{1}{\sqrt{2}}|\downarrow\rangle$$

Random events

50% left / 50 % right

$$|\uparrow\rangle = \frac{1}{\sqrt{2}}|+\rangle + \frac{1}{\sqrt{2}}|-\rangle$$

N times:
$$|\mathrm{electron}\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle + \frac{1}{\sqrt{2}}|\downarrow\rangle$$

 B_{x}

N times:
$$|\mathrm{electron}\rangle = \frac{1}{\sqrt{2}}|\uparrow\rangle + \frac{1}{\sqrt{2}}|\downarrow\rangle$$

$$\mathbf{3}_{\mathsf{Z}}$$

N times:
$$|\text{electron}\rangle = \frac{1}{\sqrt{2}} |\uparrow\rangle + \frac{1}{\sqrt{2}} |\downarrow\rangle$$