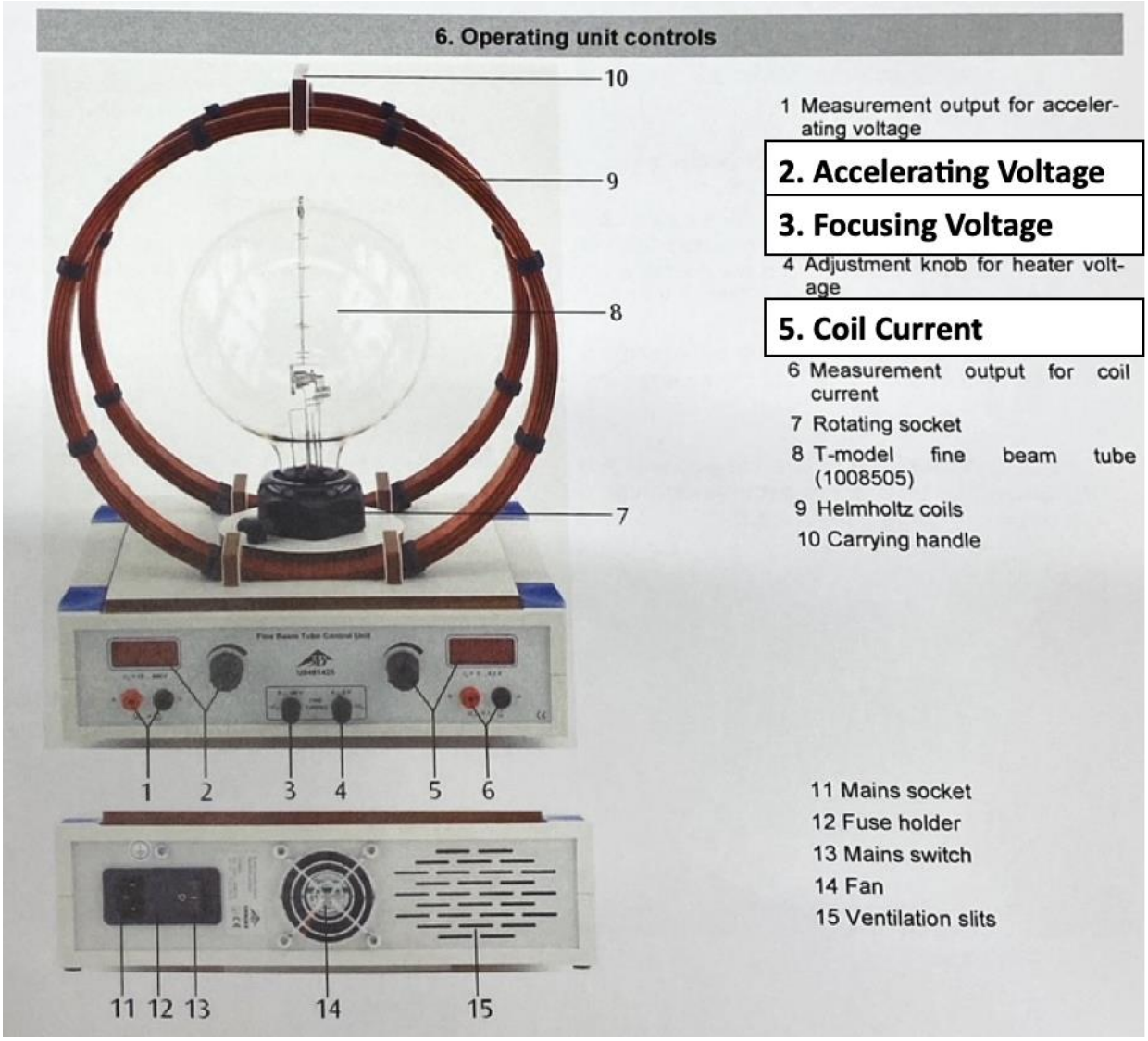
Option: Physics

Goal: Control an electron beam inside an electron globe

Overview: What you should know about the operation of the electron globe:



Task 1:
Investigate electron beam trajectory.

- Turn all knobs to zero.
- Ask your tutor to switch off the lights.
- Switch on the device (black switch at the back) **after making sure the ventilation at the back is not obstructed**.
- Turn current to 2A. You should see a faint orange glow. Wait a few seconds for this to stabilise.
- Turn up the voltage. What do you observe?
- Use the focusing voltage to calibrate the electron beam.

How does changing the current or voltage affect what you see?

Explanation

Why is the colour different to the electron tube?

This beam has a different energy ☐
The electron globe contains a different gas than the tube ☐
This beam is made up of protons ☐

Task 2:
Exploration.

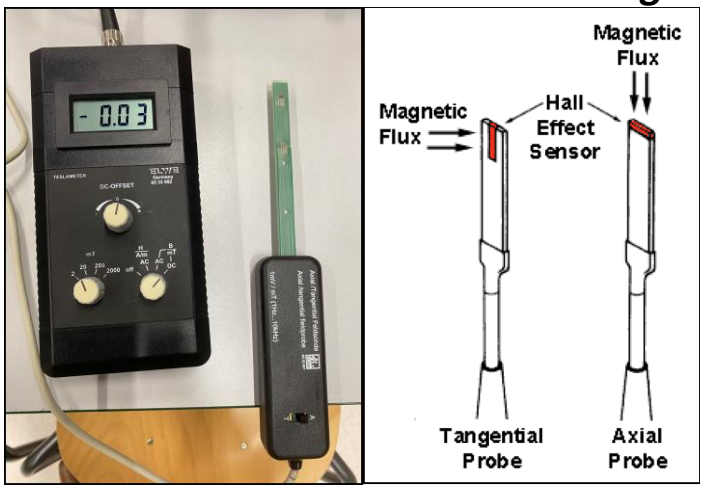
- **Use coil current**, to investigate how the strength of the magnetic field affects the radius of the circular trajectory.
- Investigate what happens if you bring a **bar magnet** close to the trajectory. **Be careful not to touch the glass!**

- **Investigate rotating socket** and learn how an electron beam behaves when NOT at 90° to magnetic field.

Operator challenge: 2 operators are each responsible for 1 setting (current or voltage). **Your task is to try and keep a constant circle trajectory** while decreasing the current. Use the guiderails inside the globe as a reference to try and keep a steady circle of 5cm!

Task 3: Measure magnetic field of electron globe using a Teslameter.

Teslameter **T or A setting**



- Set Teslameter Settings: **20mT and B - DC.**
- **Write down meter offset** **B_{offset} = _____ units _____**
- Set coil current of your choice. **Coil Current = ____ units _____**
- Measure maximum magnetic field around electron globe **<u>without touching it!</u>** **$B_{measured}$ = ____ units _____**
- Calculate magnetic field. **B = $B_{measured}$ - B_{offset} =_____ units _____**

Optional Task:
Calculate the radius of circular accelerator.

Calculate the radius required for circular accelerators that achieve the same momentum as the LHC (Large Hadron Collider), or the FCC (Future Circular Collider) if you used the electromagnets from the electron globe.

Rule of thumb for relativistic particles

$$p = 300rB$$

Momentum	p	in units of	TeV/c
Radius	r	in units of	km
Magnetic Field Strength	B	in units of	mT

Radius required for LHC particles (p = 8 TeV/c)

_____

_____

Radius required for FCC particles (p = 100 TeV/c)

_____

_____

For comparison:

Radius of LHC:	2.8 km
Radius of FCC (planned):	15.9 km
Radius of Earth:	6,371 km
Geostationary Orbit:	35,785 km
Distance Earth-Moon:	384,400 km