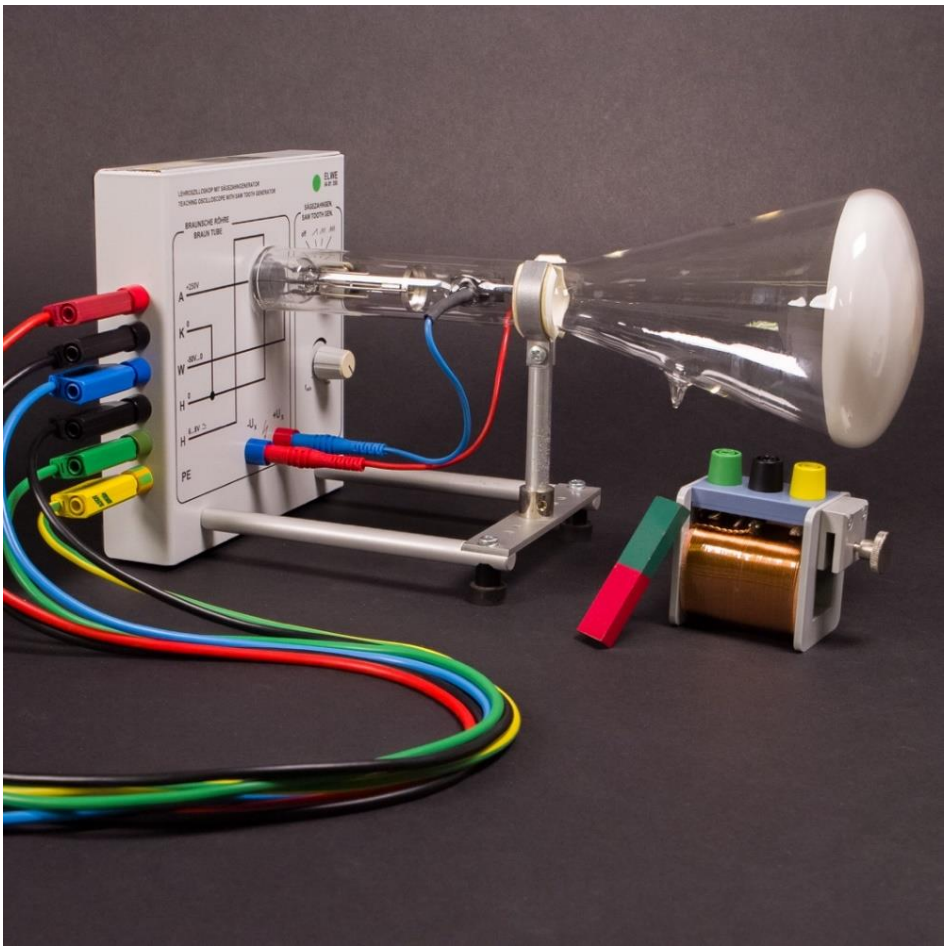


Electron Beams

Learn how to make and control electron beams and observe how electrons behave in magnetic fields.

Spokesperson:	……
Scientific writer:	……
Safety manager:	……
Technical Coordinator:	……

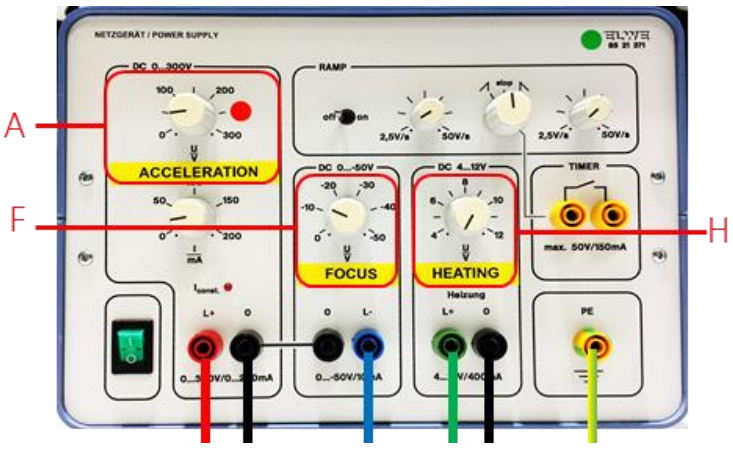
Lab Activities

Task 1:
Make an electron beam.

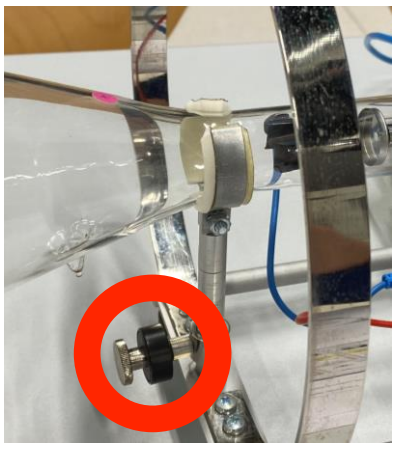
- Turn all knobs to zero.
- Switch on the device (green main switch).
- Turn on the heating voltage to 6 V. If you don't see a faint (orange) glow at the heating wire after 10 sec, increase the voltage in 1V steps.
- Turn on the acceleration voltage slowly and observe the beam.

  At which voltage does it reach the fluorescent screen? _____**V**
- Look at the fluorescent screen. Can you find a bright green spot?
- Use the ring magnet (see below) to calibrate the electron beam so it hits the centre of the screen (front view).
- Vary the focusing voltage, until the beam is focused optimally.

Power supply



Ring Magnet



A = Acceleration **F** = Focusing **H** = Heating

DANGER

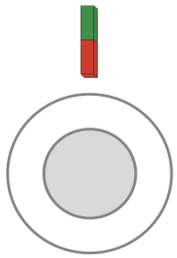
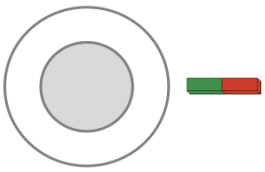
Maximum Values:
Acceleration = 250 V. Heating voltage = 10 V.

Task 2:
Control an electron beam (using bar magnets).

Prediction

Think first! What effect would a bar magnet have on the electron beam, when you lead it along the metal ring?

- Mark your predictions for the position of the beam spot with a cross ✗ for the 2 magnet positions below.

Magnet position 1	Student 1	Student 2
		
	Student 3	Student 4
Magnet position 2	**Student 1**	**Student 2**
		
	Student 3	Student 4

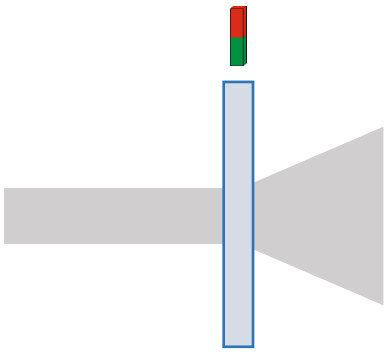
Observation

Now try out the 2 positions of the magnet and mark your observation with a **circle** ○ on the **same** diagram.

- Did your observations match your predictions?
- Switch everything off when you are done.

Front View

Side View



Explanation

1. What is the angle between the **direction of the magnetic field** and the **force on the electrons**?

Approx. 0° ☐
Approx. 45° ☐
Approx. 90° ☐
Approx. 135° ☐
Approx. 180° ☐

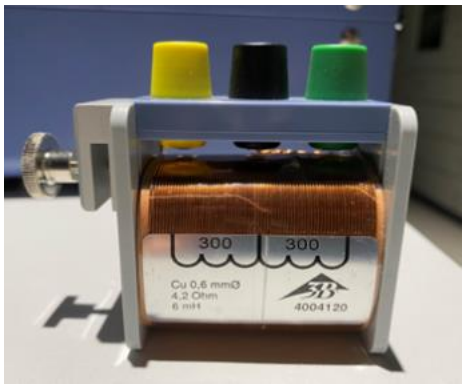
2. What is the angle between the **flight direction of the electrons** and the **force on the electrons?**

Approx. 0° ☐
Approx. 45° ☐
Approx. 90° ☐
Approx. 135° ☐
Approx. 180° ☐

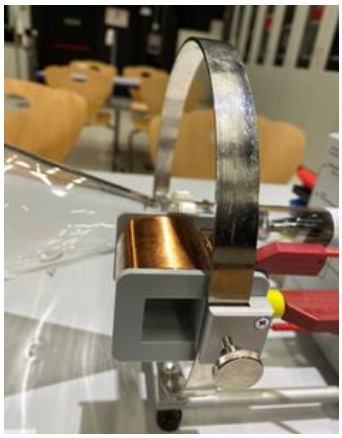
Task 3:
Control an electron beam (using electromagnets).

- Attach electromagnet to ring as shown below.

Electromagnet

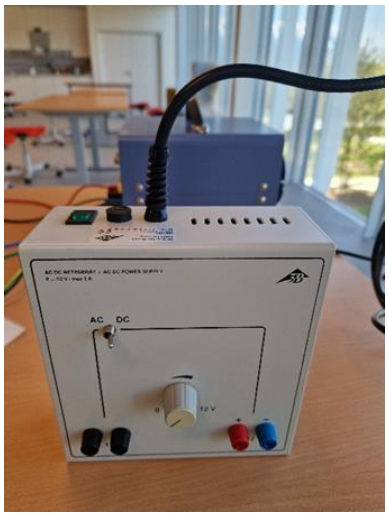


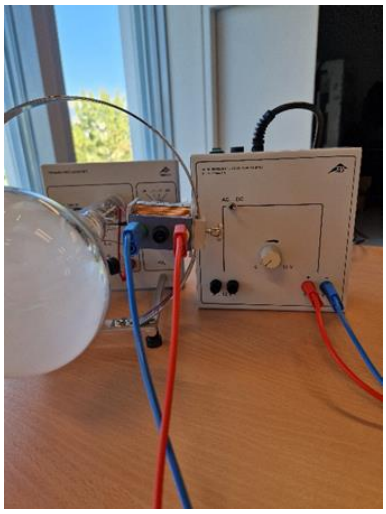
Attachment of the electromagnet



- Get second power supply, turn knob to zero and switch to DC.
- Connect the electromagnet to the second power supply (+/-) by using the red and blue cables as shown below.

Second Power supply





- Connect the second power supply to mains.
- Set up electron beam as in Task 1.
- Switch on second power supply (green switch on top).
- Gradually increase voltage on second power supply and observe.

CAREFUL! Slowly increase voltage!

- Switch off voltage of the second power supply.
- Swap the cables on the power supply to change polarity of electromagnet.
- Turn second power supply back on and observe.

Observation What happened when you swapped the cables of the second power supply to change the polarity of the electromagnet?

- Switch off both power supplies when finished.

Explanation

1. What are advantages of using an **electromagnet** to control an electron beam? (more than 1 possible answers)

Better control of the magnetic field strength ☐
Can be switched on and off easily ☐
Is more energy efficient ☐
Can produce a stronger magnetic field ☐

2. How can you **make** an electromagnet **stronger**?

Increase number of turns to the coil ☐
Increase electric current through the coil ☐
Insert iron core ☐

Optional Task: The e-beam Alignment Challenge.

Your mission is to align the e-beam and deflect it to hit 4 specific points indicated by 4 pink dots somewhere on the glass of your electron tube, by using a bar magnet. Set up as in Task 1 “Make an electron beam.

Learn more

1. The LHC at CERN uses superconducting magnets. How are superconducting magnets different to regular electromagnets?

2. Why are magnetic fields used to bend particle beams and not electric fields?