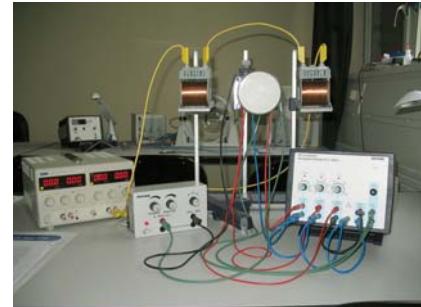


## Quick reference guide

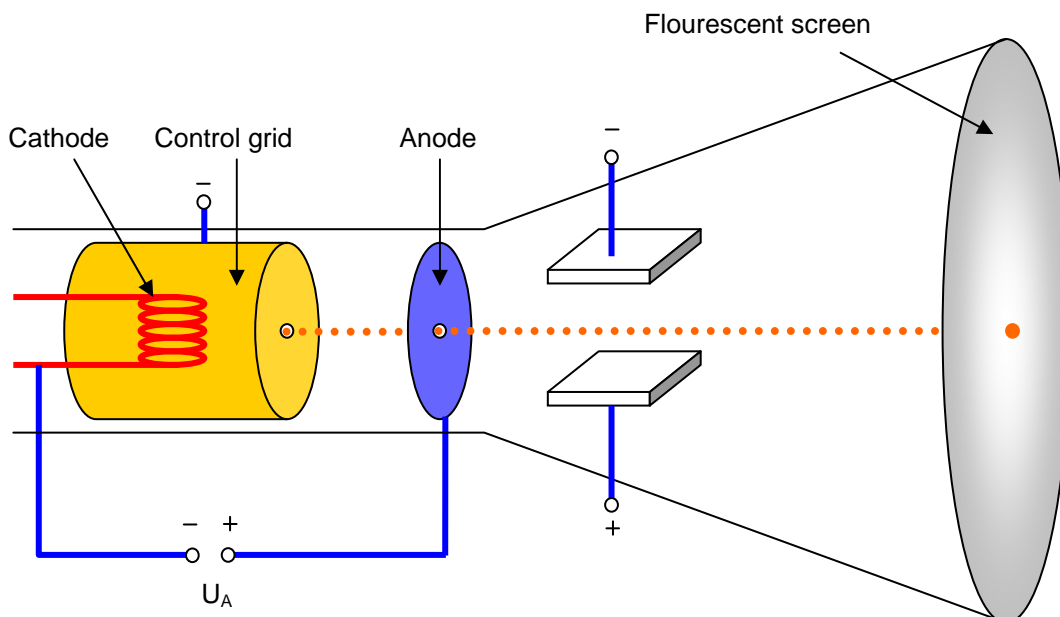
### Introduction

The Cathode Ray Tube or Braun's Tube was invented by the German physicist Karl Ferdinand Braun in 1897 and is today used in computer monitors, TV sets and oscilloscope tubes. The path of the electrons in the tube filled with a low pressure rare gas can be observed in a darkened room as a trace of light. Electron beam deflection can be effected by means of either an electrical or a magnetic field.



### Functional principle

- The source of the electron beam is the electron gun, which produces a stream of electrons through thermionic emission at the heated cathode and focuses it into a thin beam by the control grid (or "Wehnelt cylinder").
- A strong electric field between cathode and anode accelerates the electrons, before they leave the electron gun through a small hole in the anode.
- The electron beam can be deflected by a capacitor or coils in a way which causes it to display an image on the screen. The image may represent electrical waveforms (oscilloscope), pictures (television, computer monitor), echoes of aircraft detected by radar etc.
- When electrons strike the fluorescent screen, light is emitted.
- The whole configuration is placed in a vacuum tube to avoid collisions between electrons and gas molecules of the air, which would attenuate the beam.



## Safety precautions

- Don't touch cathode ray tube and cables during operation, voltages of 300 V are used in this experiment!
- Do not exert mechanical force on the tube, danger of implosions!



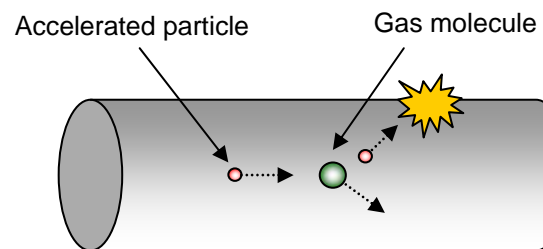
## Experimental procedure

1. Set the voltage of the auxiliary anode to 10 V using the first knob on the dc power supply
2. Set the voltage of the anode to about 30...50 V using the second knob on the dc power supply
3. Use the third knob to intensify the beam (200...300 V)
4. Modulate the voltage of the anode and the auxiliary anode to get a sharp beam (knob 1+2)
5. The cathode ray tube consists of a vacuum tube. Why?

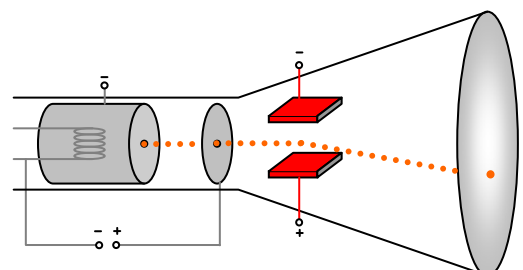
The Braun's tube is a vacuum tube to avoid collisions between electrons and gas molecules of the air. Collisions would slow down and leak the electrons, without vacuum the image on the screen would be less bright.

Collisions between particles and gas molecules are undesired in particle accelerators as well. The leaked particle will be lost when it hits the metal of the beam pipe.

The solution is the same as in the cathode ray tube: the creation of a ultra high vacuum to increase the mean free path (the average distance a particle can fly without hitting a gas molecule). There is 9000 m<sup>3</sup> of pumped volume in the LHC, like pumping down a cathedral. Instead of 10<sup>19</sup> molecules / cm<sup>3</sup> there are only 3 million molecules per cm<sup>3</sup> left.



6. Switch on the Braun's tube operation unit
7. Add a tension (-80V...+80V) to the deflection plates by adjusting the zero-point: the horizontal position of the light spot will change
8. Add a tension to the deflection plates by increasing the amplitude of the Braun's tube operation unit. The electron beam will wander from the left to right when writing the time base. We can also change the frequency of this tension.



9. Magnetic deflection of the electron beam can be demonstrated by approaching the pole of a bar magnet to the cathode ray tube. We can provide magnetic field to the tube by using another power supply. The tension that this device provides is DC, so the deflection caused to the light spot is standing and **perpendicular**.
10. It is possible to produce a set-up for periodic deflection of the electron beam with the aid of an alternating magnetic field, setting two series connected coils, 1200 winding, on a coil holder which (possibly with the aid of clamping columns) can be secured to retort stands; the common coil axis should intersect the cathode ray tube between the anode and deflector plates.

