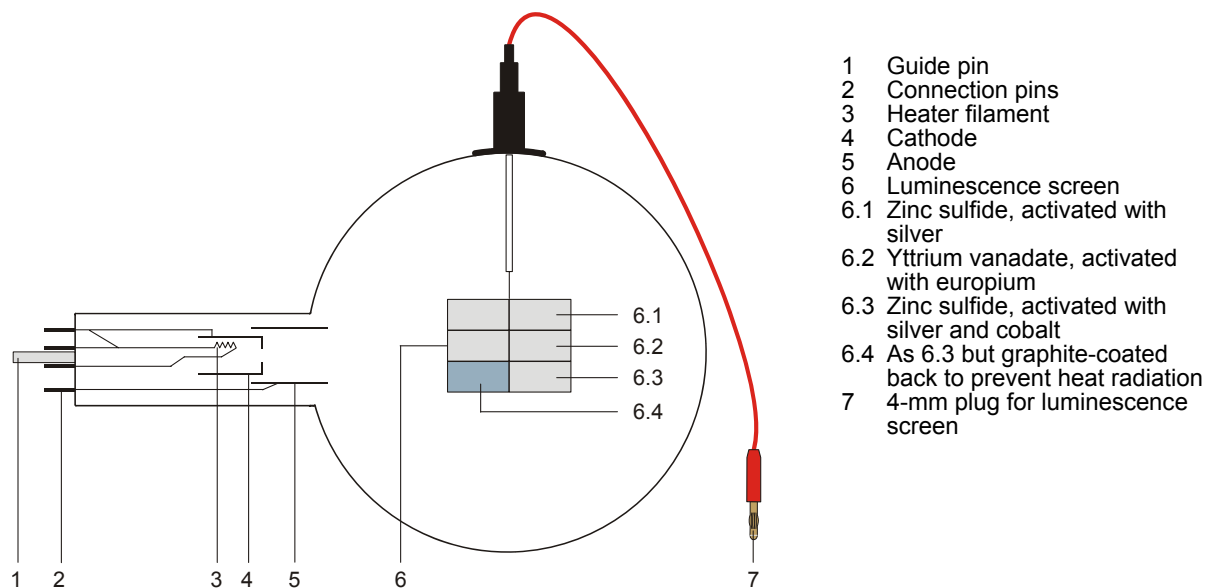


## Luminescence Tube S 1000615

### Instruction sheet

12/12 ALF



- 1 Guide pin
- 2 Connection pins
- 3 Heater filament
- 4 Cathode
- 5 Anode
- 6 Luminescence screen
  - 6.1 Zinc sulfide, activated with silver
  - 6.2 Yttrium vanadate, activated with europium
  - 6.3 Zinc sulfide, activated with silver and cobalt
  - 6.4 As 6.3 but graphite-coated back to prevent heat radiation
- 7 4-mm plug for luminescence screen

### 1. Safety instructions

Hot cathode tubes are thin-walled, highly evacuated glass tubes. Treat them carefully as there is a risk of implosion.

- Do not subject the tube to mechanical stresses.
- Do not subject the connection leads to any tension.
- The tube may only be used with tube holder S (1014525).

If voltage or current is too high or the cathode is at the wrong temperature, it can lead to the tube becoming destroyed.

- Do not exceed the stated operating parameters.
- Only use safety experiment leads for connecting circuits.
- Only change circuits with power supply equipment switched off.
- Only exchange tubes with power supply equipment switched off.

When the tube is in operation, the stock of the tube may get hot.

- Allow the tube to cool before dismantling.

The compliance with the EC directive on electromagnetic compatibility is only guaranteed when using the recommended power supplies.

### 2. Description

The luminescence tube serves to demonstrate the luminescence of a phosphorous anode when excited by electrons (cathodoluminescence) or ultraviolet light (photoluminescence).

The luminescence tube is a highly evacuated tube with an electron gun consisting of a pure tungsten heater filament inside an apertured "cathode can" and a cylindrical anode contained in a clear glass bulb. A luminescence screen with three mica flags with different phosphors is mounted on a metal support.

### 3. Technical data

Filament voltage:	6.0 V AC/DC (8.0 V max.)
Filament current:	1.6 A typical at $U_F = 6.0$ V
Anode voltage:	2000 - 5000 V DC
Anode current:	160 $\mu$ A typical at $U_A = 4500$ V
Phosphor screen current:	100 $\mu$ A typical at $U_S = 4500$ V
Glass bulb:	130 mm diam. approx.
Total length:	260 mm approx.
Luminescence screen:	
6.1: fluorescent blue, approx. 450 nm, me- dium decay time	
6.2: fluorescent red, approx. 625 nm, me- dium short decay time	
6.3: fluorescent green, approx. 510 nm fluo- rescent, approx. 515 nm phosphorescent, long decay time	

### 4. Operation

To perform experiments using the luminescence tube, the following equipment is also required:

1 Tube holder S	1014525
1 High voltage power supply 5 kV (115 V, 50/60 Hz)	1003309
or	
1 High voltage power supply 5 kV (230 V, 50/60 Hz)	1003310
1 Analogue multimeter AM51	1003074
1 High-pressure mercury vapour lamp	1000852
Spectrum tube power supply (115 V, 50/60 Hz)	1003195
or	
Spectrum tube power supply (230 V, 50/60 Hz)	1003196
1 Infra-red light source	

#### 4.1 Setting up the tube in the tube holder

The tube should not be mounted or removed unless all power supplies are disconnected.

- Press tube gently into the stock of the holder and push until the pins are fully inserted. Take note of the unique position of the guide pin.

#### 4.2 Removing the tube from the tube holder

- To remove the tube, apply pressure with the middle finger on the guide pin and the thumb on the tail-stock until the pins loosen, then pull out the tube.

### 5. Example experiments

#### 5.1 Excitation by cathode ray bombardment

- To better observe the afterglow effects (phosphorescence), carry out the the last step of the experiment in a darkened room.

- Set up the luminescence tube as shown in fig.1.
- Connect both the screens and the anode to earth for maximum safety.
- Set the voltage  $U_A$  to about 3500 V.
- Observe the luminescence.

The three phosphors fluoresce at different wavelengths (colours).

- Vary the voltage between 2500 V and 4500 V.
- Observe the change of the luminous phenomenon.

While the intensity of the fluorescence varies with the voltage, wavelength does not.

- With  $U_A$  at 4500 V use a hand held spectroscope to view the emissions from each phosphor.

Note that the emission from the red phosphor comprises a number of discrete emission lines.

- Switch off the power supply and observe the afterglow (phosphorescence).

The removal of the source of thermionic bombardment causes luminescence to cease. The decay of emission from the phosphors is particularly apparent on the green phosphor.

#### 5.2 Excitation by ultra-violet light

- Carry out the experiment in a darkened room.
- Set up the luminescence tube as shown in fig.2.
- Do not switch on the power supply.

Note that there is no visible photoluminescence due to the ambient light levels.

- Illuminate the gun side of the screen with ultra-violet light and note the initial time dependency of emission intensity.

The three phosphors fluoresce at the same wavelength as when excited by cathode ray bombardment.

- Vary the intensity of the ultra-violet light, either by changing the distance between the light source and the phosphor, or by interposing suitable filters.

While the intensity of the fluorescence varies with the intensity and energy of the exciting radiation, wavelength does not.

- Remove the ultraviolet light and observe the afterglow (phosphorescence).

The decay characteristic of the green phosphor appears longer than was observed after removal of cathode ray bombardment. The reason for this is that the phosphorescence of this material is quenched by infra-red radiation. When the filament supply is switched off there remains sufficient infra-red emission from the cooling filament to partially quench phosphorescence.

- Set the voltage to about 4500 V and note the current flowing (typically 0.02  $\mu$ A due to leakage on or through the glass bulb).
- Illuminate the phosphors with ultra-violet light and note that there is no change in current.

Since there is no change in current, it is clear that the emission from the phosphorous materials is due to excitation processes and not to ionisation.

### 5.3 Phosphorescence and quenching

- Remove all connecting leads from the tube (refer to fig. 3).
- Set up a ultra-violet light source so that the gun side of the screen can be illuminated.
- Set up a infra-red light source so that the backside of the screen can be illuminated.

- Illuminate the phosphors with ultra-violet light until the green phosphor has built up to full intensity.
- Switch off the ultra-violet light source and immediately switch on the infra-red light source.

The phosphorescence of the unprotected half of the green phosphor is quenched while the other half remains unaffected.

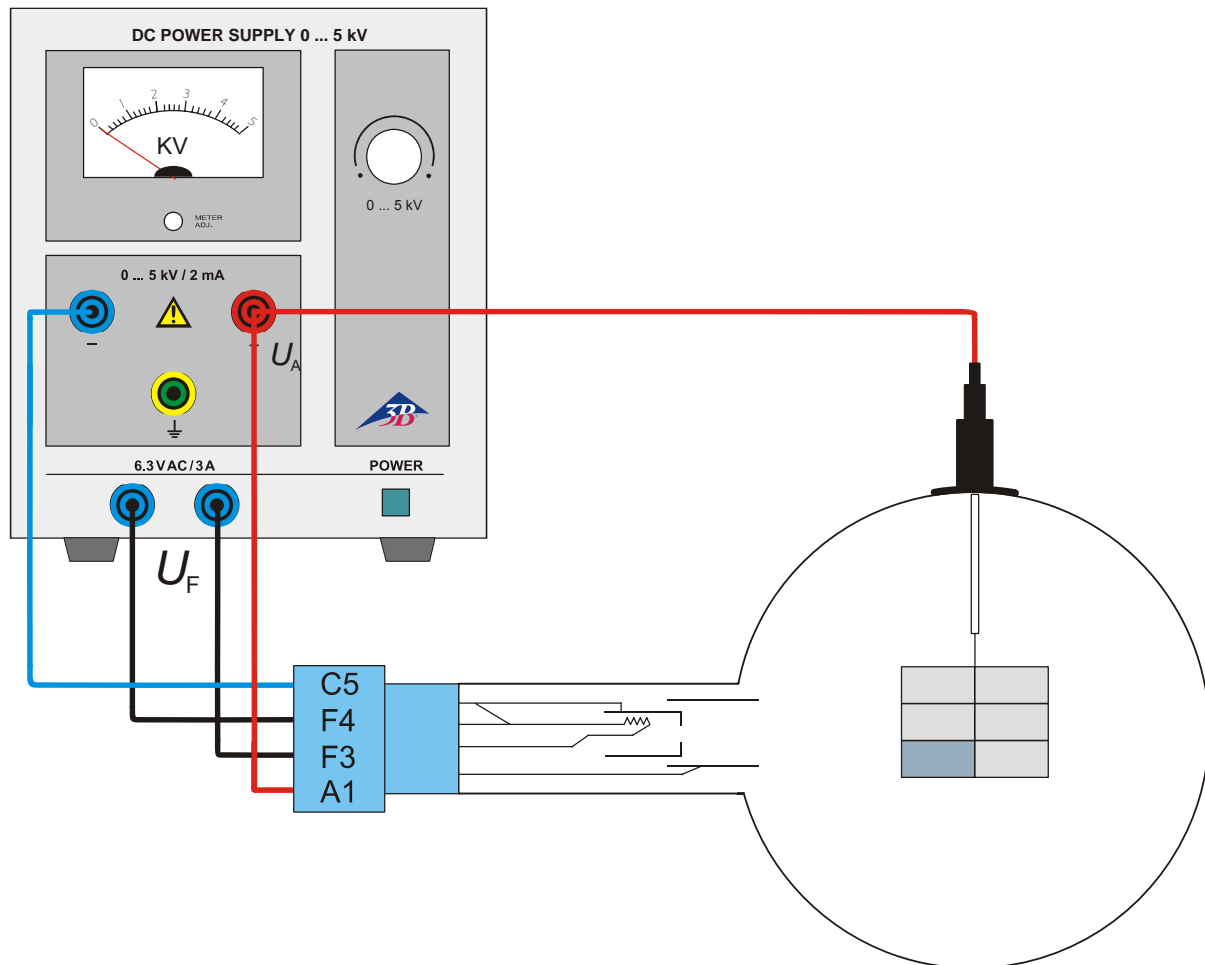


Fig. 1 Excitation by cathode ray bombardment

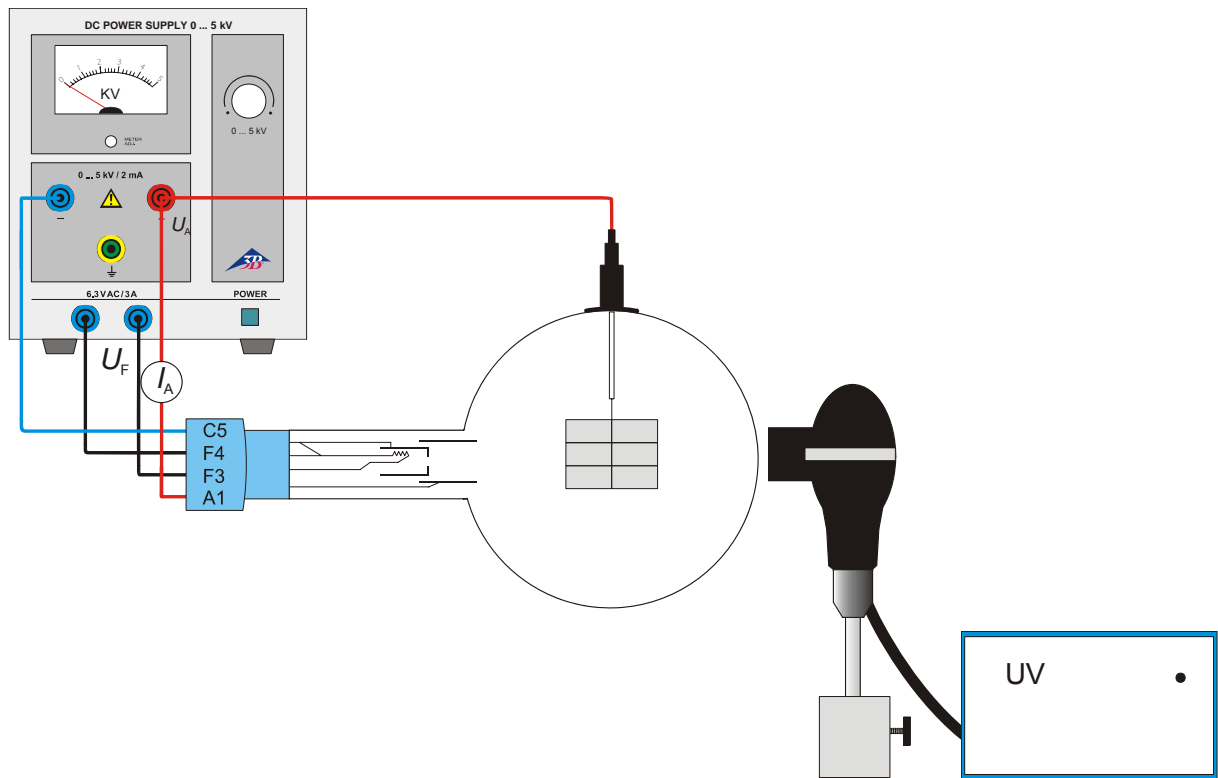


Fig. 2 Excitation by ultraviolet light

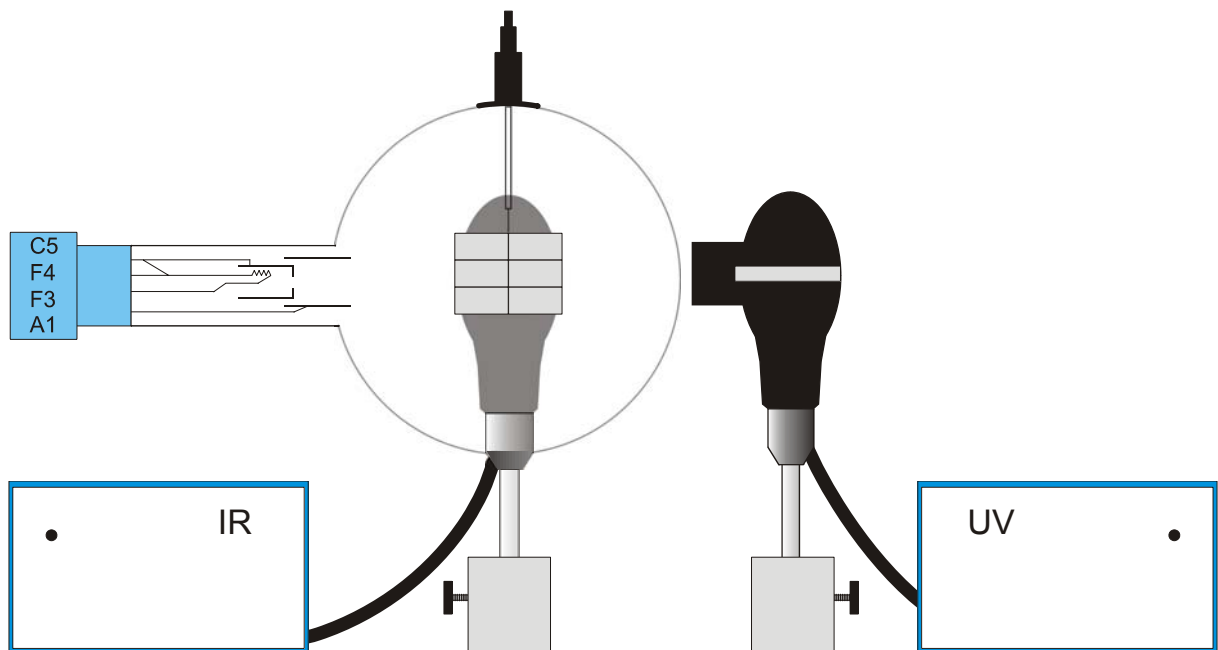


Fig. 3 Phosphorescence and quenching