Standard Operation Procedure (SOP)
X-ray Fluoresence setup with microsource

Jens Uhlig

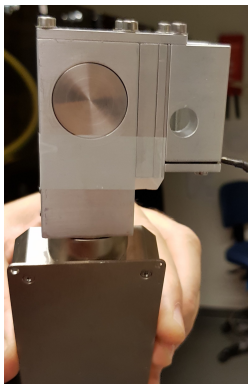
December 2018

The source must ONLY be operated together with the double bounce fluorescence chamber shown in the figure below.

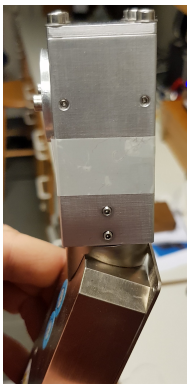
This source consists of a small x-ray tube with build in high voltage supply. Find detailed specifics of the source in the attached product sheet. This source has a silver through anode deposited on a thin beryllium window. The window is directly visible and very brittle. During assembling please make sure that at no time the window can be touched by any equipment. Breaking the window will result in loss of the vacuum and thus permanently damage the source. The source in itself can produce an anode current of 100 µA at a maximum acceleration Voltage of 50.000 V.
The produce x-ray flux is beyond any permissible limits and thus the source must not be used without the fully assembled double bounce fluorescence chamber and the controller prepared for this system. An Interlock cable is connected between the fluorescence chamber and the special operating cable insures that the source can not be turned on without the chamber connected.

Figure 1: Lorem ipsum

(a) source with interlock cable connected



(b) fluorescence chamber mounted with interlock cable on the right



(c) fluorescence chamber mounted with two small set screws on the bottom fixing chamber and source together

The source is controlled by an specially configured box connected over a specially configured plug. The plug is connected to a RS232 connector, which has a receiver on the control box. Any straight RS232 connection cable (no modem cable!) can be used to extend the distance between the control box and the source. Connected to the control box are an emergency off button that should be placed in a good reachable position and a warning light light engages as soon as the source is activated (even at zero current).
The main elements of the control box are:

1. a power input with needs 11V and minimum 1A
2. One control dial for the current (without grading)
3. One control for the acceleration voltage (without grading)
4. One red labeled enable button

(a) Control box with attached (on long cables for convenient placement) emergency button and warning light

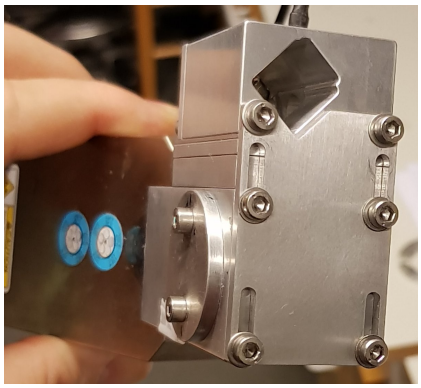
(b) Main controls for daily use, current and voltage dial, enable button

(c) Power input (most left) and additional control interfaces

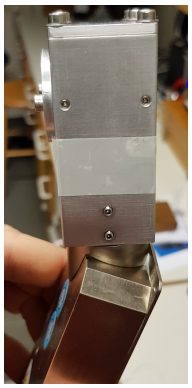
In addition there are a number of connectors that are only to be used for measurement of the applied conditions. These additional connections can be connected to a voltmeter with the common ground of the power supply plug. The current and voltage are mapped 0–4 V → 5–50 V and 0–4 V → 0–100 µA. The controller is programmed to limit maximum current to a level where the source is not emitting radiation beyond the allowed level. The current dial thus maps for a fixed acceleration voltage between 0 A and the maximum permissible.

1 Daily operation

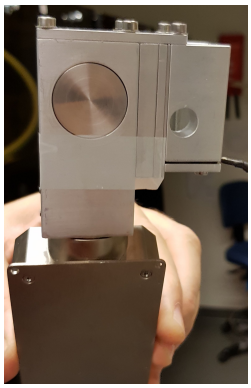
During operation the source must be mounted! For daily operation of the source. Make sure that the fluorescence chamber is solidly connected to the source and that the interlock cable is connected. Connect power to the minus and plus poles. The primary radiation cylinder has two positions, one typically filled with Copper-foil. The secondary (science) holder is a standard cyvette placed in the second holder. Place the exit opening in front of the detector. Engage the source with the red button and regulate the Voltage and current until the desired emission is reached.



(a) Fluoresence chamber top. on the bottom the cylinder with the primary radiation target is visible. It is put in position and locked with the two horizontal setscrews visible in the middle figure. On the top the opening for the cyvette is visible



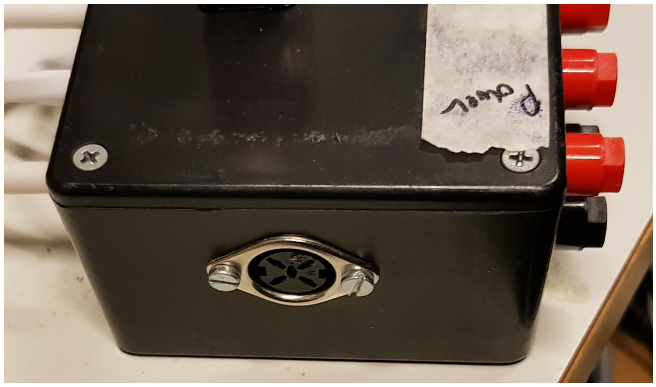
(b) side-view of the mounted fluorescence chamber. The top two setscrews secure the primary fluorescence target



(c) facing the emission hole of the source (right side)

2 Setup

The fluorescence chamber consists of two parts that are flexible connected. In the first part a cylinder is mounted that contains the primary fluorescence. The lines indicate when it is positioned at its optimal angle. The second chamber is connected over a series of spacers that allow to select the angular excitation. The further the second target is from the primary target the less radiation will reach it ($\sim 1/r^2$) but the cleaner the polarization of this radiation is selected. The secondary target holder is a cyvette that either contains the sample or to which the foil is attached. the bottom of the cyvette holder can be opened to allow access to the chamber and maybe mount a jet or clean the chamber.
The source controller is programmed to allow maximum flexibility, at sufficient safety. The programming is only possible by connecting a computer to the transfer cable to the specially designed port shown in the figure below. Any alteration to the program must be uploaded to the control unit by the radiation officer of Chemical Physics (who has the exclusive access to the transfer cable).



(a) programming input of the control box

(b) Specially designed USB-control box cable

3 Radiation control

Any handling of this equipment must be performed by personal that has undergone and documented the x-ray education procedure of Chemical Physics. The maximum flux of the source and fluorescence chamber are calibrated to be safe for the user. Additionally, for regular work weir a film dosimeter, use the geiger counter for checking of stray radiation and if available weir an electronic dosimeter with level alarm.

(a) Geiger counter

(b) electronic dosimeter