

## **ID10B**

instrument description and some hints for the  
beamline alignment

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# Chapter 1

## Introduction

TROIKA beamline is a high-brilliance, multipurpose undulator beamline with two separate branches ID10A/C and ID10B (or TROIKA-II). It is located at insertion device port ID10 and x-ray transparent diamond optics allows almost independent operation of the two branches. Independent operation is achieved by splitting the white beam from the undulators with an X-ray transparent monochromator crystal. ID10B uses photons within the energy range between 8 keV and 22.2 keV provided by a diamond double-crystal monochromator located in the common ID10 Optics Hutch. A separate (horizontally displaced) beam pipe contains the elements of focusing and diagnostics optics and guides the ID10B monochromatic beam through an independent PSS shutter into the ID10B Experimental Hutch, where a versatile 2+2 circle diffractometer for surface/interface studies in soft- and hard condensed matter systems is placed. ID10B has been conceived as a multipurpose beamline for the study of liquid and solid interfaces, combining grazing-incidence diffraction (GID), x-ray reflectivity (XR), and grazing-incidence small-angle scattering (GISAXS) techniques at a single instrument. Scattering experiments can be performed in both horizontal and in vertical scattering geometry. High-resolution studies with analyzer crystals stages are possible in both scattering geometries orientations. A speciality of ID10B is the study of organic thin films on solid and (particularly) liquid surfaces. With the techniques of GID, XR and GISAXS, length scales from sub-nm to 100 nm, in some cases even up to 1000 nm, can be explored. This allows to investigate self-organization processes at surfaces, interfaces and in thin films. New grazing incidence diffuse scattering (GIXOS) method of measurements provides information about in-depth electron density distribution within sub-minute time scale, making it possible to do in-situ studies of slow kinetic processes on the sample surface.

# Chapter 2

## Troika beamline computers network

### 2.1 Computers

The network which controls the Troika ID10A/C and ID10B beamlines consists of several PC computers and UNIX stations.

The username/password what refers to PC and stations: `opid10/troika02`

ID10A UNIX station: `tina2`

ID10A PC computers: `tinb`, `tinc`

`max` is the network name of the main PC in the ID10B control room. It uses Linux operation system. Main instrument control software is SPEC (some of the most frequently used SPEC commands are listed in the Section A)

On `max` several SPEC application can be started. Two frequently used applications are:

- `id10b` – control of the diffractometer and the Experimental Hutch
- `optics` – control of the optic elements in the Optic Hutch

Main application `id10b` should be started from the directory of current experiment. For example, user Ivanov, who is performing his experiment in the second half of the year 2007, should start `id10b` from

```
/opid10/data/user07.2/Ivanov
```

It is useful to create also in this directory sub-directory `/data` where SPEC will store the data files by default.

Directory `/Ivanov` with its internal structure is physically located on the main ESRF data-storage facility NICE with the following path:

```
/mntdirect/.data_id10b_inhouse/user07.2/Ivanov
```

Application `optics` should be started from

```
/opid10/data/user07.2/id10b
```

with recommended file name 'optics' and extension equivalent to the current date. For example `optics.311207`

The control of the undulators, checking the machine status and messages from the machine operators can be done from the application `idappli` which can be started in any shell console.

### Attention!

No USB devices are allowed to be connected to the slots of max. Also it is not recommended to run any unnecessary programs (like Internet browsers) that can slow down SPEC or completely crash the system.

From `opid10/common/go2linux.txt`

28/03/2003 Transition from UNIX to LINUX

#### Names:

**max** – main LINUX machine to control ID10B (pauline)

#### Useful Directories:

`/users/opid10/` – located on the max, automatically backed up, limited with 2GB

`/data/max1/` – located on the max, not backed up

`/data/opid10/` – located on the NICE, backed up

`/users/blissadm/local/spec/macros` – location of local macros that is run with default path by command `udo`

`/users/blissadm/local/spec/old_macros/dmacros` – location of old macros

`/users/blissadm/local/spec/spec.d` – location of config and setup files of all SPEC application

`PyMca` – new application to plot selected MCA spectra(um). Run on max in any X-terminal, !!! alpha version.

## 2.2 NICE

As an official ESRF user you will have an account on the NICE computer environment (unix).

From Run 04/08 starting on 26 August, the format of the password, that gives access to the NICE ACCOUNT for the collection and transfer of the data generated on the beamline, has changed.<sup>1</sup> It will NOT be anymore a combination of the two first letters of the main proposers surname followed by the experiment number (smtx123 for proposal MX-123 with Main Proposer John Smith).

The system will randomly generate an INITIAL PASSWORD per scheduled proposal at the time of creation of the NICE account, and store it in the database. All the users registered for an experimental session will have access to the initial password of their proposal, that will be displayed in their **A Form**, and will be able to modify it at any time.

---

<sup>1</sup>e-mail from Agnès Carlet and Nadine Petricola (User Office) 29.07.2008

Local Contact also have access to the initial password of all the proposals:  
- via the SMIS Web Client Application (use your SMIS personal password):  
<http://vmis1.esrf.fr:8080/misapps/SMISWebClient/>  
Select:

- the "Experiments" tab - A form (in the left-hand menu) - "View A Form" (see "Initial Password" in the "Session Information")

The A Form of the experimental session displays only "Initial password", but if the users modify it, you will have to contact the users to obtain it. IF the users have modified the password and can't remember it, you, as LOCAL CONTACT should send a trouble ticket to [hotline@esrf.fr](mailto:hotline@esrf.fr) to issue a new password.

More Details on the NICE account are given in the information web page "Data Collection and Transfer" (<http://www.esrf.fr/UsersAndScience/UserGuide/Preparing/DataCollection>).

The main proposers and co-proposers of the proposals that will be scheduled from August 2008 will be informed by e-mail.

For data analysis you can use MatLab installed on NICE. In the directory `/data/id10b/archive/matlab/MatSpec/` you can find a package for building 2D maps from the linear PSD spectra under MatLab. See how to use it in the Section B.

## 2.3 Software

Apart from `max` there is another PC under Windows XP available for users in the control room. It is connected to the network and can be used to perform on-line data-analysis etc. Up-to-date standard MS-Office pack and some other programs are available on the user PC.

Free network plugs as well as a wireless connection are available for your own computer equipment. There are 6 IP addresses reserved for the temporary use:

id10tmp0 - 160.103.30.50

id10tmp1 - 160.103.30.51

id10tmp2 - 160.103.30.52

id10tmp3 - 160.103.30.53

id10tmp4 - 160.103.30.54

id10tmp5 - 160.103.30.55

Please do always `#ping id10tmpN` to see if it is used (before putting your PC on the network). More information about available software, data storage policy etc. is available from your local-contact.

## 2.4 Printer, fax and copy machine

A post-script printer (a4bid10b) is connected to all computers in the ID10B control hutch. A4 paper for the printer can be found in the cabinet drawer below the printer. Here, you may also find additional office articles (small calculators, pens and scotch tape).

A fax and copy machines are available for users at the mezzanine, and can be reached by climbing the stairs in front of ID07 or ID11 beamline.

A CD burner is available on the troika PC. Users can use it to save the data acquired during the experiment time. The program to burn the CD it is called 'RecordNow!Plus' and the burning procedure consists of following steps:

- copy you data from max to disk D: on troika\_PC using FTP or SSH
- open 'RecordNow!Plus' program
- copy all the data in the right window of the program
- from menu chose "*create data CD*"
- be patient, it might take a while according to the size and number of your files!



# Chapter 3

## Optics

### 3.1 Undulators

The beamline can be supplied simultaneously with photons from three undulators:

1. Either U27 or U35 undulator installed on the revolver support, which is motorized with `urevN` (`urevN=1` – U27 is operational; `urevN=2` – U35 is operational). Motor `urevgap` controls the gap.
2. U27
3. U35

The undulator spectra are shown on Fig.3.1.

The undulators gaps (and **Front End**, i.e. main shutter) are controlled either by a special graphical application

`idappli`

running on `maxpc` or like common motors in SPEC application `optics`. Once the undulator gaps are set in `idappli` and `automatic` mode is chosen (in menu `commands`) the undulators will normally return to these values after being accidentally or by purpose fully opened during refilling.

Usually undulators keep the gap during the refilling process.

Note that the automatic mode expires after 72 hours, then the **Front End** will close i.e. the beam is blocked.

DO NOT CHANGE THE UNDULATOR GAPS ONCE THEY HAVE BEEN SET BY  
THE ID10B STAFF!

With help of SPEC macros one can calculate the undulators gap for a certain energy:  
`OPTICS>u27_harmonic 3` – if 3<sup>rd</sup> harmonic should be used  
`OPTICS>u27_gap 8` – gives the gap for 8 keV and selected harmonic  
`OPTICS>u35_energy 19.9` – gives the energy for a gap of 19.9 mm and selected harmonic

Undulators are also under control of main machine computer ...  
`OPTICS>idon` – connect to the main machine computer  
`OPTICS>idoff` – disconnect from the main machine computer (use in the case of strange messages from ...)

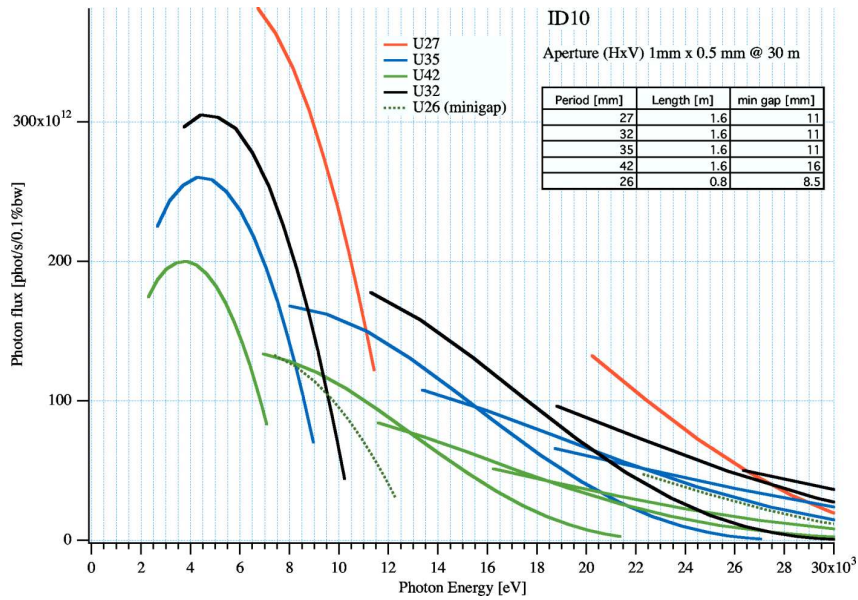


Figure 3.1: Flux vs. energy for the ID10 undulators

## 3.2 Primary slit

Primary slit is installed after the undulators to divine the shape of the beam. Usually:  
 primary slit 1.0 mm horizontal size  
 primary slit 0.5 mm vertical size.

Since the X-ray beam position can change due to instability of the electron beam a special macro exists to make scans by the primary slit. From any console window  
`maxpc:~% pslits`

This application must be also started on the main computer of ID10A that will be used by `maxpc` as a server. If command `wa` gives strange values for the motor positions it means ID10A have not started `pslits` application.

It is recommended to adjust position of the primary slit after every shutdown.

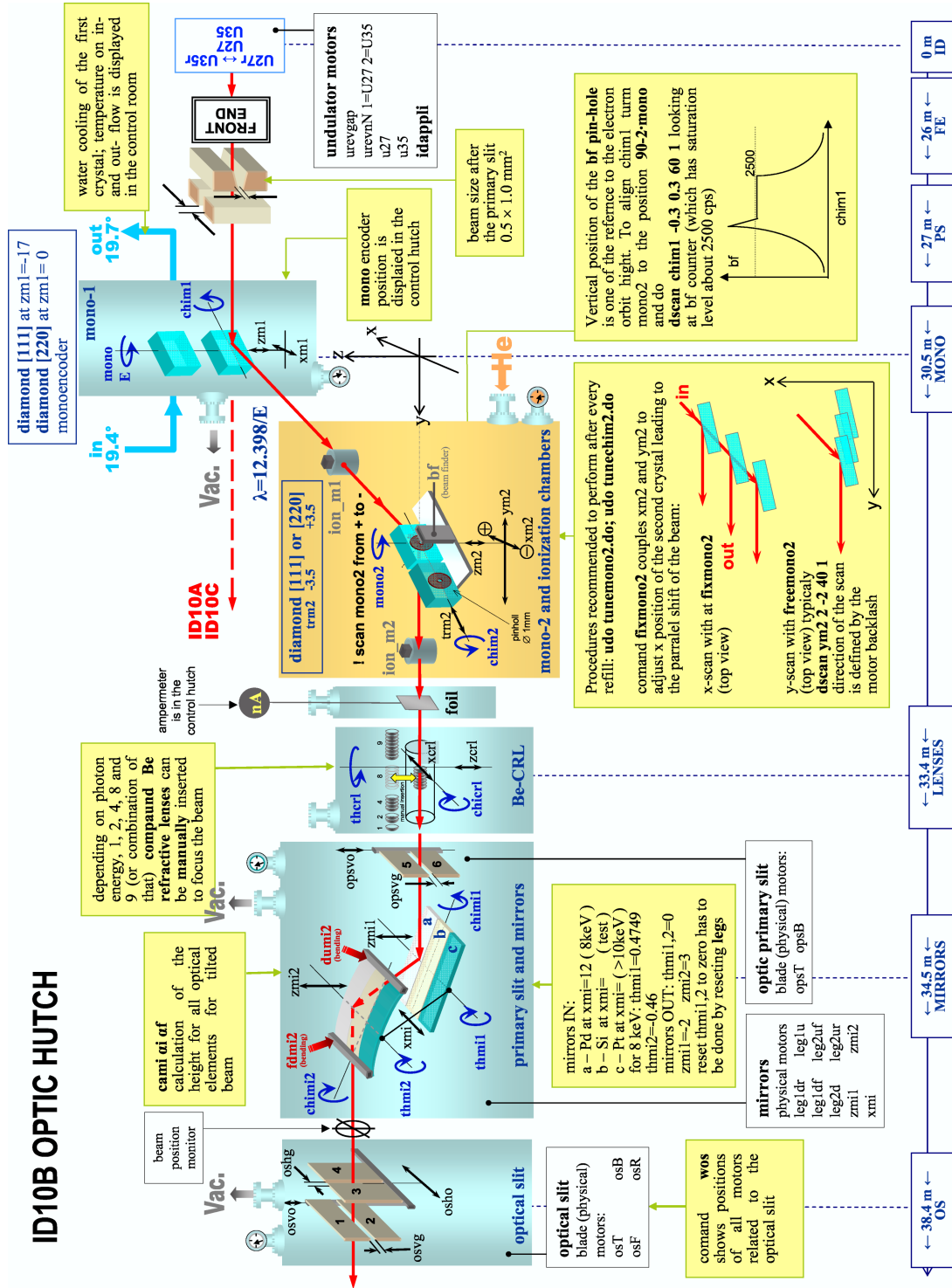


Figure 3.2: General view of the equipment in the optic hutch. Translation motors are shown by the black arrows, rotation motors – by the blue arrows.

### 3.3 Monochromators

ID10B has a fixed-exit diamond double-crystal monochromator (M1, M2) located in the common ID10 Optics Hutch. Monochromator works is symmetric Bragg-Brag reflection in horizontal plane. Depending on the photon energy either a pair of (111) diamonds or (220) diamonds crystals is used.

$$\begin{aligned} & \text{C(111) for } E = 7.8 - 13.8 \text{ keV} \\ & \text{C(220) for } E = 12.8 - 22.2 \text{ keV} \end{aligned}$$

Due to the wavelength-selective Bragg reflection, first crystal M1 splits the beam into two parts – white transmitted beam (for ID10A/C) and monochromatic beam for ID10B, which by means of another Bragg reflection from M2 goes parallel to the white beam at a fixed distance of 850 mm.

M1 (111) crystal – a 120  $\mu\text{m}$  thick diamond plate – in symmetric Bragg geometry provides for the reflected beam narrow energy band  $\Delta E/E = 6 \cdot 10^{-5}$ . Transmission of M1 is between 40% to 70% depending on the Bragg angle of the crystal, it is about 65% for photons with  $E \approx 9$  keV. The crystal holder has two additional slots (vertically stacked on a joint crystal holder) which can be inserted into the white beam by mean of vertical translation. One of this slots is occupied with an alternative diamond (220) crystal (for higher  $E$ ) and second is free.

Motorization of M1 crystal (see Fig.3.2):

E or mono – Bragg angle

xm1 – horizontal translation, perpendicular to the beam

zm1 – vertical translation: at zm1=-17 a center of (111) crystal is in the white beam, at zm1=0 – (220)

chim1 – tilt.

Note: all M1 motors are protected by a password and only the beamline staff is allowed to change M1 position.

Ionization chamber, ion\_m1 is used for tuning of the M1.

Second monochromator crystal M2 is placed in a He filled chamber. It is equipped with the following motors:

mono2 – the  $\Theta$  Bragg angle of the crystal

chim2 – the tilt of the crystal, defines position of the reflected monochromatic beam in vertical plane

zm2 – vertical translation

ym2 – translation along the beam

xm2 – translation perpendicular to the beam

trm2 – horizontal translation to put either C(111) [trm2=-3.5] or C(220) [(trm2=3.5)] into the beam.

OPTICS> fixmono2 – command to couple the movement of xm2 and ym2 motors, so that scan by xm2 will translate the second monochromator along the line parallel to the beam reflected by the first monochromator (see Fig.3.3). This provides transversal scan of M2 with keeping the beam spot on the same place of M2. In this mode it is impossible to scan mono2 or chim2.

OPTICS> freemono2 – decouples all motors related to the second monochromator

The monochromatic beam has to pass through the center of the second crystal. A monitor photo-diode bf is placed on the center of the back side of crystal behind of the

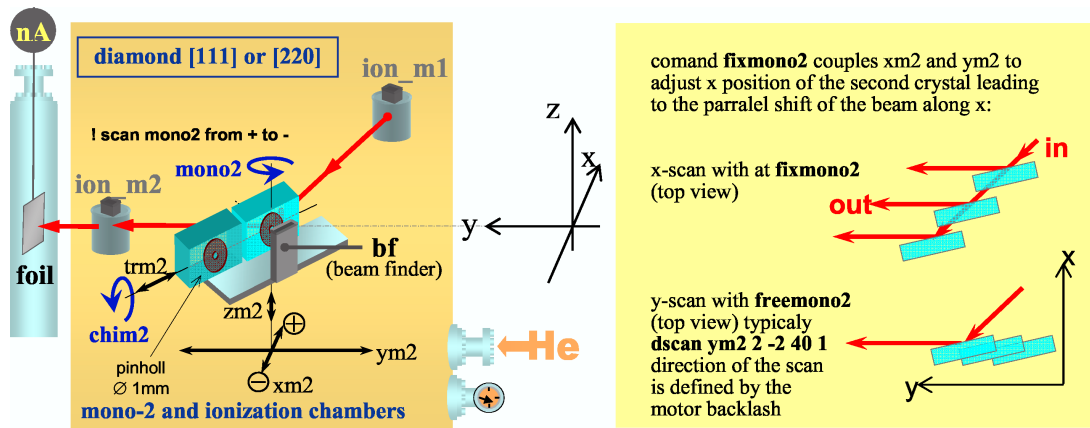


Figure 3.3: Composition of the second monochromator (left) and illustration to the `fixmono2` option (right).

pinhole  $\varnothing 1$  mm. Vertical position of this pinhole [`zm2=-0.8`] is adjusted to the height of electrons pass in the storage ring, so it is an important reference which defines horizontality of the beam to be transferred into experimental hutch, where it should meet second reference – horizontal line drawn on the wall behind the detector (see Chapter 9).

### 3.4 Ionization chambers and beam-position monitor

Ionization chambers `ion_m1` and `ion_m2` after the first and the second monochromator crystals are used to track the beam. Each chamber is a capacitor consisting of two parallel charged plates. The current between them depends on intensity and energy of the X-ray beam passing through. Attention has to be paid at the exit signal, it is not linear. If the saturation level is reached the scan will present an asymmetric peak. To correct this the slits should be closed, at  $0.2 \times 0.2 \text{ mm}^2$  for example.

A beam-position monitor is placed after the `ion_m2` chamber measures photo-current produced by the X-ray beam. It consists of 4 sectors, each one is a counter. Total intensity is displayed by a counter `bpmi`. Intensity is negative and the typical value is  $2 \cdot 10^{-8}$ . Counters of `bpmi` are active if a special SPEC application `bpmi` is running in a separate console window. `timescan` in this application can be used as a permanent indicator of the beam status

The commands to select one of the monitors are:

```
OPTICS> plotselect ion_m1
OPTICS> plotselect ion_m2
OPTICS> plotselect bpmi
```

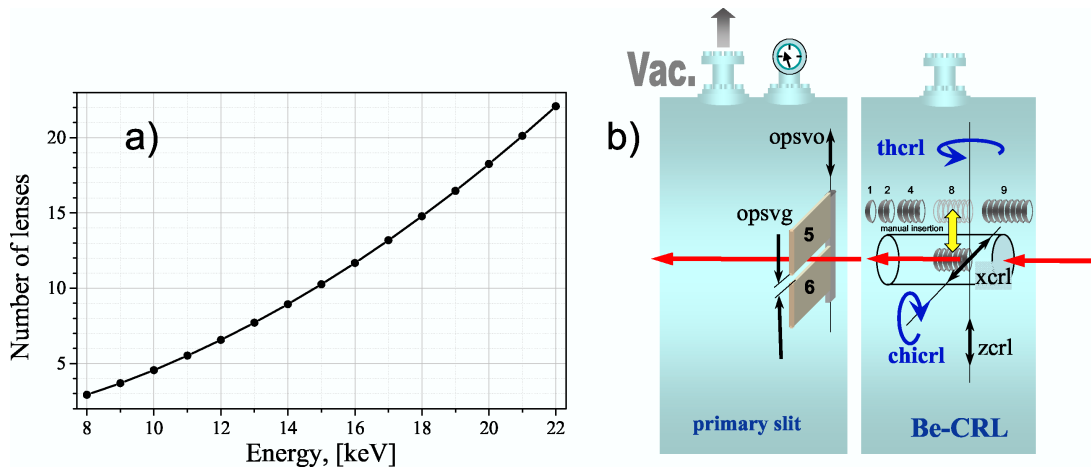


Figure 3.4: Schematic view of the Be-lenses unit and optical primary slit.

### 3.5 Beryllium lenses

As an alternative to the focusing mirror located downstream (see Chapter 3.7) ID10B is equipped with a set of Be compound refractive lenses (CRL). A slot with 1, 2, 4, 8 or 9 lenses (or different combination of the slots) can be inserted into the beam **manually** in the Optic Hutch. Number of CRL to be inserted in the beam depends on the beam energy and should provide a focal point in the Experimental Hutch. Fig.3.4 shows relation between the energy and number of lenses. A Further alignment of the lenses can be done in SPEC `optics` application by the following motors (see Fig.3.4b):

`xcrl` – horizontal translation perpendicular to the beam

`zcrl` – vertical translation

`thcrl` – rotation around vertical axis (blocked)

`chicrl` – rotation around x-axis

## 3.6 Optic primary slit

Optic primary slit is a two-blade horizontal slit devoted to the reduction of the background in the Experimental Hutch and preliminary collimation of the beam before the focusing mirrors. It has the following motors:

`opsvg` – pseudomotor of the vertical gap

`opsvo` – pseudomotor of the vertical offset

`opsT` – motor of the top blade

`opsB` – motor of the bottom blade



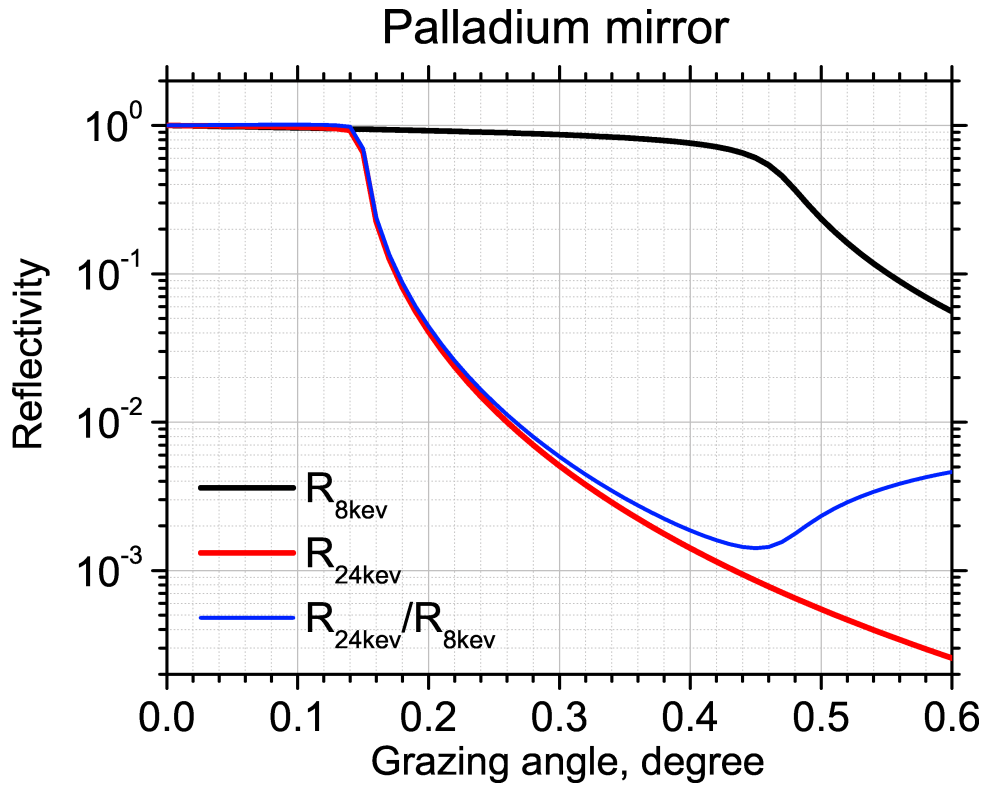


Figure 3.5: Reflectivity of a single (!) Pd mirror.

### 3.7 Mirrors

A double mirror set-up is used to filter out high energy harmonics (3rd and higher) using the fact that total reflection angle of the mirror is different (inversely proportional) for different energies of the photons. Two mirrors are mounted in a vacuum vessel ( $p = 10^{-8}$  mbar). Each mirror is driven with three-leg jacks that provide a vertical translation, and rotation perpendicular (rocking) and parallel (tilt) to the beam direction. Since the heatload is negligible in the monochromatic beam, the mirrors can be operated close to the critical angle (slightly above), maximizing the suppression of higher harmonics, that allows short mirror length of 300 mm. Both mirrors have three strips of different coating material (Pt, Si, Pd) which can be changed by the horizontal translation  $x_{mi}$  :

Pt at  $x_{mi}=-12$  – for  $E > 10$  keV

Pd at  $x_{mi}=12$  – for  $E < 10$  keV

Si at  $x_{mi}=0$  – for the tests.

The reflectivity of the Pd double mirror at 8 keV and incidence angle  $0.37^\circ$  is about 70%. For a reflectivity curve of the mirrors see Fig.3.5.

Here is a full list of **pseudo** motors controlling the mirror system:

$z_{mi1}$  – vertical translation of first (bottom) mirror

$z_{mi2}$  – vertical translation of second (top) mirror

$\theta_{mi1}$  – rocking rotation of first mirror ( $\theta_{mi1}=0.36$  for 8 keV)

$\theta_{mi2}$  – rocking rotation of second mirror ( $\theta_{mi2}=-0.36$  for 8 keV)

$\chi_{mi1}$  – rotation of first mirror around beam axis

$\chi_{mi2}$  – rotation of first mirror around beam axis

$x_{mi}$  – coupled horizontal translation both mirrors perpendicular to the beam (used to choose between different mirror coating)

Actually, each mirror is controlled by a three leg (jack) system which are driven by

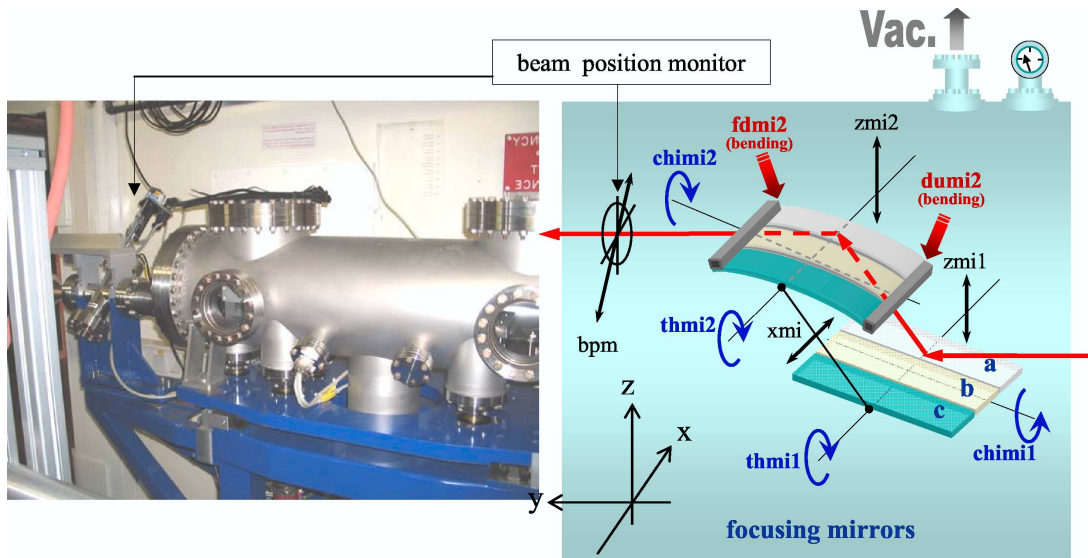


Figure 3.6: Photo and schematic view of the focusing mirrors and beam position monitor.

the following **physical** motors:

leg1dr leg1u leg1df – three legs of first mirror

leg2uf leg2d leg2ur – three legs of second mirror

Attention! Move ONLY ONE pseudomotor related to the mirror at once!  
Otherwise the jack system controlling the position of the mirror can crash.

**Second mirror can bend to provide focusing of the reflected beam.**

fdmi2 and fumi2 – bending motors (to provide focusing should move *theoretically* in the same direction)

OPTICS> wmi – to see the positions of all motors related to the mirrors.

Alignment of the mirrors is described in Section 9.5

### 3.8 Wire (old) beam position monitor

At the exit of the mirror chamber, a beam position monitor is installed for alignment purposes consisting of crossed  $50\ \mu\text{m}$  tungsten wires traveling at  $45^\circ$  relative to the horizontal plane.

bpm – translation of the beam position monitor

## 3.9 Optic slit

The optics system is completed by a set of secondary slits (vertical and horizontal) in front of the photon shutter at the downstream end of the common ID10 optics hutch. These slits clean up the beam after the mirror. The bottom blade is equipped with an additional beamstop in order to stop high-energy fraction of the beam that can pass above the first mirror

Optic slit (os) determines the size of the beam and blocks diffuse scattering from the mirrors. There are four independent motors for each blade

osT – top blade

osB – bottom blade

osF – front blade

osR – rear blade

and four pseudo-motors

osvg – vertical gap

oshg – horizontal gap

osvo – vertical offset

osho – horizontal offset.

OPTICS> wos – shows position of all motors related to the optical slit.

# Chapter 4

## Experimental hutch

### 4.1 Motor control

All motors are controlled by either old controllers DPAP which are partially replaced by new controllers ICEPAP. Complete replacement is planned in 2010. In the case of need of physical plug IN/OUT of the cable, corresponding motor controller must be turned in to "disable" mode by the appropriate switch, which disables full rack in case of DPAP and individual controller in case of ICEPAP.

In case of error during the operation ICEPAP is restarted from the appropriate SPEC session. For example:

```
1539.ID10B> icepap
Icepap MASTER network name (iceid102:5000)? (Press ENTER)
10.ICEPAP console> #reset 1 (i.e. the problem was with the controller in the rack
Number 1; number is shown with red indicator on the rack )
RESET OK
11.ICEPAP console> :power on
12.ICEPAP console> quit
and make reconfig in ID10B
```

Another way to manage with icepap

In the console window:

```
ssh -X blissadm@max
pw:
icepapcms
```

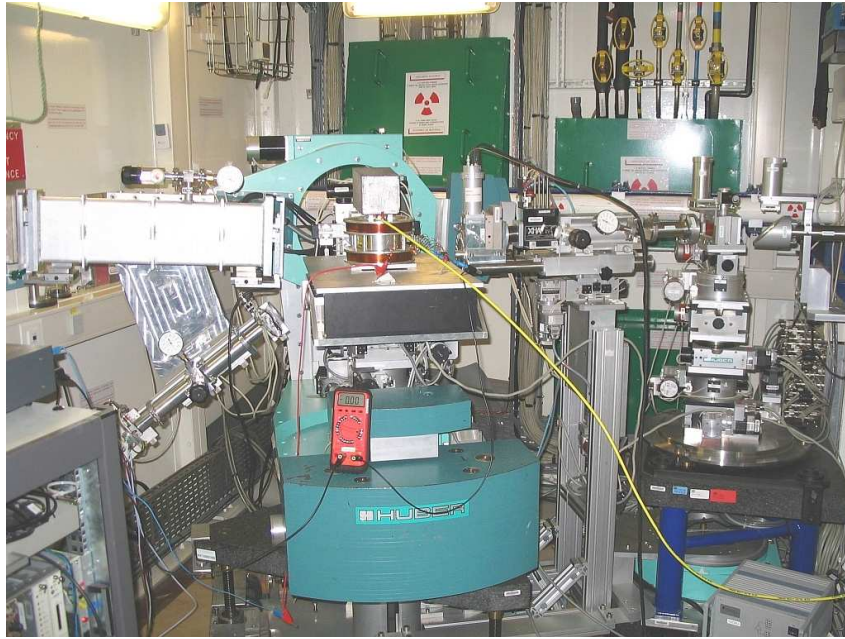


Figure 4.1: Experimental hutch.

## 4.2 Slits s0, s1 and s2

Slit **s0** determines beam size before the sample. It is placed at the end of the incident flightpath (in front of the monitor) and has the following (physical) motors

- s0vg – vertical gap of **s0** (max 5 mm)
- s0hg – horizontal gap of **s0** (max 5 mm)
- s0vo – vertical offset of **s0**
- s0ho – horizontal offset of **s0**

Distance between sample position (COR) and **s0** is 300 mm.

Slits **s1** and **s2** (Huber) are placed on the detector arm on the rail X48 and define acceptance of the point detector (det) or 50 mm linear MBRAUN detector (MCA1) in the reflectivity experiments. Blade motors of **s1** are:

s1T, s1B, s1R, s1F – top, bottom, front and rear blades of **s1** respectively. See `opid10/common/Huber_slit_1_setting.txt` help file for the blade settings.

Pseudo-motors of **s1** are:

- s1vg – vertical gap of **s1** (max 20 mm)
- s1hg – horizontal gap of **s1** (max 20 mm)
- s1vo – vertical offset of **s1**
- s1ho – horizontal offset of **s1**

Slit **s2** does not have offset motors but only gap motors:

- s2vg – vertical gap of **s2** (max 8 mm)
- s2hg – horizontal gap of **s2** (max 8 mm)

Use motors

- `gam` instead of vertical offset
- `de1` instead of horizontal offset.

Sometime JJXRay 4-blades slits can be used instead of Huber **s1** and **s2**. JJXRay slits are mounted on X95 rail.

See `opid10/common/JJXray_slit_1_setting.txt` help file for the blade settings.

### 4.3 Deflector stage

The deflector is a flexible optical device consisting of a 3+1 axis goniometer and translations in three orthogonal directions. Its main function is to deflect the beam downward from horizontal plane by variable angle  $\mu$  ( $\mu$ ) for scattering on liquid surfaces. For small incident angles up to  $1^\circ$ , i.e. for grazing-incidence diffraction, a tilt of the Pt mirror can be used for this purpose. For larger deflection angles – up to  $6^\circ$ , a Bragg diffraction from Ge(111) crystal has to be employed.

The following motors (see Fig.4.4 and Fig.4.2) are used to control the deflecting crystal (last letter **d** refers to the deflector):

**thd** – Bragg angle of the crystal

**rhod** – rotation of the crystal around the incident beam - rotation of both **thd** and **chid**

Motors **thd** and **rhod** have encoders, to read values:

```
ID10B> wread rhod_enc
```

```
ID10B> wread thd_enc
```

**chid** – parasitic tilt of crystal

**phid** – compensation of the misalignment angle between **rhod** axis and the beam direction

**xd** – horizontal translation perpendicular to the beam

**zd** – vertical translation

**yd** – horizontal translation along the beam

**xd** and **yd** are used to align **thd** axis and **sigmat** axis. They translate all other goniometer axis (**thd**, **chid**, **rhod**, **phid**). Once aligned they should not be moved.

```
ID10B> fixtable – coupling of several motors for the pseudomotor mu
```

```
ID10B> freetable – decoupling of motors
```

```
ID10B> mv mu 3 – movement of all coupled motors to provide  $\mu = 3^\circ$ 
```

```
ID10B> do fixtable.do – macro that defines which motors will be involved in creation of a pseudomotor mu. In order to tilt the exit x-ray beam downward while the incident beam stays at the Bragg angle, the whole assembly can be rotated around the incident beam with the rhod arc ( $\rho$ ). A careful alignment of the assembly is necessary, so that the beam will be reflected properly over the whole angular range. The beam deflection is described by
```

$$\sin(\mu) = \sin(\rho) \sin(2\Theta),$$

thus the tilt angle  $\mu$  of the x-ray beam with respect to the horizontal plane is a function of  $\Theta$ , i.e. of the photon energy. However, the critical angle for total external reflection from a liquid surface is inversely proportional to the energy. The proper quantity to consider for reflectivity is the momentum transfer

$$q_z = \frac{4\pi}{\lambda} \sin(\Theta), \quad (4.1)$$

because its critical value  $q_c$  is independent of energy.

**It is possible to obtain the reflectivity data in the  $q_z$  range upto  $\leq 0.8\text{\AA}^{-1}$  at all energies available on ID10B: 7.8–22.2 keV.**

The deflected beam follows a Scherrer cone and hence also has a horizontal deflection  $\sigma$  given by

$$\tan(\sigma) = \cos(\rho) \tan(2\Theta).$$

At  $\mu = 0$  (no vertical tilt)  $\sigma = 2\Theta_B$ . In order to accommodate this movement the diffractometer table is furnished with three airpads staying on polished marble floor, so

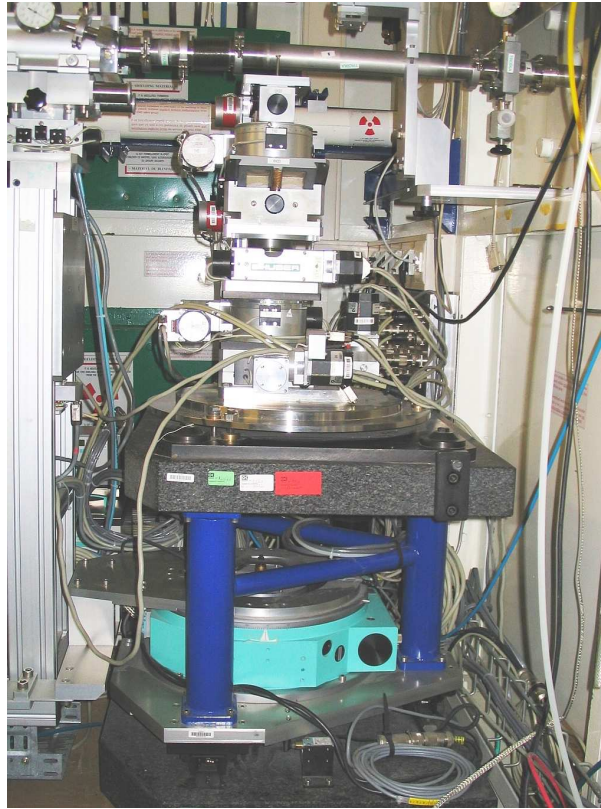


Figure 4.2: Deflector stage as it is without any load.

the table can be rotated around the vertical deflector axis (motor **sigma**) to follow the beam. Also flightpath height and diffractometer height have to be properly adjusted.

Optionally, some other units can be installed on the deflector stage like:

- Be-CRL (beryllium compound refractive lens for focusing)
- FZP (Fresnel zone plate for focusing/defocusing)
- Si (111) post-monochromator (horizontal scattering plane)
- Si [333] post-monochromator (vertical vertical scattering plane)
- Mirror for focusing in horizontal plane



## 4.4 Incident flight-path, incident collimation slits and attenuator wheel

The incident flight-path comprises an evacuated tube with the incident slit `s0` (see Chapter 4.2), monitor of the incident beam and attenuator wheel just before the sample. The incident slits `s0` (two independent units for horizontal and vertical collimation) are motorized Huber slits with a home-made design, that allows easy access and exchange of components. For further collimation, a second pair of motorized slits can be set-up at the entrance of the flight path (motors for the blades: `gsT`, `gsB`, `gsR`, `gsL`; pseudomotors for the gaps and offsets: `gsvg`, `gshg`, `gsvo`, `gsho`). The incident beam intensity is checked by a scintillation detector (= monitor) – counter `mon`. It is placed at 90° to the beam and measures scattering from a thin 80  $\mu\text{m}$  kapton film. Variable apertures in front of the detector ranging from 0.5 mm to 2 mm allow to adjust the scattered photon flux to the dynamic range of the detector (up to  $10^5$  cps).

`ID10B> plotselect mon` – chooses monitor for the current SPEC plot window. It is usually used to align tilt angle of the second monochromator crystal `chim2`.

Counter `mon` is used to measure absolute flux at the sample position assuming that  
Aperture (pinhole in front of the counter) = 1 mm  
Distance (vertical from the beam to the counter) = 32 mm  
Kapton film thickness = 0.08 mm  
Energy = 8 keV  
Efficiency = 1.36187e-6 counts/photon  
`ID10B> flux`  
`ID10B>>> Normalized flux = 2.2272e+10 photons/sec x 100mA`  
`ID10B>>> Flux = 1.9192+10 photons/sec`

The flight-path is equipped with two motors:  
`arcf` – tilt angle  
`zf` – vertical position. This motor is more accurate than `s0vo` and can be used as an alternative to set vertical offset of the 1st slit.

The final optical element in the flight-path is an attenuator wheel (revolver mechanism) with 20 slots of absorbing material. For low-energy photons (8 keV) slots are filled with Al foil, so the total thickness can be varied from 0 to 1.9 mm in steps of 0.1 mm. For high-energy photons ( $\approx 20$  keV) slots are filled with Cu foil, so the total thickness can be varied from 0 to 0.95 mm in steps of 0.05 mm. The attenuator is a very important tool that keeps the radiation dose onto sensitive organic samples to a minimum during the alignment. Once grazing-incidence geometry is reached, the attenuation can be safely removed.

`ID10B> setfilter 11` – sets slot 11 in the beam (1.1 mm of Al or 0.55 mm of Cu)  
`ID10B> setfilter 0` – zero attenuation  
`ID10B> getfilter` – to check which slot is active at the moment. Also gives value of transmission for the current 'filter'. Position of the attenuation wheel can be seen during counting as a pseudo-counter `curratt`, which 'position' is saved in the SPEC data file.

Physical motor `att0` rotates attenuator wheel continuously  
`ID10B> mv att0 12.388`

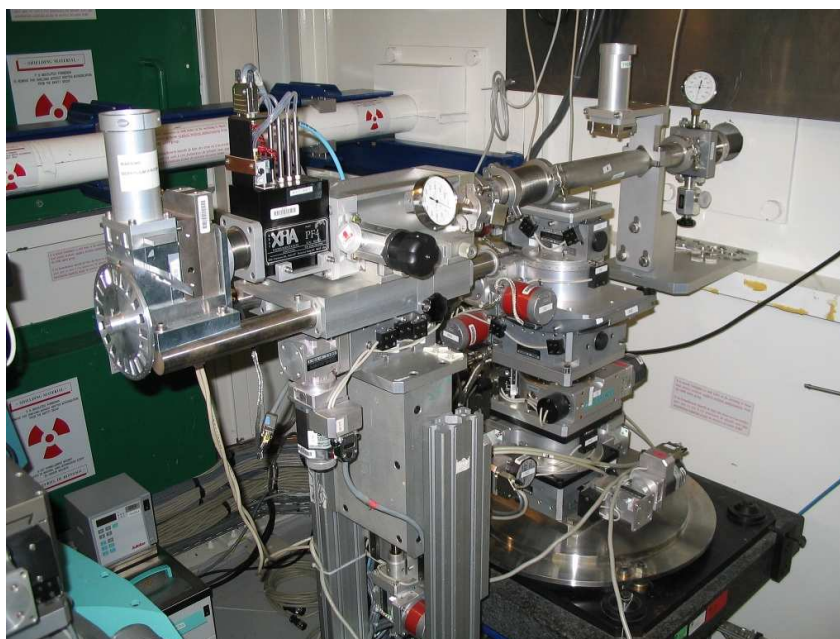


Figure 4.3: Flight-path with absorber wheel and deflector stage (on the back).

that can be used for the wheel alignment.

From help file on `maxpc opid10/common/autof.txt`<sup>1</sup>  
`AUTOF_FS[filTW][energy]` = 8.32 – updates energy value for the wheel absorber  
`autof_updateE(8.54)` – updates energy value  
`p AUTOF_FS` – shows all elements of the array related to the absorbers  
`ID10B> autof_sync` – updates LAMBDA

Config file (`ID10config.autof`) for definition of absorption is located in

`/users/blissadm/local/spec/userconf/`

Copy `ID10config.autof.Al` to `ID10config.autof` when use attenuator wheel with Al foils (0.108 mm each)

Copy `ID10config.autof.Cu` to `ID10config.autof` when use attenuator wheel with Cu foils (0.046 mm each)

Absorber can be set in automatic mode so that it provides the flux which fits the dynamic range of the current detector. At higher flux the counter will be saturated or even damaged. To chose the counter you are currently working with use

`id10b> autof` – this gives a list of possible counters: `det`, `all0`, `all1` etc., for which the the count rate is checked to set the appropriate position of the absorber of the attenuator

`ID10B> autofon` – switch on automatic mode

`ID10B> autofoff` – switch off automatic mode

During the scan in the automatic mode SPEC at every point will check if absorber has an optimal value. If it is not the case SPEC will change absorber accordingly and repeat counting. This sequence repeats until an optimal count rate is achieved. Then the data is written in to the data file – all intermediate results are not stored.

`ID10B> fct` – automatic setting of the optimal absorber, works only at `autofon`.

<sup>1</sup>See also `opid10/common/autFilters.txt` and `opid10/common/filters.txt`

## 4.5 Diffractometer

The diffractometer was designed to satisfy the following requirements:

- the instrument should be able to work in both horizontal geometry and vertical scattering geometry
- there should be enough space for bulky sample environments such as a Langmuir trough or an in-situ vacuum chamber.

The set-up of the goniometer and the detector arm is shown in Fig. 4.4.

The two-component detector arm has a  $\gamma$  (motor `gam`) circle moving the detector in the vertical scattering plane. This arm sits on the horizontal stage  $\delta$  (motor `del`) which is turn-table.

The vertical sample stage (the sample surface is usually vertical) has an  $\omega$  (motor `om`) rotation which allows to rotate the sample around its normal. Vertical sample stage includes also Huber goniometer comprising crossed tilting arcs  $\varphi$  (motor `phiV`) and  $\chi$  (motor `chiV`) as well as translations along X (vertical, motor `xgV`), Y (parallel the beam, motor `ygV`) and a long Z (horizontal, perpendicular to the beam, motor `zgV`). Translation `zgV` actually brings the sample into the beam. The crossed arcs  $\chi/\varphi$  allow precise alignment of the surface normal with respect to the  $\omega$  axis. The long translation `zgV` of +10 mm and -150 mm can also be used to remove the vertical sample stage from the center of the instrument, in order to vacate space for bulky equipment, which can be mounted only on the horizontal sample stage. **Attention: maximum load on vertical sample stage is 2 kg!**

The horizontal sample stage consists of a Z translation (motor `zgH`) controlling the sample height and crossed arcs  $\varphi$  (motor `phi`) and  $\chi$  (motor `chi`) to align the surface normal or to set a desired tilt of the sample with respect to the beam. As an option, two additional horizontal X-Y translations (motors `xgH` and `ygH`) can be mounted, reducing the distance between from the top surface of the goniometer to the sample position from 170 mm to 110 mm. All components are heavy duty ones and can support up to 100 kg of sample environment. There is enough space to support a  $200 \times 800\text{mm}^2$  Langmuir trough or an ultra-high vacuum chamber for in-situ growth studies or cryogenic environment for solid and liquid samples.

The SPEC commands concerning the diffractometer and the two sample stages are:

```
ID10B> air_sigmat or ID10B> air_xt – opens the valve of pressurized air, so that
air will circulate in the air-pads and the diffractometer can use motor sigma for rotation
around the vertical axis which is aligned to coincide with the the deflector axis
ID10B> air_check – try in the case the air does not switch on. Check also the compres-
sion (blue) valve in the experimental hutch.
ID10B> air_stop – stop air
ID10B> mv sigmat – diffractometer rotation around the vertical axis of the deflector
ID10B> mv zt – lifting the entire diffractometer up and down
```

Horizontal sample stage:

```
ID10B> mv xgH – horizontal translation perpendicular to the beam
ID10B> mv ygH – horizontal translation parallel to the beam
ID10B> mv zgH – vertical translation
ID10B> mv chid – sample cradle rotation around the horizontal axis perpendicular to the
beam
ID10B> mv phi – sample cradle rotation around the axis of the beam
```

Vertical sample stage:

ID10B> mv xgV – vertical translation

ID10B> mv ygV – horizontal translation parallel to the beam

ID10B> mv zgV – horizontal translation perpendicular to the beam

ID10B> mv phigV – sample cradle tilting (depends on om position)

ID10B> mv chigV – sample cradle tilting (depends on om position)

ID10B> mv om – rotation of the sample around its normal

# ID10B EXPERIMENTAL HUTCH

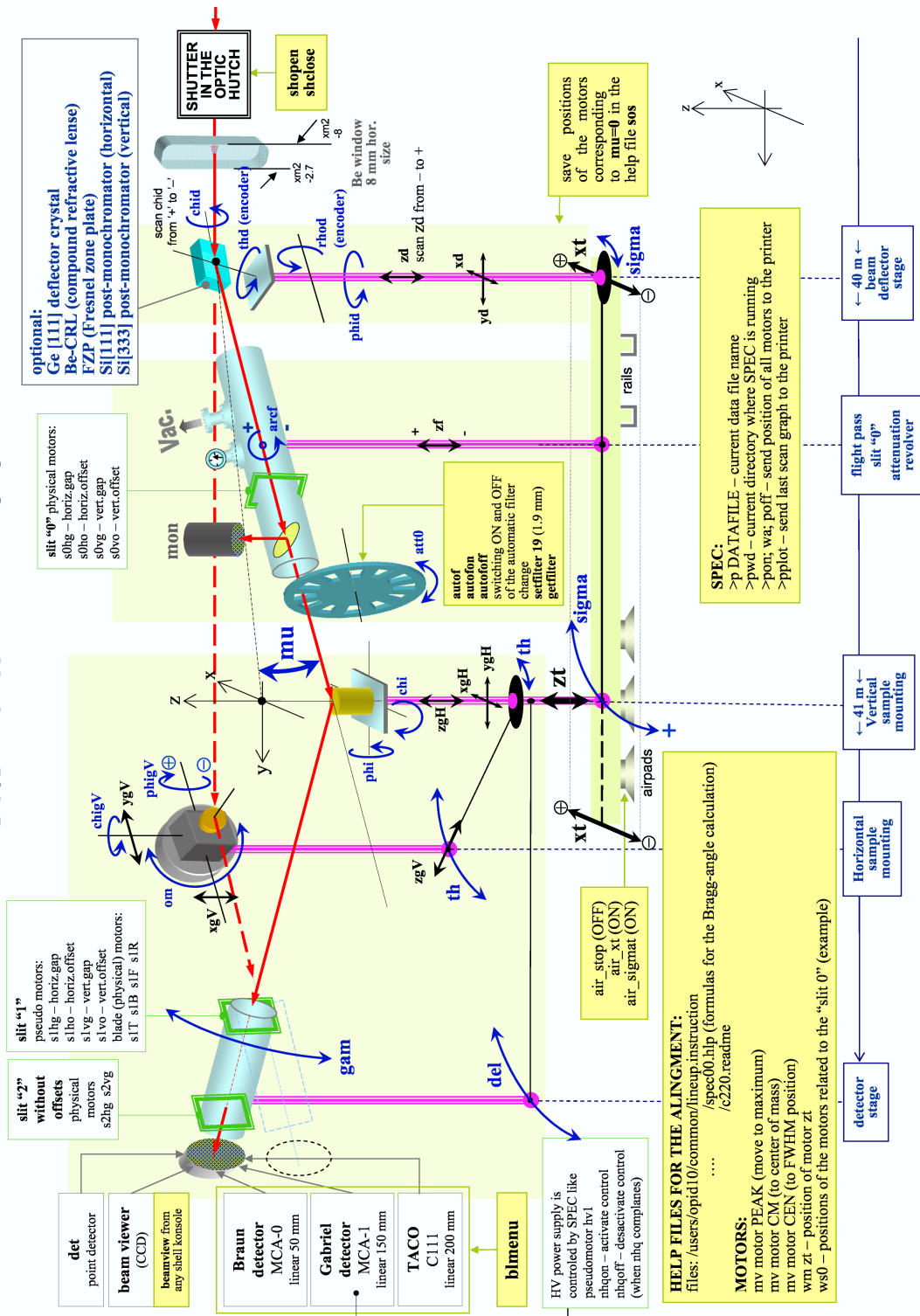


Figure 4.4: General view of the equipment in the experimental hutch that consists of the beam deflector, the incident flight path and the diffractometer, including various configurations of detector arms. Translation motors are shown by black arrows, rotation motors – by blue arrows.

### Mounting langmuier through + antivibration system with analyser crystal + 150 mm PSD

- Rotate zgV stage towards the doors of the control hutch when zgV=0 (i.e. Move manually theta to 180 deg)
- Move zgV=-130 so that the support of the through with the antivibration system can fit on the horizontal goniometer stage
- Mount the stage with antivibration system
- Mount the support plate
- Mount the through
- Plug in antivibration system
- Plug in driving of the barrier
- Plug in chiller (if required)
- Mount analyser flight path 10cm to the back wall on the horizontal support – 2 screws back
- Clean the trough: water than ethanol+ water over night, next day sack out the surfactants first

- Switch on the measurement of the surface tensions,
  - 1) Put the filter paper on the hook into the water (insert by the plastic screw until the paper is in, then one another half-turn), set the value on the display by the regulator to 0, in the P mode)
  - 2) Remove the paper and set the value on the display to 72 mN/m by the another regulator
  - 3) Repeat the process iteratively until you obtain the right values
- Put the sample into the through
- Screw the lid on top of the through
- Plug in He source – the valve should be pressed whenever putting in or out the cable
- Switch on the measurement of the  $O_2$ , before measurement wait until  $O_2$  concentration decrease under 0.5%

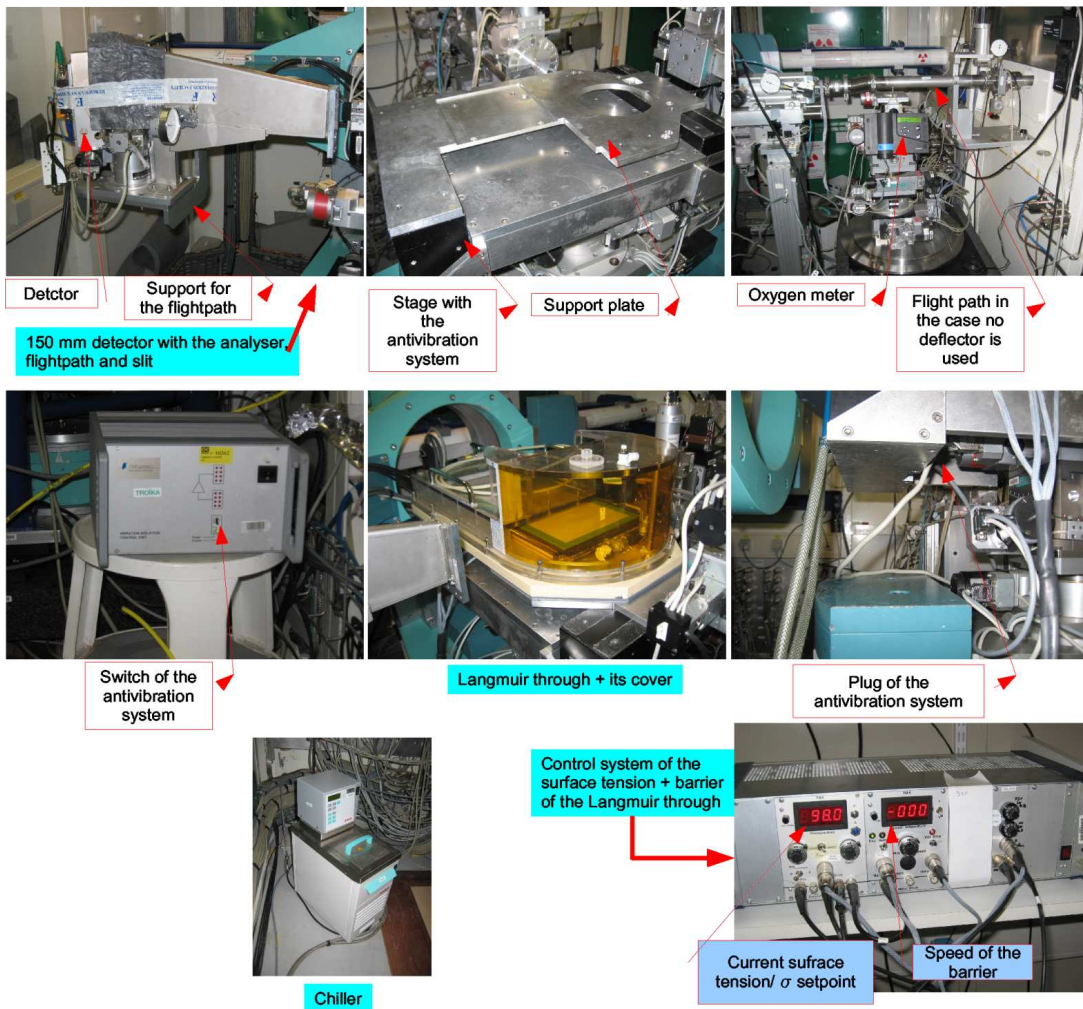


Figure 4.5: The most frequent sample environment – Langmuir Through.

# Chapter 5

## Switching ID10B on after shutdown

- **Optic Hutch**

1. Start cooling chiller of the first monochromator: switch on temperature control ( $T \approx 20^\circ$ ) and water circulation
2. Close to `mono1` switch on electronic block of the `ion_m1` control. If it is ON than without X-ray beam `ion_m1` counts around 180 cps
3. Under `mono2` vessel switch on electronic block of the `ion_m2` and `foil` monitor control. In the control room switch on multimeter showing the value of `foil monitor`". Change its state from `zero calibration` to `measurement in Amp`. Change diapason (range) to measurement in nA with one digit before comma.

- **Experimental hutch**

1. Switch on WAGO box
2. Turn power on for two upper rows of the detector rack electronics
3. Start LINUX PC handling TDC
4. Start GPIB - black box on the top of LINUX PC
5. Turn on power of the video camera - the switch is in the cut slot of the bottom cover.

- **Control room**

1. Between ID10A and ID10C turn on power of the network crate.
2. Start main work station on ID10A (local server)
3. Start 'optical' crate VMI (internal check takes about 15 min)
4. Start 'optical' DPAPs (power switch + blocking keys)
5. Start 'diffractometer' crate VMI (internal check takes about 15 min)
6. Start 'diffractometer' DPAPs (power switch + blocking keys)
7. Start industrial `Win_XP` PC handling `X-ray_eye` and MCAs - it is under 'diffractometer' VMI crate, main switch is from the back side of the blue rack. `Win_XP` PC should be switch on after detector electronics in the experimental hutch and before SPEC start on `MAXPC`.
8. Turn on NIM unit for the point detectors.

9. Turn on printer, video camera screen, oscilloscope.
10. Turn on power for the 'gray box' (above PSS rack) showing temperature and position (Z-position encoder) of mono1
11. Start MAXPC
12. In the appropriate directories start OPTICS and ID10B



# Chapter 6

## Detectors

### 6.1 Automatic system for the detector protection

Under construction.

### 6.2 Point detectors Cyberstar

One for the detector arm - **Detector**, second is used as a monitor on the flight-pass - **Monitor**.

Cyberstar settings for 8 keV.

	Monitor	Detector
HV	782	834
gain	3.28	5.75
LL	1.20	1.50
HL	8.40	8.50

Cyberstar settings for 22 keV.

	Monitor	Detector
HV	690	794
gain	3.08	4.00
LL	1.20	1.50
HL	8.40	8.50

### 6.3 50 mm linear MBRAUN detector MCA0 and 150 mm linear detector (Gabriel) MCA1

MBRAUN linear detector works in the regime of constant gas flow. That is why it is permanently connected with the tubes through the pressure reducer to the orange gas bottle with Ar-C<sub>2</sub>H<sub>6</sub>+R<sub>14</sub> mixture in the Experimental hutch . Connection includes pressure reducer directly on the bottle and flowmeter which is a NIM unit. After long pause MBRAUN detector should be flushed several time with the fresh gas.

For the normal operation of the PSD, the discriminator output plug 'POSITION' is used. However, for the high voltage (HV) alignment the output 'ENERGY' should be

used for transferring to SPEC a certain 'energy' spectrum. In the case that detector is fine, this spectrum looks like a Gaussian distribution. By adjusting of HV level the maximum of this Gaussian should be placed in the middle of channel range. There are two scales – real scale which shows voltage in Volts and turn wheel to adjust HV. If turn wheel is set to position *ttt*, than real voltage is  $ttt/2 \cdot 1000$ . Example: if turn wheel is at position 6.80 then real voltage 3400 V.

To shift energy spectrum on 100 channel the voltage should be changed on 100 V, that is 0.2 units of the turn wheel

In space resolution mode  
HV=7.10 kV for 8 keV photons  
HV=6.8 kV for 22 keV photons

To change gain and range parameters of the MBRAUN detector:

ID10B> `can9635menu`

By default (after `reconfig`) gain=2048 and range=2048.

In the energy-dispersive mode gain=8192 (maximum) and range=2048.

In `blmenu` parameter (3 - memory group size) is 1024 for space resolution and 4096 for energy resolution. In the 'energy' case change also in `mcplotsetup` the range for plotting - from 1 to 3000.

There are two identical detector units.

Ser.N°371197

Ser.N°260899.

In both the standard Cu cathode has been replaced on Ag one to reduce fluorescence.

ID10B> `blmenu` – gives on access to the MCA setup where one can  
– activate/desactivate MCA  
– create/edit/delete region(s) of interest  
– saving to the datafile options.

Direct way to set a region of interest (ROI) that can be used in macro files:

ID10B> `mcaroi dir0 0 1 1023` – sets the limits of ROI for pseudocounter with the name `dir0` of MCA0 (MBRAUN) from channel 1 to channel 1023

ID10B> `mcplotsetup` – parameters of the graphic window showing MCA spectrum

ID10B> `mcplot` – re-plot the MCA graphic window with new settings.

Drivers for both detectors are running on industrial Windows PC (XP). All necessary drivers are started automatically when SPEC applications are restarted and also every time after `reconfig` procedure. However drivers could be started directly on the controlling Windows PC. To emulate a screen of Windows XP machine on `maxpc` open X-terminal

`maxpc:~% vncviewer w-id10b-1` – this is device name

password: `troika02`

close and re-open application `McaAIM(a23)`

Another way to restart Detector - MCA0(1):

- switch OFF and then ON power of the crate with MCA. Wait while internal test are finished (the LED TEST is off)

- switch OFF industrial Windows PC (black box) on the bottom part of the right rack with the motor controllers, wait few minutes
- switch ON Windows PC, wait few minutes until hard-drive LED is not blinking
- ID10B> reconfig
- check setting in blmenu

If liquid surface reflectivity experiment is running at the moment than do also:  
redo freetable  
fixtablesetup ... sigma(t)  
fixtable  
FT\_DXF  
FT\_DXFCOR

Maximum count rate for the Gabriel (150 mm) PSD is 3000 cps in the case of sharp beam and up to 10000 cps in the case of flat field illumination.

## 6.4 High voltage power supply (for MCA0 and MCA1)

From help file on maxpc opid10/common/high\_voltage.txt

SPEC application id10b includes a pseudo-motor called hv1 to drive the power supply. Use nhqon/nhqoff to activate/desactivate this pseudo-motor. Motor hv1 is activated after SPEC startup by default. The ramp rate (in V/s) can be adjusted on the setup line (last parameter). It is set to 100 V/s for now (range is from 2 to 255). The macros is written so that it can handle several high voltage units for future use.

Settings of hv1 in the config

Unit/[Module/]Channel	0/0
Name	hv1
Mnemonic	hv1
Spectrometer	common
Steps per degree/mm	2000
Sign of user * dial	1
Backlash [steps]	50
Steady-state rate [Hz]	2000
Base rate [Hz]	200
Acceleration time [msec]	125
Motor accumulator	6010000
Restrictions <>	NONE
Dial = accumulator / steps	
High limit	10000.0000
Current	3005.0000
Low limit	-1.0000
User = sign * dial + offset	
Offset	0.0000
'High' limit	10000.0000
Current	3005.0000
'Low' limit	-1.0000

## 6.5 200 mm linear detector (Kocsis) C111

UNDER CONSRUCTION

## 6.6 CCD beam viewer

Beam Viewer (X-ray eye – another name) is a small CCD camera for visualization the beam shape profile in the Experimental Hutch. It is particularly useful to control focusing of the beam by the mirrors (see Chapter 3.7) or Be lenses (see Chapter 3.5).

It works with zero absorber (because of Al window in front) – make sure all other detectors are in the save situation when you use Beam Viewer.

New application (from 05.06.2007) for displaying beam-viewer ccd camera was introduced to our maxpc. Program name: bpmGUI

```
maxpc:~ % bpmGUI
```

Some of features:

- selection of ROI, moving the selection by holding shift and pressing left mouse button + drag
- measurement of distances and angles
- before printing, change the printer in the set-up (default to file)
- the page for print could be customized and several ccd shots could be added -saving images in jpg,png,...

The image size is $640 \times 495$ pixels, $3.14 \times 2.40$ mm <sup>2</sup> , i.e. 1 pixel is $4.9 \mu\text{m}$	Old software
---	--------------

for Beam Viewer can be started from any shell console on maxpc by typing:

```
maxpc:~ % beamview
```

## 6.7 Linear 50 mm Vantec detector

Vantec electronics (including internal computer and power supply) and is big unit in the electronic rack in the Experimental Hutch.

The WiKi Vantec notes page of id01

```
http://wiki/id01/index.php/NOTES_on_BRUKER_VANTEC_controller
```

```
#2009.2F11.2F04_---_vantec_macros_.2F_new_.26_upgrade
```

with the test codes edited by Roberto Homs of the entry points of the device server for:

- discriminator levels (as pseudomotors)
- ratemeter counters (as pseudocountes)
- time constants of the rate meters (as commands)

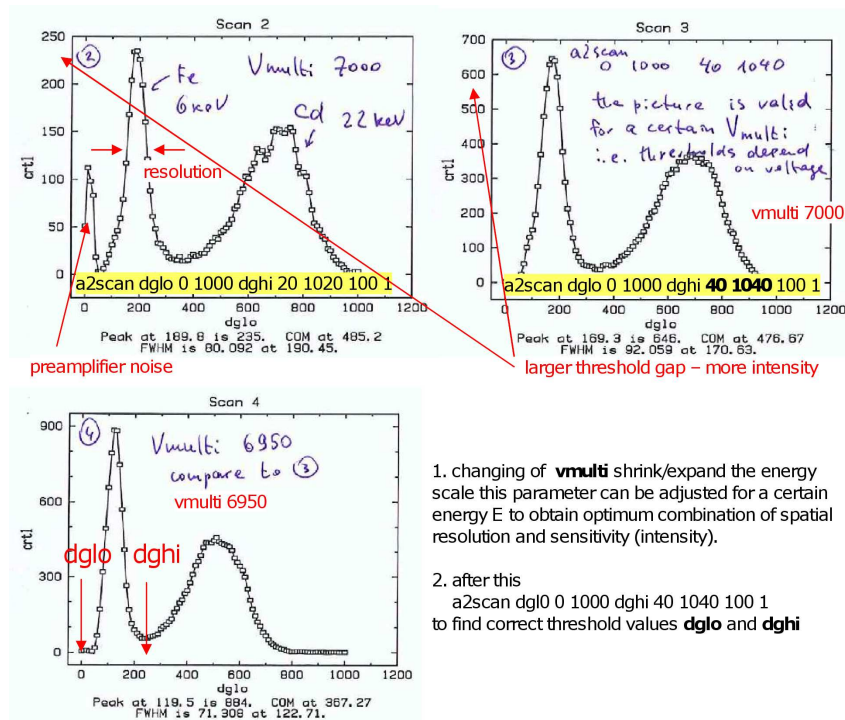
read/write were tested, but spec macro is only for read.

## 6.8 TDC system

TDC (time-to-digital converter) system works with industrial Linux PC installed in the electronic rack in the Experimental Hutch. It is used for the Vantec detector (see Section 6.7)

See help file in `opid10/common/readme.WindowsXp_at_MAX`

Linux PC for TDC name: l-id10b-1



1. changing of **vmulti** shrink/expand the energy scale this parameter can be adjusted for a certain energy E to obtain optimum combination of spatial resolution and sensitivity (intensity).
2. after this  
a2scan dglo 0 1000 dghi 40 1040 100 1  
to find correct threshold values **dglo** and **dghi**

Figure 6.1: Principle of Vantec alignment: voltage and threshold.

```
maxpc:~% telnet l-id10b-1
user: root
password: rtk98
```

To stop LINUX PC:  
shutdown -y now  
or  
> init 0

To start again:  
> init 6  
or  
> reboot

## 6.9 Energy-dispersive Vortex detector

It is used for fluorescent measurements. To activate and setup Vortex

```
ID10B> blmenu
#6 XMAP - Vortex detector
e - i.e. extra
#6 XMAP setup
```

The following menu will appear

```
1- Acquisition setup.....:
- Acq. Mode = MCA
```

- External Gate = NO
- Auto-Clear = YES
- Preset Mode = RealTime
- Spectrum Size = 2048
- 2- Configuration File.....: 22kev\_05us.ini
- 3- XIA active on ct/scans.....: YES
- 4- ROIs definition.....: 3
- 5- Statistic Counters.....: Avg
- 6- Detectors sum.....: None
- 7- Spectrum corrections.....: LVT MON Saved
- 8- Saving options .....
- Save during scans = NO
- Save after ct/xiaacq. = YES
- Directory = /data/id10b/inhouse/user09.2/shapovalov/vortex (given by a user)
- File radix = generic (given by a user)

Change the options if needed.

22keV-05us.ini - file contains parameters of the detector adjusted for 22 keV photons. Energy calibration is  $E[\text{keV}] = -0.0243 + 0.01126 * \text{channel}$ .

Option #7 allows for correction on the lifetime and monitor of the output spectrum written in to the file. Filename has a structure like `generic_xiaXX_0000_0000_0000.edf`.

To activate/desactivate saving in to the file after a single counting

ID10B> `XIA_SAVE["ct"]`=1 or 0 respectively

To activate/desactivate saving in to the file after a scan

ID10B> `XIA_SAVE["scan"]`=1 or 0 respectively

Vortex rights in to .edf files which can be vied with **PyMca** software.

console> `PyMca`

To convert EDF files to ASCII

`xiamcaconvert -h` gives help message (the -c option has been added for column files.

If not set, you get spec mca format)

`xiamcaconvert -c mydatafiles_*.edf myothers_*.edf` converts all input files to column format. Result files stored in same directory as input files.

`xiamcaconvert -c -o mcadir mydatafiles_*.edf myothers_*.edf` converts all input files to column format and save these files in directory <mcadir>

`xiamcaconvert -c -i mydata -o mymcadir` converts all files found in directory <mydata> and save the output mca files in directory <mymcadir>

Output filenames are deduced from original EDF filename:

`mydata_xia01_0023_0000_0000.edf` will gives `mydata_xia01_0023_0000_0000.dat` with one column for each scan point

`mydata_xiact_0024_0000_0000.edf` will gives `mydata_xiact_0024_0000_0000.dat` with one column for each detector (one in your case !!)

## 6.10 MARCCD

Such detectors – MAR CCD 165 (SN012), MAR CCD 133 (SN003), MAR CCD 133 (SN008) – can be ordered from the Instrument Pool (responsible COHEN Cedric, tel: 28-14).

First, switch on cooling system on the refrigerator unit.

On the PC coming together with the detector:

`marccd -r` – to start an application

Go to `configure->detector->reboot`

Answer `yes` on question about cooling.

Use `acquire` to get a single image.

In SPEC

ID10B> `setup`

In the text editor window find and remove comment symbols in two lines related to `marccd`, something like:

```
#p *** setup MarCCD ***
```

```
# mccdsetup
```

Save and quit the editor.

ID10B> `mccdtake 1` – take image during 1 sec

Use also

ID10B> `mccd` and Tab button to see all other possible commands.

## 6.11 Princeton CCD 'Bazooka' and BEAMSTOP

`princeton_ccd.help` - the manual and some experiences, namely:

1) Evacuate ccd before usage (use round screw on the ccd body to open/close vacuum)

2) Start flushing with nitrogen

3) Start chilling

4) Connect the source to CCD

4a) Connect the network cable to the source

5) On maxpc start connection to the windows PC W-id10b-1

```
maxpc:~ % vncviewer wid10b1
```

6) In SPEC start on-line viewing of the ccd data via the command:

```
ID10B> camera_online
```

7) Connect beam-stopper to `gsT`

8) In SPEC reconfig `gsT` motor via the command:

```
ID10B> config + configuration see ~/common/gsT_2_beamstop.txt +
```

```
ID10B> slitunsetup huberg huberg huberg
```

9) Configure the writing of ccd data to files in SPEC:

```
ID10B> blmenu - see princeton_ccd.help
```

10) useful commands:

```
ID10B> ccdtake - take image
```

```
ID10B> ccddsave - save last taken image to a *.edf file
```

11) If there is an crash of the CCD viewer:

```
look for process: ps -ef | grep -i GUI
```

if CCD GUI crashes:

```
kill process using kill -9 <process number> and the restart with camera_online
```

`gsT_2_beamstop.txt` - configuration for the garde slit `gslit`, used as an additional slit between the flightpath and deflector goniometer to reduce background on the sample position. Cable related to the top blade of `gslit` is used for the motor controlling the BEAMSTOP, that is necessary for the measurements with Princeton CCD. Appropriate settings for `gsT` are written in `gsT_2_beamstop.txt`

Add `gsT` slit by:

```
ID10B> slitsetup huberg gsho gshg gsR gsF gsvo gsvg gsT gsB
```

Remove `gsT` as slit by:

```
ID10B> slitunsetup huberg huberg huberg
```



# Chapter 7

## IP video camera

IP video cameras are installed in ID10A and ID10B hutches. One can reach the video streaming by typing "id10video1" for ID10A or "id10video2" for ID10B in the web browser address field.

The appropriate links are:

<http://id10video1/view/index.shtml> (ID10A)

<http://id10video2/view/index.shtml> (ID10B)

Enjoy zoom 26X, capture etc.

# Chapter 8

## Switching ID10B on after shutdown

- **Optic Hutch**

1. Start cooling chiller of the first monochromator: switch on temperature control ( $T \approx 20^\circ$ ) and water circulation
2. Close to `mono1` switch on electronic block of the `ion_m1` control. If it is ON than without X-ray beam `ion_m1` counts around 180 cps
3. Under `mono2` vessel switch on electronic block of the `ion_m2` and `foil` monitor control. In the control room switch on multimeter showing the value of `foil monitor`". Change its state from `zero calibration` to `measurement in Amp`. Change diapason (range) to measurement in nA with one digit before comma.

- **Experimental hutch**

1. Switch on WAGO box
2. Turn power on for two upper rows of the detector rack electronics
3. Start LINUX PC handling TDC
4. Start GPIB - black box on the top of LINUX PC
5. Turn on power of the video camera - the switch is in the cut slot of the bottom cover.

- **Control room**

1. Between ID10A and ID10C turn on power of the network crate.
2. Start main work station on ID10A (local server)
3. Start 'optical' crate VMI (internal check takes about 15 min)
4. Start 'optical' DPAPs (power switch + blocking keys)
5. Start 'diffractometer' crate VMI (internal check takes about 15 min)
6. Start 'diffractometer' DPAPs (power switch + blocking keys)
7. Start industrial `Win_XP` PC handling `X-ray_eye` and MCAs - it is under 'diffractometer' VMI crate, main switch is from the back side of the blue rack. `Win_XP` PC should be switch on after detector electronics in the experimental hutch and before SPEC start on `MAXPC`.
8. Turn on NIM unit for the point detectors.

9. Turn on printer, video camera screen, oscilloscope.
10. Turn on power for the 'gray box' (above PSS rack) showing temperature and position (Z-position encoder) of mono1
11. Start MAXPC
12. In the appropriate directories start OPTICS and ID10B

# Chapter 9

## Some steps of the beamline alignment

### 9.1 General

The elements of the beamline are controlled by means of SPEC applications `optics`, `id10b` and sometime `sixs`. **Attention!** Some actions made during the alignment of ID10B influence also the beam status at ID10A. Thus movement of the undulators, FRONT-END shutter, the primary slit and ID10B first monochromator should be coordinated.

Before starting the alignment one should make note some information to the Optics logbook (optics and experiment logbooks in use can be found normally on the desk next to maxpc station, if not – in the back cupboard):

- front end (FE) status (open/close)
- primary slit (just after FE) position – the information can be taken from `tina2` in ID10A control hutch or through `pslits` application that can be run on `maxpc` in the case it is also running on `tina2` (ID10A).

- `machinfo`

Print machine information concerning ID10 beamline:

```
ID10B>pon;machinfo;poff
```

Print position of all motors in optic and experimental hutches:

```
OPTICS>pon;wa;poff
```

```
ID10B>pon;wa;poff
```

The alignment procedure starts with upstream elements and continues progressively to downstream element. Usually it consists of the following steps:

1. centering pin – can be performed without the beam, the day before a new experiment starts
2. undulator gaps – if they are open after the shutdown or if a new experiment requires change of the beam energy
3. monochromator crystals M1 and M2
4. mirrors

5. optic primary slit (**ops**)
6. slits before the sample – optical slit (**os**) and slit zero (**s0**)
7. slits at the detector arm
8. additional elements like beam deflector
9. sample goniometer

Once the alignment is finished, print again position of all motors together with the results of one second counting:

```
OPTICS> pon; wa; ct; poff
```

Also write down the size of the slit **s0** and the size of the pinhole at the monitor counter (usually a pin hole  $\varnothing$  1 mm is used.)

Stick this printout in to the logbook.

## 9.2 Centering pin (pinhole)

The function of the pinhole is to provide a hard reference which coincides with the center of rotation of the diffractometer, thus at the end of the alignment the beam should go through the pinhole.

Procedure to set the pinhole in the center of rotation is as follows:

1. Move  $xgV$   $ygV$   $chigV$   $phigV$  to dial zero position (motors of the vertical sample stage) and  $zgV$  to user zero position
2. Mount pinhole on the vertical sample stage. Attention has to be paid to the right orientation of the pinhole plate – due to the thickness of the plate there is only one surface that gives the correct center (see Fig.9.1).
3. Rotate manually  $\Theta$  (motor  $th$ ) to the position  $330^\circ$  on the hard scale (unscrew bolt on motor  $th$ ),  $\omega$  should be at  $180^\circ$  (a mark on the hard scale of motor  $om$  **if one looks from the top**) – see Fig.9.1a. Measure position (horizontal and vertical) of the pinhole with a telescope situated outside ID10B experimental hutch, in front of the optic hutch. Care has to be taken that the telescope has a good horizontality. This can be checked with the water level on the right side of the telescope, the air bubble should be centered. The measurements taken with the telescope has to be done always in the same direction (starting from up to down for example), otherwise the backlash might lead to the errors in reading.
4. Rotate manually  $\Theta$  to the position  $150^\circ$  and  $\omega$  to  $0^\circ$  – see Fig.9.1b. Take care about the cables the movement in  $\omega$ . Find new position of the pinhole with the telescope. If the pinhole is already in the center of rotations (COR) the pinhole position will not change.
5. If there is a difference in the vertical position, measure both values  $z_1$  and  $z_2$  using a appropriate micrometer screw of the telescope. Move vertically the crosshair to the mean position  $(z_1 + z_2)/2$  and adjust vertical position of the pinhole with a micro-translation stage of the pinhole mounting.
6. If there is a difference in horizontal position, without touching the telescope translate horizontally the pinhole with motor  $zgV$ , to place the pinhole at the position of the

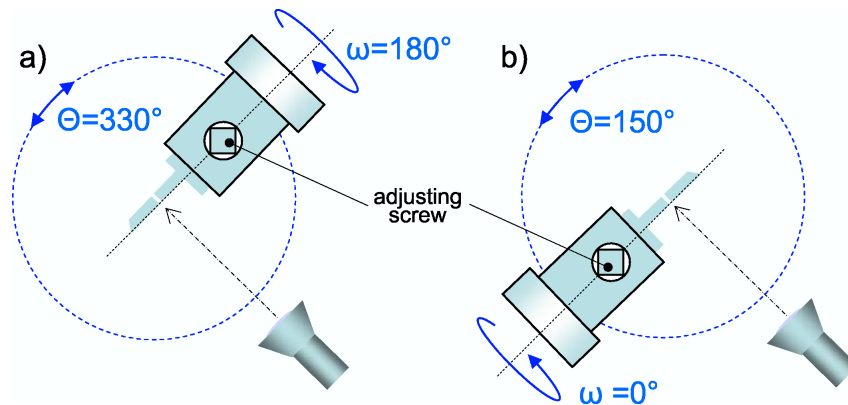


Figure 9.1: Two positions of the centering pin for the aligning with the telescope. Top view.

crosshair. Move **zgV** to the mean value and set **zgV** to 0. Move the telescope rotation table to have the pinhole and crosshair coincided.

7. One has to check also the absolute vertical position of the pinhole. On the wall, at the end of the detector arm there is a reference line giving the height of the beam (corresponds to the electron orbit). Take vertical position of this line with the telescope, check the pinhole height and correct the difference by moving **zt** or adjusting screw on the pinhole micro-goniometer.
8. At this stage one has opportunity and check the absolute level of the flight path (at **arcf = 0**) by moving **zf** so that reference of the flight path (dashed lines on the white sticker) is placed on the same height as the reference line on the wall.
9. Check once again!

This position of the pinhole will be a reference for the rest of the alignment, therefore reset to 0 value of both **zgV** and **zt**.

```
ID10B> set zgV 0
```

```
ID10B> set zt 0
```

## 9.3 Undulators

See, first, section 3.1.

Start `idappli`. In the case of discrepancy in the undulator gaps shown in `idappli` window and in the OPTICS application of SPEC do `OPTICS> idon`

Calculate the undulator gaps for the desired energy:

```
OPTICS> u27_harmonic 3 – if 3rd harmonic will be used
```

```
OPTICS> u27_gap 8 – gives the gap for 8 keV
```

```
OPTICS> u35_energy 19.9 – gives the energy for a gap of 19.9 mm
```

```
OPTICS> mv urevN 1 – U27 is operational on the revolver
```

```
OPTICS> mv urevN 2 – U35 is operational on the revolver
```

Move undulator gaps to the position either from `idappli` or from SPEC `optics` using the motors

```
urevgap
```

```
u27
```

```
u25
```

In `idappli` set 'automatic mode'. Remember that it expires in 72 hours.



## 9.4 Alignment of the monochromator crystals

See, first, Section 3.3.

Hereafter the first and second crystals are called M1 and M2 respectively.

### 9.4.1 M1

Since M1 diamond crystal is the most important and the most delicate element on the entire beamline, its motors are protected from any accidental movement. To move them it is necessary to access a sub-shell 'wizard' which is protected by the password.

Before opening of the Front End make sure that the monochromator cooling system (chiller) is switched on! For that there is a flowmeter and temperature meter in the Optic Hutch (see Fig.??)

Since M1 movements affects ID10A/C, alignment of M1 has to be coordinated with ID10A/C stuff members.

Motorization of M1 crystal (see Fig.3.2):

`mono` – Bragg angle

`xm1` – horizontal translation, perpendicular to the beam

`zm1` – vertical translation (`zm1` is substantially different for all three crystals)

`chim1` – tilt.

Change of the crystal, i.e. `zm1` movement from C(111) to C(220) and vice versa must be done only with **FRONT END CLOSED!**

Ionization chamber `ion_m1` is used for tuning of the M1. In order to set Bragg reflection of M1 to the maximum of the undulator energy spectrum, an 'energy' scan is to be performed (from higher to smaller  $E/\text{mono}$  values in order to avoid the backlash of the motor.

```
OPTICS> plotselect ion_m1
```

```
OPTICS> Escan 8.5 7.5 50 1
```

```
OPTICS> moveE PEAK
```

During the Energy scan a real motor `mono` moves according to the Bragg law  $12.4/E = 2d_{\text{hkl}} \sin \Theta_B$  so instead of `Escan` one can perform `mono` scan

```
OPTICS> dscan mono -0.5 0.5 100 1
```

```
OPTICS> umv mono PEAK
```

Motor `mono` has encoder which position can be read like: `OPTICS> monoencoder`

It is worthwhile to write this value in the log-book.

Horizontal (`xm1`) position must also to be checked. high attention has to be paid to `zm1` movement. Be careful! the crystal holder should not be inserted into the white beam – otherwise it will melt. Check the width of the scan, should be around 1.5 mm.

Typical scans are (see Fig.9.2):

```
OPTICS> dscan xm1 -1.5 1.5 50 1
```

```
OPTICS> dscan zm1 -1.5 1.5 50 1
```

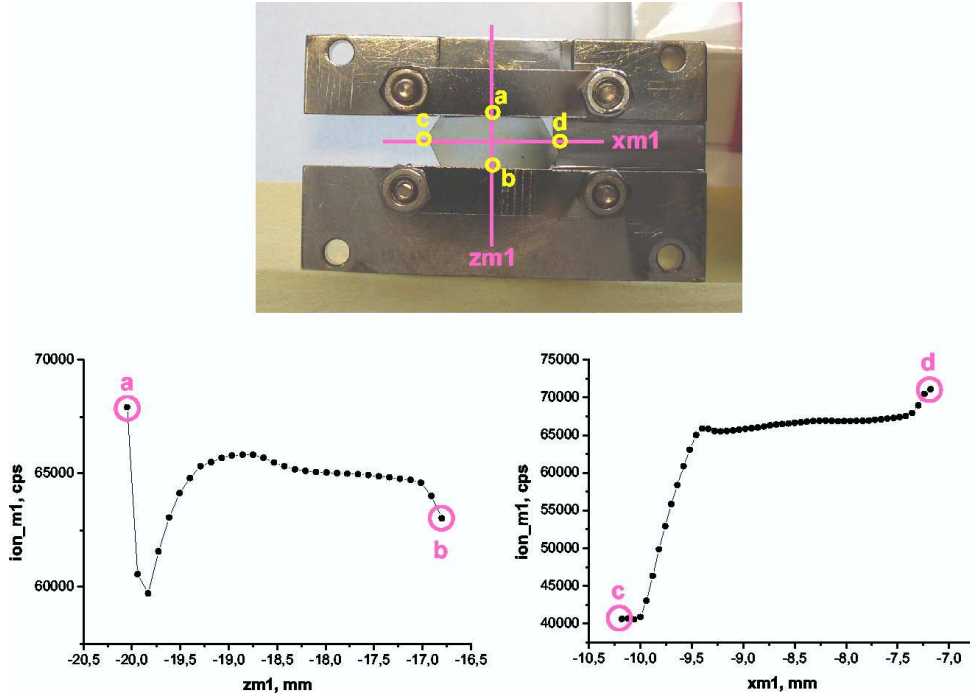


Figure 9.2: Top: Diamond crystal (111) in a real holder. Lines indicate how the white beam crosses the crystal during x- and z- alignments scans. Bottom typical  $z_{m1}$  and  $x_{m1}$  scans. At the points 'a' and 'd' the beam hit the metal frame which increases diffuse background level at ionization chamber. At point 'a' the beam starts to go beside the crystal.

To be sure, one can start these scans with the smaller range and larger steps to avoid excessive heat load on the frame during long time.

Usually the experiments on ID10B are carried out at  $E \approx 8$  keV, however there are cases when a different energy is needed. Here is a description of how to calculate  $\Theta_B$  of M1 for desired energy. In the following equations  $\lambda$  and  $d$  are in  $\text{\AA}$ .

$$2d \sin \Theta_B = n\lambda \quad (9.1)$$

$$2d \sin \Theta_B = \frac{12.4}{E[\text{keV}]} \quad (9.2)$$

$$d_{C(111)} = \frac{3.568}{\sqrt{3}} \quad (9.3)$$

$$\Theta_B = \arcsin \frac{12.4}{E \cdot 2d} \quad (9.4)$$

$$ym_{210} - ym_{28} = h \tan \varphi_{10} - h \tan \varphi_8 \quad (9.5)$$

$$\varphi_{10} = (\pi/2) - 2\Theta_{10} \quad (9.6)$$

$$ym_2 = h \tan \varphi \quad (9.7)$$

$$\varphi = (\pi/2) - 2\Theta_B \quad (9.8)$$

## 9.4.2 M2

Y-position of M2 crystal depends on position of the Bragg angle (i.e. on photons energy) of the first monochromator like:

```
ym2 = 850/tan(rad(2*A[mono]))-815
```

or

```
ym2 = 850/tan(2*asin(12.4/(E*2*2.05941)))-815 for C(111)
```

and

```
ym2 = 850/tan(2*asin(12.4/(E*2*1.26148)))-815 for C(220).
```

Move `ym2` to the appropriate position and set M2 crystal perpendicular to the beam reflected by M1 crystal:

```
OPTICS> mv mono2 XXX (where XXX =2Θ - 90, Θ is the Bragg angle M1)
```

```
OPTICS> plotselect bf
```

Note, that the saturation level of the `bf` photo-diode is 2500. Set the beam position into the center of the M2 in the vertical plane:

```
OPTICS> dscan chim1 -0.15 0.15 30 1
```

```
OPTICS> mv chim1 CEN
```

Set the center of the M2 in the beam in the horizontal plane:

```
OPTICS> dscan ym2 4 -4 40 1 (inverted direction of the scan)
```

```
OPTICS> mv ym2 CEN
```

Attention! In the case of using high-energy beam ( $\approx 20$  keV) alignment of M2 has to be done with use of counter `mon` or `det` in the Experimental Hutch, since counters `ion_m2` and `foil` are not sensitive to the high-energy photons. Energy independent counter placed after M2 is in the project of the future improvement of the beamline.

If the `chim1` offset is significant, the energy scan (`mono`) should be repeated. Once the tuning of M1 is finished M2 is moving to the Bragg angle for the current energy ( $\approx$ `mono`).

Scattered intensity after M2 is monitored on the second ionization chamber, `ion_m2`. The correct position implies the Bragg angle (motor `mono2`) of the crystal and the Y-position (along the beam, motor `ym2`).

```
OPTICS> plotselect ion_m2
```

```
OPTICS> dscan mono2 0.01 -0.01 50 1 (be careful with the direction of the scan)
```

```
OPTICS> mv mono2 PEAK
```

```
OPTICS> dscan ym2 1 -1 30 1
```

```
OPTICS> mv ym2 PEAK
```

The scans by `mono2` and `ym2` must be repeated several times. Trajectory of the beam in vertical plane is determined by the tilt of M2 – motor `chim2`. To check it one needs to use the monitor in the experimental hutch, with the slits `os` and `s0` wide open.

```
OPTICS> plotselect mon
```

```
OPTICS> dscan chim2 -0.05 0.05 50 1
```

```
OPTICS> mv chim2 PEAK
```

Another check can be done by placing green or yellow paper (special paper sensitive to the X-rays) on the pinhole and correcting the offset of the beam by moving `chim2`.

M2 horizontal position tuning is done by coupling `xm2` and `ym2`:

```
OPTICS> fixmono2
```

```
OPTICS> dscan xm2 -3 3 30 1
```

```
OPTICS> mv xm2 CEN
```

```
OPTICS> freemono2
```

After that it is advisable to re-tune `chim2`.

Check of the beam position should be done by scan of the pinhole in horizontal (`zgV`) and vertical plane (`xgV`).

ID10B> plotselect det – detector is on the detector arm (after the pin hole) in the regime of 'air-scattering'

ID10B> dscan zgV -1.5 1.5 30 1 – the offset will be corrected by moving xm2 in fixed mode

ID10B> dscan xgV -1.5 1.5 30 1 – the offset  $\Delta xgV$  will be corrected by moving chim2, namely:

OPTICS> umvr chim2  $\Delta xgV/100$

A SPEC macro is available to help users to re-tune the mono2 after refilling or in case of beam loss. The macro can be started by typing:

OPTICS> udo tunemono2.do

The macro will print the scan of mono2, therefore if the tuning it is done manually don't forget to print the scan and put it on the optics logbook. Another element which has to be adjusted at the beam position is the height of the flight path in order to be sure that it will not cut the beam.

ID10B> plotselect mon

ID10B> dscan zf 5 -5 100 1

ID10B> mv zf CEN

### 9.4.3 Typical settings for monochromators

File common/kev8\_2008\_C111\_1998.do

# settings for 8 keV

# created 13/05/2008

# (on the base of alignment 08/05/2008 logbook #22 page 46)

# 8 keV with the new monochromator\_1 stage

# and diamond(111) 1998 year crystal

# monoencoder

onwiz

umv mono 19.1630

umv chim1 0.0058

umv zm1 10.7500

umv xm1 -8.4322

umv mono2 22.2160

umv chim2 -0.0979

umv ym2 63.4825

umv zm2 -0.8000

umv xm2 -6.1482

umv trm2 -3.5

umv xmi 11.5000

wm mono chim1 zm1 xm1

wm mono2 chim2 ym2 zm2 wm xm2 trm2 xmi

# trm2 C111 at -3.5 C220 at +3.5

# umv trm2 -3.5

# xmi Pt at -11 Pd at +11 umv xmi 11

# Cyberstar settings for 8 keV

# Monitor Detector

# HV 782 834

# gain 3.28 5.75

```

# LL      1.20      1.5
# HL      8.40      8.5
# u27 13.2382

# u27_rev 13.1145
# u35 11.9200

    File common/kev22_2008.do
# created on 25/01/2008
# 22 keV with the new monochromator_1 stage
# and azimuthal repositioned C(111) 1998
# and new diamond(220) crystal
# front end slit 0.5 mm x 0.5 mm !!!!
#monoencoder -47.8133
    umv mono 14.0400

umv chim1 0.7139
umv zm1 -4.3498
umv xm1 -8.3999
umv mono2 13.3332
umv chim2 -0.9030
umv ym2 970.1270
umv zm2 -0.8000
umv xm2 -6.3526
umv trm2 3.5
umv xmi -12.8000
# encoder display for zm1 is -07
wm mono chim1 zm1 xm1
wm mono2 chim2 ym2 zm2
wm xm2 trm2 xmi
# Cyberstar settings for 21.9 keV

#      Monitor      Detector
# HV      690      794
# gain    3.08      4.0
# LL      1.20      1.5
# HL      8.40      8.5
# u27 12.2970

```

## 9.5 Alignment of focusing mirrors

See, first, Section 3.7.

For practical alignment of the mirrors first the zero points in the height and in rotation has to be determined. This is done for one mirror at once, second mirror should be removed from the beam:

```
OPTICS> umv zmi2 3
```

Make sure that motors `thmi1`, `thmi2`, `zt`, `zf` and `arcf` are at zero position before the alignment.

Attention! Move ONLY ONE pseudomotor related to the mirror at once! Otherwise the jack system controlling the position of the mirror can crash.

Align `s0` and open it vertically 0.2 mm:

```
ID10B> umv s0vg 0.2
```

```
ID10B> dscan s0vo -2 2 40 1
```

```
ID10B> umv s0vo CEN
```

Open widely optical slit:

```
OPTICS> umv osvg 5
```

```
OPTICS> umv oshg 4
```

Use monitor for the further alignment:

```
OPTICS> plotselect mon
```

Macro `miral.do` can be used now for the alignment of the mirrors.

```
OPTICS> udo miral.do
```

It makes the following:

First mirror is raised (`zmi1`) until it intercepts about half of the beam, then it is rocked (`thmi1`) until it is parallel to the beam.

```
OPTICS> plotselect mon
```

```
OPTICS> mv zmi1 0
```

```
- insert 1st mirror into the beam OPTICS> dscan zmi1 -0.8 0.8 40 1
```

```
OPTICS> mv zmi1 CEN
```

```
OPTICS> dscan thmi1 -0.2 0.2 30 1
```

```
OPTICS> mv thmi1 CEN
```

Reset of the zero position of the mirror height has to be done for each jack separately and not by `set zmi1 0` which will introduce an *erroneous* zero position.

```
OPTICS> set leg1dr 0
```

```
OPTICS> set leg1u 0
```

```
OPTICS> set leg1df 0
```

This procedure is to be repeated with second mirror:

```
OPTICS> umv zmi1 -2
```

```
OPTICS> mv zmi2 0
```

```
OPTICS> dscan zmi2 -0.8 0.8 40 1
```

```
OPTICS> mv zmi2 CEN
```

```
OPTICS> dscan thmi2 -0.2 0.2 40 1
```

```
OPTICS> mv thmi2 CEN
```

```
OPTICS> set leg2ur 0
```

```
OPTICS> set leg2uf 0
```

```
OPTICS> set leg2d 0
```

It could be useful to repeat `miral.do` once again.

For the further alignment a macro

```
cam1  $\alpha_1 - \alpha_2$ 
```

is used for calculation of the optical element heights to set a certain incident angle in vertical plane. It calculates

- height for the optic slit vertical offset `osvo`
- height of the flightpath `zf`
- height of the diffractometer `zt`
- height of the second mirror `zmi2`

If  $|\alpha_1| = |\alpha_2|$  a resulting beam should be horizontal

```
cam1 0.35 -0.35 – example of the horizontal beam for 8 keV
```

If  $|\alpha_1| > |\alpha_2|$  a resulting beam will be tilted by  $\Delta\alpha = (|\alpha_2| - |\alpha_1|) \cdot 2$ , that can be used for GID and GIXOS measurements from liquid surfaces instead of using of the deflector crystal. Make sure to stay below the critical angle of the mirrors.

```
cam1 0.35 -0.295 – example of 8 keV beam tilted downward by 0.11°
```

A fine tuning is consist in the following.

Center of the beam should coincides with the center of the second mirror, that is to be checked:

```
ID10B> umv s0vg 3
OPTICS> plotselect mon
OPTICS> dscan zmi2 -2 2 50 1
OPTICS> mv zmi2 CEN
```

If this CEN value differs from the position `zmi2cam1` calculated by `cam1`, than positions of all `zf`, `zt` and `osvo` must be corrected accordingly to the difference `CEN - zmi2cam1`.

Final tuning of `thmi2`:

```
OPTICS> plotselect det
OPTICS> dscan thmi2 -0.005 0.005 25 1
OPTICS> mv thmi2 CEN
```

Measure the actual angle of incidence by doing `gam` scan with the detector placed after `s2`. In the case the actual angle is not equal to the desired angle correct this discrepancy by relative movement of `thmi2`. After that the hight of `zt` should be corrected (find the value from `xgV` scan with detector installed after the pinhole). Adjust finally position of `s0` (scan `zf`) and `osvo` (scan `osvo`). Check again the actual angle of incidence by doing `gam` scan with detector installed after `s2`.

Beam Viewer (X-ray eye – another name) – a small CCD camera for visualization the beam profile – can be used to control on-line quality of the focusing (see Chapter 6.6). It works with zero absorber (because of Al window in front) – make sure all other detectors are in the save situation when you use Beam Viewer, i.e. set the narrowest pinhole underneath of the monitor and empty window (without kapton) for the detector. The software for Beam Viewer can be started from any shell console on `maxpc` by typing:  
`maxpc:~ % bpmGUI`

X-ray is focused on the sample position by means of bending of the second mirror, which is done by the motors `fumi2` and `fmi2`. They are the only motors where the input

is in microns and not in mm, therefore it makes no sense to move them with the step less than 5 (microns).



## 9.6 Alignment of the deflector Ge(111) crystal

See first Section 4.3.

1. Make sure that the beam is horizontal. Before the Ge(111) alignment the alignment of the **diffractometer centering pin** (Section 9.2), **monochromator M1 and M2** (Section 9.4) and **slit s2** on the detector should be done. It means the beam goes through both the diffractometer centering pin and s2.
2. Align s0 in the experimental hutch – it will be an important reference. Note it is better to use motor `zf` than `s0vo`.
3. ID10B> `plotselect mon`
4. Mount deflector pinhole.
5. ID10B> `mv rhod 0`  
On the hard scale of `rhod` one should actually see position  $11^\circ$  (due to the special adaptor plate). Check horizon along `rhod` with water level on the upper surface of the `phid` turn table.
6. Move `zd` to the current position of `zt`
7. Open s0 slit  
ID10B> `mv s0vg 2`  
ID10B> `mv s0hg 4`
8. Switch ON airpads and Scan `xt` (positive direction towards the ring) to find horizontal position of deflector pinhole.  
ID10B> `air_xt`  
ID10B> `dscan xt -1 1 20 1`  
ID10B> `umv xt CEN`  
ID10B> `air_stop`
9. Scan `zd` to find vertical position of deflector pinhole.  
ID10B> `dscan zd -1 1 20 1`  
ID10B> `umv zd CEN`
10. Scan `sigmat` to set both the axis of diffractometer and the axis of deflector goniometer in to the beam.  
Put detector on the detector arm.  
ID10B> `plotselect det`  
ID10B> `air_sigmat -- air-pads are on`  
ID10B> `dscan sigmat -0.2 0.2 20 1`  
ID10B> `mv sigmat CEN`  
ID10B> `set sigmat 0`  
ID10B> `air_stop`  
ID10B> `dscan zgV -1 1 20 1` – to check the position with air OFF.

11. Remove deflector pinhole and mount Ge(111) crystal
12. Scan `thd` to set the crystal surface parallel to the beam. The scan graph should be a triangle-like curve where one needs to find maximum.
 

```
ID10B> plotselect mon
ID10B> umv thd 0
ID10B> dscan thd 0.5 -0.5 50 1 (scan from positive to negative)
ID10B> umv thd PEAK – or result of linear approximation
ID10B> set thd 0
```
13. Calculate `thd` Bragg angle for the current energy of the photons<sup>1</sup>

```
ID10B> p deg(asin((12.3985/E)*sqrt(3)/(2*5.65735)))
```

 For 8keV  $\Theta_{\text{Ge}(111)} = 13.76^\circ$   
 For 22keV  $\Theta_{\text{Ge}(111)} = 4.95^\circ$ 

```
ID10B> umv thd  $\Theta_{\text{Ge}(111)}$ 
```

 The finest `thd` scan when motor does not lose steps

```
ID10B> dscan thd 0.008 -0.008 20 1
```
14. Install detector in the holder just after the Ge crystal.
15. Tune `thd` to find Bragg reflection, i.e. max det counts (scan from "+" to "-")

```
ID10B> plotselect det
ID10B> dscan thd 0.03 -0.03 30 1 (scan from positive to negative)
```
16. Remove the shielding carpet from the marble floor and clean the floor with a vacuum cleaner (stored in PLUO)
17. Move `sigmat` to  $2\Theta_{\text{Ge}(111)}$ 

```
ID10B> air_sigmat
ID10B> umv sigmat 27.52 – for 8 keV
ID10B> air_stop
```
18. Make the beam after deflector horizontal:

```
ID10B> plotselect mon
ID10B> umv s0vg 0.2
ID10B> dscan chid -0.3 0.3 30 1
```
19. Repeat `thd` scan 15
20. Mount the point detector (90° to the beam) on the detector arm

```
ID10B> plotselect det
```
21. Scan `zgV` to find an offset for `sigmat`

```
ID10B> plotselect det
ID10B> dscan zgV -2 2 20 1
ID10B> p CEN
```

 $\Delta\text{sigmat} = \text{deg}(\text{atan}(\text{CEN}/1000))$  (or PEAK if scan data is very asymmetric).  
 Correct `sigmat` and reset `thd` to the value `sigmat/2`

---

<sup>1</sup>See help file `opid10/common/spec00.hlp`

22. Scan `xgV` to find vertical offset that will be corrected by `chid` or just scan `chid` like 18.
23. Put det after `s2` and scan `gam`. If maximum is not at 0 but at `XXX` do (if the `thd` value is at the true Bragg angle value)  
`ID10B> fixtable`  
`ID10B> tableca XXX`  
 or specify also the true Bragg angle yourself  
`ID10B> tableca XXX  $\Theta_{\text{Ge}(111)}$`   
`ID10B> freetable`  
 It will calculate correction for `chid` (see the value of `rhod` calculated by `tableca`).
24. After this correction of `chid` the beam is horizontal but the height is changed. Put detector after the sample pinhole.  
`ID10B> umv s0vg 3`  
 Scan `xgV` to find vertical offset  $\Delta z$   
`ID10B> dscan xgV -2 2 40 1`  
`ID10B> p CEN`  
 Correct by moving of `zt`  
`ID10B> umvr zt CEN` (Attention! Relative movement!)
25. Scan `zgV` and correct by moving `sigmat` like in 21.
26. Repeat 23
27. For the final alignment some macros should be loaded from  
`ID10B> udo deflector.do`
28. Give for SPEC new value of `thd` and two distances:  
`ID10B> THD_0=13.773` – current value of `thd`  
`ID10B> FT_DXF=399.029` – distance ... (take it from previous SOS file – should be around 400 mm)  
`ID10B> FT_DXCOR=998.0564` – distance deflector-sample pinhole, i.e. `COR` (take it from previous SOS file – should be around 1000 mm)
29. Install the detector just after the Ge (111) crystal and run  
`ID10B> defl_thd`  
**If these scans are aborted move `rhod` to 0**, before restarting `defl_thd`. Print and put into the logbook the output file.  
 This procedure determines correction to the motor `phid`.  
 Run  
`ID10B> caphid`  
 It will ask for the Bragg angle, maximum value of `rhod` (enter the modulus of `rhod`) and corresponding maximum value of  $\Delta\text{thd}$  obtained in `defl_thd` with the actual sign plus or minus. The result will be one number `YYY` – also with its own sign!  
 Note, if  $(\Delta\text{thd}=\text{thd\_CEN}(\mu=0)-\text{thd\_CEN}(\mu>0)) > 0$  then `phid` should be moved in positive direction.  
`ID10B> umvr phid YYY`  
`ID10B> umvr thd -YYY`  
`ID10B> umv rhod 0`  
 Repeat `defl_thd`.

Also averaged value of  $\overline{\text{thd}}$  found in the `defl_thd` procedure is an optimal value for the reflectivity measurement, so

```
ID10B> umv thd  $\overline{\text{thd}}$ 
ID10B> set thd sigmat/2
ID10B> thd0=sigmat/2
```

30. Hint: use

```
ID10B> wdeflector to see positions of all related motors.
```

31. Check tracking of the beam with `zf` using `mon` as a counter. For this one should, first, identify which motors are involved into `fixtable` macro.

```
ID10B> udo id10bfixtable.mac
```

(There is a possibility to set optimal values of `rhod` in a form of table for different ranges of `mu`. To use this option one should enable parameter `THDCOR_ON=1`, if it is `THDCOR_ON=0` the table does not work. )

```
ID10B> fixtablesetup mu thd rhod arcf zf sigmat
```

```
ID10B> fixtable
```

```
ID10B> umv s0vg 0.2
```

Find parameter `FT_DXF` and `zf` at `mu=0` for the final macro. For this do

```
ID10B> defl_zf
```

Print and put into the logbook the output file.

At `mu=0` do

```
ID10B> umv mu 0
```

```
ID10B> freetable
```

```
ID10B> umv zf zf-new-value
```

New value of `FT_DXF` should be stored in the 'SOS' macro and also reset in ID10B

```
ID10B> FT_DXF= FT-DXF-new-value
```

32. Check tracking of the beam with `zt`. For this install the detector on the detector arm in front of the slit `s2`.

**First of all check low limit** of the detector arm motor `gam`. The motor should be able to go in the negative direction at least to the value

$-(\text{mu}_{\text{max}} - 1)$

Then

```
ID10B> fixtablesetup mu thd rhod arcf zf sigmat zt
```

```
ID10B> fixtable
```

Find parameter `FT_DXCOR` and `zt` at `mu=0` for the final macro. For this do

```
ID10B> defl_zt
```

Print and put into the logbook the output file.

New value of `FT_DXCOR` should be stored in the 'SOS' macro and also reset in ID10B but only at `mu=0!!!`

```
ID10B> umv mu 0
```

```
ID10B> freetable
```

```
ID10B> umv zt zt-new-value
```

```
ID10B> FT_DXCOR= FT-DXCOR-new-value
```

33. Create SOS macro that brings the goniometer back to the basic position (i.e. deflected beam is horizontal) if the alignment is lost.

See an example in `users/opid10/common/sos_example.do` or in the end of this

chapter.

Motors thd and rhod have encoders, to read values:

```
ID10B> wread rhod_enc
```

```
ID10B> wread thd_enc
```

Write values of the encoders as a comment in the SOS macro (also at  $\mu=0$ ).

Example of 'SOS' macro from 13.12.2006

```
# Experiment CH-2281
# do sosmu_131206.do
# done for energy 8 keV
# restore motors position for mu=0

shclose
setfilter 19
freetable
#udo fixtable_oleg.mac
#fixtablesetup mu thd rhod arcf zf sigmat zt
#restores mu position

air_sigmat
FT_DXF= 399.029
FT_DXCOR= 998.0564
FT_OFS=0.0
THD_0=13.805
mv mu 0.0000

#mv chid -0.1755
#mv phid 1.3000
# xd -0.8800
# yd 0.0230
# mv thd 13.805

mv rhod 0
mv arcf 0
mv zf 5.1032
mv zt 5.0018
mv sigmat 27.6101

fixtable

## bonus # freetable # fixtable # air_stop # air_sigmat #
tableca # wtilt # blmenu
#wm mu thd rhod arcf zf sigmat
#wm zt chid phid xd yd zd
#_sleep=0
```

## 9.7 Detector arm GIXOS or GISAXS experiment

From help file on maxpc opid10/readme/GIXOS\_setup.txt

Description of the typical setup for GIXOS measurements with the ID10B 150mm slits and ID10B vacuum flightpath (150 mm).

Rail X48 : length 800 mm

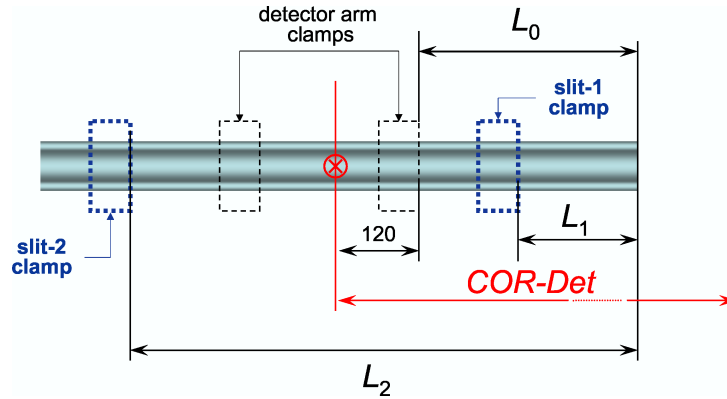


Figure 9.3: Optimal distances

$L_0 = 235$ mm		Distance between the upstream end of X48 and the upstream clamp on the detector arm
$L_1 = 103$ mm		Distance between the upstream end of X48 and S1 clamp (upstream side)
$L_2 = 562$ mm		Distance between the upstream end of X48 and S2 clamp (upstream side)
COR-Det = 582 mm		Distance between center of rotation (goniometer) and center of the detector arm

At this positions of the elements the distance between slits S1 and S2 is 635 mm.

To align the long slits use macro `longslit.do`

# Appendix A

## Some of SPEC commands

### A.1 General

`p DATAFILE` – shows a name of the current datafile and a path to its directory

`pwd` – shows directory from which SPEC is started

`ct xxx` – count xxx seconds

`ct` – count 1 sec

`mv motor name xxx` – move motor to the absolute position xxx

`mvr motor name xxx` – move motor relatively from the current position on xxx

`umv motor name xxx` – move motor to the absolute position xxx and see on-line how its position changes

`umv motor name1 xxx1 motor name2 xxx2` – move simultaneously motor1 to the absolute position xxx1, motor2 to the absolute position xxx2 and see on-line how its position changes

`set_lm motor name xxx1 xxx2` – set software limits for a motor *motor name*

`onwiz` – enter to the area of protected motors/paprmeters (password must be provided)

`offwizz` – quit from wiz (automatic quit in 10 min)

`u` – enter UNIX

`u ls` – shows the content of the directory

`u td xxx` – search of the word 'xxx' in the ESRF telephone directory

`exit` – quit UNIX

`pplot` – send graph of the last scan to the printer

`splot` – re-plot graphic window of the last scan with new settings (after `plotselect`)

`laser` – send any of the open graph windows to the printer

`plotselect` – select a counter for plotting scan data

`plotselect det` – complete command choosing counter `det` for the graph window

`a2ps -f6.4 filename` — `lp` – printing of 2 pages of text document on one A4 page

`wa` – writes the positions of all configured in the SPEC application motors

`mishkon` – wait for an appropriate reading of the (ring) machine status to allow for scan start

`mishkoff` – no communication the (ring) machine

## A.2 OPTICS application

## A.3 ID10B application

autof – choose the counter for the automatic filter change  
autofon – set automatic filter  
autoff – quit automatic filter  
fct – automatic setting of the optimal absorber, works only at autofon.  
ratiosetup – defines pseudo-counter `ratio=counter1/counter2`  
ratiosetup (name)<sup>1</sup> (counter2) (counter1) – complete command  
newsample *sample name* – name of the sample to be written to the header of the SPEC datafile  
flux – to measure absolute flux at the sample position.

Activating-deactivating of pseudocounters `fb_Pi` (surface pressure in the Langmuir trough) and `fb_A` (surface area) or any other.

ID10B> `config`

Press `c` to change the page until you see `counter page`

Press `Shift` and `g` to go to the bottom of the counter list.

If `fb_Pi` is set as `common` then this counter is active in all SPEC applications.

Press `+` and choose `surf` instead of `common`. Now `fb_Pi` is active only in a dummy application `surf`.

Press `w` to save the changes and `Ctrl c` to quit.

Two specific counters `fb_Pi` and `fb_A` can be also turn ON/OFF in `blmenu`.

### LOG SCANS FOR SAXS

A macro called `logscan.mac` on `maxpc` is to perform scan with steps constant in log scale. Either restart your spec session, or do `udo logscan`”” in your running session. `lsdef log*` to see all available scans.

Also, once the scan is finished, you can use following plotting commands: `xlogplot`, `ylogplot` or `xylogplot`. The standard plot command remains and use options you set using `setplot`.

The `logscan` macros can also accept two parameters for time:

ID10B> `logscan m0 0 30 50 0.5` – acquisition constant at 0.5 sec.

ID10B> `logscan m0 0 30 50 0.25 0.75` – acquisition goes linearly from 0.25 sec to 0.75 sec.

The same applies on all logscans (`logdscan`, `loga2scan`,...).

SPECIAL AUTOFILTER MODE FOR TIME RESOLVED MEASUREMENTS assuming fast kinematics in the system

Inside spec:

ID10B> `udo autof.mac` (to reload the macro)

ID10B> `autofrepeatoff` – in this mode if counting is done with a non optimal absorber value (too big or too small), the result of the counting is written anyway to the file

---

<sup>1</sup>usually 'ratio'



and *counting is not repeated at this scan point with adjusted absorber value*. Corrected absorber value will be used for the next point of the scan.

ID10B> autofrepeaton – normal way: counts are repeated if necessary

ID10B> autofrepeat – just print the current "repeat mode".

# Appendix B

## MatLab application

By J. Novák<sup>1</sup>

### B.1 Introduction

MatSpec is package for visualizing spectra of a position sensitive detector (PSD), i.e. a 1-D detector, collected by SPEC software using Matlab. This is a documentation for usage of the MatSpec package on the ID10B beamline at the ESRF. The document describes main features of the package, its usage at the ID10B beamline and suggestions for the "home" usage. The document is written on the new-user-level and does not go into details of the package. An experienced user can freely modify clones of the scripts. Most of the instructions in this document are accompanied by examples, i.e. commands which should be written on the command line of your computer. The examples are written in `typewriter` typeface.

See a special manual.

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