SLS-TME-TA-2009-0318
September 21, 2012

# Manual for the X09DA Beamline (updated/2012)

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Details of setup, use and maintenance of the X-ray and UV-Vis beamlines.

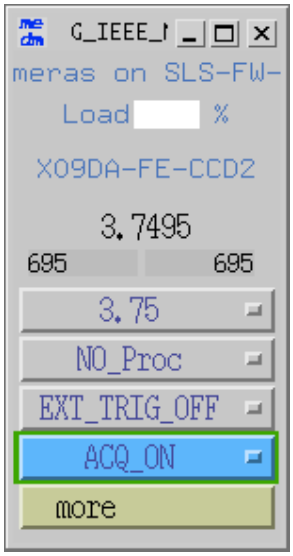
# MANUAL FOR THE X09DA BEAMLINE

## X-RAY BRANCH

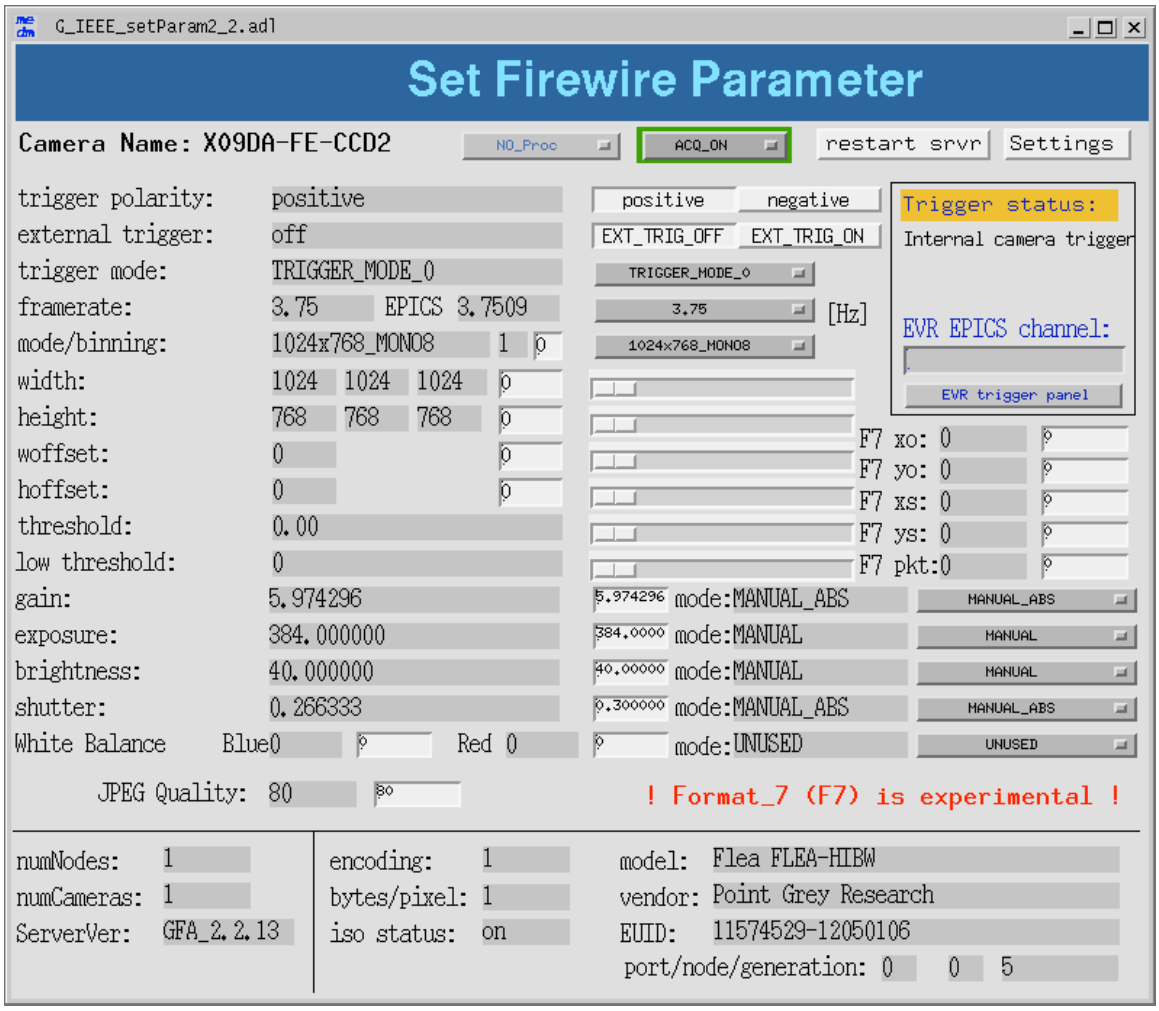
### Controlling the camera:

Camera name: X09DA-FE-CCD2

To control some features of this cam one should open the following window:
The path to open it in the SLS launcher is: Diagnostics → Beam Size Monitor X09DA → Camera Server of X09DA-FE-CCD2




One needs to click on the “More” button and chose “params.” to get a new window and control the following features




Main features to control:
**Gain: Default 412** gives 5.974296dB (as shown in the blue field right after)
**Shutter time: Default 500** gives 152.787 ms (as shown in the blue field right after)
Please observe that the shutter time is dependant on the chosen Frame rate and Trigger mode (see below), and that the blue field is not updated if there is a change of these properties. To see the correct shutter time one has to enter the shutter value once again!!!!

**Frame rate: Default 3.75 Hz**

**Camera data: NO_Proc.** Since no precessing is made on the camera image this option should be default, in case you choose another option it can make the reate at which images come to the control room much slower than what is chosen in Frame Rate.

**Trigger polarity: Default positive**

**External trigger: Default off**.
With the new camera server this camera does not work with the option trigger on, the image gets frozen, waiting for a trigger that never comes.

Please observe external trigger on/off usually affects the shutter time!!! That is, the real shutter time changes even though the same shutter value is given. To see the correct shutter time one has to enter the shutter value once again!!!!

**Trigger mode: Default TRIGGER_MODE_0,** which means that the camera is externally triggered, but the shutter time is still controlled by the camera software and not by the trigger pulse length.

**Brightness: Default 40.** This "knob" affects the background and should only be changed if the noise level for non-illuminated pixels is too high or too low. Most dangerous if it is too low (=0, this is shown as blue background in the CAM application). Then the beam profile fits will not be OK (, and beam sizes will be underestimated). However, if there is an amount of roughly 10-30 % of blue pixels, the fits are still OK.

**The rest of the features I always tried not to touch!!!!**
In fact, the application has a tendency to hang if too many settings are touched. If it hangs one can try the "soft" Reboot button. If this does not help one has to go over to the SLS building and turn off and turn on the computer server, marked **CCD2** (located on the outside of the shielding wall at the exit ports of Straight L09 and Dipole X09). Even though this is an inconvenience, I have especially asked Mirec **not to update** the server software version. Later versions I have not checked up concerning shutter time, gain etc., and still they sometimes hang.

**The above settings should give a maximum pixel intensity of approximately 125-150 units, for 400 mA and beam sizes sigmax=56 um and sigmay=9 um (as measured with the visible branch).**Please observe that the Max Pixel Intensity (blue field top right) on the main window could occasionally show a higher value, probably because of radiation. The max pixel intensity should better be checked in Andreas CAM application window that continuously writes some data for each analyzed picture. There one can see the maximum content in a pixel within the ROI chosen (at least in some CAM-versions), and one becomes less sensitive to the radiation problem.

## *Normal operation, X-ray branch:*

By normal operation I mean *relative* beam size measurements at currents of 400mA and below. *The X-ray branch will not give correct absolute values*, mainly because of phosphor related effects (degradation, non-uniform light exchange), but can still be used for relative measurements.
For such measurements, the only feature needed to be touched is the shutter time. It should be decreased in case of smaller beam sizes, and it should be increased in case of lower current or larger beam sizes, to give a maximum pixel intensity of 125-150 units (see below under camera linearity). For very low beam currents one has to start removing Mo-filters (see below under controlling motors). *If this maximum pixel intensity is maintained, the accuracy of the measurements should be as good as at 400 mA, and one can still trust small relative beam size changes.*
This diagnostic X-ray branch is well suited for determining the horizontal and vertical dispersion in the center of the X09 Dipole. This is important in order to derive the

horizontal and vertical emittances from the absolute beam sizes measured by the Vis-UV branch. In this respect, the Vis-UV branch is not so well suited, since the image position fluctuates too much, probably because of air movements in the tunnel. Andreas will provide two channels: X09DA-FE-CCD2:X-POS andX09DA-FE-CCD2:Y-POS, that can be plotted while Michael's automatized BPM dispersion measurement runs, or while doing manual RF changes. One should remember to check the camera roll alignment with a pure horizontal bump before calculating the dispersions.

**A final operational remark: it might be tempting to remove Mo filters to shorten the shutter time, but this could have detrimental effects on the downstream phosphor screen.!!!! Even with the present set-up the phosphor degrades. Not to degrade the phosphor too fast, only remove Mo filters in correspondence to lower currents (in order not to have too long integration times)!! If the shutter time, after adjustment to reach a maximum pixel intensity of 125-150, is much shorter than 150 ms, please consider inserting more Mo-filters!**

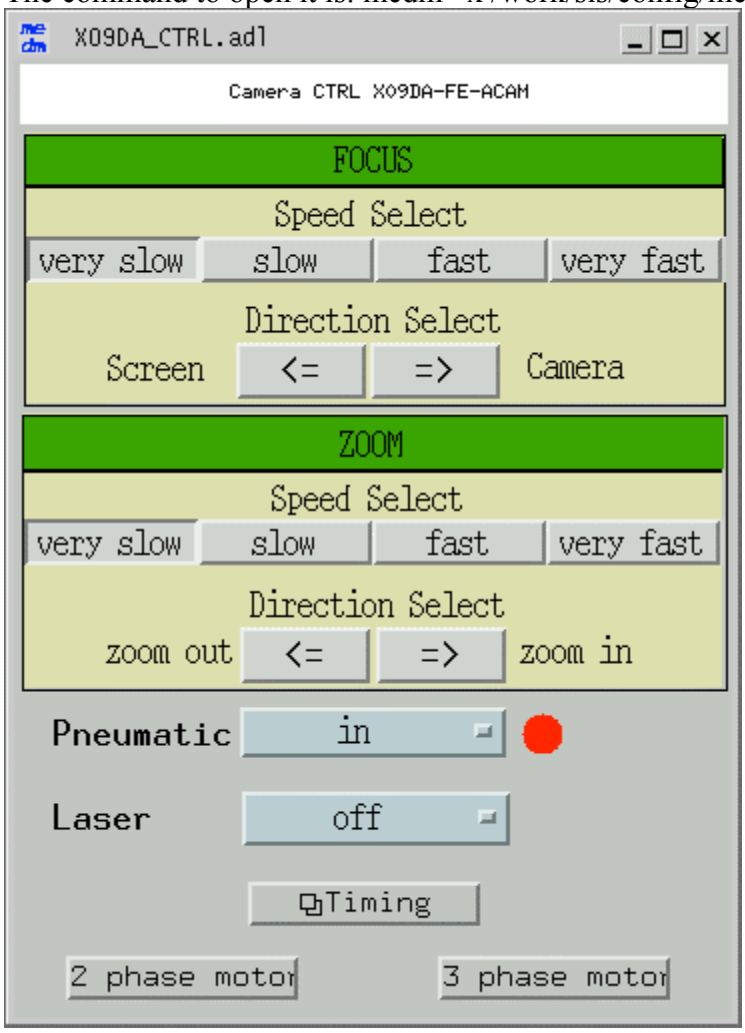
*Camera linearity related issues, X-ray branch:*

The pixel content as a function of light exposure should be linear. However, this is usually not the case. This function also changes wit the aging of the camera. The first simple check can be made as follows. Assure that the beam conditions are stable (user operation). Check that you are in the range of 125-150 units for maximum pixel intensity. Shorten the shutter time with 10-20%. Then the measured beam sizes should not differ by more than 1-2%. A second step to check the camera linearity is to vary the integration time over a wider range and plot the maximum pixel intensity (as described above one should use Andreas CAM application with a small ROI) as a function of shutter time. Please, always do these tests under stable machine operation like user operation. For the moment (March 2008) with the above Gain setting (6 dB) the camera is quite linear up to **160 units in the pixels**. When exposing the cam to more light (within the shutter time) than this, the pixel output will be lower than in the linear case (, and beam sizes will be overestimated). I will supply an excel file where some linearity check-ups are presented. If you for some reason start to acquire images with a higher maximum pixel content than 160, please go down in shutter time, or insert more Mo-filter (see below**). Do not change Gain!** If you acquire images with lower maximum pixel content than 160, for example if you want to measure at lower currents, you can increase the shutter time, or remove Mo-filters (see below). **Do not change the Gain!**

**If one changes the Gain, one changes the range over which the cam is linear, and one should perform a new linearity check as described above!**

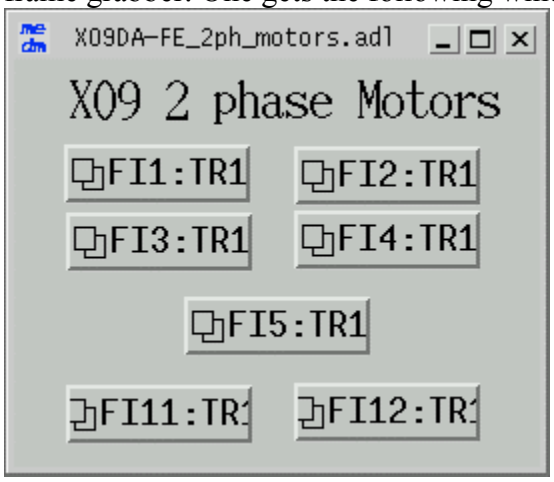
## Controlling five different motors at the end of the beamline

All these motors are situated on top of the optical table at the end of the beamline. All components driven by the motors are outside vacuum.
To control these motors one should open the following window:
The command to open it is: medm –x /work/sls/config/medm/X09DA_CTRL.adl



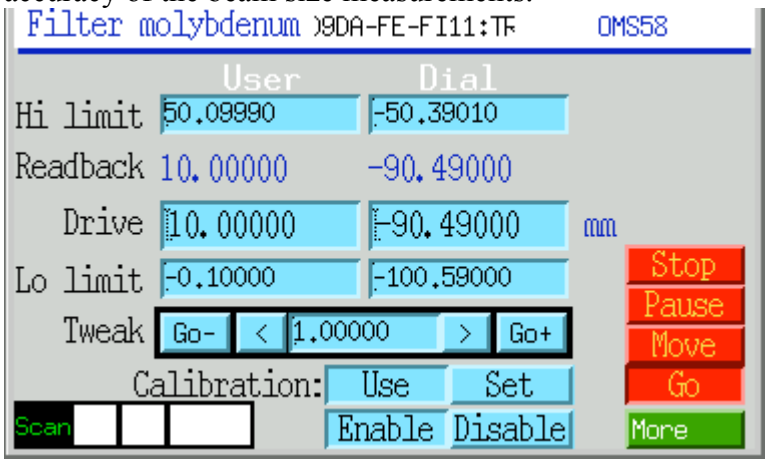

The two first motors to control are two servo motors, namely **FOCUS** and **ZOOM**. Since they are servo motors they suffer from some backlash. There are no read-back signals. The motors are situated on the lens system between the CCD2 cam and the phosphor screen. They have been set to zoom in on four pinhole images that originate from pinholes that are 15 um in diameter, and the focus has been carefully adjusted to give minimum spot size, i.e. the camera is exactly in the image plane. **Do not touch these motors unless something urgent has happened! It takes a while to adjust them again!** If one needs to move the motors, one should use the "very slow" speed and be patient. It is not always the higher speeds work.
There are three more motors for this X-ray branch. They are 2–phase stepper motors and will be found by clicking on **"2 phase motors"**. All other knobs in this window belong to

the Vis-UV branch. The “Timing” knob is out of date, it belonged to the old camera with frame grabber. One gets the following window by clicking on “2 phase motors”:

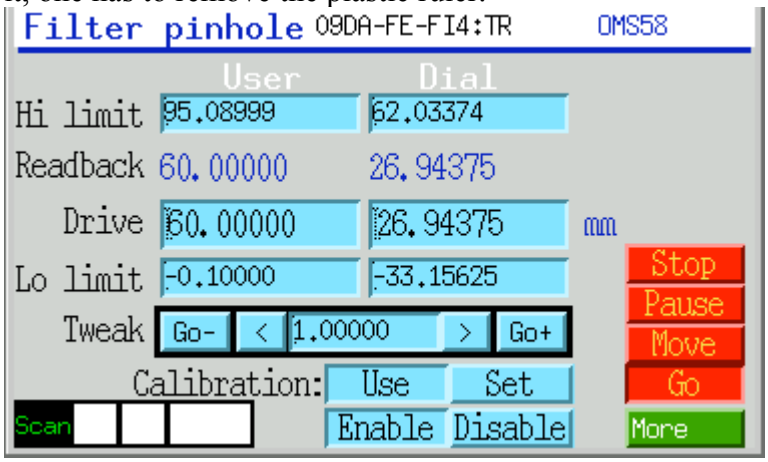



Please observe, there are more motors than three, but they belong to the Vis-UV branch. **Only FI4, FI11 and FI12 belong to the X-ray branch! Do not touch the other ones, they will affect the on-line beam size measurements!**
**For all motor controls described below, I find it always safest to enter the desired value in the Drive window, and press Return, not to use Go- or Go+!!!!**

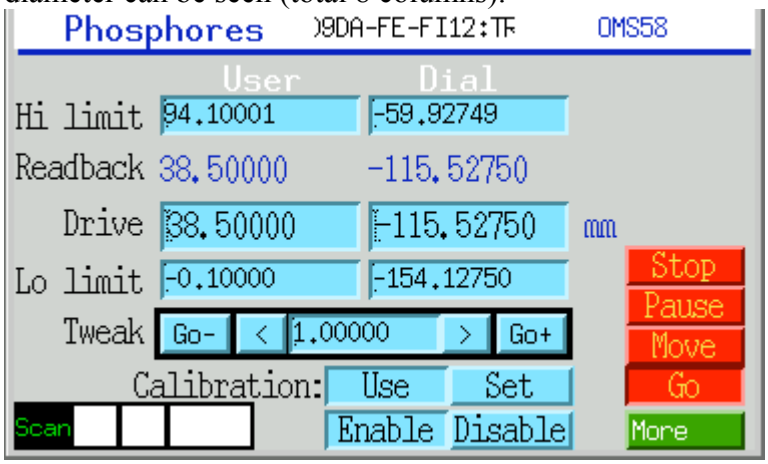
The first item that the X-ray beam sees is the **Molybdenum filter set-up FI11**. It can be moved horizontally placing different numbers of Mo sheets in the beam path. Maximum number of sheets (5) are in when the motor is at 0 mm (Please neglect all numbers given under “Dial”). The motor can be moved to 50 mm, but all sheets are out much before. Roughly one sheet is moved out per 6 mm. **Default value is 10 mm. This is 4 sheets**. Please note that if one takes out (or forgets to put back) Mo sheets when there is 400mA in he machine, one exposes the phosphor screen to higher power levels! The degradation of the phosphor is one of the main limitations of the X-ray branch, considering the accuracy of the beam size measurements.



The next item that the X-ray beam sees is the **Phosphor screen set-up.** It is driven by the motor **FI4. Please note that the denotation in the motor control window is wrong! Trust FI4, not the name!** It can be moved horizontally allowing for the possibility to expose a fresh(er) phosphor area to the X-rays. **Default value is 60 mm.** (Please neglect all numbers given under "Dial"). The motor can be moved between 0 mm and 95 mm, but the phosphor is only roughly 30 mm in diameter. Furthermore, the mount of the phosphor "hides" some of its area. The actual range in which the phosphor is seen is thus less than 30 mm**. Please go in and check at the mount before moving to higher values than 75 mm!!! There is a plastic ruler mounted to check the focusing of the cam without an X-ray beam. This has to be removed before one can go fully to 95 mm. However for the moment there is no need to go fully out to 95 mm!!** The degradation of the phosphor is one of the main limitations of the X-ray branch, considering the accuracy of the beam size measurements. To move the phosphor and observe how the beam size values vary, gives you a feeling of how bad this "situation" is. To get a real fresh phosphor area one should actually go into the set-up and turn the phosphor in its mount, or put in a new one. The present is a P43 of 6 micron thickness. On the same mount is a P43 of 20 micron thickness, but so far it tends to give larger sigmay values than a fresh 6 micron phosphor, and the light gain is not tremendous. If one wants to use it, one has to remove the plastic ruler.



The last motor **FI12** is moving the **camera and lens system** horizontally. **Please note that the denotation in the motor control window is wrong! Trust FI12, not the name!** It can be moved horizontally allowing observation of images of pinholes of larger diameters than 15 um. **Default value is 38.5 mm.** (Please neglect all numbers given under “Dial”). Here are the images of the 15 um pinholes situated. The motor can be moved between 0 mm and 95 mm, but the images of the pinholes are in the range between 38.5 and roughly 45 mm. In this range two columns of 15, 20, 25, and 30 um diameter can be seen (total 8 columns).

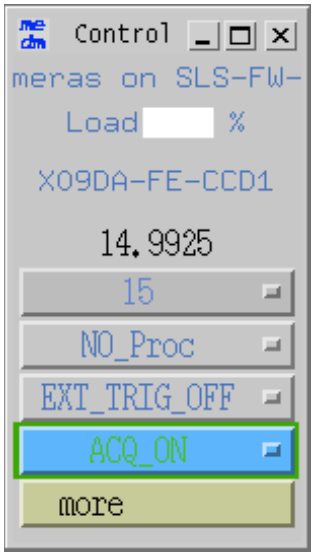


# Vis-UV BRANCH

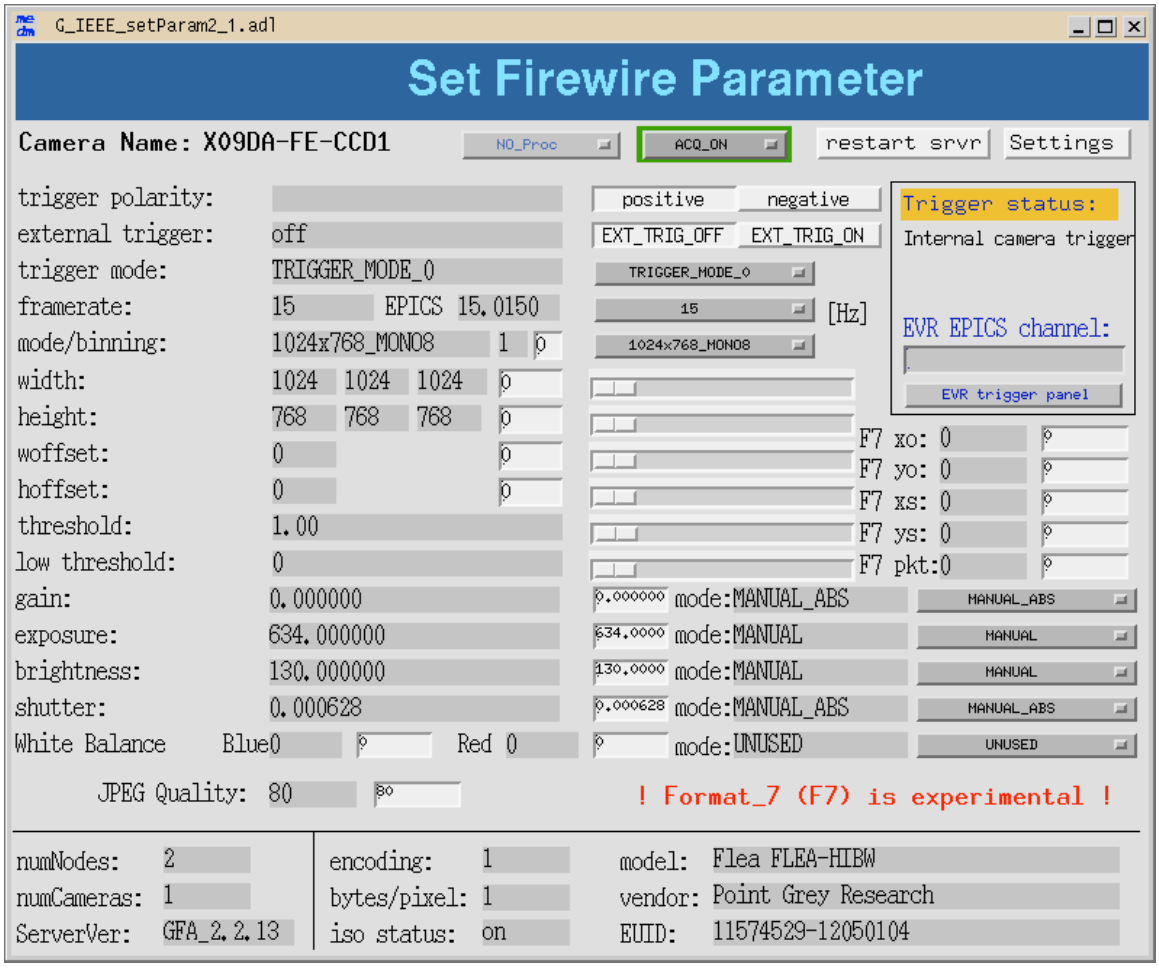
## Controlling the camera:

Camera name: X09DA-FE-CCD1

To control some features of this cam one should open the following window:
The path to open it in the SLS launcher is: Diagnostics → Beam Size Monitor X09DA → Camera Server of X09DA-FE-CCD1




One needs to click on the “More” button and chose “params.” to get a new window and control the following features




Main features to control:
**Gain: Default 245 (MANUAL mode)** gives 0.00dB (as shown in MANUAL_ABS mode)
**Shutter time: Default 49 (MANUAL mode)** gives 0.628 ms (as shown in MANUAL_ABS mode)
Please observe that the shutter time is dependant on the chosen Frame rate and Trigger mode (see below), and that the blue field is not updated if there is a change of these properties. To see the correct shutter time one has to enter the shutter value once again!!!!

**Frame rate: Default 15 Hz**
Please observe that this frame rate still affects the shutter time even if the external trigger mode is on!!!

**Camera data: NO_Proc.** Since no precessing is made on the camera image this option should be default, in case you choose another option it can make the reate at which images come to the control room much slower than what is chosen in Frame Rate.

**Trigger polarity: Default positive**

**External trigger: Default off**.
The camera can be externally triggered by the 3Hz injection trigger, and is not freely running with its internal clock rates.
Please observe external trigger on/off usually affects the shutter time!!! That is, the real shutter time changes even though the same shutter value is given. To see the correct shutter time one has to enter the shutter value once again!!!!

**Trigger mode: Default TRIGGER_MODE_0,** which means that the camera is externally triggered, but the shutter time is still controlled by the camera software and not by the trigger pulse length.

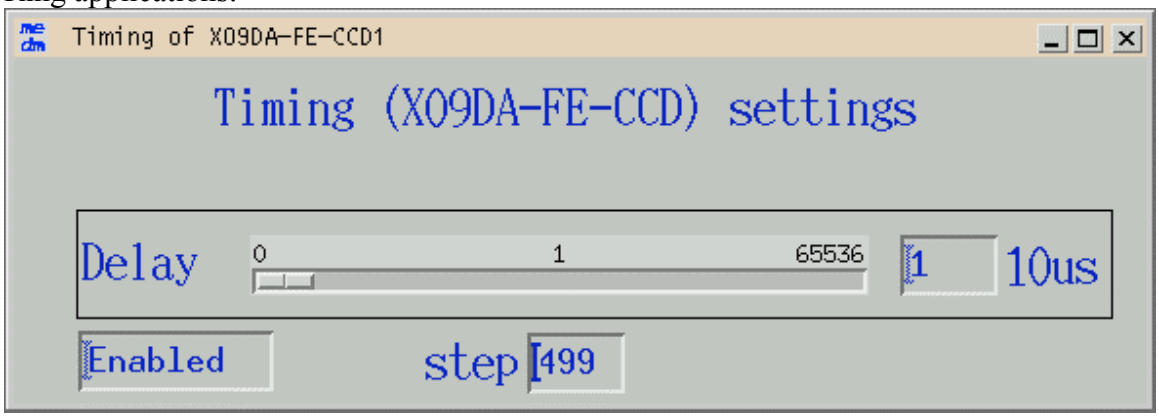
**Brightness: Default 130.** This "knob" affects the background and should only be changed if the noise level for non-illuminated pixels is too high or too low. Most dangerous if it is too low (=0, this is shown as blue background in the CAM application). Then the beam profile fits will not be OK (, and beam sizes will be underestimated). However, if there is an amount of roughly 10-30 % of blue pixels, the fits are still OK.

**The rest of the features I always tried not to touch!!!!**
In fact, the application has a tendency to hang if too many settings are touched. If it hangs one can try the "soft" Reboot button. If this does not help one has to go over to the SLS building and turn off and turn on the computer server, marked **CCD1** (located on the outside of the shielding wall at the exit ports of Straight L09 and Dipole X09). Even though this is an inconvenience, I have especially asked Mirec **not to update** the server software version. Later versions I have not checked up concerning shutter time, gain etc., and still they sometimes hang.

**The above settings should give a maximum pixel intensity of approximately 150 units, for 400 mA and beam sizes sigmax=56 um and sigmay=9 um (as measured with this Vis-UV branch).**Please observe that the Max Pixel Intensity (blue field top right) on the main window could occasionally show a higher value, probably because of radiation. This problem is less severe in this Vis-UV branch than in the X-ray branch. However, the max pixel intensity should better be checked in Andreas CAM application window that continuously writes some data for each analyzed picture. There one can see the maximum content in a pixel within the ROI chosen (at least in some CAM-versions), and one becomes less sensitive to the radiation problem.

## *Normal operation, Vis-UV branch:*
By normal operation I mean precise *absolute* beam size measurements at currents of 400mA and below.
For such measurements, the only feature needed to be touched is the shutter time, and maybe a fine tuning of the polarizer (see below under controlling 2-phase motors). The shutter time should be decreased in case of smaller beam sizes, and it should be increased in case of lower current or larger beam sizes, to give a maximum pixel intensity of approx. 150 units (see below under camera linearity). For very low beam currents one has to use lower attenuation (ND) filters (see below under controlling 2-phase motors). *If this*

*maximum pixel intensity is maintained, and the polarizer is adjusted, the accuracy of the measurements should be as good as at 400 mA.*
Since the shutter time of this camera is quite short, around 0.6 ms at 400mA, this diagnostic branch is well suited for synchronized measurements. For example, the beam size could be studied as a function of time after the injection event. For this one needs to open a timing window that can be found in the SLS Launcher under Diagnostics and Ring applications:




Please note that step should be 499, otherwise just enter this value! Default delay is zero, since this is far away from the time of injection. The time of injection should be roughly at a delay of 14600*10 us, and here one should measure a beam size that is affected (mostly vertically) by the injection kickers.
**A final operational remark: it might be tempting to remove attenuation (ND) filters to shorten the shutter time, but this could have detrimental effects on the downstream bandpass (BP) filters, and maybe even on the camera!!!! Only remove ND filters in correspondence to lower currents (in order not to have too long integration times)!! If the shutter time, after adjustment to reach a maximum pixel intensity of around 150, is much shorter than 0.6 ms, please immediately insert more attenuation filters!**

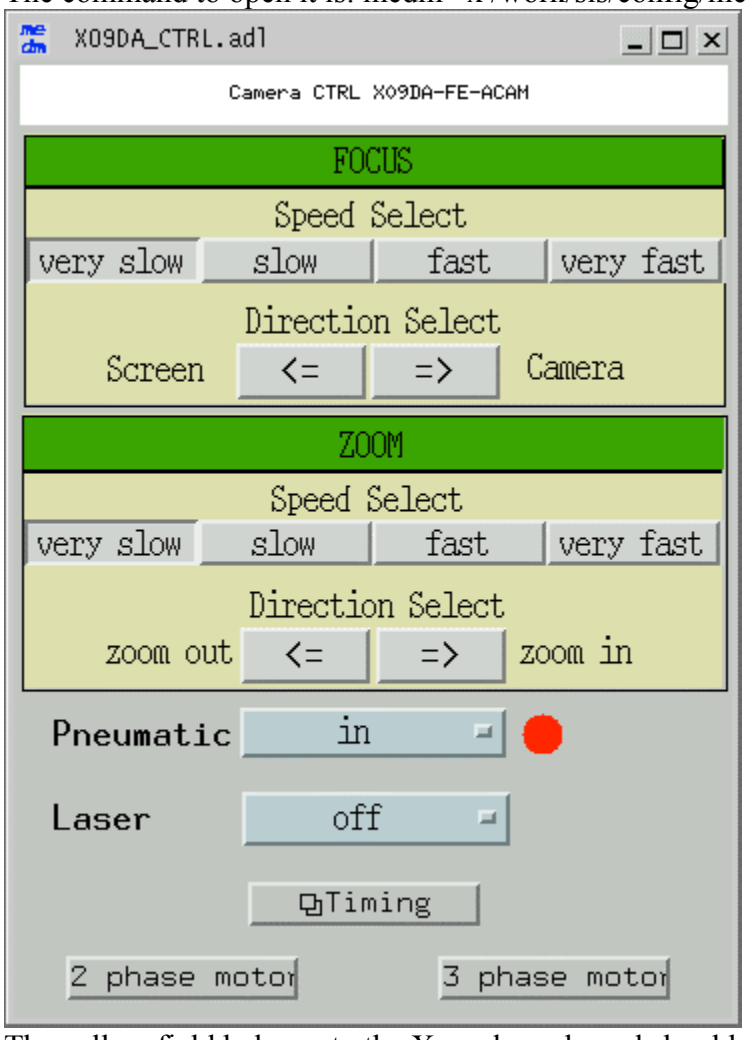
## *Camera linearity related issues, Vis-UV branch:*

The pixel content as a function of light exposure should be linear. However, this is usually not the case. This function also changes wit the aging of the camera. The first simple check can be made as follows. Assure that the beam conditions are stable (user operation). Check that you have roughly 150 units for maximum pixel intensity. Shorten the shutter time with 10-20%. Then the measured beam sizes should not differ by more than 0.5-1%. A second step to check the camera linearity is to vary the integration time over a wider range and plot the maximum pixel intensity (as described above one should use Andreas CAM application with a small ROI) as a function of shutter time. Please, always do these tests under stable machine operation like user operation. For the moment (March 2008) with the above Gain setting (0 dB) the camera is quite linear up to **160 units in the pixels**. When exposing the cam to more light (within the shutter time) than this, the pixel output will be lower than in the linear case (, and beam sizes will be overestimated). I will supply an excel file where some linearity check-ups are presented. If you for some reason start to acquire images with a higher maximum pixel content than 160, please go down in shutter time, or insert more ND-filters (see below**). Do not**

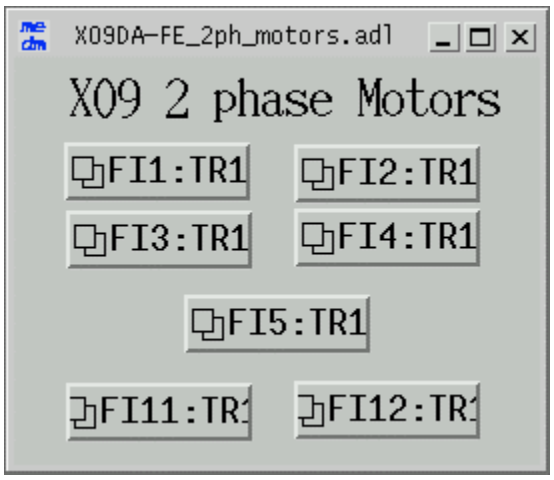
**change Gain!** If you acquire images with lower maximum pixel content than 160, for example if you want to measure at lower currents, you can increase the shutter time, or remove ND-filters (see below). **Do not change the Gain!**
**If one changes the Gain, one changes the range over which the cam is linear, and one should perform a new linearity check as described above!**

## Controlling four 2-phase stepper motors at the end of the beamline

All these motors are situated on top of the optical table at the end of the beamline. All components driven by the motors are outside vacuum.
To control these motors one should open the following window:
The command to open it is: medm –x /work/sls/config/medm/X09DA_CTRL.adl




The yellow field belongs to the X-ray branch, and should not be touched. Pneumatic and Laser belongs to the Vis-UV branch, but are more for expert use (see below). . The "Timing" knob is out of date, it belonged to an old camera with frame grabber. The four 2-phase stepper motors can be found by clicking on **"2 phase motors"**. One then gets the following window:

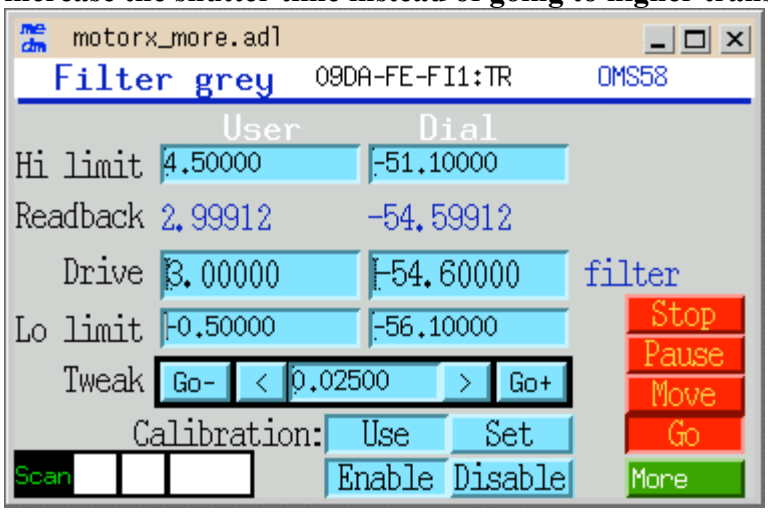



Please observe, there are more motors than four, but they belong to the X-ray branch.
**Only FI1, FI12, FI3 and FI5 belong to the Vis-UV branch! Do not touch the other ones, they will affect the X-ray branch!**
**For all motor controls described below, I find it always safest to enter the desired value in the Drive window, and press Return, not to use Go- or Go+!!!!**

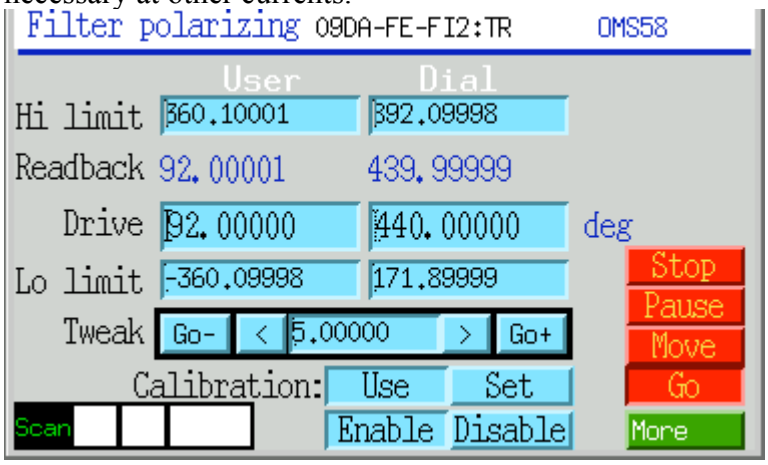
The first item that the Vis-UV beam sees outside vacuum is the **Grey filter or Neutral density (ND) filter set-up FI1**. It is a filter wheel for five different filters. The filter positions (Please neglect all numbers given under "Dial") and corresponding transmission values are given in the table below. **Please enter only these specific values in the Drive window. This minimizes the risk of loosing motor steps!!!** *One can use smaller steps of 0.025 units in order to investigate filter wave form distortions, but I would like this to be reserved for "expert use". If one suspects that the filter wheel has lost a lot of steps and that the Filter position given does not correspond to the actual filter wheel position please do the following: When there is a tunnel access, enter first 3.0 in the Drive window, then go in to the set-up and turn the wheel ( the one closest to the vacuum window) until a white mark with the text 3 is in its top position.*

| Filter position | Transmission (%) |
|---|---|
| 4 | 1 |
| 3 | 3 |
| 2 | 10 |
| 1 | 30 |
| 0 | 100 (no filter) |

**Default value is 3, i.e. 3% transmission**. "**Safe" positions are 3 and 4**. Please note that if one goes to a higher transmission, or forgets to go back to the default transmission, when there is 400mA in the machine, one exposes downstream bandpass filters to higher power levels! This could destroy or degrade the bandpass filters. **It is always safer to increase the shutter time instead of going to higher transmission!**



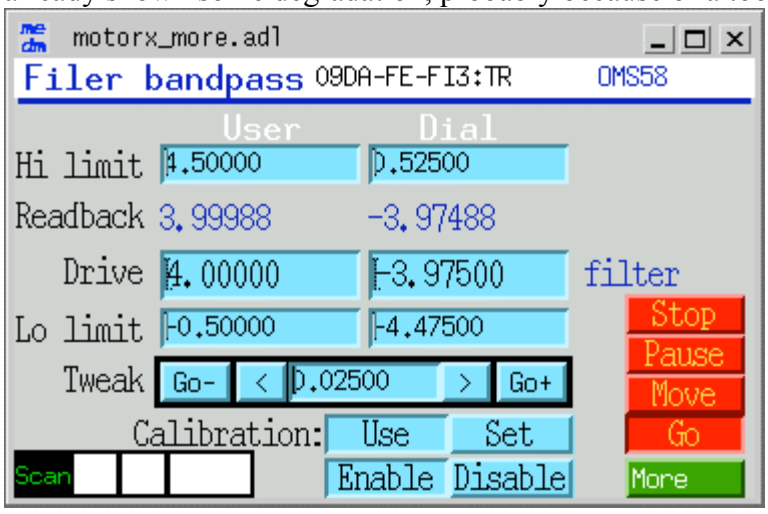
The next item that the Vis-UV beam sees is the **Polarizer set-up, FI2.** This is a Glan-Taylor polarizing prism. It can be turned +-360 degrees (two full turns). **Default value is around 90 degrees.** (Please neglect all numbers given under “Dial”). This device is quite robust and can stand 100% transmission. I have not noticed any loss of steps in this device. Some (not yet fully understood) long term effects makes it necessary to sometimes adjust the polarizer a few degrees around 90 degrees, in order to get equal intensity in the two peaks in the image. The basic adjustment should always be performed under stable conditions at 400mA (user operation), but a small readjustment might be necessary at other currents.



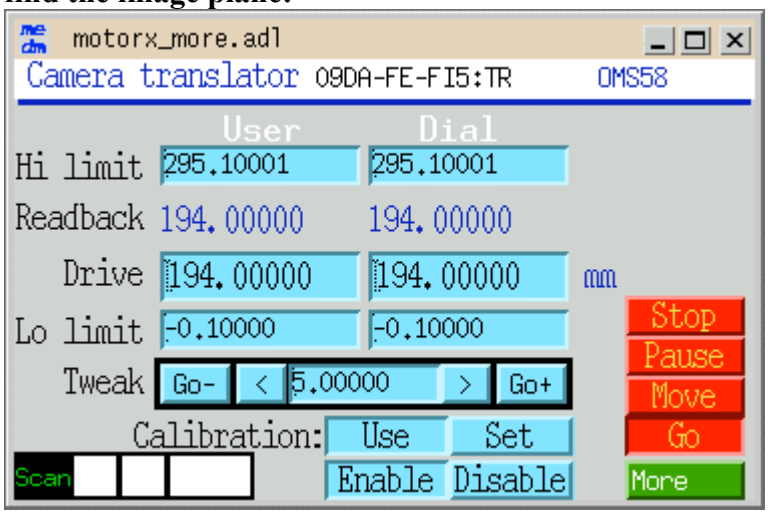
The third item that the Vis-UV beam meets outside vacuum is the **Bandpass filter (BP) filter set-up FI3**. It is a filter wheel for five different filter combinations. The filter positions (Please neglect all numbers given under "Dial") and corresponding transmitted wavelength values are given in the table below. **Please enter only these specific values in the Drive window. This minimizes the risk of loosing motor steps!!!** *One can use smaller steps of 0.025 units in order to investigate filter wave form distortions, but I would like this to be reserved for "expert use". If one suspects that the filter wheel has lost a lot of steps and that the Filter position given does not correspond to the actual filter wheel position please do the following: When there is a tunnel access, enter first 0.0 in the Drive window, then go in to the set-up and turn the wheel ( the one closest to the camer) until a black mark is in its top position.*

| Filter position | Transm. @ [nm] | FWHM [nm] | Combination |
|---|---|---|---|
| 4 | 364 | 1.4 | Edm BP plus Edm.LL (1) |
| 3 | 403 | 3 | CVI |
| 2 | 325 | 1.4 | Melles G. BP plus Edm. LL |
| 1 | 364 | 1.4 | Edm BP plus Edm.LL (2) |
| 0 | 266 | 1.4 | Edm BP plus Edm.LL (2) |

**Default value is 4, i.e. peak transmission at 364 nm**. **At 400 mA one should always use the ND filter setting 3 or 4, for any of the BP filter combinations**. Please note, only transmission at 364 nm will place the image plane correctly at the camera CCD ship. Since using another wavelength than 364 nm requires movement of the next motor FI5 (which sometimes looses steps), I would like to reserve such operation only for "expert" use. This leaves us with the only choices of BP filter combinations being 1 or 4. We have used **position 4**, i.e. a new BP filter combination since 12th of March 2008, **always in combination with ND filter 3 (3% transmission) at 400 mA**. For the old (identical) BP filter combination 1, one might try even ND filter 2 (10% transmission) if it is crucial to use a shorter shutter time. However, please note that this BP filter combination has already shown some degradation, probably because of a too high power load.

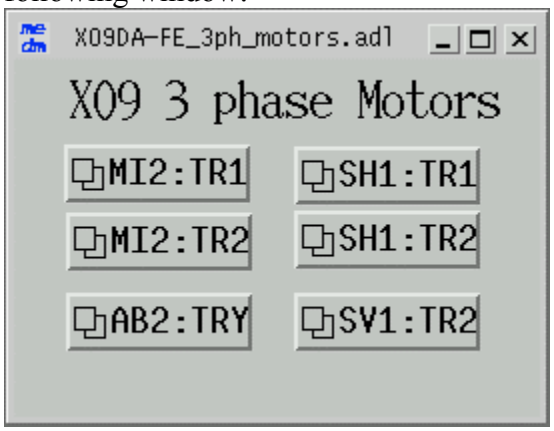


The **Camera translator FI5** is a longitudinal 295 mm translator that actually moves the camera together with all the three above described items. **Default value is 194 mm**. Usually it is OK to move this motor between 180mm and 275mm, but outside this range it might loose steps However, its position has been carefully adjusted to put the camera exactly in the image plane for transmitted light at 364 nm. **Do not touch this motor unless something urgent has happened! There is a special "expert" procedure to find the image plane!**



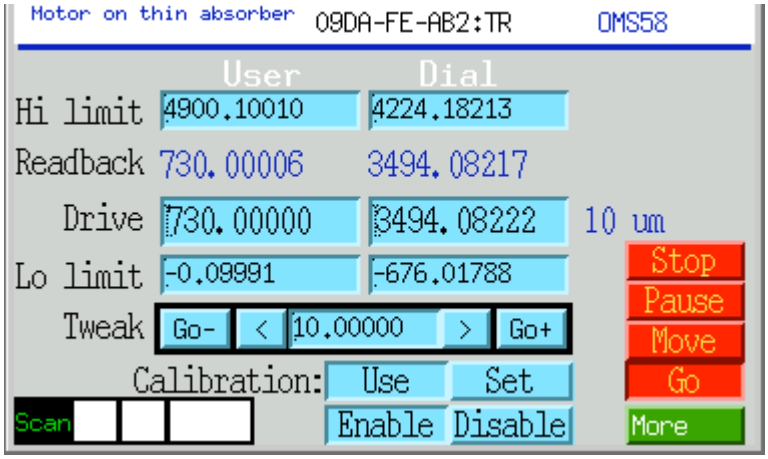
Controlling six 3-phase stepper motors along the vacuum part of the beamline.

**All these motors are only for "expert use", not needed in normal operation**. All the motors are situated along the vacuum part of the beamline. All components driven by the motors are inside vacuum. So far there is no indication that these motors loose steps. They are only affecting the Vis-UV branch. The six 3-phase stepper motors can be found by clicking on **"3 phase motors"** in the X09DA_CTRL.adl window. One then gets the following window:

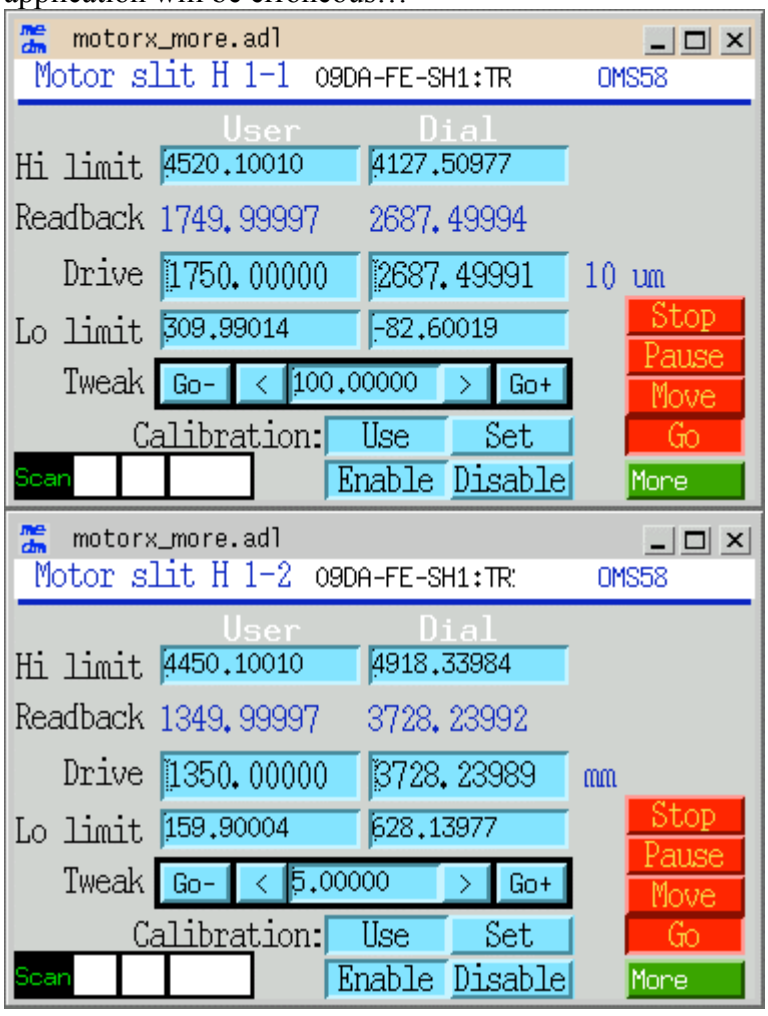



**For all motor controls described below, I find it always safest to enter the desired value in the Drive window, and press Return, not to use Go- or Go+!!!!**

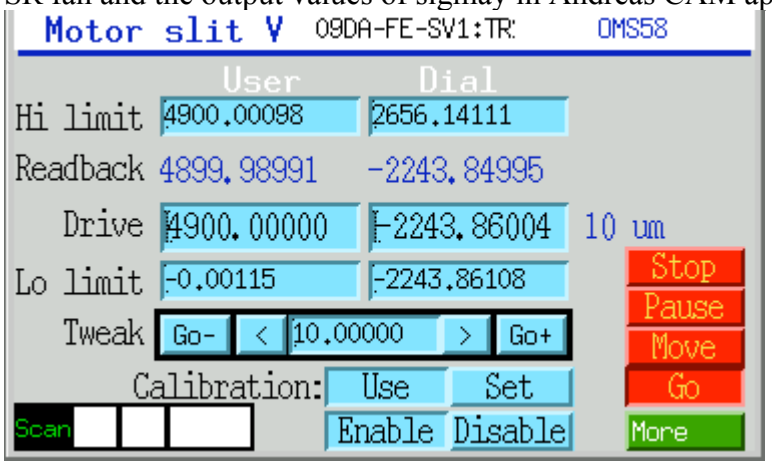
The first item inside vacuum that can be controlled by the 3-phase motors is a vertically movable -4 mm in height- absorber, the **"Thin absorber" AB2:TRY**. **Default value is 730*10 um.** (Please neglect all values under "Dial"). **It is extremely important not to move this absorber!!!!** It has been carefully adjusted to minimize the power load on the first mirror in the Vis-UV branch (see below under Equipment Protection System EPS). If there is a need to move this away from the default value, one should first consider if the beam orbit is correct.



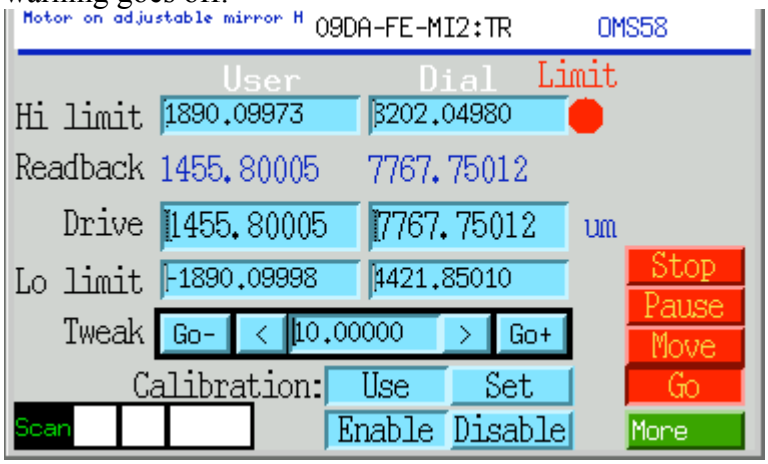

The next motor controlled items in vacuum are two horizontal blades **SH1:TR1 and SH1:TR2**, that define the horizontal acceptance of the Vis-UV branch**. Default values are 1750*10 um and 1350*10 um respectively.** (Please neglect all values under "Dial"). Please note that if these values are changed, the output values of sigmax in Andreas CAM application will be erroneous!!!

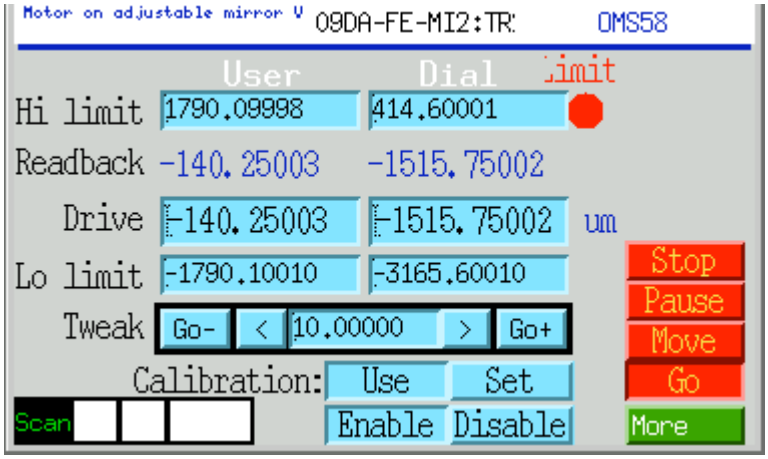


The next motor controlled item in vacuum is a vertical blade **SV1:TR2**, that might define the upper vertical acceptance of the Vis-UV branch**. Default value is 4900*10 um.** (Please neglect all values under “Dial”). This value places the vertical blade far outside the SR fan. Please note that if this value is below approx. 2600*10 um, it starts to cut the SR fan and the output values of sigmay in Andreas CAM application will be erroneous!!!



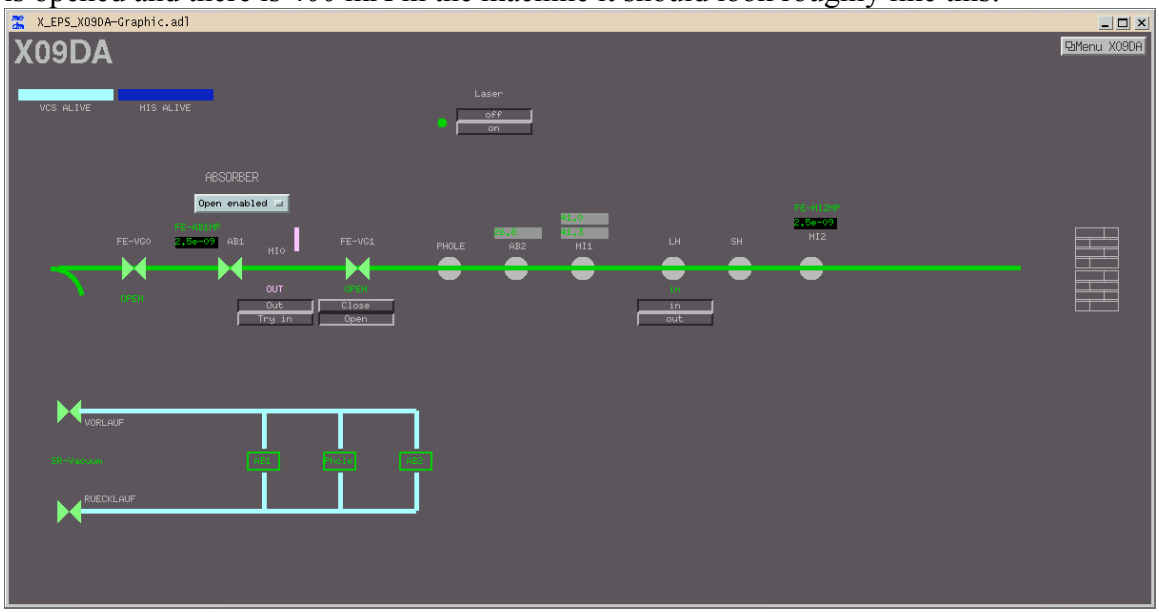
The last motor controlled item in vacuum is the **Adjustable mirror MI2**. TR1 moves the image on the CCD horizontally, and TR2 moves the image vertically. **Default values are 1455.8 um and -140.25 um.** (Please neglect all values under "Dial"). These values place the image roughly at the position shown in the first camera controlling window (see above). These motor values have not been changed for over a year. If the beam spot cannot be found at the CCD, one can try to move this mirror in steps of 10 um (corresponds to approx. 1/3 to ¼ of the whole CCD chip). However, the cause of the need to move the mirror should better be investigated (maybe a real beam movement?) In the fig below I show an example of the motor control that could occur after a shutdown or power break: the read Limit warning is on, but this is not a correct indication. After moving the mirror one "Tweak" step (**not Go- or Go+!!!**) back and forth, the Limit warning goes off.






The Equipment Protection System (EPS) window for X09DA.

The EPS window for X09DA can be opened from the SLS Launcher. When the beamline is opened and there is 400 mA in the machine it should look roughly like this:




Both pressure gauges should show a value in the low E-9 mbar range. Two temperature sensors situated on the mirror MI1 should show roughly 41 degree Celsius. One temperature sensor, situated in the outgoing cooling water pipe from the thin absorber AB2, should show roughly 26.8 degree Celsius. If one observes higher pressures or

temperatures than these, one can (and should) manually close the first absorber AB1 and the valve FE-VG1. This will not dump the stored beam, it will only protect the beamline. (The first valve FE-VG0 is controlled from the vacuum group and/or the MIS, and cannot be operated from this window.) What normally happens if one closes AB1, is that the temperature on the water cooling of AB2 goes immediately down to 26.2 degrees, while the mirror temperatures slowly decrease, over a period of several hours, down to about 25 degrees. The pressure gauge, FE-AB1MP, at AB1 will show a somewhat higher value, because SR induced desorbtion now occurs at AB1 instead of at the thin absorber AB2.

## Which are the interlocks:

The main reason for the EPS is to protect the mirror MI1. There should be a warning (yellow temperature numbers and also some indication for the operators) if its temperature exceeds 44 degrees. If its temperature reaches 45 degrees AB1 will close. **(Please check this now and then with Stefan Speckert!!)**
AB1 will also close if the pressure gauge FE-MI2MP exceeds 1E-7. **(Please check this now and then with the vacuum group!!)**. This gauge is the one closest to MI1, and if the mirror is suddenly accidentally exposed to a high SR power, it will immediately outgas. This is probably a faster interlock than the temperature, and should be kept "alive". One could even consider going down to 1E-8 for the interlock level.
Finally, there is an interlock warning level of 50 degrees and closing level of 60 degrees, on the water cooling of the thin absorber, AB2. This is mainly to prevent from a too low water flow in the narrow water pipe of AB2.

## What to do if AB1 has closed:

Check the three temperatures and the two pressures in the archiver. It will give some hint on what has happened. If the temperatures on the MI1 show a fast rise and/or they were higher than 45 degrees **one should not try to open the beamline with 400mA in the ring!!!**
If the reason for high temperatures/pressures is not found, one can do the following:

1) Run SLS at roughly 10 mA. The power level of the SR is then that low, that the MI1 cannot be damaged even if the thin absorber is out of position.
2) In the control room one can reach a survey camera situated at the optical table in the tunnel. One should be able to see a paper with a square whole in the middle when the SR is let through the beamline without the lens inserted.
3) If it is OK from vacuum point of view, open AB1 and valves.
4) Retract the lens by clicking on LH "out".
5) One should now be able to see the "footprint" of the SR on the paper by help of the survey camera. It should be about 8 cm (see indications on paper) in height. The shadow of the thin absorber should be seen slightly below the centre of the light footprint. If it is not there, this is probably the reason for the closing of the beamline. Please investigate carefully why it is not there!

## Two extra features to be controlled in the EPS window:

As can be seen there is an extra mirror MI0 and a Laser that can be controlled from the EPS window. With laser on and MI0 in, one can make some equipment investigations even without a beam in the machine. I would like to reserve it for “expert use”. However, if it has been used, one must not forget to retract (out) the mirror MI0. **Otherwise AB1 cannot be opened**.

## Whom to contact:

Mechanical issues: Martin Rohrer
Control issues: Werner Portman
Camera Server issues: Damir Anicic
Other issues: Natalia Milas

# Check-up list for the UV diagnostic beam line and emittance monitor

N. P. Abreu and A. Andersson

1. Checks from the control room and CCD monitor outside the tunnel

   1.1. Beam line Setup

   The main part of the beam line setup is show in Figure 1. There one can see how the filters are mounted and in which order they are disposed.

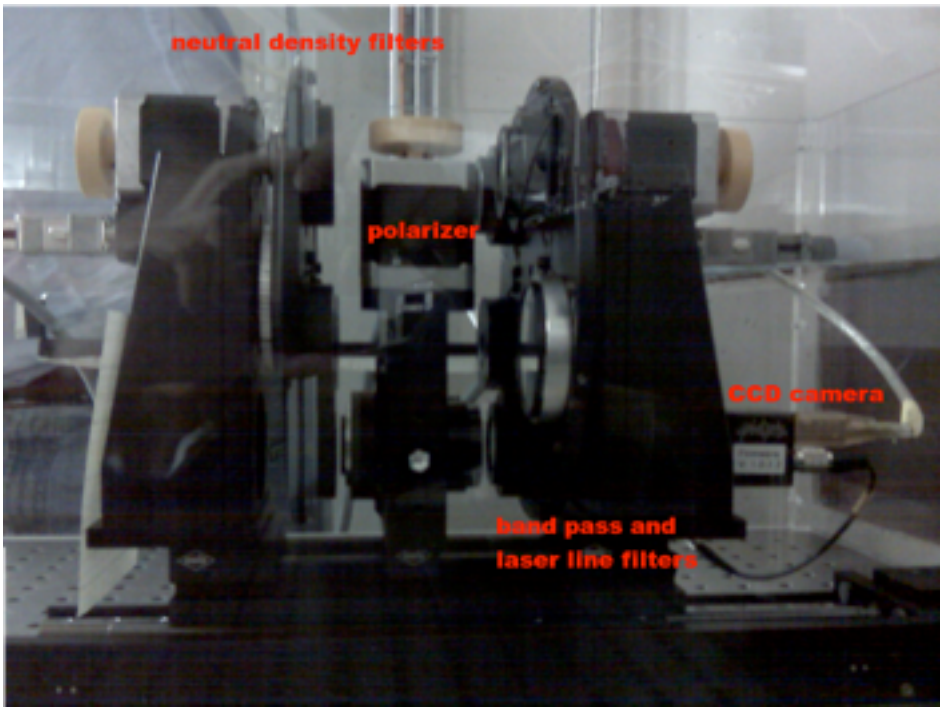



**Figure 1:** UV beam line setup.

   1.2. Check linearity of the CCD

To check the linearity of the CCD it is necessary to vary the shutter time and record the average max pixel intensity. For small shutter times this dependence should be a straight line and for shutter times that gives intensities around 150 or greater a deviation from the linear fit should be observed. Also it is important to observe how the beam size measurement behaves as the shutter times increases. The last measurement done is show in Figure 2. Note that for shutter times up to 1 ms there is not much disagree-

ment between the linear fit and measurement however the beam size measurement starts to deteriorate for shutter times greater then 0.6 ms. One possible explanation of this effect is that slightly larger σx and σy values are measured for shutter times longer than 0.6 ms (in spite the fact that the camera linearity seems OK up to 1.1 ms, corresponding to a maximum pixel value of 150) would be that small photon beam motion starts to contribute to the measured beam sizes. The photon beam motions are probably due to some vibration in the diagnostic line. In order to exclude this effect to come into the measurement results, one should repeat the linearity check with somewhat larger transmission, say 10%. Consistent beam size results should then hopefully be achieved over the whole linear region (which should then appear at shorter shutter times).

The measurement shown in Figure 2 was performed using the Neutral Density (ND) filter #3 (transmission 3%) and a band pass filter of 10 nm from Edmund Optics combined with a laser line filter both centered around a wavelength of 364 nm.

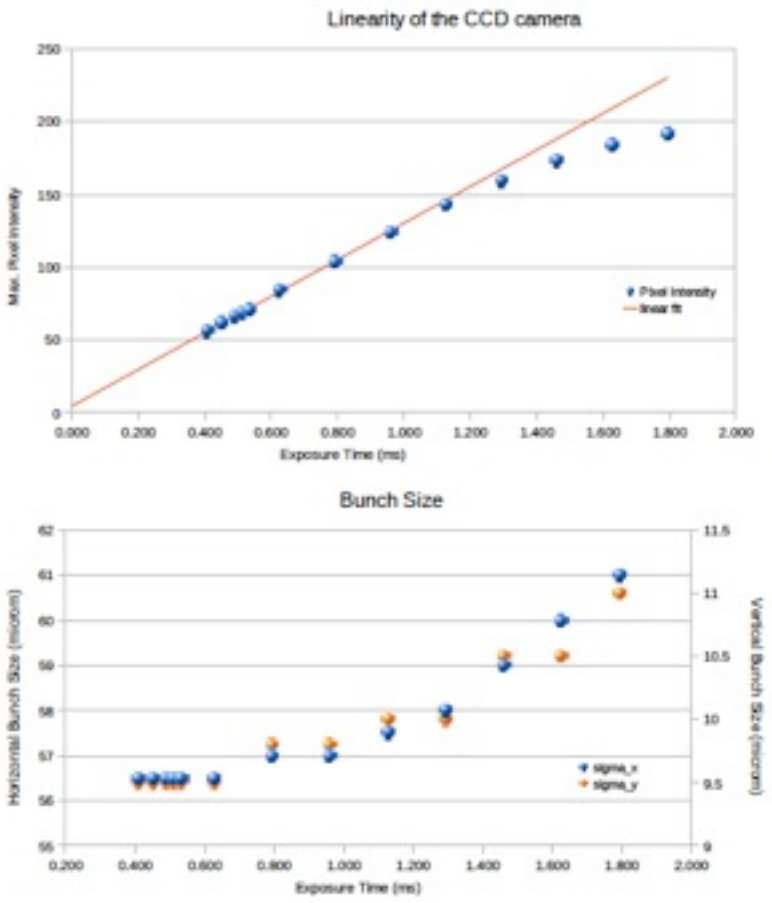



**Figure 2:** (top) check of linearity of the ccd varying the shutter time and (bottom) changes in beam size during the linearity check.

### 1.3. Optimize the emittance measurement (filter movements, shutter time and fitting)

To guarantee the that the measured beam sizes are right it is necessary from time to time to check the position and quality of fit for the emittance monitor. First check the max pixel amplitude to be sure you are not in a saturated situation, which can lead to beam sizes bigger then the real values. If that's the case, it would be necessary to either reduce the shutter time or change the ND filter to one with a lower transmission rate. As a rule of thumb the max pixel intensity should not be above 150 to avoid saturation of the CCD.

After this first check, if the peaks for the vertical emittance calculation are not equal then one can move the polarizer to correct the amplitudes. Also do small steps of the order 0.025 in the BP and laser line filter (they are mount together so it is not possible to move only one separately) could improve the measurement resolution if it is possible to find a better region of the filter. Bad regions can occur because of aging/ deterioration of the BP filter (see section 2.1 bellow). The total angular size of this filter is between 6 and 8 steps of 0.025[1]. To ensure a good fit of the data it is important also to check the background which should be as flat as possible.

### 1.4. Check the beam footprint

To check the light beam alignment, remove the lenses from the light way (Pneumatic ➡ out). In Figures 3 and 4 there are the cases without and with the lenses on the light path to the CCD camera. In the case of no lenses one should be able to observe the following characteristics:

- 8 cm of light in the vertical direction (8 boxes of the grid) and around 3.5 cm in the horizontal direction (3.5 boxes of the grid)
- a long shadow is around the middle of the image which corresponds to the cold finger (absorber) of the beam line
- some light reflected on the right side

[1] The minimum step of the step motor is 0.0083, or one third of 0.025, and it corresponds to a movement of 10.5 mrad which in a filter support with of 60 mm diameter corresponds to a movement of the filter by 0.6 mm.

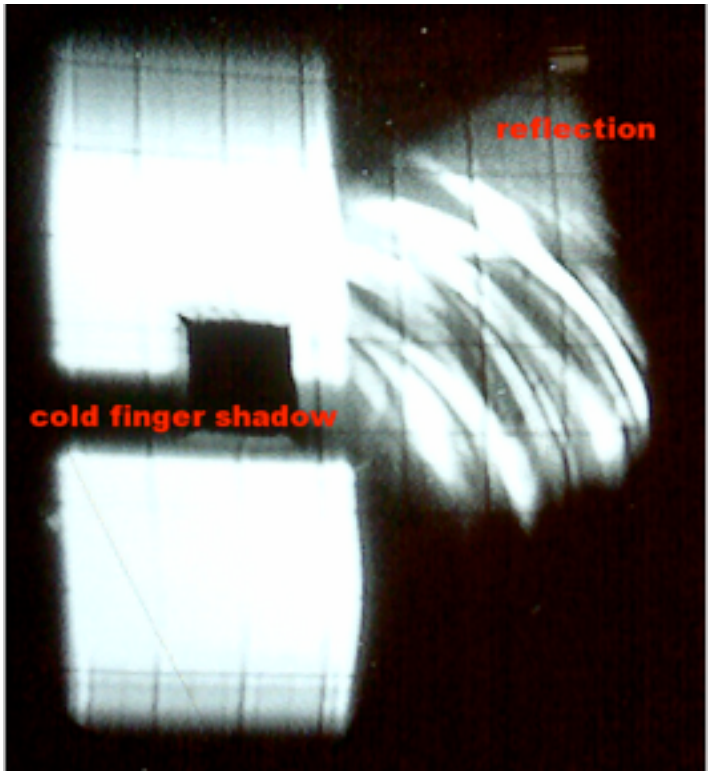



**Figure 3:** Beam light footprint without the lenses.

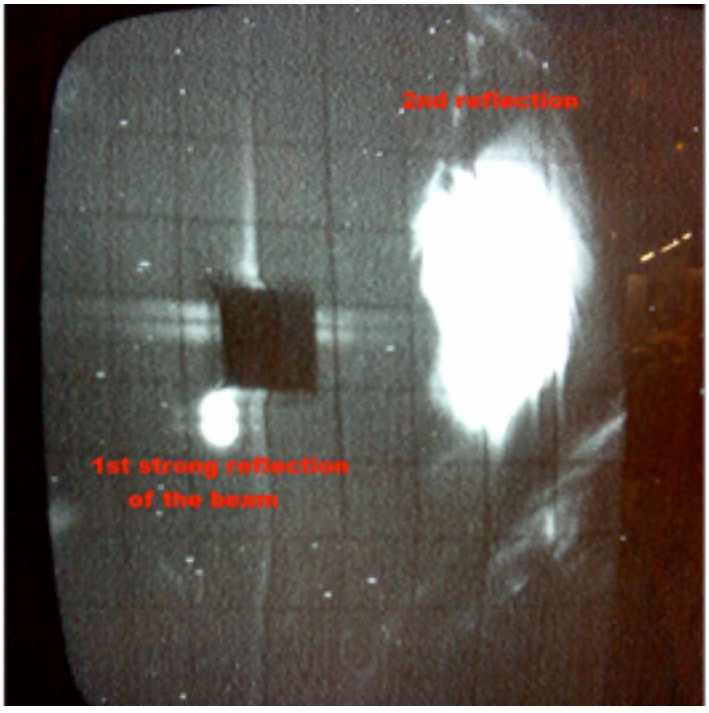



**Figure 4:** Beam light footprint with the lenses.

- it is possible to see a weak fading of the synchrotron light at the top of the picture but not at the bottom because there is an absorber restricting the light in this direction

once the lenses are back the following characteristics should be noted (Figure 4)

- a strong reflection on the left bottom side of the image and still some light reflected on the top right side

When the lenses are put back in position it can happen that the bunch sizes are much bigger than before, in this case just repeat the process of retracting and putting the lens back in place. An example of this effect is shown in Figure 5. A possible explanation for this strange effect is that when the lens are moved in/out it does not come back to the exactly same position as before and the focused light does not pass the BP filter at the same region as before also. In case the BP filter has deteriorated, this can have a large impact on the beam size measurement (see section 2.1 below).

## 2. Checks in the beam line (ring access required)

### 2.1. Check filters quality and position

It was observed that with time and BP filter deteriorates in quality leading to a systematic bigger emittance measurement. From time to time it would be prudent to check the quality of this filter (like in section 1.2) and if there is too much changes in the beam size measurement with small changes in the filter position this filter should be replaced. It would be also interesting to clean the filter in the beam line. All the filters from

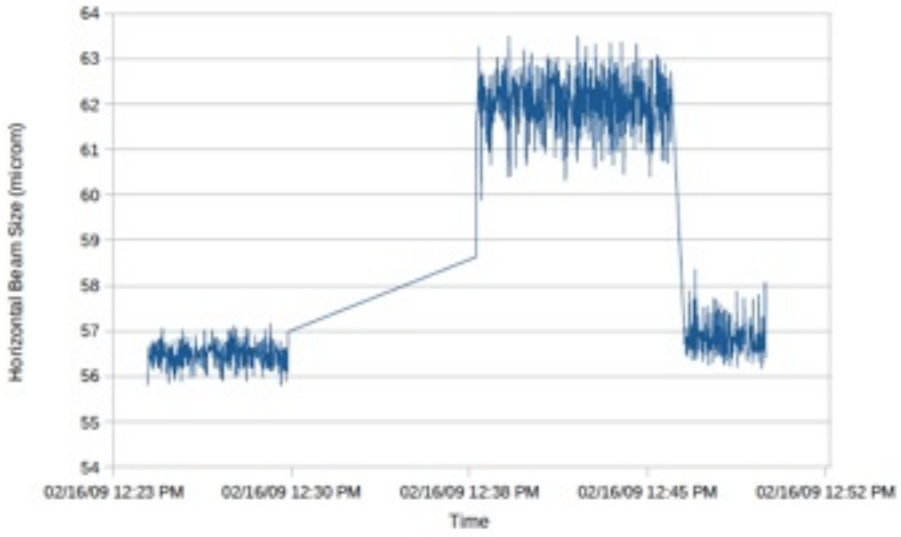



**Figure 5:** Observed change in the bunch size measurement when checking the light footprint.

the optics should be cleaned only with compressed air (no rubbing of the surface!!). Once the filters are cleaned and are ready to be assemble back remember that the mirror-like side of the BP filter should be always face of the incident light.

### 2.2. Check exit window

In every maintenance period it is important to check and clean the exit window to avoid deposition on its surface and thus deterioration of the image quality at the CCD. To clean the exit window just a tissue and some alcohol is enough.

## 3. Check spare parts availability

Since some of the filters of the UV line deteriorates in the time span of about 1 year its is interesting to check from time to time if there are enough spare parts available before any annual maintenance check-up. Also interesting would be to make sure that there is a spare CCD camera compatible with software requirements at hand all the time. The software for the cameras are being updated and we should make sure the one for the beam line camera won't be changed.

## 4. Some additional remarks

- The exit window is already marked due to deposition of some compound on its internal/external surface;
- The motor which moves the BP and laser line filter tends to loose steps very often;
- If at some point it is necessary to change the CCD camera the following procedure should be used: a) try to put the new camera in the same longitudinal and angular position as the last one; b) in case there is a slight change in longitudinal position it is possible to move all the setup longitudinally to get the focus right and c) to check for the angular alignment one can make a horizontal bump in the line and observe that the light is moving in the right direction in the CCD. To further check if the camera is in the focal point it is possible to move the whole setup longitudinally and look only at the horizontal bunch size first and them find the minimum, after that for a finer alignment it is possible to close a scraper in the line (motor SV1:TRY) and block a little of the vertical light coming in and moving the setup the lobes of the vertical profiles will be unharmed only when you are at the focal point otherwise one peak will be higher than the other.
- In case we decide to change the BP filter remember to check its transmission at high $\lambda$ , since the camera has a hight sensitivity all the way up to 1000 nm. A new type of filter, or combination of filters, has to block these wavelengths effectively. We already tried a combination of four short pass Edmund Optics filters and they barely block enough.
- There are still some high fringes on the side of the vertical profile measured which are, for the time being, unexplained.

- It is also possible to move a motorized mirror (in vacuum) and move the image to adjust it in the CCD. In this case the minimum step size is 1 microm.
- FIlter specifications:
    - Polarizer: Ealing 43-6741-000 (this is a spare polarizer) and the one in the beam line is a Melles Griot 03-PTY-101/A (new name is PTYL-10.0-425-675);
    - Laser line filter: Edmund Optics NT47-539 (λ = 363.8 nm) and
    - Band Pass filter: Edmund Optics NT43-103 (λ = 365 nm and bandwidth of 10 nm).