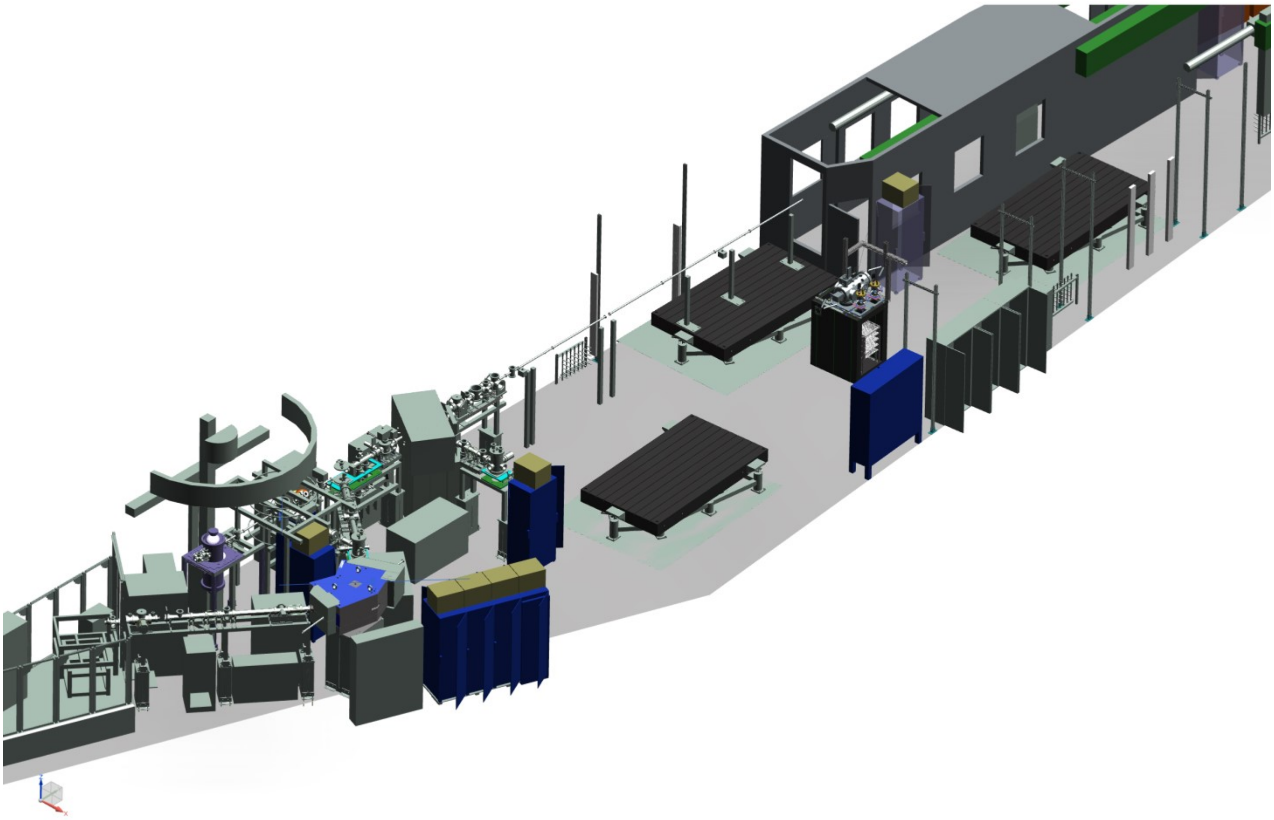
P04 Set Up Manual



Version 0.96

09. July 2019

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1. The Variable Polarization XUV Beamline

Welcome to the P04 beamline at sector 3 inside the Max-von-Laue hall (47c) at PETRA III, DESY (Hamburg/Germany).

It is the goal for all members of the P04 team to provide a world-class facility for our users.

In order to make your beamtime at P04 a success we have compiled this manual to give you an overview and useful information at hand. This manual concentrates on the process of beamtime preparation rather than the research aspects of beamline P04. The main beamline parameters of P04 you can find online at Link: P04-Beamline. Usually we're giving an overview about the beamline control on the day prior to your beamtime. However feel free to get in touch earlier especially if you want to use your own computer.

Don't hesitate to contact the P04 team (see last page of this manual) if you are missing some information or if you have further suggestions.

2. Planning your Beamtime

Prior to your arrival you have to satisfy the usual DOOR related registration and safety issues and computer registration as mentioned on the P04-Checklist (chapter 8).

In general we expect you to file in the necessary documents online at DOOR at least 4 weeks in advance. However if you are having beamtime at P04 for the first time or if you have special requests concerning media, infrastructure or safety matters (e.g. chemistry lab or lasers), you should contact the P04 team well in advance, ideally right after you are granted beamtime. It is never too early to do it!

The beamtimes usually begin on Thursdays 7 AM and end at Wednesdays on 7 AM. Sometimes P04-staff won't use their commissioning time on Wednesday night, so be prepared to take the beam on late Wednesday afternoon. In case your beamtime does not start on a Thursday (e.g. after a service week) or in case your experiment needs extra setup time, you should contact the P04 team in advance as well.

2.1. Arrival

Arrival on site should be planned for the Tuesday afternoon prior to your beamtime. Then you should make contact with Moritz Hoesch (-4220) and the group that is using P04 at the moment (P04 beamline phones -6124 (Endstation) or -6144 (PIPE)) to discuss the process of changing over your experiments.

The crane can only be used during maintenance periods (usually on Wednesdays) when there is no current in the ring. You have to get in touch with T. Hasenkamp (-3730). Please consider that he has many other duties, so please call him early!

It is customary that the experimental platform is empty at 11 AM latest on the day of user change.

2.2. Departure

On your last day of beamtime you have to leave the experimental platform till 11 AM. This rule can only be changed in agreement with Moritz Hoesch (-4220) and the group that is next in schedule. Sometimes this might result in losing some hours of beam, when your setup has to warm up/cool down. Perhaps this can be avoided during your setup-phase by installation of additional valves, heating or cooling equipment.

Your equipment can stay close to the beamline a little longer, but space is always precious. Therefore we expect you to collect all of your equipment during the day on which you have removed your setup.

3. Experimental Stations

The experimental stations of P04 are located after the diagnostic unit girders and before the secondary experimental stations. The experimental stations each consist of a granite platform and supply stations. The granite platforms have nine T-grooves oriented along the beam axis. They're 3600mmx2000mmx300mm in size and have a groove every 200mm. For your experiment it's generally allowed to use the space above the experimental platform.

Setups requiring space outside of this box should be announced in an early stage of their beamtime-preparation!

In the space next to the long side of the platform you can put racks or tables.

The platforms can carry weights up to 3.5 tons, but there should be always less than 1000kg load on any area of 150x150mm². The planarity of the platform surface is within 50µm without any payload.

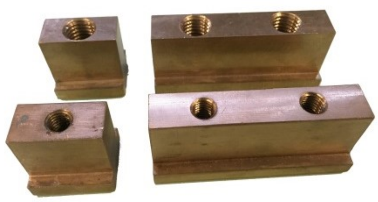

Figure 1: Nuts for granite

P04-Staff can provide you with nuts for M8 and M12 screws (Figure 1).

ONLY use T-nuts for the platforms that were provided by P04-Team, otherwise it can result in damage to the granite!

On special request the platform can be equipped with fiducials for the exact positioning of setups. This has to be arranged at least 4 weeks before your beamtime.

The given ranges in 3.1 and 3.2 do not correspond to the focus travel ranges!

Tolerances given in this chapter are to be assumed to be valid for all beamtimes individually!

The beamlines end with non-rotatable CF40-connections in the last valve.

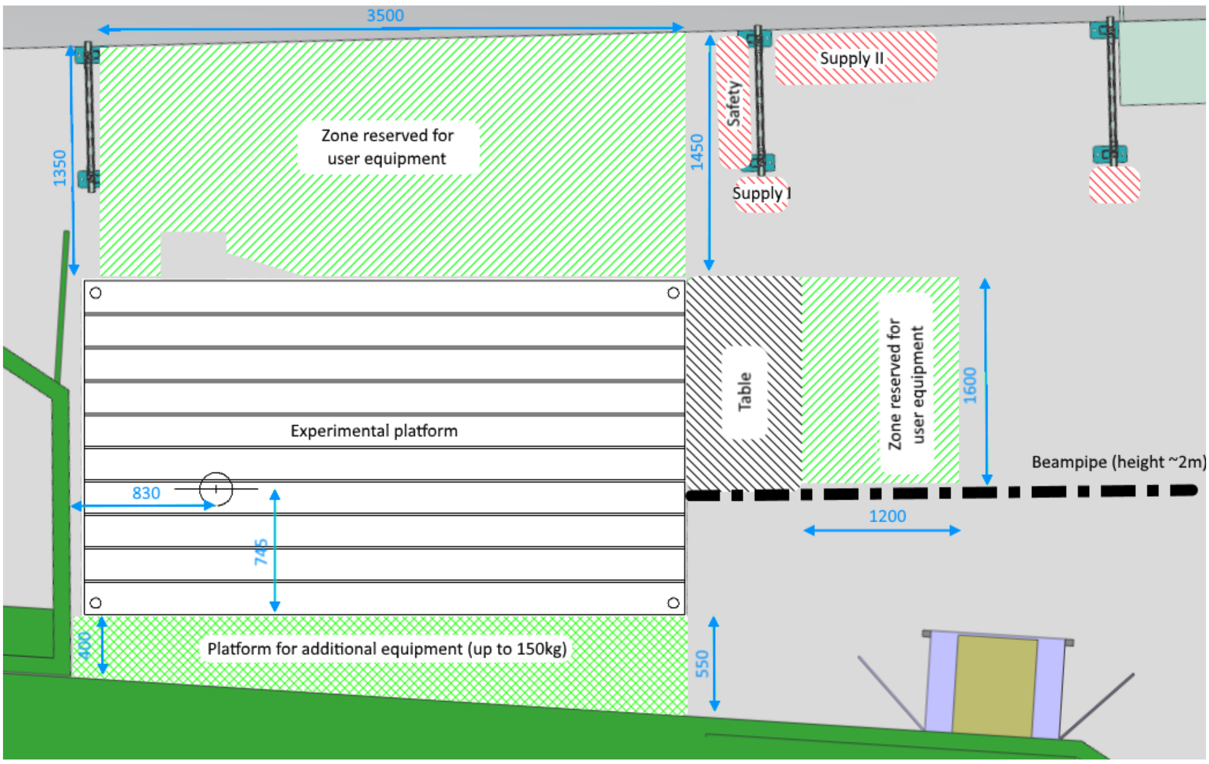

Figure 2: Experimental platform of branch 1.

3.1. Branch 1

The platform is 550±15mm above the floor of the hall and 95±15mm away from the upstream wall of the beamline hutch.

The focal position of branch 1 is located 1400±30mm above the experimental platform. It is 965±30mm downstream of the last valve (which itself is 120mm±20mm inside the last hutch) and 745±20mm away from the edge on the ring side (left side looking upstream) of the granite (Figure 2).

The spot size was measured to 12µm x 12µm (width x height, FWHM).

The focus position can be moved and its size optimized by P04-Staff, but this will require some time and effort!

3.2. Branch 2

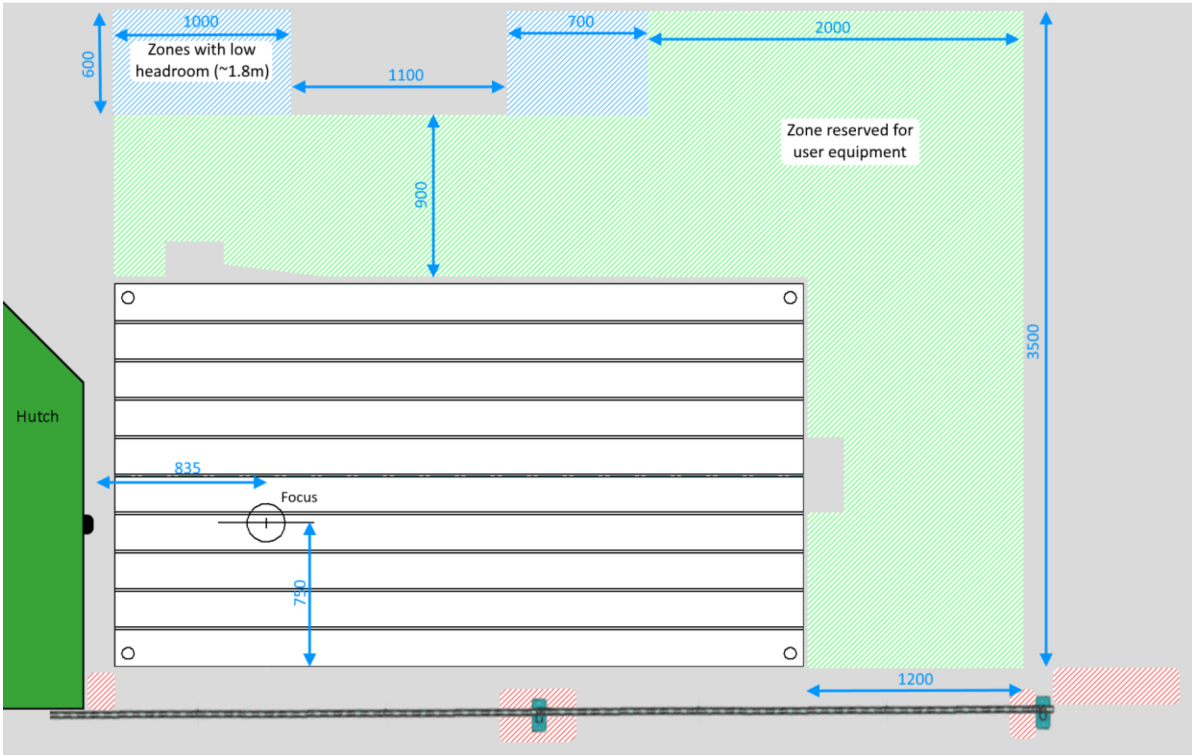

Figure 3: Experimental platform of Branch 2

The platform is 655±15mm above the floor of the hall and 95±15mm away from the upstream wall of the beamline hutch.

The focal position of branch 2 is located 1400±30mm above the experimental platform. It is 835±30mm downstream of the last valve (which itself is 25mm±10mm outside the last hutch) and 750±20mm away from the edge on the ring side (left side looking upstream) of the granite (Figure 3).

The spot size was measured to 12µm x 12µm (width x height, FWHM). The minimum size determined by a user experiment was at 10 µm diameter. This is not a guaranteed value but the measured value for a given set of conditions in the beamline.

The focus position can be moved and its size optimized by P04-Staff, but this will require some time and effort!

3.3. Differential Pumping Unit

The P04-team has an additional differential pumping unit (DPU) for use between your experiment and the beamline.

The need for this unit should be announced in an early stage of your beamtime-preparation!

It consists of a CF63 to CF40 cross and has a turbomolecular pump and an Ionivac attached to the CF63 ports. It is 126mm long in direction of the beam.

Different capillaries can be mounted to fit the DPU to your needs. This will add another 13mm to its length (per capillary).

3.4. Silicon Photodiode

A silicon photodiode (SXUV100 from Optodiode) can also be available on early on request. It's mounted on a CF-40 6-way cross combined with a Ce-YAG screen on a linear stage. This can be used as is or not at all. Please bring your own preferred equipment for current reading.

3.5. Alignment

There are several systems to help with the alignment. They are roughly listed in accordance to precision, which is also inversely true for their usability:

- Water level laser
- Vertical line laser from the top of the last hutch
- Frontend laser
- Backend laser
- White light
- Synchrotron light

There is a window valve at the end of the beamline which means P04 can provide the alignment tools during most of the alignment phase even when there is no synchrotron light available yet.

The water level and vertical line laser are permanently installed and can be used at any time. It's good to have some marks at your setup to help translating them to your interaction region.

Front and backend laser can be put to operation together with P04-staff at any time. The frontend laser gives you a slightly weaker spot, which has "seen" all optical elements, whereas the backend laser is brighter.

White light can be provided by P04-staff when there is current in the ring. Usually this happens at Wednesday late afternoon/early evening. It's the best choice for the alignment procedure due to its brightness (no direct eye contact please!) and early availability. However its brightness might vary due to fluctuations in the ring. It is provided by the bending magnet in front of the undulator and is located at the outward edge of the synchrotron light.

Synchrotron light can be used, after "User operation" is permitted by the control room. This happens usually at Wednesday evenings. P04-staff will assist you to optimize the beam for your experimental requirements.

Special alignment requirements (e.g. fiducialization on the platform) make the involvement of the DESY alignment group necessary. This has to be arranged well in advance (at least 4 weeks before).

4. Supply Systems

Here are the supply-systems listed that are usually provided for your experiment, for further needs please contact P04-Staff well in advance (at least 4 weeks before).

Not officially listed is our small shop, where you can buy coffee, nuts or sweets for emergencies.

4.1. Electrical

4.1.1. Power

The P04 provides the following AC-power sockets at Supply II (Figure 3):

Socket Type	Picture	Voltage [V]	Max. Current [A]	Max. Power [kW]	Pin Configuration	Quantity
CEE-red-32		400	32	22	3P+N+E	1
CEE-red-16		400	16	11	3P+N+E	1
CEE 7		230	16/4	3,5/4	P+N+E	4
CEE 7 (gr.)		230	16/4	3,5/4	P+N+E	4

Table 1: Power connectors

These sockets have a nominal AC frequency of 50Hz.

P04-Staff can help you with some additional cabling on request.

4.1.2. Earthing System

The grounding system offers direct wire connections for 2.5-25mm² cables at Supply II (Figure 3).

4.1.3. Ethernet

Wireless LAN is available for the DESY guest networks and eduroam. However it is not possible to control or access the P04 beamline via these networks.

There are a two Ethernet ports at Supply II (Figure 3)provided for you to control or access the P04 beamline or the DESY network in general (e.g. for data storage and analysis). It is DESY-standard to use the left ports in the sockets. These are only accessible by devices which comply with the DESY-IT standards (e.g. up-to-date OS) and are registered with DESY-IT.

Register your Ethernet-devices with DESY-IT during your beamtime preparation phase!

Switches have to be registered explicitly. They're supposed to use the right ports at Supply II (Figure 3).

4.1.4. Bunchtrigger

There are 4 BNC-ports at Supply II (Figure 3), which can be used for the bunchtrigger-signals. NIM and TTL levels are available with either bunchpattern- or singlebunch-trigger.

4.2. Media

4.2.1. Pressurized Air

Figure 4: Eurostandard-7.2-coupling

Pressurized air is available with 6±1 bar absolute pressure at Supply II (Figure 3). There are 2 types of connectors available depending on the amount of flow you need. You can use a 6mm OD hose to connect to the FESTO-QS-6-plugs or you can use the brass Eurostandard-7.2-couplings (for applications demanding more flow, Figure 4). The air is filtered with 0.1µm mesh for particles, has residual oil of 0.01mg/m³ and residual water of 0.88g/m³.

4.2.2. Cooling Water

Figure 5: ISO 7241-B connectors

At the experimental station are two lines for cooling water provided for you at Supply II (Figure 3). Water temperature is 20±1°C at 8bar in, 2 bar out. The lines are using brass, self-sealing quick-plugs ISO 7241-B with G1/4" or G3/8" (i.e. 60-Series from Parker BH2 or BH3, Figure 5)

Cooling water may only be connected together with P04-staff.

Each line can be switched on and off individually.

4.2.3. Nitrogen Gas

There is a gaseous dry nitrogen line available at Supply II (Figure 3), i.e. to safely vent your setups. The purity should be better than 5.6 at 1.5bar absolute pressure. P04-standard is 8mm OD hose (red) connected to FESTO-QS-8-plugs. The P04-staff can help you with a small valve and a pressure-relief valve (1.01 bars absolute) to protect your windows and bellows.

4.2.4. Other Gasses

Other gasses can be used in our gas cabinets or with small volumes of gas (e.g.minicans) directly at the experiment. DESY service groups can provide gasses, liquid helium/nitrogen on request. You can order them with I. Braining (-5678). Please remember to declare and order them in advance.

You are responsible to provide the right reducers, connections and safety clearance.

Pressure reducers (for input pressures of 200bar or more) have to be equipped with a metallic membrane. On the low pressure side there has to be a 6mm Swagelok-pipethread or a 1/4"-VCR-connection (see 7.6). For dangerous gases this is also needed at the pressure relief valve.

In general it is not allowed to bring your own gases!

Please have a look at the gas-rules by DESY-groups FS-TI and D5, provided via Online Safety Training in DOOR. Contact the P04 team in case DESY (via Mr. Braining) is not able to fulfill your needs.

Gasses used in P04 gas cabinets can be delivered with pressures up to **32 bar** to the experimental station. There is even a small number of connections for higher pressures. Please make sure you have declared the need for one of those in advance.

4.3. Pre-Vacuum

P04 is currently preparing to offer pre-vacuum from the wall at Supply I (Figure 3). Please feel free to give some input if you are interested.

4.4. Exhaust-System

There are two exhaust systems at P04:

- The main exhaust collects all the burning, toxic, dirty gaseous stuff that comes out of the experiment at Supply I+II (Figure 3). If you've registered any of these substances in your safety declaration this exhaust line will be monitored by the interlock system and may not be opened after those substances are set free. Once this interlock is activated, make sure to contact the safety group before you vent or change the exhaust line. **Failing to do so will force the DESY SAVE group to immediately show up at your experiment!**
- The Helium line is to be used to conserve the precious Helium that was used for cooling. A non-return flap is installed opening at a pressure of 3-5 mbar.

4.5. Vacuum Interlock

The vacuum interlock (VIL) is located at Supply II (Figure 3). It needs one pressure signal relais (NC, normal close) set to close below 1e-6mbar to protect the beamline from bad vacuum conditions. The P04-DPU can be used for this requirement (see 3.3). P04-standard is an Ionivac from Oerlikon-Leybold which must be attached to the most upstream vacuum section of the user experiment.

Please have the manual for your pressure gauge and controller at hand!

The VIL-GUI can be used to control further valves on the beam axis but you'll always need an additional pressure signal.

4.6. Tool Trolley

At P04 you can borrow one of our tool trolleys if you want to travel light. We offer an assortment of metric tools suitable for the usual problems.

You will be provided with a tool trolley for your group with a fixed list of items. Please use only your own tools and those in your trolley to prevent chaos ;-) At the end of your beamtime we want the tool trolley back sorted according to the list of items.

Please ask for details if you're interested.

5. Beamline-Control

The beamline can be controlled with the GUI on the movable computer (haspp04foc.desy.de) at the beamline or via socket connection from your computer.

5.1. GUI

To start the GUI use a linux terminal with one of the following commands to open the panel for branch1 or branch2:

panel1 or **panel2**

A new window should appear (Figure 6).

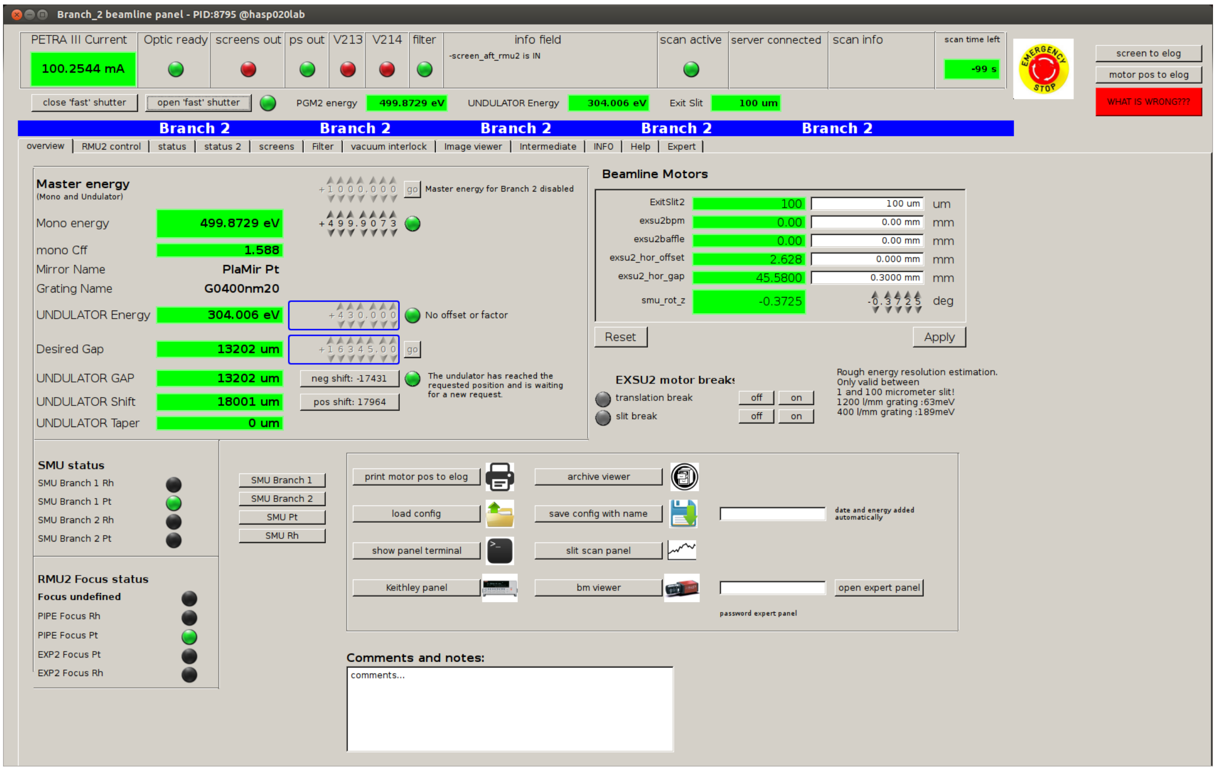

Figure 6: GUI branch 2 - Main screen

In this GUI you are able to check and manipulate the most important beamline features.

Additional are these buttons (Table 2), which allow you to start external scripts and additional windows.

Button	
print motor pos to elog	Save beamline status and write most important values to P04-ELog.
load config	Load a previously saved configuration.
save config with name	Save beamline status and make it available for loading.
show panel terminal	Brings the GUI-XTerm to front. Mostly for debugging.

Keithley panel	Shows Keithley Current in a graph.
archive viewer	TINE archive viewer (see 6.2).
slit scan panel	Opens the scan-tool.
What’s wrong	Checks beamline computers for usual problems.

Table 2: GUI-Buttons

5.2. ComServer

It is possible to remote control the P04 beamline using a TCP-IP connection via DESY-IT registered PC connected to the DESY LAN. The P04 team has scripts available for the command syntax in order to run existing user systems. Contact for details: Jörn Seltmann (-5760).

5.2.1. SETUP:

The server gets started by calling:

python /common/p04/ComServer/ComServer.py -b {1,2}

-b {1,2}, --Branch {1,2}: Which branch do you want to use?

on one of these computers:

- haspp04exp1
- haspp04exp2

The client can connect to the server via socket connection on port 3001 for branch 1 or on 3002 for branch 2.

The client asks the server for measurements/changes in the beamline. This is done in the format:

<COMMAND> <ALIAS> {<VALUE> <PARSERS>} eoc

COMMAND and ALIAS are always necessary, VALUE and PARSERS are optional.

5.2.2. COMMAND:

The Commands 'send', 'set' and 'OTF' can only be used when the switching mirror position from VIL corresponds to the branch defined with the server-call.

Command	Description	Answer
check	Checks if the device is ready, gives back "1" for ready.	'{value} eoa'
closeconnection	closes socket sconnection	'bye! eoa'
OTF	Move undulator and monochromator synchronously.	'started eoa'
read	Reads one defined value (Position, Current,...) for the defined ALIAS	'current **value** : {value} eoa',

		exceptions see ALIAS-table
send	Checks if it could initiate a movement and then sends the ALIAS to the desired position without waiting until this position is reached	'started eoa'
set	Assumes that the ALIAS is ready to move, starts the movement and waits until the desired position is reached	'done eoa'

5.2.3. ALIAS:

Allowed sets of COMMAND and ALIAS (sometimes PARSERS are required).

X gives the standard answer as in COMMAND-table.

Alias	READ	CHECK	SEND	SET	Comment
branch	**X**	**X**			Switching mirror branch direction
exitslit	X	X	X	X	Size in micron
exsu_right	X	**X**		X	Right slit
exsu_left	X	**X**		X	Left slit
fast_shutter	Co	X	X	X	'**Response**: {value}\t {value} eoa'
helicity	X	**X**	X	X	Direction of circular polarization
hv_setpoint	**X**	**X**			Setpoint for mono energy
keithley1	X	**X**			Diode measurements
keithley2	X	**X**			Mesh measurements
mono	X	X	X	X	Monochromator energy
mono_cff	X	X		X	Monochromator Cff value
mono_order	**X**	**X**		**X**	Monochromator order of diffraction
photonenergy	X	X	X	X	Undulator and Monochromator energy
pressure_cb	X	**X**			Vacuum pressure cookiebox [mbar]
pressure_exp	**X**	**X**			Vacuum pressure experiment [mbar]
ringcurrent	X	**X**			PETRA-current [mA]
rmu_rotx	X	**X**	X		RMU rotation around x [µrad]
rmu_rotz	X	**X**	X		RMU rotation around z [µrad]
rmu_transx	X	**X**			RMU translation along x [mm]
rmu_transz	X	**X**			RMU translation along z [mm]
screen	X	X	X	X	Position beamline diode/mesh/out {0/1/2}
server_act	**X**	**X**			ComServer running flag
slt2hleft	X	**X**		X	PS2 left side [mm]
slt2hright	X	**X**		X	PS2 right side [mm]
slt2vgap	X	**X**		X	PS2 vertical gap size [mm]
slt2voffset	X	**X**		X	PS2 vertical gap offset [mm]

stop		**X**			Stops OTF scan
undu	X	**X**		X	Undulator energy
undu_factor	X			X	Factor for photon energy
undu_offset	**X**			**X**	Offset for photon energy
undugap	X	**X**		X	Undulator gap [µm]
undushift	X	**X**			Undulator shift [µm]
wl_pb		**X**			WhiteLight/PinkBeam {1/2}

6. Data Archives

6.1. ASAP3

DESY is providing the ASAP3 data storage system for all users. The ASAP3 storage is divided into two so-called GPFS file-systems: the beamline file-system and the core file-system. The beamline file-system is optimized for the ingestion of data in high speed bursts, while the core file-system has been optimized for capacity and parallel concurrent access. Data can be made available in two ways.

- Each beamline has a “Common”-section where beamline data and -scripts can be stored. This section can be accessed by everyone, but only beamline-staff is allowed to write data here.
- Data taken during a beamtime can be written to the file-system under a unique beamtime ID, and is then concurrently synced to the core file-system from where it can be accessed and analyzed with a delay of a few minutes. Once the beamtime is stopped, the data corresponding to this beamtime ID can only be accessed from the core file-system by every DOOR-registered participant of the beamtime.

Contact the P04 team in case you want to use the ASAP3/GPFS system to store and analyze your data.

6.2. TINE

There is a big archive mostly for machine related data called “TINE Archive System”. The machine is delivering valuable data there and even some P04 beamline data is stored there:

- Pressures
- Motor Positions
- Temperatures
- Vibration data

6.3. P04-Archive

For reference purpose beamline-settings for P04 are recorded periodically. This data will be made available via ASAP3-Common folder.

7. Recommendations for the construction of an experiment for P04

7.1. Size and Weight

The setup should not exceed the borders of the experimental platform (chapter3, 3.6x2m²).

Maximum weight for the platforms is 3.5 ton. However this is for an evenly distributed load over the whole platform. Make sure there is no load exceeding 1000kg on any area of 150x150mm².

7.2. Lifting points

Each setup is a one of a kind solution to your demands and it needs a firm frame to place it at the beamline. This frame has to carry the weight of the setup when it is at the experimental station, when it's transported around, when it's carried with a forklift and when it is lifted with a crane. Think about the path of the forces involved and how to keep your setup in place at all times. You should visualize the center of gravity when you implement space for the forklift and where to place the lifting points for the crane. For the forklift you have to place wheels under your setup to cover the last meter. Lifting points for the crane have to be above the center of gravity of your setup and should be equidistant to the center of gravity when viewed from above. It helps a lot to have both options available.

7.3. Degrees of Freedom

As explained in chapter 3 there are several tolerances to all positions given for the focal position. It is usually possible to place your experiment with the crane within 50mm of the actual focus position. Be prepared to have enough degrees of freedom in your experimental setup for further optimization. These should be usable by a **single** person in a **reproducible** manner.

7.4. Screens

Keep in mind you are trying to use a 10µm synchrotron beam to hit something inside a UHV-chamber. Therefore in-vacuum removable fluorescent screens have proven to be essential.

Each differential pumping stage or other obstacle can block or even reflect the beam. So you'll want to have a screen after every obstacle and one in your interaction region. **This saves precious hours of beamtime!**

7.5. Vacuum

Vacuum (oil-free) is needed to perform experiments at P04. Make sure that all your vacuum pumps are oil free and all put on suitable vibration dampers. Then your setup should accomplish a pressure better than 1e-7 mbar and then you should perform a leaktest and take a RGA-spectrum prior to your arrival on site.

7.5.1. Leak Check

The leak check must be performed with Helium and the leakrate over all may not exceed 1e-10 mbar·l/sec. Inner enclosures should be tested prior to their final assembly.

Upon request the P04 team can supply a leak checker having a KF25 connector.

7.5.2. Hydro-Carbonates and Desorption Rate

Components can be treated as hydro-carbonate-free when the leak-free system has reached a pressure better than 1e-7 mbar and when the sum of partial pressures of the atomic-masses 45-100 is smaller than over-all-pressure divided by 1000.

7.6. Standard connectors

As mentioned in chapter 4, there are certain standard-connectors used at P04.

Medium	**Connector**
Pressurized air	6mm OD hose with FESTO-QST (blue), Eurostandard-7.2-couplings
Cooling water	self-sealing quick-plugs ISO 7241-B with G1/4” or G3/8”
Nitrogen	8mm OD hose with FESTO-QST (red)
Gas cabinet system	1/4” VCR
Exhaust systems	KF40

Table 3: Connection standards at P04

8. P04 User Timetable Checklist

At least 4 weeks before beamtime starts		DONE
	Provide safety declaration, provide safety concept and contact P04 team and safety group in case it is non-standard (toxic chemicals, laser, etc.)	
	Check special requirements: media, equipment, chemistry lab, nano-lab, beamline parameters,...	
	Provide list of participants, book accommodation in DESY Hostel	
At least 2 weeks before		
	Re-check safety declaration in case it is above normal standards, contact safety group	
	Re-check special requirements, agree for a date/time for local training (e.g. chemistry lab)	
	Re-check participants, check their DOOR accounts, do the safety training	
	Agree on date/time for beamline check-in with preceding group and P04 team	
	In case of heavy equipment check that the transportation group is informed and prepared	
At least 2 work days before		
	Check media in case there are special requirements (liquid helium/nitrogen)	
	Confirm date/time for beamline check-in	
Upon arrival		
	Final check of safety	
	Final check of special requirements	
	Register user PC in case it must remote control the P04 beamline	
	Check safety training of all participants, perform local training (e.g. chemistry lab)	
	Perform “P04 beamline check-in” (for all participants who want to “push buttons”)	
Latest at the final day of beamtime		
	Provide beamtime feedback (oral feedback appreciated by the P04 team members, but essential: online feedback in DOOR!)	
Latest at the final day of beamtime		
	All P04 stuff which was borrowed is back?	
	Experimental area at P04 tidy again?	
	All samples safely disposed	
After the beamtime		
	Provide Experimental Report in DOOR	
	Register all your publications in DOOR	

9. Contacts (P04 and DESY/FS Service Groups)

Link	Contact	Remarks
DOOR		Registration of participants Online safety training Declaration of substances and apparatus Register lasers
P04	1. Moritz Hoesch (-4220) 2. Kai Bagschik (-5516) 3. Florian Trinter (-4856) 4. Meng-Jie Huang (-5562) 5. Frank Scholz (-1715) 6. Jörn Seltmann (-5760) 7. Mathias Bohn (-5564) Beamline mobile (-96104)	leading scientist scientist scientist scientist engineer engineer technician
Technical shift service	Mo-Fr 8-16 Uhr: 8. I. Braining (-5678) FS-Shift-Service (-93868) 9. T. Hasenkamp (-3730)	Gases Liquid helium/nitrogen Crane Set up space
Chemistry lab	A. Ciobanu (-4683), S. Lessmann-Bassen (-3180), B. Heilmann (-5707), M. Lippmann (-4691)	Registration via DOOR On-site-instruction
Nano lab	A. Stierle (2005)	Sample preparation Surface Spectroscopy X-Ray diffraction Microscopy
Safety group	M. Herrmann (-2815) H. Sidal (-2884) S. Lessmann-Bassen (-3180)	Safety declaration, Safety installations, Radiation safety, Laser

Table 4: Contacts