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Summary and Conclusions of the Two Orbit / TRIBs User Test Week

KW08 2018, 19. – 25. 02.2018

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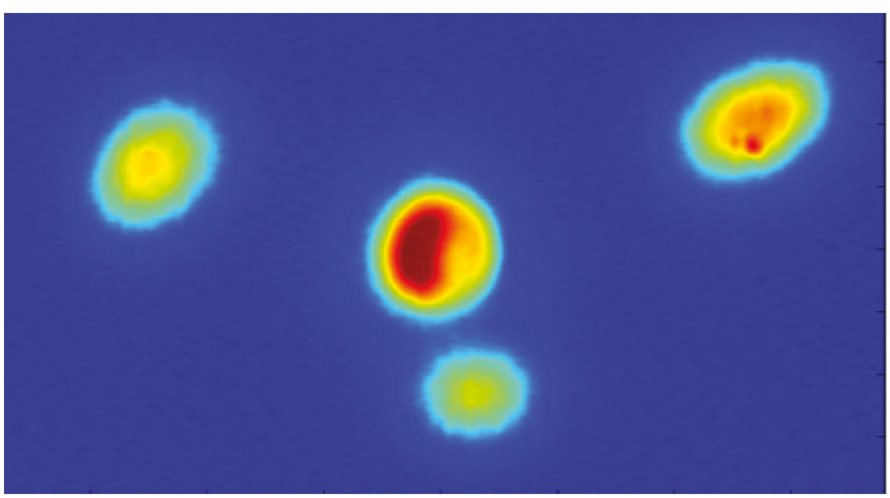

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1) Introduction, Objectives and Schedule

The Two Orbit operation mode is a special storage ring setting providing two well separated, independent orbits (main orbit and island orbit), which can be used to store, to some extent, two independent fill pattern, i.e., beams in one storage ring. It is a very elegant electron bunch separation scheme based on non-linear beam dynamics using transverse resonance island buckets (TRIBs), which could be of great benefit for the synchrotron user community. This scheme can be used to offer simultaneously two different photon pulse repetition rates to the synchrotron user community and it is one promising bunch separation option for the long and short bunches of the future BESSY VSR.

The aim of these studies is to define and establish a TRIBs user operation mode at BESSY II, where a multi bunch (MB) fill is stored on the main orbit (200 mA to 295 mA) and a single bunch (SB) (5-X mA) or few bunch (FB) (4 or 8 bunches, 20 mA, 40 mA) on the island orbit.

1.1) Objectives of the Two Orbit user test week

1. General verification if this operation mode could reach the beam quality necessary for a realistic user operational mode in terms of
    a. electron orbit, i.e., photon signal stability
    b. injection efficiency and lifetime, i.e., TopUp conditions
    c. simultaneous use of multiple IDs and bends
2. Verify that the MB signal from the main orbit is not disturbed by the island orbit signal
3. Increase the accessibility of the island orbit at most beamlines

1.2) Rough daily schedule of the Two Orbit user test week

07:00 – 10:00: Storage ring optimization and preparation for the …
10:00 – 15:00: **Common Experiment** with a special machine setting, far away from user operation
15:00 – 18:00: Restoring the TRIBs TopUp user mode (and sometimes small individual experiments)
18:00 – 07:00: **TRIBs User Run**

During the **Common Experiment** (see section 1.3)) the offered machine setting and synchrotron radiation was far away from the envisaged future user operation mode to study the questions raised in section 1.1).

During the **TRIBs User Run** the beam was offered to the experimental stations. The MB train was stored on the main orbit with and without gap and SB or FB on the island orbit. The availability of the machine was at 99.78 % with only one outage (caused by an operator error). The injection efficiency ranges between 92 - 97 %.

1.3) Detailed daily schedule of the Two Orbit user test week

Day/Time

19.02. Monday:

14:00 – 18:00: Standard BESSY II user mode, decaying beam, BeamShutter (BS) open
18:00 – 21:00: Switching to TRIBs mode, BS closed
21:00 – 09:30: TRIBs User Run, MB in main orbit, SB in island orbit, 200ns gap, BS open

20.02. Tuesday:

10:00 – 14:00: TRIBs mode, decaying beam, all bunches on main orbit, BS open
14:00 – 16:00: Restoring TRIBs user mode
16:00 – 07:00: TRIBs User Run, MB in main orbit, SB in island orbit, 200ns gap, BS open

21.02. Wednesday:

10:00 – 14:30: TRIBs mode, increasing every 30 minutes the number of bunches on the island orbit: (TopUp) SB, +2, +4, +6, +10, (TopUp Off, Decaying Beam) +50, +100, +225, all bunches
14:30 – 18:00: Restoring TRIBs user mode
18:00 – 07:00: TRIBs User Run, MB in main orbit, SB in island orbit, 200ns gap, BS open

22.02. Thursday:

10:00 – 14:00: TRIBs mode, decaying beam, complete fill on island orbit: MB without gap + slicing bunches + FB (position 1, 101, 201, 301)
14:00 – 18:20: Restoring TRIBs user mode
18:20 – 07:00: TRIBs User Run, MB in main orbit, FB in island orbit, no gap, BS open

23.02. Friday:

since 10:00: TRIBs User Run, MB in main orbit, SB in island orbit, no gaps, BS open until Monday

2) Peculiarities of the TRIBS operation mode compared to standard BESSY II TopUp setting

2.1) TopUp Injection & population of both orbits

- The injection into the TRIBs mode was derived from the standard injection process, i.e., all charge provided by the booster is injected on the main orbit with a four kicker bump. Therefore all charge (or bunches) from the island orbit has to be pushed to the main orbit. Up to now it is not possible (and it was not studied how) to inject individually on both orbits.
    - During injection (5s before and 3s after the injection = 8s) all bunches are pushed to the main orbit by the Bunch-By-Bunch Feedback (BBFB) X system. The BBFB X system is switched on to clear all charge from the island orbit and stays active for the whole

    injection process (in total 8s), to guarantee that no stored or injected charge is trapped on the island orbit.
    - After successful injection the BBFB X system changes it's excitation frequency and bunch pattern and the timing bunches (SB or FB) are pushed back to the island orbit until next injection, when the procedure repeats.
- Clearing the island orbit for 8s leads to an increase of current of the main orbit and an additionally shaking and widening of the main orbit beam. This depopulation of the island orbit and population of the main orbit is the main disturbance source of user measurements focused on radiation from the main orbit.
- Depending on the amount of bunches (or charge) stored on the island orbit, also the orbit feedback can be disturbed by the population process and the orbit changes between injection and data taking time.

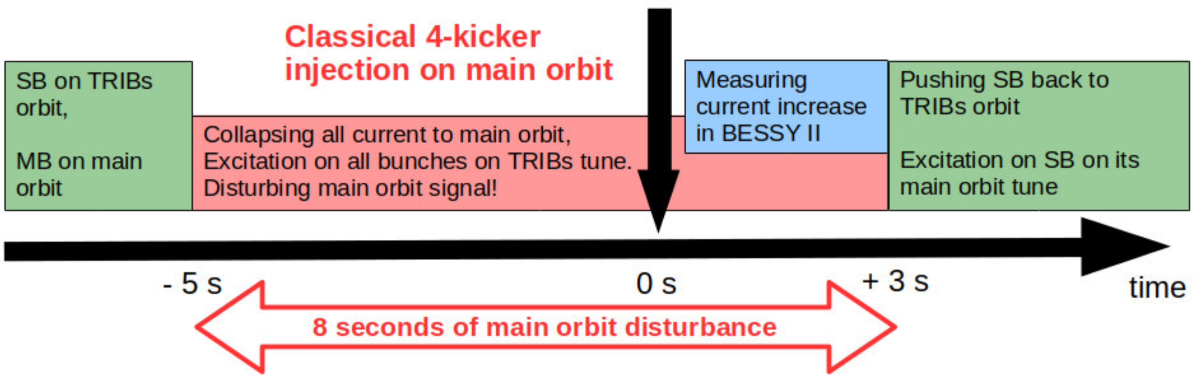


FIGURE 1: THE INJECTION PROCESS INTO THE TRIBS OPERATION MODE WITH RE-POPULATION OF THE TRIBS ORBIT.

2.2) Main Orbit

- Excluding the injection process the main orbit for the TRIBs optics and the BESSY II standard optics is at the same position.
- The emittance of the main orbit increases from 7 nmrad to 8 nmrad and beta and dispersion function are nearly the same with negligible deviations, i.e., the horizontal source sizes are nearly the same as in the standard mode, only increased by 10 - 20%.
- Lifetime is reduced due to reduced dynamic aperture and momentum acceptance. For TopUp user operation the lifetime has been increased by a stronger vertical noise excitation of 1.8V instead of 1.1V, which increases the vertical source size.

2.3) Island Orbit

- So far, not more than 4mA/bunch have been stored on the main orbit in this TRIBs mode. That means at a third order resonance with three TRIBs populated equally with charge, only one third of the charge is seen by the beamline resulting in 1.333 mA/spot with 1.25 MHz repetition rate. It is also possible to push all current from one main orbit bunch to only one of the three TRIBs buckets, providing 4mA/spot with a repetition rate of 0.41666 MHz on the island orbit.

- The separation, i.e, the orbit displacement and orbit angle relative to the main orbit, is shown in Fig. 1.
    - Spatial separation - orbit displacement:
        - Assuming 20m as conservative value for the beta-function, leading to a source size of σ = 400 µm.
        - In all D straights at least one beam spot of the island orbit is more than 4 mm separated from the main orbit. With the source size σ = 400 µm a spatial separation of more than 10 σ is reached.
        - In T straights at least one beam spot of the island orbit is 1-2 mm displaced from the main orbit, resulting in a spatial separation of more than 2.5 σ.
    - Angle separation - orbit angle:
        - The divergence of the beam is σ' = 20 µrad (assuming 20 m beta functions).
        - In D straights at least one beam spot differs in angle from the path of the main orbit by about 0.3 mrad - 0.4 mrad, resulting in an angle separation of 20 σ.
        - In T straights at least one beam spot differs in angle from the path of the main orbit by 1.6 mrad, resulting in an angle separation of 80 σ.

So far the selection of individual beam spots of the different orbits was shown only at beamlines placed at **D straights** (D2, (D5, D6, D7 – with bumps)). Using the front end apertures only one spot far away of the main orbit was selected (D2) and additionally the small orbit angle was corrected by a small orbit bump of 0.2 – 0.3 mrad (D5, D6, D7).

At **T straights a** selection of one of the three beam spots of the island orbit was not shown yet. It could be challenging to reach the large angle separation with a three steerer bump, required by the island orbit.

2.4) Additional remarks

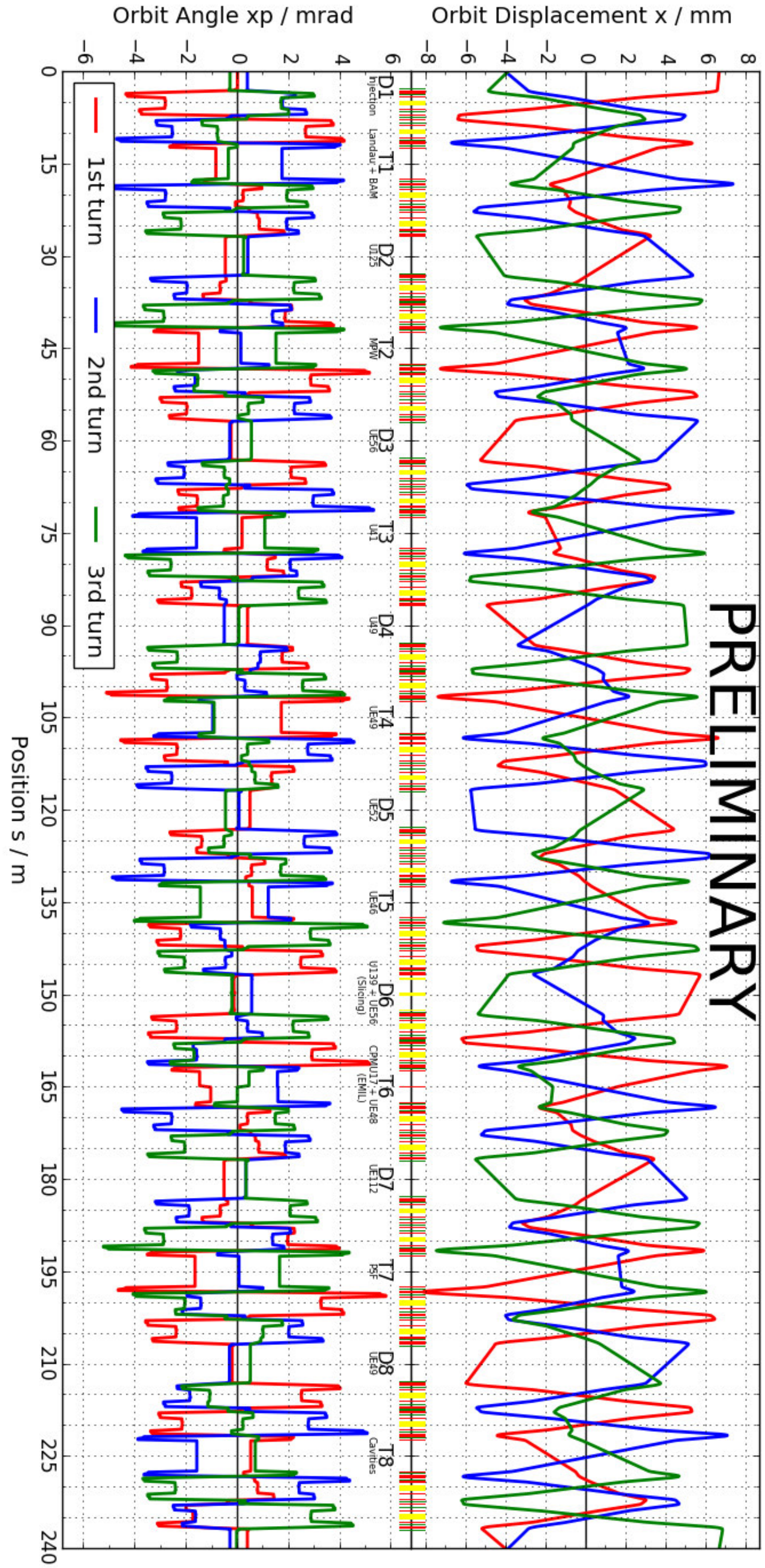
TRIBs and slicing (see A.ID2: ID D6 U139 Slicing, Karsten Holldack et al.):
When slicing laser is switched on, slicing bunches from main orbit are pushed to island orbit.
Is it possible to avoid this population by increasing the separation between the two orbits?

Diffusion rates between main and island orbit (see A.B1: Bend T4 D81 PM4, Ruslan Ovsyannikov):
The ratio between SB/MB stored on the island orbit decreases during two injections, showing a diffusion of the charge of the MB bunches stored on the main orbit to the island orbit.

This can be counteracted by

- An increase of the separation, but it was intentionally reduce to meet the injection requirements (injection efficiency > 90 %).
- Additional bunch-by-bunch excitation (as provided by the BBFB X feedback units), one for the bunches on the island orbit and one for the bunches on the main orbit.
- An increase of the damping (by additional radiation sources, feedbacks, …)

FIGURE 2: SEPARATION OF THE TWO ORBITS. ISLAND ORBIT DISPLACEMENT (TOP) AND ANGLE SEPARATION (BOTTOM).



3) Next steps, To Do's (sorted by urgency); Towards a realistic TRIBs user mode

3.1) TopUp injection and re-population of orbits

- By removing the MultiPoleWiggler (MPW) the radiation damping, which helps at injection and with diffusion rates between the two orbits, is reduced and injection becomes more difficulty. **TopUp Injection without MPW** has to be developed and it has to be verified if injection in TRIBs with efficiencies >90% is possible. And what total current can be stored with acceptable diffusion rates with reduced damping?
- In order **to avoid the re-population process for injection** with BBFB system, which causes the main disturbance at the user experiments and disturbs the orbit feedback correction, **individually injection in both orbits have to be studied and developed**.
- If this is impossible at BESSY II, than additional bunch-by-bunch excitation is needed for injection and control of diffusion rates, and a solution for the orbit feedback when re-populating the orbits is required. In total three different bunch-by-bunch excitations are needed, one for depopulation of island orbits, one for depopulation of the main orbit and one for excitation of one bunch for phase tracking tune measurement. This can be realized by
    - Three BBFB X systems from dimtel
    - A modification/upgrade of the existing BBFB X with one drive module which has to be extended to 3 different drive settings. (Clarify with dimtel)
- Optimize setting for dynamic aperture, lifetime, separation and injection efficiency.

3.2) Separation and spot selection at beamlines

- Successful separation and spot selection have been shown at D straights and bending beamlines with intermediate focus.
- Separation at T straights have failed so far, due to the absence of orbit bumps in T straights. The T bumps have to reach 1.6 mrad (better 2mrad), which has to be shown.
- **So far it is unclear if bending magnet beamlines without intermediate focus can select the beam spots from one and the other orbit by front-end-apertures or other optical elements.**

3.3) Recommendations for next TRIBs user test week

- Reduce the number of common experiments far away from the envisaged user conditions.
- Provide a user setting which is most similar to the standard BESSY II standard setting:
    - MB train on main orbit with gap and SB (or FB) on island orbit
    - MB train on main orbit without gap and SB (or FB) on island orbit

4.) References about TRIBs at HZB (BESSY II and MLS)

[1] P. Goslawski et al., “Bunch Separation with Resonance Island Buckets”, ESLS XXII Workshop, ESRF, Grenoble, France, 2014: http://www.esrf.eu/files/live/sites/www/files/events/conferences/2014/XXII%20ESLS/GOSLAWSKI_RI.pdf

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[3] P. Goslawski et al., “Resonance Island Experiments at BESSY II for User Applications”, IPAC16, Busan, Korea, THPMR017, 2016: DOI:10.18429/JACoW-IPAC2016-THPMR017

[4] P. Goslawski et al., “Transverse Resonance Island Buckets as Bunch Separation Scheme”, IPAC2017, Copenhagen, Denmark, WEPIK057, 2017: https://doi.org/10.18429/JACoW-IPAC2017-WEPIK057

[5] F. Kramer et al., “Characterization of the Second Stable Orbit Generated by Transverse Resonance Island Buckets (TRIBs)”, IPAC2018, Vancouver, BC, Canada, TUPML052, 2018: https://doi.org/10.18429/JACoW-IPAC2018-TUPML052

[7] P. Goslawski, video: “TRIBs at BESSY II – Populating the two orbits”, 2017: https://www.youtube.com/watch?v=FRq9pT_sETQ
P. Goslawski, video: “TRIBs at BESSY II – TopUp injection into TRIBs mode”, 2017: https://www.youtube.com/watch?v=SA9wccisUJ8

Appendix (and comments from user mails):

A.B1: Bend T4 D81 PM4 Ruslan Ovsyannikov

A.B2: Bend T7 D132 XPP Matthias Roessle

A.ID1: ID D2 U125 Katerina Medjanik, Hans-Joachim Elmers

“we succeded to adjust our microscope finally. Everything works nice.
We have a 1000:1 signal to multibunch ratio in intensity.
Absolutely great, we can measure in this mode without problems.”

“We can say that at the U125 beamline Peter did a very great job to select the island orbit by adjusting the knife edges. We have an at least 1000:1 suppression of the normal orbit signal in the 4 bunch mode. We see no problems to measure in this mode.”

A.ID2: ID D6 U139 Slicing Karsten Holldack et al.

A.ID3: ID D7 UE112-PGM1 Gregor Schiwietz, Florian Trinter, Uwe Hergenhahn

„Würde vorschlagen noch hinzuzufügen, dass der Strahlstrom des Island Orbit um einen Faktor 2-3 gesteigert werden müsste (four-bunch), damit man mit COLTRIMS / Reaction Microscope Experimenten (multi-coincidence) eine vernünftige Chance hat zu messen. Es war aufregend beim Two Orbit dabei zu sein und ich denke auch es ist eine sehr aussichtsreiche Entwicklung.“

A.ID4: ID D7 UE112-PGM2 Emile Rienks

A.ID5: ID T3 U41-PGM1-XM Peter Guttmann

A.ID6: ID T4 U49-SPEEM Florian Kronast

“… Those pump-probe measurements use repetition rates from hundreds of kHz to MHz and require a dedicated filling pattern. The permanent choice of both, the multi-bunch filling pattern and a second orbit with a selected four, eight or twelve-bunch orbit, for pump-probe experiments would make a tremendous difference to present, where the combination of multi-bunch imaging and time resolved experiments can only be achieved using a gating scheme.”

A.ID7: ID T5 UE46-PGM2-MAXYMUS Markus Weigand

"…some evaluation at MAXYMUS - looks good, but fast orbit feedback needs work with Islands, and injection gating needs to be changed.”

A.ID8: ID T5 UE46-PGM1 Enrico Schierle

A.PTB:

„Ich habe von allen 4 beteiligten Strahlrohren (SX700, FCM, PGM (U49) und XPBF2) diverse Bilder und Videos bekommen. Hier der Versuch einer Zusammenfassung:

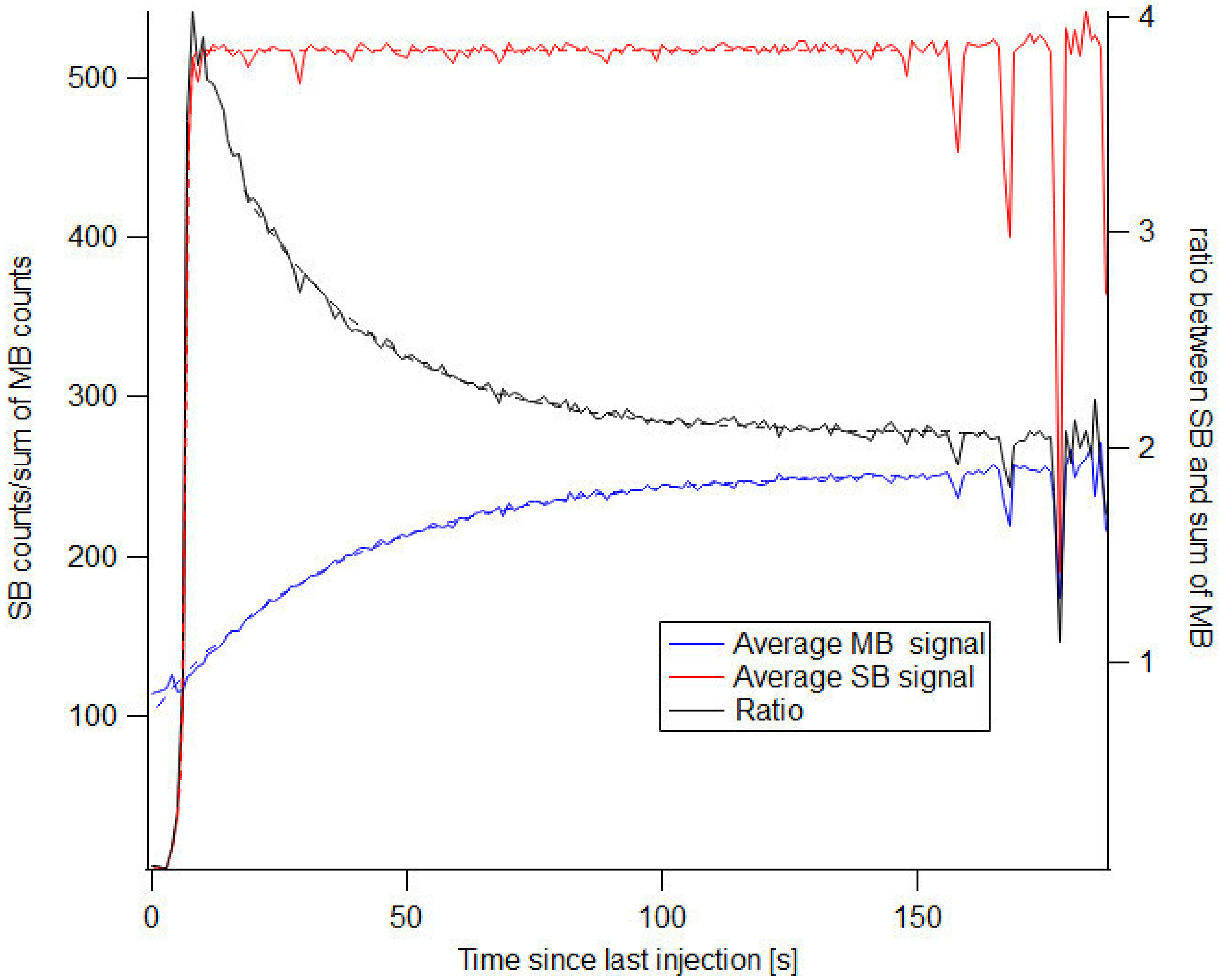
für die PTB ist die spezielle Zeitstruktur der Bunche auf dem zusätzlichen Orbit derzeit nicht relevant, für uns ist nur wichtig, dass unsere normalen Messungen weiterhin in hoher Qualität durchgeführt werden können. Wir sehen an allen Strahlrohren Beeinträchtigungen, also Verschlechterungen der Strahleigenschaften, verbunden z. B. mit Einbußen in der Energieauflösung, höherem Falschlichtanteil und natürlich zusätzlichen Spots, die sich nicht immer vom eigentlichen Spot trennen lassen. Problematisch ist auch die für hochgenaue Messungen erforderliche Normierung auf den Ringstrom, da bei der Ringstrommessung nicht zwischen den Orbits unterschieden werden kann.
Bevor es zu einer etwaigen Einführung des Two-Orbit-Betriebs als Normalbetrieb kommt, müsste dieses Problem gelöst werden und es müsste mindestens eine weitere Testwoche stattfinden, bei der man möglichst die Orbits so modifizieren sollte, dass sich die Strahlung des zweiten Orbits besser vom Hauptorbit abtrennen lässt.“

A.PTB1: Bend D4 D72 SX700 Victor Soltwisch, Frank Scholz

A.PTB2: Bend D4 XX FCM Michael Krumrey

A.PTB3: ID D4 U49-PGM Philip Hoenicke, Claudia Zech

A.B1: Bend T4 D81 PM4 Ruslan Ovsyannikov



Processing preview:
20000 seconds of acquisition was loaded. Countrates from SB and MB was averaged from detected injection time. Note: 4 strong spikes in the data at times >150 seconds are coming from averaging/ normalization procedure

Resulting times:
Time between injections: up to 188 s

SB signal averaged over in-between injections interval: ca 516 counts, practically constant

MB signal averaged over in-between injections interval: grows from ca 110 to ca 253 counts, slowly reaching saturation.
MB population rate: 38.1 seconds (as obtained by time constant of exponential fit)

Peak-to-Peak ratio SB/MB: varies between 1590 and 820
SB to "MB sum over all counts" ratio: varies between 4 and 2.06

Average time between detected injection and start of the SB signal rise: 5.4 seconds (estimated by 1/2 of 3 sigma interval)

Average rise time of SB signal (excitation process duration): 2.14 seconds (full 3 sigma interval)

TRIBs test week @ KMC3-XPP (Dipol 13.2)

Setup:

Two focussing multilayer X-ray mirrors, KMC3 Si monochromator between these two mirrors, set to “standard values” for 9 keV. In the XPP diffraction chamber, a X-ray sensitive camera was placed in the focus of the second mirror. A typical picture of the X-ray focus is shown in Figure 1.

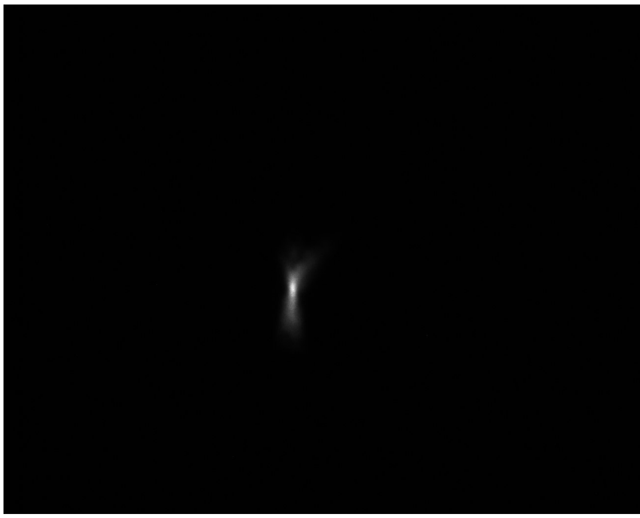


Figure 1: Typical X-ray focus at the XPP endstation in multibunch mode

Switching to SB+225; Wednesday, ~13:30

We can observe two additional emission centres and a broad background close to the main standard emission source. We could observe the transition from the quasi-normal mode around 13:30 to the new mode almost in real time with the camera. We are not sure whether we could not detect the previous filling patterns before 13:30 or whether we simply missed them. In Figure 2, the new “focus” is shown.

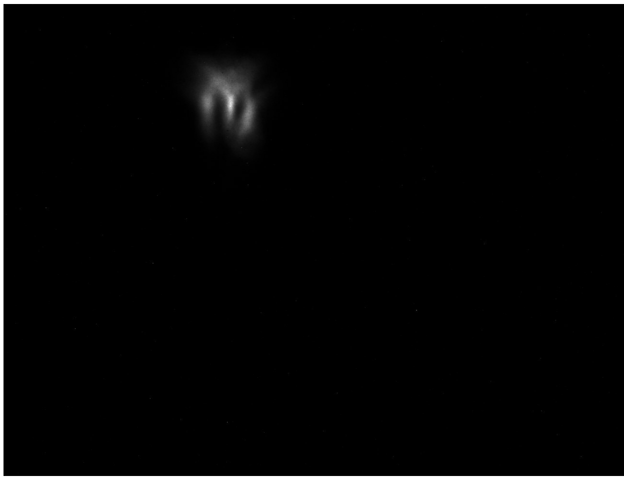


Figure 2: TRIBs SB+225

All bunches in island orbit; Wednesday, ~14:00

The individual emission “points” become more separated as seen in Figure 3. It also seems that the background in the centre becomes weaker.

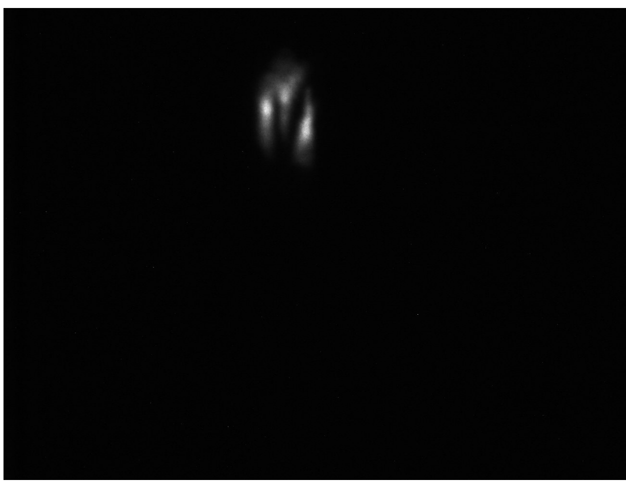


Figure 3: TRIBs, all bunches in island orbit

Summary

We could observe the different filling patters, however, we did not yet succeed in separating them in time. In principle, our gated Pilatus detector should allow us to select only one of these bunches on the other orbit as the emission characteristics of the dipole seems to be wide enough.

Time-of-flight momentum microscopy in the twin orbit mode probed in KW08

K. Medjanik, H.J. Elmers, P. Baumgärtl, G. Schönhense

In our case, the main question of the twin-orbit test run is whether it is possible to separate the signal from the twin orbit from the background signal originating from the multi-bunch electrons on the main orbit. As the twin-orbit and the main orbit are spatially separated at the position of the exit slits we have used the vertical knife edges to block the intensity from the main orbit and let pass only the signal from one of the three twin orbits. The energy of the electrons in the drift section has been set to 35 eV, which is sufficiently high to separate electrons from consecutive bunches. The energy resolution is then about 100 meV.

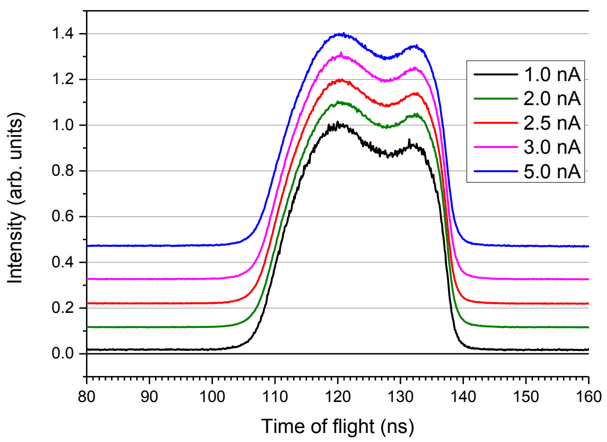


Figure 1. Time of flight spectra for different slit settings indicated by the increasing mirror current. The spectrum remains similar while the constant time-independent background from the multibunch train increases.

Figure 1 shows a sequence of time-of-flight spectra with increasing slit opening for the twin orbit intensity. The slit opening has been monitored by the mirror current on the last mirror. Starting from a mirror current of 3 nA the background intensity from the normal orbit increases and creates a homogeneous background signal that does not depend on the time of flight. On the other hand, smaller mirror currents lead to a signal to background ratio of better than 1:100. The background signal decreases with decreasing mirror current indicating an increasingly better separation. The saturation below 2 nA hints to an additional background stemming from higher order photons from the beamline.

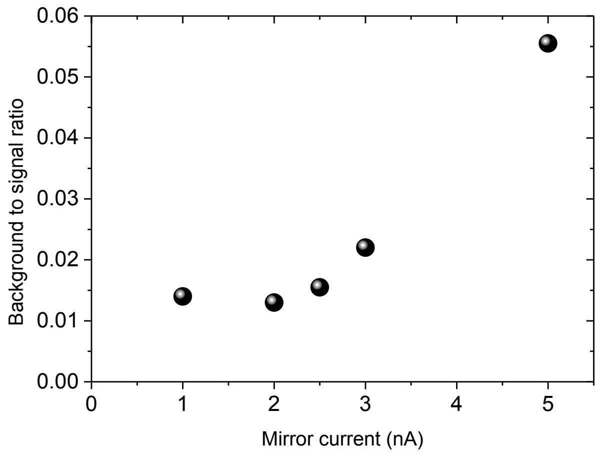


Figure 2. Ratio of background to the signal maximum indicating a good signal to background ratio below 2 nA.

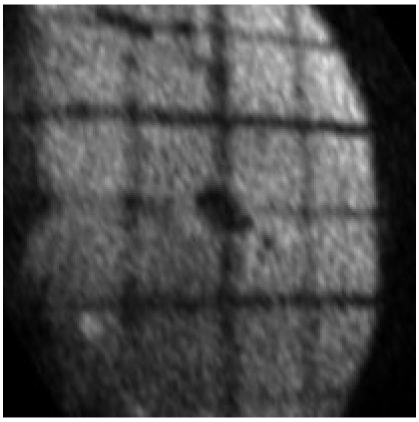


Figure 3. Image of the Chessy sample with the grid introduced into the backfocal plane. Photoelectrons excited with 18 eV. Image averaged over 100 meV close to the photoemission threshold (E_B = 13 eV). Data accumulated for 10 minutes. The sharp image of the grid proves the possibility to perform momentum microscopy.

Figure 3 shows an Image of the Chessy sample with the grid introduced into the backfocal plane. The electrons optics have been set to momentum mode. In this case, no sharp image from the surface is expected. Photoelectrons excited with 18 eV. The image has been averaged over 100 meV close to the photoemission threshold (E_B = 13 eV) and the data were accumulated for 10 minutes. The sharp image of the grid indicates the momentum mode of the instrument. The image thus proves the possibility to perform momentum microscopy in the twin orbit mode of the synchrotron.

Femtoslicing: Beobachtungen in der "Twin-Orbit-Woche"

K. Holldack, R. Mitzner, T. Kachel, N. Pontius, Ch. Schüßler-Langeheine

Erster Slicing-Überlapp zwischen Laser (1.8 mJ, 800 nm) und Elektronenstrahl in der Twin-Orbit-Woche wurde erreicht im Zustand der Maschine am Donnerstag d. 22.2. Füllmuster: Multibunch+3 slicing bunche im core-orbit, „Few Bunche" im Island-Orbit.

Beobachtungen:

- Der transversale Überlapp war horizontal verschoben gegenüber der „normalen Maschine". Der Elektronenstrahl geht in der TRIB-Maschine **unter etwas anderem horizontalen Winkel** (einige 10 µrad) durch den Modulator (U139).
- Die Energiemodulation der Elektronen (sonst ca. 1%) war etwa **30% schlechter**, was nicht ausreicht, um den Slicing-Strahl in der beamline vom core-beam zu trennen. Ursache: Ioneneinfang und damit verbundene Emittanzvergrößerung + künstliche weiße Anregung der Quelle zur Verbesserung der Injektionseffizienz führen zur Fehlanpassung zwischen Laser beam waist und Elektronenstrahl im Modulator.
- Die gemessene Laserenergiemodulation (THz-Signal) in der TRIB- Maschine ist **relativ instabi**l und schwankt im Sekundenbereich (auch im Decay mode) etwa 10% (sonst nur ca. 2%).
- Extrem störend ist der **Verlust des Slicing-Signals** während der Injektionen, ein Vorgang der bis zu 8 Sekunden dauert. Da Slicing-Nutzer meist sogenannte pump-probe Delayscans fahren, d.h. das Röntgensignal als Funktion des longitudinalen Delays zwischen Laser- und Röntgenpuls im Minutenbereich aufzeichnen, ist ein Verschwinden des Nutzsignals im Sekundenbereich inakzeptabel.
- In Kombination von Slicing und TopUp-Injektion werden **Elektronen** aus den gesliceten Bunchen **in das Island-Orbit gekickt** und sind für den Slicing-Vorgang verloren. Die Lebensdauer der Slicing-Bunche im core-orbit ist dann nur wenige Sekunden bis Minuten lang.

  Fazit: Femtoslicing-Betrieb mit den 3 Slicing-Bunchen im Core-Orbit ist **momentan nicht möglich**. Ein angedachtes Abschalten des Slicing-Lasers während der Injektionen würde das Slicing-Signal auf null ziehen und eine nachfolgende Stabilisierung des fs-Signals in der beamline im Sekundenbereich nach sich ziehen. Dies ist für unsere Slicing-Nutzer inakzeptabel.

  Ausblick: Ein möglicher aber noch zu erprobender „workaround" ist **Slicing im Island-Orbit**.

  Hierzu gibt es folgende Anmerkungen:

- Slicing Überlapp im Modulator erfordert, dass der Bunch (einer der drei Island-Bunche) vertikal on-axis durch den Modulator läuft, ansonsten wird die FEL-Resonanz verstimmt. Dazu ist die Beulengeometrie im Modulator zu verändern, Insbesondere braucht es wohl eine **vertikale 4er Beule** die es momentan noch nicht gibt.
- Zur Erhaltung des Polarisationsgrades im Radiator muss der geslicte Bunch im Island-Orbit auch **on-axis** (x und y) durch die Magnetstruktur des UE56/1 laufen. Eine **veränderte Geometrie der „Femtobeule"** und deren Stabilisierung wäre hier nötig.

- Laserenergiemodulation ist extrem empfindlich auf **vertikale Emittanz**. Optische Bilder (pinhole array) zeigen eine andere Quellform der Island-Bunche. Zu prüfen: wie effektiv ist Laserenergiemodulation überhaupt auf transversal vergrößerten Island-Bunchen möglich.
- Elektronen im Island-Orbit laufen weit off-axis vom core-orbit (bis zu 5 mm). Laserenergiemodulation führt wegen der nicht verschwindenden Dispersion im Modulator zur Anregung einer **Betatron-Oszillation** um das Island-Orbit herum und ein **Abschälen der geslicten Elektronen**, die nun sehr weit außerhalb des Golden-Orbits laufen ist sehr wahrscheinlich (dynamische Apertur).
- Da nicht direkt in das Island-Orbit injiziert werden kann, wird der **Slicing-Überlapp** und damit das Röntgensignal bei jedem TopUp **komplett auf null gezogen**, was stabilen Slicing-Betrieb nahezu unmöglich macht.

Fazit: Momentan ist ein Femtoslicing-Betrieb mit einem TRIB-Maschinensetting **nicht kompatibel**.

18106806ST-2.1-P (19-25 Feb 2018)

Report about 2018/1 (twin orbit test)

One week of few bunch beamtime produced by the novel ‘island orbit’ scheme was allotted to this project. Experiments were performed at the UE 112_PGM-1 beamline. Scientifically, our aim is the investigation of autoionization processes after initial photoionization of atomic and molecular clusters. We apply an electron-electron coincidence detection technique using a 'magnetic bottle' time-of-flight (TOF) electron spectrometer designed for the coincident detection of primary and secondary electron.

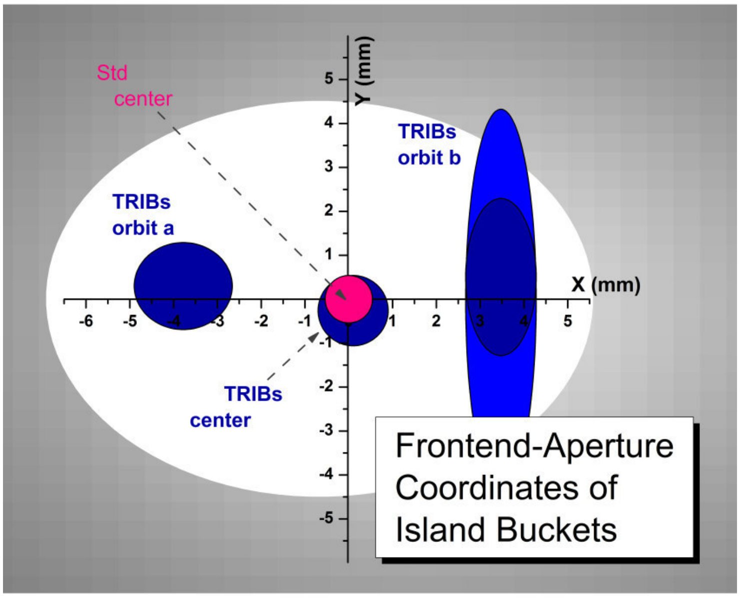


Figure 1: Size (FWHM) and positions of different beam spots determined from front-end aperture (ID blade) settings and photo-current measurements. The origin of co-ordinates is given by the standard beam center in decay mode. The central TRIBS orbit is slightly larger and two of the TRIBs island buckets (orbits a plus b) have clearly been detected. Orbit (a) has been used for the subsequent TOF experiments and for orbit (b) only the x-distribution has been determined.

As the twin orbit mode has not been demonstrated before for low photon energies, our first aim was the separation of the radiation from the island orbit(s) from the main orbit. At UE112 PGM this can be accomplished by using the front end blades, as shown in Fig. 1. A good, but not perfect separation has been achieved in the electron TOF spectra, even for low photon energies (40 eV in Fig. 2).

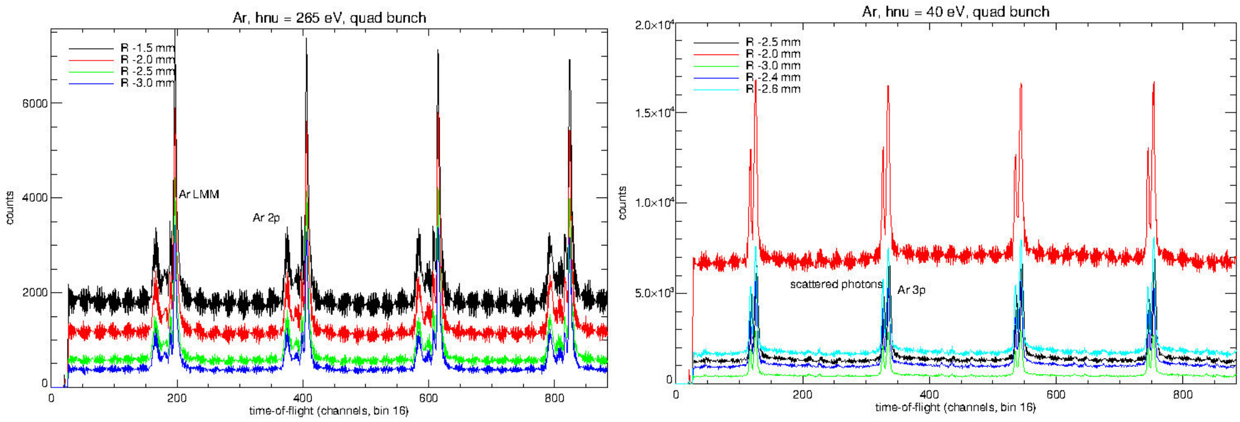


Figure 2: Electron time-of-flight spectra of Ar photo and Auger lines from island orbit (quad bunch) and main orbit for different settings of the right-hand side ID blade (R). Separation can be improved at the expense of few bunch signal, but is not perfect. Quality of the separation (peak height vs. flat background) is dependent on photon energy (left $h\nu$=265 eV, right $h\nu$=40 eV).

Further tests indicate that horizontal as well as vertically polarized x-ray photons may both be selected using island-orbit (a). However, elliptical polarization might require the use of a steerer bump. While the signal from the (multi-bunch) main orbit cannot be fully blanked out in a conventional photoelectron spectrum (Fig. 2), the main tool for our experiments is electron-electron coincidence spectra. This discriminates against the signal from the main orbit sufficiently well to make data acquisition using the single-bunch island orbits possible (Fig. 3).

Count rates were sufficient for coincidence data acquisition, however at the expense of photon-energy resolution. This would be acceptable for some but not all of our projects. A more quantitative comparison with data acquired with the same set-up in single bunch, Jan. 2014, UE112-PGM, reads:

Comparison of Ar coincidence spectra obtained at UE112_PGM-1:
Jan 2014, #63 (single-bunch beam)
hν = 50 eV
Slit size = 30 μ
Coinc. rate 41170 / 612 = 67 s^{-1}

Feb 2018, #251 (TRIBs beam)
hν = 60 eV
Slit size =1.5 mm
Coinc. rate 374694 / 1800 = 208 s^{-1}

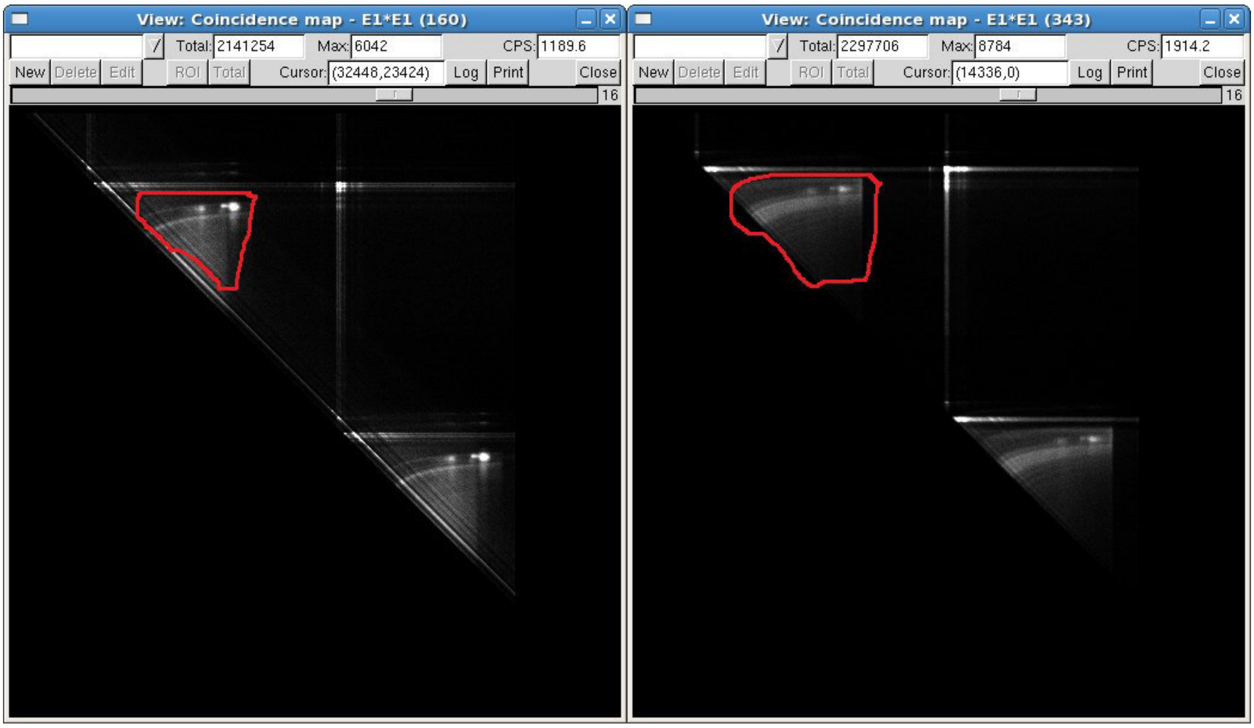


Figure 3: Electron coincidence spectra in a short time-of-flight vs. long time-of-flight representation encompassing two BESSY periods (1600 ns). True autoionization signal from molecular oxygen (bright spots marked by red boundaries) can be seen in the spectrum acquired in twin-orbit mode (left) similar to earlier measurements in single bunch (June 2016, UE56/2). (Contrast in the rhs panel is worse because of a background from water clusters.)

Correcting for the difference in exit-slit settings, count rate from the island orbit is an order of magnitude worse than normal single bunch, which can be expected from the current ratio. However, blocking of the central beam instead of selecting only one of the island orbits should increase the intensity by about a factor of two.

Due to reasons not understood so far, it was not possible to detect a signal from clusters formed in our molecular jet during this beamtime. Therefore, although technically possible from the beamline side, no scientifically new data were recorded. Differences in beam position between single bunch and island orbit radiation are one, but not the only conceivable cause.

Gregor Schiwietz
Florian Trinter
Uwe Hergenhahn

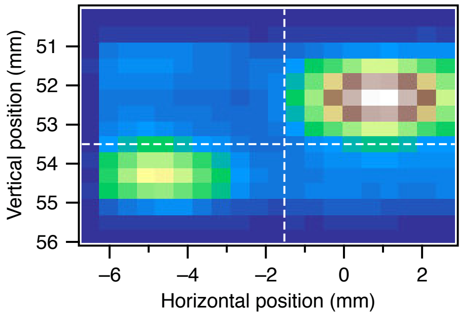


Figure 1: Intensity from UE-112 at 70 mm gap (22/2/2018 ∼ 13:45; all current carried in island orbit) mapped with the 100 μm front-end pinhole. Dashed white lines indicate the coordinates of the beam center in normal operation.

We are excited about your progress with the multi-orbit operation, since we hope this technique could one day help us to remove the higher intensity bunches that are present in the usual fill pattern. The reason is that we find our spectra to depend non-linearly on the photon flux: Increasing the flux means broadening and shifting of the measured spectrum (most likely due to the space-charge in the relatively dense photoelectron cloud). Consequently, the contribution to our spectra from the five higher intensity bunches is also broadened and shifted with respect to that from the normal bunches. Fig. 2 shows a demonstration from a few years ago. The black spectrum is obtained with the storage ring running without hybrid bunches; the red and blue spectra are obtained when the hybrid bunches are filled partially and completely, as indicated in the inset.

Because we have not found another feasible method to discard the signal from the high-intensity bunches, we would very much welcome the possibility to separate them from the main intensity. In addition, gapless filling would further help us, since it would allow to use the same flux with a lower intensity per pulse. Finally, it would be very helpful if the ring current could be divided more evenly over the bunches. As mentioned above, different bunch intensities give rise to a spectrum of differently shifted and broadened components. It would be helpful if the bunch intensity distribution (inset in Fig. 3) could be narrowed.

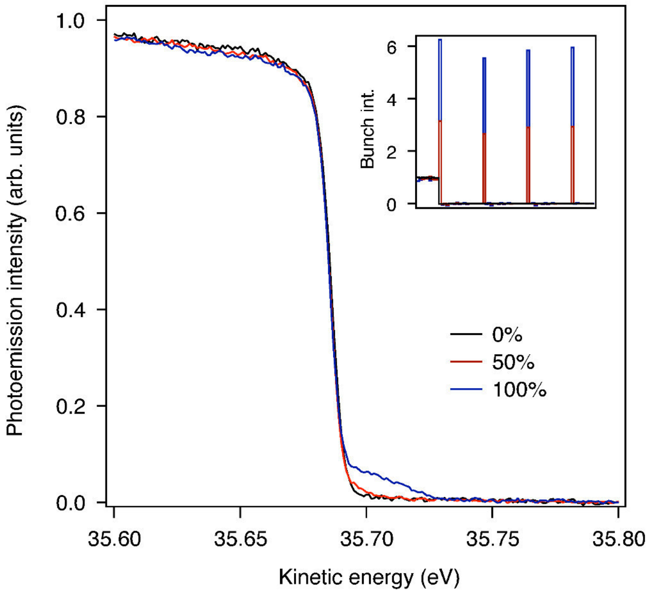


Figure 2: Effect of the hybrid bunch intensity on photoelectron spectra. Black curve is obtained with a storage ring filling of 300 equally intense bunches. Red and blue spectra taken with four additional bunches of approximately three and six times higher intensity (inset).

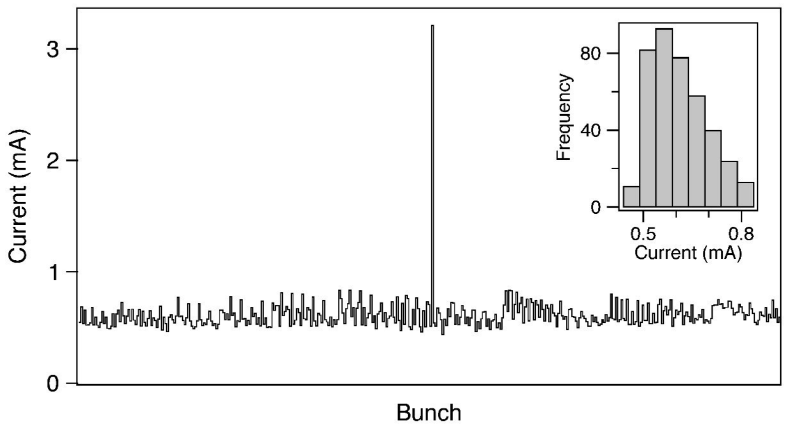


Figure 3: `CUMZR:MBcurrent` snapshot from (23/2/2018). Inset: Histogram of the bunch intensities excluding the single high intensity bunch.

A.ID5: ID T3 U41-PGM1-XM Peter Guttmann

U41-L06-PGM1-XM – TwinOrbit Test week (KW08), February 19th - 25th, 2018

Goal for this beamline:

It should be checked, if the core orbit will allow the same performance as the Standard BII – orbit and if few bunches in the island orbit will affect the performance of the beamline.

At this beamline no use of the island orbit (time structure) is planned for the near future, therefore no effort was made to align the beamline for the island orbit.

Result:

There are no significant changes in the performance of the beamline visible between the Standard BII – orbit and the core orbit with no bunches or with few bunches in the island orbit. Only if bunches in the order of 100 or more were stored in the island orbit degradation of the performance is occurring.

Within TopUp operation of the TwinOrbit mode the injection scheme is an issue, as the about 8 sec beam instability in the horizontal direction will influence the time of data taking. For the TXM images with several seconds exposure time are taken. So far, during TopUp mode operation only several milliseconds of beam instability during injections are observed and we do not have to take care about the scheme of taking images as this time is short compared to the exposure time. But having 8 sec for the injection will change drastically the script for data taking and will increase the time necessary for a data set (now about 15 min for 120 images – in the worst case this will be increased by 120 x 8 sec = 960 sec = 16 min).

More detailed results are shown on the following pages.

U41-L06-PGM1-XM – TwinOrbit Test week (KW08), February 19^{th} - 25^{th}, 2018

Standard beamline commissioning settings:

Gap	24. 663 mm (E = 400 eV)
FE-PH 100 µm	-5.35 mm / -47.44 mm
FE-PH 100 µm + diode	-5.35 mm / -21.44 mm
FE-ASBL offset (u/l/w/r)	7.07/-9.02/8.69/-5.39
FE-ASBL aperture (u/l/w/r)	1.00/-1.00/1.50/-1.50
SMU-1 (IDa)	13000/535000/39000/288500/560000
WAU-1 (u/l/dsl/dsr)	45.4/46.0/45.9/46.9 (2.1/1.9/2.4/2.8)
Mono – offset angle PM/PG	8.162802°/3.237837°
cff	2.25
AU-1 (u/l/dsl/dsr)	26.9/28.0/27.8/27.3 (1.6/3.1/2.0/2.6)
SMU-2 (M3c = XM)	285000/132000/146000/151000/149000
Exit-Slit vert/hor/hor-trans/unit-trans	20 µm / 1600µm / 1.25 mm / 45.0 mm
Diode behind exit slit	24.5 mm
Diode in front of TXM	37.25 mm

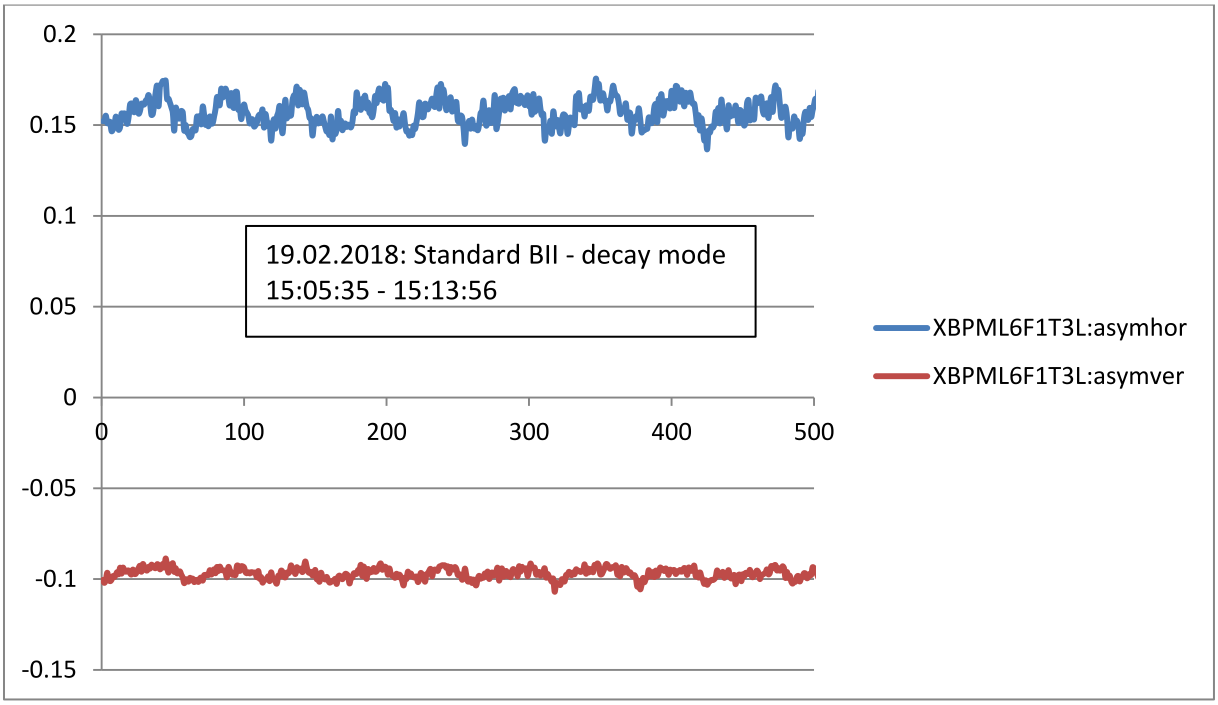
N_2 gas: $2 \cdot 10^{-3}$ mbar, +50 V external PS

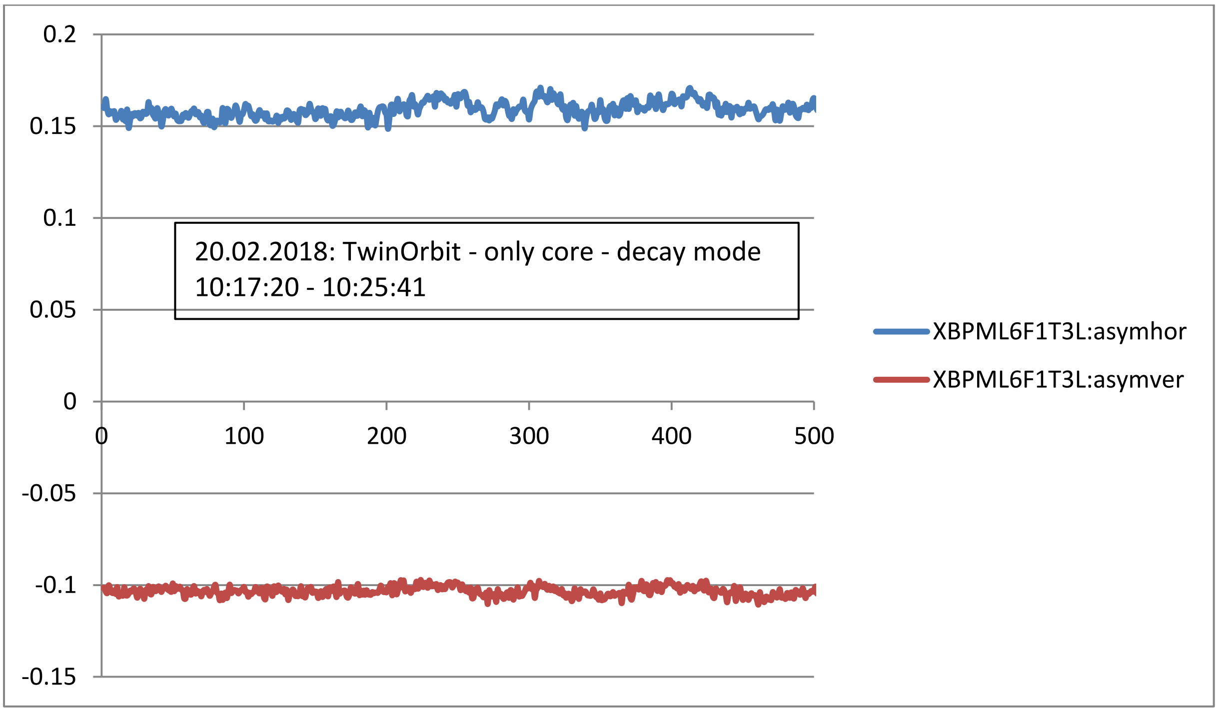
Planned measurements:

1) FE-PH scan vertical
2) FE-PH scan horizontal (full range)
3) Undulator harmonic - a) ASBL opening 0.2 mm x 0.2 mm
   b) ASBL standard opening 2.0 mm x 3.0 mm
4) HDSO = 20 µm, HDST – scan (horizontal focus determination)
   a) with diode behind exit slit
   b) with diode in front of TXM
5) Flatfield series at 400 eV – a) w/o condenser wobbling
   b) with condenser wobbling
6) Energy resolution with ionization chamber for different cff-values

U41-L06-PGM1-XM - Beamline

Beam stability: XBPM1 – values for gap = 24.663 mm

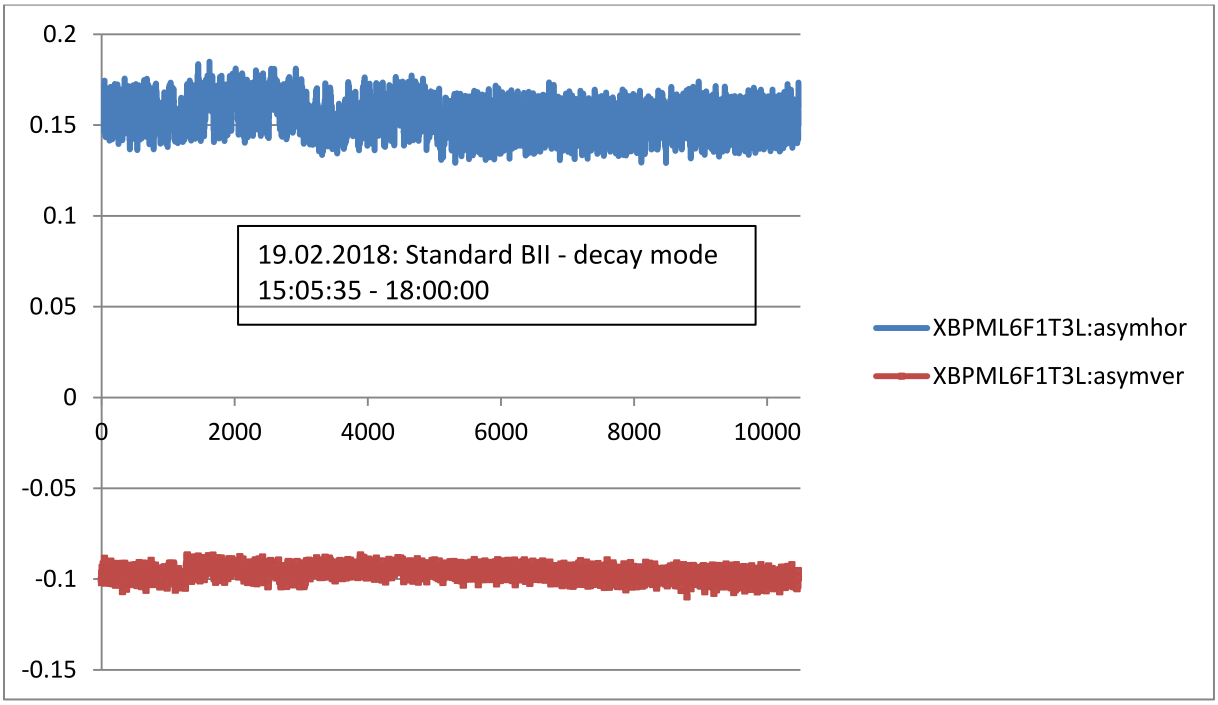


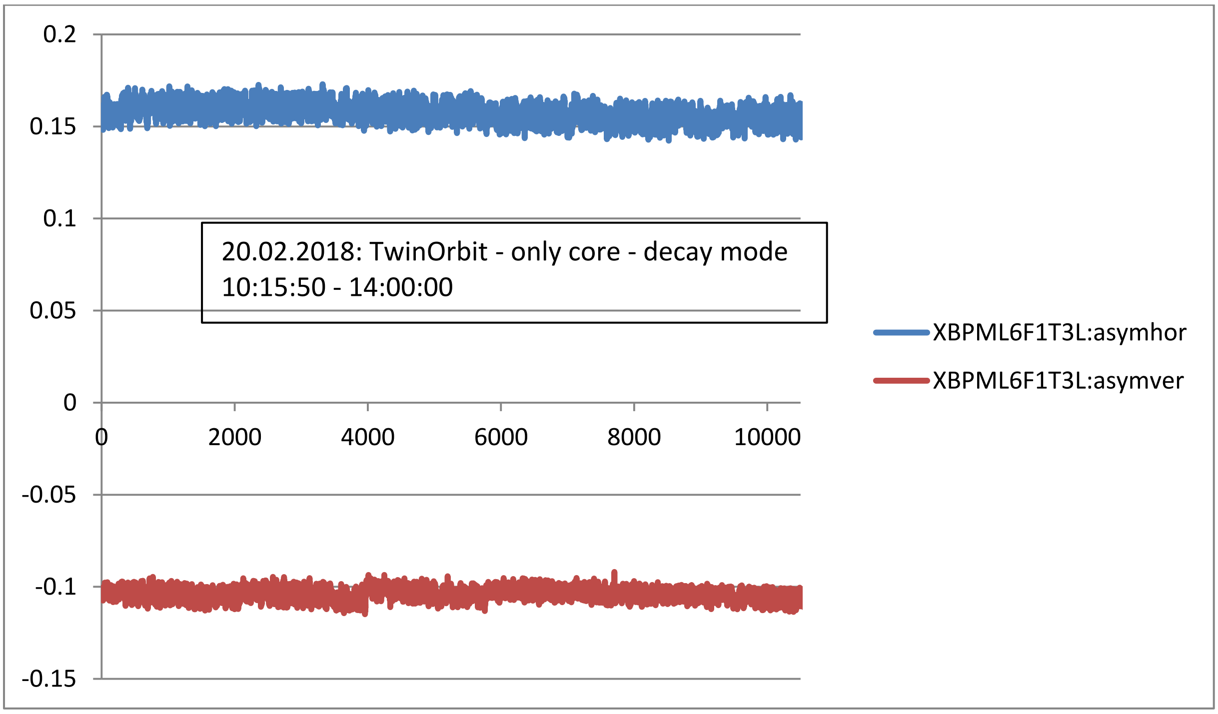


Data files: 20180220-02.dat
20180220-08.dat

U41-L06-PGM1-XM - Beamline

Beam stability: XBPM1 – values for gap = 24.663 mm

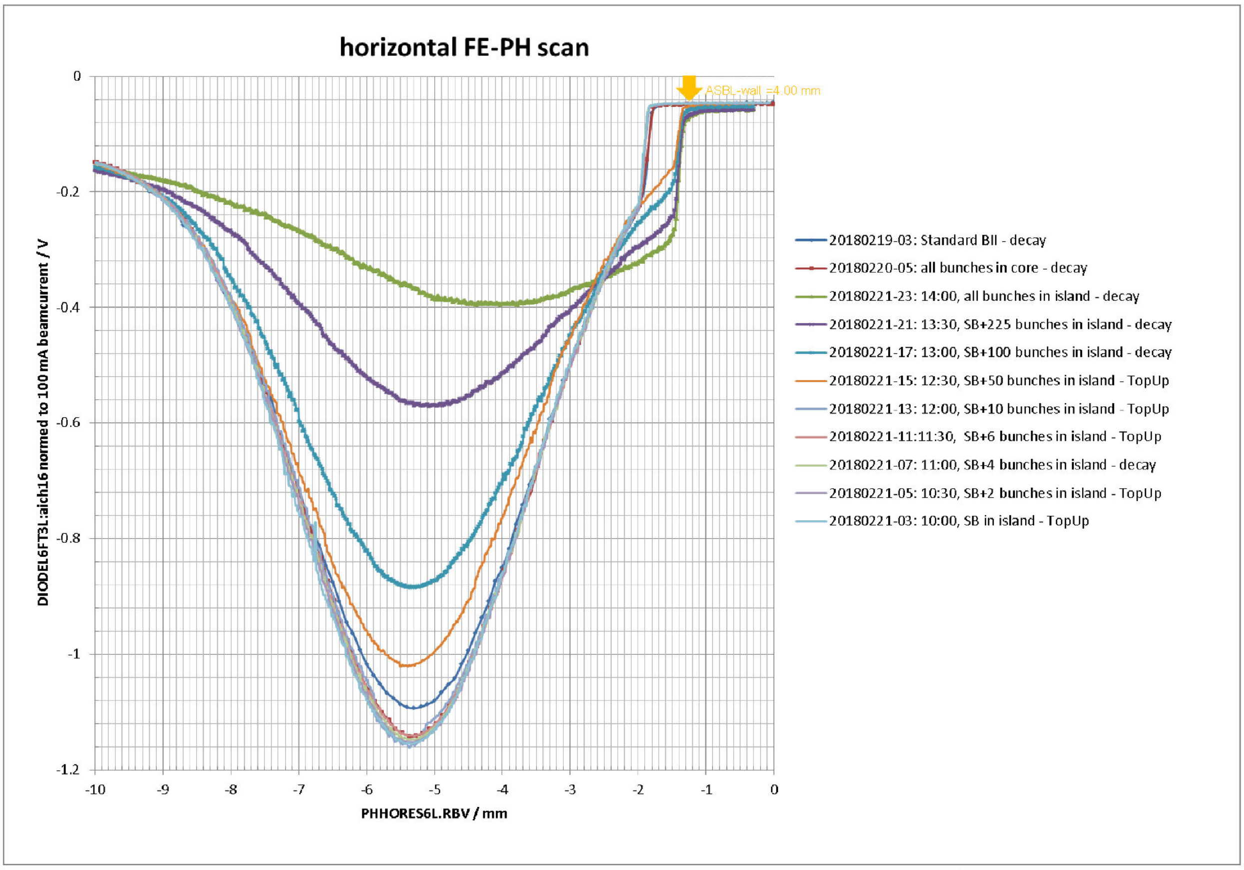


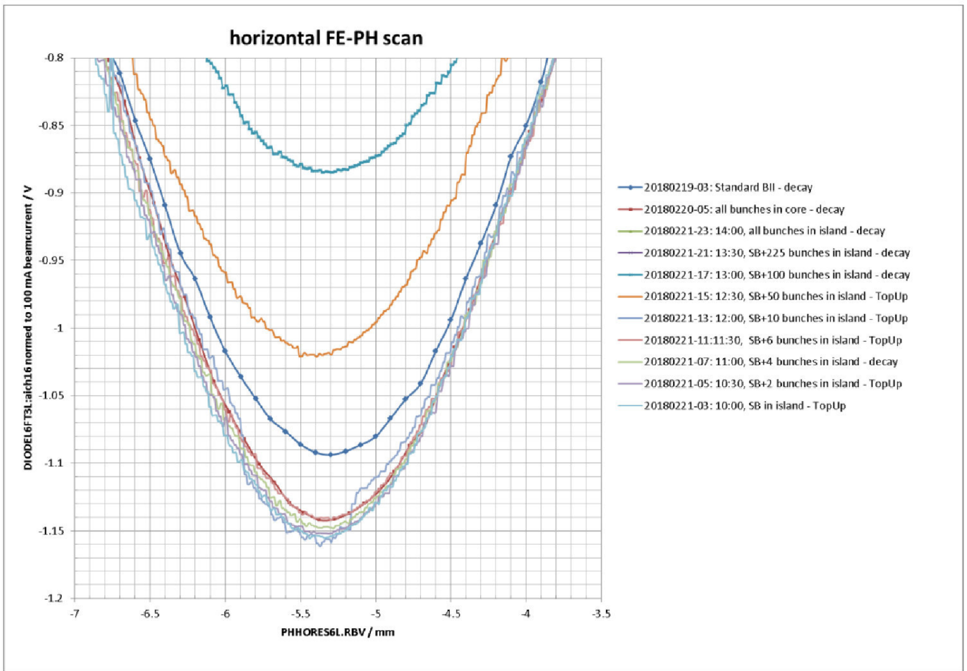


Data files: 20180220-02.dat
20180220-08.dat

U41-L06-PGM1-XM - Beamline

FE-PH scan in horizontal direction defining the position of the beam in front of the first mirror M1 – FE-PH is placed around 10.3 m from the source - gap = 24.663 mm; PHVERES6L.RBV = -21.44 mm





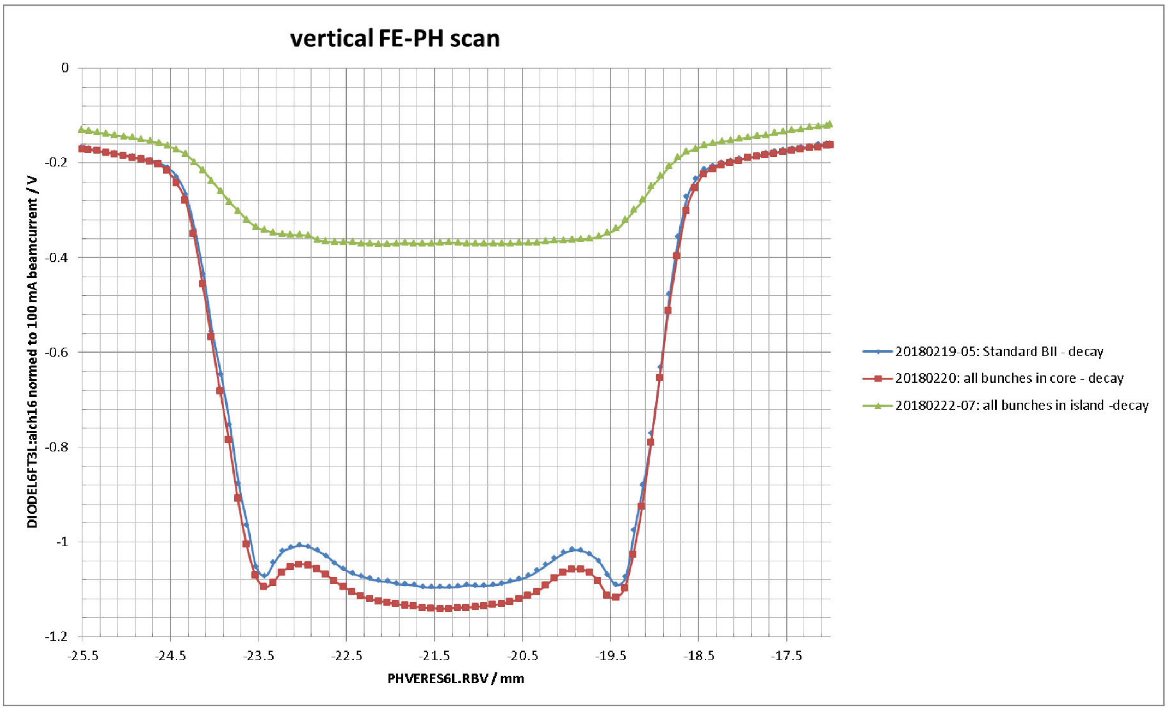
Data file: PHHOR-scans.xlsx (original measurement data files are named in that file)

The peak position is similar for all cases except having all or SB+225 bunches in the island orbit. Up to SB+10 bunches in the island orbit the peak intensity (for the core) is the same. The peak intensity for Standard BII was a little bit lower.

No separation of the core beam and island beam is visible; the peak position is shifted to the island position by filing up the island orbit.

U41-L06-PGM1-XM - Beamline

FE-PH scan in vertical direction defining the position of the beam in front of the first mirror M1 – FE-PH is placed around 10.3 m from the source - gap = 24.663 mm; PHHORES6L.RBV = -5.35 mm



Data file: PHVER-scans.xlsx

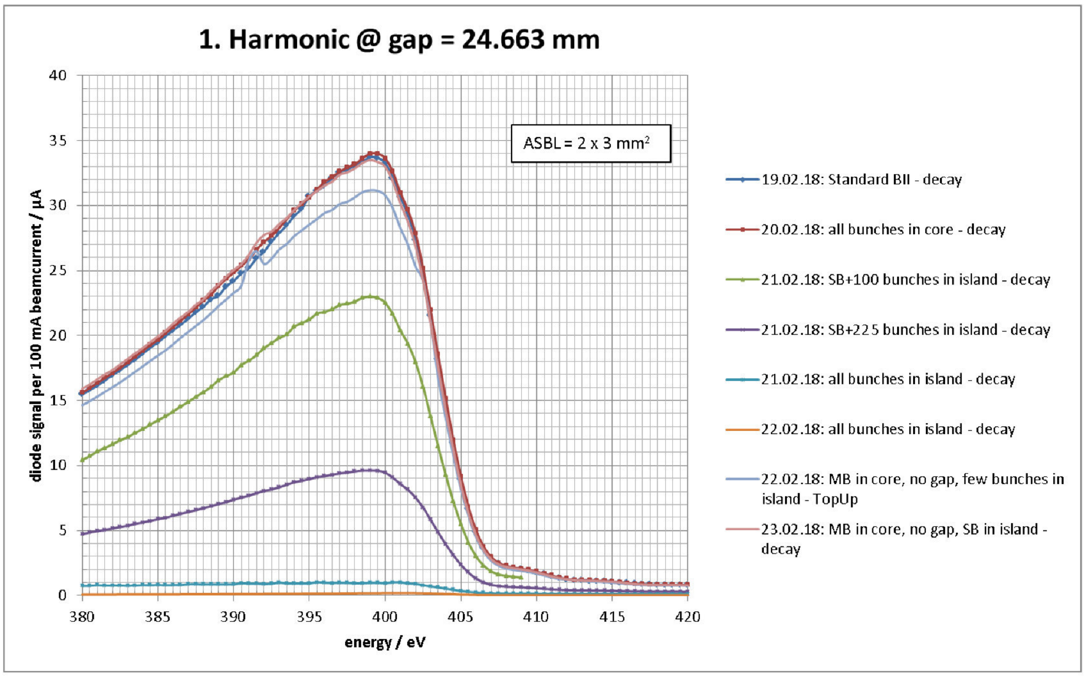
(original measurement data files are named in that file)

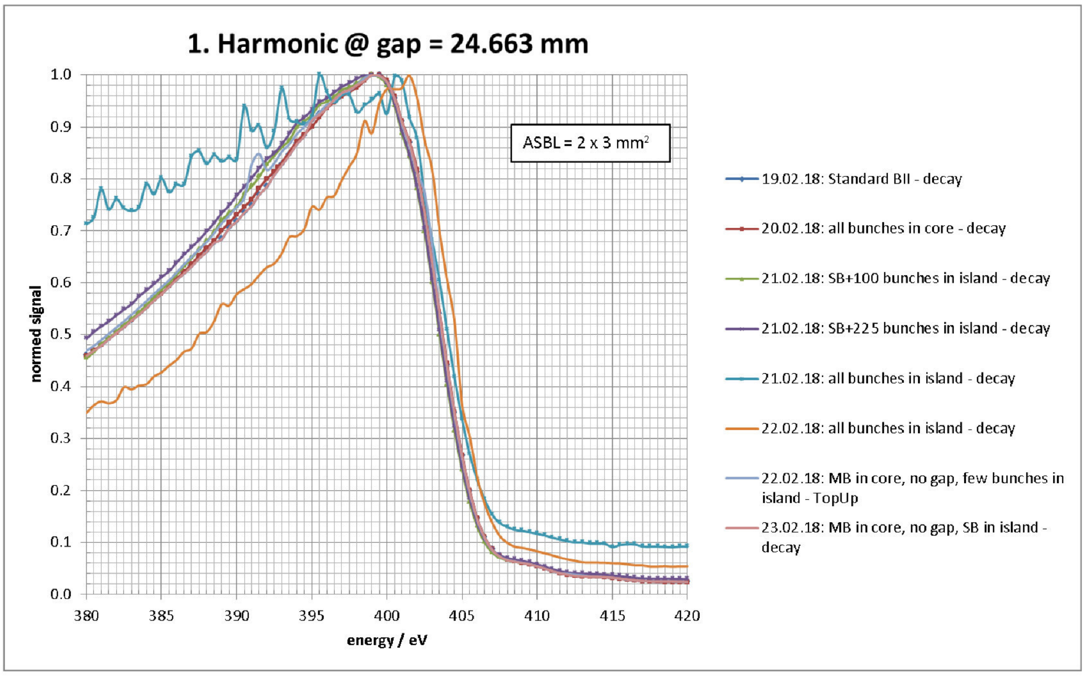
There is no shift in the vertical position between the different modes (Standard BII, all bunches in core orbit, all bunches in island orbit). Only the intensity for all bunches in island orbit is lower.

Note, the island orbit was partially obstructed by the ASBL-wall blade.

U41-L06-PGM1-XM - Beamline

Undulator harmonic for gap =24.663 mm and ASBL standard opening 2.0 mm x 3.0 mm measured with the diode behind the exit slit





Data file: U-Harm-24p663.xlsx

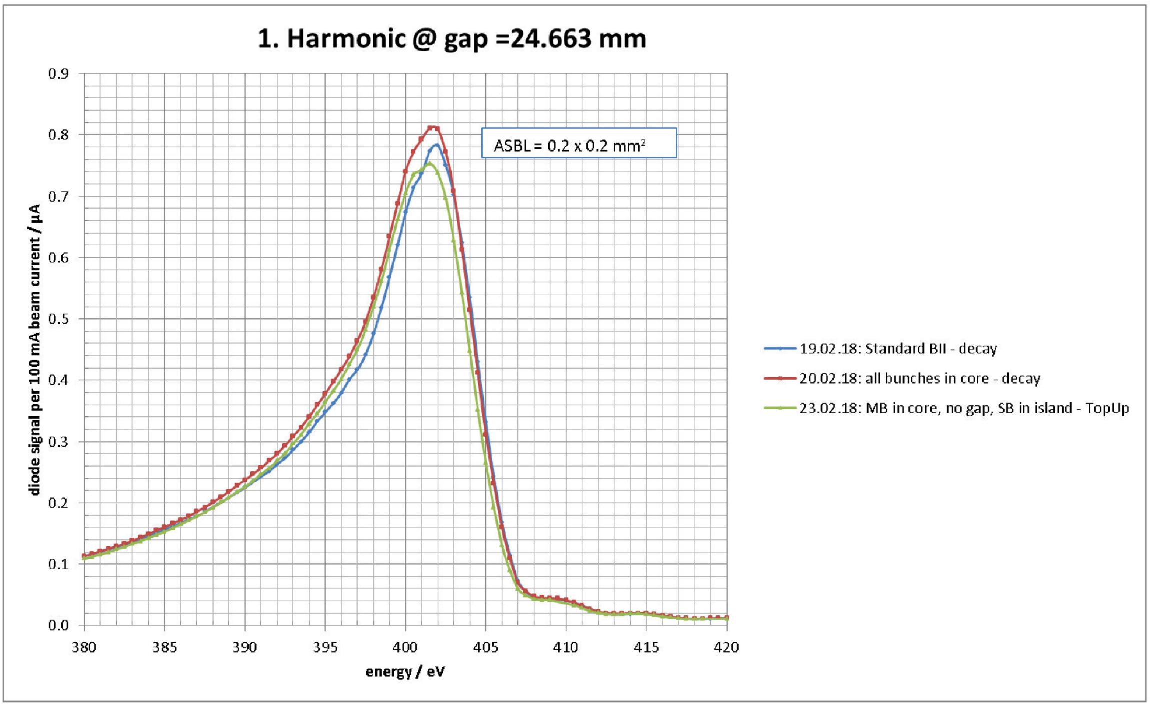
(original measurement data files are named in that file)

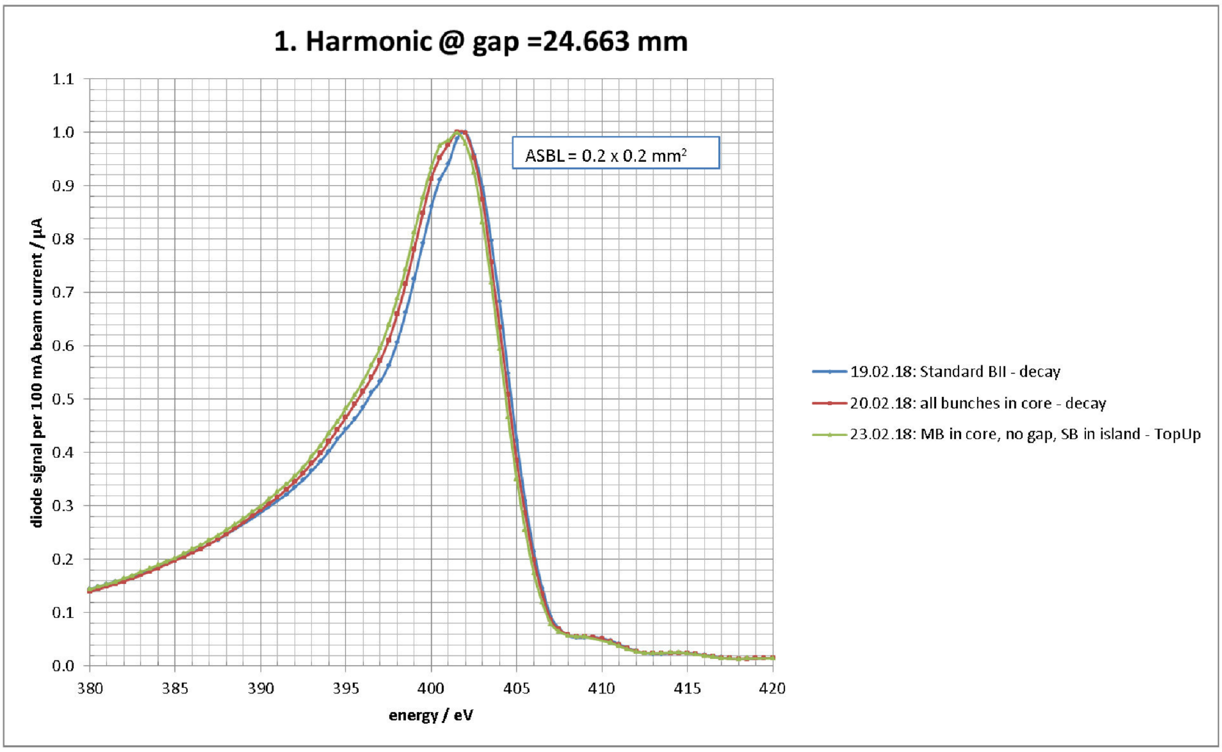
The intensity of the peak of the harmonic is decreasing for more bunches in the island orbit. The peak energy and the FWHM of the harmonic is the same for all conditions up to SB+100 bunches in island orbit. But for higher bunch numbers in the island orbit the FWHM increases.

The behavior on February 22nd is different – may be because of the different XBPM-values.

U41-L06-PGM1-XM - Beamline

Undulator harmonic for gap =24.663 mm and ASBL opening 0.2 mm x 0.2 mm measured with the diode behind the exit slit





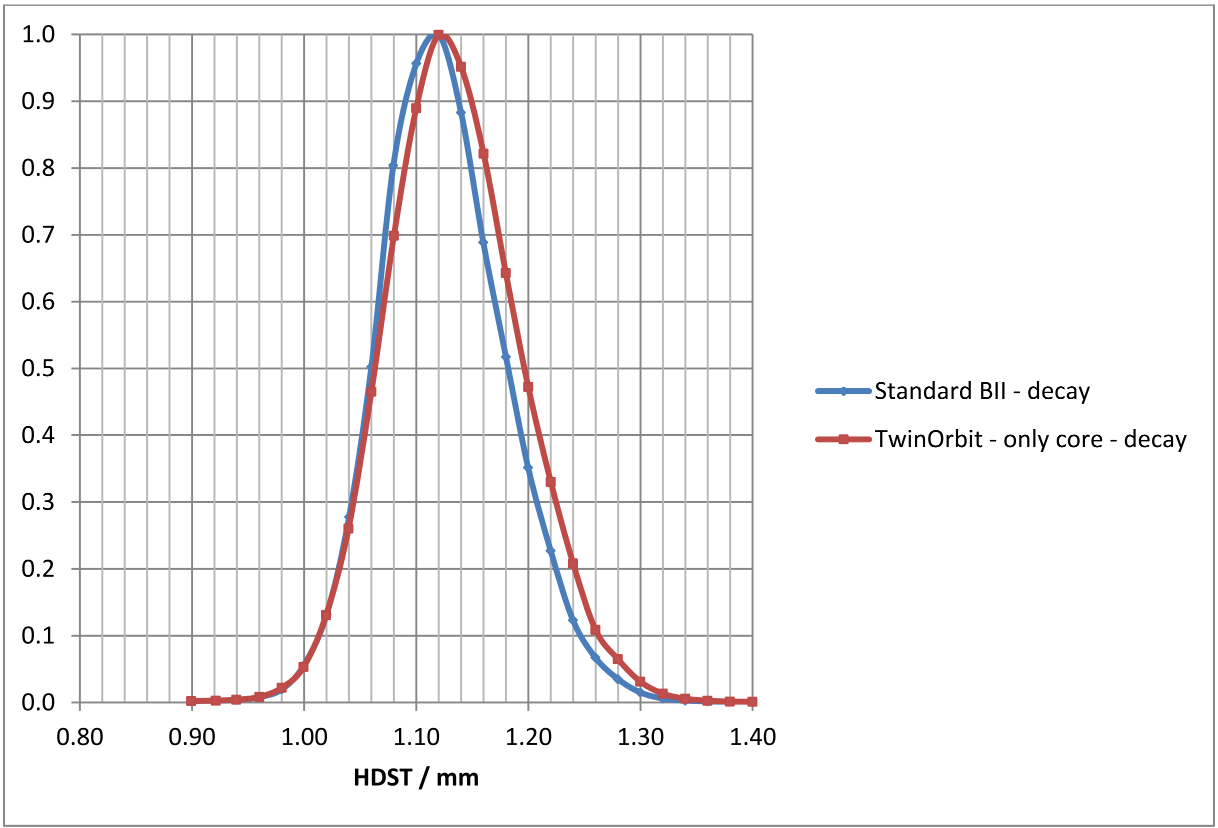
Data file: U-Harm-24p663_kl_ASBL.xlsx

(original measurement data files are named in that file)

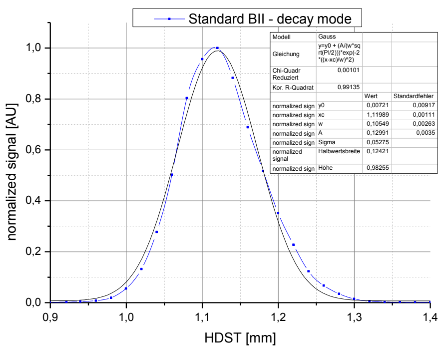
The peak energy of the harmonic is the same for all three conditions. The FWHM is a little bit higher for all bunches in the core compared to Standard BII and even a little bit higher for the TopUp conditions on February, 22nd.

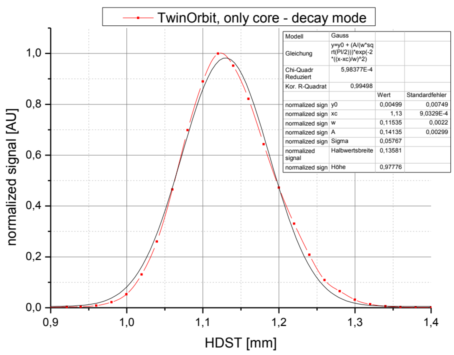
U41-L06-PGM1-XM - Beamline

Horizontal focus size at the exit slit position for gap = 24.663 mm, measured with the TXM-diode (in front of the TXM) with HDSO = 20 µm, VDSO = 20 µm



Data files: 20180219-154013-data-scan.txt
20180220-104547-data-scan.txt





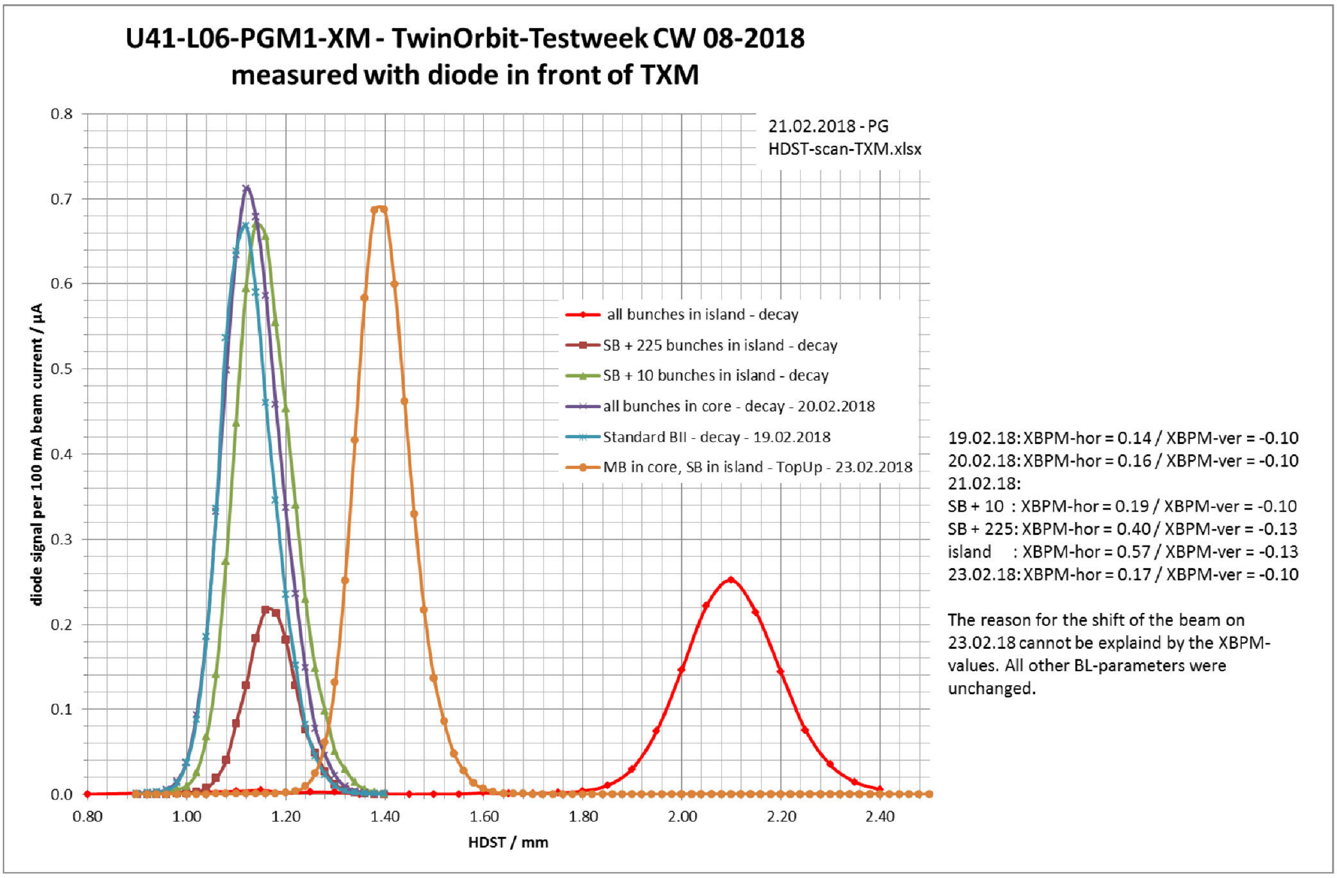
Standard BII: FWHM = 124 µm (19.02.2018)

TwinOrbit, only core: FWHM = 136 µm (20.02.2018)

Data file: hor_focus_HDST-scan.opj
using 20180219-154013-data-scan.txt and 20180220-104547-data-scan.txt

U41-L06-PGM1-XM - Beamline

Horizontal beam position at the exit slit position for gap = 24.663 mm, measured with the TXM-diode (in front of the TXM) with HDSO = 20 µm, VDSO = 20 µm



The measurement was extended to HDST > 1.40 mm only for “all bunches in island – decay” and for “MB in core, SB in island – TopUp – 23.02.2018”.

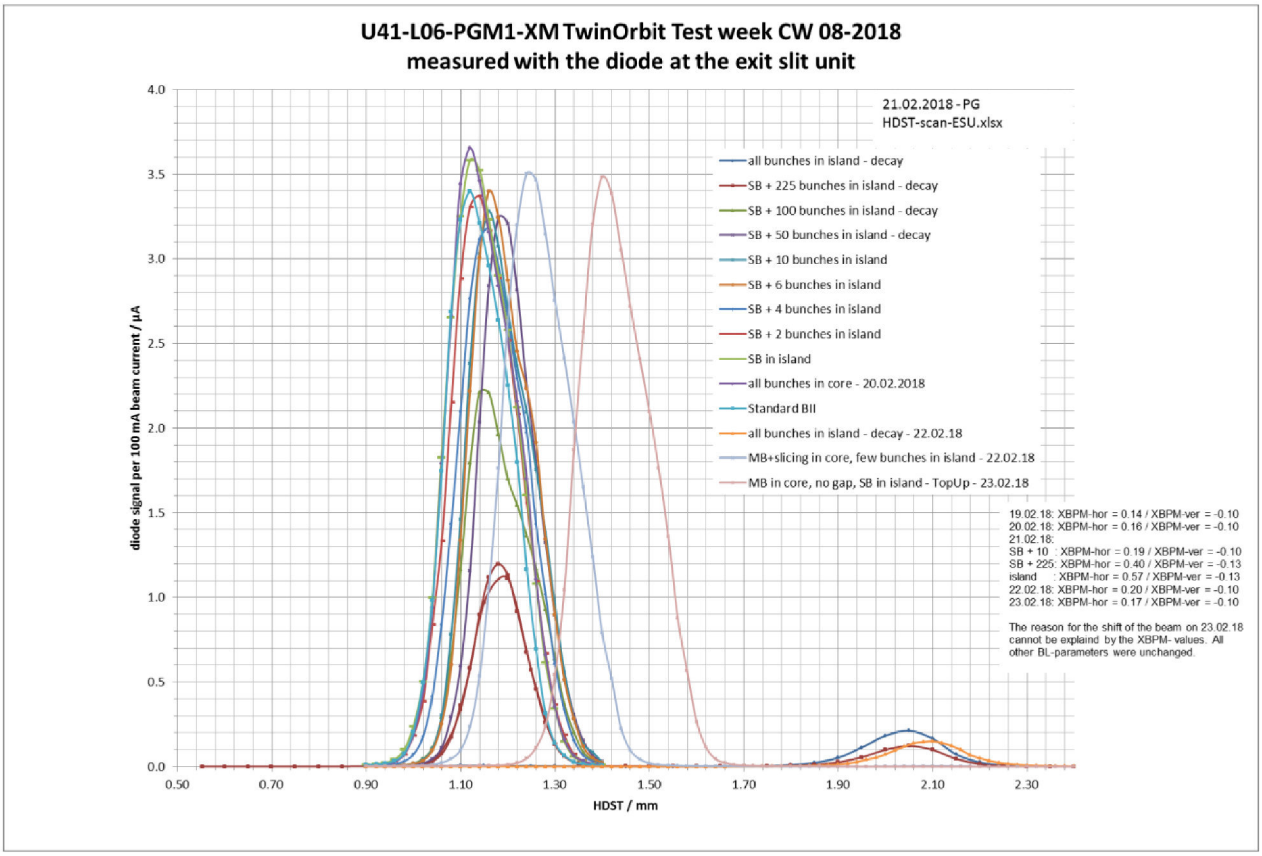
The peak position of the core beam is nearly unchanged, only the intensity goes down if more bunches are in the island orbit. A second position occurs for the island orbit. The intensity of this peak is lower as part of the beam is already cropped by the WAU in front of the monochromator.

The reason for the shift of the beam on Feb 23th is unclear as all parameters were kept over the whole week and as also the XBPM-values are not different.

Data file: HDST-scan-TXM_20180307.xlsx
(original measurement data files are named in that file)

U41-L06-PGM1-XM - Beamline

Horizontal beam position at the exit slit position for gap = 24.663 mm, measured with the ESU-diode (directly ds of the exit slit unit) with HDSO = 20 µm, VDSO = 20 µm



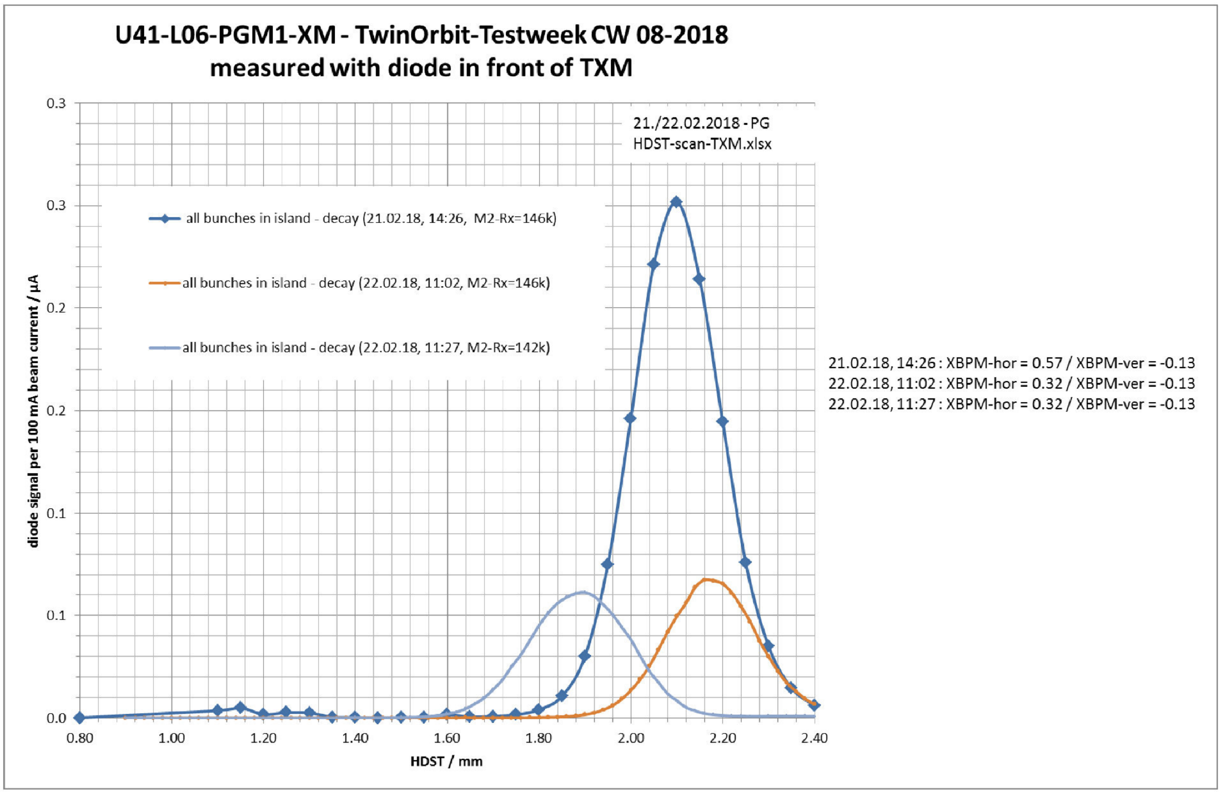
The peak position of the core beam is nearly unchanged, only the intensity goes down if more bunches are in the island orbit. A second position occurs for the island orbit. The intensity of this peak is lower as part of the beam is already cropped by the WAU in front of the monochromator.

The reason for the shift of the beam on Feb 23th is unclear as all parameters were kept over the whole week and as also the XBPM-values are not different.

Data file: HDST-scan-ESU_20180221.xlsx
(original measurement data files are named in that file)

U41-L06-PGM1-XM - Beamline

Horizontal beam position at the exit slit position for gap = 24.663 mm, measured with the TXM-diode (in front of the TXM) with HDSO = 20 µm, VDSO = 20 µm

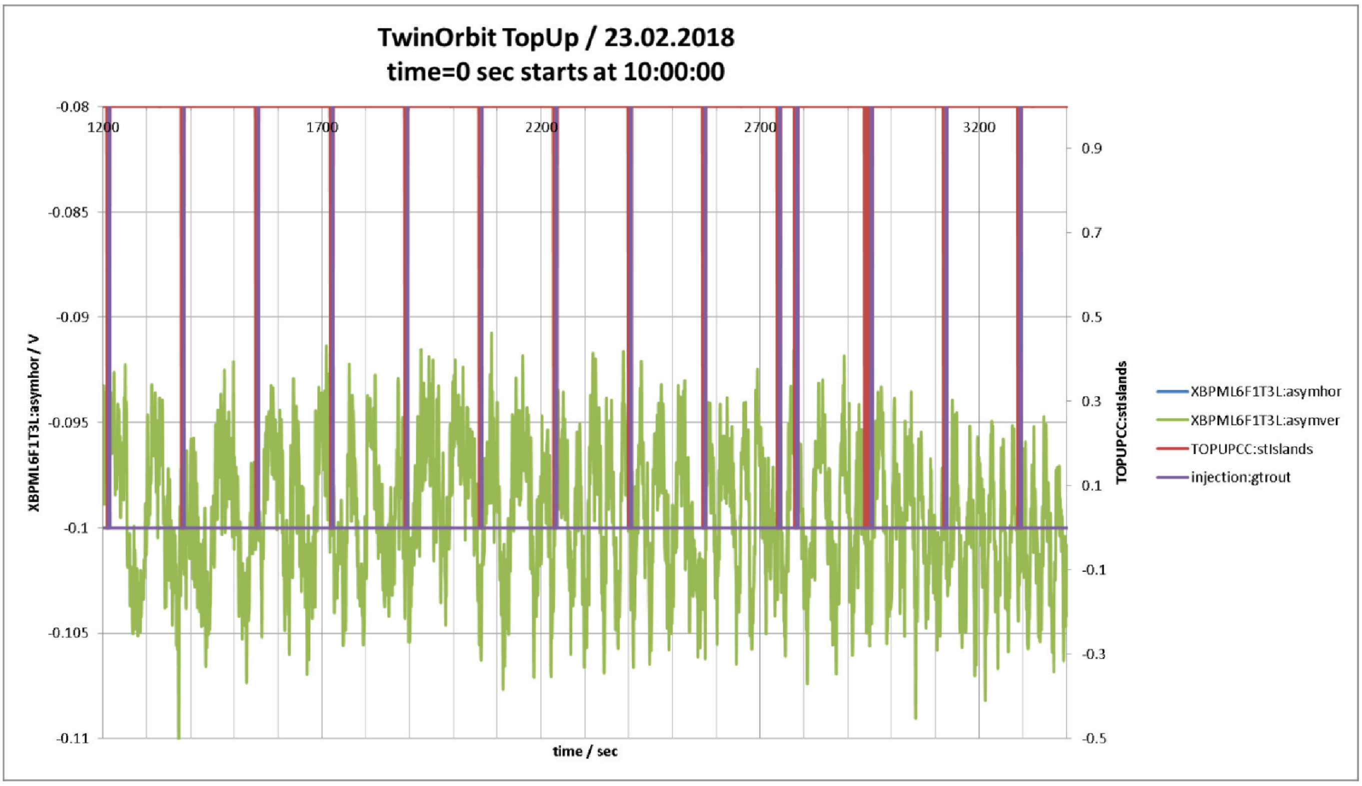


Note the difference especially in the intensity between Feb 21st and Feb 22nd. This might be due to the difference in the XBPM-hor values. There must be different beam conditions! ???

Data file: HDST-scan-TXM_20180307.xlsx
(original measurement data files are named in that file)

U41-L06-PGM1-XM - Beamline

Beam stability: XBPM1 – values for gap = 24.663 mm in TwinOrbit – TopUp – mode / 23.02.2018

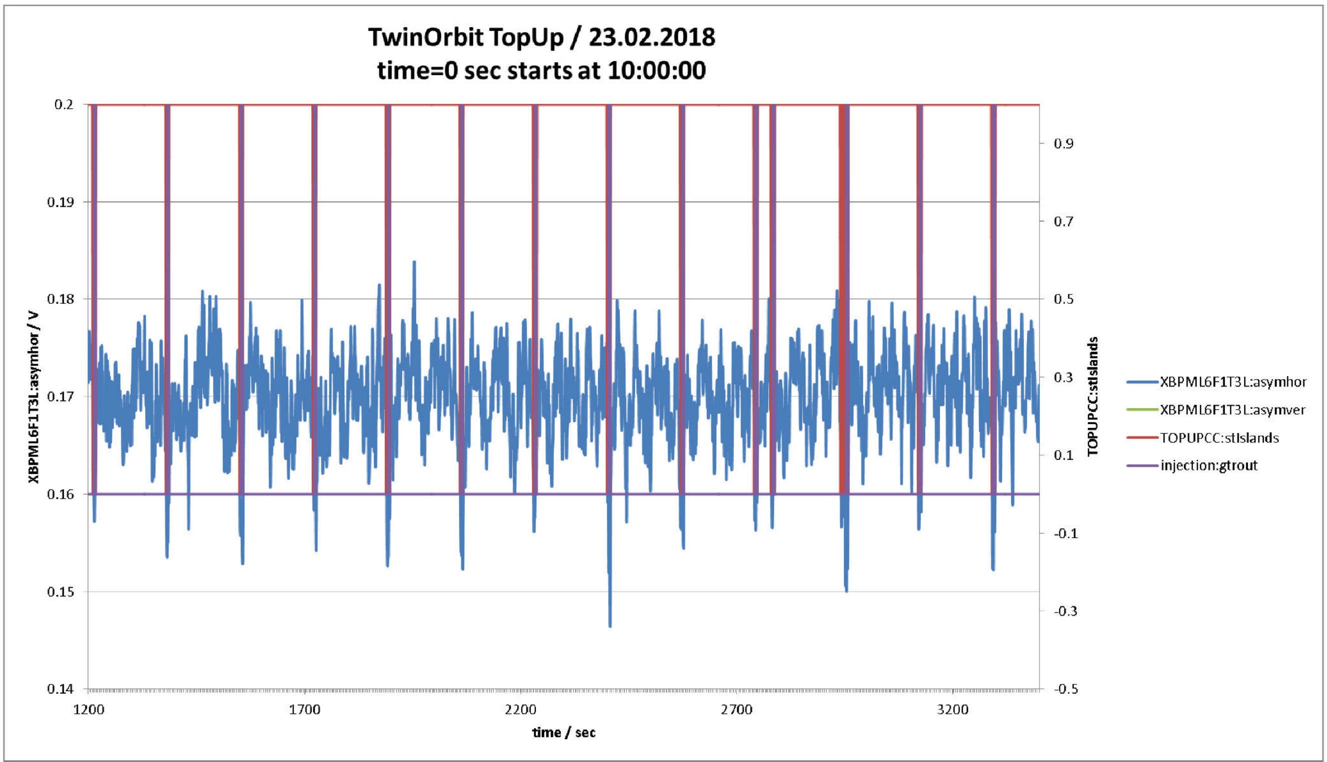


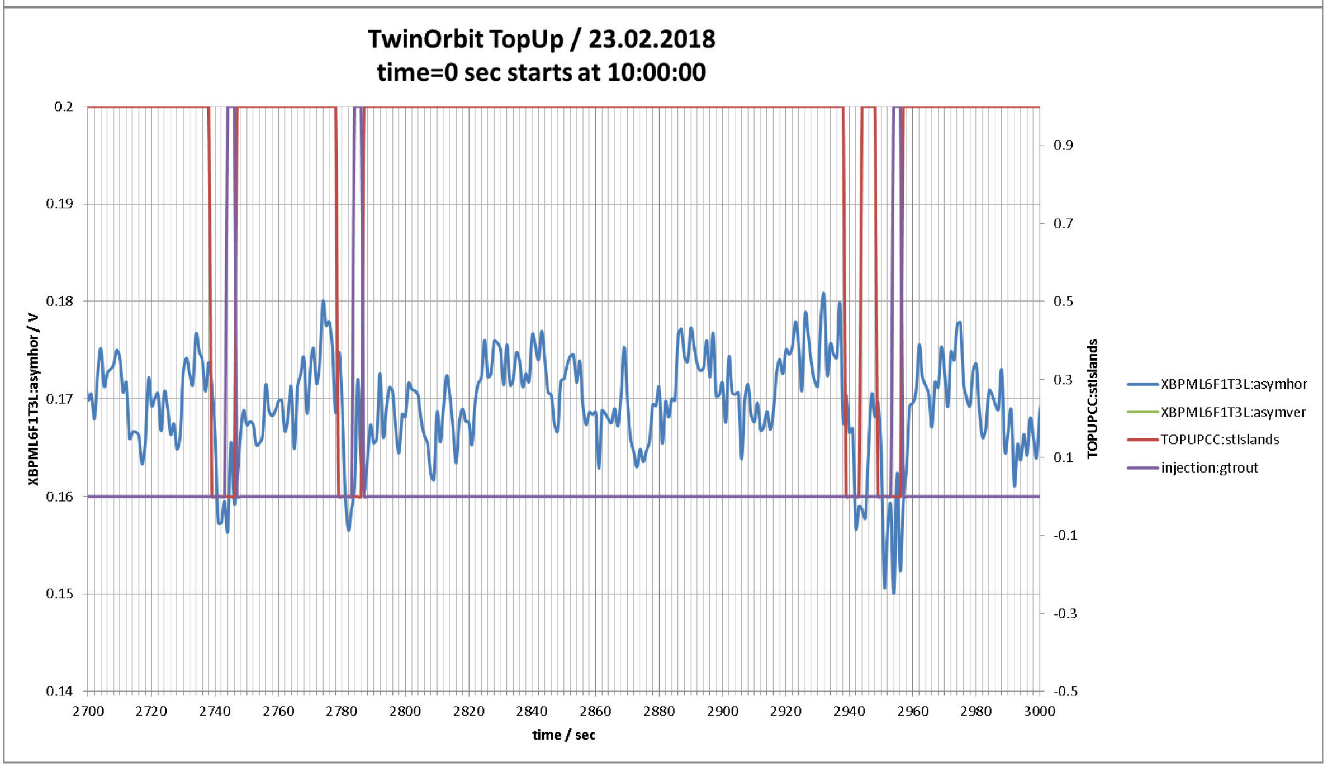
Data file: 20180223-04.xlsx

No significant influence can be seen during the injection preparation and injection in the vertical beam position.

U41-L06-PGM1-XM - Beamline

Beam stability: XBPM1 – values for gap = 24.663 mm in TwinOrbit – TopUp – mode / 23.02.2018



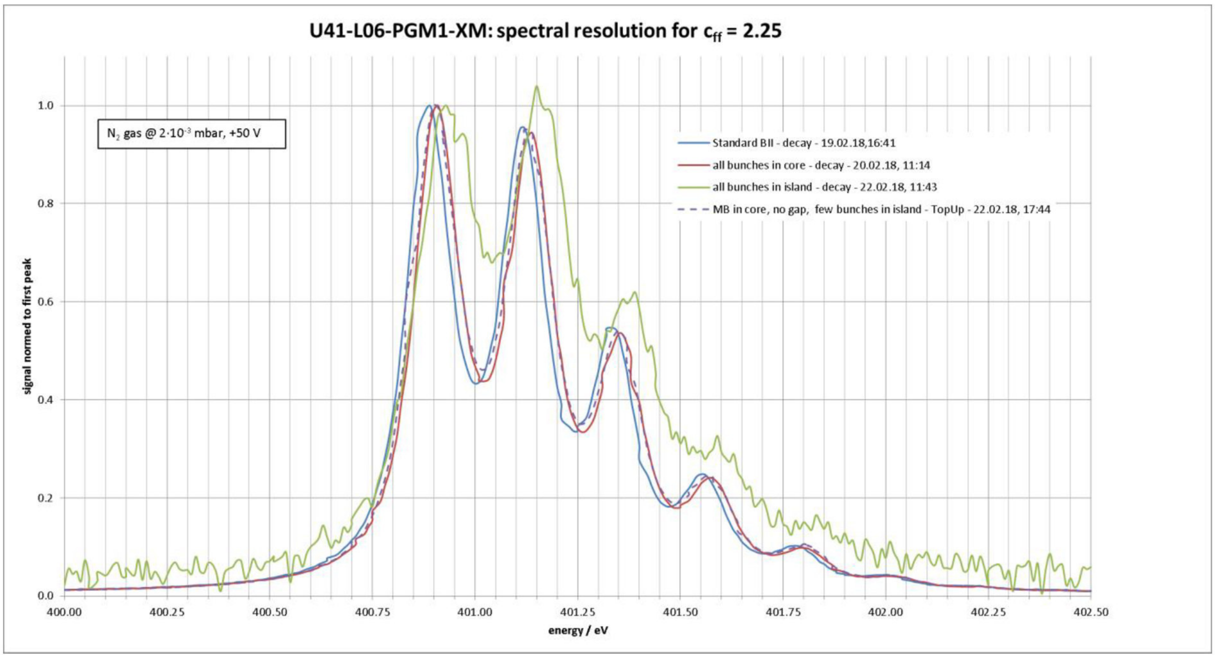


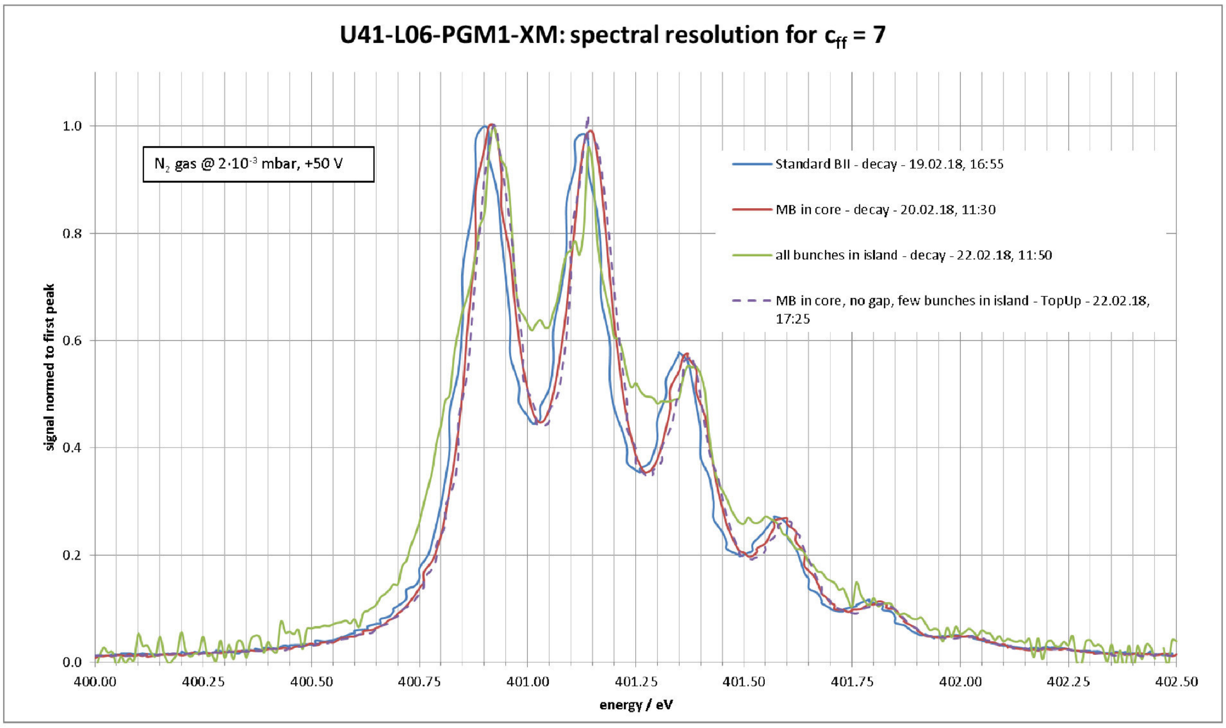
Data file: 20180223-04.xlsx

Significant influence observed during the injection preparation and injection for about 8 sec in the horizontal beam position.

U41-L06-PGM1-XM - Beamline

Spectral resolution





Data files: cff_2p25.xlsx
cff_7p0.xlsx

U41-L06-PGM1-XM - Beamline

Spectral resolution – calculated 1.valley/3.peak-numbers for measurements with the ionization chamber

Beam conditions	C_{ff} = 2.25	C_{ff} = 5	C_{ff} = 7	C_{ff} = 10	C_{ff} = 2.25, 2.order	C_{ff} = 7, 2.order
Standard BII - decay - 19.02.18, 16:41-17:38	0.79	0.77	0.77	0.76		0.75
MB in core orbit - decay - 20.02.18, 11:14-12:29	0.82	0.81	0.78	0.77	0.75	0.76
all bunches in island - decay - 22.02.18, 11:43-12:15	1.1	----	1.12	no calculation possible	0.88	---
MB in core, no gap, few bunches in island, 22.02.18, 17:25-17:44	0.85	0.78	0.77	0.78	---	----

There is no change for the spectral resolution as long as there are enough bunches in the core orbit. Only if all bunches are in the island orbit, the spectral resolution is getting worse.

A.ID6: ID T4 UE49-SPEEM Florian Kronast

Observations at UE49 SPEEM during Twin orbit test week

- Full separation no signal of island buckets in the core orbit
- Island orbit not accessible without bump
- Collapsing island buckets for injection causes severe problems with beam size and divergence. We find intensity modulations of about 3% in the center and 10% in the outer parts of the X-ray beam.

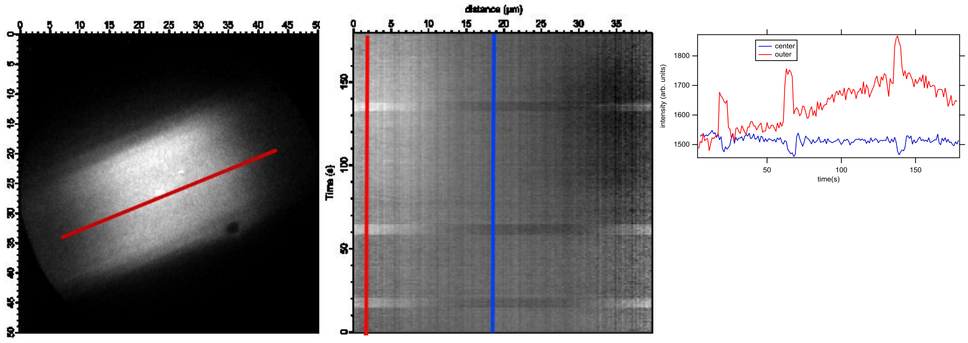


Fig.1 a) X-ray spot (central orbit), b) intensity modulation along the lineprofile indicated in (a) during injections. c) lineprofiles showing the amplitude of these modulations.

Despite the above mentioned problems we are enthusiastic about the experimental possibilities offered by the twin orbit mode and strongly support further tests with the goal to establish this mode as standard for future storage ring operation. At the SPEEM we have several applications such as laser induced switching, domain formation, domain motion, or magnetic phase changes in which high-resolution magnetic images are required to analyze and understand the initial state as well as the final sate of our system after excitation by laser or current pulses. These high-resolution images require ideally a multi-bunch filling pattern for reasonable acquisition times and highest spatial resolution. However, understanding of the dynamic process during excitation might require time-resolved measurements, too. Those pump-probe measurements use repetition rates from hundreds of kHz to MHz and require a dedicated filling pattern. The permanent choice of both, the multi-bunch filling pattern and a second orbit with a selected four, eight or twelve-bunch orbit, for pump-probe experiments would make a tremendous difference to present, where the combination of multi-bunch imaging and time resolved experiments can only be achieved using a gating scheme. Gating can only isolate in bunch in the orbit, limiting the repetition rate to 1.25MHz or divisions of that and compromises signal-to-noise ratio.

Twin Orbit Test at MAXYMUS STXM

Summary:

- Beam Stability (== Image noise) OK at STXM with fast orbit loop off.
- Bad noise with fast orbit feedback on (not optimized control values?)
- Island Buckets are nearly perfectly separated at UE46-PGM2 (>99.9%)
- **During weekend, friendly users did dynamic imaging in gapless operation – this operation mode allows normalizing out beam noise due to orbit feedback):**
  - ➔ **High quality and stable dynamics without any complaints**
- **Injection still needs work:**
  - During injection, 2 image blanks appear: the injection itself, and the "combining" of the islands. Only the former is gated via the top-up gate
  - When islands are merged, intensity does not correlate to beam current (see example below)
  - Change of beam profile during merge confuses beam position feedback on beamline (needs gating similar to undulator move

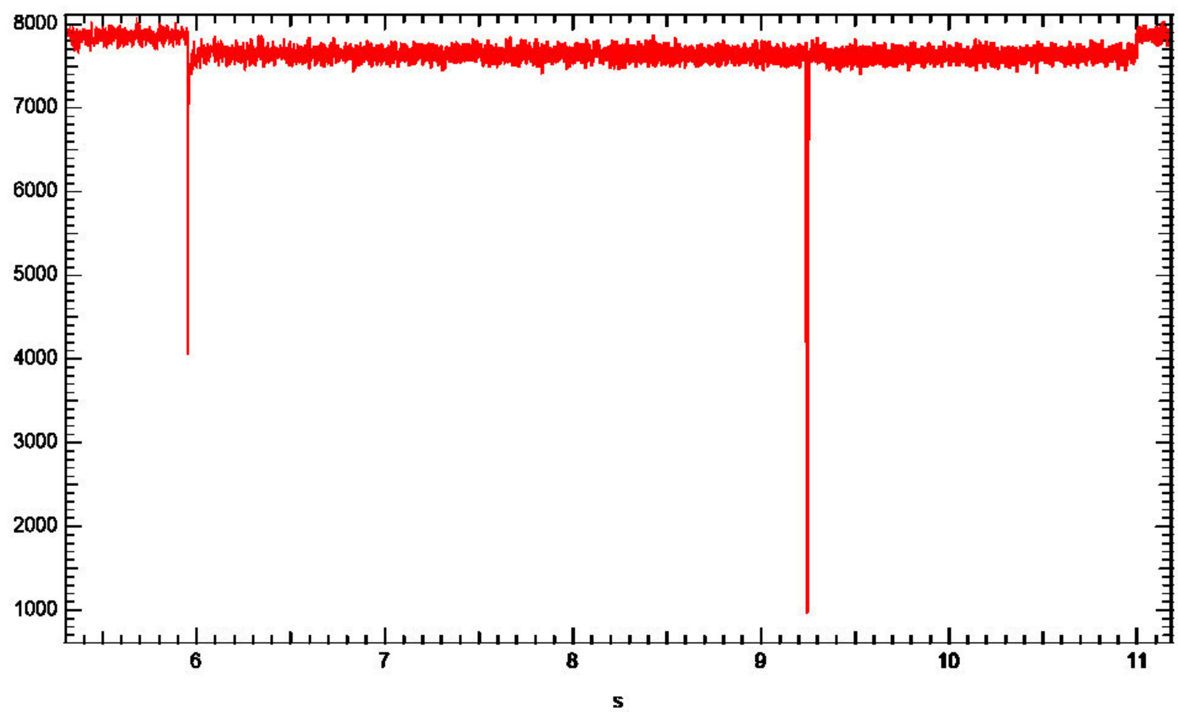


Fig: 1: Image intensity as measured at MAXYMUS during an injection. Visible are 2 dips (top-up and island merge) as well as a drop in intensity while the island was merged into the main orbit

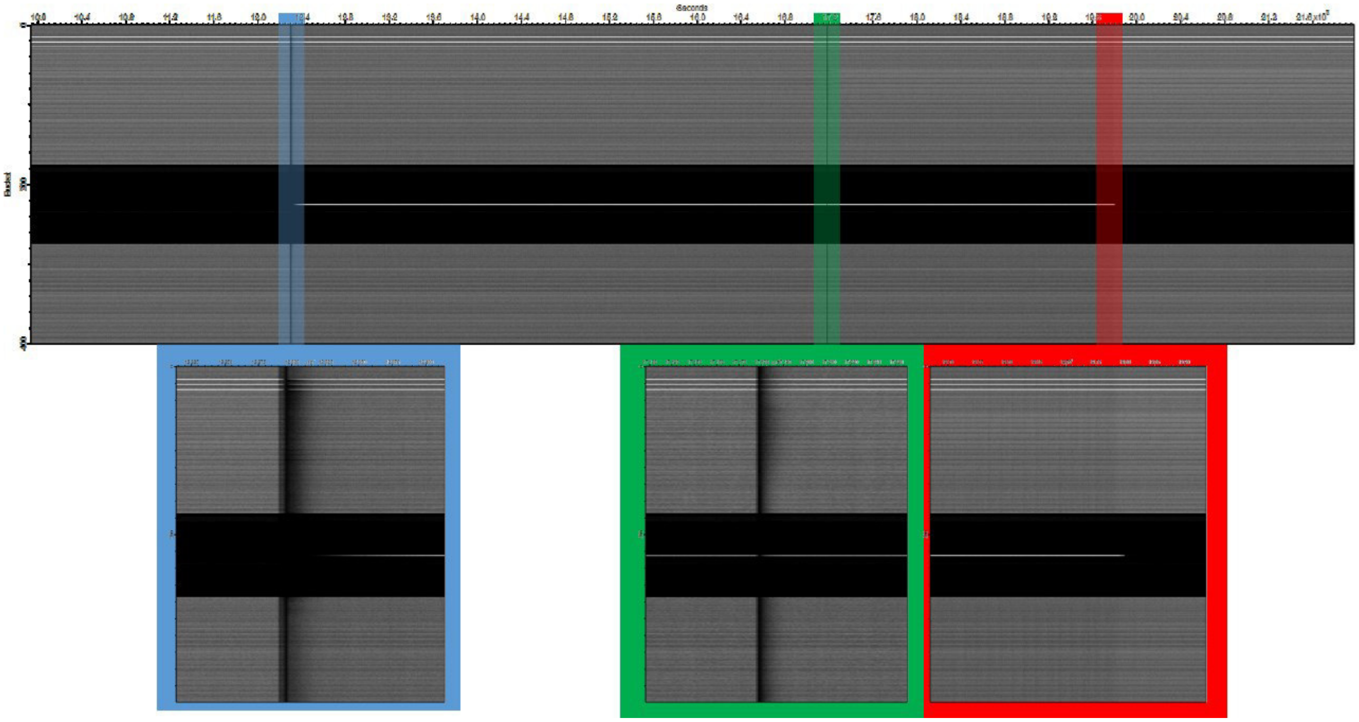


Fig. 2: Injection analyzed at bunch level. Vertical axis synchrotron bunch, horizontal time (1ms/pixel). Blank of the Multibunch train can be seen about 25ms before arrival of the island into the main orbit (blue cut-out), with notable differences in length depending on the position in the multibunch train. Green cutout shows the injection, red the un-merge of the island at the end of the injection cycle. Noise can be seen in the red cut-out due to the beamline BPC being confused by the beam shape during the merger

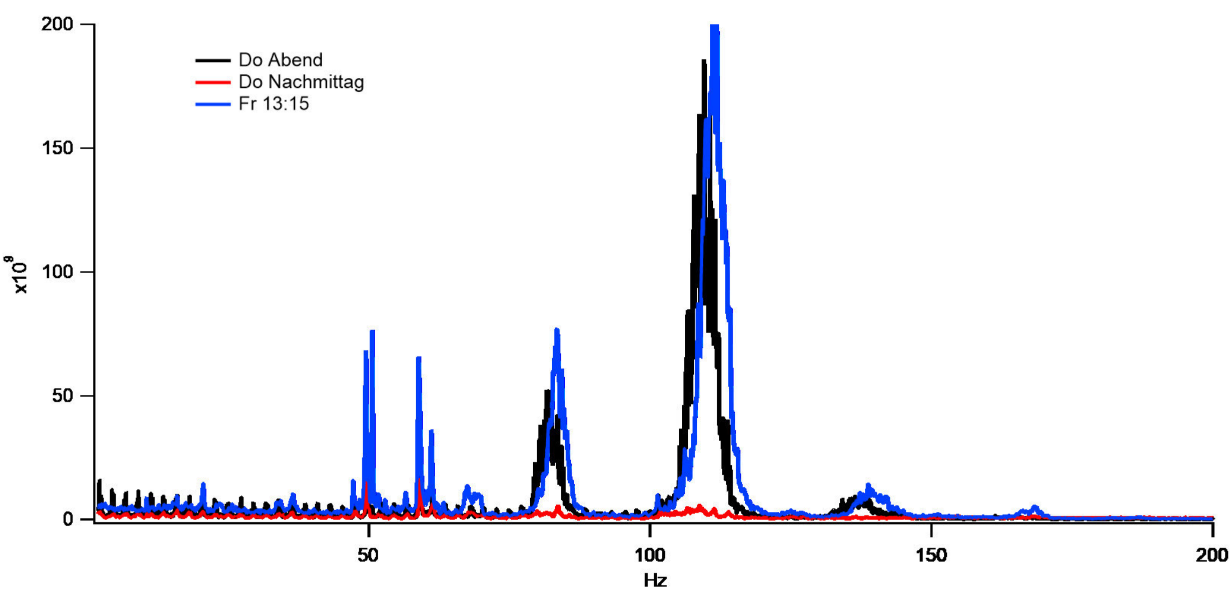


Fig: 3: Noise spectrum (arbitrary units with fast orbit feedback off (red line) and on (blue/black). Noise level was not suitable for spectromicroscopy (very bad image distortion) with fast orbit feedback on, but otherwise fine.

A.ID8: ID T5 UE46-PGM1 Enrico Schierle

Ziel/Motivation: Momentan ist der UE46/1-PGM-1 ein reiner "Core-Beam" (CB) - Nutzer. Die Frage war, wie gut der CB für Standardexperimente nutzbar sein wird.

Ergebnis:

(1) Trennung von Islands und Core ist beinahe perfekt. Die Islands selbst können im Rahmen üblicher Strahlrohrjustage nicht nutzbar selektiert werden, der CB ist an der für Standard-Bedingungen üblichen Position. Ein Ausläufer eines der Islands reicht bis zur Position des CB. Mit SB in den Islands und MB im core ist diese "hereinleckende" Intensität irrelevant und unterhalb der Nachweisgrenze. Lediglich bei einem "inversen" Betrieb, also SB im core und MB in den Islands, könnten Probleme beim Nutzen des "core-orbits" verursacht werden.

(2) Außerhalb der Injektionen waren Strahllage und -qualität des MB-core Signales identisch mit Standard-Bessy-Decay Bedingungen. Einzige Ausnahme war eine leichte Zunahme des Rauschens im Monitor-Signal des Strahlrohres nach Umstellen auf Twin-Orbit-Optik (Montag: 0.2 %; Dienstag bis Freitag: 0.4%). Ein zur Not akzeptabler Zustand, der mir aber ohnehin mit großer Wahrscheinlichkeit verbesserungsfähig erscheint.

(3) Einziges Problem: Während der 8s-Injektionsphase treten Schwierigkeiten beim Normieren der Probensignale auf. Die Folge sind "Sprünge" im Signalverlauf. Etwa die Häfte der üblichen Experimente könnte diese Perioden ausblenden; Spektroskopie mittels schneller continous-mode scans leidet darunter aber in inakzeptabler Art und Weise. Es wurde viel Aufwand darauf verwendet, diesen Zustand zu kompensieren und die Ursache zu identifizieren. Das Ergebnis war:

> (a) Es gelang unter allen getesteten Bedingungen (Füllmustern) mittels Einstellungen des Strahlrohres diesen Effekt bis zur Unmeßbarkeit zu minimieren. Allerdings schränken diese Bedingungen unsere Möglichkeiten, auf weitere Schwierigkeiten eines konkreten Nutzerexperimentes zu reagieren, massiv ein.
>
> (b) Die notwendigen Strahlrohrjustagen zur Behebung von in (3) geschildertem Problem waren Zeit (vermutlich Füllmuster-) abhängig. Ohne Verbesserung dieses Zustandes könnte also jede Änderung des Füllmusters ein "Beamline-commissioning" nach sich ziehen.
>
> (c) Ursache ist eine Veränderung der Quelle während der Injektionsphase, sowohl in Ihrer Ausdehnung (Größe oder Divergenz) als auch in ihrer Position (während der Injektionsphase war am Mittwoch die Quelle horizontal verbreitert am Freitag jedoch vertikal weniger breit und horizontal verschoben).

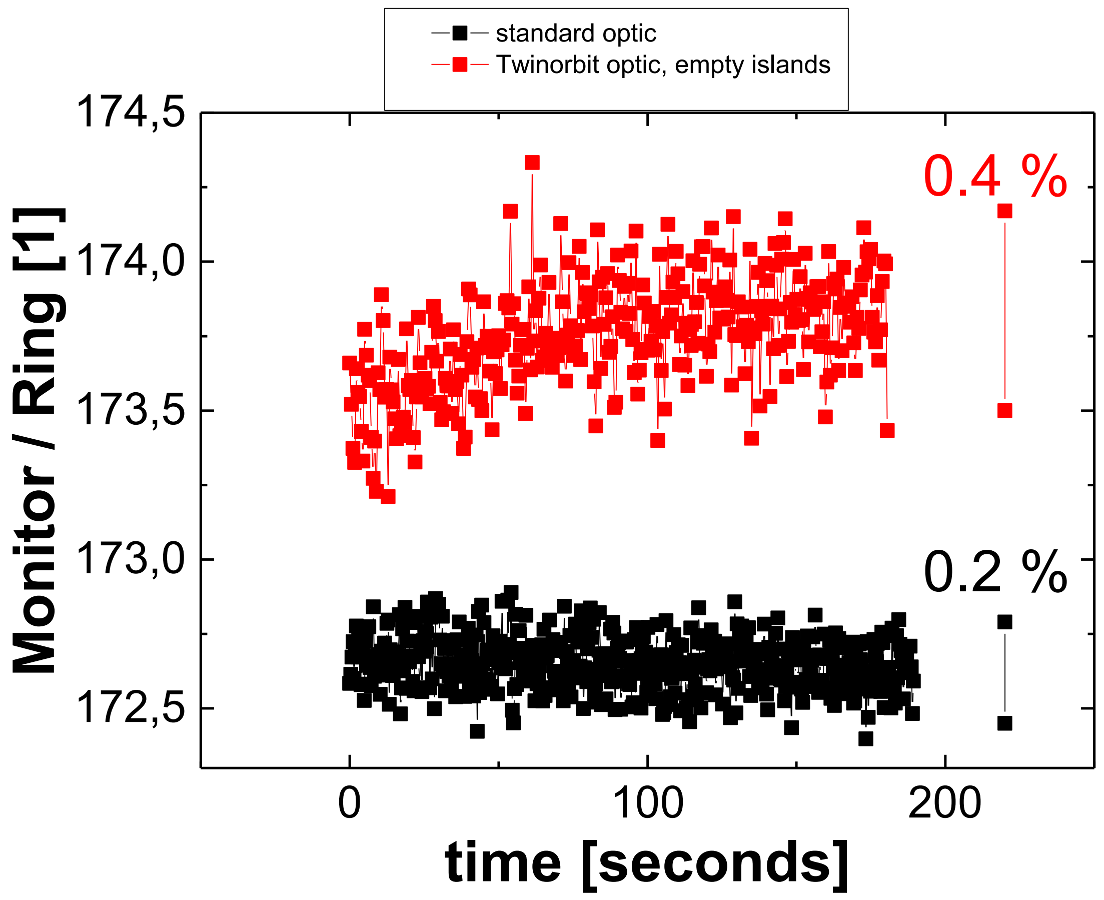
Mit den in Deinem Report erwähnten anvisierten Modifikationen des Injektionsablaufes kann man auf ein Verschwinden dieser Problematik hoffen.

Erhöhtes Rauschniveau während Twin-Orbit Optik:

Dargestelltes Signal ist „der Beamline Monitor“ (in diesem Fall der Spiegelstrom des letzten Spiegels) normiert auf den integrierten Ringstrom.

Schwarz: Referenz gemessen am Montag (Standard-Optik, „decay“)

Rot: nach Umstellung auf Twin-Orbit Optik und Neujustage/optimierung des Strahlrohres

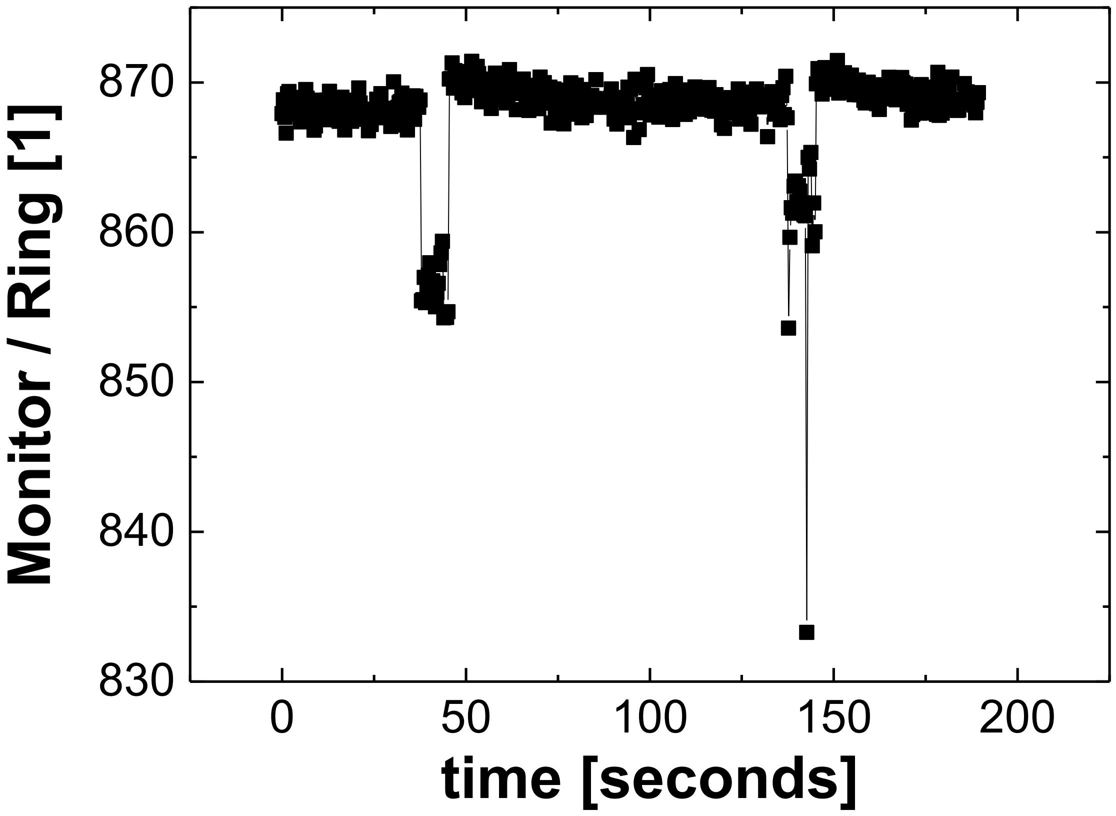


Kommentar: Erhöhung um Faktor 2 prinzipiell sehr problematisch, aber oft ist dieses Monitor-Rauschen und das Rauschen eines Nutzerprobensignals teilweise korreliert, so dass auf Monitor normierte Nutzersignale ein kleineres resultierendes „Rauschen“ zeigen können. Möglicherweise ein Problem speziell am UE46PGM1.

Störungen durch das Injektionsereignis:

Dargestelltes Signal ist „der Beamline Monitor“ (in diesem Fall der Spiegelstrom des letzten Spiegels) normiert auf den integrierten Ringstrom.

Intensitätseinbrüche finden während der Injektionsphase statt. Nutzerprobensignale zeigen ähnliche Anomalien. Man beachte, dass durch den Kollaps der „Islandbunche“ auf den „Core-Orbit“ eigentlich eine Intensitätszunahme zu erwarten wäre. Diese Anomalien treten auch in normierten Probensignalen (= Probensignal / Monitorsignal) auf, können hier aber durch geeignete Strahlrohreinstellungen auf akzeptabel kleine Werte minimiert werden.

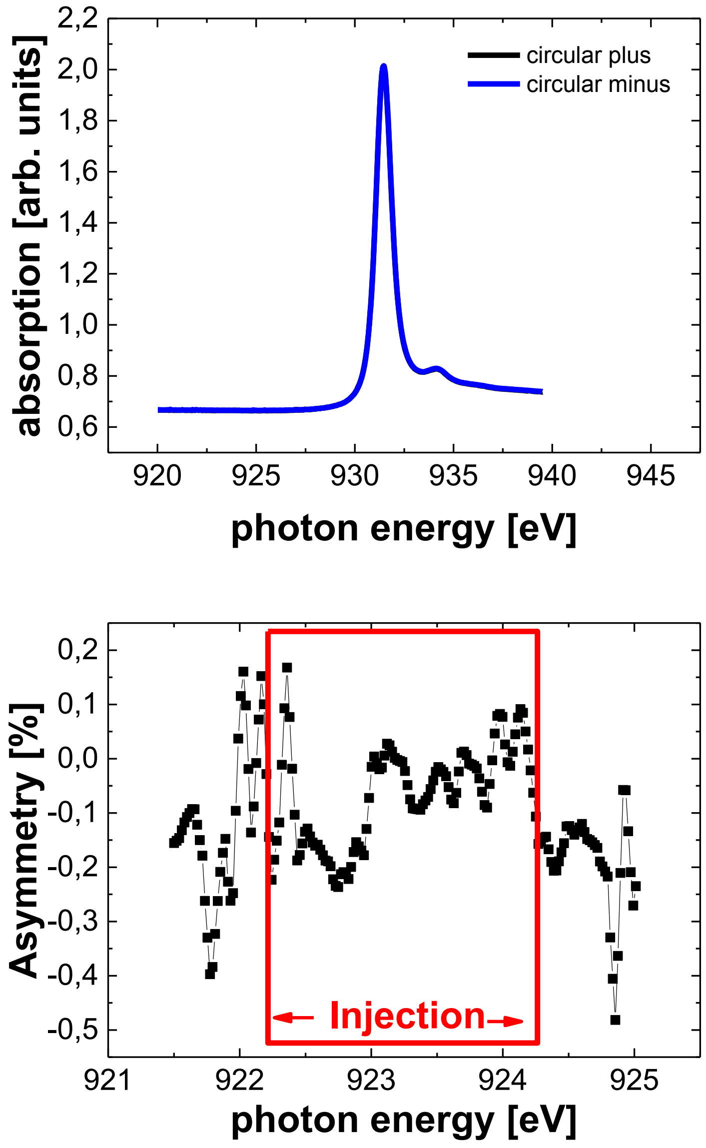


Störungen durch das Injektionsereignis:

Dargestelltes Signal ist der Probenstrom einer Nutzerprobe (TEY).

oben: 2 Spektren mit unterschiedlicher Zirkularpolarisation.

unten : XMCD, d.h. die normierte Differenz obiger Spektren.
Der rote Rahmen markiert ein Injektionsereignis während des Messens einer der Spektren – es stört potentiell beinahe 2eV des Spektrums, allerdings mit einer Stärke die kleiner gleich dem Rauschen außerhalb der Injektionen ist. Diese „Qualität" ist akzeptabel, benötigt aber ein zur Effektminimierung speziell eingestelltes Strahlrohr.



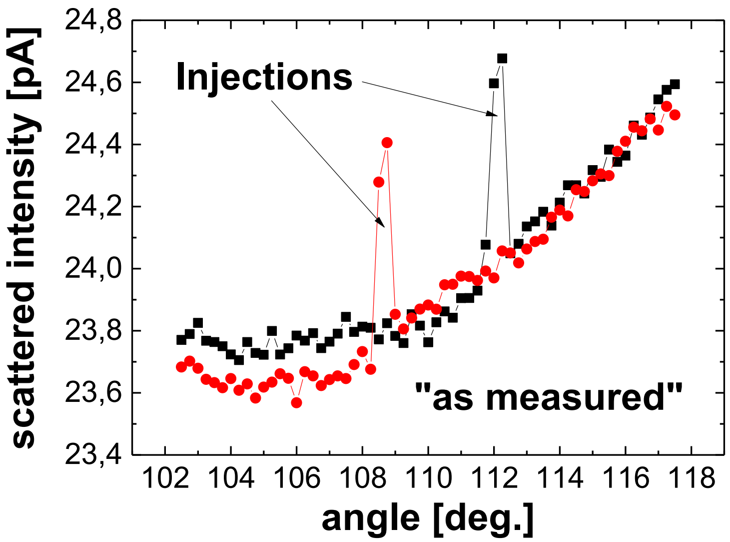
Störungen durch das Injektionsereignis:

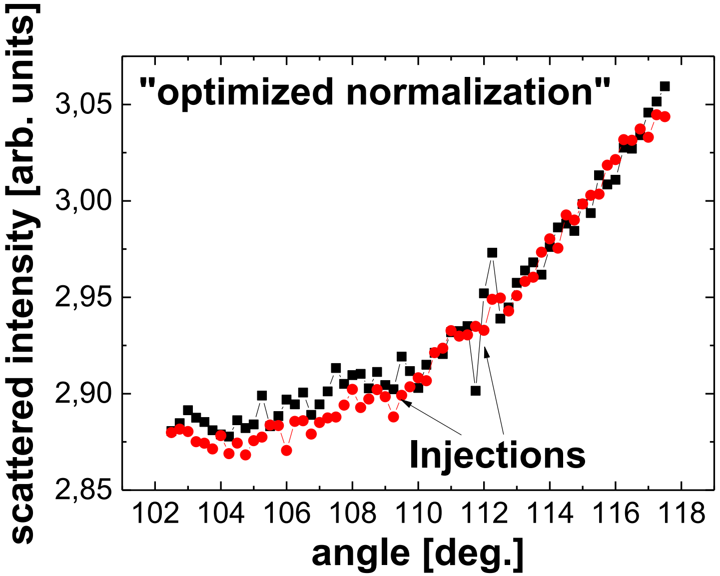
Dargestelltes Signal ist das von einer Nutzerprobe gestreute Signal.
Beide Kurven (schwarz und rot) sollten identisch sein.

oben: beide Kurven enthalten je eine Injektionsanomalie.

unten : Kurven aus obigem Diagramm, nach Anwendung verbesserter Normierungsmethoden.

Diese „Qualität“ ist akzeptabel, benötigt aber ein zur Effekt-Minimierung speziell eingestelltes Strahlrohr und zusätzliche (normalerweise nicht notwendige) Referenzmessungen.





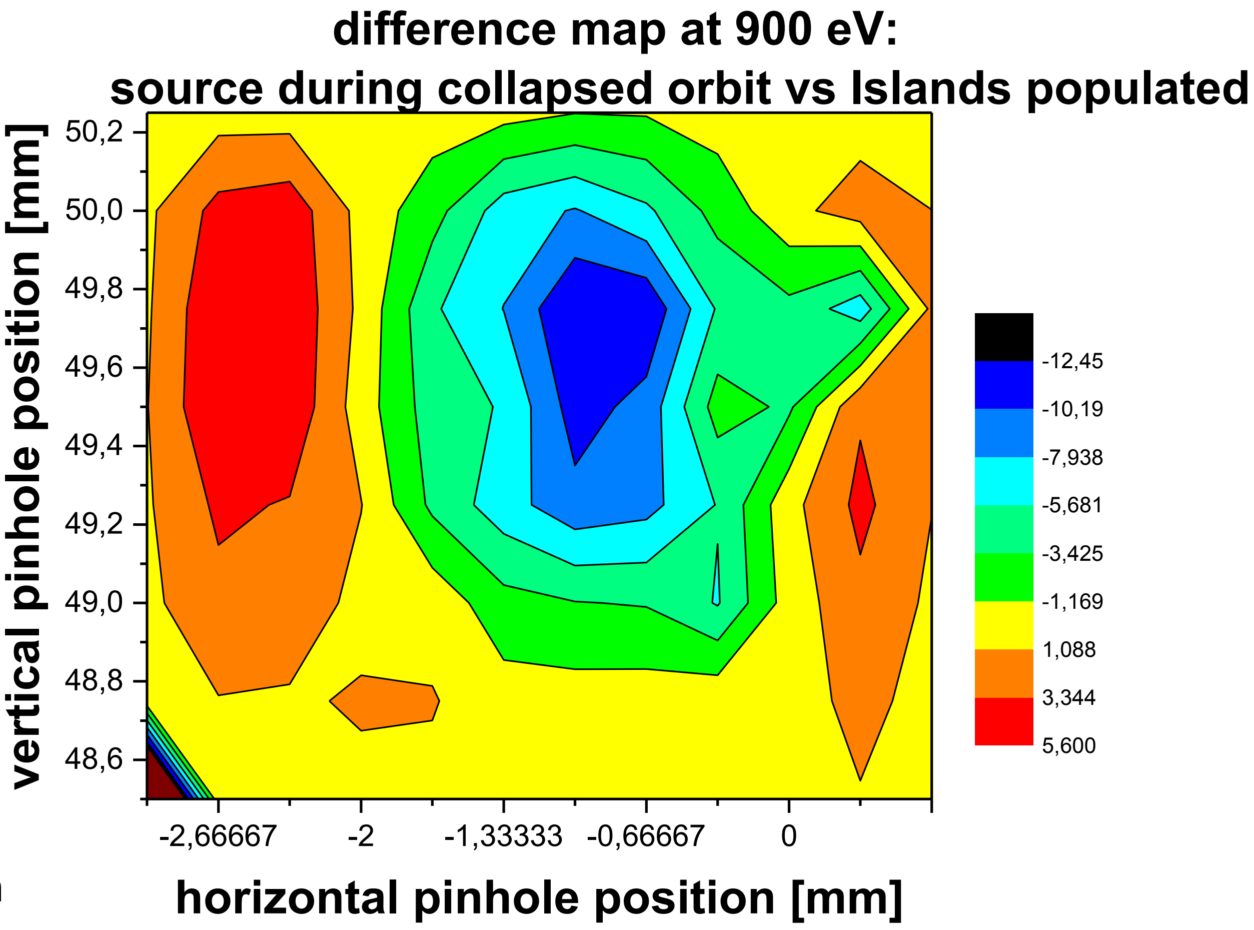
Quelle während des Injektionsereignisses:

Signal wurde mittels Strahlrohr-Photodiode durch „Pinhole-Scans“ (Auslaßsystem) bestimmt. Dargestelltes Signal ist die Differenz zweier solcher „Pinhole-Maps“:

(„Map“ während Injektionsphase) – („Map“ vor Injektion)

⇒ Während Injektionsphase ist Quelle horizontal verbreitert. Keine Hinweise auf eine Verschiebung der Position.

Tag der Messung: Mittwoch; Messungen am Freitag zeigen ein anderes Verhalten.



Quelle während des Injektionsereignisses:

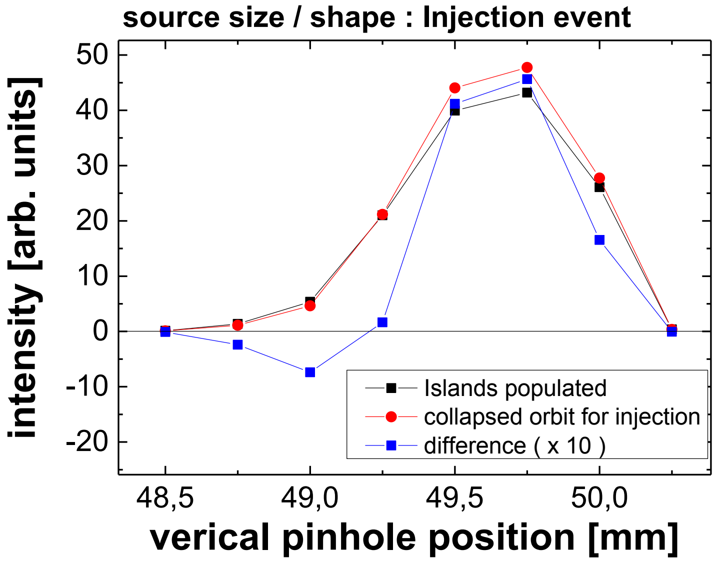
Signal wurde mittels Strahlrohr-Photodiode durch „Pinhole-Scans“ (Auslaßsystem) bestimmt.
Dargestellte Signale sind solche „Scans“ vor (schwarz) und während (rot) der Injektionsphase. Blau ist die Differenz beider.

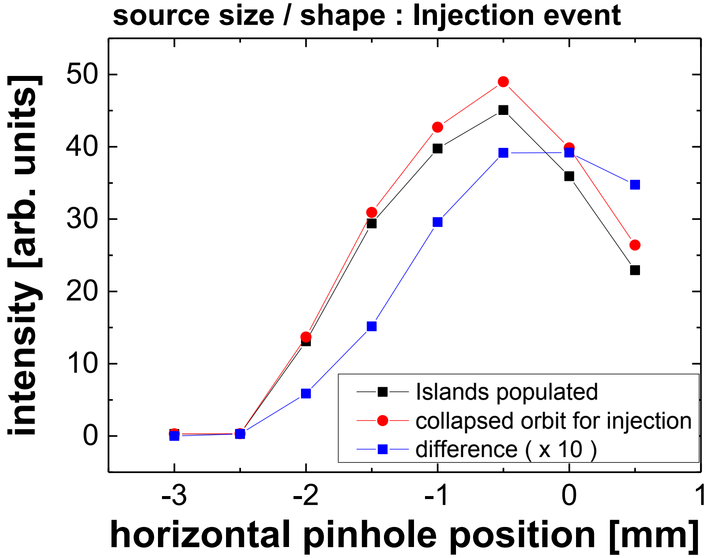
oben: vertikale Richtung zeigt eine „verschmälerte“ Quelle während der Injektionsphase.

unten: horizontale Richtung zeigt eine Quellverschiebung.

$\Rightarrow$ während Injektionsphase ist Quelle intensiver
aber vertikal auch weniger breit und horizontal verschoben.

Tag der Messung: Freitag

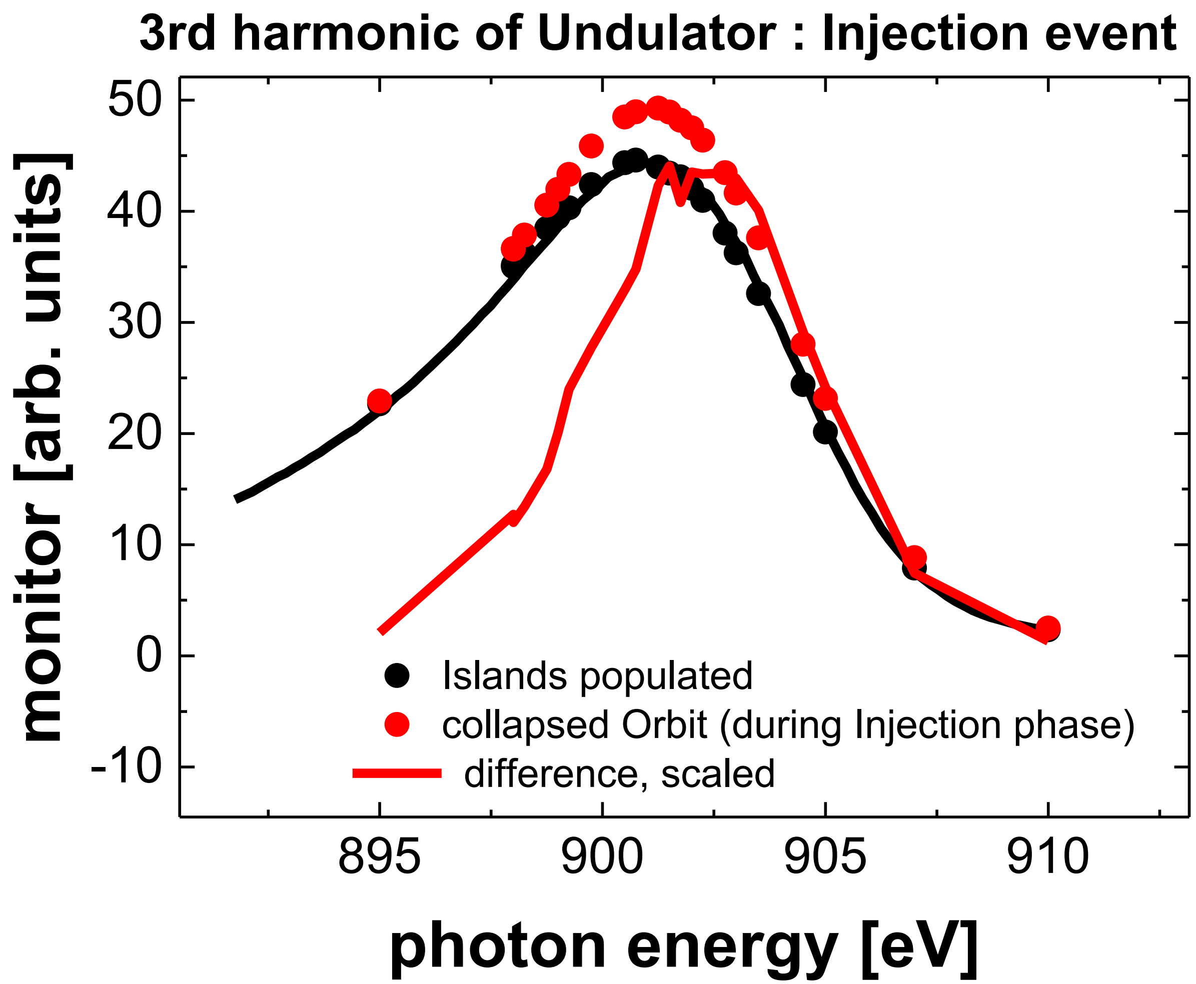




Quelle während des Injektionsereignisses:

Signal ist der Strahlrohr-Monitor während
eines Mono-"Scans" bei festem Gap zwischen zwei Injektionsphasen (schwarz) und während einer Injektionsphase (rot).

Die Differenz beider Kurven deutet auf eine „Blauverschiebung" der Harmonischen während der Injektionsphase hin.

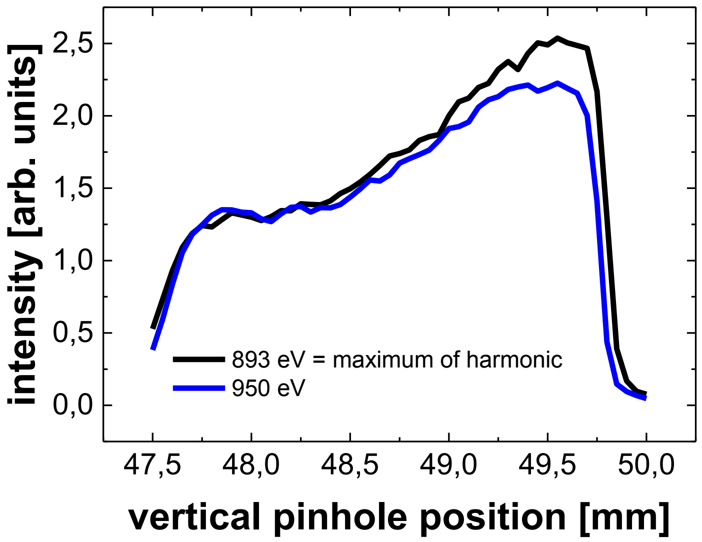


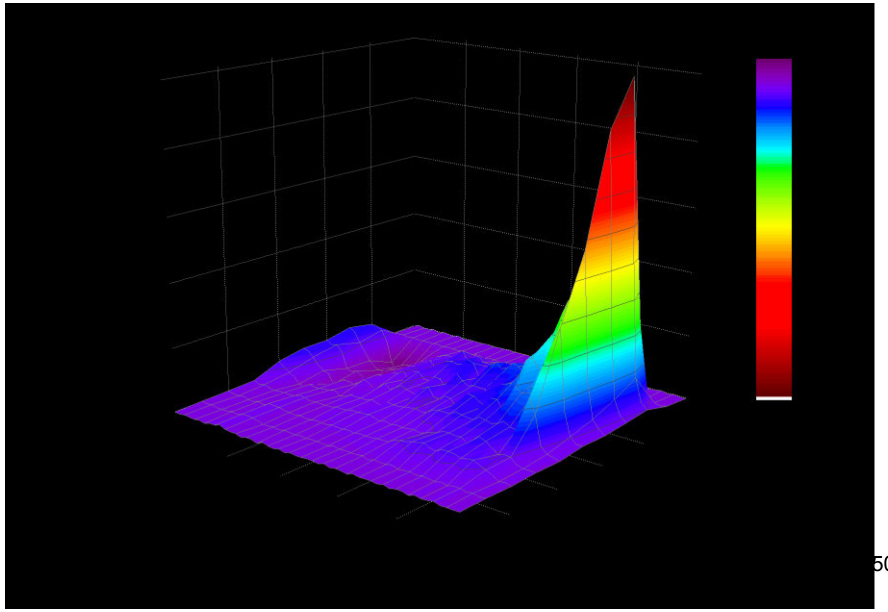
Quelle während „All bunches in Islands“:

Signal wurde mittels Strahlrohr-Photodiode durch „Pinhole-Scans“ (Auslaßsystem) um die nominelle Position des (leeren) „Core-Beams“ herum bestimmt.

Oben: diffuser Untergrund (blau) und auf der Harmonischen des Islandsignals (schwarz). Differenz beider entspricht dem „reinen“ „Island“-signal und ist für ein 2D-“Map“ (vertikal x horizontal) unten dargestellt.

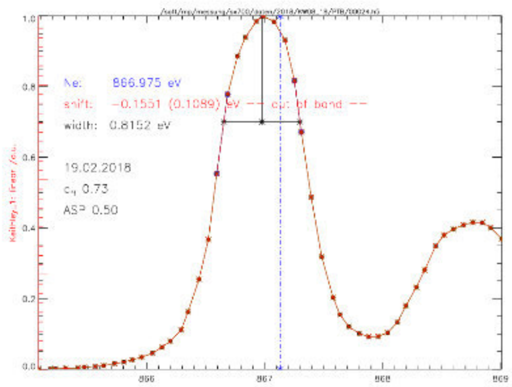
Erkennbar ist der Ausläufer eines der „Islands“ mit geringer aber messbarer Intensität am Ort des „Core“ Strahles.

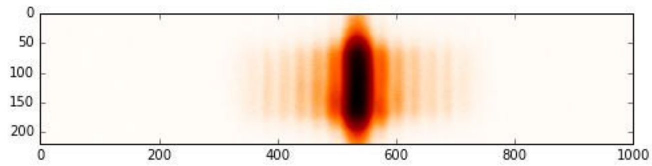


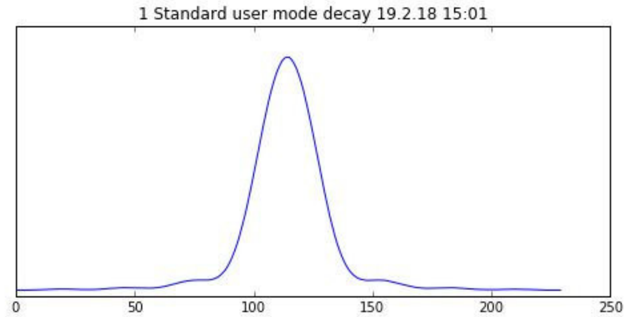


Überblick Messungen im Twin Orbit Test-Betrieb

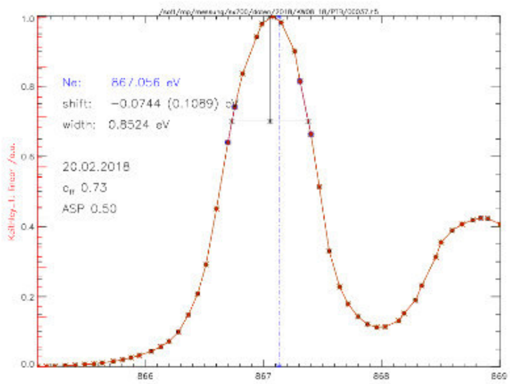
Montag 19.02.2018 →Standard user mode (decaying beam)



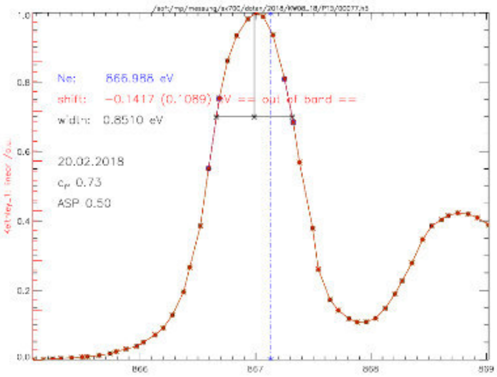


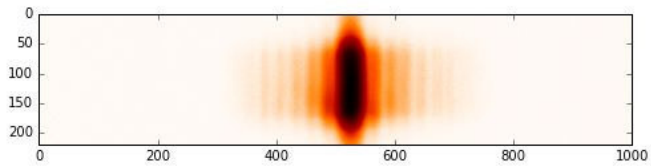


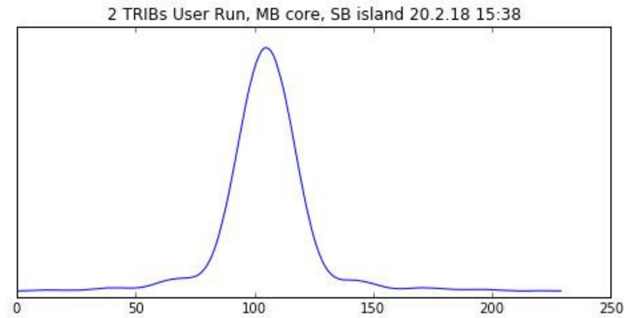
Dienstag 20.02.2018 → TRIBs User Run, MB in core orbit, SB in island orbit



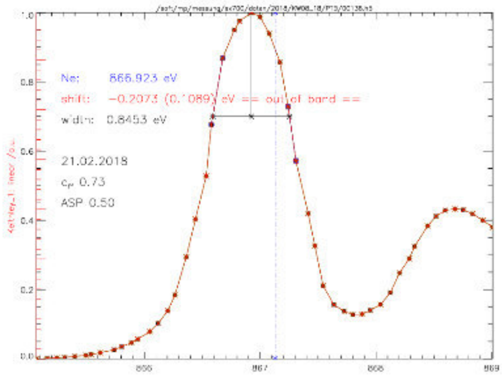
Dienstag 20.02.2018→ TRIBs mode (decaying beam)



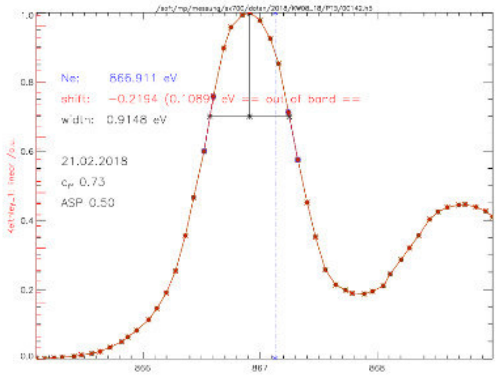




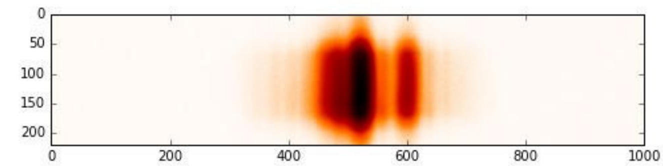
Mittwoch 21.02.2018→ TRIBs mode, increasing the number of bunches stored in island orbit
SB+Bunch11-20 in island orbit

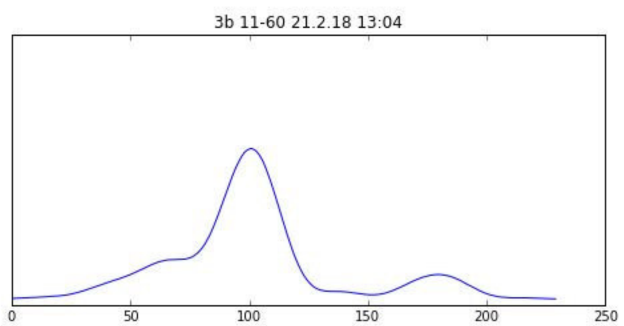


SB+Bunch11-60 in island orbit

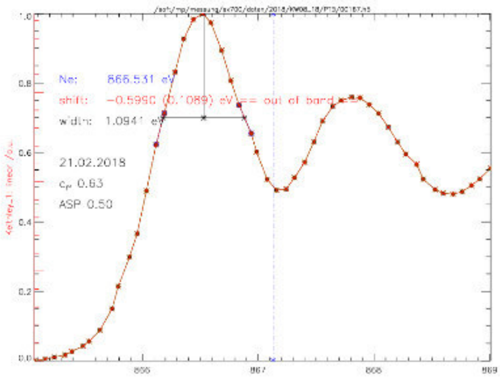


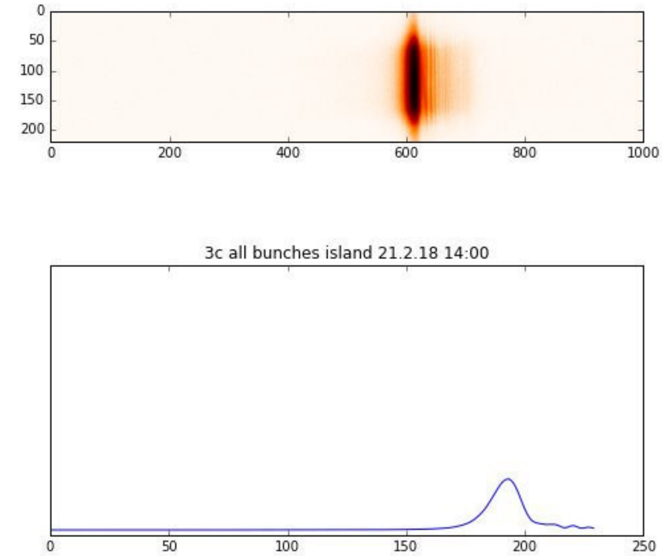
SB+Bunch11-110 in island orbit



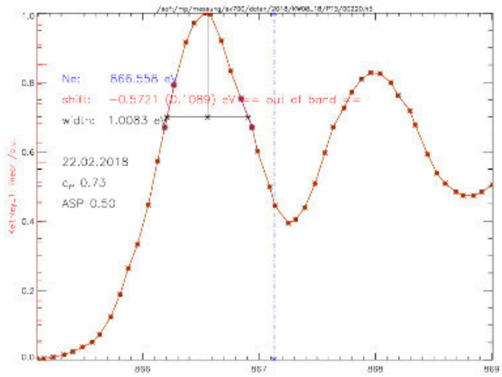


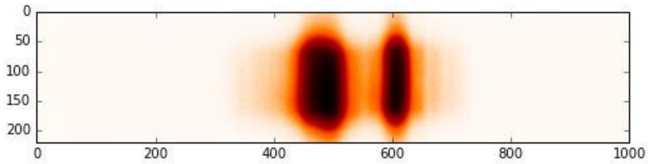
All Bunches in island orbit

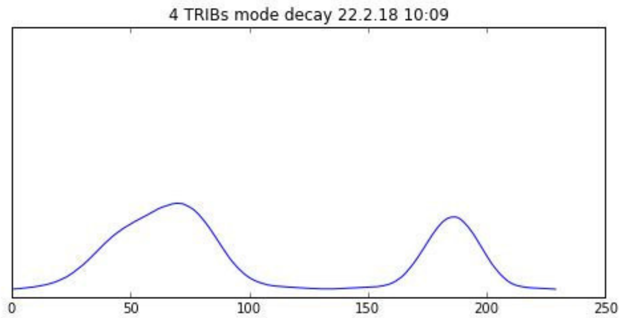




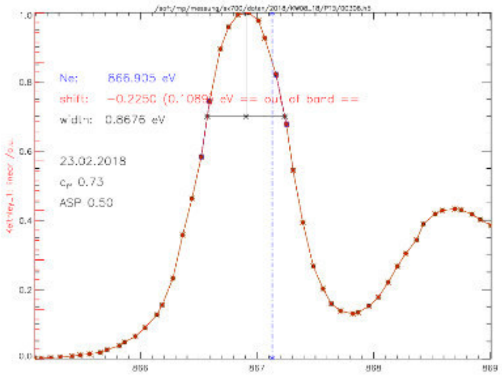
Donnerstag 22.02.2018 –> TRIBs mode (decaying beam), complete fill in island orbit

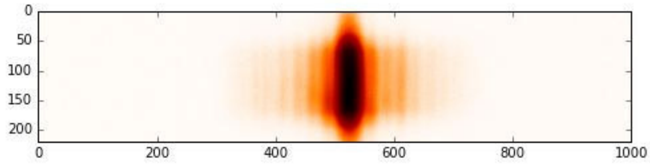


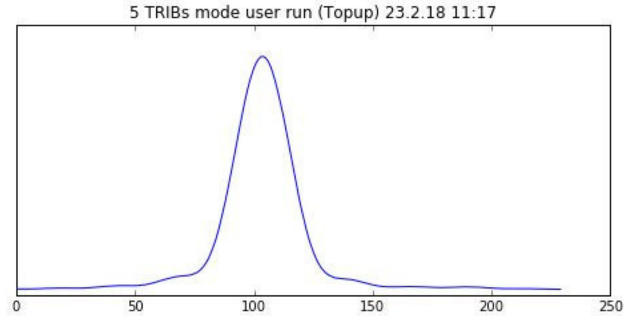




Freitag 23.02.2018→TRIBs mode user run (TopUP), MB without gap in core orbit, SB in island orbit

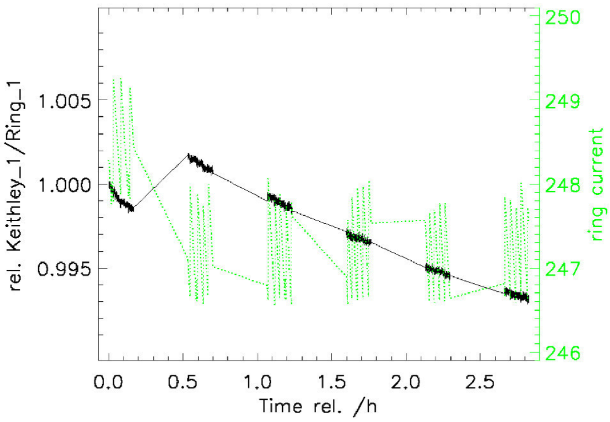


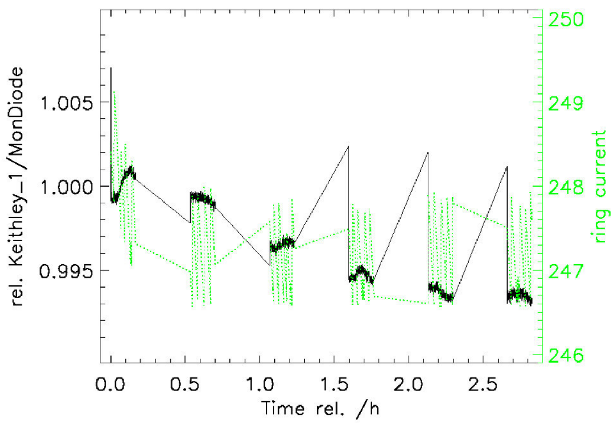


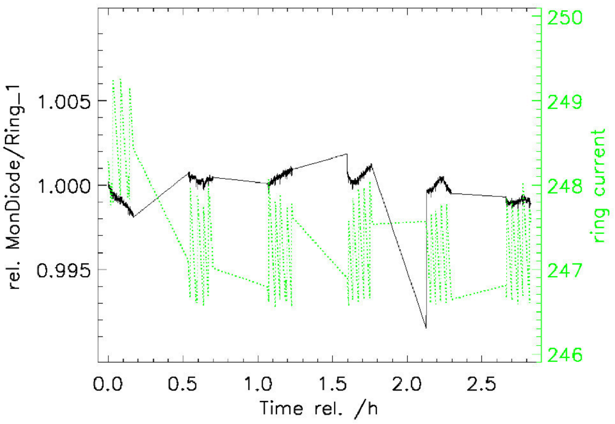


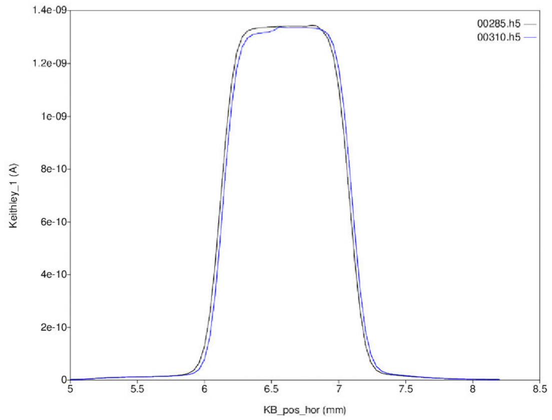
Timescans/Stabilität

We observe instabilities in our monitor signal, maybe this is related to beam movement (see kb_pos_hor)









A.PTB2: Bend D4 XX FCM Michael Krumrey

M. Krumrey, PTB 22.3.18

Twin Orbit Woche, FCM, Feb. 2018

Bild 9: S1 , S4 auf, 19.2. 17:39, normal

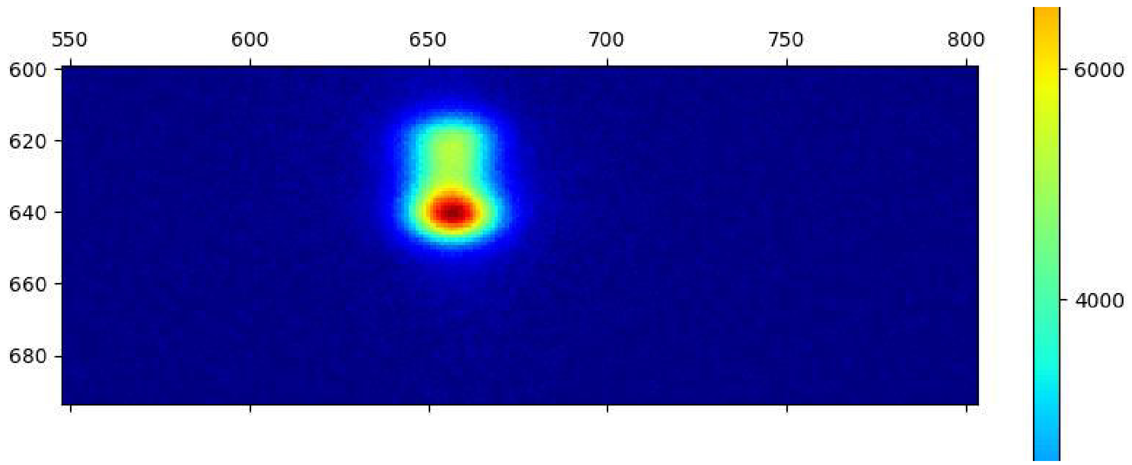


Bild 29: S1 1x1, S4 auf, 21.2. 13:48 IO: SB + 225 bunche

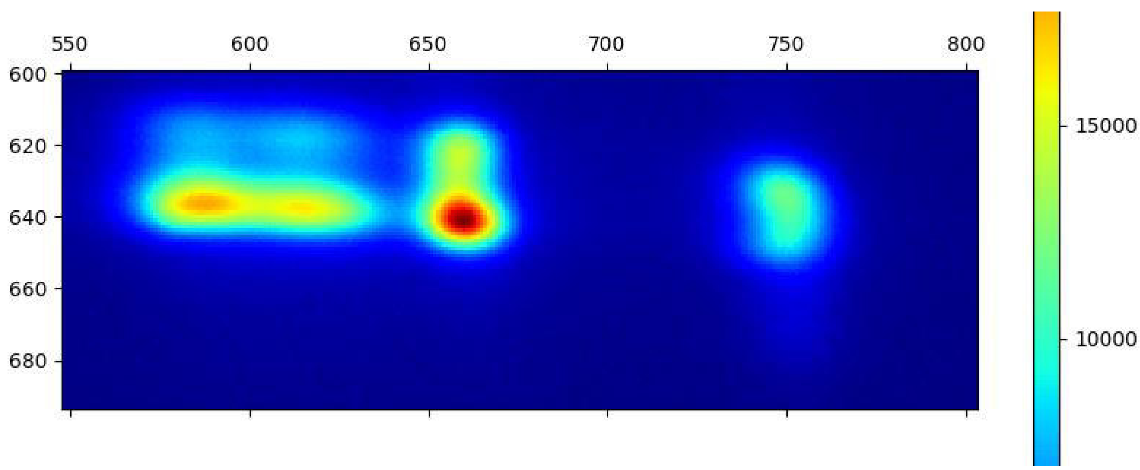


Bild 32: S1 1x1, S4 hor 1, 21.2. 13:50 IO: SB + 225 bunche

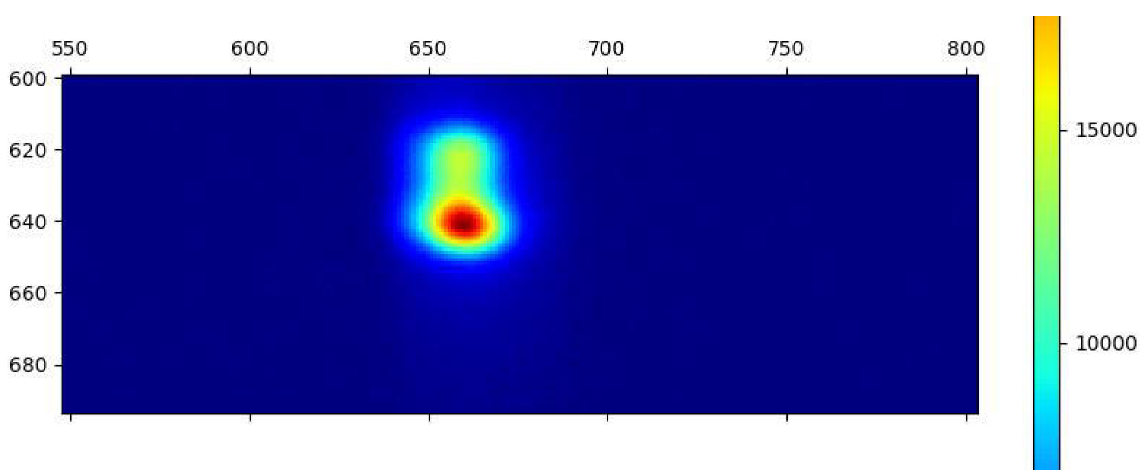


Bild 33: S1 hor 20, S4 hor 1 21.2. 13:52   IO: SB + 225 bunche

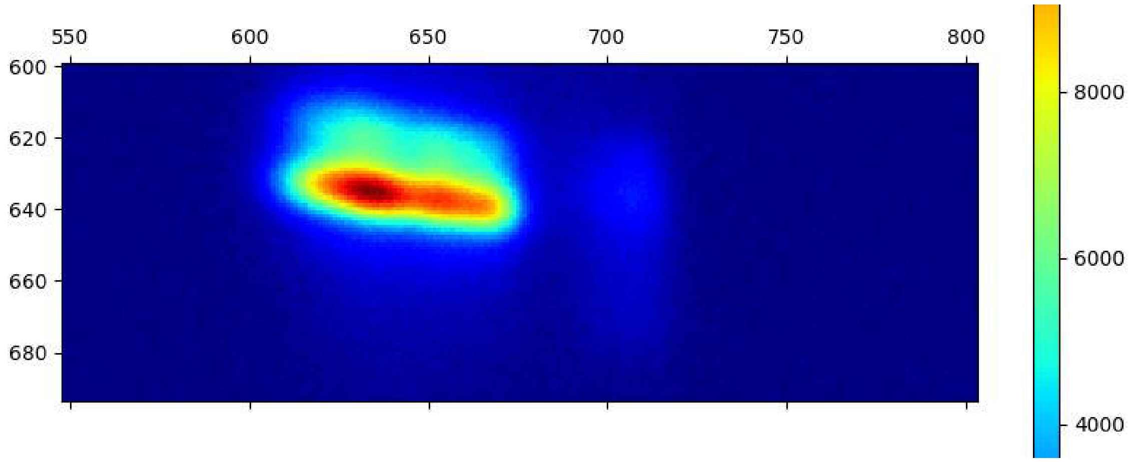


Bild 34: S1 hor 20, S4 hor 10 21.2. 13:53   IO: SB + 225 bunche

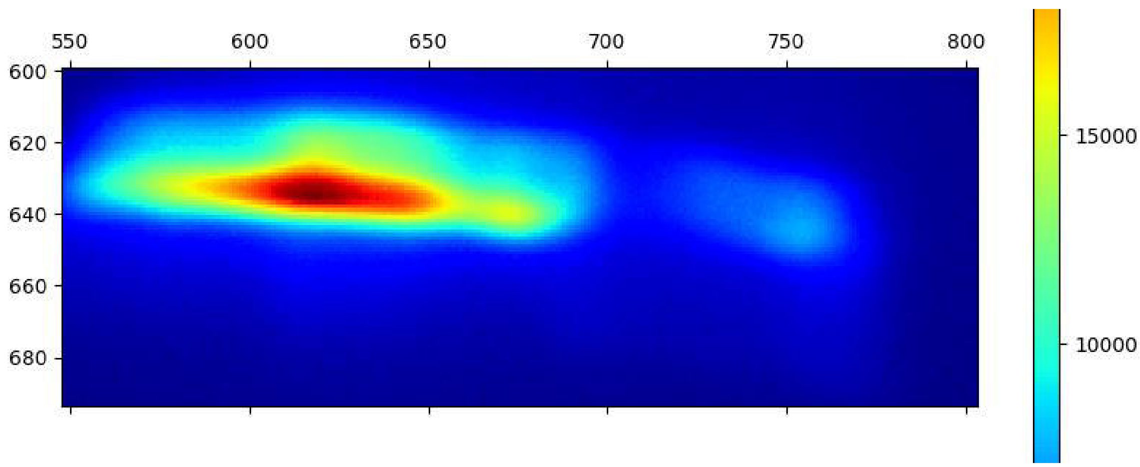


Bild 36:S1 hor 1, S4 hor 10 21.2. 13:57 IO: SB + 225 bunche

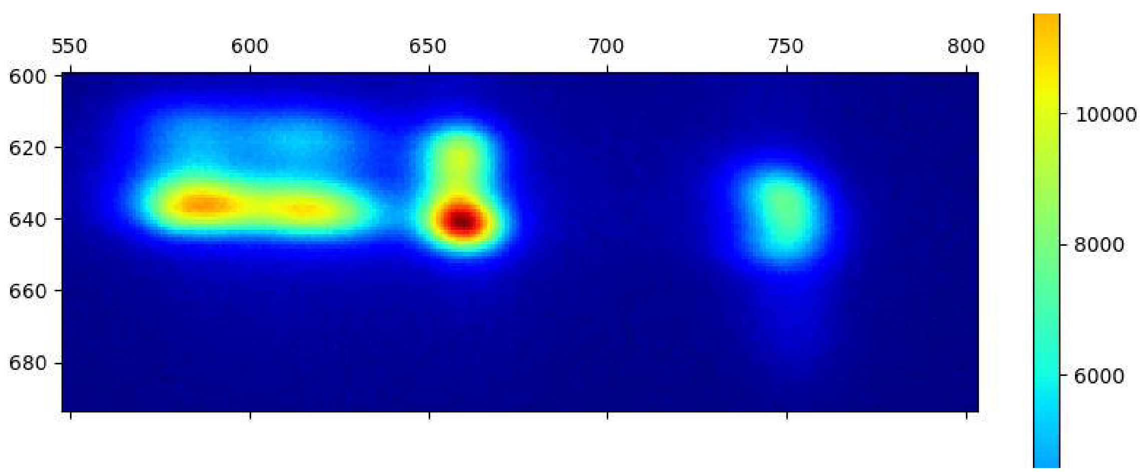


Bild 38: S1 hor 20, S4 hor 10 21.2. 14:16 IO: all

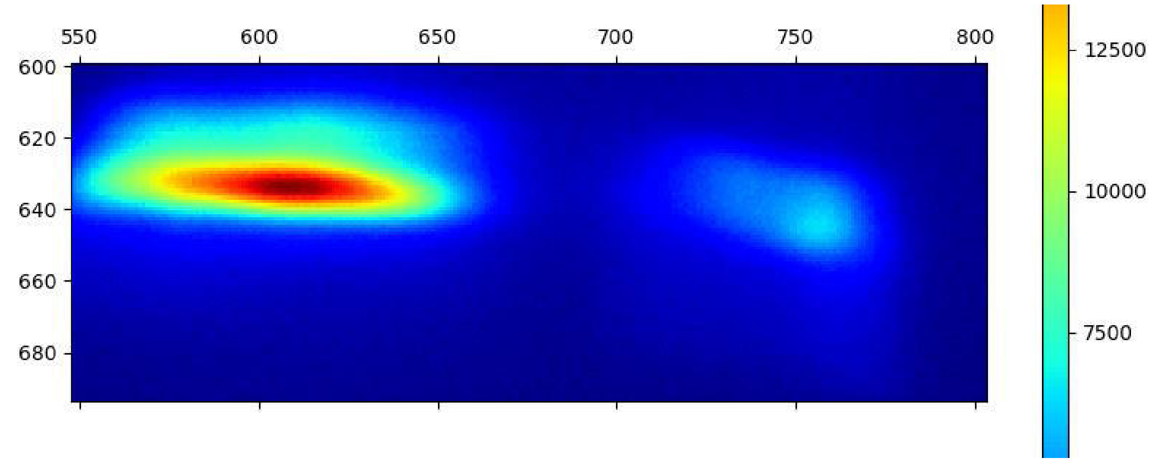


Bild 39: S1 hor 1 21.2. 14:17 IO: all

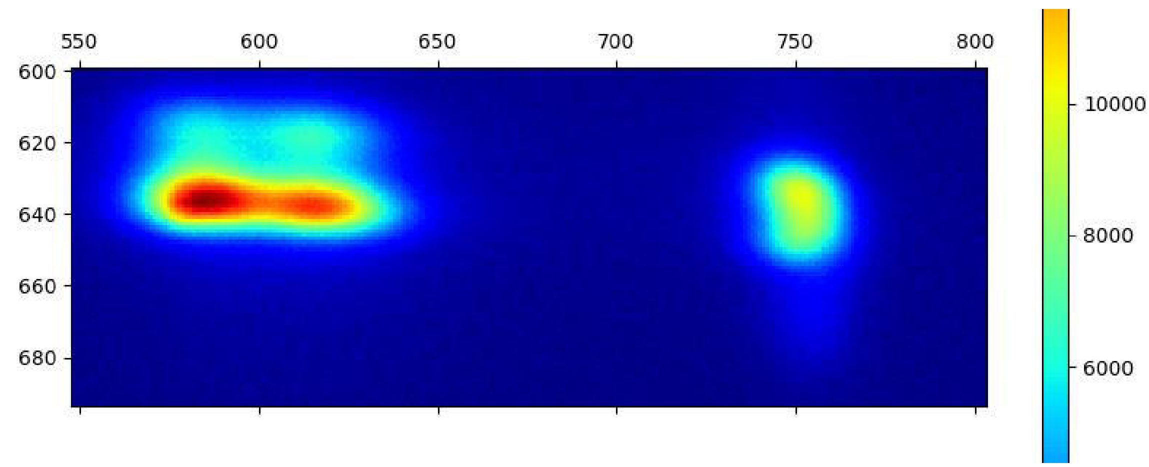


Bild 43: S1 hor 1 21.2. 15:14 IO: ?

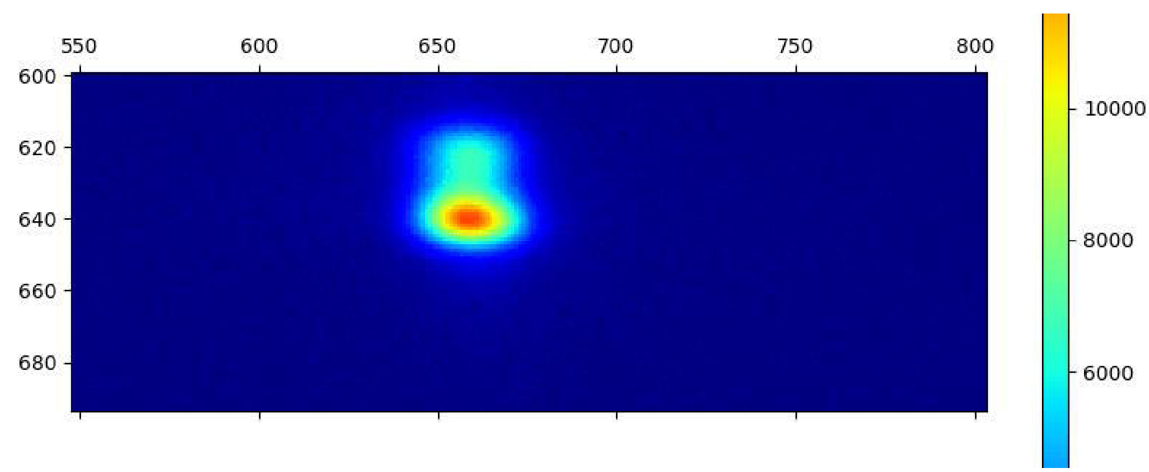


Bild 48: S1 hor 20 21.2. 15:17 IO: ?

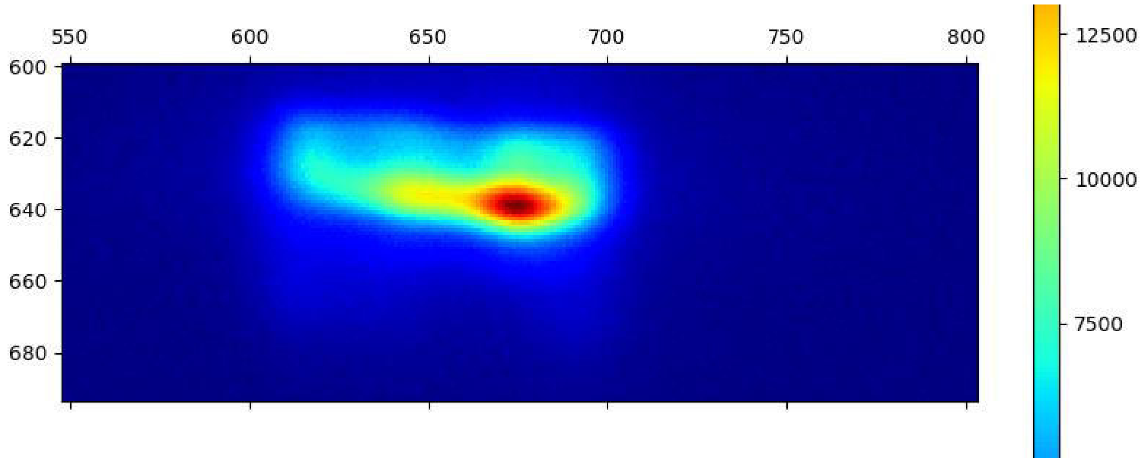


Bild 51: S1 hor 1, 22.2. 10:22 IO: all

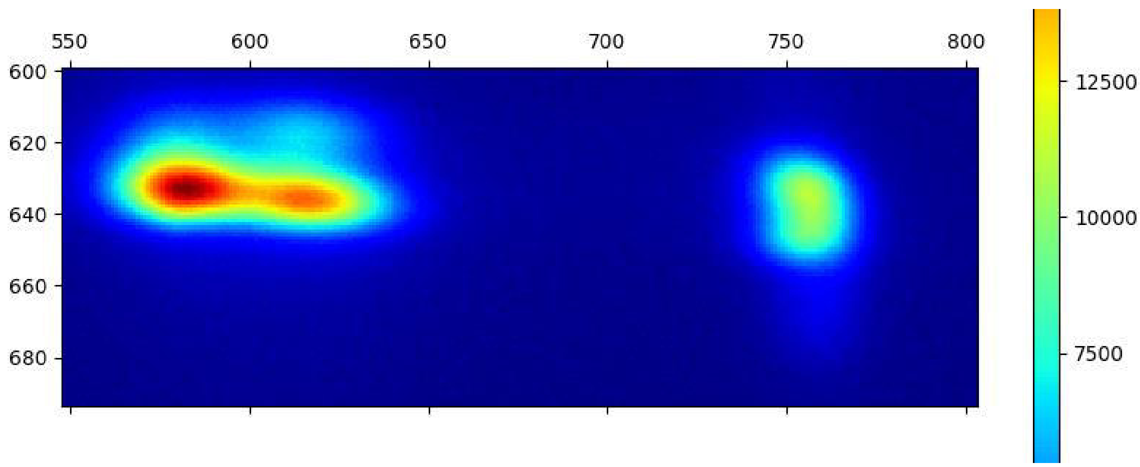
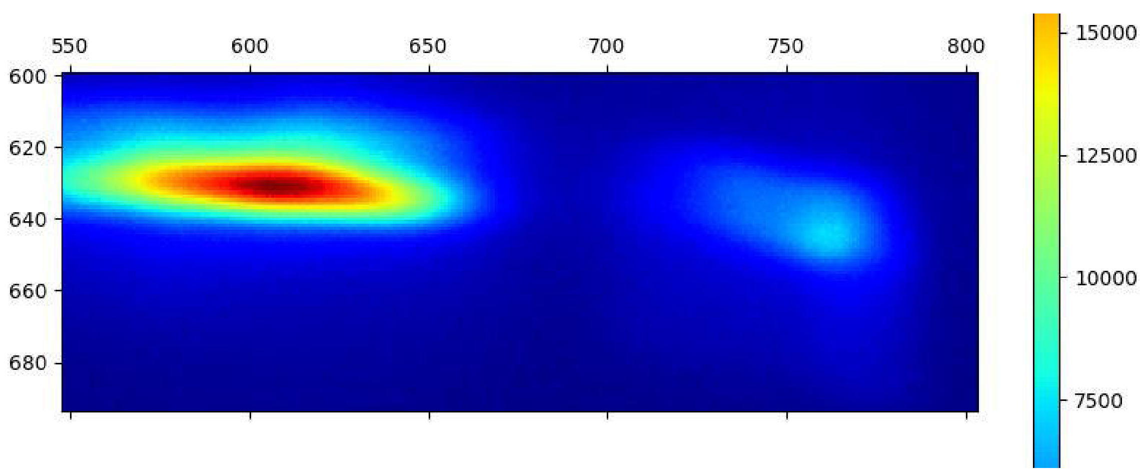


Bild 52: S1 hor 20, 22.2. 10.27 IO: all



Twin-Orbit Test Woche 8 2018 (pgm0001.h5) PGM Undulatorbeamline AG 7.24 PTB

Zusammenfassung:

Der reine Island Betrieb hat ca. 1/10 Fluss gegenüber des Core (+ Island) Modus. Die Lage und Breite der Blenden ändert sich im Islandmodus sehr stark (Verbreiterungen um 400% für Blende oben und unten). Die Energieachse wird dabei nicht verändert oder verbreitert (Überprüfung mit Kantenscans). Im Timescan wird das kurze Zusammenziehen der Strahlanteile vor dem Topup sichtbar. Für den reinen Island Betrieb ist kein charakteristischer Undulator Verlauf der Energie sichtbar. Für Core+Island Betrieb sind Lage und Breite der Blenden nahezu identisch – ein Wegschneiden des Islandanteils ist allein durch die Blenden vermutlich nicht möglich. Es ist ein dipolartiger starker Untergrund sichtbar (Frage an BESSY: können wir diesen unterdrücken/verringern?).

Gesamtübersicht

Tag	Modus	520 eV	1060 eV	1622 eV	Cr/Al Filter für E-Achse
Mo	Normal	#11-22 Zuerst noch Filter von 1060 drin gewesen!	#1-10	#23-28	-
Di	Normal + optiken für Twin	#63-73	#53-62	#29-52	#74-82
Mi	Core mit steigender Islandanzahl aller 30 Min	#133-143	#121-132	#99-119 und #144-152	#85-89
Do	Nur Islands ohne Core	-	#155-159 und #190-222	Nur 1 U Scan gemacht (#154)	#181-189
Fr	Core und Island				-

Alle Messungen mit D21 (K3)

Donnerstag zusätzlich mit Schneide Messungen gemacht bei Y= 0, -55, +55

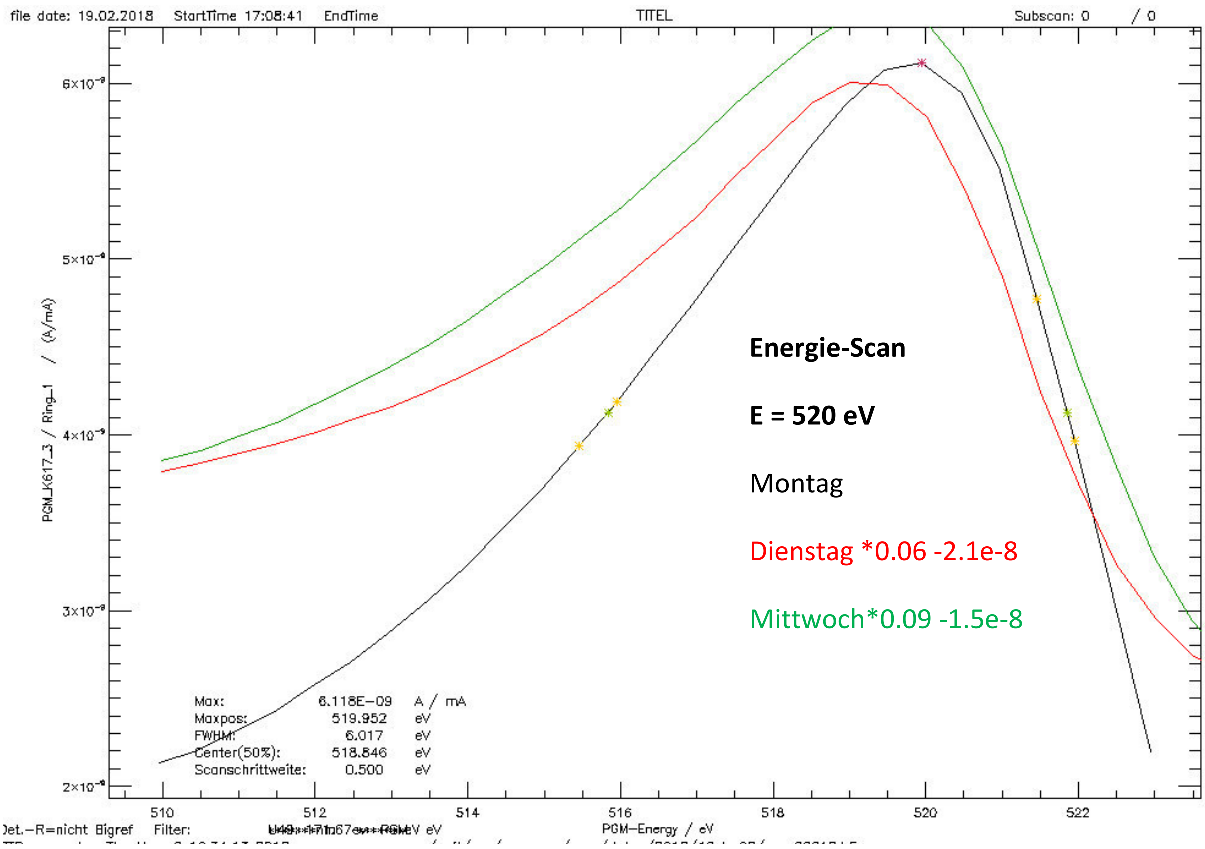
Nur Island-Modus: Ziemlich genau eine Größenordnung weniger Fluss als bei Core (bzw Core +Island) Modus.

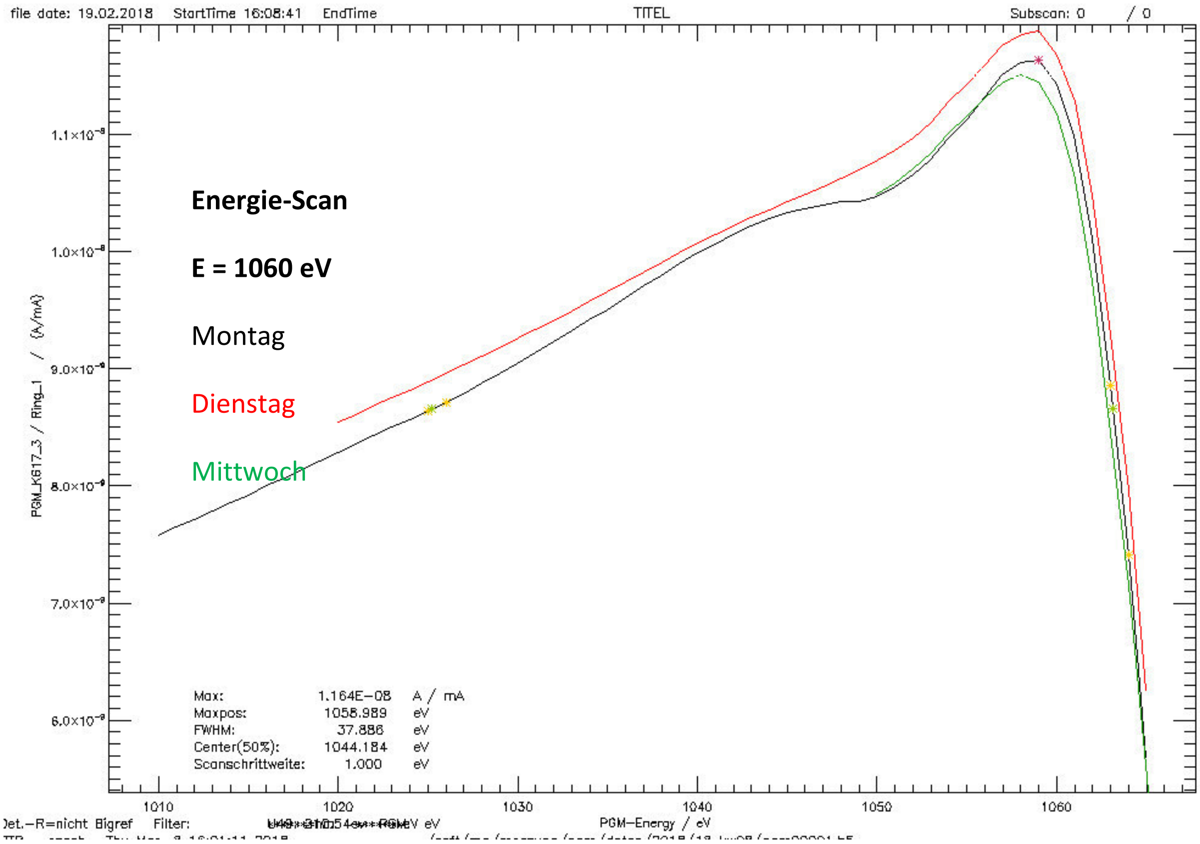
Energie-Undulator Beziehung

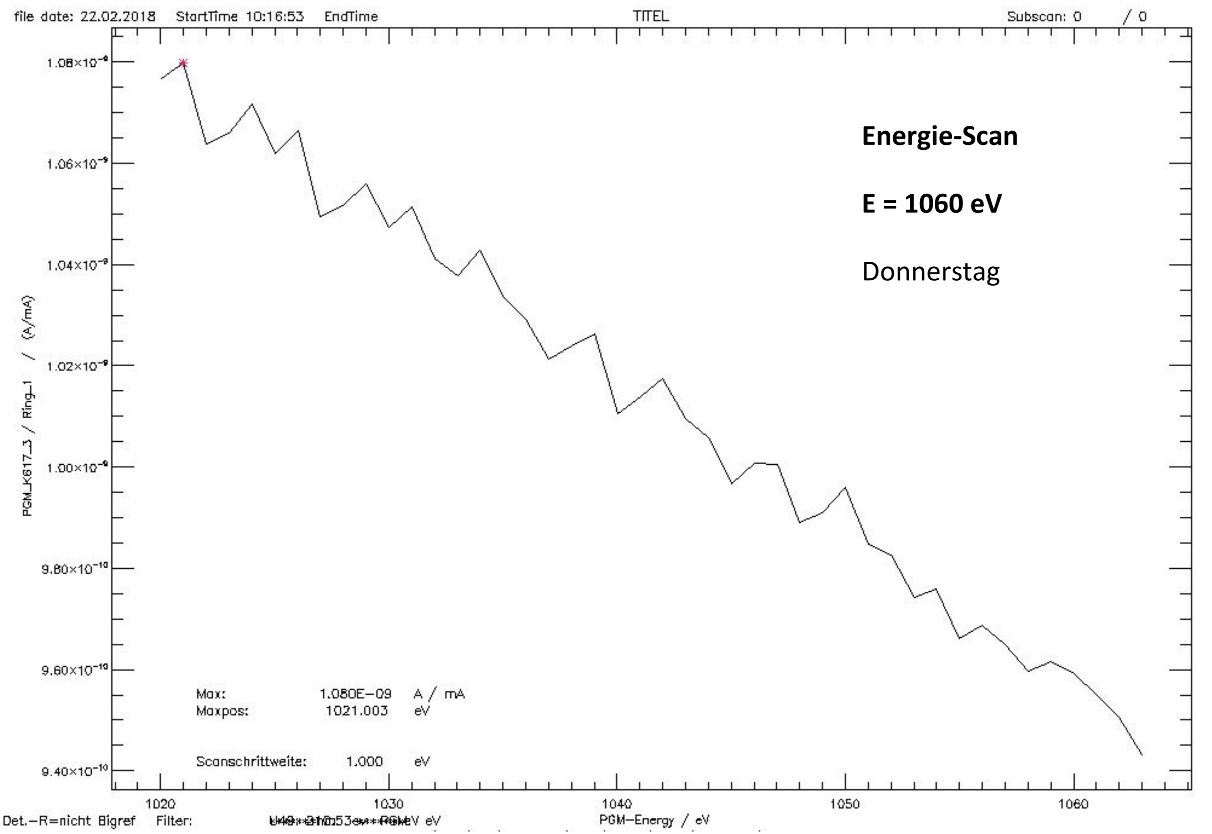
E=1060

Scan	Mo	Di	Mi	Do
1060 eV U49	#1	#55	#123	#155
520 eV U49	#12	#65	#134	-
1622 eV U49	#23 (2.1)	#48 (2.1 50%) #49 (2.1 auf)	#100(2.1)	#154

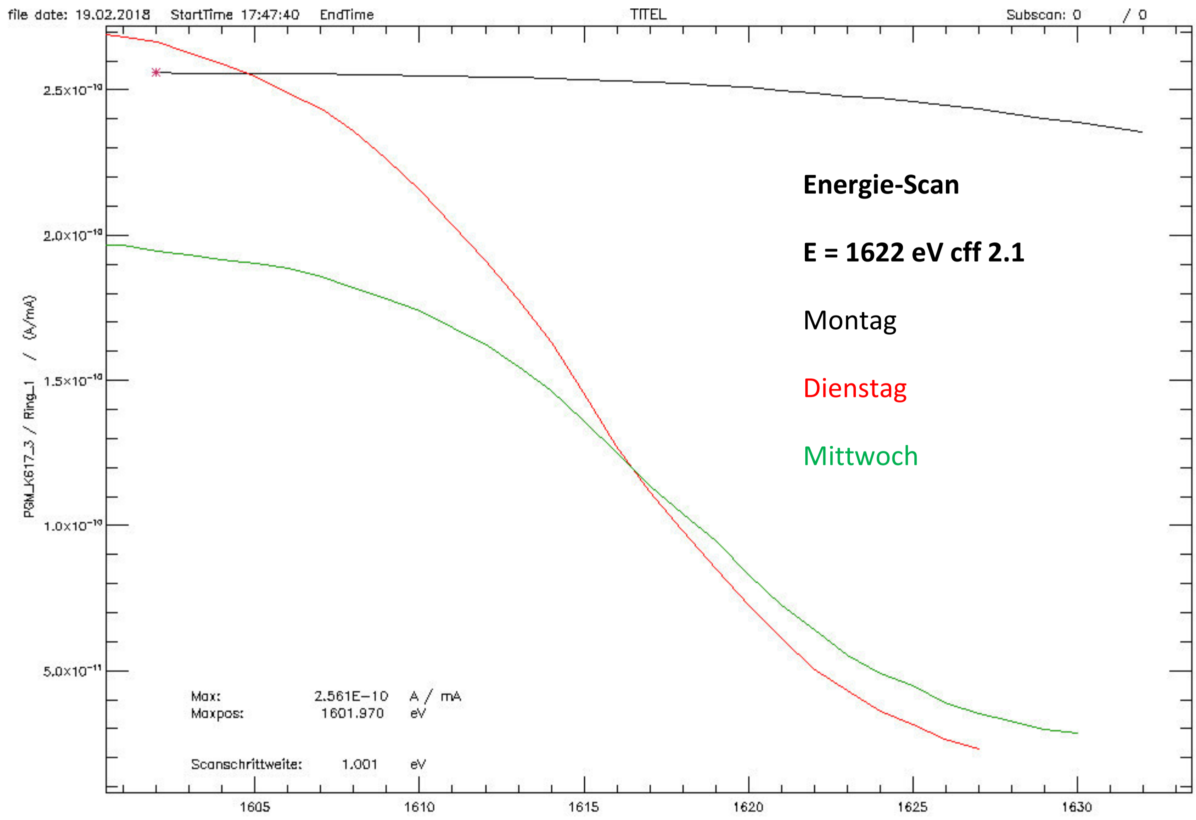
Anmerkung**: Am Montag war für 520 eV noch der Mg anstelle des Cr Filters drin**

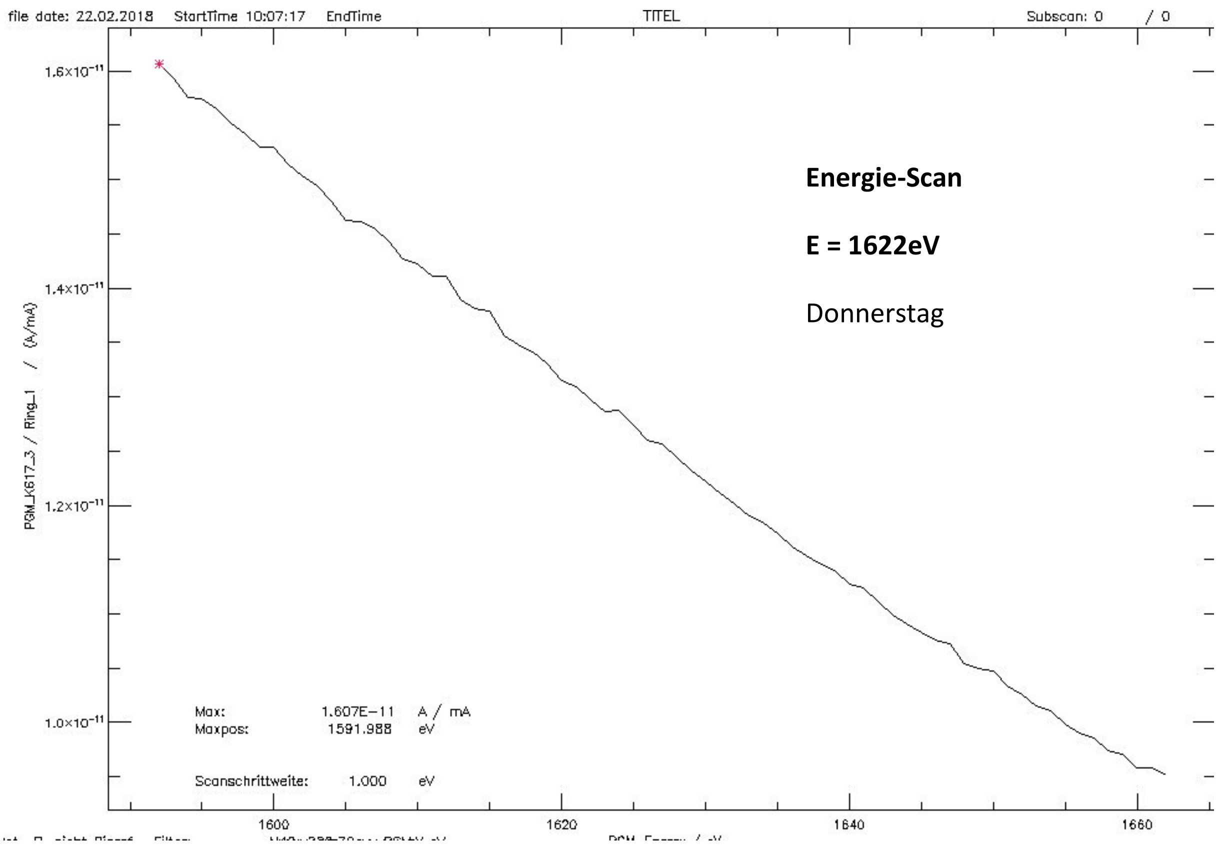






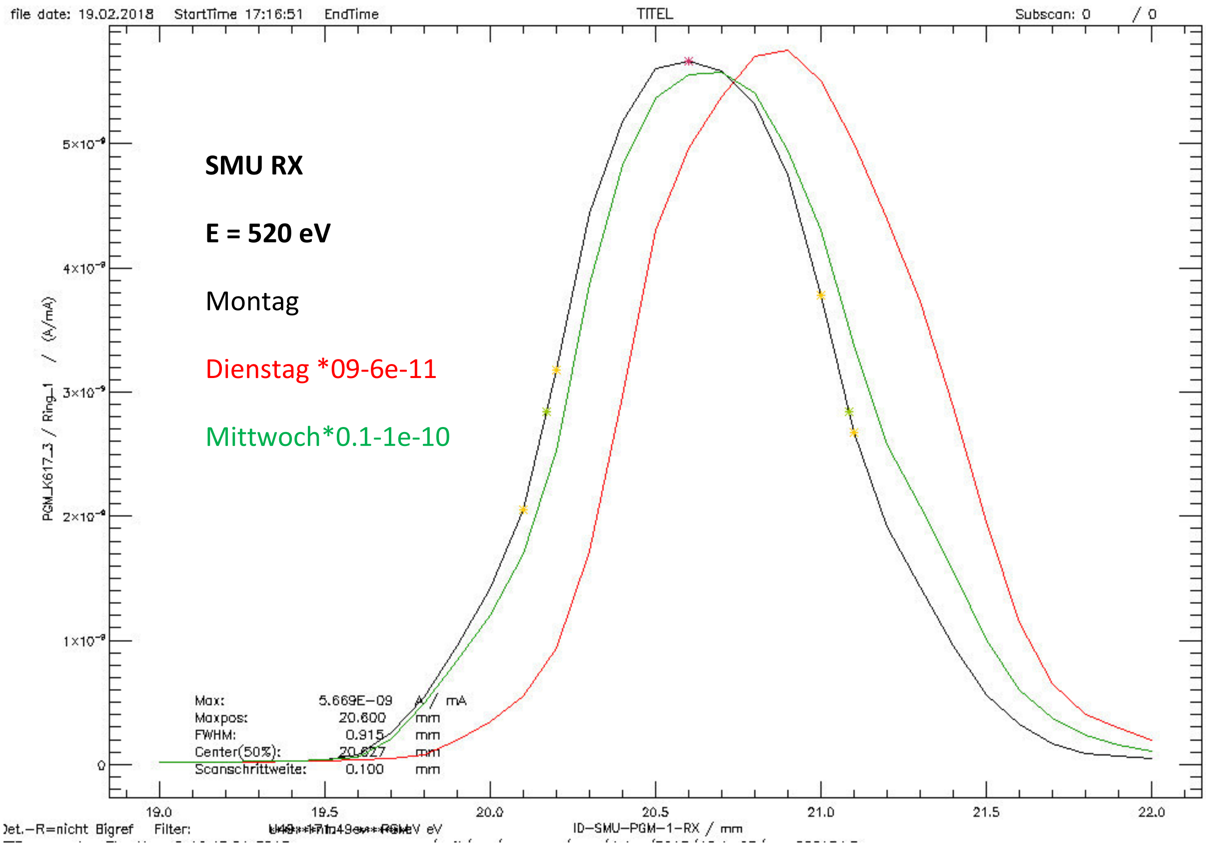
Fluss um ca. eine Größenordnung kleiner wenn nur Island-Betrieb

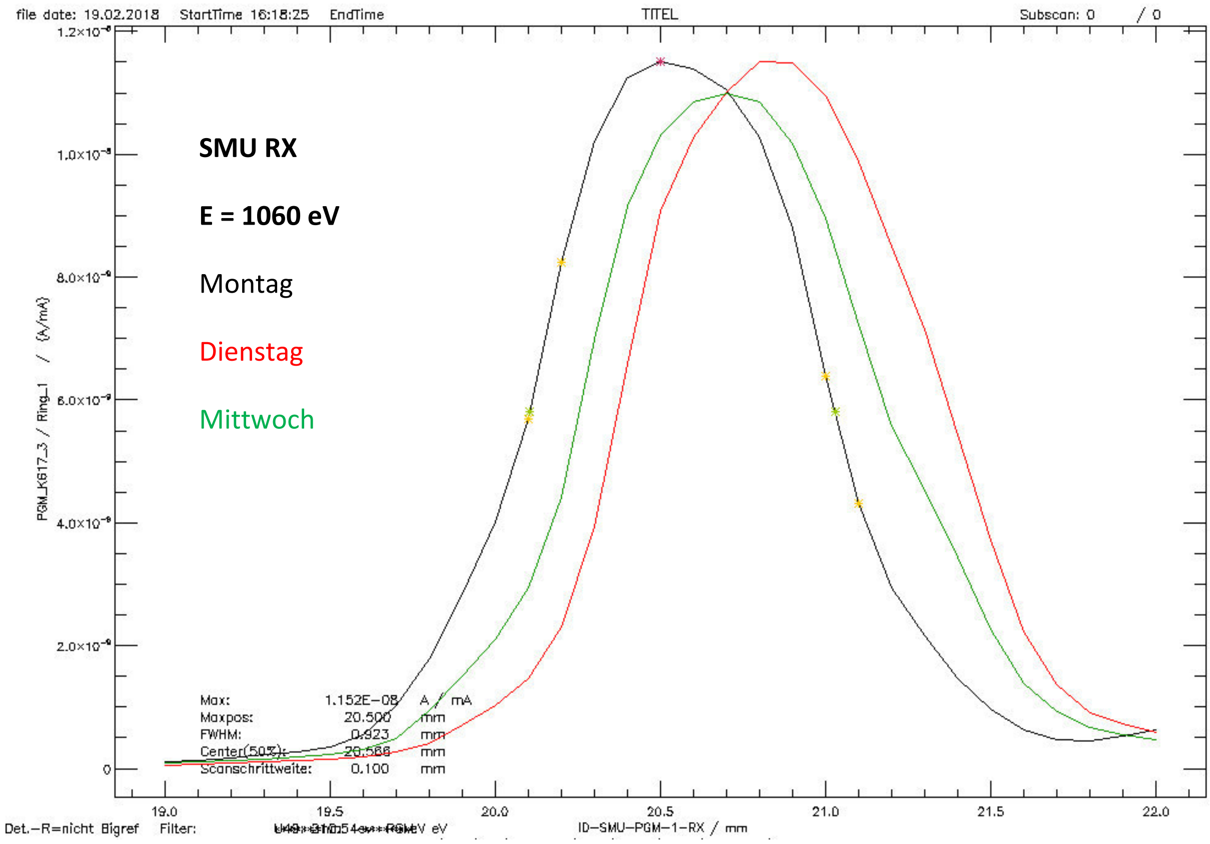

file date: 19.02.2018 StartTime 17:47:40 EndTime
TITEL
Subscan: 0 / 0
PGM_K617_3 / Ring_1 / (A/mA)
Energie-Scan
E = 1622 eV cff 2.1
Montag
Dienstag
Mittwoch
Max: 2.561E−10 A / mA
Maxpos: 1601.970 eV
Scanschrittweite: 1.001 eV

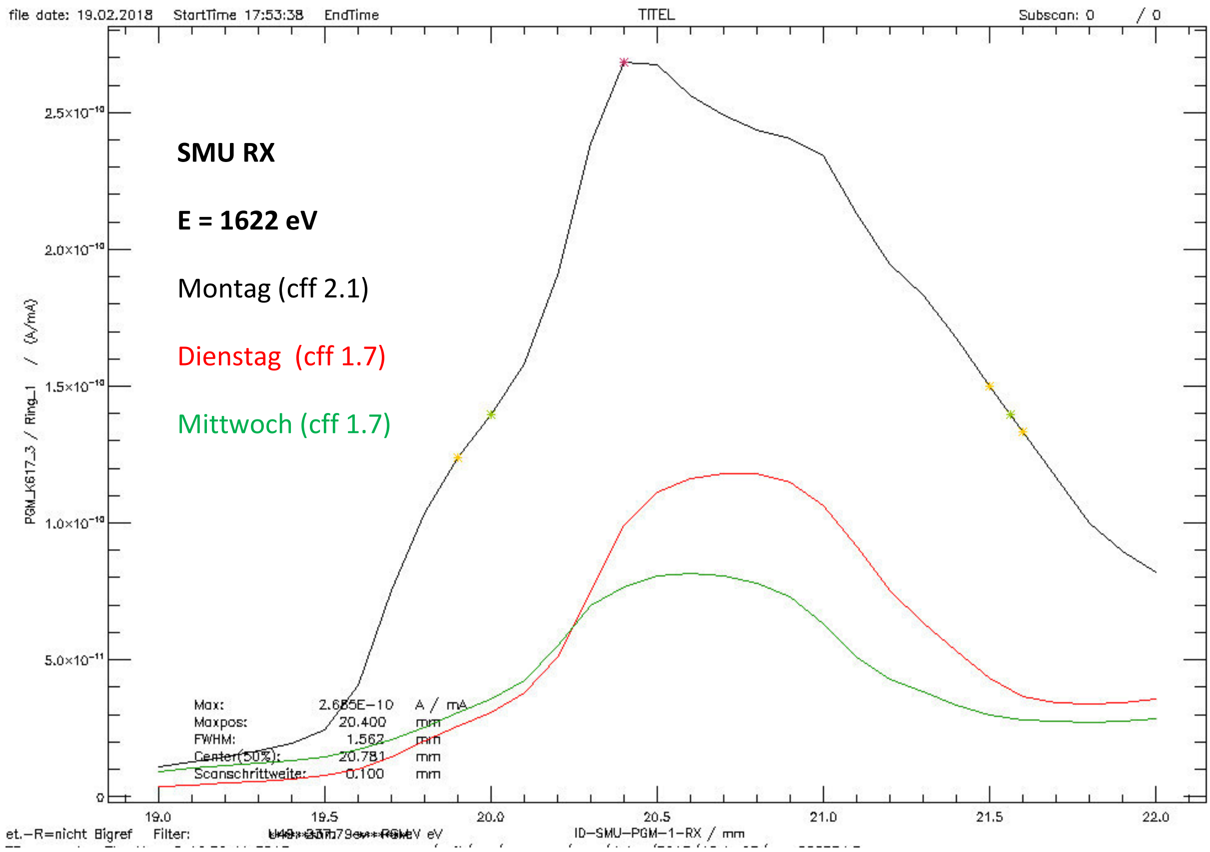

file date: 22.02.2018 StartTime 10:07:17 EndTime
TITEL
Subscan: 0 / 0
PGM_K617_3 / Ring_1 / (A/mA)
Energie-Scan
E = 1622eV
Donnerstag
Max: 1.607E−11 A / mA
Maxpos: 1591.988 eV
Scanschrittweite: 1.000 eV

Switching Mirror RX Scans

Scan	Mo	Di	Mi	Do
1060 eV SMU RX	#2	#56	#124	-
520 eV SMU RX	#13	#66	#135	-
1622 eV SMU RX	#25 (2.1)	#42 (1.7) #	#108 (1.7)	-




file date: 19.02.2018 StartTime 16:18:25 EndTime
TITEL
Subscan: 0 / 0
SMU RX
E = 1060 eV
Montag
Dienstag
Mittwoch
Max: 1.152E-08 A / mA
Maxpos: 20.500 mm
FWHM: 0.923 mm
Center(50%): 20.566 mm
Scanschrittweite: 0.100 mm
PGM_K617_3 / Ring_1 / (A/mA)
Det.-R=nicht Bigref Filter:
ID-SMU-PGM-1-RX / mm


file date: 19.02.2018 StartTime 17:53:38 EndTime
TITEL
Subscan: 0 / 0
SMU RX
E = 1622 eV
Montag (cff 2.1)
Dienstag (cff 1.7)
Mittwoch (cff 1.7)
Max: 2.685E-10 A / mA
Maxpos: 20.400 mm
FWHM: 1.562 mm
Center(50%): 20.781 mm
Scanschrittweite: 0.100 mm
PGM_K617_3 / Ring_1 / (A/mA)
et.-R=nicht Bigref Filter:
ID-SMU-PGM-1-RX / mm

Blenden – Lage und Breite der Kante

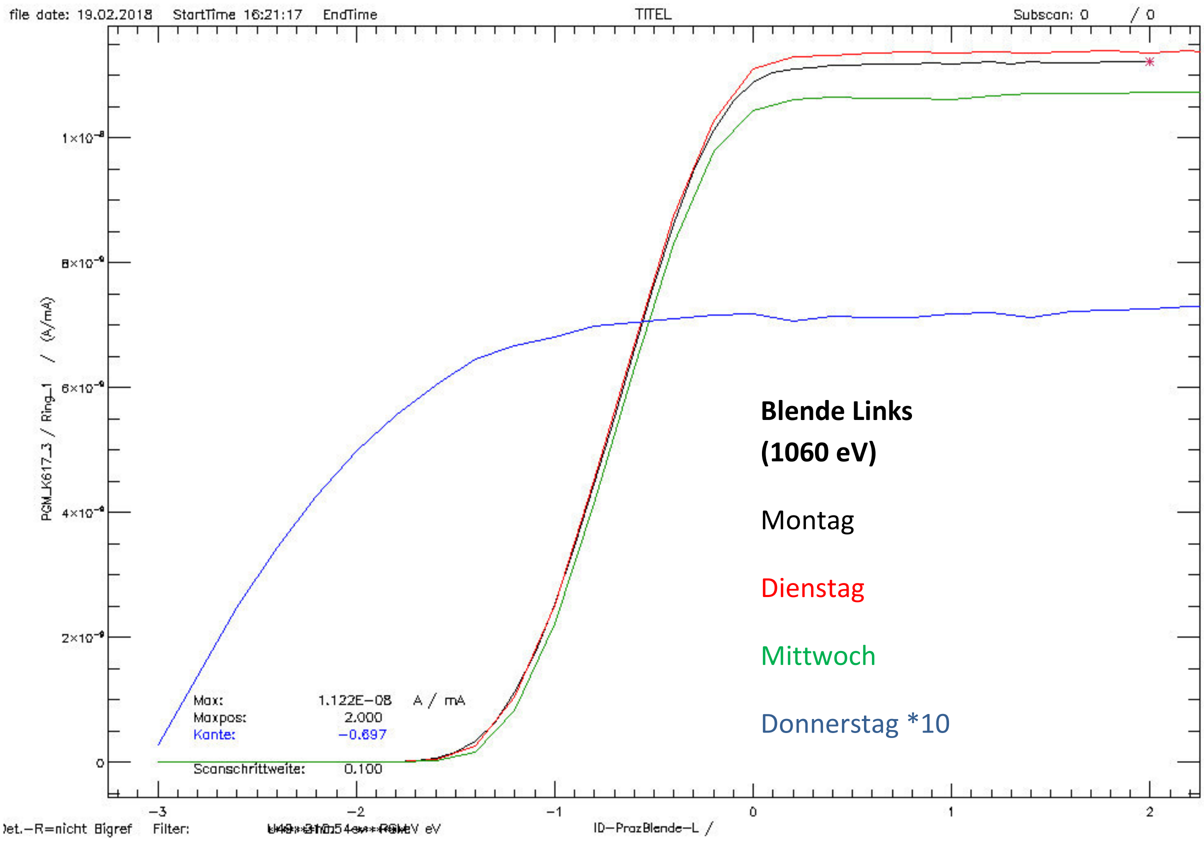
Scan	Mo	Di	Mi	Do
1060 eV Blenden	#3-6	#57-60	#125-128	#157-160
520 eV Blenden	#14-20	#68-71	#136-139	-
1622 eV Blenden	# 26-28(2.1)	# 43-46(1.7) #30-33 (2.1)	# 109-113(1.7)	-

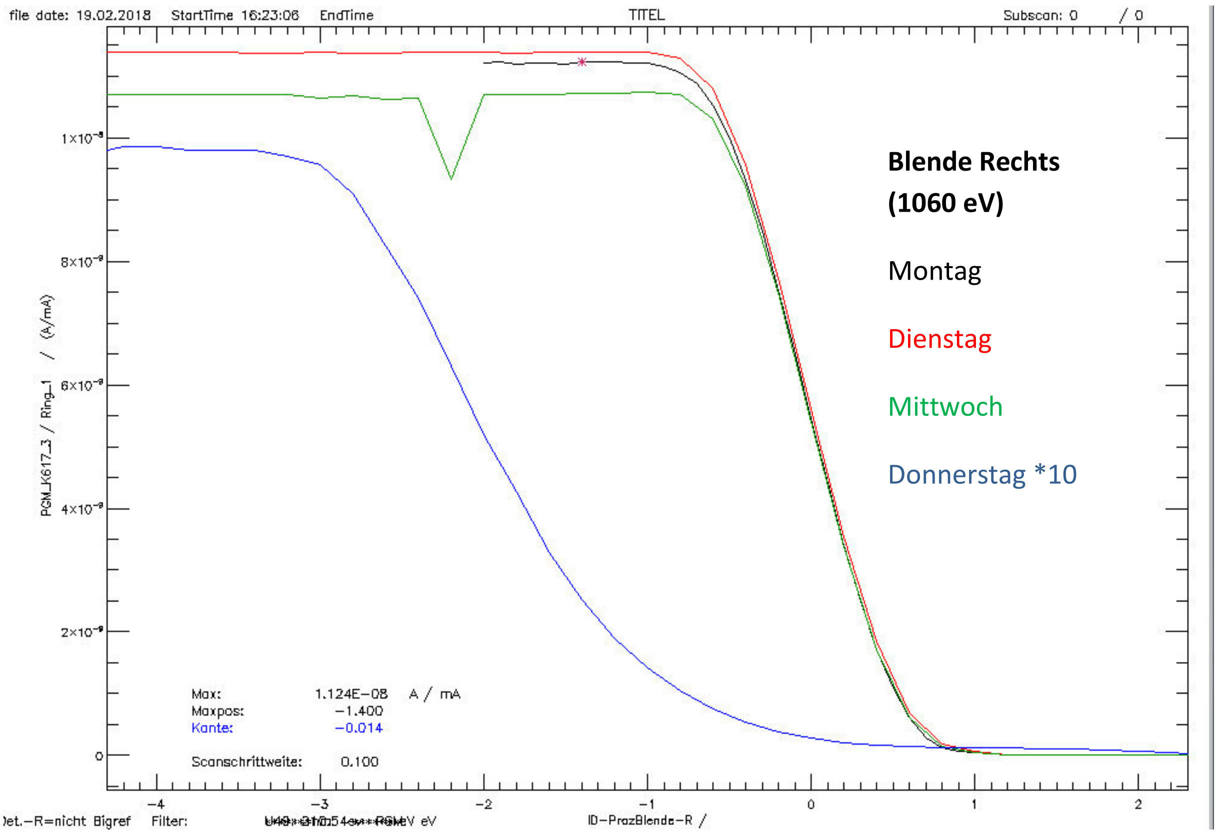
1060 eV Blendenlagen Für 98% offen	**Mo**	**Di**	**Mi**	**Do (nur Island!)**
Rechts	-0.8	-0.8	-0.65	**-3.07**
Links	0.1	0.05	0.02	**-0.75**
Oben	0.35	0.4	0.44	**1.69**
Unten	1.4	1.4	1.22	**1.09**

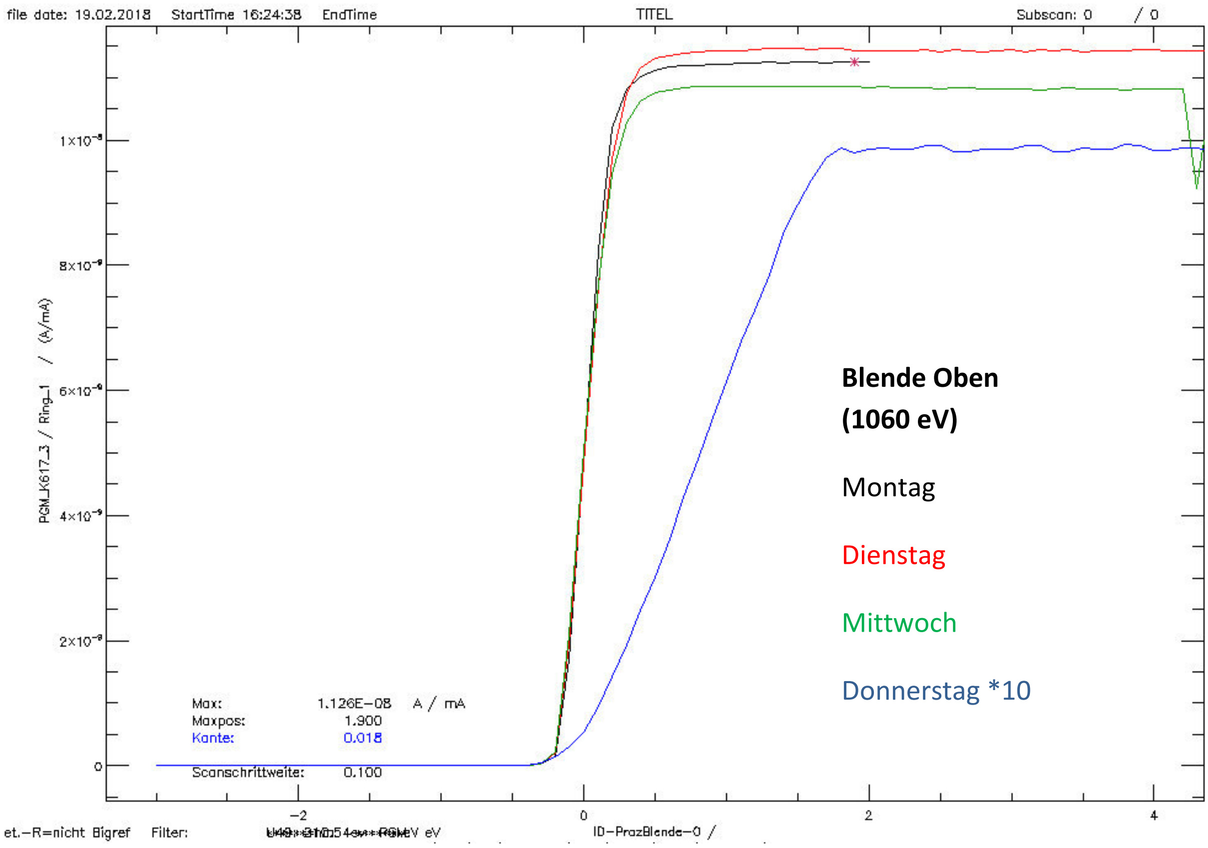
Bei nur Island-Modus wird Lage der Blenden (also Lage des Strahls) stark beeinflusst! Blende Rechts und Blende oben sind weiter offen als sonst, Blende Links und Blende unten sind weiter zu.

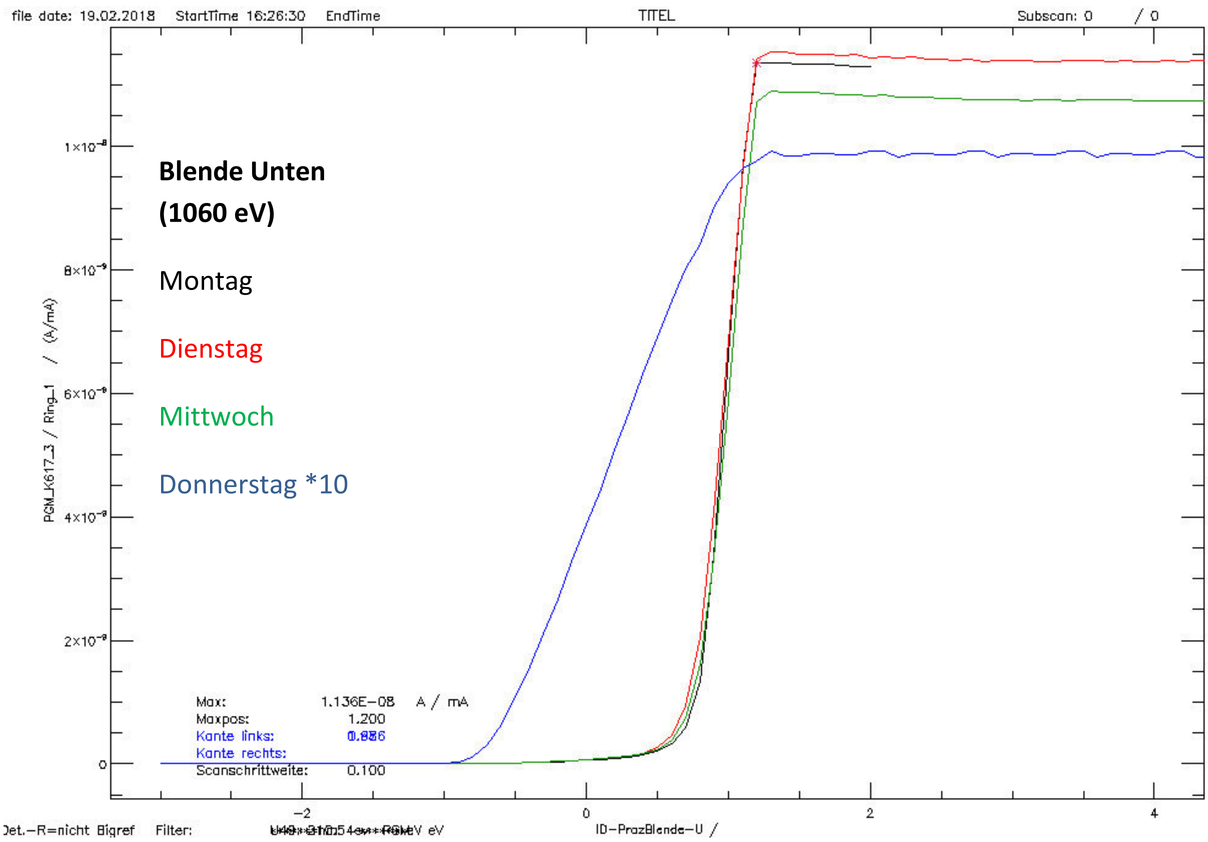
1060 eV Kantenlage (Breite)	**Mo**	**Di**	**Mi**	**Do (nur Island!)**
Rechts	0.0 (1.0)	0.0 (1.1)	0.0 (1.1)	**-2.0** **(1.7)**
Links	-0.7 (1.0)	-0.7 (1.1)	-0.7 (1.0)	**Ca. -2.4** **(nicht bestimmbar)**
Oben	0.0 (0.38)	0.0 (0.43)	0.0 (0.41)	**0.81** **(1.64)**
Unten	0.98 (0.39)	0.97 (0.43)	0.98 (0.42)	**0.18** **(1.68)**

Breite der Kante erhöht sich in horizontaler Ebene um ca.70 %, in der vertikalen Ebene vervierfacht sich sogar der Wert!

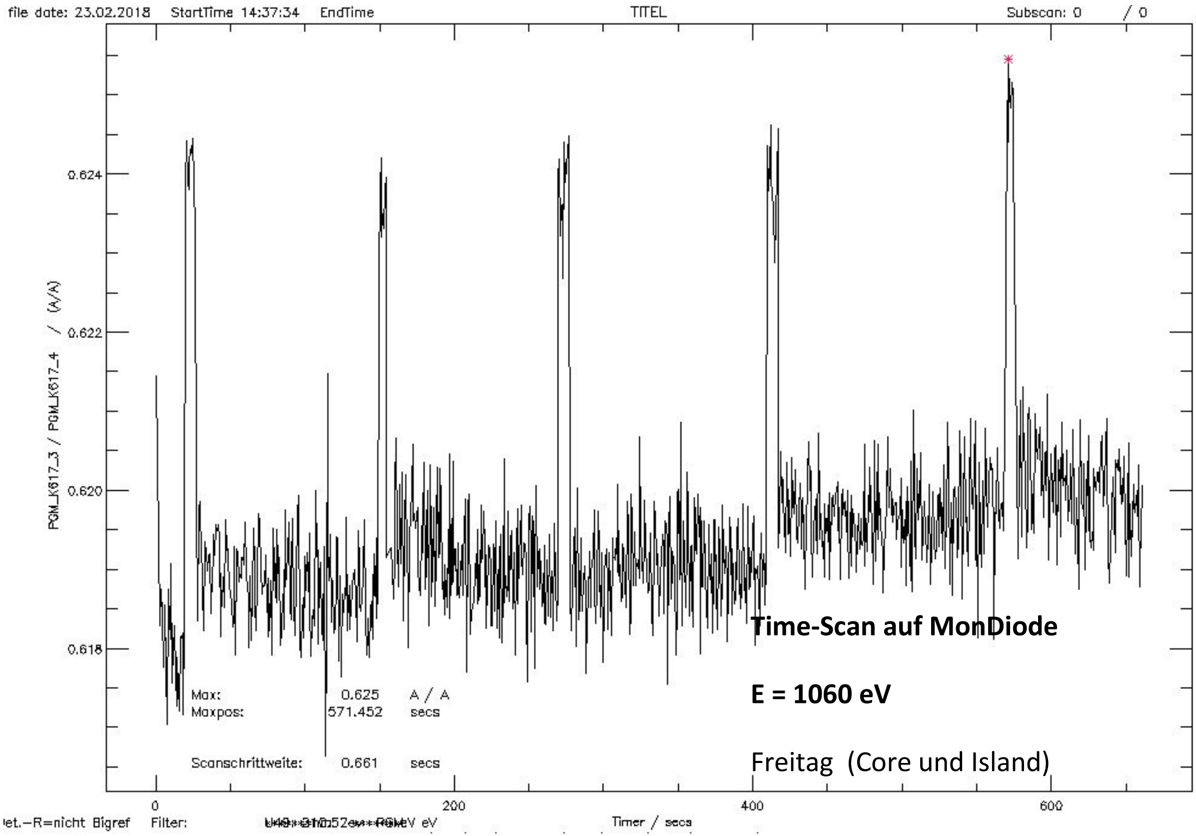

file date: 19.02.2018 StartTime 16:21:17 EndTime
TITEL
Subscan: 0 / 0
PGM_K617_3 / Ring_1 / (A/mA)
Max: 1.122E-08 A / mA
Maxpos: 2.000
Kante: -0.697
Scanschrittweite: 0.100
ID-PrazBlende-L /
Filter:
Blende Links
(1060 eV)
Montag
Dienstag
Mittwoch
Donnerstag *10

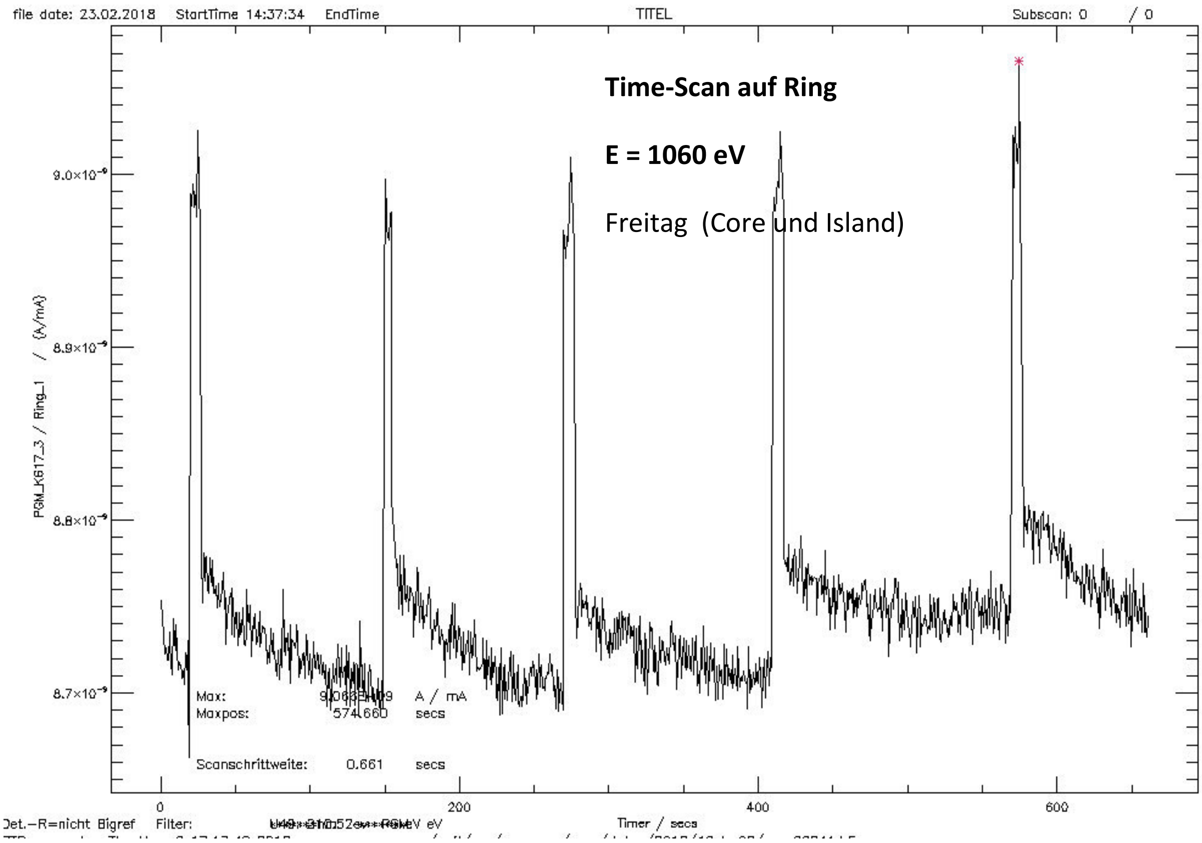

file date: 19.02.2018 StartTime 16:23:06 EndTime
TITEL
Subscan: 0 / 0
PGM_K617_3 / Ring_1 / (A/mA)
Max: 1.124E-08 A / mA
Maxpos: -1.400
Kante: -0.014
Scanschrittweite: 0.100
ID-PrazBlende-R /
Filter:
Blende Rechts
(1060 eV)
Montag
Dienstag
Mittwoch
Donnerstag *10


file date: 19.02.2018 StartTime 16:24:38 EndTime
TITEL
Subscan: 0 / 0
PGM_K617_3 / Ring_1 / (A/mA)
Blende Oben
(1060 eV)
Montag
Dienstag
Mittwoch
Donnerstag *10
Max: 1.126E-08 A / mA
Maxpos: 1.900
Kante: 0.018
Scanschrittweite: 0.100
ID-PrazBlende-O /


file date: 19.02.2018 StartTime 16:26:30 EndTime
TITEL
Subscan: 0 / 0
PGM_K617_3 / Ring_1 / (A/mA)
Blende Unten
(1060 eV)
Montag
Dienstag
Mittwoch
Donnerstag *10
Max: 1.136E-08 A / mA
Maxpos: 1.200
Kante links:
Kante rechts:
Scanschrittweite: 0.100
ID-PrazBlende-U /

Timescan bei Core + Island Modus

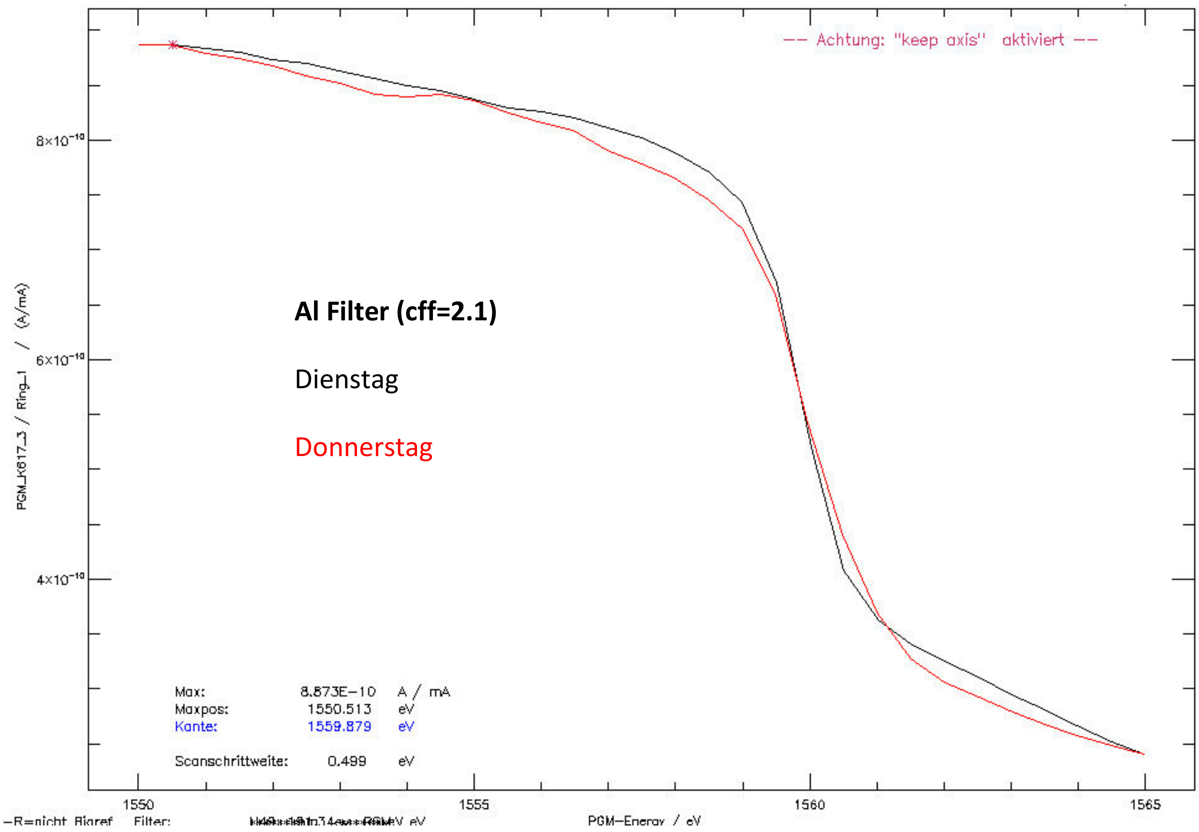


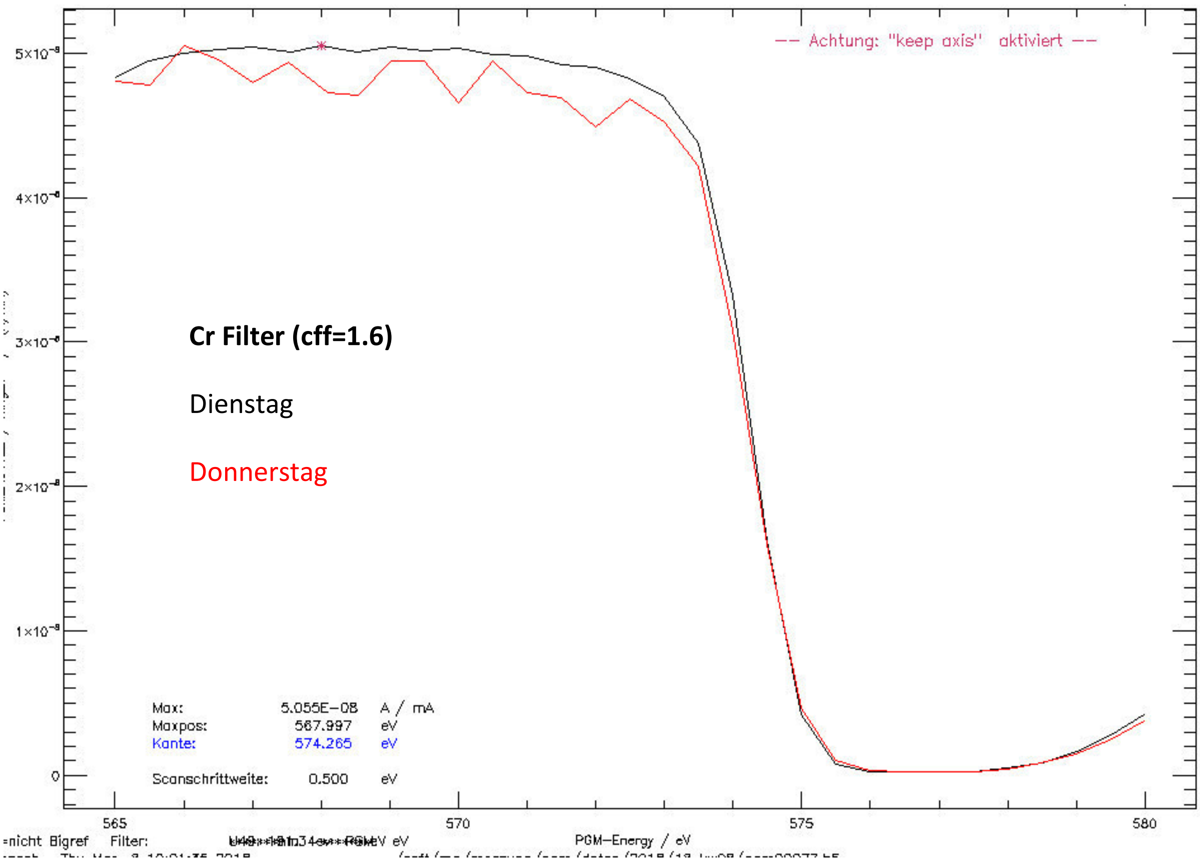


Energieachsenüberprüfung mit Filter

(Lagen bestimmt mit mKolbe Auswerteroutine aus Wiki)

Element (cff)	Di	Mi	Do
Al (2.1)	1560.0 eV	1559.5 eV	1560.0 eV
Al (4.2)	1559.5 eV	1559.5 eV	1559.5 eV
Cr (3.2)	574.5 eV	574.5 eV	574.5 eV
Cr (1.6)	574.5 eV	574.5 eV	574.25 eV





Kantenlage und Breite ändert sich nicht -> keine Verschlechterung der Energieauflösung