## XFEL Operator Training Start-Up Procedure

Matthias Scholz MXL

Hamburg, 23.02.2017





European XFEL

#### What is the aim of this operator training?

- You will learn how to restart the XFEL after maintenance day and how to ensure safely machine operation.
- That includes:
  - What is necessary for tunnel search
  - Granting magnet current and beam permission
  - Using the sequencer
  - Ensuring proper magnet and RF settings
  - Ensuring proper beam parameters
  - Trouble shooting

...



#### **Tunnel search**

- So far, we have in total 7 interlock areas that have to be set for beam operation in the XTL:
  - Injector 1
  - Labyrinths 1 and 2
  - XTL/XSE and XTL/XS1
  - MS ZSIN and MS XSE
- Each of these areas has to be searched by two trained operators. A third operator can participate as trainee.
- You need the following for tunnel search:
  - Safety shoes
  - Helmet
- Flashlight
- Oxy-Box
- Tunnel search instruction
- Interlock key from BKR.





Matthias Scholz, 23.02.2017

BKR interlock keys for labyrinths and media shafts (L/MS), Injector 1 and XTL



**European XFEL** 

#### XFEL operator training, start-up procedure

## **Sequencer files**

	File Operator XI	FEL	
<u>F</u> ile	e <u>V</u> iew <u>O</u> ptions <u>T</u> ools Remote-Control <u>H</u> elp		
χ	Last file restored (or saved): 2017-02-22T	14:21:06+01 ( ID=7848 ) diff.= 27	
Í 🖳	Machine File Catalog 🛛 🧟 Sequence files 🖉 Symbolic files 🗍 📝 Re-writable files		
	XFEL has 38 sequence files. With the following filters: 9 fi FILTERS	iles listed in the table below. remove all filters	
Γ.	Title	Filename	
	Shut down XFEL (XTIN1–XSE–XTL–XS1)	seq_shutdown.xml	-1
	Shut down XTIN1	seq_shutdown_xtin1.xml	-1
	Start up: Cup to B1D	seq_snutaown_xti.xmi	-1
	Start up: Gun to G1D (gun mode)	seg startup_010.xml	-1
	Start up: Gun to IID (injector 1)	seg startup i1d.xml	
	Start up: Gun to TL/TLD	seq_startup_tld.xml	
	Switch to injector 1 mode (beam to I1D, BS closed)	seq_switch_to_injector1_mode.xml	
	Switch to linac mode (beam through dogleg, BS open)	seq_switch_to_linac_mode.xml	
•			
	Selected SEQUENCE file:	open in sequencer	
			_

Matthias Scholz, 23.02.2017

- Open the sequencer (Main Taskbar, Operations Procedures, Sequencer)
- Select the start-up sequence suitable for the planed machine operation. For example 'Start up: Gun to TL/TLD'.
- Press the 'open sequence'-button appearing on the bottom right of the panel.



4

#### 5

#### **Start-up sequence**

- Start the sequence
- It will take care of all steps necessary to get beam in the XTL.
- The sequence will stop at the following lines:
  - Await magnet permission
  - Await un-grounding
  - Await beam permission
- Magnet and beam permission have to be granted at the interlock console.
- Un-grounding of the magnets has to be done by MKK shift crew.

🔴 😑 🔵 File Edit	t View C	Options Help		File Operator XFEL						
XŦ	ΈL	SEQUENCE: Start up: Gun Filename: seq_startup_tld.xml	to TL/TL	3						
	S	equencer Control								
		START sequence	STOP s	equence STATUS: id	le	CLOS	SE window			
User Par	ameters									
Initiali	ze magne	ts: yes 🔻								
Open v	alves: ye	·S 💌								
	enabled	description	status	remarks	restore	check	user actions			
	V	Disallow bunch production	-		3 data					
	r	Block laser	-		1 data					
	r	Verify modulators for XTIN1 are off	-			3 data				
	V	Verify modulators in XTL are off	-			25 data				
	r	Await magnet permission XTIN1	-			1 data				
	r	Await un-grounding of XTIN1 magn	-			1 data				
	r	Await magnet permission XTL	-			1 data				
	r	Await un-grounding of XTL magnets	-			1 data				
	V	Remove write protection from interl	-		2 data	+2 data				
	V	Activate dump dipoles	-		6 data	+6 data				
	r	Start standardization of dump dipol	-		6 data					
	r	Activate magnet power supplies	-		650 data	+650 data				
	r	Deactivate unused power supplies	-		34 data	+34 data				
	V	Await standardization of dump dipo	-			8 data				
	V	Switch off unused dump dipoles	-		4 data	+4 data				
	V	Force CBBs into clean state	-		2 data	2 data				
	V	Set write protection on interlocked	_		2 data	2 data				
	r	Solenoids to minimum operational c	_		2 data	2 data				
	V	Await beam permission XTIN1	_			1 data				
	V	Check beam permission XTL	-			1 data				
	V	Enable RF FSMs	-		29 data	+29 data				
		Start modulators	-		29 data	29 data				
	V	Start TLD dump vacuum pump	-		1 data	1 data				
		Await opening of TLD dump exhaus	-			1 data				
		Onen TLD dumn valve	_		1 data	1 data				
		Open C1-TLD valves	_		41 data	42 data				
		Open G1*TLD valves			-i uata	TZ UALA				

Matthias Scholz, 23.02.2017

#### Magnet current permission

If you are interested in the magnet current permission status in the single areas, open the following panel: Main Taskbar, Operations and Procedures, Personnel Interlock, Magnetstromfreigaben





Matthias Scholz, 23.02.2017

#### **Beam permission**

If you are interested in the beam permission status in the single areas, open the following panel: Main Taskbar, Operations and Procedures, Personnel Interlock, Strahlfreigaben



**European XFEL** 



## Symbolic files in the sequencer

The sequence run before can not (yet) load a file including magnets strengths, RF settings as well as diagnostics parameters.

This has to be done in the next step.

			File Operator	XFEL		
ie view Options Tools	<u>H</u> elp					
KFEL	Last	file restored (or sav	ed): 2017-02-227	[14:21:06+0]	1 (ID=7848) diff.= 33	
Machine File Catalog	Sequence files	🔁 Symbolic files	📝 Re-writable files			
			XFEL has 7 sym	bolic files.		
Filenam	e	Title		File ID	File timestamp	File comment
injector_gun_5MW_on_	crest_0020pC.xml	Injector, gun 5 I	/W, on crest, 20 pC	4464	Sun 2016-07-17 15:18:17	20 pC, many bunches, matched optics
injector gun 5MW on	crest 0100pC.xml	Injector, gun 5 M	W, on crest, 100 pC	4451	Sun 2016-07-17 12:24:46	100pc 1 bunch emittance h0.525 v0.97
injector_gun_5MW_on	crest_0200pC.xml	Injector, gun 5 M	W, on crest, 200 pC	2821	Thu 2016-04-21 04:30:54	Matched optics for 0.2 nC, Gun 5MW,
injector_gun_5MW_on_	crest_0500pC.xml	Injector, gun 5 M	W, on crest, 500 pC	2811	Thu 2016-04-21 03:26:06	Matched optics for 0.5 nC, Gun 5 MW,
injector_gun_5MW_on_	crest_0700pC.xml	Injector, gun 5 M	W, on crest, 700 pC	2807	Thu 2016-04-21 02:52:12	Matched optics for 0.7 nC, Gun 5 MW,
injector_gun_5MW_on_	crest_1000pC.xml	Injector, gun 5 MW	, on crest, 1000 pC	2801	Wed 2016-04-20 21:43:29	Matched optics for 1 nC, Gun 5 MW, 1
	optics_file.xml		optics file	59	Mon 2015-12-21 21:21:12	Design beam optics
ECTED FROM TABLE		ID =	timestam	ıp =	REST	ORE: selected file ——> Machine
write select	ed MACHINE file:		ID=	==> into selec	ted SYMBOLIC file:	

**European XFEL** 

Select a symbolic file according to the machine setup plans. Restore the file using the button on the bottom right of the panel.

Typically the run coordinator will tell you which file to use.

There will be additional symbolic files soon.



#### File catalog

In case there is no symbolic file matching the machine operation requirements, load one of the files in the file catalog.

The run coordinator should tell you which one to chose.

The provided filters may help you to find your file in the catalog.

View Or	ptions <u>T</u> ools <u>H</u> elp	Last file re	estored (o	r saved):	File Op	-23T18:14:50+01(ID=7887) diff.= 31		(1-1)
.721								305
Machine F	File Catalog 🛛 🧟 Sequence fi	iles 🛛 🖭 Sy	mbolic fi	les 🛛 🗹 🛛	Re-writable	e files		
VEE	T Catalan has 7450 files	With the	fallowing	filtoner	105 61	a listed in the table below		filters
AFE	L Catalog has 7450 mes.	with the	Tonowing	, inters.	105 1116	inde inters		inters
	S							
	remove all	filtors						
	remove an	inters						
Show w	vith TYPE: 🔲 temp 🗹 norma	l 🗹 refere	nce 🗹 sp	ecial 🗵 o	ptics	Search text (in Status):		
Charry						Search text (in Commont):	]	
Show w	with CLASSIFICATION: 🗹 with	i errors 🗹	without e	rrors 🗹 e	excellent	Search text (in Comment):		
Show w	vith: errors errors in w	ritables				Search text (in Authors):		
		incubico						
Shov	w newer than 01.January.201	.3	*			Search text (in Category): sequencer		
L								
ID	Timestamp	Beamline	E [GeV]	λ [nm]	SASE [µJ]	Comment File type	Authors	e-log link
7215	Wed 2017-02-15 22:30:36					B2D, 0.5nC,2.3GeV,magnets cycled reference	dtischhauser	<b>^</b>
7101	Tue 2017-02-14 21:50:53					B2D full transmission, 400 pC, on-crest reference	Sanzone	
7094	Mop 2017 02 12 19:12:24					cransmission ~ 96% to BID with energy normal	mechalz Carth	
7020	Mon 2017-02-13 18:12:24					Injector 500pC on-crest matched asy reference	Certh mscholz	
7024	Mon 2017-02-13 18:07:17					Injector 500 pC on-crest matched sy reference	Gerth, mscholz	
6865	Thu 2017-02-09 23:48:30					0.5nC 1 bunch 600MeV 77% B2 trans normal	tamras majano	
6803	Tue 2017-02-07 05:35:09					Ini. Mode trans 100% only 94% at 64m normal	KAH	
6799	Mon 2017-02-06 23:18:25					Inj. Mode trans only 96% to Dump normal	KAH	
6797	Mon 2017-02-06 16:44:36					orbit for laser heater studies normal	F.Brinker	
6741	Sun 2017-02-05 22:28:55					design dipoles and sextupoles in the d normal		
6733	Sun 2017-02-05 17:27:10					Practically no linear dispersion leaking normal		
6732	Sun 2017-02-05 17:15:16					linear dispersion about 1 cm at the ma normal		
6729	Sun 2017-02-05 16:26:47					100 pC to B1 dump, dogleg from previ normal		
6624	Sat 2017-02-04 21:41:59					sextupoles off, dipoles in the second ar normal		
6621	Sat 2017-02-04 20:09:26					Before setting dogleg to design values normal		
6609	Sat 2017-02-04 18:05:05					1.8 CoV, 04% to P2, 20 bunches, 0.5 pC, normal		
6605	Sat 2017-02-04 15:01:44					18 unch 500nC 95% transmission R2D normal	tamras majano	
66003	F-: 2017 02 02 22:02:00				L	1.0 CeV 0.5 aC 0.500 transmission to D	tannas, malano	•
	SELECTED FROM TABLE							_
								_
	Selected file:		ID:	=		TOPE: selected file - Machine WRIT	Finto a symb file	
	bereeten mei					TORE Selected The Machine	L mto a symb. me	



#### Magnet energizer

The sequencer writes kick strengths to the magnets, not currents. The magnet ML server calculates the correct current from the kick strengths and from the momentum setpoint of the magnets.

The momentum setpoint of the magnets can be easily changed using the magnet energizer.

- **B0** B1 B1D B1M B1T B2 B2D B2M B2T • • • CL G1 G1D I1D (GeV)I1M I1T 1.5 1.1 12  $E_{\rm beau}$ 1.0 13 MAG\_B1D MAG B2D  $E_{mag}$ 0.5 MAG G1D MAG I1D MAG T4D 300 MAG\_T5D z (m)MAG\_TLD OP\_B1D Energy (abs.) Subtrain SA1 OP\_I1D ΔE (MeV) I∆E/Ebeaml (%) OP\_T4D Magnet name z (m) ≜ Emag (MeV) Ebeam (MeV OP T5D 0.30 QI.118.I1 129.6 118.91 130.0 04 read OP\_TLD SA1 Q.134.L1 134.18 283.5 285.8 -2.3 0.79 read SA2 CY.134.L1 134.33 283.5 285.8 -2.3 0.79 ready SA3 T1 CX.134.L1 134.33 283.5 285.8 -2.3 0.79 read Τ2 тз Q.146.L1 146.17 485.2 -5.3 1.09 479.9 ready τ4 CY.146.L1 146.32 479.9 485.2 -5.3 1.09 ready T4D **T5** CX.146.L1 485.2 -5.3 1.09 146.32 479.9 read T5D TL TLD Q.158.L1 158.16 635.8 643.7 -8.0 1.24 ready TLM TLT CY.158.L1 158.31 635.8 643.7 -8.0 1.24 ready CX.158.L1 158.31 635.8 643.7 -8.0 1.24 ready UN1 UN2 Q.170.L1 170.15 800.0 810.7 -10.8 1.33 ready CY.170.L1 810.7 -10.8 1.33 170.30 800.0 ready CX.170.L1 810.7 -10.8 1.33 170.30 800.0 ready 01476 04 0107 10.0 170 10
- You can find the energizer here: Main Panel, Magnets, Magnet Energizer
- Select the beamline in the third dropdown menu. The beamlines starting with OP\_ include all magnets from the gun to the named dump.
  - The momentum setpoints have to be in agreement with the beam energy at each position in the beamline.
  - If that is not the case, select 'keep strength (scaling)' and press the 'set to beam energy' button. This relies (yet) on properly calibrated RF stations.



#### **Magnet overview**

Open the magnet overview here: Main Panel, Magnets, Magnet Overview.

Select the correct beamline and check for magnets that are off or in an error state.

Filter only the dirty magnets, open group control and cycle only the magnets that need cycling.

Filter the busy magnets (SP and RBV are different). Refresh the filter by clicking on 'busy' from time to time. The number of shown magnets should become less and less.

Wait until no magnets are busy any more.

Check one more time for magnets that are off or in an error state.

				XFELMagOv	erview.xml XFEL.MA	GNETS/MAGNET.ML/*	1					
XFEL MAGNET OVER	RVIEW											Print
Some Magnets need cycling! Cycling: show hide		-~			•	<b>~</b> ==		<b>_</b> 1				
Magnet groups for entire beamlines (gun to dum GUN INJECTOR BC1 Close	np): BC2	LINAC	SE1/3 SASE2	-					~			
MAG_B2D	CX.39.I1	CBL.88.I1	CIY.92.11	CIY.94.11	CIX.95.I1	CIY.103.I1	CIX.109.I1	CBB.229.B1D	CCX.232.B1	CCY.232.B1	CY.285.L2	Q.309.L2
Show: Set Group Magnets	ОК	ок	ОК	ОК	ок	ОК	ОК	ОК	ОК	ОК	ОК	ОК
All Busy On Clean ON	need cycling	need cycling	need cycling	need cycling	need cycling	need cycling	need cycling	need cycling				
OFF OFF	0.258 mrad	-0.400 mrad	-0.800 mrad	-0.700 mrad	0.150 mrad	-0.400 mrad	0.100 mrad	-0.100 mrad	0.302 mrad	0.230 mrad	-0.108 mrad	-0.04 rad/m
Number of Magnets: 283 Cycle Group Magnets	0.71.4	-0.87.4	-0.49.4	-0.43.4	0.09.4	-0.24 A	0.06.4	0.20 A	0.75.4	0.57.4	-2 77 A	-2.43.4
	PS	PS	PS	PS	PS	PS	PS	PS	PS	PS	PS	PS
✓ All ON	Switched on	Switched on	Switched on	Switched on	Switched on	Switched on	Switched on	Switched on	Switched on	Switched on	Switched on	Switched on
() Cycling needed	No fault	No fault	No fault	No fault	No fault	No fault	No fault	No fault				
✓ All idle	Idle	idle	Idle	ldle	Idle	Idle	idle	Idle	Idle	ldle	Idle	Idle
Group Control Close	н	н	н	н	н	Н	н	н	н	н	н	
	•											Þ

Open the tool here: Main Panel, Beam Dynamics, Design Kick Control

This is the best tool we have so far to compare the magnets settings in the machine with the design values.

You can select the magnets with the check boxes and write the design values to the machine. To do that, click on 'Magnets' in the menu bar of the window.

								Figure 1							
File Edit	View I	nsert Tool	s Desktop	Window	Help Mag	nets									3
	Circuit	Class	Middle Layer	Design Circuit	Design Magnet	On	Busy	Error	Min	Max	Section	Z	Combined power supplies	Diff	Set
BL.87.I1	8.11	Dipole	-0.1110	-0.1110	NaN	1	0	0	-0.1850	-0.0012 11		87.832	8 BL.83.I1 [BL.87.I1] BL.88.I	0	
QI.88.I1	22.11	Quadrupole	1.1012	1.1012	NaN	1	0	0	-2.4323	2.4323 I1		88.229	6 QI.83.I1 [QI.88.I1]	0	
BL.88.I1	8.11	Dipole	-0.1110	-0.1110	NaN	1	0	0	-0.1850	-0.0012 l1		88.627	6 BL.83.11 BL.87.11 [BL.88.11	0	
SC.89I.I1	1.11	Sextupole	9.8181	9.8175	NaN	1	0	0	0	17.9884 l1		89.257	7 SC.74I.I1 SC.77.I1 SC.79I.I	0	
QI.89.I1	23.11	Quadrupole	-1.1864	-1.1864	NaN	1	0	0	-2.4323	2.4323 I1		89.507	6 QI.86.I1 [QI.89.I1] QI.92.I1	0	
SC.89II.I1	2.11	Sextupole	5.9488	5.9482	NaN	1	0	0	0	17.9884 l1		89.757	5 SC.74II.I1 SC.76.I1 SC.79II	0	
BL.90.11	7.11	Dipole	0.0427	0.0427	NaN	1	0	0	0.0010	0.1242 11		90.048	4 BL.75.I1 BL.76.I1 BL.80.I1	0	
QI.90.I1	24.11	Quadrupole	1.1946	1.1950	NaN	1	0	0	-2.4323	2.4323 I1		90.755	4 QI.85.I1 [QI.90.I1]	0	
BL.91.I1	7.11	Dipole	0.0427	0.0427	NaN	1	0	0	0.0010	0.1242 11		91.462	3 BL.75.11 BL.76.11 BL.80.11	0	
SC.91.I1	2.11	Sextupole	5.9488	5.9482	NaN	1	0	0	0	17.9884 l1		91.751	6 SC.74II.I1 SC.76.I1 SC.79II	0	
QI.92.I1	23.11	Quadrupole	-1.1864	-1.1864	NaN	1	0	0	-2.4323	2.4323 11		92.000	1 QI.86.I1 QI.89.I1 [QI.92.I1]	0	
SC.92.I1	1.11	Sextupole	9.8181	9.8175	NaN	1	0	0	0	17.9884 l1		92.248	6 SC.74I.I1 SC.77.I1 SC.79I.I	0	
BL.92.I1	8.11	Dipole	-0.1110	-0.1110	NaN	1	0	0	-0.1850	-0.0012 l1		92.875	5 BL.83.I1 BL.87.I1 BL.88.I1	0	
QI.93.I1	25.11	Quadrupole	-0.1694	-0.1694	NaN	1	0	0	-2.4323	2.4323 11		93.276	7	0	
QI.94.I1	26.11	Quadrupole	0.8026	0.8026	NaN	1	0	0	-2.4323	2.4323 I1		94.786	В	0	
QI.95.I1	27.11	Quadrupole	-0.7251	-0.7251	NaN	1	0	0	-2.4323	2.4323 I1		95.796	8	0	
BB.96.I1	1.11	Dipole	-0.1167	-0.1196	NaN	1	0	0	-0.6690	-0.0039 l1		96.646	8 [BB.96.I1] BB.98.I1 BB.100	0.4364	Image: A start and a start
BB.98.11	1.11	Dipole	0.1167	0.1196	NaN	1	0	0	0.0039	0.6690 11		98.146	8 BB.96.I1 [BB.98.I1] BB.100	0.4364	Image: A start and a start
BB.100.I1	1.11	Dipole	0.1167	0.1196	NaN	1	0	0	0.0039	0.6690 l1		100.146	8 BB.96.I1 BB.98.I1 [BB.100	0.4364	Image:
BB.101.I1	1.11	Dipole	-0.1167	-0.1196	NaN	1	0	0	-0.6690	-0.0039 I1		101.646	8 BB.96.I1 BB.98.I1 BB.100.I	0.4364	Image: A start and a start
QI.102.I1	28.11	Quadrupole	0.1635	0.1635	NaN	1	0	0	-2.4323	2.4323 I1		102.506	8	0	
QI.103.I1	29.11	Quadrupole	-0.3231	-0.3231	NaN	1	0	0	-2.4323	2.4323 11		103.616	8	0	
QI.104.I1	30.11	Quadrupole	0.3560	0.3560	NaN	1	0	0	-2.4323	2.4323 I1		104.786	8	0	
QI.107.I1	31.11	Quadrupole	-0.3619	-0.3619	NaN	1	0	0	-2.4323	2.4323 11		107.286	8 [QI.107.I1] QI.112.I1	0	
QI.109.I1	32.11	Quadrupole	0.3619	0.3619	NaN	1	0	0	-2.4323	2.4323 11		109.786	8	0	
QI.112.I1	31.11	Quadrupole	-0.3619	-0.3619	NaN	1	0	0	-2.4323	2.4323 11		112.286	8 QI.107.I1 [QI.112.I1]	0	
QI.114.I1	33.11	Quadrupole	0.2096	0.2097	NaN	1	0	0	-2.4323	2.4323 11		114.936	8	0	
QI.116.I1	34.11	Quadrupole	0.2318	0.2318	NaN	1	0	0	-2.4323	2.4323 I1		116.811	8	0	
QI.118.I1	35.11	Quadrupole	-0.2620	-0.2620	NaN	1	0	0	-2.4323	2.4323 I1		118.911	8	0	
Q.134.L1	.2.1.L1	Quadrupole	0.0806	0.0806	NaN	1	0	0	-0.5650	0.5640 L	1	134.175	6	0	
Q.146.L1	.2.2.L1	Quadrupole	-0.0667	-0.0667	NaN	1	0	0	-0.3338	0.3332 L	1	146.167	3	0	
Q.158.L1	.2.3.L1	Quadrupole	0.0387	0.0387	NaN	1	0	0	-0.2520	0.2515 L	1	158.159	D	0	
Q.170.L1	2.4.L1	Quadrupole	0.0301	-0.0412	NaN	1	0	0	-0.2003	0.1999 L	1	170.150	7	17.8138	



#### **Chicane server**

#### Open the tool here: Main Panel, Magnets, Chicane Server

- This tool should be used to change the dipoles of the bunch compressor chicanes.
- You can either set the
  - deflection angle
  - the R56 transfer matrix element
  - or the beam offset in the chicane.
- The dipole currents are calculated by the magnet ML server.

	KFEL Ch	ican	e S	erver		_	_			_				[	Pi
	LH			E	C0			В	C1			E	C2		
Energy	129.63	MeV	H	Energy	130.00	MeV	H	Energy	799.95	MeV	H	Energy	2100.00	MeV	н
Angle	<u> </u>	dea	H	Angle	<u>2^2 88</u>	dea	Π	Angle	<u></u>	dea	H	Angle	<u>-</u> ^2 61	dea	н
Design: 5.70	000-00	ucy		Design: -6.85	228.88	ucy	-	Design: -2.86	276.88	ucg		Design: -2.39	279.89	ucg	
Rec	<u> </u>	mm		Rec	<u>-36.26</u>	mm		Rec	<u>-</u> ââ, î2	mm	н	Rec	-36.80	mm	н
50	000000			50	000100			50	000000			50	000100		
BC	<u></u>	mm	н	"BC	<u>-</u> 1%2-8	mm	н	"BC	-920-0	mm	н	"BC	- <del>3</del> 11-8	mm	н
dt	7.30	ps	н	dt	59.93	ps	н	dt	73.45	ps	н	dt	61.28	ps	н
<sup>2</sup> ower supply c Class	ircuit Dipole			Power supply circu Class	lit Dipole			Power supply circu Class	it Dipole			Power supply circi	ult Dipole		
PS Circui	t BL.1.I1			PS Circuit	BB.1.I1			PS Circuit	BB.1.B1			PS Circuit	BB.1.B2		
V PS Or	n/Off			PS On/Of	f to protoction			PS On/Off				PS On/Of	f		
	white protection			Circuit wi	te protection			Circuit wit	le protection			Circuit wi	te protection		
<ul> <li>Switch</li> <li>No fau</li> </ul>	ed on It ldle		н	<ul> <li>Switched</li> <li>No fault</li> </ul>	on Idle		н	<ul> <li>Switched of</li> <li>No fault</li> </ul>	n Idle		н	<ul> <li>Switched</li> <li>No fault</li> </ul>	on Idle		н
					1010										
Magnet 1: Magnet 2:	BL.48I.I1 BL.48II.I1			Magnet 1: Magnet 2:	BB.96.11 BB.98.11			Magnet 1: Magnet 2:	BB.182.B1 BB.191.B1			Magnet 1: Magnet 2:	BB.393.B2 BB.402.B2		
Magnet 3:	BL.50I.I1			Magnet 3:	BB.100.I1			Magnet 3:	BB.193.B1			Magnet 3:	BB.404.B2		
Magnet 4:	BL.50II.I1			Magnet 4:	BB.101.I1			Magnet 4:	BB.202.B1			Magnet 4:	BB.413.B2		



- Any error messages from FSMs shown?
- Is the laser blocked by the MPS?
- Cryo and Vacuum ok?
- Are the slow feedbacks on/off?
- Is the DAQ ok?

...

What is the status of the magnets?



15 h 20 h

21 h 22.2.2017 0 15 h 21 h 3 h 9 h 22 2 2 017 23 2 2017 23 2 2017 23 2 2017

16 h

Matthias Scholz, 23.02.2017

מממדת ו המתרכות המרכידת הדרומות המת



**European XFEL** 

### **Cockpit panel**

- This panel contains all important functionalities that you need to operate the machine!
- Information that is not present on the panel itself it typically linked. Either on the panel at good visible positions or in the drop down menu on the top left.
- This panel is professionally maintained.





Matthias Scholz, 23.02.2017

# Cockpit panel, injector view

gun phasescan.xml XFEL.RF/GUN PHASESCAN/GUN.I1/\*

Expert

Phase Stability

XFEL

Automatic Scan Manual Scan

GUN PHASE SCAN



Reduce the charge to 100 pC using the charge feedback.

- Open the gun phase scan tool, which you can find on the main panel after pressing the 'Injector' tab.
- Scan the gun phase.
- More about the gun phase on the next slide.
- Go back to initial bunch charge.
- Measure A1 and AH1 phase with IntelliPhase.



This is a temporary solution. Some steps will not be necessary any more in the future.

### Set gun phase

Measure the gun phase using the provided tool.

- Lets assume the recommended gun phase is -46 degree.
- Change the gun phase on the gun LLRF panel to -1 degree (-46 + 45 = -1, 45 degree is the default gun phase).

Use the LLRF on-crest Matlab tool to set the gun phase.

- Go back to -45 degree gun phase.
- You can find the tool on the Main Panel, RF, Set On-Crest Phase
- The on-crest server, that is linked below the Matlab tool is not yet capable to set the gun phase.



gur_phasescall.xill XFEE.KT/OOK_PHASESCAR/OOK.T/	
GUN PHASE	SCAN Lets assume the recom
Charge vs. Gun Phase	Change the gun phase (-46 + 45 = -1, 45 degree Use the LLRF on-crest
0       -0.02       -0	VetL.GUN.lift_main.xml       XFEL.RF/LLRF.CONTROLLER/GUN.l1/         Print         ILLRF CONTROL MAIN.GUN.l1         Main Control         Voltage       \$\$\hat{2}, \$\hat{2}, \$\hat{0}\$\hat{0}\$         S2.48 MV/m         Phase       \$\hat{2}, \$\hat{2}, \$\hat{0}\$\hat{0}\$         42.25 deg       Pulse Width Modulation         Overview Panal       Pulse Width Modulation         Prescience       Image: Control         Print       Pulse Width Modulation         Overview Panal       Prescience         Prescience       Image: Control         VM       KLY1         WG 3       WG 34         WG 34       WG 34
AutoScan: Recommended phase -46.0 deg (= -1.0 deg - 45.0 deg)         Clear       Start Automatic Scan         Send to xfellog       F	Virtual Probe         RF Meas.         GUN Power         LLRF Special           60.
European XFEL	-10

#### **Orbit panel**

You can find the panel here: Main Panel, Orbit, Orbit (Inj-TLD)



- This panel provides both, beam orbit along the beamlines as well as steerer strengths.
- You can click on one of the steerers to open a magnet middle layer panel where you can change the kick setpoint.
- This is one of the panels, that should always be open!
- Unblock the beam and check the beam orbit along the machine.
- Use either the orbit feedback or the orbit correction tool to correct the beam orbit.
- Only minor corrections should be done with point to point steering.



#### **Beam energy**

- Verify the beam energy in the dogleg. The default beam energy of the injector is 130 MeV.
- You can find the beam energy either on the cockpit panel or you can open the foreseen panel here: Main Panel, Diagnostics, Beam Energy Measurement.
  - The beam energy measurement in the bunch compressors is not available yet.



🖲 😑 XFEL_beam_e	nergy_measurement	.xml XFEL.DIAG/B	EAM_ENERGY_ME	ASUREMENT/LH/*
	1 ENERGY	MEASUF	REMENT	SERVER
B0 B1 B1D	B2 B2D CL	Expert Lat	tice	IIT
Measured energies:	Litt(old)			 ∠ Online
incubated energies.	SA1	SA2	SA3	
Beam energy: delta at lattice start: x at lattice start: y at lattice start: x' at lattice start: y' at lattice start: y' at lattice start:	131.45 MeV 0.0111 NaN mm 1.0285 mm NaN mrad 1.2543 mrad	0.0 0.0 0.0 0.0 0.0 0.0 0.0	0.0 0.0 0.0 0.0 0.0 0.0	first bunch only (realtime)
First bunch: Mean: Min: Max: Peak-to-peak: Standard deviation:	0.00 MeV 0.00 MeV 0.00 MeV 0.00 MeV 0.0000 MeV 0.0000 MeV	0.00 MeV 0.00 MeV 0.00 MeV 0.00 MeV 0.000 MeV 0.0000 MeV	0.00 MeV 0.00 MeV <sup>BE</sup> 0.00 MeV 0.00 MeV 0.0000 MeV 0.0000 MeV	MPLEMENTED all bunches (slow update)
0.08 0.04 -0.04 -0.04 -0.04 -0.04 -0.04	GY_SLOW.TD Res≕1/	16 (MeV)		
-50. 50.	150. 250.	350. 450.	550. 650.	750. 850. []
		ok		
		Send	to xfellog	Help
				• % • • • • • •

0.01 W

#### **Measure emittances**

You can find the emittance measurement tool here: Main Panel, Beam Dynamics, Emittance Monitor



Measure beam optics and emittances in the injector.

- The emittances should be of the same size in both planes.
- If this is not the case, you can change the main solenoid to get a better symmetry.
- Consider, you can not believe the emittance measurement if the mismatch amplitude is about or larger than 2.

File Setup	ittanceMonitor		<u>ب</u>						
injector			0						
status:		ready							
current dataset:		no current dat	a						
current optics status:	Phase Adv	/ance: 77.05 de	g / 75.42 deg						
start measurement									
close laser shutter		laser shutter open							
activate cameras in I1		not all cameras	in I1 are on						
can not configure cameras in I1	not all cameras in I1 are on								
insert off-axis screens in I1	screens in I1 out								
🗸 off-axis kicking	slice emittance								
take new background	🗌 use	e "Optics Serve	r"(⊤M)						
fully remove screens	🛃 aut	🗹 automatic gain control							
1	natch beam								
actual beam energy [MeV]:	129.	601	read energy						
magnet reference energy [MeV]:	130								
bunch number to kick:	1	train end	train end+1						



#### Match the beam

File Setup	ittanceMonitor	3						
injector		0						
status:	ready							
current dataset:	no current data							
current optics status:	Phase Advance: 77.05 deg / 75.42 de	g						
start measurement								
alaa laan ahuttar								
close laser shutter	laser shutter open							
activate cameras in 11	not all cameras in I1 are on							
can not configure cameras in I1	not all cameras in I1 are on							
insert off-axis screens in I1	screens in I1 out							
off-axis kicking	slice emittance							
🗸 take new background	use "Optics Server"(TM)							
✓ fully remove screens	🔽 automatic gain control							
r	natch beam							
actual beam energy [MeV]:	129.601 read energy	read energy						
magnet reference energy [MeV]:	130							
bunch number to kick:	1 train end train en	d+1						

- You can/should match the beam after an emittance measurement by pressing the 'match beam' button on the emittance monitor panel.
- The mismatch amplitude in both planes should be smaller than 1.1 before you continue.
- The beam should be matched latest after 3-4 matching iterations.





### Beam beyond the dogleg

There should be already transmission to the B2D dump since you corrected the orbit.

The injector delivers now a well defined beam to the linac.

#### The next steps are:

- Switch on the B1D dump dipole BB.229.B1D (-12 degree deflection angle) and measure the on-crest phase of A2 using IntelliPhase.
- Set BB.229.B1D back to zero current (be careful, zero deflection angel is not possible) and correct the remanend filed using the dipole's correction coil CBB.229.B1D.
- Do the same for L2 (A3, A4 and A5) while the beam goes to the B2D dump.
- In the near future, it will not be necessary to measure the on-crest phases of A2-A5 in the dump beamlines. But until the E-BPMs in the chicanes are in operation, we have to do it this way.
- Now you can start to optimize beam optics and emittancens in B1 and B2. Use the Emittance Monitor as described before (and as described in the particular operator training).
- After that, you can open the valve to L3 and set the B2D dump dipole to zero current.
  - Futher steps will be discussed in future versions of this operator training.



### Some ideas for trouble shooting

- Assuming there is no transmission through the beamline. What can it be that stops the beam?
   A closed valve or a screen that was forgotten in the beamline.
  - A strong steerer that deflects the beam towards the vacuum chamber.
  - In general, a wrong magnet setup (kick set points or momentum set points).
  - There might be a collimator in the bunch compressor moved in too far for the aimed beam orbit.
  - If an RF station fails, the beam has not enough energy to pass through chicanes.
  - Assuming there is no RF pulse in one of the modules/RF stations. What can you do?
    - Check the overview panel which RF station failed.
  - Open the FDM panel of the concerning station (Main Panel, RF, FSM -> select the station in the drop down menu on the top right).
  - If there is an error message, try to solve the underlying problem (if you can). Otherwise had over to the experts from MKK or to the expert on call from MHF-p (MIN in case of AH1 or TDS) or LLRF.

