Dechirper longitudinal phase space (LPS) measurements for beginners

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Operator Training, 11.12.2024





HELMHOLTZ

Disclaimer

- LPS measurements with the post-SASE2 dechirper are easy to perform and relatively safe for the machine.
- Always save the machine file before conducting measurements or making any changes to the machine. This is a good practice!
- Minimize beam usage to reduce radiation load.
- Note: Passive streaker = dechirper = corrugated structure = wakefield structure = chirper.

Passive streaker Linac L3 Linac L1 Linac L2 CRISP A25 A2 BC1 Α3 A4 A5 BC2 A6 **BCO** gun A1 AH1 130 MeV 700 MeV 2.4 GeV TDS up to 17.5 GeV 🍎 SASE1 ASE3 TDS



BC(0,1,2) – bunch compressor | TDS – transverse deflecting structure | CRISP – coherent diffraction diagnostics





Short introduction into passive streaker LPS measurement

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What systems/devices we change or can potentially change during usage of the dechirper tool. Or how to restore the machine manually

- Correctors in the T3 section (after SA2) and the last air coils in SA2: These correctors are used to create a bump and adjust the beam to get a better spot on the screen.
- **Quadrupoles in the T3 section:** Beam optics are adjusted here.
- **Screen OTRC.2560.T3** Can be still in
- **Corrector CFX.2154.T1** in front of SA2. We suppress SASE with this corrector
- **Orbit FBs SA2 and T5D** can be switched off
- **Number of bunches in SA2 branch.** Likely to be set to 0.
- **Bunch pattern –** restore 1 Hz operation
- **Only if measuring dispersion!** (not part of the standard procedure)
 - CL energy FB
 - A24 or A25 table/scalar mode and voltage

How to start measurements

Update CRISP

- Save machine file
- Set 1 bunch in SA2
- Open dechirper tool

Click "Prepare measurements"

- The tool adjusts the orbit, inserts and powers the screen, and applies special optics.
- You might need to acknowledge that the orbit is not optimal and the screen is not yet powered (this may require a bit more time).
- Using the bunch pattern builder, set 3 Hz in the SA2 branch.
- Click "Beam ON" button. You should see unstreak beam
- Adjust bump amplitude. 2 mm is good starting point. Around 3 mm is our usual bump amplitude



Done!

How to start measurements

Update CRISP

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Need more details?

European XFEL

Sergey Tomin, BKR, 11.12.2024



- Press Low Frequencies and wait
 Current Grating: LOW_FREQ
- Press High Frequencies and wait
 Current Grating: HIGH_FREQ

How to update CRISP

• •		XFELMai	inTaskbar.xml		
European XFEL	Status Safety MPS	Operations Procedures	Feedbacks Automation	Diagnostics	Tools Vacuum Dumps □ 0 Controls
Diagnostics	BLMS BLM Overview BLM & Toroid Alarms Darkcurrent BLMs L1-3	BPMS Undulator BPM Offsets BPM Offset Overview BPM Orbit Server	Wire Scanners Wire Scanner Controls	Toroids (TIS) Transmission B2D Transmission T4D Integrated Charge	Utilities Temperature Monitoring Tunnel Temperatures
Expert Panels	Compression	Arrival Time	Dark Current	Laser Timing THz Diagnostics	Energy
	BCM Compact	BAM for Operators	Overview	CRISP	Beam Energy Measurement
	BCM Server	User statistics Injector stability		2	Energy Histories
	Dosimetry	Miscellaneous	Laser-Based		
	Machine Dosimetry 🔻	Injector Losses	Synchronization		
	Pandoras Injector	Diagnostics Server Error	LbSync Overview		
	Pandora Tunnel	Intra-train Overview	REFM-OPT Overview		
	Pandora Air	LPS ML server			
	RadCon overview RadCon expert	ML Pointing Predictions			

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Whole procedure will take about couple of minutes

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How to open Dechirper tool

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	Status	Operations Procedures	Feedbacks O Automation	Diagnostics 1	Tools	•••		XFELDiagnost	icsExpert.xml ///		
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	BCM Server	User statistics			Energy Histories						
		Injector stability									
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						SA2 D-Chirper 3	Overview	System Overview	SDiag Overview	MDI Expert Panels	Synchronizat
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	Machine Dosimetry 🛡	Injector Losses	Synchronization						SPS Overview	Dump Cameras	
	Pandoras Injector	Diagnostics Server Error	LbSync Overview						SDM Overview		
	Pandora Tunnel	Intra-train Overview	REFM-OPT Overview						Longitudinal Response Tool		
	Pandora Air	LPS ML server									
	RadCon overview	ML Pointing Predictions									
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How to make 3 Hz

- Set 1 bunch in SA2 brunch
- Open bunch pattern builder
 - Press Add Pattern

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How to make 3 Hz

Set 1 bunch in SA2 brunch

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Open bunch pattern builder

Add pattern

In B Pattern set D instead of **2**

1. & 2. Pulse Type:	3					4. Bund	ch Counte	ers							8. Apply, Save & Load	
0: No bunch • 6: G1D • I: I1D • b: B1D • B: B2D • D: TLD • 1: SA1 • 2: SA2 • 3: SA3 • 4: SA4 • X: TLD w/ marker • Y: SA3 w/ bit 17						BUNCH_COUNTER_1 Pulse IDs generating these bunches:								1, 356×2, 25×D, 300×13, 1×D, [B] 1505 kHz, 86×D, 356×D, 25×D, 300×13		
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						800	900	1000	1100	1200	1300	1400	1500	1600 [µs]	For destination T5D (SASE2)	
Machine	Patterr	1				View	Pattern	Open th	e Pattern \	liewer in a se	eparate win	dow.			These switches have immediate effect on the timing system.	

bunch_pattern_server_pattern_builder.xml XFEL_SIM.UTIL/BUNCH_PATTERN/PATTERN_BUILDER/PULSE_TYPE_0

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How to make 3 Hz

- Set 1 bunch in SA2 brunch
- Open bunch pattern builder
- Add pattern
- **In B Pattern set D** instead of **2**
 - Set new Pattern Sequence [A] 2 [B]

Apply & Switch

••• bunch_pattern_server	_pattern_builder.xml XFEL_SIM.UTIL/BUNCH_PATTERN/PATTERN_BUILDER/PULSE_TYPE_0
	BUNCH PATTERN SERVER: PATTERN BUILDER (MACHINE PATTERN
1. & 2. Pulse Types	4. Bunch Counters 8. Apply, Save & Load
0: No bunch • G: G1D • I: 11D • b: B1D • B: B2D • D: TLD • I: SA1 • 2: SA2 • 3: SA3 • 4: SA4 • X: TLD w/ marker • Y: SA3 w/ bit 17	BUNCH_COUNTER_1 Pulse IDs generating these bunches: SA1 Excess bunches at the end of the train are replaced by: D
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X <u>1509.1</u> µs RF transition p	7. Review Pattern for event ID:
Machine Pattern	9.0 100 100 1200 1300 1400 1500 1600 Image: User Pattern Open the Pattern Viewer in a separate window. 9.0 1000 100 1500 1600

Video from BKR







Passive streaker tool improvements



Prepare measurement

✓ Beam ON ✓ Orbit Set

✓ Beam OFF ✓ Screen IN

Bump Contro

3.00 mm

Reset Orbit

en Contro CRISP:

✓ Online Recon

Rep. Rate

GUI

10 8 6 4 2 0

Energy Calibration Disp. Dx [m]

Beam Energy [GeV]

Energy Axis

Image Analysis

Number Saved Images Allowed Number of Shots 300

Kill SASE

✓ Special Optics Set (Dx=30.4 cm) ✓ Orbit FB T5D OFF

Screen Trigger is ON

OK

Restore

Beam ON

✓ Subtract Background Take Background 1.00 0

Hz

0.30

11.48 ✓ Display Energy Axis

Optics Viewer

OTRC.2560.T3 0

Send to LogBook

0.00

C urad

Set Bump

✓ Flip Current

Counter 50