

SwissFEL week 46

- **Setup proposal**
- **System checks**
- **Aramis setup**
- **Athos setup**
- **MD shifts**
- **Systems commissioning**
- **Conclusions**

S. Bettoni (with a lot of material and work from many people)
November 9-15 2020

Proposal for the next startup (from the last SEM)

In several occasions demonstrated the **parallel operation** of Aramis and Athos (also in case of high lasing in both lines)

Goal: try to better organize already from the coming startup to make parallel operation as the **standard** and not as the exception.

At the upcoming (?) startup

Day 1: System checks

Day 2: Basic check with the beams: emittance, compression, bunch length, lasing in Aramis, check in Athos

Day 3: Aramis optimization starting from a good lasing snapshot file

Day 4: Athos setup

- Athos optimization changing step by step the Aramis settings which have a bad impact on Athos (if there are-to be investigated)
- Trying to keep as high as possible also the Aramis and Athos lasing
- Run PSICO on both lines?



Technical Startup-from Fri

- Started with “cold checks” on Fri 6.11. 7:00 (improved the startup check list and extended it)
- Big mess with the path change from `/sf/controls/common/config/qt` to `/ioc/qt` (some panels were missing completely & a lot of developers had hardcoded the path to panels...) -> shift crew together with Simon Ebner did a mass-renaming
- Power-Brick disaster...
 - First troubles with several Power Bricks for the collimators -> needed an exchange
 - SARUN18 Power Brick ignored the end switch -> investigating an exchange
 - Emergency repair: put in a new beam pipe straighten the line, disconnecting all devices from this power brick (SARUN18&19 quad movers, SARUN18 dechirper) -> further repair needed



Startup with Beam-Mon

M. Boll, N. Hiller, C. Kittel (remote)

- Tunnel closed around 16:00 on Fri -> thanks to the great work of the technical groups!
- Conditioning of SINEG01, SINSB02 & 04, SINXB01, S20CB02 over the weekend
- Mon 9.11.
 - tunnel access for final checks of SARUN18 section by the vacuum group
 - Laser PSYS problem preventing laser shutters from opening -> took until 19:00 to be fixed
 - Mizar needed repair by external company -> only available from Thur onwards
 - SINSB04 had troubles -> termination of directional coupler exchanged in tunnel
 - First beam on gun around 20:00
 - Until 23:30 Operation set up transmission through injector and phased the RF stations

Initial beam checks Tue-PM

M. Boll, N. Hiller, C. Kittel, D. Voulot

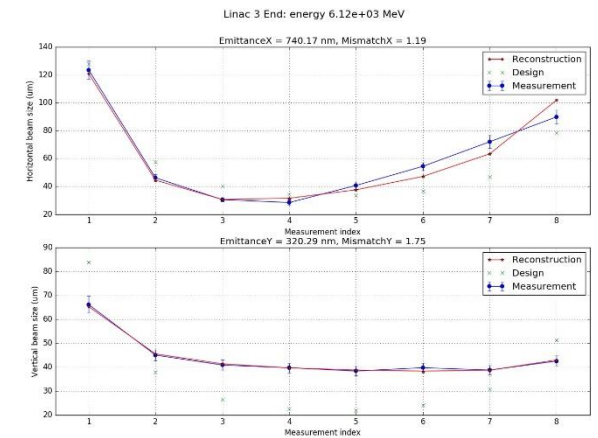
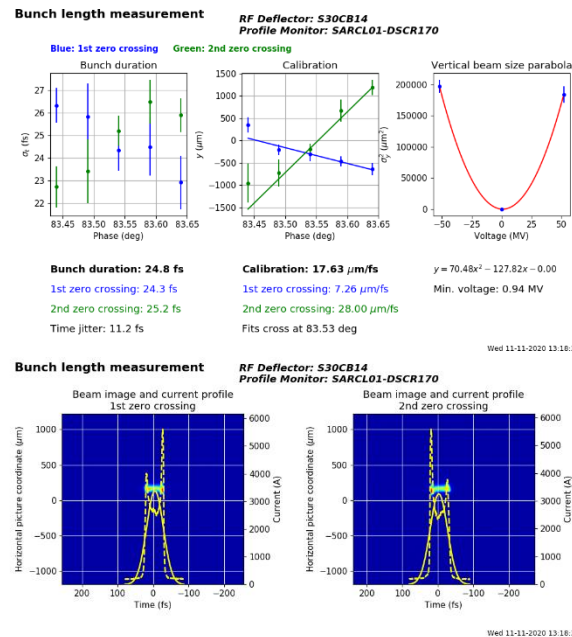
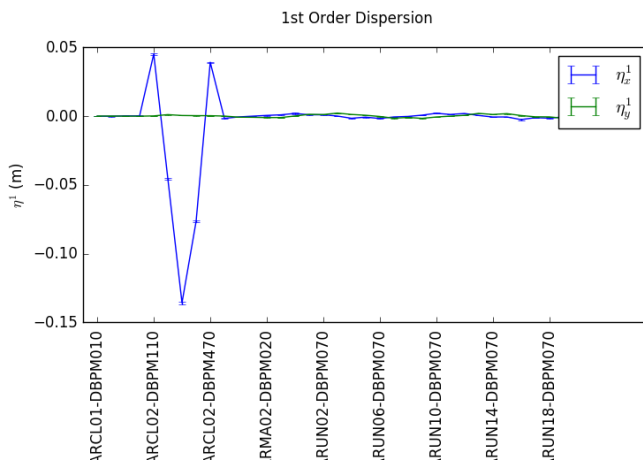
- Setting up transmission and RF phasing until Aramis energy collimator (including feedbacks and basic beam checks e.g. emittance, bunch length)
- Problem with low clock signal level of BPMs revealed bigger issue of reference distribution levels being too low after the work on the master oscillator during the shutdown -> emergency fix by Cezary S. (could be combined with additional tunnel access for SINSB04 repair)
- Afterwards laser timing had to be shifted completely, phasing had to be re-done but transmission was preserved. -> we are now at a slightly different overall delay (see Didier's slides)
- Late shift achieved transmission through both lines -> BPM re-commissioning could take place
- Energy spread measurements with the laser heater -> see in few slides (if provided)
- From Wed onwards -> systematic Aramis setup

Aramis setup: beam optimization-Wed

S. Bettoni, F. Loehl, C. Kittel, T. Schietinger, D. Voulot
Support from E. Prat, S. Reiche

Beam quality and optimization:

- Beam at the laser heater: with $(M_x, M_y) = (1.01, 1.05)$, $(\sigma_x, \sigma_y) = (182, 333)$ nm. We keep this measurement only to check the emittance values (see next slide)
- Compression in BC1, in in BC2 slightly optimized
- Beam at the undulator entrance: $(M_x, M_y) = (1.19, 1.75)$, $(\sigma_x, \sigma_y) = (740, 320)$ nm
- Dispersion down to 2 mm peak in the undulators



If we trust the measurements, electron beam optimized (some of the smallest or smallest emittances measured at the LH and for short pulse)

Aramis setup: some comments

Some more checks for the next start up (this time limited time available):

- No full transmission at the end of the Aramis line at 1 Hz (orbit issue due to the accident)
- We re-phased the full machine. Some stations out also by 5 degrees
- BC2 chicane off position by 0.5 mm. This changed the reading for the compression monitor, ... To check missing energy, we checked all the timing of the stations in Linac1

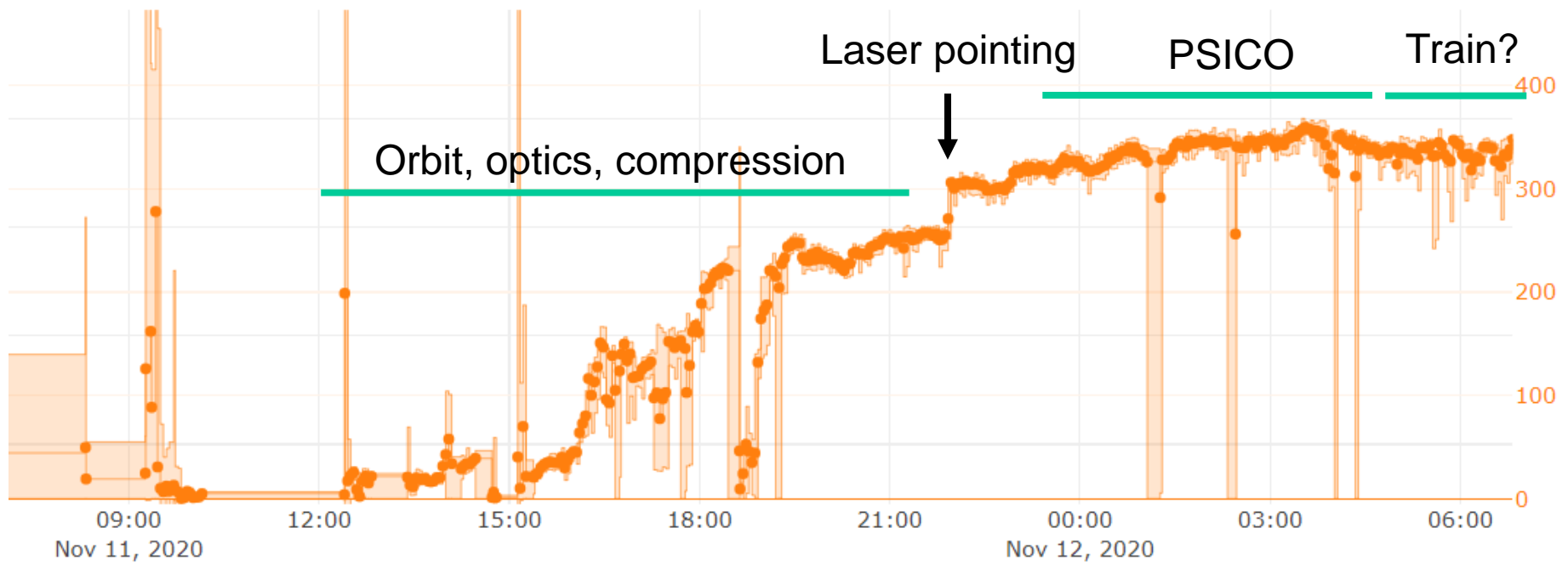
More issues:

- Jitter in the gun orbit 25 times larger than usually. Florian changed the settings of the feed-back, and re-measured the response
- SRM monitor entering and going out was seen as a global exception for the feed-backs. Controls investigated it, and quick fix by Florian, who bypassed it in the feed-back
- Tool to send the nominal optics and old version of adaptive orbit do not work from the control room, but on the NX machine connection

Improvements and comments:

- New optics feed-back from Florian. Added dispersion group. Thanks.
- V. Arsov setup the BAM, so that we could close the arrival time feed-back
- On Wed evening all feed-backs closed, and e-beam setup

Aramis setup: lasing at 12 keV (day 1 Aramis)



What happened:

- ◆ Setup gave manually 310 uJ
- ◆ PSICO for a night brought it to 370 uJ
- ◆ Thursday morning lasing preserved, in the afternoon drop to 250 uJ during Athos setup (reason not understood). Athos priority, so it will be re-optimized

Aramis setup: lasing at 11.3 keV

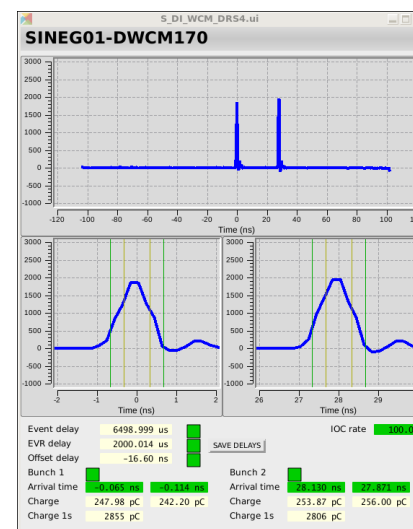
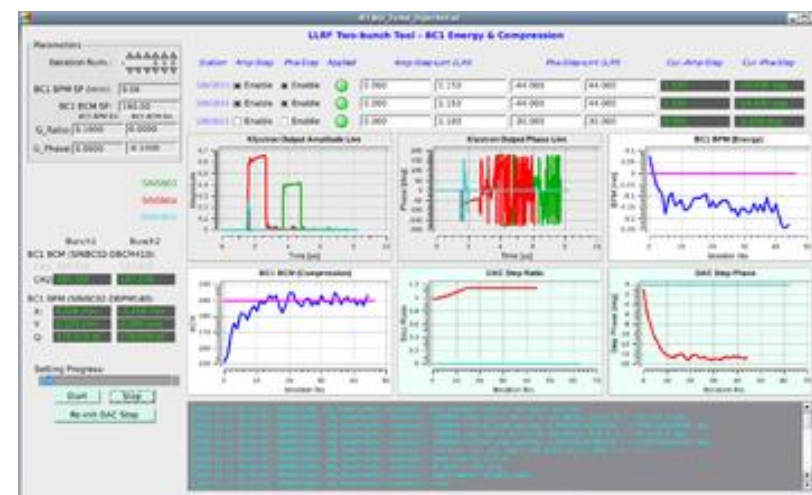
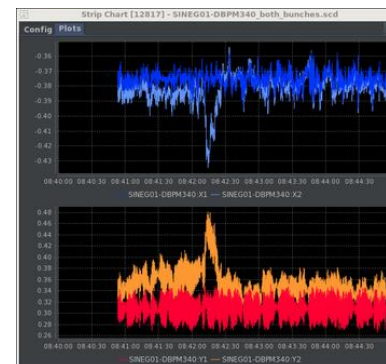


What happened:

- ◆ We decided to switch to 11.3 keV to not swap S10CB13/14 to streak
- ◆ Small tweaking in parallel to Athos setup
- ◆ SINXB changed to improve BW during BPM shift
- ◆ Orbit loops
- ◆ Other small tweaking
- ◆ Maximum of 440 μ J

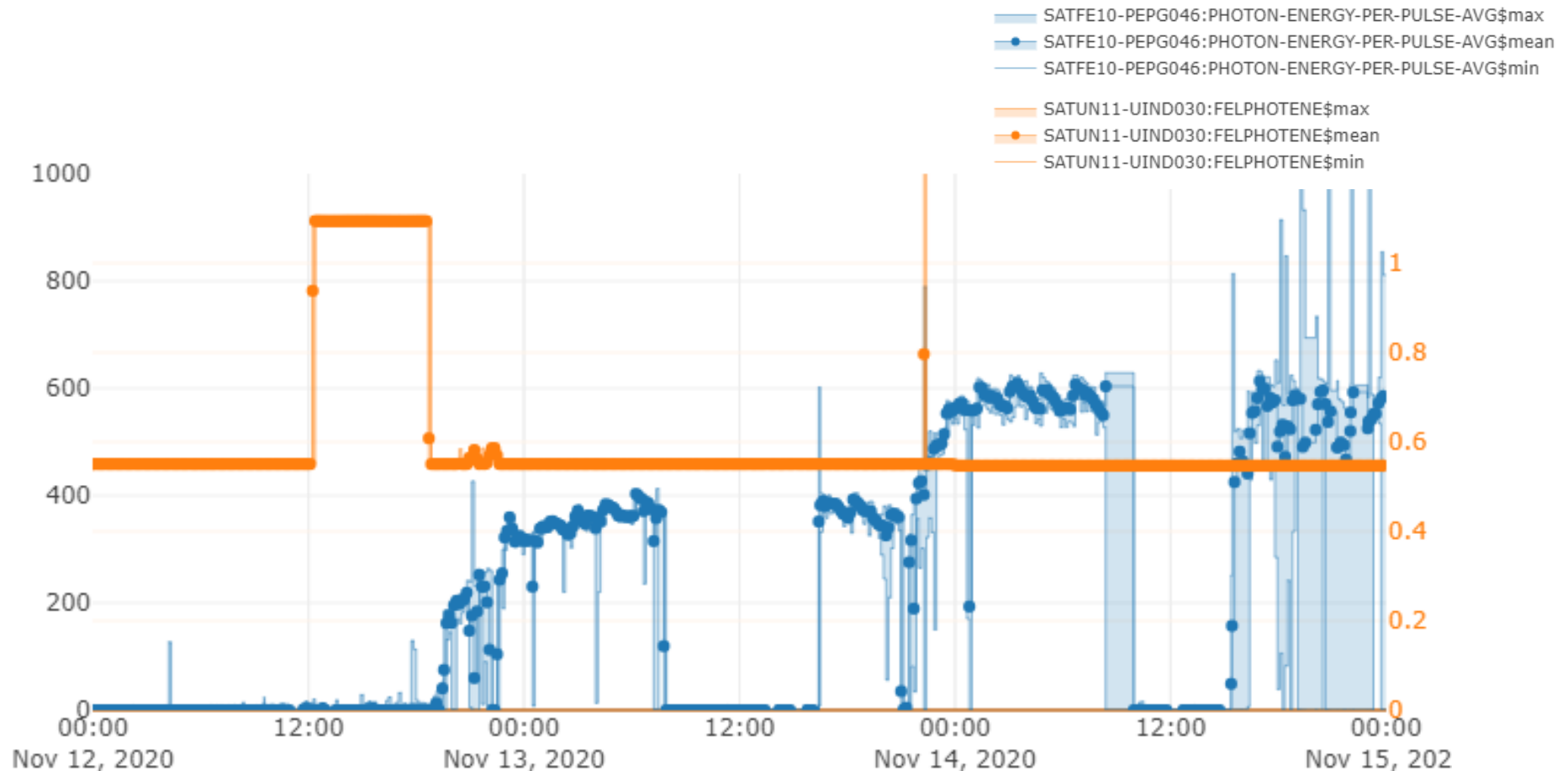
2 bunch setup

- Set-up Mizar timing after Mizar repair (Martin)
 - Adjust arrival time with Mizar delay
 - Correct Mizar path to overlap bunch positions on the first BPM
- 2-bunch set-up using LLRF's (Qiao) set-up tools
 - Tools work fine
 - No correction of S-band arrival time were needed
- Both bunches appears with -0.13 ns error on the WCM since the T&S restart
 - Should the timing offset be reset to zero?



Athos setup (Thursday)

E. Ferrari, C. Kittel, E. Prat, S. Reiche,
S. Bettoni (to see)



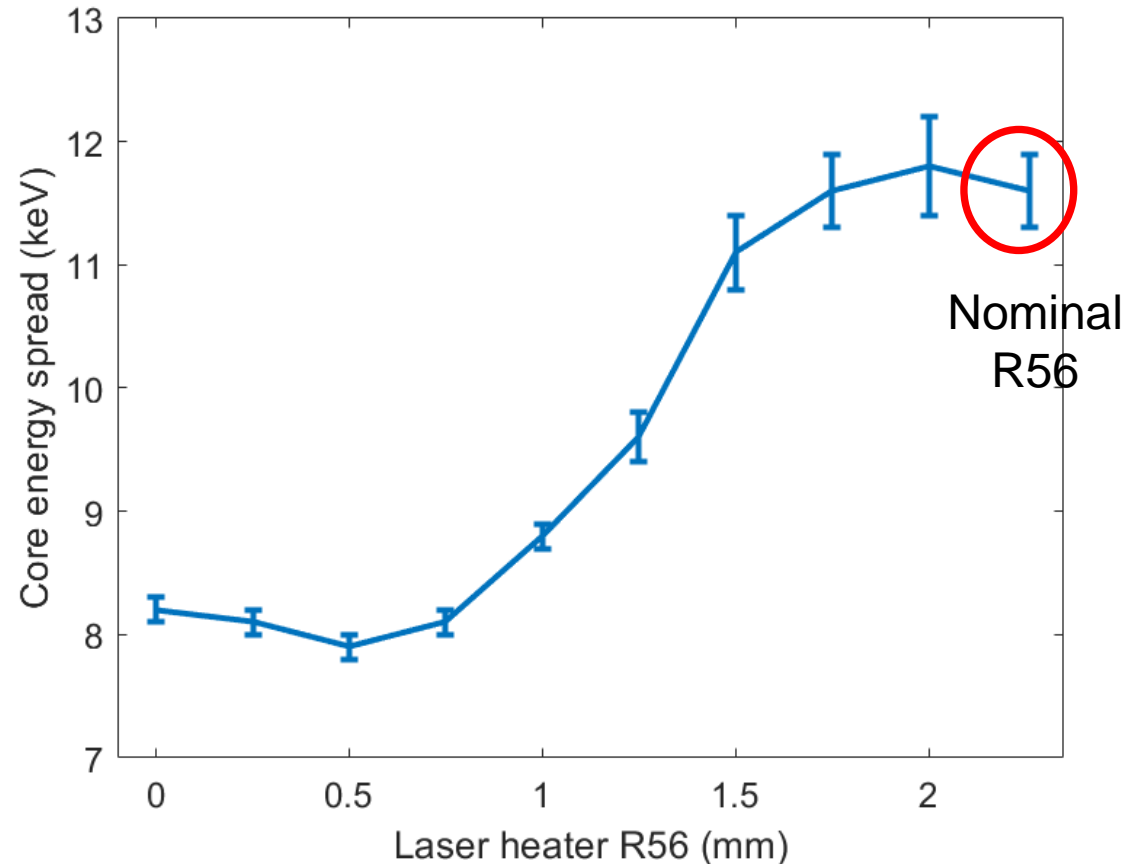
What happened:

- ◆ Minimization of the losses
- ◆ Orbit checked
- ◆ Dispersion in the switchyard optimized
- ◆ Some checks on the e-beam along the line
- ◆ Undulator area optimization
- ◆ PSICO run

Energy spread measurements (Tuesday PM/night)

E. Ferrari, C. Kittel, E. Prat, S. Reiche

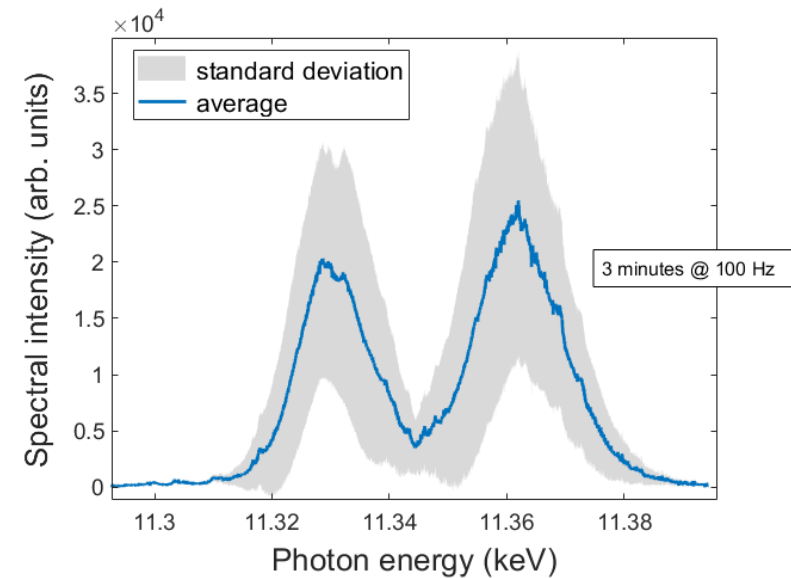
- Intrinsic e- beam energy spread larger than expected, limiting SwissFEL performance.
- Previous studies suggested that microbunching is important and that reducing laser heater R56 would help
- Measurement of energy spread for different laser heater R56
- Energy spread reduced from ~12 to ~8 keV
 - Significant improvement, qualitatively consistent with simulations.
 - 8 keV is still large (IBS, resolution, etc.)
- More details in shift summary: <https://elog-gfa.psi.ch/SwissFEL+commissioning/16844>
- More measurements next (MD) week



Two colour FEL with two photocathode lasers (Sat-AM)

- We generated two-colour FEL @ 11.3 keV
- Stable FEL spectrum, energy up to 115 μJ (~30% of the FEL energy in single colour)
- Some difficulties due to not uniform lasing along the bunch (during the setup time)
- Studies of the two-colour reshaping with laser delay and with the x-band retuning
- Next steps: data analysis and confirm possible application/experiment of this two colour setup

C. Vicario, S. Bettoni, and M. Huppert (remote support)



Stable spectral shape

BBA-undulator alignment-Sat/Sun

E. Ferrari, C. Kittel, N.
Hiller

Electron orbit (E. Ferrari):

- BBA orbit determined

Undulator alignment (C. Kittel):

- Pointing adjusted
- Undulator alignment
- More BBA loops
- Trying to optimize the rest of the machine with the new orbit to check if it is better

VERIFICATION TO SEE WITH
LASING IF THIS ORBIT IS
BETTER ONGOING...

Systems commissioning

Charge measurement (G. L. Orlandi, P. Craievich, F. Marcellini)-Fri AM:

- ICT, WCM, F-C data acquired vs charge (Bunch1 and Bunch2, 10 to 200pC). Measurements to be completed by calibration measurements of the FC cable

Loss monitor (G. L. Orlandi)-Sun AM:

- SATDI01-DBLM305 and SATUN09-DLLM035 commissioned

Athos BPM (B. Keil)-kind of parasitically when possible:

- Checked the calibration of SATUN05-12 , and SATUN14, which are now usable in the orbit feedback
- Difficult to calibrate BPM because of the high losses and low rep rate. In this conditions ~10% accuracy should be expected. To be rechecked (1-2 hours) with better conditions

Aramis BPM (B. Keil, F. Loehl)-Friday PM:

- Repeated calibration using the movers of all BPMs in the undulator area (last time Aug 2020)
- New calibration applied (before only for BBA shifts)
- SARUN01 had a defective cable, major difference compared to the previous calibration
- All reference files and snapshots modified accordingly

Conclusions for the setup

System checks and failures:

- Issue with the PSYS door in the laser hutch
- Mizar available just for the Athos day setup, and not really perturbation for the work in the laser hutch during the Aramis setup day: thanks to the laser group
- Pumps of the Athos gas detector went off on Sunday: optimization stopped
- Better conditions at the end of day 2 (delay because of the issues)

Aramis:

- Lasing manually up to 310 uJ at 12 keV the first day and 370 uJ after a night of PSICO
- Scaled to 11.3 keV for practical reason, after some optimizations up to 440 uJ BW =0.135%
- Systems commissioning as scheduled
- MD activities as scheduled
- BBA-undulator alignment as scheduled. Verification of the result ongoing

Athos:

- Some issues again with the losses
- After some optimizations and PSICO, about 600 uJ at 0.540 keV 1 Hz