

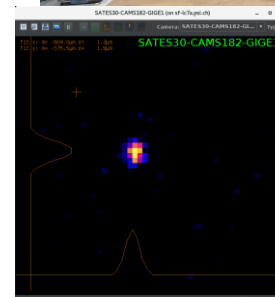
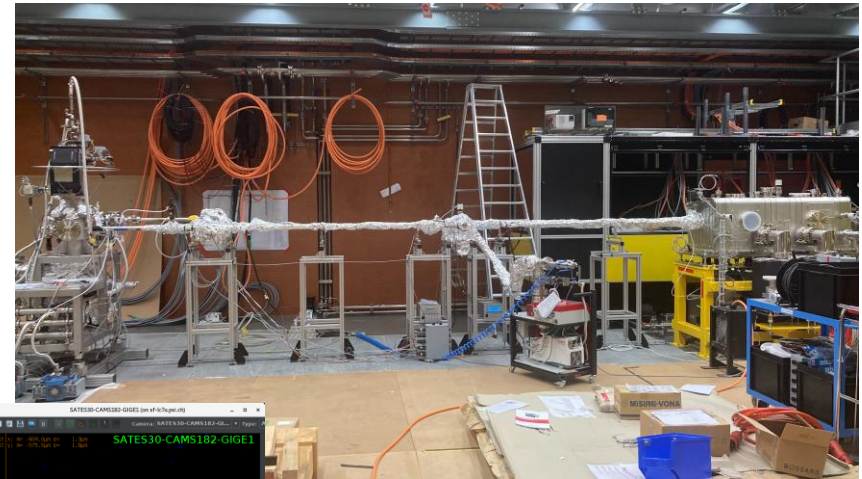


WIR SCHAFFEN WISSEN – HEUTE FÜR MORGEN

SwissFEL operation overview

SwissFEL Performance Workshop, 26 January 2022, D. Voulot

- Athos undulator line completed: 16 undulators/15 CHICs, 8 April
- First user run (Pilot experiment) in Maloja, 24 February – 2 March, in total 5 successful Maloja runs last year
- First beam in Furka, 30 June
- Cristallina installation completed, expect first beam in March
- New modes used in operation, e.g. two colors with tilted beam / fresh slices in Athos, short intense pulses for Aramis (see BD talk)



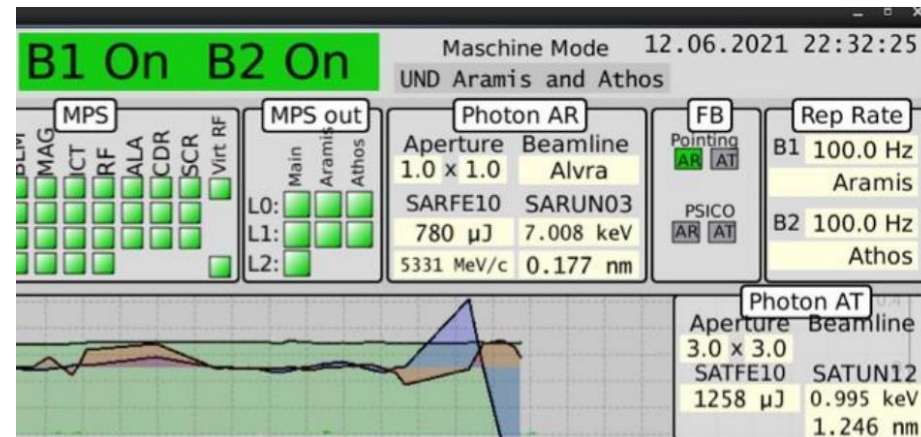
Parallel operation established at 100 Hz in both lines!

Some important milestones

- July 2020: first parallel operation, Athos limited to 2.5 Hz due to undulator losses (120 uJ @ 550 eV)
- June 2021: first parallel user operation, still difficulties with losses but 100 Hz can be reached
- September 2021: one week of parallel operation (7days) Aramis 12 keV 100 Hz / Athos 50 Hz
- November-December: 100 Hz on both lines achieved routinely

Key ingredients towards success:

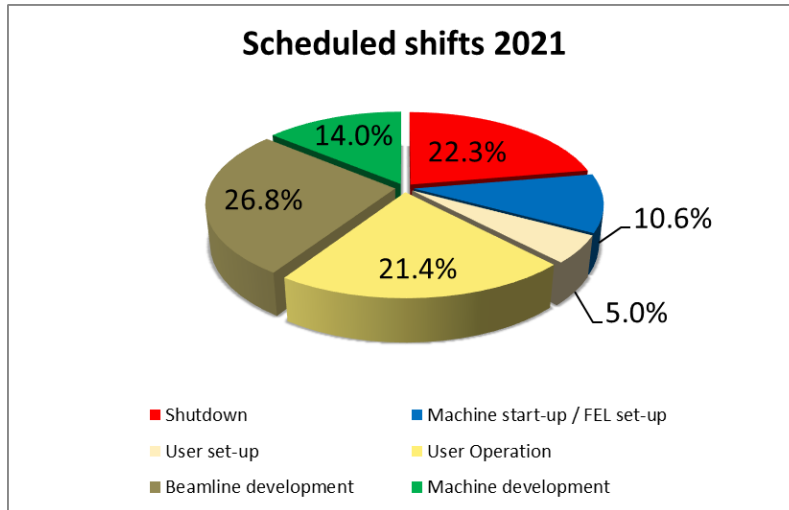
- High stability/reliability of the kicker system
- 2-bunch timing, adaptation of laser and MPS to 2-bunch operation
- **RF step**, 2-bunch feedbacks: independent control of the second bunch
- Improvement with **beam-based-alignment**
- Physical realignment of component (vacuum valves)
- Improvement in the set-up and losses mitigation



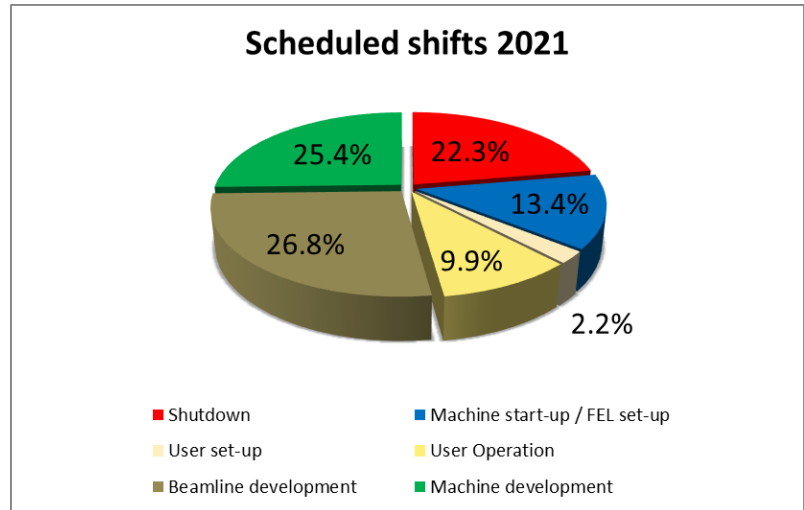
New record performances in 2021:

- Aramis
 - 100 μJ at 15 keV (December)
 - 775 μJ at 12 keV (November)
 - 1 mJ at 11.3 keV (January 2022)
 - 1.4 mJ at 7.5 keV (November)
 - 1.1 mJ at 3 keV (November)
- Athos
 - 300 μJ at 1.6 keV (December)
 - 1.85 mJ at 1 keV (December)
 - 3 mJ at 0.54 keV (December)
 - 1.7 mJ at 0.25 keV (November)
- Both lines above 1 mJ at the same time for the first time (June)

Aramis

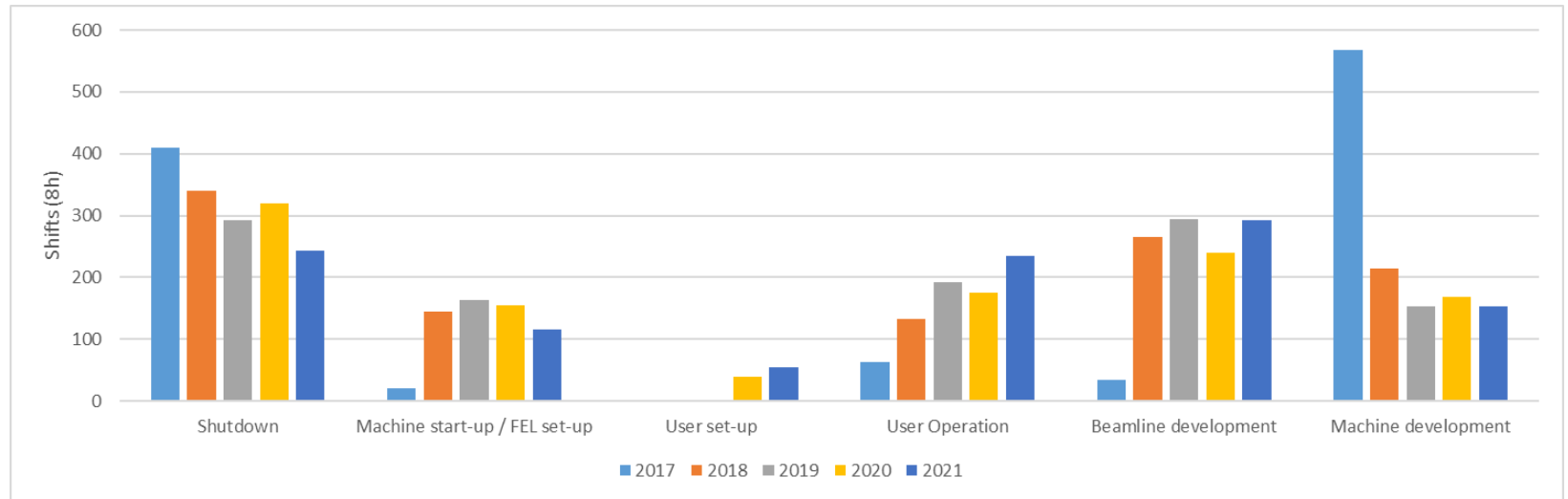


Athos



- More beam operation less shutdown and machine development in 2021
- More than 50% beam operation on Aramis for the first time
- More beam operation on Athos too (>3300h)
- Larger fraction of MD for Athos: we are still commissioning

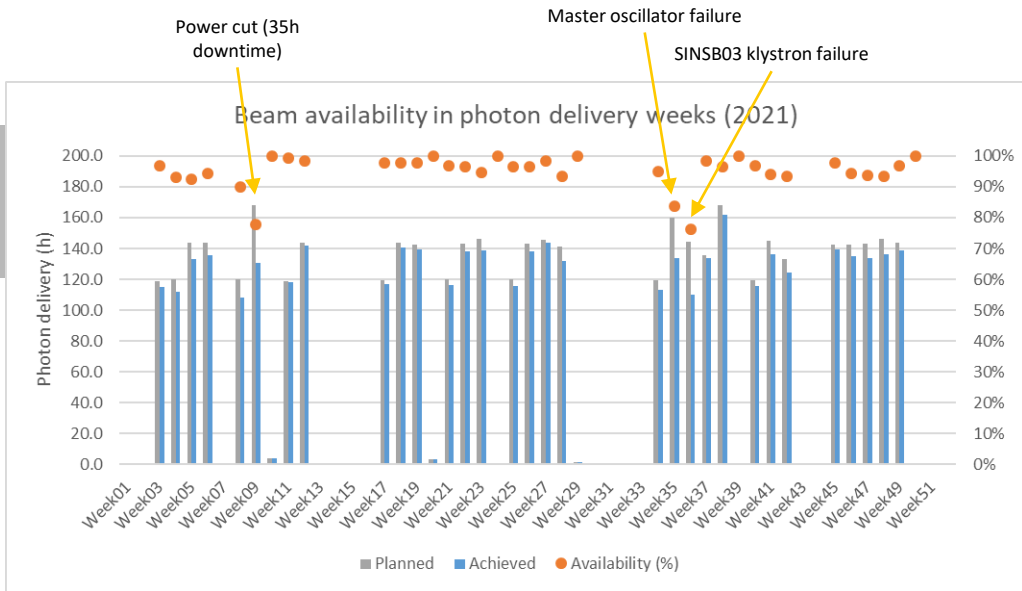
Scheduled shift evolution (Aramis)



	2017	2018	2019	2020	2021
Shutdown	410	340	293	320	244
Machine start-up / FEL set-up	20	144	163	154	116
User set-up	0	0	0	40	55
User Operation	63	132	192	176	234
Beamline development	34	265	294	239	293
Machine development	568	214	153	169	153

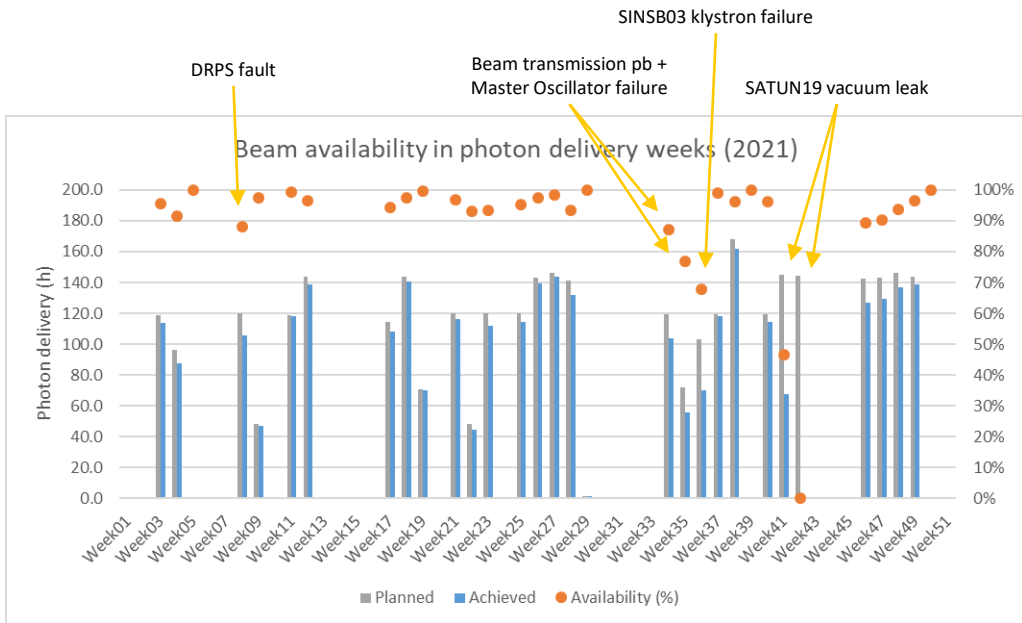
* 2020: including rescheduling due to COVID crisis

Beam availability



Aramis

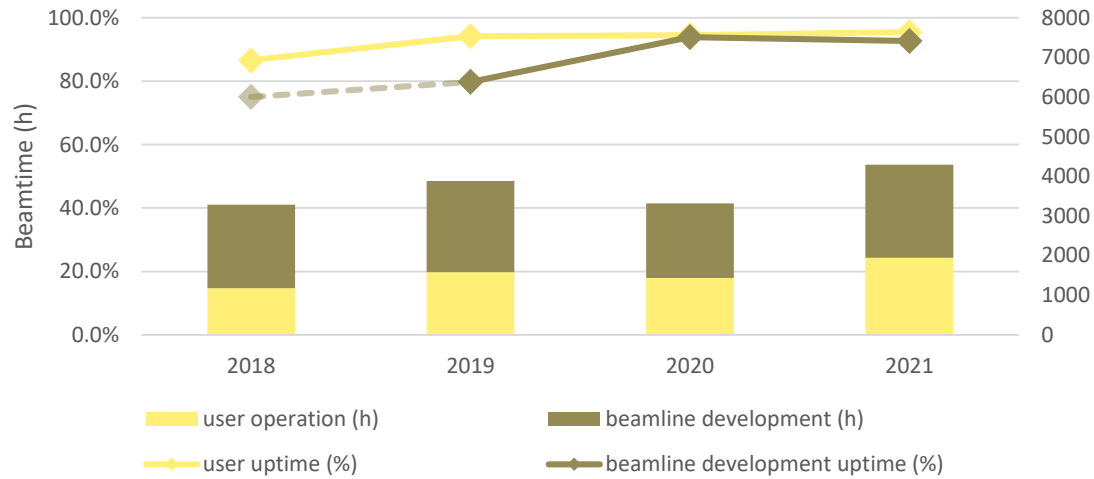
	2021	
	Beam-time (h)	Availability (%)
Total photon delivery	4294.8	94.0
Beamline development	2350.3	92.7
User operation	1944.4	95.5



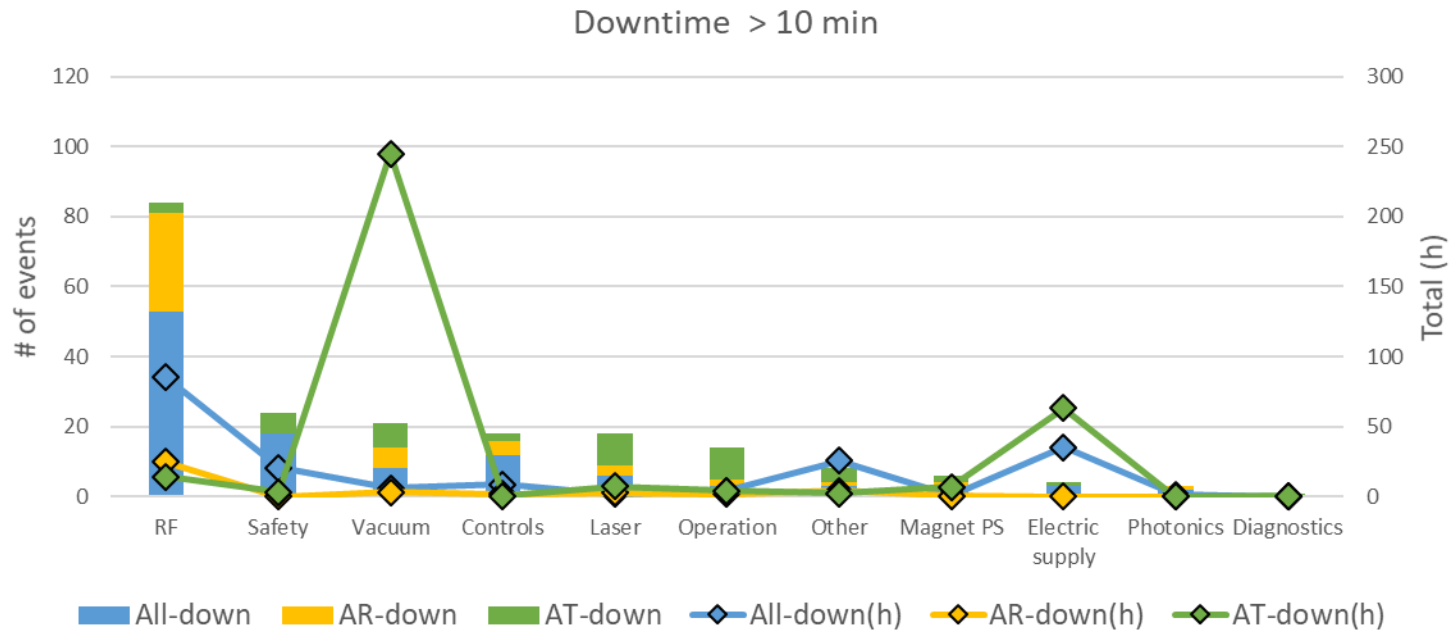
Athos

	2021	
	Beam-time (h)	Availability (%)
Total photon delivery	3380.8	87.5
Beamline development	2371.7	93.3
User operation	1009.2	73.7

Aramis beam availability (2018-2021)



Downtime causes (2021)

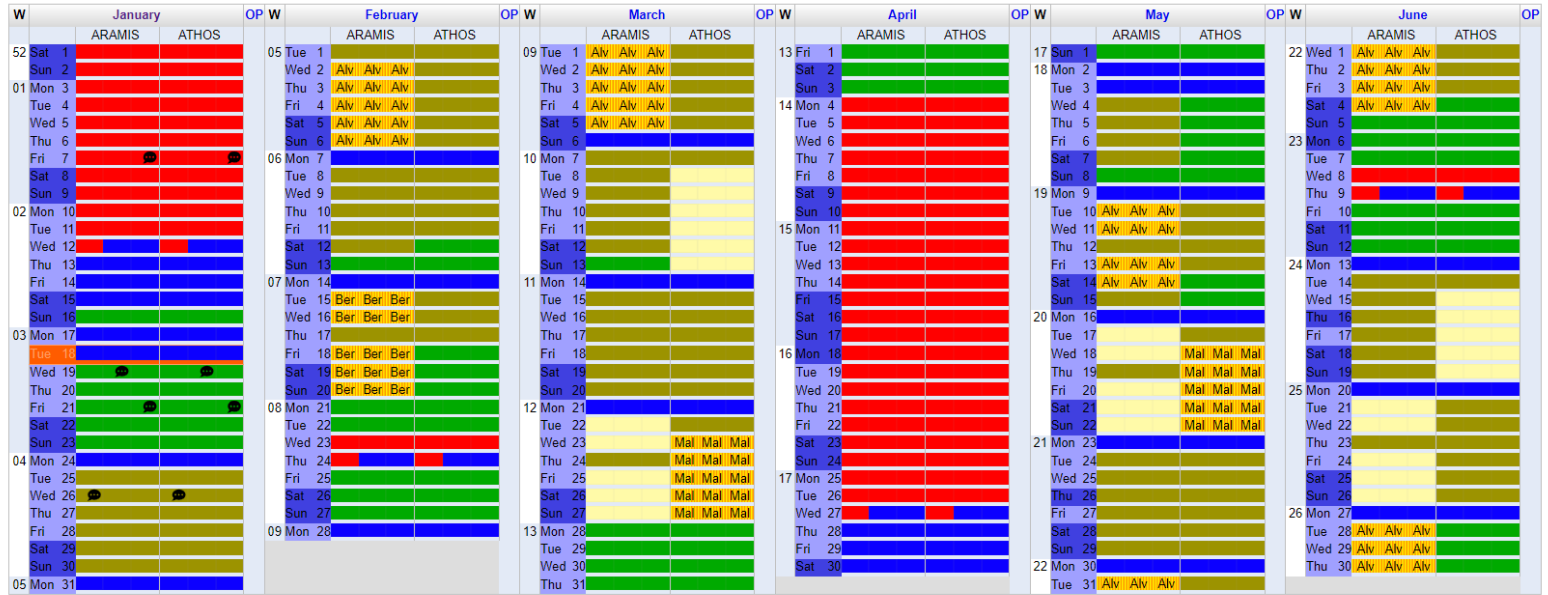


A few large disasters caused most of the downtime:

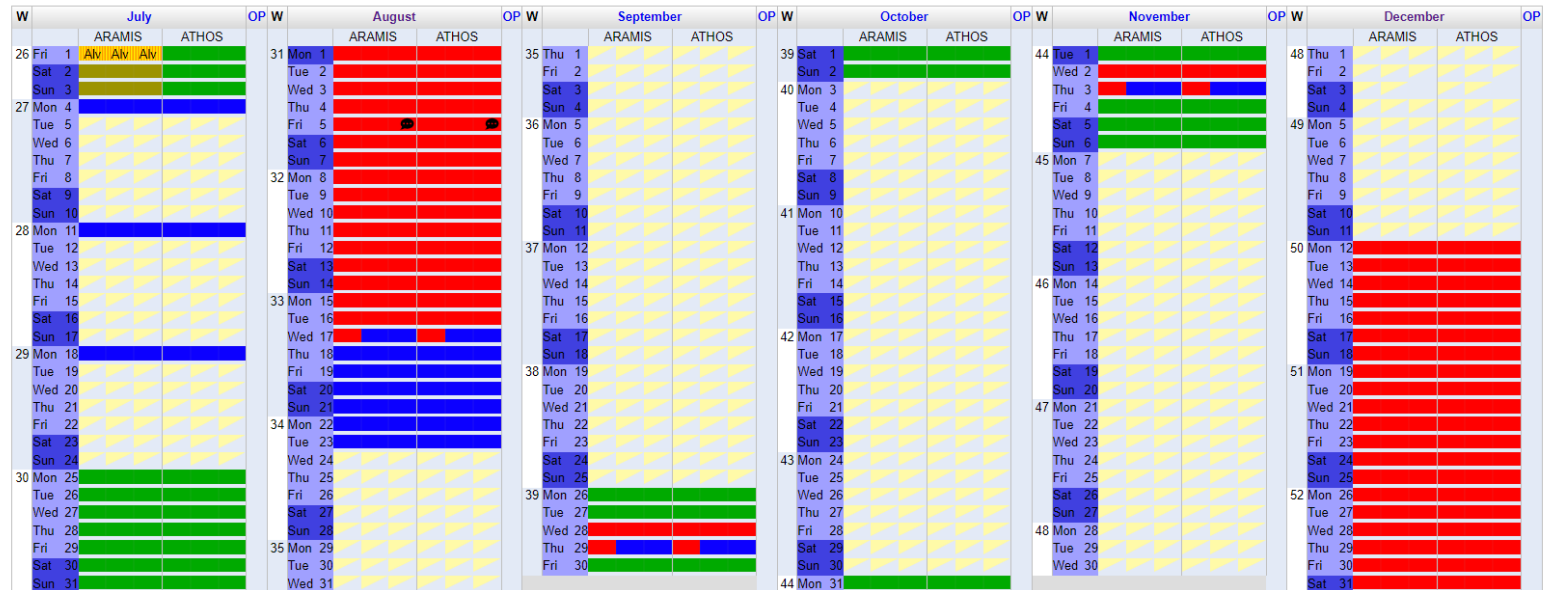
- SATUN19 undulator vacuum leak (October)
- Power cut and difficult machine recovery (March)
- SINSB03 Klystron failure (September)
- Laser room ventilation failure (December)
- Laser synchronization failure (August)



DUO 2022



Shift types



Start-up sequence

Mon	SU			Mon	SU	
Tue	SU			Tue	SU	12h
Wed	SU	12h		Wed	SU	
Thu	SU			Thu	SU	
Fri	SU			Fri	MD	Set-up reserve/MD
Sat	SU			Sat	MD	Set-up reserve/MD
Sun	MD	Set-up reserve/MD		Sun	MD	Set-up reserve/MD
Mon	SU			Mon	SU	
Tue	SU			Tue	BD	beam ready day
Wed	BD	beam ready day		Wed	BD	
Thu	BD			Thu	BD	
Fri	BD			Fri	BD	
Sat	BD			Sat	BD	
Sun	BD			Sun	BD	

The last start-ups went fast:

- January, lasing after 2 days
- November, lasing after 1.5 days
- August, lasing after 2.5 days

7 days of set-up is clearly too much but it is good to keep some back-up

Important to have set-up days during the week, support groups available

Note: the weekly set-up days could also be reduced from 3 to 2 shifts, the night is never used for tuning

New SwissFEL operator position opened to reinforce operation team

- Cover more shifts with 4 operators e.g. all early and late shifts in the week
- Increase pool of run coordinators
- More operation support during MD shifts
- Support for operation software / tools

Progress in the machine operation: faster set-ups, higher involvement of regular operators, lower load on RC

- Better organization: start-ups and set-up days under OP responsibility (without direct involvement of the RC)
- Progress in operator training, gain of set-up experience
- Improvement of tools and automation
- More reliable systems (RF)
- And of course... **great support from beam dynamics!**

=> Keeping good BD support is essential for SwissFEL operation: operation support, difficult set-ups, special modes... This is not sustainable with only two persons.

Too many calendars :

- Google operation calendar: detailed planning of the week
- DUO calendar: yearly overview, official calendar
- SwissFEL scheduling helper: planning tool for end stations
- Requirements form for ARAMIS: list of user runs with detailed beam parameters

Would benefit from a simpler unique way of collecting beam requests:

- Extend one of the existing tools
- Use the SEM to announce beam requests a few weeks in advance

Maybe a new meeting at intermediate periodicity (between SEM and DUO meetings) to collect beam requests and requests for beam developments in MD shifts

Main operation goals for 2022:

- Maintain fast and reliable set-ups
- Improve reproducibility and maintain peak performances
- Consolidate weak systems, improve tools and procedures

Commissioning and projects:

- Athos X-band deflector
- New beamlines: Cristallina, Furka
- HERO
- Preparation for Porthos



- A successful year for SwissFEL operation
- Great performances achieved at the end of the year
- Looking forward to a successful 2022!