33rd European Synchrotron Light Source Workshop

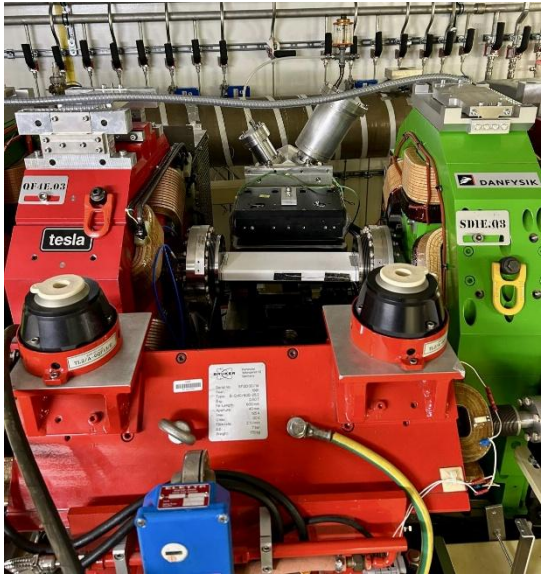
Synchrotron SOLEIL

29th-31st October 2025

Accelerator operation

Jean-Luc Revol, Nicola Carmignani

On behalf of the EBS Accelerator Team



- Statistics and failures
- Shutdown activities
- Beam parameters
- Projects and development

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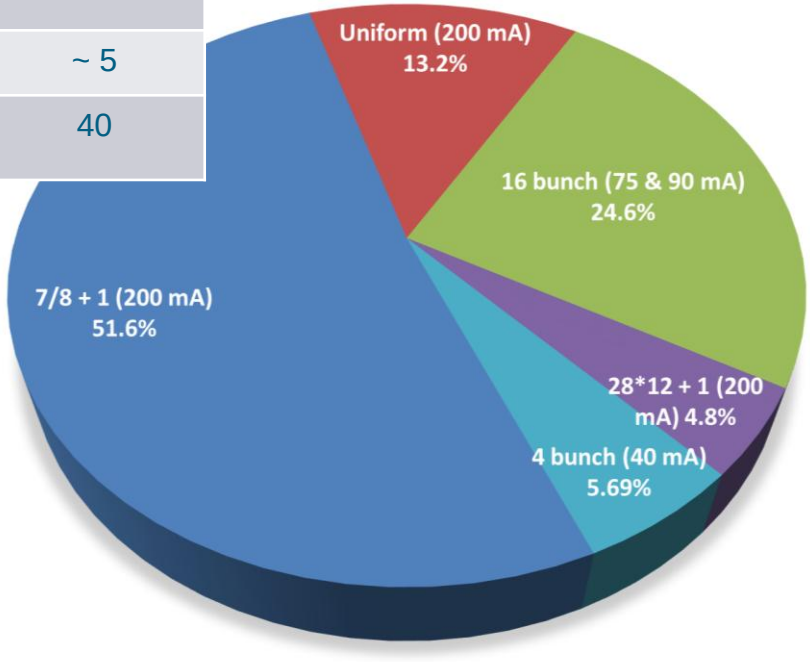
BEAM DELIVERY OCTOBER 2024 ➔ OCTOBER 2025

	7/8 + 1	Uniform	28*12+1 (Hybrid)	16 bunch	4 bunch
I_{max} (mA)	192+8	200	192 + 8	**90**	40
Lifetime (h)	> 20	~ 25	> 16	**6**	~ 5
ε_v (pm)	10	10	20	**40**	40

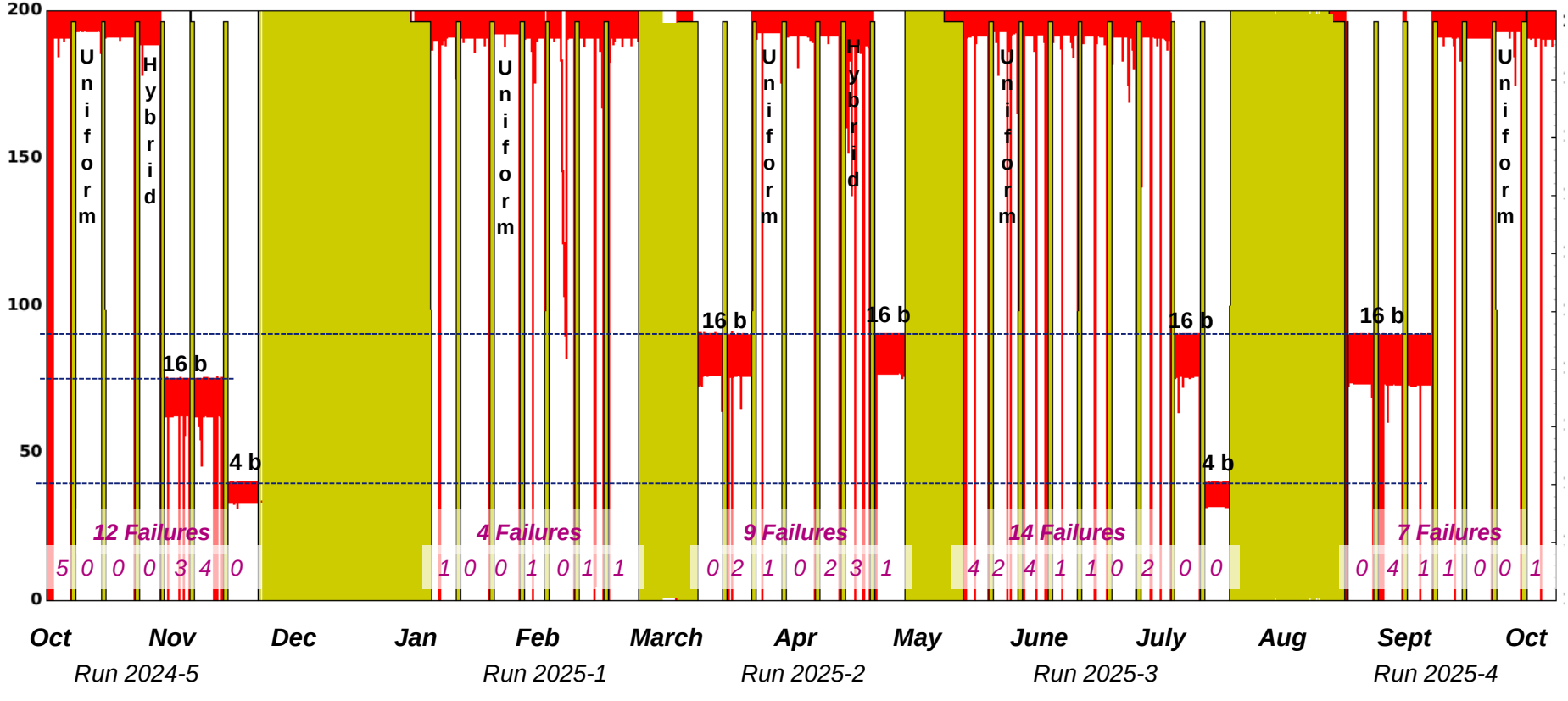


** Vertical emittance artificially increased from 1 pm rad to get an operational lifetime*

** All timing modes delivered with a purity of 10^{-9} with cleaning process in the booster*

- All beam modes delivered since last MAC
- 16 Bunch achieved at nominal current (90 mA) in January 2025 *(delivered at 75 mA before)*

BEAM CURRENT OCTOBER 2024 ➔ OCTOBER 2025



- ✓ *Non labelled weeks are delivered in 7/8+1*
- ✓ *Green is MDT day or shutdown1*

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STATISTICS OCTOBER 2024 ➔ OCTOBER 2025

RUN NUMBER	2024-05	2025-01	2025-02	2025-03	2025-04	Overview
Scheduled Beam Time (H)	1056.00	1032.00	1028.00	1320.00	1029.00	5465.00
Delivered Beam Time (H)	1045.20	1027.10	1015.50	1303.00	1013.10	5403.90
Availability	**98.98%**	**99.53%**	**98.78%**	**98.71%**	**98.45%**	**98.88%**
Dead time for failures	1.02%	0.47%	1.22%	1.29%	1.55%	1.12%
Number of failures	12	4	9	14	7	46
Mean time between failures (H)	88.0	258.0	114.2	94.3	147.0	**118.8**
Mean duration of a failure (H)	0.90	1.23	1.39	1.21	2.27	1.33

Bad run, mostly RF failures

Very good despite a long failure of the injector

Not a single RF fault ! Beamline, flowmeters, vacuum

Bad run, mostly RF and flow meters

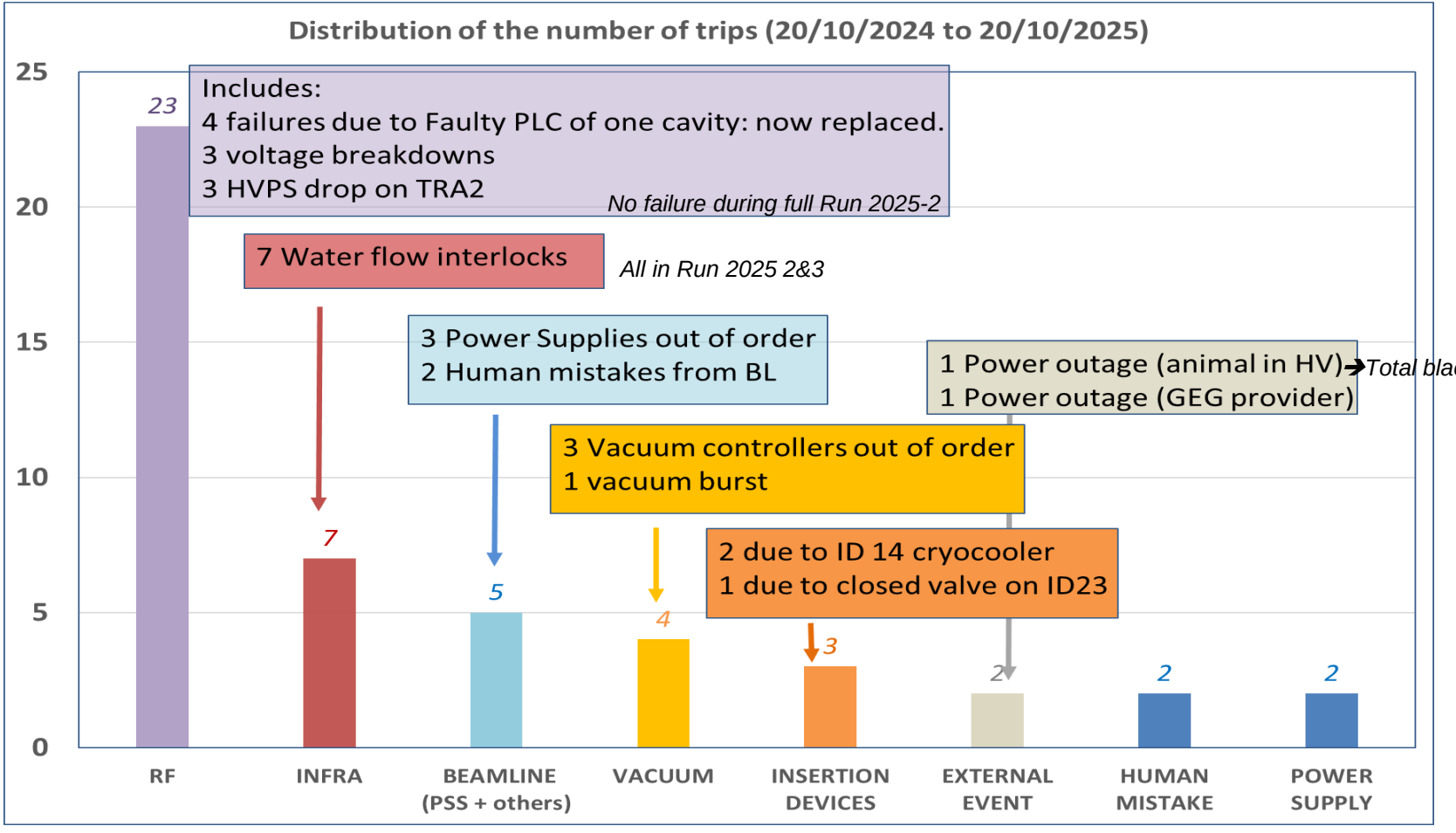
Long power outage & RF failures

Number of topup refills	**1028**	**1020**	**1004**	**1291**	**997**	**5340**
Number of skipped topup refills	**9**	**44**	**16**	**34**	**15**	**118**
	0.9%	**4.3%**	**1.6%**	**2.6%**	**1.5%**	**2.2%**

Due to 1 long failure of injector

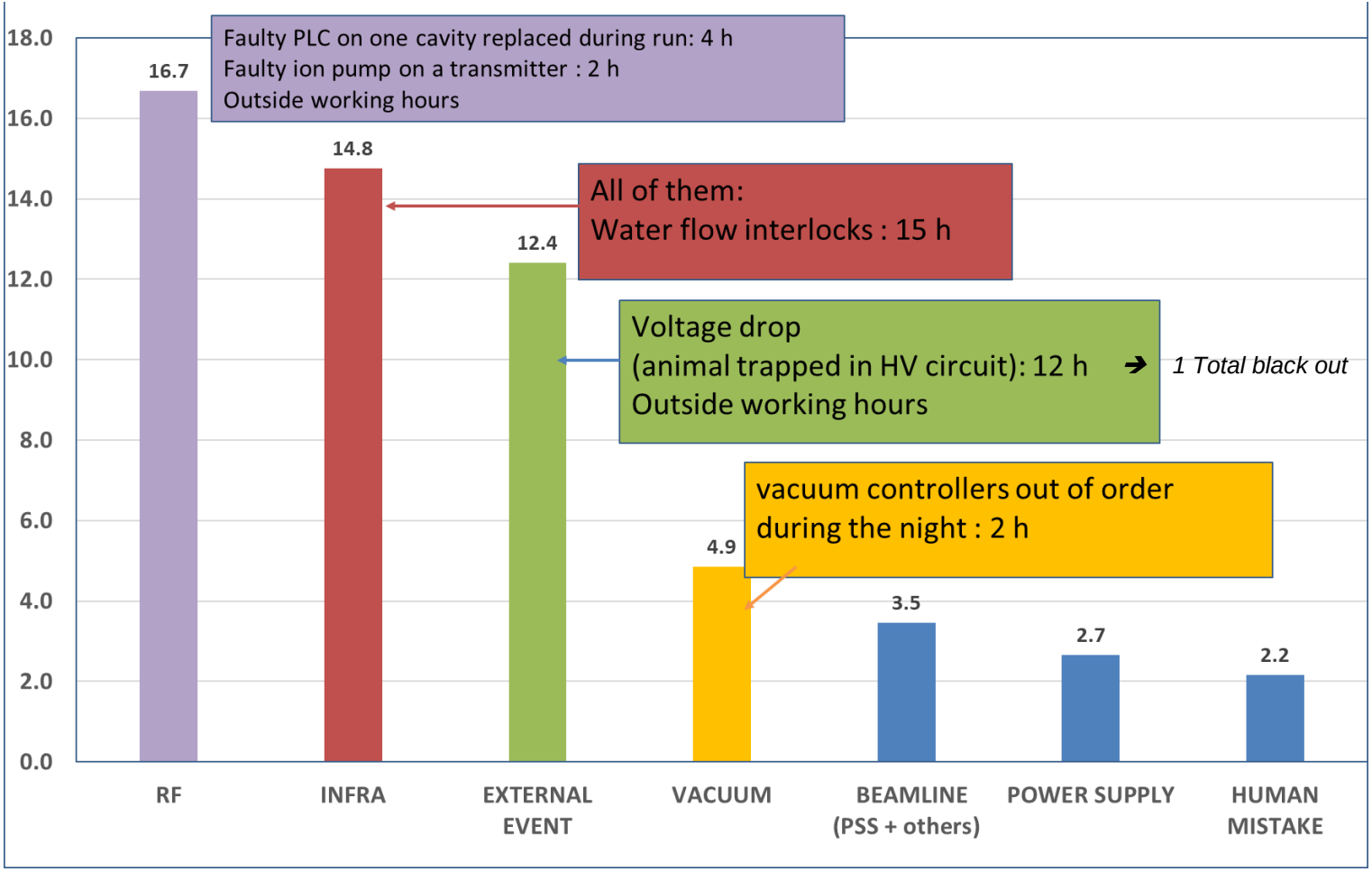
Due to injection kicker, timing and RIPS control

DISTRIBUTION OF NUMBER OF TRIPS FROM 20/10/2024 TO 20/10/2025

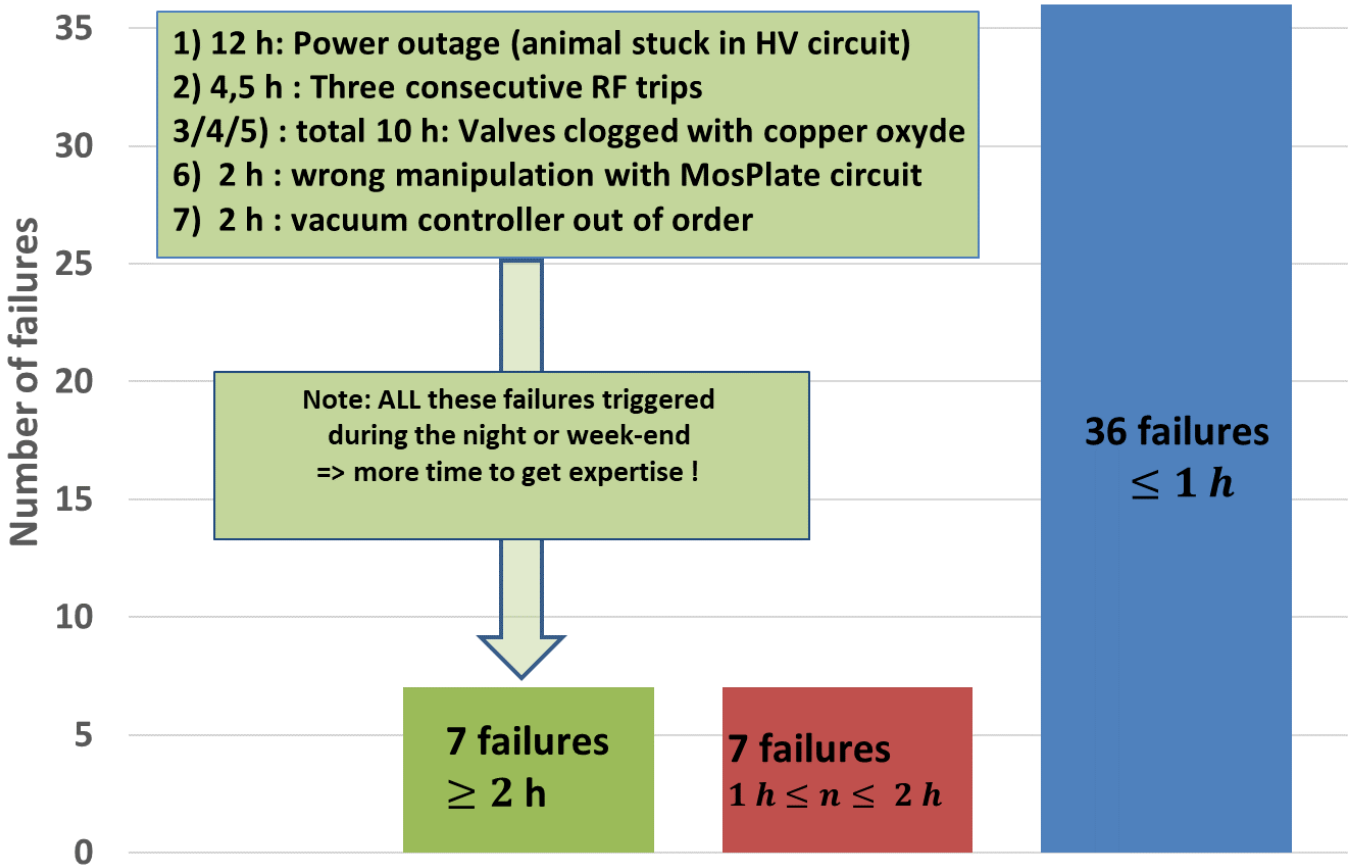


** All failures counted as a single failure*

DISTRIBUTION OF AMOUNT OF TIME LOST FROM 20/10/2024 TO 20/10/2025

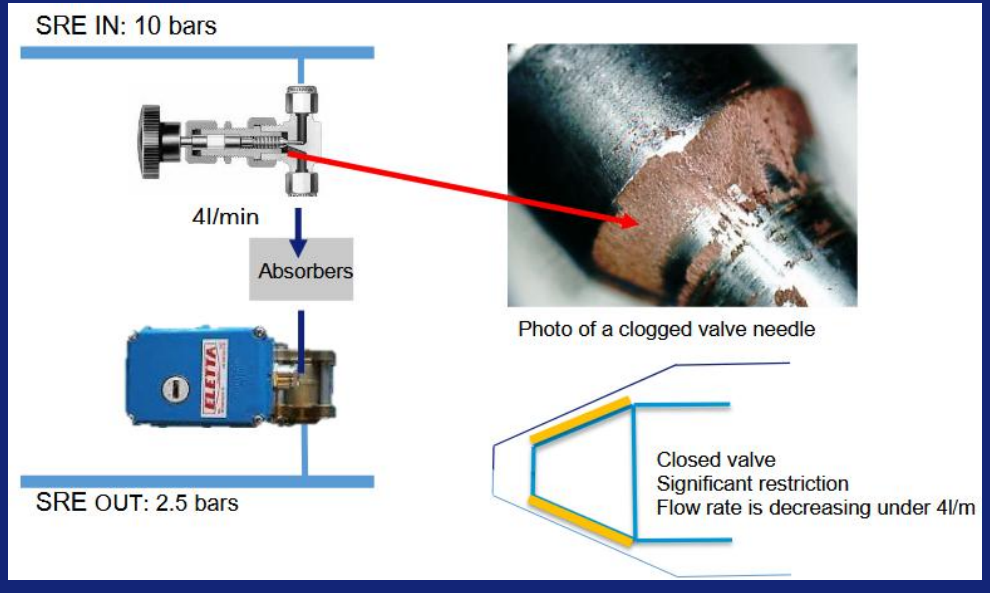


DISTRIBUTION OF FAILURES VS DURATION



** All failures counted as a single failures*

COOLING ISSUE DURING RUN 2055-2 AND 2025-3



Needle valves are installed on the cooling circuits of :

- The absorbers
  (4 valves / cell – 1 valve / girder)

And

- The room temperature in-vacuum insertion devices water cooling

In June 2021, we suffered from 2 beam trips due to clogging of the absorbers' needle valves.
=> All of the absorbers' needle valves were fully open in order to avoid new beam trip and to take time to understand the problem and react.
In May 2023, the absorbers' needle valves in ¼ of the SR were tuned @ nominal flow rate (~ 5l/mn).
In August 2023, All the absorbers' needle valves were tuned @ nominal flow rate.

➔ **Since then no specific cooling issues**.

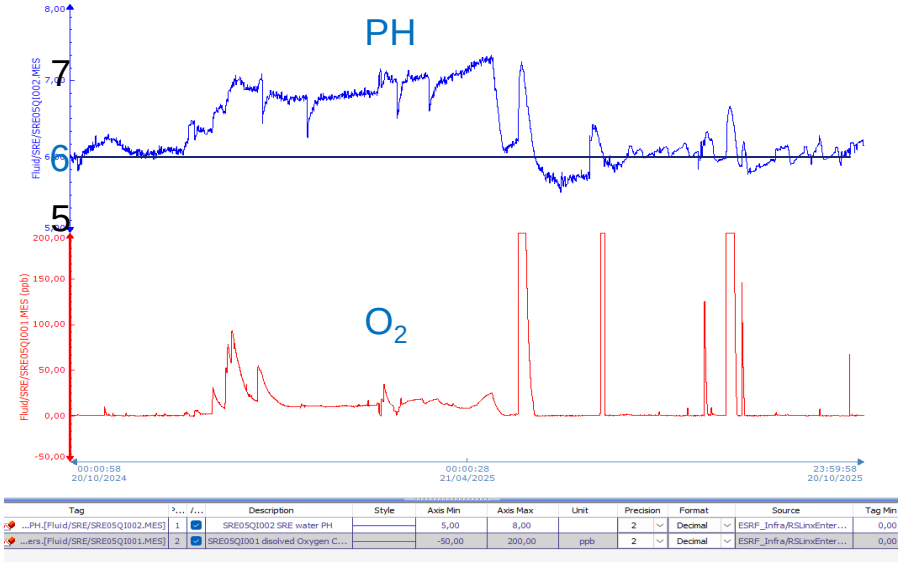
COOLING ISSUE DURING RUN 2025-2 AND 2025-3

- Monday 28/04/2025 (MDT) : 11 alarms
  - ➔ Decision to fully open All the absorbers' needle valves during MDT
- Then water flow interlock in Cell 9, cooling of the straight section.
  - ➔ flow was set to nominal flow by opening the valve
- Then on 1 May at 17:33 beam lost on cooling cell 16

Observation of a regular decrease of the flow for a few days.

➔ Intervention during MDT to check all flow in straight sections and

➔ Check and correct PH and low O_2 level



Tag	Description	Style	Axis Min	Axis Max	Unit	Precision	Format	Source	Tag Min
...PH.[Fluid/SRE/SRE05QI002.MES]	SRE05QI002 SRE water PH		5,00	8,00		2	Decimal	ESRF_Infra/RSLinxEnter...	0,00
...ers.[Fluid/SRE/SRE05QI001.MES]	SRE05QI001 disolved Oxygen C...		-50,00	200,00	ppb	2	Decimal	ESRF_Infra/RSLinxEnter...	0,00

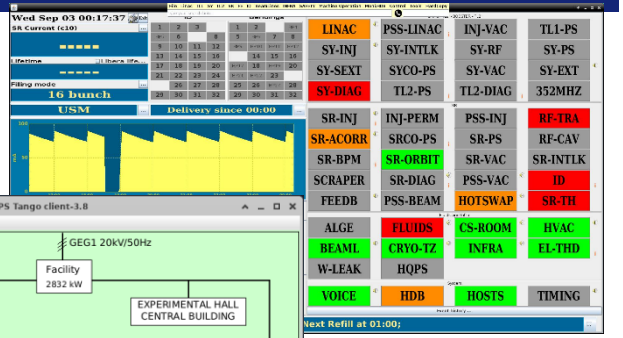
Serious problem of solid copper deposit due to an abnormally high level of O_2 in the circuit *(despite the 1 μm filters in each cell and 0.1 μm in PGUT)*

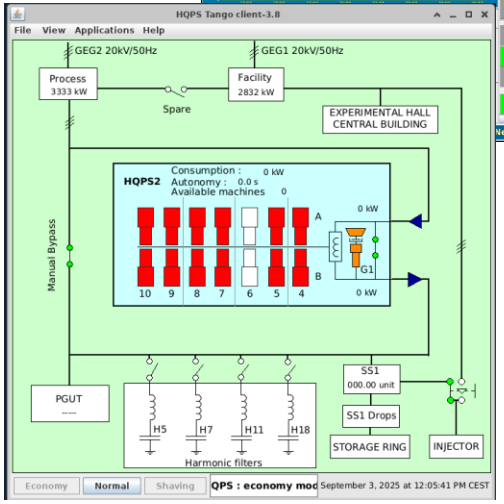
PH carefully monitored and corrected at 6, but slow process

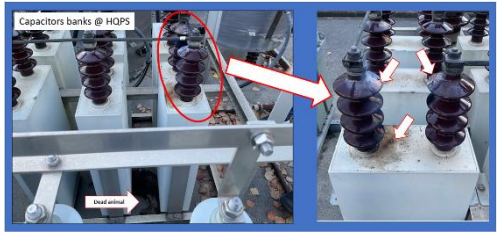
(Risk of erosion of cooper (dissolved copper if Low PH) instead of solid copper (High PH))

➔ The situation is now stable with no flowmeter issues but requires a careful follow up during shutdowns (and sometime MDT).

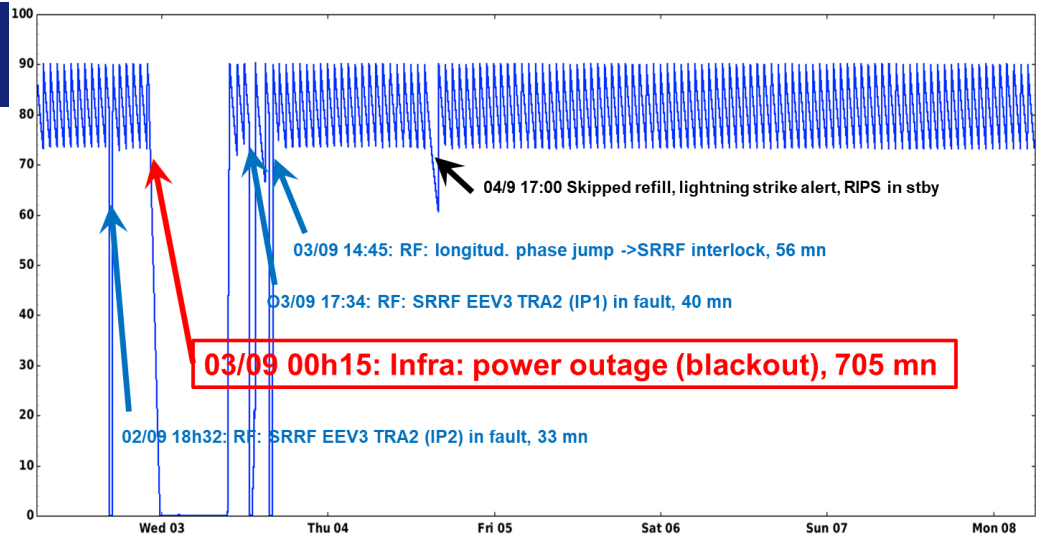
BLACK OUT ON 3 SEPTEMBER







Short circuit in the 20 kV harmonic filters due to an animal, <u>downstream HQPS</u>



A similar black out occurred last year on 1st September due to the feeding line
Lessons learned*:*

- All standbys on site to restart the equipment of the accelerators

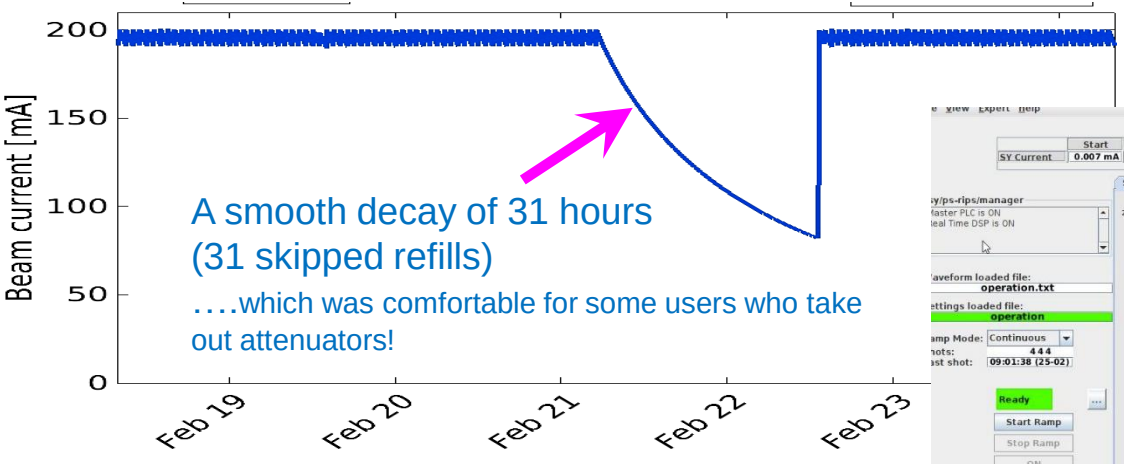
As usual, it is difficult to restart after a complete black out. Some equipment is broken, some settings are not correct, a few pieces of equipment hidden… Need time …..

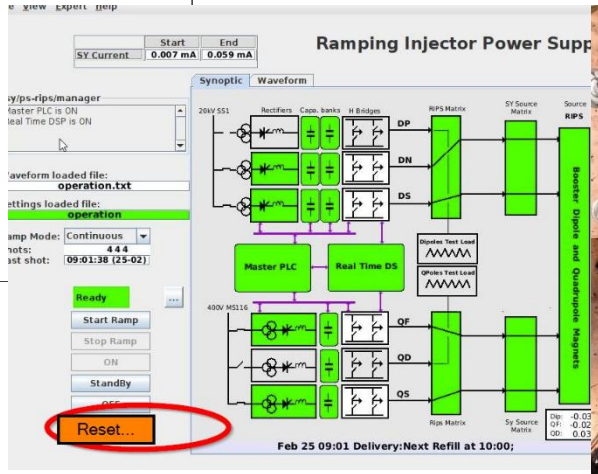
Detailed restart in back-up slide

➔ *situation has improved but some procedures still needed concerning control restart*

- CPMUs cryo-coolers this time kept cooled up after the power outage
  ➔ *No problem this time thanks to the new dual powering system*
- Diesel engineer repaired
  ➔ *But of no use due to the origin of the black out*
- Single mailing list for information diffusion
  (address to be contacted done but single list still not done)

RUN 2025-01: FIFTH WEEK: 31 SKIPPED REFILLS



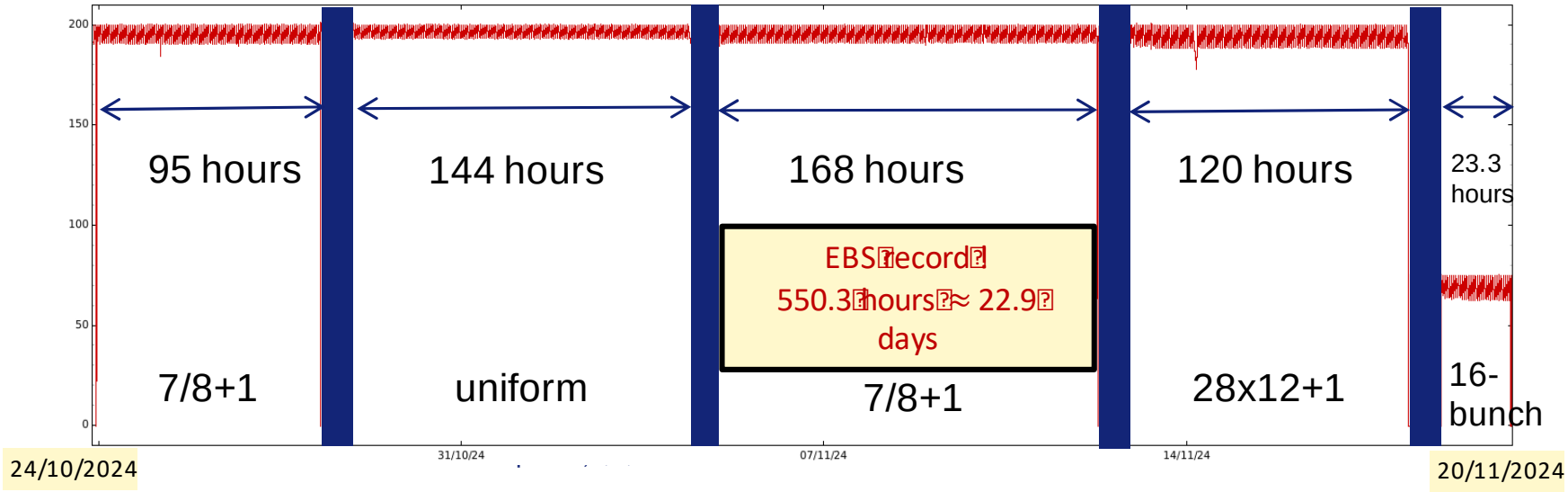


- 2016 Commissioning of RIPS
- 2016-2024:
  - Running smoothly since 2018 after fixing minor design issues
    - About 20 millions cycles accumulated
- July 2024: installation of a NEW spare IGBT stack in DP H-Bridge…
  … exploded after only 2.3 million cycles / 6 months' operation on 21/02 at 06:00
- Replaced by spare power supply after careful checks
- Procurement and repair took 5 months without operational spares

  Use of RIPS was a constraint during this period to minimize the operation risk.
  In particular, 16 bunch mode was delivered at 40 pm.rad instead of 20 in order to gain in lifetime.
- Back to operation on 15/07

EBS OPERATION RECORD

- 5372 hours of beam delivered in 2024 out of 5486 hours scheduled
- Overall availability in 2024: 97.92 %, with MTBF = 72 hrs and MDF = 1.59 hrs
- In 2025, 4358.7 hours of beam delivered in 2025 out of 4409 scheduled [in progress]
- Overall availability 2025: 98.86 % [in progress]
- ECO mode in USM operation maintained

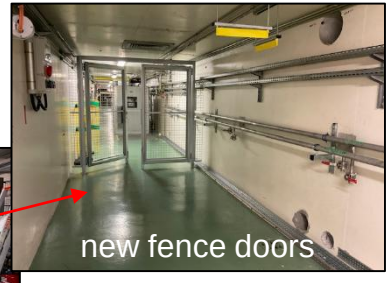


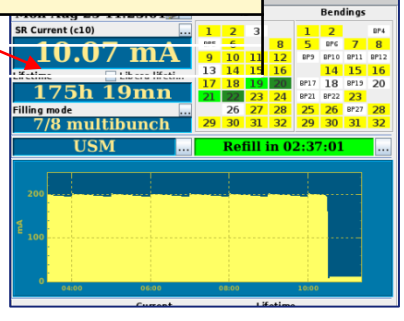
MAIN INTERVENTIONS DURING SHUTDOWNS

Detailed list in back-up slide

Winter shutdown 2025
SRTU : refurbishment of search button cables of the PSS
TZ04-8-HSC04 : Sext/Octu Mopslate installation
CELL03-arc : K1 Friatec vessel against Solcera vessel
CELL28-SS : 2 room temp in vacs
March shutdown 2025
LINAC : Extension of the SRE network
CELL28-SS : phase shifter middle SS
May shutdown 2025
RIPS: Removal of the broken IGBT stack (DP H-bridge)
Cell08-SS CV2300/6mm in downstream position (prototype AL vessel)
Cell23-SS Replacement of the CV5000 (canted straight section)
Cel24-SS: New revolver upstream position + phase shifter civil work
Summer shutdown 2025
Linac: Preparatory works (civil works, cabling, cooling, wave guide network, …)
SRRF : TRA2 klystron replacement : EEV5 → EEV-3
CELL29-SS Removal of the cryogenic in vacuum device – IVU in the middle
CELL13-SS : cryogenic in vacuum device installation middle position
CELL24-SS : New revolver - Downstream position
Cell08-SS Replacement of the CV2300/6 by the CV2300 coming from CELL13-SS
CELL17-CELL21: Partial re-alignment of girders
October shutdown 2025
SYTU : replacement of QF28 & QF29
CELL01-SS : room temp in vacuum device

Al PS are now covered by hot swap system





Every shutdown:

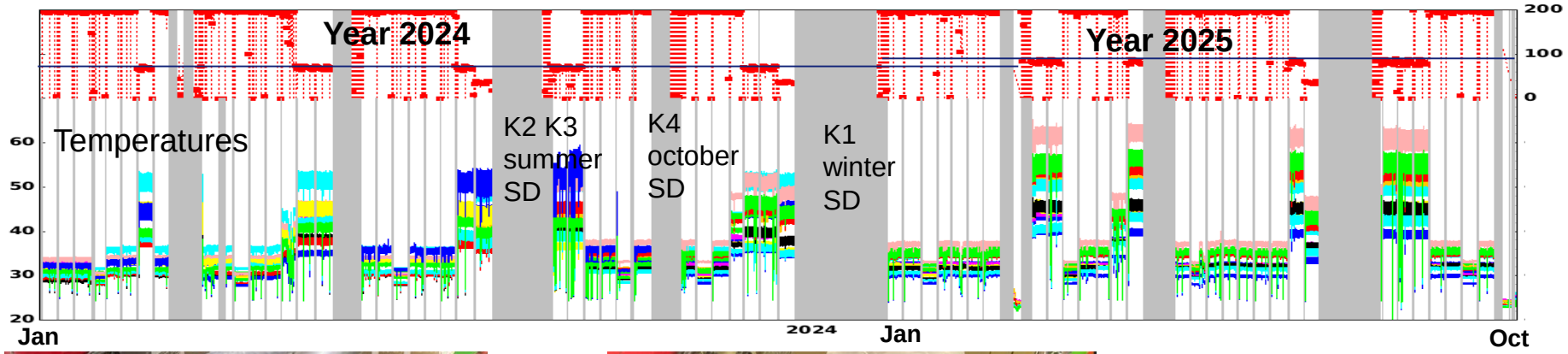
SRTU &SYTU: Flow meter maintenance

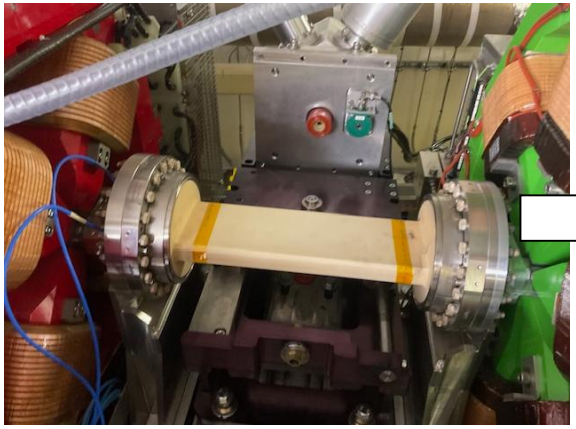
FE maintenance

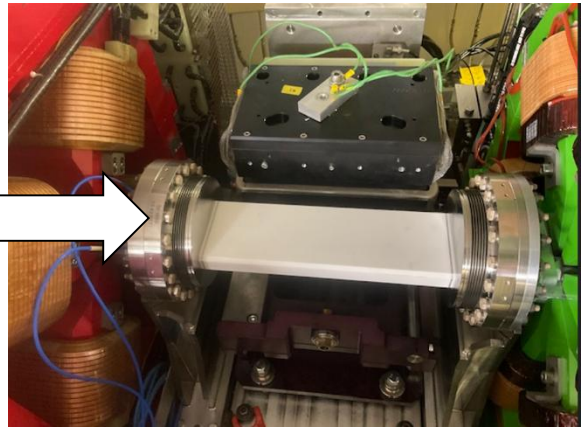
Partial realignment of Cell 17 to Cell 21 during summer shutdown (See David's talk). No specific issues at restart and for the beamlines

Benefit for the machine will only be seen when the total realignment is performed

CELL03-ARC : REPLACEMENT OF THE LAST FRIATEC CERAMIC VESSEL





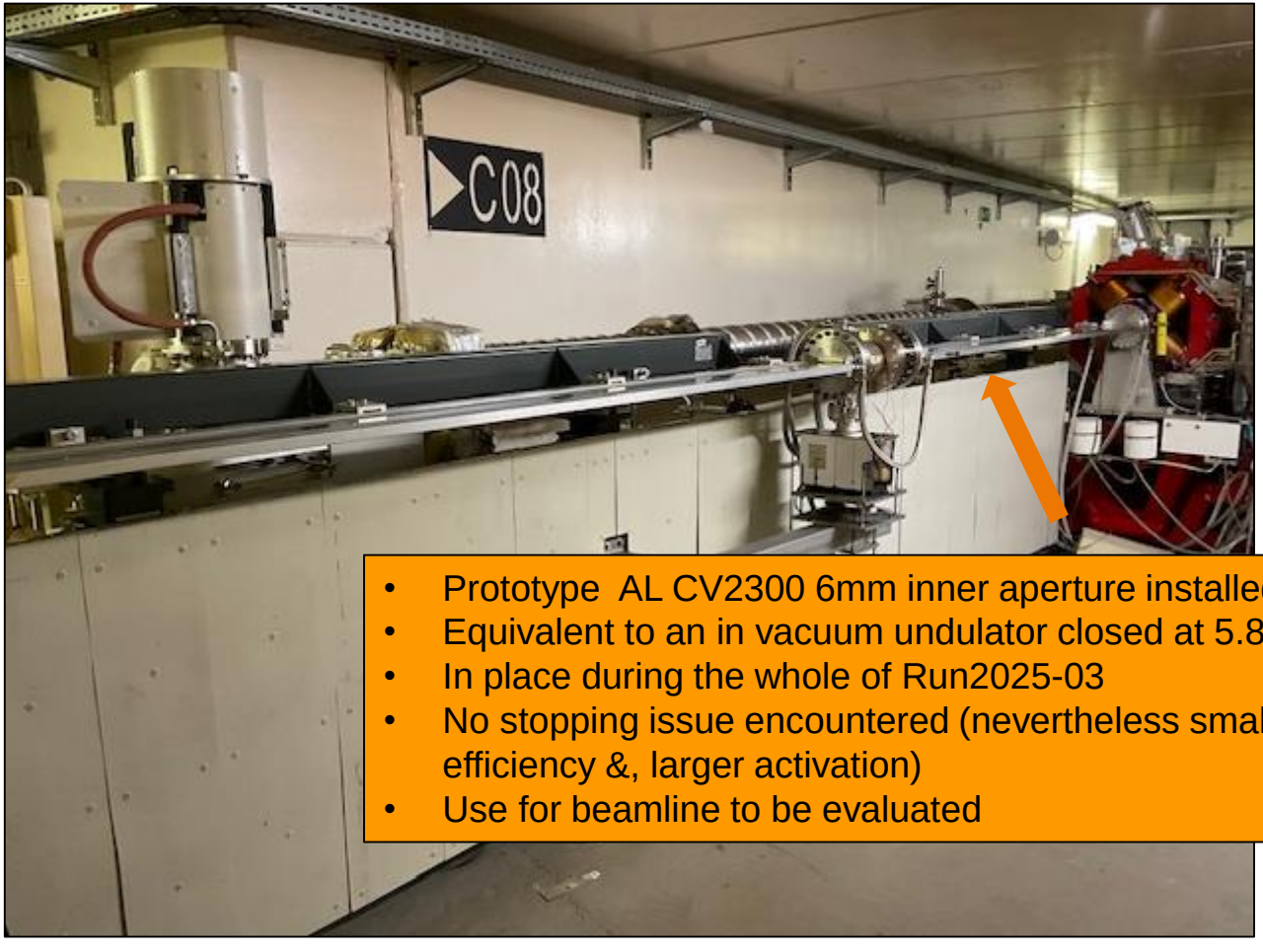


K1 replaced during the 2024 winter shutdown, was the last step allowing 90 mA in 16 bunch.

Temperatures at expected values (less coating, higher in the middle) and stable

All 4 Solcera chambers behave well in all beam modes and 90 mA has been reached since January 2025.

CELL08-SS : CV2300 (8 X 10MM) REPLACED BY CV2300 (6 X 8MM)



- Prototype AL CV2300 6mm inner aperture installed downstream in cell8
- Equivalent to an in vacuum undulator closed at 5.8 mm
- In place during the whole of Run2025-03
- No stopping issue encountered (nevertheless small reduction of injection efficiency &, larger activation)
- Use for beamline to be evaluated

LOCATION OF THE IN-VACUUM DEVICES

	Position		
	Upstream	Middle	Downstream
CELL01			~~XXXXX uncooled~~
CELL03		CPMU16.4/2	
CELL06	CPMU18/1		
CELL09	ppi23/1		ppi17/1
CELL11	CPMU18/2		hpi22/1
CELL13		CPMU16-4b	
CELL14	CPMU18.6/1		
CELL15	CPMU18/3		hpi20/1
CELL16	CPMU20.5/1		
CELL22		hpi26/1	
CELL27		CPMU18/4	
CELL28	hpi22/2		hpi13.3/1 **uncooled**
CELL29		ppi21/1	
CELL31		CPMU14.4/1	
Total	7	6	5

9 Cryogenic in-vacuum

7 Room temperature in-vacuum devices (IVU) water

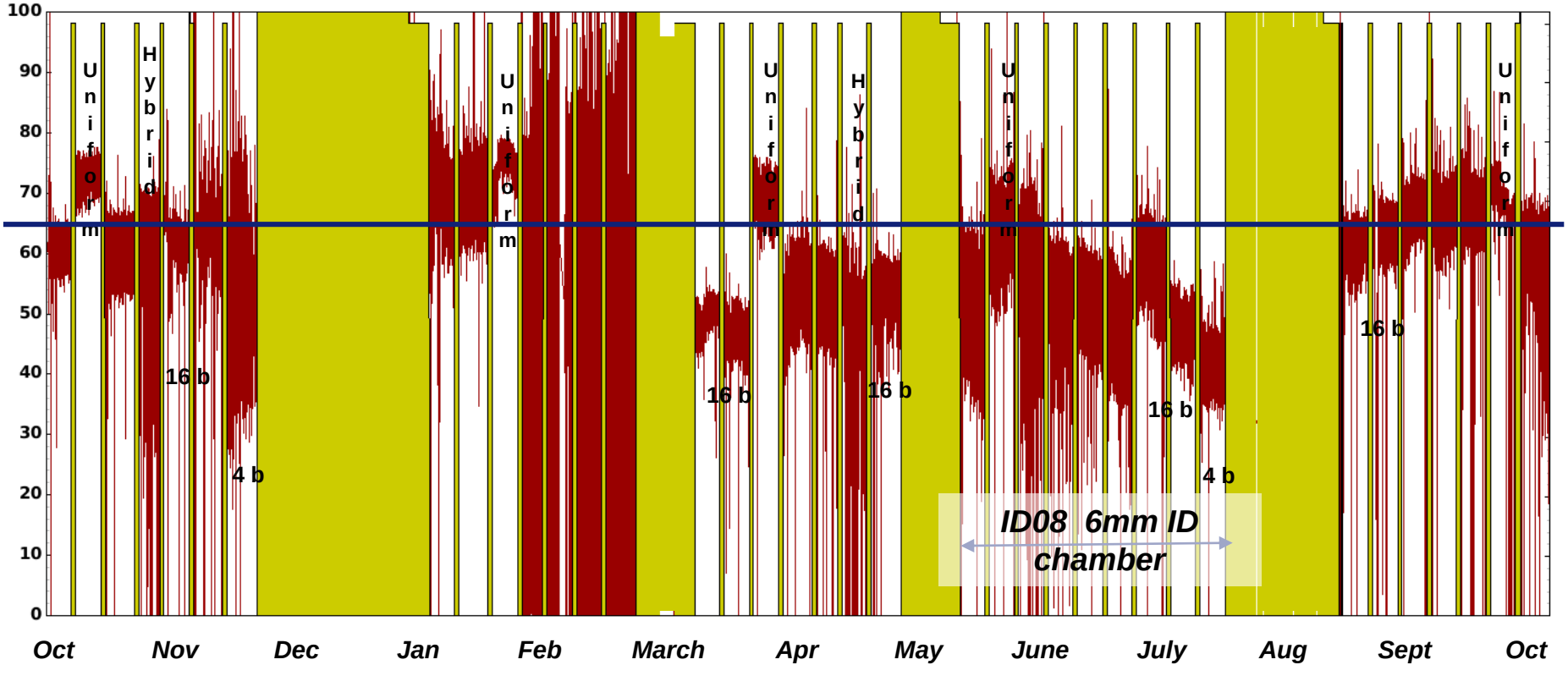
~~2~~ **1** Room temperature in-vacuum devices uncooled

✓ Installed during October 2025 shutdown,
✓ Removed this week-end

Cell13-ss : cryo-invac coming from id29 in middle position

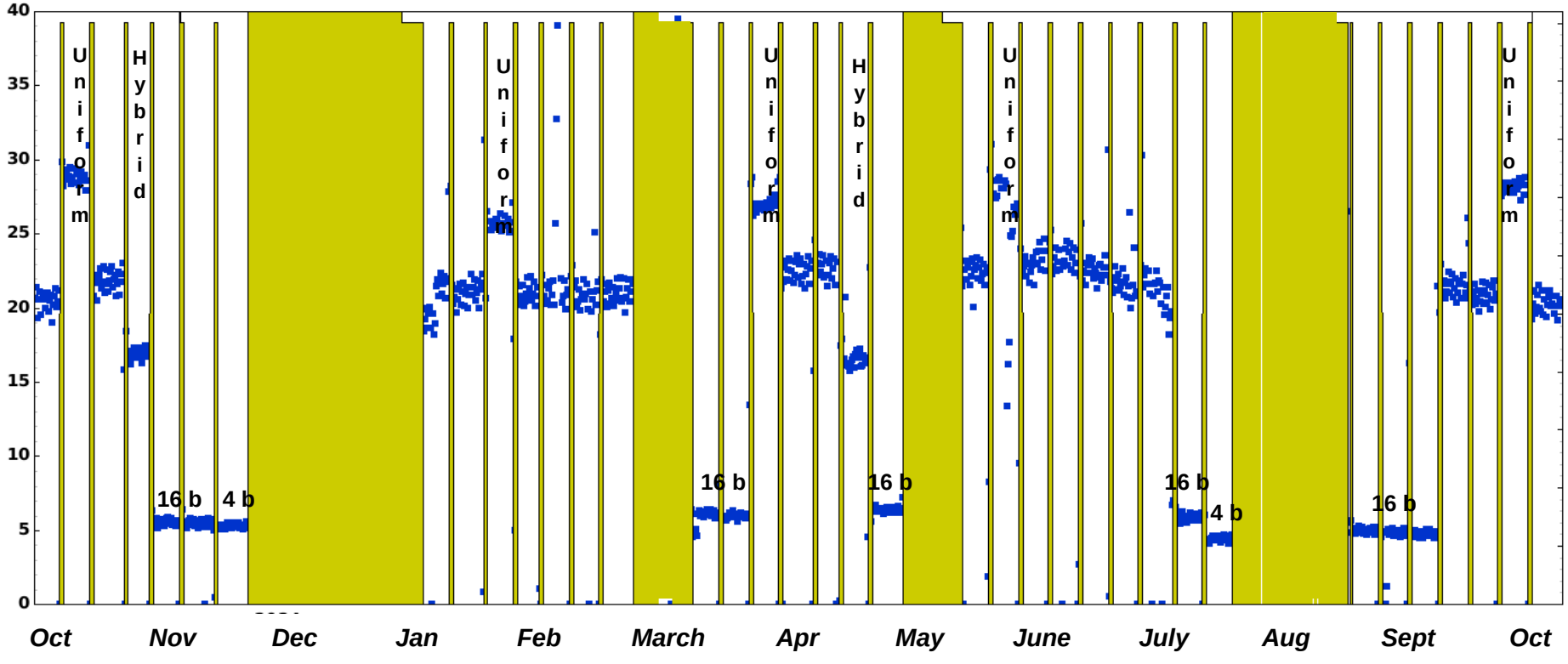
Cell29-SS : IVU shifted in middle position

INJECTION EFFICIENCY OCTOBER 2024 ➔ OCTOBER 2025



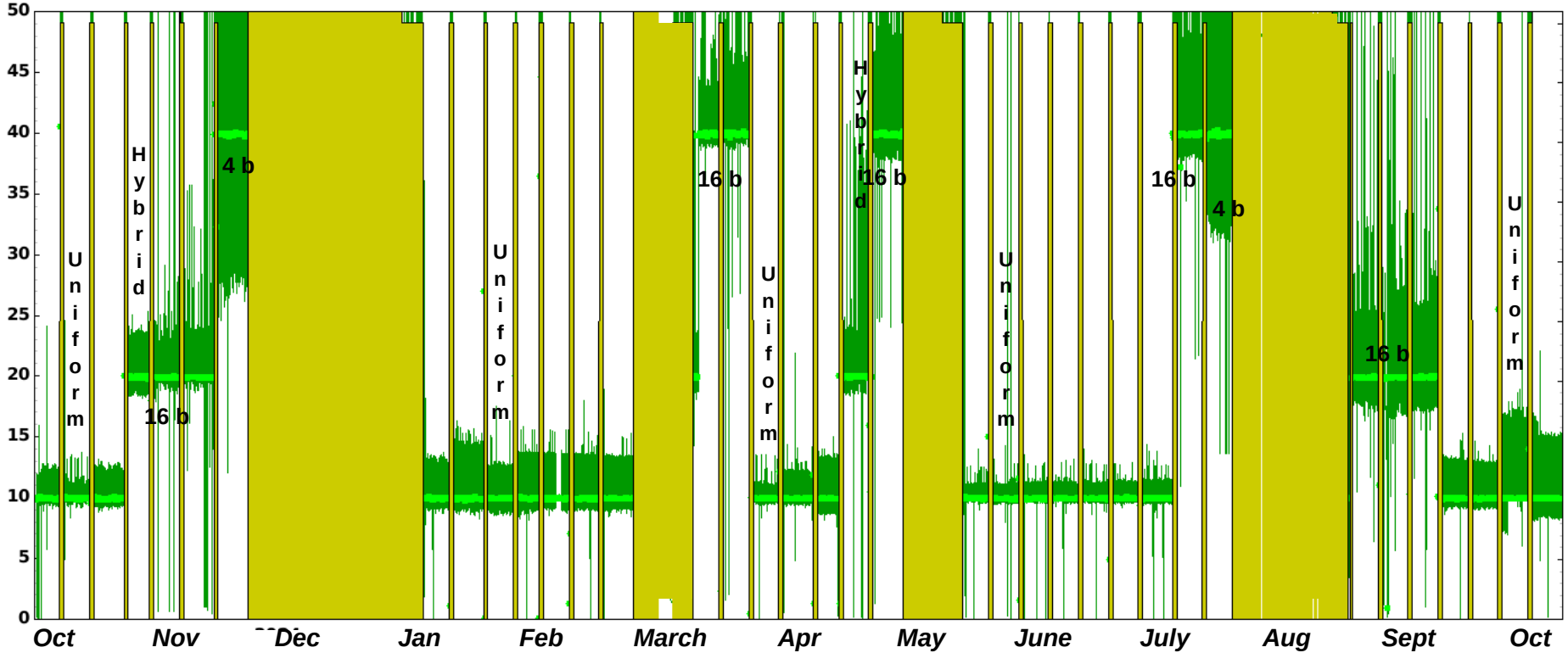
- ✓ Average during the period: 65%, upgrade of the injector is a key issue to improve injection efficiency.
- ✓ Injection efficiency re-optimized at each restart (manual +badger) and regularly by operators
- ✓ 10% reduction observed since March, but difficult to recover, not well understood, some ideas under investigation
- ✓ *7/8+1 affected by saturation on single bunch for a long time (linked to impedance effect, study with simulation and MDT)*

LIFETIME OCTOBER 2024 ➔ OCTOBER 2025



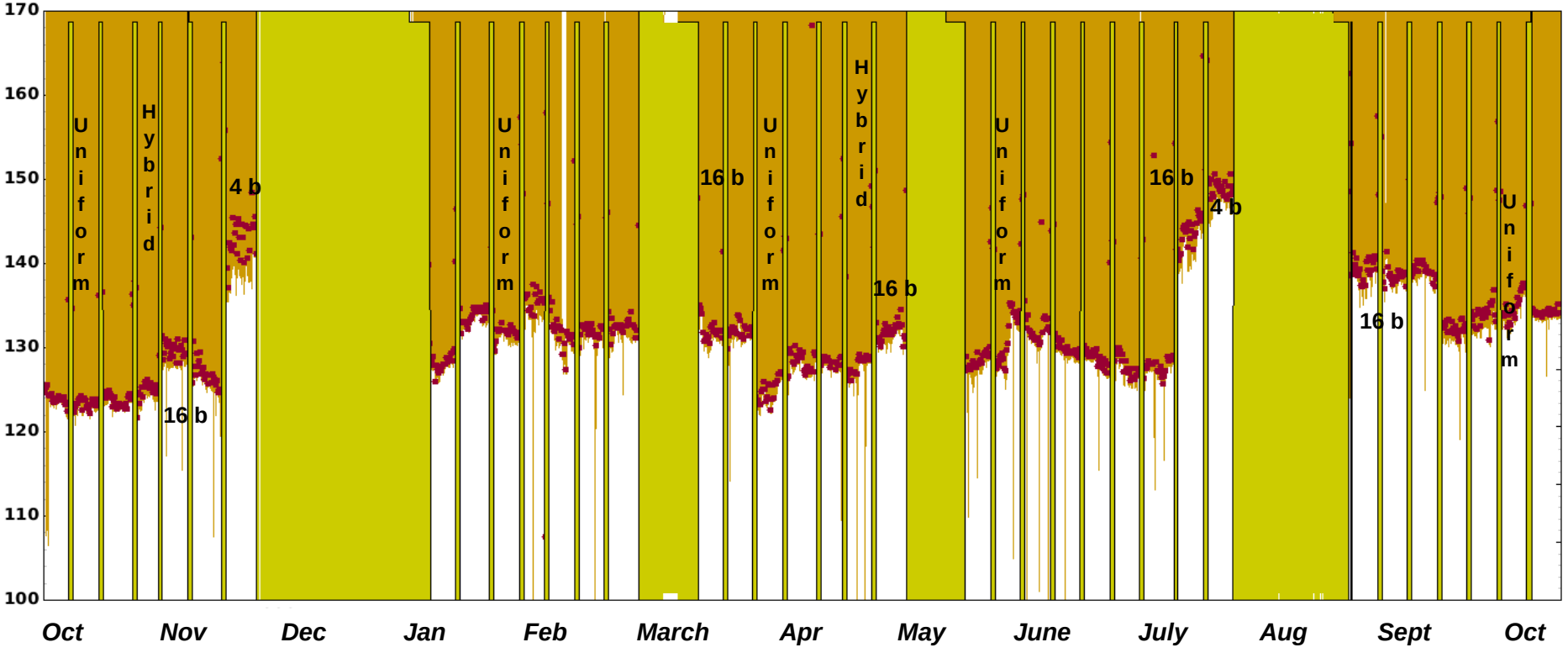
- ✓ Average beam mode maintained compared to previous years
- ✓ Lifetime re-optimized at each restart (manual +badger)
- ✓ Collimators retuned at each change of beam mode (set at 7% reduction gap open)
- ✓ Lifetime increased in 16 bunch run 2025-2&3 to protect RIPS

VERTICAL EMITTANCE OCTOBER 2024 ➔ OCTOBER 2025



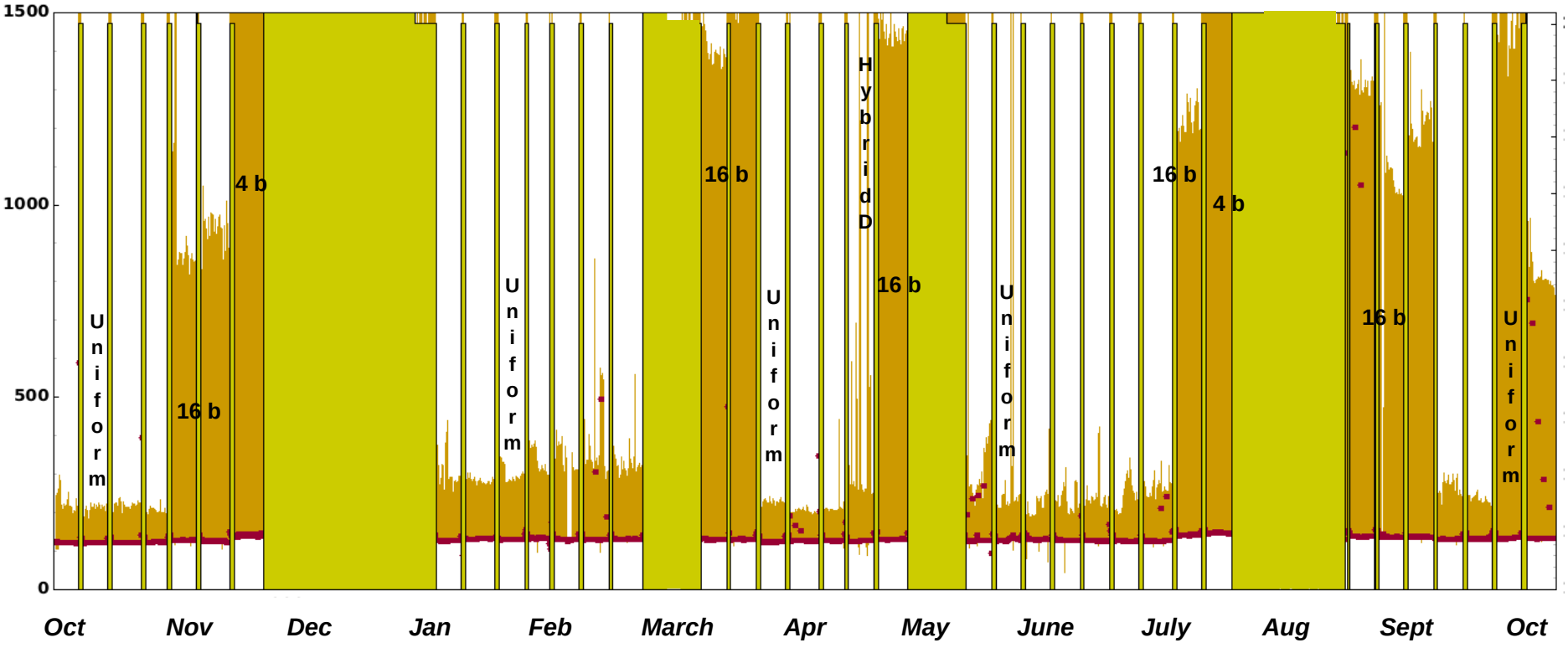
- ✓ Vertical emittance increased from 1 to 10, 20 or 4 pm.rad to maintain lifetime
- ✓ Vertical emittance increased from 20 to 40 pm in 16 bunch run 2025-2&3 to protect RIPS
- ✓ Less than 5 pm blow-up at injection in multibunch mode

HORIZONTAL EMITTANCE OCTOBER 2024 ➔ OCTOBER 2025



- ✓ Horizontal emittance in average of 128 pm
- ✓ A few pm variation with ID gap variation (ID power of 100kW in average at 200 mA)

HORIZONTAL EMITTANCE (INJECTION PERTURBATION) OCT 2024 ➔ OCT 2025



- ✓ Less than 200 pm blow-up at injection in multi-bunch mode when the compensation system and the optics (tune) are well tuned *(the most sensitive beamlines do not take data during refill)*
- ✓ Compensation system not working in 16 and 4 bunch mode
- ✓ No complaints from users even when the system is not perfectly tuned *(like the large perturbation in the uniform of last run, most probably due to compensation system not well tuned to the injection settings)*

Accelerator programs in next 5 years

1. High reliability, availability, stability and sustainability of USM operation

- SSAs for RF system @ storage ring – consolidate the storage ring operation
- ID constructions, ID controls – provide more light sources, better control, and explore the potential of EBS
- Energy saving (ECO mode) maintained in USM operation
- Injector upgrade (linac refurbishment & booster light upgrade)

2. Improvement of beam delivery and performance

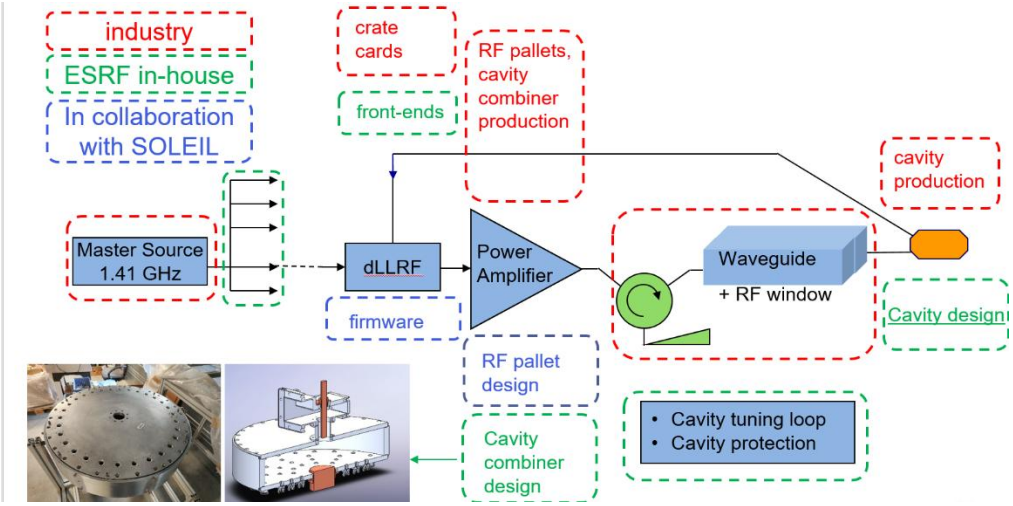
- Injection improvement – injection efficiency promotion, transparent injection
- 4^{th} harmonic cavity – improve the beam performance @ timing modes – Higher brightness & coherence, future upgrade
- Low-gap IDs, other new type IDs (HTS) – under investigation
- New linac (COLD) – Increased linac energy, test facility for new technology of linac structure

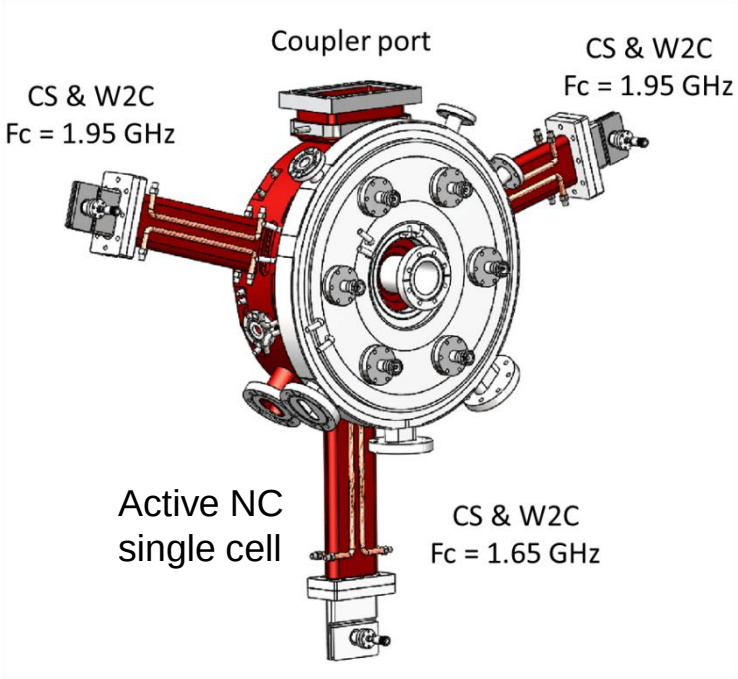
Courtesy Q Qin

4TH HARMONIC CAVITY

The ESRF is providing the complete cavity design to SOLEIL II within a collaboration contract

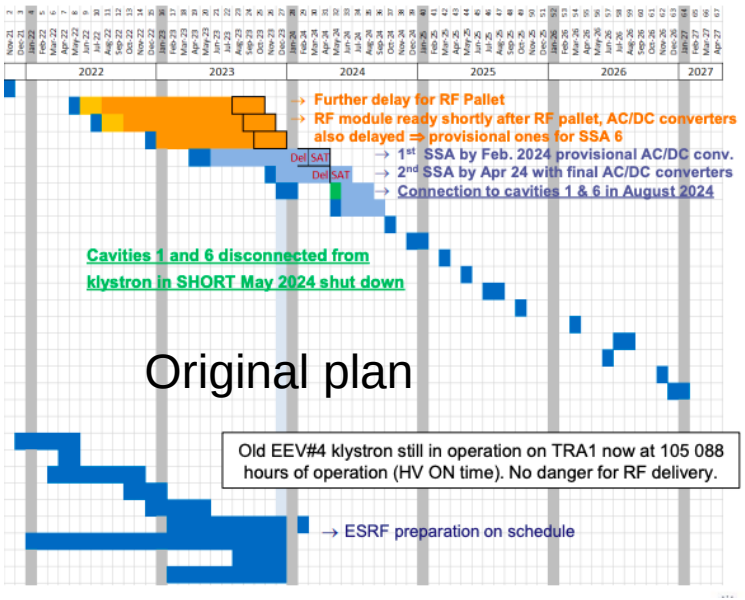
Close design project relaunched in 2025 for ESRF





Courtesy P Boroviec

MEDIUM TERM STRATEGY PROGRAMS – RF PROJECTS (SSA)



SSA0, a prototype of technical verification at JEMA

SSA0, test at the ESRF

Solid State Amplifiers situation

- An amendment was signed in April 2024, to have an SSA0 to be the technical validation for JEMA
- SSA0 delivered in on 18th Oct, 2024, but SAT not yet fulfilled due to a series technical issues. The scheduled 1000 hrs test even not yet started.
- SSA2, as the milestone 2, scheduled to finished in June 2025, tests failed until 20th Oct.
- The contract to JEMA France most probably to be terminated, due to these uncompleted milestones.

Courtesy P Boroviec

MEDIUM TERM STRATEGY PROGRAMS – ID

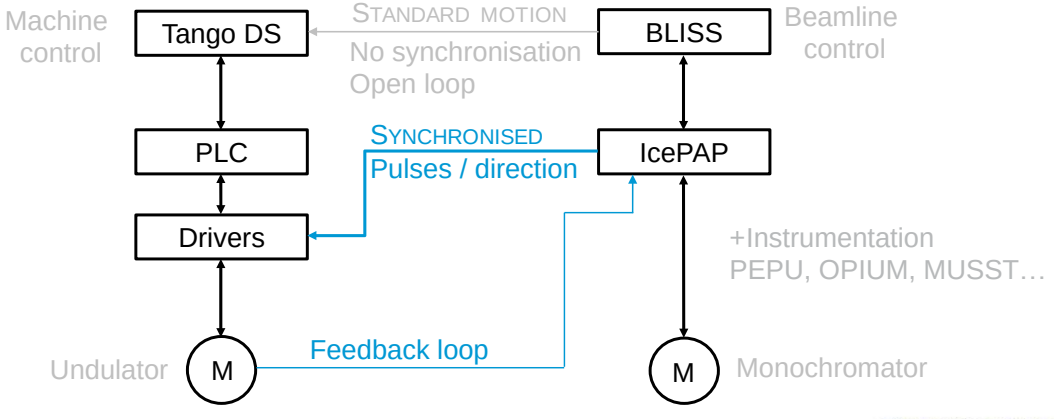
ID construction

Insertion device	Beamline	Comment	2026					2027					2028				
			Mar.	May	Aug.	Oct.	Dec.	Mar.	May	Aug.	Oct.	Dec.	Mar.	May	Aug.	Oct.	Dec.
CPMU20.5 (2m) #1	ID20																
CPMU20.5 (2m) #2	ID20																
IVU16 (2m)	ID14																
CPMU18.6 (2.5m)	ID18																
U27 (1m)	ID03																
CPMU20.5 (2m) #3	ID11	To be confirmed															
W150 (1m)	ID19	To be confirmed															
HELIOS #4	ID12	Refurbishment															
HELIOS #2	ID12	Refurbishment															
Revo 27/32 #1	ID21	Refurbishment															
Revo 27/32 #2	ID26	Refurbishment															
Revo 27/32 #3	ID26	Refurbishment															

ID synchrotronization

Courtesy G LeBec

Simplified diagram



INJECTOR UPGRADE PROGRAMME

Injectors upgrade

Short term

Linac refurbishment
Procurement
1.5 M€

More reliability
Modernization

Booster refurbishment
Advanced Design & procurement
0.5 M€

Lower natural emittance
Higher injection efficiency in SR
Higher extraction efficiency

SR Injection section improvement
In construction
3 M€

Non-linear injector kicker
Transparent injections
Maintain injection efficiency

Mid-term

COLD
Started
5 M€

Long-term

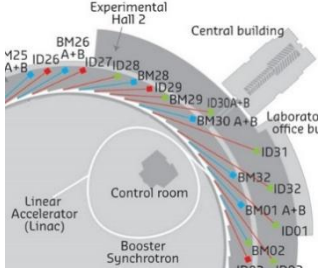
NEW Linac

Replace existing injectors with a full energy injector linac

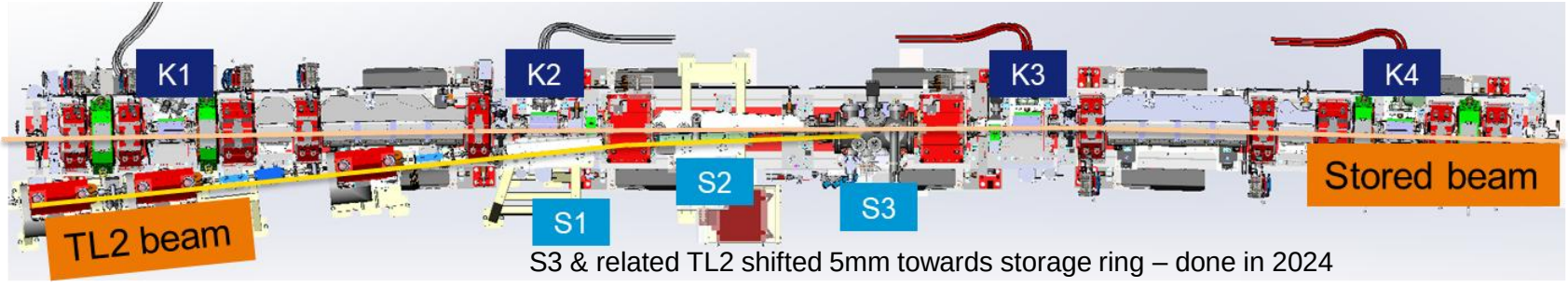
Higher injection efficiency, lower injection perturbation, enable/facilitate future SR upgrades

6GeV + margin
> 600 pC (single bunch)
< 1 nm.rad at SR injection
< 0.1 % energy spread
< 1 mm bunch length
> 4 Hz repetition rate
Bunch spacing 2.8ns (in the SR)
Fits on site (maximum 180m)
As low energy consumption as possible
User facility grade :

- Reliability
- Reproducibility Maintainability



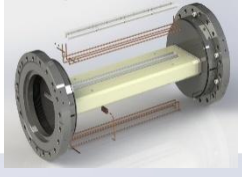
MEDIUM-TERM SCIENTIFIC PROGRAMS – INJECTION IMPROVEMENT



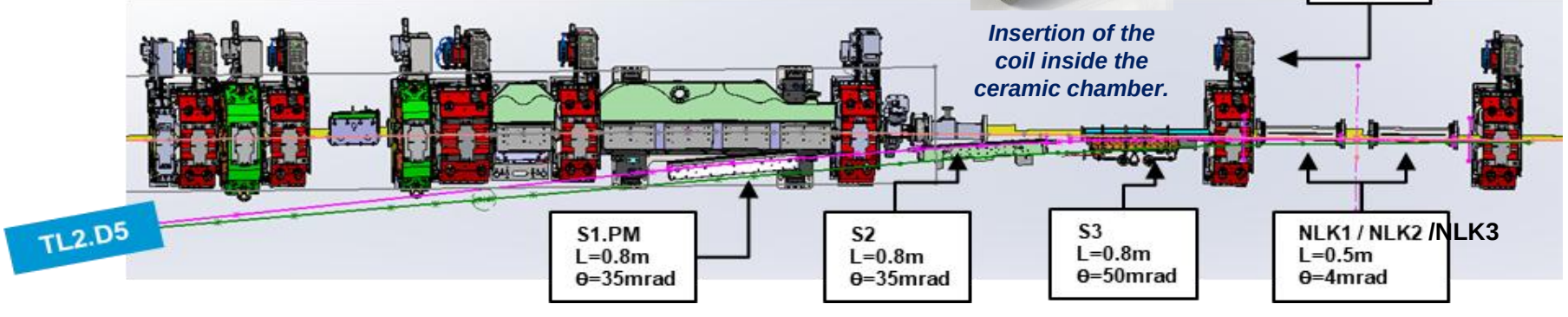
S3 & related TL2 shifted 5mm towards storage ring – done in 2024

Nonlinear kicker scheme

Courtesy A Sauret



Insertion of the coil inside the ceramic chamber.



- Assembly end 2025 of the NLK, same procedure as SOLEIL
- Installation in May 2026 in the ID8 test section for test and validation
- Installation in 2029 in the injection section of 3 NLK for a total angle of 12.2 mrad.

BOOSTER LIGHT UPGRADE

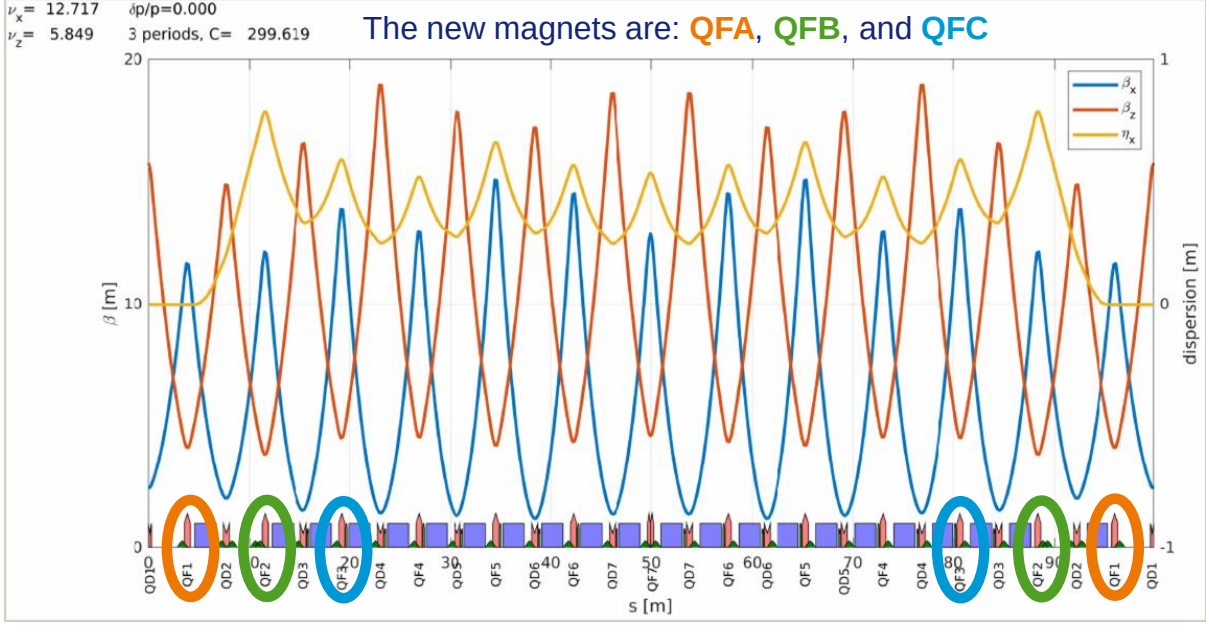
Basic idea: increase the number of quadrupole families from 2 to more (4, 5 or 6) to reduce horizontal emittance.
The 3 additional QF families will be powered by the same booster power supply (RIPS), but the 18 magnets will be shorter in order to have a smaller gradient.

Present lattice
2 quad families

- 39 QD, 39 QF
- ε_x = 83.1 nm
- BL = 22.6 mm

New lattice
5 quad families

- 39 QD, 21 QF,
- 6 QFA, 6 QFB, 6 QFC
- ε_x = 59.6 nm
- BL = 19.9 mm



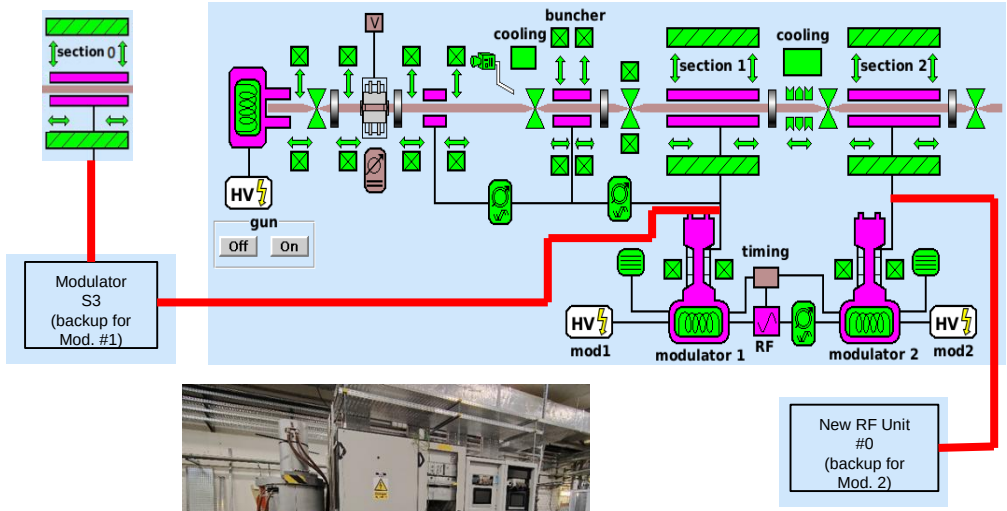
The installation in the booster should be during the winter shutdown 2027/2028.

Courtesy N Carmignani

LINAC – REFURBISMENT

Implemented actions:

- Modulator #3 moved to a new position to provide the RF for:
  - Section #1 in the Linac
  - Spare accelerating section during conditioning
- Spare accelerating section -> CFT awarded by RI GmbH
  - All cavities have been machined
  - Brazing and tuning in November
  - Delayed delivery due to lead time of ceramic for the RF window (input splitter) *December 2025*
- Solid state RF Unit -> CFT awarded by ScandiNova
  - Canon klystron has been selected
  - FAT accepted.
  - SAT in November
- Purchase of vacuum chamber to replace any section -> delivered

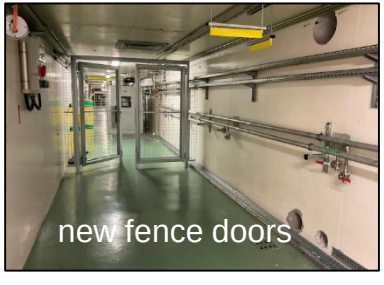


Linac, beam dynamic simulations by BD Group.

- Existing Linac is modelized

Courtesy P Boroviec

Preparation work in progress

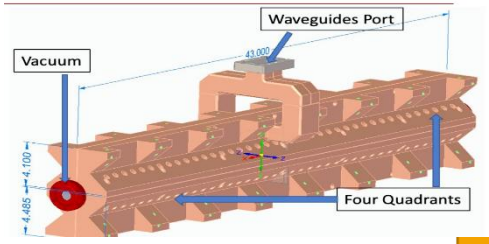


COLD PROJECT

C^2 cold copper

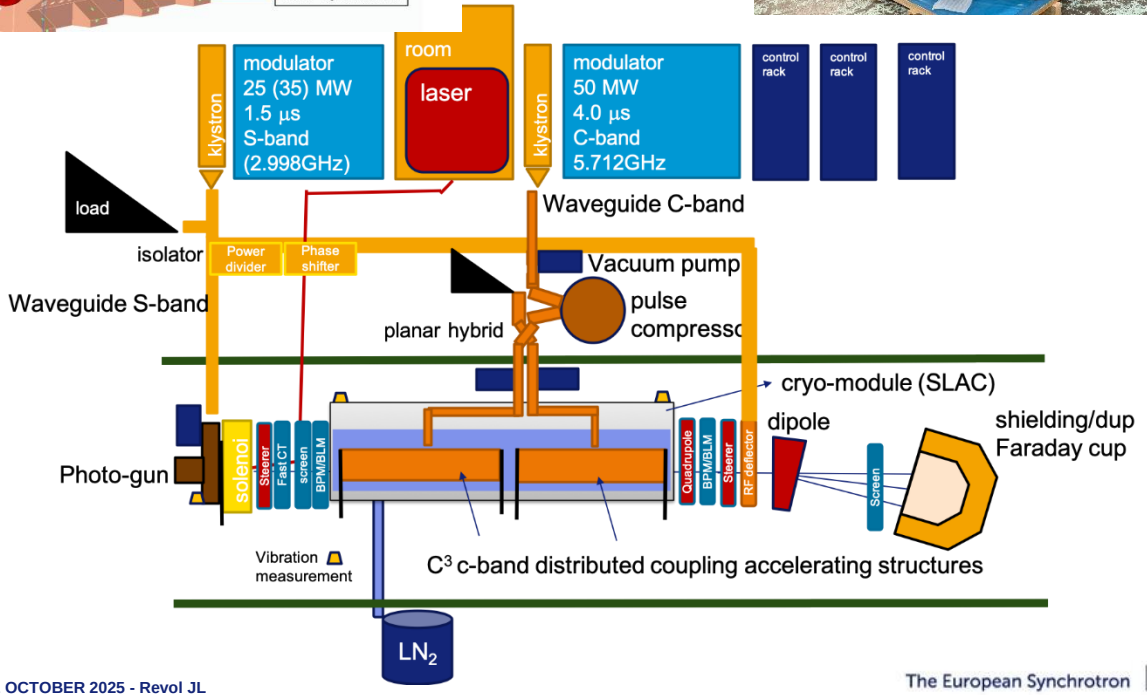
Operation Linac Demonstrator

SLAC distributed coupling standing wave cryogenic accelerating strucutres and cryomodule



high gradient (135MV/m peak field)
Low breakdown rates at 77K

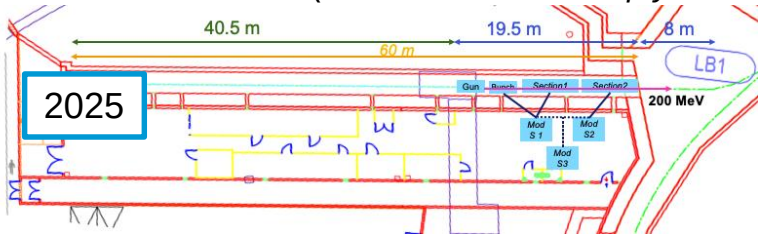
A demonstrator to prove **high gradient cryogenic accelerating structures**(about 80 MeV/m energy gain) for users facility grade **operation** at low repetition rate.
The **pre-injector** of a new 6GeV linac.



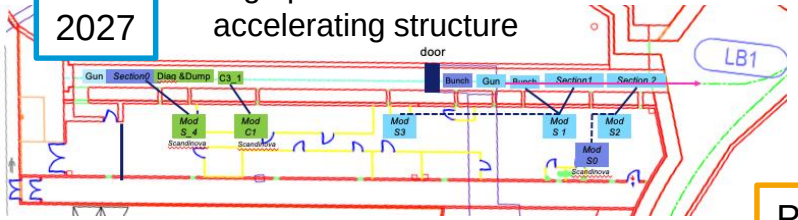
Courtesy S Liuzzo

INSTALLATION IN THE TUNNEL

Present situation (2/3 of linac tunnel empty

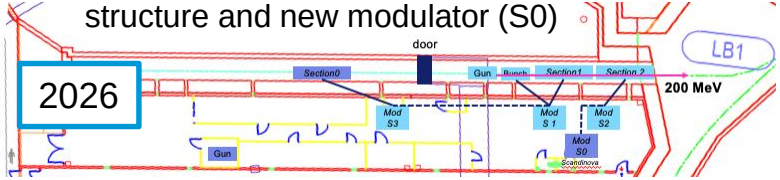


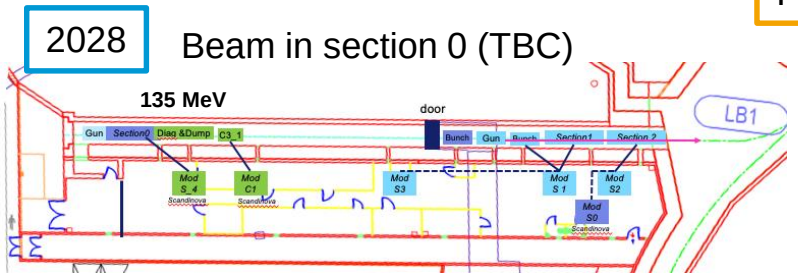
High power RF test of C^3 accelerating structure



Phase 0

High power RF test of spare accelerating structure and new modulator (S0)

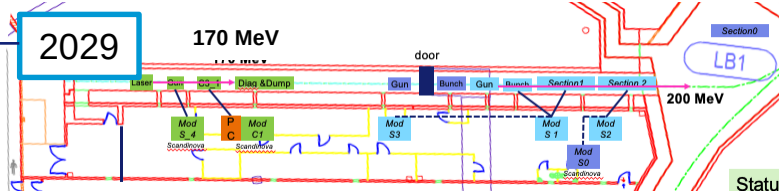




Beam in section 0 (TBC)

Photo Gun available in 2028

Beam in C^3 acc. structures.

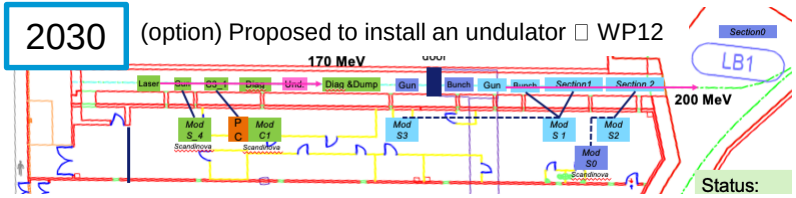


Phase 1

Take decision to continue or not toward 6GeV linac

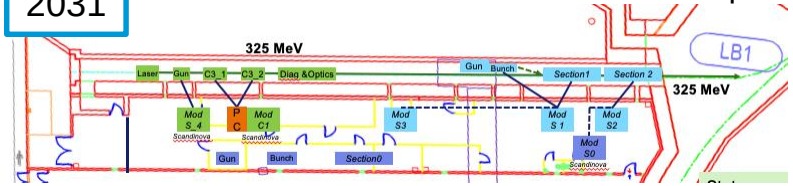
INSTALLATION IN THE TUNNEL

2030 (option) Proposed to install an undulator □ WP12



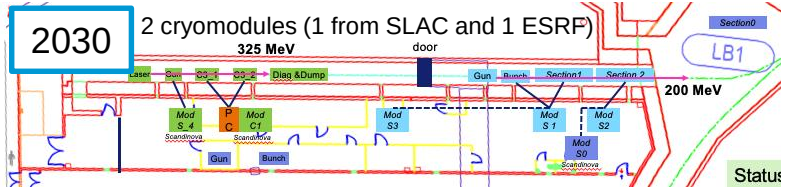
Phase 3

2031 Beam to ESRF booster and old linac as spare

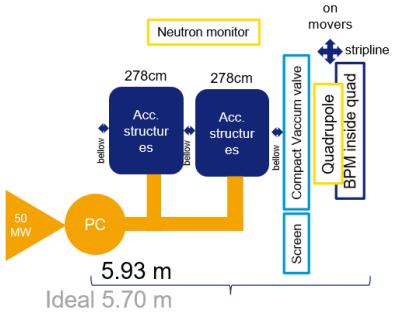


Phase 2

2030 2 cryomodules (1 from SLAC and 1 ESRF)



2032-35(?) 6GeV Linac construction during shutdowns and commissioning during USM



Fits on ESRF site

6.159 GeV in **131m**, 21 x 5.93m modules

80+4 accelerating C^3 structures

5.6mm.mrad, ~500pmrad@6GeV

0.18% energy spread

0.5mm bunch length

2035 (?)

2 month shutdown to install new Transfer line linac to SR and commission new injection

OVERVIEW OF EBS OPERATION AND CONCLUSION

	Units	ESRF	ESRF-EBS
Energy	*GeV*	6	6
Circumference	*m*	844.4	844
Lattice		DBA	HMBA
Current	*mA*	200	200
Lifetime	*h*	50	25
Emittance H	*pm.rad*	4000	133
Emittance V	*pm.rad*	4	1 to 40

	2018	2024	2025*
Availability (%)	*98.47*	**97.92**	**98.86**
Number of failures	*53*	**72**	**34**
Mean Time Between Failures (hrs)	*104.30*	**76.2**	**129.7**
Mean Duration per Failure (hrs)	*1.60*	**1.6**	**1.5**

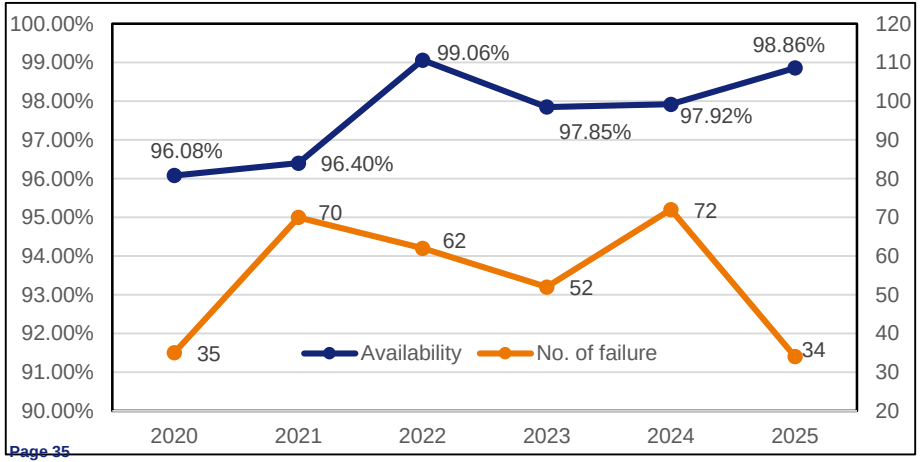
** statistics until 14th October for 2025*
Two failures occurring in less than 1 hour counted as a single long failure
Failures affecting a single beamline are not counted

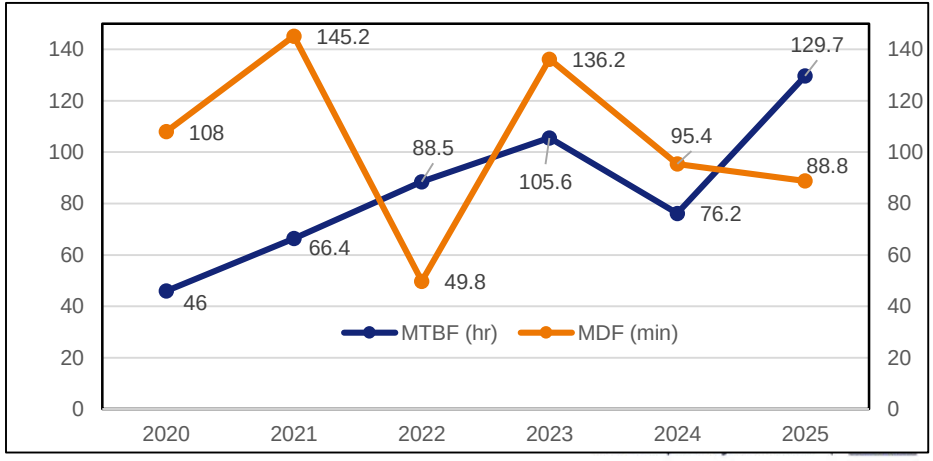
- ✓ EBS fully operational at nominal parameters.
  - ➔ 90 mA current routinely delivered in 16 bunch
- ✓ Reliability, reproducibility and tuning of the machine are very good.
  - ➔However injection efficiency is an issue
- ✓ Injection perturbation *(imposing 1h topping up)* is still an issue despite the efforts to reduce it
  - ➔ New injection scheme is in development
- ✓ Statistics are better for 2025 with fewer failures and very few long beam interruptions.
  - ➔ securing the SR RF system is mandatory (SSA)
- ✓ Maintaining and improving lifetime
  - ➔ 4th harmonic cavity project restarted
- ✓ Upgrade of the injector
  - ➔ Linac upgrade programme is ongoing

MANY THANKS FOR YOUR ATTENTION

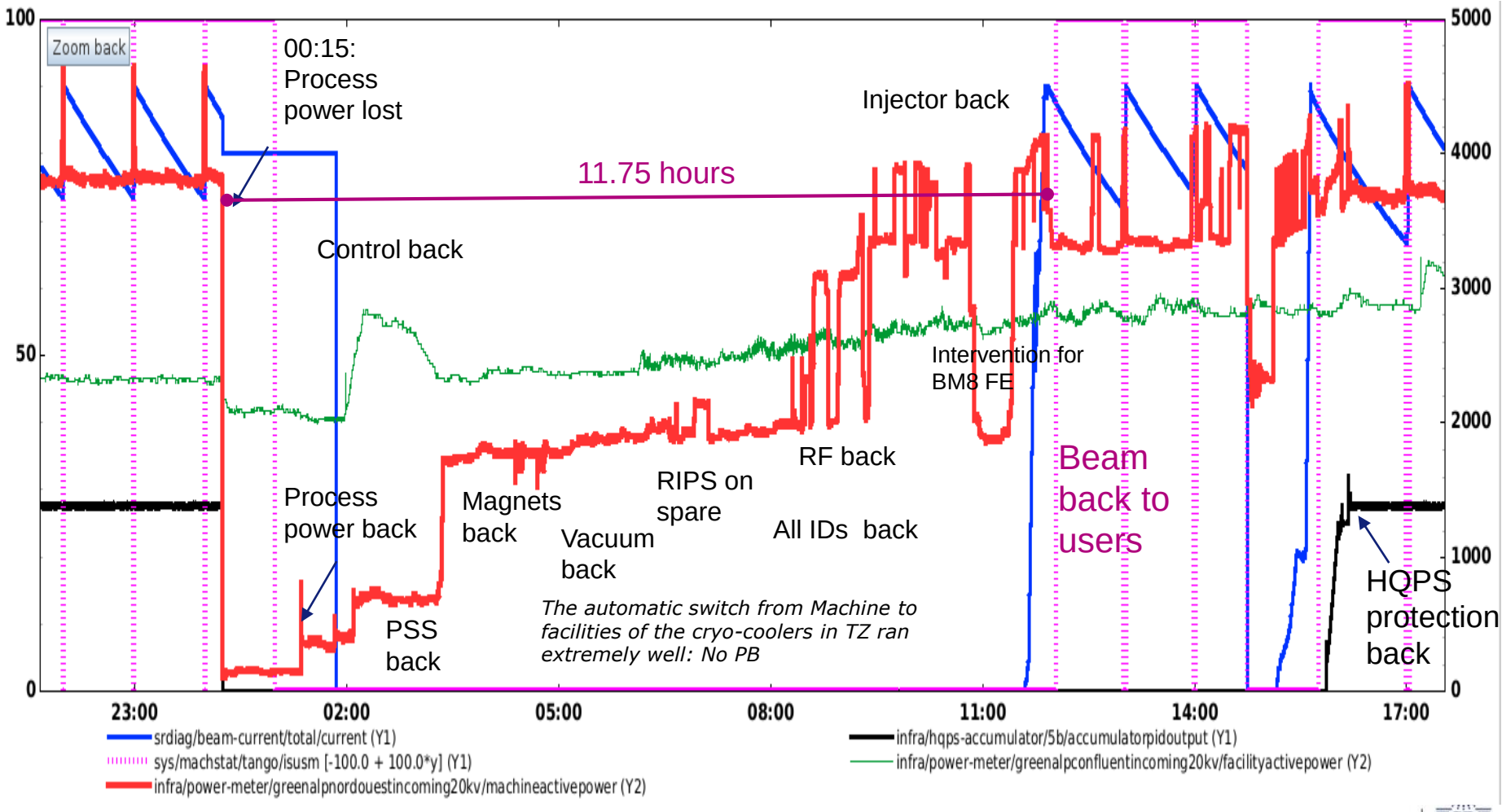
EBS 5-YEAR OPERATION SINCE 25/08/2020

	2020 (4 months)	2021	2022	2023	2024	2025 (4 runs)
Scheduled beam time (hrs)	1609	3616	5490	5492	5486	4409
Delivered beam time (hrs)	1545.90	3547.27	5438	5374	5372	4358.7
Availability	96.1%	96.35%	99.06%	97.85%	97.92%	98.86%
Number of failures	35	70	62	52	72	34
Mean time between failures (hrs)	46.0	66.4	88.5	105.6	76.2	129.7
Mean duration of a failure (hrs)	1.8	1.32	0.83	2.27	1.59	1.48





OVERVIEW OF THE RESTART AFTER BLACK OUT



MAIN INTERVENTIONS DURING SHUTDOWNS

New installations	Preventive maintenance
Winter shutdown 2025	
Booster-sector1: 20 buttons vacuum vessel installation	SY-RF / SR-RF : Greasing and check of tuners
TL2-correctors : New power supplies	**SRTU : refurbishment of search button cables**
TZ04-8-HSC04 : Sext/Octu Mopslate installation	CELL04-G0 : Refurbishment of S2 cooling system
CELL03-arc : K1 Friatec vessel against Solcera vessel	TL1-QD3 : brazing of a leaky water copper box
CELL06-BPM7 : Clamp installed	CELL06-SS : Re-installation of cryogenic invacuum device
CELL14-SS : Phase shifter installation	CELL30-SS : New carriage on upstream mechanic (taper)
CELL28-SS : 2 room temp invac devices* + phase shifter support	FE maintenance
March shutdown 2025	
LINAC : Extension of the SRE network	SRTU &SYTU: Flow meter maintenance
CELL15-BM15 : New CV990 Al NEG coated	TL2-G0 : vertical re-alignment mainly S2
CELL28-SS : phase shifter installation middle SS	CELL14-ch7 : Replacement of the ch07 RF finger
CELL32-BPM4 : clamp installation	FE maintenance
May shutdown 2025	
RIPS: Removal of the broken IGBT stack (DP H-bridge)	SRTU &SYTU: Flow meter maintenance
Cell08-SS CV2300/6mm installation in downstream position (prototype AL vessel)	Cell30-FE-ID30: Motorization stage replacement
Cell23-SS Replacement of the CV5000 (canted straight section)	FE maintenance
Cel24-SS: New revolver upstream position + phase shifter civil work	
Summer shutdown 2025	
Linac: Preparatory works for new section (civil works, cabling, cooling, wave guide network, …)	SRTU &SYTU: Flow meter maintenance
SRRF : TRA2 klystron replacement : EEV5 ➔ EEV-3	**CELL17-CELL21: Partial re-alignment of girders**
CELL29-SS Removal of the cryogenic invacuum device – IVU in the middle	ID03& ID13 : Slits upgrade/motorization stages & fast shutter replacement
CELL13-SS : Cryogenic trench & cryogenic invacuum device installation middle position	TZ14 : cryo-cooler replacement
CELL24-SS : New revolver - Downstream position	False floor repair in TZ
Cell08-SS Replacement of the CV2300/6 by the CV2300 coming from CELL13-SS	FE maintenance
October shutdown 2025	
SYTU : replacement of QF28 & QF29	MTBN / MTBS / PINJ concrete doors check
CELL01-SS : room temp invacuum device installation	TZ14 : cryo-cooler intervention
	CELL15-arc : AL ch07 : New RF finger
	Roof C5-7RF : Installation of grids on the air cooling circuits of the couplers
	FE maintenance

NO BEAM IS A PROBLEM BUT WHAT CONCERN OTHER BEAM PARAMETERS?

	Consequences	Report/complain to operation	*Comment*
Failures	No beam	Yes	
Skipped refill	20 mn or more delay of injection	No	
Injection perturbation	Position & emittance increase	No	*But the most sensitive cannot work in any case*
Longer refill		No	*Due to lower injEff & beam mode*
Lifetime drop/reduction	Faster decay	No	
Purity	$> 10^{-9}$	Yes	*ID14*
Larger V emittance	Stabilized from 1 to 10&20&40 pm.rad	No	*Could be reduced (7 pm.rad at least in multi)*
H emittance stability	20 pm. variation beam mode& gap closure	N0	
Beam position		Yes	*Small bump from CTRM when BL needed*
Beam stability/fast motion		Some	*Mostly ID24*
Filling pattern flatness		No	*Could be reduced*
Bunch length	Factor 4 with beam mode	No	*Depending optics, current/bunch RF voltage*
Energy spread	Factor 2 with beam mode	No	*Depending optics, current/bunch*

MASTER PLANNING AND SHUTDOWN SCHEDULE (SUMMARY)

Del.	Date	Instrument added to the installation	Beam achievements	project
Del. 1	*2025-October SD*	**ModS3 RF-unit displacement**		*Linac refurbishment*
Del. 1	*2025-October SD*	**ModS0 RF-unit (SAT)**		*Linac refurbishment*
Del. 1	*2025-December SD*	**6m section (RF Cond)**		*Linac refurbishment*
Del. 2	*2025-2026*	**Thermo-ionic gun assembly in test-stand**		*Linac refurbishment*
Del. 4	*2026-December SD*	**ModS4- RF-unit (SAT)**		*COLD*
Del. 2	*2026-December SD*	**Thermoionic gun in tunnel**		*Linac refurbishment*
Del. 2	*2026-DecemberSD*	**Diag and beam dump in tunnel**		*Linac refurbishment*
Del. 2	*2027-April*		**135MeV Beam**	*Linac refurbishment*
Del. 3	*2027-May SD*	**First C-band RF-unit**		*COLD*
Del. 3	*2027-Aout SD*	**First C-band acc. Struct.**		*COLD*
Del. 4	*2028-May SD*	**S-band photo-gun + laser**	***7MeV photogun beam***	*COLD*
Del. 4	*2028-May SD*	**Diag and beam dump upgrade**		*COLD*
Del. 4	*2029-January*		**170MeV beam**	*COLD*
Del. 5	*2029-August SD*	**Undulator + 170MeV beam**	***Xray beam***	*COLD*
Del. 6	*2029-December SD*	**Second C-band RF-unit and acc.struct**		*COLD phase 2*
Del. 6	*2030-September*		**325MeV beam**	*COLD phase 2*
Del. 7	*2031-August SD*	**TL1upgrade and inject in booster**	**325MeV beam to booster**	*COLD phase 2*