Elettra
Sincrotrone
Trieste

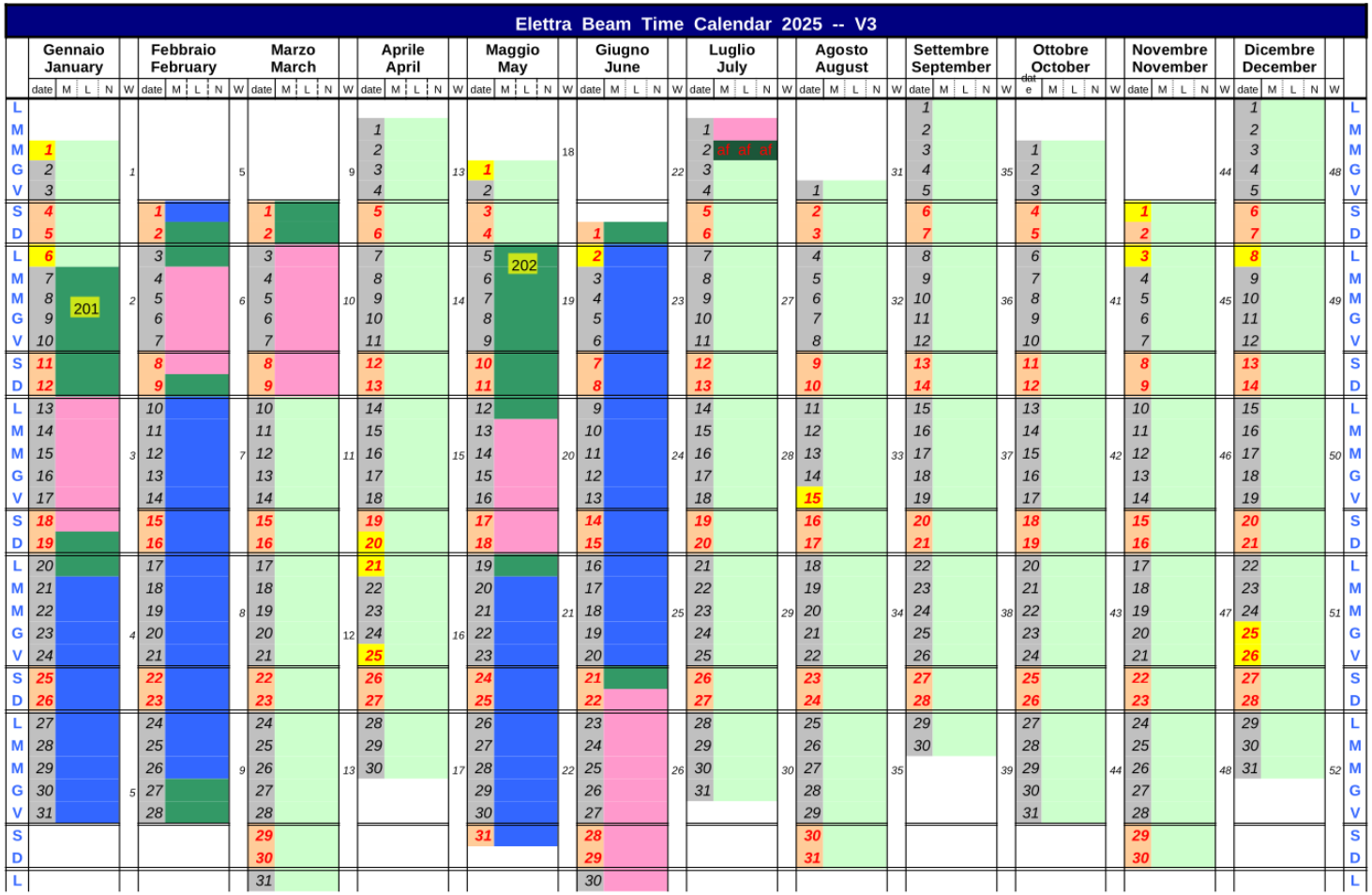
Elettra Report

on behalf of the Elettra team

www.elettra.eu

Operation schedule 2025

Elettra Sincrotrone Trieste



Elettra Beam Time Calendar 2025 -- V3

	Gennaio January				Febbraio February				Marzo March				Aprile April				Maggio May				Giugno June				Luglio July				Agosto August				Settembre September				Ottobre October				Novembre November				Dicembre December			
	date	M	L	N	date	M	L	N	date	M	L	N	date	M	L	N	date	M	L	N	date	M	L	N	date	M	L	N	date	M	L	N	date	M	L	N	date	M	L	N	date	M	L	N	date	M	L	N
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M	22				19				19				23				21				18				23				20				24				21				23				19			
G	23				20				20				24				22				19				24				21				25				22				24				20			
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S									29								31				28								30								31								29			
D									30												29								31																30			
L									31												30																								31			

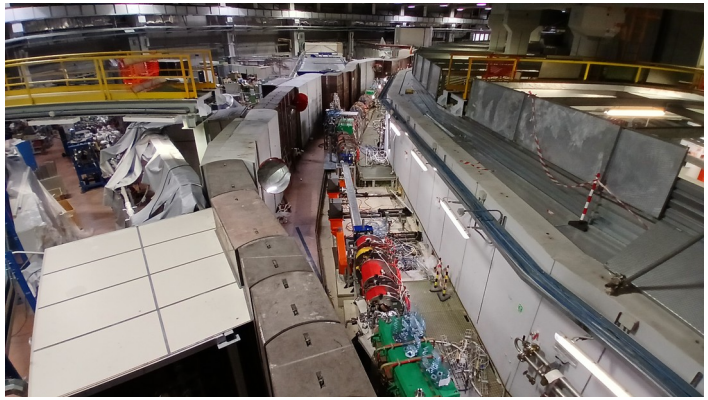
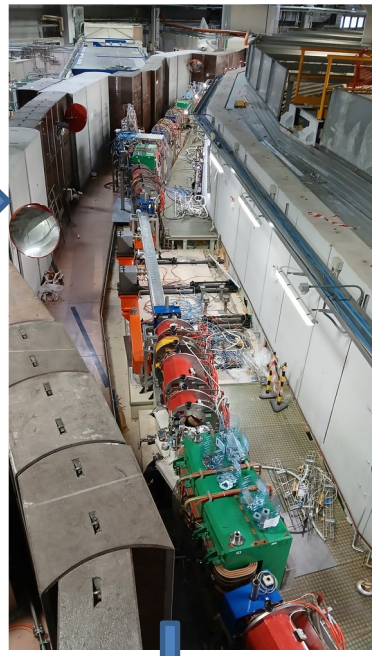
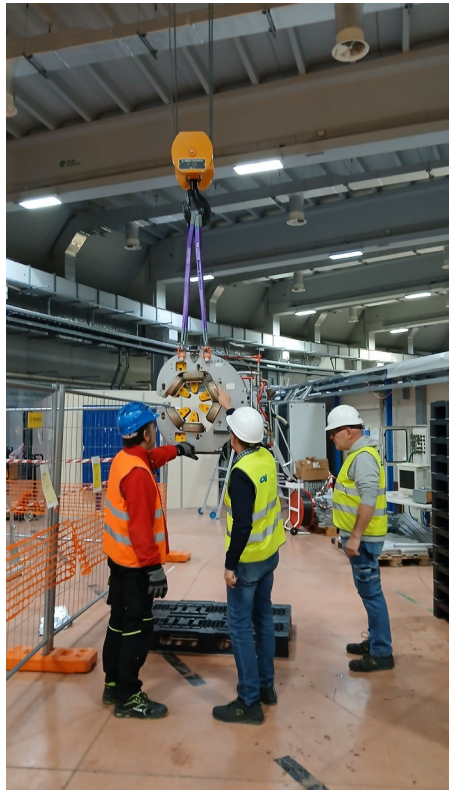
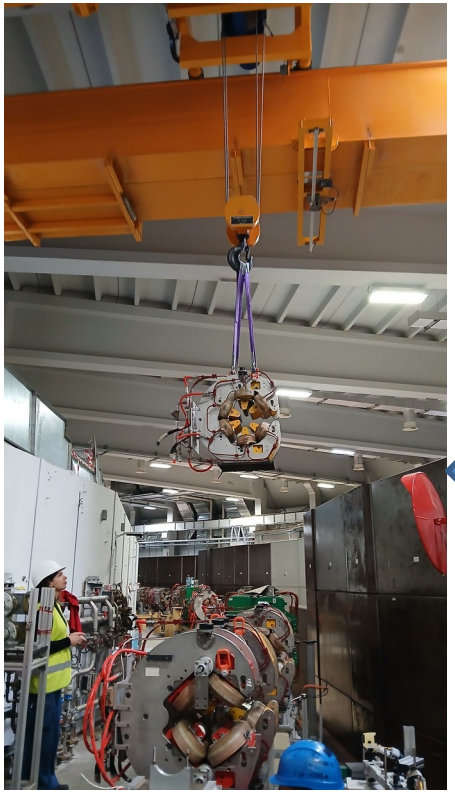
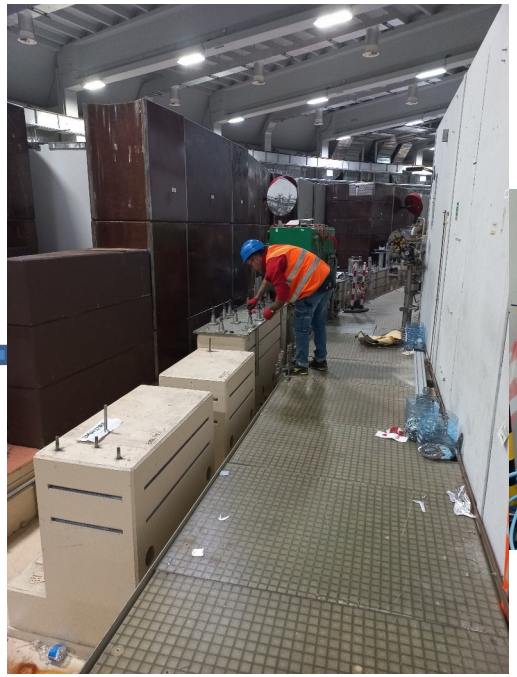
Even with the required preparation work for the dark period, the same % of user hours as in previous 2 years was provided in a single semester. For 2023 and 2024 the user operation time was reduced by 40% due to energy cost increase.

STATISTICS

TOTAL SHIFTS	2904	Hours		33,2%	of the year
Users shifts	2256	Hours		77,7%	of total
Users at 2.0 GeV	1440	Hours		63,8%	of users
Users at 2.4 GeV	816	Hours		36,2%	of users
SYRMEP dedicated shifts at 2.4 GeV	0	Hours		0,0%	of users
Accelerator Physics shifts	648	Hours		22,3%	of total
Shutdown	5856	Hours		66,8%	of the year
TOTAL shifts and shutdown	8760	Hours		365	days

End user mode on 2/7/2025 at 12:30 with a ceremony. The dark period started immediately after as programmed, first task the removal of the old machine

Dark period activities highlights
Storage ring removal

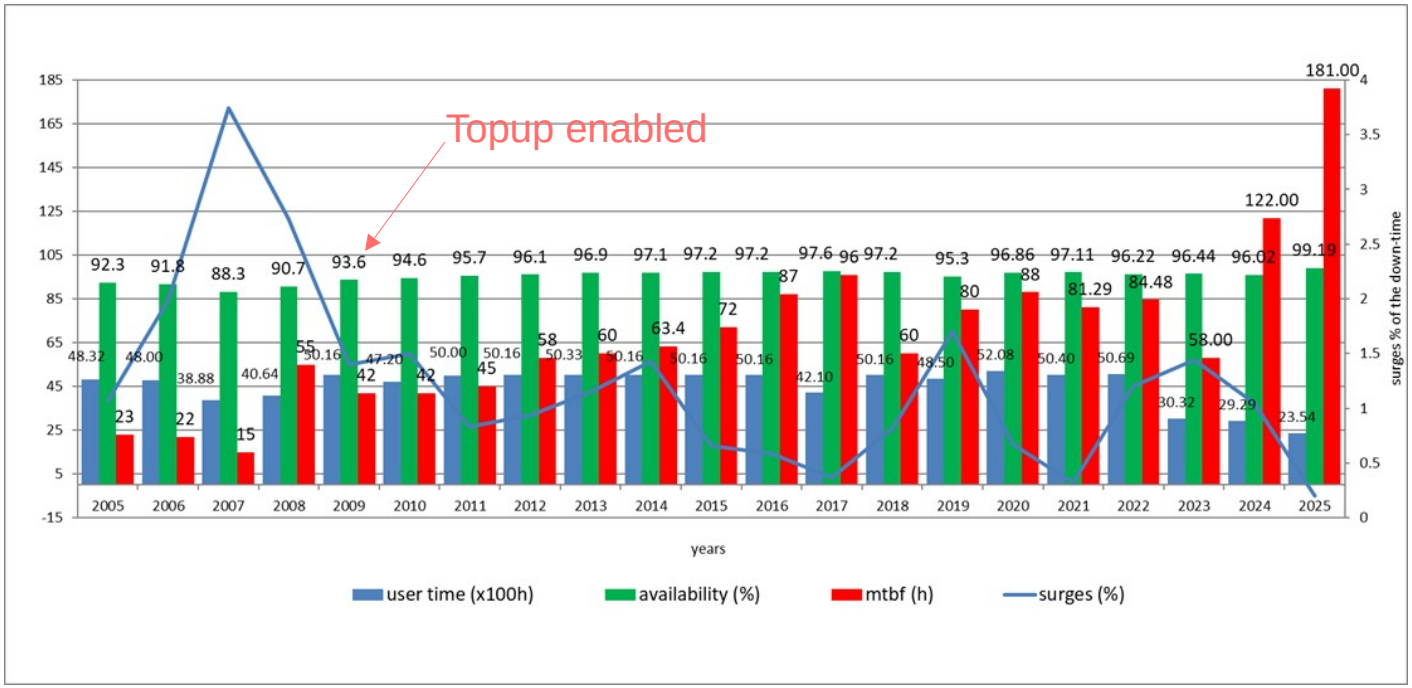








Dark period activities highlights
Service area removal






Elettra has been a very successful and stable storage ring

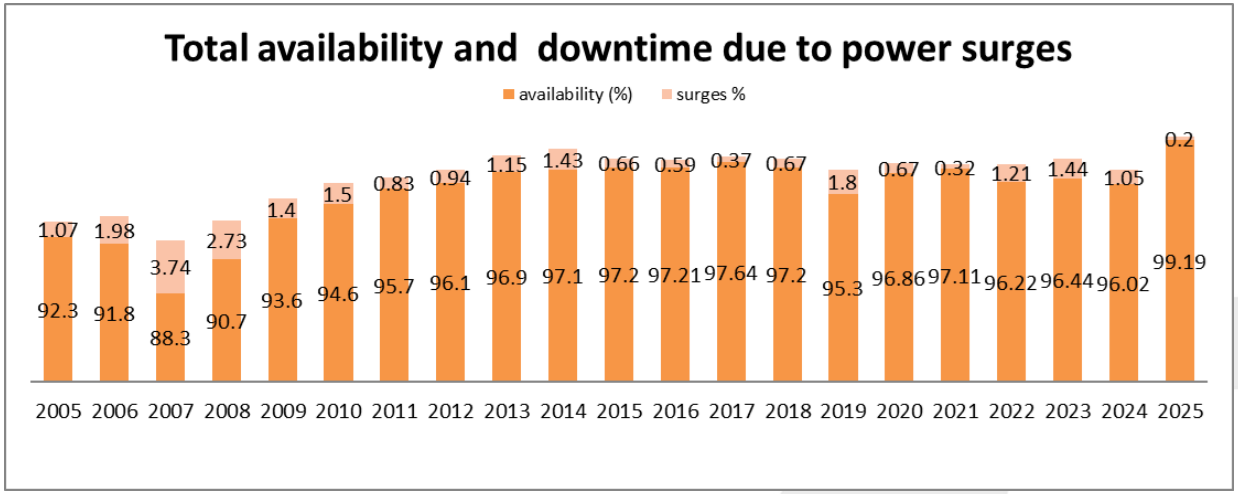


1993-2025, 32 years of operations with 5000 hours/year most of the time for users and a total of 35545 Ah

The 2025 was … the best year in the entire Elettra history

Beam availability of 99.19 %.

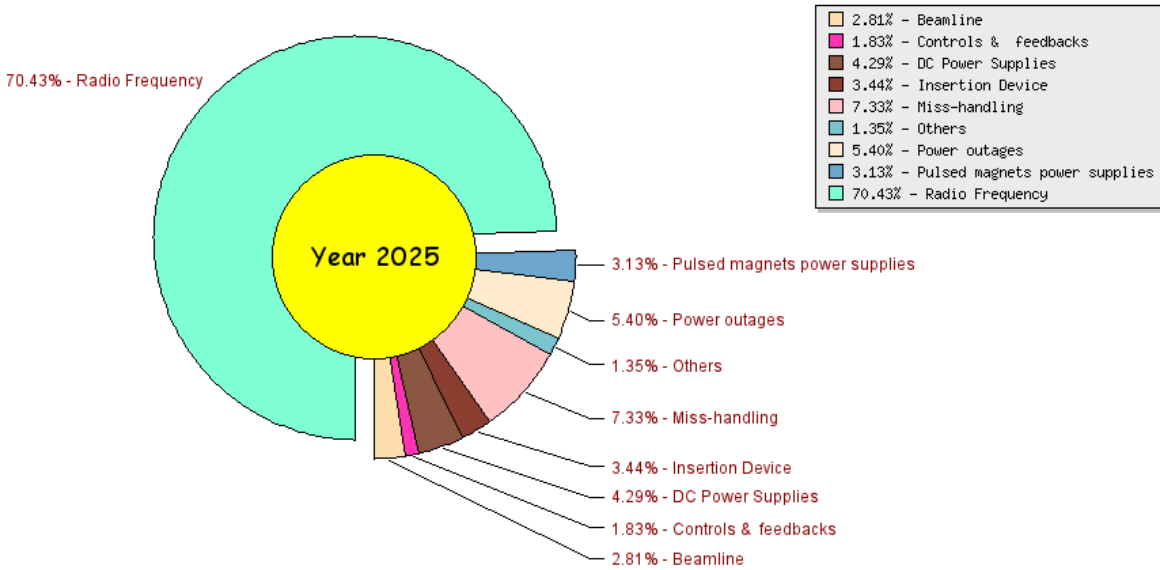
MTBF of 181 hours.



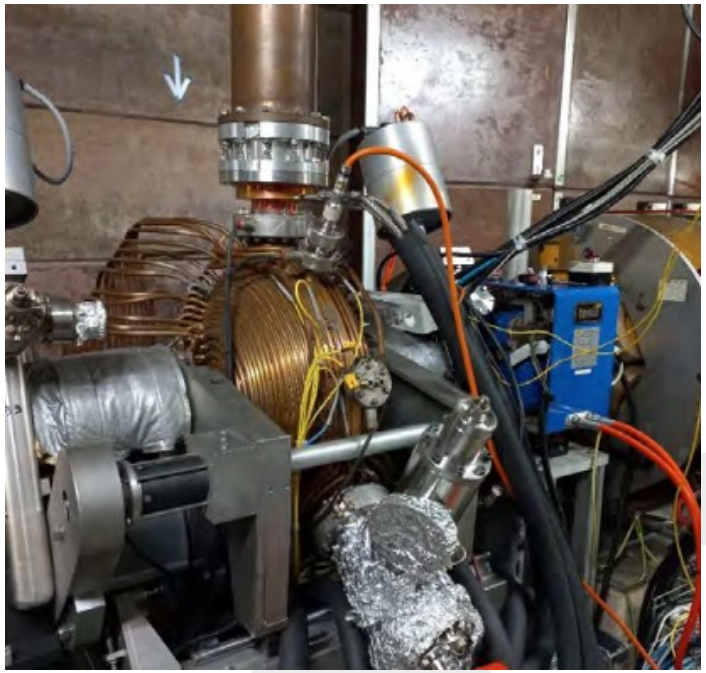
2025 faults

Major fault of 65h due to the failure of the cavity #3 feed-through, during machine physics studies in an unstable beam condition.
Only two downtimes due to system upgrades related to the Elettra 2.0 project.

- Short, consecutive beam interruptions due to a commissioning script executed on the machine instead of on the simulator
- Air-to-vacuum leak occurred the day before the last startup due to incorrect operation during frontend removal

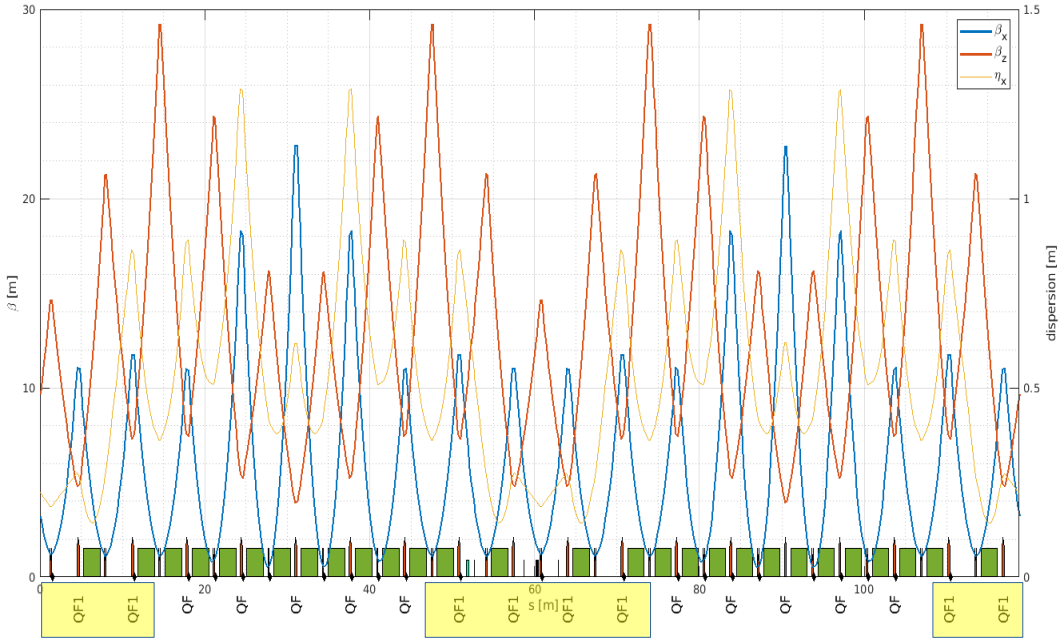


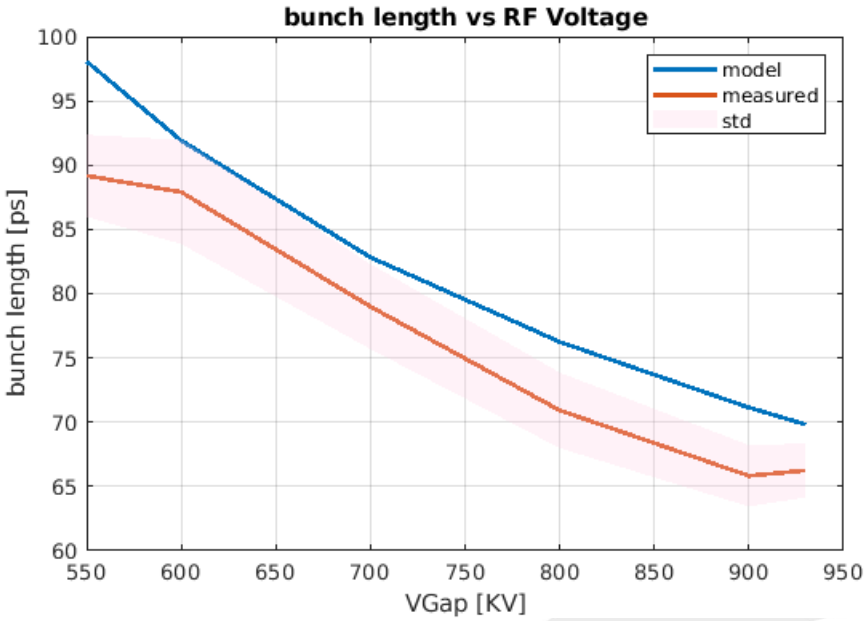
Minor fault due to water leaks on steerers and RF cavity.
Last RUN with one RF cavity operated at limited power, due to reduced cooling.



Injector preparation

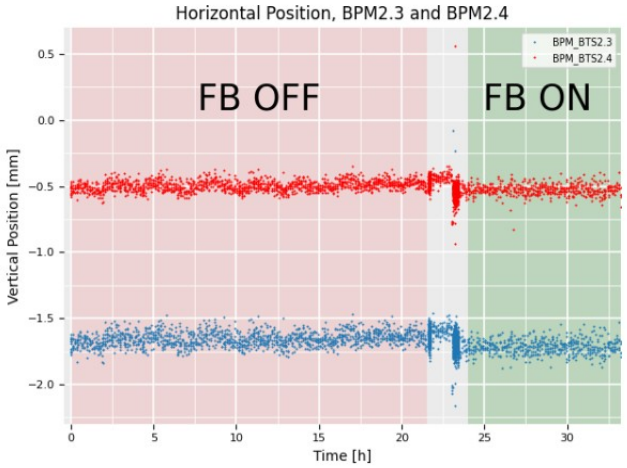
- Booster
  - Increased RF power from 0.6 MV to 1 MV → the bunch length reduces from 27 mm to 20 mm (InjEff +5%)
  - Changed Booster optics, reducing the hor emittance from 230 nmrad down to 160 nmrad
  - In Jan ’26, an additional PS QF2 family will be introduced to reduce the horizontal emittance to 130 nmrad, increasing InjEff from 65% to >77%.
  - Using the emittance exchange by crossing a coupling resonance InjEff: 77% → >97%

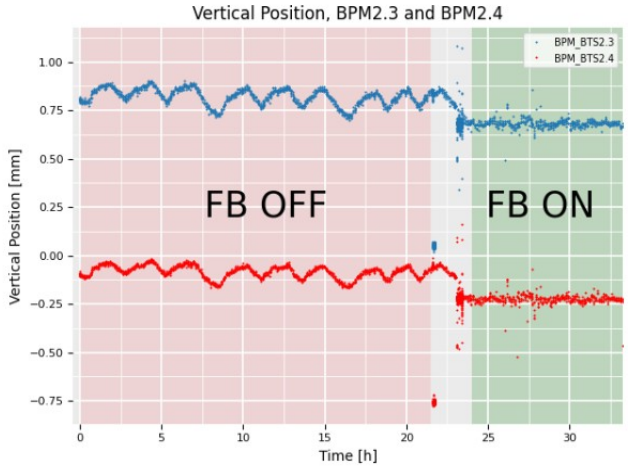




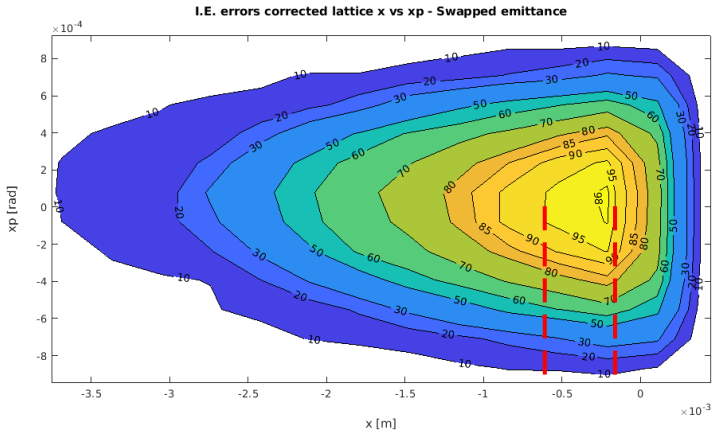
Injector preparation

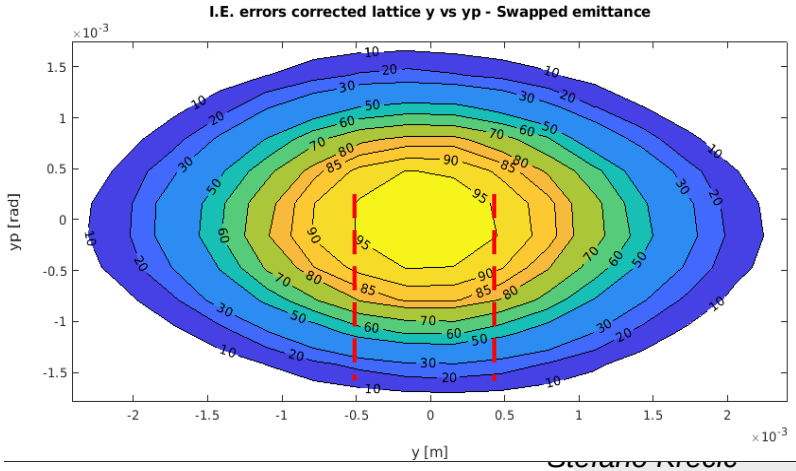
- Booster To Storage ring
  - Implemented the Trajectory feedback along BTS to compensate the slow drifts
    - Good regults in vertical plane
    - Slight improvement in horizontal plane mainly due to bad PS stability during ramping (400 mA) → the Booster PS of quads and bends will be replaced in early 2026





In order to archive an injection efficiency > 95 %, the trajectory stability of the injected beam must be within x±250 um y±500 um





Elettra 2.0

Elettra Sincrotrone Trieste

Elettra 2.0 will operate mostly at 2.4 GeV with a bare **emittance** of 212 pm-rad.
The **brilliance** will increase by more than 2 orders of magnitude at 10 keV, 36 times at 1 keV.
The **coherence** level will increase by a factor of 60 at 1 keV.

Emittance reduction	48 times
Useful length at long straights	4.94 m
Useful length at short straights	1.26 m
Useful length as % of total length	28.5%

		Elettra	Elettra 2.0
Operating for users		1994-2025	2027-
Beam energy	GeV	2.4 (25%) --- 2.0 (75%)	2.4 GeV (2.0 for some time)
Photon energies	keV	0.003-25	0.015 - 60
e – emittance - coupling	nm-rad	10 --- 7 - 1%	0.212 --- 0.150 – 3%
ID slots		11 Long + 1 short	11 Long + 5 short
Beam lines (IDs, Dipoles)	#	28 (19, 9)	32 (25 $_{3\ IVU}$, 7 $_{3\text{-}4\ from\ 3\ SB}$)
e-beam size at LS (σx,σy)	μm	286,16	36,6
Brilliance (ph/s/mm²/mrad²/0.1%bw)		$2x10^{19}$	10^{22}
Coherence ratio at 1 keV	%	0.5	30
e - intensity	mA	160 --- 310	400
Lattice -symmetry		2BA - 12 fold	S6BA-E(nhanced)-12 fold
Fill patterns		multi-bunch, single or few bunch, hybrid	whatever

- Main operating energy 2.4 GeV
- ***Possibility for installing bunch deflection scheme***
- Inclusion of super-bends and in-vacuum-undulators
- Increase of the number of slots available for insertion devices

Contraints:

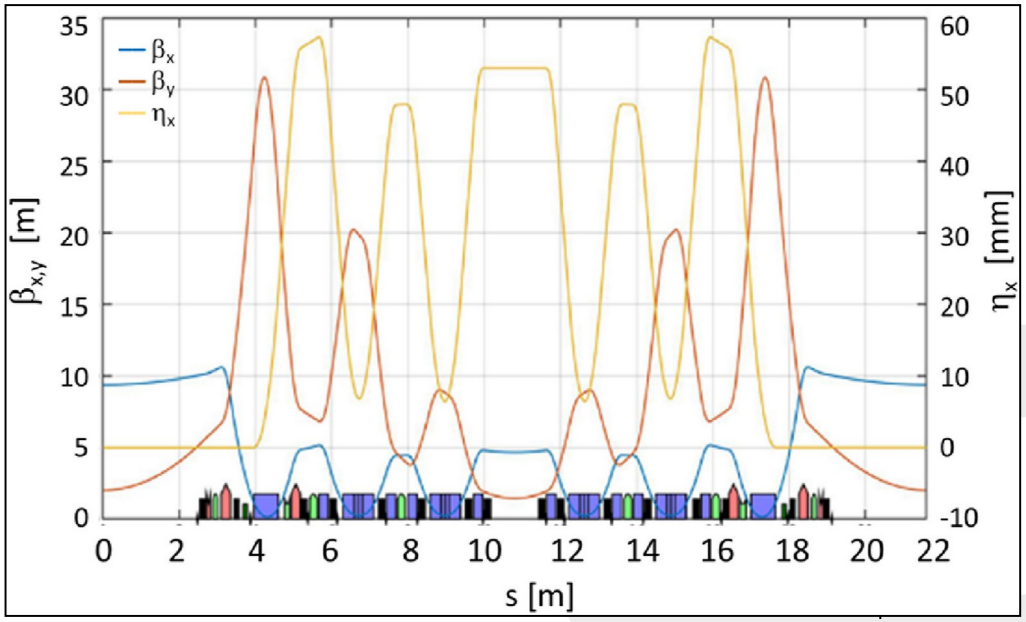
- Keep same building, injector and ring circumference
- Keep same source point and length for long straight sections

Parameter	Value	unit
Energy	2.4	GeV
Circumference	259.2	m
Emittance	212	pm rad
coupling	3	%
Harmonic number	432	
Average current	400	mA
Energy loss per turn	450 (620*)	keV
RF peak voltage	2	MV

Parameter	Value	unit
Main radiofrequency	499.654	MHz
Bunch length rms	6 (15**)	ps
Energy spread rms	0.09	%

* Including all IDs and SBs
** Including 3HC at 2.5x

	Long Straights	Short Straights
σ_x (um) / σ_x'(urad)	36 / 5.7	63 / 6
σ_y (um) / σ_y'(urad)	3.2 / 1.9	3.5 / 1.8



Project organization

Elettra Sincrotrone Trieste

M. Svandrlik (GM)
G. Paolucci (CSO)
M. De Franceschi (CFO)

A. Franciosi, President and CEO
BOARD OF DIRECTORS

E. Karantzoulis PROJECT DIRECTOR — A. Fabris EXECUTIVE OFFICER

TECHNICAL INTEGRATION
(project director)

MACHINE SUBPROGRAMME	E. Karantzoulis
BEAMLINES SUBPROGRAMME	L. Gregoratti/ S. Lizzit
INFRASTRUCTURE SUBPROGRAMME	S. Noé
REMOVAL,INT.AND INST. SUBPROGRAMME	R. Visintini
CHIEF ENGINEER	I. Cudin
ACCELERATOR SYSTEMS ENGINEERING MANAGER	D. Castronovo

PROJECT MANAGEMENT
(executive officer)

PMO – Elettra 2.0	R. Laghi
COSTS	R. Laghi
SCHEDULE	A. Fabris (Interim)
SECRETARIAT	N. Sambraello
RISK MANAGEMENT	M. Lonza
CHANGE CONTROL	A. Fabris
CONFIGURATION MANAGEMENT	I. Cudin
DOCUMENTATION	R. Visintini (Interim)
REVIEWS	A. Fabris
QA/QC	R. Sauro
INFORMATION TECHNOLOGY	R. Pugliese
ES&H	F. Bavdaz
PURCHASING DEPT	D. Chicco
PURCHASING – INFRASTRUCTURES E2.0	D. Maggi
ADMINISTRATION	P. Bembich
PMO	N. Guidi
TRAVELS	I. Massarotti
HR	C. Garettini
GROUP COORDINATORS	

MACHINE | INFRASTRUCTURES | BEAMLINES | REMOVAL, INTEGRATION, INSTALLATION (RI2)

EXECUTIVE MANAGEMENT NA *A. Fabris*
- TECHNICAL COORDINATION AND INTEGRATION NAC *E. Karantzoulis*
- MEETING ORGANIZATION AND TRAVELS NAV *E. Karantzoulis*
- PROJECT MANAGEMENT NAA *A. Fabris*
- HUMAN RESOURCES NPA *A. Fabris*
- COLLABORATION AGREEMENTS MANAGEMENT NAO *A. Fabris*
- ENVIRONMENTAL HEALTH AND SAFETY NAB *F. Bavdaz*

MACHINE NM *E. Karantzoulis*
- MAGNETS NMM *D.Castronovo*
- SUPPORTS & FEs NME *I. Cudin*
- PS & CABLING NMP *M. Cautero*
- RF NMR *C. Pasotti*
- VACUUM SYSTEMS NMV *L. Rumiz*
- VACUUM CHAMBER NMU *I. Cudin/L. Rumiz*
- INJECTION NMI *R. Fabris*
- INSTRUMENTATION AND TIMING NMS *S. Bassanese/A. Carniel*
- CONTROLS NMC *C. Scafuri/ R. Borghes*
- INJECTOR UPGRADE NMB *A. Carniel*
- RADIOPROTECTION NMD *G. Scian*
- ALIGNEMENT NMA *P. Furlan*
- ACC. PHYSICS & COMMISSONING NMF *S. Krecic*

INFRASTRUCTURES NI *S. Noé*
- EDILIZIA NIO *D. Baron*
- IMPIANTI ELETTRICI NIE *A. Martinolli*
- MECCANICO-FLUIDISTICA NIF *M. Miculin*

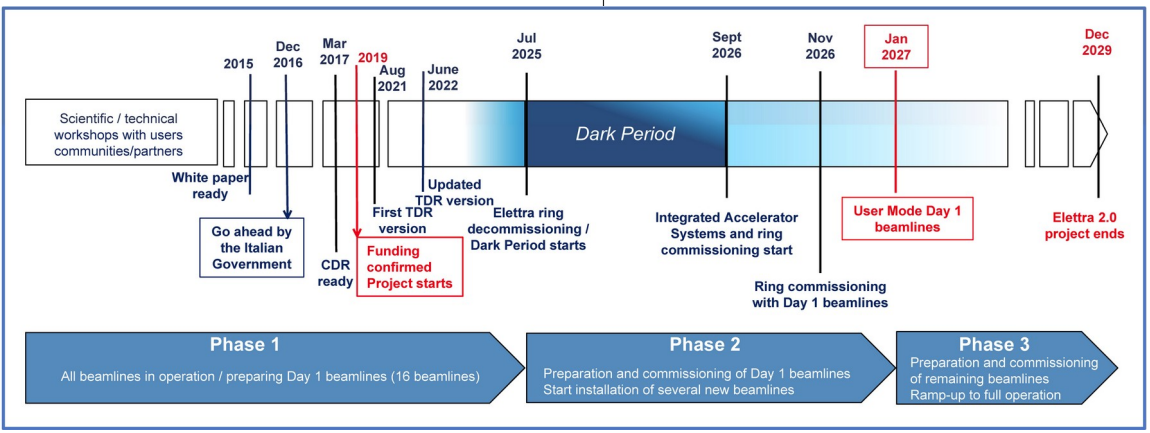
BEAMLINES NB *L. Gregoratti /S. Lizzit*
- EXPERIMENTAL (ENDSTATION) NBE *S.Lizzit / L. Gregoratti*
- ALL ENDSTATION E TRASPORTO FASCIO NBA *S.Lizzit / L. Gregoratti*
- TRASPORTO FASCIO NBT *L Gregoratti /S. Lizzit*
- SUPPORTO BEAMLINES NBS *L Gregoratti / S. Lizzit*
- INSERTION DEVICES NBI *B. Diviacco*
- CRYOGENIC DIPOLES NBC *D. Castronovo*

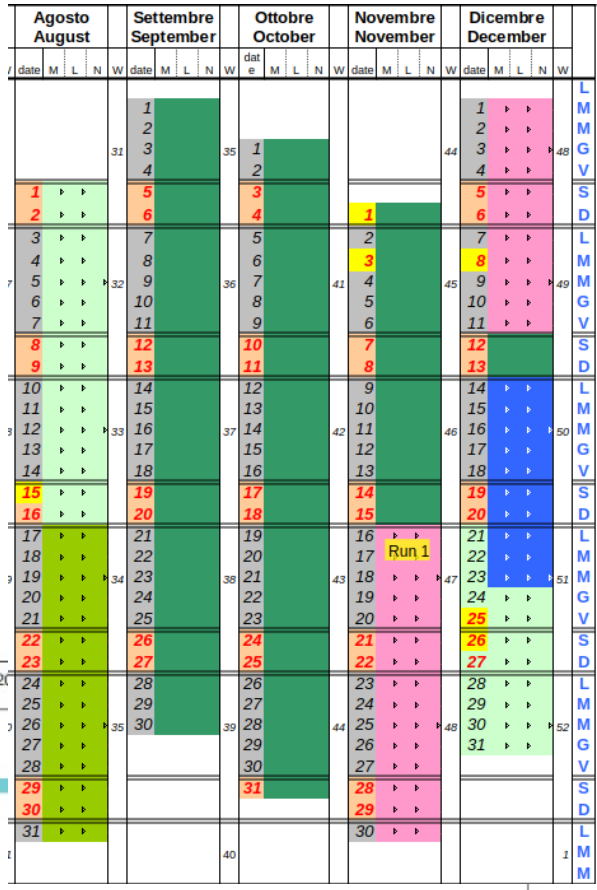
RI2 NR *R. Visintini*
- REMOVAL AND DISPOSAL NRR *R. Visintini*
- SYSTEMS INTEGRATION NRS *M. Lonza / R. Visintini*
- INSTALLATIONS NRI *R. Visintini*
- HANDLING NRH *R. Visintini*

PRE-TDR *E. Karantzoulis*

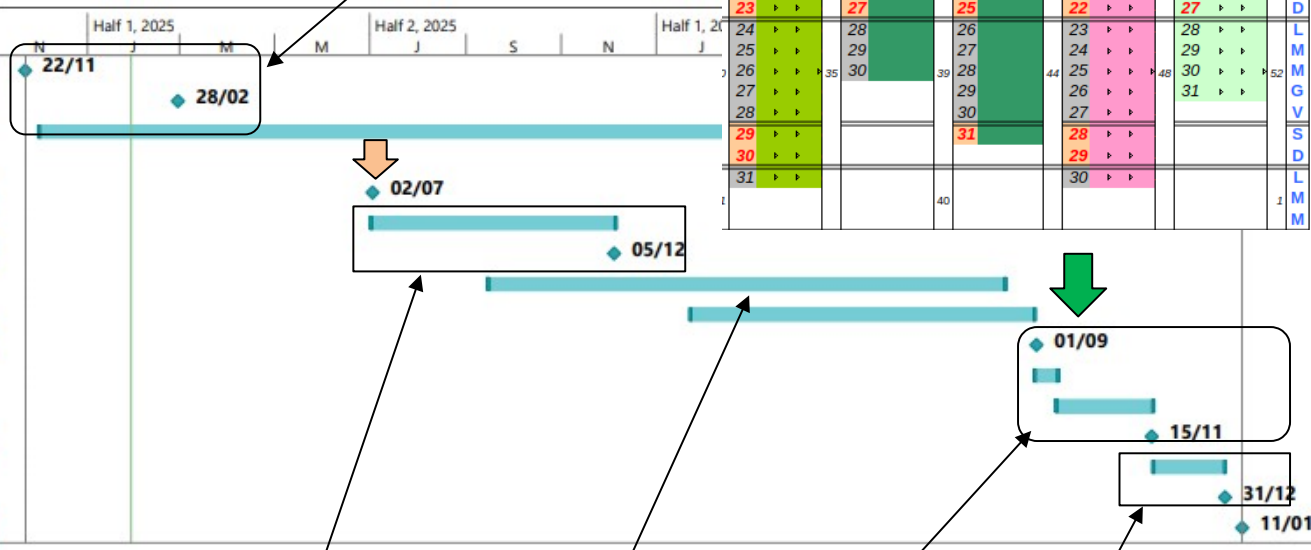
Schedule

Elettra Sincrotrone Trieste





Task Name	Duration	Start	Finish
New Building (labs and store new)	0 days	22 Nov	22 Nov
RP Building (old machine storage)	0 days	28 Feb	28 Feb
Preparations and preassembly	444 days	01 Dec	12 Aug
Preparations and pre-assembly end	0 days	12 Aug	12 Aug
End of user mode	0 days	02 Jul	02 Jul
Ring decommissioning	113 days	02 Jul	05 Dec
Ring decomissioning end	0 days	05 Dec	05 Dec
Installations	238 days	15 Sep	12 Aug
Accelerator systems tests	157 days	23 Jan	31 Aug
Installation end - Ring closed	0 days	01 Sep	01 Sep
Integrated Accel. systems commissioning	11 days	01 Sep	15 Sep
Ring Commissioning with beam	45 days	15 Sep	15 Nov
End commissioning with beam	0 days	15 Nov	15 Nov
Ring commissioning with beam lines	34 days	16 Nov	31 Dec
End ring commissioning with beam lines	0 days	31 Dec	31 Dec
Elettra 2.0 user mode	0 days	11 Jan	11 Jan



Temporary buildings

decommissioning

Installations and tests

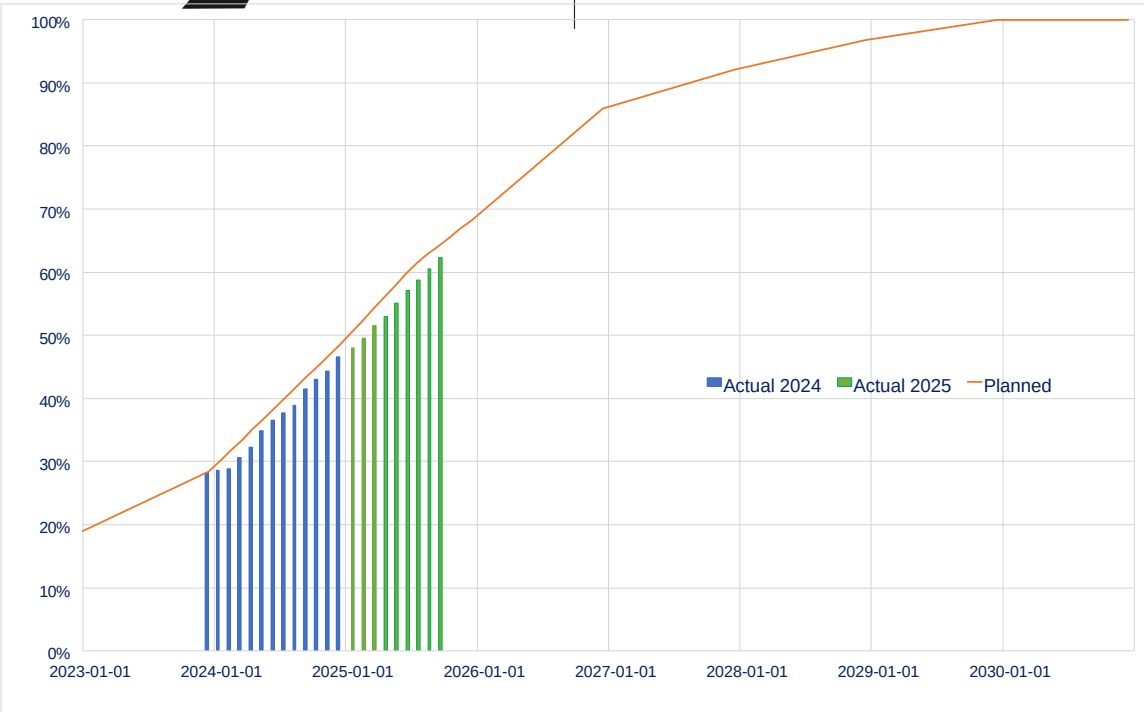
commissioning

Friendly users

The schedule baseline remains unchanged at present

Project progression

Ref: A. Fabris



	MONTH	ACTUAL	PLANNED	DELTA
2024	0	28,28%	28,28%	0,00%
	1	28,60%	29,97%	-1,37%
	2	28,91%	31,65%	-2,75%
	3	30,60%	33,34%	-2,74%
	4	32,29%	35,02%	-2,73%
	5	34,88%	36,71%	-1,83%
	6	36,57%	38,39%	-1,82%
	7	37,77%	40,08%	-2,31%
	8	38,96%	41,76%	-2,80%
	9	41,57%	43,44%	-1,87%
	10	43,04%	45,13%	-2,09%
	11	44,33%	46,81%	-2,49%
	12	46,57%	48,50%	-1,93%

	MONTH	ACTUAL	PLANNED	DELTA
2025	0	46,57%	48,50%	-1,93%
	1	48,00%	50,35%	-2,35%
	2	49,59%	52,21%	-2,61%
	3	51,55%	54,06%	-2,51%
	5	55,15%	57,77%	-2,62%
	6	57,17%	59,63%	-2,46%
	7	58,76%	61,48%	-2,72%
	8	60,57%	62,82%	-2,24%
	9		64,16%	
	10		65,50%	
	11		66,84%	
	12		68,18%	

Percent Complete at the end of September 2025: 62,30 % (64.16% planned)

*Percent complete= (value of work performed)/(budget approved at completion)*100*

Project management tools are in place and actively used to monitor the project. They include:
Work Breakdown Structure, Project Management Plan, Configuration Management Plan, Change Control Process, **Risk Management Plan**, Risk Registry, **Schedule and budget control**.

Spending overview

Total Value (Planned)	Total Value (Committed)	Total Value (To be committed)
172,25 M€	**149,93 M€ (87,0 %)**	**22,32 M€ (13,0 %)**

All values VAT included
All values updated to September 30, 2025

Elettra Sincrotrone Trieste

Beam lines

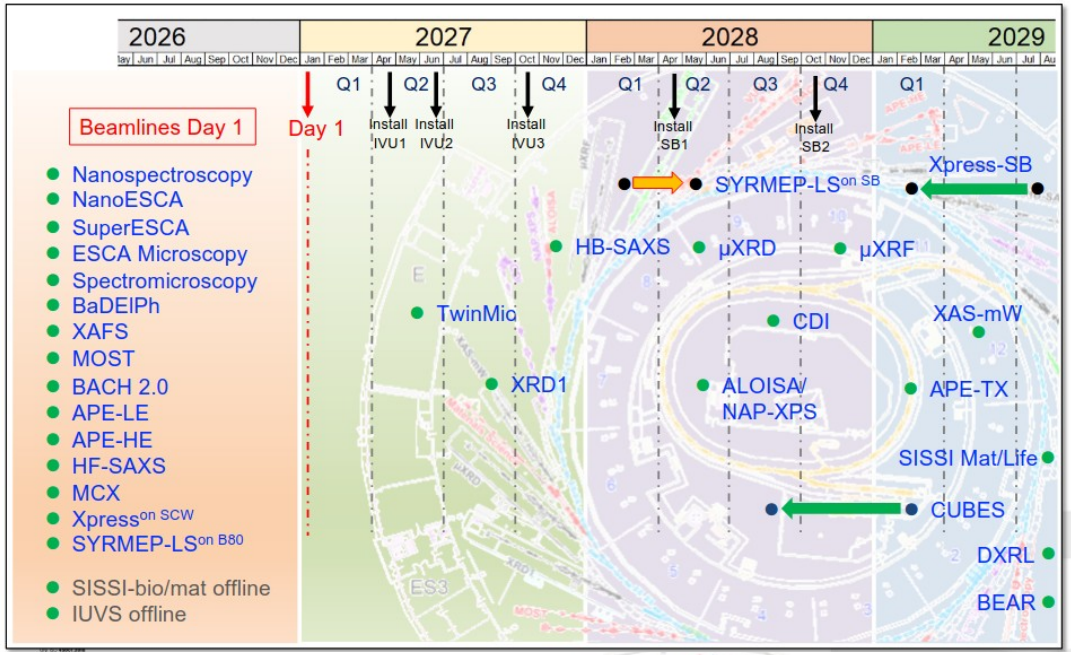
- Increased # of beam lines from 28 to 32 Also 5 in the short straights
- Shift towards tender and hard x-rays (65% proposals for hard x rays)

- Day 1 with 15 beam lines
  - 13 from Insertion Device
  - 2 from Bending
- Short section:
  - 4 for RF cavity
  - 3 for diagnostics instrumentation
  - 5 for beam lines

8 beam lines are removed

9 beam lines keep the same position (IDs)

8 new beam lines



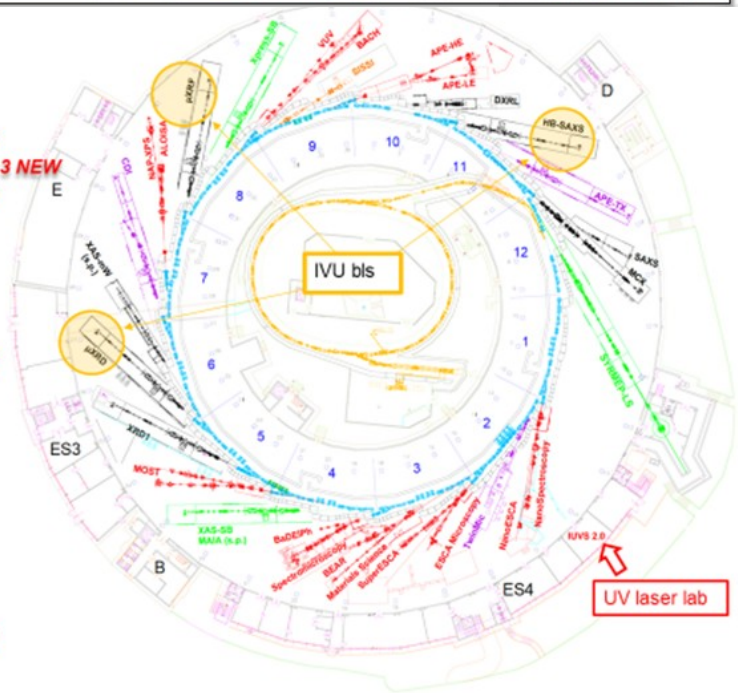
Up to 32 beamlines

9 → 12 BIs hard X-rays
- 2 on ScBM *2 NEW*
- 3 on IVU for micro-spot *3 NEW*
- 4 on sW in SS *1 NEW*
- 2 on SCW
- 1 on BM

0 → 3 BIs Soft-tender X
- 1 APU in SS
- 1 EPU in SS *1 NEW*
- 1 EPU in LS

17→15 BIs VUV-SoftX
- 7 on EPU in LS
- 2 on LPU in LS
- 2 on F8 in LS
- 2 on APU (LP) in SS
- 2 on BM

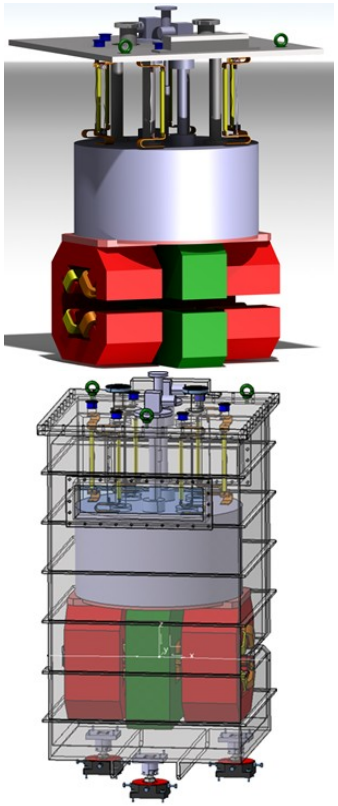
2 → 2 IR/THz beamline *1 NEW*



SC magnets and IDs

Ref. B. Diviacco

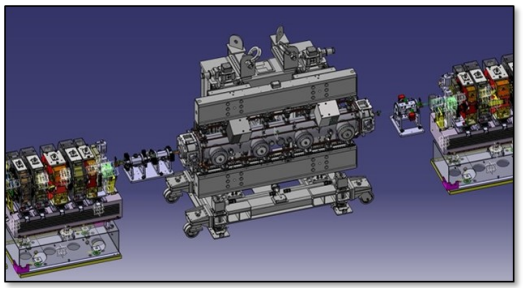
Two super-conducting 6 T dipoles (60 – 140 keV)



Ref. D. Castronovo, M. Modica, EK

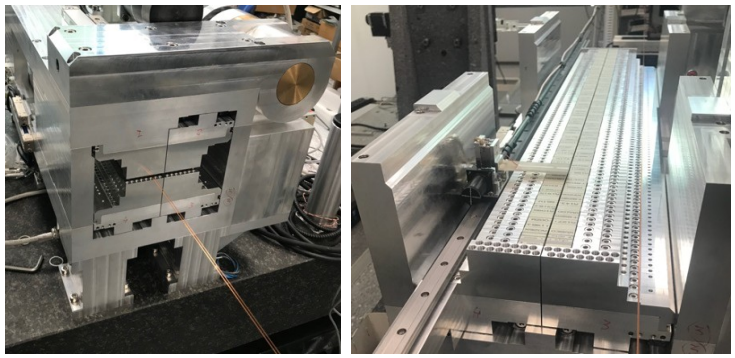
Four APPLE-II Undulator – outsourced to ***KYMA***)

ID	Beamline	Position	Period (mm)	Nper	Length (m)	Bo (T)	Kmax
EU100	Nanospectr/NanoESCA	S01_Long	100.4	2 x 20	2 x 2.0	1.02 0.78	Ky=9.6 Kx=7.3
APU	TwinMic	S02_Short	39.6	19	0.8	0.82	Ky=3.0
U46	SuperESCA/ESCAmicroscopy	S02_Long	46.0	2 x 49	4.6	0.92	Ky=4.0
Figure-8	Spectroμ/BaDElPh	S03_Long	140	2 x 16	2 x 2.2	0.75 0.14	Ky=9.8 Kx=3.6
EU50	MOST-HE	S04_Long	50.4	28	1.5	0.85 0.62	Ky=4.0 Kx=2.9
EU132	MOST-LE	S04_Long	132.0	18	2.6	0.40 0.65	Ky=4.9 Kx=8.0
W96	XRD1	S05_Short	96.4	15 poles	0.8	1.83	Ky=16.5
IVU17	μXRD	S05_Long	17.0	117	2	0.94	Ky=1.5
W96	XAS-mW		96.4	15 poles	0.8	1.83	Ky=16.5
EU44	CDI	S06_Long	44	2 x 45	2 x 2.1	0.58 0.58	Ky=2.4 Kx=2.4
Twin-APU	ALOISA NAP-XPS	S07_Short	75.6 39.6	10 19	0.8 0.8	0.43 0.46	Ky=3.0 Ky=1.7
IVU22	μXRF	S07_Long	22.0	90	2	1.27	Ky=2.6
EU77	BACH-LE	S08_Long	77	28	2.1	0.92 0.64	Ky=6.6 Kx=4.6
EU47	BACH-HE	S08_Long	47	44	2.0	0.62 0.62	Ky=2.7 Kx=2.7
EU125	APE-LE	S09_Long	125.36	17	2.1	0.77 0.60	Ky=9.0 Kx=6.9
EU44	APE-HE	S09_Long	44	45	2.1	0.58 0.58	Ky=2.4 Kx=2.4
IVU17	HB-SAXS	S10_Long	17.0	117	2	0.94	Ky=1.5
EU32	APE-TX	S11_Short	32.4	22	0.8	0.83 0.61	Ky=2.5 Kx=1.9
SCW	HF-SAXS/MCX/Xpress	S11_Long	64	49 poles	1.5	2.5	Ky=19.6

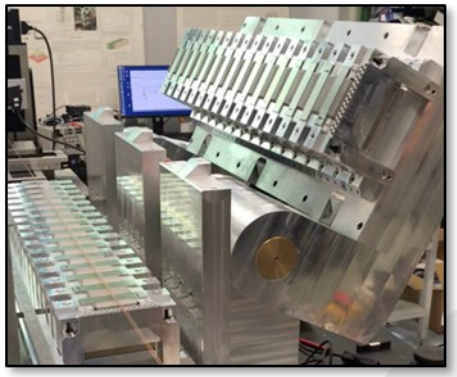


Short-period in-vacuum LPUs will be used to extend the photon energy range into the hard X-ray regime, reaching up to 18 keV (period 17.2-22 mm).

One of the requirements for the new lattice is to extend the number of beamlines. In fact five out of the twelve short straight sections are dedicated to the beam lines and due to space limitations compact undulators and wigglers are developed with a useful length of only 80 cm. Already 4 short Ids are built in-house.



EU32: compact EPU for the APE-TX beamline



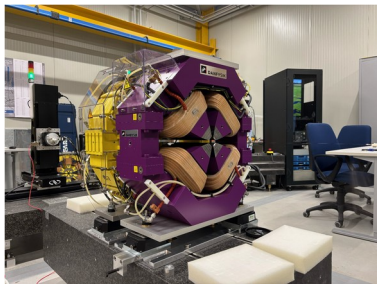
λ_0 = 96.4 mm
N_{POLES} = 15
gap = 12 mm
B_0 = 1.8 T
K = 16

Magnets and power supplies

MAGNETS

Ref. D. Castronovo

- **First girder assembled**
- All quadrupoles magnets delivered
- Sextupoles and octupoles magnets:
  - 4 out of 6 deliveries completed
  - Last delivery: scheduled early Jan. ‘26
- Bending magnets:
  - First of Series measured
  - In production
  - Last delivery scheduled mid Jan. ‘26



POWER SUPPLIES

- All dipoles PS delivered
- All multipolar magnets PS delivered
- Corrector PS:
  - 450 out of 700 built
  - Completion foreseen mid Nov. ‘25
- Contract for racks’ assembly effective

Multipolar magnets P.S. in storage

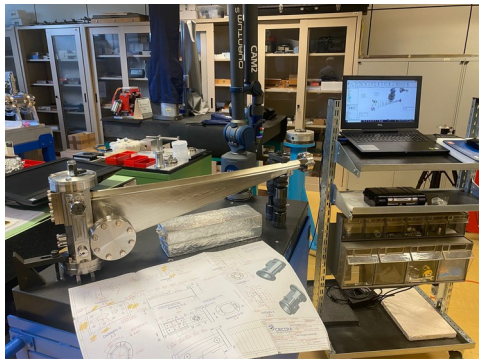
Ref. M Cautero

Chambers and vacuum systems

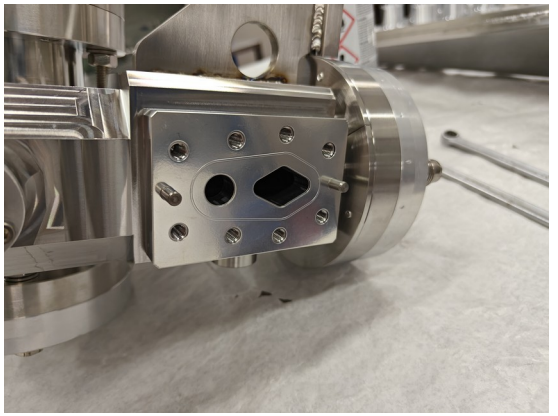
- Ion pumps and NEG pumps: delivered
- Vacuum gauges: delivered
- Vacuum valves: in production, First batch received, last scheduled in March ‘26
- Vacuum chambers:
  - Under construction
  - Dipole chamber prototype under SAT.
  - Deliveries in batches. Last item scheduled in Aug. ‘26
- Other vacuum components (bellows, aborbers, tapers, etc): under construction, to be completed in Spring 26

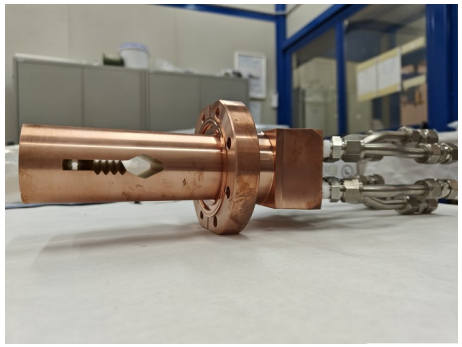
Ref. L. Rumiz

Ref. G. Scrimali



Dipole vacuum chamber tests





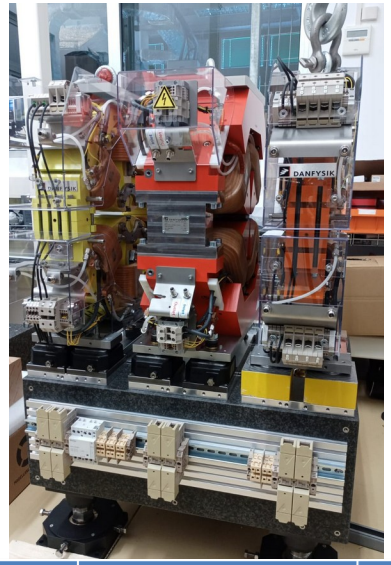
Photon absorbers

It’s crucial to closely follow the production and validation process, including frequent visits to the manufacturers. Many issues were corrected during these stages, thereby preventing potential problems.

Supports, BPMs and Injection

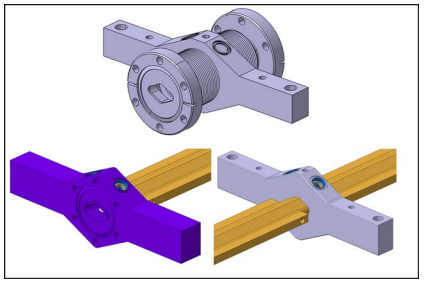
Elettra Sincrotrone Trieste

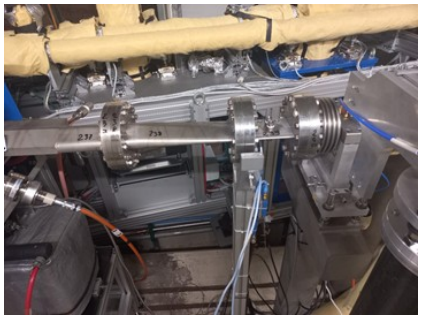
8 granite slabs per achromat for the multipoles (1.5x0.6x0.3 m) + 6 for the dipoles in total 168 girders.

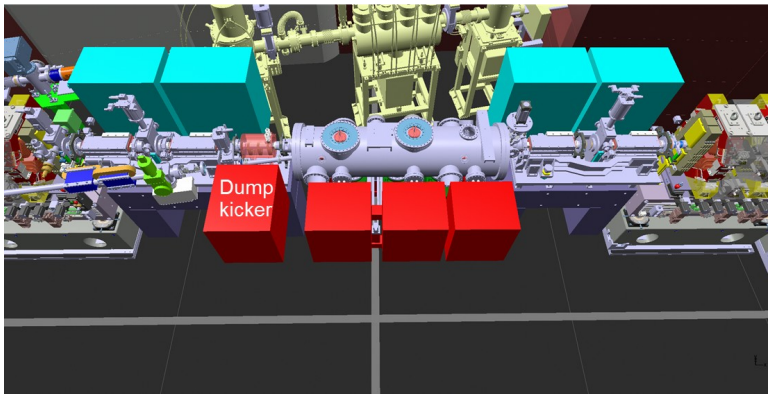


Component	State	Shipping to Elettra
Wedges	(MC SYSTEMS (AIRLOCK)	received
Magnets plates	(COSTAM)	received
Granite slabs	(ZALI)	received
Alignment feet	(PIGNAT/MEC+)	received
Basements	Ordered and arriving (JJ-XRAY)	12/2025
Grouting plates	Ordered and arriving (OCSAM/MICRA)	11/2025

item	status
BPM electronics	All delivered – 8 already installed in Elettra
BPM feedthroughs	Delivery expected to be completed in Feb. 2026







Kickers: Design phase from the contractor (Danfysik) completed. Delivery expected within June 2026.

Septum: Design phase from the contractor (Research Instruments) close to completion

Ceramic Chambers: Contract signed on January 2025 (Kyocera) . Delivery expected in Jan – Feb 2026

Dump kicker: The Contractor (Reasearch Instuments) received the invitation letter. Delivery expected in Jan 2027

Girders and mechanical supports for injection, all received

Storage space

Elettra Sincrotrone Trieste

Two buildings have been constructed 700m^2. These are used as laboratories for magnetic measurements, for vacuum systems, and for the storage of incoming and outgoing materials.

BUT space it is never enough!

Storage space , vacuum lab, and magnet measurements lab

Mainly old machine

Conclusions

- Elettra has been a very successful storage ring for 32 years
- Elettra's performance has not been affected by the Elettra 2.0 project
- We are now concentrated on the completion of procurement of the remaining components and services, needed to ensure the start of the facility commissioning according to plan
- The schedule is continuously monitored, mitigation strategies are in place for possible delays, however at present we do not consider schedule baseline changes
- According to the schedule, the new ring will be completed for commissioning in September 2026

Thank you for your attention