

The new Rb vapour source

AWAKE collaboration meeting, CERN

05/10/2023

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- Installation and commissioning
- Operations during Run 2b
- Further upgrades



05/10/2023

Michele Bergamaschi

GWA Technology



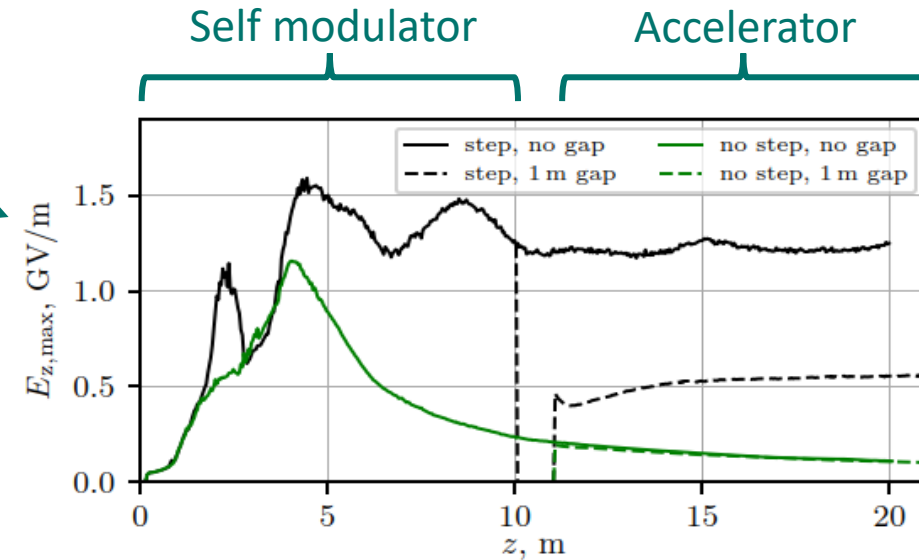
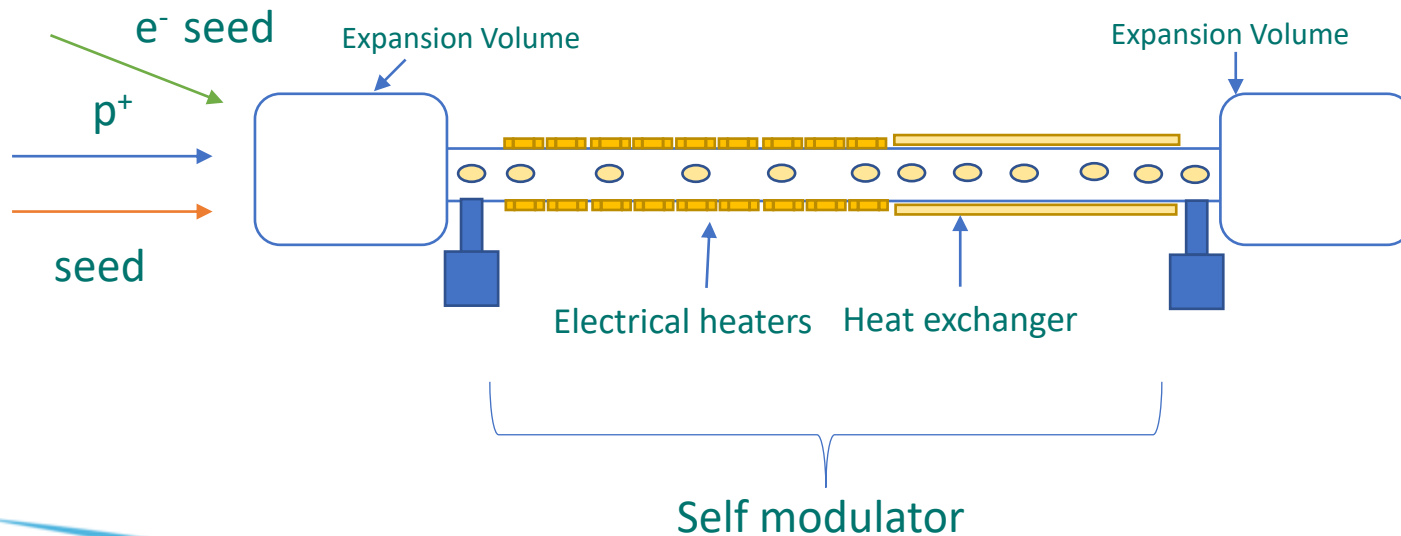
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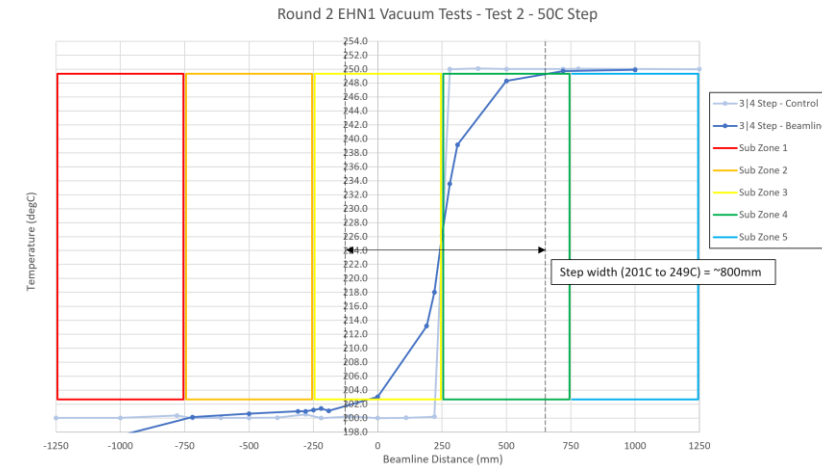
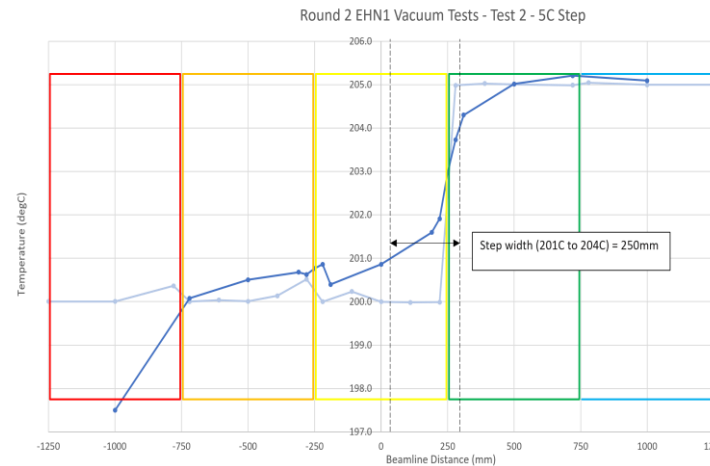
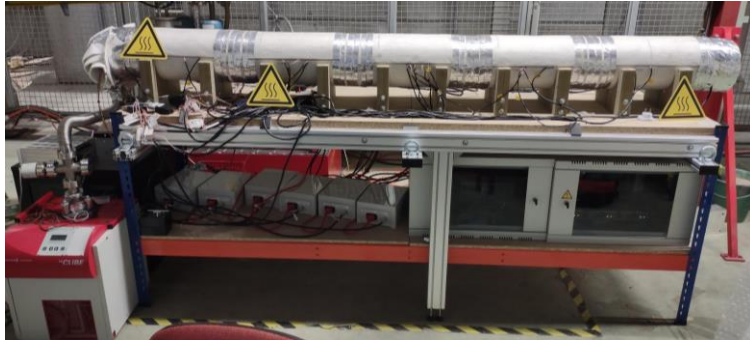
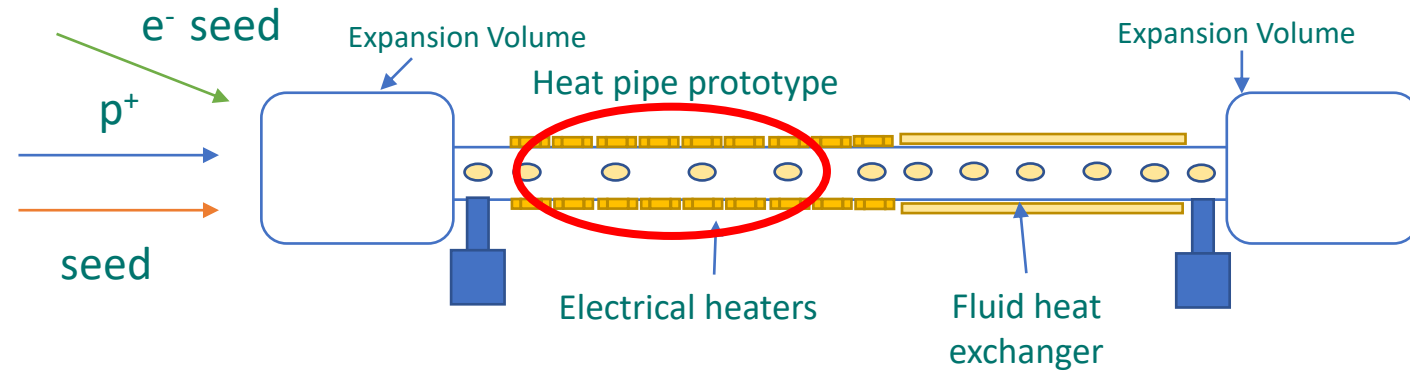
Run 2b Vapour Source

- Same requirements as Run 1 for Rb density uniformity and max value as for Run1 and Run 2a $\delta T (^{\circ}K)/T(^{\circ}K) \approx 0.2\%$
- Additionally have to implement a “sharp” (tens of cm) step from 1% to 10% $\delta T (^{\circ}K)/T(^{\circ}K)$ from 5 to 50°C



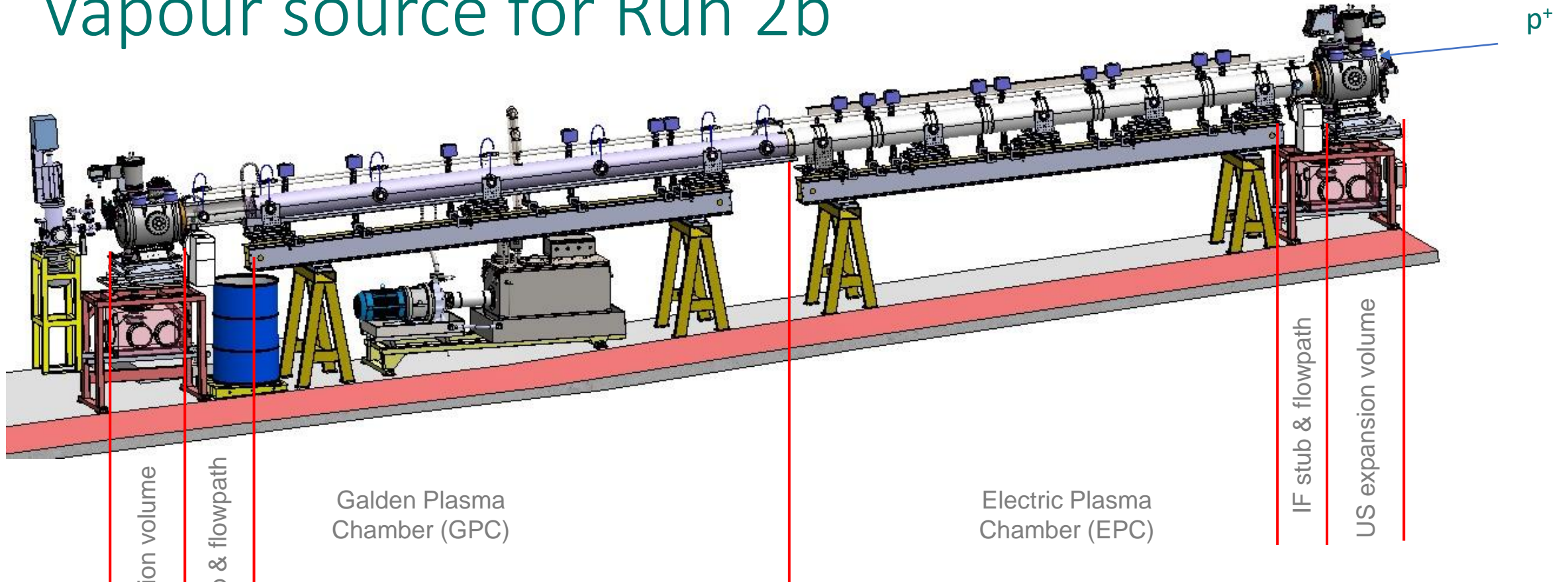
- With a density step in the selfmodulator, wakefields maintain a level close to saturation amplitude after the saturation

Run 2b Vapour Source



- Stand alone electrically heated section with 5 zones (HPP)
- Tested in 2021 at CERN (EHN1)

Vapour source for Run 2b



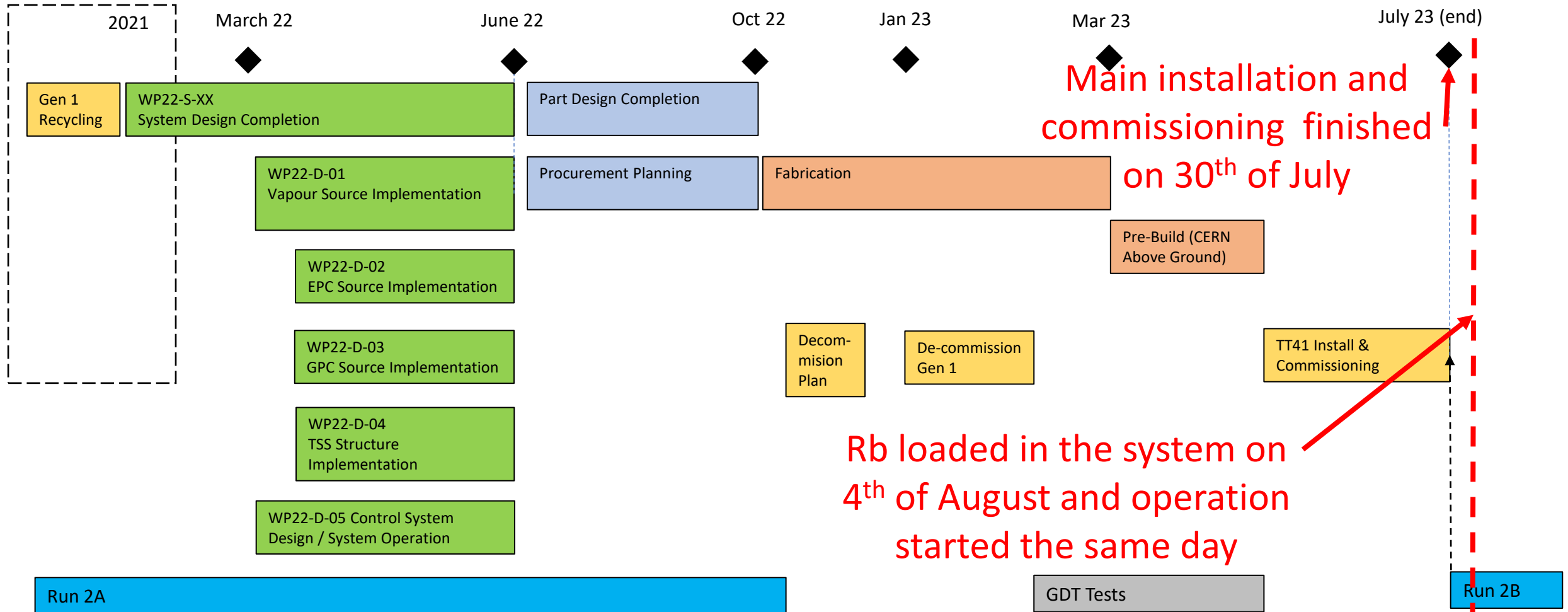
Golden Plasma Chamber (GPC)

Electric Plasma Chamber (EPC)

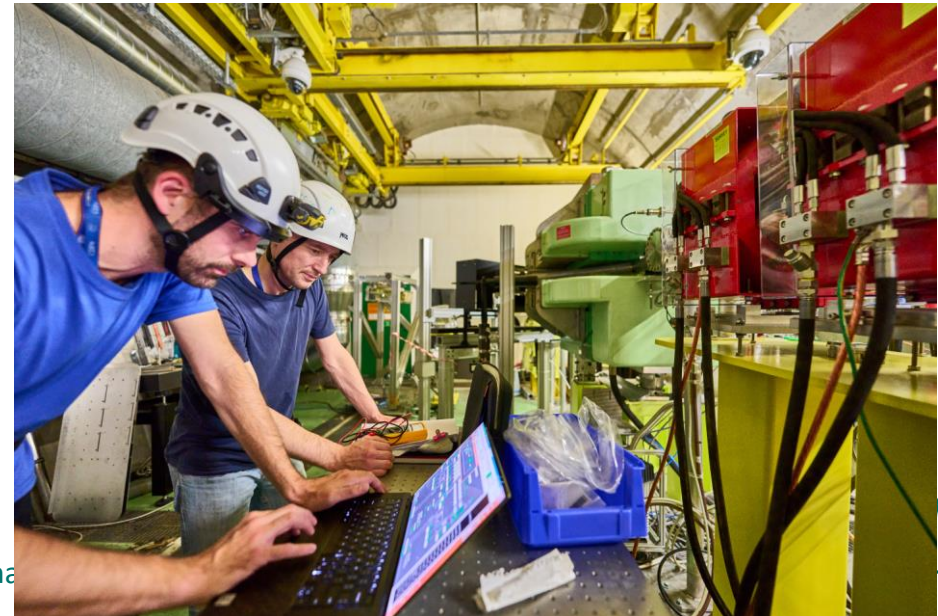
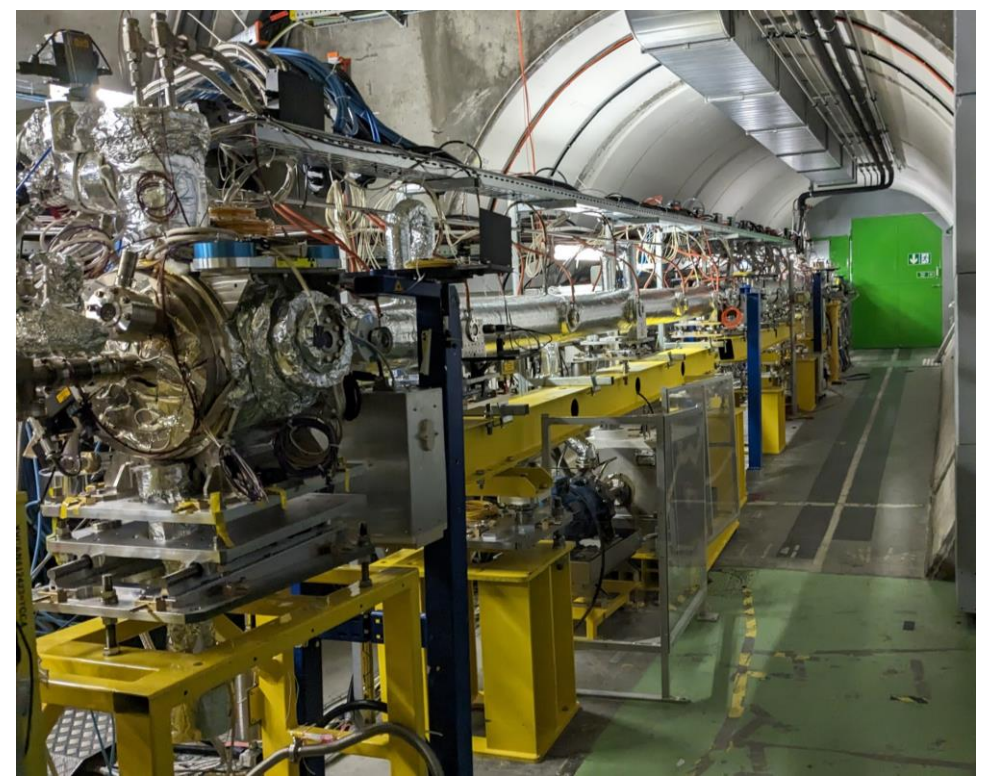
- Length: ~ 10 m
- Independent electrical heater of 50 cm from 0.235 to 4.735 meters
- 5.3m of golden heated section
- Step height up to $\pm 10\%$
- 10x2 diagnostic viewport, for plasma light + 3x2 for density diagnostic

Installation and commissioning

Plan of Reference 2022-23 Implementation Outline



Installation and commissioning



Run 2b Operations

- Downtime to impose the step (3%) passed from 1h40 to ~40min thanks to PID params and control algorithm optimization
- Thanks to support from control team, continuous development and upgrade of control software led to user friendly GUI for awake operator

VAPS_AWAKE - 08:57:45 AM 08-Sep-2023

System Status: awakeop

Target Set Point: 210.00 C, Step Value: 0.00 C, Step Position: SZ3

UPSTR. FLASK MASTER OFFSET: -14.90 C
DOWNSTR. FLASK MASTER OFFSET: -14.40 C

	RR. SET		LH2		LH1	
	SP-OFFSET VS VAP. CELL SET		TARGET DEVIAT. RANGE LIMIT		OUT OF RANGE DEVIAT. LIMIT	
	UPSTREAM	DOWNSTREAM	UPSTREAM	DOWNSTREAM	UPSTREAM	DOWNSTREAM
RB FLASK	0.00 C	0.00 C	0.00 C	0.00 C	20.00 C	20.00 C
RB FLASK EXIT	1.00 C	1.00 C	0.00 C	0.00 C	20.00 C	20.00 C
MANUAL VALVE BODY	7.00 C	7.00 C	0.00 C	0.00 C	20.00 C	20.00 C
MANUAL VALVE OUTLET	7.00 C	7.00 C	0.00 C	0.00 C	20.00 C	20.00 C
INTRAVALVE TUBE	0.00 C	0.00 C	0.00 C	0.00 C	20.00 C	20.00 C
CONTROL VALVE BODY	12.00 C	12.00 C	0.00 C	0.00 C	20.00 C	20.00 C
BEAMLINE INTERFACE FLANGE	14.00 C	14.00 C	0.00 C	0.00 C	20.00 C	20.00 C
APERT. PLATE UPPER T.	0.00 C	0.00 C	0.00 C	0.00 C	20.00 C	20.00 C
APERT. PLATE LOWER T.	0.00 C	0.00 C	0.00 C	0.00 C	20.00 C	20.00 C
DENSITY VIEWPORT TEMP. 1	0.00 C	0.00 C	0.00 C	0.00 C	20.00 C	20.00 C
DENSITY VIEWPORT TEMP. 2	0.00 C	0.00 C	0.00 C	0.00 C	20.00 C	20.00 C
EPC CELLS TEMPER.				0.70 C		20.00 C
VAPOUR CELL TEMPER.				1.50 C		20.00 C
OIL BATH TEMPERATURE				0.00 C		20.00 C

TEMPERATURE UNIFORMITY DEVIATION LIMIT FOR BEAMLINE: 2.00 C
 TEMPERATURE UNIFORMITY DEVIATION LIMIT FOR UPSTREAM RB FLASK: 0.50 C
 TEMPERATURE UNIFORMITY DEVIATION LIMIT FOR DOWNSTREAM RB FLASK: 0.50 C
 VAPOUR CELL MAIN TEMPER. LAG IN HEAT RAMP, WHICH INITIATES RAMP CHANGE OF SP: 14.00 C
 VAPOUR CELL MAIN TEMPER. LAG IN COOLING, WHICH INITIATES RAMP CHANGE OF SP: 16.00 C

EXPANSION CHAMBER TEMPERATURE ALARM LIMIT: 33.50 C
 EXPANSION CHAMBER TEMPERATURE COOLANT ALARM LIMIT: 22.00 C
 TIME LIMIT FOR TEMPERATURE STABILIZATION BEFORE TRANSITION TO EXPERIMENT: 60 sec
 TEMPERAT. OF BEAMLINE, BELOW WHICH SYSTEM IS COLD ENOUGH THAT RB IS SOLID AND SYSTEM IN STOP: 50.00 C
 Time for RB to distribute in the system: between flow path valve opening and viewport valve opening: 180 sec
 Cooldown: Cycle time after which pump is started for 1 min: 90.00 min
 Vapour cell set temp. (Flask = -15°C): 216.84 C
 HEAT-UP / COOL-D. RATE LIMIT (beaml.): 1.000 C/min

Commands: Stepper, Overview, Parameters

Remaining time: Device: VAPS_XAWAV2_USRTR_STAB

2023.09.07 17:58:54 817 INFO Device=XAWAV2_USRTR_STAB on/open request sent.
 2023.09.07 18:00:54 038 INFO automatic deselect Device=XAWAV2_USRTR_STAB

VAPS_AWAKE - 08:57:51 AM 08-Sep-2023

System Status: awakeop

Target Set Point: 210.00 C, Step Value: 0.00 C, Step Position: SZ3

UPSTR. FLASK MASTER OFFSET: -14.90 C
DOWNSTR. FLASK MASTER OFFSET: -14.40 C

AWAKE - Tunnel

Ambient Temperature: 23.59 C, 23.69 C

Beamline average: 209.75 C, Beamline maximum: 225.65 C

GPC average: 210.00 C

Setpoint: 194.960 C, 196.49 C, 196.82 C

Parameters:

Parameter	Step value	Step position
Galden target	210.00 C	0.00 C
Flask main offsets setting	-14.90 C	-14.40 C

Heater Set points:

Parameter	Upstream	Downstream
Master temperature	210.00 C	210.00 C
Step temperature	210.00 C	210.00 C
Density Port 1	210.000 C	210.001 C
Density Port 2	210.000 C	210.001 C
Lower Aperture Plate	210.000 C	210.001 C
Upper Aperture Plate	210.000 C	210.001 C
Beamline Flange	209.101 C	209.601 C
Control Valve Body	207.101 C	207.601 C
Intravalue Tube	204.101 C	204.601 C
Manual Valve Outlet	202.101 C	202.601 C
Manual Valve Body	202.101 C	202.601 C
Rb Flask Exit	194.960 C	194.960 C
Rb Flask	194.960 C	194.960 C

Pressure gauge diagnostics: Under Range, Switch reacting, Under Range, Downstream when it should?

Failsafe cards diagnostics: PASSIV, QBAD, ACK-REQ, Upstream, Downstream, DI, DO

Emergency: Oil Bath & Emergency button Alarm, Start Key Interlock, Bypass for valve opening with High Pressure

Instrument air pressure: Upstream, Downstream

PLC Power Reset, 24V Redundancy, OTC

Status: STABILIZ. RANGE

GO TO STOP, GO TO DIAGNOSE, GO TO HEATUP, GO TO HALT, GO TO EXPERIMENT, GO TO SHUTDOWN, GO TO COOLDOWN

AL1: Overtemperature
 AL2: Uniformity o.o.range
 AL3: Cold spot risk
 AL4: Out of Range
 AL5: > 2 Overtemp.s
 AL6: Out of target range
 AL7: Cumulative each probe

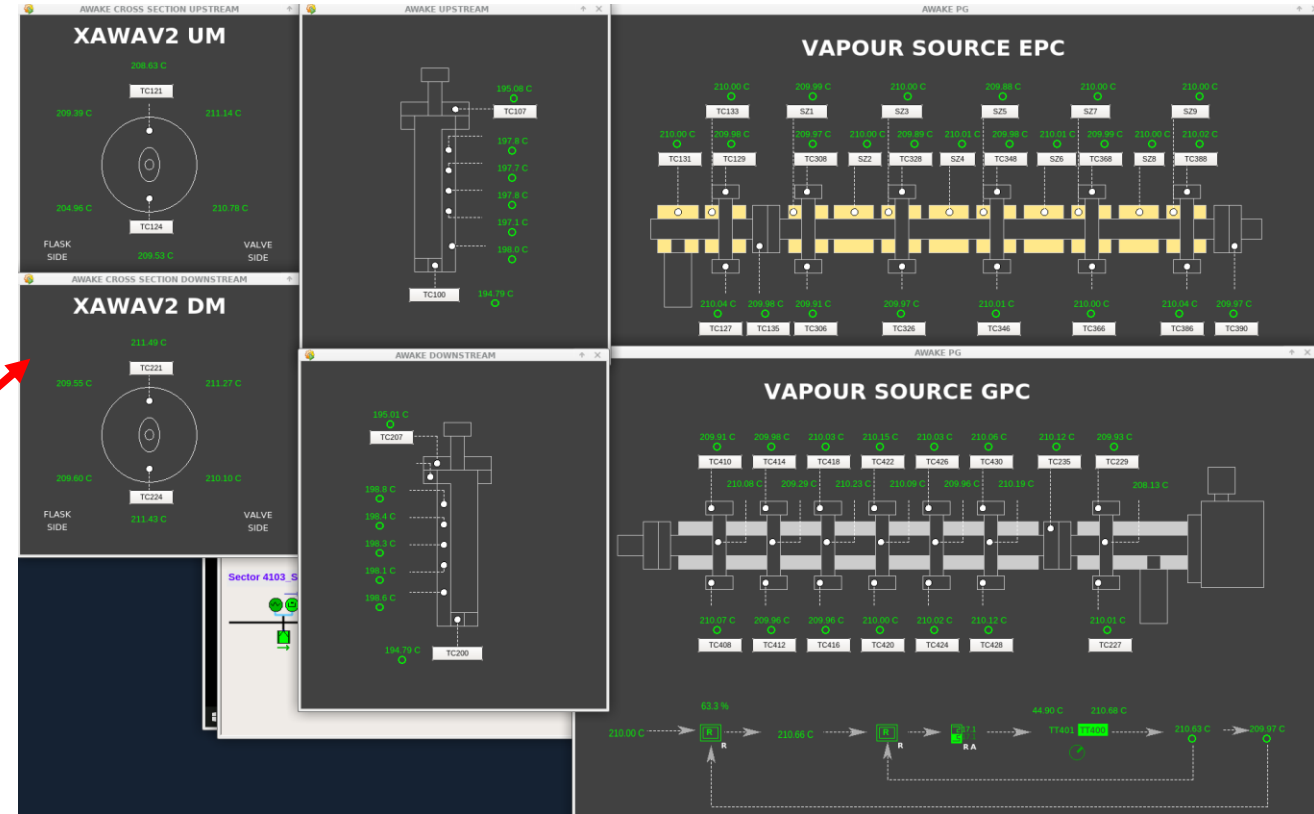
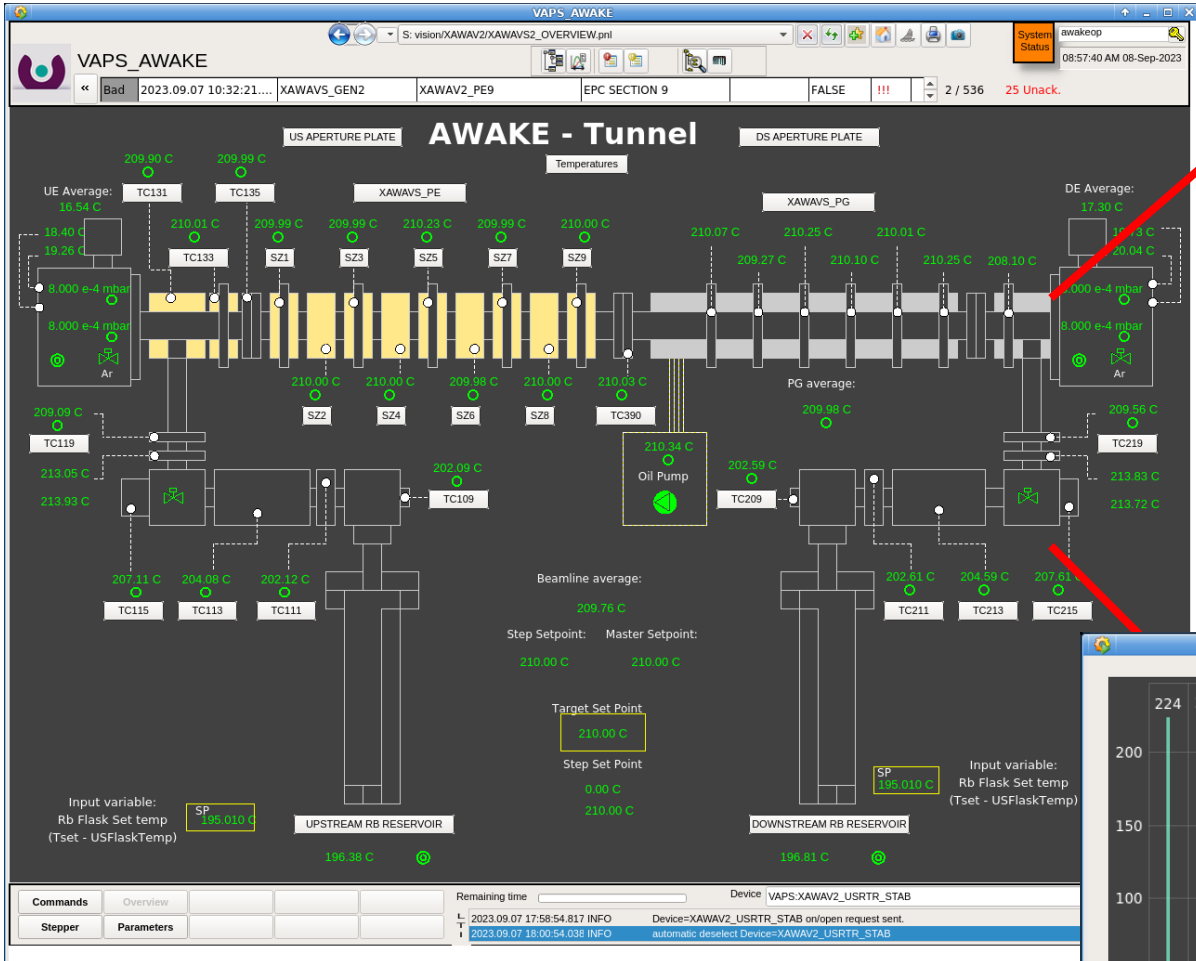
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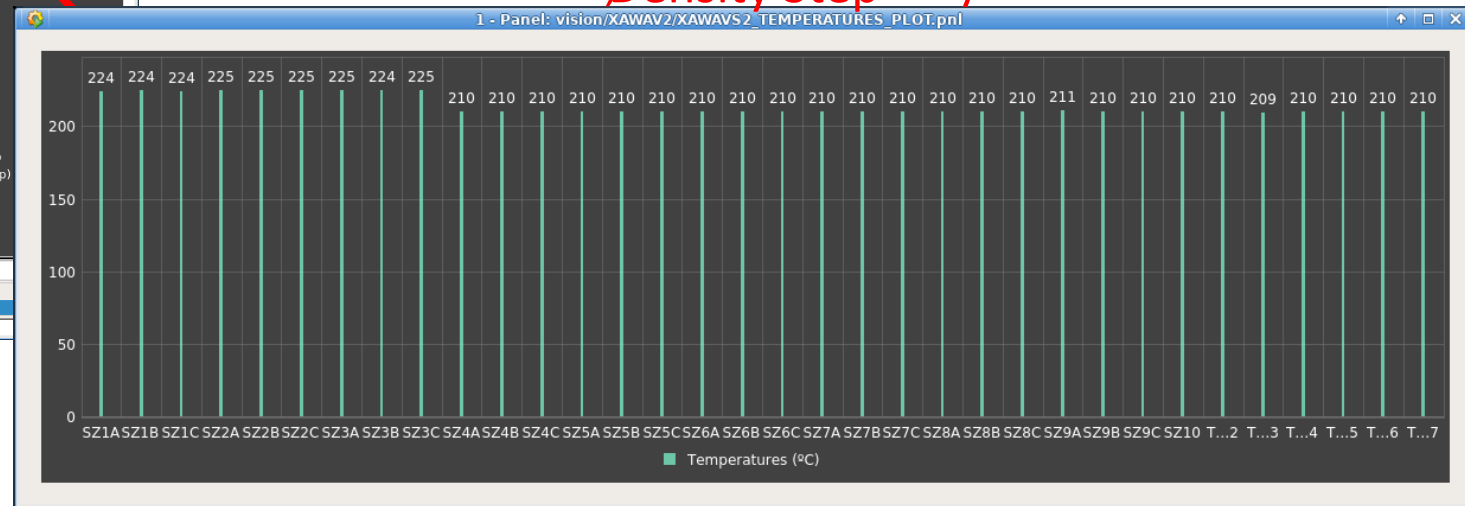
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Run 2b Operations

- Control GUI



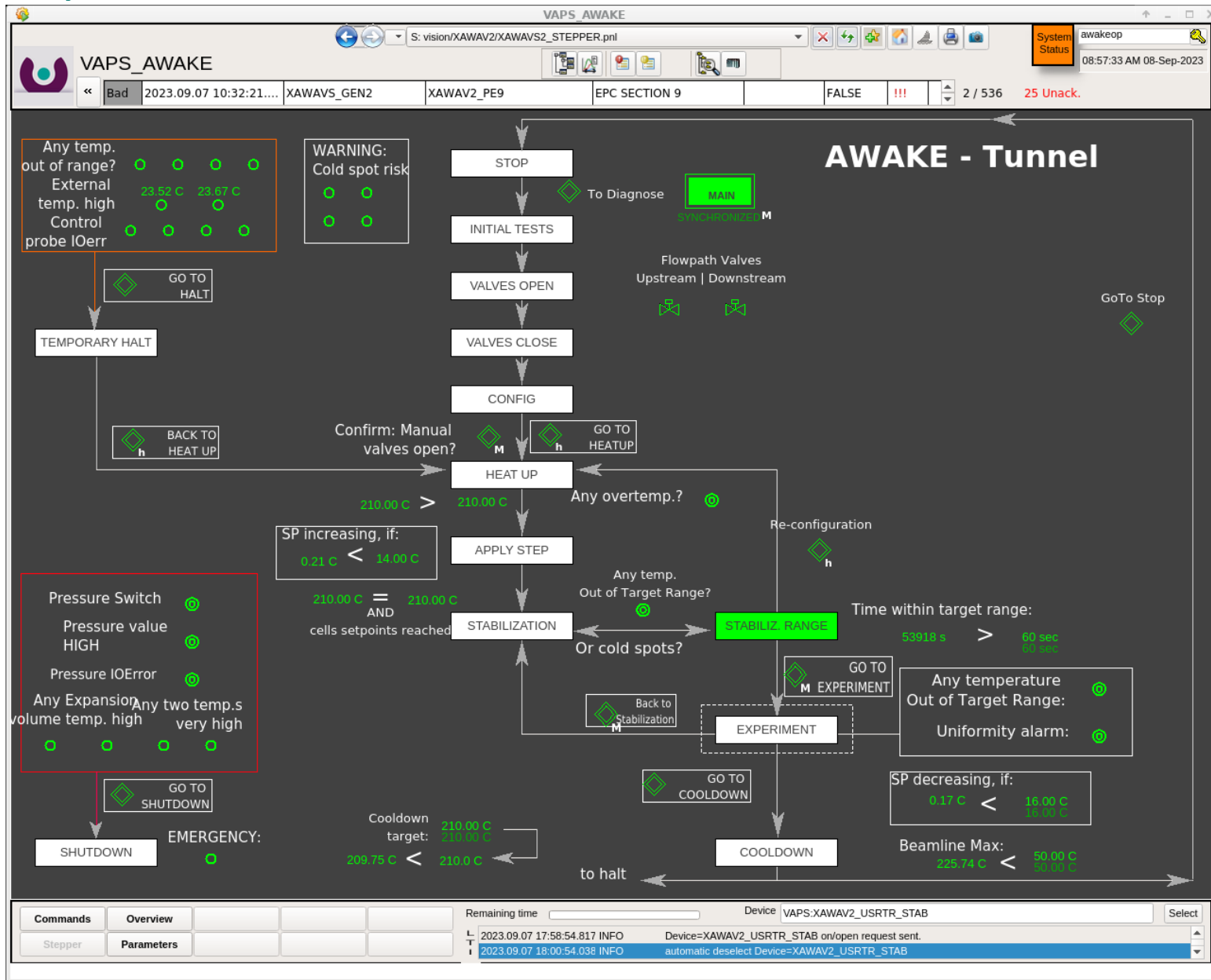
Flat Density step



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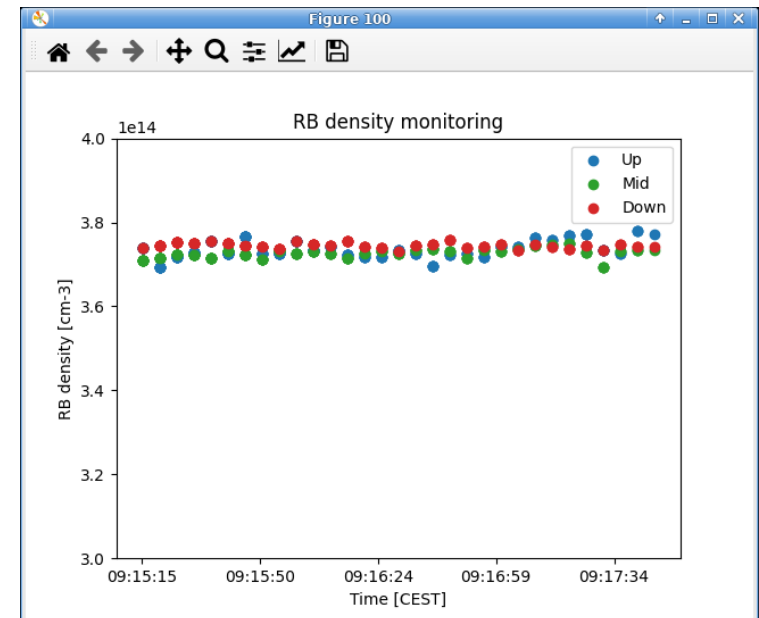
Run 2b Operations

- Control GUI



Run 2b Operations, critical points

- Main cause of downtime during run was OTCs (over temperature cutout circuits) failure, happened 4 times. Different causes (to close to threshold, loose connectors, probes cable impedance), needed hardware bypass in the tunnel. Now fixed with two intervention by WDL
- Other access needed to reboot the control rack for a failsafe card, now remote reset implemented and tested
- Density diagnostic tuned between first and second run, US spectrometer found with wrong factory calibration was giving incorrect values. Now fixed in software that calculate density, measurement between Up, Middle and Downstream viewport show agreement in 0.2%



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Further upgrades

- Mu-metal shielding installation happening now in the tunnel
- Test of effect of magnetic field on electron bunch started, show some effect to be investigated more in details with Mu-metal
- Suppression mechanism already implemented, all heaters off for 200ms during proton passage through the experiment. Successfully Tested trigger on vapor source control system, to be tested with proton events
- Veto on expansion volume BTV and Rb reservoirs valves to minimize RB coating of screen in implementation phase
- Shorter plasma: Under study/design feasibility plungers with laser dump inside the vapor source, for a possible installation before 2024 Run.



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Thank you for your attention

