FLASH2020+

13th Progress Review Meeting

Welcome

Lucas Schaper
On behalf of all people contributing to the success of FLASH2020+
Hamburg, 28.02.2025

HELMHOLTZ

DESY.

Agenda

Start	End	Topic	Speaker	Duration
10:00	10:15	Welcome + Agenda		15‘
10:15	10:45	Project Update	Lucas Schaper	20‘+10‘
10:45	11:15	Shutdown Schedule & Infrastructure	Olaf Rasmussen	20‘+10‘
11:15	11:45	Electron Beamline Installation	Christopher Gerth	20‘+10‘
11:45	12:15	Photon Diagnostics Update	Sven Toleikis	20‘+10‘
12:15	13:15	Lunch Break		60‘
13:15	13:45	Seed Laser & Laser Transport	Ingmar Hartl	20‘+10
13:45	14:15	Update on Sub-synchronisation	Sebastian Schulz	20’+10
14:15	14:45	Seeding Update	Pardis Niknejadi	20’+10
14:45	15:00	Discussion and AOB	Lucas Schaper	15’

FLASH2020+

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Project Update

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On behalf of all people contributing to the success of FLASH2020+
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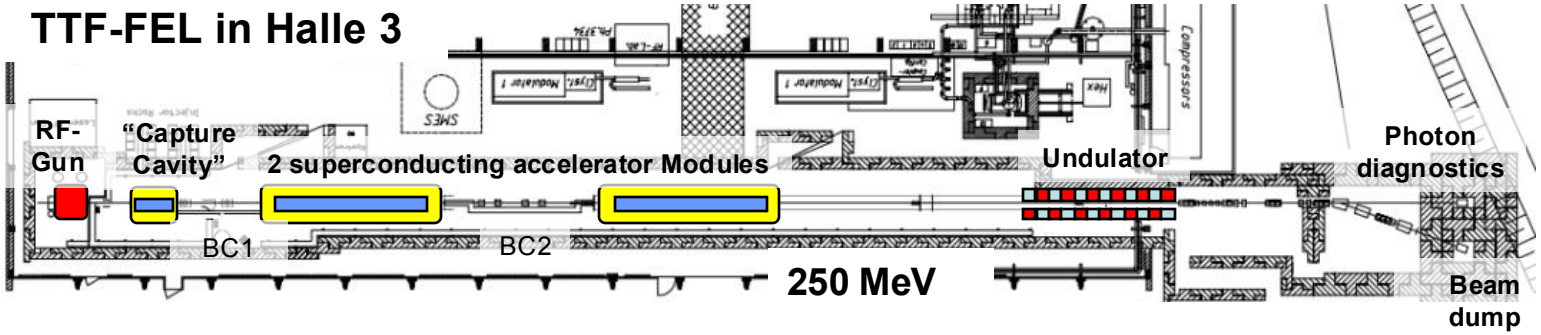
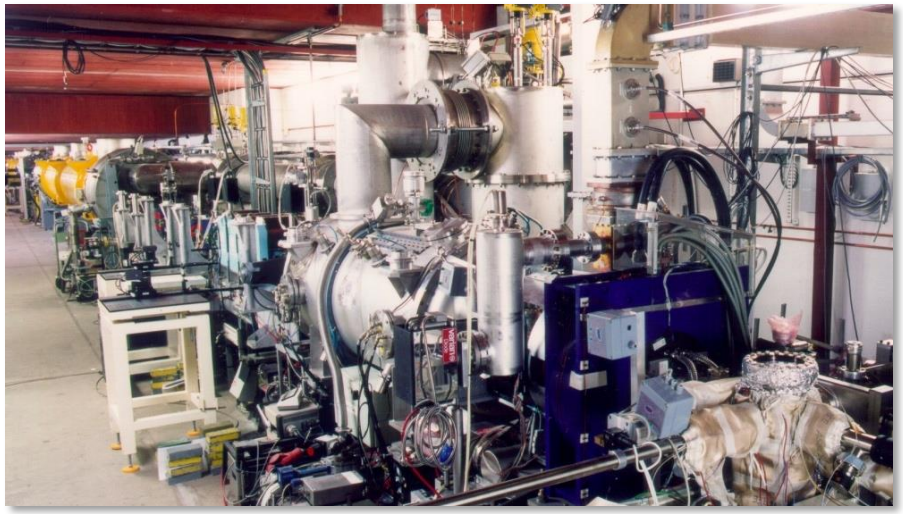
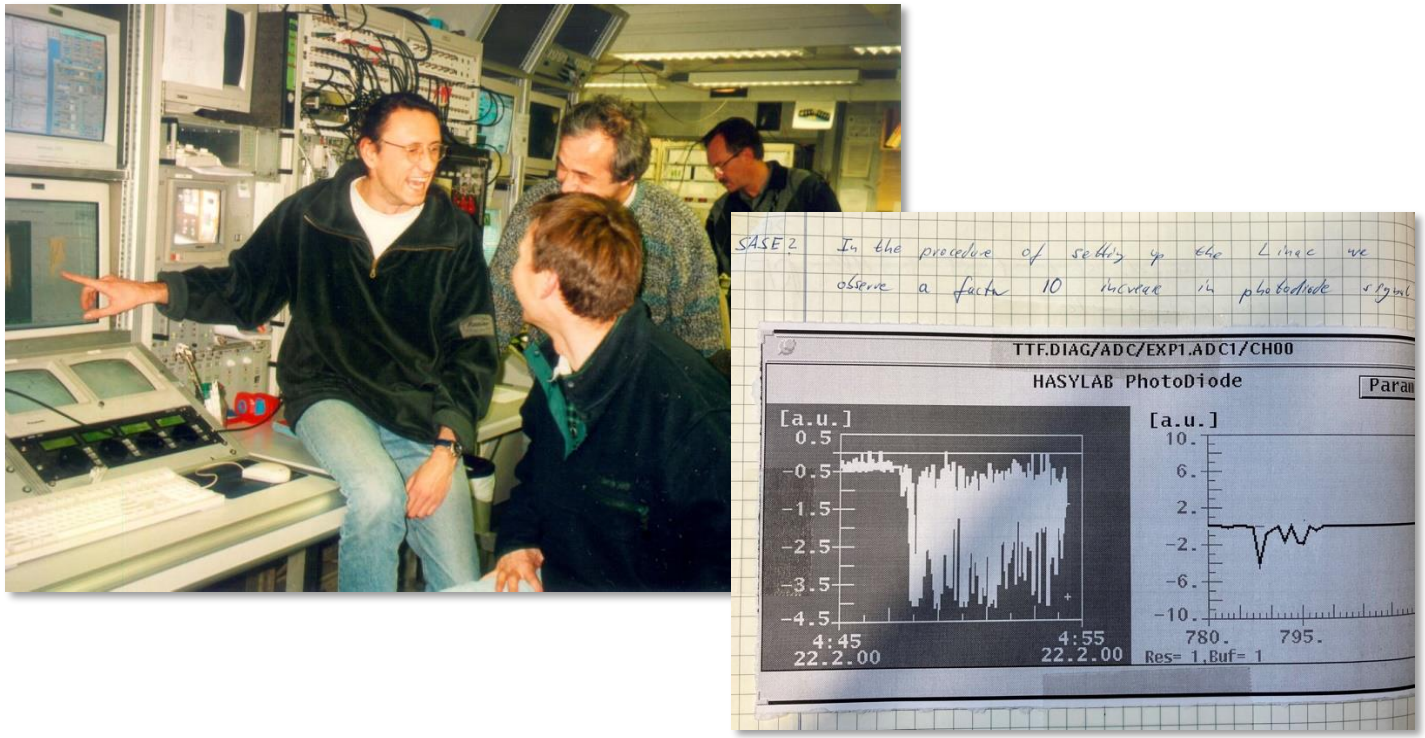
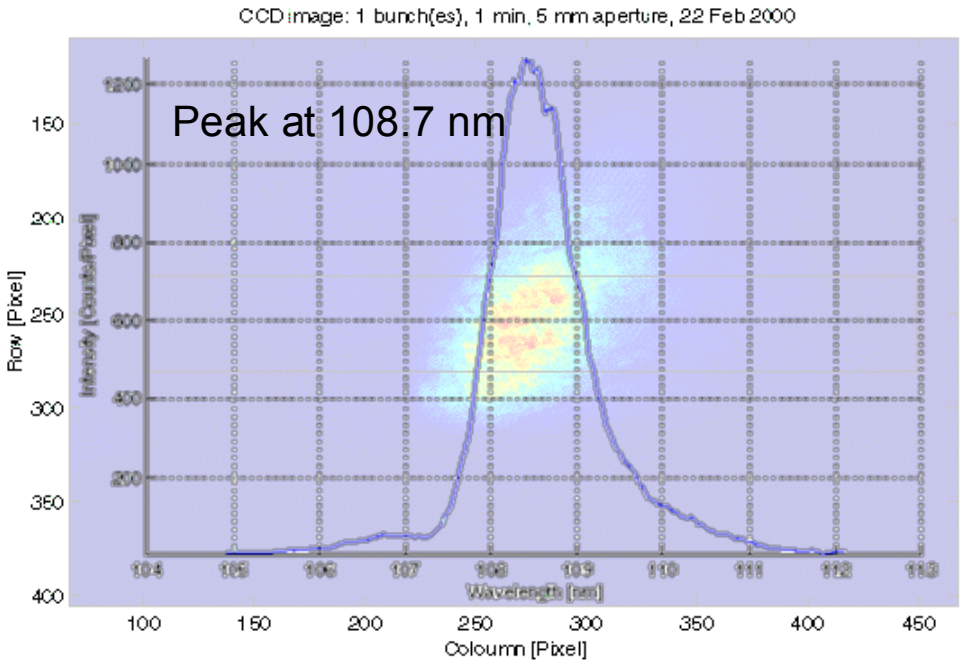
FLASH
Accelerator - Lasers - Photon Science

A Bit of History





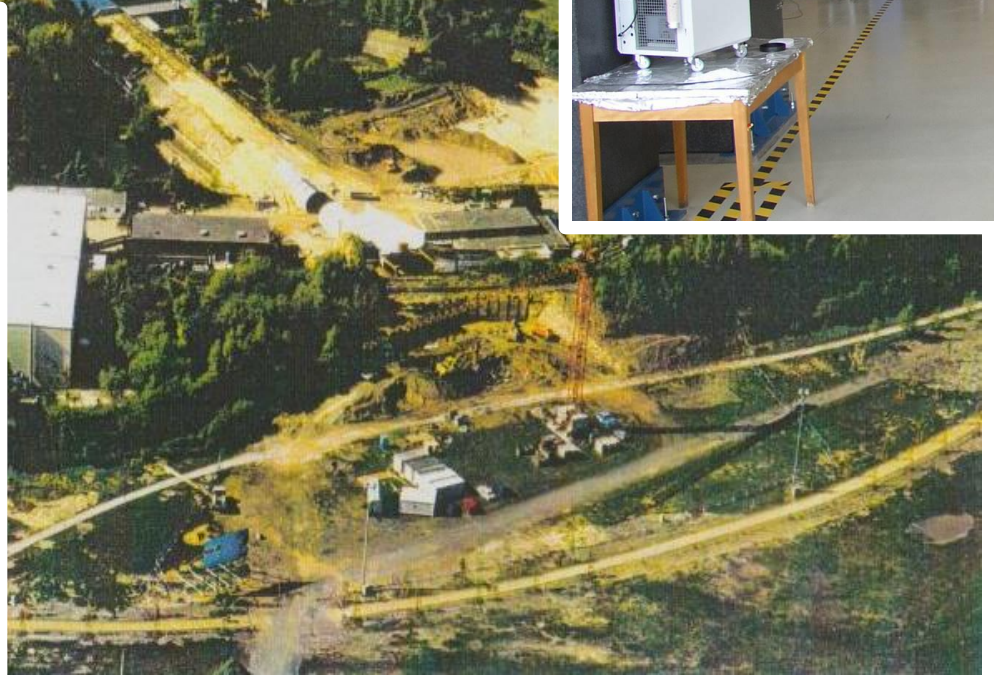




Courtesy: Katja Honkavaara

Construction of FLASH tunnel in 2002

The last time tunnel and hall were empty



Albert Einstein hall

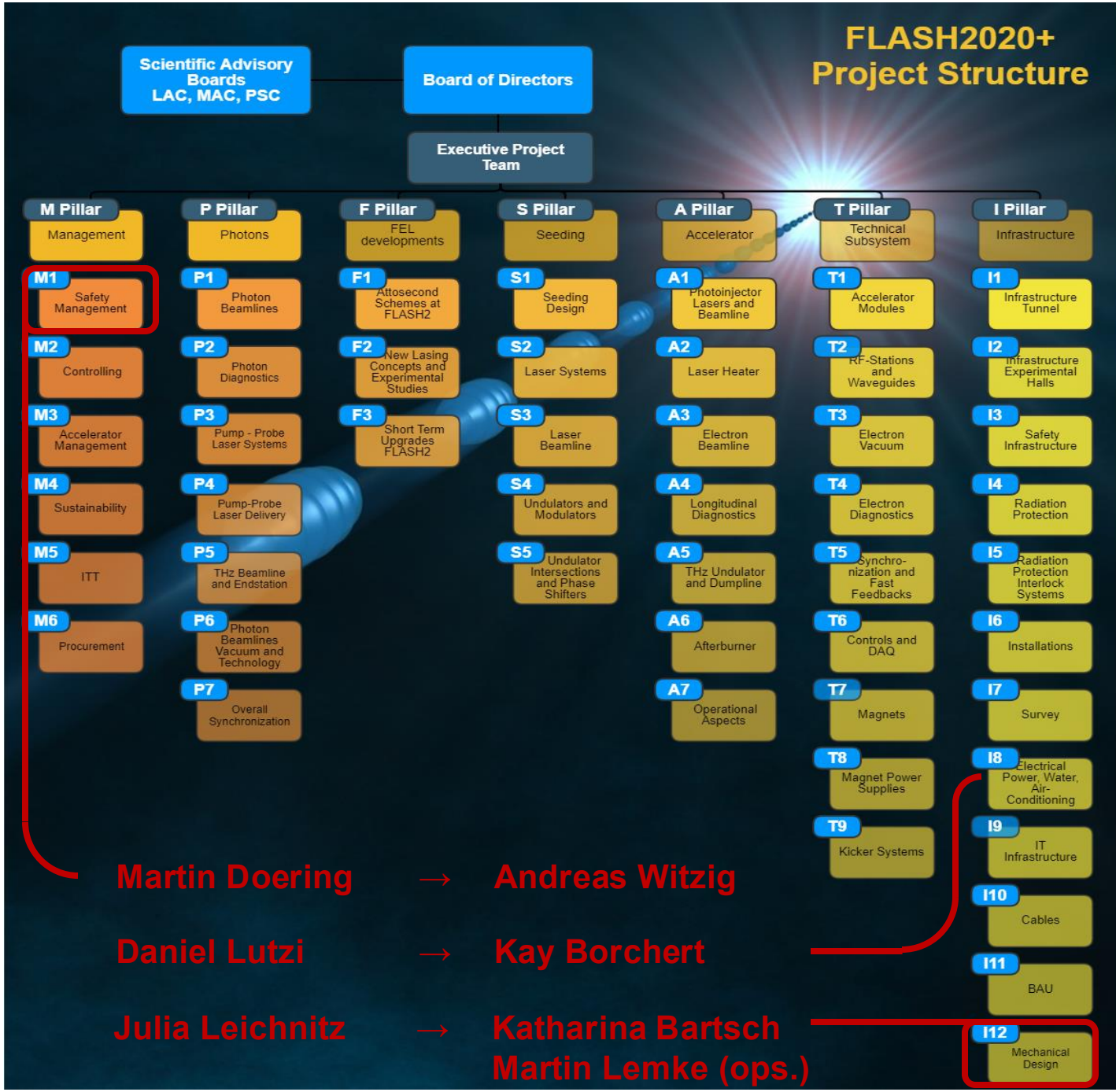
Undulator section in tunnel

Courtesy: Siggi Schreiber & Rolf Treusch

FLASH2020+

Organization

- Machine coord: Mathias Vogt (interim)
  → Please include in all discussions on safety and operational aspects!
- Radiation SOs: Juliane Roensch-Schulenburg & Arne Brinkmann
- Laser SO: Maximilian Falke
- Schedule: Olaf Rasmussen
- Seed laser: Ingmar Hartl
- Beamline inst.: Christopher Gerth
- Commissioning
  without beam: Katja Honkavaara
  with beam Juliane Roensch-Schulenburg



FLASH2020+

Miscellanous

Confluence → XWIKI

Migration from Confluence to XWIKI finished

- Far from ideal…
- …especially during project execution & shutdown
- Please continue using XWIKI
  - FLASH2020+ project https://xwiki.desy.de/xwiki/bin/view/FLASH2020/
  - FLASH machine operation https://xwiki.desy.de/xwiki/bin/view/FLM/

- Please help in preventing spread of rumours / gossip / ‘fake news’
- Participate in project meetings for most recent information

  In doubt?
  → **Redirect people to project management**

FLASH2020+

Facility is in shutdown

Lifecycle management via continuous upgrades

Linac upgrade: *Finished*

3rd BC FLASH2	Injector laser
New BCs (linac)	Energy upgrade
Laser heater	Afterburner FLASH2
Fast orbit correctors	New beamline FL23 (FLASH2)
TDS (FLASH2)	Interim P-P laser (FLASH1)

Seeding upgrade: *Now!*

- High rep. rate seeding (FLASH1)
- Photon diagnostics (FLASH1)
- THz generation

Short term upgrades

- Flexible pump-probe lasers
- New beamlines
- Intense THz Source

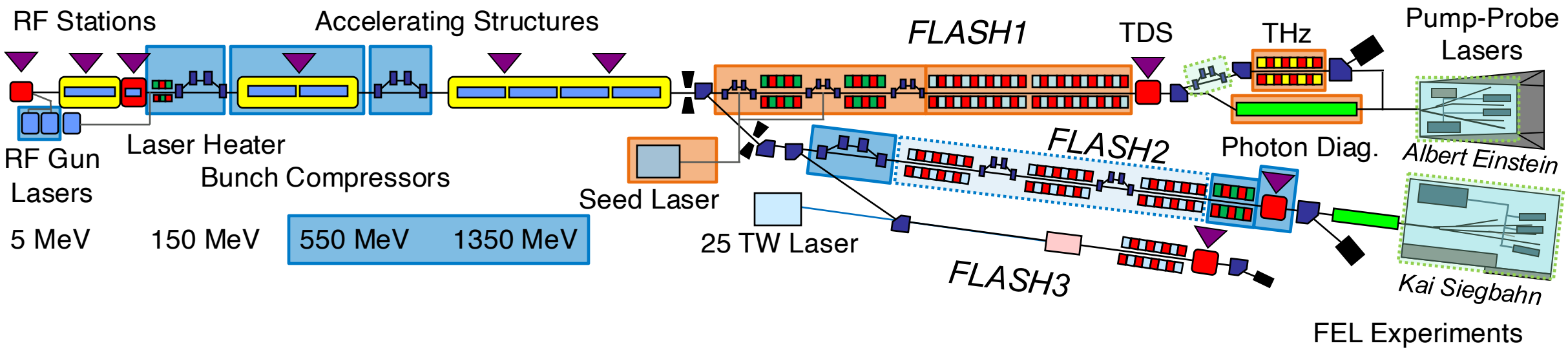
Mid term upgrades

- New undulator schemes (FLASH2)
- New lasing concepts (FLASH2)

- Added new operation modes
- Increased parameter range
- Improved electron beam & diagnostics

→ **Enabled new user experiments already**

New Sub-Synch
Sub 50 fs FHWM demonstrated



FLASH2020+

Lifecycle management via continuous upgrades

Facility is in shutdown

DAYS TO GO
156

Linac upgrade: *Finished*

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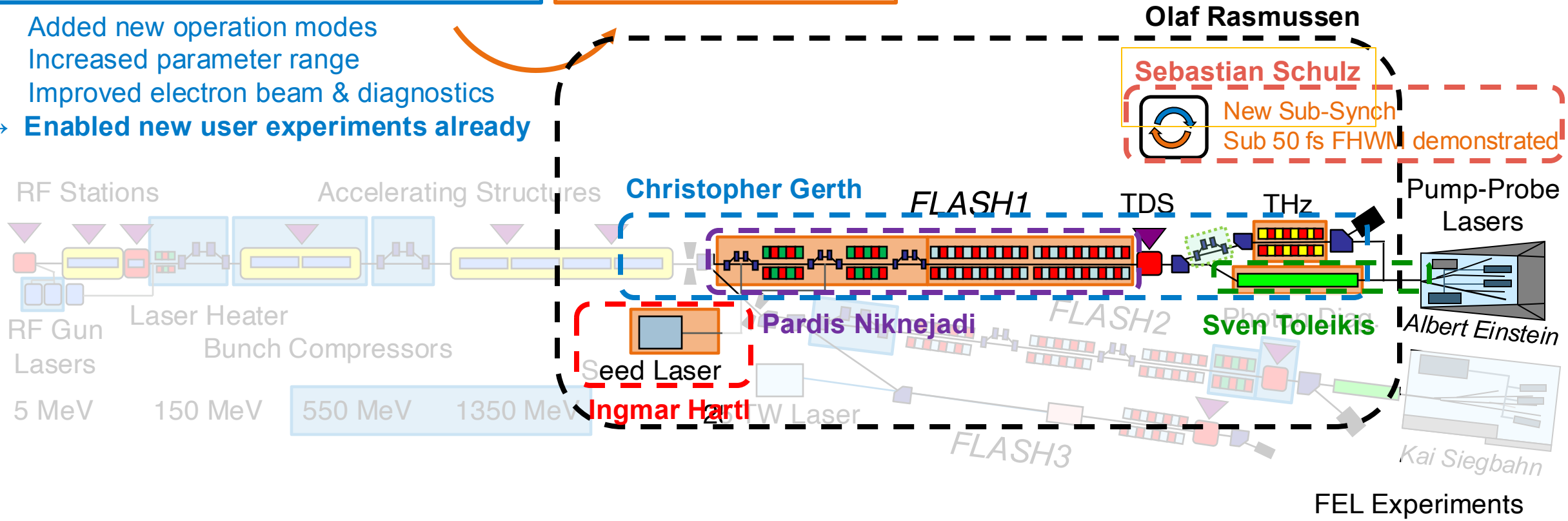
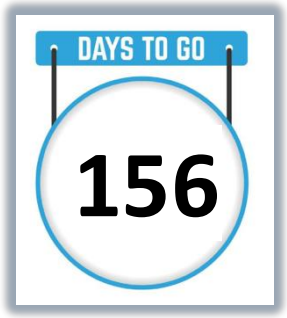


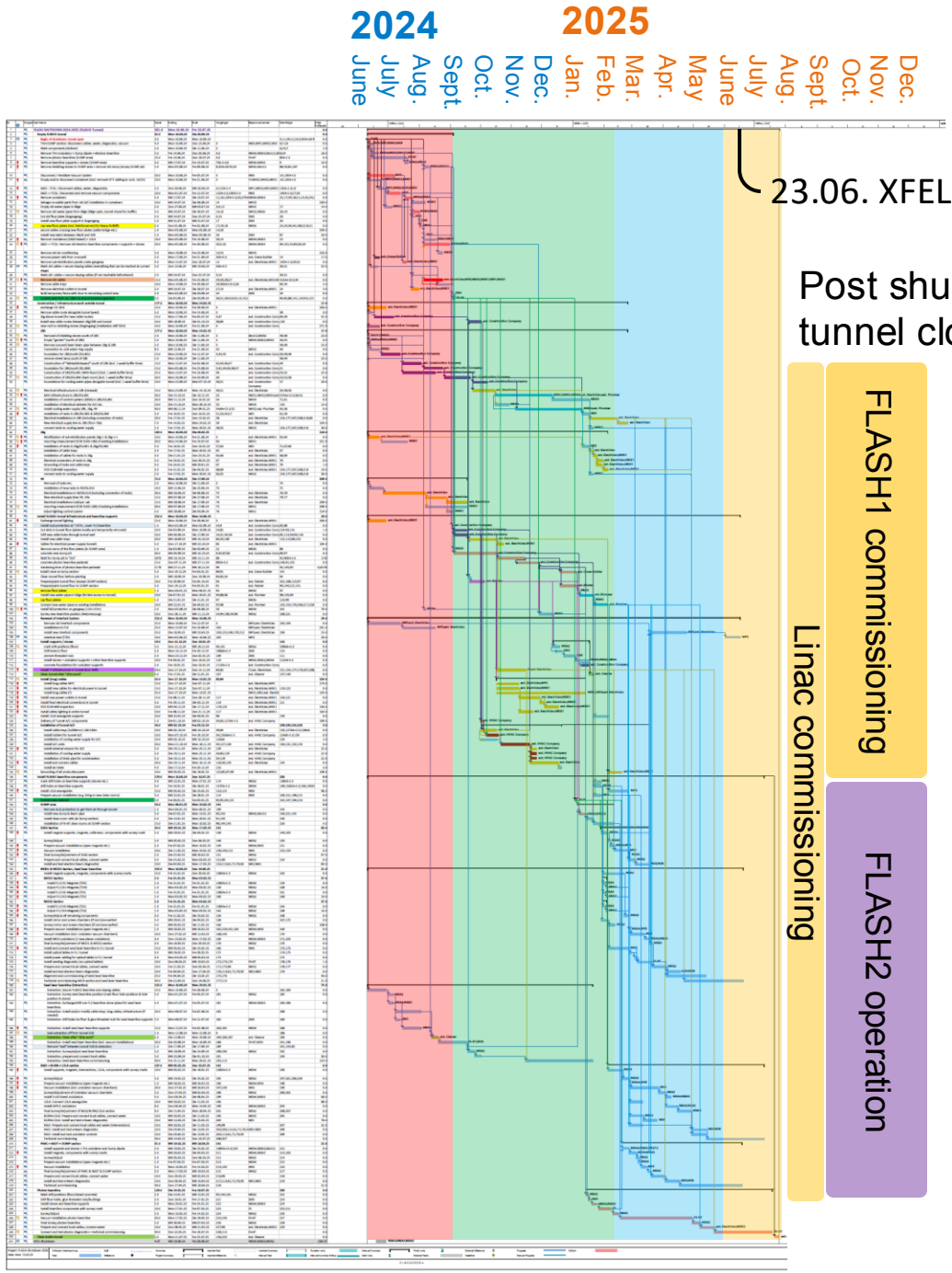
Shutdown on a tight schedule

Transition from construction to assembly phase

Rough overview: 4 phases

1) Dismantling/removal
2) Construction work
3) Assembly/installation
4) Technical commissioning





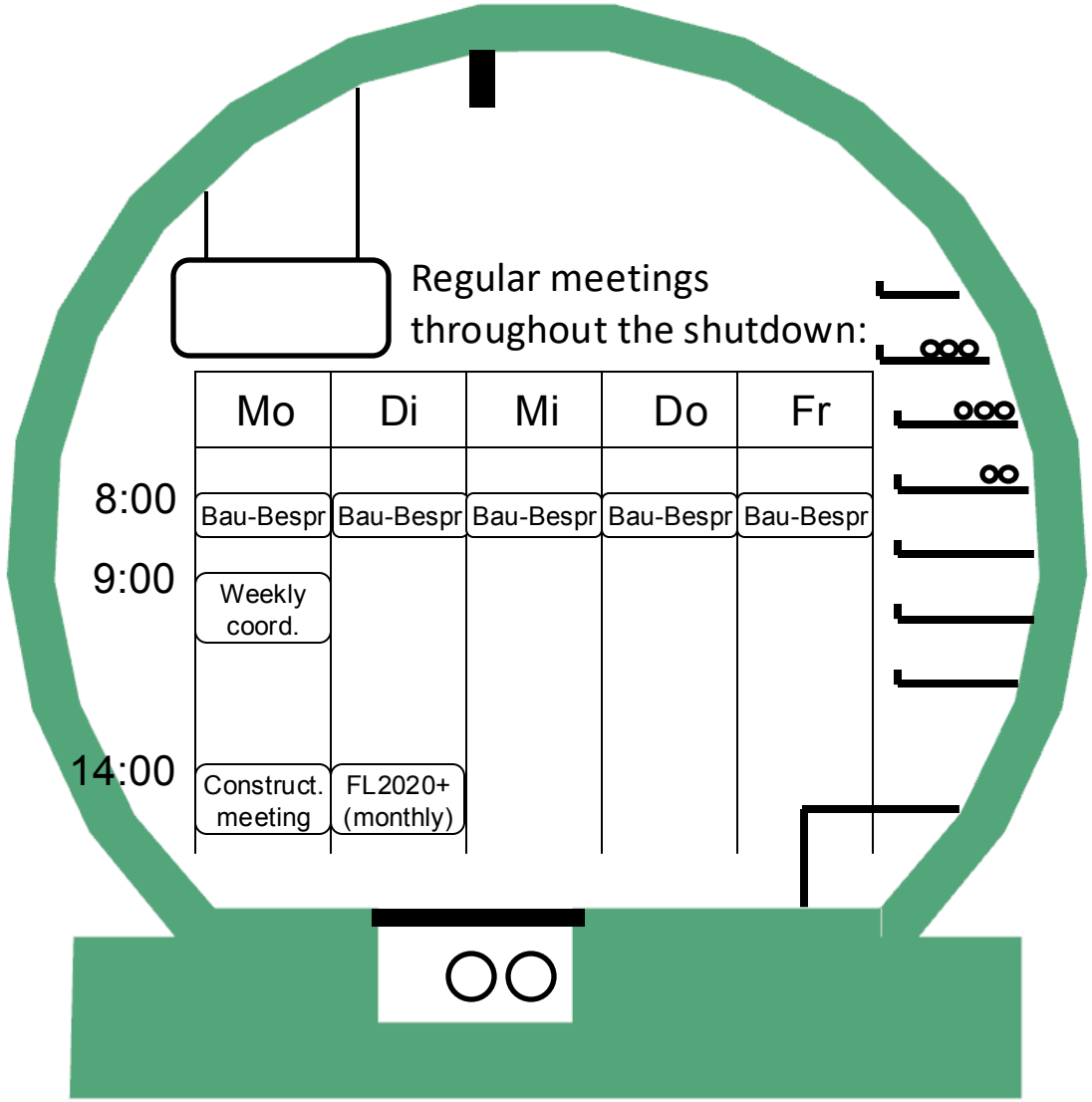
Installation started!

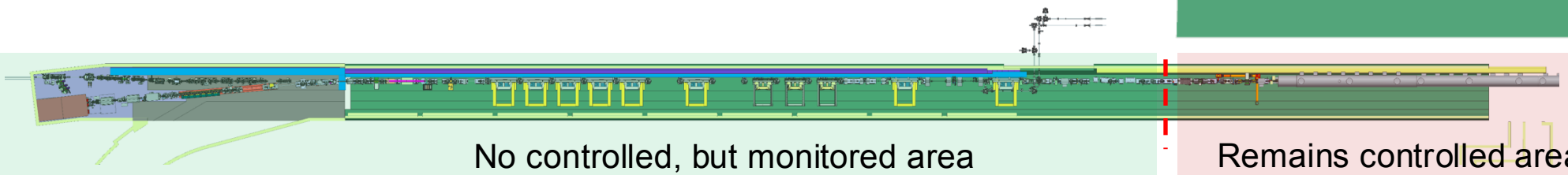
Thanks for all the hard work you put in!

Changes in tunnel since shutdown start

- Containers out
- Bilge emptied & covered with new plates
- Old cables and walkway removed
- Old FLASH1 deconstructed
- Monorail power rails removed
- Old AC removed

- Part of the tunnel transferred to radiation monitored area
- Already installed: Water pipes, cable trays, air condition, …





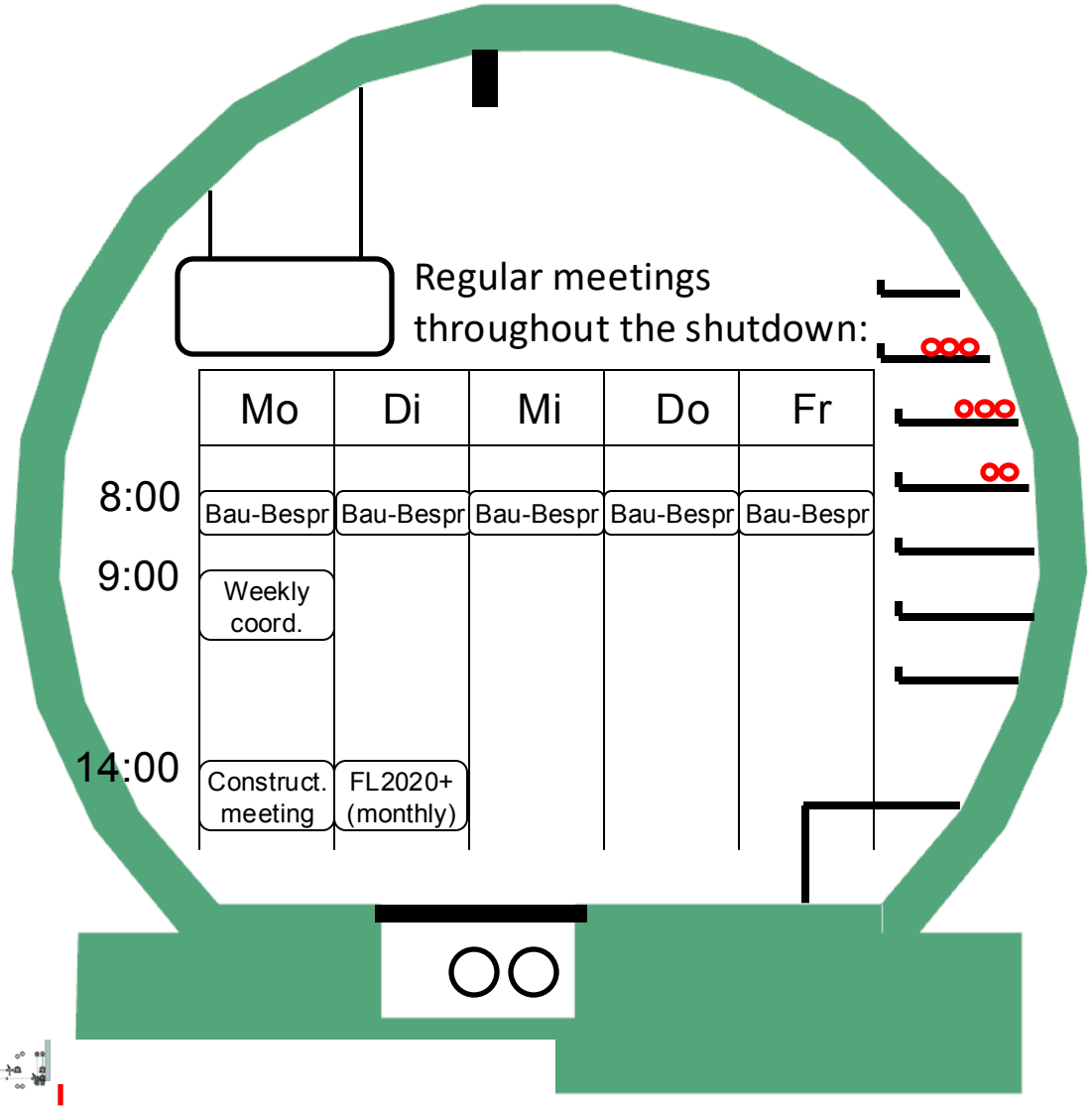
No controlled, but monitored area

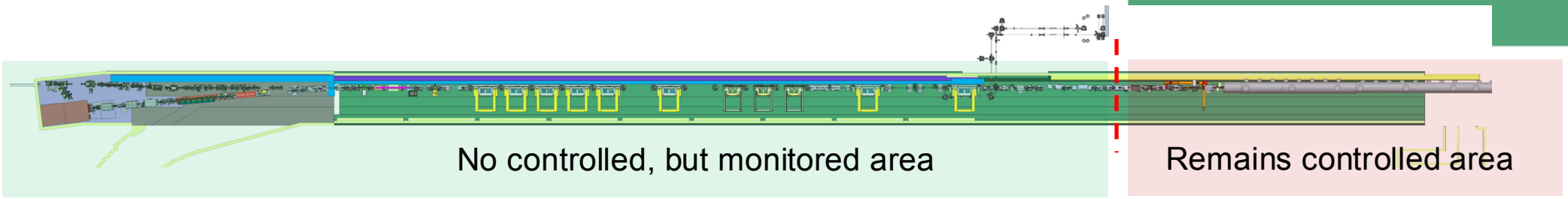
Remains controlled area

Cables, power, …

Check if everything you need is included in plan

- All cables can be installed from now on
  - Cable routing layout exists
  - Please use feedthroughs to technical support buildings according to plan!
- Critically reevaluate & check if all infrastructure and cables you need is in the corresponding plans → Now is the last chance





Controlled area?

Allows companies without §25 permit to work

Components that can be installed:

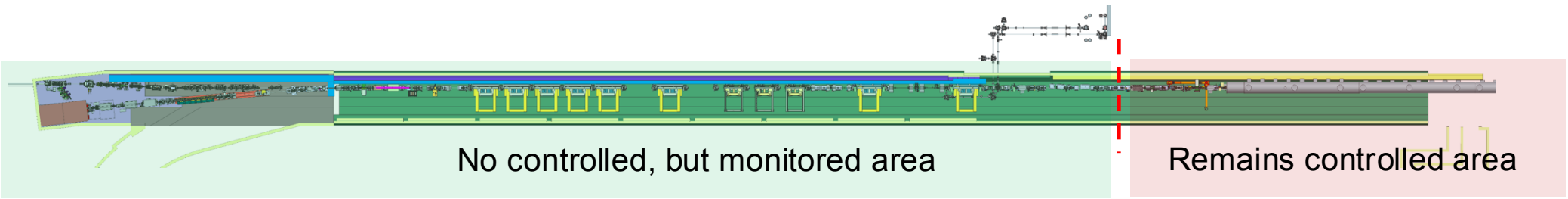
- Installation of weakly activated components possible:
  Dose rate < 5 µSv/h at 30 cm distance

Clearing components:

- If something from within tunnel needs to be brought outside and may have seen beam: Usual procedure!
  - Generate clearance ticket in D3 ticket system via SSB
- Exception: Everything that was brought into the tunnel during the shutdown or any newly fabricated components that have never seen beam.
- In doubt generate ticket!

Installation ‘holy’ stone upfront dump:

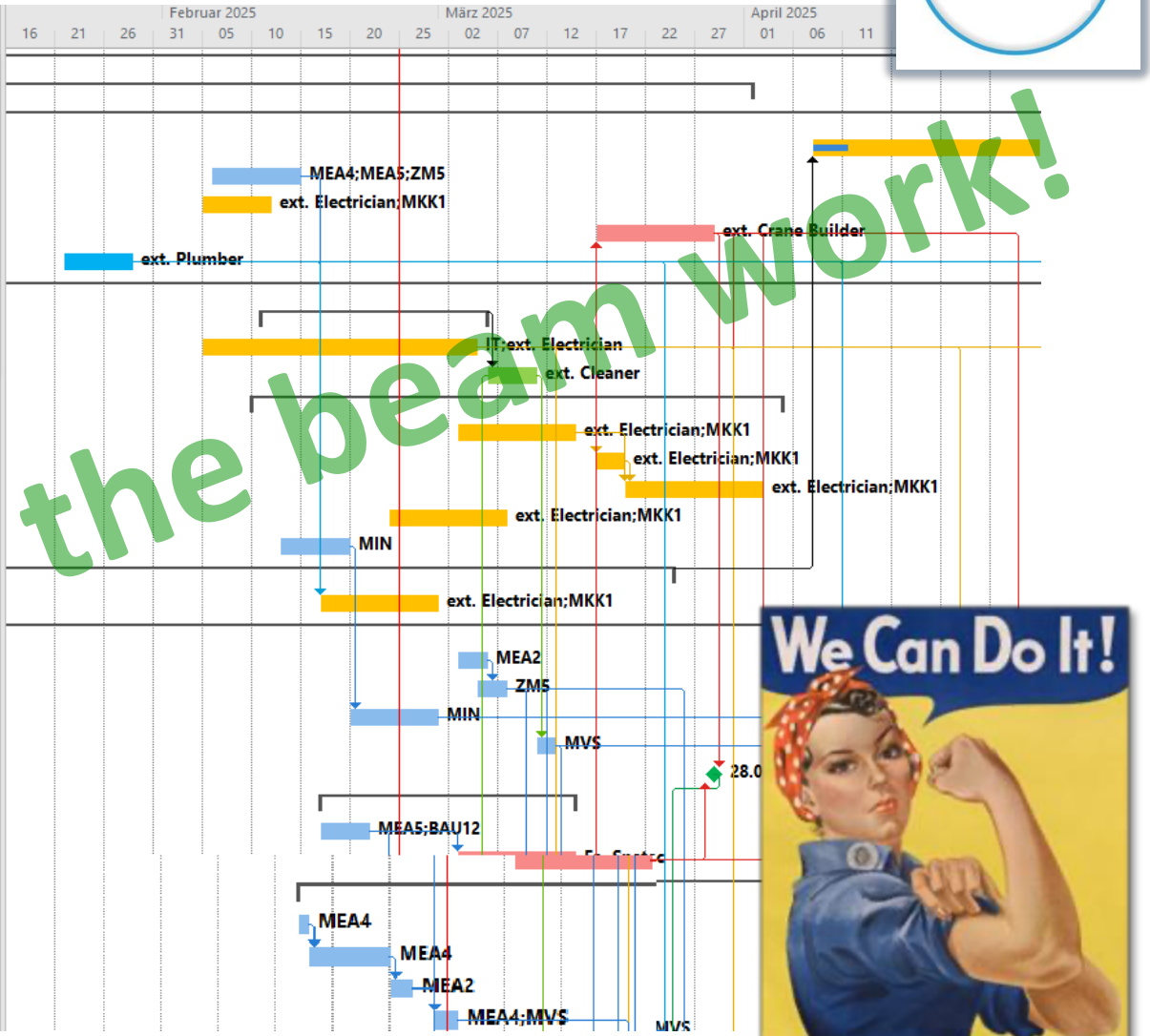
- Tunnel will temporarily become controlled area again for a few days in week 11



FLASH2020+ : Progress

Infrastructure modifications in progress

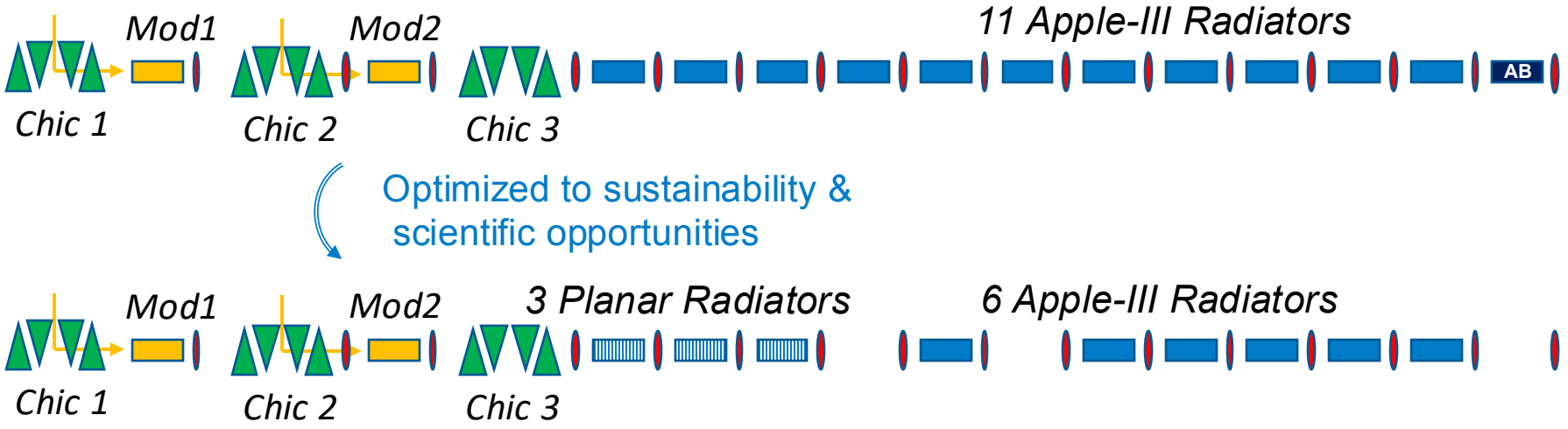
	Vorg	Task Name	Dau	Anfang	Ende
1		FLASH SHUTDOWN 2024-2025 (FLASH1 Tunnel)			
41		Construction / infrastructure work outside tunnel			
122		Install FLASH1 tunnel infrastructure and beamline supports			
123		Exchange tunnel lighting			
127		Install gangway on right side of beamline (below cable trays)			
128		Cables for electrical power supply (tunnel)			
140		install crane at dump section			
150		Connect new water pipes to existing installations			
152		Renewal of Interlock System			
159		Install supports / stones			
166		Install IT infrastructure in Tunnel (incl. Wifi)			
167		Clean tunnel after "dirty work" (walls & floor; NOT machine)	3 d	Don 06.03.25	Mon 10.03.25
168		Install (long) cables	40 d	Mon 10.02.25	Fre 04.04.25
172		Install new power outlets in tunnel	10 d	Mon 03.03.25	Fre 14.03.25
173		Install fixed electrical connections in tunnel	3 d	Mon 17.03.25	Mit 19.03.25
174		VDE 0100-600 inspection	10 d	Don 20.03.25	Mit 02.04.25
175		Install safety lighting in entire tunnel	10 d	Mon 24.02.25	Fre 07.03.25
176		Install LOLA waveguide supports	5 d	Don 13.02.25	Mit 19.02.25
178		Installation of tunnel A/C	64 d	Mon 16.12.24	Mon 24.03.25
196		Grounding of all conductive parts	10 d	Mon 17.02.25	Fre 28.02.25
197		Install FLASH1 beamline components	283 d	Die 11.06.24	Mit 30.07.25
198		mark drill holes on beamline supports (stones etc.)	3 d	Mon 03.03.25	Mit 05.03.25
199		drill holes on beamline supports	3 d	Mit 05.03.25	Fre 07.03.25
200		Install LOLA waveguides	7 d	Don 20.02.25	Fre 28.02.25
201		Prepare vacuum installation (e.g. bring in new clean rooms)	2 d	Die 11.03.25	Mit 12.03.25
202		Control area restored	0 d	Fre 28.03.25	Fre 28.03.25
203		DUMP area	20 d	Mon 17.02.25	Fre 14.03.25
204		Install new dump & beam pipe	5 d	Mon 17.02.25	Fre 21.02.25
205		Installation of FS-BT clean rooms at DUMP section	10 d	Mon 03.03.25	Fre 14.03.25
206		DIAG Section	43 d	Mit 12.02.25	Fre 11.04.25
207		Drill holes on beamline supports (existing supports @ DIAG)	1 d	Mit 12.02.25	Mit 12.02.25
208		Install magnet supports, magnets, ... (components with survey mark) on existing su	5 d	Don 13.02.25	Mit 19.02.25
209		Survey/Adjust components on existing supports (10)	2 d	Don 20.02.25	Fre 21.02.25
210		Prepare vacuum installations (open magnets etc.) on existing supports (10)	2 d	Mon 24.02.25	Die 25.02.25
211		Vacuum installation on existing supports (10)	7 d	Don 13.03.25	Fre 21.03.25

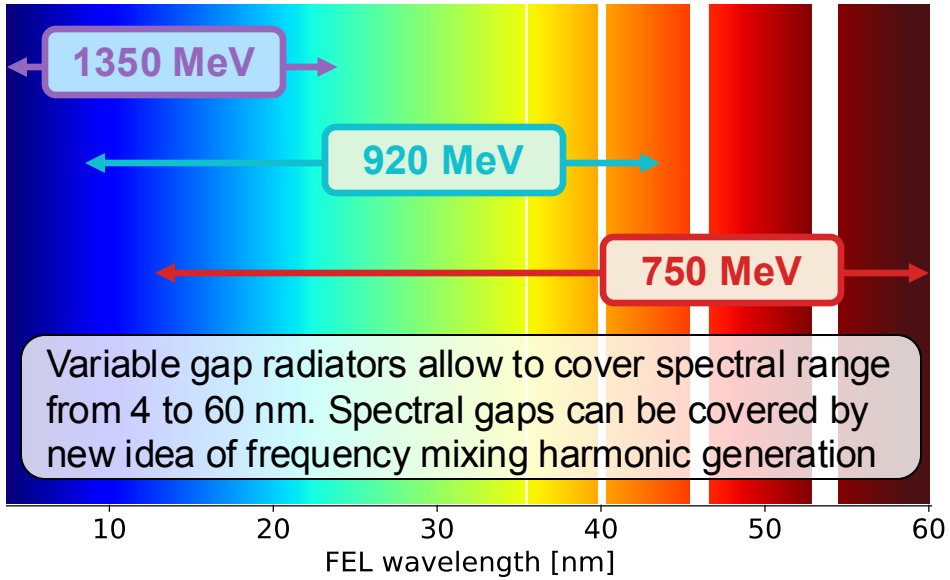


Shutdown schedule available at: https://xwiki.desy.de/xwiki/short/7e569

Optimized facility design for scientific output

Highly sustainable solution for seeded FELs





- Full wavelength range with only 3 linac operation points
  → reduced setup time, better optimised machine
- Spectrally wide tunable laser system with high system availability
  → successful beam delivery & user experiments
- Increased complexity in operation compared to SASE
  → well prepared via training of staff & experiments

Commissioning Schedule

Goal: Ready for operation 4th August 2025

Technical commissioning **without beam**
Point of contact: **Katja Honkavaara**

- KW 18: Interlock Pre-Test
- KW19: Starting cool down
- KW23: Interlock final in house test
- KW28: TUEV Interlock Test
- KW29: Starting gun conditioning
  Tunnel closed weekends (negotiable)
- KW32: Starting beam operation
  → **Tunnel closed**

Available in: FLASH logbook → Op. Schedules

April 2025

KW	Mon	Tue	Wed	Thu	Fri	Sat	Sun
18	28.04.	29.04.	30.04.	01.05.	02.05.	03.05.	04.05.
	Interlock pre-test						
	Tunnel installations (limited access)						

May 2025

KW	Mon	Tue	Wed	Thu	Fri	Sat	Sun
19	05.05.	06.05.	07.05.	08.05.	09.05.	10.05.	11.05.
	Cool-Down						
	Tunnel installations (tunnel open)						
20	12.05.	13.05	14.05.	15.05.	16.05.	17.05.	18.05.
	Cool-Down						
	Tunnel installations (tunnel open)						

May 2025

KW	Mon	Tue	Wed	Thu	Fri	Sat	Sun
21	19.05.	20.05	21.05.	22.05.	23.05.	24.05.	25.05.
	Cool-Down						
	Tunnel installations (tunnel open)						
22	26.05.	27.05.	28.05.	29.05.	30.05.	31.05.	01.06.
	(Cool-Down reserve)						
	Tunnel installations (tunnel open)						

June 2025

KW	Mon	Tue	Wed	Thu	Fri	Sat	Sun
23	02.06.	03.06.	04.06.	05.06.	06.06.	07.06.	08.06.
	Interlock General Probe						
				Magnets GUN			
	Tunnel Installations (limited access)						

June 2025

KW	Mon	Tue	Wed	Thu	Fri	Sat	Sun
24	09.06.	10.06.	11.06.	12.06.	13.06.	14.06.	15.06.
	Tunnel installations (tunnel open)						
		Vacuum tech. comm.					
		Diagnostics tech. comm.					
		Seed Laser Beamline comm.					
25	16.06.	17.06.	18.06.	19.06.	20.06.	21.06.	22.06.
	Tunnel installations (tunnel open)						
	Vacuum tech. comm.						
	Diagnostics tech. comm.						
	Seed Laser Beamline comm.						
26	23.06.	24.06.	25.06.	26.06.	27.06.	28.06.	29.06.
	Restarbeiten (Tunnel open)						
	Vacuum tech. comm.						
	Diagnostics tech. comm.						
	Seed Laser Beamline comm.						

June 2025

KW	Mon	Tue	Wed	Thu	Fri	Sat	Sun
27	30.06.	01.07.	02.07.	03.07.	04.07.	05.07.	06.07.
	Restarbeiten (Tunnel open)						
	Test of vacuum Valves (MPS)						
	Diagnostics tech. comm.						
	Injector Lasers (virtual cathode)						
	Seed Laser Beamline comm.						
	FL1 photon beamline tech. comm.						

July 2025

KW	Mon	Tue	Wed	Thu	Fri	Sat	Sun
28	07.07.	08.07.	09.07.	10.07.	11.07.	12.07.	13.07.
	Interlock Test TÜV						
				Magnets GUN			
	Restarbeiten (very limited access)						
29	14.07.	15.07.	16.07.	17.07.	18.07.	19.07.	20.07.
	Restarbeiten (Tunnel open)						
							RF-gun conditioning
							LLRF RF-Gun
	Techn. interlocks (RF-gun)						
	Test GUN mode (MPS)						
	Prep. GUN RF-Station&waveguides						
	Check GUN cameras and screens						
	Diagnostics tech. comm.						
	Waveguides techn. comm.						
	RF-stations conditioning (load)						
	Seed Laser Beamline comm.						
	FL1 photon beamline tech. comm.						
	FL1 undulator techn. comm.						

July 2025

KW	Mon	Tue	Wed	Thu	Fri	Sat	Sun
30	21.07.	22.07.	23.07.	24.07.	25.07.	26.07.	27.07.
	Restarbeiten (Tunnel open)						
					RF-gun conditioning		
	Techn. interlocks (Modules)						
	Diagnostics tech. comm.						
	Waveguides techn. comm.						
	RF-stations conditioning (load)						
	Seed Laser Beamline comm.						
	FL1 photon beamline tech. comm.						
	FL1 undulator techn. comm.						
31	28.07.	29.07.	30.07.	31.07.	01.08.	02.08.	03.08.
	Restarbeiten (Tunnel open)						
					RF-gun conditioning		
				Inj. Lasers, Timing			
					Beam in GUN mode		
					IDUMP, QE		
	Techn. interlocks (Modules)						
	Check GUN&FL0 cameras & screens						
	Prep. RF-stations&waveguides						
	RF-stations conditioning (load)						
	Seed Laser Beamline comm.						
	FL1 photon beamline tech. comm.						
	FL1 undulator techn. comm.						

August 2025

KW	Mon	Tue	Wed	Thu	Fri	Sat	Sun
32	04.08.	05.08.	06.08.	07.08.	08.08.	09.08.	10.08.
	Cavity tuning						
		LLRF w/o beam					
		Cavity/Coupler conditioning					
			RF-gun conditioning				
	Inj. Lasers						
			Beam in GUN mode				
				(IDUMP, QE)			
		LOLA conditioning					
	Seed Laser commissioning						
			PolariX conditioning				
	Magnet tests FL0+EXTR						

Available in: FLASH logbook → Op. Schedules

Commissioning Schedule

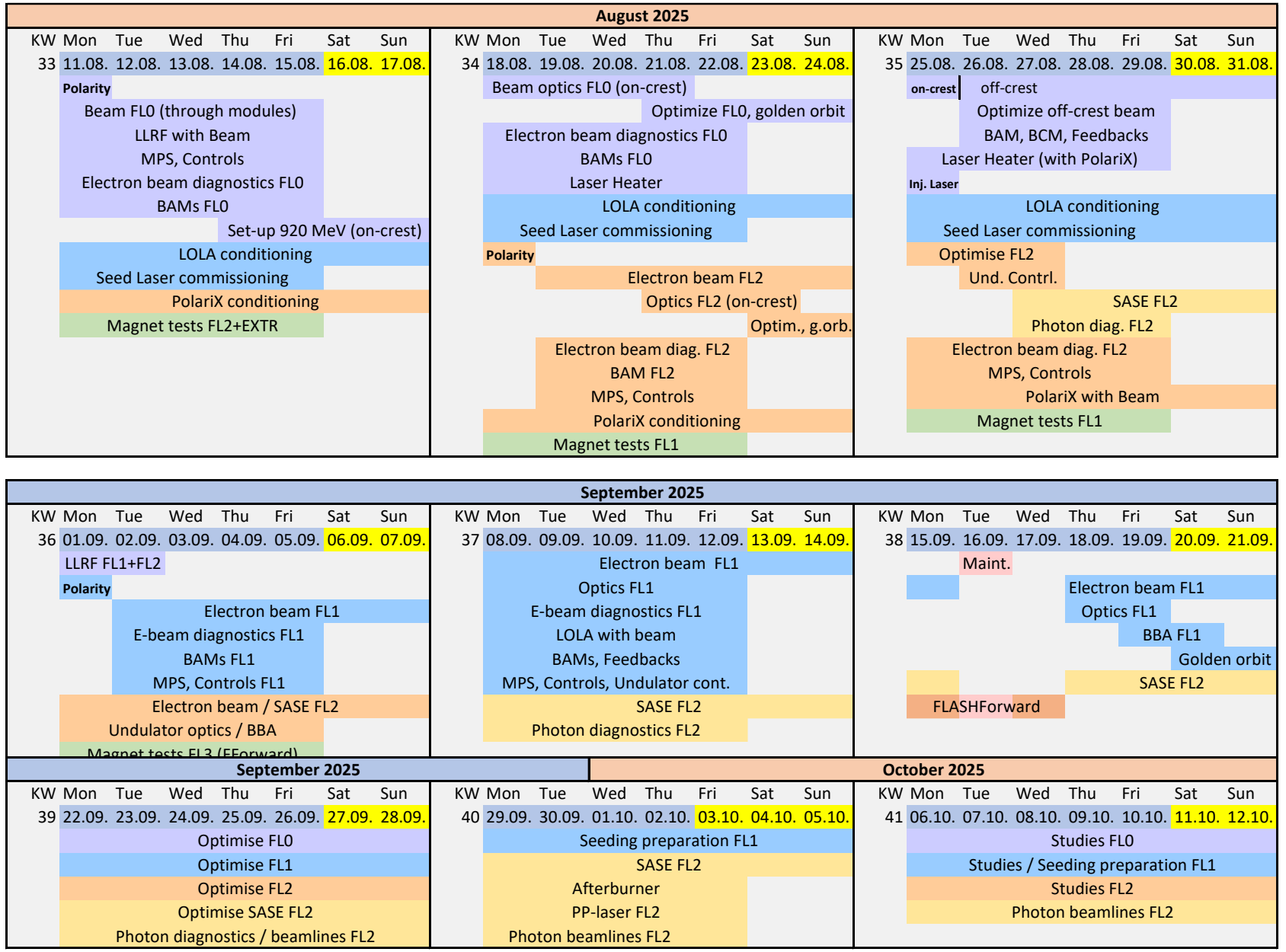
Priority: FL0 > FL2 > FL1

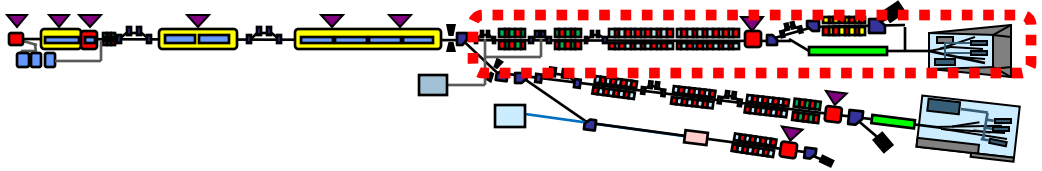
Technical commissioning **with beam**
Point of contact:
Juliane Roensch-Schulenburg

- Prioritisation
  1. FLASH0
  2. FLASH2

     Transiting into user operation 3. Nov. 2025
  3. FLASH1

     Beamline commissioning until end 2025. First experiments are being developed in community proposals.



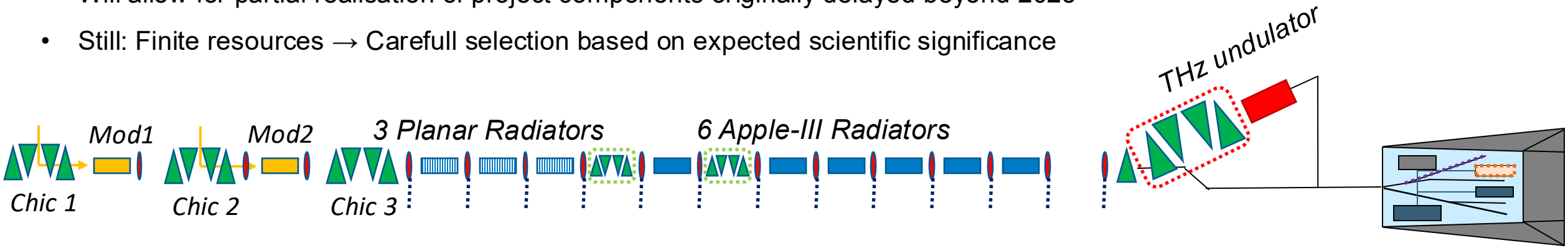


New near term upgrades

Unlocking additional capabilities in near future

Overall financial situation at DESY benefits of using of the FLASH invest buget from years 2026 and 2027 in 2024 and 2025

- Will allow for partial realisation of project components originally delayed beyond 2025
- Still: Finite resources → Carefull selection based on expected scientific significance



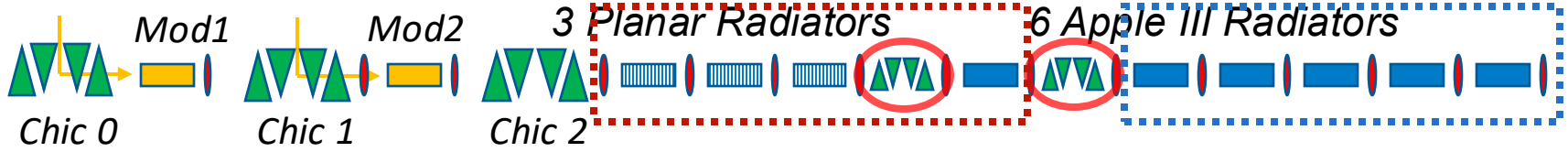
- **THz bunch compressor :** Allows to generate 3 orders of magnitude more intense THz radiatation
- **New beamline FL11 :** Higher transmission for shortest wavelength
- **P-P laser MOD1 :** Adds high intensity pump probe capabilities for new FL11
- **Wirescanners :** Optimizing performance of undualtor section
- **Advanced seeding chicanes :** Improves operation and unlocks new operation modes

New PSP elements in place for each sub-project → Component ordering has started

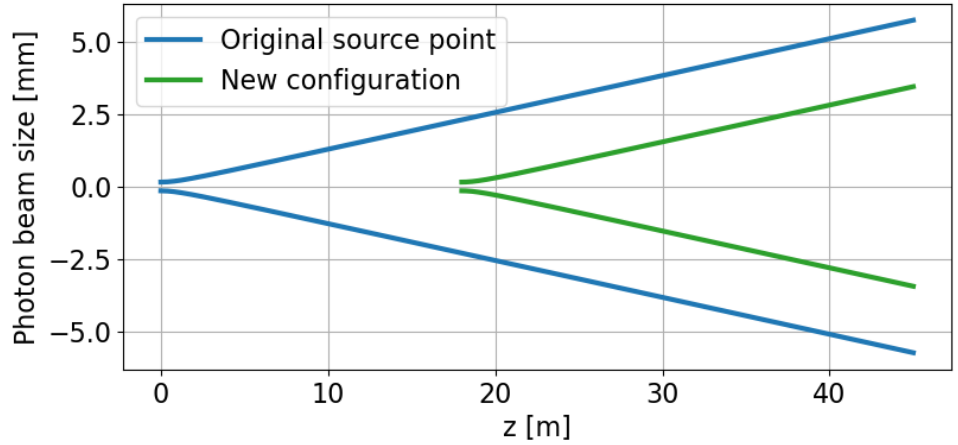
More details in presentations in the next progress review meeting

Why chicanes?

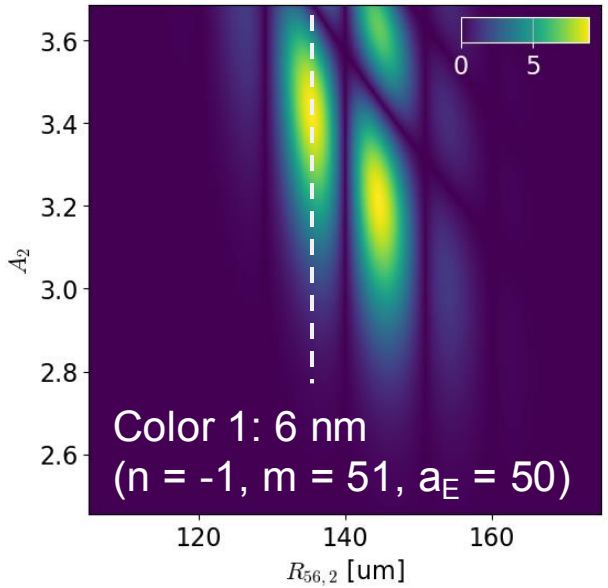
New operation modes

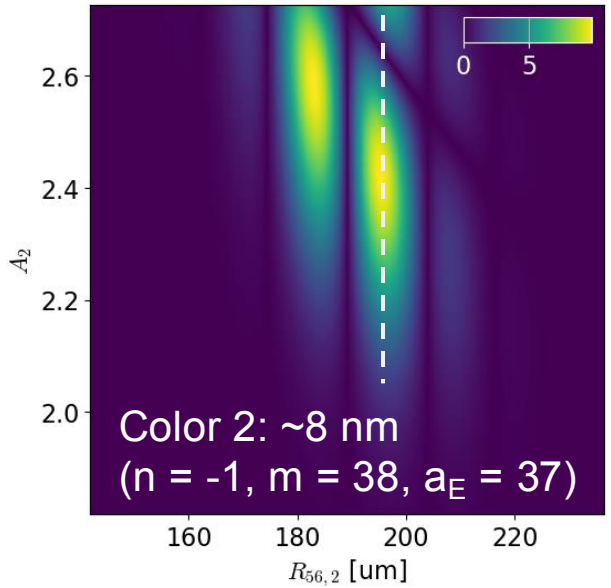


- Shift of the source point towards the users
  - This can be critical at long wavelengths
  - Transport only an energy modulation to avoid debunching



- Efficient multicolor emission in EEHG:
  - One or multiple pulses from from seed2
  - Tweak EEHG optimum using the chicanes

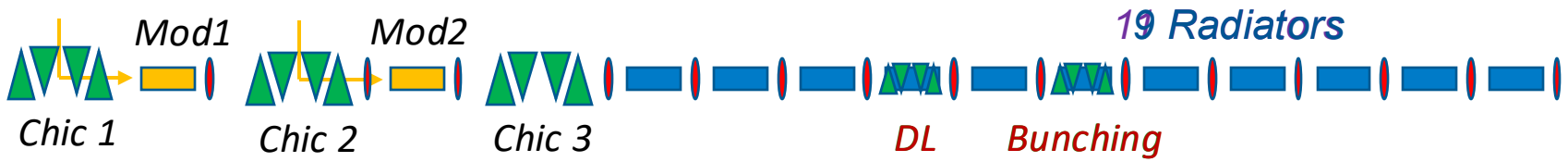


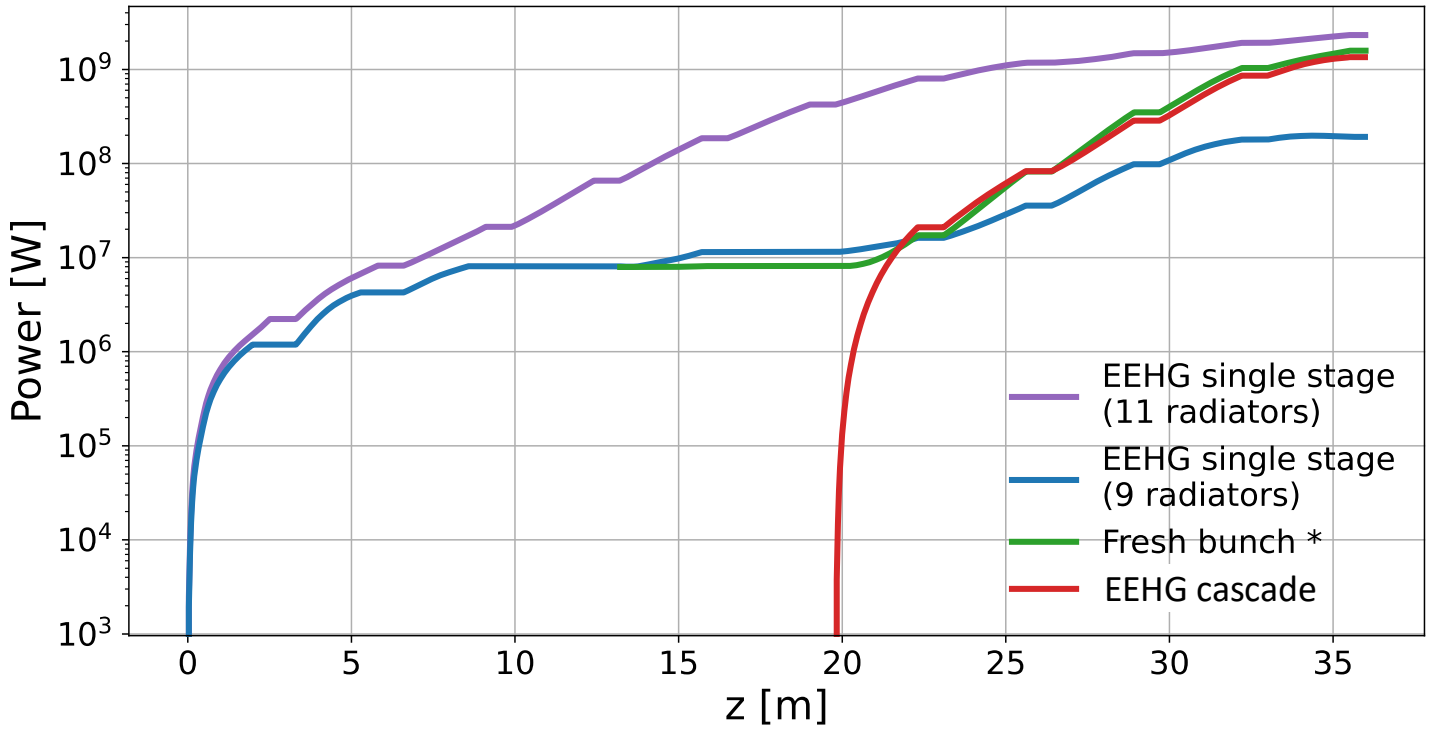


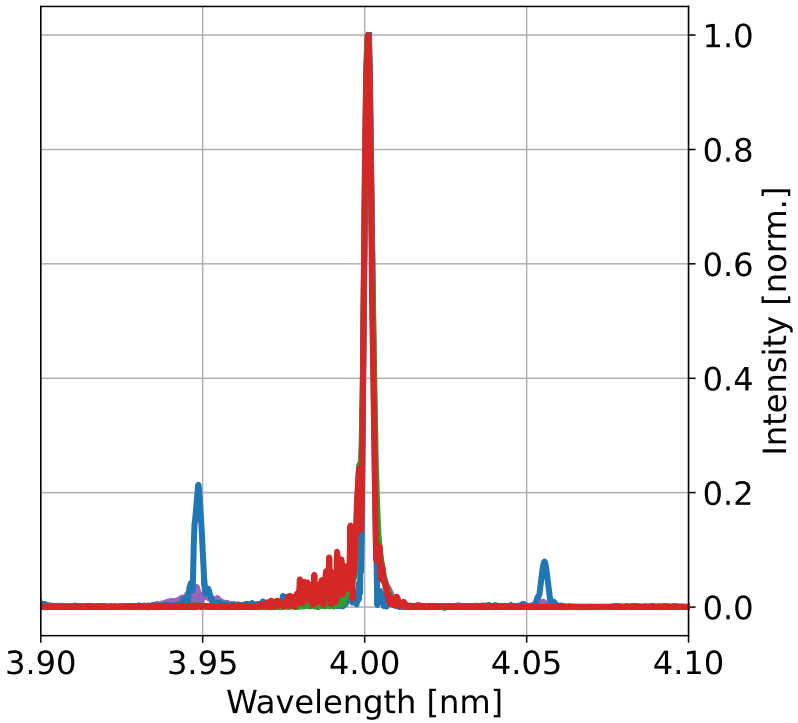
- Also benefits for
  - short pulse generation and
  - short wavelength operation

Driving seeding innovation

Cascaded EEHG scheme improves performance







EEHG Cascade provides superior pulse properties at minimized undulator length

- Avoids harmonic crowding → clean spectra at lowest wavelength
- Harmonic down- and up- conversion at superior bunching fraction possible → wider tuning range
- Designed for FLASH, applicable to existing and future seeded FELs worldwide

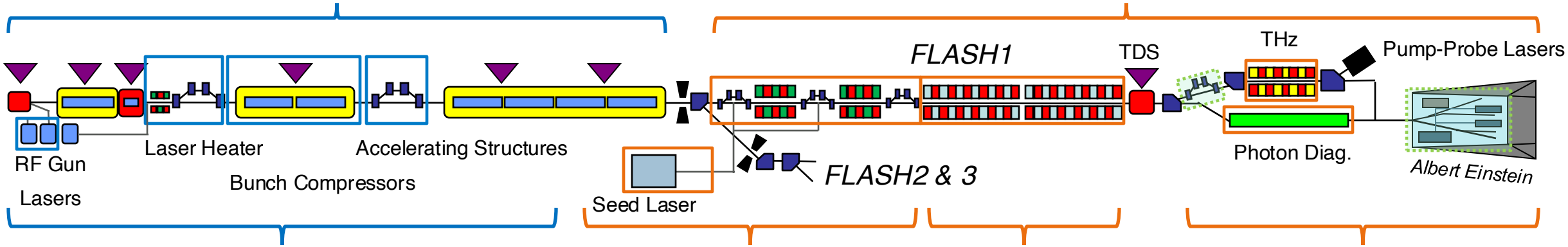
Phys. Rev. Accel. Beams 27, 110705, 2024

FLASH & FLASH2020+

Fully coherent beams at MHz rep. rate

Finished: Linac successfully upgraded & operational

Now: Externally seeded pulses & variable polarization



Increased energy and beam quality

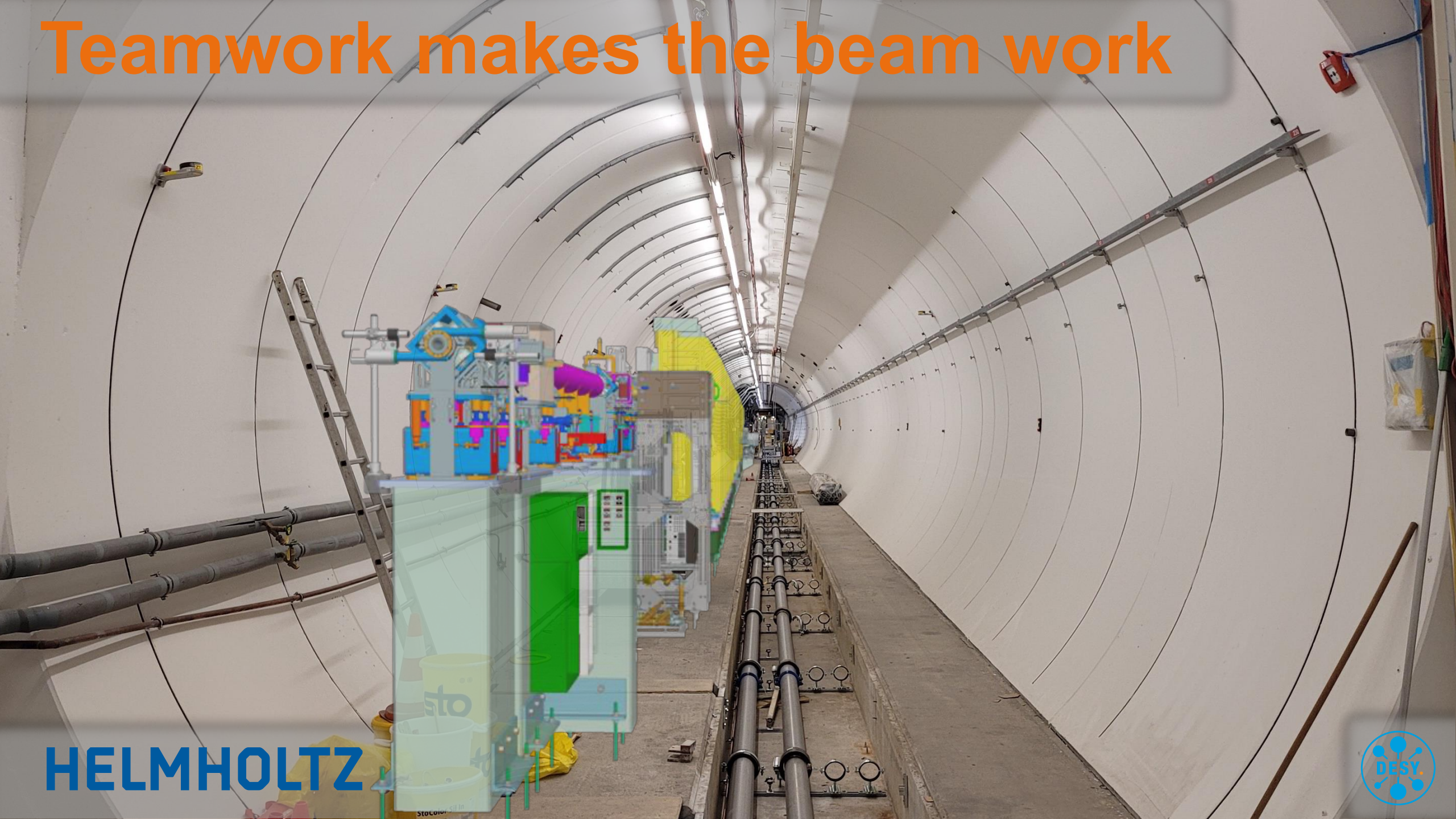
Ultra stable high rep rate seed laser & seeding section

Polarisation adjustable radiator chain

New experiments with fully coherent pulses

Strategy: Maximize scientific output deploying short- & mid-term upgrades

Teamwork makes the beam work



HELMHOLTZ

DESY.

Agenda

Start	End	Topic	Speaker	Duration
10:00	10:15	Welcome + Agenda		15‘
10:15	10:45	Project Update	Lucas Schaper	20‘+10‘
10:45	11:15	Shutdown Schedule & Infrastructure	Olaf Rasmussen	20‘+10‘
11:15	11:45	Electron Beamline Installation	Christopher Gerth	20‘+10‘
11:45	12:15	Photon Diagnostics Update	Sven Toleikis	20‘+10‘
12:15	13:15	Lunch Break		60‘
13:15	13:45	Seed Laser & Laser Transport	Ingmar Hartl	20‘+10
13:45	14:15	Update on Sub-synchronisation	Sebastian Schulz	20’+10
14:15	14:45	Seeding Update	Pardis Niknejadi	20’+10
14:45	15:00	Discussion and AOB	Lucas Schaper	15’