

FLASH2020+

12th Progress Review Meeting

Welcome

Lucas Schaper

On behalf of all people contributing to the success of FLASH2020+
Hamburg, 18.10.2024

HELMHOLTZ



Agenda

Start	End	Topic	Speaker	Duration
10:00	10:15	Welcome + Agenda	Franz Kärtner Wim Leemans Lucas Schaper	15'
10:15	10:40	Project Update	Lucas Schaper	20'+5'
10:40	11:05	Shutdown Schedule & Infrastructure	Olaf Rasmussen	20'+5'
11:05	11:30	Electron Beamline Installation	Christopher Gerth	20'+5'
11:30	11:55	Undulators	Kathrin Götze	20'+5'
11:55	12:05	Motivation	Markus Gühr	10'
12:05	13:05	Lunch Break		60'
13:15	13:45	Laser Systems	Tino Lang	20'+10
13:45	14:15	Updates on Seeding	Pardis Niknejadi	20'+10
14:15	14:30	Discussion and AOB	Lucas Schaper	15

FLASH2020+

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Project Update

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FLASH

Accelerator - Lasers - Photon Science

FLASH2020+

Organization

- Machine coordinator: Mathias Vogt (interim)
→ Please include in all discussions on safety and operational aspects!
- Radiation SOs: Juliane Roensch-Schulenburg & Arne Brinkmann
- Laser SO: Maximilian Falke
- Katja H. (WP M3) available again 😊
Coordinating getting FLASH back in operation

Shutdown schedule → Olaf Rasmussen



FLASH2020+

Staged upgrade approach

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 Source

Short term upgrades

Flexible pump-probe lasers
New beamlines
THz Source

Mid term upgrades

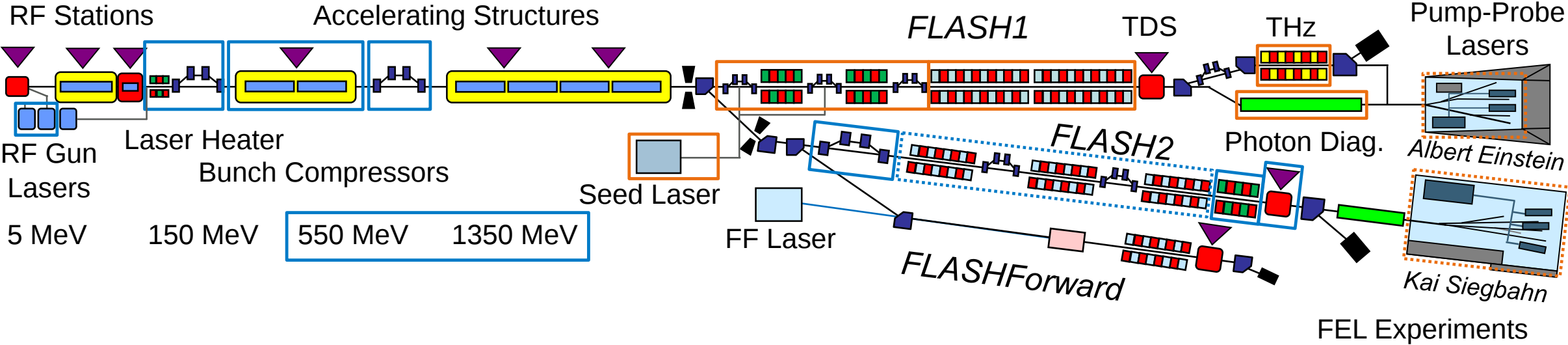
New undulator schemes (FLASH2)
New lasing concepts (FLASH2)

Realized (mostly) in
shutdown in 2021 & 2022

Currently in shutdown
Restart: August 2025



New Sub-Synch
Sub 50 fs FWHM demonstrated



Increased electron beam quality

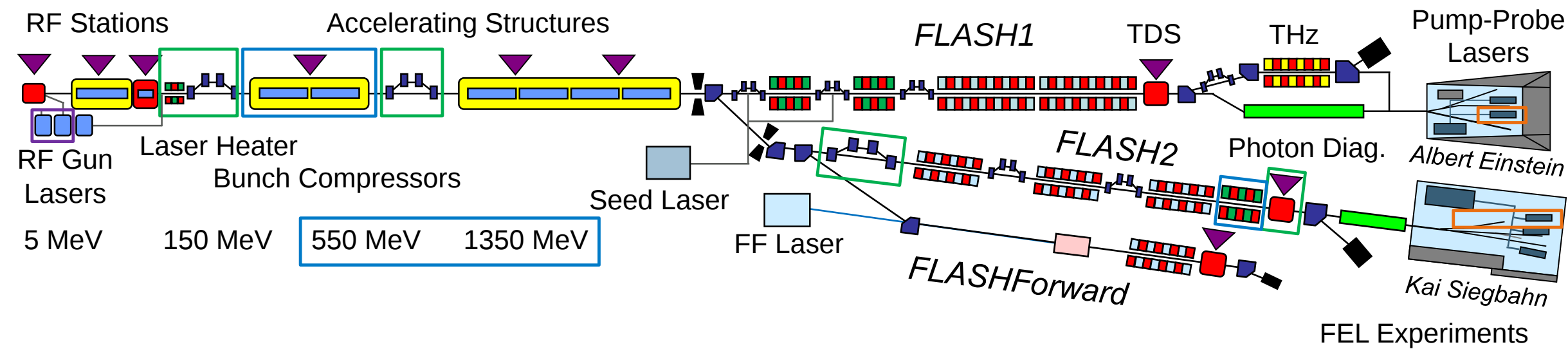
New user experiments already benefit of the enhanced parameter range

Linac upgrade: *Finished*

3rd BC FLASH2
New BCs (linac)
Laser heater
Fast orbit correctors
TDS (FLASH2)

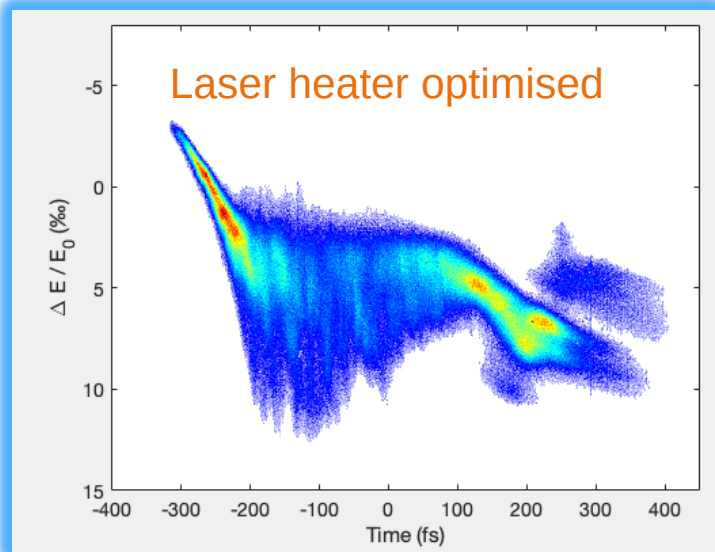
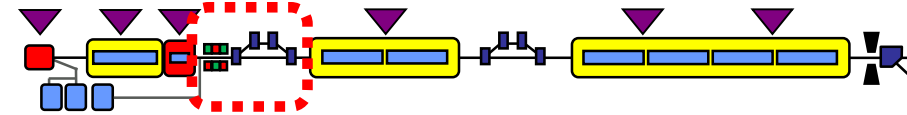
Injector laser
Energy upgrade
Afterburner FLASH2
New beamline FL23 (FLASH2)
Interim P-P laser (FLASH1)

- ✓ Improved electron beam & diagnostics
- ✓ Adds new operation modes
- ✓ Increases parameter range
- ✓ Enables new experiments

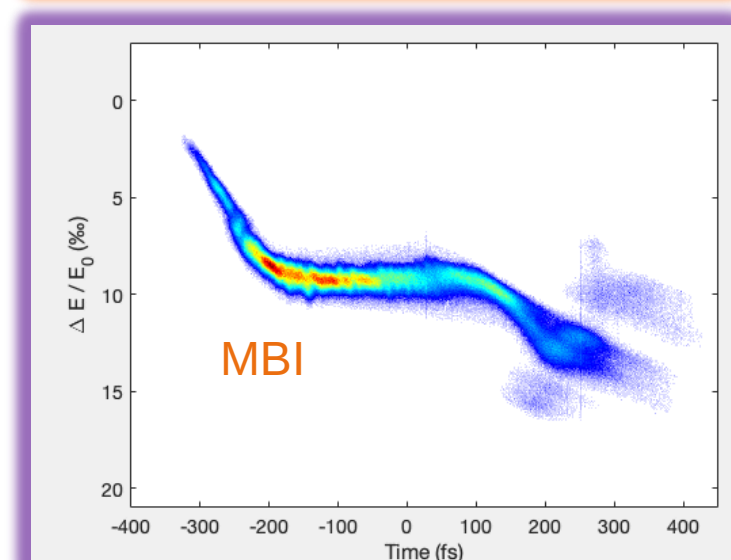
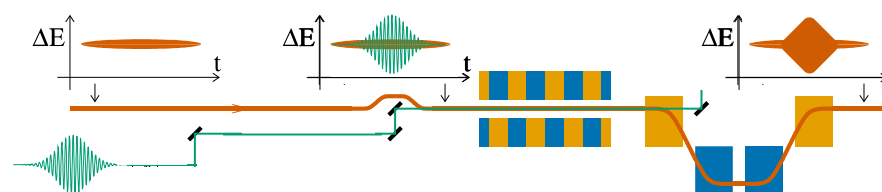
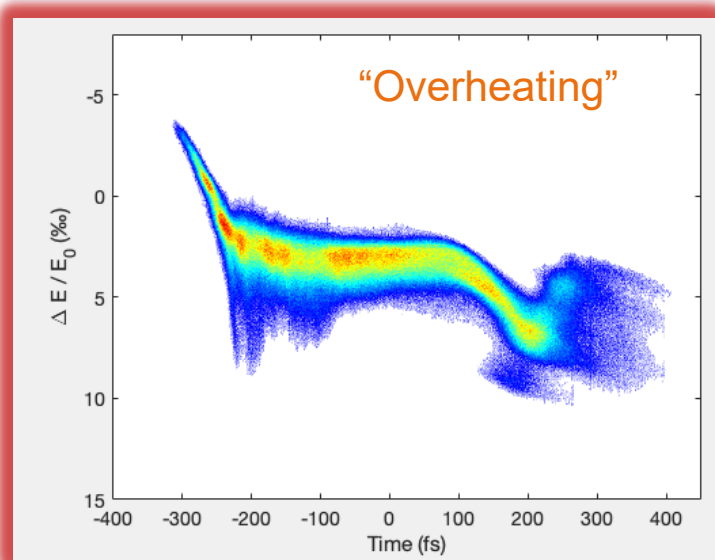
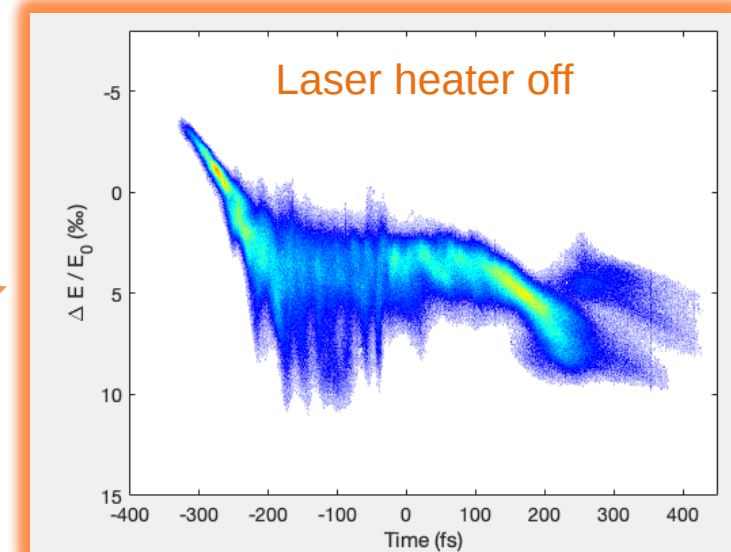
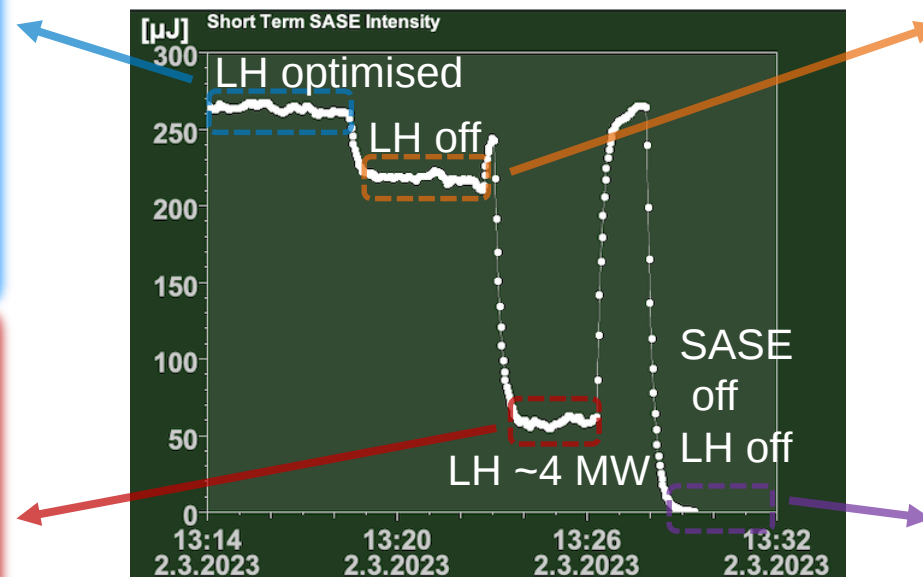


Laser heater in (regular*) user operation

Single pulse heating for stability and increased SASE performance

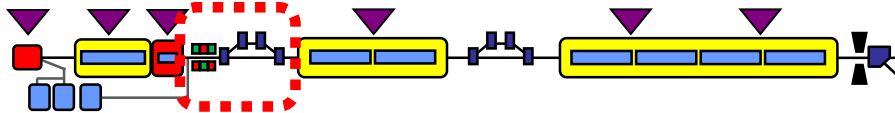


*Only few selected experiments
Controls for standard operation
need finalization

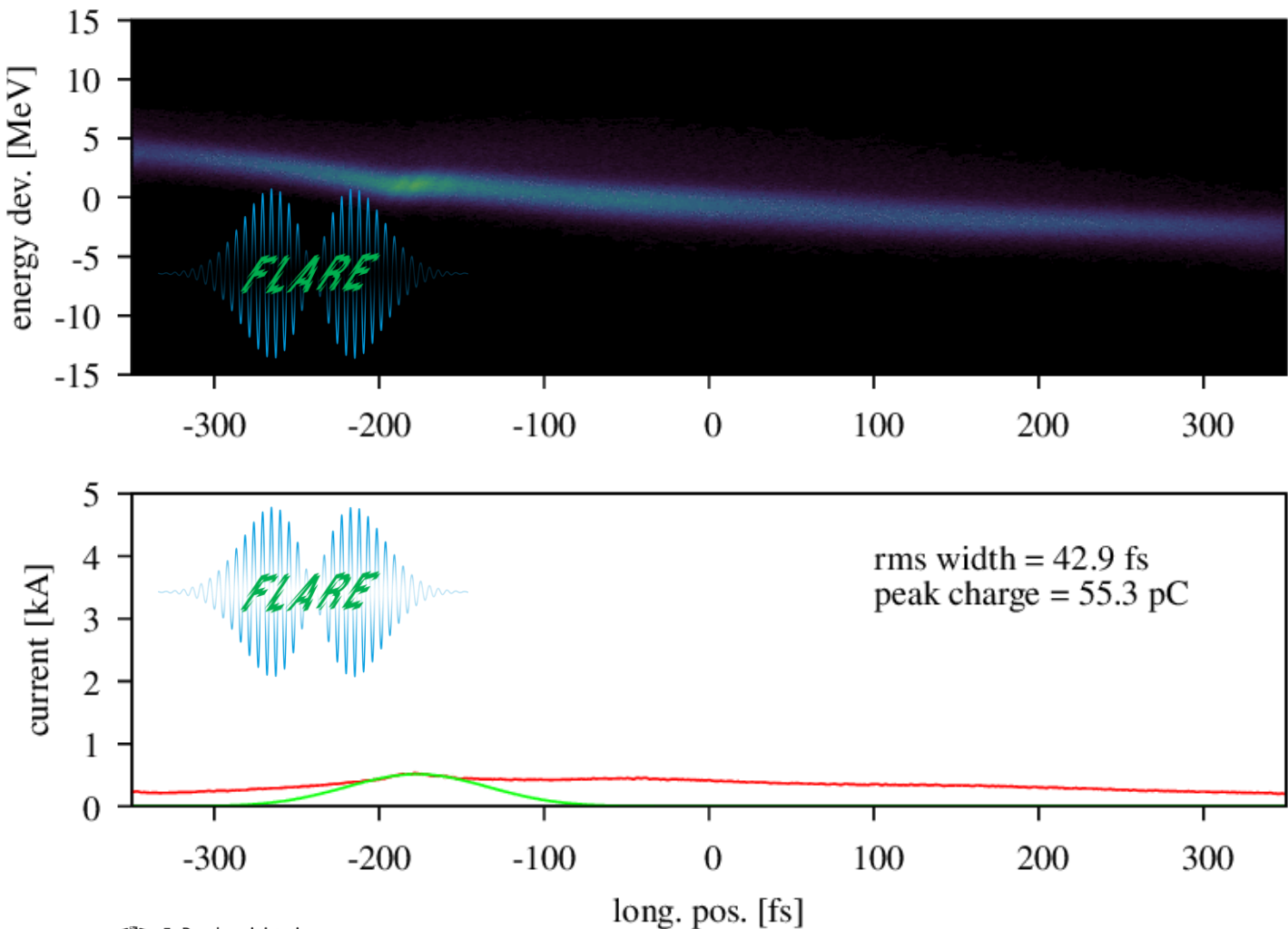
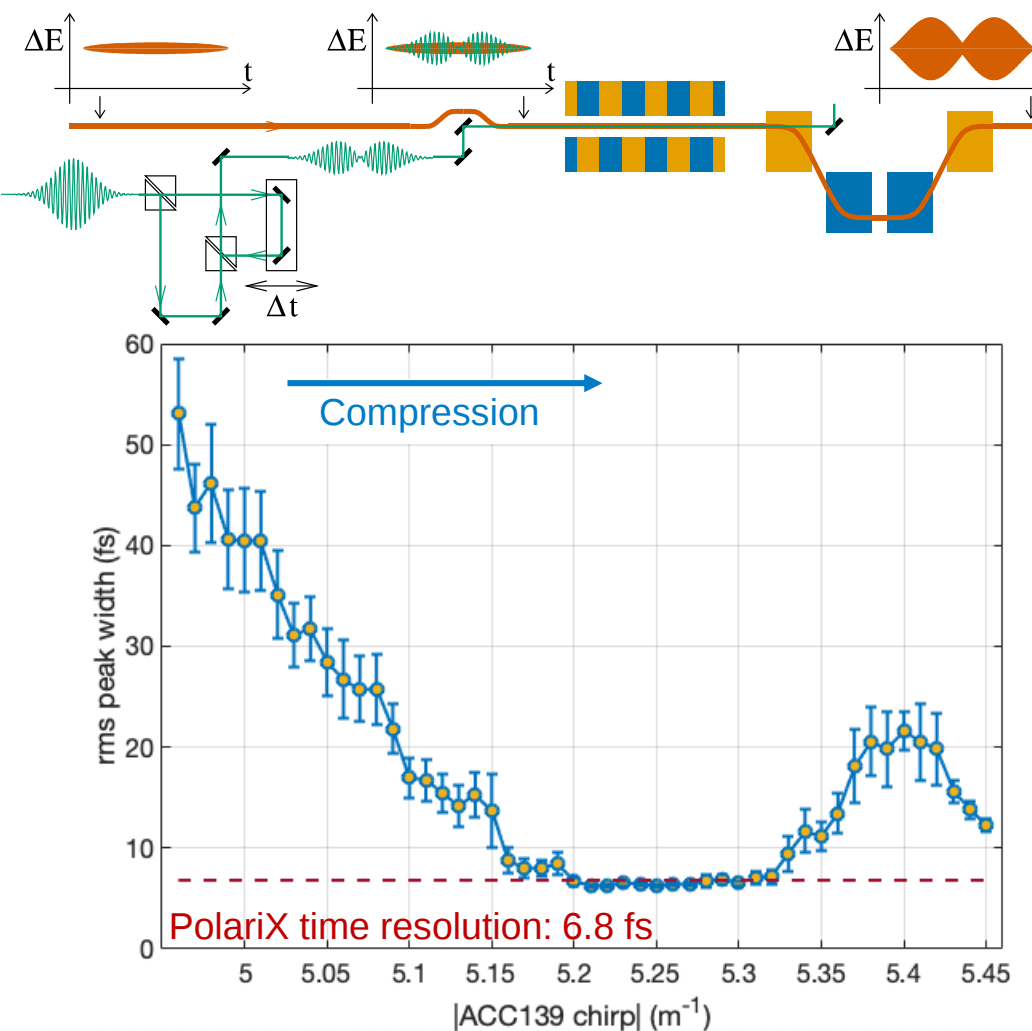


Variable pulse duration by laser heater

Sub 7 fs pulses beyond 5 kA



P. Amstutz et al: Towards short-pulse generation
FLASH via laser-assisted electron bunch manipulation
DOI: [10.18429/JACoW-IPAC2024-MOPG65](https://doi.org/10.18429/JACoW-IPAC2024-MOPG65)

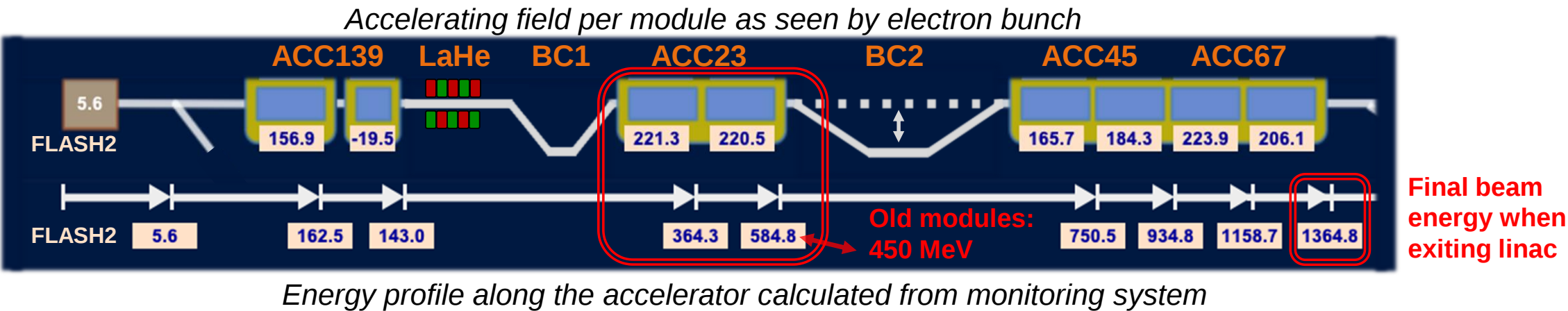
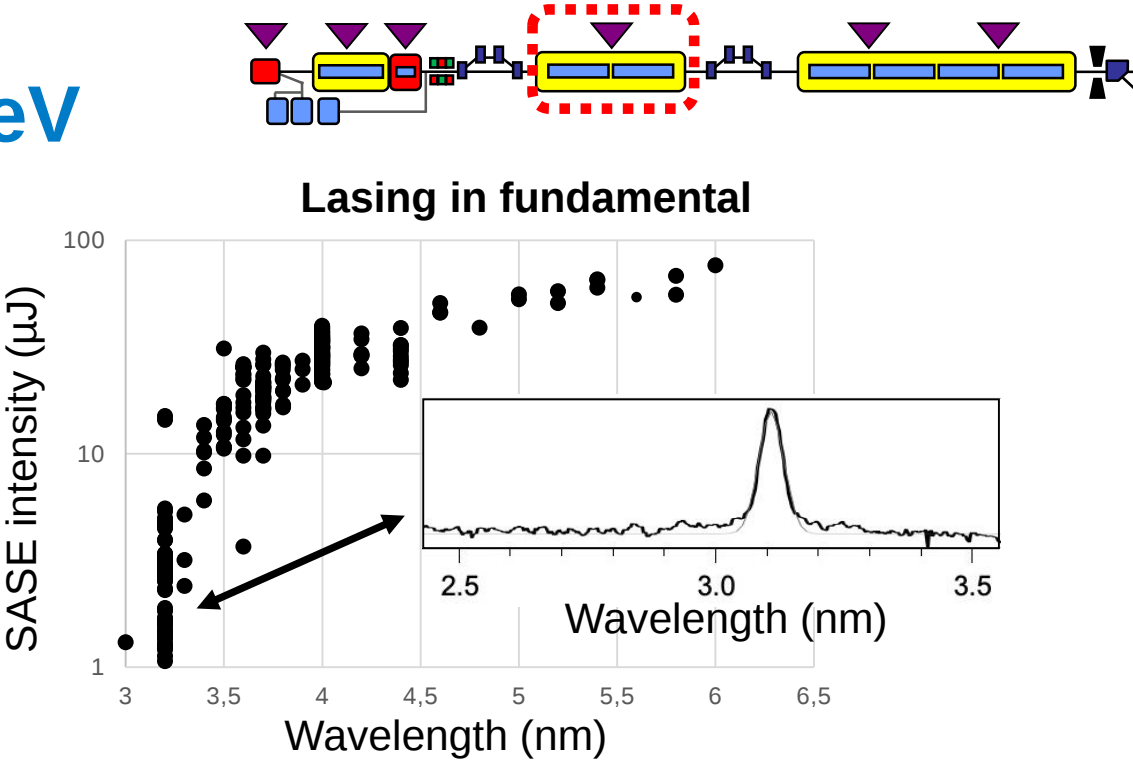


Exceeded design energy of 1350 MeV

Highest gradient operation at nominal RF flattop length

Brilliant performance of new modules ACC23

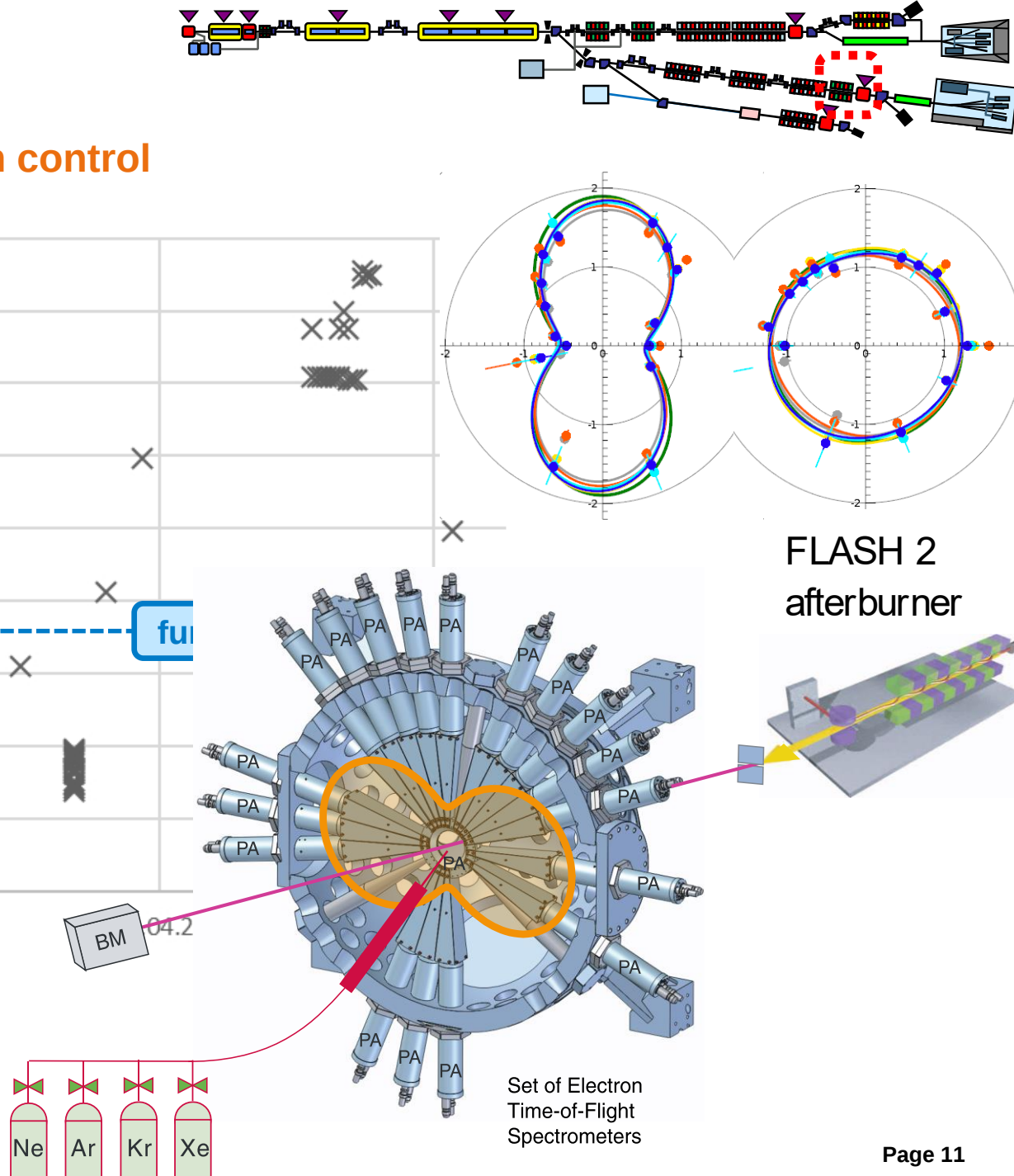
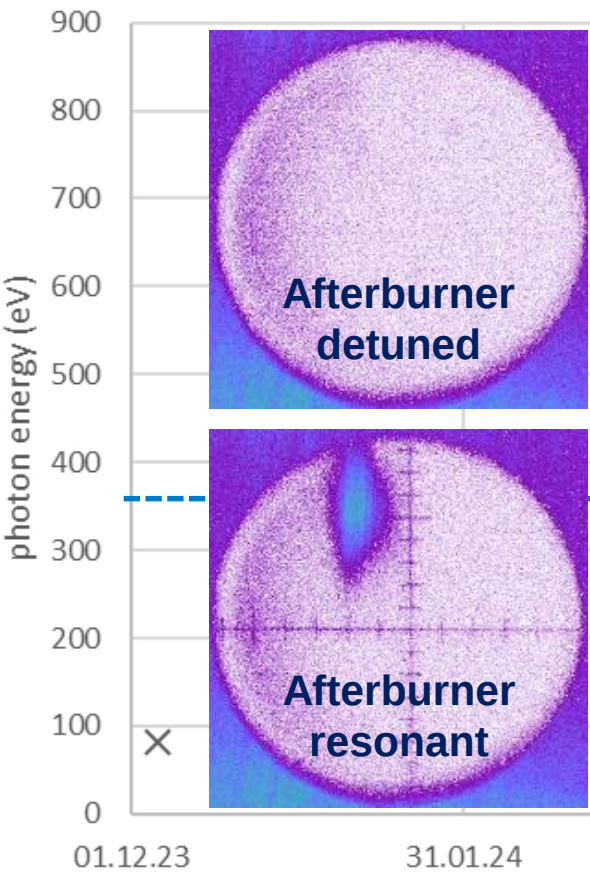
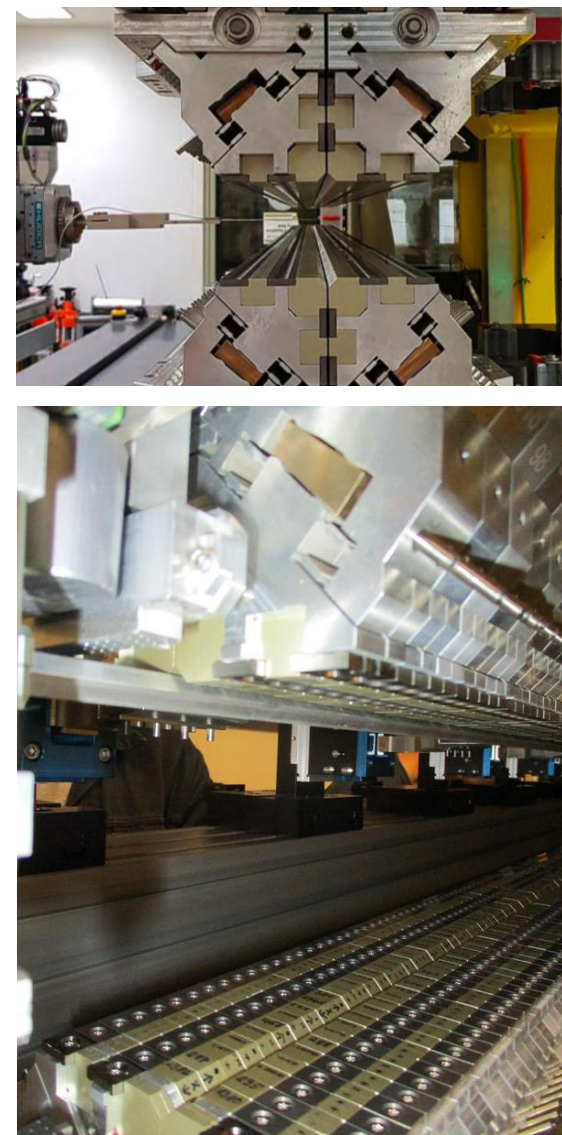
- > 28.5 MV/m → overachieving design gradient
 - Excellent amplitude and phase stability
- Example given below is exceeding standard operation point



Stable operation at 1350 MeV & full RF flattop length possible ✓

Generation of shortest wavelength

Apple3 device for 3rd harmonic boost and polarization control



Main Mission: External Seeding

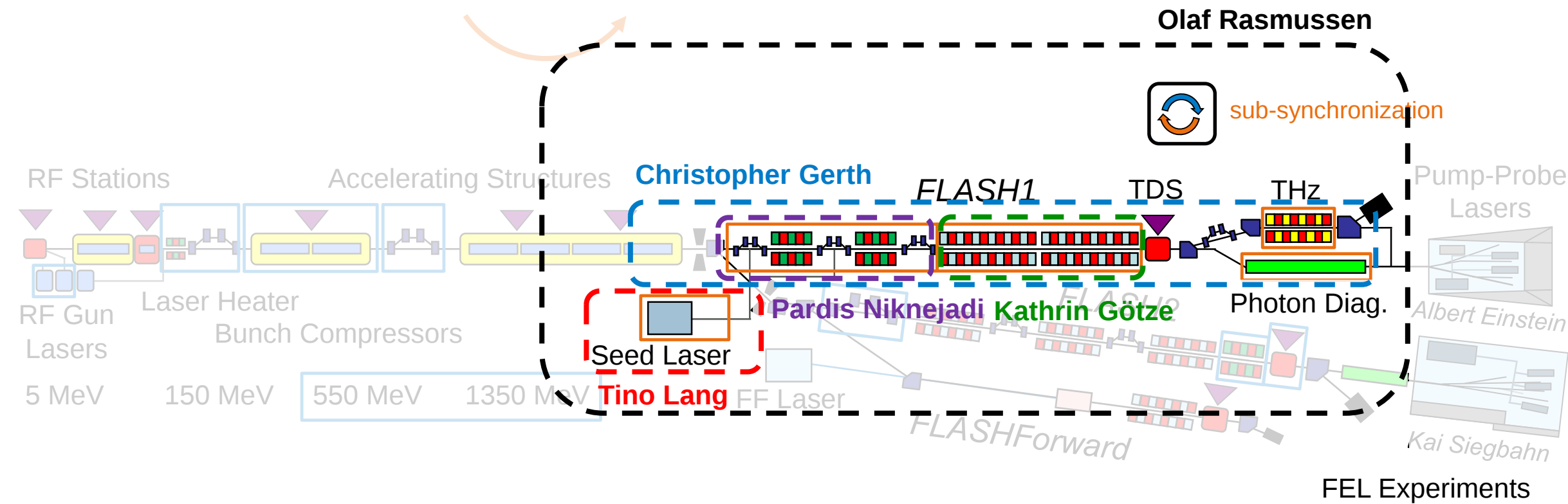
Goal: Deliver fully coherent soft x-ray photon pulses to users

Tackled

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)

Now: Seeding

High rep. rate seeding (FLASH1)
Photon diagnostics (FLASH1)
THz Source



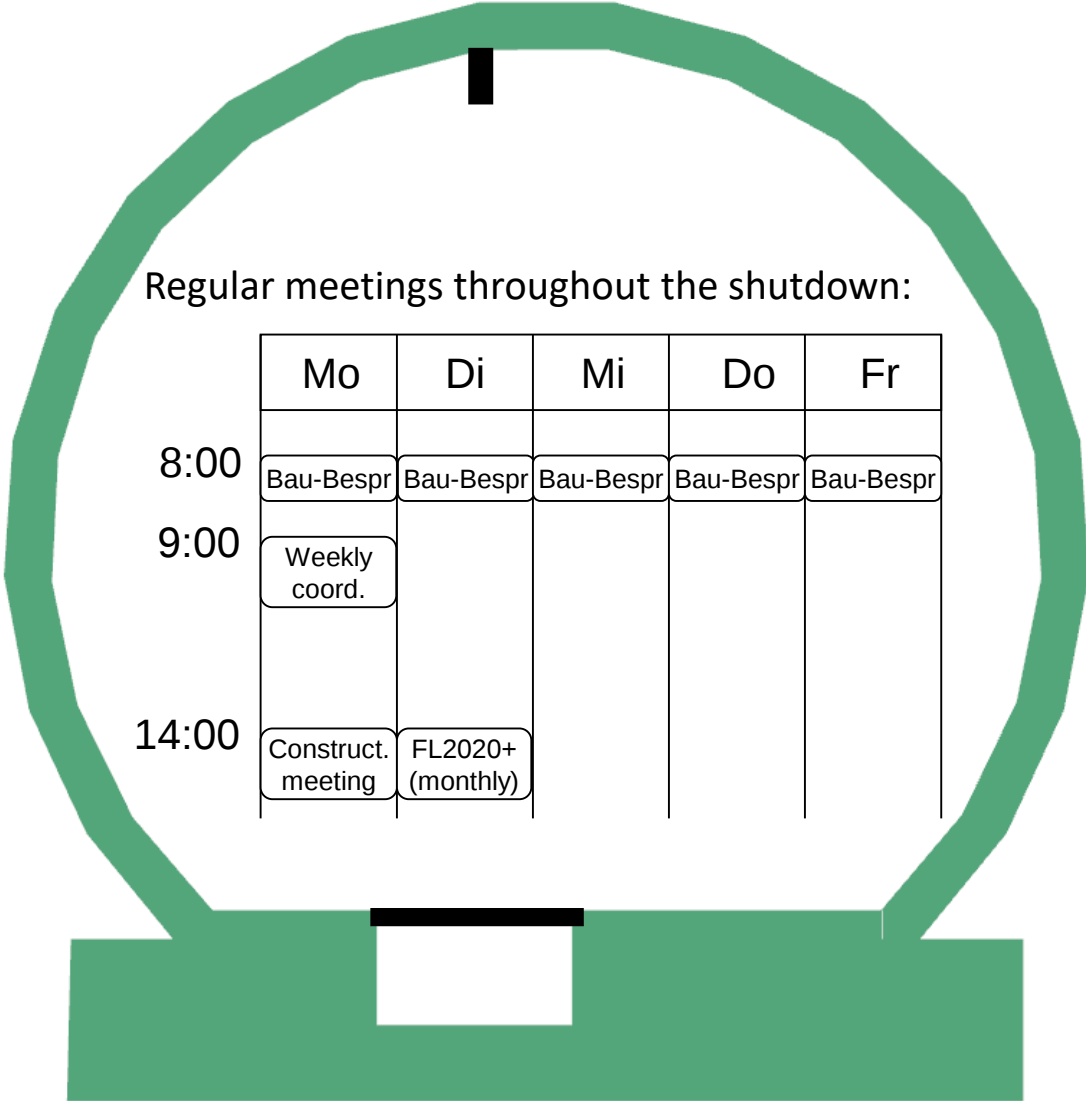
Tunnel is empty

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

Procedures with D3 for component removal worked well



FLASH2020+ : Shutdown impressions mid July

Removed photon diag



FLASH2020+ : Shutdown impressions mid August

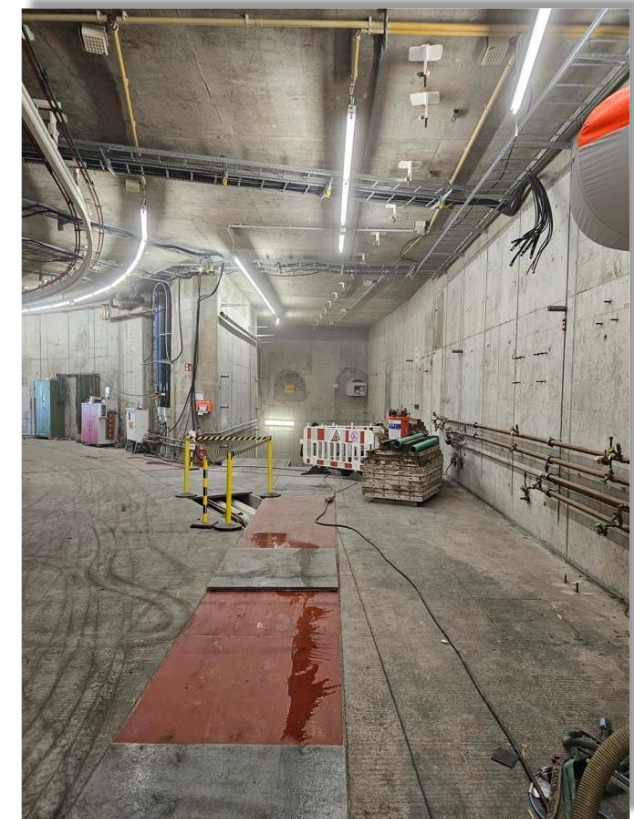
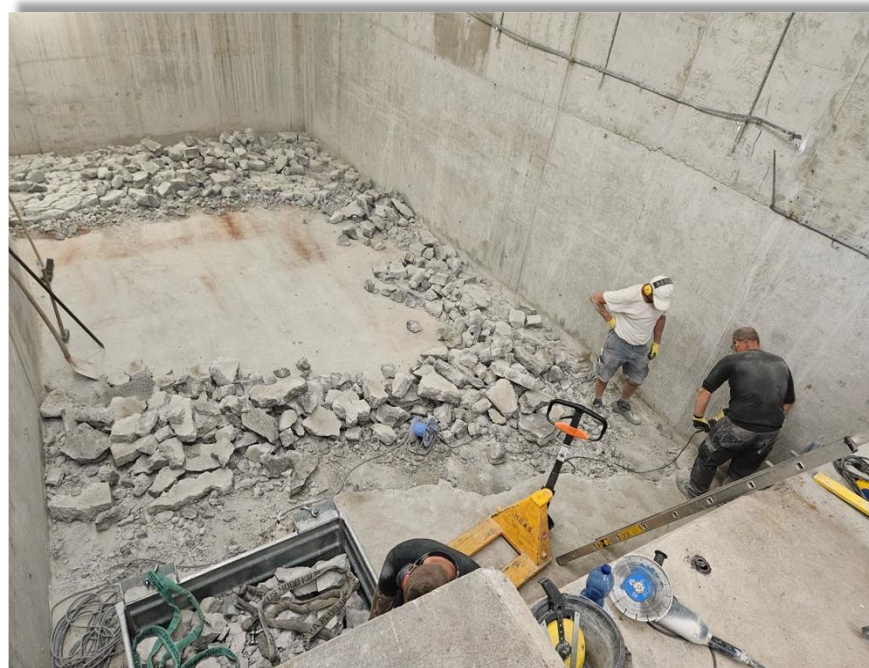
Further emptying tunnel



Please respect existing safety regulations

Avoid contamination!

FLASH tunnel remains radiation monitored zone, working on activated components (e.g. drilling into wall) needs D3 approval

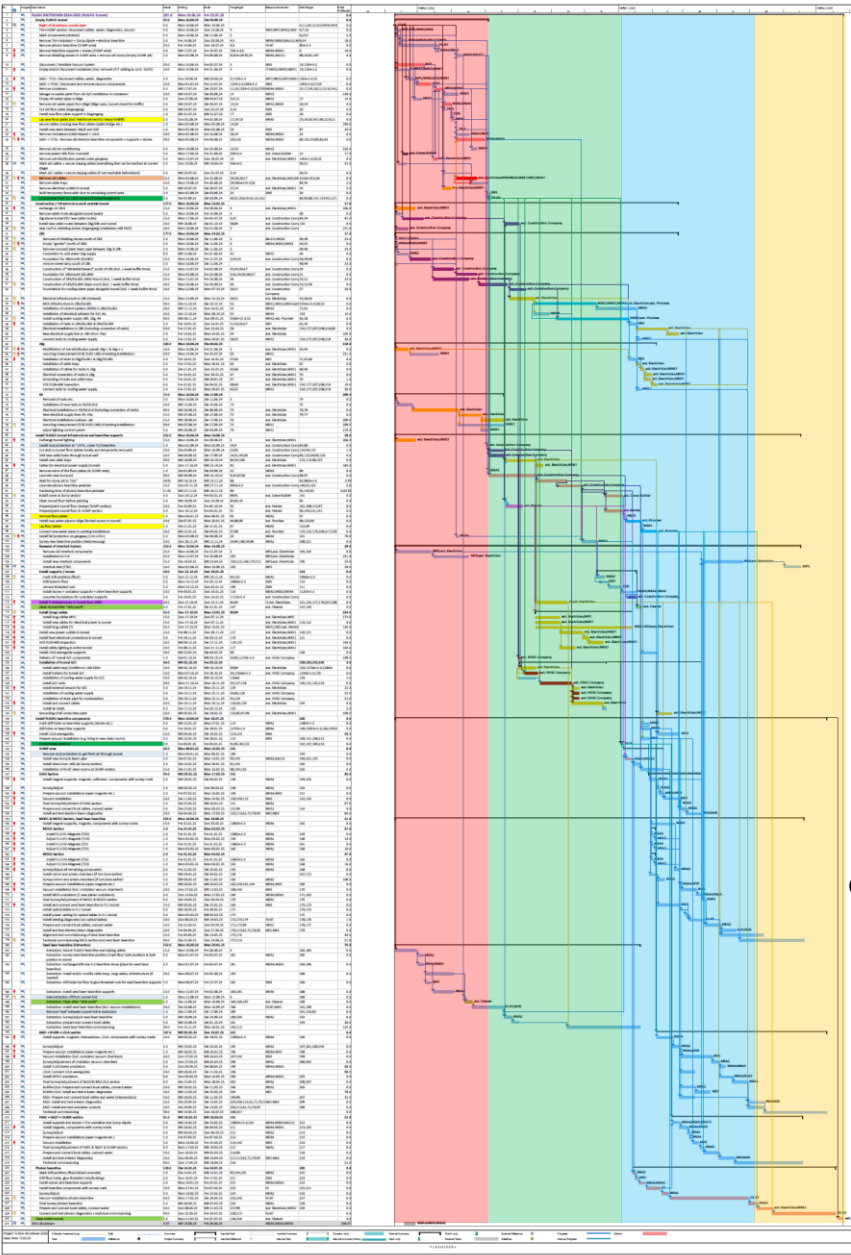


Shutdown on a tight schedule

Currently in construction phase

Rough overview: 4 phases

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



Post shutdown,
tunnel closed

FLASH1 commissioning

Linac commissioning

FLASH2 operation



Restart and commissioning

Cool down, interlock tests, conditioning, ...

Facility will go back into operation on 4th August 2025

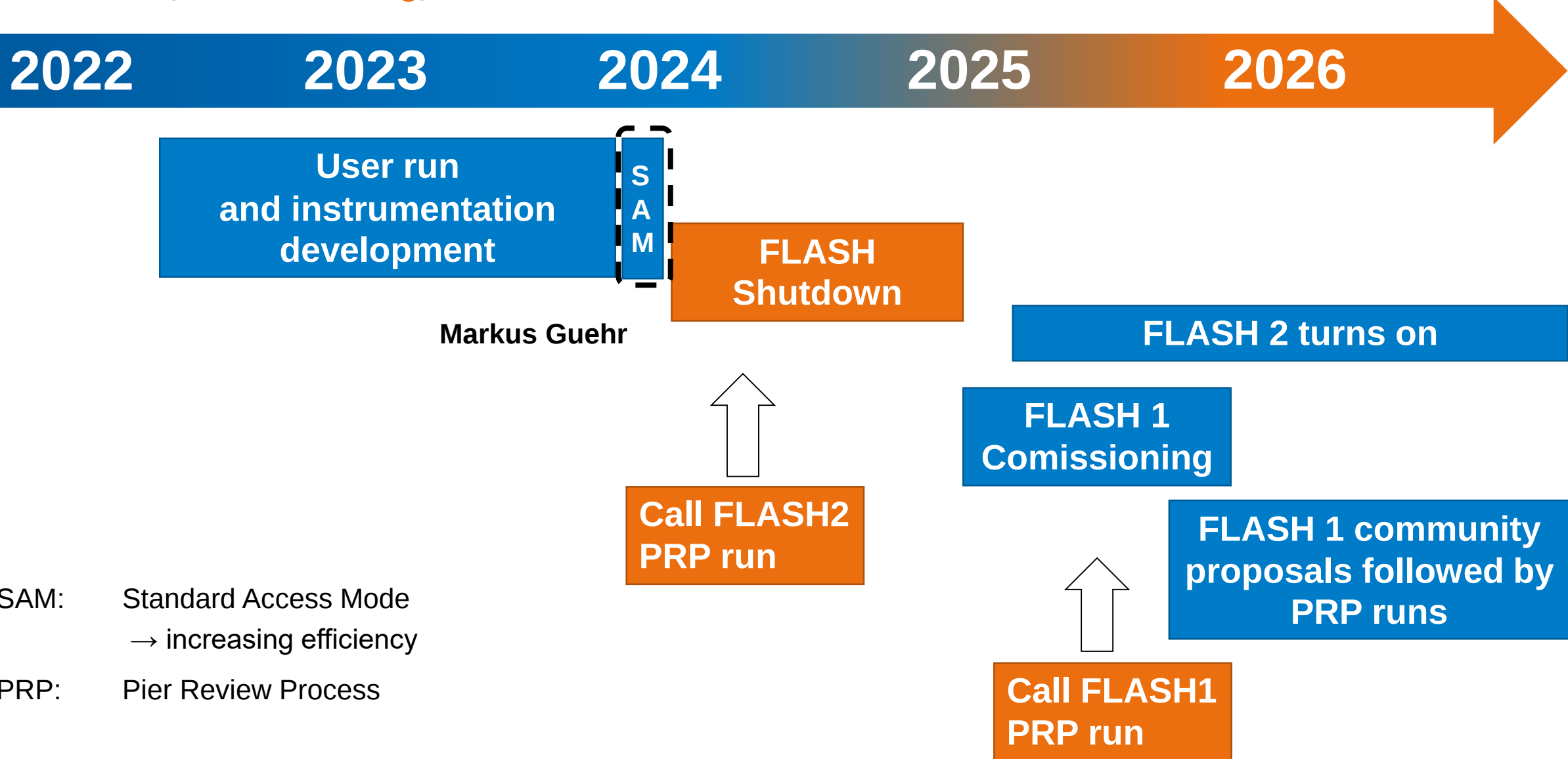
Started to develop plan for transition from shutdown into operations → We need **your** input → Planning: Katja & Juliane

2025	15	7-Apr - 13-Apr	Open		
2025	16	14-Apr - 20-Apr	Open		
2025	17	21-Apr - 27-Apr	Open		
2025	18	28-Apr - 4-May	Part-time Closed	Personnel Interlock pre-tests	
2025	19	5-May - 11-May	Open	Cool-down	Tunnel accessible (like warm-up) Regulations in next review meeting
2025	20	12-May - 18-May	Open	Cool-down	
2025	21	19-May - 25-May	Open	Cool-down	
2025	22	26-May - 1-Jun	Open	reserve	
2025	23	2-Jun - 8-Jun	Part-time Closed	Personnel Interlock "Generalprobe"	FL0 Magnets?
2025	24	9-Jun - 15-Jun	Open	RF-stations conditioning (load)	
2025	25	16-Jun - 22-Jun	Open	RF-stations conditioning (load)	
2025	26	23-Jun - 29-Jun	Part-time Closed	Personnel Interlock TÜV test	FL0 Magnets?
2025	27	30-Jun - 6-Jul	Open	Technical interlocks, waveguides, RF-stations (load), etc.	
2025	28	7-Jul - 13-Jul	Open	Technical interlocks, waveguides, RF-stations (load), etc.	
2025	29	14-Jul - 20-Jul	Open, Closed Fri-Sun	RF-gun conditioning (Fri-Sun)	Optional: Cavity tuning, RF to Modules (Fri-Sun)
2025	30	21-Jul - 27-Jul	Open, Closed Fri-Sun	RF-gun conditioning (Fri-Sun)	Optional: Cavity tuning, RF to Modules (Fri-Sun)
2025	31	28-Jul - 3-Aug	Open, Closed Fri-Sun	RF-gun conditioning (Fri-Sun)	Optional: Cavity tuning, RF to Modules (Fri-Sun)
2025	32	4-Aug - 10-Aug	Closed	Cavity tuning, Cavity/Coupler conditioning, LLRF w/o beam, Magnet tests, RF-gun	
2025	33	11-Aug - 17-Aug	Closed	Start beam operation, LLRF with beam, Magnet tests	
2025	34	18-Aug - 24-Aug	Closed	Commissioning with beam, Magnet tests	

For commissioning tasks: Please send request via <https://zeitplaene.desy.de/e334422/e334423> deadline 16 Nov 2024

Near term facility trajectory

Shutdowns, commissioning, calls & user runs

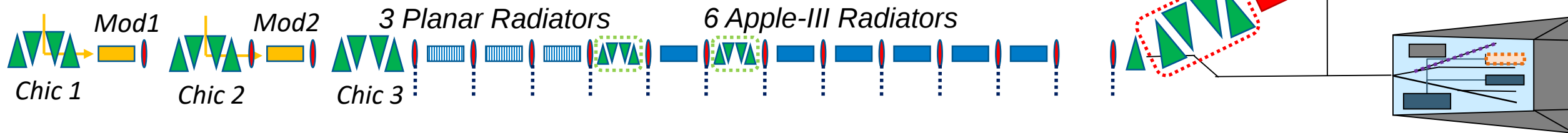


New near term upgrades

Unlocking additional capabilities in near future

Overall financial situation at DESY benefits of using of the FLASH invest budget 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



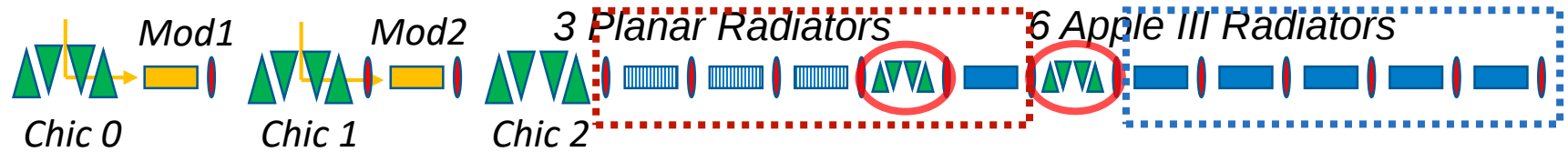
- **THz bunch compressor :** Allows to generate 3 orders of magnitude more intense THz radiation
- **New beamline FL11 :** Higher transmission for shortest wavelength
- **P-P laser MOD1 :** Adds high intensity pump probe capabilities for new FL11
- **Wireshcanners :** Optimizing performance of undualtor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

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

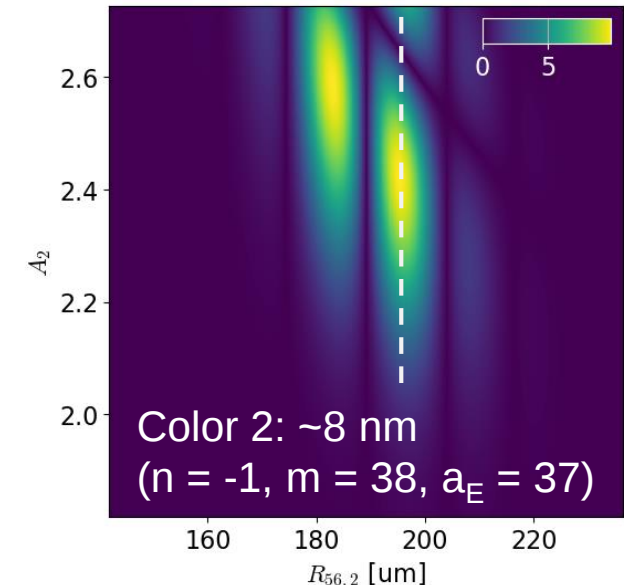
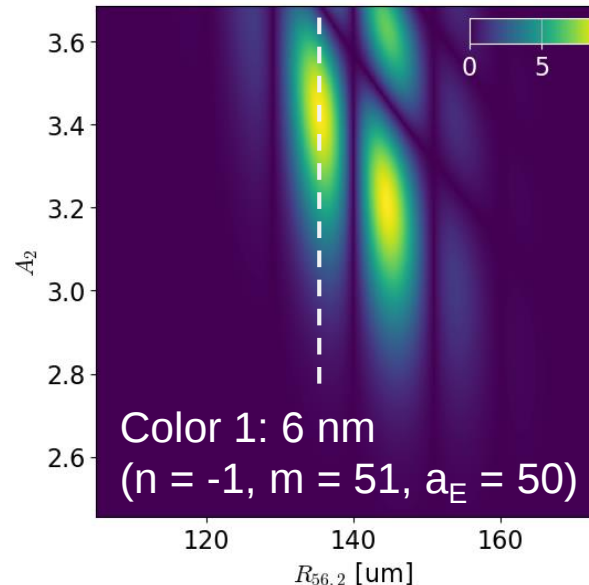
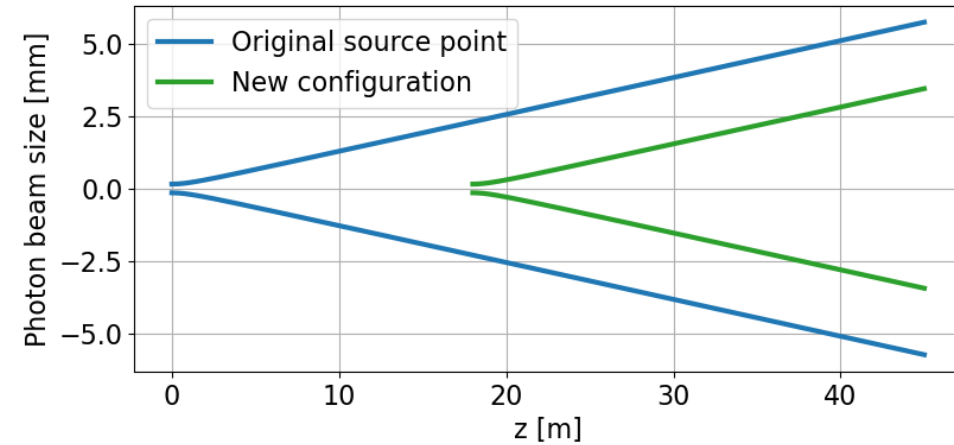
More details in presentations in the next progress review meeting

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



FLASH & FLASH2020+

Enabling next generation experiments



DAYS TO GO

289

Priority: Externally seeded pulses & variable polarization
After: Get machine in operation & deliver beam to users

> Currently in shutdown
 > Start-up: August 2025

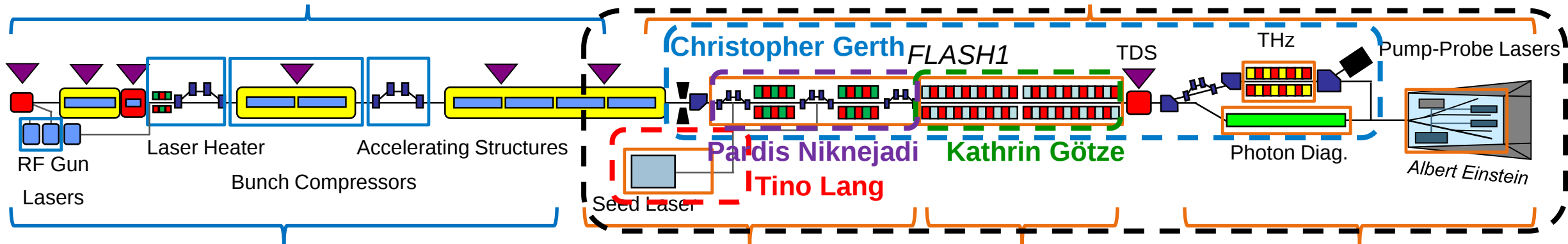
- > Reduced shortest wavelength to 3.2 nm in fundamental and 1.4 nm in 3rd harmonic
- > Unlocked user selectable **variable polarisation** at FLASH2
- > Short pulses & reduced microbunching via laser heater → e-beams suitable for seeding
- > **Tunnel emptied**, on a tight schedule for installation & restart



Successfully upgraded & in user operation

Current installations

Olaf Rasmussen



Increased energy and beam quality

Ultra stable high rep rate
seed laser &
seeding section

Polarisation
adjustable
radiator chain*

New experiments with
fully coherent pulses

Thank you for all your hard work

Questions ???

Contact

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