

# FLASH2020+

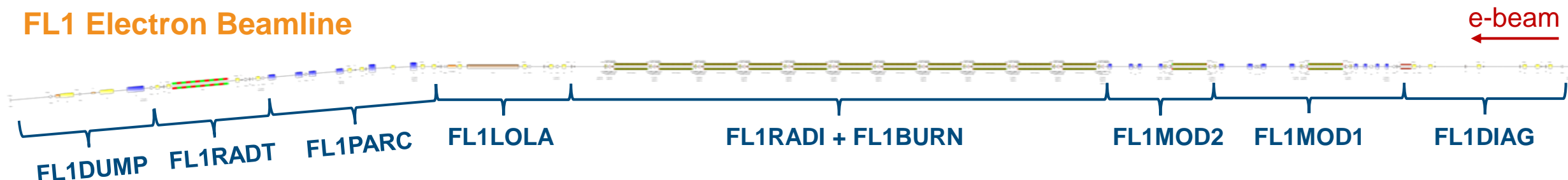
# Progress Review

FL1 Electron Beamline (Installation)

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08-March-2024

# Introduction

## FL1 Electron Beamline



FL1 Beamline is divided into **sections** according to their (physics) **functionality**.

Organisation similar to FL0 Beamline in last shutdown:

- **Documentation** in Confluence Space “**FLASH2020+ Machine**”
  - FL1 beamline **sections** (shutdown 2024/2025 = “**STAGE\_0**”):
    - <https://confluence.desy.de/display/FLM/FL1+Beamline>
    - Lattice List, Overview Drawing, Vacuum String, MBOM
  - Overall **mechanical design** by ZM: **Konstruktionsmeeting** Mondays at 14:00
    - <https://confluence.desy.de/display/FLM/Monday-Meeting%3A+Konstruktionsmeeting>
    - **section reviews** to freeze and release lattice parts
  - Hand-over of **vacuum parts** from ZM to MVS
    - <https://confluence.desy.de/display/FLM/FL1+Vakuum>
- **Note:** No information on installation timeline
  - see Shutdown Meetings (next 19.03.24, 10:00)
  - Documentation in Confluence Space “**FLASH Operation**” => FLASH Shutdown 2024/2025



# FL1DIAG

[Link to FL1DIAG](#)



**e-beam preparation** (diagnostics, matching and collimation) for seeding sections (FL1MOD1 and FL1MOD2)

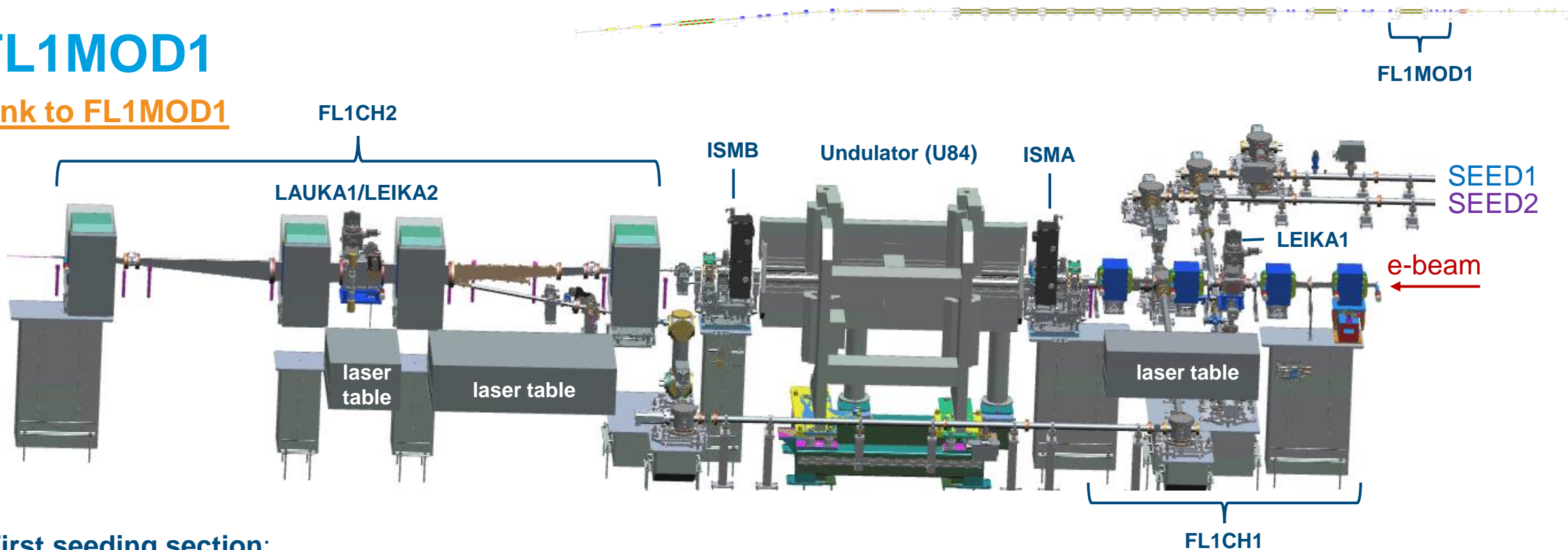
- “standard” beamline components and supports (note: access from rear side limited due to FL2 beamline)
- **Last component** that stays in the tunnel: beam shutter **4TCOL at 148 m**
- First 10 concrete supports (after septum) are shared with FL2 beamline and remain (marked with blue tape **#01 - #10**)

## Status:

- Section review finished: Lattice parts are frozen and released ✓
- The two long vacuum chambers are finished soon, all other vacuum parts are ready for hand-over to MVS

# FL1MOD1

[Link to FL1MOD1](#)



## First seeding section:

Most complex section as both SEED laser beamlines coming from Extract area cross both e-beamlines (FL2 not shown) and are coupled into the e-beam vacuum.

- In-coupling of **SEED1** laser in **FL1CH1** chicane (**LEIKA1**), energy modulation in **undulator** (planar U84), density modulation and out-coupling of **SEED1** laser in the **FL1CH2** chicane (**LAUKA1**).
- Two intersections (**ISMA/B**) with view screens to establish overlap between e-beam and **SEED 1** laser
- In addition, in-coupling of **SEED2** laser in **FL1CH2** (**LEIKA2**)

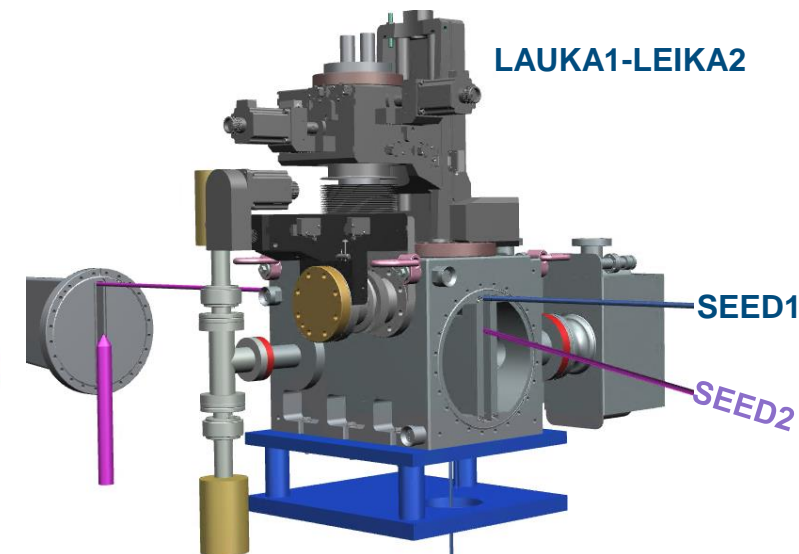
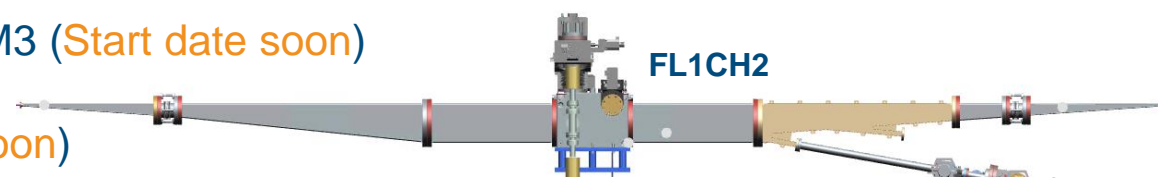
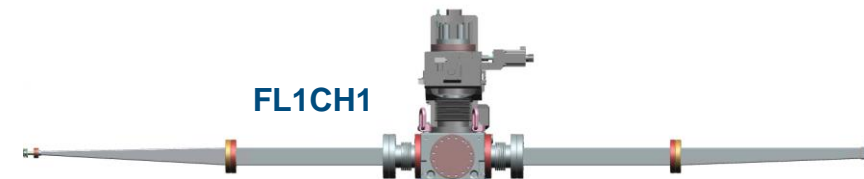
**Status:** Section review open, several "gaps" are obvious ... status sub-components see next page



# FL1MOD1

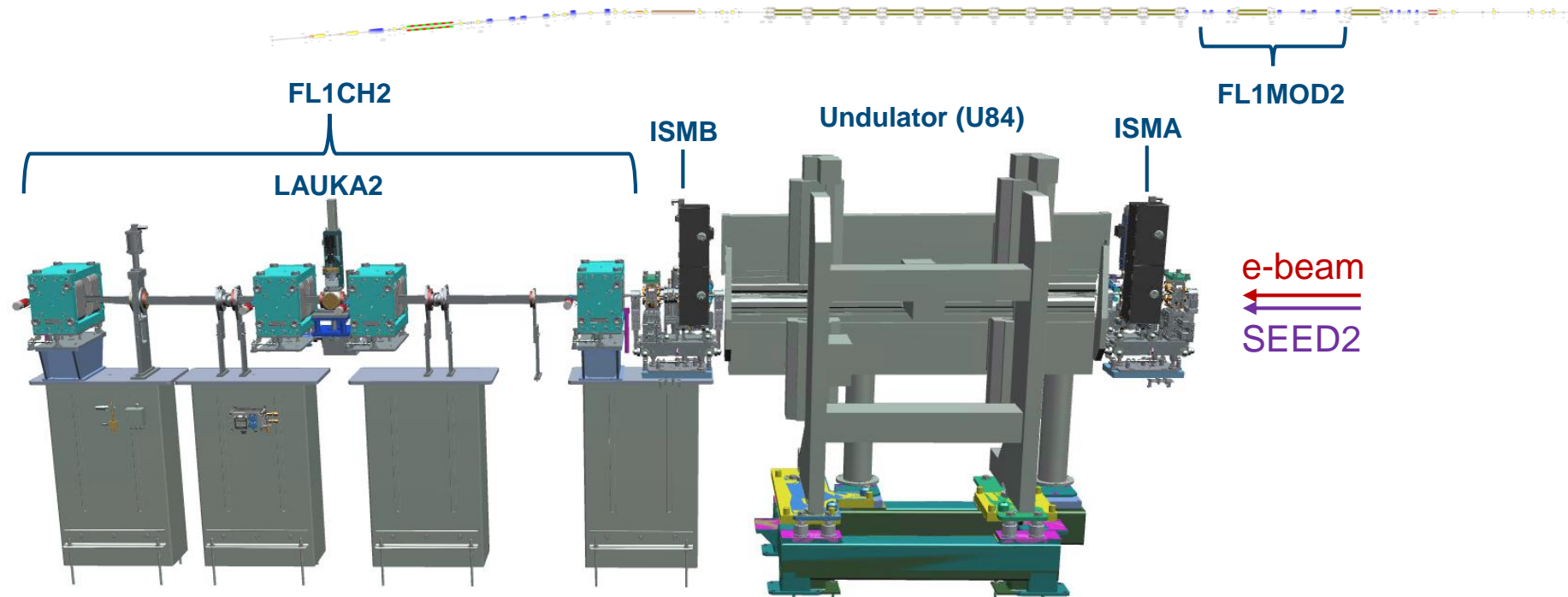
## Status of Sub-components

- Chicane Dipole Magnets
  - FL1CH1 (TDK): call for tender till 04.04.24, delivery time ~ 12 months
  - FL1CH2 (TDI): In fabrication (delivery date Jan 25, Feb 25 RFI)
- Chicane Vacuum Chambers
  - FL1CH1: 2 mm (sheet width) chambers fabrication at ZM3 (Start date soon)
  - FL1CH2:
    - 2 mm (sheet width) chambers at ZM3 (Start date soon)
    - 4 mm (sheet width) chambers external fabrication (deliver date 06.05.24 + welding flanges + copper plating)
  - LEIKA1 / LAUKA1-LEIKA2 external milling tests on-going (delivery time 16w from order)
- Undulator (planar U84)
  - Vacuum chamber: existing FLASH2 spare chamber
  - Magnet structure and support to be delivered in 05/24
- Two Intersections (Type ISMA/B)
- Supports
  - Mechanical design of many supports on-going due to complexity and interfaces between components
- SEED laser beamline:
  - see presentation of I. Hartl



# FL1MOD2

[Link to FL1MOD2](#)



## Second seeding section:

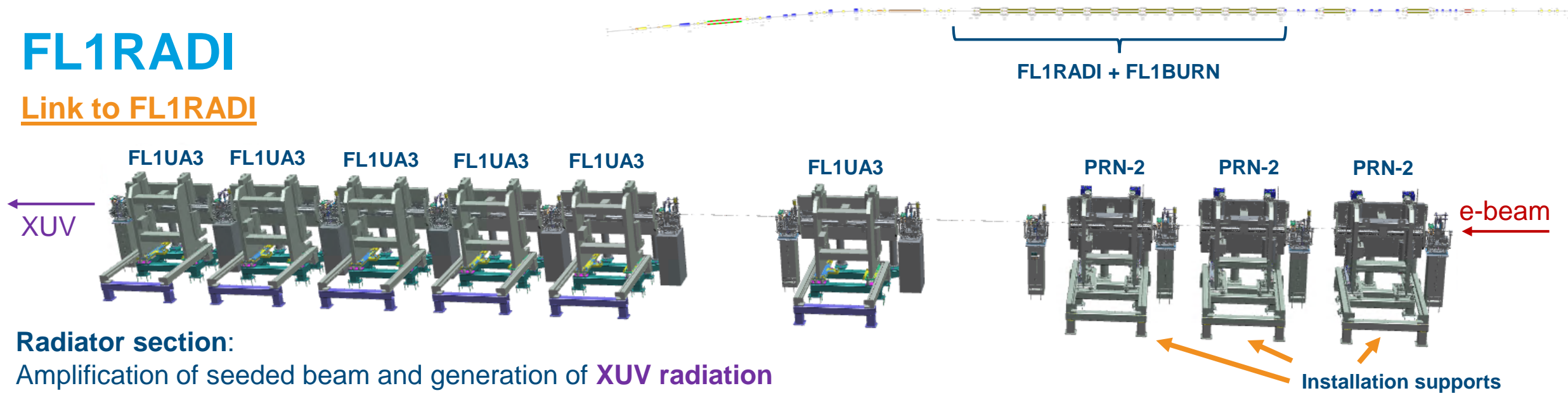
- Energy modulation in **undulator** (planar U84), density modulation and out-coupling of **SEED2** laser in the **FL1CH3** chicane (**LAUKA2**).
- Two intersections (**ISMA/B**) with view screens to establish overlap between e-beam and **SEED 2** laser

## Status: Section review still open

- Chicane Dipole Magnets
  - FL1CH3 (TDJ): existing EEHG dipole magnets get new poles (spare magnet for tests are in preparation)
- Chicane Vacuum Chambers
  - FL1CH3: 2 mm (sheet width) chambers fabrication at ZM3 (Start date soon)
  - LAUKA2: OTR station 6ORS to be re-used
- Modulator (planar U84) and two Intersections (Type ISMA/B) => see FL1MOD1

# FL1RADI

[Link to FL1RADI](#)



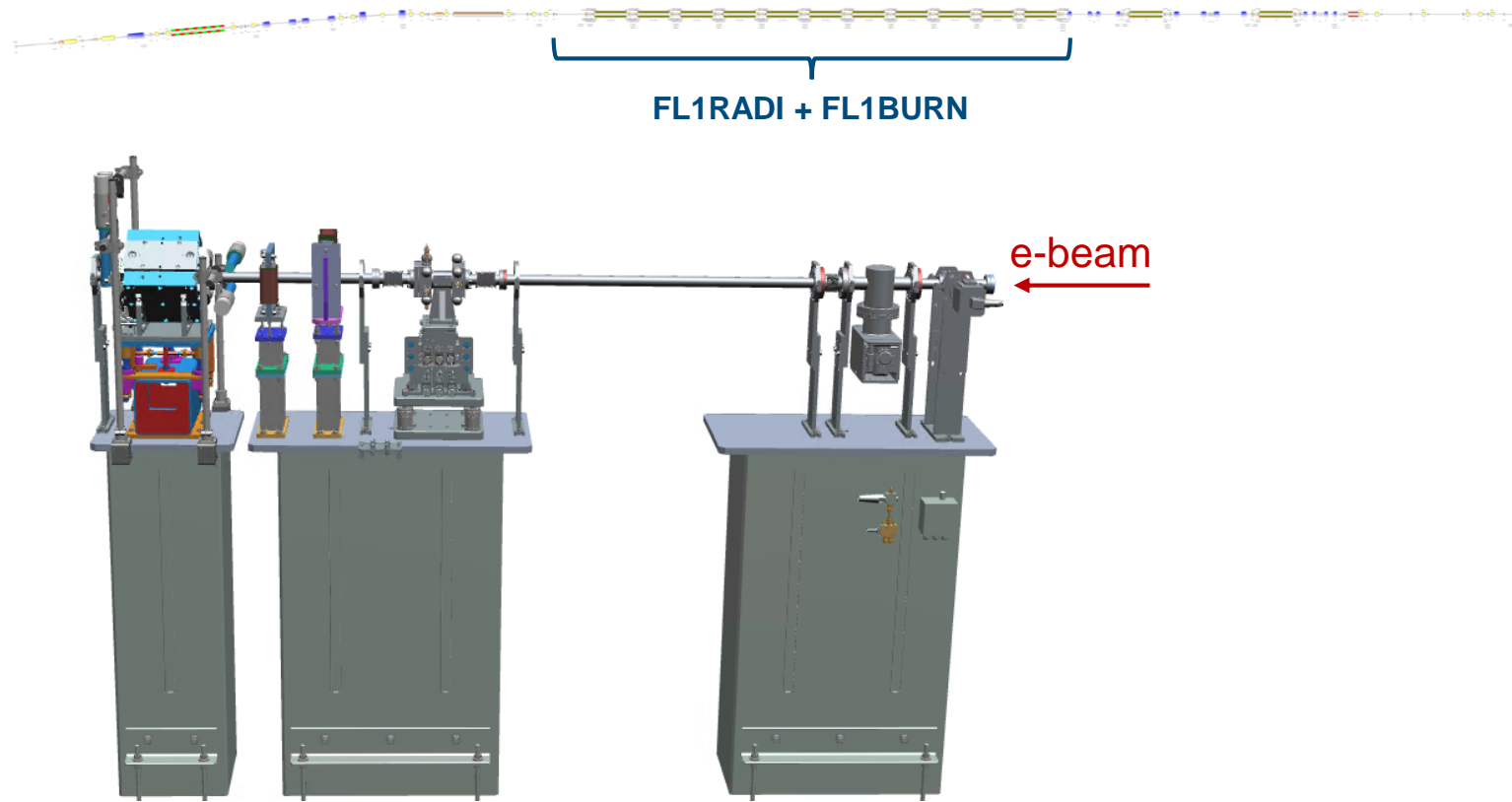
## Radiator section:

Amplification of seeded beam and generation of **XUV radiation**

- 11 (repetitive) radiator sections including 11 intersections (+ 1 additional intersection at the end)
  - Radiators:
    - 3 currently installed XSEED undulators (PRN-2, 2.0m long with vacuum chamber + 0.5 m copper tube)
    - 2 “empty” sections (2.5 m long copper tubes with 6 mm inner diameter, handed-over to MVS)
    - 6 new APPLE3 type undulators (FL1UA3, 2.5m long, vacuum chamber produced at MVS)
      - Support, main girder, linear motion, controls delivered by 06/24
      - **Magnet structure: call for tender out next week (serious estimate for RFI date only after call for tender)**
    - Installation: tricky procedure by pulling the undulator on the installation support
  - Intersections (600 mm):
    - 12 intersections (+ 4 in FL1MOD1/2) => several technical groups involved, organisational issue
    - 4 types (ISRA/B/C/D) of intersections (+ 2 more types ISMA/B in FL1MOD1/2)
    - Goal: Hand-over to MVS 04/24, pre-assembly and transfer measurement finished by start of shutdown
- **Status:**
  - Section review open, vacuum parts in good shape

# FL1BURN

[Link to FL1BURN](#)



## Afterburner section (3.2 m):

Placeholder for later installation of 3<sup>rd</sup> harmonic afterburner undulator

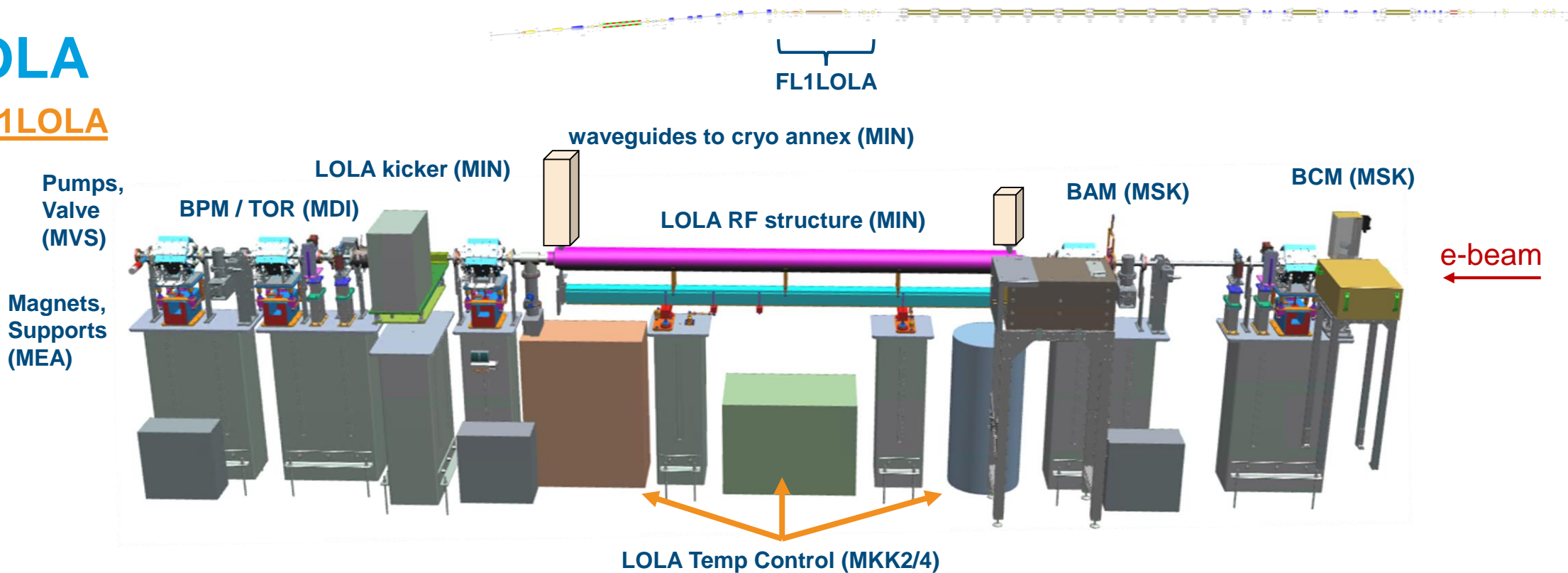
### Status:

- Section review finished: Lattice parts are frozen and released ✓
- All vacuum parts hand-over from ZM3 to MVS ✓



# FL1LOLA

[Link to FL1LOLA](#)



- **LOLA: Transverse deflecting RF structure:** Important electron beam diagnostics for seeding operation
  - “Microscope” to measure local current and energy spread => makes SEED laser and FEL process “visible”
  - Will be “moved” 35 m downstream from current position  $z = 192$  m to  $z = 227$  m
  - LOLA kicker to be reinstalled

⇒ Many components to be re-used, but many devices/technical groups in only 10 m of electron beamline

⇒ LOLA RF structure has several sub-systems => next page

## Status:

- Section review soon (only small changes to be finished)
- Vacuum parts hand-over from ZM3 to MVS ✓

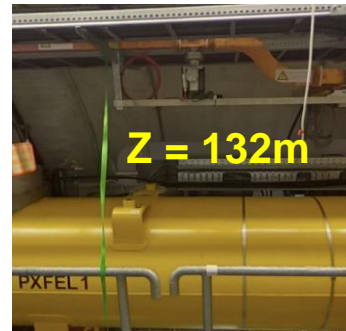
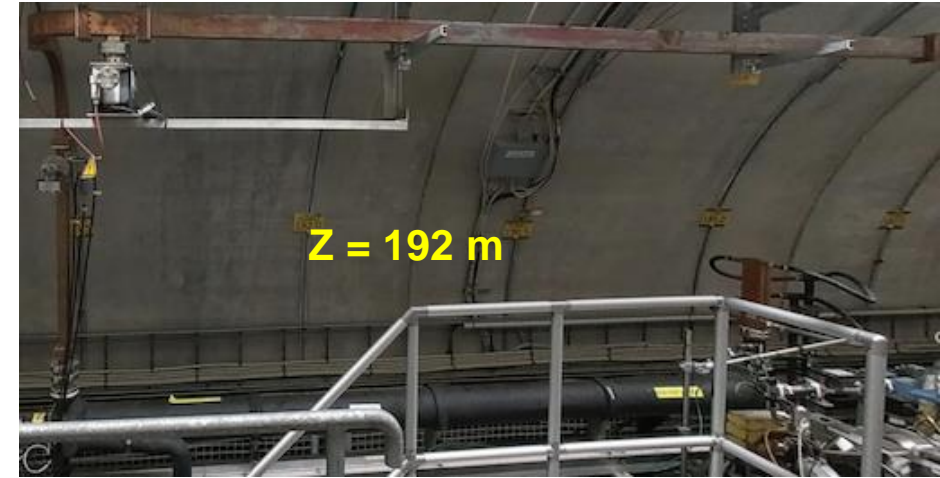
# FL1LOLA

## LOLA: RF Structure, Waveguides & Temperature Regulation

LOLA will be moved 35m downstream (from  $z = 192$  m to  $z = 227$  m)

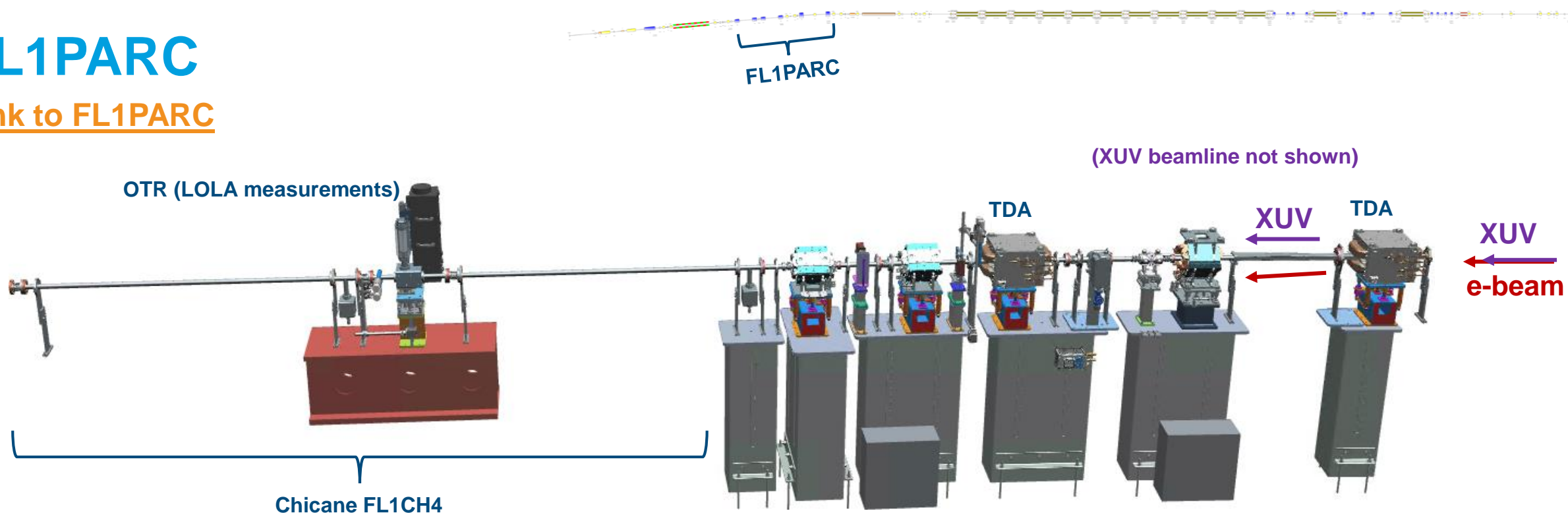
- **LOLA RF structure** (*J. Rothenburg, MIN*)
  - To be taken out of the tunnel, stored and re-installed
  - **To be decided:** Storage space and pumping during storage
- **Waveguides** (*J. Rothenburg, MIN*)
  - Waveguides and pumps to be disassembled (~60 m), stored, reinstalled and extended by 35 m of new waveguides
  - New waveguide line already included in NX-TC
    - Ion-Pumps ideally not at air-condition inlets => CAD model of air-conditioning not yet in NX-TC
    - Position of pumps to be finalised to start production of new waveguides (35m)!
  - Disassembly: before containers are removed (easier access) => **to be included in shutdown planning**
  - Assembly: **assembly platform required**
- **LOLA Temperature Regulation** required to tune resonant RF frequency.
  - Water circuit (*D. Lutzi, MKK2*)
    - to be removed from container (C23), stored & maintained (activated ?), reinstalled underneath the e-beamline
    - cannot be fully planned in CAD: too many unknowns => requires flexibility during installation
    - Installation needs to be coordinated with beamline installation
  - Control Unit (*O. Krebs, MKK4*)
    - to be removed from container (C23), new control unit to be installed outside the tunnel

FL1LOLA



# FL1PARC

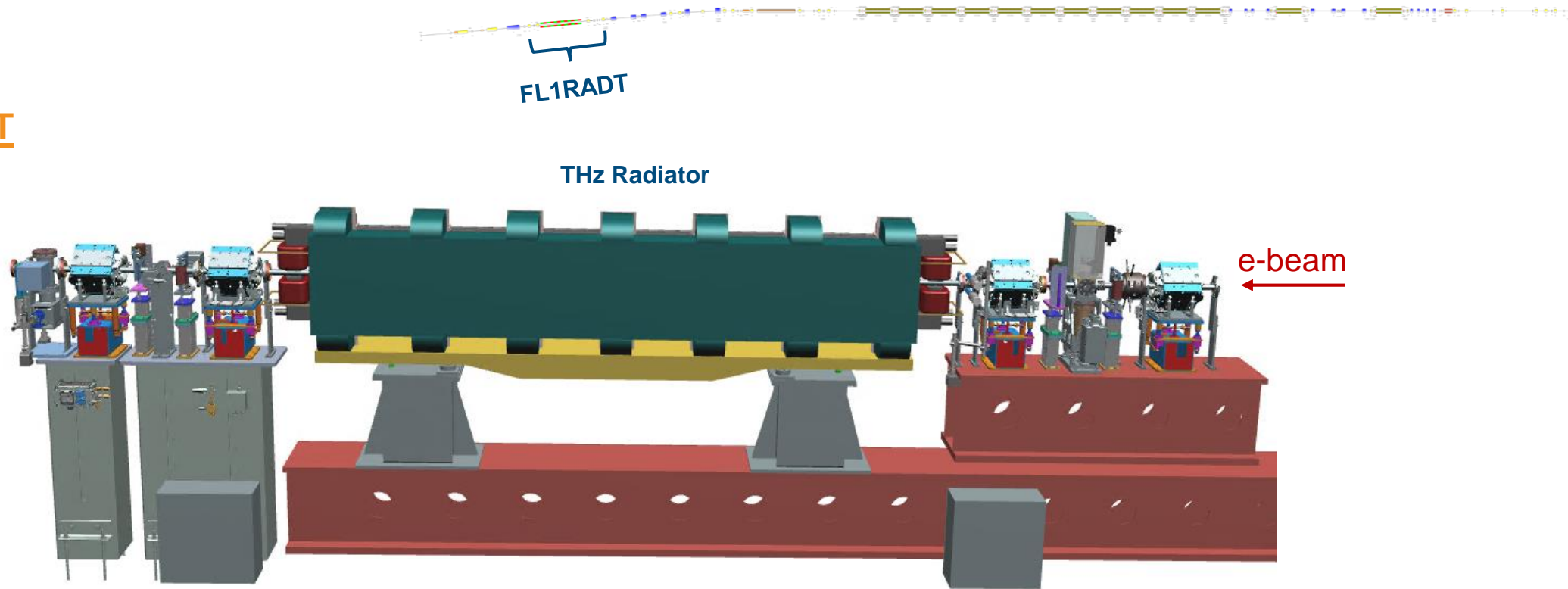
[Link to FL1PARC](#)



- **PARC:** Post-compression arc (after seeding and XUV generation) for **THz radiator**
  - Seeding requires “long” bunches and THz undulator “short” bunches
  - **FL1CH4:** Independent **bunch compression** for **THz radiator** to optimise THz radiation
  - However, No dipole magnets available in STAGE\_0
- Horizontal deflection (2 TDA) by 5 deg to **separate XUV photons (seeding) from THz undulator (next section)**
  - Eases out-coupling of THz radiation and laser safety for THz radiation
- OTR (in dispersive section) for LOLA measurements
- **Status:**
  - Section review finished: Lattice parts frozen and released ✓
  - Vacuum chambers for FL1CH4 still in production, all other new vacuum parts are produced

# FL1RADT

[Link to FL1RADT](#)

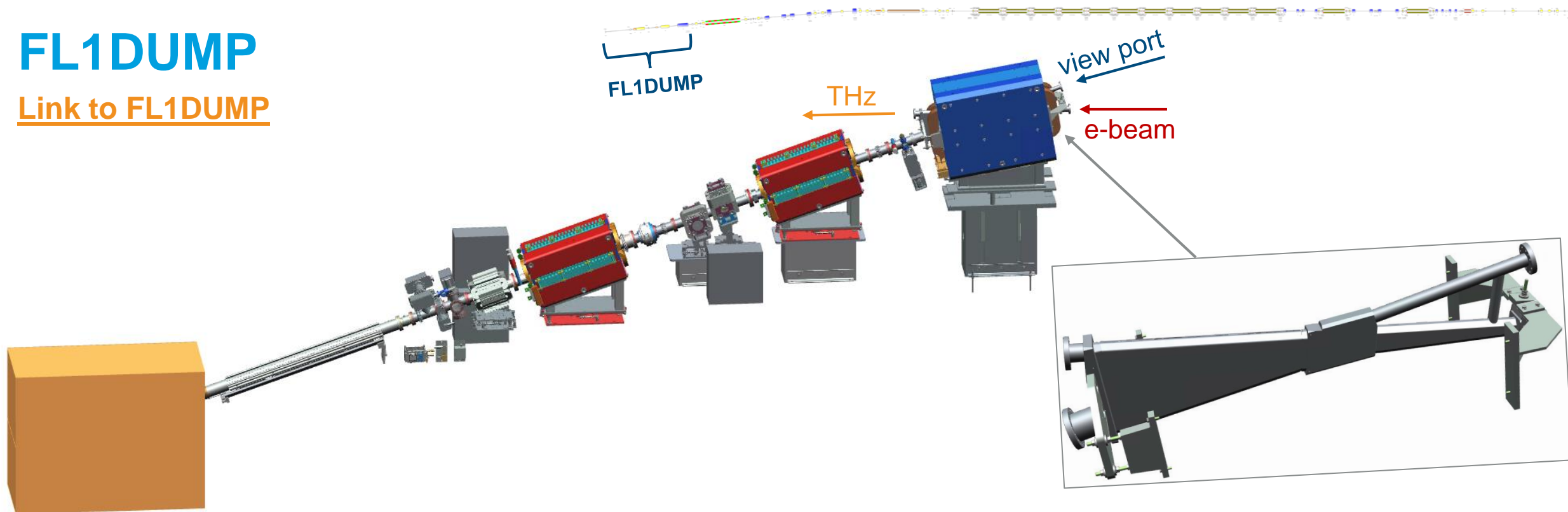


- **RADT: THz Radiator**
  - Needs to be taken out and stored
  - Will be installed with backside to the transport way (residual magnet fields measured => OK for FS-FLASH-D)
  - Water cooling connection under discussion due to limited space
- Beamline crosses the bilge: one long girder re-used by MEA (eases supports on bilge, bilge not shown here)
- **Status:**
  - Section review finished: release of one sub-component open
  - All new vacuum parts are produced and handed over to MVS ✓



# FL1DUMP

[Link to FL1DUMP](#)



- **Dump beamline:** vertical deflection 19 deg (horizontal and vertical deflection de-coupled)
- Only 3 new vacuum parts:
  - Dump dipole (TDC): drawings released, fabrication process very complex (not ready before start of shutdown)
- Beam Dump:
  - It is planned to use the spare dump
  - The existing dump will become spare dump

## Status:

- Section review open
- Dipole chamber fabrication process open



# Status Overview

## Section Reviews and hand-over of Vacuum Parts

FL1 START: z = 146,7610004 m

CADNAME	X	Y	Z	DG Assembly	Section Review	Lattice released	Vacuum parts (ZM3 to MVS)
FL1DIAG	0,000000	0,000000	0,000000	D10000000523348	📅 22 Jan 2024	📅 22 Feb 2024	
FL1MOD1	0,000000	0,000000	12,389219	D10000000523351			
FL1MOD2	0,000000	0,000000	25,289219	D10000000523352			
FL1RADI	0,000000	0,000000	33,389217	D10000000524071			
FL1BURN	0,000000	0,000000	69,354218	D10000000523353	📅 08 Jan 2024	📅 22 Feb 2024	📅 08 Feb 2024
FL1LOLA	0,000000	0,000000	72,569221	D10000000523354			📅 07 Mar 2024
FL1PARC	0,000000	0,000000	82,469215	D10000000523355	📅 05 Feb 2024	📅 23 Feb 2024	
FL1RADT	0,828233	0,000000	93,838875	D10000000523356	📅 19 Feb 2024		📅 22 Feb 2024
FL1DUMP	1,516764	0,000000	101,708817	D10000000523357			

# Summary

## “Critical Parts”

- **Vacuum Parts**

- Critical parts (that do not fulfil wish / rule = “vacuum part ready for installation before start of shutdown”)
  - Chicane chambers FL1CH1 and FL1CH2 in FL1MOD1
  - Chicane chamber FL1CH3 in FL1MOD2
  - LEIKA1 / LAUKA1-LEIKA2 Laser in-coupling chambers in FL1MOD1
  - Dump Dipole TDC chamber FL1DUMP
- Estimated still to be ready in time for installation => vacuum beamline closed before end of shutdown

- **Magnets**

- Dipoles
  - 4 TDK in FL1MOD1: call for tender till 04.04.24, delivery time ~ 12 months
  - 4 TDI in FL1MOD1: In fabrication (delivery date Jan 25, Feb 25 RFI)
- Installation schedule can become critical in case delivery is delayed.
- Still: Beam operation possible without dipoles with limitations for seeding operation (later installation)

- **Undulators**

- 6 new APPLE3 type undulators (FL1UA3) in FL1RADI
  - Magnet structure: call for tender out next week (serious estimate for RFI date only after call for tender)
- Delayed undulators will be installed later in short shutdowns (experience from FL2 afterburner)

- Main Message: Critical parts have no influence on end of shutdown date

# Last but not least,

Do not forget to mark  
your components

Wiedereinbau in FI1

Verbleibt im Tunnel

Zurück in die Fachgruppe

Verschrottung / D3



Remember the colour code ...

## Contact

**DESY.** Deutsches  
Elektronen-Synchrotron

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