ELBEX: Contribution by DESY

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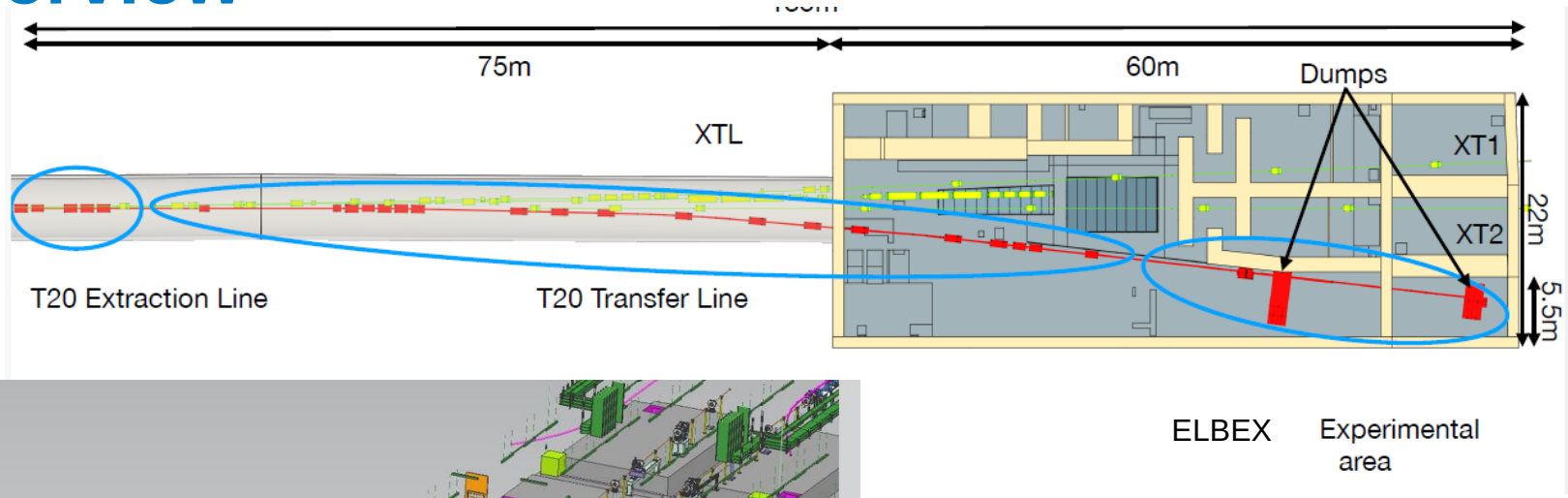
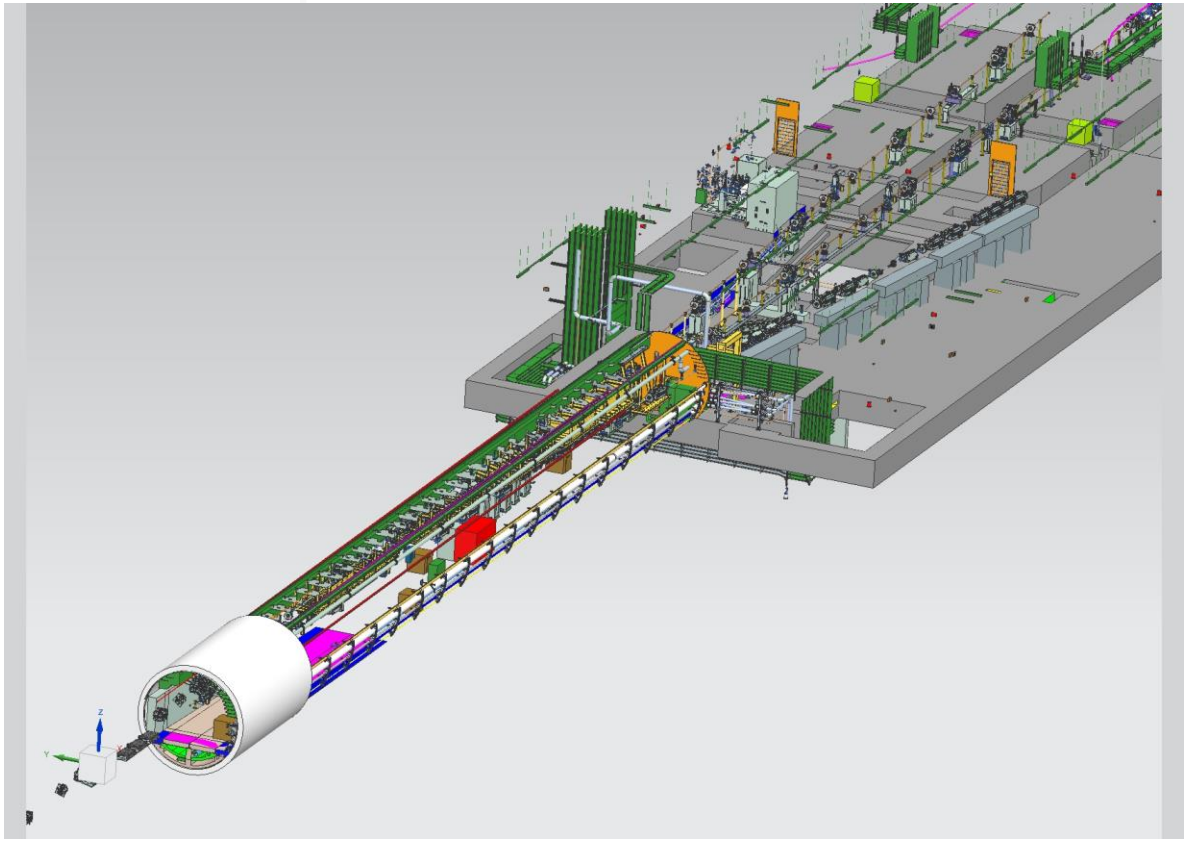
ELBEX kick-off workshop
27.01.2025

AN ELECTRON BEAMLINE AT THE European-XFEL

HELMHOLTZ

ELBEX overview

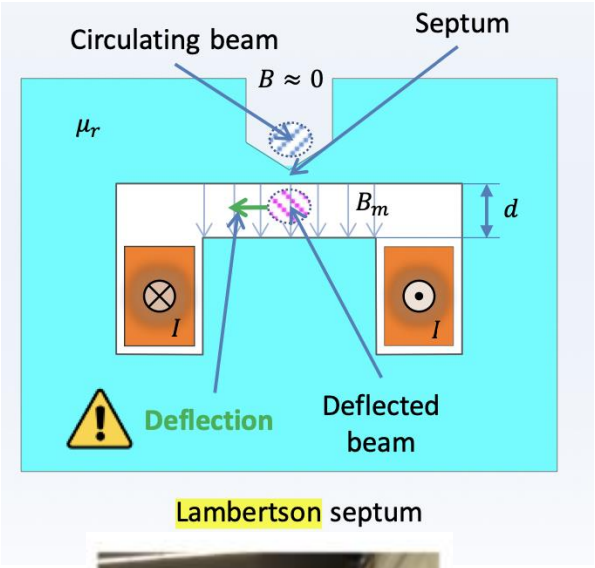


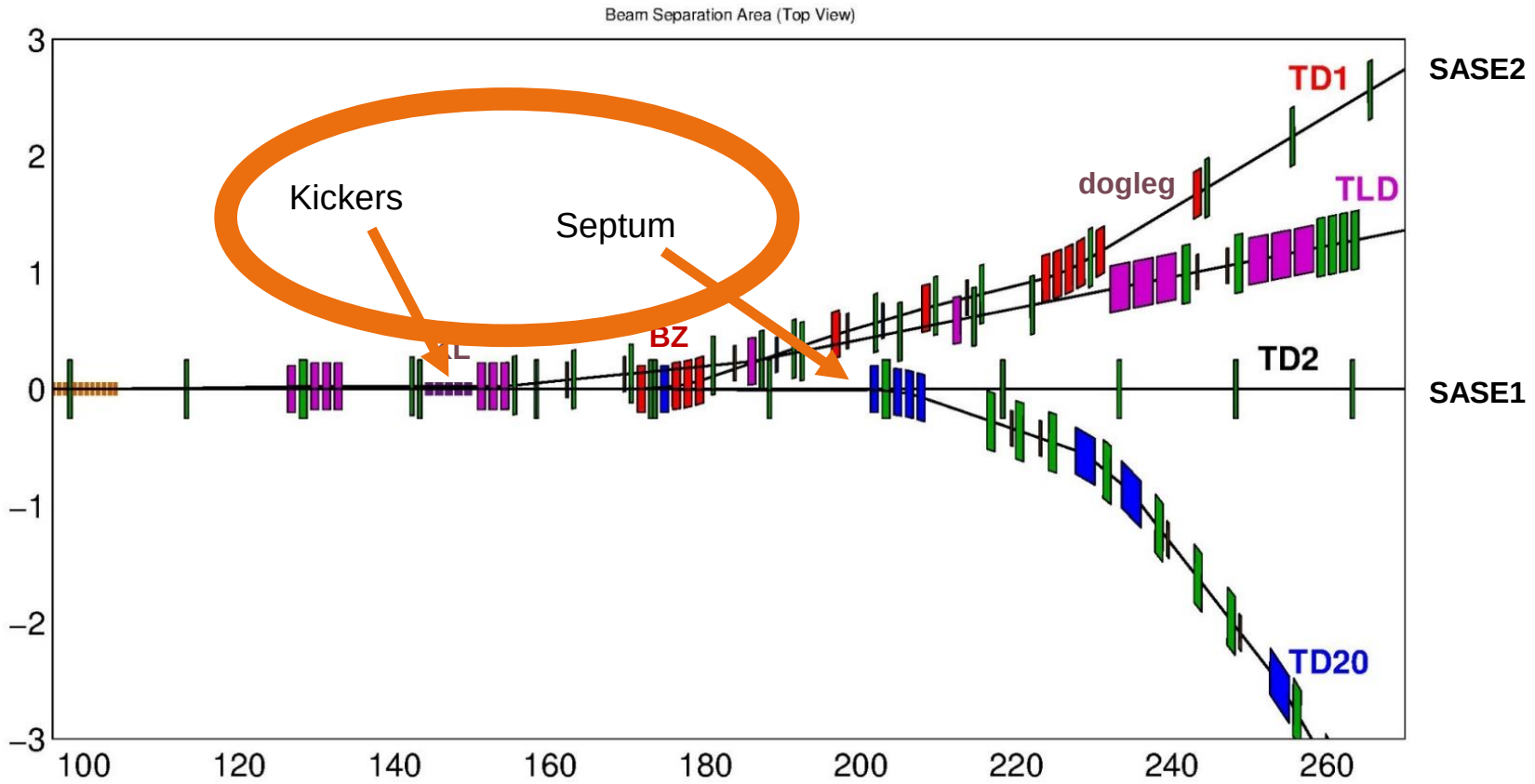


- Aim of ELBEX: extract the EuXFEL 16.5 GeV electron beam and provide it to user experiments
- Install new extraction beamline guiding the electron beam into experimental area
- Here: conceptual overview what DESY will do within ELBEX project
- more detailed status in D. Thodens talk tomorrow!

The Switchyard

from T20 beamline CDR



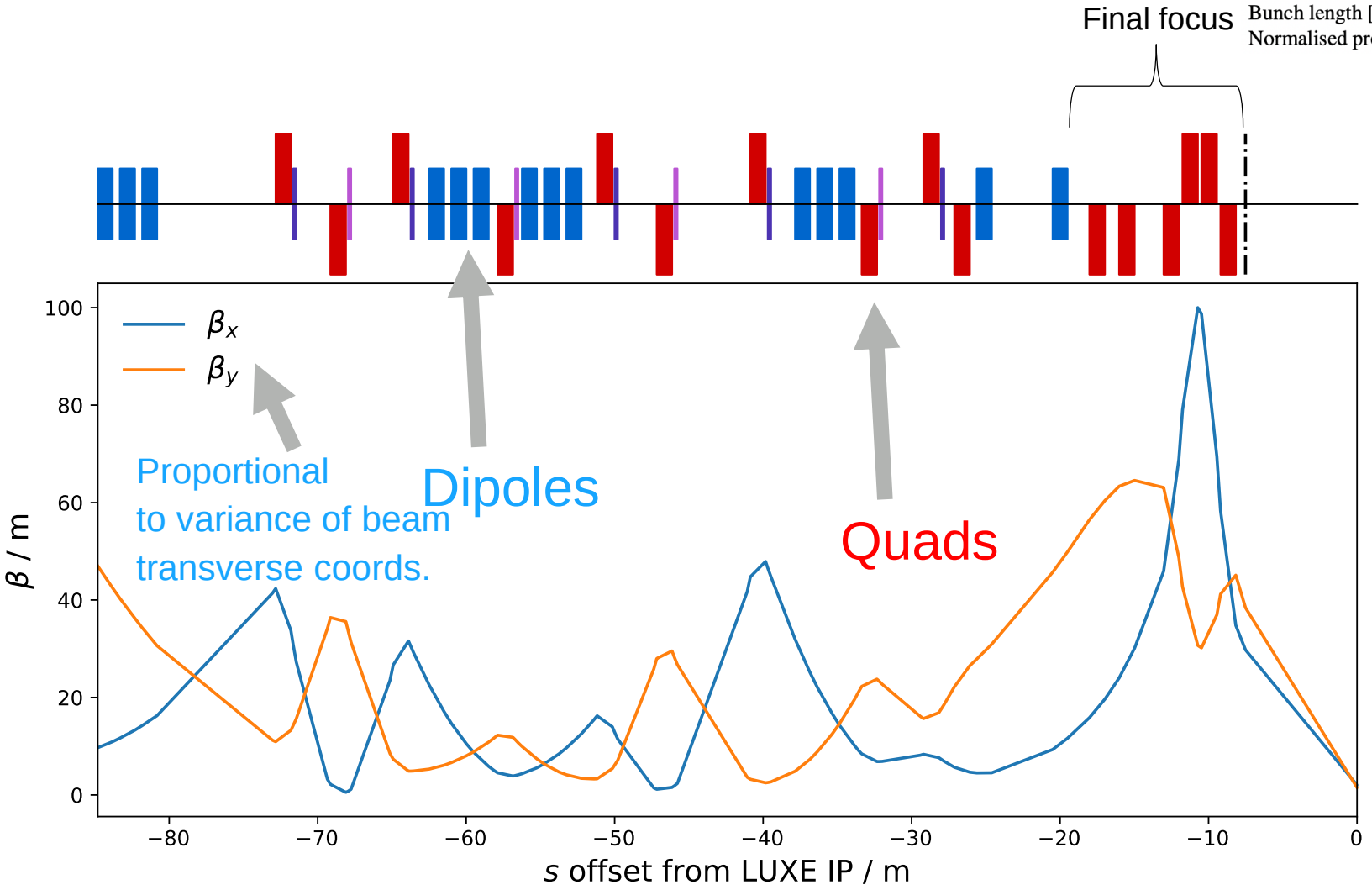


- T20 has the biggest bending angle at -6.742° versus 2.286° for T1 to SASE2.
- Bending to LUXE is in both vertical and horizontal planes due to the kicker/Lambertson septum pair.

T20 with final focus at IP

from T20 beamline CDR

Parameter	Value XFEL.EU	Assumed Values for LUXE
Beam Energy [GeV]	≤ 17.5	16.5
Bunch Charge [nC]	≤ 1.0	0.25
Number of bunches/train	2700	1
Repetition Rate [Hz]	10	10
Spotsize at the IP [μm]	–	5
Bunch length [μm]	30–50	30–50
Normalised projected emittance [mm mrad]	1.4	1.4



- Lattice conceptual design
- beam parameter requirements for SF-QED user experiment

Beamline Magnets, Diagnostics & Vacuum system

XBZ

XBD

XQH

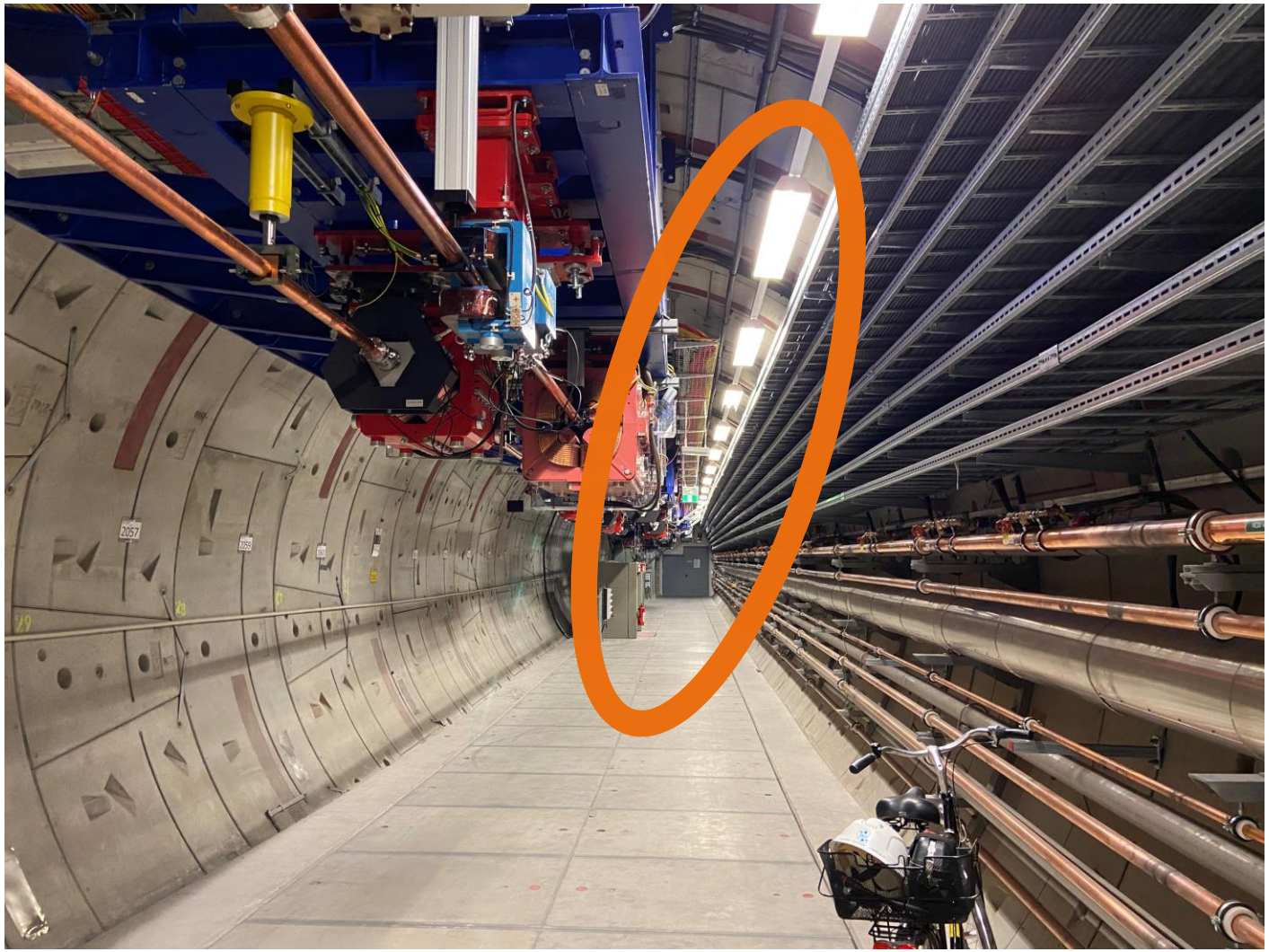
XCH

Type	Number
Dipole BD vertical	2
Dipole BD horizontal	9
Septum BZ short	4
Quadrupole QH	10
Corrector CHX	5
Corrector CHY	5

- Reusing magnet designs from EuXFEL
- For ELBEX, order new ones (long lead-times!) + HV power supplies
- Once magnets arrive, take into operation and test!
- For quadrupoles, potentially could refurbish old magnets from HERA (under discussion)
- Vacuum system (beam pipe, gate valves, pumps etc.) depends on magnet design, bespoke, especially for Septa region
- Beam diagnostics (partly → CSIC): 10 BPMs
- 3 toroids, a screen, standard design

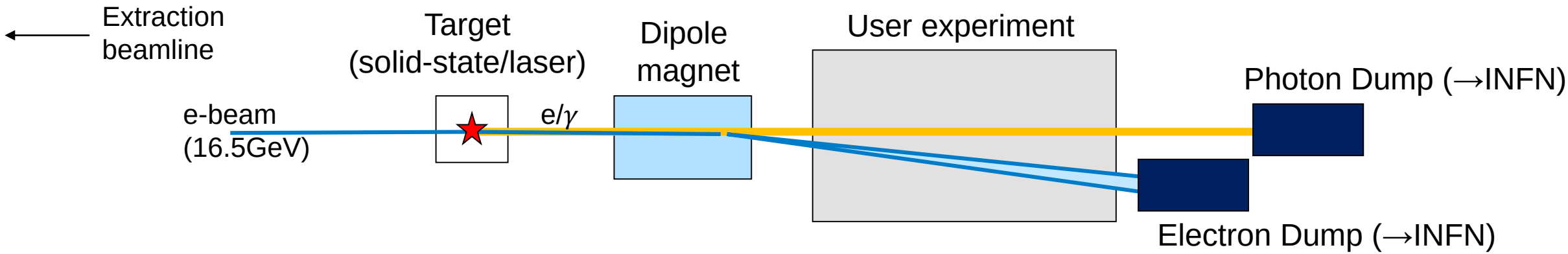
Installation Strategy

- Need to disassemble existing beamlines XTD1/2 beamlines (~20m around branching point, 2.3m above tunnel floor)
- Rebuild support frame (new design accomodating ELBEX beamline)
- Installation of modified XTD2 and T20
- Reinstallation of XTD1 beamline
- Could be done in ~12 week extended maintenance stop
- **Subject to approval by EuXFEL!**
- Goal of ELBEX: prepare such that installation can happen, if approval is given



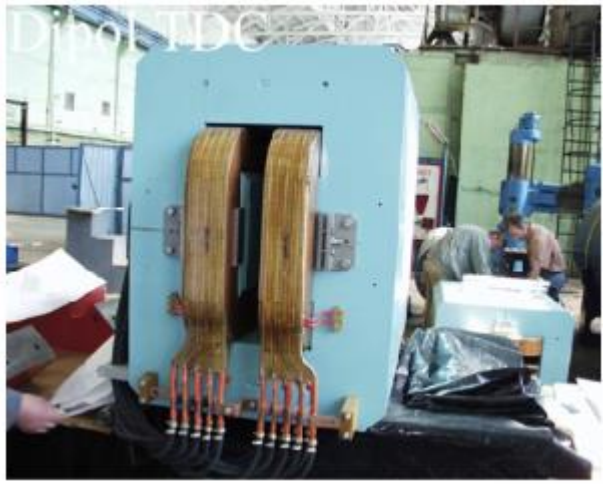
Challenge for installation and user operation: Access to areas only during EuXFEL maintenance stops (~half day every two weeks, ~2-4 weeks every 6 months)

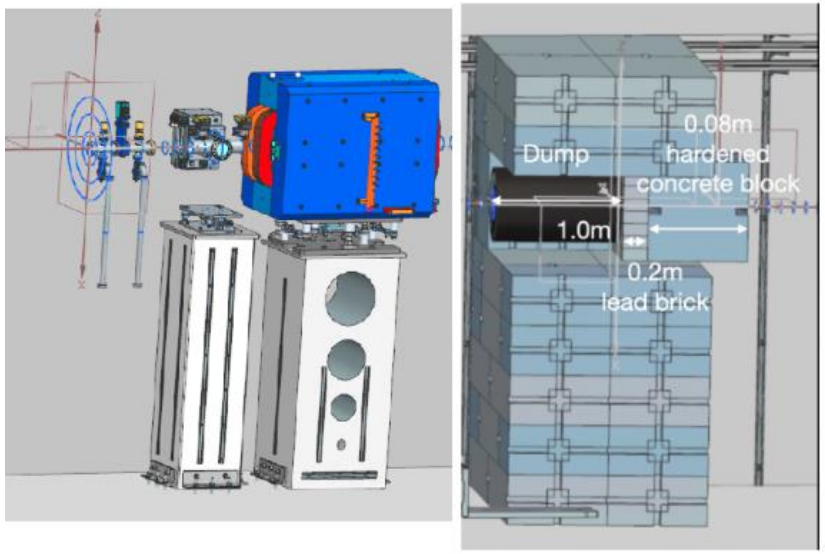
ELBEX Experimental Area



Note: for plasma boosting experiments, the setup looks different (see Bennos talk tomorrow)

- Magnet used in experimental area must bend high-energy electrons
- Use existing design for TDC magnets at FLASH + HV PS



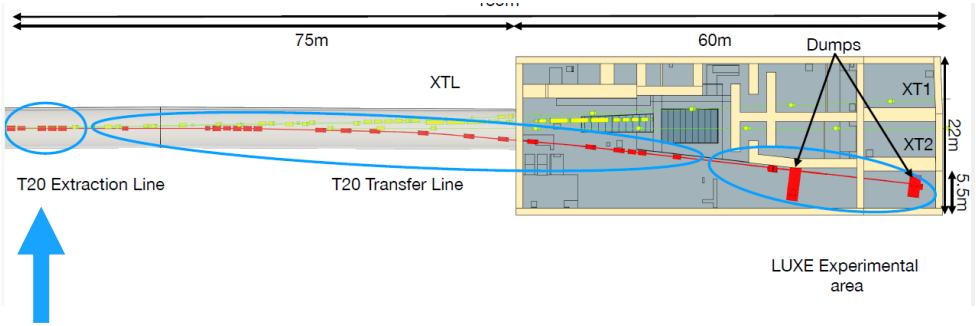


ELBEX work packages

Work Package No	Work Package name	Lead Beneficiary	Effort (Person-Months)	Start Month	End Month
WP1	Beam extraction line	1 - DESY	81.00	1	60
WP2	Beam transfer line	4 - UMAN	180.00	1	60
WP3	Beam dumps	3 - INFN	30.20	1	60
WP4	Service infrastructure	2 - EUROPEAN XFEL	45.00	1	60
WP5	Project management	1 - DESY	96.00	1	60

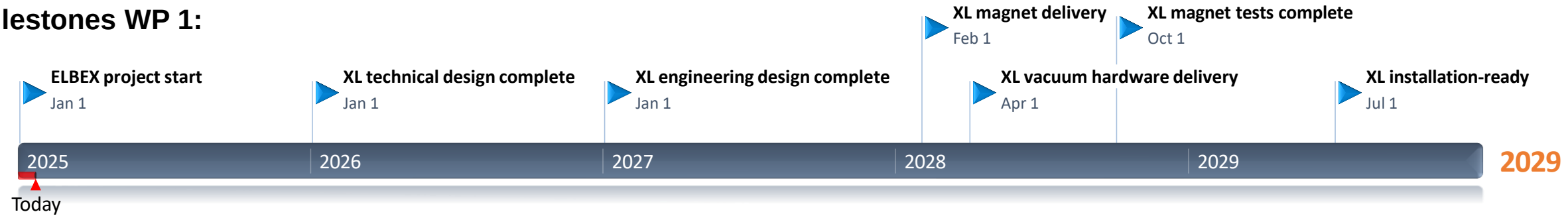
WP1: ELBEX extraction beamline

- design, component procurement, installation planning of extraction beamline (i.e. until after septa)
- magnets, HV power supplies, vaccuum systemn, control, monitoring system, infrastructure, software
- initial design → installation-ready state
- led by DESY, all tasks DESY



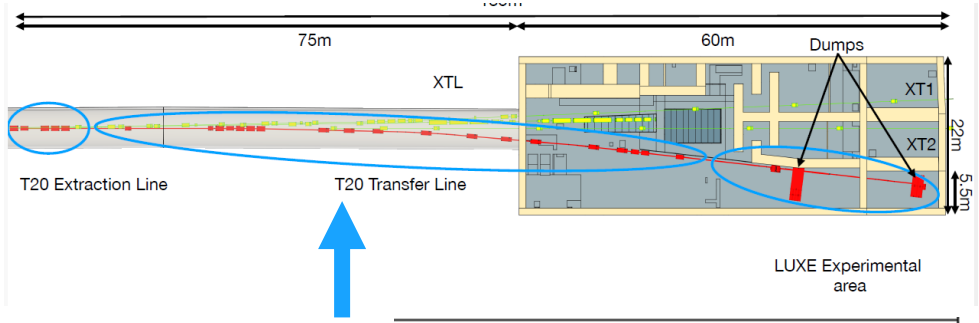
Deliverables
D1.1 – Technical design of the extraction beamline D1.2 – Engineering design of the extraction beamline D1.3 – Extraction beamline installation-readiness report

Milestones WP 1:



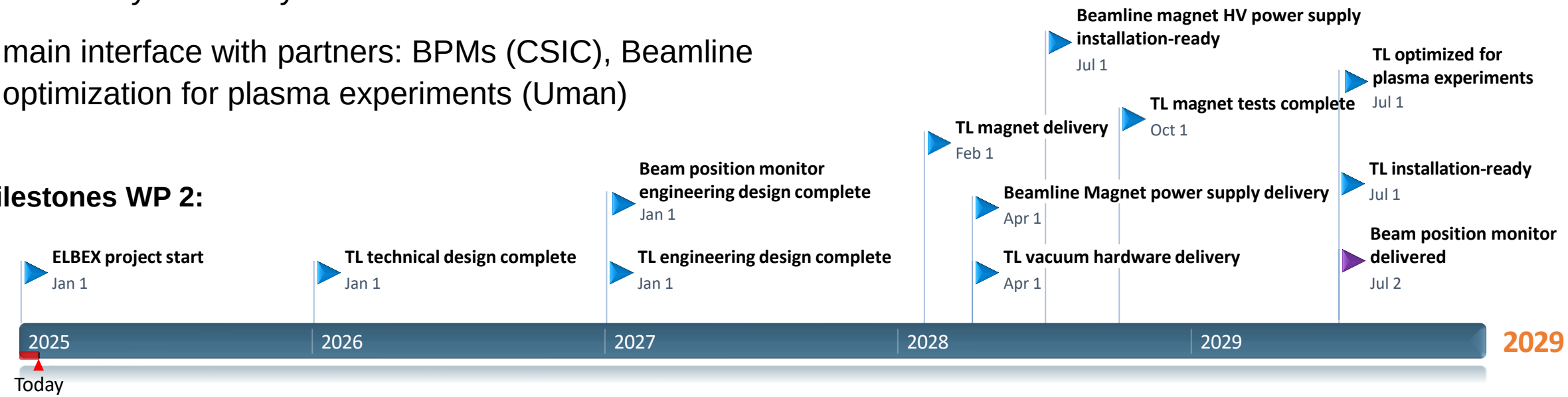
WP2: ELBEX Transfer beamline

- design, component procurement, installation planning of extraction beamline (i.e. until after septa)
- magnets, HV power supplies, vaccuum systemn, control, monitoring system, infrastructure, software, mounting structures
- initial design → installation-ready state
- WP led by University of Manchester
- main interface with partners: BPMs (CSIC), Beamline optimization for plasma experiments (Uman)



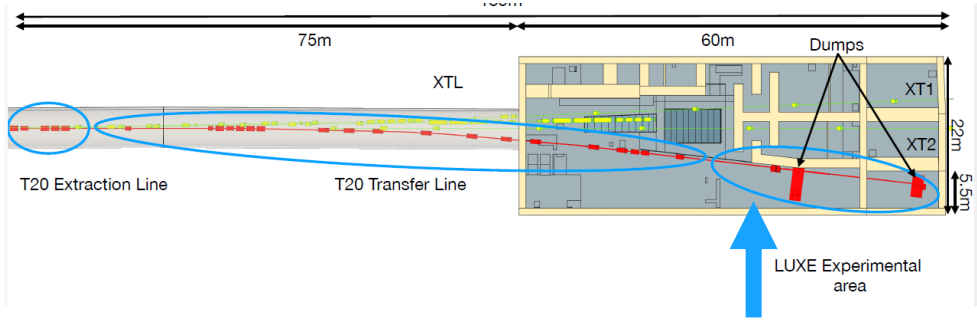
D2.1 – Technical design of the transfer beamline
D2.2 – Engineering design of the transfer beamline
D2.3 – Transfer beamline installation-readiness review
D2.4 – Magnet high-voltage power supplies
D2.5 – Engineering design of beam position monitors
D2.6 – Beam position monitors
D2.7 – Plasma experiment design study

Milestones WP 2:



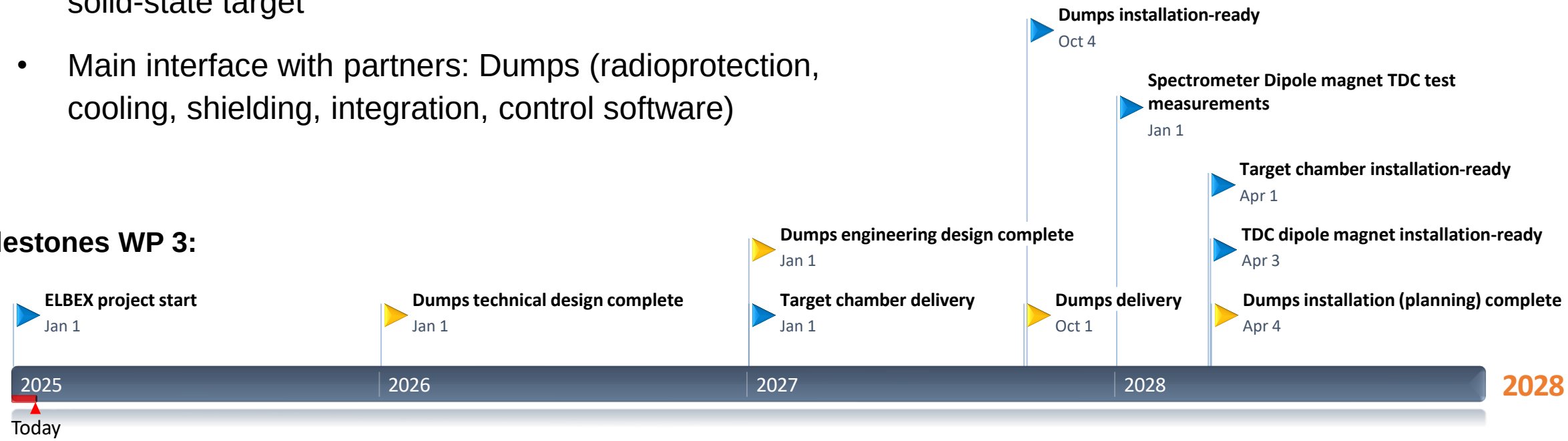
WP3 Beam dumps

- WP led by INFN
- Dumps provided by INFN
- Procurement, testing and commisioning of TDC dipole magnet
- Design, construction of vacuum chamber hosting solid-state target
- Main interface with partners: Dumps (radioprotection, cooling, shielding, integration, control software)

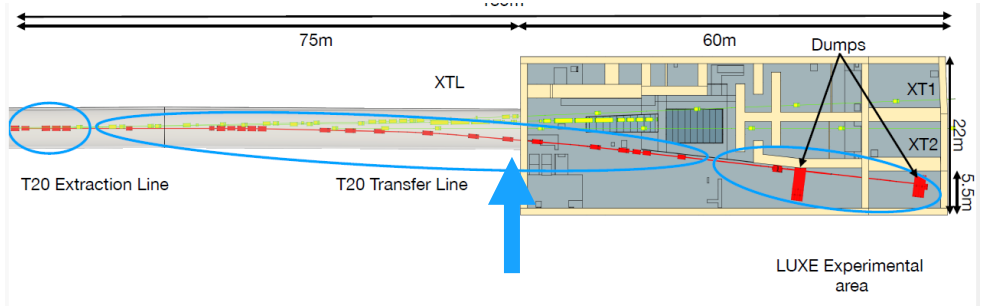


D3.1 – Engineering design of the electron dump
D3.2 – Engineering design of the photon dump
D3.3 – Electron beam dump
D3.4 – Photon beam dump
D3.5 – Target chamber
D3.6 – TDC dipole magnet

Milestones WP 3:



WP4: Service Infrastructure



- WP lead: EuXFEL
- Building infrastructure modifications (EuXFEL) necessary to prepare ELBEX installation
- Magnet and vacuum system mounts (DESY)
- Main interface with partners: beamline design, safety aspects (DESY)

D4.1 – Tunnel infrastructure modification implementation plan

Milestones WP 4:

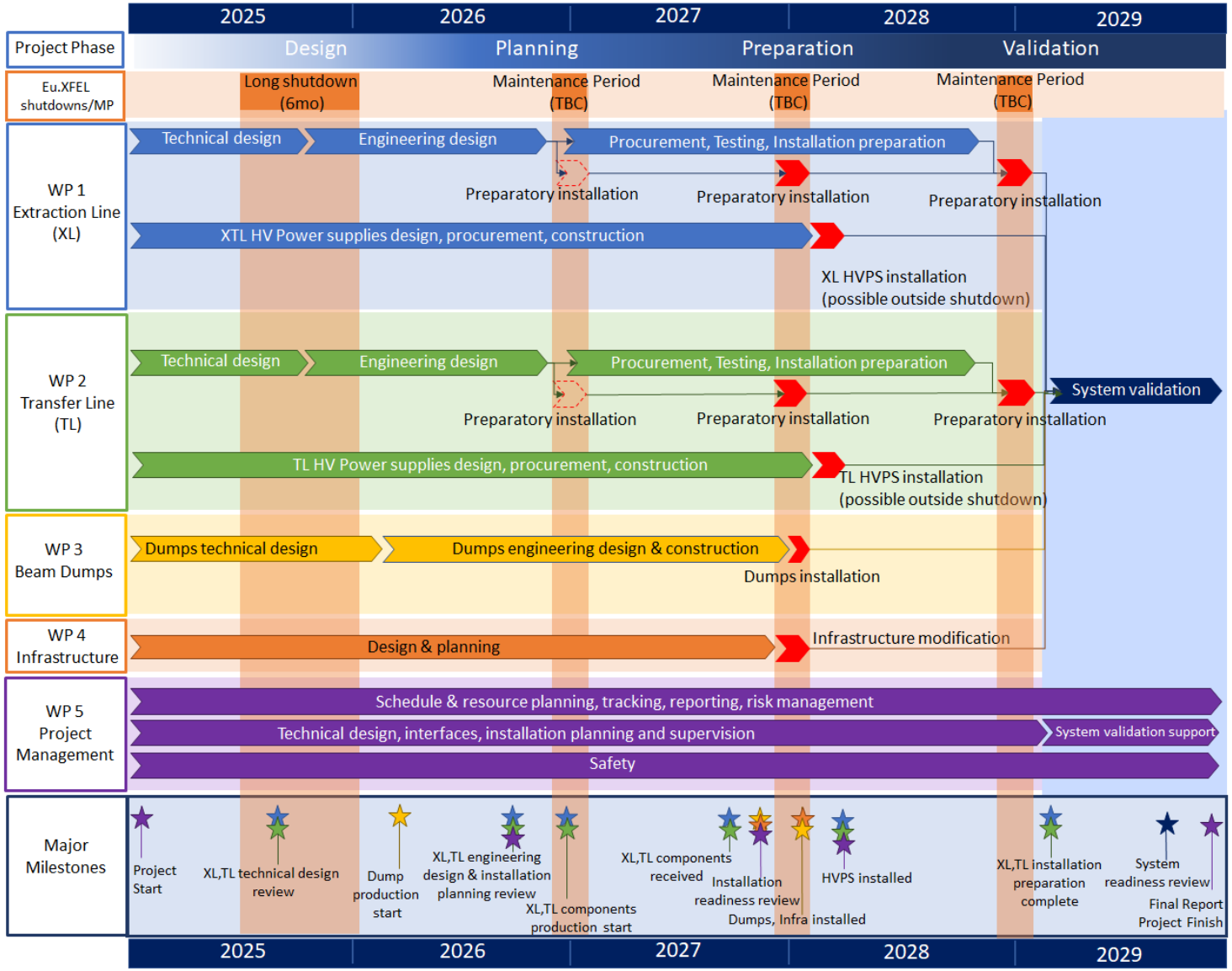
WP5: Project management

- WP lead and all tasks: DESY
- Coordination of EU project
- Project engineering: systems engineering, requirements and interface management, CAD integration
- Technical coordination: coordinate activities between work packages and involved technical groups, safety
- Project management: Develop and track schedule, cost, work across all WP, including risk management
- Dissemination officer: expand reach of the facility and attractiveness for users, outreach and communication

D5.1 – ELBEX installation-ready
D5.2 – Safety concept
D5.3 – Technical design report
D5.4 – Installation Schedules
D5.5 – Data management plan
D5.6 – Engineering design report
D5.7 – Project final report
D5.8 – Document on project impact
D5.9 – Dissemination to ELBEX user community
D5.10 – Policy brief

Milestones WP 5:

Schedule


2025
2026
2027
2028
2029
Project Phase
Design
Planning
Preparation
Validation
Eu.XFEL shutdowns/MP
Long shutdown (6mo)
Maintenance Period (TBC)
Maintenance Period (TBC)
Maintenance Period (TBC)
WP 1 Extraction Line (XL)
Technical design
Engineering design
Procurement, Testing, Installation preparation
Preparatory installation
Preparatory installation
Preparatory installation
XTL HV Power supplies design, procurement, construction
XL HVPS installation (possible outside shutdown)
WP 2 Transfer Line (TL)
Technical design
Engineering design
Procurement, Testing, Installation preparation
System validation
Preparatory installation
Preparatory installation
Preparatory installation
TL HV Power supplies design, procurement, construction
TL HVPS installation (possible outside shutdown)
WP 3 Beam Dumps
Dumps technical design
Dumps engineering design & construction
Dumps installation
WP 4 Infrastructure
Design & planning
Infrastructure modification
WP 5 Project Management
Schedule & resource planning, tracking, reporting, risk management
Technical design, interfaces, installation planning and supervision
System validation support
Safety
Major Milestones
Project Start
XL,TL technical design review
Dump production start
XL,TL engineering design & installation planning review
XL,TL components production start
XL,TL components received
Installation readiness review
Dumps, Infra installed
HVPS installed
XL,TL installation preparation complete
System readiness review
Final Report
Project Finish
2025
2026
2027
2028
2029

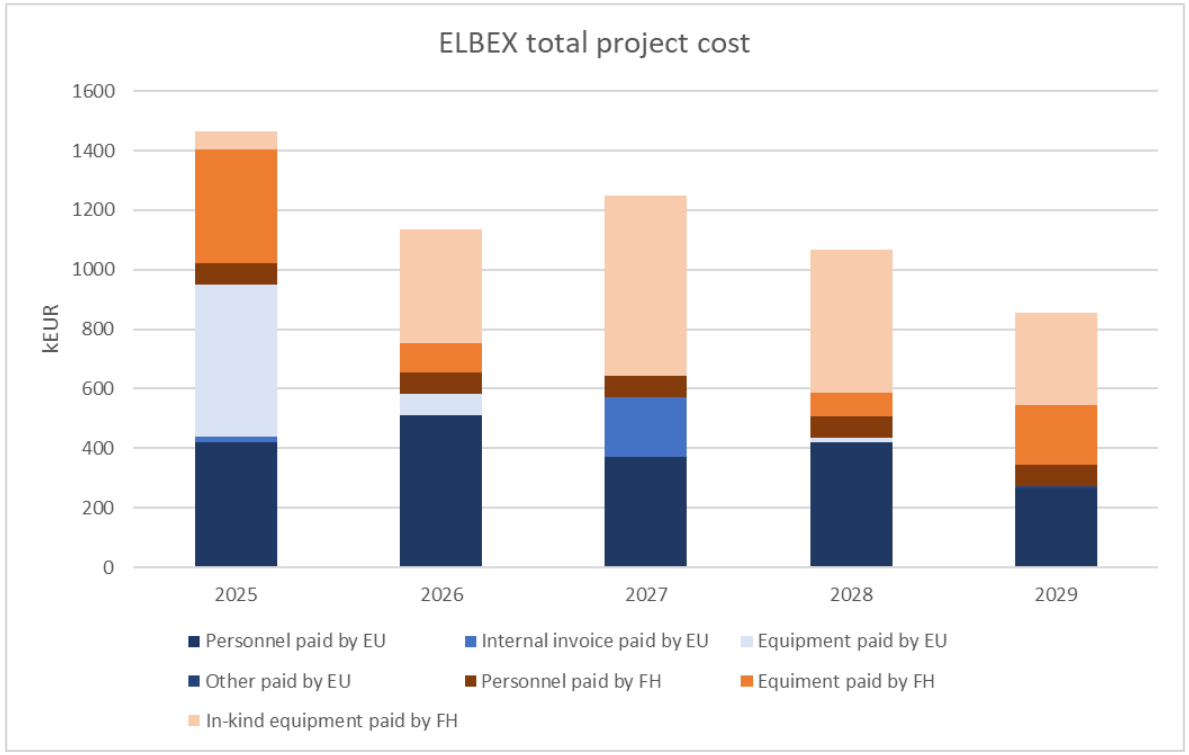
Risks

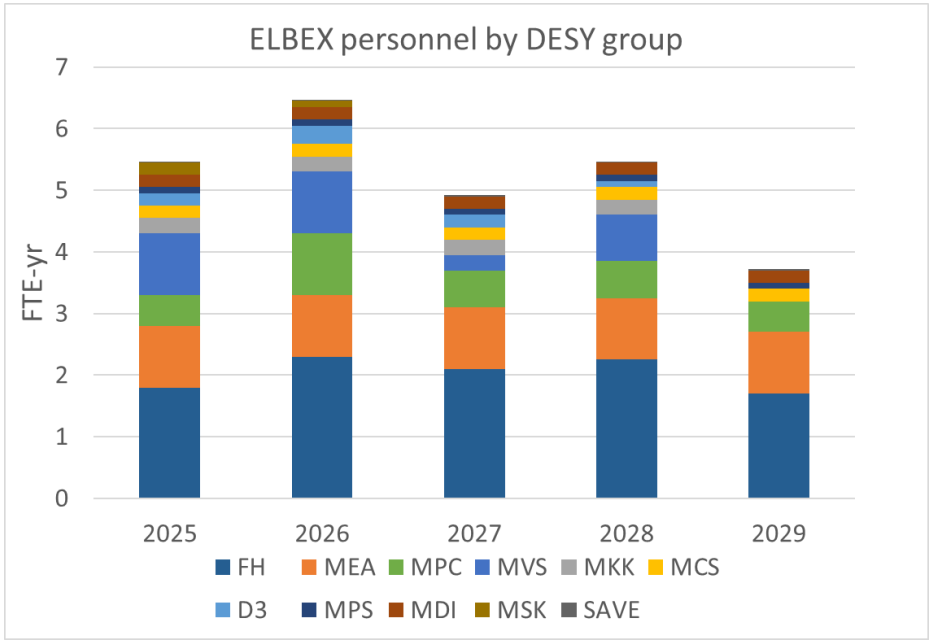
Critical risks & risk management strategy

Grant Preparation (Critical Risks screen) — Enter the info.

Risk number	Description	Work Package No(s)	Proposed Mitigation Measures
1	Damage to equipment or existing Beamline infrastructure during preparatory work for installation (likelihood <5%, severity: Medium), Consequence: Prolongation of maintenance periods to repair	WP4, WP2, WP1	Trained personnel Proper planning Good workmanship Excellent track record
2	Beam Dumps damaged during transport and installation (likelihood <5%, severity: Low) Consequence: Delay of installation to repair	WP3	Careful planning, hiring and training personnel
3	Long lead-time items delivered too late for installation readiness report, (likelihood: 20%, severity: Low) Consequence: Delay of overall schedule	WP3, WP4, WP2, WP1	Careful planning with contingencies, diversify suppliers, identification of high-priority items, ordering as soon as possible
4	Schedule and space constraints for preparatory installation during XFEL maintenance periods prevent work from being completed in time (likelihood 10%, severity: low)	WP3, WP4, WP2, WP1	Careful planning, hiring and training people, establish efficient communication with technical service groups on-site
5	Fluctuating market price for electronics components may lead to price increase with respect to time of estimate (likelihood: high, severity: moderate)	WP3, WP4, WP2, WP1	Careful planning with contingencies, cost tracking, diversifying suppliers
6	Scheduling of an extended shutdown confirmed by XFEL managament, full installation can take place (likelihood: high, severity: low)	WP2, WP1	Careful planning of installation work, frequent communication with EuXFEL management, perform as much preparatory installation work in previous maintenance periods as possible, train personnel, such that installation work can start efficiently and quickly if extended shutdown is granted
7	Limited availability of experienced technical personnel due to parallel on-campus activities at DESY (likelihood: moderate, severity: moderate)	WP2, WP1	Careful planning of technical personnel, training newly hired technical personnel at the beginning of the project
8	Budget shortfall because of inflation and wage increases: High inflation and sharply rising prices for equipment and rising wages may compromise the overall budget of the project	WP5	Careful monitoring of the progress and budget,; de-scoping of parts of the project to ensure timely deliverable of the key goalsof delivering beam into the area.

Resource planning from DESY perspective





Funds for realizing ELBEX are included in DESY planning for on-site particle physics experiment program!

Summary

- DESY‘s role in ELBEX:
  - Robust Providing main beamline components and infrastructure
  - ELBEX EU project coordinator
  - Coordination of the ELBEX local project in close collaboration with EuXFEL
- DESY has a robust ressource planning for ELBEX realization
- ELBEX is embedded in DESY on-site experiment program

Backup

Budget

	Estimated eligible[1] costs (per budget category)										Estimated EU contribution[2]			
	Direct costs								Indirect costs	Total costs	EU contribution to eligible costs			Maximum grant amount[6]
	A. Personnel costs			B. Subcontracting costs	C. Purchase costs			D. Other cost categories	E. Indirect costs[3]		Funding rate %[4]	Maximum EU contribution[5]	Requested EU contribution	
	A.1 Employees (or equivalent) A.2 Natural persons under direct contract A.3 Seconded persons		A.4 SME owners and natural person beneficiaries	B. Subcontracting	C.1 Travel and subsistence	C.2 Equipment	C.3 Other goods, works and services	D.2 Internally invoiced goods and services	E. Indirect costs					
Forms of funding	Actual costs	Unit costs (usual accounting practices)	Unit costs[7]	Actual costs	Actual costs	Actual costs	Actual costs	Unit costs (usual accounting practices)	Flat-rate costs[8]					
	a1	a2	a3	b	c1	c2	c3	d2	e = 0,25 * (a1 + a2 + a3 + c1 + c2 + c3)	f = a+b+c+d+e	U	g = f * U%	h	m
1 - DESY	2 299 500.00	0.00	0.00	0.00	9 600.00	655 000.00	8 500.00	217 500.00	743 150.00	3 933 250.00	80	3 146 600.00	3 146 600.00	3 146 600.00
2 - EUROPEAN XFEL	432 000.00	0.00	0.00	0.00	4 000.00	0.00	8 500.00	0.00	111 125.00	555 625.00	80	444 500.00	444 500.00	444 500.00
3 - INFN	87 600.00	0.00	0.00	0.00	6 000.00	0.00	161 700.00	0.00	63 825.00	319 125.00	80	255 300.00	255 300.00	255 300.00
4 - UMAN	190 880.00	0.00	0.00	0.00	9 600.00	0.00	0.00	0.00	50 120.00	250 600.00	80	200 480.00	200 480.00	200 480.00
5 - CSIC	97 500.00	0.00	0.00	0.00	8 000.00	0.00	95 000.00	0.00	50 125.00	250 625.00	80	200 500.00	200 500.00	200 500.00
Total consortium	3 107 480.00	0.00	0.00	0.00	37 200.00	655 000.00	273 700.00	217 500.00	1 018 345.00	5 309 225.00		4 247 380.00	4 247 380.00	4 247 380.00