Equipment for testing

- **Testing in grouping per half-shell per layer**

	Testing Step	#Modules	#Data Uplink lines	#Cmd lines	#Twinax cables	#Data Uplink opto	#Cmd Opto	#SP-chains
ENDCAP during layer integration in assembly sites (per half-shell)	6 HR L2 (1 link/FE)	96	384	96	480	72	24	12
	5 HR L2 (0.5 link/FE)	80	160	80	240	30	10	10
	11 HR L2	176	544	176	720	102	34	22
	8 HR L3 (0.5 link/FE)	176	352	176	528	64	32	16
	9 HR L4 (0.25 link/FE)	234	234	234	468	54	36	18

	Testing Step	#SP-chains	#Opto boxes	#MPO24	#FELIX board	#PP1 Connector	#type-2 PWR	#type-3 LV	#LV PSU	# HV PSU
ENDCAP during layer integration in assembly sites (per half-shell) (2 sites)	6 HR L2 (1 link/FE)	12	3	6	4	4	12	24	1.5	3
	5 HR L2 (0.5 link/FE)	10	2	4	3	2	10	20	1.25	2.5
	11 HR L2	22	5	10	7	5	22	44	2.75	5.5
	8 HR L3 (0.5 link/FE)	16	4	8	5	4	16	32	2	4
	9 HR L4 (0.25 link/FE)	18	5	9	6	5	18	36	2.25	4.5

Preliminary

Preliminary

	#SP-chains	#Opto boxes	#MPO24	#FELIX board	#PP1 Connector	#type-2 PWR	#type-3 LV	#LV PSU	# HV PSU
Ideal amount of equipment for test per EC	22	5	10	7	6	22	44	3	6
Fraction of total	0.20	0.18	0.19	0.19	0.20	0.20	0.20	0.20	0.20

To be discussed if equipment comparable to 20% of endcap needs available from pre-production or to be purchased for use in integration sites (if production possible at all)

Current assumption is availability of equipment for 12.5% (still to be confirmed for some items)

Split of 11 HR for L2 in two test results in about 14% equipment

Equipment for testing

- List of items
  - FELIX readout boards and SWRODs: purchased via TDAQ 66 Phase-I boards for Pixels
  - Power supplies from production
  - Optoboxes: large amount, availability linked to reviews
  - Type-2, type-3, type-4 cables, PP2, PP3 as off-detector pre-production. Eventual different lengths for sites outsite of SR1. To be seen if then non-core
  - DCS/Interlock units (7 from pre-production for EC assembly sites, OB layer integration, inner system integration, any other site needs custom made ones)
  - DAQ/DCS FW/SW: “ready for integration sites”
  - SR1 infrastructure equipment

Equipment for testing: Felix Phase 1

4945		DAQ/ DCS	630 days	March 22, 2022	August 20, 2024
4946		DAQ/DCS FW/ SW ready for assembly sites	0 days	March 22, 2022	March 22, 2022
4947		DAQ/DCS FW/ SW ready for integration sites	0 days	October 5, 2022	October 5, 2022

Phase 1 FELIX and PCs first batch available	0 days	September 28, 2020	September 28, 2020
Phase 1 FELIX and PCs second batch available	0 days	December 21, 2020	December 21, 2020
Phase 1 FELIX and PCs Final batch available	0 days	March 15, 2021	March 15, 2021
Phase 2 FELIX and PCs available	0 days	August 22, 2023	August 22, 2023

Equipment for testing: Optoboard

ITk 2.1.10: Data Transmission - Opto - Milestone Status

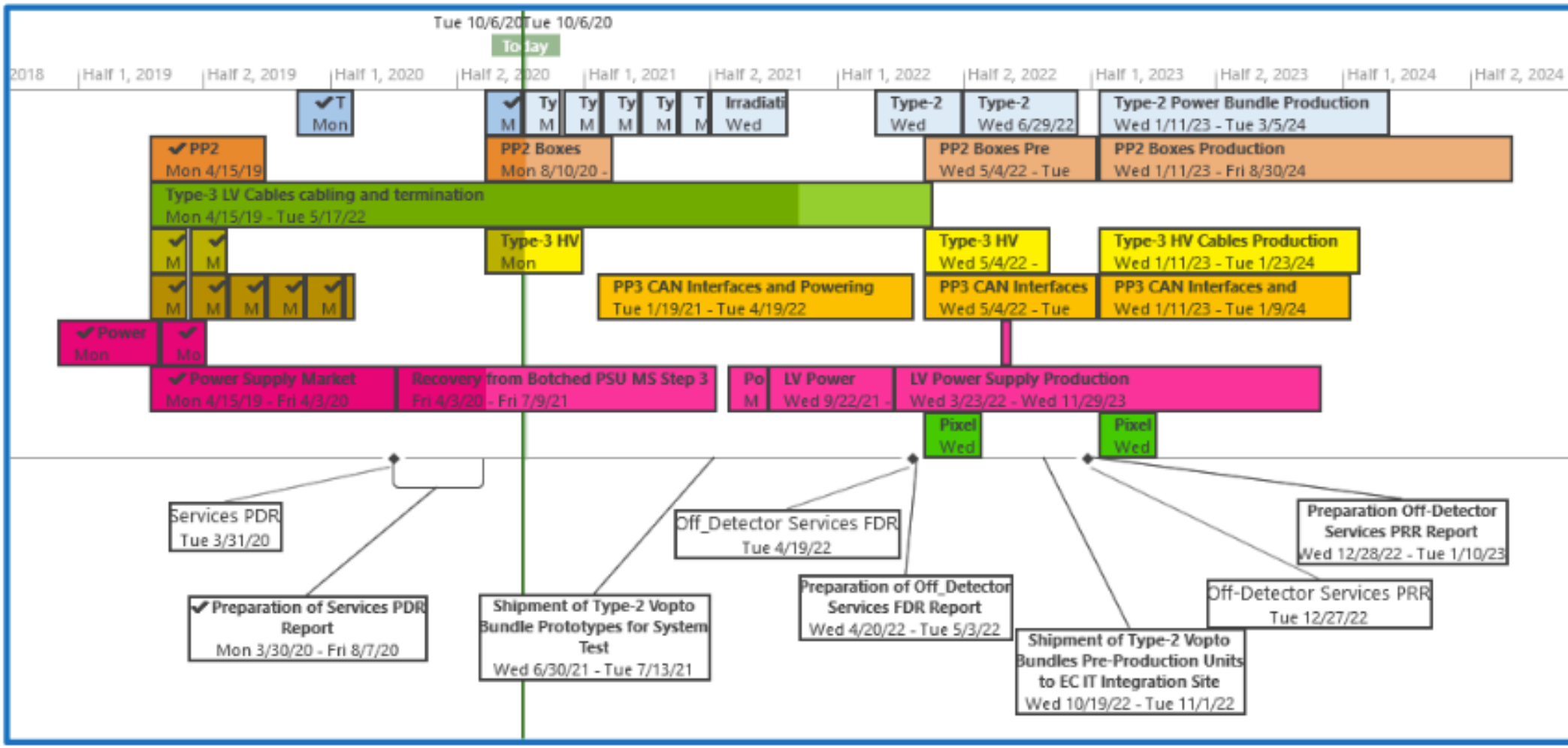
- **Services PDR** 25.-26.3.2020
- Services FDR Feb 2022, data transmission ready Aug 2021
- On-detector services PRR Nov 2022, data transmission ready Oct 2022

- Delivery:
  - Optosystem units for system tests Nov **2020**
  - Optosystem units for loading sites July **2021** (possibly non final)
  - Optosystem pre-production units (10%) at reception and integration sites Sept **2022**
  - Optosystem completed June 2024

- Depend on delivery of opto components (GBCR, lpGBT, VTRx, MOPS, bPOL2V5, bPOL12V)
  - clear timelines defined
  - reasonable float
  - associated risks assessed (delays within float)

- Uncertainty in fiber responsibility and timeline

2.1.8: Off-Detetor Services – Schedule Overview



Integration of Endcaps

Task Name	Duration	Start	Finish
UK EndCap	**960.25 days**	**Thu 24/03/22**	**Thu 27/11/25**
Reception test and test infrastructure of UK Endcap half-rings	**613.25 days**	**Mon 19/09/22**	**Thu 23/01/25**
Tooling and Test infrastruction for Outer Endcap Half-cylinder integration in UK	**160 days**	**Thu 24/03/22**	**Wed 02/11/22**
Installation and test of services on half-cylinders UK	**310 days**	**Mon 20/03/23**	**Fri 24/05/24**
Test infrastructure for Outer Endcaps UK	**0 days**	**Fri 17/02/23**	**Fri 17/02/23**
Test infrastructure of Outer Endcaps UK ready and commissioned	0 days	Fri 17/02/23	Fri 17/02/23
Cooling plant and manifolding available UK	0 mons	Fri 17/02/23	Fri 17/02/23
Full test infrastructure for Outer Endcap ready in Liverpool	0 days	Fri 17/02/23	Fri 17/02/23
Half-ring integration in half-cylinders UK	**520 days**	**Thu 10/08/23**	**Thu 07/08/25**
Test of Outer Endcaps Completed in UK	2 mons	Thu 07/08/25	Thu 02/10/25
Outer Endcap UK and test equipment transport box and shipment	**723.25 days**	**Mon 20/02/23**	**Thu 27/11/25**
Outer EndCap C delivered at CERN	0 days	Thu 27/11/25	Thu 27/11/25
Italy Endcap	**960.25 days**	**Thu 24/03/22**	**Thu 27/11/25**
Reception test and test infrastructure of Italy Endcap half-rings	**602.25 days**	**Mon 19/09/22**	**Wed 08/01/25**
Tooling and Test infrastruction for Outer Endcap Half-cylinder integration in Italy	**160 days**	**Thu 24/03/22**	**Wed 02/11/22**
Installation and test of services on half-cylinders in Italy	**318 days**	**Mon 20/03/23**	**Wed 05/06/24**
Test infrastructure for Outer Endcaps in Italy	**0 days**	**Fri 17/02/23**	**Fri 17/02/23**
Test infrastructure for Outer Endcaps Italy Ready and Commissioned	0 days	Fri 17/02/23	Fri 17/02/23
Cooling plant and manifolding available Italy	0 mons	Fri 17/02/23	Fri 17/02/23
Full test of Infrastructure for Outer Endcaps ready in Frascati	0 days	Fri 17/02/23	Fri 17/02/23
Half-ring integration in half-cylinders in Italy	**520 days**	**Thu 10/08/23**	**Thu 07/08/25**
Test of Outer Endcaps Completed in Italy	2 mons	Thu 07/08/25	Thu 02/10/25
Outer Endcap Italy and test equipment transport box and shipment	**723.25 days**	**Mon 20/02/23**	**Thu 27/11/25**
Outer EndCap A delivered at CERN	0 days	Thu 27/11/25	Thu 27/11/25
SR1 Pixel equipment ready for installation from EC outside sites	0 days	Thu 27/11/25	Thu 27/11/25

- Integration in Frascati, Italy and Liverpool, UK
- Equipment like off-detector services and FELIX readout foreseen to be used there before use in SR1
- Production flow optimized in recent BCP to mitigate delays in many components

24/03/22 tooling and test infrastructure

Tooling and Test infrastruction for Outer Endcap Hs	160 days	March 22, 2022	October 31, 2022
Production EC-A half Cyclinder Holding tooling: pa	2 mons	March 22, 2022	May 16, 2022
Production EC-A half Cyclinder Holding tooling: pa	2 mons	May 17, 2022	July 11, 2022
Production EC-A half Cyclinder Holding tooling: pa	2 mons	July 12, 2022	September 5, 2022
Production EC-A half Cyclinder Holding tooling: pa	2 mons	September 6, 2022	October 31, 2022
Production EC-A Service Trolley part 1	2 mons	March 22, 2022	May 16, 2022
Production EC-A Service Trolley part 2	2 mons	May 17, 2022	July 11, 2022
Production EC-A Service Trolley part 3	2 mons	July 12, 2022	September 5, 2022
Production EC-A Service Trolley part 4	2 mons	September 6, 2022	October 31, 2022
Production EC-A Half Ring Integration Tooling part	2 mons	March 22, 2022	May 16, 2022
Production EC-A Half Ring Integration Tooling part	2 mons	May 17, 2022	July 11, 2022
Production EC-A Half Ring Integration Tooling part	2 mons	July 12, 2022	September 5, 2022
Production EC-A Half Ring Integration Tooling part	2 mons	September 6, 2022	October 31, 2022
Production EC-A Service Installation Tooling part 1	2 mons	March 22, 2022	May 16, 2022
Production EC-A Service Installation Tooling part 2	2 mons	May 17, 2022	July 11, 2022
Production EC-A Service Installation Tooling part 3	2 mons	July 12, 2022	September 5, 2022
Production EC-A Service Installation Tooling part 4	2 mons	September 6, 2022	October 31, 2022
Tooling and infrastructure for half-cylinder holdin	0 days	October 31, 2022	October 31, 2022
Tool for Outer Endcap services handling at PP1 Ita	0 days	October 31, 2022	October 31, 2022
Tooling for half-ring integration to half-cylinders It	0 days	October 31, 2022	October 31, 2022
Tool for services installation Italy Ready	0 days	October 31, 2022	October 31, 2022
Test infrastructure for services of half-cylinders Ita	0 days	October 31, 2022	October 31, 2022
Installation and test of services on half-cylinders in	331 days	March 6, 2023	June 10, 2024
Inner half-cylinders: Add Type 1 & test 25% Italy	1.5 mons	March 6, 2023	April 14, 2023
Inner half-cylinders: Add Type 1 & test 50% Italy	1.5 mons	April 17, 2023	May 26, 2023
Inner half-cylinders: Add Type 1 & test 75% Italy	1.5 mons	May 29, 2023	July 7, 2023
Inner half-cylinders: Add Type 1 & test 100% Italy	1.5 mons	July 24, 2023	September 1, 2023
Outer half-cylinders: Add Type 1 & test 25% Italy	1 mon	October 3, 2023	October 30, 2023

Produzione e test dei tool/trolley

Installazione e test dei servizi

Reviews	712.5 days	November 30, 2020	August 24, 2023
Integration PDR	0 days	November 30, 2020	November 30, 2020
Final design review of integration tooling	0 days	March 21, 2022	March 21, 2022
SR1 ready for integration of Itk Pixel (from Comm	0 days	August 24, 2023	August 24, 2023

Test infrastructure for Outer Endcaps in Italy	0 days	February 3, 2023	February 3, 2023
Test infrastructure for Outer Endcaps Italy Ready	0 days	February 3, 2023	February 3, 2023
Cooling plant and manifolding available Italy	0 mons	February 3, 2023	February 3, 2023
Full test of Infrastructure for Outer Endcaps ready	0 days	February 3, 2023	February 3, 2023
Half-ring integration in half-cylinders in Italy	560.5 days	August 3, 2023	September 25, 2025
Inner half-cylinders: Add half-rings & test 12.5% IT	4 mons	August 3, 2023	November 23, 2023
Inner half-cylinders: Add half-rings & test 25% IT	2 mons	November 23, 2023	January 18, 2024
Inner half-cylinders: Add half-rings & test 37.5% IT	1 mon	January 18, 2024	February 15, 2024
Inner half-cylinders: Add half-rings & test 50% IT	1 mon	February 15, 2024	March 14, 2024
Inner half-cylinders: Add half-rings & test 62.5 IT	1 mon	March 14, 2024	April 11, 2024
Inner half-cylinders: Add half-rings & test 75% IT	1 mon	April 11, 2024	May 9, 2024
Inner half-cylinders: Add half-rings & test 87.5% IT	1 mon	May 9, 2024	June 6, 2024
Inner half-cylinders: Add half-rings & test 100% IT	1 mon	June 6, 2024	July 4, 2024
Join inner half-cylinders & re-route type 1 Italy	3 mons	July 4, 2024	September 26, 2024
Inner half-cylinder clamped	0 days	September 26, 2024	September 26, 2024
Outer half-cylinders: Add half-rings & test 12.5% I	1 mon	September 26, 2024	October 24, 2024
Outer half-cylinders: Add half-rings & test 25% IT	1 mon	October 24, 2024	November 21, 2024
Outer half-cylinders: Add half-rings & test 37.5% I	0.5 mons	November 21, 2024	December 5, 2024
Outer half-cylinders: Add half-rings & test 50% IT	0.5 mons	December 5, 2024	December 19, 2024

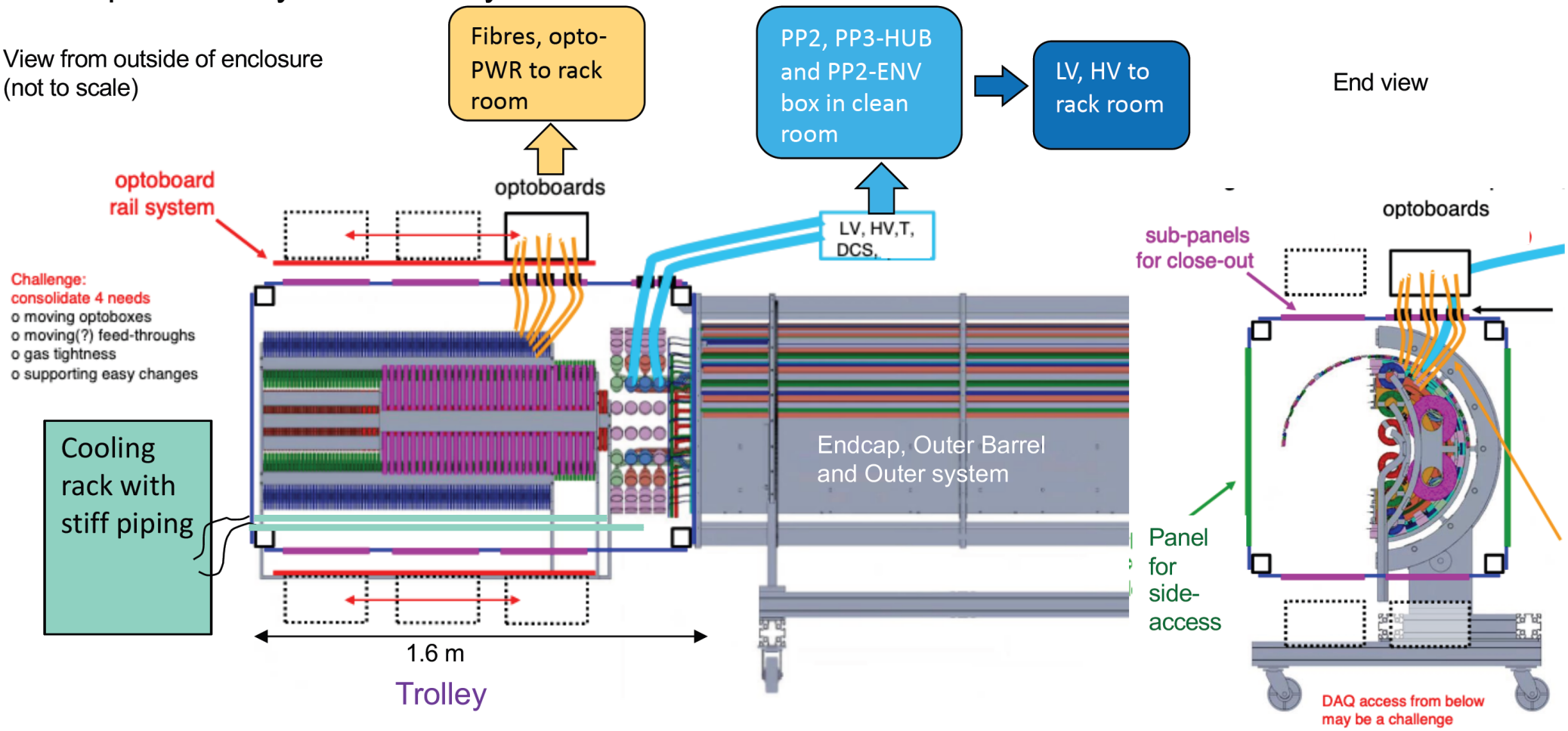
Test infrastrutture per half-rings

Installazione half-rings su half-shell

Testing and services during integration

- Twinax cables and type-1 services extruding detector
- Many services to handle during integration and installation → Trolleys

Concept for trolleys of Outer System



1. Type-2 opto-PWR and fibres to be movable on top and bottom of setup because optoboxes have to be movable (including cooling at 10C, monophase)
2. PP2 and PP3-HUB < 12-15m from PP1 connectors, routing of type-3 to rack room
3. Cooling piping inside trolley with stiff pipes and connection outside of trolley (incl. spare loops)