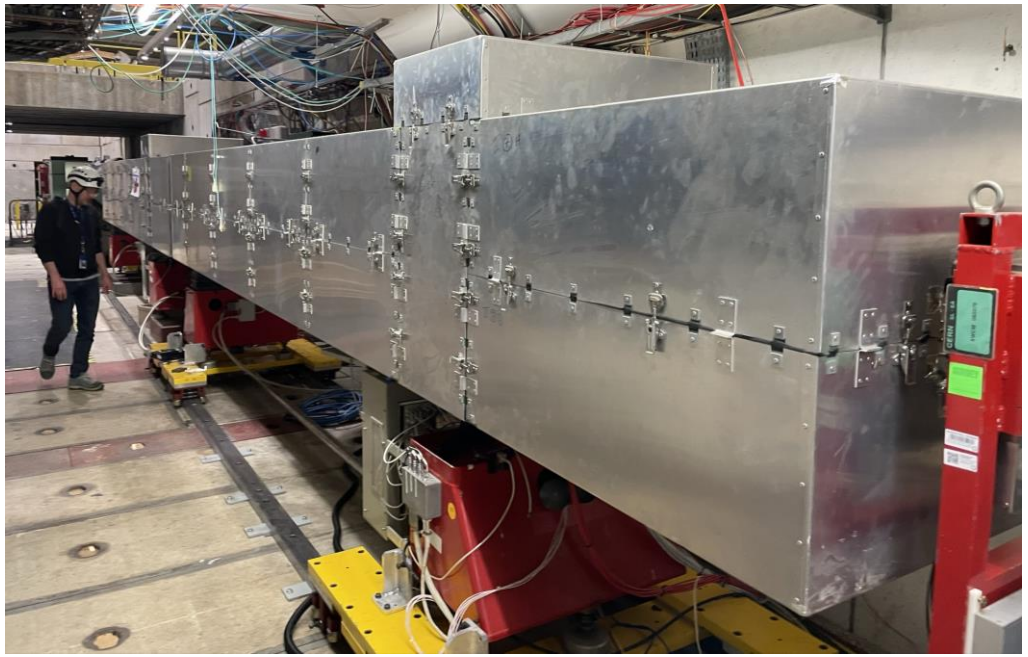
January 2024, 165th EATM
XCED – YETS 2023-2024

On Behalf of BE-EA, SY-BI and CEDAR TEAM
16.01.2024

OVERVIEW



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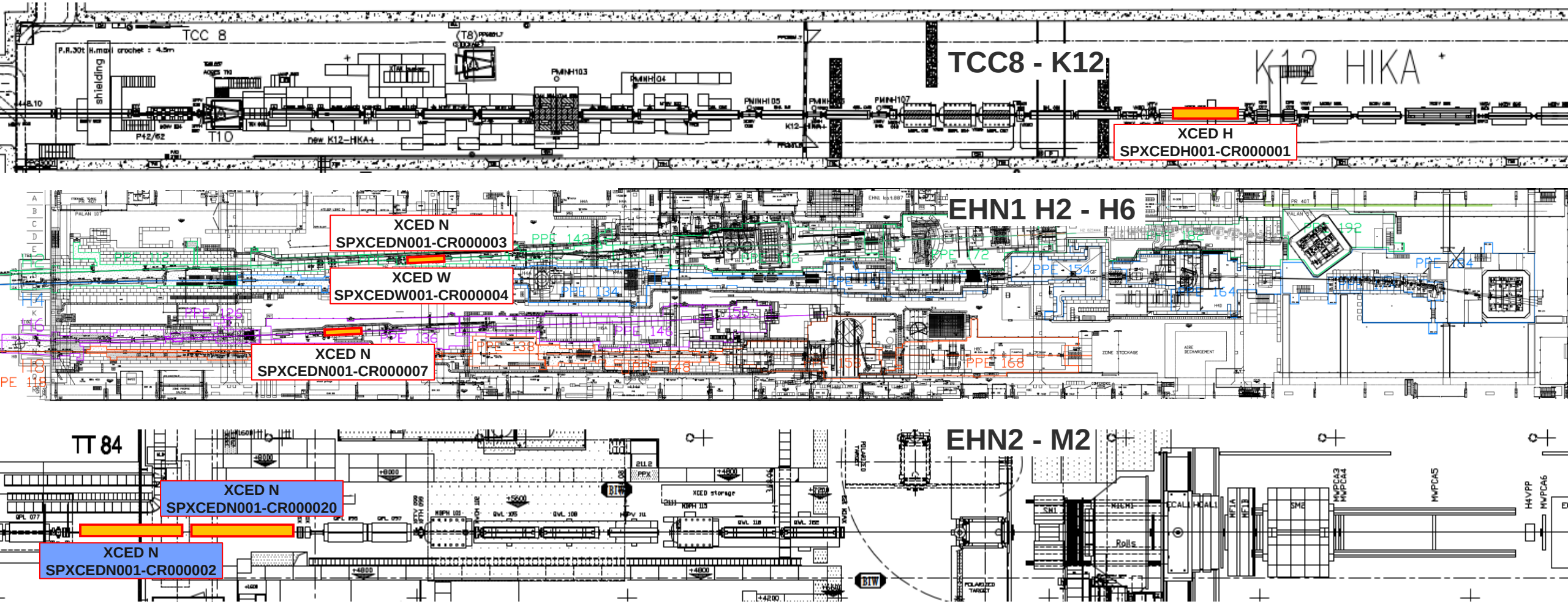
INTRODUCTION

INSTALLED LOCATIONS - TCC8/EHN1/EHN2



2022/2023 ISSUES SUMMARY

System	Fault	Cause	Consequences	Solution
Gas	Pressure control	Degraded resolution of Hamilton pressure sensor (50 years old!)	Gas losses, Precision, False readings, issues with the feedback algorithm	**New pressure sensors –TERPS pressure sensor**
	Electro valves	Ageing. Obsolete model no spares available	Gas control issues, Pressure regulation, Safety	**New electro valve**
	Plastic gas pipes	Ageing. Heavily degraded	Gas losses, Pressure regulation, Safety	**All piping in the CEDAR shall be replaced by new rad. hard piping compliant with operation pressures**
Mechanical / Software	Diaphragm precision	Loss of “pulse-mode” in control electronics. Wear & tear of mechanical components.	Loss of accuracy from 10 µm to 200 µm, no repeatability	**Software optimization. Mechanical Refurbishment**
	X-Y table movement precision	Not identified	Alignment loss, repeatability loss	**Convergence algorithms implemented as mitigation. Mechanical refurbishment**
Mechanical	Motorization and limit switches	Ageing, faulty assembly, human error	Not achieving nominal precision	**Replace with new mechanical parts.**
Alignment	Alignment	References	Alignment	**New alignment procedure**
Control & acquisition	Electronics	Ageing	Wrong acquisition and control (pressure, PMTs, motors…)	**New electronics being developed to be deployed during LS3**
PMTs	Detection efficiency	Ageing	Unacceptable detection efficiency	**Quantum efficiency measurements of NOS PMTs. New 9829 PMTs and voltage dividers to be acquired. Requires mechanical works to modify the CEDARs for compliance.**

STRATEGY

All CEDARs in operation (6) are showing heavy signs of aging, with most of its subsystems presenting faults, accentuated by the last 2023 run.

To address this issues and on a more general level recover the former reliability levels, a staged refurbishment program is proposed until LS3, driven by the criticality for operation, user requirements but also available resources.

With the objective of refurbishing at least two XCEDs/p year a two-stage program is defined:

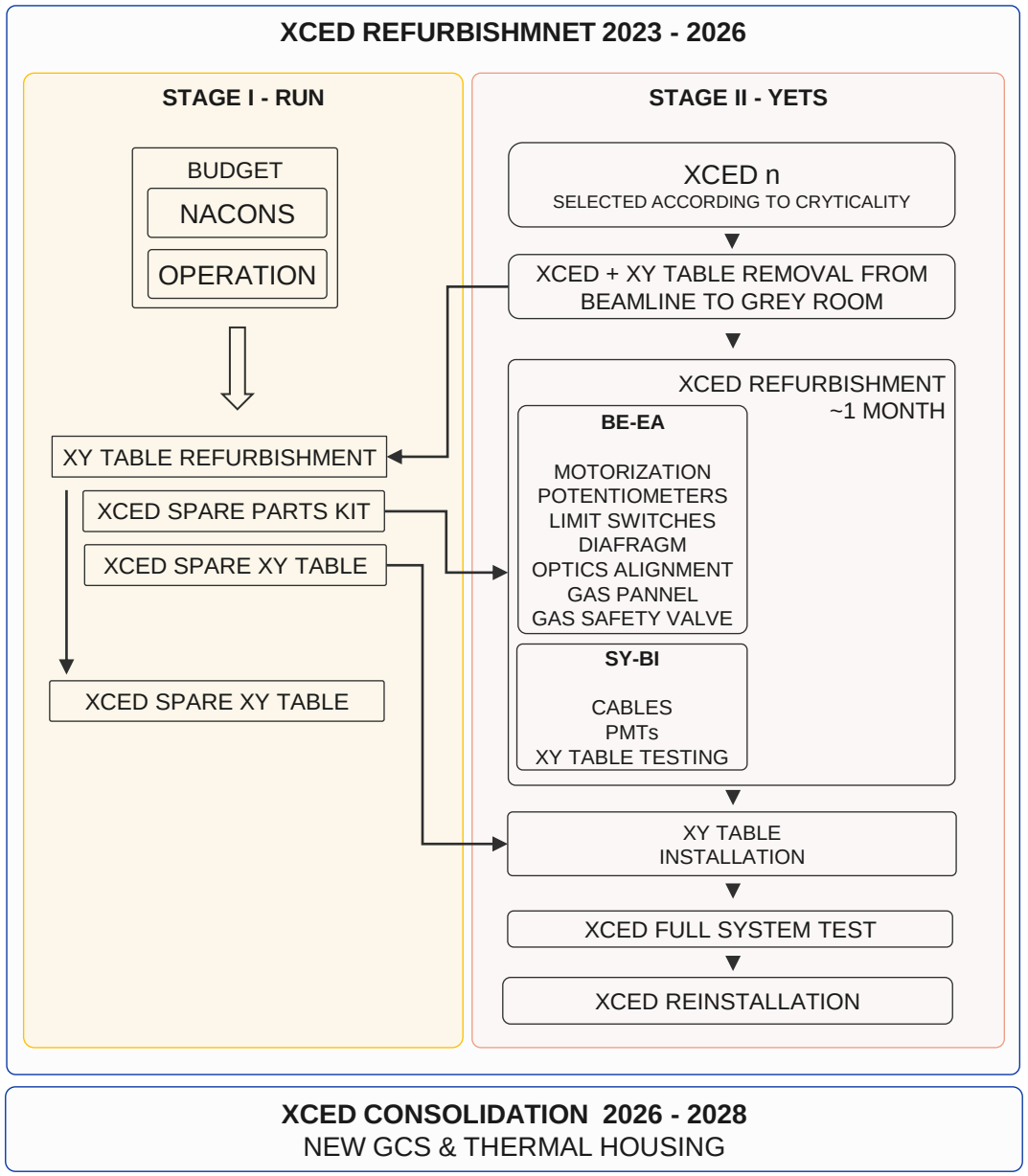
STAGE I – During the yearly run

1. Selection of the XCEDs to be refurbished based on criticality
2. Assembling spare kit sets comprising all components needed for the predicted refurbishment
3. Refurbishment of one set of supports + XY tables

STAGE II – During YETS

1. Removal of the selected XCEDs from beamline
2. Full refurbishment including supports
3. Full system testing
4. Reinstallation

In parallel a full CEDAR spare type N will be refurbished from the XCED spare park during 2024 covering availability needs.

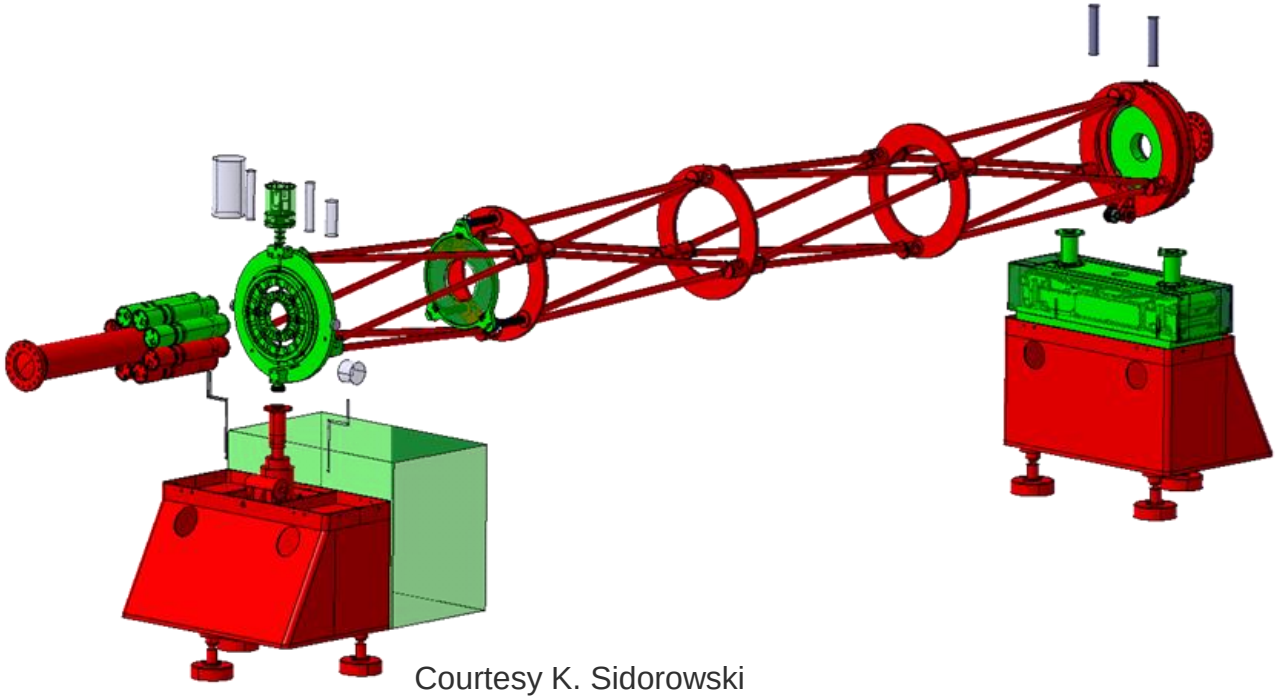


YETS 2023/2024 PRIORITIES

The open issues were compiled and reported at the end of the 2023 run. In a consensus between EA/BI and users, criticality for operation, availability, and resources/planning two CEDARs are being refurbished:

M2 - SPXCEDN001 - CR000002
M2 - SPXCEDN001- CR0000020

- Diaphragm – Mechanics Refurbishment
- Motor + Switches – Replacement
- Gas – Gas pipes refurbishment (correct sized shape etc.)
- Joints – Replacement
- Optics – Alignment
- XY Table – Table precision check / replacement
- Alignment – Realignment of CEDAR



Courtesy K. Sidorowski

For all CEDARS

- Installing new pressure sensors
- Validating new diaphragm movement algorithm
- Measuring quantum efficiency of spare PMTs – To requalify or discard the spare park of PMTs

YETS 2023/2024 PLANNING

			Duration	Start	Finish
1	SPXCEDN001 - CR000002/20	**XCED YETS 2023/2024**	**75 days**	**Sun 17/12/23**	**Fri 29/03/24**
2		**Spares**	**55 days**	**Sun 17/12/23**	**Fri 01/03/24**
3		Spares check list	19 days	Sun 17/12/23	Wed 10/01/24
4		Spares confirmation	1 day	Thu 11/01/24	Thu 11/01/24
5		Diaphragm refurbishment	5 days	Mon 08/01/24	Fri 12/01/24
6		Gas Pipes Procurement	30 days	Mon 08/01/24	Fri 16/02/24
7		**GAS Piping M2 and H2**	**10 days**	**Mon 19/02/24**	**Fri 01/03/24**
8		Tubes replacement	10 days	Mon 19/02/24	Fri 01/03/24
9		**XCED M2 XY table refurbishment**	**10 days**	**Mon 19/02/24**	**Fri 01/03/24**
10		XY tables tests	10 days	Mon 19/02/24	Fri 01/03/24
11	SPXCEDN001 - CR000002/20	**XCED N M2 Refurbishment**	**58 days**	**Wed 10/01/24**	**Fri 29/03/24**
12	SPXCEDN001 - CR000002/20	Empty XCED/Degazage	1 day	Wed 10/01/24	Wed 10/01/24
13	SPXCEDN001 - CR000002/20	Prepare Grey Room area	1 day	Wed 10/01/24	Wed 10/01/24
14	SPXCEDN001 - CR000002/20	Transport to Grey Room Area	1 day	Fri 12/01/24	Fri 12/01/24
15	SPXCEDN001 - CR000002/20	Remove Thermal Housing	1 day	Mon 15/01/24	Mon 15/01/24
16	SPXCEDN001 - CR000002/20	Remove Gas Connections/From Pannel	1 day	Mon 15/01/24	Mon 15/01/24
17	SPXCEDN001 - CR000002/20	Prepare CEDAR to GREY ROOM feet etc..	1 day	Mon 15/01/24	Mon 15/01/24
18	SPXCEDN001 - CR000002/20	Place XCED to Gray Room	1 day	Mon 15/01/24	Mon 15/01/24
19	SPXCEDN001 - CR000002/20	Cleaning Grey Room	1 day	Tue 16/01/24	Tue 16/01/24
20	SPXCEDN001 - CR000002	Opening the nose of CEDAR	1 day	Wed 17/01/24	Wed 17/01/24
21	SPXCEDN001 - CR000002	Replace control - motor - potentiometer - limit switches	12 days	Thu 18/01/24	Fri 02/02/24
22	SPXCEDN001 - CR000002	Diaphragm inspection/Replacement	12 days	Thu 18/01/24	Fri 02/02/24
23	SPXCEDN001 - CR000002	Change joints nose and PTM windows	12 days	Thu 18/01/24	Fri 02/02/24
24	SPXCEDN001 - CR000002	Testing/Systems Check	1 day	Mon 05/02/24	Mon 05/02/24
25	SPXCEDN001 - CR000002	Extracxt XCED Optics + Red trolley + Optics outside	1 day	Tue 06/02/24	Tue 06/02/24
26	SPXCEDN001 - CR000002	Check and Align optics	3 days	Wed 07/02/24	Fri 09/02/24
27	SPXCEDN001 - CR000002	Close XCED optics and nose	1 day	Mon 12/02/24	Mon 12/02/24
28	SPXCEDN001 - CR000002	Final Check system check	1 day	Mon 12/02/24	Mon 12/02/24
29	SPXCEDN001 - CR000002	Leak Test	2 days	Tue 13/02/24	Wed 14/02/24
30	SPXCEDN001 - CR0000020	Opening the nose of CEDAR	1 day	Thu 15/02/24	Thu 15/02/24
31	SPXCEDN001 - CR0000020	Replace control - motor - potentiometer - limit switches	12 days	Fri 16/02/24	Mon 04/03/24
32	SPXCEDN001 - CR0000020	Diaphragm inspection/Replacement	12 days	Fri 16/02/24	Mon 04/03/24
33	SPXCEDN001 - CR0000020	Change joints nose and PTM windows	12 days	Fri 16/02/24	Mon 04/03/24
34	SPXCEDN001 - CR0000020	Testing/Systems Check	1 day	Tue 05/03/24	Tue 05/03/24
35	SPXCEDN001 - CR0000020	Extracxt XCED Optics + Red trolley + Optics outside	1 day	Wed 06/03/24	Wed 06/03/24
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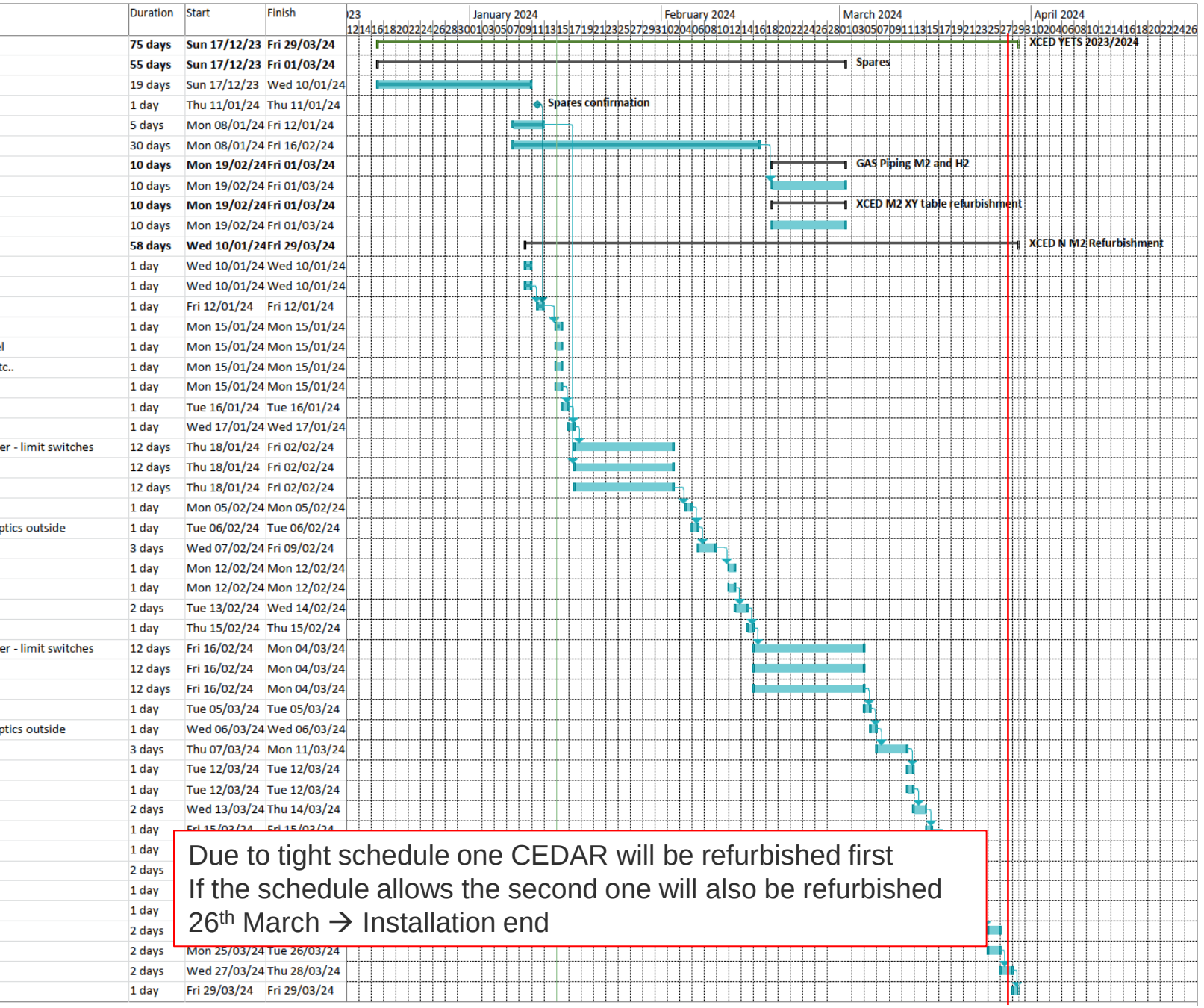
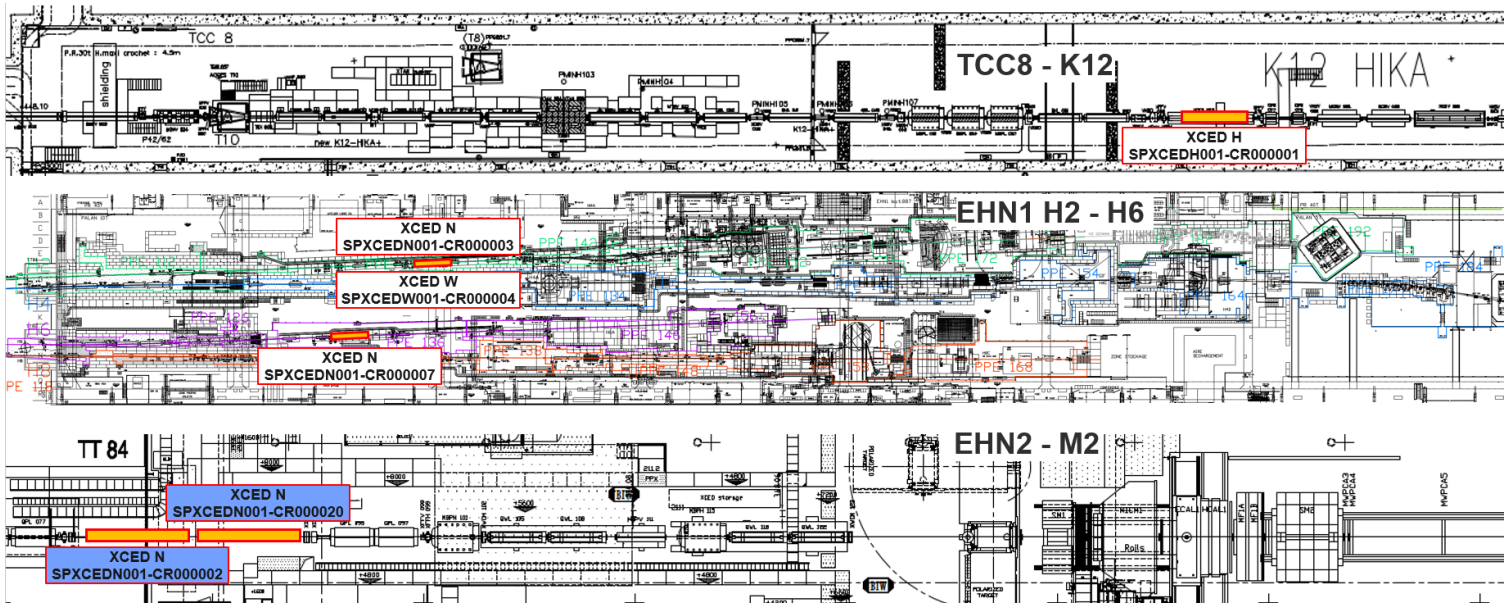
38	SPXCEDN001 - CR0000020	Final Check system check	1 day	Tue 12/03/24	Tue 12/03/24
39	SPXCEDN001 - CR0000020	Leak Test	2 days	Wed 13/03/24	Thu 14/03/24
40	SPXCEDN001 - CR000002/20	Remove XCED from Grey Room	1 day	Fri 15/03/24	Fri 15/03/24
41	SPXCEDN001 - CR000002/20	Move CEDAR to workshop	1 day		
42	SPXCEDN001 - CR000002/20	Pressure test	2 days		
43	SPXCEDN001 - CR000002/20	Purge	1 day		
44	SPXCEDN001 - CR000002/20	Transport to beamline	1 day		
45	SPXCEDN001 - CR000002/20	Thermal housing assembly	2 days		
46	SPXCEDN001 - CR000002/20	Gas Connection	2 days	Mon 25/03/24	Tue 26/03/24
47	SPXCEDN001 - CR000002/20	Controll connection	2 days	Wed 27/03/24	Thu 28/03/24
48	SPXCEDN001 - CR000002/20	Comission	1 day	Fri 29/03/24	Fri 29/03/24



Due to tight schedule one CEDAR will be refurbished first
If the schedule allows the second one will also be refurbished
26th March → Installation end

CONCLUSION

M2 - SPXCEDN001 - CR000002 /20	
System	**Solution**
Gas	**New pressure sensors –TERPS pressure sensor**
	New electro valve
	All piping in the CEDAR shall be replaced by new rad. hard piping compliant with operation pressures
Mechanical / Software	**Software optimization. Mechanical Refurbishment**
	Convergence algorithms implemented as mitigation. Mechanical refurbishment
Mechanical	**Replace with new mechanical parts.**
Alignment	**New alignment procedure**
Control & acquisition	**New electronics being developed to be deployed during LS3**
PMTs	**Quantum efficiency measurements of NOS PMTs. New 9829 PMTs and voltage dividers to be acquired. Requires mechanical works to modify the CEDARs for compliance.**



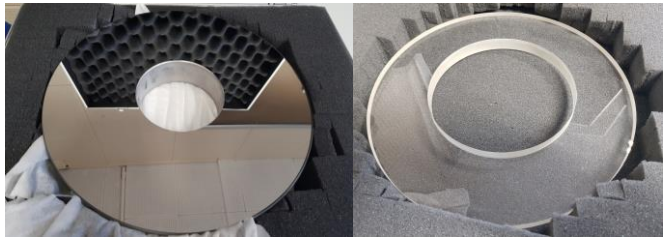
NEW OPTICS N 2023 TESTS INTRUDUCTION

Originally, 15 optical systems were produced (7 W and 8 N)
From these currently we have:

- 15 N optical sets → 3 Spares (one new produced between 2021 and 2022)
- 1 W optical set → No spares
- 1 H Optical set → No spares

A New set of N optics was purchased in between 2021 and 2022 based on an updated technical specification developed for the XCED H.
Technical Description - Supply of New Optics for the CEDAR detectors → EDMS2608867

At the same time a new optics alignment procedure was developed to ensure the correct installation of the optical components in the XCEDs
CEDAR Optics alignment procedure → EDMS2895876



26.07.2023 – 08.09.2023 → N optics testing campaign With the objective to validate the optics and the manufacturing procedure.

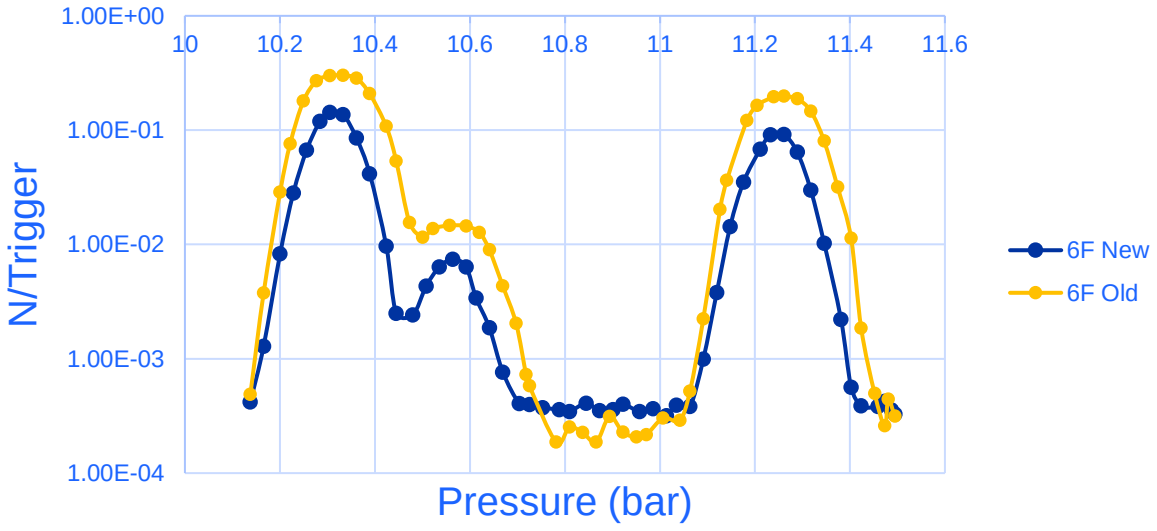
NEW OPTICS N 2023 TESTS RESULTS

The tests were performed in H6 beamline using the **XCED N SPXCEDN001-CR000007** retrofitted with new PMTs (efficiencies checked with 20mm diaphragm opening. Counting about 70 to 75% for both thest)

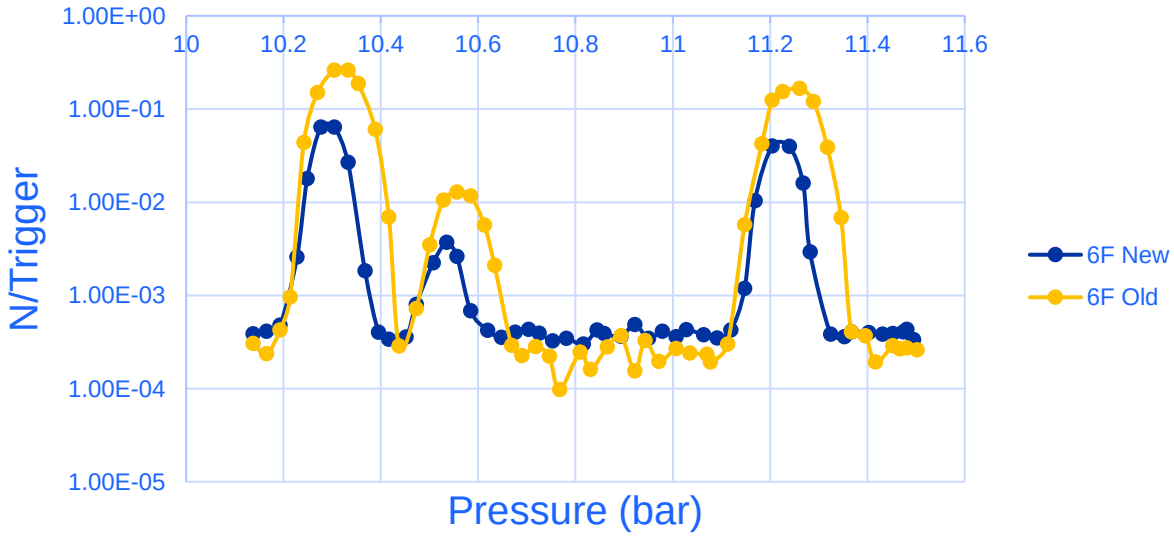
2 Optic sets / 2 tests:

- New XCED N optics (Chromatic corrector + Mangin mirror)
- Old XCED N optics (Chromatic corrector + Mangin mirror) → **REFERENCE**

COMPARISON 2023 TEST – 2 MM DIAPHRAGM
COURTESY D. BANERJEE



COMPARISON 2023 TEST – 1 MM DIAPHRAGM
COURTESY D. BANERJEE



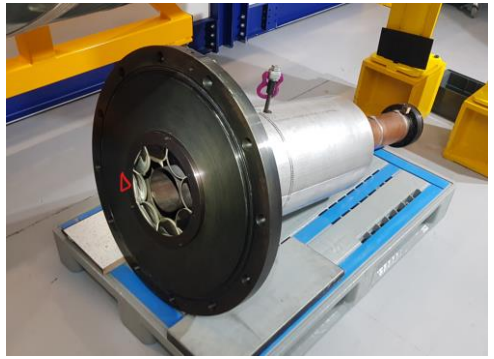
NEW OPTICS N 2023 TESTS CONCLUSIONS

The new optics seem to lack the efficiency of the old ones.
Such low efficiency fall off from the user requirements and if confirmed the new optics cannot be used.

ACTION:

A new test will be placed in 2024

- Confirm results
- Eliminate any source of potential errors → PROCEDURE!

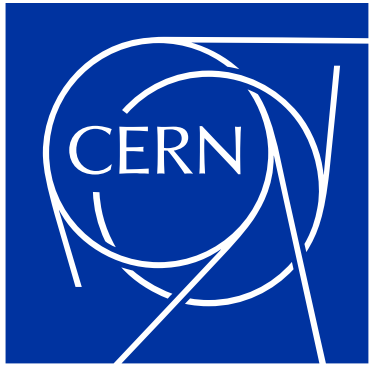


Between tests it was noted that the following lens in the nose was slightly tilted, and we moved it to the correct position. So, the tests with the old optics might have seen better condition.

Review Metrology and FAT of the New N Optics VS Old optics

IF CONFIRMED:

XCED Optics model to understand in depth the working of the optical system of the XCEDS
Review of the manufacturing process
Study of the new optics (Interferometry, Spectrophotometry, Reflectivity)



Thank you very much for your attention!

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