

# Module-0 Experience

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# Module-0 PDS document

<https://edms.cern.ch/document/2875448/1>

- The document describing pre-testing, assembly, testing and installation is posted in EDMS
- Many lessons learned in the document

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# Ingredients

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- Clear set of goals
- Well defined timeline
- Understand interplay between R&D and production/installation
- Production and testing of components
- Logistics: detailed tracking of component status and shipments
- Human resources at CERN
- XA testing and assembly infrastructures at CERN
- Interfaces with other consortia
- Fluid communication with Neutrino Platform coordination team

# Different XA configurations

- In Module-0 we had many different configurations
- Do we expect something similar for Module-1 ?
- Having a clear list of configurations ASAP will be beneficial

	WLS dimples	DF size (mm <sup>2</sup> )	DF	SiPM	PoF	SoF	shared <u>elec.</u> box
<b>M1</b>		100x200	ZAOT	HPK			x
<b>M2</b>		100x200	ZAOT	HPK			x
<b>M3</b>	x	100x200	ZAOT	HPK			x
<b>M4</b>	x	100x200	ZAOT	HPK			x
<b>M5</b>	x	150x150	PE	FBK		x	
<b>M6</b>	x	150x150	PE	HPK			
<b>M7</b>	x	150x150	PE	HPK			
<b>M8</b>	x	150x150	PE	FBK			
<b>C1</b>		100x200	ZAOT	HPK	x	x	
<b>C2</b>		100x200	ZAOT	HPK	x	x	
<b>C3</b>		150x150	PE	FBK	x	x	
<b>C4</b>	x	150x150	PE	HPK	x	x	
<b>C5</b>	x	150x150	ZAOT	HPK	x	x	
<b>C6</b>	x	150x150	ZAOT	HPK	x	x	
<b>C7</b>	x	150x150	ZAOT	FBK	x	x	
<b>C8</b>	x	150x150	ZAOT	HPK	x	x	



- R&D, mainly on electronics, was ongoing during Module-0 production and installation
  - This implied testing of electronics components at CERN and last minute changes
- The mechanical design of some components was also changed during production and installation of the 16 modules
  - Shielding mesh
  - vikuity for backplane and flexes
- For Module-1 we should try to avoid that

# Logistics

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- Timely planning for component production and delivery to assembly sites
- Detailed tracking of the status of each component
- Detail tracking of shipment of components, between institutes, between institutes and industry, to CERN

# Tracking of components status

- This was not available when we started production for Module-0
- Having this table was crucial to meet the schedule

Component	Membrane (non-TCO) Installation Feb 2nd		CATHODE (non-TCO) Installation Feb 8th				Membrane (TCO) Installation Feb 28th		CATHODE (TCO) Installation in Cathode Feb 28th		
	M1	M2	C1	C2	C3	C4	M3	M4	C5	C6	C7
DATE assembled needed			Feb 6th	Feb 6th	Feb 9th	Feb 10th	Feb 20th	Feb 21st	Feb 24nd	Feb 27rd	Feb 28th
<b>Frame</b>	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN
<b>Flex and SiPMs</b>	OK at CERN (Hamamatsu)	OK at CERN (Hamamatsu)	OK at CERN	OK at CERN	OK at CERN (FBK)	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN
<b>Vikuiti for Flex</b>	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN (installation to be done on flexes)	OK at CERN (installation to be done on flexes)	OK at CERN	OK at CERN	OK at CERN
<b>Vikuit for ribs</b>	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN
<b>Vikuiti for backplane</b>	OK at CERN (4 pieces for one backplane)	OK at CERN (Installed on backplane)	N/A	N/A	N/A	N/A	Come installed on backplane.	Come installed on backplane.	N/A	N/A	N/A
<b>Cables from flex to MB</b>	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	Ok at CERN	Ok at CERN	Ok at CERN	Ok at CERN
<b>Motherboard</b>	Two vendor-populated (2) DMEM v1.0 and two hand populated at CERN. Worried about 47uF X5R caps (Peter is bringing them). WE DON'T KNOW YET WHICH BOARD WILL BE INSTALLED. NO WORRY ABOUT SHIPMENTS		Ok at CERN (laser adaptors w/lasers, motherboards, LBL bias)	Ok at CERN (laser adaptors w/lasers, motherboards, LBL bias)	Ok at CERN (laser adaptors w/lasers, motherboards, LBL bias)	Ok at CERN (laser adaptors w/lasers, motherboards, LBL bias)	Ok at CERN (modifications being done)	Ok at CERN (modifications being done)	Ready	Need different laser to test it	Need test
<b>Electronics box</b>	Peter (1 box) & Bias cards		OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	OK at CERN	Ok at CERN.	Ok at CERN	Ok at CERN
<b>HD-style Cold cables</b>	OK at CERN		N/A	N/A	N/A	N/A	Ok at CERN	Ok at CERN	N/A	N/A	N/A
<b>WLS</b>	OK at CERN (not dimpled)	OK at CERN (not dimpled)	OK at CERN (not dimpled)	OK at CERN (not dimpled)	OK at CERN (not dimpled)	OK at CERN (dimples)	OK at CERN (dimples)	OK at CERN (dimples)	OK at CERN (dimples)	OK at CERN (dimples)	OK at CERN (dimples)
<b>Filters</b>	OK at CERN (ZAOT 100x200)	OK at CERN (ZAOT 100x200)	OK at CERN (ZAOT 100x200)	OK at CERN (ZAOT 100x200)	OK at CERN (PE 143x143)	OK at CERN (PE 143x143)	Ok at CERN	Ok at CERN	Ok at CERN.	Ok at CERN.	Ok at CERN
<b>Shielding Mesh</b>	Arrived on the 24th to be pick up on 25th		N/A	N/A	N/A	N/A	Ok at CERN (finishing and cleaning)	Ok at CERN (finishing and cleaning)	N/A	N/A	N/A
<b>Counterweight</b>	OK at CERN	OK at CERN	N/A	N/A	N/A	N/A	Ok at CERN	Ok at CERN	N/A	N/A	N/A
<b>Mounting vertical lines</b>	OK at CERN/Installed	OK at CERN/Installed	N/A	N/A	N/A	N/A	OK at CERN/Installed	OK at CERN/Installed	Ok at CERN	Ok at CERN	Ok at CERN
<b>Response Monitoring System</b>	OK will be brought from CIEMAT on Jan 23rd						N/A	N/A	N/A	N/A	N/A
<b>Penetration</b>	Not til February - first module cables will not be pulled up until BDE cables are ready to be pulled up. Flange at CERN. Septum sent to production. Expected at CERN end Feb. Hardware at CERN.										
<b>Frame to hold two mem. modules</b>	OK at CERN		N/A	N/A	N/A	N/A	OK at CERN		N/A	N/A	N/A
<b>Cathode fibers</b>	N/A	N/A	Ok at CERN	Ok at CERN	Ok at CERN	Ok at CERN	N/A	N/A	Ok at CERN	Ok at CERN	Ok at CERN
<b>Cathode Frame-to-Mesh supports</b>	N/A	N/A	Ok at CERN	Ok at CERN	Ok at CERN	Ok at CERN	N/A	N/A	Ok at CERN	Ok at CERN	Ok at CERN



# Detail tracking of all shipments

- We could use the same approach as for Module-0, where we had to deal with more than 70 shipments

1	Product	Size	Weight (kg)	From	To	Responsible	Date sent	Date expected	Date delivered	Collected by	Company	Tracking number
2	Electronics box	31x7x6 in.	1.36	Iowa City	CERN-Meyrin	Paul Debbins	13/12/2022	19/12/2022	19/12/2022, 11:38	Anselmo	FedEx	7707 6696 5099
3	ZAOT dichroic filters (37 units, 97x97 mm)	15x19x29 cm	1.55	Unicamp	CERN-Meyrin	Ana/MCecilia	12/12/2022	20/12/2022	20/12/2022, 11:36	Anselmo	UPS	1ZE286536791072173
4	ZAOT dichroic filters (78 units, 200x100 mm)	26x37x44 cm	8.75	Unicamp	CERN-Meyrin	Ana/MCecilia	12/12/2022	20/12/2022	20/12/2022, 11:36	Anselmo	UPS	1ZE286536790230388
5	ZAOT dichroic filters (42 units, 200x100 mm) (6 units, 77x100)	17x37x47 cm	5.60	Unicamp	CERN-Meyrin	Ana/MCecilia	12/12/2022	20/12/2022	20/12/2022, 11:36	Anselmo	UPS	1ZE286536791509791
6	Membrane Suspension Lines, PD modules fixation & the light calibration system elements	300 x 16 cm	20.0	CIEMAT	CERN-Preessin	Iván Martín	14/12/2022	20/12/2022	20/12/2022	Anselmo	Cedex	
7	HPK SiPMs (700 units bought by Fermilab through CERN)	22x26x31 cm	1.0	HPK	CERN-Meyrin	Wei Shi			12/12/2022	Anselmo		
8	Fibers, diffusers, SMA FT	14x14x9 in.	2.27	ANL	CERN-Preessin	Zelimir	21/12/2022		6/01/2023, 10:15	F. Resnati	FedEx	540651804252
9	PoF Fibers	1 box		MH GoPower Taiwan	CERN-Preessin	Bill P.	19/12/2022			F. Resnati	DHL	<a href="#">8377656350</a>
10	HPK SiPMs (700 units bought by Fermilab through CERN)	22x26x31 cm	1.0	IFIC-Valencia	SCEN-Italy	Anselmo	29/12/2022	30/12/2022	??	SCEN	UPS	1Z208A4A8692947378
11	6 Flex Circuits with Hamamatsu SIPMs	30x40x8cm	1.0	NIU	CIEMAT	K.Francis	5/1/2023	9/1/2023		A. Verdugo	UPS	1ZK8604T0400003018
12	2 DMEM boards	34x32x8 cm	1	Milano-Bicocca	CERN-Preessin	C.Gotti	12/1/2023		16/1/2023	Franciole	UPS	1Z66A73Y0496195320
13	Cables from flex to motherboard (100 units)			Fermilab	CERN-Preessin		17/01/2023	19/01/2023	19/01/2023	Franciole (20/01)	FedEx	<a href="#">606030526619</a>
14												



# XA mechanics and assembly I

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- The **WLS sags**. This would be partially resolved with the thicker WLS that has been proposed
- The **C-Channels bend at the corners**
- Issues applying **Vikuiti**
  - On the FBK flex circuits
  - Need a better design for the Vikuiti that wraps around the copper clad G10
  - The large sheets of Vikuiti on the membrane mount backplane
- Find a way to attach the frames to the housing that doesn't require screws to be threaded in from and then carefully unscrewed and rethreaded from the other direction to **prevent the spacers from coming loose**.

# XA mechanics and assembly II

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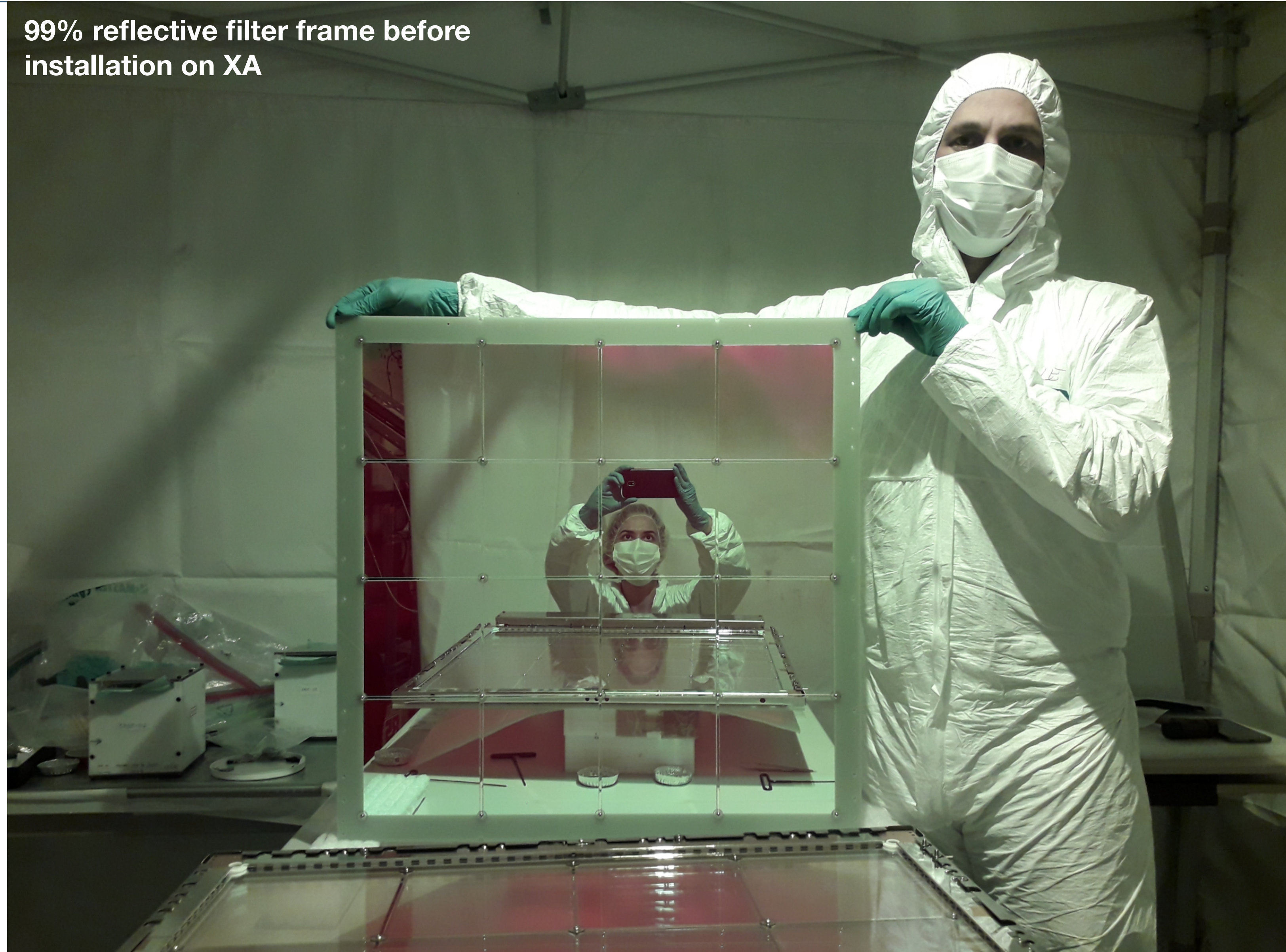
- Loosening spring pocket spacers → (cryo-approved) Loctite 326
- WLS centering on SiPM → PTFE pads now constrain WLS in housing
- Faraday Cage Design → Added grounding points for SiPM lead cables
- Electronics Enclosure Mounting. Arms must be installed earlier. Directionality must be established and tracked earlier
- Protection of WLS during assembly
- WLS Pin Dimension → change from 3mm to 4.5mm slot in WLS
- Sourcing Copper Clad G10 → Easy to source and inexpensive
- Vikuiti Adhesion
- Improved SiPM Lead Cable Routing/Grounding



# The clean tent

- A clean tent with air filter was setup inside the PDS room for Module-0 assembly
- Do we need a clean tent for Module-1 ?
- Not so important since in principle only filters need to be added
- However, if available I would use it

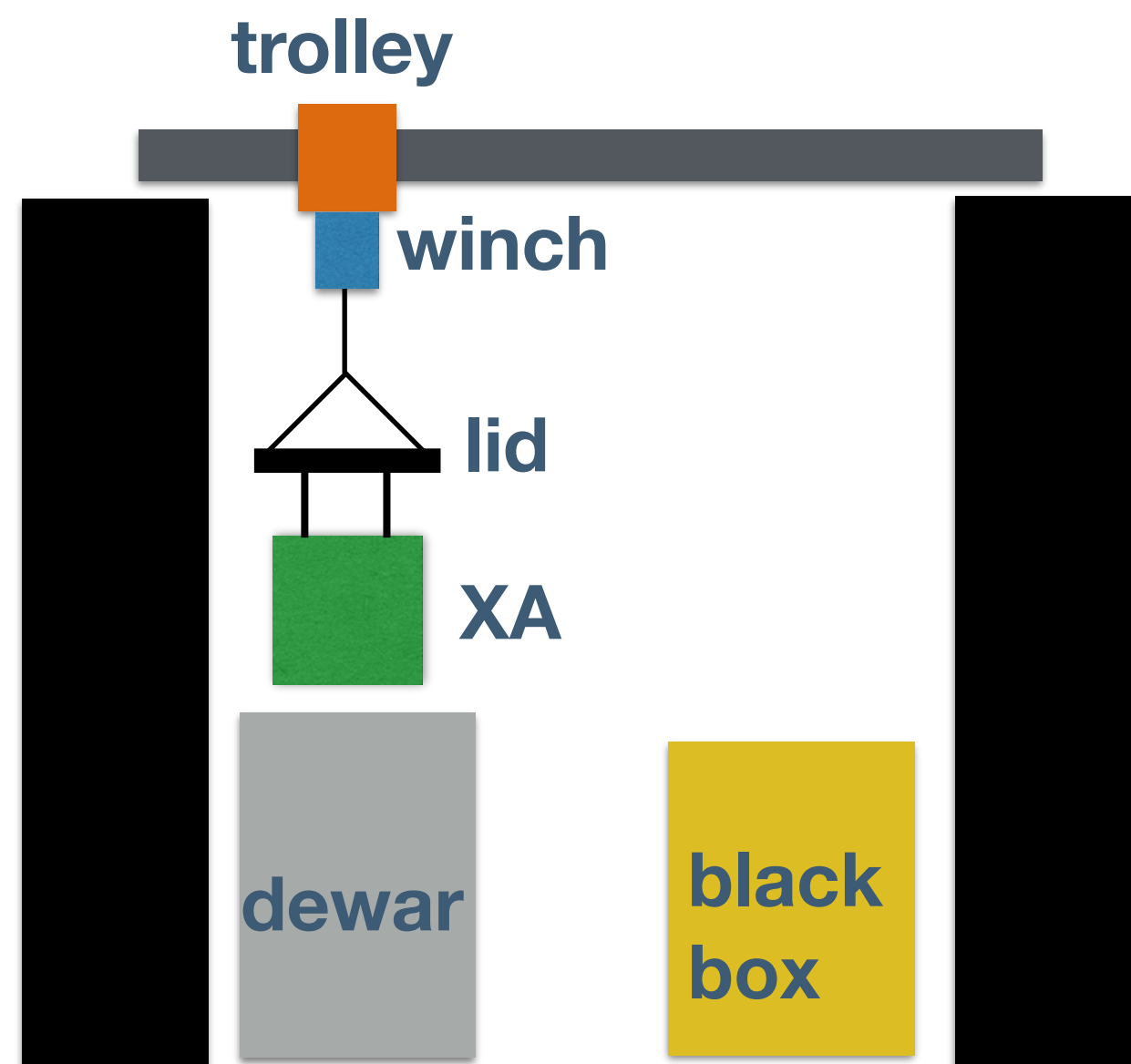
99% reflective filter frame before installation on XA





# Test stand at CERN

- For FD2, there will be dedicated assembly and testing facilities decoupled from installation. This was not possible for Module-0, nor will be for Module-1, and testing has to be done at CERN
- A test stand was setup in December in front of the PDS room, below the 3rd barrack





# Testing

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- The test stand at CERN have been crucial for Module-0. Cold testing is fundamental to ensure all modules are operational
- The cold testing procedure was refined during Module-0 installation
  - Proper cool-down and warmup are fundamental
  - Need to reduce EM noise with proper shielding and grounding
- Experience from Module-0 tells us that it would be better to concentrate testing all 6 modules in the same week(s):
  - Less LAr consumption
  - No change in conditions, e.g. EM noise
  - More human resources available during a well defined period

# Human resources

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- Having a good team at CERN was crucial to meet the schedule
  - We had experts in XA assembly, electronics and installation + supporting people
- The situation now is a bit different since assembly is expected to be done elsewhere, also the installation is much simpler
- Testing and installation could be probably concentrated in 2 weeks
  - Mainly need electronics experts (at least two), able to modify motherboards, with experience in PoF and SoF
  - + 2 more people to assemble filters in the frame and help with logistics