

ioLaser Update

David Rivera

ioLaser Group Meeting

October 18, 2022

Ongoing activities at LANL

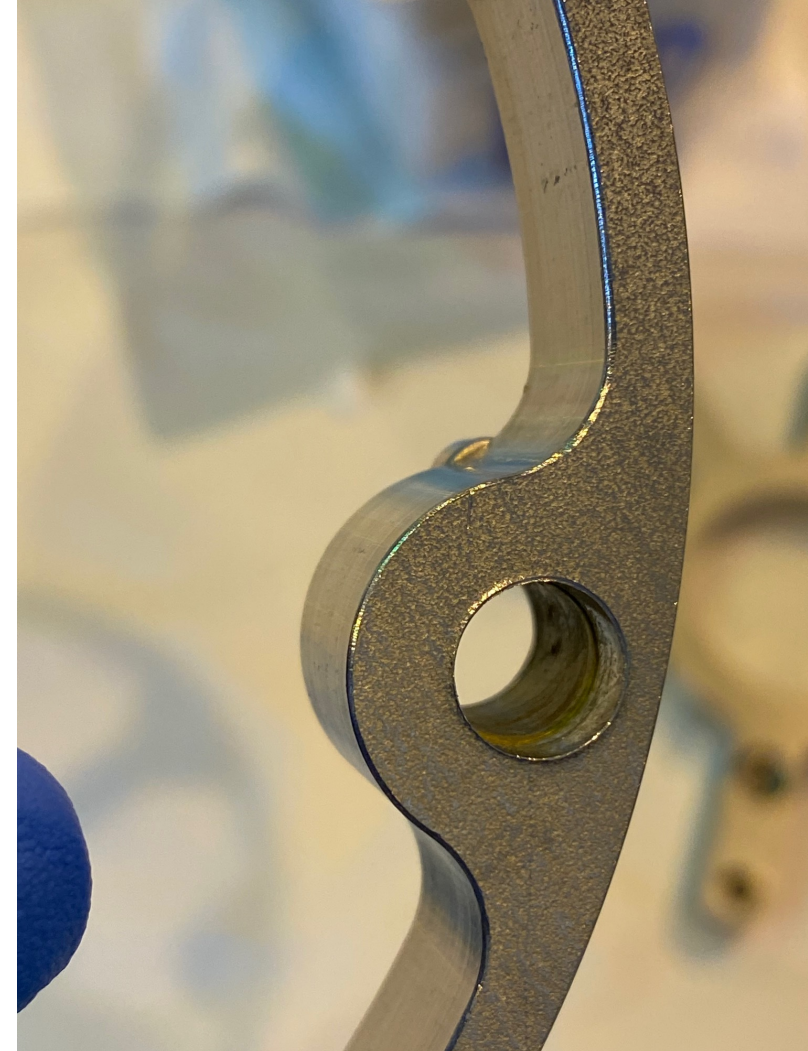
- ~~Cleaning periscope rods (steel and Torlon)~~
 - Torlon water retention tests
- Packing feedthrough components
- Packing actuator rods (steel and Torlon)
- Cleaning and packing Quartz tubes (more on this next time)

Cleaning Periscope Components

- Both periscopes have been fully disassembled
 - Steel rods marked w/ marking punch to distinguish between rods for P1 & P2
 - Steel rods are marked w/ a reference designator to indicate where it was installed
 - Torlon rods not marked but packaged systematically and packaging labelled
 - Torlon components such as tube-holders, spacers, and mirror holders marked w/ marking punch
- Stainless Steel hardware first cleaned in ultrasonic bath with detergent
- Rinsed w/ distilled water and/or received a second bath in 70% isopropyl alcohol
 - Steel spacer rods wiped down after first cleaning. Too large to submerge in 70% isopropyl
 - Small screws and parts (e.g. target) cleaned in ultrasonic bath w/ 70% isopropyl (60C, 30 min)
- Metal spacers have Torlon bushings for each of the two long stainless steel rods
 - Very tight fit, and some showed damaged from use
 - Not removed. Instead surface cleaned w/ 70% isopropyl

Torlon bushing

- Roughed up
 - Initially these had to be drilled to allow for the SS rods for the target and mirror actuator rods to pass through
 - Some cracked/chipped a little bit



Torlon® Polyamide-Imide (PAI) 4203

- Registered trademark by Solvay
 - Design guide by Solvay [here](#)
- 4203 is the grade we have chosen. Extruded
- High strength (over large temperature range)
- Low creep
- Good dielectric properties
 - Dielectric strength: 23.6 kV/mm
- Water absorption, 24 hours: 0.33%
 - Higher than other grades of Torlon
- Must avoid soaking or placing Torlon in high humidity environments over extended periods of time

Table 5: Tensile properties per ASTM D1708

		Grade					
Property	Unit	4203L	4301	4275	4435	5030	7130
Tensile strength							
23 °C	MPa	192	164	131	110	205	203
73 °F	kpsi	27.8	23.7	19.0	16.0	29.7	29.4
135 °C	MPa	117	113	116	90	160	158
275 °F	kpsi	16.9	16.3	16.9	13.0	23.1	22.8
232 °C	MPa	66	73	56	52	113	108
450 °F	kpsi	9.5	10.6	8.1	7.5	16.3	15.7
Tensile elongation at break							
23 °C	%	15	7	7	6	7	6
73 °F	%						
135 °C	%	21	20	15	4	15	14
275 °F	%						
232 °C	%	22	17	17	3	12	11
450 °F	%						
Tensile modulus							
23 °C	GPa	4.5	6.8	8.8	14.5	14.6	16.5
73 °F	kpsi	700	950	1,130	1,410	1,560	3,220

Table 6: Properties of Torlon® PAI molding resins at -196 °C (-321 °F)

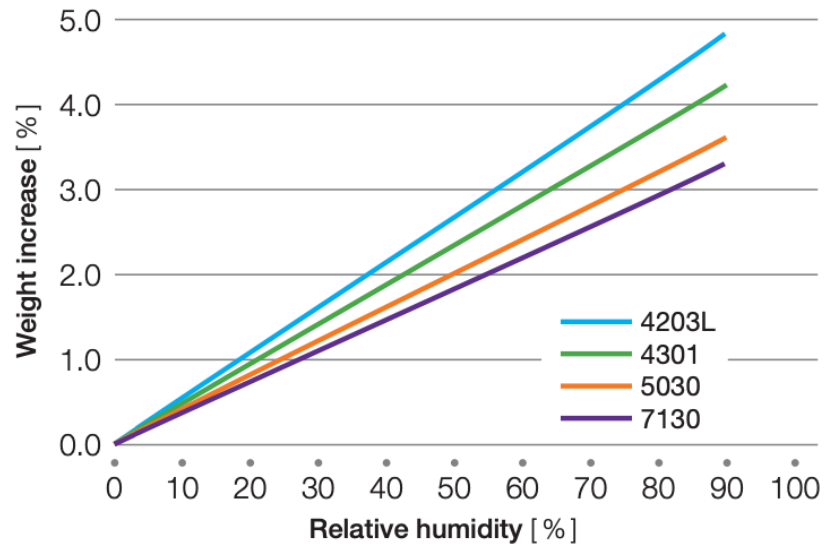
		Grade			
Property	Unit	4203L	4275	5030	7130
Tensile strength ⁽¹⁾	MPa	216	129	203	157
	kpsi	31.5	18.8	29.5	22.8
Elongation at break ⁽¹⁾	%	6	3	4	3
Flexural strength ⁽²⁾	MPa	282	200	374	310
	kpsi	41.0	29.0	54.4	45.0
Flexural modulus ⁽²⁾	GPa	7.8	9.6	14.0	24.6
	kpsi	1,140	1,390	2,040	3,570

⁽¹⁾ ASTM D1708

⁽²⁾ ASTM D790

Effects of water absorption

Figure 32: Equilibrium moisture absorption vs. relative humidity



Absorbed water reduces the electrical resistance of Torlon® PAI resin and slightly changes dielectric properties. With 2 % moisture, Torlon® PAI specimens had volume and surface resistivities of $3 \cdot 10^{14}$ ohm/m ($1 \cdot 10^{16}$ ohm/inch) and $1 \cdot 10^{17}$ ohm respectively, and dielectric strength of 24 kV/mm (620 V/mil).

Table 27: Property change of Torlon® 4203L at 2 % absorbed water

Property	Change [%]
Tensile strength	-7
Tensile modulus	-11
Elongation	13
Shear strength	1
Izod impact strength	20
Dielectric constant	18
Dissipation factor	53

Chemical compatibility

- Cleaned unused components (original Torlon target pieces, short rods, and older revision of Torlon screws) with **20% isopropyl alcohol**

- 60C, 30 min

- Noted larger than expected changes in the weight before and after (0.3% for the short bath)

- Looked into chemical compatibility and Torlon design guide from Solvay

- Increased the isopropyl concentration to 70%

- Reduced temperature to 45 C

	Conc. (%)	Temp. (°C)	ERTALON (NYLATRON (PA) *	ERTACETAL C (POM C)	ERTACETAL H (POM H)	ERTALYTE (PET)	PC 1000	CESTILENE ** (PE-HD)	CELAZOLE PBI	TORLON PAI	KETRON PEEK *	TECHTRON HPV PPS	PPSU 1000	PEI 1000	PSU 1000	PVDF 1000	FLUOROSINT	Chemical Group	Syn. Nr.	
Iron(III)-chloride (FeCl ₃)	10	RT	B	B			A	A		A	A	A	A	A	A	A	A		67	
	50	100		C						B	A	A	A		A	A	A		67	
	SS	RT	C				A	A		A	A	A			A	A	A		67	
Iso-octane			see synonyms page 5 and 26															ALHC	144	
	UD	125													B		A			
Isobutanol			see synonyms page 5 and 26															ALCO	170	
Isobutyl acetate (CH ₃ COOCH ₂ CH(CH ₃) ₂)	UD	RT		A						A	A			B			A	ESTR		
Isobutyl alcohol ((CH ₃) ₂ CHCH ₂ OH)	UD	RT			A				A	A					C		A	ALCO	70	
Isopropanol			see synonyms page 5 and 26															ALCO	115	
Isopropyl acetate (CH ₃ COOCH(CH ₃) ₂)	UD	RT		A					A	A				B			A	ESTR		
Isopropyl alcohol ((CH ₃) ₂ CHOH)	UD	RT	A	A		B	C	A	A	A					A	A	A	ALCO	15	
	UD	60		A		B	C	A		A				A	A	A	A		15	
	UD	100					C			A					A	A	A		15	
Washing waters			see synonyms page 5 and 26															ELSE	196	
Water (H ₂ O)	UD	RT	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ELSE	
	UD	60	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		
	UD	80	B	A	B	B	A			A	A	A	A	A	A	A	A			
	UD	95		B						A	A	A	A	A	A	A	A			
	UD	100	B	B		C			B	B	A	B	A	A	A	A	A			
Water (chlorid) (H ₂ O)	UD	RT	A	A	A	A	A	A		B	A	A	A	A	A	A	A	ELSE		
Water (demineralised) (H ₂ O)	UD	RT	A	A	A	A	A	A		B	A	A	A	A	A	A	A	ELSE		
Water (distilled) (H ₂ O)	UD	RT	A	A	A	A	A	A		B	A	A	A	A	A	A	A	ELSE		

Chemical compatibility of various plastics including Torlon. [1]

Meaning of the symbols

RESISTANCE RATINGS:

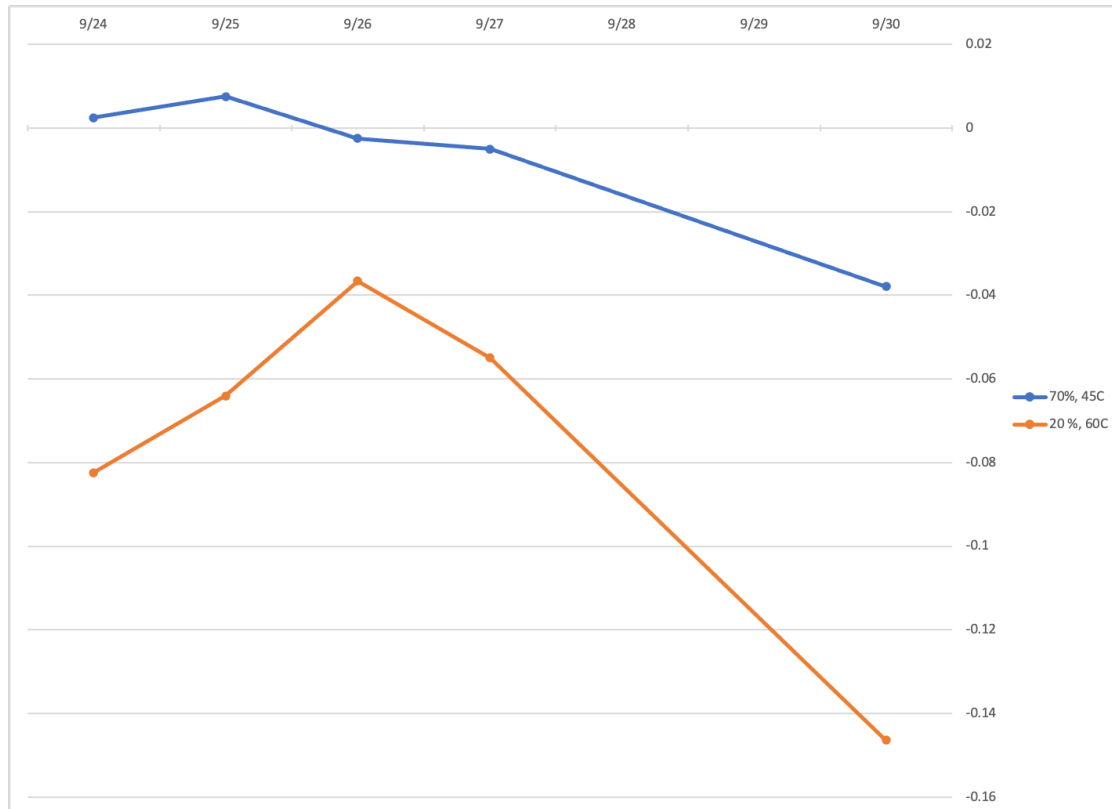
- A: Resistant. Little or no change in weight. Small effect on mechanical properties. Generally suitable for practical use.
- B: Partially resistant. In course of time, there is a distinct deterioration in mechanical properties and a change in weight. In many cases a short exposure may be considered allowable.
- C: Non-resistant. After a short time, the material is seriously affected (considerable reduction of the mechanical strength and changes in weight). Using the material under these conditions is not recommended.
- O: Dissolves.

CONCENTRATIONS:

%; Indicates "g of solute per 100 g of aqueous solution".
UD: Undiluted (technically pure chemical).
SS: Saturated aqueous solution (at 23°C).
CA: As commercially available.

TEMPERATURES:

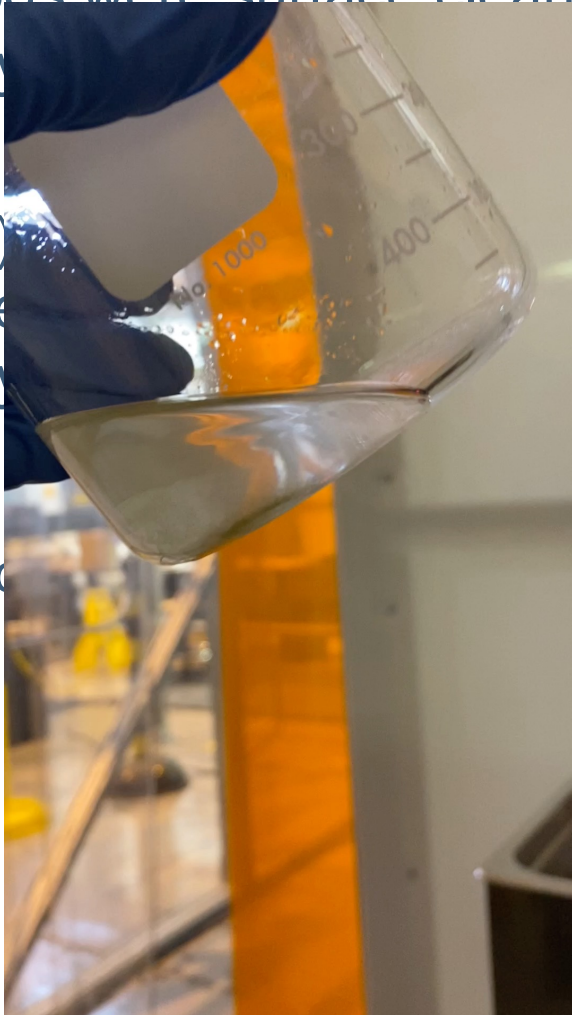
RT: Room temperature (15 – 25°C).



- Larger fluctuations in the % change in weight observed for Torlon pieces originally cleaned with 20% isopropyl alcohol and 60C vs. 70% isopropyl and 45C
- Disclaimer: different pieces of torlon have different geometries and can also affect the amount of water absorbed
- Will repeat tests w/ identical pieces after allowing them to equilibrate

Torlon Cleaning

- Long rods were surface cleaned w/ 70% isopropyl alcohol
- Stages (mirror holders, rods & nuts) cleaned w/ 70% isopropyl alcohol
 - Small amount of residue observed
 - **A lot** of residue removed



- Torlon parts all allowed to dry next to HEPA filter for >2 days
- Changes in weight before and after the sonic bath and over dry time generally below



- Large spacers and parts (gear rack, gear, mirror holders, etc.) weighed after doing a quick surface cleaning w/ 70% isopropyl alcohol (to remove visible dust/grime)
 - Weighed again for two days while allowing parts to dry
 - P-1 % change in weight after 2 days of drying: (0.065 ± 0.084) %
 - P-2 % change in weight after 2 days of drying: (0.022 ± 0.028) %
- In both cases the change in weight is less than 0.1 percent
 - For P-1, one light piece outlier with a 0.37% change in weight

Quartz tubes

- 6 total
- 1 largely unused
- 1 used heavily (Quartz tube #4)
 - Cold tests
 - Installation tests
 - This one shows contamination or striations on the inner surface – noted at the time of first inspection (April 1st)
- 4 used for periscope tests of P1 and P2
- Over time, tubes have collected dust and some show “water spots” and other contaminants on their surface from their handling in installation and through testing
- Will show more videos and pictures next time
- The same cleaning agent from Photonic Cleaning Solutions, LLC identified for cleaning the quartz glass windows will be employed for cleaning the tubes

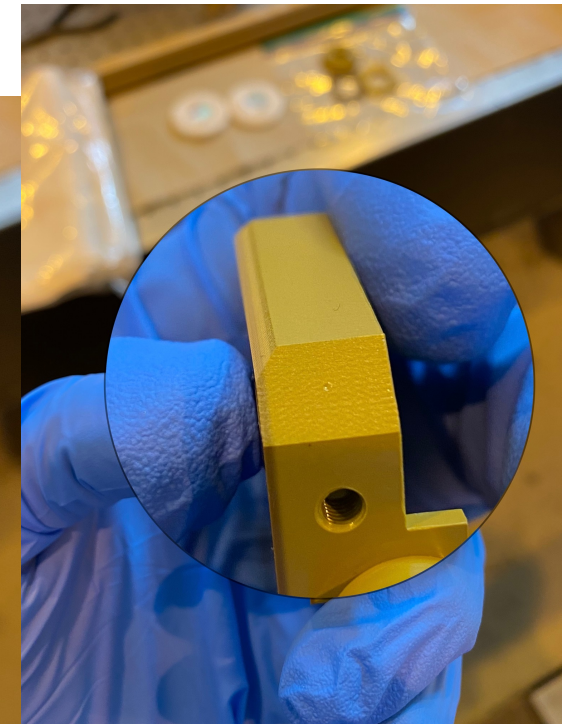
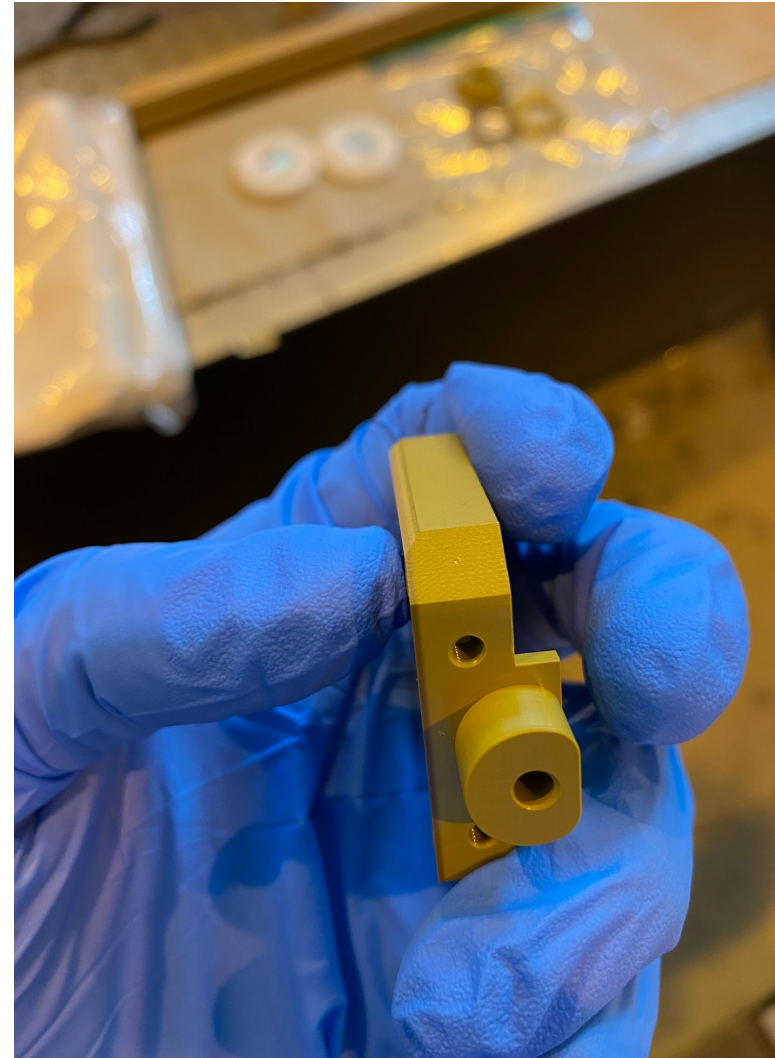
Q4



BACKUP

Packing

- All steel and Torlon components have a reference designators in their respective packing
 - In addition steel rods and components have an ID etched onto them
 - Torlon components such as spacers were marked with small divets to distinguish between P1 and P2
 - Order and orientation of the Torlon spacers also encoded
- All periscope components except for the quartz tubes are expected to ship this week



P-1 steerable mirror holder





Packaged and ready to ship as part of Shipment 11.



- Inside surface of the MDCs is particularly difficult to clean (it is recessed)
- Received two spare MDCs
- Developed protocol for cleaning the quartz windows for the MDCs using one of the spares to test

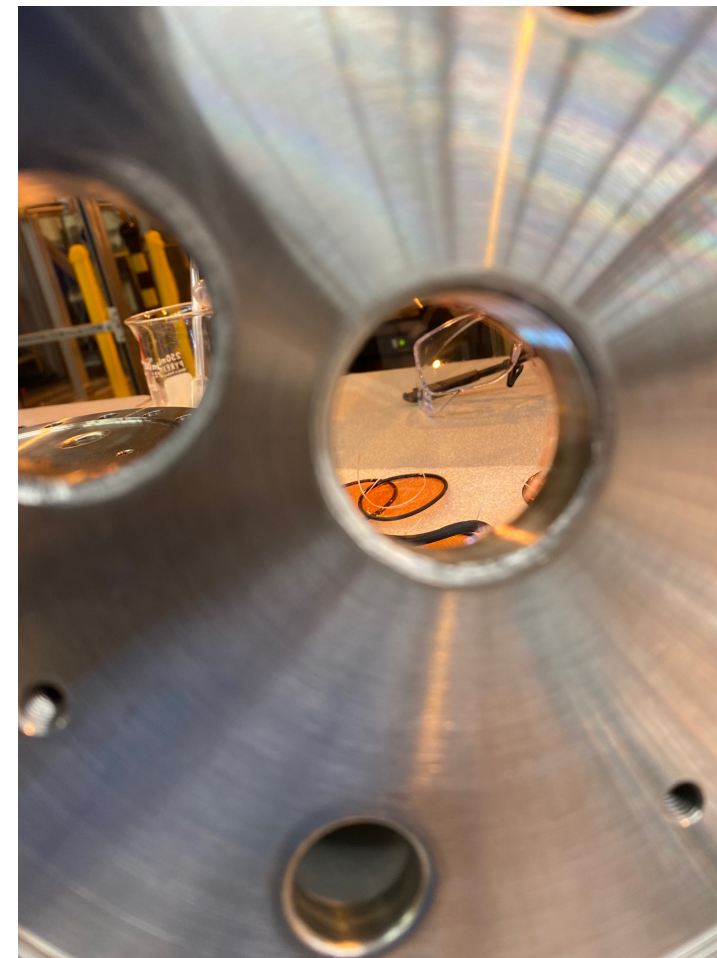
P1 MDC



Significant dust and a spot on outer edge of beam window. Camera viewport also looked dusty.

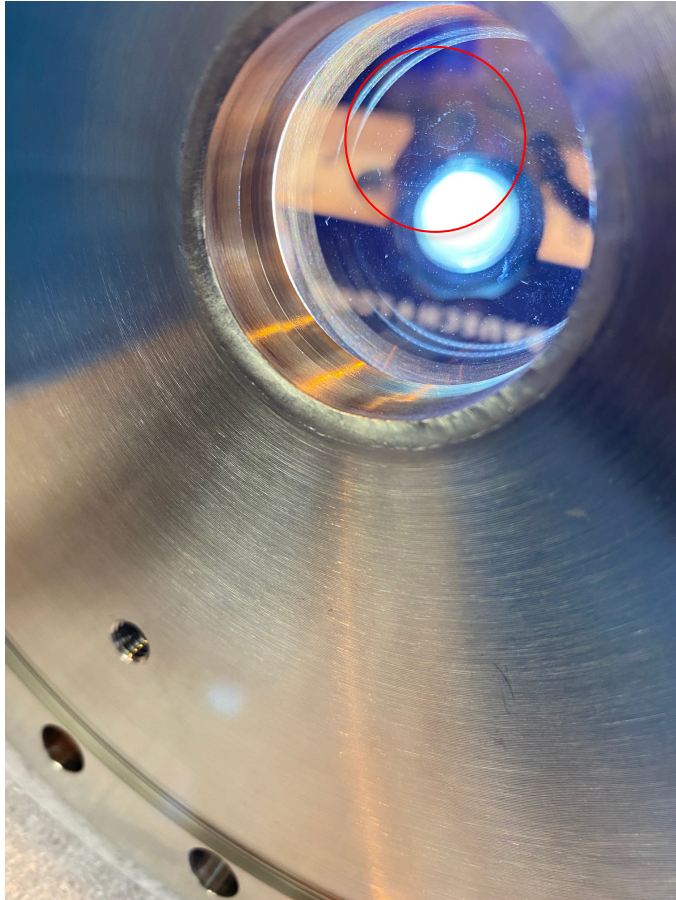


Camera viewport



After cleaning both ports (outer and inner surfaces of quartz windows).

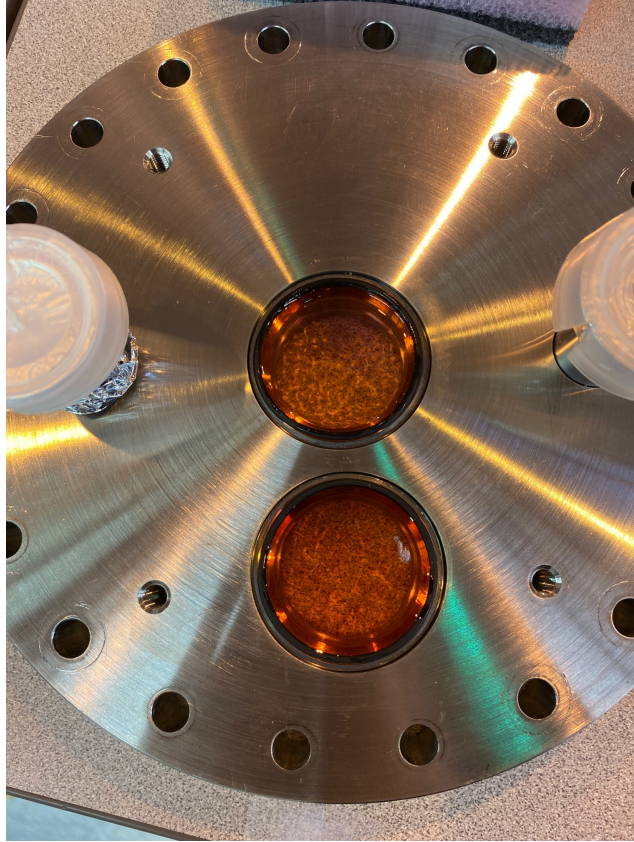
P-2 MDC



Spots on beam window and significant dust



After cleaning w/ waterspot treatment on all quartz windows (inner and outer surfaces)



After the removal of the spots and dust, a protective layer of the polymer cleaning agent applied to protect all quartz window surfaces during shipment. These will be removed at CERN during installation.



MDCs packed along with the two top nipples and the P-1 middle nipple as part of shipment 9

