# **PMT Coating Status**

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# **Coating Facility**

- using facility developed for ICARUS experiment
- ICARUS coated 360 PMTs with it
- position of the PMT optimized for uniform coating
- full description of the

system: <u>https://arxiv.org/pdf/</u> <u>1807.07123.pdf</u>

- system available at CERN for everyone
- great support from CERN Thin Film facility











- test samples also useful for thickness calibration
  all PMT have been coated with more than 0.2mg/cm<sup>2</sup> in the middle.
- •maximum difference in thickness is expected to be <20% from the extreme edge to the middle (middle-center <5%).

- test sample coating to test the system after transport and to learn
- spend 1.5 weeks on learning process
- easy but annoying job







## Procedure

- visual inspection of box => all fine
- PMT was left in box, HV cable was taken out, the box was covered with black sheets
- Dark count test at 1200 V => all fine
- Photo from PMT outside box to have reference for PMT orientation
- dismanteling of the PMT+support
- cleaning of the PMT surface with acetone and isopropanol + drying the surface => crucial for good coating quality







## Procedure

- Fixing the PMT in the vessel
- Placing carefully the cable so that the PMT can rotate
- cover cable and base with alu foil
- pumping down to below 3\*10-5 mbar
- heating up TPB to 220 C monitoring every minute the parameters











# Procedure

- Re-assembling of the support structure with PMT
- checking coating with UV lamp + photo
- adding acrylic plate to protect TPB
- place in box with silikat gel to keep dry => 35 of 40
- Dark count test after coating



## Documentation

- each PMT treatment/coating document following ICARUS scheme
- Parameters measured:
  - mass of TPB used (m=0.815 g)
  - thickness on test sample
  - coating duration
  - pressure
  - hour + date

#### • change of TPB bottle

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1	PMT No	Serial No.	Box No.	DarkCount Rate Test before	e coating	Date of County	Hour of Coating	TPB Weight [g	3 Starting Pressure [*10 (-5) mbar]	Opening Pressure [*10 (-5) mbar]	Final Pressure [*10 (-5) mbar]	Time Coating (min)	End total thickness	Mylar before [g	Mylar after [g]	delta weight [g]	coated area eample (mm2)	density [mg/cm2]	DarkCount Rate Test after coating	2 Commente
2	1	FA0115	3	Passed	-	19/07/2018	evening	0.8124	2.80	4.36	1.94	13:39	6.124	0.1957	0.1995	0.0038	2510	0.15139	Passed *	
3	2	FA0121	4	Passed	+	10/08/2018	morning	0.8152	2.00	3.92	2.03	14:54	6.451	0.1795	0.1836	0.0040	2353	0.17000	Passed *	new drying method
4	3	FA0123	1	Passed	-	02/08/2018	evening	0.8140	2.50	4.31	1.90	14:21	5.988	0.1742	0.1778	0.0036	2394	0.15038	Passed *	new drying method
5	4	FA0143	test	Passed	-	17/07/2018	evening	0.8115	2.83	5.00	2.20	13:35	5.912	0.1859	0.1900	0.0041	2325	0.17634	Passed *	Test PMT sent to CERN already one year ago; 1st TPB bottle
6	5	FA0114	2	Passed	-	30/07/2018	evening	0.8151	2.87	3.92	1.93	13:20	6.230	0.1736	0.1775	0.0039	2355	0.16561	Passed *	4th TPB bottle started
7	6	FA0132	2	Passed	-	31/07/2018	evening	0.8154	1.60	3.17	1.38	13:29	5.957	0.1882	0.1922	0.0040	2411	0.16591	Passed *	
8	7	FA0153	3	Passed	*	23/07/2018	evening	0.8146	2.85	3.95	1.98	14:42	6.028	0.1752	0.1793	0.0041	2384	0.17198	Passed *	
9	8	FA0120	4	Passed	*	13/08/2018	evening	0.8159	2.75	4.17	2.50	14:31	6.374	0.1669	0.1704	0.0035	2401	0.14577	Passed *	new drying method, first coating attempt failed due to non uniformities
10	9																			
11	10	FA0155	1	Passed	*	03/08/2018	morning	0.8155	0.55	2.80	0.54	13:42	6.558	0.1808	0.1852	0.0044	2420	0.18182	Passed *	5th TPB bottle started, new drying method
12	11	FA0115	2	Passed	*	31/07/2018	evening	0.8129	2.77	3.13	1.92	13:57	6.016	0.1793	0.1829	0.0036	2350	0.15319	Passed *	
12	12	FA0139	4	Passed	-	14/08/2018	morning	0.8171	1.60	3.60	1.70	15:00	7.032	0.1803	0.1844	0.0041	2373	0.17278	Passed *	7th TPB bottle started, new drying method
14	13	FA0113	1	Passed	-	03/08/2018	evening	0.8113	2.60	4.10	1.95	14:10	6.190	0.1703	0.1742	0.0039	2330	0.16738	Passed *	new drying method
15	14	FA0107	3	Passed	-	23/07/2018	evening	0.8144	2.95	4.04	2.07	13:46	6.138	0.1760	0.1798	0.0038	2272	0.16725	Passed -	
16	15	FA0129	3	Passed	-	23/07/2018	morning	0.8112	0.38	2.30	0.38	13:25	6.241	0.1912	0.1955	0.0043	2537	0.16949	Passed -	2nd TPB bottle started, first coating attempt failed due to non uniformities
17	16	FA0110	2	Passed	-	27/07/2018	morning	0.8153	0.60	2.41	0.59	14:16	6.555	0.1665	0.1704	0.0039	2311	0.16876	Passed *	
18	17	FA0133	4	Passed	-	14/08/2018	evening	0.8159	2.84	5.53	2.51	14:31	6.678	0.1599	0.1634	0.0035	2197	0.15931	Passed *	new drving method, without humidity bag
19	18	FA0140	3	Passed	*	25/07/2018	evening	0.8145	2.64	4.40	1.91	13:43	6.130	0.1815	0.1853	0.0038	2376	0.15993	Passed *	
20	19	FA0137	3	Passed	*	18/07/2018	evening	0.8146	2.81	4.75	2.10	13:50	6.097	0.1895	0.1933	0.0038	2384	0.15940	Passed *	
21	20	FA0148	1	Passed	*	05/08/2018	morning	0.8131	0.37	2.30	0.37	13:57	6.431	0.1797	0.1834	0.0037	2300	0.16087	Passed *	new drving method
22	21	FA0105	4	Passed	*	15/08/2018	morning	0.8110	1.50	3.01	1.52	14:55	6.859	0.1794	0.1832	0.0038	2333	0.16288	Passed *	new drving method, without humidity bag
23	22	EA0111	4	Passed	*	15/08/2018	evening	0.8172	2.90	4.21	2.55	14:49	6.851	0.1620	0.1653	0.0033	2068	0.15957	Passed *	new drving method, without humidity bag
24	23	FA0105	2	Passed	+	02/08/2018	morning	0.8191	0.61	2.70	0.60	13:58	6.046	0.1780	0.1816	0.0036	2248	0.16014	Passed *	new drving method
25	24	FC0005	1	Passed	+	07/08/2018	evening	0.8157	2.81	3.99	1.92	13:52	6.410	0.1724	0.1766	0.0042	2454	0.17115	Passed	new drving method
26	25	FA0134	4	Passed	-	15/08/2018	evening	0.8157	2.89	4.42	2.55	15:16	6.845	0.1748	0.1787	0.0039	2380	0.16387	Passed	new drving method, without humidity bag
27	26	FA0149	1	Passed	-	05/08/2018	evening	0.8154	1.97	3.98	1.48	14:39	6.536	0.1631	0.1670	0.0039	2214	0.17615	Passed	new drying method, first coating attempt failed due to non uniformities
28	27	FA0135	1	Passed	-	08/08/2018	morning	0.8173	0.54	2.25	0.63	14:42	6.612	0.1811	0.1854	0.0043	2405	0.17879	Passed	new drying method
29	28	FA0151	3	Passed	-	24/07/2018	evening	0.8125	2.50	4.15	1.85	13:34	6.258	0.1720	0.1758	0.0038	2320	0.16379	Passed	
30	29	EA0147	1	Passed	-	08/08/2018	evening	0.8163	2.95	4.81	2.04	13:47	6.473	0.1775	0.1815	0.0040	2360	0.16949	Passed	6th TPB bottle started, new drying method
31	30	EA0157	3	Passed		25/07/2018	morning	0.8189	0.51	2.25	0.49	13:00	6.142	0.1885	0.1928	0.0043	2400	0 17917	Passed *	3rd TPB bottle started
32	31	EA0112	3	Passed	*	25/07/2018	morning	0.8126	0.57	2.74	0.56	13:54	6 186	0.1742	0.1780	0.0038	2304	0 16493	Passed *	
33	32	FA0104	3	Passed	*	20/07/2018	morning	0.8157	0.59	2.71	0.59	13:48	6 320	0.1930	0 1970	0.0040	2417	0 16549	Passed v	
24	33	FA0124	1	Passed	*	09/08/2018	morning	0.8178	0.55	2.41	0.53	13:40	6 764	0.1739	0.1777	0.0038	2357	0 16122	Passed v	new drying method
25	34	FA0150	4	Passed	*	16/08/2018	evening	0.8163	2.96	5.05	2.31	13:52	6.887	0.1783	0 1824	0.0041	2487	0.16456	Passed v	new drying method, without humidity bag
26	35	FA0155	2	Passed	*	27/07/2018	evening	0.8120	2.95	4.81	2.03	13/33	5.910	0.1705	0.1742	0.0037	2330	0 15550	Passed	After change of cristal to measure total thickness
37	36	EA0119	2	Passed	-	30/07/2018	morning	0.8131	0.22	2.68	0.78	15:00		0.1719	0.1755	0.0037	2325	0.15914	Passed	Xtal fall in the thickness mesurement
22	37	FA0122		Passed	-	09/082018	evening	0.8144	1.50	3.57	1.29	13:57	6 534	0.1744	0.1781	0.0037	2374	0 15555	Passed	new drying method
29	38	EA0145	2	Dassed	-	30/07/2018	evening	0.8146	2.95	3.85	1.91	13:53	5 894	0.1743	0.1778	0.0035	2392	0 14632	Dassed 7	
40	30	ECODO4	4	Dassarl	+	16/08/2018	evening	0.8185	2.55	4.03	1.92	14:30	7 143	0.1554	0.1590	0.0036	2155	0 16698	Dassari	Sth TOR bottle started, new diving method, without humidity hap
41	40	FA0136	2	Dassart	+	01/08/2018	evening	0.8147	2.89	4.97	2.31	13:10	6 100	0.1795	0.1835	0.0040	2361	0.16942	Dassart	Sansihility not that opping the others => want to say yery low DC rate but minht be d
42	41	EA0130	2	Daccarl	-	25/07/2018	evening	0.8139	2.54	3.21	1.82	14:29	5.043	0.1777	0.1815	0.0038	2388	0.15913	Dassart	Sansihility not that good as the others => want to say yery low DC rate but might be d
43	-					2010112010	croning	0.0103	200	0.21	1.05	14.65	0.240		0.1010	0.0000		0.10010		containing net that good be the careful - mark to cay hely for bot the bar high be a
44																				
48																		OMTs fully finished	40	
																		Demontano	100	
-																		Percentage	100	
47				40																
-																				

# Qeff Measurement

- 40 PMTs now stored in EHN1
- 4 PMTs will be brought back to Meyrin for Qeff measurement
- producing missing part currently => after 7<sup>th</sup> of September
- only >200 nm and quantitative not qualitative
- trying to contact ICARUS group to explore possibility to measure at 128 nm
- not clear if setup still exists

#### Absolute QE measurements

from Thin Film & Glass lab

http://cdsweb.cern.ch/record/1164394/files/PH-EP-Tech-Note-2009-001.pdf



# Summary + Outlook

- 40 PMTs were coated with ICARUS facility at CERN
- 2 PMTs/day coated (ICARUS w/o base 4 PMTs/day)
- Learned a lot:
  - Drying process after cleaning crucial
  - PMTs ideally stored after coating in sealed Mylar/Alu bag
- Visual inspection with UV lamp fine
- Open question: Surface preparation => ArDM seemed to have no preferences but ICARUS sand blasted all 360 PMTs
- Trying to organize Qeff measurement at 128 nm
- PMTs at EHN1 waiting for installation

# Cesar, Danaisis, Paula and the coating vessel

