

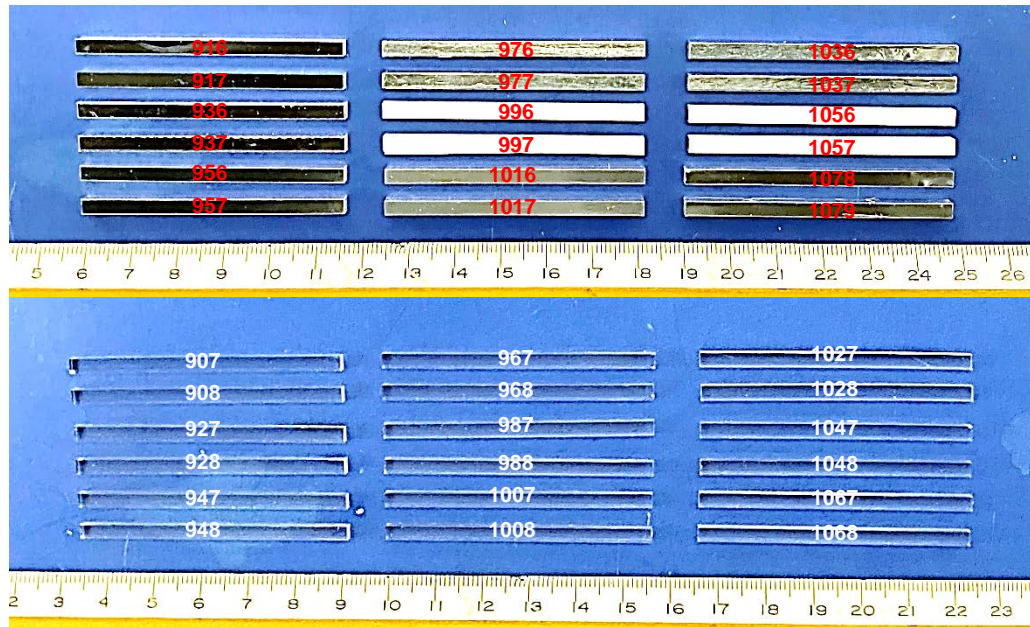


TF:p Irradiation Experiment at Fermilab ITA: TSW-1830

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36 2021 BTL LYSO Bars with & w/o ESR



ID	Dimension (mm ³)	#	Polishing
BTL LYSO-907~1079	3.00x3.12x56.3	36	All faces

All were received on April 6th, 2021. 18 bars were shipped to Fermilab on April 30th

Irradiation to 2.5×10^{13} p/cm² by 400 MeV protons in the middle of June at ITA

Experiments

Properties measured before irradiation at room temperature:

Longitudinal Transmittance (LT), Light Output (LO) & Decay Time (τ)

Cross Link of LYSO Sample ID

18 samples each went to ITA/Lowell for proton/neutron irradiation

Caltech ID	Barcode	Producer	Test
1	907	1	Proton
2	908	1	Neutron
3	927	8	Proton
4	928	8	Neutron
5	947	5	Proton
6	948	5	Neutron
7	967	10	Proton
8	968	10	Neutron
9	987	3	Proton
10	988	3	Neutron
11	1007	9	Proton
12	1008	9	Neutron
13	1027	6	Proton
14	1028	6	Neutron
15	1047	4	Proton
16	1048	4	Neutron
17	1067	2	Proton
18	1068	2	Neutron

Caltech ID	Barcode	Producer	Test
ESR 1	916	1	Proton
ESR 2	917	1	Neutron
ESR 3	936	8	Proton
ESR 4	937	8	Neutron
ESR 5	956	5	Proton
ESR 6	957	5	Neutron
ESR 7	976	10	Proton
ESR 8	977	10	Neutron
ESR 9	996	3	Proton
ESR 10	997	3	Neutron
ESR 11	1016	9	Proton
ESR 12	1017	9	Neutron
ESR 13	1036	6	Proton
ESR 14	1037	6	Neutron
ESR 15	1056	4	Proton
ESR 16	1057	4	Neutron
ESR 17	1078	2	Proton
ESR 18	1079	2	Neutron

Result of TF:n of $3.2 \times 10^{14} n_{eq}/cm^2$ is also reported in this meeting

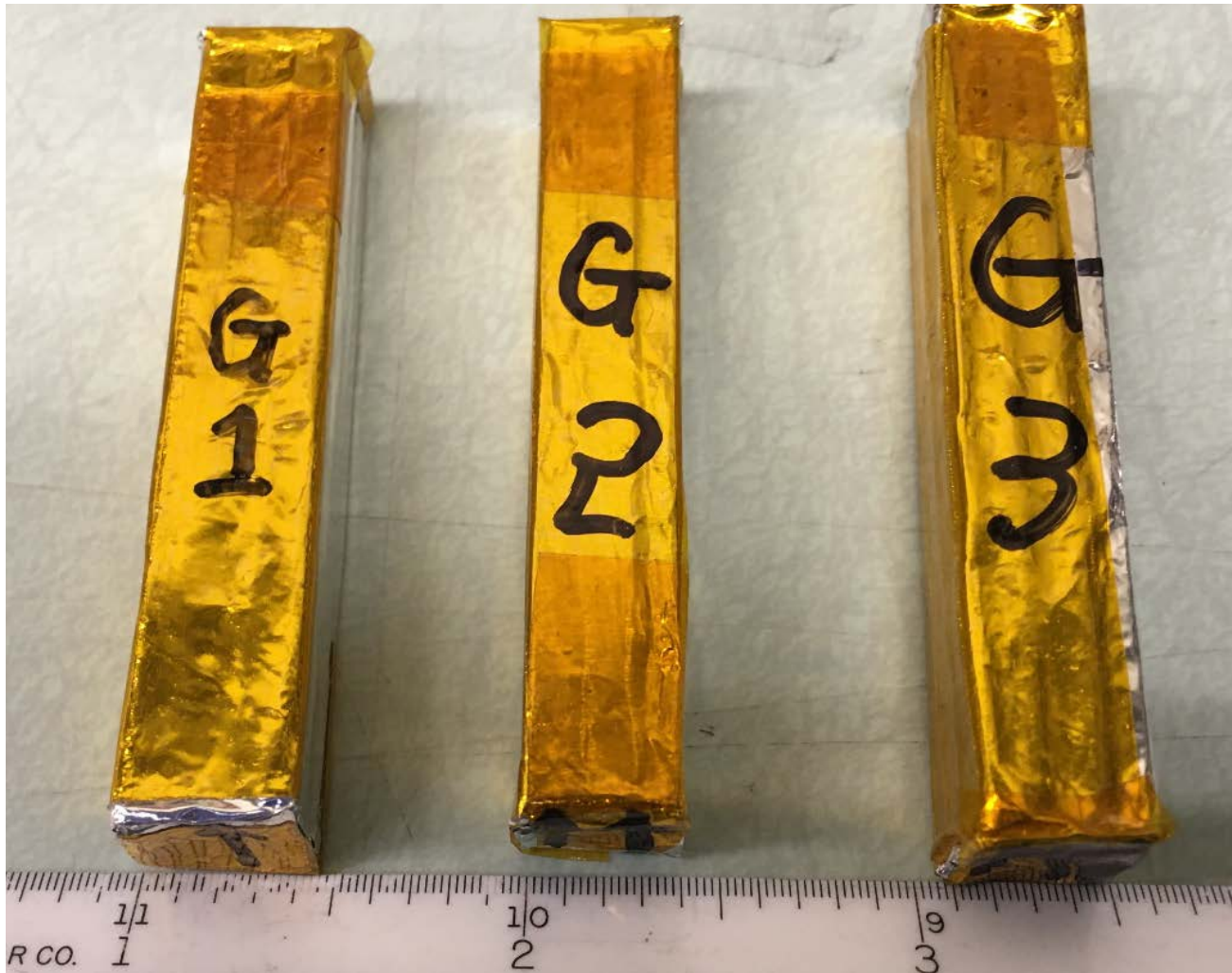
Fermilab Irradiation Test Area (ITA)

The Fermilab ITA at the end of the MTA beamline provides 400 MeV protons with a typical flux of 4.7×10^{12} p/min and a FWHM spot size adjustable from 10 to 25 mm.

A total of 27 LYSO bars in three groups of 9 each were irradiated to 2.5×10^{13} p/cm² at ITA during the 3rd week of June. They are two groups of 2021 LYSO bars with ESR and Al foil wrapping, and a 3rd group of 2019 LYSO bars of 57.0x3.12x3.75 mm³ with Al foil wrapping. The 2019 LYSO bars in the 3rd group went 5 Mrad and 3.2×10^{14} n_{eq}/cm².

Protons aimed at one end of an LYSO group. A larger beam spot provides a better fluence uniformity among 9 LYSO bars in the group. Two Al foils were placed at the front and back for each LYSO bar, providing proton fluence.

27 LYSO Bars in Three Groups

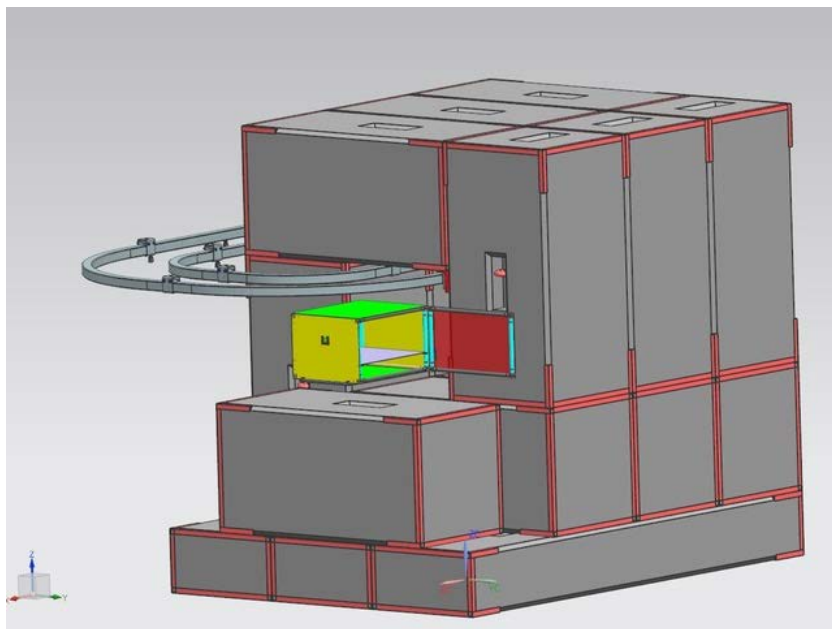


G1: Nine 2021 LYSO bars with ESR wrapping

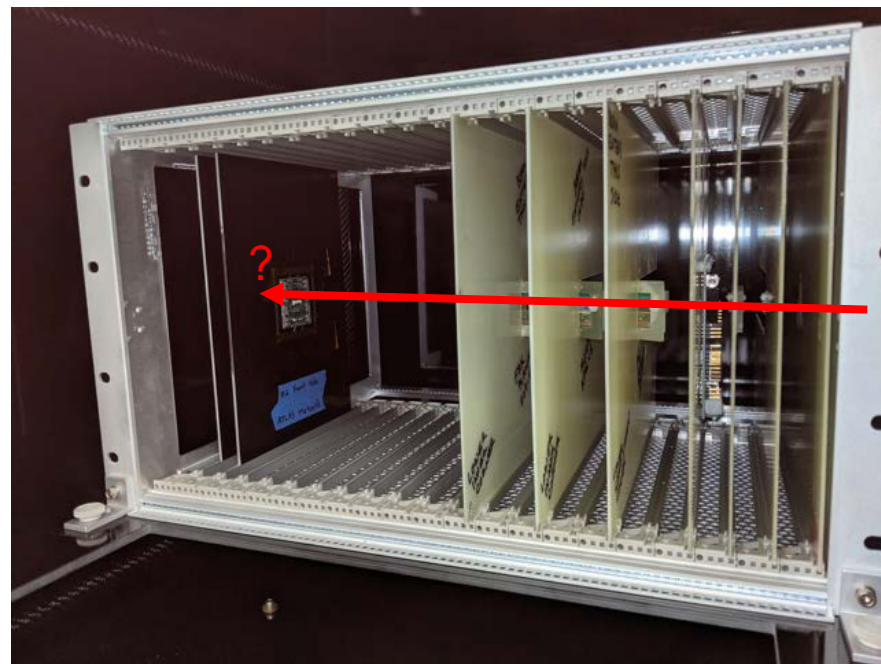
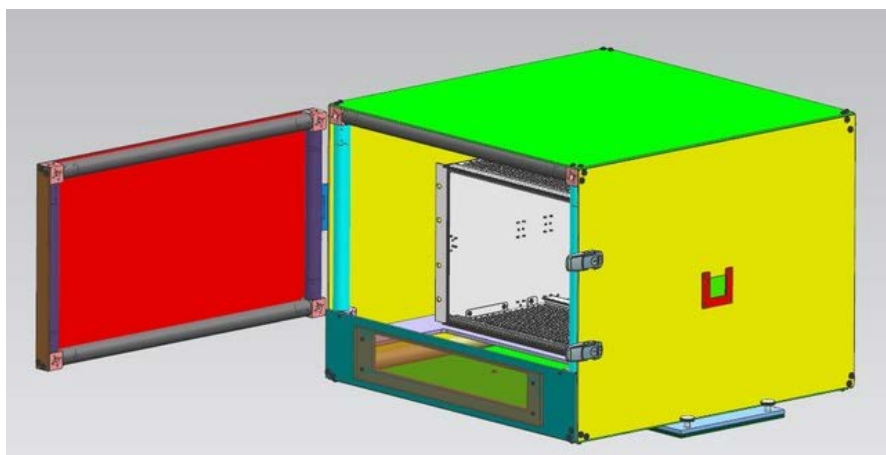
G2: Nine 2021 LYSO bars with Al wrapping

G3: Nine 2019 LYSO bars after 5 Mrad and $3.2 \times 10^{14} n_{eq}/cm^2$

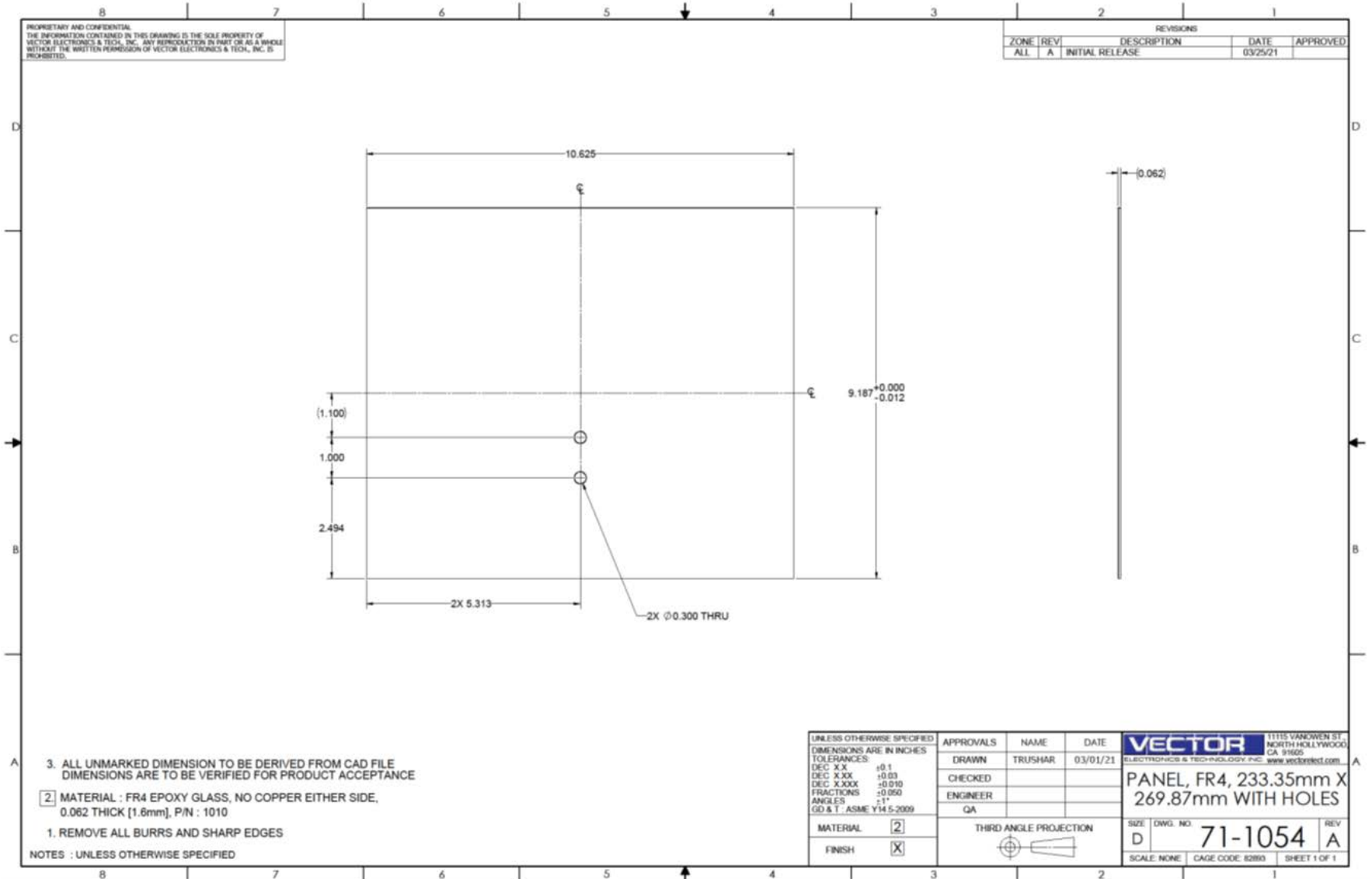
Using ITA Irradiation Crate



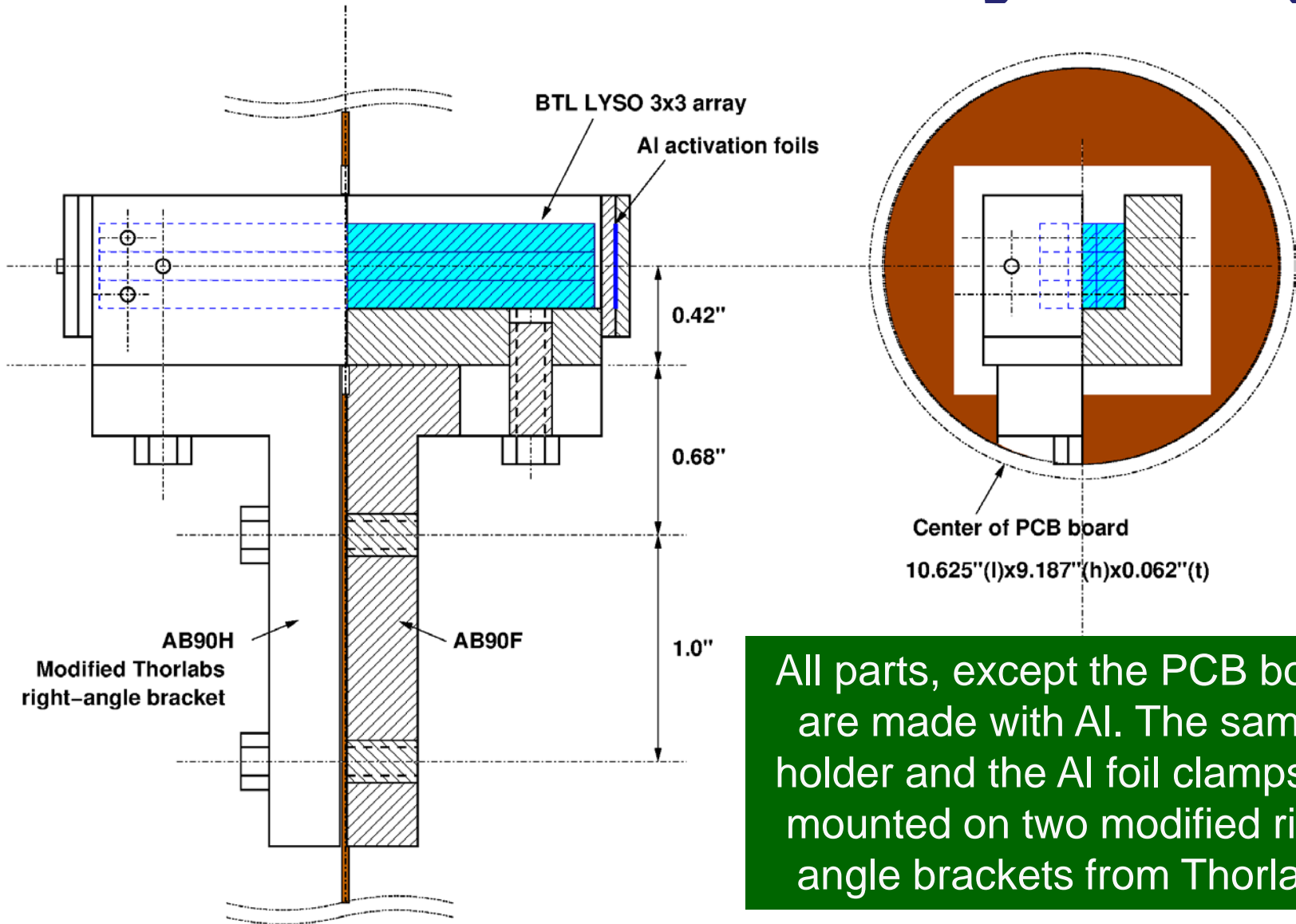
Each group is mounted at the center of a PCB board to be inserted into an existing ITA crate for easy alignment and replacement



PCB Board Design



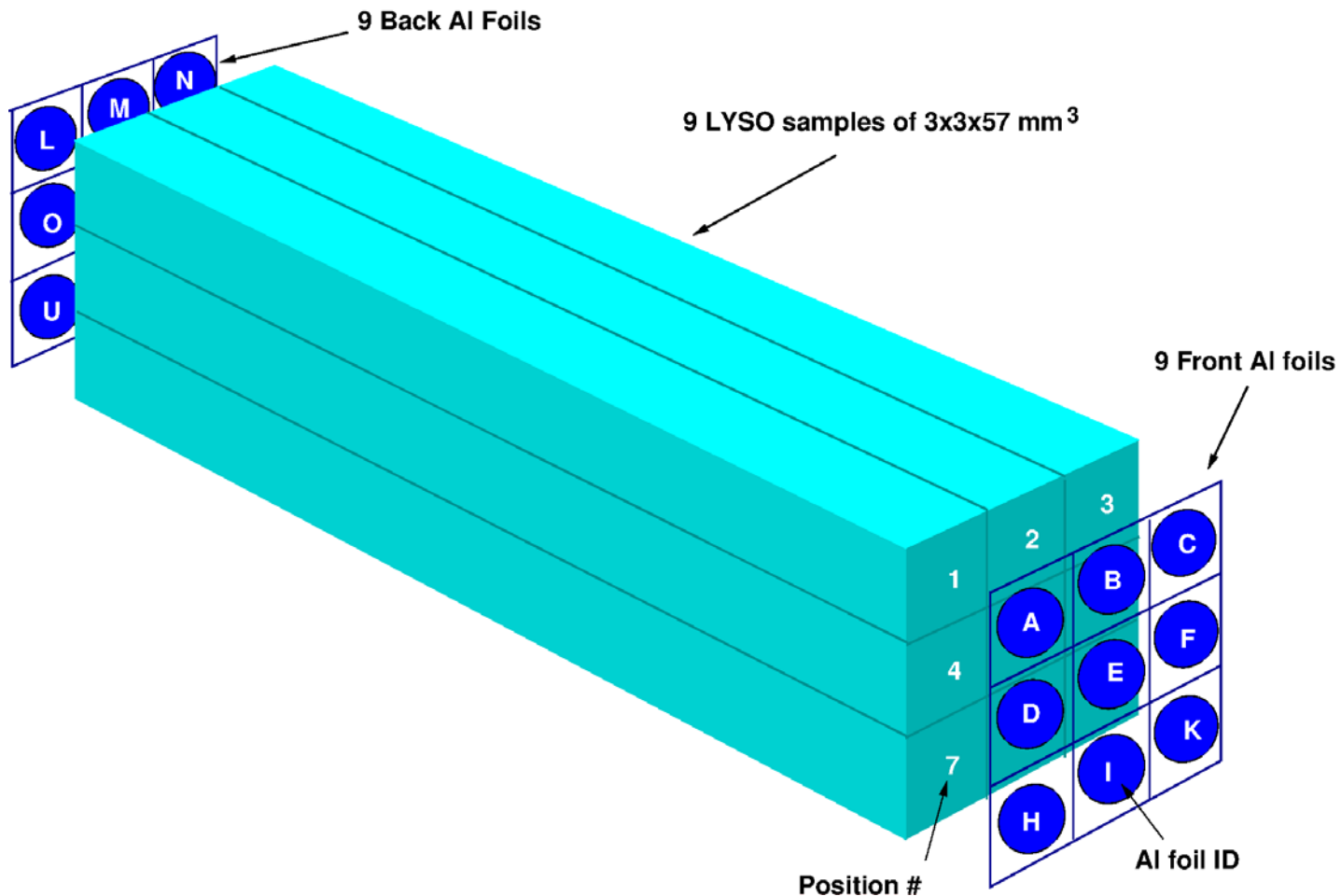
PCB Board Assembly Design



All parts, except the PCB board, are made with Al. The sample holder and the Al foil clamps are mounted on two modified right-angle brackets from Thorlabs.

A Group of Nine LYSO Bars

Each LYSO bar with individual Al foils mounted at the front and back ends for fluence measurement

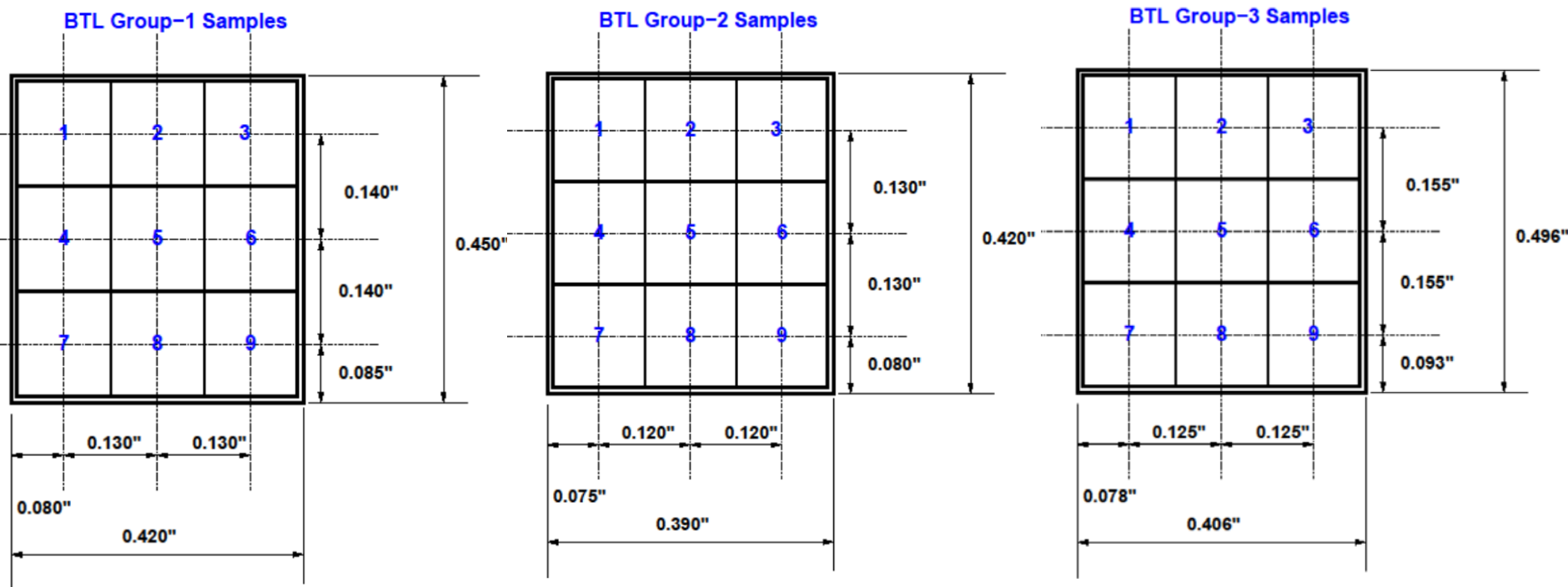


Dimension of 27 LYSO Bars

Group	Position	CMS ID	Caltech ID	Dimensions with ESR and Al foils (inch)				Front Al ID	Rear Al ID
				W	H	L	W, H err (\pm)		
1	1	916	1	0.129	0.135	2.235	0.003	A	L
	2	936	3	0.131	0.133	2.235	0.003	B	M
	3	956	5	0.129	0.135	2.235	0.003	C	N
	4	976	7	0.130	0.135	2.235	0.003	D	O
	5	996	9	0.131	0.135	2.235	0.003	E	R
	6	1016	11	0.130	0.135	2.235	0.003	F	S
	7	1036	13	0.131	0.137	2.235	0.003	H	U
	8	1056	15	0.130	0.135	2.235	0.003	I	X
	9	1078	17	0.129	0.135	2.235	0.003	K	Y
				Average	0.130	0.135	2.235	0.003	
2	1	907	un1	0.121	0.126	2.235	0.003	A	L
	2	927	un3	0.122	0.126	2.235	0.003	B	M
	3	947	un5	0.120	0.124	2.235	0.003	C	N
	4	967	un7	0.120	0.125	2.235	0.003	D	O
	5	987	un9	0.121	0.124	2.235	0.003	E	R
	6	1007	un11	0.120	0.125	2.235	0.003	F	S
	7	1027	un13	0.120	0.125	2.235	0.003	H	U
	8	1047	un15	0.120	0.126	2.235	0.003	I	X
	9	1067	un17	0.120	0.125	2.235	0.003	K	Y
				Average	0.120	0.125	2.235	0.003	
3	1	BTL-7	B7	0.124	0.156	2.235	0.003	A	L
	2	BTL-8	B8	0.126	0.150	2.235	0.003	B	M
	3	CPI-8	C8	0.125	0.130	2.235	0.003	C	N
	4	BTL-4	B4	0.124	0.151	2.235	0.003	D	O
	5	BTL-5	B5	0.125	0.150	2.235	0.003	E	R
	6	BTL-6	B6	0.125	0.150	2.235	0.003	F	S
	7	BTL-1	B1	0.125	0.150	2.235	0.003	H	U
	8	BTL-2	B2	0.126	0.151	2.235	0.003	I	X
	9	BTL-3	B3	0.125	0.150	2.235	0.003	K	Y
				Average	0.125	0.149	2.235	0.003	

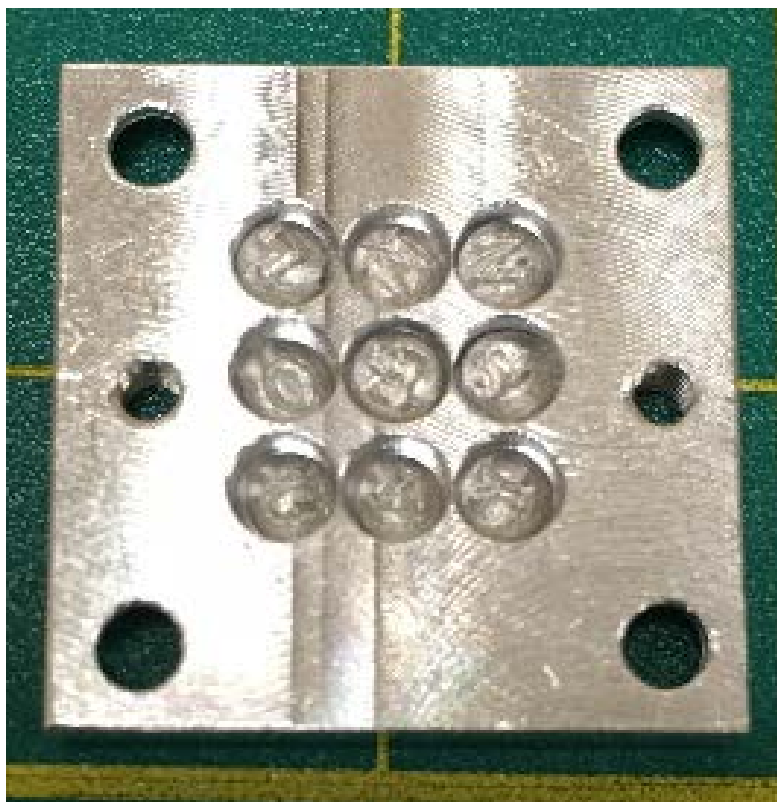
Overall Dimension of 3 Groups

Alignment between samples and their Al foils is maintained by CMM machined Al foil clamps

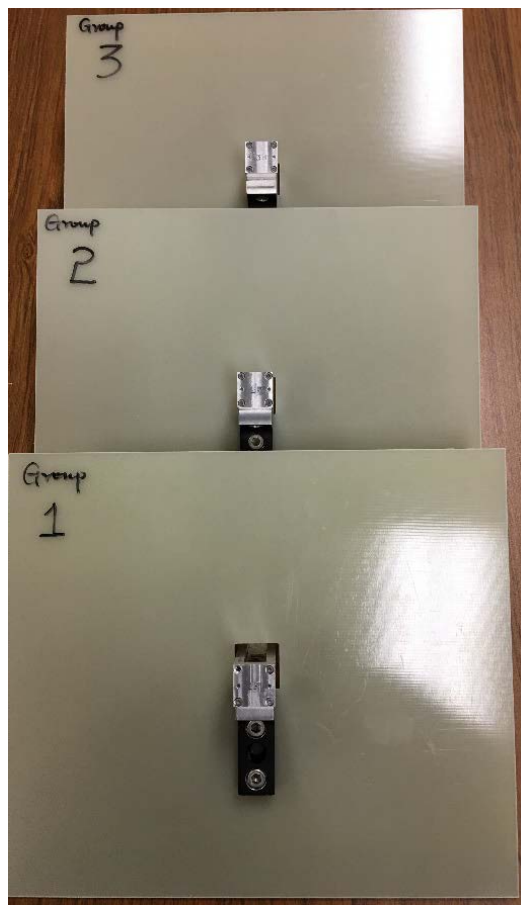


Fully Assembled Group 2 with Front and Back Al Foils Mounted

9 Al foils with ID marked

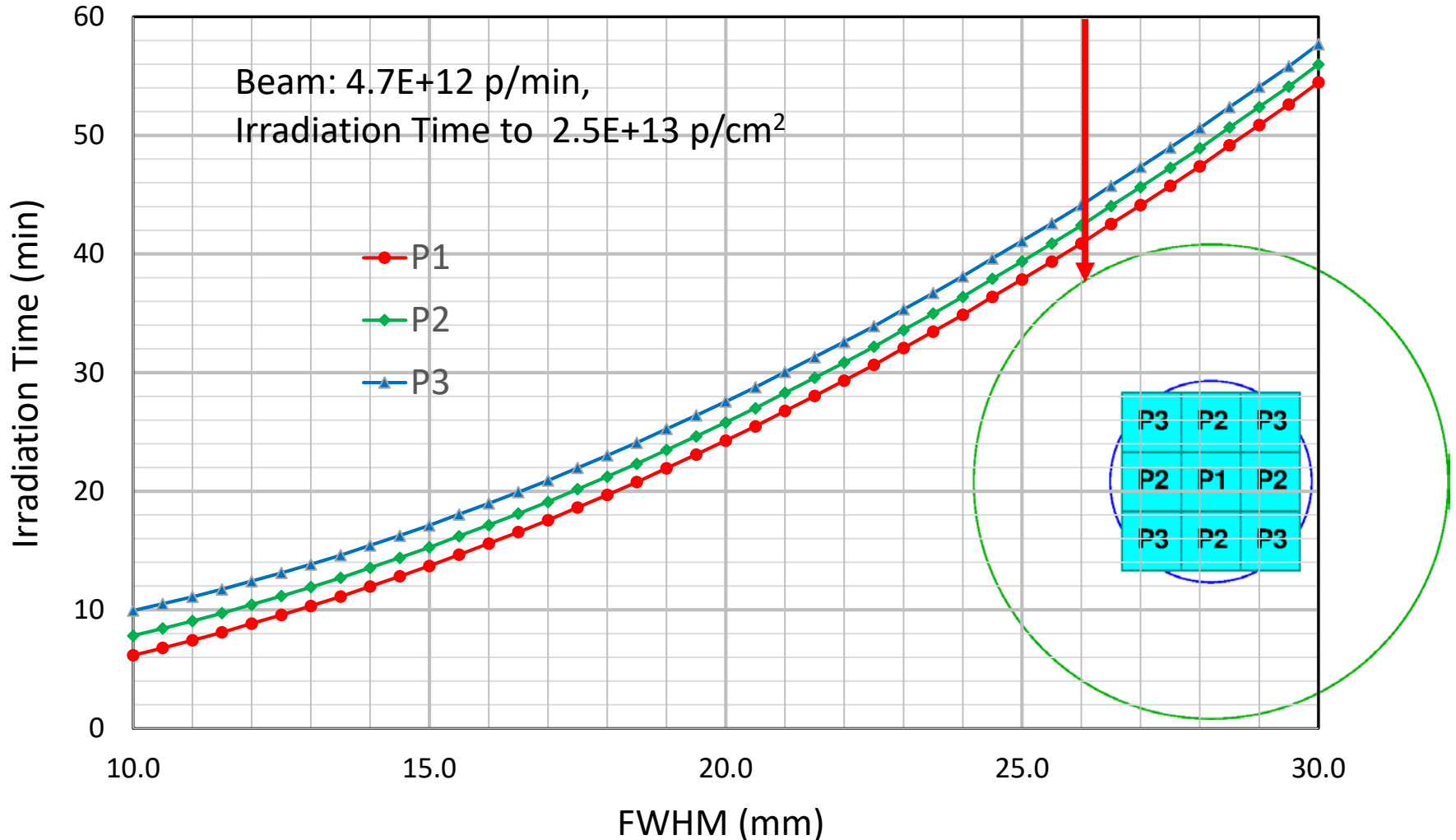


Three PCB Board Assemblies Arrived Fermilab on May 3, and Irradiated in the Middle of June



Estimated Time to Reach 2.5×10^{13} p/cm²

A Gaussian beam with 26 mm FWHM and a flux of 4.7×10^{12} p/min
 2.5×10^{13} p/cm² requires 40.9/42.4/44.1 minutes for P1/P2/P3



Summary

Initial LT, LO and τ measured for thirty six 2021 BTL LYSO bars without and with ESR wrapping were reported in the BTL general meeting on 5/19/21. Neutron induced damage in LYSO bars without and with ESR after $3.2 \times 10^{14} n_{eq}/cm^2$ is reported today.

Three groups of nine LYSO bars each were irradiated to $2.5 \times 10^{13} p/cm^2$ by 400 MeV protons at Fermilab ITA in the middle of June.

All samples will be shipped back to Caltech after cooled down. The Fermilab team will also provide proton fluence values for each LYSO bars by measuring activation of the Al foils at the front and back. Proton induced damage in LYSO bars without and with ESR after $2.5 \times 10^{13} p/cm^2$ will be reported in a future BTL meeting.