



Report on Radiation Damage in Eight SIC CsI Crystals

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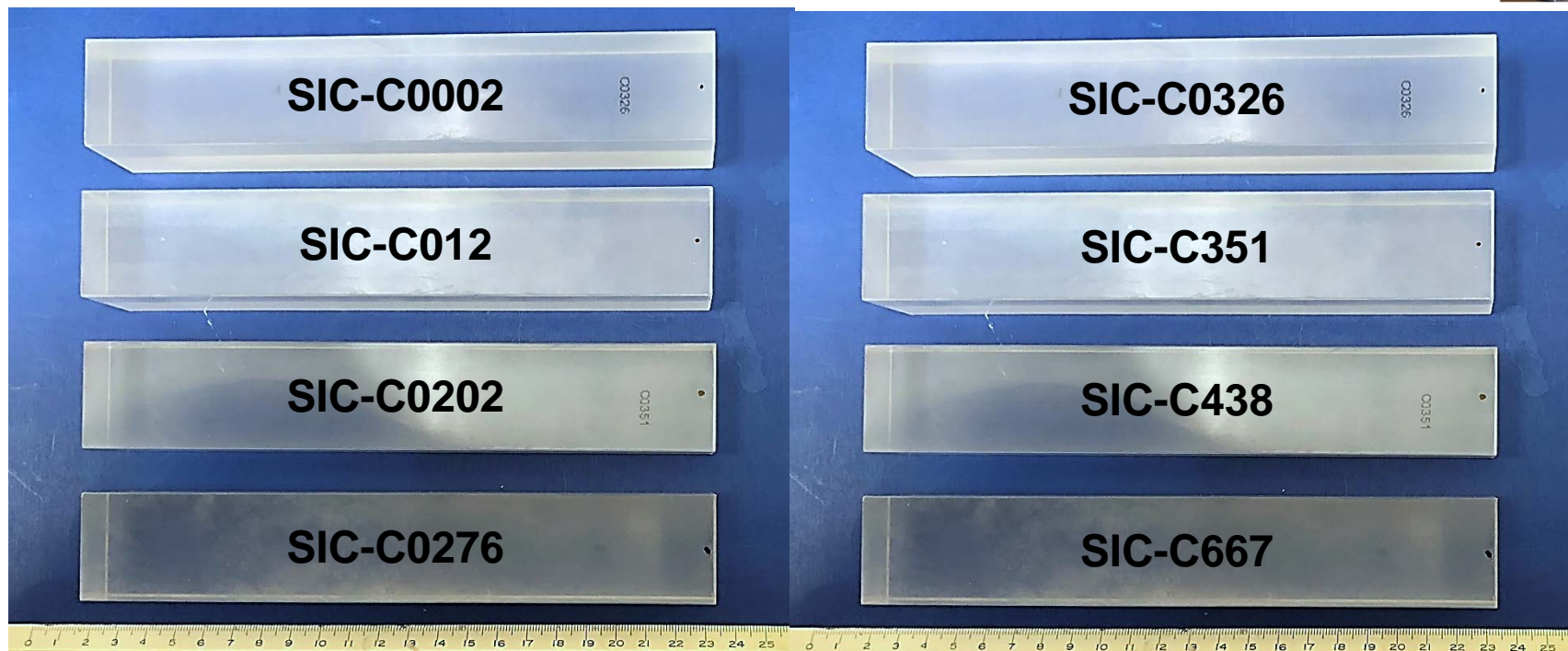
California Institute of Technology

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Eight SIC CsI Crystals



ID	Dimension (mm ³)	Polishing
SIC-002, 012, 202, 276, 326,351,438, 667	34x34x200	All faces

Experiments

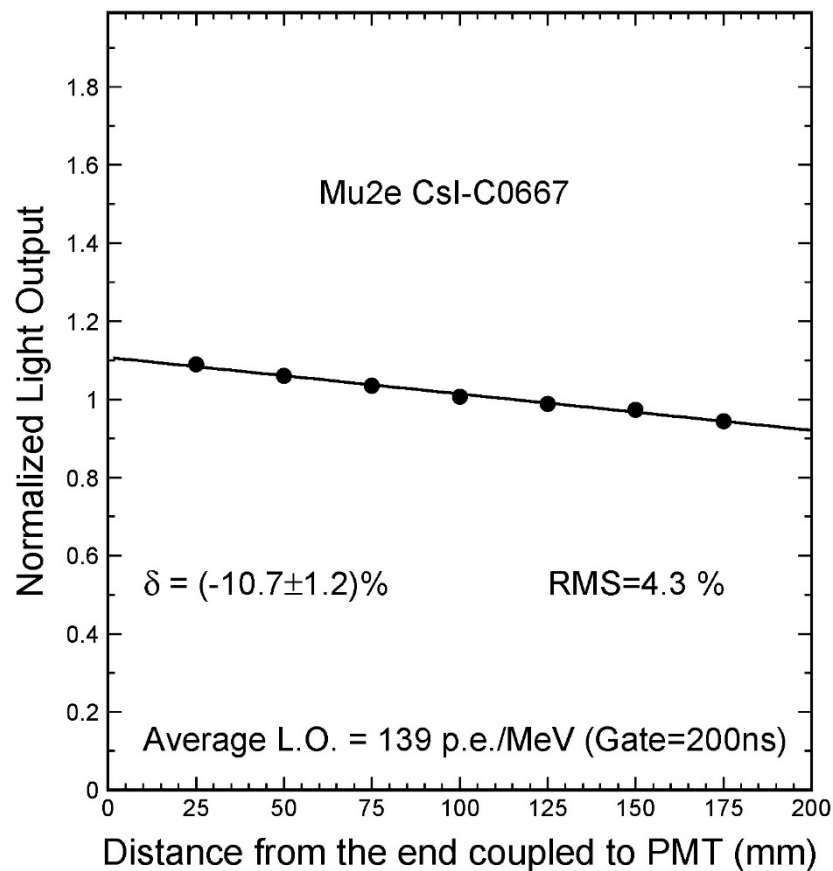
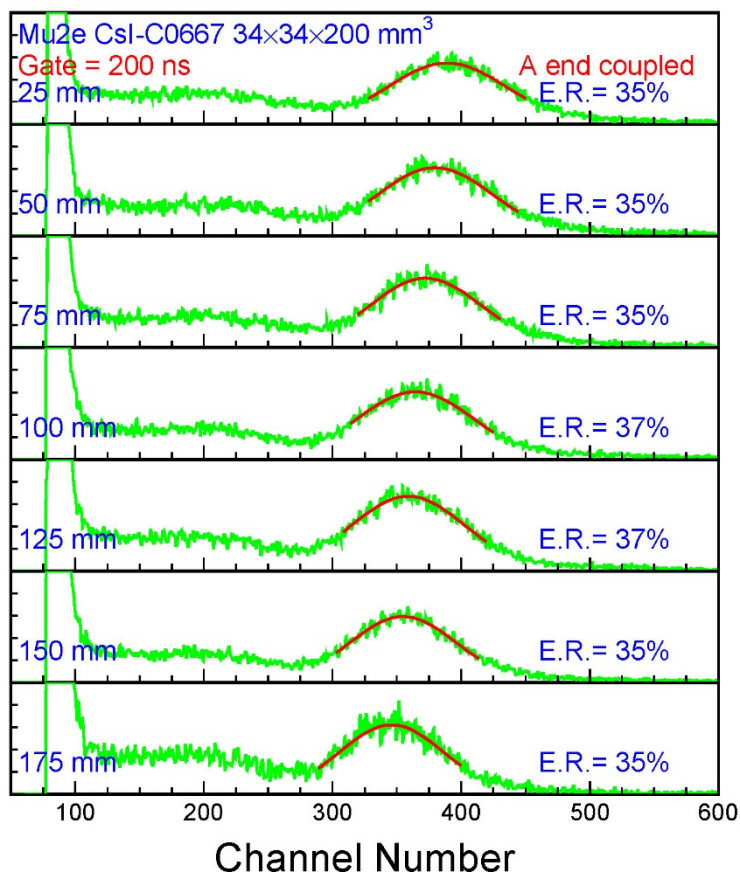
- Properties measured before and after 10 and 100 krad at room temperature : LO, ER, F/T, and LRU



Mu2e CsI Crystal C0667



Crystal ID	Coupling end	L.O. (p.e./MeV)	E.R. (%)	F/T (%)	LRU (%)
C0667	A	139	35	88	4.3

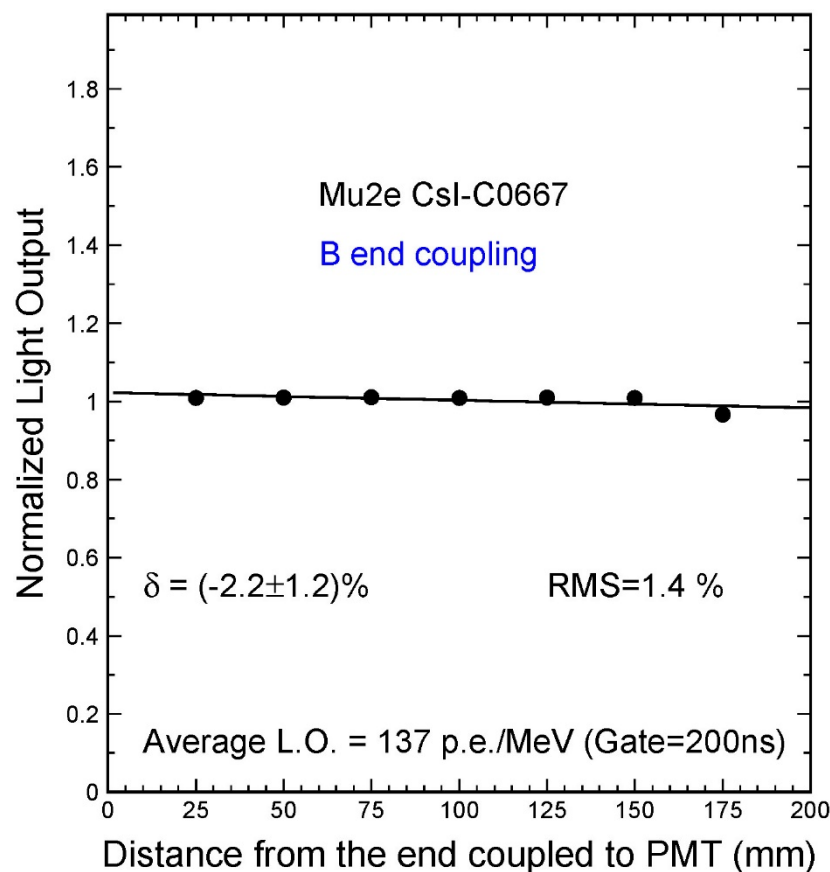
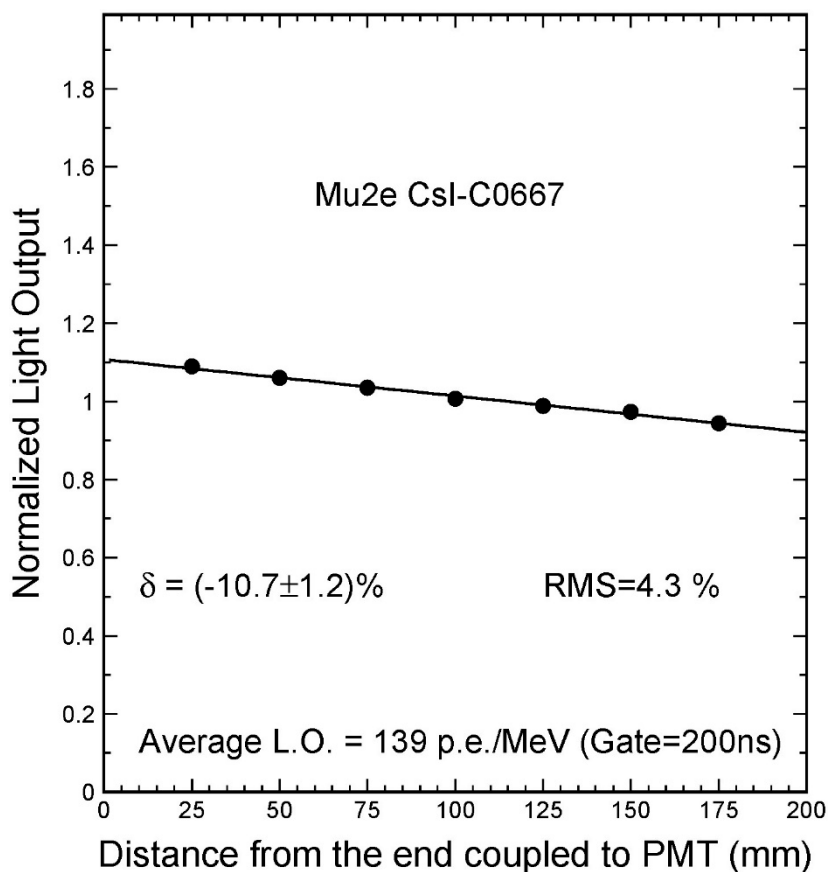




CsI Crystal C0667 (B end Chosen)



Crystal ID	Coupling end	L.O. (p.e./MeV)	E.R. (%)	F/T (%)	LRU (%)
C0667	A	139	35	88	4.3
	B	137	35	80	1.4

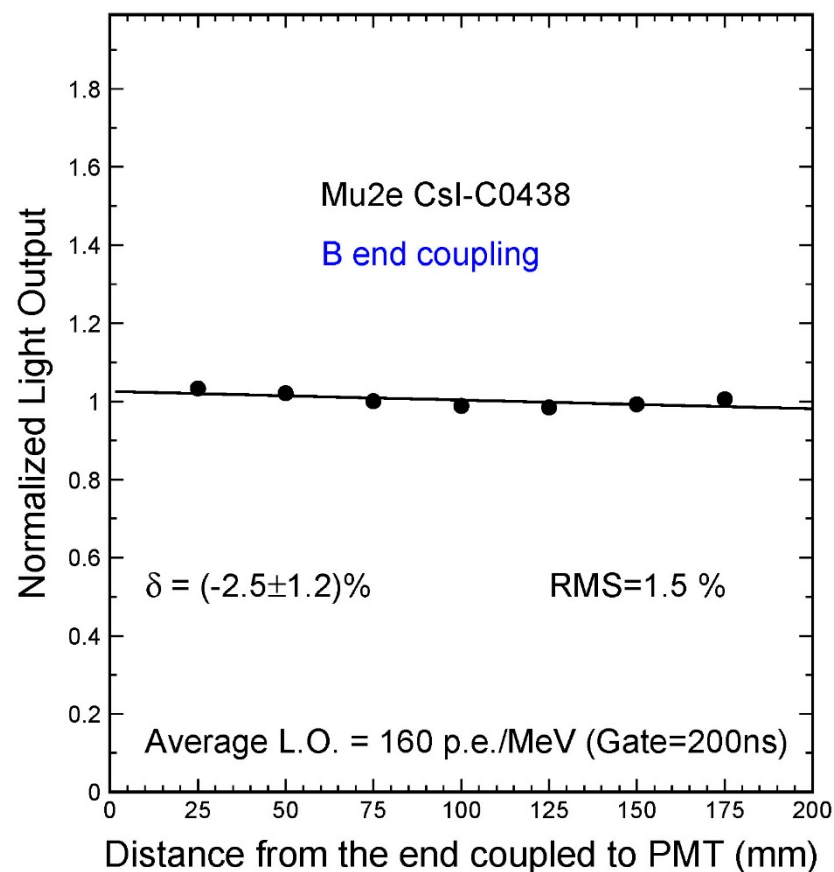
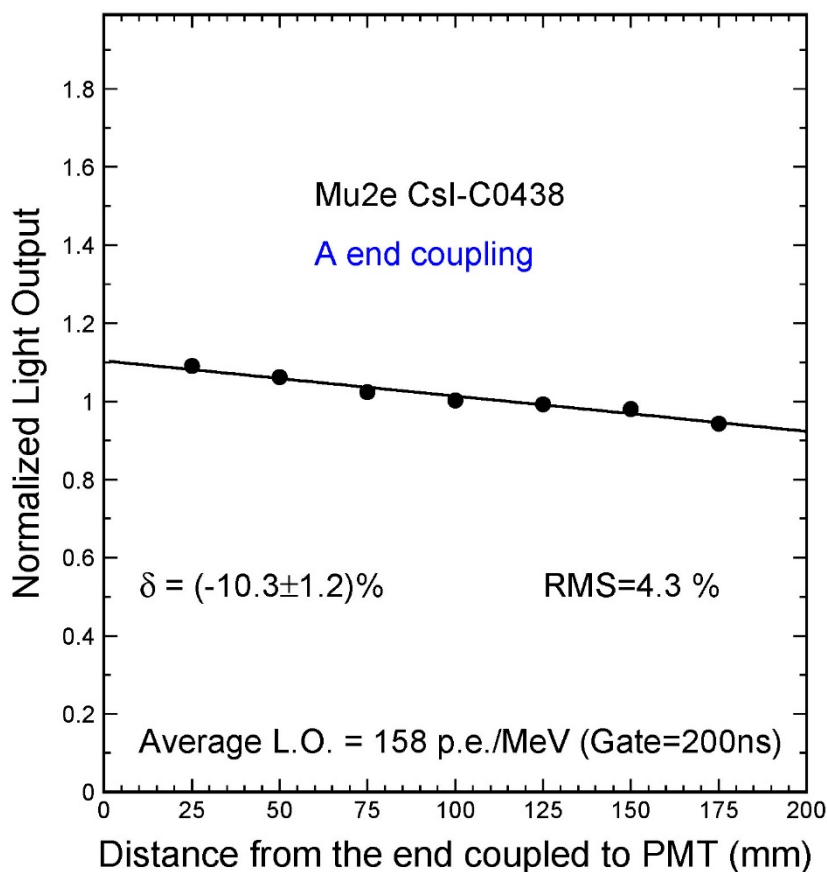




CsI Crystal C0438 (B end Chosen)



Crystal ID	Coupling end	L.O. (p.e./MeV)	E.R. (%)	F/T (%)	LRU (%)
C0438	A	158	34	92	4.3
	B	160	34	95	1.5

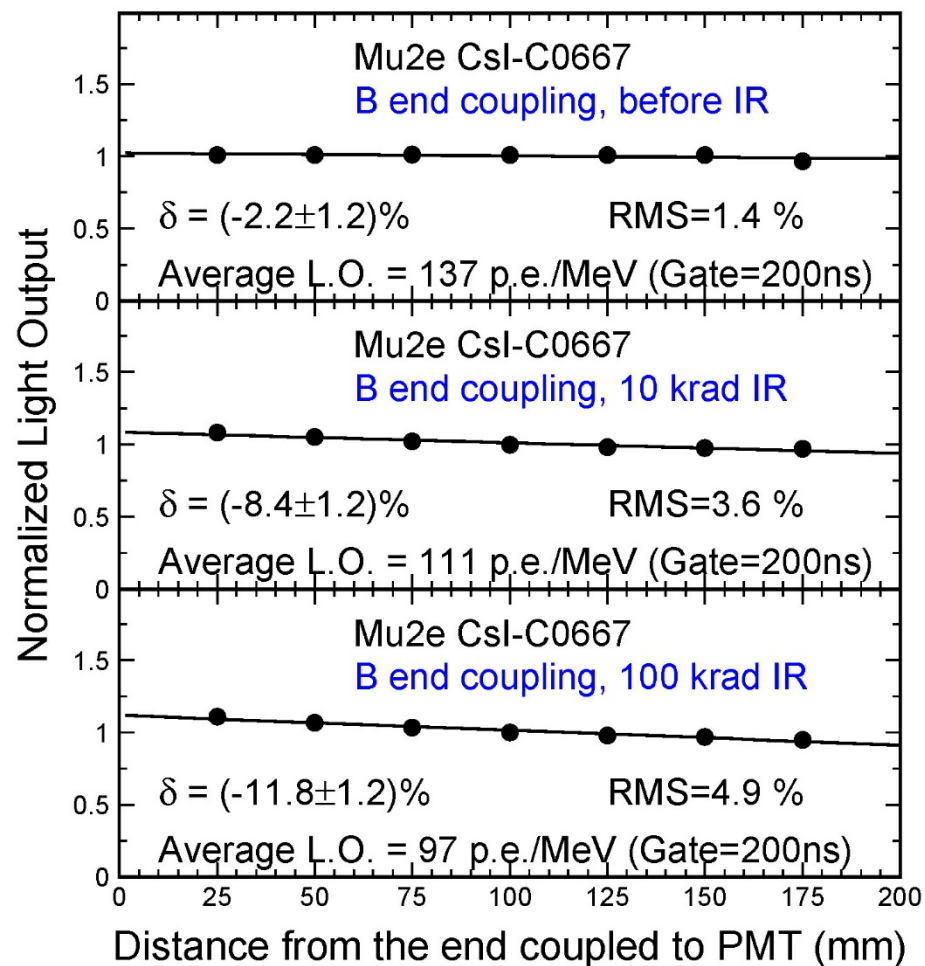
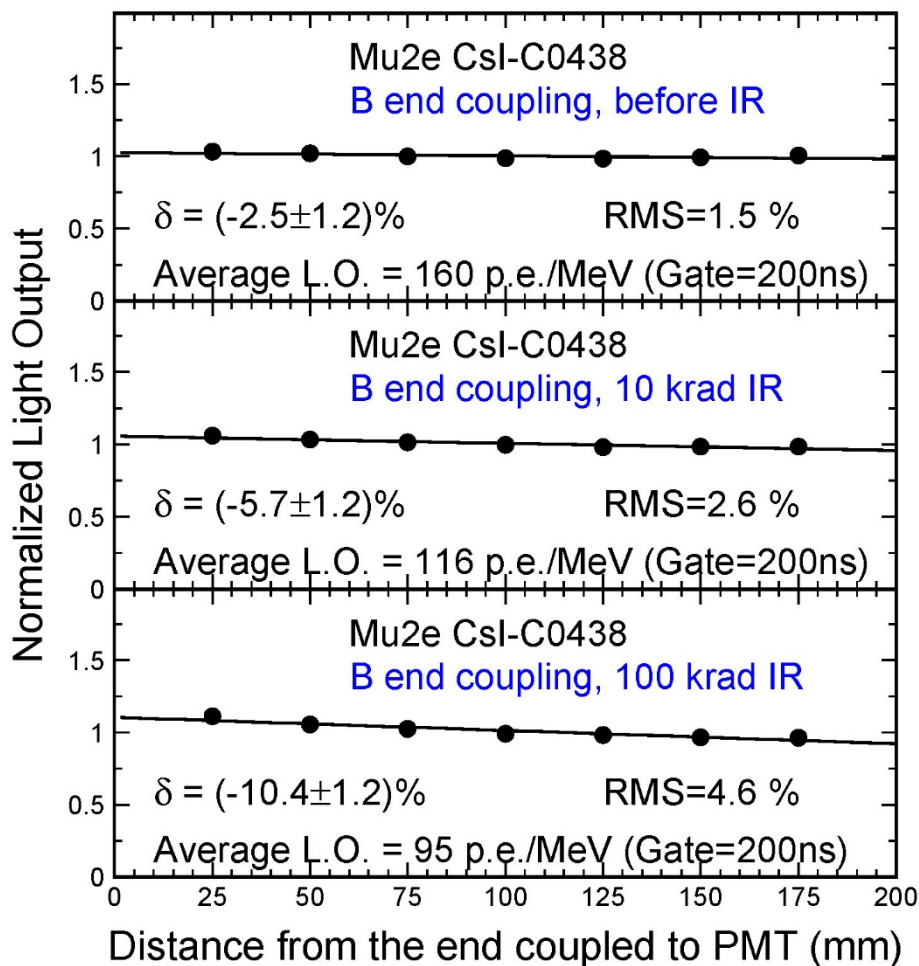




LO & LRU after 10 and 100 krad



LO after 100k is less than 100, but more than 95 p.e./MeV





Summary: Eight SIC Crystals



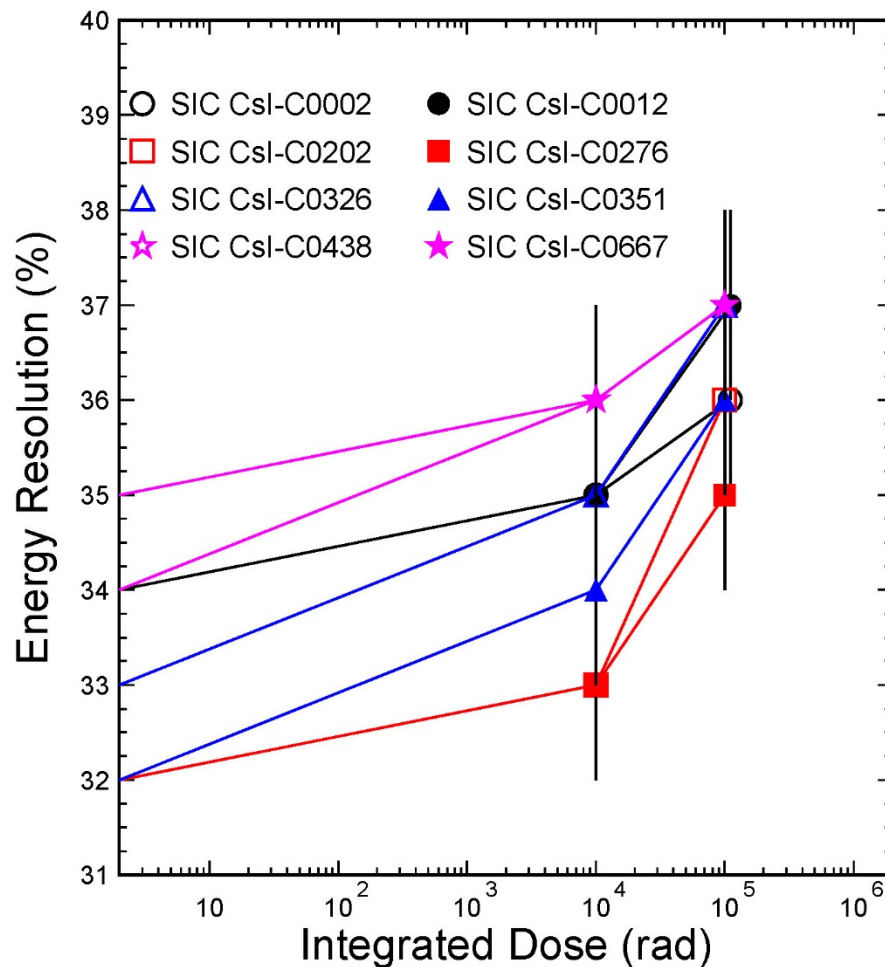
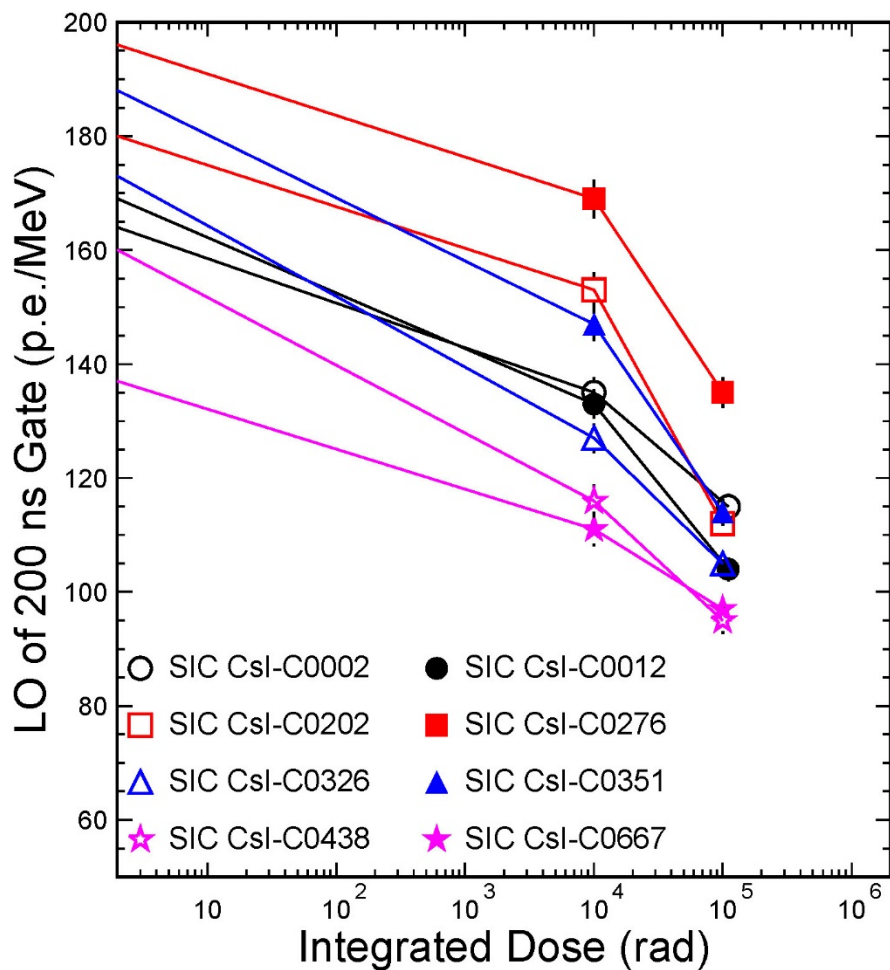
Crystal ID	Dose	L.O. (p.e./MeV)	E.R. (%)	F/T (%)	LRU (%)
SIC-C0002	Before IR	164	34	91	2.2
	10 krad	135 (82%)	35	90	0.83
	110 krad	115 (70%)	36	92	1.9
SIC-C0012	Before IR	169	33	89	2.7
	10 krad	133 (79%)	35	89	1.2
	110 krad	104 (62%)	37	90	1.5
SIC-C0202	Before IR	180	32	82	2.9
	10 krad	153 (85%)	33	86	1.0
	100 krad	112 (62%)	36	90	2.8
SIC-C0276	Before IR	196	32	86	2.9
	10 krad	169 (87%)	33	86	1.1
	100 krad	135 (69%)	35	85	1.5
SIC-C0326	Before IR	188	32	85	1.4
	10 krad	147 (78%)	34	85	1.7
	100 krad	114 (61%)	36	86	2.6
SIC-C0351	Before IR	173	33	90	2.2
	10 krad	127 (73%)	35	88	2.1
	100 krad	105 (61%)	37	91	3.5
SIC-C0438	Before IR	160	34	95	1.5
	10 krad	116 (73%)	36	92	2.6
	100 krad	95 (60%)	37	93	4.6
SIC-C0667	Before IR	137	35	80	1.4
	10 krad	111 (81%)	36	80	3.6
	100 krad	97 (71%)	37	79	4.9
Average (RMS)	Before IR	171 (10%)	33 (1.1)	87 (5.3%)	2.2 (0.61)
	10 krad	136 (13%)	34 (1.1)	87 (3.9%)	1.8 (0.89)
	100 krad	110 (11%)	36 (0.70)	88 (4.9%)	2.9 (1.2)



Summary of LO and ER



Mu2e CsI specifications: LO > 100 p.e./MeV & FWHM < 45%

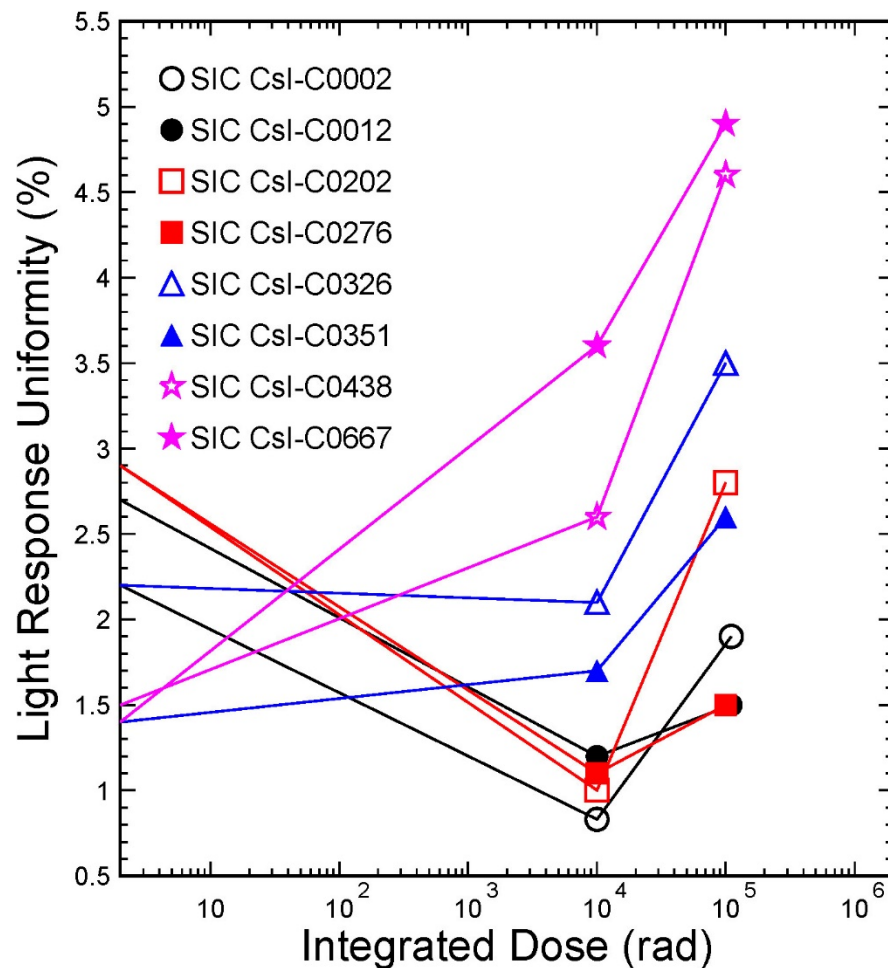
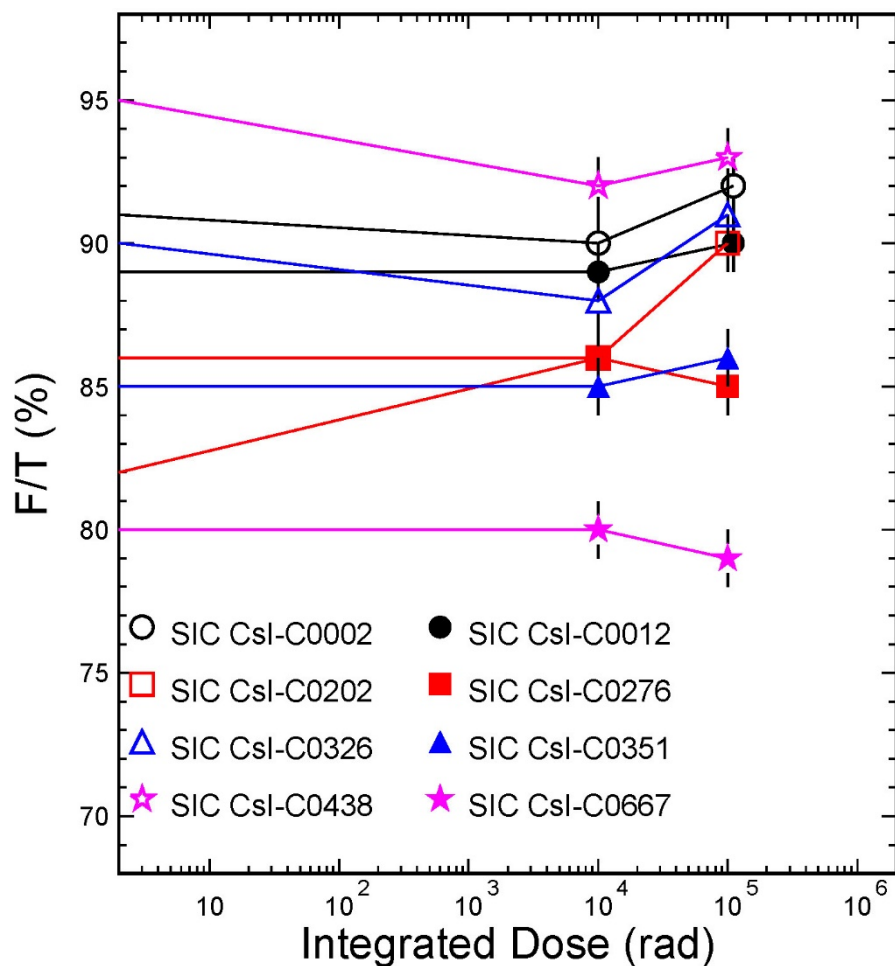




Summary of F/T and LRU



Mu2e CsI specifications: F/T ratio > 75% & LRU < 5%

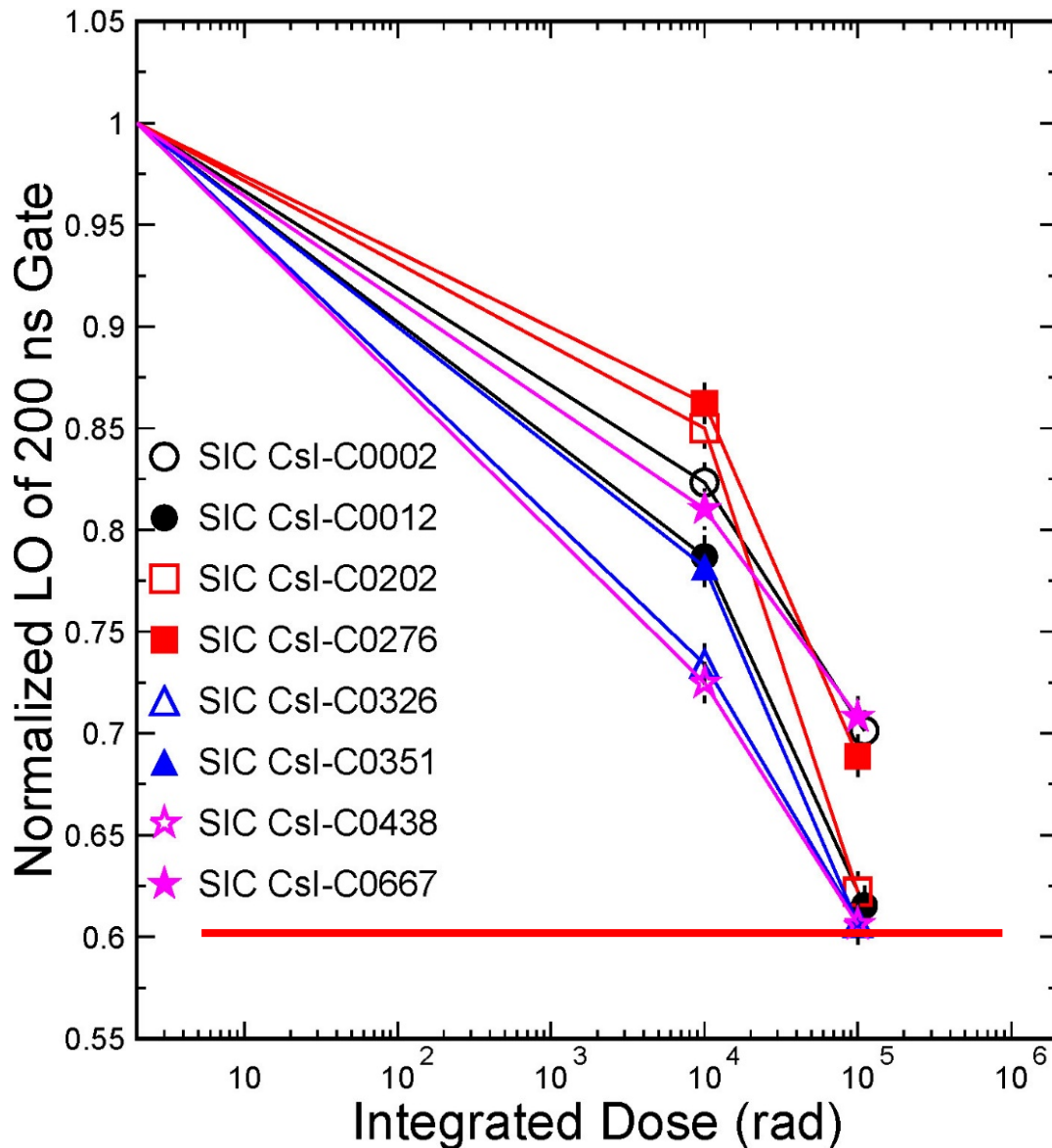




Normalized LO vs Dose



All eight crystals meet Mu2e RH spec for CsI: >60% after 100 krad

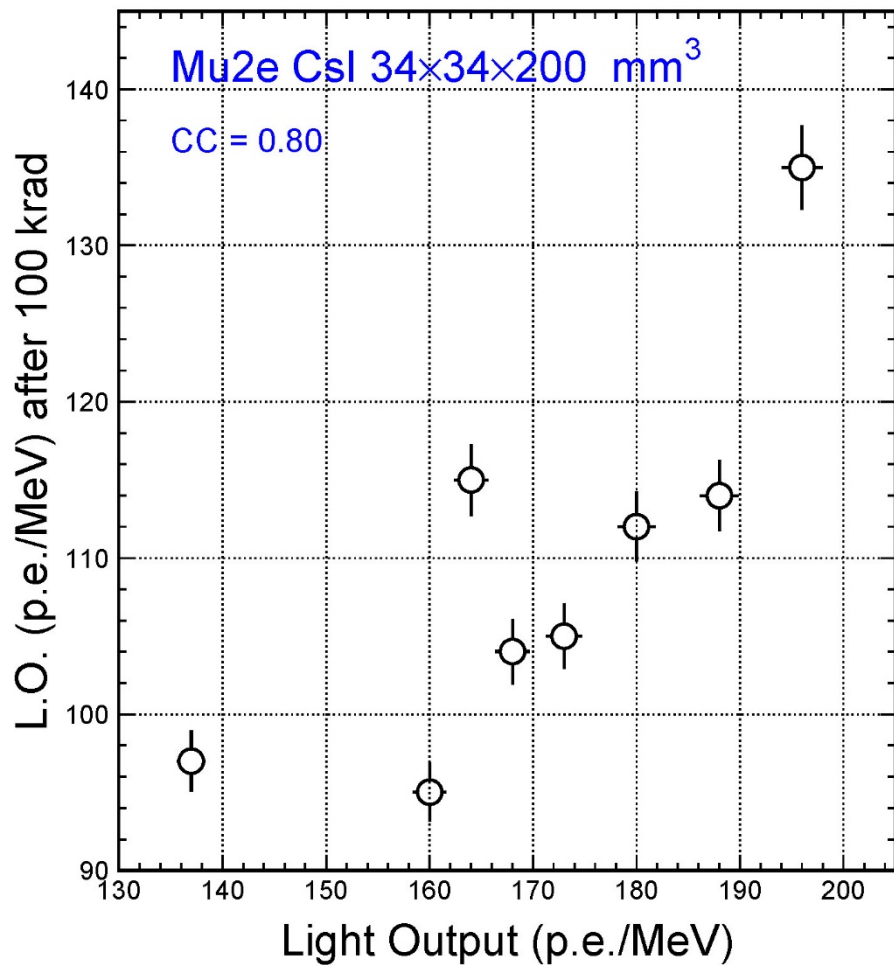
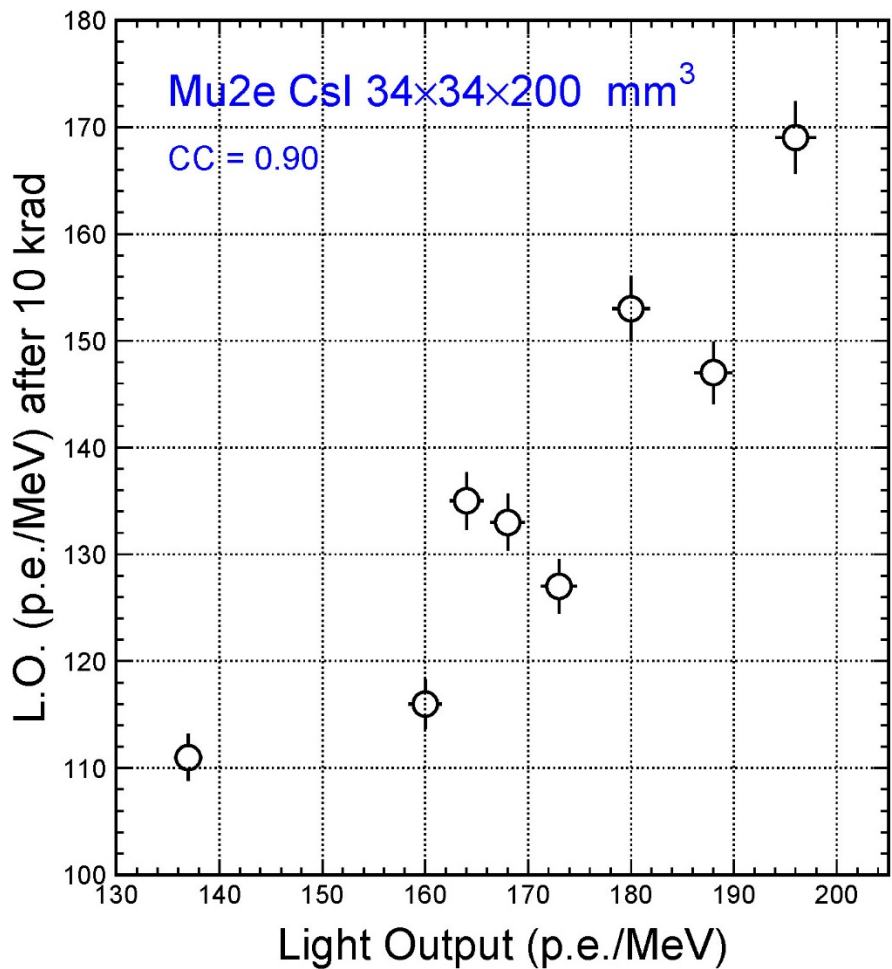




Correlations: LO_{before} vs LO_{after}

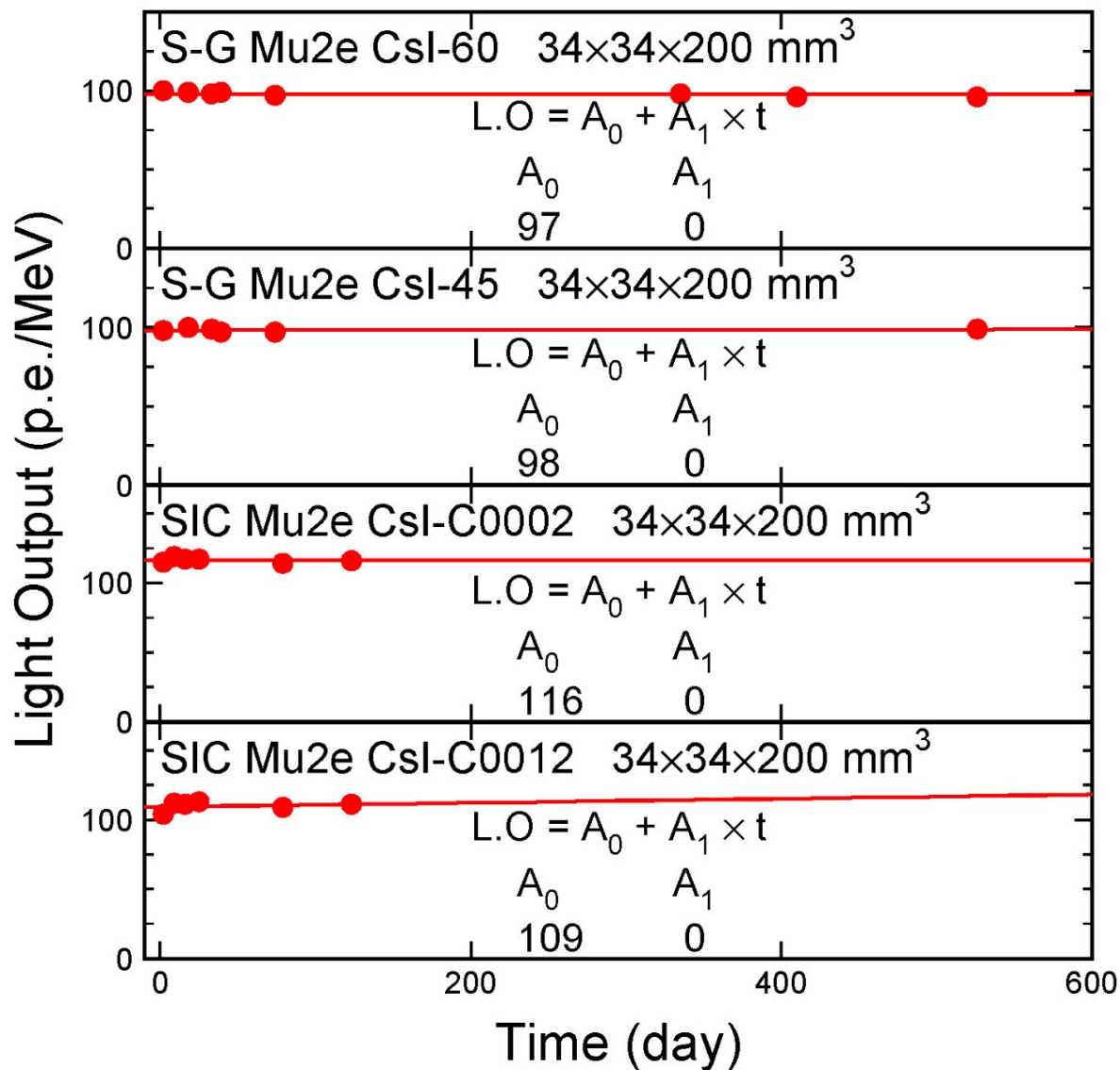


Positive correlations between LO before and after radiation





LO Recovery: S-G and SIC Csl



No recovery observed up to 526 & 123 days for two CsI crystals each from S-G and SIC, respectively



Summary

- Eight SIC CsI crystals were irradiated in two steps to 10 and 100 krad. Their average light output after 10 and 100 krad is 80% and 64%, respectively. All meet the Mu2e CsI RH specification after 100 krad.
- Their light output after 100 krad is higher than 95 p.e./MeV, indicating a working calorimeter for the entire Mu2e operation.
- No recovery observed up to 526 and 123 days after irradiation in two CsI crystals each from S-G and SIC, respectively, indicating a stable calorimeter with no dose rate dependence.