Fermilab

TS-SSC-91-242 *
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Estimation From Ten Stack Measurement Results

Sample Number		pressure *ksi*	H layer	HA layer	LT layer	GT layer	$D_{initial}$ (in)	D_{final} (in)
1	H2	6.0	4	0	0	0	0.6345	0.6255
2	H1	10.0	4	0	0	0	0.6345	0.6205
3	GT9	6.0	2	0	0	1	0.6270	0.6180
4	GT8	10.0	2	0	0	1	0.6250	0.6035
5	HA3	6.0	0	3	1	0	0.6220	0.6110
6	HA2	10.0	0	3	1	0	0.6215	0.6045
7	HA50-3	6.0	0	2	1	0	0.6075	0.5985
8	HA50-1	10.0	0	2	1	0	0.6100	0.5950

*Fig.*1 is the corelation plot of initial thickness and final thickness. It is clear that every data has almost constant shift from the equal line. The shift seems like a linear function of the pressure during the curing. Therefore we could predict the final thickness, D_{final} by:

$$D_{predicted} = D_{initial} - 0.0016 \times P \tag{1}$$

*Fig.*2 is the corelation plot of $D_{predicted}$ and D_{final}. The good agreement of these prediction is seen in the figure. Although, glass tape seems to have an extra reduction probably due to the fiber nature. All Kapton thickness keeps linear relationship with the pressure in the range of 6 to 10 ksi. Since 6 ksi data looks better in this view, one can try to estimate the final thickness of each insulation from these data. From the difference between Sample 5 and 7, Kapton HA/LT thickness is found to be 0.66 mil. If base thickness, 0.560 in, is defined using this thickness, Sample 1 gives the Kapton H thickness as 0.82 mil. Using Sample 3, and Kapton H thickness, the glass tape thickness is given as 1.27 mil. These results have significant disagreement with recent coil measurement results. Coils with 4 layer Kapton H was measured way too small compared to glass tape one. Ten stack data says it should be too large. In general difference between HA and H is small in coil but is large in ten stack. A 4 layer insulation of Kapton

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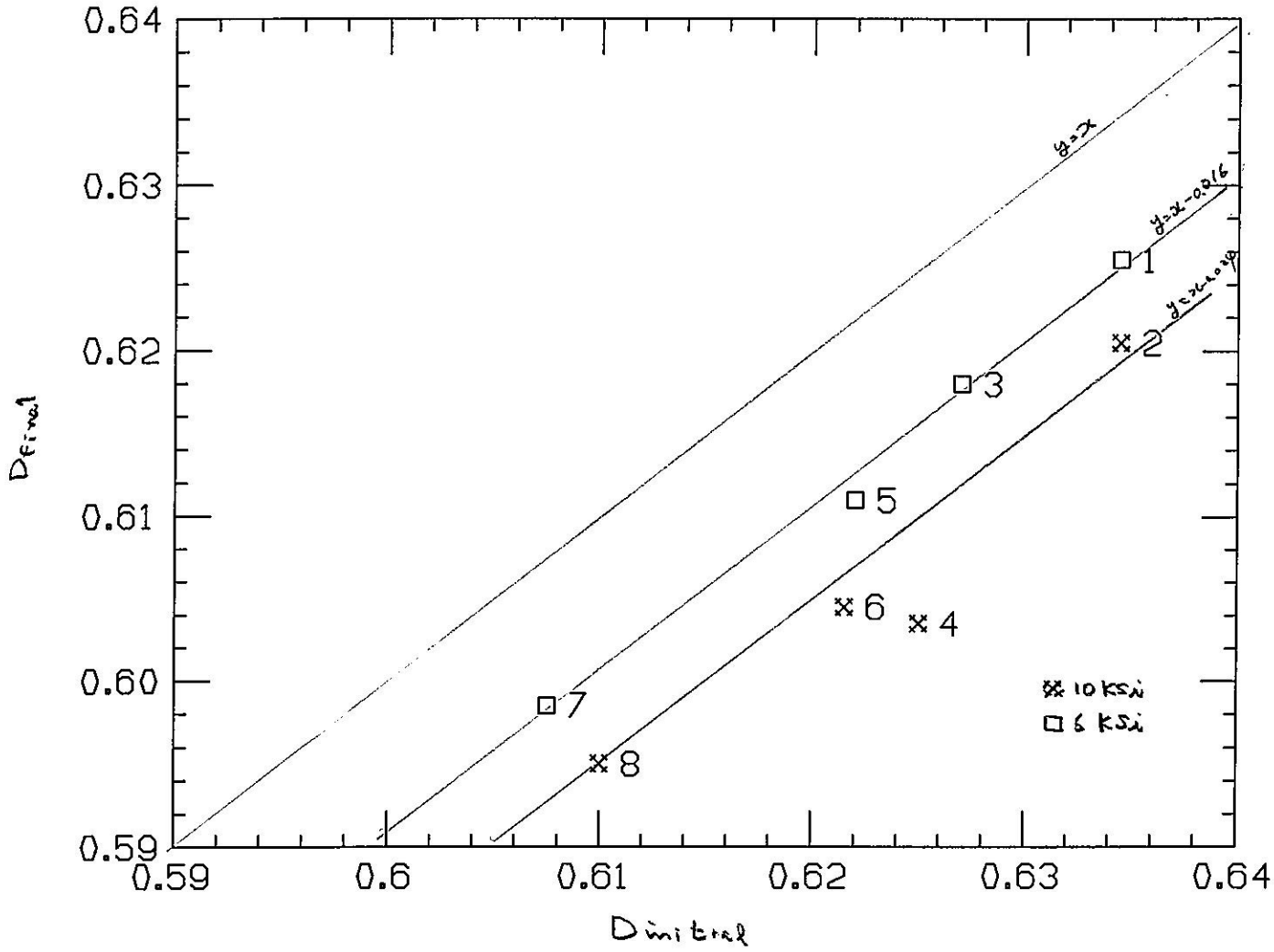
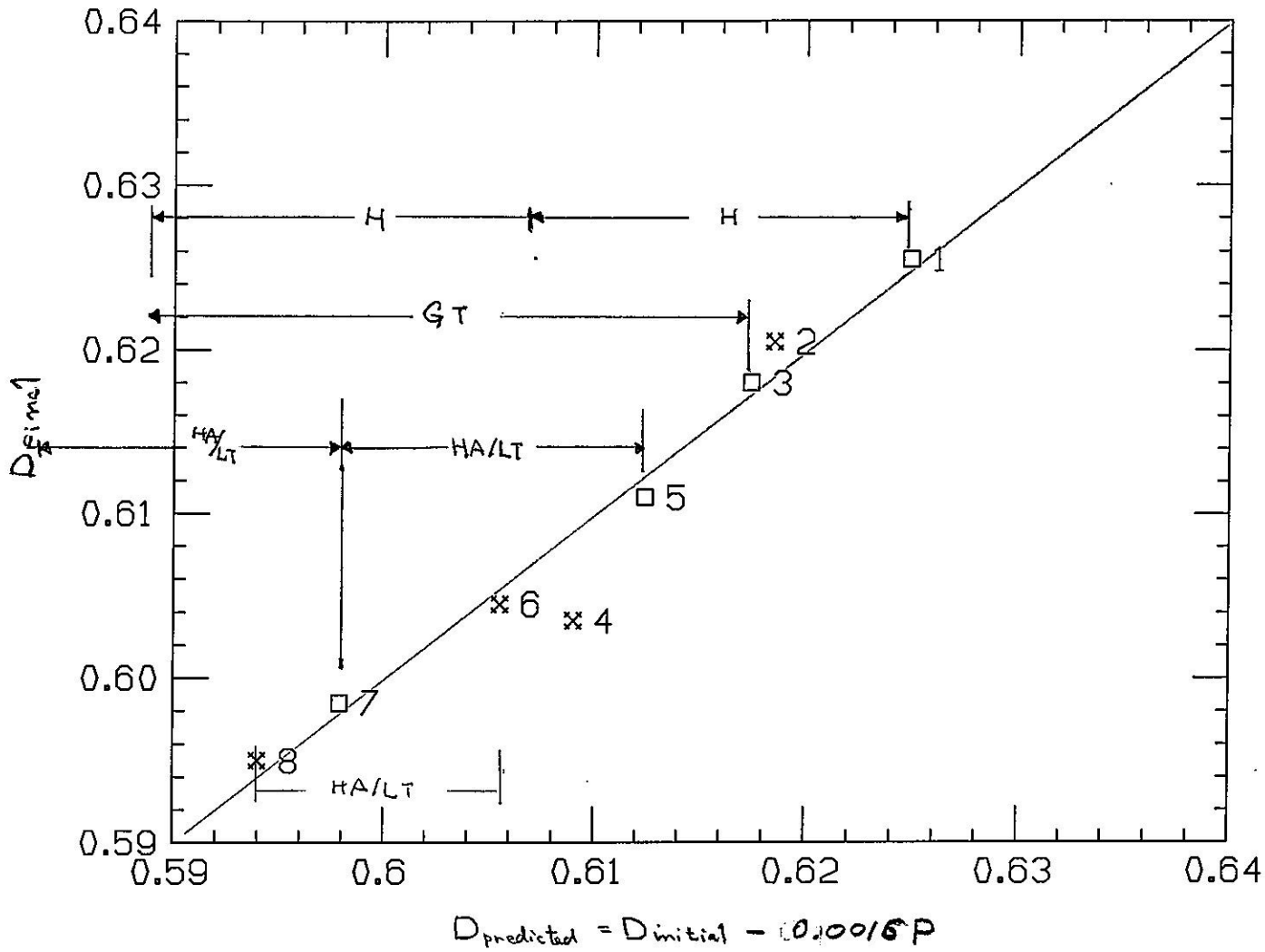
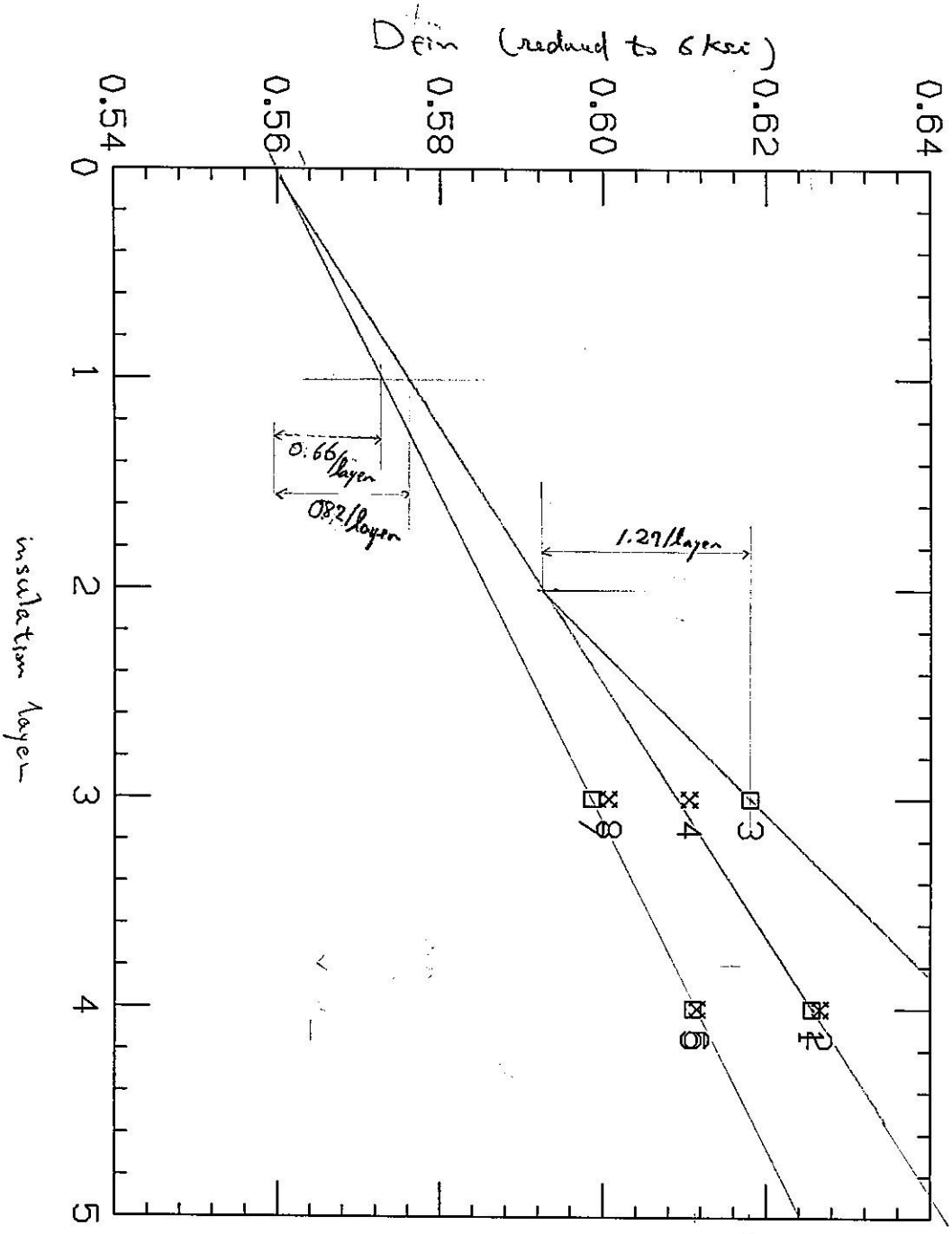
HA/LT would be closer as long as looking at the ten stack data. In summary, the insulation thickness at 6 ksi which may be good for designing as an average pressure, are given consistently as follows from the ten stack result. Correction for the temperature should be considered after getting creep measurement results. Comparison with the coil size may not be straightforward.

material	thickness
Kapton-H	0.82 mil
Kapton-HA/LT	0.66 mil
Glass Tape	1.27 mil

Correction in pressure can be made using equation (1). The relative relationship among these thickness will be kept even if temperature and pressure are changed.


0.64
0.63
0.62
0.61
0.60
0.59
0.59
0.6
0.61
0.62
0.63
0.64
Dfinal
Dinitial
y=x
y=x-0.016
y=x-0.038
1
2
3
4
5
6
7
8
10 ksi
6 ksi


0.64
0.63
0.62
0.61
0.60
0.59
0.59
0.6
0.61
0.62
0.63
0.64
H
H
GT
HA/LT
HA/LT
HA/LT
1
2
3
4
5
6
7
8
D_{final}
$D_{predicted} = D_{initial} - 0.00016P$


Dein (reduced to 6 ksi)
0.54
0.56
0.58
0.60
0.62
0.64
0
1
2
3
4
5
insulation layer
0.66/layer
0.82/layer
1.27/layer
3
4
8
5
6