

Magnet temperature Margin
Operating Current Vs. temperature
(*Rev $\Delta T = 0.9$ K)

Hall D Solenoid Magnet

Reference - JLab_HALL D
(Superconducting Magnet Solenoid)

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The Temperature margin is been evaluated¹ as discussed below-

Assumptions-

1. The Current to field data for I_c is taken as 1.6kA at 4.2K, 4T (Grade B Conductor) and 2.0 kA at 4.2K, 5T (Grade A Conductor)
2. The Temperature margin with $\sim 0.9K$ is evaluated for the defining the operating current and temperature with Iron as in the system configuration HALL D magnet.\

The plots are drawn for the following conditions-

- a. At 4.2 K , $I_{op} = 1500$ A (Min. temperature margin 0.76 K in Coil #1)
- b. At 4.2 K, $I_{op} = 1450$ A (Min. temperature margin 0.93 K in Coil #1)
- c. At 4.2 K, $I_{op} = 1400$ A (Min. temperature margin 1.10 K in Coil #1)

Suggestion -

1. With the team recommendation having 0.9 K as a minimum, $I_{op} = 1500$ A even at 4.2 K is not advisable.
2. The scenario of running the magnet up to 1400 A at 4.2 K qualifies the team recommendation and could go up to 1420 A at 4.2 K momentarily as required for mapping.

Note:

- a. The margin is about 0.9 K in all cases and is reasonable to say and concurs with team recommendation on 11th June 2013.
- b. This needs to be looked together with the calculated data reported on 31st May 2013.

¹ The error in field calculation for 1500 A is corrected to 3.03 T from 3.30 T - P Ghoshal

Table 1 - Calculated data for the Temperature margin at 4.2 K operation (with a margin of 0.9 K-Target)

HALL D	HALL D	4.2 K, 1500A				4.2 K, 1450A				4.2 K, 1400A				Rev Target Margin (K)
Coil	Coil	Bmax (T)	Ic (at Bmax) (A)	% of SSP	Temp Margin (K)	Bmax (T)	Ic (at Bmax) (A)	% of SSP	Temp Margin (K)	Bmax (T)	Ic (at Bmax) (A)	% of SSP	Temp Margin (K)	
1A	1	2.97	1862	80.56	0.76	2.85	1891	76.68	0.93	2.72	1924	72.77	1.10	0.9
1B	2	2.91	1876	79.97	0.79	2.81	1901	76.27	0.95	2.69	1931	72.49	1.11	0.9
1c	3	2.25	2042	73.46	1.12	2.16	2065	70.21	1.27	2.08	2085	67.14	1.42	0.9
1D	4	2.07	2087	71.88	1.21	1.99	2108	68.79	1.36	1.92	2126	65.86	1.49	0.9
1E	5	2.58	1958	76.60	0.96	2.48	1984	73.07	1.11	2.38	2010	69.67	1.27	0.9
1F	6	2.80	1903	78.81	0.85	2.69	1931	75.08	1.01	2.564	1963	71.31	1.18	0.9
1G	7	2.79	1907	78.67	0.85	2.68	1934	74.98	1.01	2.56	1964	71.28	1.18	0.9
2A	8	3.03	1846	81.27	0.73	2.91	1876	77.30	0.90	2.81	1901	73.64	1.05	0.9
2B	9	2.85	1892	79.28	0.82	2.73	1921	75.47	0.99	2.63	1947	71.92	1.14	0.9
2C	10	2.83	1896	79.13	0.83	2.72	1924	75.37	0.99	2.6	1954	71.64	1.16	0.9
2D	11	2.73	1921	78.08	0.88	2.63	1947	74.49	1.04	2.51	1977	70.82	1.20	0.9
3A	12	3.07	1835	81.76	0.71	2.95	1866	77.71	0.88	2.81	1901	73.64	1.05	0.9
3B	13	2.90	1878	79.86	0.80	2.78	1909	75.97	0.96	2.67	1936	72.30	1.12	0.9
3C	14	2.80	1903	78.81	0.85	2.7	1929	75.17	1.00	2.59	1957	71.55	1.16	0.9
3D	15	2.63	1946	77.09	0.93	2.53	1972	73.54	1.09	2.43	1997	70.11	1.24	0.9
4A	16	3.46	2580	58.14	1.55	3.32	2632	55.10	1.69	3.15	2695	51.94	1.85	0.9
4B	17	4.53	2177	68.91	1.00	4.35	2246	64.57	1.17	4.16	2317	60.43	1.35	0.9

Table 2 - Calculated data for the Temperature margin at 4.5 K operation at 1360 A

HALL D	HALL D	4.5 K, 1360A			
Coil	Coil	Bmax (T)	Ic (at Bmax) (A)	% of SSP	Temp Margin (K)
1A	1	2.67	1796	75.71	0.91
1B	2	2.63	1806	75.30	0.93
1c	3	2.03	1955	69.57	1.23
1D	4	1.86	1997	68.10	1.31
1E	5	2.324	1882	72.26	1.08
1F	6	2.52	1833	74.18	0.99
1G	7	2.51	1836	74.08	0.99
2A	8	2.73	1781	76.34	0.88
2B	9	2.56	1824	74.58	0.97
2C	10	2.55	1826	74.48	0.97
2D	11	2.46	1848	73.58	1.02
3A	12	2.77	1772	76.77	0.86
3B	13	2.61	1811	75.09	0.94
3C	14	2.53	1831	74.28	0.98
3D	15	2.37	1871	72.70	1.06
4A	16	3.11	2505	54.29	1.63
4B	17	4.08	2148	63.31	1.15

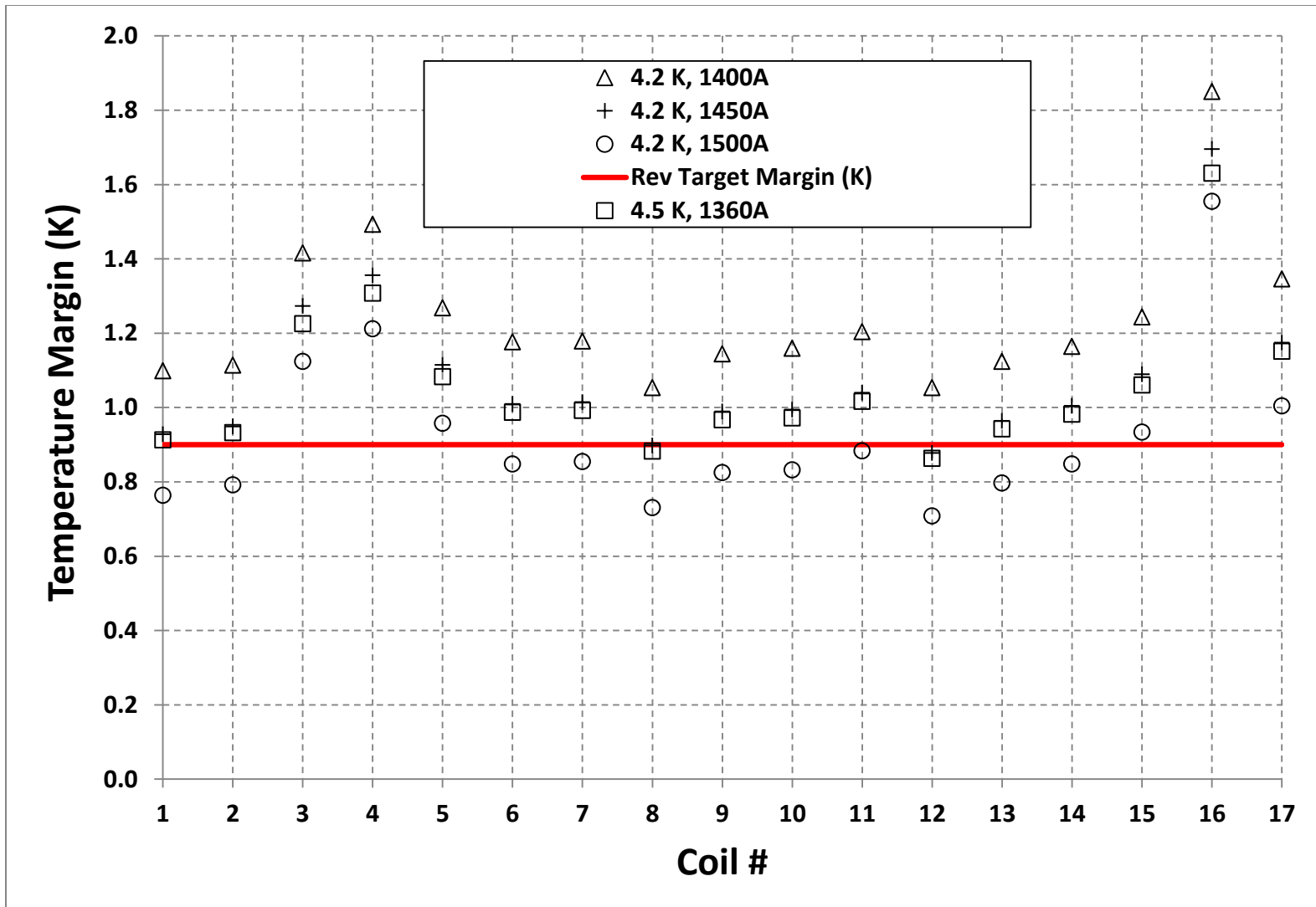


Figure 1 - Data plotted from Table 1 and Table 2.

Plots and data calculated earlier and reported on 31st May 2013

Table 3 – Calculated data for the Temperature margin based on Alcorn et al Conductor Specification for a few operating cases

HALL D	HALL D	4.5 K, 1500A				4.6 K, 1500A				4.65 K, 1400A				4.65 K, 1350 A				4.5 K, 1350 A				4.65 K, 1300A				4.65 K, 1250A				Target
Coil	Coil	Bmax (T)	lc (at Bmax) (A)	% of SSP	Temp Margin (K)	Bmax (T)	lc (at Bmax) (A)	% of SSP	Temp Margin (K)	Bmax (T)	lc (at Bmax) (A)	% of SSP	Temp Margin (K)	Bmax (T)	lc (at Bmax) (A)	% of SSP	Temp Margin (K)	Bmax (T)	lc (at Bmax) (A)	% of SSP	Temp Margin (K)	Bmax (T)	lc (at Bmax) (A)	% of SSP	Temp Margin (K)	Bmax (T)	lc (at Bmax) (A)	% of SSP	Temp Margin (K)	Target Margin (K)
1A	1	2.97	1723	87.05	0.47	2.97	1677	89.46	0.37	2.72	1714	81.69	0.66	2.63	1736	77.77	0.81	2.63	1806	74.74	0.95	2.53	1760	73.84	0.96	2.43	1785	70.03	1.11	1
1B	2	2.91	1737	86.37	0.50	2.91	1690	88.75	0.40	2.69	1721	81.34	0.67	2.6	1743	77.44	0.82	2.6	1814	74.44	0.97	2.5	1768	73.54	0.97	2.4	1792	69.74	1.13	1
1c	3	2.25	1900	78.95	0.83	2.25	1852	80.97	0.73	2.08	1871	74.83	0.97	2	1891	71.40	1.11	2	1962	68.80	1.26	1.93	1908	68.14	1.25	1.86	1925	64.93	1.38	1
1D	4	2.07	1944	77.16	0.92	2.07	1896	79.09	0.82	1.92	1910	73.29	1.05	1.85	1928	70.04	1.18	1.85	2000	67.52	1.33	1.78	1945	66.85	1.32	1.71	1962	63.71	1.46	1
1E	5	2.58	1818	82.53	0.66	2.58	1771	84.71	0.56	2.38	1797	77.89	0.82	2.29	1819	74.20	0.97	2.29	1890	71.41	1.12	2.21	1839	70.69	1.11	2.12	1861	67.16	1.26	1
1F	6	2.80	1764	85.05	0.55	2.80	1717	87.36	0.46	2.564	1752	79.90	0.73	2.47	1775	76.05	0.88	2.47	1846	73.14	1.03	2.38	1797	72.33	1.03	2.3	1817	68.80	1.17	1
1G	7	2.79	1767	84.89	0.56	2.79	1720	87.19	0.46	2.56	1753	79.86	0.74	2.47	1775	76.05	0.88	2.47	1846	73.14	1.03	2.378	1798	72.31	1.03	2.29	1819	68.70	1.18	1
2A	8	3.03	1641	91.44	0.44	3.03	1595	94.07	0.34	2.81	1692	82.76	0.61	2.71	1716	78.66	0.77	2.71	1786	75.57	0.91	2.61	1741	74.68	0.92	2.51	1765	70.81	1.07	1
2B	9	2.85	1753	85.59	0.53	2.85	1706	87.92	0.43	2.63	1736	80.65	0.70	2.54	1758	76.79	0.85	2.54	1829	73.83	1.00	2.44	1783	72.93	1.00	2.35	1805	69.26	1.15	1
2C	10	2.83	1756	85.41	0.54	2.83	1710	87.74	0.44	2.6	1743	80.31	0.72	2.51	1765	76.47	0.86	2.51	1836	73.53	1.01	2.42	1787	72.73	1.01	2.33	1810	69.08	1.16	1
2D	11	2.73	1781	84.21	0.59	2.73	1735	86.48	0.49	2.51	1765	79.30	0.76	2.43	1785	75.63	0.90	2.43	1856	72.75	1.05	2.34	1807	71.94	1.05	2.25	1829	68.33	1.20	1
3A	12	3.07	1696	88.42	0.41	3.07	1650	90.90	0.32	2.81	1692	82.76	0.61	2.71	1716	78.66	0.77	2.71	1786	75.57	0.91	2.61	1741	74.68	0.92	2.51	1765	70.81	1.07	1
3B	13	2.90	1739	86.25	0.50	2.90	1693	88.62	0.40	2.67	1726	81.11	0.68	2.58	1748	77.22	0.83	2.58	1819	74.23	0.98	2.48	1773	73.33	0.98	2.39	1795	69.64	1.13	1
3C	14	2.80	1764	85.04	0.55	2.80	1717	87.35	0.46	2.59	1746	80.20	0.72	2.49	1770	76.26	0.87	2.49	1841	73.33	1.02	2.4	1792	72.53	1.02	2.31	1815	68.89	1.17	1
3D	15	2.63	1806	83.08	0.64	2.63	1759	85.29	0.54	2.43	1785	78.43	0.80	2.35	1805	74.81	0.94	2.35	1876	71.98	1.09	2.26	1827	71.16	1.09	2.17	1849	67.61	1.24	1
4A	16	3.46	2377	63.11	1.26	3.46	2309	64.96	1.16	3.15	2388	58.64	1.41	3.04	2428	55.61	1.53	3.04	2531	53.34	1.68	2.92	2471	52.60	1.66	2.81	2512	49.77	1.78	1
4B	17	4.53	1981	75.71	0.71	4.53	1916	78.30	0.61	4.16	2019	69.33	0.90	4.01	2074	65.09	1.05	4.01	2174	62.10	1.20	3.86	2129	61.07	1.20	3.71	2183	57.25	1.35	1

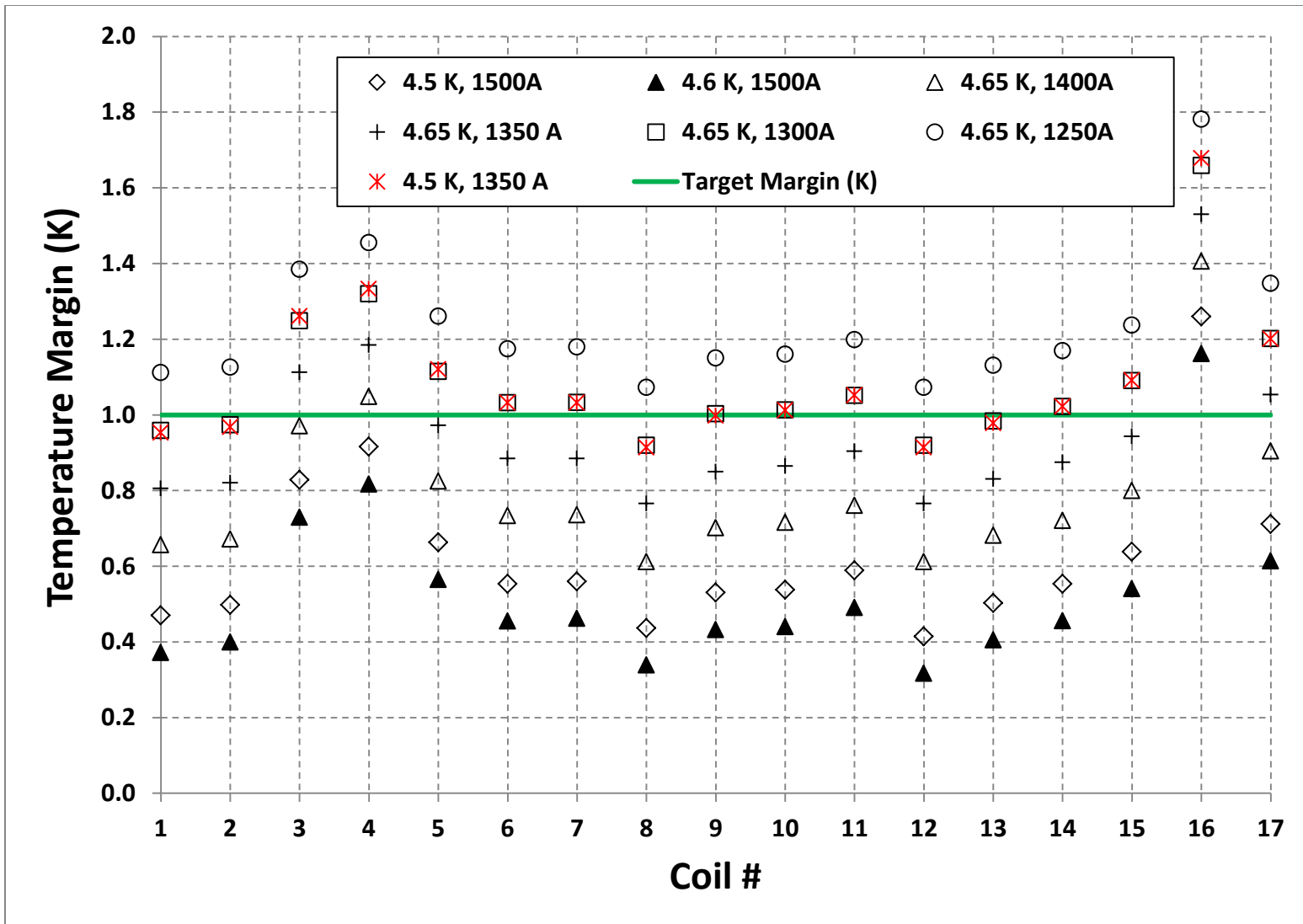


Figure 2 - Data plotted from Table 3