FERMILAB Technical Division	7500A HTS Power leads for the LHC DFBX	Doc. No. Rev. No. 1 Date: August 18, 2003 Page 1 of 1 Author: Sandor Feher
	0. Cover Sheet for Check Out Form	DFLX - 03

Power leads being tested: 7500 A DFLX 03 7500 A DFLX 04

Task #	Responsible	Task	Received Date,time		Performed Date,time	
1	Inspection	Unpack the leads				
2	Inspection	IB4 mech. & Tolerances				
3	Mechanical	Move the leads to MTF			12/10	0730
4	Electrical	Initial electrical check out			1/22/03	1500
4a	Mechanical	Preliminary leak check			112103	112603
5	Mechanical	Installation of the current leads			121103	
6	Mechanical	Pressure test			121203	
7	Mechanical	Leak check			121503	
7a	Mechanical	Top plate insertion into the dewar			121603	
8	M. Tartaglia	Configuration of the DAQ system				
9	Electrical	Room temp. electrical test			12/16/03	1000
10	Mechanical	Installation of the top plate			121603	
10.1	Electrical	Room temp. GHe hipot			12/16/03	
12	Mechanical	Cool down			12/17	0615
13	Electrical	Electrical & instrumentation test				
14	Mechanical	Connect the leads to the Power Supply & configure			12/17	
15	Electrical	Electrical & instrumentation test				
16	M. Thompson	Cold test of the power lead			12/17	0930
17	Mechanical	Perform a Thermal cycle			12/17	1600
18	M. Thompson	Cold test of the power lead			12/18	0900
19	Mechanical	Warm up			12/18	1400
20	Electrical	Electrical & instrumentation test				
21	Mechanical	Remove the top plate			010604	
22	Mechanical	Remove the leads from the top plate			010604	
23	Mechanical	Pack and move the leads			011303	

FERMILAB Technical Division	7500A HTS Power leads for the LHC DFBX **1. Unpacking Check Out Form**	Doc. No. Rev. No. Date:January 6, 2003 Page 1 of 1 Author: Sandor Feher

Performed by SUDHIR GHANTA [signature]
(name typed) (signature)

Date & time 1/9/03 10.30 Am

Note: Save the shipping container for storing and moving the leads around TD and after the test is complete to ship them to the DFBX manufacturer.

1.1 Container Identification: 7500 A DFLX 03 7500 A DFLX 04
(Leads serial numbers are on one side of the container)

1.2 Note condition of shipping container
No damage ☑ Slight damage ☐ Massive damage ☐

1.3 Examine condition of g-load indicators
a. Each side of the box are Shock Watch-s are installed
Not tripped ☑ Tripped (red) ☐ Remark: ____
Not tripped ☑ Tripped (red) ☐ Remark: ____

b. Each leads have a Shock Watch installed onto their body
Not tripped ☑ Tripped (red) ☐ Remark: ____
Not tripped ☑ Tripped (red) ☐ Remark: ____

c. Each leads have another "10G DROP" devices installed on the flag of the leads
Not tripped ☐ Tripped (Black) ☐ Remark: MISSING
Not tripped ☐ Tripped (Black) ☐ Remark: MISSING

1.4 Container content:
a. Power leads: 7500 A DFLX 03 ; 7500 A DFLX 04
b. Travel document for each lead in an envelope ☑
c. In a plastic box:
1. One clamp: Item No. C105-12-401; Description NW16/10 Clamping ring ST/STEEL PK1 ☑
2. One valve made by "precision Cryogenic System" ☑
3. One O-ring seal with brass insert ☑

PART NAME : 7.5 KA CURRENT LEAD ASSY (LBNL01)
REV NUMBER :
SER NUMBER :
STATS COUNT : 1

7500A DFLX 03
WITH INSULATOR

MM	DIM CYL -A-DIA= LOCATION OF CYLINDER CYL -A-						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
D	99.000	0.200	0.200	99.026	0.026	0.000	

MM	DIM -A-= ROUNDNESS OF CYLINDER CYL -A-						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
M	0.000	0.200	0.000	0.048	0.048	0.000	

MM	DIM -B-= FLATNESS OF PLANE PLN -B-						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
M	0.000	0.050	0.000	0.005	0.005	0.000	

MM	DIM PERP1= PERPEND OF PLANE PLN -B- TO CYLINDER CYL -A- EXTEND=0.00(						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
M	0.000	0.130	0.000	0.180	0.180	0.050	

MM	DIM PERP2= PERPEND OF PLANE LRG FLANGE TO CYLINDER CYL -A- EXTEND=5(						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
M	0.000	0.130	0.000	0.191	0.191	0.061	

MM	DIM -C- DIA= LOCATION OF CYLINDER -C-						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
D	80.000	0.200	0.200	80.154	0.154	0.000	

MM	DIM CONCEN2=CONCENTRICITY FROM CYLINDER -C- TO CYLINDER CYL -A-						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
M	0.000	0.250	0.000	1.148	1.148	0.898	

MM	DIM RND2= ROUNDNESS OF CYLINDER -C-						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
M	0.000	0.200	0.000	0.059	0.059	0.000	

MM	DIM DIST1= 2D DISTANCE FROM PLANE PLN -B- TO PLANE LRG FLANGE PAR T(						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
M	561.000	1.000	1.000	560.798	-0.202	0.000	

MM	DIM LOC5= TRUE POSITION OF CIRCLE CIR2							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
X	0.000				0.000	0.000		
Z	123.571				123.459	-0.112		
DF	16.000	0.200	0.200		17.965	1.965	1.765	
TP	RFS	0.400		0.000		0.223	0.000	

PART NUMBER=7.5 KA CURRENT LEAD ASSY (LBNL01) DATE=1/9/2003 TIME=2:35:30 PM

MM	DIM LOC10= TRUE POSITION OF CIRCLE CIR3							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
X	-78.890				-78.955	-0.065		
Z	95.047				94.954	-0.093		
DF	16.000	0.200	0.200		17.966	1.966	1.766	
TP	RFS	0.400		0.000		0.226	0.000	

MM	DIM LOC11= TRUE POSITION OF CIRCLE CIR4							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
X	78.890				78.942	0.052		
Z	95.047				94.944	-0.103		
DF	16.000	0.200	0.200		17.970	1.970	1.770	
TP	RFS	0.400		0.000		0.230	0.000	

MM	DIM LOC12= TRUE POSITION OF CIRCLE CIR5							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
X	78.890				78.922	0.032		
Z	-95.047				-95.139	-0.092		
DF	16.000	0.200	0.200		17.949	1.949	1.749	
TP	RFS	0.400		0.000		0.195	0.000	

MM	DIM LOC13= TRUE POSITION OF CIRCLE CIR6							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
X	-78.890				-78.976	-0.086		
Z	-95.047				-95.120	-0.074		
DF	16.000	0.200	0.200		17.966	1.966	1.766	
TP	RFS	0.400		0.000		0.226	0.000	

MM	DIM LOC09= TRUE POSITION OF CIRCLE ID1							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.556	0.006		
PA	-153.000				-152.940	0.060		
DF	8.407	0.200	0.200		8.506	0.098	0.000	
TP	RFS	0.080		0.000		0.191	0.111	

MM	DIM LOC20= TRUE POSITION OF CIRCLE ID2							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.568	0.018		
PA	-171.000				-170.934	0.066		
DF	8.407	0.200	0.200		8.507	0.099	0.000	
TP	RFS	0.080		0.000		0.213	0.133	

MM	DIM LOC31= TRUE POSITION OF CIRCLE ID3							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.580	0.030		
PA	-135.000				-134.958	0.042		
DF	8.407	0.200	0.200		8.512	0.105	0.000	
TP	RFS	0.080		0.000		0.145	0.065	

PART NUMBER=7.5 KA CURRENT LEAD ASSY (LBNL01) DATE=1/9/2003 TIME=2:35:31 PM

MM	DIM LOC1= TRUE POSITION OF CIRCLE ID4							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.538	-0.012		
PA	171.000				171.073	0.073		
DF	8.407	0.200	0.200		8.505	0.098	0.000	
TP	RFS	0.080		0.000		0.230	0.150	

MM	DIM LOC2= TRUE POSITION OF CIRCLE ID5							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.446	-0.104		
PA	153.000				153.036	0.036		
DF	8.407	0.200	0.200		8.526	0.119	0.000	
TP	RFS	0.080		0.000		0.238	0.158	

MM	DIM LOC3= TRUE POSITION OF CIRCLE ID6							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.406	-0.144		
PA	135.000				135.046	0.046		
DF	8.407	0.200	0.200		8.519	0.111	0.000	
TP	RFS	0.080		0.000		0.322	0.242	

MM	DIM LOC4= TRUE POSITION OF CIRCLE ID7							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.392	-0.158		
PA	117.000				117.019	0.019		
DF	8.407	0.200	0.200		8.514	0.106	0.000	
TP	RFS	0.080		0.000		0.322	0.242	

MM	DIM LOC6= TRUE POSITION OF CIRCLE ID8							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.419	-0.131		
PA	99.000				98.995	-0.005		
DF	8.407	0.200	0.200		8.514	0.107	0.000	
TP	RFS	0.080		0.000		0.262	0.182	

MM	DIM LOC7= TRUE POSITION OF CIRCLE ID9							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.372	-0.177		
PA	81.000				81.001	0.001		
DF	8.407	0.200	0.200		8.540	0.132	0.000	
TP	RFS	0.080		0.000		0.355	0.275	

MM	DIM LOC8= TRUE POSITION OF CIRCLE ID10							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.396	-0.154		
PA	63.000				62.948	-0.052		
DF	8.407	0.200	0.200		8.531	0.124	0.000	
TP	RFS	0.080		0.000		0.348	0.268	

3-4

PART NUMBER=7.5 KA CURRENT LEAD ASSY (LBNL01) DATE=1/9/2003 TIME=2:35:32 PM

MM	DIM LOC14= TRUE POSITION OF CIRCLE ID11							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.416	-0.134		
PA	45.000				44.923	-0.077		
DF	8.407	0.200	0.200		8.530	0.123	0.000	
TP	RFS	0.080		0.000		0.363	0.283	

MM	DIM LOC15= TRUE POSITION OF CIRCLE ID12							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.458	-0.092		
PA	27.000				26.900	-0.100		
DF	8.407	0.200	0.200		8.519	0.111	0.000	
TP	RFS	0.080		0.000		0.365	0.285	

MM	DIM LOC16= TRUE POSITION OF CIRCLE ID13							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.471	-0.078		
PA	9.000				8.924	-0.076		
DF	8.407	0.200	0.200		9.070	0.663	0.463	
TP	RFS	0.080		0.000		0.287	0.207	

MM	DIM LOC17= TRUE POSITION OF CIRCLE ID14							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.566	0.016		
PA	-9.000				-9.090	-0.090		
DF	8.407	0.200	0.200		8.509	0.101	0.000	
TP	RFS	0.080		0.000		0.287	0.207	

MM	DIM LOC18= TRUE POSITION OF CIRCLE ID16							
AX	NOMINAL	+TOL	-TOL	BONUS	MEAS	DEV	OUTTOL	
PR	90.550				90.565	0.015		
PA	-27.000				-27.070	-0.070		
DF	8.407	0.200	0.200		8.513	0.105	0.000	
TP	RFS	0.080		0.000		0.224	0.144	

MM	DIM 1450= 2D DISTANCE FROM LINE FRT END TO LINE LIN2 PAR TO YAXIS						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
M	1450.000	0.400	0.400	1452.827	2.827	2.427	

MM	DIM 130.0DIA= LOCATION OF CIRCLE OD1						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
D	130.000	0.200	0.200	129.956	-0.044	0.000	

MM	DIM 502 COOLING HOLE= 2D DISTANCE FROM CIRCLE ID15 TO PLANE LRG FLAN						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
M	502.000	0.400	0.400	500.978	-1.022	0.622	

MM	DIM X LOC OF COOLING HOLE= LOCATION OF CIRCLE ID15						
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL	
X	0.000	0.200	0.200	-3.381	-3.381	3.181	

37

PART NUMBER=7.5 KA CURRENT LEAD ASSY (LBNL01) DATE=1/9/2003 TIME=2:35:33 PM

DEG	DIM WARM TERMINAL= 3D ANGLE (TRUE) FROM PLANE PLN2 TO ZAXIS					
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL
A	0.000	0.100	0.100	-1.164	-1.164	1.064

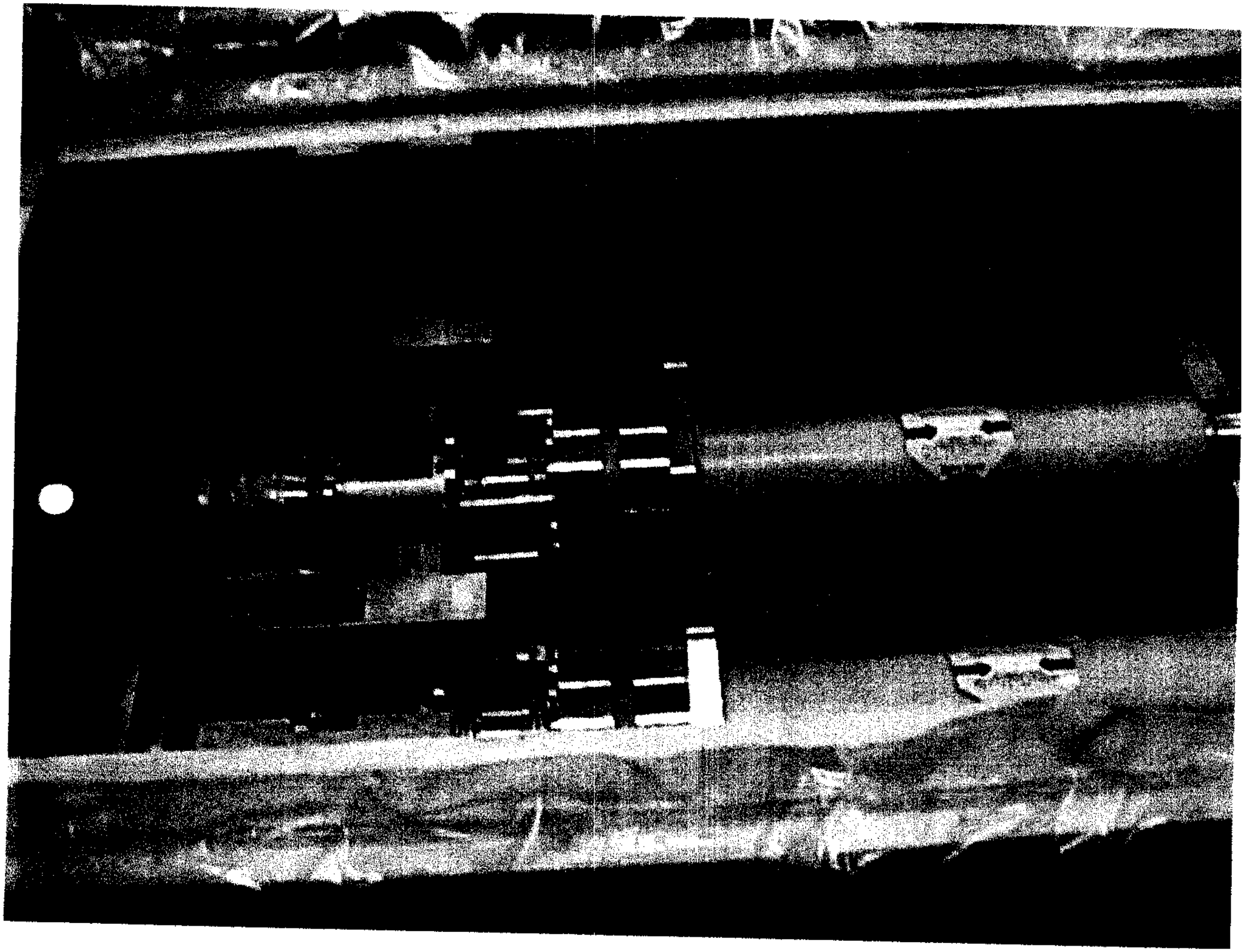
IN	DIM X LOC OF WARM TERM= LOCATION OF PLANE MID PLN					
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL
X	0.000	0.100	0.100	-0.165	-0.165	0.065

IN	DIM POLAR ANGLE OF COOLING HOLE= LOCATION OF CIRCLE ID15					
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL
PA	90.000	0.500	0.500	93.627	3.627	3.127

MM	DIM 442.5= 2D DISTANCE FROM LINE FRT END TO PLANE PLN -B- PAR TO YA>					
AX	NOMINAL	+TOL	-TOL	MEAS	DEV	OUTTOL
M	442.500	0.400	0.400	444.912	2.412	2.012

7500A DFLX 03,04

WITH INSULATORS



3. Form for moving power leads

Power leads need to be moved from NW8 to MTF are:
7500 DFLX 03 & 7500 DFLX 04
Approved by__________SandorFeher________________________
(name typed) (signature)
Date & time ______________________

The request should go through Marsha Schmidt who is responsible keeping track of whereabouts of the power leads.

Requested by ROGER RABEHL [signature]
(name typed) (signature)
Date & time DECEMBER 9, 2003 1100

Delivered by G. VOZAIN [signature]
(name typed) (signature)
Date & time 12/10/03 7:25 AM

Received by DEAN VALIDIS [signature]
(name typed) (signature)
Date & time 12-10-03 0727

The next person ____________ responsible to perform Checkout form #5 (5. Installation of the current leads into the top plate) has been

Notified by ______________________
(name typed) (signature)
Date & time ______________________

This form should be copied and each copy should be placed into the folders of both of the power leads

Material Control Job Ticket

Date of Request: 12/9/2003

Time of Request: 11:26:46 AM

Job Ticket Number: 4937

ID#	First Name	Last Name	Extension
04223	Marsha	Schmidt	4377

TASK#

Location of Material: PW8

Pieces	Weight	Routing Form #	Purchase Order #
2 pcs			

Additional Information:

Please pull 2 pcs. of LHC DFBX power leads (Fake #4) from PW8 and take them ot IB 1/MTF. (S/Ns 03 & 04) Roger would like them by 12/10/03 AM and be sure to leave original form with him when the parts are dropped off.

B/C-LYY 300/1.1.3.4.2

Date Completed:

Who Performed Work:

Activity Card: ○ Yes ○ No

FERMILAB Technical Division	7500A HTS Power leads for the LHC DFBX	Doc. No. Rev. No. Date:January 15, 2003 Page 1 of 2 Author: Sandor Feher
	4. Initial Electrical Checkout	

Note: Save the shipping container for storing and moving the leads around TD and after the test is complete to ship them to the DFBX manufacturer.

Performed by DAN EDDY (name typed) [signature] (signature)

Date & time 1/22/03 3 00 P.M.

Power Lead 7500 A DFLX 03

3.1 Voltage segment and drop measurement.

Apply 5 Amps between the copper flag and the LTS cable.

Record the applied current 5 A

Use HP3458 DVM, set it to 40 line cycle integration time.

Measure the voltages between the following pins:

Voltage tap Connector 1 (Fisher DEE104A06)(PRIMARY)

Pin 1 - pin 2	81 u V	Pin 2 - pin 3	231 u V
Pin 1 - pin 3	313 u V	Pin 3 - pin 4	327 u V
Pin 1 - pin 4	642 u V	Pin 4 - pin 5	FLOAT V
Pin 1 - pin 5	FLOAT V	Pin 5 - pin 6	FLOAT V
Pin 1 - pin 6	FLOAT V		

Voltage tap Connector 2 (Fisher DEE104A06)(REDUNDANT)

Pin 1 - pin 2	82 u V	Pin 2 - pin 3	232 u V
Pin 1 - pin 3	314 u V	Pin 3 - pin 4	333 u V
Pin 1 - pin 4	647 u V	Pin 4 - pin 5	FLOAT V
Pin 1 - pin 5	FLOAT V	Pin 5 - pin 6	FLOAT V
Pin 1 - pin 6	FLOAT V		

3.2 Verify that between pin 5 and the coiled wire at the bottom of the lead has continuity:

Connector 1: between pin 5 and the end of the wire continuity is OK ☑ not OK ☐

Connector 2: between pin 5 and the end of the wire continuity is OK ☑ not OK ☐

3.3 Temperature sensor resistance measurements.

3.3.1 Two wire measurement on connector 3 (Fisher DEE104Z086):

Resistance between Pin 1 and pin 2	.814 Ω
Resistance between Pin 1 and pin 3	108.16 Ω
Resistance between Pin 1 and pin 4	108.16 Ω
Resistance between Pin 2 and pin 3	108.15 Ω
Resistance between Pin 2 and pin 4	108.14 Ω
Resistance between Pin 3 and pin 4	.798 Ω
Pin 1,2,3,4 resistance to lead	∞ Ω
Pin 1,2,3,4 resistance to flange	∞ Ω

Resistance between Pin 5 and pin 6	.809 Ω
Resistance between Pin 5 and pin 7	108.16 Ω

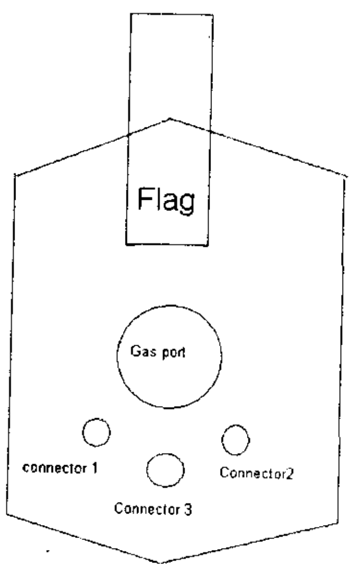
Resistance between Pin 5 and pin 8 108.17 Ω
Resistance between Pin 6 and pin 7 108.17 Ω
Resistance between Pin 6 and pin 8 108.17 Ω
Resistance between Pin 7 and pin 8 .809 Ω
Pin 5,6,7,8 resistance to lead ∞ Ω
Pin 5,6,7,8 resistance to flange ∞ Ω

Resistance between Pin 9 and pin 10 .730 Ω
Resistance between Pin 9 and pin 11 108.06 Ω
Resistance between Pin 9 and pin 12 108.06 Ω
Resistance between Pin 10 and pin 11 108.04 Ω
Resistance between Pin 10 and pin 12 108.04 Ω
Resistance between Pin 11 and pin 12 .709 Ω
Pin 9,10,11,12 resistance to lead ∞ Ω
Pin 9,10,11,12 resistance to flange ∞ Ω

3.3.2 Using HP3458 DVM measure temperature sensor resistance with the four wire measurement technique:

Resistance of T1 ________ Ω (I+ at pin 3, I- at pin 4, U+ at pin 1, U- at pin 2)
Resistance of T2 ________ Ω (I+ at pin 7, I- at pin 8, U+ at pin 5, U- at pin 6)
Resistance of T3 ________ Ω (I+ at pin 11, I- at pin 12, U+ at pin 9, U- at pin 10)

Resistance of T1 107.35 Ω (I+ at pin 1, I- at pin 3, U+ at pin 2, U- at pin 4)
Resistance of T2 107.35 Ω (I+ at pin 5, I- at pin 7, U+ at pin 6, U- at pin 8)
Resistance of T3 107.33 Ω (I+ at pin 9, I- at pin 11, U+ at pin 10, U- at pin 12)



Looking from the top of the lead down where the LTS cable is located

FERMILAB
Technical Division

Stand 3 LHC-HTS Lead Testing: Mechanical Installation Procedure

Lead Pair

Negative Lead: DFLX04

Positive Lead: DFLX03

CHARLIE HESS/ROGER RABEHL JAN. 30, 2003
JAN. 31, 2003

Roger Rabehl
C.E. Hess

1. **Mechanical Integration of Current Leads in Test Facility**

1.1 Using wedges, tilt the insert by 10° so that the power leads will be vertical when installed.
1.2 Clean sealing surfaces inside the chimneys with acetone and/or alcohol wipe.
1.3 Position the upper insulator in each chimney according to Figure 1.3.
1.4 Position the PEEK seal in each chimney according to Figure 1.3.
1.5 Position the lower insulator in each chimney according to Figure 1.3.

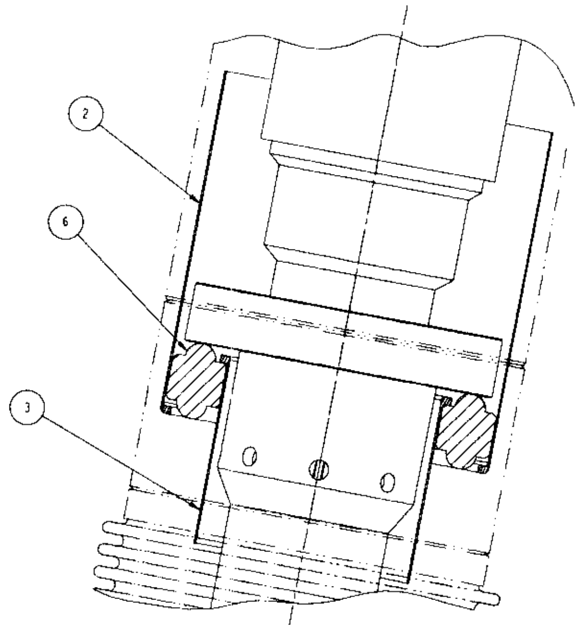


Figure 1.3 2 – Upper Insulator, 3 – Lower Insulator, 6 – PEEK Seal

1.6 Sling the lead to the overhead crane, and remove the lead from the shipping container.
1.7 Remove the protective rubber cover from the lower flange and the protective paper from the lower flange sealing surface, and place the lead on the steel table with the lower flange in the end support.
1.8 Remove the protective micarta flange from the power lead upper flange.
1.9 Clamp the end support around the lower flange.
1.10 Bolt the insertion tool to the lead at the flag as shown in Figure 1.10.

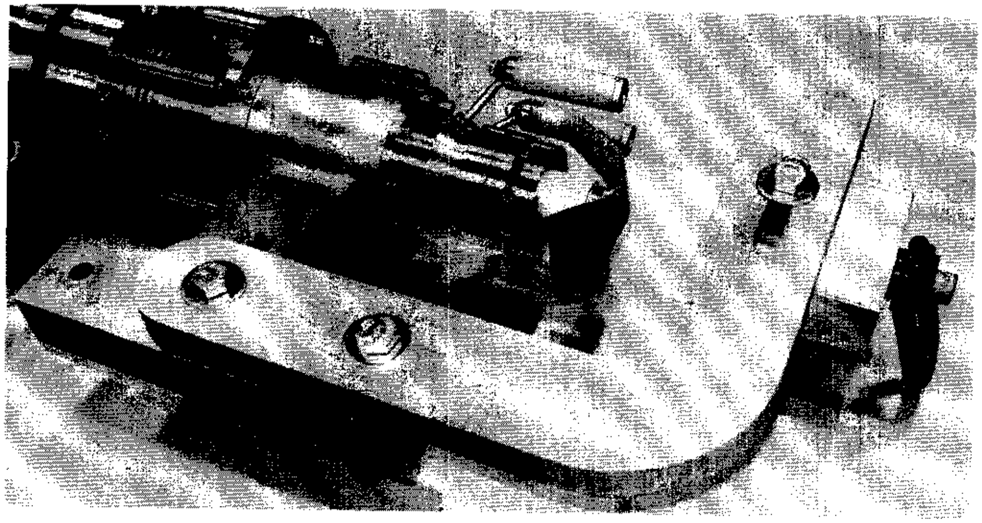


Figure 1.10 The insertion tool installed on a power lead flag.

1.11 Prepare to install the power lead baffle by removing the short threaded rods to open the baffle.

1.12 Install the baffle on the lead with the pointed tips of the threaded rods pointing toward the bottom of the lead. An installed baffle is shown in Figure 1.12.

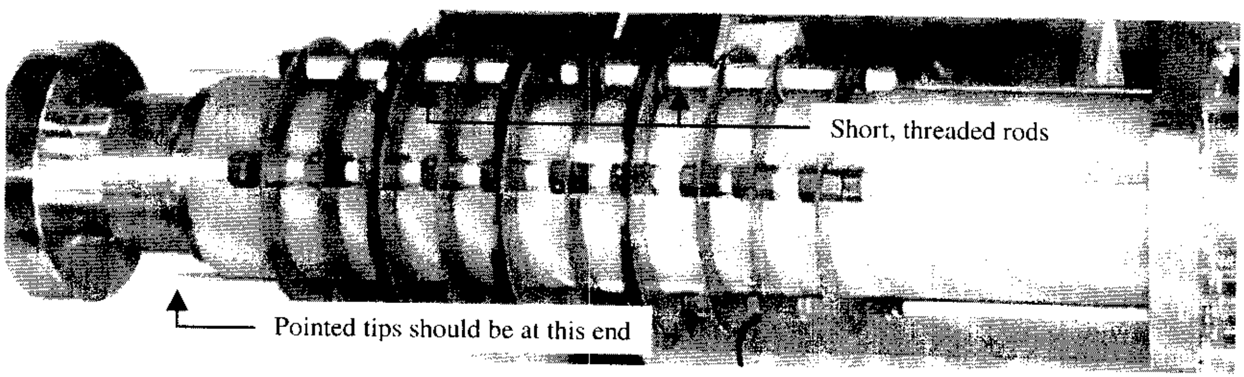


Figure 1.12 A baffle installed on a power lead.

1.13 Clean the top plate Conflat flange knife edge and copper gasket. Install the gasket on the top plate Conflat flange.

1.14 Align the top plate rotatable Conflat flange to the orientation shown on Figure 1.14, where the leak check grooves on the flange align with the middle tensioning studs.

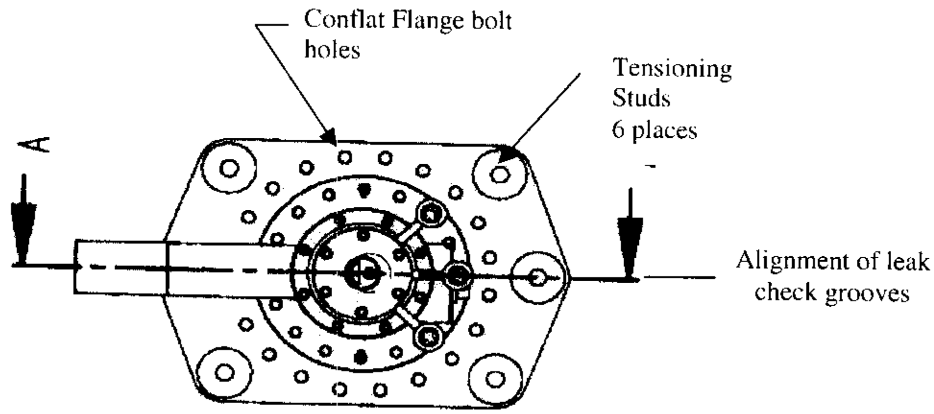


Figure 1.14 The 20-hole Conflat bolt pattern is bisected by center tensioning studs.

1.15 Back down the nuts on the tensioning studs.
1.16 Clean the knife edge of the power lead Conflat flange.
1.17 Strapping the overhead crane to the insertion tool and manually lifting the lower end support, lift the lead and position it vertically while not allowing any loading on the bottom end of the lead.
1.18 Remove the lower end support.
1.19 Clean the lower flange sealing surface.
1.20 Tie a weighted string to the LTS bus to help guide it through the chimney during installation.
1.21 Install the lead in the chimney per Figure 1.21a until the lower sealing flange bottoms out. The negative lead is installed on the left hand side, and the positive lead is installed on the right hand side as shown in Figure 1.21b.

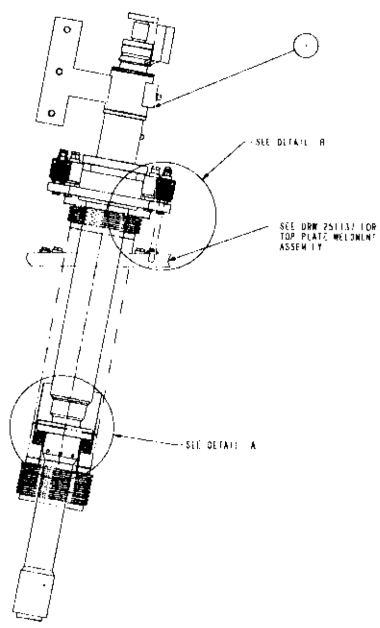


Figure 1.21a HTS Lead in Test Chimney. Note: CERN chimneys do not have bellows.

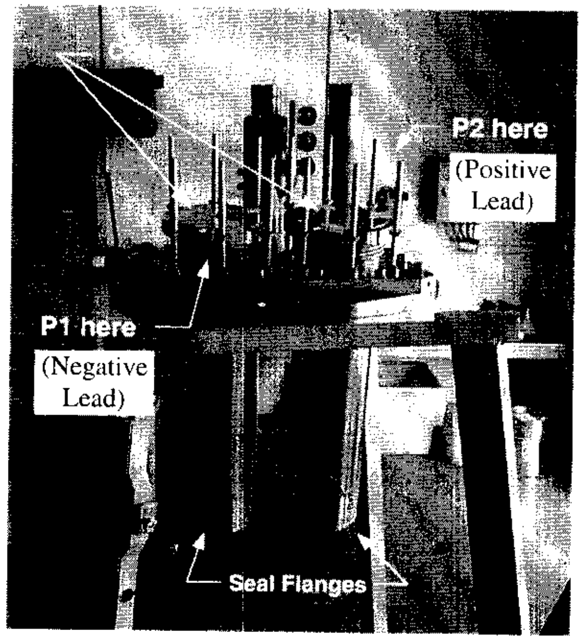


Figure 1.21b Locations of the negative and positive leads.

1.22 Raise the nuts on the tensioning studs to hold the lead in place, as shown in Figure 1.22.

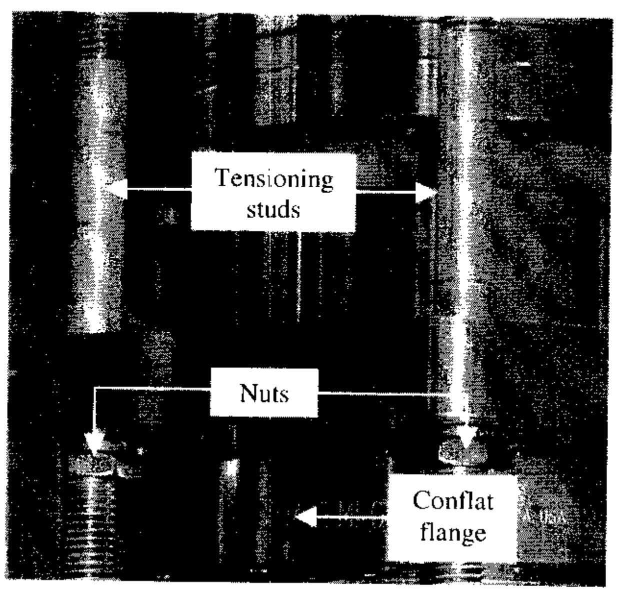


Figure 1.22 The positions of the tensioning studs, nuts, and top plate Conflat flange as the 20 Conflat bolts are tightened.

1.23 If there is a gap between the top plate Conflat flange and the Pirelli flange, pull the bellows up to close the gap.

1.24 Use a 5/16 12-point socket to tighten the 20 Conflat bolts. The tightening must be made gradually in 1/4-1/2 turn increments to a final torque of 15 ft-lbf. A suggested tightening order is given by Fig. 1.24.

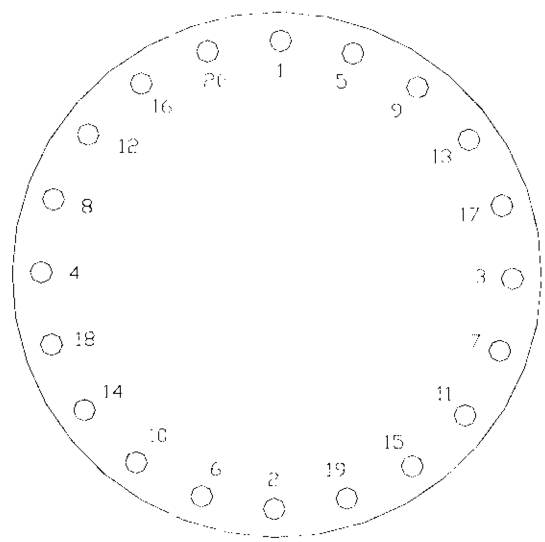


Figure 1.24 A suggested tightening order for the 20 Conflat bolts.

1.25 Install Belleville Washer Assemblies on each tensioning stud per Figures 1.25a and 1.25b. In the figures: Items 11 (10 each) are Belleville Washers, arranged as shown; Items 6 (2 each) are flat washers; Items 4 and 5 are the Belleville Washer Holder; Item 10 are Spherical Washers for above and below the washer holder; Item 9 is a loading nut; and Item 8 is a jam nut.

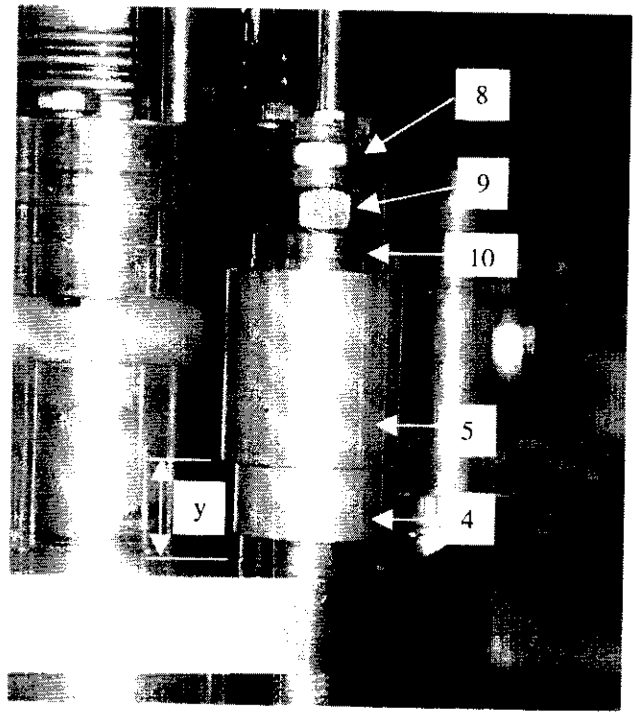


Figure 1.25a An installed Belleville Washer Assembly.

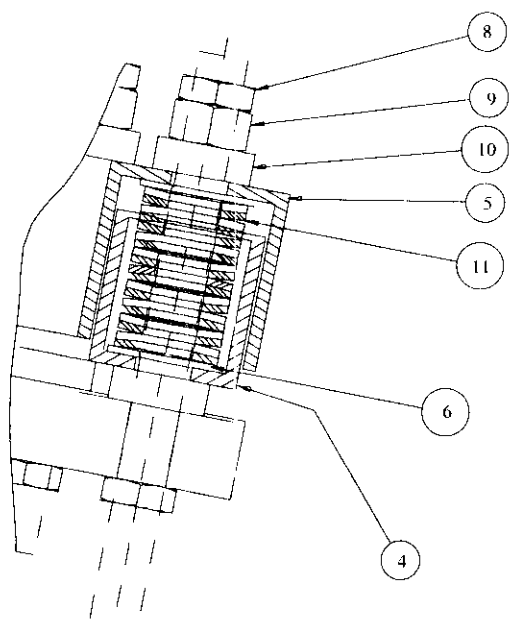


Figure 1.25b An installed Belleville Washer Assembly.

1.26 Unbolt the insertion tool from the flag of the installed power lead.

1.27 Tighten the 6 Belleville Washer Assemblies to apply load to the PEEK seal.

1.27.1 Washers for Negative Lead

1.27.1.1 Ensure that the tensioning rod nuts used in 1.22 have a gap of about 5 mm below the lead flange.

1.27.1.2 Center the lower end of the lead in the chimney using two Teflon centering rings. The inner Teflon centering ring goes between the power lead and the lower insulator. The outer Teflon centering ring goes between the lower insulator and the chimney. A small rubber mallet may be used to help install the Teflon centering rings. The installed Teflon centering rings are shown in Figure 1.27.1.2.

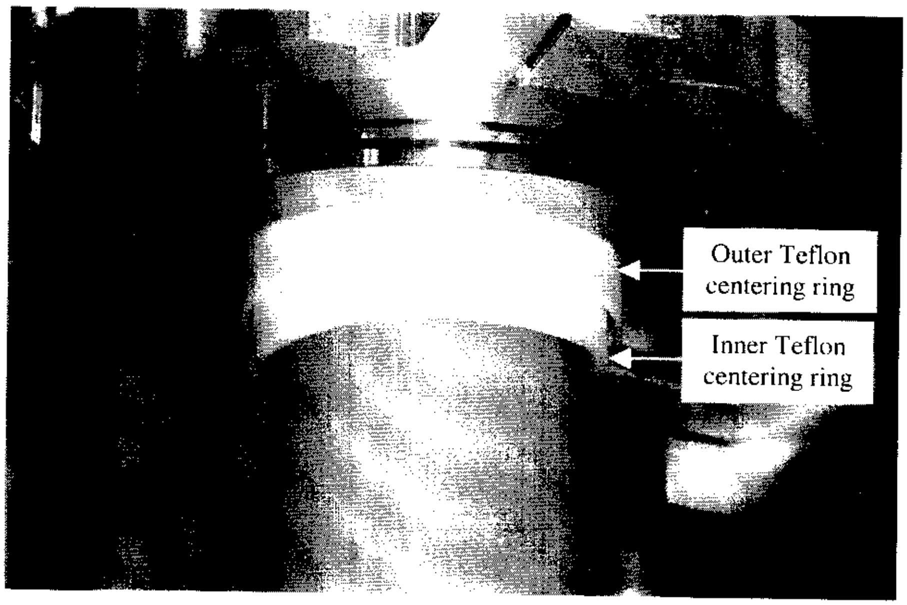


Figure 1.27.1.2 The installed Teflon centering rings.

1.27.1.3 Tighten the 6 loading nuts finger-tight. Measure and record the gap "y" indicated in Figure 1.25a between Item 5 and the current lead top flange at the 6 locations specified in Figure 1.27.1.4.

A 24.27 B 24.12 C 23.78 D 23.63 E 23.93 F 23.90

1.27.1.4 Using the sequence A through F in Figure 1.27.1.4, tighten the loading nuts ¼ turn until the total compression is 1.8 mm at each of the six locations. Record measurements below.

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A 22.43 B 22.32 C ✓ D ✓ E ✓ F ✓

A ______ B ______ C 21.94 D 21.76 E 22.11 F 22.04

A ______ B ______ C ______ D ______ E ______ F ______

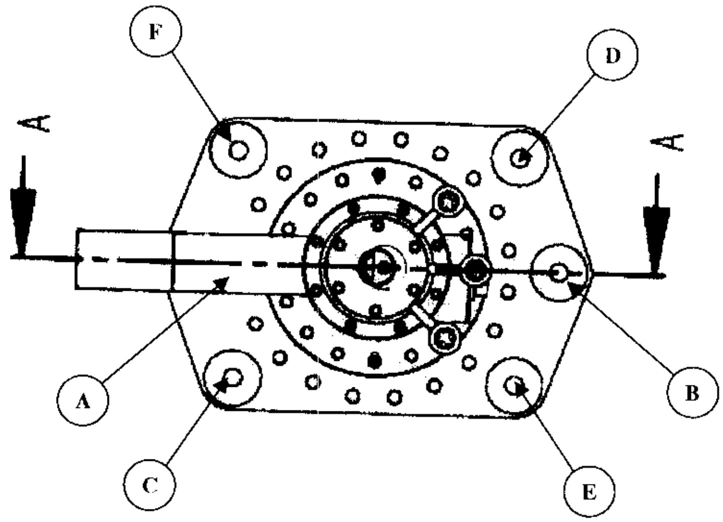


Figure 1.27.1.4 The specified sequence for tightening the Belleville Washer Assemblies.

1.27.1.5 Remove the Teflon centering rings from the installed power lead.

1.27.2 Washers for Positive Lead

1.27.2.1 Ensure that the nuts used in 1.22 have a gap of about 5 mm below the lead flange.

1.27.2.2 Center the lower end of the lead in the chimney using two Teflon centering rings. One Teflon centering ring goes between the power lead and the lower insulator. The second Teflon centering ring goes between the lower insulator and the chimney. A small rubber mallet may be used to help install the Teflon centering rings.

1.27.2.3 Tighten the 6 loading nuts finger-tight. Measure and record the gap "y" indicated in Figure 1.25a between Item 5 and the current lead top flange at the 6 locations specified in Figure 1.27.1.4.

A 24.01 B 24.52 C 23.74 D 23.95 E 24.18 F 24.09

1.27.2.4 Using the sequence A through F in Figure 1.27.1.4, tighten the loading nuts ¼ turn until the total compression is 1.8 mm at each of the six locations. Record measurements below.

A 23.43 B 24.07 C 23.38 D 23.76 E 23.78 F 23.90

A 23.07	B 23.83	C 23.13	D 23.53	E 23.56	F 23.56
A 22.78	B 23.57	C 22.93	D 23.20	E 23.23	F 23.34
A 22.72	B 23.36	C 22.44	D 22.82	E 22.94	F 23.12
A 22.37	B 23.00	C 22.23	D 22.64	E 22.68	F 22.77
A 22.19	B 22.49	C 22.04	D 22.37	E 22.41	F 22.44
A ______	B ______	C 21.90	D 22.13	E ______	F 22.29
A ______	B ______	C ______	D ______	E ______	F ______
A ______	B ______	C ______	D ______	E ______	F ______

1.27.2.5 Remove the Teflon centering rings from the installed power lead.

1.28 On both power leads, tighten down the jam nuts to secure the loading nuts on the installed Belleville Washer Assemblies.

1.29 Tighten the nuts on the underside of the current lead top plate against the plate to provide stability during transportation.

2. Pressure Test

2.1 Follow the procedure specified in the document entitled, "Stand 3 LHC-HTS Lead Testing: Pressure Test Procedure.

3. Leak Check

3.1 Follow the procedure specified in the document entitled, "Stand 3 LHC-HTS Lead Testing: Leak Check Procedure.

4. Electrical Integration of Current Leads in Test Facility

4.1 Make connection to LTS pigtails. Use a "Praying Hands" type joint 120 mm-long as shown in Figures 4.1a and 4.1b. The ends of the LTS pigtails are individually pretinned for about 120 mm by Pirelli, and the joint is a mechanical connection with indium foil (supplied by LBNL) between the cables to ensure good electrical connection. The conductors are arranged in a spiral path so the NbTi cables in the joint are facing each other, with the copper cables against the stainless steel mechanical clamp.

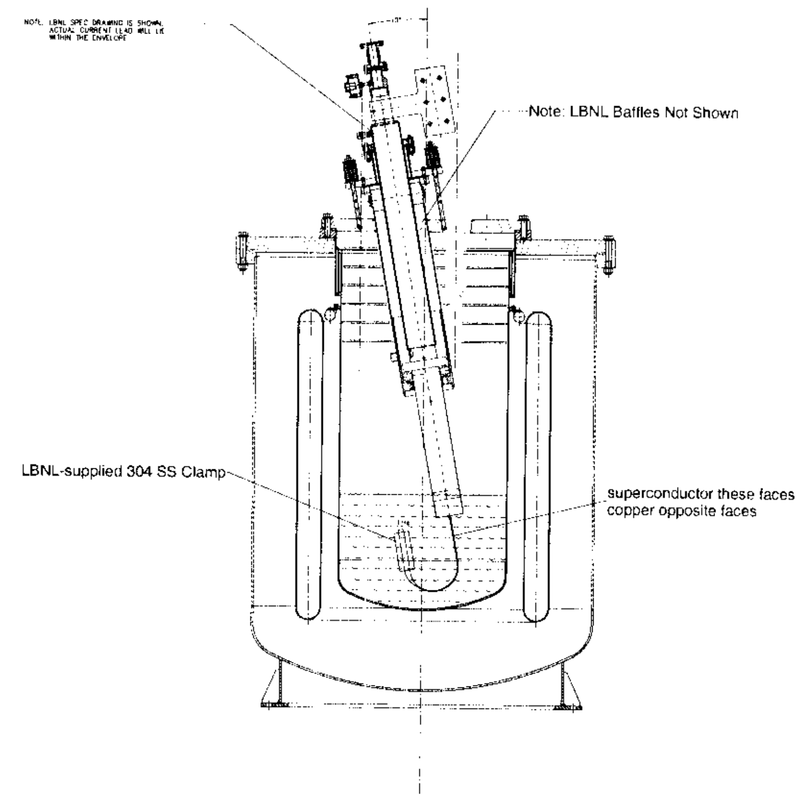


Figure 4.1a Side View of Lead in Cryostat with the LTS cables connected in a "Praying Hands" Type Joint.

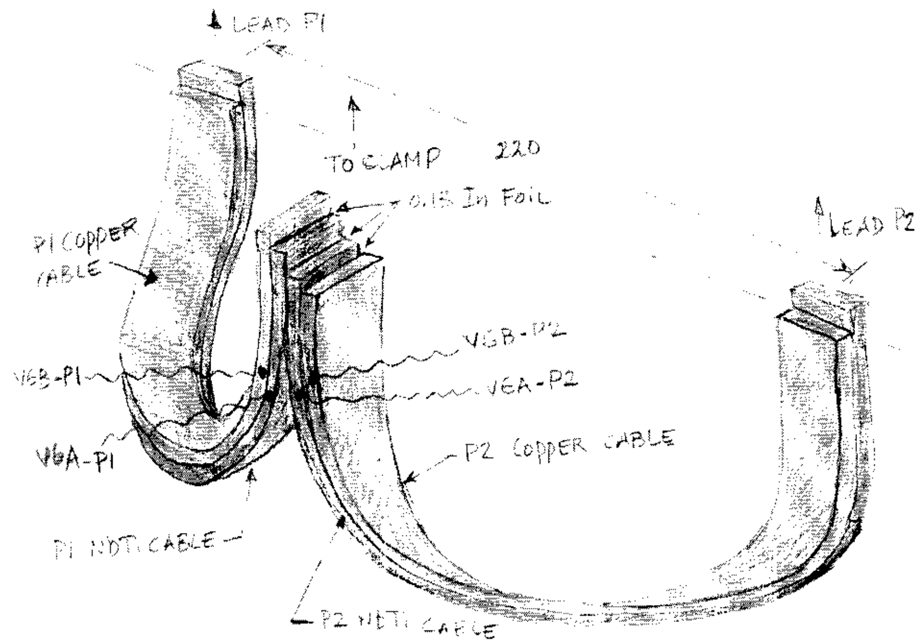


Figure 4.1b Illustration of LTS Pigtail Routing to Praying Hands Joint.

4.2 Attach the G-10 clamshell clamp at the bottoms of the power leads, and install the splice block support.
4.3 Attach the voltage tap wires labeled "V6" to the LTS cables as indicated on Figure 4.1b.
4.4 Insulate the conductor as needed with Kapton tape, and secure it with Kevlar string and/or G-10 support plates.
4.5 Install He space temperature sensors and LHe liquid level probes.
4.6 Adjust position of the LHe level sensor so the level can be controlled with respect to the maximum and minimum LHe levels marked on the current leads
4.7 Install assembly into test dewar.

5. Cooldown

5.1 Before cooldown, loosen the nuts on the underside of the lead plate that were tightened in 1.29 at least 0.5 mm below the top plate.
5.2 Complete the Stand 3 LHC-HTS Lead Testing: Pre-Cooldown Checklist.
5.3 Cool down the test system using the Stand 3 LHC-HTS Lead Testing: Cooldown Procedure.

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7500 A HTS Power Leads for the LHC DFBX:
6. Pressure Test Procedure

Lead Pair

Negative Lead: DFLX01

Positive Lead: DFLX03

Signed CHARLIE HESS / ROGER RABEHL Date FEB. 13, 2003

Roger Rabehl
C. E. Hess Jr.

1. Preparation for Pressurization

1.1 Install the bayonet plug into the 4-20 K supply bayonet on the top plate. Tie it down.

1.2 On the 4-20 K female bayonet vacuum jacket, cap off one of the 1/4 inch compression fittings. Connect the test gauge and associated tubing to the second 1/4 inch compression fitting.

1.3 Install Conflat blankoffs on the vents of the installed power leads.

1.4 Put the cover cans over each lead vent and tie them down.

1.5 Connect a nitrogen bottle to the pressure test tubing.

2. Pressurization

2.1 Pressurize the 4-20 K circuit to 65 psia (50 psig) and record the initial pressure from the test gauge.

Initial pressure: 66.1 psia

2.2 Wait five minutes and record the final pressure from the test gauge.

Final pressure: 65.6 psia

3. Release of Pressure

3.1 Isolate the nitrogen bottle.

3.2 Release the pressure by opening the hand valve on the pressure test tubing.

3.3 Disconnect the pressure test tubing from the top plate/insert.

FERMILAB
Technical Division

7500 A HTS Power Leads for the LHC DFBX: 7. Leak Check Procedure

Lead Pair

Negative Lead: DFLX01

Positive Lead: DFLX03

Signed CHARLIE HESS / ROGER RABEHL Date FEB. 13, 2003

Roger Rabehl
C.E. Hess Jr.

1. Preparation for Leak Checking

1.1 Cap/plug the two 1/4 inch compression fittings on the 4-20 K female bayonet vacuum jacket.

1.2 Remove the Conflat blankoff from one of the lead vents and install the modified Conflat with a vacuum pumpout.

1.3 Attach a leak detector to the vacuum pumpout installed on the top of one of the power leads.

2. Leak Check

2.1 Pump out the 4-20 K circuit with the leak detector.

2.2 Record the baseline reading from the leak detector.

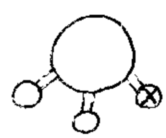
Baseline: 64 DIV × 50 SCALE

2.3 Spray all joints with He and watch for a signal from the leak detector

2.4 Record the maximum leak detector reading.

Maximum reading: 62 DIV × 5000 SCALE

NOTE: FOUND ON CONNECTOR INDICATED BELOW



LEAK RATE IS ABOUT 5.8×10^{-5} atm·cc/s. THIS IS WITH THE LEAK DETECTOR ROUGHING PUMP OPEN, SO LEAK RATE MAY BE TWICE THAT LISTED.

FERMILAB Technical Division	7500A HTS Power leads for the LHC DFBX	Doc. No. Rev. No. Date:January 15, 2003 Page 1 of 2 Author: Sandor Feher
	4. Initial Electrical Checkout	

Note: Save the shipping container for storing and moving the leads around TD and after the test is complete to ship them to the DFBX manufacturer.

Performed by DAN EDDY (name typed) [signature] (signature)

Date & time 1/22/03 3:00 P.M.

Power Lead 7500 A DFLX 03

3.1 Voltage segment and drop measurement.

Apply 5 Amps between the copper flag and the LTS cable.
Record the applied current 5 A
Use HP3458 DVM, set it to 40 line cycle integration time.
Measure the voltages between the following pins:

Voltage tap Connector 1 (Fisher DEE104A06)(PRIMARY)

Pin 1 - pin 2	81 u V	Pin 2 - pin 3	231 u V
Pin 1 - pin 3	313 u V	Pin 3 - pin 4	327 u V
Pin 1 - pin 4	642 u V	Pin 4 - pin 5	FLOAT V
Pin 1 - pin 5	FLOAT V	Pin 5 - pin 6	FLOAT V
Pin 1 - pin 6	FLOAT V		

Voltage tap Connector 2 (Fisher DEE104A06)(REDUNDANT)

Pin 1 - pin 2	82 u V	Pin 2 - pin 3	232 u V
Pin 1 - pin 3	314 u V	Pin 3 - pin 4	333 u V
Pin 1 - pin 4	647 u V	Pin 4 - pin 5	FLOAT V
Pin 1 - pin 5	FLOAT V	Pin 5 - pin 6	FLOAT V
Pin 1 - pin 6	FLOAT V		

3.2 Verify that between pin 5 and the coiled wire at the bottom of the lead has continuity:

Connector 1: between pin 5 and the end of the wire continuity is OK ☑ not OK ☐
Connector 2: between pin 5 and the end of the wire continuity is OK ☑ not OK ☐

3.3 Temperature sensor resistance measurements.

3.3.1 Two wire measurement on connector 3 (Fisher DEE104Z086):

Resistance between Pin 1	and pin 2	.814 Ω
Resistance between Pin 1	and pin 3	108.16 Ω
Resistance between Pin 1	and pin 4	108.16 Ω
Resistance between Pin 2	and pin 3	108.15 Ω
Resistance between Pin 2	and pin 4	108.14 Ω
Resistance between Pin 3	and pin 4	.798 Ω

Pin 1,2,3,4 resistance to lead ∞ Ω
Pin 1,2,3,4 resistance to flange ∞ Ω

Resistance between Pin 5	and pin 6	.809 Ω
Resistance between Pin 5	and pin 7	108.16 Ω

4. Initial Electrical Checkout

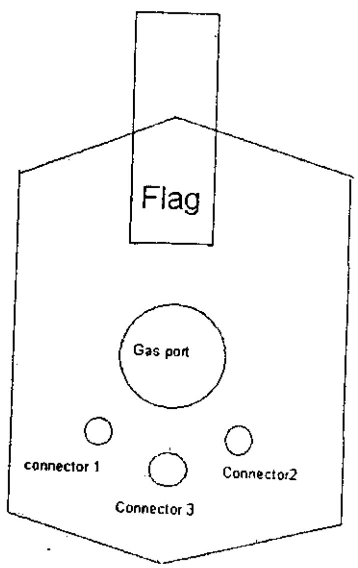
Resistance between Pin 5 and pin 8 108.17 Ω
Resistance between Pin 6 and pin 7 108.17 Ω
Resistance between Pin 6 and pin 8 108.17 Ω
Resistance between Pin 7 and pin 8 .809 Ω
Pin 5,6,7,8 resistance to lead ∞ Ω
Pin 5,6,7,8 resistance to flange ∞ Ω

Resistance between Pin 9 and pin 10 .730 Ω
Resistance between Pin 9 and pin 11 108.06 Ω
Resistance between Pin 9 and pin 12 108.06 Ω
Resistance between Pin 10 and pin 11 108.04 Ω
Resistance between Pin 10 and pin 12 108.04 Ω
Resistance between Pin 11 and pin 12 .709 Ω
Pin 9,10,11,12 resistance to lead ∞ Ω
Pin 9,10,11,12 resistance to flange ∞ Ω

3.3.2 Using HP3458 DVM measure temperature sensor resistance with the four wire measurement technique:

Resistance of T1 ________ Ω (I+ at pin 3, I- at pin 4, U+ at pin 1, U- at pin 2)
Resistance of T2 ________ Ω (I+ at pin 7, I- at pin 8, U+ at pin 5, U- at pin 6)
Resistance of T3 ________ Ω (I+ at pin 11, I- at pin 12, U+ at pin 9, U- at pin 10)

Resistance of T1 107.35 Ω (I+ at pin 1, I- at pin 3, U+ at pin 2, U- at pin 4)
Resistance of T2 107.35 Ω (I+ at pin 5, I- at pin 7, U+ at pin 6, U- at pin 8)
Resistance of T3 107.33 Ω (I+ at pin 9, I- at pin 11, U+ at pin 10, U- at pin 12)



Looking from the top of the lead down where the LTS cable is located

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7500 A HTS Power Leads for the LHC DFBX: 4a. Preliminary Leak Check Procedure

Lead Number: 03

Signed C.E. Hess Jr Date 11.21.03

1. Preparation for Leak Checking

1.1 Attach the lifting/insertion tool to the lead flag as shown in Figure 1.1 and remove the lead from the shipping container.

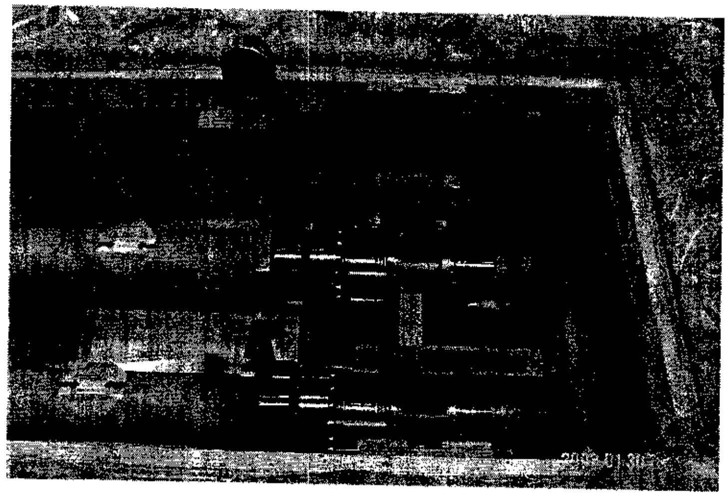

Figure 1.1 The lifting/insertion tool bolted to a power lead in preparation for removing it from the shipping container.

1.2 Remove the plastic plug from the 4-20 K gas inlet on the lead body.
1.3 Put the power lead on the steel table, with the power lead lower flange resting in a V-block.
1.4 Hose clamp a rubber gasket and PVC clamshells around the lead to cover and seal the 4-20 K inlet.
1.5 Attach an adapter to the top of the power lead so that a leak detector can be connected.
1.6 Wrap the voltage tap wires around the bottom of the lead and secure them with tape.

2. Leak Check-Lead Number 03

2.1 Pump out the power lead with the leak detector.
2.2 Record the baseline reading from the leak detector.

Baseline: 2.0 e-7 atm cc sec^{-1}

2.3 Spray all joints with He and watch for a signal from the leak detector
2.4 Record the maximum leak detector reading.

Maximum reading: 2.0 e-7 atm cc sec^{-1}

Lead DFLX 03

FERMILAB
Technical Division

Stand 3 LHC-HTS Lead Testing: 5. Installation of the Current Leads

Lead Pair

Negative Lead: 03

Positive Lead: 04

Signed C. E. Hess Jr. Date 12.11.03

1. Mechanical Integration of Current Leads in Test Facility

1.1 Using wedges, tilt the insert by 10° so that the power leads will be vertical when installed.

1.2 Clean sealing surfaces inside the chimneys with acetone and/or alcohol wipe.

1.3 Position the upper insulator in each chimney according to Figure 1.3.

1.4 Position the PEEK seal in each chimney according to Figure 1.3.

1.5 Position the lower insulator in each chimney according to Figure 1.3.

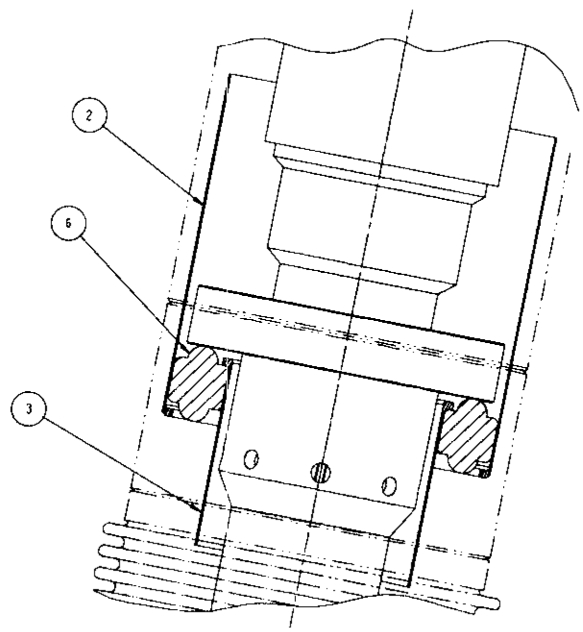

Figure 1.3 2 – Upper Insulator, 3 – Lower Insulator, 6 – PEEK Seal

1.6 Attach the lifting/insertion tool to the lead flag as shown in Figure 1.6 and lift the lead from the steel table where the preliminary leak check was performed.

Negative Lead DFLX 03 Positive Lead DFLX 09

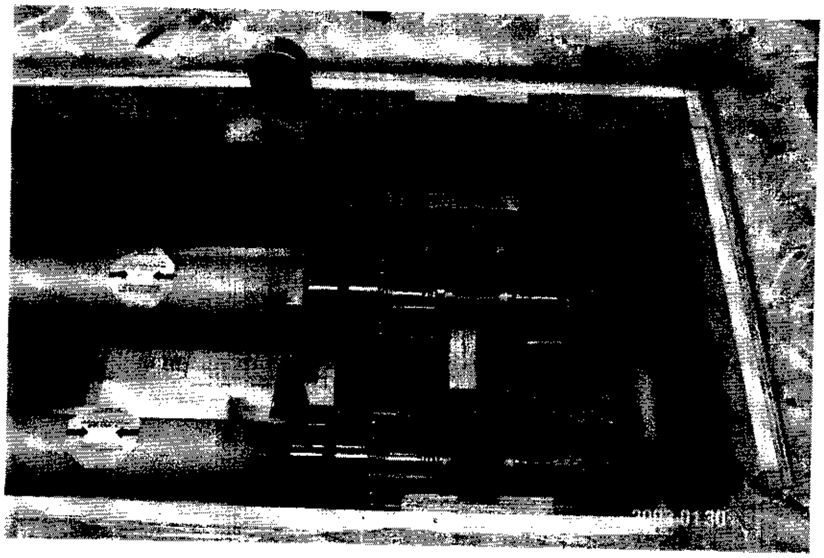

Figure 1.6 The lifting/insertion tool bolted to a power lead.

1.7 Remove the rubber gasket and PVC clamshells from the 4-20 K gas inlet on the lead body.
1.8 Remove the protective covers from the lower and upper flanges.
1.9 With alcohol, clean the lower flange and the upper flange knife edge and sealing surface.
1.10 Prepare to install the power lead baffle by removing the short threaded rods to open the baffle.
1.11 Install the baffle on the lead with the pointed tips of the threaded rods pointing toward the bottom of the lead. An installed baffle is shown in Figure 1.11.

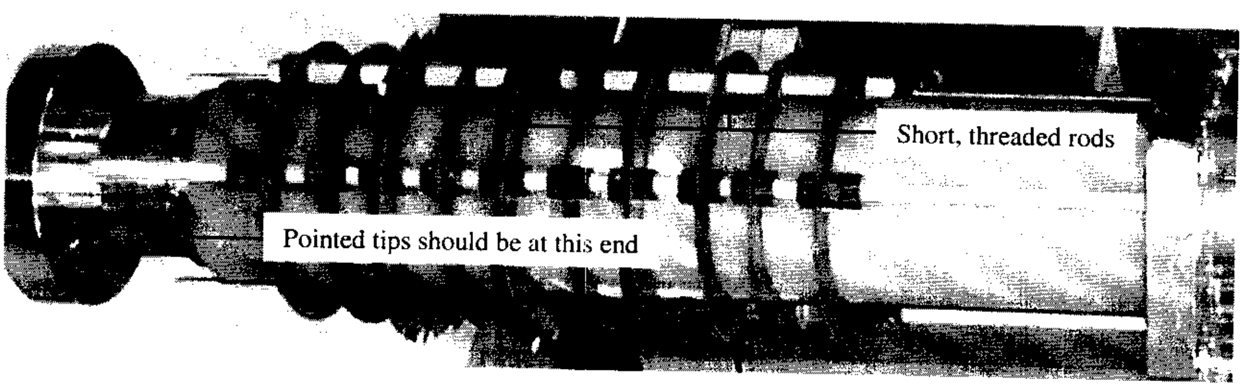

Figure 1.11 A baffle installed on a power lead.

1.12 Clamp the end support around the lower flange so that the handles will rest on the backs on the C-channels clamped to the steel table.
1.13 Set the lead in the C-channels on the steel table.
1.14 Clean the top plate Conflat flange knife edge and copper gasket. Install the gasket on the top plate Conflat flange.

Negative Lead DFLX 03 Positive Lead DFLX 04

1.15 Align the top plate rotatable Conflat flange to the orientation shown on Figure 1.15, where the leak check grooves on the flange align with the middle tensioning studs.

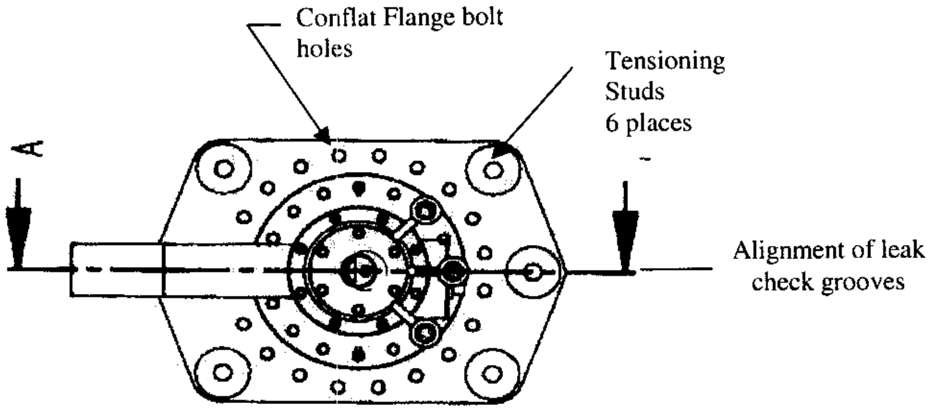

Figure 1.15 The 20-hole Conflat bolt pattern is bisected by center tensioning studs.

1.16 Back down the nuts on the tensioning studs.
1.17 Swing the lifting/insertion tool 180 degrees as shown in Figure 1.17 in preparation for lifting the power lead into the vertical position.

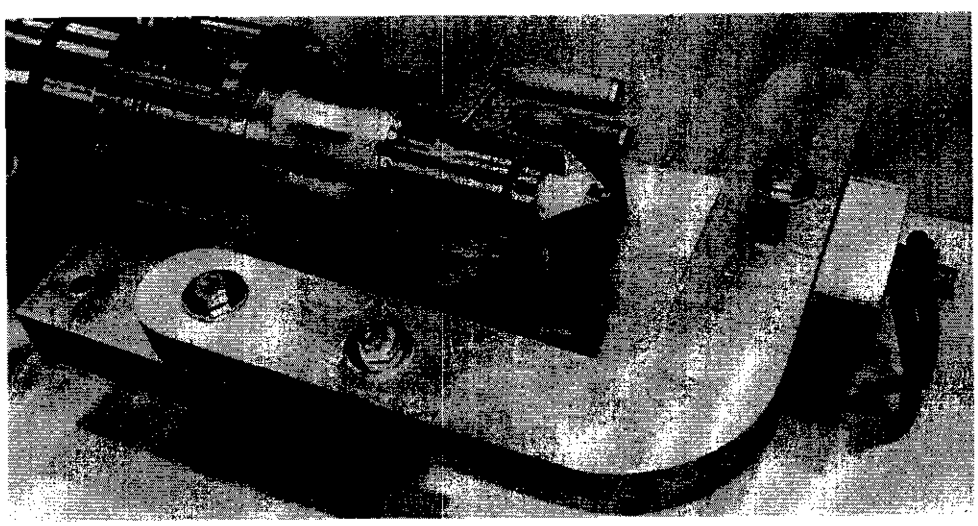

Figure 1.17 The lifting/insertion tool in position to lift the power lead into a vertical position.

1.18 Strapping the overhead crane to the lifting/insertion tool and manually guiding the lower end support, lift the lead and position it vertically while not allowing any loading on the bottom end of the lead.

Negative Lead DFLX 03 Positive Lead DFLX 04

1.19 Remove the lower end support.

1.20 Tie a weighted string to the LTS bus to help guide it through the chimney during installation.

1.21 Install the lead in the chimney per Figure 1.21a until the lower sealing flange bottoms out. The flag should be toward the bayonet connections on the insert. The negative lead is installed on the left hand side, and the positive lead is installed on the right hand side as shown in Figure 1.21b.

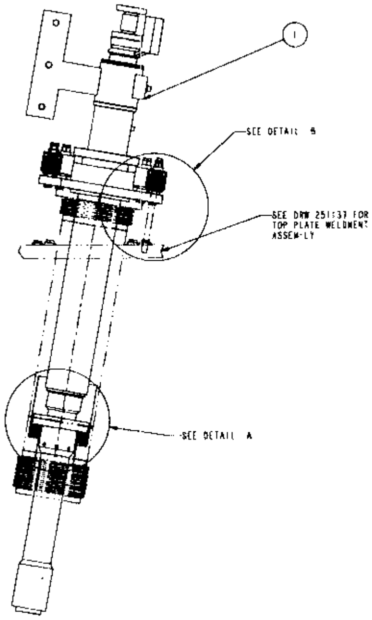

Figure 1.21a HTS Lead in Test Chimney. Note: CERN chimneys do not have bellows.

Negative Lead DFLX 03 Positive Lead DFLX 04

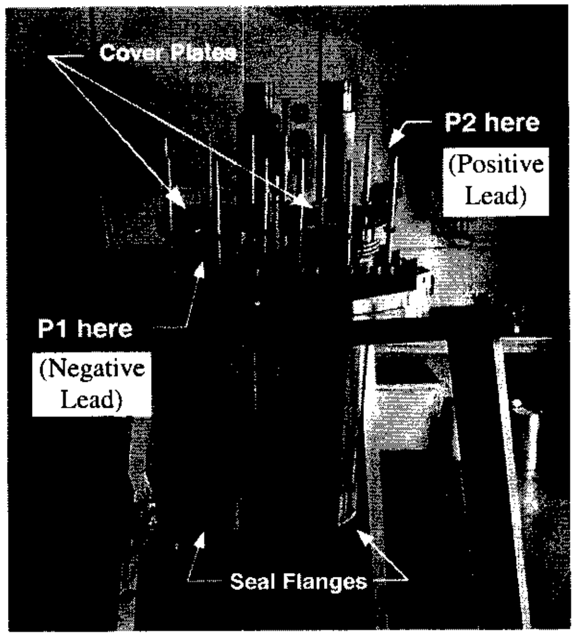

Figure 1.21b Locations of the negative and positive leads.

1.22 Raise the nuts on the tensioning studs to hold the lead in place, as shown in Figure 1.22.

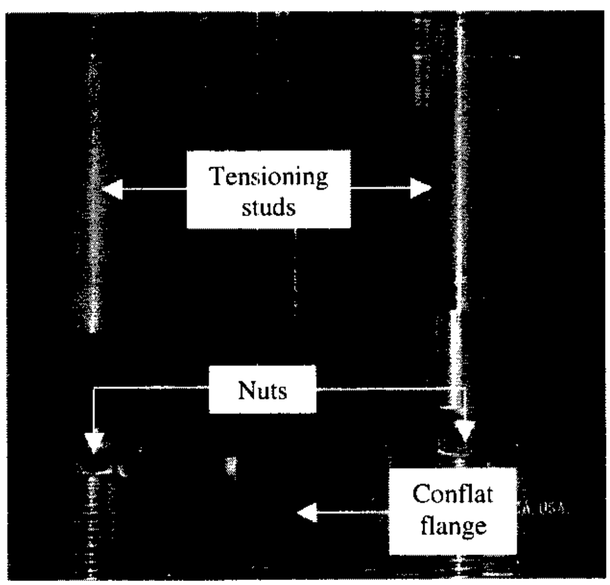

Figure 1.22 The positions of the tensioning studs, nuts, and top plate Conflat flange as the 20 Conflat bolts are tightened.

Negative Lead DFLX 03 Positive Lead DFLX 04

1.23 Center the lower end of the lead in the chimney using the centering shim blocks. The Teflon inner centering shim blocks are labeled with an 'I' and go between the power lead and the lower insulator. The Teflon outer centering shim blocks are labeled with an 'O' and go between the lower insulator and the chimney. The installed Teflon centering shim blocks are shown in Figure 1.23.

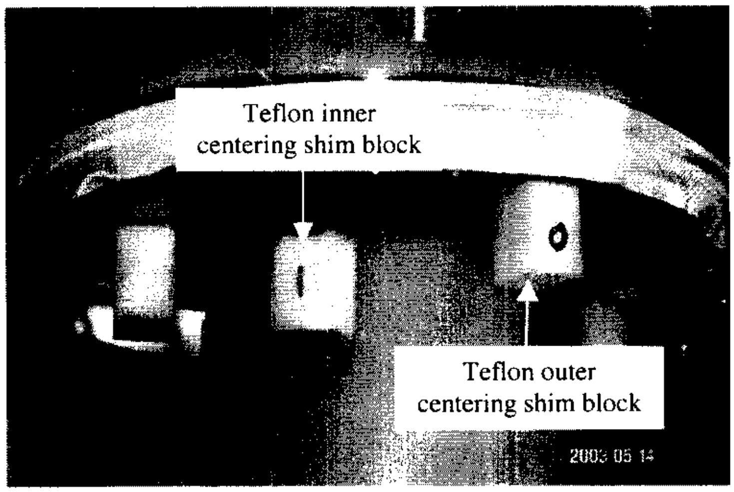

Figure 1.23 The installed Teflon centering shim blocks.

1.24 On the power lead flange, number the Conflat bolt holes 1 through 20 as indicated by Figure 1.24.

1.25 If there is a gap between the top plate Conflat flange and the Pirelli flange, pull the bellows up to close the gap using bolts 1 through 4.

1.26 Use a 5/16 12-point socket to tighten the 20 Conflat bolts. The tightening must be made gradually in ¼ turn increments to a final torque of 15 ft-lbf (180 in-lbf). The tightening sequence is given by Fig. 1.26.

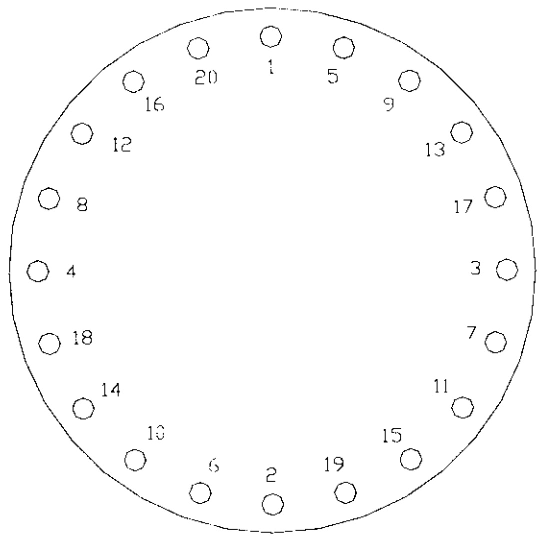

Figure 1.24 Tightening sequence for the 20 Conflat bolts.

1.27 Unbolt the lifting/insertion tool from the installed power lead.

1.28 Install Belleville Washer Assemblies on each tensioning stud per Figures 1.28a and 1.28b. A spherical washer must be placed below the Belleville washer holder on each stud. In the figures: Items 11 (10 each) are Belleville Washers, arranged as shown; Items 6 (2 each) are flat washers; Items 4 and 5 are the Belleville Washer Holder; Item 10 are Spherical Washers for above and below the washer holder; Item 9 is a loading nut; and Item 8 is a jam nut.

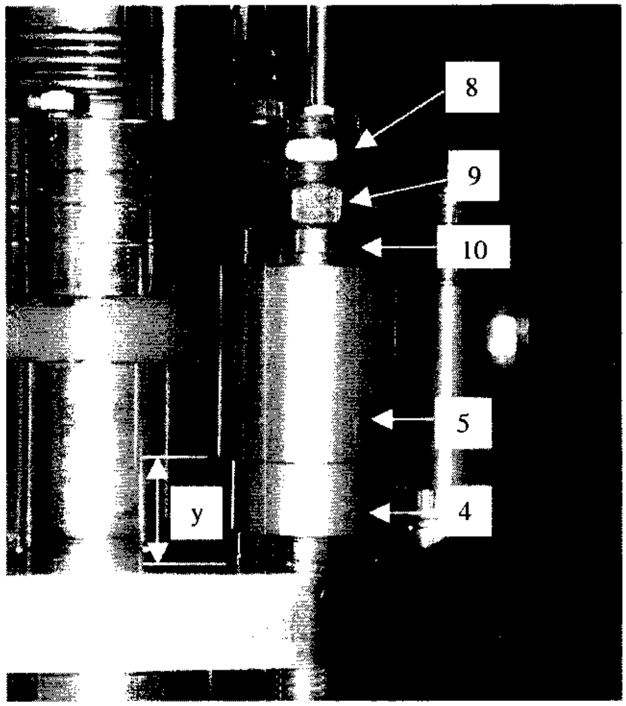

Figure 1.28a An installed Belleville Washer Assembly.

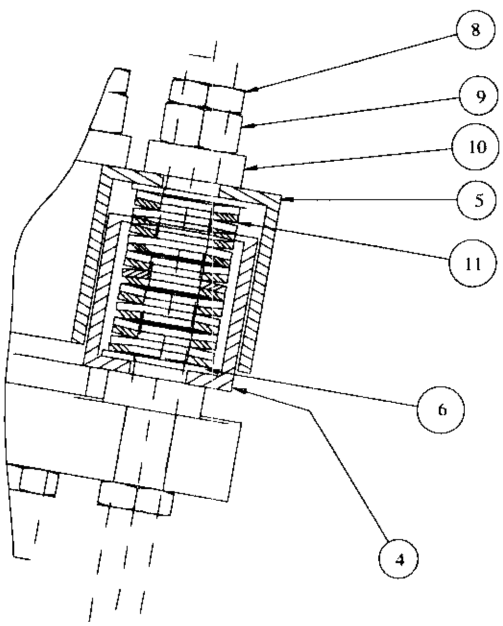

Figure 1.28b An installed Belleville Washer Assembly.

1.29 Tighten the 6 Belleville Washer Assemblies to apply load to the PEEK seal.

1.29.1 Washers for Lead **DFLX** 03

Negative Lead DFLX 03 Positive Lead DFLX 04

1.29.1.1 Ensure that the tensioning rod nuts used in 1.22 have a gap of about 5 mm below the lead flange.

1.29.1.2 Tighten the 6 loading nuts finger-tight. With adjustable parallels, measure and record the gap "y" indicated in Figure 1.28a between Item 5 and the current lead top flange at the 6 locations specified in Figure 1.29.1.5. Units are mm.

A 24.03 B 24.32 C 24.11 D 23.99 (23.99) E 24.28 F 23.93

1.29.1.3 For each of the six studs: remove the adjustable parallel, adjust it for 1.8 mm of compression, and return the adjustable parallel into position under the Belleville washer holder. Record the adjusted heights of the adjustable parallels. Units are mm.

A 22.23 B 22.52 C 22.31 D 22.19 E 22.48 F 22.18

1.29.1.4 Using the sequence A through F in Figure 1.29.1.5, tighten the loading nuts ¼ turn until the total compression is 1.8 mm at each of the six locations. As each loading nut is tightened ¼ turn, check off the appropriate line.

A ✓	B ✓	C ✓	D ✓	E ✓	F ✓
A ✓	B ✓	C ✓	D ✓	E ✓	F ✓
A ✓	B ✓	C ✓	D ✓	E ✓	F ✓
A ✓	B ✓	C ✓	D ✓	E ✓	F ✓
A ✓	B ✓	C ✓	D ✓	E ✓	F ✓
A ✓	B ✓	C ___	D ___	E ___	F ✓
A ___	B ___	C ___	D ___	E ___	F ___
A ___	B ___	C ___	D ___	E ___	F ___

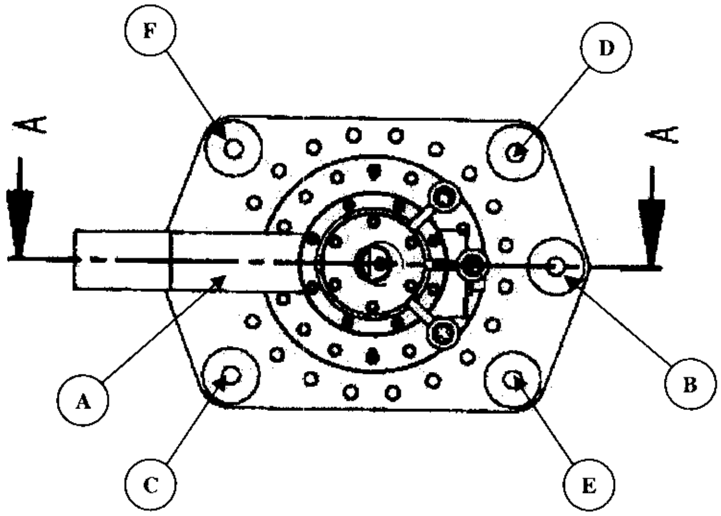

Figure 1.29.1.5 The specified sequence for tightening the Belleville Washer Assemblies.

1.29.1.5 Record the final measured gaps 'y' in Figure 1.28a. Units are mm.

A 22.23 B 22.51 C 22.28 D 22.19 E 22.47 F 22.19

1.29.1.6 Remove the Teflon centering shim blocks from the installed power lead.

1.29.2 Washers for Lead **DFLX** 04

1.29.2.1 Ensure that the nuts used in 1.22 have a gap of about 5 mm below the lead flange.

1.29.2.2 Tighten the 6 loading nuts finger-tight. With adjustable parallels, measure and record the gap "y" indicated in Figure 1.28a between Item 5 and the current lead top flange at the 6 locations specified in Figure 1.29.1.5. Units are mm.

A 24.26 B 24.05 C 24.20 D 24.25 E 24.46 F 23.81

1.29.2.3 For each of the six studs: remove the adjustable parallel, adjust it for 1.8 mm of compression, and return the adjustable parallel into position under the Belleville washer holder. Record the adjusted heights of the adjustable parallels. Units are mm.

A 22.46 B 22.25 C 22.40 D 22.45 E 22.66 F 22.01

1.29.2.4 Using the sequence A through F in Figure 1.29.1.5, tighten the loading nuts ¼ turn until the total compression is 1.8 mm at each of the six locations. As each of the loading nuts is turned ¼ turns, check off the appropriate line.

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

65.4 15:50 65.0 15:55 23.2x50

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A ✓ B ✓ C ✓ D ✓ E ✓ F ✓

A ______ B ______ C ______ D ______ E ______ F ______

A ______ B ______ C ______ D ______ E ______ F ______

A ______ B ______ C ______ D ______ E ______ F ______

1.29.2.5 Record the final measured gaps 'y' in Figure 1.28a. Units are mm.

A 22.45 B 22.75 C 22.40 D 22.45 E 22.60 F 21.98

1.29.2.6 Remove the Teflon centering shim blocks from the installed power lead.

1.30 On both power leads, tighten down the jam nuts to secure the loading nuts on the installed Belleville Washer Assemblies.

1.31 Tighten the nuts on the underside of the current lead top plate against the plate to provide stability during transportation.

2. Pressure Test

2.1 Follow the procedure specified in the document entitled, "7500 A HTS Power Leads for the LHC DFBX: 6. Pressure Test Procedure."

3. Leak Check

3.1 Follow the procedure specified in the document entitled, "7500 A HTS Power Leads for the LHC DFBX: 7. Leak Check Procedure."

4. Electrical Integration of Current Leads in Test Facility

4.1 Attach the G-10 clamshell clamp at the bottoms of the power leads, and install the clamp support.

4.2 Clean the LTS pigtails with alcohol.

4.3 Make connection to LTS pigtails. The joint is a mechanical connection with a stainless steel clamp block (supplied by LBNL) and indium foil between the cables to ensure good electrical contact. Torque each of the clamp block fasteners to **10 ft-lbf**. Figure 4.3a shows a rendition of the installed power leads. Figure 4.3b shows the G-10 clamshell clamp, the clamp support, and the mechanical clamp.

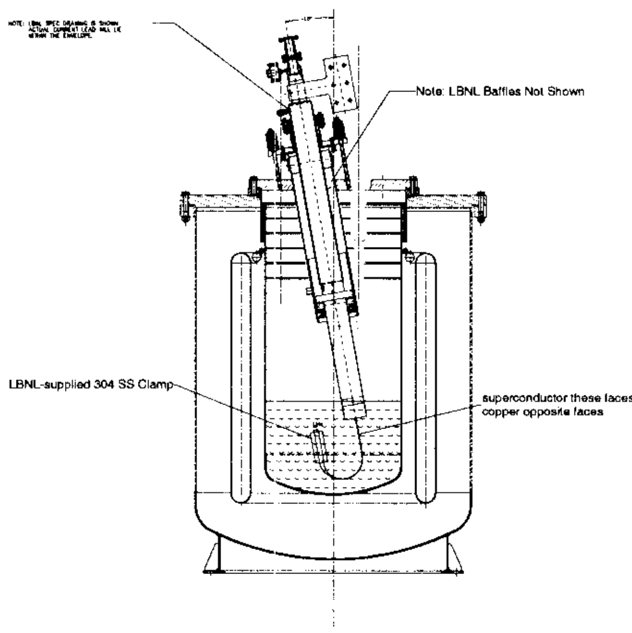

Figure 4.3a Side View of Lead in Cryostat with the LTS cables connected.

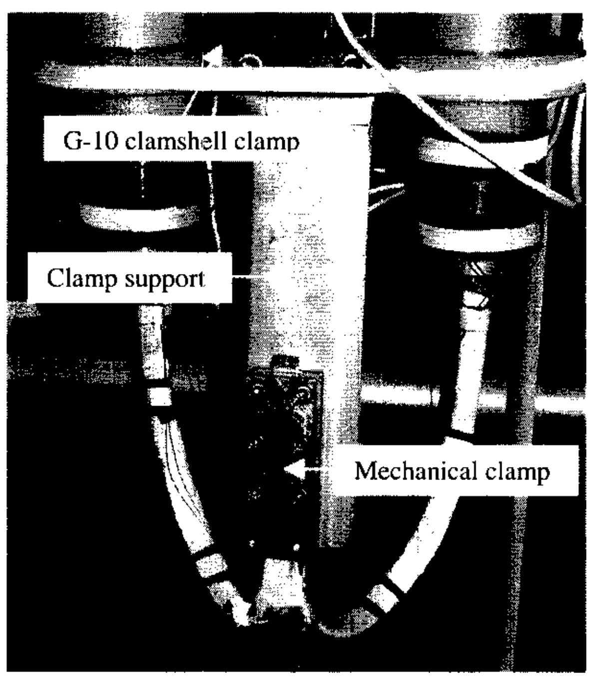

Figure 4.3b Electrical integration of the LTS sections.

Negative Lead DFLX 03 Positive Lead DFLX 04

4.4 Clamp a piece of bus wire and a small amount of indium to the LTS cable. Solder the two V5 voltage tap wires to the bus wire. Wind excess voltage tap wire around the bottom of the lead, securing it with Kapton and glass tape.

4.5 Insulate the superconducting cable with Kapton and glass tape.

4.6 Install He space temperature sensors and LHe liquid level probes.

4.7 Install the bottom fill tube.

4.8 Bolt the heaters to each power lead. Use grease at the interface to improve the thermal contact between the heater and power lead.

4.9 Measure and record dimensions required for the insert map.

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Technical Division

7500 A HTS Power Leads for the LHC DFBX:
6. Pressure Test Procedure

Lead Pair
Negative Lead: 03
Positive Lead: 04

Signed C. E. Hess Jr. Date 12.12.03

1. Preparation for Pressurization

1.1 Install the bayonet plug into the 4-20 K supply bayonet on the top plate. Tie it down.

1.2 On the 4-20 K female bayonet vacuum jacket, cap off one of the 1/4 inch compression fittings. Connect the test gauge and associated tubing to the second 1/4 inch compression fitting.

1.3 Install Conflat blankoffs on the vents of the installed power leads.

1.4 Put the cover cans over each lead vent and tie them down.

1.5 Connect a nitrogen bottle to the pressure test tubing.

2. Pressurization

2.1 Pressurize the 4-20 K circuit to 65 psia (50 psig) and record the initial pressure from the test gauge.

Initial pressure: 65.4 psia

2.2 Wait five minutes and record the final pressure from the test gauge.

Final pressure: 65.1 psia

3. Release of Pressure

3.1 Isolate the nitrogen bottle.

3.2 Release the pressure by opening the hand valve on the pressure test tubing.

3.3 Disconnect the pressure test tubing from the top plate/insert.

Negative Lead DFLX 03 Positive Lead DFLX 04

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7500 A HTS Power Leads for the LHC DFBX: 7. Leak Check Procedure

Lead Pair

Negative Lead: 03

Positive Lead: 04

Signed C. E. Hess Jr. Date 12.15.03

1. **Preparation for Leak Checking**
   - **1.1** Cap/plug the two 1/4 inch compression fittings on the 4-20 K female bayonet vacuum jacket.
   - **1.2** Remove the Conflat blankoff from one of the lead vents and install the modified Conflat with a vacuum pumpout.
   - **1.3** Attach a leak detector to the vacuum pumpout installed on the top of one of the power leads.

2. **Leak Check**
   - **2.1** Pump out the 4-20 K circuit with the leak detector.
   - **2.2** Record the baseline reading from the leak detector.

     Baseline: 3.19e-7 atm cc sec^{-1} 23.2 d X 50s

   - **2.3** Spray all joints with He and watch for a signal from the leak detector
   - **2.4** Record the maximum leak detector reading.

     Maximum reading: 3.19e-8 atm cc sec^{-1} 23.2 d X 50s

Note: Both PEEK seals leak to saturation

Negative Lead DFLX 03 Positive Lead DFLX 04

FERMILAB
Technical Division

7500 A HTS Power Leads for the LHC DFBX: 7a. Top Plate Insertion into the Dewar

Lead Pair

Negative Lead: 03

Positive Lead: 04

Signed C.E. Haas Jr. Date 12.16.03

√ **1.** Grease and install an o-ring on the top flange of the dewar extension.

√ **2.** Remove the 10 degree blocks from under the top plate.

√ **3.** Lift the top plate and insert from the roll-around cart and set them onto the dewar extension. The leads must be on the south side of the test dewar.

√ **4.** Install a power lead vent stack on each power lead, keeping in mind the orientation of the vent line.

√ **5.** Verify that the heaters are bolted to the power leads.

Negative Lead DFLX 03 Positive Lead DFLX 04

FERMILAB Technical Division	7500A HTS Power leads for the LHC DFBX 9. Room Temperature Electrical Checkout	Doc. No. Rev. 1 (SF) Date:January 31, 2003 Page 1 of 1 Author: Fred Lewis

Note: Save the shipping container for storing and moving the leads around TD and after the test is complete to ship them to the DFBX manufacturer.

Performed by DANIEL EDDY [signature]
(Name typed) (Signature)

Date & time 12/16/03 10:00

Pos. Power Lead 7500 A DFLX 04 and Neg. Power Lead 7500 A DFLX 03

When checkout is complete, make sure you place the original and a copy of this document in the Traveler Binder.

1.0 Before beginning checkout, be sure that the following is done:

Make sure all of the 4-pin circular Hypertronic connectors inside dewar have been connected and taped up with fiberglass tape.
Cool down and check pos and neg lead heaters. ~1ohm
Install positive and negative lead heaters.
Be sure to apply thermal compound on the back of heaters before attaching to leads.
Attach primary and redundant labels to the fisher connector assembly on each lead

Primary = Left Redundant=Right

2.0 Voltage drop measurement for Vtap & flag cables.

2.1 Connect Kepco power supply cable to the LHC power leads. This is the gray two-conductor cable (black to negative lead and clear to positive lead).
2.2 Connect before and After Flags ring terminals to both leads.
2.3 Configure the Kepco distribution box on the Stand 4 platform to power the LHC power leads (jumper should be in the Checkout power/Stand-3 Power leads position).
2.4 Turn on Kepco power supply and set the output for 10 amps. (5v on HP meter=10 amps)
2.5 Connect stand 3 trim current cable to shunt current monitor above the Kepco power supply.
2.6 Log into cryo computer (left computer at Stand 3). Password is: ScMagsRU
NOTE: Be sure that Mike T has rebooted the system and scans are active or values will not show
2.7 Bring up a terminal and type the following to bring up the numerical display
ssh mdtf34
The password is: ScMagsRU (can also rlogin mdtf24)
You should be in the directory mdtf34: home/mdtf34/cryo

Type the command: numdisp –n mtfvx27&
(numeric display on mtfuz27 shows up)
Click on chooser
Click the File button on numeric display.
Then choose Load setup
Enlarge window
In **directories**, double click: home/mdtf34/cryo/Setups and then home/mdtf34/cryo/Setups/Stand3
After you are in the Stand3 directory, under **Files**: double click LHC02_Dvm_CheckoutVariables.numdisp_setup
This will bring up a preset display with the trim current and all Stand 3 RTD's
You won't need to check the RTD's until later in checkout.
Record the applied current(trim)__10__A (Should be approx. 10A)

2.8 Connect both primary and redundant Vtap cables to positive and negative leads.
2.9 Remove the four primary and redundant Vtap cables from the back of the Vtap distribution box (these cables are located on the right side).
2.10 Using the dual 8-pin breakout box, connect the cables as per the following instructions:
2.11 Use HP3457 DVM, set it to 40-line cycle integration time.

Positive Lead (single cable test)
Voltage tap Connector 1 (**Primary**)

Pin 1 - pin 2	**(160uv)** 163u V	Pin 2 - pin 3	**(450uv)** 481u V
Pin 1 - pin 3	**(610uv)** 645u V	Pin 3 - pin 4	**(480uv)** 526u V
Pin 1 - pin 4	**(1.1mv)** 1.2m V	Pin 4 - pin 5	**(3.5mv)** 3.3m V
Pin 1 - pin 5	**(4.7mv)** 4.5m V	Pin 5 - pin 6	**(float)** —— V
Pin 1 - pin 6	**(float)** —— V	Pin 6 – pin 7	**(float)** —— V
Pin 1 - pin 7	**(-20uv)** -178u V	Pin 7 – pin 8	**(0v)** 0 V
Pin 1 - pin 8	**(-20uv)** -182u V		

Voltage tap Connector 2 (**Redundant**)

Pin 1 - pin 2	**(160uv)** 166u V	Pin 2 - pin 3	**(450uv)** 473u V
Pin 1 - pin 3	**(610uv)** 634u V	Pin 3 - pin 4	**(480uv)** 543u V
Pin 1 - pin 4	**(1.1mv)** 1.2m V	Pin 4 - pin 5	**(3.5mv)** 3.3m V
Pin 1 - pin 5	**(4.7mv)** 4.5m V	Pin 5 - pin 6	**(float)** —— V
Pin 1 - pin 6	**(float)** —— V		

DFLX 04 DFLX 03

Negative Lead (single cable test)

Voltage tap Connector 1 (**Primary**)

Pin 1 - pin 2	**(-160uv)**	-163u V	Pin 2 - pin 3	**(-450uv)**	-457u V
Pin 1 - pin 3	**(-600uv)**	-618u V	Pin 3 - pin 4	**(-480uv)**	-587u V
Pin 1 - pin 4	**(-1.1mv)**	-1.2m V	Pin 4 - pin 5	**(-3.5mv)**	-3.3m V
Pin 1 - pin 5	**(-4.7mv)**	-4.5m V	Pin 5 - pin 6	**(float)**	— V
Pin 1 - pin 6	**(float)**	— V	Pin 6 – pin 7	**(float)**	— V
Pin 1 - pin 7	**(+20uv)**	78u V	Pin 7 – pin 8	**(0v)**	0 V
Pin 1 - pin 8	**(+20uv)**	86u V			

Voltage tap Connector 2 (**Redundant**)

Pin 1 - pin 2	**(-160uv)**	-162u V	Pin 2 - pin 3	**(-450uv)**	-457u V
Pin 1 - pin 3	**(-600uv)**	-618u V	Pin 3 - pin 4	**(-480uv)**	-587u V
Pin 1 - pin 4	**(-1.1mv)**	-1.2m V	Pin 4 - pin 5	**(-3.5mv)**	-3.3m V
Pin 1 - pin 5	**(-4.7mv)**	-4.5m V	Pin 5 - pin 6	**(float)**	— V
Pin 1 - pin 6	**(float)**	— V			

Connection 1 (**Primary**) (dual cable test)

Positive Lead Pin 1 - Negative Lead pin 5 **(3.7mv)** 3.5m V
Positive Lead Pin 1 - Negative Lead pin 4 **(7.3mv)** 6.8m V
Positive Lead Pin 1 - Negative Lead pin 3 **(7.7mv)** 7.3m V
Positive Lead Pin 1 - Negative Lead pin 2 **(8.2mv)** 7.8m V
Positive Lead Pin 1 - Negative Lead pin 1 **(8.3mv)** 8.0m V

Connection 2 (**Redundant**) (dual cable test)

Positive Lead Pin 1 - Negative Lead pin 5 **(3.7mv)** 3.5m V
Positive Lead Pin 1 - Negative Lead pin 4 **(7.3mv)** 6.7m V
Positive Lead Pin 1 - Negative Lead pin 3 **(7.7mv)** 7.3m V
Positive Lead Pin 1 - Negative Lead pin 2 **(8.2mv)** 7.8m V
Positive Lead Pin 1 - Negative Lead pin 1 **(8.3mv)** 8.0m V

2.12 When finished taking voltage measurements reconnect the Vtap cables on back of the Vtap Distribution box.

3.0 Voltage Drop measurements for Quench Character Cables

3.1 Connect QC POS LEAD & QC NEG LEAD Connectors on Stand 4 platform Quench Management Vtap Box to the breakout box.

3.2 Use a 3457 DVM to check the voltages on specified pins.

DFLX 04 DFLX 03

QC POS LEAD (+VTAP QC RR STN3 DBOX +VTAP QC STN4 QMBOX)

Pin 1 - pin 2 **(160uv)** 161u V
Pin 3 - pin 4 **(950uv)** 1.0m V
Pin 5 - pin 6 **(480uv)** 525u V
Pin 7 - pin 8 **(3.5mv)** 3.3m V

QC NEG LEAD

Pin 1 - pin 2 **(-160uv)** -164u V
Pin 3 - pin 4 **(-950uv)** -1.0m V
Pin 5 - pin 6 **(-480uv)** -588m V
Pin 7 - pin 8 **(-3.5mv)** -3.3m V

Restore QC cables

3.3 When voltage measurements are complete, turn off kepco power supply and disconnect kepco power cable on positive and negative LHC power leads. Disconnect the before and After Flags.

4.0 RTD resistance measurements.

4.1 Using the special RTD test cable (cable should be located in the bottom of the rack for Stand 3), use the standard blue breakout box (box should be in the breakout box cabinet), connect it to each LEADS RTD connectors. This is the connector between the primary and redundant Vtap connectors. Each RTD connector connect to 3 sets of RTDs. The LHC lead RTD's are
4.2 511-3, 512-3, 509-3A, 509-3B, 510-3A, and 510-3B.
4.3 Using a hand-held meter, perform a two-wire measurement on connector #3 of Positive Lead

Resistance between Pin 1 and pin 2 **(.800)** [redacted].894 Ω
Resistance between Pin 1 and pin 3 **(109)** 109.3 Ω
Resistance between Pin 1 and pin 4 **(109)** 109.5 Ω
Resistance between Pin 2 and pin 3 **(109)** 108.9 Ω
Resistance between Pin 2 and pin 4 **(109)** 108.9 Ω
Resistance between Pin 3 and pin 4 **(.800)** .894 Ω

Pins 1-4 resistance to lead **(infinite)** ∞ Ω
Pins 1-4 resistance to ground **(infinite)** ∞ Ω

DFLX 04 DFLX 03

Resistance between Pin 5 and pin 6 (**.800**) .920 Ω
Resistance between Pin 5 and pin 7 (**109**) 108.9 Ω
Resistance between Pin 5 and pin 8 (**109**) 108.9 Ω
Resistance between Pin 6 and pin 7 (**109**) 108.9 Ω
Resistance between Pin 6 and pin 8 (**109**) 108.9 Ω
Resistance between Pin 7 and pin 8 (**.800**) .914 Ω

Pins 5-8 resistance to lead (**infinite**) ∞ Ω
Pins 5-8 resistance to ground (**infinite**) ∞ Ω

Resistance between Pin 9 and pin 10 (**.800**) .843 Ω
Resistance between Pin 9 and pin 11 (**109**) 108.9 Ω
Resistance between Pin 9 and pin 12 (**109**) 108.9 Ω
Resistance between Pin 10 and pin 11 (**109**) 108.9 Ω
Resistance between Pin 10 and pin 12 (**109**) 108.9 Ω
Resistance between Pin 11 and pin 12 (**.800**) .815 Ω

Pins 9-12 resistance to lead (**infinite**) ∞ Ω
Pins 9-12 resistance to ground (**infinite**) ∞ Ω

4.4 Using HP3458 DVM measure temperature sensor resistance with the four wire measurement technique:

Resistance of T1 108.0 Ω(**108.5**)(I+ at pin 1,U+ at pin 2,I- at pin 3,U- at pin 4)
Resistance of T2 108.0 Ω(**108.5**) (I+ at pin 5, U+ at pin 6, I- at pin 7, U- at pin 8)
Resistance of T3 108.0 Ω(**108.5**)(I+ at pin 9,U+ at pin 10,I- at pin 11,U- at pin 12)

4.5 Two wire measurement on connector 3 of Negative Lead (Fisher DEE104Z086):

Resistance between Pin 1 and pin 2 (**.800**) .935 Ω
Resistance between Pin 1 and pin 3 (**109**) 108.9 Ω
Resistance between Pin 1 and pin 4 (**109**) 108.9 Ω
Resistance between Pin 2 and pin 3 (**109**) 108.9 Ω
Resistance between Pin 2 and pin 4 (**109**) 108.9 Ω
Resistance between Pin 3 and pin 4 (**.800**) .910 Ω

Pins 1-4 resistance to lead (**infinite**) ∞ Ω
Pins 1-4 resistance to ground (**infinite**) ∞ Ω

DFLX 04 DFLX 03

Resistance between Pin 5 and pin 6 (.800) .927 Ω
Resistance between Pin 5 and pin 7 (109) 108.9 Ω
Resistance between Pin 5 and pin 8 (109) 108.9 Ω
Resistance between Pin 6 and pin 7 (109) 108.9 Ω
Resistance between Pin 6 and pin 8 (109) 108.9 Ω
Resistance between Pin 7 and pin 8 (.800) .924 Ω

Pins 5-8 resistance to lead (**infinite**) ∞ Ω
Pins 5-8 resistance to ground (**infinite**) ∞ Ω

Resistance between Pin 9 and pin 10 (.800) .846 Ω
Resistance between Pin 9 and pin 11 (109) 108.8 Ω
Resistance between Pin 9 and pin 12 (109) 108.8 Ω
Resistance between Pin 10 and pin 11 (109) 108.8 Ω
Resistance between Pin 10 and pin 12 (109) 108.8 Ω
Resistance between Pin 11 and pin 12 (.800) .820 Ω
Pins 9-12 resistance to lead (**infinite**) ∞ Ω
Pins 9-12 resistance to ground (**infinite**) ∞ Ω

4.6 Using HP3458 DVM measure temperature sensor resistance with the four wire measurement technique:
Resistance of T1 108.0 Ω(**108.5**)(I+ at pin 1,U+ at pin 2,I- at pin 3,U- at pin 4)
Resistance of T2 108.0 Ω (**108.5**)(I+ at pin 5, U+ at pin 6, I- at pin 7, U- at pin 8)
Resistance of T3 108.0 Ω(**108.5**)(I+ at pin 9,U+ at pin 10,I- at pin 11,U- at pin 12)

4.7 **Check remaining RTDs**
Connect the following cables
Connect four-pin N2 shield
594-3
Connect four-pin outlet HE for each lead
513-3, 514-3
Connect cables for three 19-pin top plate connectors
dewar 0, dewar 1, dewar inlet HE te/ll

All Stand 3 RTD's can be read out on the numeric display that was opened earlier in the checkout. Be sure that Mike T has rebooted the system and scans are active. Check that all Temps for the RTDs read approximately 295K on all channels below.

507-3A__, 507-3B__, 509-3A__, 509-3B__, 510-3A__, 510-3B__, 511-3__, 512-3__, 513-3__, 514-3__, 515-3__, 516-3__, 526-3__, 530-3__, 531-3__, 532-3__, 533-3__, 534-3__, 535-3__, 594-3__

DFLX 04 DFLX 03

9. Room Temperature Electrical Checkout

4.8 TE 507-3B doesn't always read the correct temp; the display will have 507-3B's resistance. It should read approx. 60 Ω.
To exit click Exit.

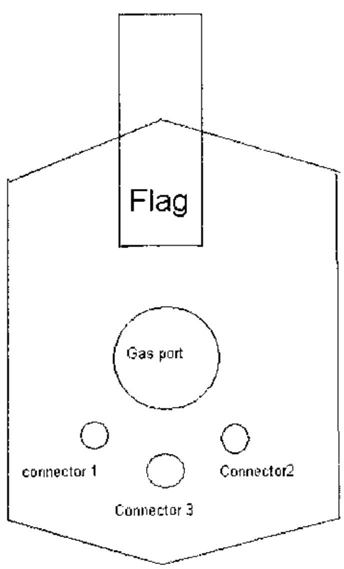
4.9 Check all three liquid levels probes (12", 30", and 36").
The 12" liquid level is connected to pins 9-12 of "dewar inlet HE te/ll" cable.
Connect 4-pin cable on top plate for 30" probe.
Disconnect J1 at the back of each liquid level meter and do a 4-wire resistance measurement on each probe.

Using a breakout box measure the resistance of each probe on J1:

1. pin1(red) to pin 8(blue)	should be approx. 5 Ω
2. pin 8(blue) to pin 6(yellow)	should be approx. (13.75 X active length of probe) 165 Ω for 12" and 412.5 Ω for 30"
3. pin 6(yellow) to pin 7(black)	should be something less than 5 Ω
4. pin 1(red) to pin 7(black)	should approximately equal resistance from #2 + #1

4.10 Do a 4-Wire resistance measurement:
12" Dewar 163.6 30" Dewar 411.9 30" Phase sep. 403.3

	12" Dewar	30"Dewar	30" Phase sep
1.1(red) to 8(blue)	9.2	9.5	10.5
2. 8(blue) to 6(yellow)	164.8	405.1	406.5
3. 6(yellow) to 7(black)	3.5	2.3	3.1
4. 1(red) to 7(black)	172.7	413.7	413.3



Looking from the top of the lead down where the LTS cable is located.
Connector 2= Redundant, Connector 1= Primary and Connector 3= RTD.

NOTE: After checkout is complete, be sure to set up kepco with function generator

DFLX 04 DFLX 03

for +/- 10 amps and then turn off. Cryo techs will turn on when they begin cool down.

Set up function generator for square wave. You should see current go from +10A to –10A. Frequency should be set at .01 (approx. 100 seconds).

DFLX 04 DFLX 03

FERMILAB
Technical Division

7500 A HTS Power Leads for the LHC DFBX: 10. Installation of the Top Plate

Lead Pair

Negative Lead: 03

Positive Lead: 04

Signed C. E. Hess Jr. **Date** 12.16.03

__✓__ **1.** Install all bolts to fasten the top plate to the dewar extension.

__✓__ **2.** Loosen the tensioning rod nuts on the undersides of the lead plates at least 0.5 mm below the lead plate.

__✓__ **3.** Install the transfer lines for maintaining the test dewar liquid level.

__✓__ **4.** Install the transfer lines supplying the 4-20 K circuit.

__✓__ **5.** Install the test dewar flexible vent line.

__✓__ **6.** Connect the vent lines (thermally insulated, non-conductive hoses) to the power lead vent stacks.

__✓__ **7.** Connect the lines labeled "+ LD PDT L" and "- LD PDT L" to the positive and negative lead vent stacks, respectively. These lines connect to the low side of the differential pressure transducers.

__✓__ **8.** Connect the lines labeled "+ LD PDT H" and "- LD PDT H" at the 4-20 K female bayonet vacuum jacket. These lines connect to the high side of the differential pressure transducers.

__✓__ **9.** Connect the power leads' warm gas supply line to the 4-20 K transfer line.

__✓__ **10.** Connect one end of the bypass line at the phase separator and the other end at the vent piping.

Negative Lead DFLX __03__ Positive Lead DFLX __04__

FERMILAB Technical Division	7500A HTS Power leads for the LHC DFBX	Doc. No. Rev. No. Date: March 5,2003 Page 1 of 1 Author: Dan Eddy
	10.1 Warm Temp Hi-pot In Gasous He Environment	

Note: Save the shipping container for storing and moving the leads around TD and after the test is complete to ship them to the DFBX manufacturer.

.

Performed by DANIEL EDDY (Name typed) Daniel Eddy (Signature)

Date & time 12/16/03

Pos. Power Lead 7500 A DFLX 01 and Neg. Power Lead 7500 A DFLX 03

This hi-pot should be performed after dewar has been filled with gaseous helium. <u>Notify the Cryo Operator before you disconnect cables</u>. When checkout is complete, make sure you place the original and a copy of this document in the Traveler Binders.

1.0 Short all of the temperature sensors together using the special RTD high pot cable. High pot each set of temperature sensor to 300v with respect to the Lead (ground).

Record breakdown voltage (if any) ——— V.
Record current .01 μA A

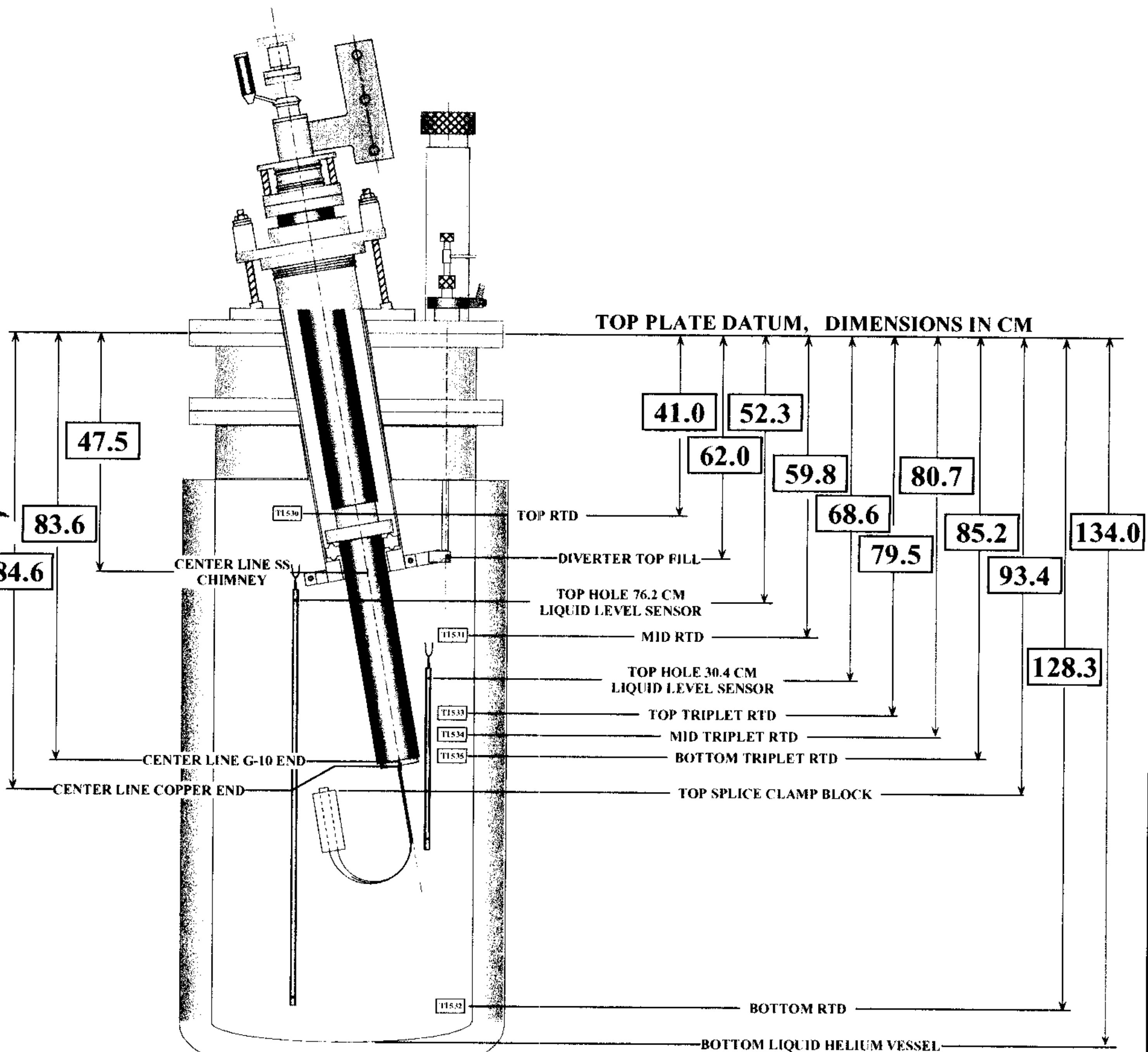
1.2 Hi-pot the leads in a gaseous He environment to 1500V (1.3 Bar) using a Droege HV power supply. Connect the positive clip to one lead and the negative clip to ground. Also, short all of the temperature sensors together using the special RTD high pot cable. Connect the ring terminal from each connector to the flag of each lead. **Be sure to disconnect all voltage tap cables on both leads and the power connections from Kepco power supply.**

Record breakdown voltage (if any) ——— V.
Record current .03 A.
Record approximate temp. 295 K. (Record Temp of TI532-3)
Record approximate test dewar pressure 16.3 PSIA.

NOTE: **After checkout is complete, be sure to set up kepco with function generator for +/- 10 amps and then turn off. Cryo techs will turn on when they begin cool down. Also reconnect Vtaps and RTDs when finished.**

Set up function generator for square wave. You should see current go from +10A to –10A. Frequency should be set at .01 (approx. 100 seconds).

LHC HTS POWER LEAD TESTING @ TEST STAND 3
PAIR - DFLX- 03 (-) & DFLX- 04 (+)



SUBJECT	TITLE	DATE	SKETCH DWG NO.
LHC HTS POWER LEADS (-) DFLX- 03 & (+) DFLX- 04	POWER LEAD TEST DIMENSION MAP	12.15.03	CEH031215-1

FERMILAB
Technical Division

7500 A HTS Power Leads for the LHC DFBX: 12a. Cryogenic Operating Procedure

I. Pre-test

1. Check all insulating vacuums (dewar, transfer lines, etc.). Make a note of them in the LHC-HTS Lead Test logbook.

II. Purge before cool-down

1. Close all system valves.
2. Supply GHe to the test dewar via regulator PRV549-3 and rotameter FI549-3, and vent through diverter valve HV524-3 set to the bottom fill position. Open level control valve LCV547-3 through the FIX32 system. This will push the air out of the test dewar and replace it with GHe. Maintain flow for at least 5 minutes.
3. Close level control valve LCV547-3.
4. Purge the test dewar vent lines by opening rotameter FI519-3 and then valves HV519-3 and HV520-3 in turn for 1 minute each.
5. Purge the test dewar cooldown vent by opening valve HV517-3 for 1 minute.
6. Prepare to purge the lead flow paths by turning on the two Edwards vacuum pumps.
7. Establish a flow path through the negative lead by opening rotameters FI513-3 and FI515-3 and opening the mass flow controller FC509-3 100%.
8. Establish a flow path through the positive lead by opening rotameters FI514-3 and FI516-3 and opening the mass flow controller FC510-3 100%.
9. Supply GHe to the leads via regulator PRV504-3, rotameters FI504-3 and FI505-3, and valve HV502-3.
10. Flow GHe for 1 minute.
11. Close HV502-3, turn off the two Edwards vacuum pumps, and close mass flow controllers FC509-3 and FC510-3.

III. Initial LN2 cool down

1. Enable the LN2 supply solenoid automatic control loop to begin cooling the dewar shield via TY594-3.

IV. Helium cooldown of the dewar.

1. Complete the cooldown checklist ("12. Cooldown Checklist").
2. Turn on the AC line switch on the back of the enclosure on the side of the instrumentation rack. This switch provides power to all of the heater controllers.
3. Enable the lead flag heaters, the 4-20 K transfer line heater, and the phase separator heater by flipping on the switches to the right of the instrumentation rack front.
4. Open the test dewar cooldown vent HV517-3.
5. Attach a pressurizing line to the portable LHe dewar supplying the test dewar, and supply pressure via regulator PRV502-3, rotameter FI502-3, and valve HV522-3. The portable dewar pressure can be read out on gauge PI522-3. Maintain 80 inH2O of transfer differential as measured by PDI522-3.
6. Sting the portable dewar with the test dewar fill transfer line.
7. Place a permanent magnet on the flexible transfer line to open the built-in check valve.
8. Supply liquid helium (LHe) to the test dewar with the diverter valve HV524-3 in the bottom fill position.
9. Put level control valve LCV547-3 into Automatic mode with a 6 in. setpoint.
10. Make sure the lead flow bypass valve HV513-3 and HV514-3 are closed.

11. Sting the second portable dewar with the lead flow transfer line.
12. Attach the second pressurizing line to the portable LHe dewar supplying the leads. At the gauge panel, open valve HV523-3, pressurizing rotameter FI504-3, and vent rotameter FI505-3. Adjust regulator PRV504-3 to pressurize the portable dewar to 8 psig. The portable dewar pressure can be read out on gauge PI523-3.
13. Place a permanent magnet on the flexible transfer line to open the built-in check valve.
14. With the Edwards vacuum pumps on, put both mass flow controllers FC509-3 and FC510-3 into Automatic mode with 50 K setpoints.
15. Briefly open bypass valve HV507-3 to help purge out the phase separator, then close down on bypass valve HV507-3 until it is ¼ turn open. Set the phase separator heater control loop LIC526-3 to Automatic mode with a 12 in. setpoint.

VII. LHe fill

1. Keep the lead temperature control loops TIC509-3 and TIC510-3 in Automatic mode with 50 K setpoints.
2. Keep the test dewar liquid level control loop LIC547-3 in Automatic mode with a 6 in. setpoint. The maximum reading on the liquid level gage is 12 in. Avoid overfilling.
3. Keep the phase separator liquid level control loop LIC526-3 in Automatic mode with a 12 in. setpoint.

VIII. 4.2 K operation

1. Keep lead mass flow control loops TIC509-3 and TIC510-3 in Automatic mode with 50 K setpoints.
2. Diverter valve HV524-3 can be switched into the top fill position.
3. During power tests, use LCV547-3 and its PID loop LIC547-3 to maintain liquid level in the test dewar at 6 in.
4. Use the heater control loop TIC507-3 in Automatic mode with a 20 K setpoint to control the GHe temperature being supplied to the leads.
5. Use temperature control loops TIC509-3 and TIC510-3 in Automatic mode to control the lead HTS warm terminal temperatures. These control loops accomplish this by varying the mass flow rates through the leads.

IX. Warm up from 4.5 K to 300 K

1. Shut off LN2 shield flow by switching the LN2 supply solenoid TY594-3 to Disable.
2. Isolate the LN2 source by closing the hand valve on the 240 l dewar.
3. Stop transfer from the LHe dewars by closing pressurization valves HV522-3 and HV523-3. Remove the pressurization lines and the stingers from the portable dewars.
4. Shut down the Edwards vacuum pumps, and close the mass flow controllers FC509-3 and FC510-3 by setting them to 0% in Manual mode.
5. Put heater control loops TIC507-3 and LIC526-3 to 0% in Manual mode.
6. Switch the liquid level control loop LIC547-3 to manual mode and close LCV547-3.
7. Remove the flexible transfer line supplying the lead flow, and cap off the phase separator port.
8. Remove the flexible transfer line supplying the test dewar, and place a G-10 tube on the end of the U-tube.
9. Supply warm gas to the test dewar via regulator PRV549-3 and rotameter FI549-3.

10. Switch the test dewar diverter valve HV524-3 to the bottom fill position.
11. Open LCV547-3 to push the liquid out of the test dewar and back through the transfer line. Close cooldown vent HV517-3 and dewar vents HV519-3 and HV520-3.
12. Supply warm helium gas to the power leads via regulator PRV504-3, rotameter FI504-3, and valve HV502-3.
13. Establish flow through the leads by opening lead bypass valves HV513-3 and HV514-3.
14. Once LN2 temperature has been reached, the system can be warmed with nitrogen gas supplied by the plant.
15. Stop the GHe lead flow by closing HV502-3. Disconnect the supply at the transfer line. Connect a nitrogen line at the same point.
16. Remove the G-10 tube from the test dewar fill U-tube and attach a nitrogen line.
17. Once the test dewar transfer lines are warm, the test dewar warmup can be speeded up by removing the transfer lines and connecting the nitrogen line with a Hot Watt heater at the test dewar top plate.
18. Attach a thermocouple to the Hot Watt heater and control the power so that the thermocouple temperature gets no higher than 50 C.

X. Overnight condition

1. Shut off the LN2 shield flow by switching the LN2 supply solenoid TY594-3 to Disable.
2. Turn off the pressurizing circuit to the portable LHe dewar supplying the test dewar by closing HV522-3.
3. Turn off the pressurizing circuit to the portable LHe dewar supplying the power leads by closing HV523-3.
4. Close level control valve LCV547-3.
5. Remove the stingers from the portable LHe supply dewars.
6. Remove the permanent magnets from the other end of the flexible transfer lines and place them on the transfer line Unistrut support.
7. Shut off the two Edwards vacuum pumps.
8. Switch the lead temperature control loops TIC509-3 and TIC510-3 to Manual mode, and close the mass flow controllers FC509-3 and FC510-3.
9. Switch the heater control loop TIC507-3 into Manual mode and set the output to 0%.
10. Switch the phase separator liquid level control loop LIC526-3 into Manual mode and set the output to 0%.
11. Open test dewar auxiliary vent valve HV520-3 to allow check valve FCV520-3 to maintain a 1 psi backpressure on the test dewar.
12. Close test dewar vent valve HV519-3.
13. Close cooldown vent valve HV517-3.

XI. Resumption of LN2 and LHe filling after an overnight pause

1. Open the LN2 dewar supply valve and switch the LN2 supply solenoid TY594-3 to Enable.
2. Open cooldown vent valve HV517-3.
3. Close test dewar auxiliary vent valve HV520-3.
4. Insert the stingers into the LHe supply dewars, and put the small permanent magnets on the bayonets at the other end of the flexible transfer lines to hold open the check valves.

5. Turn on the pressurizing circuit to the portable LHe dewar supplying the test dewar by opening HV522-3.
6. Turn on the pressurizing circuit to the portable LHe dewar supplying the power leads by opening HV523-3.
7. Set diverter valve HV524-3 to bottom fill position.
8. Set level control valve LCV547-3 to Automatic with a 6 in. setpoint to begin refilling the test dewar.
9. Turn on the two Edwards vacuum pumps.
10. Set the lead mass flow control loops TIC509-3 and TIC510-3 in Automatic mode with a 50 K setpoint.
11. Set the phase separator liquid level control loop LIC526-3 in Automatic mode with a 12 in setpoint.
12. Verify that the phase separator bypass valve HV507-3 is open ¼ turn.

XII Securing the test stand

1. Turn off the Hot-Watt heater that is warming the GN2 entering the test dewar.
2. After allowing the heater to cool for a few minutes, turn off the GN2 supply to the test dewar.
3. Turn off the GN2 supply to the power leads.
4. Close test dewar vent valve HV519-3.

FERMILAB
Technical Division

7500 A HTS Power Leads for the LHC DFBX:
12. Cooldown Checklist

Lead Pair

Negative Lead: 03

Positive Lead: 04

Signed [signature] Date 12/17/03

GK 1. ±5 A applied to the current leads during cooldown.

GK 2. DAQ system is operational (temperature sensor readouts in the test dewar helium space are updating).

GK 3. Test dewar and power leads cooled down as per the cooldown procedure "7500 A HTS Power Leads for the LHC DFBX: 12a. Cryogenic Operating Procedure".

Negative Lead DFLX ______________ Positive Lead DFLX ______________

FERMILAB Technical Division	7500A HTS Power leads for the LHC DFBX / 13. Cold Temp Hi-pot In HE Environment	Doc. No. Rev. No. Date: March 5,2003 Page 1 of 1 Author: Dan Eddy

Note: Save the shipping container for storing and moving the leads around TD and after the test is complete to ship them to the DFBX manufacturer.

Performed by DANIEL EDDY (Name typed) [signature] (Signature)

Date & time 12/17/03 10:30

Pos. Power Lead 7500 A DFLX 04 and Neg. Power Lead 7500 A DFLX 03

This hi-pot should be performed after dewar has been filled with liquid helium. Notify the Cryo Operator before you disconnect cables. When checkout is complete, make sure you place the original and a copy of this document in the Traveler Binders.

1.1 Short all of the temperature sensors together using the special RTD high pot cable. High pot each set of temperature sensor to 300v with respect to the Lead (ground).

Record breakdown voltage (if any) —— V.
Record current .01μ A

1.2 Hi-pot the leads in a cold (4.5K) He environment to 1500V (1.3 Bar) using a Droege HV power supply. Connect the positive clip to one lead and the negative clip to ground. Also, short all of the temperature sensors together using the special RTD high pot cable. Connect the ring terminal from each connector to the flag of each lead. **Be sure to disconnect the redundant voltage taps on both leads and the power connections from Kepco power supply.**

Record breakdown voltage (if any) —— V.
Record current .06μ A.
Record approximate temp. 4.2 K. (Record Temp of TI532-3)
Record approximate test dewar pressure 14.7 PSIA.

NOTE: Reconnect Vtaps and RTDs when finished.

FERMILAB
Technical Division

7500 A HTS Power Leads for the LHC DFBX: 14. Connect the Leads to the Power Supply & Configure

Lead Pair

Negative Lead: DFLX 03

Positive Lead: DFLX 04

Signed Roger Rabehl Date 12/17/03

1. Bus Connection Changes – VMTF End

✓ 1.1 Visually verify completion of electrical connection of the green flex leads to the Stand 4 hard bus in the trench.

✓ 1.2 Visually verify completion of LCW connections between the green flex leads and the Stand 4 hard bus in the trench.

✓ 1.3 Visually verify completion of electrical connection of the 1000 MCM flexible leads and Main Injector dipoles.

✓ 1.4 Visually verify all exposed bus has been wrapped with rubber insulation for personnel safety.

2. Bus Connection Changes – Stand 4 Platform

✓ 2.1 Visually verify that the Stand 3 hard bus has been mated with the Stand 4 flexible bus on the Stand 4 platform and that the polarity is correct.

3. Bus Connection Changes – Stand 3 Test Dewar

✓ 3.1 Visually verify the flex leads and chill blocks have been bolted to the power lead flags. with Penetrox E conductive grease applied to the cooling block-lead flag joint.

✓ 3.3 Visually verify that voltage taps VFF-A and VFF-B have been connected at the negative and positive flex lead flags, respectively, and voltage taps VLF-A and VLF-B have been connected at the negative and positive power lead flags, respectively. These taps will allow the combined voltage drop across the flex lead/chill block joint and chill block/power lead joint to be measured.

✓ 3.4 Visually verify Kapton-wrapped platinum temperature sensors TE515-3 and TE516-3 have been attached to the positive and negative lead flags, respectively, using glass tape.

✓ 3.5 Visually verify the power lead flags have been wrapped with rubber insulation for personnel safety.

✓ 3.6 Visually verify the plexiglass enclosure has been installed around the power leads for personnel safety.

Negative lead DFLX 03 Positive lead DFLX 04

3. Power Supply System Configuration

__✓__ **3.1** On the FIX32 HMTF Power Interlock screen, switch the selector switch to the Stand 3 position.

__✓__ **3.2** Switch warning lights at the VMTF pit and at the Stand 4 platform to the "Stand 3" position.

__✓__ **3.3** Adjust the power supply time constant by setting the resistance to 500 μΩ.

__✓__ **3.4** Adjust the power supply time constant by setting the inductance to 0.5 mH.

__✓__ **3.5** Adjust the dump resistance to 30 mΩ.

__✓__ **3.6** Place the VMTF ground switch in the "off" position.

__✓__ **3.7** Place the Stand 4 ground switch in the "on" position.

__✓__ **3.8** Place the Stand 3/VMTF ground switch on the ETS panel in the Stand 3 (up) position and press the Master Reset.

__✓__ **3.9** Remove the power control cable, which contains QLM, PLC, etc. signals, from the VMTF "j" plug and insert into the Stand 4 "j" plug.

__✓__ **3.10** Switch LCW control box switch to Main Injector Magnets In position to enable flow switches in PLC interlock logic.

4. LCW System Verification

__✓__ **4.1** Record the flow indicator readings for LCW flow to the 1000 MCM flexible leads and the Main Injector dipoles.

1000 MCM Flexible lead flow FI2239 (IB1 south wall): __12__ gpm (12 gpm nominal)
Main Injector dipole 1 flow FI2278: __4.5__ gpm (5 gpm nominal)
Main Injector dipole 2 flow FI2279: __5__ gpm (5 gpm nominal)
Main Injector dipole combined flow FI2236: __9__ gpm (10 gpm nominal)

__✓__ **4.2** Record the flow indicator readings for LCW flow to the 750 MCM green flexible leads.

Positive flex lead flow FI2230: __11__ gpm (12 gpm nominal, 11 gpm actual)
Negative flex lead flow FI2231: __9__ gpm (12 gpm nominal, 9 gpm actual)

__✓__ **4.3** Record the flow indicator readings for LCW flow to Stand 3.

10 ft negative flex lead on the Stand 4 platform FI553-3: __4__ gpm (4 gpm nominal)
10 ft positive flex lead on the Stand 4 platform FI554-3: __4__ gpm (4 gpm nominal)
Copper bus flow FI556-3: __11__ gpm (12 gpm nominal)
6 ft flex leads at the Stand 3 test dewar FI558-3: __3.7__ gpm (4 gpm nominal)

Negative lead DFLX __03__ Positive lead DFLX __04__

FERMILAB Technical Division	7500A HTS Power leads for the LHC DFBX	Doc. No. Rev. No. 1 Date: Sept. 11, 2003 Page 1 of 3 Author: Sandor Feher
	16. Cold test of the power leads	

Performed by ROGER RABEHL (name typed) Roger Rabehl (signature)

Date & time DECEMBER 17, 2003 0930

Power Lead 7500 A DFLX 03 & 7500 A DFLX 04

✓ 16.0 Set the DAQ system ScribeLeads and ScribeFix32 Data Logging Intervals to capture data every 5 seconds.

✓ 16.1. Establish cryogenic parameters for normal high current operating conditions.

Set the liquid level at 6in location using the 1 foot LL probe ✓

Set the copper section inlet cooling gas temperature to 15-20K range ✓

Set the LHe vapor cooling control loop in automatic mode to keep the upper HTS terminal temperature at 50 K for ½ hour ✓

Neg. lead flow rate 0.123 g/s Pos. lead flow rate 0.128 g/s

Neg. lead diff. pressure 0 mbar Pos. lead diff. pressure 0 mbar

Set the upper HTS temperature to 75 K and keep it there for ½ hour ✓

Neg. lead flow rate 0.136 g/s Pos. lead flow rate 0.139 g/s

Neg. lead diff. pressure 0 mbar Pos. lead diff. pressure 0 mbar

Frost observed on leads? (Y/N) N

✓ 16.1.1 Set software quench detection thresholds by executing:

/usr/vmtf/sh/lhchts_setquenchthreshold_run.sh

✓ 16.2 Stair step profile test.

Turn on the Power Supply. Set HTS terminal temperature to 50K and apply current profile 1 (/usr/vmtf/sh/hmtf3_run_prf.sh) ✓

Monitor voltages and make sure that the data is recorded.

Run data analysis tool on the obtained data file to determine joint resistances.

7500 A DFLX 03 R(joint between V2 & V3) = $\frac{0.000172+0.000114\ V}{7500\ A}$ = 38.1 nΩ

(-) R(joint between V3 & V4) = $\frac{0.0000416-0.0000214\ V}{7500\ A}$ = 2.7 nΩ

7500 A DFLX 04 R(joint between V2 & V3) = $\frac{0.000508-0.000180\ V}{7500\ A}$ = 43.7 nΩ

(+) R(joint between V3 & V4) = $\frac{0.000259-0.000236\ V}{7500\ A}$ = 3.1 nΩ

✓ 16.3 Coolant loss test.

Apply 7500 A and

a) Close the coolant flow for 7500 A DFLX 03 (-)

Wait until QD detects the quench and record

T1 = 83 K ; T2 = 305 K; V12 = -48.8 mV; V23 = -0.852 mV ; V34 = 0.0247 mV ;

T1 is the HTS warm terminal temp., TI509-3 (neg. lead) or TI510-3 (pos. lead).

T2 is the upper copper temp., TI511-3 (neg. lead) or TI512-3 (pos. lead).

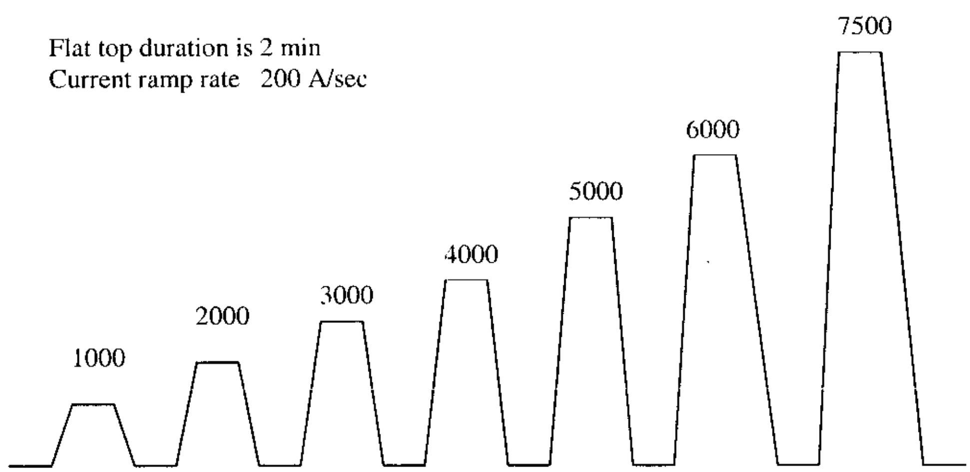
b) Re-establish operating conditions
c) Close the coolant flow for 7500 A DFLX 04 (+)
Wait until QD detects the quench and record
T1 = 79 K ; T2 = 293 K; V12 = 95.9 mV ; V23 = 1.05 mV ; V34 = 0.264 mV;

16.4a Set the upper HTS terminal temperature to 45 K and apply current profile 2.
Neg. lead flow rate 0.499 g/s Pos. lead flow rate 0.481 g/s
Neg. lead diff. pressure 3.1 mbar Pos. lead diff. pressure 3.9 mbar

16.4b Set HTS terminal temp to 50 K and apply current profile 2.
Neg. lead flow rate 0.463 g/s Pos. lead flow rate 0.462 g/s
Neg. lead diff. pressure 3.6 mbar Pos. lead diff. pressure 4.6 mbar

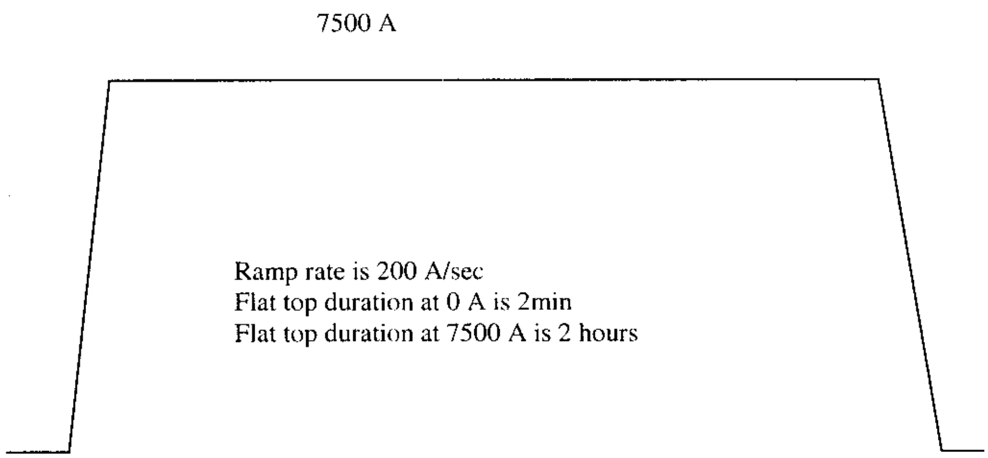
16.5 When test is completed, set the ScribeLeads and ScribeFix32 Data Logging Intervals to 300 seconds.
Note: If any irregularity occur call Sandor.

Profile 1:



16. Cold test of the power leads

Profile 2:



Performed by ROGER RABEHL (name typed) [signature] (signature)

Date & time DECEMBER 18, 2003 0900

Power Lead 7500 A DFLX 03 & 7500 A DFLX 04

✓16.0 Set the DAQ system ScribeLeads and ScribeFix32 Data Logging Intervals to capture data every 5 seconds.

16.1. Establish cryogenic parameters for normal high current operating conditions.
Set the liquid level at 6in location using the 1 foot LL probe ✓
Set the copper section inlet cooling gas temperature to 15-20K range ✓
Set the LHe vapor cooling control loop in automatic mode to keep the upper HTS terminal temperature at 45 K for ½ hour ✓
Neg. lead flow rate 0.140 g/s Pos. lead flow rate 0.142 g/s
Neg. lead diff. pressure 0 mbar Pos. lead diff. pressure 0 mbar
Set the upper HTS temperature to 50 K and keep it there for ½ hour ✓
Neg. lead flow rate 0.125 g/s Pos. lead flow rate 0.127 g/s
Neg. lead diff. pressure 0 mbar Pos. lead diff. pressure 0 mbar
Frost observed on leads? (Y/N) N

✓16.1.1 Set software quench detection thresholds by executing:
/usr/vmtf/sh/lhchts_setquenchthreshold_run.sh

✓16.2 Stair step profile test.
Turn on the Power Supply. Set HTS terminal temperature to 50K and apply current profile 1 (/usr/vmtf/sh/hmtf3_run_prf.sh) ✓
Monitor voltages and make sure that the data is recorded.
Run data analysis tool on the obtained data file to determine joint resistances.

* SEE NOTE P. 2

7500 A DFLX 03 (−) R(joint between V2 & V3) = $\frac{0.000171 + 0.000105\text{ V}}{7500\text{ A}}$ = 36.8 nΩ
R(joint between V3 & V4) = $\frac{0.0000711 - 0.0000534\text{ V}}{7500\text{ A}}$ = 2.4 nΩ

7500 A DFLX 04 (+) R(joint between V2 & V3) = $\frac{0.000494 - 0.000171\text{ V}}{7500\text{ A}}$ = 43.1 nΩ
R(joint between V3 & V4) = $\frac{0.000273 - 0.000250\text{ V}}{7500\text{ A}}$ = 3.1 nΩ

✓16.3 Coolant loss test.
Apply 7500 A and
a) Close the coolant flow for 7500 A DFLX 03 (−)
Wait until QD detects the quench and record
T1 = 82 K; T2 = 304 K; V12 = −98.5 mV; V23 = −0.871 mV; V34 = 0.0475 mV;

T1 is the HTS warm terminal temp., TI509-3 (neg. lead) or TI510-3 (pos. lead).
T2 is the upper copper temp., TI511-3 (neg. lead) or TI512-3 (pos. lead).

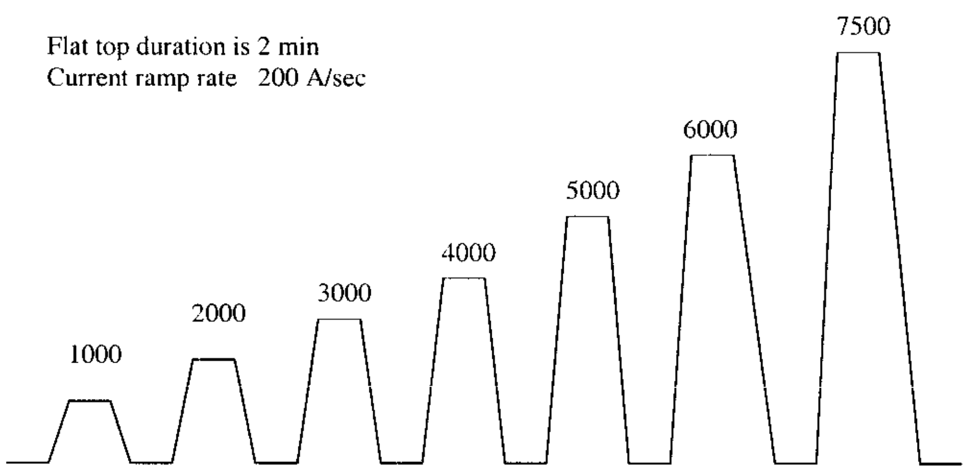
b) Re-establish operating conditions
c) Close the coolant flow for 7500 A DFLX 04 (+)
Wait until QD detects the quench and record
T1 = 80 K ; T2 = 292 K; V12 = 96.3 mV ; V23 = 1.06 mV; V34 = 0.271 mV;

✓16.4a Set the upper HTS terminal temperature to 45 K and apply current profile 2.
Neg. lead flow rate 0.495 g/s Pos. lead flow rate 0.490 g/s
Neg. lead diff. pressure 3.0 mbar Pos. lead diff. pressure 3.7 mbar

✓16.4b Set HTS terminal temp to 50 K and apply current profile 2.
Neg. lead flow rate 0.470 g/s Pos. lead flow rate 0.467 g/s
Neg. lead diff. pressure 2.8 mbar Pos. lead diff. pressure 3.6 mbar

✓16.5 When test is completed, set the ScribeLeads and ScribeFix32 Data Logging Intervals to 300 seconds.
Note: If any irregularity occur call Sandor.

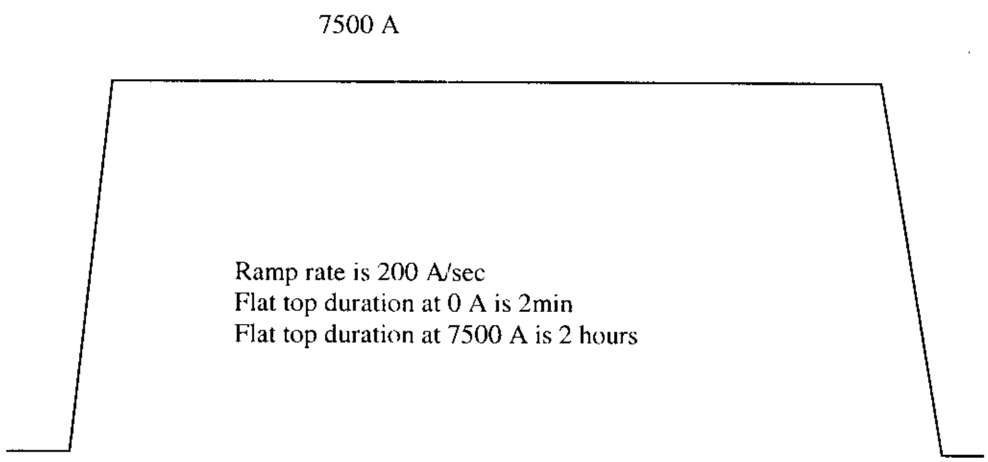
Profile 1:



* V2 - V3 VOLTAGES WERE NOT STEADY FOR EITHER LEAD AT 7500 A. FOUND LEAD FLOW ROTAMETERS NOT FULLY OPEN.
FOR BOTH LEADS, ALL RESISTANCES WERE CALCULATED FROM DATA OF 50 K/7500 A FLAT-TOP (STEP 16.4b).

16. Cold test of the power leads

Profile 2:



FERMILAB Technical Division	7500A HTS Power leads for the LHC DFBX **20. Warm Temp Hi-pot In Gasous He Environment**	Doc. No. Rev. No. Date: March 5,2003 Page 1 of 1 Author: Dan Eddy

Note: Save the shipping container for storing and moving the leads around TD and after the test is complete to ship them to the DFBX manufacturer.

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Performed by DAN EDDY (Name typed) Dan Eddy (Signature)

Date & time 1/05/04 14:00

Pos. Power Lead 7500 A DFLX 04 and Neg. Power Lead 7500 A DFLX 03

This hi-pot should be performed after dewar has been filled with gaseous helium after the second test cycle has been completed and the dewar is at room temperature. When checkout is complete, make sure you place the original and a copy of this document in the Traveler Binders.

1.1 Short all of the temperature sensors together using the special RTD high pot cable. High pot each set of temperature sensor to 300v with respect to the Lead (ground).

Record breakdown voltage (if any) ——— V.
Record current .01μ A

1.2 Hi-pot the leads in a cold (4.5K) He environment to 1500V (1.3 Bar) using a Droege HV power supply. Connect the positive clip to one lead and the negative clip to ground. Also, short all of the temperature sensors together using the special RTD high pot cable. Connect the ring terminal from each connector to the flag of each lead. **Be sure to disconnect the redundant voltage taps on both leads and the power connections from Kepco power supply.**

Record breakdown voltage (if any) ——— V.
Record current .03 μA A.
Record approximate temp. 295 K. (Record Temp of TI532-3)
Record approximate test dewar pressure 16.9 PSIA.

NOTE: Reconnect Vtaps and RTDs when finished.
Turn OFF Main Power Switch to Hoffman Enclosure on Side of END RACK!!!!

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7500 A HTS Power Leads for the LHC DFBX: 21. Removal of the Top Plate from the Dewar

1. **Electrical Disconnections**
   - **1.1** Put the power system into LOTO.
   - **1.2** Remove the plexiglass shield around the power leads.
   - **1.3** Remove the Kapton-wrapped platinum temperature sensors TE515-3 and TE516-3 from the positive and negative lead flags, respectively.
   - **1.4** Remove voltage taps VF-A and VF-B from the negative and positive flex lead flags, respectively.
   - **1.5** Disconnect the flex leads and chill blocks from the power lead flags.

2. **Piping Disconnections**
   - **2.1** Disconnect the GN2 warmup supply line from the 4-20 K supply line.
   - **2.2** Disconnect the GN2 warmup supply line from the top plate.
   - **2.3** Remove the Hot Watt if it was used to during the warmup.
   - **2.4** Disconnect the lines labeled "+ LD PDT +" and "- LD PDT +" from the 4-20 K female bayonet vacuum jacket. The lines connect to the high side of the differential pressure transducers.
   - **2.5** Disconnect the lines labeled "+ LD PDT – " and "- LD PDT –" from the positive and negative lead vent stacks, respectively. These lines connect to the low side of the differential pressure transducers.
   - **2.6** Disconnect the vent lines (thermally insulated, non-conductive hoses) to the power lead vent stacks.
   - **2.7** Remove the power lead vent stack from each power lead.
   - **2.8** Remove the test dewar flexible vent line.
   - **2.9** Remove the transfer lines supplying the 4-20 K circuit.

3. **Top Plate and Insert Removal**
   - **3.1** Remove all bolts fastening the top plate to the dewar extension.
   - **3.2** Lift the top plate and insert from the test dewar and set them onto the roll-around cart.
   - **3.3** Tighten the nuts on the underside of the current lead top plate against the plate to provide stability during transportation.

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Stand 3 LHC-HTS Lead Testing:
22. Removal of the Current Leads

1. **Electrical Disconnection of Current Leads from Test Facility**
   - **1.1** Unbolt the heater from each power lead flag.
   - **1.2** Remove the bottom fill tube.
   - **1.3** Remove the He space temperature sensors and the liquid level probes.
   - **1.4** Remove the Kapton and glass tape insulating the low temperature superconducting cable.
   - **1.5** Unclamp the V5 voltage tap wires from the LTS cable.
   - **1.6** Unwind the excess voltage tap wire from around the bottom of each power lead and gather it into a coil. Secure it with tape and let it hang from the end of the power lead.
   - **1.7** Separate the joined LTS cables by opening the mechanical clamp. Recover as much indium as possible.
   - **1.8** Remove the mechanical clamp, the clamp support, and the G-10 clamshell clamp.

2. **Mechanical Removal of Current Leads from Test Facility**
   - **2.1** Using wedges, tilt the insert by 10° so that the power leads are vertical.
   - **2.2** Remove the jam nuts from the tensioning studs.
   - **2.3** Remove the loading nuts and Belleville washer assemblies from the tensioning studs. Put each Belleville washer assembly/loading nut/jam nut group on a threaded rod for storage.
   - **2.4** Use a 5/16 12-point socket to loosen and remove the 20 Conflat bolts connecting the lead plate to the insert top plate.
   - **2.5** Attach the lifting/insertion tool to the lead flag and carefully lift the lead from the top plate.
   - **2.6** With the lead supported by the crane at a reasonable working height, remove the power lead baffle.
   - **2.7** Remove the Conflat copper gasket from the knife edge on the underside of the lead plate.
   - **2.8** Clamp the end support around the lead lower flange so that the handles can rest on the backs of C-channels when the lead is put on a steel table.
   - **2.9** Place the lead on the C-channels, using the end support to prevent any loading on the lower part of the lead.
   - **2.10** Recover as much indium as possible from the power lead LTS cables.
   - **2.11** Remove the upper insulator, PEEK seal, and lower insulator from each chimney.
   - **2.12** Put each upper insulator, PEEK seal, and lower insulator in LN2. This will drive off the absorbed helium and will greatly improve the system background during the leak check of the next pair of leads to be tested.

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Stand 3 LHC-HTS Lead Testing: 23. Pack and Ship the Leads

Lead Pair

Negative Lead: 03

Positive Lead: 04

Signed C. E. [signature] Date 01.13.04

1. **Pack the Leads**

1.1 With the lead on the steel table, swing the insertion/lifting tool 180° so that the lead can be picked up and remain horizontal as shown in Figure 1.1.

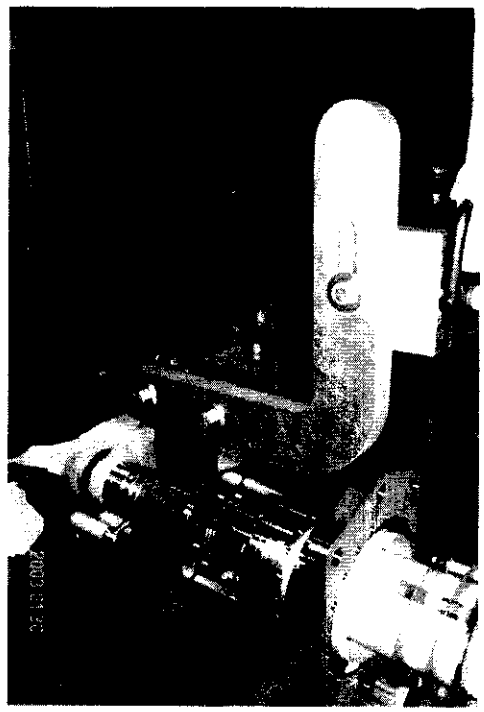

Figure 1.1 Orientation of the insertion/lifting tool to allow the power lead to be held horizontally.

1.2 Lift the power lead off of the steel table.

1.3 While supporting the lead from the crane, remove the end support clamped around the lower flange of the power lead.

1.4 Complete the lead preparation checklist:

✓ ✓ **a)** Install the protective covers for the lead top plate knife edge sealing surface and for the lower flange sealing surface on each lead. Secure them with tape.

✓ ✓ **b)** Insert a protective plastic cap into the 4-20 K gas port for each lead.

✓ ✓ **c)** Reattach the g-force indicators that were attached to the leads when they arrived.

✓ ✓ **d)** Wrap the ceramic insulator at the top of each lead in bubble wrap.

✓ ✓ **e)** Place a cap on the Conflat flange at the top of each lead.

Negative Lead DFLX 03 Positive Lead DFLX 04

√ √ **f)** Wrap the power lead vacuum pumpout in aluminum foil.

√ √ **g)** Secure the power lead bus and voltage tap wires to the power lead lower G-10 section with tape.

√ √ **h)** Set each lead in the shipping crate and remove the insertion/lifting tool.

1.5 Complete the packing checklist:

√ **a)** Reinstall the wooden supports in the crate to hold the lead in place during shipping.

√ **b)** Make two photocopies of all documents in the lead travelers, and place the power lead travelers in the shipping crate. One copy of the documents is for Sandor, the second copy is for Marsha Schmidt.

√ **c)** Verify the following items are in the shipping crate:

√ **i)** Two flag heaters

√ **ii)** Two flag heater connectors

√ **iii)** Vacuum pumpout actuator

√ **iv)** NW16 clamp

√ **v)** NW16 o-ring

1.6 Close the shipping crate

2. Ship the Leads

2.1 Complete the shipping checklist:

√ **a)** Call Marsha Schmidt (X-4377) to request that the power leads be shipped to storage.