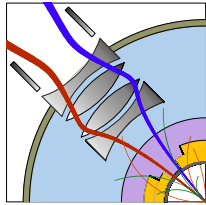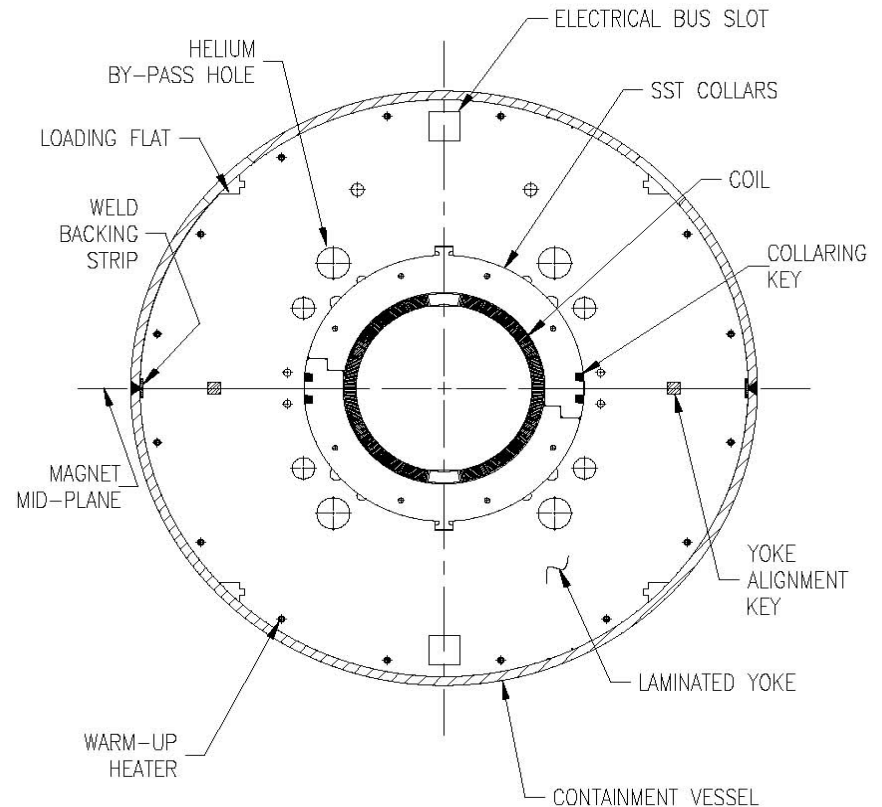# D1 separation dipole

RHIC DX magnet

- Coil aperture   180 mm
- Cold bore   163/174 mm
- Warm bore   140 mm
- Magnetic length   3.7 m
- Operating temp   4.5 K
- Field   4.4 T
- Current   6.8 kA
- Stored energy   1100kJ
- Inductance   49 mH

D1 = two DX in one cryostat

LHC/BNL/D1 Version (1a)

Expected values of body (straigth section) harmonics
in 180 mm aperture dipoles for LHC at 2000 A :
**(assumes one coldmass with two warm and two cold measurements
will be used for tuning of geometric and saturation harmonics)**

***** Reference Radius is 40 mm *****

Body harmonics in units (European notation; n=1 is dipole)
[<bn> = mean, d(bn) = uncertainty in mean]
[sig(bn) = sigma for bn, sig(an) = sigma for an]

n	<bn>	d(bn)	sig(bn)	<an>	d(an)	sig(an)
2	0.0	0.5	0.60	0.0	1.5	2.00
3	0.0	1.0	1.00	0.0	0.2	0.30
4	0.0	0.1	0.10	0.0	0.2	0.30
5	0.0	1.0	0.10	0.0	0.1	0.05
6	0.00	0.05	0.02	0.0	0.10	0.05
7	-0.20	0.30	0.02	0.0	0.02	0.02
8	0.000	0.002	0.003	0.0	0.02	0.007
9	-0.100	0.100	0.003	0.0	0.01	0.001
10	0.00	0.001	0.001	0.0	0.005	0.001
11	-0.02	0.020	0.0003	0.0	0.0003	0.0002
12	0.00	0.0001	0.0001	0.0	0.0002	0.0002
13	0.01	0.010	0.0001	0.0	0.0001	0.0001
14	0.00	0.0001	0.0001	0.0	0.0001	0.0001
n	<bn>	d(bn)	sig(bn)	<an>	d(an)	sig(an)

Following harmonics may show significant variation as a function of current
(as compared to the uncertainty in mean)
Persistant current changes are incorporated in <b3>
and saturation in d(b3) and d(a2)

I (A)	<b3>	d(b3)	sig(b3)	<a2>	d(a2)	sig(a2)
360	-5	2.0	1.1	0	1.5	2.0
1000	-1	1.5	1.0	0	1.5	2.0
2000	0	1.0	1.0	0	1.5	2.0
4000	0	2.0	1.0	0	2.0	2.2
5600	0	2.0	1.0	0	2.0	2.5
6500	0	2.5	1.0	0	2.5	3.0
7500	0	3.0	1.1	0	3.0	3.5

Expected values of end harmonics based on present design
in 180 mm aperture dipoles for LHC at all currents:
(end harmonics may be improved if ends are re-designed)
***** Reference Radius is 40 mm *****

Lead-End harmonics in unit-meters

n	\<Bn\>	d(Bn)	sig(Bn)	\<An\>	d(An)	sig(An)
2	-0.3	0.7	1.0	1.7	1.3	2.0
3	4.0	2.0	0.7	-4.0	2.0	0.5
4	0.0	0.2	0.2	0.1	0.3	0.4
5	2.5	0.5	0.1	0.2	0.4	0.05
6	0.00	0.04	0.05	-0.02	0.20	0.03
7	0.20	0.10	0.02	-0.10	0.10	0.01
8	0.00	0.02	0.01	-0.005	0.010	0.010
9	0.020	0.020	0.005	-0.008	0.020	0.003
10	0.000	0.004	0.004	-0.003	0.005	0.002
11	-0.020	0.010	0.002	0.003	0.007	0.001

Return-End harmonics in unit-meters

n	\<Bn\>	d(Bn)	sig(Bn)	\<An\>	d(An)	sig(An)
2	0.3	1.0	2.0	-1.00	1.50	2.0
3	1.0	1.5	1.0	-0.40	0.40	0.5
4	0.0	0.15	0.2	-0.03	0.15	0.4
5	0.8	0.6	0.1	-0.04	0.04	0.05
6	0.0	0.03	0.1	-0.01	0.03	0.04
7	0.1	0.10	0.03	0.00	0.02	0.02
8	0.0	0.01	0.01	-0.01	0.01	0.01
9	0.0	0.01	0.01	0.000	0.004	0.005
10	0.003	0.005	0.005	-0.003	0.003	0.005
11	-0.02	0.02	0.005	0.000	0.002	0.005

LHC/BNL/D1 Version (1a)

Ramesh Gupta, 11/26/2008

LHC/BNL/D1 Version (1b)

Expected values of integral harmonics at 2000 A in
180 mm aperture D1 dipoles for LHC (consisted of two RHIC DX):

(assumes one coldmass with 2 warm and 2 cold measurements to be used for tuning of INTEGRAL geometric and saturation harmonics)

***** Reference Radius is 40 mm *****

Harmonics in units (European notation; n=3 is sextpole)

[<bn> = mean, d(bn) = uncertainty in mean]
[sig(bn) = sigma for bn, sig(an) = sigma for an]

n	<bn>	d(bn)	sig(bn)	<an>	d(an)	sig(an)
2	0.0	0.5	0.6	0	2	2
3	0	2	1	-1	2	0.3
4	0.0	0.2	0.1	0.0	0.3	0.4
5	0.0	1.0	0.1	0.0	0.1	0.05
6	0.0	0.05	0.02	0.0	0.10	0.05
7	-0.2	0.3	0.02	0.0	0.02	0.02
8	0.000	0.002	0.003	0.0	0.02	0.01
9	-0.05	0.100	0.003	0.0	0.01	0.001
10	0.00	0.001	0.001	0.0	0.005	0.001
11	-0.02	0.020	0.0003	0.0	0.0003	0.0002
12	0.00	0.0001	0.0001	0.0	0.0002	0.0002
13	0.01	0.010	0.0001	0.0	0.0001	0.0001
14	0.00	0.0001	0.0001	0.0	0.0001	0.0001
n	<bn>	d(bn)	sig(bn)	<an>	d(an)	sig(an)

Following harmonics may show significant variation as a function of current
(as compared to the uncertainty in mean)
Persistant current changes are incorporated in <b3> and saturation in d(b3) and d(a2)

I (A)	<b3>	d(b3)	sig(b3)	<a2>	d(a2)	sig(a2)
360	-5	2.5	1.1	0	2	2
1000	-1	2	1	0	2	2
2000	0	2	1	0	2	2
4000	0	2	1	0	2.5	2.2
5600	0	2	1	0	2.5	2.5
6500	0	2.5	1.0	0	3.0	3.0
7500	0	3.0	1.1	0	3.0	3.5

LHC/BNL/D1 Version (1b)

Ramesh Gupta, 12/2/2008