BNL-114544-2017-TECH
CBETA/011;BNL-114544-2017-IR

Transverse forces in the first girder magnets

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April 2017

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy
USDOE Office of Science (SC), Nuclear Physics (NP) (SC-26)

DISCLAIMER

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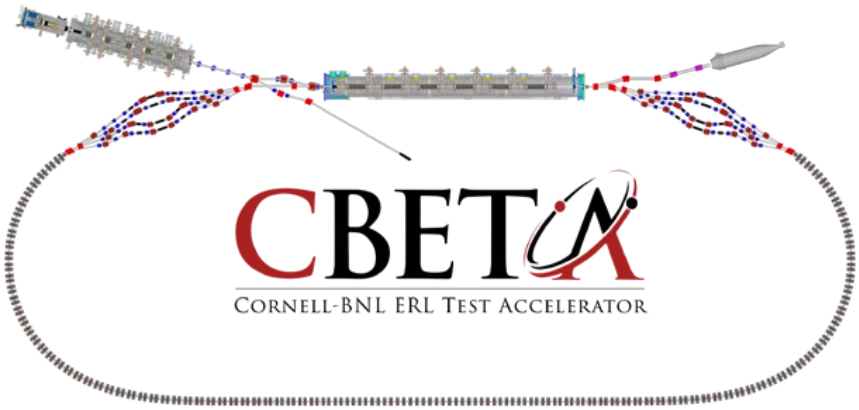

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Funded by NYSERDA contract 102192

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Transverse Forces in the First Girder Magnets

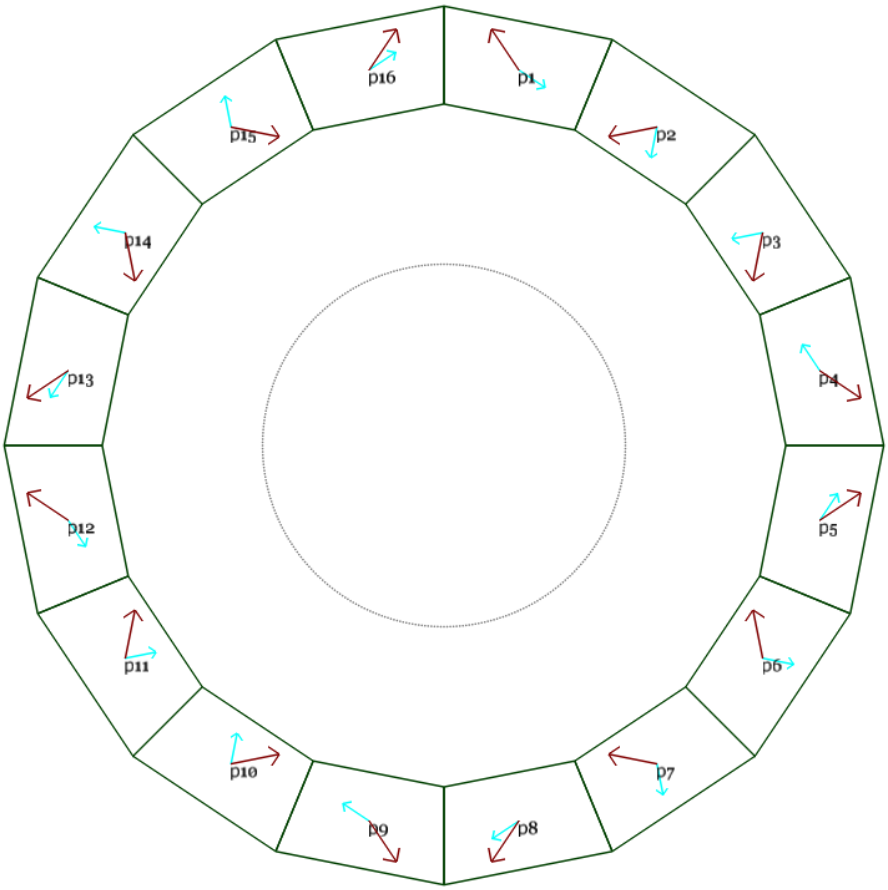
Stephen Brooks 2017-Apr-14 CBETA machine note #11

1. Introduction

These force calculations were done for the Halbach magnets for the CBETA "First Girder" as described in note [CBETA001] and purchased for the assembly of that girder.

2. QF Magnet

The picture below shows the transverse forces on each block as vectors (dark red), when the QF magnet is assembled. The light blue arrows are the magnetisation direction.



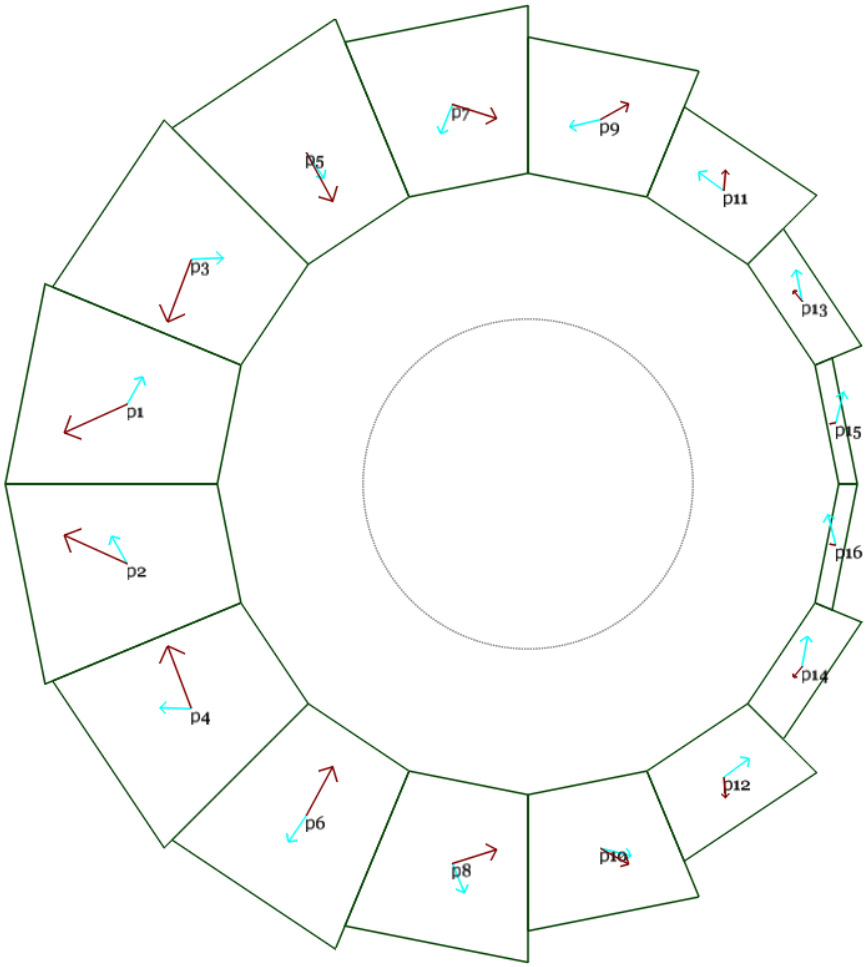
The pieces are labelled arbitrarily p1-p16 so that the corresponding forces can be written in the table below. For actual block type names from the factory, consult the assembly instructions.

The force can be stated as a force per unit length (Newtons/metre), or a force per block, or for the two blocks constituting the total length of the magnet. The latter gives the force on the outer aluminium shell. (Fx,Fy) force vectors are given in each cell.

Block label in diagram	Force per unit length (N/m)	Force per block (N)	Force per block (lbf)	Force full length (N)	Force full length (lbf)
p1	(-3470,5177)	(-231,345)	(-52,77.6)	(-463,690)	(-104,155.2)
p2	(-6129,-1228)	(-408,-82)	(-91.8,-18.4)	(-817,-164)	(-183.7,-36.8)
p3	(-1228,-6129)	(-82,-408)	(-18.4,-91.8)	(-164,-817)	(-36.8,-183.7)
p4	(5177,-3470)	(345,-231)	(77.6,-52)	(690,-463)	(155.2,-104)
p5	(5177,3470)	(345,231)	(77.6,52)	(690,463)	(155.2,104)
p6	(-1228,6129)	(-82,408)	(-18.4,91.8)	(-164,817)	(-36.8,183.7)
p7	(-6129,1228)	(-408,82)	(-91.8,18.4)	(-817,164)	(-183.7,36.8)
p8	(-3470,-5177)	(-231,-345)	(-52,-77.6)	(-463,-690)	(-104,-155.2)
p9	(3470,-5177)	(231,-345)	(52,-77.6)	(463,-690)	(104,-155.2)
p10	(6129,1228)	(408,82)	(91.8,18.4)	(817,164)	(183.7,36.8)
p11	(1228,6129)	(82,408)	(18.4,91.8)	(164,817)	(36.8,183.7)
p12	(-5177,3470)	(-345,231)	(-77.6,52)	(-690,463)	(-155.2,104)
p13	(-5177,-3470)	(-345,-231)	(-77.6,-52)	(-690,-463)	(-155.2,-104)
p14	(1228,-6129)	(82,-408)	(18.4,-91.8)	(164,-817)	(36.8,-183.7)
p15	(6129,-1228)	(408,-82)	(91.8,-18.4)	(817,-164)	(183.7,-36.8)
p16	(3470,5177)	(231,345)	(52,77.6)	(463,690)	(104,155.2)

3. BD Magnet

The picture below shows the transvers forces on each block as vectors (dark red), when the BD magnet is assembled. The light blue arrows are the magnetisation direction.



The force vectors on each piece of the BD magnet are written in the table below.

Block label in diagram	Force per unit length (N/m)	Force per block (N)	Force per block (lbf)	Force full length (N)	Force full length (lbf)
p1	(-8764,-3967)	(-533,-241)	(-119.9,-54.3)	(-1067,-483)	(-239.8,-108.5)
p2	(-8764,3967)	(-533,241)	(-119.9,54.3)	(-1067,483)	(-239.8,108.5)
p3	(-3330,-8775)	(-203,-534)	(-45.6,-120)	(-405,-1068)	(-91.1,-240.1)
p4	(-3330,8775)	(-203,534)	(-45.6,120)	(-405,1068)	(-91.1,240.1)
p5	(3695,-6845)	(225,-417)	(50.6,-93.6)	(450,-833)	(101.1,-187.3)
p6	(3695,6845)	(225,417)	(50.6,93.6)	(450,833)	(101.1,187.3)
p7	(6137,-1937)	(373,-118)	(83.9,-26.5)	(747,-236)	(167.9,-53)
p8	(6137,1937)	(373,118)	(83.9,26.5)	(747,236)	(167.9,53)
p9	(3909,2199)	(238,134)	(53.5,30.1)	(476,268)	(107,60.2)
p10	(3909,-2199)	(238,-134)	(53.5,-30.1)	(476,-268)	(107,-60.2)
p11	(241,2846)	(15,173)	(3.3,38.9)	(29,346)	(6.6,77.9)
p12	(241,-2846)	(15,-173)	(3.3,-38.9)	(29,-346)	(6.6,-77.9)
p13	(-1170,1438)	(-71,88)	(-16,19.7)	(-142,175)	(-32,39.3)
p14	(-1170,-1438)	(-71,-88)	(-16,-19.7)	(-142,-175)	(-32,-39.3)
p15	(-806,-139)	(-49,-8)	(-11,-1.9)	(-98,-17)	(-22.1,-3.8)
p16	(-806,139)	(-49,8)	(-11,1.9)	(-98,17)	(-22.1,3.8)