

ATF2 Q magnets

FF magnets

Qname	length[m]	K1[1/m]	#	T/m
QM16	0.2	-0.366	1	-7.93
QM15	0.2	0.564	1	12.22
QM14	0.2	-1.664	1	-36.053333
QM13	0.2	0.52	1	11.2666667
QM12	0.2	0.882	1	19.11
QM11	0.2	-0.0019	1	-0.0421633
QD10	0.2	-0.314	2	-6.8033333
QF9	0.2	0.374	2	8.10333333
QD8	0.2	-0.56	1	-12.133333
QF7	0.2	0.6	1	13
QD6	0.2	-0.56	1	-12.133333
QF5	0.2	0.374	2	8.10333333
QD4	0.2	-0.314	2	-6.8033333
QD2B	0.2	0.588	1	12.74
QF3	0.2	-0.25	1	-5.4166667
QD2A	0.2	-0.274	1	-5.9366667
QF1	0.4	0.914	1	9.90166667
QD0	0.5	-1.494	1	-12.948

22

EXT→FF magnets

Qname	length[m]	K1[1/m]	#	T/m
Q1C	0.2	1.59	1	34.45
Q2C	0.2	0.894	1	19.37
Q3C	0.2	-0.64	1	-13.86667
Q4C	0.2	0.894	1	19.37
Q5C	0.2	1.59	1	34.45

Field gradient T/m is estimated at E=1.3 GeV.

All the Q has its bore 32ϕ .

$B' = 45\text{T/m} \rightarrow$ pole-tip field of 0.72T @r=16mm.

? Tolerance for **stability**
multipole comp.

Estimation of SX component limit in Q

Calculate $\Delta\sigma$, until $\Delta\sigma > 0.5 \sigma_0$ increasing K2 by factor 10 for each Q.

Then $d\sigma/dK2 = \Delta\sigma / 10^n$
 beam size

sigx[m] 2.37E-06
 sigy[m] 3.36E-08

Qname	K2 for 10% beam size increase		x	y	minK2	B2@r=10mm	K1	B2/B1@r=10mm
	dsigx/dK2	dsigy/dK2						
QM16	2.36E-08	3.02E-10	1.00E+01	1.11E+01	1.00E+01	1.09E-02	-0.366	-1.37E-01
QM15	6.87E-10	1.39E-11	3.45E+02	2.42E+02	2.42E+02	2.62E-01	0.564	2.14E+00
QM14	5.75E-09	1.44E-10	4.12E+01	2.33E+01	2.33E+01	2.53E-02	-1.664	-7.02E-02
QM13	8.44E-09	1.25E-10	2.81E+01	2.69E+01	2.69E+01	2.91E-02	0.52	2.58E-01
QM12	1.03E-08	2.33E-09	2.30E+01	1.44E+00	1.44E+00	1.56E-03	0.882	8.17E-03
QM11	2.40E-09	1.01E-08	9.89E+01	3.31E-01	3.31E-01	3.59E-04	-0.002	-8.29E-01
QD10	6.09E-08	1.19E-07	3.89E+00	2.83E-02	2.83E-02	3.07E-05	-0.314	-4.51E-04
QD10A	1.60E-07	1.79E-07	1.48E+00	1.88E-02	1.88E-02	2.04E-05	-0.314	-2.99E-04
QF9	2.39E-06	1.10E-07	9.91E-02	3.05E-02	3.05E-02	3.30E-05	0.374	4.08E-04
QF9A	2.19E-06	5.35E-08	1.08E-01	6.28E-02	6.28E-02	6.80E-05	0.374	8.39E-04
QD8	8.66E-08	1.40E-08	2.74E+00	2.40E-01	2.40E-01	2.60E-04	-0.56	-2.14E-03
QF7	5.41E-09	9.79E-11	4.38E+01	3.43E+01	3.43E+01	3.72E-02	0.6	2.86E-01
QD6	9.21E-08	1.35E-08	2.57E+00	2.50E-01	2.50E-01	2.71E-04	-0.56	-2.23E-03
QF5	2.59E-06	5.37E-08	9.16E-02	6.26E-02	6.26E-02	6.78E-05	0.374	8.37E-04
QF5A	2.26E-06	1.10E-07	1.05E-01	3.06E-02	3.06E-02	3.31E-05	0.374	4.08E-04
QD4	1.91E-07	1.77E-07	1.24E+00	1.90E-02	1.90E-02	2.05E-05	-0.314	-3.02E-04
QD4A	5.70E-08	1.14E-07	4.16E+00	2.96E-02	2.96E-02	3.20E-05	-0.314	-4.71E-04
QD2B	3.83E-08	3.93E-09	6.19E+00	8.56E-01	8.56E-01	9.27E-04	0.588	7.28E-03
QF3	6.08E-08	1.30E-09	3.90E+00	2.59E+00	2.59E+00	2.80E-03	-0.25	-5.17E-02
QD2A	1.34E-07	2.14E-09	1.77E+00	1.57E+00	1.57E+00	1.70E-03	-0.274	-2.87E-02
QF1	1.51E-05	3.18E-07	1.57E-02	1.06E-02	1.06E-02	5.72E-06	0.914	5.78E-05
QD0	4.43E-07	3.57E-07	5.36E-01	9.42E-03	9.42E-03	4.08E-06	-1.494	-3.15E-05

SX component might be corrected by SEXT magnets.

The above estimation does not include the correction.

Estimation of 12-pole component limit in Q

Calculate $\Delta\sigma$, until $\Delta\sigma > 0.5 \sigma_0$ increasing K5 by factor 10 for each Q.

Then $d\sigma/dK5 = \Delta\sigma / 10^n$

beam size

sigx[m] 2.40E-06

sigy[m] 3.46E-08

K5 for 10% beam size increase

Qname	dsigx/dK5	dsigy/dK5	x	y	minK2	B5@r=10mm	K1	B5/B1@r=10mm
QM16	5.63E-23	8.38E-25	4.26E+15	4.13E+15	4.13E+15	7.82E+05	-0.366	-6.16E+06
QM15	6.64E-21	3.38E-21	3.61E+13	1.02E+12	1.02E+12	1.94E+02	0.564	9.90E+02
QM14	1.64E-23	3.05E-24	1.46E+16	1.13E+15	1.13E+15	2.15E+05	-1.664	-3.72E+05
QM13	5.52E-20	4.22E-22	4.35E+12	8.20E+12	4.35E+12	8.23E+02	0.52	4.57E+03
QM12	1.36E-20	6.28E-21	1.77E+13	5.51E+11	5.51E+11	1.04E+02	0.882	3.41E+02
QM11	3.79E-21	3.46E-20	6.33E+13	9.99E+10	9.99E+10	1.89E+01	-0.002	-2.73E+04
QD10	4.89E-19	1.34E-18	4.90E+11	2.58E+09	2.58E+09	4.88E-01	-0.314	-4.48E+00
QD10A	1.01E-17	9.05E-18	2.38E+10	3.82E+08	3.82E+08	7.24E-02	-0.314	-6.65E-01
QF9	1.37E-15	4.68E-17	1.76E+08	7.39E+07	7.39E+07	1.40E-02	0.374	1.08E-01
QF9A	1.05E-15	2.96E-17	2.28E+08	1.17E+08	1.17E+08	2.21E-02	0.374	1.70E-01
QD8	2.92E-18	3.13E-19	8.22E+10	1.11E+10	1.11E+10	2.09E+00	-0.56	-1.08E+01
QF7	5.45E-20	2.72E-22	4.40E+12	1.27E+13	4.40E+12	8.33E+02	0.6	4.01E+03
QD6	3.32E-18	4.32E-19	7.24E+10	8.01E+09	8.01E+09	1.52E+00	-0.56	-7.81E+00
QF5	2.32E-15	5.03E-17	1.03E+08	6.88E+07	6.88E+07	1.30E-02	0.374	1.00E-01
QF5A	8.60E-16	5.32E-17	2.79E+08	6.50E+07	6.50E+07	1.23E-02	0.374	9.49E-02
QD4	1.81E-17	9.62E-18	1.33E+10	3.60E+08	3.60E+08	6.81E-02	-0.314	-6.25E-01
QD4A	1.80E-18	1.58E-18	1.34E+11	2.19E+09	2.19E+09	4.15E-01	-0.314	-3.82E+00
QD2B	2.03E-18	1.26E-19	1.18E+11	2.76E+10	2.76E+10	5.22E+00	0.588	2.56E+01
QF3	9.54E-19	4.35E-21	2.52E+11	7.95E+11	2.52E+11	4.76E+01	-0.25	-5.50E+02
QD2A	2.48E-17	9.02E-19	9.67E+09	3.83E+09	3.83E+09	7.26E-01	-0.274	-7.64E+00
QF1	4.03E-14	1.03E-15	5.95E+06	3.35E+06	3.35E+06	3.17E-04	0.914	2.00E-03
QD0	5.47E-17	3.52E-17	4.39E+09	9.84E+07	9.84E+07	7.45E-03	-1.494	-3.60E-02

Estimation of 20-pole component limit in Q

Calculate $\Delta\sigma$, until $\Delta\sigma > 0.5 \sigma_0$ increasing K9 by factor 10 for each Q.

Then $d\sigma/dK9 = \Delta\sigma / 10^n$

beam size

sigx[m] 2.38E-06

sigy[m] 3.55E-08

K9 for 10% beam size increase

Qname	dsigx/dK9	dsigy/dK9	x	y	minK2	B9@r=10mm	K1	B9/B1@r=10mm
QM16	5.81E-41	2.00E-41	4.10E+33	1.78E+32	1.78E+32	7.30E+11	-0.366	-5.75E+12
QM15	1.30E-40	2.66E-42	1.83E+33	1.33E+33	1.33E+33	5.48E+12	0.564	2.80E+13
QM14	1.31E-42	1.48E-42	1.82E+35	2.40E+33	2.40E+33	9.86E+12	-1.664	-1.71E+13
QM13	1.33E-36	4.43E-38	1.78E+29	8.02E+28	8.02E+28	3.29E+08	0.52	1.82E+09
QM12	2.77E-37	1.46E-37	8.59E+29	2.43E+28	2.43E+28	9.99E+07	0.882	3.27E+08
QM11	1.77E-35	3.05E-36	1.34E+28	1.16E+27	1.16E+27	4.77E+06	-0.002	-6.88E+09
QD10	1.85E-34	6.19E-34	1.29E+27	5.73E+24	5.73E+24	2.35E+04	-0.314	-2.16E+05
QD10A	4.32E-32	1.26E-31	5.51E+24	2.82E+22	2.82E+22	1.16E+02	-0.314	-1.06E+03
QF9	5.13E-29	6.42E-30	4.64E+21	5.53E+20	5.53E+20	2.27E+00	0.374	1.75E+01
QF9A	2.15E-29	1.57E-30	1.11E+22	2.26E+21	2.26E+21	9.27E+00	0.374	7.15E+01
QD8	3.67E-33	3.53E-34	6.48E+25	1.00E+25	1.00E+25	4.12E+04	-0.56	-2.12E+05
QF7	3.60E-37	5.26E-39	6.60E+29	6.75E+29	6.60E+29	2.71E+09	0.6	1.30E+10
QD6	6.33E-33	5.71E-34	3.76E+25	6.22E+24	6.22E+24	2.55E+04	-0.56	-1.31E+05
QF5	8.53E-28	4.62E-30	2.79E+20	7.69E+20	2.79E+20	1.14E+00	0.374	8.83E+00
QF5A	1.28E-28	6.66E-30	1.86E+21	5.33E+20	5.33E+20	2.19E+00	0.374	1.69E+01
QD4	4.71E-32	6.51E-32	5.05E+24	5.45E+22	5.45E+22	2.24E+02	-0.314	-2.06E+03
QD4A	1.25E-33	1.49E-33	1.90E+26	2.38E+24	2.38E+24	9.75E+03	-0.314	-8.96E+04
QD2B	2.71E-33	5.54E-34	8.77E+25	6.41E+24	6.41E+24	2.63E+04	0.588	1.29E+05
QF3	1.81E-33	2.03E-36	1.32E+26	1.75E+27	1.32E+26	5.40E+05	-0.25	-6.23E+06
QD2A	1.62E-31	5.86E-33	1.47E+24	6.06E+23	6.06E+23	2.48E+03	-0.274	-2.62E+04
QF1	7.86E-26	1.20E-27	3.03E+18	2.95E+18	2.95E+18	6.05E-03	0.914	3.82E-02
QD0	4.18E-31	7.51E-31	5.70E+23	4.73E+21	4.73E+21	7.76E+00	-1.494	-3.75E+01

Stability of Q

Calculate $\Delta\sigma$, until $\Delta\sigma > 0.5 \sigma_0$ increasing dK1 by factor 2 for each Q.

Calculate $\Delta\sigma$, until $\Delta\sigma > 0.5 \sigma_0$ decreasing dK1 by factor 2 for each Q

Then $d\sigma/dK1 = \text{Max}(\Delta\sigma / dK1)$

dK1/K1 for 10% beam size increase

Qname	dsigx/(dK1/K	dsigy/(dK1/K x	y	minK2	sigx	sigy	
QM16	1.47E-06	1.01E-07	1.61E-01	3.33E-02	3.33E-02	2.36E-06	3.36E-08
QM15	4.71E-06	1.30E-07	5.01E-02	2.59E-02	2.59E-02	2.36E-06	3.36E-08
QM14	6.53E-06	1.27E-06	3.62E-02	2.65E-03	2.65E-03	2.36E-06	3.36E-08
QM13	3.20E-05	3.03E-07	7.38E-03	1.11E-02	7.38E-03	2.36E-06	3.36E-08
QM12	3.73E-05	1.02E-05	6.33E-03	3.29E-04	3.29E-04	2.36E-06	3.36E-08
QM11	1.62E-08	2.31E-07	1.46E+01	1.46E-02	1.46E-02	2.36E-06	3.36E-08
QD10	4.61E-05	1.02E-04	5.12E-03	3.29E-05	3.29E-05	2.36E-06	3.36E-08
QD10A	1.54E-04	9.10E-05	1.53E-03	3.69E-05	3.69E-05	2.36E-06	3.36E-08
QF9	8.02E-04	2.59E-05	2.94E-04	1.30E-04	1.30E-04	2.36E-06	3.36E-08
QF9A	8.25E-04	1.09E-05	2.86E-04	3.08E-04	2.86E-04	2.36E-06	3.36E-08
QD8	9.89E-05	2.05E-05	2.39E-03	1.64E-04	1.64E-04	2.36E-06	3.36E-08
QF7	2.27E-05	1.68E-07	1.04E-02	2.00E-02	1.04E-02	2.36E-06	3.36E-08
QD6	1.18E-04	2.01E-05	1.99E-03	1.67E-04	1.67E-04	2.36E-06	3.36E-08
QF5	7.71E-04	1.17E-05	3.06E-04	2.88E-04	2.88E-04	2.36E-06	3.36E-08
QF5A	7.69E-04	2.66E-05	3.07E-04	1.27E-04	1.27E-04	2.36E-06	3.36E-08
QD4	1.61E-04	8.78E-05	1.47E-03	3.83E-05	3.83E-05	2.36E-06	3.36E-08
QD4A	4.63E-05	9.96E-05	5.10E-03	3.37E-05	3.37E-05	2.36E-06	3.36E-08
QD2B	7.50E-05	1.38E-05	3.15E-03	2.44E-04	2.44E-04	2.36E-06	3.36E-08
QF3	3.96E-05	8.01E-07	5.96E-03	4.20E-03	4.20E-03	2.36E-06	3.36E-08
QD2A	1.56E-04	9.52E-07	1.51E-03	3.53E-03	1.51E-03	2.36E-06	3.36E-08
QF1	0.0071257	9.60E-05	3.31E-05	3.50E-05	3.31E-05	2.36E-06	3.36E-08
QD0	0.0011439	6.31E-04	2.06E-04	5.32E-06	5.32E-06	2.36E-06	3.36E-08