PIP-II parameters required to support design work on civil construction

TRS for MEBT quads and dipoles: Project X Document 1159 **http://projectx-docdb.fnal.gov/**
Results of measurements are presented in Project X Document 1323
TRS for SC linac quads and dipoles: **http://pxie.fnal.gov/PIPIImeetings/Design_of_warm_magnets_for_PIP-II.pdf**

Parameters of quadrupoles

ii :=

	0
0	"Type"
1	"Number of quads"
2	"Current [A]"
3	"Number of turns per pole"
4	"Wire cross-section [mm^2]""
5	"Inscribed radius [mm]"
6	"length [m]"
7	0

M :=

	0	1	2	3	4
0	"MEBT L."	"MEBT S."	"Sc Linac"	"Beamline"	"Booster inj"
1	11	14	40	35	6
2	10	10	12	150	12
3	143	143	260	12	260
4	6.4	6.4	8	100	8
5	17	17	24	24	24
6	0.1	0.05	0.2	0.2	0.2
7	0	0	0	0	0

$\rho_{Cu} := 1.47 \cdot 2 \cdot 10^{-6}$ Ω cm

$i := 0 .. 4$ $N_{Q_i} := M_{1,i}$ $I_{Q_i} := M_{2,i}$ $N_{tQ_i} := M_{3,i}$ $s_{wQ_i} := 10^{-2} \cdot M_{4,i}$ $a_{Q_i} := 0.1 \cdot M_{5,i}$ $L_{Q_i} := 100 \cdot M_{6,i}$

$B_{Qpole_i} := \frac{0.8 \cdot \pi \cdot I_{Q_i} \cdot N_{tQ_i}}{a_{Q_i}}$ $G_{Q_i} := \frac{B_{Qpole_i}}{a_{Q_i}}$ $GdL_i := G_{Q_i} \cdot \left(L_{Q_i} + a_{Q_i}\right)$ $R_{Q_i} := \rho_{Cu} \cdot \frac{2 \cdot L_{Q_i} + 3 \cdot a_{Q_i}}{s_{wQ_i}} \cdot 4 \cdot N_{tQ_i}$

$U_{Q_i} := I_{Q_i} \cdot R_{Q_i}$ $P_{Q_i} := I_{Q_i} \cdot U_{Q_i}$ $P_{Qtot_i} := N_{Q_i} \cdot P_{Q_i}$

$Mr := \text{augment}\left(N_Q, I_Q, U_Q, P_Q, \frac{G_Q}{1000}, \frac{B_{Qpole}}{1000}, \frac{GdL}{1000}, R_Q, \frac{P_{Qtot}}{1000}\right)^T$

AQ :=

	MEBT L	MEBT S	SC Linac	Beamline	Booster inj
Number of quads	11	14	40	35	6
Max. quad current [A]	10	10	12	150	12
Max. quad voltage [V]	6.59534	3.9677	21.6478	0.99913	21.647808
Power per quad [W]	65.9534	39.677	259.774	149.8694	259.773696
Gradient [kG/cm]	1.24359	1.2436	1.36136	0.785398	1.36135682
Tip B field [kG]	2.11411	2.1141	3.26726	1.884956	3.26725636
Field integral [kG]	14.55	8.3321	30.4944	17.59292	30.4943927
Resistence per quad [Ohm]	0.65953	0.3968	1.80398	0.006661	1.803984
Total power per quad type [kW]	0.72549	0.5555	10.3909	5.24543	1.55864218

Mr

Parameters of dipoles and dipole correctors

MEBT and SC linac correctors are two coordinates, other single coordinate

ii :=

	0
0	"Type"
1	"Number of dipoles"
2	"Current [A]"
3	"Number of turns per pole"
4	"Wire cross-section [mm^2]""
5	"Gap [mm]"
6	"length [m]"
7	"#N. of Correctors per core"

Md :=

	0	1	2	3
0	"MEBT"	"SC linac"	Beamline dip."	"Beamline cor"
1	9	20	32	39
2	4	10	150	15
3	610	380	60	130
4	2.545	8	400	10
5	150	150	48	48
6	0.03	0.15	2.45	0.15
7	2	2	1	...

$i := 0..3 \quad N_{D_i} := Md_{1,i} \quad I_{D_i} := Md_{2,i} \quad N_{tD_i} := Md_{3,i} \quad s_{wD_i} := 10^{-2} \cdot Md_{4,i} \quad h_{D_i} := 0.1 \cdot Md_{5,i} \quad L_{D_i} := 100 \cdot Md_{6,i}$

$$B_{pole_i} := \frac{0.4 \cdot \pi \cdot I_{D_i} \cdot N_{tD_i}}{h_{D_i}} \qquad BdL_i := B_{pole_i} \cdot \left(L_{D_i} + \frac{h_{D_i}}{1.72} \right) \qquad R_{D_i} := \rho_{Cu} \cdot \frac{\left[\left(2 \cdot L_{D_i} + 6 \cdot h_{D_i} \right) \cdot (i > 1) \right] + \left(2 \cdot L_{D_i} + 5.5 \right) \cdot (i \le 1)}{s_{wD_i}} \cdot 2 \cdot N_{tD}$$

$$U_{D_i} := I_{D_i} \cdot R_{D_i} \qquad P_{D_i} := I_{D_i} \cdot U_{D_i} \qquad P_{Dtot_i} := Md_{7,i} \cdot N_{D_i} \cdot P_{D_i} \qquad M_R := \mathrm{augment}\left(N_D, I_D, U_D, P_D, \frac{B_{pole}}{1000}, \frac{BdL}{1000}, R_D, \frac{P_{Dtot}}{1000} \right)^T$$

AD :=

	MEBT	SC Linac	Beamline dip	Beamline Cor.
Number of dipoles	9	20	32	39
Dipole current [A]	4	10	150	15
Dipole voltage [V]	6.483018	9.91515	6.863724	6.742008
Power per dipole [W]	25.93207	99.1515	1029.5586	101.13012
Field [kG]	0.204413	0.318348	2.35619449	0.510508806
Field integral [kG cm]	2.39591	7.551512	583.8430766	9.082307831
Resistence per dipole [Ohm]	1.620754	0.991515	0.04575816	0.4494672
Total power per dipole type [kW]	0.466777	3.96606	32.9458752	3.94407468

M_R

Conclusions for estimate of power released in dipole and quads

1. Total power from all quads installed in the SC linac tunnel is equal to: $10^{-3} \cdot \sum_{i=0}^{2} P_{Qtot_i} = 11.672$ kW

2. Maximum total power from all dipole corerctors installed in the SC linac tunnel is equal to: $10^{-3} \cdot \sum_{i=0}^{1} P_{Dtot_i} = 4.433$ k

W

3. Total power from all quads installed in the transfer line is equal to: $10^{-3} \cdot \sum_{i=3}^{4} P_{Qtot_i} = 6.804$ kW

4. Total power from all dipoles in the transfer line is equal to: $10^{-3} \cdot P_{Dtot_2} = 32.946$ kW

5. Total power from all dipole correctprs in the transfer line is equal to: $10^{-3} \cdot P_{Dtot_3} = 3.944$ kW

1. MEBT long (L=10 cm, G = 1.5 kG/cm) – 11
2. MEBT short (L=5 cm, G = 1.5 kG/cm) – 14
3. MEBT dipole correctors (two coordinate) – 9
4. SC linac (L=20 cm, G = 1.5 kG/cm) – 40 (includes 5 doublets (10 quads) at the linac end after the last SC cryomodule)
5. SC linac dipole correctors (two coordinate) – 20
6. Transport arc quads (L=20 cm, G =0. 7 kG/cm) - 35 (all quads are connected serially)
7. End of the transport arc (L=20 cm, G = 1.5 kG/cm) - 6 (the same design as for SC linac quads, item # 4)
8. Transport arc dipole correctors (one coordinate) – 39