FERMILAB-LU-151

15 May 1989

Symbol	Device	Length [cm]
B	beam position monitor	3.00
C	current pickup	1.00
Q	standard quadrupole	8.00
Q′	DTL quadrupole	16.46
S	steering trim magnet	6.00
T	toroid current monitor	3.10
V	vacuum gate valve	4.90
W	wire scanner	5.0

Available for devices $3\beta\lambda/2 - 9.92$ cm.

Module /Sect.	Grad. [MV/m]	KE_{out} [MeV]	L_{rf} [m]	L_{sep} [m]	Devices (upstream)	D_Q [m]	P_{Cu} [MW]	P_{beam} [MW]	$\Delta\psi_{x,y}$ [deg]	$\Delta\psi_z$ [deg]
0										
1	4.95	116.5	0.4254	0.3927	Q′/2 B V	0.0000	0.28	0.00		
2	3.16	116.5	0.2552	0.9751	Q	0.2613	0.07	0.00		
			0.0000	1.5748	W Q B S T V B S Q/2	0.1900				
			0.6806	2.9426			0.35	0.00		
			3.6232				0.35			
1	8.04									
1		125.1	1.3814	0.1418	Q/2 W C	0.0000	1.72	0.43		
2		133.8	1.4215	0.2628	T Q W	0.1168	1.84	0.44	77	109
3		142.8	1.4606	0.2703	B Q S	0.1201	1.89	0.45		
4		152.1	1.4987	0.2775	B Q S	0.1234	1.88	0.46	78	106
			5.7621	0.9524			7.33	1.78		
			6.7145				9.11			
2	7.82									
1		161.2	1.5353	0.2846	V Q W C	0.1265	1.69	0.46		
2		170.6	1.5704	0.2912	T Q W	0.1295	1.81	0.47	80	103
3		180.2	1.6046	0.2977	B Q 7S/6	0.1323	1.85	0.48		
4		190.0	1.6380	0.3041	B Q 7S/6	0.1352	1.84	0.49	80	101
			6.3482	1.1776			7.19	1.90		
			7.5258				9.09			
3	7.63									
1		199.7	1.6700	0.3102	V Q W C	0.1379	1.67	0.48		
2		209.5	1.7008	0.3161	T Q W	0.1405	1.79	0.49	81	98
3		219.6	1.7308	0.3218	B Q 7S/6	0.1430	1.83	0.50		
4		229.8	1.7600	0.3273	B Q 7S/6	0.1455	1.82	0.51	81	96
			6.8616	1.2754			7.11	1.98		
			8.1370				9.09			
4	7.46									
1		239.9	1.7881	0.3327	V Q W C	0.1479	1.64	0.51		
2		250.1	1.8151	0.3379	T Q W	0.1502	1.77	0.51	81	94
3		260.5	1.8414	0.3428	B Q 4S/3	0.1524	1.81	0.52		
4		271.1	1.8670	0.3477	B Q 4S/3	0.1546	1.80	0.53	80	92
			7.3115	1.3611			7.02	2.07		
			8.6726				9.09			
5	7.32									
1		281.5	1.8917	0.3524	V Q W C	0.1567	1.64	0.52		
2		292.1	1.9155	0.3570	T Q W	0.1587	1.75	0.53	80	90
3		302.8	1.9386	0.3614	B Q 4S/3	0.1606	1.80	0.53		
4		313.6	1.9612	0.3657	B Q 4S/3	0.1625	1.77	0.54	79	89
			7.7069	1.4364			6.96	2.12		
			9.1434				9.08			
6	7.18									
1		324.4	1.9829	0.3698	V Q W C	0.1644	1.62	0.54		
2		335.2	2.0039	0.3738	T Q W	0.1662	1.74	0.54	79	87
3		346.1	2.0244	0.3777	B Q 3S/2	0.1679	1.77	0.55		
4		357.1	2.0443	0.3815	B Q 3S/2	0.1696	1.76	0.55	78	85
			8.0555	1.5028			6.89	2.18		
			9.5583				9.07			
7	7.07									
1		368.1	2.0635	0.3852	V Q W C	0.1712	1.61	0.55		
2		379.1	2.0821	0.3887	T Q W	0.1728	1.73	0.55	77	84
3		390.2	2.1002	0.3921	B Q 3S/2	0.1743	1.76	0.56		
4		401.5	2.1179	0.3955	B Q 3S/2	0.1758	1.75	0.56	76	82
			8.3636	1.5614			6.85	2.22		
			9.9251				9.07			
Grand			51.0901	12.2098			49.70	14.25		
Total			63.2998				63.95			

400 MeV Linac Upgrade - Principal Mechanical Dimensions

Module /Sect.	KE_{out} [MeV]	L_{rf} [m]	L_{sep} [m]	L_{cum} [m]	Devices (upstream)	D_Q [m]	L_{device} [m]	L_{cell} [m]	L_{gap} [m]
0									
1	116.5	0.42539	0.39270	0.81809	Q'/2 B V	0.00000	0.1613	0.08508	0.04211
2	116.5	0.25524	0.97510	2.04843	Q	0.26130	0.0800	0.08508	0.04211
		0.00000	1.57481	3.62324	W Q B S V T B S Q/2	0.19000	0.3700		
		0.68063	2.94261						
1									
1	125.1	1.38139	0.14179	5.14642	Q/2 W C	0.00000	0.1280	0.08637	0.04275
2	133.8	1.42148	0.26284	6.83074	T Q W	0.11683	0.1500	0.08884	0.04402
3	142.8	1.46057	0.27027	8.56158	B Q S	0.12013	0.1700	0.09129	0.04527
4	152.1	1.49868	0.27750	10.33776	B Q S	0.12335	0.1700	0.09367	0.04649
		5.76212	1.06585						
2									
1	161.2	1.53529	0.28455	12.15761	V Q W C	0.12648	0.1680	0.09596	0.04768
2	170.6	1.57042	0.29123	14.01926	T Q W	0.12945	0.1500	0.09815	0.04882
3	180.2	1.60465	0.29773	15.92152	B Q 7S/6	0.13234	0.1800	0.10028	0.04994
4	190.0	1.63798	0.30406	17.86356	B Q 7S/6	0.13516	0.1800	0.10237	0.05105
		6.34822	1.17758						
3									
1	199.7	1.67002	0.31023	19.84381	V Q W C	0.13790	0.1680	0.10438	0.05211
2	209.5	1.70082	0.31608	21.86070	T Q W	0.14050	0.1500	0.10630	0.05314
3	219.6	1.73079	0.32177	23.91327	B Q 7S/6	0.14303	0.1800	0.10817	0.05415
4	229.8	1.75997	0.32732	26.00056	B Q 7S/6	0.14549	0.1800	0.11000	0.05514
		6.86160	1.27539						
4									
1	239.9	1.78806	0.33271	28.12133	V Q W C	0.14789	0.1680	0.11175	0.05609
2	250.1	1.81507	0.33785	30.27424	T Q W	0.15017	0.1500	0.11344	0.05702
3	260.5	1.84137	0.34284	32.45846	B Q 4S/3	0.15239	0.1900	0.11509	0.05792
4	271.1	1.86698	0.34771	34.67315	B Q 4S/3	0.15456	0.1900	0.11669	0.05880
		7.31148	1.36112						
5									
1	281.5	1.89166	0.35244	36.91725	V Q W C	0.15666	0.1680	0.11823	0.05966
2	292.1	1.91546	0.35697	39.18968	T Q W	0.15867	0.1500	0.11972	0.06048
3	302.8	1.93863	0.36137	41.48968	B Q 4S/3	0.16063	0.1900	0.12116	0.06129
4	313.6	1.96119	0.36565	43.81652	B Q 4S/3	0.16253	0.1900	0.12257	0.06209
		7.70694	1.43643						
6									
1	324.4	1.98294	0.36983	46.16929	V Q W C	0.16439	0.1680	0.12393	0.06285
2	335.2	2.00392	0.37381	48.54702	T Q W	0.16616	0.1500	0.12524	0.06359
3	346.1	2.02435	0.37769	50.94906	B Q 3S/2	0.16788	0.2000	0.12652	0.06432
4	357.1	2.04425	0.38147	53.37478	B Q 3S/2	0.16956	0.2000	0.12777	0.06503
		8.05546	1.50280						
7									
1	368.1	2.06349	0.38515	55.82342	V Q W C	0.17120	0.1680	0.12897	0.06571
2	379.1	2.08208	0.38868	58.29419	T Q W	0.17277	0.1500	0.13013	0.06638
3	390.2	2.10020	0.39212	60.78651	B Q 3S/2	0.17430	0.2000	0.13126	0.06703
4	401.5	2.11786	0.39548	63.2998	B Q 3S/2	0.17579	0.2000	0.13237	0.06767
		8.36363	1.56144						

Devices Needed in Inter-tank Spaces

Symbol	Device	Length [cm]
B	beam position monitor	3.00
C	current pickup	1.00
Q	standard quadrupole	8.00
Q'	DTL quadrupole	16.46
S	steering trim magnet	6.00
T	toroid current monitor	3.10
V	vacuum gate valve	4.90
W	wire scanner	3.90

Note: Available for devices $3\beta\lambda/2 - 9.92$ cm.

400 MeV Linac Upgrade - Kinematic and Dynamic Quantities

Module /Sect.	KE_{out} [MeV]	L_{rf} [m]	γ	β	$\bar{\beta}$	$\beta\gamma$	$\Delta\psi_{x,y}$ [deg]	$\Delta\psi_z$ [deg]	$\hat{\beta}$ [m]	$\check{\beta}$ [m]	β_φ [deg/keV]
0											
1	116.54	0.4254	1.12421	0.456904	0.456904	0.513655			2.26	0.52	0.0501
2	116.54	0.2552	1.12421	0.456904	0.456904	0.513655					
1											
1	125.06	1.3814	1.13329	0.470524	0.463662	0.533241					
2	133.83	1.4215	1.14263	0.483812	0.477118	0.552819	77	109	8.11	0.98	0.0127
3	142.83	1.4606	1.15223	0.469767	0.490239	0.572389					
4	152.06	1.4987	1.16207	0.509390	0.503030	0.591946	78	106	8.33	1.03	0.0116
2											
1	161.24	1.5353	1.17185	0.521336	0.515318	0.610928					
2	170.62	1.5704	1.18185	0.532974	0.527110	0.629895	80	103	8.49	1.07	0.0109
3	180.20	1.6046	1.19206	0.544310	0.538560	0.648850					
4	189.97	1.6380	1.20247	0.555345	0.549786	0.667787	80	101	8.66	1.13	0.0101
3											
1	199.68	1.6700	1.21281	0.565817	0.560540	0.686230					
2	209.55	1.7008	1.22333	0.576014	0.570878	0.704656	81	98	8.78	1.18	0.0095
3	219.58	1.7308	1.23403	0.585940	0.580938	0.723066					
4	229.88	1.7600	1.24490	0.595602	0.590732	0.741462	81	96	8.92	1.24	0.0089
4											
1	239.89	1.7881	1.25567	0.604789	0.600160	0.759417					
2	250.15	1.8151	1.26660	0.613735	0.609226	0.777360	81	94	9.02	1.29	0.0085
3	260.55	1.8414	1.27769	0.622444	0.618054	0.795289					
4	271.08	1.8670	1.28891	0.630921	0.626650	0.813203	80	92	9.13	1.36	0.0080
5											
1	281.54	1.8917	1.30006	0.639014	0.634934	0.830758					
2	292.12	1.9155	1.31134	0.646894	0.642922	0.824297	80	90	9.22	1.42	0.0077
3	302.82	1.9386	1.32274	0.654566	0.650699	0.865823					
4	313.64	1.9612	1.33427	0.662036	0.658271	0.883337	79	89	9.31	1.49	0.0073
6											
1	324.35	1.9829	1.34569	0.669167	0.665572	0.900494					
2	335.18	2.0039	1.35723	0.676115	0.672613	0.917641	79	87	9.38	1.55	0.0071
3	346.10	2.0244	1.36887	0.682881	0.679471	0.934776					
4	357.13	2.0443	1.38062	0.689473	0.686150	0.951900	78	85	9.47	1.63	0.0068
7											
1	368.07	2.0635	1.39229	0.695794	0.692608	0.968746					
2	379.11	2.0821	1.40406	0.701954	0.698848	0.985582	77	84	9.53	1.69	0.0066
3	390.24	2.1002	1.41592	0.707957	0.704930	1.002410					
4	401.46	2.1179	1.42787	0.713808	0.710857	1.019227	76	82	9.62	1.79	0.0063

400 MeV Upgrade Linac - RF Power Budget

Module /Sect.	Grad. [MV/m]	KE_{out} [MeV]	L_{rf} [m]	P_{acc} [MW]	P_{bridge} [MW]	P_{beam} [MW]	P_{total} [MW]
0							
1	4.95	116.5	0.4254	0.28	0.00	0.00	0.28
2	3.16	116.5	0.2552	0.07	0.00	0.00	0.07
				0.35	0.00	0.00	0.35
1	8.04						
1		125.1	1.3814	1.72	0.00	0.43	2.15
2		133.8	1.4215	1.73	0.11	0.44	2.28
3		142.8	1.4606	1.75	0.14	0.45	2.34
4		152.1	1.4987	1.77	0.11	0.46	2.34
				6.97	0.36	1.78	9.11
2	7.82						
1		161.2	1.5353	1.69	0.00	0.46	2.15
2		170.6	1.5704	1.70	0.11	0.47	2.28
3		180.2	1.6046	1.72	0.13	0.48	2.33
4		190.0	1.6380	1.73	0.11	0.49	2.33
				7.19	0.35	1.90	9.09
3	7.63						
1		199.7	1.6700	1.67	0.00	0.48	2.15
2		209.5	1.7008	1.68	0.11	0.49	2.28
3		219.6	1.7308	1.70	0.13	0.50	2.33
4		229.8	1.7600	1.71	0.11	0.51	2.33
				6.76	0.35	1.98	9.09
4	7.46						
1		239.9	1.7881	1.64	0.00	0.51	2.15
2		250.1	1.8151	1.67	0.10	0.51	2.28
3		260.5	1.8414	1.68	0.13	0.52	2.33
4		271.1	1.8670	1.69	0.11	0.53	2.33
				6.68	0.34	2.07	9.09
5	7.32						
1		281.5	1.8917	1.64	0.00	0.52	2.16
2		292.1	1.9155	1.65	0.10	0.53	2.28
3		302.8	1.9386	1.67	0.13	0.53	2.33
4		313.6	1.9612	1.67	0.10	0.54	2.31
				6.63	0.33	2.12	9.08
6	7.18						
1		324.4	1.9829	1.62	0.00	0.54	2.16
2		335.2	2.0039	1.64	0.10	0.54	2.28
3		346.1	2.0244	1.64	0.13	0.55	2.32
4		357.1	2.0442	1.66	0.10	0.55	2.31
				6.56	0.33	2.18	9.07
7	7.07						
1		368.1	2.0635	1.61	0.00	0.55	2.16
2		379.1	2.0821	1.63	0.10	0.55	2.28
3		390.2	2.1002	1.63	0.13	0.56	2.32
4		401.5	2.1179	1.65	0.10	0.56	2.31
				6.52	0.33	2.22	9.07
Grand Total				49.70	2.39	14.25	63.95