

## **Chapter I. Constraints, design and needs of the new T10 line.**

### **Section 1: General and vicinity constraints.**

The new T10 shall fit the geometry as defined in EHNL5 document (ref. 1.), with adequate optical characteristics and no incidence on T11 which we will keep untouched. The consequences on T9 should be minimal and compatible with its own requirements and solutions. It is desirable to reuse the presently available magnets and power supplies as far as practical.

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<b>Total</b>			<b>640</b>	<b>460</b>

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 Bend coord. given at Xing point of straight lines  
 Angle to the left or to the up side is >0  
 Z axis stands as the altitude  
 Program version 1.1 - any complain to JYH (CERN)

Run at 17.07.34 11/11/96

Name	ds1	S.lgth	S.x	S.y	S.z	B.pos	Length	Field	deg	rad
Start Ax,Ay,Az (radians)=			1.7370	-.1662	-1.5326					
---TV7	.000	.000	2076.407	2182.183	1.326	.000				
*QDE1	7.700	7.700	2083.995	2180.910	1.620	7.700	.900	-8.9518		
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*QDE5	.980	29.042	2105.152	2181.083	2.436	29.035	1.160	-9.1652		
>BVT2	1.795	30.837	2106.921	2181.381	2.505	30.830	1.180	7.5664	-2.1909	-.0382
__Foc	3.470	34.308	2110.343	2181.957	2.505	34.300				
__ENDP	5.000	39.308	2115.274	2182.787	2.505	39.300				
Final Ax,Ay,Az (radians)=			1.4041	.1667	-1.5708					
BHZ1	H	140								
BHZ2	H	140								
BHZ3	H	52.931								
BVT2	V	38.238								

EHNLS D T10new v5.1 7.0 GeV/c 4/11/96 "

Table 2. Geometry of the new T10 line, version 5.1

Required power, kW		ZT10.QDE01	ZT10.QFO02	ZT10.BHZ01	ZT10.QFO03	ZT10.BHZ02	ZT10.BHZ03	ZT10.QFO04	ZT10.QDE05	ZT10.BVT02	Line total
Momentum		ZT10.QFO01	ZT10.QFO02	ZT10.BHZ01	ZT10.QFO03	ZT10.BHZ02	ZT10.BHZ03	ZT10.QFO04	ZT10.QDE05	ZT10.BVT02	
1.00	1.57	1.94	4.39	4.39	0.21	4.39	0.48	0.61	0.91	0.25	14.74
1.50	3.56	4.41	9.86	9.86	0.46	9.86	1.07	1.37	2.04	0.56	33.20
2.00	6.39	7.94	17.49	17.49	0.82	17.49	1.89	2.44	3.64	0.99	59.09
2.50	10.11	12.61	27.26	27.26	1.27	27.26	2.93	3.81	5.70	1.55	92.50
3.00	14.78	18.50	39.16	39.16	1.83	39.16	4.19	5.50	8.23	2.21	133.58
3.50	20.48	25.74	53.21	53.21	2.49	53.21	5.66	7.51	11.27	3.00	182.56
4.00	27.29	34.44	69.44	69.44	3.25	69.44	7.34	9.84	14.84	3.89	239.79
4.50	35.31	44.74	87.96	87.96	4.12	87.96	9.25	12.53	19.01	4.90	305.77
5.00	44.63	56.82	108.93	108.93	5.10	108.93	11.39	15.59	23.87	6.01	381.27
5.50	55.39	70.97	132.63	132.63	6.21	132.63	13.80	19.05	29.55	7.24	467.48
6.00	67.79	87.77	159.54	159.54	7.46	159.54	16.52	22.97	36.31	8.59	566.49
6.50	82.18	108.77	190.49	190.49	8.89	190.49	19.60	27.43	44.58	10.06	682.49
7.00	99.38	142.82	227.01	227.01	10.53	227.01	23.12	32.54	55.30	11.65	829.36

**Table 3. Computed power in magnets function of momentum for the nominal focus.**

## Chapter II : precomputed behaviour of the T10 line.

This chapter presents what is to be expected from the modified T10 line. Some of the values may change slightly during implementation and will have to be confirmed at commissioning time.

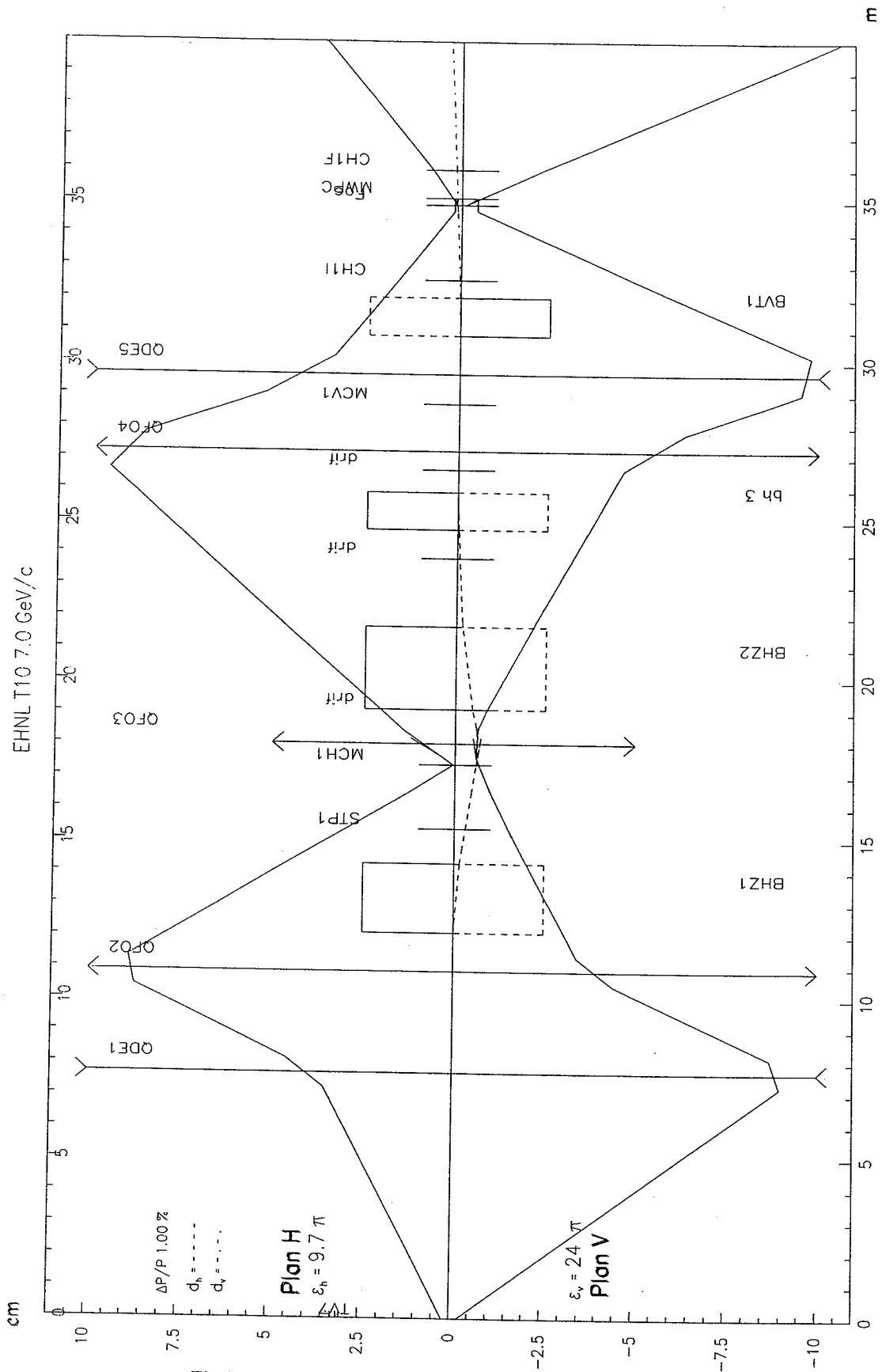
### Characteristics of the beam T10.

Maximum design momentum		7.0 GeV/c
Length at reference focus <sup>1</sup>		34.3 m
Beam height		2.505 m
Production angle from target	H	61.06 mrad
	V	8.24 mrad
	total	61.6 mrad
Horizontal angular acceptance <sup>2</sup> (in QFO02)		4.85 mrad
Vertical angular acceptance <sup>2</sup> (in QDE01)		12.4 mrad
solid angle acceptance <sup>3</sup>		189 $\mu$ sr
Horizontal magnification at momentum slit		0.3
Momentum slit displacement		5.0 mm for 1% $\Delta p/p$
Theoretical momentum resolution <sup>4</sup>		0.24%

Optical characteristics at reference focus (minimum  $\Delta p/p$ , multiple scattering not included).

dispersion ( /% $\Delta p/p$ )	H	0 mm/ 0 mrad (first order full correction)
	V	1.33 mm/ 0.38 mrad
magnification from target	H	0.84
	V	0.62

- 
- 1 Reference focus is located 3.47 m downstream of the last magnet centre (vertical dipole)
  - 2 The physical aperture limit is inside the first two quadrupoles, inner radius of 92 mm.
  - 3 The aperture limit is an ellipse with semi-axis 35.2\*89.8 (mm, H\*V) at the entrance face of the first quadrupole, located 7.25m from the target plane.
  - 4 For an effective production target of 4\*4 mm<sup>2</sup>.



**Fig 1. First order optics for the T10 line (nominal focus).**

Momentum	ZT10.QDE01	ZT10.QFO02	ZT10.BHZ01	ZT10.QFO03	ZT10.BHZ02	ZT10.BHZ03	ZT10.QFO04	ZT10.QDE05	ZT10.BVT02
1.0	84.4	94.0	108.9	52.7	56.8	47.7	53.8	65.7	34.5
1.5	127.1	141.6	163.3	78.9	85.1	71.4	80.8	98.6	51.7
2.0	170.4	190.0	217.4	105.1	113.3	94.9	107.7	131.6	68.8
2.5	214.3	239.4	271.4	131.2	141.4	118.1	134.7	164.7	85.8
3.0	259.2	290.0	325.3	157.3	169.4	141.2	161.8	198.0	102.7
3.5	305.1	342.0	379.2	183.4	197.4	164.1	189.1	231.7	119.5
4.0	352.2	395.6	433.2	209.6	225.6	187.0	216.5	265.9	136.1
4.5	400.6	450.9	487.6	235.9	254.0	209.8	244.3	300.9	152.7
5.0	450.4	508.2	542.6	262.6	283.0	232.9	272.4	337.1	169.2
5.5	501.8	568.0	598.7	289.7	313.0	256.4	301.2	375.1	185.7
6.0	555.1	631.6	656.7	317.6	344.6	280.5	330.7	415.8	202.3
6.5	611.2	703.2	717.5	346.6	379.2	305.5	361.4	460.8	218.8
7.0	672.1	805.7	783.3	377.3	419.7	331.8	393.6	513.2	235.6

Table 4. Computed currents for the nominal focus (A), function of momentum.

Momentum	ZT10.QFO04 nominal focus	ZT10.QDE05	ZT10.QFO04 +2.5 m	ZT10.QDE05	ZT10.QFO04 +5.0 m	ZT10.QDE05	ZT10.QFO04 +7.5m	ZT10.QDE05	ZT10.QFO04 +10 m	ZT10.QDE05
1.0	53.8	65.7	49.6	54.2	46.8	48.2	44.9	44.6	43.5	42.0
1.5	80.8	98.6	74.4	81.3	70.3	72.4	67.4	66.8	65.3	63.1
2.0	107.7	131.6	99.2	108.5	93.7	96.5	89.9	89.1	87.1	84.1
2.5	134.7	164.7	124.0	135.7	117.2	120.7	112.4	111.5	108.9	105.2
3.0	161.8	198.0	148.9	163.0	140.7	144.9	135.0	133.8	130.7	126.3
3.5	189.1	231.7	173.9	190.4	164.3	169.2	157.6	156.2	152.6	147.4
4.0	216.5	265.9	199.1	218.1	188.0	193.7	180.3	178.7	174.6	168.6
4.5	244.3	300.9	224.4	246.0	211.9	218.3	203.1	201.4	196.7	189.9
5.0	272.4	337.1	250.1	274.4	235.9	243.2	226.1	224.1	218.9	211.3
5.5	301.2	375.1	276.1	303.4	260.3	268.3	249.4	247.2	241.4	232.9
6.0	330.7	415.8	302.6	333.3	285.0	294.0	272.9	270.5	264.1	254.7
6.5	361.4	460.8	329.8	364.3	310.3	320.2	296.9	294.2	287.1	276.8
7.0	393.6	513.2	358.0	396.9	336.2	347.3	321.4	318.4	310.6	299.3

Table 5. Computed currents in the last doublet (A), function of momentum and distance from the nominal focus.



**CURRENT VALUES FOR THE MAGNETIC ELEMENTS OF T10 LINE**

Momentum (GeV/c)	ZT10.QDE01	ZT10.QFO02	ZT10.BHZ01	ZT10.QFO03	ZT10.BHZ02	ZT10.BHZ03	ZT10.QFO04	ZT10.QDE05	ZT10.BVT01
1	98	94	108.93	42	57	55	56	65	44
2	180	187	217	99	113	109	109	131	86
3	275	290	325	148	169	164	164	198	125
4	360	381	433	197	226	219	216	272	170
5	458	500	542	247	283	270	269	342	220
6	564	616	656	298	344	326	329	419	270
7	679	779	783	356	420	390	391	519	295

Table 1. Computed currents (A) for the nominal focus, function of the momentum

Momentum (GeV/c)	ZT10.QFO04	ZT10.QDE05	ZT10.QFO04	ZT10.QDE05	ZT10.QFO04	ZT10.QDE05	ZT10.QFO04	ZT10.QDE05	ZT10.QFO04	ZT10.QDE05
Focus at	2m	2m	4m	4m	6m	6m	8m	8m	10m	10m
1	51.91	56.21	49.46	50.57	47.67	46.91	46.3	44.32	45.21	42.39
2	103.88	112.49	98.97	101.2	95.38	93.85	92.63	88.67	90.45	84.81
3	156.04	169.04	148.63	151.99	143.21	140.91	139.08	133.11	135.8	127.31
4	208.68	226.28	198.68	203.21	191.38	188.28	185.81	177.79	181.41	170
5	262.34	285.05	249.54	255.34	240.23	236.29	233.14	222.96	227.54	213.08
6	318	346.84	301.95	309.2	290.37	285.48	281.58	269.02	274.67	256.89
7	377.35	414.6	357.17	366.25	342.79	336.76	331.97	316.63	323.52	301.92

Table 2. Computed currents (A) in the last doublet, function of momentum and distance from the nominal focus

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CV46	1.210	27.832	2103.960	2180.882	2.390	27.825				
*QDE5	.980	29.042	2105.152	2181.083	2.436	29.035	1.160	-9.1652		
>BVT2	1.795	30.837	2106.921	2181.381	2.505	30.830	1.180	7.5664	-2.1909	-.0382
Foc	3.470	34.308	2110.343	2181.957	2.505	34.300				
ENDP	5.000	39.308	2115.274	2182.787	2.505	39.300				
Final Ax,Ay,Az (radians)=			1.4041	.1667	-1.5708					
BHZ1	H	140								
BHZ2	H	140								
BHZ3	H	52.931								
BVT2	V	38.238								

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Table 2. Geometry of the new T10 line, version 5.1

Required power, kW		ZT10.QDE01	ZT10.QFO02	ZT10.BHZ01	ZT10.QFO03	ZT10.BHZ02	ZT10.BHZ03	ZT10.QFO04	ZT10.QDE05	ZT10.BVT02	Line total
Momentum											
1.00	1.57	1.94	4.39	0.21	4.39	0.48	0.61	0.91	0.25	14.74	
1.50	3.56	4.41	9.86	0.46	9.86	1.07	1.37	2.04	0.56	33.20	
2.00	6.39	7.94	17.49	0.82	17.49	1.89	2.44	3.64	0.99	59.09	
2.50	10.11	12.61	27.26	1.27	27.26	2.93	3.81	5.70	1.55	92.50	
3.00	14.78	18.50	39.16	1.83	39.16	4.19	5.50	8.23	2.21	133.58	
3.50	20.48	25.74	53.21	2.49	53.21	5.66	7.51	11.27	3.00	182.56	
4.00	27.29	34.44	69.44	3.25	69.44	7.34	9.84	14.84	3.89	239.79	
4.50	35.31	44.74	87.96	4.12	87.96	9.25	12.53	19.01	4.90	305.77	
5.00	44.63	56.82	108.93	5.10	108.93	11.39	15.59	23.87	6.01	381.27	
5.50	55.39	70.97	132.63	6.21	132.63	13.80	19.05	29.55	7.24	467.48	
6.00	67.79	87.77	159.54	7.46	159.54	16.52	22.97	36.31	8.59	566.49	
6.50	82.18	108.77	190.49	8.89	190.49	19.60	27.43	44.58	10.06	682.49	
7.00	99.38	142.82	227.01	10.53	227.01	23.12	32.54	55.30	11.65	829.36	

**Table 3. Computed power in magnets function of momentum for the nominal focus.**

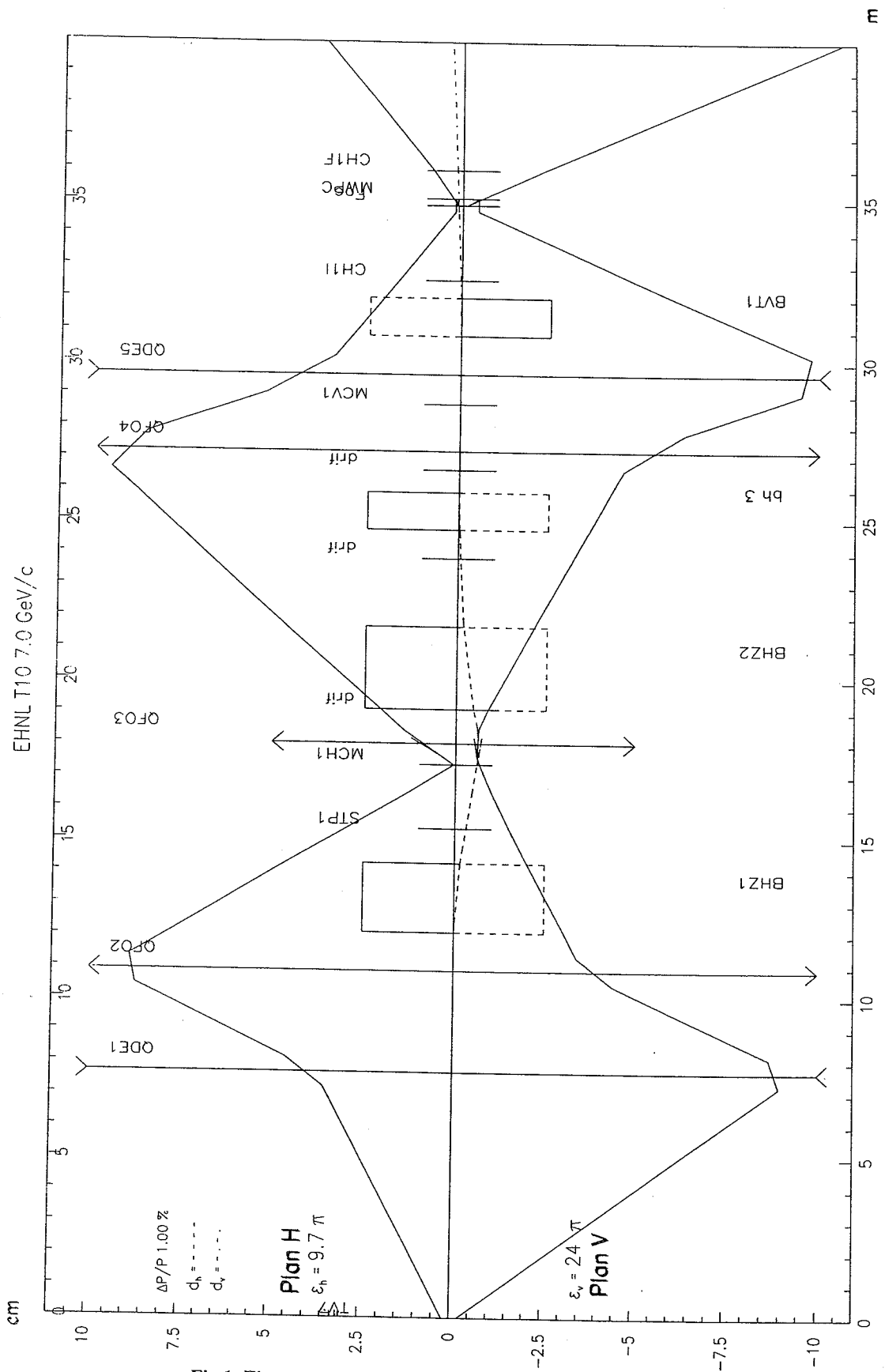
## Chapter II : precomputed behaviour of the T10 line.

This chapter presents what is to be expected from the modified T10 line. Some of the values may change slightly during implementation and will have to be confirmed at commissioning time.

### Characteristics of the beam T10.

Maximum design momentum		7.0 GeV/c
Length at reference focus <sup>1</sup>		34.3 m
Beam height		2.505 m
Production angle from target	H	61.06 mrad
	V	8.24 mrad
	total	61.6 mrad
Horizontal angular acceptance <sup>2</sup> (in QFO02)		4.85 mrad
Vertical angular acceptance <sup>2</sup> (in QDE01)		12.4 mrad
solid angle acceptance <sup>3</sup>		189 $\mu$ sr
Horizontal magnification at momentum slit		0.3
Momentum slit displacement		5.0 mm for 1% $\Delta p/p$
Theoretical momentum resolution <sup>4</sup>		0.24%
Optical characteristics at reference focus (minimum $\Delta p/p$ , multiple scattering not included).		
dispersion ( /% $\Delta p/p$ )	H	0 mm/ 0 mrad (first order full correction)
	V	1.33 mm/ 0.38 mrad
magnification from target	H	0.84
	V	0.62

- 
- 1 Reference focus is located 3.47 m downstream of the last magnet centre (vertical dipole)
  - 2 The physical aperture limit is inside the first two quadrupoles, inner radius of 92 mm.
  - 3 The aperture limit is an ellipse with semi-axis 35.2\*89.8 (mm, H\*V) at the entrance face of the first quadrupole, located 7.25m from the target plane.
  - 4 For an effective production target of 4\*4 mm<sup>2</sup>.



**Fig 1. First order optics for the T10 line (nominal focus).**



Momentum	ZT10.QDE01	ZT10.QFO02	ZT10.BHZ01	ZT10.QFO03	ZT10.BHZ02	ZT10.BHZ03	ZT10.QFO04	ZT10.QDE05	ZT10.BVT02
1.0	84.4	94.0	108.9	52.7	56.8	47.7	53.8	65.7	34.5
1.5	127.1	141.6	163.3	78.9	85.1	71.4	80.8	98.6	51.7
2.0	170.4	190.0	217.4	105.1	113.3	94.9	107.7	131.6	68.8
2.5	214.3	239.4	271.4	131.2	141.4	118.1	134.7	164.7	85.8
3.0	259.2	290.0	325.3	157.3	169.4	141.2	161.8	198.0	102.7
3.5	305.1	342.0	379.2	183.4	197.4	164.1	189.1	231.7	119.5
4.0	352.2	395.6	433.2	209.6	225.6	187.0	216.5	265.9	136.1
4.5	400.6	450.9	487.6	235.9	254.0	209.8	244.3	300.9	152.7
5.0	450.4	508.2	542.6	262.6	283.0	232.9	272.4	337.1	169.2
5.5	501.8	568.0	598.7	289.7	313.0	256.4	301.2	375.1	185.7
6.0	555.1	631.6	656.7	317.6	344.6	280.5	330.7	415.8	202.3
6.5	611.2	703.2	717.5	346.6	379.2	305.5	361.4	460.8	218.8
7.0	672.1	805.7	783.3	377.3	419.7	331.8	393.6	513.2	235.6

Table 4. Computed currents for the nominal focus (A), function of momentum.

Momentum	ZT10.QFO04 nominal focus	ZT10.QDE05	ZT10.QFO04 +2.5 m	ZT10.QDE05	ZT10.QFO04 +5.0 m	ZT10.QDE05	ZT10.QFO04 +7.5m	ZT10.QDE05	ZT10.QFO04 +10 m	ZT10.QDE05
1.0	53.8	65.7	49.6	54.2	46.8	48.2	44.9	44.6	43.5	42.0
1.5	80.8	98.6	74.4	81.3	70.3	72.4	67.4	66.8	65.3	63.1
2.0	107.7	131.6	99.2	108.5	93.7	96.5	89.9	89.1	87.1	84.1
2.5	134.7	164.7	124.0	135.7	117.2	120.7	112.4	111.5	108.9	105.2
3.0	161.8	198.0	148.9	163.0	140.7	144.9	135.0	133.8	130.7	126.3
3.5	189.1	231.7	173.9	190.4	164.3	169.2	157.6	156.2	152.6	147.4
4.0	216.5	265.9	199.1	218.1	188.0	193.7	180.3	178.7	174.6	168.6
4.5	244.3	300.9	224.4	246.0	211.9	218.3	203.1	201.4	196.7	189.9
5.0	272.4	337.1	250.1	274.4	235.9	243.2	226.1	224.1	218.9	211.3
5.5	301.2	375.1	276.1	303.4	260.3	268.3	249.4	247.2	241.4	232.9
6.0	330.7	415.8	302.6	333.3	285.0	294.0	272.9	270.5	264.1	254.7
6.5	361.4	460.8	329.8	364.3	310.3	320.2	296.9	294.2	287.1	276.8
7.0	393.6	513.2	358.0	396.9	336.2	347.3	321.4	318.4	310.6	299.3

Table 5. Computed currents in the last doublet (A), function of momentum and distance from the nominal focus.

**CURRENT VALUES FOR THE MAGNETIC ELEMENTS OF T10 LINE**

Momentum (GeV/c)	ZT10.QDE01	ZT10.QFO02	ZT10.BHZ01	ZT10.QFO03	ZT10.BHZ02	ZT10.BHZ03	ZT10.QFO04	ZT10.QDE05	ZT10.BVT01
1	98	94	108.93	42	57	55	56	65	44
2	180	187	217	99	113	109	109	131	86
3	275	290	325	148	169	164	164	198	125
4	360	381	433	197	226	219	216	272	170
5	458	500	542	247	283	270	269	342	220
6	564	616	656	298	344	326	329	419	270
7	679	779	783	356	420	390	391	519	295

Table 1. Computed currents (A) for the nominal focus, function of the momentum

Momentum (GeV/c)	ZT10.QFO04	ZT10.QDE05	ZT10.QFO04	ZT10.QDE05	ZT10.QFO04	ZT10.QDE05	ZT10.QFO04	ZT10.QDE05	ZT10.QFO04	ZT10.QDE05
Focus at	2m	2m	4m	4m	6m	6m	8m	8m	10m	10m
1	51.91	56.21	49.46	50.57	47.67	46.91	46.3	44.32	45.21	42.39
2	103.88	112.49	98.97	101.2	95.38	93.85	92.63	88.67	90.45	84.81
3	156.04	169.04	148.63	151.99	143.21	140.91	139.08	133.11	135.8	127.31
4	208.68	226.28	198.68	203.21	191.38	188.28	185.81	177.79	181.41	170
5	262.34	285.05	249.54	255.34	240.23	236.29	233.14	222.96	227.54	213.08
6	318	346.84	301.95	309.2	290.37	285.48	281.58	269.02	274.67	256.89
7	377.35	414.6	357.17	366.25	342.79	336.76	331.97	316.63	323.52	301.92

Table 2. Computed currents (A) in the last doublet, function of momentum and distance from the nominal focus