

ALIGNMENT OPERATIONS FOR THE DAΦNE UPGRADE

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Introduction

In 2007 the DAΦNE team has realized an upgrade of the collider based on the novel crabbed waist collision scheme [1]. The upgrade is aimed at pushing the luminosity towards $10^{33} \text{ cm}^{-2} \text{ s}^{-1}$. This has required a substantial aligning work in order to realize the new magnetic layout (Figure 1) of the machine.

First of all a complete redefinition of the network of reference nodes has been accomplished. Secondly the alignment of the accelerator components has been either done anew or simply checked and readjusted when necessary.

In this paper the procedure and the instruments used for the measurement and redefinition of the reference network are described. Results are shown and a comparison between new and old positions of the network nodes is discussed. At last the fiducialisation data necessary for the alignment of the magnetic components is listed.

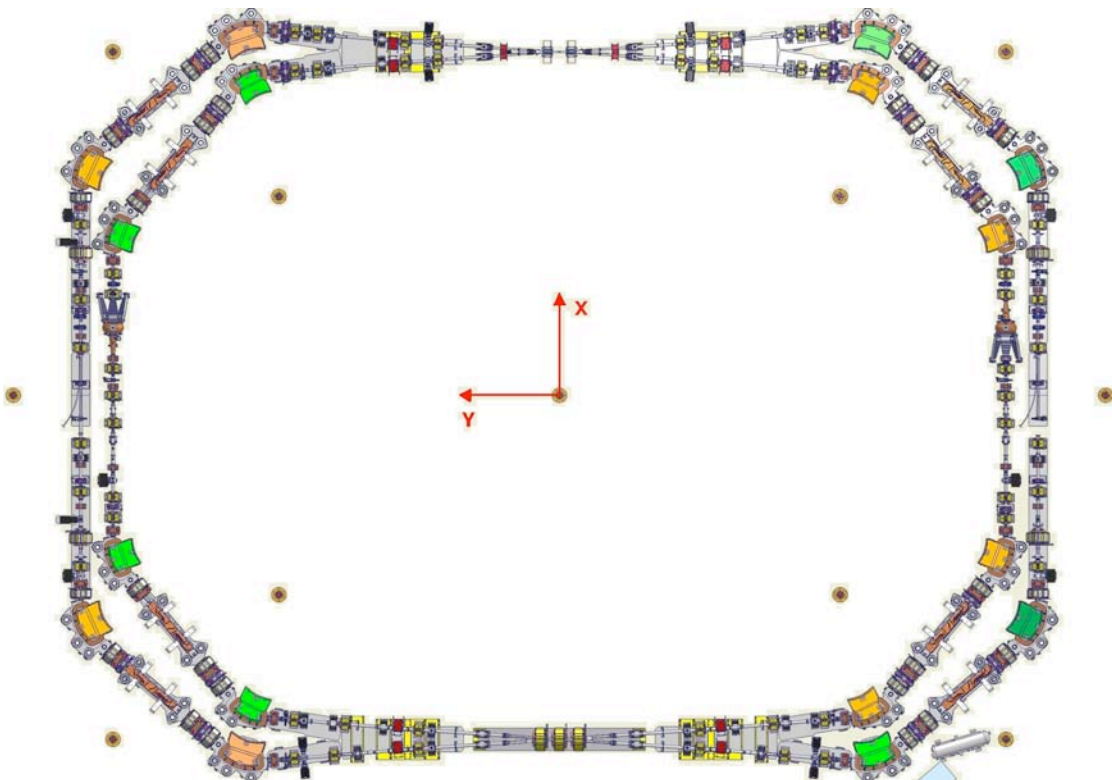


Figure 1: DAΦNE Accelerator.

1. Requalification of the Reference Network

A network of reference nodes had been realized in the DAΦNE Hall back in 1997. This Network [2] is composed of 15 principal nodes (Figure 2), each one consists of a permanent pillar equipped with a survey reference socket (Figure 3), and of 64 additional nodes (4 reference sockets fixed on top of each one of the 16 total dipoles).

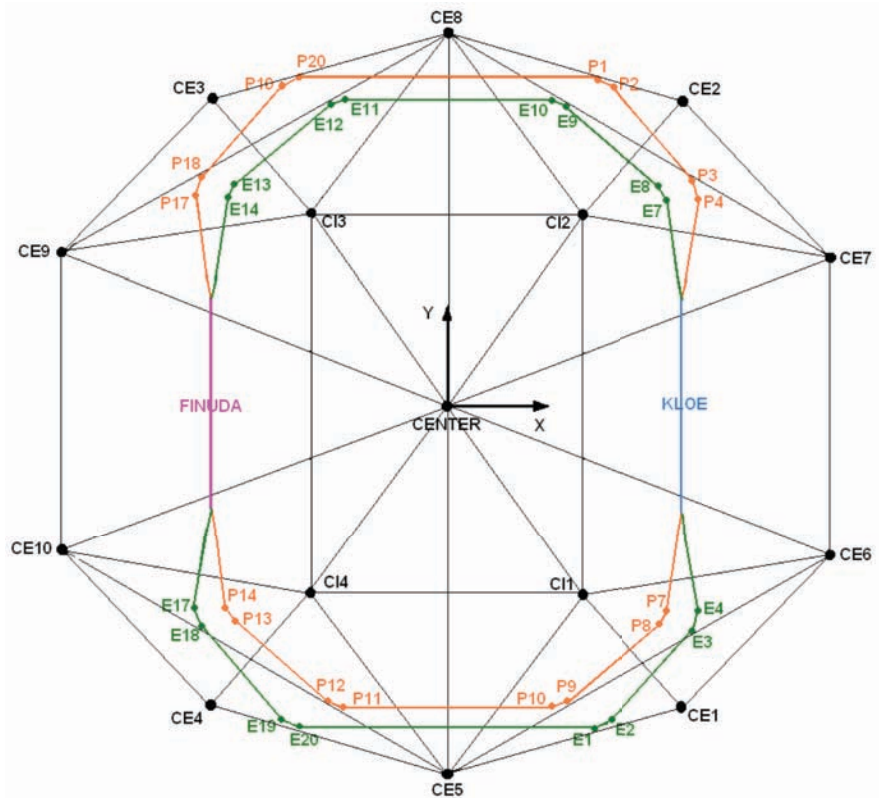


Figure 2: DAΦNE Reference Network and DAΦNE Coordinate System (DCS).

The availability of more advanced measuring instruments, along with the necessity of checking the building stability and precisely determining the position of some dipoles that have been moved, suggested the importance of a complete campaign of measurements aimed at verifying and, if necessary, updating the 3D coordinates of the reference nodes.

The measurements have been realized using a Leica Laser Tracker LTD 840 [3], the data collected have then been analysed and treated by means of Leica Axyz software. The entire campaign required 10 measuring stations strategically positioned inside the DAΦNE Hall. The choice of the optimal position for each station has been made with the purpose of maximizing the number of visible nodes within an acceptable measuring distance and assuring sufficient node measurement redundancy among the different stations. The latter is essential to orient the network, i.e. to link the stations together and visualize all the points in a unique base coordinate system. The environmental conditions (noise generated by cooling devices and by human activity, temperature instability, air conditioning) suggested to set a value of approximately 15m for the maximum acceptable measuring distance. The data value for each point comes from an average of 200 measurements every 0.02s. All the measurements with an RMS value of the residuals greater than 0.03 mm have been rejected. The elaboration of the collected data consists in the orientation of the network and the definition of the DAΦNE Coordinate System (DCS). It takes all the existing measurements, or a sub-set edited by the user, and builds, mathematically, a measurement

network. This operation is performed in two steps: an initial and approximate estimation of station parameters and a final and optimized estimation, known as bundle adjustment. The initial estimation of values makes use of a mathematical 3D transformation that takes into account only the bare minimum data required. The bundle adjustment is a least squares optimization. It takes the “bundles” of instrument pointings and makes successive adjustments to the network parameters until there is a best fit between the mathematical model of the network and the actual measurements. The output is then displayed along with some details such as the number of iterations, the pointing error for each point and the RMS value of the perpendicular and spatial offsets of the calculated point locations from the measured pointings. In our case the orientation of the network has been solved in 3 iterations with a maximum pointing error of 0.124 mm and an RMS value of 0.033 mm.

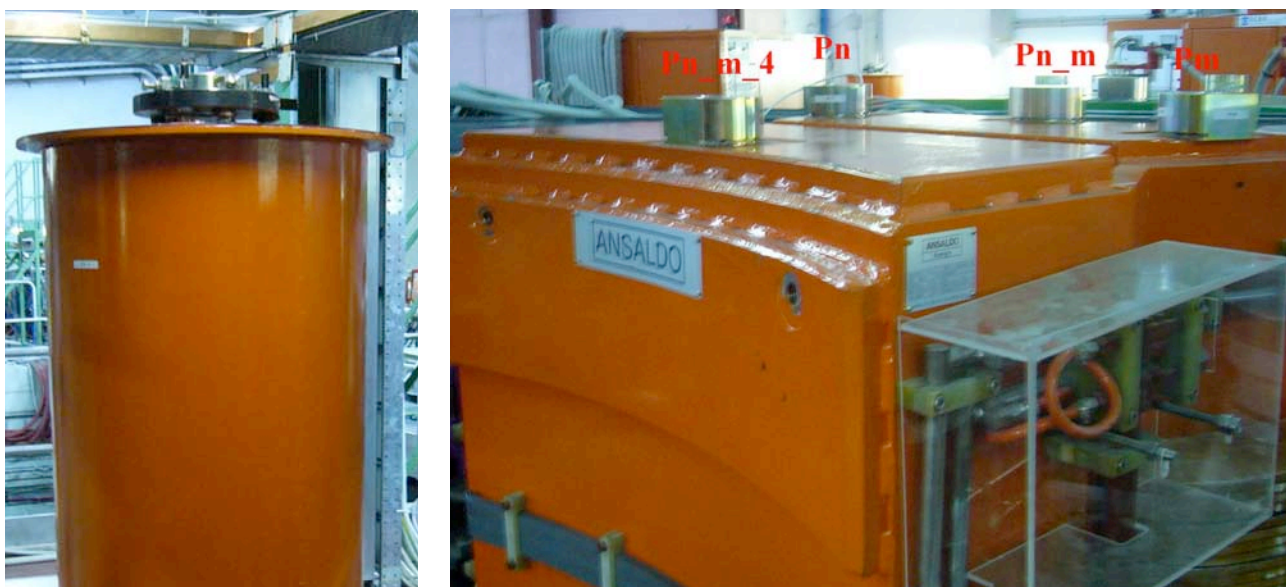


Figure 3: Pillar and Dipole Equipped with Reference Sockets.

The coordinates of the network nodes are shown in Table 1, Table 2 and Table 3. They are referred to the DAΦNE Coordinate System (DCS) that is the right handed Cartesian coordinate system shown in Figure 2.

The six parameters necessary to define the DCS in the Axyz program are the following coordinates:

	X	Y	Z
Center	0	0	717.47
CI2	6750.00	-	715.67
CI3	-	-	716.14

The height of the center pillar over the beam plane and the Δx of node CI2 have been taken from the 1997 DAΦNE Coordinate System. The vertical offsets of CI2 and CI3 with respect to the center node have been measured during this alignment campaign (leica level).

DAΦNE REFERENCE NETWORK

		X [mm]	Y [mm]	Z [mm]
PILLARS	CENTER	0.00	0.00	717.47
	CI1	6750.84	-9527.50	715.42
	CI2	6750.00	9527.96	715.67
	CI3	-6749.57	9526.65	716.14
	CI4	-6749.32	-9528.24	715.17
	CE1	11659.12	-15160.96	715.07
	CE2	11657.94	15161.29	715.69
	CE3	-11658.34	15159.40	716.53
	CE4	-11657.83	-15161.72	714.86
	CE5	1.27	-18550.42	714.75
	CE6	18949.75	-7435.87	715.33
	CE7	18949.07	7437.08	715.77
CE8	0.06	18548.78	715.98	
CE9	-18949.30	7436.52	715.65	
CE10	-18948.59	-7437.47	715.26	

Table 1: Coordinates of the DAΦNE Reference Network Nodes (Pillar Sockets)

Dipole		X [mm]	Y [mm]	Z [mm]
DHREL101	E1	7315.74	-16253.95	714.91
	E2	8187.55	-15851.85	714.87
	E1_2	7844.31	-16253.68	714.94
	E1_2_4	7536.15	-15585.74	714.95
DHSEL102	E3	12128.05	-11240.66	714.72
	E4	12420.96	-10326.38	714.96
	E3_4	12485.06	-10851.10	714.24
	E3_4_4	11784.49	-10626.35	716.30
DHSES101	E7	10911.67	10206.57	714.54
	E8	10565.62	10883.10	714.72
	E7_8	10863.58	10608.80	714.29
	E7_8_4	10251.87	10295.85	716.36
DHRES102	E9	5858.55	14898.55	715.38
	E10	5145.49	15161.57	715.30
	E9_10	5550.38	15161.68	715.32
	E9_10_4	5312.42	14517.18	715.38
DHRES201	E11	-5145.54	15160.41	715.71
	E12	-5858.67	14897.59	715.65
	E11_12	-5550.49	15160.42	715.67
	E11_12_4	-5313.09	14515.91	715.82
DHSES202	E13	-10564.95	10883.00	715.40
	E14	-10911.46	10206.11	715.29
	E13_14	-10862.84	10608.42	715.46
	E13_14_4	-10251.49	10295.32	715.36
DHSEL201	E17	-12418.51	-10329.17	715.00
	E18	-12125.41	-11243.39	714.92
	E17_18	-12482.49	-10853.98	714.03
	E17_18_4	-11781.71	-10629.21	717.24
DHREL202	E19	-8185.92	-15853.14	714.70
	E20	-7314.26	-16255.12	714.70
	E19_20	-7842.96	-16255.08	714.71
	E19_20_4	-7534.36	-15586.82	714.86

Table 2: Coordinates of the DAΦNE Reference Network Nodes (Electron Dipole Sockets)

Dipole		X [mm]	Y [mm]	Z [mm]
DHRPL101	P1	7314.59	16253.89	715.16
	P2	8186.38	15851.82	715.05
	P1_2	7843.16	16254.05	715.12
	P1_2_4	7534.93	15585.47	715.21
DHSPL102	P3	12127.54	11240.60	715.60
	P4	12420.25	10326.28	715.22
	P3_4	12484.67	10851.09	716.18
	P3_4_4	11783.47	10626.82	713.84
DHSPS101	P7	10912.46	-10206.18	715.38
	P8	10566.41	-10883.15	715.05
	P7_8	10864.37	-10608.46	715.32
	P7_8_4	10252.69	-10295.64	715.11
DHRPS102	P9	5859.77	-14897.94	715.36
	P10	5146.77	-15161.05	715.22
	P9_10	5551.77	-15161.06	715.35
	P9_10_4	5313.96	-14516.48	715.27
DHRPS201	P11	-5145.24	-15161.98	714.77
	P12	-5858.36	-14898.88	714.66
	P11_12	-5550.48	-15161.89	714.73
	P11_12_4	-5312.58	-14517.46	714.81
DHSPS202	P13	-10565.27	-10883.86	715.02
	P14	-10911.34	-10206.95	715.09
	P13_14	-10862.98	-10609.20	715.16
	P13_14_4	-10251.38	-10296.40	715.07
DHSPL201	P17	-12419.73	10326.11	715.40
	P18	-12126.95	11240.36	715.27
	P17_18	-12484.15	10850.88	715.38
	P17_18_4	-11783.15	10626.36	715.27
DHRPL202	P19	-8186.11	15851.26	715.79
	P20	-7314.38	16253.14	715.75
	P19_20	-7842.77	16253.10	715.80
	P19_20_4	-7534.79	15584.78	715.66

Table 3: Coordinates of the DAΦNE Reference Network Nodes (Positron Dipole Sockets)

The four dipoles on the external ring, adjacent to the interaction regions, are marked in grey because they have been modified and moved [4] after the requalification of the network. Therefore the coordinates of those nodes do not correspond to their current positions (June 2008).

A comparison between the 2007 network requalification and the first measurements performed in 1997 by means of invar wires and optical levels shows that a not negligible variation of the network occurred across these years. In Diagram 1 we can see the horizontal components of the pillar node shifts from their original positions. We can notice peak values of up to 2 mm with a mean value of approximately 0.5 mm.

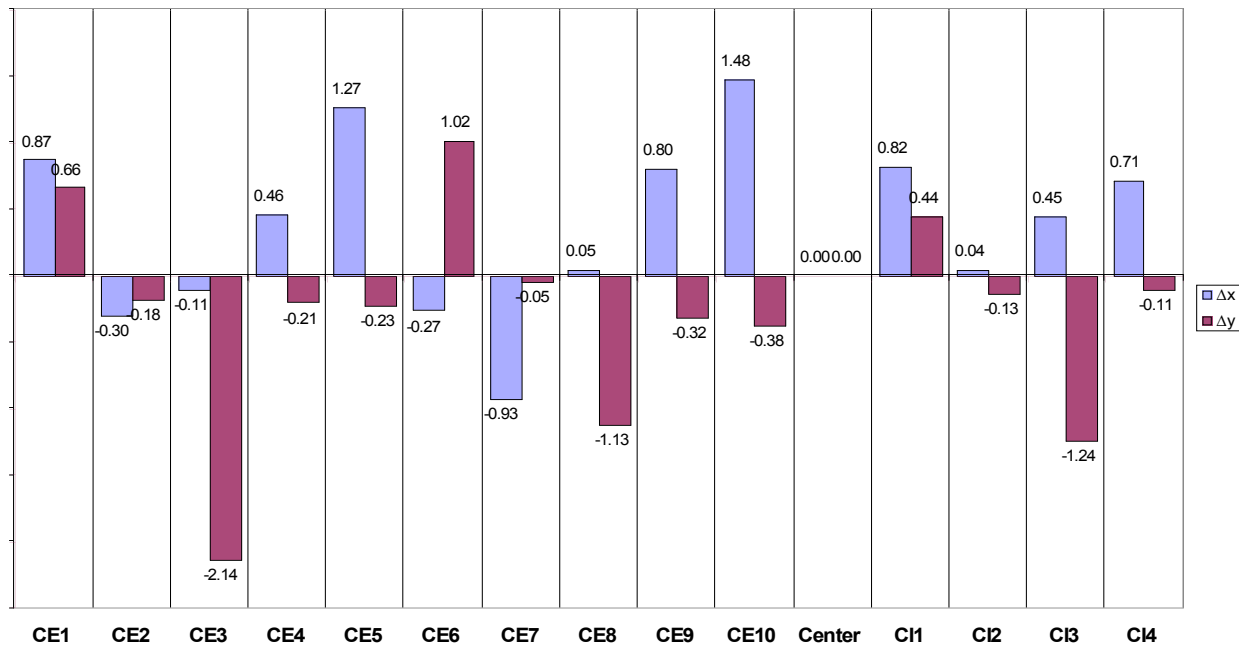


Diagram 1: Pillar Horizontal Movements (1997→2007).

Diagram 2 shows the height variation of the main pillar nodes in the last ten years. The fluctuations are of the same order of magnitude as for horizontal shifts. No general tendency is observable.

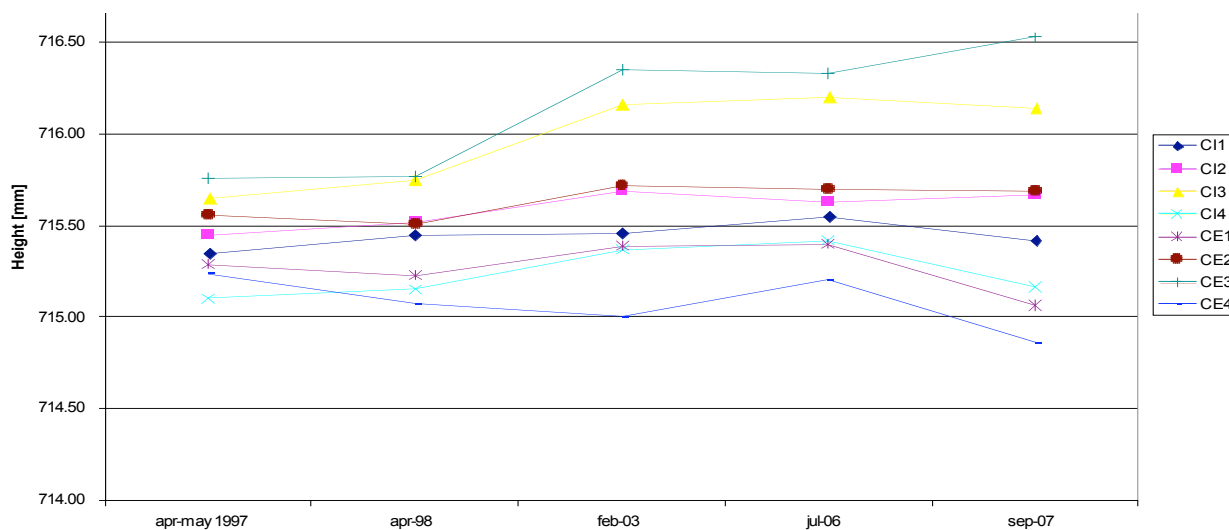


Diagram 2: Height Variations of Pillar Nodes.

2. Alignment of the Accelerator Components

The upgrade of DAΦNE required a realignment of most of the accelerator components. The alignment procedure required the use of a laser tracker, in some cases 2 laser trackers simultaneously, to make the process easier and quicker. Various other tools such as a level, to control the tilt angle, and aligning plates (Figure 4) have been used. The latter are metallic plates with two sockets (fiducial markers A and B as shown in Figure 5) mounted on translation tables moved by means of micrometric graduated screws. Each type of magnet (Small Quadrupoles, Large Quadrupoles, Large Aperture Quadrupoles, Small Sextupoles and Large Sextupoles) requires its own aligning plate, except for the Dipoles, Corrector Magnets and the Permanent Magnet Quadrupoles which have fiducial markers fixed to their external structure. These components do not need any fiducialisation. The position of the markers with respect to their axis can be taken from the mechanical design.

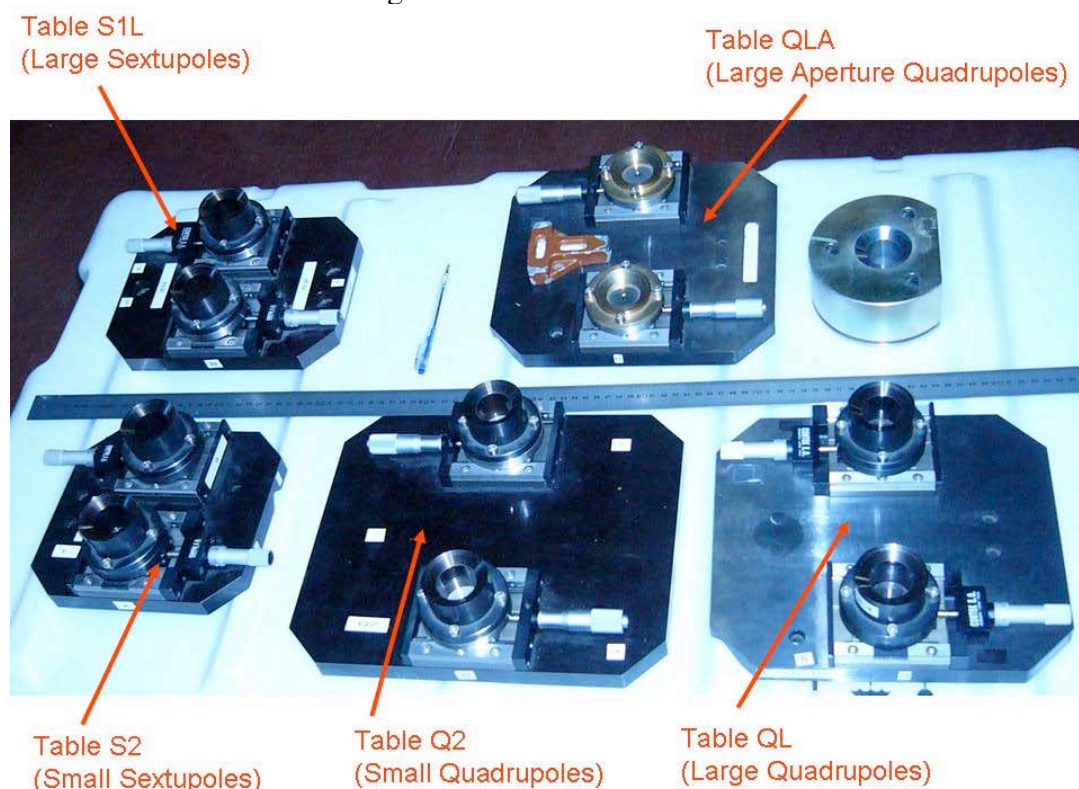


Figure 4: Aligning Plates.

The data for the alignment of the magnets using aligning plates has been retrieved from the fiducialisation work carried out in 1997 [5]. It contains the values of the screw positions necessary to place markers A and B in the vertical plane containing the magnetic axis, the height of these two fiducials above the axis and also the tilt angle to fix completely all degrees of freedom. The values taken from references [5] and [6] have been corrected by taking into account the use of different targets (a 1.5 inch corner cube reflector CCR necessary for laser tracker measurements, instead of a 3.5 inch Taylor Hobson sphere used previously with optical instruments) and are displayed as coordinates of a local right-handed Cartesian coordinate system (LCS) fixed to the magnet having:

- origin in the center of the magnet
- magnetic axis of the magnet as x axis (with positive direction pointing from A to B)
- vertical axis as z axis (with positive direction pointing upwards).

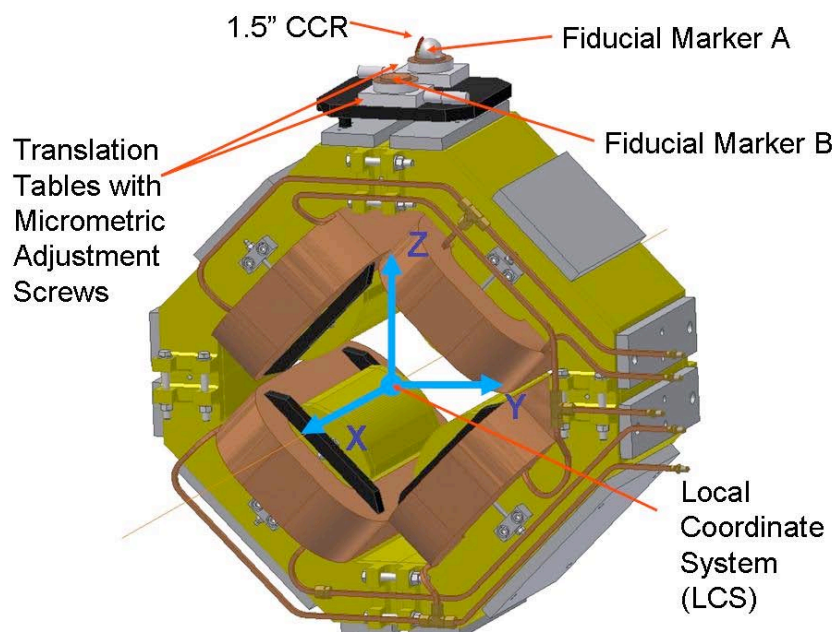


Figure 5: Magnet Local Coordinate System (LCS) and Alignment Tools.

During the DAΦNE upgrade alignment operations we have started to fiducialise three additional fiducial markers for each quadrupole and sextupole magnet. These new fiducials (M1, M2 and M3 in Figure 6) are embedded in the external structure of the magnets.

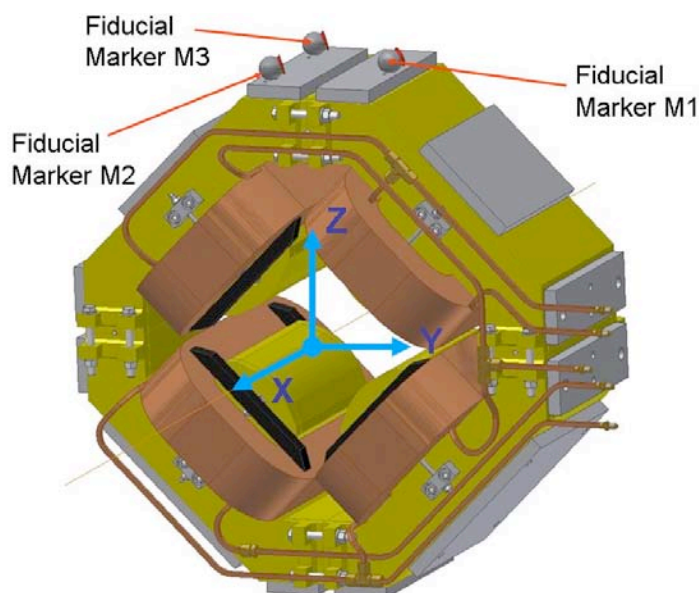


Figure 6: Fiducials M1, M2 and M3.

Knowing the position of these fiducials with respect to the magnetic axis, we will be able to perform the alignment without the use of aligning plates and levels. Nevertheless this work is still in progress, therefore the fiducialisation data for markers M1, M2 and M3 is available only for few magnets.

All the fiducialisation data for each magnet (LCS coordinates of the Fiducials, screw positions and tilt angle around the magnetic axis) are listed in the tables below. A zero value of the tilt angle means that the aligning plate must be in horizontal position; a positive value means that it must be rotated in counter-clockwise direction, observing it from the side of the cooling water connections.

SMALL QUADRUPOLES (sheet N°1)

NAME	Serial N.	Fiducial Markers Coordinates [mm]				Aligning Table Parameters	
			X	Y	Z		
QUAEL101	QS34	A	-84.92	0.00	319.40	Position Screw A	12.85
		B	84.92	0.00	319.56		
		M1				Position Screw B	11.87
		M2					
		M3					
QUAEL102	QS02	A	-84.92	0.00	319.41	Position Screw A	12.74
		B	84.92	0.00	319.66		
		M1				Position Screw B	11.79
		M2					
		M3					
QUAEL104	QS26	A	-84.92	0.00	319.41	Position Screw A	12.81
		B	84.92	0.00	319.63		
		M1				Position Screw B	11.69
		M2					
		M3					
QUAEL108	QS23	A	-84.92	0.00	319.43	Position Screw A	12.73
		B	84.92	0.00	319.57		
		M1				Position Screw B	11.75
		M2					
		M3					
QUAEL109	QS49	A	-84.92	0.00	319.40	Position Screw A	12.69
		B	84.92	0.00	319.59		
		M1				Position Screw B	11.63
		M2					
		M3					
QUAEL110	QS35	A	-84.92	0.00	319.38	Position Screw A	12.65
		B	84.92	0.00	319.55		
		M1				Position Screw B	11.81
		M2					
		M3					

SMALL QUADRUPOLES (sheet N°2)

NAME	Serial N.	Fiducial Markers Coordinates [mm]				Aligning Table Parameters	
		X	Y	Z			
QUAI1003	QS59	A	-84.92	0.00	319.47	Position Screw A	12.78
		B	84.92	0.00	319.56		
		M1				Position Screw B	11.93
		M2					
		M3					
QUAI1002	QS04	A	-84.92	0.00	319.44	Position Screw A	12.76
		B	84.92	0.00	319.65		
		M1				Position Screw B	11.99
		M2					
		M3					
QUAES101	QS27	A	-84.92	0.00	319.49	Position Screw A	12.75
		B	84.92	0.00	319.67		
		M1				Position Screw B	11.76
		M2					
		M3					
QUAES102	QS37	A	-84.92	0.00	319.40	Position Screw A	12.69
		B	84.92	0.00	319.56		
		M1				Position Screw B	11.73
		M2					
		M3					
QUAES103	QS60	A	-84.92	0.00	319.46	Position Screw A	12.71
		B	84.92	0.00	319.66		
		M1				Position Screw B	11.68
		M2					
		M3					
QUAES107	QS42	A	-84.92	0.00	319.42	Position Screw A	12.48
		B	84.92	0.00	319.57		
		M1				Position Screw B	11.99
		M2					
		M3					

SMALL QUADRUPOLES (sheet N°3)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
		A	B	M			
QUAES108	QS09	A	-84.92	0.00	319.46	Position Screw A	12.35
		B	84.92	0.00	319.59	Position Screw B	12.12
		M1				Tilt	0.00
		M2					
		M3					
QUAES109	?	A				Position Screw A	
		B				Position Screw B	
		M1				Tilt	
		M2					
		M3					
QUAES110	?	A				Position Screw A	
		B				Position Screw B	
		M1				Tilt	
		M2					
		M3					
QUAES201	QS47	A	-84.92	0.00	319.44	Position Screw A	12.52
		B	84.92	0.00	319.60	Position Screw B	11.92
		M1				Tilt	-0.26
		M2					
		M3					
QUAES202	QS31	A	-85.42	0.00	319.45	Position Screw A	12.64
		B	84.42	0.00	319.61	Position Screw B	11.89
		M1				Tilt	0.00
		M2					
		M3					
QUAES203	QS10	A	-85.42	0.00	319.41	Position Screw A	12.62
		B	84.42	0.00	319.54	Position Screw B	11.83
		M1				Tilt	0.00
		M2					
		M3					

SMALL QUADRUPOLES (sheet N°4)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
		A	X	Y			Z
QUAES207	QS29	A	-84.92	0.00	319.43	Position Screw A	12.78
		B	84.92	0.00	319.56		
		M1				Position Screw B	11.68
		M2					
		M3					
QUAES208	QS14	A	-84.92	0.00	319.44	Position Screw A	12.65
		B	84.92	0.00	319.56		
		M1				Position Screw B	11.92
		M2					
		M3					
QUAES209	QS16	A	-84.92	0.00	319.40	Position Screw A	12.65
		B	84.92	0.00	319.57		
		M1				Position Screw B	11.95
		M2					
		M3					
QUAEL201	QS40	A	-84.92	0.00	319.40	Position Screw A	12.59
		B	84.92	0.00	319.54		
		M1				Position Screw B	11.90
		M2					
		M3					
QUAEL202	QS07	A	-84.92	0.00	319.43	Position Screw A	12.48
		B	84.92	0.00	319.55		
		M1	0.23	-100.25	232.51	Position Screw B	11.99
		M2	-100.04	99.50	232.50		
		M3	99.90	99.90	232.76		
QUAEL203	QS52	A	-84.92	0.00	319.53	Position Screw A	12.66
		B	84.92	0.00	319.58		
		M1	0.30	-100.02	232.61	Position Screw B	11.69
		M2	-100.31	99.52	232.81		
		M3	100.06	100.18	232.66		

SMALL QUADRUPOLES (sheet N°5)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
		A	B	M			
			X	Y	Z		
QUAEL207	QS36	A	-84.92	0.00	319.41	Position Screw A	12.83
		B	84.92	0.00	319.57		
		M1				Position Screw B	11.73
		M2					
		M3				Tilt	0.00
QUAEL209	QS13	A	-84.92	0.00	319.35	Position Screw A	12.73
		B	84.92	0.00	319.66		
		M1				Position Screw B	11.78
		M2					
		M3				Tilt	0.00
QUAEL210	QS39	A	-84.92	0.00	319.38	Position Screw A	12.61
		B	84.92	0.00	319.54		
		M1				Position Screw B	11.85
		M2					
		M3				Tilt	-0.53
QUAPL101	QS12	A	-84.92	0.00	319.41	Position Screw A	12.49
		B	84.92	0.00	319.57		
		M1				Position Screw B	12.04
		M2					
		M3				Tilt	0.00
QUAPL102	QS11	A	-84.92	0.00	319.37	Position Screw A	12.51
		B	84.92	0.00	319.65		
		M1				Position Screw B	11.88
		M2					
		M3				Tilt	-0.35
QUAPL104	QS38	A	-84.92	0.00	319.41	Position Screw A	12.66
		B	84.92	0.00	319.59		
		M1				Position Screw B	11.84
		M2					
		M3				Tilt	-0.27

SMALL QUADRUPOLES (sheet N°6)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
			X	Y			Z
QUAPL108	QS03	A	-84.92	0.00	319.46	Position Screw A	12.69
		B	84.92	0.00	319.65		
		M1	0.31	-100.10	232.50	Position Screw B	11.76
		M2	-100.09	99.85	232.30		
		M3	99.88	100.16	232.56	Tilt	0.00
QUAPL109	QS15	A	-84.92	0.00	319.42	Position Screw A	12.66
		B	84.92	0.00	319.59		
		M1	0.18	-100.21	230.76	Position Screw B	11.93
		M2	-100.03	99.63	232.36		
		M3	100.04	99.91	232.62	Tilt	0.00
QUAPL110	QS50	A	-84.92	0.00	319.41	Position Screw A	12.68
		B	84.92	0.00	319.59		
		M1				Position Screw B	11.85
		M2					
		M3				Tilt	0.00
QUAI1001	QS54	A	-84.92	0.00	319.42	Position Screw A	12.96
		B	84.92	0.00	319.57		
		M1				Position Screw B	11.74
		M2					
		M3				Tilt	0.00
QUAI1004	QS41	A	-84.92	0.00	319.37	Position Screw A	12.76
		B	84.92	0.00	319.56		
		M1				Position Screw B	11.89
		M2					
		M3				Tilt	0.00
QUAPS101	QS18	A	-84.92	0.00	319.54	Position Screw A	12.76
		B	84.92	0.00	319.81		
		M1				Position Screw B	11.85
		M2					
		M3				Tilt	1.19

SMALL QUADRUPOLES (sheet N°7)

NAME	Serial N.	Fiducial Markers Coordinates [mm]				Aligning Table Parameters	
			X	Y	Z		
QUAPS102	QS32	A	-84.92	0.00	319.46	Position Screw A	12.68
		B	84.92	0.00	319.55		
		M1				Position Screw B	11.71
		M2					
		M3				Tilt	0.28
QUAPS103	QS17	A	-84.92	0.00	319.62	Position Screw A	12.71
		B	84.92	0.00	319.54		
		M1				Position Screw B	11.97
		M2					
		M3				Tilt	-0.35
QUAPS107	QS25	A	-84.92	0.00	319.43	Position Screw A	12.93
		B	84.92	0.00	319.59		
		M1				Position Screw B	11.56
		M2					
		M3				Tilt	0.57
QUAPS108	QS43	A	-84.92	0.00	319.41	Position Screw A	12.63
		B	84.92	0.00	319.54		
		M1				Position Screw B	11.90
		M2					
		M3				Tilt	0.00
QUAPS109	QS33	A	-84.92	0.00	319.42	Position Screw A	12.34
		B	84.92	0.00	319.55		
		M1				Position Screw B	12.08
		M2					
		M3				Tilt	0.00
QUAPS110	QS46	A	-84.92	0.00	319.42	Position Screw A	12.62
		B	84.92	0.00	319.55		
		M1				Position Screw B	11.87
		M2					
		M3				Tilt	0.00

SMALL QUADRUPOLES (sheet N°8)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
		A	X	Y			Z
QUAPS201	QS57	A	-84.92	0.00	319.54	Position Screw A	12.68
		B	84.92	0.00	319.68	Position Screw B	12.03
		M1				Tilt	-0.55
		M2					
		M3					
QUAPS202	QS30	A	-84.92	0.00	319.47	Position Screw A	12.61
		B	84.92	0.00	319.61	Position Screw B	12.00
		M1				Tilt	0.00
		M2					
		M3					
QUAPS203	QS56	A	-84.92	0.00	319.41	Position Screw A	12.75
		B	84.92	0.00	319.54	Position Screw B	11.79
		M1				Tilt	0.00
		M2					
		M3					
QUAPS207	QS01	A	-84.92	0.00	319.43	Position Screw A	12.75
		B	84.92	0.00	319.68	Position Screw B	11.81
		M1				Tilt	0.00
		M2					
		M3					
QUAPS208	QS51	A	-84.92	0.00	319.41	Position Screw A	12.78
		B	84.92	0.00	319.60	Position Screw B	11.79
		M1				Tilt	0.00
		M2					
		M3					
QUAPS209	QS24	A	-84.92	0.00	319.46	Position Screw A	12.67
		B	84.92	0.00	319.55	Position Screw B	11.73
		M1				Tilt	0.00
		M2					
		M3					

SMALL QUADRUPOLES (sheet N°9)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
		A	B	M			
QUAPL201	QS06	A	-84.92	0.00	319.46	Position Screw A	12.78
		B	84.92	0.00	319.61		
		M1				Position Screw B	11.75
		M2					
		M3					
QUAPL202	QS08	A	-84.92	0.00	319.42	Position Screw A	12.65
		B	84.92	0.00	319.58		
		M1				Position Screw B	11.86
		M2					
		M3					
QUAPL203	QS05	A	-84.92	0.00	319.43	Position Screw A	12.63
		B	84.92	0.00	319.60		
		M1				Position Screw B	11.98
		M2					
		M3					
QUAPL207	QS22	A	-84.92	0.00	319.47	Position Screw A	12.58
		B	84.92	0.00	319.63		
		M1				Position Screw B	11.86
		M2					
		M3					
QUAPL209	QS55	A	-84.92	0.00	319.51	Position Screw A	12.57
		B	84.92	0.00	319.66		
		M1				Position Screw B	11.51
		M2					
		M3					
QUAPL210	QS45	A	-84.92	0.00	319.43	Position Screw A	12.71
		B	84.92	0.00	319.56		
		M1				Position Screw B	11.81
		M2					
		M3					

LARGE QUADRUPOLES (sheet N°1)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
		A	X	Y			Z
QUAEL114	QL08	A	-74.64	0.00	477.12	Position Screw A	12.47
		B	74.64	0.00	477.12		
		M1				Position Screw B	11.42
		M2					
		M3				Tilt	0.00
QUAEL105	QL22	A	-74.64	0.00	477.14	Position Screw A	12.51
		B	74.64	0.00	477.15		
		M1				Position Screw B	11.10
		M2					
		M3				Tilt	-0.55
QUAEL106	QL18	A	-74.64	0.00	477.56	Position Screw A	12.29
		B	74.64	0.00	477.53		
		M1				Position Screw B	11.34
		M2					
		M3				Tilt	0.59
QUAEL107	QL24	A	-74.64	0.00	476.93	Position Screw A	12.57
		B	74.64	0.00	477.02		
		M1				Position Screw B	11.15
		M2					
		M3				Tilt	-0.35
QUAES104	QL11	A	-74.64	0.00	477.31	Position Screw A	12.05
		B	74.64	0.00	477.31		
		M1				Position Screw B	11.60
		M2					
		M3				Tilt	0.39
QUAES105	QL07	A	-74.64	0.00	477.42	Position Screw A	12.40
		B	74.64	0.00	477.43		
		M1				Position Screw B	11.41
		M2					
		M3				Tilt	0.00

LARGE QUADRUPOLES (sheet N°2)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
		A	X	Y			Z
QUAES106	QL25	A	-74.64	0.00	477.33	Position Screw A	12.55
		B	74.64	0.00	477.36	Position Screw B	11.31
		M1				Tilt	-0.37
		M2					
		M3					
QUAES204	QL27	A	-74.64	0.00	476.95	Position Screw A	12.12
		B	74.64	0.00	476.96	Position Screw B	11.64
		M1				Tilt	0.00
		M2					
		M3					
QUAES205	QL02	A	-74.64	0.00	477.21	Position Screw A	12.43
		B	74.64	0.00	477.27	Position Screw B	11.07
		M1				Tilt	-0.63
		M2					
		M3					
QUAES206	QL04	A	-74.64	0.00	476.95	Position Screw A	12.60
		B	74.64	0.00	476.93	Position Screw B	11.99
		M1				Tilt	-0.72
		M2					
		M3					
QUAEL204	QL13	A	-74.64	0.00	477.23	Position Screw A	12.82
		B	74.64	0.00	477.30	Position Screw B	11.21
		M1				Tilt	-0.79
		M2					
		M3					
QUAEL205	QL17	A	-74.64	0.00	477.00	Position Screw A	12.18
		B	74.64	0.00	477.09	Position Screw B	11.48
		M1				Tilt	0.00
		M2					
		M3					

LARGE QUADRUPOLES (sheet N°3)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
		A	X	Y			Z
QUAEL206	QL00	A	-74.64	0.00	477.34	Position Screw A	12.28
		B	74.64	0.00	477.33		
		M1				Position Screw B	11.45
		M2					
		M3					
QUAEL217	QL03	A	-74.64	0.00	477.11	Position Screw A	12.04
		B	74.64	0.00	477.15		
		M1				Position Screw B	11.31
		M2					
		M3					
QUAPL114	QL05	A	-74.64	0.00	477.20	Position Screw A	12.49
		B	74.64	0.00	477.18		
		M1				Position Screw B	11.15
		M2					
		M3					
QUAPL105	QL06	A	-74.64	0.00	477.31	Position Screw A	12.53
		B	74.64	0.00	477.32		
		M1				Position Screw B	11.26
		M2					
		M3					
QUAPL106	QL21	A	-74.64	0.00	477.17	Position Screw A	12.19
		B	74.64	0.00	477.16		
		M1				Position Screw B	11.59
		M2					
		M3					
QUAPL107	QL26	A	-74.64	0.00	477.19	Position Screw A	12.08
		B	74.64	0.00	477.23		
		M1				Position Screw B	11.46
		M2					
		M3					

LARGE QUADRUPOLES (sheet N°4)

NAME	Serial N.	Fiducial Markers Coordinates [mm]				Aligning Table Parameters	
			X	Y	Z		
QUAPS104	QL09	A	-74.64	0.00	477.07	Position Screw A	12.27
		B	74.64	0.00	477.13		
		M1				Position Screw B	11.37
		M2					
		M3				Tilt	0.00
QUAPS105	QL16	A	-74.64	0.00	477.24	Position Screw A	12.11
		B	74.64	0.00	477.18		
		M1				Position Screw B	11.59
		M2					
		M3				Tilt	0.36
QUAPS106	QL01	A	-74.64	0.00	476.80	Position Screw A	12.73
		B	74.64	0.00	476.84		
		M1				Position Screw B	11.93
		M2					
		M3				Tilt	-0.74
QUAPS204	QL10	A	-74.64	0.00	477.30	Position Screw A	12.51
		B	74.64	0.00	477.43		
		M1				Position Screw B	11.35
		M2					
		M3				Tilt	0.00
QUAPS205	QL12	A	-74.64	0.00	477.02	Position Screw A	12.18
		B	74.64	0.00	477.00		
		M1				Position Screw B	11.34
		M2					
		M3				Tilt	0.00
QUAPS206	QL20	A	-74.64	0.00	477.09	Position Screw A	12.49
		B	74.64	0.00	477.14		
		M1				Position Screw B	11.31
		M2					
		M3				Tilt	0.00

LARGE QUADRUPOLES (sheet N°5)

NAME	Serial N.	Fiducial Markers Coordinates [mm]				Aligning Table Parameters	
			X	Y	Z		
QUAPL204	QL15	A	-74.64	0.00	477.39	Position Screw A	12.34
		B	74.64	0.00	477.37		
		M1				Position Screw B	11.37
		M2					
		M3					
QUAPL205	QL19	A	-74.64	0.00	477.26	Position Screw A	12.80
		B	74.64	0.00	477.27		
		M1				Position Screw B	11.10
		M2					
		M3					
QUAPL206	QL14	A	-74.64	0.00	477.30	Position Screw A	12.33
		B	74.64	0.00	477.31		
		M1				Position Screw B	11.37
		M2					
		M3					
QUAPL217	QL23	A	-74.64	0.00	477.23	Position Screw A	12.43
		B	74.64	0.00	477.25		
		M1				Position Screw B	11.26
		M2					
		M3					

LARGE APERTURE QUADRUPOLES

NAME	Serial N.	Fiducial Markers Coordinates [mm]				Aligning Table Parameters	
		X	Y	Z			
QUAEL103	QLA02	A	-74.67	0.00	477.95	Position Screw A	12.68
		B	74.67	0.00	477.90		
		M1				Position Screw B	13.63
		M2					
		M3					
QUAEL208	QLA06	A	-74.67	0.00	477.92	Position Screw A	13.08
		B	74.67	0.00	477.92		
		M1				Position Screw B	13.49
		M2					
		M3					
QUAI2001	QLA07	A	-74.67	0.00	477.78	Position Screw A	13.14
		B	74.67	0.00	477.78		
		M1				Position Screw B	13.11
		M2					
		M3					
QUAI2002	QLA01	A	-74.67	0.00	477.99	Position Screw A	12.71
		B	74.67	0.00	478.04		
		M1				Position Screw B	13.36
		M2					
		M3					
QUAI2007	QLA08	A	-74.67	0.00	477.83	Position Screw A	12.91
		B	74.67	0.00	477.87		
		M1				Position Screw B	13.77
		M2					
		M3					
QUAPL103	QLA05	A	-74.67	0.00	477.97	Position Screw A	12.88
		B	74.67	0.00	477.84		
		M1				Position Screw B	13.51
		M2					
		M3					
QUAPL208	QLA03	A	-74.67	0.00	477.87	Position Screw A	12.77
		B	74.67	0.00	477.84		
		M1				Position Screw B	13.48
		M2					
		M3					

SMALL SEXTUPOLES (sheet N°1)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters	
		X	Y	Z		
SXPEL100	?	A				Position Screw A
		B				Position Screw B
		M1				Tilt
		M2				
		M3				
SXPEL101	SS01	A	-49.88	0.00	319.47	Position Screw A 12.01
		B	49.88	0.00	319.37	Position Screw B 11.71
		M1				Tilt 0.00
		M2				
		M3				
SXPES201	SS11	A	-49.88	0.00	319.53	Position Screw A 11.88
		B	49.88	0.00	319.29	Position Screw B 11.67
		M1				Tilt 0.00
		M2				
		M3				
SXPEL204	SS03	A	-49.88	0.00	319.54	Position Screw A 12.15
		B	49.88	0.00	319.31	Position Screw B 11.42
		M1				Tilt 0.00
		M2				
		M3				

SMALL SEXTUPOLES (sheet N°2)

NAME	Serial N.	Fiducial Markers Coordinates [mm]			Aligning Table Parameters		
		A	X	Y			Z
SXPPL100	?	A				Position Screw A	
		B					
		M1					Position Screw B
		M2					
		M3					
SXPPL101	SS02	A	-49.88	0.00	319.60	Position Screw A	11.82
		B	49.88	0.00	319.28	Position Screw B	11.49
		M1					
		M2					
		M3	Tilt	0.00			
SXPPS201	SS05	A	-49.88	0.00	319.52	Position Screw A	11.81
		B	49.88	0.00	319.33	Position Screw B	11.69
		M1					
		M2					
		M3	Tilt	0.00			
SXPPL204	SS04	A	-49.88	0.00	319.48	Position Screw A	11.82
		B	49.88	0.00	319.34	Position Screw B	11.67
		M1					
		M2					
		M3	Tilt	0.00			

LARGE SEXTUPOLES (sheet N°1)

NAME	Serial N.	Fiducial Markers Coordinates [mm]				Aligning Table Parameters	
			X	Y	Z		
SXPEL102	SL12	A	-49.77	0.00	469.10	Position Screw A	12.09
		B	49.77	0.00	469.32		
		M1				Position Screw B	12.49
		M2					
		M3				Tilt	0.00
SXPEL103	SL16	A	-49.77	0.00	469.07	Position Screw A	12.59
		B	49.77	0.00	469.30		
		M1				Position Screw B	12.12
		M2					
		M3				Tilt	0.00
SXPEL104	SL08	A	-49.77	0.00	469.14	Position Screw A	12.08
		B	49.78	0.00	469.31		
		M1	0.36	79.85	375.99	Position Screw B	12.53
		M2	28.72	-80.18	376.08		
		M3	-28.31	-80.13	376.10	Tilt	0.00
SXPEL101	SL10	A	-49.77	0.00	469.05	Position Screw A	12.37
		B	49.77	0.00	469.25		
		M1	0.30	80.11	375.90	Position Screw B	12.23
		M2	28.78	-79.92	375.92		
		M3	-28.25	-79.91	375.93	Tilt	0.00
SXPEL102	SL11	A	-49.77	0.00	469.04	Position Screw A	12.30
		B	49.77	0.00	469.19		
		M1				Position Screw B	12.27
		M2					
		M3				Tilt	0.00
SXPEL203	SL01	A	-49.77	0.00	469.18	Position Screw A	12.15
		B	49.77	0.00	469.28		
		M1				Position Screw B	12.28
		M2					
		M3				Tilt	0.00

LARGE SEXTUPOLES (sheet N°2)

NAME	Serial N.	Fiducial Markers Coordinates [mm]				Aligning Table Parameters	
			X	Y	Z		
SXPEL202	SL06	A	-49.77	0.00	468.96	Position Screw A	12.29
		B	49.77	0.00	469.12		
		M1				Position Screw B	12.33
		M2					
		M3				Tilt	0.00
SXPEL203	SL04	A	-49.77	0.00	469.05	Position Screw A	11.95
		B	49.77	0.00	469.10		
		M1				Position Screw B	12.13
		M2					
		M3				Tilt	0.00
SXPPL102	SL07	A	-49.77	0.00	469.22	Position Screw A	12.07
		B	49.77	0.00	469.19		
		M1				Position Screw B	12.53
		M2					
		M3				Tilt	0.00
SXPPL103	SL02	A	-49.77	0.00	469.35	Position Screw A	12.14
		B	49.77	0.00	469.47		
		M1				Position Screw B	12.39
		M2					
		M3				Tilt	0.00
SXPPL104	SL09	A	-49.77	0.00	469.25	Position Screw A	12.57
		B	49.78	0.00	469.30		
		M1	0.20	80.39	376.09	Position Screw B	11.99
		M2	28.63	-79.63	376.10		
		M3	-28.39	-79.60	376.14	Tilt	0.00
SXPPS101	SL05	A	-49.77	0.00	469.05	Position Screw A	12.15
		B	49.76	0.00	469.20		
		M1	0.32	79.86	375.98	Position Screw B	12.49
		M2	28.72	-80.16	376.02		
		M3	-28.26	-80.12	375.95	Tilt	0.00

LARGE SEXTUPOLES (sheet N°3)															
NAME	Serial N.	Fiducial Markers Coordinates [mm]				Aligning Table Parameters									
		A	B	M1	M2			M3	X	Y	Z				
SXPPS102	?	A												Position Screw A	
		B												Position Screw B	
		M1												Tilt	
		M2													
		M3													
SXPPS103	SL03	A	-49.77	0.00	469.02									Position Screw A	12.10
		B	49.77	0.00	469.14									Position Screw B	12.48
		M1	0.21	79.87	375.97									Tilt	0.00
		M2	28.66	-80.12	375.91										
		M3	-28.41	-80.13	375.84										
SXPPS202	SL13	A	-49.77	0.00	469.22									Position Screw A	12.60
		B	49.77	0.00	469.21									Position Screw B	11.95
		M1												Tilt	0.00
		M2													
		M3													
SXPPS203	SL15	A	-49.77	0.00	469.15									Position Screw A	12.49
		B	49.77	0.00	469.19									Position Screw B	12.11
		M1												Tilt	0.00
		M2													
		M3													
SXPPL202	SL17	A	-49.77	0.00	469.12									Position Screw A	12.69
		B	49.77	0.00	469.16									Position Screw B	12.29
		M1												Tilt	0.00
		M2													
		M3													
SXPPL203	SL14	A	-49.77	0.00	469.13									Position Screw A	12.18
		B	49.77	0.00	469.34									Position Screw B	12.31
		M1												Tilt	0.00
		M2													
		M3													

Table 4: Fiducialisation Data for Quadrupole and Sextupole Magnets

The coordinates of the magnetic center of each component in the DCS, according to the upgraded magnetic layout are shown in Table 5

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
SXPEL100	SS?	393.00	-16254.41
QUAEL101	QS34	1615.00	-16254.41
CHVEL101	CHVS07	2000.00	-16254.41
OCTEL101	OCT01		
BPBEL101			
OCTEL102	OCT05		
SXPEL101	SS01	2880.00	-16254.41
QUAEL102	QS02	3255.00	-16254.41
CHVEL102	CHVS08	3570.00	-16254.41
QUAEL103	QLA02	4830.00	-16254.41
QUAEL104	QS26	5798.00	-16254.41
CHVEL103	CHVSQ15	6372.00	-16254.41
BPBEL102			
QUAEL114	QL08	6712.00	-16254.41
DHREL101	DHR01		
BPBEL103			
QUAEL105	QL22	8749.67	-15193.10
CHVEL104	CHVL		
SXPEL102	SL12	9090.63	-14793.89
BPBEL104			
WGLEL101	WGL	9886.20	-13862.39
BPBEL105			
QUAEL106	QL18	11022.74	-12531.68
CHVEL105	CHVL	11211.08	-12311.16
SXPEL103	SL16	11379.94	-12113.46
QUAEL107	QL24	11607.24	-11847.32
BPBEL106			
DHSEL102	DHS	12484.06	-10854.86
CHVEL106	CHVSQ	12367.66	-9690.07
SXPEL104	SL08	12336.78	-9305.30
BPBEL107			
QUAEL108	QS23	12310.65	-8981.34
BPBEL108			

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
QUAEL109	QS49	12248.50	-8218.79
DHCEL101	DHC	12039.71	-5641.12
QUAEL110	QS35	12011.62	-5246.11
BPBEL109			
QUAI1003	QS59	11932.17	-4128.94
CHVEI101	CHVI	11773.40	-1896.51
BPBEL110			
PMQFEL01	PMQF	11707.86	-974.54
PMQDI101	PMQDI	11658.28	-414.00
PMQDI102	PMQDI	11658.28	414.00
PMQFES01	PMQF	11608.70	974.54
BPBES199			
CHVEI102	CHVI	11543.16	1896.51
QUAI1002	QS04	11384.39	4128.94
BPBES100			
QUAES101	QS27	11304.94	5246.11
DHCES101	DHC	11276.85	5641.12
QUAES102	QS37	11068.04	8218.79
BPBES101			
QUAES103	QS60	11005.91	8981.34
BPBES102			
SXPES101	SL10	10979.78	9305.30
CHVES101	CHVSQ	10948.90	9690.07
DHRES102	DHR		
BPBES103			
QUAES104	QL11	9859.88	11481.30
SXPES102	SL11	9593.74	11708.61
CHVES102	CHVL	9396.03	11877.46
QUAES105	QL07	9175.52	12065.80
BPBES104			
WGLES101	WGL	7844.47	13202.62

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
BPBES105			
SXPES103	SL10	6913.31	13997.91
CHVES103	CHVL	6727.01	14157.03
QUAES106	QL25	6514.09	14338.87
BPBES106			
DHRES102	DHR		
CHVES104	CHVSQ	4605.19	15161.57
QUAES107	QS42	4134.20	15161.57
BPBES107			
OCTES101	OCT		
QUAES108	QS09	3447.00	15161.57
CHVES105	CHVS	1246.20	15161.57
QUAES109	QS?	914.20	15161.57
BPBES108			
CHVES106	CHVS	300.00	15161.57
QUAES110	QS?	0.00	15161.57
BPBES201			
QUAES201	QS47	-914.20	15161.57
BPBES202			
CHVES201	CHVS	-2294.19	15161.57
QUAES202	QS31	-3447.19	15161.57
SXPES201	SS11	-3769.19	15161.57
BPBES203			
QUAES203	QS10	-4134.19	15161.57
CHVES202	CHVSQ	-4605.19	15161.57
DHRES201	DHR		
BPBES204			
QUAES204	QL27	-6514.09	14338.87
CHVES203	CHVL	-6727.01	14157.03
SXPES202	SL03	-6913.31	13997.91
BPBES205			
WGLS201	WGL	-7844.47	13202.62

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
BPBES206			
QUAES205	QL02	-9175.52	12065.80
CHVES204	CHVL	-9396.03	11877.46
SXPES203	SL01	-9593.74	11708.61
QUAES206	QL04	-9859.88	11481.30
BPBES207			
DHSES202	DHS		
CHVES205	CHVSQ	-10948.73	9690.06
QUAES207	QS29	-11004.30	9001.27
BPBES208			
QUAES208	QS14	-11143.42	7276.88
BPBES209			
DHCES201	DHC	-11287.77	5487.51
QUAES209	QS16	-11335.40	4782.11
BPBES210			
BPBES211			
QUAI2001	QLA07	-11658.28	1000.00
QUAI2002	QLA01	-11658.28	0.00
QUAI2007	QLA08	-11658.28	-1000.00
BPBEL298			
BPBEL299			
QUAEL201	QS40	-11981.16	-4782.11
DHCEL201	DHC	-12028.79	-5487.51
BPBEL200			
BPBEL201			
QUAEL202	QS07	-12202.89	-7645.63
BPBEL202			
QUAEL203	QS52	-12312.26	-9001.27
CHVEL201	CHVSQ	-12367.83	-9690.06
DHSEL201	DHS	-12484.06	-10854.87
BPBEL203			

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
QUAEL204	QL13	-11607.24	-11847.32
SXPEL202	SL06	-11379.94	-12113.46
CHVEL202	CHVL	-11211.08	-12311.16
QUAEL205	QL17	-11022.74	-12531.68
BPBEL204			
WGLEL201	WGL	-9886.20	-13862.39
BPBEL205			
SXPEL203	SL04	-9090.63	-14793.89
CHVEL203	CHVL	-8931.51	-14980.19
QUAEL206	QL00	-8749.67	-15193.10
BPBEL206			
DHREL202	DHR		
QUAEL217	QL03	-6712.00	-16254.41
BPBEL207			
CHVEL204	CHVSQ	-6372.00	-16254.41
QUAEL207	QS36	-5798.00	-16254.41
QUAEL208	QLA06	-4830.00	-16254.41
CHVEL205	CHVS04	-3750.00	-16254.41
QUAEL209	QS13	-3255.00	-16254.41
BPBEL208			
SXPEL204	SS03	-2880.00	-16254.41
CHVEL206	CHVS06	-2350.00	-16254.41
QUAEL210	QS39	-1615.00	-16254.41

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
SXPPL100	SS?	393.00	16254.41
QUAPL101	QS12	1615.00	16254.41
CHVPL101	CHVS14	2000.00	16254.41
OCTPL101	OCT02		
BPBPL101			
OCTPL102	OCT04		
SXPPL101	SS02	2880.00	16254.41
QUAPL102	QS11	3255.00	16254.41
CHVPL102	CHVS09	3570.00	16254.41
QUAPL103	QLA05	4830.00	16254.41
QUAPL104	QS38	5798.00	16254.41
CHVPL103	CHVSQ	6372.00	16254.41
BPBPL102			
QUAPL114	QL05	6712.00	16254.41
DHRPL101	DHR		
BPBPL103			
QUAPL105	QL06	8749.67	15193.10
CHVPL104	CHVL	8931.51	14980.19
SXPPL102	SL07	9090.63	14793.89
BPBPL104			
WGLPL101	WGL	9886.20	13862.39
BPBPL105			
QUAPL106	QL21	11022.74	12531.68
CHVPL105	CHVL	11211.07	12311.74
SXPPL103	SL02	11379.94	12113.46
QUAPL107	QL26	11607.24	11847.32
BPBPL106			
DHSPL102	DHS02	12484.06	10854.86
CHVPL106	CHVSQ09	12367.66	9690.07
SXPPL104	SL09	12336.78	9305.30
BPBPL107			
QUAPL108	QS03	12310.65	8981.34
BPBPL108			

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
QUAPL109	QS15	12248.50	8218.79
DHCPL101	DHC	12039.71	5641.12
QUAPL110	QS50	12011.62	5246.11
BPBPL109			
QUAI1001	QS54	11932.17	4128.94
CHVPI102	CHVI	11773.40	1896.51
BPBPL110			
PMQFPL01	PMQF	11707.86	974.54
PMQFPS01	PMQF	11608.70	-974.54
BPBPS199			
CHVPI101	CHVI	11543.16	-1896.51
QUAI1004	QS41	11384.39	-4128.94
BPBPS100			
QUAPS101	QS18	11304.94	-5246.11
DHCPS101	DHC	11276.85	-5641.12
QUAPS102	QS32	11068.04	-8218.79
BPBPS101			
QUAPS103	QS17	11005.91	-8981.34
BPBPS102			
SXPPS101	SL05	10979.78	-9305.30
CHVPS101	CHVSQ	10948.90	-9690.07
DHSPS101	DHS		
BPBPS103			
QUAPS104	QL09	9859.88	-11481.30
SXPPS102	SL?	9593.74	-11708.61
CHVPS102	CHVL	9396.03	-11877.46
QUAPS105	QL16	9175.52	-12065.80
BPBPS104			
WGLPS101	WGL	7844.47	-13202.62
BPBPS105			
SXPPS103	SL05	6913.31	-13997.91
CHVPS103	CHVL	6727.01	-14157.03
QUAPS106	QL01	6514.09	-14338.87

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
BPBPS106			
DHRPS102	DHR		
CHVPS104	CHVSQ	4605.19	-15161.57
QUAPS107	QS25	4134.20	-15161.57
BPBPS107			
OCTPS101	OCT		
QUAPS108	QS43	3447.00	-15161.57
CHVPS105	CHVS	1246.20	-15161.57
QUAPS109	QS33	914.20	-15161.57
BPBPS108			
CHVPS106	CHVS	300.00	-15161.57
QUAPS110	QS46	0.00	-15161.57
BPBPS201			
QUAPS201	QS57	-914.20	-15161.57
BPBPS202			
CHVPS201	CHVS	-2294.19	-15161.57
QUAPS202	QS30	-3447.19	-15161.57
SXPES201	SS05	-3769.19	-15161.57
BPBPS203			
QUAPS203	QS56	-4134.19	-15161.57
CHVPS202	CHVSQ	-4605.19	-15161.57
DHRPS201	DHR		
BPBPS204			
QUAPS204	QL10	-6514.09	-14338.87
CHVPS203	CHVL	-6727.01	-14157.03
SXPPS202	SL13	-6913.31	-13997.91
BPBPS205			
WGLPS201	WGL	-7844.47	-13202.62
BPBPS206			
QUAPS205	QL12	-9175.52	-12065.80
CHVPS204	CHVL	-9396.03	-11877.46
SXPPS203	SL15	-9593.74	-11708.61
QUAPS206	QL20	-9859.88	-11481.30

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
BPBPS207			
DHSPS202	DHS		
CHVPS205	CHVSQ	-10948.73	-9690.06
QUAPS207	QS01	-11004.30	-9001.27
BPBPS208			
QUAPS208	QS51	-11143.42	-7276.88
BPBPS209			
DHCPS201	DHC	-11287.77	-5487.51
QUAPS209	QS24	-11335.40	-4782.11
BPBPS210			
BPBPS211			
BPBPL298			
BPBPL299			
QUAPL201	QS06	-11981.16	4782.11
DHCPL201	DHC06	-12028.79	5487.51
BPBPL200			
BPBPL201			
QUAPL202	QS08	-12202.89	7645.63
BPBPL202			
QUAPL203	QS05	-12312.26	9001.27
CHVPL201	CHVSQ08	-12367.83	9690.06
DHSPL201	DHS04	-12484.06	10854.87
BPBPL203			
QUAPL204	QL15	-11607.24	11847.32
SXPPL202	SL17	-11379.94	12113.46
CHVPL202	CHVL	-11211.08	12311.16
QUAPL205	QL19	-11022.74	12531.68
BPBPL204			
WGLPL201	WGL	-9886.20	13862.39
BPBPL205			
SXPPL203	SL14	-9090.63	14793.89
CHVPL203	CHVL	-8928.27	14983.99
QUAPL206	QL14	-8749.67	15193.10

NAME	TYPE & S.Nr.	CENTER POINT COORDINATES	
		X	Y
BPBPL206			
DHRPL202	DHR02		
QUAPL217	QL23	-6712.00	16254.41
BPBPL207			
CHVPL204	CHVSQ05	-6372.00	16254.41
QUAPL207	QS22	-5798.00	16254.41
QUAPL208	QLA03	-4830.00	16254.41
CHVPL205	CHVS11	-3750.00	16254.41
QUAPL209	QS55	-3255.00	16254.41
BPBPL208			
SXPPL204	SS04	-2880.00	16254.41
CHVPL206	CHVS01	-2350.00	16254.41
QUAPL210	QS45	-1615.00	16254.41

Table 5: Center Point Coordinates of the DAΦNE Components

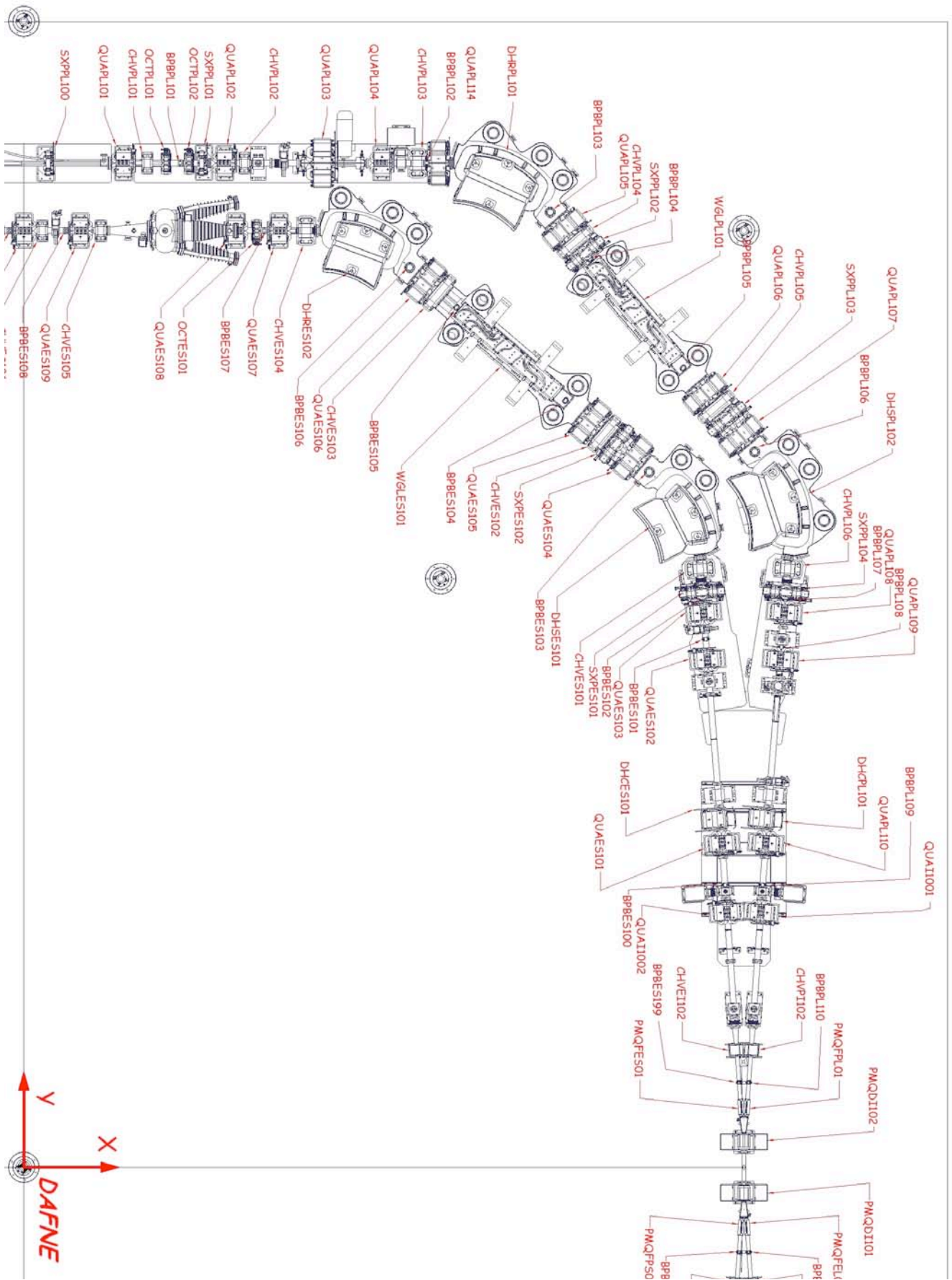


Figure 7: DAΦNE Upgrade Layout (I Sector).

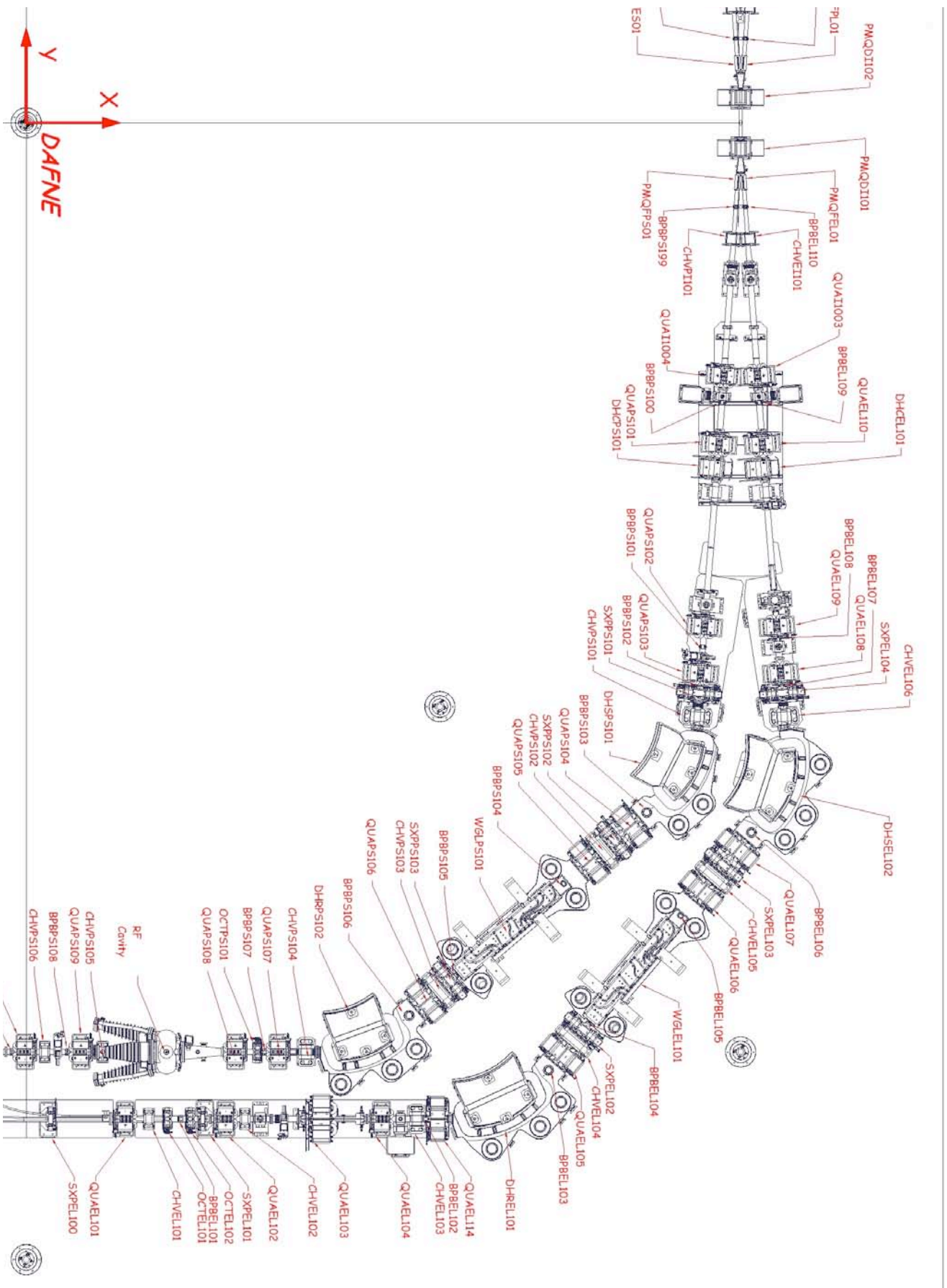


Figure 10: DAΦNE Upgrade Layout (IV Sector).

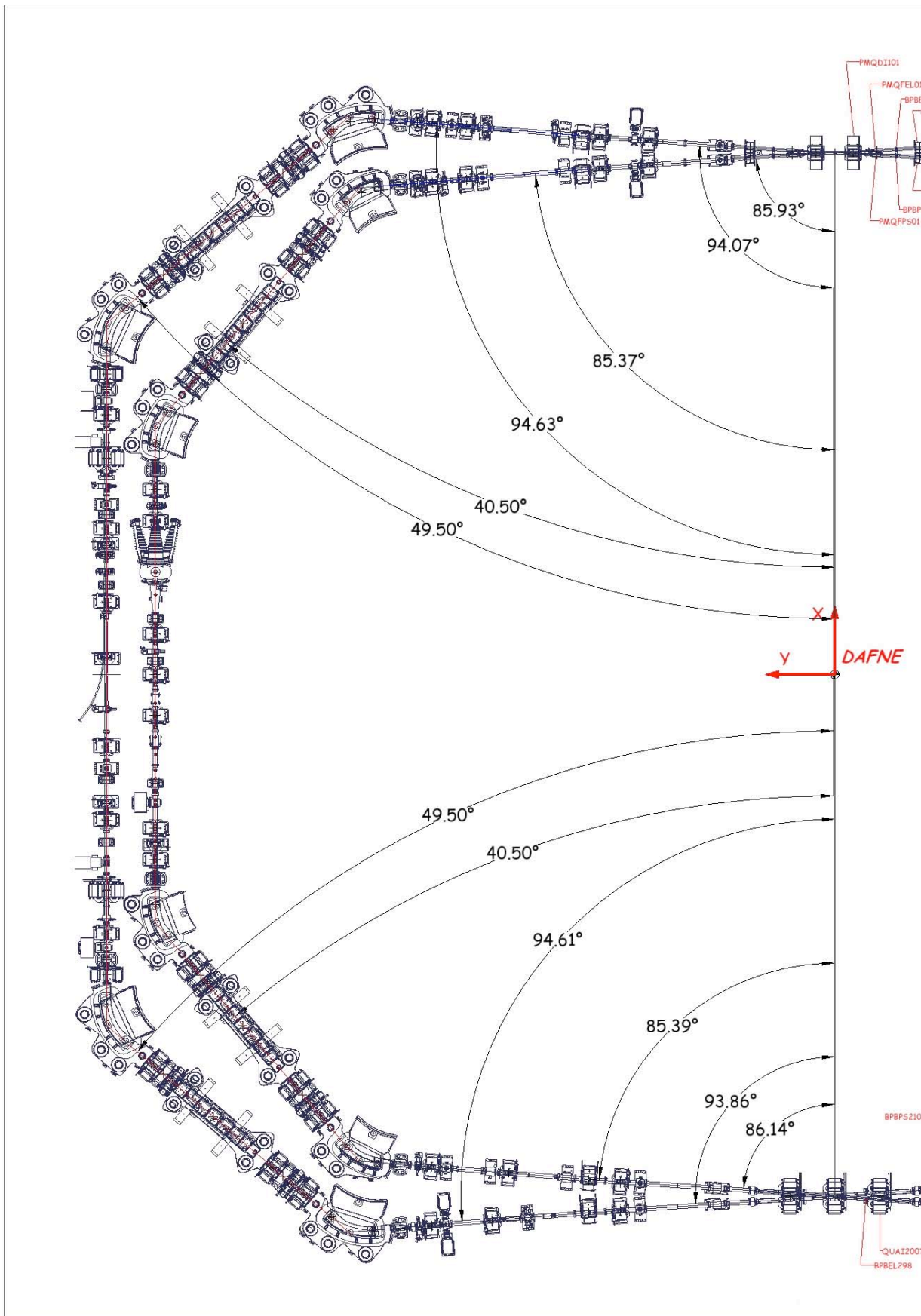


Figure 11: DAΦNE Upgrade Layout (Angles between the Beam Lines and the X-axis of the DAΦNE Coordinate System).

3. References

- [1] M.Zobov: "DAΦNE Status and Upgrade Plans", INFN-LNF Frascati, Italy, for the DAΦNE Collaboration Team, September 2007.
- [2] F. Sgamma, M. Paris, M. Troiani: "DAΦNE . Allineamento dei Magneti Curvanti, degli Splitter e dei Compensatori. Metodica Usata e Stato Attuale", INFN-LNF, DAΦNE Techniocal Note ME-8, 1999.
- [3] www.leica-geosystems.com.
- [4] M. Preger, S. Tomassini: "[Beam Trajectory Inside the Modified Dipoles for the DAFNE Upgrade](#)", L-39, 11/03/2008.
- [5] B. Bolli, N. Ganlin, F. Iungo, F. Losciale, M. Paris, M. Preger, C. Sanelli, F. Sardone, F. Sgamma, M. Troiani: "[Comparison of Magnetic and Mechanical Center Positions of Small Quadrupoles and Sextupoles in the DAFNE Main Rings](#)", MM-23, 19/3/1997.
- [6] B. Bolli, N. Ganlin, F. Iungo, F. Losciale, M. Paris, M. Preger, C. Sanelli, F. Sardone, F. Sgamma, M. Troiani: "[Comparison of Magnetic and Mechanical Center Positions of the Large Quadrupoles and Sextupoles in the DAFNE Main Rings Achromats](#)", MM-27, 23/5/1997.