

DAΦNE Transfer Line and Storage Ring



MAGNETS
FOR FUSION



MAGNETS FOR HIGH
ENERGY PHYSICS



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SERVICES & REPAIRS

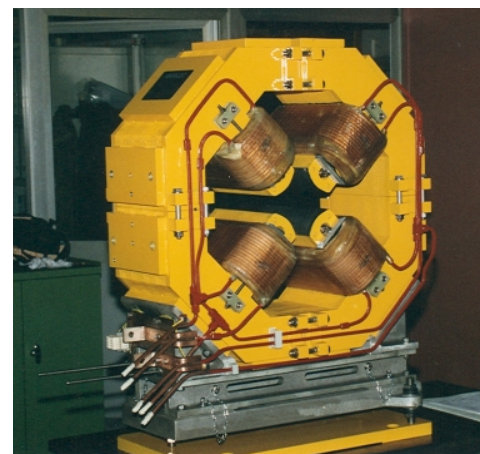
In 1993 the Company was awarded by INFN-LNF a contract for the turn-key construction of the Transfer Lines for the e⁺e⁻ factory DAΦNE in Frascati - Rome. The contract included resistive dipoles, quadrupoles and correctors of 14 different types, more than two hundred vacuum chambers and diagnostics, the whole support system, installation and preliminary alignment of the lines for a total length of about 155 m.

Besides the Company drew up a supply contract for about 16 dipoles, 28 large quadrupoles and 18 large sextupoles for the Storage Ring of the same project. Conceptual and detailed design have been developed on LNF baseline design.

DAΦNE Storage ring

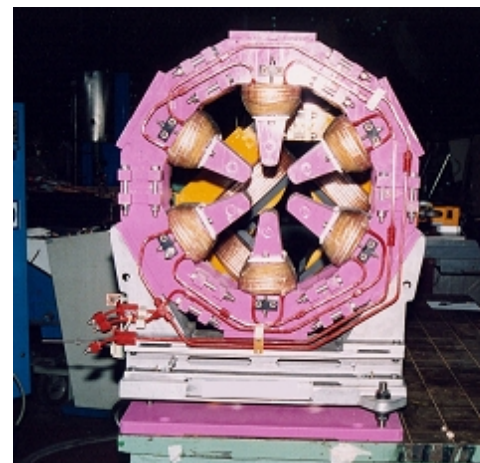
	Long	Short	
Energy	510	700	MeV
Gradient	3.6	8	T/m
Magnet Bore Diameter		54	mm
Good Field Region		±30	mm
Field Quality		<5 10 ⁻⁴	
Magnetic Length		300	mm
Ampere-Turns per Pole		65	
Current	65.9	146.5	A
Conductor Size		7 x 7	mm ²
Coolant Hole Diam.		4.5	mm
Magnet Resistance		0.114	Ohm
Power	0.5	2.45	kW
Water Circuits per Magnet		4	
Total Flow Rate		0.06	l/sec
Pressure Drop per Circuit		1.72	atm
Water Temp. Rise	2	10	°C

Type: **Laminated Yoke Quadrupole**
Yoke: **Low carbon steel Magnetil B-C**
Conductor: **OFHC copper**



	Long	Short	
Energy	510	700	MeV
Gradient	90	234	T/m
Magnet Bore Diameter		54	mm
Good Field Region		±30	mm
Field Quality		<5 10 ⁻⁴	
Magnetic Length		150	mm
Ampere-Turns per Pole	1900	4975	
Current	79.2	207.3	A
Conductor Size		7 x 7	mm ²
Coolant Hole Diam.		4.5	mm
Magnet Resistance		0.04	Ohm
Power	0.26	1.74	kW
Water Circuits per Magnet		2	
Total Flow Rate		0.04	l/sec
Pressure Drop per Circuit		2.4	atm
Water Temp. Rise	1.5	10	°C

Type: **Laminated Yoke Quadrupole**
Yoke: **Low carbon steel Magnetil B-C**
Conductor: **OFHC copper**





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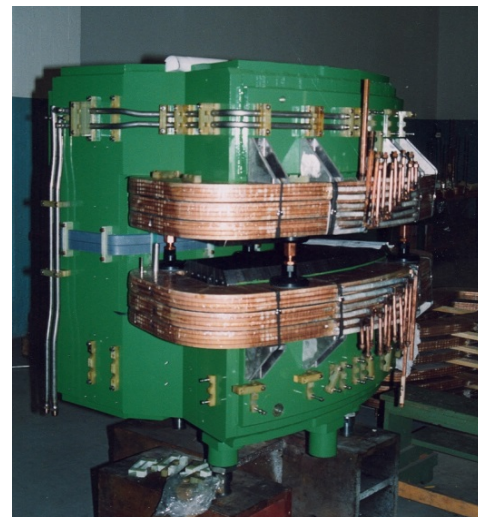


SERVICES & REPAIRS

DAΦNE Storage ring

	Long	Short	
Energy	510		MeV
Nominal Magnet Field	1.2		T
Bending Radius	1400		mm
Deflection Angle	49.5	40.5	degree
Magnetic Arc Length	1210	990	mm
Magnet Gap		75	mm
Good Field Region		±30	mm
Field Quality		±1.5 10 ⁻⁴	
Ampere-Turns per Pole		37834	
Current		262.8	Amp
Conductor Size		12 x 12	mm ²
Coolant Hole Diam.		7	mm
Magnet Resistance	0.22	0.20	Ohm
Power	15.6	13.7	KW
Water Circuits per Magnet		12	
Total Flow Rate	0.37	0.33	l/sec
Pressure Drop per Circuit	1.4	1	atm
Water Temp. Rise		10	°C

Type: **Laminated Yoke Sector Like Dipole**
 Yoke: **Low carbon steel Magnetil B-C**
 Conductor: **OFHC copper**



	Long	Short	
Energy	510		MeV
Nominal Magnet Field	1.2		T
Bending Radius	1400		mm
Deflection Angle	49.5	40.5	degree
Magnetic Arc Length	1210	990	mm
Magnet Gap		75	mm
Good Field Region		±30	mm
Field Quality		±1.5 10 ⁻⁴	
Ampere-Turns per Pole		37834	
Current		262.8	Amp
Conductor Size		12 x 12	mm ²
Coolant Hole Diam.		7	mm
Magnet Resistance	0.20	0.17	Ohm
Power	13.7	12.2	KW
Water Circuits per Magnet		12	
Total Flow Rate	0.33	0.30	l/sec
Pressure Drop per Circuit	1	0.72	atm
Water Temp. Rise		10	°C

Type: **Laminated Yoke Parallel End Dipole**
 Yoke: **Low carbon steel Magnetil B-C**
 Conductor: **OFHC copper**





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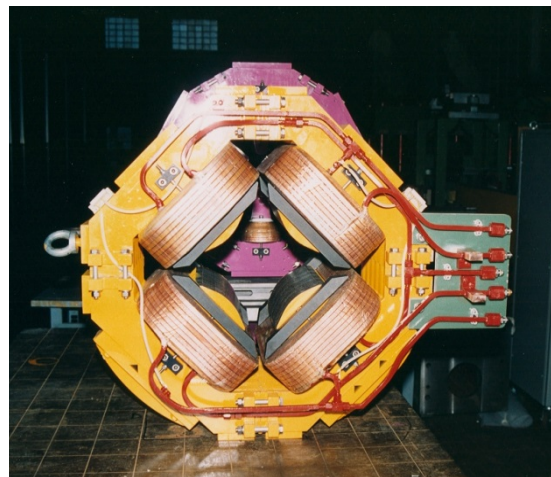
DAΦNE Storage ring

Energy	510	MeV
Gradient	6.2	T/m
Magnet Bore Diameter	100	mm
Good Field Region	±66	mm
Field Quality	<5 10 ⁻⁴	
Magnetic Length	300	mm
Ampere-Turns per Pole	24830	
Current	459.8	A
Conductor Size	10x10	mm ²
Coolant Hole Diam.	6	mm
Magnet Resistance	0.06	Ohm
Power	12.9	kW
Water Circuits per Magnet	4	
Total Flow Rate	0.15	l/sec
Pressure Drop per Circuit	2.6	atm

Type: **Laminated Yoke Large aperture Quadrupole**

Yoke: **Low carbon steel Magnetil B-C**

Conductor: **OFHC copper**



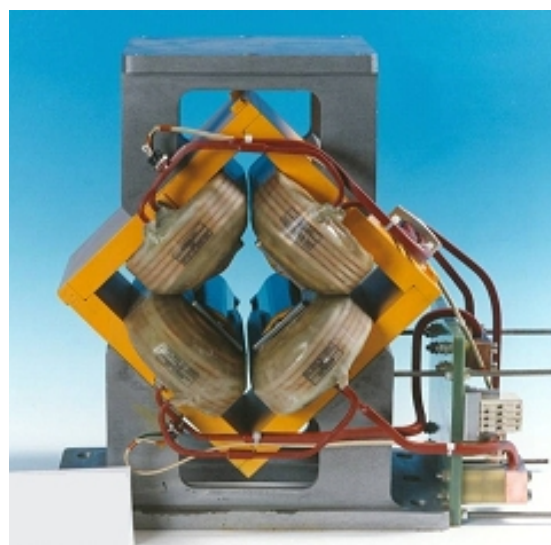
DAΦNE Transfer Line

Gradient	10	T/m
Magnet Bore Diameter	60	mm
Good Field Region	±25	mm
DG/G	+3.9 10 ⁻³ / -1.3 10 ⁻²	
Magnetic Length	200 ±2	mm
Ampere-Turns per Pole	3633	
Current	86.5	A
Conductor Size	5 x 5	mm ²
Coolant Hole Diam.	3	mm
Magnet Resistance	0.12	Ohm
Magnet Inductance	11.9	mH
Power	0.87	KW
Water Circuits per Magnet	2	
Total Flow Rate	0.012	l/sec
Pressure Drop per Circuit	2.7	atm
Water Temp. Rise	18	°C
Magnet Weight	95	Kg

Type: **Solid Yoke Quadrupole**

Yoke: **Low carbon steel (AISI 1006)**

Conductor: **OFHC copper**





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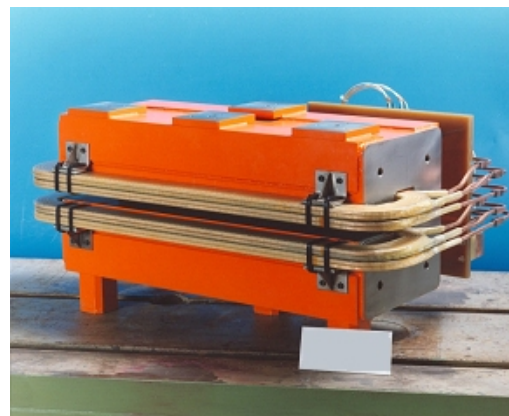
DAΦNE Transfer Line

Energy	800	MeV
Nominal Magnet Field	0.444	T
Bending Radius	6	mm
Deflection Angle	6.52	degree
Magnetic Arc Length	683 ±0.7	mm
Magnet Gap	25	mm
Good Field Region	±25	mm
Field Quality	-2.97 10 ⁻⁴ / +7.43 10 ⁻⁵	
Ampere-Turns per Pole	4423	
Current (peak)	184.3	Amp
Conductor Size	6 x 6	mm ²
Coolant Hole Diam.	3.5	mm
Magnet Resistance	0.066	Ohm
Magnet Inductance	10.4	mH
Power	2.24	KW
Water Circuits per Magnet	4	
Total Flow Rate	0.03	l/sec
Pressure Drop per Circuit	0.8	atm
Water Temp. Rise	18	°C
Magnet Weight	380	Kg

Type: **Laminated Yoke Pulsed C-type Dipole**

Yoke: **Non-oriented annealed electrical grade silicon steel sheets (Fe V 270-35 HA)**

Conductor: **OFHC copper**

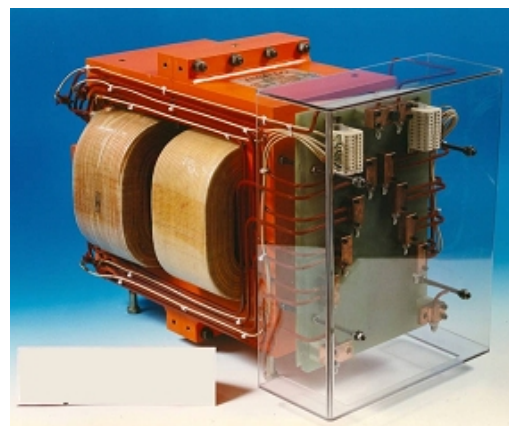


Energy	510	MeV
Nominal Magnet Field	0.933	T
Good Field Region	±23	mm
Field Quality	+0 / -8.6 10 ⁻⁴	
Bending Radius	1823	mm
Deflection Angle	11	degree
Magnetic Arc Length	350 ±0.4	mm
Magnet Gap	54	mm
Ampere-Turns per Pole	22800	
Current	95	A
Conductor Size	5 x 5	mm ²
Coolant Hole Diam.	3	mm
Magnet Resistance	0.6	Ohm
Magnet Inductance	311	mH
Power	5.4	KW
Water Circuits per Magnet	10	
Total Flow Rate	0.058	l/sec
Pressure Drop per Circuit	2.7	atm
Water Temp. Rise	22	°C
Magnet Weight	510	Kg

Type: **Solid Yoke H-Type Dipole**

Yoke: **Low carbon steel (AISI 1006)**

Conductor: **OFHC copper**





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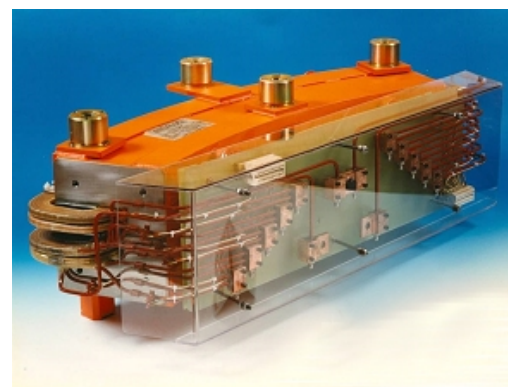
DAΦNE Transfer Line

Energy	510	MeV
Nominal Magnet Field	±1.2	T
Bending Radius	1417	mm
Deflection Angle	45	degree
Magnetic Arc Length	1113 ±1	mm
Magnet Gap	25	mm
Good Field Region	±25	mm
Field Quality	-1.57 10 ⁻³ / +0	
Ampere-Turns per Pole	13272	
Current (peak)	553	Amp
Conductor Size	6 x 6	mm ²
Coolant Hole Diam.	3.5	mm
Magnet Resistance	0.098	Ohm
Magnet Inductance	13	mH
Power	30	KW
Water Circuits per Magnet	12	
Total Flow Rate	0.29	l/sec
Pressure Drop per Circuit	2.9	atm
Water Temp. Rise	25	°C
Magnet Weight	600	Kg

Type: **Laminated Yoke Pulsed C-type Dipole**

Yoke: **Non-oriented annealed electrical grade silicon steel sheets (Fe V 270-35 HA)**

Conductor: **OFHC copper**

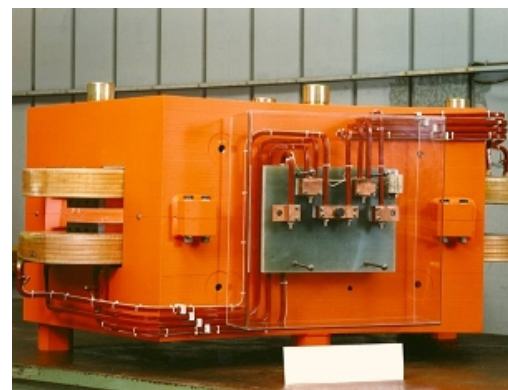


Energy	800	MeV
Nominal Magnet Field	1.549	T
Bending Radius	1723	mm
Deflection Angle	45	degree
Magnetic Arc Length	1353 ±1.4	mm
Magnet Gap	42	mm
Good Field Region	±20	mm
Field Quality	-7 10 ⁻⁴ / +0	
Ampere-Turns per Pole	28080	
Current (peak)	585	Amp
Conductor Size	12 x 12	mm ²
Coolant Hole Diam.	7	mm
Magnet Resistance	0.063	Ohm
Magnet Inductance	81.6	mH
Power	21.5	KW
Water Circuits per Magnet	4	
Total Flow Rate	0.2	l/sec
Pressure Drop per Circuit	3.0	atm
Water Temp. Rise	26	°C
Magnet Weight	4550	Kg

Type: **Solid Yoke H-type Dipole**

Yoke: **Low carbon steel (AISI 1006)**

Conductor: **OFHC copper**





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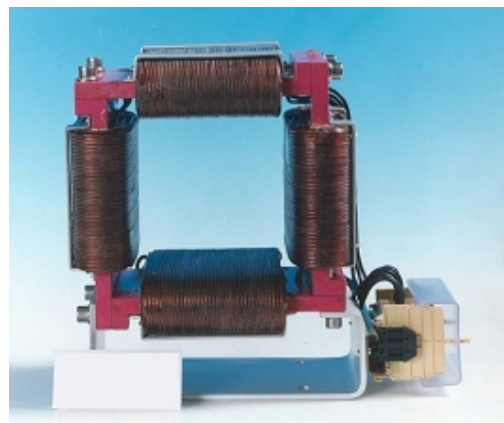
DAΦNE Transfer Line

Energy	510	MeV
Nominal Magnet Field	150	Gauss
Deflection Angle	0.1	degree
Magnetic Steel Length	100	mm
Magnetic Length	230 ±2	mm
Magnet Gap	154	mm
Ampere-Turns per Pole	1900	
Current	8	A
Wire Diameter	2.6	mm
Magnet Resistance	0.9	Ohm
Magnet Inductance	33.6	mH
Power	60	W
Magnet Weight	23	Kg

Type: **Corrector Magnet**

Yoke: **Low carbon steel (AISI 1006)**

Conductor: **Enamel coating type**



Type: **Solid Yoke H-type Dipole**
Yoke: **Low carbon steel (AISI 1006)**
Conductor: **OFHC copper**

Energy	510	MeV
Nominal Magnet Field	1.07	T
Bending Radius	1592	mm
Deflection Angle	36	degree
Magnetic Arc Length	1000 ±1	mm
Magnet Gap	31	mm
Good Field Region	±15	mm
Field Quality	-3.8 10 ⁻³ / +4.9 10 ⁻⁴	
Ampere-Turns per Pole	13720	
Current	98	Amp
Conductor Size	8 x 8	mm ²
Coolant Hole Diam.	5	mm
Magnet Resistance	0.41	Ohm
Magnet Inductance	1000	mH
Power	3.91	KW
Water Circuits per Magnet	6	
Total Flow Rate	0.046	l/sec
Pressure Drop per Circuit	1.7	atm
Water Temp. Rise	20	°C
Magnet Weight	5180	Kg

Type: **Laminated Yoke C-type Dipole**
Yoke: **Non-oriented, annealed electrical grade silicon steel sheets (Fe V 270-35 HA)**
Conductor: **OFHC copper**

Energy	510	MeV
Nominal Magnet Field	±1.2	T
Bending Radius	1417	mm
Deflection Angle	45	degree
Magnetic Arc Length	1113 ±1	mm
Magnet Gap	25	mm
Good Field Region	±25	mm
Field Quality	-1.57 10 ⁻³ / +0	
Ampere-Turns per Pole	13272	
Current	553	Amp
Conductor Size	6 x 6	mm ²
Coolant Hole Diam.	3.5	mm
Magnet Resistance	0.098	Ohm
Magnet Inductance	13	mH
Power	30	KW
Water Circuits per Magnet	12	
Total Flow Rate	0.288	l/sec
Pressure Drop per Circuit	2.9	atm
Water Temp. Rise	25	°C
Magnet Weight	610	Kg


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Type:	Solid Yoke H-type Dipole	
Yoke:	Low carbon steel (AISI 1006)	
Conductor:	OFHC copper	
Energy	800	MeV
Nominal Magnet Field	1.549	T
Bending Radius	1723	mm
Deflection Angle	60	degree
Magnetic Arc Length	1803 ±1.5	mm
Magnet Gap	30	mm
Good Field Region	±40	mm
Field Quality	-3.43 10 ⁻³ / +0	
Ampere-Turns per Pole	20416	
Current	232	Amp
Conductor Size	12 x 12	mm ²
Coolant Hole Diam.	7	mm
Magnet Resistance	0.135	Ohm
Magnet Inductance	471	mH
Power	7.25	KW
Water Circuits per Magnet	4	
Total Flow Rate	0.11	l/sec
Pressure Drop per Circuit	2.25	atm
Water Temp. Rise	16.4	°C
Magnet Weight	5840	Kg

Type:	Solid Yoke H-type Dipole	
Yoke:	Low carbon steel (AISI 1006)	
Conductor:	OFHC copper	
Energy	510	MeV
Nominal Magnet Field	1.217	T
Bending Radius	1396	mm
Deflection Angle	31.06	degree
Magnetic Arc Length	757 ±0.7	mm
Magnet Gap	20	mm
Good Field Region	±25	mm
Field Quality	-1.3 10 ⁻⁴ / +0	
Ampere-Turns per Pole	9956	
Current	155.6	Amp
Conductor Size	8 x 8	mm ²
Coolant Hole Diam.	5	mm
Magnet Resistance	0.12	Ohm
Magnet Inductance	145	mH
Power	2.9	KW
Water Circuits per Magnet	4	
Total Flow Rate	0.035	l/sec
Pressure Drop per Circuit	0.57	atm
Water Temp. Rise	32	°C
Magnet Weight	946	Kg

Type:	Solid Yoke H-type Dipole	
Yoke:	Low carbon steel (AISI 1006)	
Conductor:	OFHC copper	
Energy	510	MeV
Nominal Magnet Field	0.91	T
Bending Radius	1862	mm
Deflection Angle	13.88	degree
Magnetic Arc Length	451 ±0.5	mm
Magnet Gap	30	mm
Good Field Region	±15	mm
Field Quality	-1.7 10 ⁻⁵ / +0	
Ampere-Turns per Pole	11072	
Current	173	Amp
Conductor Size	8 x 8	mm ²
Coolant Hole Diam.	5	mm
Magnet Resistance	0.078	Ohm
Magnet Inductance	61.9	mH
Power	2.34	KW
Water Circuits per Magnet	2	
Total Flow Rate	0.03	l/sec
Pressure Drop per Circuit	1.9	atm
Water Temp. Rise	32	°C
Magnet Weight	560	Kg

Type:	Solid Yoke H-type Dipole	
Yoke:	Low carbon steel (AISI 1006)	
Conductor:	OFHC copper	
Energy	510	MeV
Nominal Magnet Field	1.184	T
Bending Radius	1436	mm
Deflection Angle	30.2	degree
Magnetic Arc Length	757 ±0.7	mm
Magnet Gap	30	mm
Good Field Region	±25	mm
Field Quality	-2.1 10 ⁻⁴ / +0	
Ampere-Turns per Pole	14912	
Current	233	Amp
Conductor Size	8 x 8	mm ²
Coolant Hole Diam.	5	mm
Magnet Resistance	0.12	Ohm
Magnet Inductance	101	mH
Power	6.476	KW
Water Circuits per Magnet	4	
Total Flow Rate	0.078	l/sec
Pressure Drop per Circuit	2.26	atm
Water Temp. Rise	20	°C
Magnet Weight	936	Kg



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Type: **Solid Yoke H-type Dipole**
Yoke: **Low carbon steel (AISI 1006)**
Conductor: **OFHC copper**

Energy	510	MeV
Nominal Magnet Field	1.2	T
Bending Radius	1417	mm
Deflection Angle	18.26	degree
Magnetic Arc Length	451 ±0.5	mm
Magnet Gap	30	mm
Good Field Region	±15	mm
Field Quality	-6.8 10 ⁻⁵ / +0	
Ampere-Turns per Pole	15232	
Current	238	Amp
Conductor Size	8 x 8	mm ²
Coolant Hole Diam.	5	mm
Magnet Resistance	0.078	Ohm
Magnet Inductance	60.2	mH
Power	4.45	KW
Water Circuits per Magnet	4	
Total Flow Rate	0.05	l/sec
Pressure Drop per Circuit	0.68	atm
Water Temp. Rise	21.5	°C
Magnet Weight	560	Kg

Type: **Solid Yoke H-type Quadrupole**
Yoke: **Low carbon steel (AISI 1006)**
Conductor: **OFHC copper**

Gradient	7	T/m
Magnet Bore Diameter	70	mm
Good Field Region	±30	mm
DG/G	-3.3 10 ⁻³ / -1 10 ⁻³	
Magnetic Length	300 ±2	mm
Ampere-Turns per Pole	3486	
Current	83	A
Conductor Size	5 x 5	mm ²
Coolant Hole Diam.	3	mm
Magnet Resistance	0.15	Ohm
Magnet Inductance	16.5	mH
Power	1.04	KW
Water Circuits per Magnet	2	
Total Flow Rate	0.01	l/sec
Pressure Drop per Circuit	2.5	atm
Water Temp. Rise	25	°C
Magnet Weight	120	Kg