TECHNICAL SPECIFICATIONS FOR A WATER COOLED ACTIVELY SHIELDED GRADIENT SYSTEM WITH RT SHIM SET

SGRAD 395/290/HD/S

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GENERAL DESCRIPTION

The SGRAD 395/290/HD/S is a fully self-shielded gradient system designed to suit ≥400mm room temperature bore superconducting magnets and gradient systems.

The design incorporates fully optimised X, Y and Z coil configurations. The X and Y coils are made from the highest quality copper plates machined with CNC technology. The Z coil is wound from heavy duty copper strip.

The /HD range of gradients have been engineered to allow for high duty cycle experiments.

The room temperature shim set has been specially designed to minimise coupling between gradients and shims during pulsing. Finally the gradient set is fully vacuum impregnated to minimise mechanical vibration and noise.

1. MECHANICAL

1.1	Dimensions and weight			
	Total length	:	To suit magnet	
	External diameter	:	395mm	±3mm
	Internal diameter	:	290mm	±0.5mm
	Approximate weight	:	250 kg	
1.2	Finish			
	Bore tube	:	Natural GRP	
	End plates	:	Plated aluminium	
1.3	Mounting			
	Method at access end	:	Flange bolted to magnet OVC	
	Method at service end	:	'O'-ring clamp	
	Adjustment	:	±5mm axially	
	Loading	:	Service end only	
1.4	Electrical connectors			
	Gradients	:	Lemo (ERA.6S.304.CLL)	
	Temperature sensors	:	Lemo (FGJ.4B.320.CLA)	
	RT shims	:	Lemo (FGJ.4B.324.CLL)	
1.5	Temperature sensors			
	Type	:	Type T thermocouples	
	Number on inner section	:	4 typical	
	Number of outer section	:	2 typical	
1.6	Water cooling system			
	Volumetric flow rate	:	6.6 litres/min	
	Supply pressure (typical)	:	4 bar	
	Internal pressure drop	:	2-3 bar	
	Heat extraction	:	4.7 kW for $\Delta T=10K$ and $T_{inlet}=10^0C$	
	Gradient connectors	:	Double shut-off connector	
	Fitting for supply hose	:	1/2" ID barbed hose fitting	
	Recommended water supply	:	Recirculating water chiller	

2. GRADIENT COILS

2.1	Strength			
	X/Y/Z axis		:	0.33mT/m/A ±5%
2.2	Linearity per axis (see figure 1) over 200mm DSV			
	X/Y		:	≤5%
	Z		:	≤5%
	Definition		:	% Linearity = Max spatial deviation as a percentage of the plotting radius.
2.3	Residual eddy currents (before pre-emphasis)[1]			
	X/Y/Z axis		:	< 1%
2.4	Inductance[2]			
	X axis		:	290μH ±15%
	Y axis		:	325μH ±15%
	Z axis		:	285μH ±15%
2.5	DC Resistance[2]			
	X axis		:	130mΩ ±25mΩ
	Y axiz		:	150mΩ ±25mΩ
	Z axis		:	215mΩ ±25mΩ
2.6	Safe operating conditions			
	Peak voltage		:	≤500V
	Peak current		:	≤300A
	RMS current		:	≤100A RMS indefinitely all axes together
			:	≤200A RMS indefinitely Y axis only
	Peak internal temperature		:	$\leq 60^0$C
2.7	Typical peak strength and rise-times (estimated)			
	Peak strength @300A X/Y/Z		:	100mT/m
	Rise-time[2] (0-98%)	X	:	280μs
	@ 300A, 350V	Y	:	320μs
		Z	:	300μs

[1] Measured 5ms after a 20ms trapezoidal pulse, and extrapolated to 1ms after the pulse.

[2] Excluding the effects of lead resistance and filter impedance.

2.8	Orthogonality		
	X to Y	:	90°+/-1°
2.9	Insulation		
	Between X, Y, Z, shims, sensors, cooling & enclosure	:	> 200 MΩ at 1000 Volts DC

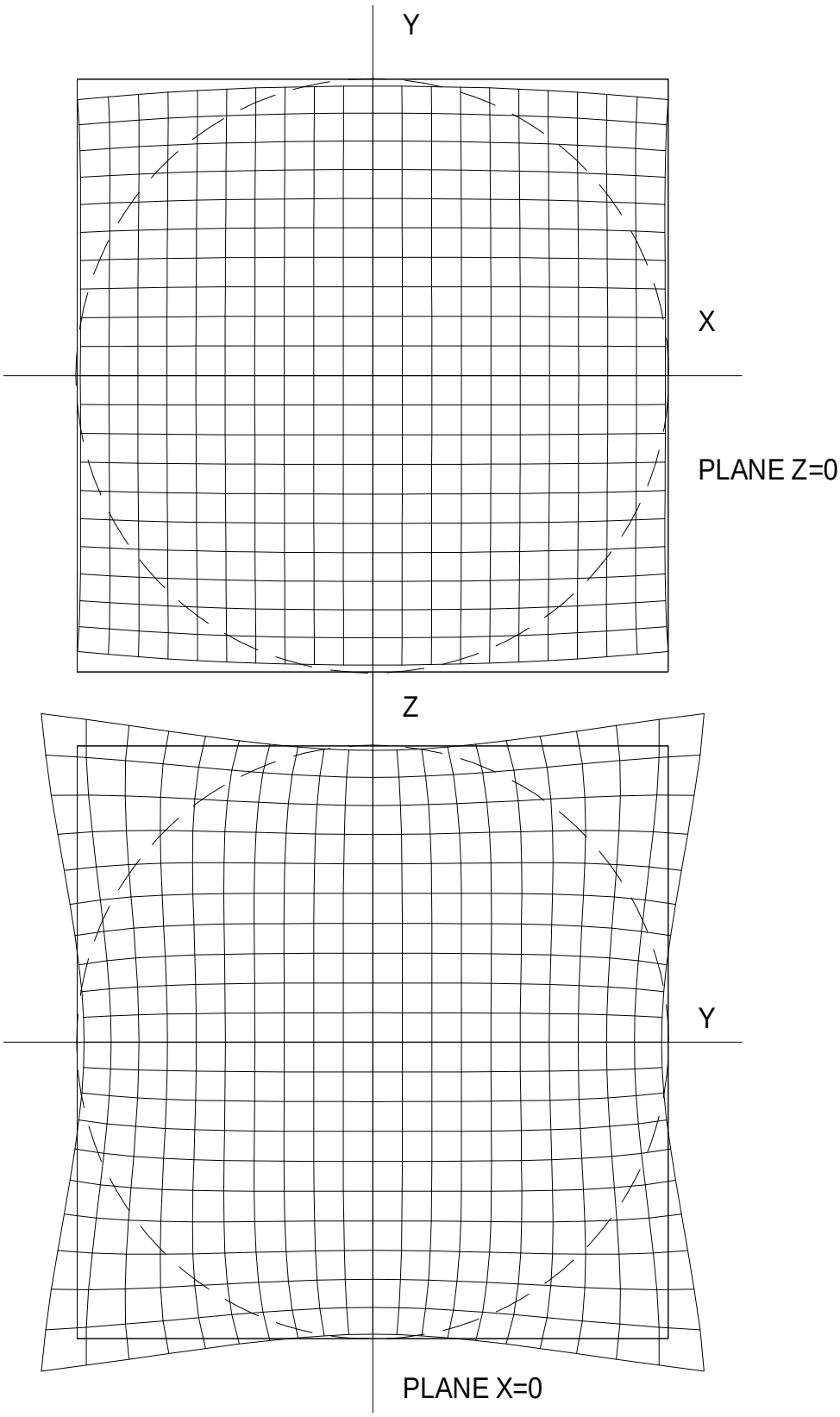

Figure 1 : Theoretical image distortion of a 200mm cube phantom. DSV is denoted by the dashed circle.

3. SHIM SYSTEM

3.1 Room temperature shims

First order shimming is achieved by DC offsets to the gradient coils. The nominal shim performances are shown below.

Shim	**Strength ($mG/cm^n/A$)**	**Inductance (mH)**	**Resistance (Ω)**	**Peak current (A)**
shielded Z^0 (B_0)	348	0.21	1.60	10
Z^2	16.6	10.4	2.35	10
ZX,ZY	5.1	5.00	2.05	10
XY,X^2-Y^2	2.5	3.05	2.35	10

4. SCOPE OF SUPPLY

4.1 Gradient:-

1 off	Actively shielded gradient, type SGRAD mk. IV 395/290/HD/S	

4.2 Standard ancillaries:-
(Not included on inserts)

1 off	Set of X/Y/Z cables, standard length 15m	C0463150
1 off	RT shim cable, standard length 15m	C0398150
1 off	Thermometry cable, standard length 15m	C0399150

4.3 Optional extras:-

1 off	Stand alone temperature monitor unit	E3515g
1 off	Gradient management unit, consisting of:- (i) Computer controlled X, Y and Z pre-emphasis (ii) Computer controlled Zo (Bo) pre-emphasis	E3500