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<u>TECHNICAL SPECIFICATIONS</u> <u>FOR A WATER COOLED ACTIVELY SHIELDED</u> <u>GRADIENT SYSTEM WITH RT SHIM SET</u>

SGRAD 305/210/HD/S

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GENERAL DESCRIPTION

The SGRAD 305/210/HD/S is a fully self shielded gradient system designed to suit \geq 310mm 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. <u>MECHANICAL</u>

1.1	Dimensions and weight			
	Total length	:	To suit magne	et
	External diameter	:	305mm	±3mm
	Internal diameter		210mm	+0.5mm
	Approximate weight		120kg	_0.011111
	ripproximate weight	•	120119	
12	Finish			
	Bore tube		Natural GRP	
	End plates		Plated alumin	ium
	The human	•		
1.3	Mounting			
	Method at access end	:	Flange bolted	to magnet OVC
	Method at service end	:	'O'-ring clam	p
	Adjustment		+5mm axially	L
	Loading		Service end or	nlv
	Louding	•		iii j
1.4	Electrical connectors			
	Gradients	:	Lemo (EGJ-5)	B-304-CLA)
	Temperature sensors	:	Lemo (EGJ-4)	B-320-CLA)
	RT shims	:	Lemo (EGJ-4)	B-324-CLA)
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1.5	Temperature sensors			
	Туре	:	Type T therm	ocouples
	Number on inner section	:	4 typical	
	Number of outer section	:	2 typical	
			51	
1.6	Water cooling system			
	Volumetric flow rate	:	5.6 litres/min	
	Supply pressure (typical)	:	4 bar	
	Internal pressure drop	:	2-3 bar	
	Heat extraction	:	4.2 kW for ΔT	$T=10K$ and $T_{inlet}=10^{\circ}C$
	Gradient connectors	:	Double shut-o	off connector
	Fitting for supply hose	:	3/8" ID barbe	d hose fitting
	Recommended water supply	:	Recirculating	water chiller

2. <u>GRADIENT COILS</u>

2.1	Strength				
	X/Y/Z axis		:	1.0mT/m/A ±5%	
2.2	Linearity per axis (se	e figure	1) over	120mm DSV	
	X/Y		:	≤6%	
	Z		:	≤5%	
	Definition		:	% Linearity =Max spatial deviation as a percentage of the plotting radius.	
2.3	Residual eddy curren	ts (befo	re pre-e	mphasis) ¹	
	X/Y/Z axis		:	< 0.5%	
2.4	Inductance ²				
	X axis		:	430μH ±15%	
	Y axis		:	450μH ±15%	
	Z axis		:	400µH ±15%	
2.5	DC Resistance ²				
	X axis		:	$250m\Omega \pm 25m\Omega$	
	Y axiz		:	$270 \mathrm{m}\Omega \pm 25 \mathrm{m}\Omega$	
	Z axis		:	$280m\Omega \pm 25m\Omega$	
2.6	Safe operating condit	tions			
	Peak voltage		:	≤300V	
	Peak current ³		:	≤300A	
	RMS current		:	≤70A RMS indefinitely all axes together	
			:	≤120A RMS indefinitely Y axis only	
	Peak internal tempera	ature	:	$\leq 60^{\circ}$ C	
2.7	Typical peak strength and rise-times (estimated)				
	Strength @300A	X/Y/Z	:	300mT/m	
	Peak strength		:	300mT/m	
	Rise-time ² (0-98%)	Х	:	573µs	
	@ 300A, 300V	Y	:	616µs	
		Ζ	:	556µs	

¹ Measured 1ms after a 20ms trapezoidal pulse.

² Excluding the effects of lead resistance and filter impedance.

³ Maximum Pulse Length at Peak Current = 20ms

2.8	Orthogonality		
	X to Y	:	90°+/-1°

2.9 Insulation Between X, Y, Z, shims, : $> 200 \text{ M}\Omega \text{ at } 1000 \text{ Volts DC}$ sensors, cooling & enclosure



Theoretical image distortion of a 120mm cube phantom. DSV is denoted by the dashed circle.

3. <u>SHIM SYSTEM</u>

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)	380	0.10	0.85	10
Z^2	29.7	5.20	2.35	10
ZX,ZY	12.2	3.10	1.80	10
$XY, X^2 - Y^2$	5.60	2.20	2.25	10

4. <u>SCOPE OF SUPPLY</u>

4.1	Gradient:-				
1 off	Actively shielded gradient, type SGRAD mk IV 305/210/HD/S				
4.2	Standard ancillaries:- (Not included on inserts)				
1 off	Set of X/Y/Z cables, standard length 15m	C0397150			
1 off	RT shim cable, standard length 15m	C0398150			
1 off	Thermometry cable, standard length 15m	C0399150			
4.3	Optional extras:-				
2 off	RF doors (Lemo type)	ARZ330642			
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			