

Vertical Bore Imaging, 3-Axes Gradient Probes

Gradient Probes

for High-Field Vertical Bore MRI Microscopy

5 mm to 12 mm Imaging Probes

- Highest S/N
- 350 G/cm at 2.3% duty cycle, water cooled
- Quick, convenient, multi-X tuning
- For magnets up to 900 MHz
- 5, 8, 10, or 12 mm RF Coils

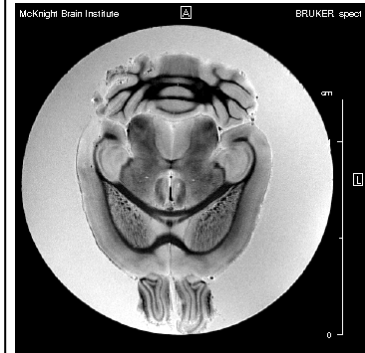
Our MRI probe is designed for high-field magnets with 40 to 72 mm inside the RT shims. The MRI probe includes the 26-40 gradient coil and ^1H or $^1\text{H}/\text{X}$, rf *Litz* coils. This probe is normally provided with conventional top "NMR-tube" access. The probe permits highest gradients at highest fields.

Effectiveness of the litzcage coil can be seen in the 50 micron resolution of the mouse brain and baby shark images taken at 750 MHz.

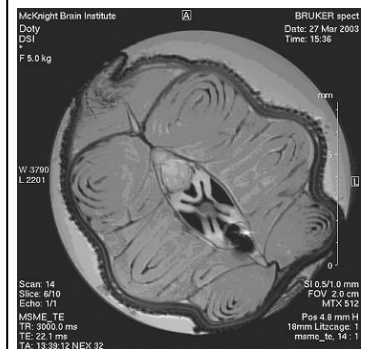


NB MRI Probe with 26-40 Gradients and an RF coil

50-micron resolution
Using 21 mm CP *Litzcage* at 750 MHz inside a Doty vertical bore imaging probe. Courtesy of Dan Plant, Univ. of Florida.



Mouse Brain



Baby Sharpnose Shark,

RF Litz Volume Coils For NB or WB Vertical Bore Probes

Probe O.D. (mm)	RF Coil I.D. (mm)	Shield Diameter (mm)	Tuning	^1H MHz	Mod. Load τ_{90} 's (μs)		Heavy Load τ_{90} 's (μs)	
					^1H	^{31}P	^1H	^{31}P
40-72	10	26	$^1\text{H}/\text{X}$	500	9	12	10	14
40-72	12	26	^1H	500	9	-	12	-
40-72	10	26	$^1\text{H}/\text{X}$	600	11	13	12	15
40-72	12	26	^1H	800	10	-	16	-

For the above coils, the length of homogeneous region is 80% of the coil ID. Coils with a multi-x channel normally tune ^{31}P through ^{13}C simply by changing plug-in capacitors. All coils feature simple tuning, high B_1 homogeneity, external rf shield, and susceptibility matching near the sample region.

Small MRI 3-Axes Gradient Coils

All models feature active shielding and B_0 eddy current compensation.

- ✓ **Maximum Sample Volume** ✓ **Low Noise and Vibration** ✓ **High Continuous Gradients**

Advances in hardware for magnetic resonance imaging (MRI) are needed to improve image quality, ease of use, and functionality in high-field MRI research using small-animal models. Doty's MRI gradient coils fill this need.

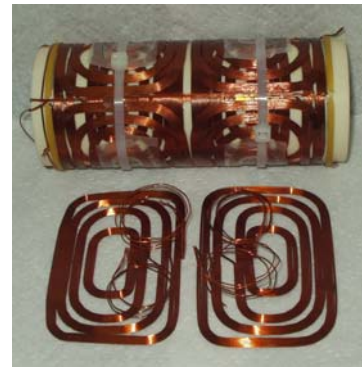
Low-amplitude B_0 eddies are induced in the magnet radiation shields primarily from minute variations in coil diameters along the axis or from axial registration errors between the gradient and shield coils. Our use of alumina ceramic for both the gradient and shield formers allows higher precision to be maintained, and low-amplitude eddy current to be minimal. Ceramic coil forms, together with heavy Golay windings dramatically reduce vibration and noise, even at the highest fields.

Any remaining B_0 eddy is compensated by a time-dependent correction applied to a B_0 shim coil. Another advantage of the alumina coil form is its very high thermal conductivity, which helps equilibrate hot spots. The cooling requirements are then satisfied with relatively minor constraints on the winding geometry.

Higher-order eddies are minimized by active shielding. Our coil designs often achieve a factor of 2 better shielding of the transverse gradients than alternative designs.

There is a strong benefit from gradient coil construction with an alumina ceramic coilform and multilayer windings. We significantly reduce acoustic noise, vibration, and recovery time, compared to gradient coils from other microscopy MR vendors.

Parameter	Model 16-39	Model 26-40	Units
Cooling method	water	water	
diameter (d_i) for 4% local deviation	5	14	mm
length (z_i) for 4% local deviation	12	17	mm
diameter (d_i) for 10% local deviation	7	18	mm
length (z_i) for 10% local deviation	17	22	mm
Nearest Gradient Null point	9.2	15.4	mm
Outside diameter, d_o	39.0	39.6	mm
Coil half-length, h_1	36	36.1	mm
RF shield diameter, d_s	16	26	mm
Clear bore, d_j	14	23.6	mm
Max inductance, L	86	37	μH
Max DC resistance, R_E	1.5	1.4	Ω
Min gradient gain, α	200	48	mT/Am
Max shielding error at $1.5 d_o$	0.5	0.4	%
Min slew rate, $G_S = \alpha V/L$, at 1 V	2800	1,189	T/m/s
Continuous current, I_{RMS}	10	11	A
Continuous gradient, G_C	200	53	G/cm
Peak Voltage	120	120	V
Approx. EPI Acoustic Noise, 7 T	70	70	dBa
Rise time to G_C for 100 V	9	4.6	μs
Total mass	0.5	0.4	kg



gradients partially assembled



Local deviation (or differential linearity) is defined as the rms deviation from the mean gradient over the specified diameter, d_i , and length, z_i , of the cylindrical sample region. The half-length h_1 is the distance from the center to the closer of the two external end surfaces. Eddy currents from the internal RF shield are negligible. The gradient slew rate G_S is the instantaneous rate of change in gradient when a 1 V step is applied. The continuous current ratings are *true* continuous ratings for a single axis with no time limit and adequate cooling. Derate the current 30% when all three axes are driven simultaneously.