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MAGNETIC FIELD VERSUS COIL CURRENT FOR THE DIPOLE MAGNET

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Magnetic field versus coil current for the dipole magnet

objective: To determine the relation between the magnetic field and the coil current for the dipole magnet and to check the alignment of the magnet with respect to the barrel.

The following procedure was adopted for determining the magnetic field versus coil current for the dipole magnet.

1. The target fixed with three Hall probes, labeled top, back and side, with their planes mutually perpendicular to each other, was mounted on to the target ring holder. With a current of 218 Amps in the dipole magnet coils, the outputs of the three Hall probes were measured. The orientation of the target ring holder was adjusted until the readings for the back and the side Hall probes were 0.0 and -0.3 mv respectively. This indicates that the plane of the target ring holder contains the dipole field and it is perpendicular to the solenoid field.

2. In this position of the target holder, the top Hall probe reading was measured for various values of dipole current. Up to 315 Amp current, the Hall voltages for back and side Hall probes were also measured. The maximum readings were 0.5mv for side Hall probe and 0.1mv for back Hall probe. The Hall voltage recorded for various dipole coil current are tabulated in table I.

3. Top Hall probe was removed from the target and calibrated using standard magnets. Table II shows the measured Hall voltage in the standard magnetic field. The present Hall voltage values are within 0.2% of the values reported by J. B. Aidun in his thesis.

4. Top Hall probe was again attached to the standard target which was then mounted on the target holder. Hall probe reading for 318 Amp current in the dipole magnet

was recorded. This reading was close to that measured in step 2. This indicates that the target holder was not disturbed.

5. Using the calibration for Top Hall probe measured in step (3), the Hall voltages in table I were converted to the magnetic fields. This magnetic field versus coil current data is tabulated in table III. Table III also compares the measured magnetic field and coil current data supplied along with the magnet. (Please see the note of Dr. Y. M. Gupta dated July 16, 1982.) Figure 1 graphically displays the magnetic field versus coil current data.

6. Steps 1-5 measure the dipole field but do not ensure that the axis of the magnet (solenoid) is aligned with that of the barrel. If we show that the plane of the target holder is perpendicular to the barrel axis, or it is parallel to the face of the impactor mounted on the projectile inserted in the barrel, then we can infer that the axis of the magnet and the barrel coincide. So, the parallelism between the target holder face and the impactor face was examined by measuring the depth of the impactor at four locations with respect to the face of the target holder. The depths at the four positions are recorded in table IV. The tilt is about 1 mrad. This implies that the axis of the magnet coincides with that of the barrel within one milliradian.

7. To reassure that the barrel axis and the solenoid field axis coincide another technique was used. A standard long Lucite projectile was inserted into the barrel. This projectile had a key which fits into the slot of the barrel and avoids its rotation. Its end that was projecting out of barrel held three mutually perpendicular Hall probes: one with its face normal to the barrel axis (back Hall probe), second with its face normal to the barrel diameter through the slot (top Hall probe) and, the third with its face normal to the other two Hall probes (side Hall probe). A locking

pin on the projectile allows to position the Hall probes in the center of the area where magnetic field is expected to be uniform. The signal of these Hall probes for different dipole current and solenoid current are recorded in table V. This table shows that when only dipole currents is on, the back and side Hall probes show almost zero signal indicating that the dipole magnetic field is along the diameter of the gun passing through the slot. It also shows that when only the solenoid current is on, the top and the side Hall probes signals are almost zero indicating that the solenoid field is along the axis of the barrel. This confirms that the magnet solenoid axis coincide with the barrels axis and the dipole field is along the diameter of the barrel passing through its slot.

TABLE I

Measured Hall voltages for various coil currents

Power supply used is PS1 (500Amp)
Current through the Hall probe = 100.01 mA

Coil Current (A)	VH Top mV	VH Side mV	VH back mV
0	-000.2	-000.1	-000.2
218	-45.1	-000.3	0.0
237	-48.9	-000.4	0.0
277	-57.0		0.1
315	-64.1	+000.5	0.1
358	-72.1		
396	-77.9		
436	-83.7		
472	-88.8		
472	-88.7		
512	-94.1		
512	-94.0		
318*	-64.7		

* measurement made after Hall probe calibration

Table II
Calibration of Top Hall probe

Mag field	Current	Hall voltage	K_H(G/mv)	Avg. (G/mv)
2.80kG	100.01mA	86.3.mV	32.44	
	100.00	-86.4	32.41	32.44
3.00	100.00	92.4	32.46	
	100.00	-92.4	32.46	

Table III
Comparison of measured and calculated dipole magnetic field

dipole current (A)	Hall voltage (mV)	*B* (Gauss)	Calculated * *B* (Gauss)	ΔB (Gauss)
0	-0.2	0		
218	45.1	1463	1370	92
237	48.9	1586		
277	57.0	1849	1724	125
315	64.1	2079		
358	72.1	2339	2178	161
396	77.9	2527		
436	83.7	2715	2561	154
472	88.8	2881		
512	94.1	3053	2858	195
318	64.7	2099		

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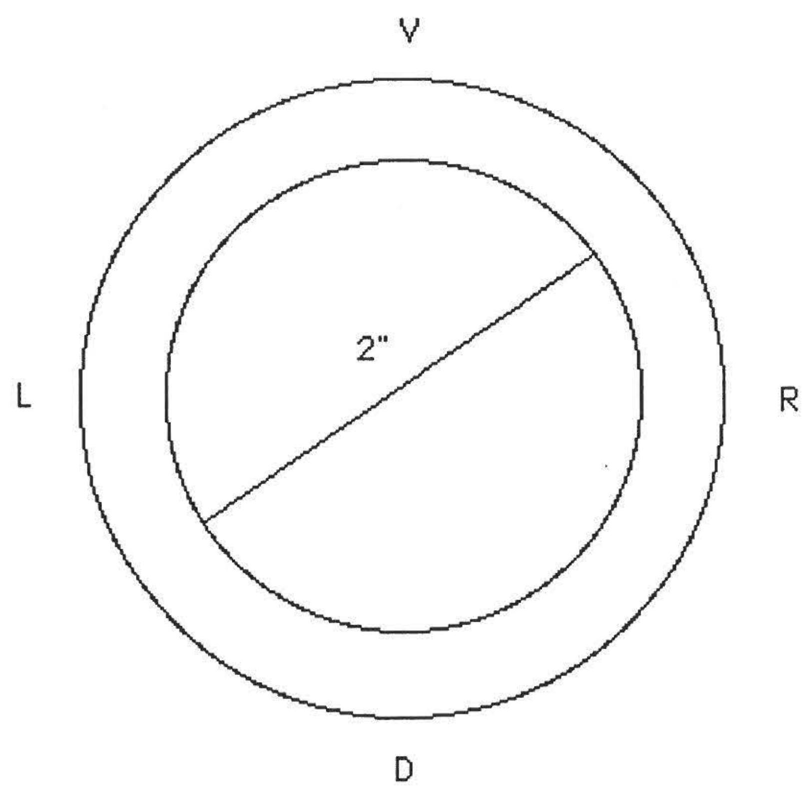
* using expression $B_D=6.346I_D - 5.697 \times 10^{-9} I_D^4$

Table IV
Dial indicator reading with respect to various locations on the impactor face (dial gauge was located one inch away from the axis of the barrel).

Vertical	.455inch
Right 90°	.452
down	.454
left 90°	.450



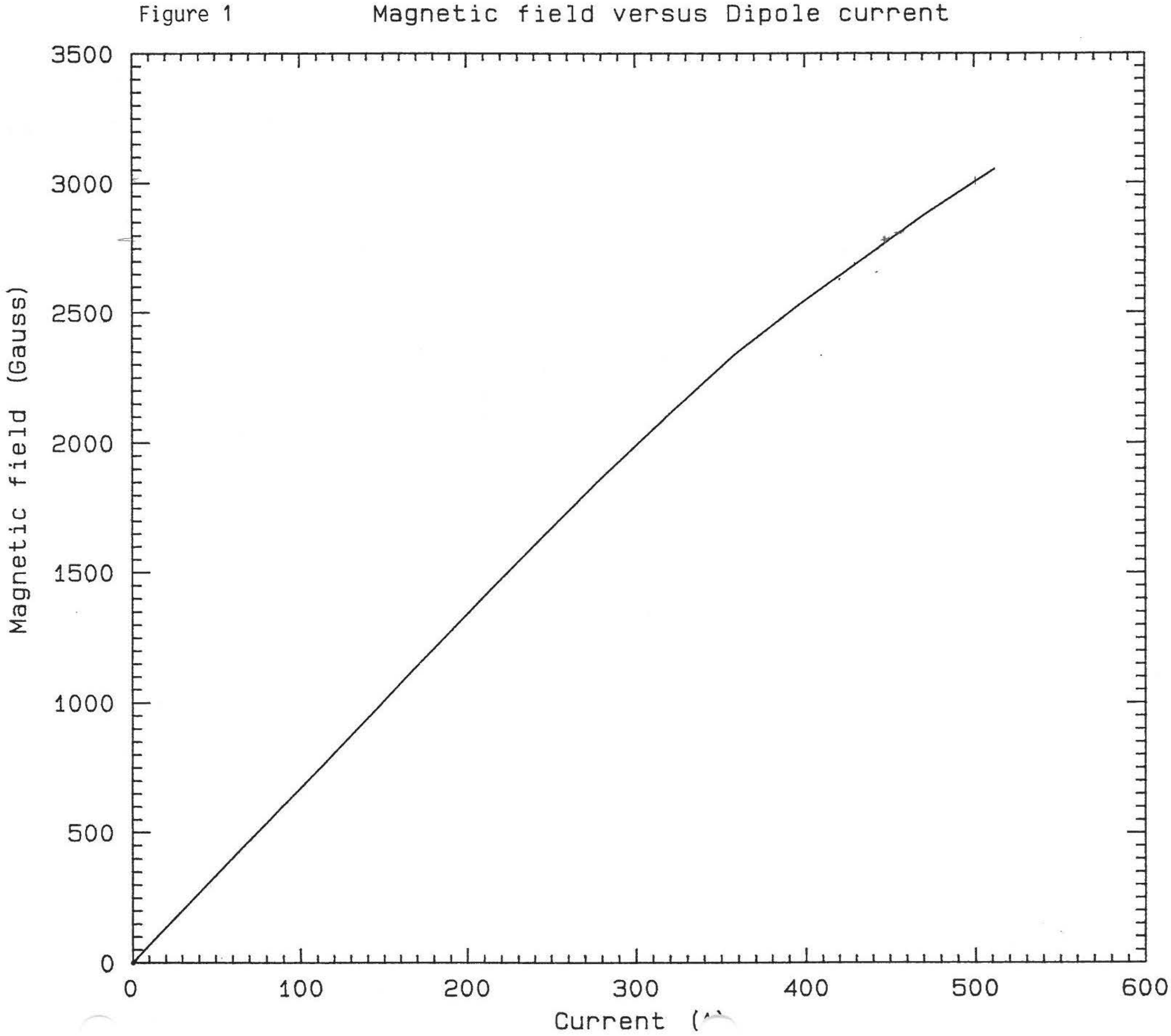
top to bottom 0.5mrad
left to right 1.0mrad

Table V
Hall Current = 100.01mA

dipole coil current (A)	VHtop (mV)	VHside (mV)	VH back (mV)
0.1	-0.4	-0.1	-0.2
233	-25.7	+0.1	-0.4
416	-42.7	+0.3	-0.5
511	-49.3	+0.4	-0.6
Solenoid current			
0	-.4	-.2	-.2
153.8	+.1	+.3	+26.4
287.2	+.5	+.6	+49.6

B(I)

Figure 1



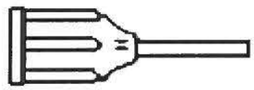
Magnetic field versus Dipole current
Magnetic field (Gauss)
3500
3000
2500
2000
1500
1000
500
0
0
100
200
300
400
500
600
Current (A)

CAMMDA CORPORATION

REFERENCE CHART FOR SPECIALIZED DISPENSING TIPS

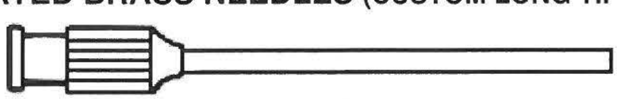
PART NUMBER	DESCRIPTION	SHAFT LENGTH (in.)	I.D. (in.)	O.D. (in.)	PKG QTY	NOTES

ALUMINUM NEEDLES



PART NUMBER	DESCRIPTION	SHAFT LENGTH (in.)	I.D. (in.)	O.D. (in.)	PKG QTY	NOTES
TS 14M-1/2-B	14GA. Alum. Hub Needle	0.50	.063	.083	25	**CONFIGURATION**
TS 14M-1-B	14GA. Alum. Hub Needle	1.00	.063	.083	25	• Aluminum Luer Lock Hub • Stainless Steel Shaft
TS 14M-2-B	14GA. Alum. Hub Needle	2.00	.063	.083	25	• Precision Burr-free Blunt Ends • Solvent Flushable
TS 14M-3-B	14GA. Alum. Hub Needle	3.00	.063	.083	25	• Re-usable
TS 15M-1/2-B	15GA. Alum. Hub Needle	0.50	.054	.072	25	
TS 15M-1-B	15GA. Alum. Hub Needle	1.00	.054	.072	25	**RECOMMENDED FOR DISPENSING**
TS-15M-1-1/2-B	15GA. Alum. Hub Needle	1.50	.054	.072	25	• Solvents • Epoxies
TS 16M-1-B	16GA. Alum. Hub Needle	1.00	.047	.065	25	• Lubricants
TS 18M-1-B	18GA. Alum. Hub Needle	1.00	.033	.049	25	
TS 22M-1-B	22GA. Alum. Hub Needle	1.00	.016	.028	25	
TS 23M-1-B	23GA. Alum. Hub Needle	1.00	.013	.025	25	
TS 25M-1-B	25GA. Alum. Hub Needle	1.00	.010	.020	25	

NICKEL PLATED BRASS NEEDLES (CUSTOM LONG TIP AVAILABLE)



PART NUMBER	DESCRIPTION	SHAFT LENGTH (in.)	I.D. (in.)	O.D. (in.)	PKG QTY	NOTES
660-0108-06	8GA. NI/Brass Needle	2.00	.135	.165	1	• Nickel Brass Luer Lock Hub • Stainless Steel Blunt Shaft • Re-usable
660-0110-06	10GA. NI/Brass Needle	2.00	.106	.134	1	

660-0112-06	12GA. NI/Brass Needle	2.00	.085	.109	1	• For Use with High Viscosity Fluids
660-0113-06	13GA. NI/Brass Needle	2.00	.071	.095	1	

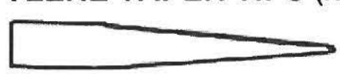
TEFLON NEEDLES

660-0004-60	14GA. All Teflon Needle, Orange	2.00	.063	.083	10	• Flexible Teflon Shaft • Teflon Luer Lock Hub • Re-usable • For Use With Solvents Or Cyanoacrylates
660-0006-60	16GA. All Teflon Needle, Gray	2.00	.047	.065	10	
660-0008-60	18GA. All Teflon Needle, Blue	2.00	.033	.049	10	
660-0010-60	20GA. All Teflon Needle, Pink	2.00	.023	.039	10	

POLYETHYLENE NEEDLES

TS 15P-1-1/2B	15GA. Polyethylene Needle, Grey	1.50	.054	.072	10	• Flexible All Plastic Tips • Luer Lock Hub • Corrosion Resistant • For Use With All Types of Adhesives Including Cyanoacrylates
TS 16P-1-1/2B	16GA. Polyethylene Needle, Brown	1.50	.047	.067	10	
TS 18P-1-1/2B	18GA. Polyethylene Needle, Red	1.50	.032	.053	10	
TS 20P-1-1/2B	20GA. Polyethylene Needle, Yellow	1.50	.024	.039	10	
TS 22P-1-1/2B	22GA. Polyethylene Needle, Black	1.50	.015	.032	10	
TS 25P-1-1/2B	25GA. Polyethylene Needle, Red	1.50	.013	.029	10	

POLYPROPYLENE TAPER TIPS (NON-LOCKING)



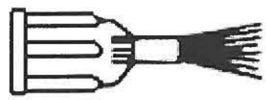
CT 18-B	18GA. Polypropylene Taper Tip	1.50	.032	N/A	10	• Luer Slip (Non-locking) • Max Flow - Min. Obstruction • For Heavily Filled Compounds
CT 20-B	20GA. Polypropylene Taper Tip	1.50	.024	N/A	10	
CT 22-B	22GA. Polypropylene Taper Tip	1.50	.015	N/A	10	

POLYPROPYLENE TAPER TIPS (LUER-LOCKING)

TT 14-1-1/4-B	14GA. Polypropylene Taper Tip, Tan	1.25	.063	N/A	50	• Luer Lock Hub • Same Uses As CT Tips • Also Good With
TT 16-1-1/4-B	16GA. Polypropylene	1.25	.047	N/A	50	

	Taper Tip, Grey					Cyanoacrylates
TT 18-1-1/4-B	18GA. Polypropylene Taper Tip, Pink	1.25	.032	N/A	50	
TT 20-1-1/4-B	20GA. Polypropylene Taper Tip, Yellow	1.25	.024	N/A	50	
TT 22-1-1/4-B	22GA. Polypropylene Taper Tip, Black	1.25	.015	N/A	50	

NEEDLE BRUSHES



660-5140-00	Soft Bristle Brush	.050	.054	.250	1	• Luer Locking Needle Brushes
660-5141-00	Stiff Bristle Brush	.050	.054	.250	1	• Use With Lubricants and Solvents

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