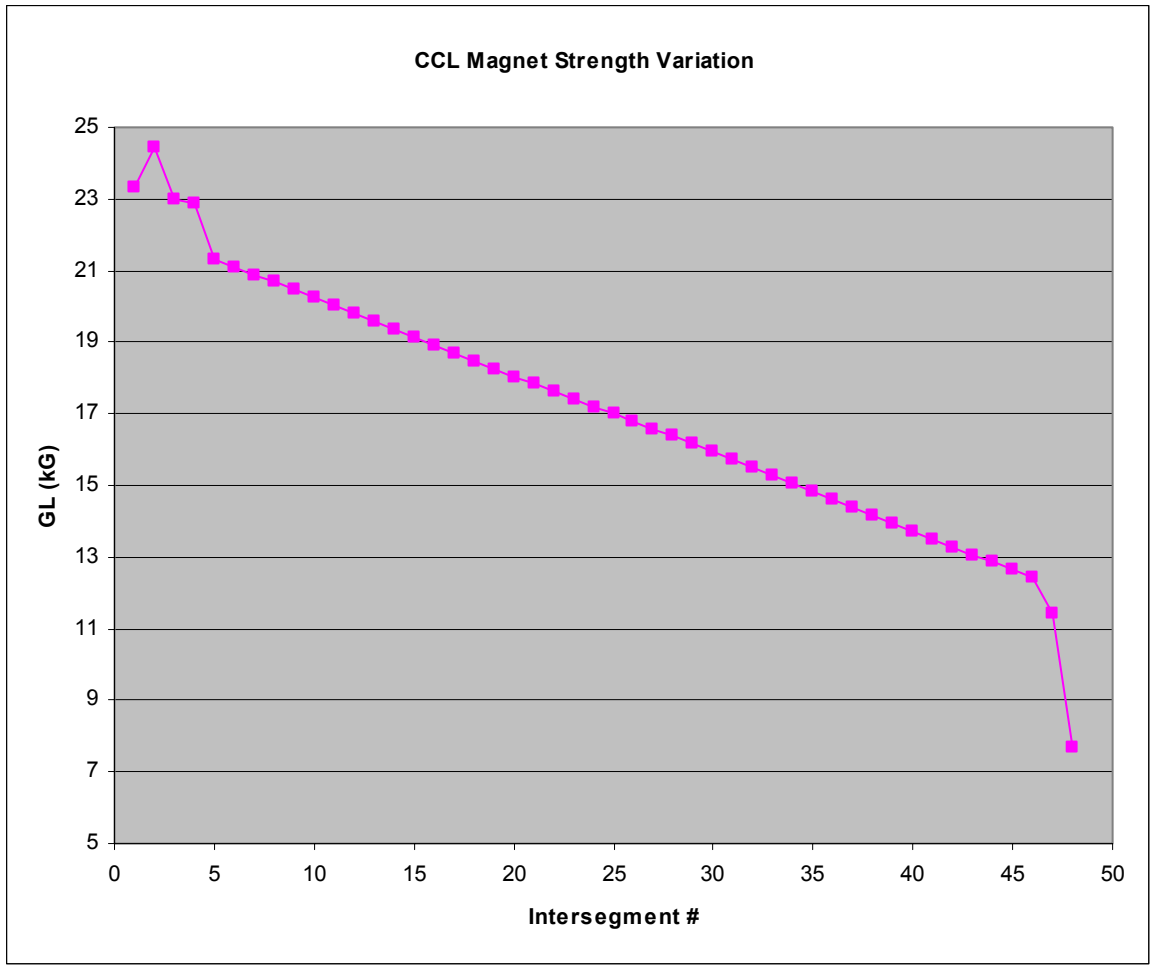
SNS Linac Magnet Design Simulations at LANL

Ted Hunter

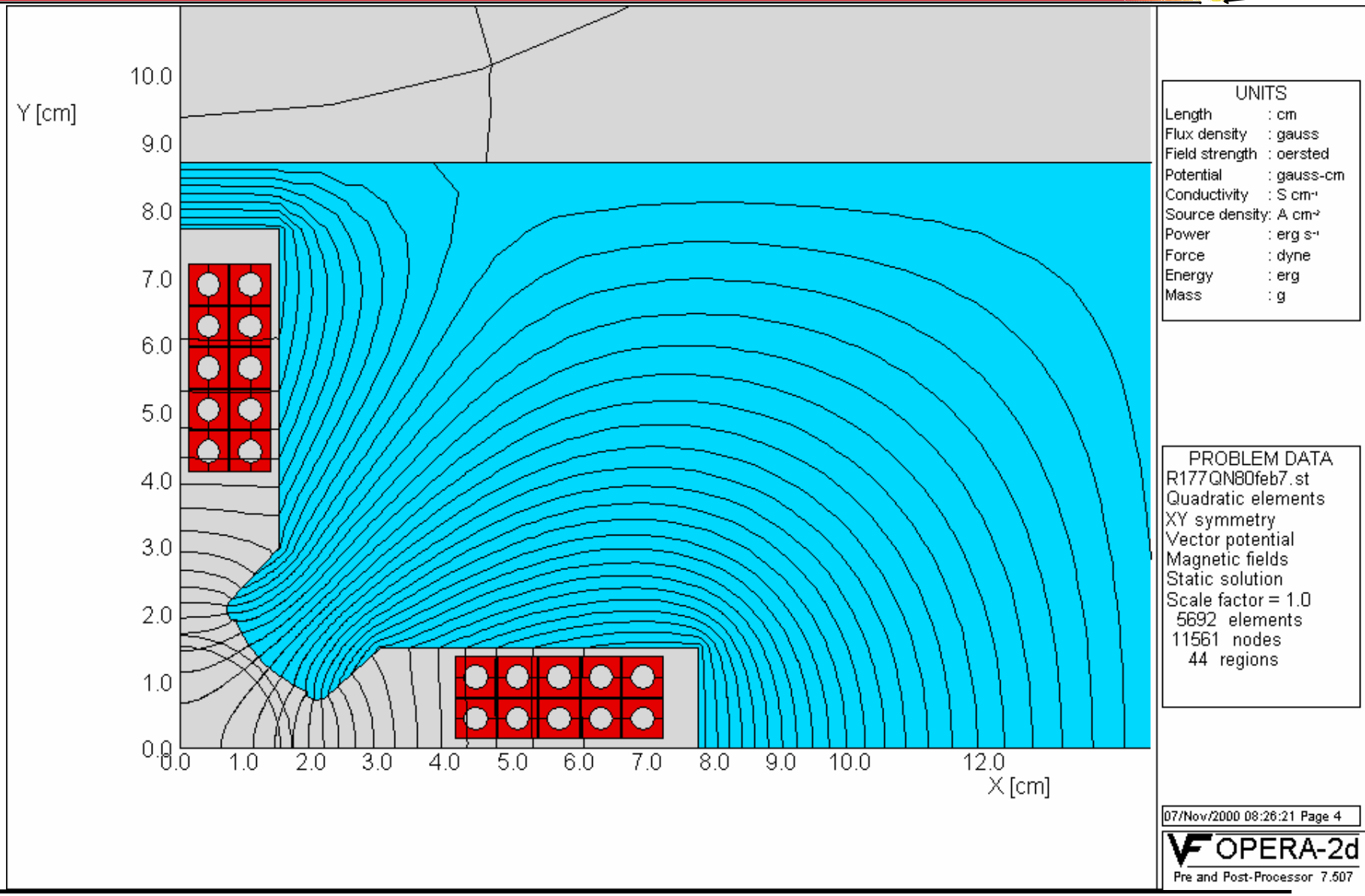
ORNL

May 18, 19, 2005

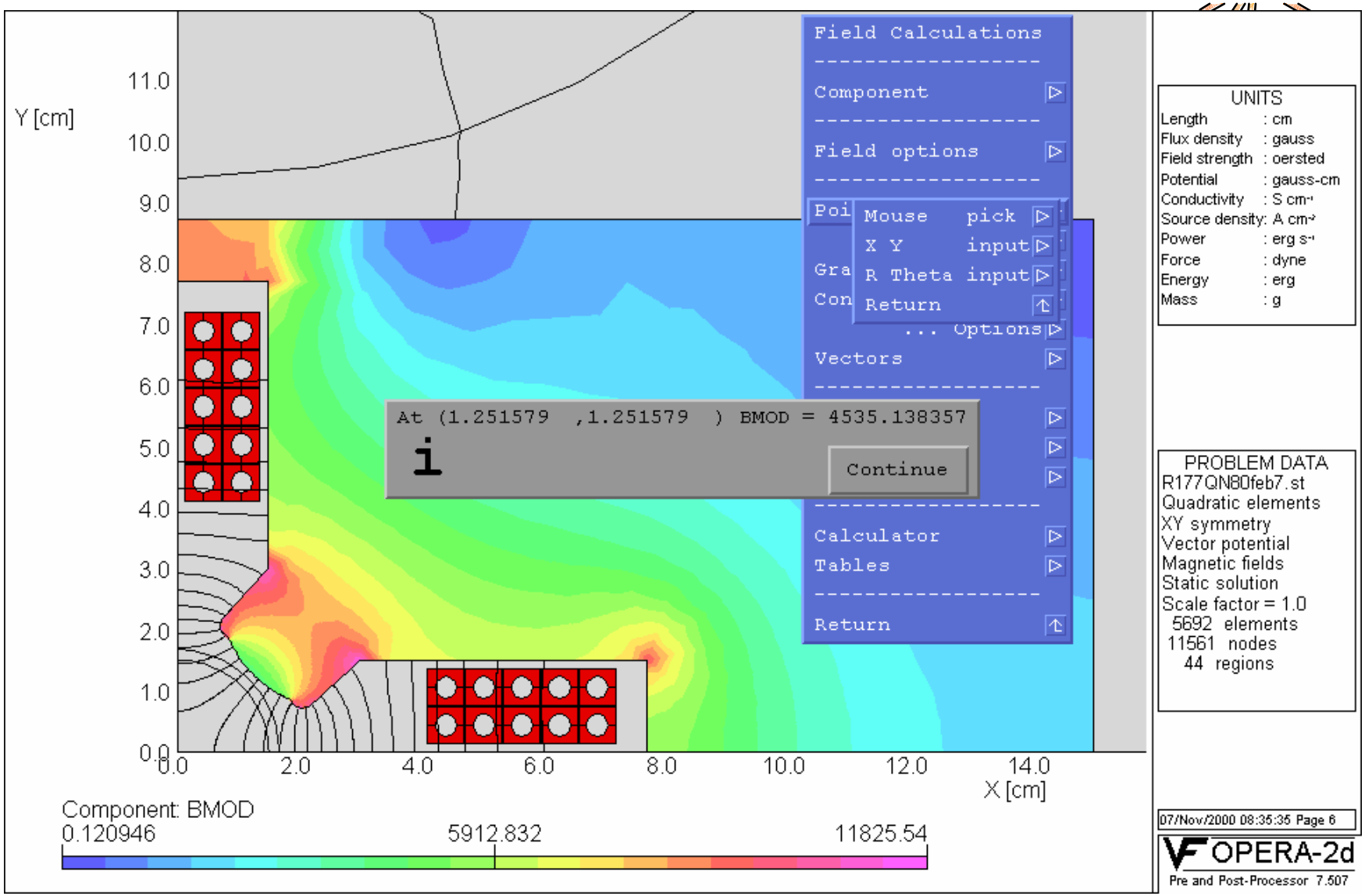
CCL Quadrupoles



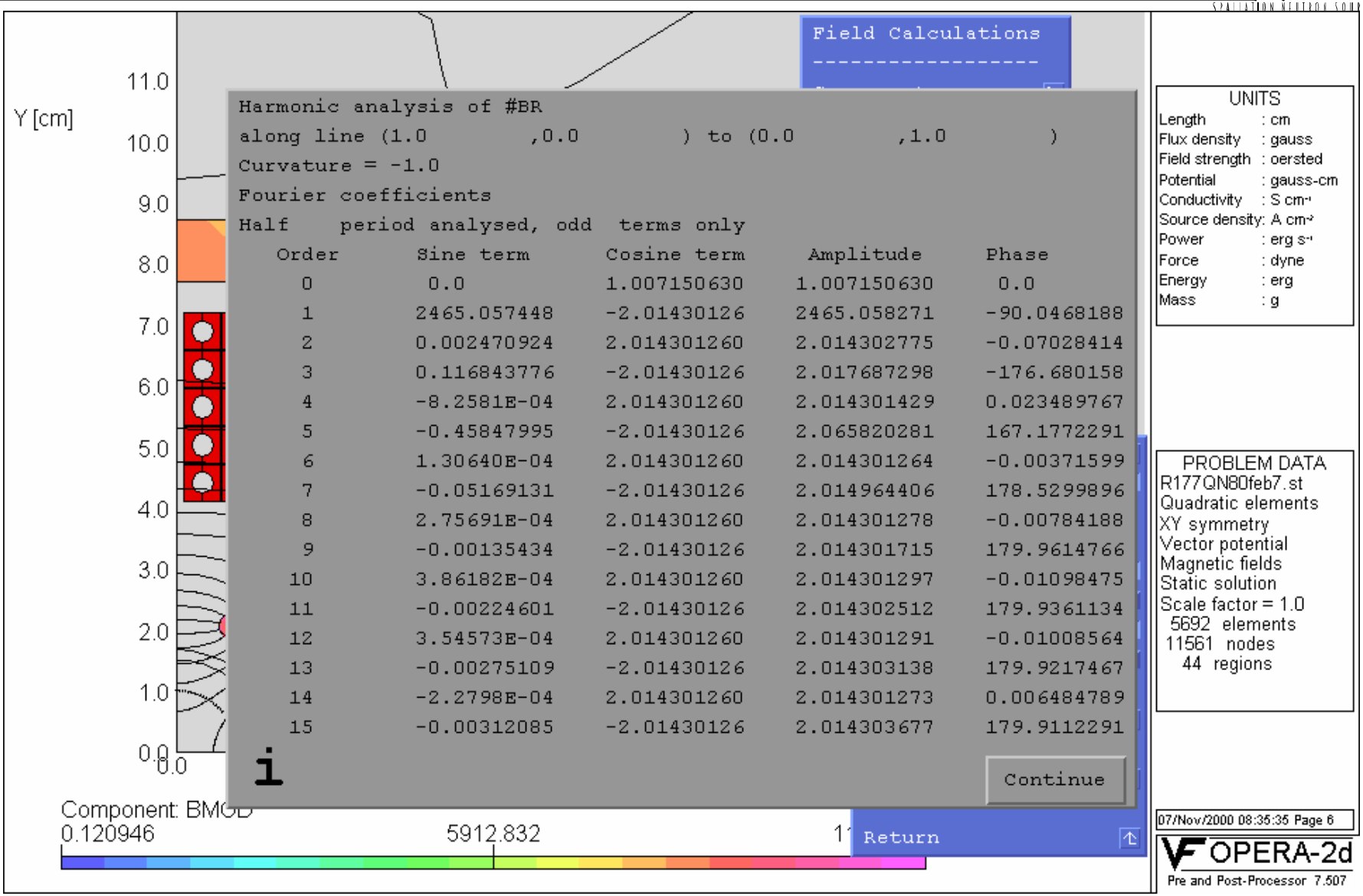
CCL Quadrupoles



CCL Quadrupoles



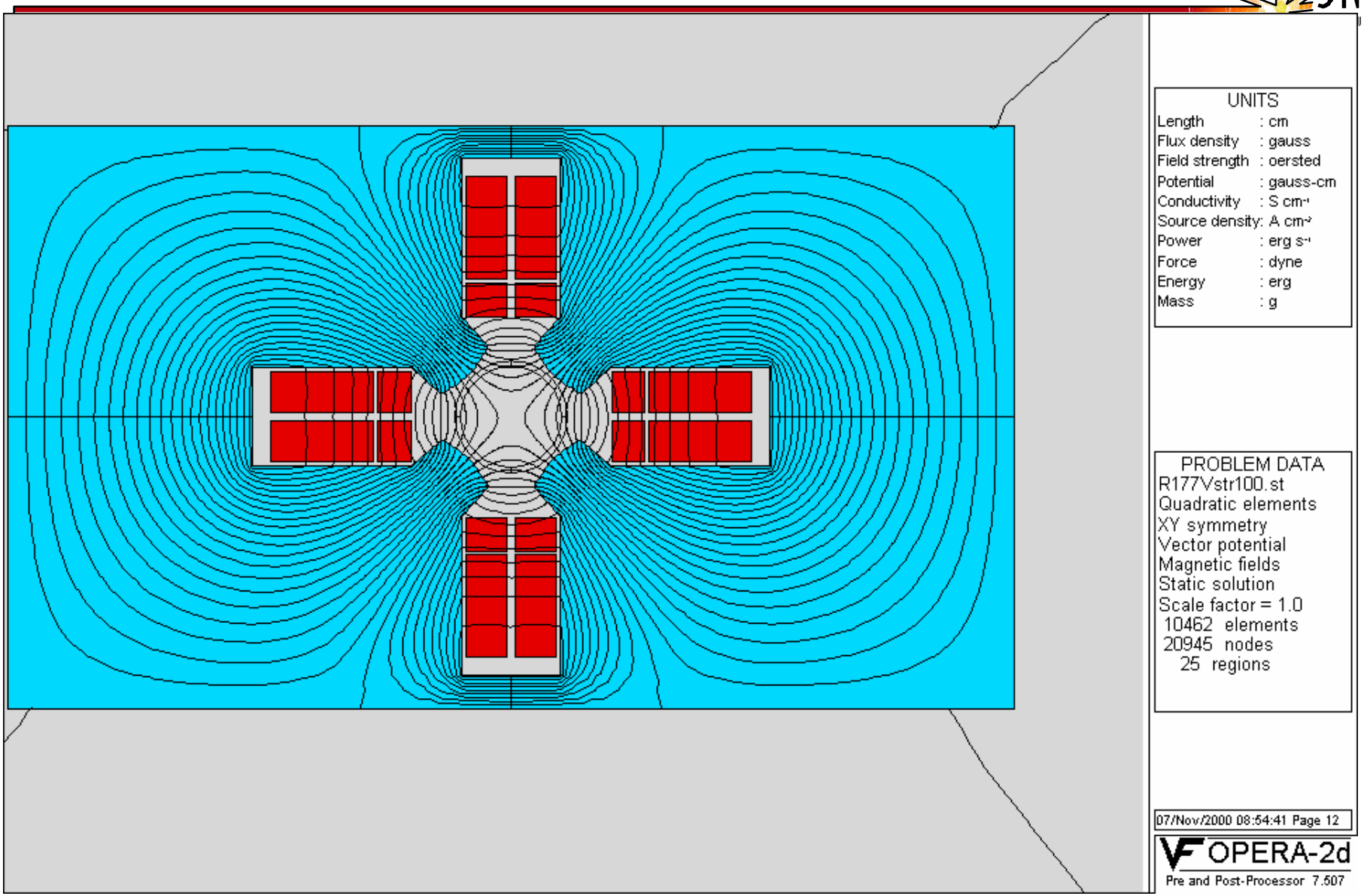
CCL Quadrupoles



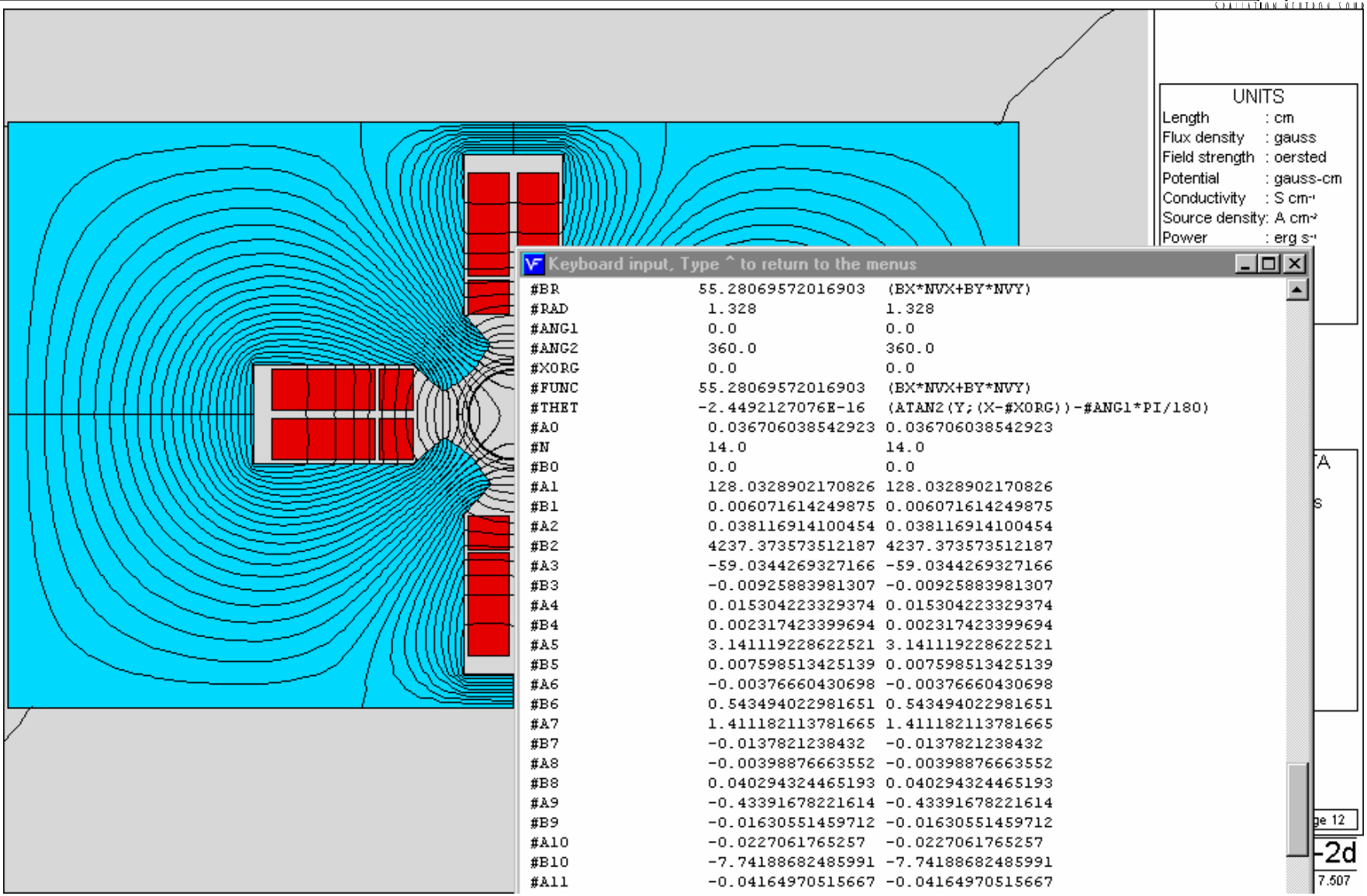
CCL Quadrupoles

Quadrupole Data	***User Inputs***	
Steel Length	***8.00***	*cm*
Steel Area	***111.44***	*cm^2*
Bore Radius	***1.77***	*cm*
Turns/Pole	***10***	*Turns*
Turns/Cooling Circuit	***10***	*Turns*
Turn Length	***12.60***	*in*
Flow Velocity	***8.00***	*ft/sec*
Pole Tip Field	***4535***	*gauss*
Current	***308***	*amps*
Stored Energy	***18134388***	ergs
Inductance	3.735E-04	henry
Amp Turns	3080	amp-turns
Total Length/Circuit	125.98	in
Gradient	2562	Gauss/cm
Leff	9.77	cm
GdL	2.50	T
Conductor Information		
Type	2	
Square O.D.	0.187	in
Cooling Tube I.D.	0.125	in
Area Cu	0.020	in^2
Water Area	0.012	in^2
D.C. Electrical Calculations		
Total Amp-Turns	12320	
Amperes	308	amps
Ohms/circuit	0.005	ohms
Volts	1.53	volts
Power/coil	0.47	kw
Current density	15400	amps/in^2
Cooling Calculations		
Circuit Length	10.50	ft.
Flow	0.31	gpm
Delta-T	10.49	deg f
FrictFact	0.042	
Delta-P	18.05	lb/in^2
Steel Calculations		
Magnet Length	8.00	cm
Steel Area	445.76	cm^2
Steel Weight	60.93	lbs

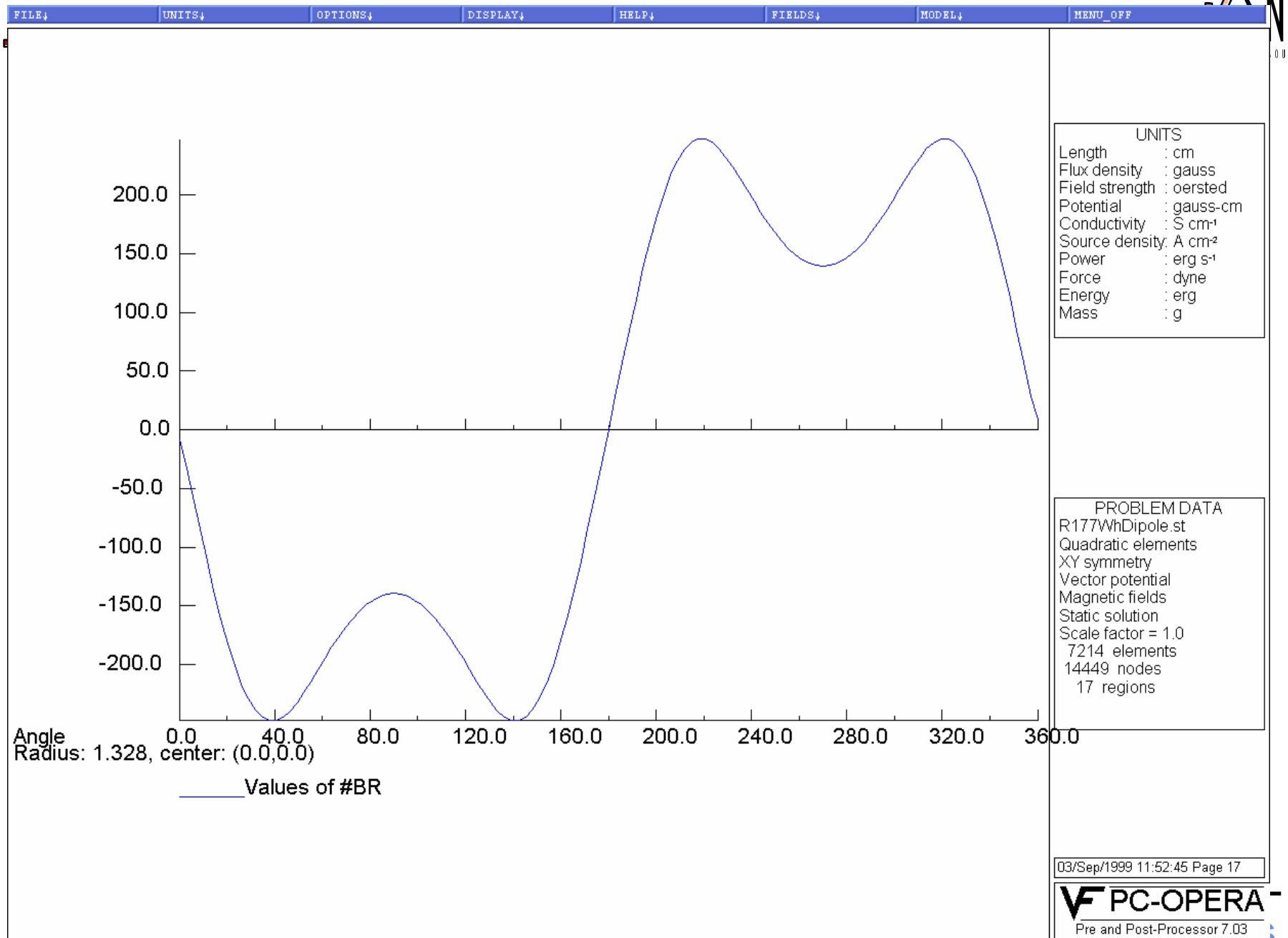
CCL Quadrupoles



CCL Quadrupoles

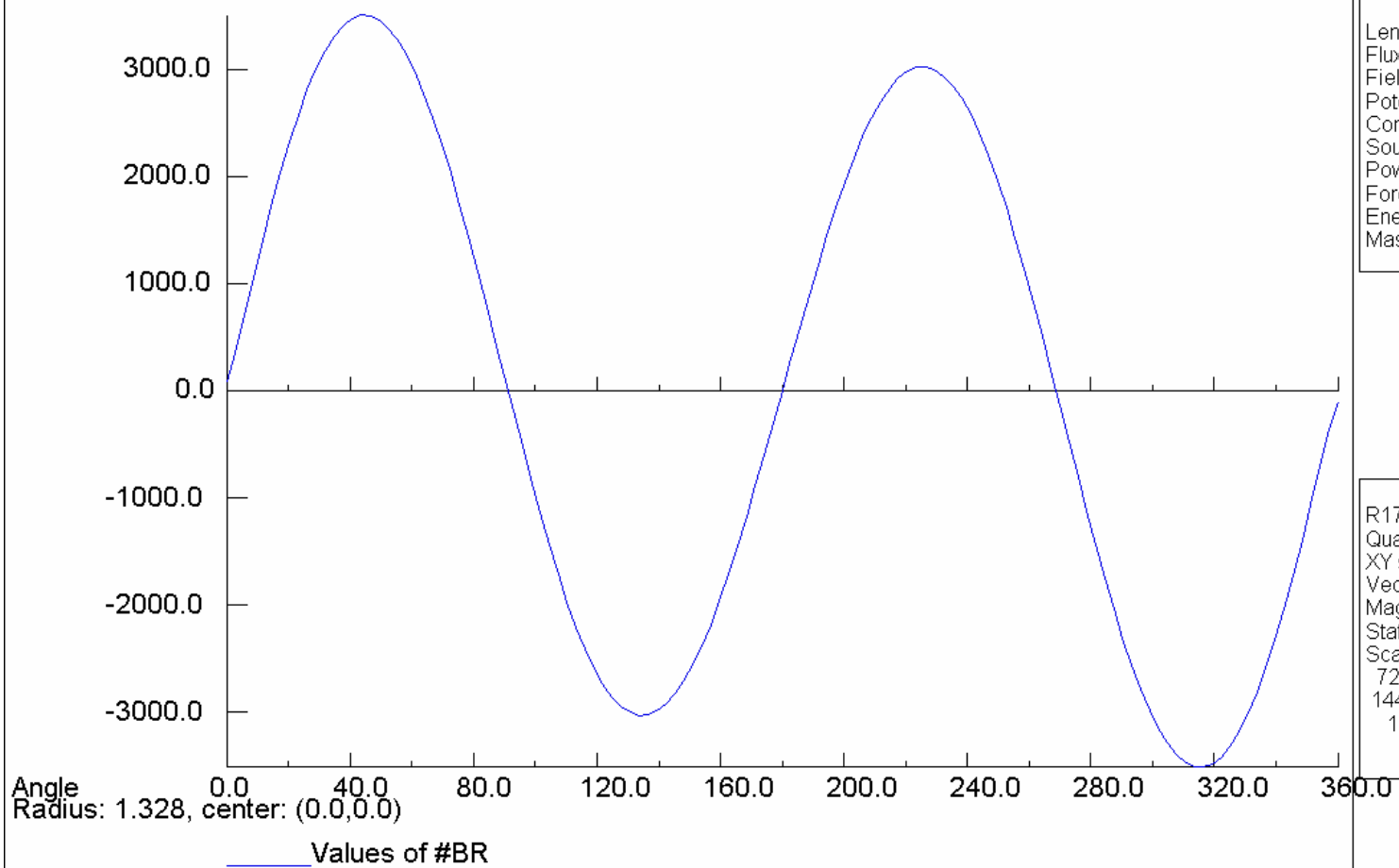


R177QN80 DIPOLE



R177QN80 Horizontal Shunt

FILE↓ UNITS↓ OPTIONS↓ DISPLAY↓ HELP↓ FIELDS↓ MODEL↓ MENU_OFF



UNITS

Length	: cm
Flux density	: gauss
Field strength	: oersted
Potential	: gauss-cm
Conductivity	: S cm^{-1}
Source density:	A cm^{-2}
Power	: erg s^{-1}
Force	: dyne
Energy	: erg
Mass	: g

PROBLEM DATA
R177Hor100.st
Quadratic elements
XY symmetry
Vector potential
Magnetic fields
Static solution
Scale factor = 1.0
7214 elements
14449 nodes
17 regions

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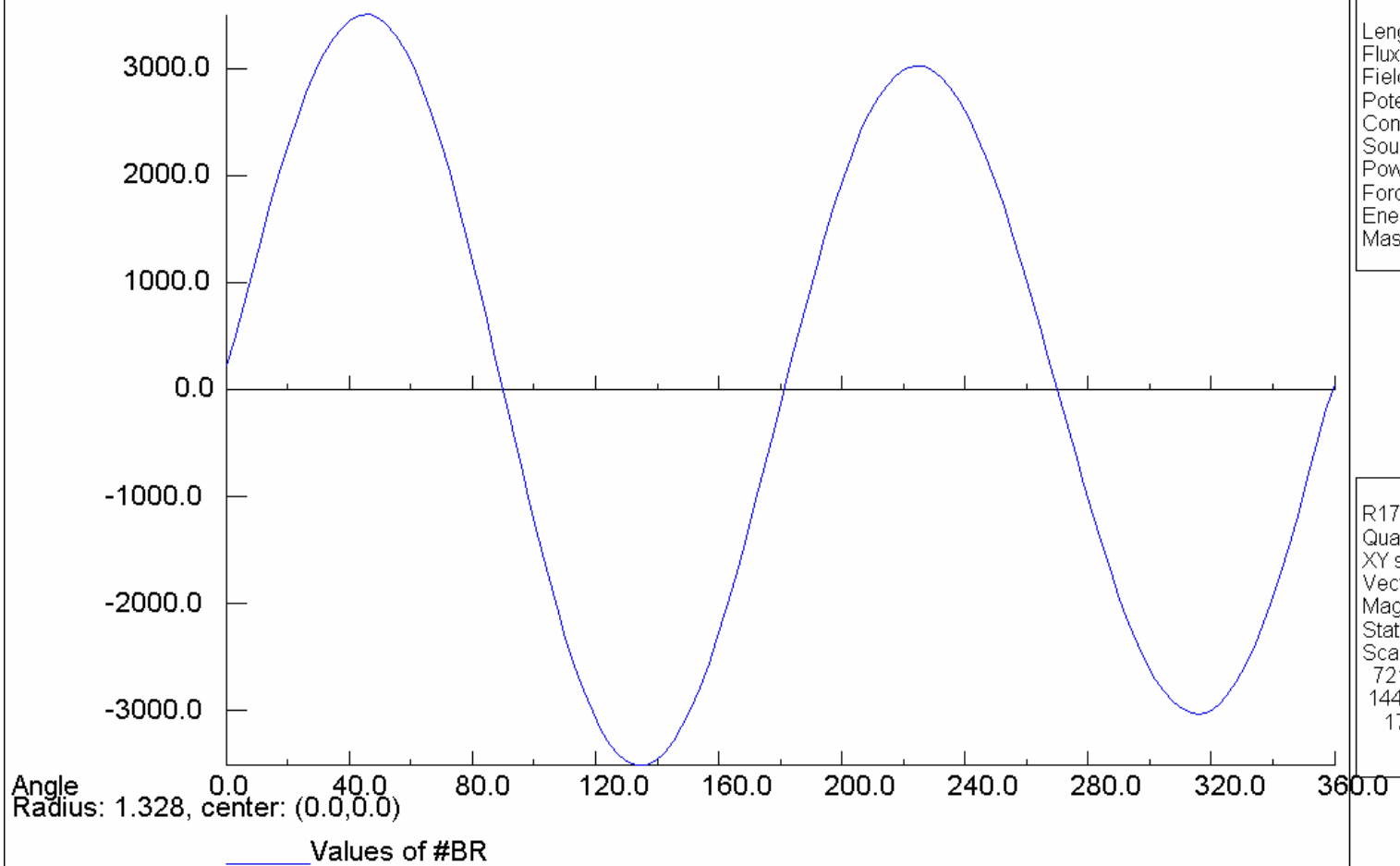
PC-OPERA
Pre and Post-Processor 7.03

R177QN80 Vertical Steering

FILE↓ | UNITS↓ | OPTIONS↓ | DISPLAY↓ | HELP↓ | FIELDS↓ | MODEL↓ | MENU_OFF



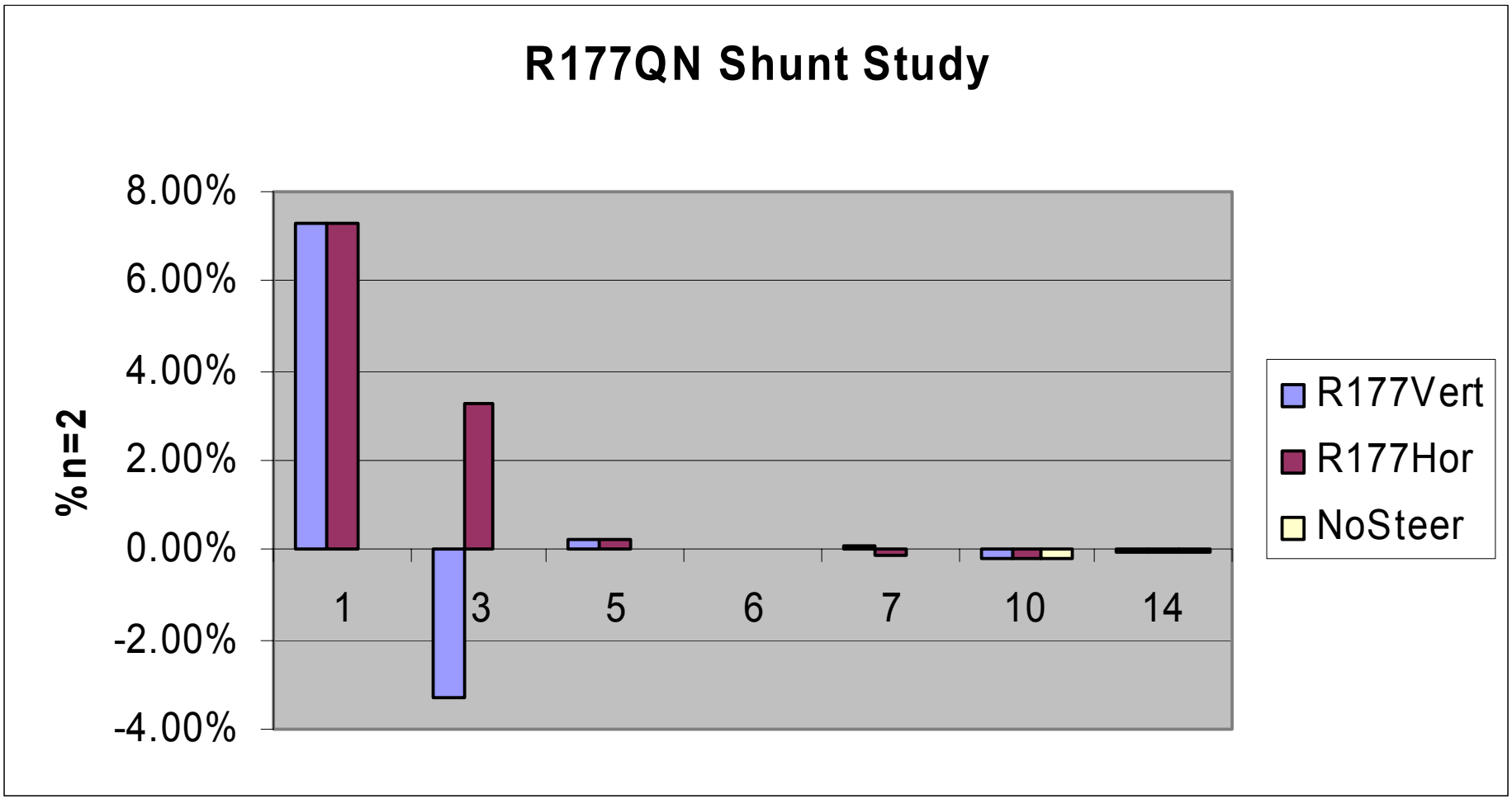
UNITS

Length	: cm
Flux density	: gauss
Field strength	: oersted
Potential	: gauss-cm
Conductivity	: S cm^{-1}
Source density	: A cm^{-2}
Power	: erg s^{-1}
Force	: dyne
Energy	: erg
Mass	: g

PROBLEM DATA
R177Vert100.st
Quadratic elements
XY symmetry
Vector potential
Magnetic fields
Static solution
Scale factor = 1.0
7214 elements
14449 nodes
17 regions

03/Sep/1999 12:12:07 Page 21

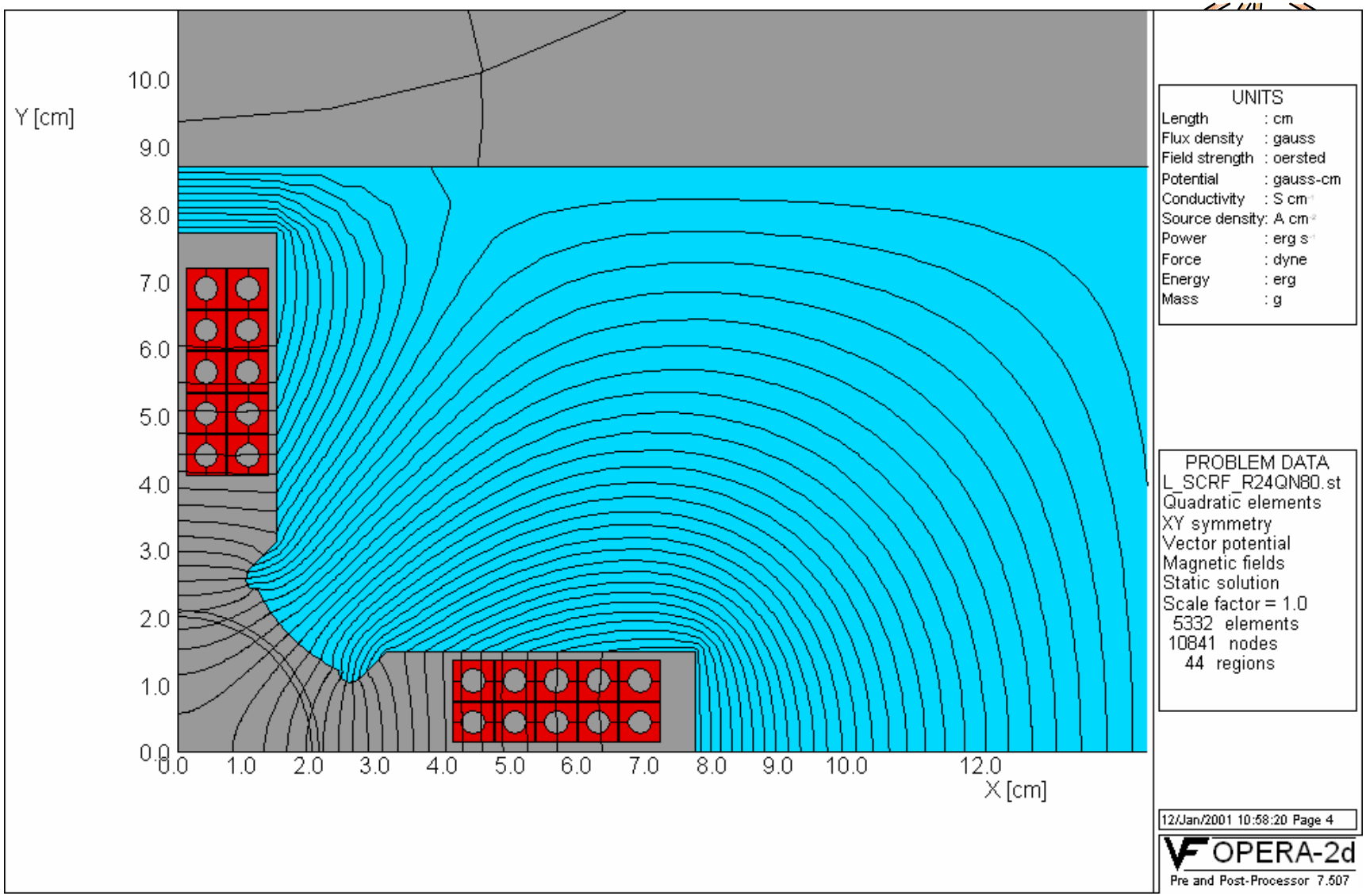
PC-OPERA
Pre and Post-Processor 7.03


R177QN Shunt Study
8.00%
6.00%
4.00%
2.00%
0.00%
-2.00%
-4.00%
%n=2
1
3
5
6
7
10
14
R177Vert
R177Hor
NoSteer

CCL Quadrupoles

11/7/00 9:08			Copper Wire					
	OD Cu	A cu	OD Build	A Build	A Build	ohms		
Size AWG	in	in^2	in	in^2	cm^2	per 1000ft		
6	0.1604	0.020	0.1686	0.022	0.144	0.403		
7	0.1429	0.016	0.1507	0.018	0.115	0.508		
8	0.1272	0.013	0.1348	0.014	0.092	0.641		
9	0.1133	0.010	0.1205	0.011	0.074	0.808		
10	0.1009	0.008	0.1079	0.009	0.059	1.019		
12	0.0798	0.005	0.0868	0.006	0.038	1.620		
	Number	Max Amps	Amp	Dens	Length	ohms	w/coil	v/coil
	Turns	@1000/in^2	Turns	amp/cm^2	ft	per coil	watts	volts
6	8	20.2	161.655	132.504	8.4	0.0034	1.383	0.068
7	10	16.0	160.382	131.460	10.5	0.0053	1.372	0.086
8	13	12.7	165.199	135.409	13.65	0.0087	1.413	0.111
9	16	10.1	161.313	132.224	16.8	0.0136	1.380	0.137
10	20	8.0	159.920	131.082	21	0.0214	1.368	0.171
12	31	5.0	155.045	127.086	32.55	0.0527	1.319	0.264
R177QN80	xSection	1.2200	cm^2					
	L/turn	12.6	in					

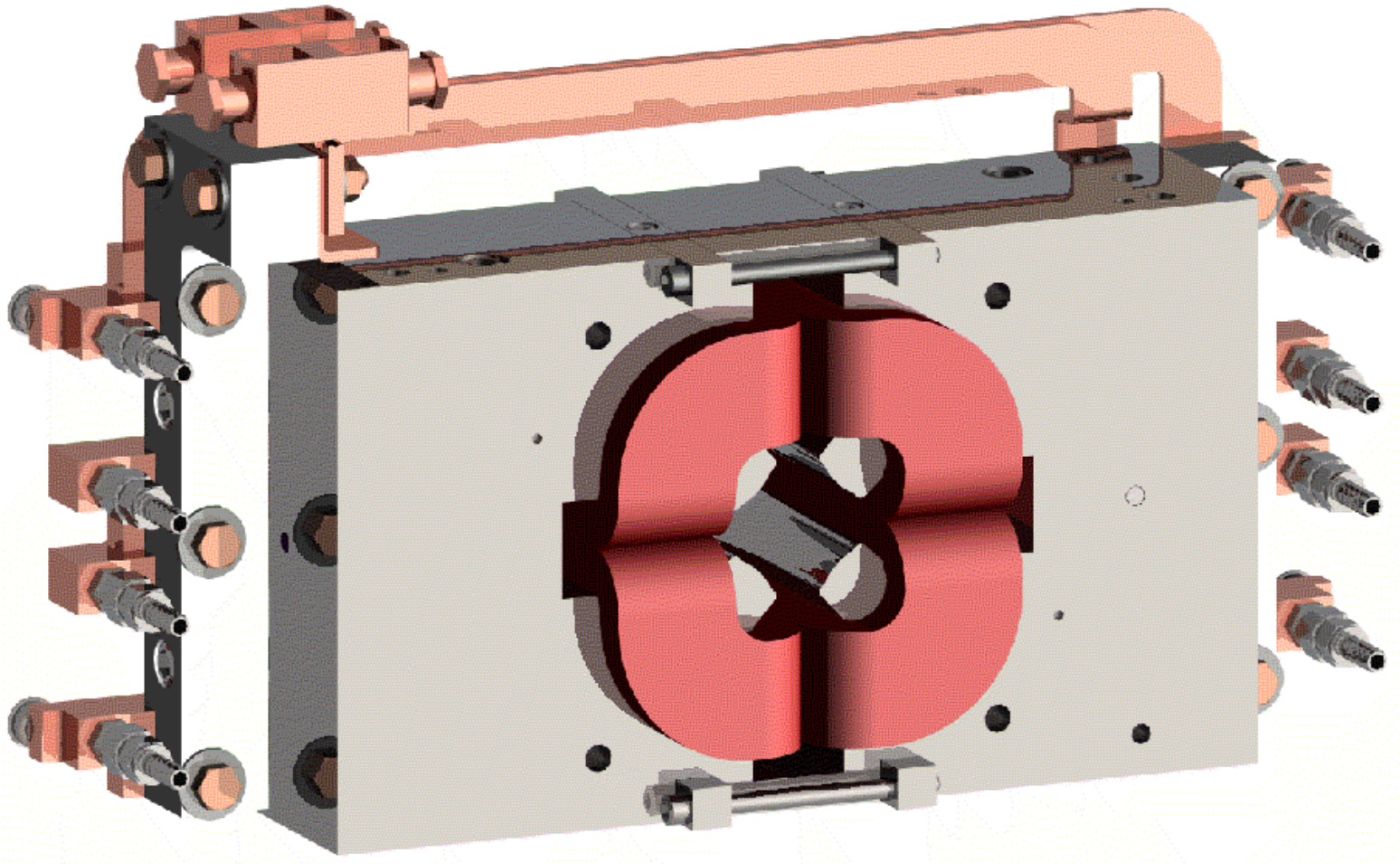
CCL/SC Quadrupoles



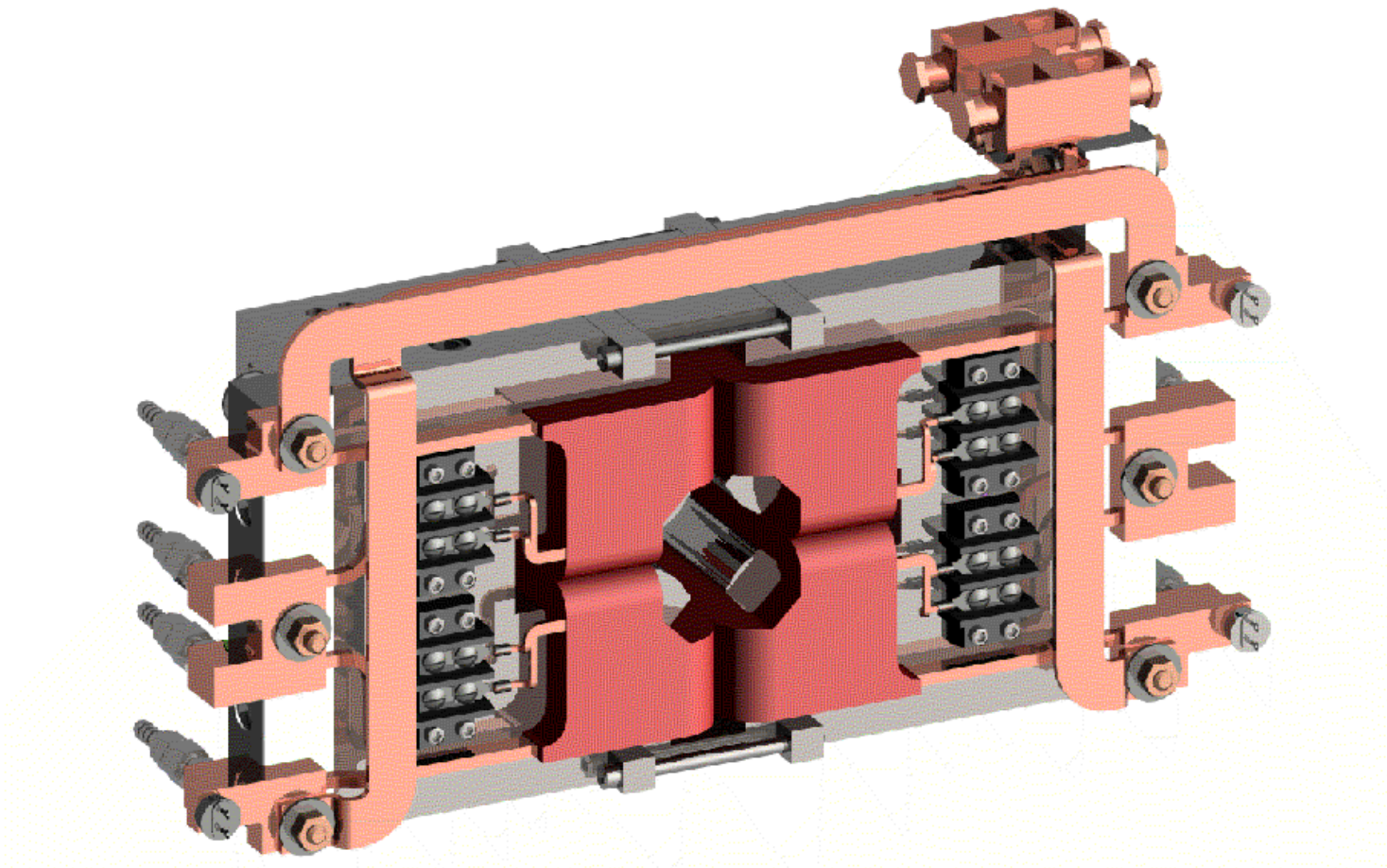
CCL/SC Quadrupoles

1/12/01 11:14		
Ted Hunter		
SNS R24QN80	1/12/01	
R24QN80 10 turn Calc.xls		
Quadrupole Data	***User Inputs***	
Steel Length	***8.00***	*cm*
Steel Area	***110.34***	*cm^2*
Bore Radius	***2.40***	*cm*
Turns/Pole	***10***	*Turns*
Turns/Cooling Circuit	***10***	*Turns*
Turn Length	***12.60***	*in*
Flow Velocity	***8.00***	*ft/sec*
Pole Tip Field	***4918***	*gauss*
Current	***462***	*amps*
Stored Energy	***31716696***	ergs
Inductance	3.095E-04	henry
Amp Turns	4617	amp-turns
Total Length/Circuit	125.98	in
Gradient	2049	Gauss/cm
Leff	10.40	cm
GdL	2.13	T
Conductor Information		
Type	2	
Square O.D.	0.187	in
Cooling Tube I.D.	0.125	in
Area Cu	0.020	in^2
Water Area	0.012	in^2
D.C. Electrical Calculations		
Total Amp-Turns	18468	
Amperes	462	amps
Ohms/circuit	0.005	ohms
Volts	2.29	volts
Power/coil	1.06	kw
Current density	23086	amps/in^2
Cooling Calculations		
Circuit Length	10.50	ft.
Flow	0.31	gpm
Delta-T	23.58	deg f
FrictFact	0.042	
Delta-P	18.05	lb/in^2
Steel Calculations		
Magnet Length	8.00	cm
Steel Area	441.36	cm^2
Steel Weight	60.33	lbs

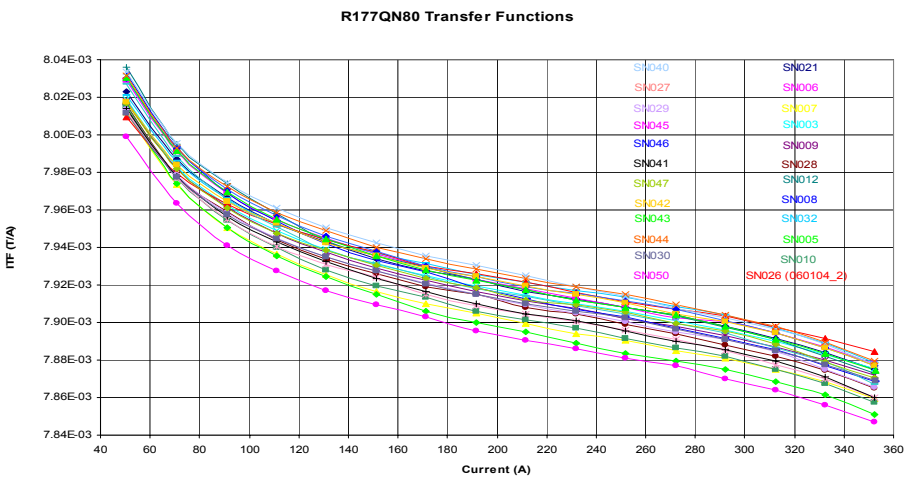
CCL Quadrupoles



CCL Quadrupoles



CCL Quad ITF


R177QN80 Transfer Functions
ITF (T/A)
Current (A)
8.04E-03
8.02E-03
8.00E-03
7.98E-03
7.96E-03
7.94E-03
7.92E-03
7.90E-03
7.88E-03
7.86E-03
7.84E-03
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
SN040
SN027
SN029
SN045
SN046
SN041
SN047
SN042
SN043
SN044
SN030
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SN007
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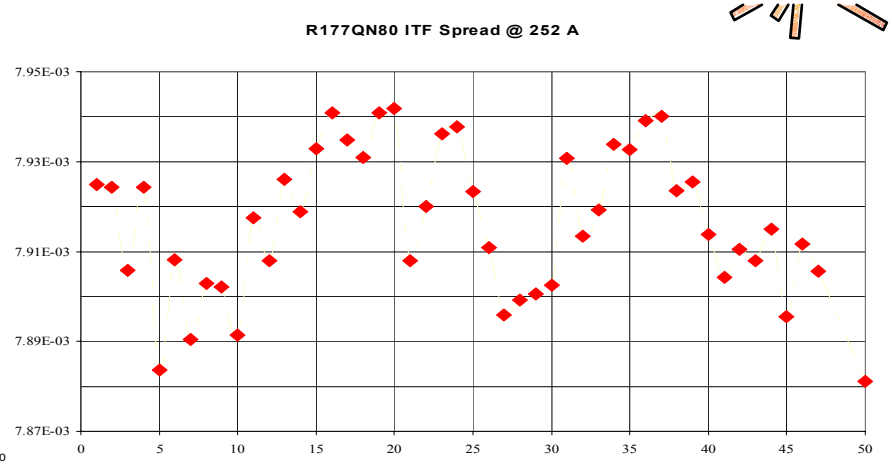
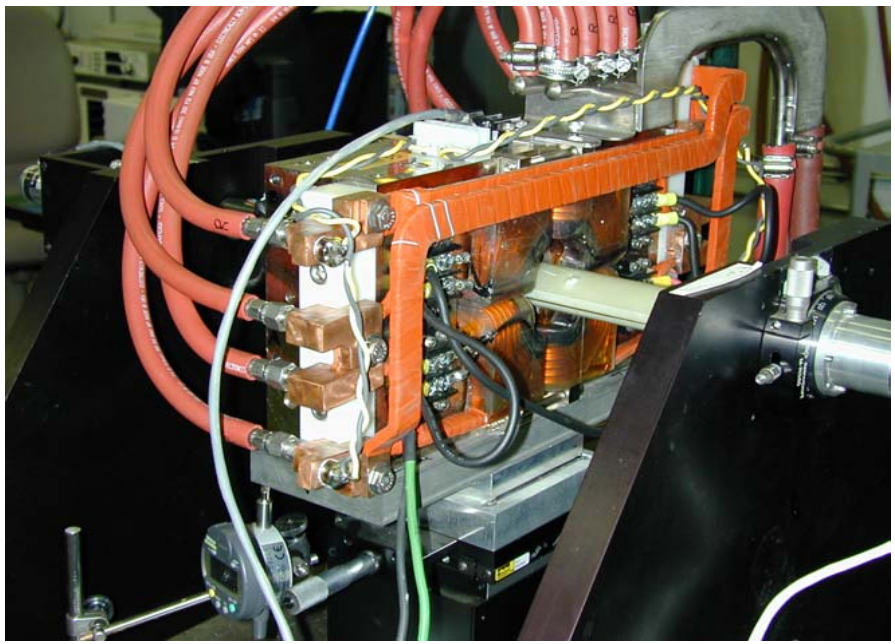
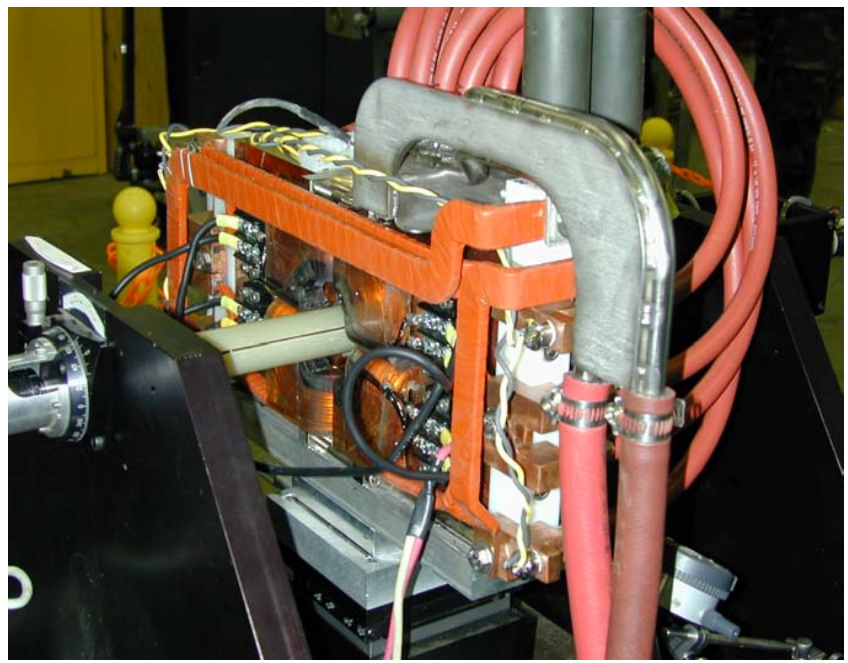
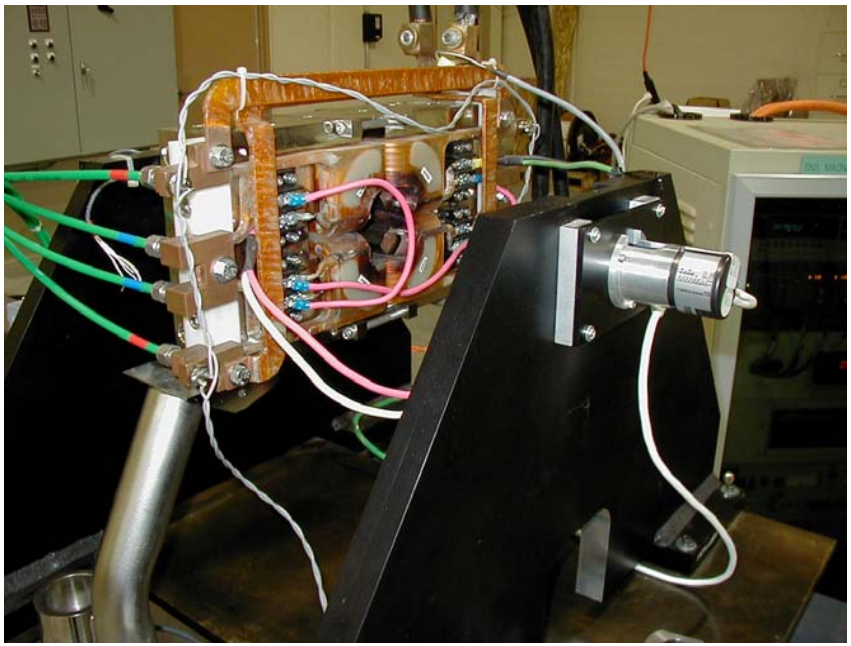
SN032
SN005
SN010
SN026 (060104_2)

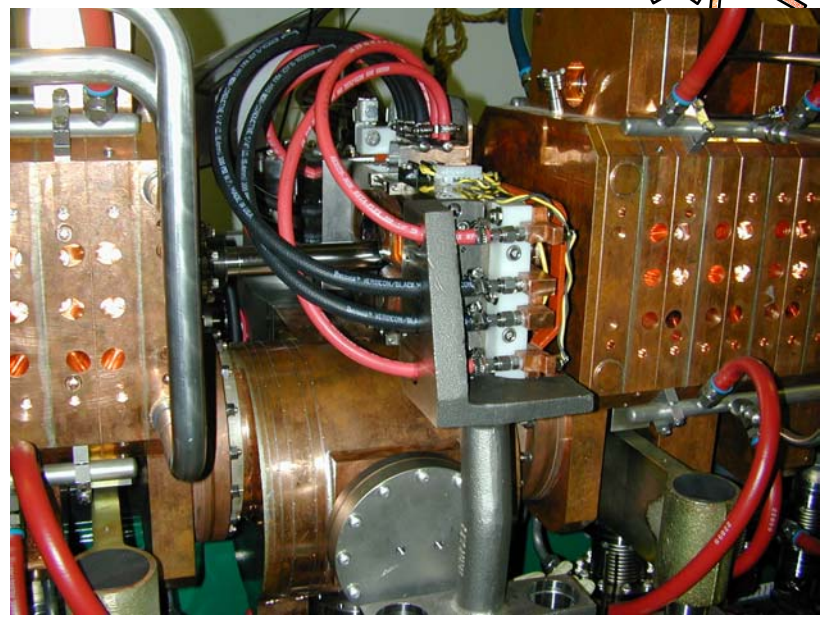

R177QN80 ITF Spread @ 252 A
7.95E-03
7.93E-03
7.91E-03
7.89E-03
7.87E-03
0
5
10
15
20
25
30
35
40
45
50



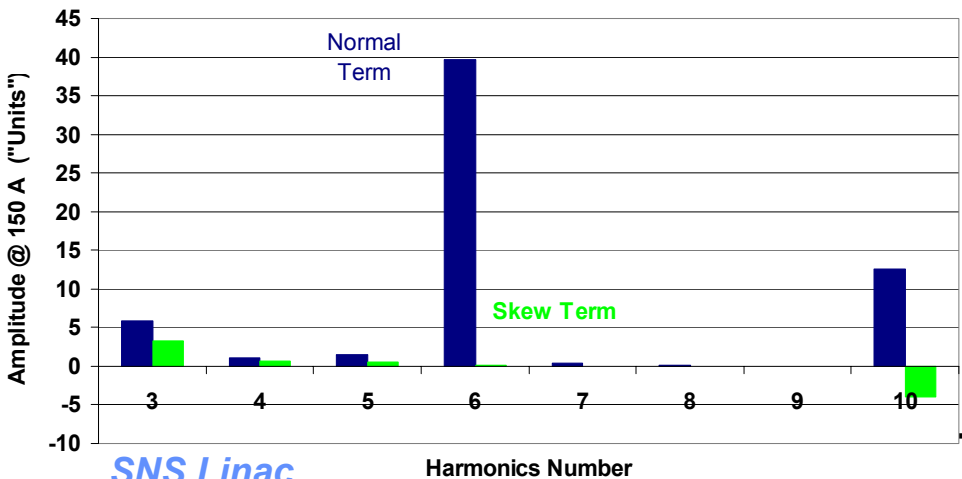
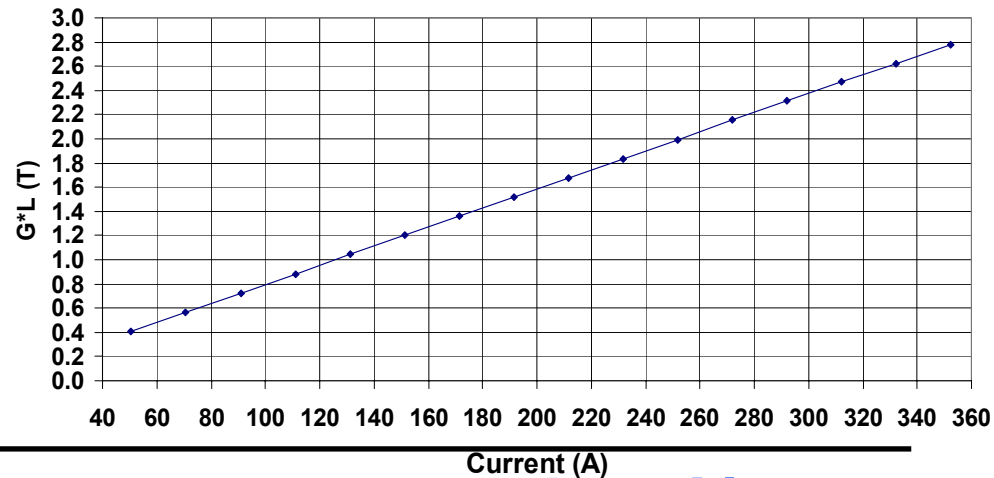


CCL Quadrupoles Measurement





R177QN80 SN006 Harmonics



R177QN80 SN006 Integrated Gradient