Fuzzy Logic
(Power Control/System Integration)

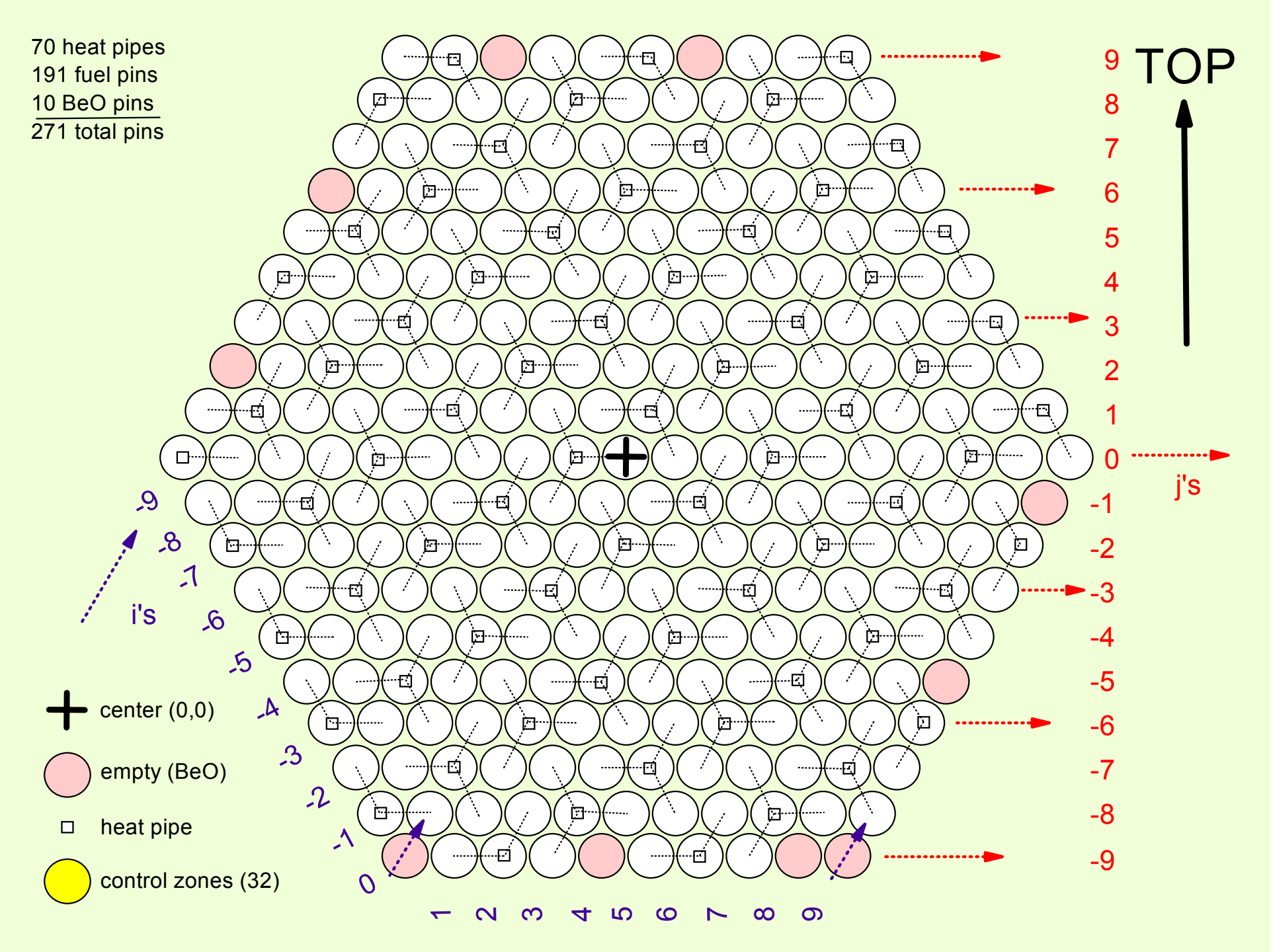
by

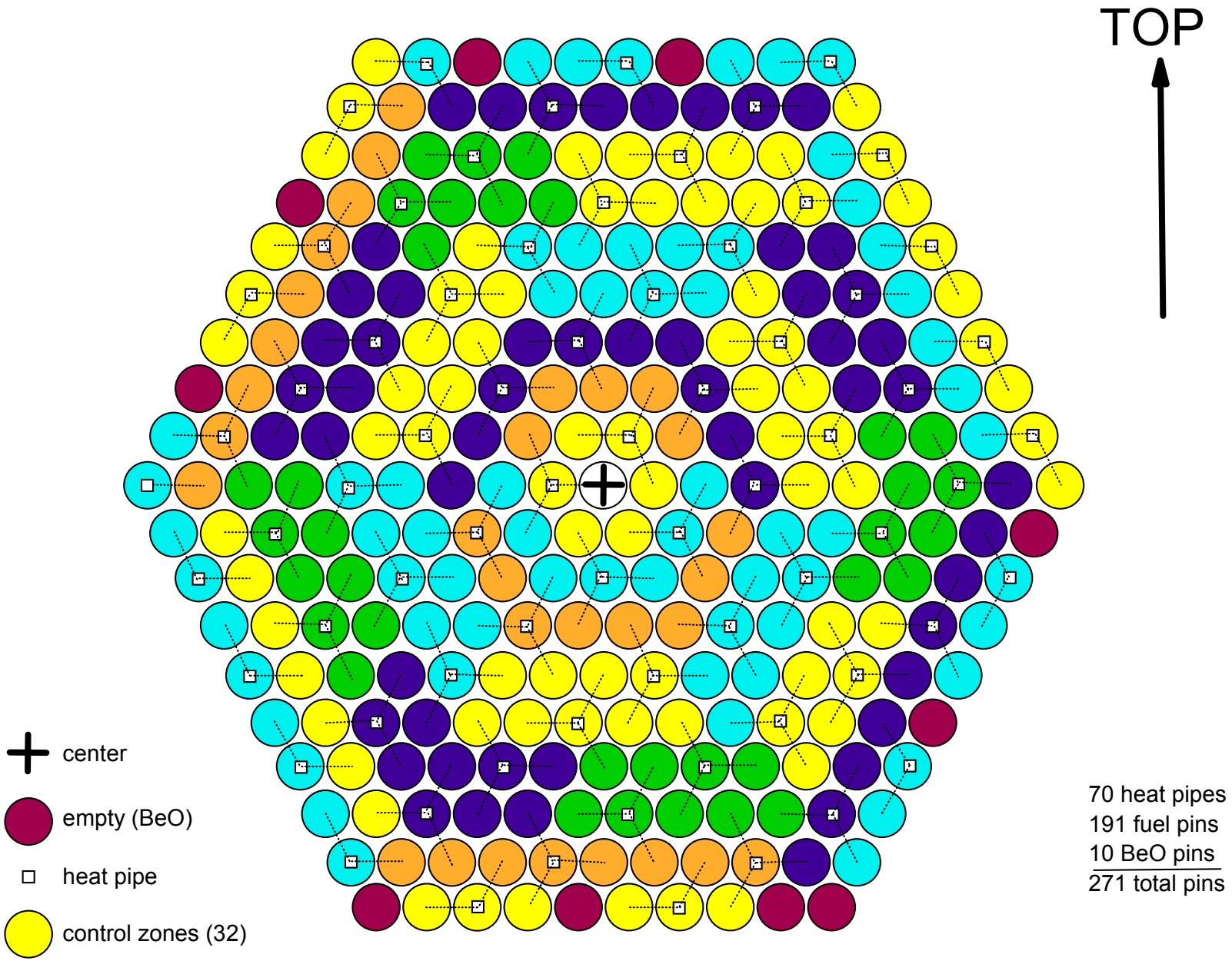
Claude Irvine

The Major Questions

- Why power control?
- What is being accomplished?
- When will it be finished?
- Where is the work performed?

Power Profile Mapping


70 heat pipes
191 fuel pins
10 BeO pins
271 total pins
TOP
j's
i's
center (0,0)
empty (BeO)
heat pipe
control zones (32)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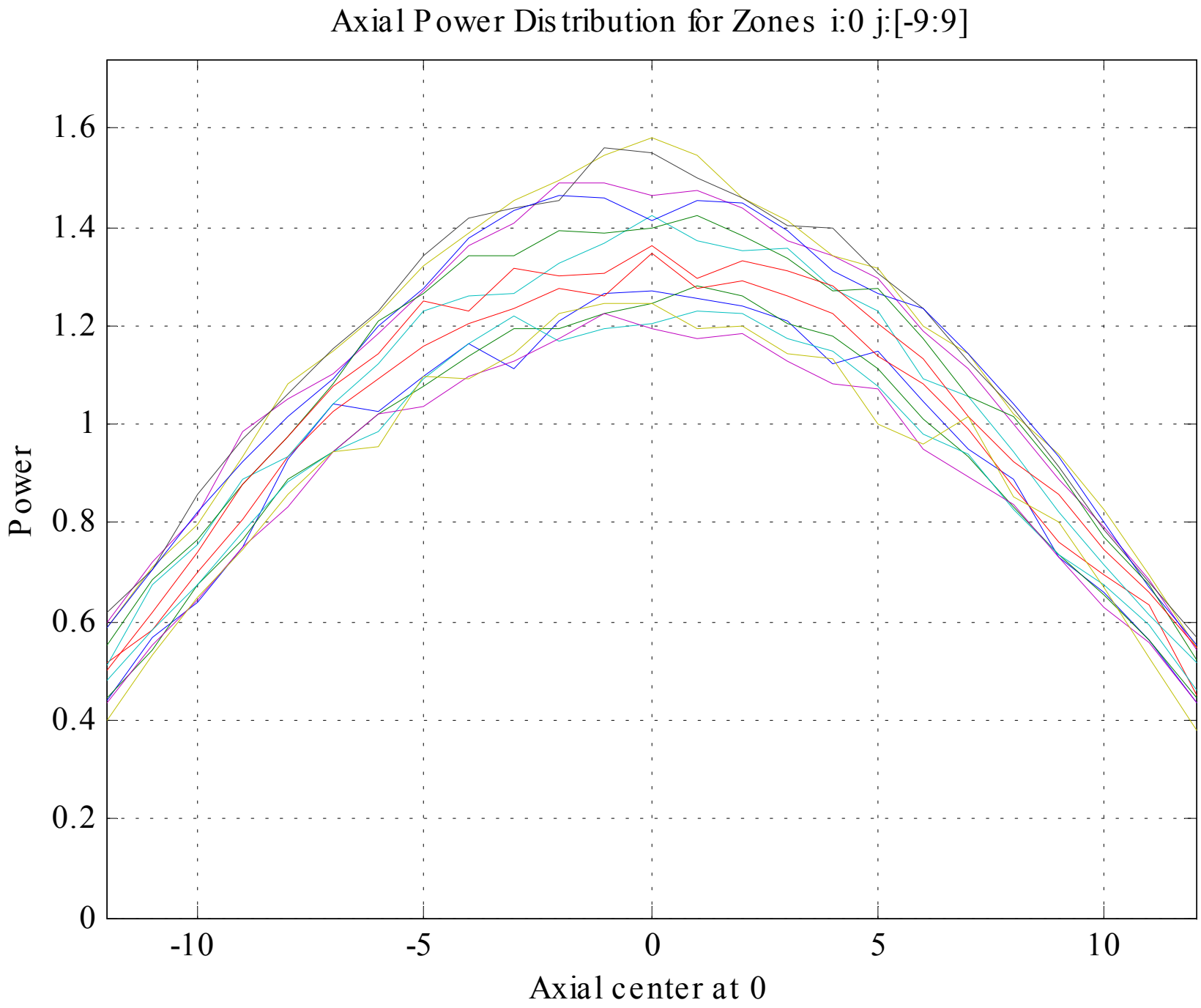
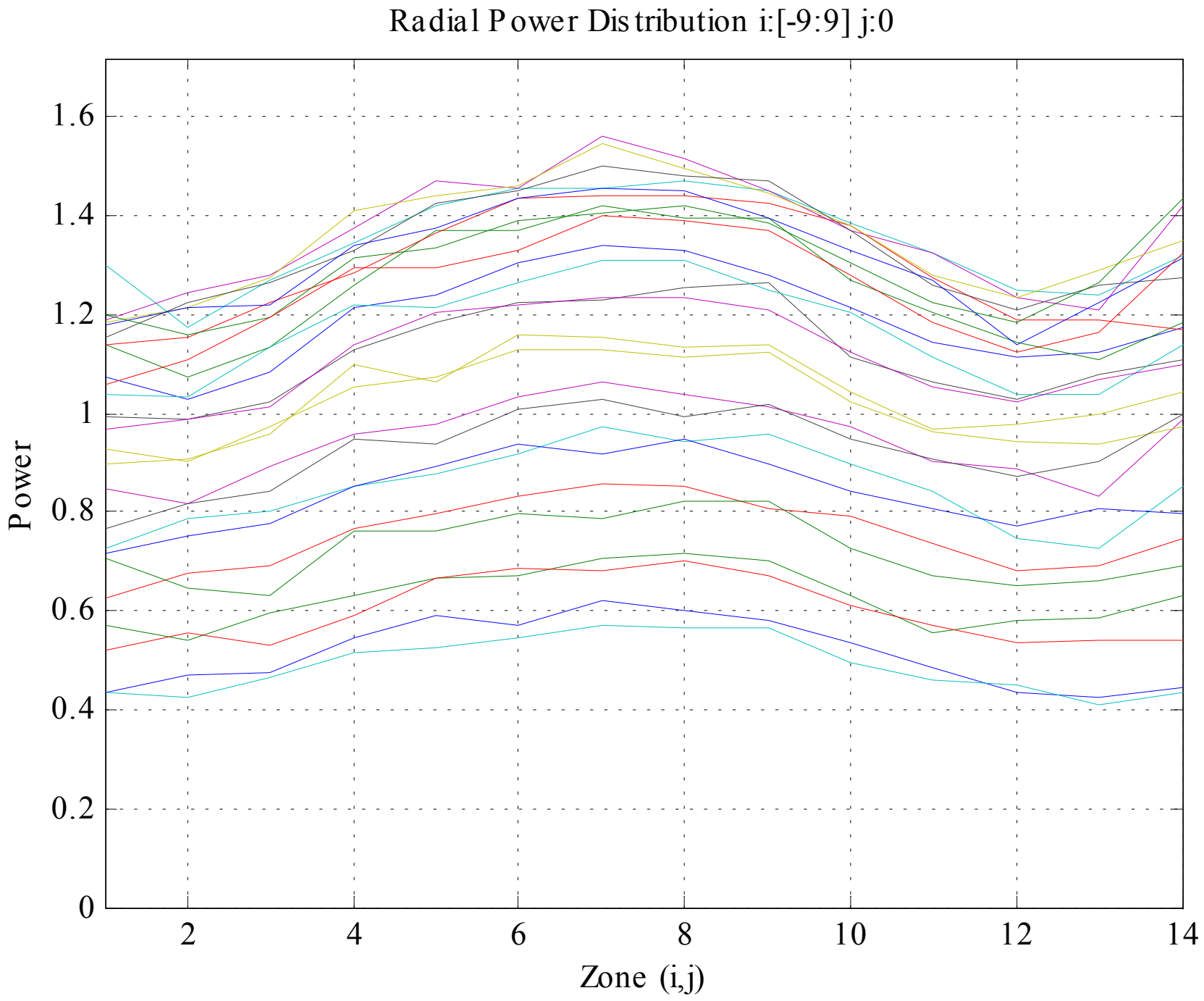
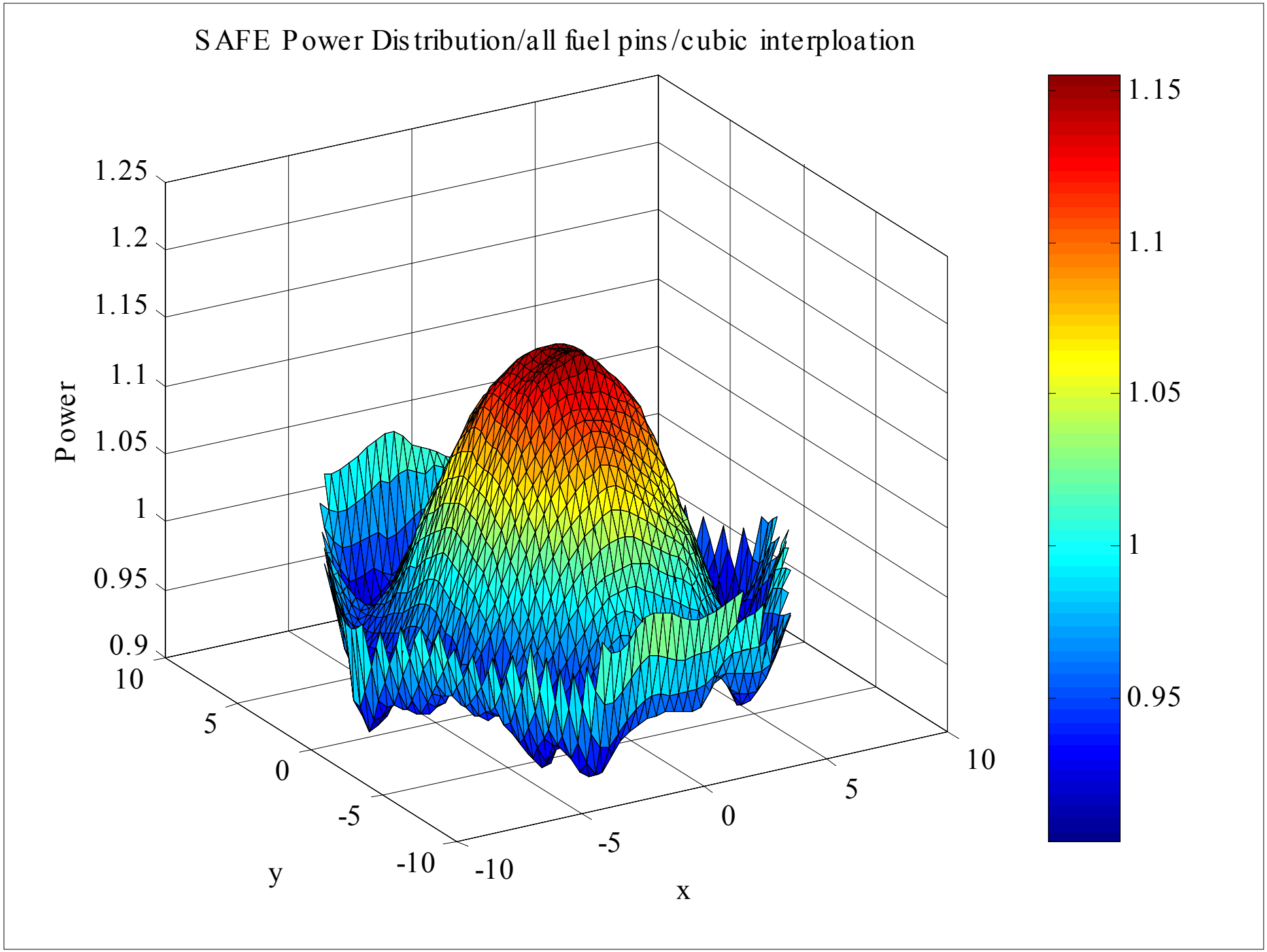
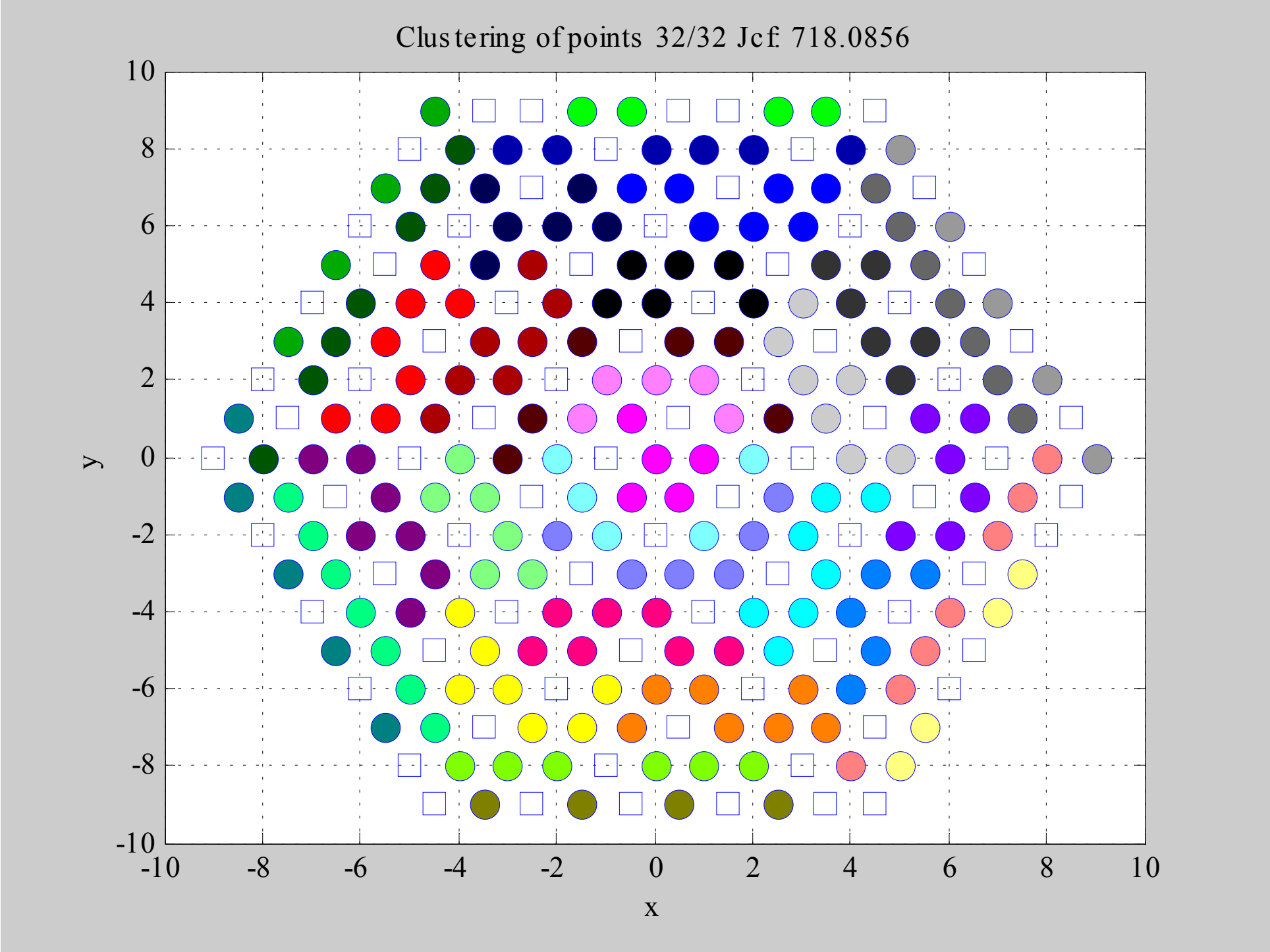
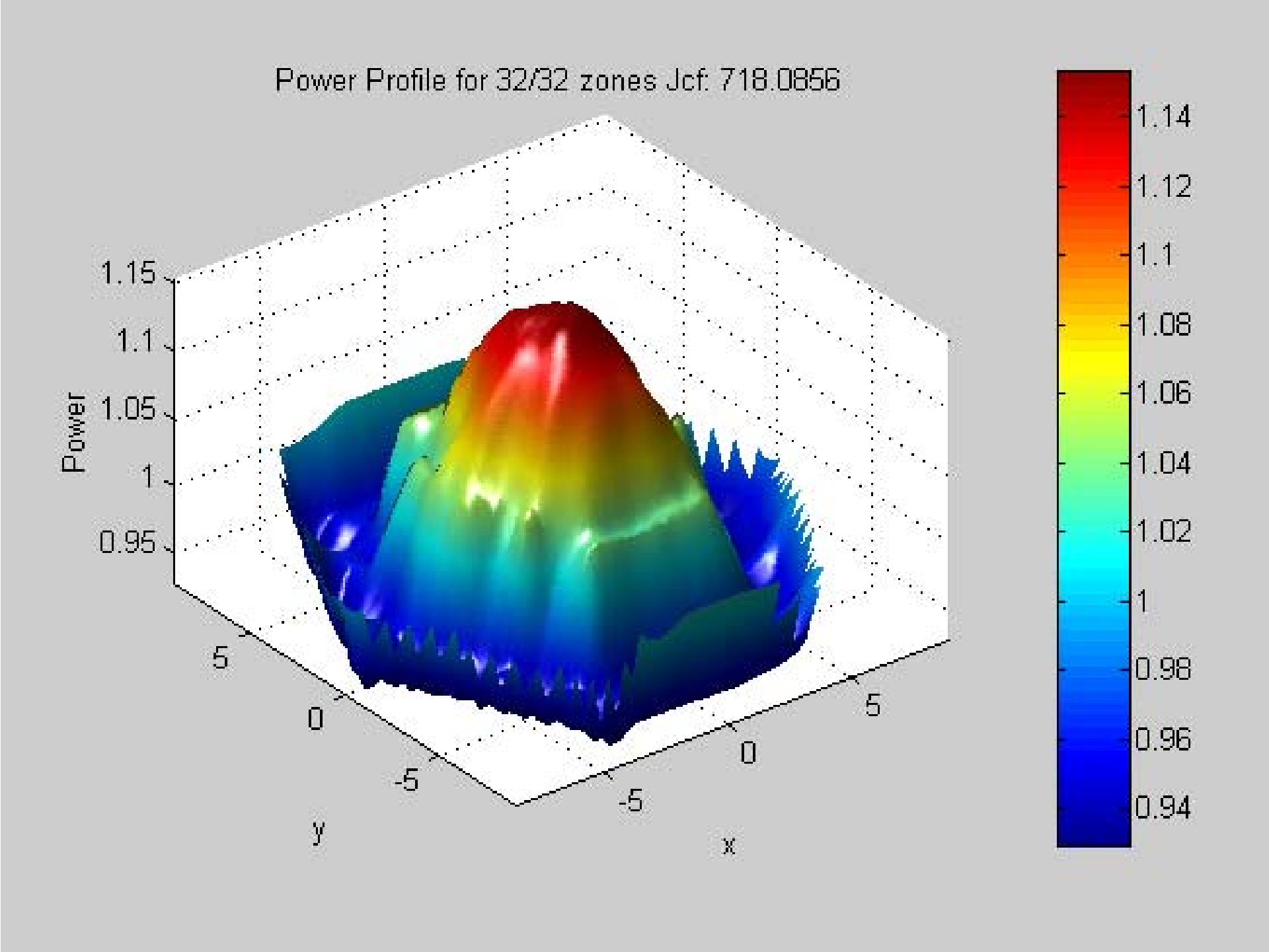
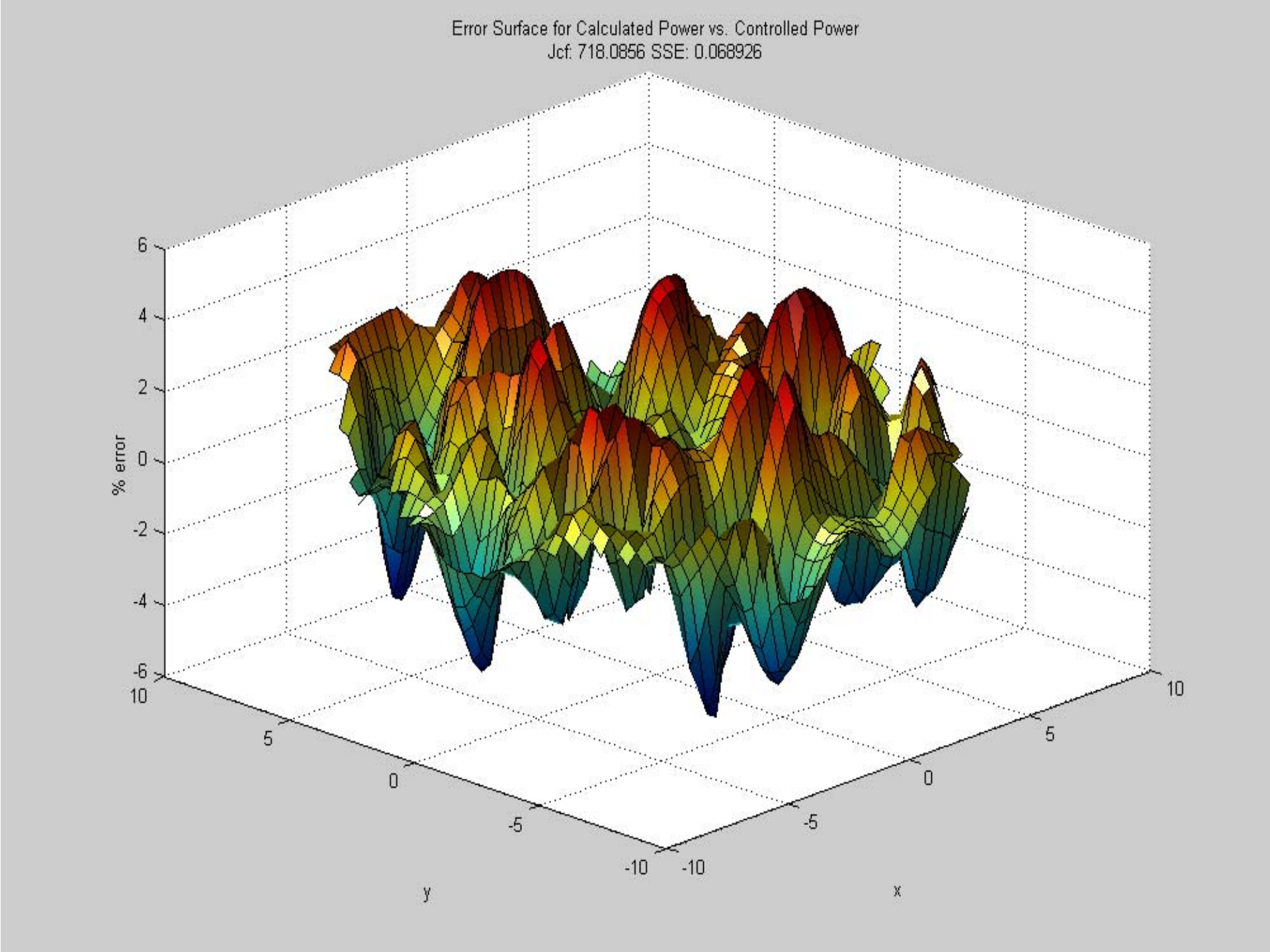

Axial Power Distribution for Zones i:0 j:[-9:9]
Power
Axial center at 0
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-10
-5
0
5
10

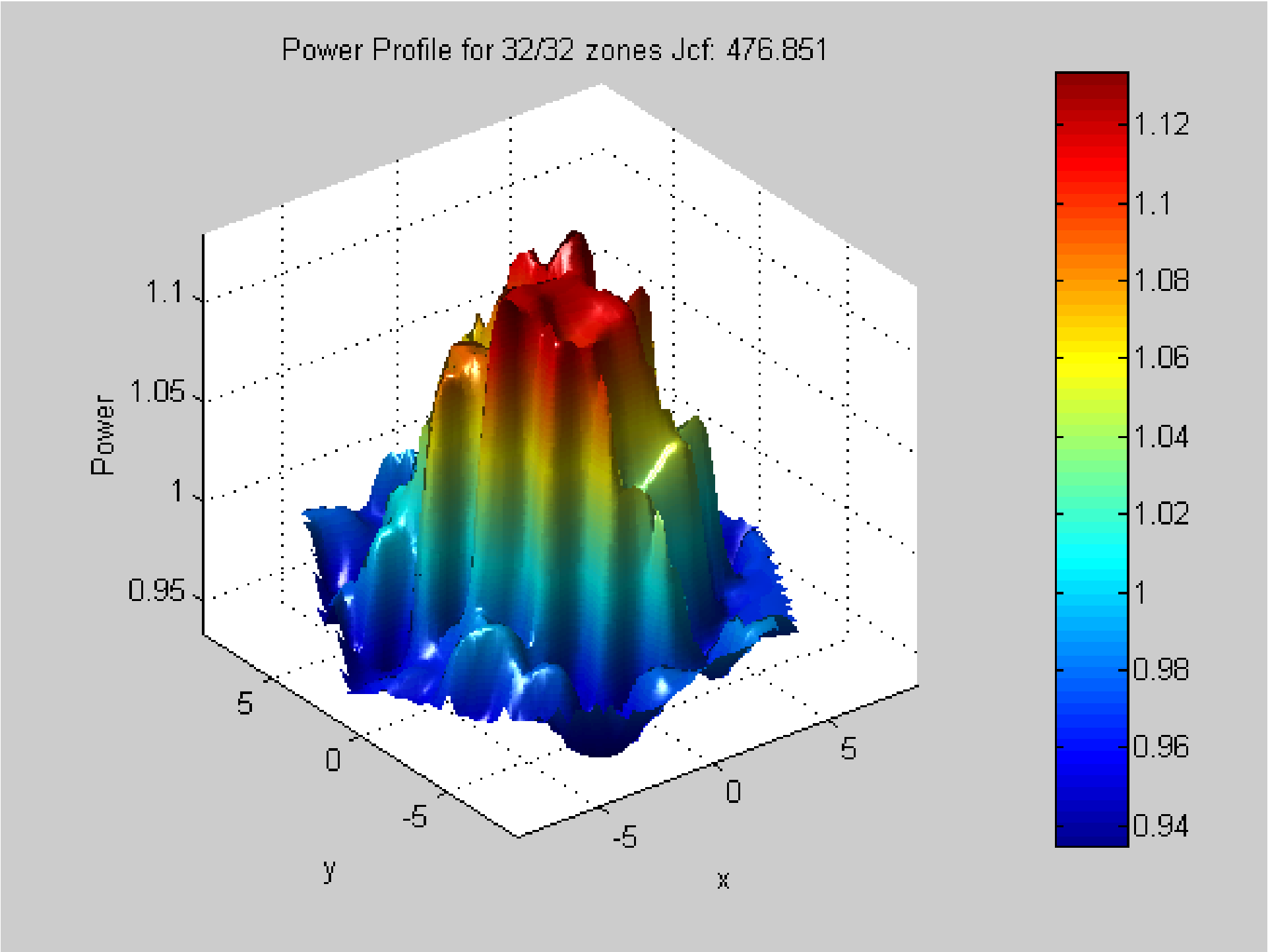

Radial Power Distribution i:[-9:9] j:0
Power
Zone (i,j)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
2
4
6
8
10
12
14

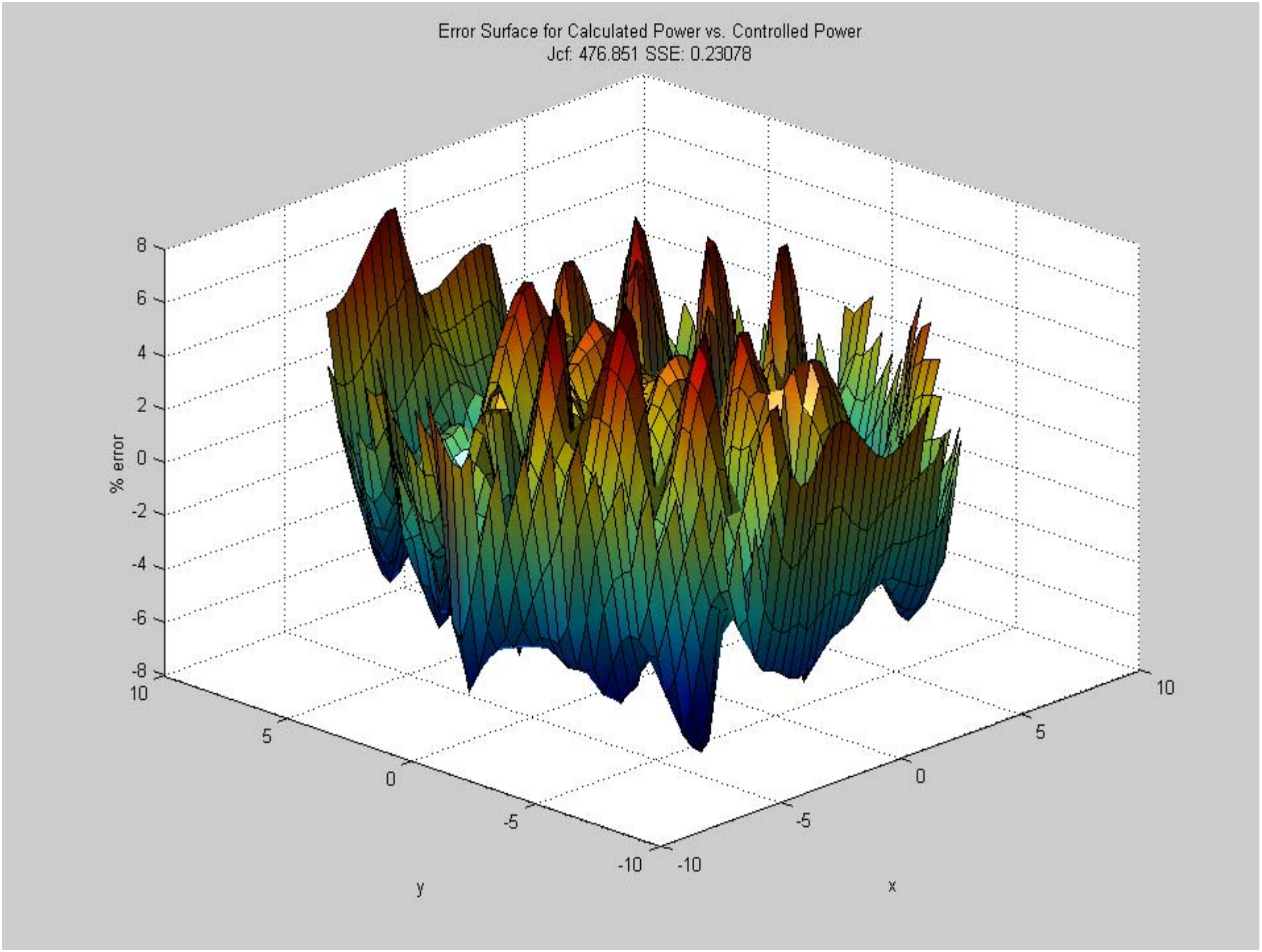

SAFE Power Distribution/all fuel pins/cubic interploation
Power
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
10
5
0
-5
-10
y
-10
-5
0
5
10
x
1.15
1.1
1.05
1
0.95


Clustering of points 32/32 Jcf: 718.0856
10
8
6
4
2
0
-2
-4
-6
-8
-10
y
-10
-8
-6
-4
-2
0
2
4
6
8
10
x

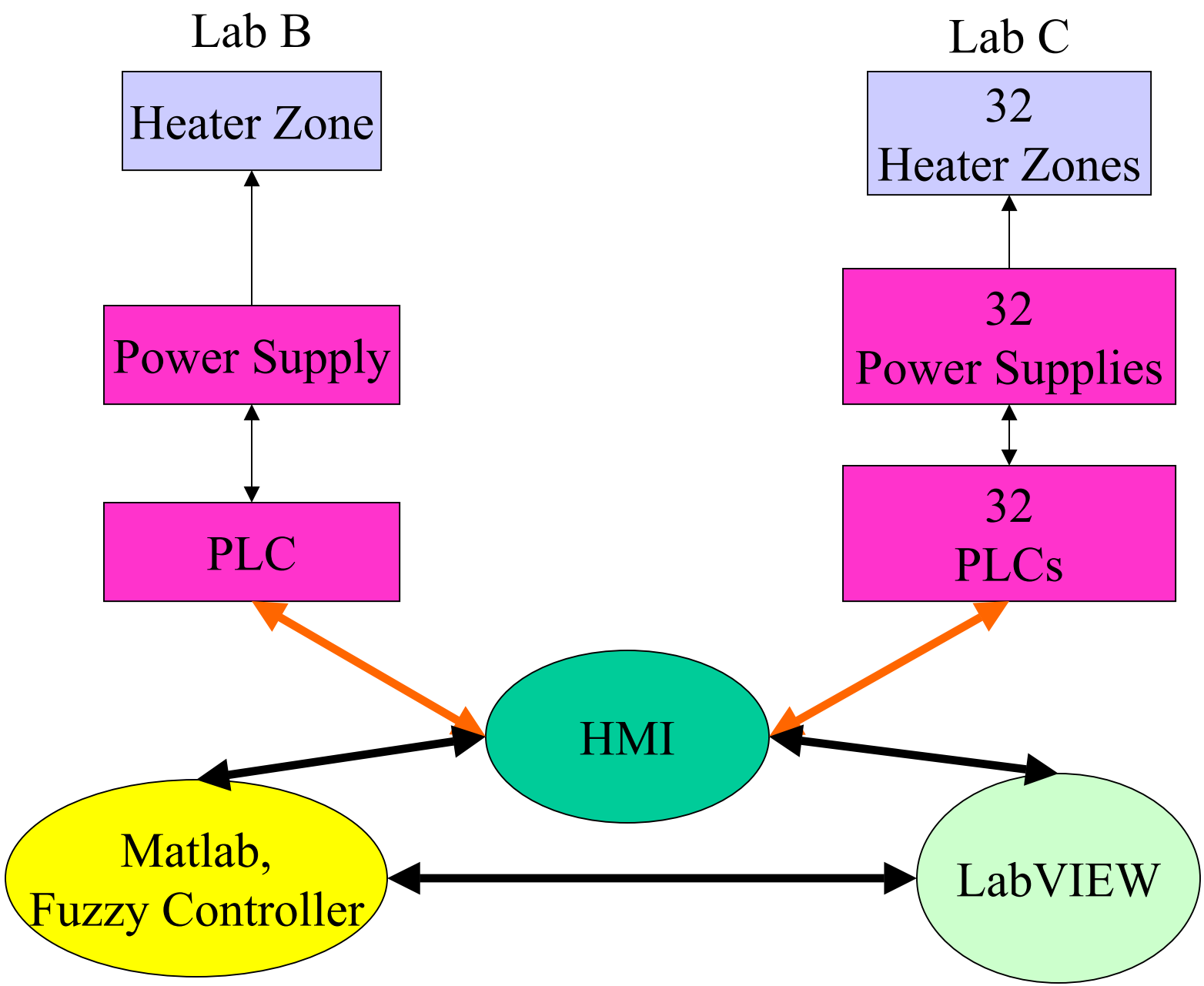

Power Profile for 32/32 zones Jcf: 718.0856
Power
1.15
1.1
1.05
1
0.95
5
0
-5
y
-5
0
5
x
1.14
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94

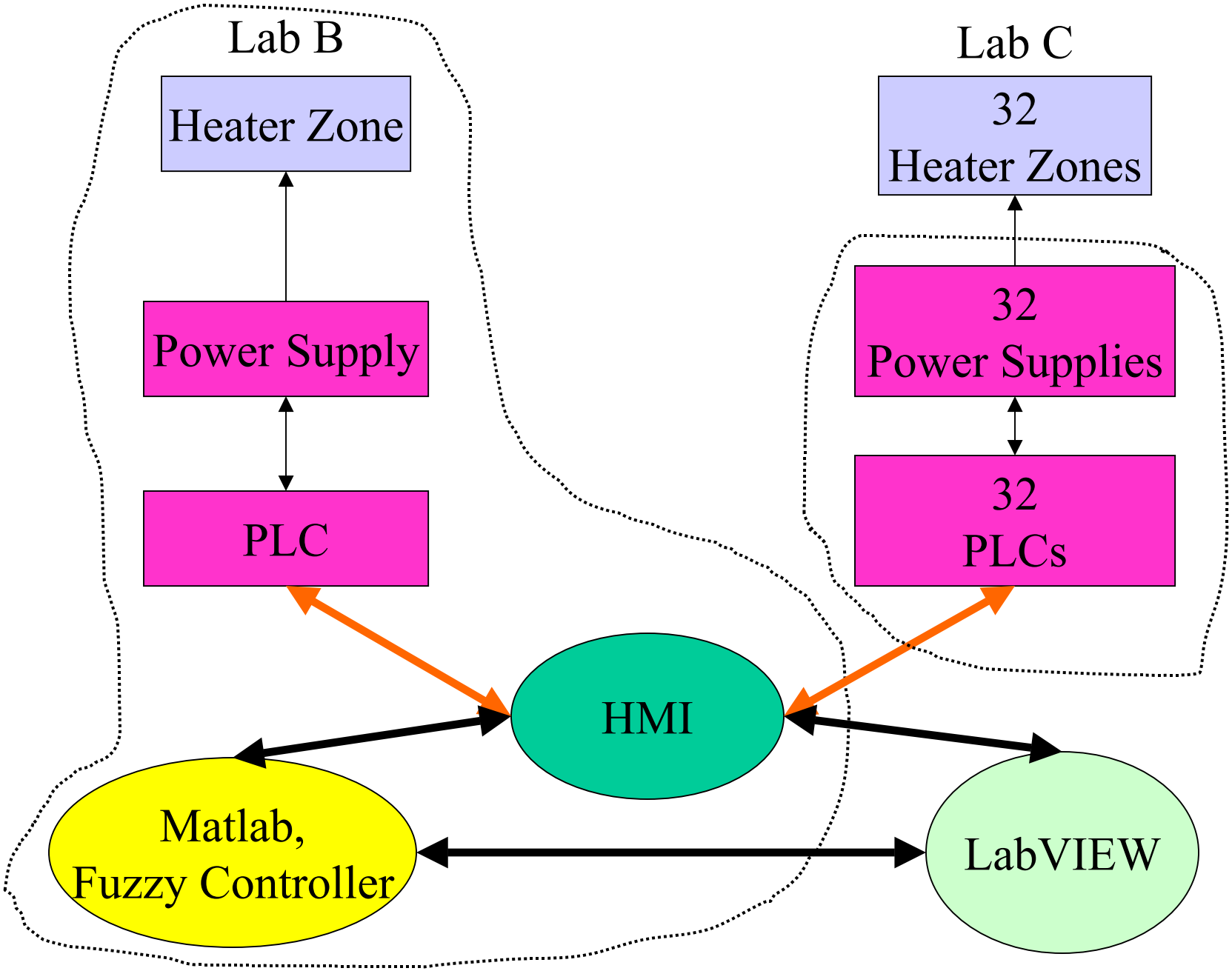

Error Surface for Calculated Power vs. Controlled Power
Jcf: 718.0856 SSE: 0.068926
% error
6
4
2
0
-2
-4
-6
10
5
0
-5
-10
y
-10
-5
0
5
10
x


Power Profile for 32/32 zones Jcf: 476.851
Power
1.1
1.05
1
0.95
5
0
-5
y
-5
0
5
x
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94


Error Surface for Calculated Power vs. Controlled Power
Jcf: 476.851 SSE: 0.23078
% error
8
6
4
2
0
-2
-4
-6
-8
10
5
0
-5
-10
y
-10
-5
0
5
10
x

Experiment Pictures


Lab B
Heater Zone
Power Supply
PLC
Lab C
32
Heater Zones
32
Power Supplies
32
PLCs
HMI
Matlab,
Fuzzy Controller
LabVIEW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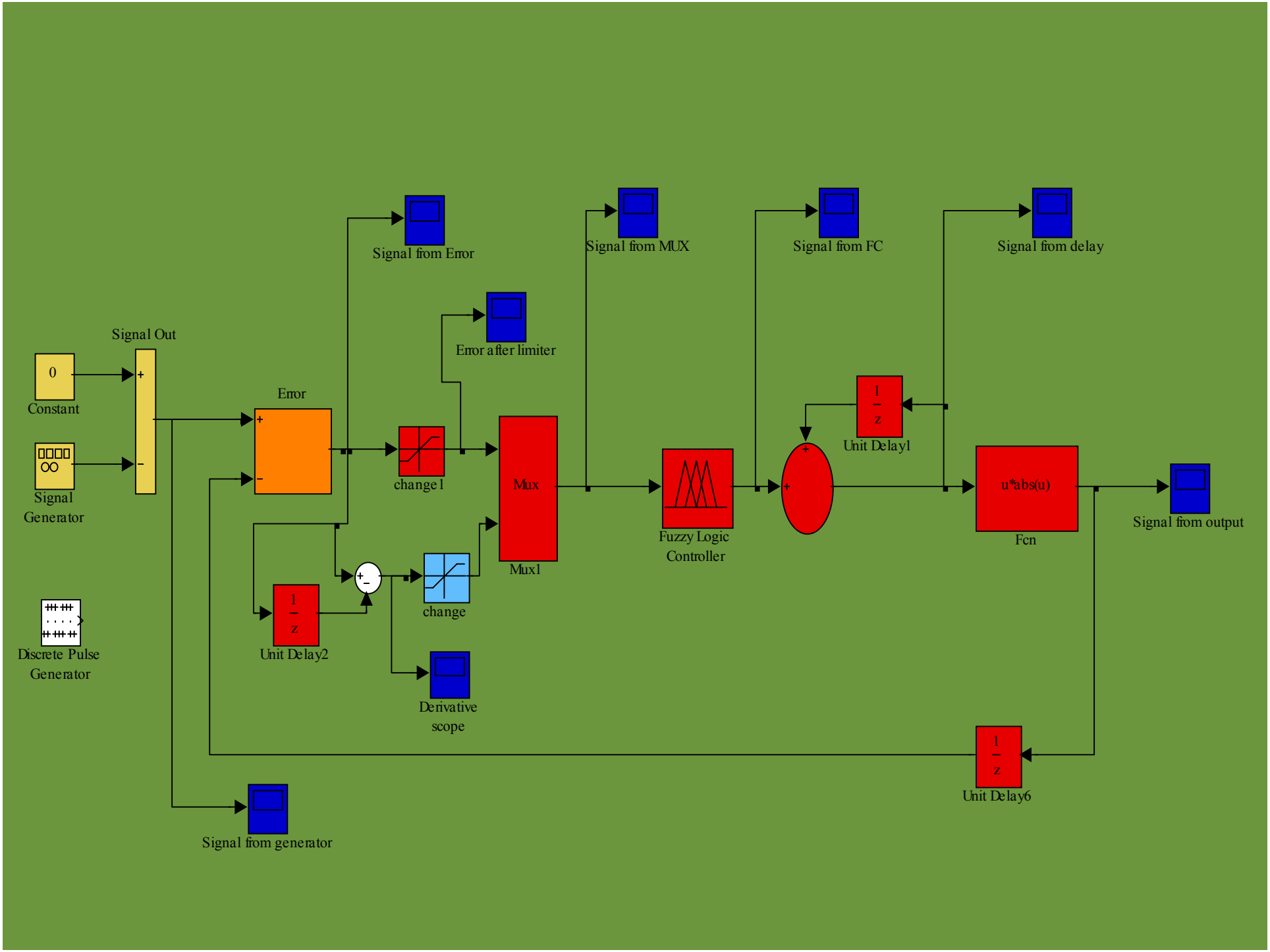

Signal from Error
Signal from MUX
Signal from FC
Signal from delay
Error after limiter
Signal Out
0
Constant
Signal Generator
Error
change1
Mux
Mux1
Fuzzy Logic Controller
1
z
Unit Delay1
u*abs(u)
Fcn
Signal from output
Discrete Pulse Generator
1
z
Unit Delay2
change
Derivative scope
1
z
Unit Delay6
Signal from generator

RSView32 Works 1500 - [STATUS SCREEN]

REMOTE MODE | LOCAL MODE | SYSTEM START | SYSTEM STOP | SETPOINTS SCREEN | ALARMS SCREEN

REMOTE | ACTIVE

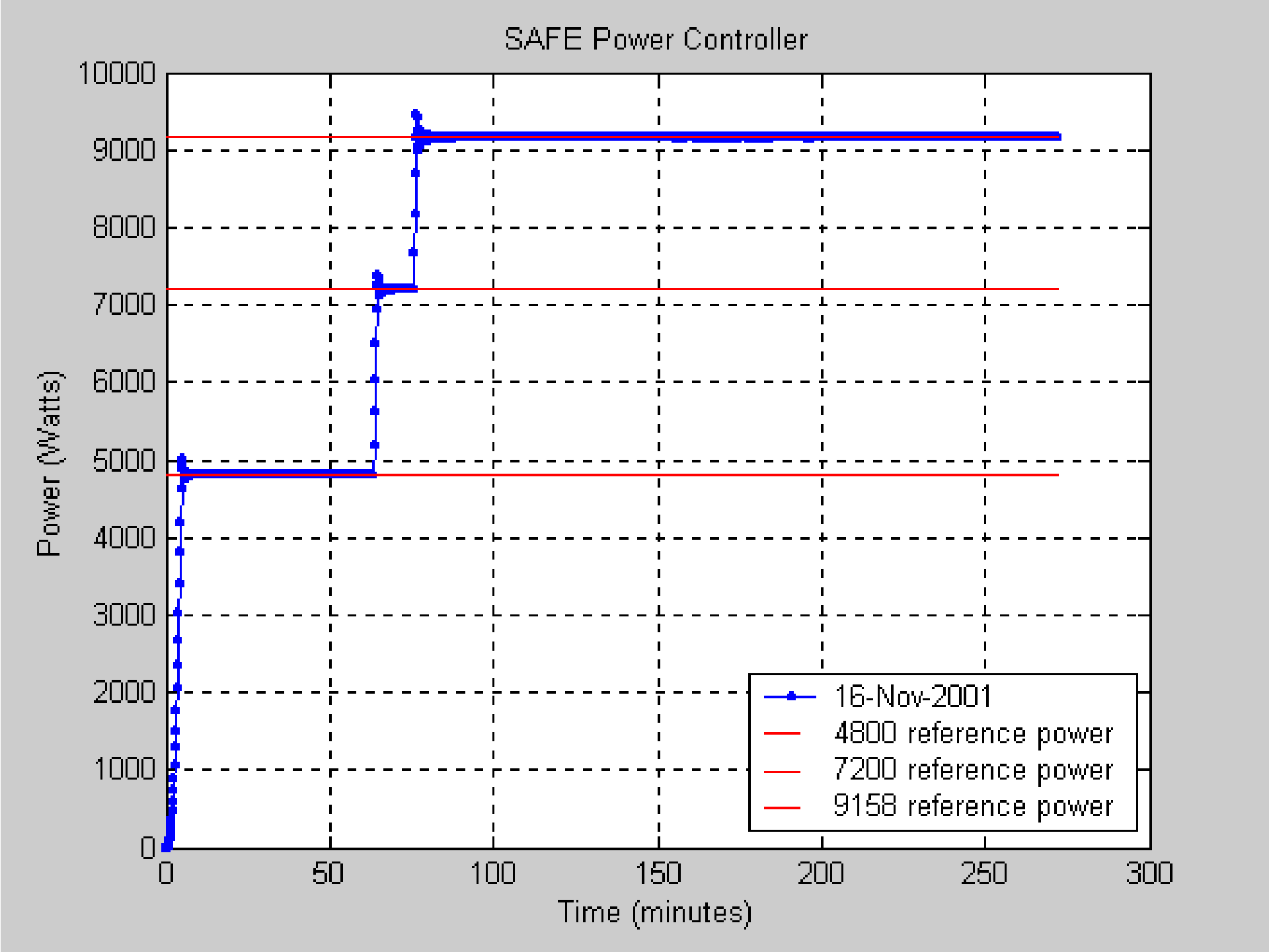
SYSTEM STATUS

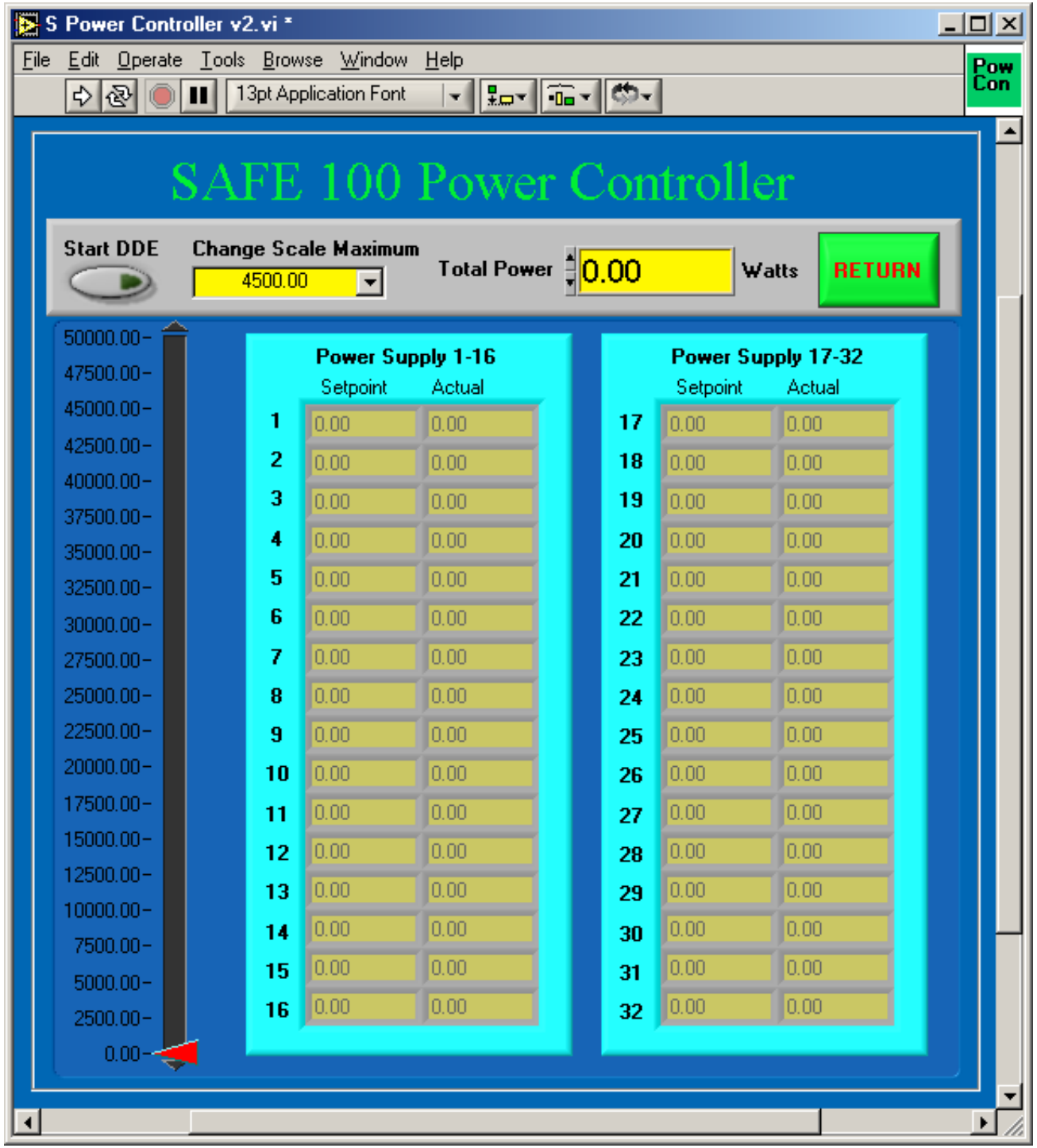
	RACK #1				RACK #2				RACK #3				RACK #4			
	THERMOCOUPLES				THERMOCOUPLES				THERMOCOUPLES				THERMOCOUPLES			
	T/C #1=	0.0	T/C #3=	0.0	T/C #1=	0.0	T/C #4=	0.0	T/C #1=	0.0	T/C #4=	0.0	T/C #1=	0.0	T/C #4=	0.0
	T/C #2=	0.0	T/C #4=	0.0	T/C #2=	0.0	T/C #3=	0.0	T/C #2=	0.0	T/C #3=	0.0	T/C #2=	0.0	T/C #3=	0.0
POWER SUPPLY	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
VOLTAGE SETPOINT	0.0	70.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CURRENT SETPOINT	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.
VOLTAGE ACTUAL	0.0	68.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CURRENT ACTUAL	0.0	64.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POWER	0	4416	0	0	0	0	0	0	0	0	0	0	0	0	0	0

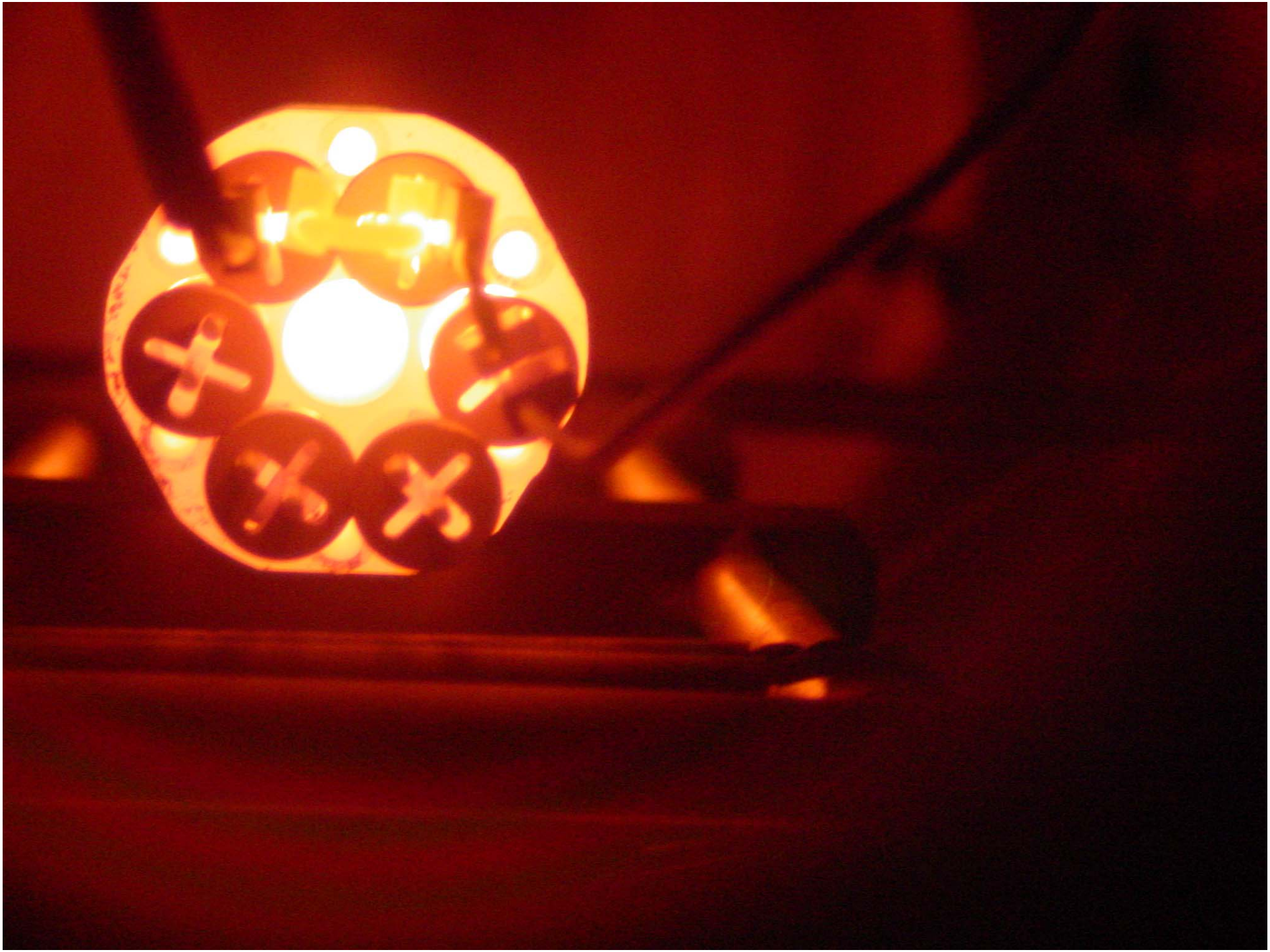
	RACK #5				RACK #6				RACK #7				RACK #8			
	THERMOCOUPLES				THERMOCOUPLES				THERMOCOUPLES				THERMOCOUPLES			
	T/C #1=	0.0	T/C #3=	0.0	T/C #1=	0.0	T/C #4=	0.0	T/C #1=	0.0	T/C #4=	0.0	T/C #1=	0.0	T/C #4=	0.0
	T/C #2=	0.0	T/C #4=	0.0	T/C #2=	0.0	T/C #3=	0.0	T/C #2=	0.0	T/C #3=	0.0	T/C #2=	0.0	T/C #3=	0.0
POWER SUPPLY	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
VOLTAGE SETPOINT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CURRENT SETPOINT	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.
VOLTAGE ACTUAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CURRENT ACTUAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POWER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

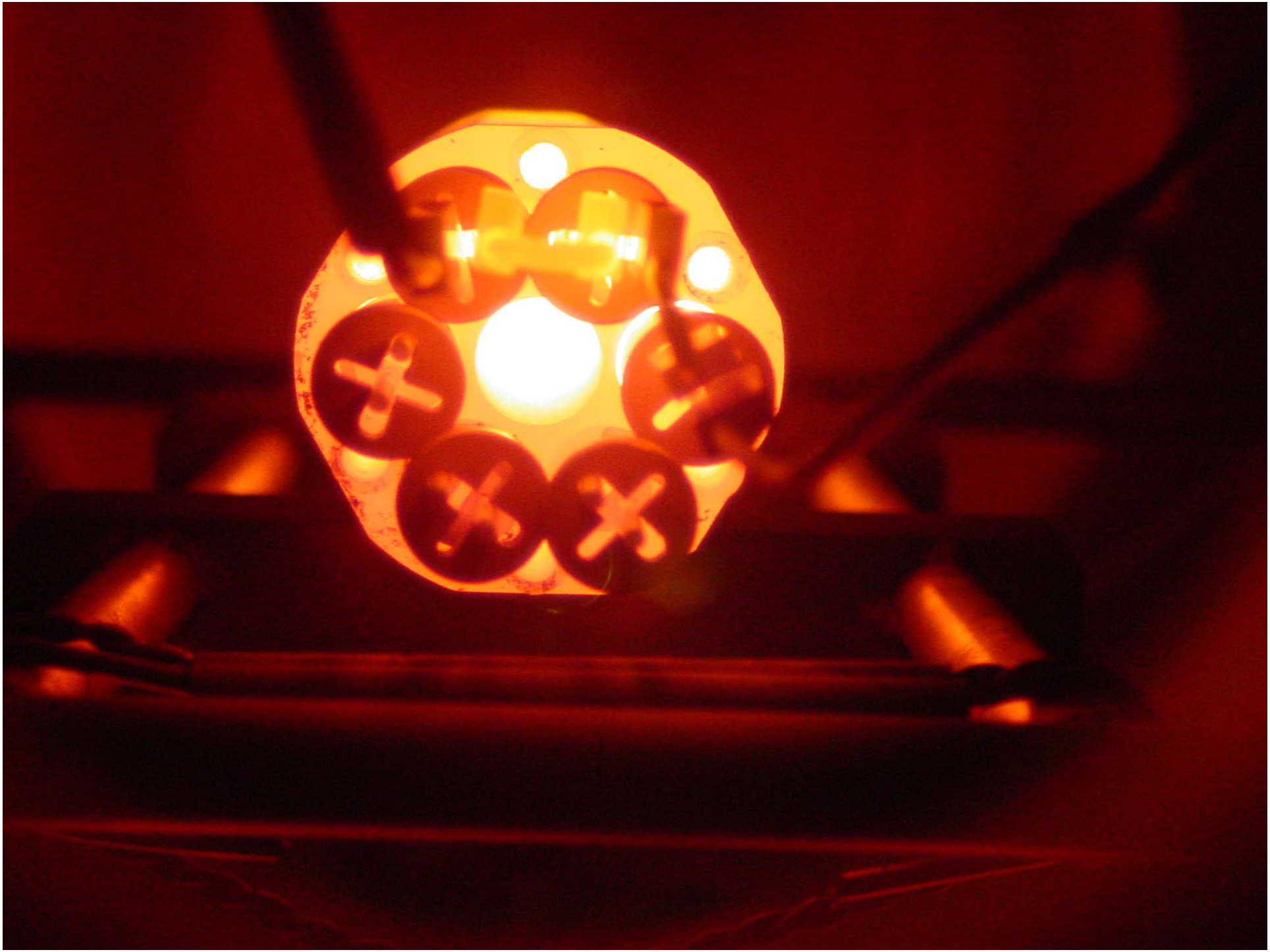
Clear | Clear All

Start | RSView32 W... | TagServer | Creative PlayCe... | Exploring - F:\ | MATLAB | F:\MATLAB6p1... | Micrografx Pictur... | 1:41 PM

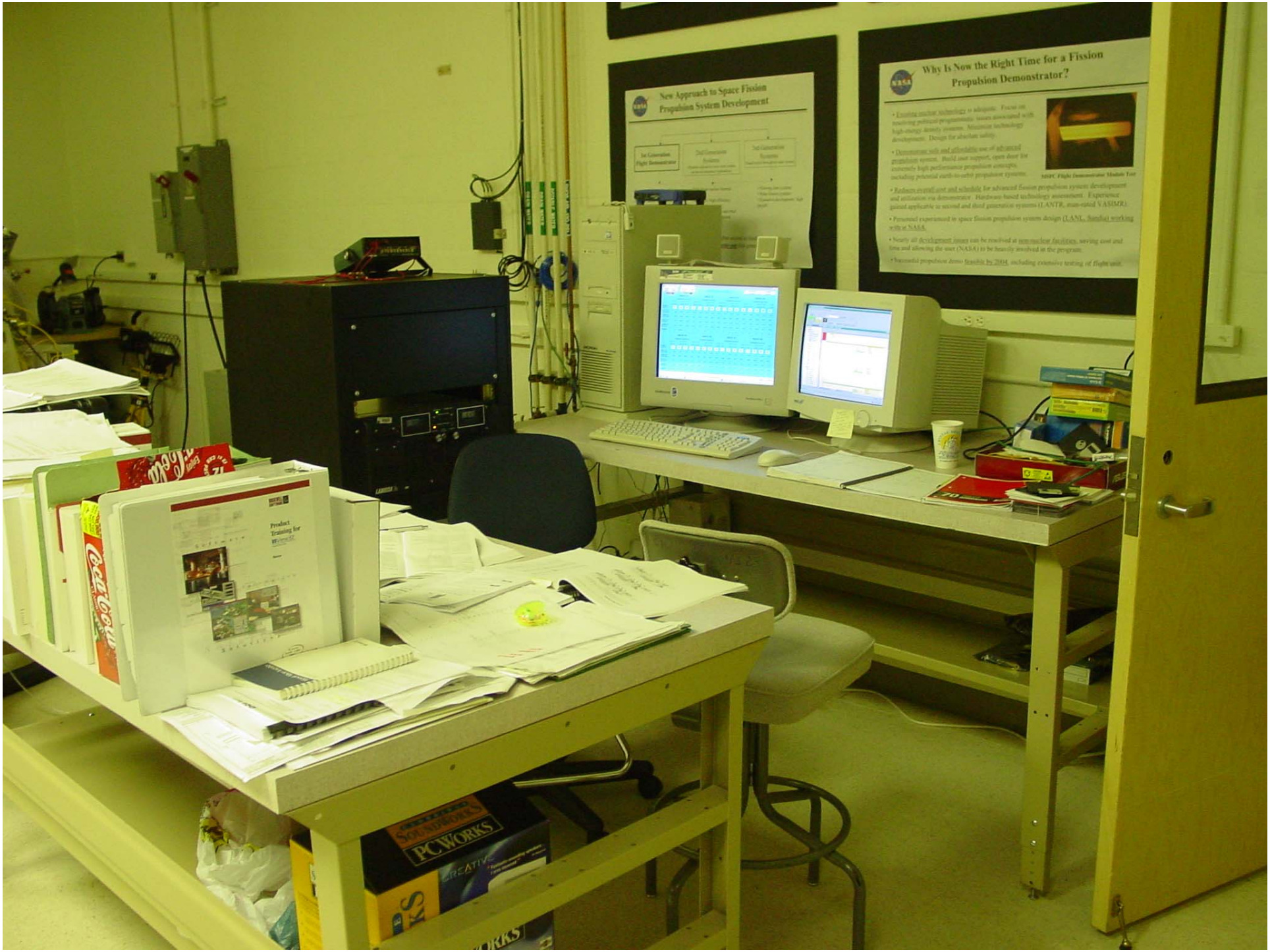

SAFE Power Controller
Power (Watts)
Time (minutes)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
50
100
150
200
250
300
16-Nov-2001
4800 reference power
7200 reference power
9158 reference power


S Power Controller v2.vi *
File Edit Operate Tools Browse Window Help
13pt Application Font
Pow Con
SAFE 100 Power Controller
Start DDE
Change Scale Maximum
4500.00
Total Power
0.00
Watts
RETURN
50000.00
47500.00
45000.00
42500.00
40000.00
37500.00
35000.00
32500.00
30000.00
27500.00
25000.00
22500.00
20000.00
17500.00
15000.00
12500.00
10000.00
7500.00
5000.00
2500.00
0.00
Power Supply 1-16
Setpoint Actual
1 0.00 0.00
2 0.00 0.00
3 0.00 0.00
4 0.00 0.00
5 0.00 0.00
6 0.00 0.00
7 0.00 0.00
8 0.00 0.00
9 0.00 0.00
10 0.00 0.00
11 0.00 0.00
12 0.00 0.00
13 0.00 0.00
14 0.00 0.00
15 0.00 0.00
16 0.00 0.00
Power Supply 17-32
Setpoint Actual
17 0.00 0.00
18 0.00 0.00
19 0.00 0.00
20 0.00 0.00
21 0.00 0.00
22 0.00 0.00
23 0.00 0.00
24 0.00 0.00
25 0.00 0.00
26 0.00 0.00
27 0.00 0.00
28 0.00 0.00
29 0.00 0.00
30 0.00 0.00
31 0.00 0.00
32 0.00 0.00





Lab B


New Approach to Space Fission Propulsion System Development
Why Is Now the Right Time for a Fission Propulsion Demonstrator?
Product Training for
SOUNDWORKS
PCWORKS
CREATIVE

Timeframe

- Fuzzy-logic controller integration finished by Oct-Nov 2001
- Interface, software, and all power system integration completed by Nov 2001

- Future Work: fuzzy c-elliptotypes adaptive clustering algorithm for control zones