THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Final Class

Dunbar P. Birnie, III
dbirnie@rci.rutgers.edu

13 December 2004

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Outline

- Analysis of Design Competition
- Discussion of Multi-Band-Gap Optimization
- Discussion of Motor/Cell Matching HW
- Overview of Expectations for Final

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Competition Raw Data

Team Number	Time	Mass (g)	Height (ft)
1	4:06	464.6	5.00
2	1:52	222.2	5.00
3	3:31	523.2	5.00
4	4:11	305.9	4.25
5	4:33	691.8	5.00
6	3:45	465.1	4.00
7	2:05	302.0	5.00

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Competition Data – Better Units

Team Number	total time (s)	Mass (kg)	Height (m)
1	246	0.4646	1.524
2	112	0.2222	1.524
3	211	0.5232	1.524
4	251	0.3059	1.2954
5	273	0.6918	1.524
6	225	0.4651	1.2192
7	125	0.3020	1.524

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Final Results

Team Number	Mass (kg)	Height (m)	Mass*Height
5	0.6918	1.524	1.054
3	0.5232	1.524	0.797
1	0.4646	1.524	0.708
6	0.4651	1.2192	0.567
7	0.3020	1.524	0.460
4	0.3059	1.2954	0.396
2	0.2222	1.524	0.339

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

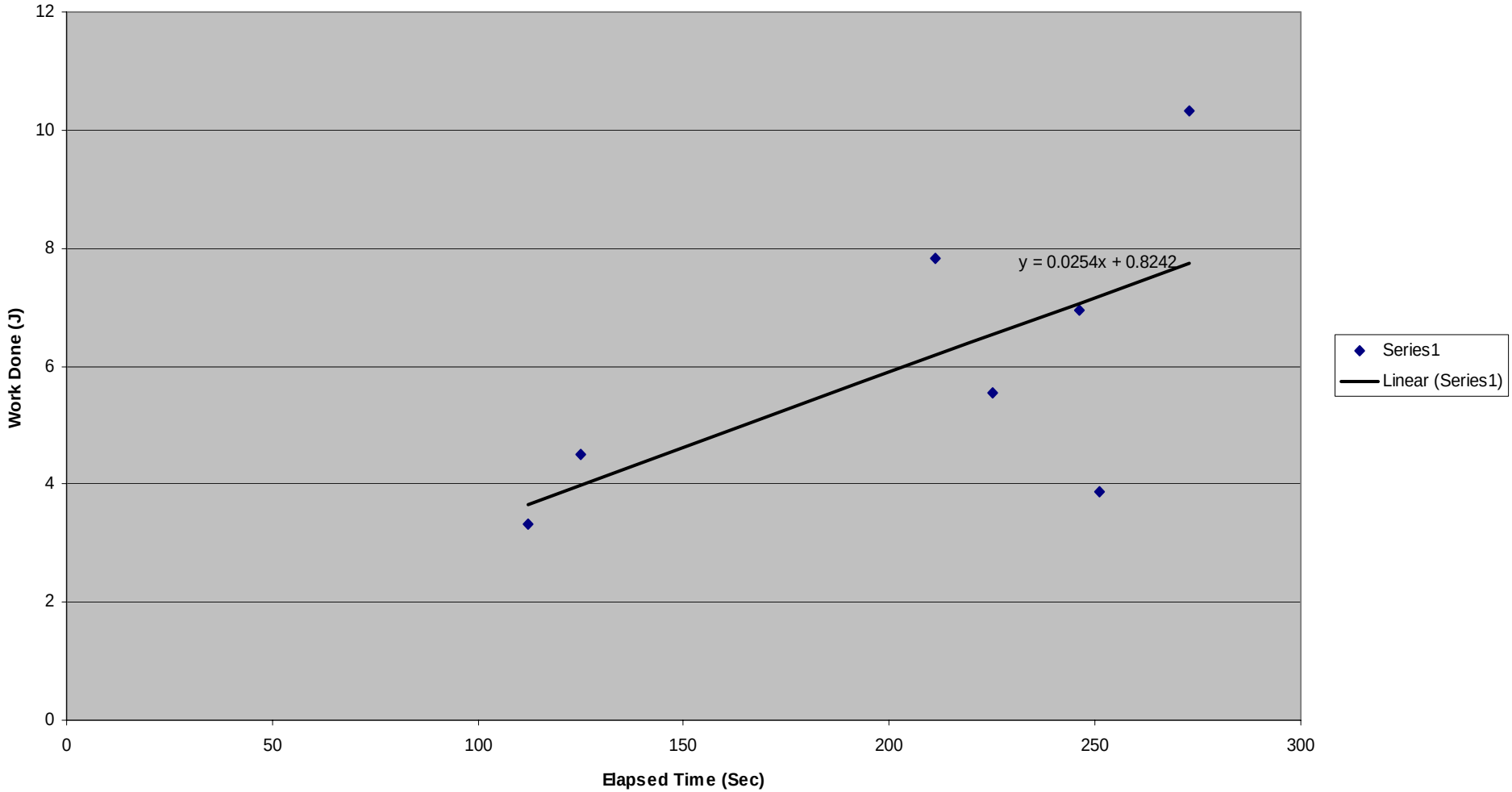
Final Results – Power Output

Team Number	Mass (kg)	Height (m)	Power (Watts)
5	0.6918	1.524	0.038
3	0.5232	1.524	0.037
7	0.3020	1.524	0.036
2	0.2222	1.524	0.030
1	0.4646	1.524	0.028
6	0.4651	1.2192	0.025
4	0.3059	1.2954	0.015

Compare to 0.125 W at Peak for Cell !!!

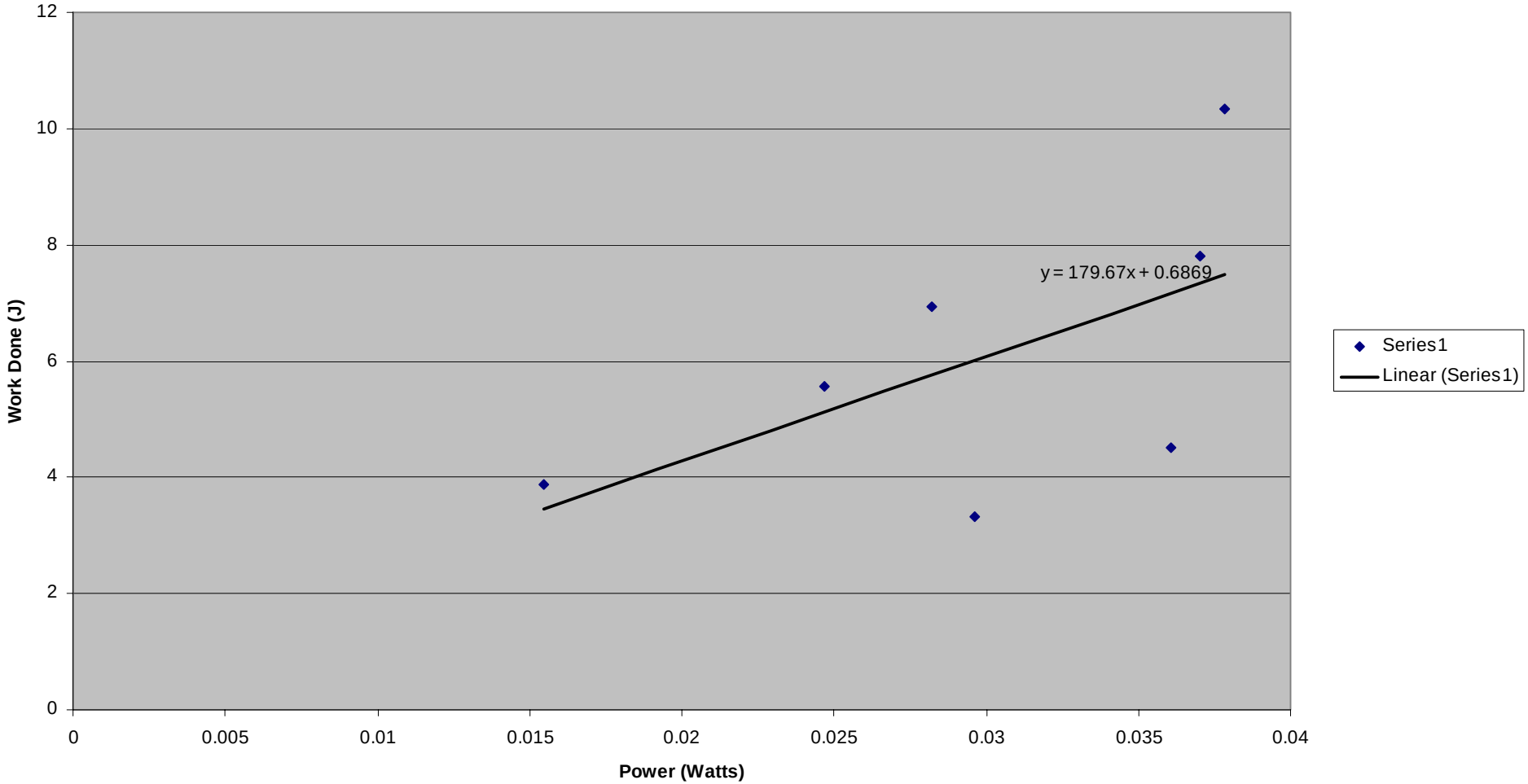
THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Work Correlation with Time



THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Work Correlation with Power



THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Project Conclusions

- Important to Raise Weight Slowly
- Use Full Time → Maximize Work
- Reduce Friction
- Small Axle Seemed Better
- Needed to Match Torque vs. Rotation Rate
- Map Real Rotation Rate with Weight (Torque)

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

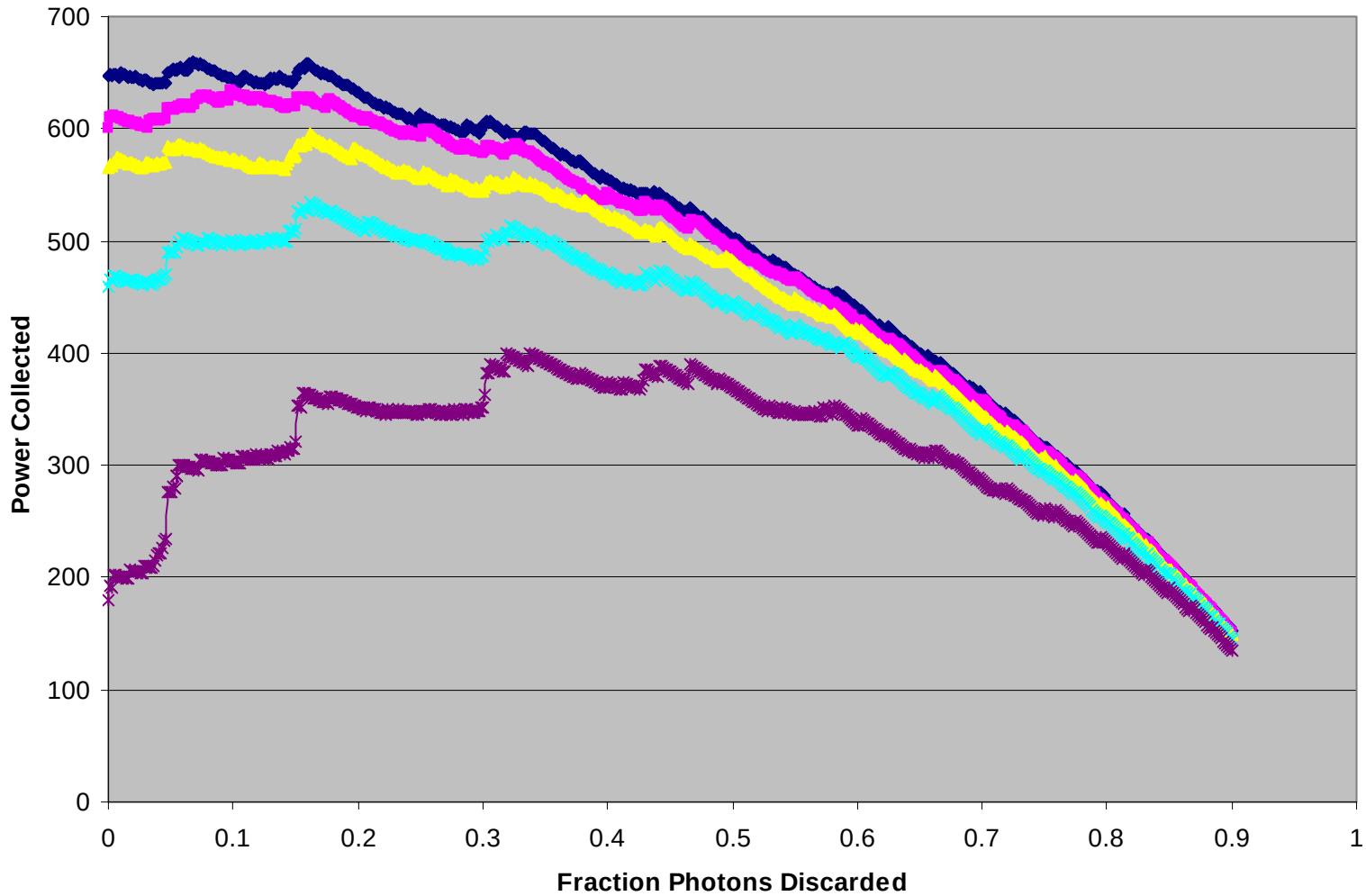
MultiLayer Gap Optimization

- Select Variable Amount of Spectrum to Discard – Use this as the Independent Var.
- Add up Voltages in Series
- Current = 1/N of Non-Discarded Photons
- Output Power = I*V

- Find Maximum Power

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Results - Graphical



THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Band Gap Results: Direct Solar

- 6.8% Photons Discarded is Best
- Eg(1) = 1.94
- Eg(2) = 1.43
- Eg(3) = 1.14
- Eg(4) = 0.76
- Eg(5) = 0.52

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

MultiLayer Summary

N Layers	Peak Watts	Fraction Photons Discarded
1	399	33.9%
2	532	16.7%
3	594	16.5%
4	634	9.8%
5	659	6.8%

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Motor/Cell Matching HW

- Power Output for Cell ==I*V
- PEAK Power Output for Motor = $V^2/4R$
- Matching Point when Current and Voltage are Same
- Look at Overlap of Power vs. Voltage

- Find Highest **Spot Lower than Both Curves**