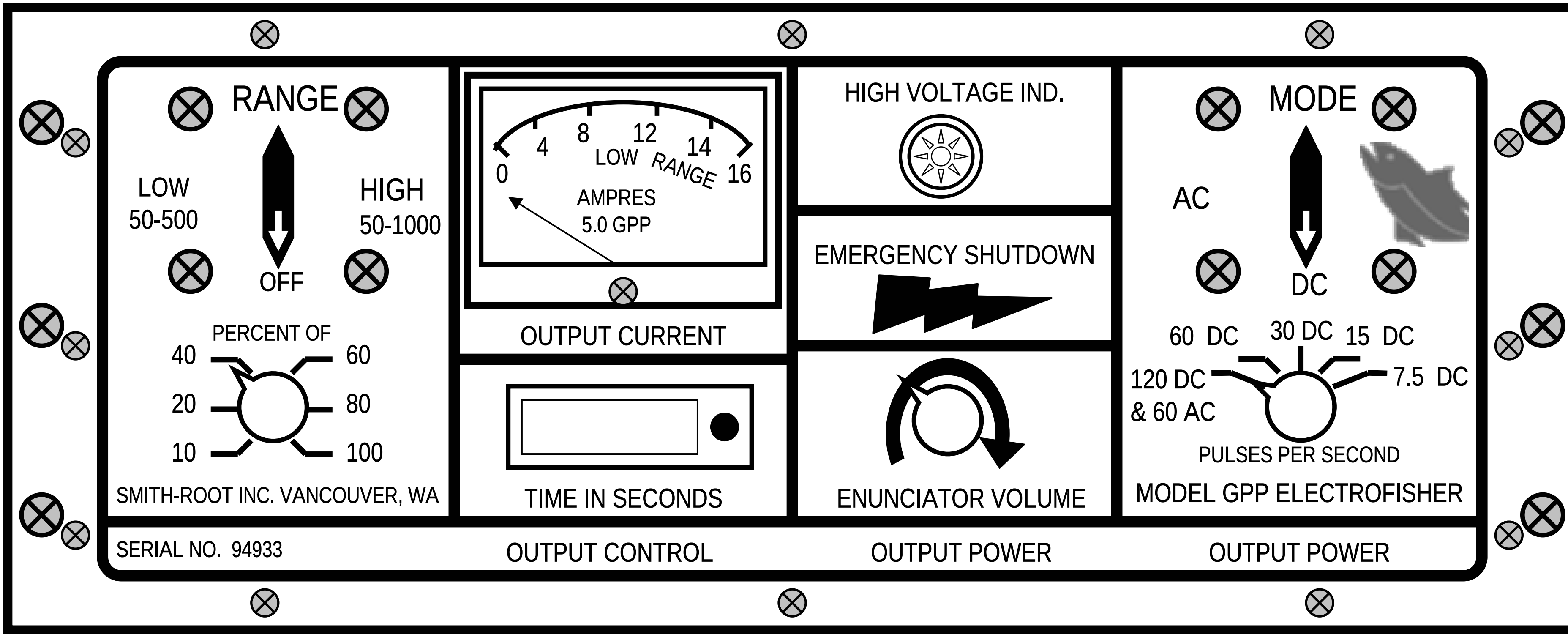
Monitoring the Performance of Boat-mounted 5.0-GPP Electrofishers



Pat Martinez, Aquatic Researcher, CDOW

Larry Kolz, PE, retired (USFWS-NCTC)

Introduction:

- UCRB-RIP aluminum-hulled electrofishing fleet

- 6-offices: CDOW-Gr. Jct, CSU-LFL-Ft. Collins, UDWR-Moab & Vernal, USFWS-CRFP-Gr. Jct. & Vernal

- 2-4 electrofishing boats per office

- most use Smith-Root 5.0-GPP electrofishers

- electrofishing in critical habitat

- increased electrofishing for nonnative fish removal

- capture efficiency, data comparability, injury & mortality

Literature:

Burkhardt & Gutreuter. 1995. Improving Electrofishing Catch Consistency by Standardizing Power. NAJFM 15:375-381

Miranda. 2005. Refining Boat Electrofishing Equipment to Improve Consistency and Reduce Harm to Fish. NAJFM 25:609-618.

Miranda & Dolan. 2003. Test of a Power Transfer Model for Standardized Electrofishing. TAFS 132:1179-1183

Miranda & Dolan. 2004. Electrofishing Power Require-ments in Relation to Duty Cycle. NAJFM 24:55-62

Miranda & Spencer. 2005. Understanding the Output of a Smith-Root GPP Electrofisher. NAJFM 25:848-852

Standardization:

- equipment & procedures applied consistently
- helps ensure that stock assessment is consistent
- Power Transfer Theory of electrofishing (Kolz 1989)
- electrofisher settings adjusted for water conductivity
- consistent, but not excessive, power applied to fish
- active capture - cannot control all variables (human)
- always strive to standardize controllable variables
- standardize equipment configuration & power output

<u>Standardization</u>: (con't):

1. Human factors

   - experience of boat/GPP operator

   - number & experience of netters

   - dipnet size, aperture & usability vs. fish capture

2. Fish capture

   - immobilization vs. injury & mortality (avoid tetany!)

   - monitor fish behavior & condition (narcosis only!)

   - habitat (depth, clarity, cover, flow, temperature, etc)

Standardization: (con’t):

3. Equipment configuration

   - boat (size, hull condition, hull used a cathode?)

   - anode (shape, size, number & spacing)

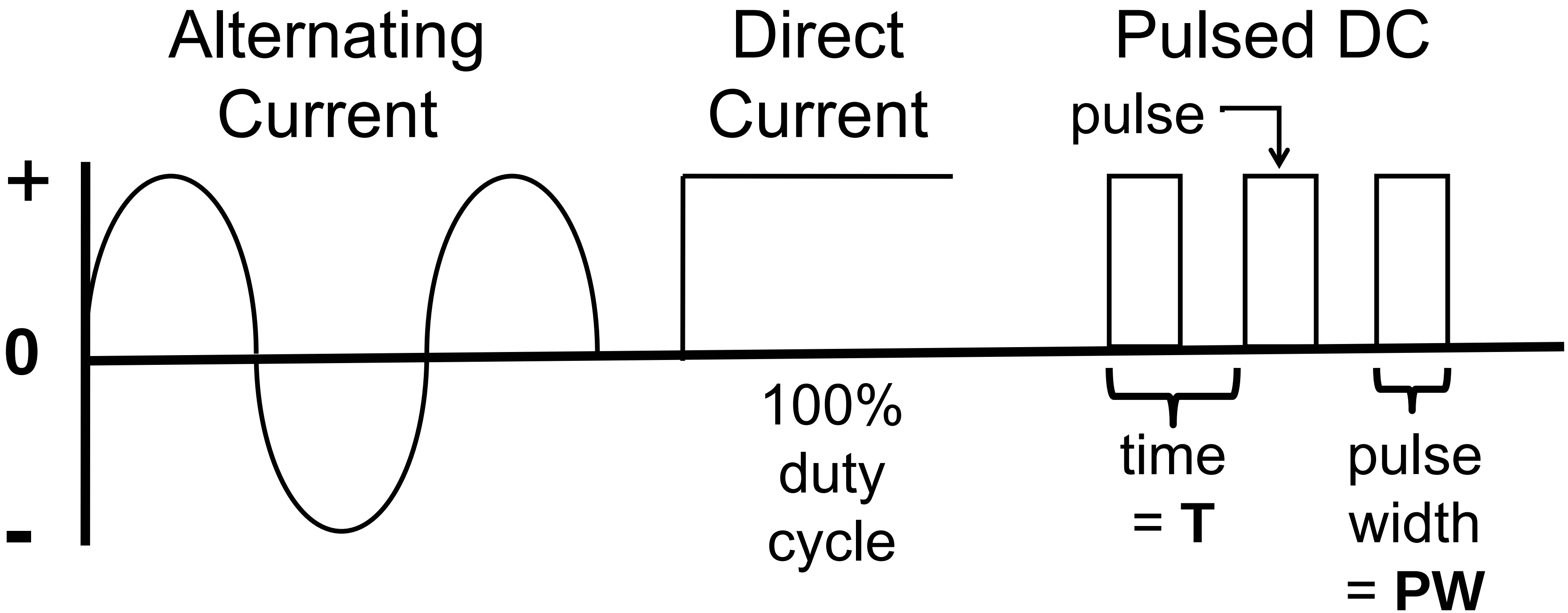
   - system resistance (boat + anodes)

4. Electrical output

   - waveform : AC, DC, PDC (amps x volts = watts)

   - duty-cycle of PDC (percent “on-time)

   - power correction factor for ambient conductivity



- PDC = off-on DC, reduces power demand

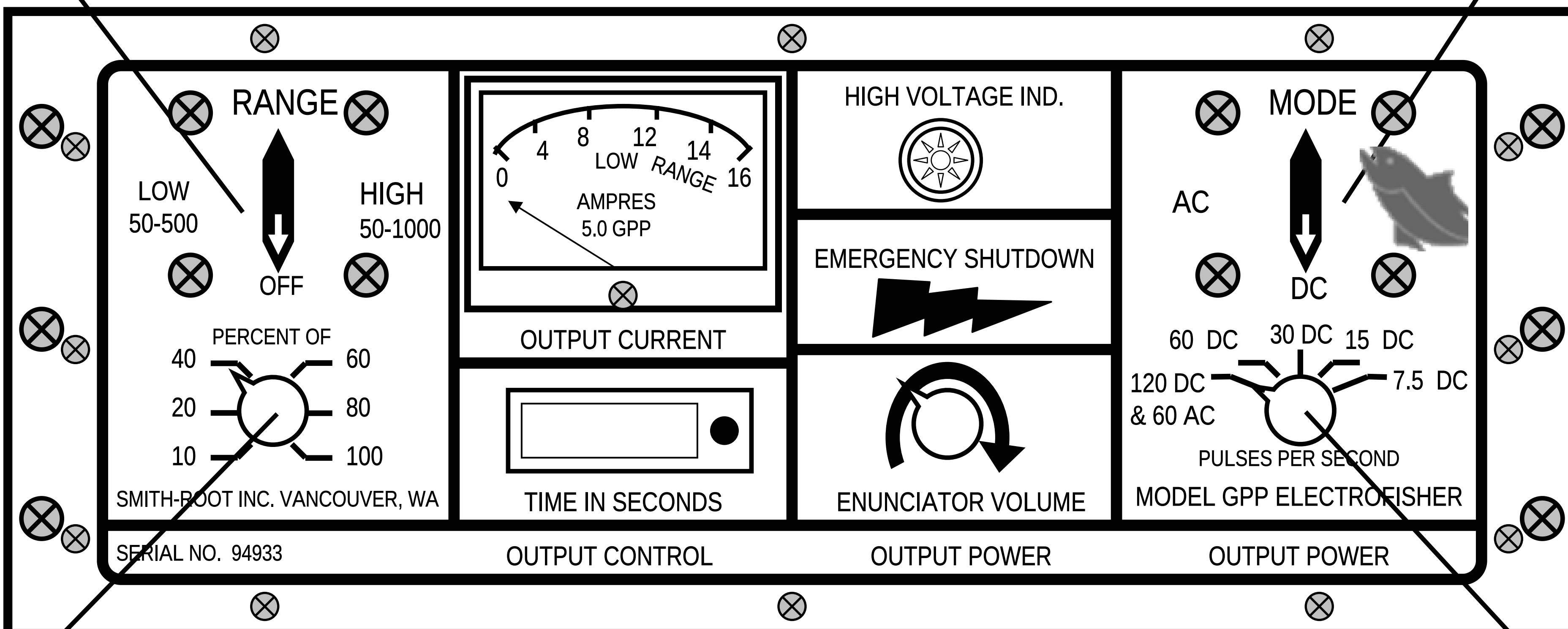
- PDC pulse rate = number of pulses per second or frequency = Hertz (Hz) = 1000/**T** $_{\text{milliseconds}}$

- PDC duty cycle = percent “on time” = (**PW** / **T**) x 100

Smith-Root Model 5.0-GPP

peak voltage controlled in two steps (500 & 1,000 V)

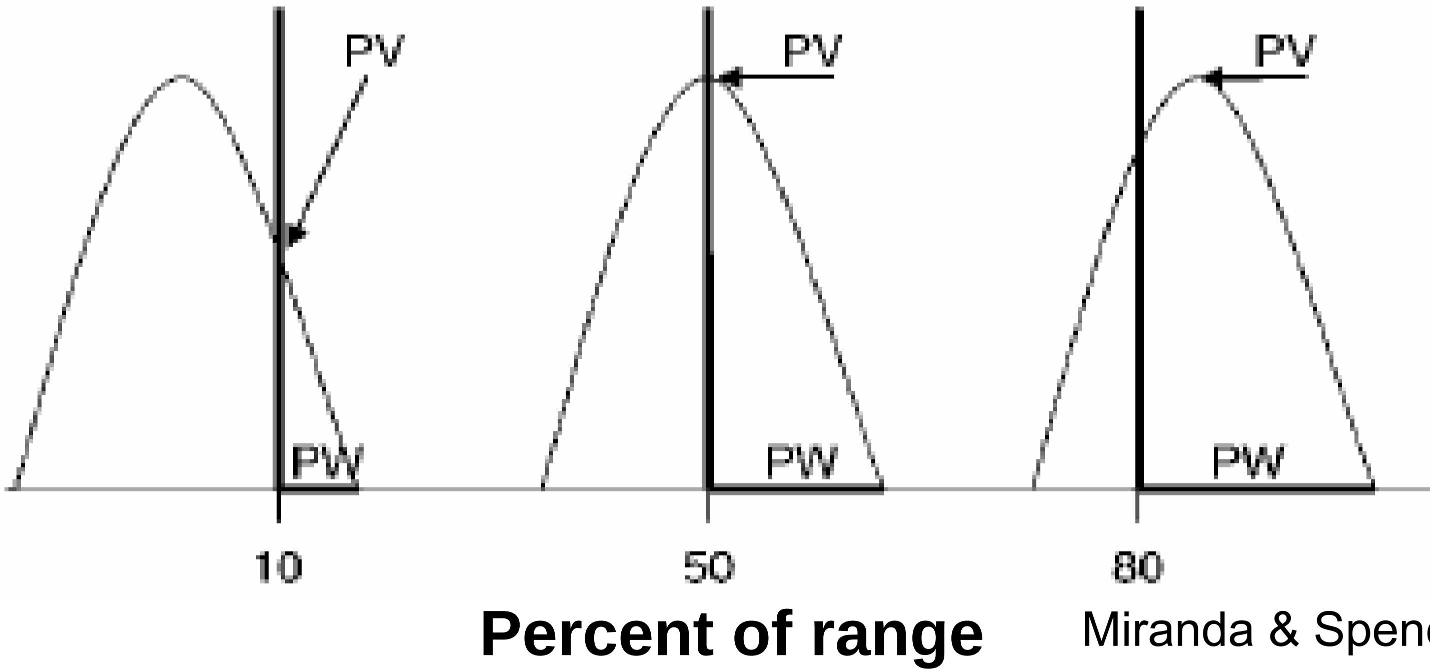
controls output of pulsed DC frequencies (Hz)



limits peak voltage of pulses in selected range & changes pulse width from 1-5ms

S-R: if not sure of mode, start with 120 pps DC

Standardizing electrical output hampered by fusion of pulse width & peak voltage in GPP electrofishers



Miranda & Spencer 2005

As percent of range (POR) is adjusted to control voltage output, pulse width & duty cycle are being changed

POR controls applied power by increasing peak voltage & pulse width from 0-50% & pulse width from 50-100%

UCRB Electrofishing Fleet Parameters:

- stainless steel spheres used as anodes

- spheres 10-in. diameter

- two anodes suspended from fiberglass booms

- anodes deployed half-submerged

- 16-18 ft. aluminum boat hulls serve as cathode

- anodes 80-in. apart & 90-in. away from boat bow

- S-R 5.0-GPP electrofisher

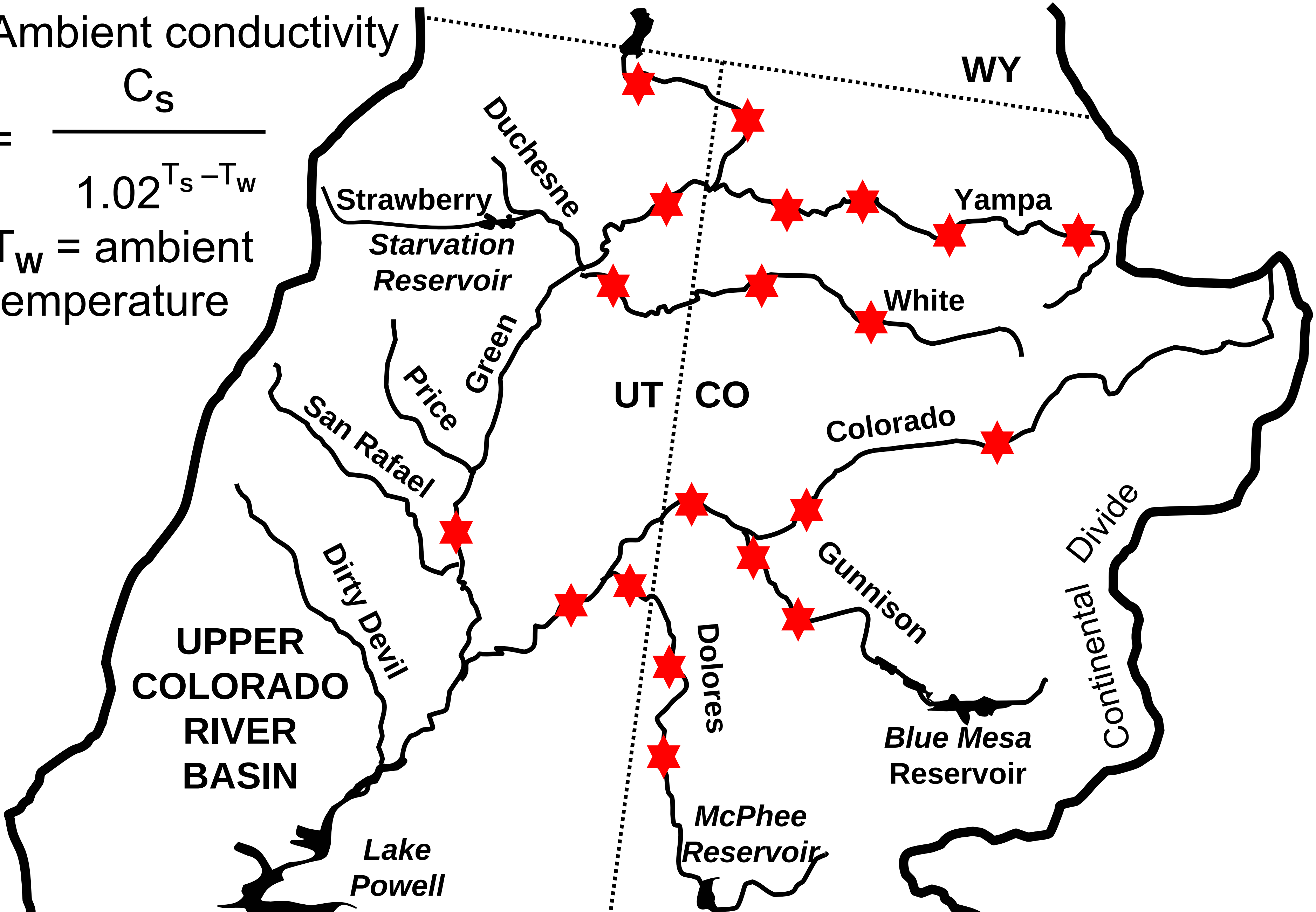
- pulsed direct current

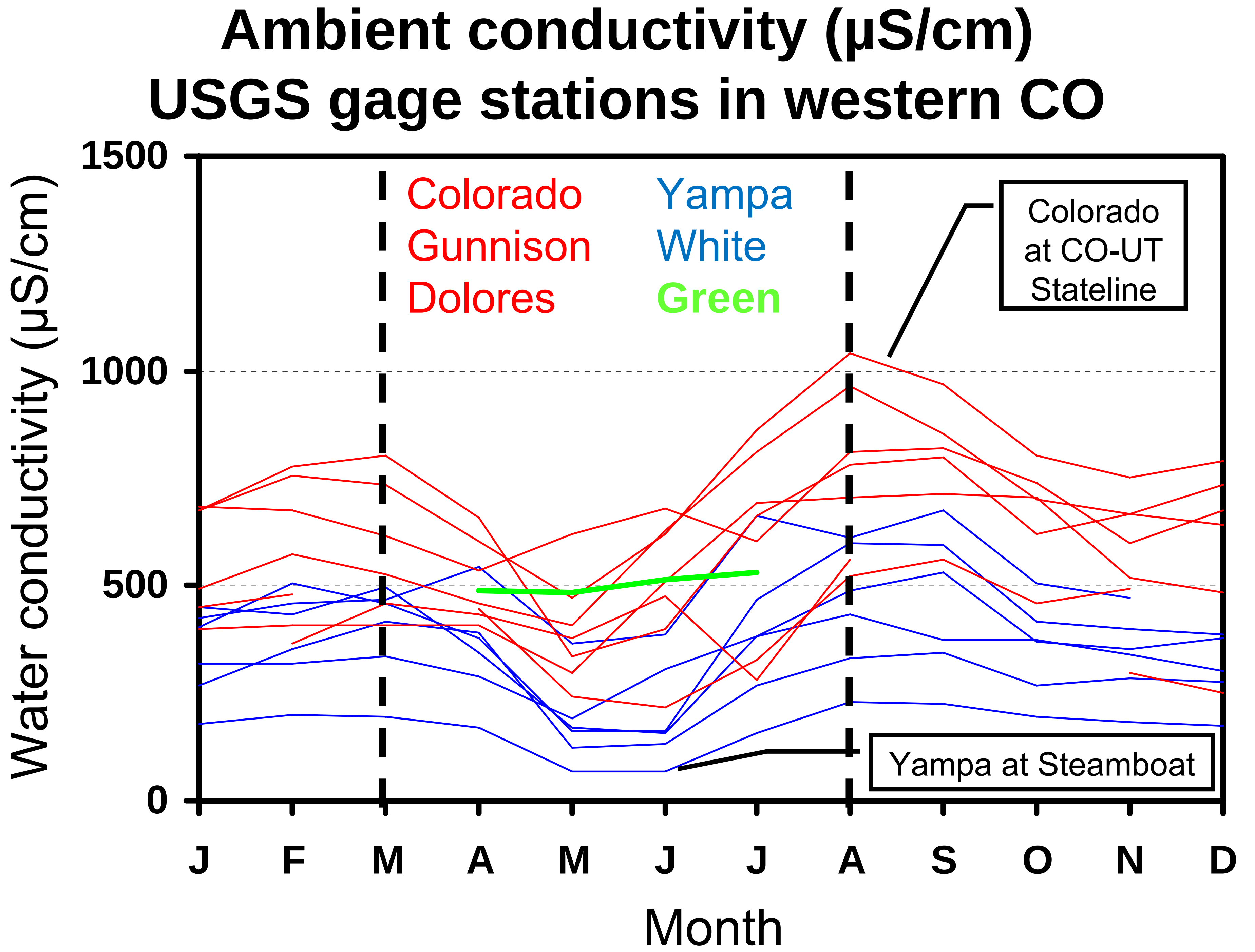
USGS, specific conductivity (C_s=μS/cm) @ 25°C (T_s)

Ambient conductivity

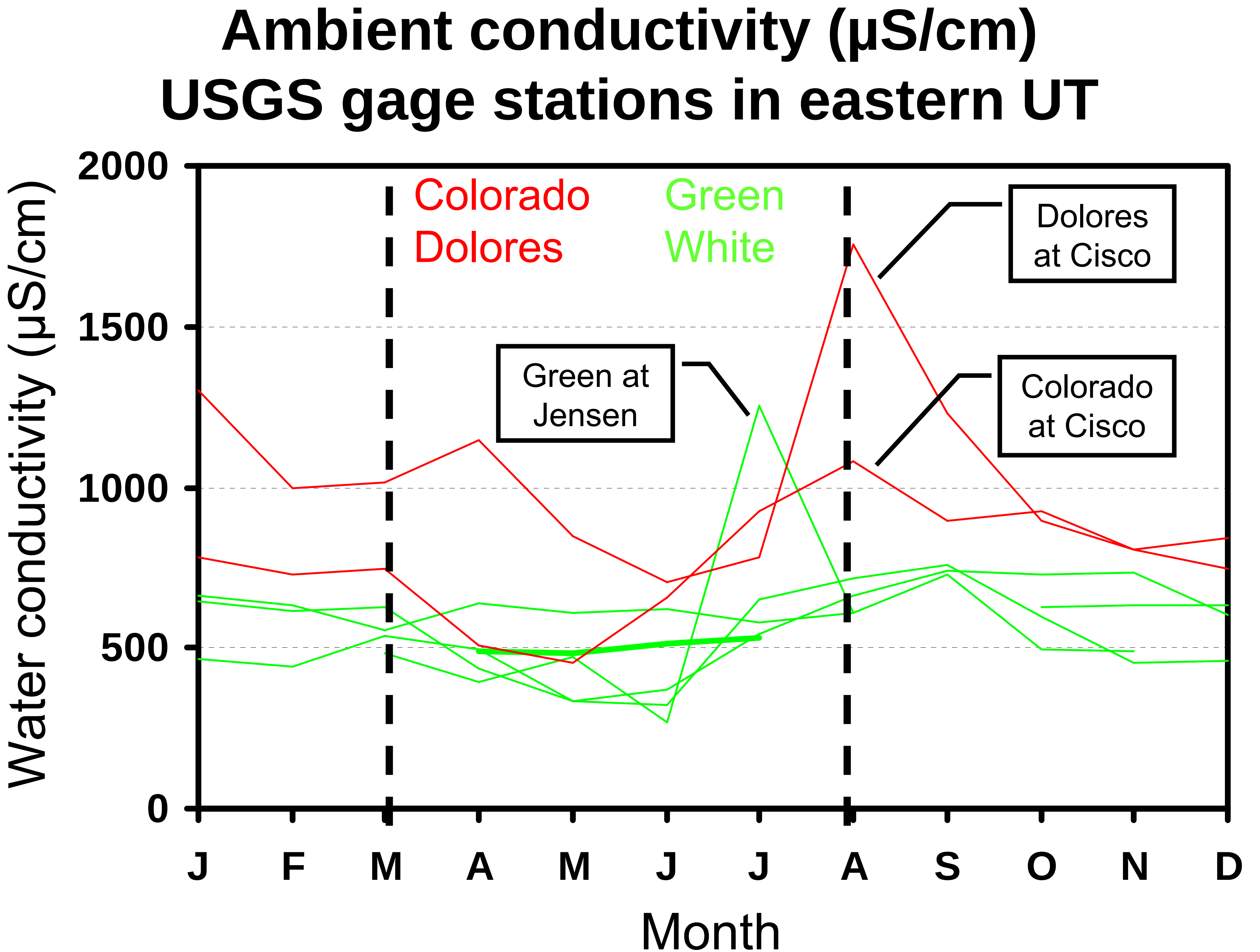
$$= \frac{C_s}{1.02^{T_s - T_w}}$$

T_w = ambient temperature



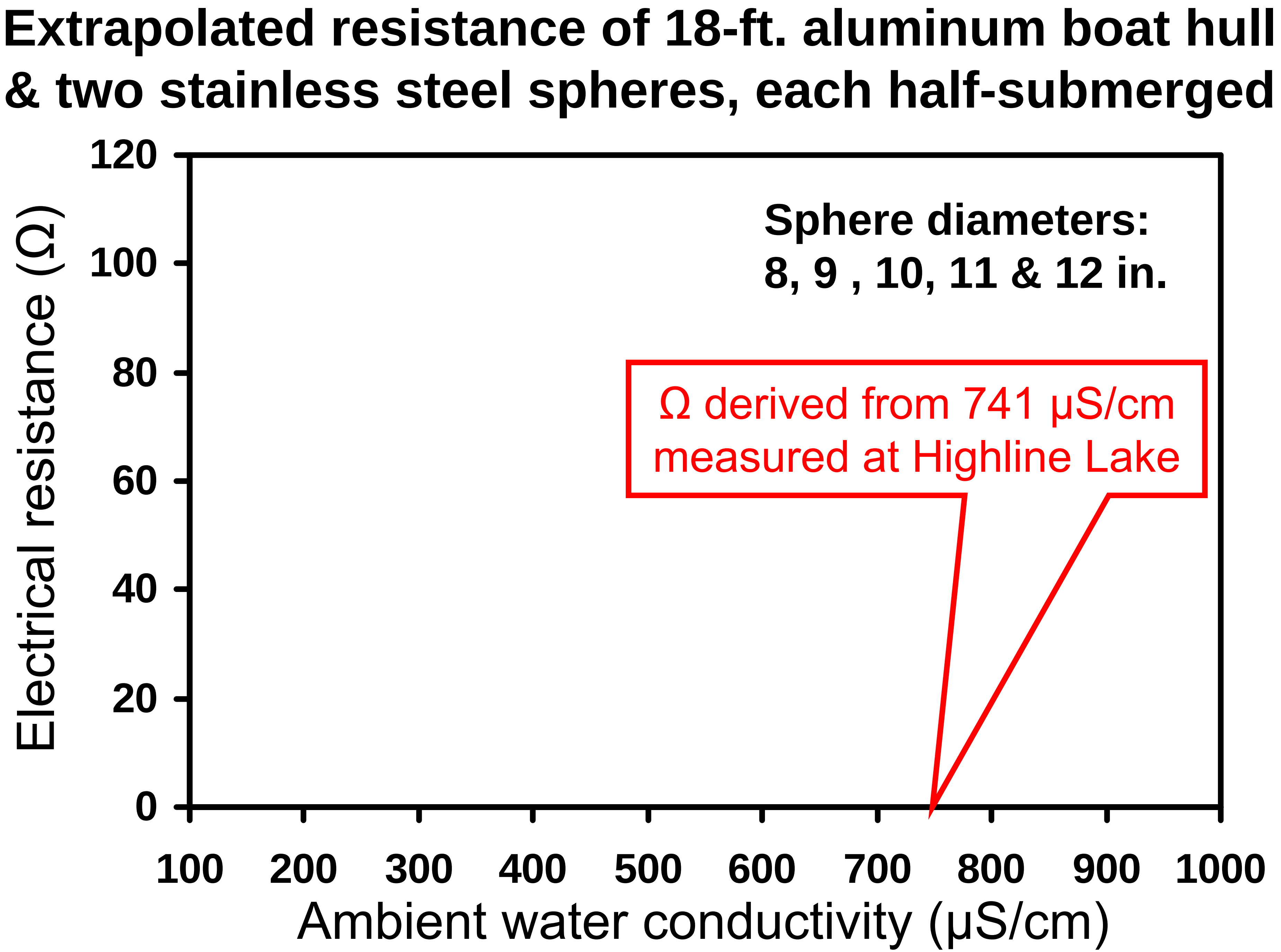


Ambient conductivity (µS/cm)
USGS gage stations in western CO
Water conductivity (µS/cm)
1500
1000
500
0
Colorado
Gunnison
Dolores
Yampa
White
Green
Colorado at CO-UT Stateline
Yampa at Steamboat
J F M A M J J A S O N D
Month

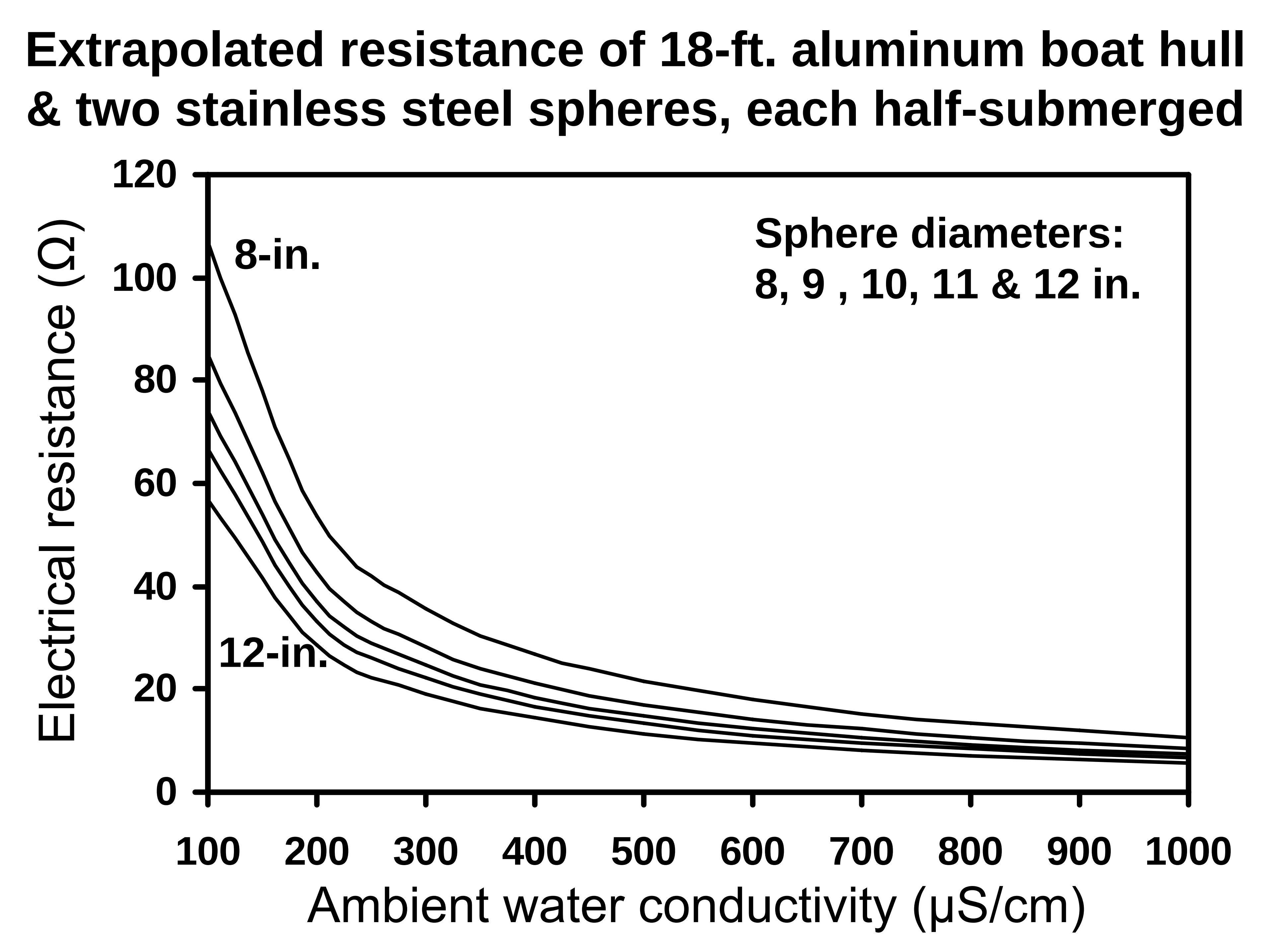

Ambient conductivity (µS/cm)
USGS gage stations in eastern UT
Colorado
Dolores
Green
White
Dolores at Cisco
Green at Jensen
Colorado at Cisco
Water conductivity (µS/cm)
2000
1500
1000
500
0
J
F
M
A
M
J
J
A
S
O
N
D
Month







Extrapolated resistance of 18-ft. aluminum boat hull
& two stainless steel spheres, each half-submerged
Sphere diameters:
8, 9 , 10, 11 & 12 in.
Ω derived from 741 µS/cm
measured at Highline Lake
Electrical resistance (Ω)
0
20
40
60
80
100
120
100
200
300
400
500
600
700
800
900
1000
Ambient water conductivity (µS/cm)



Extrapolated resistance of 18-ft. aluminum boat hull
& two stainless steel spheres, each half-submerged
Sphere diameters:
8, 9 , 10, 11 & 12 in.
8-in.
12-in.
Electrical resistance (Ω)
0
20
40
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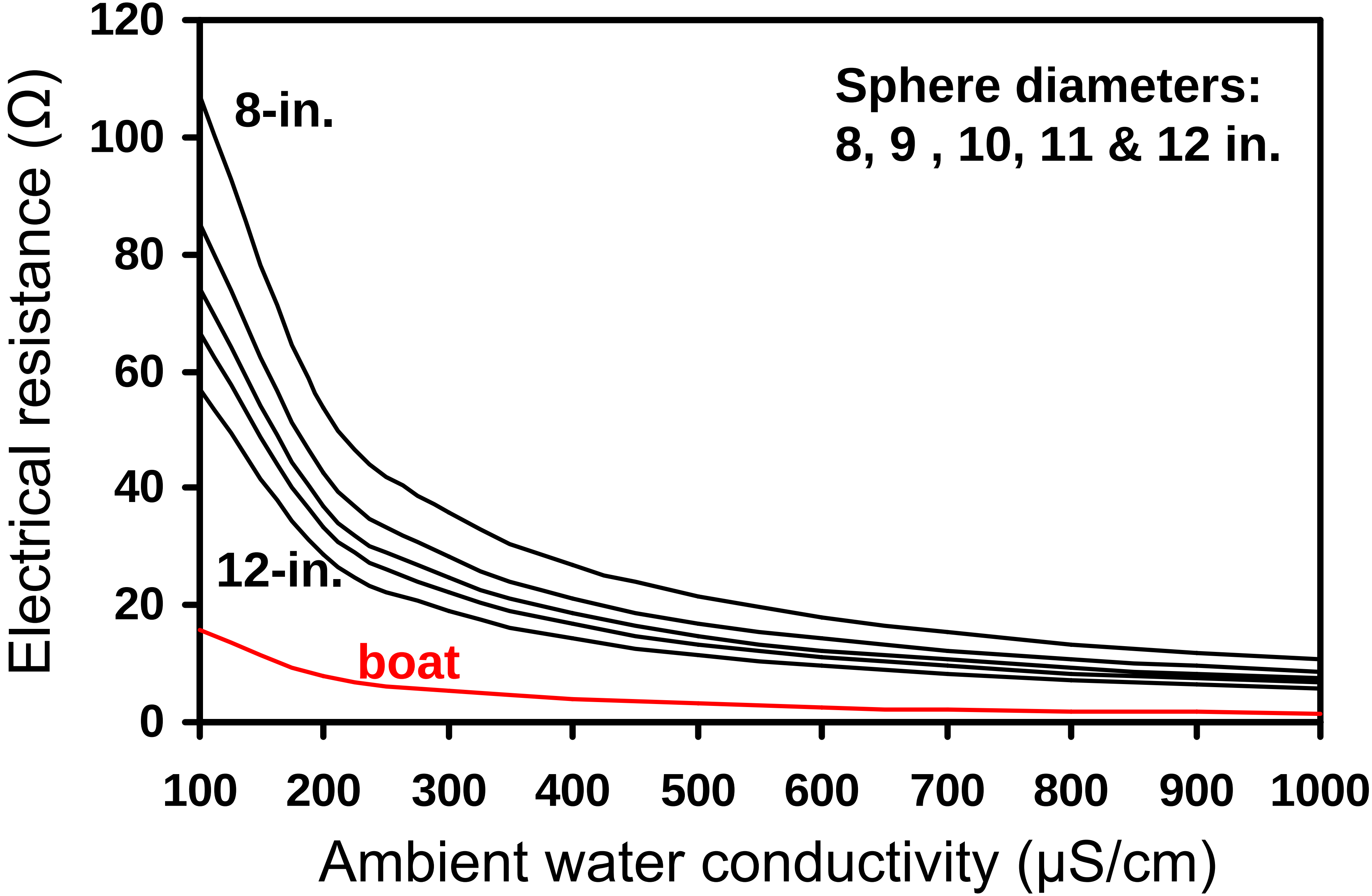
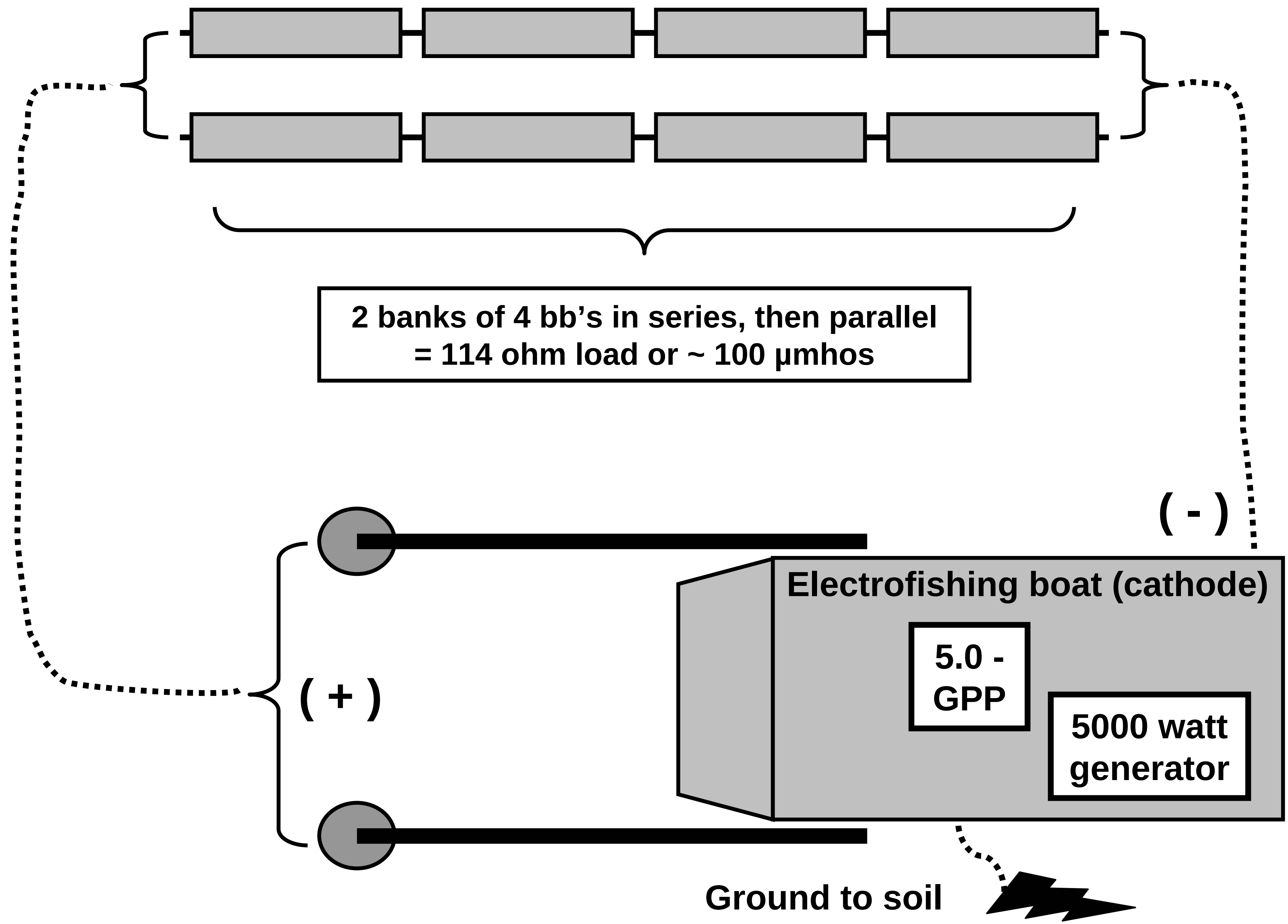
80
100
120
100
200
300
400
500
600
700
800
900
1000
Ambient water conductivity (µS/cm)

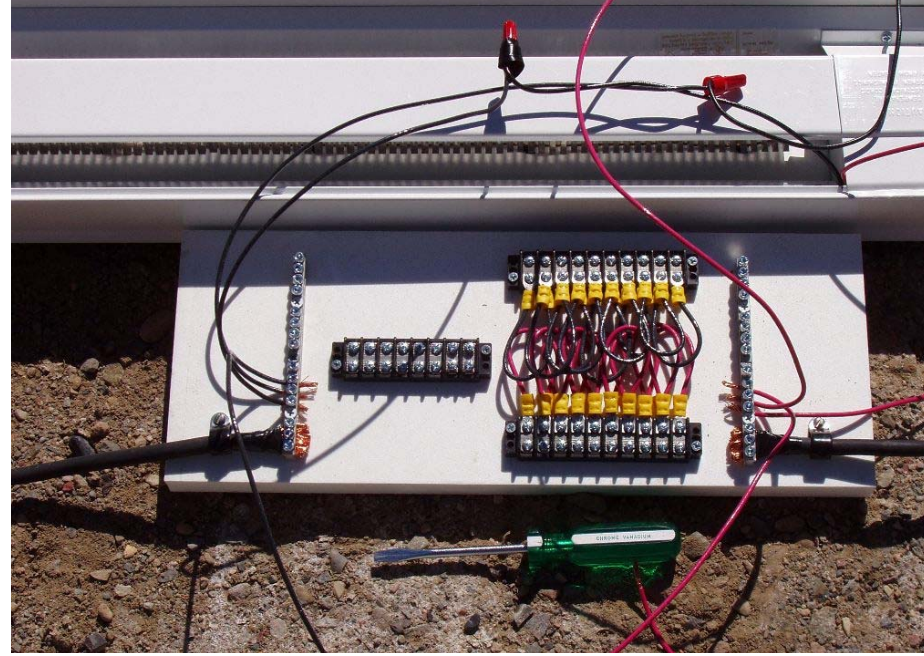
Extrapolated resistance of 18-ft. aluminum boat hull & two stainless steel spheres, each half-submerged



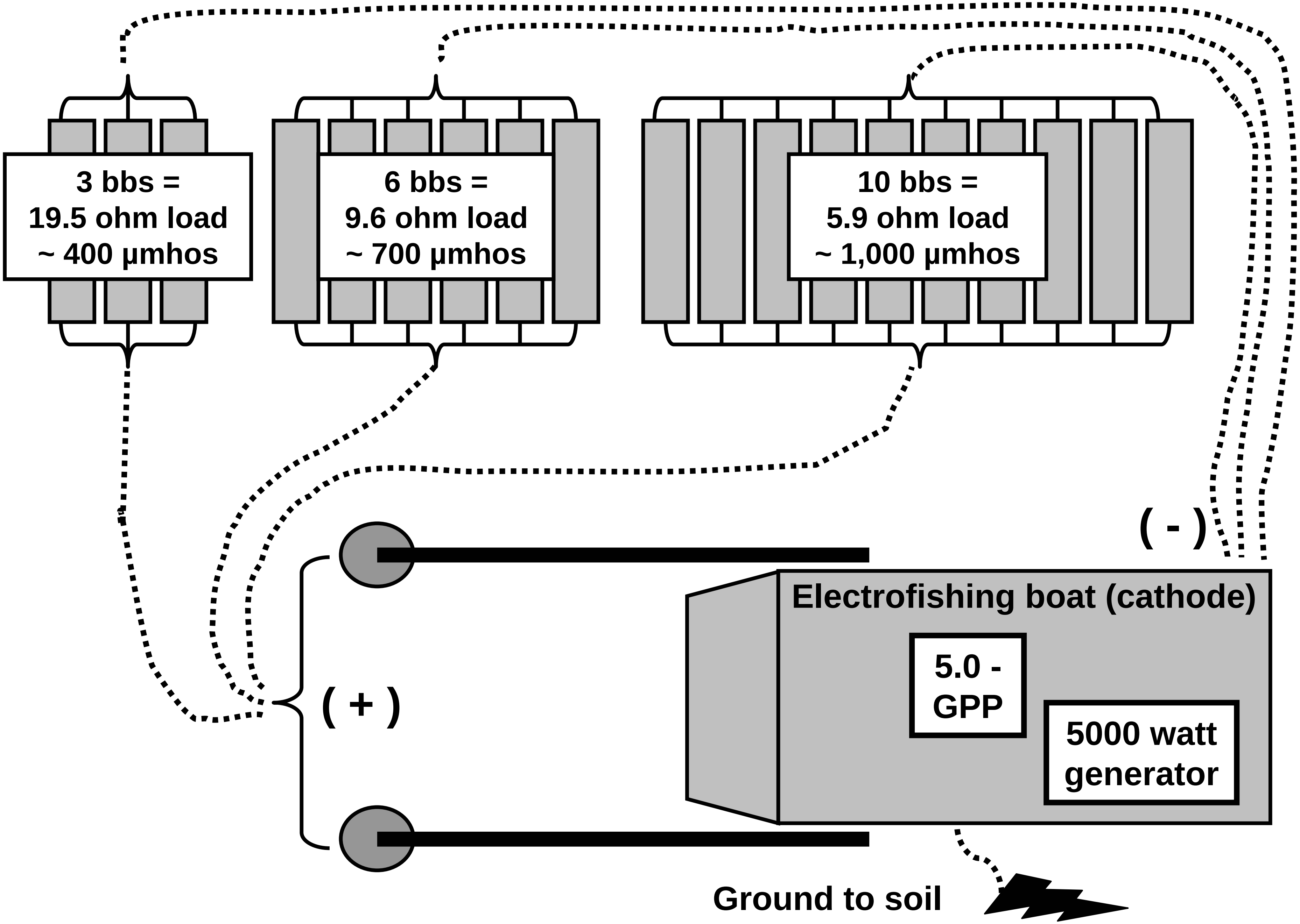
Electric baseboard (bb) heaters @ ~ 55-60 ohms (ave.~59 ohms) in series

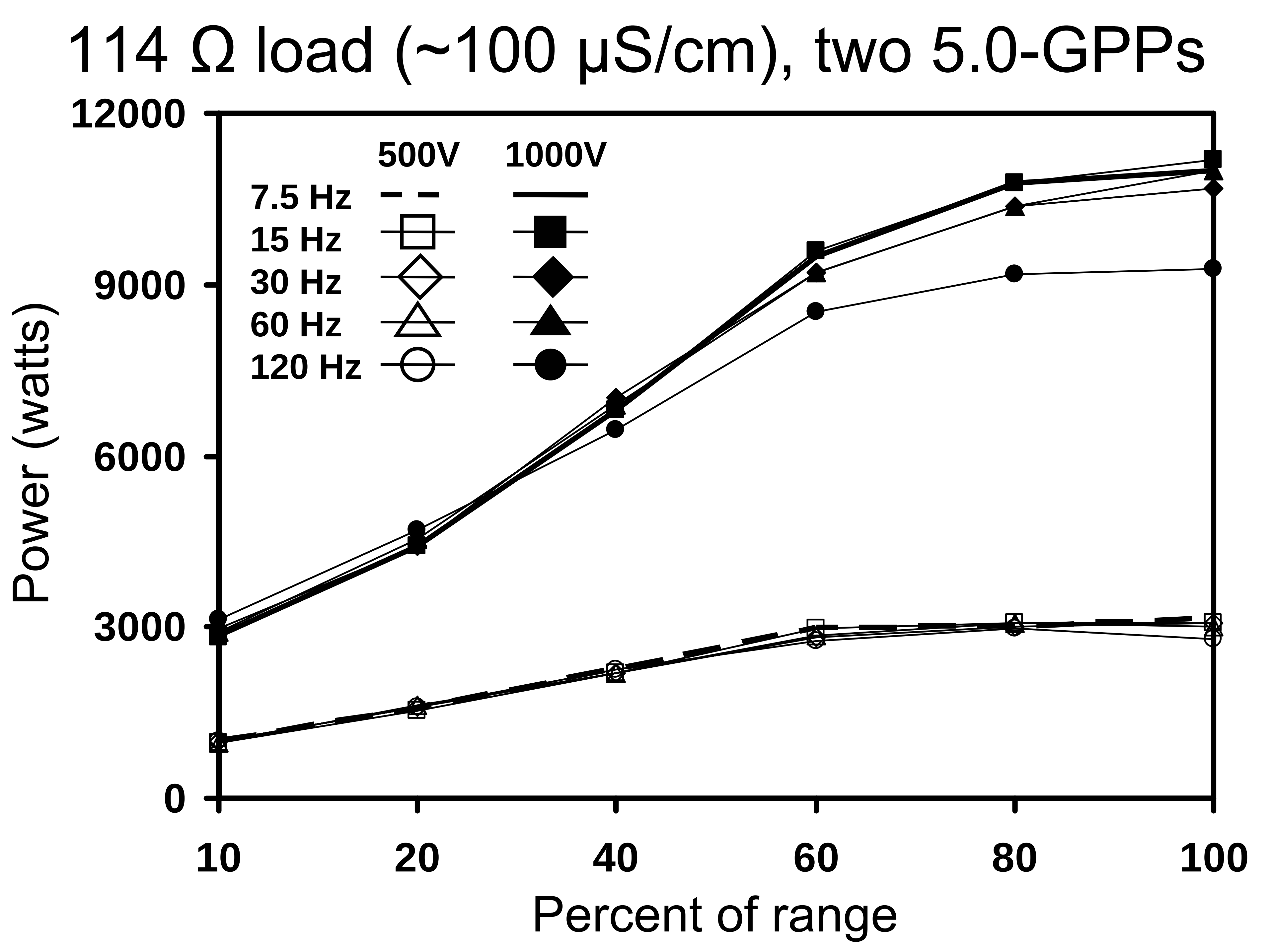


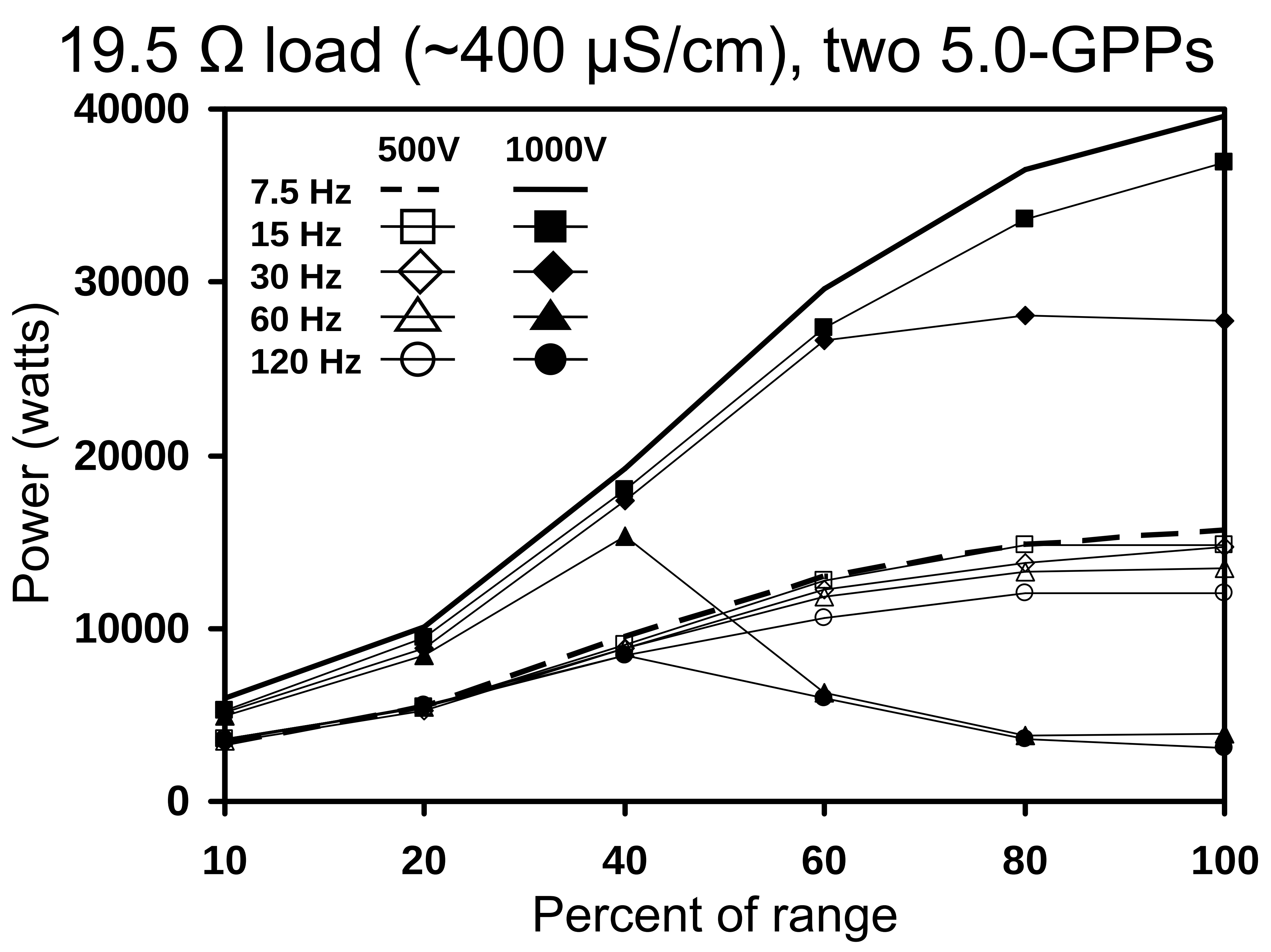

MERCURY
OptiMax
CLARKS DuraSport



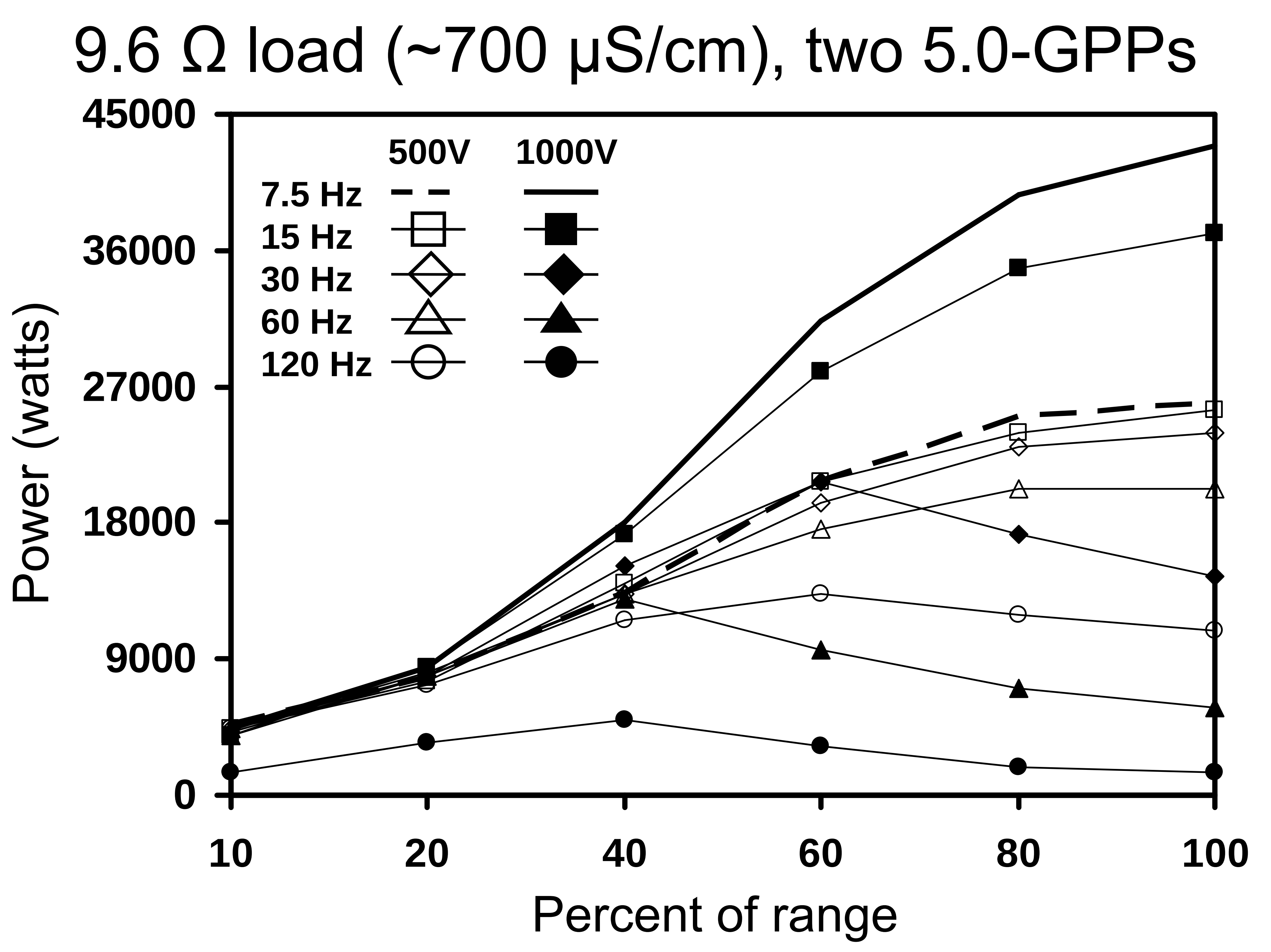
Electric baseboard (bb) heaters @ ~ 55-60 ohms (ave.~59 ohms) in parallel




114 Ω load (~100 μS/cm), two 5.0-GPPs
Power (watts)
12000
9000
6000
3000
0
500V
1000V
7.5 Hz
15 Hz
30 Hz
60 Hz
120 Hz
10
20
40
60
80
100
Percent of range

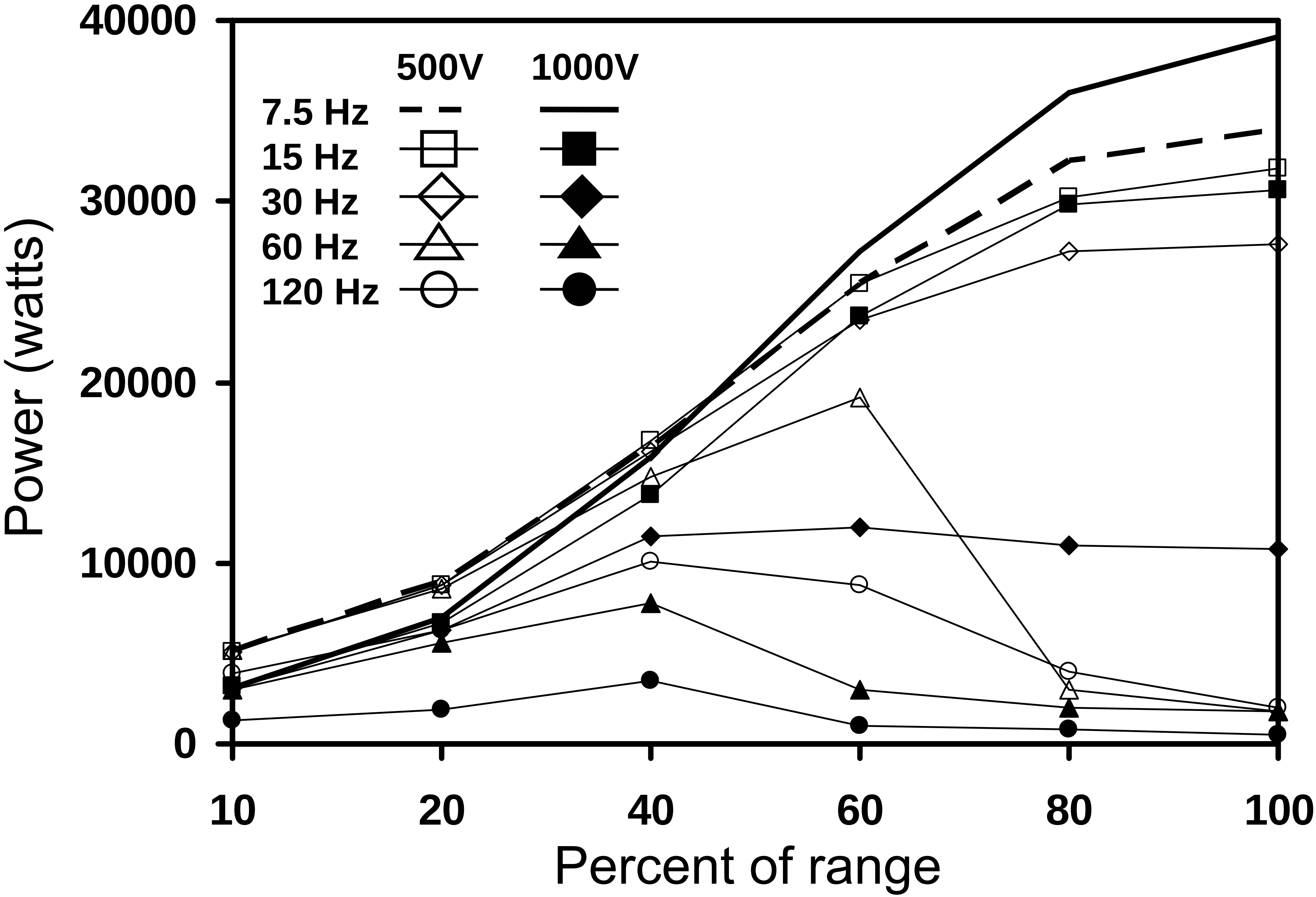


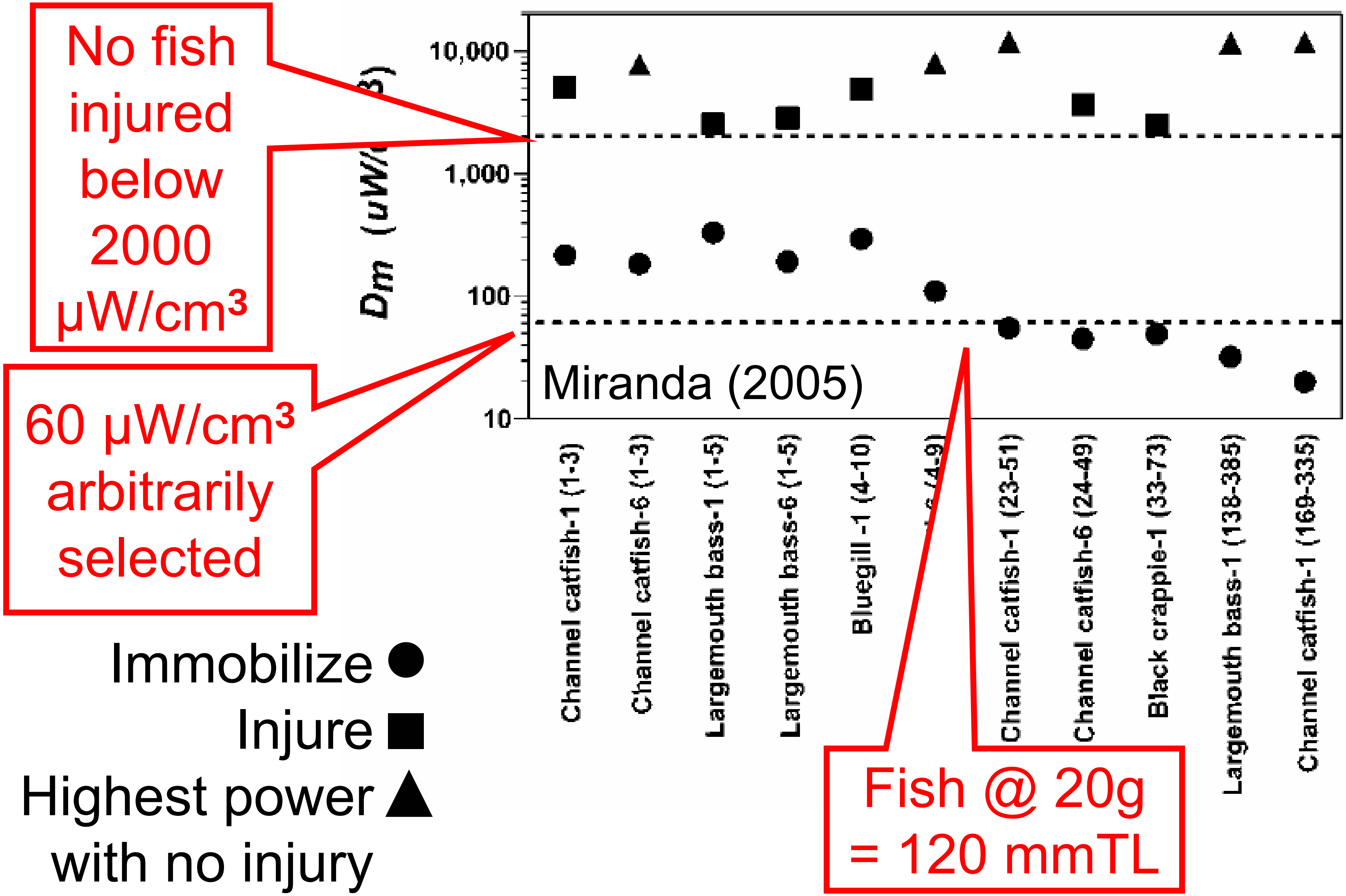
19.5 Ω load (~400 µS/cm), two 5.0-GPPs
Power (watts)
0
10000
20000
30000
40000
500V
1000V
7.5 Hz
15 Hz
30 Hz
60 Hz
120 Hz
10
20
40
60
80
100
Percent of range



9.6 Ω load (~700 µS/cm), two 5.0-GPPs
Power (watts)
45000
36000
27000
18000
9000
0
500V
1000V
7.5 Hz
15 Hz
30 Hz
60 Hz
120 Hz
10
20
40
60
80
100
Percent of range

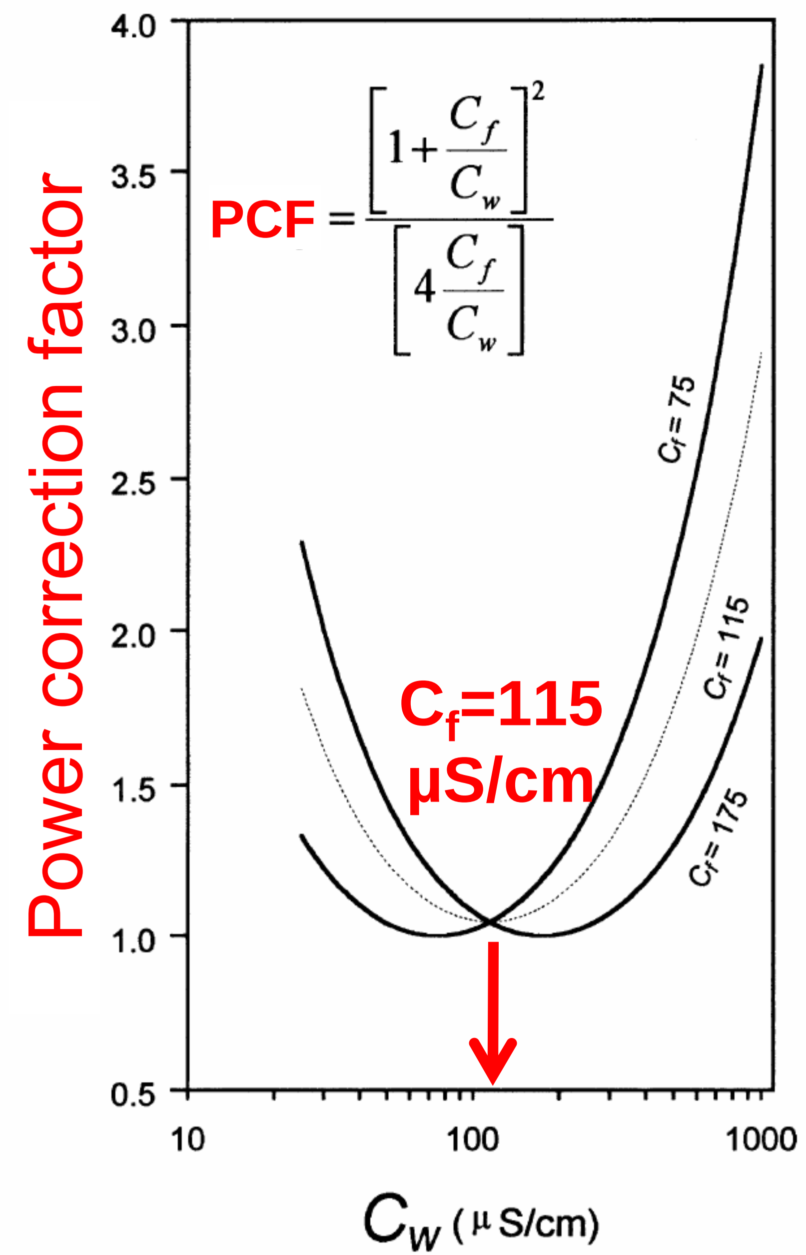
5.9 Ω load (~1000 μS/cm), three 5.0-GPPs



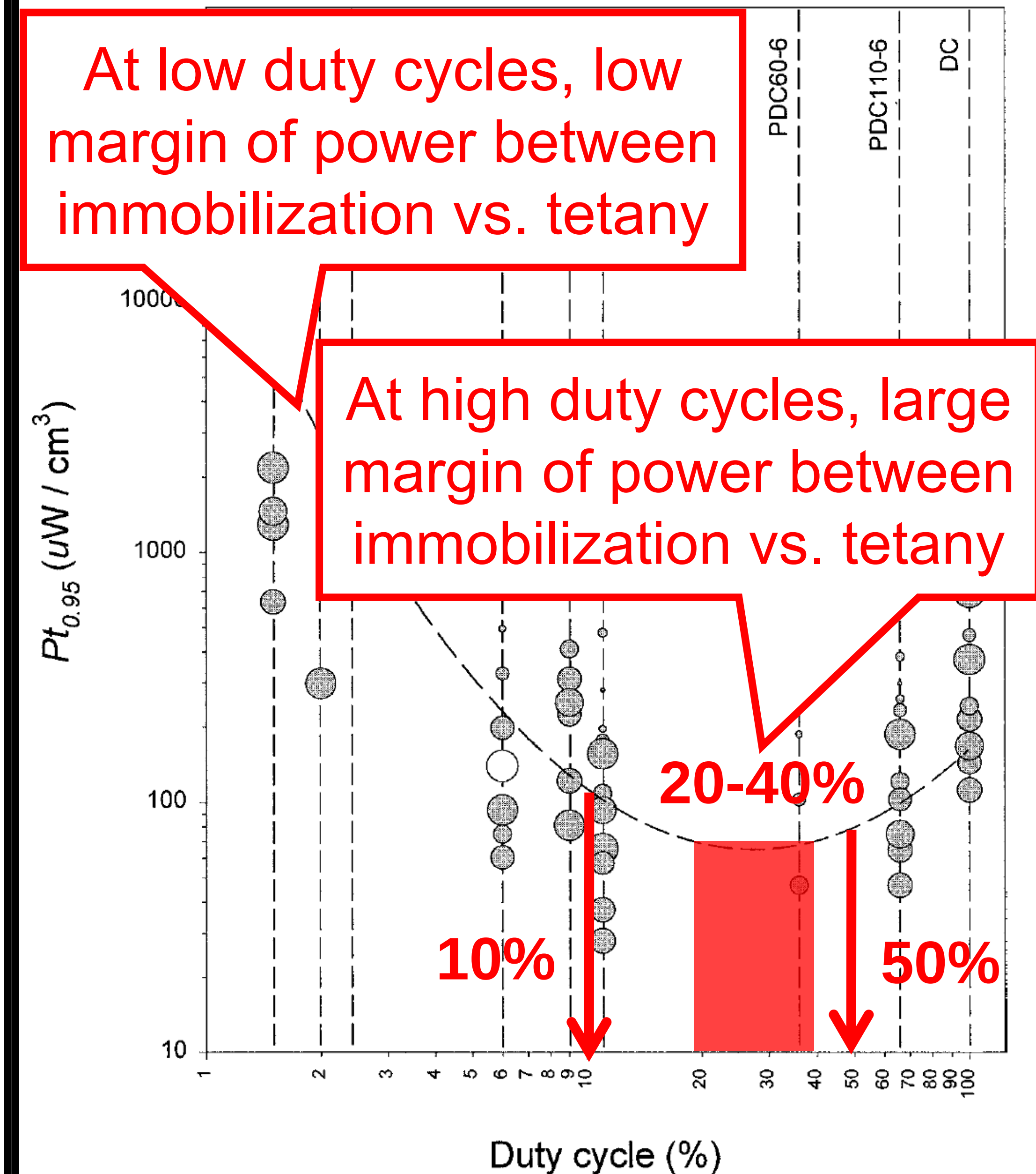


Power to anodes = **~2700 watts @ ~100 μS/cm**

(Burhardt & Gutreuter 1995; Miranda 2005)



Miranda & Dolan 2003

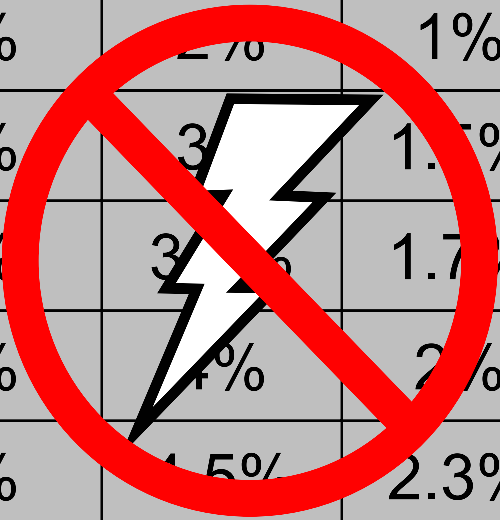


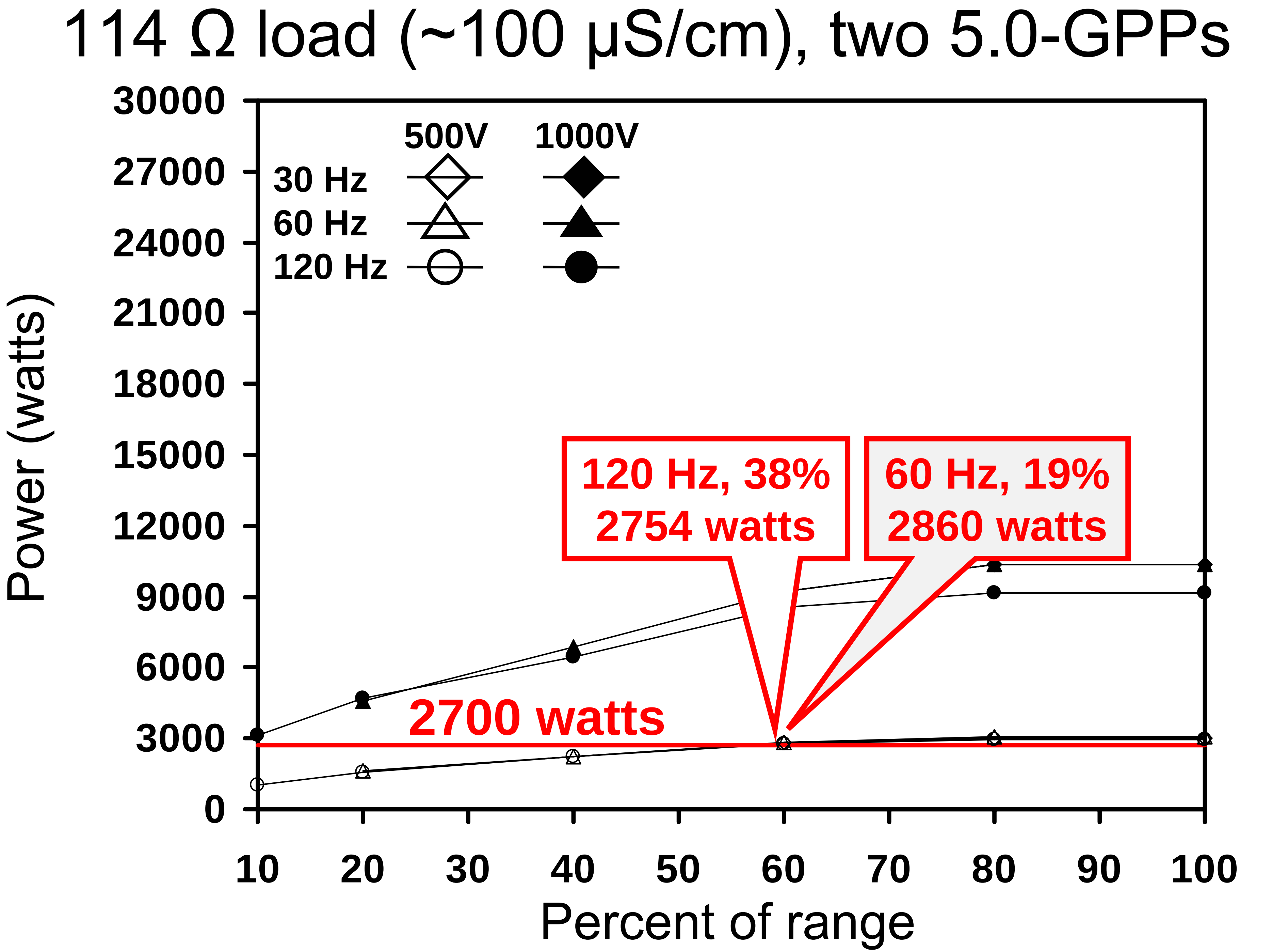
Miranda & Dolan 2004

Ambient µS/cm	Fish: H_2O	Power correction factor	Power target	Percent of range & Hz	Duty cycle	Watts
100	**1.15**	**1.0**	**2700**			
200	0.57	1.1	2970			
300	0.38	1.25	3375			
400	**0.28**	**1.46**	**3942**			
500	0.23	1.64	4428			
600	0.19	1.86	5022			
700	**0.16**	**2.1**	**5670**			
800	0.14	2.32	6264			
900	0.13	2.45	6615			
1000	**0.12**	**2.61**	**7047**			

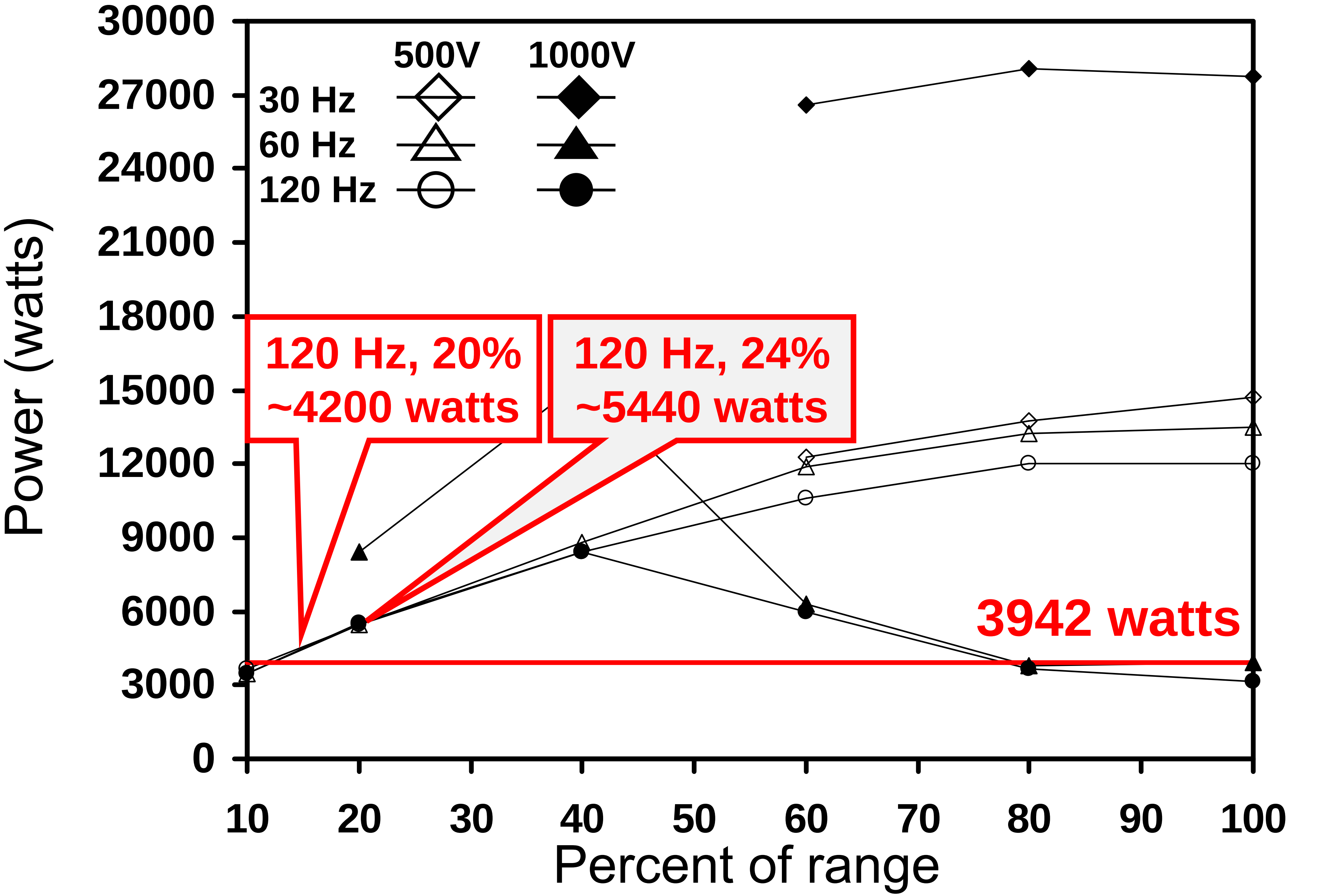
Percent of range	Pulse width	Duty cycle @ pulse settings				
		120	60	30	15	7.5
10	1.3	16%	8%	4%	2%	1%
20	2.0	24%	12%	6%	3%	1.5%
30	2.3	28%	14%	7%	3.5%	1.7%
40	2.7	32%	16%	8%	4%	2%
50	3.0	36%	18%	9%	4.5%	2.3%
60	3.2	38%	19%	10%	5%	2.5%
70	3.5	42%	21%	10.5%	5.3%	2.7%
80	3.8	47%	23%	11.5%	5.7%	2.9%
90	4.0	48%	24%	12%	6%	3%
100	4.2	50%	25%	13%	6.3%	3.1%

Percent of range	Pulse width	Duty cycle @ pulse settings				
		120	60	30	15	7.5
10	1.3	16%	8%	4%	2%	1%
20	2.0	24%	12%	6%	3[illegible]	1.[illegible]5%
30	2.3	28%	14%	7%	3[illegible]	1.7[illegible]%
40	2.7	32%	16%	8%	4%	2[illegible]%
50	3.0	36%	18%	9%	4.5%	2.3%
60	3.2	38%	19%	10%	5%	2.5%
70	3.5	42%	21%	10.5%	5.3%	2.7%
80	3.8	47%	23%	11.5%	5.7%	2.9%
90	4.0	48%	24%	12%	6%	3%
100	4.2	50%	25%	13%	6.3%	3.1%

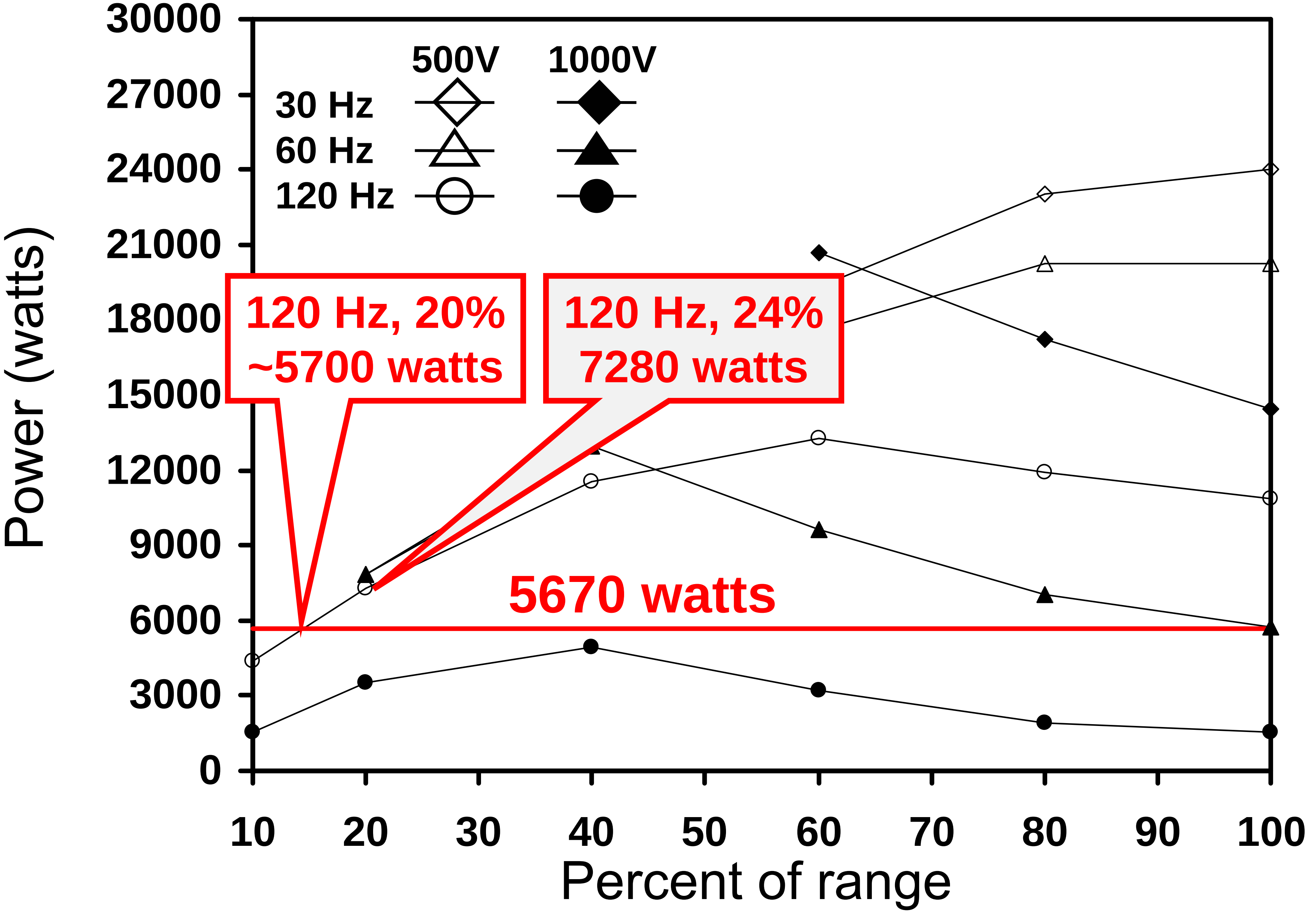



114 Ω load (~100 µS/cm), two 5.0-GPPs
Power (watts)
30000
27000
24000
21000
18000
15000
12000
9000
6000
3000
0
500V
1000V
30 Hz
60 Hz
120 Hz
120 Hz, 38%
2754 watts
60 Hz, 19%
2860 watts
2700 watts
10
20
30
40
50
60
70
80
90
100
Percent of range

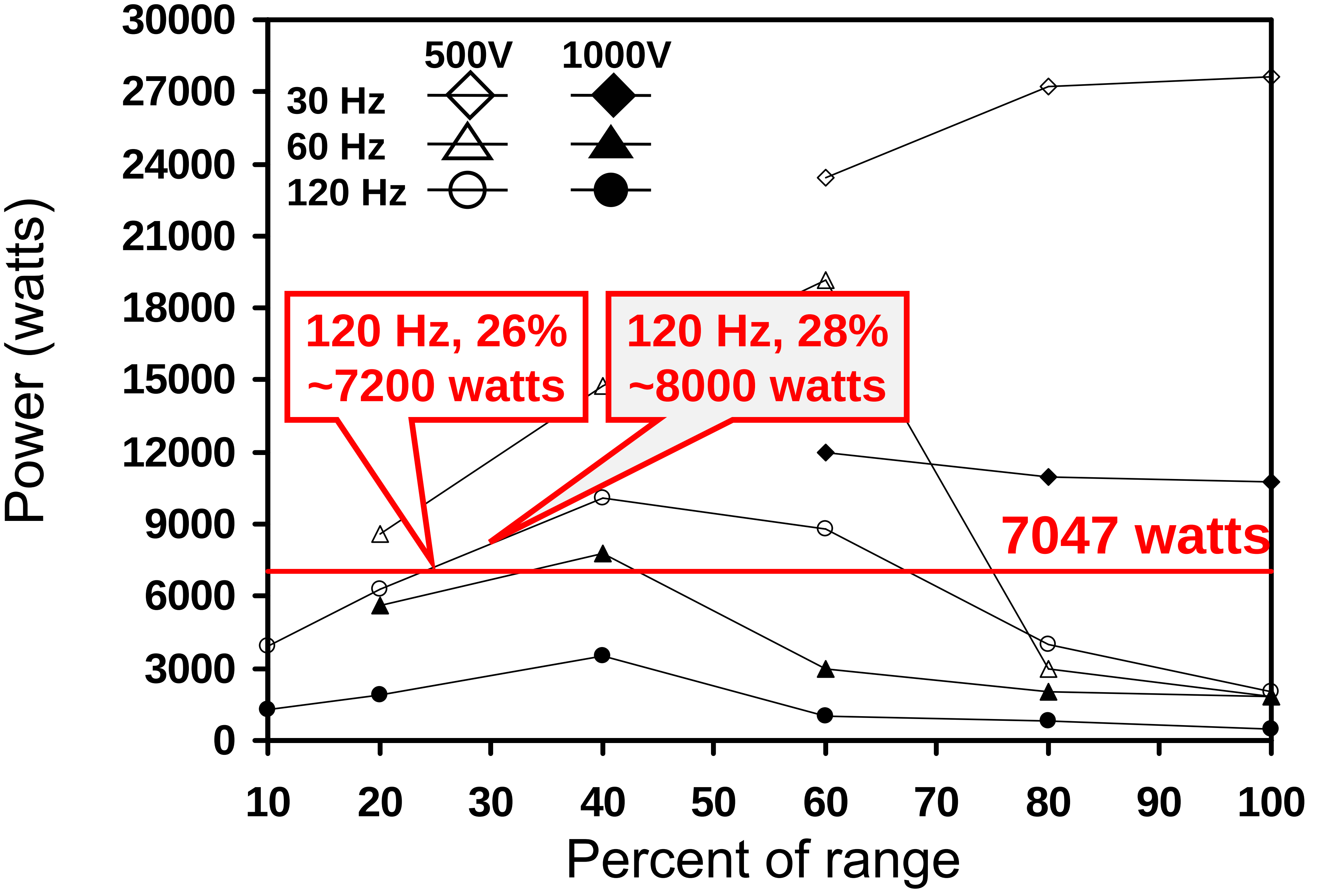
19.5 Ω load (~400 µS/cm), two 5.0-GPPs



9.6 Ω load (~700 μS/cm), two 5.0-GPPs



5.9 Ω load (~1000 µS/cm), three 5.0-GPPs



Ambient µS/cm	Fish: H_2O	Power correction factor	Power target (500V)	Percent of range @120 Hz	Duty cycle	Watts
100	**1.15**	**1.0**	**2700**	**60**	**38%**	**2754**
200	0.57	1.1	2970			
300	0.38	1.25	3375			
400	**0.28**	**1.46**	**3942**	**15**	**20%**	**~4200**
500	0.23	1.64	4428			
600	0.19	1.86	5022			
700	**0.16**	**2.1**	**5670**	**15**	**20%**	**~5700**
800	0.14	2.32	6264			
900	0.13	2.45	6615			
1000	**0.12**	**2.61**	**7047**	**25**	**26%**	**~7200**

Conclusions & recommendations:

- UCRB-RIP fleet well-suited to standardization
- key components already in use (anodes = spheres)
- configuration feasible (boat cathode & anode spacing)
- determine electrical resistance of fleet's boats/anodes
- must use conductivity meter to set constant power
- one or two boats test recommended settings in 2008
- monitor fish behavior & condition (avoid injury & tetany)
- cost-effective means to improve sampling consistency

Acknowledgements:

- Bob Muth, Angela Kantola, Kathy Wall, Tom Czapla & Pat Nelson – RIP

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- Bob Burdick, USFWS–CRFP, Grand Junction

- National Fish and Wildlife Foundation - Rebecca Kramer