Novel Energy Systems for Distributed and Mobile Power Generation

William E. Lear
University of Florida
Department of Mechanical & Aerospace Engineering
Gainesville, FL

Department of Mechanical & Aerospace Engineering

UF Energy & Gas Dynamics Laboratory

Advanced Direct Methanol Fuel Cell for Mobile Computing

University of North Florida

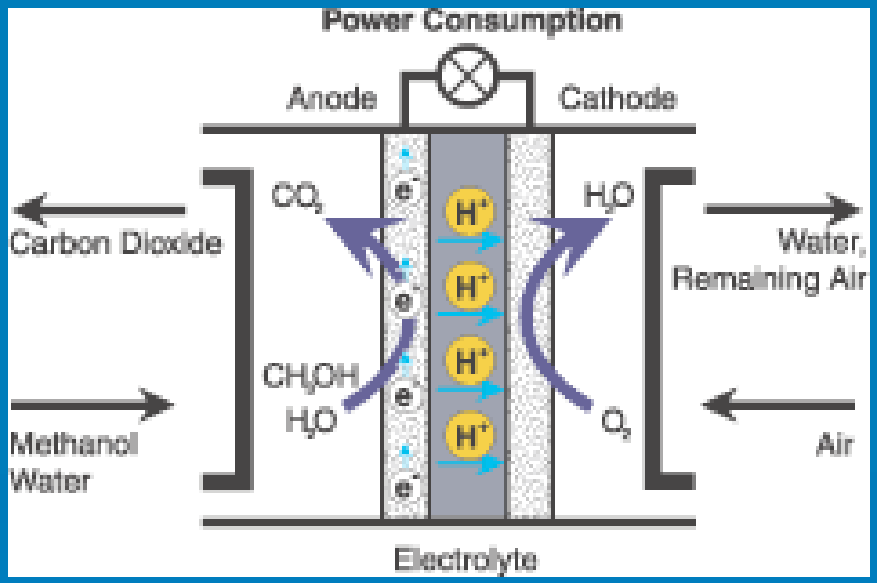
and

University of Florida

Objective

- Develop a DMFC power supply for mobile computing
  - Use novel passive water recycling technology
  - Enable significant simplification of DMFC systems
- Reduce size/weight by order of magnitude

DMFC Introduction

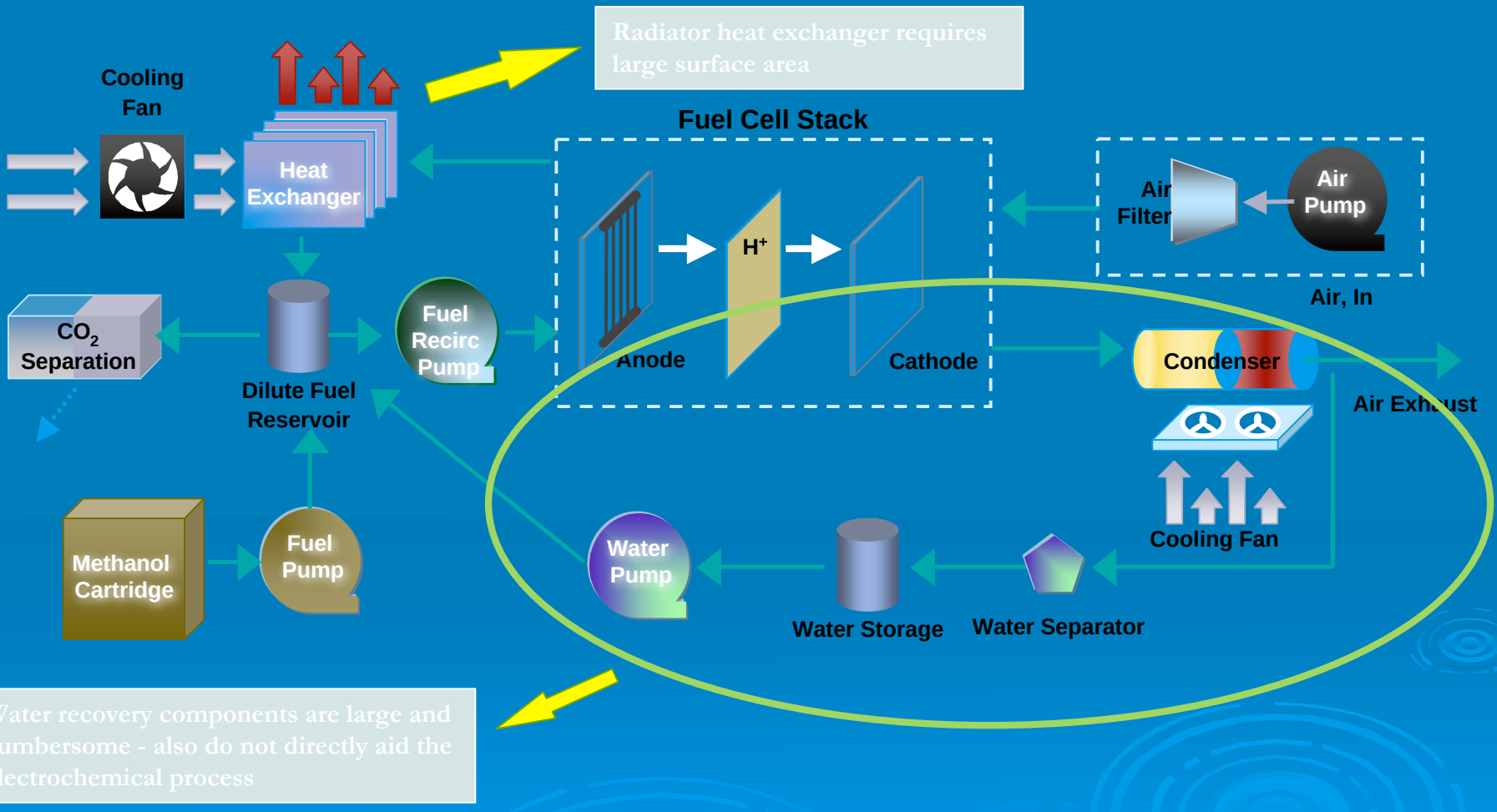


$$CH_3OH_{(l)} + \frac{3}{2}O_2 \rightarrow CO_2 + 2H_2O_{(l)}$$

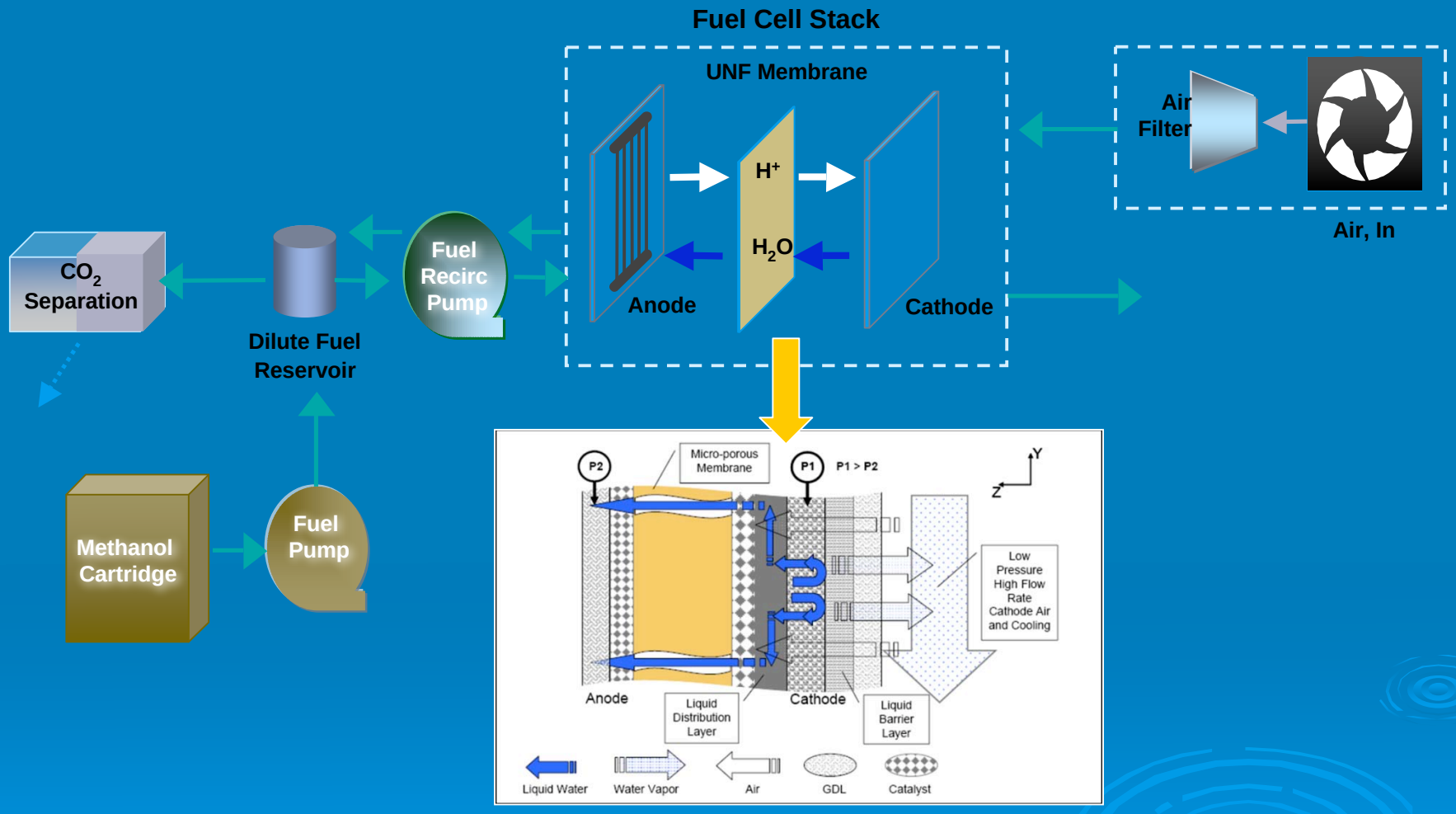
$$Anode : CH_3OH + H_2O \rightarrow CO_2 + 6H^+ + 6e^-$$

$$Cathode : \frac{3}{2}O_2 + 6H^+ + 6e^- \rightarrow 3H_2O$$

Conventional DMFC System



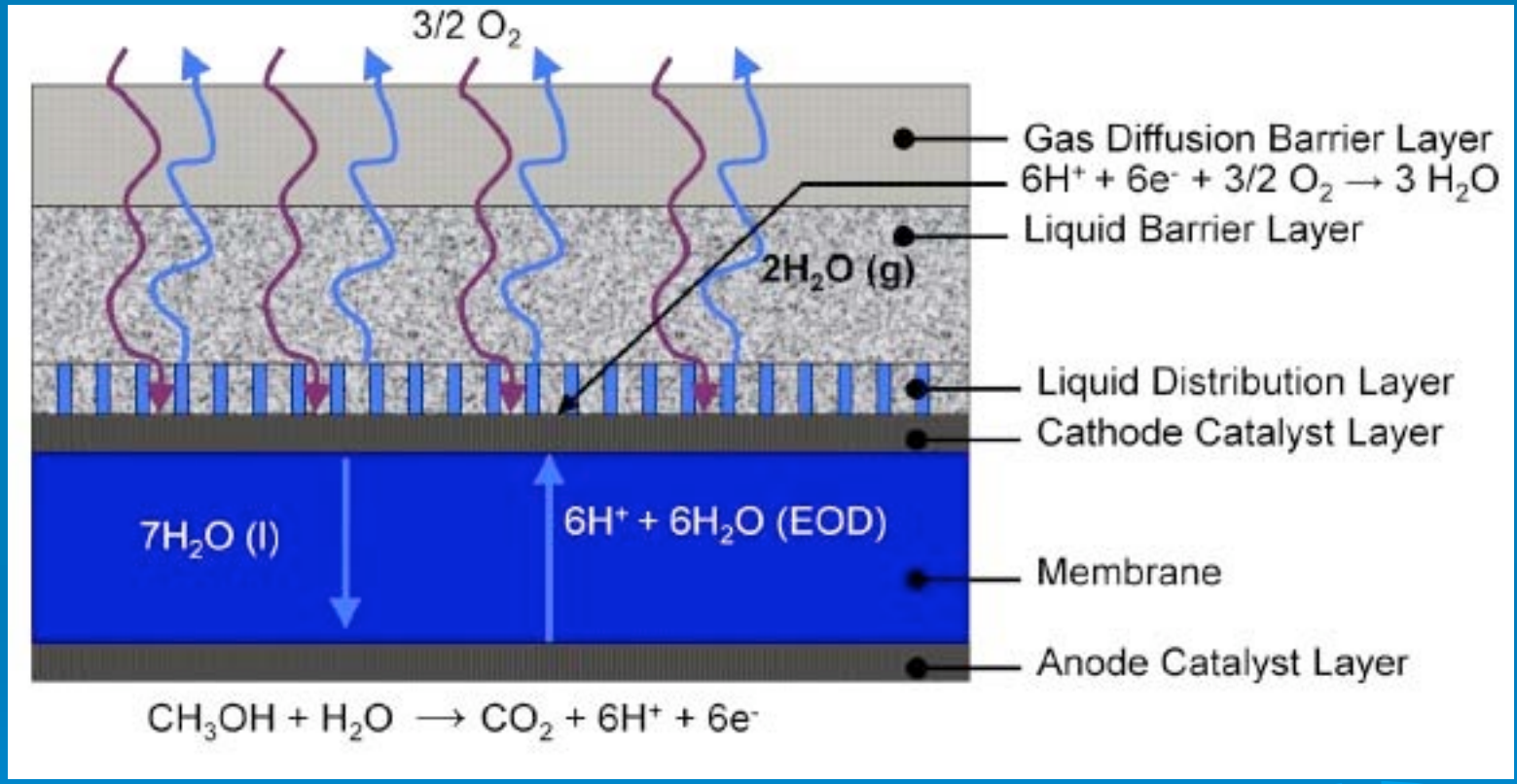
Simplified DMFC System



UNF Passive Water Recovery MEA Design

Novel passive water recovery MEA significantly reduces the number of balance of plant components

Passive Water Recovery



Impact

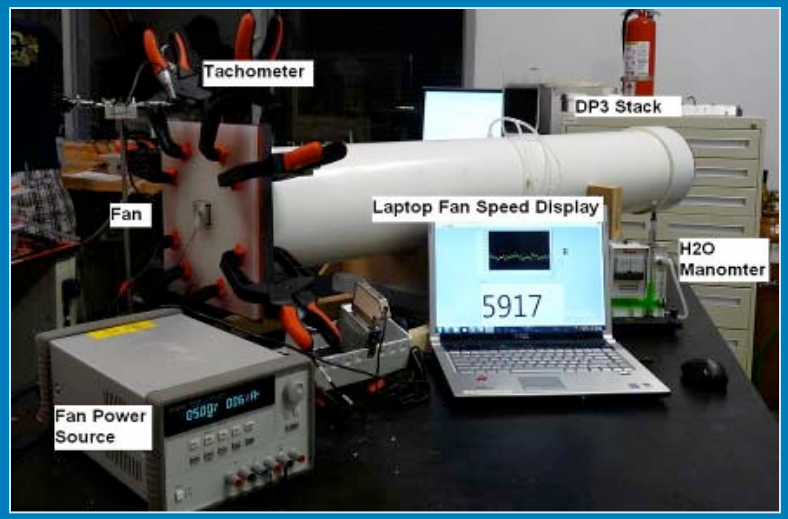
- Baseline Membrane Electrode Assembly (MEA) provides path to system simplification and increased power and energy density, with lower system cost.

Characteristic	Units	UNF 15 W DP3 2008 Status	DOE 2010 Target	UNF Proposed 20 W System Design
Specific Power [a]	W / kg	35	100	41.5
Power Density [a]	W / L	48	100	55 .6
Energy Density	W-hr / L	250 (1 x 100ml)[b] 396 (1 x 200ml)[b]	1000	193 (1 x 100ml) 321 (1 x 200ml) 575 (3 x 200 ml)
	W-hr/kg	155 (1 x 100ml) [b] 247 (1 x 200ml) [b]	N/A	162 (1 x 100 ml) 307 (1 x 200 ml) 638 (3 x 200 ml)
Lifetime [c]	Operating Hours	1,000 hrs in single cell	5,000	2,500 Integrated System
Cost	$ / Watt	11 (est. in volume)	<3	< 10 (est. in volume)

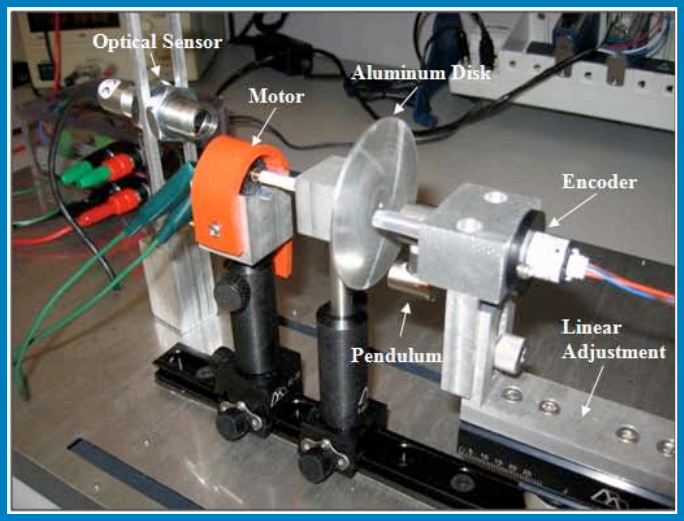
[a] Beginning of life, 30°C, sea level,50% R.H., excluding hybrid battery, power module alone
[b] Normalized from DP3 data from 150 ml cartridge to either 100ml or 200ml for comparison purposes
[c] Lifetime measured to 80% of rated power

Marked improvement on the road towards commercialization.

Component Engineering Rigs

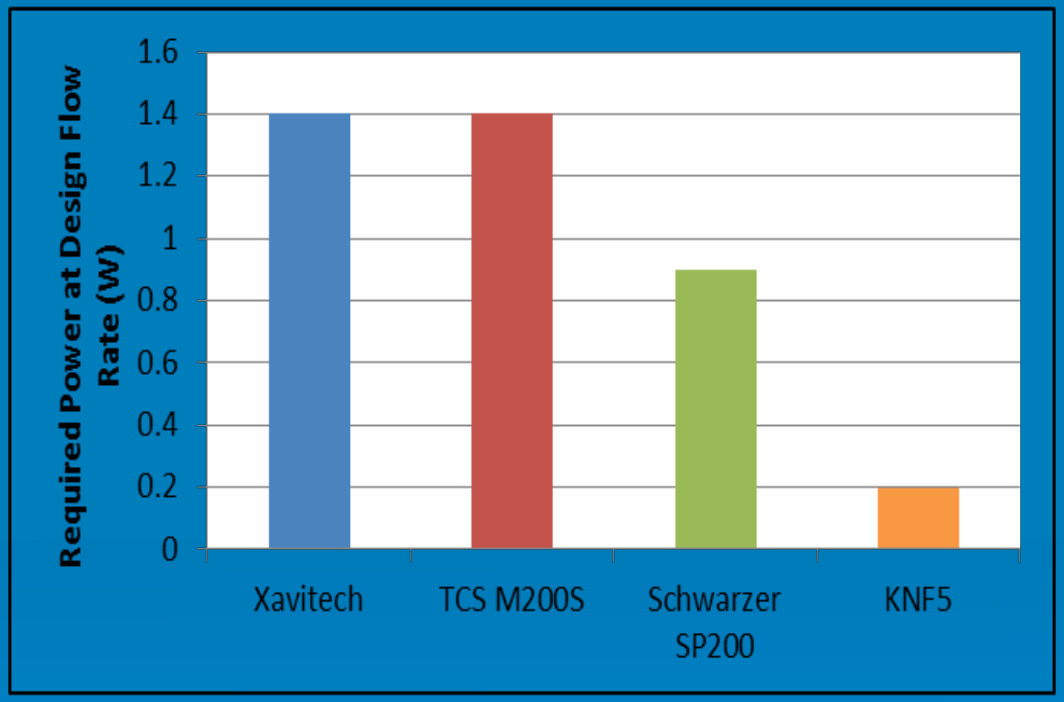


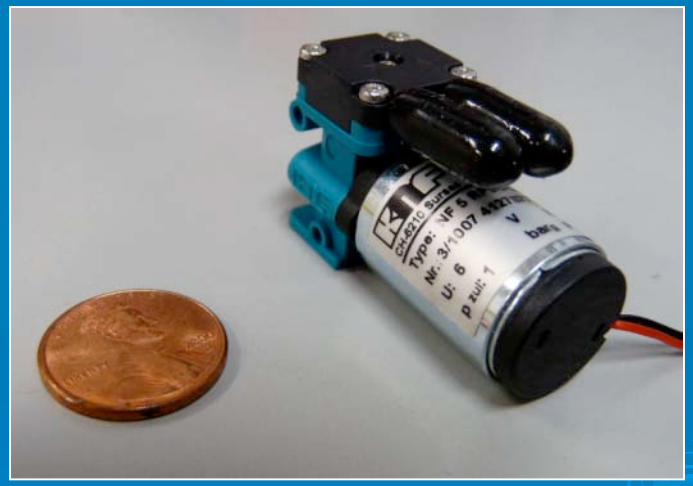
Cooling Fan Test Stand: Used to measure the performance and efficiency of cathode fans.



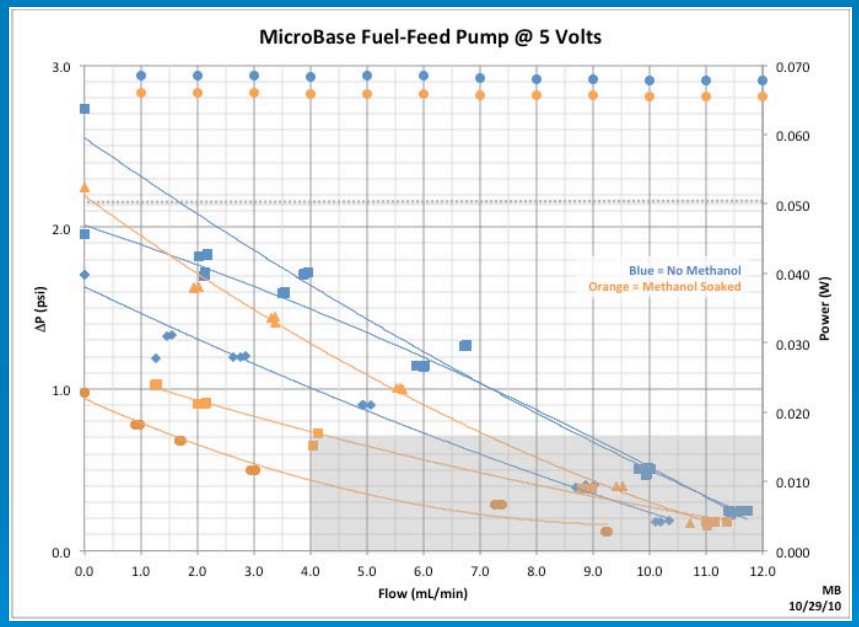
Electric Motor Dyno: Used to measure the performance and efficiency of electric motors for pumps and fans.

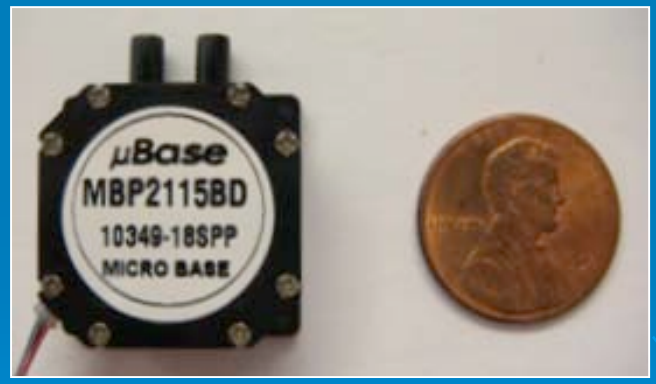
Anode Recirculation Pump





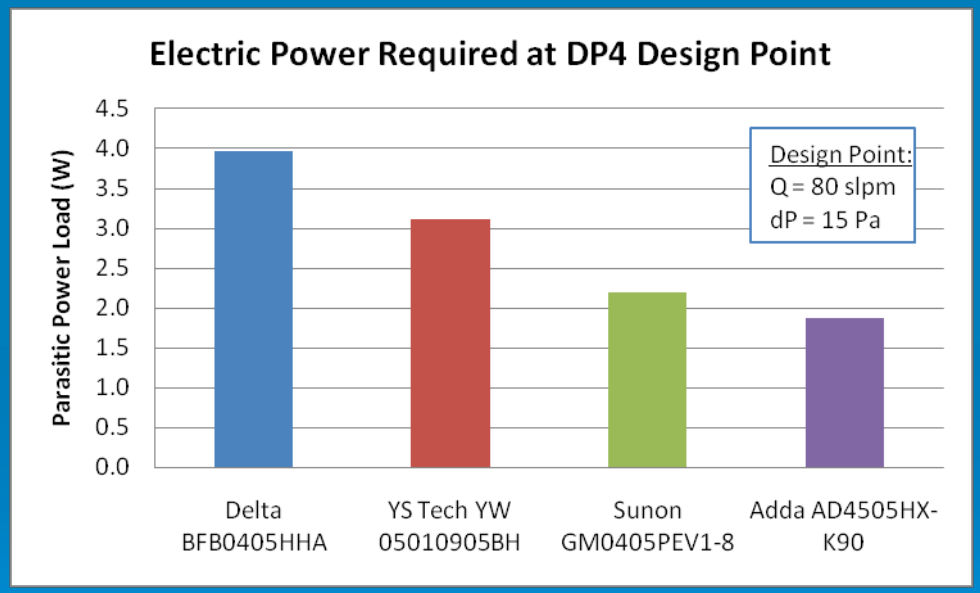
Methanol Injection Pump

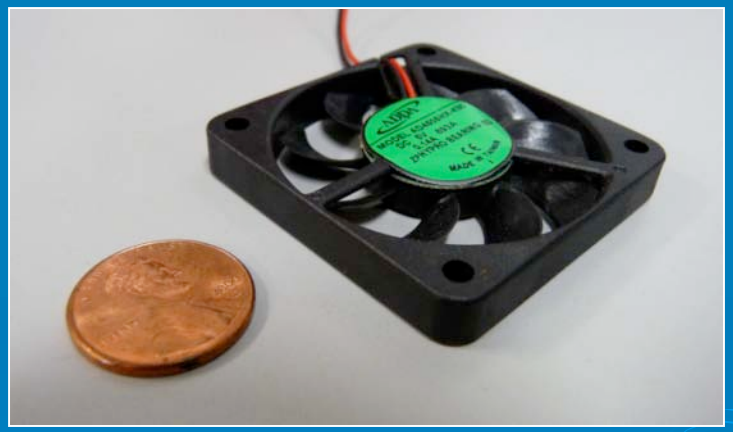


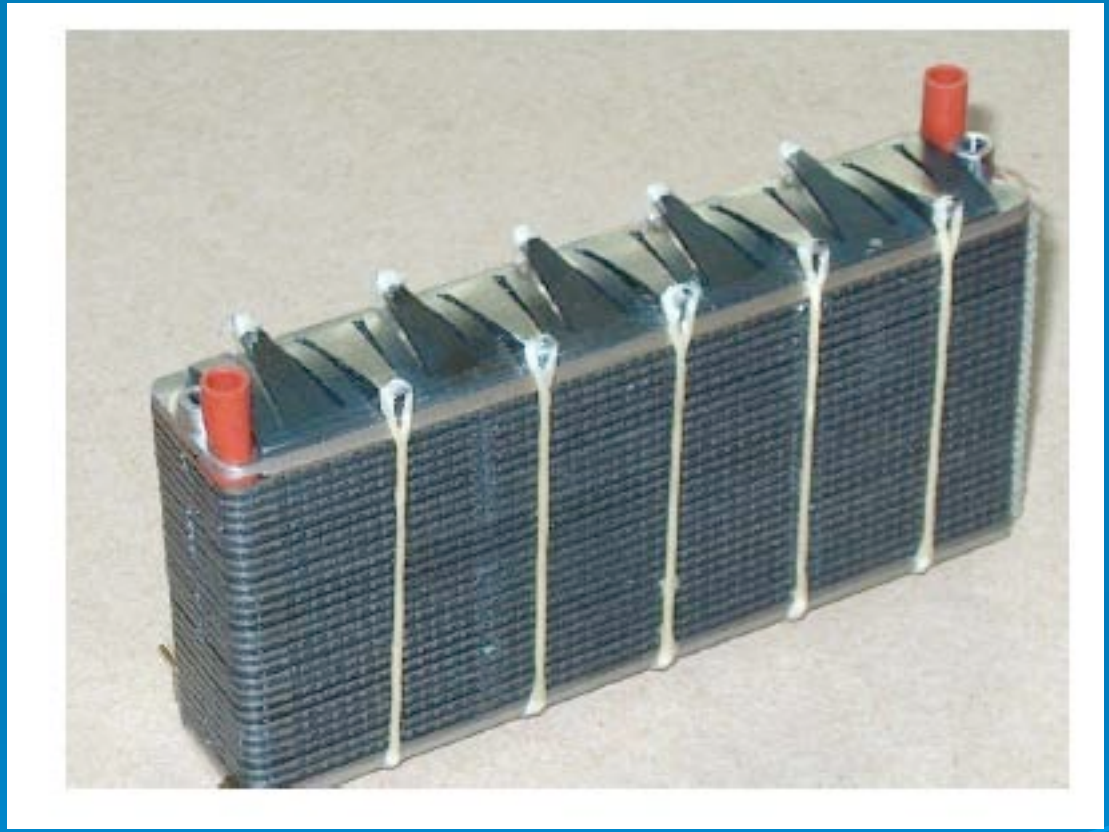


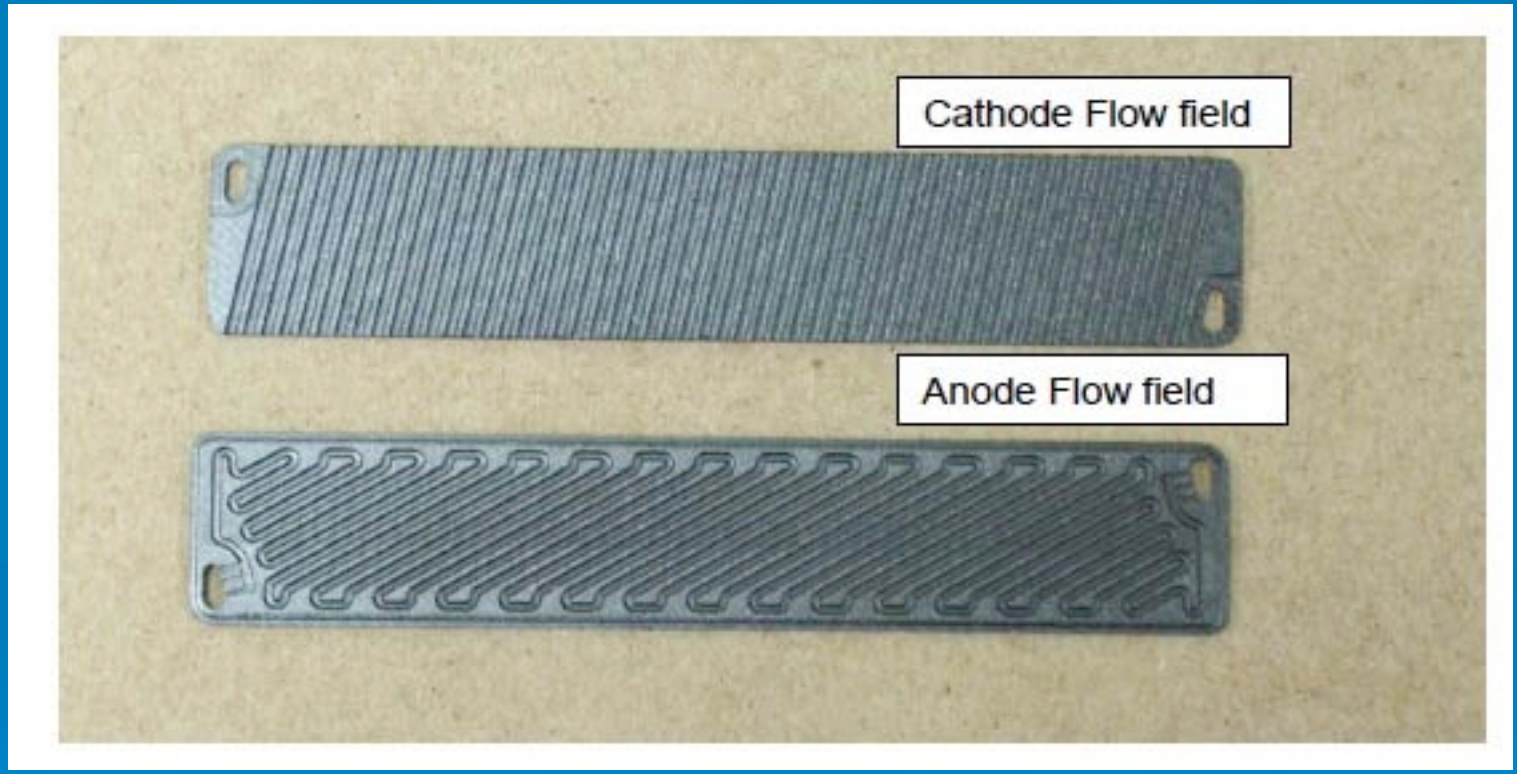
Grey area indicates system load curve.

Cathode Reactant/Cooling Fan

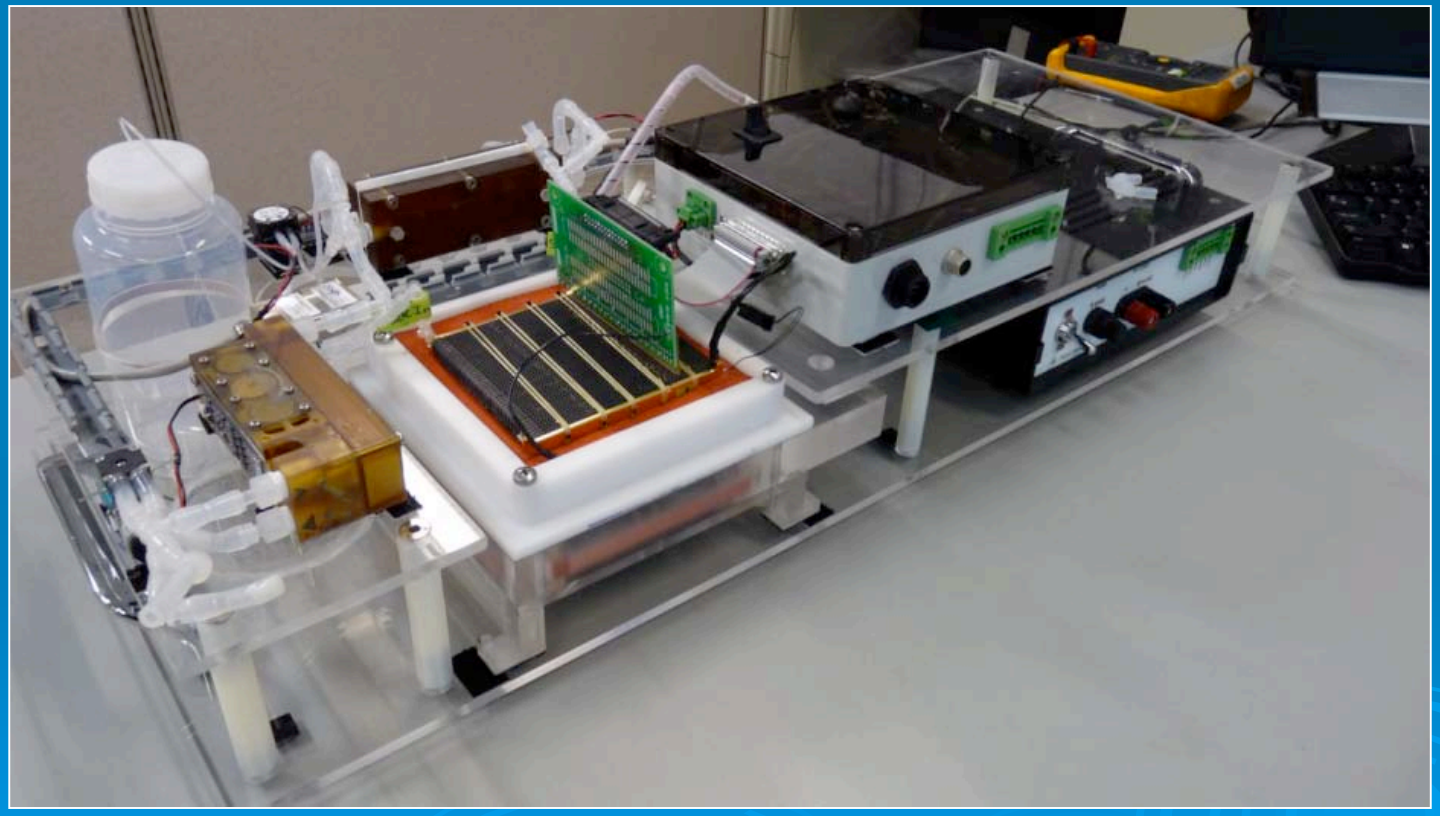




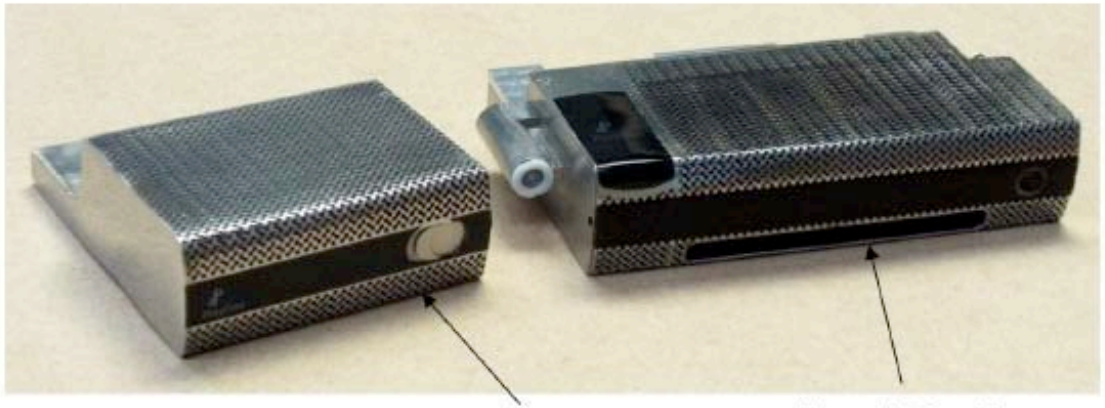



Cathode Flow field
Anode Flow field

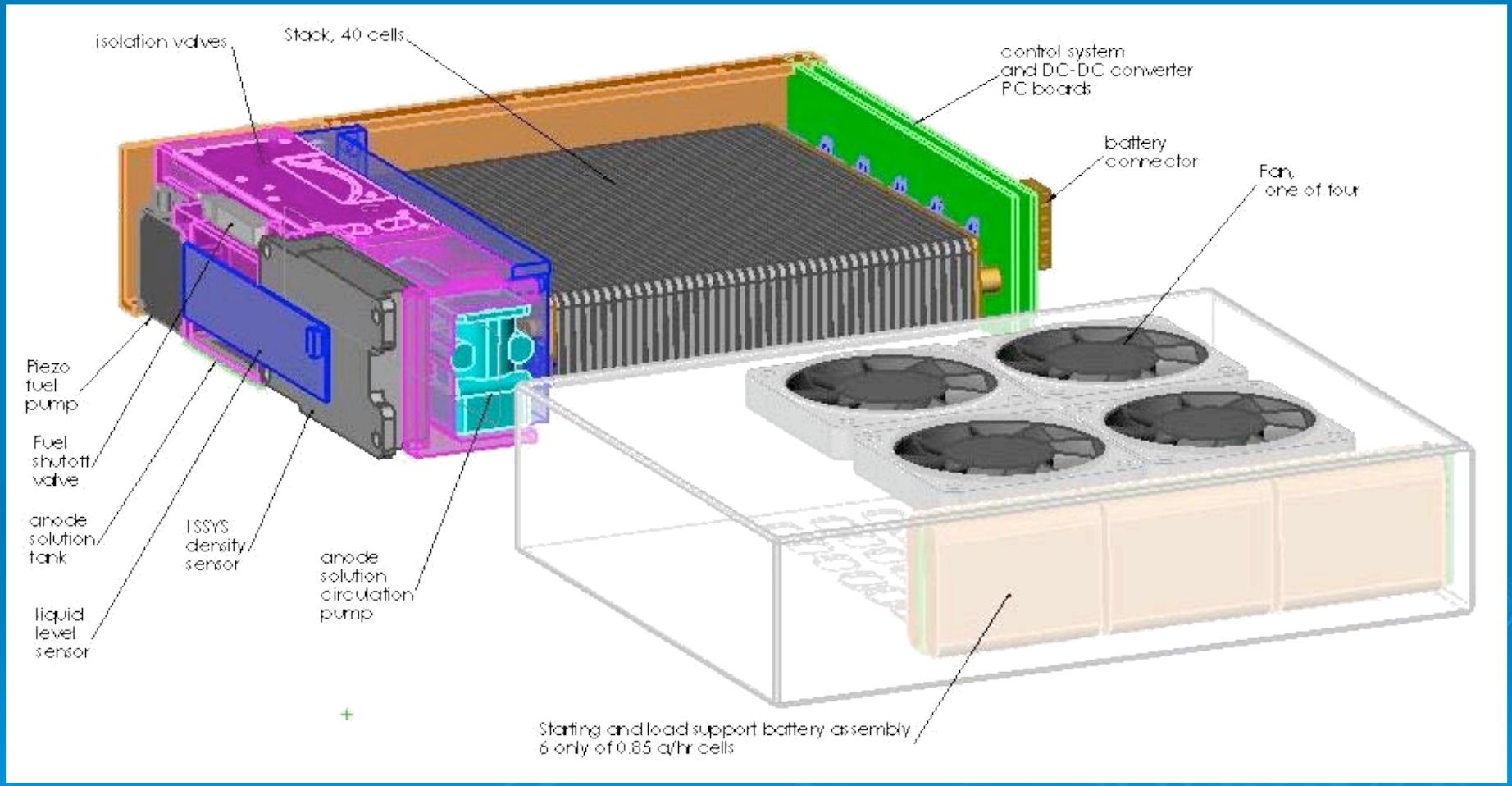
System Engineering: Brassboard (Unpackaged System)



Each brassboard has over 500 hours of operation.

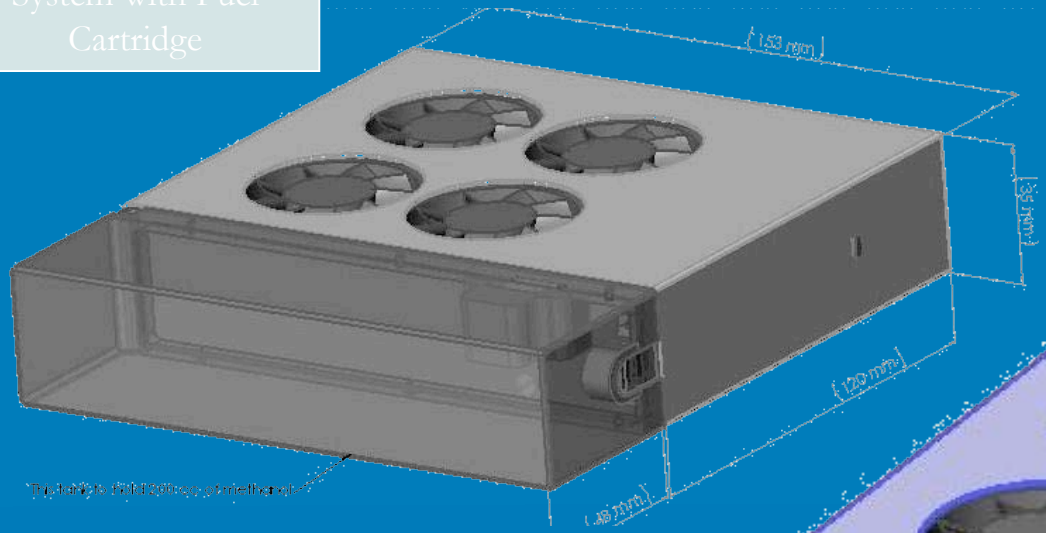

Fuel Tank
Fuel Cell System

System Engineering: Packaged System



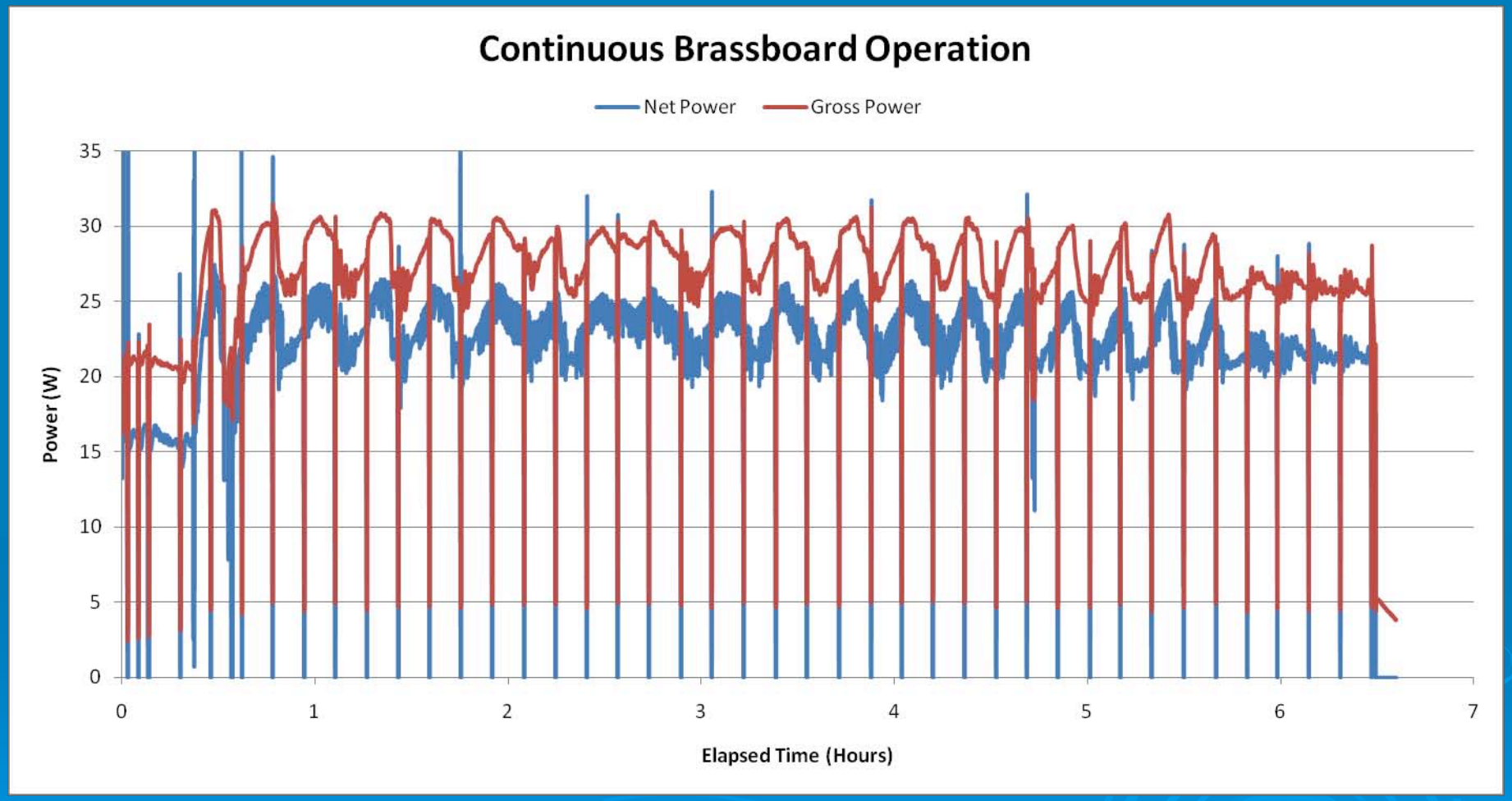
System Engineering: Packaged System

System with Fuel Cartridge



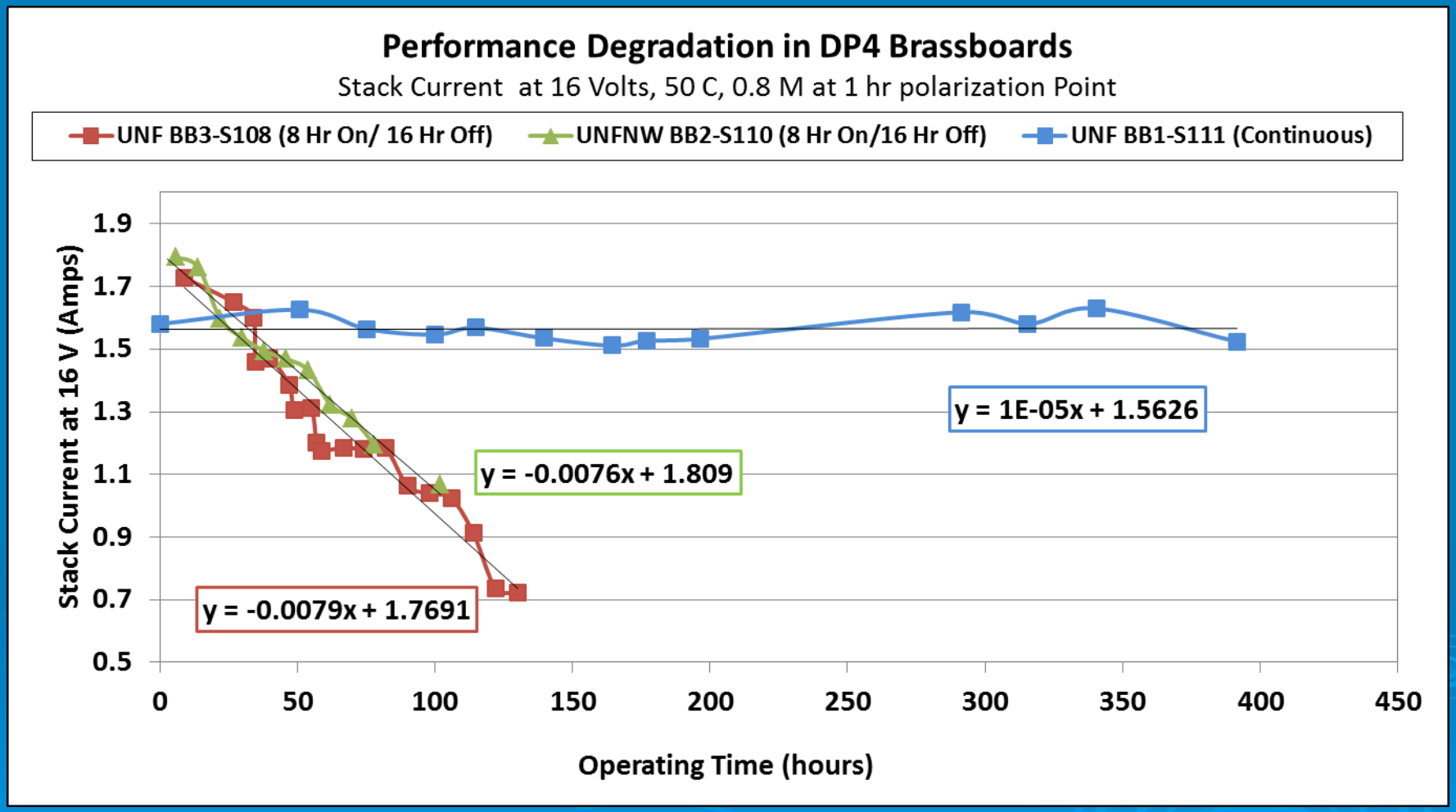
System without Fuel Cartridge

System Validation Testing: Continuous Operation



Consistent brassboard operation .

System Validation Testing:
Off-State Degredation



Brassboard performance degradation two orders of magnitude less with continuous operation.

Questions