Protonex™

FUEL CELL POWER SYSTEMS FOR EXTENDED DURATION UAV AND UGV SYSTEMS

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THE NEXT GENERATION OF PORTABLE POWER.™

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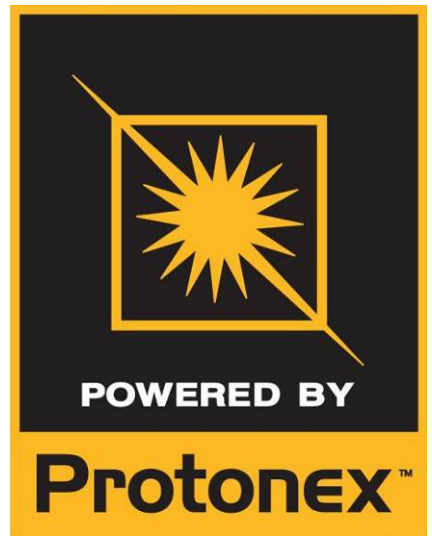
AGENDA

- Company Overview
- Technology and Products
- Markets
- Ultra High Performance Power Systems
  - UAV Power Systems
  - UGV Power Systems
- Summary



PROTONEX OVERVIEW

- Leading provider of 10 - 1000 watt fuel cell based power solutions
  - Portable, remote and mobile power
  - Targeting applications underserved by batteries and small generators

- Strong traction to date with US Government agencies
  - Over $35m* in program value with Air Force, Army, Navy, SOCOM, DARPA, DOE, NASA…

- Well positioned to deliver product for military and commercial applications
  - Offering PEM and SOFC products to meet diverse application needs
  - Capable of high performance and low cost

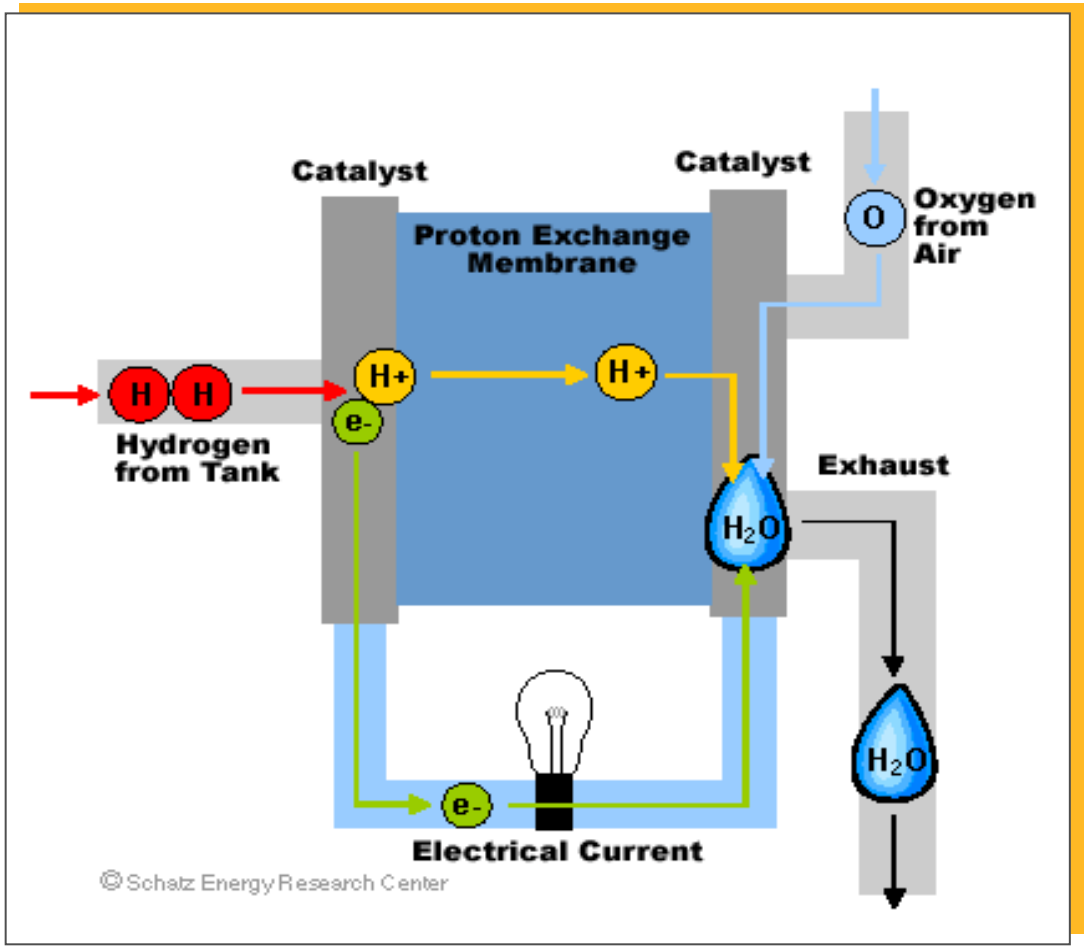
- Key strategic partnerships in place
  - Parker Hannifin, Cummins, Raytheon, CBC, Northrop Grumman, US Military

- Headquartered in Southborough, Massachusetts
  - Over 90 employees today and growing

- Publicly traded on the AIM market of the LSE - symbols: PTX and PTXU

** Includes contracts awarded to Mesoscopic Devices before acquisition in April 2007*

FUEL CELL SYSTEMS



VS. ADVANCED BATTERIES

- Reduced weight
- Extended run times
- Reduced size
- Lower life cycle cost
- Enables new applications

VS. ICE GENERATORS

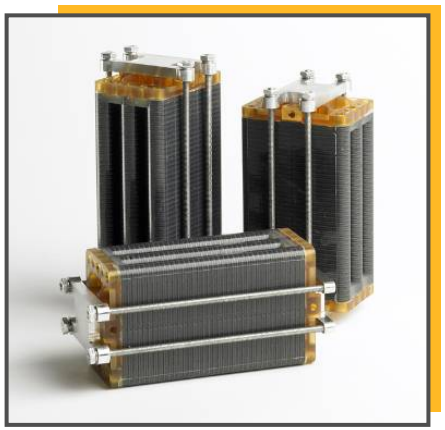
- Greater efficiency
- Reduced emissions
- Lower noise level
- Lower heat signatures
- Lower life cycle cost

Fuel cell based power systems provide many advantages over existing technologies

TWO TECHNOLOGY PLATFORMS AT PROTONEX

- **Proton Exchange Membrane (PEM)**
  - Fuels
    - Methanol
    - Chemical Hydride
    - Hydrogen
  - Operating temperature: 50˚C – 75˚C
  - Readiness: now

- **Solid Oxide Fuel Cell (SOFC)**
  - Fuels
    - Propane
    - Gasoline, Diesel and JP-8
    - Biofuels
  - Operating temperature: 650˚C - 750˚C
  - Readiness: 1-2 years



Fuel flexibility to address multiple applications
Strong overlap between PEM and SOFC

CURRENT PRODUCTS IN DEVELOPMENT

- Fully integrated power systems - fuel in, power out
- PEM or SOFC core technology
  - Similar control and power management components
  - Hybridized with batteries to “drop into” existing apps
- Supporting multiple fuel types
  - Hydrogen, chemical hydrides, methanol, propane – **today**
  - Gasoline, kerosene, diesel, JP8, biofuels – **future**
- Strong and expanding IP base
  - 43 patents issued/pending

ProCore™ UAV and UGV Propulsion Systems
Chemical Hydride and Hydrogen

Quantum™ P125 Power System
Propane

Xtend™ M250 Backup Module
Reformed Methanol

Pulse™ M250 Battery Charger
Reformed Methanol

Quantum™ M250 Multi-Purpose APU
Reformed Methanol

TARGETING A BROAD RANGE OF POWER APPLICATIONS

MILITARY	GOVERNMENT
▪ Field and portable generator ▪ Vehicle auxiliary power units ▪ Squad battery charger ▪ UAV and UGV propulsion ▪ Soldier or remote power source ▪ Power management devices	▪ Field and portable generator ▪ Emergency backup systems ▪ First responder equipment ▪ Vehicle auxiliary power units ▪ Persistent surveillance
Pulse™ M250, J500 Pulse™ UAV, UGV Pulse™ P125	Quantum™ M250, D500 ProCore™ M250 Procore™ UAV Xtend™ M250, M500, M1000

Protonex products are “horizontal” in nature, addressing many diverse applications currently using batteries or generators

MAJOR SEGMENTS AND APPLICATIONS – Non Military

DC Backup Power

- Telecom Wireless
- Telecom Wireline
- Traffic Systems
- Broadband / CATV
- Critical Systems
- Security Systems

Recreation

- Portable Power
- RV Power
- Marine Power
- Campsite Power
- Remote Cabins
- Expeditions

Emergency

- Homeowner Emergency
- Battery Chargers
- Communications Equipment
- Emergency Response
- Security Systems
- Traffic Control Systems

Professional

- Scientific Equipment
- Power Tools
- Battery Charging
- Communication Systems
- Security Systems
- Video Equipment

Mobile

- Electric Motorbikes
- Personal Mobility
- Vehicle APUs
- Golf / Utility Carts
- Mobile Signage
- Commercial Robots

Renewable

- Solar Power Systems
- Wind Power Systems
- Remote Monitoring
- Remote Signaling
- Off-Grid Homes


Protonex™
ULTRA HIGH PERFORMANCE POWER SYSTEMS
THE NEXT GENERATION OF PORTABLE POWER.™

PROCORE™ UAV / UGV PROPULSION SYSTEMS

- Air Force and Navy Programs
- Significantly **extended mission time**
- 2-4 times the energy density of batteries
- Equivalent performance (power)

- **Broadens mission capabilities**
- Ability to carry greater payload
- **Silent**, reliable power

NAVAL RESEARCH LAB UAV FLIGHT – HYDROGEN BASED

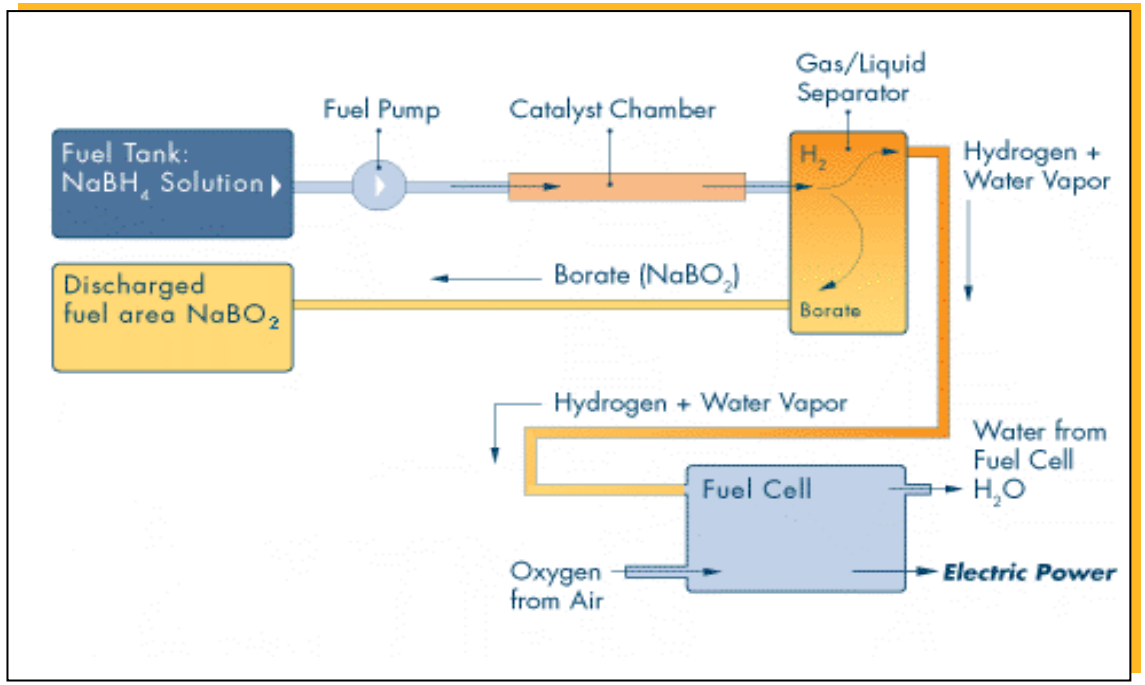
Propulsion System	Flight Time
Typical battery solution	1 - 2 hours
Protonex fuel cell system with available compressed hydrogen tank	3 hour 19 min.
Protonex fuel cell system with compressed hydrogen tank built in	6-24 hours

Navy Research Laboratory
N00173-08-C-2045

300W net power @ <1kg

CHEMICAL HYDRIDE FUEL CARTRIDGE SODIUM BOROHYDRIDE [$NaBH_4$]

- Simple design
- High storage metrics
- Cartridge system
- Hydrogen as needed
- **Non-flammable**
- Non-toxic
- **Wide temperature range**
- Low cost materials



FIELD WATER FOR CARTRIDGE HYDRATION

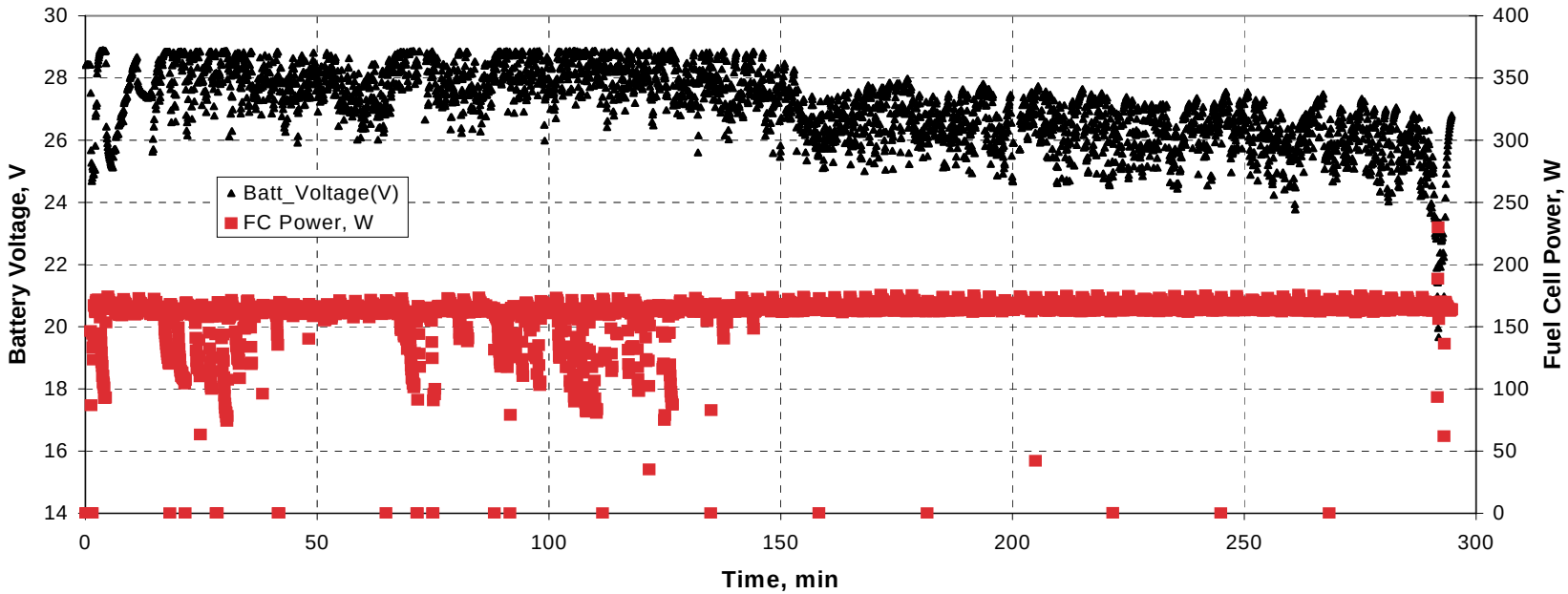
- Chemical hydride system can use a wide variety of field waters
- Shown to be robust to contamination from:
  - Tap water
  - Fresh water (lake, stream)
- Waste waters, such as grey water or bodily fluids may be used with filtration
- Advantage: Warfighter may carry lighter, dry cartridge into field and use available water for power

HAND LAUNCHABLE UAV POWER SYSTEMS

- Chemical hydride fueled [$NaBH_4$]
- Fuel cell system 100-200W
- Flight time targets:
  - Current battery systems
    - 2-4 hrs
  - FY07 – 6+ hrs
  - FY08 – 10+ hrs
- Demonstrate fuel cells in currently fielded UAVs
  - PUMA selected for initial integration
  - Minimal changes to existing plane

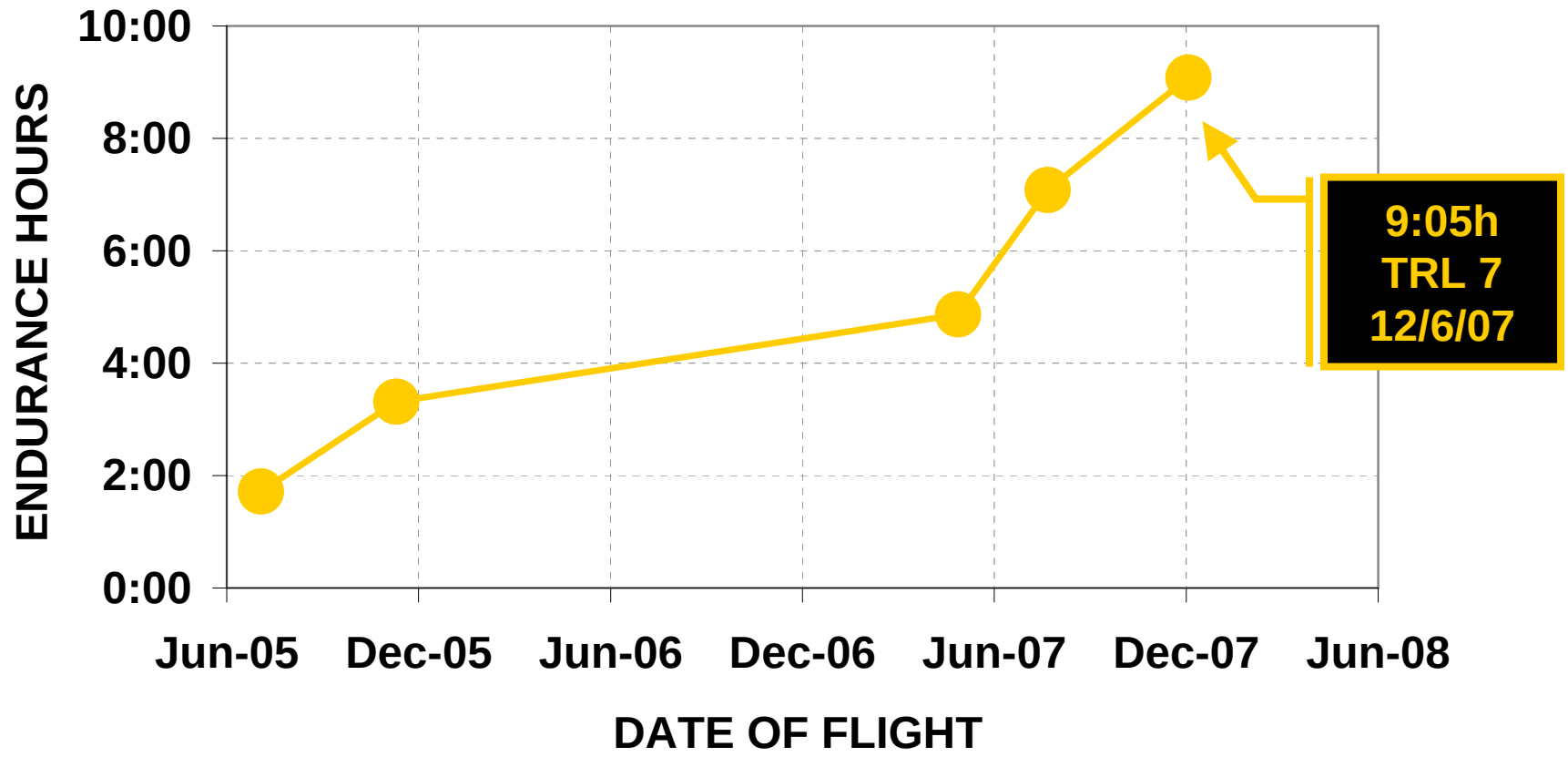
Air Force Research Laboratory
FA8650-06-C-2677

EARLY FLIGHT RESULTS (5/4/07)



- 4 hr 53 min flight
- Wind conditions (3-10 m/s)
- Average power >150W with higher winds (>7 m/s)
- 55 min. additional airtime remaining in cartridge

UAV ENDURANCE PROGRESS



UAV SIZE & CLASS

RAVEN B

Aerovironment

Power plant**: Electric Motor**
Weight: **4.2 lbs**
Wingspan: **53”**
Endurance: **90 min**

PUMA

Aerovironment

Power plant**: Electric Motor**
Weight: **13 lbs**
Wingspan: **102”**
Endurance: **150 min**

STALKER

Lockheed Martin

Power plant**: Electric Motor**
Weight: **14 lbs**
Wingspan: **120”**
Endurance: **120 min**

DESERT HAWK III

Lockheed Martin

Power plant**: Electric Motor**
Weight: **6.5 lbs**
Wingspan: **54”**
Endurance: **90 min**

SILVER FOX

Advanced Ceramics Research

Power plant**: Gas Engine g**
Weight: **26.2 lbs**
Wingspan: **94”**
Endurance: **600 min**

SCAN EAGLE

Boeing

Power plant**: Gas Engine ff**
Weight: **39.6 lbs**
Wingspan: **120”**
Endurance: **900 min**

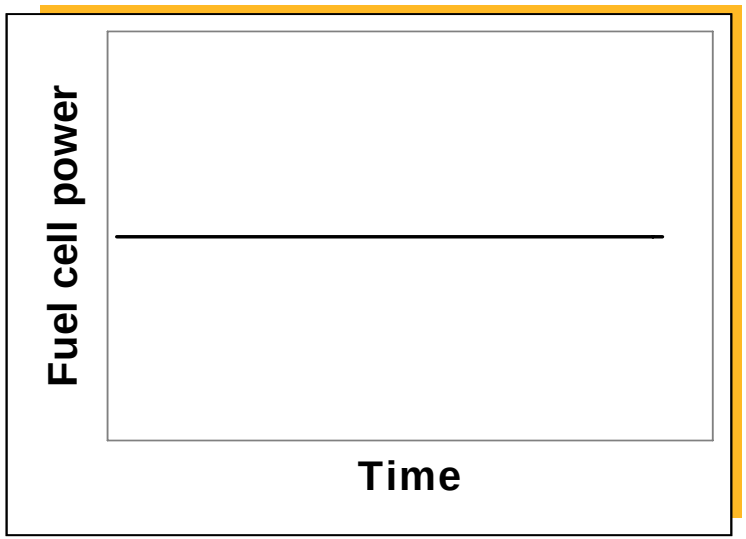
HYBRID POWER SYSTEM FOR TALON ROBOT

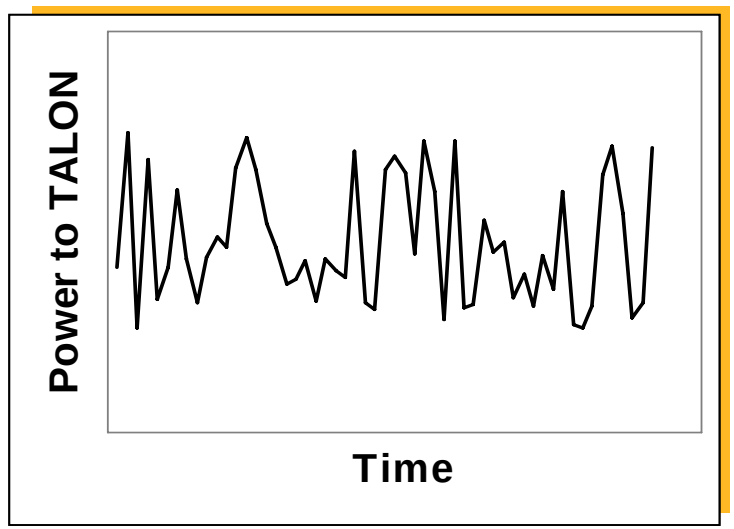
High Specific Energy

Fuel Cell

High Specific Power

Hybrid battery



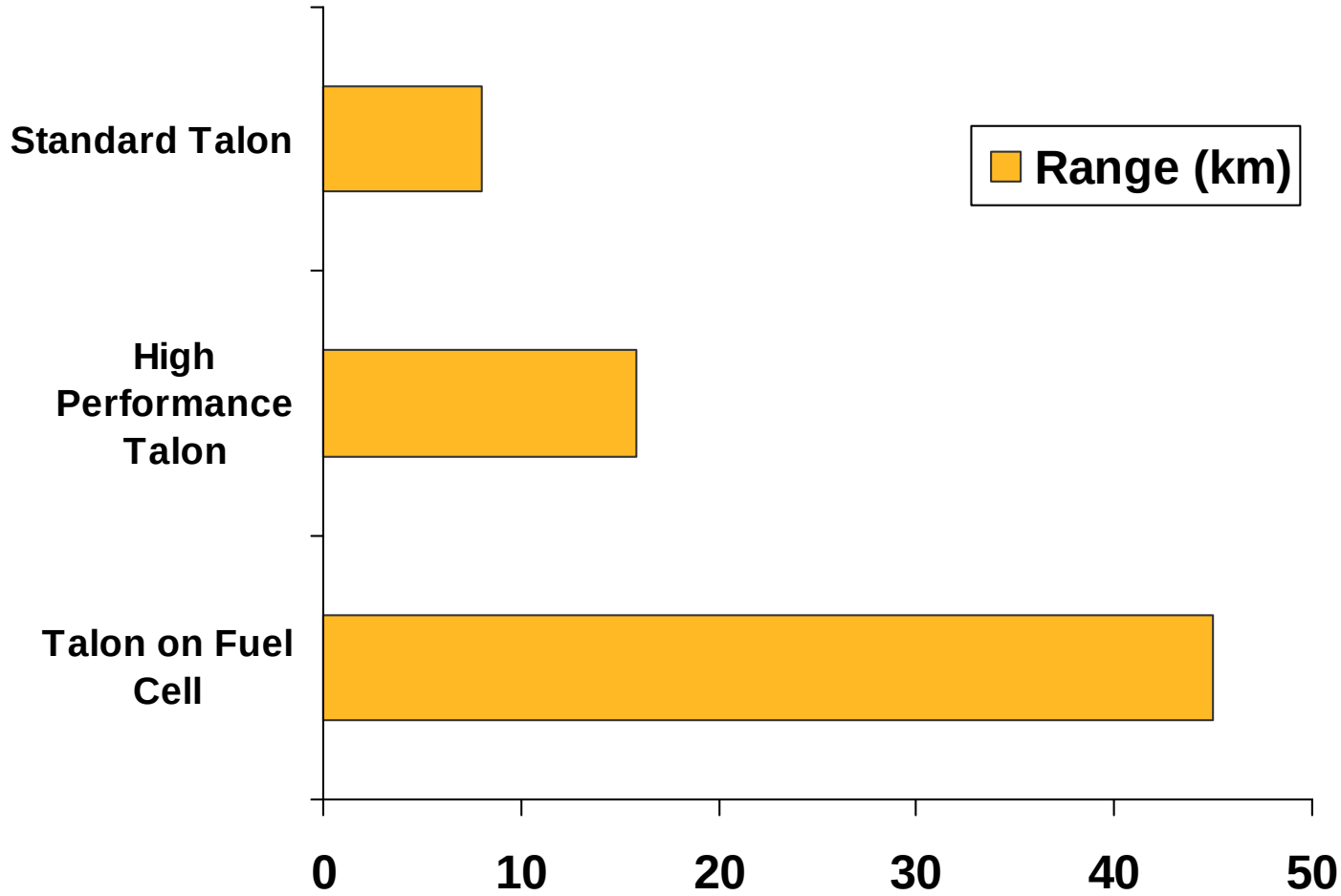


PROTONEX FUEL CELL SYSTEM

QinetiQ North America | Foster-Miller

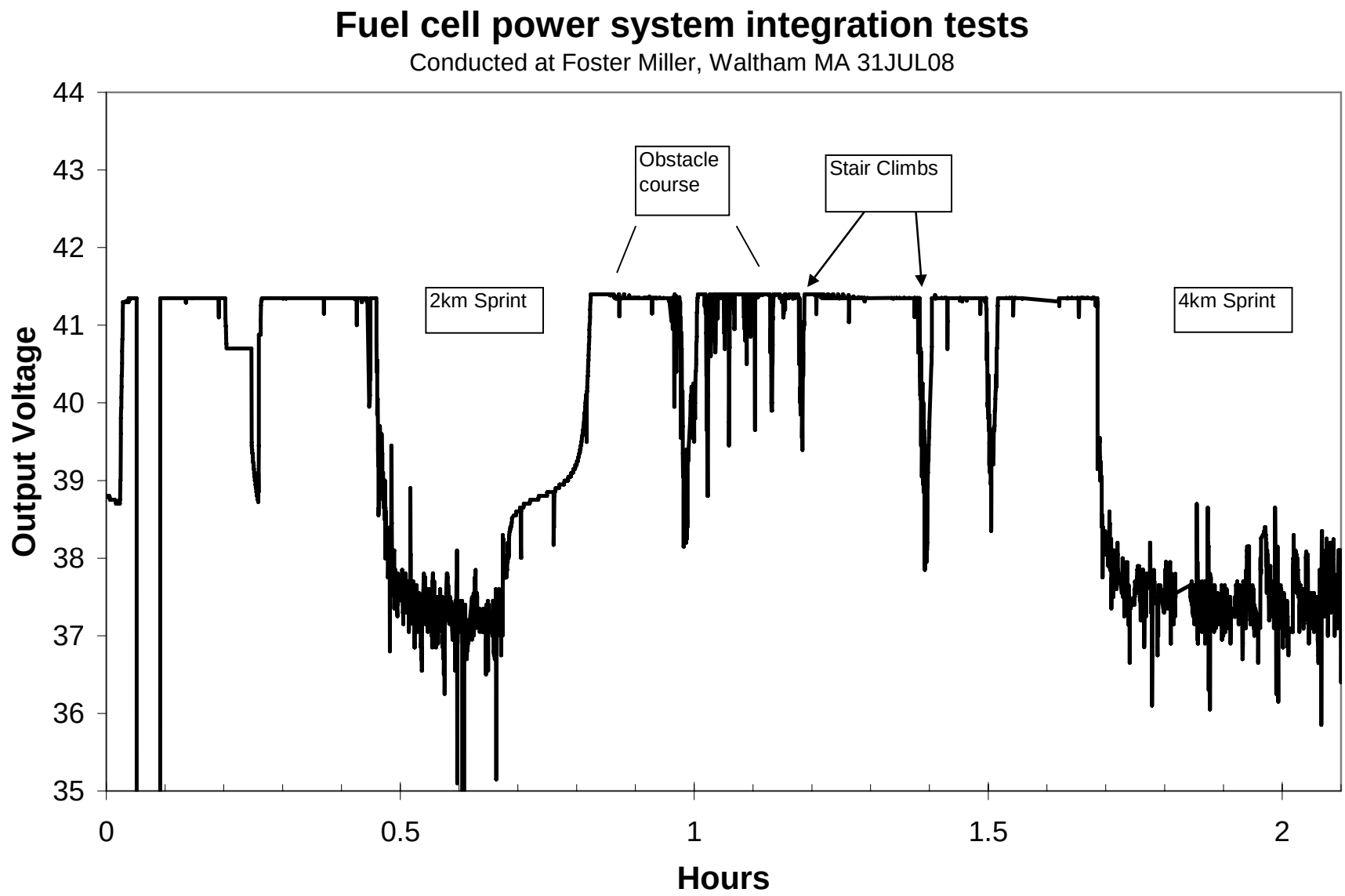
Navy (Crane) through NGMTI prime
N00164-06-D-6655

ENERGY STORAGE COMPARISON

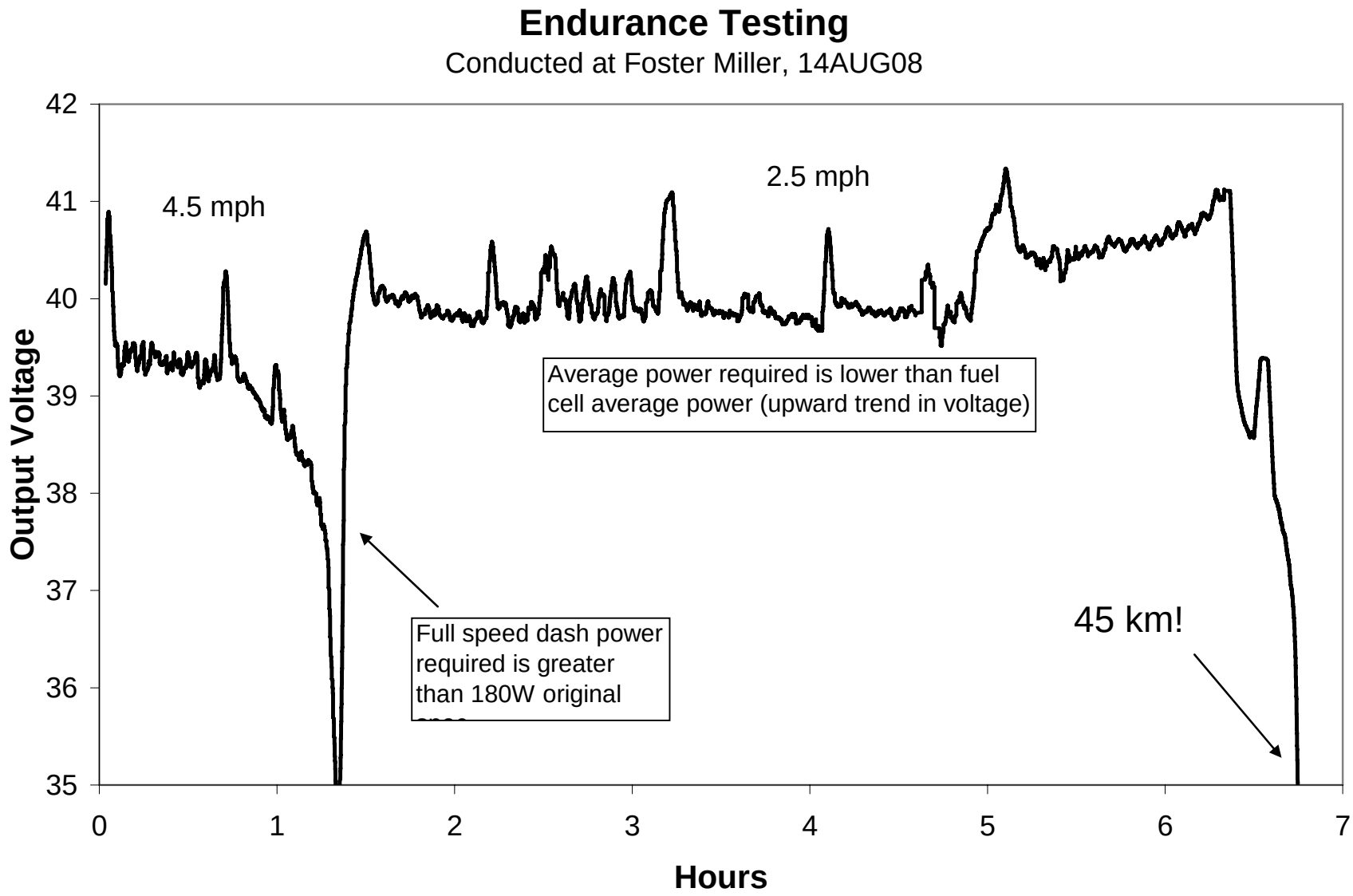


- Greater than 2X more energy storage compared to advanced batteries

OBSTACLES AND STAIRS DATA



ENDURANCE DATA



FUEL CELL POWER SYSTEM - TALON PERFORMANCE SUMMARY

	Target Performance	Demonstrated System
Total energy capacity	750 W·hr	1396 W·hr
Continuous average power capability	180 W	210 W
Peak power capability	1260 W	1305 W
Voltage limits	42-32	43.5V-35V
Peak current delivery	30A	30A
Weight	16 lbs	14 lbs
Volume	Fits within existing Talon Battery Space	

POTENTIAL MISSIONS FOR LONG DURATION ROBOTS

- Border / perimeter patrol
- Identification / clearing of land mines
- Material transport at the squad level
- Surveillance, long term recon
- Combat engagement

WHY FUEL CELLS FOR UAVS / UGVS?

- Hybrid power systems with **2-4x** energy of best battery
- More mission capability:
  - **More time on station**
  - **More data**
  - **More functionality**

WHY PROTONEX?

- Fuel cell team with pragmatic strategies
  - Portable sub-kilowatt focus - best fuel cell opportunity
  - Securing world-class commercial partners
  - Company delivering on commitments
- Protonex is well-positioned to capitalize on the global demand for environmentally friendly and energy efficient power

Not just another fuel cell company…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