

# **Energizer's Lithium Iron Disulfide –** The best of all worlds for the most demanding applications

2<sup>nd</sup> Israeli Power Sources, Batteries, Fuel-Cells & EV  
Conference

Jack Marple





# Only Energizer can offer the unparalleled performance of the Lithium AA and AAA batteries

*– the best batteries for the most demanding devices*

LASTS UP TO

# 9X

LONGER VS.  
ENERGIZER MAX

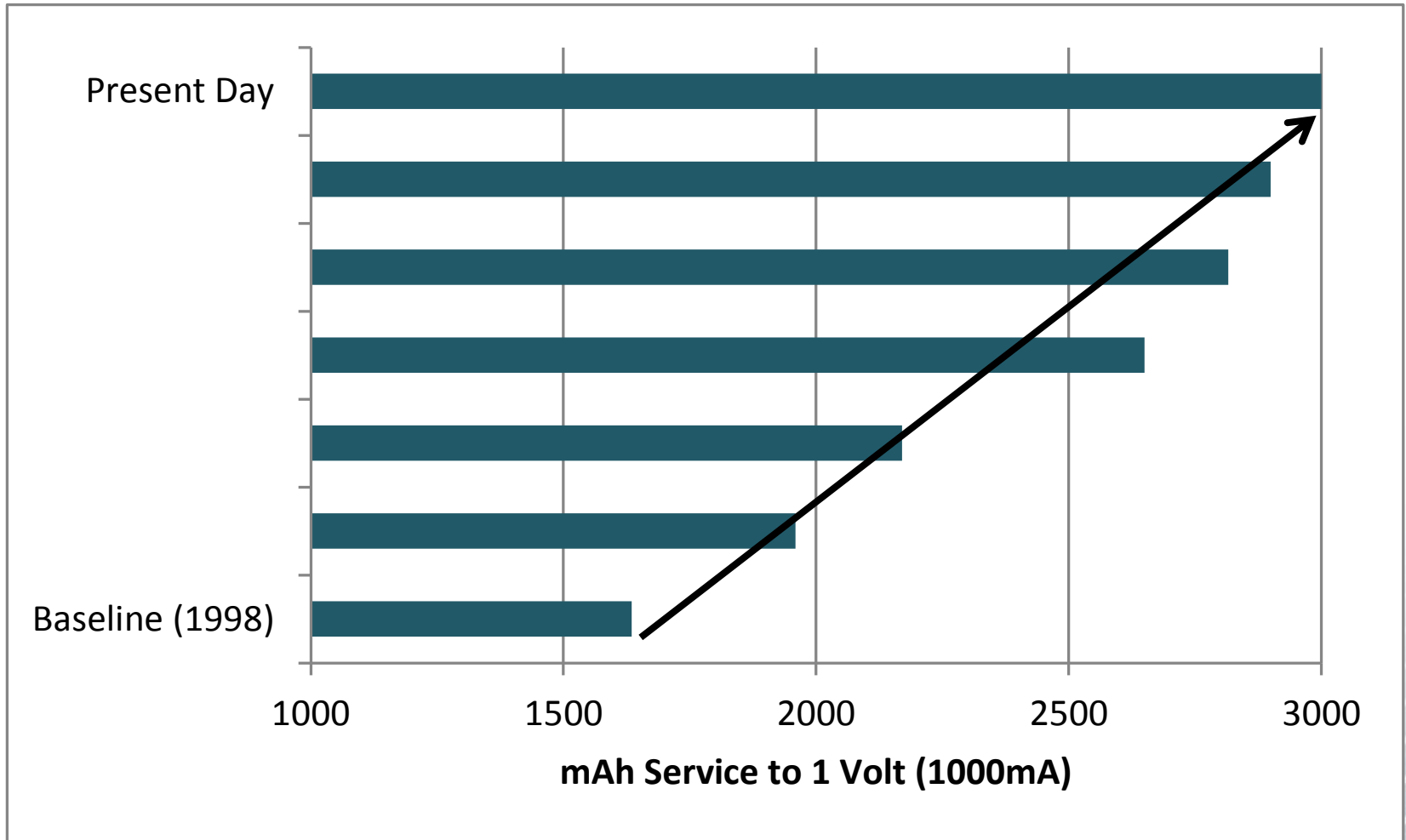


Only Energizer can offer a complete portable power portfolio of products...

...and today, more than ever:

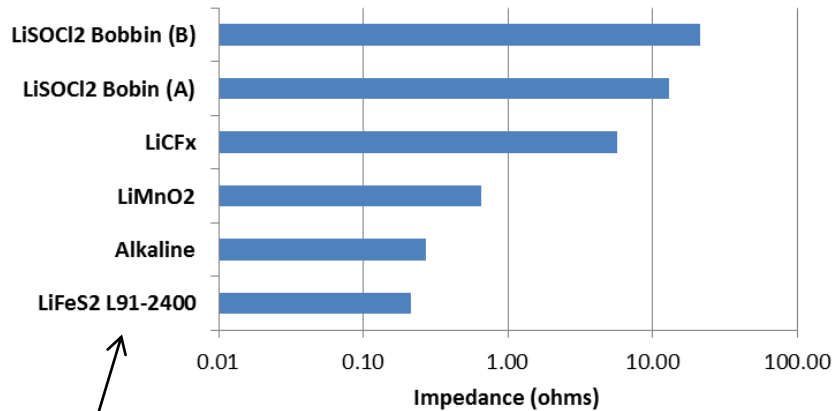
Over 100% Improvement

L91, AA 1000mA Constant Current Test (ambient)

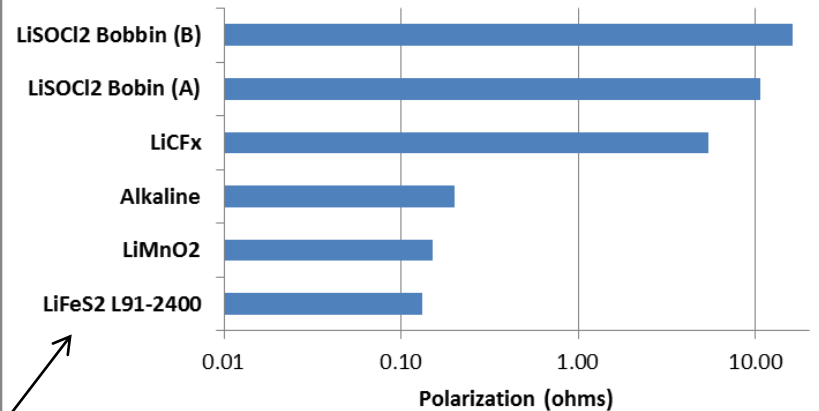


# Comparisons of Some Key Metrics Primary 2/3A and AA Options

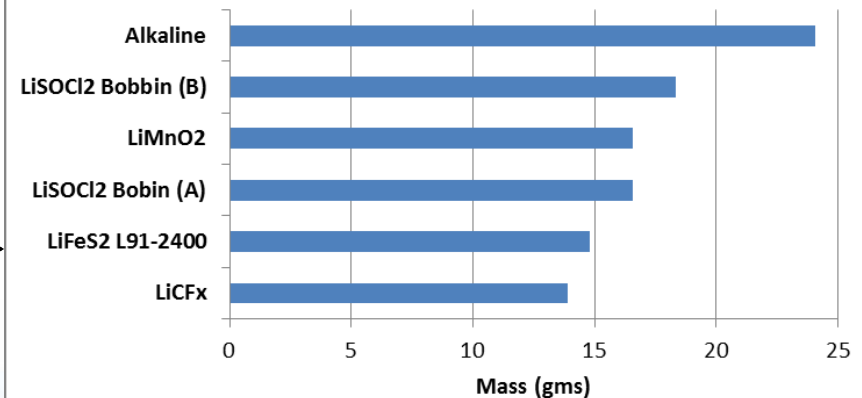
### Cell IR (measured at 10KHz)



### Charge Transfer (10KHZ-10Hz)



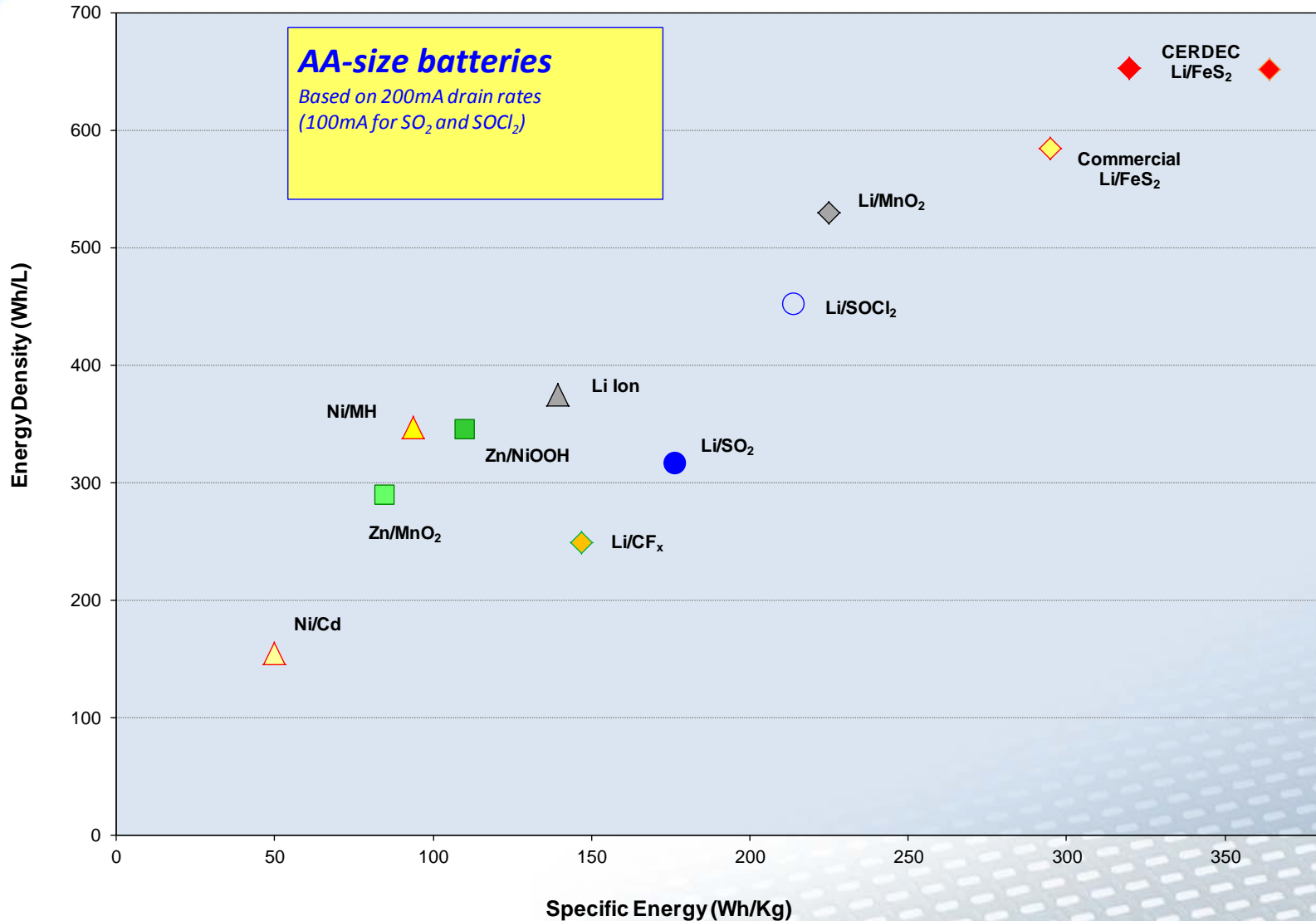
### Cell Weight



LiFeS<sub>2</sub>, Best Combination of:  
Low Impedance and Weight

# Li-FeS<sub>2</sub> vs. Competitive Systems

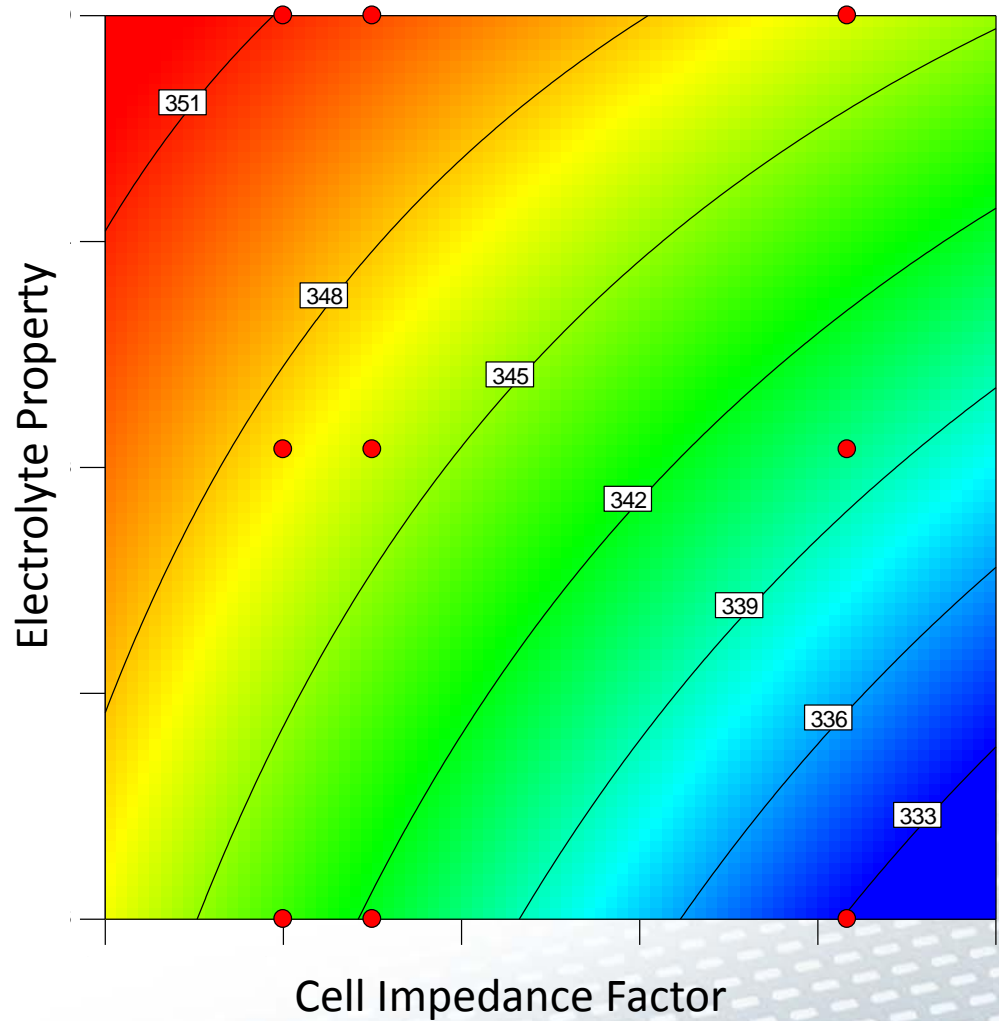
RAGONE Plot of Commercial AA Size Cells



# Recent 9X Product Improvement

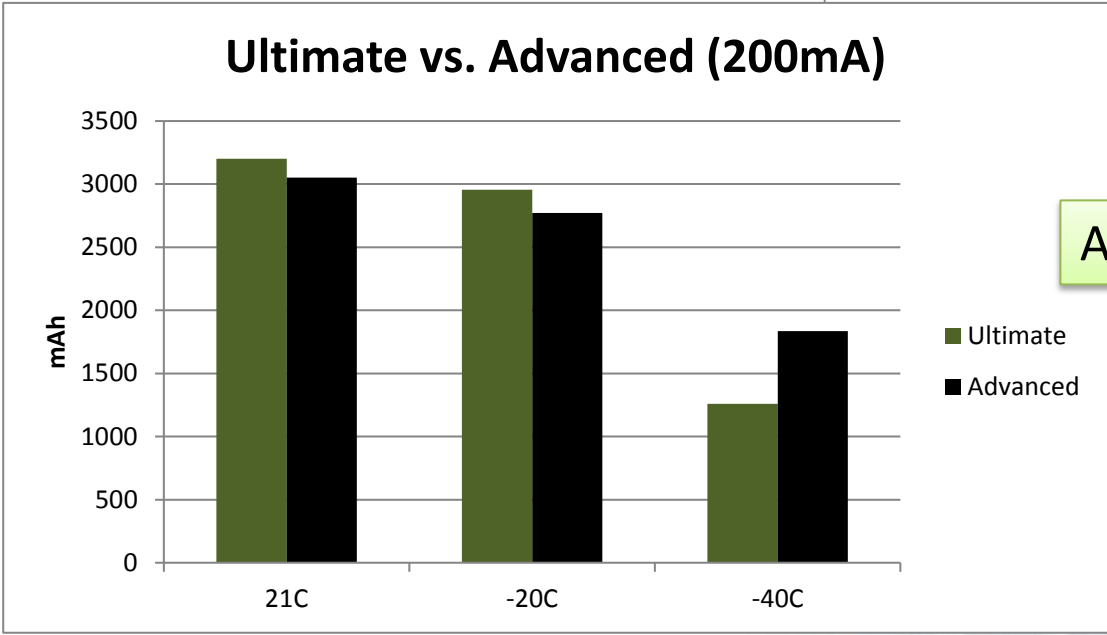
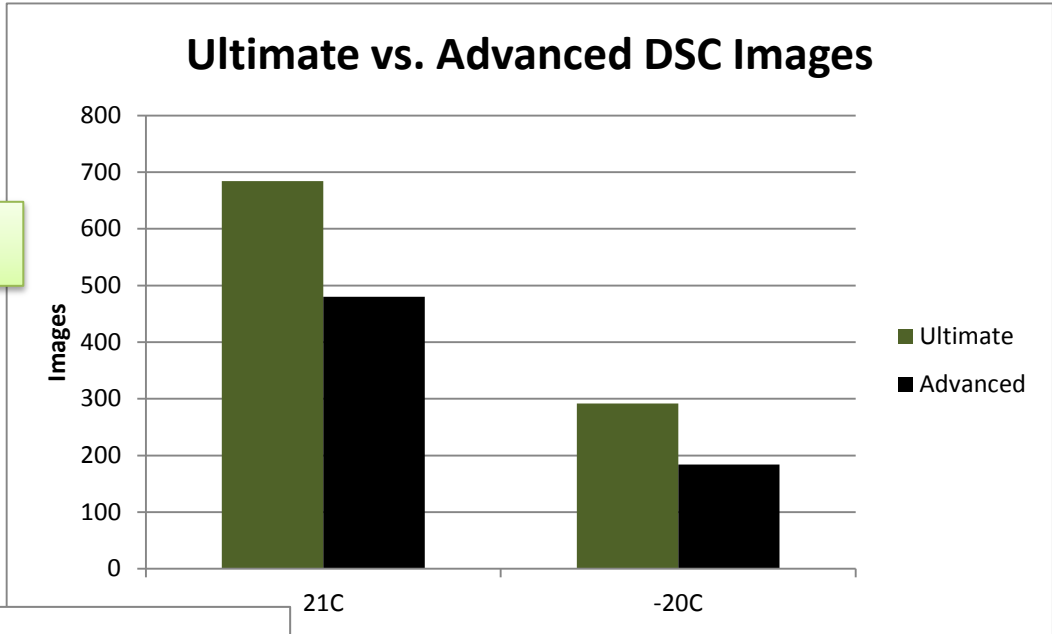
Digital Still Camera Performance:  
ANSI Simulation (1.5W/.65W)

Product Improvement Based  
On DFSS and Fundamental  
Understanding of Interactions  
Based on Transfer Functions



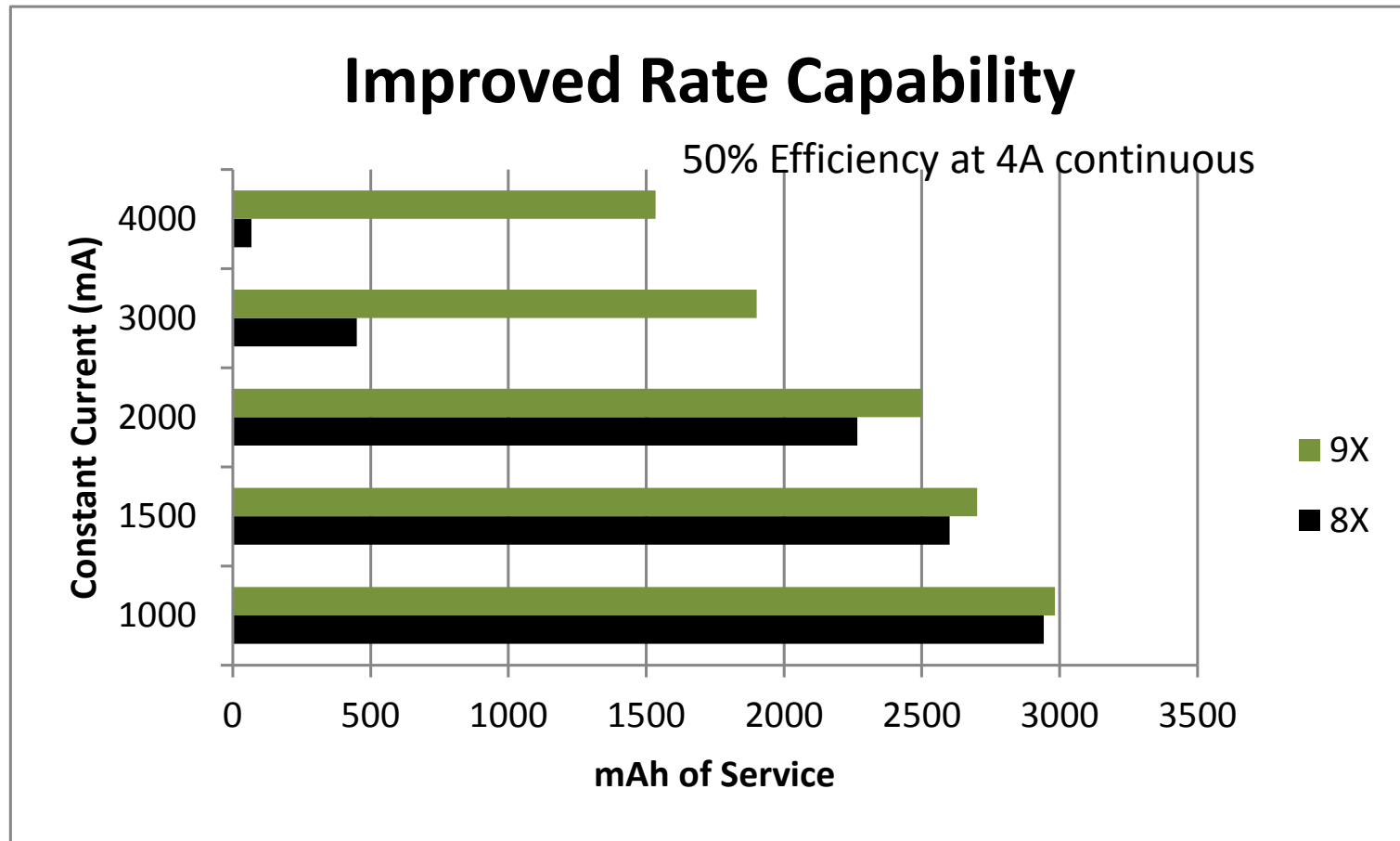
# Design Influences:

Ultimate designed for high rate



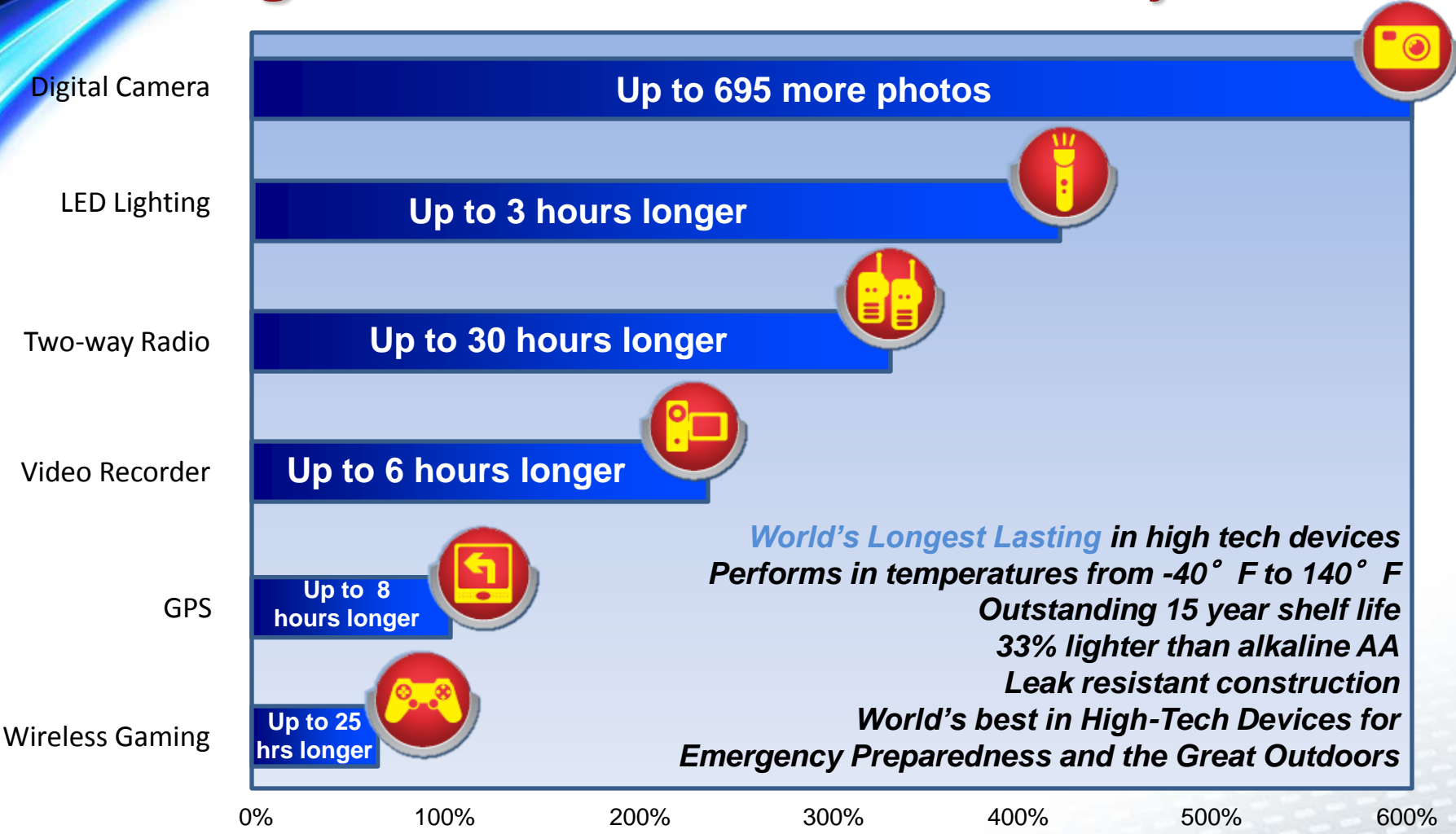
Advanced better low temperature

# Improved Ultra High Rate ENERGIZER New 9X, AA Improvement





# Energizer® Ultimate Lithium® in a variety of devices

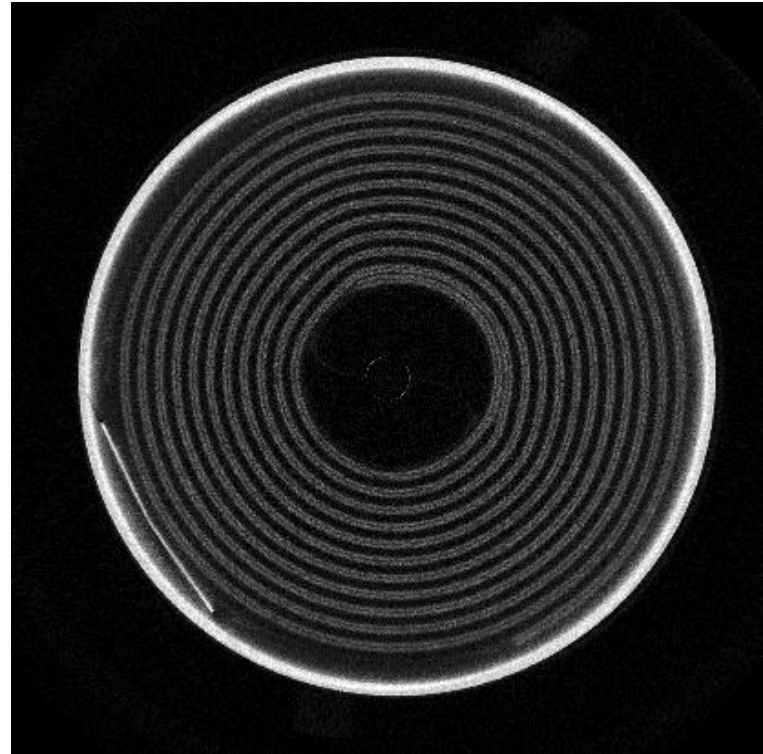
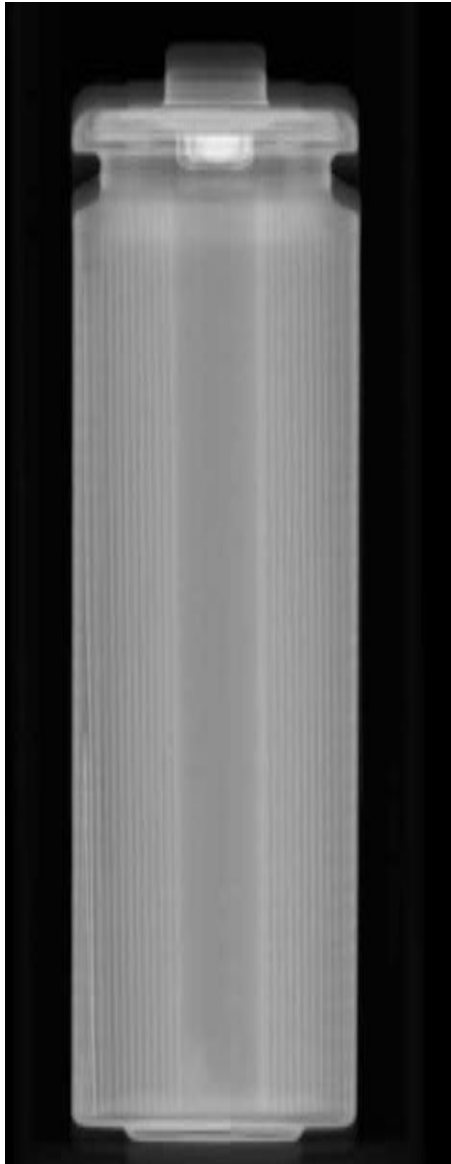


*World's Longest Lasting in high tech devices*  
*Performs in temperatures from -40° F to 140° F*  
*Outstanding 15 year shelf life*  
*33% lighter than alkaline AA*  
*Leak resistant construction*  
*World's best in High-Tech Devices for*  
*Emergency Preparedness and the Great Outdoors*

Energizer® Ultimate Lithium® AA vs. Energizer® MAX® Results Vary by Device

# LITHIUM IRON DISULFIDE - DESIGN FOR SAFETY

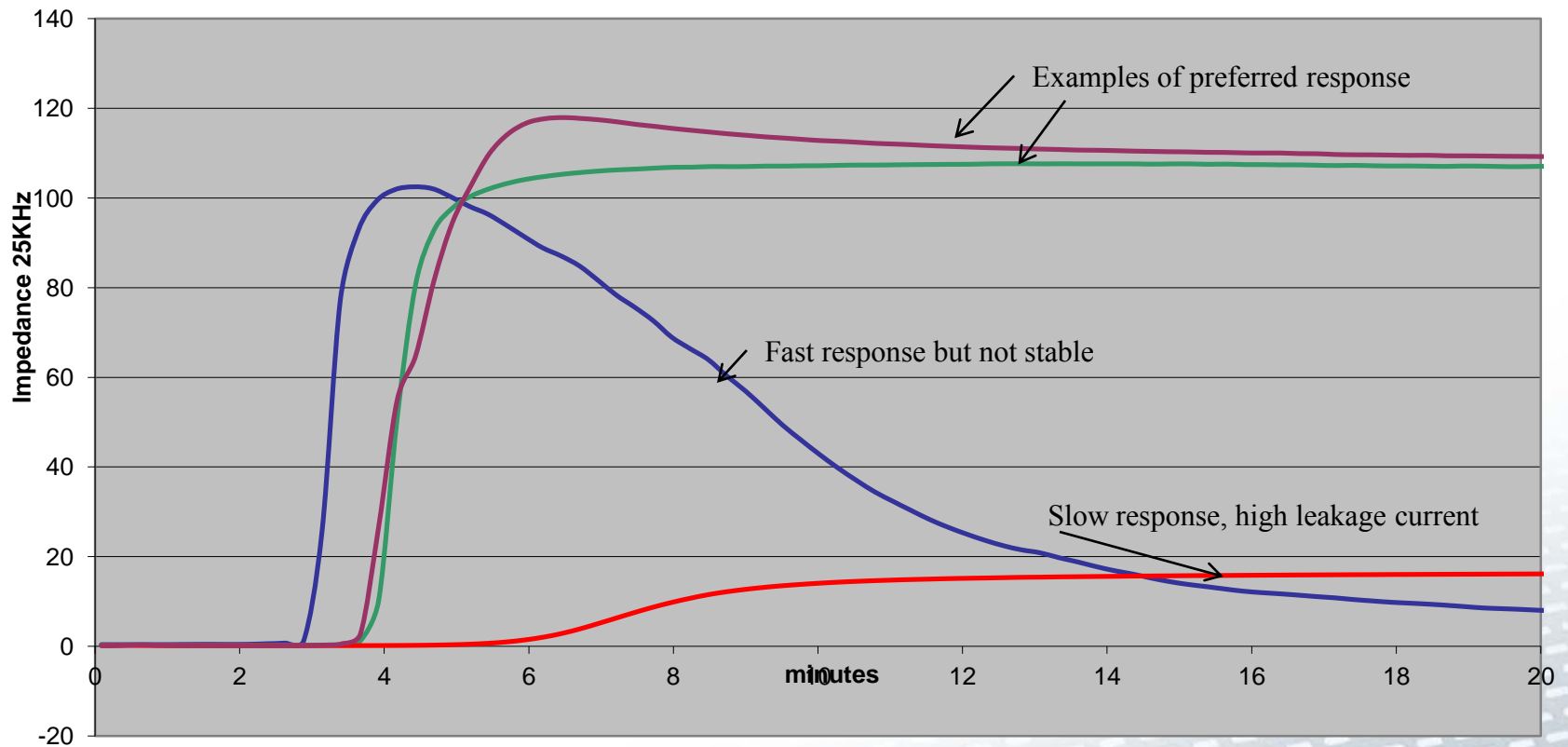
Critical Process steps use self correcting feedback.  
More than twenty, 100% in line inspections



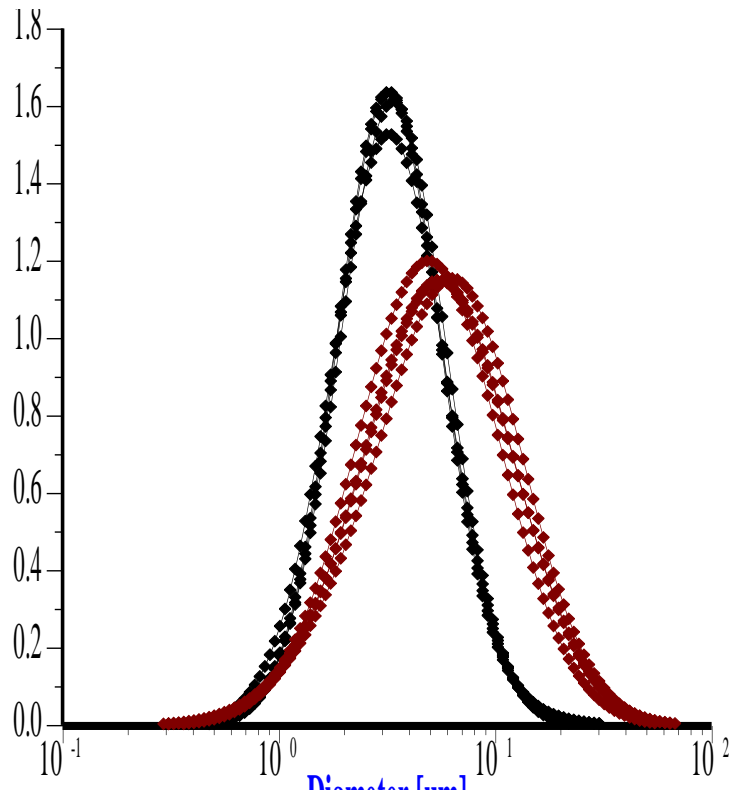
Quality at the source: sensors, cameras, vision, electrical,  
Critical processes self correcting.

# In Situ Thermal Response Test of Microporous Films

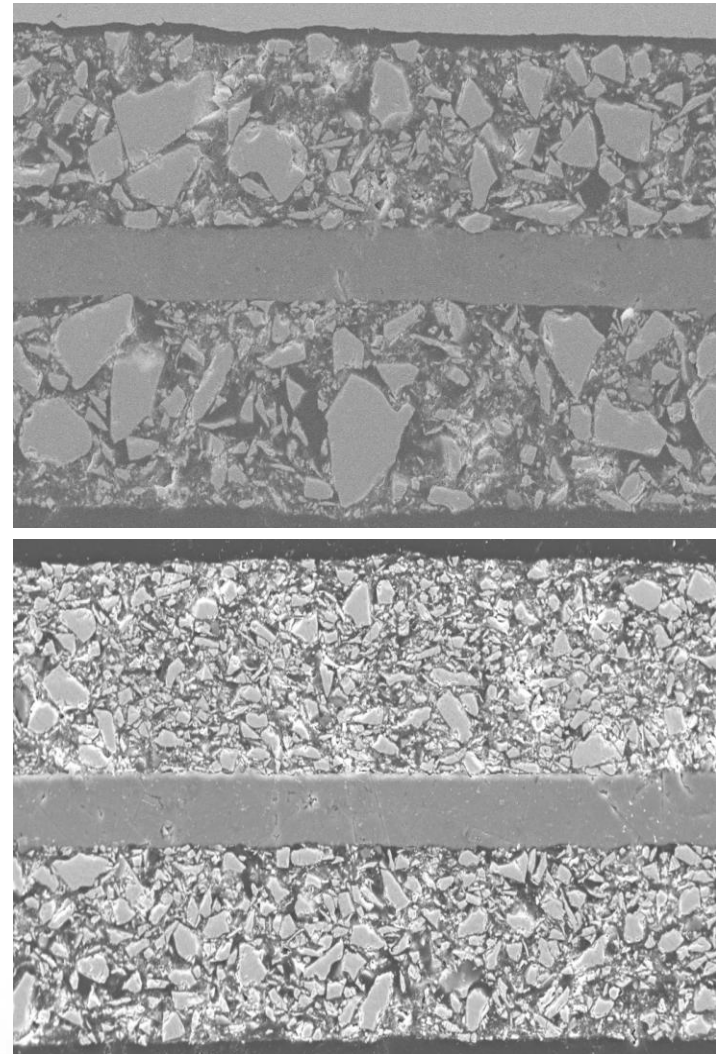
Thermal Response of Various Commercial Separators  
150C LiLi Cells Hot Oil Bath



# Reduction in Pyrite Particle Size for Improved Reliability and Performance



High Percent Solids Particle Size Analysis Based on Sound Waves



# Commercial and Military Applications

## Applications

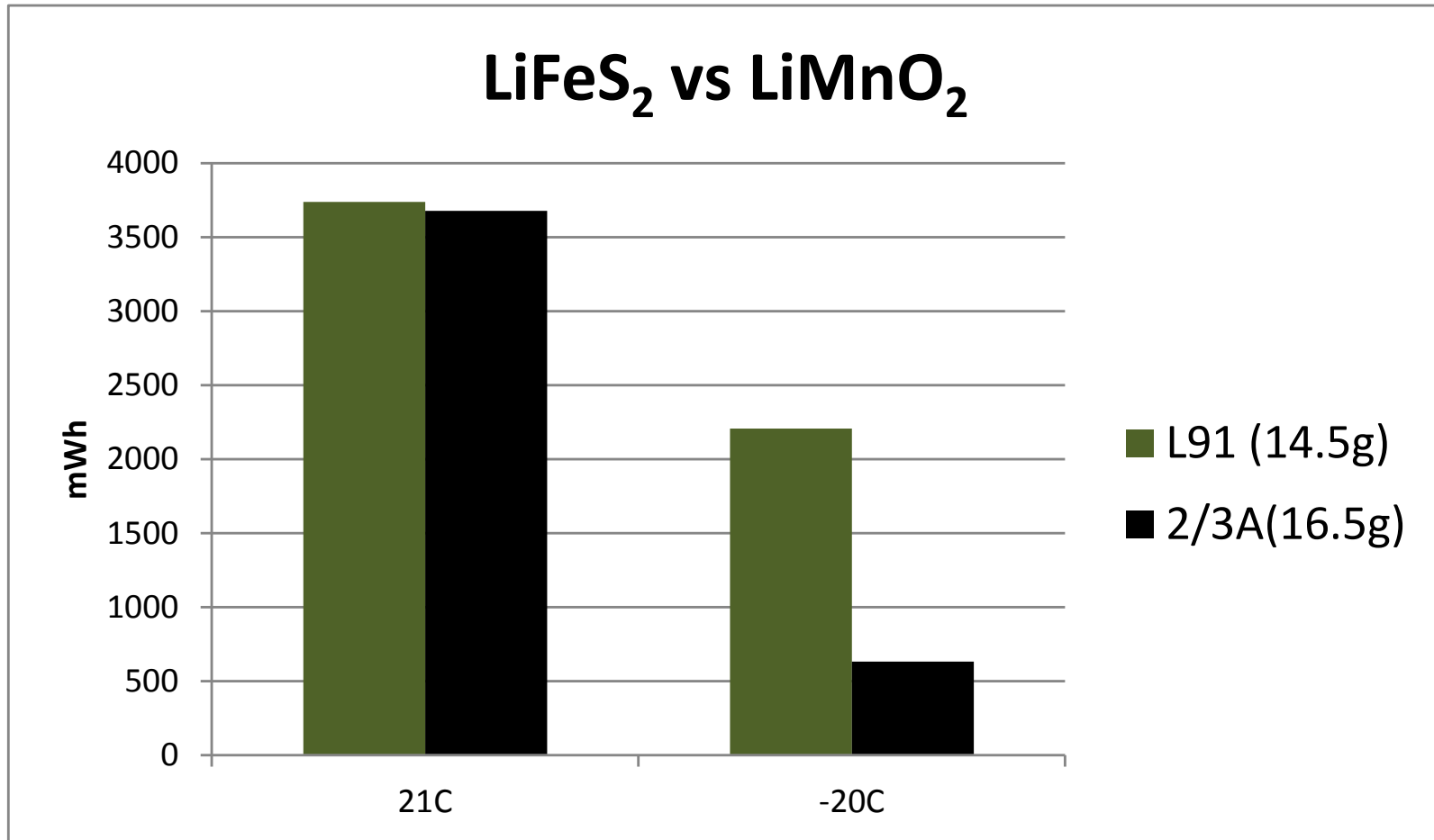
- Night Vision Goggles
- Thermal Weapon Sights
- GPS Receivers
- Survival Radios
- Strobe Beacons
- Headsets
- Digital Cameras
- Flashlights

## Advantages

- Excellent shelf life (15yrs+) minimizes inventory replacement.
- Excellent low temperature performance provides service where other systems fail.
- Grid independence, no need for charger and wires.
- Reduced weight.
- Safe –(overcharge and heat protection)
- Widely available to the end user
- User replaceable

# More Energy, Lower Weight, Better Low Temp.

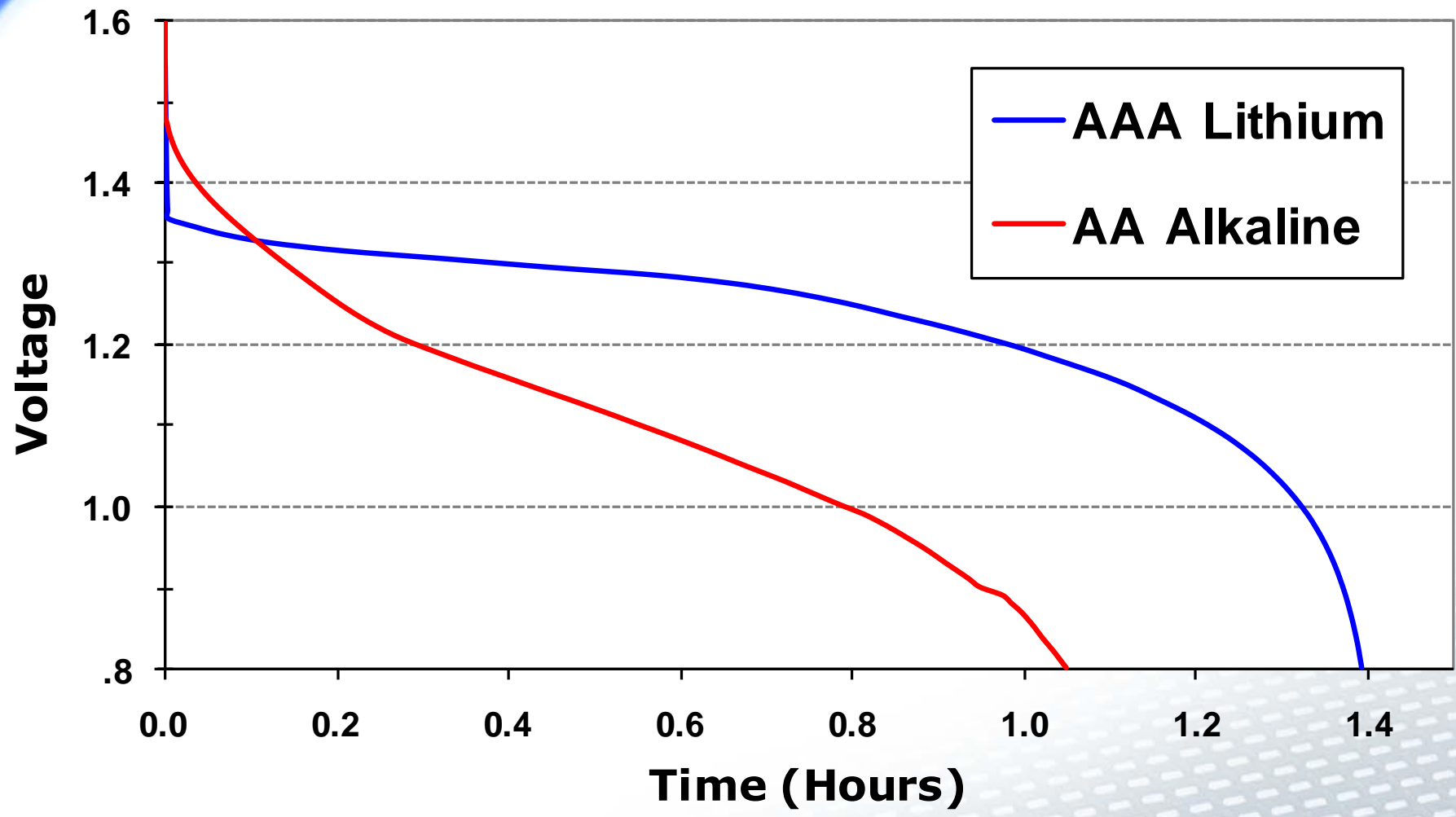
Based on 1W Continuous Discharge





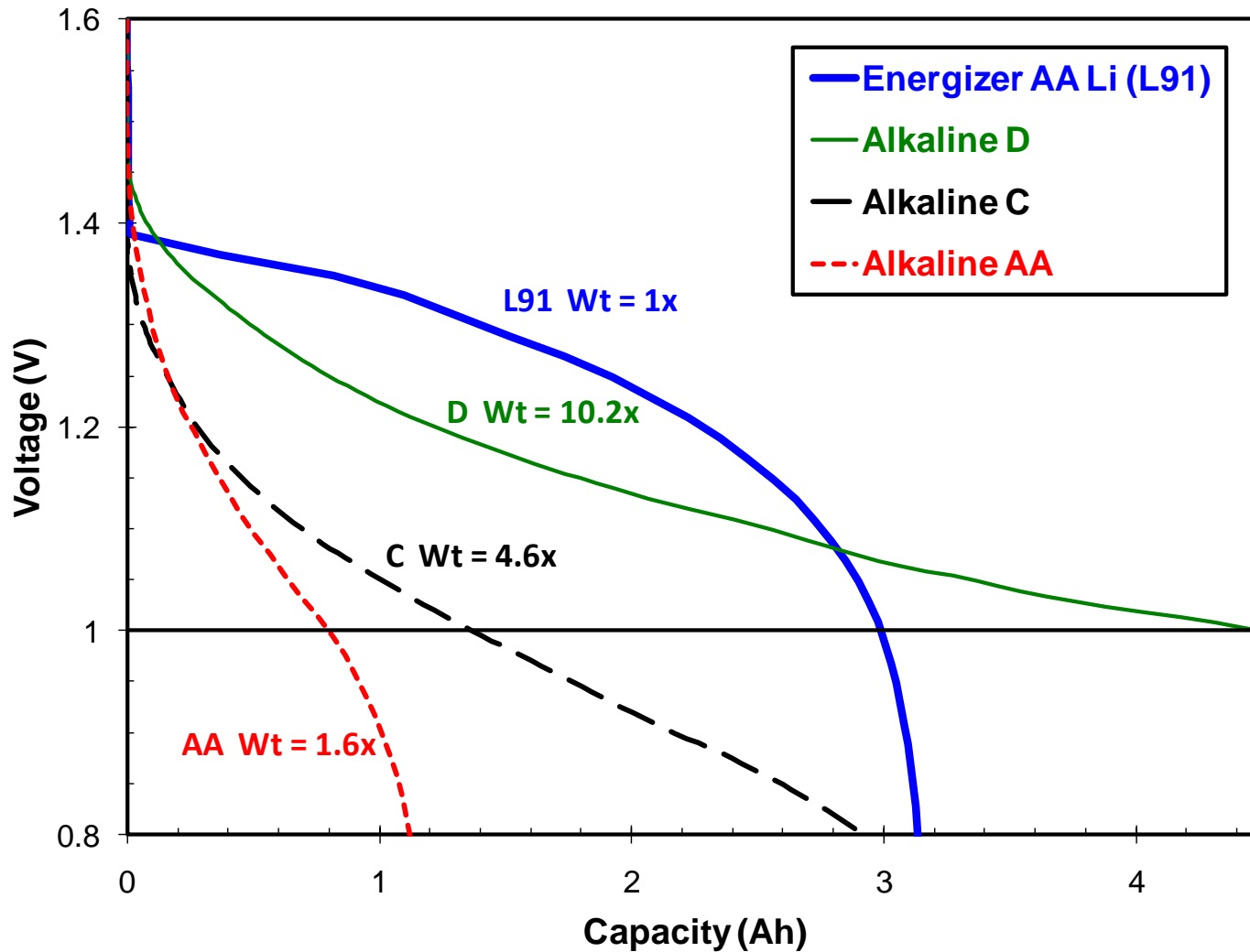
# Smaller and Better at High Rate

**1000 mW CONSTANT POWER DISCHARGE**



# LiFeS<sub>2</sub>, AA vs. Alkaline Cells (AA, C, D)

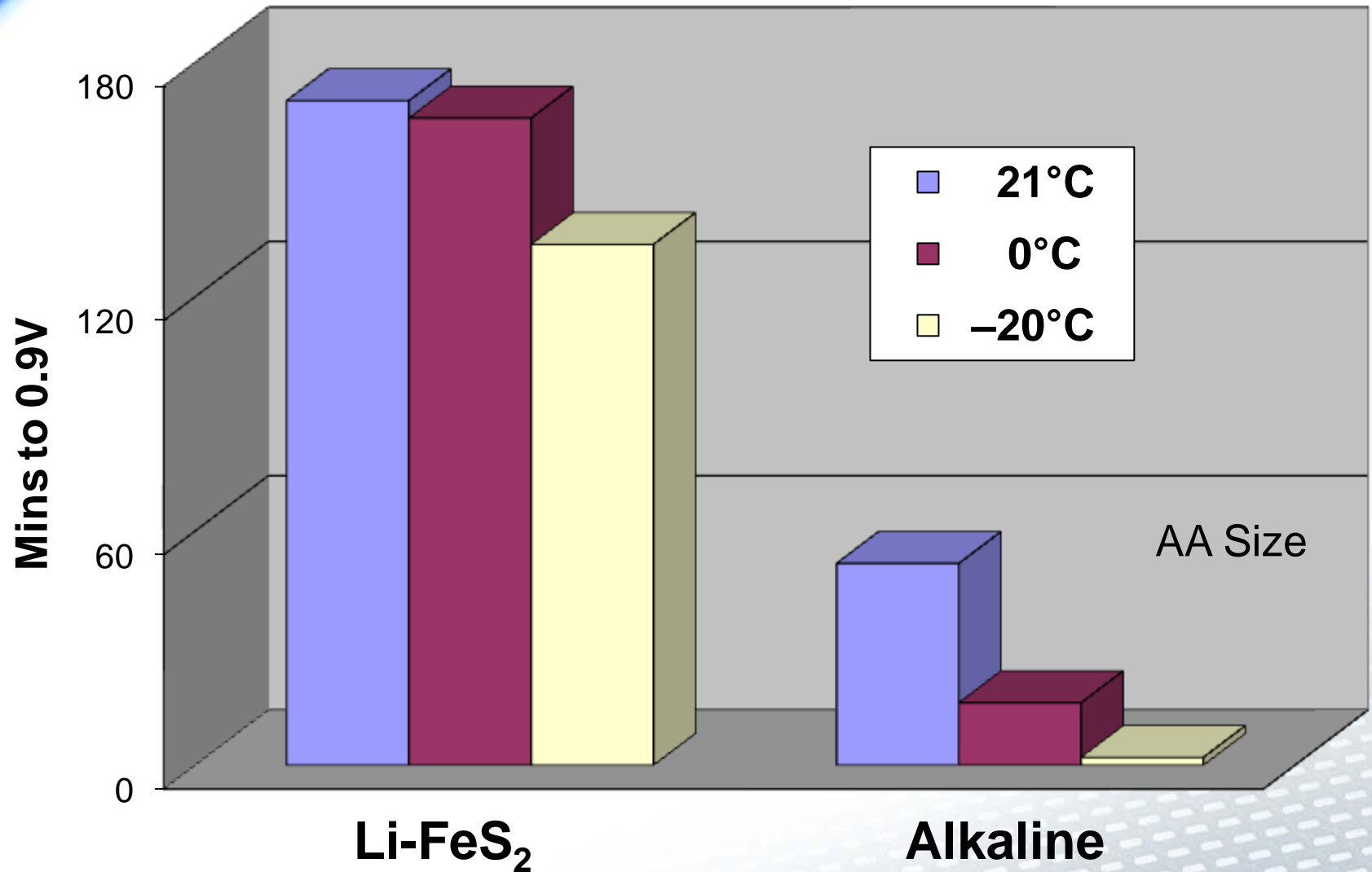
## 1A Continuous Discharge



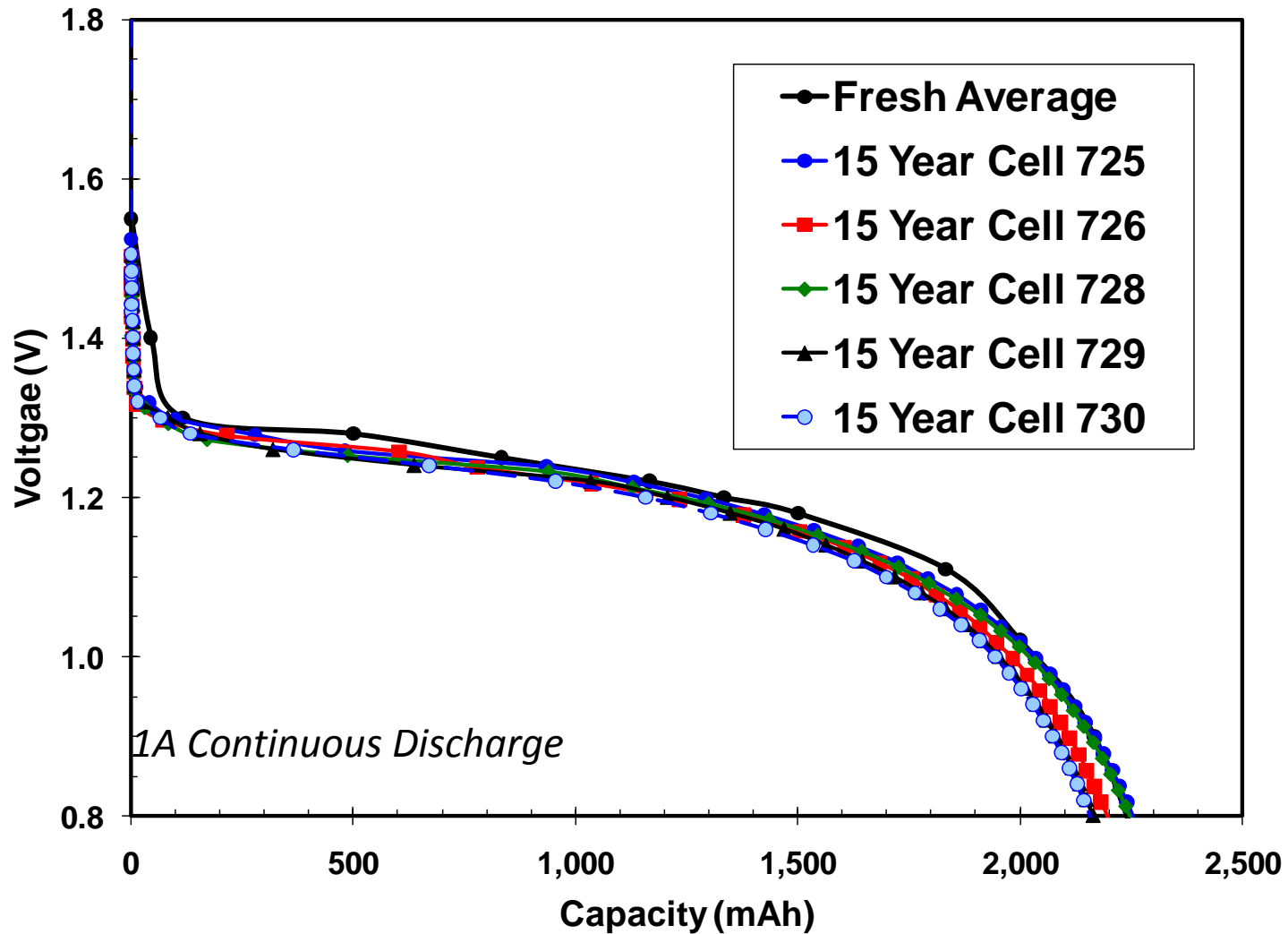


# L91 vs. Alkaline

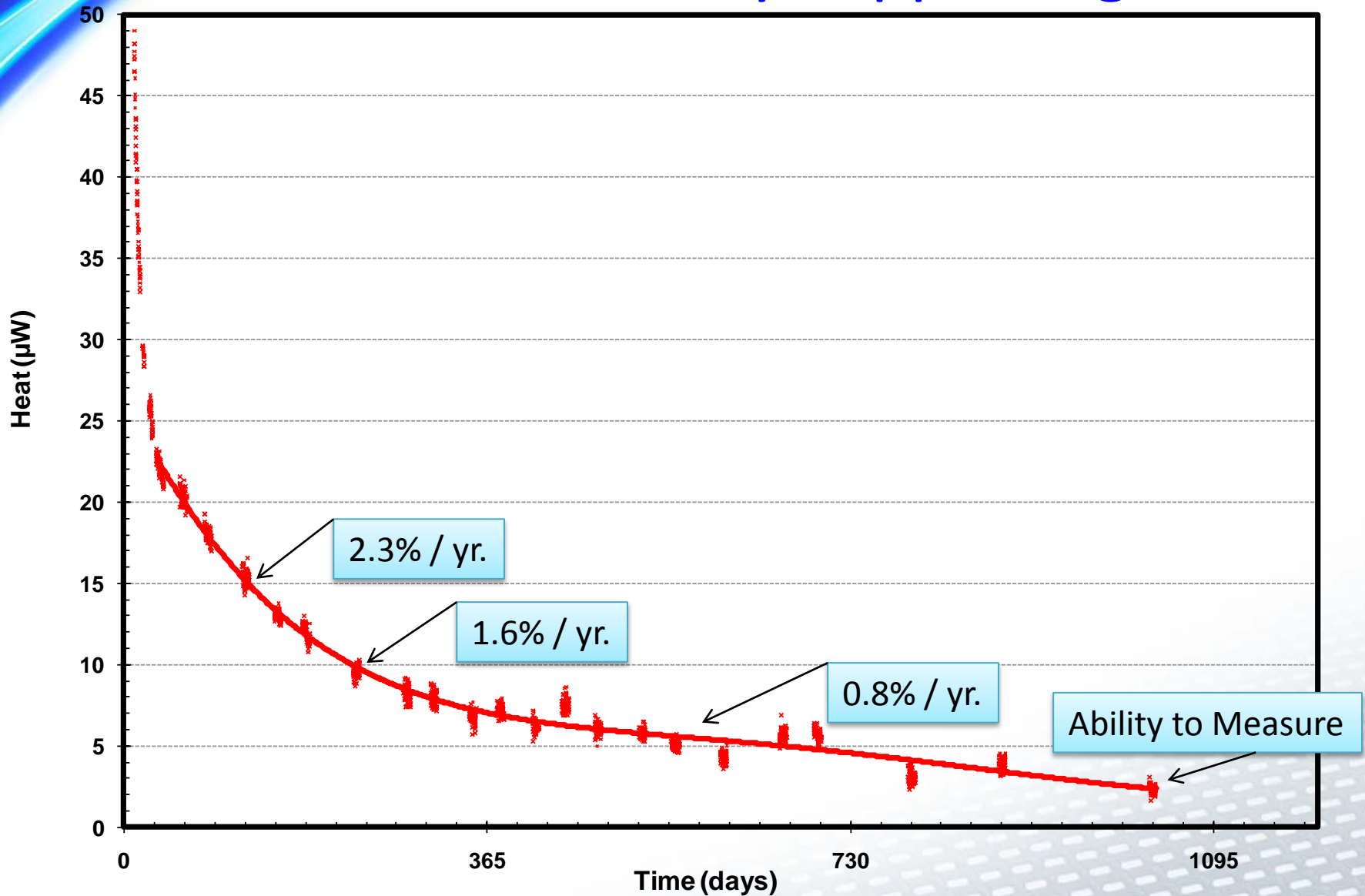
Run Time on 1A Continuous at Low Temperature



# Excellent Shelf Life: Real Time Data



# Microcalorimetry Supporting Data



# Performance Testing AFTER 28-Day Desert Storage Cycle

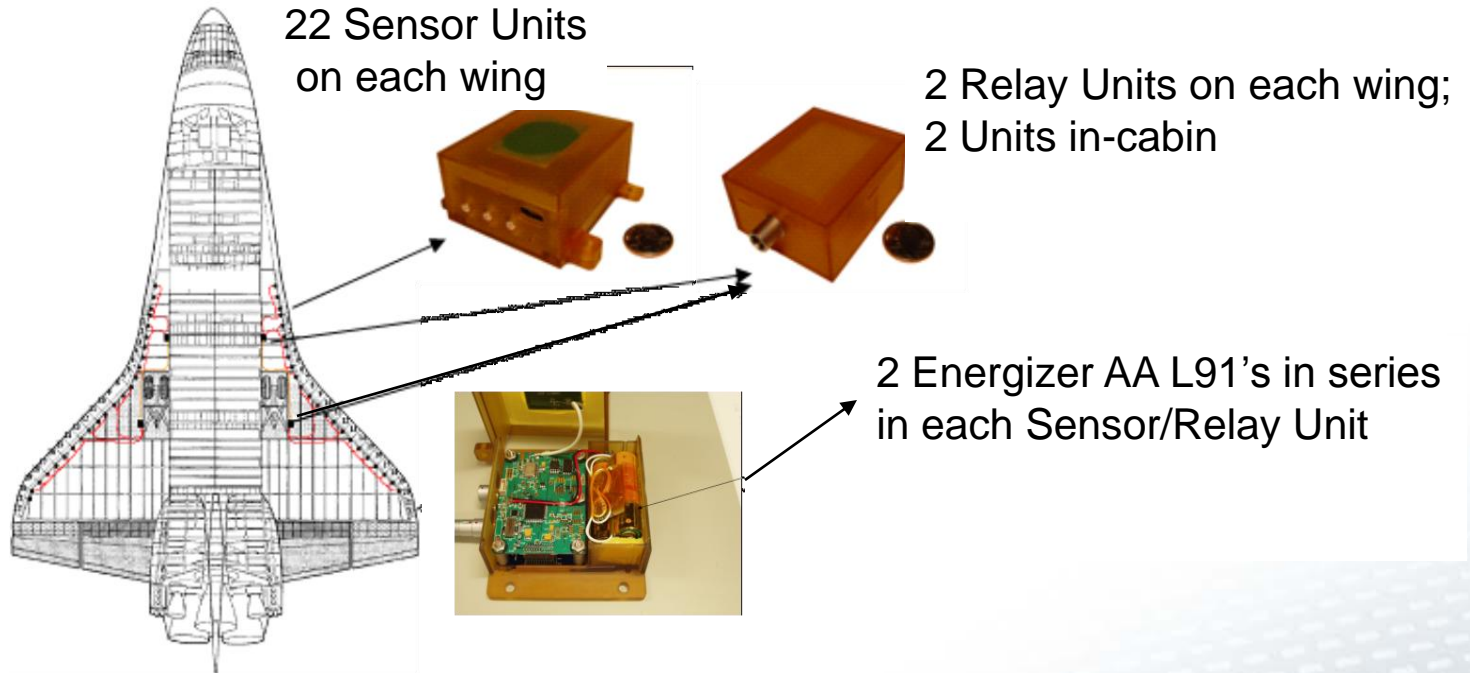
Temp. (°C)	100mA	250mA	500mA	1A	1.5A
21	99%	99%	100%	98%	98%
0	101%	100%	97%	99%	107%
-20	99%	101%	97%	92%	
-30	101%	96%	93%		
-40	102%	120%			

***Virtually no impact on performance***

*Values are % of performance before Desert Storage*

*28-day thermal cycle between 33 and 71°C (91-160°F). Average 48°C (115°F)*

# ***Energizer AA Lithium/NASA Reliability Confirmation***



## Summary



- Energizer has over 20 years of mass production and continuous improvements of its  $\text{LiFeS}_2$  products.
- High reliability is supported by excellent shelf life and safety record in the field.
- $\text{LiFeS}_2$  offers advantages of:
  - Low temperature performance
  - The highest Wh/Kg and Wh/l in a AA cell size (at the drain rate typical of the majority of commercial applications)
- Provides energy in a convenient AA, and AAA format providing the end user with other cell selection options.
- Light weight, low cost, and the convenience of a primary energy source.

