The development of the HLC:

A small rechargeable power source in a primary PulsesPlus™ battery

C. Menachem and H. Yamin

Tadiran Batteries Ltd. K. Ekron 70500, Israel

Advanced Energy Sources Meeting

Tel Aviv, January 2008

Outline

- Introduction: the PulsesPlus™ system
- HLC technology
- The development of the HLC during the last decade:

  Cycling, energy, power, stability, self-discharge, and

  performance at low temperatures

The PulsesPlus™ Battery

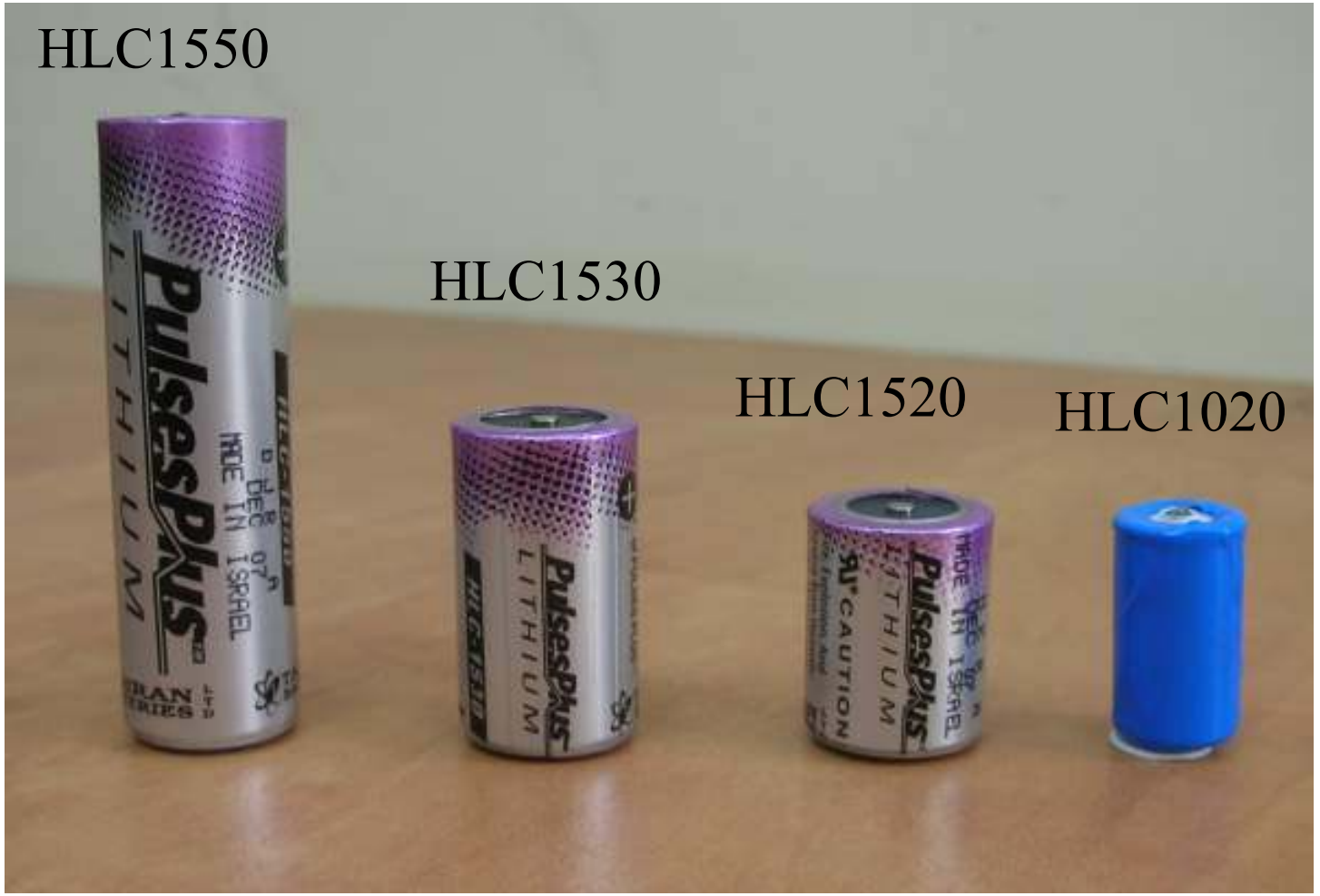
The PulsesPlus™ battery is Tadiran's unique solution for applications requiring high current pulses.

It combines the bobbin type Li/$SOCl_2$ with a novel hermetically sealed Hybrid Layer Capacitor (HLC).

This HLC is a patented battery-like capacitor consisted of intercalation compounds modified for Li/$SOCl_2$ system.

Experimental: PulsesPlus™ batteries

Experimental: HLC



Experimental: HLC1520

Hermetically sealed cell based on Li-Ion chemistry:

- **Weight: 8g. Volume: 3.5 mL.**
- **Electrodes area: 90cm^2.**
- **Cathode: Multi-metals oxide.**
- **Anode: carbon.**
- **Micro-porous separator.**
- **Electrolyte: $LiPF_6$ dissolved in carbonates mixture.**

HLC characteristics

- **Pulse capacity of 50 mAh (1520: 3.67 V to 2.5V cut-off voltage).**
- **Thousands stable cycles.**
- **High discharge rate.**
- **Wide operating temperature range: -40 to 85°C .**
- **Excellent stability of performance after long-term storage.**
- Low self discharge.

HLC improvement at low temperatures

Old design HLC:
In production until 2003

Cathode material: LiCoO2.

Very good performance at RT.

Performance at low temperatures is limited.

HLC improvement at low temperatures

The "N" Model
In production since 2002

New cathode material: multi-metal oxide

Optimization of Electrolyte composition.

Optimization of Electrodes structure.

HLC improvement at low temperatures

Current design HLC: The "A" Model
In production since 2004

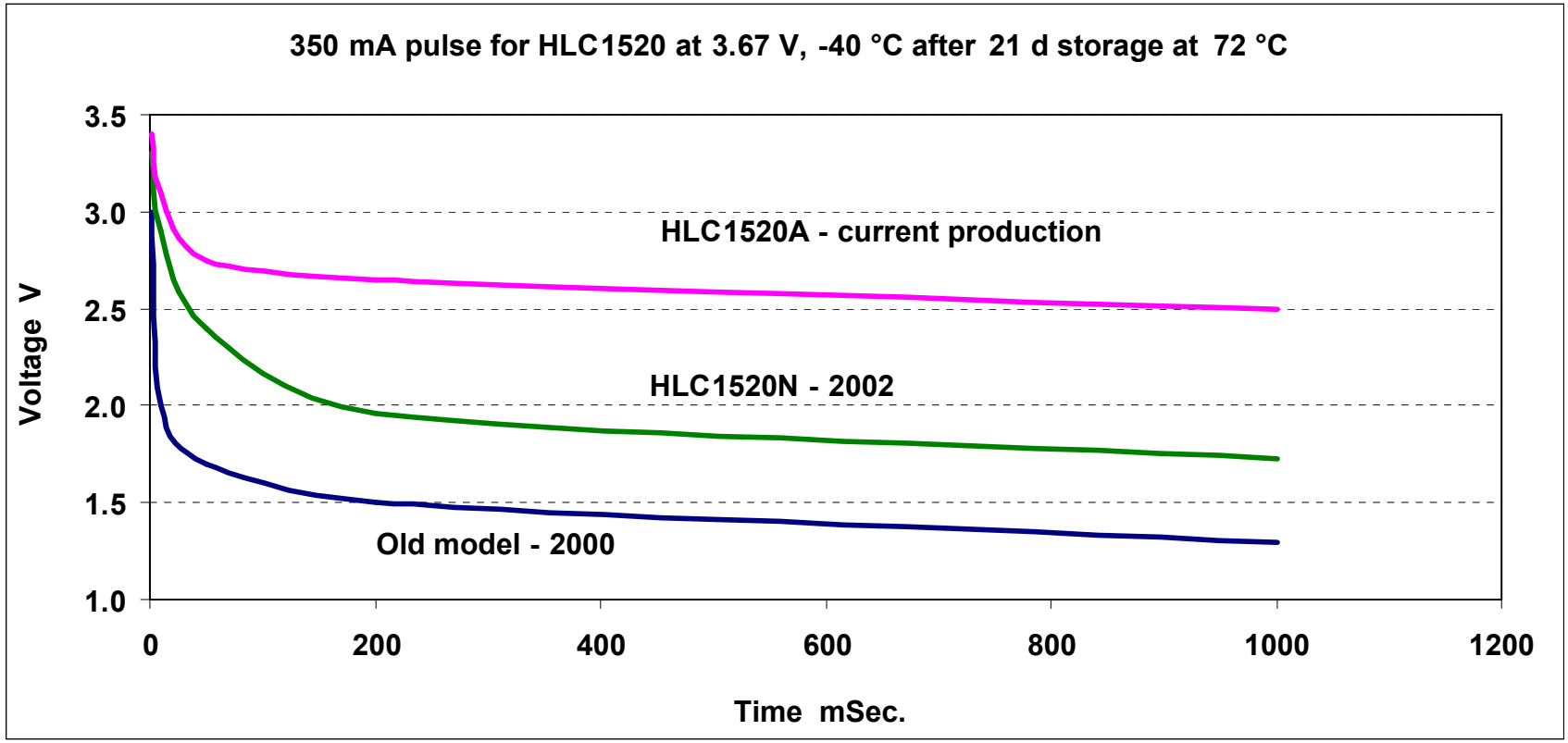
Improvement in cathode composition.

New anode material.

Modified separator.

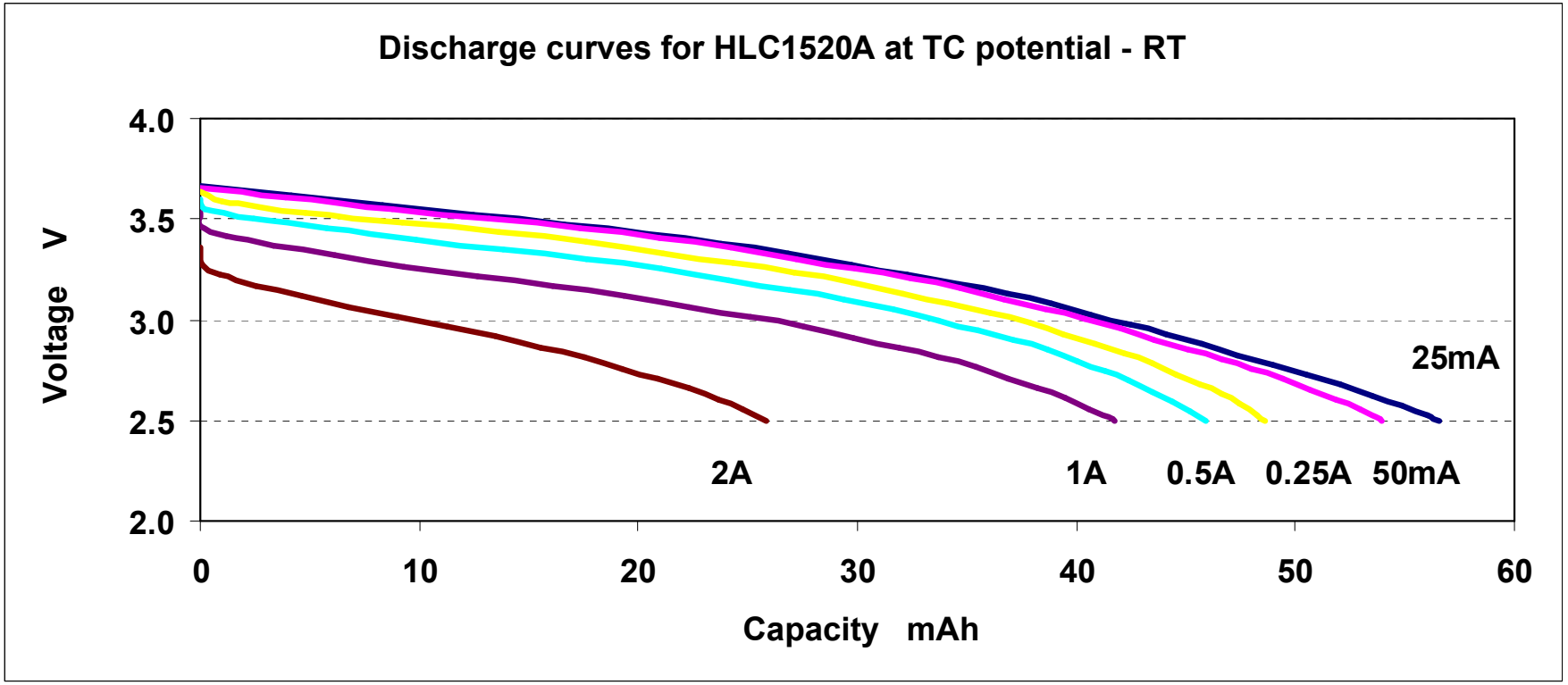
HLC performance

Performance at low temperature



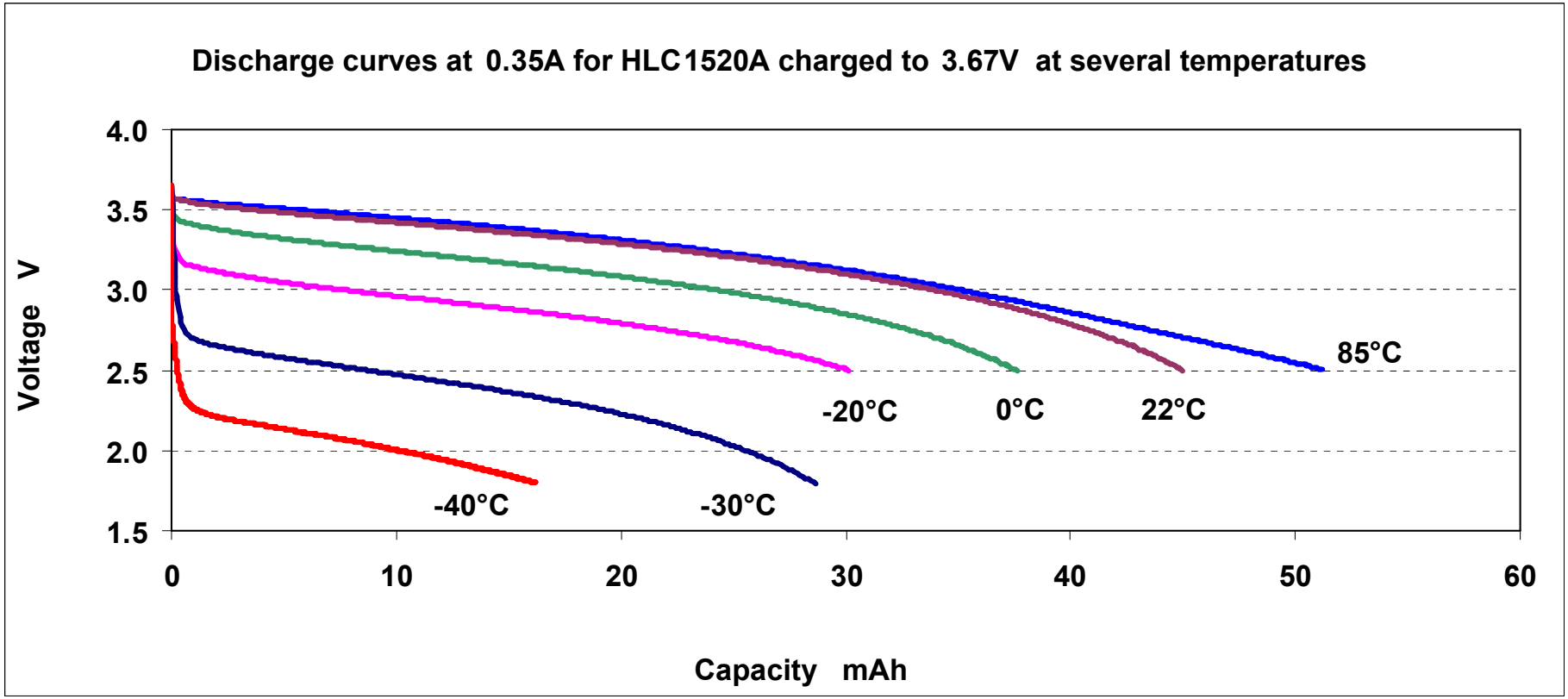
HLC performance

Discharge capabilities



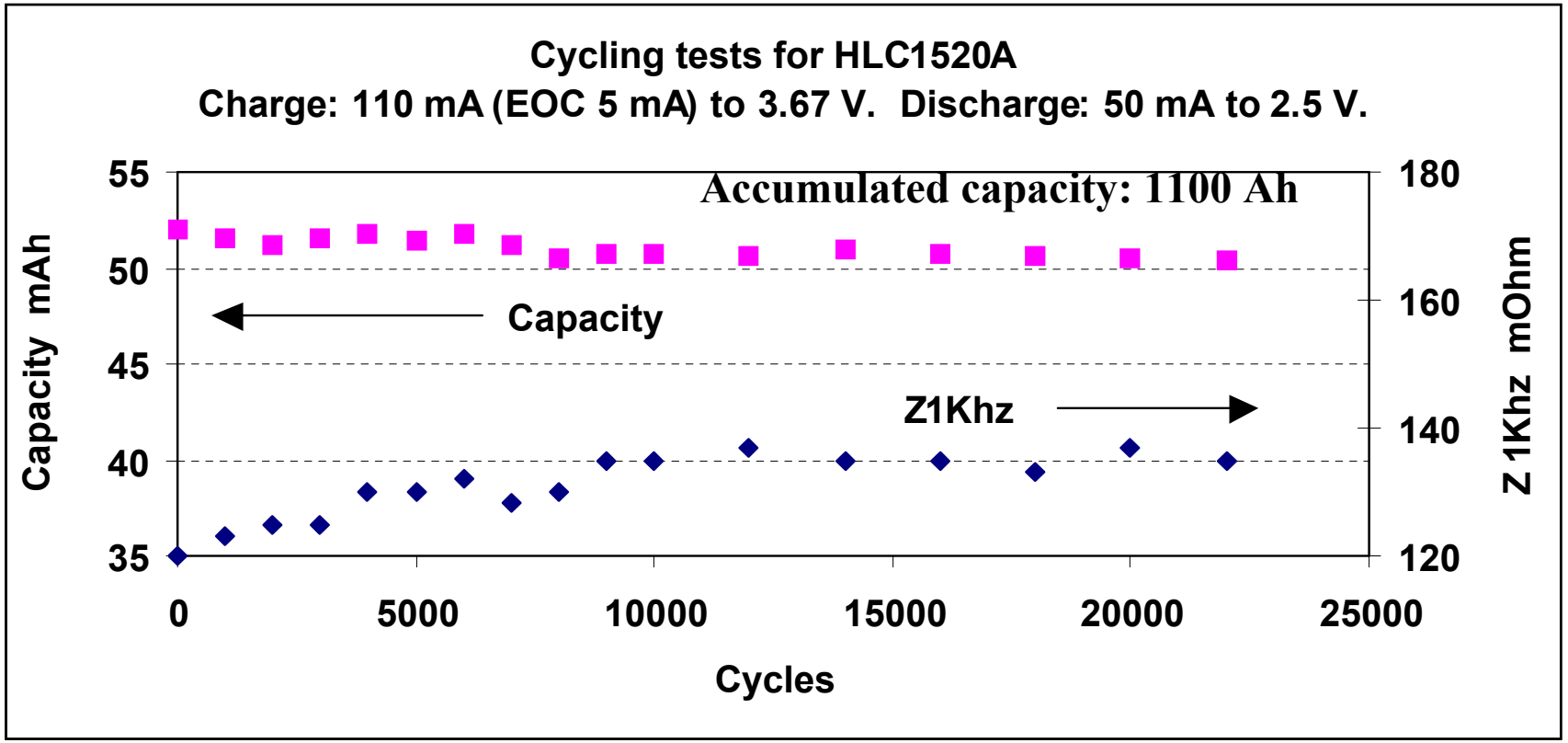
HLC performance

Performance at low temperatures



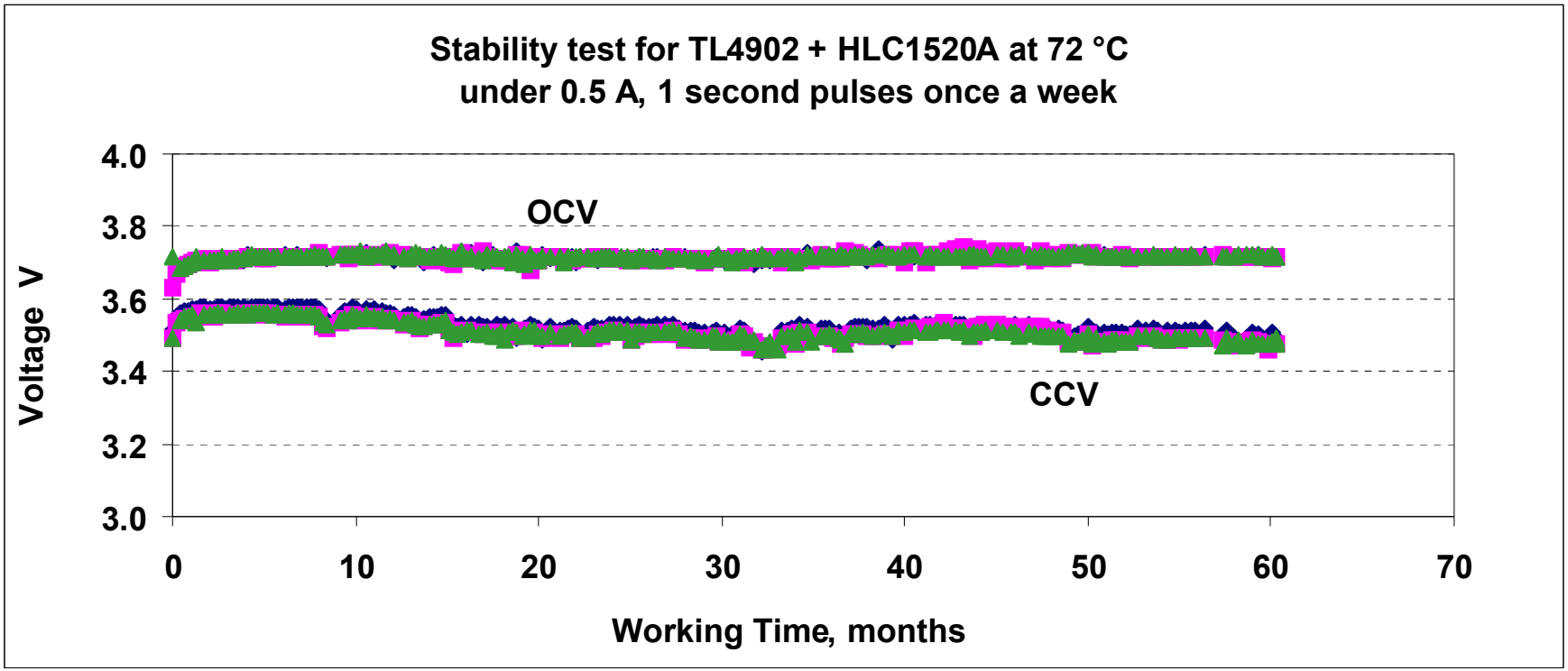
HLC performance

Capacity and Impedance stability during cycles



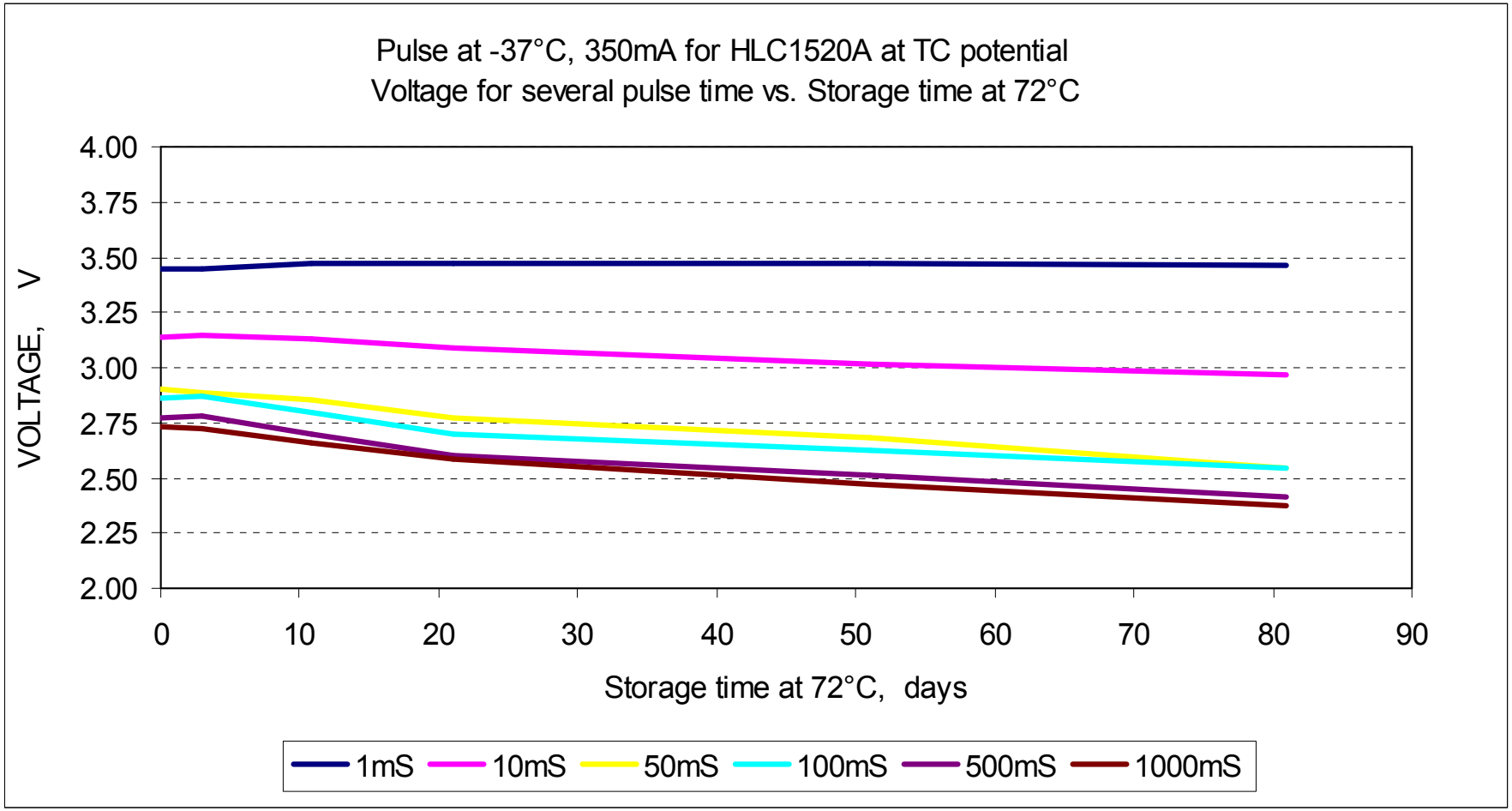
HLC performance

Voltage stability during storage at elevated temperature



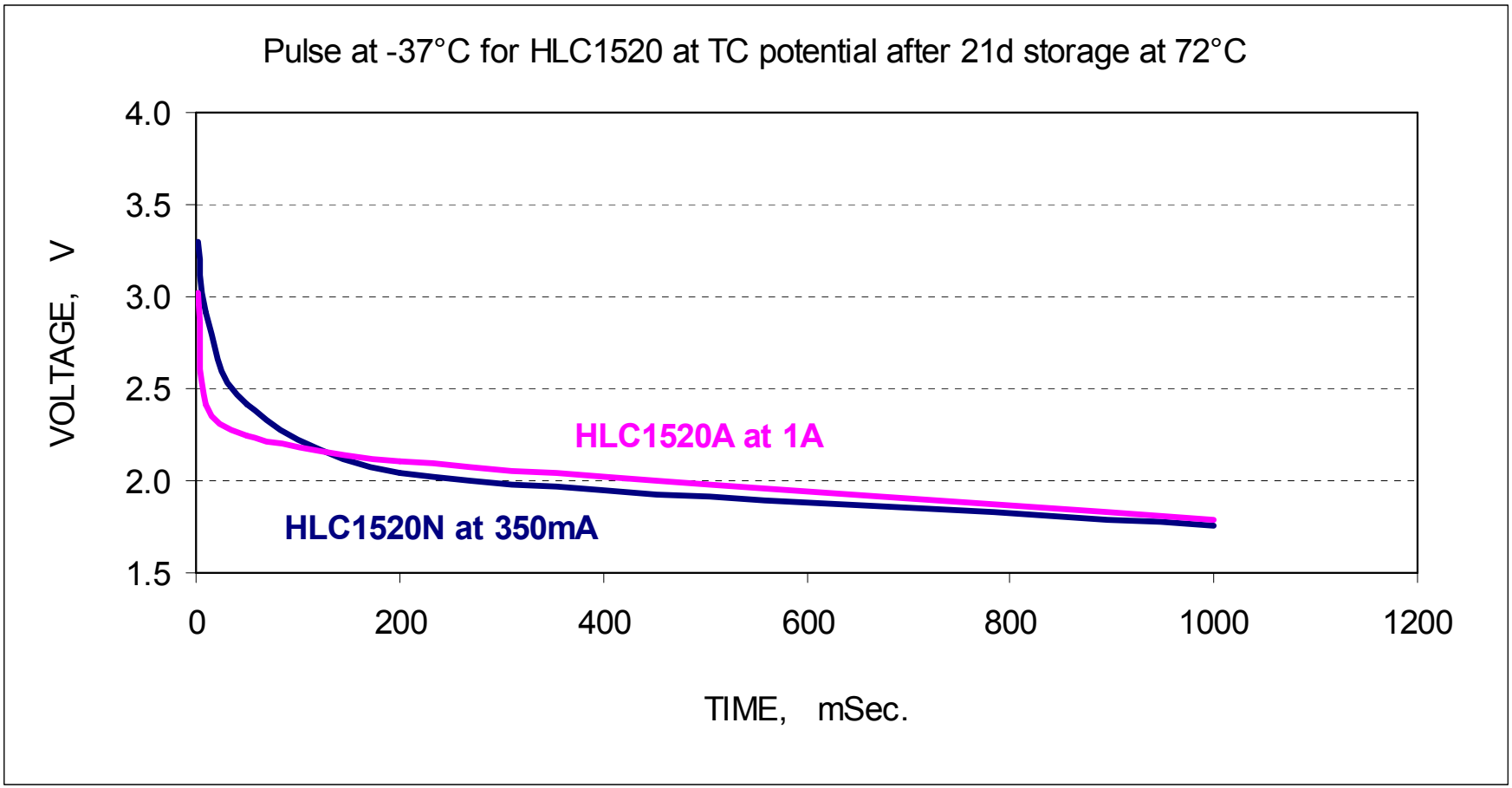
HLC performance

Stability at low temperatures



HLC performance

Performance at low temperatures



HLC improvement at low temperatures

Despite these major improvements, the "bottle neck" of HLC's performance is still at low temperatures.

Further improvement at low temperature is expected to be cost effective as it allow further decreasing in the size or the number of cells for a certain application.

HLC improvement at low temperatures

Main Development Goal

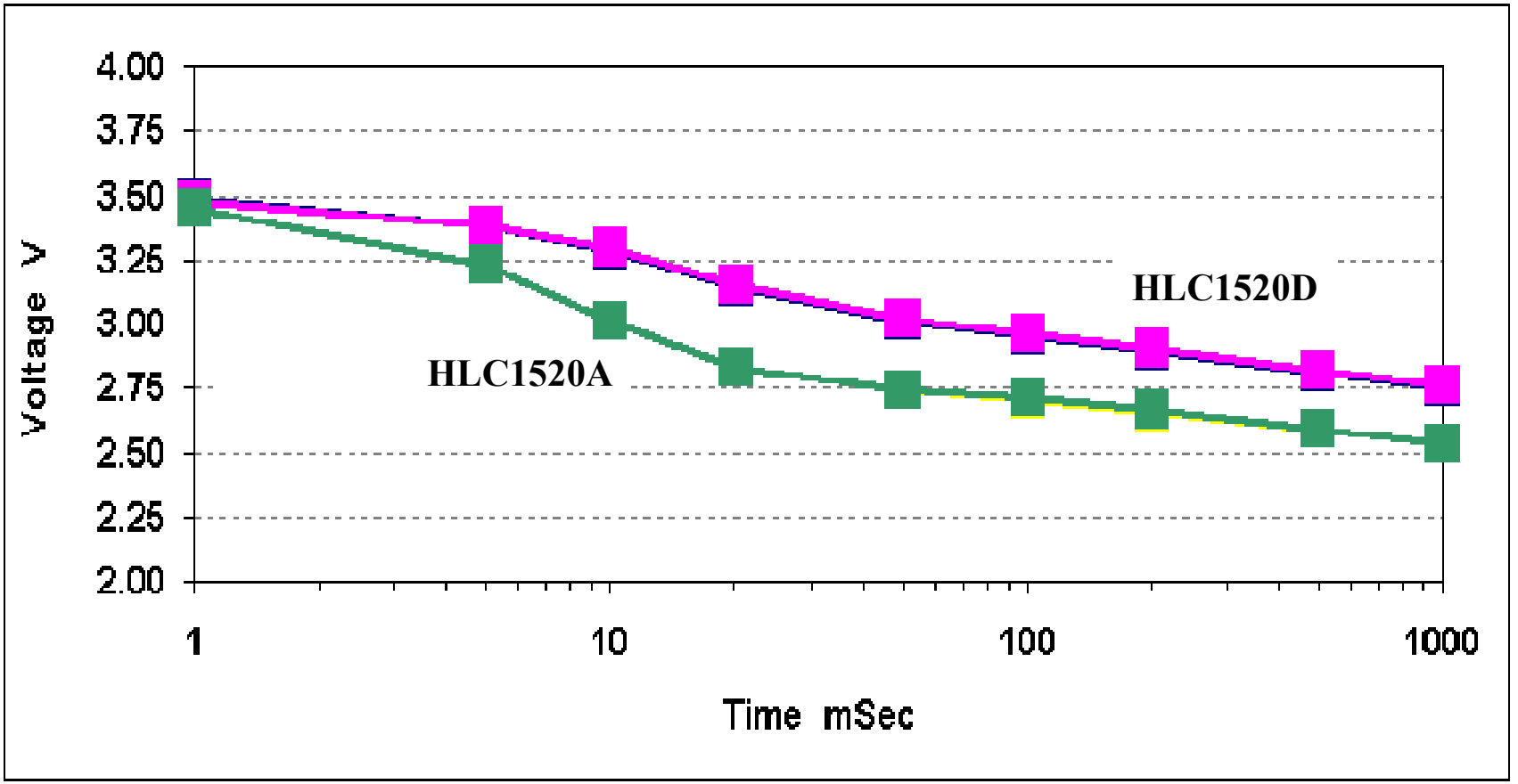
Further improvement at low temperature (-40°C):

To increase the current capability of the "A" type HLC at 1sec. pulse by 100%.

Development Time: 12 months.

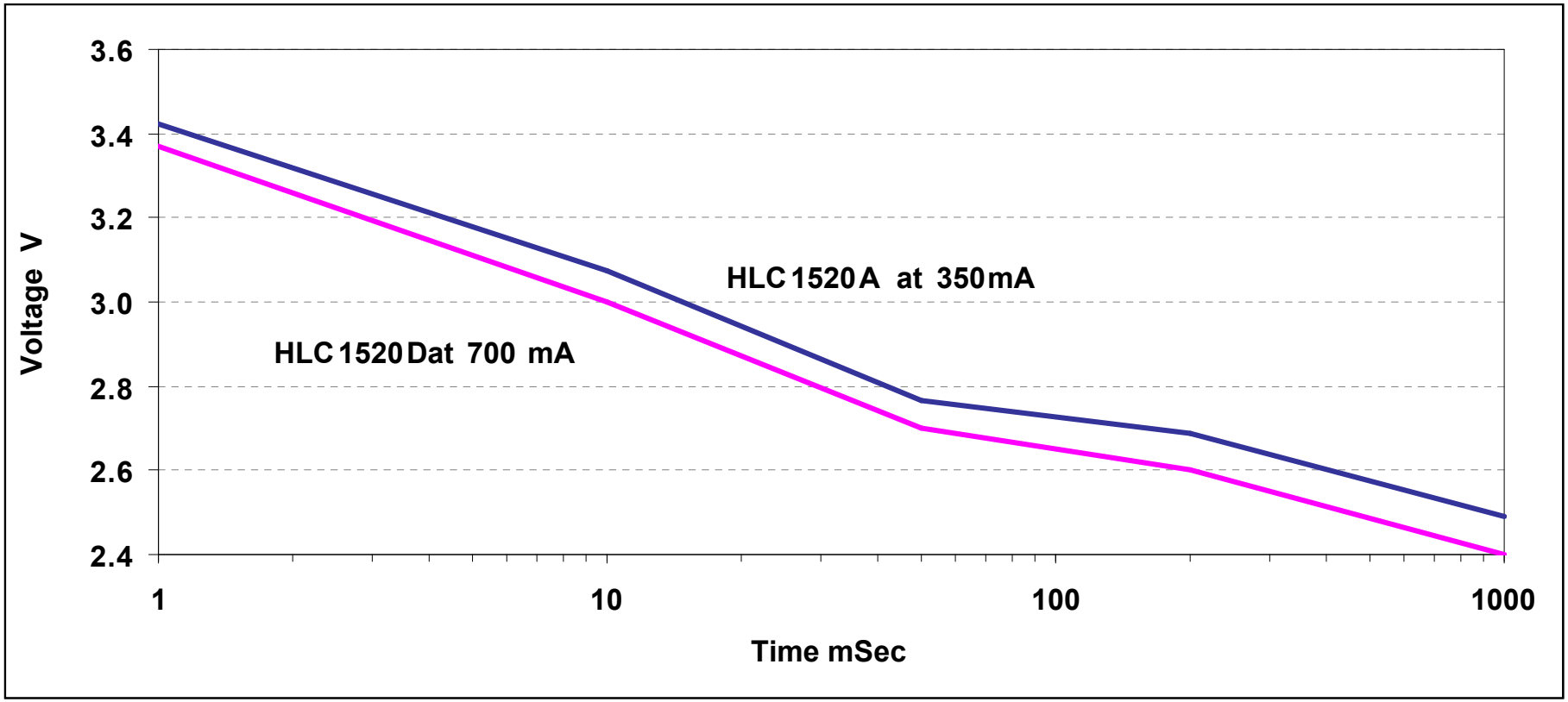
The new HLC model

HLC1520 at 350mA, -40 º C after 21 days storage at 72 º C



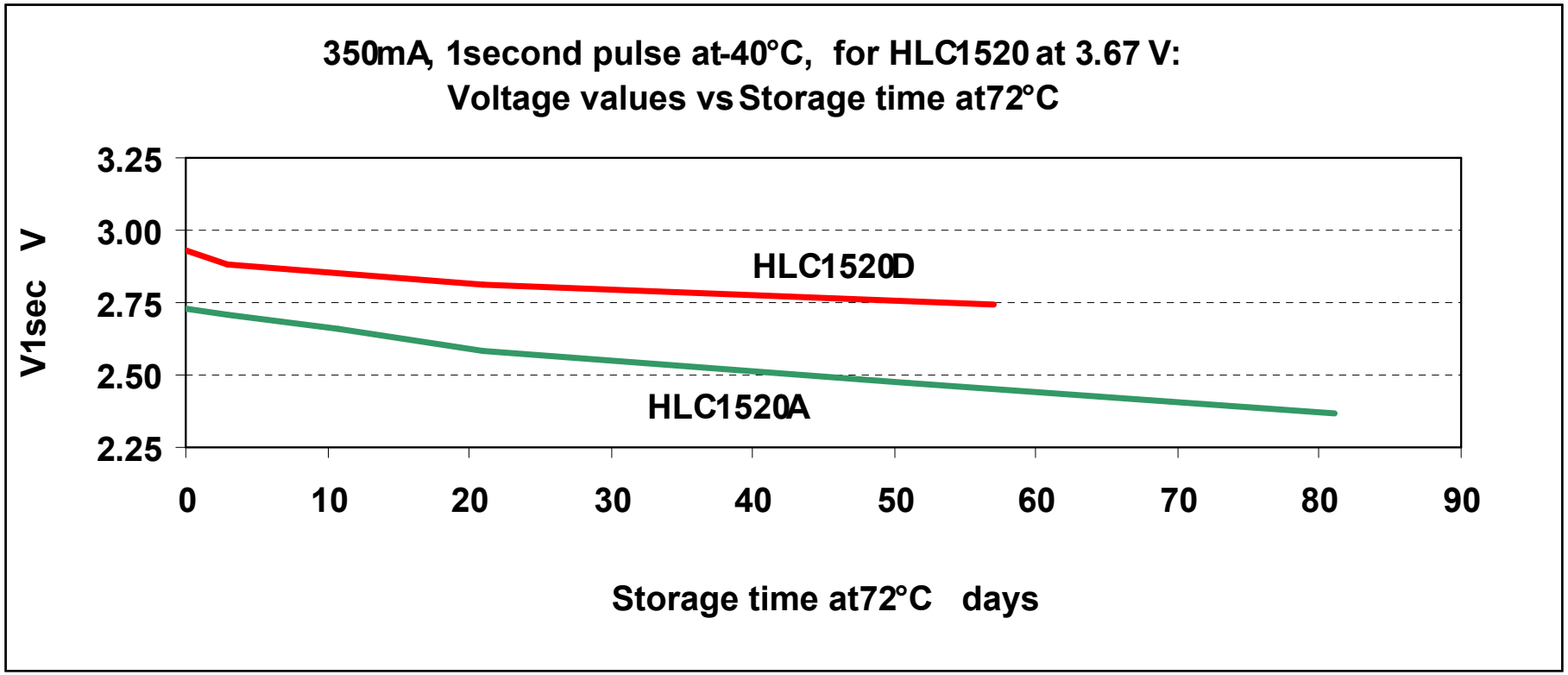
The new HLC model

HLC1520 at 350mA, -40 º C after 21 days storage at 72 º C



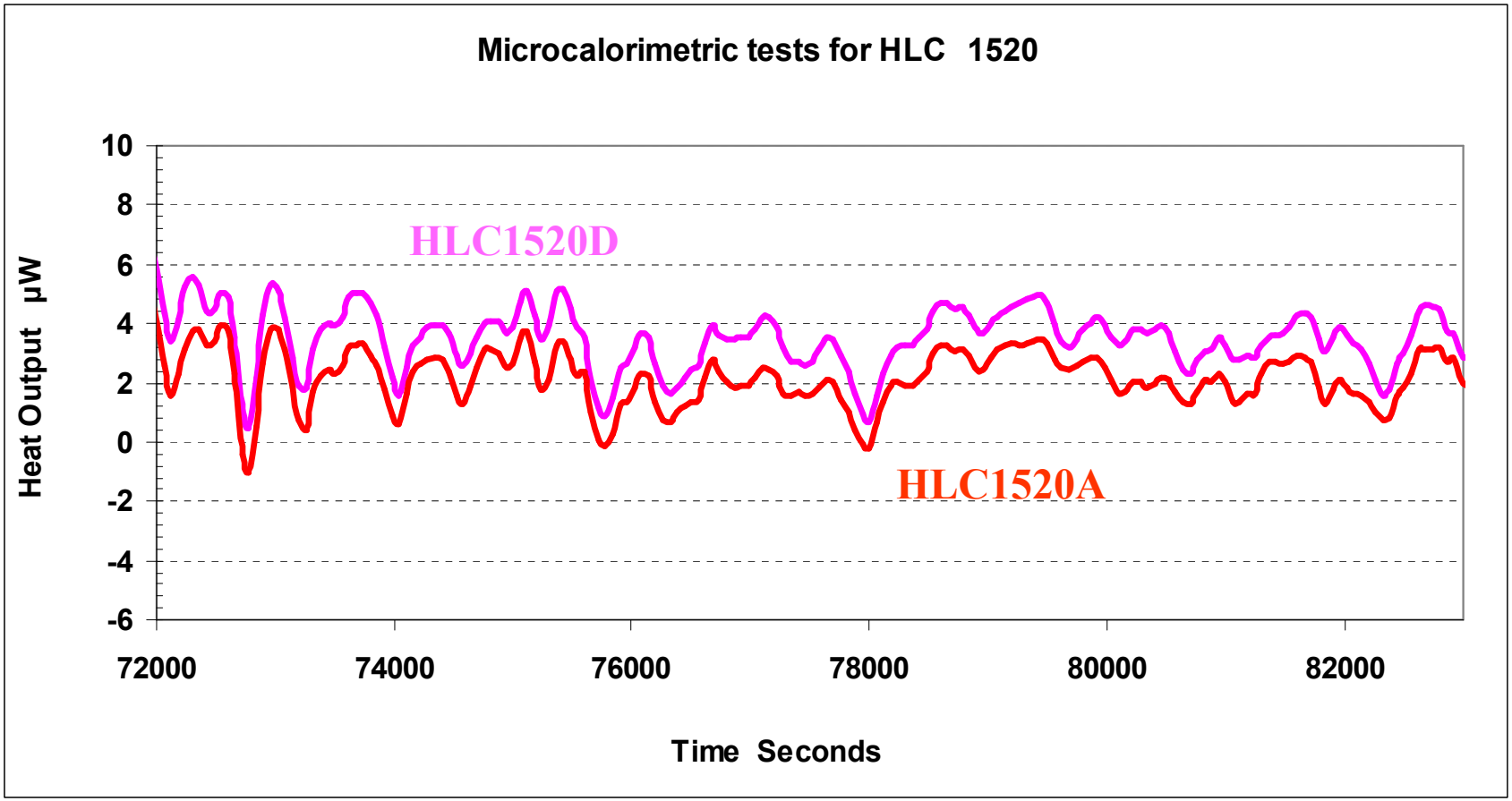
The new HLC model

Stability after storage



The new HLC model

Self discharge: about 0.5 µA



AAA Cells Development

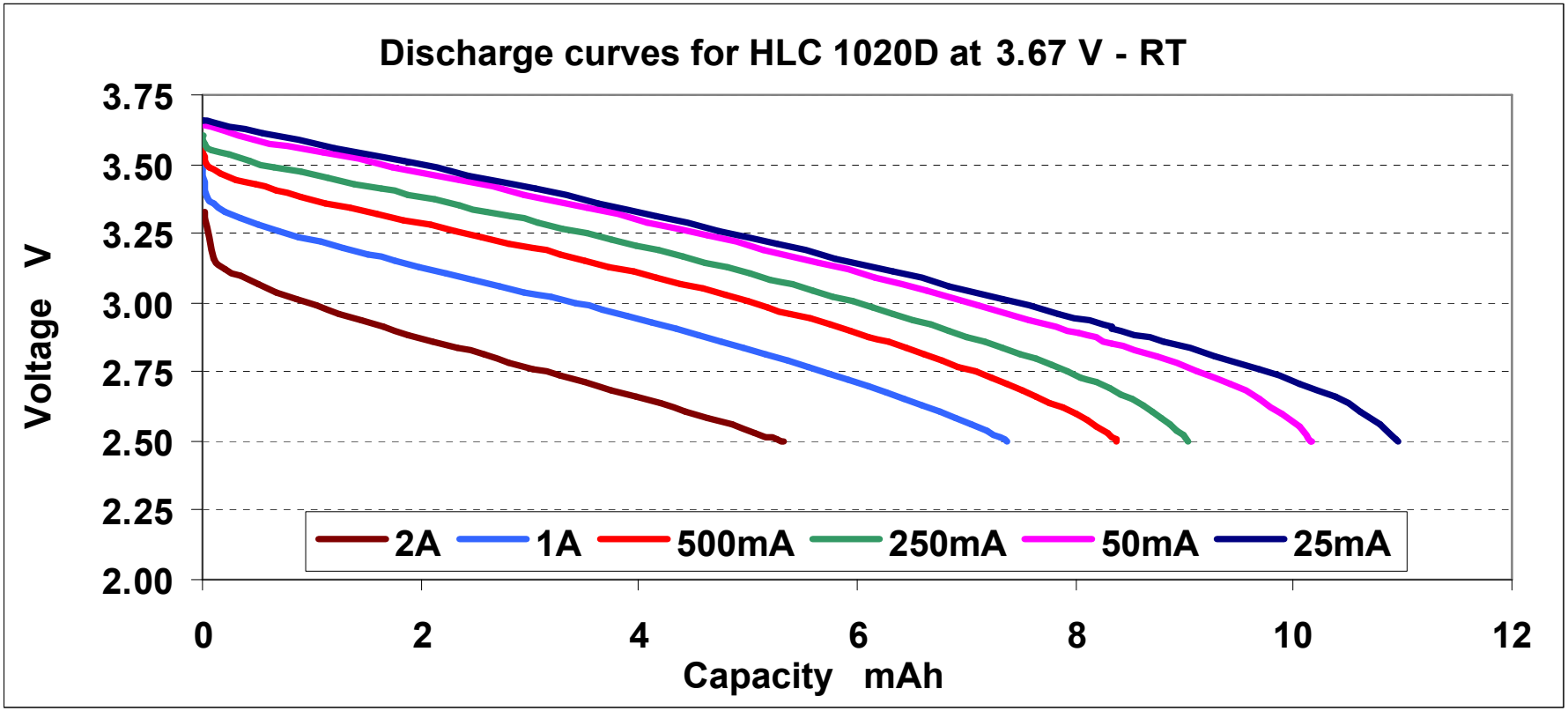
Main Development Goal

To develop a AAA diameter cells based on HLC technology with the same pulse capabilities (in the range of 100 mSec) as for AA diameter "A" type HLC.

Development Time: 12 months.

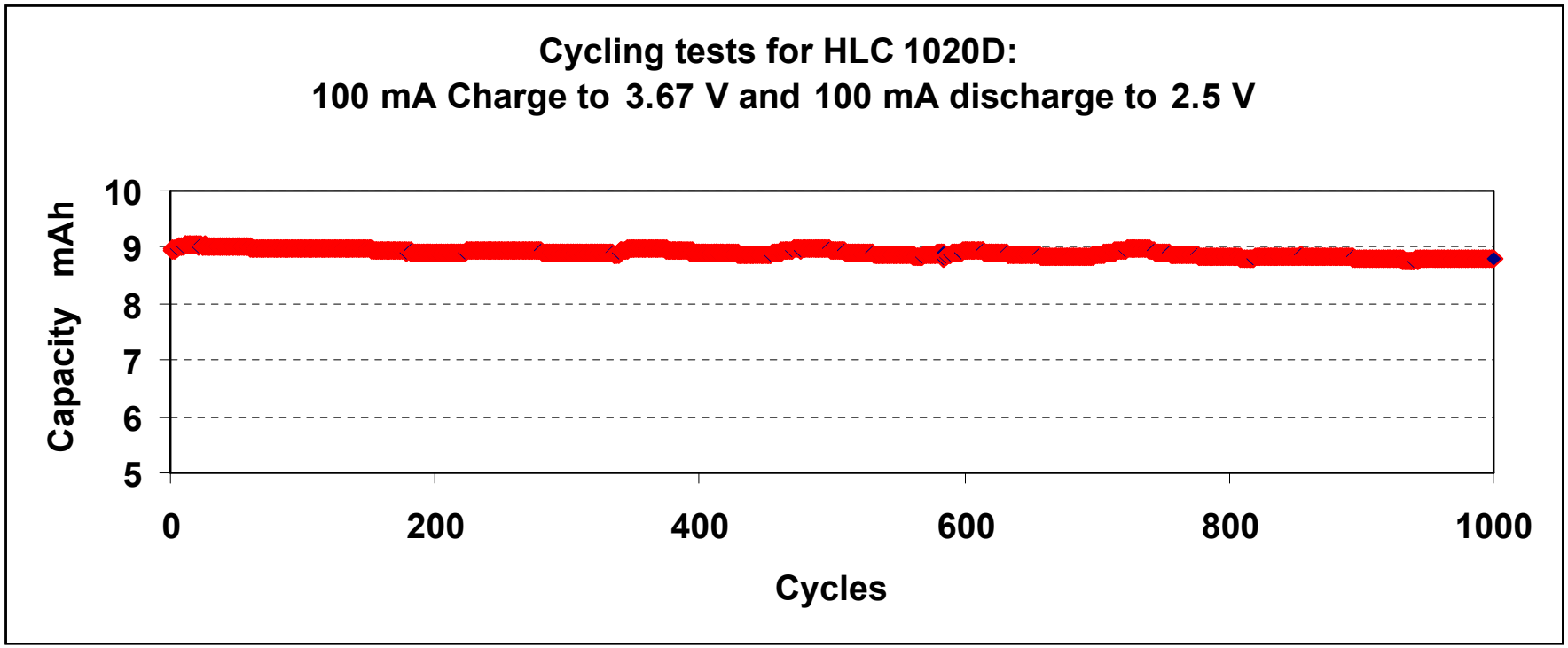
AAA Cells Development

Discharge capabilities



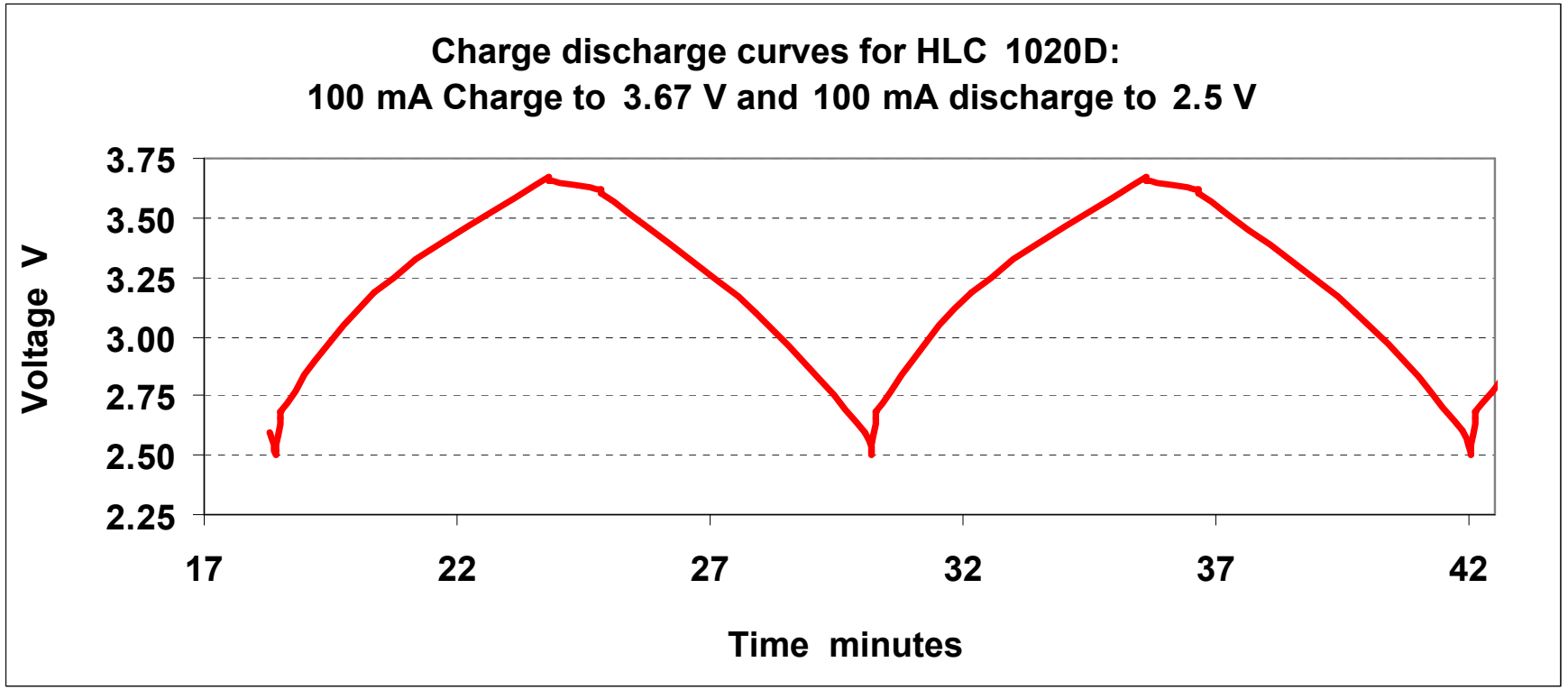
AAA Cells Development

Capacity stability during rapid cycles



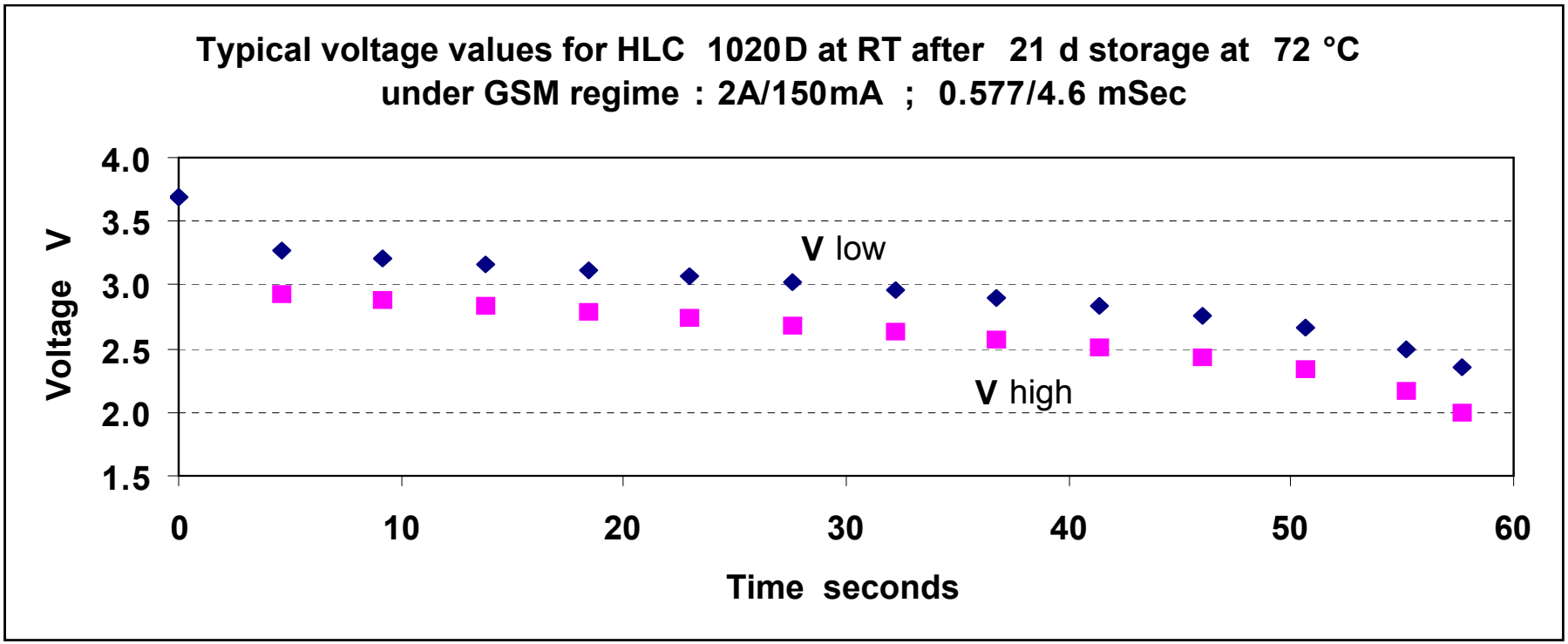
AAA Cells Development

Rapid charge discharge curves



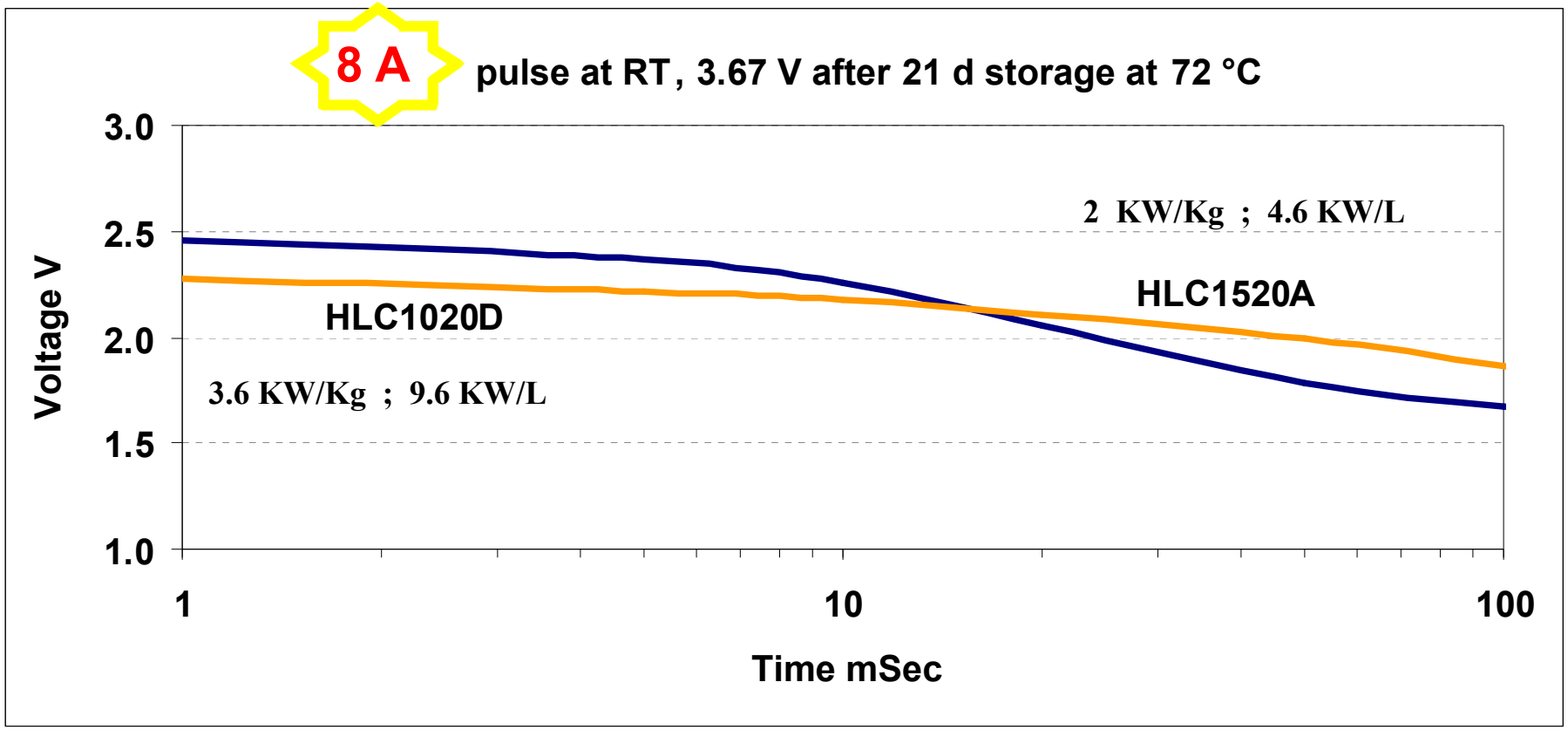
AAA Cells Development

GSM capabilities



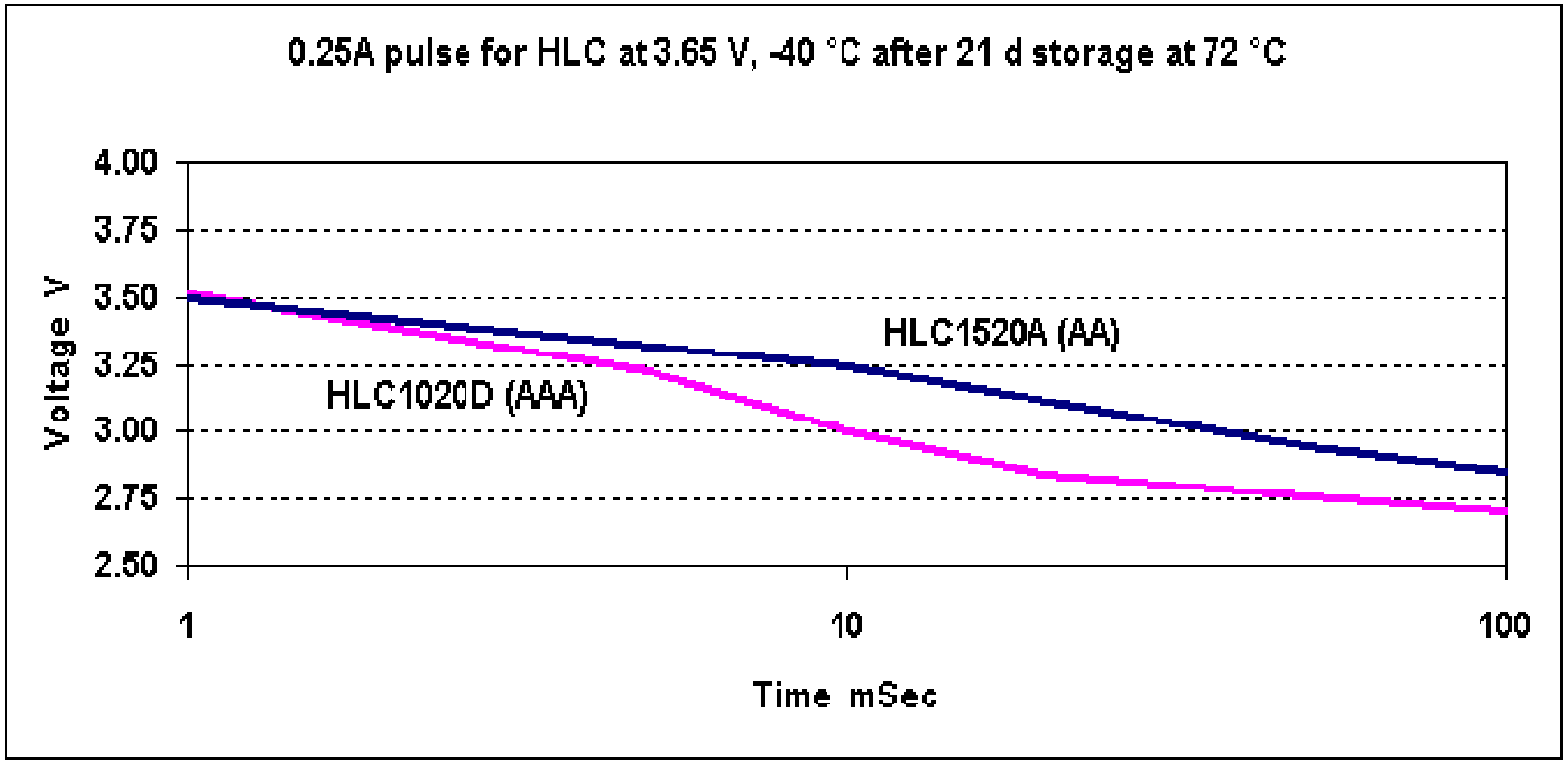
AAA Cells Development

High pulse power capability



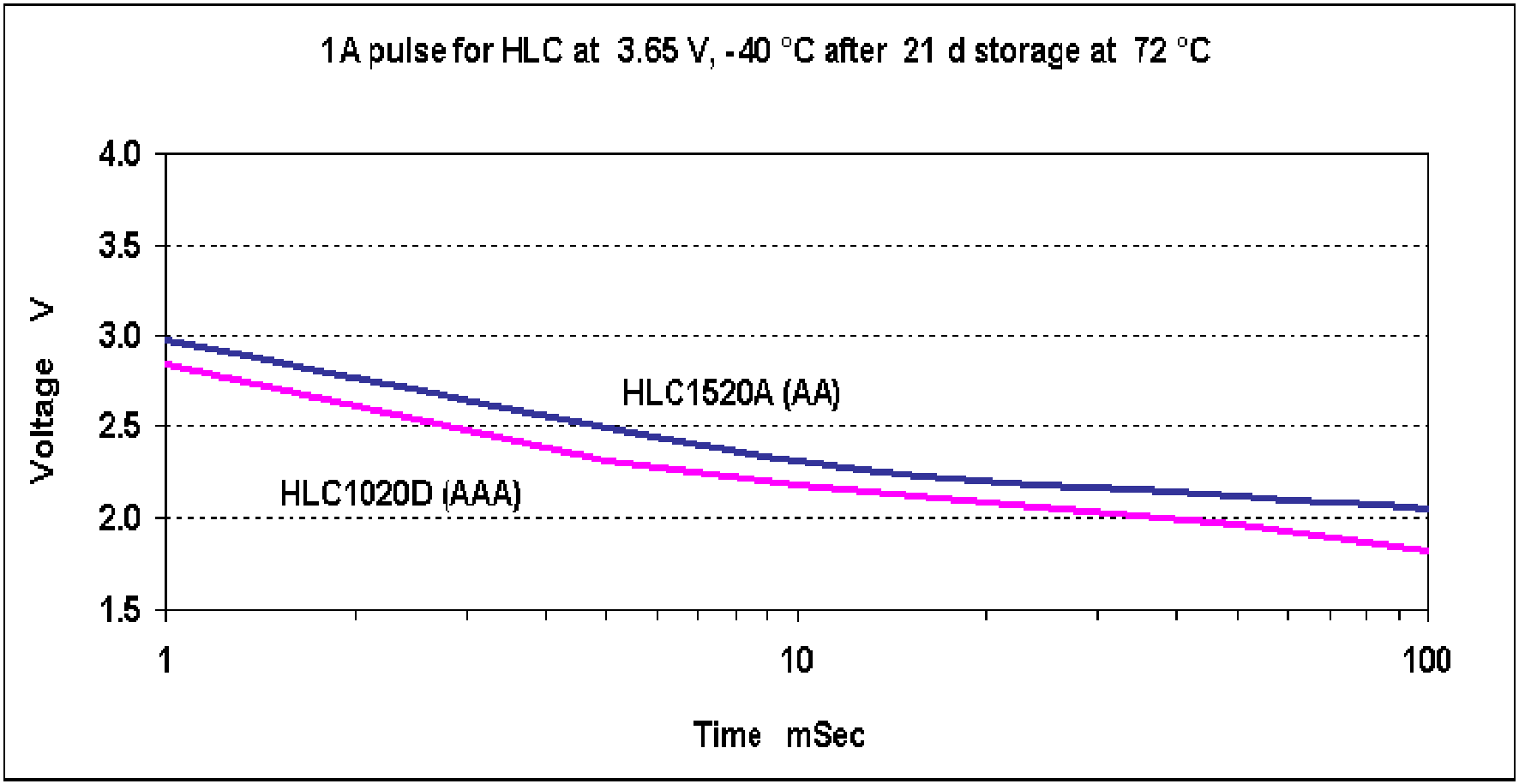
AAA Cells Development

Pulse capability at low temperatures



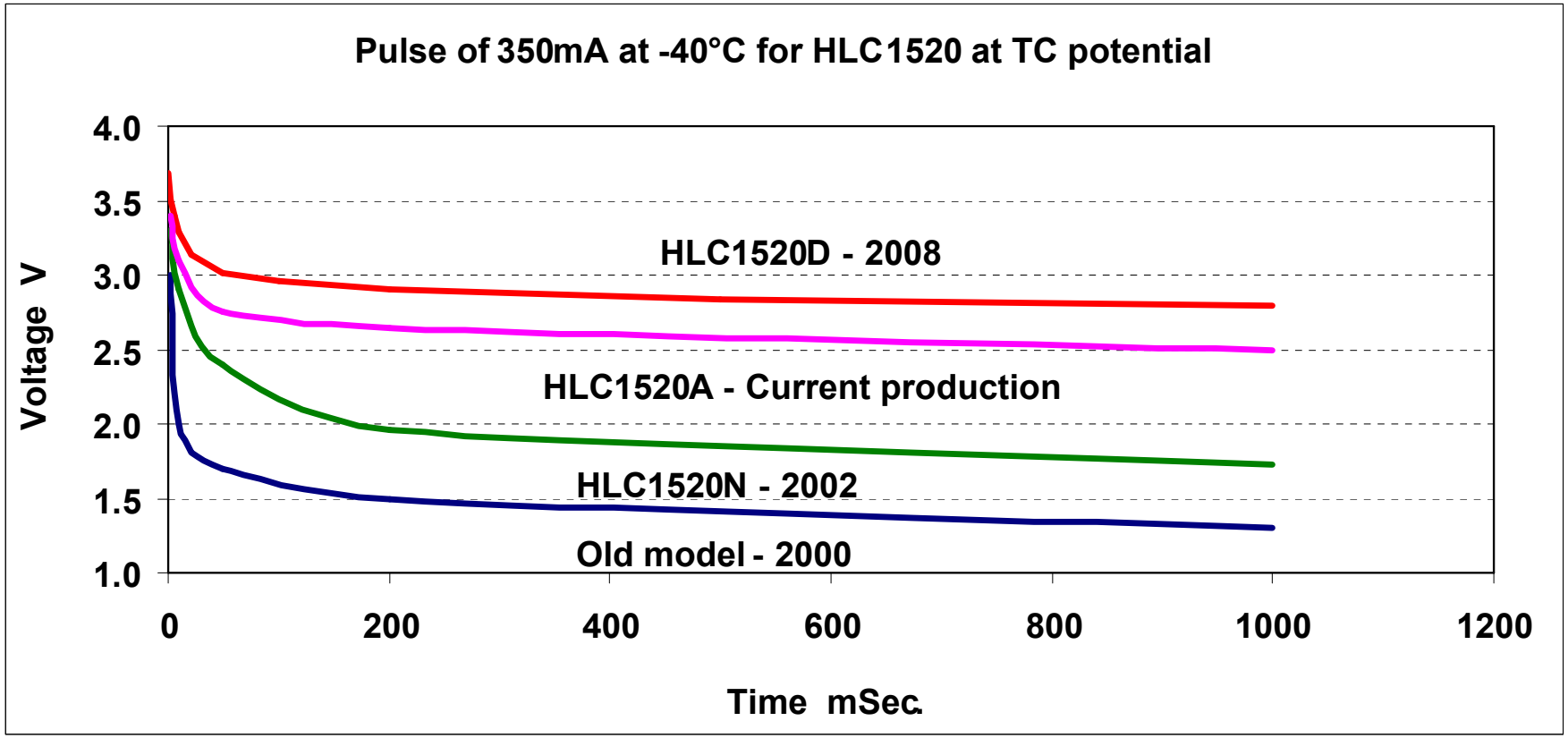
AAA Cells Development

Pulse capability at low temperatures



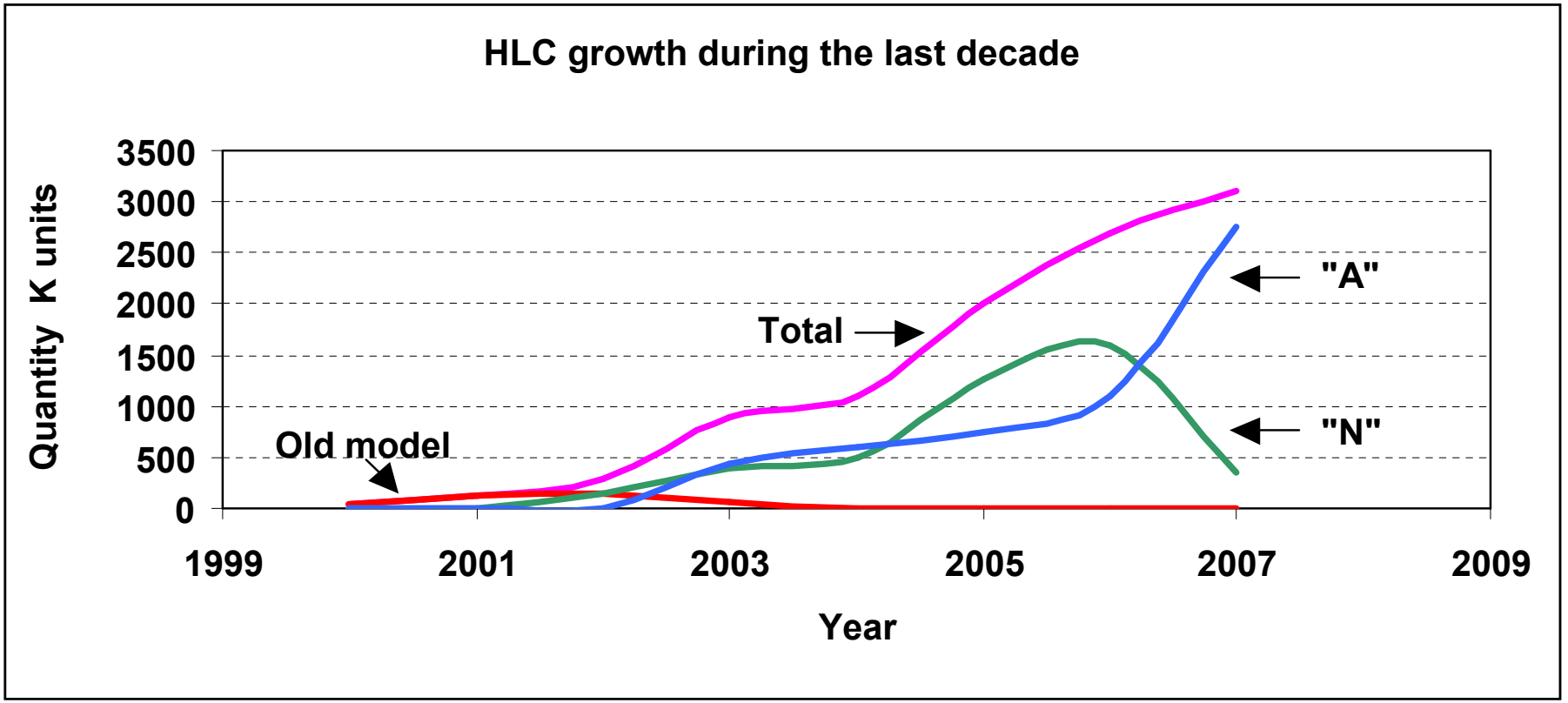
HLC development

Technology development



HLC development

Sales growth



THANKS…

The technical staff at our electrical lab.

The technical R&D group:

Mrs. S. Meir, Mr. S. Stachi and Mr. Z. Madar

R&D

THANK YOU

Questions…

Comparison to competitors

Comparison between HLC and Maxwell Ultra-capacitor cells

	Volume [mL]	Weight [g]	Capacity [F]	ESR (1Khz) [mOhm]	Self dis. [µA]	Energy [mAh]	Voltage [V]	Power density [W/g;(W/L)]
PC5	1.5	4.0	4	290	20	3	2.5	470 (1250)
PC10	3.0	6.3	10	130	40	7	2.5	660 (1390)
HLC1520D	3.5	8.0	150	110	<0.5	50	3.67	700 (1600)
HLC1020D	1.5	4.0	30	100	<0.5	10	3.67	1400 (3700)