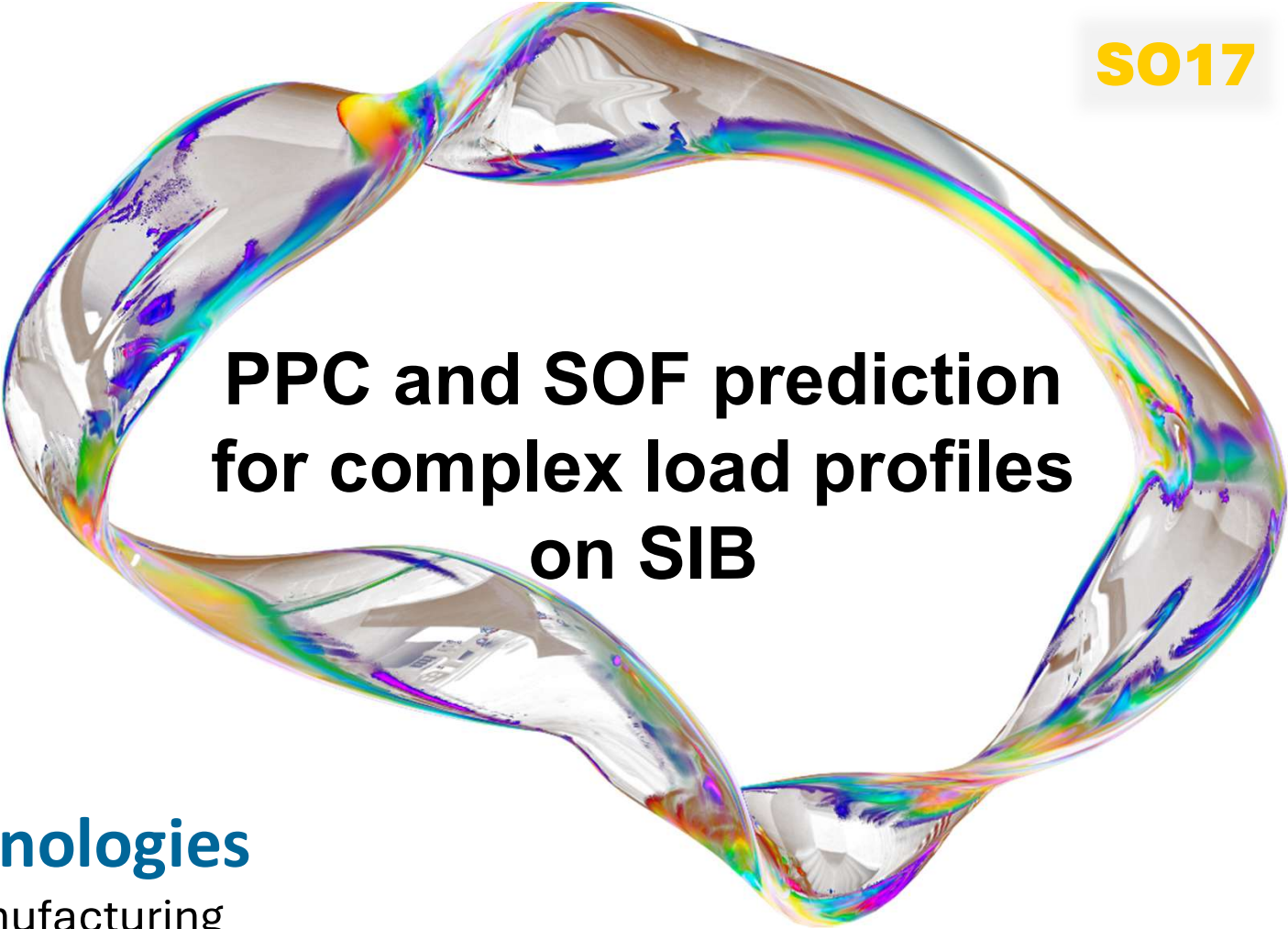


A large, abstract, colorful ring-like structure composed of many small, overlapping, translucent segments in various colors (red, orange, yellow, green, blue, purple) arranged in a circular pattern, resembling a molecular or atomic structure.

PPC and SOF prediction for complex load profiles on SIB

Na-ion Battery Technologies

Innovating – Designing – Manufacturing
Yukiyasu Nagata

Workshop on Automotive Low-Voltage Battery Advancements (ALBA 26), 19-20 May 2026, Mainz, Germany

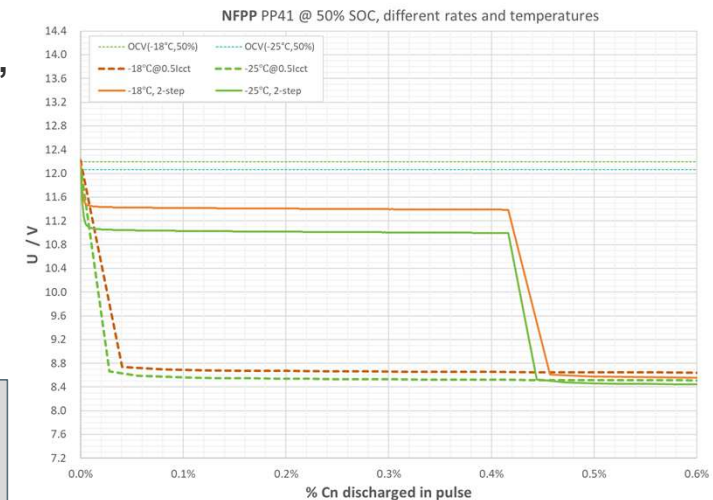
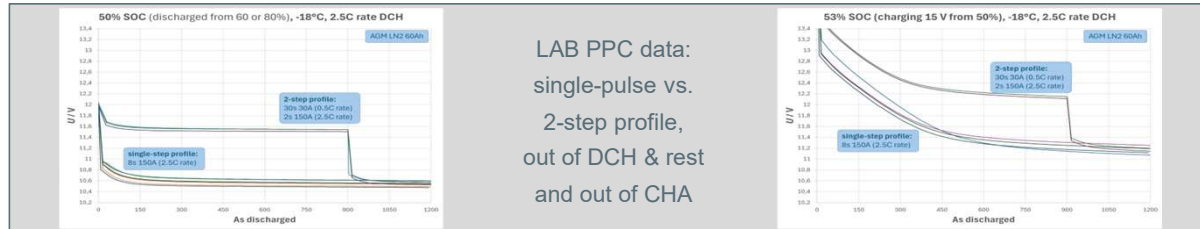
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PPC and SOF prediction for complex load profiles on SIB

Can we use the ALBA Plus sizing tool for SIB?

OEMs need to size batteries for **pulse-power** profiles (steering, braking, ...), often in scenarios that involve 30s ... 2min **base load** supply.

- CBI web tool (2025): **peak-power** (max duration 5 s) for generic LAB.
- ALBA Plus web tool 2026: valid for ≤ 2 min **base & pulse profile**, defined by only 3 parameters: **peak** current, **average** current, scenario **duration**
- Why does that work? LAB peak discharge performance is largely **invariant** against the **load-profile details**, e.g., low-rate pre-discharge vs. 1 long peak



- * -18°C Icc: 29Cn
- * -25°C Icc: 20Cn

This paper shows systematic results for 1 type SIB (NFPP cell data)

- **same modeling approach** works for both LAB and SIB
- **However, each battery type still needs its own parameter setup** depending on factors like cathode material and cell design.
- A combined sizing tool would allow **easy technology comparison!**



❑ PPC mapping: pulse discharge curves at SOC~50%

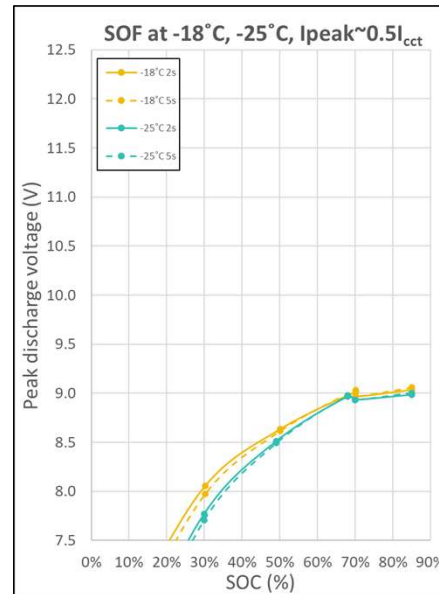
- NFPP discharge voltage almost invariant against pulse duration (similar to LAB)

- From 0.5s to 5s at 0.5 I_{cc} @ 50% SOC:

	-18°C	-25°C
NFPP	Δ 0.05V	Δ 0.06V

- SOF temperature impact:

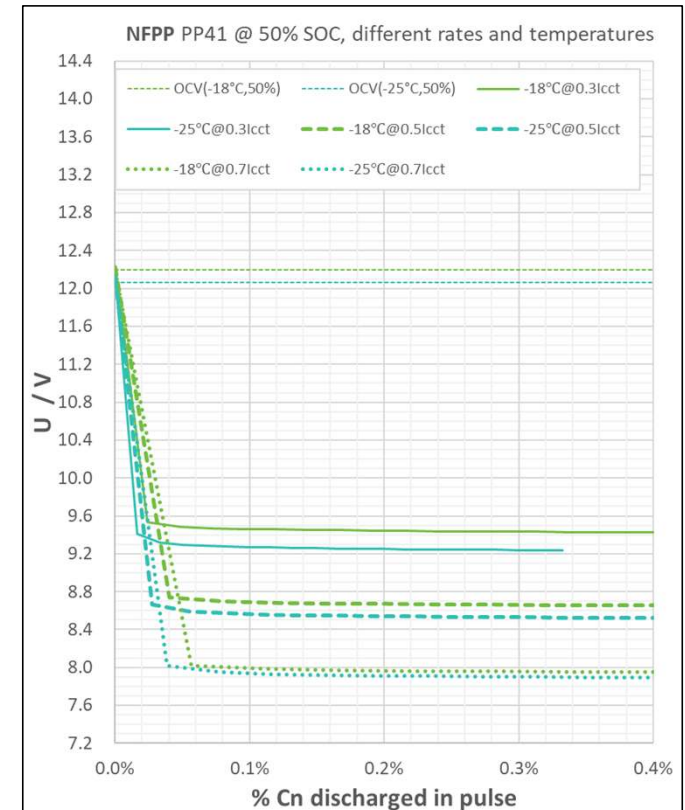
- NFPP performed well at $T \sim -18^\circ\text{C}$ or longer peak duration
- lead-acid battery (LAB): best cold/warm ratio



* -18°C I_{cc}: 29Cn
* -25°C I_{cc}: 20Cn

- OEMs demand 9~10 V for auxiliary battery SOF, typically at -18°C ~ -25°C

- Test temperature for technology comparison should be -18°C ~ -25°C



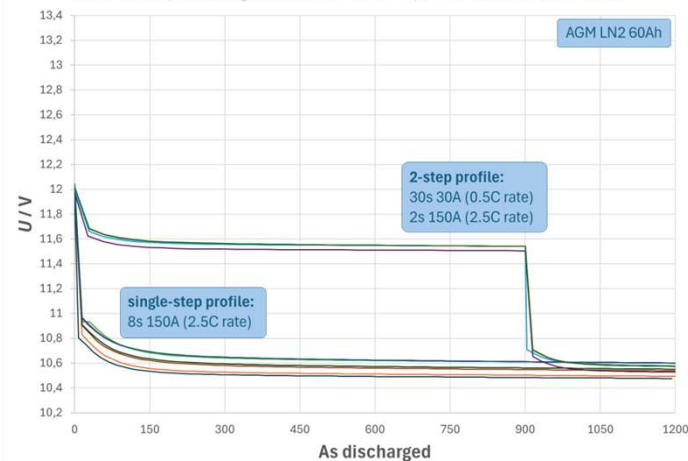
Discharge curves are not plotted over time but Ah balance for better comparison between discharge rates.

□ PPC mapping: one-step versus two-step

- Good correlation between one-step and two-step profiles shown for LFP, NFPP and LAB technologies
(at $25^{\circ}\text{C} \geq T \geq -18^{\circ}\text{C}$)
- 1-step tests are well justified
(additional verification needed for $T < -18^{\circ}\text{C}$, and -25°C)

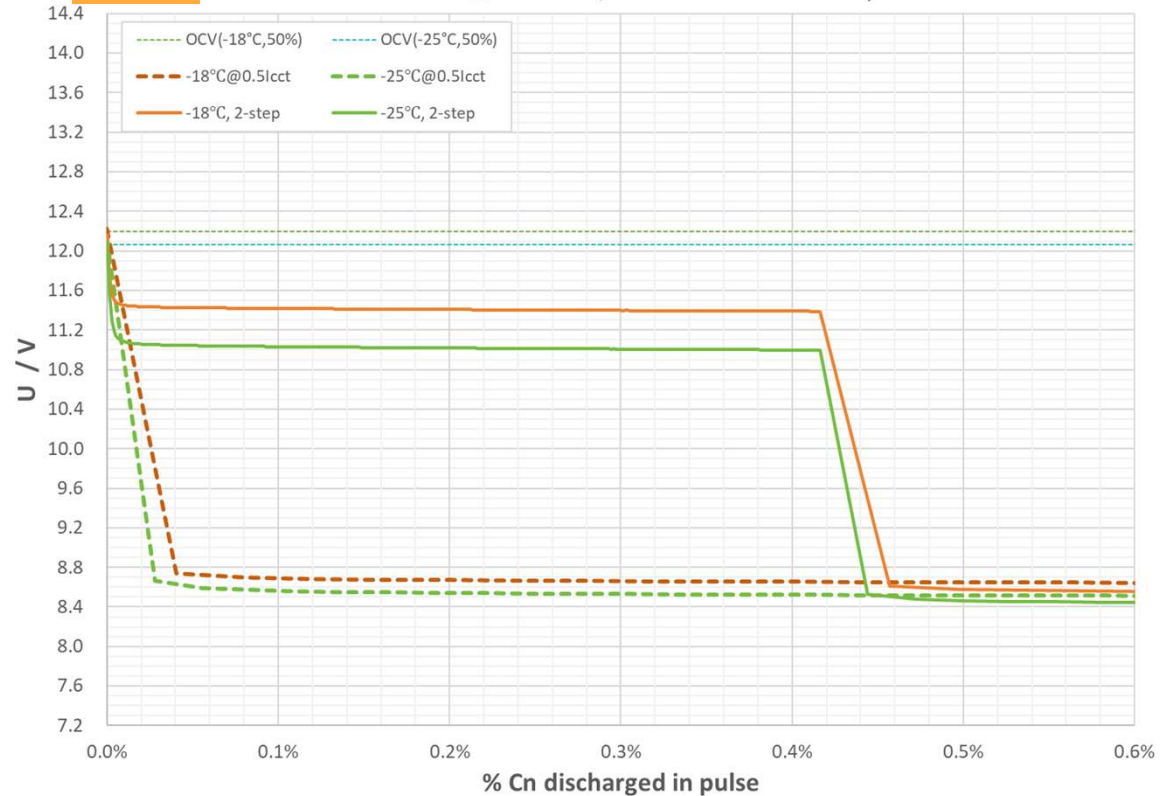
LAB

50% SOC (discharged from 60 or 80%), -18°C , 2.5C rate DCH



NFPP

NFPP PP41 @ 50% SOC, different rates and temperatures

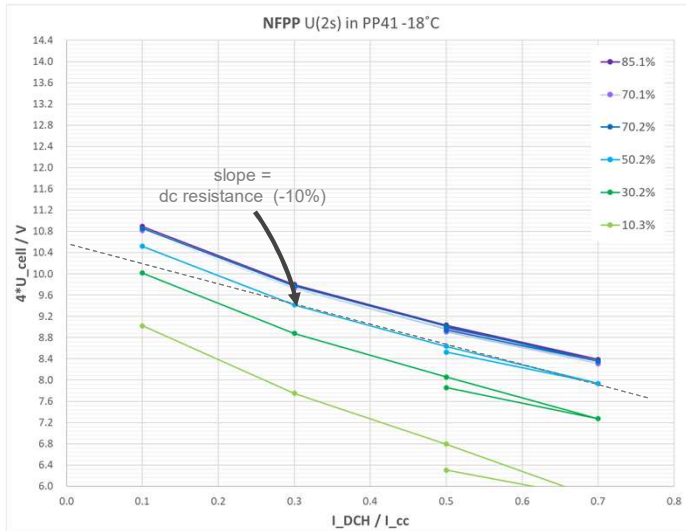


Discharge curves are not plotted over time but Ah balance for better comparison between discharge rates.

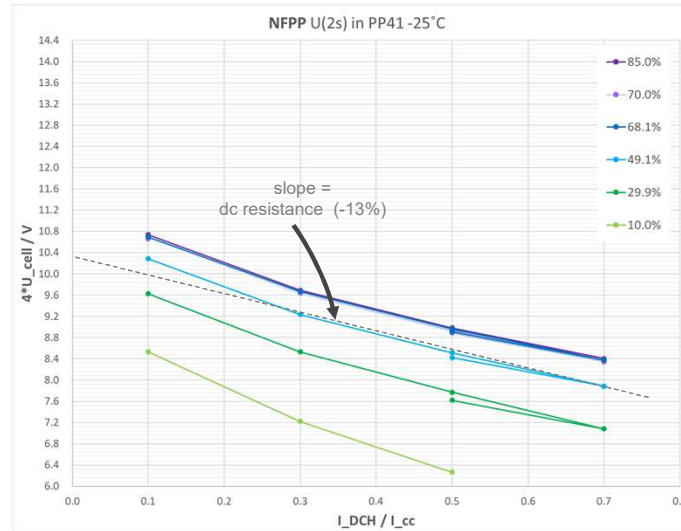
PPC mapping: $U(2s) = f(I, SOC)$

NFPP

-18°C



-25°C



- Expected voltage can be calculated for each fixed current pulse
- Each material combination may need to evaluate to understand basic performance under PP41.

□ Conclusions / next steps



- Industry is about to establish design rules for C_n and I_{cc} rating
 - C_n definition needs to clearly specify cut-off voltage 1.5V, 2.25V, 2.625V (larger impact than for LAB)
 - $I_{cc} \geq 10 \cdot C_n$ would not be maximize peak power for NFPP battery technologies ($\sim 30 \cdot C_n$) and will likely be reduced the CCA rating while reducing temperature.
 - Under SAE cold cranking standards, needs to understand the reflection of cell vs pack condition. LAB deliver about 75% of their rated CCA (at -18°C) when tested at -29°C . This ratio is weaker for LFP & NFPP cells due to higher capability at -18°C .
- IEC PPC methodology can be applied / extended for technology comparison:
 - With falling temperature, LFP performance degrades more strongly than NFPP and LAB.
 - NFPP and LAB pulse-discharge curves are flatter than LFP especially at lower temperature.
 - Single-step discharge pulses are sufficient for sizing for $T \geq -25^\circ\text{C}$.
 - PPC tool could be parameterized for NFPP technologies.

QuantumShield: About Us

Powering a Sustainable Future

Mission: Creating a safer and more sustainable energy future.

Vision: A world where all energy storage needs are met safely, economically, and sustainably, powered by sustainable materials and resilient supply chains.

Technology: Sodium-ion batteries & battery management systems.

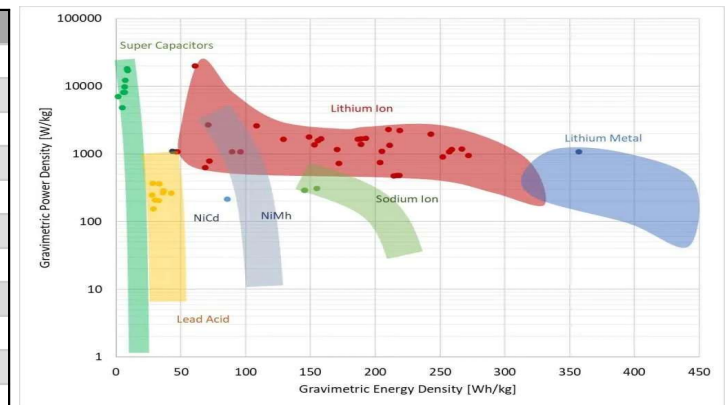
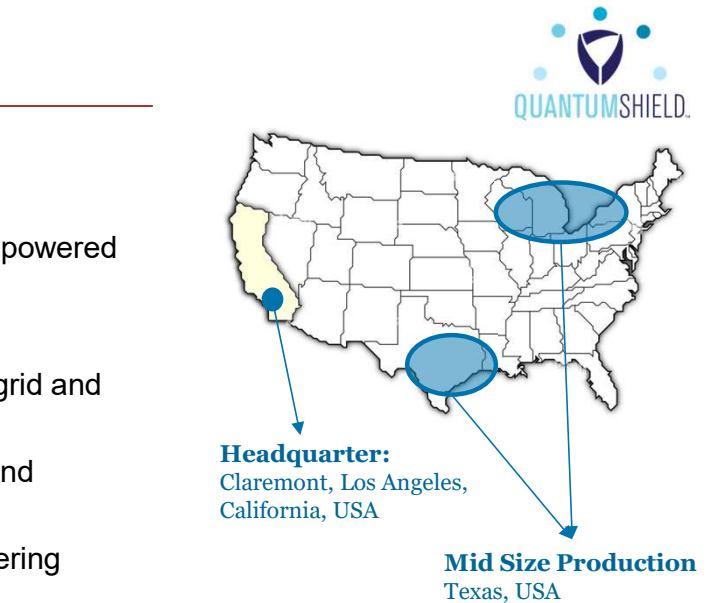
Market: BESS, automotive SLI and AUX, industrial vehicles, material handling equipment, off-grid and on-grid mission critical applications.

Differentiation: Safer than li-ion, outperforms lead-acid across extreme temperature ranges, and environmentally friendly.

Team: Our team has over two centuries of combined manufacturing experience and is a pioneering innovator in sodium-ion battery technology.



Performance	Sodium Ion	Lithium Ion	Lead Acid
Safety	Very good	Normal	Very good
-20°C Capacity retention rate	90%+	<70%	<60%
-40°C Capacity retention rate	80%+	<60%	N/A
Max Charging Rate	5C+	~4C	~0.5C
Max Discharging Rate	20C+	~10C	~10C
Deep Discharge Voltage Level	To 0V	Bad	Bad
S. Energy Density (Wh/kg)	80-145	120-200	25-50
Energy Density (Wh/L)	140-240	200-400	60-100
Cycle Life (cycles)	4,000+	3,000+	300-500
Avg Cell Voltage (V)	3.0	3.2	2
Max Operation Temperature	80°C	60°C	70°C



Source: <https://www.batterydesign.net/chemistry/>

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ALBA 26



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