Process for sorting or binning cells via a machine-learning method to optimize battery-pack layouts

EVS35 OSL2022

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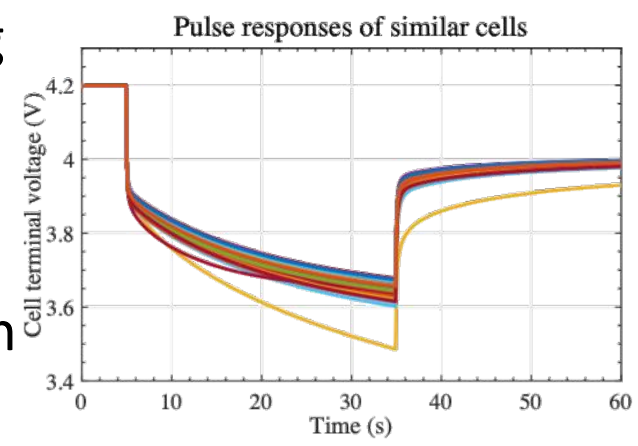
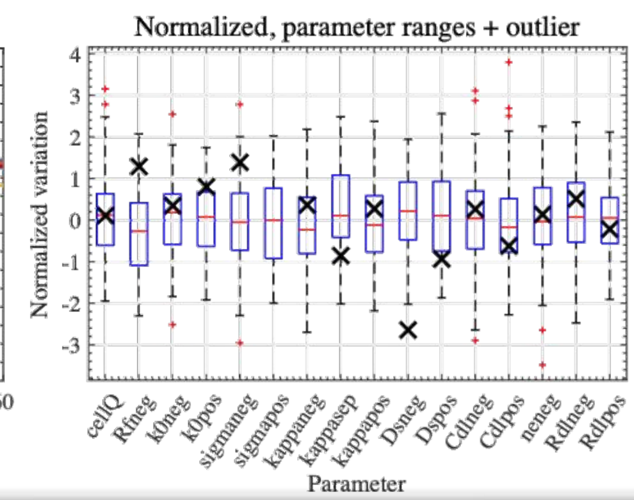
Introduction

- We wish to use **low-current measurements** + **machine learning** to predict **high-current pulse resistance**
- We further wish to **design an optimized pack layout** by matching cells

Dataset

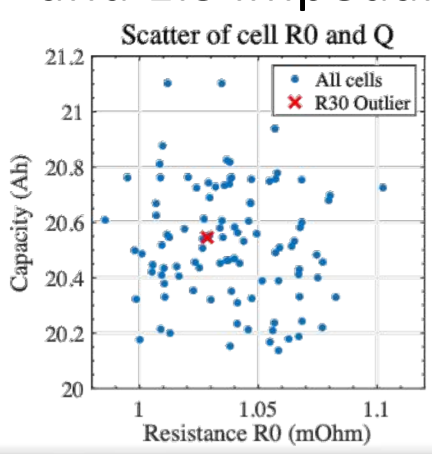
- We **simulated high-current pulses** for 100 cells having randomized physical parameter values
- We observe a **variety of responses** (not visible with low-current inputs) including an outlier response
- **Use low-current measurements** with linear-regression machine learning (ML) **to predict high-current** R_{30}^{high}

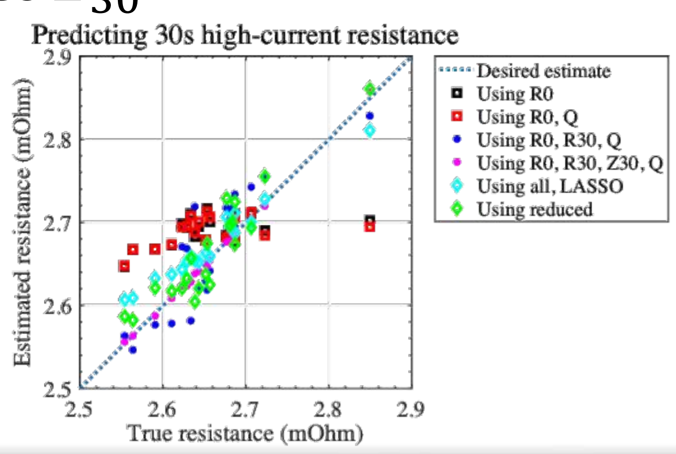




Estimating Single-Cell High-Current R30

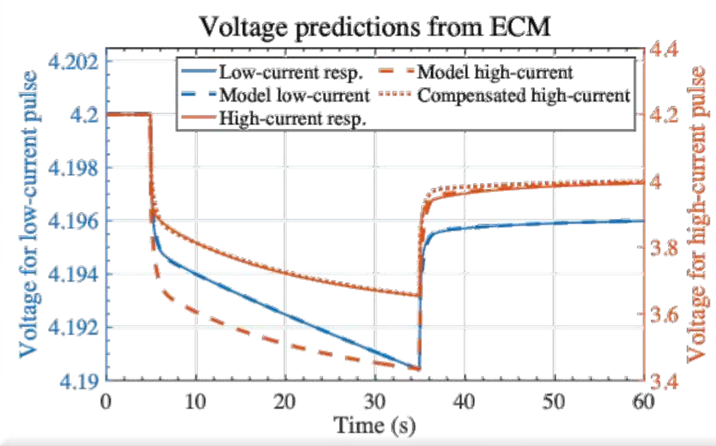
- (R0,Q) alone are insufficient to detect outlier
- Outlier can be detected and R_{30}^{high} can be predicted very well by augmenting ML feature vector with low-current pulse resistance R_{30}^{low} and EIS impedances Z_{30}

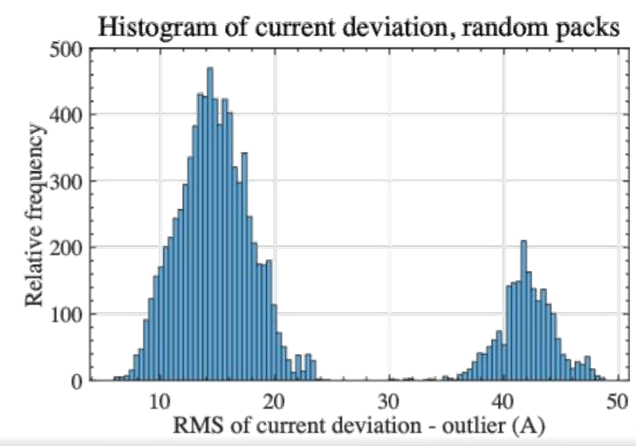




Randomized 7S3P Pack Layouts

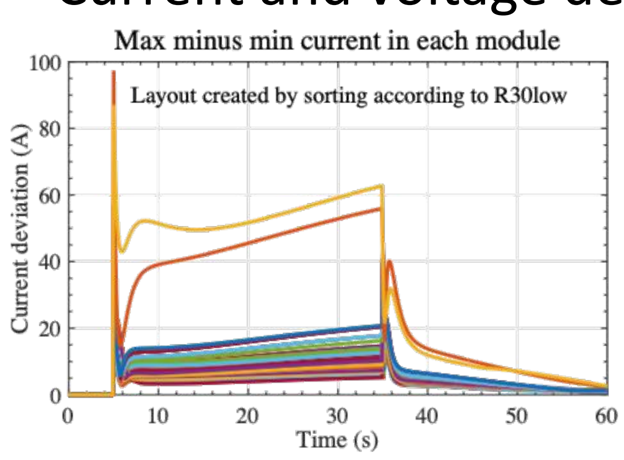
- To create pack model, first fit 2RC ECM to low-current pulse resistance data
- Then, scale resistances by $R_{30}^{high}/R_{30}^{low}$
- We find that randomized pack layouts produce undesirable high cell-to-cell current deviation

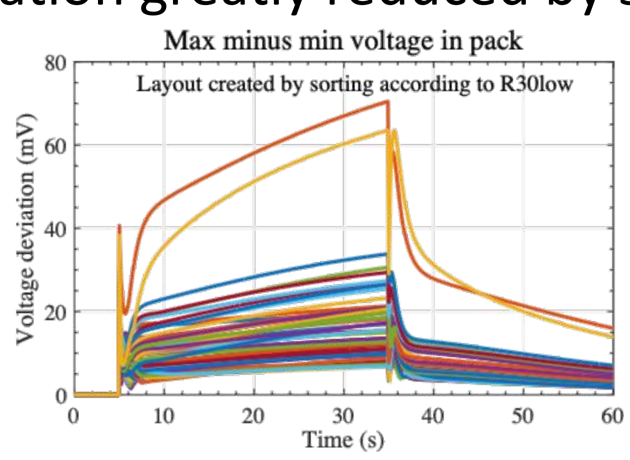


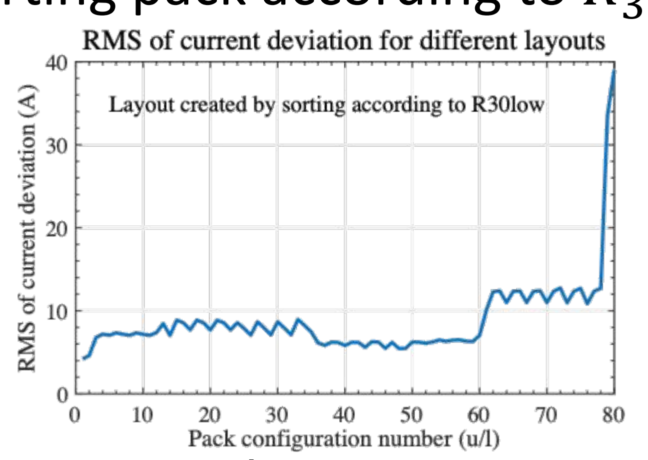


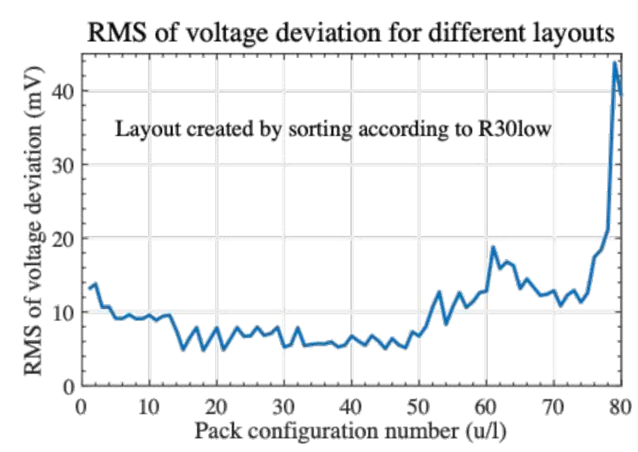
Pack Layout Simulation Results

- Current and voltage deviation greatly reduced by sorting pack according to R_{30}^{low}

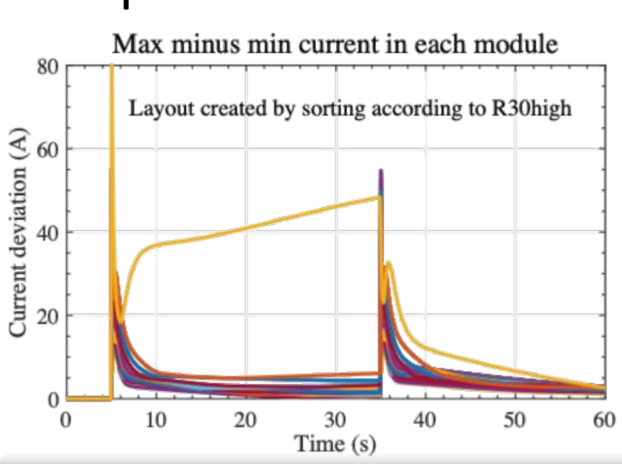


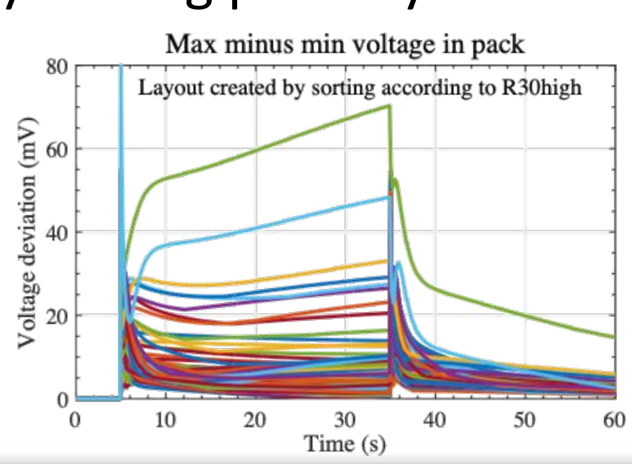


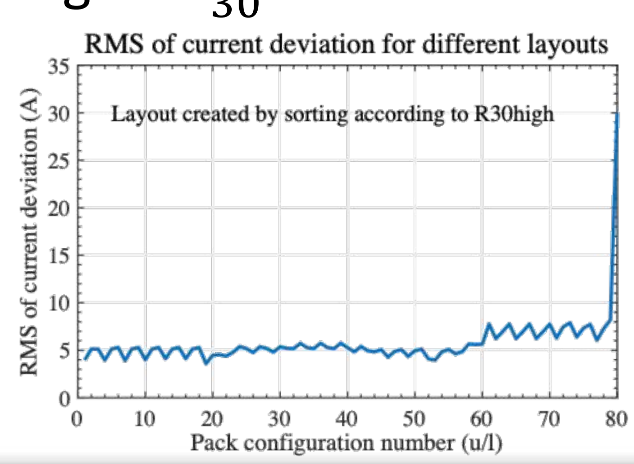


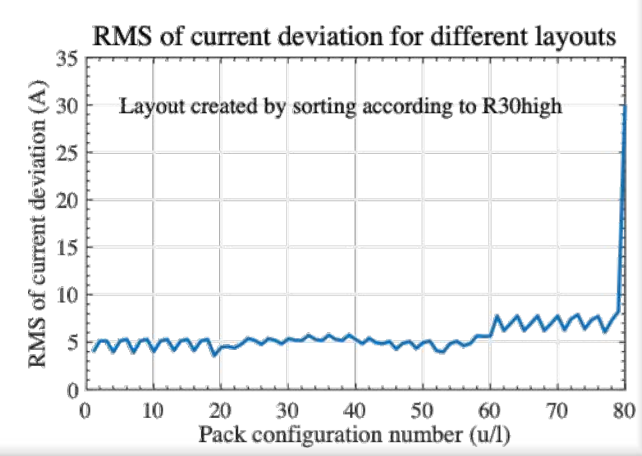


- Improved even further by sorting pack layout according to R_{30}^{high}









Summary

- Simple and fast **low-current measurements + ML enable predicting high-current pulse resistance**
- **Outliers can be detected**; **pack layout can be created** by sorting cells according to their resistance