



Battery Fingerprint Technologies

Battery diagnostics for manufacturers and users to improve capacity, reliability, and safety

Emilia Siletta

AEC 2018 - March 27th, 2018



Samsung Galaxy Note 7





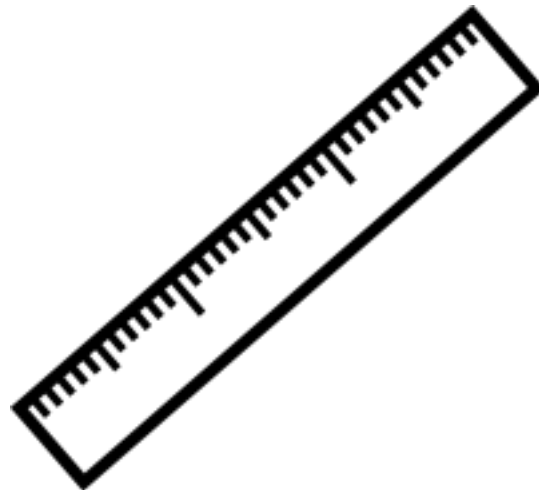


Current quality control procedures

Mass measurements



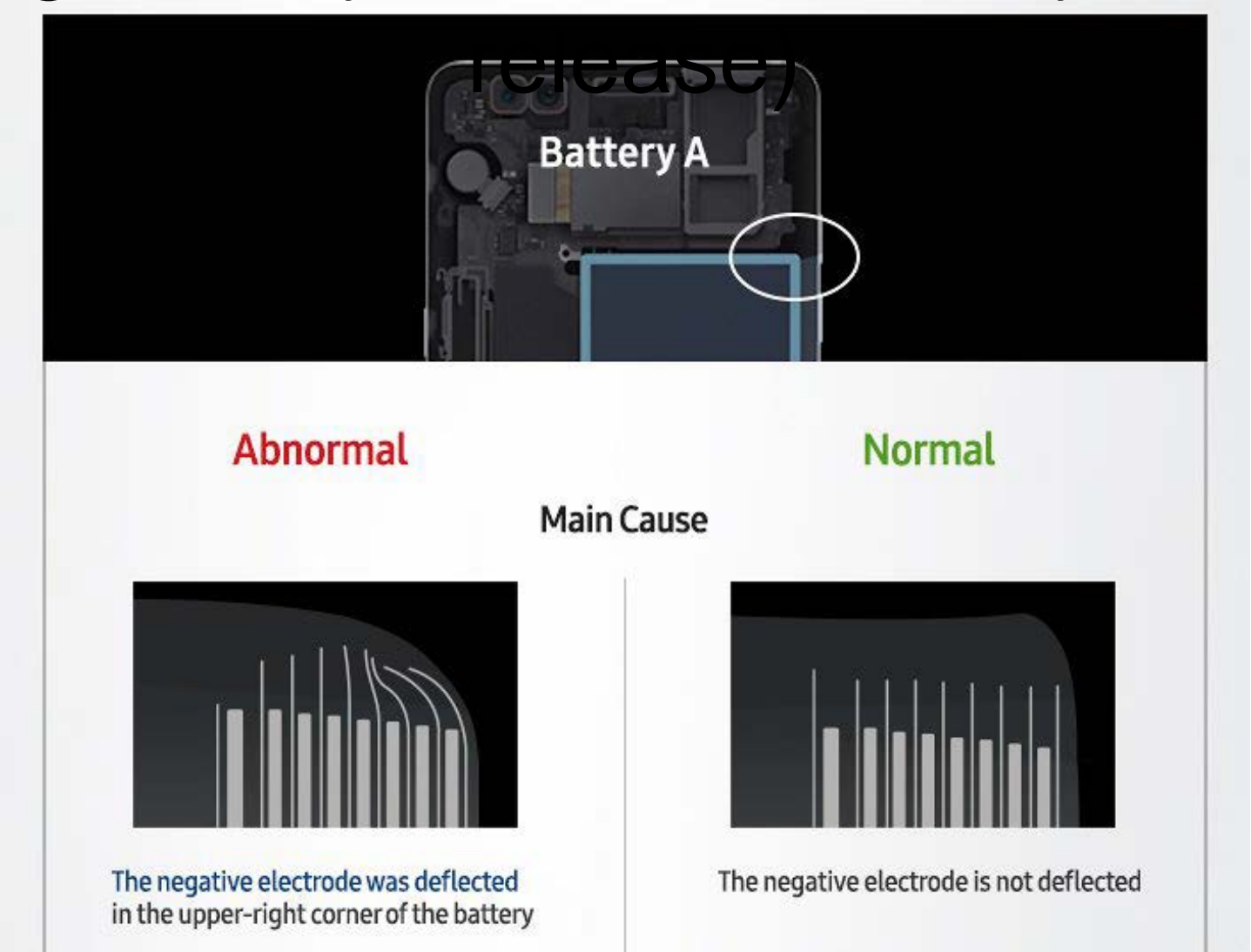
Physical measurements



Electrochemical testing



Samsung battery defects (January 2017 press release)



The diagram illustrates the internal structure of a Samsung battery, labeled "Battery A", with a white circle highlighting a specific area. Below this, two columns compare "Abnormal" and "Normal" battery conditions. The "Abnormal" column shows a deflected negative electrode in the upper-right corner, while the "Normal" column shows a non-deflected negative electrode. The "Main Cause" is identified as the deflection of the negative electrode in the abnormal case.

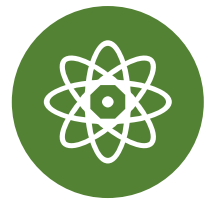
Abnormal

Normal

Main Cause

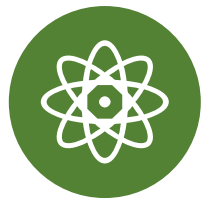
The negative electrode was deflected in the upper-right corner of the battery

The negative electrode is not deflected

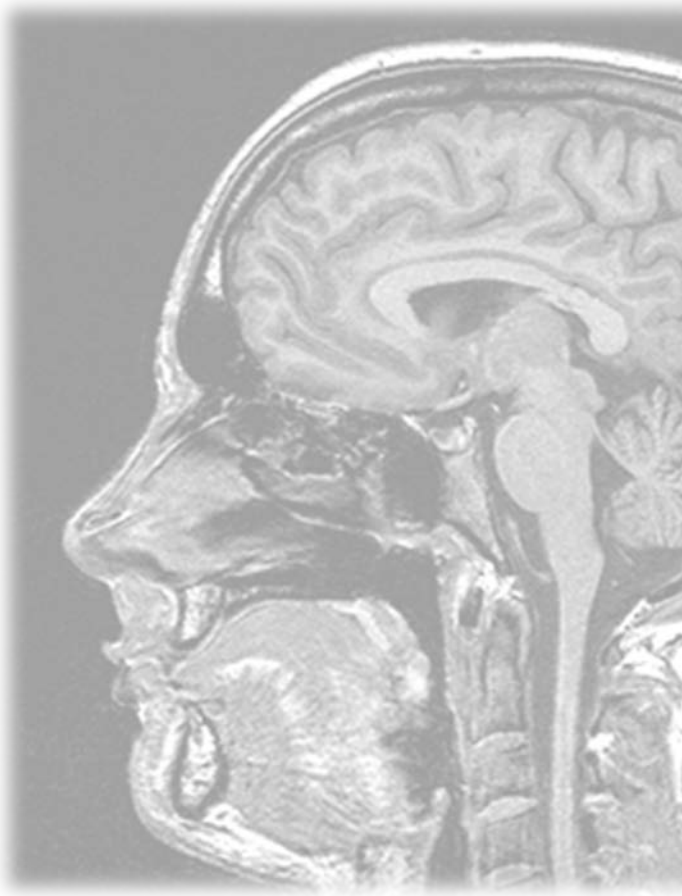


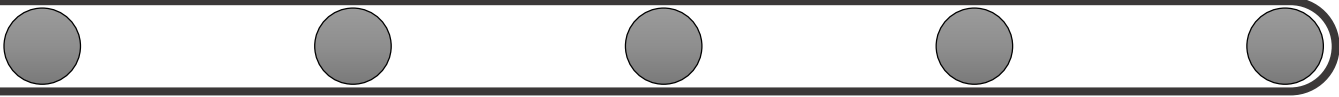
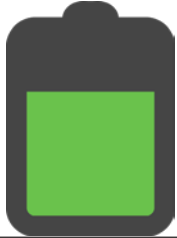
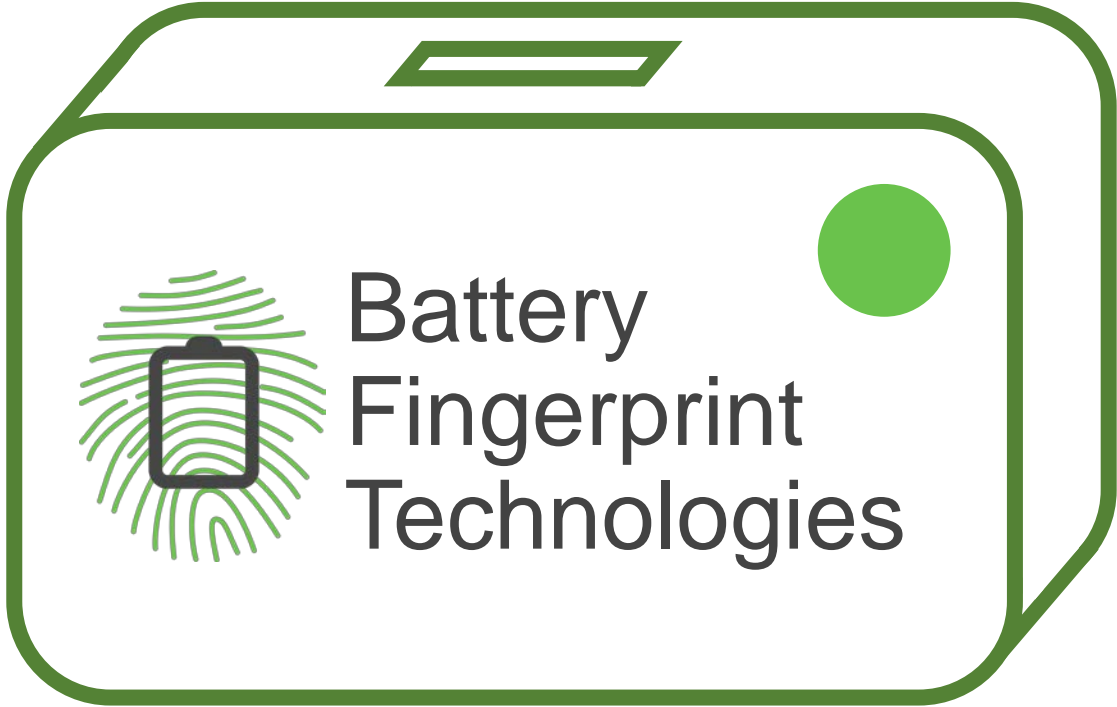
Magnetic Resonance Imaging

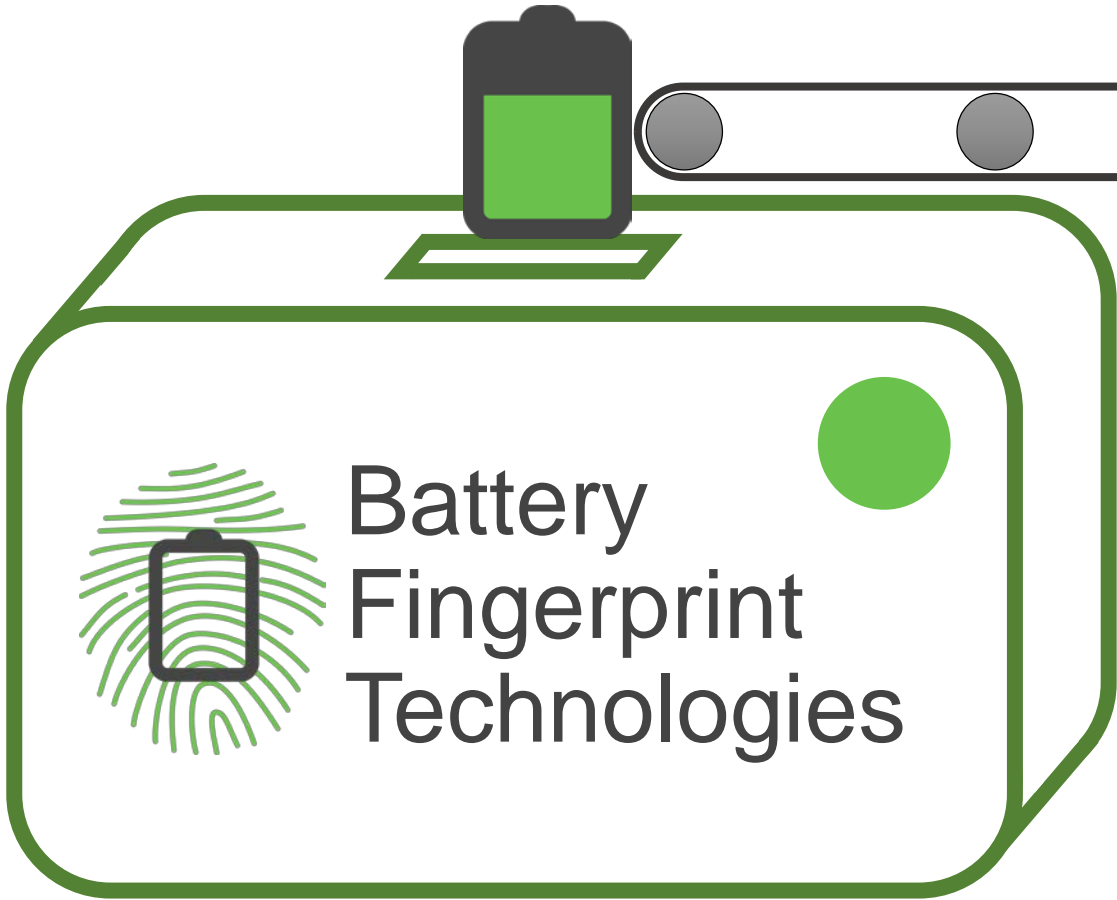




Magnetic Resonance Imaging

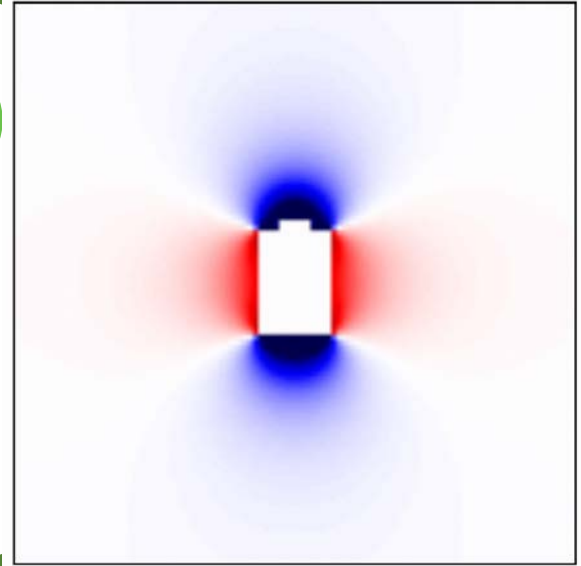








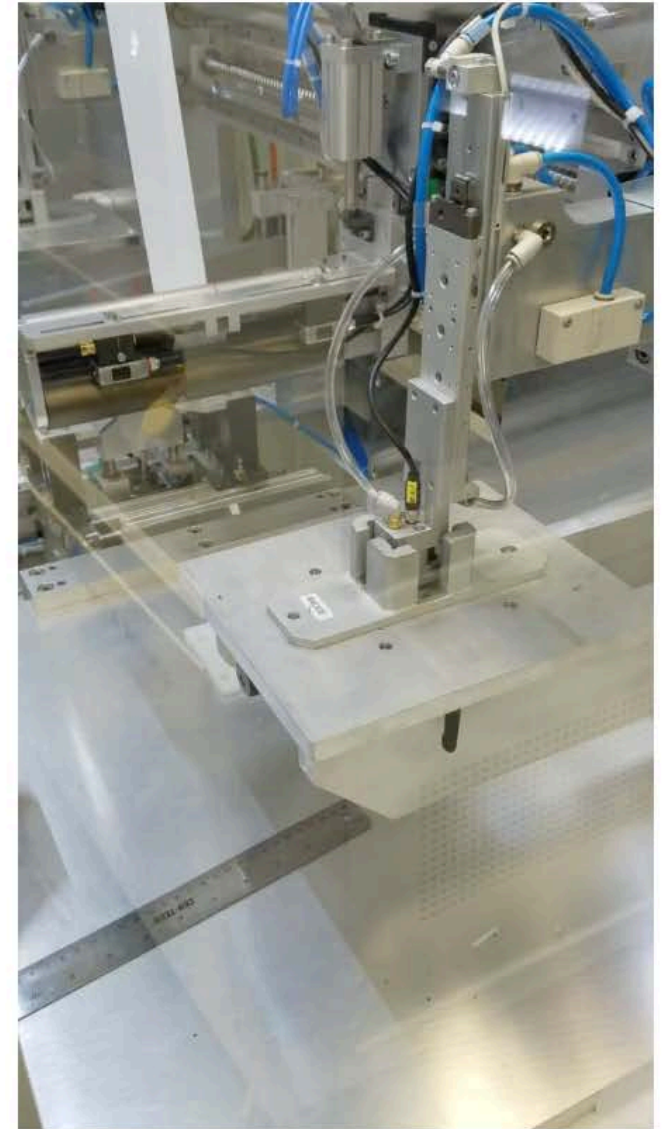
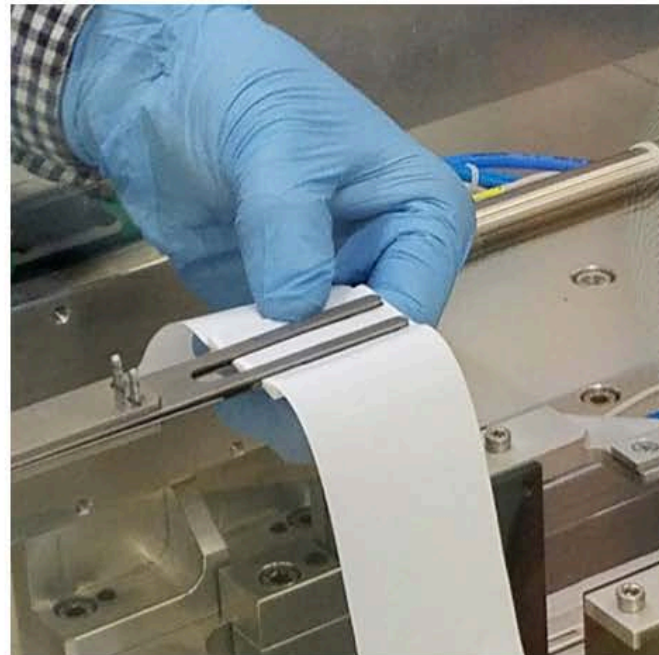
Battery Fingerprint Technologies



Reproducing battery defects



The Battery Prototyping Lab at Rochester Institute of Technology





Common defects found in the production line

Defects



Folded

Electrode

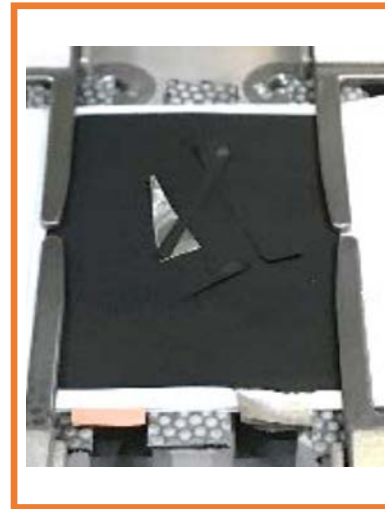


Missing

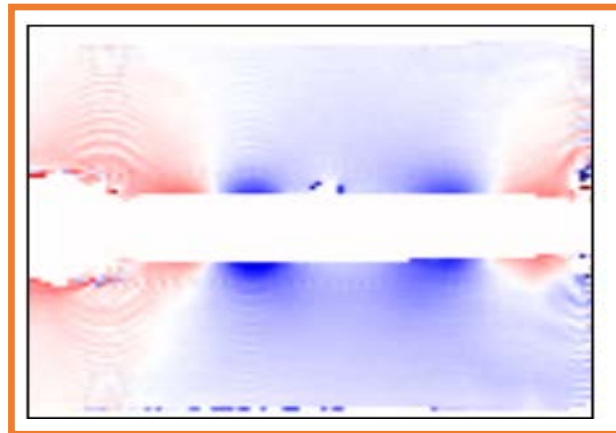
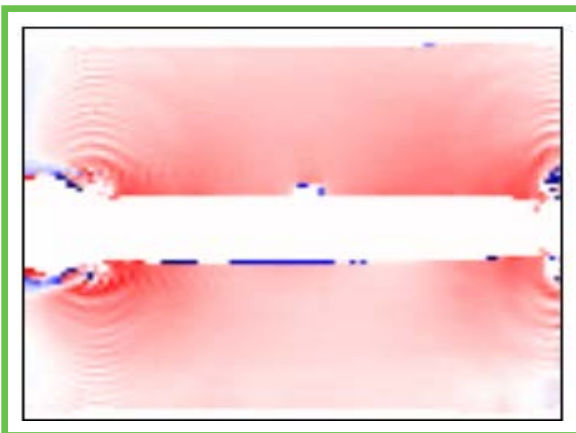
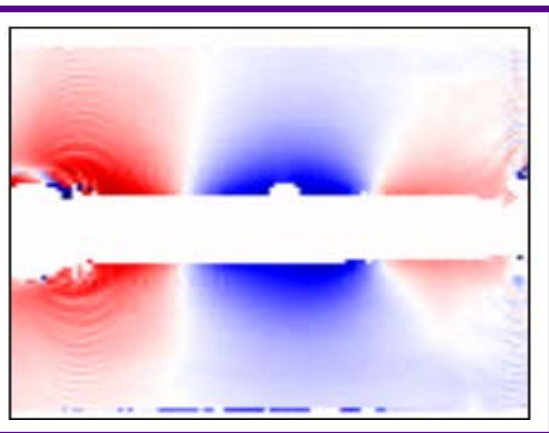
Electrode



Extra Scraps



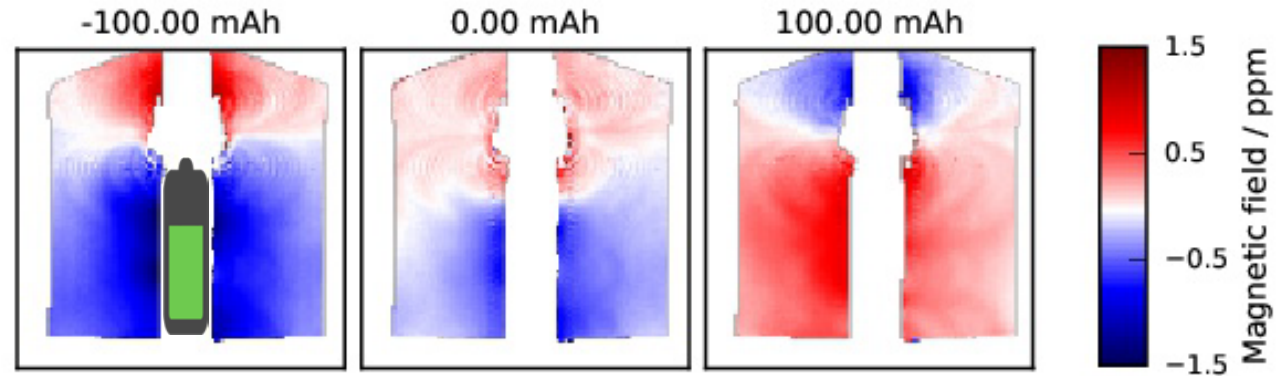
Magnetic field maps



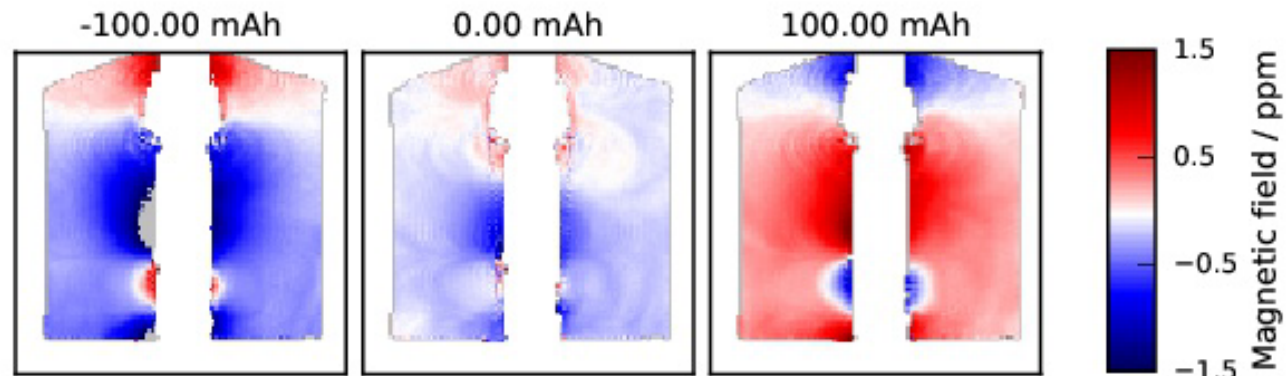


Current Distribution in Li-ion Batteries

Healthy Battery



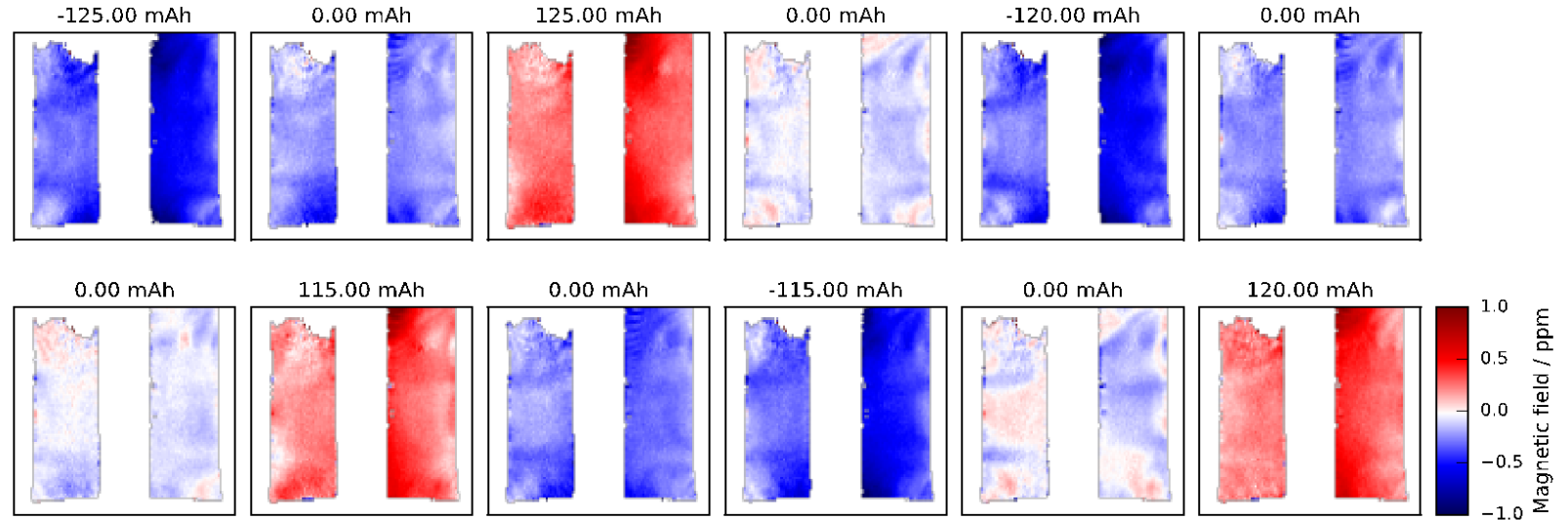
Damaged Battery



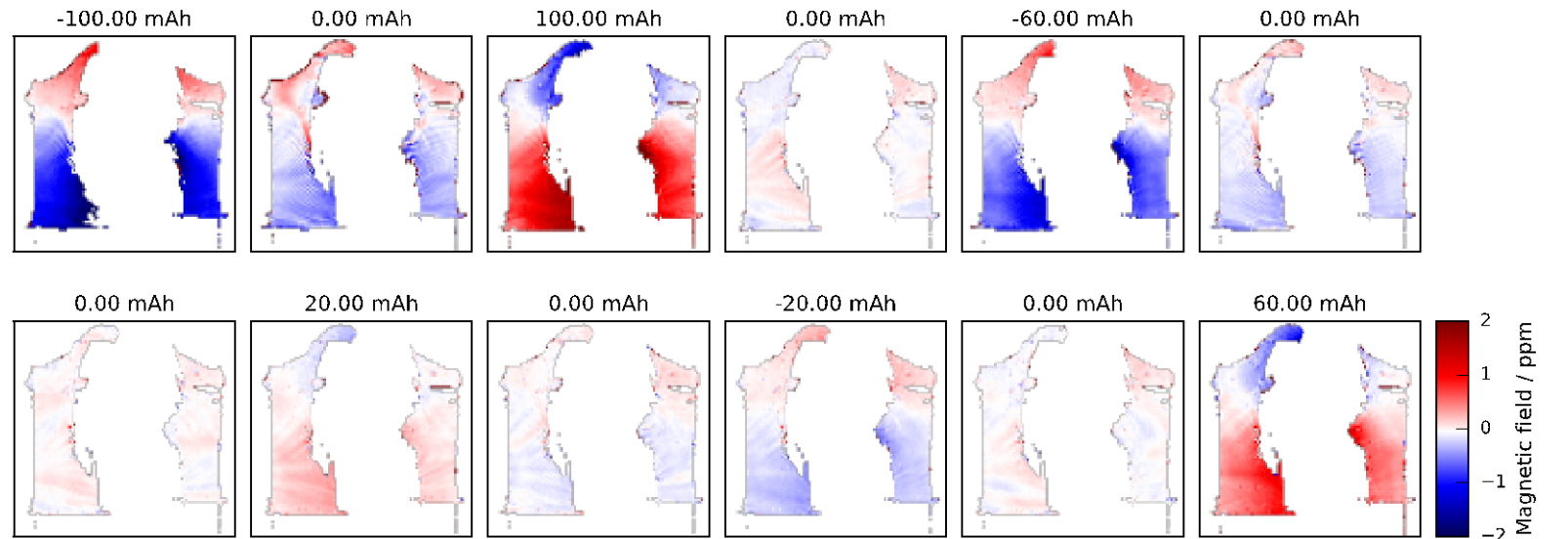


Current Distribution in Li-ion Batteries

Plain Stacked-
Electrode



Jelly Roll

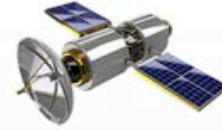




Market



Mining



Space Applications



Consumer Electronics



Power Invertors



Electric Vehicles (EV, HEV, PHEV)



Energy Storage System



Lithium Ion Batteries



Defence /Military Applications



Marines and Submarines



E-cigarettes



Telecom Towers



Solar and Wind Energy Storage



Railways



E-bikes

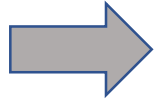


Manufacturing process

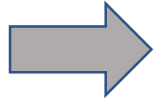
Cathode Line



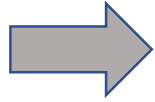
Assembly



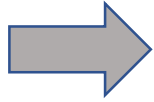
Filling



Charge Formation



Grading



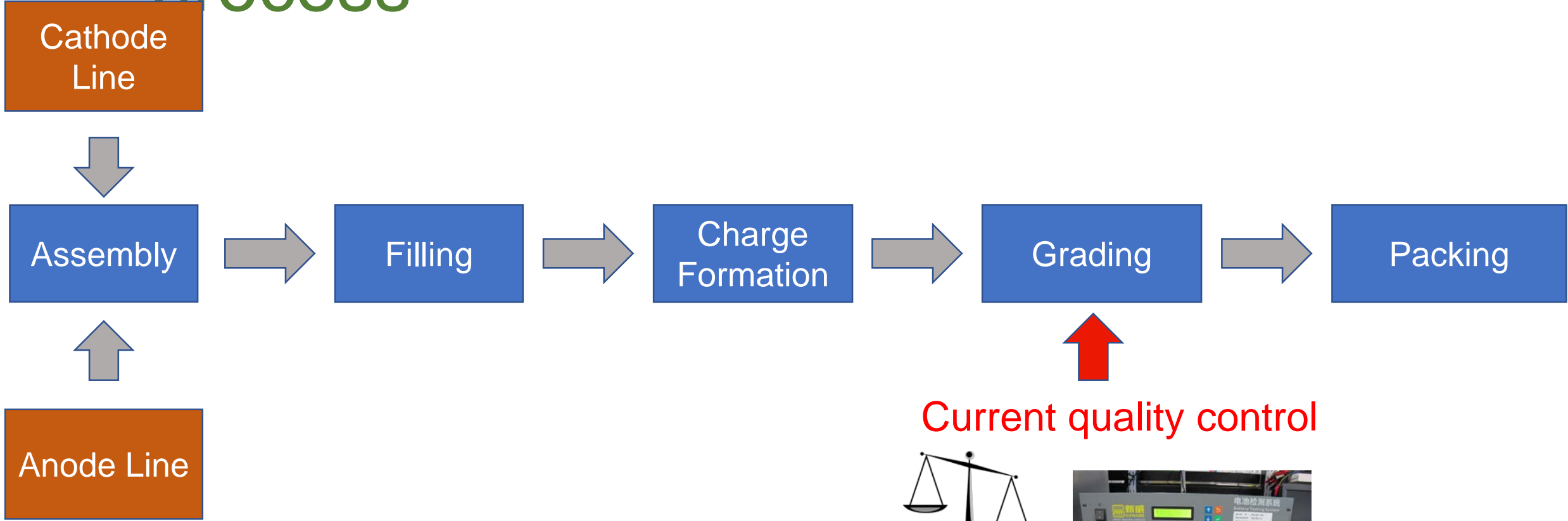
Packing



Anode Line



Manufacturing process



Current quality control





Manufacturing

process

Cathode Line

Assembly

Anode Line

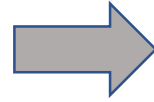
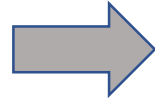
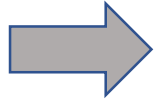
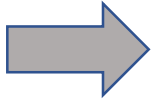
Battery
Fingerprint
Technologies

Filling

Charge
Formation

Grading

Packing



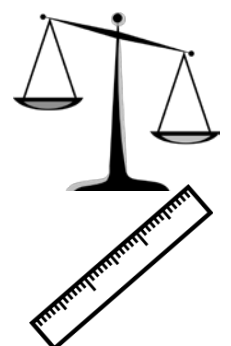
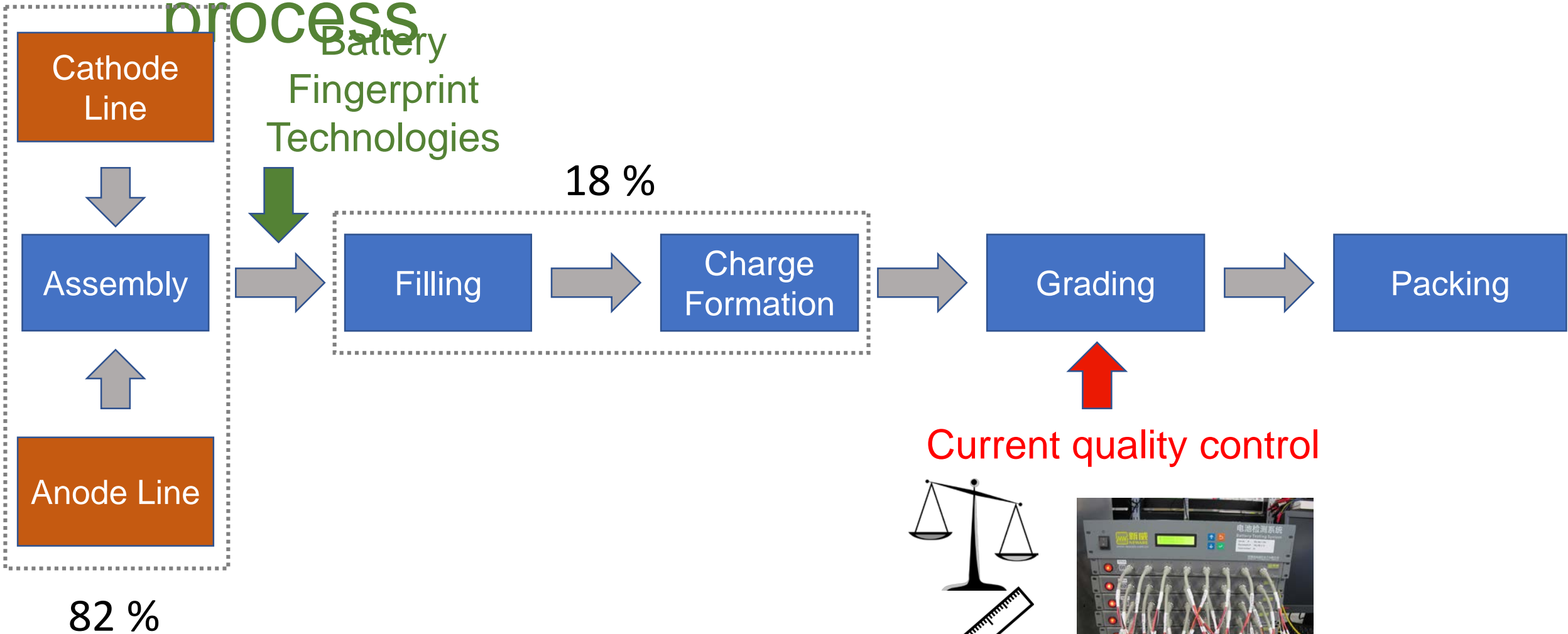
Current quality control





Manufacturing

process



Current quality control



Core Team



NEW YORK UNIVERSITY



Prof. Alexej Jerschow
Physical Chemist
Professor of Chemistry



Mohaddese Mohammadi
Electrical Engineer
PhD candidate



Dr. Emilia Silletta
Physical Chemist
Postdoctoral Researcher



Go to Market



We have entered to the program, **March 2018**



Battery Fingerprint Tech

MRI-based technology that can diagnose a battery's health without destroying the battery



Principal Investigator - Alexej Jerschow (right)
Entrepreneurial Lead - Emilia Silletta (center)
Entrepreneurial Lead - Mohaddese Mohammadi (left)

The Project

Batteries are ubiquitous. They are in our phones, computers, cars and airplanes. The use of alternative energy and electrically powered vehicles will further increase the demand for better and safer batteries. The well-known Samsung disaster, caused by defective batteries, cost Samsung \$5B in the recall, and \$25B in the stock market. This incident along with others (SONY recall, Dreamliner grounding) highlights the importance of battery performance and reliability for the success of battery integrators, such as cell phone

AWARDEE DETAILS

- NYU College of Arts and Sciences
- Cycle 5
- Lab Prototype Complete
- Power, Grid & Energy Storage
- N/A



Go to Market

Proof-of-principle demonstration at high field

MS 1

Proof-of-principle demonstration at low field

MS 2

Image analysis and data base design

MS 3

Classification of failure modes.
Software development

MS 4





Go to Market

Proof-of-principle demonstration at high field

Proof-of-principle demonstration at low field

Image analysis and data base design

Classification of failure modes. Software development

MS 1

MS 2

MS 3

MS 4

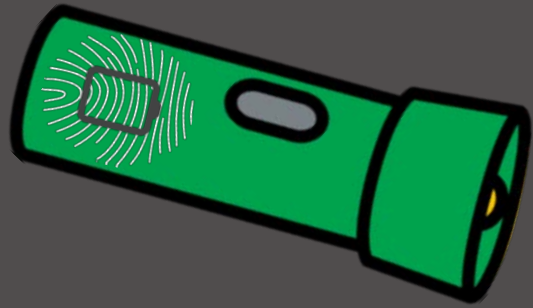


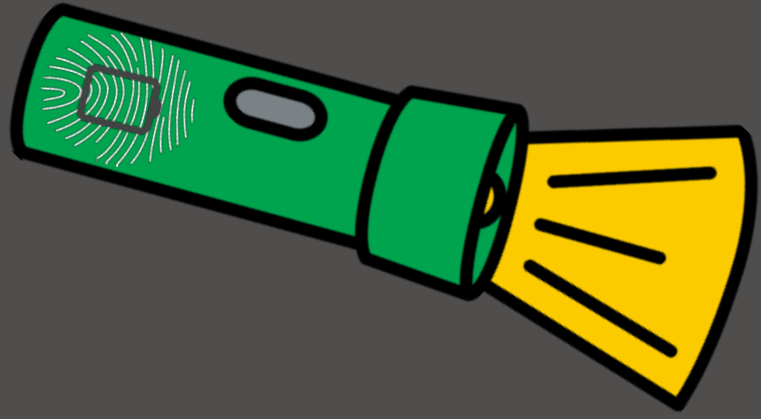
- We have to **install** the instrument in a **production line**

- We need **batteries** to growth the **data base**

- Customer discovery









Contact us



batteryfingerprinting.com



Supplemental Slides



Business Model

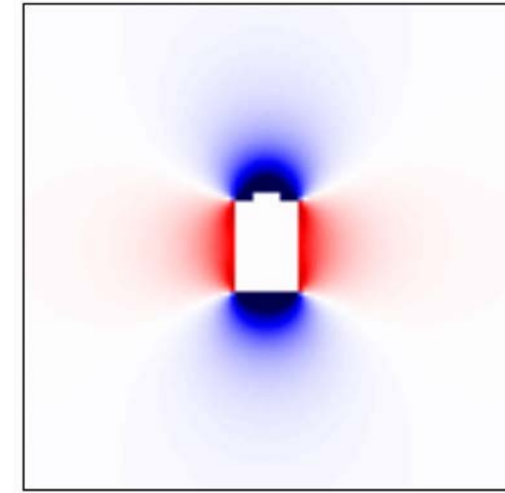
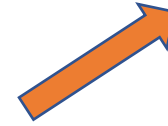
Hardware

+

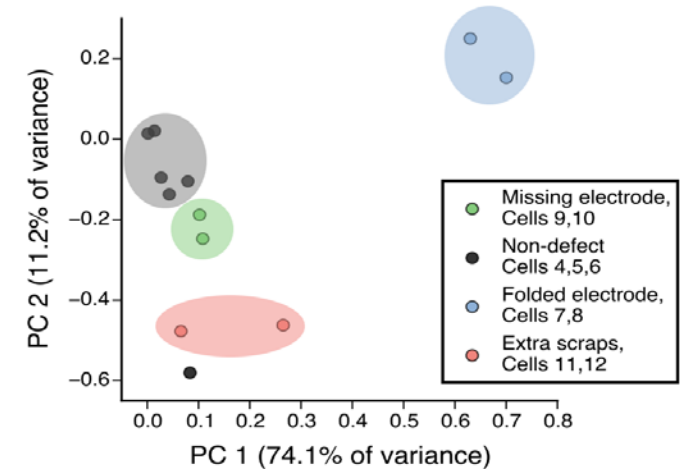
Software



- Non-defect ✓
- Folded electrode ✗
- Missing electrode ✗
- Extra scraps ✗
- ...



Algorithm (compare it to a database)





Technology and IP Status

Atty. Dkt. No. 046434-0629

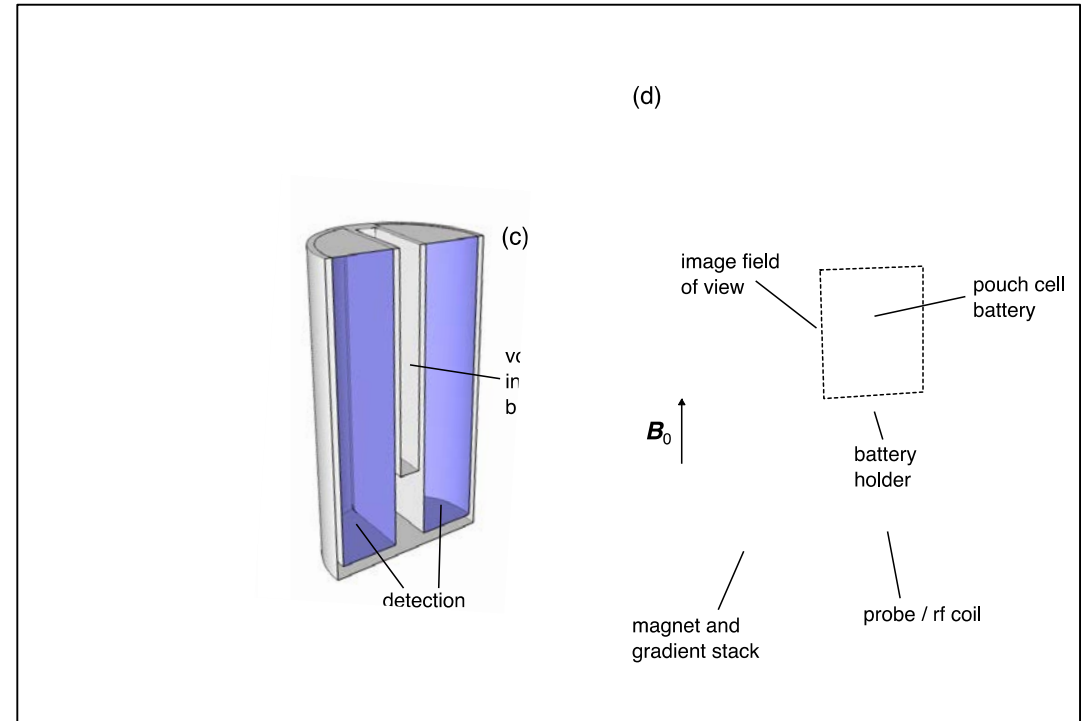
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Inventor Name: Alexej Jerschow

Title: SYSTEM AND METHOD FOR MAGNETIC RESONANCE MAPPING OF PHYSICAL AND CHEMICAL CHANGES IN CONDUCTING STRUCTURES

Appl. No.: Not Yet Assigned

Filing Date: 12/7/2016



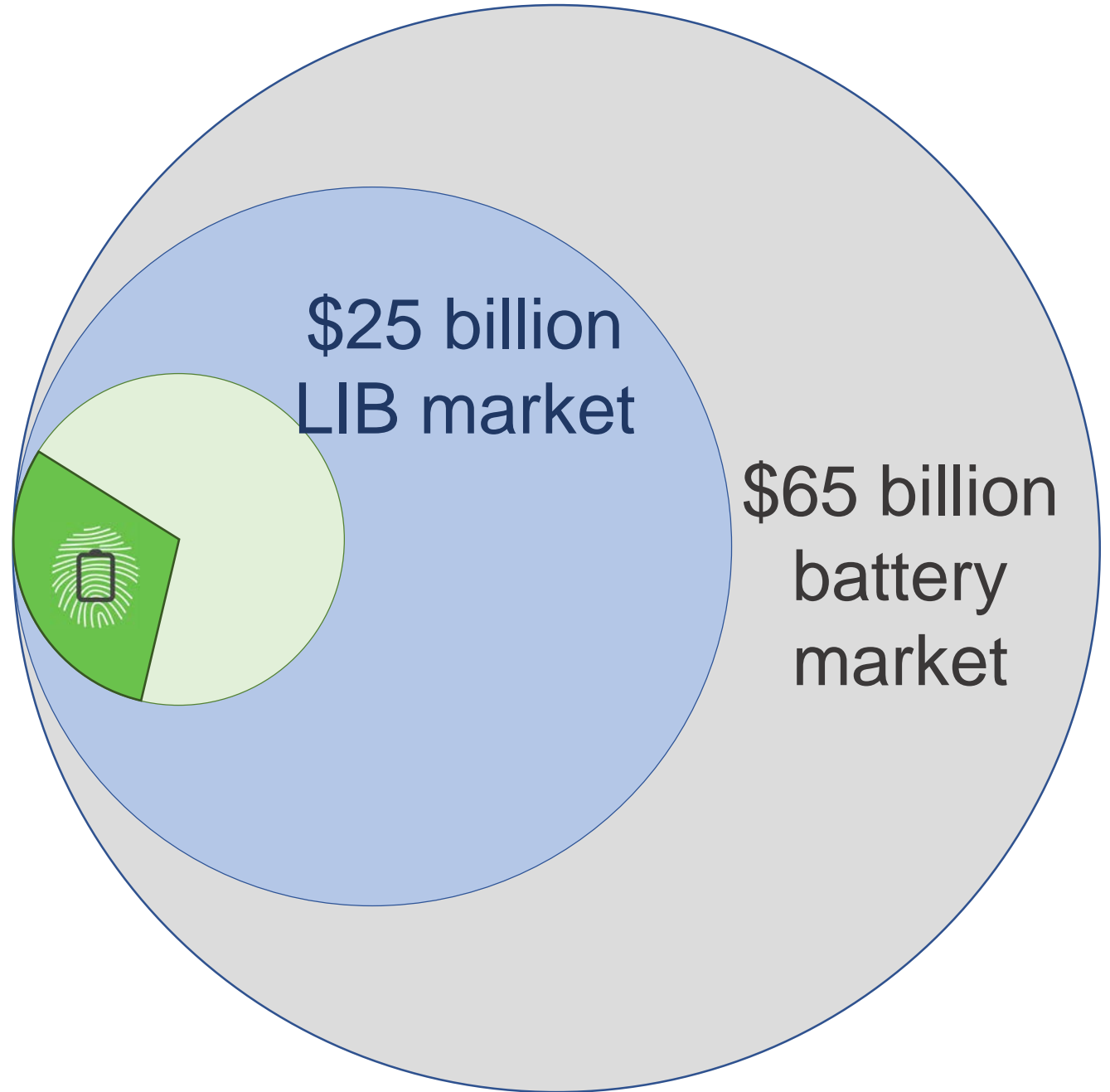
Scientific References

- [1] A. Jerschow *et al.*, Multinuclear in situ magnetic resonance imaging of electrochemical double-layer capacitors, *Nat Comm*, 5 (2014) 4536.
- [2] A. Jerschow *et al.*, Visualizing skin effects in conductors with MRI: (7)Li MRI experiments and calculations, *J Magn Reson*, 245 (2014) 143-149.
- [3] A. Jerschow *et al.*, Correlating Microstructural Lithium Metal Growth with Electrolyte Salt Depletion in Lithium Batteries Using Li-7 MRI, *J. Am. Chem. Soc.*, 137 (2015) 15209-15216.
- [4] A. Jerschow *et al.*, Investigating Li Microstructure Formation on Li Anodes for Lithium Batteries by in Situ Li-6/Li-7 NMR and SEM, *J. Phys. Chem. C*, 119 (2015) 16443-16451.
- [5] A. Jerschow *et al.*, Real-time 3D imaging of microstructure growth in battery cells using indirect MRI, *Proc Natl Acad Sci U S A*, 113 (2016) 10779-10784.



Market and Scalability

\$5 billion cell phone battery market



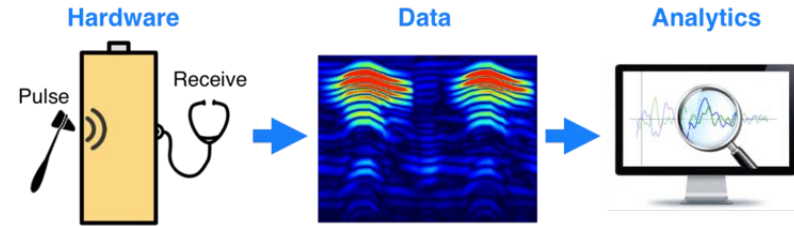


Competitor

S

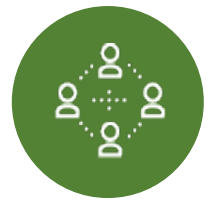
X-ray-CT

- Non-destructive
- 50 min per battery
- Not specific to chemical changes
- A trained operator is needed



This technique does not provide current distribution information

There is currently not direct competition



Potential Partnership and Strategic Investors



- Medial applications
- Process control for Oil and gas
- Rock core analyzer
- **BATTERY QUALITY CONTROL**



They can help us to develop the business plan and get connection

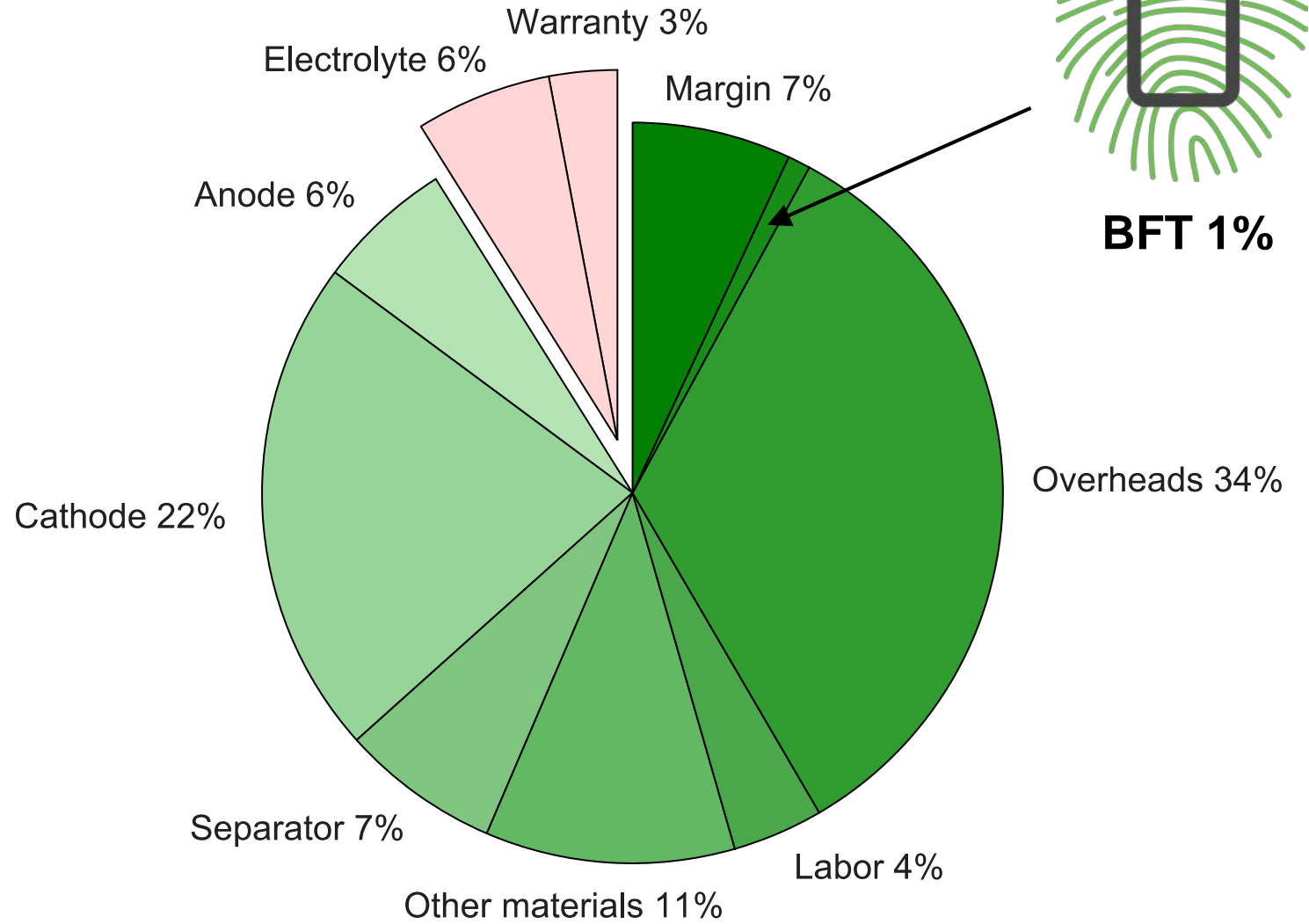


Provide us batteries and the installation of the demo in their production lines



Business Model

Cost to manufacture cell phone batteries



BFT 1%



Advisors



Bill Acker
Executive Director



John Cerveney
Director of
Resource
Development



Networking



The Battery
Prototyping Lab at
Rochester Institute of
Technology



Eastman Business Park

Provide us batteries and
the installation of the
demo in their production
lines



Capital Raise

- \$50k NYU TAC Fund
- \$125k Daimler Research Agreement
- 150k PowerBridgeNY

Under review/consideration

- \$300k NSF CBET grant
- \$200k NSF Partnerships for Innovation
- \$50k Toyota Fellowship
- Battery Fingerprint Technologies

