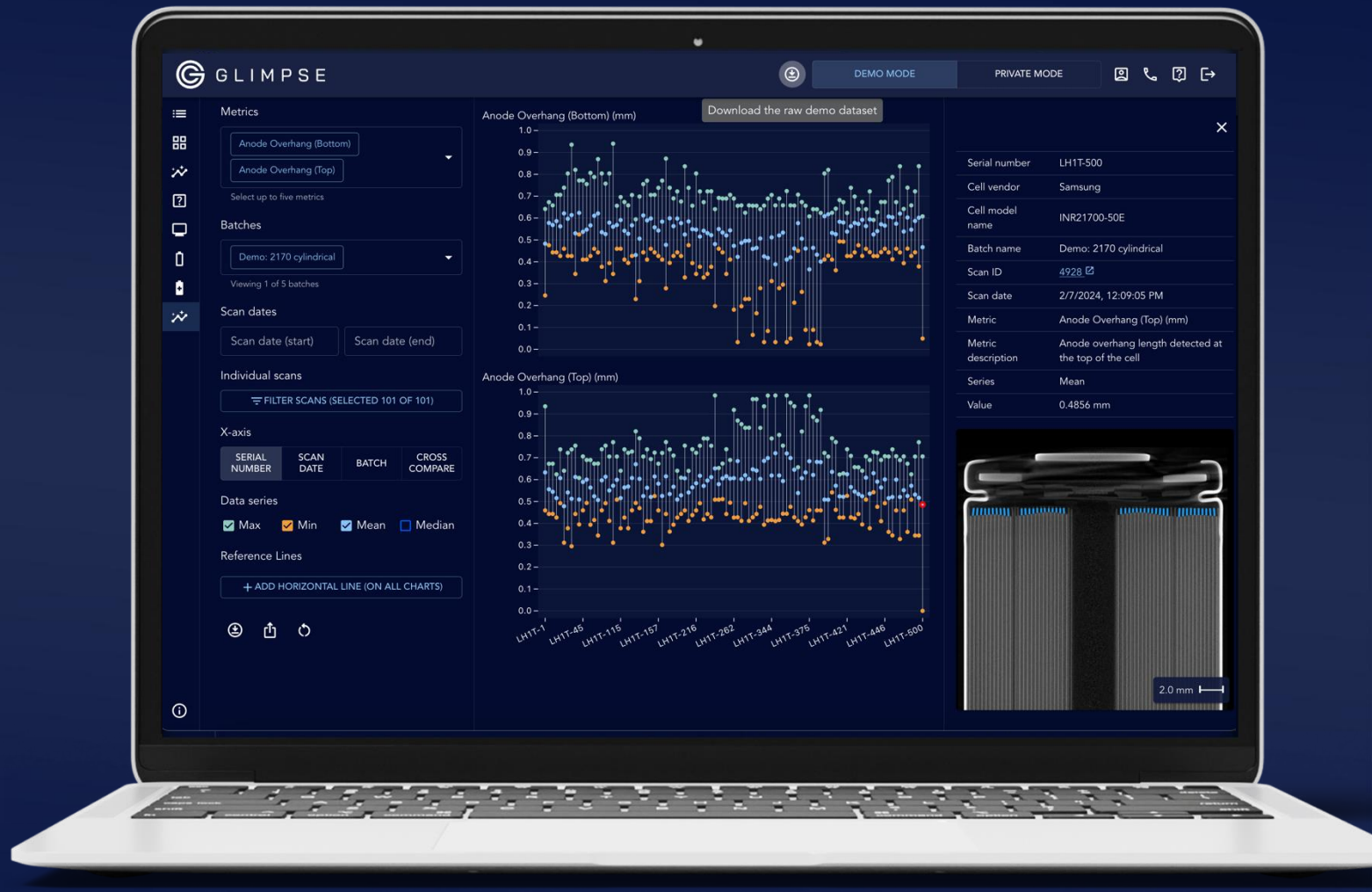
GLIMPSE

ENABLING BATTERY QUALITY AT SCALE

NASA Aerospace Battery Workshop 2025



Using Glimpse's high-throughput CT scanning capabilities to evaluate cell quality from a 60,000-cell flight lot for NASA

GOAL

Obtain **high confidence in the internal quality** of a 60,000-cell flight lot to **mitigate the risk of latent defects** that could jeopardize performance and safety in space.

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GLIMPSE

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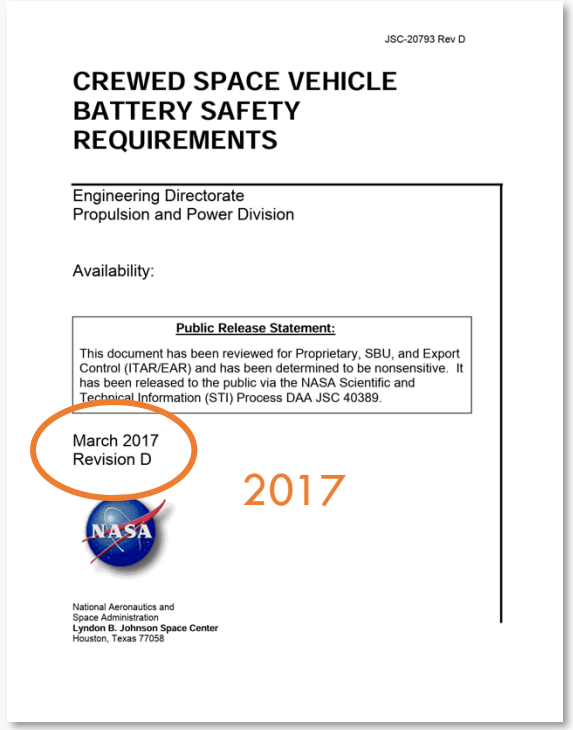
BACKGROUND: CT SCANNING IS A CRITICAL TOOL FOR EVALUATING CELL LOT QUALITY

NASA **Crewed Space Vehicle Battery Safety Requirements** (JSC-20793 Rev D) sets standards for the design, qualification, and safety verification of batteries used in crewed spacecraft.

Computed Tomography (CT) scanning is required for assessing cell quality in:

1. **Initial lot assessment**
2. **Lot acceptance testing**


JSC-20793 Rev D

CREWED SPACE VEHICLE BATTERY SAFETY REQUIREMENTS

Engineering Directorate
Propulsion and Power Division

Availability:

Public Release Statement:

This document has been reviewed for Proprietary, SBU, and Export Control (ITAR/EAR) and has been determined to be nonsensitive. It has been released to the public via the NASA Scientific and Technical Information (STI) Process DAA JSC 40389.

March 2017
Revision D

2017

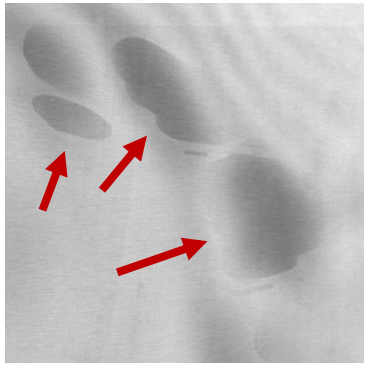
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

CELL INSPECTION TECHNIQUES

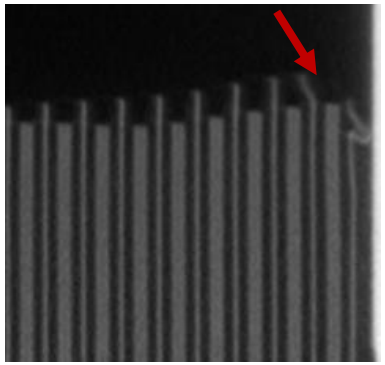
	Non-destructive	Spatially resolved	Resolution of ≤50 µm	Full cell inspection	Scalable to ≤5s/cell
Manual dissection	✗	✓	✓	✗	✗
Manual cross section	✗	✓	✓	✗	✗
Cycling & Storage	✗	✗	✗	✓	✗
Ultra High Precision Coulometry	✗	✗	✗	✓	✗
Electrochemical Impedance Spectroscopy	✓	✗	✗	✓	✗
OCV decay during formation	✓	✗	✗	✓	✗
High Potential testing (HiPot)	✓	✗	✗	✓	✓
Ultrasound	✓	✓	✗	✓	✓
In-line vision camera	✓	✓	✓	✗	✓
2D X-ray imaging	✓	✓	✓	✗	✓
Computed tomography (CT) scanning	✓	✓	✓	✓	GLIMPSE

Source: Attia et al. *Nat Commun* **16,** 611 (2025)

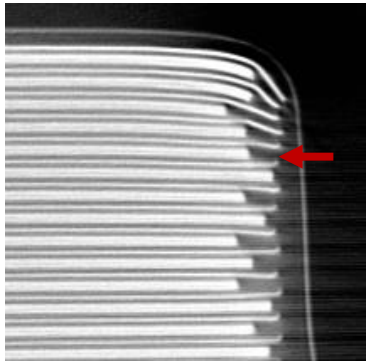
CT CAN DETECT LATENT BATTERY DEFECTS THAT FUNCTIONAL TESTING MAY MISS AT BOL



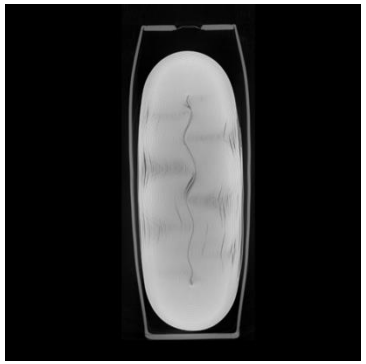
Gas bubbles



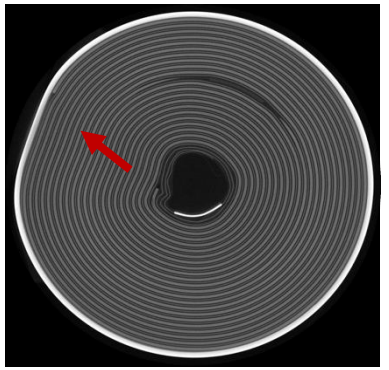
Folded anode tip



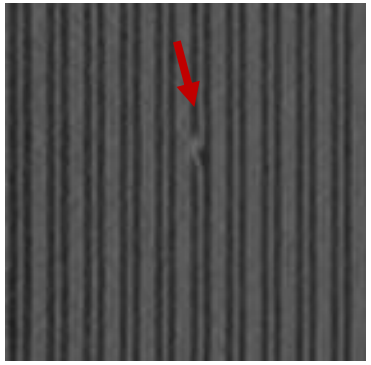
Electrode overhang violation



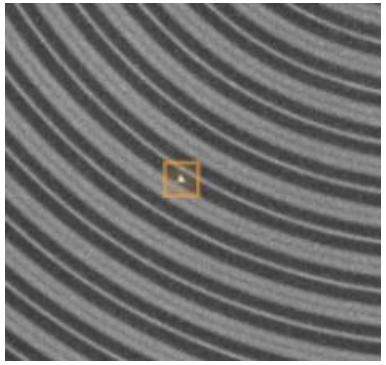
Bulging can



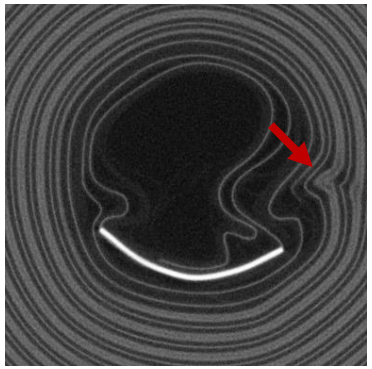
Dented can



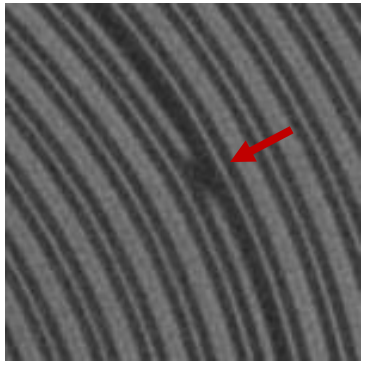
Wrinkled electrode



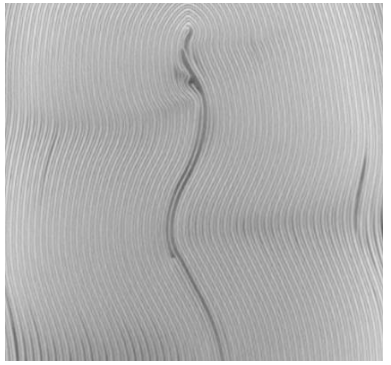
Metallic contaminant



Buckled jellyroll



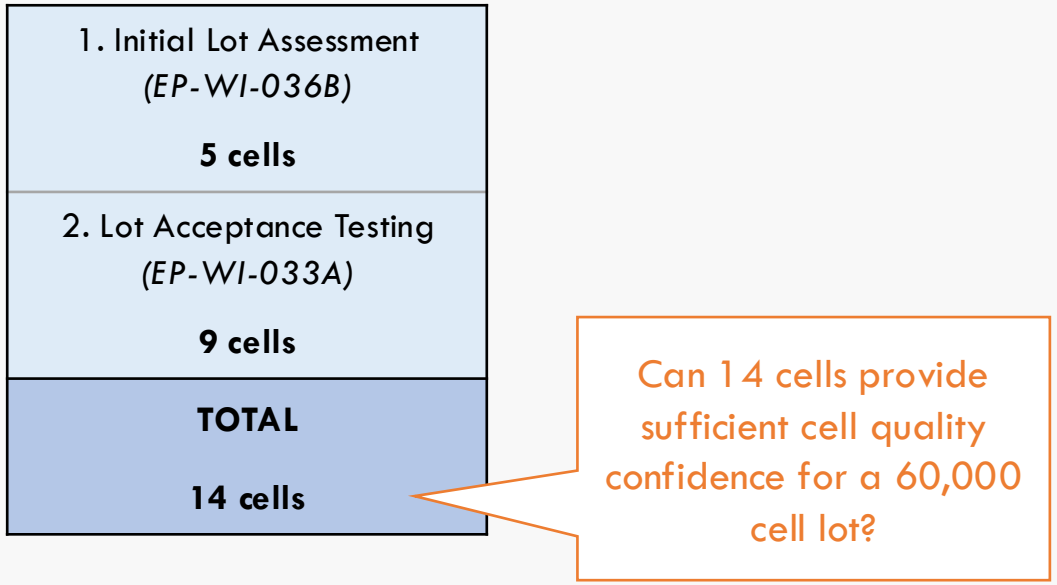
Missing electrode coating



Buckled inner windings

BACKGROUND: NASA SPECIFICATIONS DEFINE MINIMUM CT SCAN QUANTITIES FOR CELLS USED IN MANNED SPACE FLIGHTS

Minimum CT scan quantities per lot were largely **defined based on feasibility**, (i.e., cost and time required to complete CT scanning), and do not vary based on lot size.



BACKGROUND: NASA ANALYSIS SUGGESTED SIGNIFICANTLY HIGHER SAMPLING RATES ARE REQUIRED TO PROVIDE HIGH CONFIDENCE IN CELL QUALITY

Table 1. Population Proportion – Sample Size for 90% confidence level with 5% margin of error

Lot Size	Sample size	Lot Size	Sample size
131,288 +	271	7,364 – 8,255	262
46,650 – 131,288	270	6,641 – 7,363	261
28,282 – 46,649	269	6,043 – 6,640	260
20,249 – 28,281	268	5,540 – 6,042	259
15,744 – 20,248	267	5,111 – 5,539	258
12,861 – 15,743	266	4,742 – 5,110	257
10,858 – 12,860	265	4,420 – 4,741	256
9,385 – 10,857	264	4,136 – 4,419	255

60,000 cell lot

This following formula is used to calculate the sample size N_2:

EP-WI-036B

$$N_2 = N_1 * X / (X + N_1 - 1), \text{ where } X = Z_{\alpha/2}^2 \text{ -*p*(1-p) / MOE}^2$$

and $Z_{\alpha/2}$ is the critical value of the Normal distribution at $\alpha/2$ (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96), MOE is the margin of error, p is the sample proportion which is 0.5 for attributes, and N_1 is the population size.

What are the limitations preventing higher CT scanning rates?

ACHIEVING RECOMMENDED SAMPLING LEVELS WAS PREVIOUSLY IMPRACTICAL

SCANNING CHALLENGES

Slow ROI scans required to achieve sufficient image quality

4 ROI scans per cell x 2 hours per scan = **8 hours to scan each cell**

MANUAL REVIEW BURDEN

Technical software requiring expertise

Manual 3D scan **review is slow, subjective, and not scalable**

STORAGE LIMITATIONS & DATA OVERLOAD

Per-scan file size: **10 - 100 GB**

Large files are hard to store, share, and maintain traceability

HIGH COST

Cost per scan **$1k – $2k**

High volume scanning is **not economically feasible**

*for an 18650 battery cell

GLIMPSE ENABLES CT SCANNING AT SCALE

SCANNING CHALLENGES

Proprietary image quality enhancement algorithms

2 minutes per full-cell scan

14.4 µm voxel size (for 18650 full-cell scans)

MANUAL REVIEW BURDEN

Web-based scan viewer + computer vision algorithms

Scan feature extraction and defect detection in seconds

Instant access to results & insights across teams & locations

STORAGE LIMITATIONS & DATA OVERLOAD

State-of-the-art image compression

<<100 MB file size

ITAR compliant & Gov Cloud-enabled, web-based scan viewer & dashboards

HIGH COST

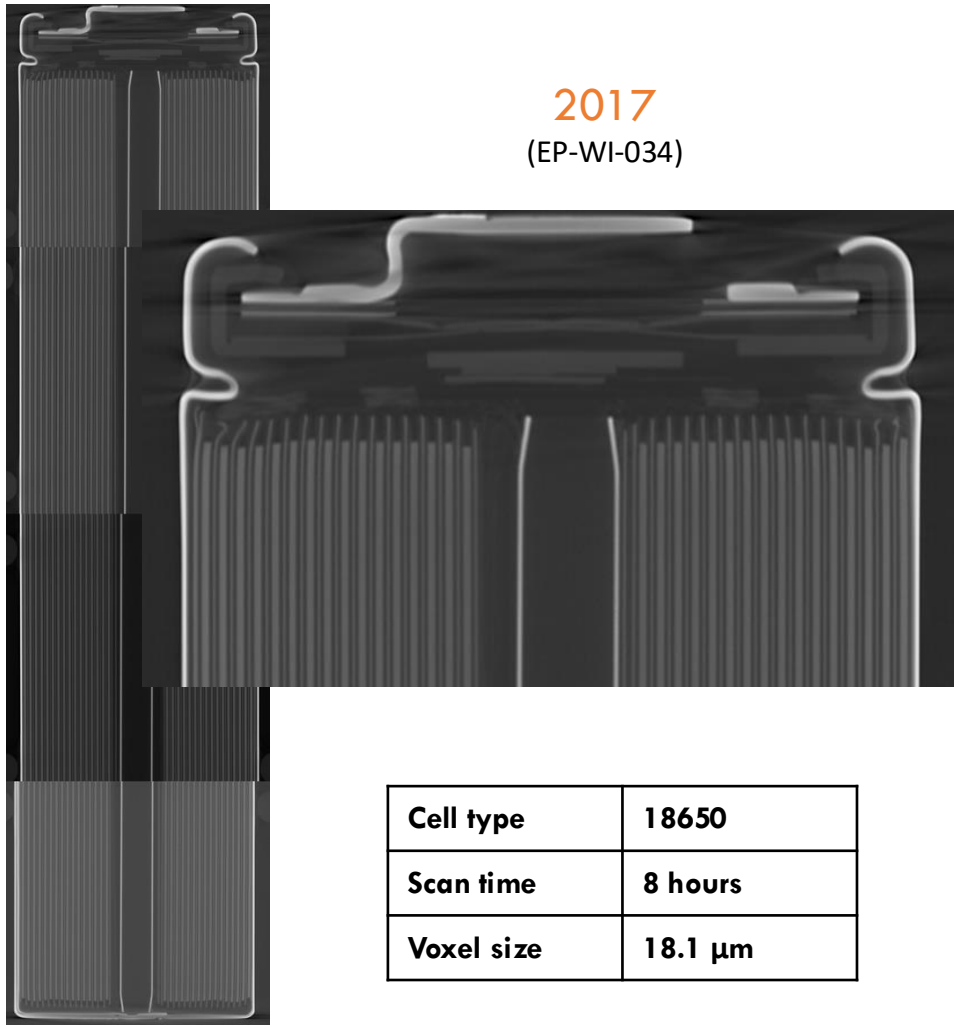
Cost per scan

Starting at $60

High volume scanning is **now economically feasible**

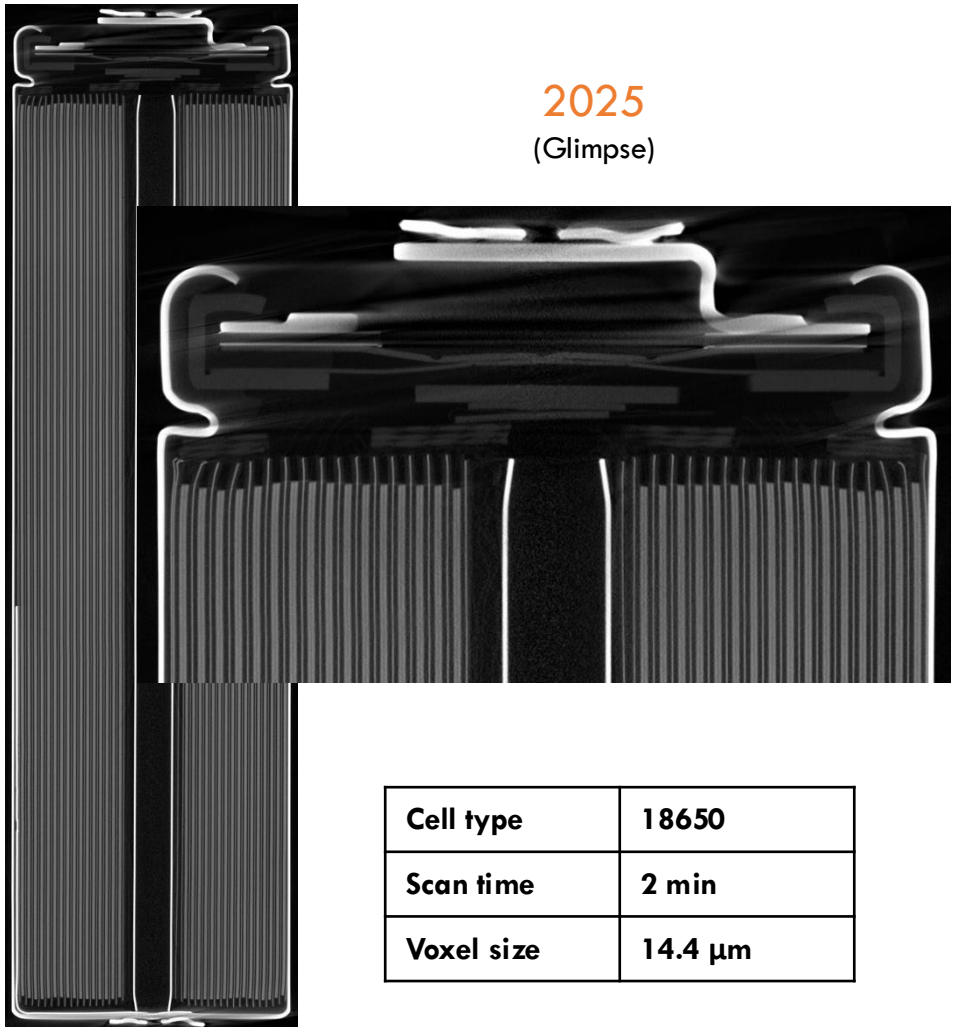
*for an 18650 battery cell

240X FASTER SCANNING WITH BETTER IMAGE QUALITY



2017
(EP-WI-034)

Cell type	**18650**
Scan time	**8 hours**
Voxel size	**18.1 µm**



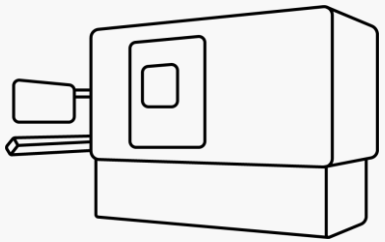
2025
(Glimpse)

Cell type	**18650**
Scan time	**2 min**
Voxel size	**14.4 µm**

HOW GLIMPSE TECHNOLOGY INCREASES SCANNING THROUGHPUT

CT SCANNER

GLIMPSE



CT scanning

*The **GlimpseBox***

Scan Processing

*The **Glimpse Portal™***

Automated Inspection, Data Visualization & Sharing

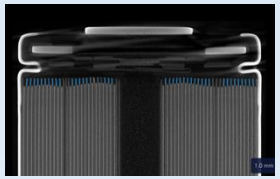
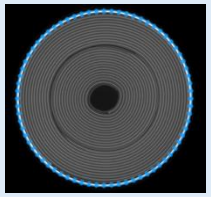
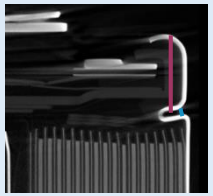
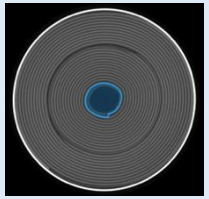
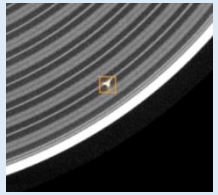
Scan time:	**2 min / cell**	→	Increase scans per day
Analysis time:	**<1 min / cell**	→	Automated inspection results available instantly
File size:	**< 100 MB**	→	Digital system of record for long-term traceability

PROJECT DESCRIPTION: RE-EVALUATION OF NASA'S 2017 ACCEPTED CELL LOT

Glimpse's CT scanning service enabled NASA to scan faster, improve time-to-insight, and reduce cost - making large-scale, statistically driven lot evaluation achievable.

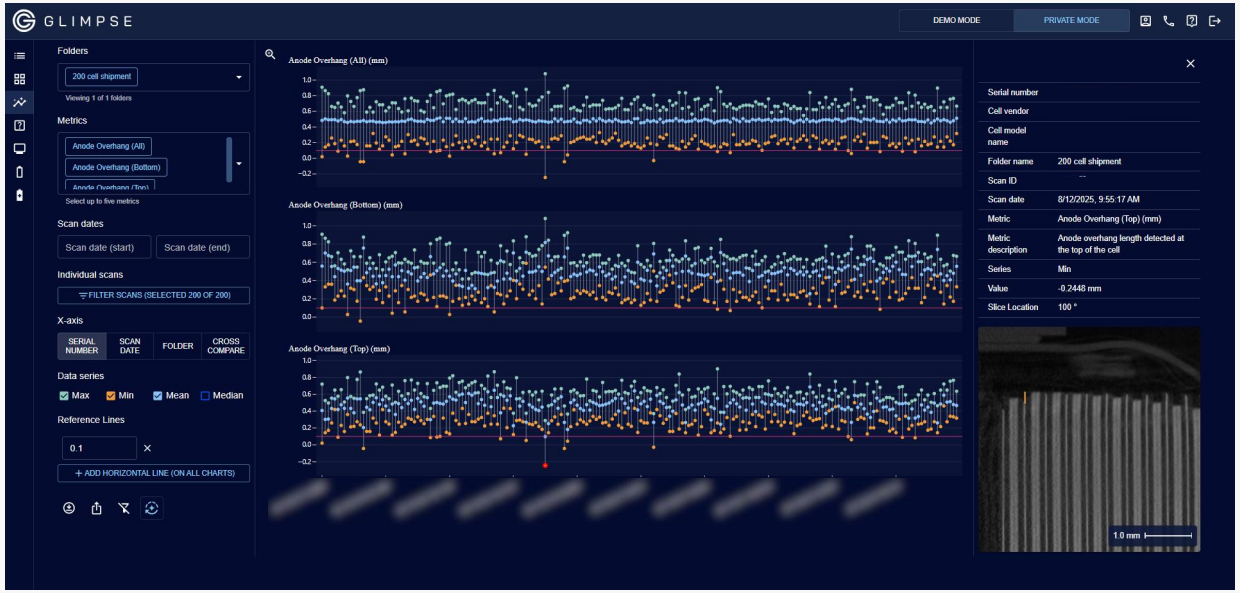
- NASA engaged Glimpse to re-investigate a previously approved cell lot
- 2017 lot evaluation included 3 CT scans; Glimpse performed 200 CT scans

ALGORITHMIC INSPECTIONS FOR KEY FEATURES AND METRICS

Electrode	• Overhang (top & bottom) • Asymmetry	
Can	• Max denting • Circularity • Inner & outer diameter • Wall thickness	
Crimp	• Crimp height • Groove gap	
Jellyroll Core	• Area • Concentricity • Effective diameter • Circularity • Jellyroll buckling	
Foreign Objects	• Metallic-particle detection	

AUTOMATED INSPECTION DASHBOARD

ON THE GLIMPSE PORTAL®



14 metrics are automatically extracted and stored in dynamic quality control dashboards.

Folders

200 cell shipment

Viewing 1 of 1 folders

Metrics

Anode Overhang (All)

Anode Overhang (Bottom)

Anode Overhang (Top)

Select up to five metrics

Scan dates

Scan date (start) | Scan date (end)

Individual scans

FILTER SCANS (SELECTED 200 OF 200)

X-axis

SERIAL NUMBER | SCAN DATE | FOLDER | CROSS COMPARE

Data series

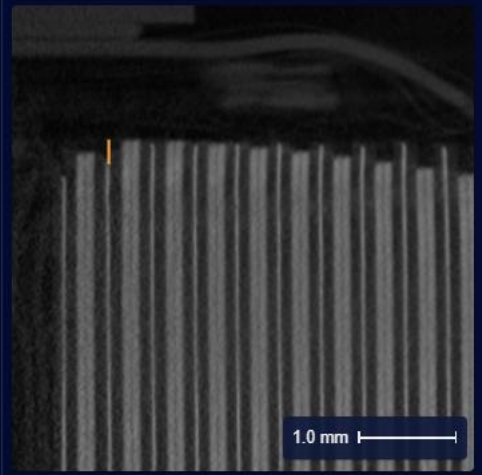
Max | Min | Mean | Median

Reference Lines

0.1

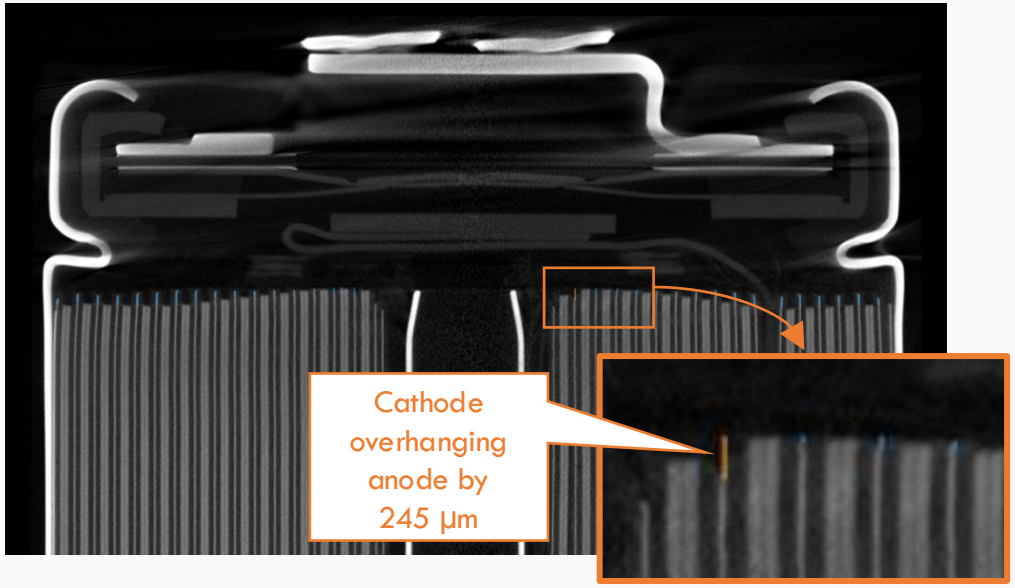
+ ADD HORIZONTAL LINE (ON ALL CHARTS)

Serial number	
Cell vendor	
Cell model name	
Folder name	200 cell shipment
Scan ID	
Scan date	8/12/2025, 9:55:17 AM
Metric	Anode Overhang (Top) (mm)
Metric description	Anode overhang length detected at the top of the cell
Series	Min
Value	-0.2448 mm
Slice Location	100 °



ELECTRODE OVERHANG ISSUES

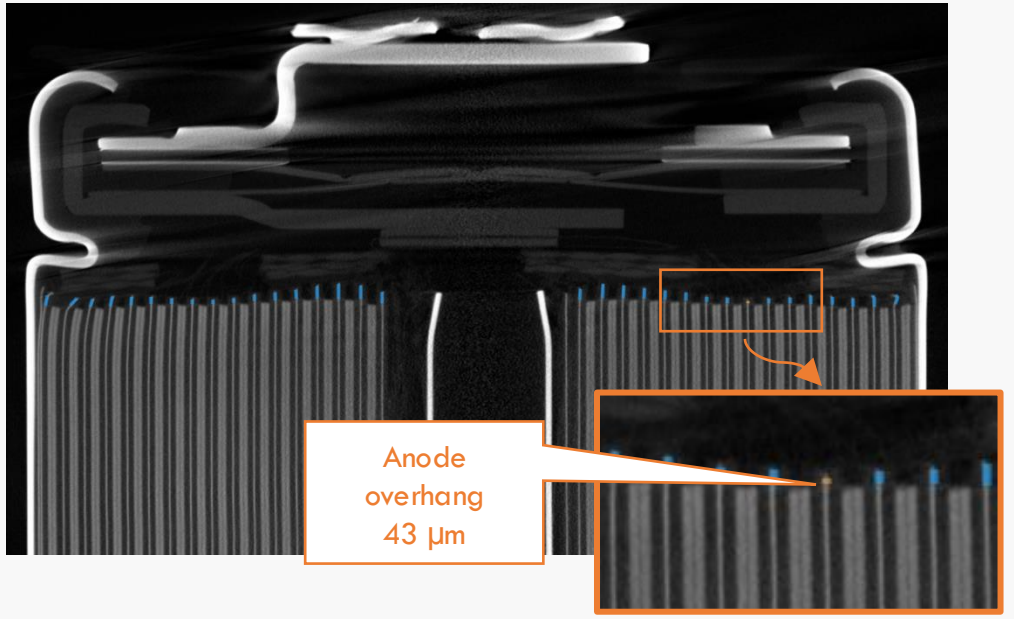
NEGATIVE OVERHANG



2.5%

of cells scanned

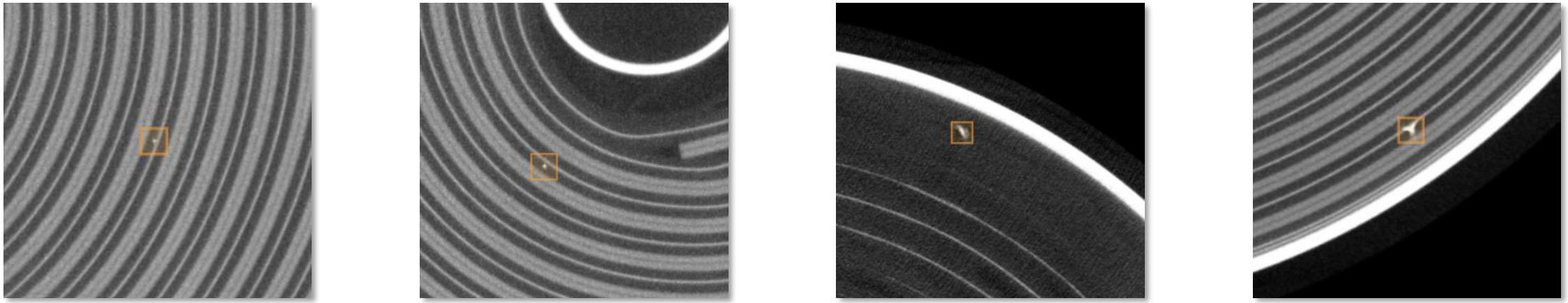
INSUFFICIENT OVERHANG (< 100 µm)



12%

of cells scanned

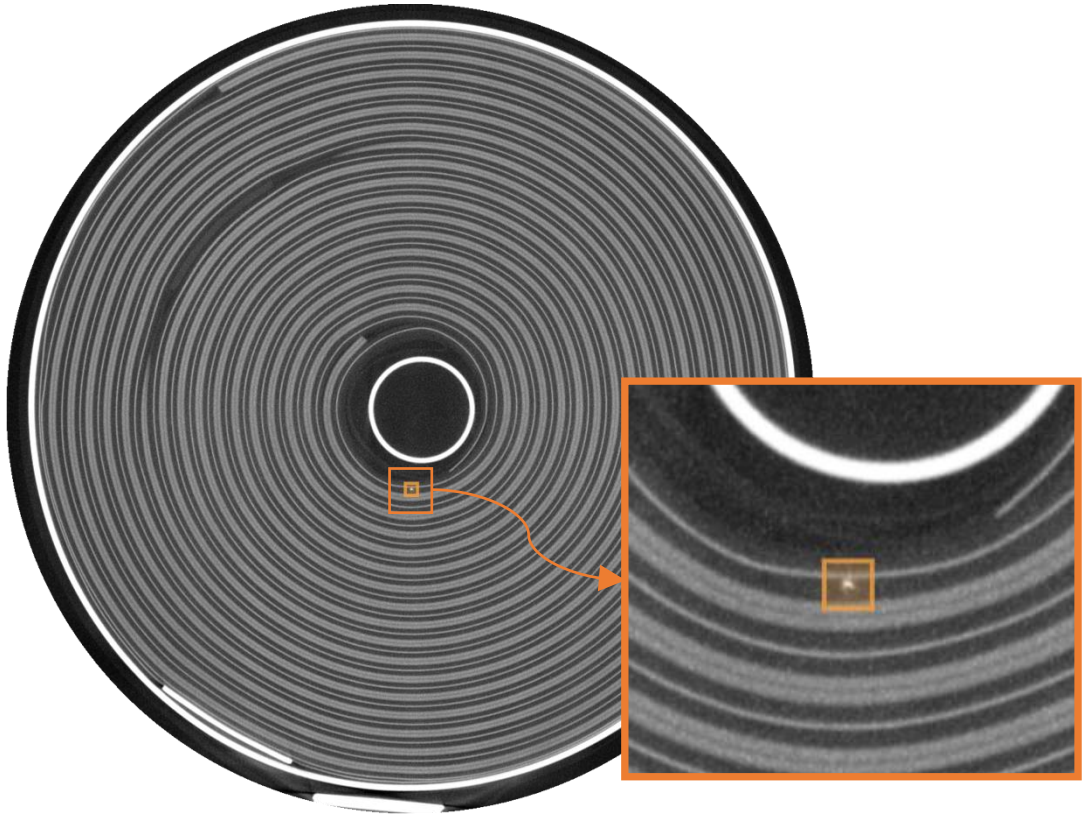
METALLIC PARTICLES & FOREIGN OBJECT DETECTION



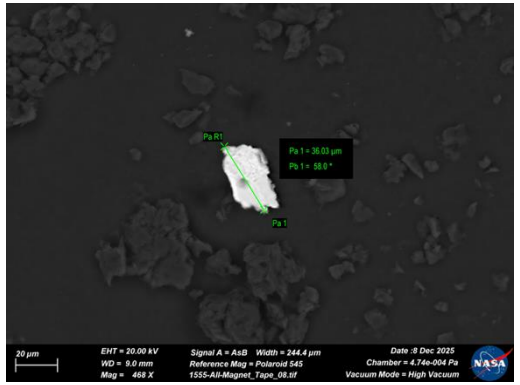
CT analysis of 200 cells identified 15 containing high-density anomalies consistent with metallic contamination - 8 within the jellyroll and 7 near the can wall or CID region

NASA IS FURTHER INVESTIGATING THESE SUSPECTED PARTICLES

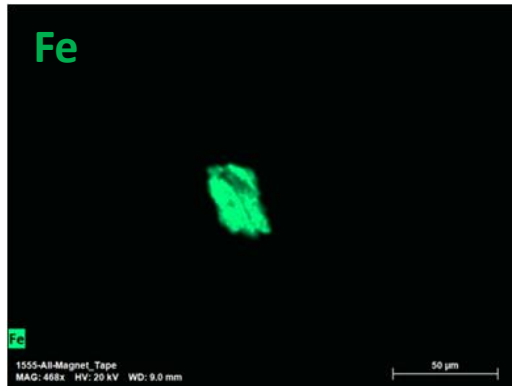
RESULTS OF NASA DESTRUCTIVE TESTING (SEM / EDS)



SEM



EDS

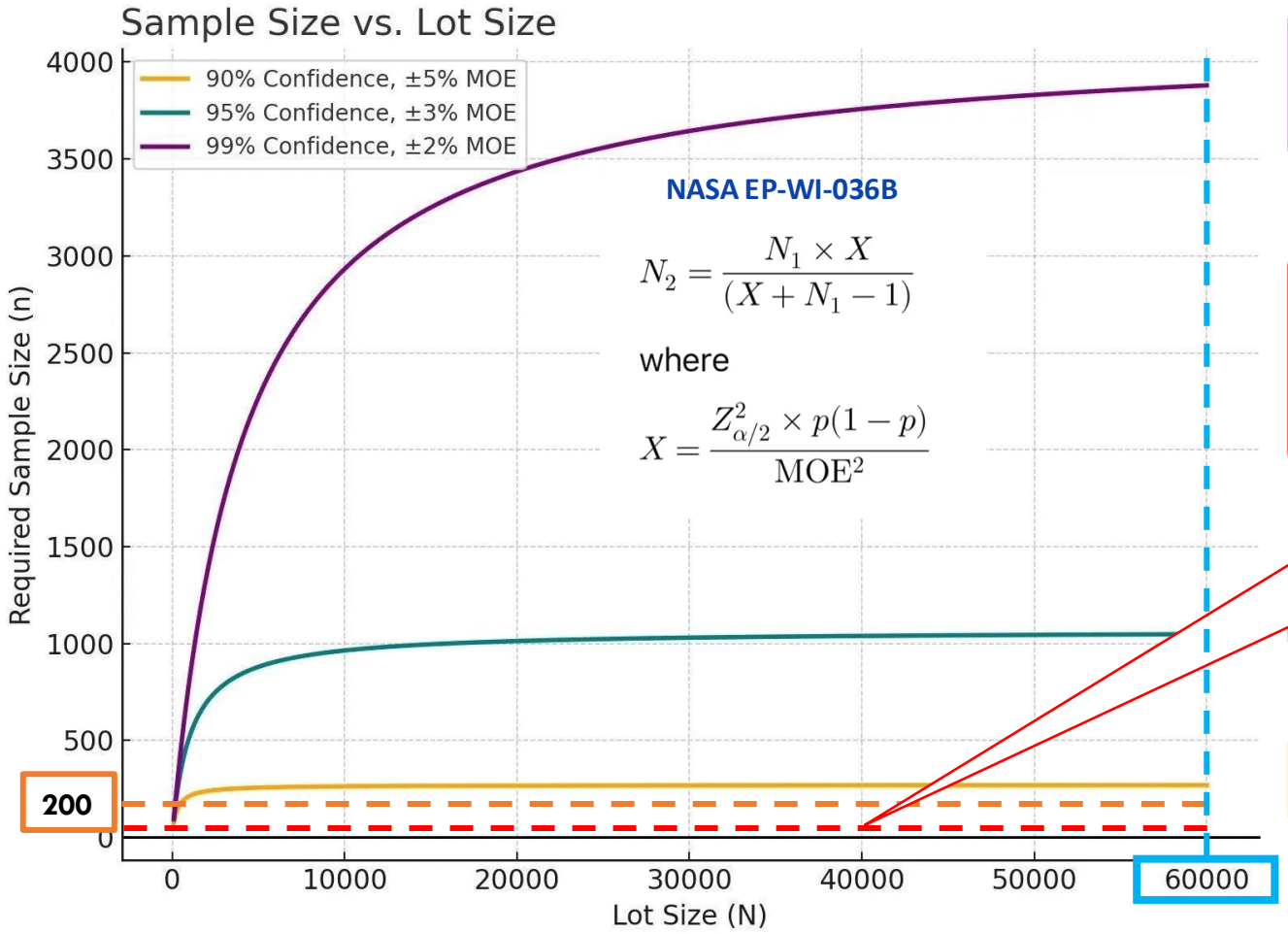


- CT-identified high-density region localized within the jellyroll
- Targeted destructive analysis performed by NASA
- SEM / EDS suggests the presence of an iron (Fe) particle
- Suggests CT finding was not an imaging artifact or a false positive

RESULTS: OBSERVED DEFECT RATES FROM THE 200 CELL SAMPLE

		Number of inspected cells with defects	Defective cell rate		Implied total defective cells
Anode	• Negative overhang (top & bottom) • Asymmetry	5	2.5%	⇨	1,500
Can	• Max denting • Circularity • Inner & outer diameter • Wall thickness	0	0%	⇨	0
Crimp	• Crimp height • Groove gap	0	0%	⇨	0
Core	• Area • Concentricity • Effective diameter • Circularity • Jellyroll buckling	0	0%	⇨	0
Foreign Objects	• Metallic-particle detection	15	7.5%	⇨	4,500

HOW MANY CELLS SHOULD IDEALLY BE SCANNED FOR FLIGHT LOTS?



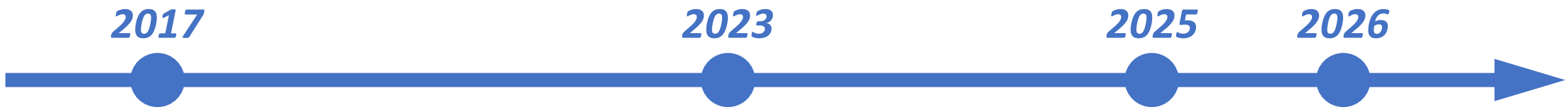
99% confidence with +/- 2% MOE → 3,880 cells

14 scans provide only ~64% confidence (±5%) for a 60,000-cell lot - far below NASA's 90% standard.

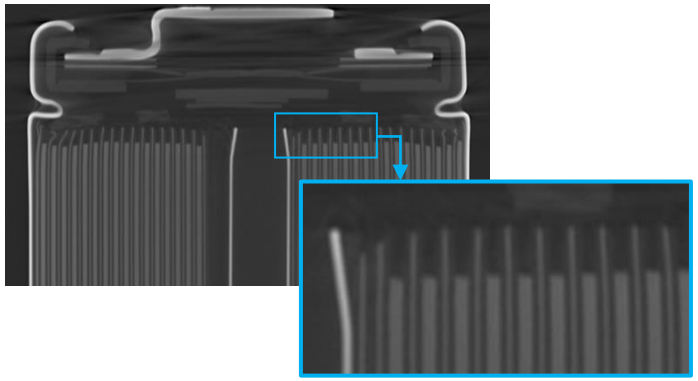
95% +/- 3% → 1,050 cells

90% +/- 5% → 270 cells

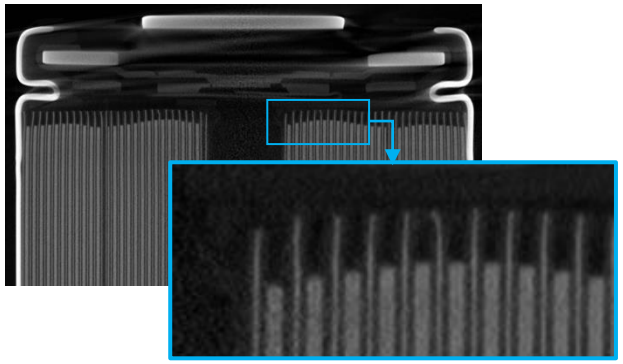
CT TECHNOLOGY CONTINUES TO ADVANCE, ENABLING GREATER SCANNING VOLUME



8 hrs

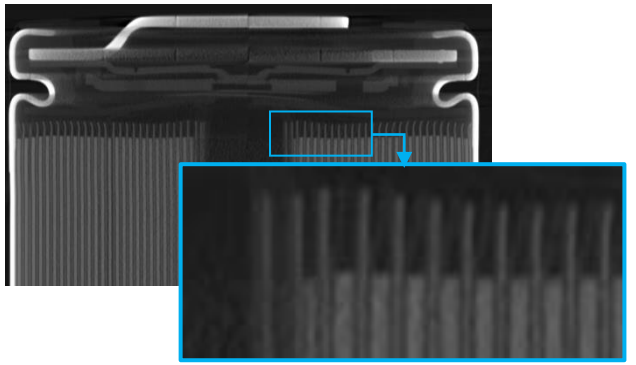


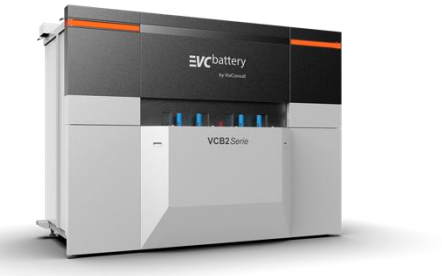
2 min



10 sec

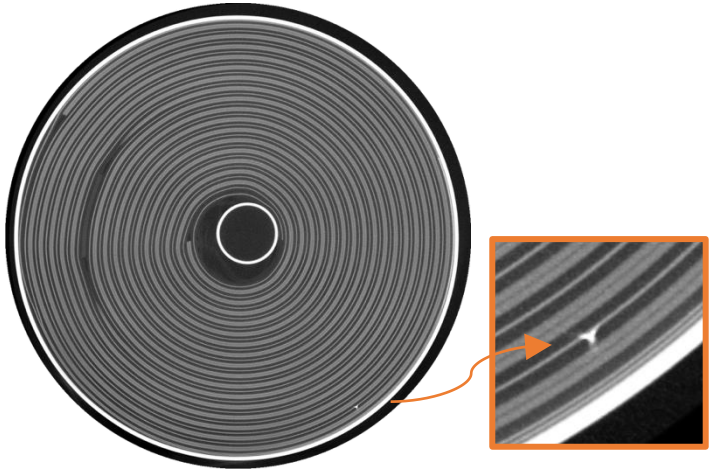
5 sec

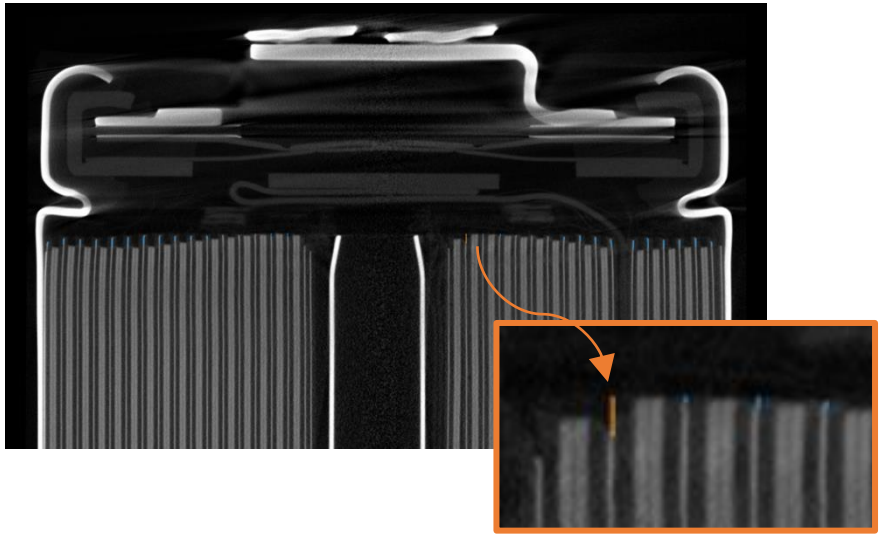




CONCLUSIONS

- Glimpse identified overhang violations and metallic particles previously missed in NASA's 2017 lot evaluation





- State-of-the-art CT technology enables 5 second scan time for full cylindrical cells
- Data management and automated inspection unlock fast time-to-insights from CT

High-throughput CT scanning makes large-sample evaluation practical for mission-critical qualification.

Easton Rasgon
easton@glimp.se

Sign up for our free demo:
https://app.glimp.se/