Yardney Lithion

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# Development of 120V Batteries for the Orion Crew Exploration Vehicle

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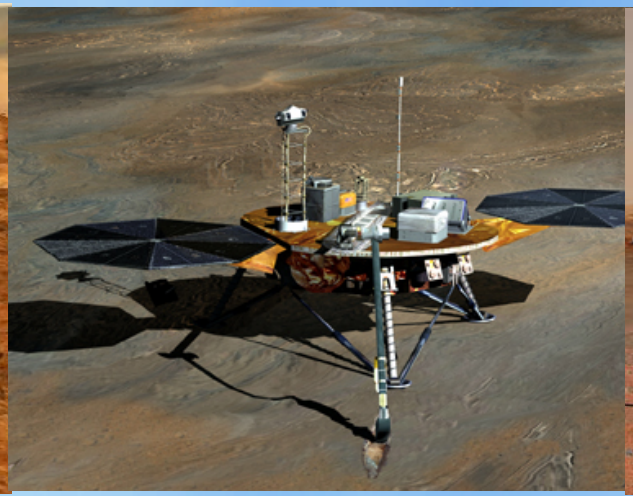
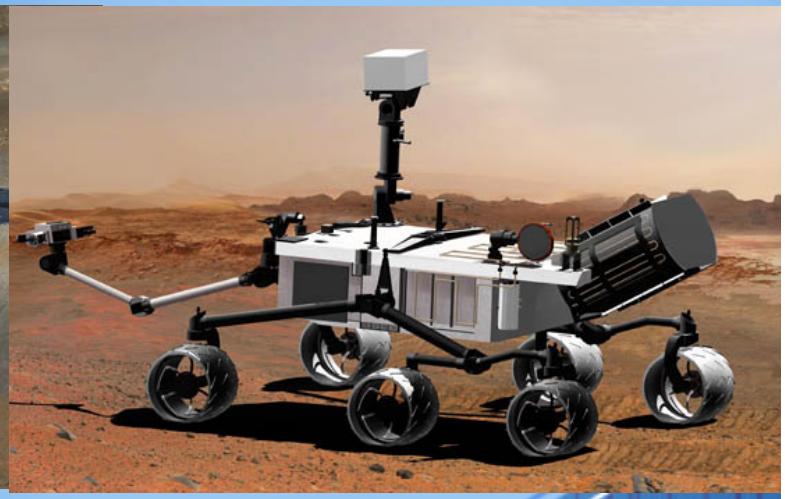
# Long History of Space Programs

- NASA Mars Missions…
  - MER Spirit and Opportunity – the 90 day missions that keep going after almost 7 years!
  - Phoenix Lander – MSP01 Design finally made it (and worked great!)
  - The Mars Science Laboratory has a 2,000 day baseline





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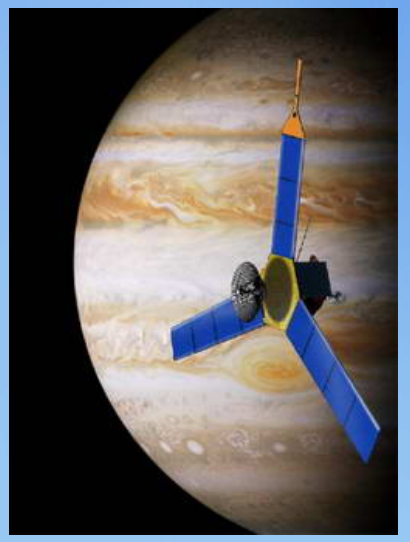
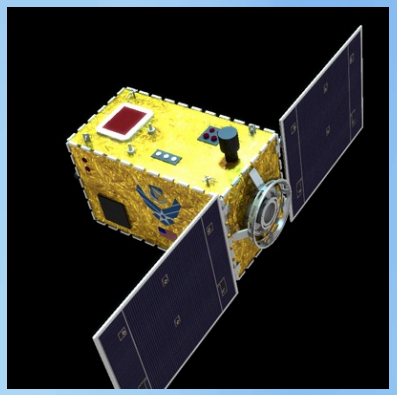
# And Others…

- Several Satellite Missions
  - Orbital Express
  - XSS-11
  - WISE
  - STP/SIV
  - Juno & GRAIL coming soon
- Launch Vehicles and more….



WISE

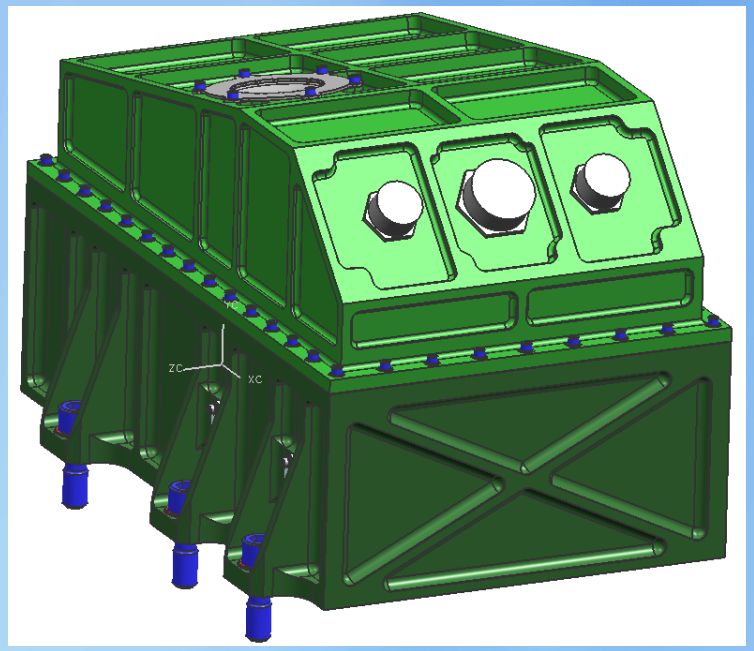


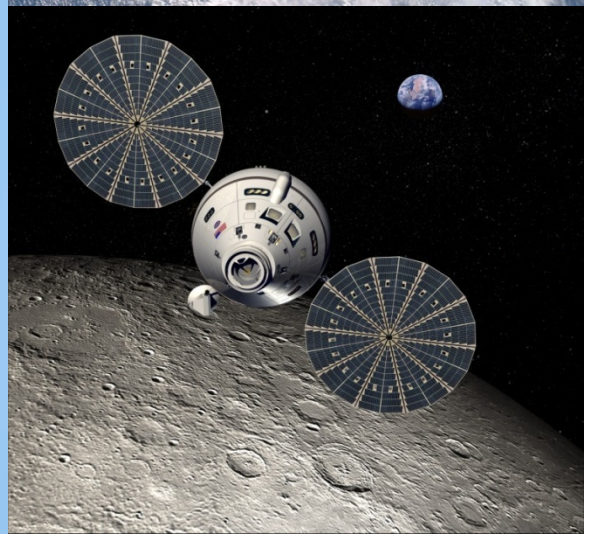
GRAIL

# NASA/Lockheed Orion/CEV

***120Volt, 30 Ah Lithium-ion Batteries in Crew Module***

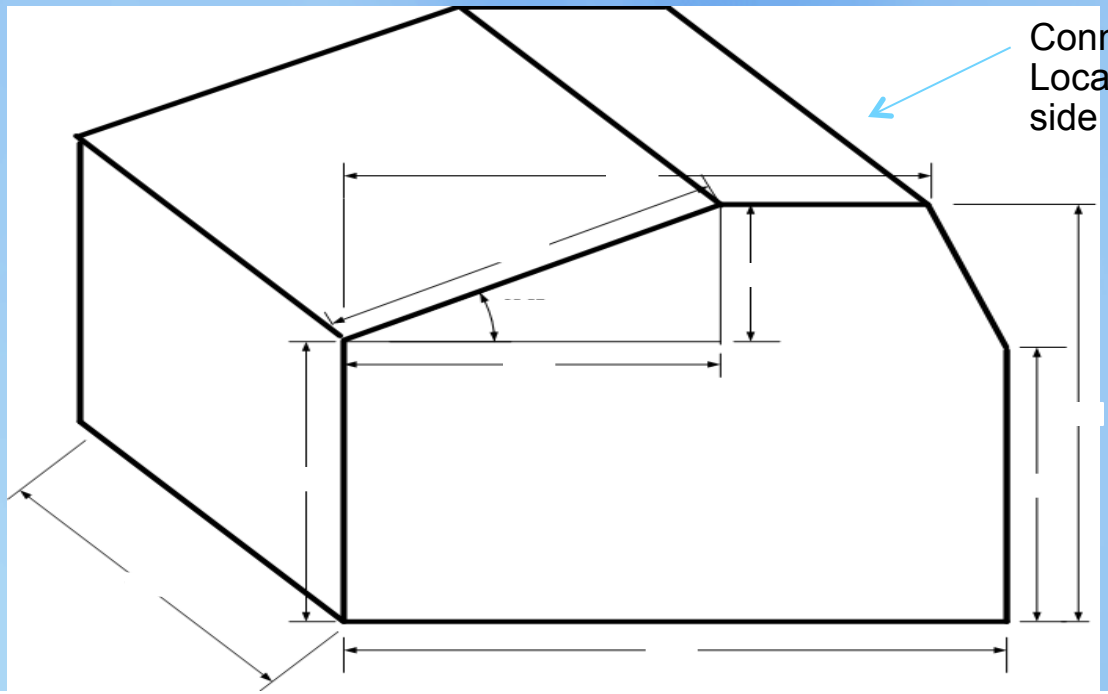
- Next Generation crew piloted spacecraft
  - Multi-Mission Capable (ISS/ Lunar Orbit)



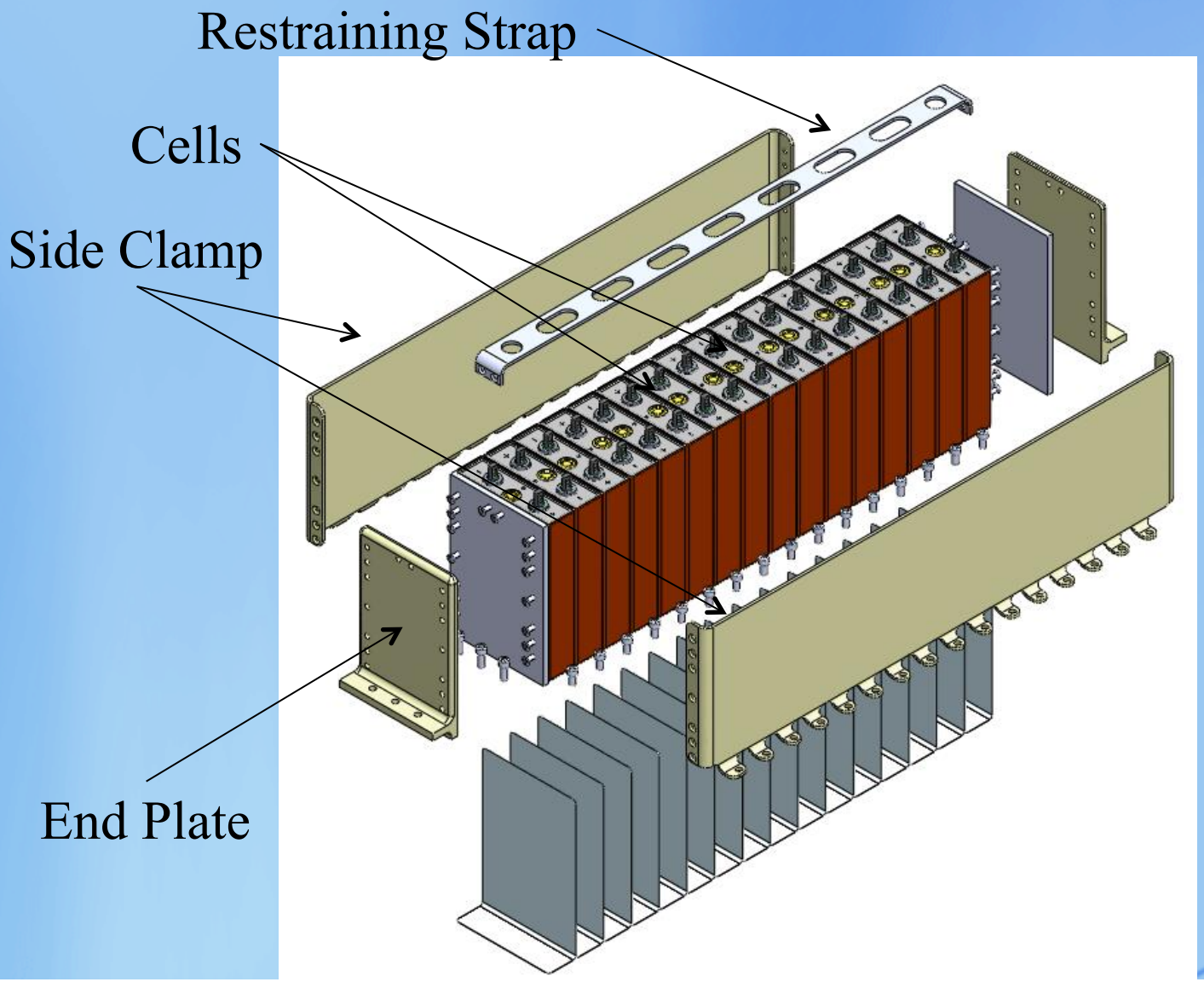


# First Challenge – Fit within available envelope

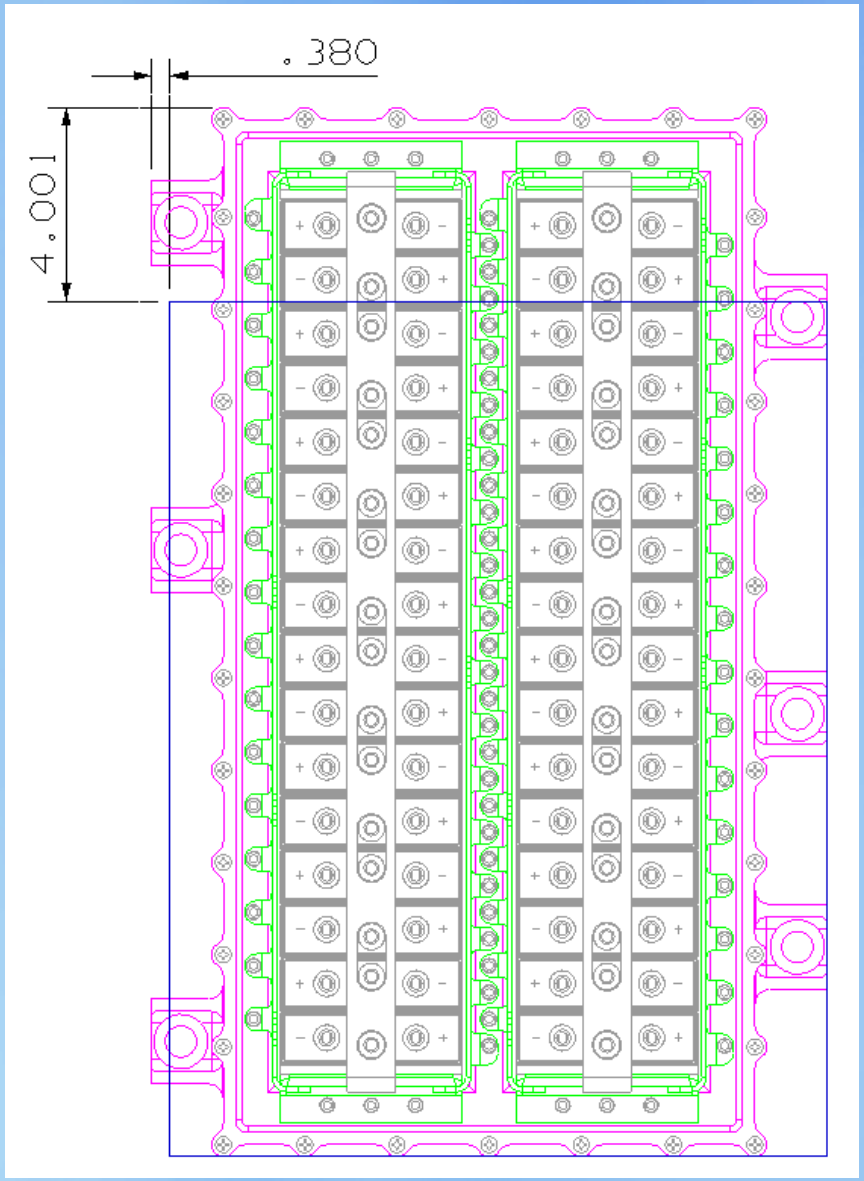
- Change to 120V system left little available space for battery design
- High vibration and shock loads required extremely robust structure
- Water tight for Splash-Down on re-entry



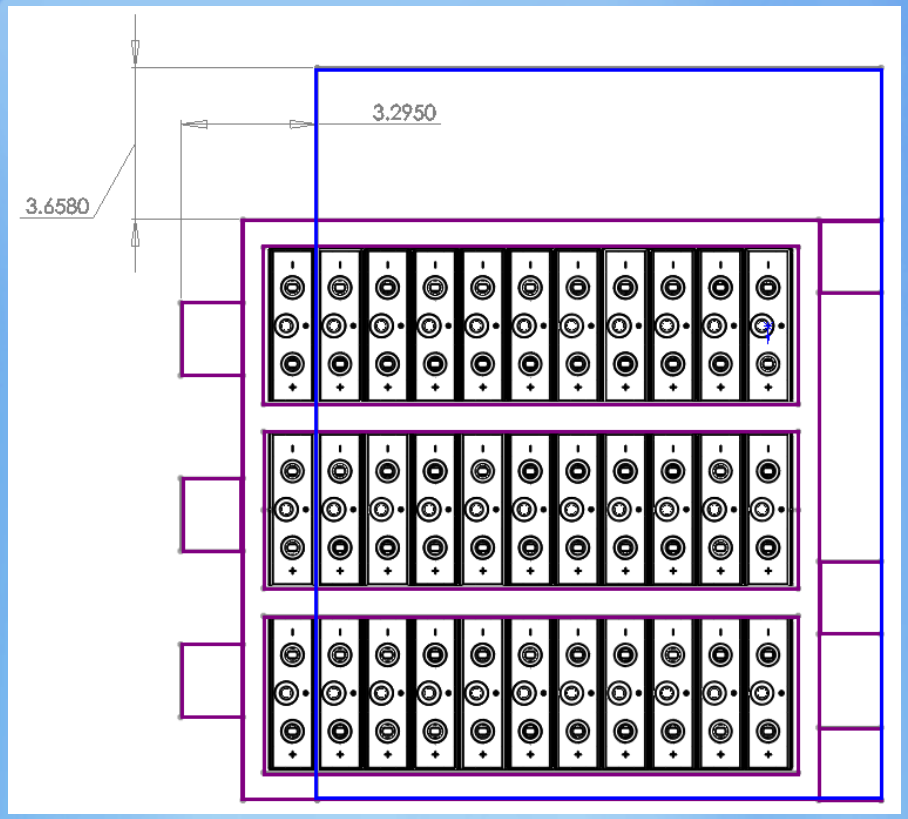
# "Standard" Cell Stack Configuration

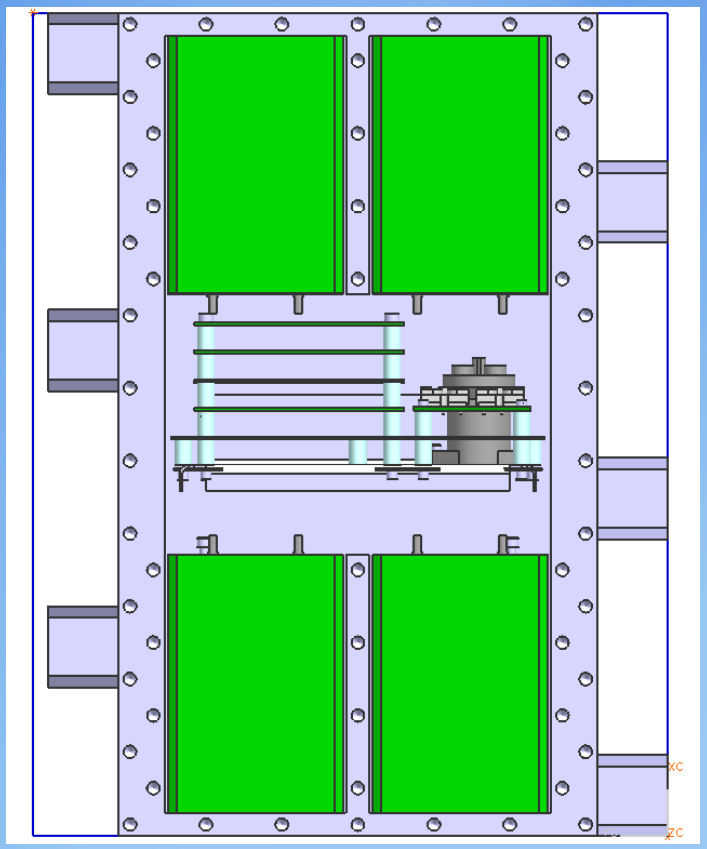


# Did not fit envelope



# Many other configurations investigated

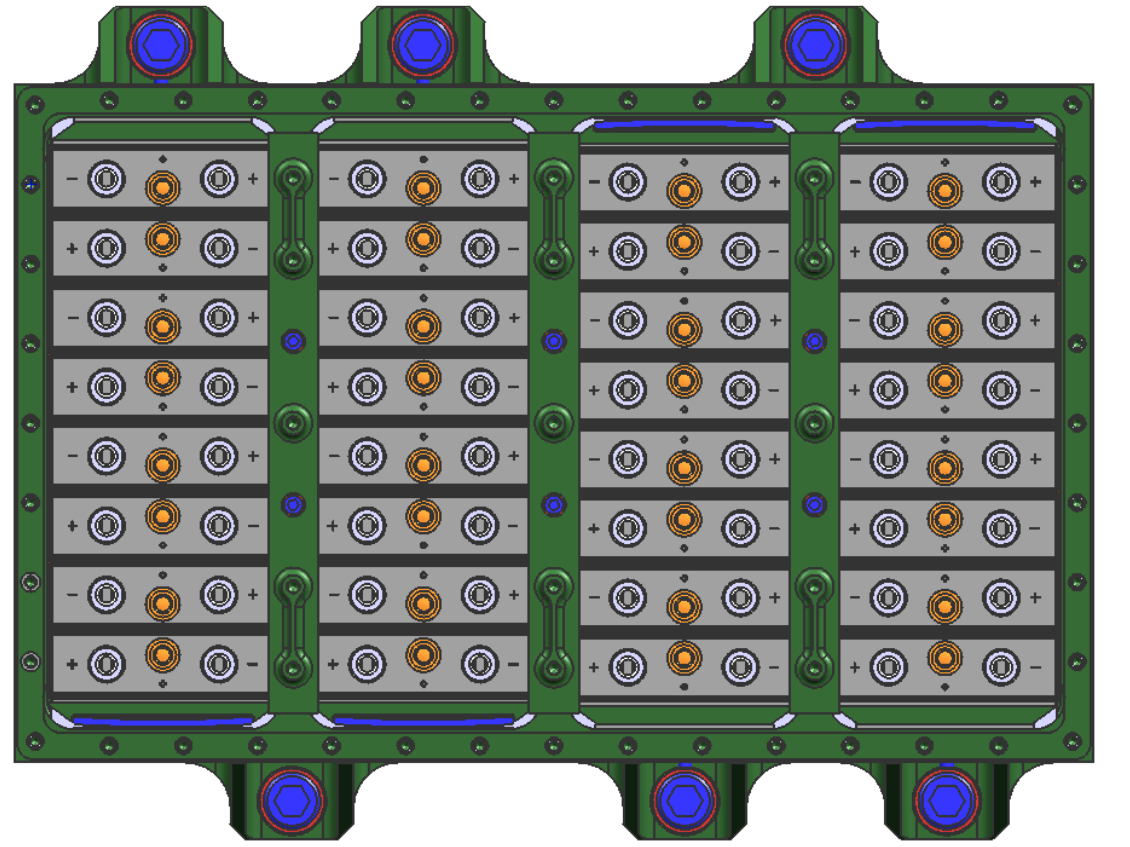


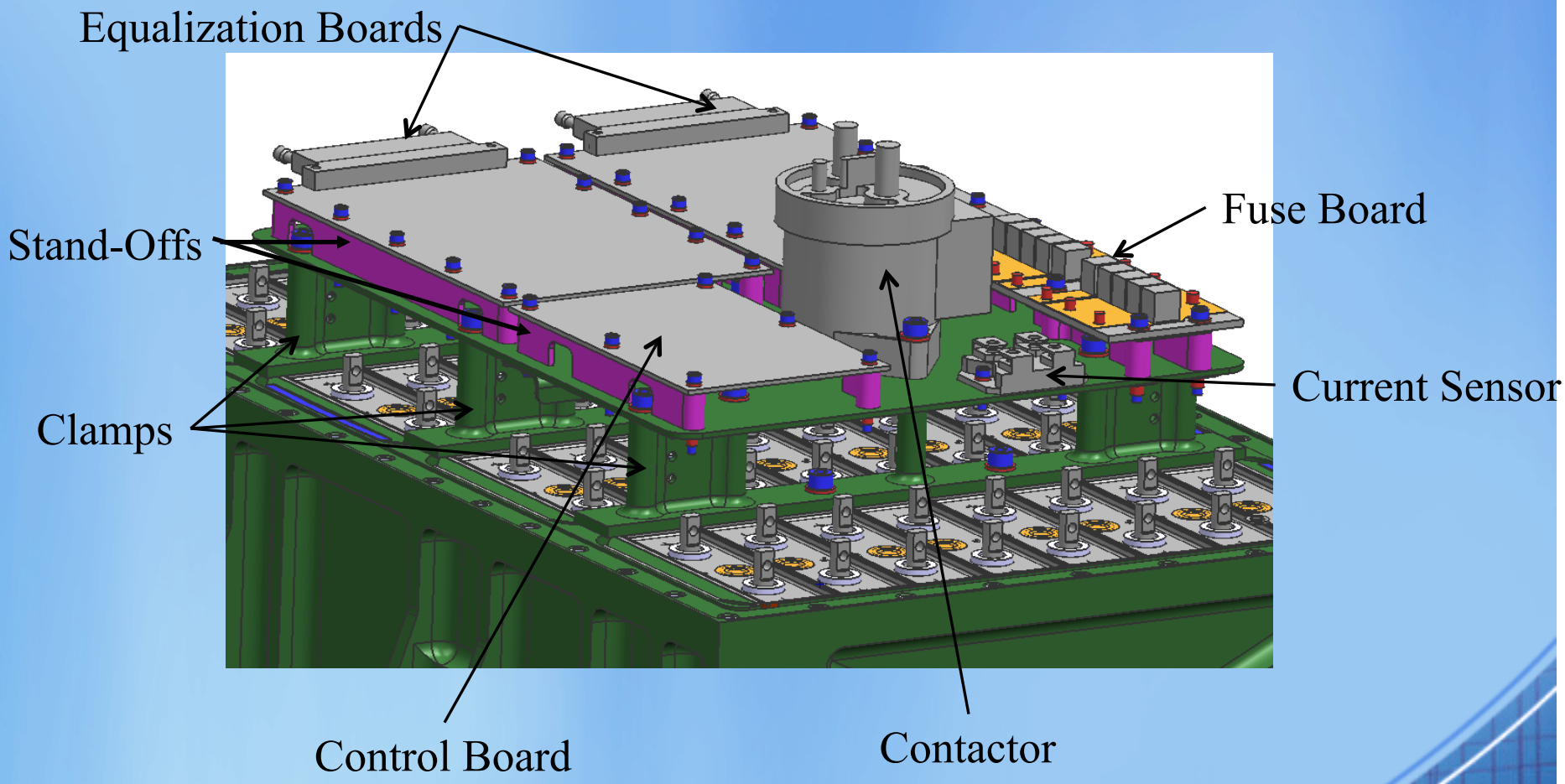
- Looked at range of options and cells
  - Traditional and Non-Traditional layouts

# Selected Design

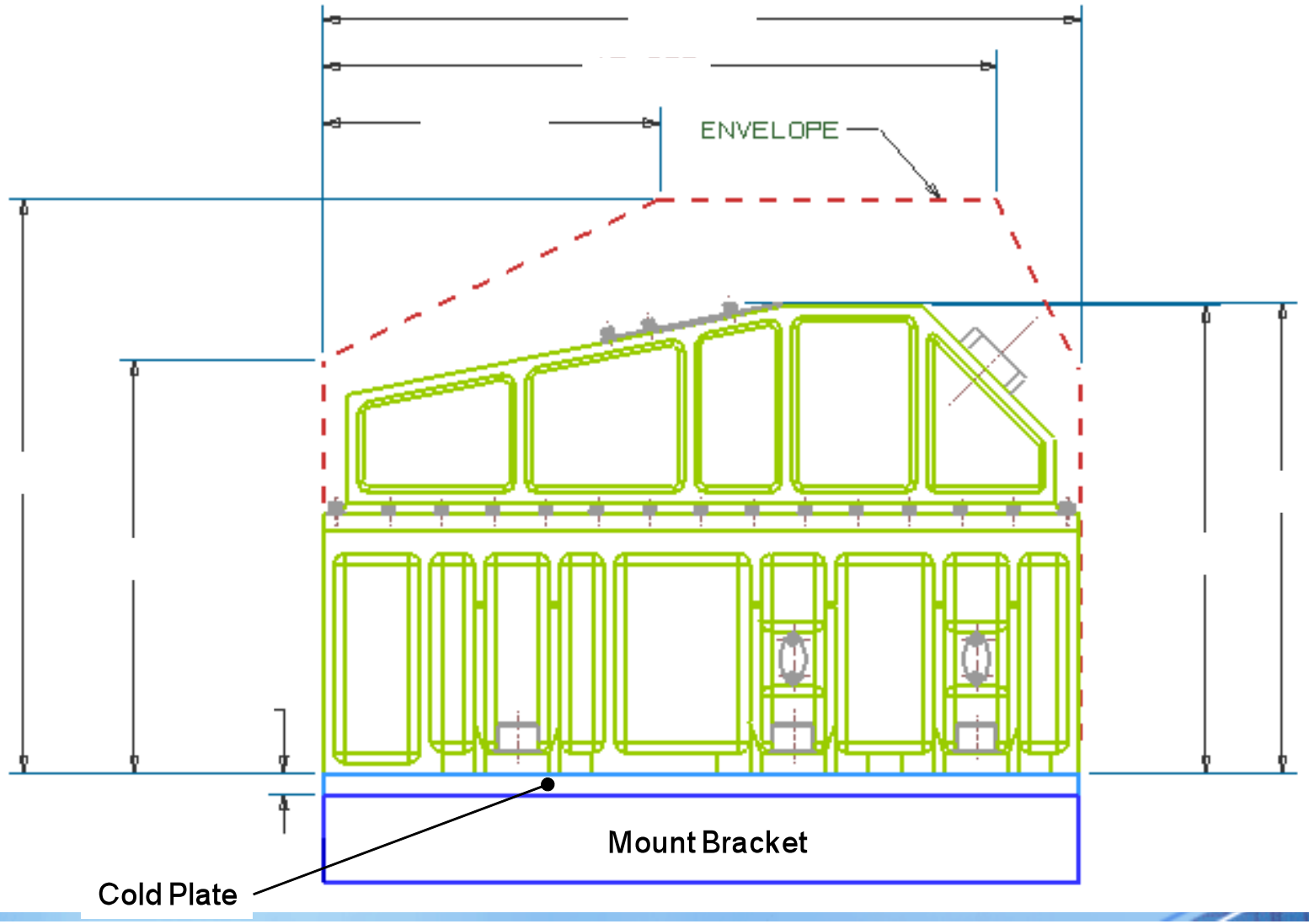
- Battery Housing provides constraint force
  - Push-rod and shim assembly technique



# Electronics Packaging

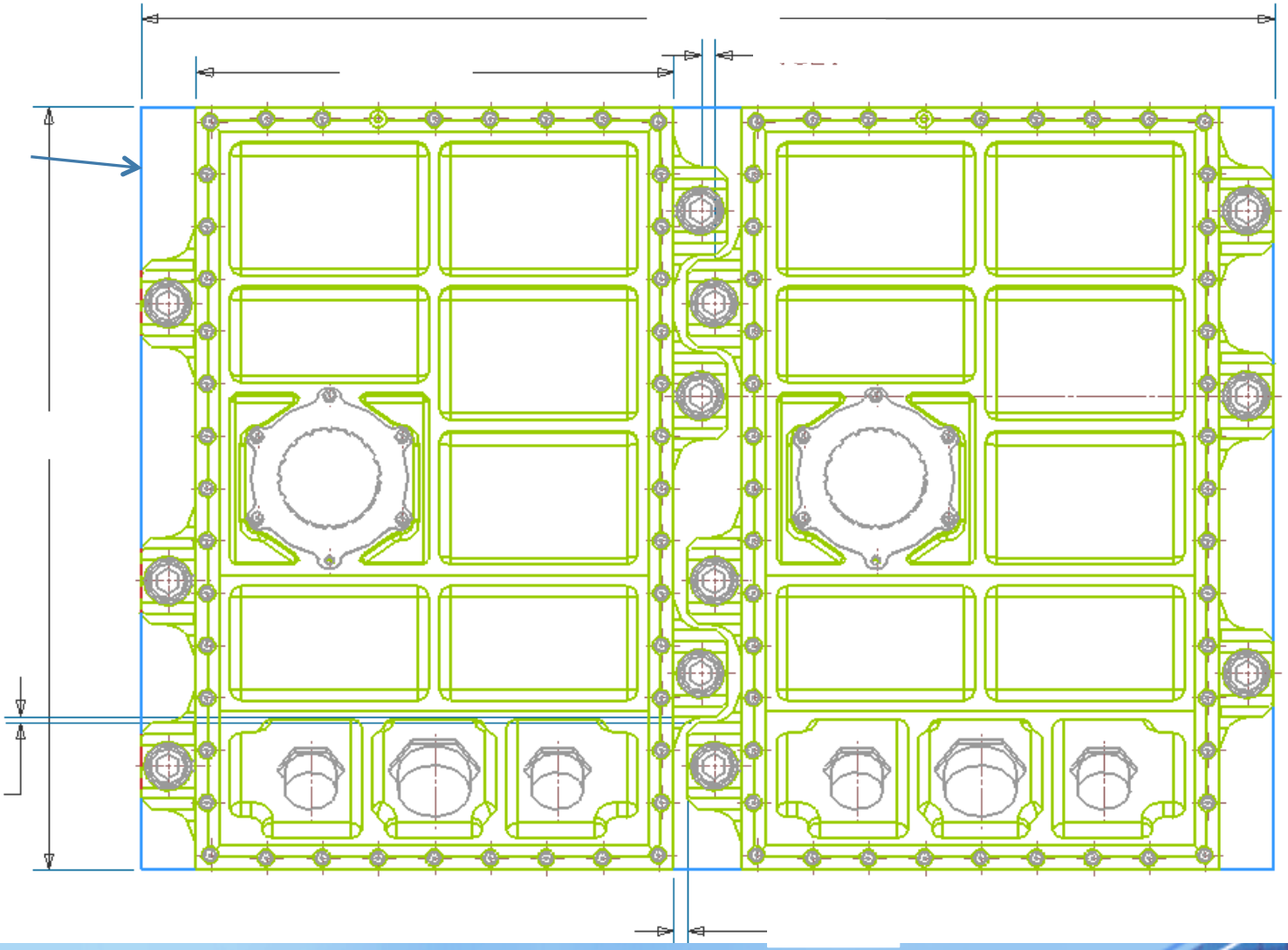


# Fits Within Envelope

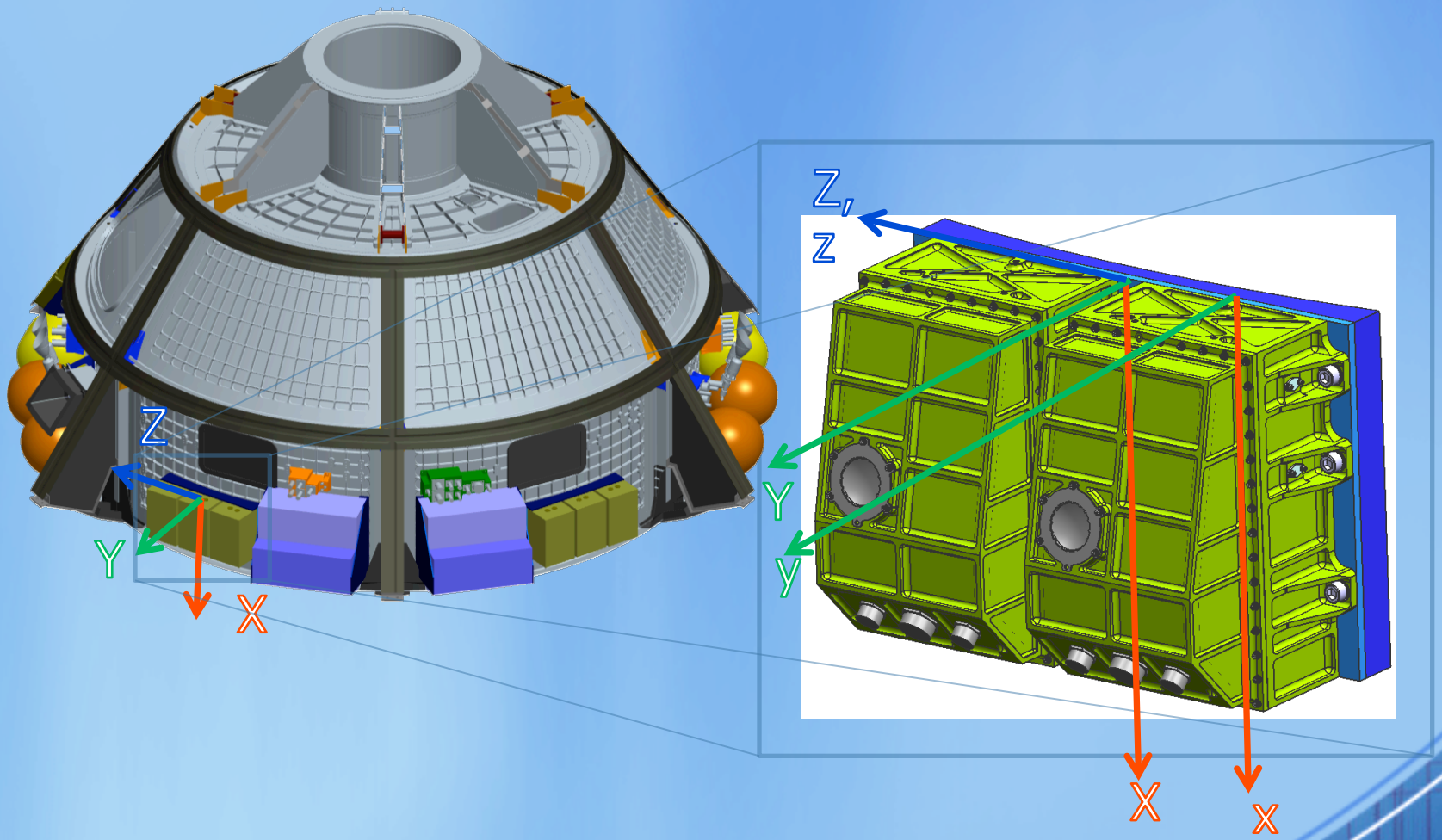


# Mounting

Cold Plate and Envelope



# Tandem Module Installation



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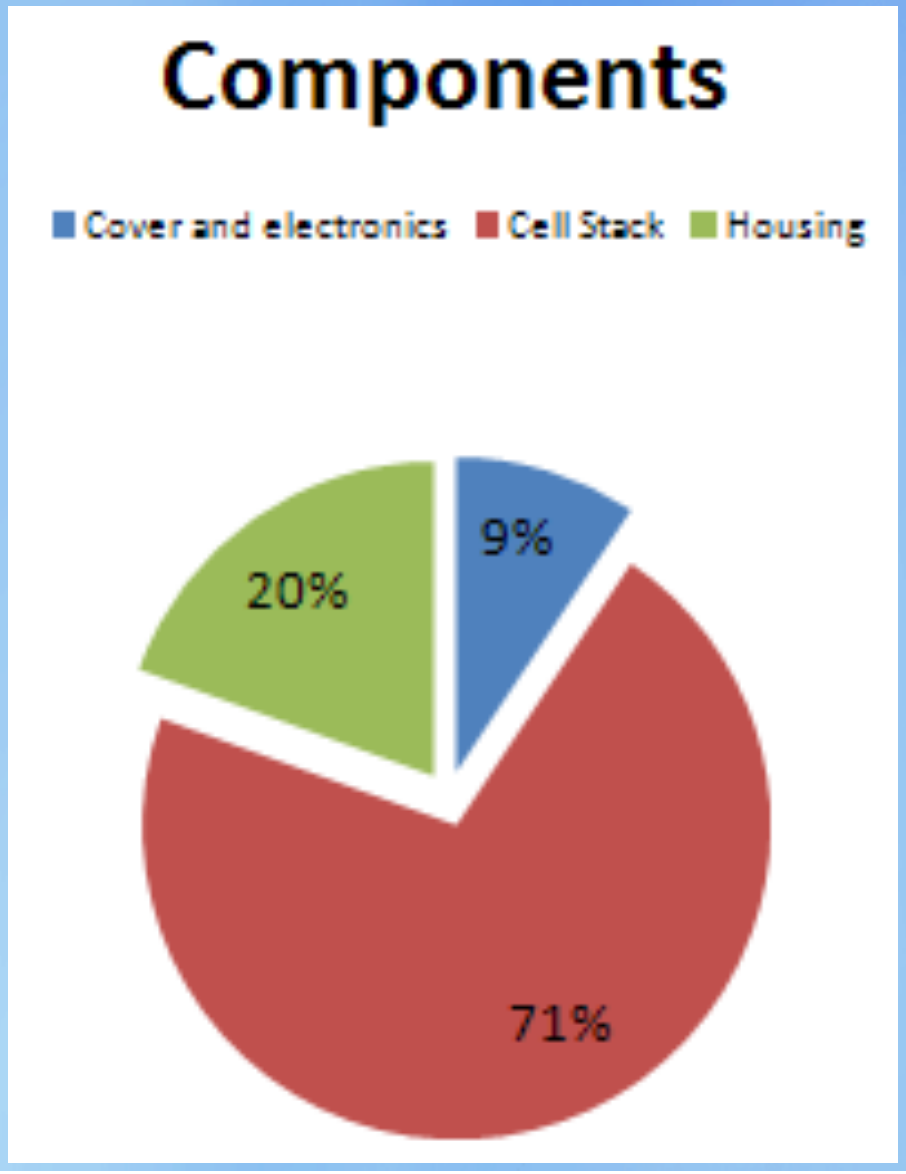
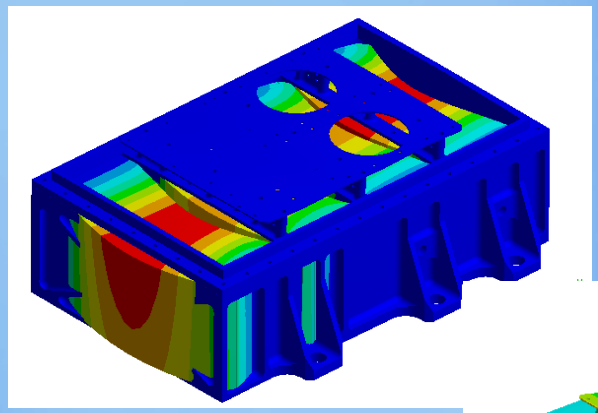
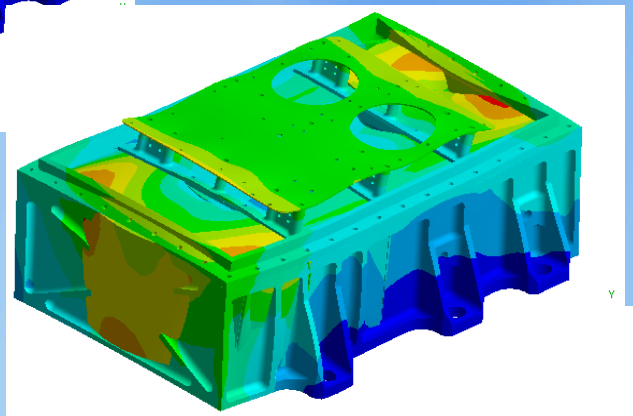
# Weight Analysis



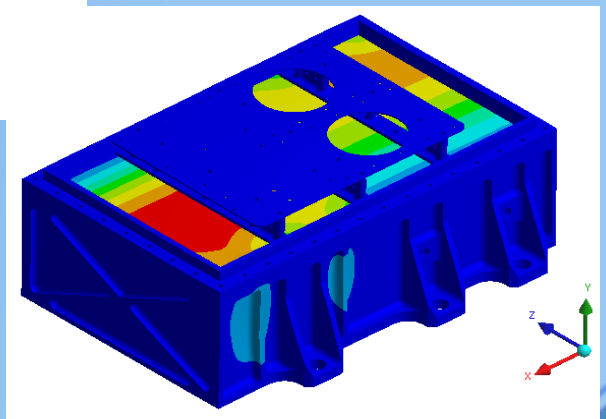
# Structural and Thermal Analysis Complete



X-Direction



Y-Direction



Z-Direction

# New Materials Evaluation Plan

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## Coating Lots

| Lot ID | Coating | Active | Binder |
|---|---|---|---|
| **C-1** | Cathode | LiNiCoO2 | Baseline |
| **C-2** | Cathode | LiNiCoAlO2 | Current Binder |
| **C-3** | Cathode | LiNiCoAlO2 | New Binder |
| **Lot ID** | **Coating** | **Active** | **Binder** |
| **A-1** | Anode | MCMB | Baseline |
| **A-2** | Anode | Anode 1 | Current Binder |
| **A-3** | Anode | Anode 1 | New Binder |
| **A-4** | Anode | Anode 2 | New Binder |

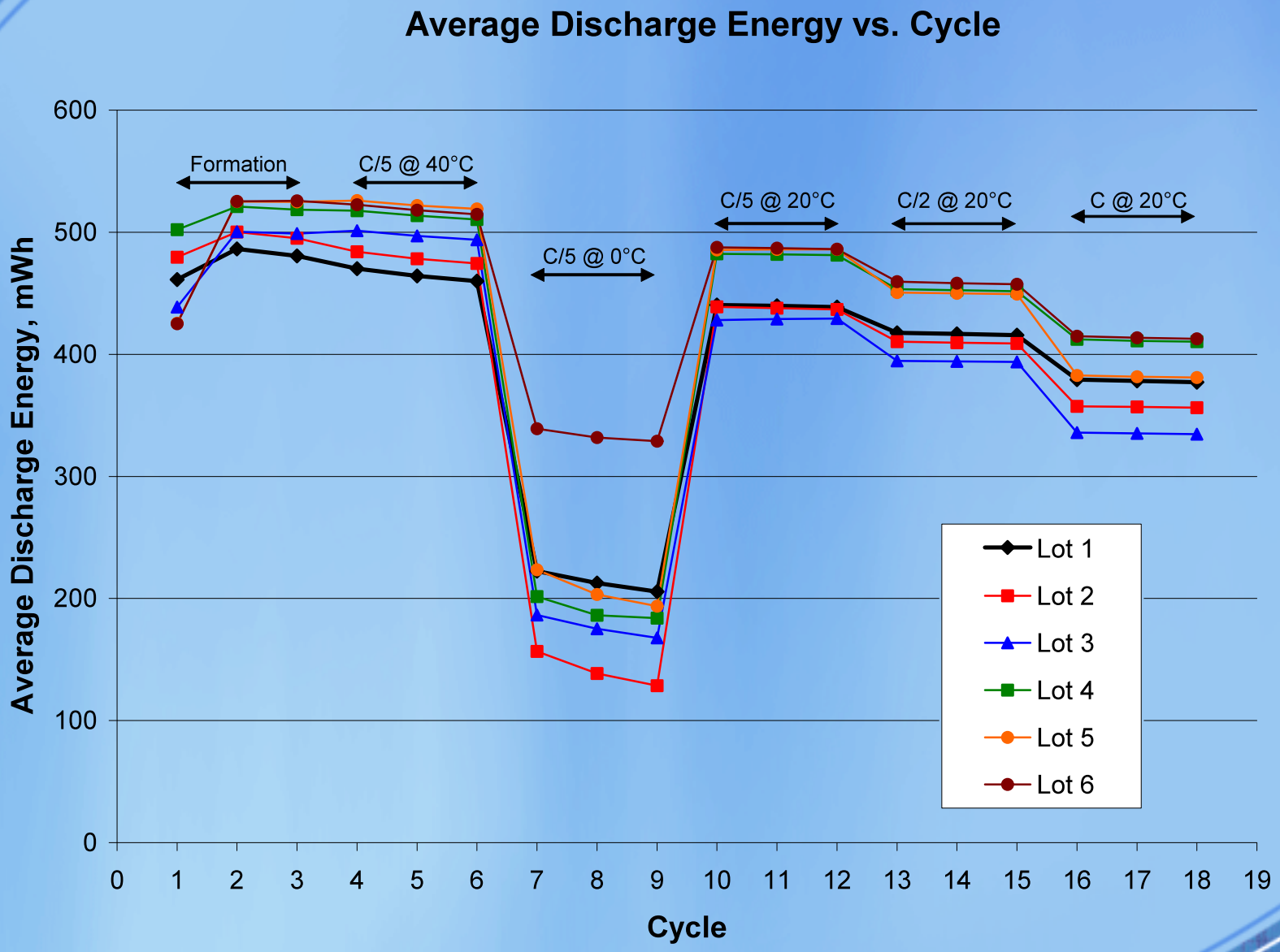
## Cell Build Lots

| | A-1 | A-2 | A-3 | A-4 |
|---|---|---|---|---|
| **C-1** | X | - | - | - |
| **C-2** | X | X | X | - |
| **C-3** | - | - | X | X |

Pouch Cell Assembly, Partial Factorial Matrix → Data/Cell Lot Reduction → Full Size Cell Build (2-3 Lots Max) → Build for Deliverable Batteries*

*after the final chemistry is selected

# Results to Date



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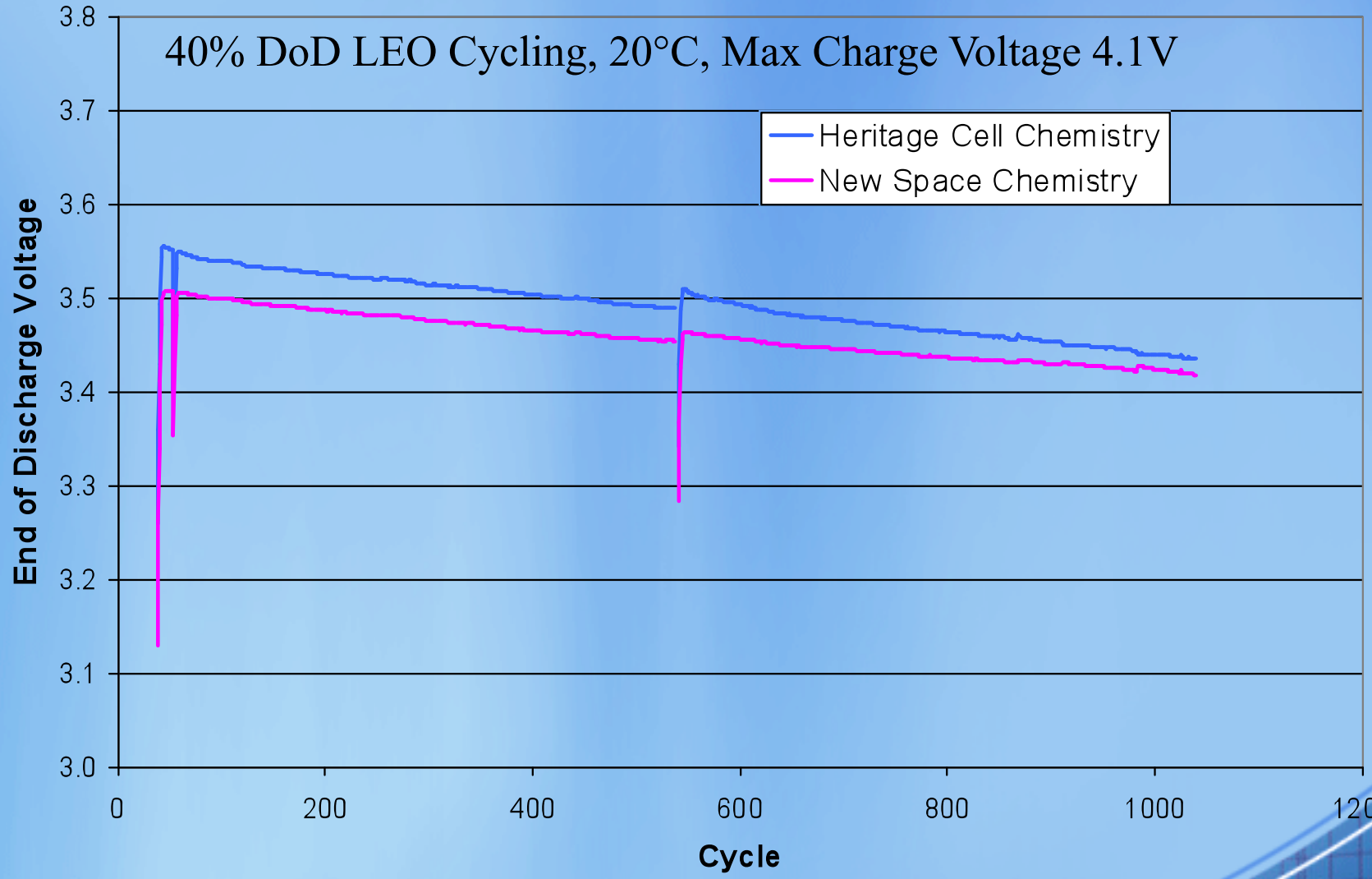
# Preliminary Life Testing



# Manufacturing Upgrades

Supporting Large-scale production for all Yardney Lithium-ion Programs

# Recent Equipment Acquisition – March 2010

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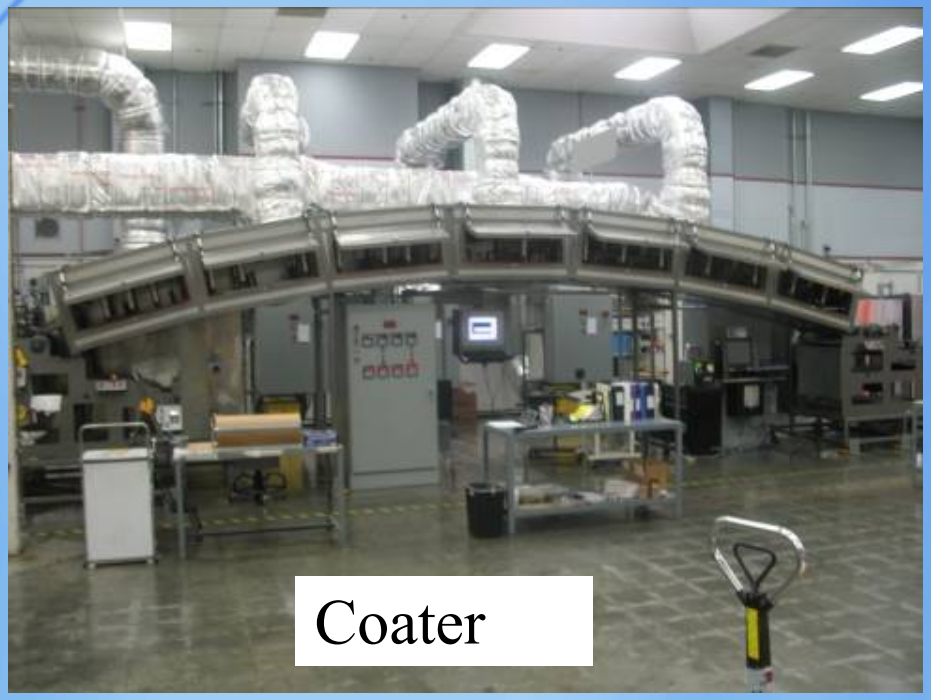
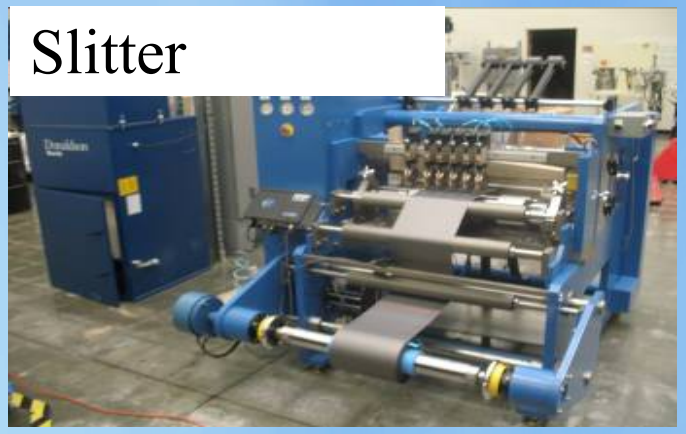


Coater

Three Large Dry Rooms

Calender

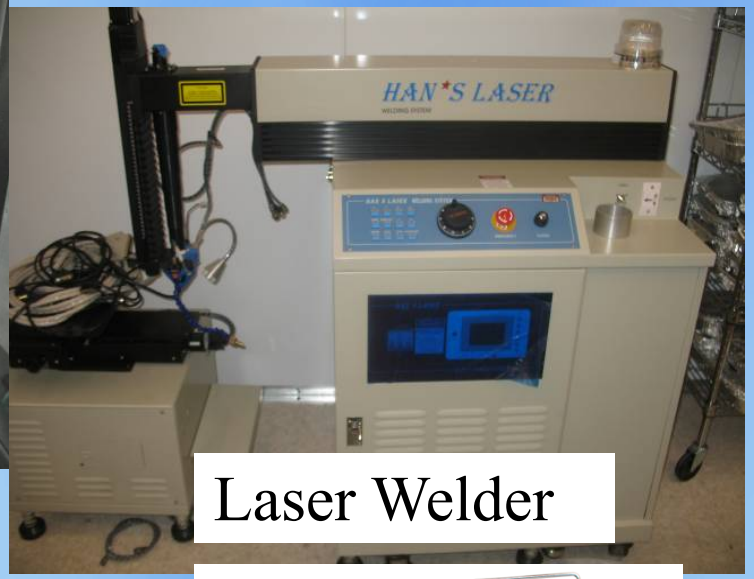


Slitter

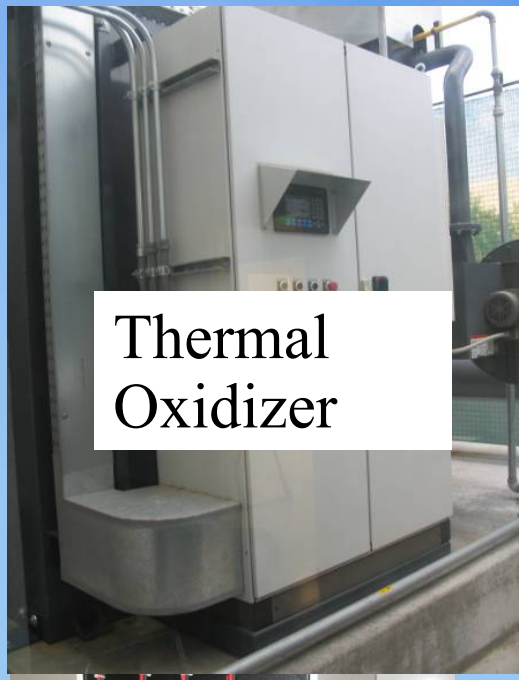
Dry Room ECS

# Miscellaneous

Gamma Backscatter

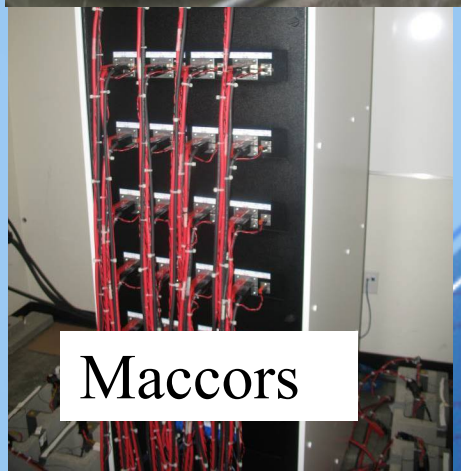



Laser Welder



Thermal Oxidizer

Mixers

Maccors

# New Equipment Summary

- The purchase of the new Equipment in March 2010 more than doubles our electrode production capability
- Additional automation equipment is planned in the near term
- New/Improved Facility required for implementation

# Acknowledgments


- Lockheed Martin Space Systems Company and NASA JSC for funding and technical support

- Co-workers and Colleagues at Yardney

- Other consultants and subcontractors who have assisted in the development of this battery design