Cross-Disciplinary Technical Problem: Delivery of a NASA Scientific Payload to the International Space Station

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- *Plant Habitat (PH)*
  - Self-sustaining biological growth chamber
    - Used for the study of long-term effects of microgravity on plant specimens
    - Aid to the International Space Station (ISS) crew
      - Advancement in life-support systems
      - Positive feedback psychological response
  - Designed by team of NASA engineers
    - Team consists of mechanical, electrical, avionics, fluids, materials, and systems engineers
    - Extended team includes project management, program representatives, NASA Chief Engineering, and subject-matter expert scientists
  - Anticipated customers:
    - U.S. Department of Agriculture
    - National Science Foundation
    - Commercial agribusiness
  - Estimated launch date of 2015

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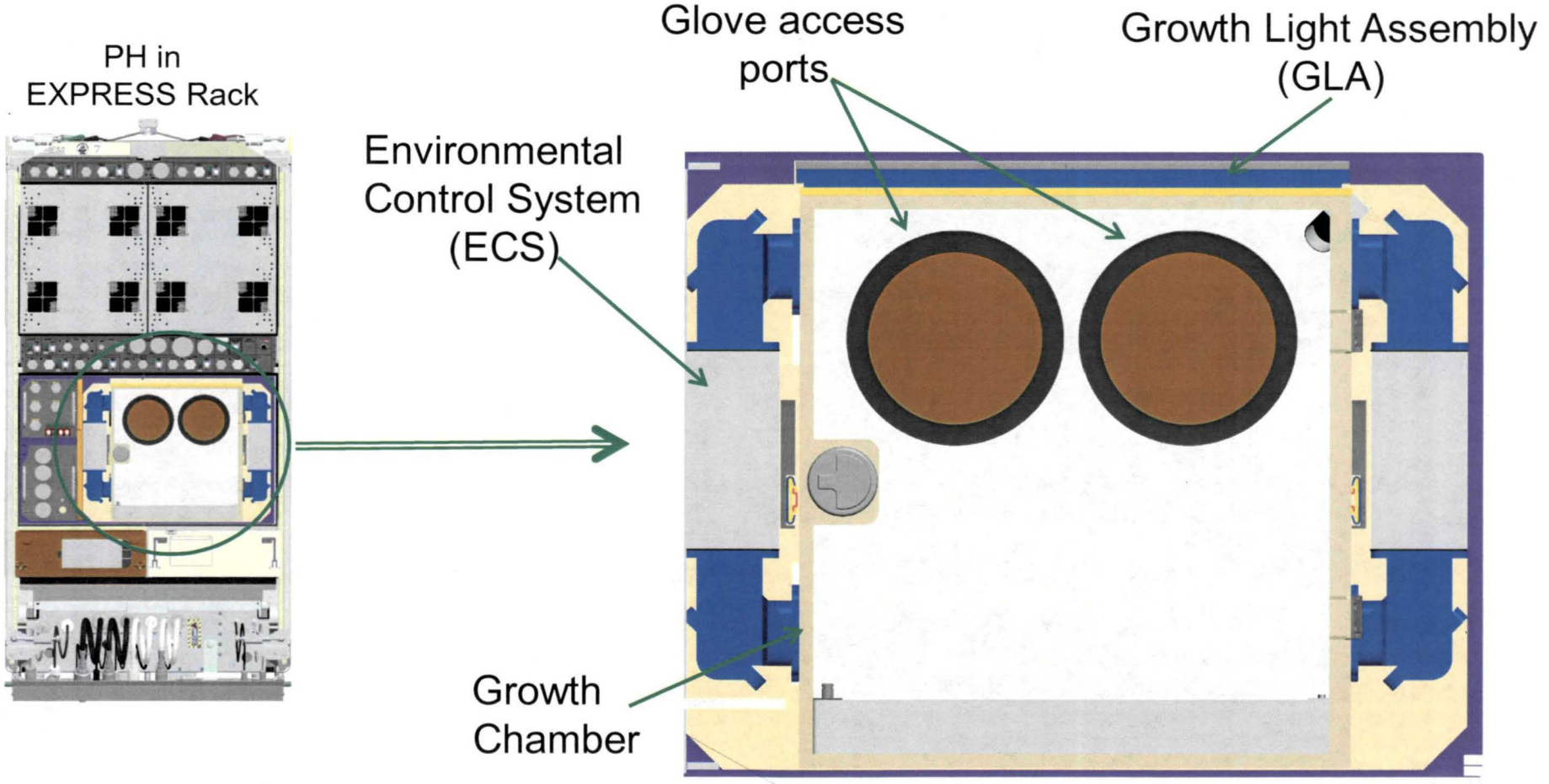

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- *Problem*

Program management directed the Engineering team to study how to fit PH within a M03 cargo transfer bag (CTB) while packed with perimeter-protective foam for stowage during launch

PH volume	M03 volume
36.75 in. x 23.5 in. x 21.75 in.	52.0 in. x 35.31 in. x 21.13 in.

Protective foam: 0.5 in. thickness

Height required to mount within EXPRESS Rack: 19.5 in.

Meet M03 bag and EXPRESS rack volume requirements:

1. Reduce PH growth chamber thickness by 0.25 in.
2. Remove 2 in. from growth chamber height
3. Decrease 3 in. from growth chamber depth

Final dimensions: 1) -2.25 in. PH height, 2) -3.00 in. growth chamber depth

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- *Impacts & Constraints*
  - Design
    - Mechanical
      - 2.00 in. reduction in growth height within growth chamber
        - ~15.5% decrease from original design
      - Smaller growth chamber volume impacts storage facilitation of PH items for launch
        - Additional CTBs (2-3) necessary
    - Fluids
      - Environmental Control System (ECS) redesign to accommodate for shorter growth height and decreased volume to account for lower flow rate; duct areas too large for new volume
    - Electrical
      - Growth Light Assembly (GLA) redesign to reduce light emitting diode (LED) luminous output due to reduction in shoot height
  - Science
    - Decreased capability for full-sized plant and certain plant species to produce O2 and food for the ISS crew
  - Personnel
    - Minimal experience of PH team designing scientific payloads
  - Schedule
    - Design process and review put on indefinite hold pending resolution
      - 6-week turnover for redesign proposal + 1-week redesign resolution and document prep

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An initial plan was being implemented by the design team to move the GLA to the top of PH, external to the housing. A simpler engineering approach was developed and presented to the team.

- *Redesign Proposal*
  - Growth Chamber
    - Transition PH to the uppermost area in the EXPRESS Rack locker, utilizing the mounting holes in the top two corners and mid-section of the EXPRESS Rack backplate
    - Extension through the bottom wall of PH to occupy remaining area within the EXPRESS Rack
      - Retain 2.00 in. Growth Chamber shoot height
- *Advantages*
  - Design
    - Minimal impacts to subsystem designs (Fluids, Electrical, Avionics)
    - Retain scientific mission to grow full-sized plants
  - Schedule
    - Continue design phase for subsystem prototyping and full system integration with minimal setback
- *Impacts*
  - Launch growth chamber in separate M01 CTB

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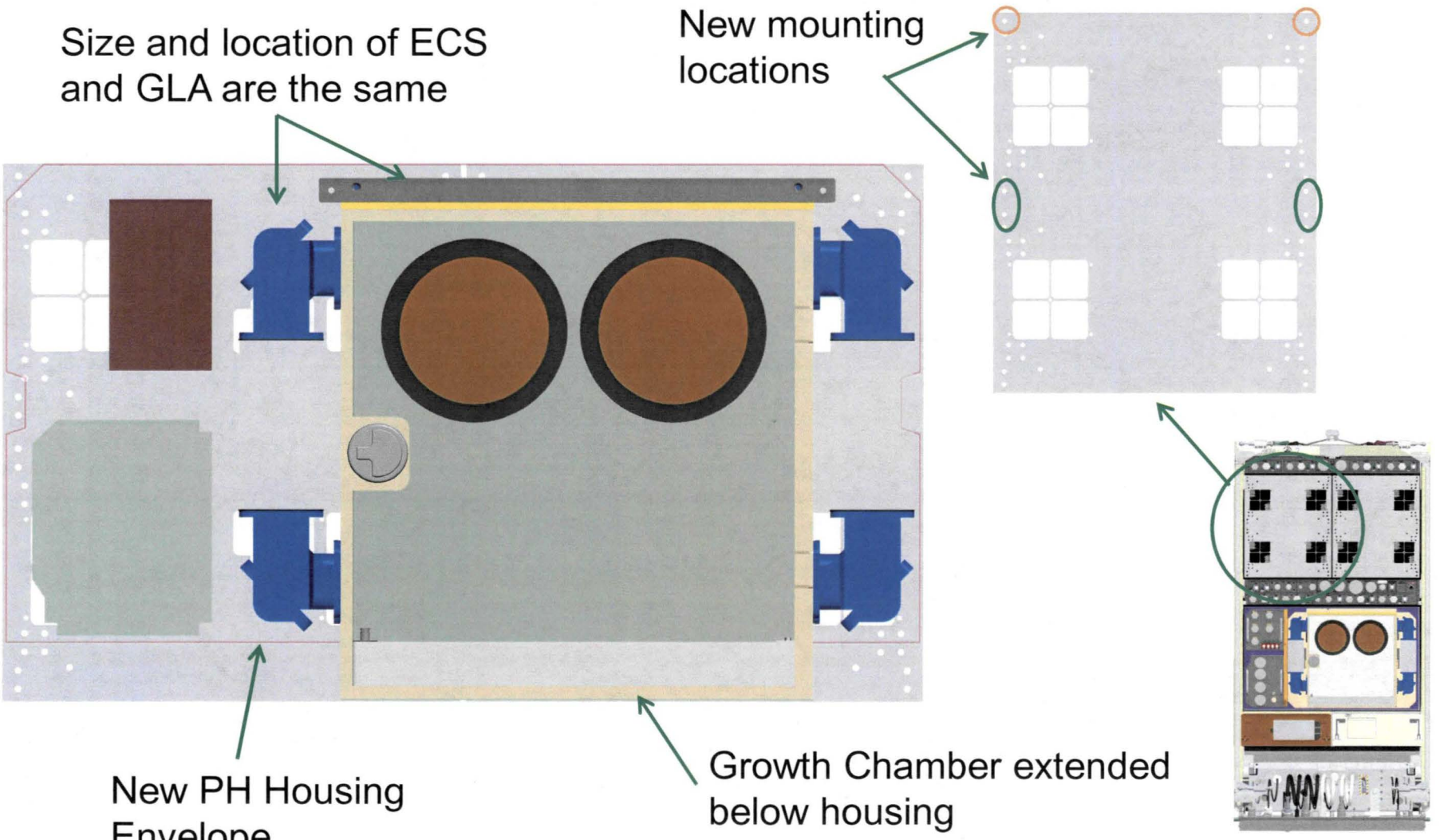

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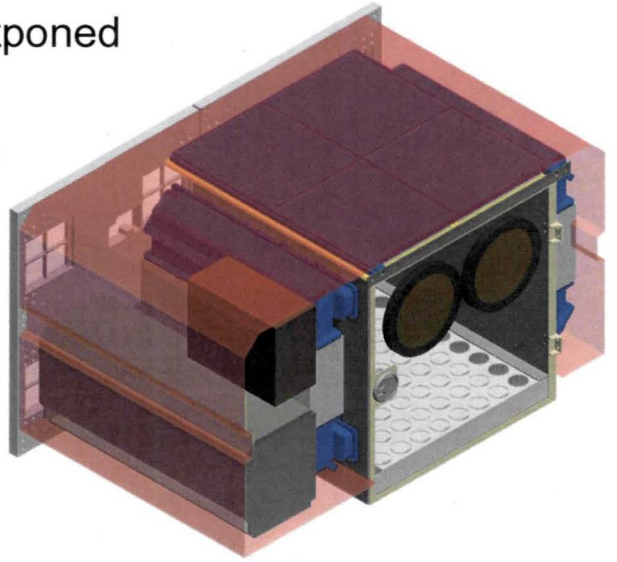
- *Recap*
  - Problem
    - Design to fit PH into CTB M03
    - Work was suspended, delivery of product postponed
    - Fast turnaround of redesign requested
    - Limited resource of personnel with experience



  - Solution
    - Redesign presented and approved
    - Science mission preserved
    - Minimal impacts on schedule, costs for all subsystems

The presented solution was adopted by the NASA Engineering team as the best redesign option and is the current design of PH going forward.

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Thank you.