TVAC Trolley
Design Status Review

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NRL TVAC Trolley System – General Design Requirement

- **General Design Requirement**
  - **The TVAC Trolley shall be capable of:**
    - **Supporting additional load of the LAT instrument and TVAC Test Fixture (test article)**
    - **Supporting the LAT test article inside the TVAC Chamber**
    - **Transporting the LAT test article to/from the NRL TVAC Chamber**

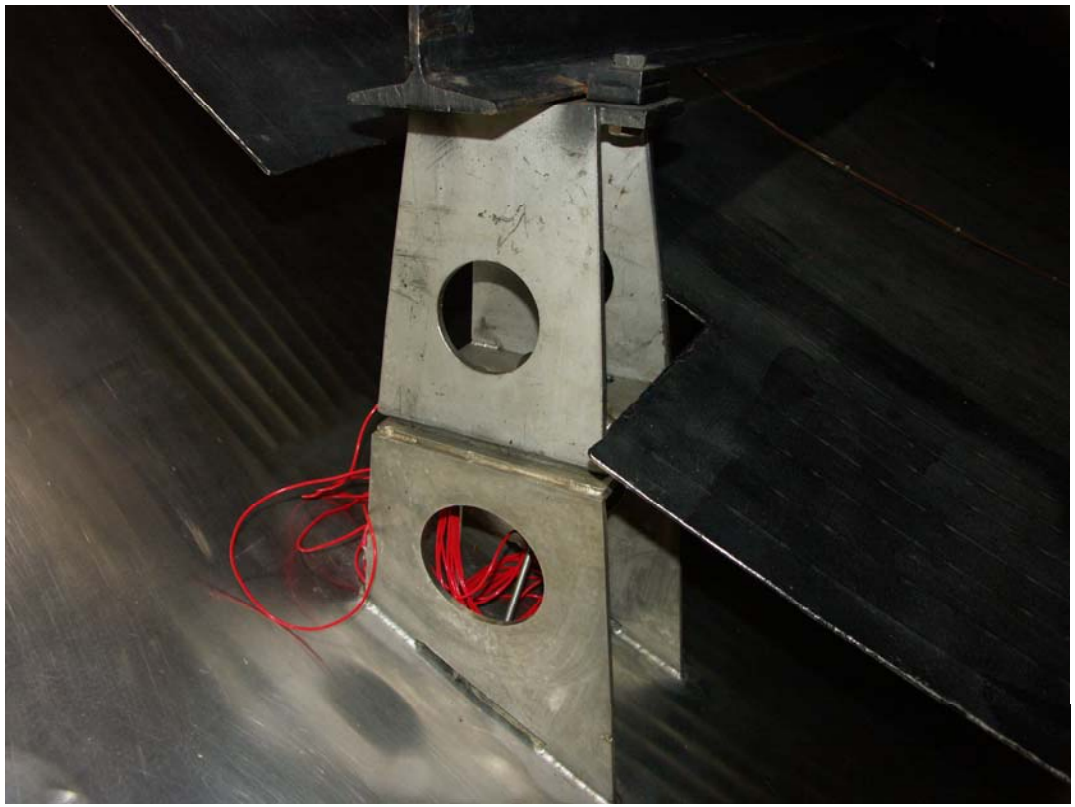
- **Overall Design**
  - **TVAC Rail Support Structure**
    - **Supports the TVAC Table within the TVAC chamber during test**
  - **TVAC Trolley consists of**
    - **TVAC Table – Supports the test article**
    - **TVAC Cart – Supports and Transports the TVAC Table and test article**

Modifications to TVAC Trolley System

- **Modifications are required so that the TVAC Trolley System can support the additional load of the LAT instrument and associated TVAC test fixtures**
  - **Test Article Mass 13,000 lbs (MAX)**

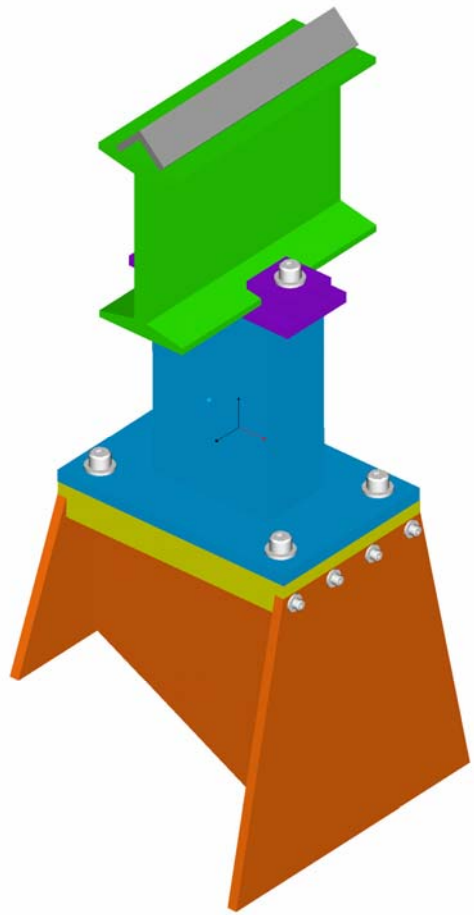
Modifications to TVAC Rail Support Structure

- **Problem Areas of Current Structure**
  - **Structure supporting the rails cannot support additional load of the LAT test article**
    - **Poor weld design (welds subjected to high bending loads)**
    - **Insufficient weld area at base**
    - **Field modifications (notching of supports) due to shroud interference severely reduce capacity**
    - **Lateral load capability (parallel to rails) inadequate**



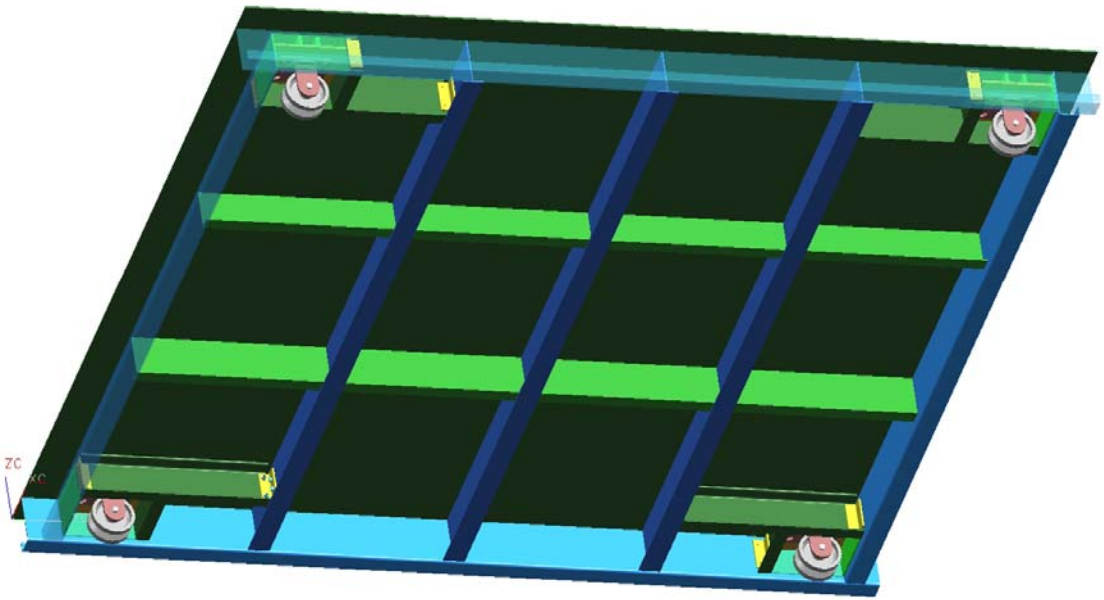
Modifications to TVAC Rail Support Structure - continued

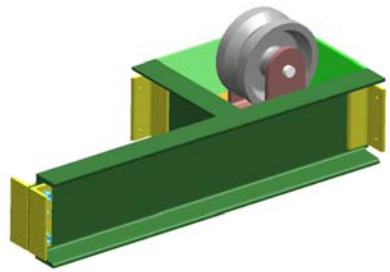
- **Required Modification**
  - **Redesign and replace current support structure to carry additional load of the LAT**
    - **Maintains two-piece design**
      - **Bottom weldment fixed to chamber wall**
      - **Top weldment removable to facilitate shroud servicing**
    - **Geometry based on existing rails, support locations and shroud openings**
    - **Improved design**
      - **Enhanced footprint**
      - **Sized primarily for vertical loading**
      - **Lateral capability commensurate with applied lateral loads**
    - **Two-piece design (top piece removable)**
  - **Add structure to support winch system**



Modifications to TVAC Table

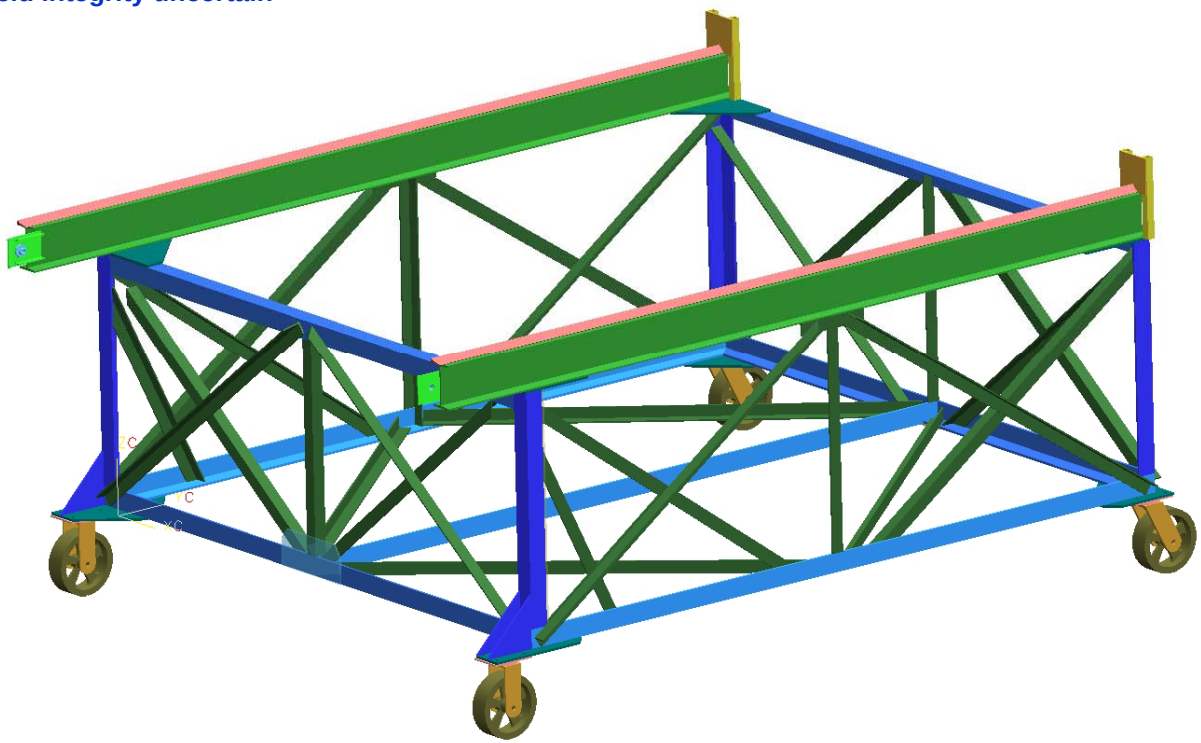
- **Problem Areas of Current Structure**
  - **High local stresses where the Test Stand leveling feet contact the TVAC table**
  - **Casters cannot support additional load of the LAT test article**
- **Required Modification**
  - **Install plates on the upper surface of the TVAC table to increase footprint of the Test Stand leveling feet.**
  - **Redesign caster structure to carry additional load of the LAT**
    - **Replace casters with higher capacity units (8000 lb heavy duty v-groove caster)**
    - **Improved caster mount to properly support load through the table structure**
  - **Add structure to support winch system**





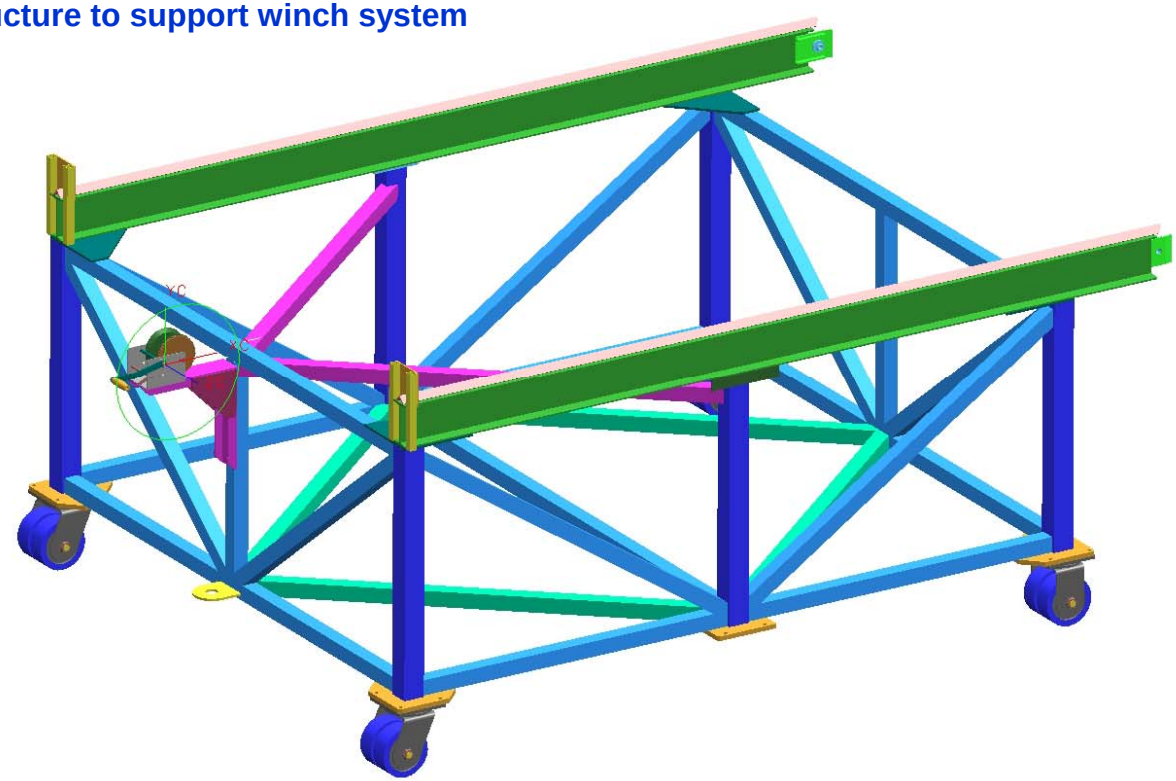
Modifications to TVAC Cart

- **Problem Areas of Current Structure**
  - **Inefficient structure for heavy loads**
    - Load lines of bracing members and columns do not intersect (i.e. induced bending and torsion of members)
    - Open section bracing members and columns (subject to crippling and buckling)
    - Eccentric loading causes beam-column instability
  - **Cart cannot support the additional load of the LAT test article**
    - Crippling and buckling of columns and braces under load
    - Casters are undersized and improperly positioned
    - Weld integrity uncertain



Modifications to TVAC Cart - continued

- **Required Redesign – replace existing structure with new design**
  - **Efficient redesign of structure**
    - Properly sized structural members using closed sections
    - Proper load path – lines of action intersect
  - **Redesign of caster structure**
    - Replace casters with higher capacity units (8000 lb)
    - Dual Caster System to enhance maneuverability
    - Improved caster mount location, i.e., minimize eccentric loading on columns
  - **Add structure to support winch system**



Status

- Components have been purchased
  - Casters for TVAC Table and Cart
- Analysis is ongoing
- Fabrication Drawings are scheduled for completion between September 12 – 23
  - Drawings for TVAC Table can be finalized
  - Drawings for TVAC Rail Support Structure Base can be finalized
- Retrofit of TVAC Rail Support Structure scheduled following TVAC test of Upper Stage

Schedule

WORK WEEK		TVAC CHAMBER RAIL AND SUPPORT STRUCTURE MODIFICATION	TVAC DECK MODIFICATION	TVAC CART MODIFICATION
01-Aug-05	05-Aug-05			
08-Aug-05	12-Aug-05			
15-Aug-05	19-Aug-05		Order Material/Casters (8/19/05)	Order Material/Casters (8/19/05)
22-Aug-05	26-Aug-05	Redesign Complete (8/26/05)		
29-Aug-05	02-Sep-05		Redesign Complete (9/02/05)	Redesign Complete (9/02/05)
05-Sep-05	09-Sep-05	TVAC Modification Review (9/8/05)		
12-Sep-05	16-Sep-05	Winch Design and Drawings Complete (9/12/05)	TVAC Deck Drawings Complete (9/16/05)	TVAC Cart Drawings Complete (9/16/05)
19-Sep-05	23-Sep-05	Rail Support Drawings Complete (9/23/05)		
26-Sep-05	30-Sep-05			
03-Oct-05	07-Oct-05			
10-Oct-05	14-Oct-05			
17-Oct-05	21-Oct-05			
24-Oct-05	28-Oct-05	**TVAC Chamber**		
31-Oct-05	04-Nov-05	Rail Support Manufacture Complete (11/04/05)	Manufacture Complete (11/04/05)	Cart Manufacture Complete (11/04/05)
07-Nov-05	11-Nov-05	**(Upper Stage)**		
14-Nov-05	18-Nov-05	Start Installation		
21-Nov-05	25-Nov-05		Deck Modification Complete (11/22/05)	
28-Nov-05	02-Dec-05	Installation Complete (12/01/05) Proof Load Complete (12/02/05)	Proof Load Complete (12/02/05)	Proof Load Complete (12/02/05)

Analysis Methodology

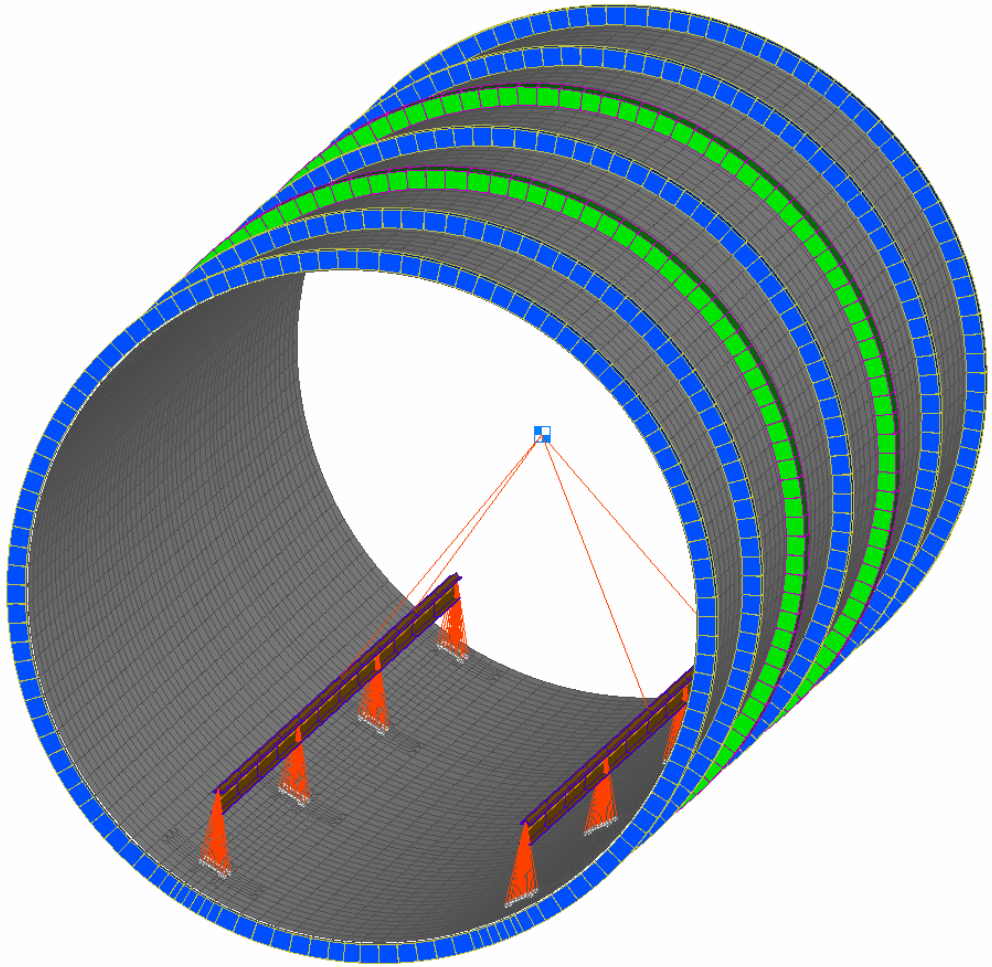
- FEA Model used to determine loads and stresses in
  - TVAC Rail Support Structure
  - TVAC Table
  - TVAC Cart
- Hand Calculations used to determine determine loads and stresses in
  - Bolted Joints
  - Welded Joints

Analysis Criteria

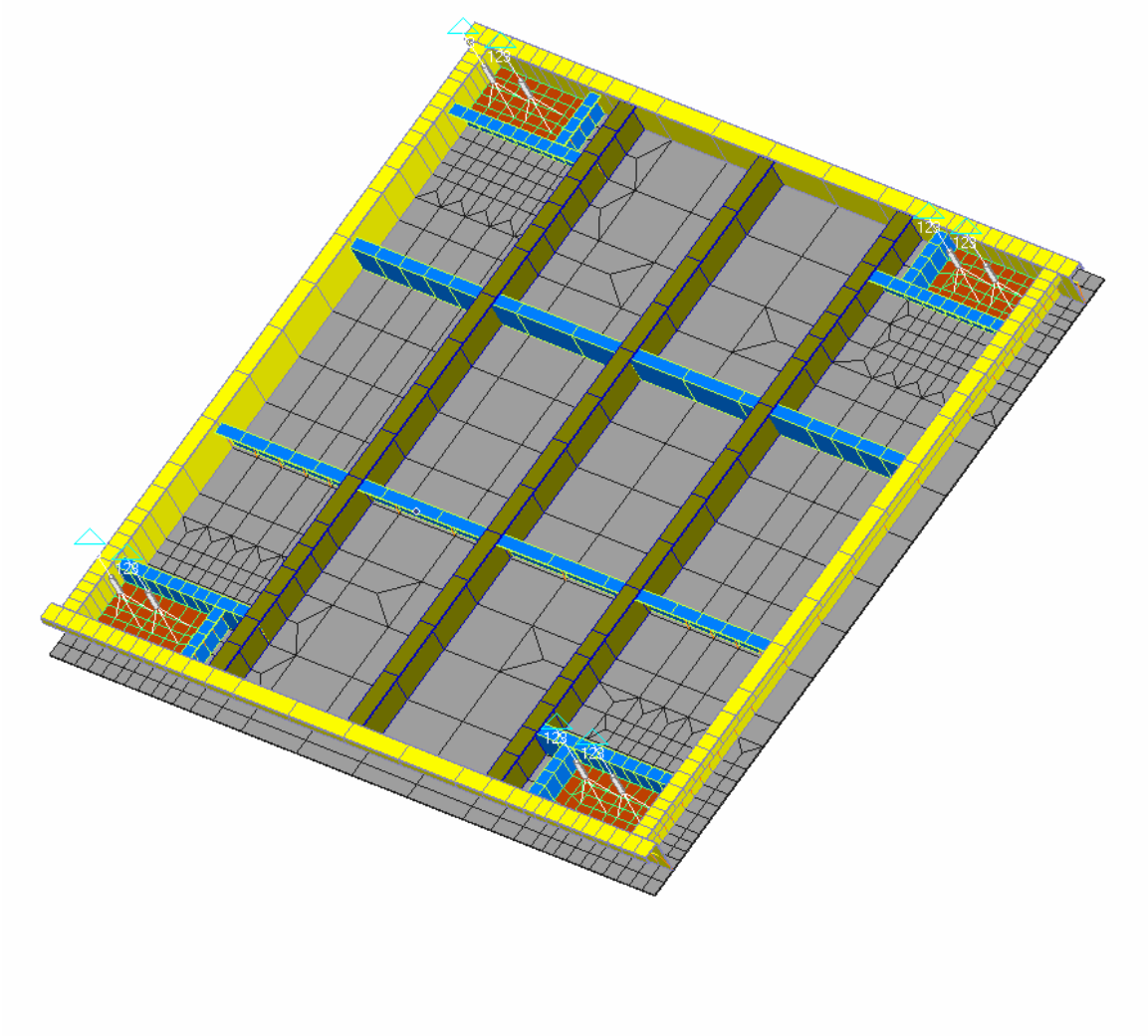
- **Design Limit Loads**
  - **Cart**
    - **Vertical** -1.0 g
    - **Lateral** ± *TBD g (based on rolling load limitations, i.e. tipping, structural)*
  - **Chamber Rail System**
    - **Vertical** -1.0 g
    - **Lateral** ± ~500 *lbs (based on personnel loading)*
    - **Longitudinal** ± *~ 1000 lbs (Winch Load)*

- **Mass Properties of LAT Test Article**
  - **Mass** 13,000 lbs, MAX
  - **CG from Floor** (0 in, 0 in, 136.35 in)
  - **CG from to surface of Table** (0 in, 0 in, 64.38 in)
- **Factors of Safety**
  - **Yield Design Load** FS = 3.0
  - **Ultimate Design Load:** FS = 5.0
- **Proof Load** 2 x Mass of Test Article = 26,000 lbs
- **Margins of Safety – Must be Positive**

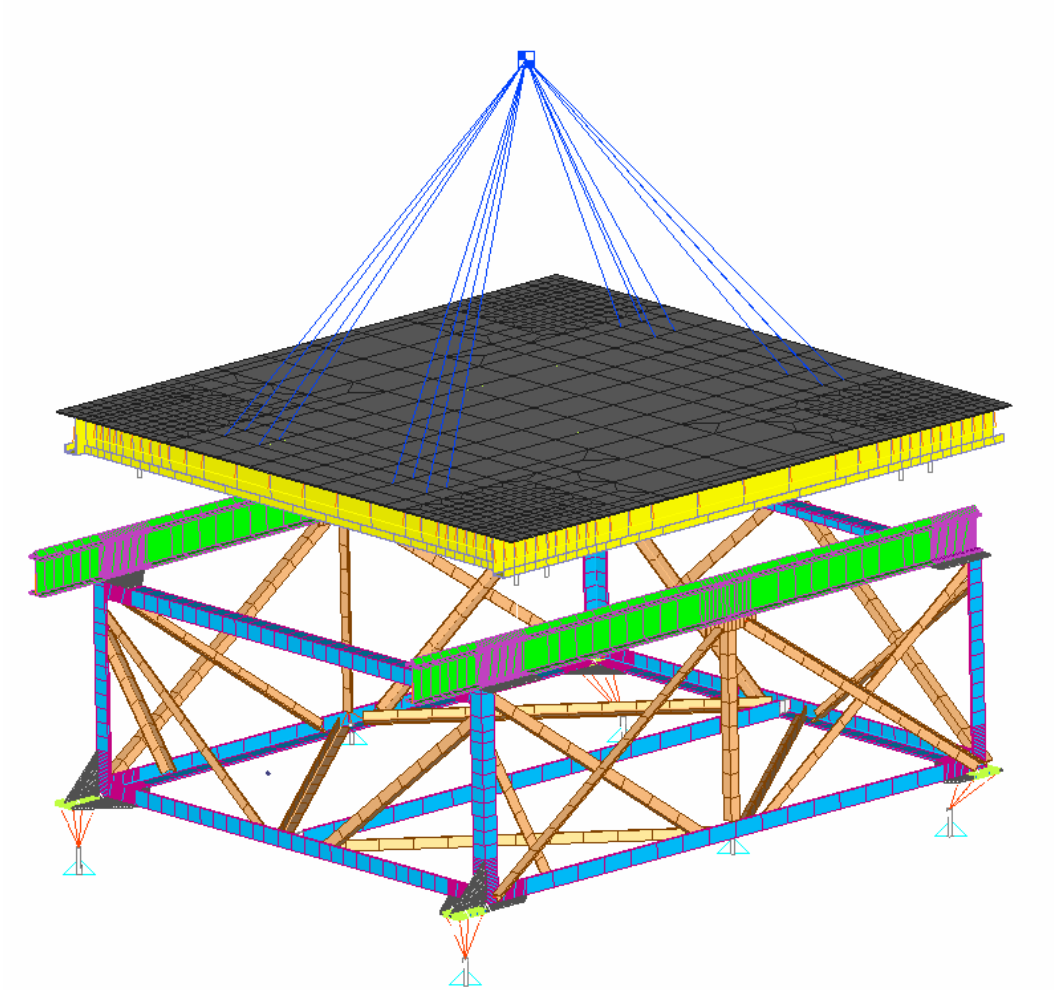
TVAC Rail Support Structure - Finite Element Model



TVAC Table - Finite Element Model



TVAC Cart - Finite Element Model



Conclusions and Open Issues

- **Preliminary sizing of Rail Supports, Table and Cart complete – detailed analysis to follow**
  - **Modification of TVAC Table can begin as soon as drawings are released**
  - **Fabrication of TVAC Rail Support Structure Base can begin as soon as drawings are released**
- **Further analysis of TVAC Rail I-Beam needs to be completed to close-out final TVAC Rail Support Structure design.**
  - **Angle strength for V-Groove Caster**
  - **I-Beam web stability**
  - **Lateral support of I-beam on Rail Supports**
- **Analysis of new TVAC Cart design needs to be completed.**
- **Additional detailed analysis on other low-risk items still needs to be completed**
- **Inspection of welds is recommended**