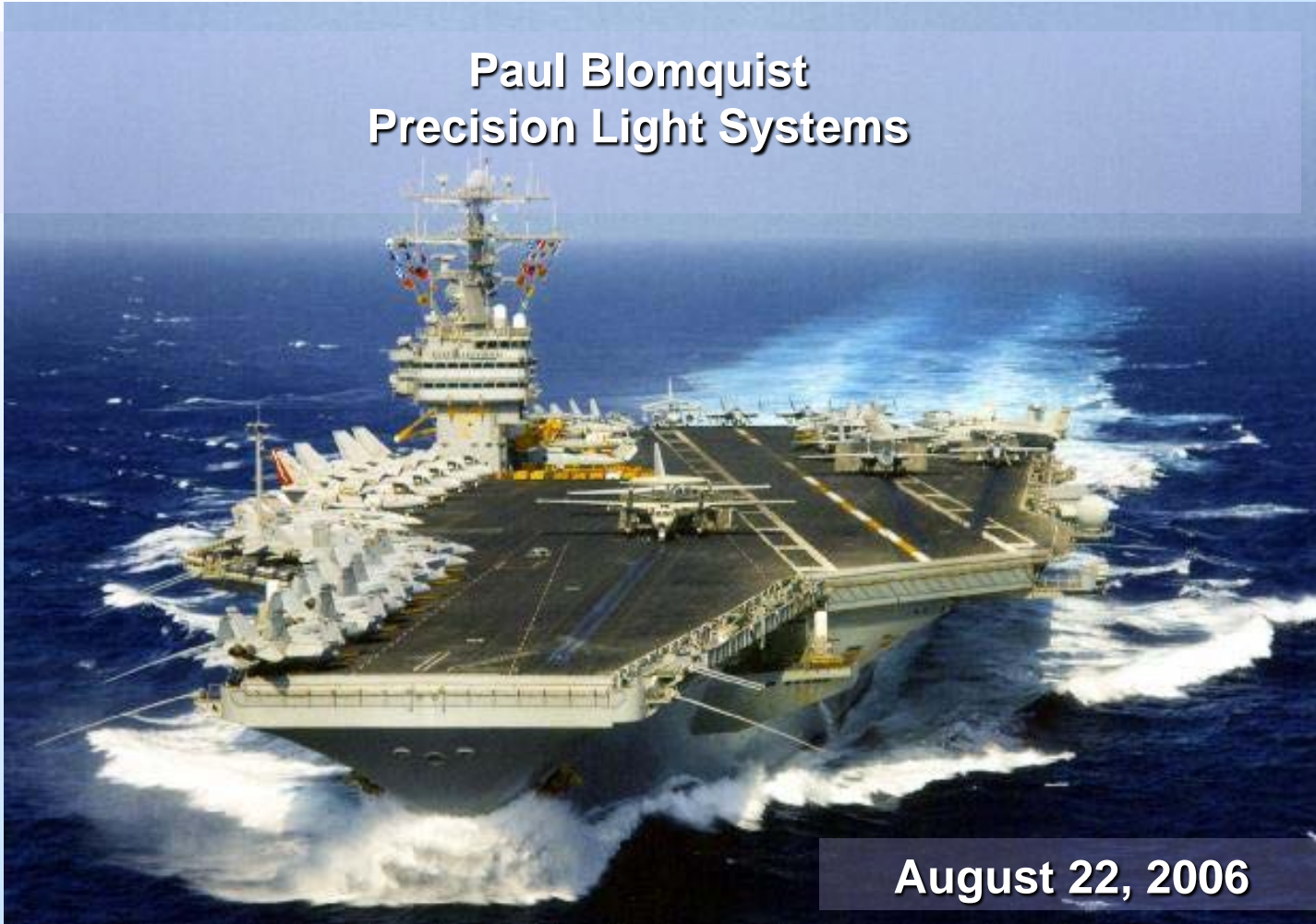




# NSRP SP-7 Meeting



Paul Blomquist  
Precision Light Systems

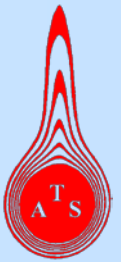


August 22, 2006



# Overview

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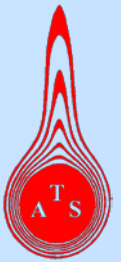
- **Current Shipbuilder-Focused Projects**
- **Common Goals & Synergy of Laser Projects**
- **SBIR Phase II Sandwich Panel Manufacturing Project**
- **SBIR Phase I “Panel Line Upgrade Project”**
- **Summary**





# Current Shipbuilder-Focused Projects

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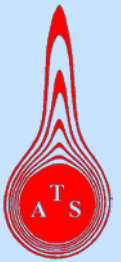
- **Laser Fabricated Structural Shapes for Naval Applications**
  - Optimized Structural Shapes for Shipbuilding
  - Trial on SSN-688 Safety Line Tracks
  - Test Beams for BIW
  - Funding Received for HSLA-65 PQR's; Quoting on HSLA-80
- **Sandwich Panel Manufacturing Project**
  - SBIR Phase II –
  - Establish Laser Panel Manufacturing Capability
    - FY06 Focus on Tooling Improvements
    - Large-Scale; Generic in Nature, Highly Flexible
    - Program Supports all Platforms





# Current Projects- Cont'd

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## CTC LASCOR Project

- Manufacture Precision Hi-Strength Sandwich Panels
- Phase I: ATS Completed 12 Panels 78" x 240"
- Phase II Application: CVN-78 Structure

## ONR SBIR Phase I – Low Distortion Panel Line Upgrade

## ATS/TSI Commercialization Efforts

- PLS Formation
- Commercialization Agreements in Place (ESAB)

## Maine Technology Institute Projects

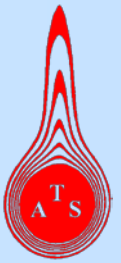
- Laser Facility (ATS) – FY 2001
- Panel Manufacturing Facility (TSI) – FY2005
- Total in Excess of \$850K State, Internal, Corporate External Funds





# Common Goals of Laser Projects

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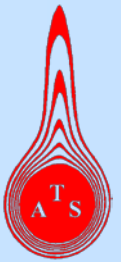
- High-speed fabrication to achieve manufacturing cost goals
- Accurate fabrication to achieve dimensional goals & reduce assy. cost
- Flexibility to achieve wide range of applications
- Design flexibility:
  - Can add to mission capability with low impact on overall vessel performance
  - Can modify Design to Suit DFA Goals
- High Accuracy Provides Significant Opportunity for Downstream Assembly Cost Savings





# Synergy of Current Projects

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## Laser Fabricated Structural Shapes for Naval Applications

- Qualified Product & Process for Hybrid Welding of T's
- System Implemented on Modified ESAB Production Equipment

## Laser Panel Welding Project

- Laser Plate Butt Welding: Transfer PC/QA System to Butt Welds
- Laser Panel Manufacturing: Adapt System to Sandwich Panels

## CTC LASCOR Project (FY04-06)

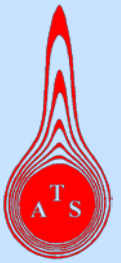
- Benefits from Prior/Concurrent Project Developments
- Target Application: CVN-78
- Scheduled to Take Advantage of Output from all COE's (iMAST, NJC, CTC & Prior Work of Others)





# Synergy of Current Projects – Cont'd

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## CTC LASCOR Project

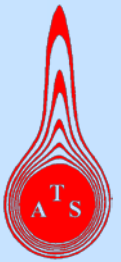
- ATS efforts do not compete with or duplicate COE objectives
- Gains leverage from Laser Panel Welding Project

## Laser Panel Welding Project

- Provides cost-share via significant non-federal investment
- Takes advantage of European successes
- Provides quick start-up for larger panels for development
- Pilot plant for lead-in to efficient larger scale manufacturing



# 10kW Fiber Laser



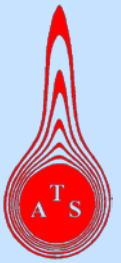
- **Fiber Laser System**
- **10 kW Continuous output**
- **High-efficiency operation**
- **SWP requires 1,000 ft of weld**
- **Some failures in fibers**
- **Some failures in power supplies**
- **All repairs performed on-site**
- **Back up and running ~ 2days**





# LASCOR Manufacturing Concepts

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## ATS/PLS Goals

**High Dimensional Accuracy**

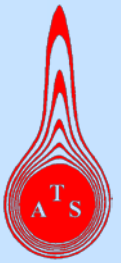
**Proper Weld Quality**

**Cost-Competitive Facility**





# LASCOR Manufacturing Concepts



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## Product Goals Put Manufacturing at Cross-Purposes:

### Welds Must Be Strong Enough

Strength Related to Width at Interface (= 100% thickness of thinnest)

### Super-Duplex Welds Must Have Proper Microstructure

Strength and Corrosion Resistance Related to A/F Ratio

### Panels Must Be Flat

Max out of Plane  $\leq L/1000$  (new requirement)

### Panels Must be Produced at Acceptable Cost

### High Welding Speeds Desirable

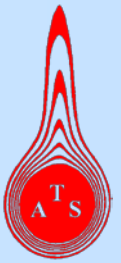
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# LASCOR Manufacturing Concepts

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## Developing

**“Material Substitution Information”**

**Required Fabrication Document**

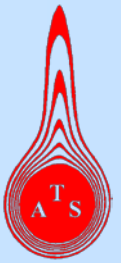
**Required Qualification Document – “Special Weld” in TP-248**

**Phase II will require qualification testing**





# 78" X 240 Lascor Panels



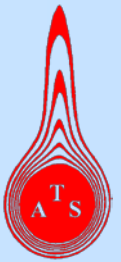
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# LASCOR Manufacturing Concepts

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## Limitations of Available Materials

**First Estimates based on 316L & HSS Materials**

**80-100 KSI Steels not readily available with desired properties**

**“Ferralium” down-selected due to properties & width**

**Width issues brought in undesirable dimensional variance**

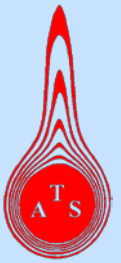
**Plate vs sheet in ASTM A-480**







# HSLA-80 Tee Fabrication



**Subcontract to fabricate 8 tees**

<b>Material:</b>	<b>HSLA-80</b>
<b>Flange Thickness:</b>	<b>1/4" - 3/8"</b>
<b>Web thickness:</b>	<b>1/4"</b>
<b>Depths:</b>	<b>6" - 14"</b>
<b>Flange widths</b>	<b>4" - 6.75"</b>
<b>Lengths:</b>	<b>300"</b>





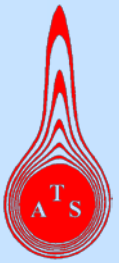
# HSLA-80 Tee Fabrication





# HSLA-80 Tee Fabrication

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## Final Dimensional Inspection:

<b>Camber -</b>	<b>0.031 - 0.250"</b>
<b>Sweep-</b>	<b>0.031 - 0.375"</b>
<b>Centering-</b>	<b>0.000 - 0.244"</b>
<b>Depth-</b>	<b>0.000 - 0.031"</b>



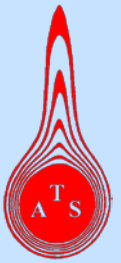


- Evaluate Suitability of Control System to:
  - Retro-Fit as GMAW-only Upgrade
  - Work within tolerance window of existing equipment
  - Achieve higher weld speed & smaller welds
  - Four variations in process implementation
    - GMAW-only, Laser-stabilized, Laser-augmented, Laser-hybrid
  
- Opportunity to use Thinner Plate
  - Lower weight
  - Lower cost (of higher performance)
  - Some designs exist, but are not implemented
  
- Phase I Project Completed 8/9/06





# SBIR - Low Distortion Panel Line Upgrade

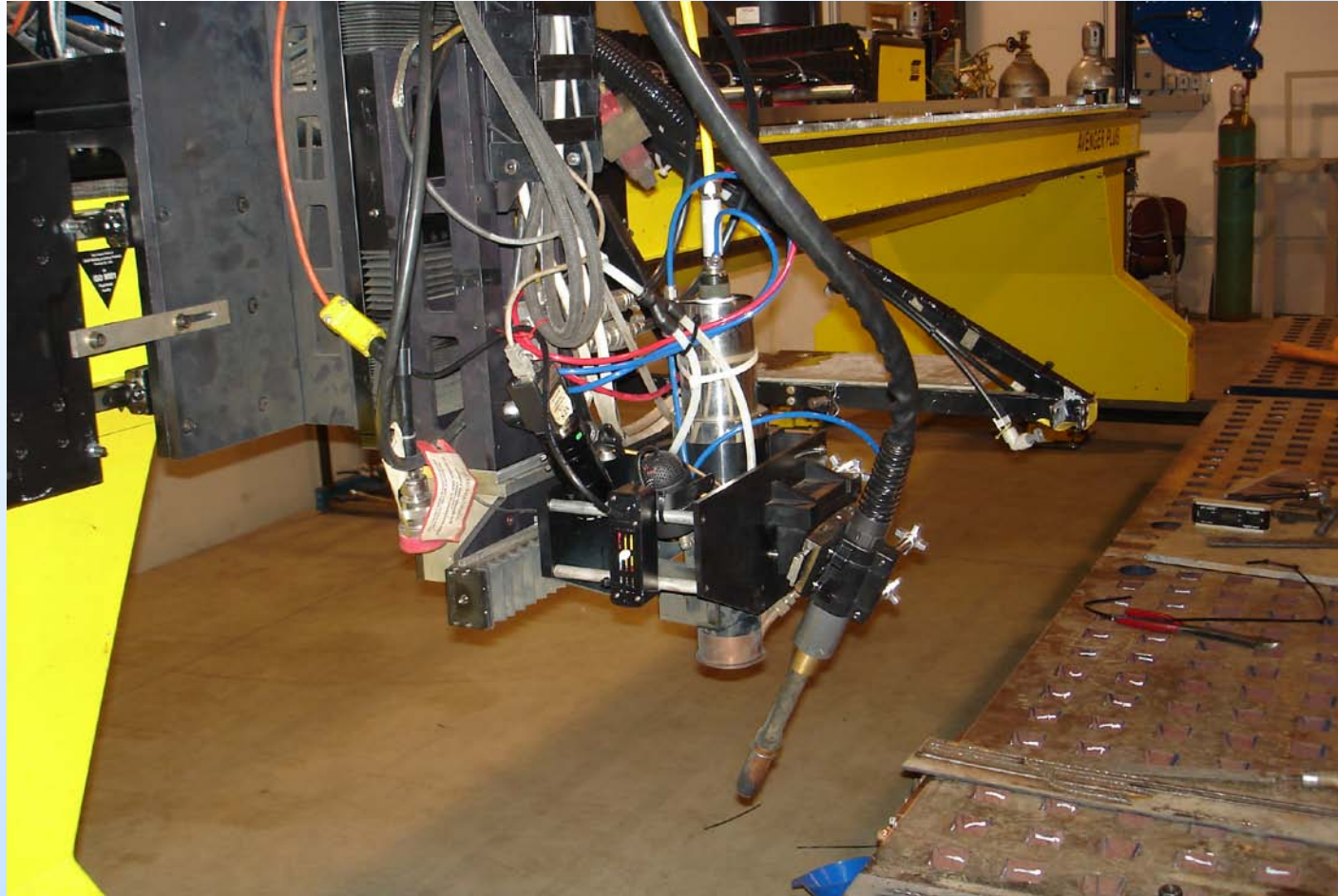
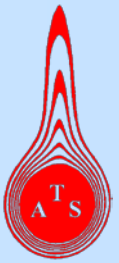


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# SBIR - Low Distortion Panel Line Upgrade



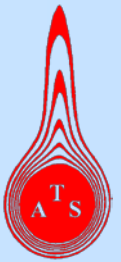
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# SBIR - Low Distortion Panel Line Upgrade

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## Four weld methodologies considered:

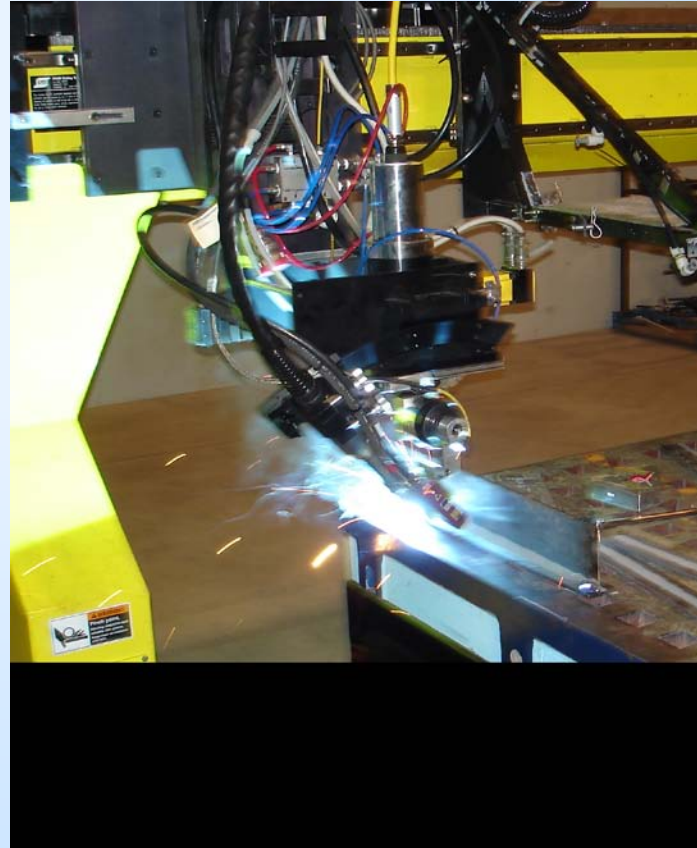
- Precision Controlled Welding (PCW) – GMAW with advanced control
- Laser-Stabilized Welding (LSW) – GMAW + low power laser to control cathode spot
- Laser Augmented Welding (LAW) – GMAW + more laser power to control bead shape
- Hybrid Laser-Welding (HLW) – GMAW + sufficient laser power for full penetration



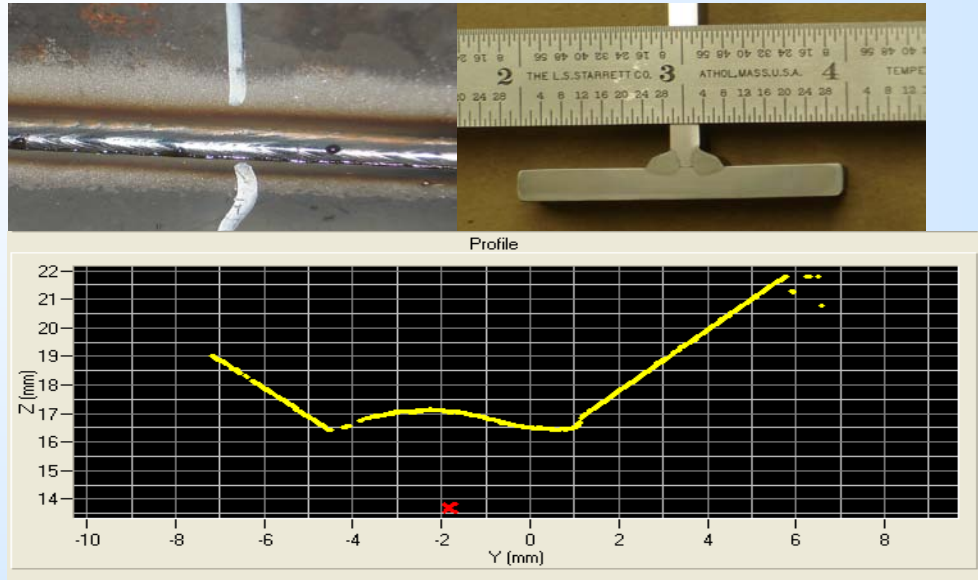


**Top: GMAW-only; Bottom: Laser-Stabilized GMAW**

**Weld speed: top to bottom: 150, 175, & 200 ipm**



Left, Tee section set up for PCW tests. Right, welding underway. Red box in lead of the process is laser-seam tracker. Welding is GMAW only, welding speed: 40 ipm.

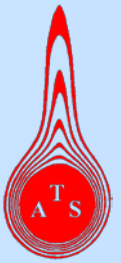


**Inspection at x = 9.00 in.**  
 Web Leg Length = 0.136 in.  
 Flange Leg Length = 0.149 in.  
 Flange Undercut = 0.002 in.

**Precision Controlled Welding. Top left, fillet weld surface. Top right, macro-section of fillet. Center, system scan of weld profile. Bottom, system report of profile data.**

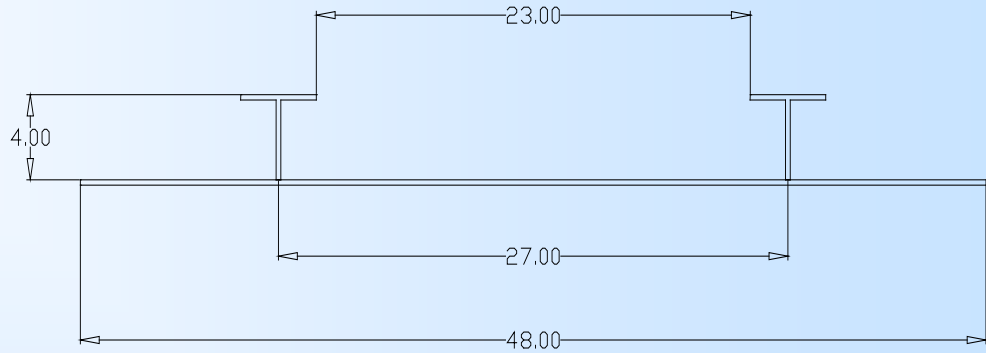


# SBIR - Low Distortion Panel Line Upgrade

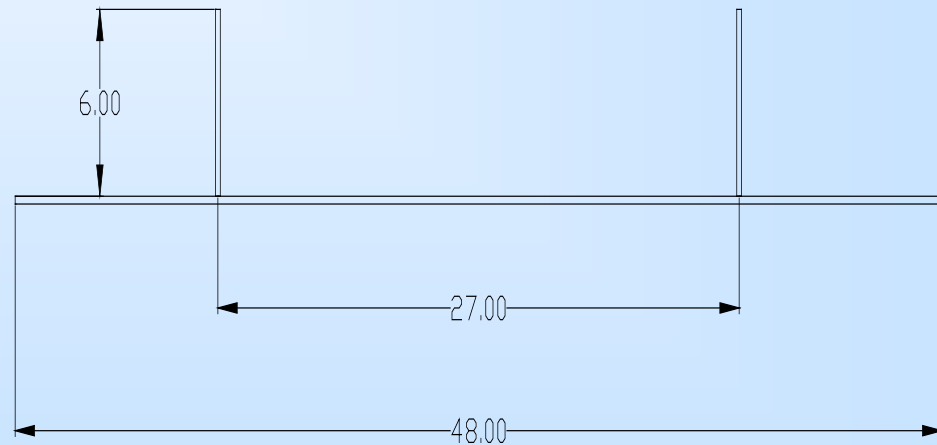


## Test panel designs

**EWI design**



**PLS design**

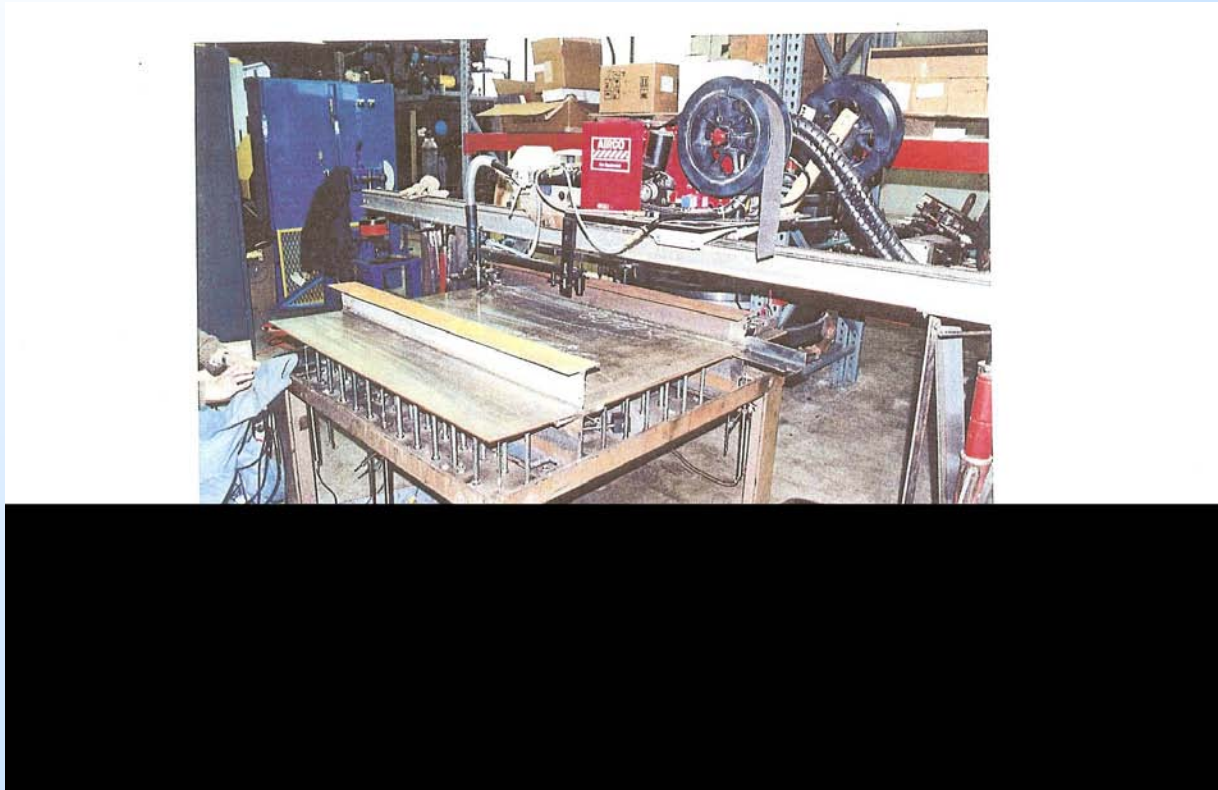
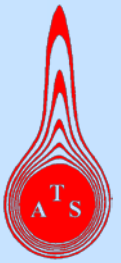




Panel after welding, set up for longitudinal distortion measurements.



# SBIR - Low Distortion Panel Line Upgrade

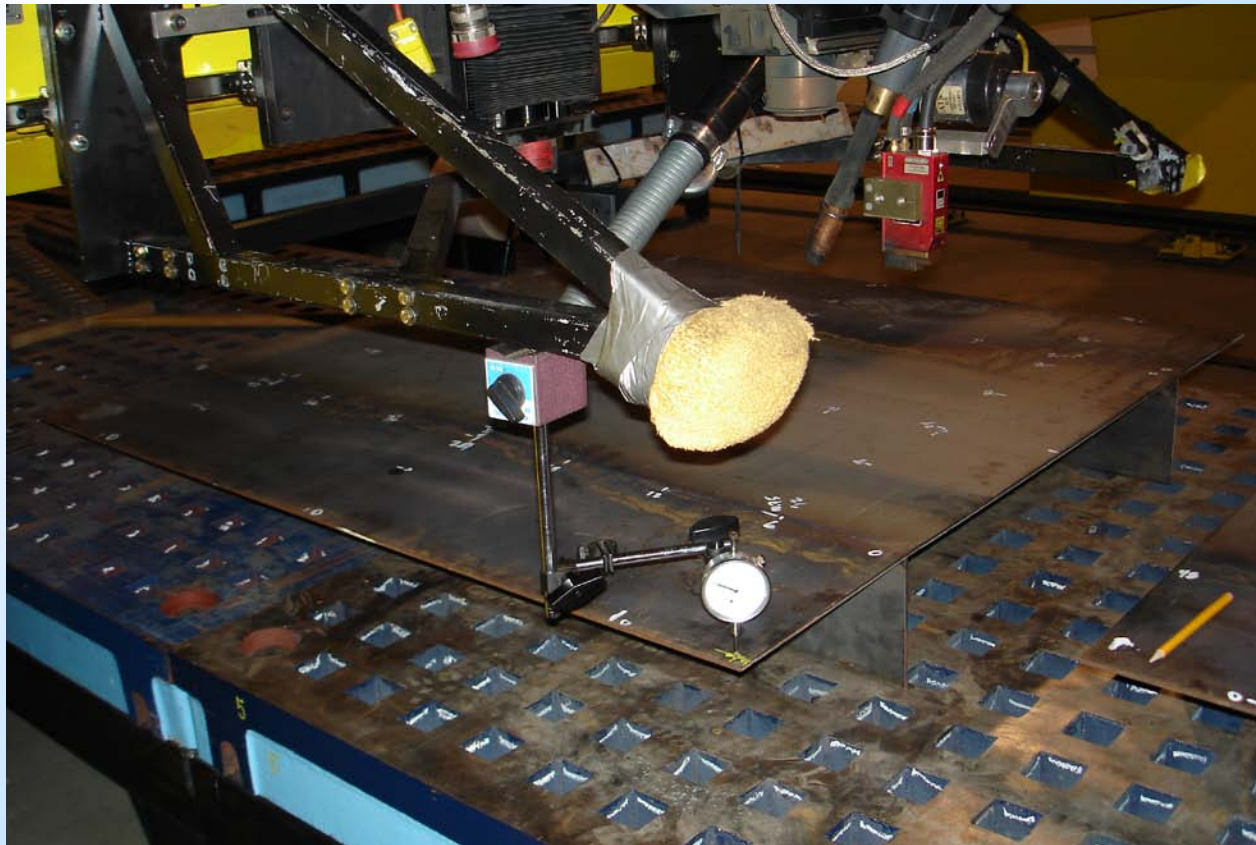
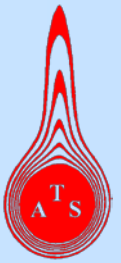


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# SBIR - Low Distortion Panel Line Upgrade

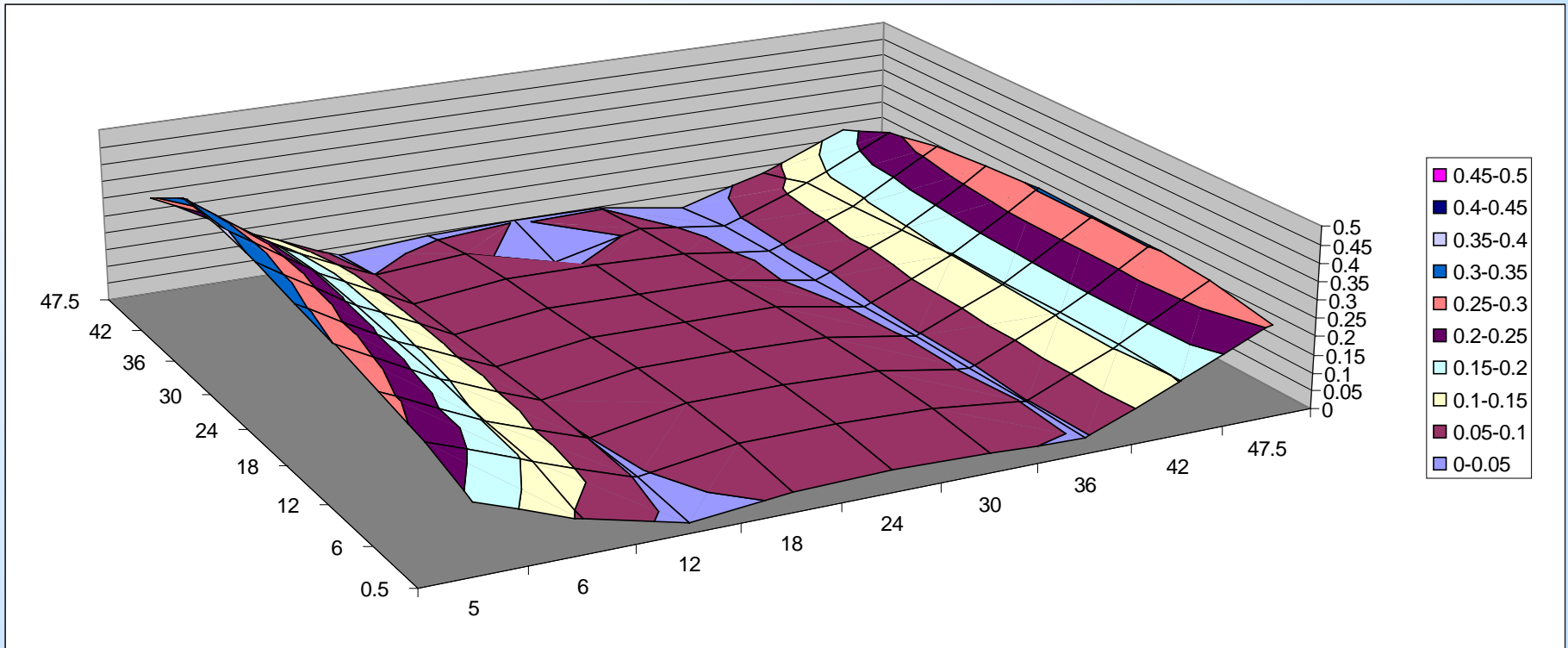
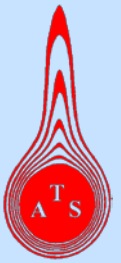


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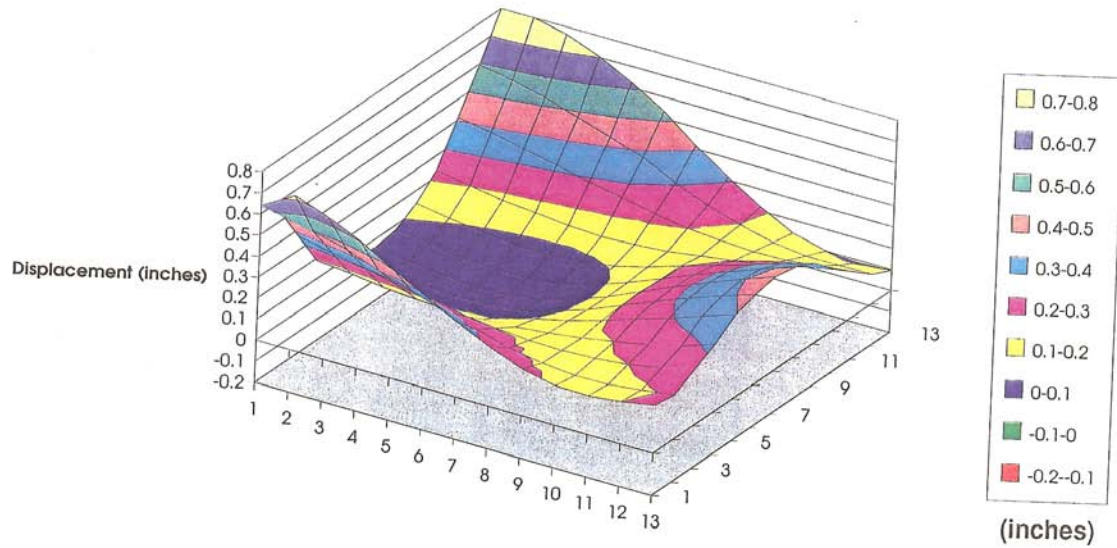


# SBIR - Low Distortion Panel Line Upgrade



Mock-Up VM-3-AH36  
 AH-36 Steel  
 Longitudinals Welded at 18 kJ/in  
 Longitudinal Fillet Weld Size = 3/16-in.

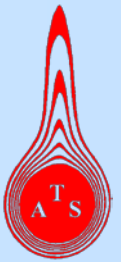
Out of Plane Displacements Measured  
 After Second Longitudinal is Welded





# Summary

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- **Firmly committed to commercialization**
- **Established PLSystems as manufacturing/commercialization activity**
- **Aggressively pursuing *total* cost-reduction**
- **Created facility capable of 15 X 50 ft panels**
- **Extending technology into other activities/programs**
- **Demonstrated ability to reduce distortion on panel lines**
- **Pursuing Phase II SBIR on panel line upgrade project**

