NASA Technology Days Overview Briefing

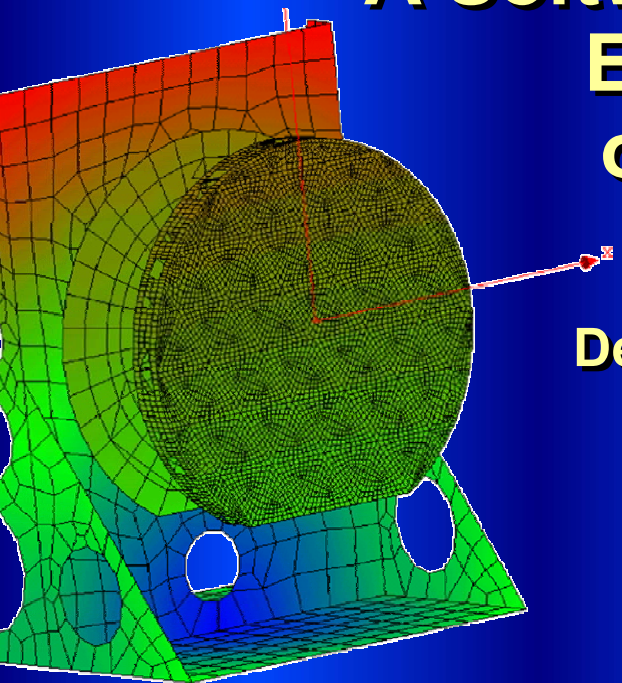
for

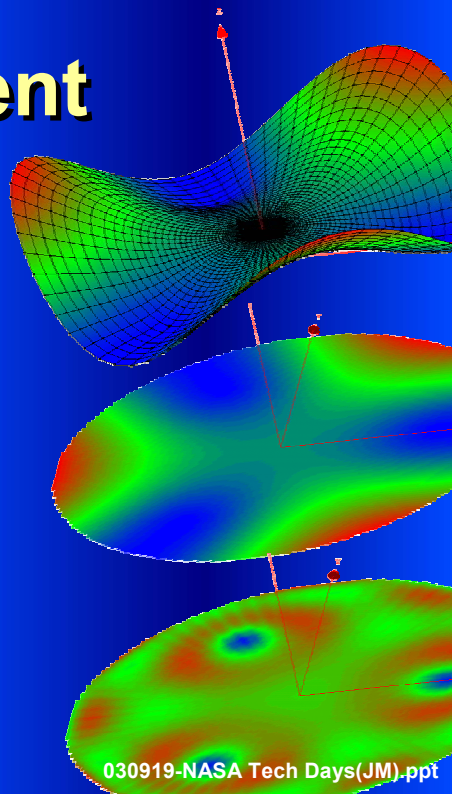
IODA

(Integrated Optical Design Analysis)

New Test Data and Modeling Features

A Software Tool for Concurrent Engineering Design of Optical Systems





16 September 2003
Developed Under Contract No.
NAS8-0005

Presented by Jim Moore
256-971-7020

Overview

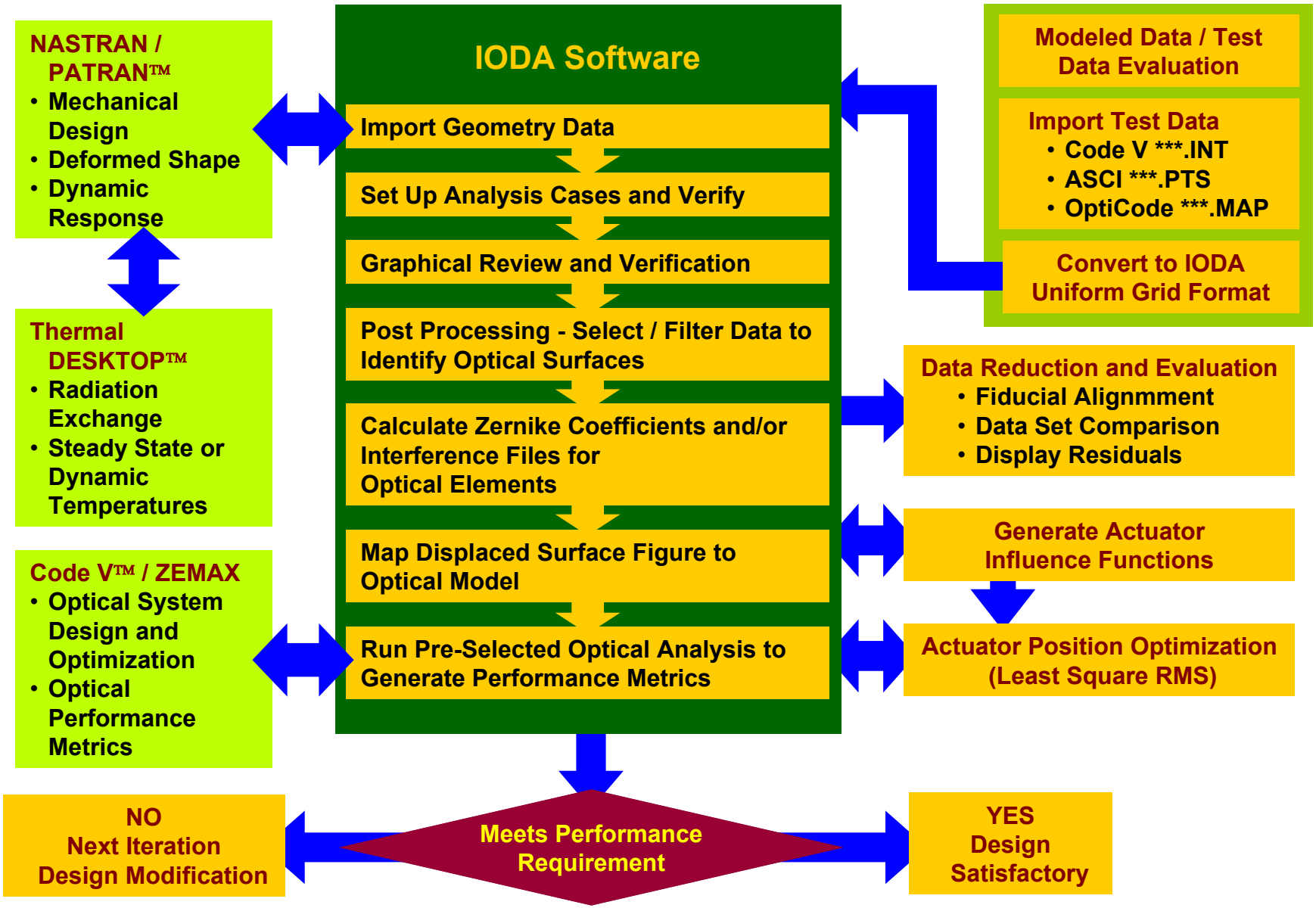
Integrated Modeling Approach

Integrated Optical Design Analysis (IODA) Software Simplifies and Automates Data Sharing for Concurrent Design by a Diverse Team of Engineering Specialist

Topics

- Summary of Features
- Review of Most Recent Features to Support Modeling
- New Features Developed to Support AMSD Testing
- Summary

Schematic of Data Flow and Software Interactions



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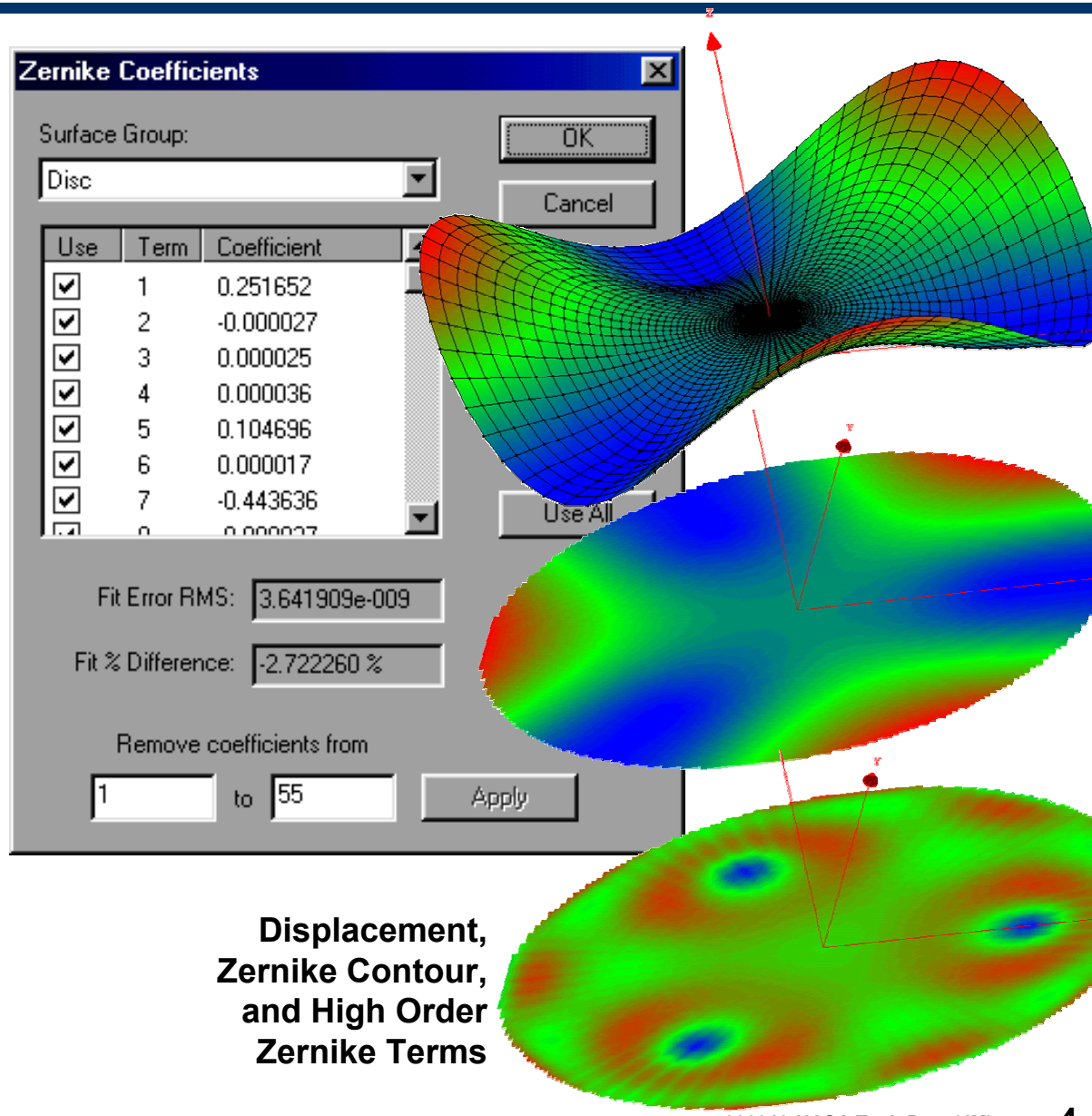
Basic Data Fitting and File Transfer Routines

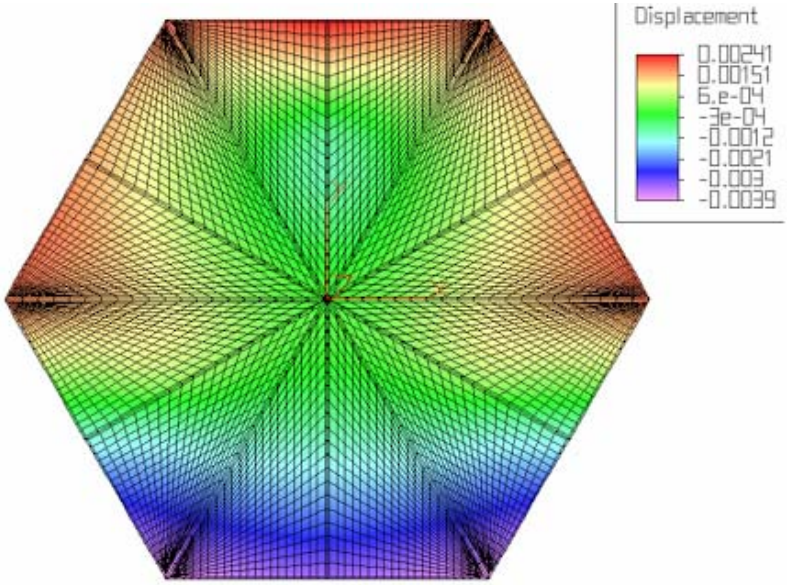
IODA Extracts Deflections from Optical Surface Nodes and Generates IODA Uniform Grids

- Point and Click Tools to Identify and Group Optical Surfaces
- Data Conversions
  - IODA - *.INT Format
  - Zernike Fit
    - Born and Wolf
    - Fringe
    - Wave Scope
- Relative De-Center and Piston Terms Calculated
- Deformed Surface Data Mapped to Optical Model



Displacement, Zernike Contour, and High Order Zernike Terms

Modeled Data Set Post Processing



- Evaluate Effects of Mirror Mount Changes, Material Substitutions or Design Changes
- Characterize the Nature of Changes Using Zernike Polynomial Fit Tools
- Supports Model to Model Comparison and Model to Measured Data Comparison

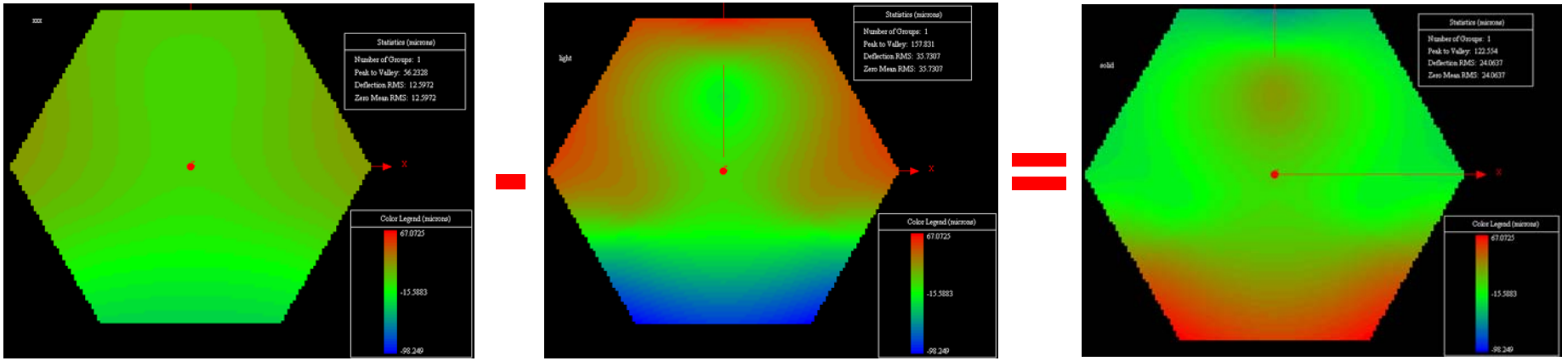


Image Analysis Including System Dynamic Response

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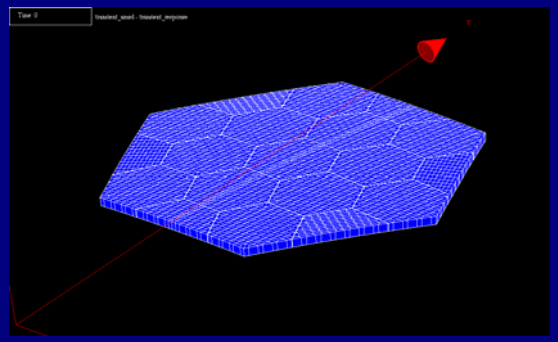
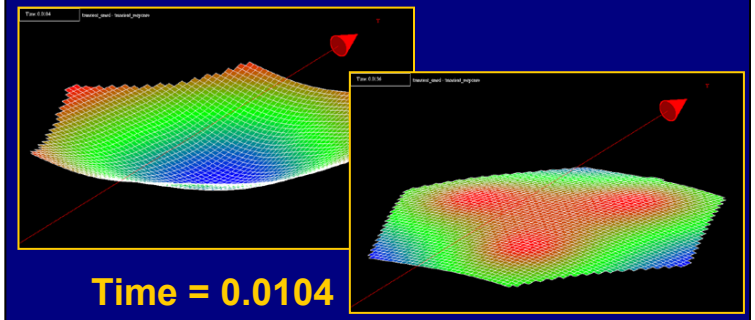
NASTRAN Dynamic Response Analysis



Nodal Displacement

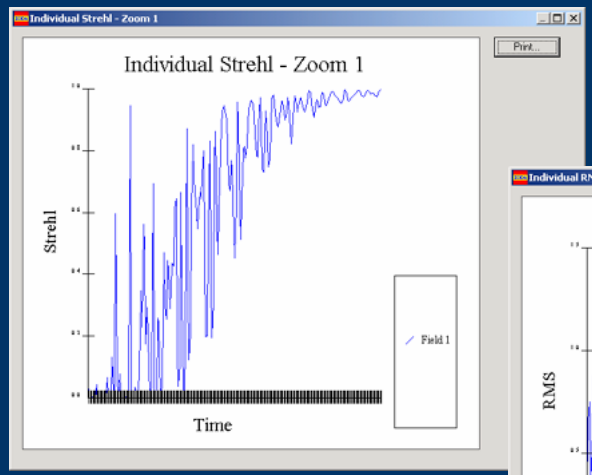


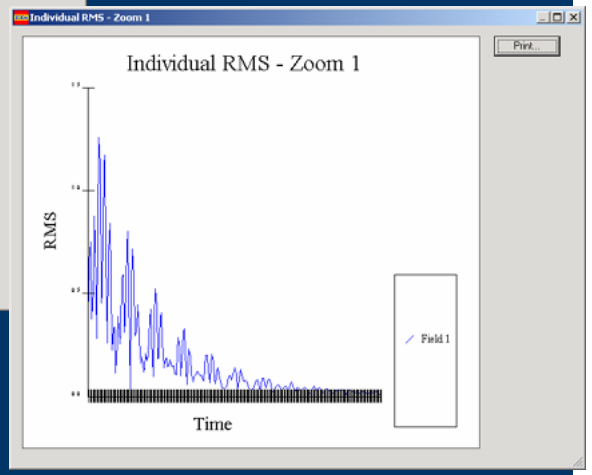
Time = 0.0104

Time = 0.0136

IODA Generated Uniform Grid File

- IODA Processes Data From Dynamic Finite Element Analysis at Frequency of FEA Output
- Each IODA Optical Group's Time Dependent Displacements Are Mapped to Code V™ Sequence File
- Code V™ Macro List Is Supported to Generate Time Dependent Performance Metrics





Automated Generation of Actuator Influence Functions and Figure Optimization

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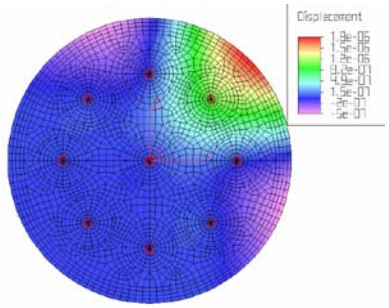
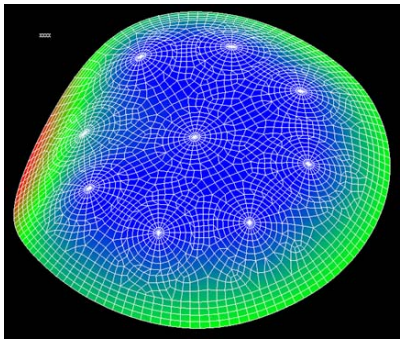
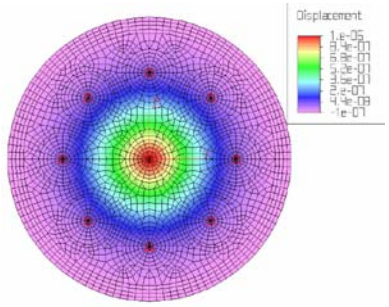


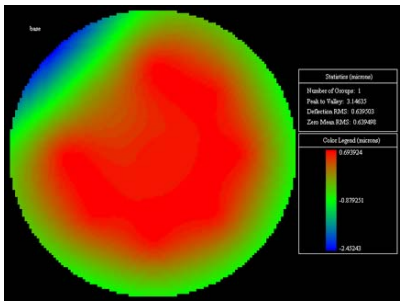
Actuator 1



Modeled Error Source (Gravity and Actuator Position Error)

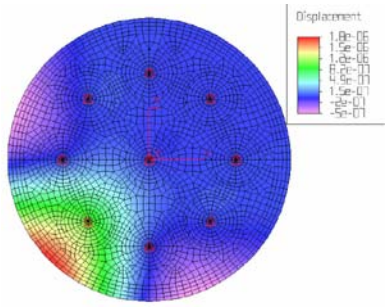


Actuator 9

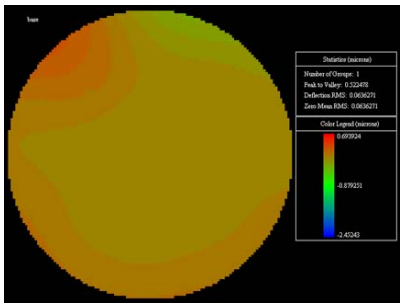


Uncorrected Figure

RMS = 0.639μ
P.V. = 3.14μ



Actuator 6



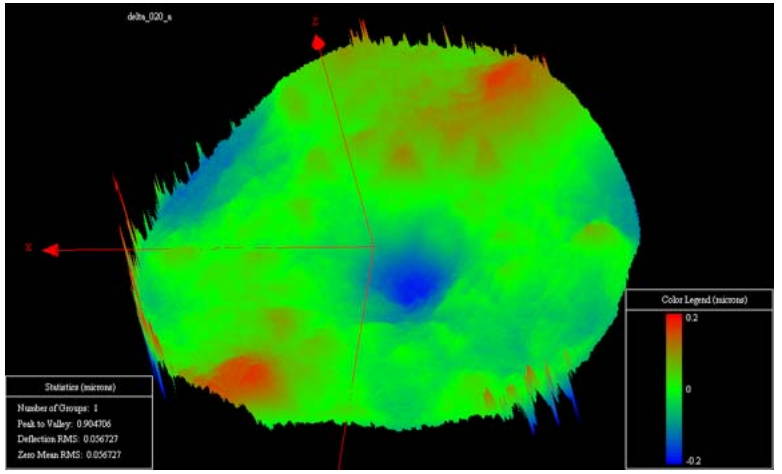
Corrected Figure

RMS = 0.063μ
P.V. = 0.522μ

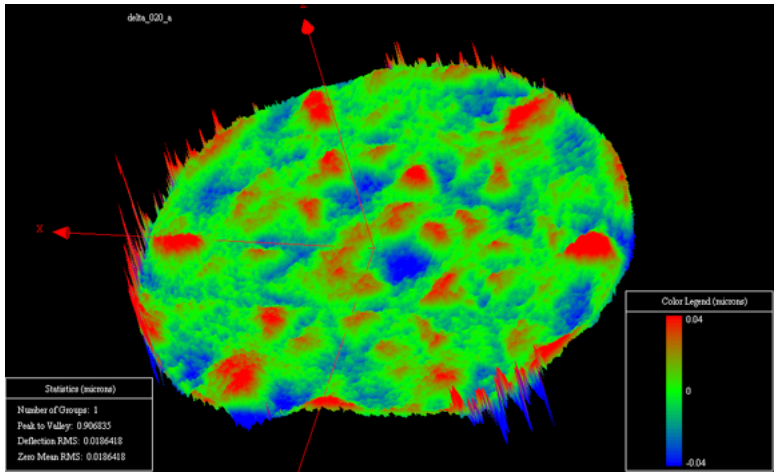
- Point-And-Click Interface Developed for Selecting Actuator Points and Creating Influence Functions
- Variable Stiffness Actuators Modeled Using SPCD in NASTRAN or Boundary Element in ALGOR
- Actuator Stroke in Optical Axis or User Defined Local Coordinate System
- Generates Influence Function for Each Actuator and Each Surface Node Included in IODA Optical Group
- Least Squares Optimization for Minimum RMS Error

Measured Data Import and Post Processing Features to Support AMSD Testing

- Routines Developed to Support Measured Data Evaluation
  - Code V *.INT Format
  - OptiCode *.MAP Format
  - ASCII Points Cloud *.PTS
- Imported Data Converted to IODA Uniform Grid Format
- Post Processing of Data
  - Null Distortion Correction
  - Zernike Fit and Decomposition
  - Data Evaluation
    - Model Results — Measured Data
    - Test 1–Test 2 with Fiducial Alignment
- Averaging of Multiple Data Sets



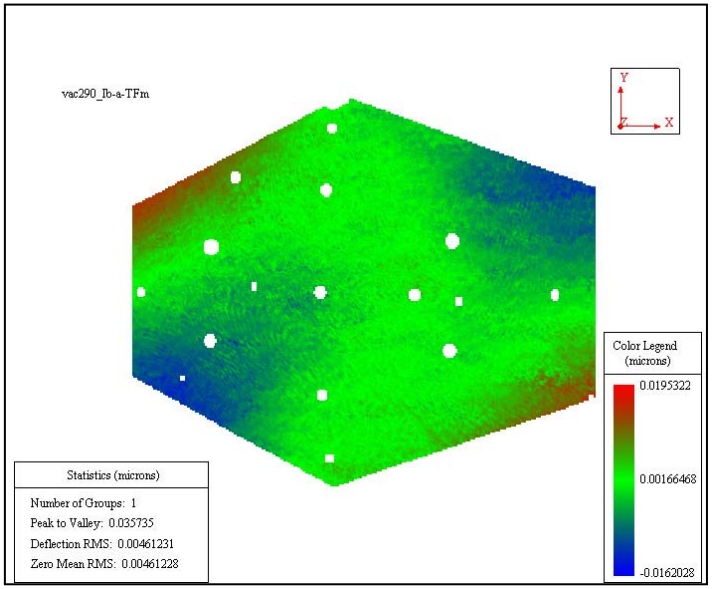
Example *.INT Data Input From XRCF Test



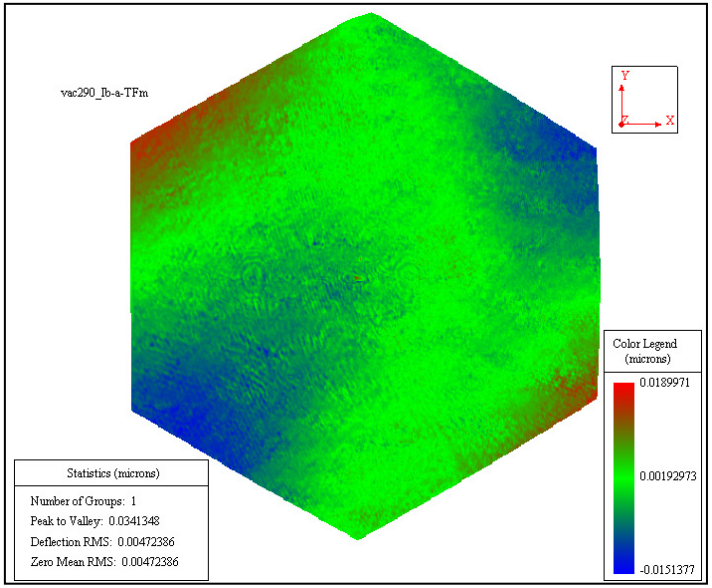
Imported Data File With 43 Wavescope Zernike Coefficients Removed

Processing of OptiCode Data to Remove Null Distortion

- OptiCode *.MAP Data Imported to IODA
  - Pixel Data
  - Test Fiducial Positions
  - User Comments
- User Defined Null Correction Applied to Data and Fiducial Points
- Data Saved As *.MAP, *.INT, or IODA Format



*.MAP Format Prior to Undistortion



Processed *.MAP Format With Null Correction

Test Data Treated As Standard IODA Uniform Grid Set

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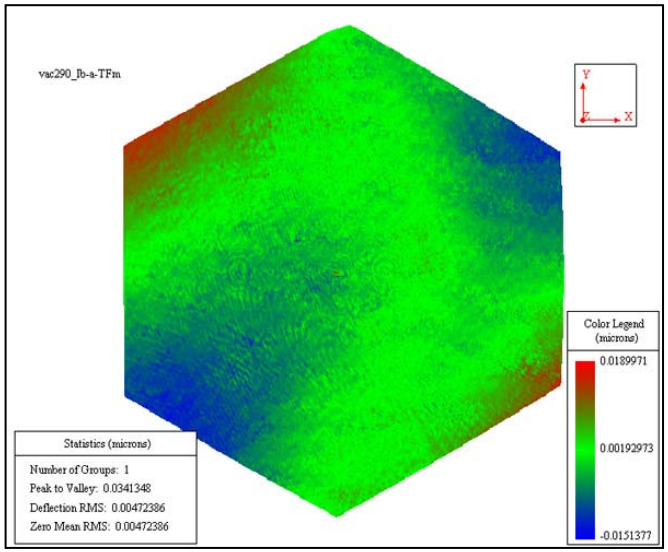
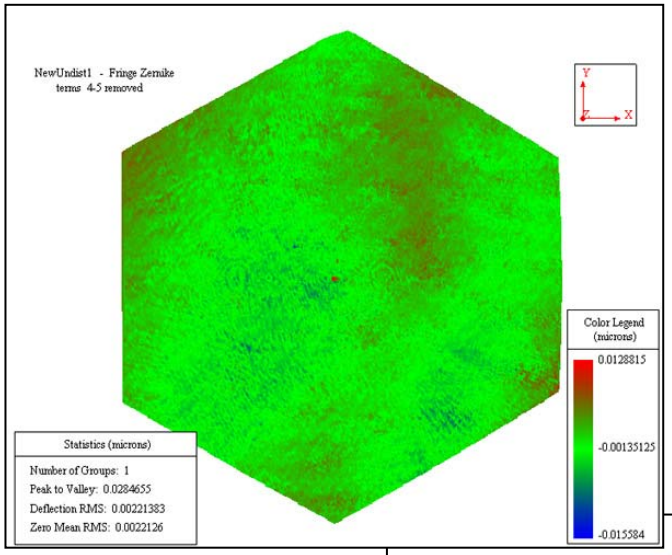
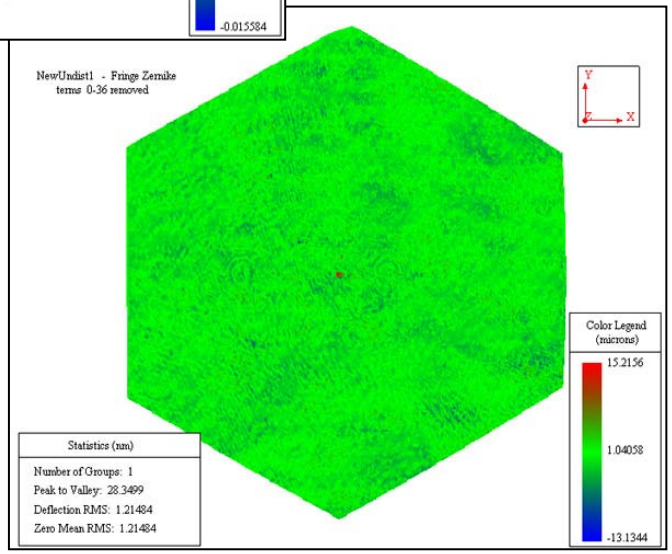
Raw Corrected Data



Zernike Fit With Astigmatism Removed



Zernike Fit Residual Error



- Imported Data Converted to Standard Uniform Grid Format
- Data Can Be Converted to Code V, or ZEMAX Compatible File and Coupled With Optical Analysis
- Fiducial Alignment Allows Comparison of Model to Measured Data and Measured to Measured Data

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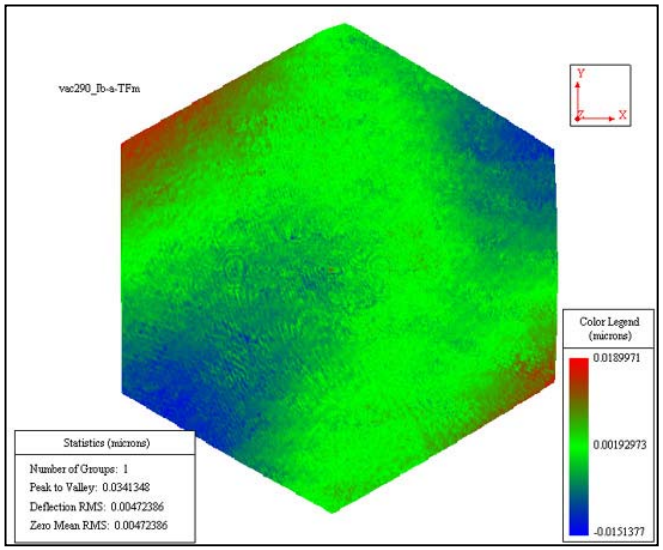
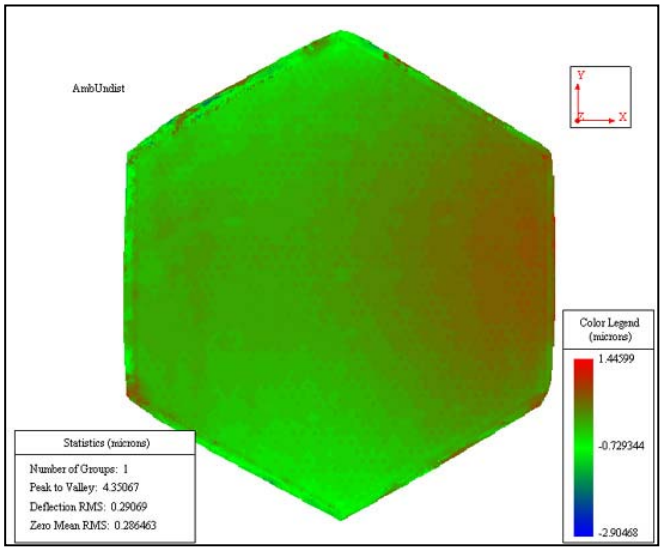
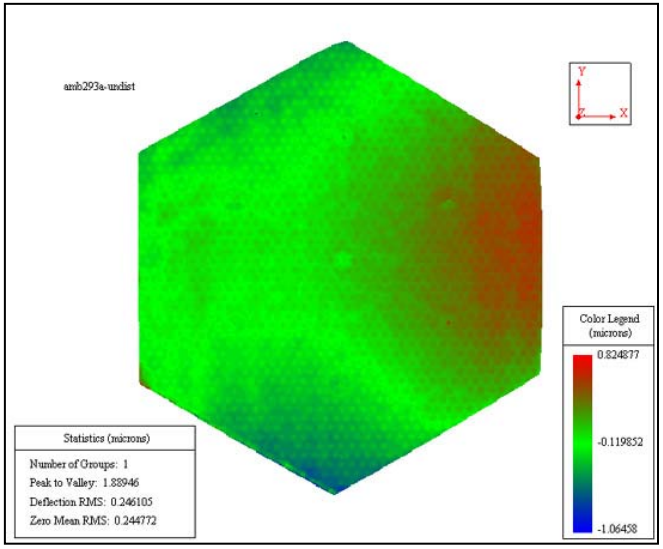
Example Showing Comparison of Multiple Data Sets



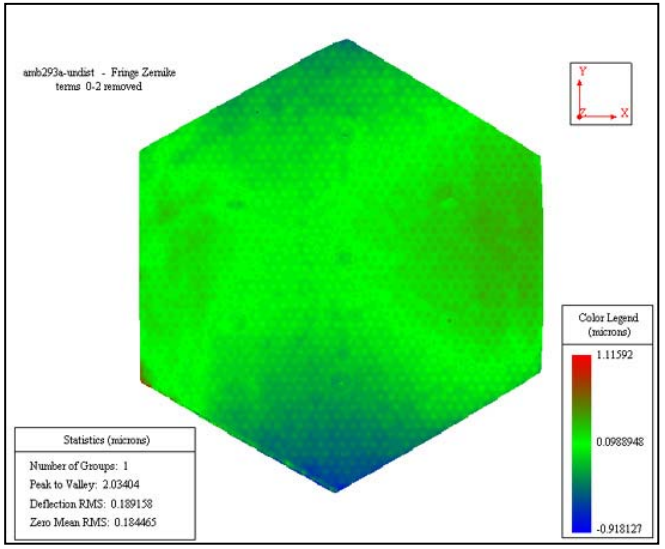
Data at Condition 2



Data at Condition 1

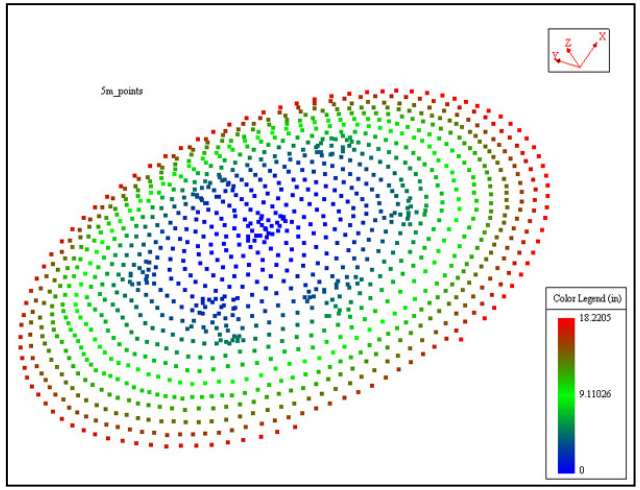


Condition 1 – Condition 2

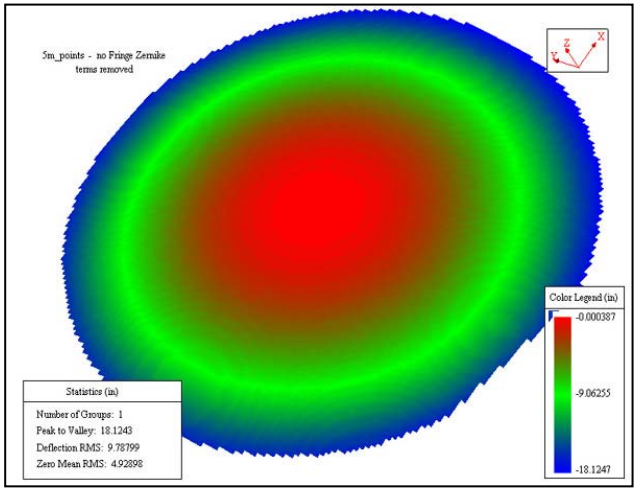


Result With Rigid Body Terms Removed

Importing Data from a Points Cloud

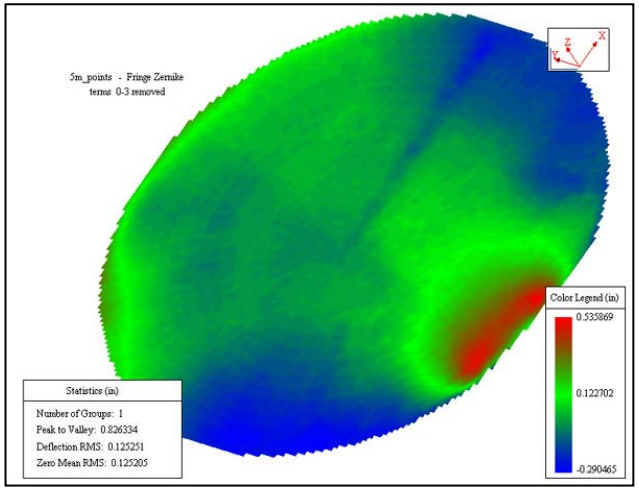


Photogrammetry
Points Cloud



Data Displayed in
Uniform Grid Format

- Data Can Be Imported from Photogrammetry, Coordinate Measurement Tool, Profilometer, etc.
- X, Y, Z Coordinates Imported from ASCII Text File *.PTS
- Resulting Data Converted to Standard IODA Format



Zernike
Surface -
Rigid Body
Terms

Summary of IODA Features

- Transfer Optical Surface Deflections from FEA to Code V™ or ZEMAX for Coupled Optomechanical Analysis
  - Select and Group Optical Surface Nodes
  - Map Optical Surface Deflections to a Uniform Grid as Required for Optical Model Definition
  - Generate Zernike Polynomials and/or Interferogram Files for Optical Model
  - Map Deformations into Optical Model Surfaces (Multiple Flexible Surfaces)
- Generate Parametric Analysis from Multiple Load Cases
- Automated Macros For Generating Most of the Optical Metrics versus Load Case
- Data Post Processing and Decomposition into Zernike Terms
- NASTRAN and ALGOR Interface Developed for Linear and Non-Linear FEA
- Automated Generation of Influence Functions For Optical Surfaces
- Least Squares Routine Developed to Solve for Actuator Positions to Minimize RMS Figure Error
- Dynamic Analysis Capability Added to Generate Wavefront and Image Analysis for Dynamic Loading
- *Comparison of Measured Data to Modeled Data and Multiple Load Cases to Each Other (*.INT, *.MAP, *.PTS)*