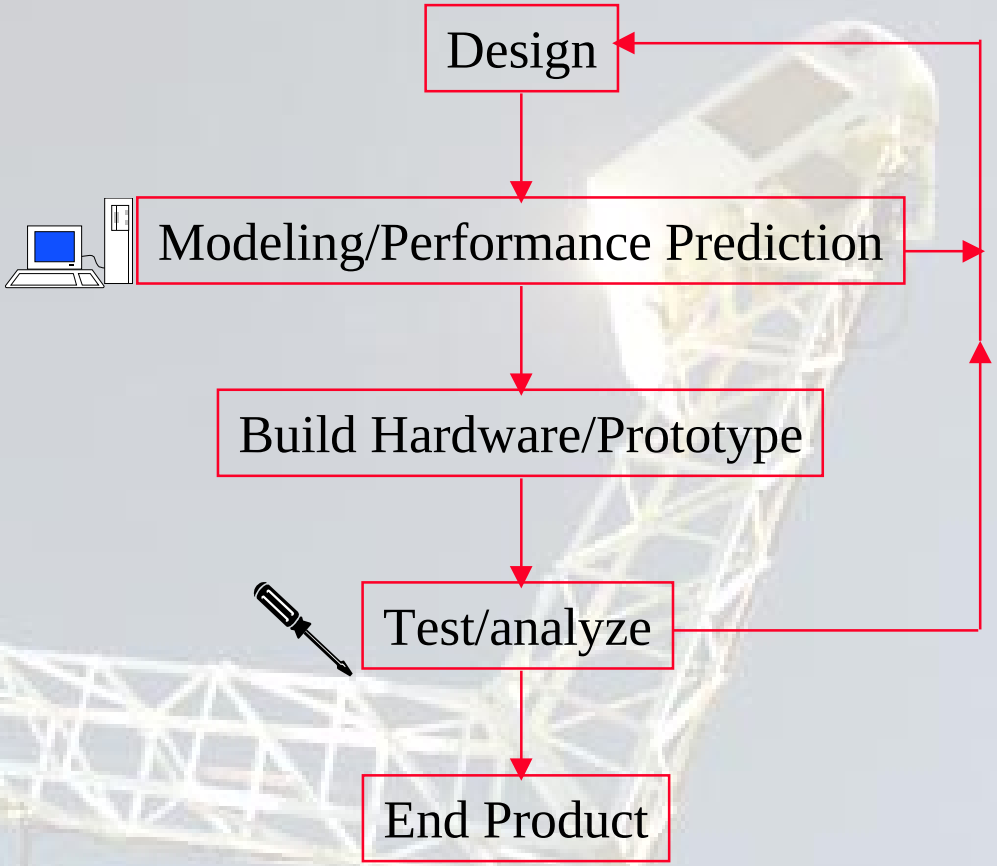
# Optical Modeling/Analysis Tools

***2001 CSP Peer Review***

Tim Wendelin, NREL

# *Concentrator RD&D Process*

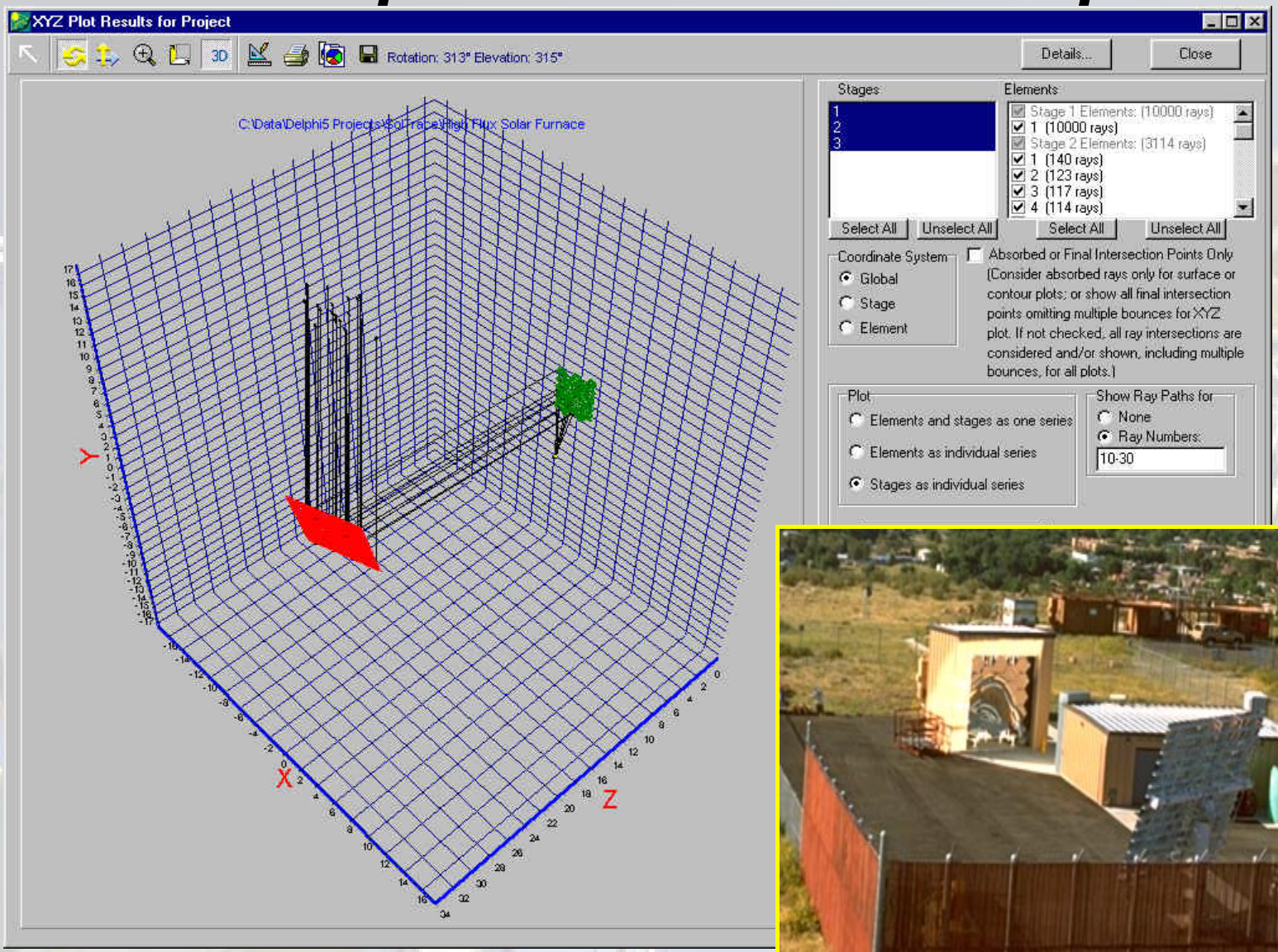
- Optical Modeling Tools
  - Used to model and design optical systems for CSP, predict performance, data used in design process
- Analysis/Characterization Tools
  - Test prototypes, assess performance, use data to further design
- SunLab Developed
- Used by both SunLab & Industry



# *Optical Modeling Tools*

- CIRCE*, HELIOS, DELSOL* (*used most often)
  - FORTRAN codes used to model concentrating systems
  - Based on convolution of moments; fast, accurate, tabular text optical input/output
- SolTRACE
  - Windows based optical design code utilizing Monte Carlo ray tracing techniques
  - Unique, can model simple or complex optical geometries.
  - Allows for variety of optical contour definitions
  - Windows-based graphical output in addition to text output

# Example of SolTRACE Output



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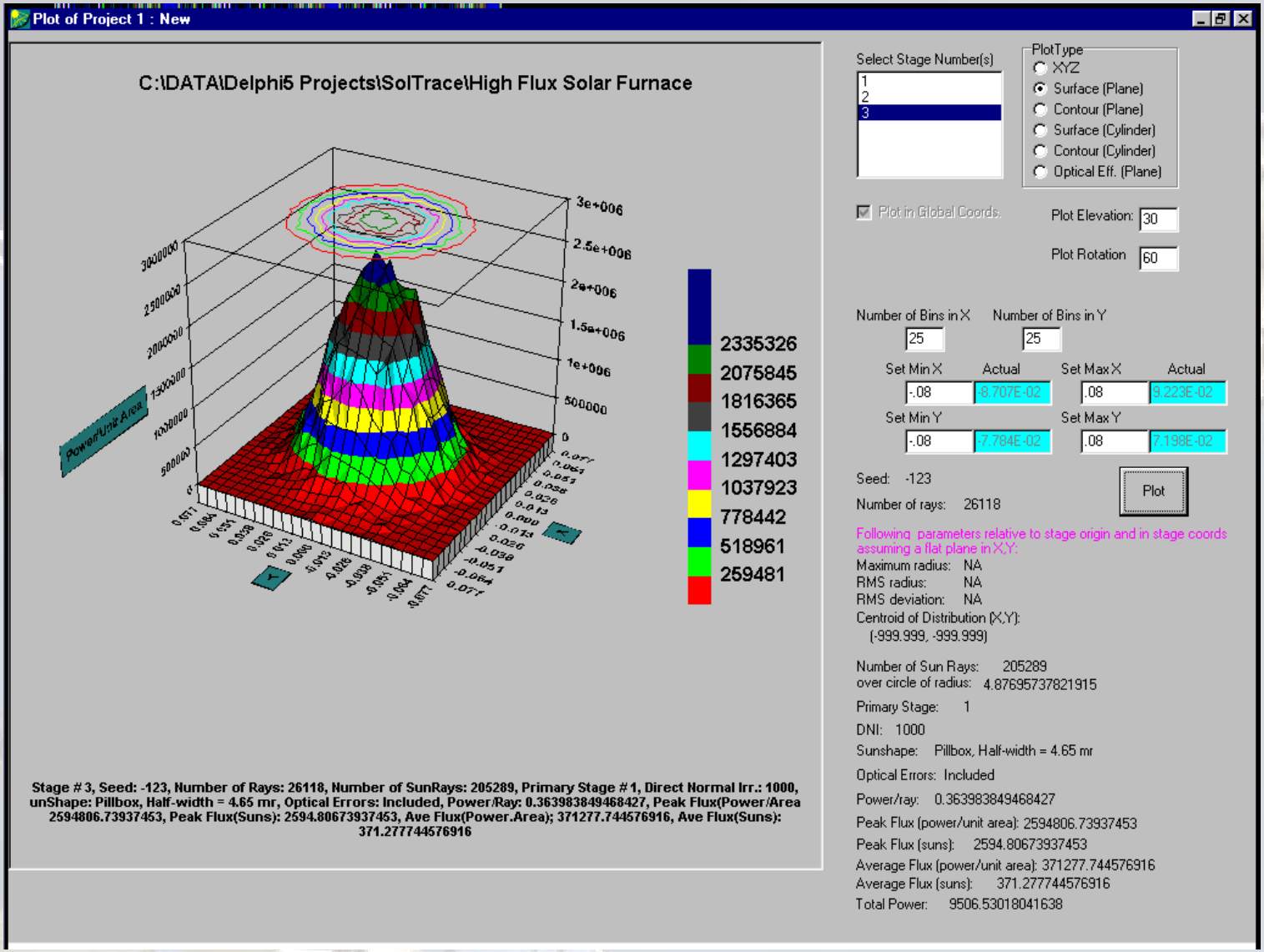

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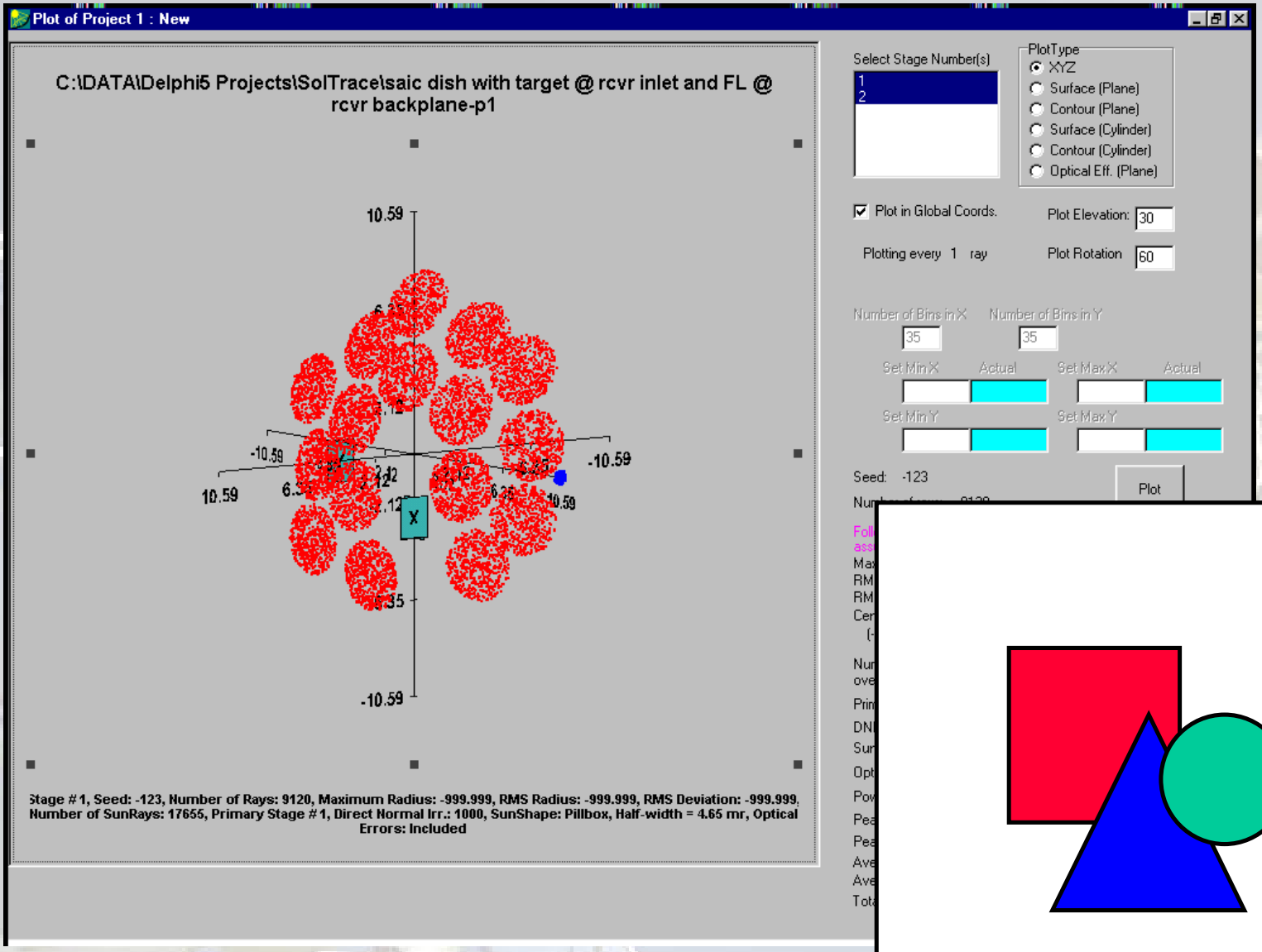


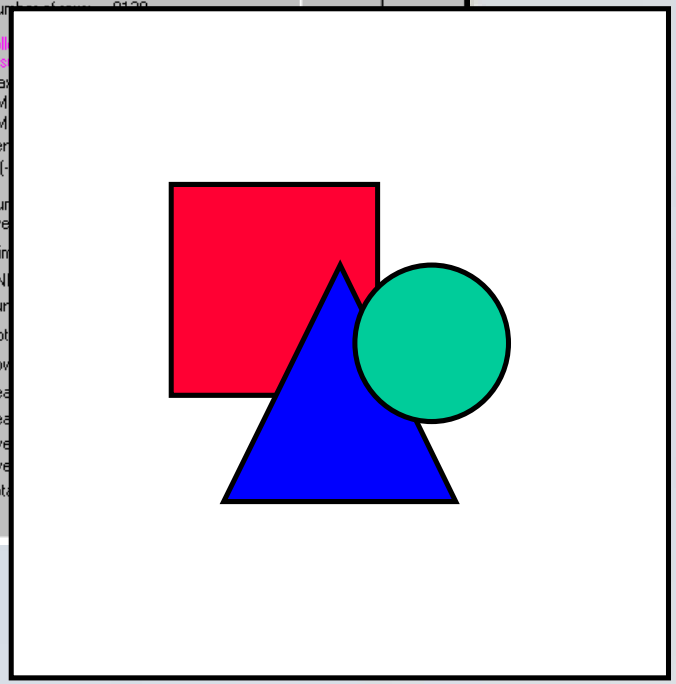

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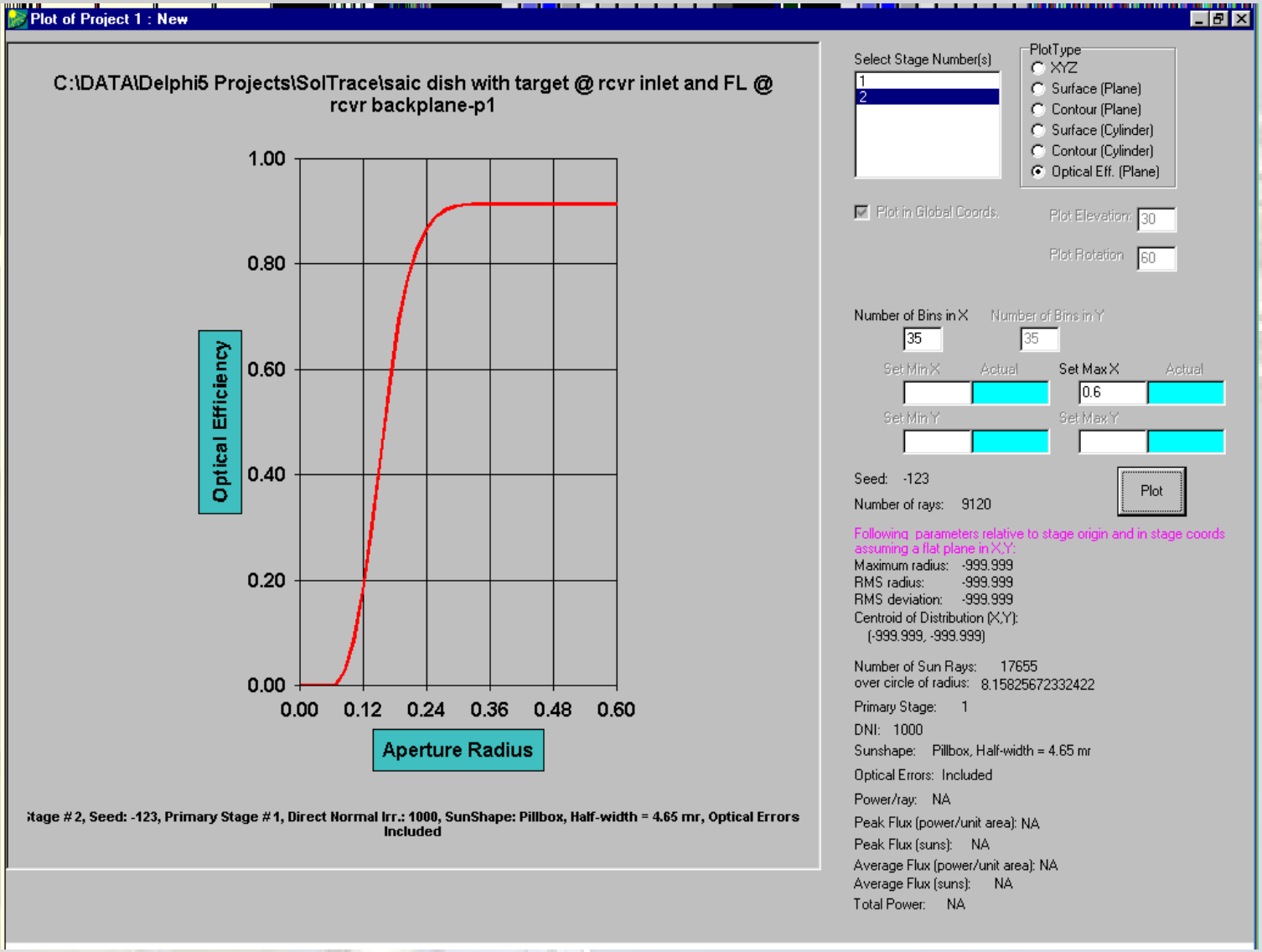
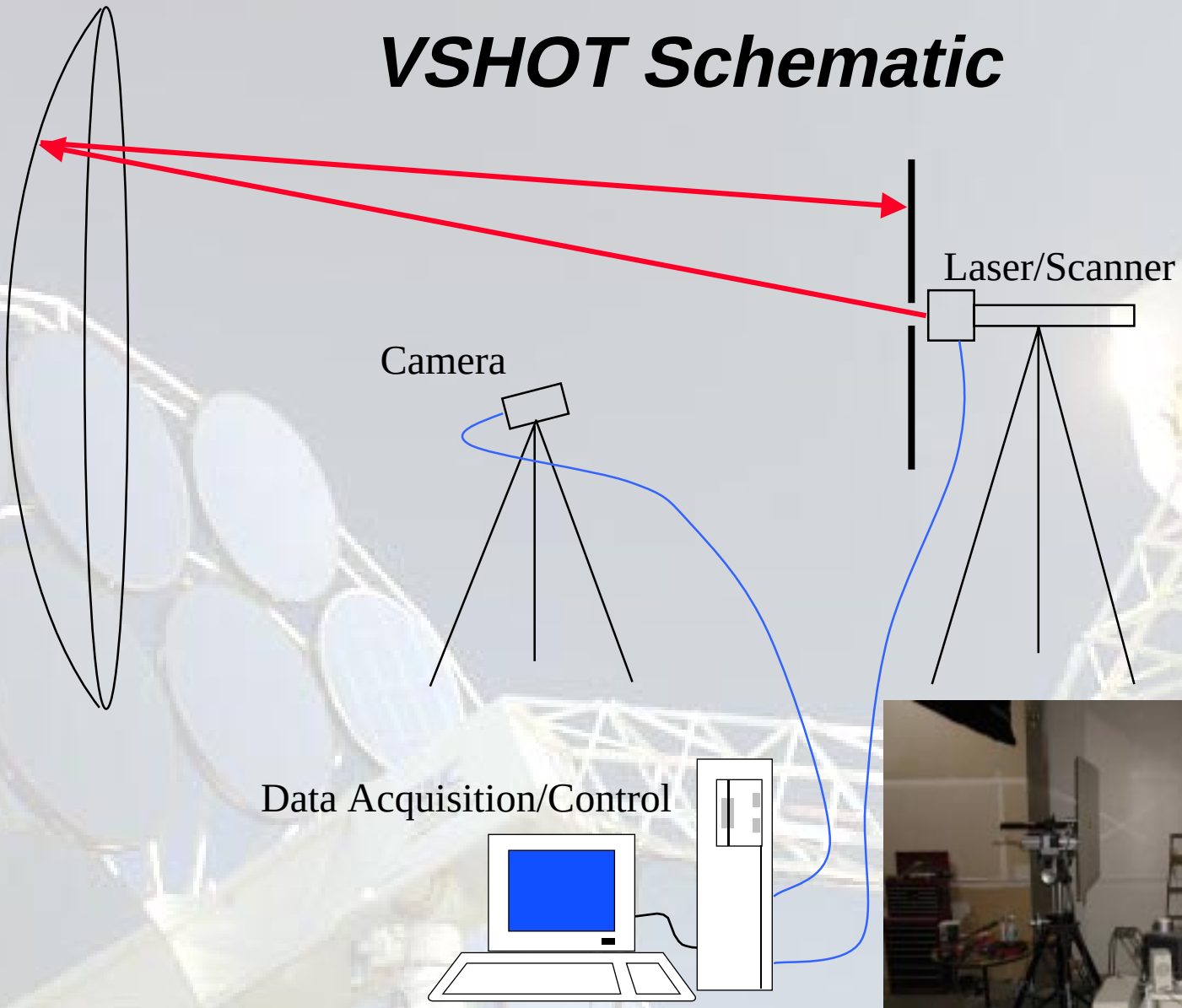


# *Optical/System Characterization Tools*

- VSHOT (Video Scanning Hartmann Optical Test)
  - Unique capability characterizes concentrating reflective optics
  - Two systems used extensively in:
    - Dish/trough mirror panel development
    - Small dish system development
    - Work for Others including Ford Automotive, Daylighting in Buildings
    - General support of industry dish systems

# VSHOT Schematic



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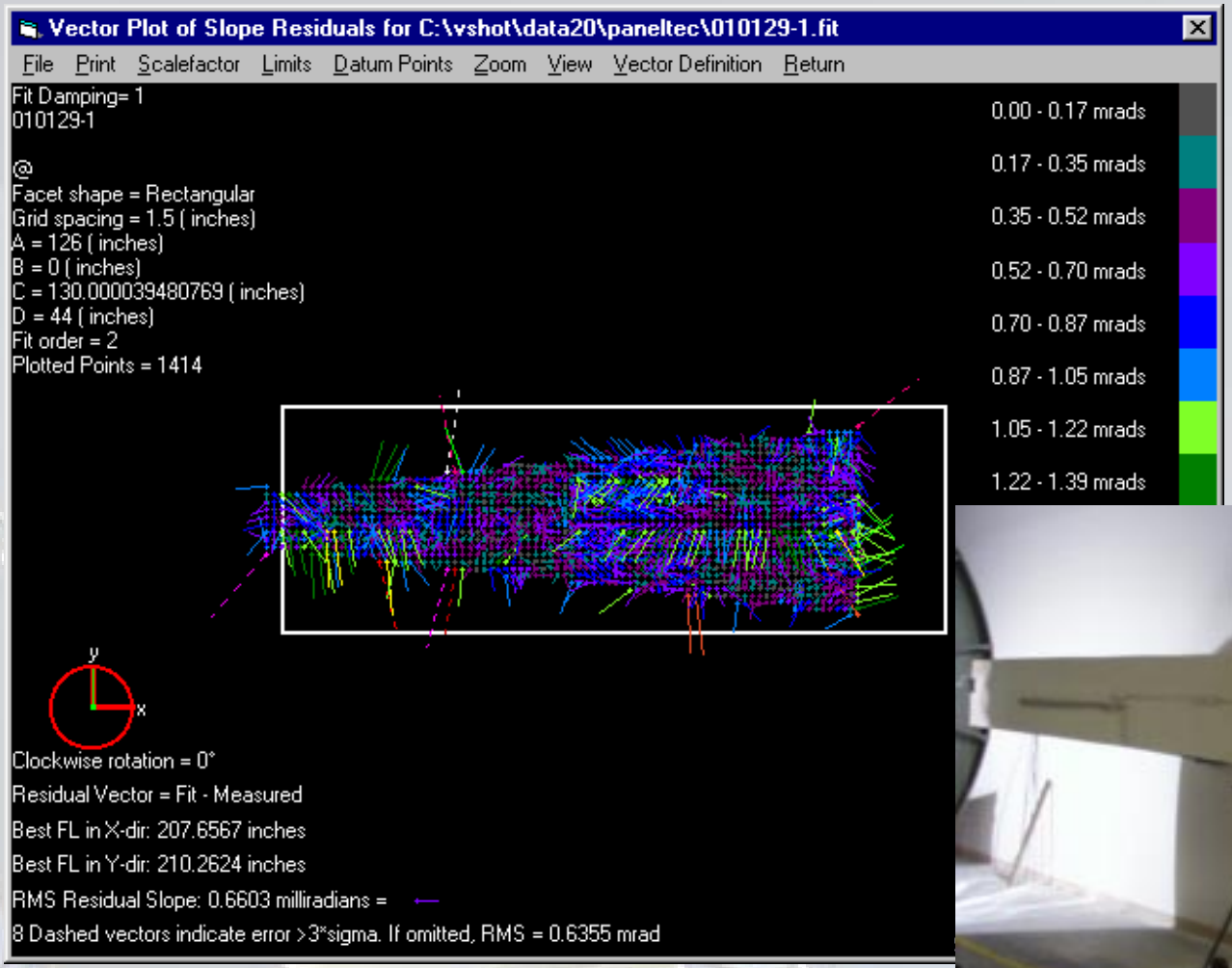
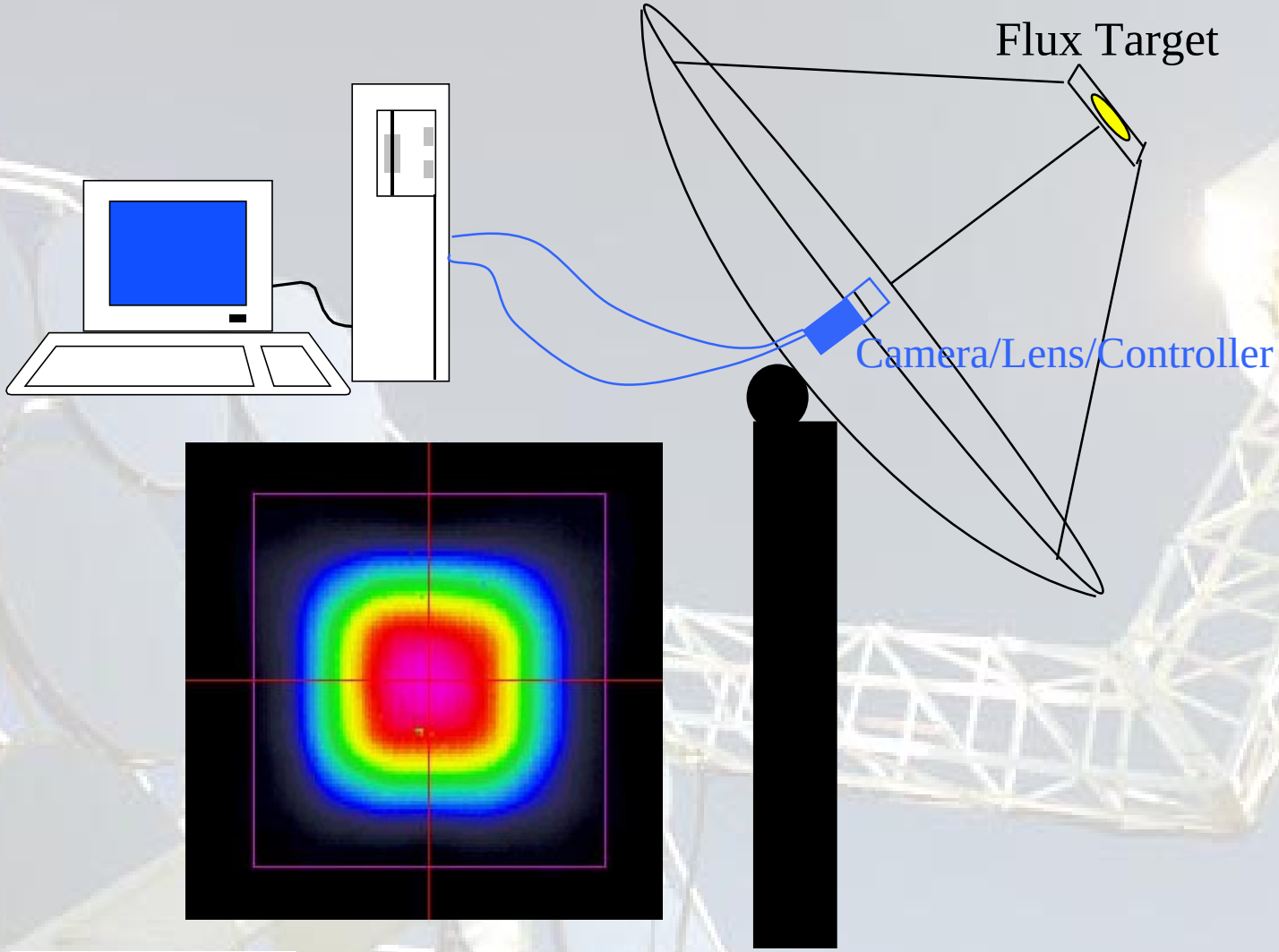


# *Optical/System Characterization Tools*

- LFOCS (Line Focus Optical Characterization System)
  - Characterizes optics of trough concentrators in the field
  - Field maintenance tool for receiver/mirror panel alignment

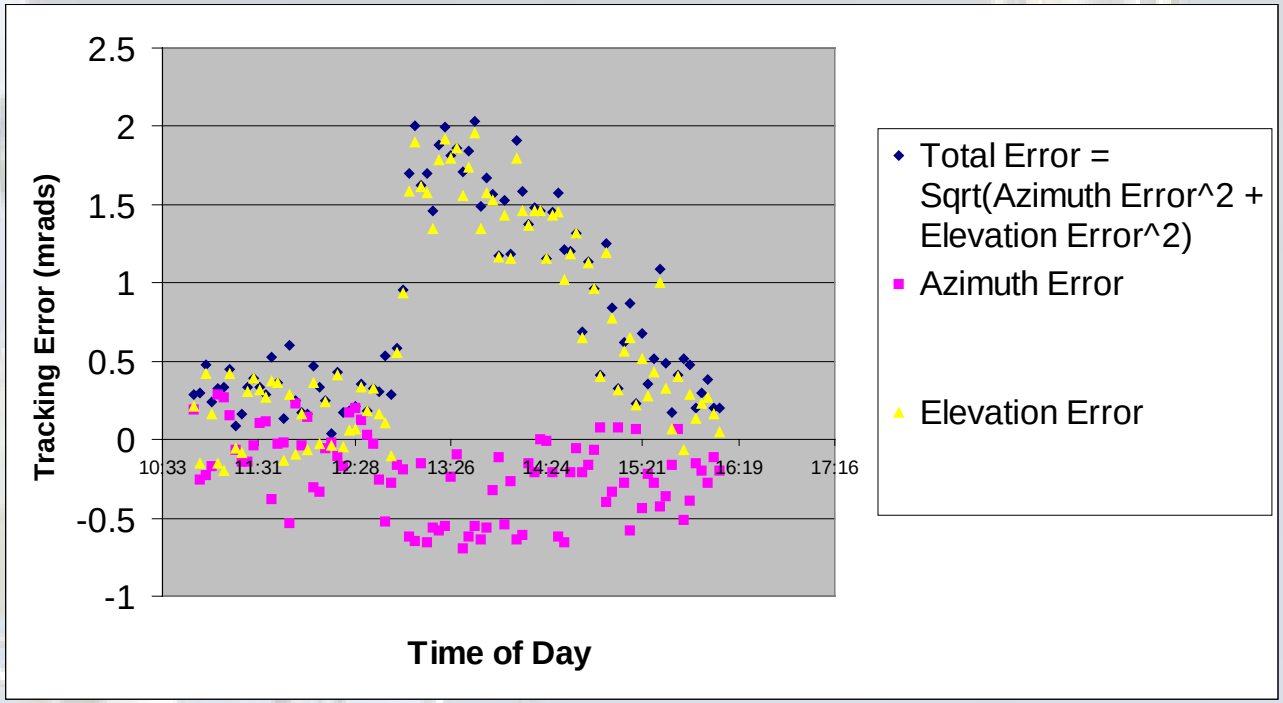
- BCS (Beam Characterization System)
  - Measures target flux distribution of concentrating solar systems
  - Used extensively in Dish/Stirling & Dish/PV development
  - Currently upgrading outdated system with new hardware/software

# BCS Schematic



# *Optical/System Characterization Tools*

- STATS (Solar Tracking Accuracy Test System)
  - Measures & monitors tracking accuracy of solar drive/tracking systems
  - Currently used in small dish system development



# STATS

# *Component Development Utilizing Tools*

- Structural Mirror Panels
  - panels made for the 10kW dish and LS-2, LS-3 trough modules
  - excellent optical performance
  - excellent structural integrity
  - production costs continue to be improved

# *Component Development Utilizing Tools*

- Drive/Trackers for Small Dish Systems
  - Two drive/tracking systems produced
    - Calculation-based open loop control system (HI)
    - Sun sensor-based closed loop control system (ATI)
  - ATI system tested and shown to meet performance goal of ± 0.5 mrad r.m.s. tracking error
  - ATI drive has since been commercialized and added to product line
  - Phase 2 objective to add additional “smarts” to ATI tracking control

Heliotstats, Inc. Drive

Array Technologies, Inc. Drive

# *Component Development Utilizing Tools*

- Small Dishes
  - VSHOT testing of off-the-shelf satellite dish products demonstrates potential to produce suitable dishes for CSP
  - Reflective surface requires further development
  - Flux tailoring for various converter concepts possible, but requires further development
  - Future efforts would focus on satellite dish industry collaboration to develop complete solar dishes

# *Notable Accomplishments*

- Copyright of VSHOT control software
- Copyright/Patent pending of SolTRACE optical analysis software
- Patent pending on STATS tracking accuracy monitor