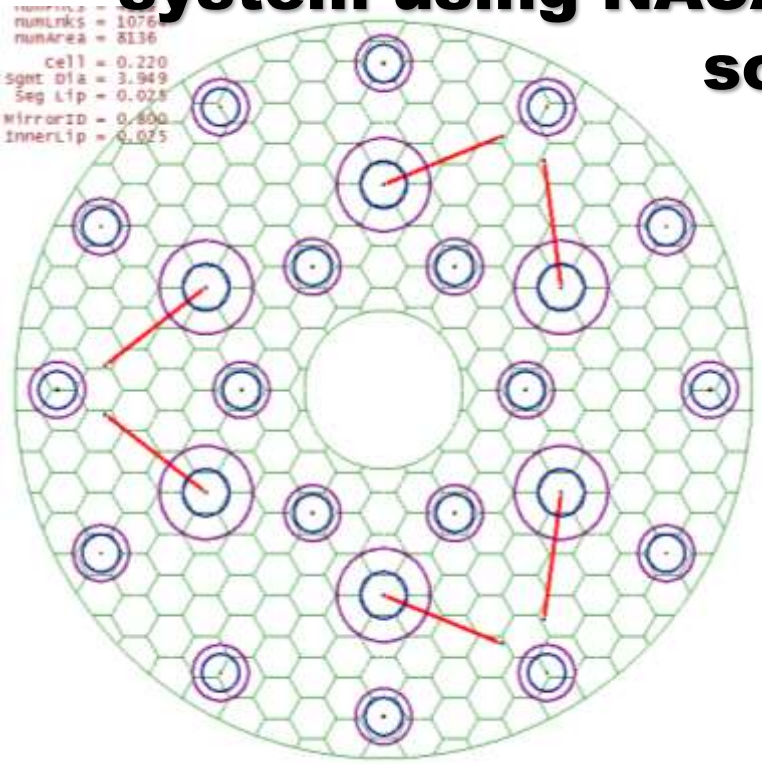
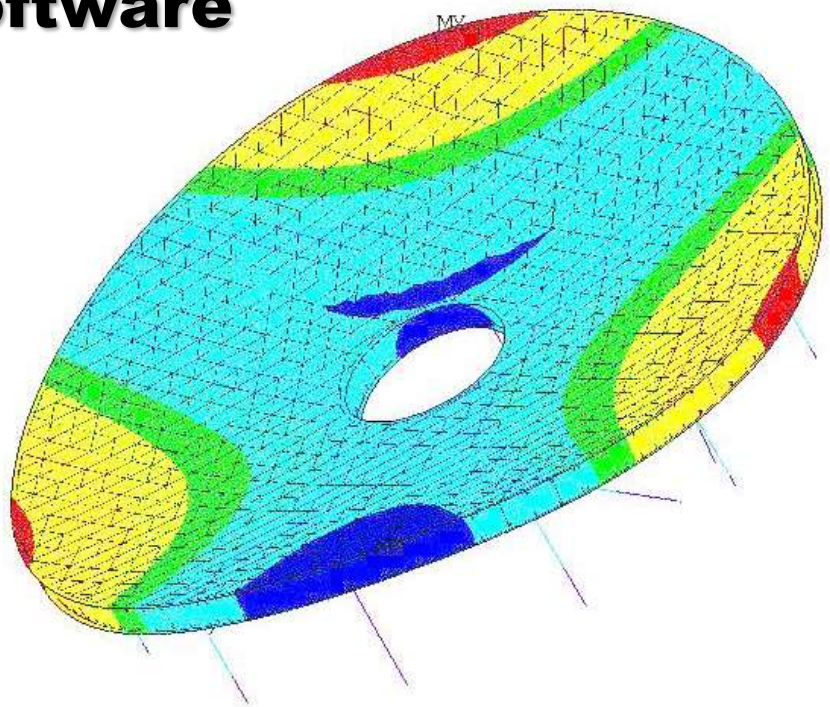
# Integration of mirror design with suspension system using NASA's new mirror modeling software




**William R. Arnold Sr., Sr. Principal Engineer, DAI, Huntsville, AL.**
**Ryan M. Bevan, NASA Intern, NASA MSFC, Huntsville, Al.**
**Dr. Phil Stahl, AMTD PI, NASA MSFC, Huntsville, Al.**

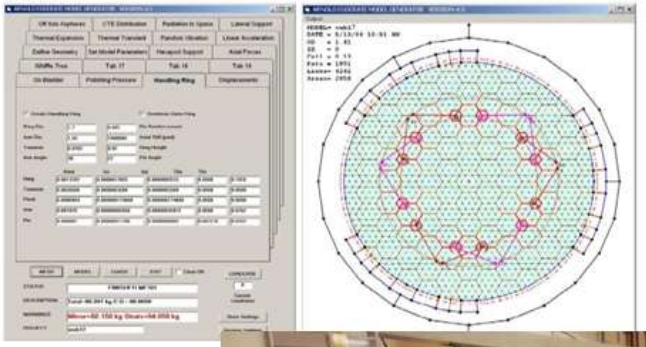
# INTRODUCTION

## TOOLS FOR INTEGRATED DESIGN OF MIRRORS & SUSPENSION SYSTEMS

- WHY WE ARE INTERESTED IN THESE TOOLS
  - LARGER SPACE-BASED UV TELESCOPES BEING PLANNED.
  - LAUNCH CAPABILITIES REMAIN UNCERTAIN
  - COST & SCHEDULE TO BUILD COMPLEX FEM MODELS
  - THIS APPROACH WAS VERY SUCCESSFUL ON KEPLER
- SUBSTRATE MATERIALS & FABRICATION ADVANCES
  - ULE (FRIT OR LOW TEMPERATURE FUSION)
  - ZERODUR (POCKET MILLED & ACID)
  - BOROSILICATE (CAST)
- SUSPENSION SYSTEMS & LIGHTWEIGHT OPTICS
  - OPERATIONAL (KINEMATIC)
  - AUXILLARY LAUNCH (DISENGAGES ON ORBIT)
  - HOW MIRROR DESIGN INTERACTS WITH SUSPENSION(S)

# INTEGRATED APPROACH TO DESIGN
## (PREDECESSOR PROGRAM USED ON KEPLER)

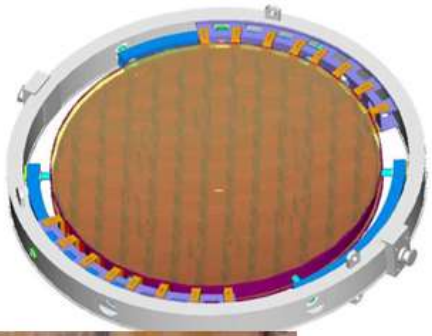
**Integrated Design of Handling Equipment**



Design tool allows evaluation a
of the mirror blank. As mirrors
manufacturing requires careful
were added to the blank specifi

Kepler

**Primary Mirror in Flipping Ring**



nforced slots in the mirro
he unit can act as a
l surfaces or fragile edges

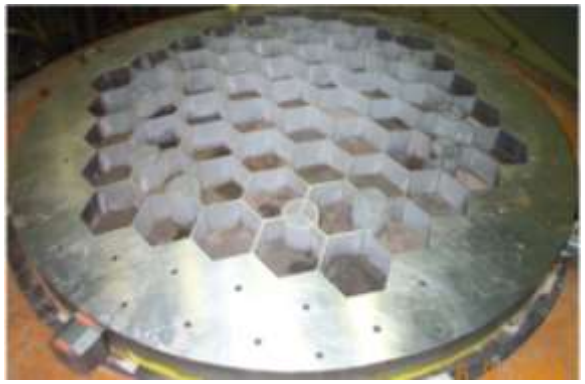
2004

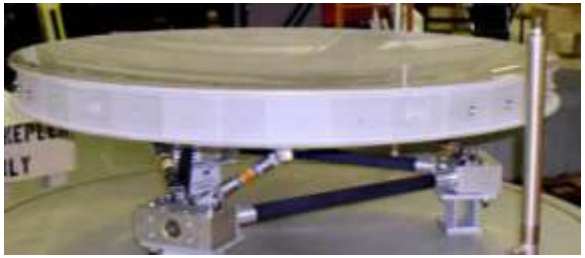
# STEPS IN A BASIC MIRROR DESIGN TRADE STUDY

- EVALUATE MATERIALS AND CONSTRUCTION
  - MASS, COST, RISK, SCHEDULE … LOOK AT SEVERAL CHOICES
- MIRROR ONLY PERFORMANCE (MODES, WEIGHT)
  - GET FEEL FOR GEOMETRIC & THICKNESS INFLUENCES
- MIRROR & OPERATIONAL SUPPORT
  - MODE SHAPES, FREQUENCIES (ON ORBIT BEHAVIOR)
- MIRROR, OPERATIONAL & AUXILLARY SUPPORT
  - LAUNCH CONDITIONS, MIN FREQ, LOCAL STRESSES, ETC
- OPTIMIZE GEOMETRY, THICKNESS, ETC
  - CELL SIZE, EDGE ZONES, LOCAL REINFORCEMENT, CONSTRUCTION

# MATERIAL CHOICE DICTATES CONSTRUCTION METHOD

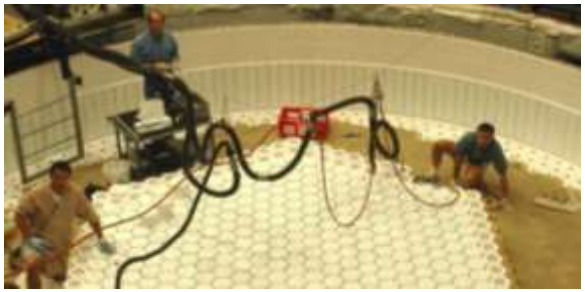
FRIT BONDED ULE





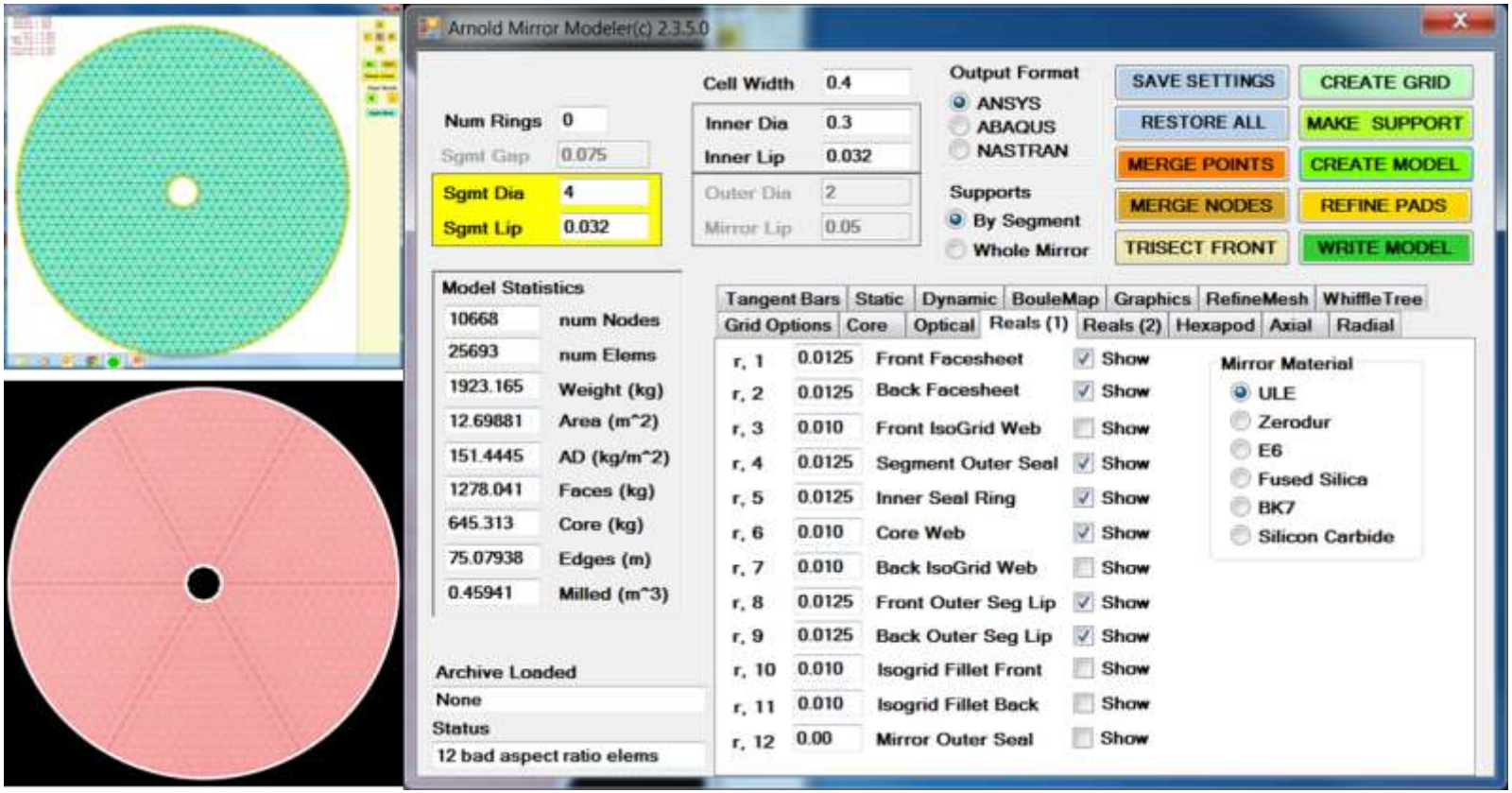
POCKET MILLED ZERODUR

CAST BOROSILICATE

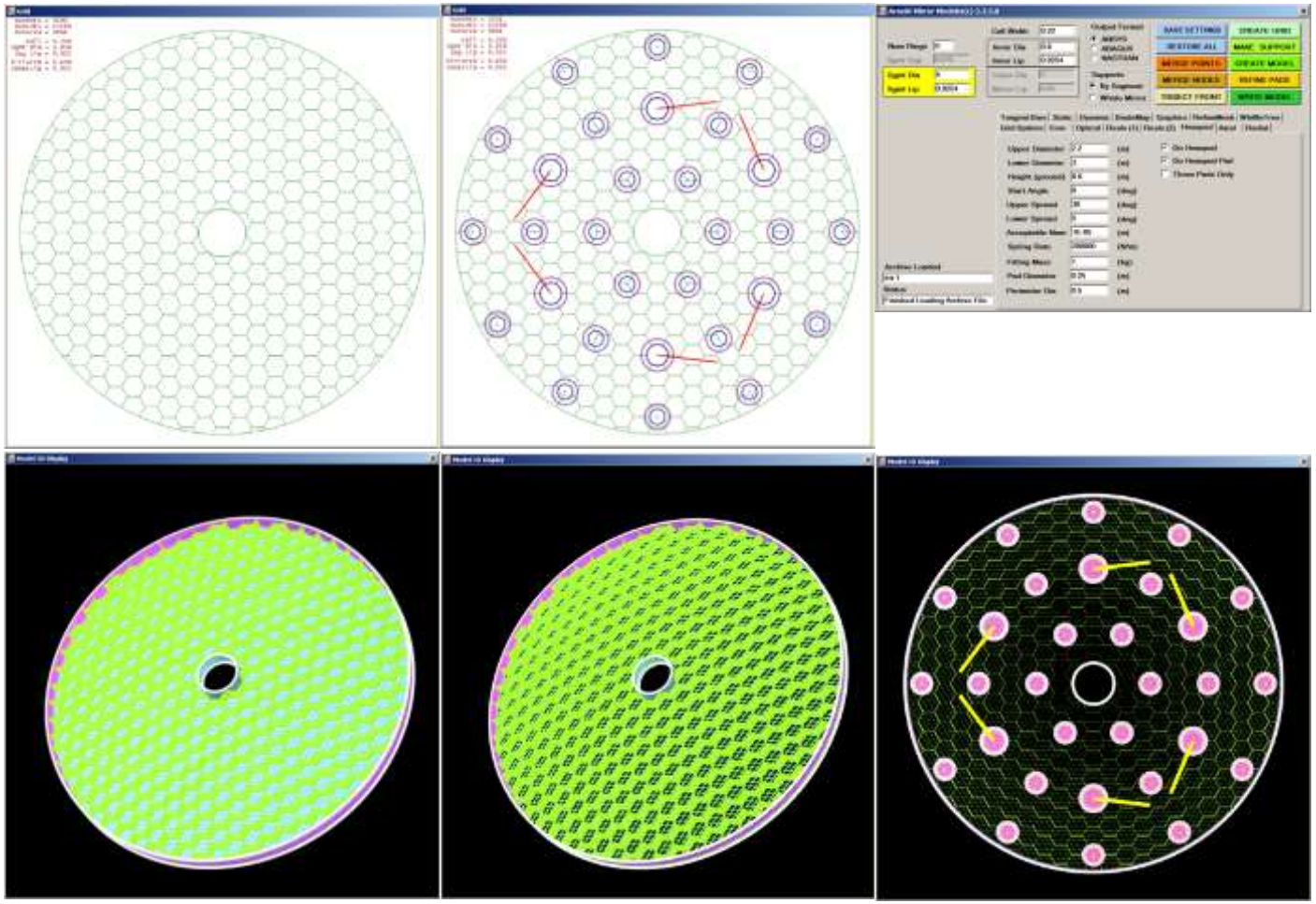


***LOW TEMPERATURE FUSION IS AN ALTERNATIVE ASSEMBLY, REQUIRES SLUMPING**

# QUICK INTRO TO MODELER

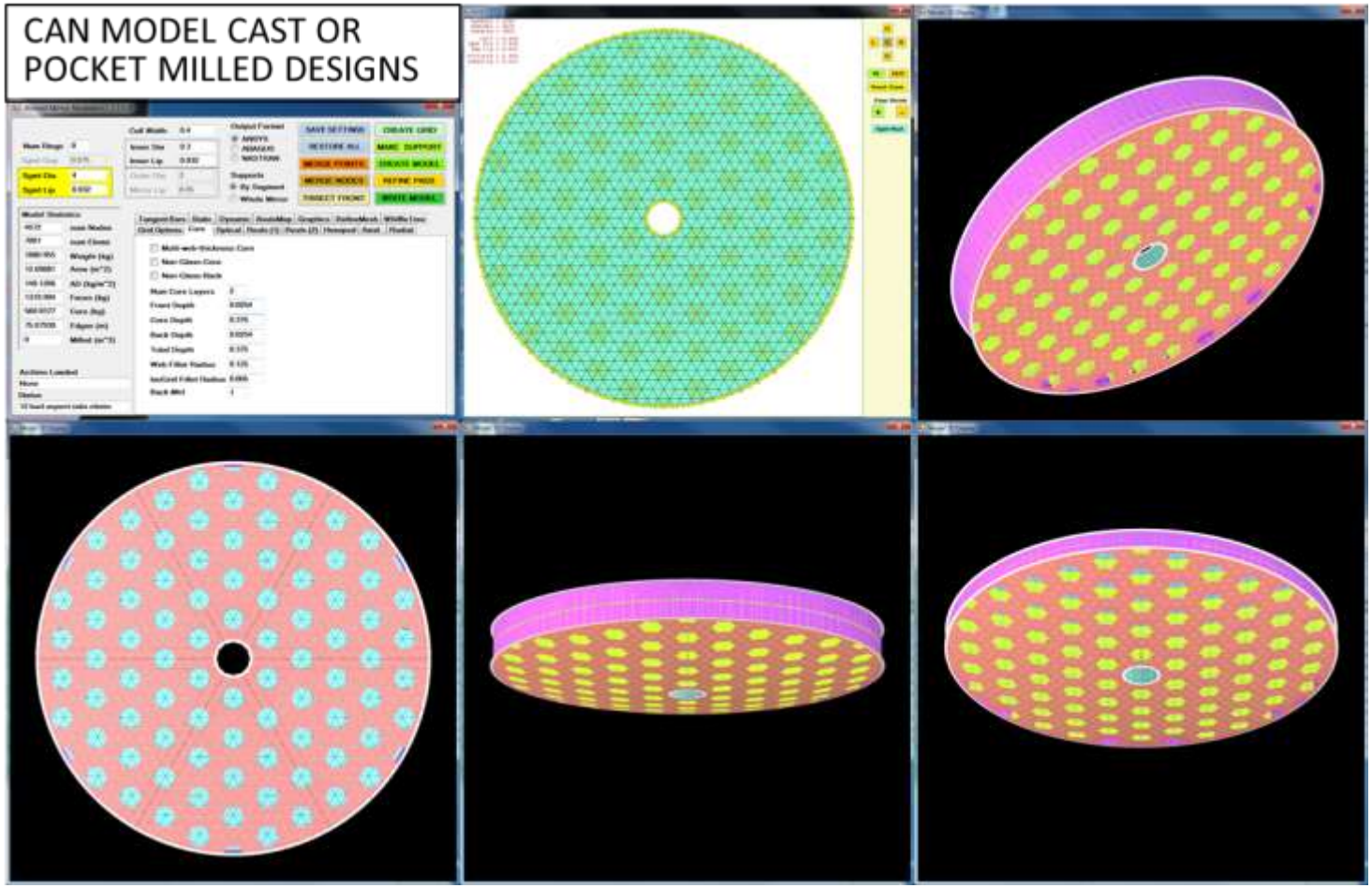


# ONE GRID PATTERN CAN CREATE MANY VARIATIONS

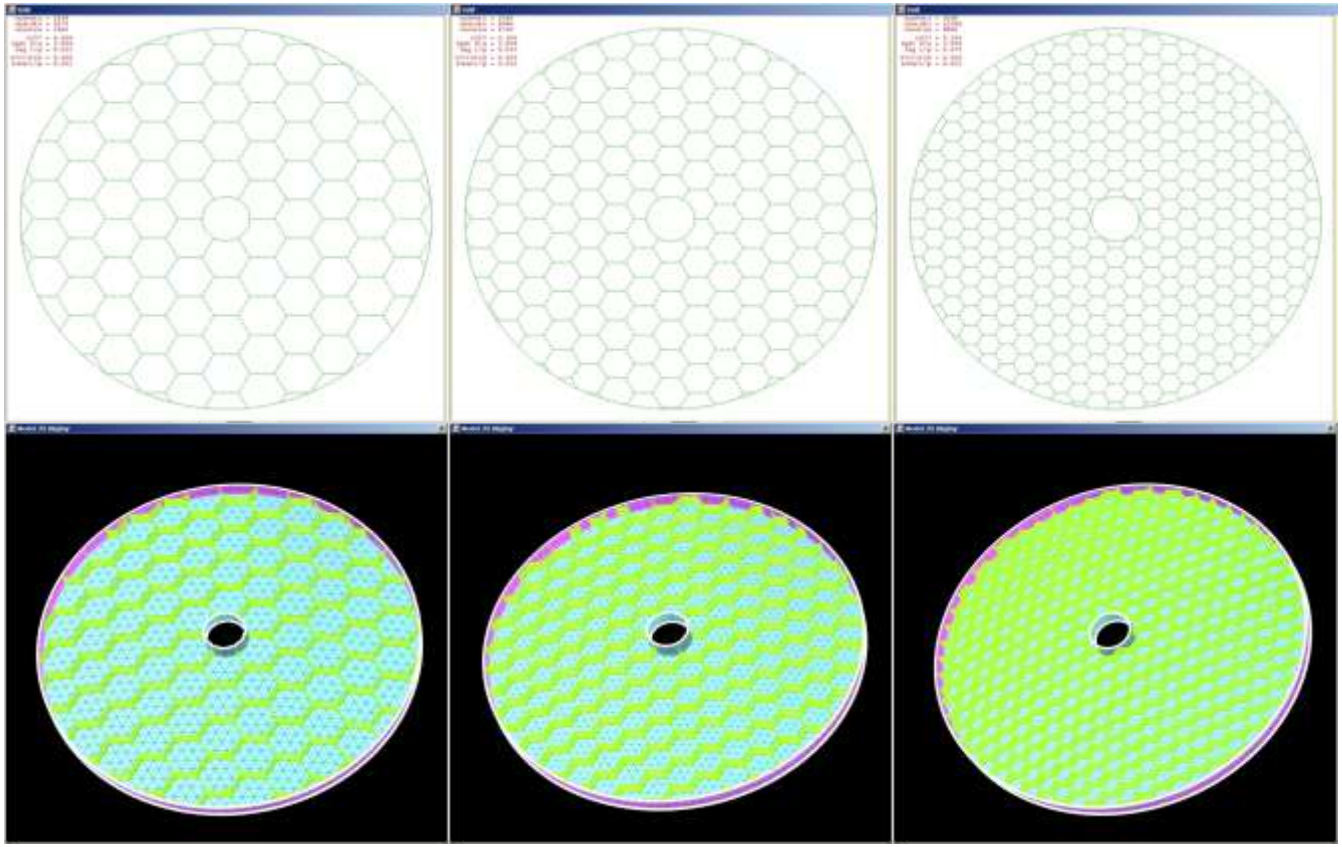


# QUICK EXAMPLE OF TRADE STUDY USING THE MODELER

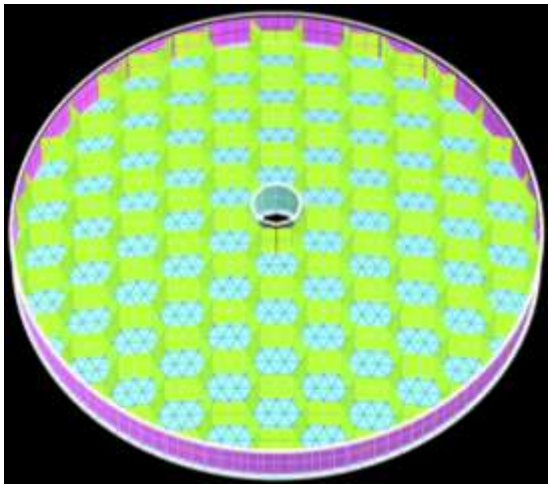
# STEP 1 - EVALUATE MATERIAL CHOICES & CONSTRUCTION



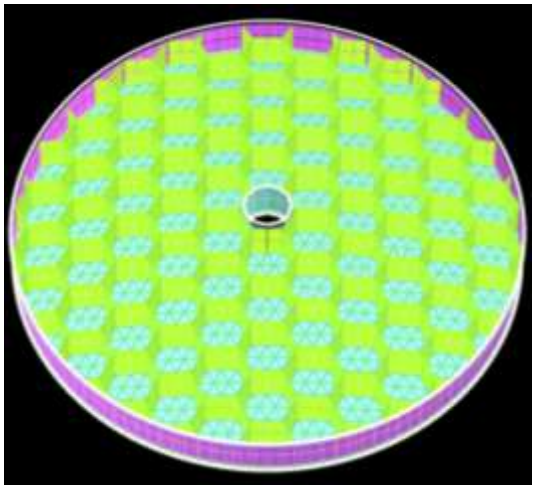
# TYPICAL INITIAL STEP TRY DIFFERENT CELL SIZES



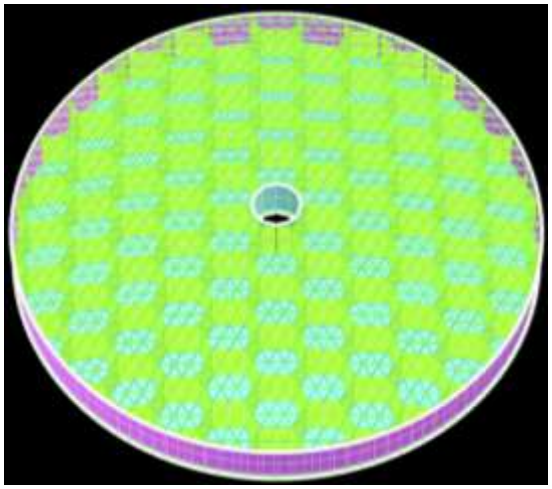
# SAME GRID CAN GENERATE MULTIPLE CONSTRUCTION STYLES



NO ISOGRID

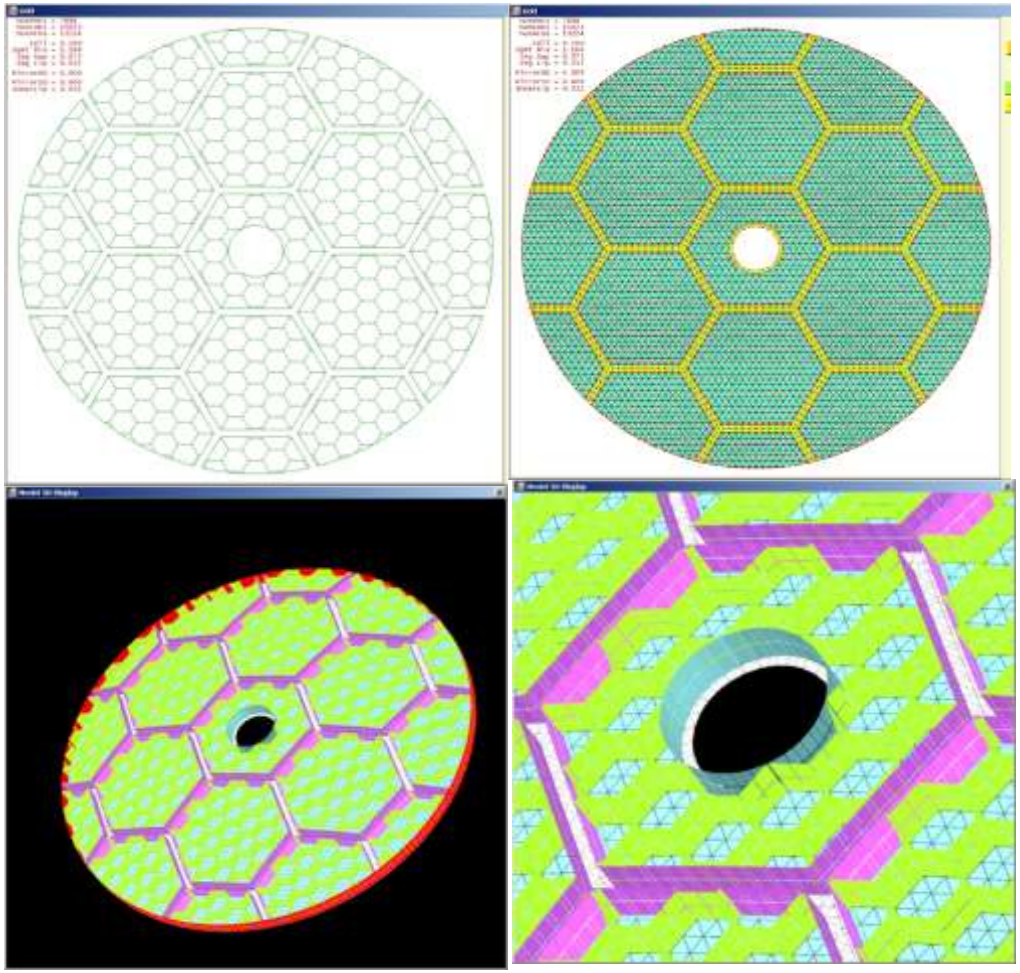


FRONT ONLY ISOGRID

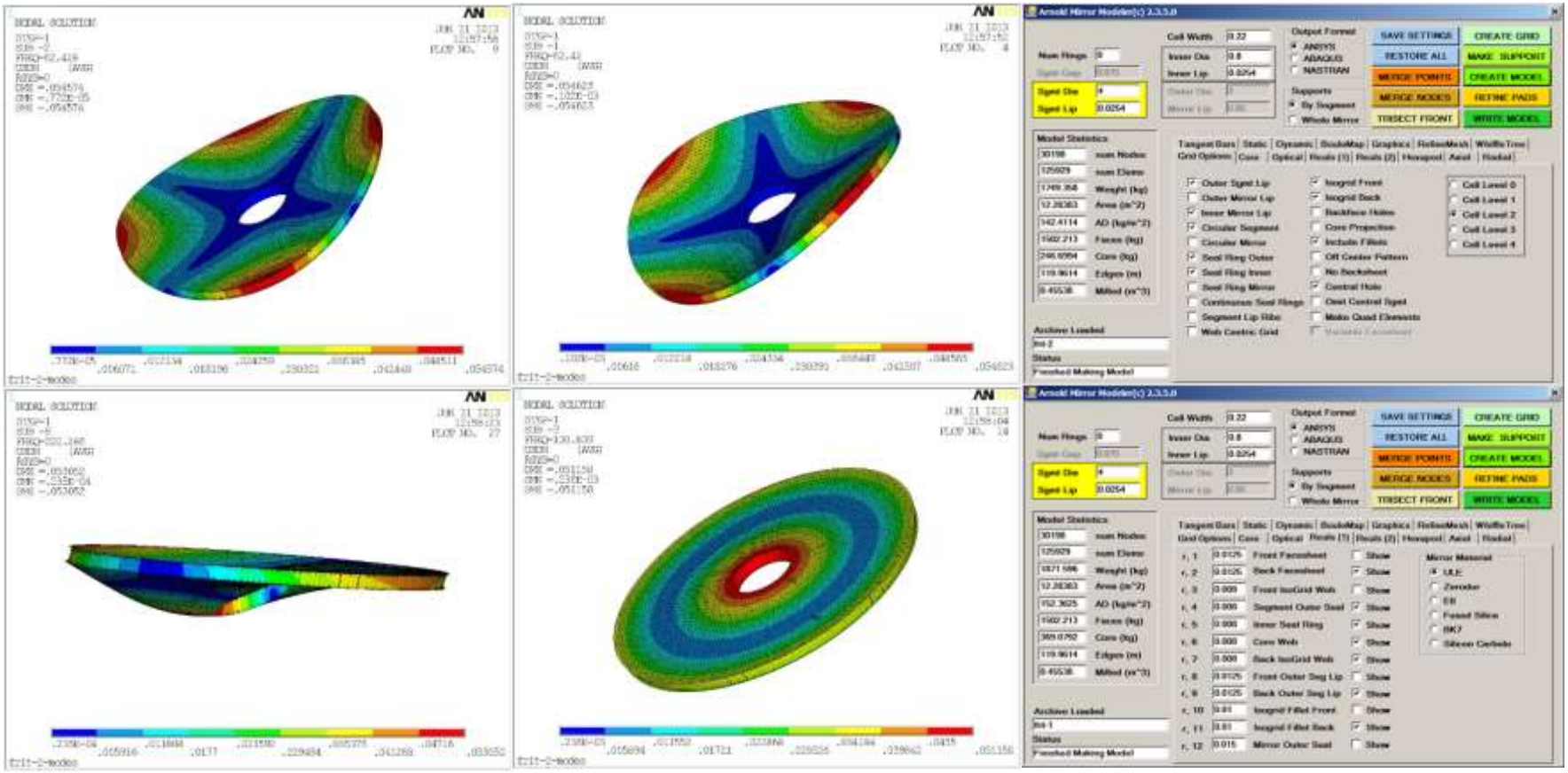


FRONT & REAR ISOGRID

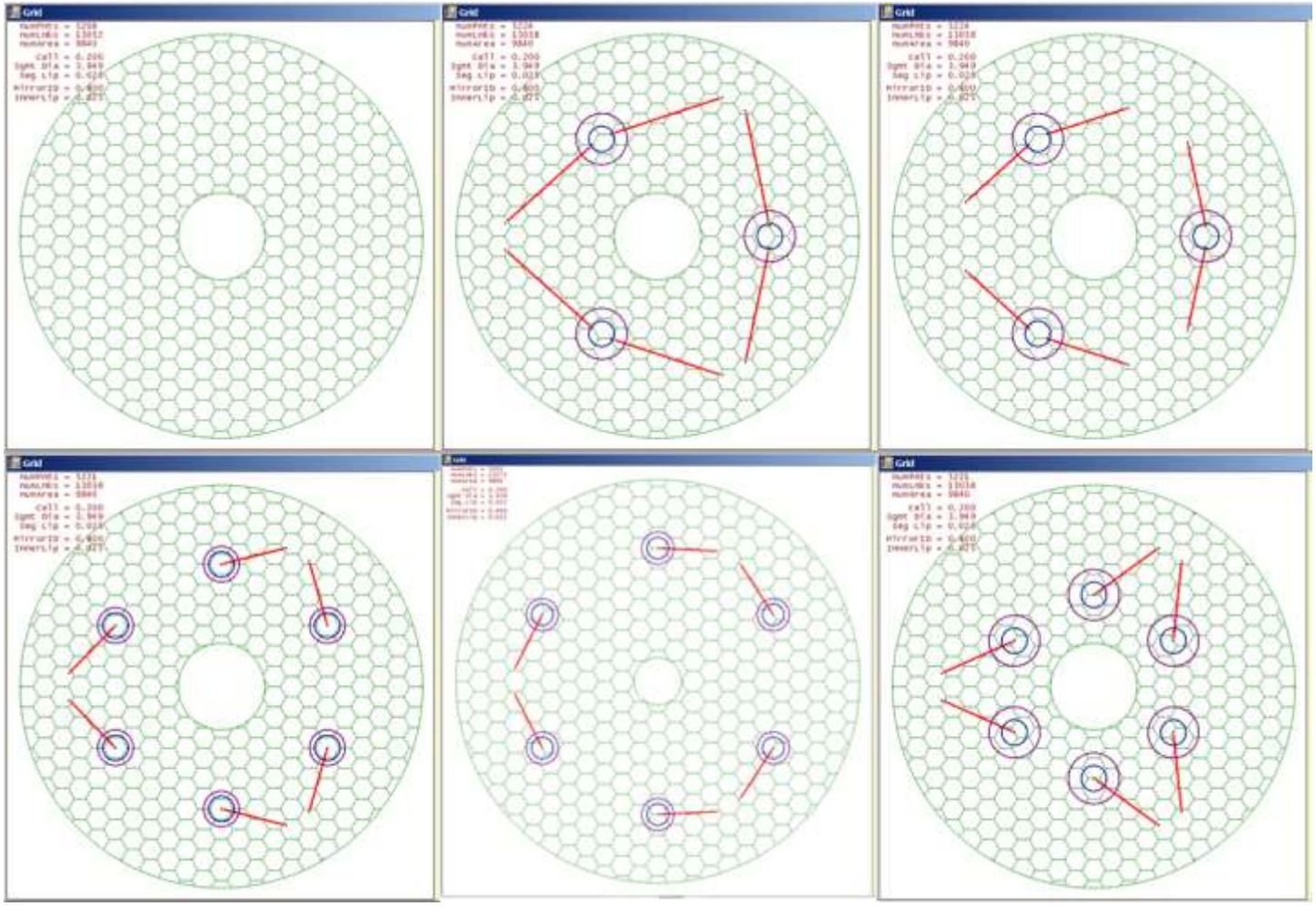
# MULTI-SEGMENT LTF CONSTRUCTION CAN BE MODELED



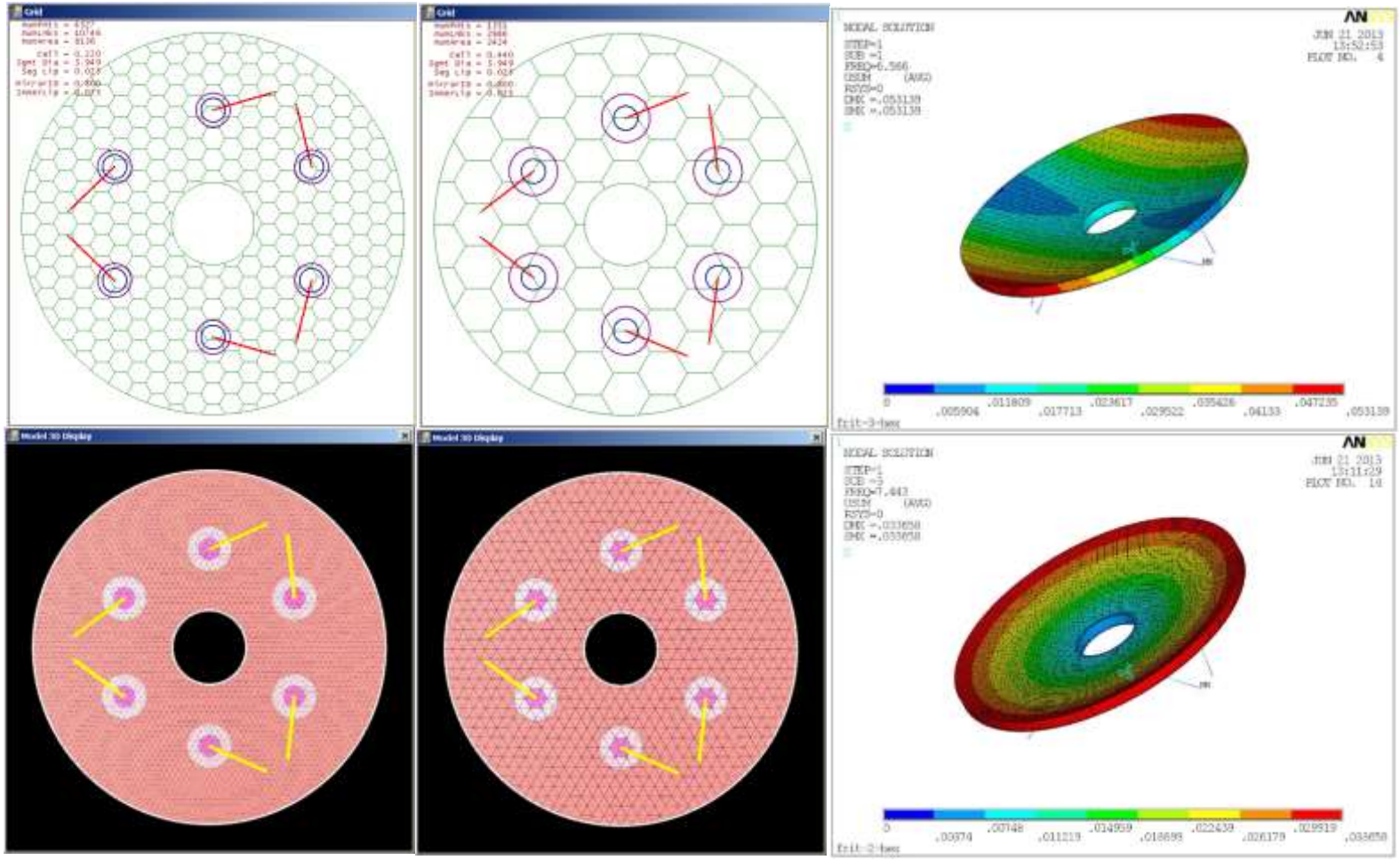
# STEP 2 – EVALUATE MIRROR ONLY PARAMETERS



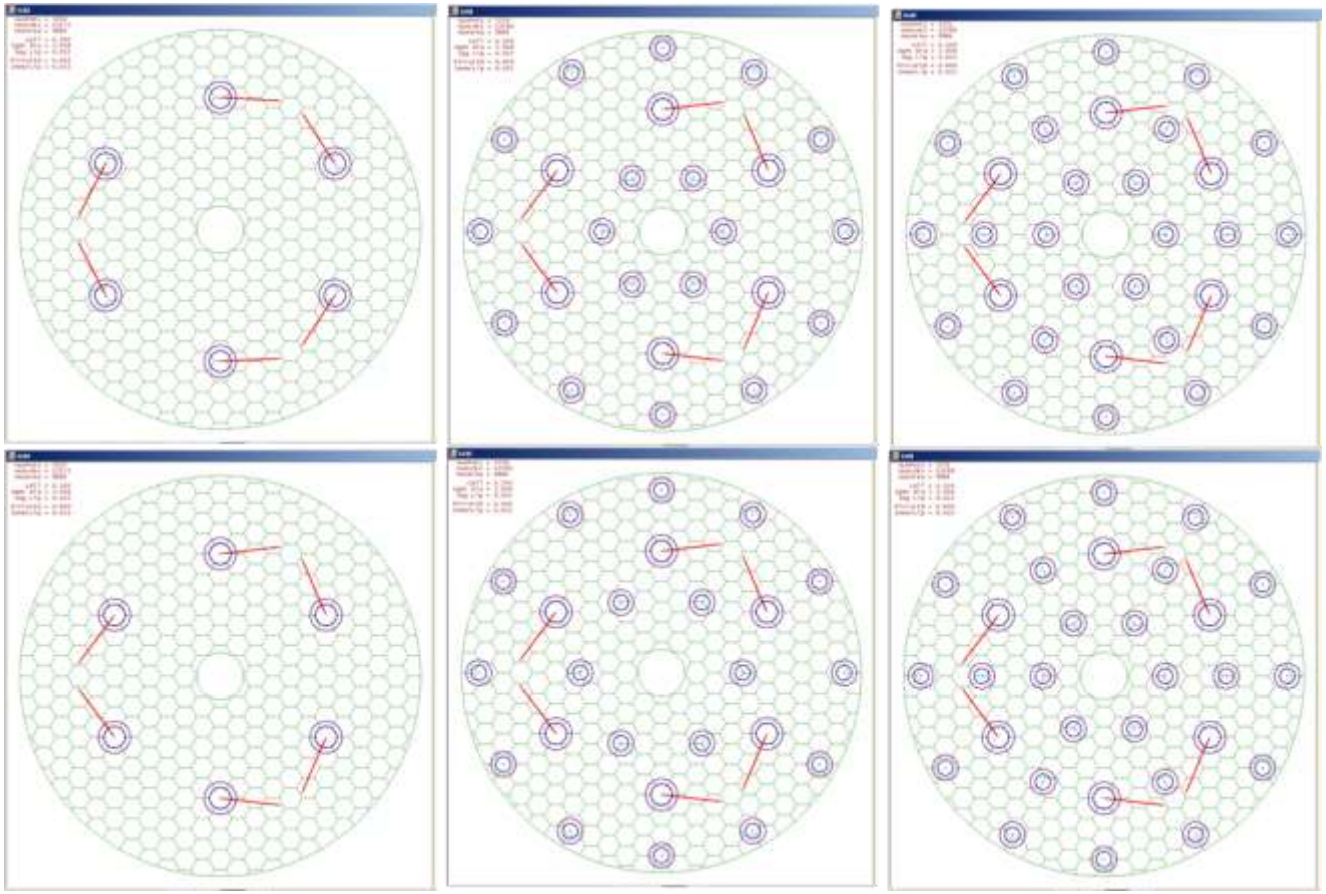
# STEP 3 - EVALUATE MIRROR & OPERATIONAL SUSPENSION



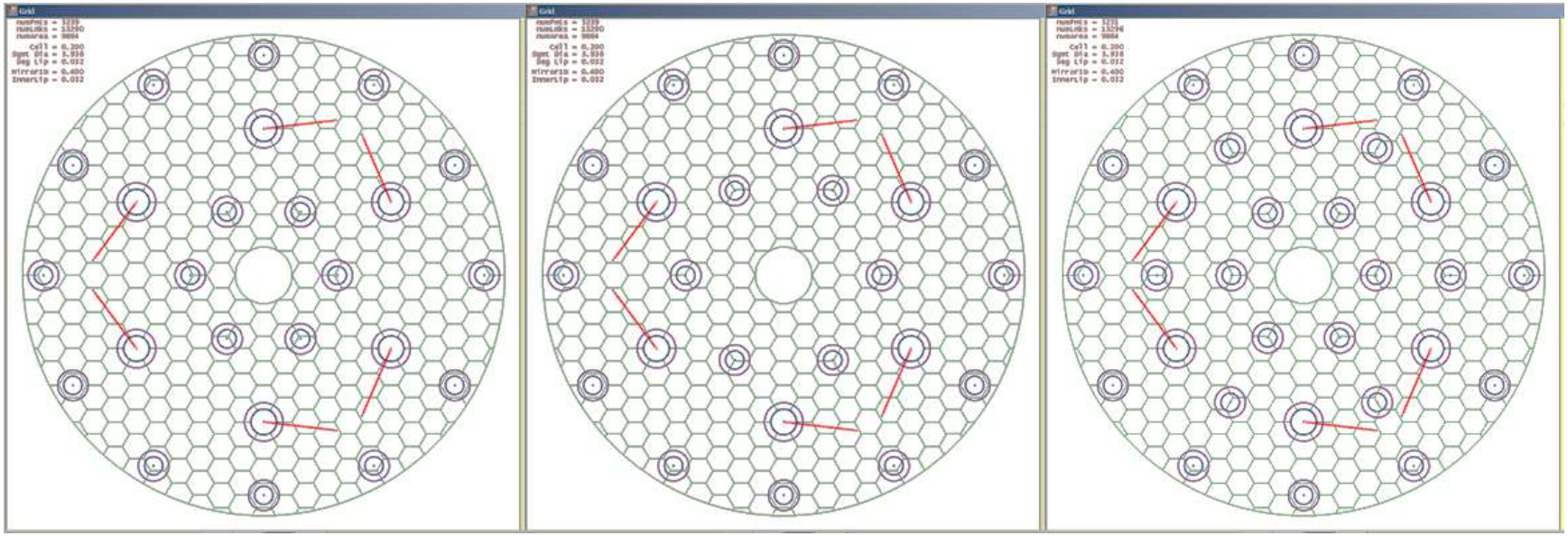
# EVALUATE CELL SIZE & SUSPENSION GEOMETRY



# STEP 4 – ADD AUXILLARY SUPPORT SYSTEM

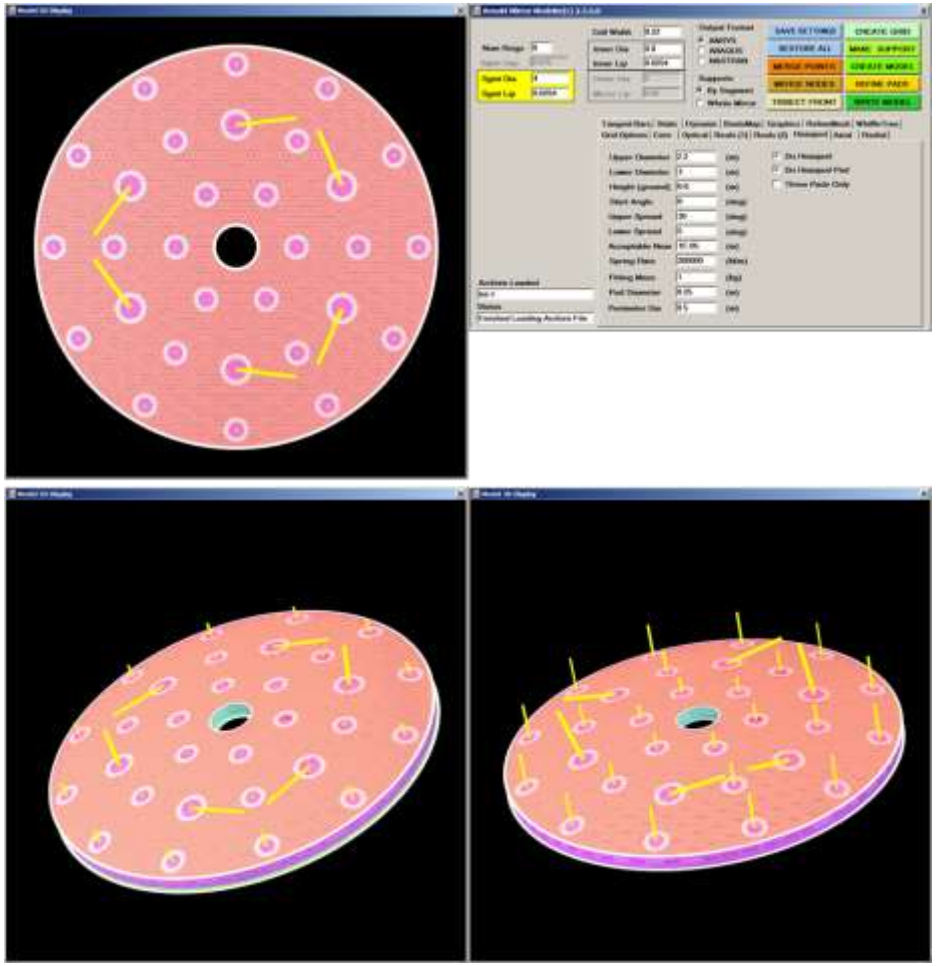


# TRY MULTIPLE VERSIONS OF AUXILLARY SUPPORT SYSTEM

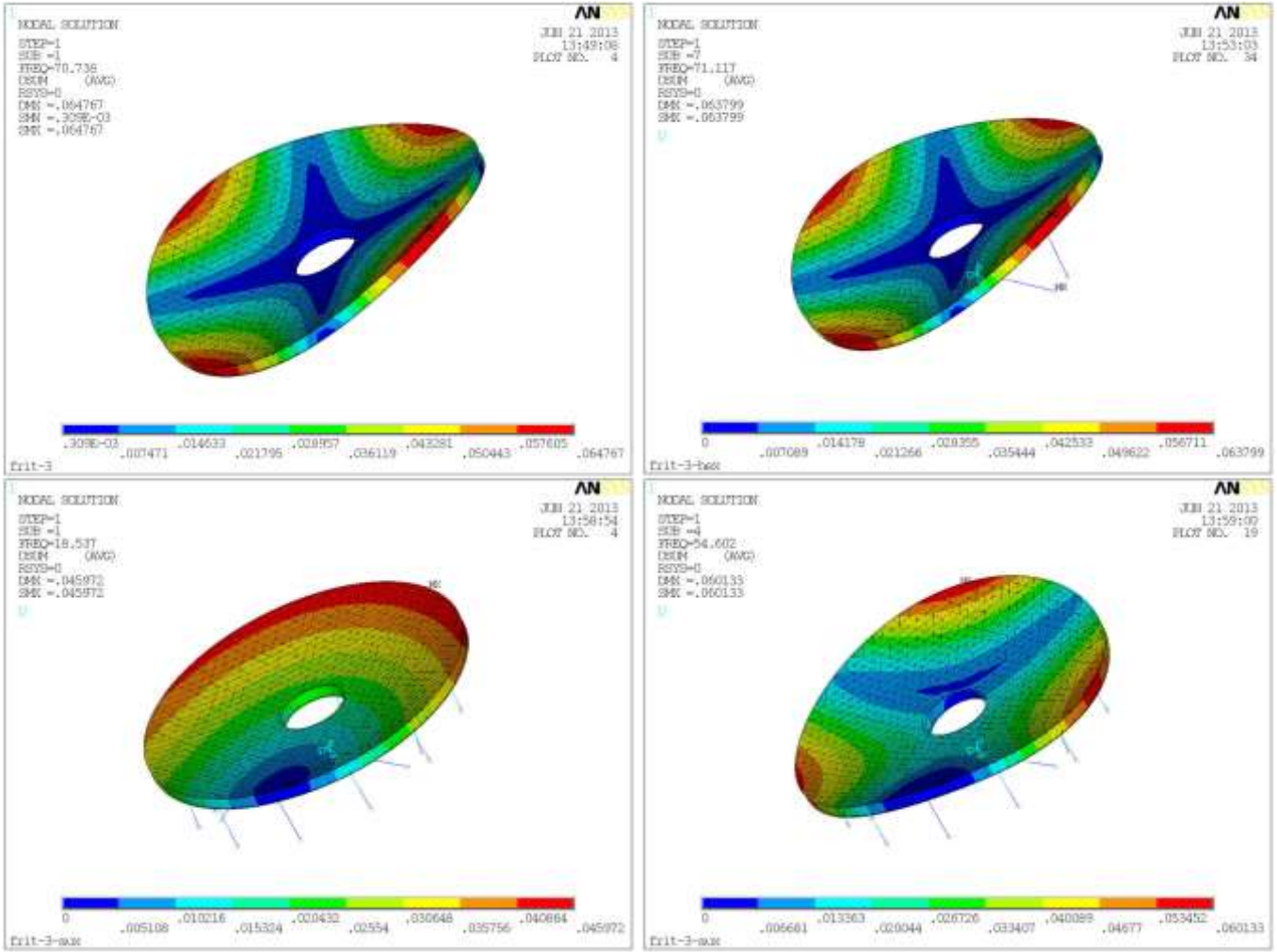


**ADJUSTING GROUP DIAMETERS, NUMBER OF DIAMETERS AND STARTING ANGLES**

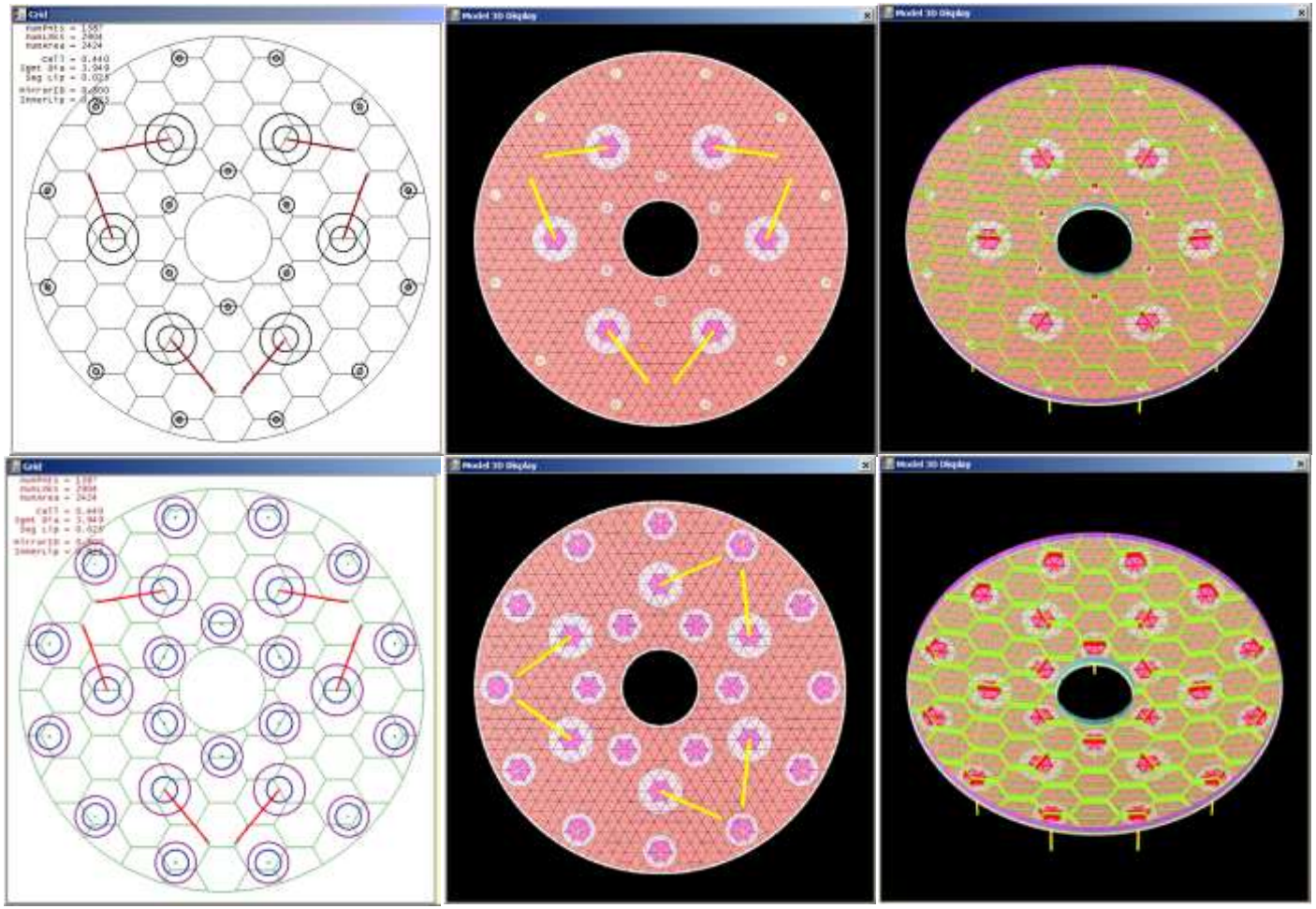
# STEP 5 – OPTIMIZE GEOMETRY, THICKNESS & REINFORCEMENTS



# ADJUSTING SUSPENSION PARAMETERS



# ADJUSTING PARAMETERS TO IMPROVE STIFFNESS



# SUMMARY

- FEATURES AND CAPABILITIES OF MODELER TO MAKE THE PROCESS ECONOMICAL
  - REDUCED MODEL GENERATION TIME
  - ANY MATERIAL AND CONSTRUCTION METHOD SUPPORTED
  - CAN PRESET LOADS AND RESULT PROCESSING
  - ARCHIVE AND RESTORE ALL SETTINGS IN MODELER
- VALUE OF INTEGRATED DESIGN METHOD
  - CAN EVALUATE FEASIBILITY OF CONSTRUCTION METHOD
  - OPTIMIZE OPERATIONAL PERFORMANCE
  - LAUNCH SURVIVAL
- TIME PERMITTING, QUESTIONS & DEMONSTRATION