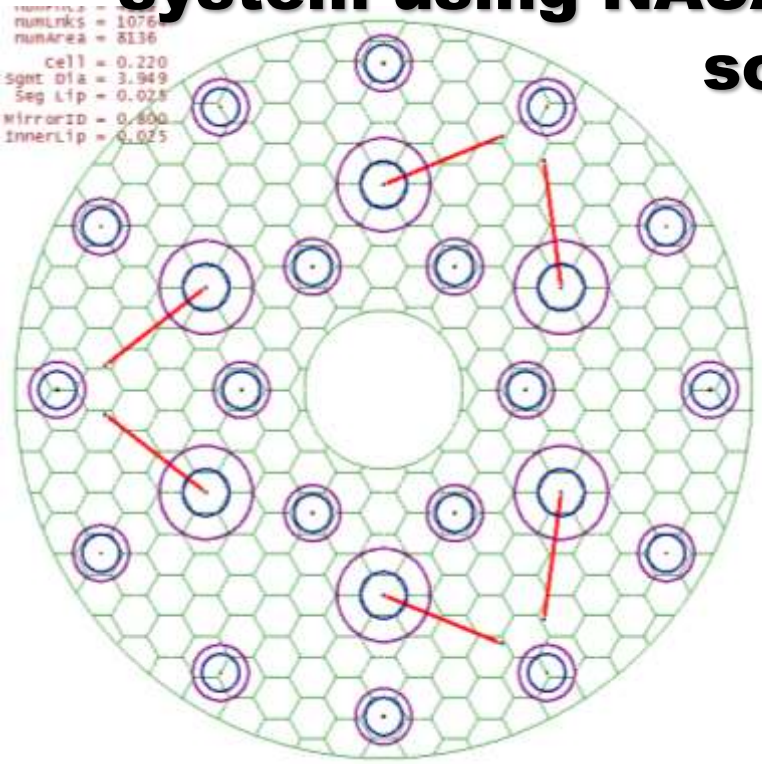
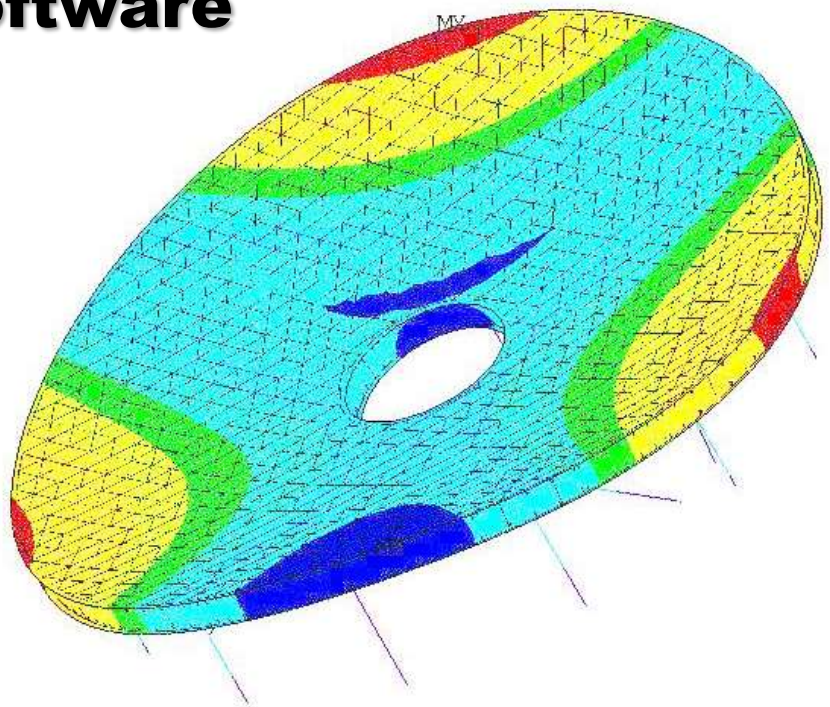
Integration of mirror design with suspension system using NASA's new mirror modeling software





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.

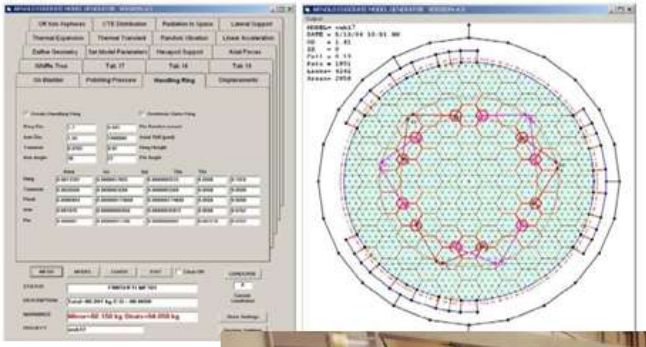
INTRODUCTION

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)

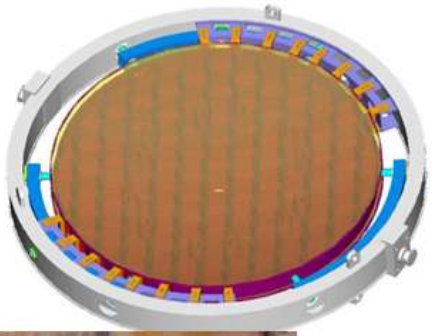
Integrated Design of Handling Equipment



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

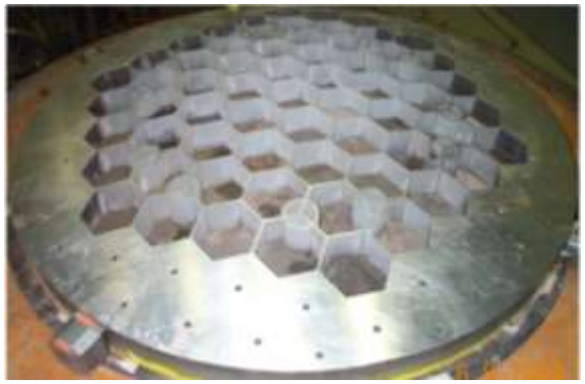
2004

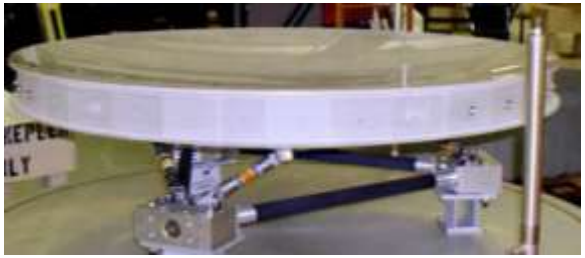
STEPS IN A BASIC MIRROR DESIGN TRADE STUDY

- 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

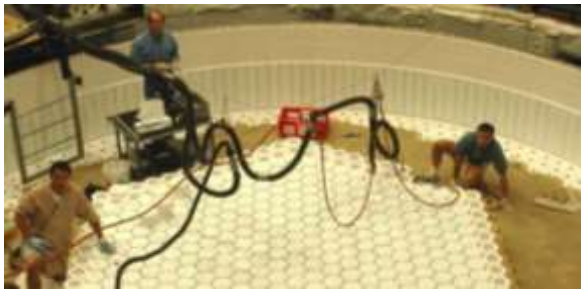
FRIT BONDED ULE





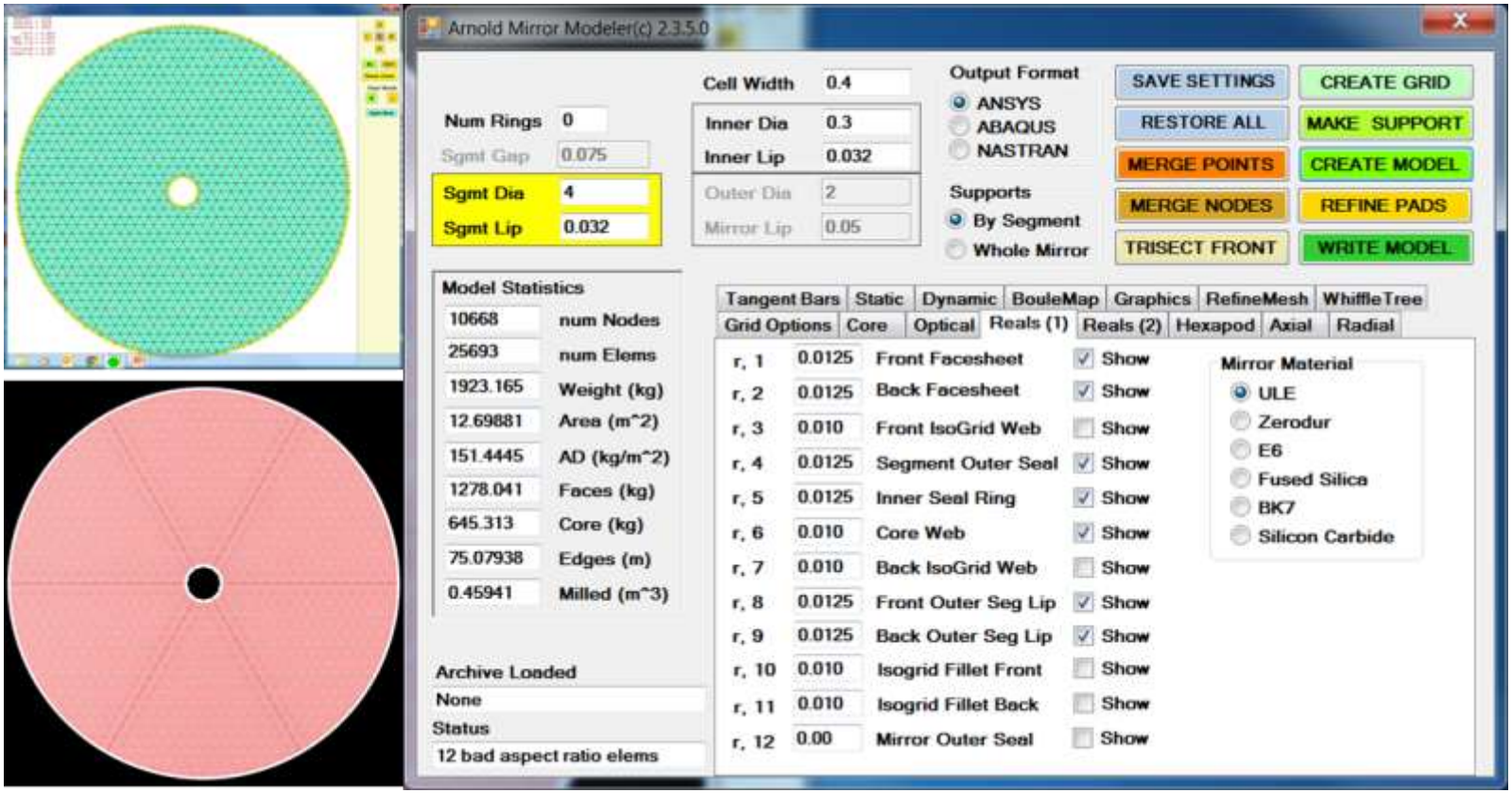
POCKET MILLED ZERODUR

CAST BOROSILICATE

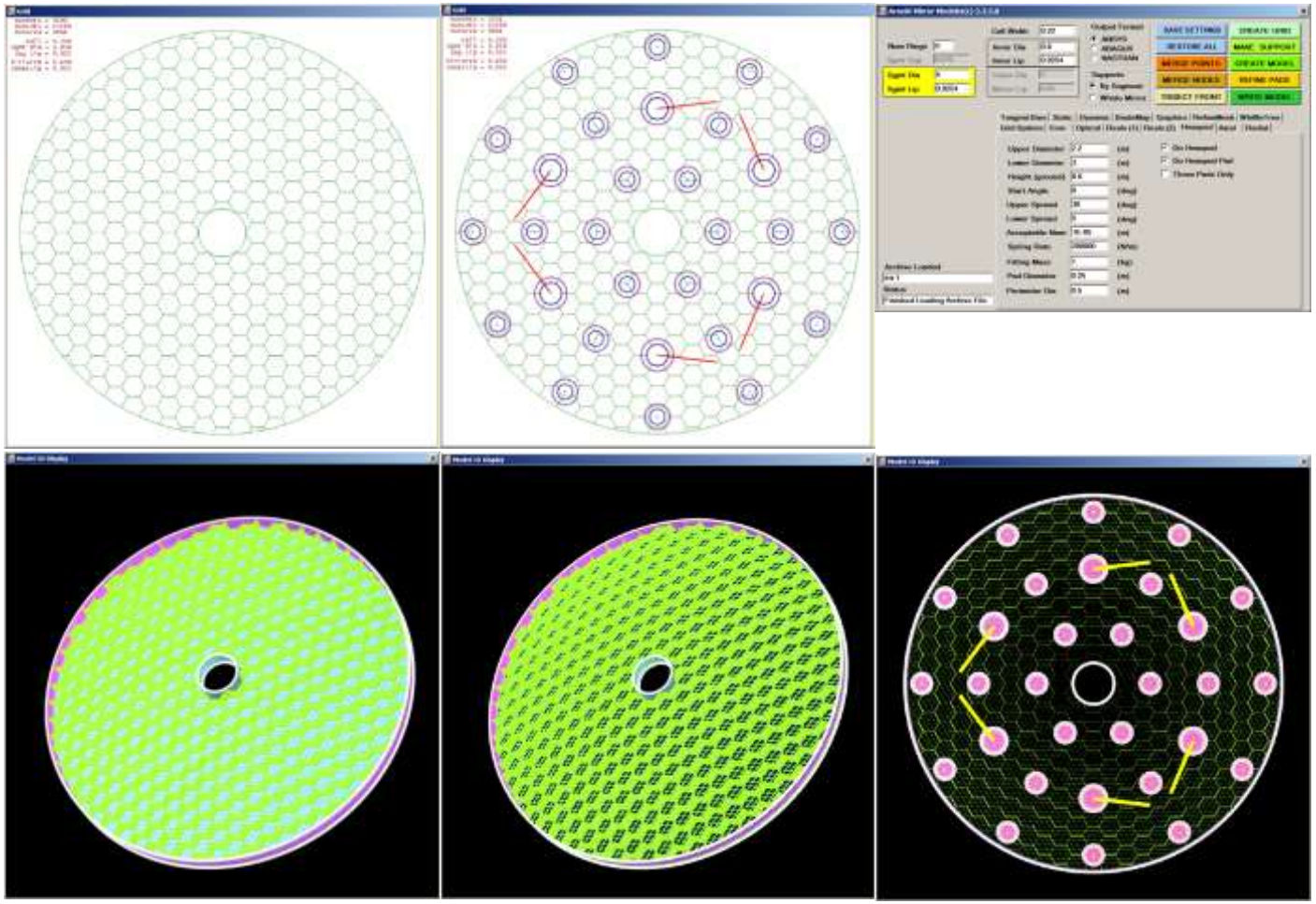


***LOW TEMPERATURE FUSION IS AN ALTERNATIVE ASSEMBLY, REQUIRES SLUMPING**

QUICK INTRO TO MODELER

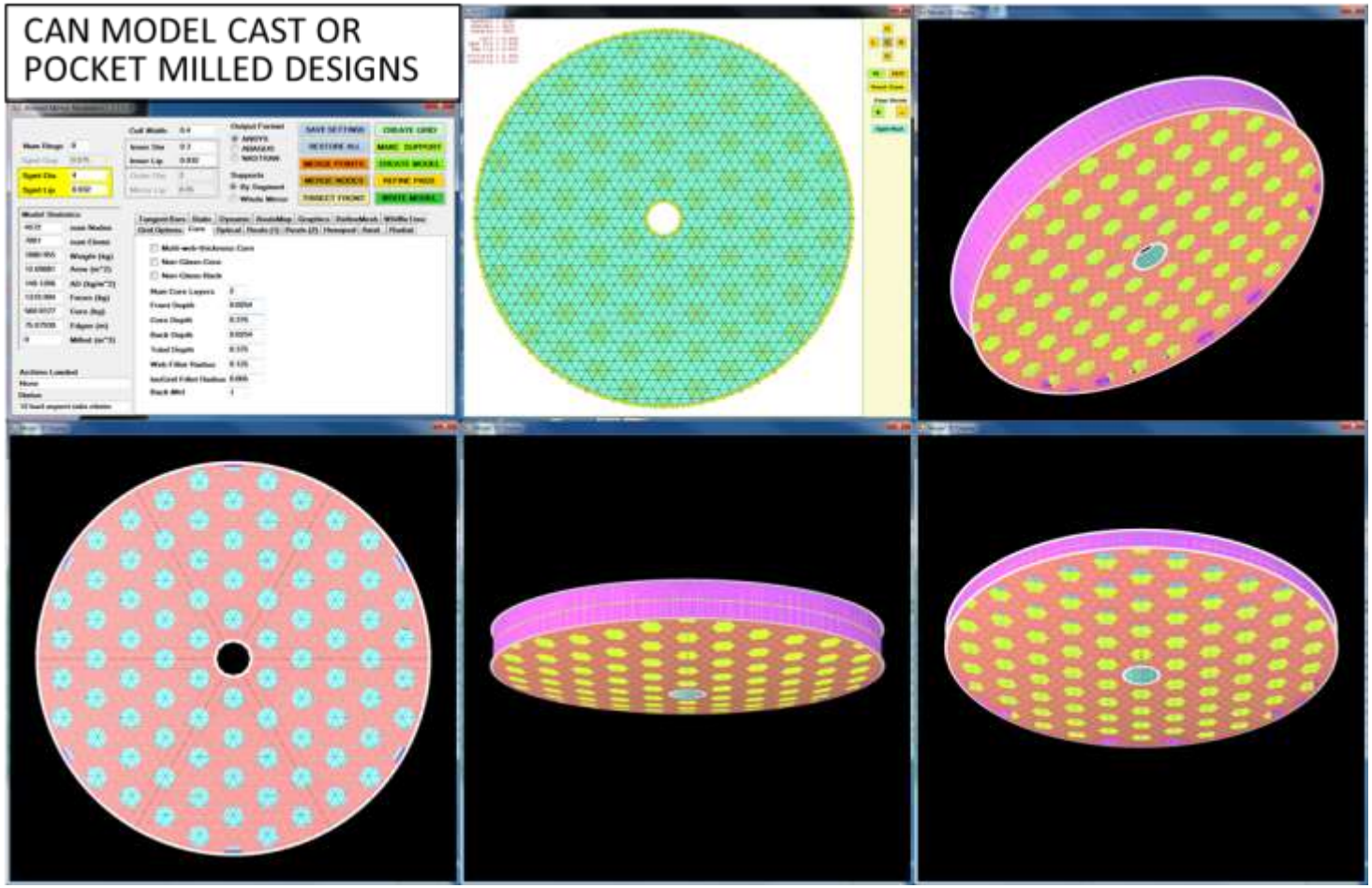


ONE GRID PATTERN CAN CREATE MANY VARIATIONS

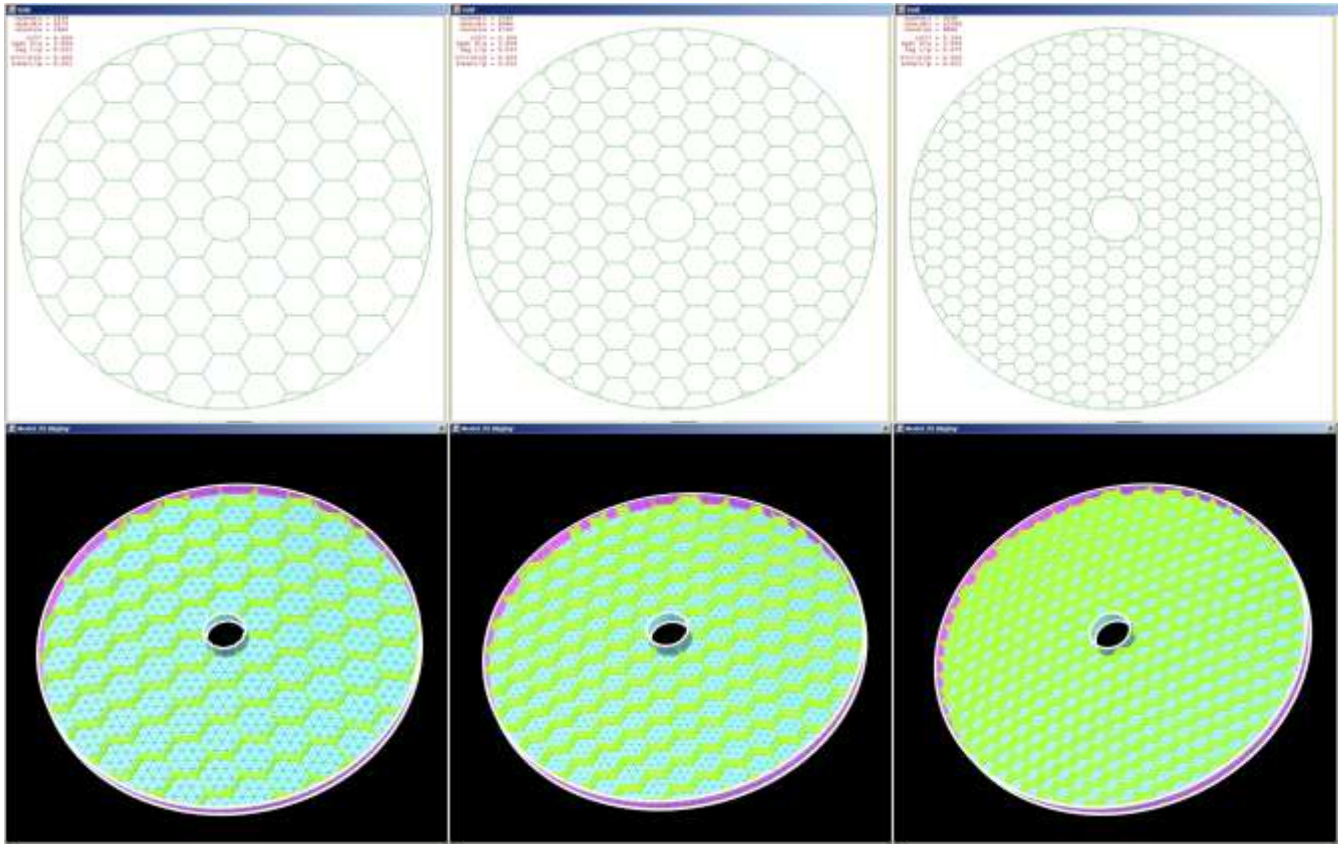


QUICK EXAMPLE OF TRADE STUDY USING THE MODELER

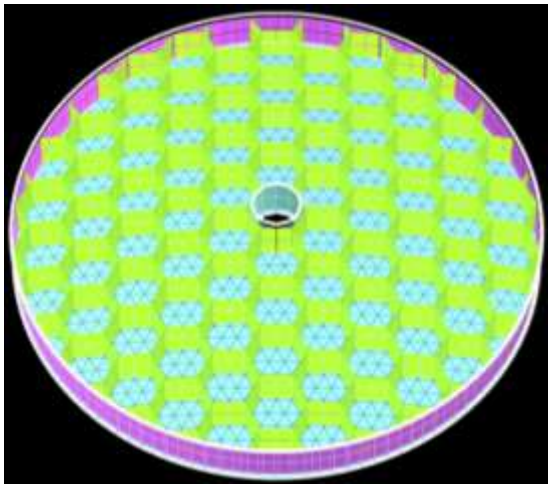
STEP 1 - EVALUATE MATERIAL CHOICES & CONSTRUCTION



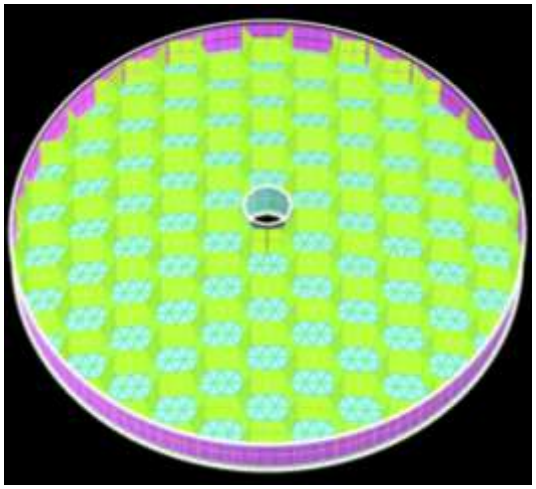
TYPICAL INITIAL STEP TRY DIFFERENT CELL SIZES



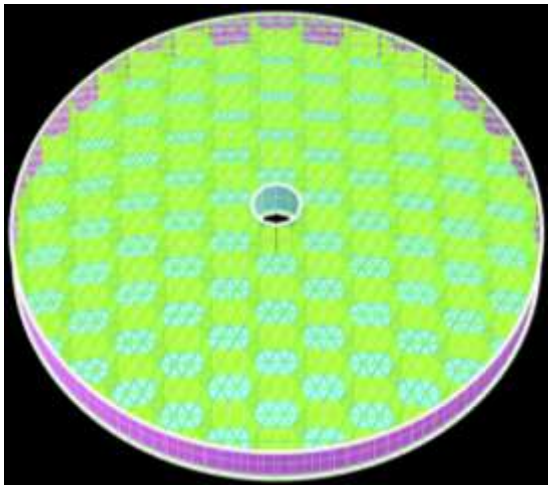
SAME GRID CAN GENERATE MULTIPLE CONSTRUCTION STYLES



NO ISOGRID

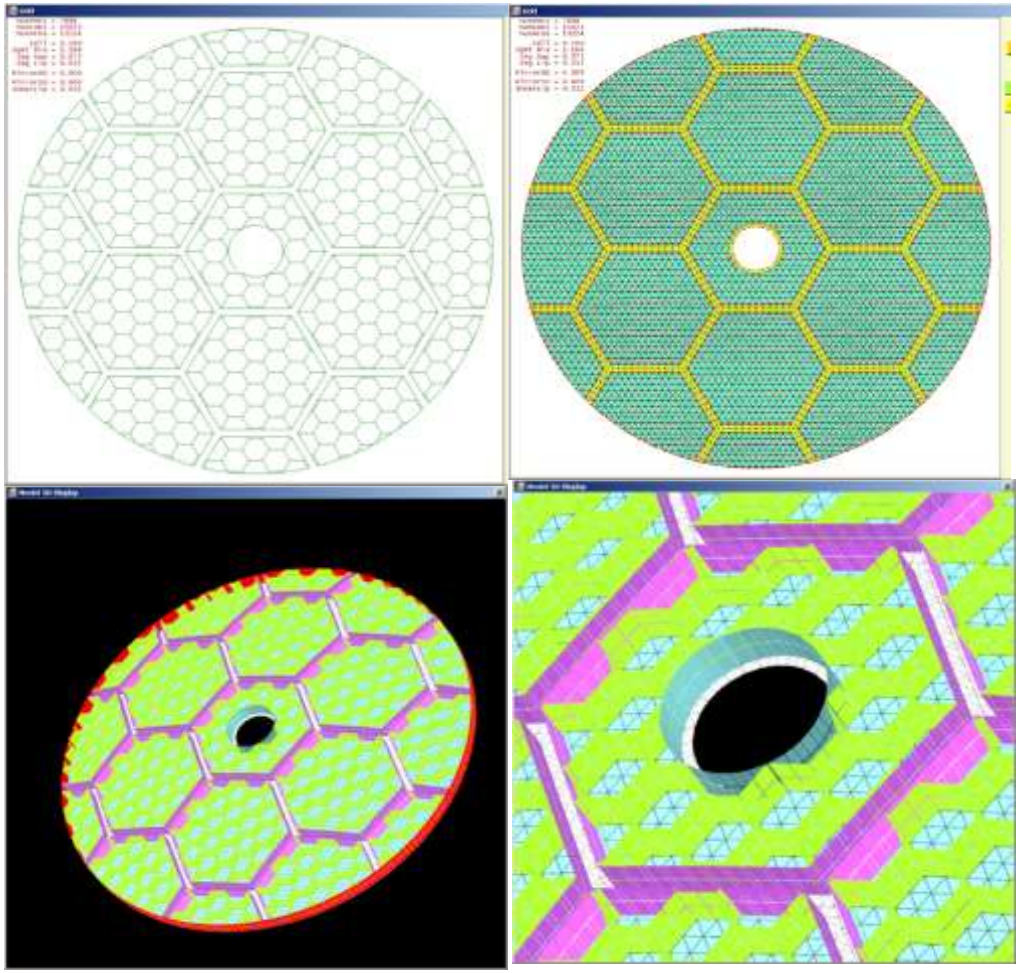


FRONT ONLY ISOGRID

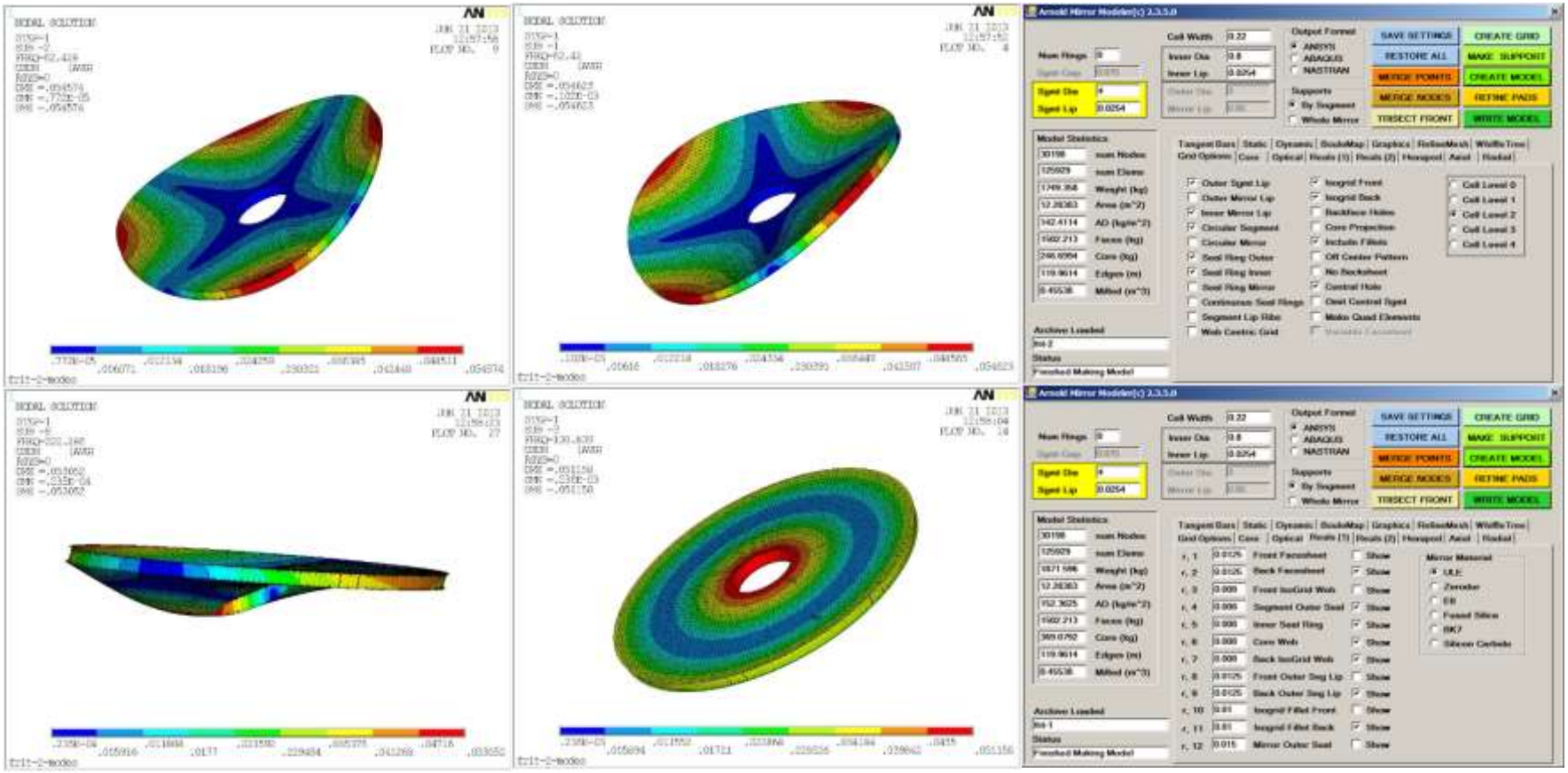


FRONT & REAR ISOGRID

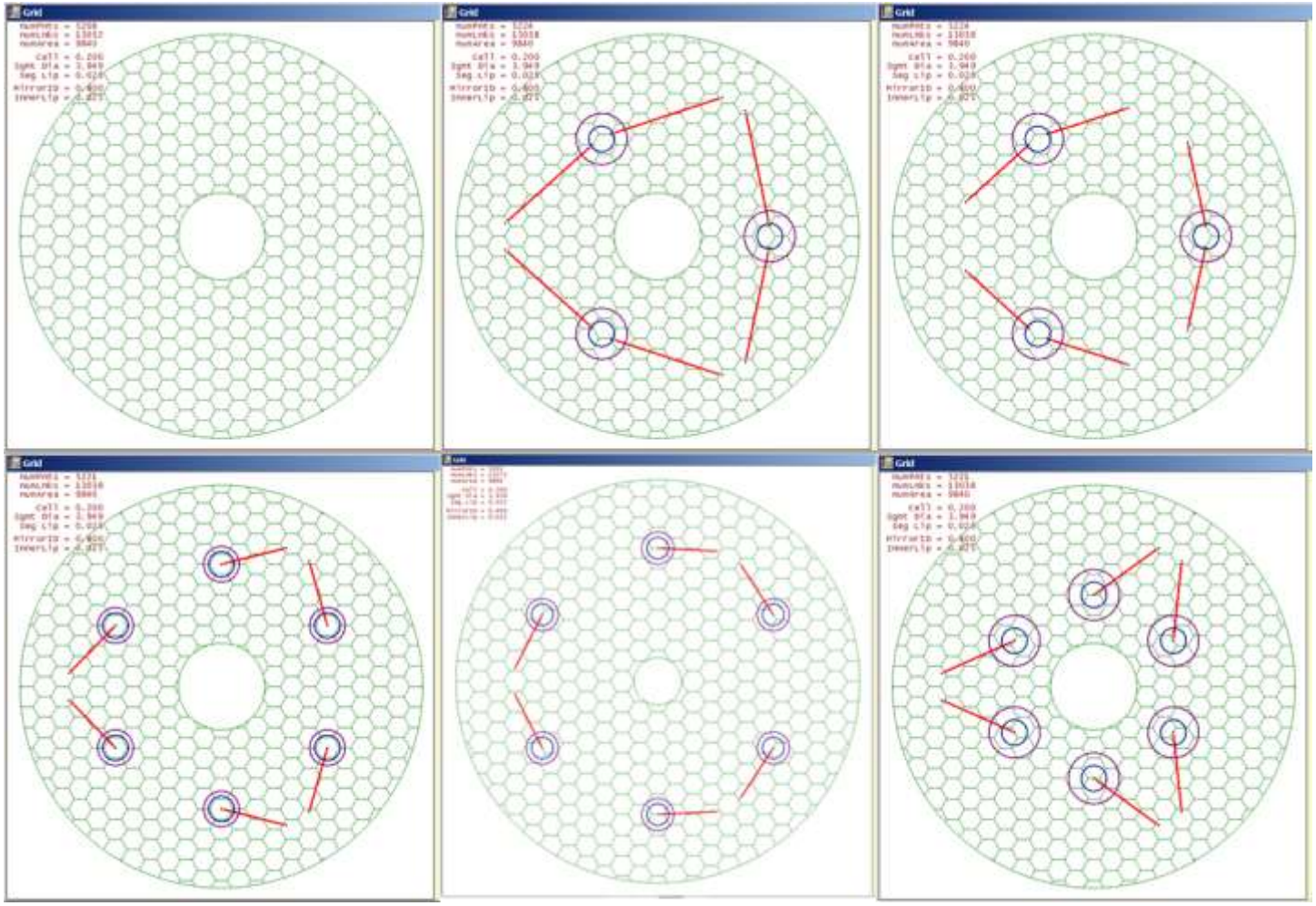
MULTI-SEGMENT LTF CONSTRUCTION CAN BE MODELED



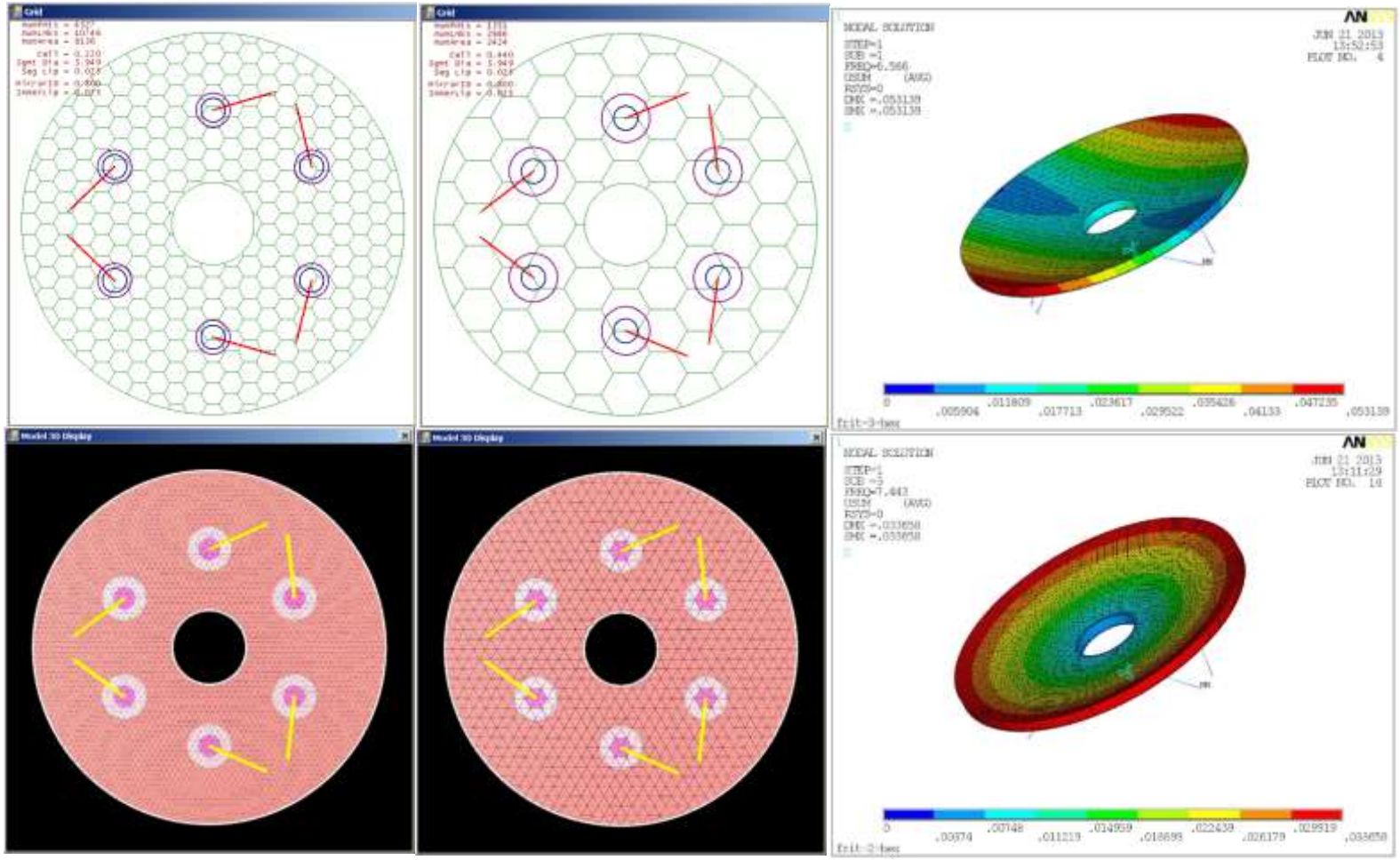
STEP 2 – EVALUATE MIRROR ONLY PARAMETERS



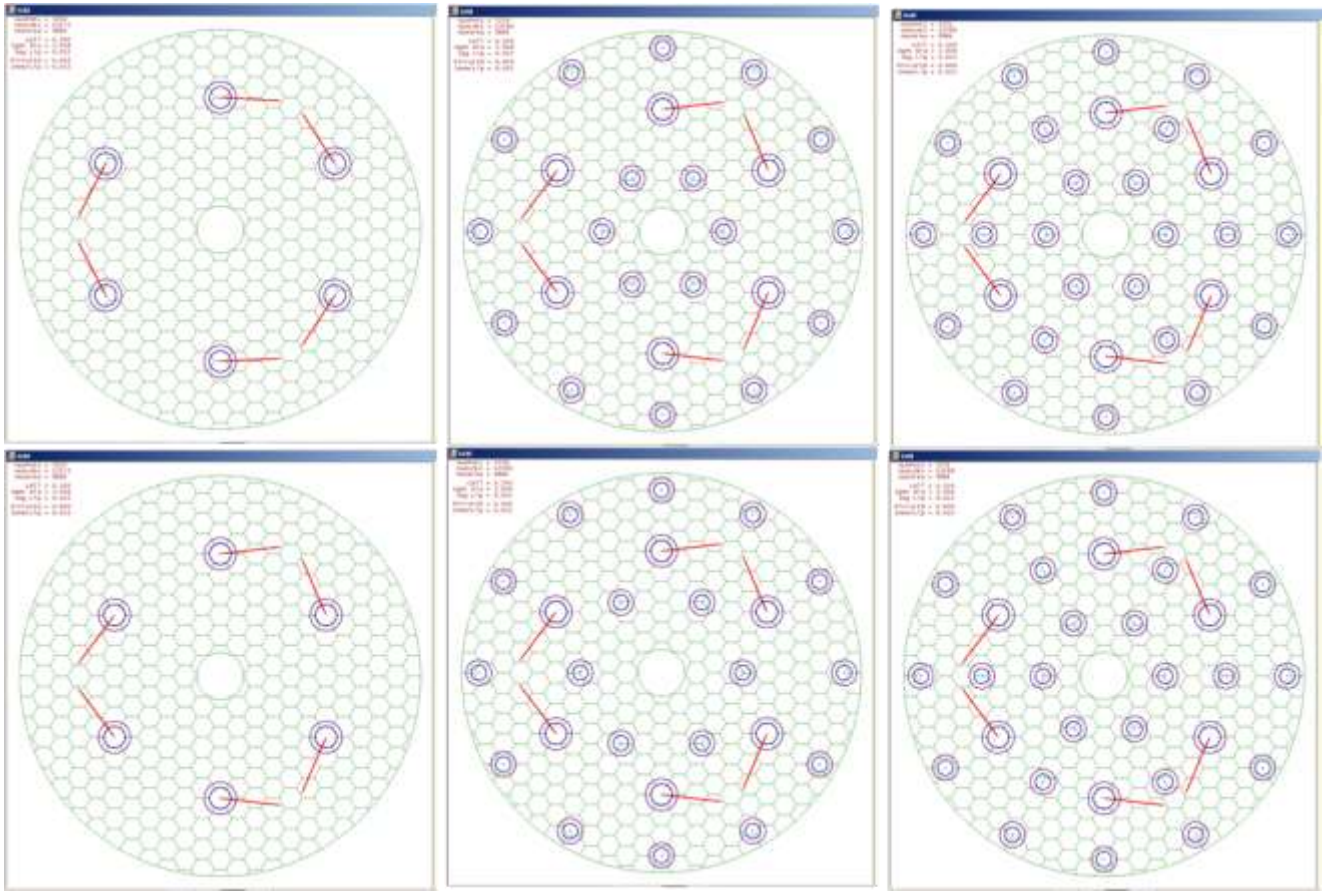
STEP 3 - EVALUATE MIRROR & OPERATIONAL SUSPENSION



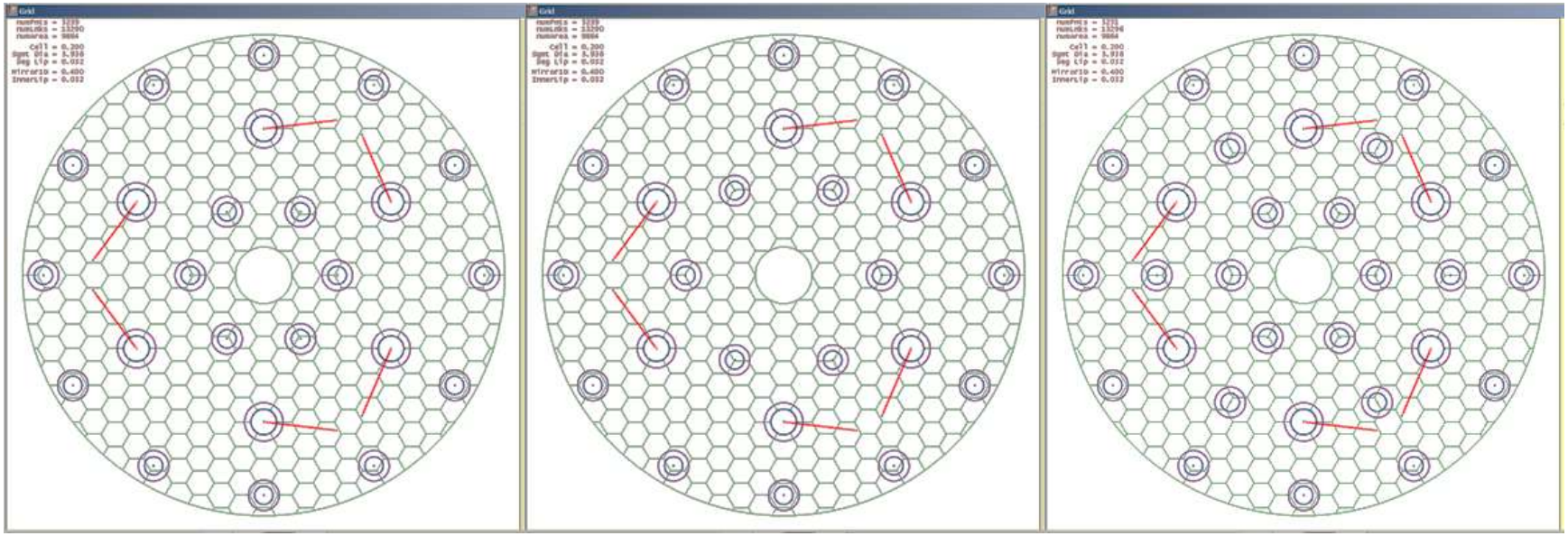
EVALUATE CELL SIZE & SUSPENSION GEOMETRY



STEP 4 – ADD AUXILLARY SUPPORT SYSTEM

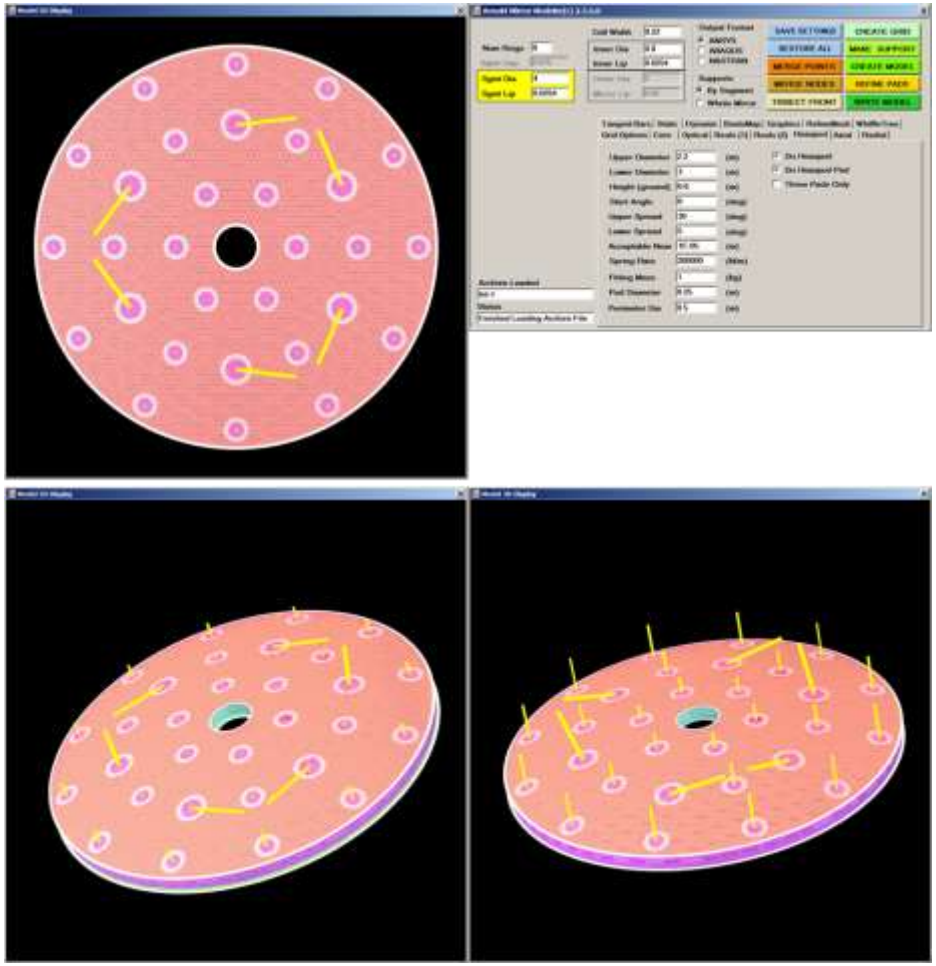


TRY MULTIPLE VERSIONS OF AUXILLARY SUPPORT SYSTEM

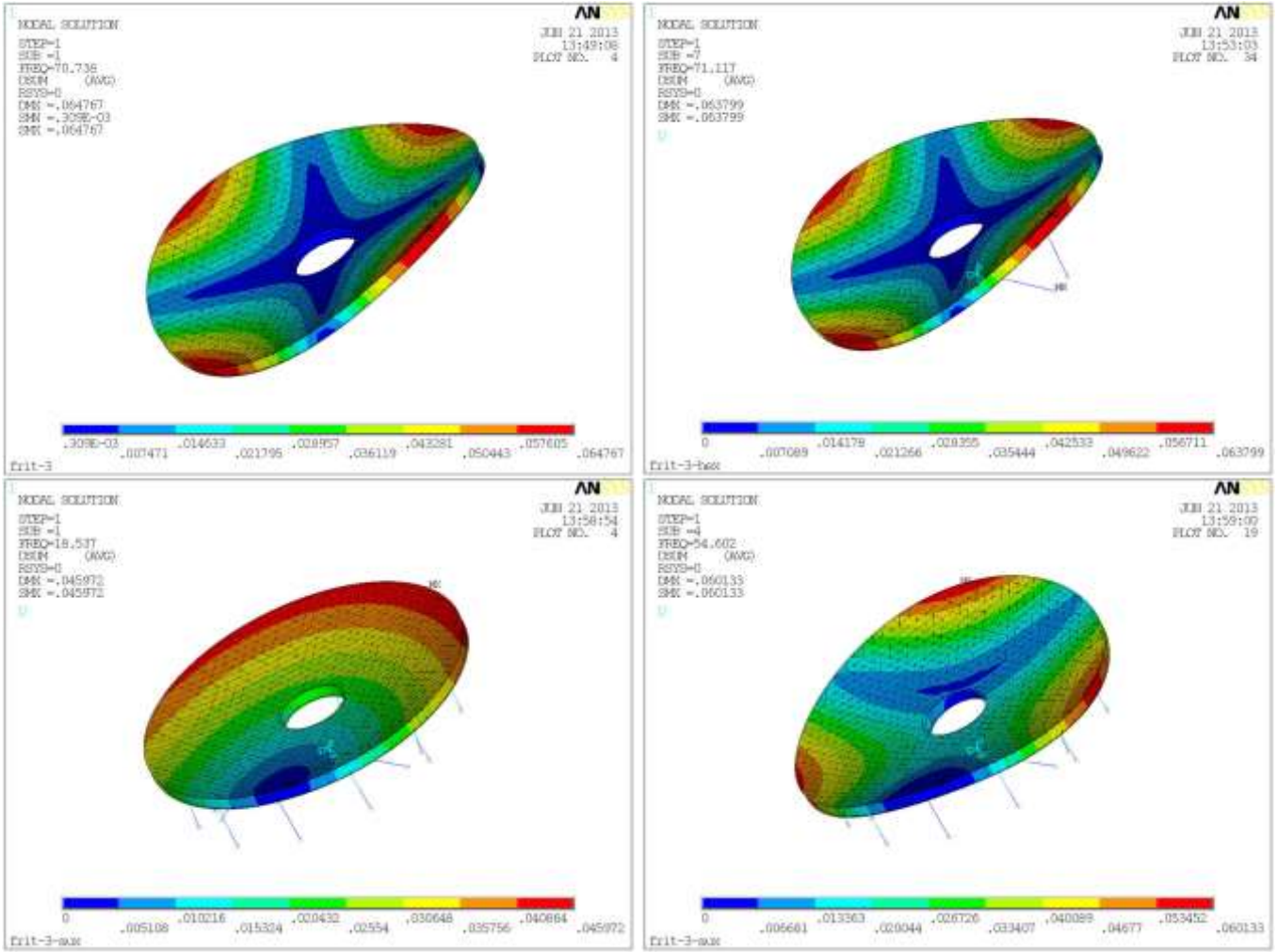


ADJUSTING GROUP DIAMETERS, NUMBER OF DIAMETERS AND STARTING ANGLES

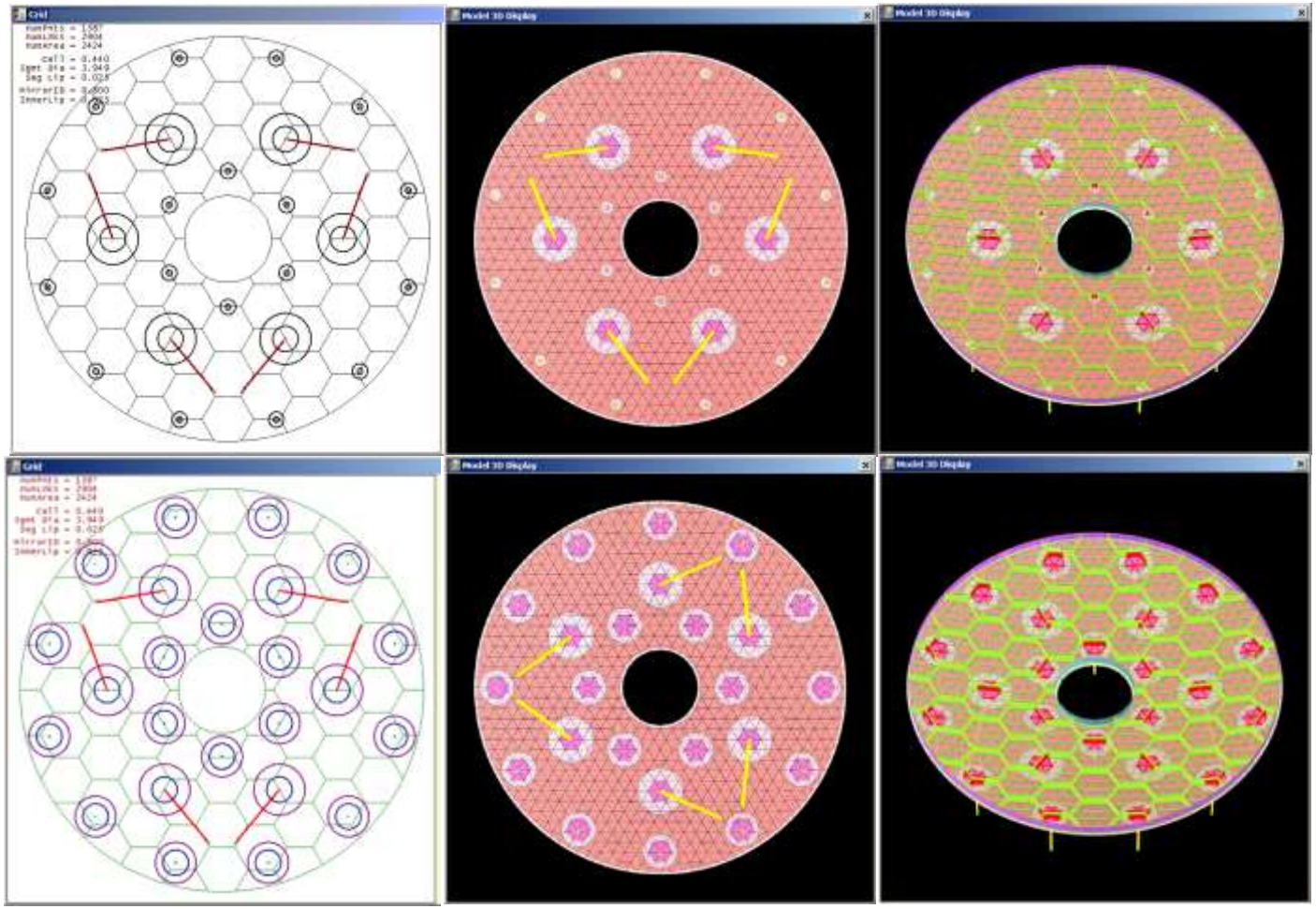
STEP 5 – OPTIMIZE GEOMETRY, THICKNESS & REINFORCEMENTS



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