MSC.Nastran 2005

ACMS Update

Presentation Outline

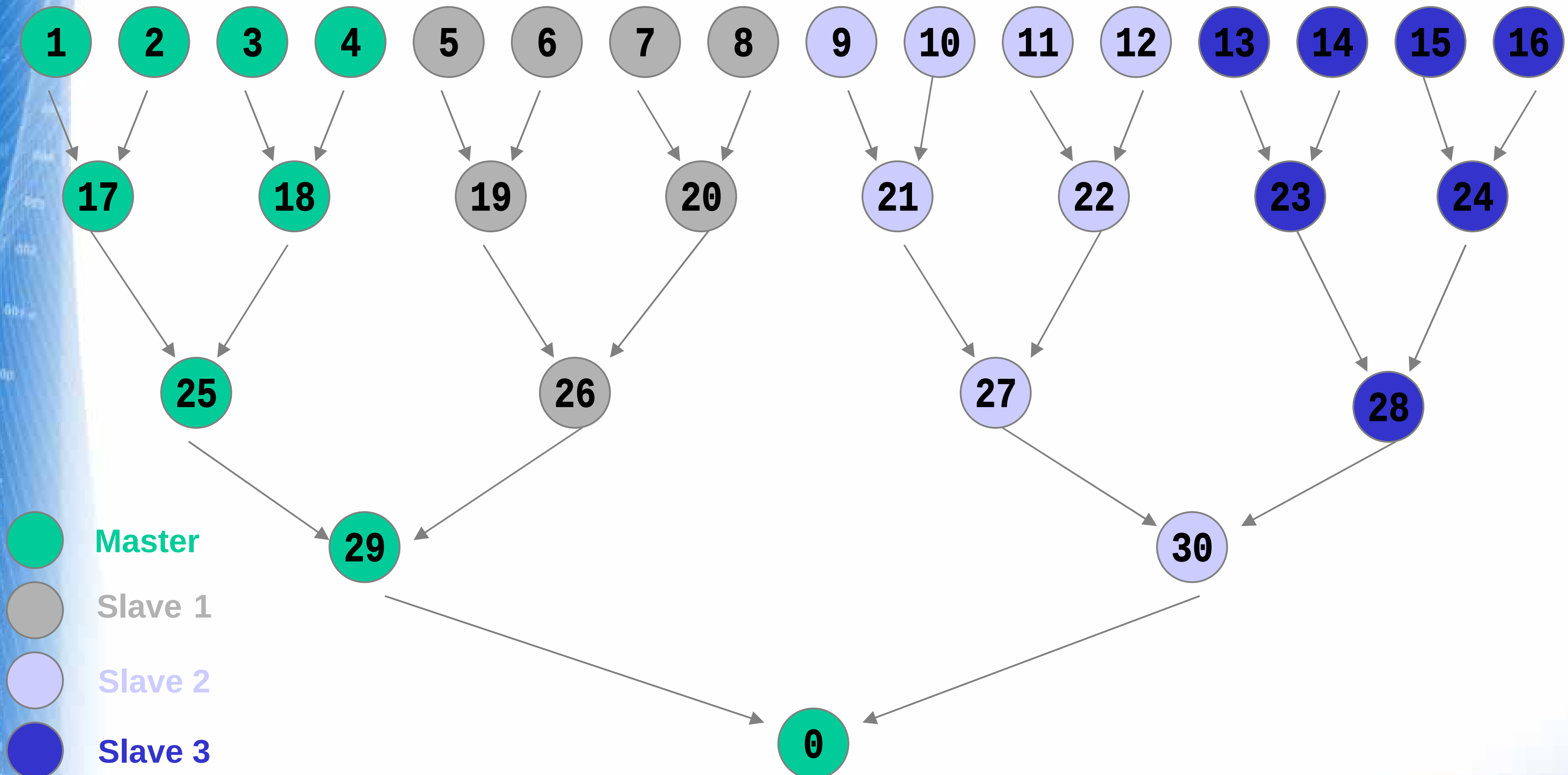
- **What's New in ACMS**
- **Performance Examples**
- **Development Plans**

ACMS: What's New?

- **Domain Switch**
- **Geometric Domain (Superelement Implementation)**
- **DOF Domain (Matrix Implementation)**
- **Change to Executive Section**
  - ***`DOMAINSOLVER ACMS (PARTOPT=DOF)`***

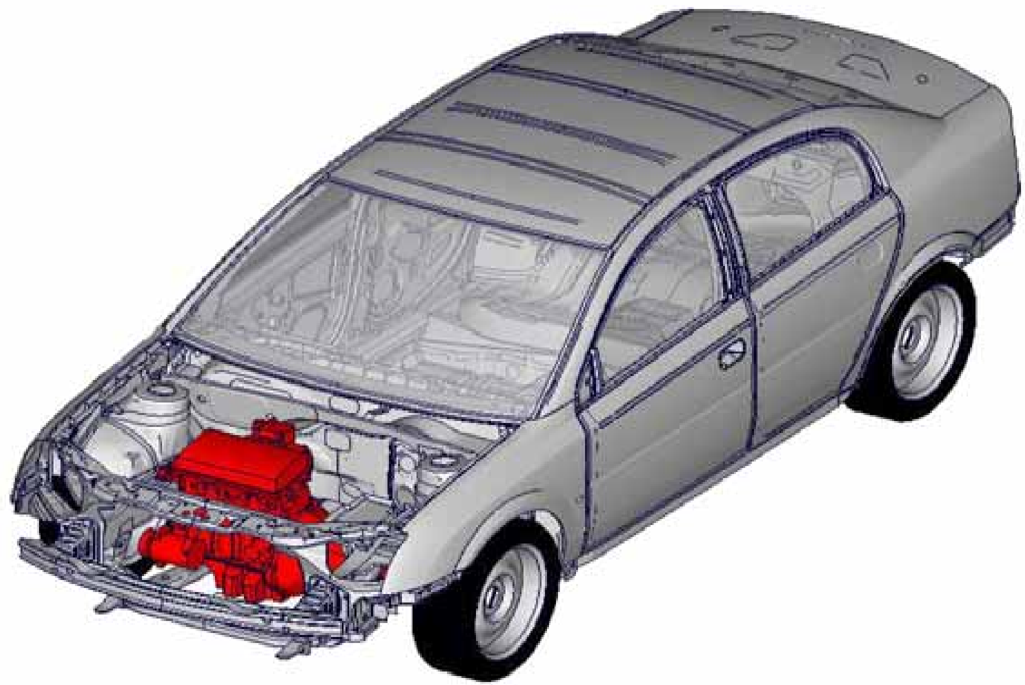
ACMS: What's New?

Same decomposition, different domain



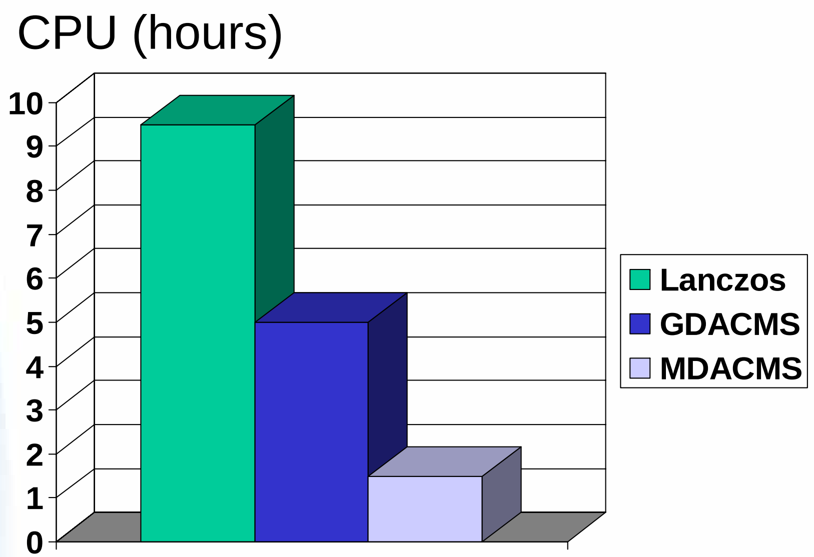
ACMS Performance Update

- **New Matrix Domain ACMS (MDACMS) option – complements existing Geometry Domain ACMS (GDACMS)**
- **Significant speed u most BIW models**
- **Better complex geometry handling**

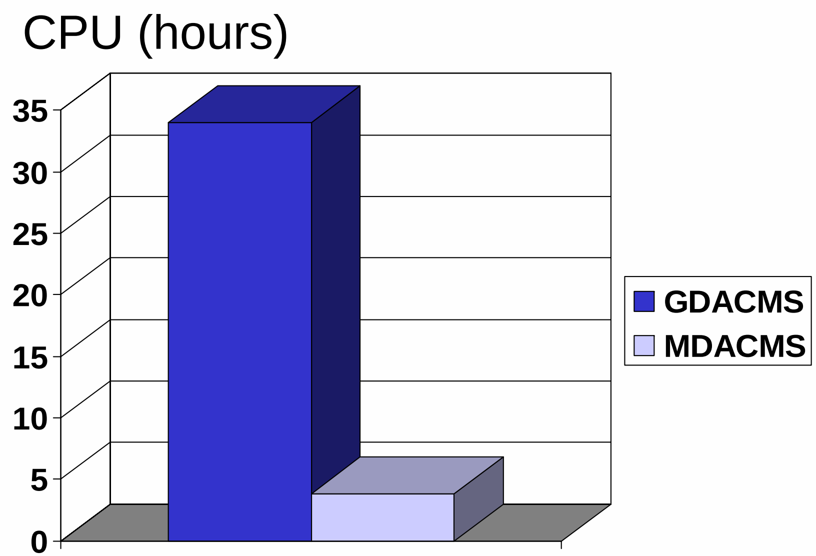


ACMS SOL 103 Benchmarks

2.6 M dofs up to 300Hz



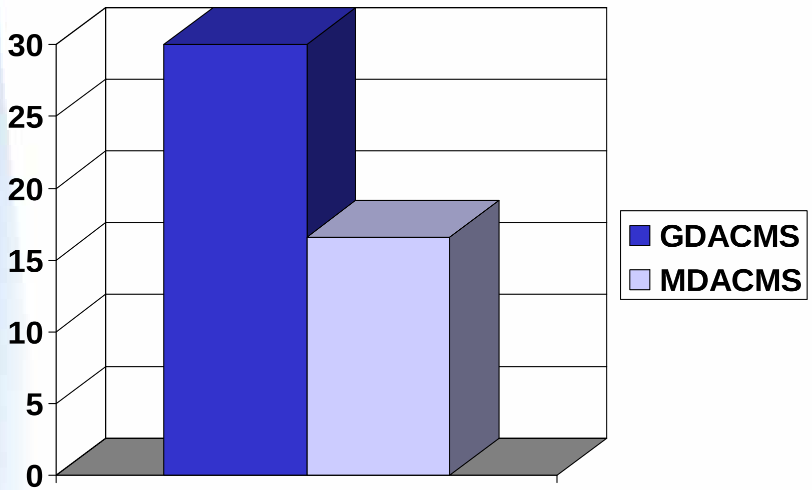
1.3 M dofs, up to 312 Hz,
1600 modes,
Fluid-coupling modeled with MPCs



ACMS SOL 111 Benchmarks

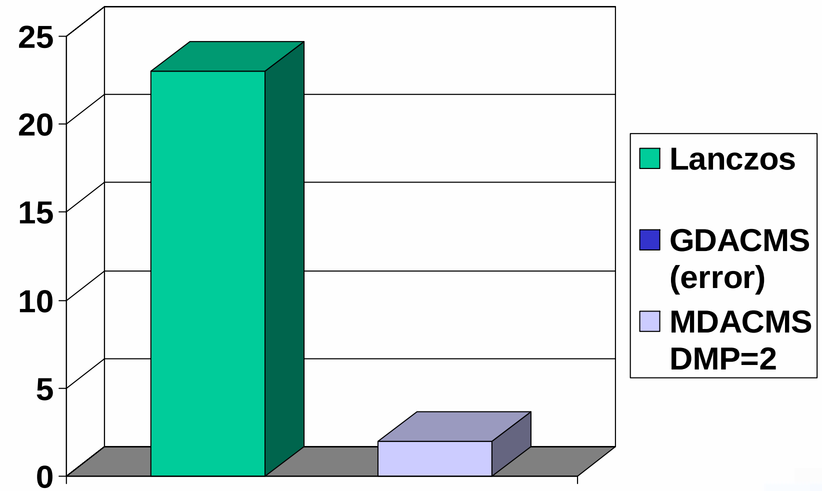
- 2.8 million dof
- Fluid/structure
- 87k RBE3s
- 4,000+ modes (0-600 Hz)
- 781 forcing frequencies

CPU (hours)



- 2.17M dofs
- 2,300 structure modes (350 Hz)
- 98 fluid modes
- 281 forcing frequencies
- Enforced motion via SPCD method

CPU (hours)



Recommendations for ACMS

- GDACMS
  - Good for problems with few MPCs
- MDACMS
  - Good for problems with many MPCs
  - Recommended method
  - SOL 103, 111, and 200

Competitive Advantages of ACMS

- More Capability
  - Available for external SE and upstream SE
  - Available in combination with AutoQSET
  - Available in combination with enforced motion
  - Available in combination with panel participation factors
- More Accuracy
  - Residual vectors are included
- Competitive Performance
  - In case of full data recovery requests (DISP=ALL)

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ACMS Plans in V2005r2 and V2006

- **Moving forward with MDACMS only**
- **Performance Improvements (V2005 r2)**
  - **Large frequency range**
  - **Distributed and shared memory parallel**
  - **Algorithmic improvements**
  - **Upstream superelements (External SE, AdamsFlex)**
- **Re-cast DMAP into single module for further performance improvements (V2006)**

Release Overview

- V2004.5 – Initial (beta) Release
- V2005r1 – Initial Production Release
  - Oct 06, 2004
- V2005r2 – Performance Improvements
  - Feb 18, 2005
- V2006r1 – Next Generation
  - Nov 18, 2005

Thank You!

Section

External Superelements

Table of Contents

Table of Contents (cont.)

What are External Superelements and why Would I Use them?

- The idea of external superelements is that you wish to replace one or more components of your model with reduced matrices
- Often, your model has many components, but you are interested in only one of more components or only in the assembly results
- Perhaps you are in the business of providing aircraft engines, but you need the properties of the rest of the airplane to get correct results - do you want to run the entire aircraft model just to change one component of your engine?

What are External Superelements and why Would I Use them (cont.)?

- As long as you are working with a component of a large assembly, it allows you to include the properties (mass, stiffness, damping) of the rest of the structure in your solution without having to include the model itself

- If you are working on the assembly, but have many small component models, it can be very advantageous to replace the small models with reduced matrices

Different Types of External Superelements

- Three different external superelement methods are availble:
  - The old style external superelement (main bulk data superelement) using the CSUPER entry (not discussed in this section)—call this “type 1”
    - Available since day 2+?
  - The new style external superelement (parts superelement) using the EXTRN entry—call this “type 2”
    - Connections are done manually
    - Available since V69+
    - See V70 Release Guide for further details
  - The new style external superelement (parts superelement) using the EXTRN entry—call this “type 3”
    - Connections are done automatically
    - Similar to automatic attachments with internal SEs
    - New in V2004 and covered in this section

New Procedure

- The new approach is a two-step procedure that involves
- Step 1 - External superelement creation run(s)
  - Perform component mode reduction of component(s) and create external superelement(s) using the EXTSEOUT Case Control command
- Step 2 - Final assembly / analysis run
  - Perform analysis of the complete system using the reduced matrices from the external superelement run(s) and obtain the desired results
- This was first introduced in version 2001 as a prototype and has been enhanced in version 2004

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Advantages of the New Procedure

- Simple two-step procedure
- Desired results are obtained in the assembly / analysis run without the need for separate data recovery run(s) for the external superelement(s)
- No DMAP alters required
- Simple user interface
- No need to specify duplicate Bulk Data entries for the reduced model(s) in the assembly run
- Reduced size of databases/files

Input for External Superelement Creation Run

- Run as a normal non-superelement MSC.Nastran job
- Employ the EXTSEOUT Case Control command to specify the data and method for saving the external SE information
- Specify boundary points using:
  - ASET / ASET1 Bulk Data entries
- Specify boundary points for component mode reduction by:
  - New Bulk Data entries BNDFIX / BNDFIX1 and BNDFREE / BNDFREE1 (or the equivalent existing BSET / BSET1 and CSET / CSET1 entries)
  - Default is all boundary points are considered fixed (Craig-Bampton method)
- Specify generalized coordinates using:
  - QSET / QSET1 Bulk Data entries

EXTSEOUT Case Control command

- The form of the EXTSEOUT Case Control command is as follows:

$$\text{EXTSEOUT}\left[\begin{array}{l}(\ \textbf{STIFFNESS},\textbf{MASS},\textbf{DAMPING},\textbf{K4DAMP},\textbf{LOADS},\\ \{\text{ASMBULK},\}\ \{\text{EXTBULK},\}\ \{\text{EXTID}=seid,\}\left\{\begin{array}{l}\textbf{MATRIXDB}\\ \text{DMIGDB}\\ \text{DMIGOP2}=unit\\ \text{DMIGPCH}\end{array}\right\})\end{array}\right]$$

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EXTSEOUT Case Control command (cont.)

where:

STIFFNESS	- writes reduced stiffness matrix
MASS	- writes reduced mass matrix
DAMPING	- writes reduced viscous damping matrix
K4DAMP	- writes reduced structural damping matrix
LOADS	- write reduced static loads matrix

If none of the above keywords STIFFNESS, MASS, DAMPING, or K4DAMP is specified, then all 4 matrices (if they exist) are written out

STIFFNESS and DAMPING may be abbreviated as STIF and DAMP

EXTSEOUT Case Control command (cont.)

ASMBULK

- Generate assembly Bulk Data entries on the *.asm punch file containing data to be used in the Main Bulk Data portion of the assembly run.

- This data consists of the following entries:
  - SEBULK
  - SECONCT
  - Boundary GRIDs
  - CORD2x entries associated with boundary GRIDs

EXTSEOUT Case Control command (cont.)

- EXTBULK
  - Generates Bulk Data entries on the standard punch file to be used in the BEGIN SUPER portion of the assembly run.
  - This keyword is IGNORED if the DMIGPCH option (see discussion later) is specified.

EXTSEOUT Case Control command (cont.)

- If the EXTBULK keyword exists, the following entries are generated on the standard punch file:

  - Boundary GRIDs
  - Interior GRIDs referenced by PLOTELs
  - CORD2x entries associated with the above GRIDs
  - EXTRN
  - ASET / ASET1
  - QSET / QSET1
  - SPOINT
  - PLOTEL

EXTSEOUT Case Control command (cont.)

EXTID = *seid*

- Specifies the external SE ID to be used in the SEBULK and SECONCT Bulk Data entries that are:
  - generated in the *.asm punch file if the ASMBULK keyword is specified and the
  - BEGIN SUPER Bulk Data entry that is generated on the standard punch file if the EXTBULK or DMIGPCH keyword is specified.
  - The EXTID keyword with an *seid* value MUST be specified if either the ASMBULK, EXTBULK, or DMIGPCH keyword is specified.

EXTSEOUT Case Control command (cont.)

- Output options:
  - MATRIXDB - Write boundary matrices and other information on the database (default)
  - DMIGDB - Similar to MATRIXDB except that the boundary matrices are written as DMIG Bulk Data entries on the database
  - DMIGOP2=*unit* - Write boundary matrices as DMIG Bulk Data entries on an OUTPUT2 file whose Fortran unit number is *unit* (An "ASSIGN OUTPUT2" statement must be specified in the File Management section in this case)
  - DMIGPCH - Write boundary matrices as DMIG Bulk Data entries on the punch file

EXTSEOUT Case Control command (cont.)

If the DMIGPCH option is specified, then the EXTBULK keyword is IGNORED. In this case, the following entries are generated on the standard punch file:

- Boundary GRIDs
- CORD2x entries associated with boundary GRIDs
- ASET / ASET1
- SPOINT
- PLOTELs referencing boundary GRIDs

Summary Report Resulting from the EXTSEOUT Command

- Matrix data action
  - Format (matrix form or DMIG form)
  - Output medium (database, OUTPUT2, or standard punch file)
  - Identification [stiffness, mass, damping (viscous, structural), loads]
- Bulk data action – Type of data written
  - Boundary related only or boundary and PLOTEL related data
- Type of reduction
  - Static condensation / Guyan reduction or component mode reduction
- List of boundary points considered fixed for component mode reduction (B-set)
- List of boundary points considered free for component mode reduction (C-set)
- List of generalized coordinate points for component mode reduction (Q-set)

Output from External Superelement Creation Run

- Matrix and Boundary-Related Data
  - Written to the selected medium
- If ASMBULK, EXTBULK, or DMIGPCH is specified
  - Bulk Data entries are generated on the appropriate punch file(s) (*.asm punch file or the standard punch file or both) for subsequent use in the assembly run

Important Points About Punch Output from the External Superelement Creation Run

- No ASMBULK, EXTBULK or DMIGPCH
  - No punch output
- ASMBULK, but no EXTBULK or DMIGPCH
  - Data is generated on the *.asm punch file for use in the MAIN Bulk Data portion of the assembly run
- No ASMBULK, but EXTBULK or DMIGPCH
  - Data is generated on the standard punch file for use in the BEGIN SUPER portion of the assembly run
- ASMBULK and EXTBULK or DMIGPCH
  - Punch output consists of TWO distinct and separate portions, one (in the *.asm punch file) meant for the MAIN Bulk Data portion of the assembly run and the other (in the standard punch file) for the BEGIN SUPER portion of the assembly run.

Bulk Data Setup for Assembly Run

BEGIN BULK $ MAIN BULK DATA

Data pertaining only to the residual – RESIDUAL BULK DATA

Data related to assembly with external SEs – ASSEMBLY BULK DATA

(SEBULK, SEBNDRY/SECONCT, etc.)

If the external SE was created using the ASMBULK option, then this is the data that is generated on the *.asm punch file for use in the MAIN Bulk Data portion. This data consists of SEBULK, SECONCT and boundary GRID Bulk Data entries and associated CORD2x entries.

BEGIN SUPER *SEID1* $ EXTERNAL SE BULK DATA

This data is needed ONLY if the external SE was created using the EXTBULK or DMIGPCH option. In this case, this is the data that is generated on the standard punch file for use in the BEGIN SUPER portion for external SE *seid1*.

BEGIN SUPER *SEID2* $ EXTERNAL SE BULK DATA

ENDDATA

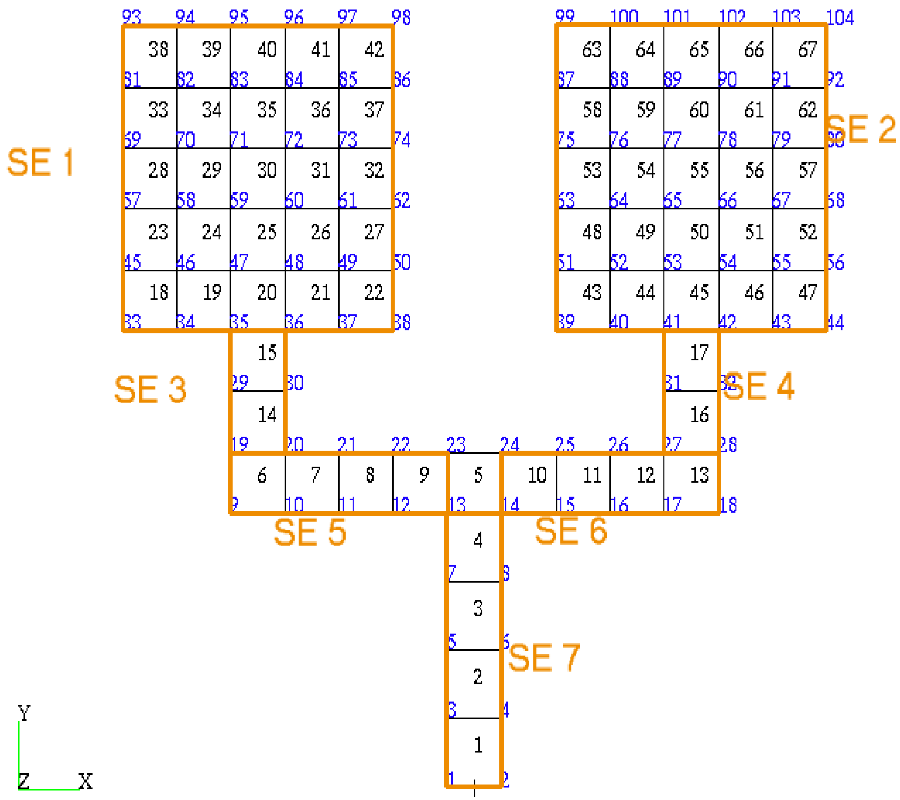
Duplicate GRID and CORD2x Entries in the Main Bulk Data Portion of Assembly Run

- If *.asm punch files resulting from the use of the ASMBULK option for more than one external SE are “included” in the main Bulk Data portion of the assembly run, it is possible that one or more boundary GRID entries or the associated CORD2x entries of one external SE may be the same as those of another external SE
- In earlier versions of MSC.Nastran, the above scenario of duplicate GRID or CORD2x entries would result in a user fatal message
- The above scenario is perfectly acceptable in the V2004 of MSC.Nastran
  - Duplicate GRIDs or CORD2xs will be deleted
  - Format of duplicate GRIDs and CORD2xs must be identical

Sample Problem

- The example is the same two-headed flyswatter divided into 7 superelements
- We will process each component separately and write the reduced data to individual database (MATRIXDB option)
- Request disp and stress output for the components in the assembly run
- Then we will create the assembly model and perform the solution for the assembly modes
- In order to see the assembled model, we will use the "PLOTEL" option for the Bulk Data output

Sample Model For External SE



Input File to Process SE (component) 1 Using the MATRIXDB Method

```
$
$  filename -  runpart1.dat
$
SOL 103
CEND
TITLE = Process superelement 1
SUBTITLE = Write reduced matrices to the database
DISP = ALL
PARAM,GRDPNT,0
PARAM,WTMASS,.00259
loadset = 99
subcase 1
method = 1
stress=all
extseout(asmbulk,extbulk,extid=1)
$
BEGIN BULK
param,resvec,yes
eigrl,1,,,6
lseq,99,1001,101
lseq,99,1002,201
lseq,99,1003,301
$
```

```
$
$ define q-set for component modes and residual vectors
SPOINT   11001   THRU    11020
QSET1    0       11001   THRU    11020
$
$ define which dofs will be retained (i.e. which dofs will form
$ the attachment to the system model when we create SE 1 )
$
ASET1     123456  35      36
$
$ print dof map for connecting the external superelement to the
$ system model, with EXTRN entry.
$ usetsel=128 will print only ASET dof
$
PARAM   USETPRT  0
PARAM   USETSTR1 A
$
include 'loadprt1.dat'
include 'part1.dat'
$
$ plotels to outline component in assembly run
$
plotel,101,33,35
plotel,102,33,93
plotel,103,93,98
plotel,104,98,38
plotel,105,38,36
plotel,106,35,36
enddata
```

Results for SE 1

```
0                                                                                      SUBCASE 1
1    PROCESS SUPERELEMENT 1                                JULY   5, 2003  MSC.NASTRAN  6/ 2/03
     PAGE    16
      WRITE REDUCED MATRICES TO THE DATABASE
0                                                                                      SUBCASE 1
 *******************************************************************
 SUMMARY OF ACTIONS RESULTING FROM THE EXTSEOUT CASE CONTROL COMMAND
 *******************************************************************


 MATRIX DATA ACTION
 ------------------

 THE FOLLOWING MATRICES HAVE BEEN WRITTEN IN MATRIX FORMAT ON THE DATABASE --

 STIFFNESS
 MASS
 DAMPING (VISCOUS)
 DAMPING (STRUCTURAL)
 LOADS

 BULK DATA ACTION
 ----------------

 BOUNDARY AND PLOTEL RELATED BULK DATA HAS BEEN WRITTEN ON THE DATABASE
 AND ON THE PUNCH FILE

 ALSO, SEBULK, SECONCT AND GRID BULK DATA ENTRIES HAVE BEEN WRITTEN
 ON THE *.ASM PUNCH FILE FOR USE IN A SUBSEQUENT ASSEMBLY RUN
```

Results for SE 1 (cont.)

```
TYPE OF REDUCTION
 -----------------

 COMPONENT MODE REDUCTION

 LIST OF BOUNDARY POINTS CONSIDERED FIXED FOR COMPONENT MODE REDUCTION (B-SET)
 -----------------------------------------------------------------------------

 POINT ID - COMP.    POINT ID - COMP.    POINT ID - COMP.    POINT ID - COMP.

       35 - 123456         36 - 123456

 LIST OF BOUNDARY POINTS CONSIDERED FREE FOR COMPONENT MODE REDUCTION (C-SET)
 ----------------------------------------------------------------------------

     NONE

 LIST OF GENERALIZED COORDINATE POINTS FOR COMPONENT MODE REDUCTION (Q-SET)
 --------------------------------------------------------------------------

 POINT ID - COMP.    POINT ID - COMP.    POINT ID - COMP.    POINT ID - COMP.

    11001 -      0      11002 -      0      11003 -      0      11004 -      0
    11005 -      0      11006 -      0      11007 -      0      11008 -      0
    11009 -      0      11010 -      0      11011 -      0      11012 -      0
    11013 -      0      11014 -      0      11015 -      0      11016 -      0
    11017 -      0      11018 -      0      11019 -      0      11020 -      0
```

Results for SE 1 (cont.)

```
 R E A L   E I G E N V A L U E S
                                       (BEFORE AUGMENTATION OF RESIDUAL VECTORS)
   MODE    EXTRACTION      EIGENVALUE            RADIANS             CYCLES            GENERALIZED         GENERALIZED
    NO.       ORDER                                                                       MASS              STIFFNESS
        1         1        2.614156E+05        5.112882E+02        8.137404E+01        1.000000E+00        2.614156E+05
        2         2        1.080109E+06        1.039283E+03        1.654070E+02        1.000000E+00        1.080109E+06
        3         3        6.900456E+06        2.626872E+03        4.180796E+02        1.000000E+00        6.900456E+06
        4         4        1.217279E+07        3.488952E+03        5.552839E+02        1.000000E+00        1.217279E+07
        5         5        2.004629E+07        4.477308E+03        7.125857E+02        1.000000E+00        2.004629E+07
        6         6        2.737869E+07        5.232465E+03        8.327726E+02        1.000000E+00        2.737869E+07


1    PROCESS SUPERELEMENT 1                                                 JULY    5, 2003  MSC.NASTRAN  6/ 2/03    PAGE    14
      WRITE REDUCED MATRICES TO THE DATABASE
0                                                                                                             SUBCASE 1

                                            R E A L   E I G E N V A L U E S
                                       (AFTER AUGMENTATION OF RESIDUAL VECTORS)
   MODE    EXTRACTION      EIGENVALUE            RADIANS             CYCLES            GENERALIZED         GENERALIZED
    NO.       ORDER                                                                       MASS              STIFFNESS
        1         1        2.614156E+05        5.112882E+02        8.137404E+01        1.000000E+00        2.614156E+05
        2         2        1.080109E+06        1.039283E+03        1.654070E+02        1.000000E+00        1.080109E+06
        3         3        6.900455E+06        2.626872E+03        4.180796E+02        1.000000E+00        6.900455E+06
        4         4        1.217279E+07        3.488952E+03        5.552839E+02        1.000000E+00        1.217279E+07
        5         5        2.004629E+07        4.477308E+03        7.125857E+02        1.000000E+00        2.004629E+07
        6         6        2.737869E+07        5.232465E+03        8.327726E+02        1.000000E+00        2.737869E+07
        7         7        4.857320E+07        6.969447E+03        1.109222E+03        1.000000E+00        4.857320E+07
        8         8        7.973098E+07        8.929221E+03        1.421130E+03        1.000000E+00        7.973098E+07
        9         9        9.421250E+07        9.706313E+03        1.544807E+03        1.000000E+00        9.421250E+07
       10        10        1.300586E+08        1.140433E+04        1.815055E+03        1.000000E+00        1.300586E+08
       11        11        1.953432E+08        1.397652E+04        2.224432E+03        1.000000E+00        1.953432E+08
       12        12        2.711912E+09        5.207602E+04        8.288156E+03        1.000000E+00        2.711912E+09
       13        13        5.893717E+09        7.677055E+04        1.221841E+04        1.000000E+00        5.893717E+09
```

Punch Files Generated by the External SE

- The ASMBULK option generates the appropriate SEBULK, SECONCT, and boundary grids for the main bulk data section (*.asm)
- The EXTBULK option generates the appropriate EXTRN; boundary grids for the external SE; ASETi, QSETi, and SPOINTs; and the PLOTELs plus the appropriate interior grid points connected to the PLOTELs (*.pch)

Punch Output for SE 1 Generated by ASMBULK

```
$***********************************************************************
$ THE FOLLOWING BULK DATA ENTRIES RELATED TO EXT. SUPERELEMENT        1
$ ARE FOR USE IN THE MAIN BULK DATA PORTION OF THE ASSEMBLY RUN
$***********************************************************************
$
SEBULK         1EXTERNAL          MANUAL
$
SECONCT        1       0               NO
              35      35      36      36
$
$ BOUNDARY GRID DATA
$
GRID    35              -3.6    6.      0.
GRID    36              -2.8    6.      0.
$***********************************************************************
```

Punch Output for SE 1 Generated by EXTBULK

```
$*************************************************************************
$ THE FOLLOWING BULK DATA ENTRIES RELATED TO EXT. SUPERELEMENT        1
$ ARE FOR USE IN THE BEGIN SUPER        1 PORTION OF THE ASSEMBLY RUN
$*************************************************************************
BEGIN SUPER        1
$
EXTRN         35  123456      36  123456   11001       0   11002       0
           11003       0   11004       0   11005       0   11006       0
           11007       0   11008       0   11009       0   11010       0
           11011       0   11012       0   11013       0   11014       0
           11015       0   11016       0   11017       0   11018       0
           11019       0   11020       0
$
$ BOUNDARY GRID DATA
$
GRID    35              -3.6    6.      0.
GRID    36              -2.8    6.      0.
$
$ INTERIOR GRID DATA
$
GRID    33              -5.2    6.      0.
GRID    38              -1.2    6.      0.
GRID    93              -5.2    10.     0.
GRID    98              -1.2    10.     0.
$
PLOTEL       101      33      35
PLOTEL       102      33      93
PLOTEL       103      93      98
PLOTEL       104      98      38
PLOTEL       105      38      36
PLOTEL       106      35      36
$
ASET          35  123456      36  123456
$
QSET1          0   11001    THRU   11020
$
SPOINT     11001    THRU   11020
$*************************************************************************
```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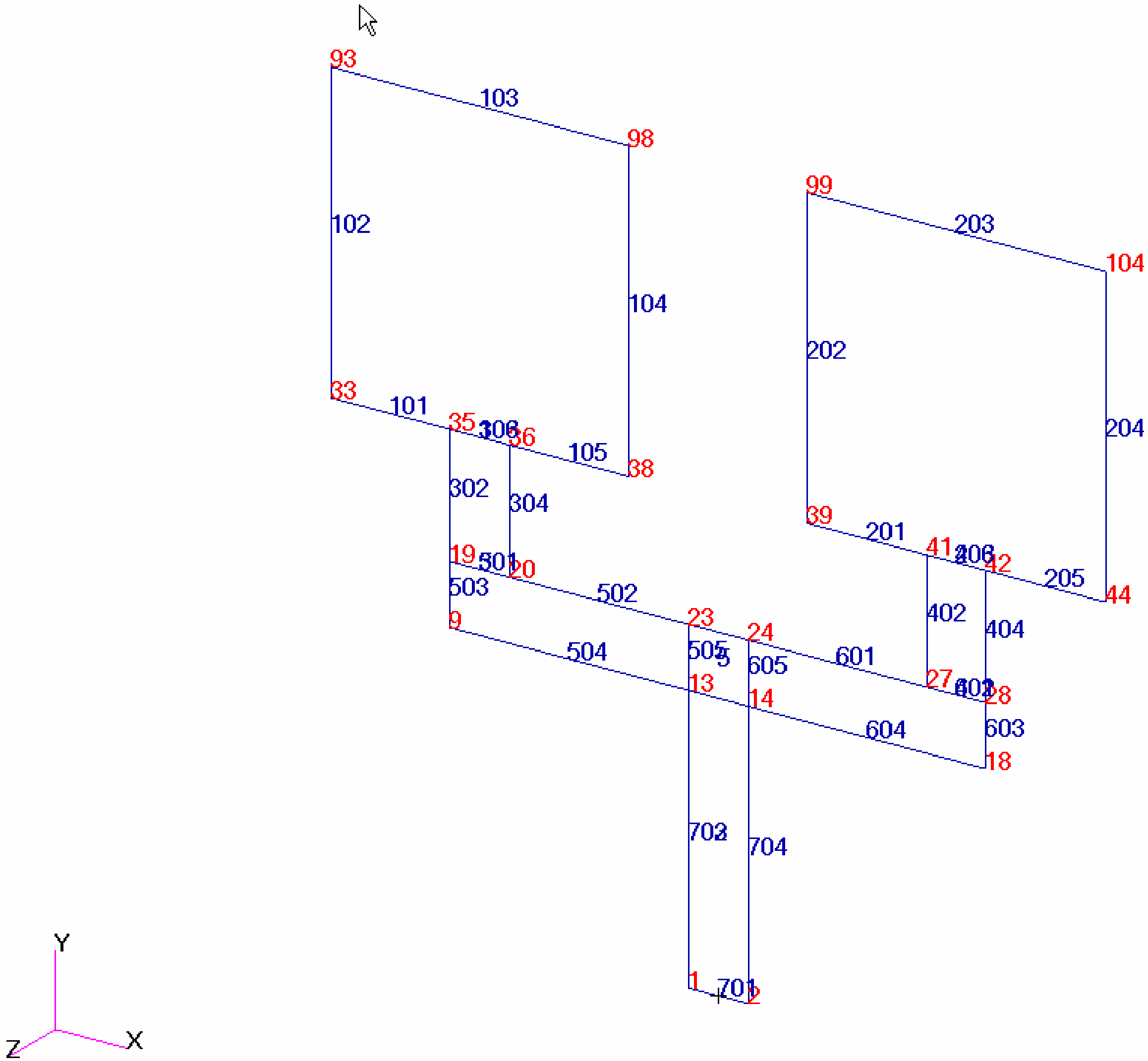
Input File for Assembly Run Using the MATRIXDB Method

```
$
assign se1db = 'runpart1.MASTER'
dblocate db=(extdb) convert(seid=1) logi=se1db
$
assign se2db = 'runpart2.MASTER'
dblocate db=(extdb) convert(seid=2) logi=se2db
$
assign se3db = 'runpart3.MASTER'
dblocate db=(extdb) convert(seid=3) logi=se3db
$
assign se4db = 'runpart4.MASTER'
dblocate db=(extdb) convert(seid=4) logi=se4db
$
assign se5db = 'runpart5.MASTER'
dblocate db=(extdb) convert(seid=5) logi=se5db
$
assign se6db = 'runpart6.MASTER'
dblocate db=(extdb) convert(seid=6) logi=se6db
$
assign se7db = 'runpart7.MASTER'
dblocate db=(extdb) convert(seid=7) logi=se7db
$
id readthem.dat $
diag 8,15,56
SOL 103
CEND
TITLE = S.E. SAMPLE PROBLEM
SUBTITLE = External superelements - read in matrices
DISP = ALL
$
$ set defaults for all se
$
param,post,0
PARAM,GRDPNT,0
PARAM,WTMASS,.00259
subcase 10
method = 1
stress = all
$
```

```
$
output(plot)
$
$ plots
$
seupplot 0
set 1 = all
ptitle = full structure
axes x,mz,y
find scale, origin 1, set 1
plot set 1 label both
plot modal deformation set 1 origin 1
$
BEGIN BULK
param,post,0
$ residual structure model
include 'part0.dat'
eigrl,1,,,9
$
include 'runpart1.asm'
include 'runpart2.asm'
include 'runpart3.asm'
include 'runpart4.asm'
include 'runpart5.asm'
include 'runpart6.asm'
include 'runpart7.asm'
$
$    external superelements
$
include 'runpart1.pch'
include 'runpart2.pch'
include 'runpart3.pch'
include 'runpart4.pch'
include 'runpart5.pch'
include 'runpart6.pch'
include 'runpart7.pch'
$
enddata
```

Undeformed Assembly Plot

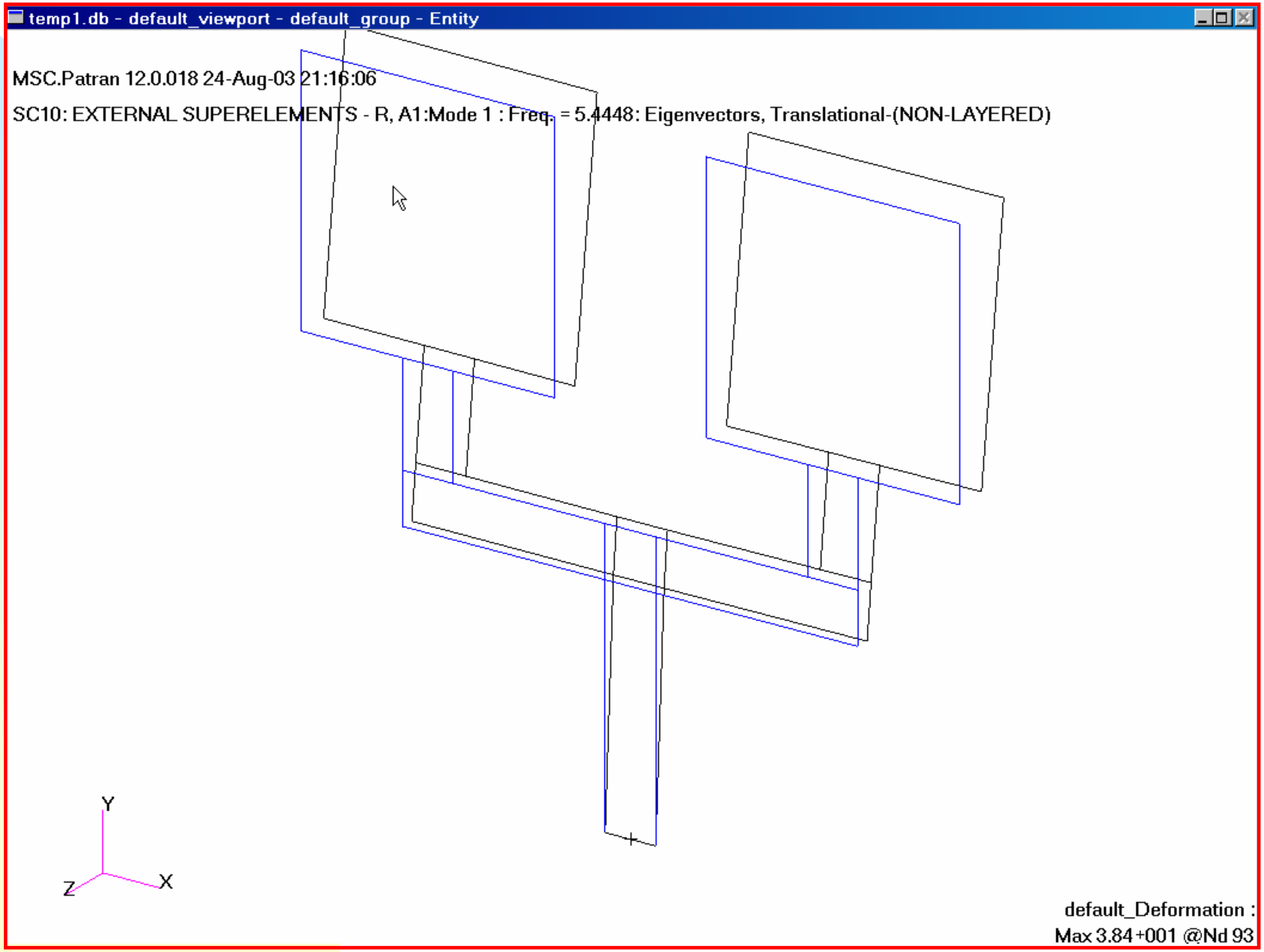


System Modes

```
   EXTERNAL SUPERELEMENTS - READ IN MATRICES                                                   SUPERELEMENT 0
0                                                                                                   SUBCASE 10

                                              R E A L   E I G E N V A L U E S
   MODE    EXTRACTION      EIGENVALUE            RADIANS             CYCLES            GENERALIZED         GENERALIZED
    NO.       ORDER                                                                       MASS              STIFFNESS
        1         1        1.170368E+03        3.421065E+01        5.444794E+00        1.000000E+00        1.170368E+03
        2         2        3.453109E+03        5.876316E+01        9.352447E+00        1.000000E+00        3.453109E+03
        3         3        3.977881E+04        1.994463E+02        3.174286E+01        1.000000E+00        3.977881E+04
        4         4        6.090933E+04        2.467982E+02        3.927914E+01        1.000000E+00        6.090933E+04
        5         5        1.185066E+05        3.442478E+02        5.478874E+01        1.000000E+00        1.185066E+05
        6         6        2.228255E+05        4.720440E+02        7.512813E+01        1.000000E+00        2.228255E+05
        7         7        2.300895E+05        4.796765E+02        7.634288E+01        1.000000E+00        2.300895E+05
        8         8        1.284227E+06        1.133237E+03        1.803603E+02        1.000000E+00        1.284227E+06
        9         9        1.328736E+06        1.152708E+03        1.834592E+02        1.000000E+00        1.328736E+06
```

Assembly Plot for Mode 1



Example Using the DMIGOP2 Option

- Repeat same example using DMIGOP2 option
- No output request for the components in the assembly run
- Procedure is virtually identical with a few exceptions:
  - Add the dmigop2=unit_number to the EXTSEOUT command in the reduction run
  - Add an assign statement for the output2 file in the reduction run
  - Output are requested only at the boundary points and selective interior locations
  - Replace the DBLOCATE commands with the appropriate assign INPUTT2 commands in the assembly run

Input File to Process SE (component) 1 Using the DMIGOP2 Method

```
assign output2='ext1.op2',unit=31,form=formatted,
     delete
SOL 103
CEND
TITLE = Process superelement 1
SUBTITLE = Write reduced matrices to an output2 file
$DISP = ALL
set 1001 = 33,35,36,38,93,98
disp = 1001
PARAM,GRDPNT,0
PARAM,WTMASS,.00259
loadset = 99
subcase 1
method = 1
$stress=all
extseout(asmbulk,extbulk,extid=1,dmigop2=31)
$
BEGIN BULK
param,resvec,yes
eigrl,1,,,6
lseq,99,1001,101
lseq,99,1002,201
lseq,99,1003,301
$
```

```
$
$ define modal coordinates for CMS
$
$ define q-set for component modes and residual vectors
SPOINT   11001   THRU    11020
QSET1    0       11001   THRU    11020
$
$ define which dofs will be retained (i.e. which dofs will form
    the
$ attachment to the system model when we create SE10 in se10.dat)
$
ASET1     123456  35      36
$
$ print dof map for connecting the external superelement to the
$ system model, with EXTRN entry.
$ usetsel=128 will print only ASET dof
$
PARAM   USETPRT  0
PARAM   USETSTR1 A
$
include 'loadprt1.dat'
include 'part1.dat'
$
$ plotels to outline component in assembly run
$
plotel,101,33,35
plotel,102,33,93
plotel,103,93,98
plotel,104,98,38
plotel,105,38,36
plotel,106,35,36
enddata
```

Input File for Assembly Run Using the DMIGOP2 Method

```
$
$ attach files with reduced matrices
$
assign inputt2='ext1.op2', unit=31, form=formatted
assign inputt2='ext2.op2', unit=32, form=formatted
assign inputt2='ext3.op2', unit=33, form=formatted
assign inputt2='ext4.op2', unit=34, form=formatted
assign inputt2='ext5.op2', unit=35, form=formatted
assign inputt2='ext6.op2', unit=36, form=formatted
assign inputt2='ext7.op2', unit=37, form=formatted
$
id readthem.dat $
diag 8,15,56
SOL 103
CEND
TITLE = S.E. SAMPLE PROBLEM  readthem.dat
SUBTITLE = External superelements - read in matrices
DISP = ALL
$
$ set defaults for all se
$
param,post,0
PARAM,GRDPNT,0
PARAM,WTMASS,.00259
subcase 10
spc = 10
method = 1
stress = all
$
```

```
$
output(plot)
$
$ plots
$
seupplot 0
set 1 = all
ptitle = full structure
axes x,mz,y
find scale, origin 1, set 1
plot set 1 label both
plot modal deformation set 1 origin 1
$
BEGIN BULK
param,post,0
$ residual structure model
include 'part0.dat'
eigrl,1,,,9
$
include 'runpart1.asm'
include 'runpart2.asm'
include 'runpart3.asm'
include 'runpart4.asm'
include 'runpart5.asm'
include 'runpart6.asm'
include 'runpart7.asm'
$
$    external superelements
$
include 'runpart1.pch'
include 'runpart2.pch'
include 'runpart3.pch'
include 'runpart4.pch'
include 'runpart5.pch'
include 'runpart6.pch'
include 'runpart7.pch'
$
enddata
```

Section 4

Numeric Enhancements

ACMS Enhancements

- ACMS has been available for several versions using the Geometric Domain Decomposition
  - Divides model into smaller sub-models
  - Based on geometry
  - Prior to constraint eliminations

- ACMS with Geometric Domain Decomposition—not very efficient for the following conditions:
  - Spot welds via manual modeling technique
  - Spot welds via CWELD elements
  - Acoustic coupling via rigid elements and MPCs
  - Model with large numbers of MPCs (or Rtype elements)

ACMS Enhancements (cont.)

- ACMS with DOF Domain Decomposition (MDACMS) added in v2005
  - Based on degrees of freedom
  - Performs domain decomposition after all constraints are eliminated

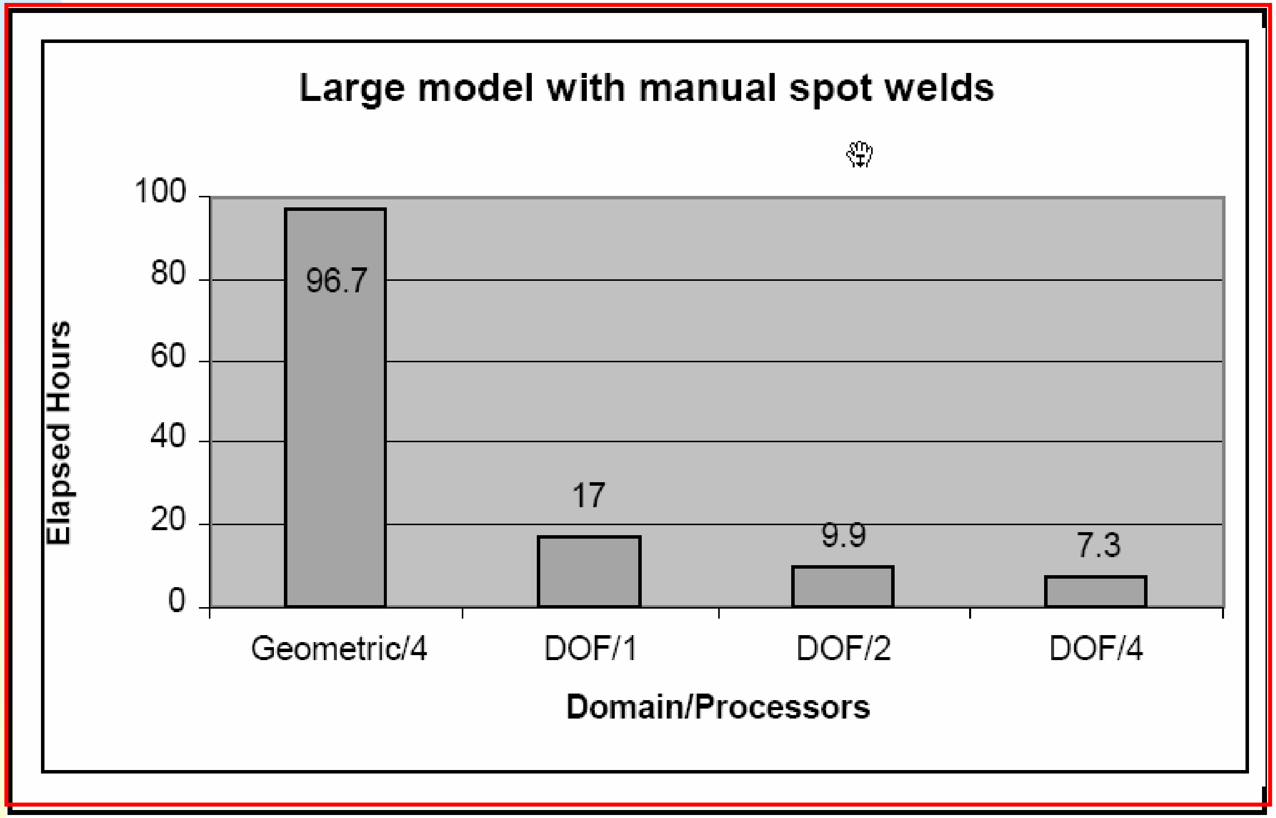
- New option on DOMAINSOLVER ACMS Executive Control Command

Format:

DOMAINSOLVER   ACMS (PARTOPT=DOF)

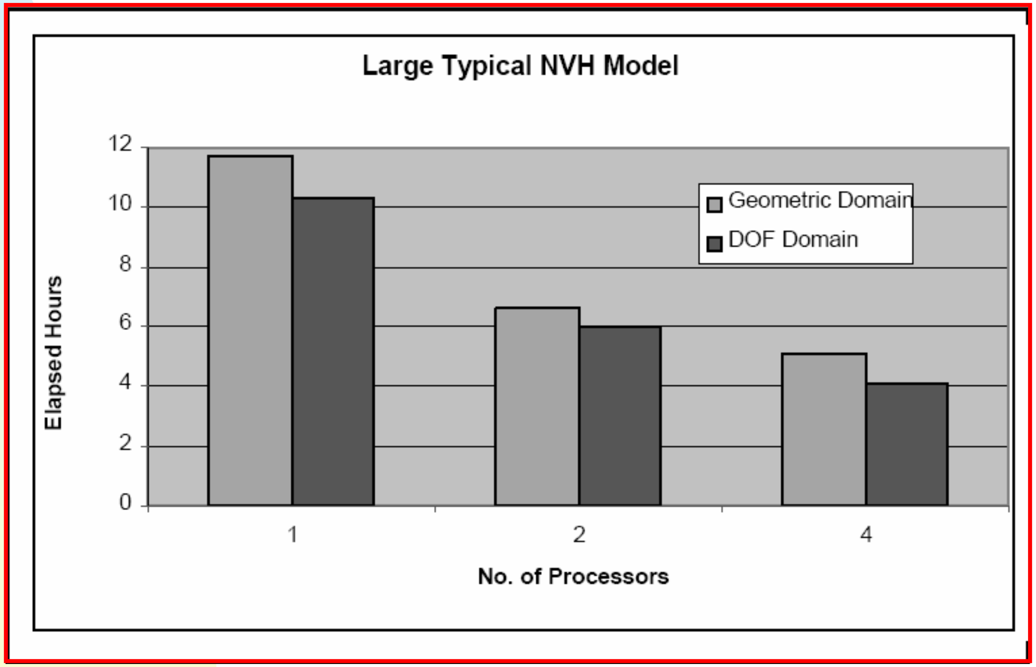
ACMS Enhancements (cont.)

- Example 1—model with manual spot welds



ACMS Enhancements (cont.)

- Example 2—normal NVH model
  - Performs at least as well as the Geometric Domain option



ACMS Enhancements (cont.)

- Other important features of DOF Domain ACMS:
  - CMS theory identical to that used in ACMS and in all other MSC.Nastran CMS techniques
  - Residual vectors are available at every component and at every level in order to maximize the accuracy of CMS
  - Distributed Memory Parallel (DMP) available for 2 or 4 processors—provides excellent parallel speedup
  - Compatible with MSC.Nastran superelement techniques, including external superelements
  - Available in SOLs 103, 111, and 200

Fast Modal Frequency Response Analysis

- In v2004, a fast direct frequency method (Krylov subspace) was available for model with small modal density
  - Turn on with system cell 387
    nastran system(387)=-1
- In v2005, a fast modal frequency response method is added
  - Turn on with parameter fastfr
    “param,fastfr,yes”

Fast Modal Frequency Response Analysis (cont.)

- This method is efficient when
  - Model is large requesting large number of modes
  - Very few dampers
  - Very few acoustic modes

- The model must satisfy the following criteria:
  - All matrices must be symmetric
  - No K2PP, M2PP, or B2PP
  - No EPOINT
  - Fluid damping, if exists,must be specified with param,gfl
  - No Acoustic absorbers
  - Symmetric formulation for acoustic coupling

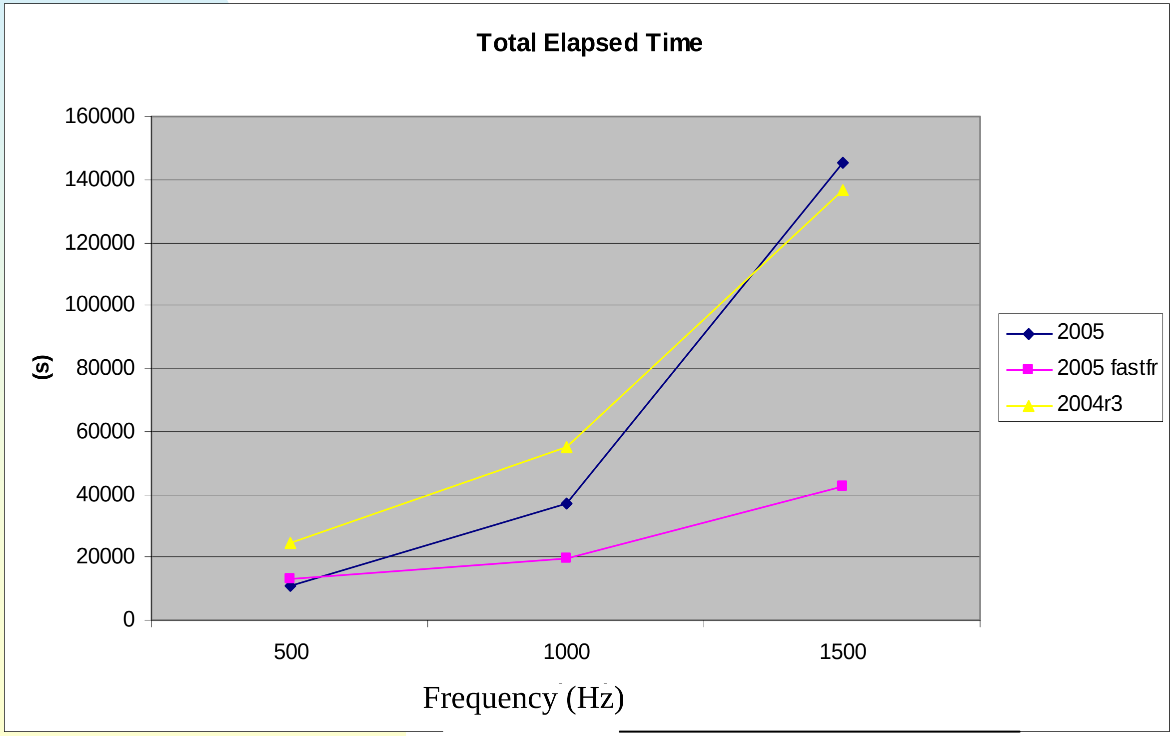
Fast Modal Frequency Response Analysis (cont.)

Model Data:

- 3.7 million dofs, modes up to 1000hz (4500 modes)
- FRF: Modal FRF up to 300hz (580 excitation frequencies)
- 120 Subcases
- Structural damping (ge)
- Compare results with direct frequency response (sol 108)
- Performance comparison between FASTFR vs FRRD1

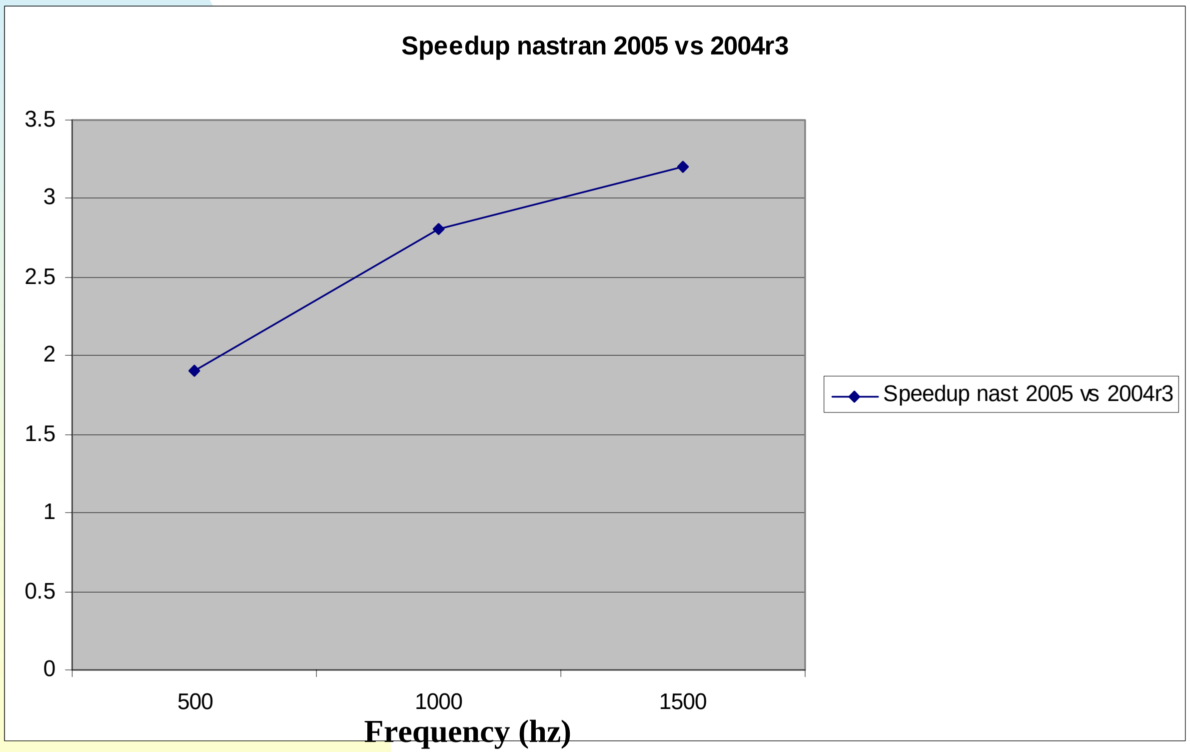
Fast Modal Frequency Response Analysis (cont.)

- Job ran 3 different ways:
  - V2004R3 with MDACMS
  - V2005 with MDACMS
  - V2005 with MDACMS + FASTFR



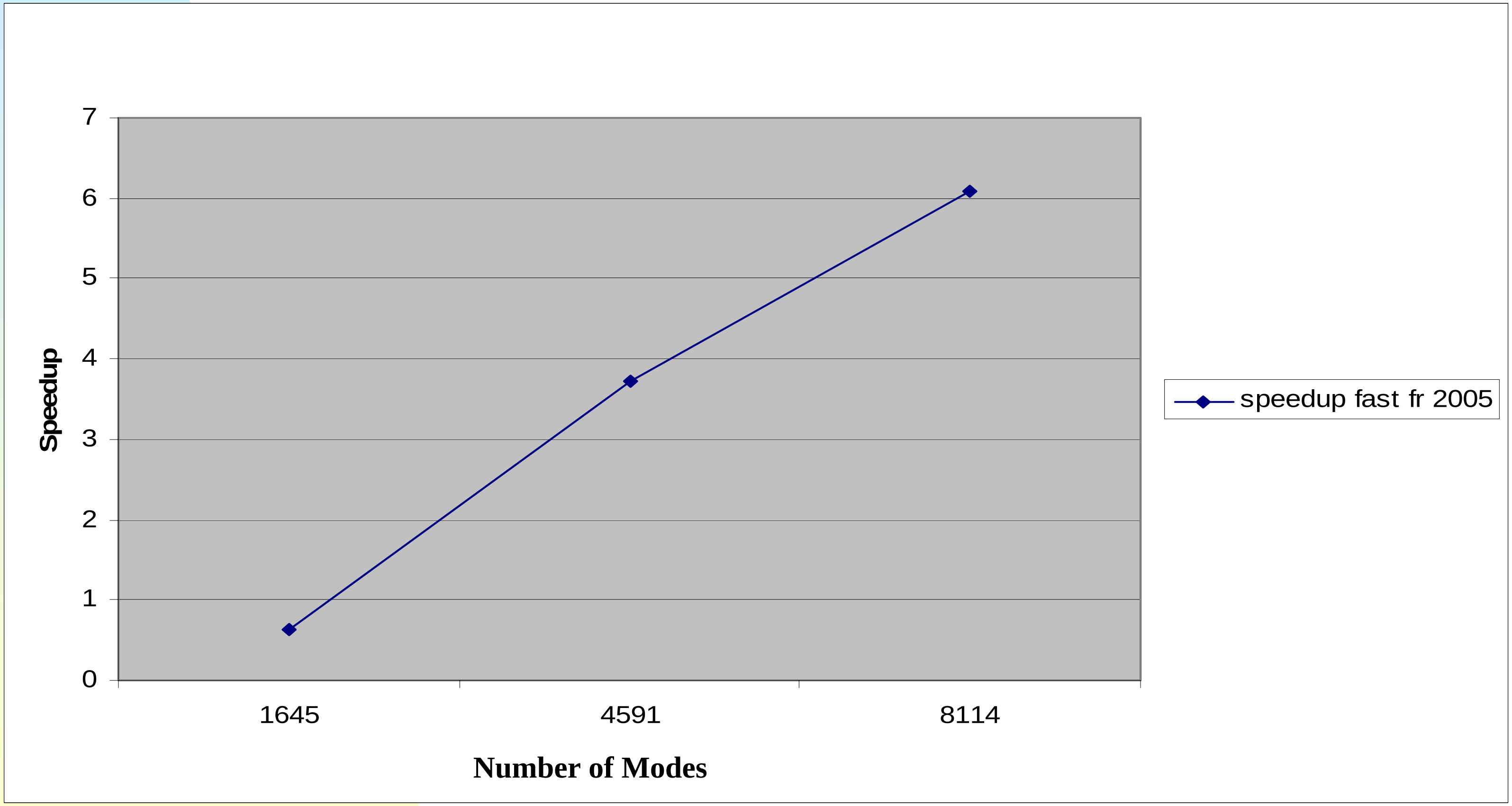
Fast Modal Frequency Response Analysis (cont.)

- Speedup of FASTFR in v2005 vs v2004R3
  - Due mainly to SDR2 performance fixes
  - Most noticeable with large # of subcases



Fast Modal Frequency Response Analysis (cont.)

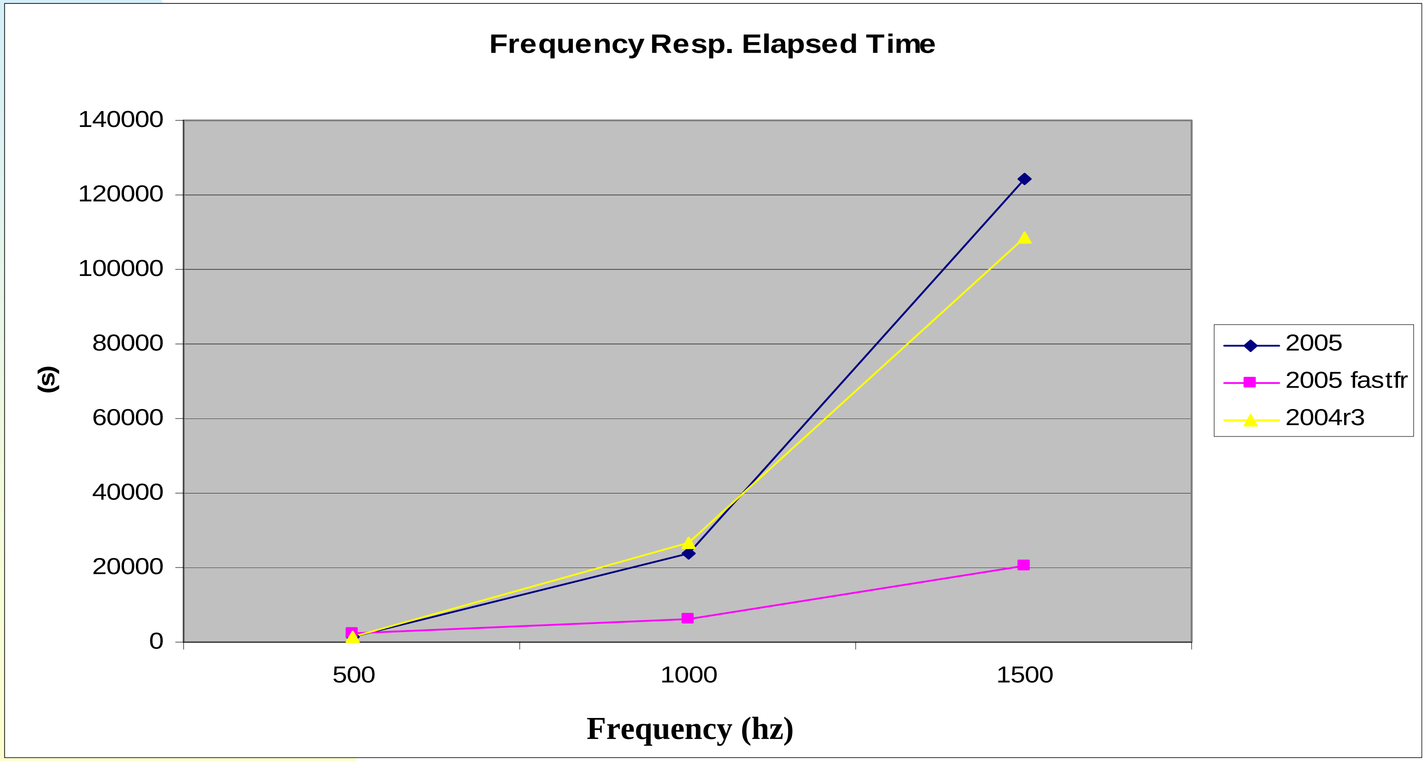
- Speedup of FASTFR vs FRRD1
  - Effects increase as the number of modes increases



MSC SOFTWARE
SIMULATING REALITY

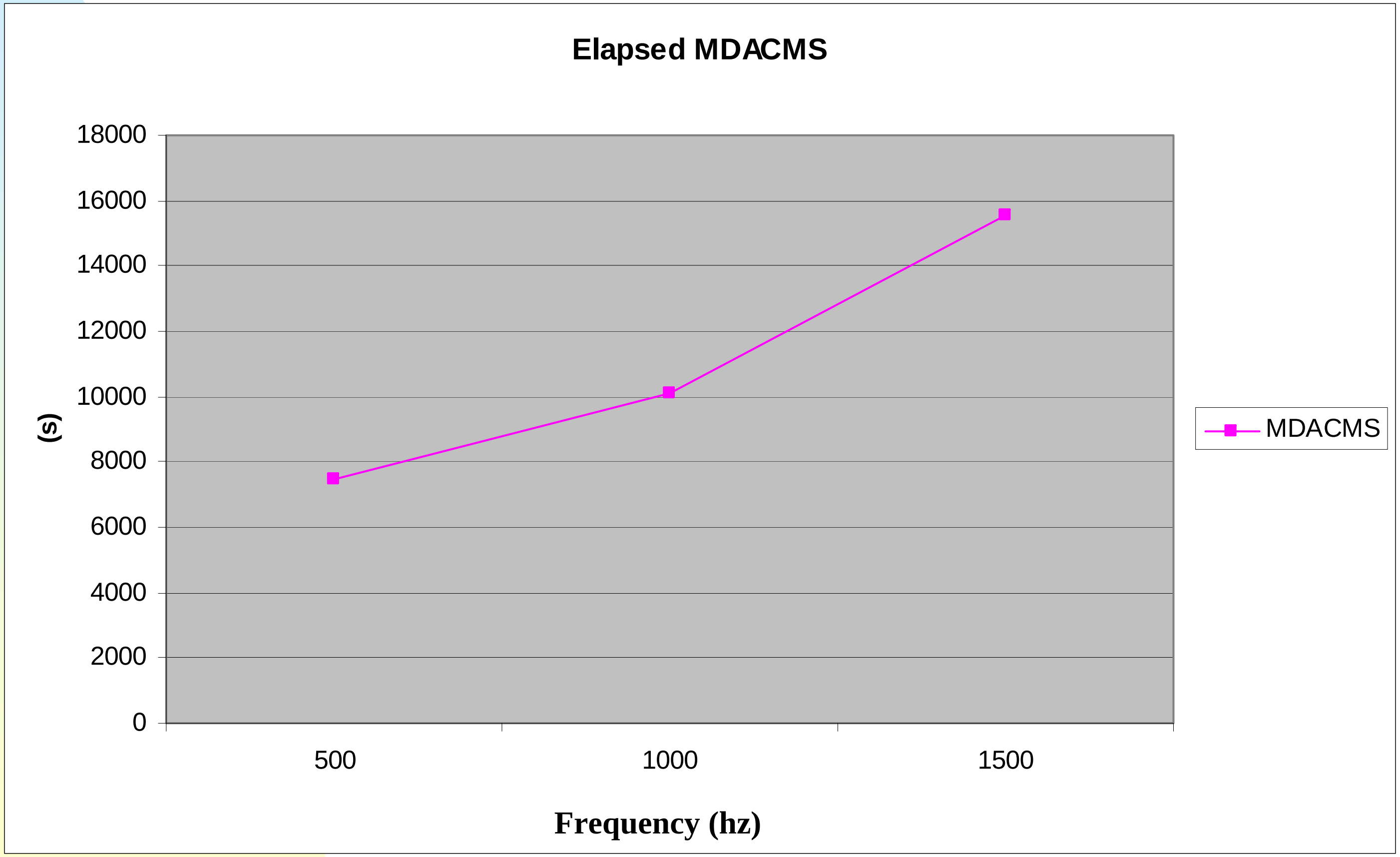
Fast Modal Frequency Response Analysis (cont.)

- Frequency Response time saving using FASTFR
  - Insignificant for this model with modes up to 500 hz (1500 modes)
  - Significant with modes up to 1500 hz (8100 modes)



Fast Modal Frequency Response Analysis (cont.)

- Time spend in modes calculation (MDACMS)



Fast Modal Frequency Response Analysis (cont.)

- Excellent correlation between Direct Frequency Response and Fastfr-mdacms