Release 2023 R1 Highlights
System Coupling

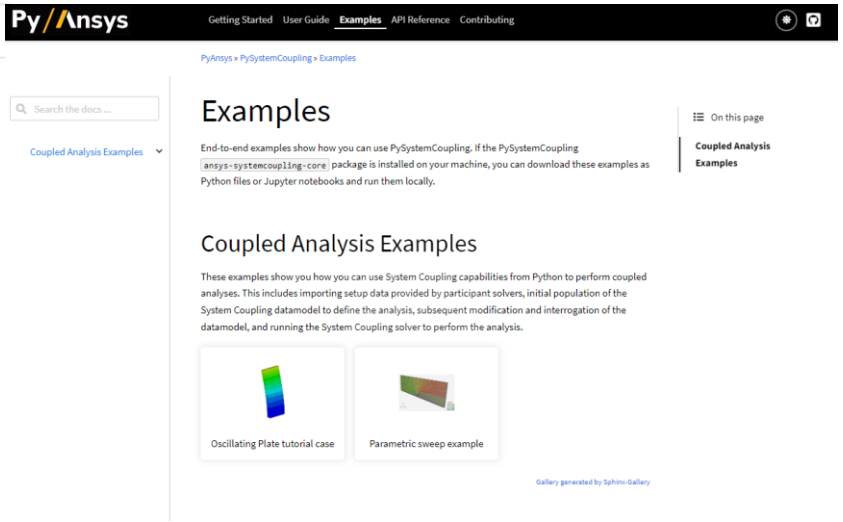
2023 R1 Update Highlights

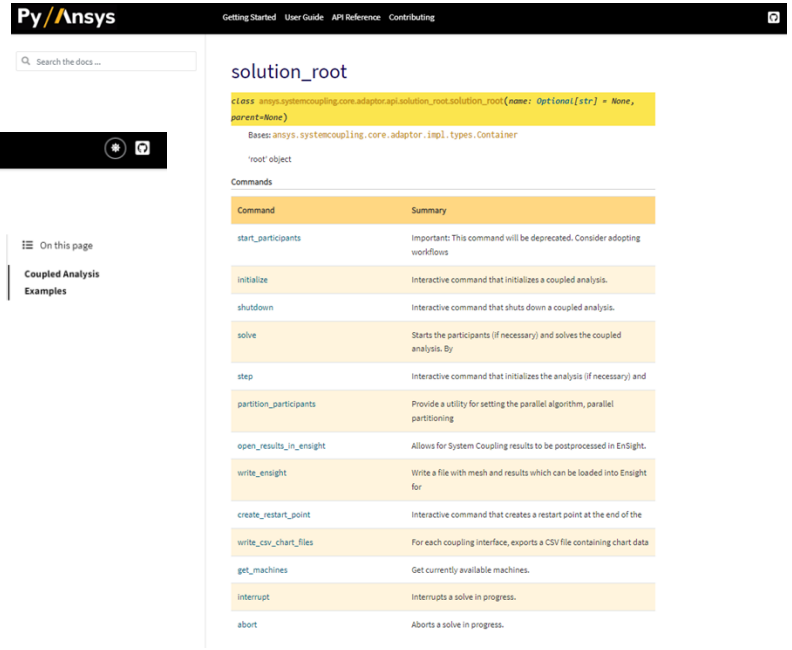
- PyAnsys/PySystemCoupling
- Aerodamping
- Automatic Interface Alignment
- Mapping Accuracy Improvements
- User Interface Improvements
- Other updates

System Coupling

PySystemCoupling

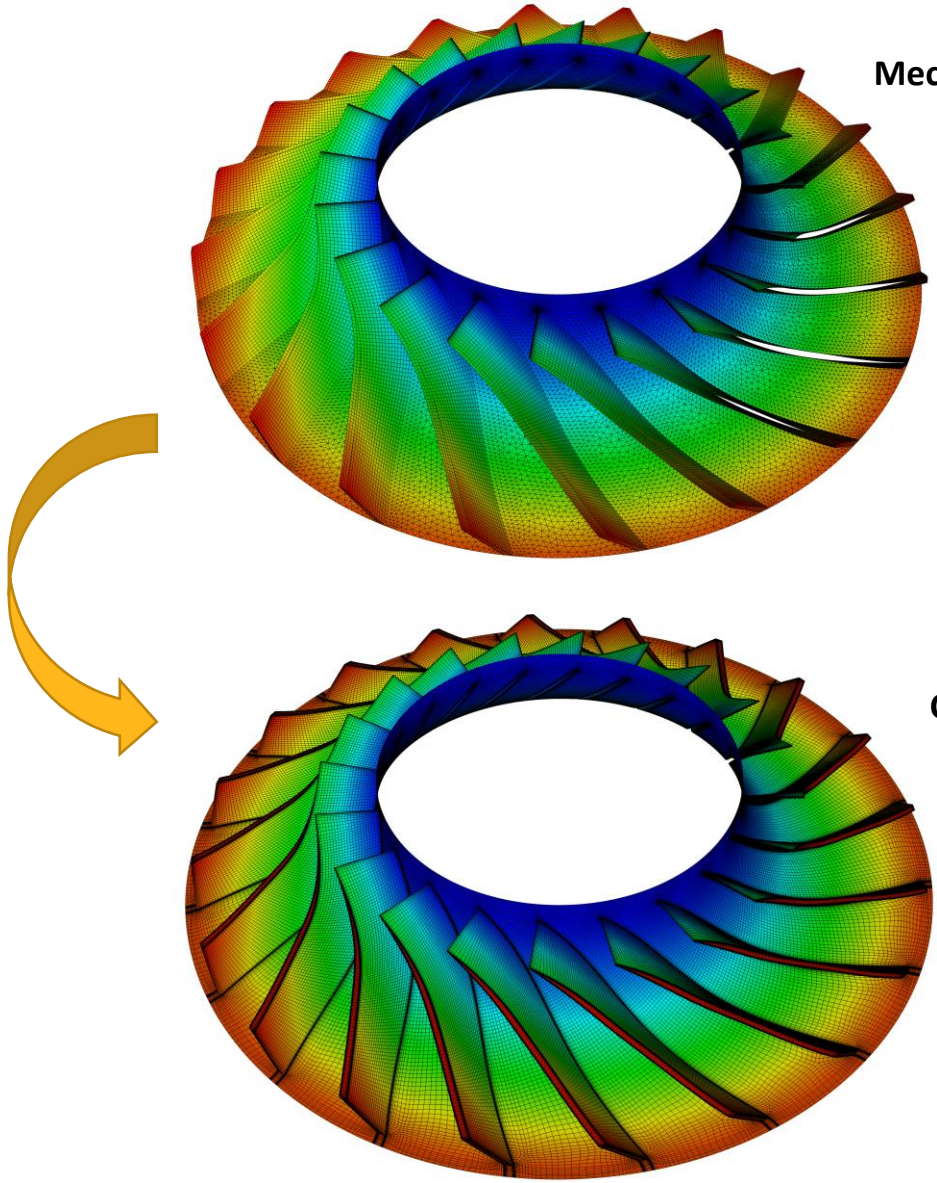
- Open-source Python module for access to System Coupling
- **github.com/pyansys/pysystem-coupling**
- Targeting first release at 2023 R1 RTP (January 2023)
- Focus on desktop deployment
  - Allows full breadth of System Coupling workflows to be executed from a Python console
  - Allows easy integration with other PyAnsys products
- Documentation
  - Automatically generated APIs reference
  - Examples via Sphinx gallery





Aerodamping

- Enable mapping of complex mode shapes for cases with cyclic symmetry
- Multi-region support
  - For cases where blade surface, tip, hub, etc. are in separate regions
- Full access to System Coupling features for easier mapping
  - Instancing
  - Geometry transformations
  - Non-overlap extrapolation algorithm
  - Previewing mapping results in EnSight
  - Automatic interface alignment (beta)
  - Etc.

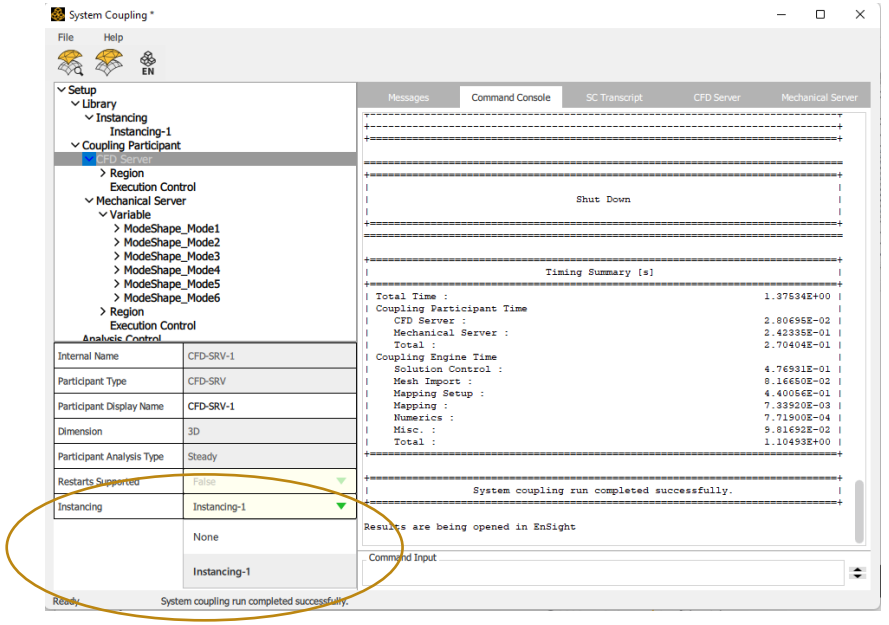


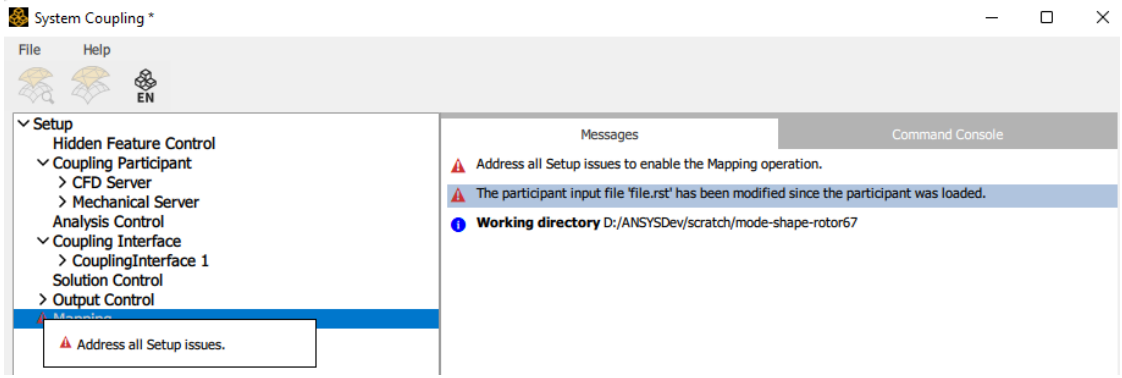
Source: Mechanical modal analysis

Target: CFX analysis

Aerodamping

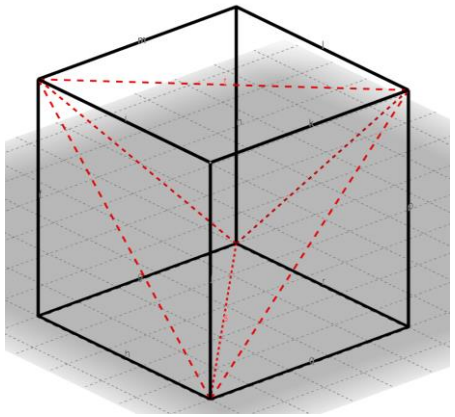
- Specify CFD instancing from System Coupling GUI
- Detect input file changes if the underlying modal analysis was updated



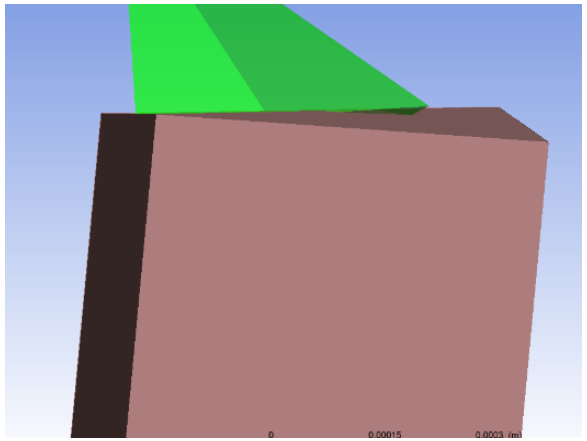


Mapping Accuracy Improvements

- Warped faces handling
- Volume mapper uses optimized cell splitting algorithm
  - Assumes all faces are planar
- Detect if a face is warped or not
- Different in 2023 R1
  - Turn off optimized cell splitting for cells with warped faces
    - Improves conservation
  - Turn on optimized cell splitting for high-order cells without warped faces
    - Dramatic speedup in mapping
      - 120 [s] -> 4 [s] for a test case



Optimized cell splitting assumes cells with no warped faces

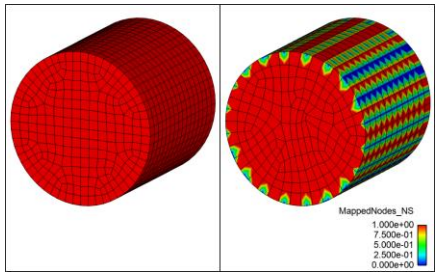


Hexahedron element with warped faces renders optimized cell splitting inaccurate

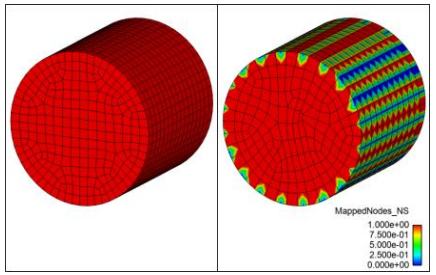
Mapping Accuracy Improvements

- Warped mesh faces handling

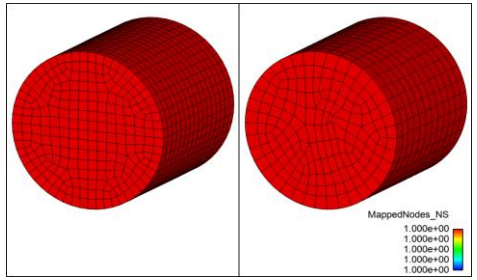
Warped face tolerance=1



Warped face tolerance=1



Warped face tolerance=1e-14



Better mapping quality with warped faces detection turned on

Mapping accuracy visualization with warped face tolerance 1,1e-6,1e-14 (from left to right)

```
MESH STATISTICS
Participant: FLUENT-1
  Number of cell regions                                  1
    Number of cells                                     992
      Hexahedral                                        992
    Number of faces                                   3 278
    Volume (m3)                                   2.449e-02
  Bounding Box (m)
    Minimum          [-2.500e-01  0.000e+00 -2.500e-01]
    Maximum          [ 6.197e-17  5.000e-01  0.000e+00]

Participant: MAPDL-2
  Number of cell regions                                  1
    Number of cells                                   2 088
      Hexahedral20                                    2 088
    Number of faces                                   6 666
    Volume (m3)                                   9.790e-02
  Bounding Box (m)
    Minimum          [-2.500e-01  0.000e+00 -2.500e-01]
    Maximum          [ 2.500e-01  5.000e-01  2.500e-01]

Total
  Number of cells                                     3 080
  Number of faces                                     9 944
  Number of nodes                                    10 947
Instancing and/or Reference Frame transformations are defined for this
analysis. Note that the mesh statistics report non-instanced/untransformed
geometries.

MAPPING SUMMARY
                                  Source          Target
CouplingInterface 1
  DataTransfer 1
    Mapped Volume [%]                100             100
    Mapped Elements [%]              100             100
    Mapped Nodes [%]                 100              94
```

```
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    Number of cells                                     992
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    Number of faces                                   3 278
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  Bounding Box (m)
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    Maximum          [ 6.197e-17  5.000e-01  0.000e+00]

Participant: MAPDL-2
  Number of cell regions                                  1
    Number of cells                                   2 088
      Hexahedral20                                    2 088
      With warped faces                                 456
    Number of faces                                   6 666
    Volume (m3)                                   9.790e-02
  Bounding Box (m)
    Minimum          [-2.500e-01  0.000e+00 -2.500e-01]
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      Hexahedral                                        992
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    Number of faces                                   6 666
    Volume (m3)                                   9.790e-02
  Bounding Box (m)
    Minimum          [-2.500e-01  0.000e+00 -2.500e-01]
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MAPPING SUMMARY
                                  Source          Target
CouplingInterface 1
  DataTransfer 1
    Mapped Volume [%]                100             100
    Mapped Elements [%]              100             100
    Mapped Nodes [%]                 100             100
```
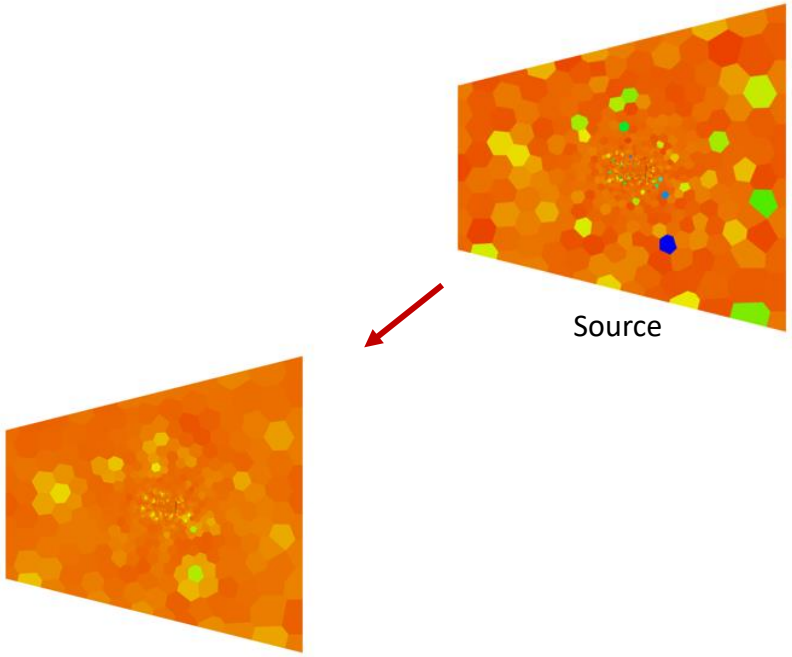
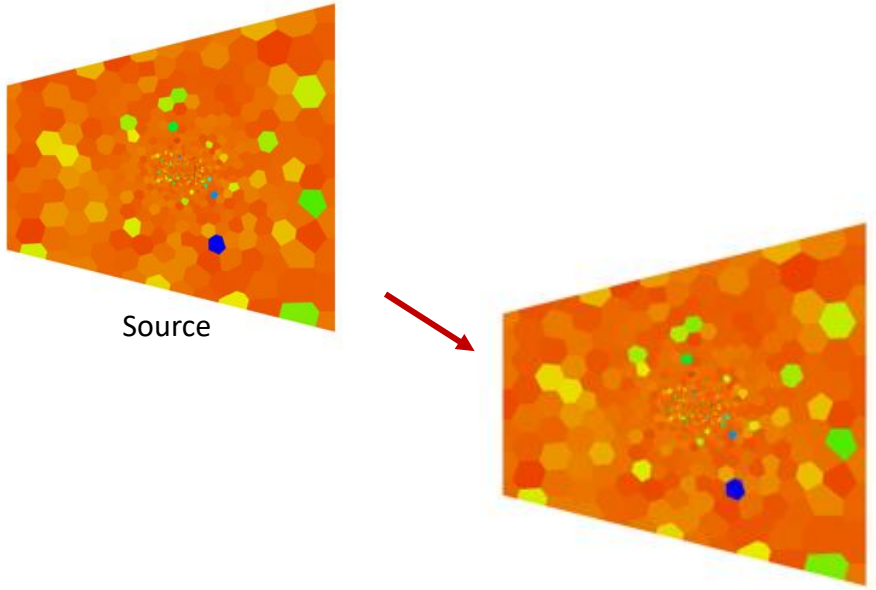

Log file mesh statics and mapping summary comparison

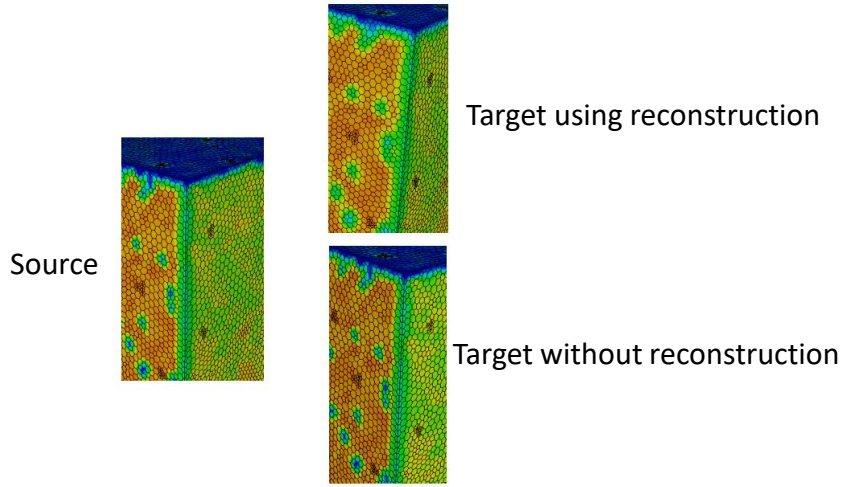
Mapping Accuracy Improvements

- Implemented new “Source Element RBF” algorithm
  - Directly uses source data if it’s on elements
- Fully eliminated node-element reconstruction steps for profile-preserving volume mapping algorithms



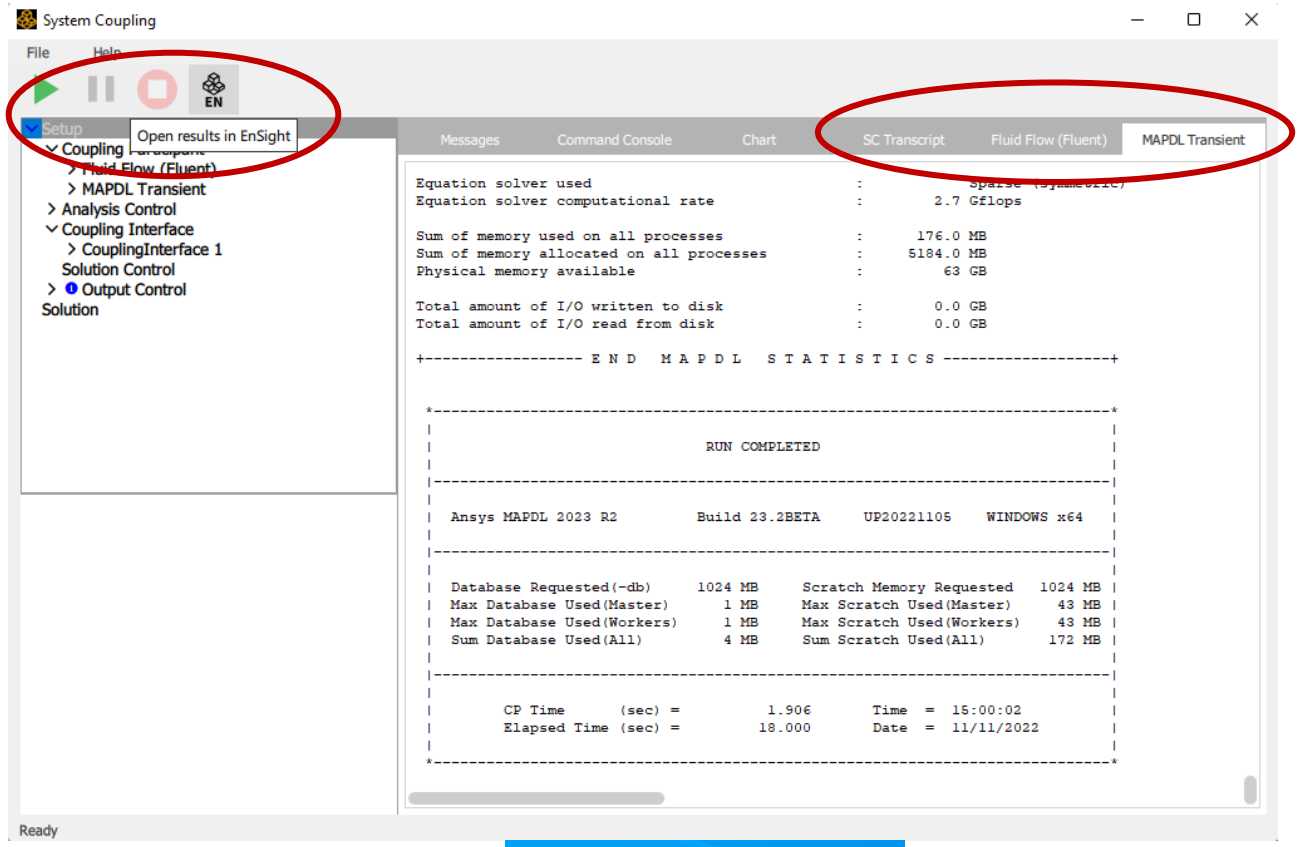
Target without reconstruction (note how the data is smeared)

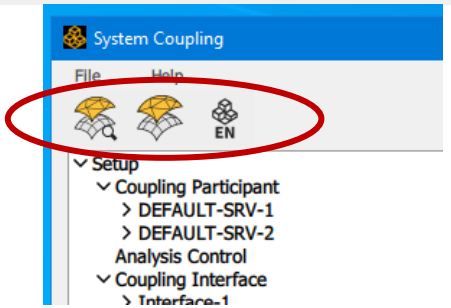




User Interface Improvements

- Participant solver transcripts available in System Coupling GUI
  - Provides a more comprehensive view of the coupled analysis inside one GUI
  - System Coupling transcript (.scl file) is also available
  - Participant APIs updated to allow participants to provide transcript file name
- GUI toolbar buttons
  - Common operations available with one click (Solve, Open Results in EnSight, etc.)
  - More to come in future releases…





User Interface Improvements

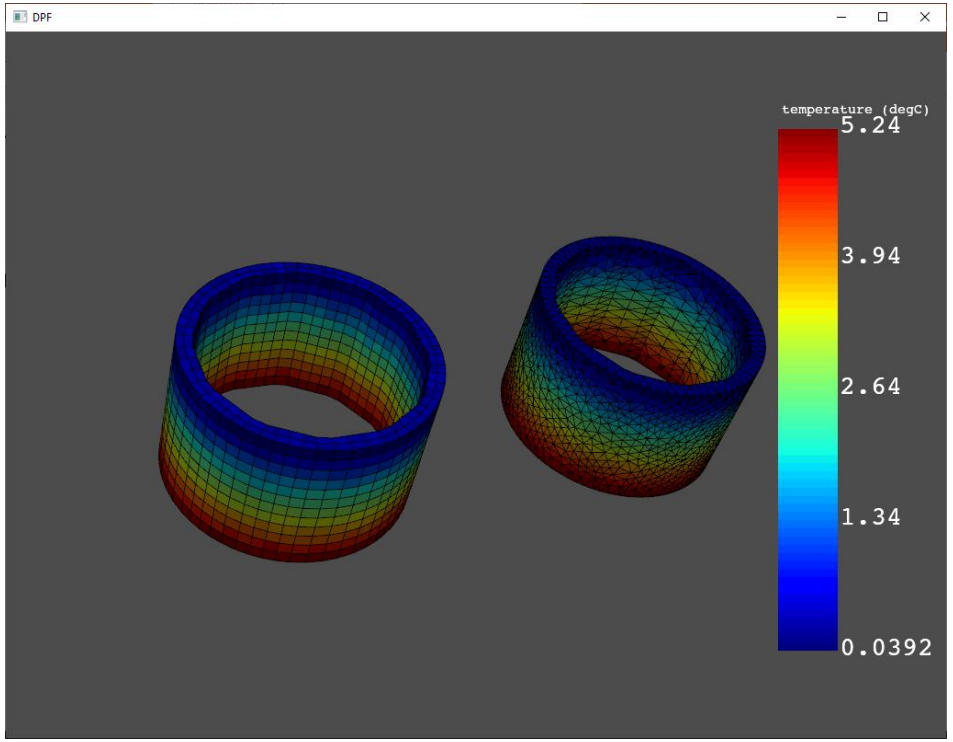
- Custom participant partitioning for distributed parallel
  - Allows full flexibility for distributing participants for parallel runs
  - Call **GetMachines()** query to get the list of machines available at run-time
    - Useful if machines unknown ahead of time, e.g. HPC cluster environment with job scheduler
  - Use Python script to assign cores and machines to participants
  - Call **PartitionParticipants()** command takes partitioning information from above and translates it to participant execution commands

```
Example script:

allMachines = GetMachines()
m1 = allMachines[0]
m2 = allMachines[1]
m3 = allMachines[2]

aedtMachines = []
aedtMachines.append(m1.copy())
aedtMachines.append(m2.copy())

fluentMachines = []
fluentMachines.append(m1.copy())
fluentMachines.append(m2.copy())
fluentMachines.append(m3.copy())

partitioningInfo = {}
partitioningInfo['AEDT-1'] = aedtMachines
partitioningInfo['FLUENT-2'] = fluentMachines

PartitionParticipants(PartitioningInfo = partitioningInfo)
```

```
+================================================================================+
|                              Execution Information                             |
+================================================================================+
|                                                                                |
| System Coupling                                                                |
|   Command Line Arguments:                                                      |
|     --cnf=lebvmsles124uge1:8,lebvmsles124uge2:8,lebvmsles124uge3:8 -R run.p    |
|     y                                                                          |
|   Working Directory:                                                           |
|     /net/nfs.lebisilon/home/aalhoura/tests/custompartitioning/aedt-2d-trans    |
|     ient-fluent-3d-steady-auto                                                 |
|                                                                                |
| Ansys Electronics Desktop                                                      |
|   Execution Command:                                                           |
|     "/net/nfs.lebisilon/home/aalhoura/AnsysEM/v231/Linux64/ansysedt" -ng -f    |
|     eatures=SF6694_NON_GRAPHICAL_COMMAND_EXECUTION -distributed -auto -mach    |
|     inelist list=lebvmsles124uge1:-1:8,lebvmsles124uge2:-1:8 -scport 44391     |
|     -schost lebvmsles124uge1.ansys.com -scname "AEDT-1" -runscript "Electri    |
|     cMotor_2D_Transient_SystemCouplingSetup1.py"                               |
|   Working Directory:                                                           |
|     /net/nfs.lebisilon/home/aalhoura/tests/custompartitioning/aedt-2d-trans    |
|     ient-fluent-3d-steady-auto/Maxwell                                         |
|                                                                                |
| Fluid Flow (Fluent)                                                            |
|   Execution Command:                                                           |
|     "/net/nfs.lebisilon/home/aalhoura/ansys_inc/v231/fluent/bin/fluent" 3dd    |
|     p -g -scport=44391 -schost=lebvmsles124uge1.ansys.com -scname="FLUENT-2    |
|     " -i FLUENT-2.jou -t24 -cnf=lebvmsles124uge1:8,lebvmsles124uge2:8,lebvm    |
|     sles124uge3:8                                                              |
|   Working Directory:                                                           |
|     /net/nfs.lebisilon/home/aalhoura/tests/custompartitioning/aedt-2d-trans    |
|     ient-fluent-3d-steady-auto/Fluent                                          |
|                                                                                |
+================================================================================+
```

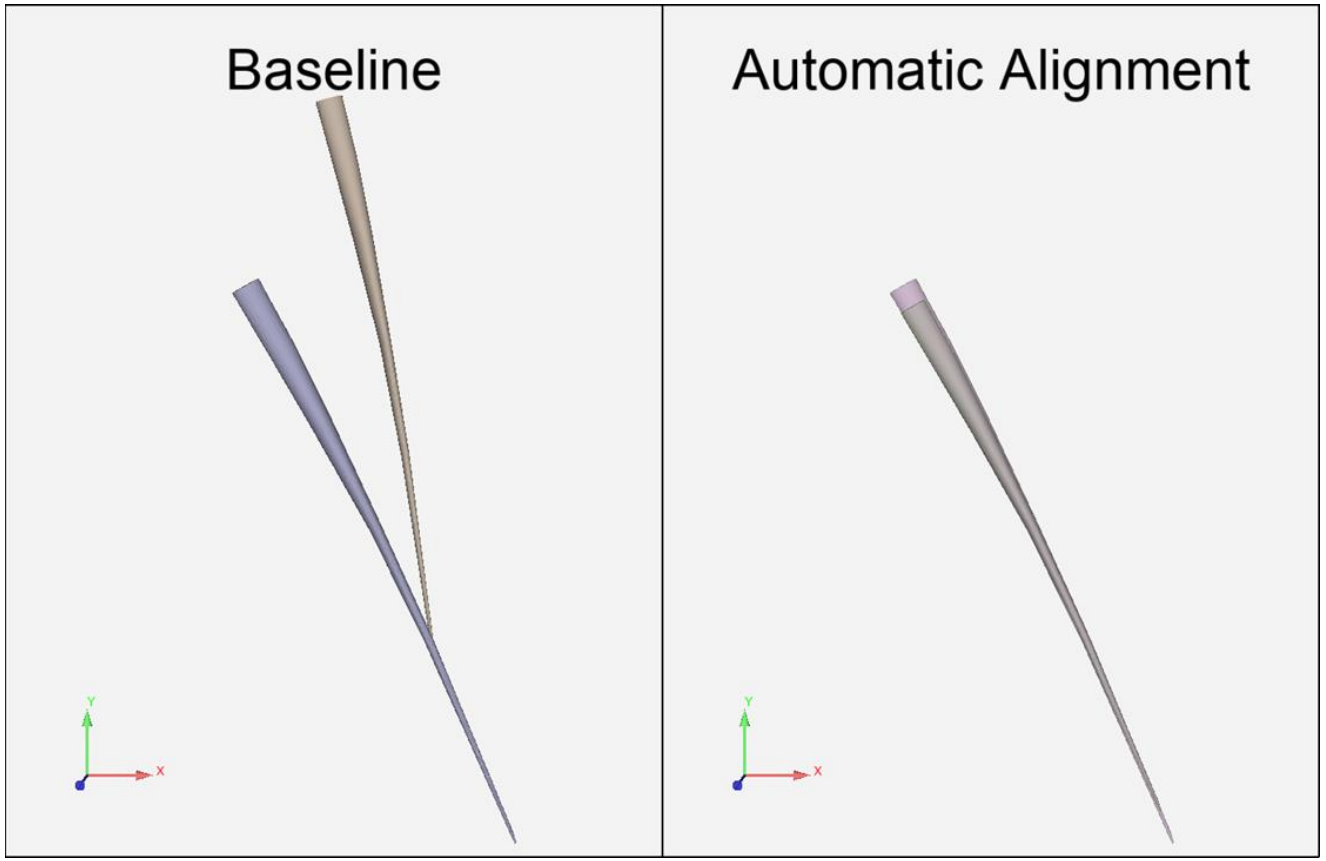
DPF Mapping Operators

- System Coupling mapping library embedded inside DPF operators
- New DPF operators
  1. sc_mapping
     - Simplified workflow version to map one variable easily
  2. create_sc_mapping_workflow + mapping_workflow
     - Separates mapping weights calculation and interpolation
     - Allows interpolating multiple variables efficiently
- Available mapping features
  - Surface, volume
  - Polyhedral meshes
  - Meshes with high order elements
  - Point cloud mapping
  - Vectors, scalars
  - Conservative, profile-preserving mapping



Automatic Interface Alignment (Beta)

- Align source and target geometry automatically
- Rigid body alignment (translation and rotation)
- Can work together with manual transformations, e.g.
  1. Manual transformation
  2. Automatic alignment
  3. Manual transformation
- Work in progress – more to come in 2023 R2




Ansys