CADMEN 虎門科技 | Ansys精英合作夥伴

Ansys

2022 R1 新技術線上研討會

Engineering What's Ahead.

4/7 (四) 14:00-14:40	Ansys CFD 進階應用_TurboWorkflow 新技術線上研討會	李奕璋
4/7 (四) 15:00-15:40	Ansys Rocky 新技術線上研討會 (Ansys Fluent、Motion & OptiSLang 耦合應用技術)	林健文
4/7 (四) 16:00-16:40	Ansys GRANTA 碳足跡應用與產業成功案例分享-新技術線上研討會	李易軒

Ansys 2022R1

New Turbo Tools

Fluent TurboWorkflow

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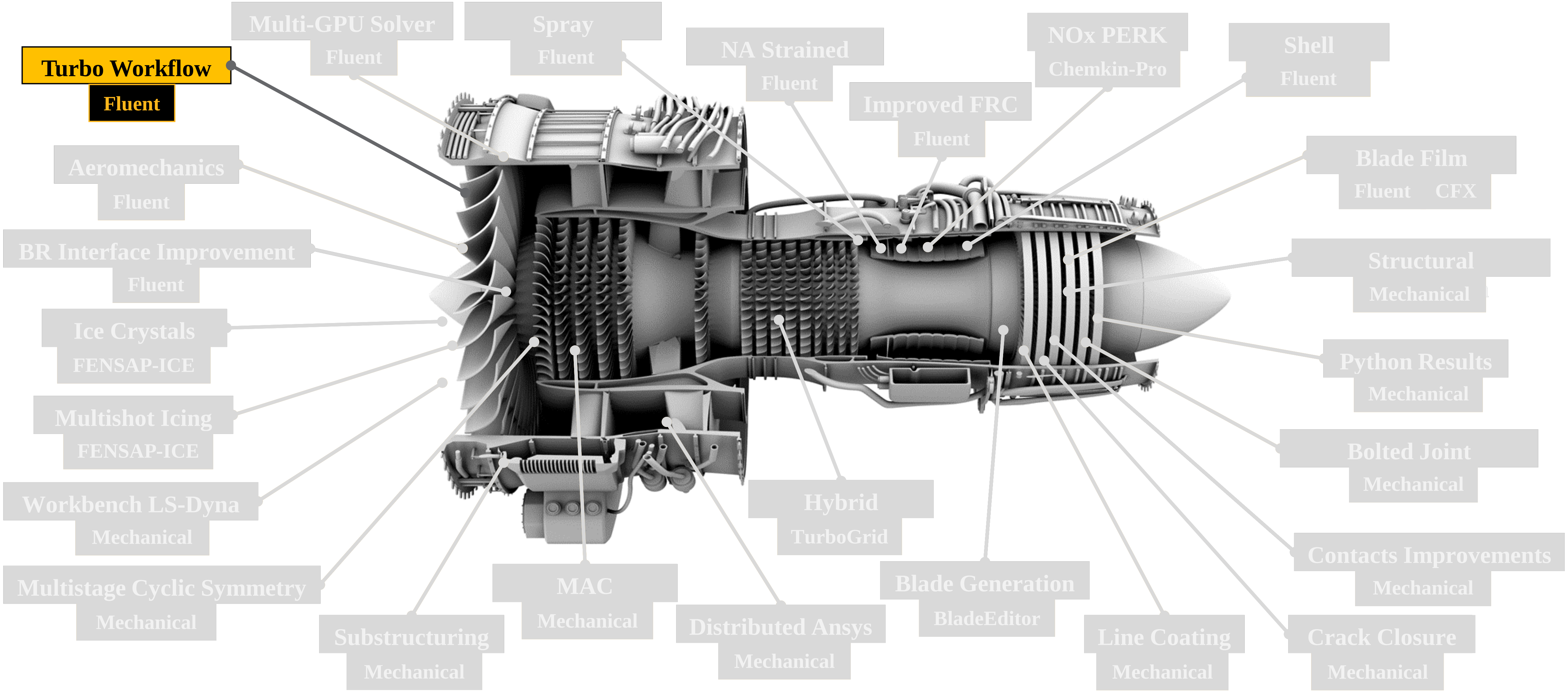
2022 R1 Features by Gas Turbine Modules - Dashboard

Speed
Accuracy
Robustness



Ansys

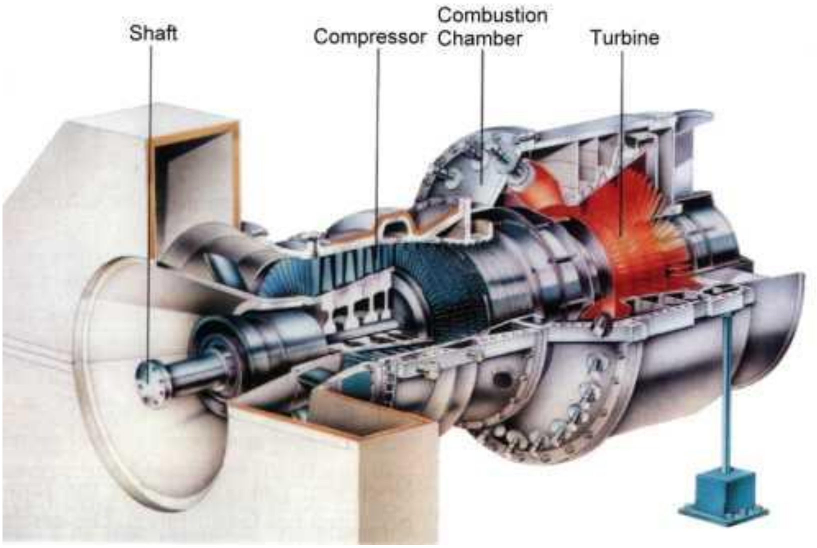
Fluent Turbo Methods and Workflow

- 2022 R1 functionality
  - **Pre-processing tool** with Turbo workflow
  - **Post-processing tool** with Periodic instancing + Turbo workflow + Simulation Report
  - **Base Turbo methods** to cover the tree pillars of Gas Turbine analysis
    - Aerodynamic analysis

      Steady & Transient , main and secondary path, axial, radial or mix components
    - Aeromechanics analysis

      Aerodynamic damping & Forcing load for Forced Response analysis
    - Aerothermodynamic analysis

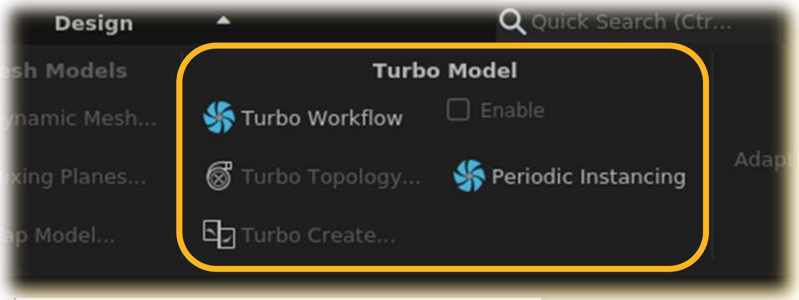
      Detailed and reduced model Blade Film Cooling

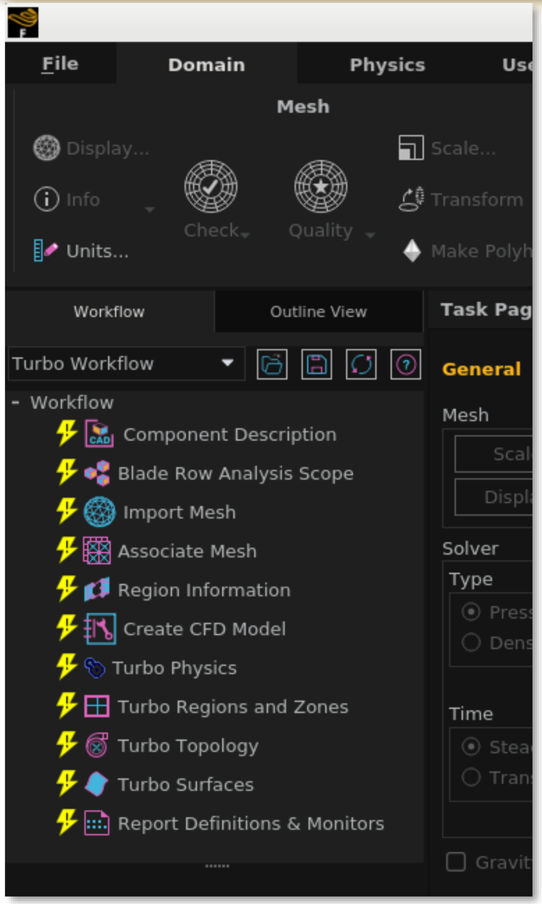


Turbo Workflow

Quickly set up turbomachinery flow problems and instrument primary performance parameters and post processing

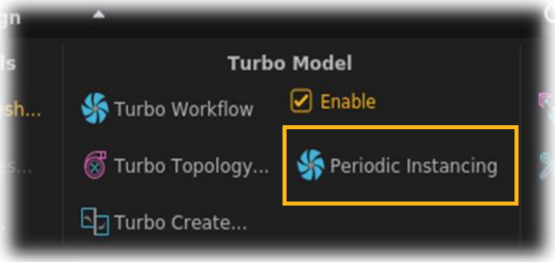
- Guided task-based approach
  - Eliminates repeated user inputs and minimize user error during setup
  - Supports reverting and editing the setup
- Features:
  - Setup for Axial/Radial Compressors & Turbines
  - Can read multiple mesh files (.msh, .def, .gtm)
  - Copy, rotate, and stitch fluid zones
  - Turbo coordinates for turbo post processing
  - Performance monitors

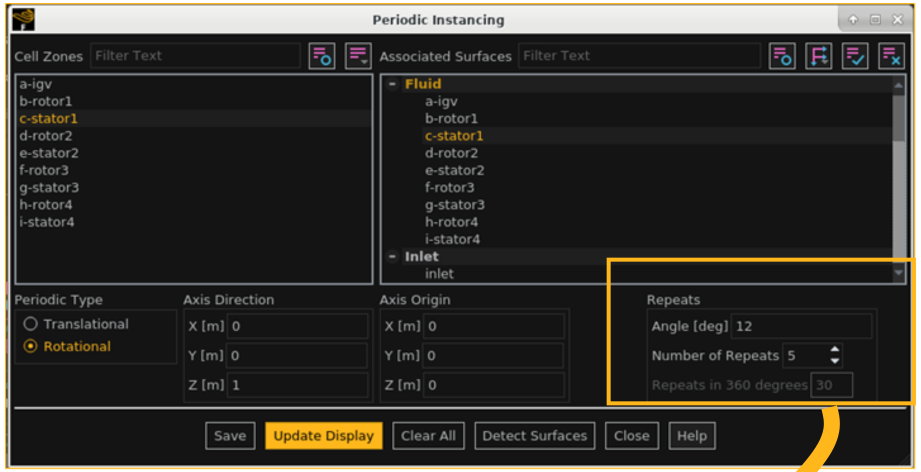


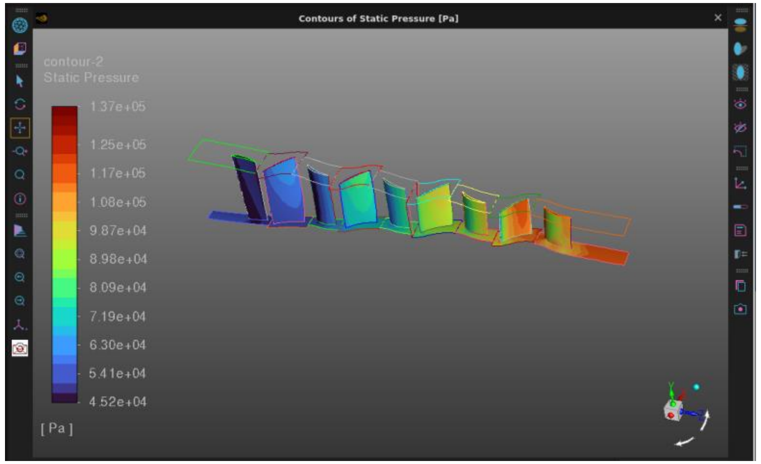


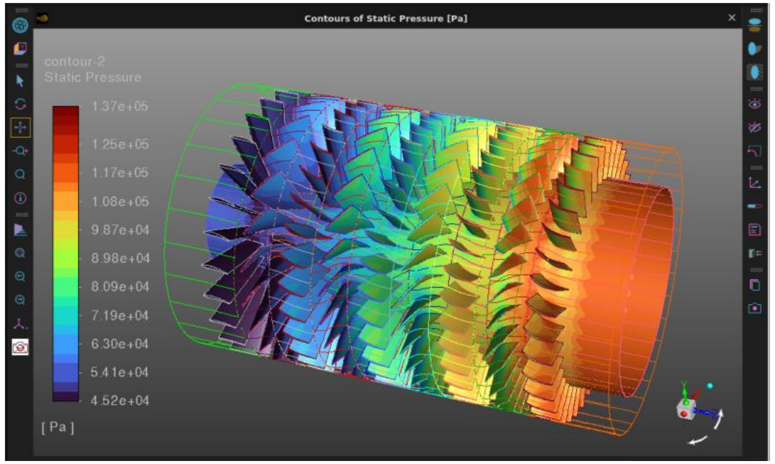
Periodic Instancing

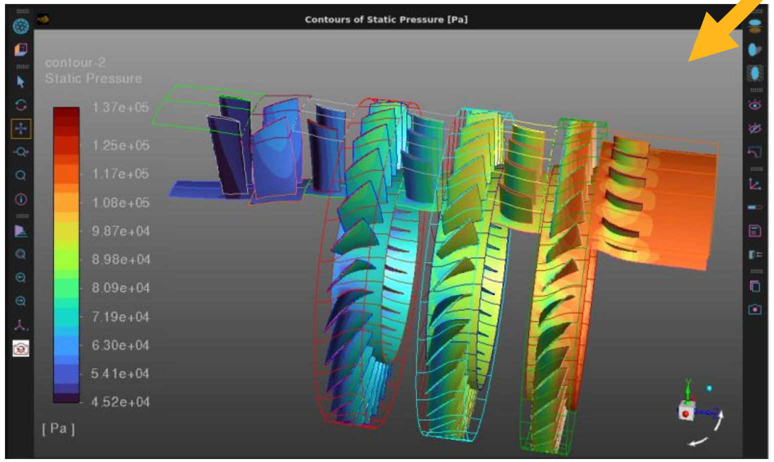
- Enhanced (and renamed) Periodic Repeats feature
- Improve post-processing for most turbomachinery applications











Clear All → **Single Repeat**

- Detect surfaces associated with each zone*
- Sets the view model to ***single repeat***

Detect Surfaces → **Full Wheel**

- Detect surfaces associated with each zone*
- Sets the view model to ***full wheel***

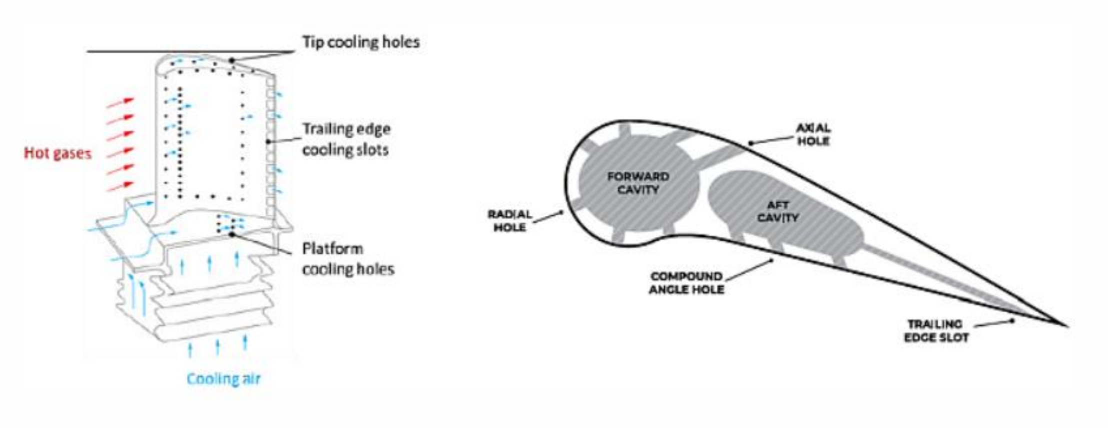
Or use the Repeats settings

- Select cell zone and enter the number of repeats
  - Positive value: forwarded instancing
  - Negative value: backward instancing

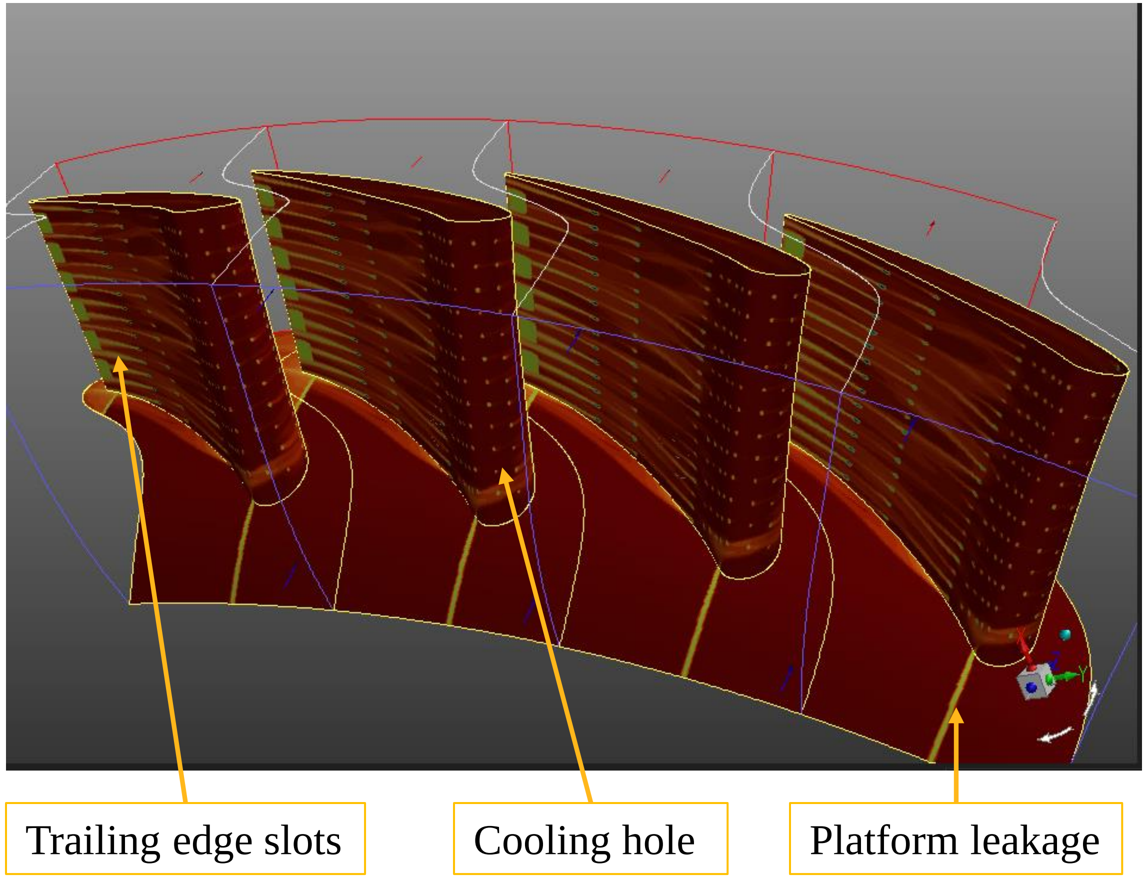
**If turbo surface cut spans more than one zone it will be ignored*

Blade Film Cooling Model for Gas Turbines

- Pre 2022 R1
  - Blade film cooling model available in CFX but not in Fluent
- 2022 R1 functionality
  - Hole coordinates and parameters are imported from profile files to create virtual geometry
    - Rectangular or circular holes oriented normal-to-surface or along specified direction

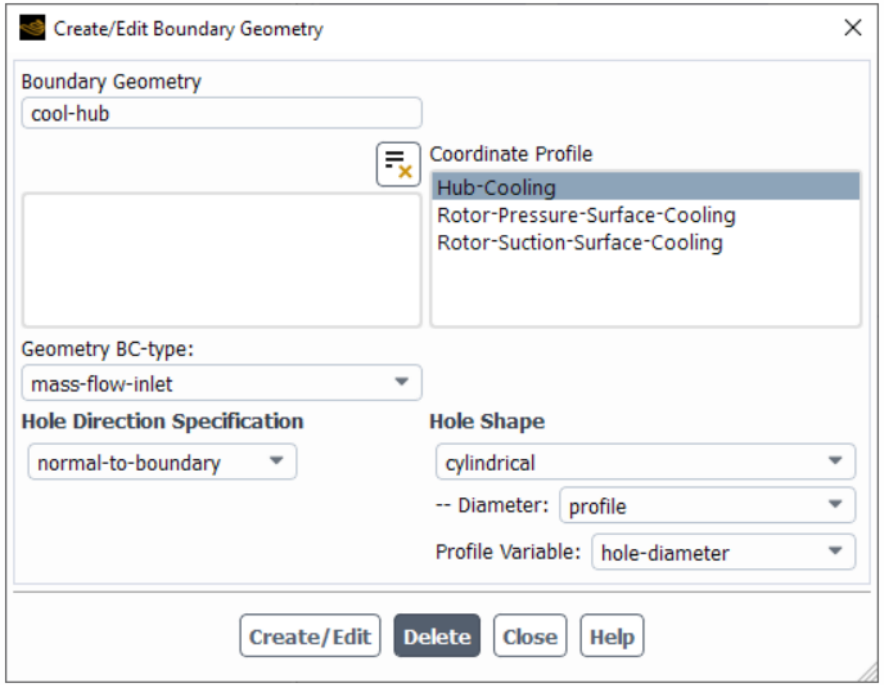


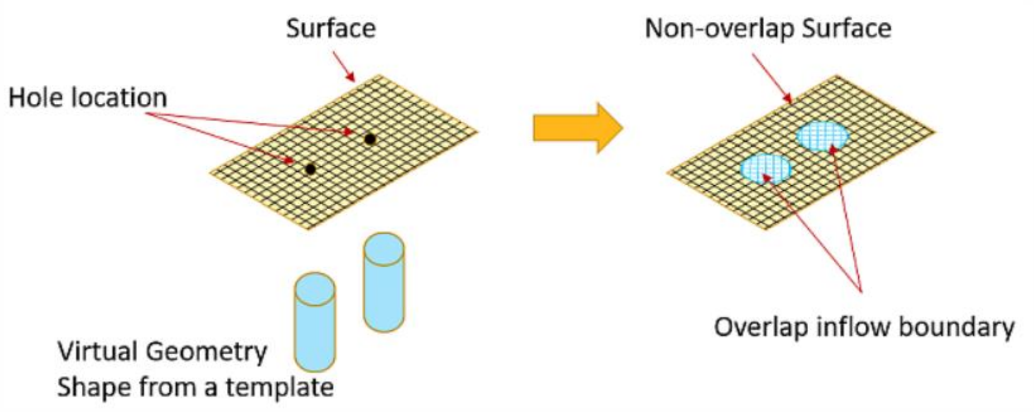
Use Virtual Geometry & Boundary Conditions to Simulate Turbomachinery Blade Cooling

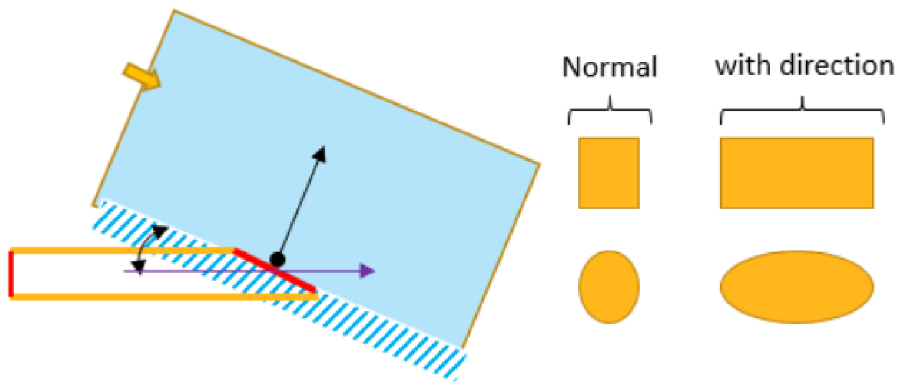


Create virtual boundary conditions

- New **Boundary Interface** intersects virtual geometry with boundary surface to form virtual boundary conditions
    - Similar to creating conventional mesh interfaces
    - Overlapped intersection becomes mass-flow-inlet or mass-flow-outlet
    - Non-overlapped intersection retains underlying surface settings
- Requires Turbo Models to be turned on



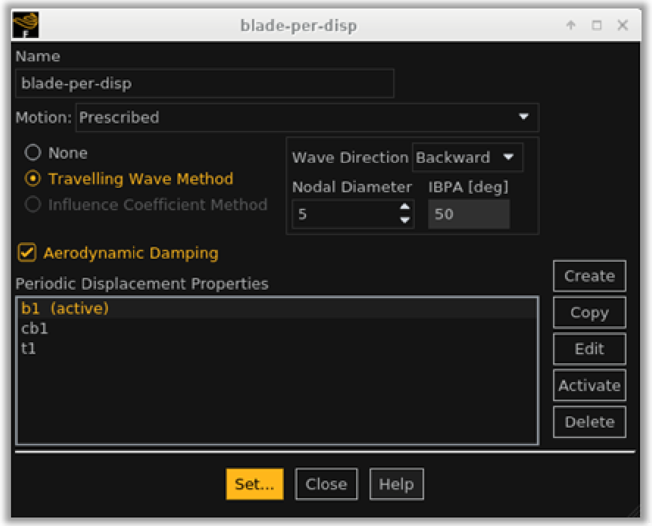


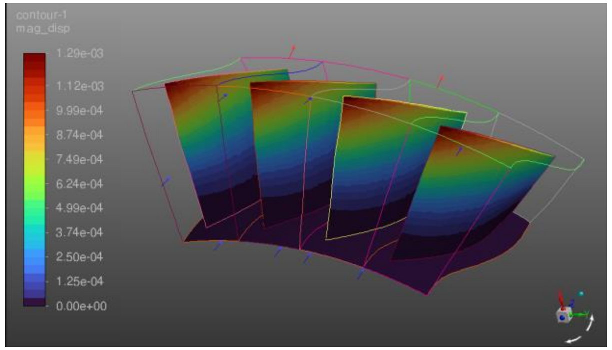


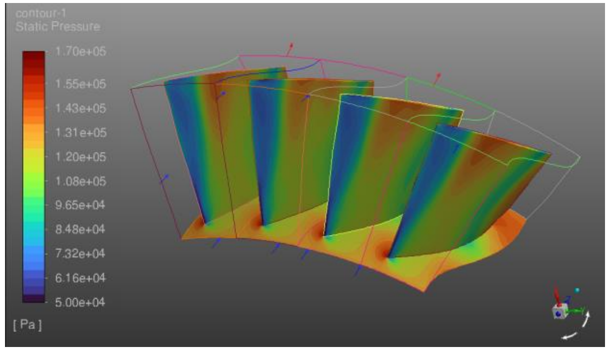
Aeromechanics: Aero Damping/Periodic Displacement

- Pre 2022 R1
  - Aerodynamic Damping computed using Energy Method
  - Single simulation per Nodal Diameter
- 2022 R1 functionality
  - Read and set up multiple mode-shape profiles which can be activated selectively to test aero-damping of different modes
  - Simulate a range of 1-way FSI problems
    - **Traveling Wave Method (TWM)** for blade-row aerodamping
    - **None** option for turbo or non-turbo applications
      - E.g. transient simulations using periodic displacements

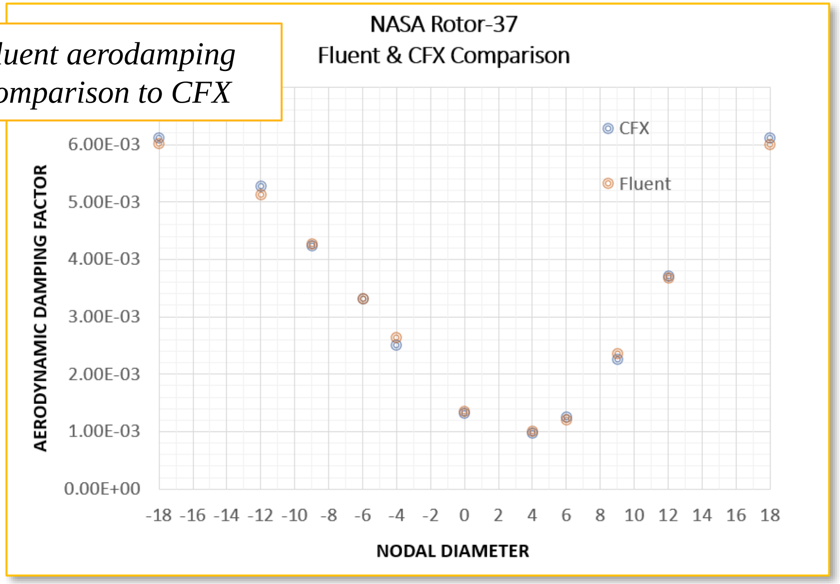
Usability Improved With New Periodic Displacement GUI







Fluent aerodamping comparison to CFX



Help Documentation

- Fluent Turbo Workflow
- Ansys Help Documentation
  - Fluent User's Guide
    - 12.1. Using the Turbomachinery Guided Workflow (ansys.com)
  - Coming soon!
    - Tutorial
    - Video

Chapter 12: Modeling Turbomachinery Flows

This chapter provides details about the turbomachinery capabilities in Ansys Fluent.

The information in this chapter is divided into the following sections:

- Using the Turbomachinery Guided Workflow
- Frozen Gust / Inlet Disturbance Flow Modeling
- Blade Row Interaction Modeling
- Aerodynamic Damping (Blade Flutter Analysis)
- Non-equilibrium Wet Steam Model for Steam Turbines
- Blade Film Cooling for Gas Turbines
- Turbomachinery Postprocessing

PART III: SOLUTION MODE | CHAPTER 12: MODELING TURBOMACHINERY FLOWS |

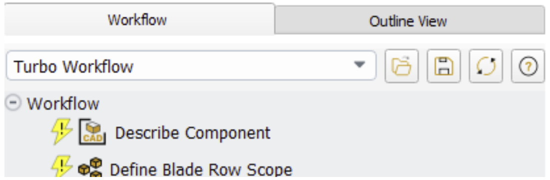
12.1. Using the Turbomachinery Guided Workflow

The **Turbo Workflow** provides you with the basic steps to defining and refining the setup and solution of your turbomach

You can access the turbomachinery guided workflow by selecting the **Enable Workflow** option in the **Turbo Workflow** dr

Domain → Turbomachinery → Turbo Workflow → Enable Workflow

This exposes a Workflow tab, alongside the Outline View, where you can use the **Turbo Workflow** to begin your work. Th through each task in order to more easily analyze your turbomachinery problem and generate an accurate simulation.



Other Fluent improvements will affect turbo users

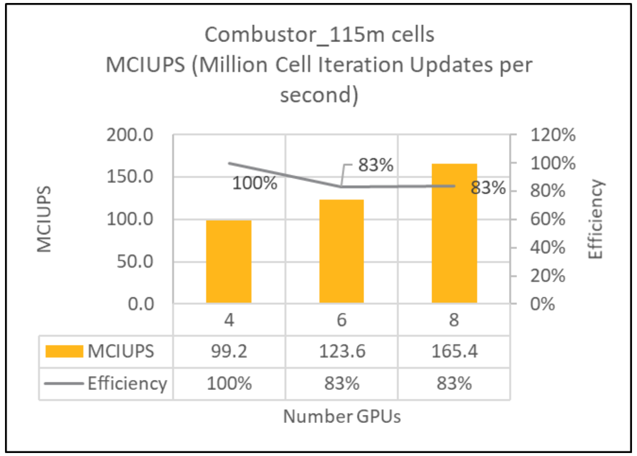
- Performance improvements
- UI enhancements
  - View synchronization
  - Materials for mesh rendering
  - Expression enhancements
- Combustion enhancements
- Acoustics
- Turbulence
- Adjoint
- More…

Multi-GPU Solver (Beta)

- Pre 2022 R1
  - GPU used in offload mode
- 2022 R1 functionality
  - New native multi-GPU Solver in Fluent platform accelerates steady-state CFD simulations
  - Single/multi-GPU (shared / distributed memory)
    - Subsonic compressible flows
    - Ideal gas
    - Material with constant properties
    - Turbulence: standard k-epsilon, GEKO k-omega
    - CHT
    - Porous media
  - Revolutionary speed-up
    - Ball park number from external aerodynamics tests

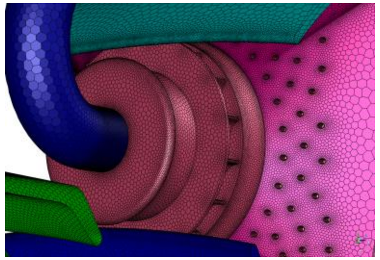
1 GPU ≈ 640 cores (on 5 nodes)
8 GPUs ≈ 3840 cores (on 32 nodes)

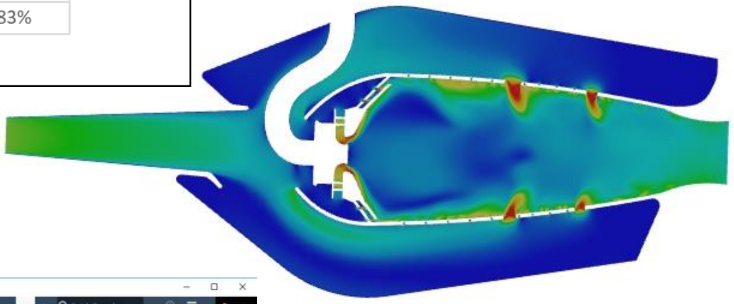
- *Nvidia A100 card vs AMD Milan cores (very similar to Xeon Gold 6142)*

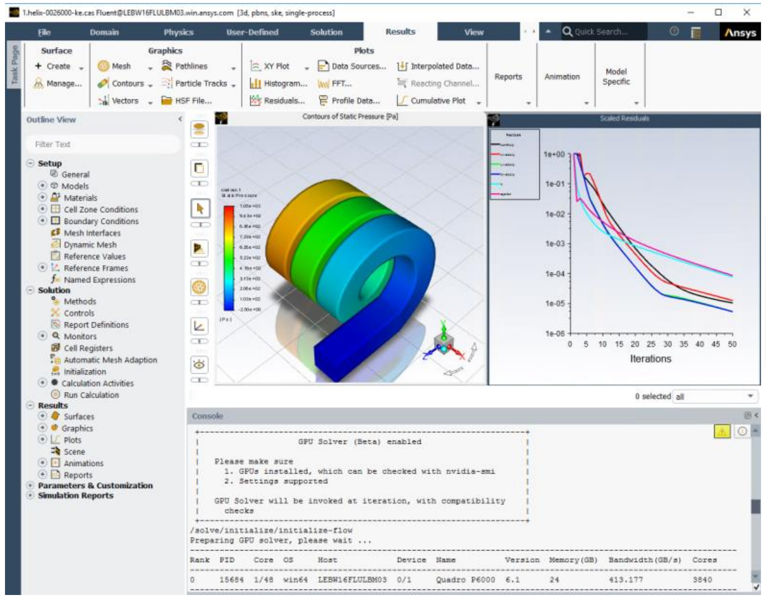


	4	6	8
MCIUPS	99.2	123.6	165.4
Efficiency	100%	83%	83%

~83% parallel efficiency with 8 GPUs





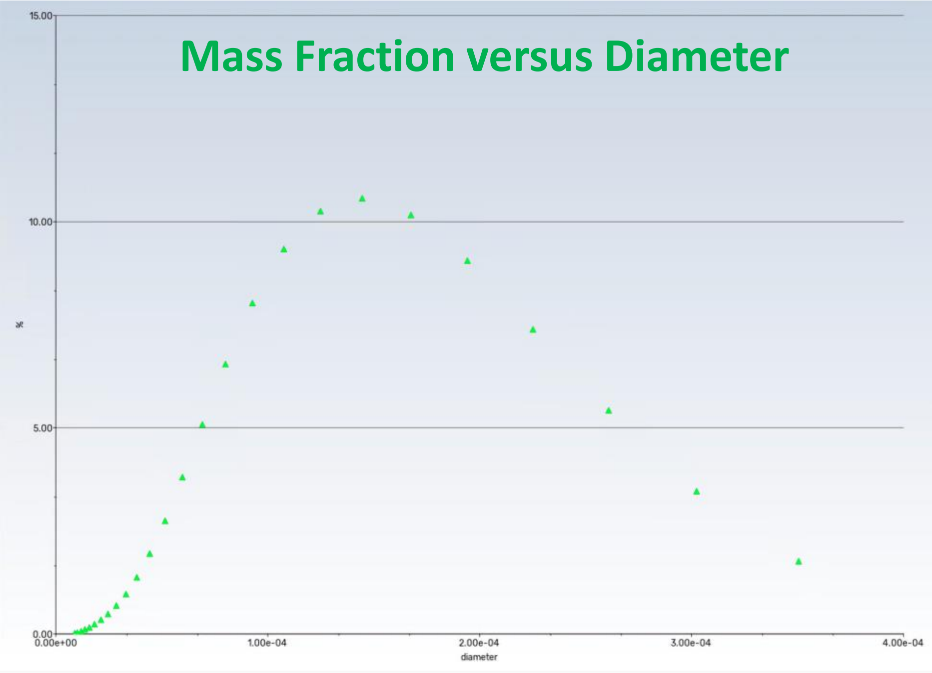


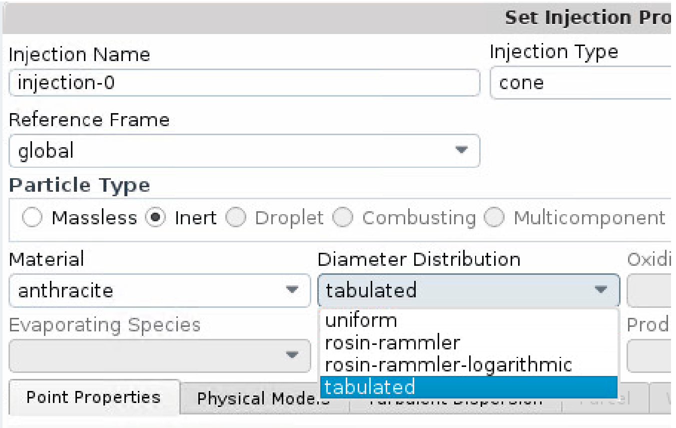
*7x cheaper hardware purchase cost and 4x lower power consumption**

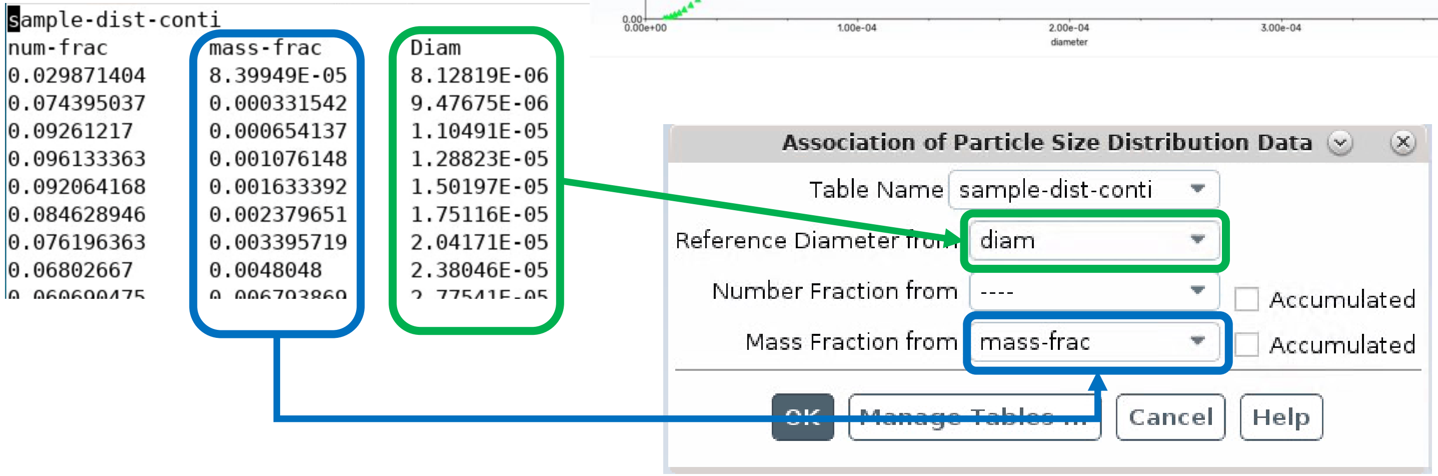
** 1024 core CPU cluster using 9600 W versus 6*V100 server using 2400 W*

Tabulated Particle Size Distribution

- Pre 2022 R1
  - Uniform and Rosin-Rammler particle diameter distributions available
- 2022 R1 Functionality
  - Import **tabulated** data for injection size distributions
  - For surface and cone injections
  - Specify mass and / or number frequency distribution of measured particle sizes
    - Either as frequency or cumulative distributions

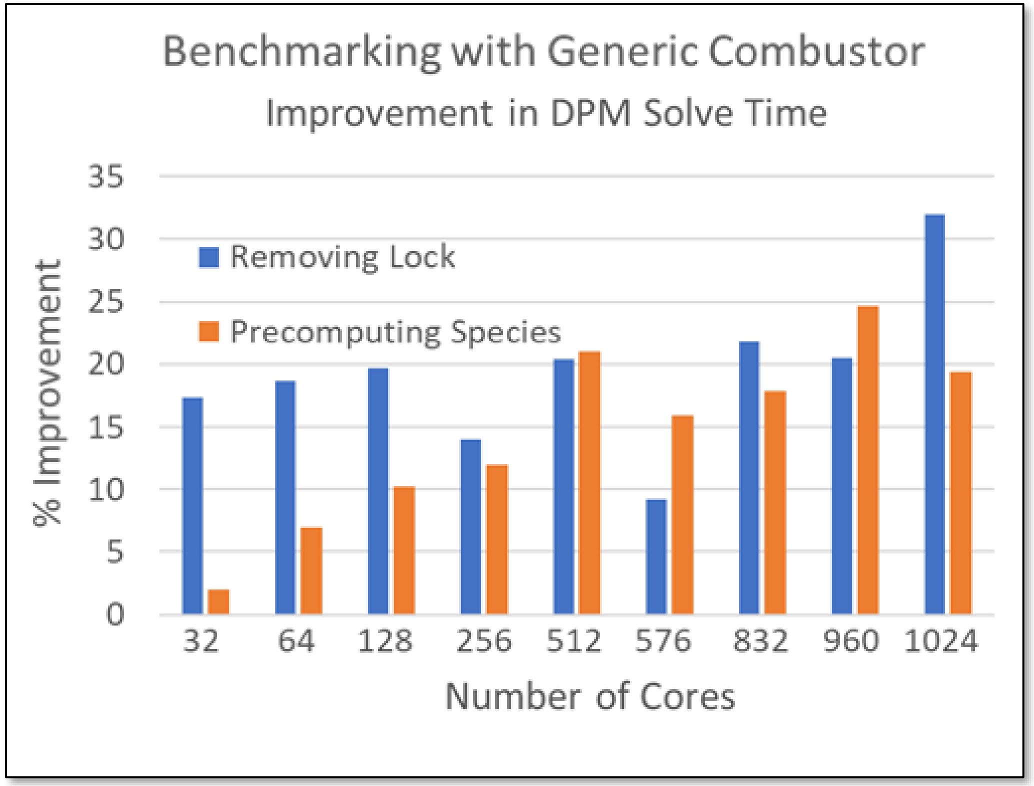






Improved Particle Tracking

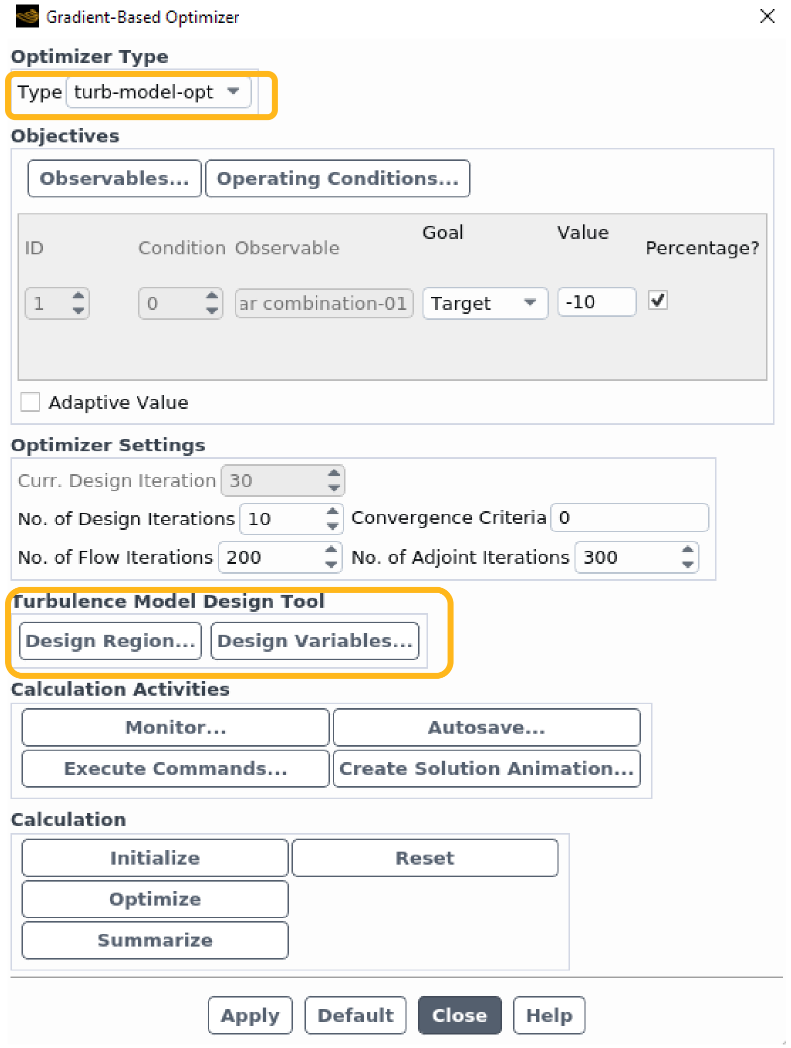
- 2022 R1 Functionality
  - Performance improvements
    - Thread lock removal improves core hybrid tracking performance
    - Precompute species option
      - Improves performance for combustion cases with all available tracking approaches and parallel modes
    - Further performance options for GTC simulations
      - Barycentric intersections
      - Timestep adaption of Darmofal and Haimes
  - Accuracy and Robustness improvements
    - Improved variable interpolation for
      - Multiphase models
      - Steep gradients within a cell
      - Lagrangian wall film particles



Significant reduction in DPM solve time
Improved robustness and accuracy in various scenarios

Turbulence Model Optimizer: GEKO

- Pre 2022 R1:
  - The GEKO model consolidates 2-equation turbulence modeling into a single model
  - Can be adjusted to different flow regimes with 4 tunable coefficients: CSEP, CMIX, CNW, Blending function
- 2022 R1 Functionality
  - Turbulence model optimizer to enhance GEKO accuracy
  - TMO Workflow:
    - Training:
      - Optimize turbulence coefficients to match data from high fidelity simulation/experiment
      - Devise Neural Network to generalize the correlation between the optimized GEKO coefficients and flow features
    - Deployment:
      - Incorporate the devised neural network into other similar simulations to reproduce tuned-GEKO behavior



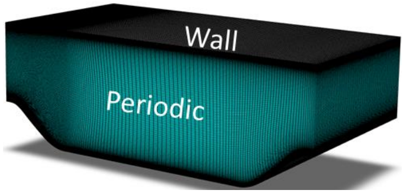
Train the GEKO turbulence model to yield results more like a high-fidelity, high-cost scale-resolving simulation

Turbulence Model Optimizer Example

Training: **3D Periodic Hills Case**

Deployment

2.5D Hump Case



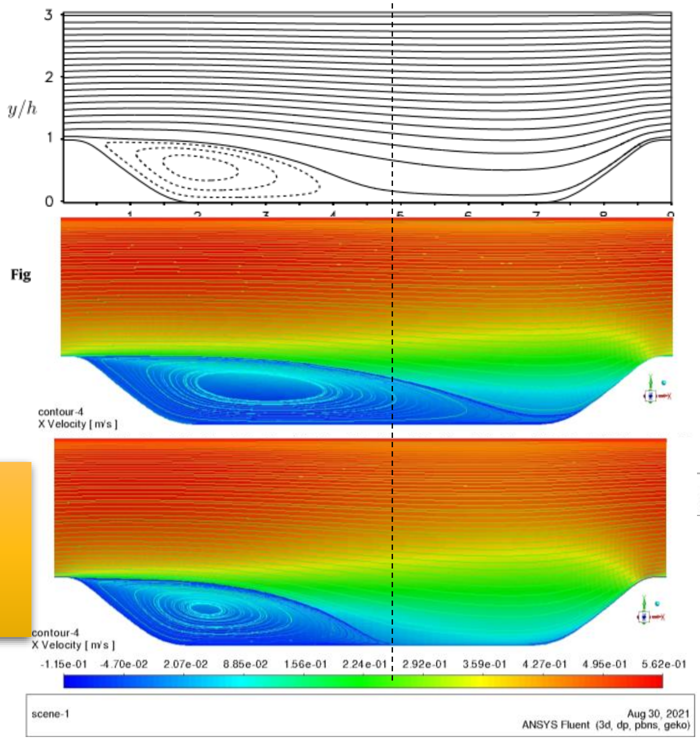
$Re_H = 10400$

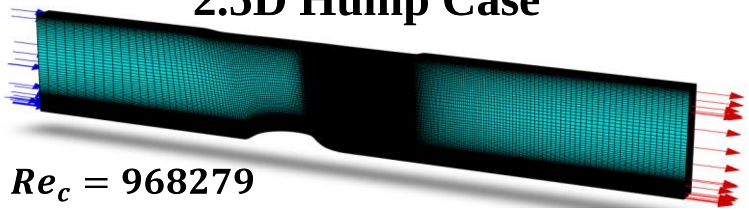
M. Breuer et al

LES Reference

GEKO Default

Neural Network Augmented





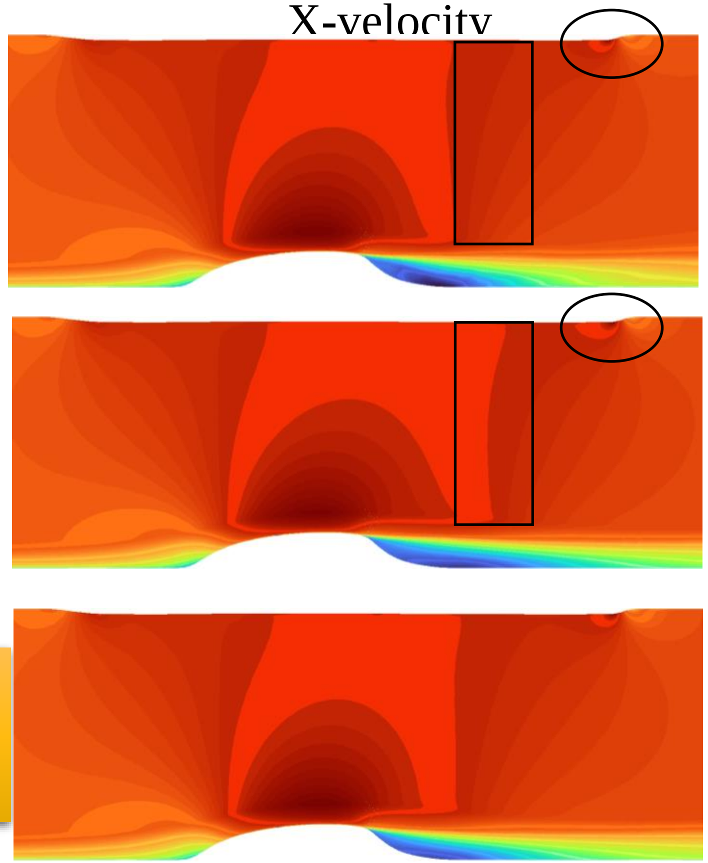
$Re_c = 968279$

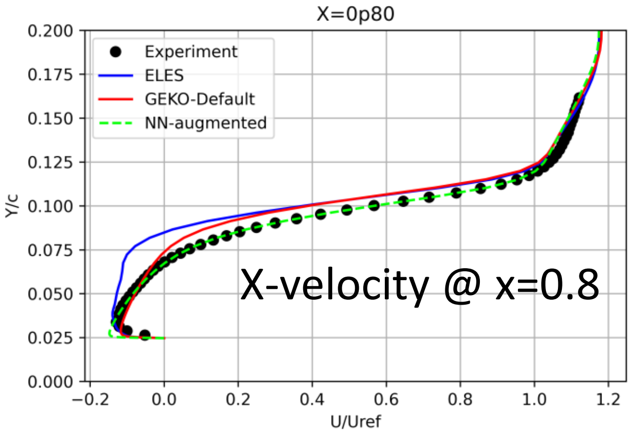
X-velocity

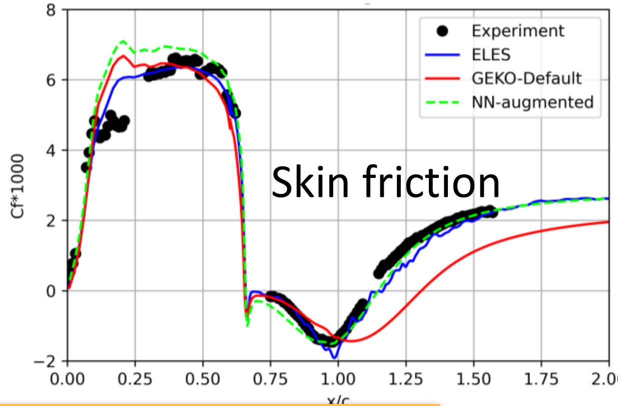
ELES Reference

GEKO Default

Neural Network Augmented





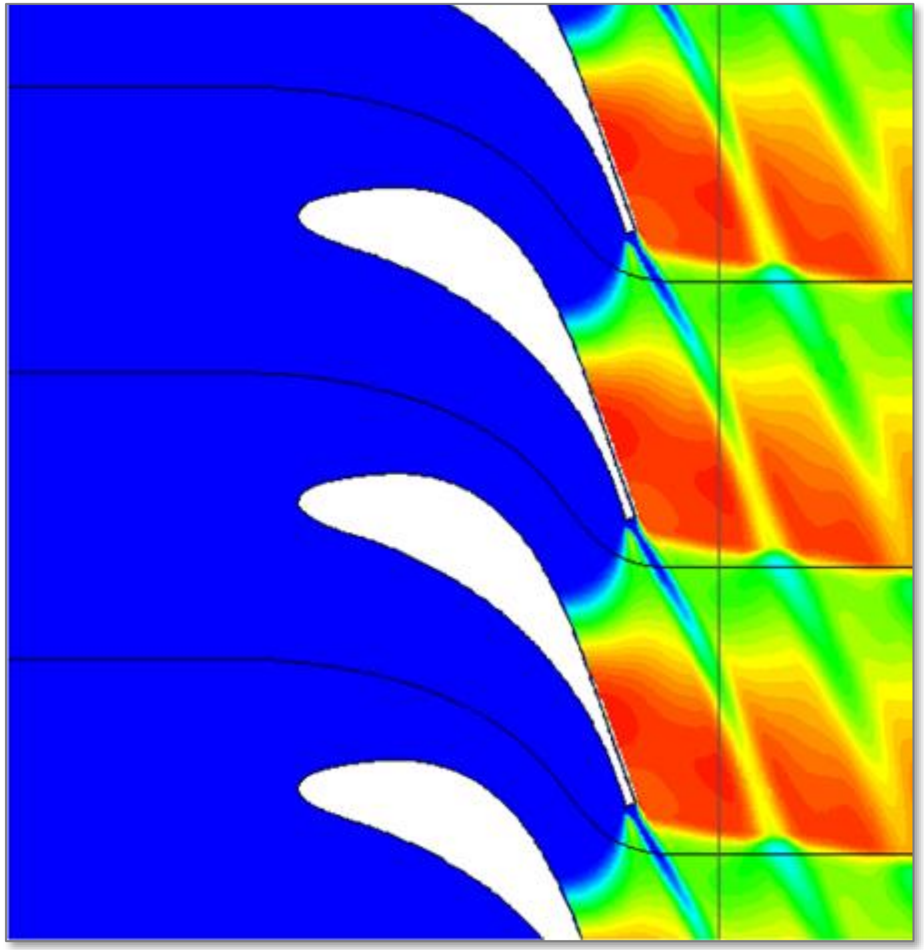


NN augmented GEKO velocity nearly match ELES/Exp.

Fluent: Non-Equilibrium Wet Steam Model

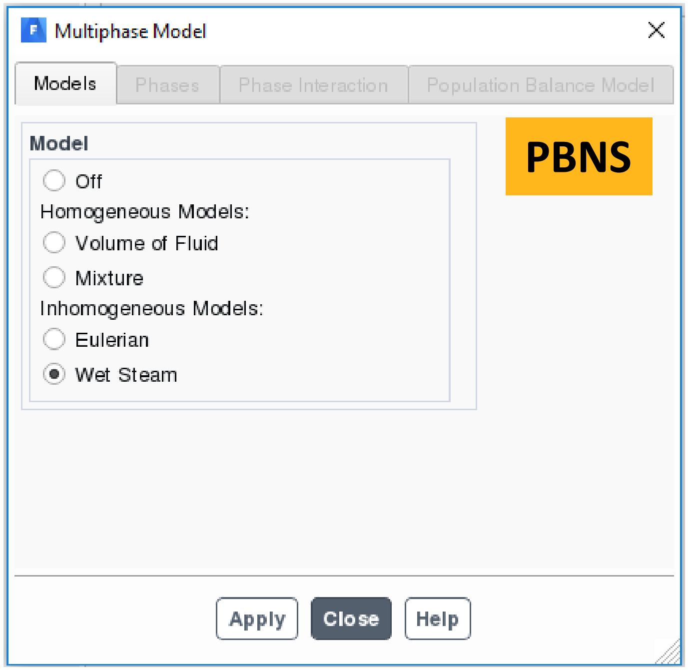
Access to IAPWS97 provides industry standard steam properties

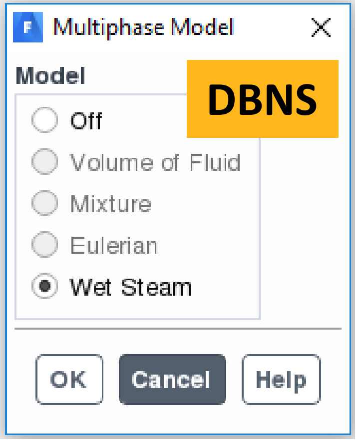
- Real Gas Property (RGP) tables for wet steam model
  - Alternative to the built-in thermodynamic wet steam properties, using the industry standard IAPWS97
    - Same format as used in the CFX real gas model
  - Built-in RGP file for steam available:
    - Turn on Turbo mode, turn on wet steam model
    - Read RGP file: file/table-manager/read-rgp-file
    - Link the RGP to wet steam model: define/models/multiphase/wet-steam/set/rgp-tables
- Enhancements to Non-Equilibrium Wet Steam
  - Convergence improvements for 2nd-order wet steam model
  - Alternate stagnation condition computation available:
    - The default method is based on mixture of vapor and liquid droplets
    - The alternative is based on vapor gas phase (similar to CFX)
    - Accessed via TUI: define/models/multiphase/wet-steam/set/stagnation-conditions



Liquid mass fraction in a stationary cascade of steam turbine blades

Wet Steam Model: User Interface



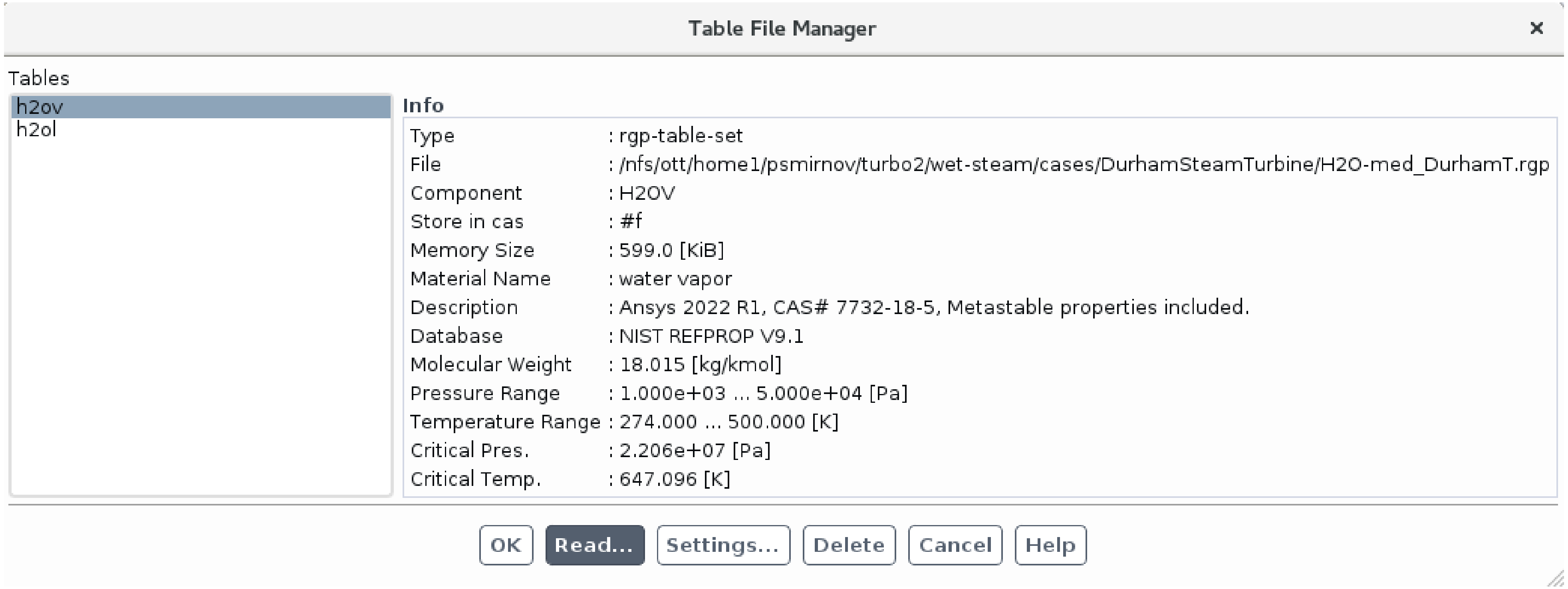


Text User Interface

```
/define/models/multiphase/wet-steam/set>
droplet-growth-rate      rgp-tables                virial-equation
max-liquid-mass-fraction stagnation-conditions

/define/models/multiphase/wet-steam/set> droplet-growth-rate
Use Hill's formula for the droplet growth rate? (if no, Young's formula will be used) [no] no
Enter modeling parameter, alpha [9] 9
Enter modeling parameter, beta [1] 1

/define/models/multiphase/wet-steam/set> virial-equation
Use Young's virial equation of state? (if no, equation from Vukalovich will be used) [no] no

/define/models/multiphase/wet-steam/set> max-liquid-mass-fraction
maximum value for liquid-phase mass-fraction? [0.1] 0.1

/define/models/multiphase/wet-steam/set> stagnation-conditions
Compute stagnation conditions using the gas phase only? (if no, mixture will be used) [no] no

/define/models/multiphase/wet-steam/set> rgp-tables
Use RGP tables for the wet steam model? [no] no
```

User Interface to link the RGP table to WS model

Step 1: load the file with the table using Table File Manager, File-> Table File Manager ...



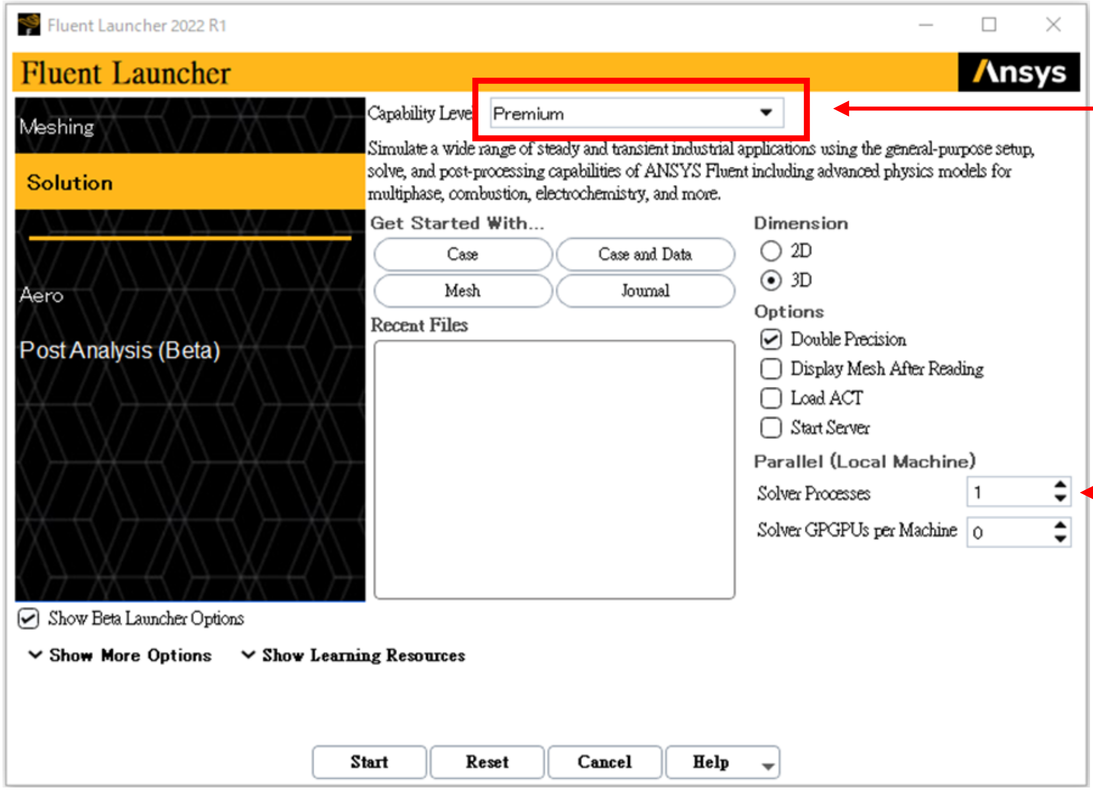
Step 2: in the TUI for the Wet Steam model, link the loaded table as follows:

```
/define/models/multiphase/wet-steam/set>
droplet-growth-rate      rgp-tables              virial-equation
max-liquid-mass-fraction stagnation-conditions
```

```
/define/models/multiphase/wet-steam/set> rgp-tables
Use RGP tables for the wet steam model? [no] yes
Available tables: (h2ov h2ol)
Select table [] h2ov
Linked table: h2ov
```

Fluent TurboWorkflow

開啟Fluent



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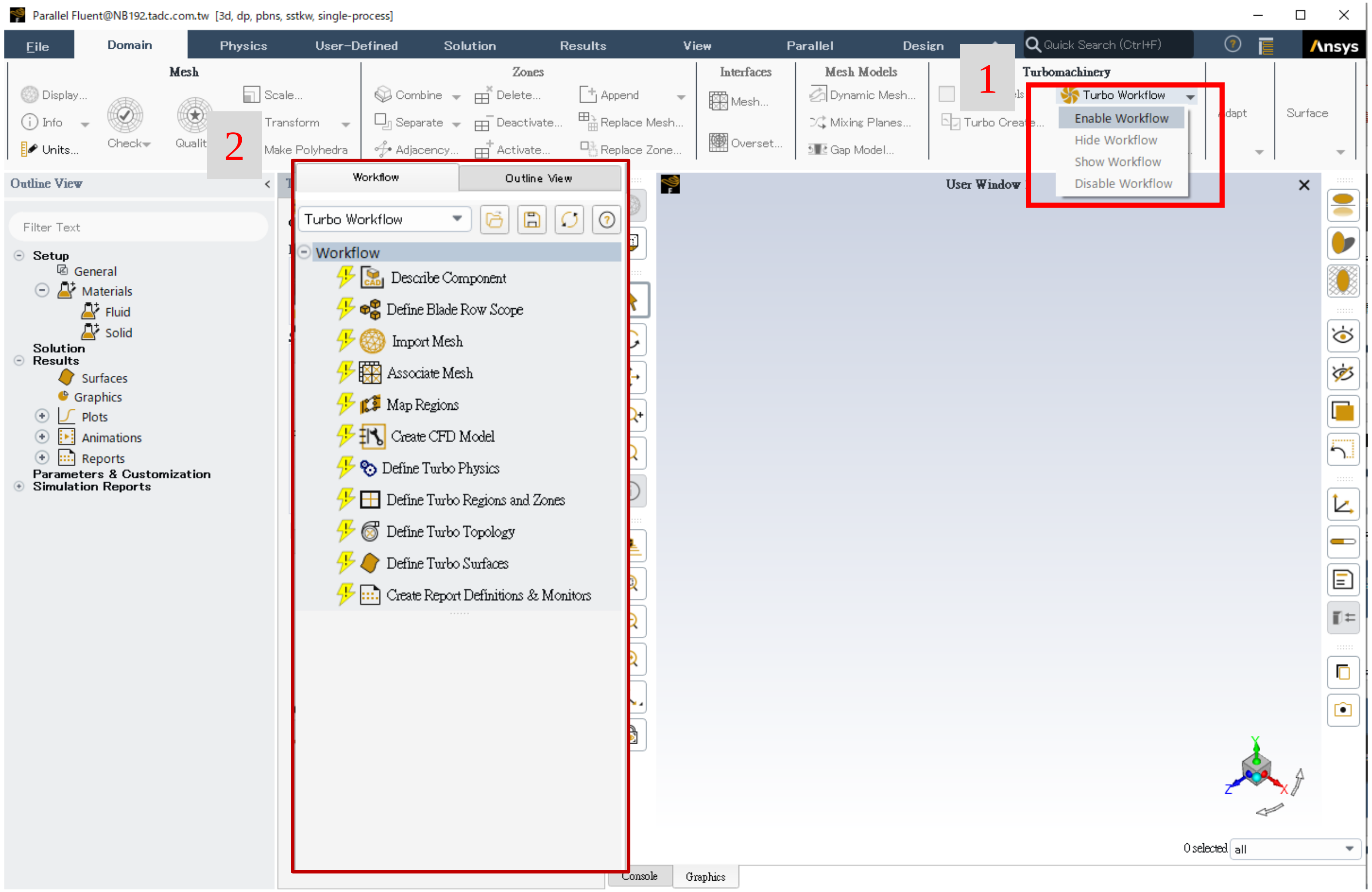
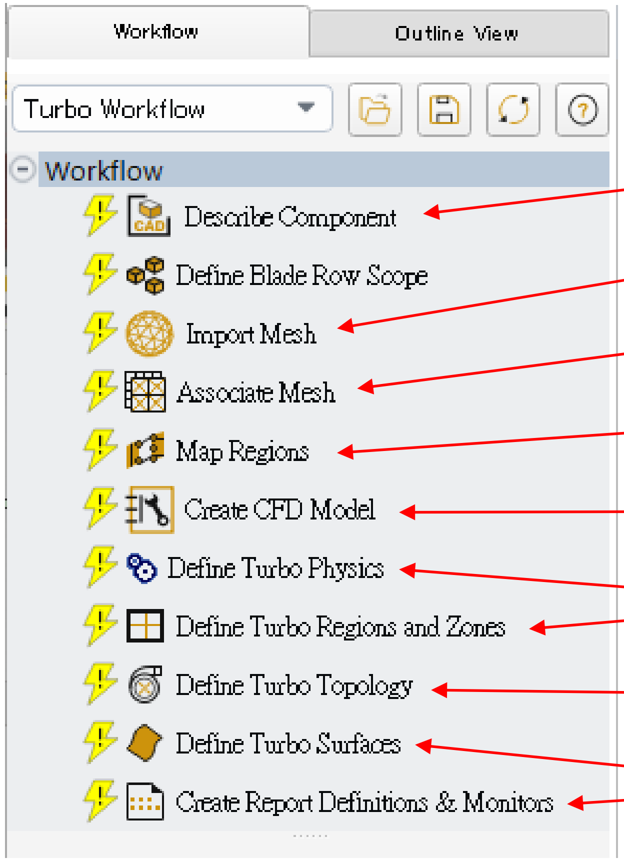
啟用多核心

開啟Fluent TurboWorkflow



1. 進入Fluent介面後，於上方Ribbon區域開啟Turbo Workflow。
2. 開啟Turbo Workflow後會自動進入到Turbo model的模式，此時可看到流程式的設定模式進程。

TurboWorkflow



分析的類型問題定義

匯入葉片的網格模型

將網格與定義的問題進行關聯的匹配

將網格命名的邊界進行定義匹配(如定義Blade、Hub…的命名匹配)

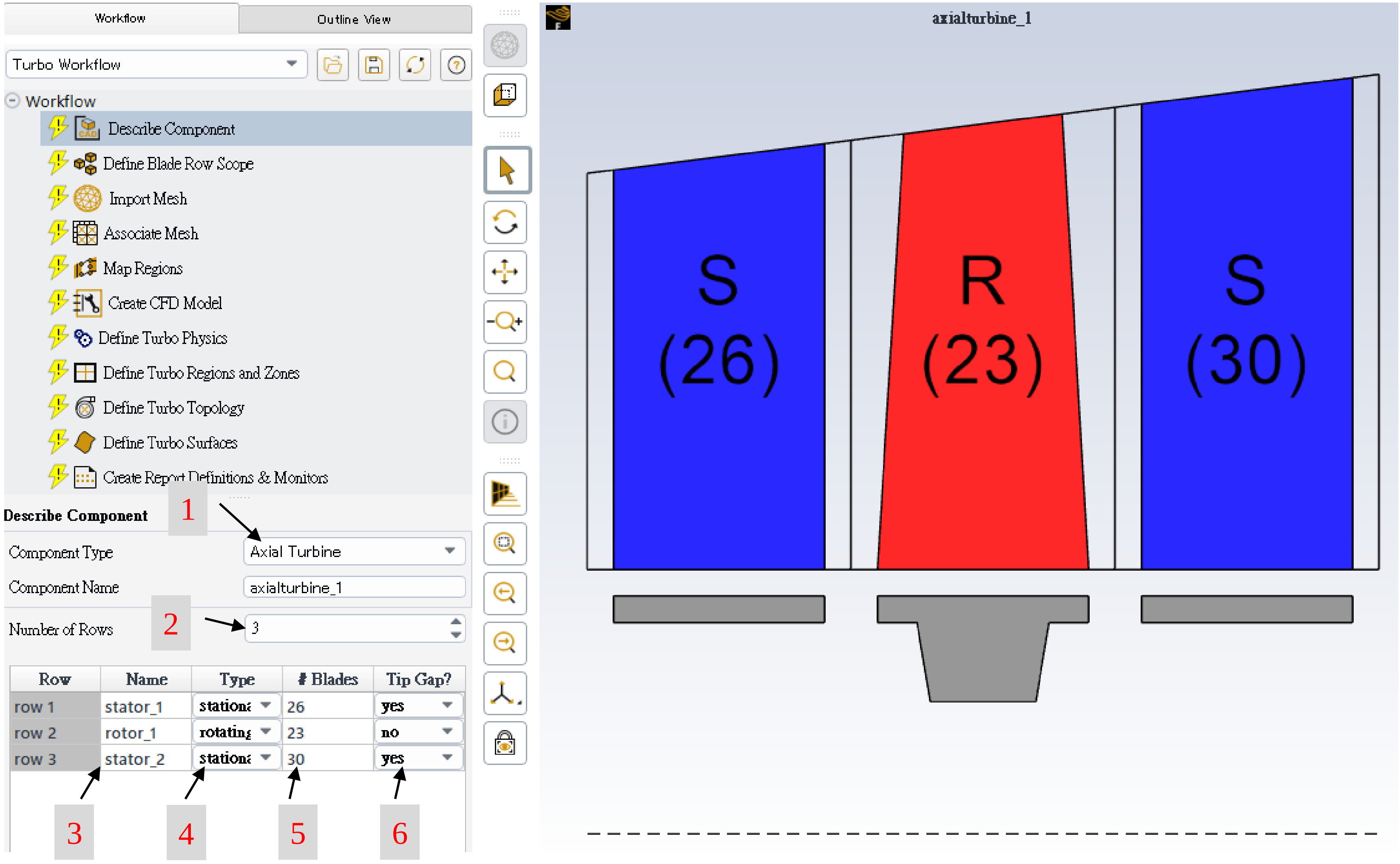
建構出CFD分析的模型定義

定義分析的邊界條件等問題

邊界條件上的整合定義(如將s1與r1的hub進行合併)

自動化的後處裡定義

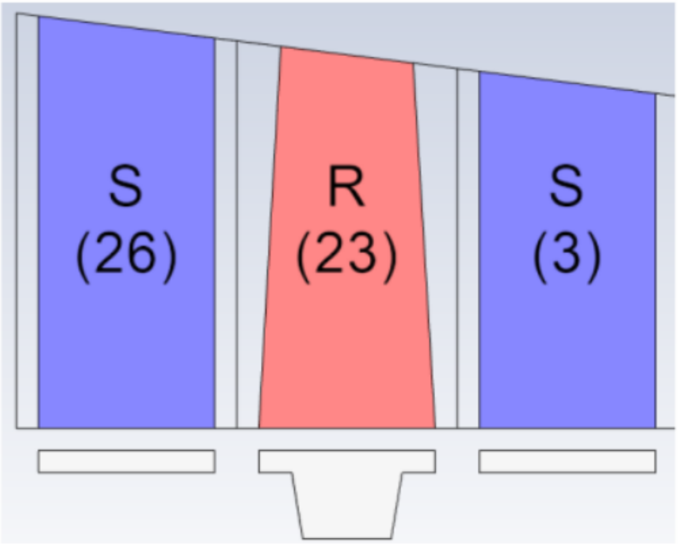
Describe Component



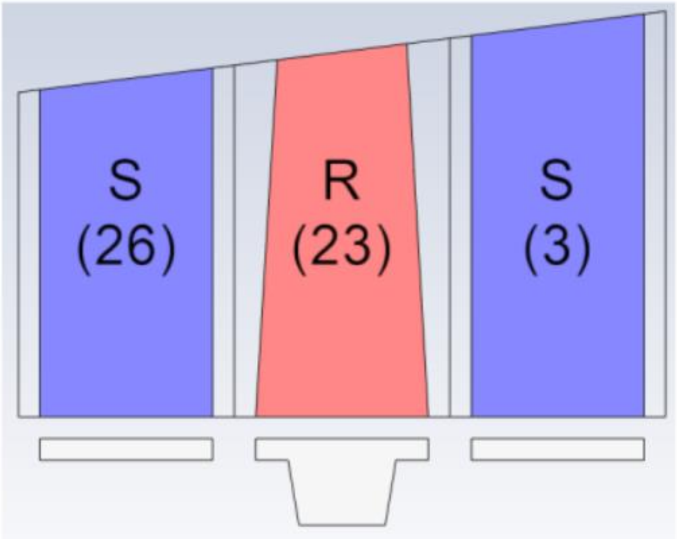
1. 描述分析的問題類型，清單下拉可選擇Compressor及Turbine
2. 描述問題Row的數量
3. 每個Row的命名
4. 每個Row的類型定義，定子/轉子
5. 葉片的數量
6. 是否於翼尖處含有Gap空間

Component type

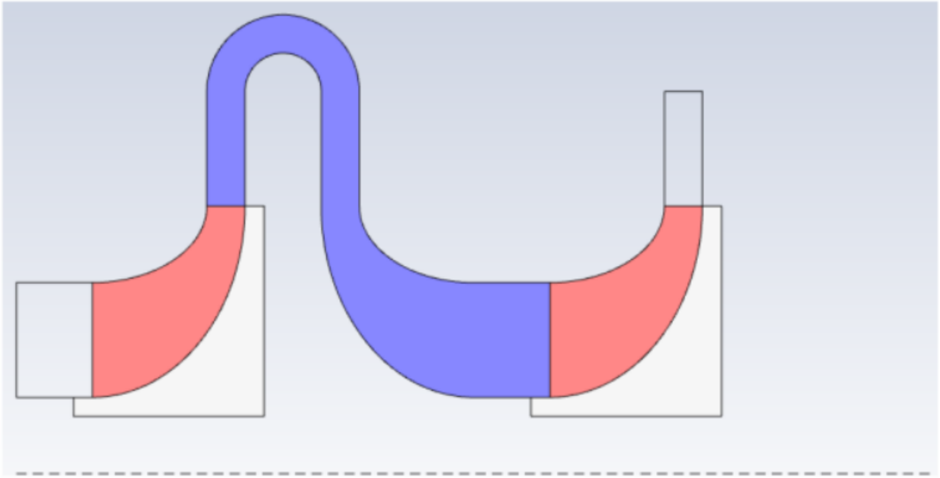
Axial Compressor



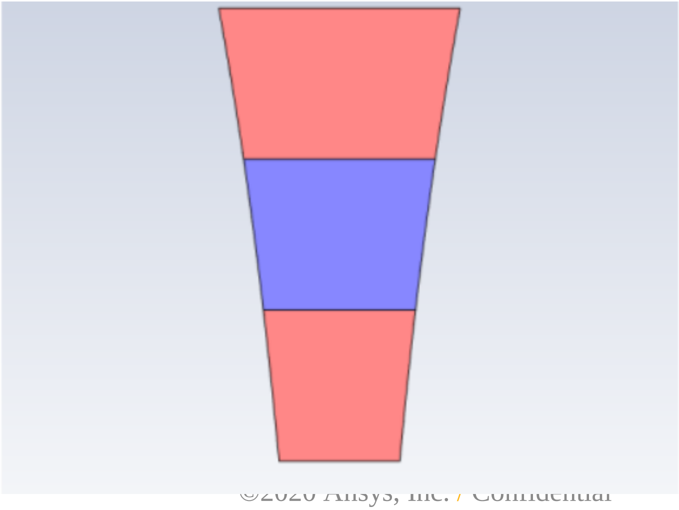
Axial Turbine



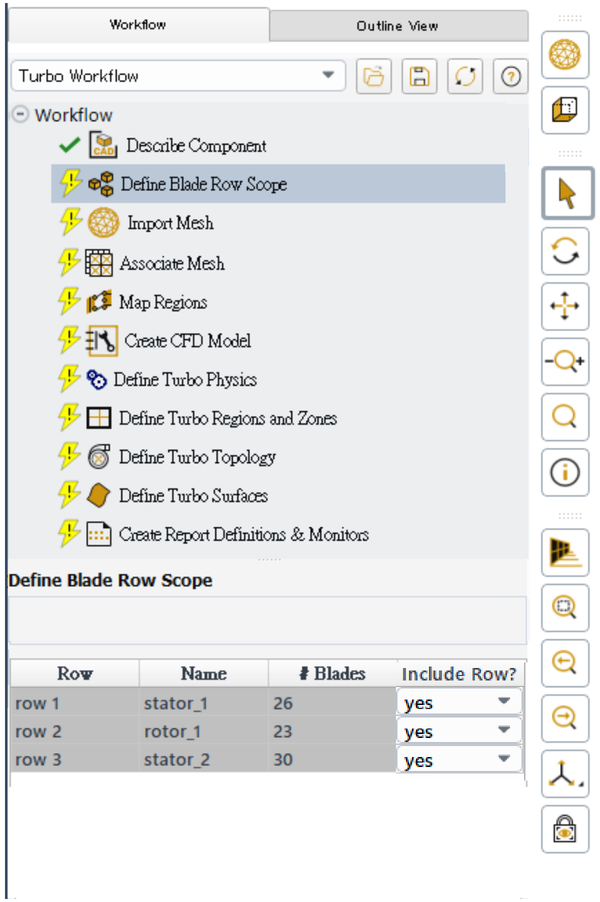
Radial Compressor



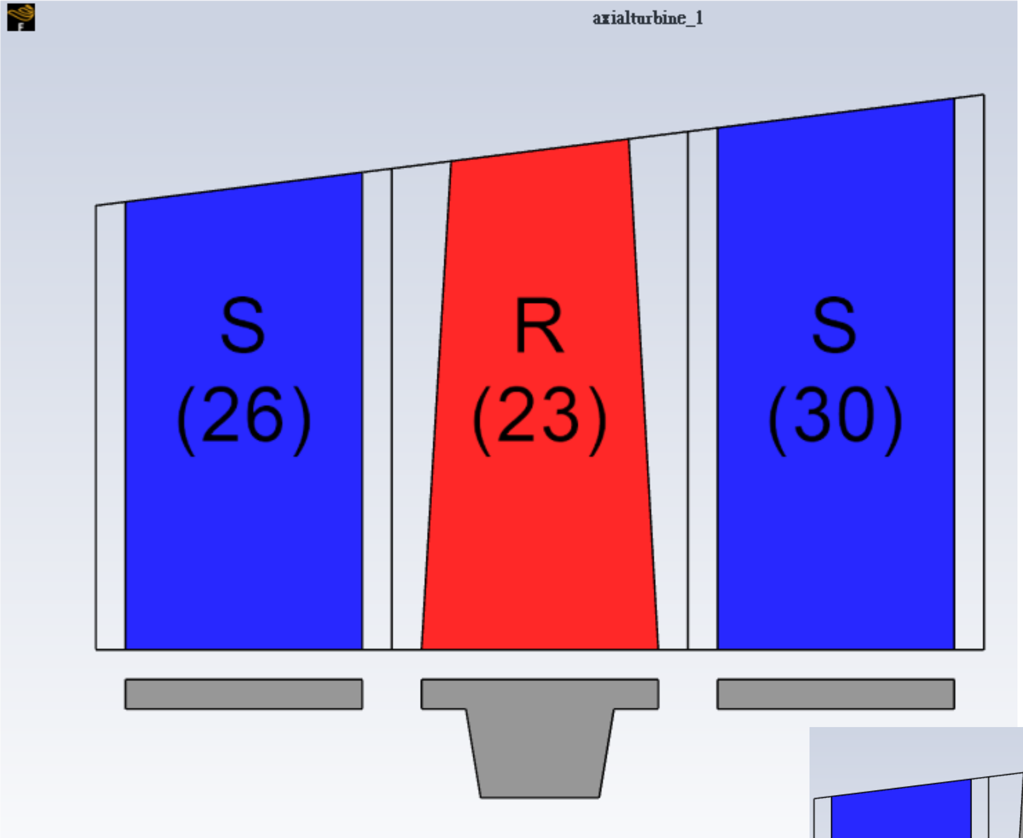
Radial Turbine



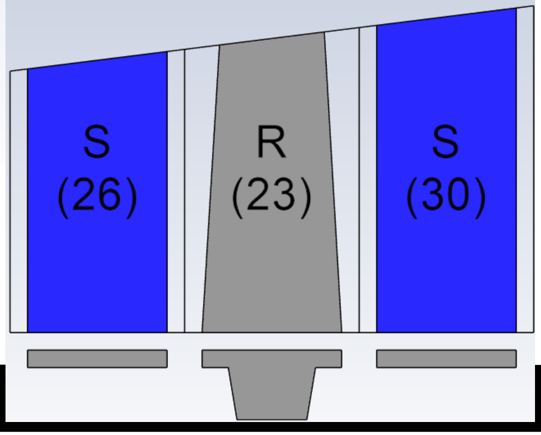
Define Blade Row Scope



Row	Name	# Blades	Include Row?
row 1	stator_1	26	yes
row 2	rotor_1	23	yes
row 3	stator_2	30	yes



Row	Name	# Blades	Include Row?
row 1	stator_1	26	yes
row 2	rotor_1	23	no
row 3	stator_2	30	yes

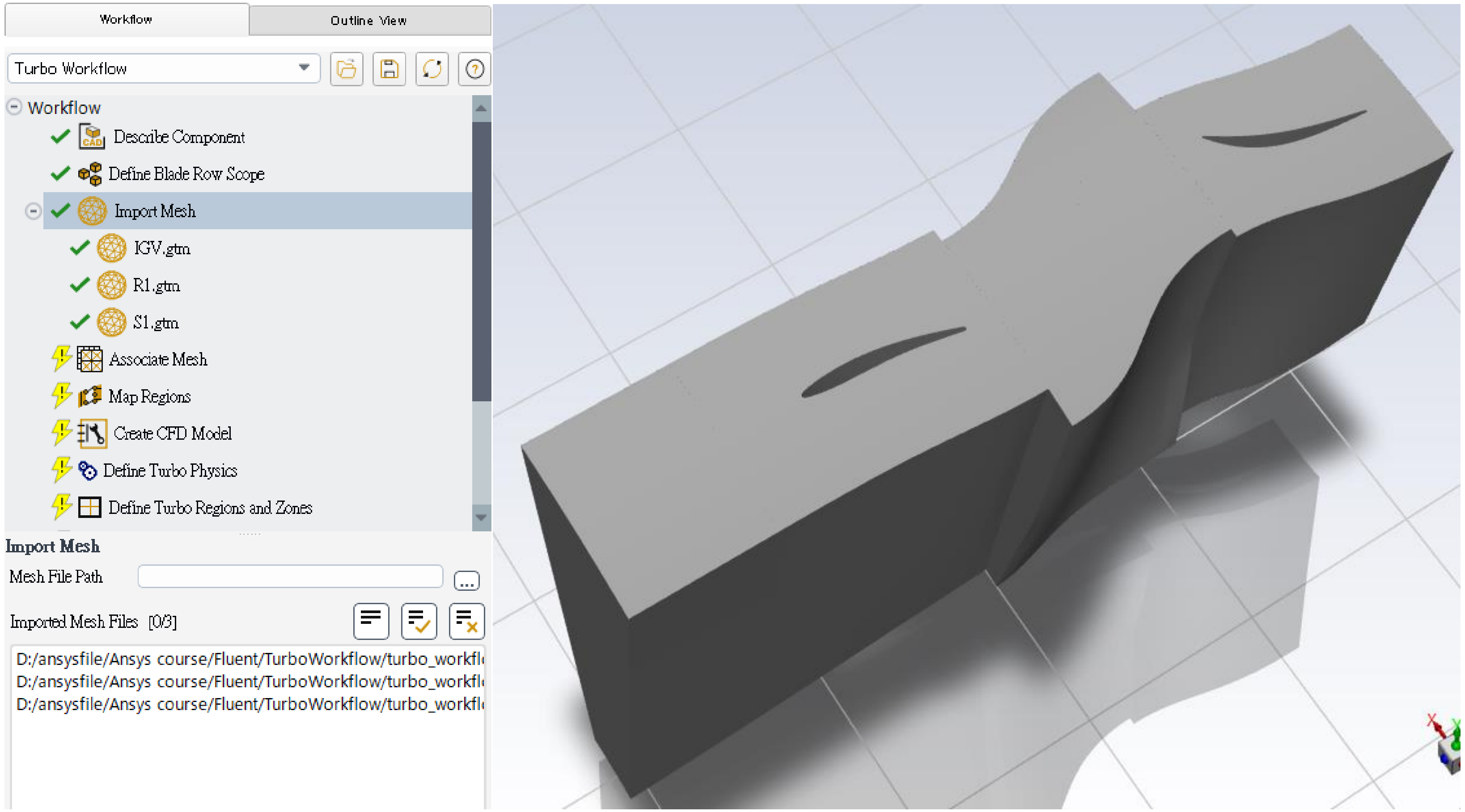


對於上一步驟所描述的Turbine或Compressor，可考慮是否要進行後續的問題定義與更進一步的分析

若只想對某幾個Row進行分析，則可以在Include Row中改成no，Row跟Row中請注意需是相連的

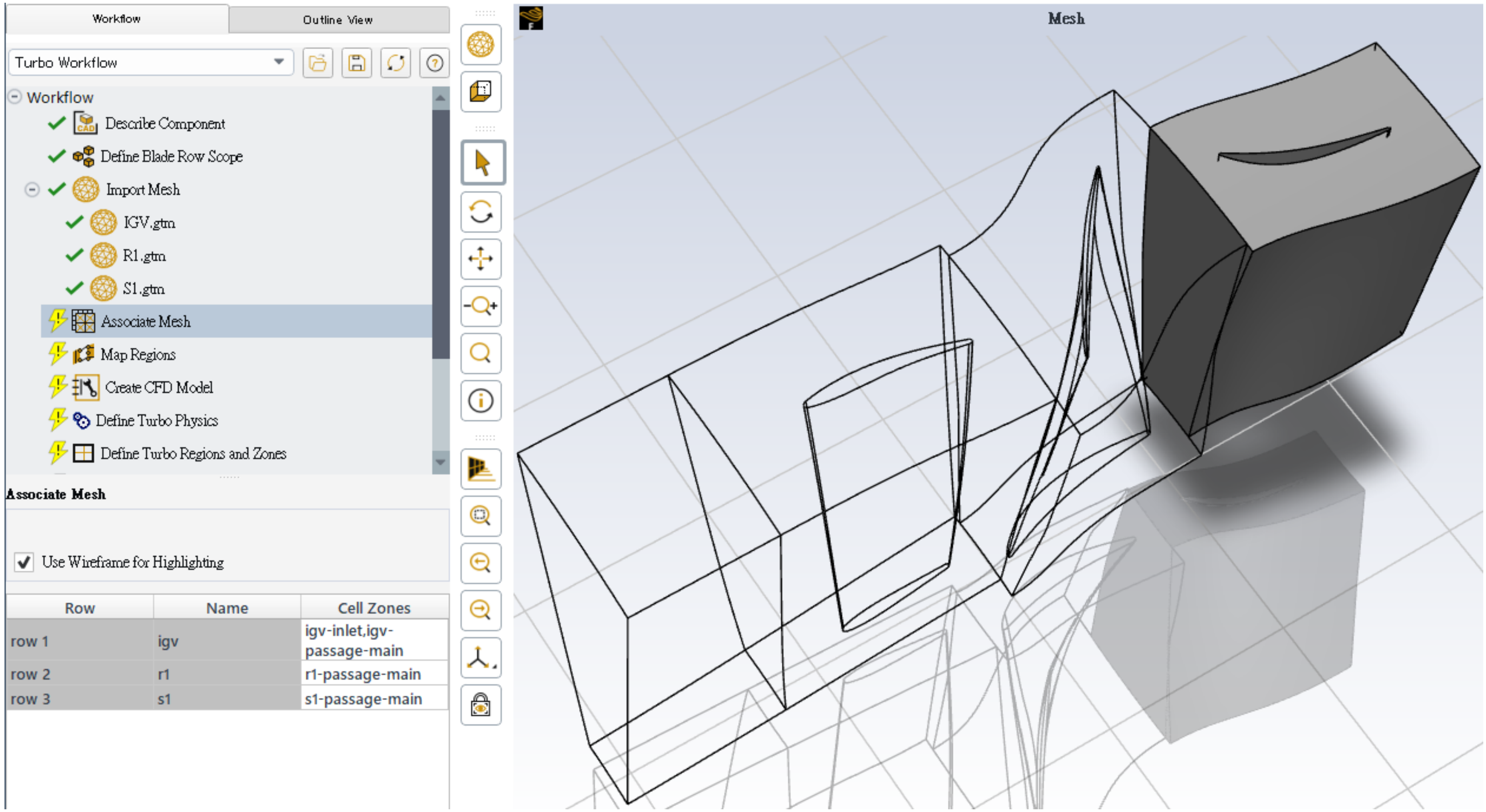
Ansys

Import Mesh



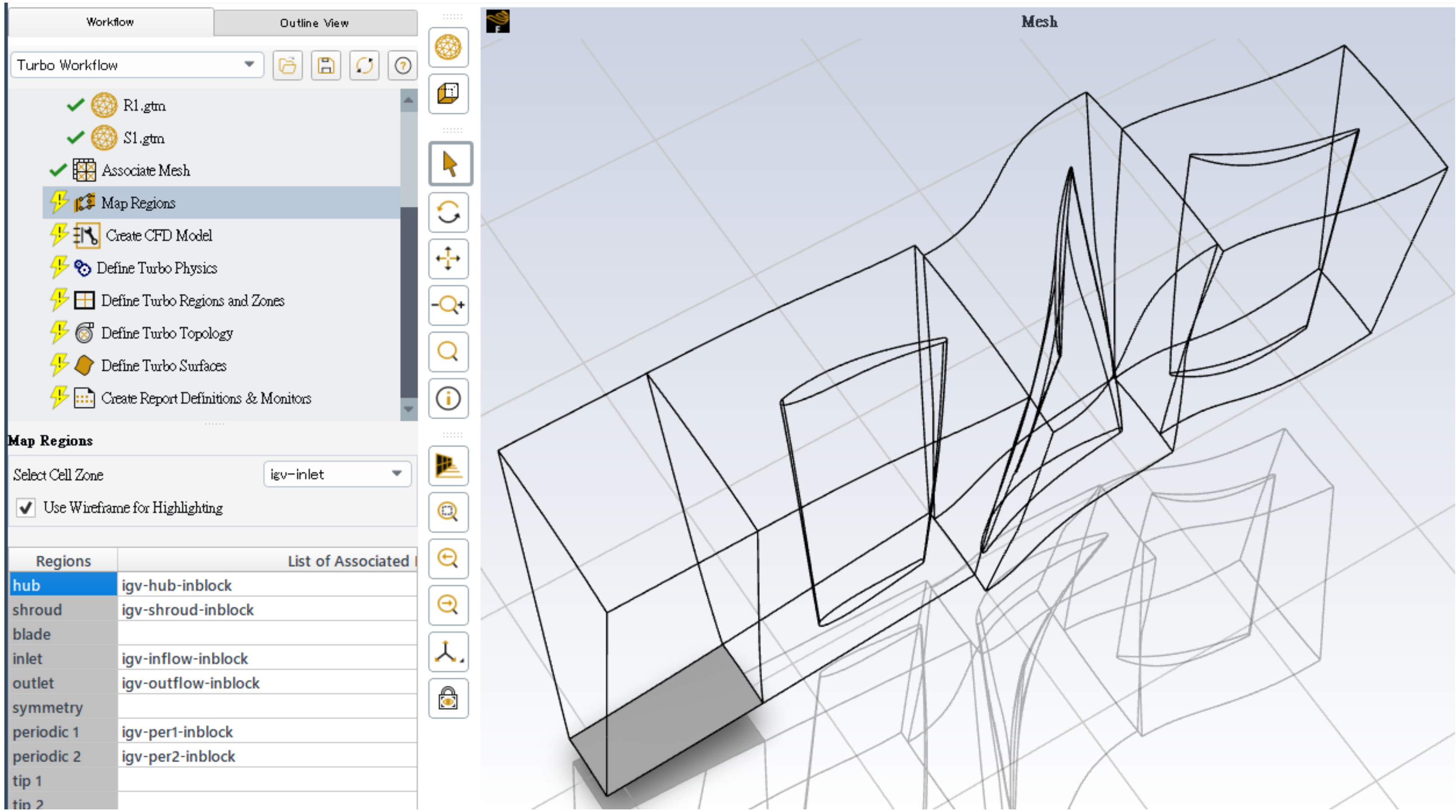
將網格匯入其中，其檔案格式可讀取.msh、.def、.cgns、.gtm

Associate Mesh



將匯入的網格與所描述的問題定義進行相關性，即將各網格定義到各個Row區域中

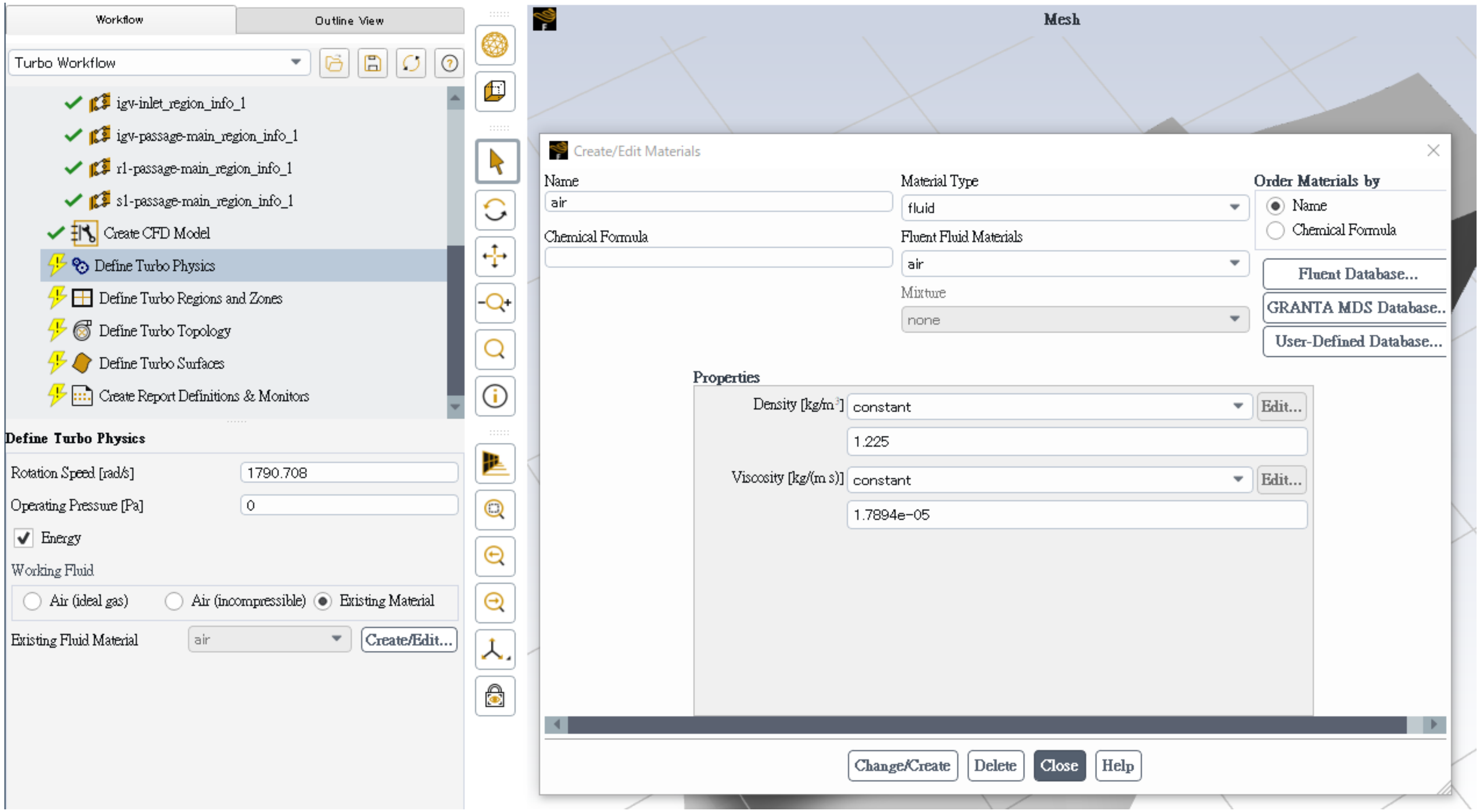
Map Regions



匯入的網格中所命名的邊界與進行Mapping的動作，例如將網格hub處的邊界區域mapping到程式中hub的區域中

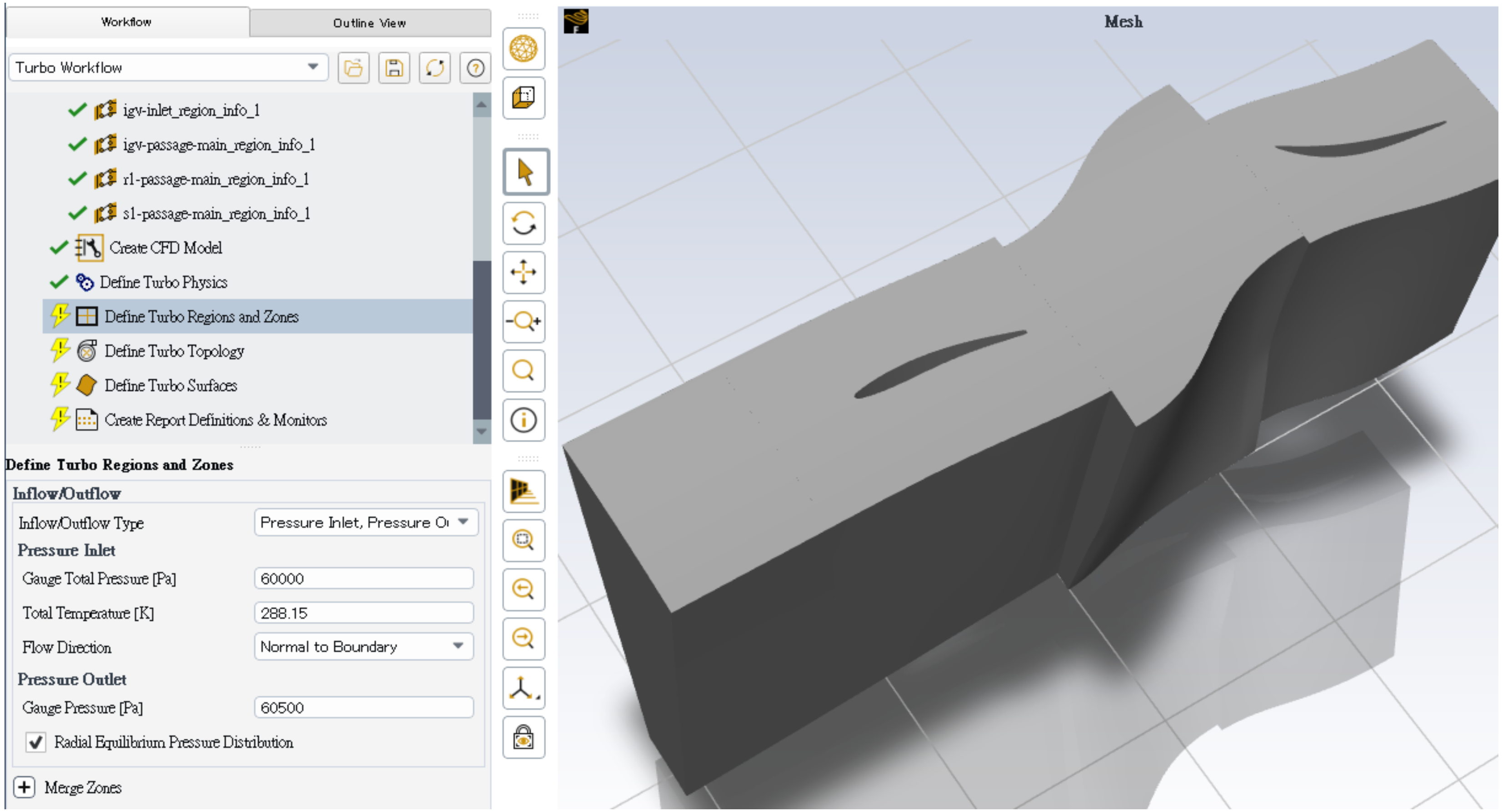
Ansys

Define Turbo Physics



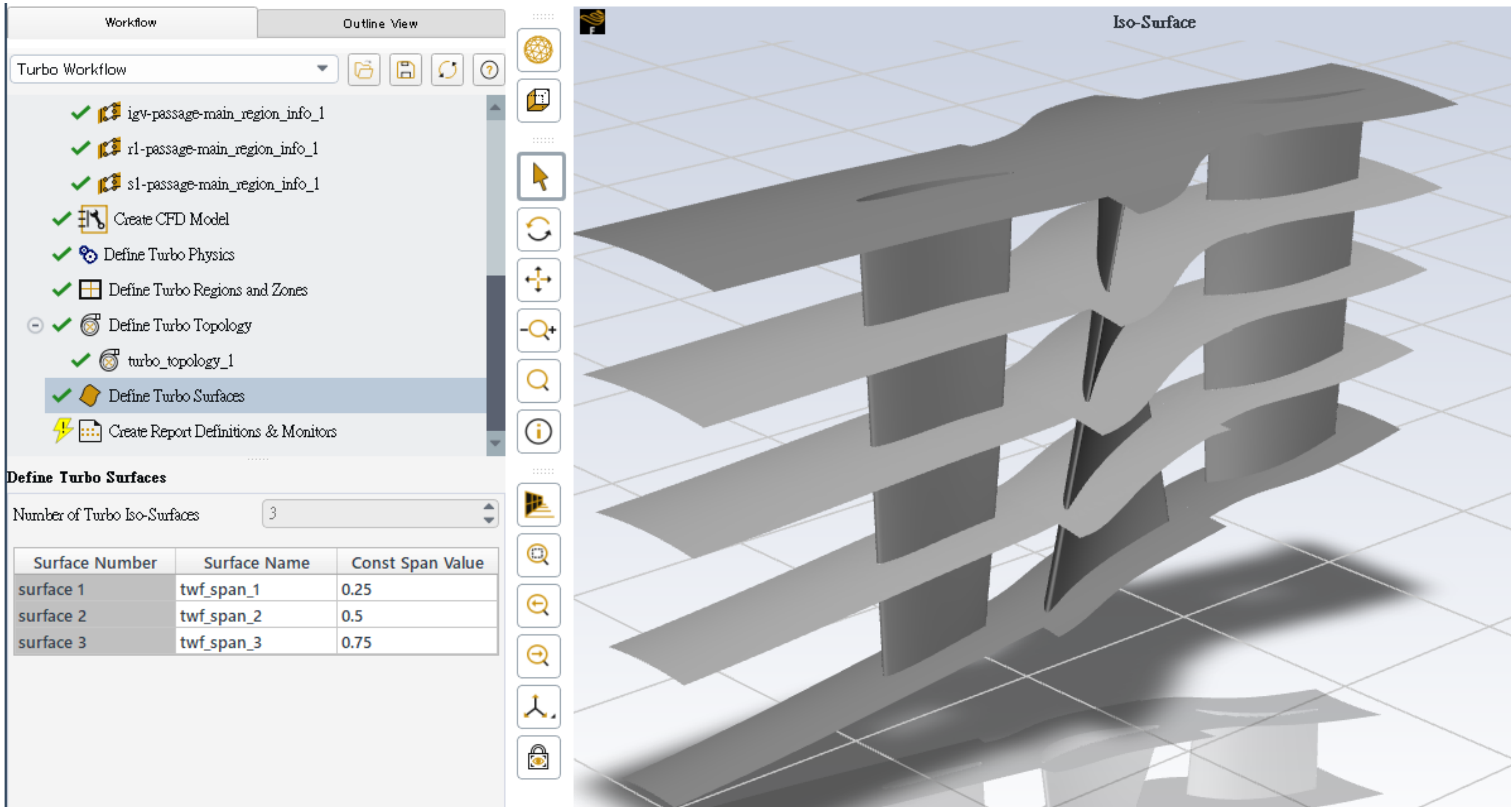
設置分析的物體條件，如轉速、材料性質等等，其材料性質可自行定義

Define Turbo Regions Zones



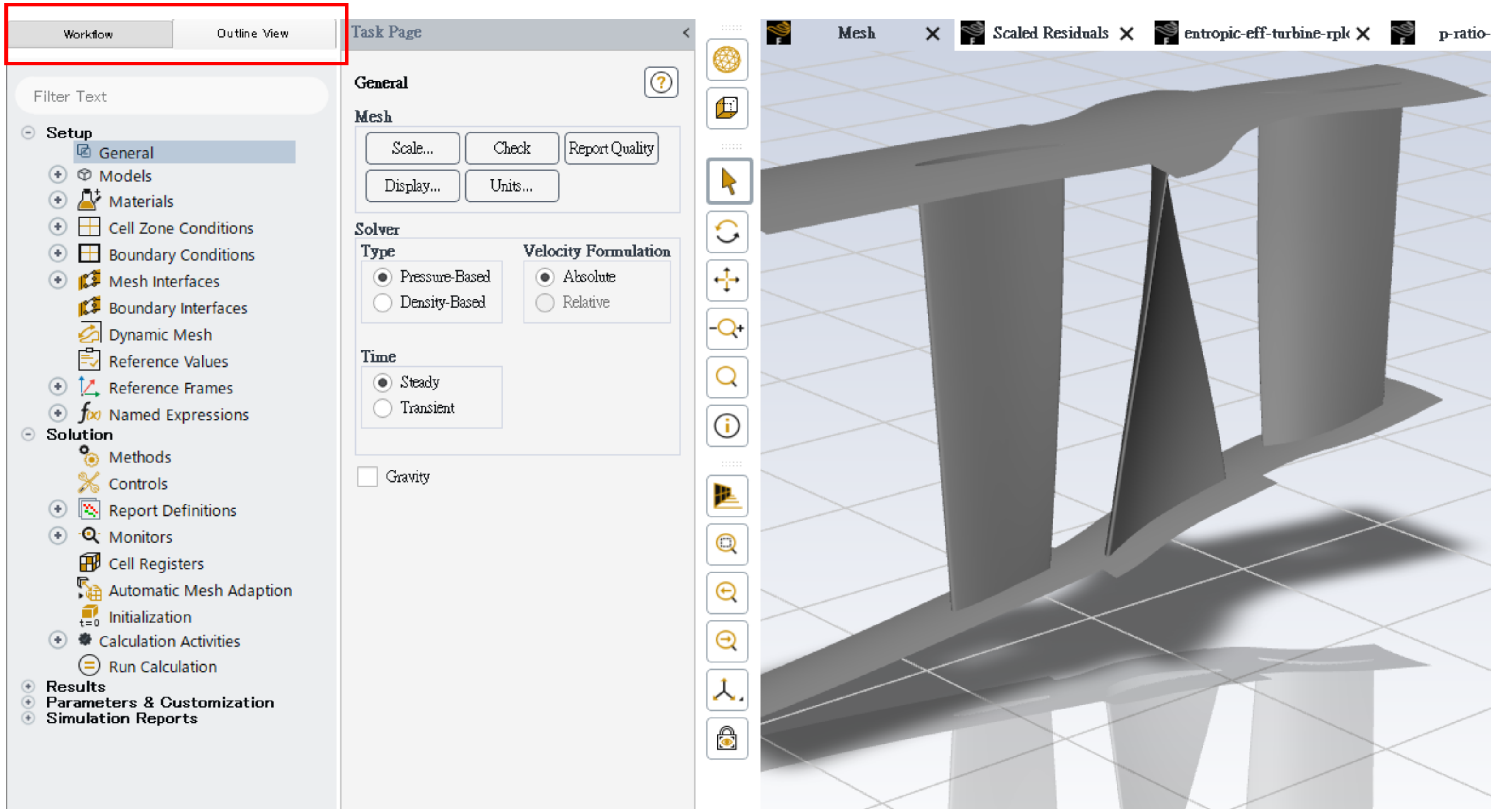
設置分析的邊界條件，可設置壓力出/入口或是值流量出/入口

Define Turbo Surface / Create Report



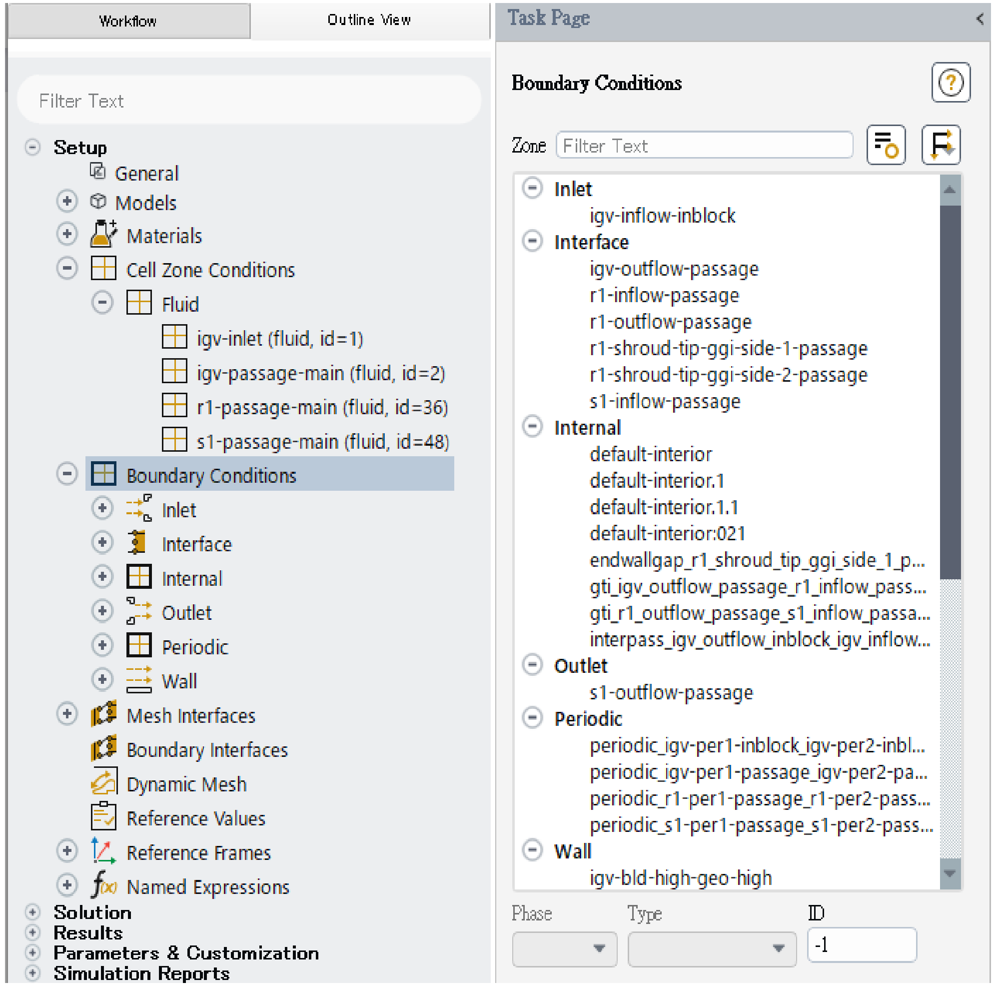
自動化建構出等值的切面位置與報告觀測值，以便於使用者在收斂上的監控與後處理的觀察

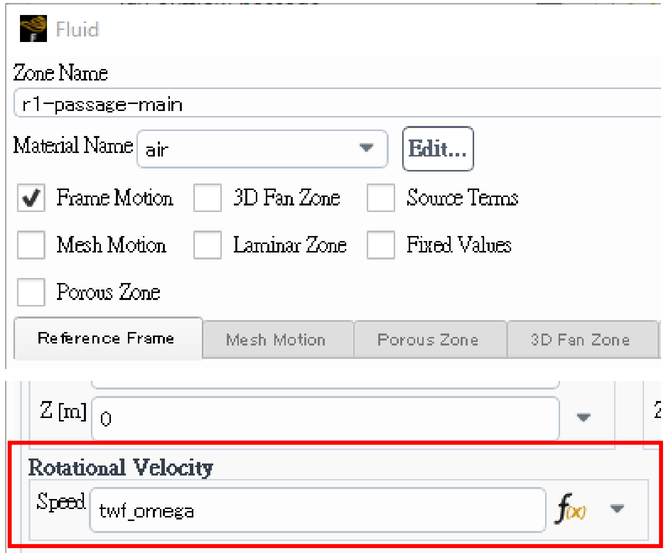
Fluent Outline

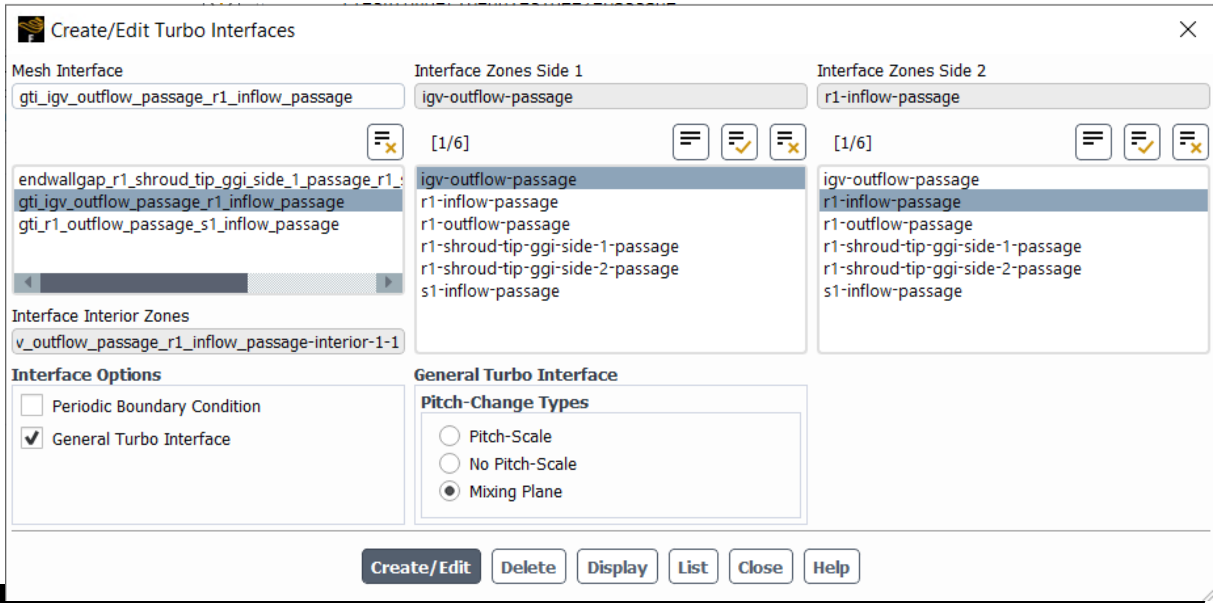


設定流程完成後，切換回到Fluent的Outline中，可發現大部份的的設定都在Turbo Workflow中完成了

Boundary Condition Setting

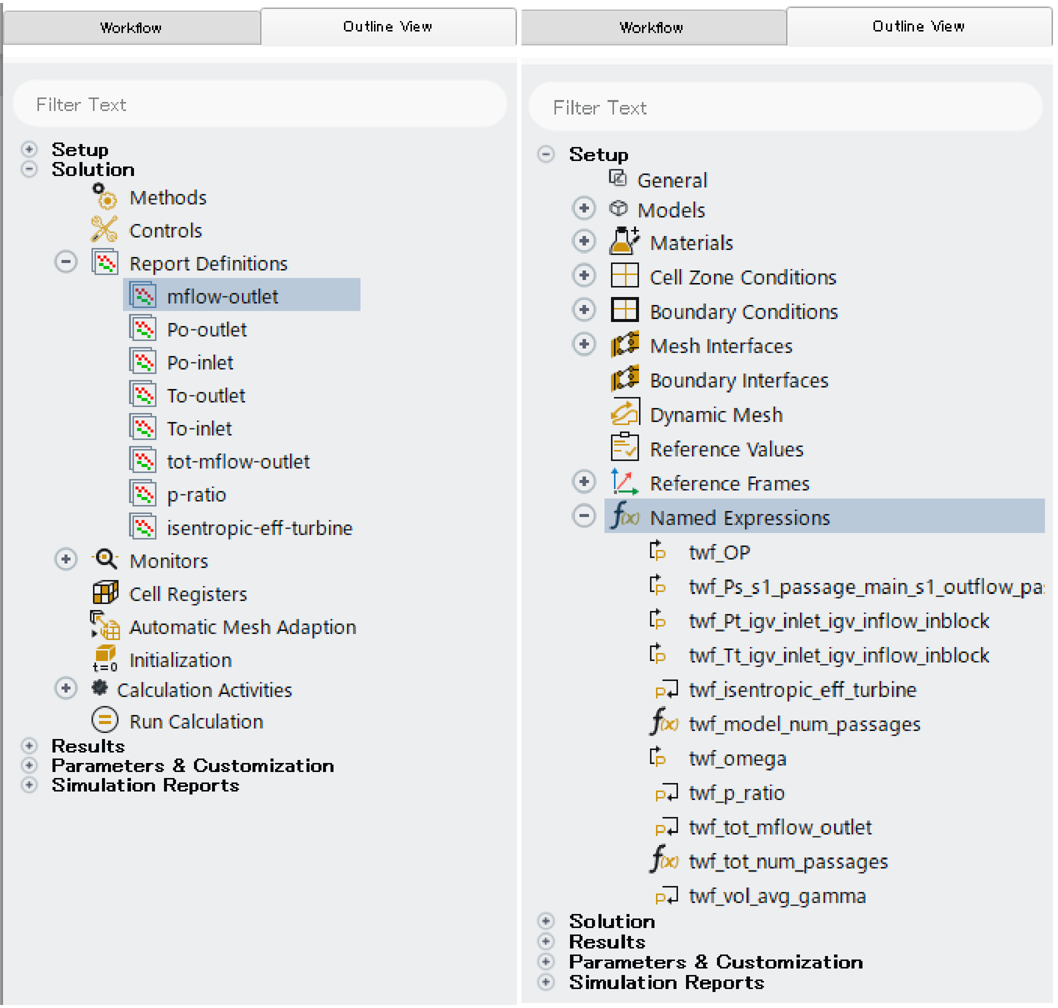


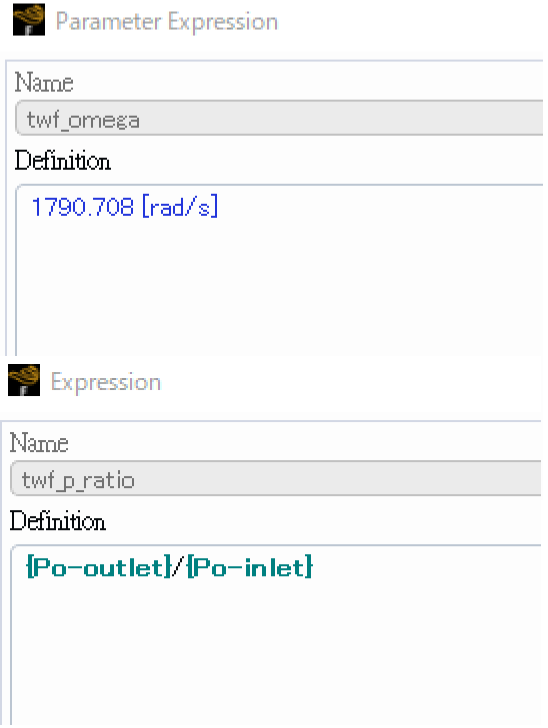




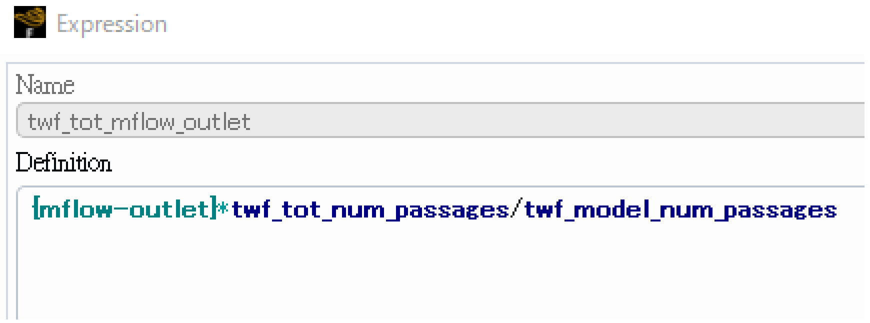
邊界條件根據在Turbo Workflow中的設定自行設置到各條件內，並且包含了Interface的接口也自行設置完成

Expression

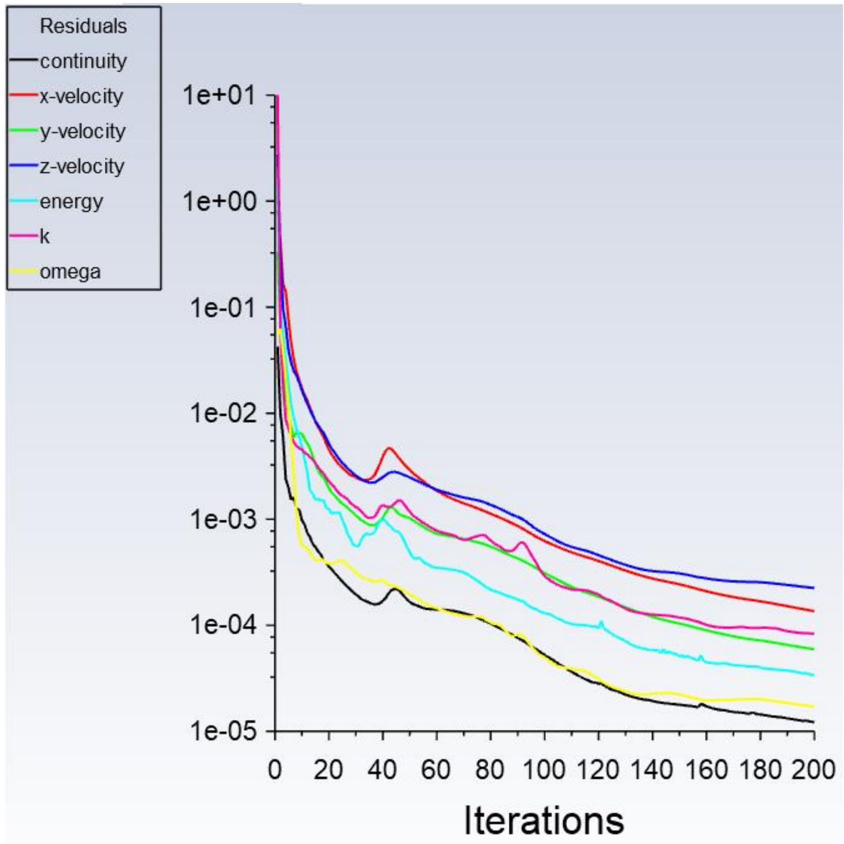


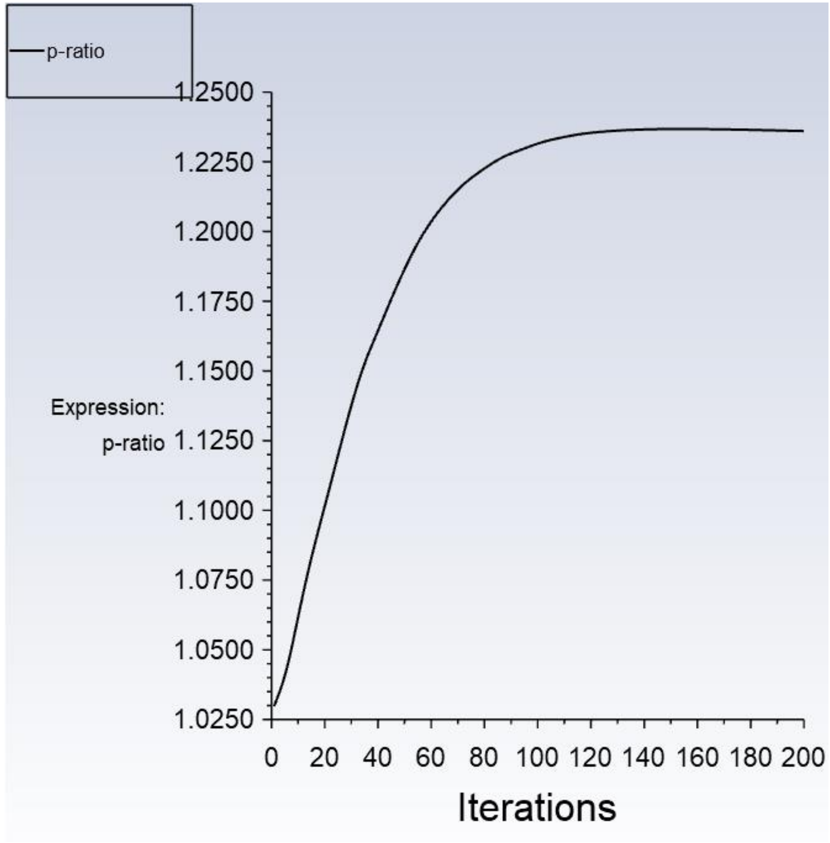


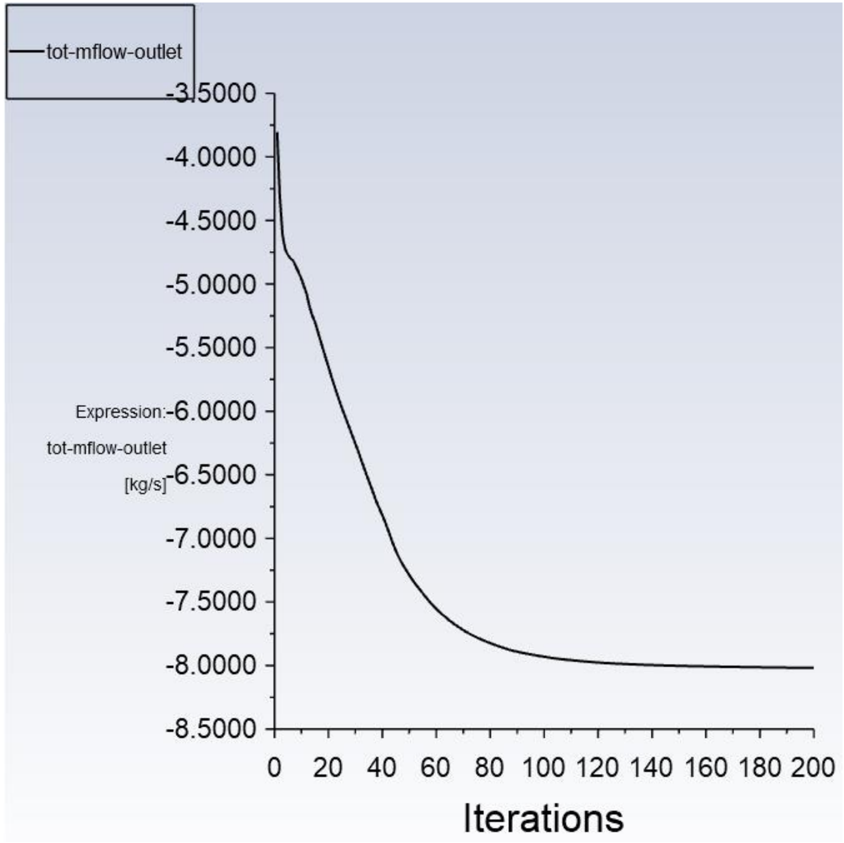
Expression中除了邊界條件外，Workflow也定義了在後處理上常會觀測到的數值，如值流量、壓縮比等等



Calculation

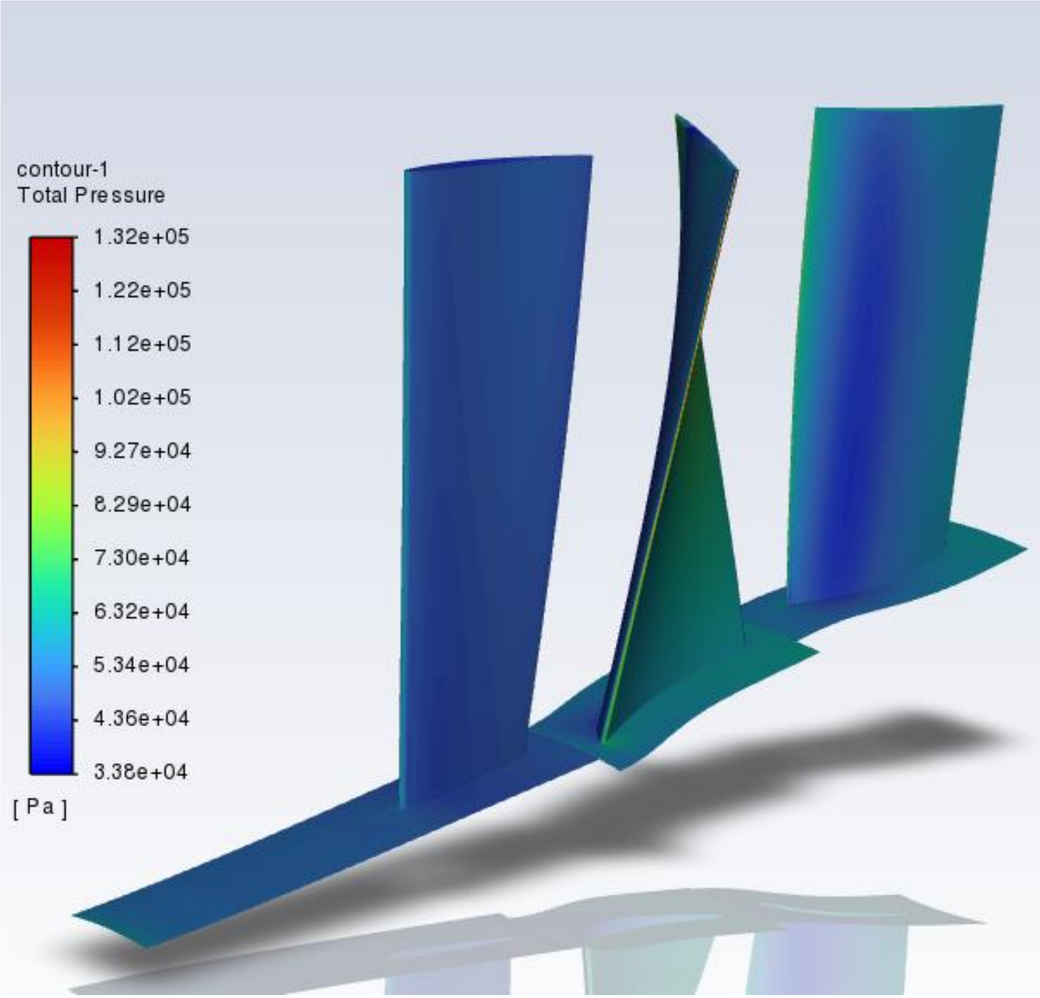




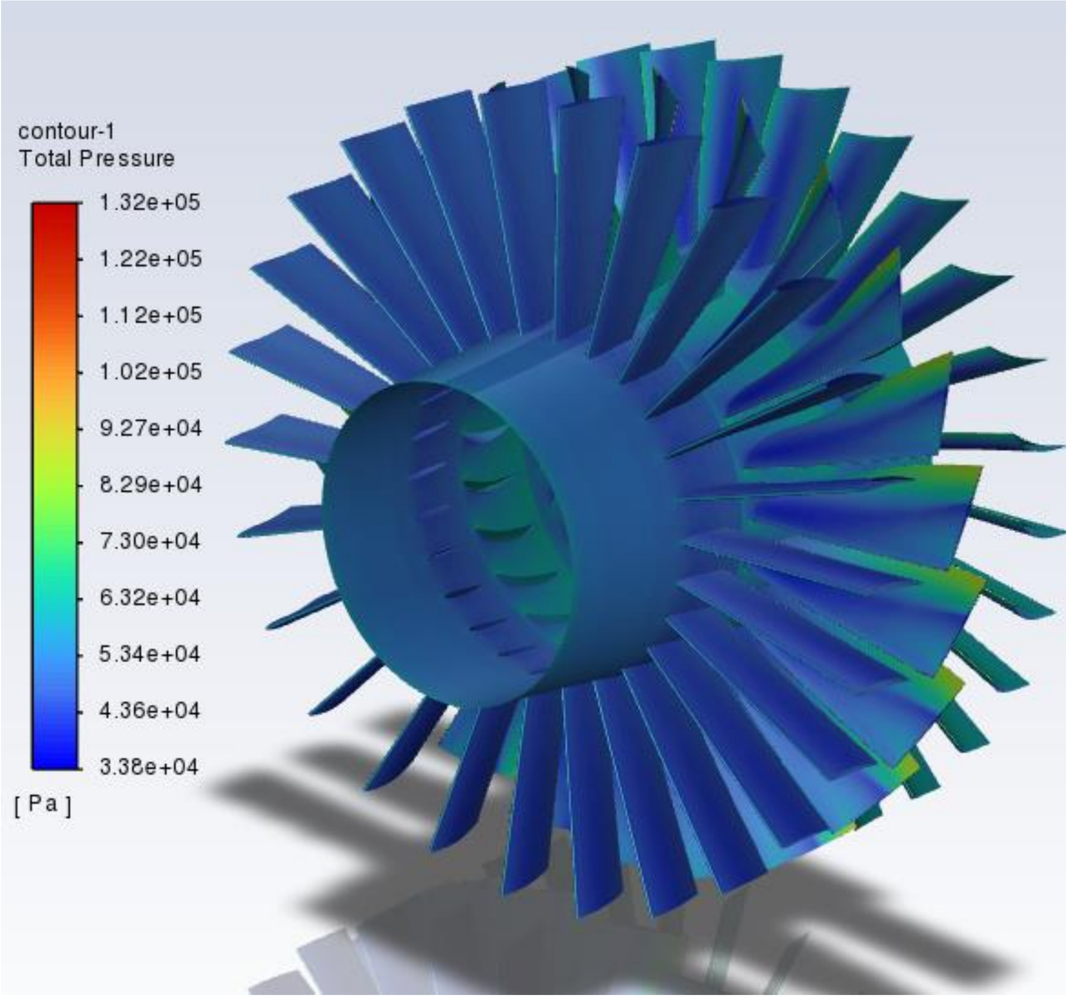


Result

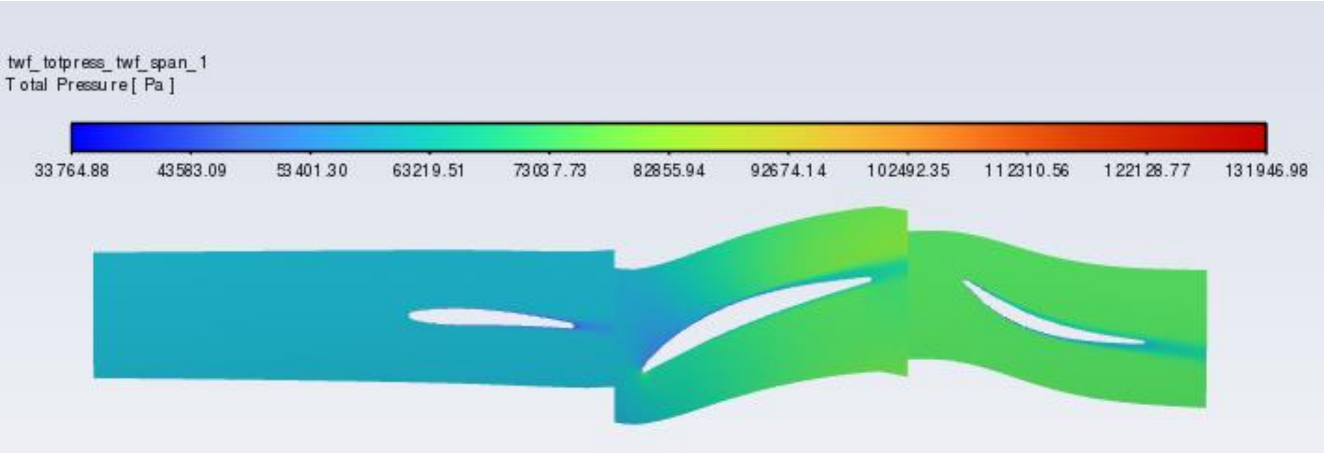
Single Passage

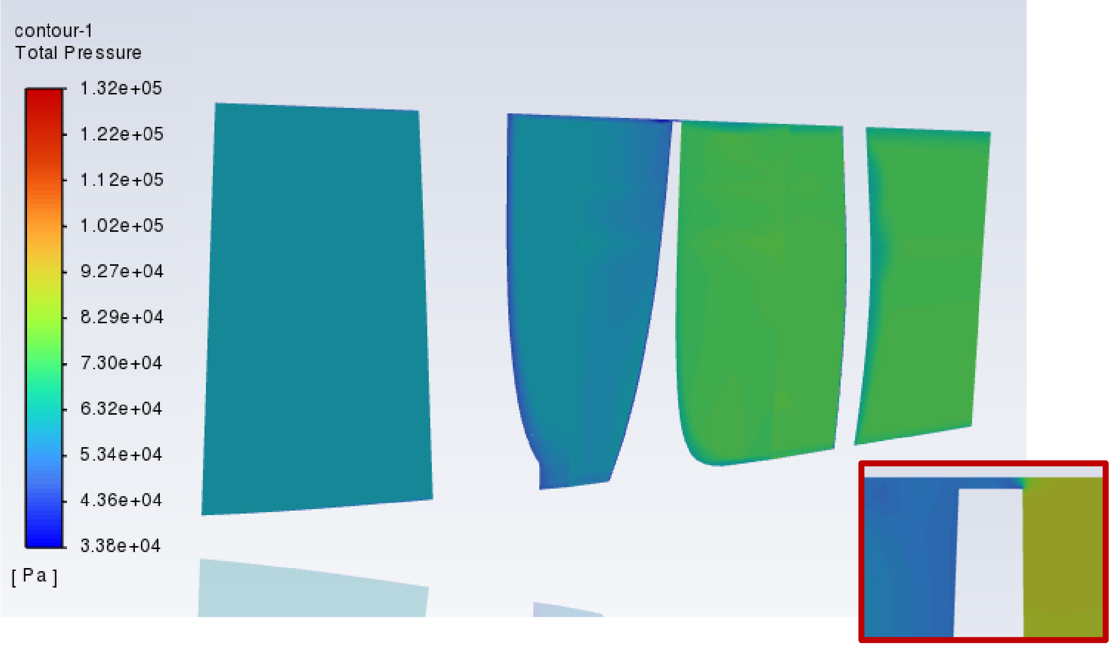


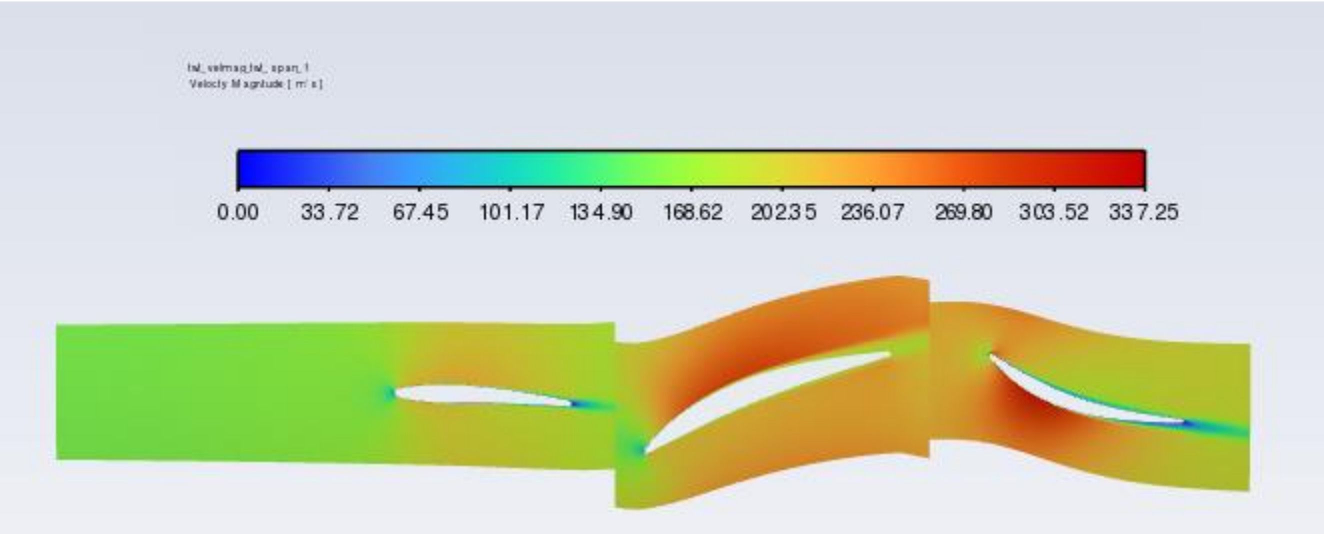
Show Full Model

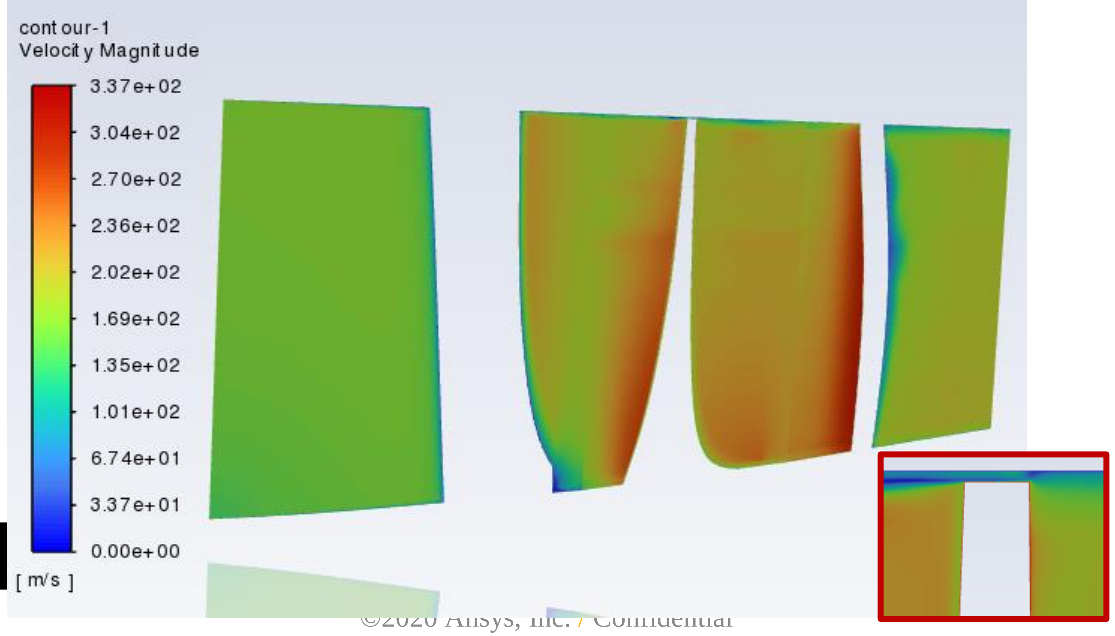


Result


twf_totpress_twf_span_1
Total Pressure [Pa]
33764.88
43583.09
53401.30
63219.51
73037.73
82855.94
92674.14
102492.35
112310.56
122128.77
131946.98


contour-1
Total Pressure
1.32e+05
1.22e+05
1.12e+05
1.02e+05
9.27e+04
8.29e+04
7.30e+04
6.32e+04
5.34e+04
4.36e+04
3.38e+04
[Pa]


0.00
33.72
67.45
101.17
134.90
168.62
202.35
236.07
269.80
303.52
337.25


contour-1
Velocity Magnitude
3.37e+02
3.04e+02
2.70e+02
2.36e+02
2.02e+02
1.69e+02
1.35e+02
1.01e+02
6.74e+01
3.37e+01
0.00e+00
[m/s]

Thanks!!

Question & Answer