



2022/R1
Engineering What's Ahead.

新技術線上研討會

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

NVIDIA QUADRO RTX 4000

即時即刻加速改變

透過 GPU 加速光線追蹤、深度學習和進階著色，滿足現今嚴苛的專業工作流程需求。採用 NVIDIA Turing™ 構架和 NVIDIA RTX™ 平台的 NVIDIA® Quadro RTX™ 4000，提供單插槽 PCIe 尺寸同級最佳的效能與功能。加速獲得深入分析和解決方案的時間，以前所未有的方式設計與創造。

立即購買



美超微電腦

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-請洽虎門科技業務團隊-

Ansys 2022R1

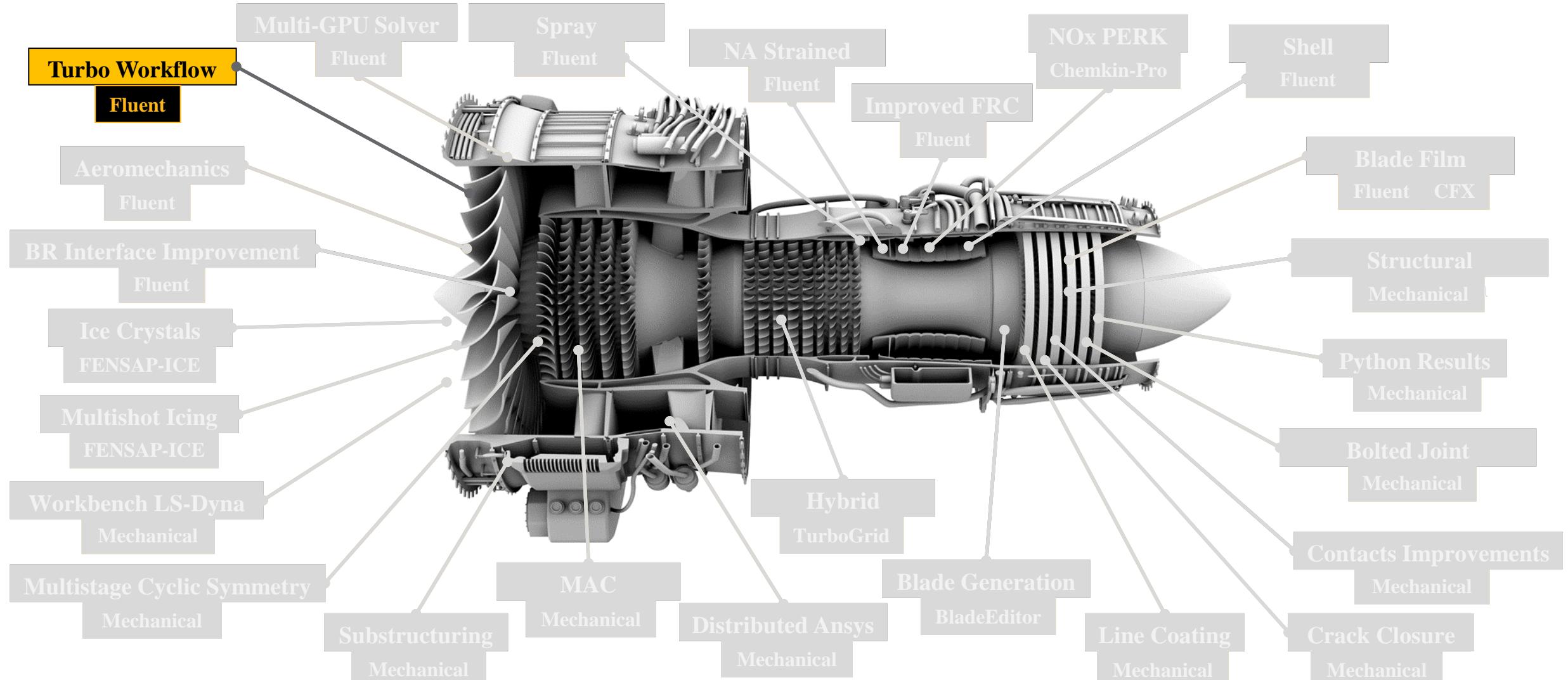
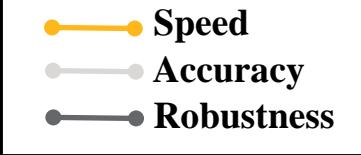
New Turbo Tools

Fluent TurboWorkflow

虎門技術工程師 Haruto
haruto.lee@cadmen.com

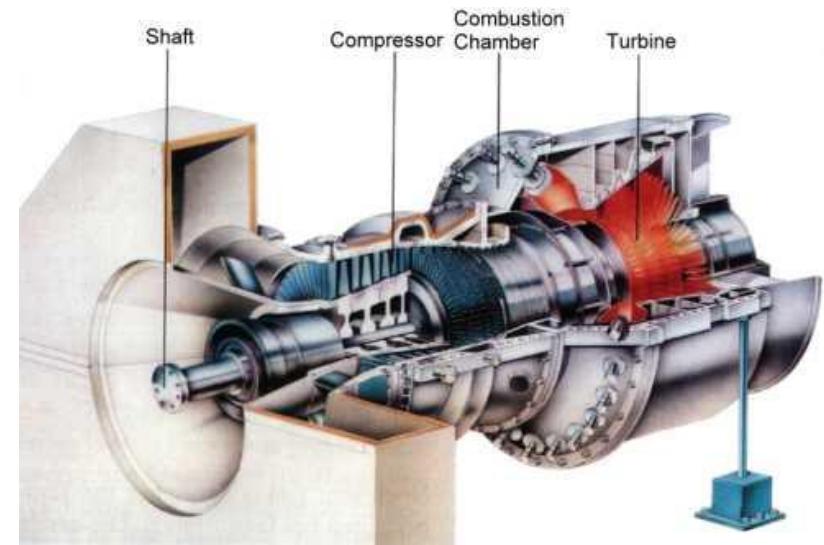


2022 R1 Features by Gas Turbine Modules - Dashboard



Fluent Turbo Methods and Workflow

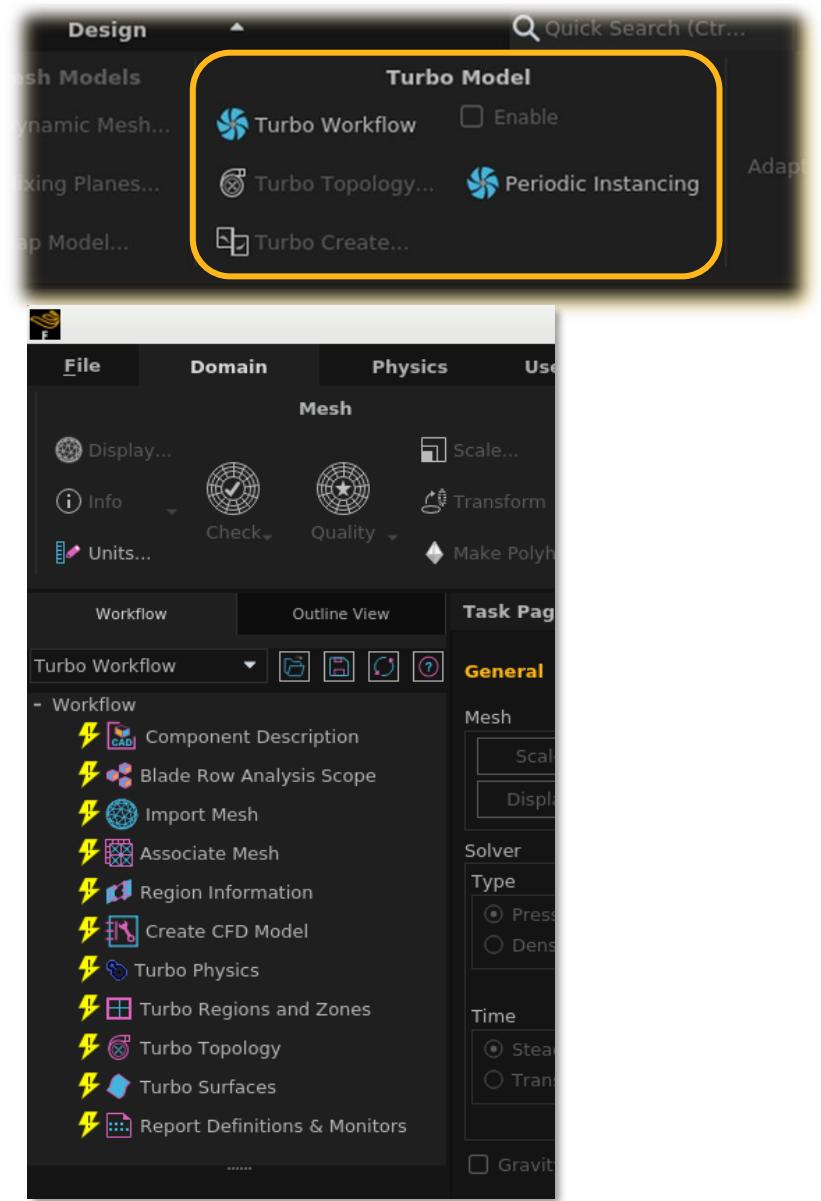
- 2022 R1 functionality
 - **Pre-processing tool** with Turbo workflow
 - **Post-processing tool** with Periodic instancing + Turbo workflow + Simulation Report
 - **Base Turbo methods** to cover the three pillars of Gas Turbine analysis
 - Aerodynamic analysis
Steady & Transient , main and secondary 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

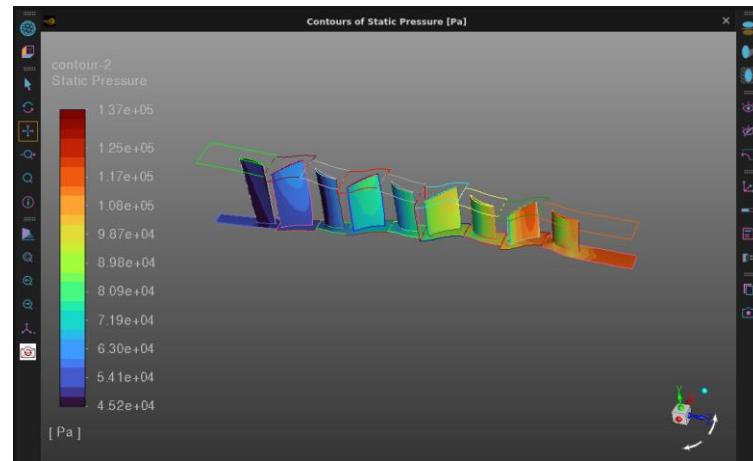
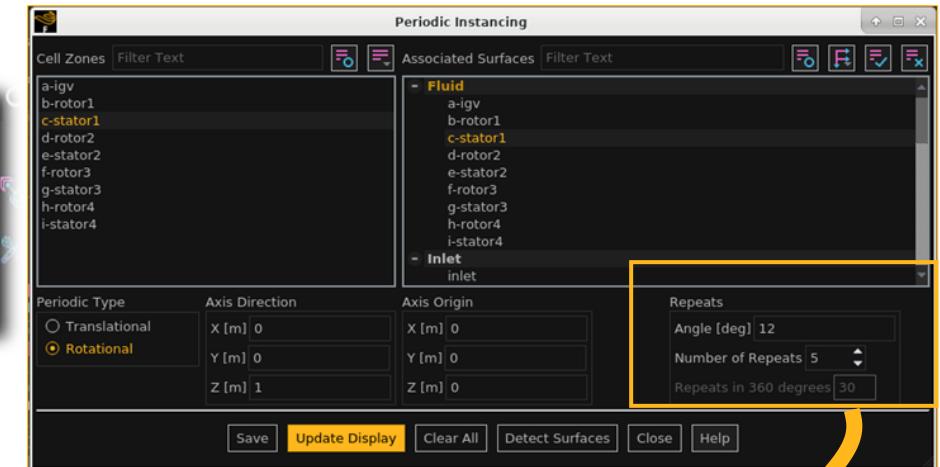
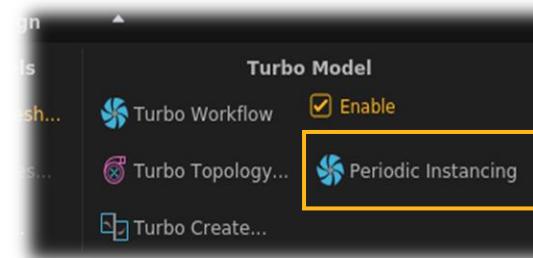
*Quickly set up turbomachinery flow problems
and instrument primary performance
parameters and post processing*

- 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

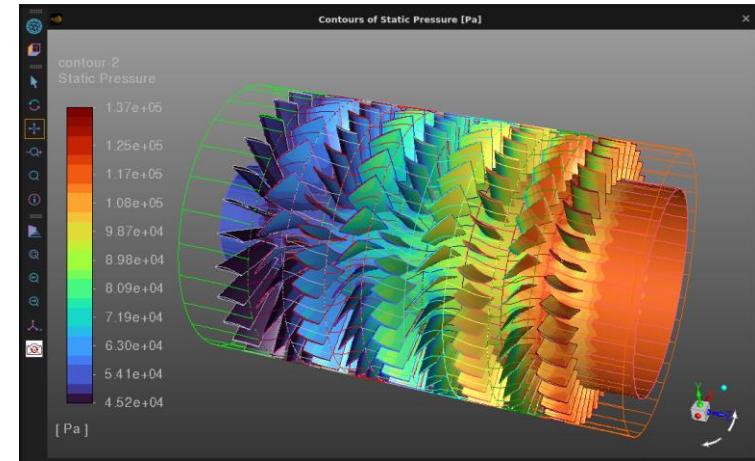


Clear All

→ Single Repeat

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

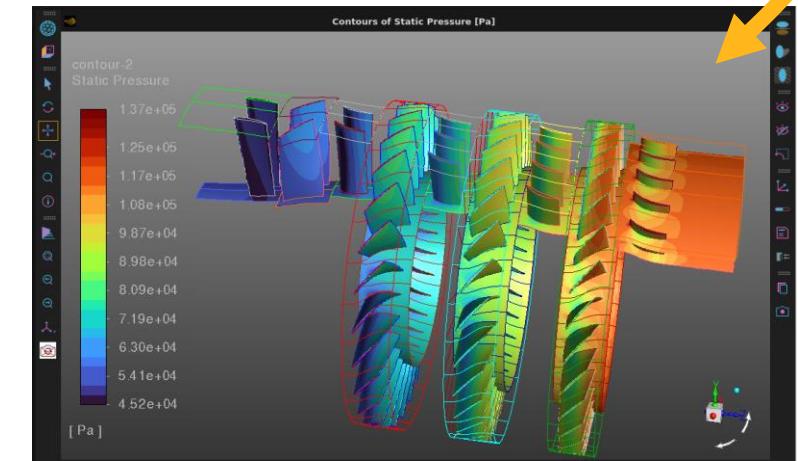
*If turbo surface cut spans more than one zone it will be ignored



Detect Surfaces

→ Full Wheel

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

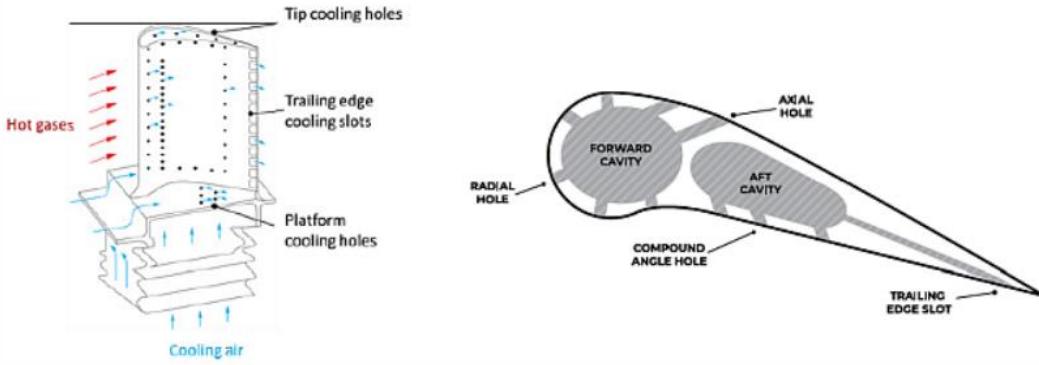


Or use the Repeats settings

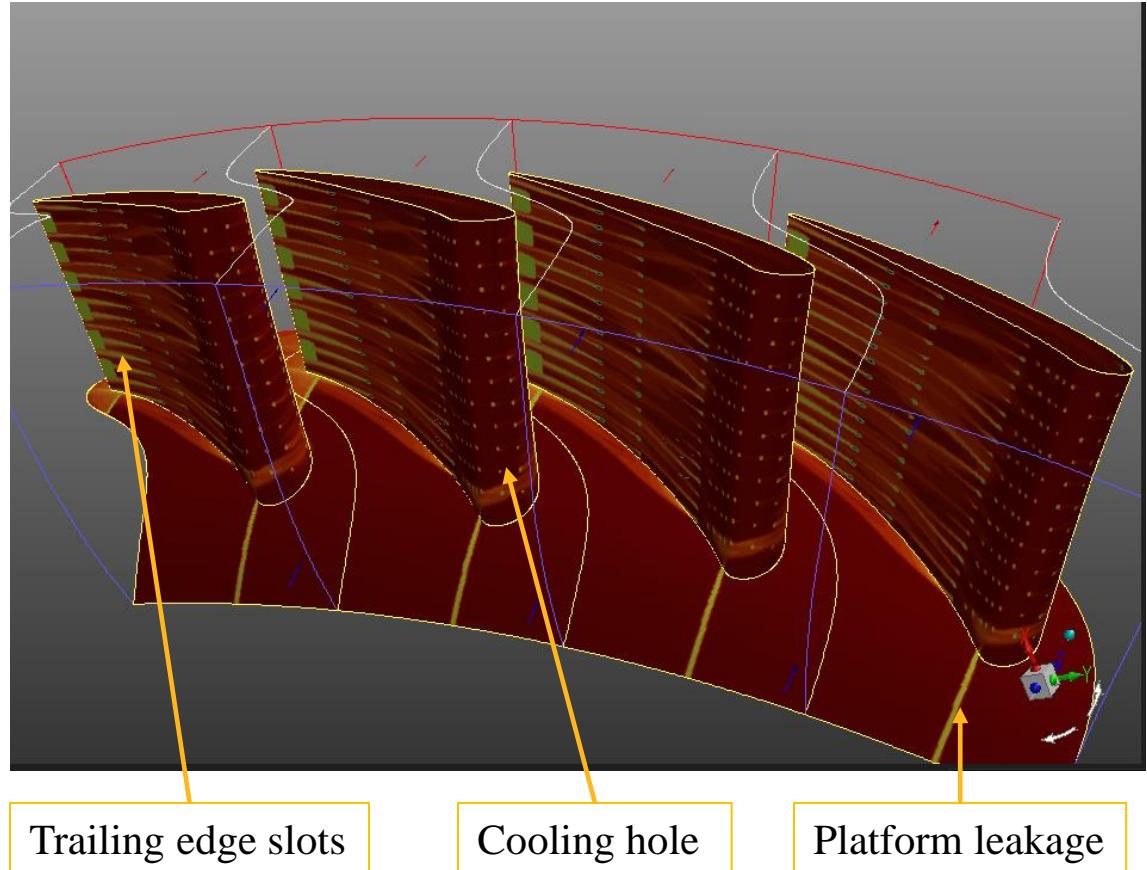
- Select cell zone and enter the number of repeats
 - Positive value: forwarded instancing
 - Negative value: backward instancing

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

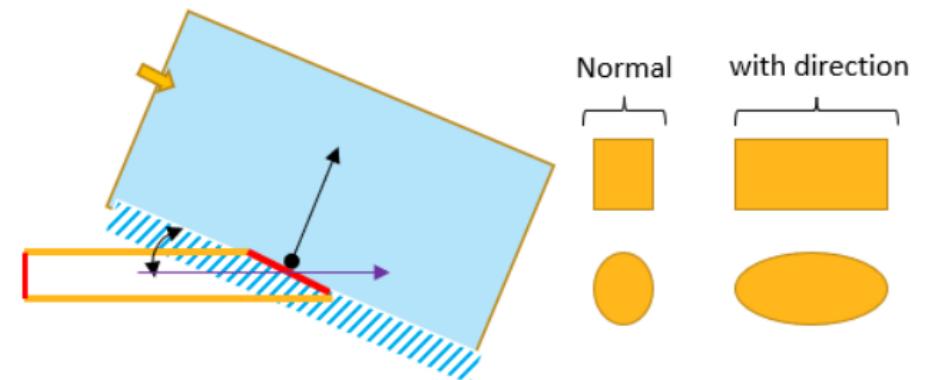
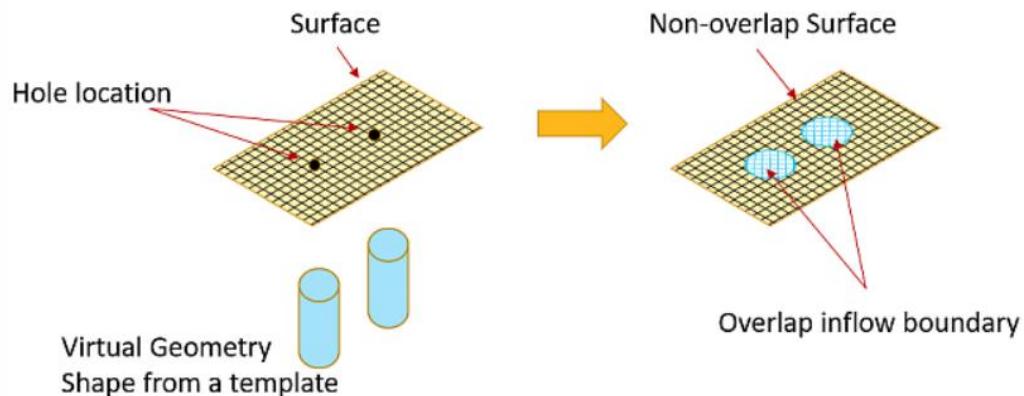
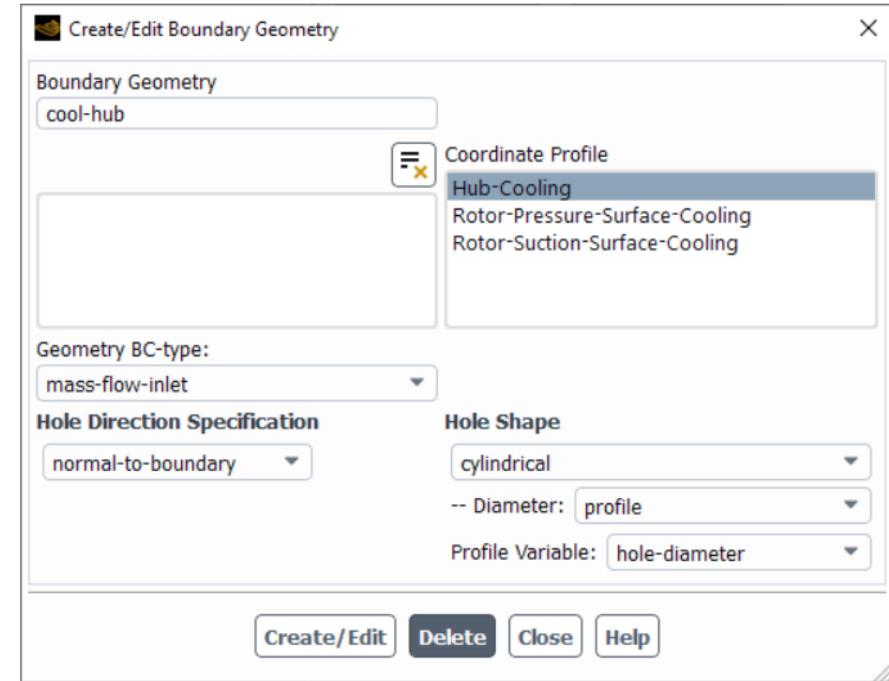


Use Virtual Geometry & Boundary Conditions to Simulate Turbomachinery Blade Cooling



Create virtual boundary conditions

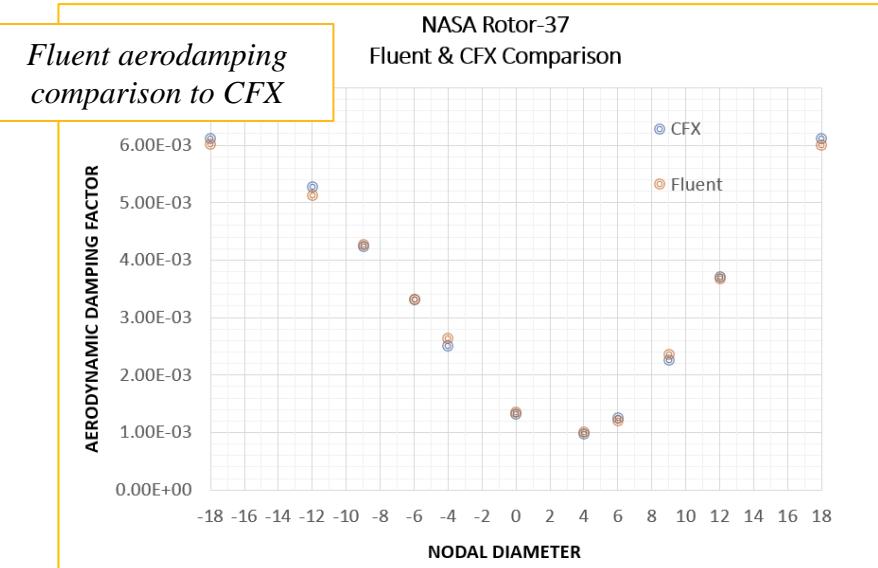
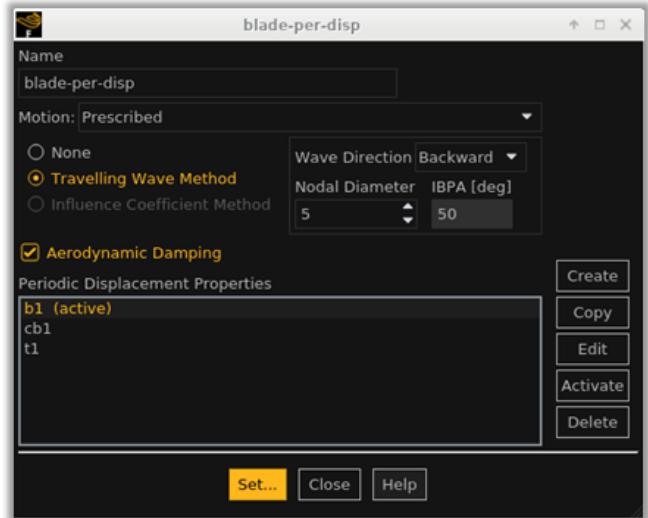
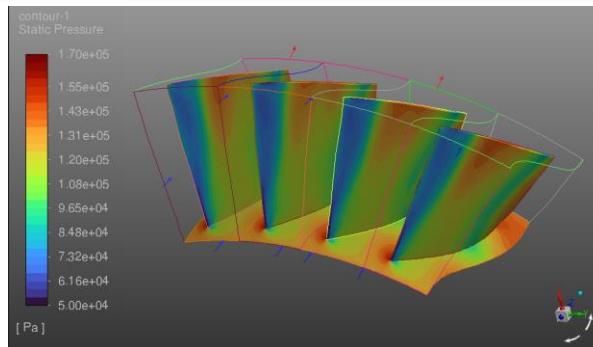
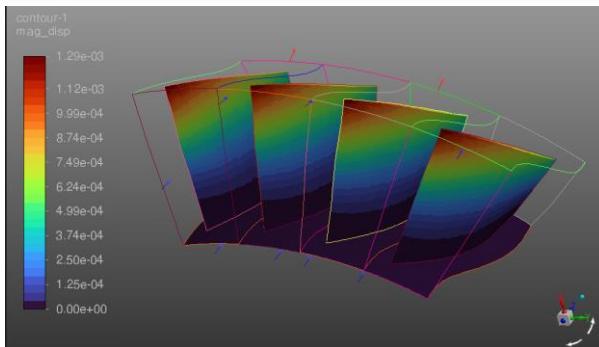
- New **Boundary Interface** intersects virtual geometry with boundary surface to form virtual boundary conditions
 - Similar to creating conventional mesh interfaces
 - Overlapped intersection becomes mass-flow-inlet or mass-flow-outlet
 - Non-overlapped intersection retains underlying surface settings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

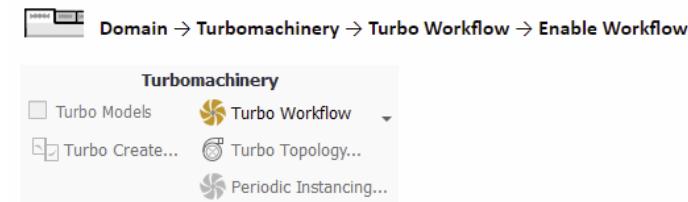
The information in this chapter is divided into the following sections:

- [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](#)

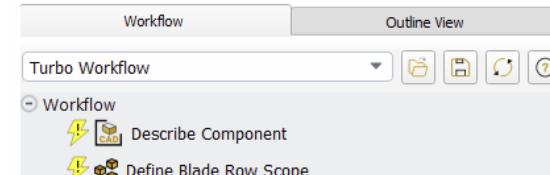
12.1. Using the Turbomachinery Guided Workflow

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

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



This exposes a **Workflow** tab, alongside the **Outline View**, where you can use the **Turbo Workflow** to begin your work. The **Turbo Workflow** dialog allows you to define and refine the setup and solution of your turbomachinery problem by working 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...

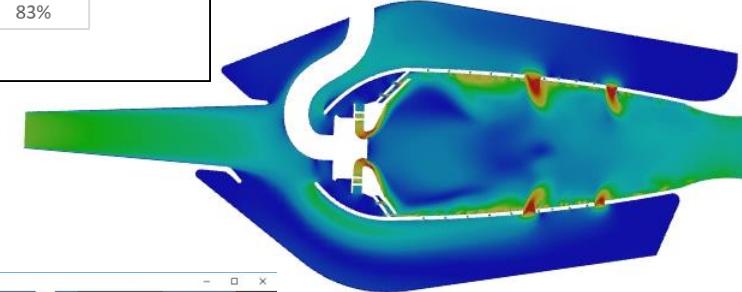
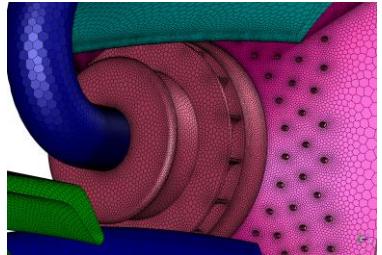
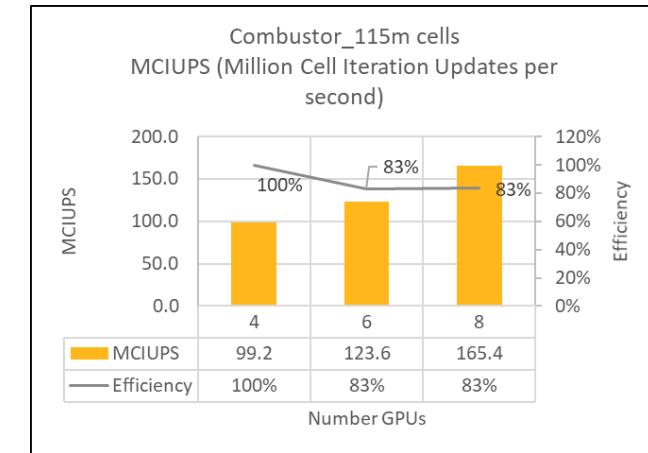
Multi-GPU Solver (Beta)

- 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

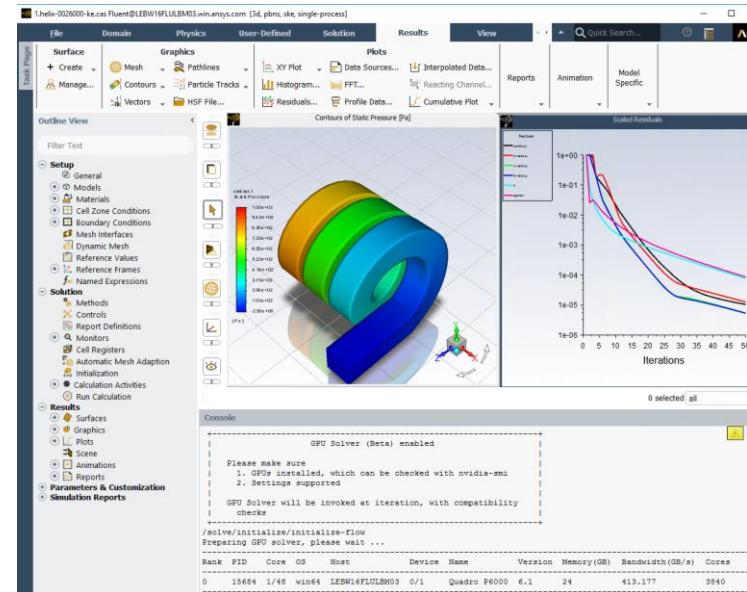
1 GPU ≈ 640 cores (on 5 nodes)

8 GPUs ≈ 3840 cores (on 32 nodes)

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



~83% parallel efficiency with 8 GPUs



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

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

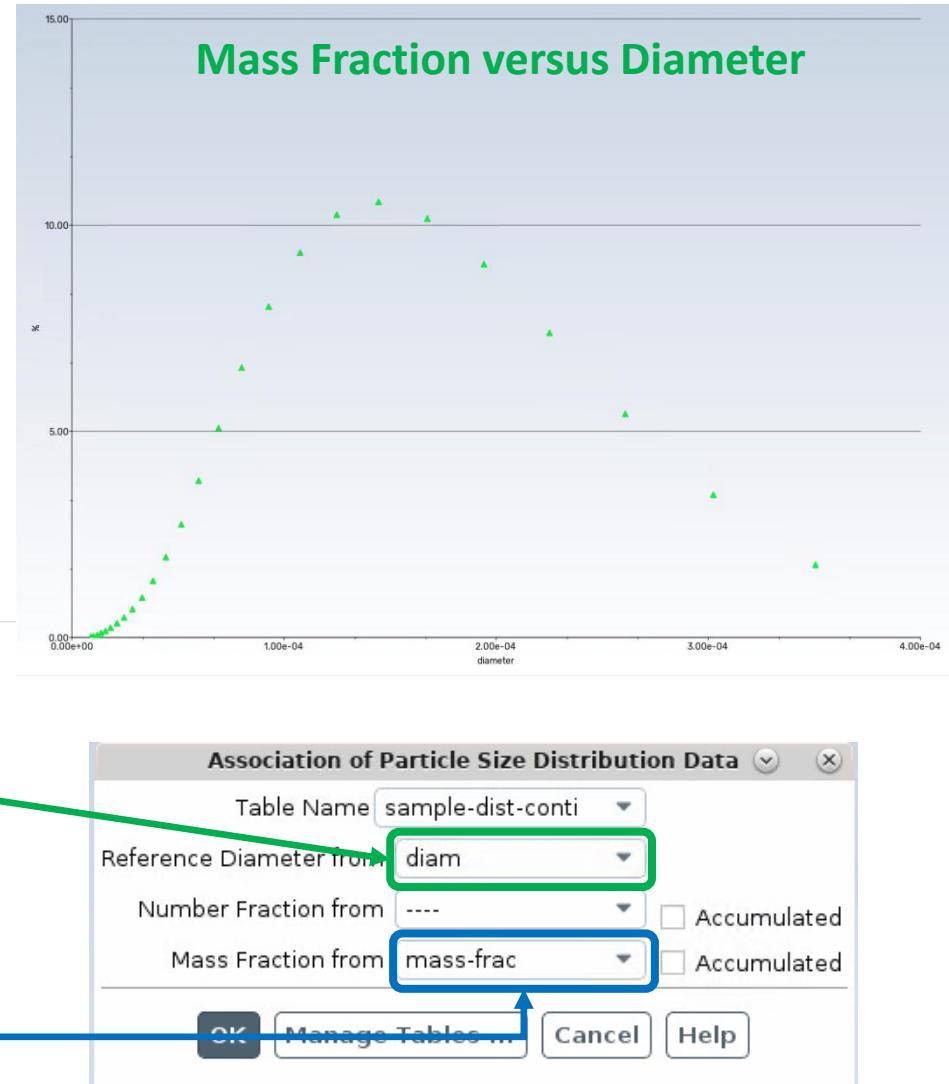
Tabulated Particle Size Distribution

- 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

Set Injection Properties

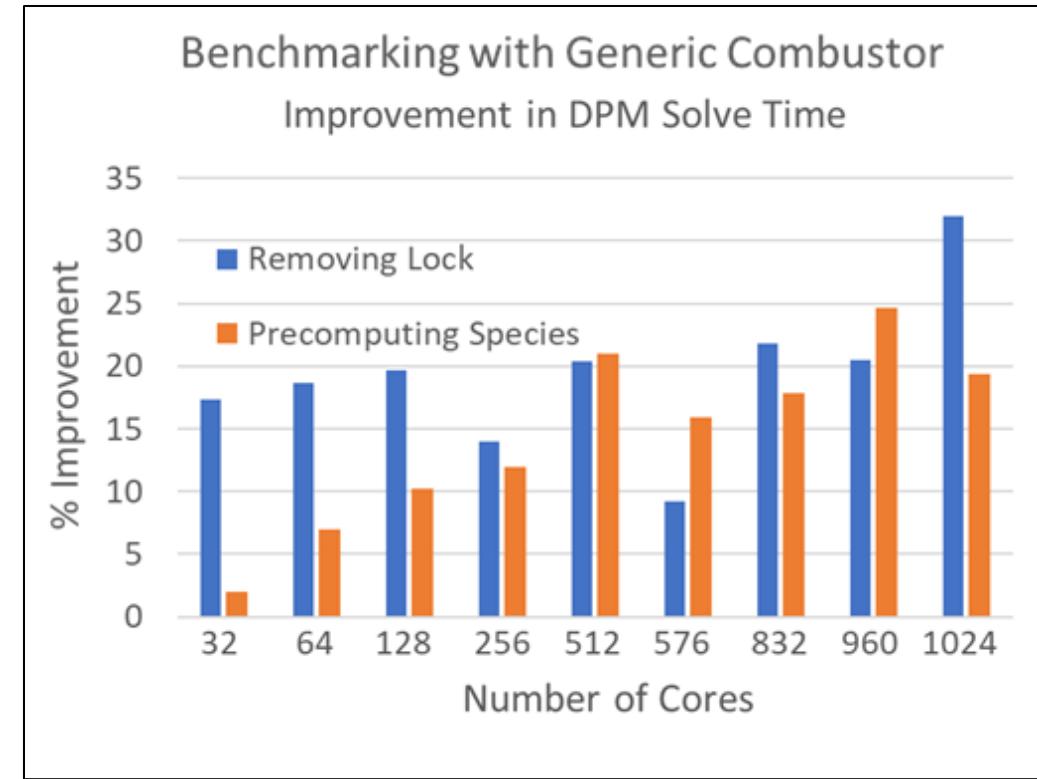
Injection Name	Injection Type	
injection-0	cone	
Reference Frame	global	
Particle Type	<input type="radio"/> Massless <input checked="" type="radio"/> Inert <input type="radio"/> Droplet <input type="radio"/> Combusting <input type="radio"/> Multicomponent	
Material	Diameter Distribution	Oxidizer
anthracite	tabulated	
Evaporating Species	uniform rosin-rammler rosin-rammler-logarithmic	Prod
Point Properties	Physical Model	Random Dispersion

sample-dist-conti	num-frac	mass-frac	Diam
0.029871404	0.029871404	8.39949E-05	8.12819E-06
0.074395037	0.074395037	0.000331542	9.47675E-06
0.09261217	0.09261217	0.000654137	1.10491E-05
0.096133363	0.096133363	0.001076148	1.28823E-05
0.092064168	0.092064168	0.001633392	1.50197E-05
0.084628946	0.084628946	0.002379651	1.75116E-05
0.076196363	0.076196363	0.003395719	2.04171E-05
0.06802667	0.06802667	0.0048048	2.38046E-05
0.0666000175	0.0666000175	0.006703260	2.77541E-05



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

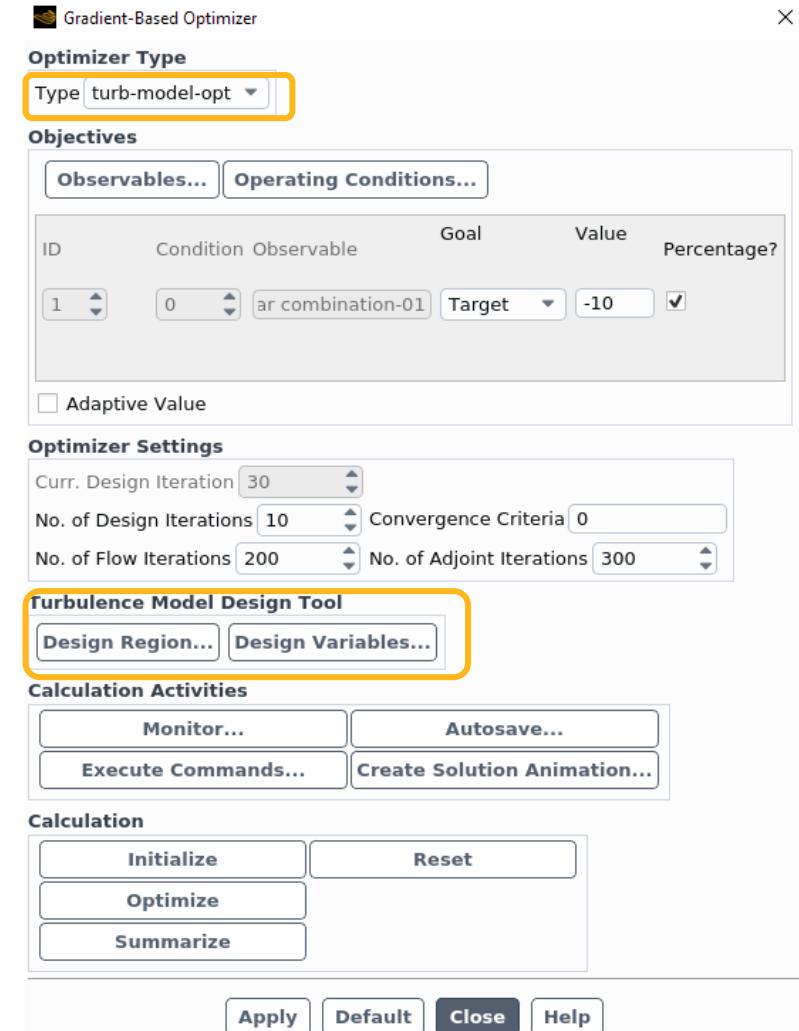


*Significant reduction in DPM solve time
Improved robustness and accuracy in
various scenarios*

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

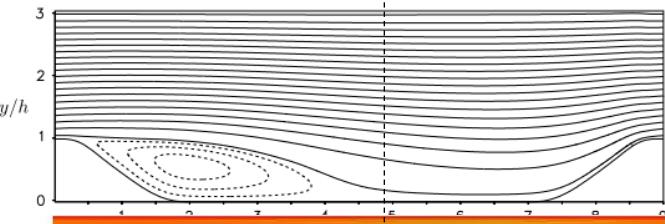
Training: 3D Periodic Hills Case



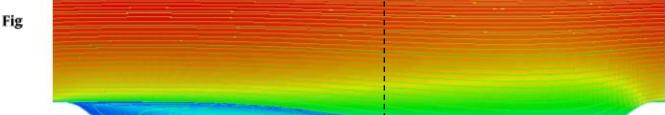
$$Re_H = 10400$$

M. Breuer et al

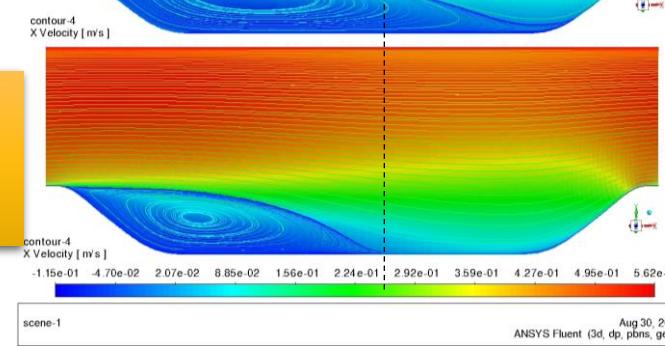
LES
Reference



GEKO
Default



Neural
Network
Augmented

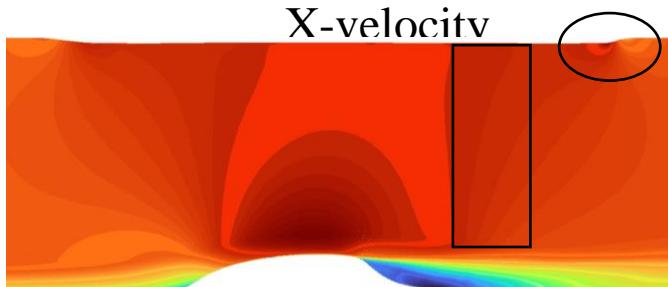


Deployment



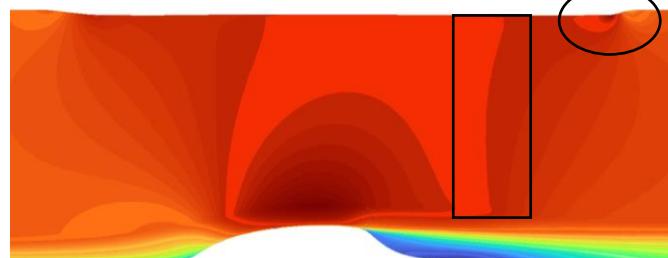
$$Re_c = 968279$$

ELES
Reference

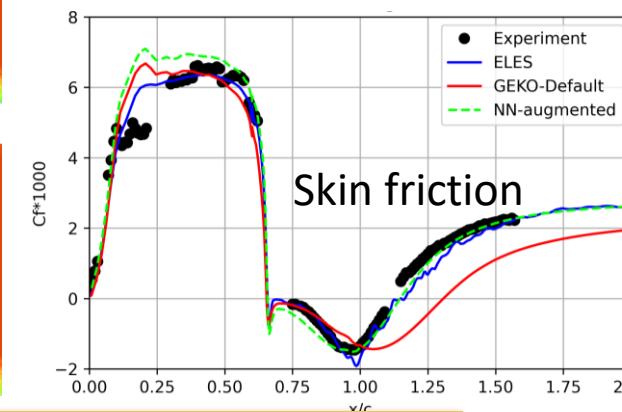
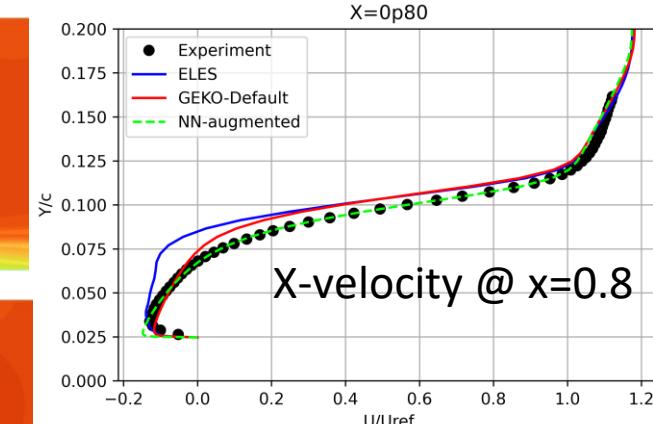
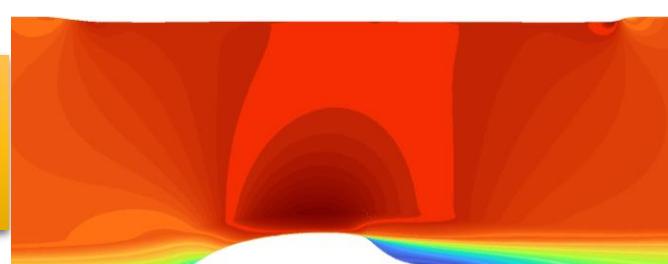


X-velocity

GEKO
Default



Neural
Network
Augmented

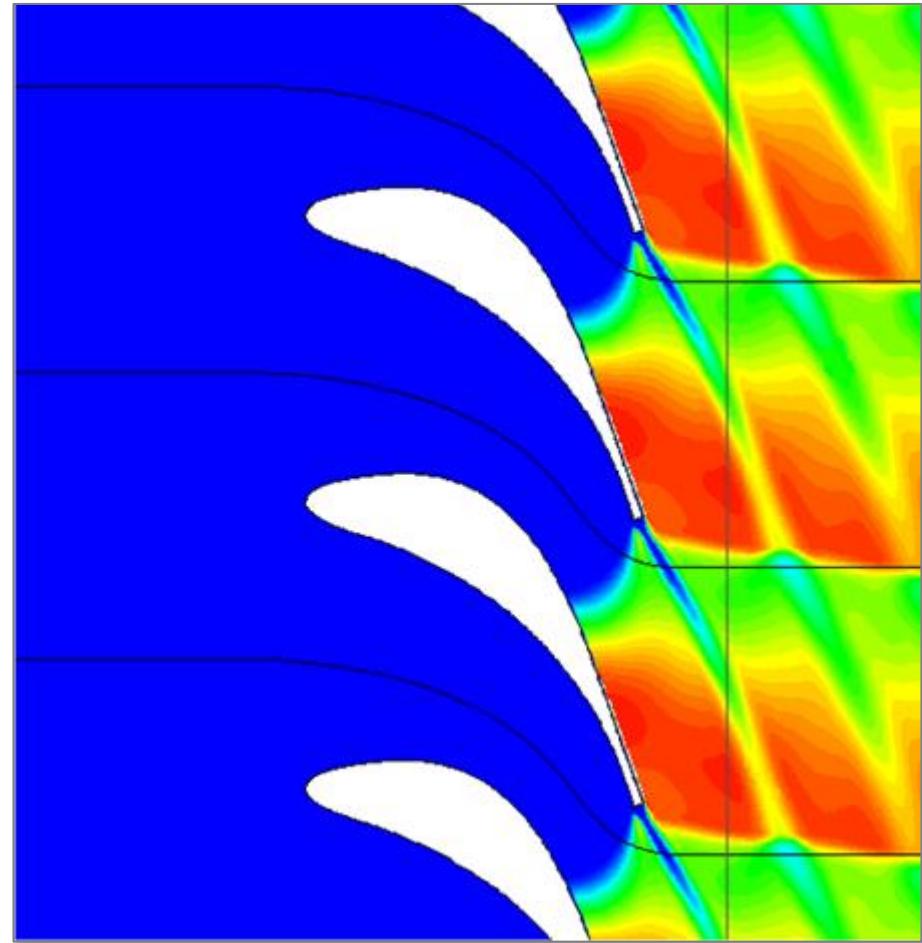


NN augmented GEKO velocity nearly match ELES/Exp.

Fluent: Non-Equilibrium Wet Steam Model

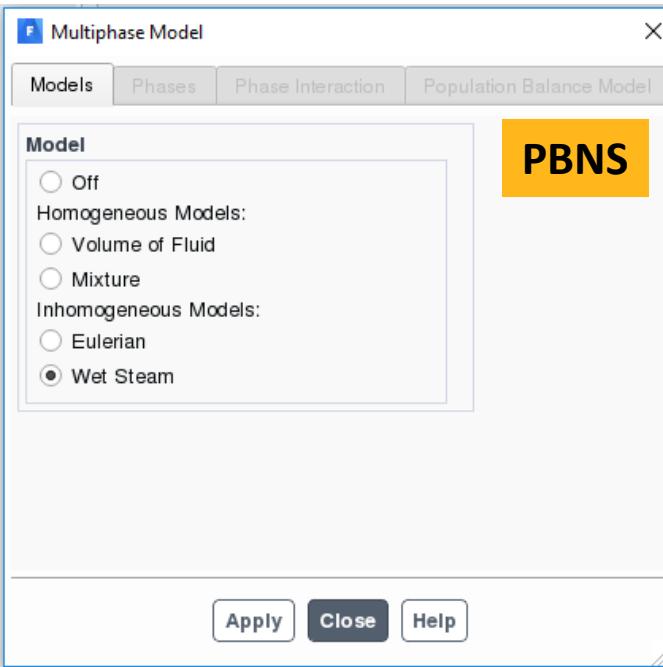
Access to IAPWS97 provides industry standard steam properties

- 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



PBNS

Text User Interface

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

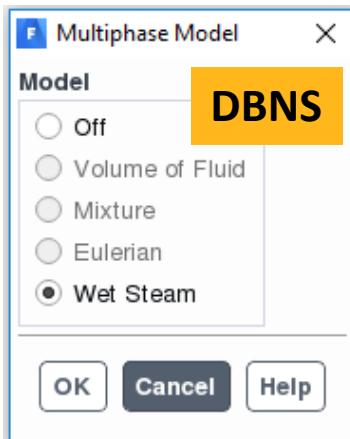
/define/models/multiphase/wet-steam/set> droplet-growth-rate
Use Hill's formula for the droplet growth rate? (if no, Young's formula will be used) [no] no
Enter modeling parameter, alpha [9] 9
Enter modeling parameter, beta [1] 1

/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

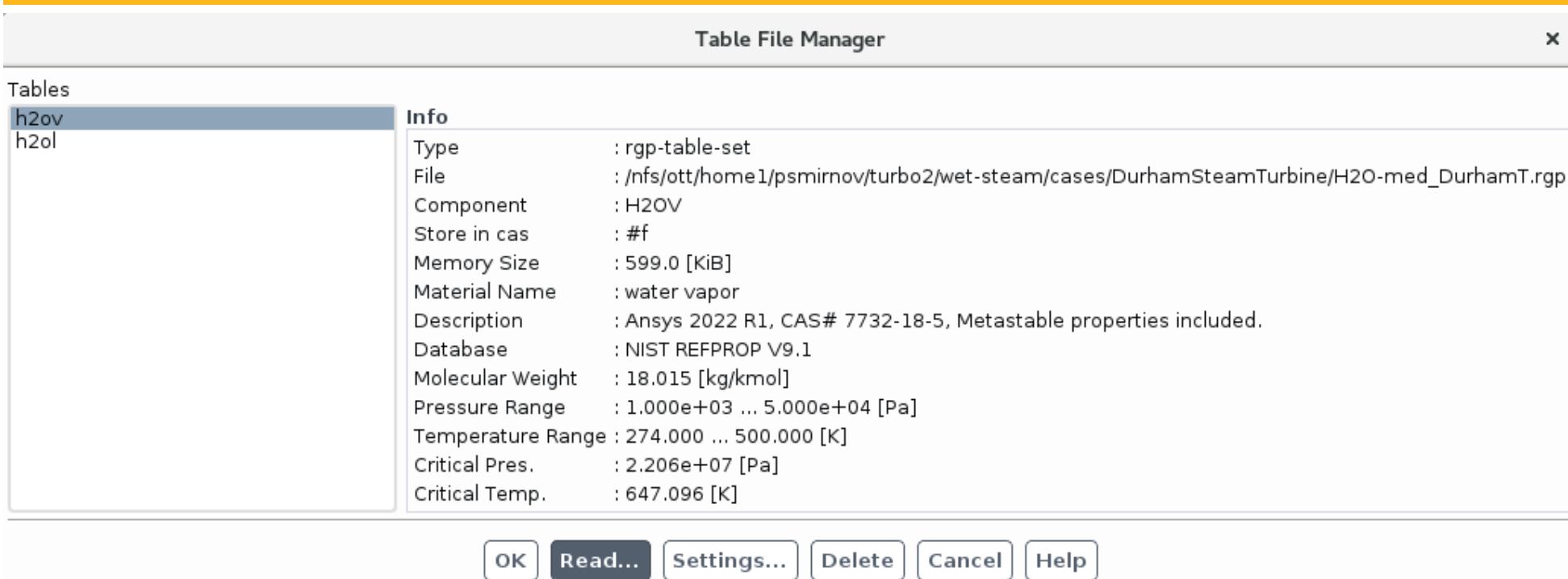
/define/models/multiphase/wet-steam/set> rgp-tables
Use RGP tables for the wet steam model? [no] no
```



DBNS

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:

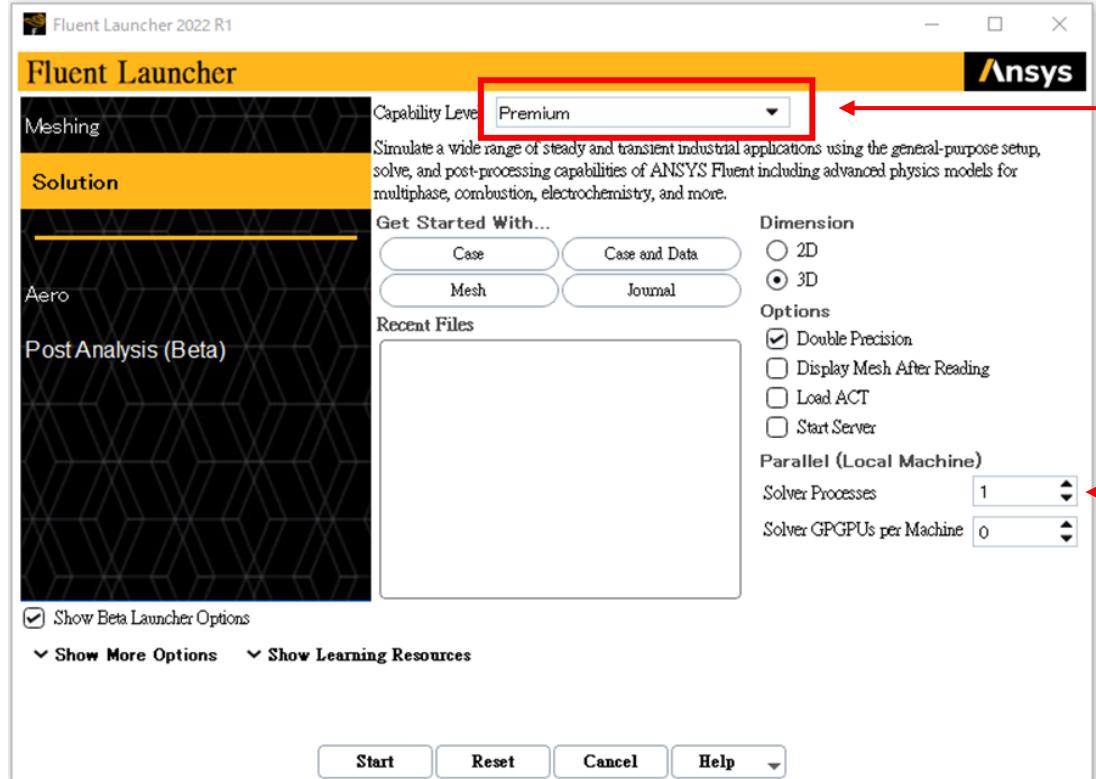
```
/define/models/multiphase/wet-steam/set>
droplet-growth-rate rgp-tables
max-liquid-mass-fraction stagnation-conditions
```

```
/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



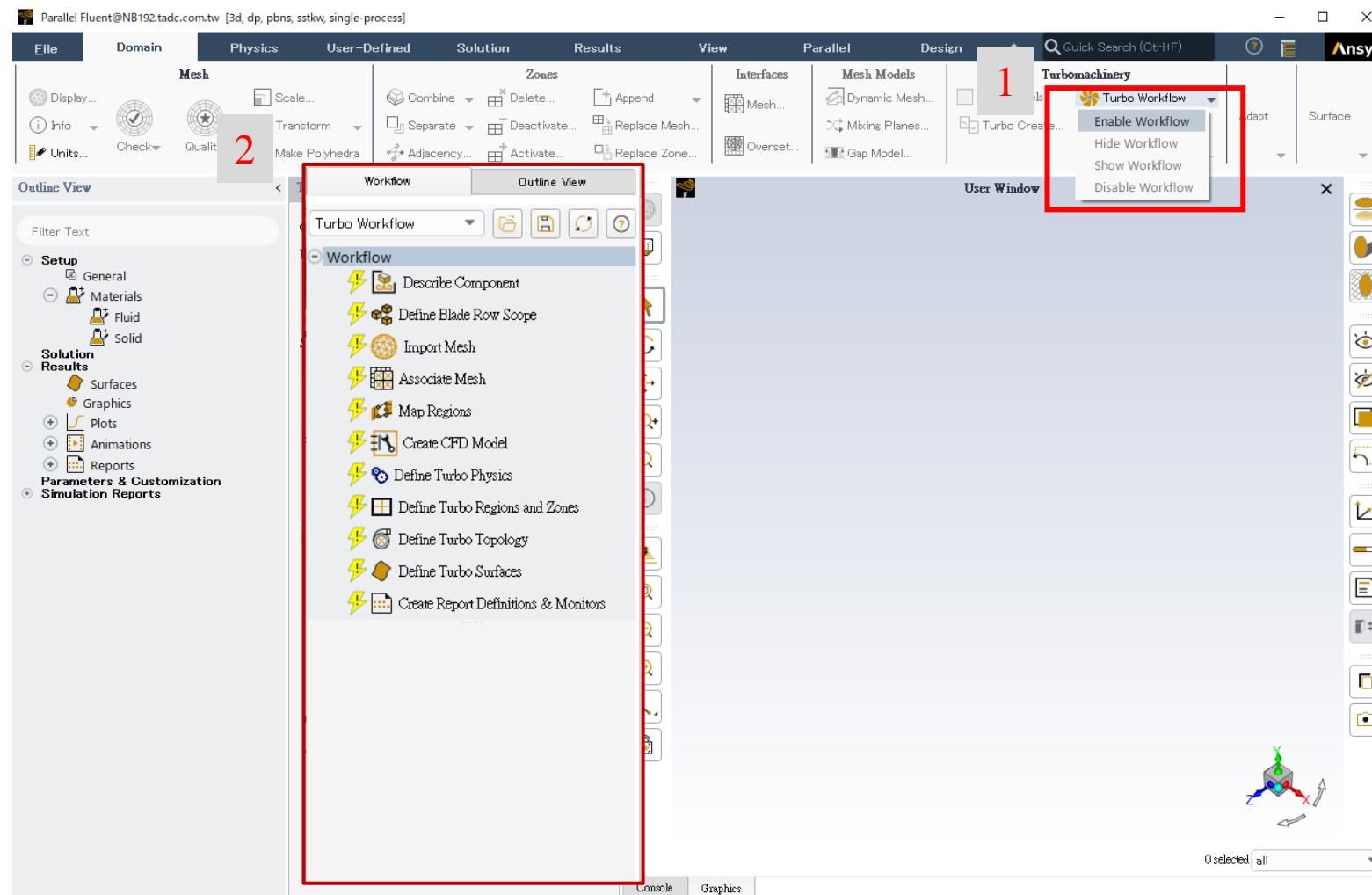
開啟Fluent



License授權必須是Premium以上(Premium或Enterprise)

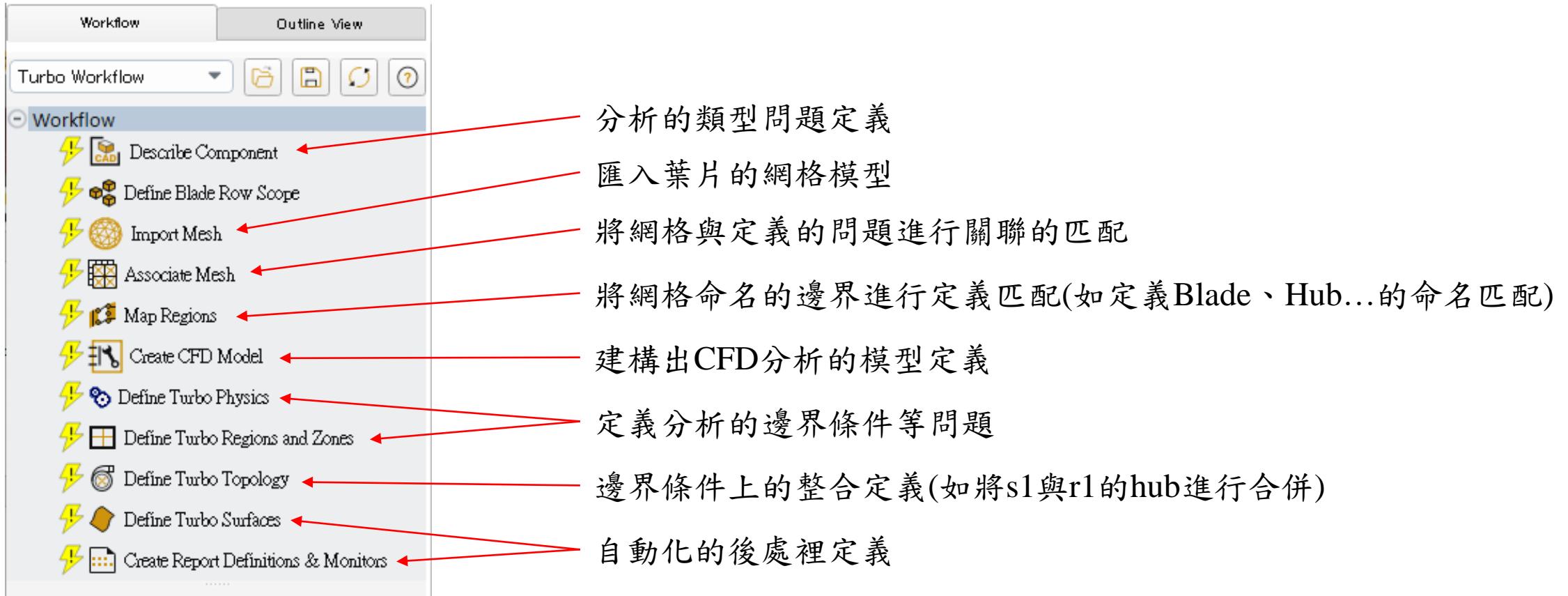
啟用多核心

開啟Fluent TurboWorkflow

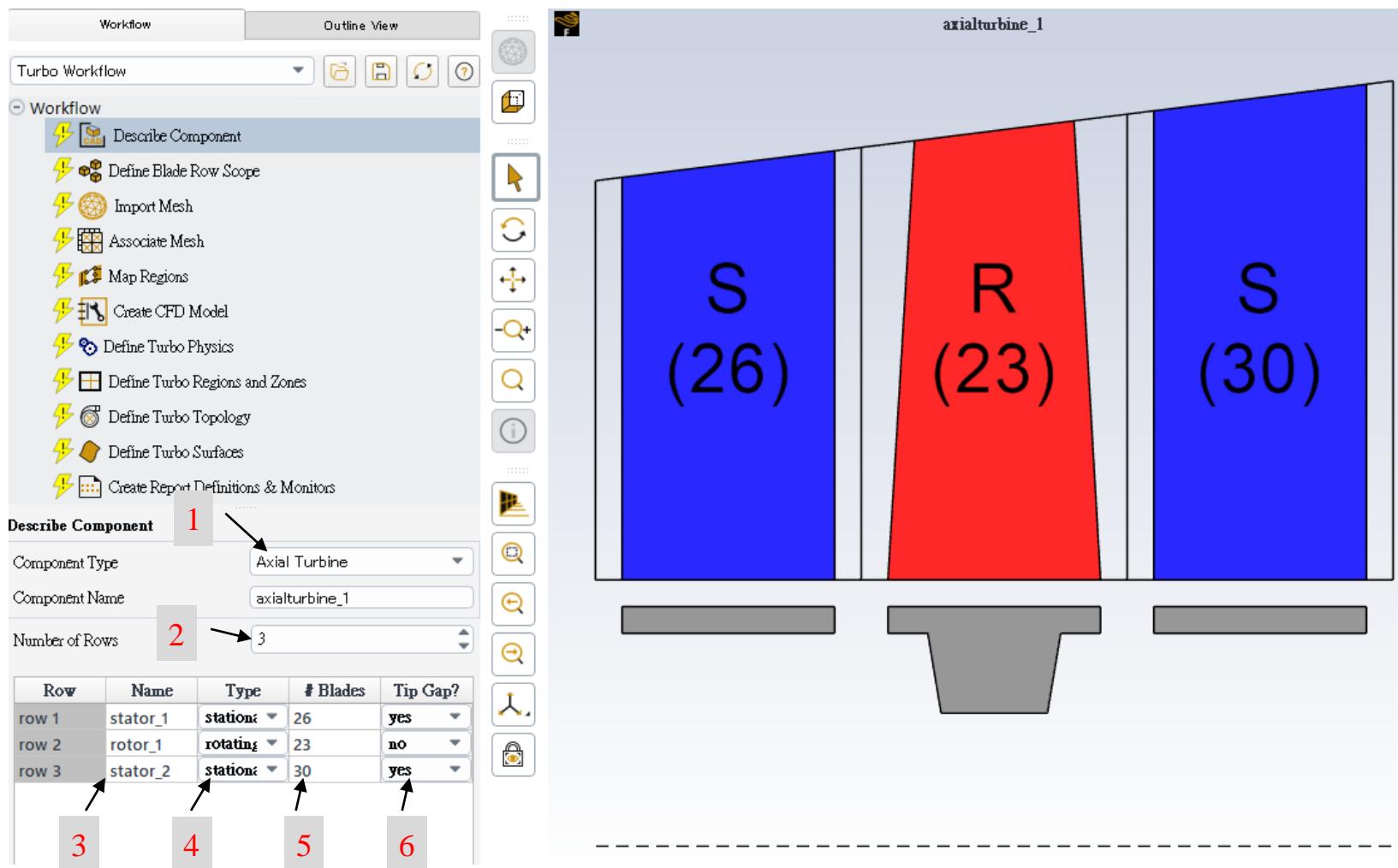


1. 進入Fluent介面後，於上方Ribbon區域開啟Turbo Workflow。
2. 開啟Turbo Workflow後會自動進入到Turbo model的模式，此時可看到流程式的設定模式進程。

TurboWorkflow



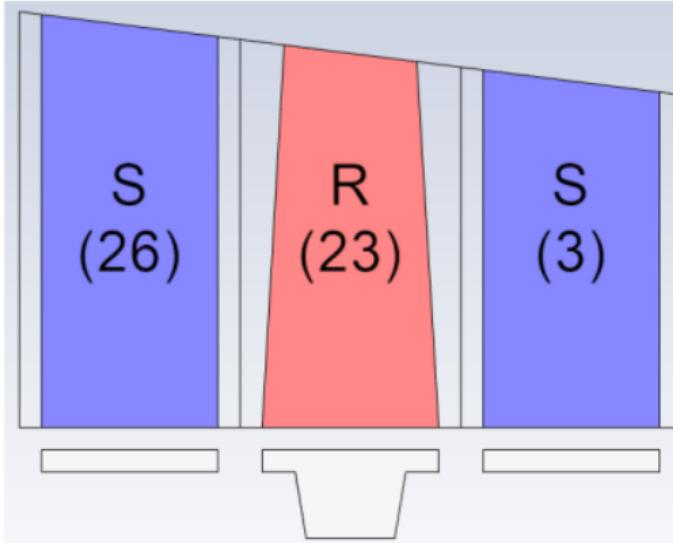
Describe Component



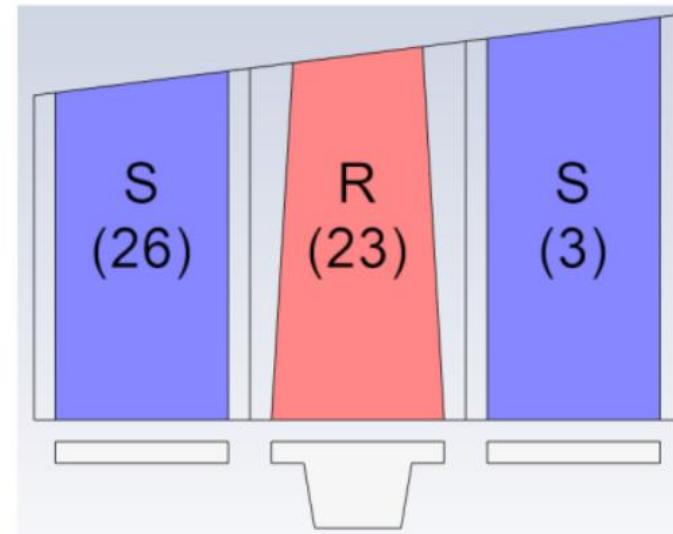
1. 描述分析的問題類型，清單下拉可選擇Compressor及Turbine
2. 描述問題Row的數量
3. 每個Row的命名
4. 每個Row的類型定義，定子/轉子
5. 葉片的數量
6. 是否於翼尖處含有Gap空間

Component type

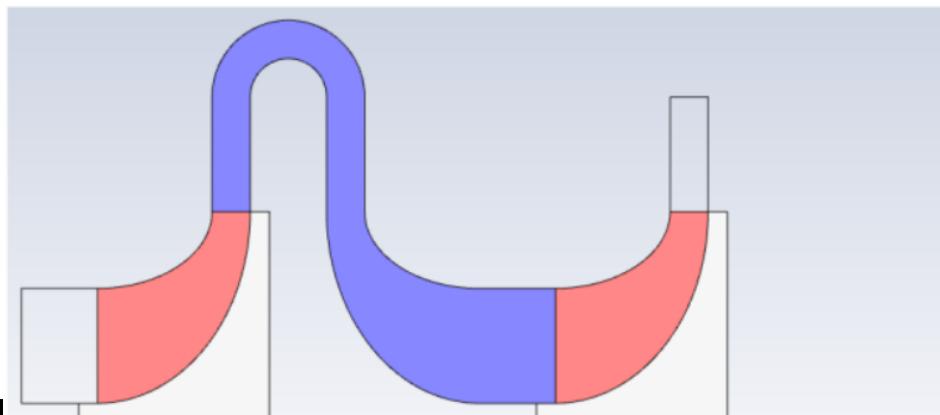
Axial Compressor



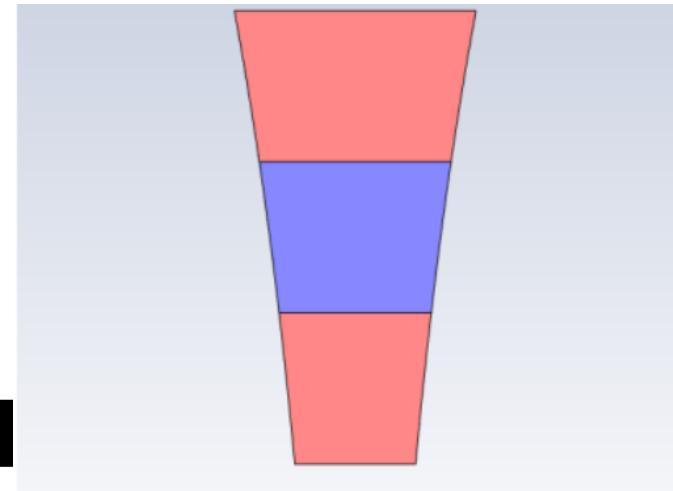
Axial Turbine



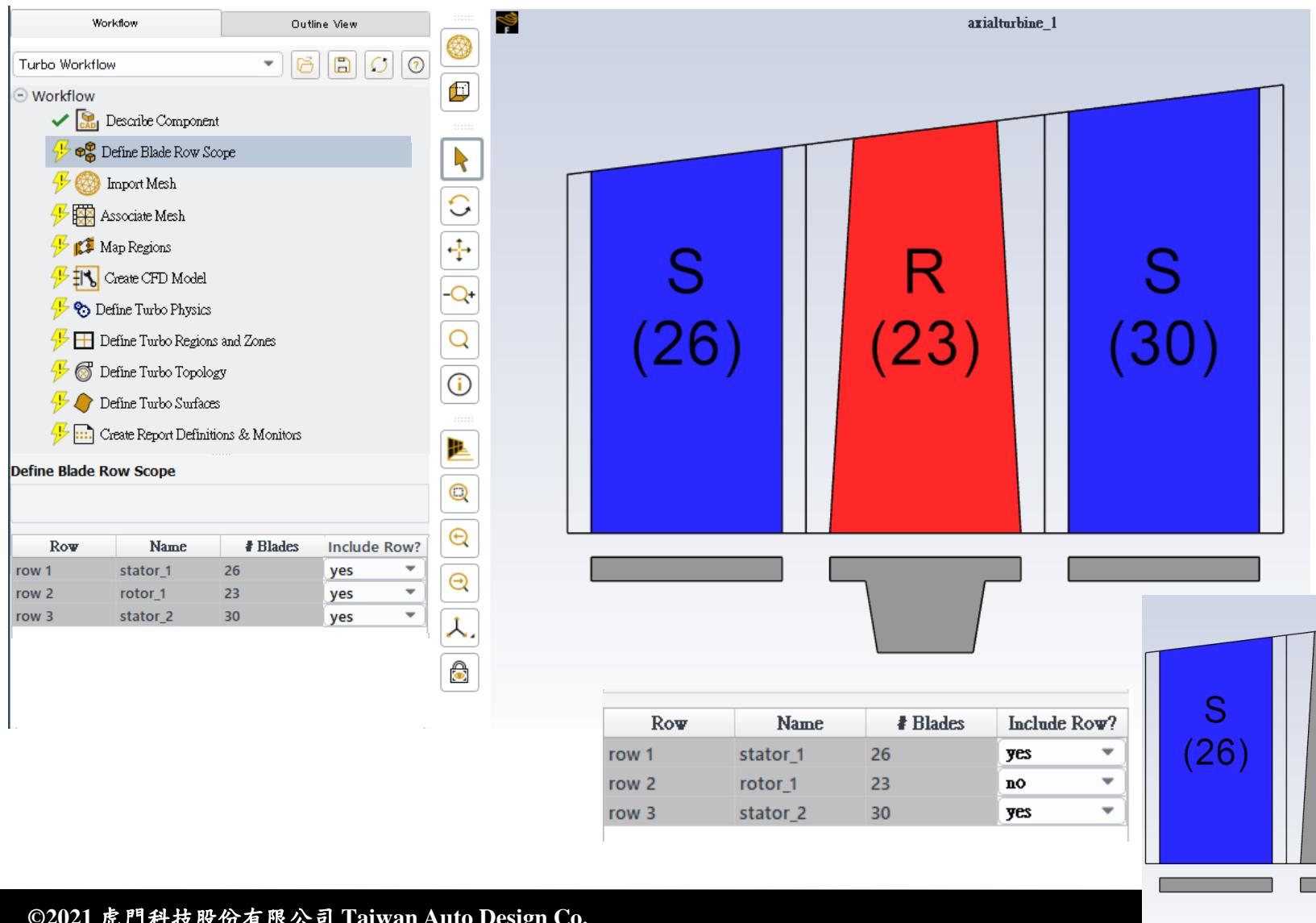
Radial Compressor



Radial Turbine



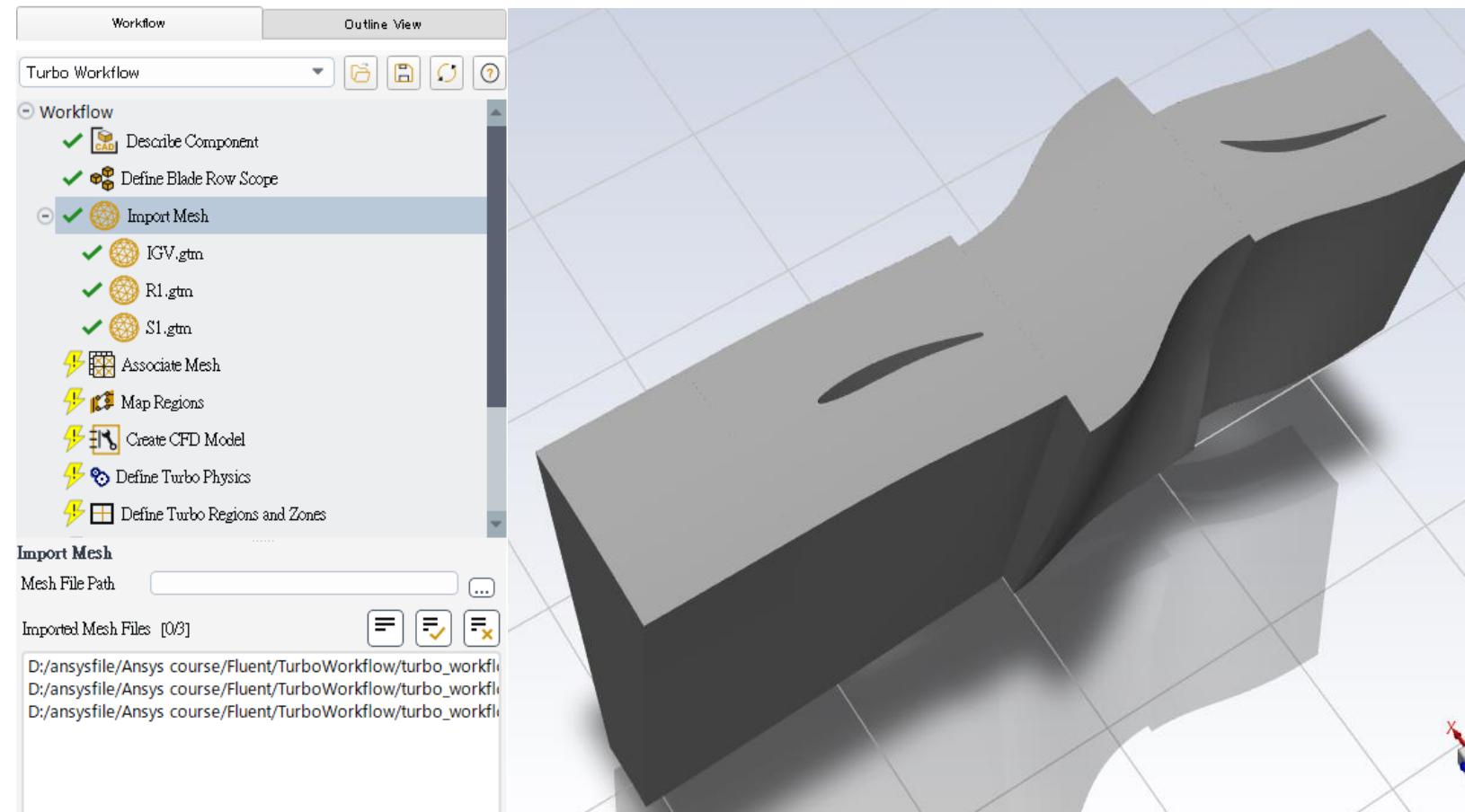
Define Blade Row Scope



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

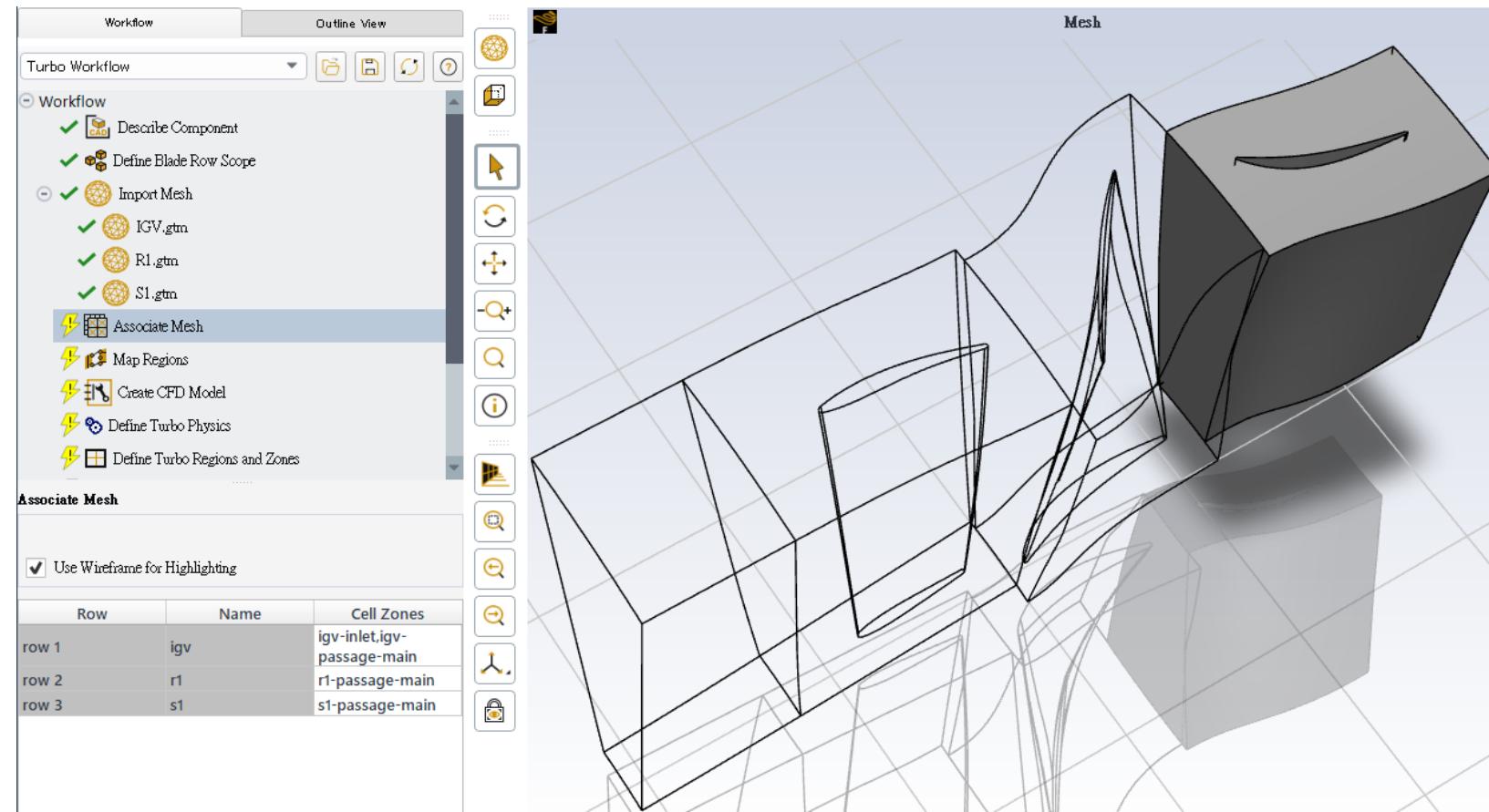
若只想對某幾個Row進行分析，則可以在Include Row中改成no，Row跟Row中請注意需是相連的

Import Mesh



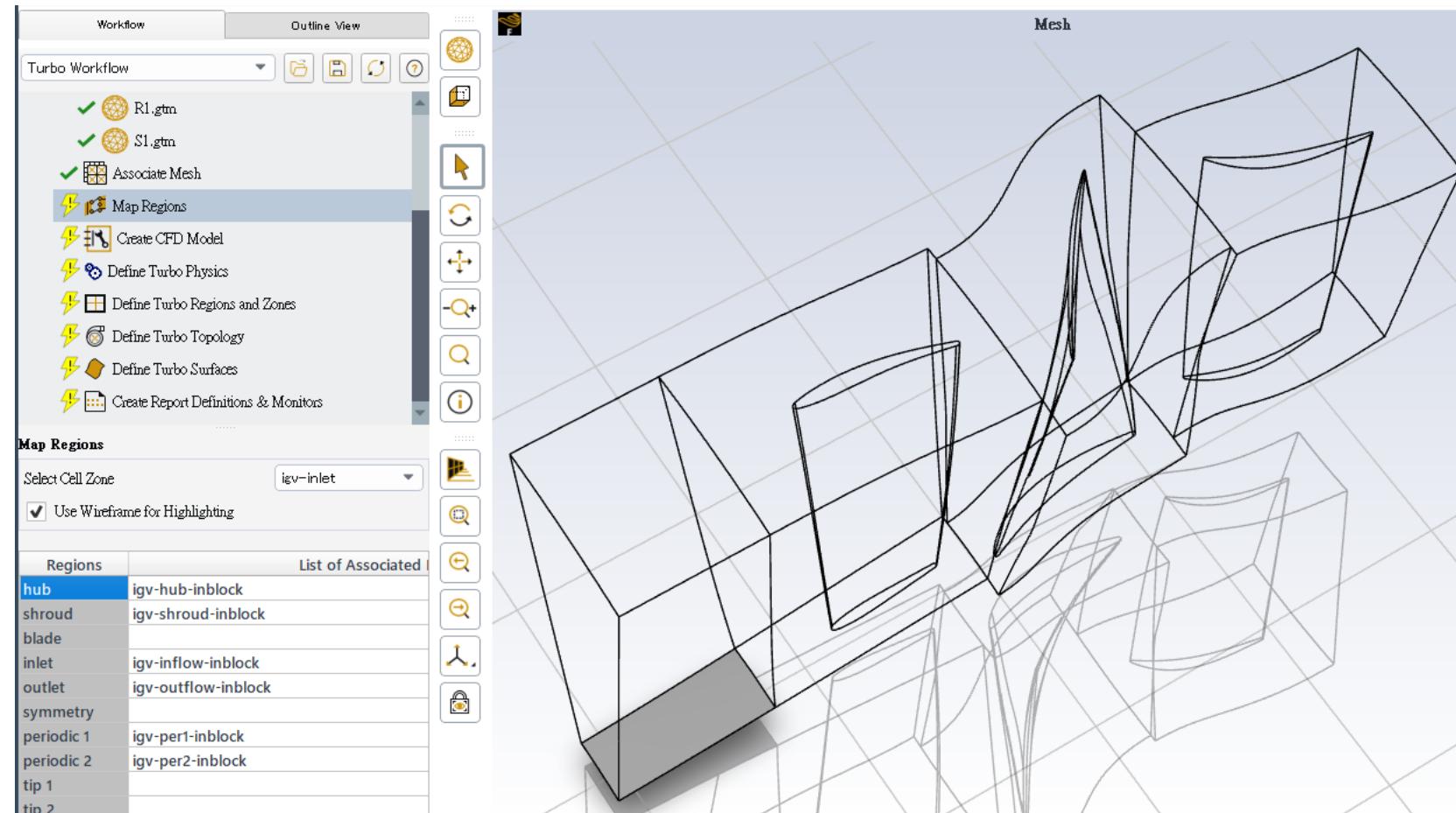
將網格匯入其中，其檔案格式可
讀取.msh、.def、.cgns、.gtm

Associate Mesh



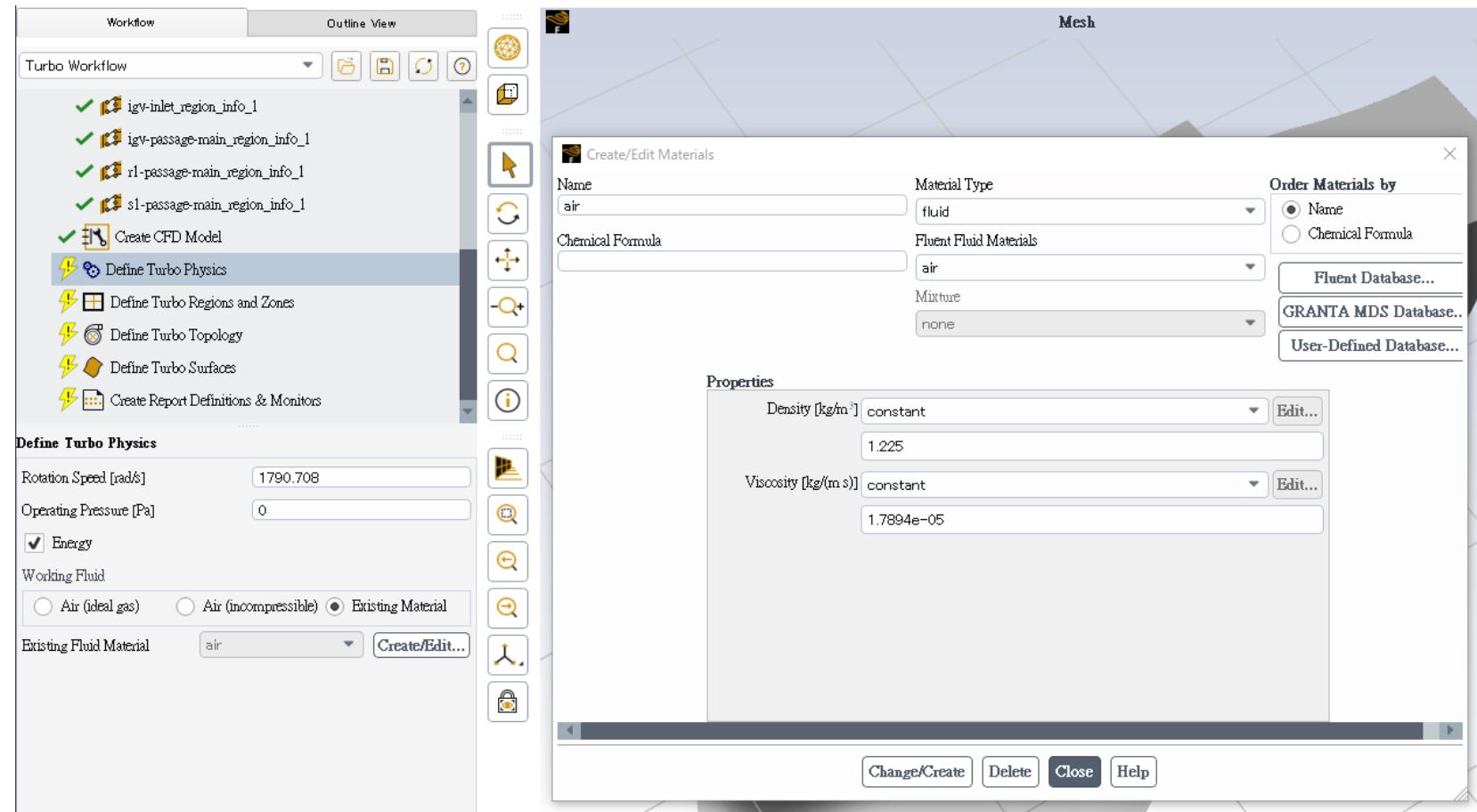
將匯入的網格與所描述的問題定義進行相關性，即將各網格定義到各個Row區域中

Map Regions



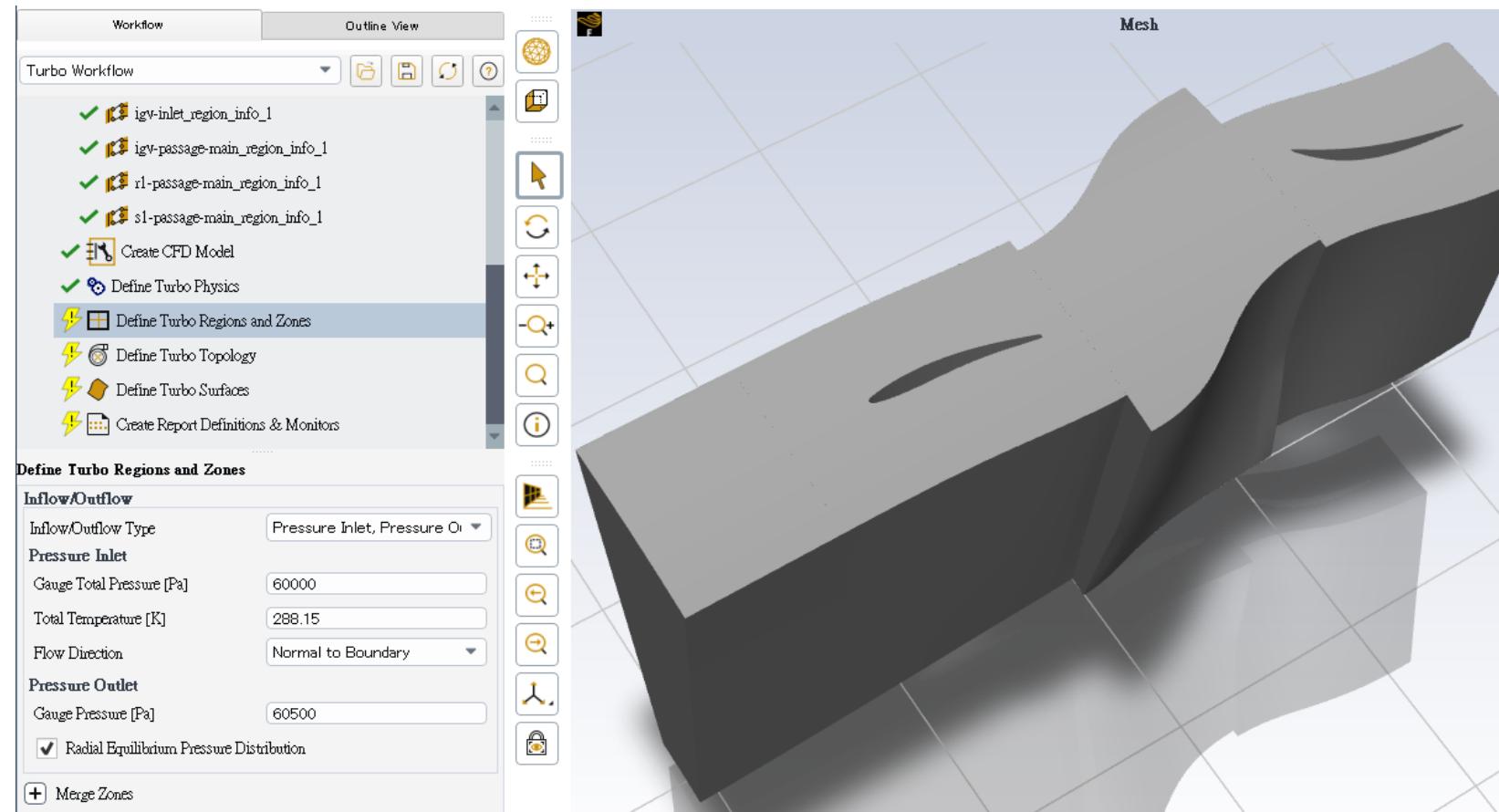
匯入的網格中所命名的邊界與進行Mapping的動作，例如將網格hub處的邊界區域mapping到程式中hub的區域中

Define Turbo Physics



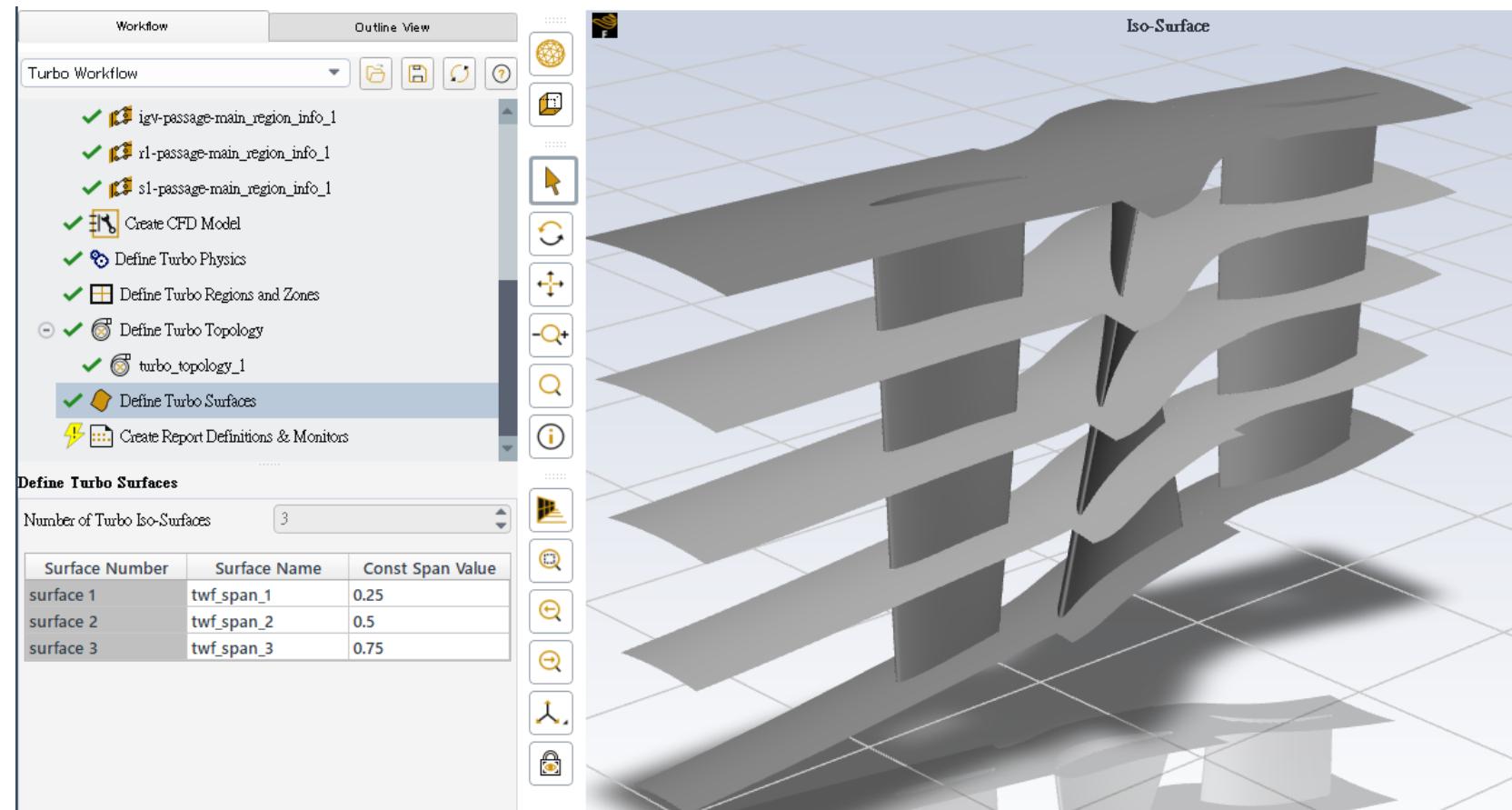
設置分析的物體條件，如轉速、材料性質等等，其材料性質可自行定義

Define Turbo Regions Zones



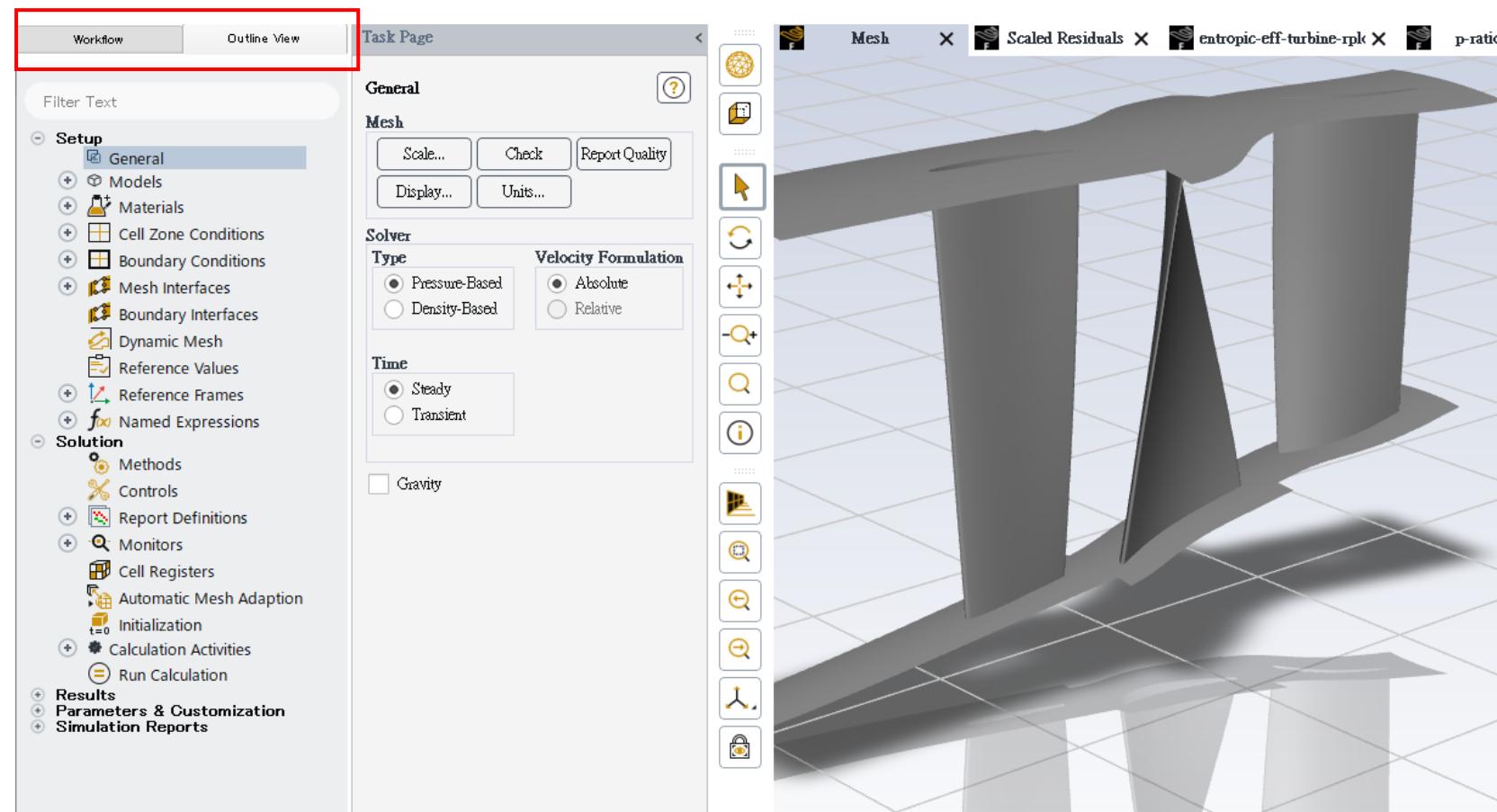
設置分析的邊界條件，可設置壓力出/入口或是值流量出/入口

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

The screenshot displays the Ansys Turbo Workflow interface. On the left, the 'Workflow' and 'Outline View' tabs are selected. The 'Setup' section is expanded, showing categories like General, Models, Materials, Cell Zone Conditions, Fluid (with sub-options igv-inlet, igv-passage-main, r1-passage-main, s1-passage-main), Boundary Conditions, Inlet, Interface, Internal, Outlet, Periodic, Wall, Mesh Interfaces, Boundary Interfaces, Dynamic Mesh, Reference Values, Reference Frames, and Named Expressions. The 'Boundary Conditions' section is currently active, showing a list of boundary conditions: Inlet (igv-inflow-inblock, igv-passage-main), Interface (igv-outflow-passage, r1-inflow-passage, r1-outflow-passage, r1-shroud-tip-ggi-side-1-passage, r1-shroud-tip-ggi-side-2-passage, s1-inflow-passage), Internal (default-interior, default-interior.1, default-interior.1.1, default-interior.021, endwallgap_r1_shroud_tip_ggi_side_1_p...), Outlet (s1-outflow-passage), Periodic (periodic_igv-per1-inblock_igv-per2-inbl..., periodic_igv-per1-passage_igv-per2-pa..., periodic_r1-per1-passage_r1-per2-pass..., periodic_s1-per1-passage_s1-per2-pass...), and Wall (igv-bld-high-geo-high). Below this list are 'Phase', 'Type', and 'ID' dropdown menus.

The main panel shows the 'Task Page' for a 'Fluid' zone named 'r1-passage-main'. The 'Material Name' is set to 'air'. Under 'Boundary Conditions', the 'Rotational Velocity' section is highlighted with a red box, showing 'Speed' set to 'twf_omega'. Other options include 'Frame Motion', '3D Fan Zone', 'Source Terms', 'Mesh Motion', 'Laminar Zone', 'Fixed Values', and 'Porous Zone'. A 'Reference Frame' tab is selected, showing 'Z [m] 0'. The 'Create/Edit Turbo Interfaces' dialog is open, showing 'Mesh Interface' as 'gti_igv_outflow_passage_r1_inflow_passage'. 'Interface Zones Side 1' includes 'igv-outflow-passage' and 'r1-inflow-passage'. 'Interface Zones Side 2' includes 'igv-outflow-passage' and 'r1-inflow-passage'. 'Interface Options' includes 'General Turbo Interface' (checked) and 'Periodic Boundary Condition' (unchecked). 'Pitch-Change Types' includes 'Pitch-Scale', 'No Pitch-Scale', and 'Mixing Plane' (selected).

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

The screenshot shows the ANSYS Workbench interface with two main windows open:

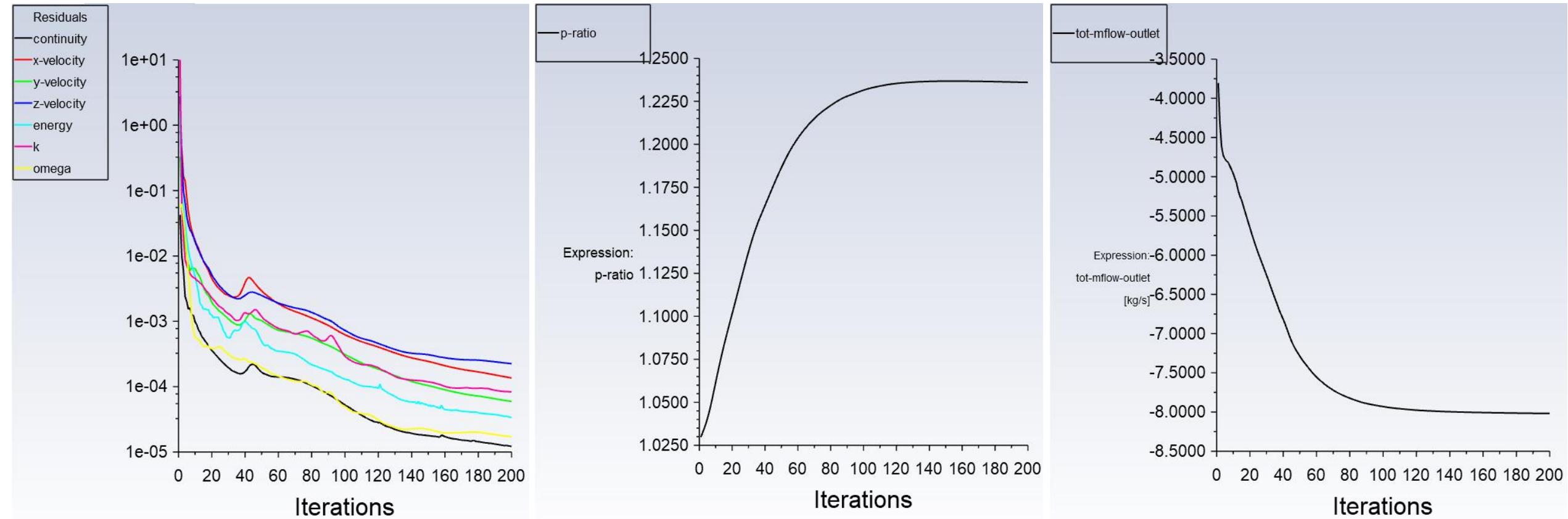
- Workflow Tab:** Shows a tree view of the project setup, including categories like Setup, Solution, Methods, Controls, Report Definitions, Monitors, Cell Registers, Automatic Mesh Adaption, Initialization, Calculation Activities, Run Calculation, Results, Parameters & Customization, and Simulation Reports.
- Outline View Tab:** Shows a detailed tree view of the current setup, specifically under the 'Setup' category. It includes items such as General, Models, Materials, Cell Zone Conditions, Boundary Conditions, Mesh Interfaces, Boundary Interfaces, Dynamic Mesh, Reference Values, Reference Frames, and Named Expressions. The 'Named Expressions' node is expanded, listing various variables and functions like twf_OP, twf_Ps_s1_passage_main_s1_outflow_pa, twf_Pt_igv_inlet_igv_inflow_inblock, twf_Tt_igv_inlet_igv_inflow_inblock, twf_isentropic_eff_turbine, twf_model_num_passages, twf_omega, twf_p_ratio, twf_tot_mflow_outlet, twf_tot_num_passages, and twf_vol_avg_gamma.

Parameter Expression Dialog: This dialog box is open and displays three entries:

- twf_omega:** Name: twf_omega, Definition: 1790.708 [rad/s].
- twf_p_ratio:** Name: twf_p_ratio, Definition: $\text{[Po-outlet]}/[\text{Po-inlet}]$.
- twf_tot_mflow_outlet:** Name: twf_tot_mflow_outlet, Definition: $[\text{mflow-outlet}]*\text{twf_tot_num_passages}/\text{twf_model_num_passages}$.

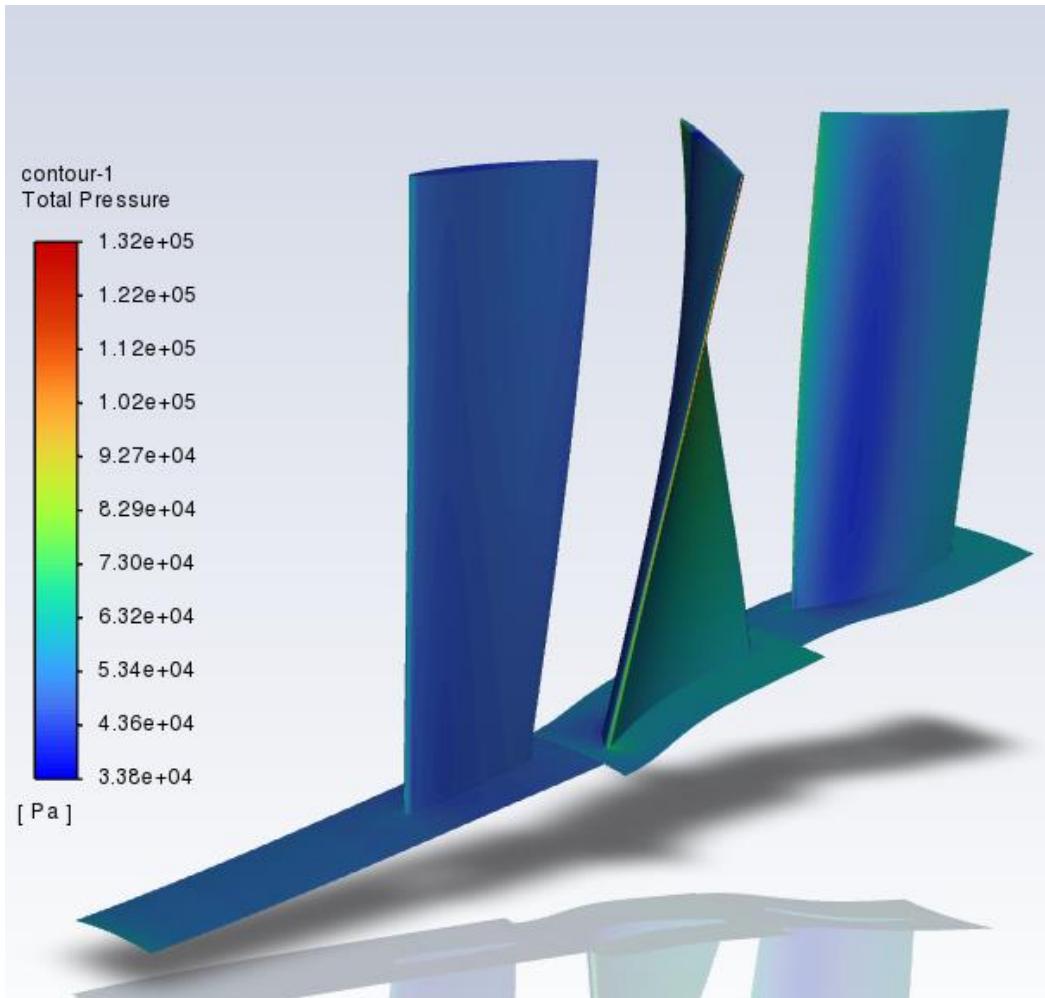
Expression 中除了邊界條件外，Workflow 也定義了在後處理上常會觀測到的數值，如值流量、壓縮比等等

Calculation

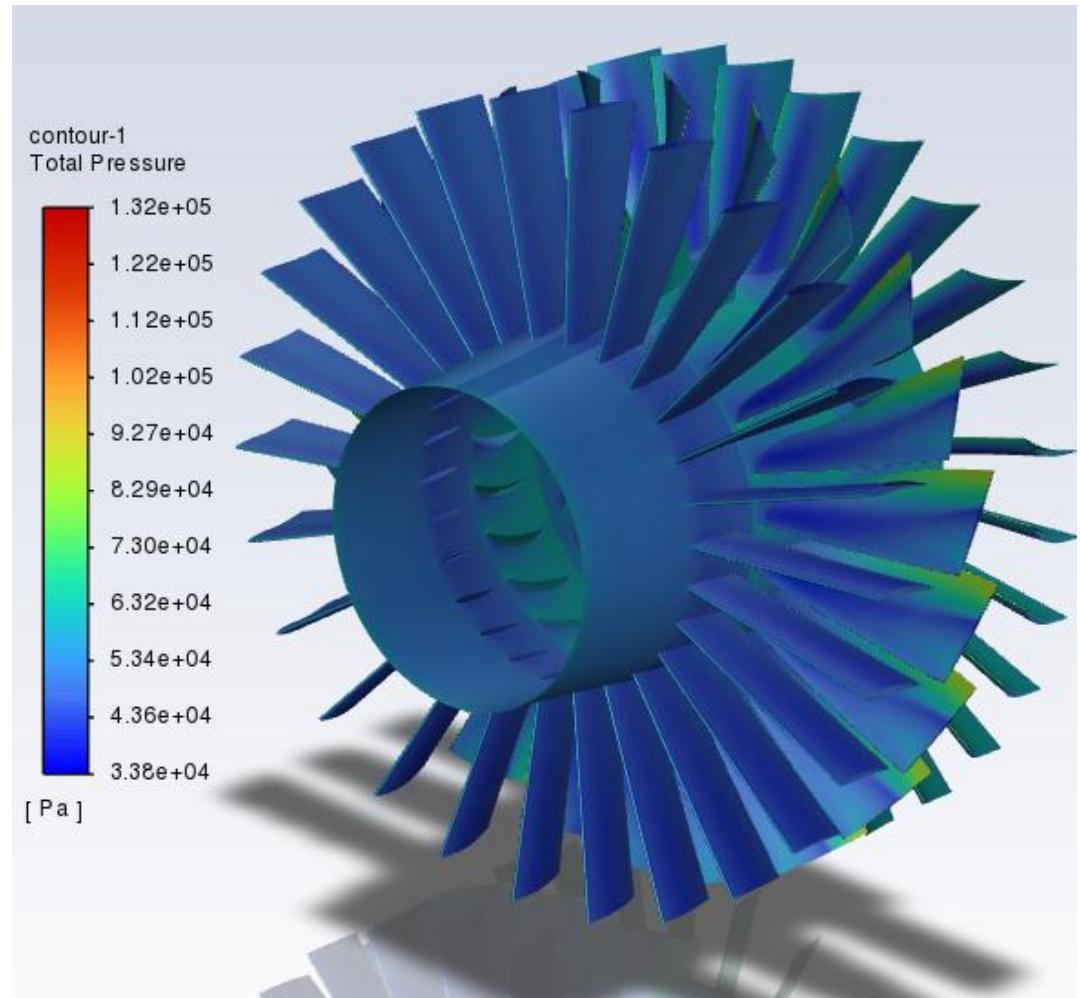


Result

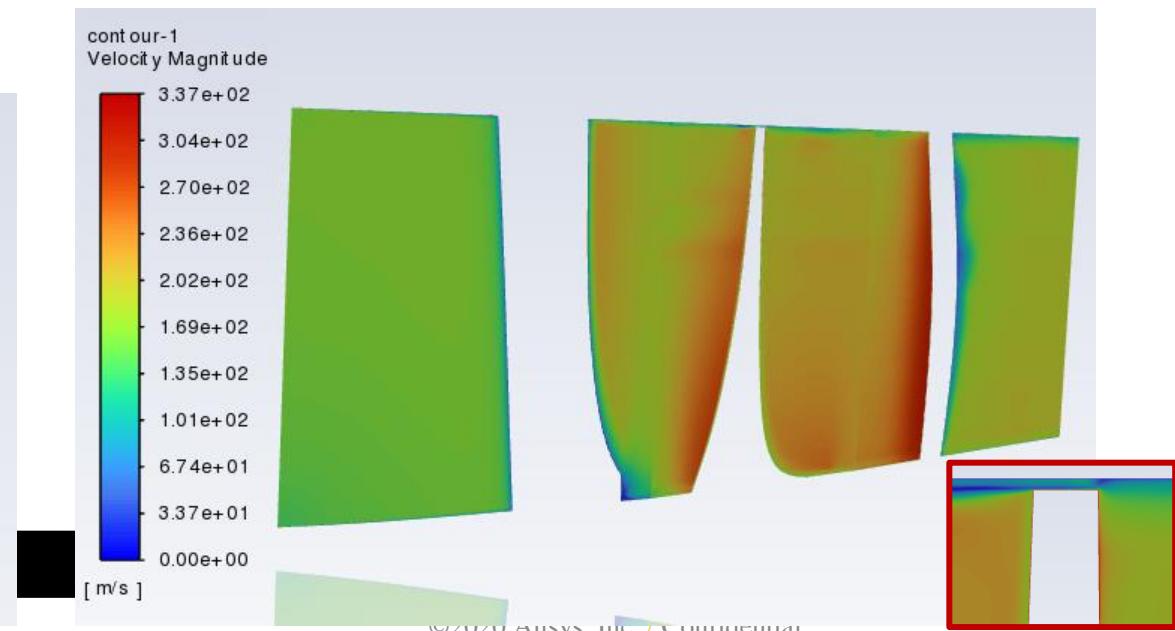
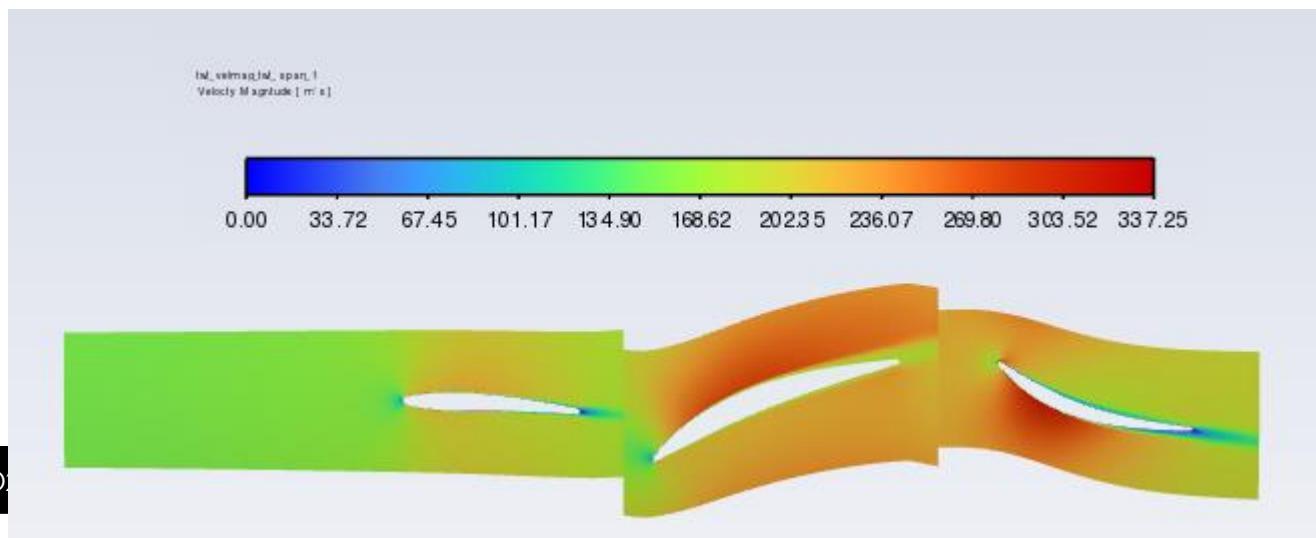
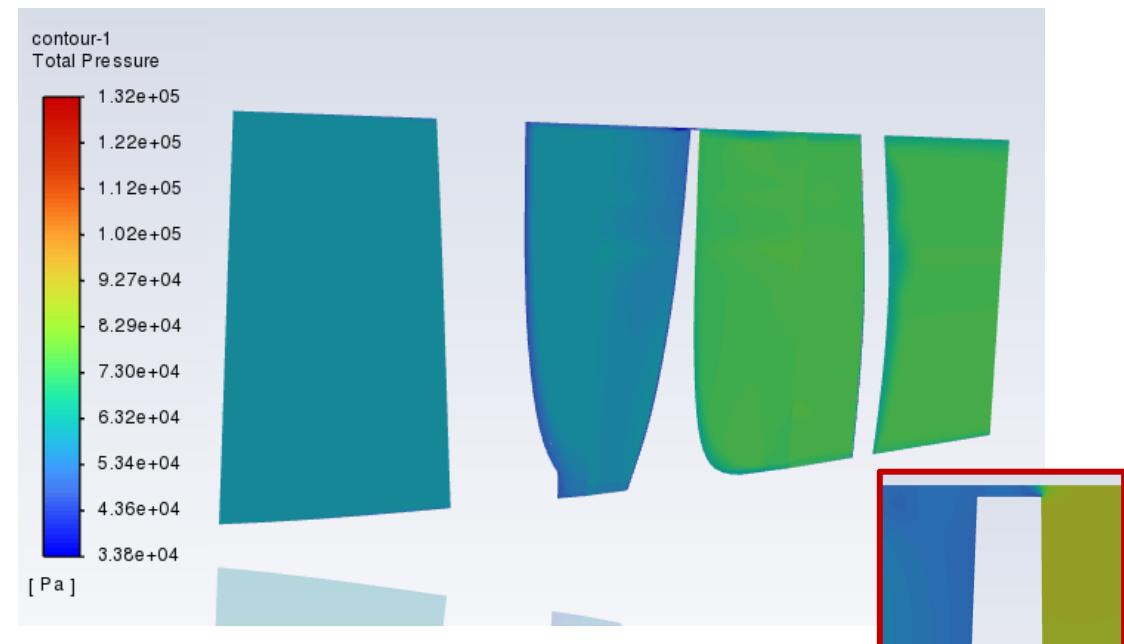
Single Passage



Show Full Model



Result



Thanks!!

Question & Answer

