

Es-ice mapping 发动机模型 流动分析设定详解

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引 言

- 从一个已经完成es-ice发动机模型，如何导入Prostar，需要进行哪些设定，设定时有什么注意事项，如何提交计算，很多用户对这个过程不是特别清楚。
- 本范例基于es-ice附带的mapping tutorial模型，一步一步详细介绍了冷流计算需要进行的各种设定，并提供了一些推荐的设定参数；
- 对于采用Trim或Sector方法制作的发动机模型，也可参考本文档进行设定。

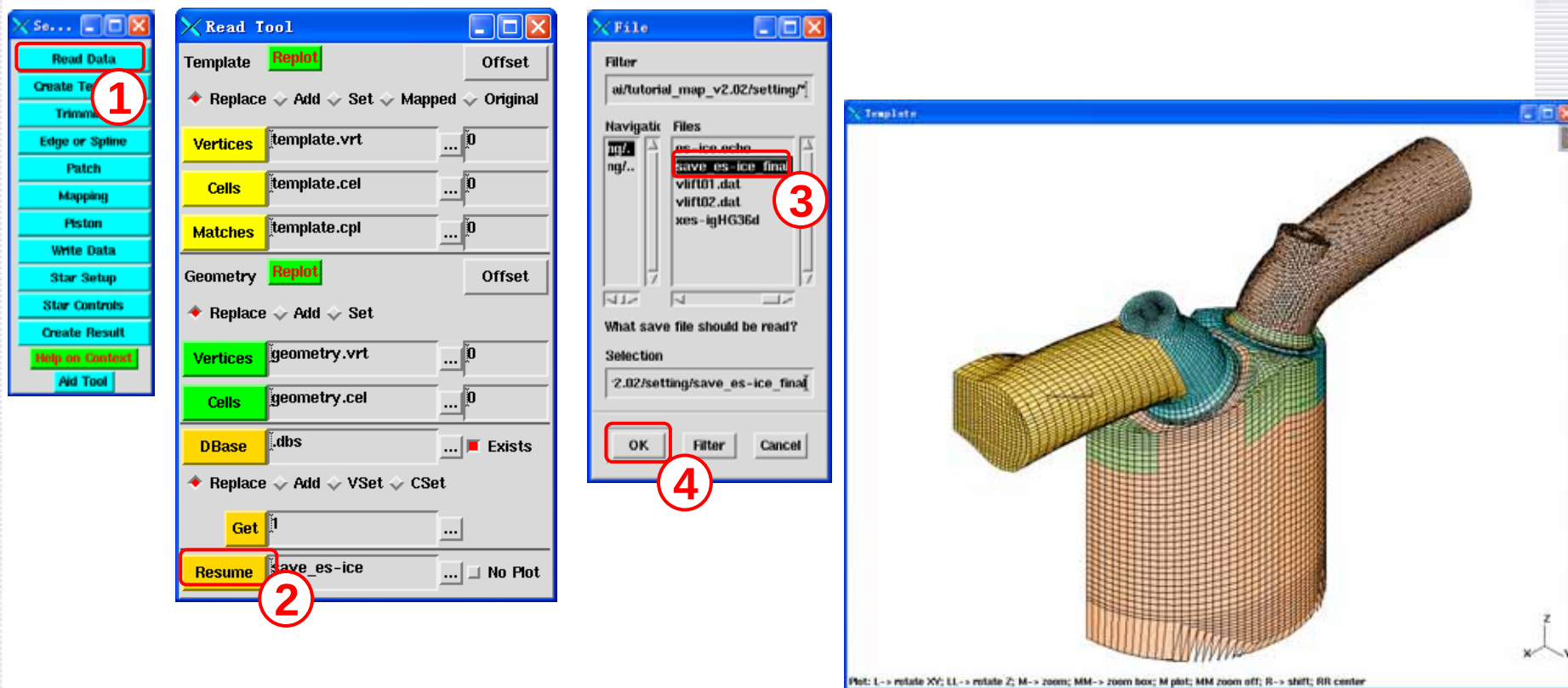
Step 1 目录及文件准备

1. 新建工作目录, 将es-ice模型(save_es-ice_final)拷贝至工作目录
2. 将vlift*.dat拷贝至工作目录

```
cdbjzhong@nec: ~/yelc/Training/Taiwan_Prof.Cai/tutorial_map_v2.02/setting
[cdbjzhong@nec setting]$ ls
save es-ice final vlift01.dat vlift02.dat
[cdbjzhong@nec setting]$
```

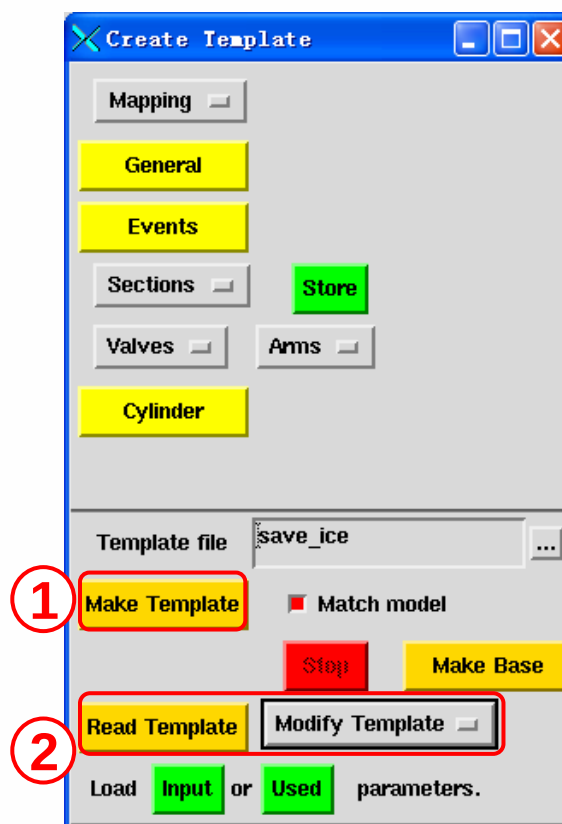
Step 2 读入模型

1. 启动es-ice, resume save_es-ice_final;



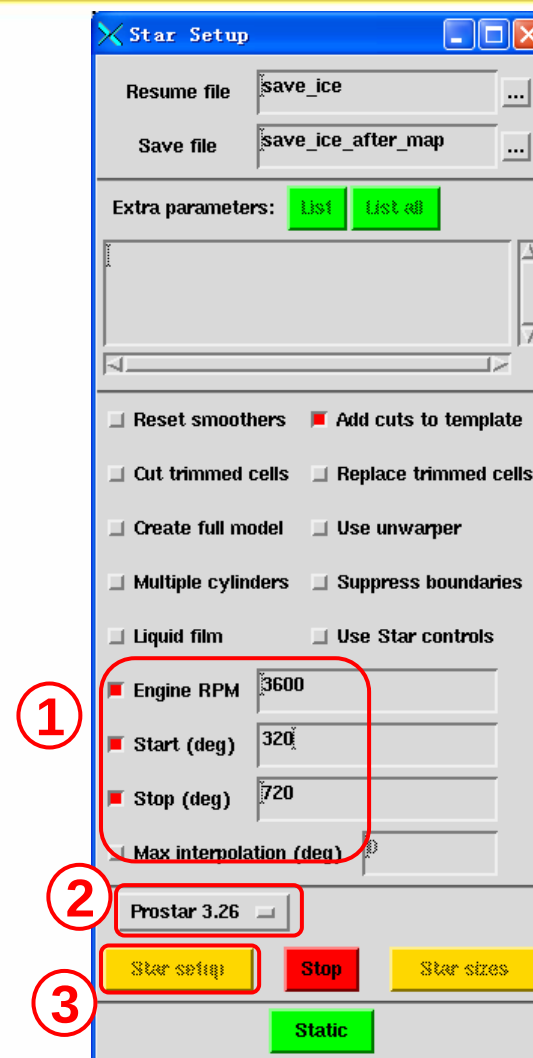
Step 3 创建及读入模板

1. Make Template;
2. Read Template with 'Modify Template' option



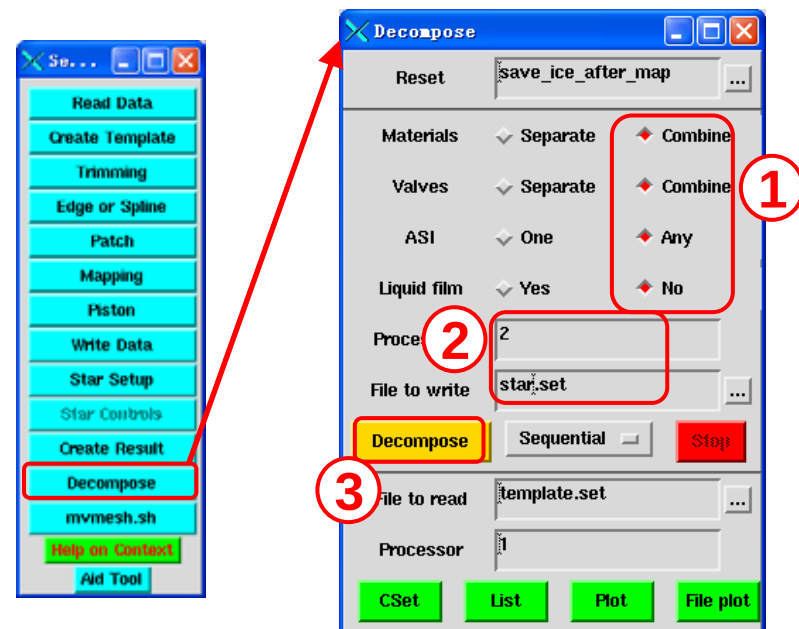
Step 4 Star setup

1. 指定RPM及起始角度;
2. 指定Prostar版本
3. 执行Star setup



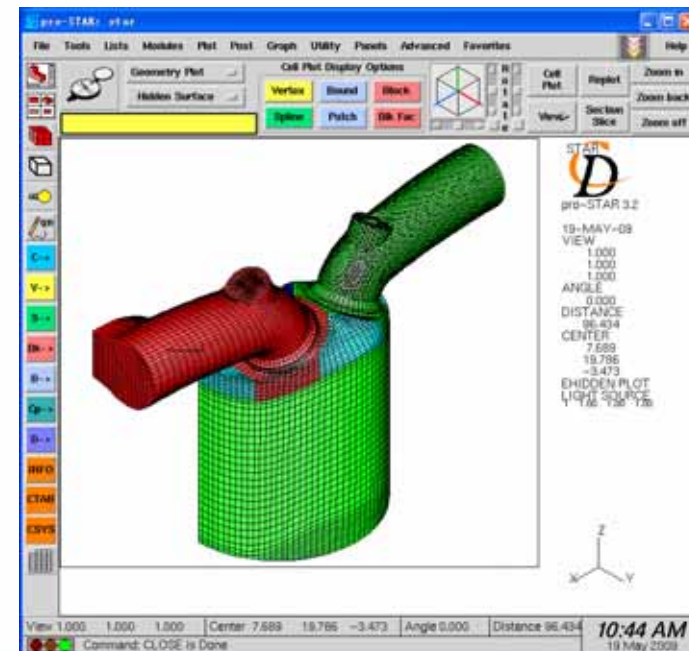
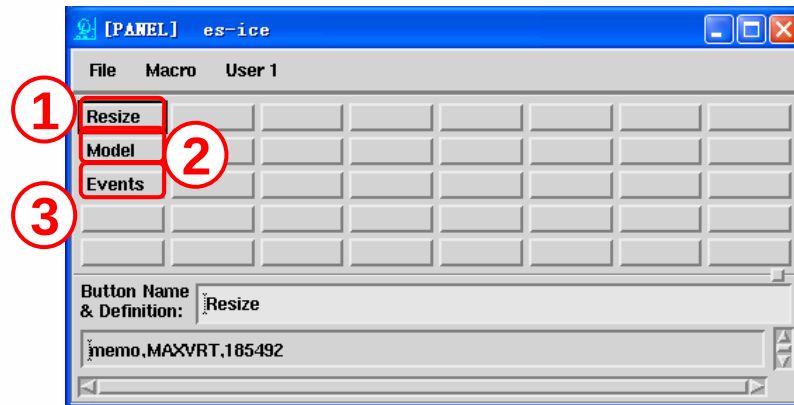
Step 5 Decompose (可选)

- 如果需要并行计算，需要执行decompose以生成.set文件：
 1. 设定控制按钮，如图示即可；
 2. 指定核数和.set文件名；
 3. 执行Decompose。



Step 6 在Prostar中读入模型

- 启动Prostar, es-ice.PNL, 如下图示, 顺次执行三个按钮:
 1. Resize, 设定各种模型参数;
 2. Model, 读入模型(网格, 节点, 边界, couple);
 3. Events, 生成star.evn文件, 控制网格增删和Attach。



Step 7 边界划分 1/6

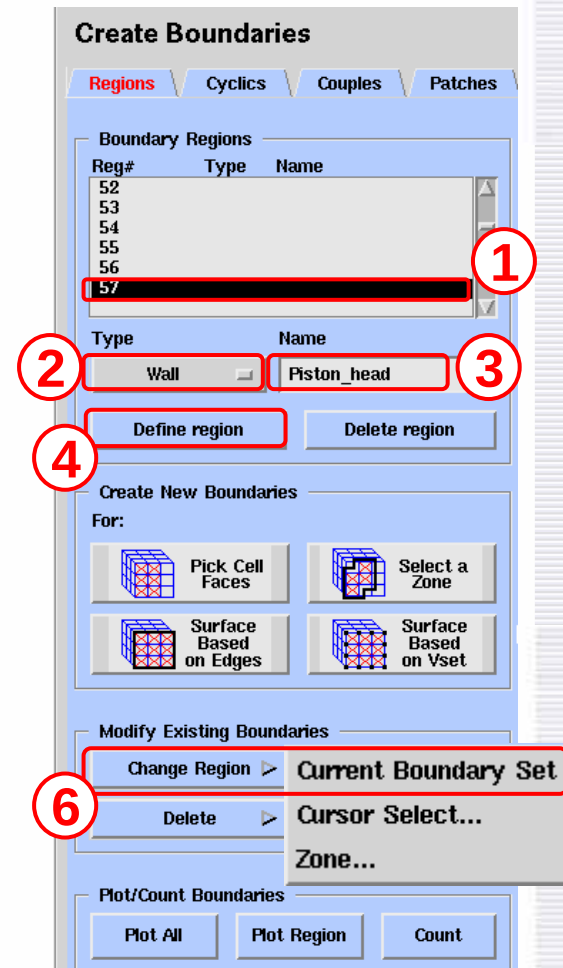
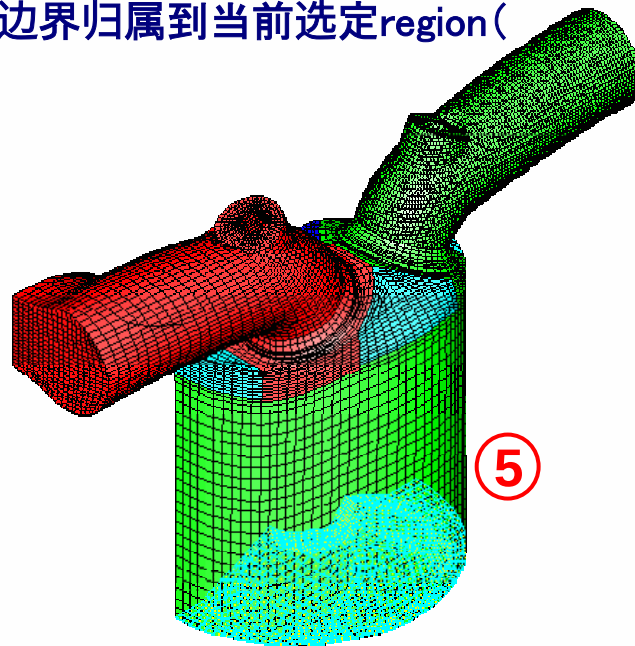
- 读入的原始模型，边界划分比较细碎，重新整理以方便边界条件设定；
- 原始的1-50号边界是关于valve, attach, cylinder_wall, symmetry, 这些边界不要改动；
- 整理的目的是将cylinder_head, Piston_head, Intake pressure, Intake port wall, Exhaust pressure及Exhaust port wall区分开来，可以使用1-50中的空编号存放，也可以使用50号以后的编号存放。
- 我们约定采用下表中Region编号来存放上述各个边界：

Region No.	Region name
57	Piston_head
58	Cylinder_head
59	Intake_pressure
60	Intake_wall
59	Exhaust_pressure
60	Exhaust_wall

Step 7 边界划分2/6-Piston_head

1. 选择region编号——57
2. 选择region类型——Wall
3. 给定region 名称——Piston_head
4. 定义Region
5. 选择Piston head上的边界，可使用用右框中命令流
6. 将当前所选边界归属到当前选定region (57)

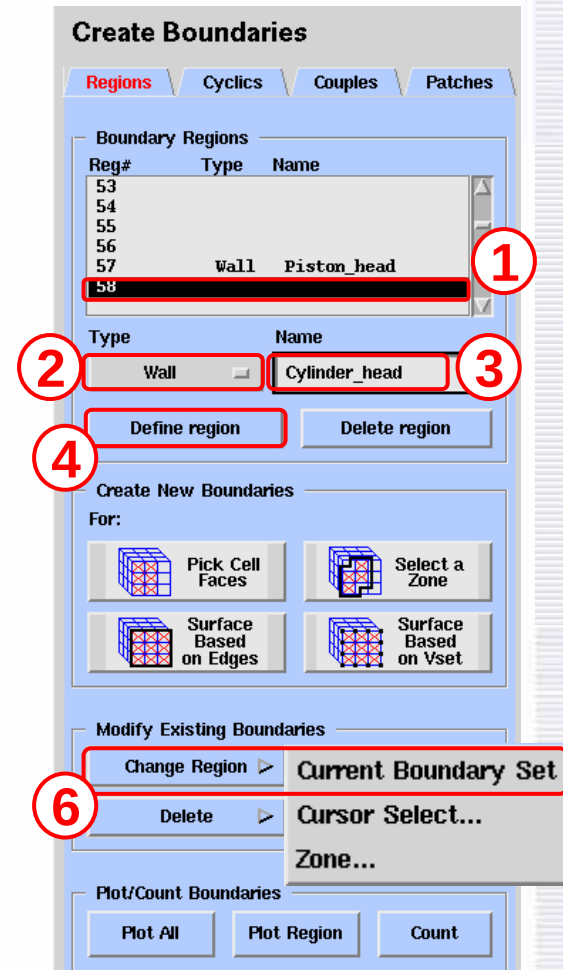
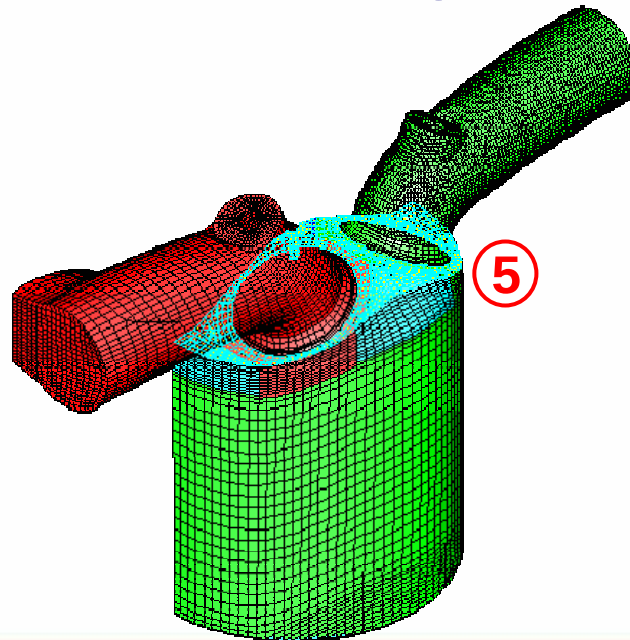
```
cset news mate 1
vset news cset
bset news vset all
bset dele regi 1 50
bset dele attach
bset subs zone
```



Step 7 边界划分3/6-Cylinder_head

1. 选择region编号——58
2. 选择region类型——Wall
3. 给定region 名称——Cylinder_head
4. 定义Region
5. 选择Cylinder head上的边界，可使用右框中命令流
6. 将当前所选边界归属到当前选定region (58)

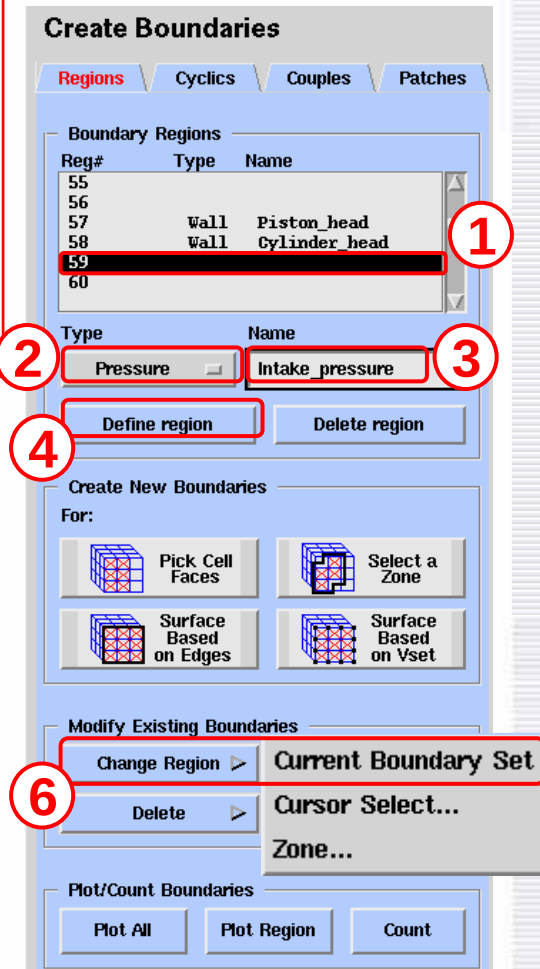
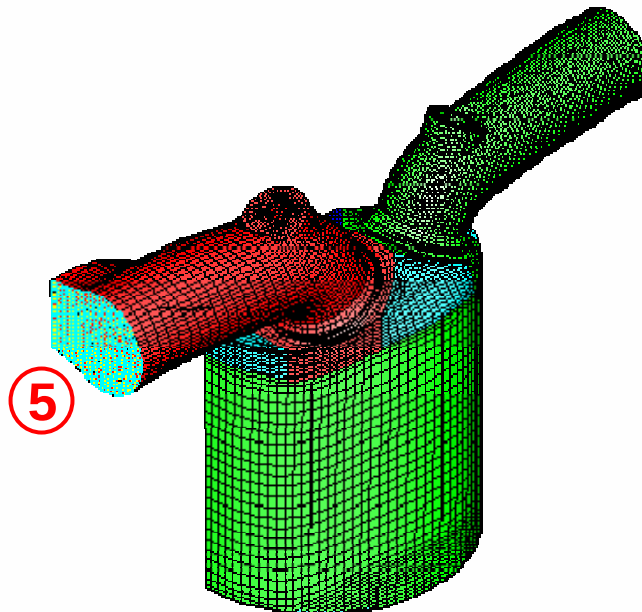
```
cset news mate 1
vset news cset
bset news vset all
bset dele regi 1 50
bset dele attach
bset dele regi 57
bset subs zone
```



Step 7 边界划分4/6-Intake pressure

1. 选择region编号——59
2. 选择region类型——Pressure
3. 给定region 名称——Intake_pressure
4. 定义Region
5. 选择Intake pressure边界, 可使用右框中命令流
6. 将当前所选边界归属到当前选定region (59)

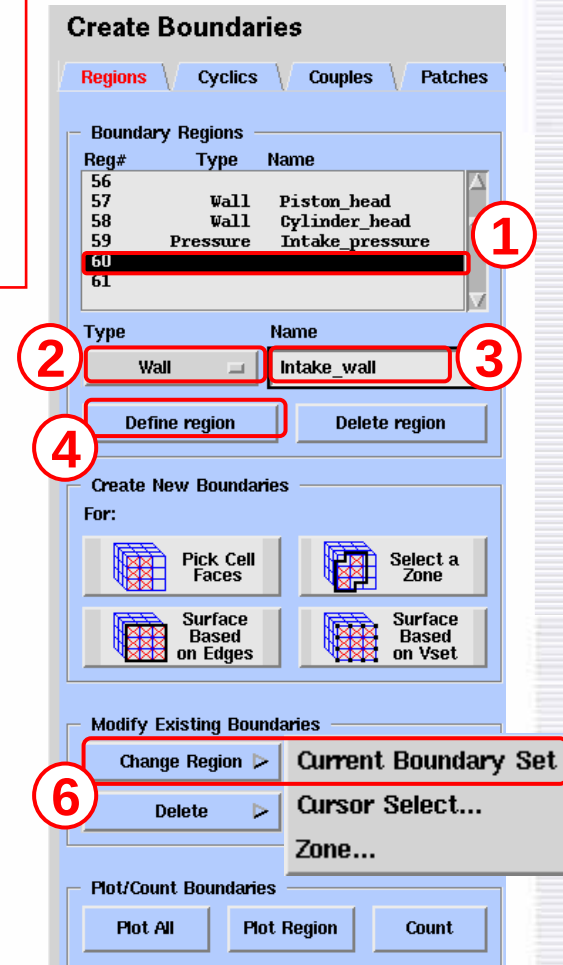
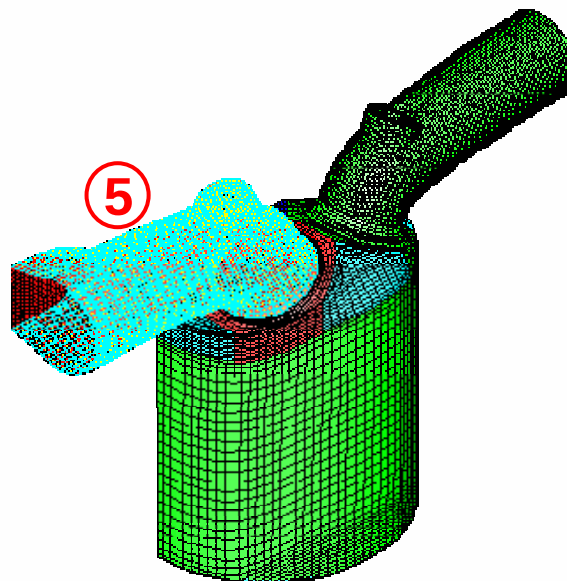
```
cset news mate 2
vset news cset
bset news vset all
bset dele regi 1 50
bset dele attach
bset dele regi 57 58
bset subs zone
或bset subs regi bxr
```



Step 7 边界划分5/6-Intake pressure

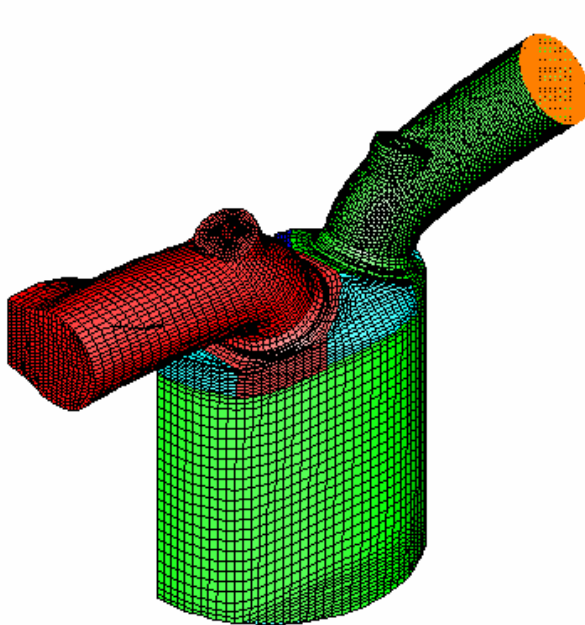
1. 选择region编号——60
2. 选择region类型——Wall
3. 给定region 名称——Intake_wall
4. 定义Region
5. 选择Intake wall边界, 可使用右框中命令流
6. 将当前所选边界归属到当前选定region (60)

```
cset news mate 2
vset news cset
bset news vset all
bset dele regi 1 50
bset dele attach
bset dele regi 57 59
```

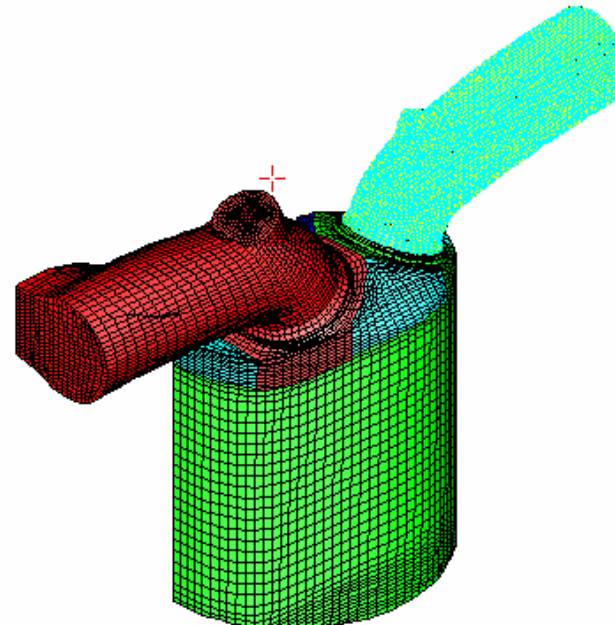


Step 7 边界划分6/6-Exhaust pressure & wall

1. 划分Exhaust port上的边界请参考前面Intake port的操作步骤进行;
2. 应将参考命令流中cset news mate 2改为cset news mate 3.



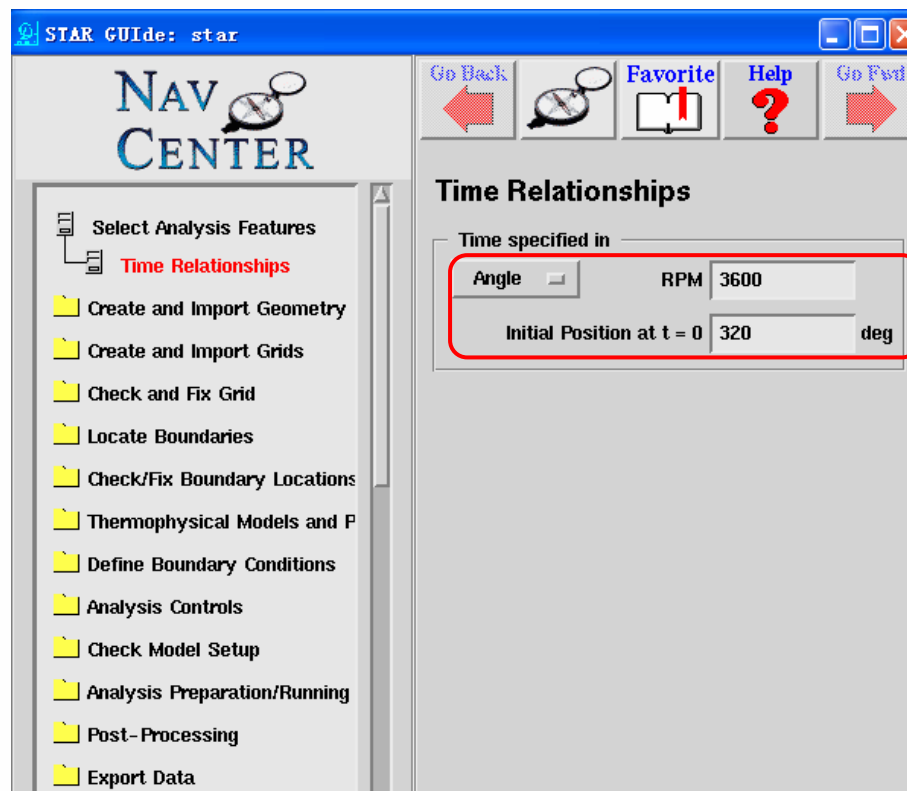
Exhaust_pressure



Exhaust_wall

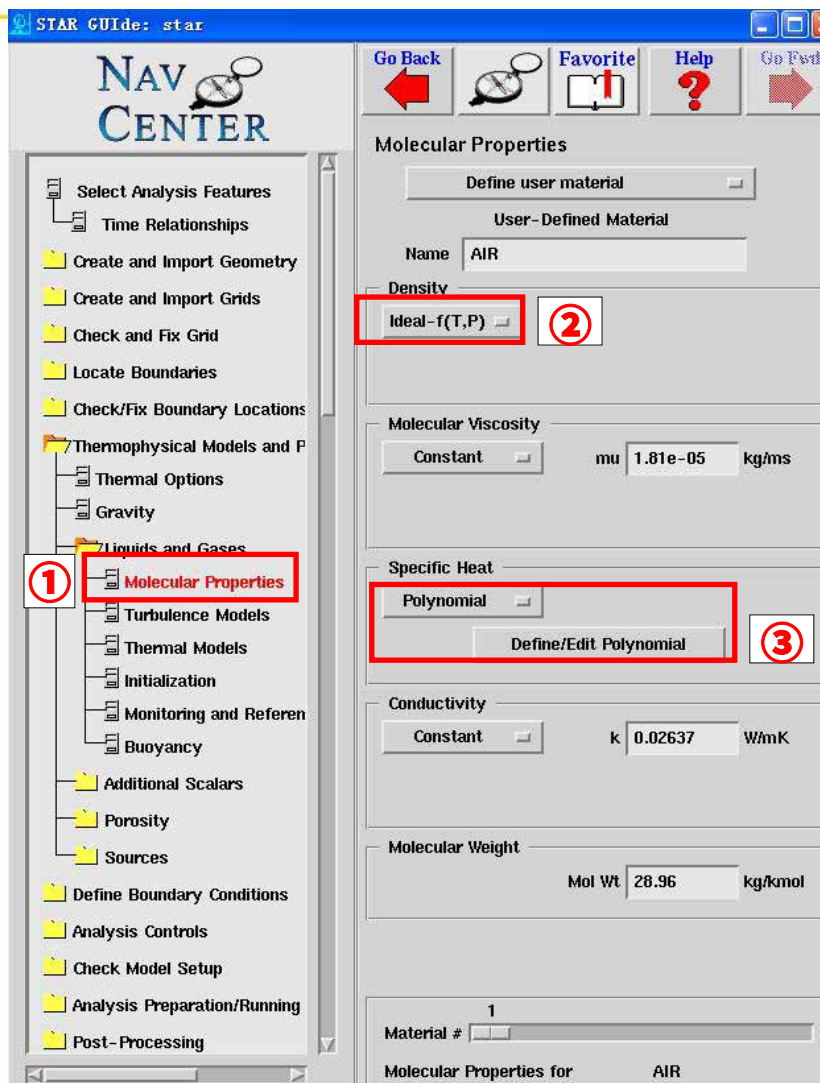
Step 8 模型及物性设定 1/4

1. 设定瞬态计算



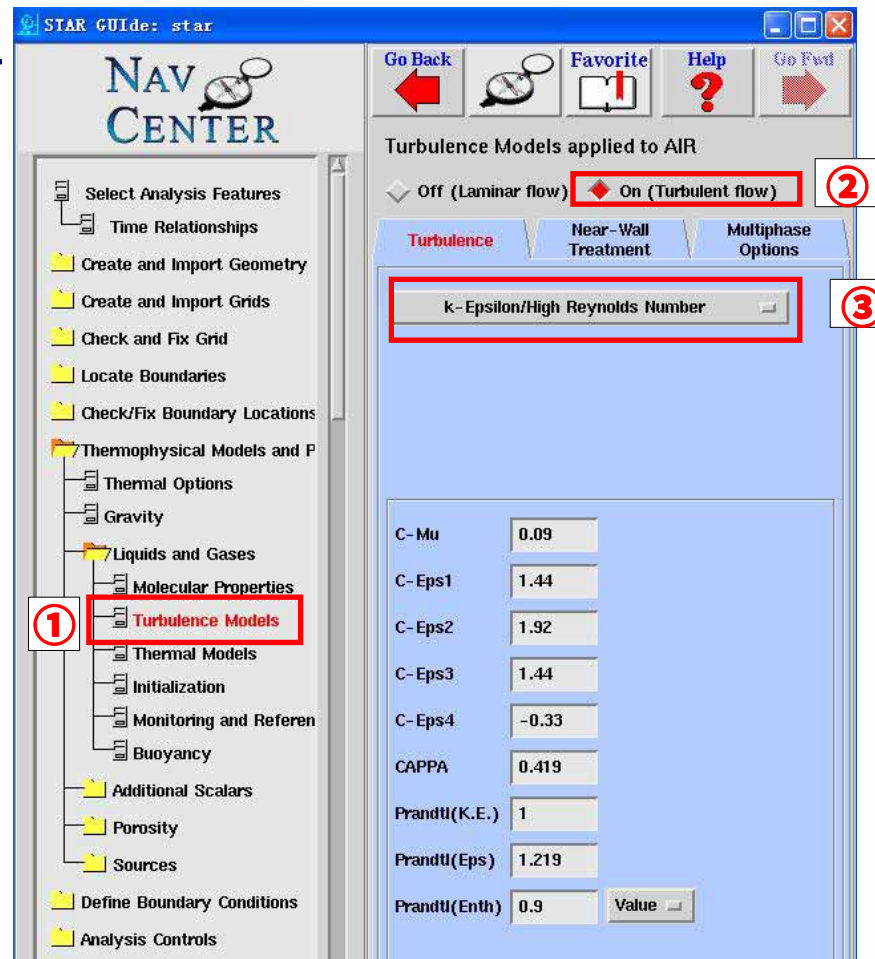
Step 8 模型及物性设定 2/4

- 设定流体属性



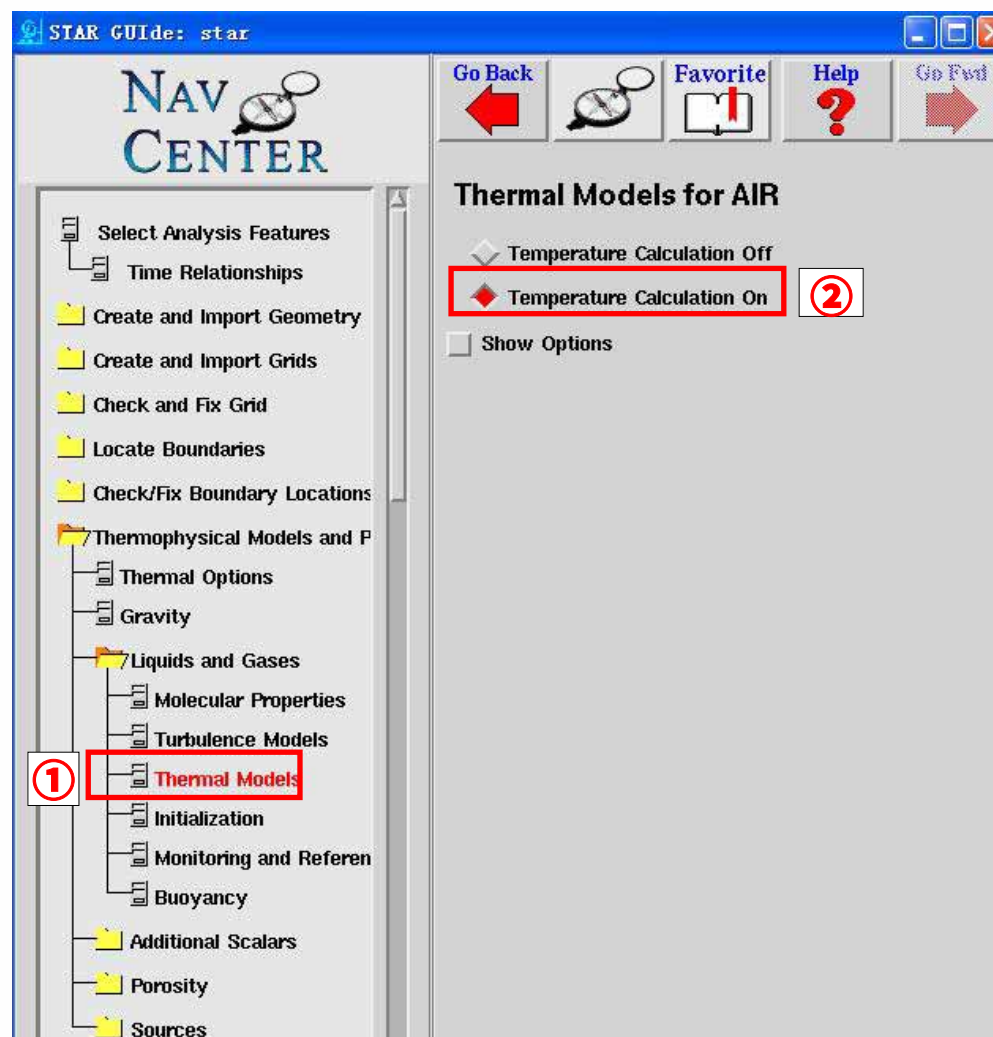
Step 8 模型及物性设定 3/4

● 设定湍流模型



Step 8 模型及物性设定 4/4

- 设定温度求解



Step 9 边界条件设定 1/3

- 对于流动计算，需要设定的边界条件主要有壁面温度（或采用绝热边界）和进出口温度/压力/湍流参数；
- 为简单起见，本例中所有壁面均采用绝热边界；进出口采用环境压力和温度，不设置湍流参数；

Define Boundary Regions

Reg#	Type	Name
56		
57	Wall	Piston_head
58	Wall	Cylinder_head
59	Pressure	Intake_pressure
60	Wall	Intake_wall
61	Pressure	Exhaust_pressure

◆ Region Setup ◇ Plot Boundary

Region Type: Region Name:

Options:

Option	Envir Press	Mean
Piezo	<input checked="" type="button" value="On"/>	Off
Pressure (Pa) 0	# Av Intervals 	
Turb. Intensity 	Length (m) 	Turb. Switch None
Temp. (K) 293		Temp. Switch Temp.
T Radiation (K) 	Emissivity 	Scalar Switch Fixed
UVW Off	Coord. Sys 	Omega (rpm)
U (m/s) 	V (m/s) 	W (m/s)

Define Boundary Regions

Reg#	Type	Name
56		
57	Wall	Piston_head
58	Wall	Cylinder_head
59	Pressure	Intake_pressure
60	Wall	Intake_wall
61	Pressure	Exhaust_pressure

◆ Region Setup ◇ Plot Boundary

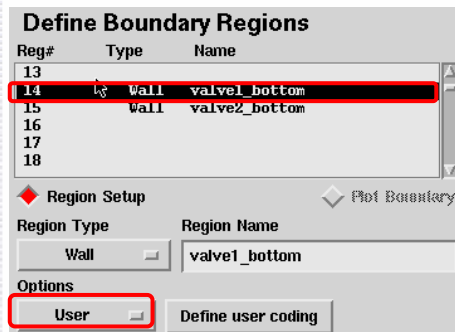
Region Type: Region Name:

Options:

Option	Envir Press	Mean
Piezo	Off	<input checked="" type="button" value="On"/>
Pressure (Pa) 0	# Av Intervals 	
Turb. Intensity 	Length (m) 	Turb. Switch None
Temp. (K) 293		Temp. Switch Temp.
T Radiation (K) 	Emissivity 	Scalar Switch Fixed
UVW Off	Coord. Sys 	Omega (rpm)
U (m/s) 	V (m/s) 	W (m/s)

Step 9 边界条件设定 2/3

- 对于运动壁面边界（包括气阀，活塞顶，所有的Attach），还需要指定壁面速度。
- 在es-ice模型star setup过程中，会在工作目录下生成一个名为bcdefw.f的用户子程序，该程序会依照气阀和活塞运动规律自动计算运动壁面速度。用户只需对相关运动边界打开用户子程序开关(指定为User)，并在bcdefw.f中指定运动边界（只需给定piston_head）的region number。
- 运动壁面边界包括：valve*_bottom; valve*_top; valve*_alternate_attachment; Piston_head.



Reg#	Type	Name
13		
14	Wall	valve1_bottom
15	Wall	valve2_bottom
16		
17		
18		

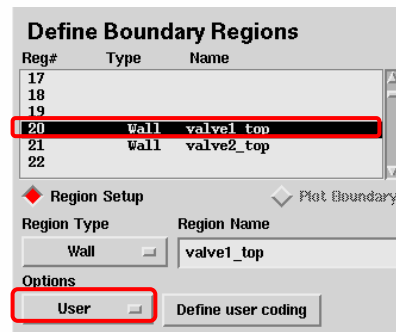
Region Setup

Region Type: Wall

Region Name: valve1_bottom

Options: ☒ User ☐ Define user coding

valve*_bottom



Reg#	Type	Name
17		
18		
19		
20	Wall	valve1_top
21	Wall	valve2_top
22		

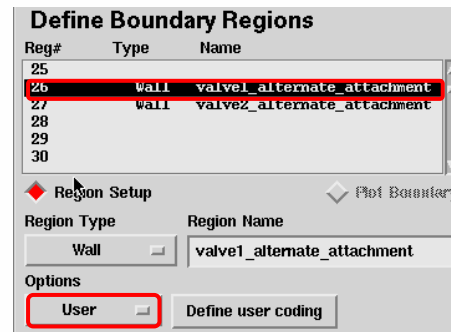
Region Setup

Region Type: Wall

Region Name: valve1_top

Options: ☒ User ☐ Define user coding

valve*_top



Reg#	Type	Name
25		
26	Wall	valve1_alternate_attachment
27	Wall	valve2_alternate_attachment
28		
29		
30		

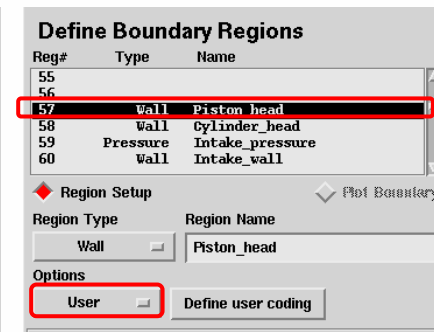
Region Setup

Region Type: Wall

Region Name: valve1_alternate_attachment

Options: ☒ User ☐ Define user coding

valve*_alternate_attachment



Reg#	Type	Name
55		
56		
57	Wall	Piston_head
58	Wall	Cylinder_head
59	Pressure	Intake_pressure
60	Wall	Intake_wall

Region Setup

Region Type: Wall

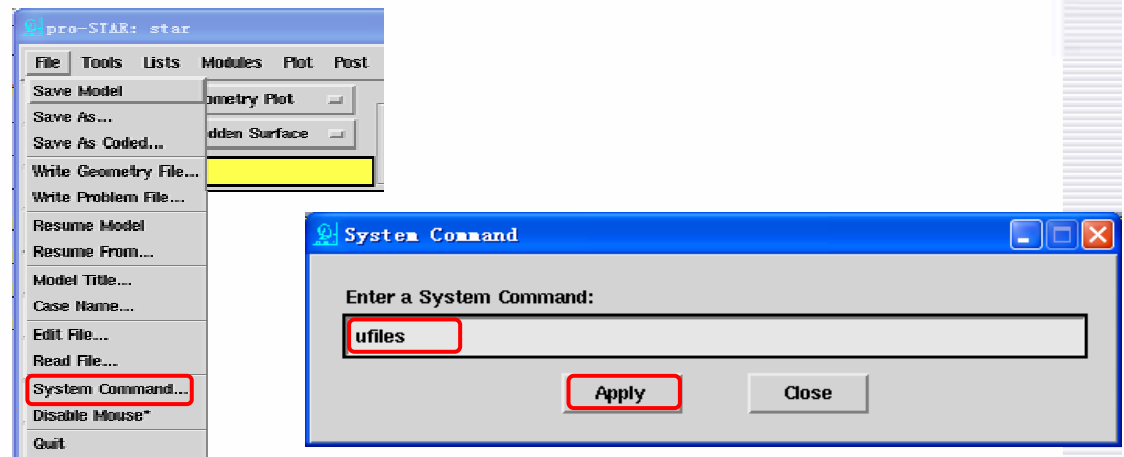
Region Name: Piston_head

Options: ☒ User ☐ Define user coding

Piston_head

Step 9 边界条件设定 3/3

1. 利用prostar面板或者直接在系统终端中执行ufiles命令，该命令会在工作目录下生成名为ufile的文件夹，用来存放用户子程序，并自动生成nom.inc, usrdat.inc两个参数文件。



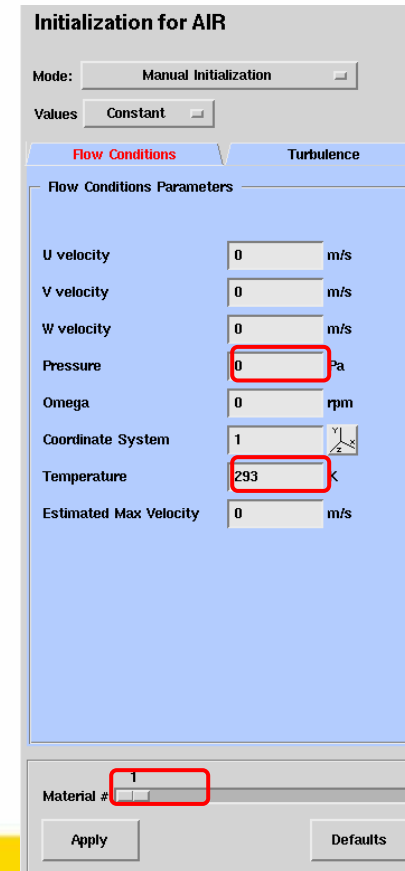
2. 将bcdefw.f文件拷贝至ufile文件夹，并增加一行内容：
 IF (57.EQ.IREG) ICE_CODE_GET=ICE_PISTON_1 ! 57为Piston_head的region number.

```

cdbjzhong@nec: ~/yelo/Training/Taiwan_Prof.Cai/tutorial_map_v2.02/setting/...
C
C   Cylinder 1.
C   Piston regions. To add an additional piston region, add the
C   line "IF (nreg.EQ.IREG) ICE_CODE_GET=ICE_PISTON_1", replacing
C   "nreg" with the additional region number.
C
C   IF (57.EQ.IREG) ICE_CODE_GET=ICE_PISTON_1
C
C   Cylinder 1.
C   Valve 1 regions. To add an additional valve 1 region, add the
C   line "IF (nreg.EQ.IREG) ICE_CODE_GET=ICE_VALVE_1_1", replacin
C
C   "nreg" with the additional region number.
C
C
17,1      0%
  
```

Step 10 初始条件设置

- 初始条件设置主要是设置温度和压力，由于发动机中进气道，气缸和排气道三个部分的参数经常有很大的差异，因此可以对三个部分(不同的material number)分别定义初始条件；
- 通常初始条件应基于测试数据给定，如果没有测试数据应根据起始计算角度和发动机运行工况设置合理的值。
- 本例中对三个部分，即material 1, 2, 3都采用默认的参数设置初始条件，即相对压力为0Pa，温度293K。



The image shows a software dialog box titled "Initialization for AIR". It has two tabs: "Flow Conditions" (selected) and "Turbulence". Under "Flow Conditions Parameters", there are input fields for U velocity, V velocity, W velocity, Pressure, Omega, Coordinate System, Temperature, and Estimated Max Velocity. The values are: U velocity: 0 m/s, V velocity: 0 m/s, W velocity: 0 m/s, Pressure: 0 Pa, Omega: 0 rpm, Coordinate System: 1, Temperature: 293 K, and Estimated Max Velocity: 0 m/s. The "Pressure" and "Temperature" fields are highlighted with red boxes. At the bottom, there is a "Material #" field with the value "1" and two buttons: "Apply" and "Defaults".

Parameter	Value	Unit
U velocity	0	m/s
V velocity	0	m/s
W velocity	0	m/s
Pressure	0	Pa
Omega	0	rpm
Coordinate System	1	
Temperature	293	K
Estimated Max Velocity	0	m/s

Step 11 求解参数设定

- 包括松弛因子, 残差, 差分格式等参数设定;
- 以下面板中的值为推荐设定。

Solution Method (Transient)

Solution Setup

Maximum Number of Corrector Stages

20

Reduction in Residual for Corrector Stages

0.25

Under-Relax. for Press. Correction

0.7

Primary Variables

Equation Status	Solver Parameters	Differencing Schemes
Relaxation and Solver Parameters		
Flow Variables		
Item	Relaxation Factor	Number of Sweeps
U-Mom		
V-Mom	0.7	100
W-Mom		
Pressure	0.3	1000
Turb. KE		
Turb. Diss	0.7	100
RSM	0.7	100
V22	0.7	100
F22		
Turb. A2	0.7	100
Temp.	0.95	1000
P1 Rel.	0.7	100
Fluid Properties		
Item	Relaxation Factor	Item
Density	1	Molec. Visc.
Viscosity	1	K

Primary Variables

Equation Status	Solver Parameters	Differencing Schemes
Differencing Schemes		
Flow Variables		
Item	Differencing Scheme	Blending Factor
U-Mom		
V-Mom	MARS	0.5
W-Mom		
Turb. KE		
Turb. Diss	MARS	0.5
V22		
Turb. A2		
Reynolds Stress	UD	0
Temp.	UD	0
Fluid Properties		
Item	Differencing Scheme	Blending Factor
Density	CD	0.01

Step 12 时间步长和结果输出设定 1/3

- 结果输出包括单步结果输出和瞬态结果输出；
- 单步结果定期备份可以方便restart计算；
- 瞬态结果输出时可以选用把Turb Kinetic Energy, Temperature等参数(默认不输出)输出, 其它参数根据用户需要选择；
- 右边面板中为推荐设定。

Analysis Output (Transient)

Post **Transient**

Solution File Setup

☒ Write final solution (restart) file

File name: star.pst

Output frequency: 50

Backup frequency: 300

Print Cell Range

Which cells: None

Additional Output Data

☐ User subroutine

Wall Data

☒ Show all ☐ Show selected

Description	Post	Print
Shear Force	Off	Off
YPLUS	Off	Off
Normal Distance	Off	Off
Wall Temperature	Off	Off
Heat Transfer Coef.	Off	Off
Heat Flux	Off	Off

Post ☐ Print ☐

Analysis Output (Transient)

Post **Transient**

☒ Data for Transient Post (.pst) file ☐ Data for Run History (.run) file

Define Output Period

Starting at time: 0 deg CA

Write data every: 5 deg CA

Choose data to write

Cell data ☒ Wall data ☐

☒ Show all ☐ Show selected

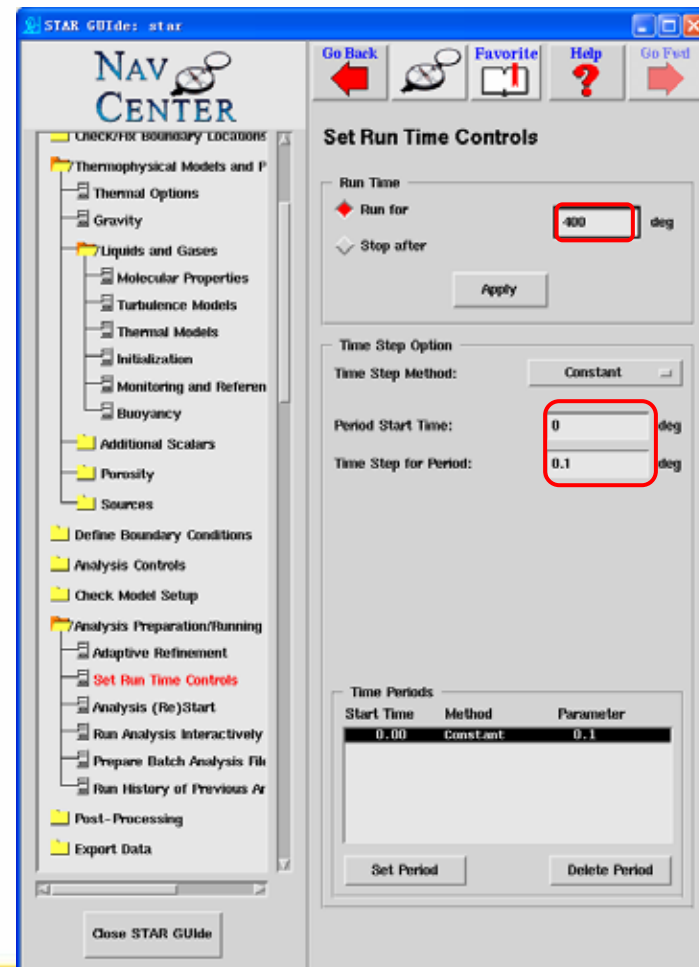
Cell Face Mass Flux	N
Velocity	Y
Pressure	Y
Turb Kinetic Energy	Y
Dissipation	N
Turbulent Viscosity	N
Temperature	Y

Post ☒ Print ☐

Apply

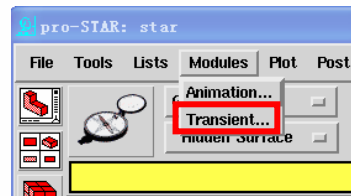
Step 12 时间步长和结果输出设定 2/3

- 本例计算角度范围为320deg-720deg, 故计算角度为400 deg.
- 时间步长推荐使用0.1deg.

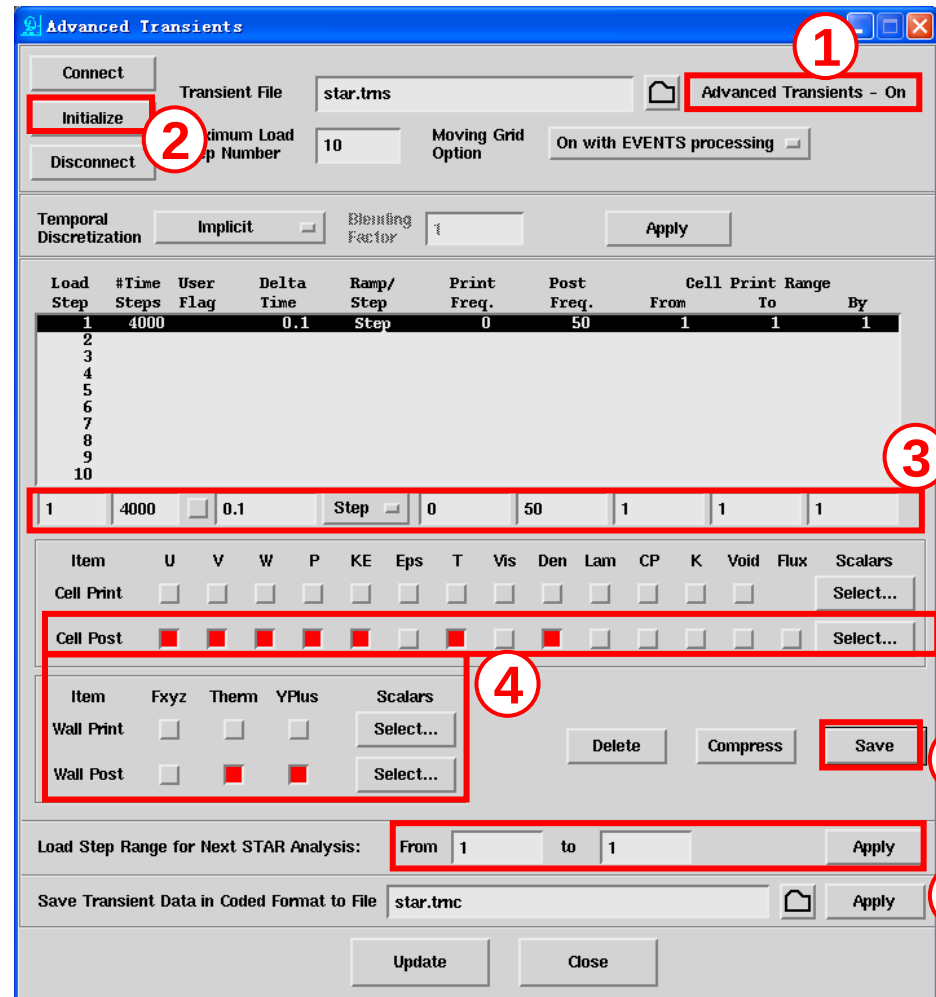


Step 12 时间步长和结果输出设定 3/3

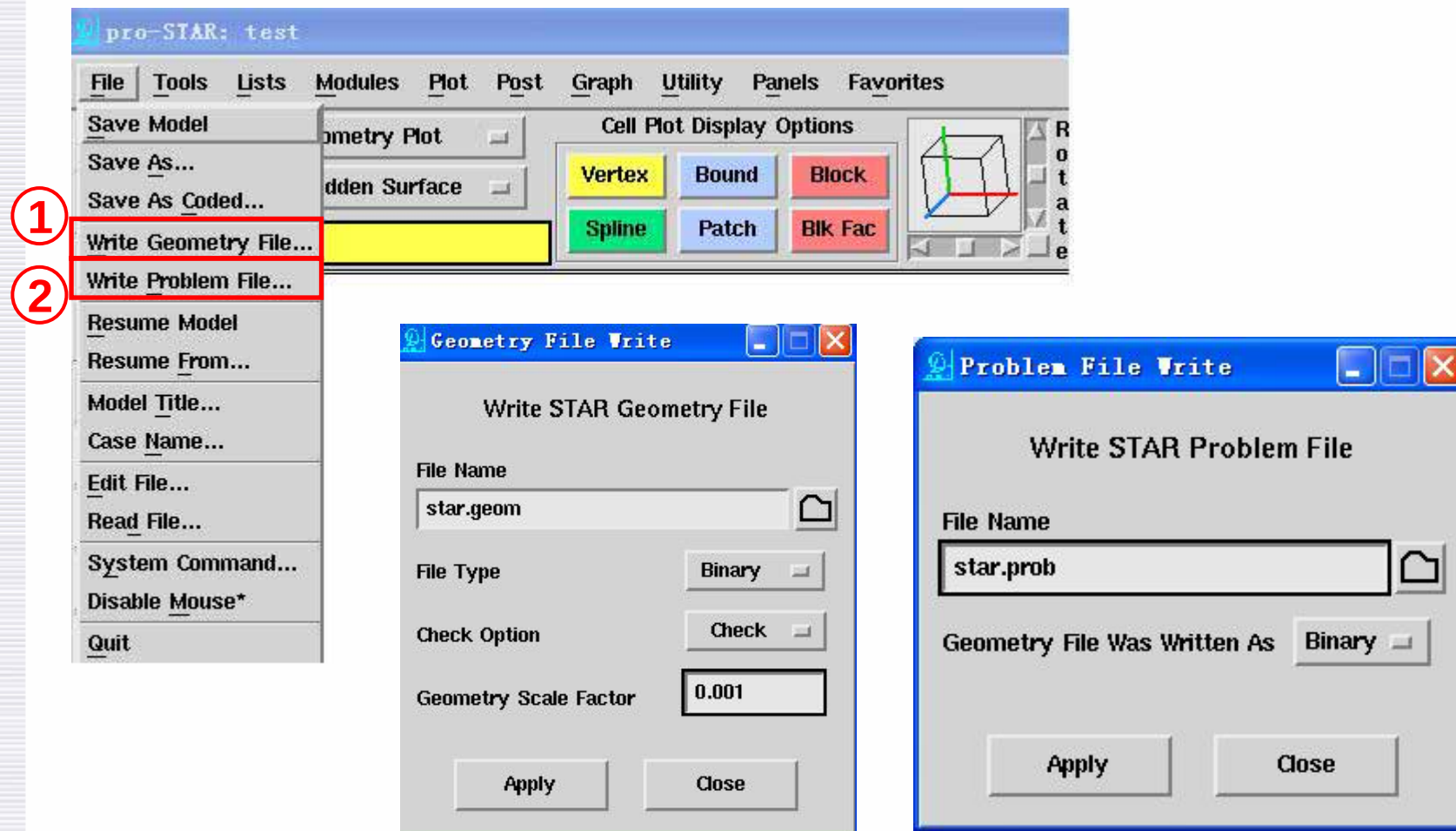
- 用户还可以采用Advanced Transients面板进行瞬态结果输出和时间步长设置；



- 如果需要定义多个Load Step, 则③④⑤需要重复执行；
- 如果定义了多个Load step,并且都想应用的话, 在From... to...中应该填入起始step的编号, 再点击Apply；
- 如果之前已经定义好了Advanced Transients, 只是想做些修改的话, 则第②步选用“Connect”；



Step 13 准备.geom和.prob文件



Step 14 提交计算

- 退出prostar，保存模型，进入linux界面输入star -dp执行计算；
- 如果为多核计算，输入star -dp -decompmeth=sets。

