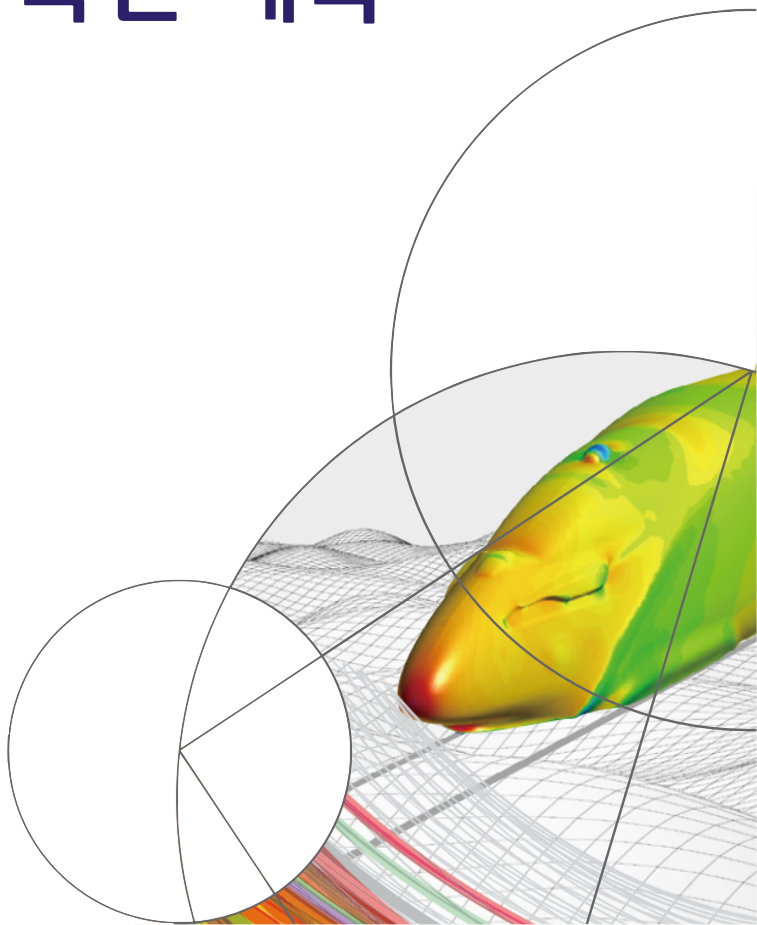
Open Source CFD Consulting

NEXTfoam open source CFD consulting

CFD를 이용한 터널내 화재 확산 예측 프로그램

tunnelPack



2015년 05월 15일

개요

- 터널 내부에서 차량 화재 발생시 연기 거동 예측 프로그램
- 오픈폼(OpenFOAM) 기반의 3차원 CFD 해석
- 프로그램의 구성
  - Smoke Dispersion Module
  - Incompressible flown Module
  - Heat transfer Module

프로그램의 기능

- 2차원 / 3차원 난류 유동 해석
- 정상상태 / 비정상상태 유동 해석
- 비압축성 유동 / 열전달 해석
- Porous, MRF, Sliding Mesh
- 연소 가스에 대한 스칼라 계산
- 시간에 따른 에너지, 스칼라 소스항

- 터널 화재 자동 격자 생성 기능 - octree-based mesh
- msh/cas 형식의 격자 변환 가능

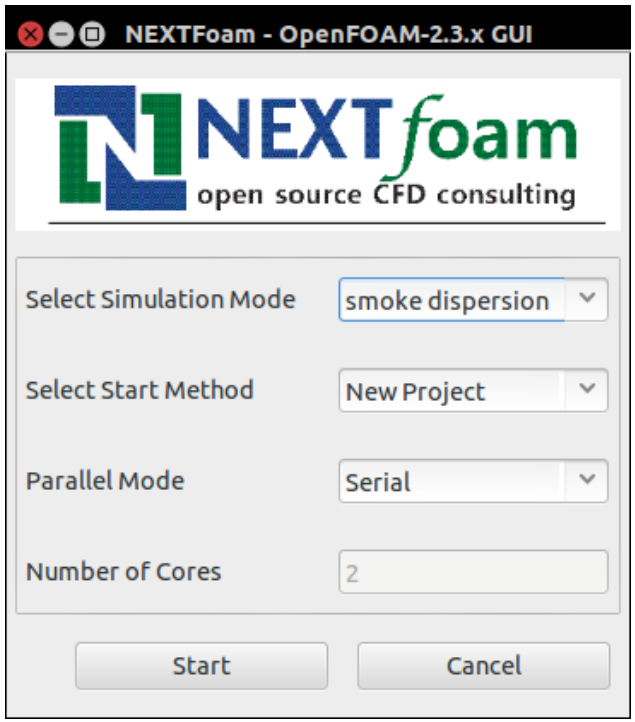
- 병렬연산 - SMP, Cluster

CFD 해석 방법

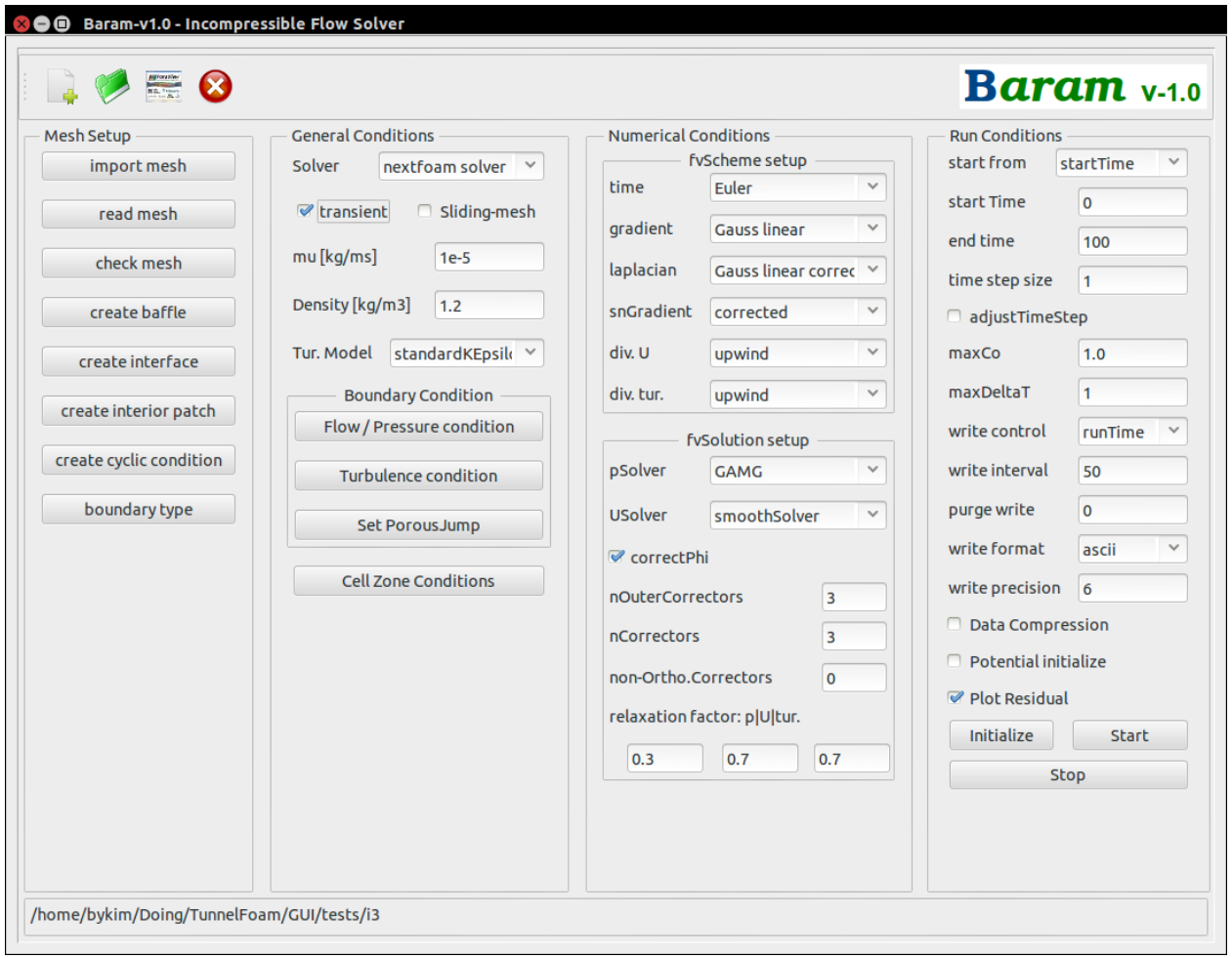
- Solver - Modified OpenFOAM solver
- Incompressible flow solver
  - nSimpleFoam(steady) / nPimpleFoam(transient)
- Heat transfer, smoke dispersion solver
  - nBuoyantSimpleFoam / nBuoyantPimpleFoam
- Modified k-epsilon turbulence model series
  - standard k-epsilon / realizable k-epsilon / RNG k-epsilon
- First / Second order discretization
- GAMG, PBiCG, smoothSolver

사용자 환경 - launcher

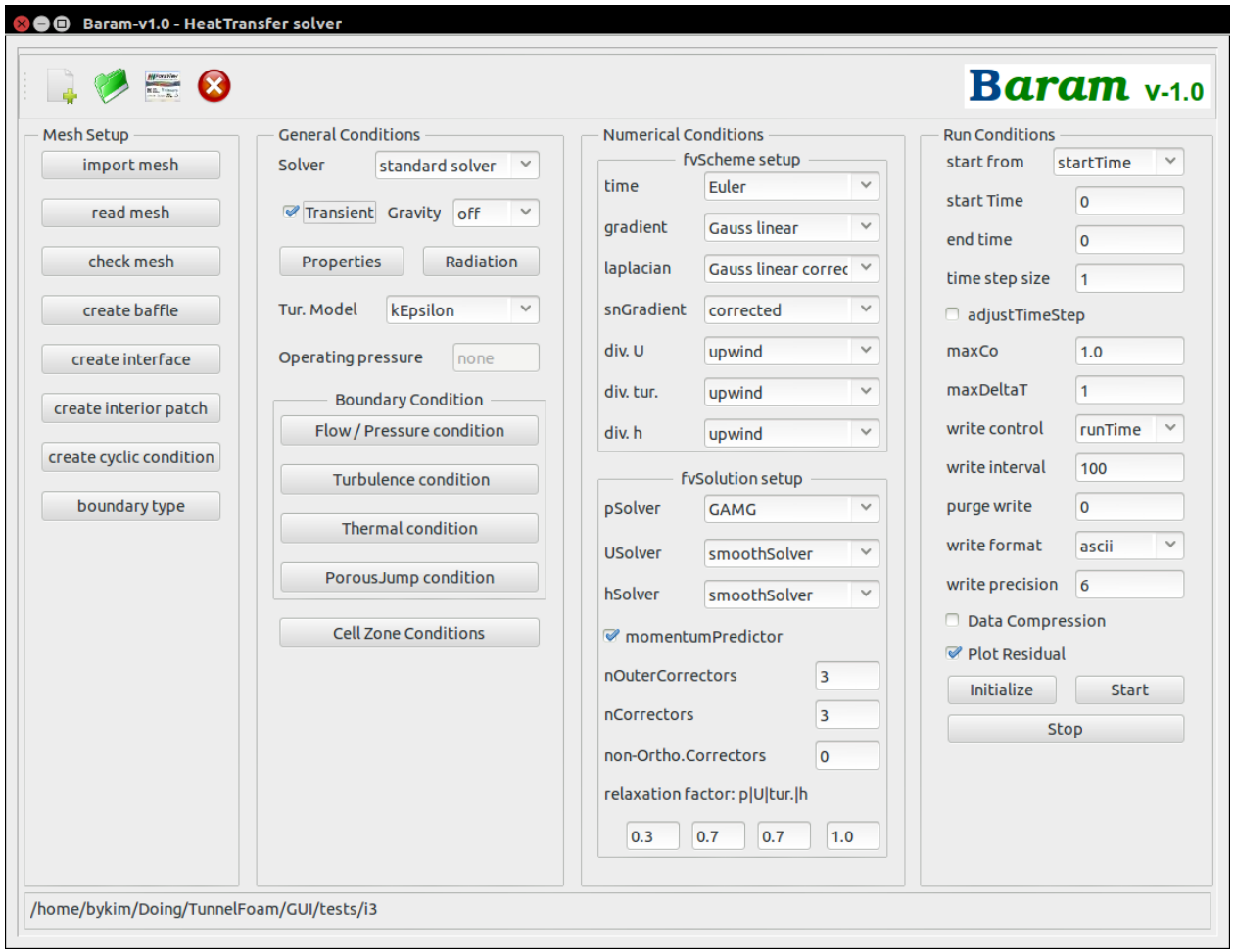
- Simulation Mode
  - incompressible
  - heatTransfer
  - smoke dispersion
- Start Method
  - New Project / Open Project
- Parallel Mode
  - Serial
  - Parallel-SMP
  - Parallel-Cluster
- Number of Cores



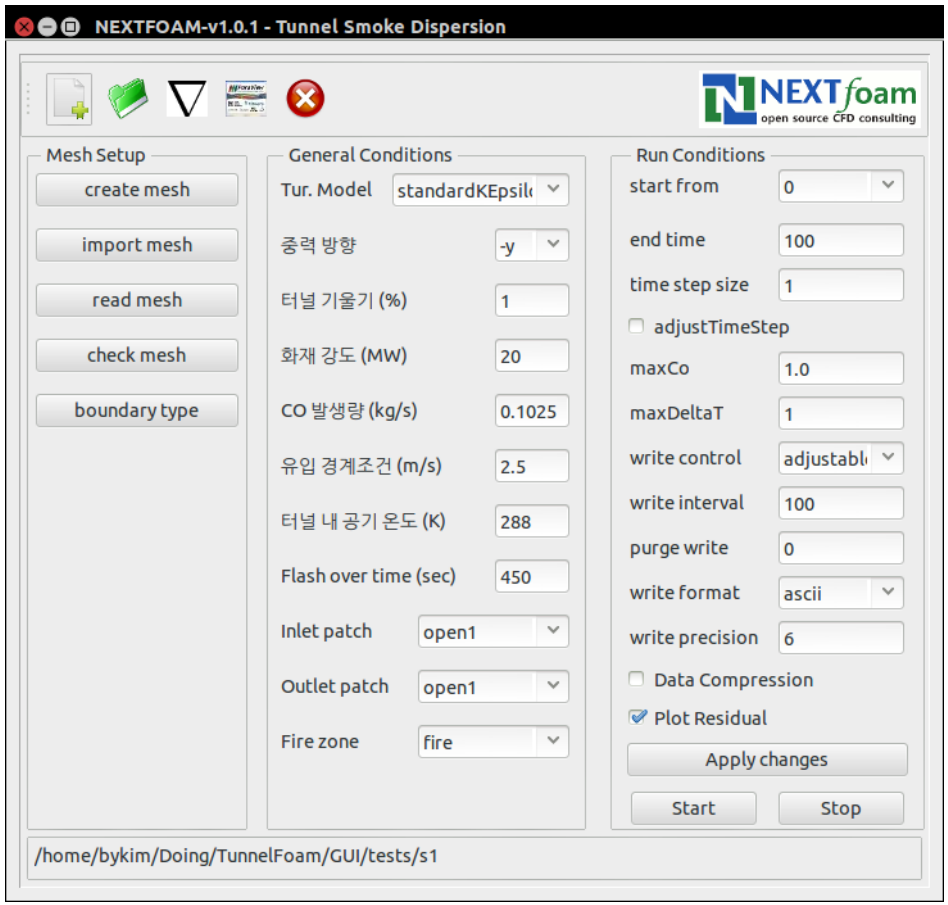
사용자 환경 - incompressible



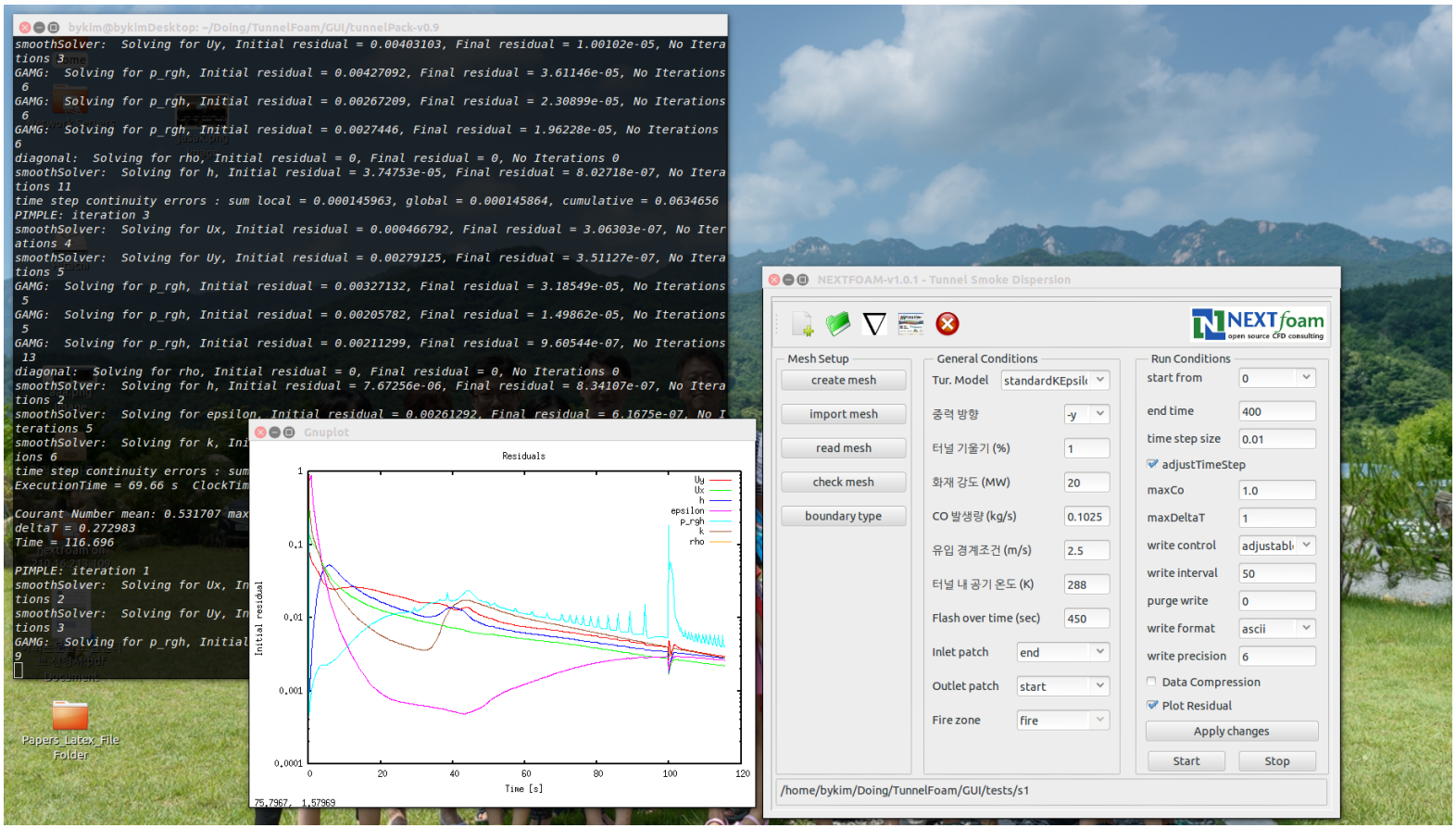
사용자 환경 - heatTransfer



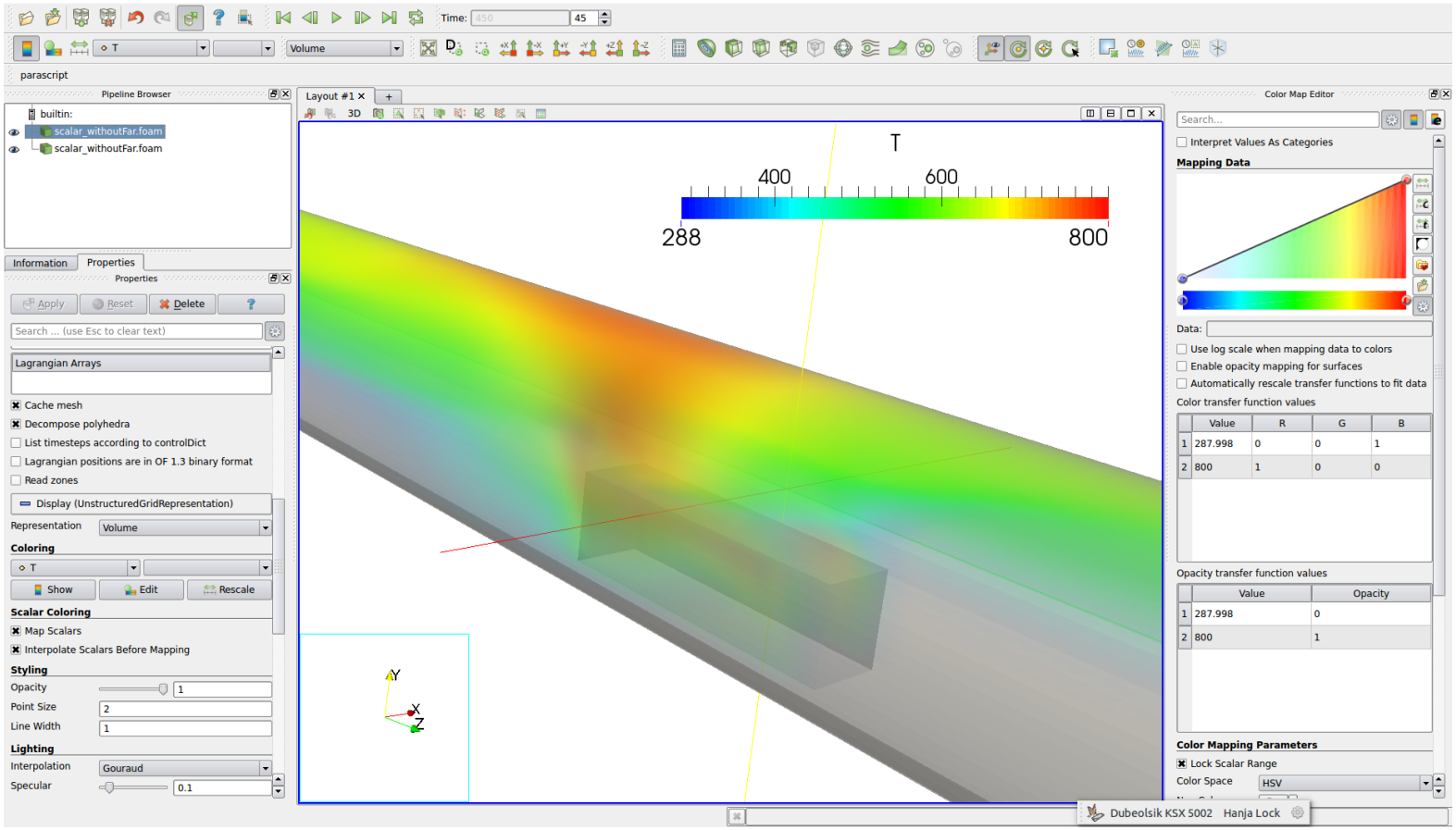
사용자 환경 - smoke dispersion



사용자 환경 - 계산 과정

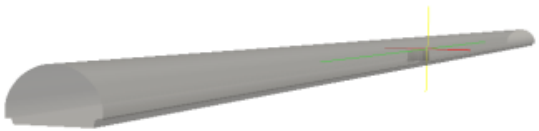

bykim@bykimDesktop: ~/Doing/TunnelFoam/GUI/tunnelPack-v0.9
smoothSolver: Solving for Uy, Initial residual = 0.00403103, Final residual = 1.00102e-05, No Iterations 3
GAMG: Solving for p_rgh, Initial residual = 0.00427092, Final residual = 3.61146e-05, No Iterations 6
GAMG: Solving for p_rgh, Initial residual = 0.00267209, Final residual = 2.30899e-05, No Iterations 6
GAMG: Solving for p_rgh, Initial residual = 0.0027446, Final residual = 1.96228e-05, No Iterations 6
diagonal: Solving for rho, Initial residual = 0, Final residual = 0, No Iterations 0
smoothSolver: Solving for h, Initial residual = 3.74753e-05, Final residual = 8.02718e-07, No Iterations 11
time step continuity errors : sum local = 0.000145963, global = 0.000145864, cumulative = 0.0634656
PIMPLE: iteration 3
smoothSolver: Solving for Ux, Initial residual = 0.000466792, Final residual = 3.06303e-07, No Iterations 4
smoothSolver: Solving for Uy, Initial residual = 0.00279125, Final residual = 3.51127e-07, No Iterations 5
GAMG: Solving for p_rgh, Initial residual = 0.00327132, Final residual = 3.18549e-05, No Iterations 5
GAMG: Solving for p_rgh, Initial residual = 0.00205782, Final residual = 1.49862e-05, No Iterations 5
GAMG: Solving for p_rgh, Initial residual = 0.00211299, Final residual = 9.60544e-07, No Iterations 13
diagonal: Solving for rho, Initial residual = 0, Final residual = 0, No Iterations 0
smoothSolver: Solving for h, Initial residual = 7.67256e-06, Final residual = 8.34107e-07, No Iterations 2
smoothSolver: Solving for epsilon, Initial residual = 0.00261292, Final residual = 6.1675e-07, No Iterations 5
smoothSolver: Solving for k, Initial residual = 0.00261292, Final residual = 6.1675e-07, No Iterations 6
time step continuity errors : sum
ExecutionTime = 69.66 s ClockTim
Courant Number mean: 0.531707 max
deltaT = 0.272983
Time = 116.696
PIMPLE: iteration 1
smoothSolver: Solving for Ux, In
tions 2
smoothSolver: Solving for Uy, In
tions 3
GAMG: Solving for p_rgh, Initial
9
Papers_Latex_File Folder
Gnuplot
Residuals
Initial residual
Time [s]
Uy
Ux
h
epsilon
p_rgh
k
rho
75.7967, 1.57969
NEXTFOAM-v1.0.1 - Tunnel Smoke Dispersion
NEXTfoam open source CFD consulting
Mesh Setup
create mesh
import mesh
read mesh
check mesh
boundary type
General Conditions
Tur. Model
standardKEpsil
중력 방향
-y
터널 기울기 (%)
1
화재 강도 (MW)
20
CO 발생량 (kg/s)
0.1025
유입 경계조건 (m/s)
2.5
터널 내 공기 온도 (K)
288
Flash over time (sec)
450
Inlet patch
end
Outlet patch
start
Fire zone
fire
Run Conditions
start from
0
end time
400
time step size
0.01
adjustTimeStep
maxCo
1.0
maxDeltaT
1
write control
adjustabl
write interval
50
purge write
0
write format
ascii
write precision
6
Data Compression
Plot Residual
Apply changes
Start
Stop
/home/bykim/Doing/TunnelFoam/GUI/tests/s1

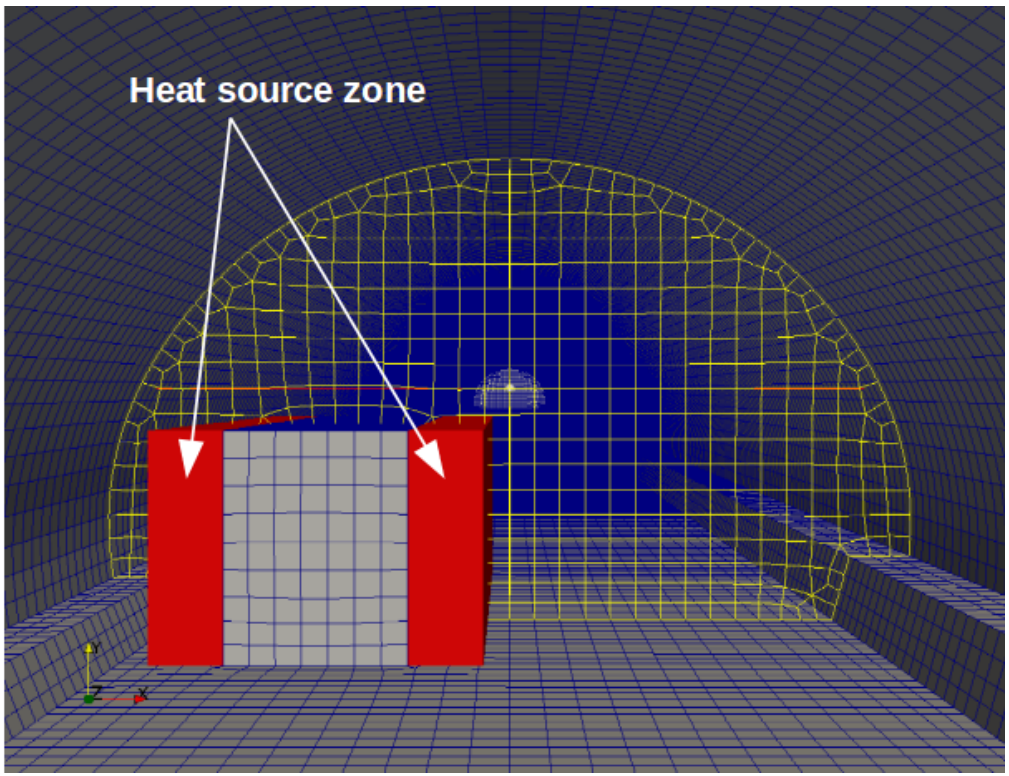
후처리 - Paraview



3차원 모델 계산

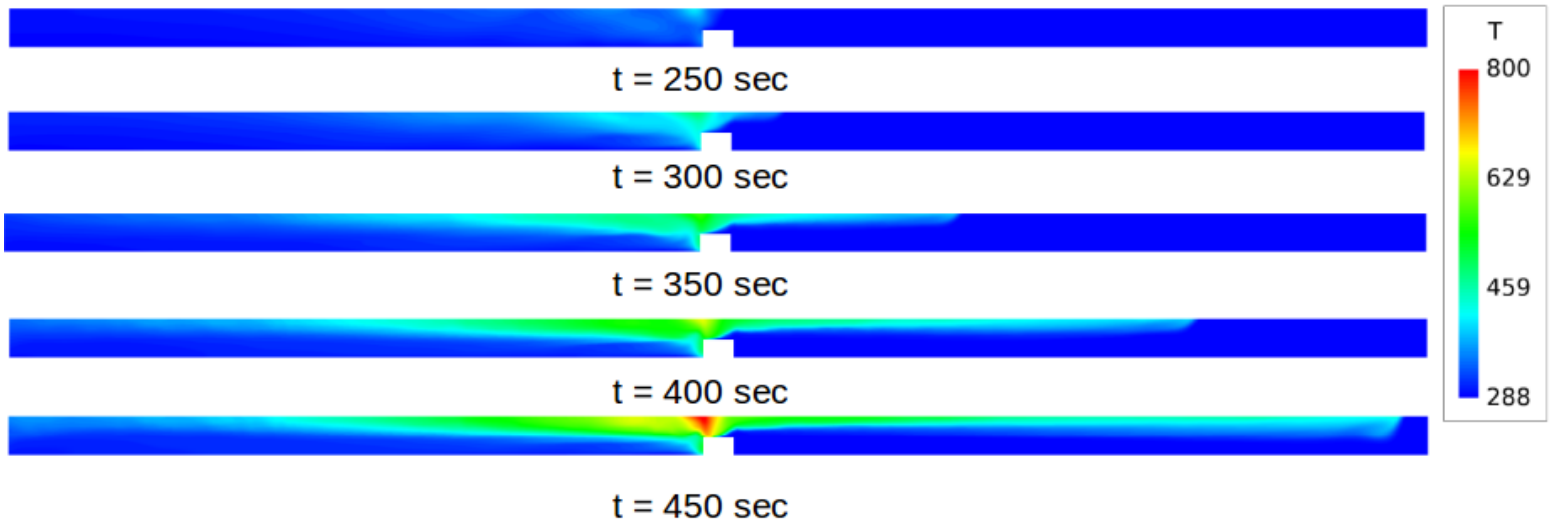
- 형상 및 격자
  - STL 파일을 이용하여 cfMesh로 격자 생성



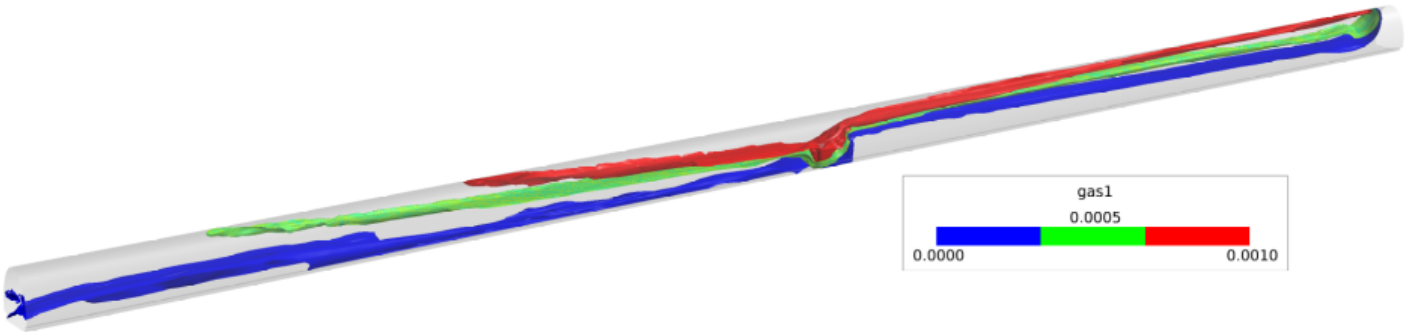


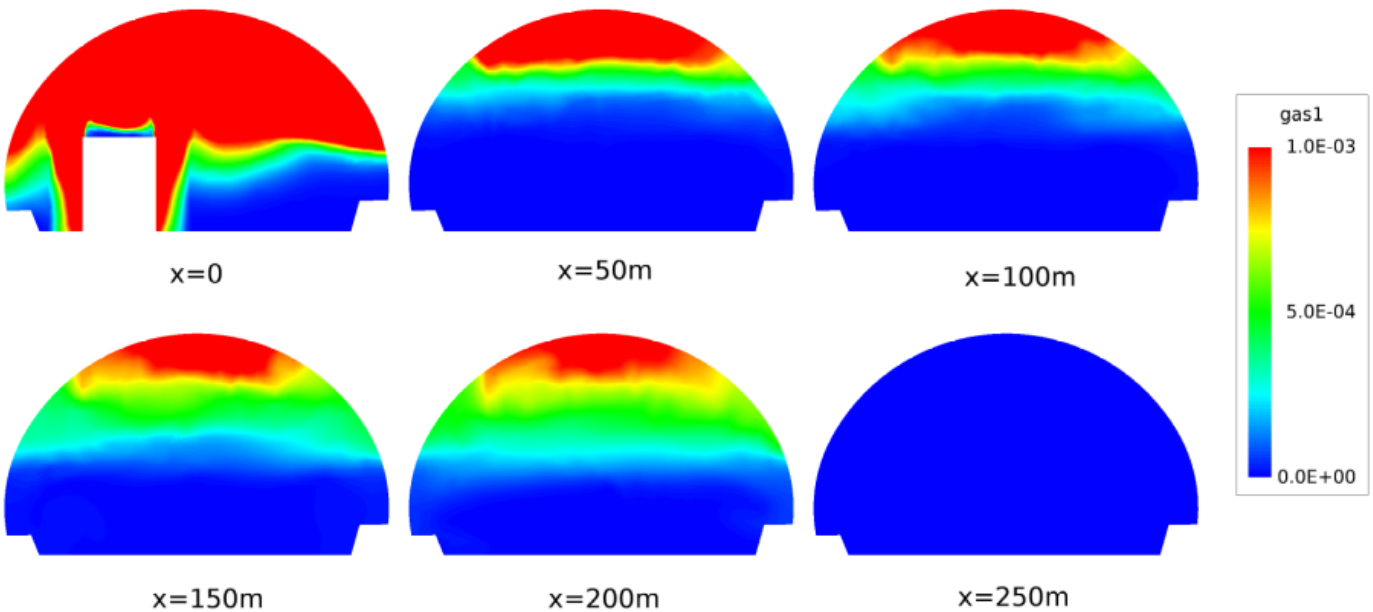
3차원 모델 계산

- 계산 결과
  - 20MW 버스 화재 조건, 2% 경사
  - 초기 유입속도 = 2.5 m/s



3차원 모델 계산


gas1
0.0005
0.0000
0.0010


x=0
x=50m
x=100m
x=150m
x=200m
x=250m
gas1
1.0E-03
5.0E-04
0.0E+00

넥스트폼

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