# OpenFOAMに基づいた流量計CFDツール

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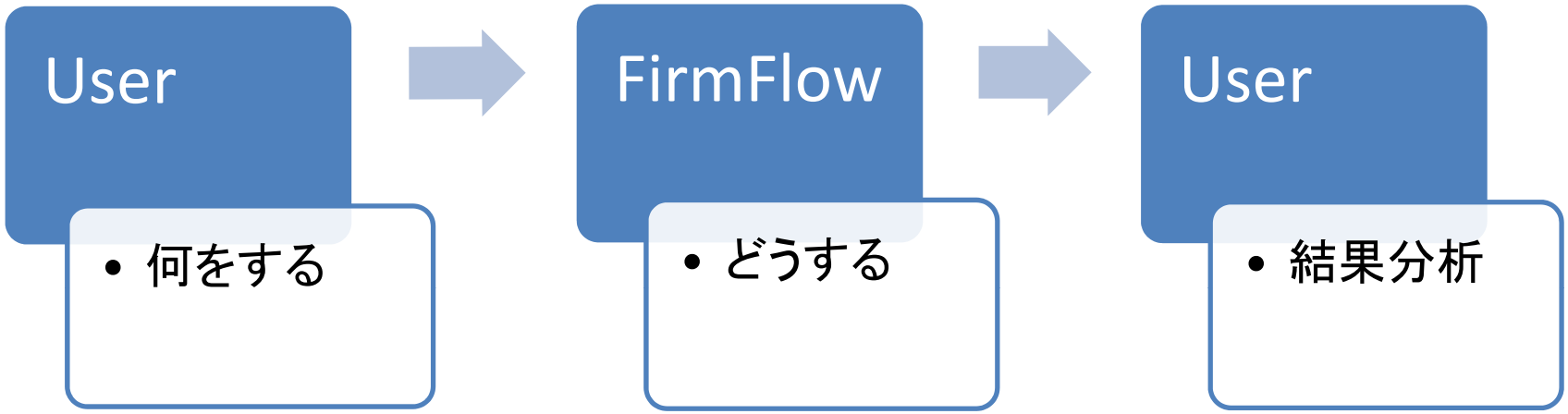
# 内容

- 背景
- 基本特徴
- GUI説明
- まとめ

# 背　景ー中小企業のCFDソフトの導入

- 汎用ソフトの導入における難点
  - 経費
  - 汎用ソフトの正確利用が難しい
  - 専用CFDエンジニアの育成
- OpenFOAMの導入における難点
  - 操作が難しい（GUIが無い）
  - メンテナンスができない
  - WindowsからLinuxへのシフト

# 背景ー設計の思想



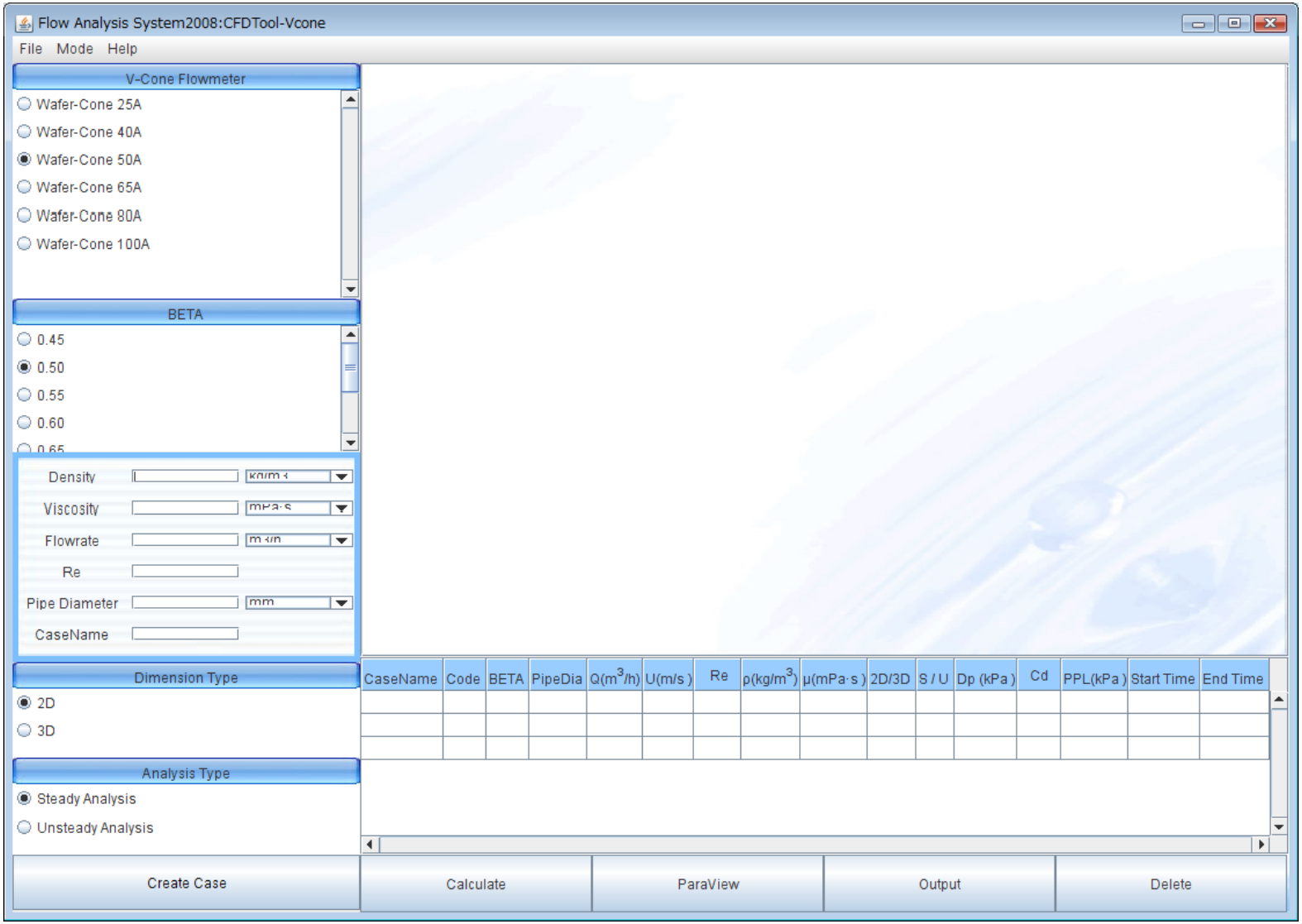
# 基本特徴

- ユーザーに特化したGUI
- 対象ユーザー
  - 使用者は普通流体エンジニア、CFD知識無し
- 簡単
  - ボタン数を最少にする
  - 入力パラメーターは使用者の熟知したモノのみ
- 完全自動格子作成
  - 事前に最適化した格子を作成
  - 使用者が格子作成する必要なし
- 特定Post処理機能付き
- OS依存しない（現在開発中）
  - 計算サーバーとGUI分離

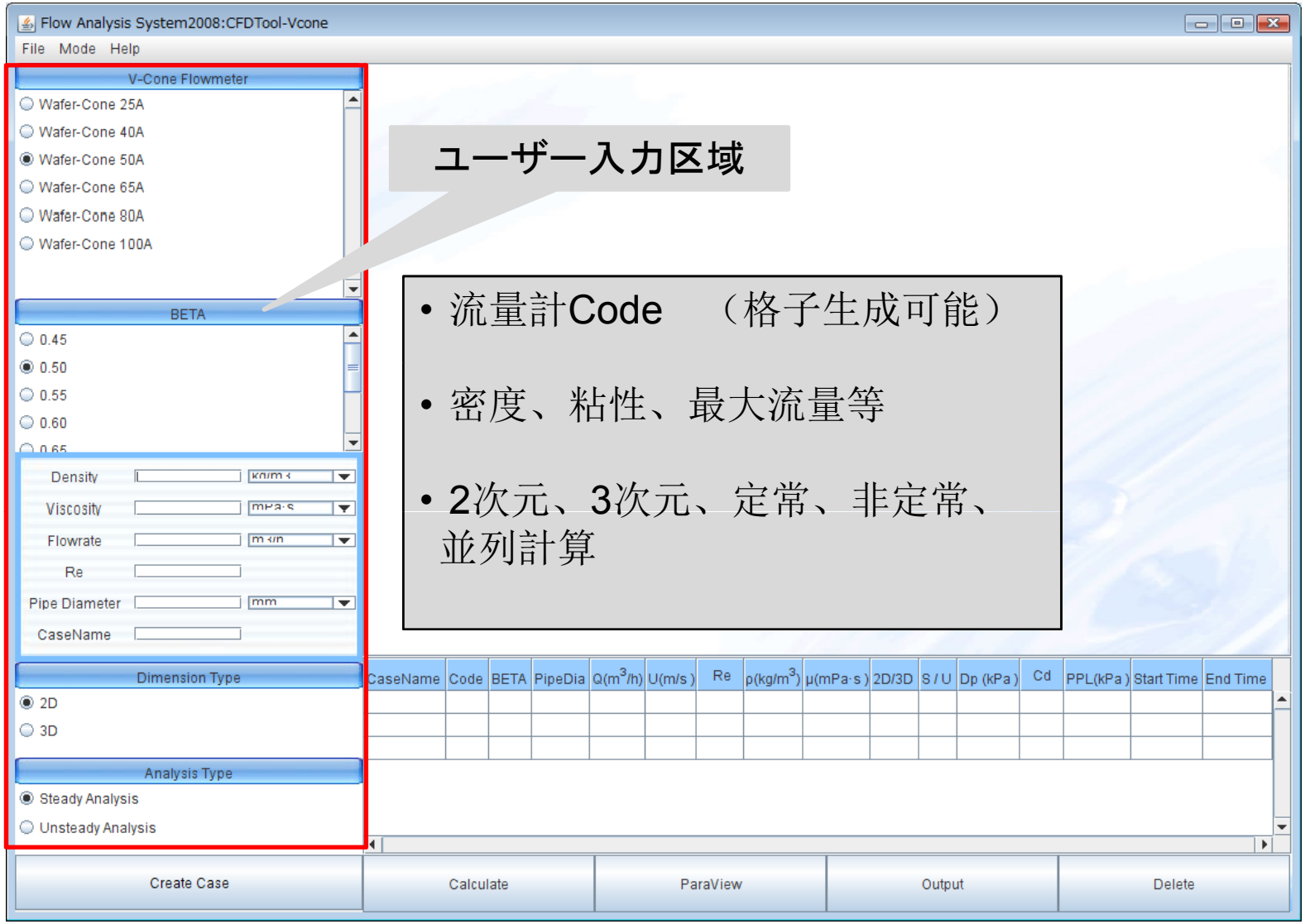
# 基本特徴

- GUI開発
  - JAVA言語
- ケース自動作成
  - OpenFOAMをベースに自社開発
  - 格子作成ツールはblockMesh
- ソルバー
  - OpenFOAM 標準solverをカスタマイズ
- 結果分析データ
  - OpenFOAMをベースに自社開発
- 可視化
  - paraFoam

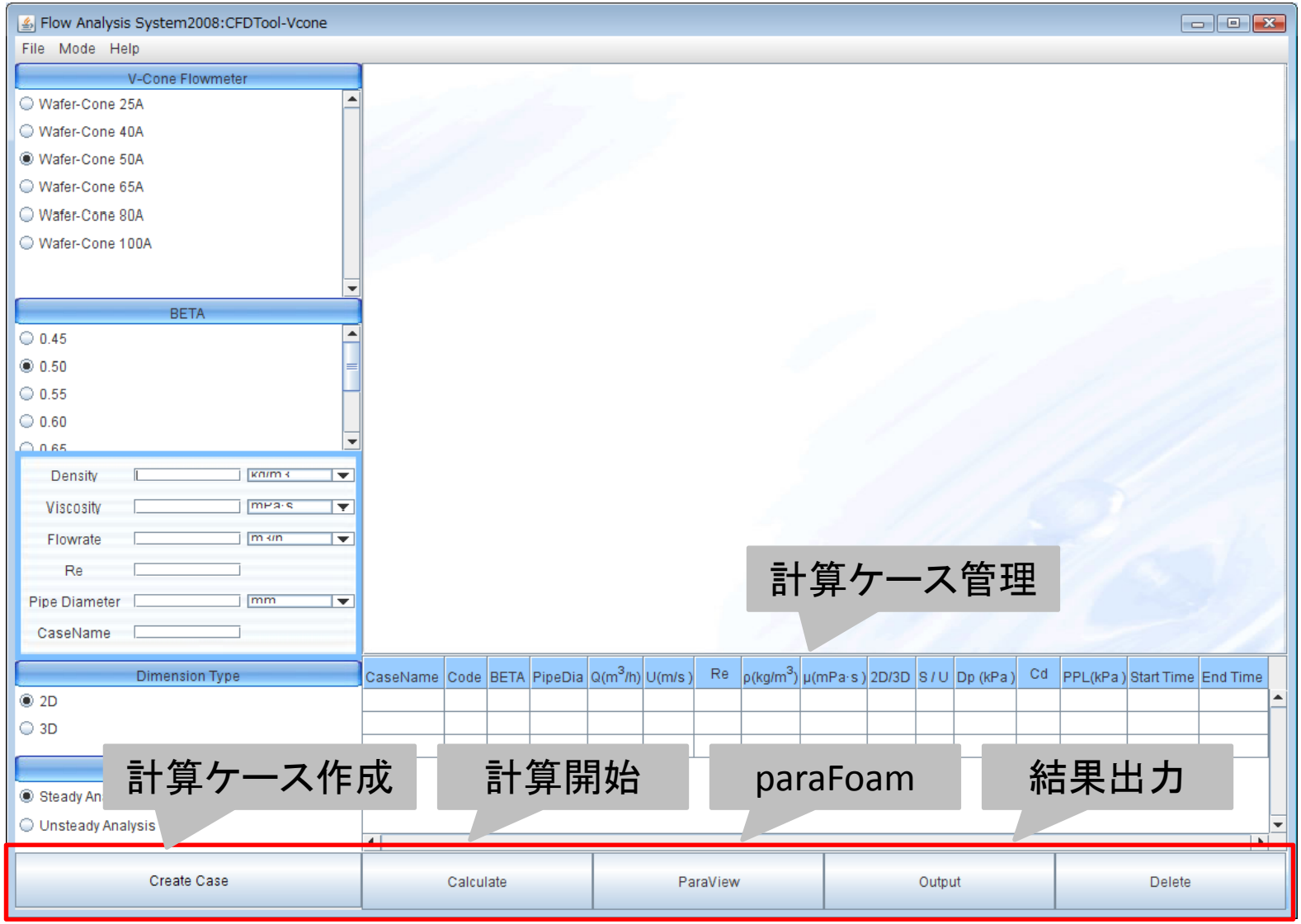
# GUI


Flow Analysis System2008:CFDTool-Vcone
File Mode Help
V-Cone Flowmeter
Wafer-Cone 25A
Wafer-Cone 40A
Wafer-Cone 50A
Wafer-Cone 65A
Wafer-Cone 80A
Wafer-Cone 100A
BETA
0.45
0.50
0.55
0.60
Density
Viscosity
Flowrate
Re
Pipe Diameter
mm
CaseName
Dimension Type
2D
3D
Analysis Type
Steady Analysis
Unsteady Analysis
CaseName Code BETA PipeDia Q(m3/h) U(m/s) Re ρ(kg/m3) μ(mPa·s) 2D/3D S / U Dp (kPa) Cd PPL(kPa) Start Time End Time
Create Case
Calculate
ParaView
Output
Delete

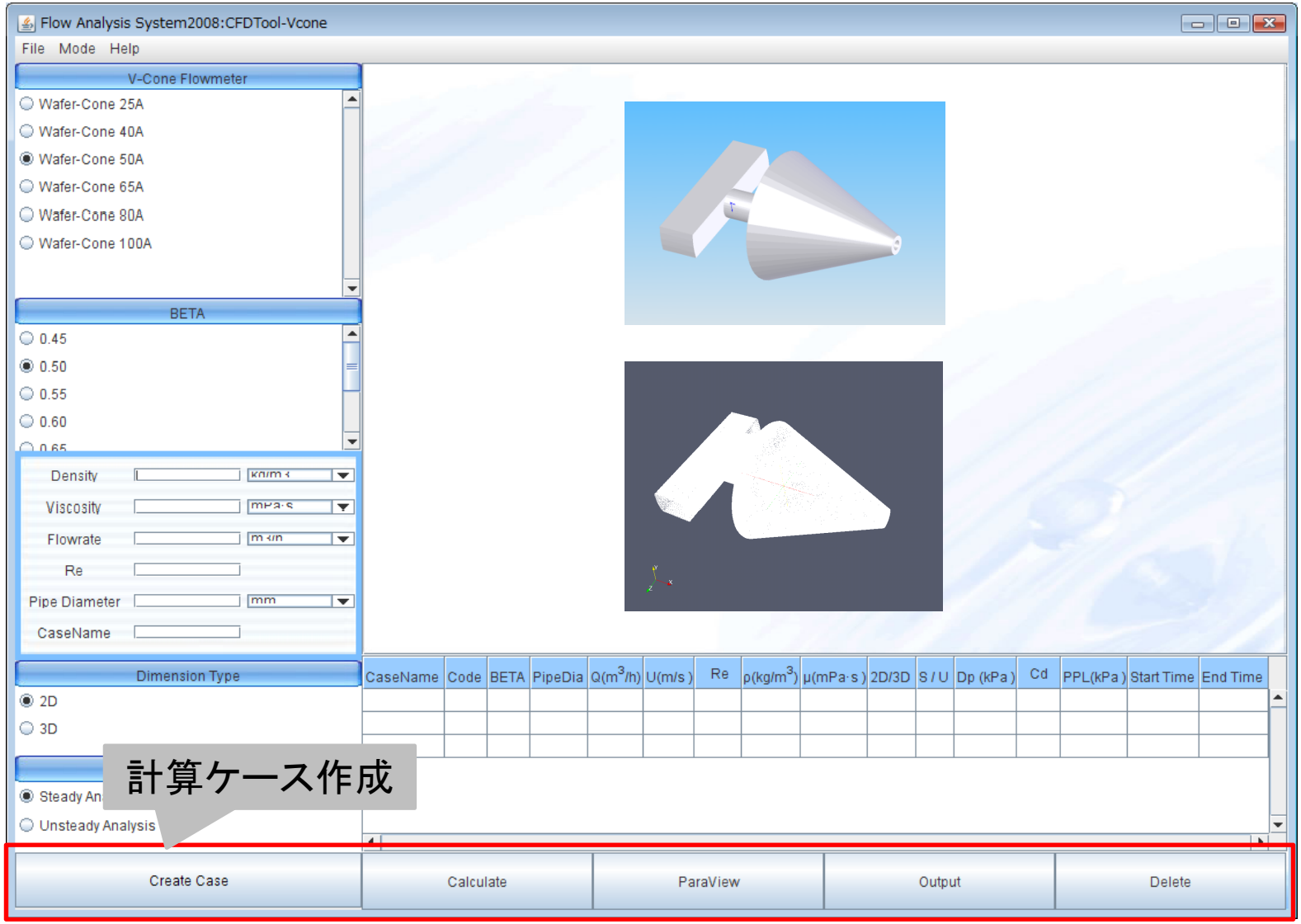
# GUI


Flow Analysis System2008:CFDTool-Vcone
File Mode Help
V-Cone Flowmeter
Wafer-Cone 25A
Wafer-Cone 40A
Wafer-Cone 50A
Wafer-Cone 65A
Wafer-Cone 80A
Wafer-Cone 100A
BETA
0.45
0.50
0.55
0.60
Density
Viscosity
Flowrate
Re
Pipe Diameter
mm
CaseName
Dimension Type
2D
3D
Analysis Type
Steady Analysis
Unsteady Analysis
ユーザー入力区域
• 流量計Code （格子生成可能）
• 密度、粘性、最大流量等
• 2次元、3次元、定常、非定常、並列計算
CaseName Code BETA PipeDia Q(m3/h) U(m/s) Re ρ(kg/m3) μ(mPa·s) 2D/3D S / U Dp (kPa) Cd PPL(kPa) Start Time End Time
Create Case
Calculate
ParaView
Output
Delete

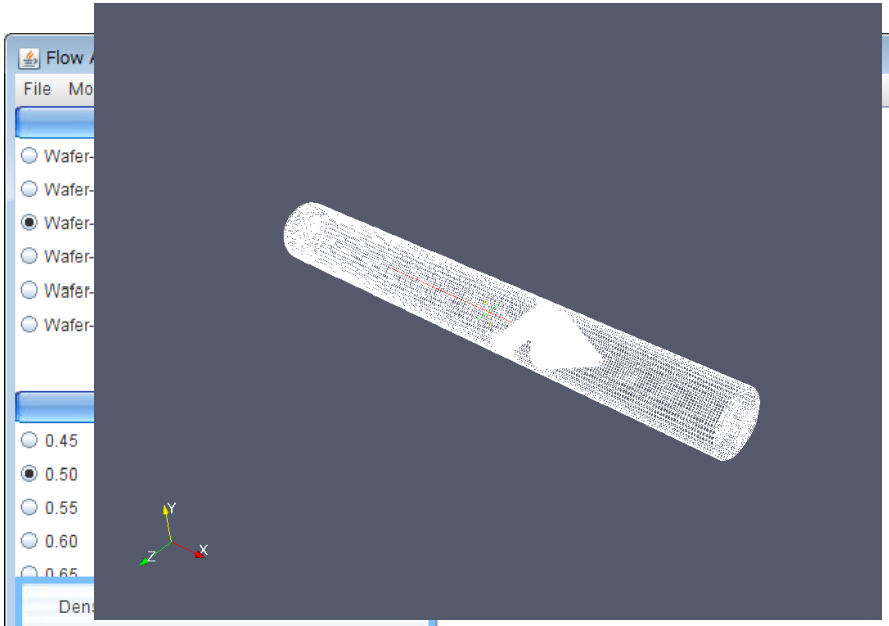
# GUI


Flow Analysis System2008:CFDTool-Vcone
File Mode Help
V-Cone Flowmeter
Wafer-Cone 25A
Wafer-Cone 40A
Wafer-Cone 50A
Wafer-Cone 65A
Wafer-Cone 80A
Wafer-Cone 100A
BETA
0.45
0.50
0.55
0.60
Density
Viscosity
Flowrate
Re
Pipe Diameter
mm
CaseName
Dimension Type
2D
3D
Steady An
Unsteady Analysis
CaseName Code BETA PipeDia Q(m3/h) U(m/s) Re ρ(kg/m3) μ(mPa·s) 2D/3D S / U Dp (kPa) Cd PPL(kPa) Start Time End Time
計算ケース管理
計算ケース作成
計算開始
paraFoam
結果出力
Create Case
Calculate
ParaView
Output
Delete

# GUI

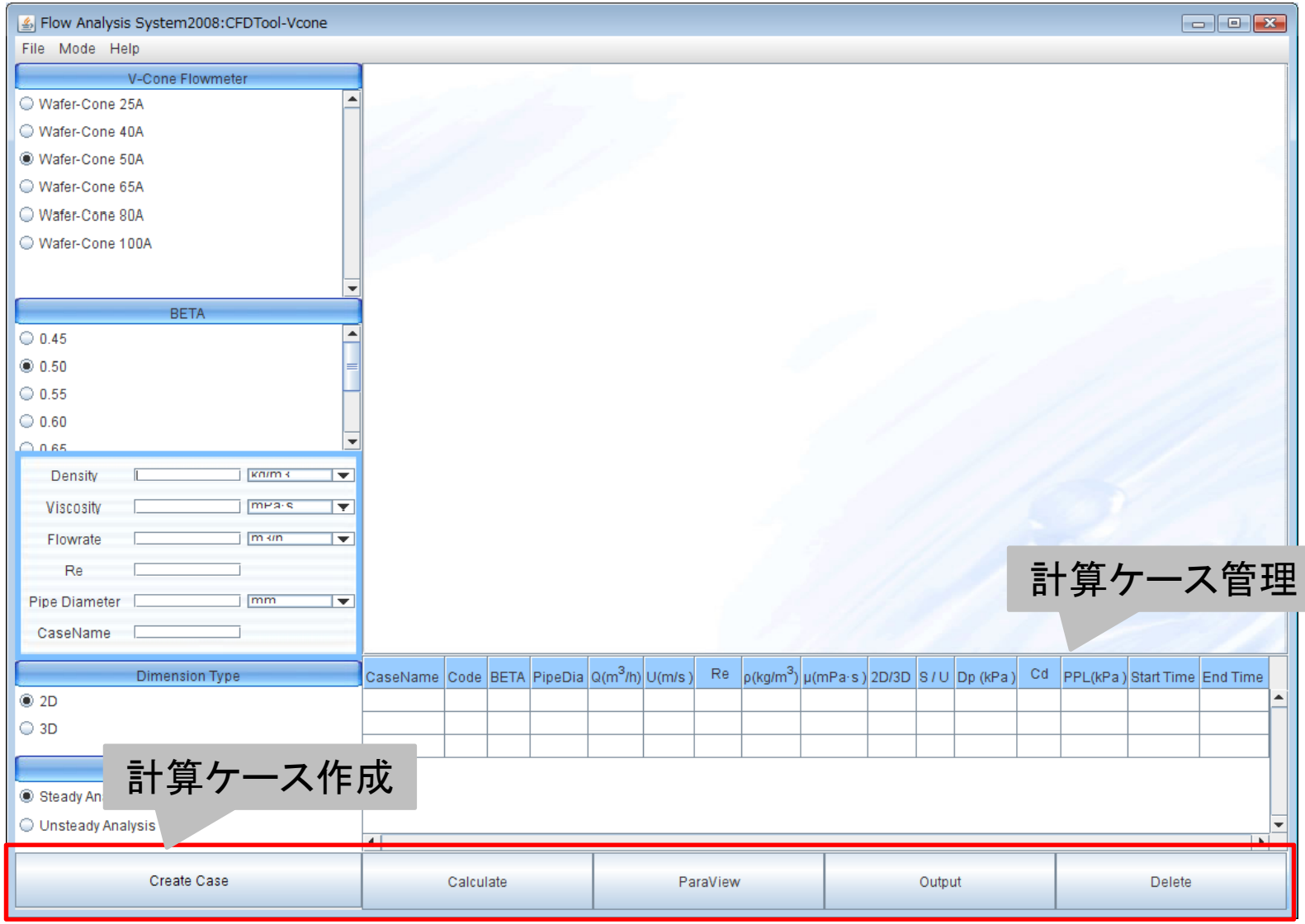

Flow Analysis System2008:CFDTool-Vcone
File Mode Help
V-Cone Flowmeter
Wafer-Cone 25A
Wafer-Cone 40A
Wafer-Cone 50A
Wafer-Cone 65A
Wafer-Cone 80A
Wafer-Cone 100A
BETA
0.45
0.50
0.55
0.60
Density
Viscosity
Flowrate
Re
Pipe Diameter
mm
CaseName
Dimension Type
2D
3D
Steady An
Unsteady Analysis
CaseName Code BETA PipeDia Q(m3/h) U(m/s ) Re ρ(kg/m3) μ(mPa·s ) 2D/3D S / U Dp (kPa ) Cd PPL(kPa ) Start Time End Time
計算ケース作成
Create Case
Calculate
ParaView
Output
Delete

# 基本特徴

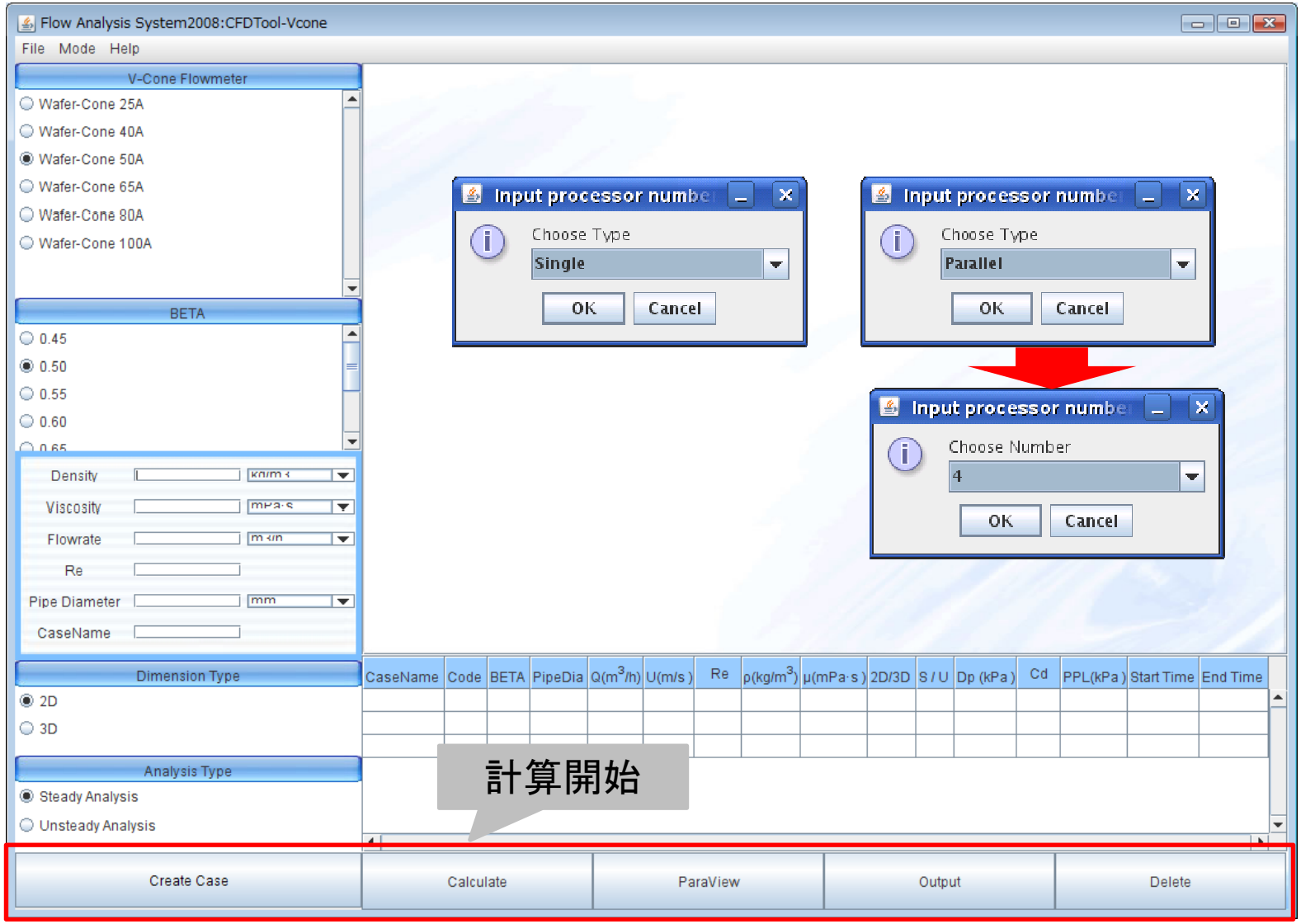



File
Wafer-
Wafer-
Wafer-
Wafer-
Wafer-
Wafer-
0.45
0.50
0.55
0.60
Viscosity
Flowrate
Re
Pipe Diameter
mm
CaseName
Dimension Type
2D
3D
Analysis Type
Steady Analysis
Unsteady Analysis
Create Case
Calculate
ParaView
Output
Delete

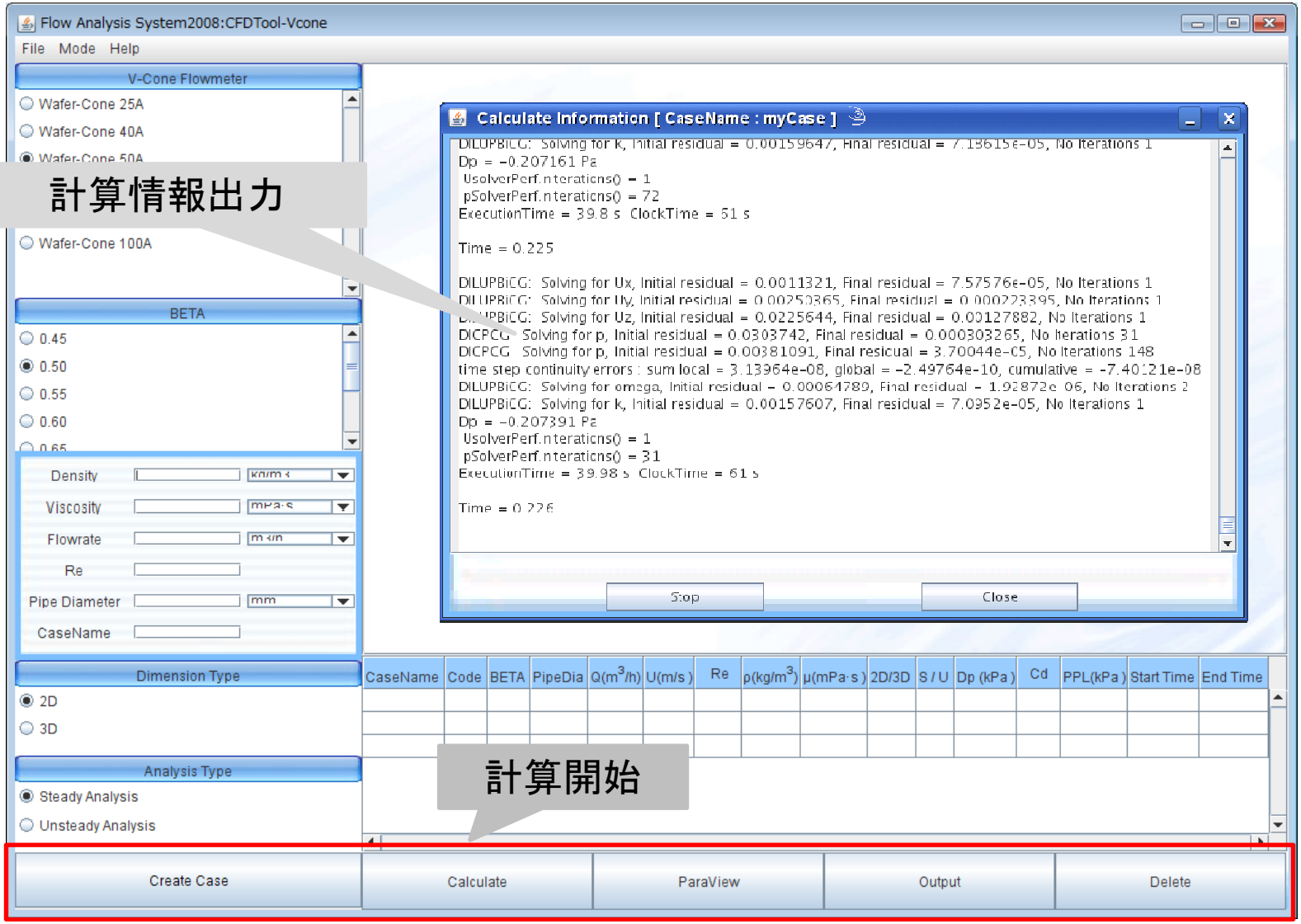
# 基本特徴


Flow Analysis System2008:CFDTool-Vcone
File Mode Help
V-Cone Flowmeter
Wafer-Cone 25A
Wafer-Cone 40A
Wafer-Cone 50A
Wafer-Cone 65A
Wafer-Cone 80A
Wafer-Cone 100A
BETA
0.45
0.50
0.55
0.60
Density
Viscosity
Flowrate
Re
Pipe Diameter
mm
CaseName
Dimension Type
2D
3D
Steady An
Unsteady Analysis
CaseName Code BETA PipeDia Q(m3/h) U(m/s) Re ρ(kg/m3) μ(mPa·s) 2D/3D S / U Dp (kPa) Cd PPL(kPa) Start Time End Time
計算ケース管理
計算ケース作成
Create Case
Calculate
ParaView
Output
Delete

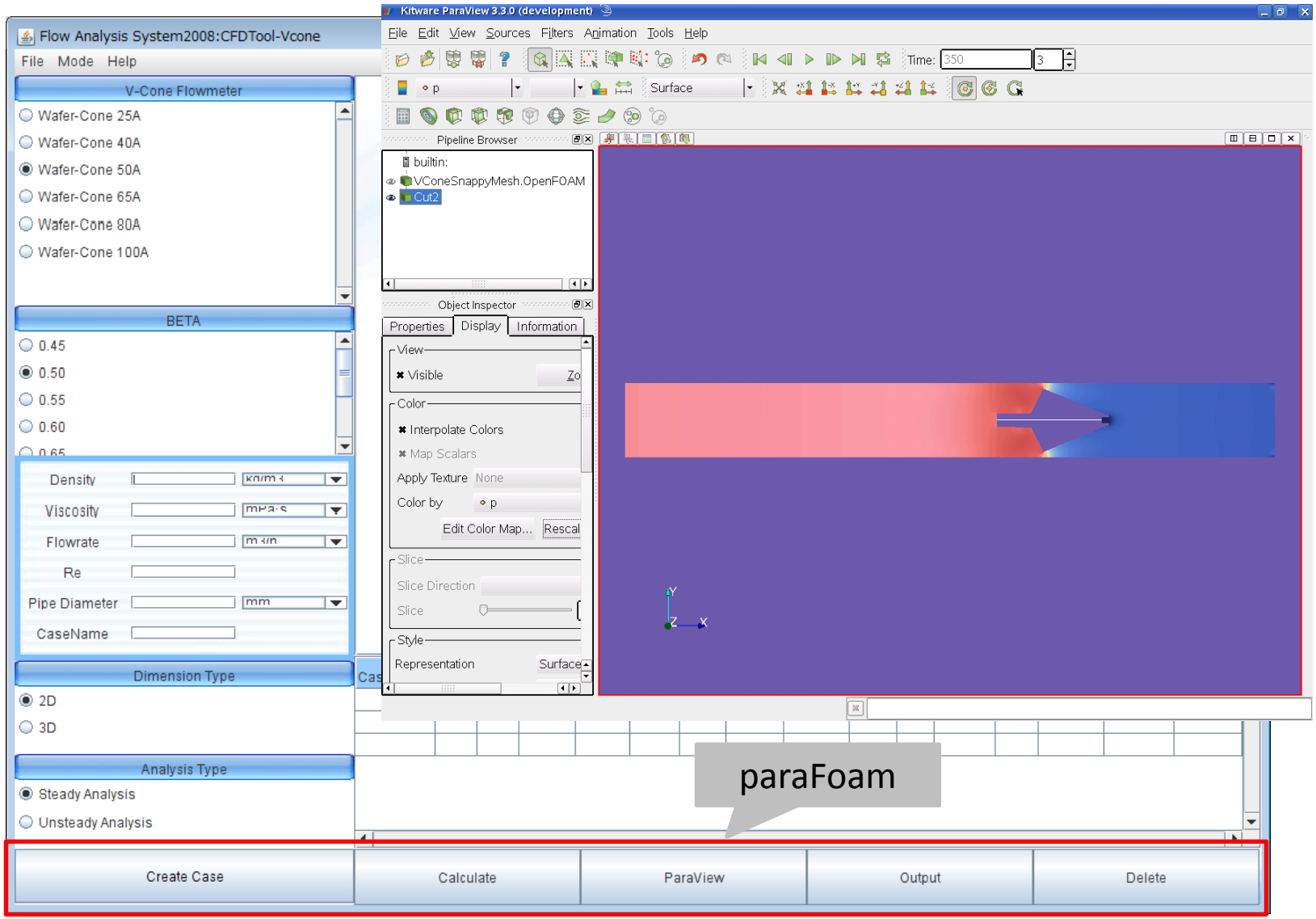
# 基本特徴


Flow Analysis System2008:CFDTool-Vcone
File Mode Help
V-Cone Flowmeter
Wafer-Cone 25A
Wafer-Cone 40A
Wafer-Cone 50A
Wafer-Cone 65A
Wafer-Cone 80A
Wafer-Cone 100A
BETA
0.45
0.50
0.55
0.60
Density
Viscosity
Flowrate
Re
Pipe Diameter
mm
CaseName
Dimension Type
2D
3D
Analysis Type
Steady Analysis
Unsteady Analysis
Input processor numbe
Choose Type
Single
OK
Cancel
Input processor numbe
Choose Type
Parallel
OK
Cancel
Input processor numbe
Choose Number
4
OK
Cancel
CaseName Code BETA PipeDia Q(m3/h) U(m/s) Re ρ(kg/m3) μ(mPa·s) 2D/3D S/U Dp (kPa) Cd PPL(kPa) Start Time End Time
計算開始
Create Case
Calculate
ParaView
Output
Delete

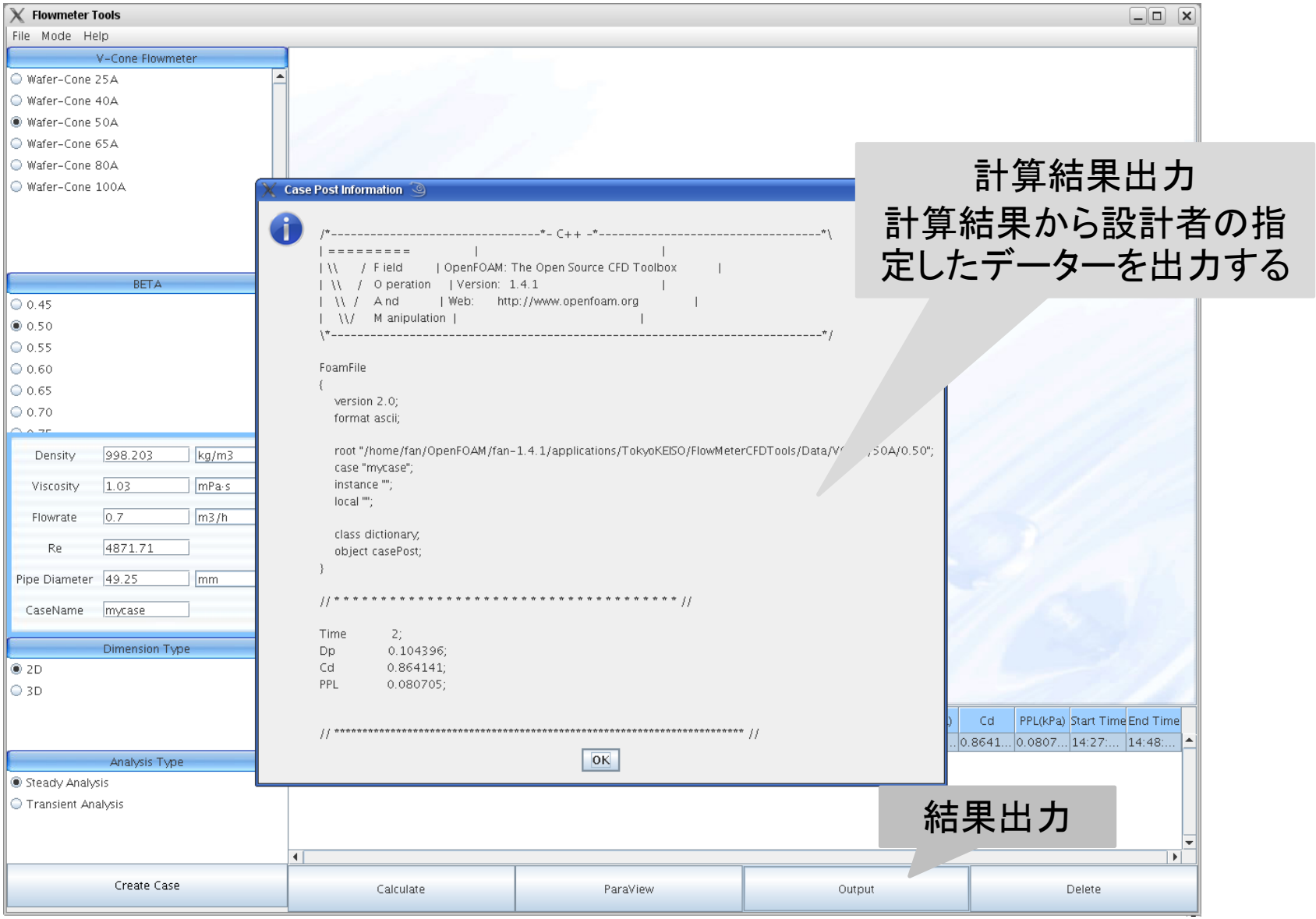
# 基本特徴


Flow Analysis System2008:CFDTool-Vcone
File Mode Help
V-Cone Flowmeter
Wafer-Cone 25A
Wafer-Cone 40A
Wafer-Cone 50A
Wafer-Cone 100A
BETA
0.45
0.50
0.55
0.60
Density
Viscosity
Flowrate
Re
Pipe Diameter
mm
CaseName
Dimension Type
2D
3D
Analysis Type
Steady Analysis
Unsteady Analysis
Calculate Information [ CaseName : myCase ]
DILUPBiCG: Solving for k, Initial residual = 0.00159647, Final residual = 7.18615e-05, No Iterations 1
Dp = -0.207161 Pa
UsolverPerf.nIterations() = 1
pSolverPerf.nIterations() = 72
ExecutionTime = 39.8 s ClockTime = 51 s
Time = 0.225
DILUPBiCG: Solving for Ux, Initial residual = 0.0011321, Final residual = 7.57576e-05, No Iterations 1
DILUPBiCG: Solving for Uz, Initial residual = 0.0225644, Final residual = 0.00127882, No Iterations 1
DICPCG: Solving for p, Initial residual = 0.0303742, Final residual = 0.000303265, No Iterations 31
DICPCG: Solving for p, Initial residual = 0.00381091, Final residual = 3.70044e-05, No Iterations 148
time step continuity errors : sum local = 3.13964e-08, global = -2.49764e-10, cumulative = -7.40121e-08
DILUPBiCG: Solving for omega, Initial residual = 0.00064789, Final residual = 1.92872e-06, No Iterations 2
DILUPBiCG: Solving for k, Initial residual = 0.00157607, Final residual = 7.0952e-05, No Iterations 1
Dp = -0.207391 Pa
UsolverPerf.nIterations() = 1
pSolverPerf.nIterations() = 31
ExecutionTime = 39.98 s ClockTime = 61 s
Time = 0.226
Stop
Close
CaseName
Code
BETA
PipeDia
Q(m3/h)
U(m/s)
Re
ρ(kg/m3)
μ(mPa·s)
2D/3D
S / U
Dp (kPa)
Cd
PPL(kPa)
Start Time
End Time
Create Case
Calculate
ParaView
Output
Delete
計算情報出力
計算開始

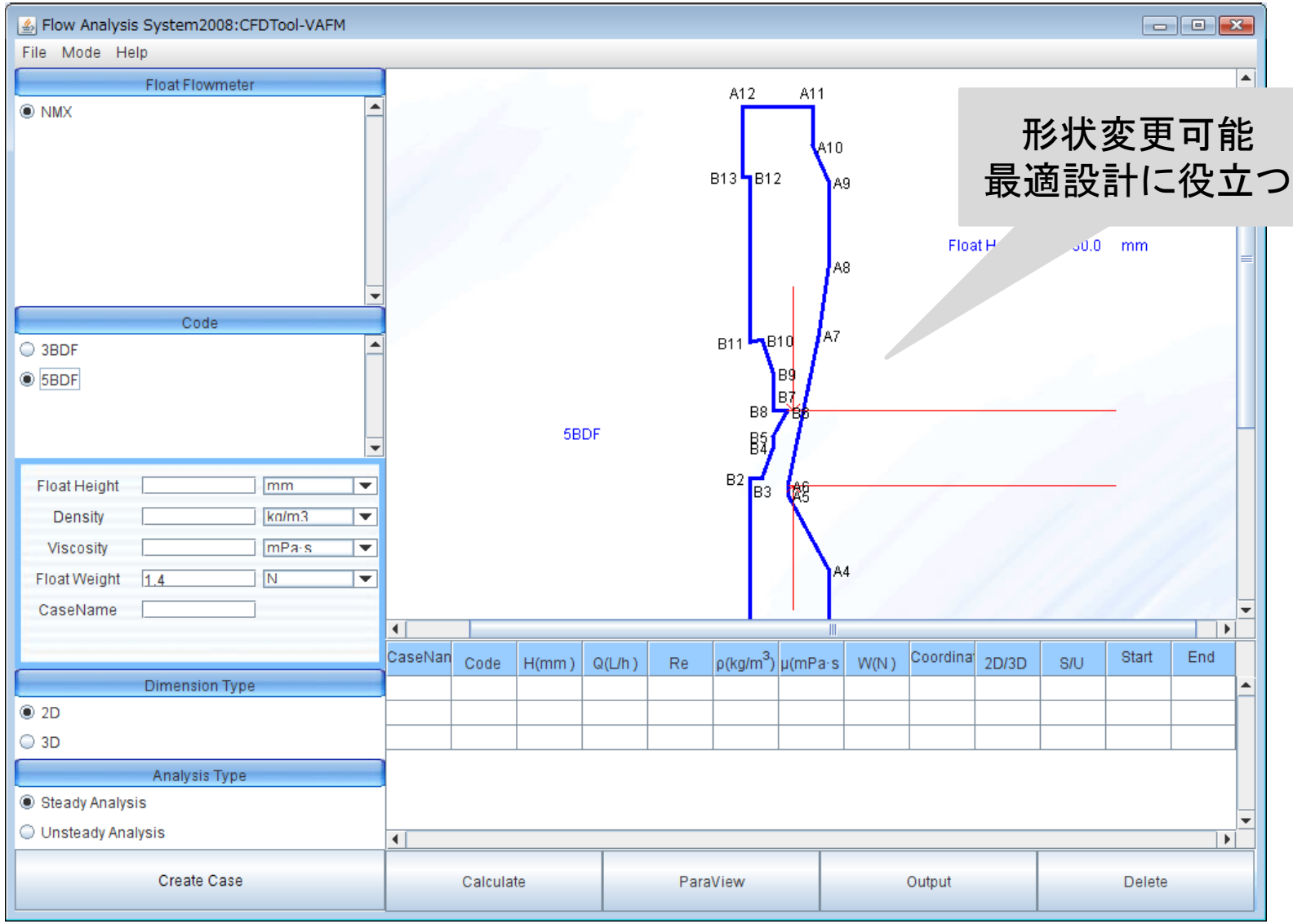
# 基本特徴


Flow Analysis System2008:CFDTool-Vcone
File Mode Help
V-Cone Flowmeter
Wafer-Cone 25A
Wafer-Cone 40A
Wafer-Cone 50A
Wafer-Cone 65A
Wafer-Cone 80A
Wafer-Cone 100A
BETA
0.45
0.50
0.55
0.60
Density
Viscosity
Flowrate
Re
Pipe Diameter
mm
CaseName
Dimension Type
2D
3D
Analysis Type
Steady Analysis
Unsteady Analysis
Kitware ParaView 3.3.0 (development)
File Edit View Sources Filters Animation Tools Help
Time:
Surface
Pipeline Browser
builtin:
VConeSnappyMesh.OpenFOAM
Cut2
Object Inspector
Properties Display Information
View
Visible
Color
Interpolate Colors
Map Scalars
Apply Texture None
Color by
Edit Color Map...
Slice
Slice Direction
Slice
Style
Representation
Surface
paraFoam
Create Case
Calculate
ParaView
Output
Delete

# GUI


Flowmeter Tools
File Mode Help
V-Cone Flowmeter
Wafer-Cone 25A
Wafer-Cone 40A
Wafer-Cone 50A
Wafer-Cone 65A
Wafer-Cone 80A
Wafer-Cone 100A
BETA
0.45
0.50
0.55
0.60
0.65
0.70
Density 998.203 kg/m3
Viscosity 1.03 mPa·s
Flowrate 0.7 m3/h
Re 4871.71
Pipe Diameter 49.25 mm
CaseName mycase
Dimension Type
2D
3D
Analysis Type
Steady Analysis
Transient Analysis
Case Post Information
FoamFile
version 2.0;
format ascii;
root "/home/fan/OpenFOAM/fan-1.4.1/applications/TokyoKEISO/FlowMeterCFDTools/Data/V ,50A/0.50";
case "mycase";
instance "";
local "";
class dictionary;
object casePost;
Time 2;
Dp 0.104396;
Cd 0.864141;
PPL 0.080705;
OK
Cd
PPL(kPa)
Start Time
End Time
0.8641...
0.0807...
14:27:...
14:48:...
Create Case
Calculate
ParaView
Output
Delete
計算結果出力
計算結果から設計者の指定したデーターを出力する
結果出力

# GUI


Flow Analysis System2008:CFDTool-VAFM
File Mode Help
Float Flowmeter
NMX
Code
3BDF
5BDF
Float Height
Density
Viscosity
Float Weight
1.4
CaseName
mm
kg/m3
mPa·s
N
Dimension Type
2D
3D
Analysis Type
Steady Analysis
Unsteady Analysis
A12 A11 A10 A9 A8 A7 A6 A5 A4
B13 B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2
5BDF
CaseNan Code H(mm) Q(L/h) Re ρ(kg/m3) μ(mPa·s W(N) Coordina 2D/3D S/U Start End
Create Case
Calculate
ParaView
Output
Delete
形状変更可能
最適設計に役立つ

# まとめ

- OpenFOAMのカスタマイズ機能を十分利用し、ユーザーがCFD技術を意識しなくてもCFD計算できるGUIを開発した。
- OpenFOAMを企業に導入する一つ方法を提案した。
- 最初GUI設計の時、お客様のニーズを正確に把握するのが難点
- 格子作成ツールの制限によって複雑境界に対応できない。snappyHexMeshに期待する。