[](http://www.comsol.com/)

Ex5 2 2 NonIso PW

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| Date | Aug 7, 2014 10:31:19 AM |

Contents

[1. Global](#cs6292056)

[1.1. Definitions](#cs8955211)

[2. Component 1](#cs8184908)

[2.1. Definitions](#cs9801050)

[2.2. Geometry 1](#cs3963825)

[2.3. Steady Flow](#cs3812517)

[2.4. Unit Input](#cs1656652)

[2.5. Set Point Flow](#cs4611720)

[2.6. Set Point Temperature](#cs9541764)

[2.7. Piecewise Constant Flow](#cs1217497)

[2.8. Piecewise Constant Temperature](#cs7405760)

[2.9. Closed Loop Flow](#cs6424138)

[2.10. Closed Loop Temperature](#cs4959283)

[2.11. Mesh 1](#cs8345372)

[3. Study 1](#cs8150421)

[3.1. Stationary](#cs8181833)

[3.2. Solver Configurations](#cs1453262)

[4. Study 2](#cs7540574)

[4.1. Stationary](#cs4426309)

[4.2. Solver Configurations](#cs7146505)

[5. Study 3](#cs6017410)

[5.1. Time Dependent](#cs9583413)

[5.2. Solver Configurations](#cs4432741)

[6. Study 4](#cs3280822)

[6.1. Time Dependent](#cs3707037)

[6.2. Solver Configurations](#cs3419478)

[7. Results](#cs1519109)

[7.1. Data Sets](#cs4548608)

[7.2. Derived Values](#cs1082231)

[7.3. Tables](#cs4686979)

[7.4. Plot Groups](#cs1669461)

1. Global

|  |  |
| --- | --- |
| Date | Jul 20, 2014 8:34:26 AM |

Global settings

|  |  |
| --- | --- |
| Name | Ex5 2 2 NonIso PW.mph |
| Path | /Users/gilliam/Desktop/collect\_15/research\_15/geo\_reg\_mono\_eugenio/Mono\_1\_15/Comsol\_EX\_GitHub/Chapter5/Chap5Ex2\_Non-Isothermal-Navier-Stokes-Flow/Ex5.2.2\_pcws\_cnstnt/Ex5\_2\_2\_NonIso\_PW.mph |
| Program | COMSOL 4.4 (Build: 150) |

Used products

|  |
| --- |
| COMSOL Multiphysics |

* 1. Definitions
     1. Parameters 1

Parameters

| **Name** | **Expression** | **Value** | **Description** |
| --- | --- | --- | --- |
| L | 1 | 1.0000 |  |
| H | 0.1 | 0.10000 |  |
| ni | 0.002 | 0.0020000 |  |
| alpha | 0.01 | 0.010000 |  |
| beta | 1 | 1.0000 |  |
| M1 | 0.25 | 0.25000 |  |
| M2 | 0.5 | 0.50000 |  |
| d1 | 0.75 | 0.75000 |  |
| d2 | 0.5 | 0.50000 |  |
| t1 | 750 | 750.00 |  |
| t2 | 2250 | 2250.0 |  |

1. Component 1

Component settings

|  |  |
| --- | --- |
| Unit system | None |

* 1. Definitions
     1. Variables

#### Variables 1a

Selection

|  |  |
| --- | --- |
| Geometric entity level | Entire model |

| **Name** | **Expression** | **Description** |
| --- | --- | --- |
| G | C(X) |  |
| yr0 | M1 |  |
| d0 | d1 |  |
| gamma0 | (yr0 - C(tZ))/G |  |
| yr | M1 + (M2 - M1)\*flc2hs(t - t1, 5) + (M1 - M2)\*flc2hs(t - t2, 5) |  |
| d | d1 + (d2 - d1)\*flc2hs(t - t1, 5) + (d1 - d2)\*flc2hs(t - t2, 5) |  |
| gamma | (yr - C(tT))/G |  |
| e | yr - C(T) |  |

* + 1. Component Couplings

#### Average 1

|  |  |
| --- | --- |
| Coupling type | Average |
| Operator name | C |

Source selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domain 9 |

* + 1. Coordinate Systems

#### Boundary System 1

|  |  |
| --- | --- |
| Coordinate system type | Boundary system |
| Tag | sys1 |

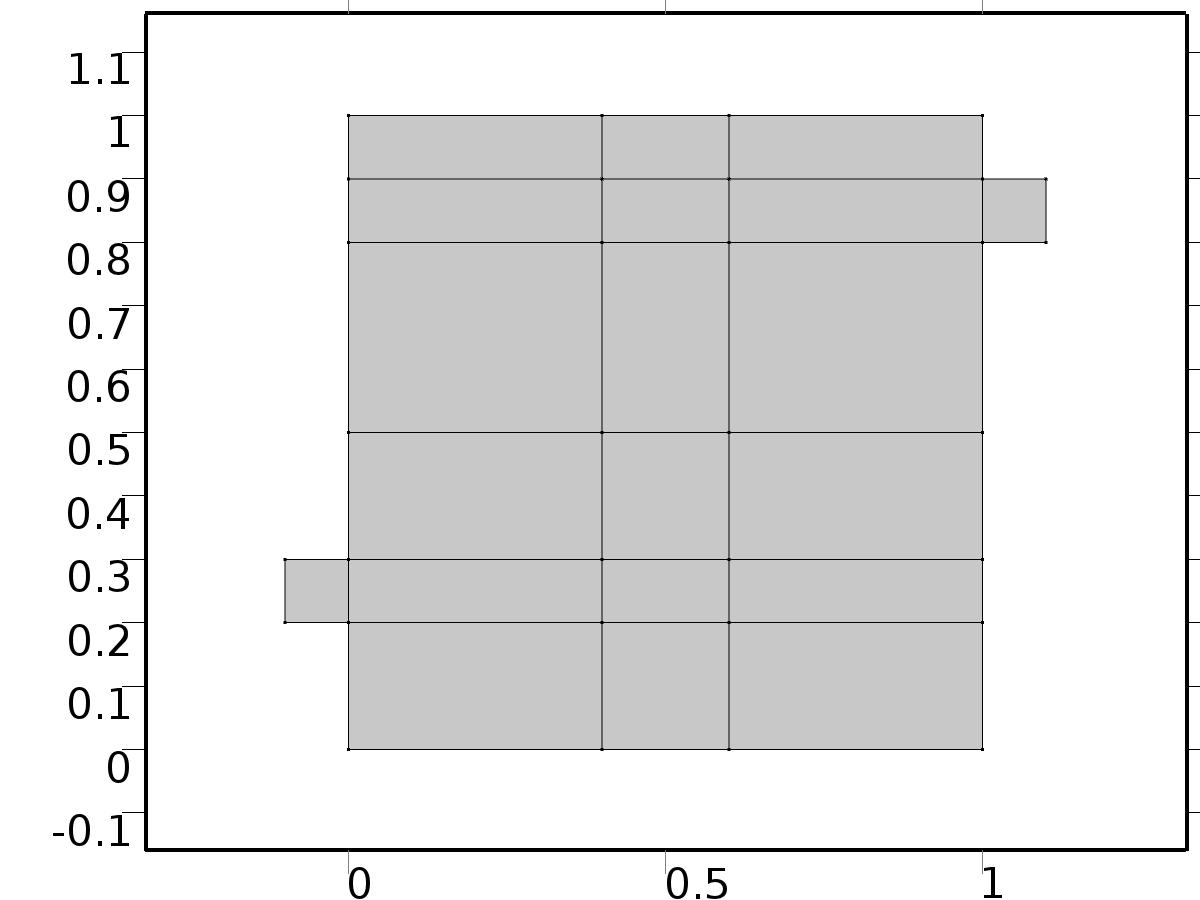
Coordinate names

| **First (t1)** | **Second (n)** | **Third (to)** |
| --- | --- | --- |
| t1 | n | to |

Settings

| **Description** | **Value** |
| --- | --- |
| Create first tangent direction from | Global Cartesian |

* 1. Geometry 1



Geometry 1

Units

|  |  |
| --- | --- |
| Length unit | m |
| Angular unit | deg |

Geometry statistics

| **Description** | **Value** |
| --- | --- |
| Space dimension | 2 |
| Number of domains | 20 |
| Number of boundaries | 51 |
| Number of vertices | 32 |

* + 1. Square 1 (sq1)

Position

| **Description** | **Value** |
| --- | --- |
| Position | {0, 0} |
| Layers |  |

Size

| **Description** | **Value** |
| --- | --- |
| Side length | L |

* + 1. Rectangle 1 (r1)

Position

| **Description** | **Value** |
| --- | --- |
| Position | {-H, 2\*H} |
| Layers |  |

Size

| **Description** | **Value** |
| --- | --- |
| Width | L + H |
| Height | H |

* + 1. Rectangle 2 (r2)

Position

| **Description** | **Value** |
| --- | --- |
| Position | {0, L - 2\*H} |
| Layers |  |

Size

| **Description** | **Value** |
| --- | --- |
| Width | L + H |
| Height | H |

* + 1. Rectangle 3 (r3)

Position

| **Description** | **Value** |
| --- | --- |
| Position | {4\*H, 0} |
| Layers |  |

Size

| **Description** | **Value** |
| --- | --- |
| Width | 2\*H |
| Height | L |

* + 1. Rectangle 4 (r4)

Position

| **Description** | **Value** |
| --- | --- |
| Position | {0, 3\*H} |
| Layers |  |

Size

| **Description** | **Value** |
| --- | --- |
| Width | L |
| Height | 2\*H |

* 1. Steady Flow



Steady Flow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations









Settings

| **Description** | **Value** |
| --- | --- |
| Discretization of fluids | P2 + P1 |
| Value type when using splitting of complex variables | {Real, Real, Real, Real, Real, Real, Real, Real, Real, Real, Real} |
| Isotropic diffusion | Off |
| Compressibility | Incompressible flow |
| Channel thickness | 1 |
| Turbulence model type | None |
| Reference pressure level | 1[atm] |
| Use pseudo time stepping for stationary equation form | Off |
| Local CFL number | 1.3^min(niterCMP, 9) + if(niterCMP>=25, 9\*1.3^min(niterCMP - 25, 9), 0) + if(niterCMP>=45, 90\*1.3^min(niterCMP - 45, 9), 0) |
| Streamline diffusion | Off |
| Crosswind diffusion | Off |

Used products

|  |
| --- |
| COMSOL Multiphysics |

Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| V.dz | 1 |  | Thickness | Domains 1–20 |
| V.pref | 1[atm] |  | Reference pressure level | Domains 1–20 |
| V.pA | P+V.pref |  | Absolute pressure | Domains 1–20 |
| V.nx | nx |  | Normal vector, x component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| V.ny | ny |  | Normal vector, y component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| V.nz | 0 |  | Normal vector, z component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| V.nx | dnx |  | Normal vector, x component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| V.ny | dny |  | Normal vector, y component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| V.nz | 0 |  | Normal vector, z component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| V.nxmesh | root.nxmesh |  | Normal vector, x component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| V.nymesh | root.nymesh |  | Normal vector, y component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| V.nzmesh | 0 |  | Normal vector, z component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| V.nxmesh | root.dnxmesh |  | Normal vector, x component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| V.nymesh | root.dnymesh |  | Normal vector, y component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| V.nzmesh | 0 |  | Normal vector, z component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |

* + 1. Fluid Properties



Fluid Properties

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Density | User defined |
| Density | 1 |
| Dynamic viscosity | User defined |
| Dynamic viscosity | ni |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| V.rho | 1 |  | Density | Domains 1–20 |
| V.mu | ni |  | Dynamic viscosity | Domains 1–20 |
| V.sr | sqrt(0.5\*(4\*Ux^2+2\*(Uy+Vx)^2+4\*Vy^2)+eps) |  | Shear rate | Domains 1–20 |
| V.divu | Ux+Vy |  | Divergence of velocity field | Domains 1–20 |
| V.Fx | 0 |  | Volume force, x component | Domains 1–20 |
| V.Fy | 0 |  | Volume force, y component | Domains 1–20 |
| V.Fz | 0 |  | Volume force, z component | Domains 1–20 |
| V.U | sqrt(U^2+V^2) |  | Velocity magnitude | Domains 1–20 |
| V.vorticityx | 0 |  | Vorticity field, x component | Domains 1–20 |
| V.vorticityy | 0 |  | Vorticity field, y component | Domains 1–20 |
| V.vorticityz | Vx-Uy |  | Vorticity field, z component | Domains 1–20 |
| V.vort\_magn | sqrt(V.vorticityx^2+V.vorticityy^2+V.vorticityz^2) |  | Vorticity magnitude | Domains 1–20 |
| V.cellRe | 0.25\*V.rho\*sqrt(emetric(U,V)/emetric2)/V.mu |  | Cell Reynolds number | Domains 1–20 |
| V.nu | V.mu/V.rho |  | Kinematic viscosity | Domains 1–20 |
| V.betaT | 0 |  | Isothermal compressibility coefficient | Domains 1–20 |
| V.mu\_eff | V.mu+V.muT |  | Dynamic viscosity | Domains 1–20 |
| V.muT | 0 |  | Turbulent dynamic viscosity | Domains 1–20 |
| V.T\_stressx | V.K\_stressx-P\*V.nxmesh |  | Total stress, x component | Boundaries 1–51 |
| V.T\_stressy | V.K\_stressy-P\*V.nymesh |  | Total stress, y component | Boundaries 1–51 |
| V.T\_stressz | V.K\_stressz-P\*V.nzmesh |  | Total stress, z component | Boundaries 1–51 |
| V.K\_stressx | V.mu\_eff\*(2\*Ux\*V.nxmesh+(Uy+Vx)\*V.nymesh) |  | Viscous stress, x component | Boundaries 1–51 |
| V.K\_stressy | V.mu\_eff\*((Vx+Uy)\*V.nxmesh+2\*Vy\*V.nymesh) |  | Viscous stress, y component | Boundaries 1–51 |
| V.K\_stressz | 0 |  | Viscous stress, z component | Boundaries 1–51 |
| V.K\_stress\_tensorxx | 2\*V.mu\_eff\*Ux |  | Viscous stress tensor, xx component | Domains 1–20 |
| V.K\_stress\_tensoryx | V.mu\_eff\*(Vx+Uy) |  | Viscous stress tensor, yx component | Domains 1–20 |
| V.K\_stress\_tensorzx | 0 |  | Viscous stress tensor, zx component | Domains 1–20 |
| V.K\_stress\_tensorxy | V.mu\_eff\*(Uy+Vx) |  | Viscous stress tensor, xy component | Domains 1–20 |
| V.K\_stress\_tensoryy | 2\*V.mu\_eff\*Vy |  | Viscous stress tensor, yy component | Domains 1–20 |
| V.K\_stress\_tensorzy | 0 |  | Viscous stress tensor, zy component | Domains 1–20 |
| V.K\_stress\_tensorxz | 0 |  | Viscous stress tensor, xz component | Domains 1–20 |
| V.K\_stress\_tensoryz | 0 |  | Viscous stress tensor, yz component | Domains 1–20 |
| V.K\_stress\_tensorzz | 0 |  | Viscous stress tensor, zz component | Domains 1–20 |
| V.K\_stress\_tensor\_testxx | 2\*V.mu\_eff\*test(Ux) |  | Viscous stress tensor test, xx component | Domains 1–20 |
| V.K\_stress\_tensor\_testyx | V.mu\_eff\*(test(Vx)+test(Uy)) |  | Viscous stress tensor test, yx component | Domains 1–20 |
| V.K\_stress\_tensor\_testzx | 0 |  | Viscous stress tensor test, zx component | Domains 1–20 |
| V.K\_stress\_tensor\_testxy | V.mu\_eff\*(test(Uy)+test(Vx)) |  | Viscous stress tensor test, xy component | Domains 1–20 |
| V.K\_stress\_tensor\_testyy | 2\*V.mu\_eff\*test(Vy) |  | Viscous stress tensor test, yy component | Domains 1–20 |
| V.K\_stress\_tensor\_testzy | 0 |  | Viscous stress tensor test, zy component | Domains 1–20 |
| V.K\_stress\_tensor\_testxz | 0 |  | Viscous stress tensor test, xz component | Domains 1–20 |
| V.K\_stress\_tensor\_testyz | 0 |  | Viscous stress tensor test, yz component | Domains 1–20 |
| V.K\_stress\_tensor\_testzz | 0 |  | Viscous stress tensor test, zz component | Domains 1–20 |
| V.upwind\_helpx | U |  | Upwind term, x component | Domains 1–20 |
| V.upwind\_helpy | V |  | Upwind term, y component | Domains 1–20 |
| V.upwind\_helpz | 0 |  | Upwind term, z component | Domains 1–20 |
| V.tau\_vdxx | 2\*V.mu\*Ux |  | Strain rate, xx component | Domains 1–20 |
| V.tau\_vdyx | V.mu\*(Vx+Uy) |  | Strain rate, yx component | Domains 1–20 |
| V.tau\_vdzx | 0 |  | Strain rate, zx component | Domains 1–20 |
| V.tau\_vdxy | V.mu\*(Uy+Vx) |  | Strain rate, xy component | Domains 1–20 |
| V.tau\_vdyy | 2\*V.mu\*Vy |  | Strain rate, yy component | Domains 1–20 |
| V.tau\_vdzy | 0 |  | Strain rate, zy component | Domains 1–20 |
| V.tau\_vdxz | 0 |  | Strain rate, xz component | Domains 1–20 |
| V.tau\_vdyz | 0 |  | Strain rate, yz component | Domains 1–20 |
| V.tau\_vdzz | 0 |  | Strain rate, zz component | Domains 1–20 |
| V.Qvd | V.tau\_vdxx\*Ux+V.tau\_vdxy\*Uy+V.tau\_vdyx\*Vx+V.tau\_vdyy\*Vy |  | Viscous dissipation | Domains 1–20 |

#### Shape functions

| **Name** | **Shape function** | **Unit** | **Description** | **Shape frame** | **Selection** |
| --- | --- | --- | --- | --- | --- |
| U | Lagrange (Quadratic) |  | Velocity field, x component | Material | Domains 1–20 |
| V | Lagrange (Quadratic) |  | Velocity field, y component | Material | Domains 1–20 |
| P | Lagrange (Linear) |  | Pressure | Material | Domains 1–20 |

#### Weak expressions

| **Weak expression** | **Integration frame** | **Selection** |
| --- | --- | --- |
| (P-V.K\_stress\_tensorxx)\*test(Ux)-V.K\_stress\_tensorxy\*test(Uy)-V.K\_stress\_tensoryx\*test(Vx)+(P-V.K\_stress\_tensoryy)\*test(Vy) | Material | Domains 1–20 |
| V.Fx\*test(U)+V.Fy\*test(V) | Material | Domains 1–20 |
| V.rho\*(-(Ux\*U+Uy\*V)\*test(U)-(Vx\*U+Vy\*V)\*test(V)) | Material | Domains 1–20 |
| -V.rho\*V.divu\*test(P) | Material | Domains 1–20 |

* + 1. Wall



Wall

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | No slip |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| V.ubndx | 0 |  | Velocity at boundary, x component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| V.ubndy | 0 |  | Velocity at boundary, y component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| V.ubndz | 0 |  | Velocity at boundary, z component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -U+V.ubndx | test(-U) | Lagrange (Quadratic) | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| -V+V.ubndy | test(-V) | Lagrange (Quadratic) | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| V.ubndz | 0 |  | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

* + 1. Initial Values



Initial Values

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Turbulent kinetic energy | spf.kinit |
| Turbulent dissipation rate | spf.epinit |
| Specific dissipation rate | spf.omInit |
| Reciprocal wall distance | spf.G0 |
| Undamped turbulent kinematic viscosity | spf.nutildeinit |
| Velocity field | {0, 0, 0} |
| Pressure | 0 |

* + 1. Inlet



Inlet

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 51 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Apply reaction terms on | All physics (symmetric) |
| Use weak constraints | Off |
| Boundary condition | Velocity |
| Velocity field componentwise | Normal inflow velocity |
| Normal inflow velocity | 4\*s\*(1 - s) |
| Turbulent intensity | 0.05 |
| Turbulence length scale | 0.01[m] |
| Turbulent kinetic energy | 0.005[m^2/s^2] |
| Turbulent dissipation rate | 0.005[m^2/s^3] |
| Specific dissipation rate | 20[1/s] |
| Undamped turbulent kinematic viscosity | 3\*spf.nu |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| V.ubndx | -nojac(V.nxmesh)\*V.U0in |  | Velocity at boundary, x component | Boundary 51 |
| V.ubndy | -nojac(V.nymesh)\*V.U0in |  | Velocity at boundary, y component | Boundary 51 |
| V.ubndz | -nojac(V.nzmesh)\*V.U0in |  | Velocity at boundary, z component | Boundary 51 |
| V.U0in | 4\*s\*(1-s) |  | Normal inflow velocity | Boundary 51 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -U+V.ubndx | test(-U+V.ubndx) | Lagrange (Quadratic) | Boundary 51 |
| -V+V.ubndy | test(-V+V.ubndy) | Lagrange (Quadratic) | Boundary 51 |
| V.ubndz | test(V.ubndz) |  | Boundary 51 |

* + 1. Outflow



Outflow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 1 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | Normal stress |
| Normal stress | 0 |
| Turbulent intensity | 0.005 |
| Turbulence length scale | 0.1[m] |
| Turbulent kinetic energy | 2.5e-3[m^2/s^2] |
| Turbulent dissipation rate | 1.1e-4[m^2/s^3] |
| Specific dissipation rate | 0.5[1/s] |
| Undamped turbulent kinematic viscosity | 3\*spf.nu |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| V.f0 | 0 |  | Normal stress | Boundary 1 |

#### Weak expressions

| **Weak expression** | **Integration frame** | **Selection** |
| --- | --- | --- |
| -V.f0\*(test(U)\*V.nxmesh+test(V)\*V.nymesh) | Material | Boundary 1 |

* + 1. Window



Window

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 45 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | No slip |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| V.ubndx | 0 |  | Velocity at boundary, x component | Boundary 45 |
| V.ubndy | 0 |  | Velocity at boundary, y component | Boundary 45 |
| V.ubndz | 0 |  | Velocity at boundary, z component | Boundary 45 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -U+V.ubndx | test(-U) | Lagrange (Quadratic) | Boundary 45 |
| -V+V.ubndy | test(-V) | Lagrange (Quadratic) | Boundary 45 |
| V.ubndz | 0 |  | Boundary 45 |

* 1. Unit Input



Unit Input

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Shape function type | Lagrange |
| Element order | Quadratic |
| Compute boundary fluxes | On |
| Apply smoothing to boundary fluxes | On |
| Value type when using splitting of complex variables | Complex |
| Dependent variable quantity | Dimensionless (1) |
| Source term quantity | None |
| Unit | m^ - 2 |

Used products

|  |
| --- |
| COMSOL Multiphysics |

Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| X.nx | nx |  | Normal vector, x component | Boundaries 1–51 |
| X.ny | ny |  | Normal vector, y component | Boundaries 1–51 |
| X.nz | root.nz |  | Normal vector, z component | Boundaries 1–51 |
| X.nxmesh | root.nxmesh |  | Normal vector (mesh), x component | Boundaries 1–51 |
| X.nymesh | root.nymesh |  | Normal vector (mesh), y component | Boundaries 1–51 |
| X.nzmesh | root.nzmesh |  | Normal vector (mesh), z component | Boundaries 1–51 |

* + 1. Coefficient Form PDE



Coefficient Form PDE

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Diffusion coefficient | {{alpha, 0}, {0, alpha}} |
| Absorption coefficient | 0 |
| Source term | 0 |
| Mass coefficient | 0 |
| Damping or mass coefficient | 0 |
| Conservative flux convection coefficient | {0, 0} |
| Convection coefficient | {U, V} |
| Conservative flux source | {0, 0} |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| domflux.Xx | -alpha\*d(X,x) |  | Domain flux, x component | Domains 1–20 |
| domflux.Xy | -alpha\*d(X,y) |  | Domain flux, y component | Domains 1–20 |

#### Shape functions

| **Name** | **Shape function** | **Unit** | **Description** | **Shape frame** | **Selection** |
| --- | --- | --- | --- | --- | --- |
| X | Lagrange (Quadratic) |  | Dependent variable X | Material | Domains 1–20 |

* + 1. Insulated Wall



Insulated Wall

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

Equations

* + 1. Initial Values



Initial Values

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Initial value for X | 0 |
| Initial time derivative of X | 0 |

* + 1. Heat Flux Bin\*1



Heat Flux Bin\*1

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 51 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary flux/source | 1 |
| Boundary absorption/impedance term | 0 |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| X.g\_X | 1 |  | Boundary flux/source | Boundary 51 |

* + 1. Outflow



Outflow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 1 |

Equations

* + 1. Window



Window

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 45 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Value on boundary | 0 |
| Prescribed value of X | On |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -X | -test(X) | Lagrange (Quadratic) | Boundary 45 |

* 1. Set Point Flow



Set Point Flow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations









Settings

| **Description** | **Value** |
| --- | --- |
| Discretization of fluids | P2 + P1 |
| Value type when using splitting of complex variables | {Real, Real, Real, Real, Real, Real, Real, Real, Real, Real, Real} |
| Isotropic diffusion | Off |
| Compressibility | Incompressible flow |
| Channel thickness | 1 |
| Turbulence model type | None |
| Reference pressure level | 1[atm] |
| Use pseudo time stepping for stationary equation form | Off |
| Local CFL number | 1.3^min(niterCMP, 9) + if(niterCMP>=25, 9\*1.3^min(niterCMP - 25, 9), 0) + if(niterCMP>=45, 90\*1.3^min(niterCMP - 45, 9), 0) |
| Streamline diffusion | Off |
| Crosswind diffusion | Off |

Used products

|  |
| --- |
| COMSOL Multiphysics |

Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bV.dz | 1 |  | Thickness | Domains 1–20 |
| bV.pref | 1[atm] |  | Reference pressure level | Domains 1–20 |
| bV.pA | bP+bV.pref |  | Absolute pressure | Domains 1–20 |
| bV.nx | nx |  | Normal vector, x component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bV.ny | ny |  | Normal vector, y component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bV.nz | 0 |  | Normal vector, z component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bV.nx | dnx |  | Normal vector, x component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bV.ny | dny |  | Normal vector, y component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bV.nz | 0 |  | Normal vector, z component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bV.nxmesh | root.nxmesh |  | Normal vector, x component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bV.nymesh | root.nymesh |  | Normal vector, y component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bV.nzmesh | 0 |  | Normal vector, z component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bV.nxmesh | root.dnxmesh |  | Normal vector, x component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bV.nymesh | root.dnymesh |  | Normal vector, y component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bV.nzmesh | 0 |  | Normal vector, z component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |

* + 1. Fluid Properties



Fluid Properties

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Density | User defined |
| Density | 1 |
| Dynamic viscosity | User defined |
| Dynamic viscosity | ni |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bV.Fx | 0 |  | Volume force, x component | Domains 1–20 |
| bV.Fy | 0 |  | Volume force, y component | Domains 1–20 |
| bV.Fz | 0 |  | Volume force, z component | Domains 1–20 |
| bV.rho | 1 |  | Density | Domains 1–20 |
| bV.mu | ni |  | Dynamic viscosity | Domains 1–20 |
| bV.sr | sqrt(0.5\*(4\*bUx^2+2\*(bUy+bVx)^2+4\*bVy^2)+eps) |  | Shear rate | Domains 1–20 |
| bV.divu | bUx+bVy |  | Divergence of velocity field | Domains 1–20 |
| bV.U | sqrt(bU^2+bV^2) |  | Velocity magnitude | Domains 1–20 |
| bV.vorticityx | 0 |  | Vorticity field, x component | Domains 1–20 |
| bV.vorticityy | 0 |  | Vorticity field, y component | Domains 1–20 |
| bV.vorticityz | bVx-bUy |  | Vorticity field, z component | Domains 1–20 |
| bV.vort\_magn | sqrt(bV.vorticityx^2+bV.vorticityy^2+bV.vorticityz^2) |  | Vorticity magnitude | Domains 1–20 |
| bV.cellRe | 0.25\*bV.rho\*sqrt(emetric(bU,bV)/emetric2)/bV.mu |  | Cell Reynolds number | Domains 1–20 |
| bV.nu | bV.mu/bV.rho |  | Kinematic viscosity | Domains 1–20 |
| bV.betaT | 0 |  | Isothermal compressibility coefficient | Domains 1–20 |
| bV.mu\_eff | bV.mu+bV.muT |  | Dynamic viscosity | Domains 1–20 |
| bV.muT | 0 |  | Turbulent dynamic viscosity | Domains 1–20 |
| bV.T\_stressx | bV.K\_stressx-bP\*bV.nxmesh |  | Total stress, x component | Boundaries 1–51 |
| bV.T\_stressy | bV.K\_stressy-bP\*bV.nymesh |  | Total stress, y component | Boundaries 1–51 |
| bV.T\_stressz | bV.K\_stressz-bP\*bV.nzmesh |  | Total stress, z component | Boundaries 1–51 |
| bV.K\_stressx | bV.mu\_eff\*(2\*bUx\*bV.nxmesh+(bUy+bVx)\*bV.nymesh) |  | Viscous stress, x component | Boundaries 1–51 |
| bV.K\_stressy | bV.mu\_eff\*((bVx+bUy)\*bV.nxmesh+2\*bVy\*bV.nymesh) |  | Viscous stress, y component | Boundaries 1–51 |
| bV.K\_stressz | 0 |  | Viscous stress, z component | Boundaries 1–51 |
| bV.K\_stress\_tensorxx | 2\*bV.mu\_eff\*bUx |  | Viscous stress tensor, xx component | Domains 1–20 |
| bV.K\_stress\_tensoryx | bV.mu\_eff\*(bVx+bUy) |  | Viscous stress tensor, yx component | Domains 1–20 |
| bV.K\_stress\_tensorzx | 0 |  | Viscous stress tensor, zx component | Domains 1–20 |
| bV.K\_stress\_tensorxy | bV.mu\_eff\*(bUy+bVx) |  | Viscous stress tensor, xy component | Domains 1–20 |
| bV.K\_stress\_tensoryy | 2\*bV.mu\_eff\*bVy |  | Viscous stress tensor, yy component | Domains 1–20 |
| bV.K\_stress\_tensorzy | 0 |  | Viscous stress tensor, zy component | Domains 1–20 |
| bV.K\_stress\_tensorxz | 0 |  | Viscous stress tensor, xz component | Domains 1–20 |
| bV.K\_stress\_tensoryz | 0 |  | Viscous stress tensor, yz component | Domains 1–20 |
| bV.K\_stress\_tensorzz | 0 |  | Viscous stress tensor, zz component | Domains 1–20 |
| bV.K\_stress\_tensor\_testxx | 2\*bV.mu\_eff\*test(bUx) |  | Viscous stress tensor test, xx component | Domains 1–20 |
| bV.K\_stress\_tensor\_testyx | bV.mu\_eff\*(test(bVx)+test(bUy)) |  | Viscous stress tensor test, yx component | Domains 1–20 |
| bV.K\_stress\_tensor\_testzx | 0 |  | Viscous stress tensor test, zx component | Domains 1–20 |
| bV.K\_stress\_tensor\_testxy | bV.mu\_eff\*(test(bUy)+test(bVx)) |  | Viscous stress tensor test, xy component | Domains 1–20 |
| bV.K\_stress\_tensor\_testyy | 2\*bV.mu\_eff\*test(bVy) |  | Viscous stress tensor test, yy component | Domains 1–20 |
| bV.K\_stress\_tensor\_testzy | 0 |  | Viscous stress tensor test, zy component | Domains 1–20 |
| bV.K\_stress\_tensor\_testxz | 0 |  | Viscous stress tensor test, xz component | Domains 1–20 |
| bV.K\_stress\_tensor\_testyz | 0 |  | Viscous stress tensor test, yz component | Domains 1–20 |
| bV.K\_stress\_tensor\_testzz | 0 |  | Viscous stress tensor test, zz component | Domains 1–20 |
| bV.upwind\_helpx | bU |  | Upwind term, x component | Domains 1–20 |
| bV.upwind\_helpy | bV |  | Upwind term, y component | Domains 1–20 |
| bV.upwind\_helpz | 0 |  | Upwind term, z component | Domains 1–20 |
| bV.tau\_vdxx | 2\*bV.mu\*bUx |  | Strain rate, xx component | Domains 1–20 |
| bV.tau\_vdyx | bV.mu\*(bVx+bUy) |  | Strain rate, yx component | Domains 1–20 |
| bV.tau\_vdzx | 0 |  | Strain rate, zx component | Domains 1–20 |
| bV.tau\_vdxy | bV.mu\*(bUy+bVx) |  | Strain rate, xy component | Domains 1–20 |
| bV.tau\_vdyy | 2\*bV.mu\*bVy |  | Strain rate, yy component | Domains 1–20 |
| bV.tau\_vdzy | 0 |  | Strain rate, zy component | Domains 1–20 |
| bV.tau\_vdxz | 0 |  | Strain rate, xz component | Domains 1–20 |
| bV.tau\_vdyz | 0 |  | Strain rate, yz component | Domains 1–20 |
| bV.tau\_vdzz | 0 |  | Strain rate, zz component | Domains 1–20 |
| bV.Qvd | bV.tau\_vdxx\*bUx+bV.tau\_vdxy\*bUy+bV.tau\_vdyx\*bVx+bV.tau\_vdyy\*bVy |  | Viscous dissipation | Domains 1–20 |

#### Shape functions

| **Name** | **Shape function** | **Unit** | **Description** | **Shape frame** | **Selection** |
| --- | --- | --- | --- | --- | --- |
| bU | Lagrange (Quadratic) |  | Velocity field, x component | Material | Domains 1–20 |
| bV | Lagrange (Quadratic) |  | Velocity field, y component | Material | Domains 1–20 |
| bP | Lagrange (Linear) |  | Pressure | Material | Domains 1–20 |

#### Weak expressions

| **Weak expression** | **Integration frame** | **Selection** |
| --- | --- | --- |
| (bP-bV.K\_stress\_tensorxx)\*test(bUx)-bV.K\_stress\_tensorxy\*test(bUy)-bV.K\_stress\_tensoryx\*test(bVx)+(bP-bV.K\_stress\_tensoryy)\*test(bVy) | Material | Domains 1–20 |
| bV.Fx\*test(bU)+bV.Fy\*test(bV) | Material | Domains 1–20 |
| bV.rho\*(-(bUx\*bU+bUy\*bV)\*test(bU)-(bVx\*bU+bVy\*bV)\*test(bV)) | Material | Domains 1–20 |
| -bV.rho\*bV.divu\*test(bP) | Material | Domains 1–20 |

* + 1. Wall



Wall

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | No slip |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bV.ubndx | 0 |  | Velocity at boundary, x component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| bV.ubndy | 0 |  | Velocity at boundary, y component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| bV.ubndz | 0 |  | Velocity at boundary, z component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -bU+bV.ubndx | test(-bU) | Lagrange (Quadratic) | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| -bV+bV.ubndy | test(-bV) | Lagrange (Quadratic) | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| bV.ubndz | 0 |  | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

* + 1. Initial Values



Initial Values

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Turbulent kinetic energy | spf.kinit |
| Turbulent dissipation rate | spf.epinit |
| Specific dissipation rate | spf.omInit |
| Reciprocal wall distance | spf.G0 |
| Undamped turbulent kinematic viscosity | spf.nutildeinit |
| Velocity field | {U, V, 0} |
| Pressure | 0 |

* + 1. Inlet



Inlet

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 51 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Apply reaction terms on | All physics (symmetric) |
| Use weak constraints | Off |
| Boundary condition | Velocity |
| Velocity field componentwise | Normal inflow velocity |
| Normal inflow velocity | 4\*s\*(1 - s) |
| Turbulent intensity | 0.05 |
| Turbulence length scale | 0.01[m] |
| Turbulent kinetic energy | 0.005[m^2/s^2] |
| Turbulent dissipation rate | 0.005[m^2/s^3] |
| Specific dissipation rate | 20[1/s] |
| Undamped turbulent kinematic viscosity | 3\*vb.nu |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bV.ubndx | -nojac(bV.nxmesh)\*bV.U0in |  | Velocity at boundary, x component | Boundary 51 |
| bV.ubndy | -nojac(bV.nymesh)\*bV.U0in |  | Velocity at boundary, y component | Boundary 51 |
| bV.ubndz | -nojac(bV.nzmesh)\*bV.U0in |  | Velocity at boundary, z component | Boundary 51 |
| bV.U0in | 4\*s\*(1-s) |  | Normal inflow velocity | Boundary 51 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -bU+bV.ubndx | test(-bU+bV.ubndx) | Lagrange (Quadratic) | Boundary 51 |
| -bV+bV.ubndy | test(-bV+bV.ubndy) | Lagrange (Quadratic) | Boundary 51 |
| bV.ubndz | test(bV.ubndz) |  | Boundary 51 |

* + 1. Outflow



Outflow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 1 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | Normal stress |
| Normal stress | 0 |
| Turbulent intensity | 0.005 |
| Turbulence length scale | 0.1[m] |
| Turbulent kinetic energy | 2.5e-3[m^2/s^2] |
| Turbulent dissipation rate | 1.1e-4[m^2/s^3] |
| Specific dissipation rate | 0.5[1/s] |
| Undamped turbulent kinematic viscosity | 3\*vb.nu |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bV.f0 | 0 |  | Normal stress | Boundary 1 |

#### Weak expressions

| **Weak expression** | **Integration frame** | **Selection** |
| --- | --- | --- |
| -bV.f0\*(test(bU)\*bV.nxmesh+test(bV)\*bV.nymesh) | Material | Boundary 1 |

* + 1. Window



Window

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 45 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | No slip |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bV.ubndx | 0 |  | Velocity at boundary, x component | Boundary 45 |
| bV.ubndy | 0 |  | Velocity at boundary, y component | Boundary 45 |
| bV.ubndz | 0 |  | Velocity at boundary, z component | Boundary 45 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -bU+bV.ubndx | test(-bU) | Lagrange (Quadratic) | Boundary 45 |
| -bV+bV.ubndy | test(-bV) | Lagrange (Quadratic) | Boundary 45 |
| bV.ubndz | 0 |  | Boundary 45 |

* + 1. Buoyancy Force



Buoyancy Force

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bV.Fx | 0 |  | Volume force, x component | Domains 1–20 |
| bV.Fy | beta\*bZ |  | Volume force, y component | Domains 1–20 |
| bV.Fz | 0 |  | Volume force, z component | Domains 1–20 |

* 1. Set Point Temperature



Set Point Temperature

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Shape function type | Lagrange |
| Element order | Quadratic |
| Compute boundary fluxes | On |
| Apply smoothing to boundary fluxes | On |
| Value type when using splitting of complex variables | Complex |
| Dependent variable quantity | Dimensionless (1) |
| Source term quantity | None |
| Unit | m^ - 2 |

Used products

|  |
| --- |
| COMSOL Multiphysics |

Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bZ.nx | nx |  | Normal vector, x component | Boundaries 1–51 |
| bZ.ny | ny |  | Normal vector, y component | Boundaries 1–51 |
| bZ.nz | root.nz |  | Normal vector, z component | Boundaries 1–51 |
| bZ.nxmesh | root.nxmesh |  | Normal vector (mesh), x component | Boundaries 1–51 |
| bZ.nymesh | root.nymesh |  | Normal vector (mesh), y component | Boundaries 1–51 |
| bZ.nzmesh | root.nzmesh |  | Normal vector (mesh), z component | Boundaries 1–51 |

* + 1. Coefficient Form PDE



Coefficient Form PDE

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Diffusion coefficient | {{{{alpha, 0}, {0, alpha}}, {{0, 0}, {0, 0}}}, {{{0, 0}, {0, 0}}, {{alpha, 0}, {0, alpha}}}} |
| Absorption coefficient | {{0, 0}, {0, 0}} |
| Source term | {0, 0} |
| Mass coefficient | {{0, 0}, {0, 0}} |
| Damping or mass coefficient | {{0, 0}, {0, 0}} |
| Conservative flux convection coefficient | {{{0, 0}, {0, 0}}, {{0, 0}, {0, 0}}} |
| Convection coefficient | {{{bU, bV}, {bU - U, bV - V}}, {{0, 0}, {U, V}}} |
| Conservative flux source | {{0, 0}, {0, 0}} |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| domflux.bZx | -alpha\*d(bZ,x) |  | Domain flux, x component | Domains 1–20 |
| domflux.bZy | -alpha\*d(bZ,y) |  | Domain flux, y component | Domains 1–20 |
| domflux.tZx | -alpha\*d(tZ,x) |  | Domain flux, x component | Domains 1–20 |
| domflux.tZy | -alpha\*d(tZ,y) |  | Domain flux, y component | Domains 1–20 |

#### Shape functions

| **Name** | **Shape function** | **Unit** | **Description** | **Shape frame** | **Selection** |
| --- | --- | --- | --- | --- | --- |
| bZ | Lagrange (Quadratic) |  | Dependent variable bZ | Material | Domains 1–20 |
| tZ | Lagrange (Quadratic) |  | Dependent variable tZ | Material | Domains 1–20 |

* + 1. Insulated Wall



Insulated Wall

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

Equations

* + 1. Initial Values



Initial Values

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Initial value for bZ | 0 |
| Initial time derivative of bZ | 0 |
| Initial value for tZ | 0 |
| Initial time derivative of tZ | 0 |

* + 1. Heat Flux Bin\*gamma0



Heat Flux Bin\*gamma0

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 51 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary flux/source | {gamma0, 0} |
| Boundary absorption/impedance term | {{0, 0}, {0, 0}} |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bZ.g\_bZ | gamma0 |  | Boundary flux/source | Boundary 51 |
| bZ.g\_tZ | 0 |  | Boundary flux/source | Boundary 51 |

* + 1. Outflow



Outflow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 1 |

Equations

* + 1. Window



Window

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 45 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Value on boundary | {d0, d0} |
| Prescribed value of bZ | On |
| Prescribed value of tZ | On |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| d0-bZ | -test(bZ) | Lagrange (Quadratic) | Boundary 45 |
| d0-tZ | -test(tZ) | Lagrange (Quadratic) | Boundary 45 |

* 1. Piecewise Constant Flow



Piecewise Constant Flow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations









Settings

| **Description** | **Value** |
| --- | --- |
| Discretization of fluids | P2 + P1 |
| Value type when using splitting of complex variables | {Real, Real, Real, Real, Real, Real, Real, Real, Real, Real, Real} |
| Isotropic diffusion | Off |
| Compressibility | Incompressible flow |
| Channel thickness | 1 |
| Turbulence model type | None |
| Reference pressure level | 1[atm] |
| Use pseudo time stepping for stationary equation form | Off |
| Local CFL number | 1.3^min(niterCMP, 9) + if(niterCMP>=25, 9\*1.3^min(niterCMP - 25, 9), 0) + if(niterCMP>=45, 90\*1.3^min(niterCMP - 45, 9), 0) |
| Streamline diffusion | Off |
| Crosswind diffusion | Off |

Used products

|  |
| --- |
| COMSOL Multiphysics |

Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bv.dz | 1 |  | Thickness | Domains 1–20 |
| bv.pref | 1[atm] |  | Reference pressure level | Domains 1–20 |
| bv.pA | bp+bv.pref |  | Absolute pressure | Domains 1–20 |
| bv.nx | nx |  | Normal vector, x component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bv.ny | ny |  | Normal vector, y component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bv.nz | 0 |  | Normal vector, z component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bv.nx | dnx |  | Normal vector, x component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bv.ny | dny |  | Normal vector, y component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bv.nz | 0 |  | Normal vector, z component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bv.nxmesh | root.nxmesh |  | Normal vector, x component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bv.nymesh | root.nymesh |  | Normal vector, y component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bv.nzmesh | 0 |  | Normal vector, z component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| bv.nxmesh | root.dnxmesh |  | Normal vector, x component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bv.nymesh | root.dnymesh |  | Normal vector, y component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| bv.nzmesh | 0 |  | Normal vector, z component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |

* + 1. Fluid Properties



Fluid Properties

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Density | User defined |
| Density | 1 |
| Dynamic viscosity | User defined |
| Dynamic viscosity | ni |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bv.Fx | 0 |  | Volume force, x component | Domains 1–20 |
| bv.Fy | 0 |  | Volume force, y component | Domains 1–20 |
| bv.Fz | 0 |  | Volume force, z component | Domains 1–20 |
| bv.rho | 1 |  | Density | Domains 1–20 |
| bv.mu | ni |  | Dynamic viscosity | Domains 1–20 |
| bv.sr | sqrt(0.5\*(4\*bux^2+2\*(buy+bvx)^2+4\*bvy^2)+eps) |  | Shear rate | Domains 1–20 |
| bv.divu | bux+bvy |  | Divergence of velocity field | Domains 1–20 |
| bv.U | sqrt(bu^2+bv^2) |  | Velocity magnitude | Domains 1–20 |
| bv.vorticityx | 0 |  | Vorticity field, x component | Domains 1–20 |
| bv.vorticityy | 0 |  | Vorticity field, y component | Domains 1–20 |
| bv.vorticityz | bvx-buy |  | Vorticity field, z component | Domains 1–20 |
| bv.vort\_magn | sqrt(bv.vorticityx^2+bv.vorticityy^2+bv.vorticityz^2) |  | Vorticity magnitude | Domains 1–20 |
| bv.cellRe | 0.25\*bv.rho\*sqrt(emetric(bu,bv)/emetric2)/bv.mu |  | Cell Reynolds number | Domains 1–20 |
| bv.nu | bv.mu/bv.rho |  | Kinematic viscosity | Domains 1–20 |
| bv.betaT | 0 |  | Isothermal compressibility coefficient | Domains 1–20 |
| bv.mu\_eff | bv.mu+bv.muT |  | Dynamic viscosity | Domains 1–20 |
| bv.muT | 0 |  | Turbulent dynamic viscosity | Domains 1–20 |
| bv.T\_stressx | bv.K\_stressx-bp\*bv.nxmesh |  | Total stress, x component | Boundaries 1–51 |
| bv.T\_stressy | bv.K\_stressy-bp\*bv.nymesh |  | Total stress, y component | Boundaries 1–51 |
| bv.T\_stressz | bv.K\_stressz-bp\*bv.nzmesh |  | Total stress, z component | Boundaries 1–51 |
| bv.K\_stressx | bv.mu\_eff\*(2\*bux\*bv.nxmesh+(buy+bvx)\*bv.nymesh) |  | Viscous stress, x component | Boundaries 1–51 |
| bv.K\_stressy | bv.mu\_eff\*((bvx+buy)\*bv.nxmesh+2\*bvy\*bv.nymesh) |  | Viscous stress, y component | Boundaries 1–51 |
| bv.K\_stressz | 0 |  | Viscous stress, z component | Boundaries 1–51 |
| bv.K\_stress\_tensorxx | 2\*bv.mu\_eff\*bux |  | Viscous stress tensor, xx component | Domains 1–20 |
| bv.K\_stress\_tensoryx | bv.mu\_eff\*(bvx+buy) |  | Viscous stress tensor, yx component | Domains 1–20 |
| bv.K\_stress\_tensorzx | 0 |  | Viscous stress tensor, zx component | Domains 1–20 |
| bv.K\_stress\_tensorxy | bv.mu\_eff\*(buy+bvx) |  | Viscous stress tensor, xy component | Domains 1–20 |
| bv.K\_stress\_tensoryy | 2\*bv.mu\_eff\*bvy |  | Viscous stress tensor, yy component | Domains 1–20 |
| bv.K\_stress\_tensorzy | 0 |  | Viscous stress tensor, zy component | Domains 1–20 |
| bv.K\_stress\_tensorxz | 0 |  | Viscous stress tensor, xz component | Domains 1–20 |
| bv.K\_stress\_tensoryz | 0 |  | Viscous stress tensor, yz component | Domains 1–20 |
| bv.K\_stress\_tensorzz | 0 |  | Viscous stress tensor, zz component | Domains 1–20 |
| bv.K\_stress\_tensor\_testxx | 2\*bv.mu\_eff\*test(bux) |  | Viscous stress tensor test, xx component | Domains 1–20 |
| bv.K\_stress\_tensor\_testyx | bv.mu\_eff\*(test(bvx)+test(buy)) |  | Viscous stress tensor test, yx component | Domains 1–20 |
| bv.K\_stress\_tensor\_testzx | 0 |  | Viscous stress tensor test, zx component | Domains 1–20 |
| bv.K\_stress\_tensor\_testxy | bv.mu\_eff\*(test(buy)+test(bvx)) |  | Viscous stress tensor test, xy component | Domains 1–20 |
| bv.K\_stress\_tensor\_testyy | 2\*bv.mu\_eff\*test(bvy) |  | Viscous stress tensor test, yy component | Domains 1–20 |
| bv.K\_stress\_tensor\_testzy | 0 |  | Viscous stress tensor test, zy component | Domains 1–20 |
| bv.K\_stress\_tensor\_testxz | 0 |  | Viscous stress tensor test, xz component | Domains 1–20 |
| bv.K\_stress\_tensor\_testyz | 0 |  | Viscous stress tensor test, yz component | Domains 1–20 |
| bv.K\_stress\_tensor\_testzz | 0 |  | Viscous stress tensor test, zz component | Domains 1–20 |
| bv.upwind\_helpx | bu |  | Upwind term, x component | Domains 1–20 |
| bv.upwind\_helpy | bv |  | Upwind term, y component | Domains 1–20 |
| bv.upwind\_helpz | 0 |  | Upwind term, z component | Domains 1–20 |
| bv.tau\_vdxx | 2\*bv.mu\*bux |  | Strain rate, xx component | Domains 1–20 |
| bv.tau\_vdyx | bv.mu\*(bvx+buy) |  | Strain rate, yx component | Domains 1–20 |
| bv.tau\_vdzx | 0 |  | Strain rate, zx component | Domains 1–20 |
| bv.tau\_vdxy | bv.mu\*(buy+bvx) |  | Strain rate, xy component | Domains 1–20 |
| bv.tau\_vdyy | 2\*bv.mu\*bvy |  | Strain rate, yy component | Domains 1–20 |
| bv.tau\_vdzy | 0 |  | Strain rate, zy component | Domains 1–20 |
| bv.tau\_vdxz | 0 |  | Strain rate, xz component | Domains 1–20 |
| bv.tau\_vdyz | 0 |  | Strain rate, yz component | Domains 1–20 |
| bv.tau\_vdzz | 0 |  | Strain rate, zz component | Domains 1–20 |
| bv.Qvd | bv.tau\_vdxx\*bux+bv.tau\_vdxy\*buy+bv.tau\_vdyx\*bvx+bv.tau\_vdyy\*bvy |  | Viscous dissipation | Domains 1–20 |

#### Shape functions

| **Name** | **Shape function** | **Unit** | **Description** | **Shape frame** | **Selection** |
| --- | --- | --- | --- | --- | --- |
| bu | Lagrange (Quadratic) |  | Velocity field, x component | Material | Domains 1–20 |
| bv | Lagrange (Quadratic) |  | Velocity field, y component | Material | Domains 1–20 |
| bp | Lagrange (Linear) |  | Pressure | Material | Domains 1–20 |

#### Weak expressions

| **Weak expression** | **Integration frame** | **Selection** |
| --- | --- | --- |
| (bp-bv.K\_stress\_tensorxx)\*test(bux)-bv.K\_stress\_tensorxy\*test(buy)-bv.K\_stress\_tensoryx\*test(bvx)+(bp-bv.K\_stress\_tensoryy)\*test(bvy) | Material | Domains 1–20 |
| bv.Fx\*test(bu)+bv.Fy\*test(bv) | Material | Domains 1–20 |
| bv.rho\*(-(bux\*bu+buy\*bv)\*test(bu)-(bvx\*bu+bvy\*bv)\*test(bv)) | Material | Domains 1–20 |
| -bv.rho\*bv.divu\*test(bp) | Material | Domains 1–20 |

* + 1. Wall



Wall

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | No slip |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bv.ubndx | 0 |  | Velocity at boundary, x component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| bv.ubndy | 0 |  | Velocity at boundary, y component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| bv.ubndz | 0 |  | Velocity at boundary, z component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -bu+bv.ubndx | test(-bu) | Lagrange (Quadratic) | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| -bv+bv.ubndy | test(-bv) | Lagrange (Quadratic) | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| bv.ubndz | 0 |  | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

* + 1. Initial Values



Initial Values

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Turbulent kinetic energy | spf.kinit |
| Turbulent dissipation rate | spf.epinit |
| Specific dissipation rate | spf.omInit |
| Reciprocal wall distance | spf.G0 |
| Undamped turbulent kinematic viscosity | spf.nutildeinit |
| Velocity field | {bU, bV, 0} |
| Pressure | 0 |

* + 1. Inlet



Inlet

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 51 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Apply reaction terms on | All physics (symmetric) |
| Use weak constraints | Off |
| Boundary condition | Velocity |
| Velocity field componentwise | Normal inflow velocity |
| Normal inflow velocity | 4\*s\*(1 - s) |
| Turbulent intensity | 0.05 |
| Turbulence length scale | 0.01[m] |
| Turbulent kinetic energy | 0.005[m^2/s^2] |
| Turbulent dissipation rate | 0.005[m^2/s^3] |
| Specific dissipation rate | 20[1/s] |
| Undamped turbulent kinematic viscosity | 3\*v.nu |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bv.ubndx | -nojac(bv.nxmesh)\*bv.U0in |  | Velocity at boundary, x component | Boundary 51 |
| bv.ubndy | -nojac(bv.nymesh)\*bv.U0in |  | Velocity at boundary, y component | Boundary 51 |
| bv.ubndz | -nojac(bv.nzmesh)\*bv.U0in |  | Velocity at boundary, z component | Boundary 51 |
| bv.U0in | 4\*s\*(1-s) |  | Normal inflow velocity | Boundary 51 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -bu+bv.ubndx | test(-bu+bv.ubndx) | Lagrange (Quadratic) | Boundary 51 |
| -bv+bv.ubndy | test(-bv+bv.ubndy) | Lagrange (Quadratic) | Boundary 51 |
| bv.ubndz | test(bv.ubndz) |  | Boundary 51 |

* + 1. Outflow



Outflow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 1 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | Normal stress |
| Normal stress | 0 |
| Turbulent intensity | 0.005 |
| Turbulence length scale | 0.1[m] |
| Turbulent kinetic energy | 2.5e-3[m^2/s^2] |
| Turbulent dissipation rate | 1.1e-4[m^2/s^3] |
| Specific dissipation rate | 0.5[1/s] |
| Undamped turbulent kinematic viscosity | 3\*v.nu |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bv.f0 | 0 |  | Normal stress | Boundary 1 |

#### Weak expressions

| **Weak expression** | **Integration frame** | **Selection** |
| --- | --- | --- |
| -bv.f0\*(test(bu)\*bv.nxmesh+test(bv)\*bv.nymesh) | Material | Boundary 1 |

* + 1. Window



Window

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 45 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | No slip |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bv.ubndx | 0 |  | Velocity at boundary, x component | Boundary 45 |
| bv.ubndy | 0 |  | Velocity at boundary, y component | Boundary 45 |
| bv.ubndz | 0 |  | Velocity at boundary, z component | Boundary 45 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -bu+bv.ubndx | test(-bu) | Lagrange (Quadratic) | Boundary 45 |
| -bv+bv.ubndy | test(-bv) | Lagrange (Quadratic) | Boundary 45 |
| bv.ubndz | 0 |  | Boundary 45 |

* + 1. Buoyancy Force



Buoyancy Force

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bv.Fx | 0 |  | Volume force, x component | Domains 1–20 |
| bv.Fy | beta\*bT |  | Volume force, y component | Domains 1–20 |
| bv.Fz | 0 |  | Volume force, z component | Domains 1–20 |

* 1. Piecewise Constant Temperature



Piecewise Constant Temperature

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Shape function type | Lagrange |
| Element order | Quadratic |
| Compute boundary fluxes | On |
| Apply smoothing to boundary fluxes | On |
| Value type when using splitting of complex variables | Complex |
| Dependent variable quantity | Dimensionless (1) |
| Source term quantity | None |
| Unit | m^ - 2 |

Used products

|  |
| --- |
| COMSOL Multiphysics |

Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bT.nx | nx |  | Normal vector, x component | Boundaries 1–51 |
| bT.ny | ny |  | Normal vector, y component | Boundaries 1–51 |
| bT.nz | root.nz |  | Normal vector, z component | Boundaries 1–51 |
| bT.nxmesh | root.nxmesh |  | Normal vector (mesh), x component | Boundaries 1–51 |
| bT.nymesh | root.nymesh |  | Normal vector (mesh), y component | Boundaries 1–51 |
| bT.nzmesh | root.nzmesh |  | Normal vector (mesh), z component | Boundaries 1–51 |

* + 1. Coefficient Form PDE



Coefficient Form PDE

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Diffusion coefficient | {{{{alpha, 0}, {0, alpha}}, {{0, 0}, {0, 0}}}, {{{0, 0}, {0, 0}}, {{alpha, 0}, {0, alpha}}}} |
| Absorption coefficient | {{0, 0}, {0, 0}} |
| Source term | {0, 0} |
| Mass coefficient | {{0, 0}, {0, 0}} |
| Damping or mass coefficient | {{1, 0.95}, {0, 0}} |
| Conservative flux convection coefficient | {{{0, 0}, {0, 0}}, {{0, 0}, {0, 0}}} |
| Convection coefficient | {{{bu, bv}, {bu - U, bv - V}}, {{0, 0}, {U, V}}} |
| Conservative flux source | {{0, 0}, {0, 0}} |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| domflux.bTx | -alpha\*d(bT,x) |  | Domain flux, x component | Domains 1–20 |
| domflux.bTy | -alpha\*d(bT,y) |  | Domain flux, y component | Domains 1–20 |
| domflux.tTx | -alpha\*d(tT,x) |  | Domain flux, x component | Domains 1–20 |
| domflux.tTy | -alpha\*d(tT,y) |  | Domain flux, y component | Domains 1–20 |

#### Shape functions

| **Name** | **Shape function** | **Unit** | **Description** | **Shape frame** | **Selection** |
| --- | --- | --- | --- | --- | --- |
| bT | Lagrange (Quadratic) |  | Dependent variable bT | Material | Domains 1–20 |
| tT | Lagrange (Quadratic) |  | Dependent variable tT | Material | Domains 1–20 |

* + 1. Insulated Wall



Insulated Wall

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

Equations

* + 1. Initial Values



Initial Values

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Initial value for bT | bZ |
| Initial time derivative of bT | 0 |
| Initial value for tT | tZ |
| Initial time derivative of tT | 0 |

* + 1. Heat Flux Bin\*gamma



Heat Flux Bin\*gamma

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 51 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary flux/source | {gamma, 0} |
| Boundary absorption/impedance term | {{0, 0}, {0, 0}} |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| bT.g\_bT | gamma |  | Boundary flux/source | Boundary 51 |
| bT.g\_tT | 0 |  | Boundary flux/source | Boundary 51 |

* + 1. Outflow



Outflow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 1 |

Equations

* + 1. Window



Window

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 45 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Value on boundary | {d, d} |
| Prescribed value of bT | On |
| Prescribed value of tT | On |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| d-bT | -test(bT) | Lagrange (Quadratic) | Boundary 45 |
| d-tT | -test(tT) | Lagrange (Quadratic) | Boundary 45 |

* 1. Closed Loop Flow



Closed Loop Flow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations









Settings

| **Description** | **Value** |
| --- | --- |
| Discretization of fluids | P2 + P1 |
| Value type when using splitting of complex variables | {Real, Real, Real, Real, Real, Real, Real, Real, Real, Real, Real} |
| Isotropic diffusion | Off |
| Compressibility | Incompressible flow |
| Channel thickness | 1 |
| Turbulence model type | None |
| Reference pressure level | 1[atm] |
| Use pseudo time stepping for stationary equation form | Off |
| Local CFL number | 1.3^min(niterCMP, 9) + if(niterCMP>=25, 9\*1.3^min(niterCMP - 25, 9), 0) + if(niterCMP>=45, 90\*1.3^min(niterCMP - 45, 9), 0) |
| Streamline diffusion | Off |
| Crosswind diffusion | Off |

Used products

|  |
| --- |
| COMSOL Multiphysics |

Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| v.dz | 1 |  | Thickness | Domains 1–20 |
| v.pref | 1[atm] |  | Reference pressure level | Domains 1–20 |
| v.pA | p+v.pref |  | Absolute pressure | Domains 1–20 |
| v.nx | nx |  | Normal vector, x component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| v.ny | ny |  | Normal vector, y component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| v.nz | 0 |  | Normal vector, z component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| v.nx | dnx |  | Normal vector, x component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| v.ny | dny |  | Normal vector, y component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| v.nz | 0 |  | Normal vector, z component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| v.nxmesh | root.nxmesh |  | Normal vector, x component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| v.nymesh | root.nymesh |  | Normal vector, y component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| v.nzmesh | 0 |  | Normal vector, z component | Boundaries 6–7, 9, 11, 13, 15, 17, 19–28, 30, 32–41, 47 |
| v.nxmesh | root.dnxmesh |  | Normal vector, x component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| v.nymesh | root.dnymesh |  | Normal vector, y component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |
| v.nzmesh | 0 |  | Normal vector, z component | Boundaries 1–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–46, 48–51 |

* + 1. Fluid Properties



Fluid Properties

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Density | User defined |
| Density | 1 |
| Dynamic viscosity | User defined |
| Dynamic viscosity | ni |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| v.Fx | 0 |  | Volume force, x component | Domains 1–20 |
| v.Fy | 0 |  | Volume force, y component | Domains 1–20 |
| v.Fz | 0 |  | Volume force, z component | Domains 1–20 |
| v.rho | 1 |  | Density | Domains 1–20 |
| v.mu | ni |  | Dynamic viscosity | Domains 1–20 |
| v.sr | sqrt(0.5\*(4\*ux^2+2\*(uy+vx)^2+4\*vy^2)+eps) |  | Shear rate | Domains 1–20 |
| v.divu | ux+vy |  | Divergence of velocity field | Domains 1–20 |
| v.U | sqrt(u^2+v^2) |  | Velocity magnitude | Domains 1–20 |
| v.vorticityx | 0 |  | Vorticity field, x component | Domains 1–20 |
| v.vorticityy | 0 |  | Vorticity field, y component | Domains 1–20 |
| v.vorticityz | vx-uy |  | Vorticity field, z component | Domains 1–20 |
| v.vort\_magn | sqrt(v.vorticityx^2+v.vorticityy^2+v.vorticityz^2) |  | Vorticity magnitude | Domains 1–20 |
| v.cellRe | 0.25\*v.rho\*sqrt(emetric(u,v)/emetric2)/v.mu |  | Cell Reynolds number | Domains 1–20 |
| v.nu | v.mu/v.rho |  | Kinematic viscosity | Domains 1–20 |
| v.betaT | 0 |  | Isothermal compressibility coefficient | Domains 1–20 |
| v.mu\_eff | v.mu+v.muT |  | Dynamic viscosity | Domains 1–20 |
| v.muT | 0 |  | Turbulent dynamic viscosity | Domains 1–20 |
| v.T\_stressx | v.K\_stressx-p\*v.nxmesh |  | Total stress, x component | Boundaries 1–51 |
| v.T\_stressy | v.K\_stressy-p\*v.nymesh |  | Total stress, y component | Boundaries 1–51 |
| v.T\_stressz | v.K\_stressz-p\*v.nzmesh |  | Total stress, z component | Boundaries 1–51 |
| v.K\_stressx | v.mu\_eff\*(2\*ux\*v.nxmesh+(uy+vx)\*v.nymesh) |  | Viscous stress, x component | Boundaries 1–51 |
| v.K\_stressy | v.mu\_eff\*((vx+uy)\*v.nxmesh+2\*vy\*v.nymesh) |  | Viscous stress, y component | Boundaries 1–51 |
| v.K\_stressz | 0 |  | Viscous stress, z component | Boundaries 1–51 |
| v.K\_stress\_tensorxx | 2\*v.mu\_eff\*ux |  | Viscous stress tensor, xx component | Domains 1–20 |
| v.K\_stress\_tensoryx | v.mu\_eff\*(vx+uy) |  | Viscous stress tensor, yx component | Domains 1–20 |
| v.K\_stress\_tensorzx | 0 |  | Viscous stress tensor, zx component | Domains 1–20 |
| v.K\_stress\_tensorxy | v.mu\_eff\*(uy+vx) |  | Viscous stress tensor, xy component | Domains 1–20 |
| v.K\_stress\_tensoryy | 2\*v.mu\_eff\*vy |  | Viscous stress tensor, yy component | Domains 1–20 |
| v.K\_stress\_tensorzy | 0 |  | Viscous stress tensor, zy component | Domains 1–20 |
| v.K\_stress\_tensorxz | 0 |  | Viscous stress tensor, xz component | Domains 1–20 |
| v.K\_stress\_tensoryz | 0 |  | Viscous stress tensor, yz component | Domains 1–20 |
| v.K\_stress\_tensorzz | 0 |  | Viscous stress tensor, zz component | Domains 1–20 |
| v.K\_stress\_tensor\_testxx | 2\*v.mu\_eff\*test(ux) |  | Viscous stress tensor test, xx component | Domains 1–20 |
| v.K\_stress\_tensor\_testyx | v.mu\_eff\*(test(vx)+test(uy)) |  | Viscous stress tensor test, yx component | Domains 1–20 |
| v.K\_stress\_tensor\_testzx | 0 |  | Viscous stress tensor test, zx component | Domains 1–20 |
| v.K\_stress\_tensor\_testxy | v.mu\_eff\*(test(uy)+test(vx)) |  | Viscous stress tensor test, xy component | Domains 1–20 |
| v.K\_stress\_tensor\_testyy | 2\*v.mu\_eff\*test(vy) |  | Viscous stress tensor test, yy component | Domains 1–20 |
| v.K\_stress\_tensor\_testzy | 0 |  | Viscous stress tensor test, zy component | Domains 1–20 |
| v.K\_stress\_tensor\_testxz | 0 |  | Viscous stress tensor test, xz component | Domains 1–20 |
| v.K\_stress\_tensor\_testyz | 0 |  | Viscous stress tensor test, yz component | Domains 1–20 |
| v.K\_stress\_tensor\_testzz | 0 |  | Viscous stress tensor test, zz component | Domains 1–20 |
| v.upwind\_helpx | u |  | Upwind term, x component | Domains 1–20 |
| v.upwind\_helpy | v |  | Upwind term, y component | Domains 1–20 |
| v.upwind\_helpz | 0 |  | Upwind term, z component | Domains 1–20 |
| v.tau\_vdxx | 2\*v.mu\*ux |  | Strain rate, xx component | Domains 1–20 |
| v.tau\_vdyx | v.mu\*(vx+uy) |  | Strain rate, yx component | Domains 1–20 |
| v.tau\_vdzx | 0 |  | Strain rate, zx component | Domains 1–20 |
| v.tau\_vdxy | v.mu\*(uy+vx) |  | Strain rate, xy component | Domains 1–20 |
| v.tau\_vdyy | 2\*v.mu\*vy |  | Strain rate, yy component | Domains 1–20 |
| v.tau\_vdzy | 0 |  | Strain rate, zy component | Domains 1–20 |
| v.tau\_vdxz | 0 |  | Strain rate, xz component | Domains 1–20 |
| v.tau\_vdyz | 0 |  | Strain rate, yz component | Domains 1–20 |
| v.tau\_vdzz | 0 |  | Strain rate, zz component | Domains 1–20 |
| v.Qvd | v.tau\_vdxx\*ux+v.tau\_vdxy\*uy+v.tau\_vdyx\*vx+v.tau\_vdyy\*vy |  | Viscous dissipation | Domains 1–20 |

#### Shape functions

| **Name** | **Shape function** | **Unit** | **Description** | **Shape frame** | **Selection** |
| --- | --- | --- | --- | --- | --- |
| u | Lagrange (Quadratic) |  | Velocity field, x component | Material | Domains 1–20 |
| v | Lagrange (Quadratic) |  | Velocity field, y component | Material | Domains 1–20 |
| p | Lagrange (Linear) |  | Pressure | Material | Domains 1–20 |

#### Weak expressions

| **Weak expression** | **Integration frame** | **Selection** |
| --- | --- | --- |
| (p-v.K\_stress\_tensorxx)\*test(ux)-v.K\_stress\_tensorxy\*test(uy)-v.K\_stress\_tensoryx\*test(vx)+(p-v.K\_stress\_tensoryy)\*test(vy) | Material | Domains 1–20 |
| v.Fx\*test(u)+v.Fy\*test(v) | Material | Domains 1–20 |
| v.rho\*(-(ux\*u+uy\*v)\*test(u)-(vx\*u+vy\*v)\*test(v)) | Material | Domains 1–20 |
| -v.rho\*v.divu\*test(p) | Material | Domains 1–20 |

* + 1. Wall



Wall

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | No slip |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| v.ubndx | 0 |  | Velocity at boundary, x component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| v.ubndy | 0 |  | Velocity at boundary, y component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| v.ubndz | 0 |  | Velocity at boundary, z component | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -u+v.ubndx | test(-u) | Lagrange (Quadratic) | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| -v+v.ubndy | test(-v) | Lagrange (Quadratic) | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |
| v.ubndz | 0 |  | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

* + 1. Initial Values



Initial Values

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Velocity field | {0, 0, 0} |
| Pressure | 0 |
| Turbulent kinetic energy | spf.kinit |
| Turbulent dissipation rate | spf.epinit |
| Specific dissipation rate | spf.omInit |
| Reciprocal wall distance | spf.G0 |
| Undamped turbulent kinematic viscosity | spf.nutildeinit |

* + 1. Inlet



Inlet

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 51 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Apply reaction terms on | All physics (symmetric) |
| Use weak constraints | Off |
| Boundary condition | Velocity |
| Velocity field componentwise | Normal inflow velocity |
| Normal inflow velocity | 4\*s\*(1 - s) |
| Turbulent intensity | 0.05 |
| Turbulence length scale | 0.01[m] |
| Turbulent kinetic energy | 0.005[m^2/s^2] |
| Turbulent dissipation rate | 0.005[m^2/s^3] |
| Specific dissipation rate | 20[1/s] |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| v.ubndx | -nojac(v.nxmesh)\*v.U0in |  | Velocity at boundary, x component | Boundary 51 |
| v.ubndy | -nojac(v.nymesh)\*v.U0in |  | Velocity at boundary, y component | Boundary 51 |
| v.ubndz | -nojac(v.nzmesh)\*v.U0in |  | Velocity at boundary, z component | Boundary 51 |
| v.U0in | 4\*s\*(1-s) |  | Normal inflow velocity | Boundary 51 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -u+v.ubndx | test(-u+v.ubndx) | Lagrange (Quadratic) | Boundary 51 |
| -v+v.ubndy | test(-v+v.ubndy) | Lagrange (Quadratic) | Boundary 51 |
| v.ubndz | test(v.ubndz) |  | Boundary 51 |

* + 1. Outflow



Outflow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 1 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | Normal stress |
| Normal stress | 0 |
| Turbulent intensity | 0.005 |
| Turbulence length scale | 0.1[m] |
| Turbulent kinetic energy | 2.5e-3[m^2/s^2] |
| Turbulent dissipation rate | 1.1e-4[m^2/s^3] |
| Specific dissipation rate | 0.5[1/s] |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| v.f0 | 0 |  | Normal stress | Boundary 1 |

#### Weak expressions

| **Weak expression** | **Integration frame** | **Selection** |
| --- | --- | --- |
| -v.f0\*(test(u)\*v.nxmesh+test(v)\*v.nymesh) | Material | Boundary 1 |

* + 1. Window



Window

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 45 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary condition | No slip |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| v.ubndx | 0 |  | Velocity at boundary, x component | Boundary 45 |
| v.ubndy | 0 |  | Velocity at boundary, y component | Boundary 45 |
| v.ubndz | 0 |  | Velocity at boundary, z component | Boundary 45 |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| -u+v.ubndx | test(-u) | Lagrange (Quadratic) | Boundary 45 |
| -v+v.ubndy | test(-v) | Lagrange (Quadratic) | Boundary 45 |
| v.ubndz | 0 |  | Boundary 45 |

* + 1. Buoyancy Force



Buoyancy Force

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| v.Fx | 0 |  | Volume force, x component | Domains 1–20 |
| v.Fy | beta\*T |  | Volume force, y component | Domains 1–20 |
| v.Fz | 0 |  | Volume force, z component | Domains 1–20 |

* 1. Closed Loop Temperature



Closed Loop Temperature

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Shape function type | Lagrange |
| Element order | Quadratic |
| Compute boundary fluxes | On |
| Apply smoothing to boundary fluxes | On |
| Value type when using splitting of complex variables | Complex |
| Dependent variable quantity | Dimensionless (1) |
| Source term quantity | None |
| Unit | m^ - 2 |

Used products

|  |
| --- |
| COMSOL Multiphysics |

Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| T.nx | nx |  | Normal vector, x component | Boundaries 1–51 |
| T.ny | ny |  | Normal vector, y component | Boundaries 1–51 |
| T.nz | root.nz |  | Normal vector, z component | Boundaries 1–51 |
| T.nxmesh | root.nxmesh |  | Normal vector (mesh), x component | Boundaries 1–51 |
| T.nymesh | root.nymesh |  | Normal vector (mesh), y component | Boundaries 1–51 |
| T.nzmesh | root.nzmesh |  | Normal vector (mesh), z component | Boundaries 1–51 |

* + 1. Coefficient Form PDE



Coefficient Form PDE

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Diffusion coefficient | {{alpha, 0}, {0, alpha}} |
| Absorption coefficient | 0 |
| Source term | 0 |
| Mass coefficient | 0 |
| Damping or mass coefficient | 1 |
| Conservative flux convection coefficient | {0, 0} |
| Convection coefficient | {u, v} |
| Conservative flux source | {0, 0} |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| domflux.Tx | -alpha\*d(T,x) |  | Domain flux, x component | Domains 1–20 |
| domflux.Ty | -alpha\*d(T,y) |  | Domain flux, y component | Domains 1–20 |

#### Shape functions

| **Name** | **Shape function** | **Unit** | **Description** | **Shape frame** | **Selection** |
| --- | --- | --- | --- | --- | --- |
| T | Lagrange (Quadratic) |  | Dependent variable T | Material | Domains 1–20 |

* + 1. Insulated Wall



Insulated Wall

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 2–5, 8, 10, 12, 14, 16, 18, 29, 31, 42–44, 46, 48–50 |

Equations

* + 1. Initial Values



Initial Values

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |

Settings

| **Description** | **Value** |
| --- | --- |
| Initial value for T | 0 |
| Initial time derivative of T | 0 |

* + 1. Heat Flux Bin\*gamma



Heat Flux Bin\*gamma

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 51 |

Equations

Settings

| **Description** | **Value** |
| --- | --- |
| Boundary flux/source | gamma |
| Boundary absorption/impedance term | 0 |

#### Variables

| **Name** | **Expression** | **Unit** | **Description** | **Selection** |
| --- | --- | --- | --- | --- |
| T.g\_T | gamma |  | Boundary flux/source | Boundary 51 |

* + 1. Outflow



Outflow

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 1 |

Equations

* + 1. Window



Window

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundary 45 |

Equations

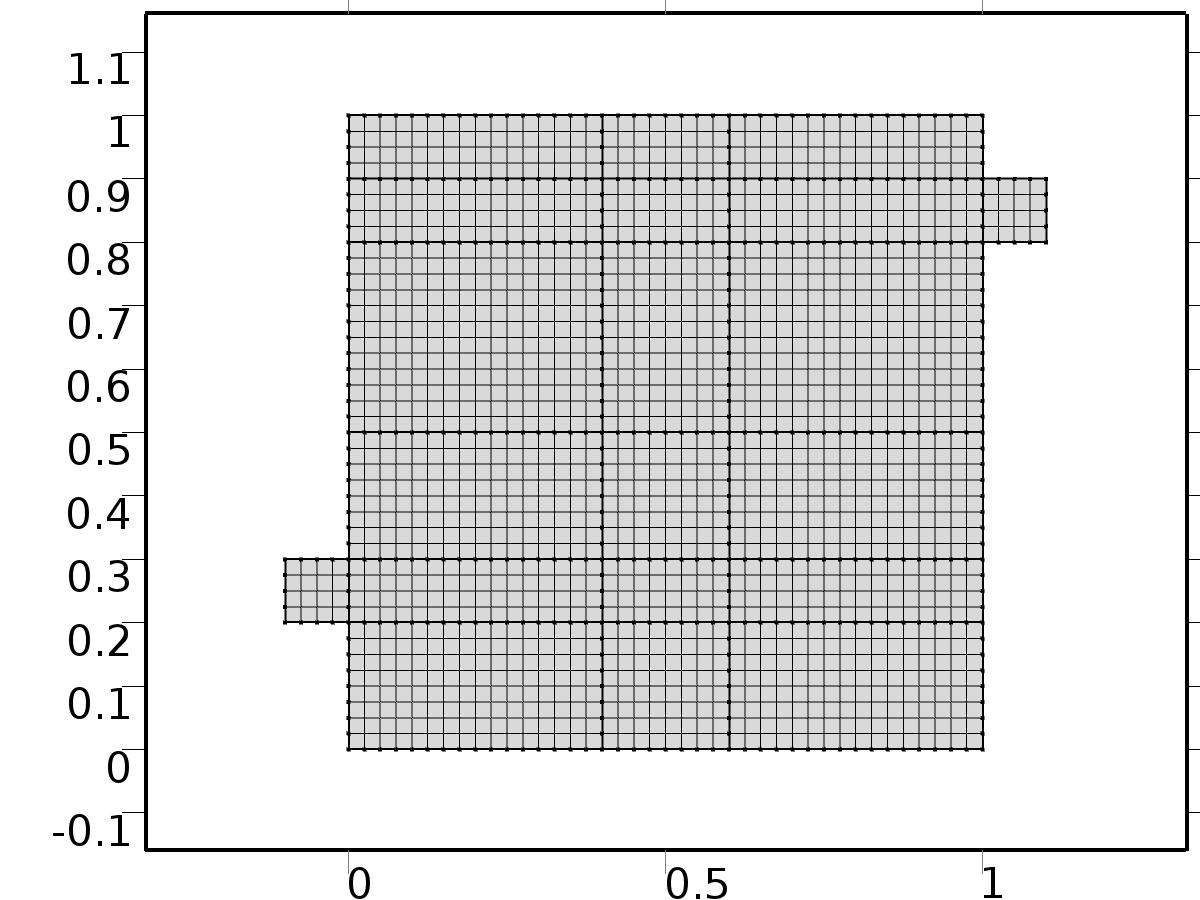
Settings

| **Description** | **Value** |
| --- | --- |
| Value on boundary | d |
| Prescribed value of T | On |
| Apply reaction terms on | Individual dependent variables |
| Use weak constraints | Off |
| Constraint method | Elemental |

#### Shape functions

| **Constraint** | **Constraint force** | **Shape function** | **Selection** |
| --- | --- | --- | --- |
| d-T | -test(T) | Lagrange (Quadratic) | Boundary 45 |

* 1. Mesh 1



Mesh 1

* + 1. Size (size)

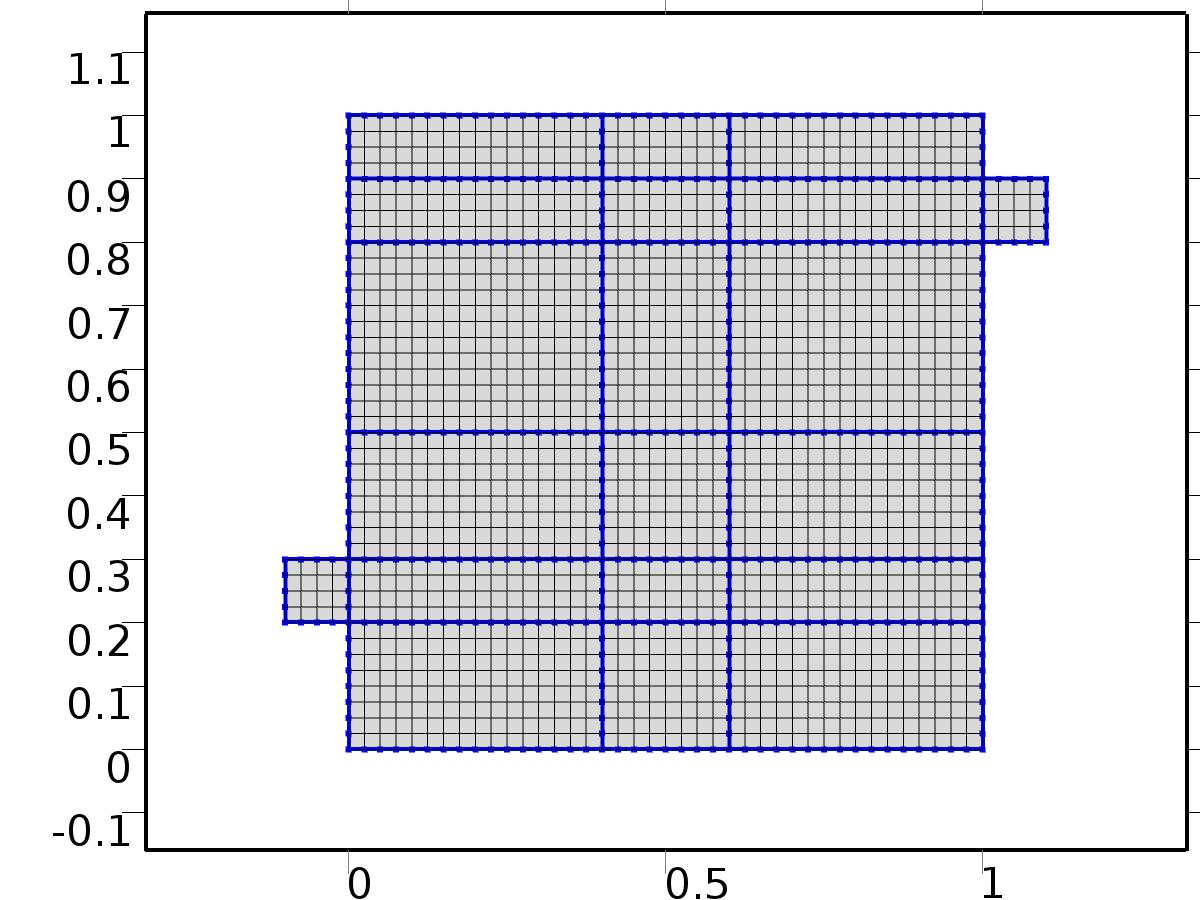
Settings

| **Description** | **Value** |
| --- | --- |
| Maximum element size | 0.0804 |
| Minimum element size | 3.6E-4 |
| Curvature factor | 0.3 |
| Maximum element growth rate | 1.3 |

* + 1. Edge 1 (edg1)

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 1–51 |

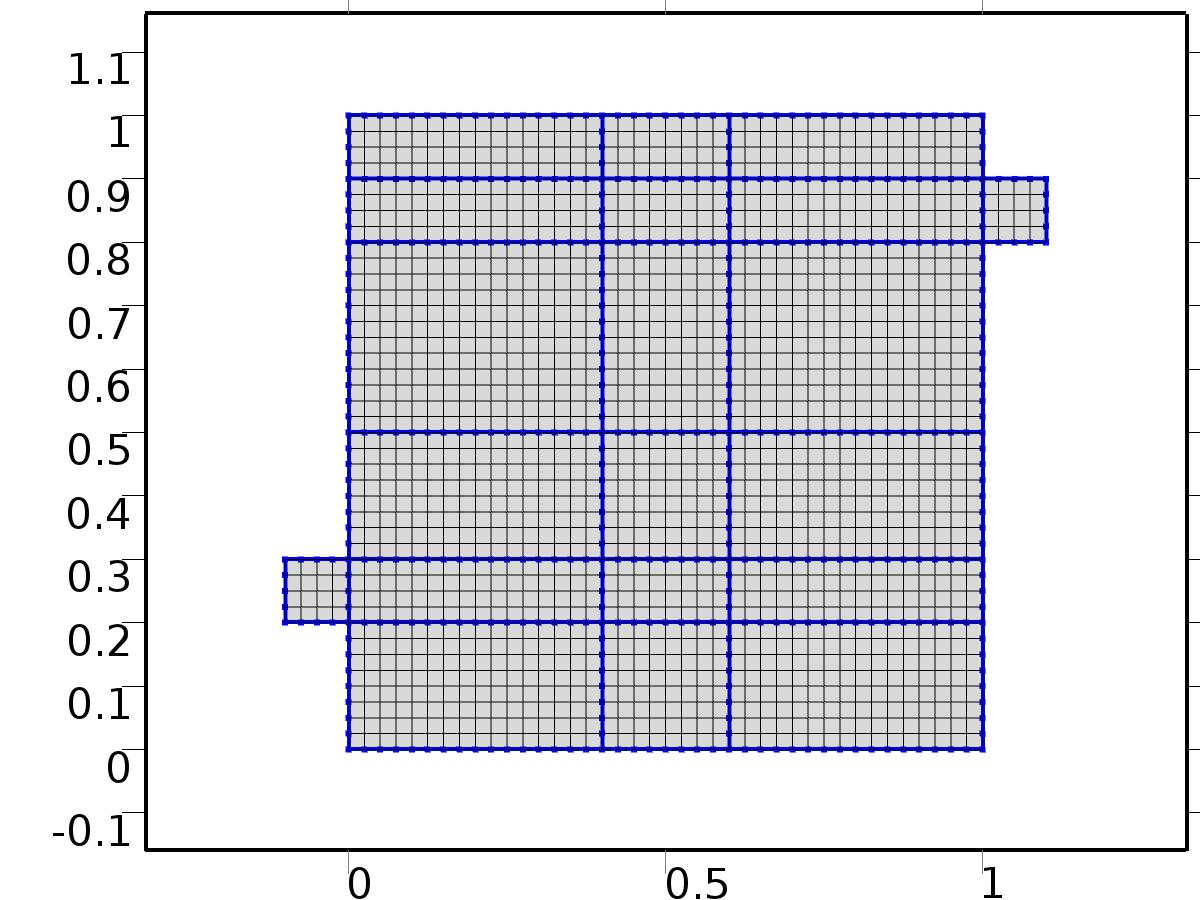


Edge 1

#### Size 1 (size1)

Selection

|  |  |
| --- | --- |
| Geometric entity level | Boundary |
| Selection | Boundaries 1–51 |



Size 1

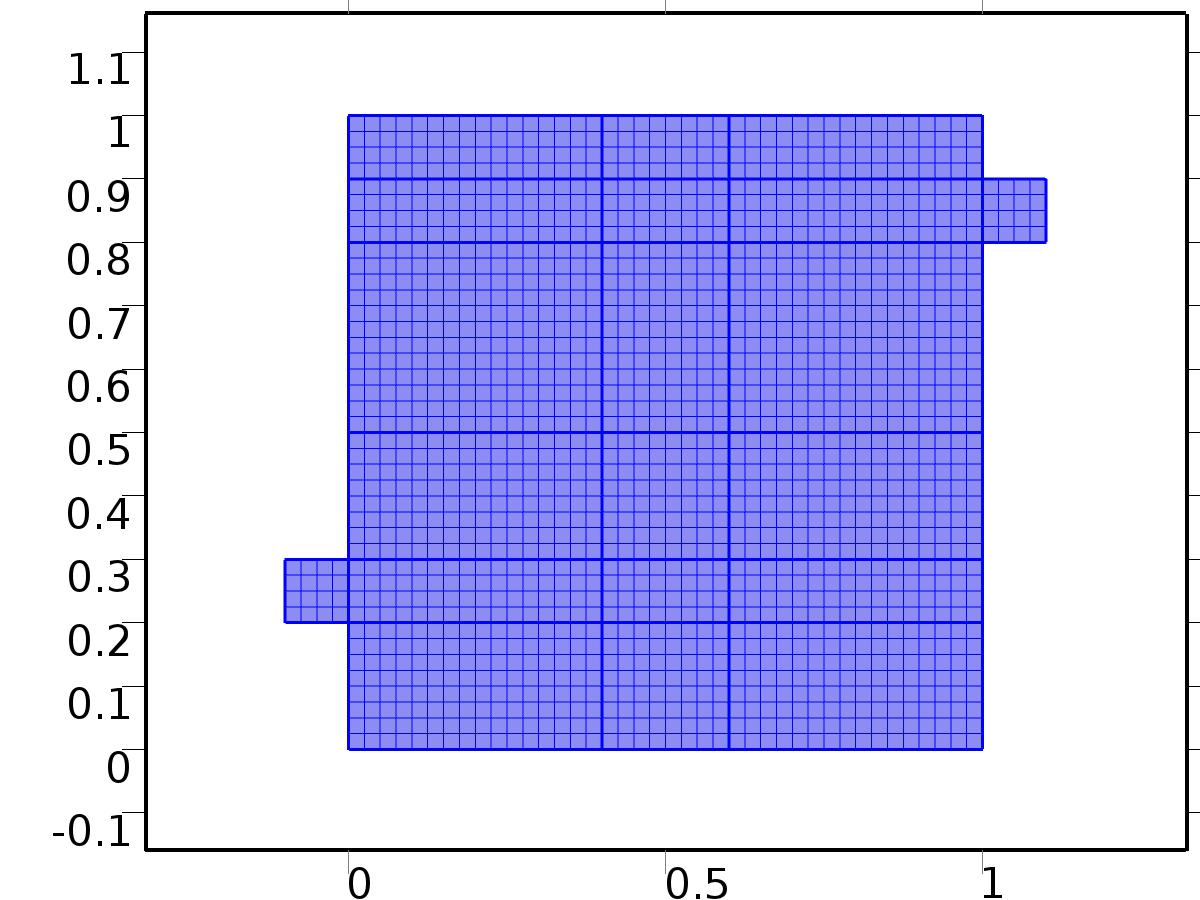
Settings

| **Description** | **Value** |
| --- | --- |
| Maximum element size | H/4 |
| Minimum element size | H/4 |
| Curvature factor | 0.3 |
| Curvature factor | Off |
| Resolution of narrow regions | Off |
| Maximum element growth rate | 1.3 |
| Maximum element growth rate | Off |
| Custom element size | Custom |

* + 1. Mapped 1 (map1)

Selection

|  |  |
| --- | --- |
| Geometric entity level | Domain |
| Selection | Domains 1–20 |



Mapped 1

1. Study 1
   1. Stationary

Study settings

| **Description** | **Value** |
| --- | --- |
| Include geometric nonlinearity | Off |

Physics and variables selection

| **Physics interface** | **Discretization** |
| --- | --- |
| Steady Flow (spf) | physics |
| Unit Input (c) | physics |

Mesh selection

| **Geometry** | **Mesh** |
| --- | --- |
| Geometry 1 (geom1) | mesh1 |

* 1. Solver Configurations
     1. Solver 1

#### Compile Equations: Stationary (st1)

Study and step

| **Description** | **Value** |
| --- | --- |
| Use study | Study 1 |
| Use study step | Stationary |

#### Dependent Variables 1 (v1)

General

| **Description** | **Value** |
| --- | --- |
| Defined by study step | Stationary |
| Constant |  |

Initial values of variables solved for

| **Description** | **Value** |
| --- | --- |
| Solution | Zero |

Values of variables not solved for

| **Description** | **Value** |
| --- | --- |
| Solution | Zero |

##### Dependent variable tZ (comp1.tZ) (comp1\_tZ)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.tZ |
| Solve for this field | Off |

##### Pressure (comp1.bP) (comp1\_bP)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bP |
| Solve for this field | Off |

##### Dependent variable T (comp1.T) (comp1\_T)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.T |
| Solve for this field | Off |

##### Pressure (comp1.bp) (comp1\_bp)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bp |
| Solve for this field | Off |

##### Dependent variable bT (comp1.bT) (comp1\_bT)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bT |
| Solve for this field | Off |

##### Pressure (comp1.P) (comp1\_P)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.P |

##### Pressure (comp1.p) (comp1\_p)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.p |
| Solve for this field | Off |

##### Velocity field (comp1.bu) (comp1\_bu)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.bu, comp1.bv} |
| Solve for this field | Off |

##### Dependent variable tT (comp1.tT) (comp1\_tT)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.tT |
| Solve for this field | Off |

##### Velocity field (comp1.bV) (comp1\_bV)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.bU, comp1.bV} |
| Solve for this field | Off |

##### Velocity field (comp1.u) (comp1\_u)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.u, comp1.v} |
| Solve for this field | Off |

##### Dependent variable X (comp1.X) (comp1\_X)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.X |

##### Velocity field (comp1.U) (comp1\_U)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.U, comp1.V} |

##### Dependent variable bZ (comp1.bZ) (comp1\_bZ)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bZ |
| Solve for this field | Off |

#### Stationary Solver 1 (s1)

General

| **Description** | **Value** |
| --- | --- |
| Defined by study step | Stationary |

Log

| **Description** | **Value** |
| --- | --- |
| Constant |  |

##### Fully Coupled 1 (fc1)

General

| **Description** | **Value** |
| --- | --- |
| Linear solver | Direct 1 |

Method and termination

| **Description** | **Value** |
| --- | --- |
| Initial damping factor | 0.01 |
| Minimum damping factor | 1.0E-6 |

1. Study 2
   1. Stationary

Study settings

| **Description** | **Value** |
| --- | --- |
| Include geometric nonlinearity | Off |

Physics and variables selection

| **Physics interface** | **Discretization** |
| --- | --- |
| Set Point Flow (phys1) | physics |
| Set Point Temperature (phys2) | physics |

Mesh selection

| **Geometry** | **Mesh** |
| --- | --- |
| Geometry 1 (geom1) | mesh1 |

* 1. Solver Configurations
     1. Solver 2

#### Compile Equations: Stationary (st1)

Study and step

| **Description** | **Value** |
| --- | --- |
| Use study | Study 2 |
| Use study step | Stationary |

#### Dependent Variables 1 (v1)

General

| **Description** | **Value** |
| --- | --- |
| Defined by study step | Stationary |
| Constant |  |

Initial values of variables solved for

| **Description** | **Value** |
| --- | --- |
| Solution | Solver 1 |

Values of variables not solved for

| **Description** | **Value** |
| --- | --- |
| Method | Solution |
| Solution | Solver 1 |

##### Dependent variable tZ (comp1.tZ) (comp1\_tZ)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.tZ |

##### Pressure (comp1.bP) (comp1\_bP)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bP |

##### Dependent variable T (comp1.T) (comp1\_T)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.T |
| Solve for this field | Off |

##### Pressure (comp1.bp) (comp1\_bp)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bp |
| Solve for this field | Off |

##### Dependent variable bT (comp1.bT) (comp1\_bT)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bT |
| Solve for this field | Off |

##### Pressure (comp1.P) (comp1\_P)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.P |
| Solve for this field | Off |

##### Pressure (comp1.p) (comp1\_p)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.p |
| Solve for this field | Off |

##### Velocity field (comp1.bu) (comp1\_bu)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.bu, comp1.bv} |
| Solve for this field | Off |

##### Dependent variable tT (comp1.tT) (comp1\_tT)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.tT |
| Solve for this field | Off |

##### Velocity field (comp1.bV) (comp1\_bV)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.bU, comp1.bV} |

##### Velocity field (comp1.u) (comp1\_u)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.u, comp1.v} |
| Solve for this field | Off |

##### Dependent variable X (comp1.X) (comp1\_X)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.X |
| Solve for this field | Off |

##### Velocity field (comp1.U) (comp1\_U)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.U, comp1.V} |
| Solve for this field | Off |

##### Dependent variable bZ (comp1.bZ) (comp1\_bZ)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bZ |

#### Stationary Solver 1 (s1)

General

| **Description** | **Value** |
| --- | --- |
| Defined by study step | Stationary |

Log

| **Description** | **Value** |
| --- | --- |
| Constant |  |

##### Fully Coupled 1 (fc1)

General

| **Description** | **Value** |
| --- | --- |
| Linear solver | Direct 1 |

Method and termination

| **Description** | **Value** |
| --- | --- |
| Initial damping factor | 0.01 |
| Minimum damping factor | 1.0E-6 |

1. Study 3
   1. Time Dependent

Study settings

| **Description** | **Value** |
| --- | --- |
| Include geometric nonlinearity | Off |

| **Times** | **Unit** |
| --- | --- |
| range(0,10,3000) | s |

Physics and variables selection

| **Physics interface** | **Discretization** |
| --- | --- |
| Piecewise Constant Flow (phys3) | physics |
| Piecewise Constant Temperature (phys4) | physics |

Mesh selection

| **Geometry** | **Mesh** |
| --- | --- |
| Geometry 1 (geom1) | mesh1 |

* 1. Solver Configurations
     1. Solver 3

#### Compile Equations: Time Dependent (st1)

Study and step

| **Description** | **Value** |
| --- | --- |
| Use study | Study 3 |
| Use study step | Time Dependent |

#### Dependent Variables 1 (v1)

General

| **Description** | **Value** |
| --- | --- |
| Defined by study step | Time Dependent |
| Constant |  |

Initial values of variables solved for

| **Description** | **Value** |
| --- | --- |
| Solution | Solver 2 |

Values of variables not solved for

| **Description** | **Value** |
| --- | --- |
| Method | Solution |
| Solution | Solver 2 |

##### Dependent variable bT (comp1.bT) (comp1\_bT)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bT |
| Field name | comp1\_T |

##### Pressure (comp1.bP) (comp1\_bP)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bP |
| Solve for this field | Off |
| Field name | comp1\_bp |

##### Dependent variable bZ (comp1.bZ) (comp1\_bZ)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bZ |
| Solve for this field | Off |
| Field name | comp1\_bT |

##### Pressure (comp1.P) (comp1\_P)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.P |
| Solve for this field | Off |

##### Pressure (comp1.bp) (comp1\_bp)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bp |
| Field name | comp1\_p |

##### Velocity field (comp1.bV) (comp1\_bV)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.bU, comp1.bV} |
| Solve for this field | Off |
| Field name | comp1\_bu |

##### Dependent variable tZ (comp1.tZ) (comp1\_tZ)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.tZ |
| Solve for this field | Off |
| Field name | comp1\_tT |

##### Velocity field (comp1.bu) (comp1\_bu)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.bu, comp1.bv} |
| Field name | comp1\_u |

##### Dependent variable X (comp1.X) (comp1\_X)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.X |
| Solve for this field | Off |

##### Velocity field (comp1.U) (comp1\_U)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.U, comp1.V} |
| Solve for this field | Off |

##### Dependent variable tT (comp1.tT) (comp1\_tT)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.tT |
| Field name | comp1\_bT2 |

##### Pressure (comp1.p) (comp1\_p)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.p |
| Solve for this field | Off |

##### Velocity field (comp1.u) (comp1\_u)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.u, comp1.v} |
| Solve for this field | Off |

##### Dependent variable T (comp1.T) (comp1\_T)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.T |
| Solve for this field | Off |
| Field name | comp1\_u2 |

#### Time-Dependent Solver 1 (t1)

General

| **Description** | **Value** |
| --- | --- |
| Defined by study step | Time Dependent |
| Time | {0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650, 660, 670, 680, 690, 700, 710, 720, 730, 740, 750, 760, 770, 780, 790, 800, 810, 820, 830, 840, 850, 860, 870, 880, 890, 900, 910, 920, 930, 940, 950, 960, 970, 980, 990, 1000, 1010, 1020, 1030, 1040, 1050, 1060, 1070, 1080, 1090, 1100, 1110, 1120, 1130, 1140, 1150, 1160, 1170, 1180, 1190, 1200, 1210, 1220, 1230, 1240, 1250, 1260, 1270, 1280, 1290, 1300, 1310, 1320, 1330, 1340, 1350, 1360, 1370, 1380, 1390, 1400, 1410, 1420, 1430, 1440, 1450, 1460, 1470, 1480, 1490, 1500, 1510, 1520, 1530, 1540, 1550, 1560, 1570, 1580, 1590, 1600, 1610, 1620, 1630, 1640, 1650, 1660, 1670, 1680, 1690, 1700, 1710, 1720, 1730, 1740, 1750, 1760, 1770, 1780, 1790, 1800, 1810, 1820, 1830, 1840, 1850, 1860, 1870, 1880, 1890, 1900, 1910, 1920, 1930, 1940, 1950, 1960, 1970, 1980, 1990, 2000, 2010, 2020, 2030, 2040, 2050, 2060, 2070, 2080, 2090, 2100, 2110, 2120, 2130, 2140, 2150, 2160, 2170, 2180, 2190, 2200, 2210, 2220, 2230, 2240, 2250, 2260, 2270, 2280, 2290, 2300, 2310, 2320, 2330, 2340, 2350, 2360, 2370, 2380, 2390, 2400, 2410, 2420, 2430, 2440, 2450, 2460, 2470, 2480, 2490, 2500, 2510, 2520, 2530, 2540, 2550, 2560, 2570, 2580, 2590, 2600, 2610, 2620, 2630, 2640, 2650, 2660, 2670, 2680, 2690, 2700, 2710, 2720, 2730, 2740, 2750, 2760, 2770, 2780, 2790, 2800, 2810, 2820, 2830, 2840, 2850, 2860, 2870, 2880, 2890, 2900, 2910, 2920, 2930, 2940, 2950, 2960, 2970, 2980, 2990, 3000} |

Absolute tolerance

| **Description** | **Value** |
| --- | --- |
| Tolerance | 5.0E-4 |

Time stepping

| **Description** | **Value** |
| --- | --- |
| Initial step | 0.0010 |

Advanced

| **Description** | **Value** |
| --- | --- |
| Fraction of initial step for Backward Euler | 0.0010 |

Log

| **Description** | **Value** |
| --- | --- |
| Constant |  |

##### Fully Coupled 1 (fc1)

General

| **Description** | **Value** |
| --- | --- |
| Linear solver | Direct 1 |

Method and termination

| **Description** | **Value** |
| --- | --- |
| Jacobian update | Once per time step |
| Maximum number of iterations | 6 |

1. Study 4
   1. Time Dependent

Study settings

| **Description** | **Value** |
| --- | --- |
| Include geometric nonlinearity | Off |

| **Times** | **Unit** |
| --- | --- |
| range(0,10,3000) | s |

Physics and variables selection

| **Physics interface** | **Discretization** |
| --- | --- |
| Closed Loop Flow (phys5) | physics |
| Closed Loop Temperature (phys6) | physics |

Mesh selection

| **Geometry** | **Mesh** |
| --- | --- |
| Geometry 1 (geom1) | mesh1 |

* 1. Solver Configurations
     1. Solver 4

#### Compile Equations: Time Dependent (st1)

Study and step

| **Description** | **Value** |
| --- | --- |
| Use study | Study 4 |
| Use study step | Time Dependent |

#### Dependent Variables 1 (v1)

General

| **Description** | **Value** |
| --- | --- |
| Defined by study step | Time Dependent |
| Constant |  |

Initial values of variables solved for

| **Description** | **Value** |
| --- | --- |
| Solution | Zero |

Values of variables not solved for

| **Description** | **Value** |
| --- | --- |
| Method | Solution |
| Solution | Solver 3 |

##### Dependent variable tZ (comp1.tZ) (comp1\_tZ)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.tZ |
| Solve for this field | Off |

##### Pressure (comp1.bP) (comp1\_bP)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bP |
| Solve for this field | Off |

##### Dependent variable T (comp1.T) (comp1\_T)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.T |

##### Pressure (comp1.bp) (comp1\_bp)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bp |
| Solve for this field | Off |

##### Dependent variable bT (comp1.bT) (comp1\_bT)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bT |
| Solve for this field | Off |

##### Pressure (comp1.P) (comp1\_P)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.P |
| Solve for this field | Off |

##### Pressure (comp1.p) (comp1\_p)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.p |

##### Velocity field (comp1.bu) (comp1\_bu)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.bu, comp1.bv} |
| Solve for this field | Off |

##### Dependent variable tT (comp1.tT) (comp1\_tT)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.tT |
| Solve for this field | Off |

##### Velocity field (comp1.bV) (comp1\_bV)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.bU, comp1.bV} |
| Solve for this field | Off |

##### Velocity field (comp1.u) (comp1\_u)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.u, comp1.v} |

##### Dependent variable X (comp1.X) (comp1\_X)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.X |
| Solve for this field | Off |

##### Velocity field (comp1.U) (comp1\_U)

General

| **Description** | **Value** |
| --- | --- |
| Field components | {comp1.U, comp1.V} |
| Solve for this field | Off |

##### Dependent variable bZ (comp1.bZ) (comp1\_bZ)

General

| **Description** | **Value** |
| --- | --- |
| Field components | comp1.bZ |
| Solve for this field | Off |

#### Time-Dependent Solver 1 (t1)

General

| **Description** | **Value** |
| --- | --- |
| Defined by study step | Time Dependent |
| Time | {0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650, 660, 670, 680, 690, 700, 710, 720, 730, 740, 750, 760, 770, 780, 790, 800, 810, 820, 830, 840, 850, 860, 870, 880, 890, 900, 910, 920, 930, 940, 950, 960, 970, 980, 990, 1000, 1010, 1020, 1030, 1040, 1050, 1060, 1070, 1080, 1090, 1100, 1110, 1120, 1130, 1140, 1150, 1160, 1170, 1180, 1190, 1200, 1210, 1220, 1230, 1240, 1250, 1260, 1270, 1280, 1290, 1300, 1310, 1320, 1330, 1340, 1350, 1360, 1370, 1380, 1390, 1400, 1410, 1420, 1430, 1440, 1450, 1460, 1470, 1480, 1490, 1500, 1510, 1520, 1530, 1540, 1550, 1560, 1570, 1580, 1590, 1600, 1610, 1620, 1630, 1640, 1650, 1660, 1670, 1680, 1690, 1700, 1710, 1720, 1730, 1740, 1750, 1760, 1770, 1780, 1790, 1800, 1810, 1820, 1830, 1840, 1850, 1860, 1870, 1880, 1890, 1900, 1910, 1920, 1930, 1940, 1950, 1960, 1970, 1980, 1990, 2000, 2010, 2020, 2030, 2040, 2050, 2060, 2070, 2080, 2090, 2100, 2110, 2120, 2130, 2140, 2150, 2160, 2170, 2180, 2190, 2200, 2210, 2220, 2230, 2240, 2250, 2260, 2270, 2280, 2290, 2300, 2310, 2320, 2330, 2340, 2350, 2360, 2370, 2380, 2390, 2400, 2410, 2420, 2430, 2440, 2450, 2460, 2470, 2480, 2490, 2500, 2510, 2520, 2530, 2540, 2550, 2560, 2570, 2580, 2590, 2600, 2610, 2620, 2630, 2640, 2650, 2660, 2670, 2680, 2690, 2700, 2710, 2720, 2730, 2740, 2750, 2760, 2770, 2780, 2790, 2800, 2810, 2820, 2830, 2840, 2850, 2860, 2870, 2880, 2890, 2900, 2910, 2920, 2930, 2940, 2950, 2960, 2970, 2980, 2990, 3000} |

Absolute tolerance

| **Description** | **Value** |
| --- | --- |
| Tolerance | 5.0E-4 |

Time stepping

| **Description** | **Value** |
| --- | --- |
| Maximum BDF order | 2 |

Advanced

| **Description** | **Value** |
| --- | --- |
| Error estimation | Exclude algebraic |

Log

| **Description** | **Value** |
| --- | --- |
| Constant |  |

##### Fully Coupled 1 (fc1)

General

| **Description** | **Value** |
| --- | --- |
| Linear solver | Direct 1 |

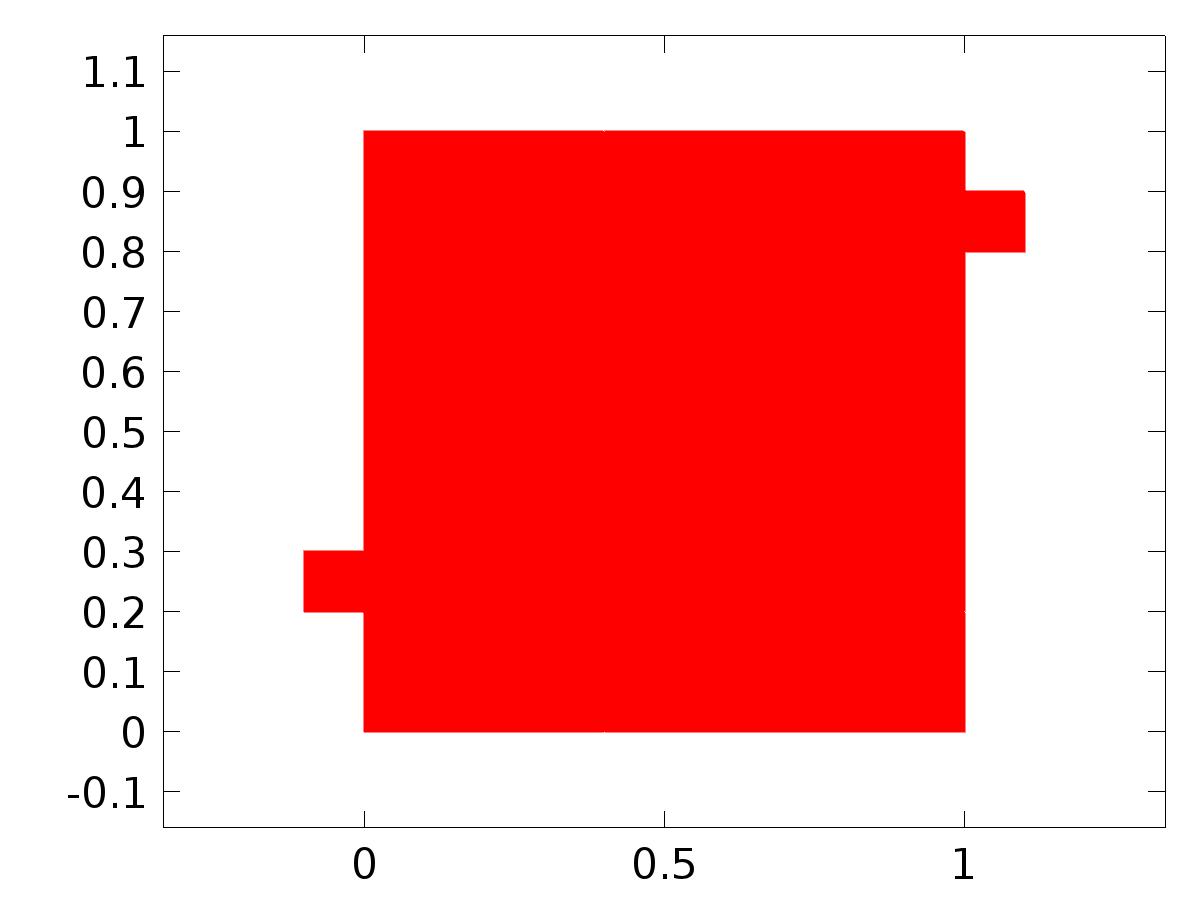
Method and termination

| **Description** | **Value** |
| --- | --- |
| Jacobian update | Once per time step |
| Maximum number of iterations | 6 |

1. Results
   1. Data Sets
      1. Solution 1

Solution

| **Description** | **Value** |
| --- | --- |
| Solution | Solver 1 |
| Component | Save Point Geometry 1 |

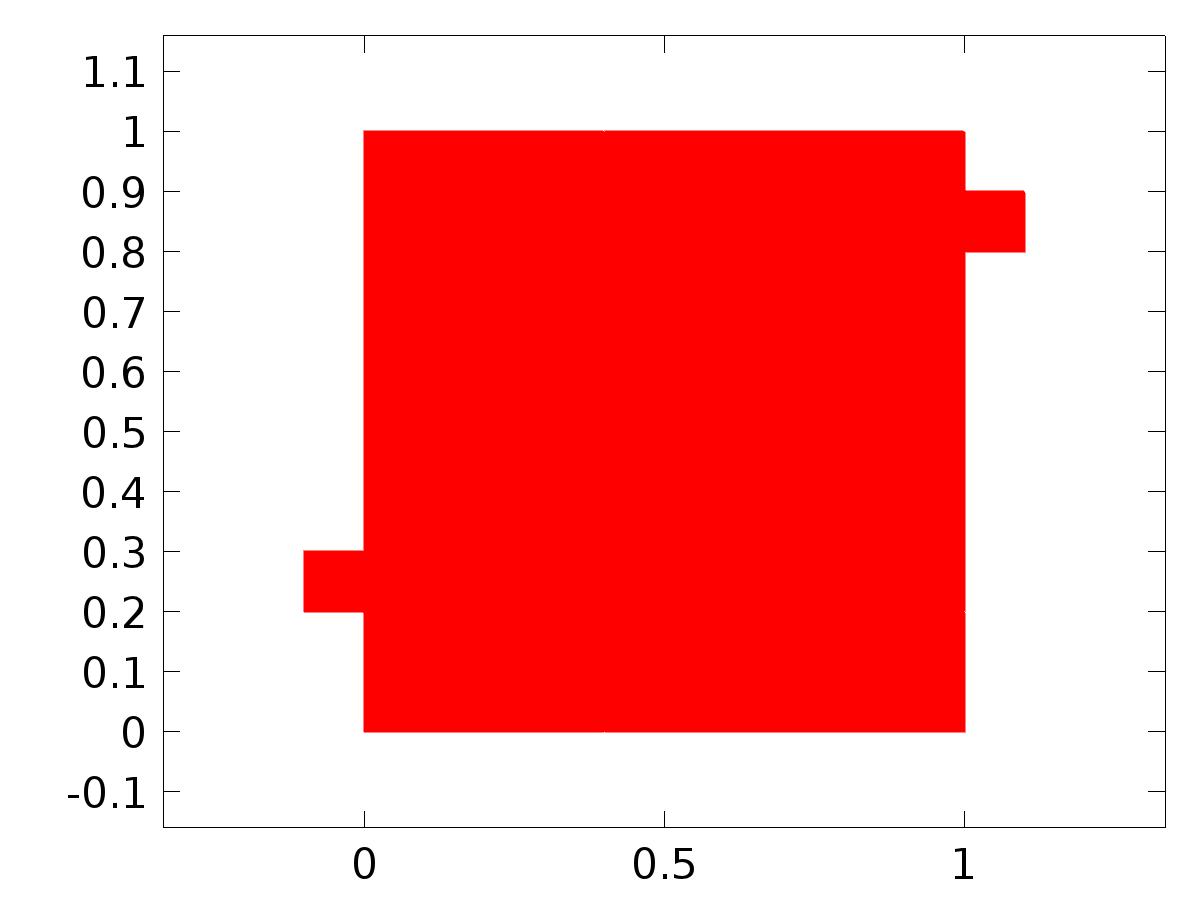


Data set: Solution 1

* + 1. Solution 2

Solution

| **Description** | **Value** |
| --- | --- |
| Solution | Solver 2 |
| Component | Save Point Geometry 1 |

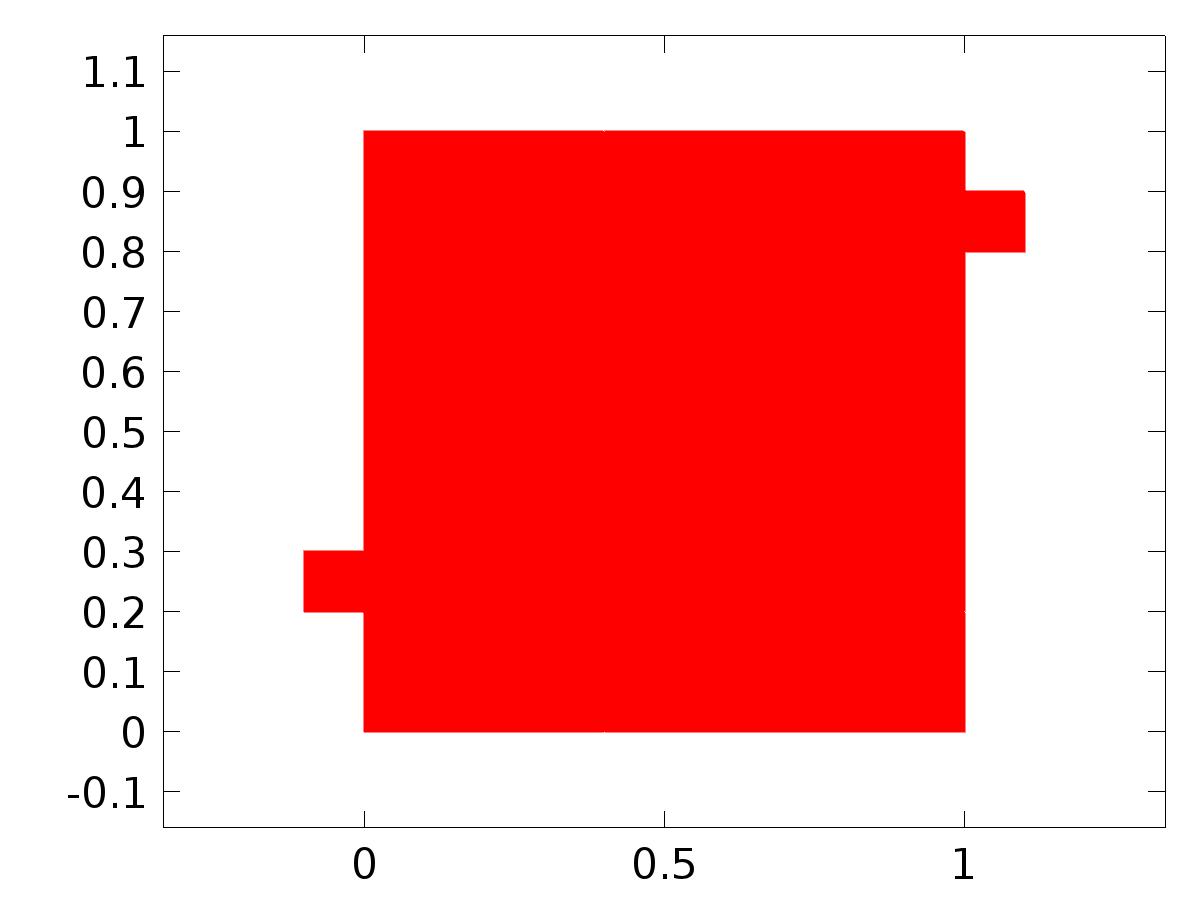


Data set: Solution 2

* + 1. Solution 3

Solution

| **Description** | **Value** |
| --- | --- |
| Solution | Solver 3 |
| Component | Save Point Geometry 1 |

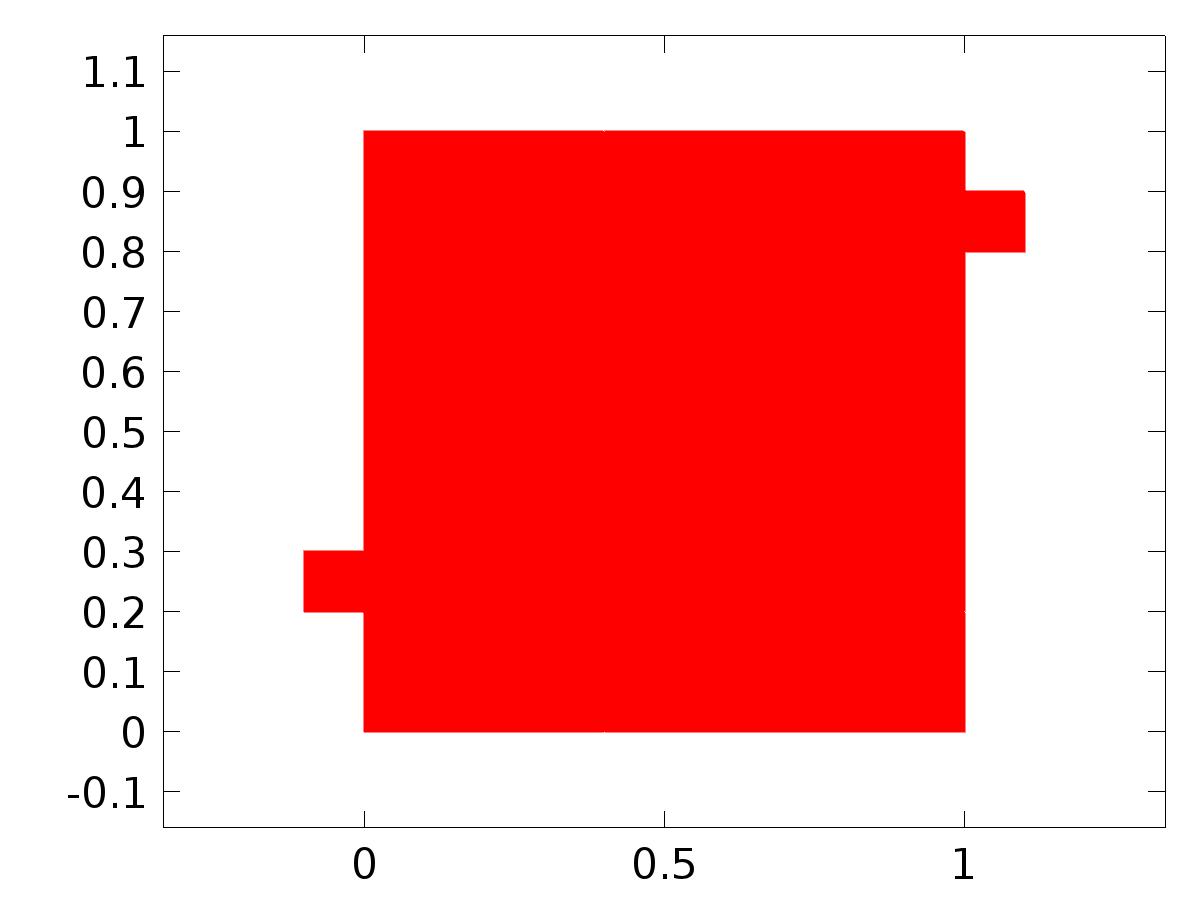


Data set: Solution 3

* + 1. Solution 4

Solution

| **Description** | **Value** |
| --- | --- |
| Solution | Solver 4 |
| Component | Save Point Geometry 1 |



Data set: Solution 4

* 1. Derived Values
     1. Global Evaluation 1

Data

| **Description** | **Value** |
| --- | --- |
| Data set | Solution 2 |

Expression

| **Description** | **Value** |
| --- | --- |
| Expression | C(bT) |
| Description | C(bT) |

* + 1. Global Evaluation 2

Data

| **Description** | **Value** |
| --- | --- |
| Data set | Solution 3 |

Expression

| **Description** | **Value** |
| --- | --- |
| Expression | C(T) |
| Description | C(T) |

* + 1. Global Evaluation 3

Data

| **Description** | **Value** |
| --- | --- |
| Data set | Solution 4 |

Expression

| **Description** | **Value** |
| --- | --- |
| Expression | e |

* 1. Tables
     1. Table 1

Global Evaluation 1 (C(bT))

Table 1

| **C(bT)** | **C(bT)** |
| --- | --- |
| 0.50000 | 0.50000 |

* + 1. Table 2

Global Evaluation 1 (C(bT))

Table 2

| **C(bT)** |
| --- |
| 0.50000 |

* + 1. Table 3

Global Evaluation 2 (C(T))

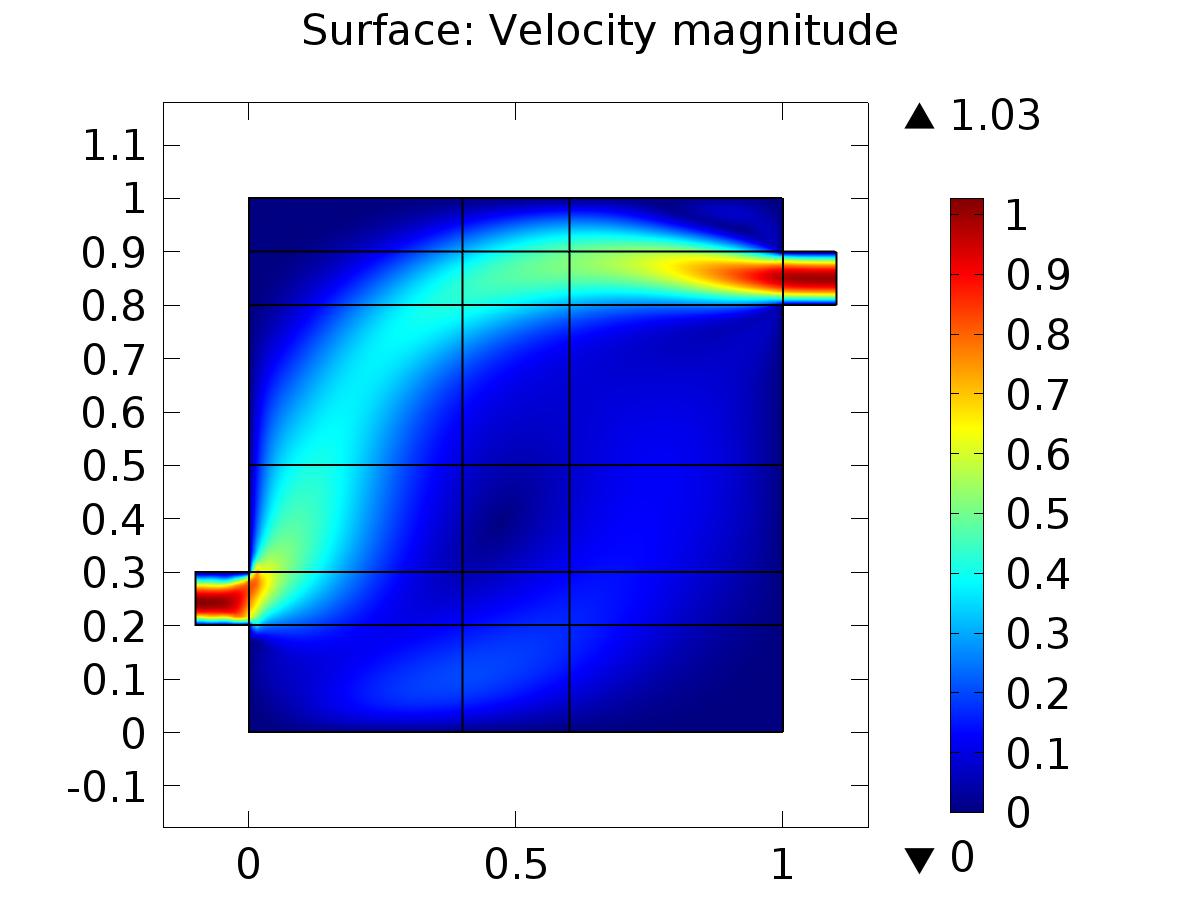
* + 1. Table 4

Global Evaluation 3 (C(T))

Table 4

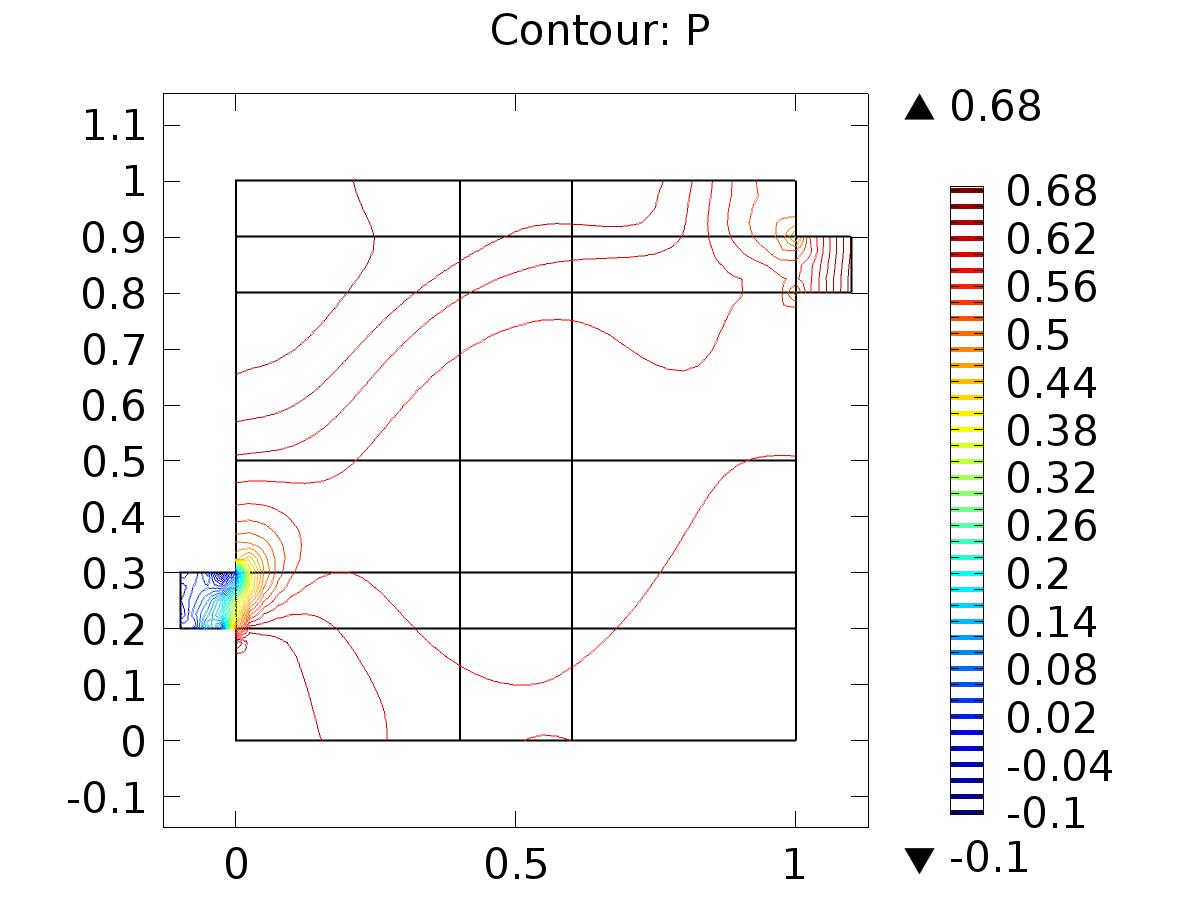
| **Time (s)** | **C(T)** | **yr** | **gamma** | **d** | **e** |
| --- | --- | --- | --- | --- | --- |
| 0.0000 | 4.9604E-22 | 0.25000 | -3.6130E-5 | 0.75000 | 0.25000 |
| 10.000 | 0.12105 | 0.25000 | -3.6130E-5 | 0.75000 | 0.12895 |
| 20.000 | 0.18158 | 0.25000 | -3.6130E-5 | 0.75000 | 0.068421 |
| 30.000 | 0.20602 | 0.25000 | -3.6130E-5 | 0.75000 | 0.043979 |
| 40.000 | 0.21600 | 0.25000 | -3.6130E-5 | 0.75000 | 0.034001 |
| 50.000 | 0.22015 | 0.25000 | -3.6130E-5 | 0.75000 | 0.029851 |
| 60.000 | 0.22196 | 0.25000 | -3.6130E-5 | 0.75000 | 0.028043 |
| 70.000 | 0.22315 | 0.25000 | -3.6130E-5 | 0.75000 | 0.026853 |
| 80.000 | 0.22411 | 0.25000 | -3.6130E-5 | 0.75000 | 0.025892 |
| 90.000 | 0.22491 | 0.25000 | -3.6130E-5 | 0.75000 | 0.025086 |
| 100.00 | 0.22572 | 0.25000 | -3.6130E-5 | 0.75000 | 0.024279 |
| 110.00 | 0.22652 | 0.25000 | -3.6130E-5 | 0.75000 | 0.023482 |
| 120.00 | 0.22728 | 0.25000 | -3.6130E-5 | 0.75000 | 0.022717 |
| 130.00 | 0.22805 | 0.25000 | -3.6130E-5 | 0.75000 | 0.021951 |
| 140.00 | 0.22878 | 0.25000 | -3.6130E-5 | 0.75000 | 0.021217 |
| 150.00 | 0.22942 | 0.25000 | -3.6130E-5 | 0.75000 | 0.020579 |
| 160.00 | 0.23006 | 0.25000 | -3.6130E-5 | 0.75000 | 0.019941 |
| 170.00 | 0.23070 | 0.25000 | -3.6130E-5 | 0.75000 | 0.019303 |
| 180.00 | 0.23134 | 0.25000 | -3.6130E-5 | 0.75000 | 0.018664 |
| 190.00 | 0.23197 | 0.25000 | -3.6130E-5 | 0.75000 | 0.018026 |
| 200.00 | 0.23258 | 0.25000 | -3.6130E-5 | 0.75000 | 0.017418 |
| 210.00 | 0.23311 | 0.25000 | -3.6130E-5 | 0.75000 | 0.016893 |
| 220.00 | 0.23363 | 0.25000 | -3.6130E-5 | 0.75000 | 0.016368 |
| 230.00 | 0.23416 | 0.25000 | -3.6130E-5 | 0.75000 | 0.015842 |
| 240.00 | 0.23468 | 0.25000 | -3.6130E-5 | 0.75000 | 0.015317 |
| 250.00 | 0.23521 | 0.25000 | -3.6130E-5 | 0.75000 | 0.014792 |
| 260.00 | 0.23569 | 0.25000 | -3.6130E-5 | 0.75000 | 0.014312 |
| 270.00 | 0.23605 | 0.25000 | -3.6130E-5 | 0.75000 | 0.013946 |
| 280.00 | 0.23642 | 0.25000 | -3.6130E-5 | 0.75000 | 0.013580 |
| 290.00 | 0.23679 | 0.25000 | -3.6130E-5 | 0.75000 | 0.013214 |
| 300.00 | 0.23715 | 0.25000 | -3.6130E-5 | 0.75000 | 0.012849 |
| 310.00 | 0.23752 | 0.25000 | -3.6130E-5 | 0.75000 | 0.012483 |
| 320.00 | 0.23788 | 0.25000 | -3.6130E-5 | 0.75000 | 0.012117 |
| 330.00 | 0.23825 | 0.25000 | -3.6130E-5 | 0.75000 | 0.011751 |
| 340.00 | 0.23861 | 0.25000 | -3.6130E-5 | 0.75000 | 0.011385 |
| 350.00 | 0.23898 | 0.25000 | -3.6130E-5 | 0.75000 | 0.011020 |
| 360.00 | 0.23935 | 0.25000 | -3.6130E-5 | 0.75000 | 0.010654 |
| 370.00 | 0.23971 | 0.25000 | -3.6130E-5 | 0.75000 | 0.010288 |
| 380.00 | 0.24004 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0099574 |
| 390.00 | 0.24030 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0097027 |
| 400.00 | 0.24055 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0094479 |
| 410.00 | 0.24081 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0091932 |
| 420.00 | 0.24106 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0089385 |
| 430.00 | 0.24132 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0086837 |
| 440.00 | 0.24157 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0084290 |
| 450.00 | 0.24183 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0081743 |
| 460.00 | 0.24208 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0079195 |
| 470.00 | 0.24234 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0076648 |
| 480.00 | 0.24259 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0074101 |
| 490.00 | 0.24284 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0071554 |
| 500.00 | 0.24307 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0069275 |
| 510.00 | 0.24325 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0067502 |
| 520.00 | 0.24343 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0065728 |
| 530.00 | 0.24360 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0063954 |
| 540.00 | 0.24378 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0062180 |
| 550.00 | 0.24396 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0060407 |
| 560.00 | 0.24414 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0058633 |
| 570.00 | 0.24431 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0056859 |
| 580.00 | 0.24449 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0055085 |
| 590.00 | 0.24467 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0053312 |
| 600.00 | 0.24485 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0051538 |
| 610.00 | 0.24502 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0049764 |
| 620.00 | 0.24519 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0048066 |
| 630.00 | 0.24535 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0046513 |
| 640.00 | 0.24550 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0044992 |
| 650.00 | 0.24565 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0043503 |
| 660.00 | 0.24580 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0042046 |
| 670.00 | 0.24594 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0040622 |
| 680.00 | 0.24608 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0039229 |
| 690.00 | 0.24621 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0037948 |
| 700.00 | 0.24630 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0036965 |
| 710.00 | 0.24639 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0036095 |
| 720.00 | 0.24647 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0035336 |
| 730.00 | 0.24653 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0034689 |
| 740.00 | 0.24658 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0034155 |
| 750.00 | 0.24515 | 0.37500 | 1.0163E-4 | 0.62500 | 0.12985 |
| 760.00 | 0.23560 | 0.50000 | 2.5367E-4 | 0.50000 | 0.26440 |
| 770.00 | 0.29450 | 0.50000 | 1.9999E-4 | 0.50000 | 0.20550 |
| 780.00 | 0.37773 | 0.50000 | 1.2112E-4 | 0.50000 | 0.12227 |
| 790.00 | 0.44894 | 0.50000 | 5.1654E-5 | 0.50000 | 0.051063 |
| 800.00 | 0.49864 | 0.50000 | 5.0044E-6 | 0.50000 | 0.0013587 |
| 810.00 | 0.52477 | 0.50000 | -1.8332E-5 | 0.50000 | -0.024765 |
| 820.00 | 0.53192 | 0.50000 | -2.3419E-5 | 0.50000 | -0.031915 |
| 830.00 | 0.52755 | 0.50000 | -1.7913E-5 | 0.50000 | -0.027547 |
| 840.00 | 0.51926 | 0.50000 | -9.4523E-6 | 0.50000 | -0.019256 |
| 850.00 | 0.51213 | 0.50000 | -2.7003E-6 | 0.50000 | -0.012134 |
| 860.00 | 0.50775 | 0.50000 | 1.0587E-6 | 0.50000 | -0.0077458 |
| 870.00 | 0.50592 | 0.50000 | 2.3888E-6 | 0.50000 | -0.0059192 |
| 880.00 | 0.50570 | 0.50000 | 2.2147E-6 | 0.50000 | -0.0056998 |
| 890.00 | 0.50618 | 0.50000 | 1.3588E-6 | 0.50000 | -0.0061821 |
| 900.00 | 0.50652 | 0.50000 | 4.4779E-7 | 0.50000 | -0.0065237 |
| 910.00 | 0.50654 | 0.50000 | -2.0279E-7 | 0.50000 | -0.0065446 |
| 920.00 | 0.50641 | 0.50000 | -4.6871E-7 | 0.50000 | -0.0064086 |
| 930.00 | 0.50623 | 0.50000 | -4.2737E-7 | 0.50000 | -0.0062307 |
| 940.00 | 0.50602 | 0.50000 | -2.6298E-7 | 0.50000 | -0.0060176 |
| 950.00 | 0.50584 | 0.50000 | -1.1608E-7 | 0.50000 | -0.0058376 |
| 960.00 | 0.50569 | 0.50000 | -5.7055E-8 | 0.50000 | -0.0056930 |
| 970.00 | 0.50555 | 0.50000 | 1.9720E-9 | 0.50000 | -0.0055484 |
| 980.00 | 0.50540 | 0.50000 | 1.8811E-8 | 0.50000 | -0.0054037 |
| 990.00 | 0.50527 | 0.50000 | 2.6692E-8 | 0.50000 | -0.0052721 |
| 1000.0 | 0.50516 | 0.50000 | 2.9579E-8 | 0.50000 | -0.0051634 |
| 1010.0 | 0.50505 | 0.50000 | 2.5574E-8 | 0.50000 | -0.0050547 |
| 1020.0 | 0.50495 | 0.50000 | 2.1569E-8 | 0.50000 | -0.0049460 |
| 1030.0 | 0.50484 | 0.50000 | 1.7564E-8 | 0.50000 | -0.0048373 |
| 1040.0 | 0.50473 | 0.50000 | 1.3558E-8 | 0.50000 | -0.0047286 |
| 1050.0 | 0.50462 | 0.50000 | 1.1318E-8 | 0.50000 | -0.0046199 |
| 1060.0 | 0.50451 | 0.50000 | 1.0202E-8 | 0.50000 | -0.0045112 |
| 1070.0 | 0.50441 | 0.50000 | 9.0863E-9 | 0.50000 | -0.0044059 |
| 1080.0 | 0.50433 | 0.50000 | 7.9704E-9 | 0.50000 | -0.0043274 |
| 1090.0 | 0.50425 | 0.50000 | 6.8544E-9 | 0.50000 | -0.0042488 |
| 1100.0 | 0.50417 | 0.50000 | 5.7385E-9 | 0.50000 | -0.0041703 |
| 1110.0 | 0.50409 | 0.50000 | 4.6226E-9 | 0.50000 | -0.0040917 |
| 1120.0 | 0.50401 | 0.50000 | 3.5066E-9 | 0.50000 | -0.0040132 |
| 1130.0 | 0.50393 | 0.50000 | 2.3907E-9 | 0.50000 | -0.0039347 |
| 1140.0 | 0.50386 | 0.50000 | 1.2748E-9 | 0.50000 | -0.0038561 |
| 1150.0 | 0.50378 | 0.50000 | 1.2007E-9 | 0.50000 | -0.0037776 |
| 1160.0 | 0.50370 | 0.50000 | 1.1348E-9 | 0.50000 | -0.0036990 |
| 1170.0 | 0.50362 | 0.50000 | 1.0688E-9 | 0.50000 | -0.0036205 |
| 1180.0 | 0.50354 | 0.50000 | 1.0029E-9 | 0.50000 | -0.0035419 |
| 1190.0 | 0.50346 | 0.50000 | 9.3692E-10 | 0.50000 | -0.0034634 |
| 1200.0 | 0.50338 | 0.50000 | 8.7097E-10 | 0.50000 | -0.0033848 |
| 1210.0 | 0.50331 | 0.50000 | 8.0502E-10 | 0.50000 | -0.0033063 |
| 1220.0 | 0.50323 | 0.50000 | 7.3907E-10 | 0.50000 | -0.0032277 |
| 1230.0 | 0.50315 | 0.50000 | 6.7312E-10 | 0.50000 | -0.0031492 |
| 1240.0 | 0.50309 | 0.50000 | 6.0717E-10 | 0.50000 | -0.0030915 |
| 1250.0 | 0.50305 | 0.50000 | 5.4122E-10 | 0.50000 | -0.0030466 |
| 1260.0 | 0.50300 | 0.50000 | 4.7527E-10 | 0.50000 | -0.0030016 |
| 1270.0 | 0.50296 | 0.50000 | 4.0932E-10 | 0.50000 | -0.0029566 |
| 1280.0 | 0.50291 | 0.50000 | 3.4337E-10 | 0.50000 | -0.0029117 |
| 1290.0 | 0.50287 | 0.50000 | 2.7742E-10 | 0.50000 | -0.0028667 |
| 1300.0 | 0.50282 | 0.50000 | 2.1147E-10 | 0.50000 | -0.0028217 |
| 1310.0 | 0.50278 | 0.50000 | 1.4552E-10 | 0.50000 | -0.0027768 |
| 1320.0 | 0.50273 | 0.50000 | 7.9575E-11 | 0.50000 | -0.0027318 |
| 1330.0 | 0.50269 | 0.50000 | 1.3626E-11 | 0.50000 | -0.0026869 |
| 1340.0 | 0.50264 | 0.50000 | -2.5775E-12 | 0.50000 | -0.0026419 |
| 1350.0 | 0.50260 | 0.50000 | -2.6433E-12 | 0.50000 | -0.0025969 |
| 1360.0 | 0.50255 | 0.50000 | -2.7090E-12 | 0.50000 | -0.0025520 |
| 1370.0 | 0.50251 | 0.50000 | -2.7748E-12 | 0.50000 | -0.0025070 |
| 1380.0 | 0.50246 | 0.50000 | -2.8405E-12 | 0.50000 | -0.0024620 |
| 1390.0 | 0.50242 | 0.50000 | -2.9063E-12 | 0.50000 | -0.0024171 |
| 1400.0 | 0.50237 | 0.50000 | -2.9720E-12 | 0.50000 | -0.0023721 |
| 1410.0 | 0.50233 | 0.50000 | -3.0378E-12 | 0.50000 | -0.0023271 |
| 1420.0 | 0.50228 | 0.50000 | -3.1036E-12 | 0.50000 | -0.0022822 |
| 1430.0 | 0.50224 | 0.50000 | -3.1693E-12 | 0.50000 | -0.0022372 |
| 1440.0 | 0.50219 | 0.50000 | -3.2351E-12 | 0.50000 | -0.0021922 |
| 1450.0 | 0.50215 | 0.50000 | -3.3008E-12 | 0.50000 | -0.0021473 |
| 1460.0 | 0.50210 | 0.50000 | -3.3666E-12 | 0.50000 | -0.0021023 |
| 1470.0 | 0.50206 | 0.50000 | -3.4323E-12 | 0.50000 | -0.0020573 |
| 1480.0 | 0.50201 | 0.50000 | -3.4981E-12 | 0.50000 | -0.0020124 |
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| 1510.0 | 0.50188 | 0.50000 | -3.6954E-12 | 0.50000 | -0.0018775 |
| 1520.0 | 0.50183 | 0.50000 | -3.7611E-12 | 0.50000 | -0.0018325 |
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| 1640.0 | 0.50150 | 0.50000 | -4.3937E-12 | 0.50000 | -0.0014993 |
| 1650.0 | 0.50147 | 0.50000 | -4.2522E-12 | 0.50000 | -0.0014738 |
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| 1670.0 | 0.50142 | 0.50000 | -3.9692E-12 | 0.50000 | -0.0014227 |
| 1680.0 | 0.50140 | 0.50000 | -3.8277E-12 | 0.50000 | -0.0013971 |
| 1690.0 | 0.50137 | 0.50000 | -3.6862E-12 | 0.50000 | -0.0013716 |
| 1700.0 | 0.50135 | 0.50000 | -3.5446E-12 | 0.50000 | -0.0013461 |
| 1710.0 | 0.50132 | 0.50000 | -3.4031E-12 | 0.50000 | -0.0013205 |
| 1720.0 | 0.50129 | 0.50000 | -3.2616E-12 | 0.50000 | -0.0012950 |
| 1730.0 | 0.50127 | 0.50000 | -3.1201E-12 | 0.50000 | -0.0012694 |
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| 1830.0 | 0.50101 | 0.50000 | -1.7050E-12 | 0.50000 | -0.0010141 |
| 1840.0 | 0.50100 | 0.50000 | -1.5635E-12 | 0.50000 | -9.9541E-4 |
| 1850.0 | 0.50098 | 0.50000 | -1.4220E-12 | 0.50000 | -9.8092E-4 |
| 1860.0 | 0.50097 | 0.50000 | -1.2805E-12 | 0.50000 | -9.6644E-4 |
| 1870.0 | 0.50095 | 0.50000 | -1.1390E-12 | 0.50000 | -9.5195E-4 |
| 1880.0 | 0.50094 | 0.50000 | -9.9747E-13 | 0.50000 | -9.3747E-4 |
| 1890.0 | 0.50092 | 0.50000 | -8.5596E-13 | 0.50000 | -9.2298E-4 |
| 1900.0 | 0.50091 | 0.50000 | -7.1445E-13 | 0.50000 | -9.0850E-4 |
| 1910.0 | 0.50089 | 0.50000 | -5.7294E-13 | 0.50000 | -8.9401E-4 |
| 1920.0 | 0.50088 | 0.50000 | -4.3143E-13 | 0.50000 | -8.7952E-4 |
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| 1990.0 | 0.50078 | 0.50000 | -2.0722E-13 | 0.50000 | -7.7813E-4 |
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| 2010.0 | 0.50075 | 0.50000 | -1.9053E-13 | 0.50000 | -7.4915E-4 |
| 2020.0 | 0.50073 | 0.50000 | -1.8218E-13 | 0.50000 | -7.3467E-4 |
| 2030.0 | 0.50072 | 0.50000 | -1.7384E-13 | 0.50000 | -7.2018E-4 |
| 2040.0 | 0.50071 | 0.50000 | -1.6549E-13 | 0.50000 | -7.0570E-4 |
| 2050.0 | 0.50069 | 0.50000 | -1.5714E-13 | 0.50000 | -6.9121E-4 |
| 2060.0 | 0.50068 | 0.50000 | -1.4880E-13 | 0.50000 | -6.7673E-4 |
| 2070.0 | 0.50066 | 0.50000 | -1.4045E-13 | 0.50000 | -6.6224E-4 |
| 2080.0 | 0.50065 | 0.50000 | -1.3210E-13 | 0.50000 | -6.4776E-4 |
| 2090.0 | 0.50063 | 0.50000 | -1.2376E-13 | 0.50000 | -6.3327E-4 |
| 2100.0 | 0.50062 | 0.50000 | -1.1541E-13 | 0.50000 | -6.1879E-4 |
| 2110.0 | 0.50060 | 0.50000 | -1.0707E-13 | 0.50000 | -6.0430E-4 |
| 2120.0 | 0.50059 | 0.50000 | -9.8719E-14 | 0.50000 | -5.8981E-4 |
| 2130.0 | 0.50058 | 0.50000 | -9.0373E-14 | 0.50000 | -5.7533E-4 |
| 2140.0 | 0.50056 | 0.50000 | -8.2027E-14 | 0.50000 | -5.6228E-4 |
| 2150.0 | 0.50055 | 0.50000 | -7.3680E-14 | 0.50000 | -5.5010E-4 |
| 2160.0 | 0.50054 | 0.50000 | -6.5334E-14 | 0.50000 | -5.3792E-4 |
| 2170.0 | 0.50053 | 0.50000 | -5.6987E-14 | 0.50000 | -5.2574E-4 |
| 2180.0 | 0.50051 | 0.50000 | -4.8641E-14 | 0.50000 | -5.1356E-4 |
| 2190.0 | 0.50050 | 0.50000 | -4.0295E-14 | 0.50000 | -5.0137E-4 |
| 2200.0 | 0.50049 | 0.50000 | -3.1948E-14 | 0.50000 | -4.8919E-4 |
| 2210.0 | 0.50048 | 0.50000 | -2.3602E-14 | 0.50000 | -4.7709E-4 |
| 2220.0 | 0.50047 | 0.50000 | -1.5256E-14 | 0.50000 | -4.6555E-4 |
| 2230.0 | 0.50045 | 0.50000 | -6.9094E-15 | 0.50000 | -4.5402E-4 |
| 2240.0 | 0.50071 | 0.50000 | -4.4006E-16 | 0.50000 | -7.1098E-4 |
| 2250.0 | 0.49975 | 0.37500 | -1.3430E-4 | 0.62500 | -0.12475 |
| 2260.0 | 0.49088 | 0.25000 | -2.7189E-4 | 0.75000 | -0.24088 |
| 2270.0 | 0.43324 | 0.25000 | -2.1781E-4 | 0.75000 | -0.18324 |
| 2280.0 | 0.35945 | 0.25000 | -1.4696E-4 | 0.75000 | -0.10945 |
| 2290.0 | 0.29543 | 0.25000 | -8.7014E-5 | 0.75000 | -0.045432 |
| 2300.0 | 0.25597 | 0.25000 | -4.8284E-5 | 0.75000 | -0.0059660 |
| 2310.0 | 0.23783 | 0.25000 | -2.9592E-5 | 0.75000 | 0.012172 |
| 2320.0 | 0.23281 | 0.25000 | -2.4260E-5 | 0.75000 | 0.017190 |
| 2330.0 | 0.23499 | 0.25000 | -2.5803E-5 | 0.75000 | 0.015006 |
| 2340.0 | 0.23816 | 0.25000 | -2.9523E-5 | 0.75000 | 0.011840 |
| 2350.0 | 0.24089 | 0.25000 | -3.2930E-5 | 0.75000 | 0.0091132 |
| 2360.0 | 0.24272 | 0.25000 | -3.5171E-5 | 0.75000 | 0.0072847 |
| 2370.0 | 0.24364 | 0.25000 | -3.6314E-5 | 0.75000 | 0.0063559 |
| 2380.0 | 0.24400 | 0.25000 | -3.6898E-5 | 0.75000 | 0.0059997 |
| 2390.0 | 0.24425 | 0.25000 | -3.7014E-5 | 0.75000 | 0.0057531 |
| 2400.0 | 0.24433 | 0.25000 | -3.6832E-5 | 0.75000 | 0.0056742 |
| 2410.0 | 0.24442 | 0.25000 | -3.6617E-5 | 0.75000 | 0.0055753 |
| 2420.0 | 0.24455 | 0.25000 | -3.6439E-5 | 0.75000 | 0.0054455 |
| 2430.0 | 0.24468 | 0.25000 | -3.6333E-5 | 0.75000 | 0.0053158 |
| 2440.0 | 0.24481 | 0.25000 | -3.6228E-5 | 0.75000 | 0.0051860 |
| 2450.0 | 0.24495 | 0.25000 | -3.6179E-5 | 0.75000 | 0.0050518 |
| 2460.0 | 0.24509 | 0.25000 | -3.6153E-5 | 0.75000 | 0.0049105 |
| 2470.0 | 0.24523 | 0.25000 | -3.6126E-5 | 0.75000 | 0.0047692 |
| 2480.0 | 0.24537 | 0.25000 | -3.6122E-5 | 0.75000 | 0.0046279 |
| 2490.0 | 0.24551 | 0.25000 | -3.6121E-5 | 0.75000 | 0.0044867 |
| 2500.0 | 0.24565 | 0.25000 | -3.6121E-5 | 0.75000 | 0.0043454 |
| 2510.0 | 0.24580 | 0.25000 | -3.6121E-5 | 0.75000 | 0.0042041 |
| 2520.0 | 0.24594 | 0.25000 | -3.6120E-5 | 0.75000 | 0.0040628 |
| 2530.0 | 0.24606 | 0.25000 | -3.6120E-5 | 0.75000 | 0.0039403 |
| 2540.0 | 0.24615 | 0.25000 | -3.6121E-5 | 0.75000 | 0.0038486 |
| 2550.0 | 0.24624 | 0.25000 | -3.6122E-5 | 0.75000 | 0.0037569 |
| 2560.0 | 0.24633 | 0.25000 | -3.6122E-5 | 0.75000 | 0.0036652 |
| 2570.0 | 0.24643 | 0.25000 | -3.6123E-5 | 0.75000 | 0.0035735 |
| 2580.0 | 0.24652 | 0.25000 | -3.6124E-5 | 0.75000 | 0.0034818 |
| 2590.0 | 0.24661 | 0.25000 | -3.6124E-5 | 0.75000 | 0.0033901 |
| 2600.0 | 0.24670 | 0.25000 | -3.6125E-5 | 0.75000 | 0.0032984 |
| 2610.0 | 0.24679 | 0.25000 | -3.6126E-5 | 0.75000 | 0.0032067 |
| 2620.0 | 0.24688 | 0.25000 | -3.6126E-5 | 0.75000 | 0.0031150 |
| 2630.0 | 0.24698 | 0.25000 | -3.6127E-5 | 0.75000 | 0.0030233 |
| 2640.0 | 0.24707 | 0.25000 | -3.6128E-5 | 0.75000 | 0.0029316 |
| 2650.0 | 0.24716 | 0.25000 | -3.6128E-5 | 0.75000 | 0.0028399 |
| 2660.0 | 0.24725 | 0.25000 | -3.6128E-5 | 0.75000 | 0.0027482 |
| 2670.0 | 0.24734 | 0.25000 | -3.6128E-5 | 0.75000 | 0.0026565 |
| 2680.0 | 0.24744 | 0.25000 | -3.6128E-5 | 0.75000 | 0.0025649 |
| 2690.0 | 0.24751 | 0.25000 | -3.6128E-5 | 0.75000 | 0.0024853 |
| 2700.0 | 0.24757 | 0.25000 | -3.6128E-5 | 0.75000 | 0.0024276 |
| 2710.0 | 0.24763 | 0.25000 | -3.6128E-5 | 0.75000 | 0.0023699 |
| 2720.0 | 0.24769 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0023121 |
| 2730.0 | 0.24775 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0022544 |
| 2740.0 | 0.24780 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0021966 |
| 2750.0 | 0.24786 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0021389 |
| 2760.0 | 0.24792 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0020811 |
| 2770.0 | 0.24798 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0020234 |
| 2780.0 | 0.24803 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0019656 |
| 2790.0 | 0.24809 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0019079 |
| 2800.0 | 0.24815 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0018502 |
| 2810.0 | 0.24821 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0017924 |
| 2820.0 | 0.24827 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0017347 |
| 2830.0 | 0.24832 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0016769 |
| 2840.0 | 0.24838 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0016192 |
| 2850.0 | 0.24843 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0015717 |
| 2860.0 | 0.24846 | 0.25000 | -3.6129E-5 | 0.75000 | 0.0015442 |
| 2870.0 | 0.24848 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0015166 |
| 2880.0 | 0.24851 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0014891 |
| 2890.0 | 0.24854 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0014616 |
| 2900.0 | 0.24857 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0014340 |
| 2910.0 | 0.24859 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0014065 |
| 2920.0 | 0.24862 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0013790 |
| 2930.0 | 0.24865 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0013514 |
| 2940.0 | 0.24868 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0013239 |
| 2950.0 | 0.24870 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0012964 |
| 2960.0 | 0.24873 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0012689 |
| 2970.0 | 0.24876 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0012413 |
| 2980.0 | 0.24879 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0012138 |
| 2990.0 | 0.24881 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0011863 |
| 3000.0 | 0.24884 | 0.25000 | -3.6130E-5 | 0.75000 | 0.0011587 |

* 1. Plot Groups
     1. Velocity (spf)



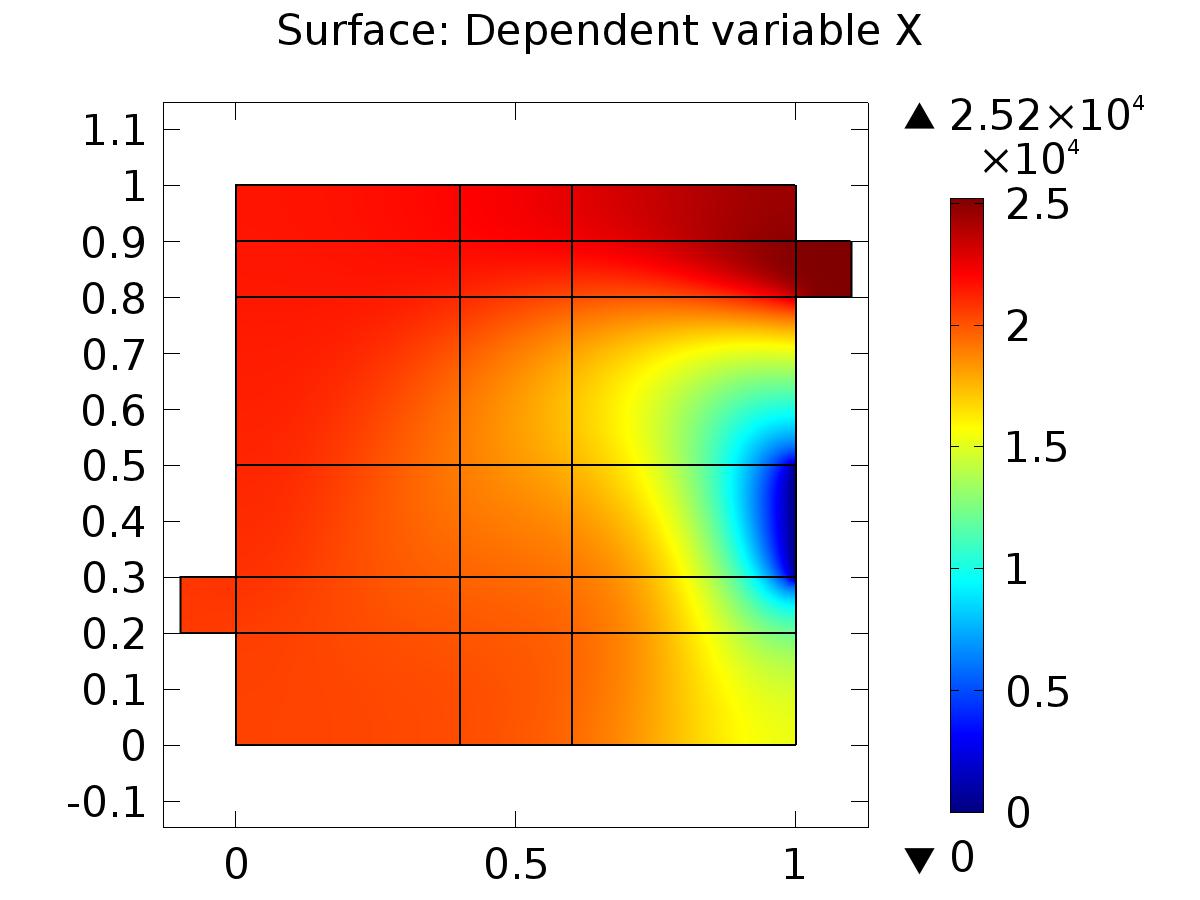
Surface: Velocity magnitude

* + 1. Pressure (spf)



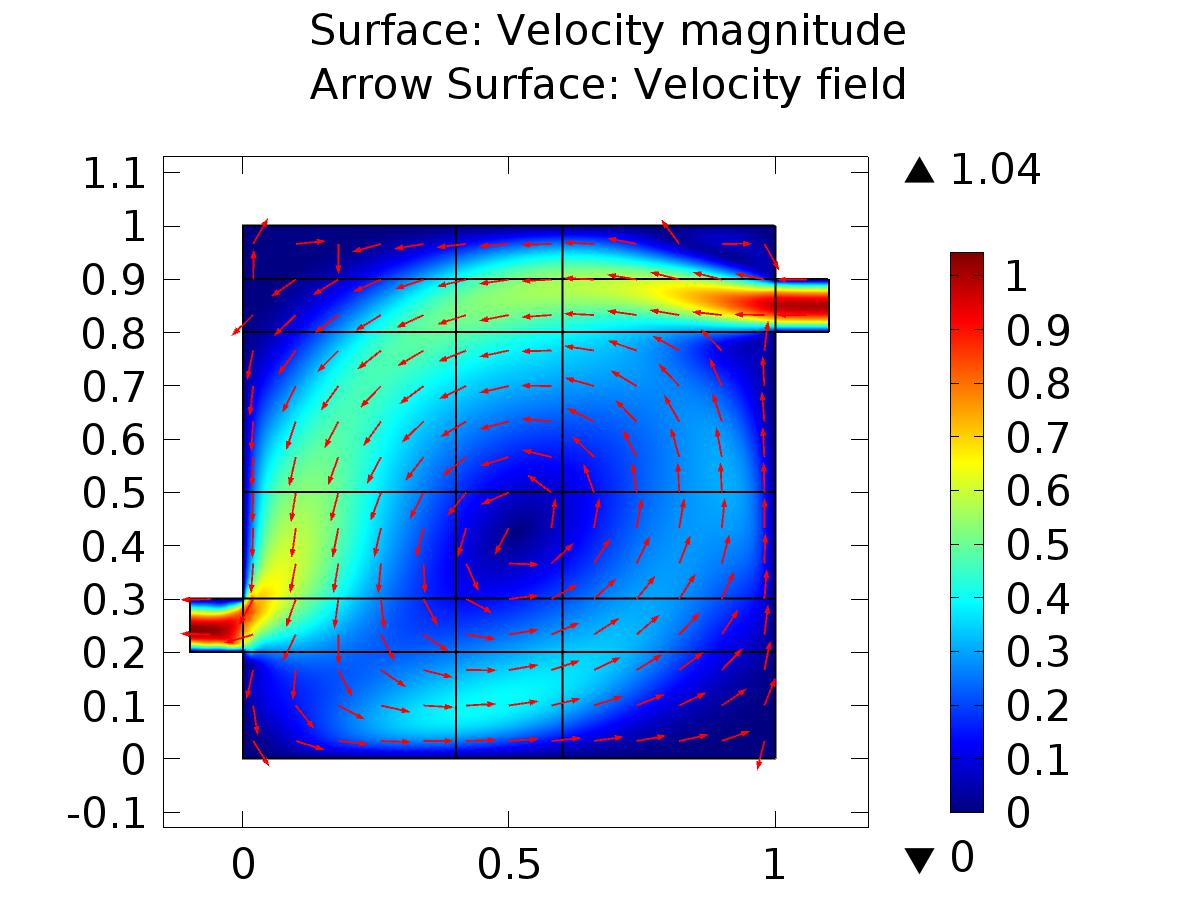
Contour: P

* + 1. 2D Plot Group 3



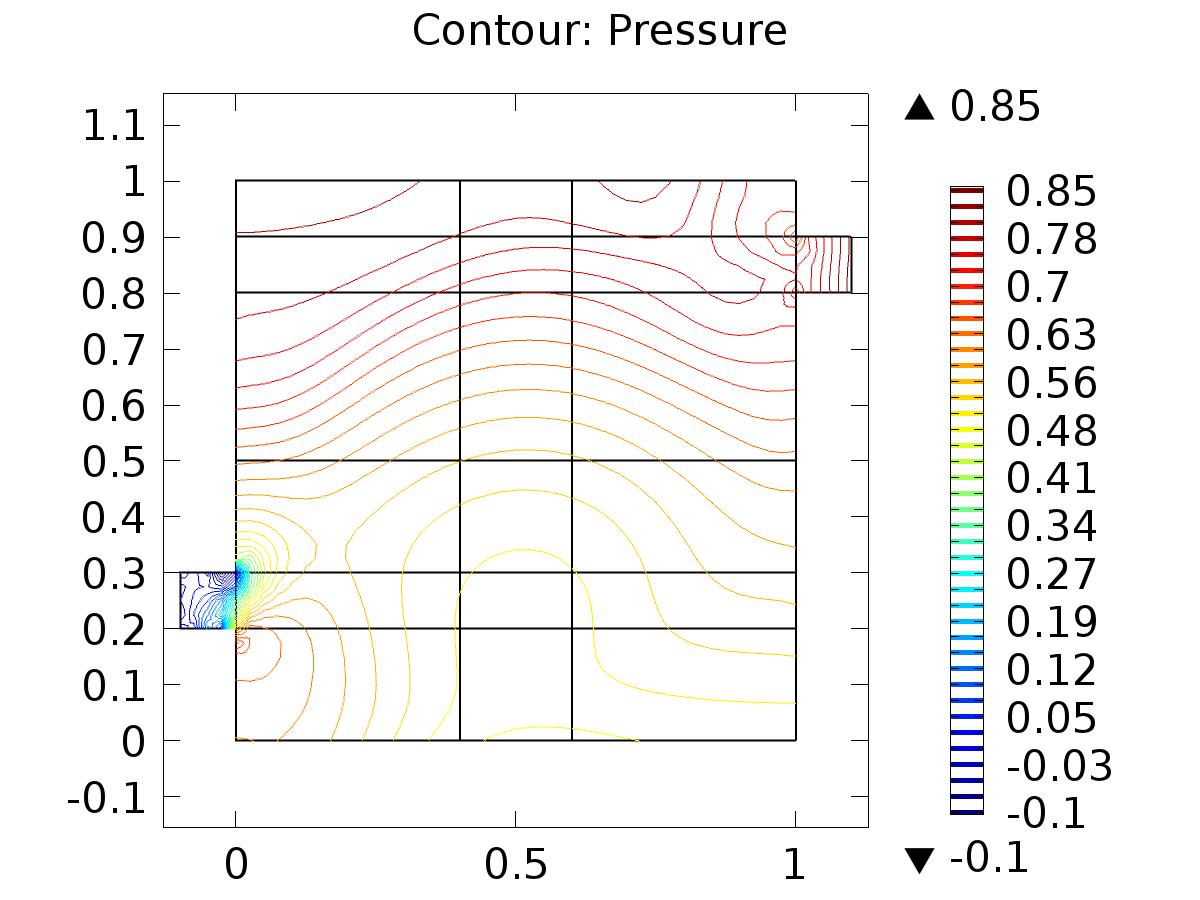
Surface: Dependent variable X

* + 1. Velocity (phys1)



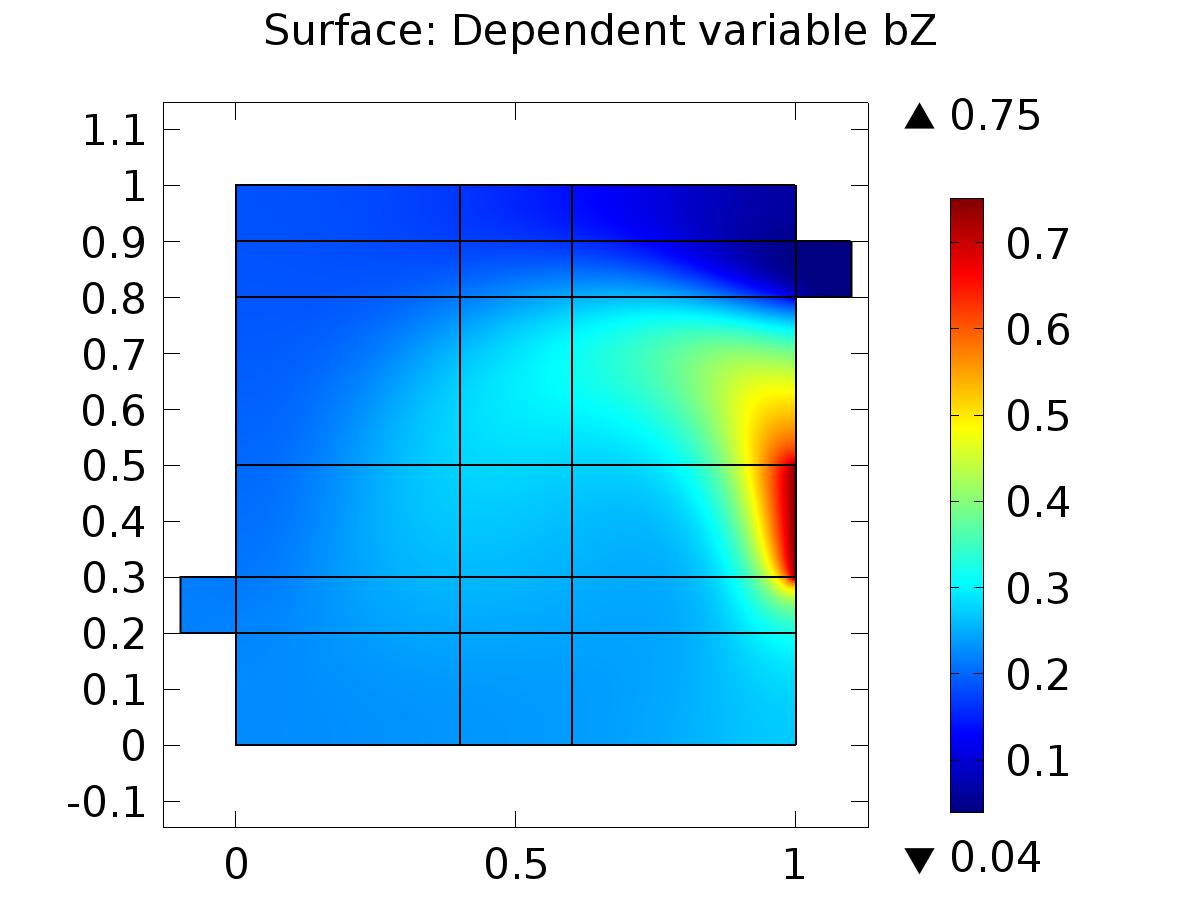
Surface: Velocity magnitude Arrow Surface: Velocity field

* + 1. Pressure (phys1)



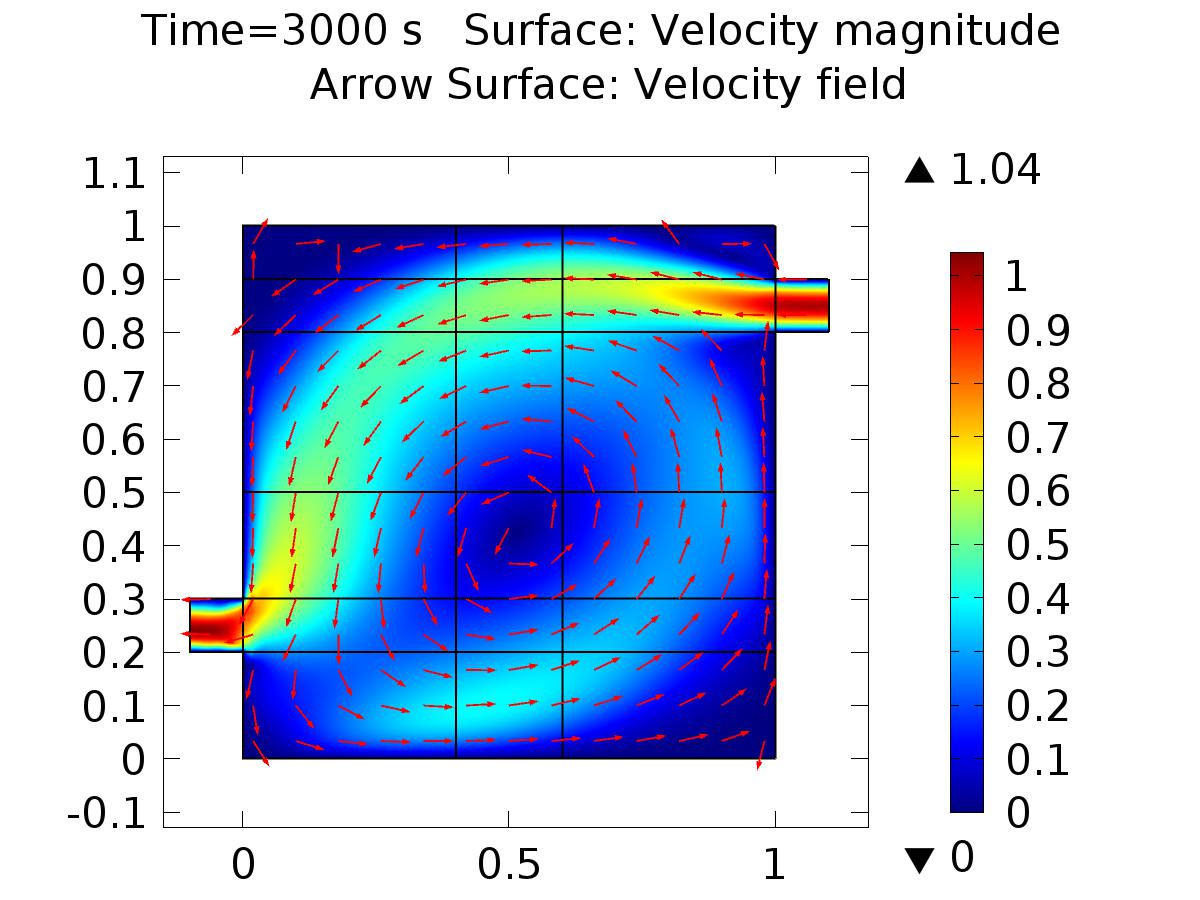
Contour: Pressure

* + 1. 2D Plot Group 6



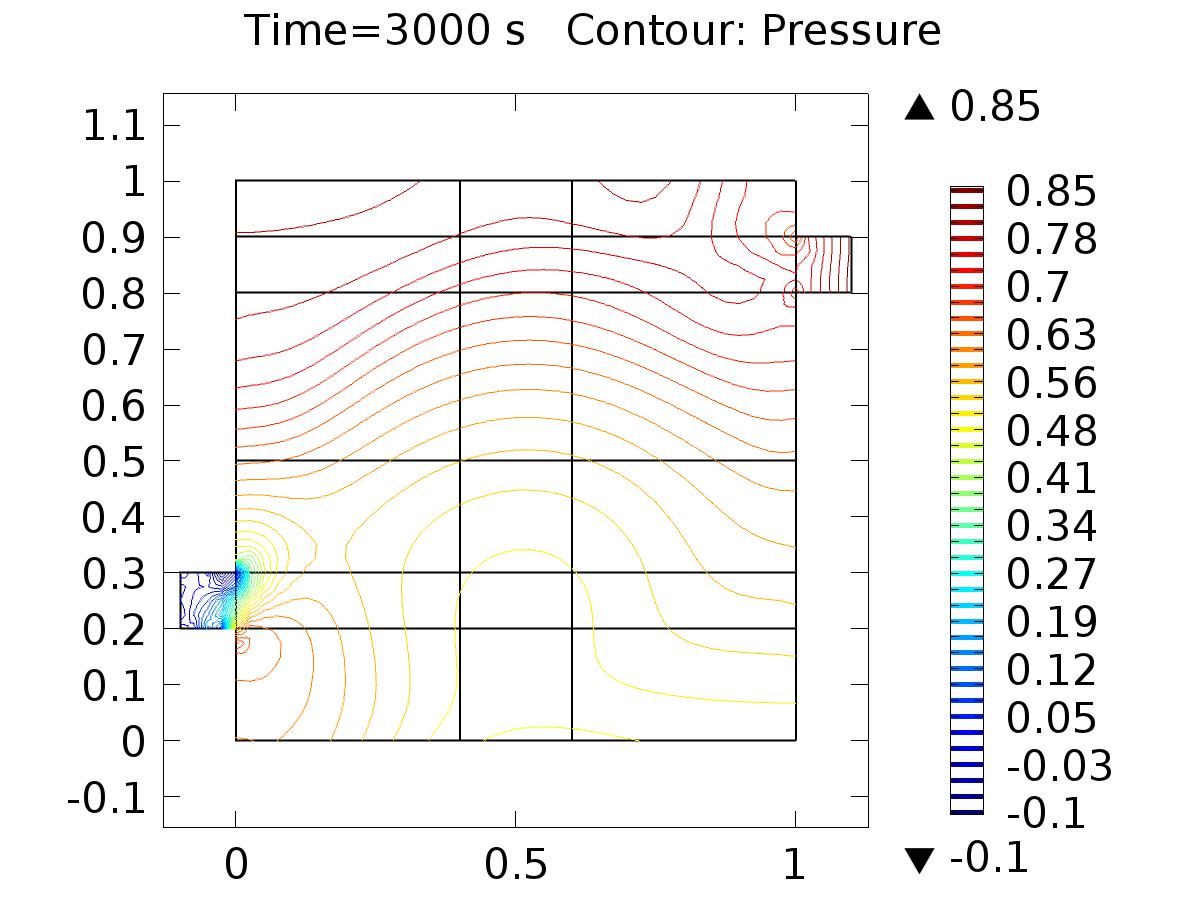
Surface: Dependent variable bZ

* + 1. Velocity (phys3)



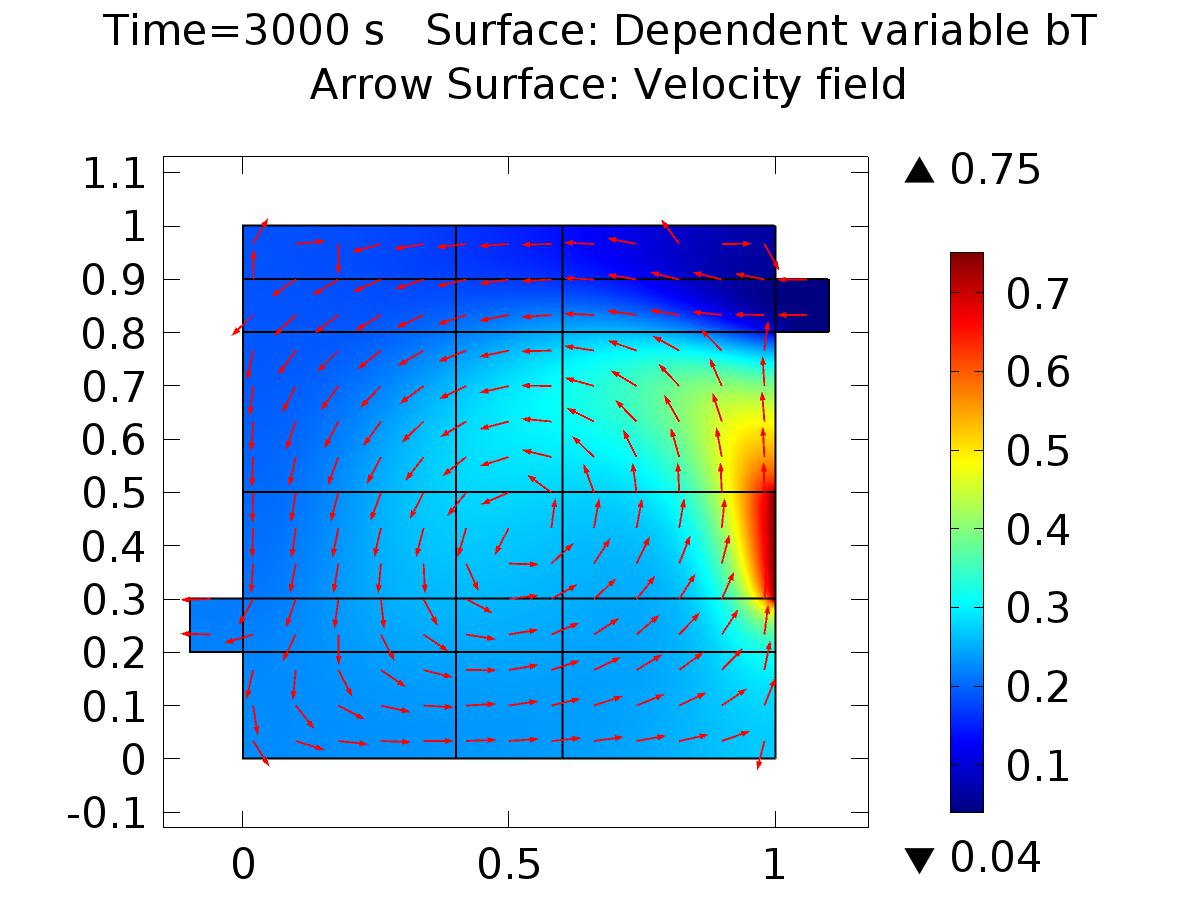
Time=3000 s Surface: Velocity magnitude Arrow Surface: Velocity field

* + 1. Pressure (phys3)



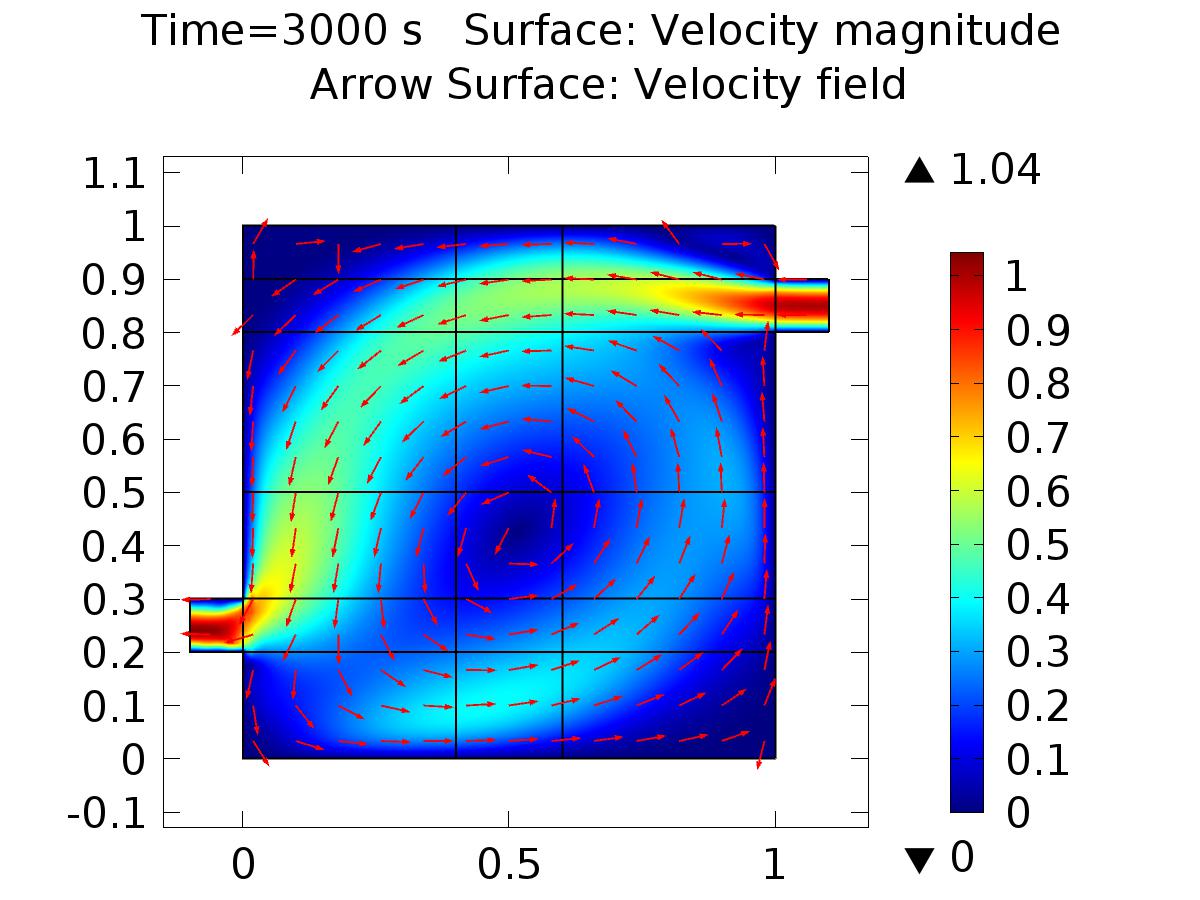
Time=3000 s Contour: Pressure

* + 1. 2D Plot Group 9



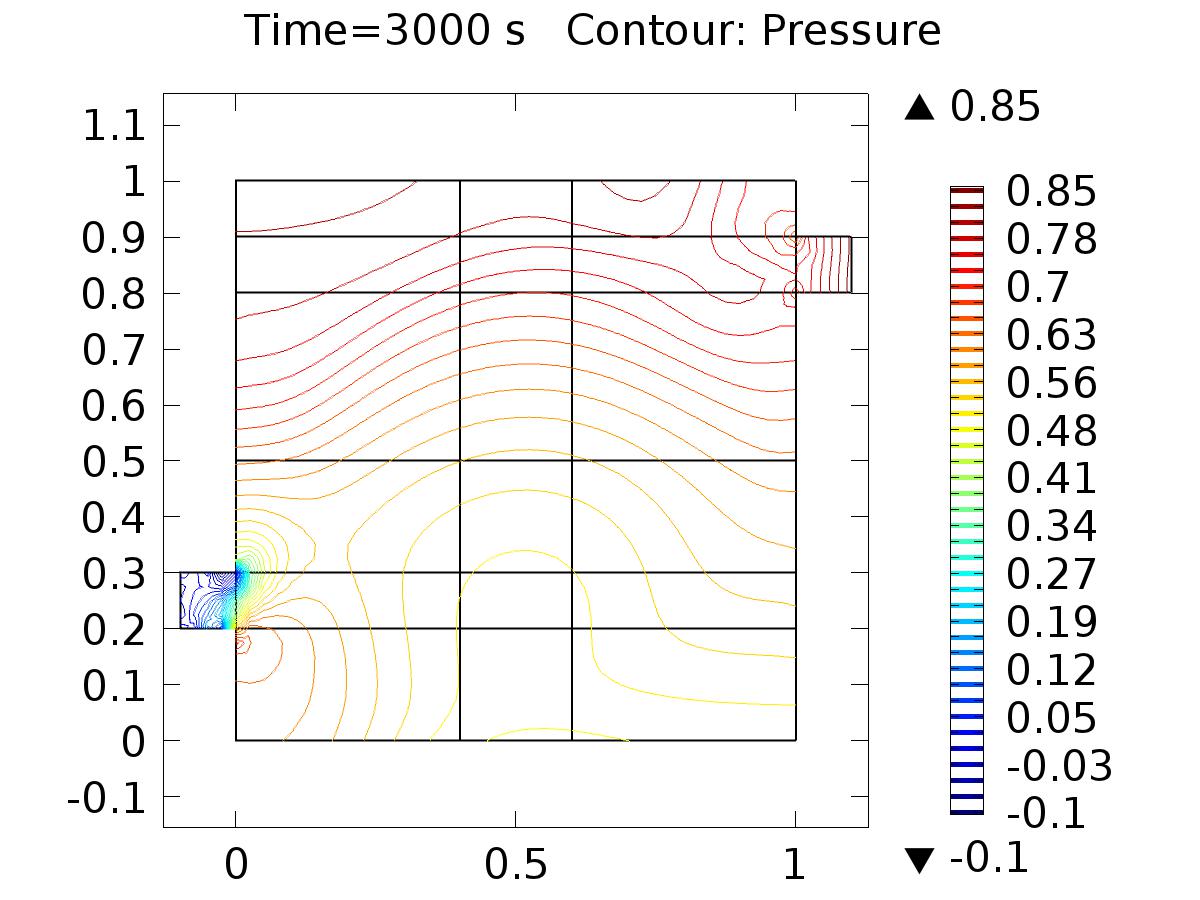
Time=3000 s Surface: Dependent variable bT Arrow Surface: Velocity field

* + 1. Velocity (phys5)



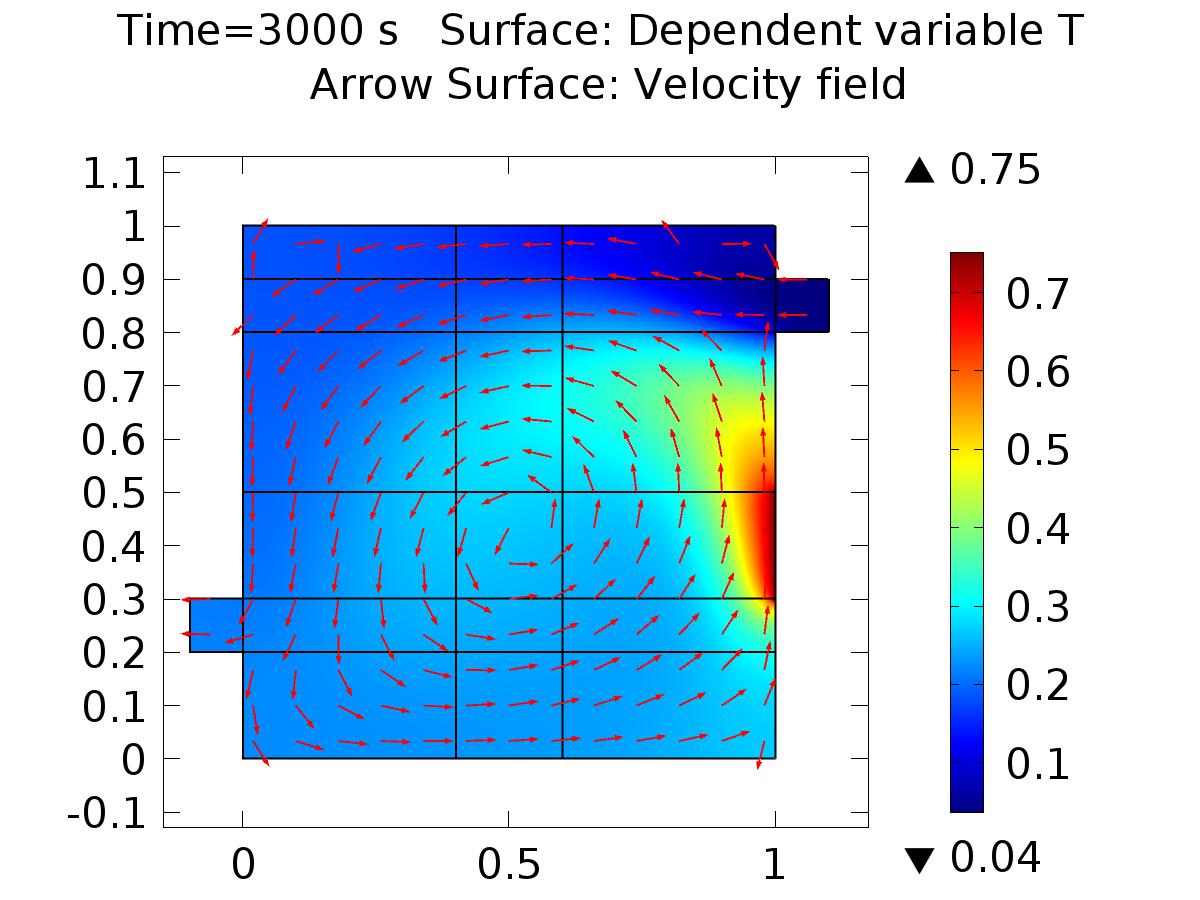
Time=3000 s Surface: Velocity magnitude Arrow Surface: Velocity field

* + 1. Pressure (phys5)



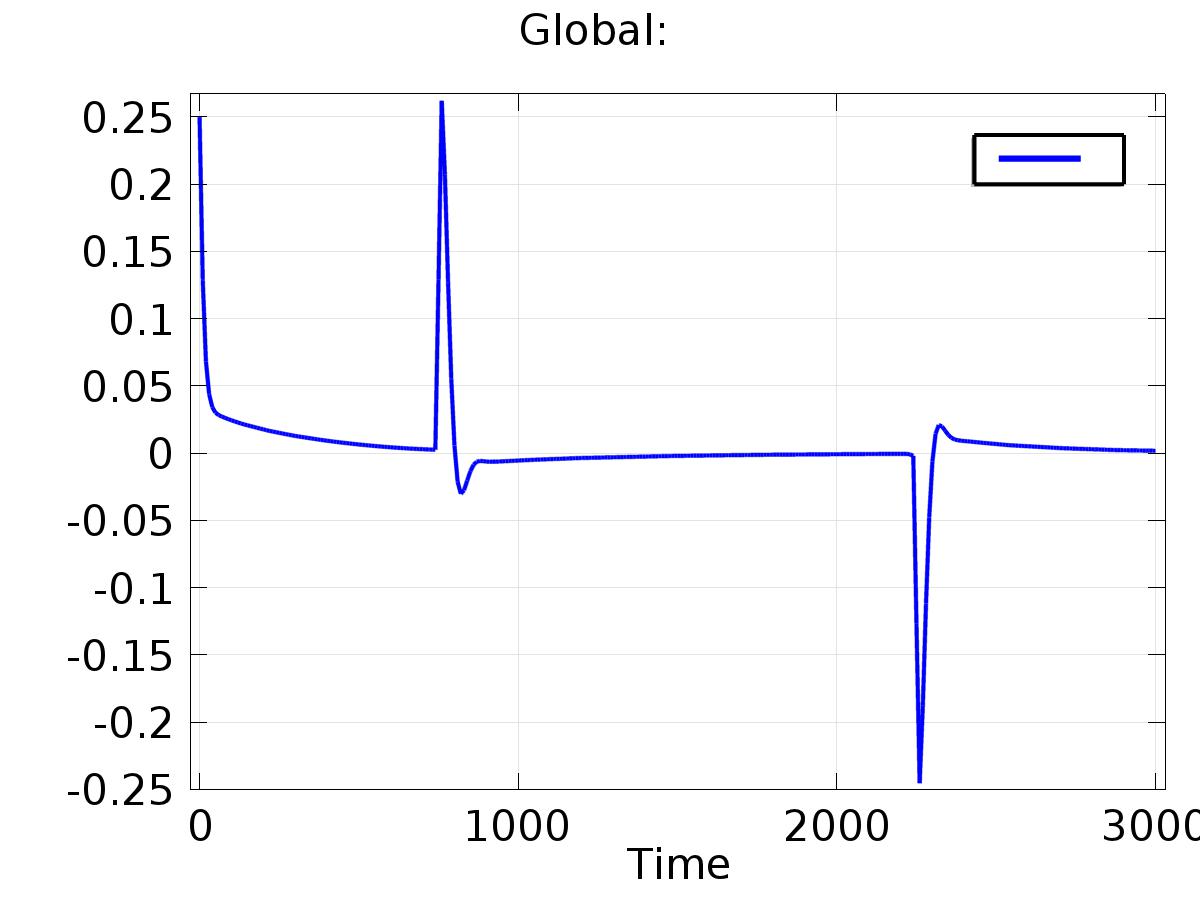
Time=3000 s Contour: Pressure

* + 1. 2D Plot Group 14



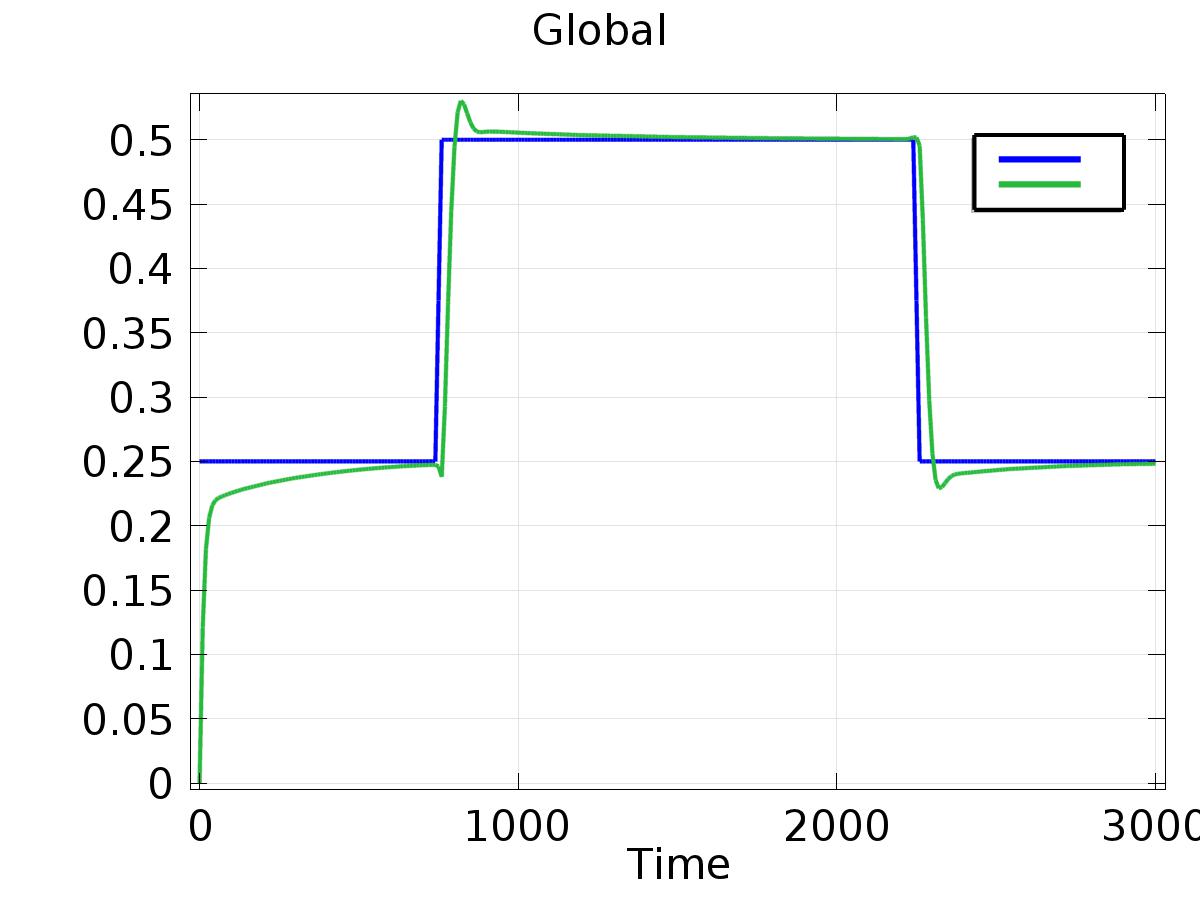
Time=3000 s Surface: Dependent variable T Arrow Surface: Velocity field

* + 1. 1D Plot Group 10



Global:

* + 1. 1D Plot Group 11



Global