Regions and Events



CONVERGE Studio Workflow

- Case Setup module
 - Begin a project
 - Import the surface geometry
 - o Prepare the surface
 - Configure case setup
 - Boundary conditions and region definitions
 - Initialization
 - Grid control
 - Physical models (turbulence, spray, combustion, sources, CHT, VOF, etc.)
 - Advanced options
 - Export input and data files to the Case Directory

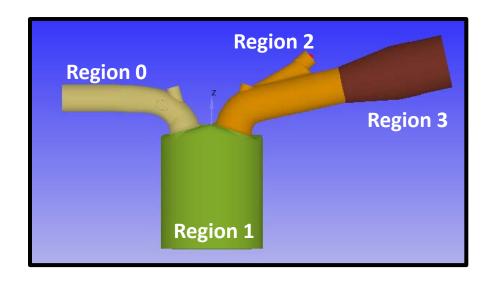
------Run CONVERGE simulation-----

- *Line Plotting* module
- Post-Processing 3D module



Introduction to Regions

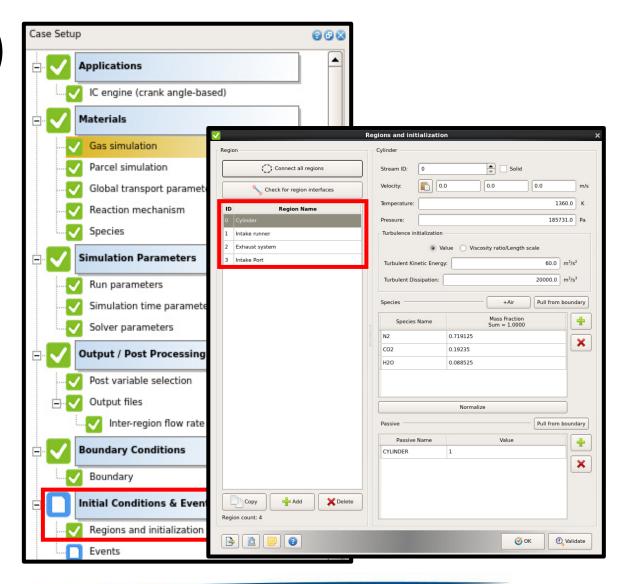
- A region is a volume bounded by boundaries
 - Delineate different areas in a geometry (e.g., Intake Port)
- Regions are useful for a variety of reasons
 - Specify initial conditions by region
 - Control flow between regions (via events)
 - Output results on a region-by-region basis
 - Apply grid control techniques by region
 - Map solutions by region
 - Specify combustion models by region
 - Use time-step determination through CFL numbers by region





Setting Up Regions (1/2)

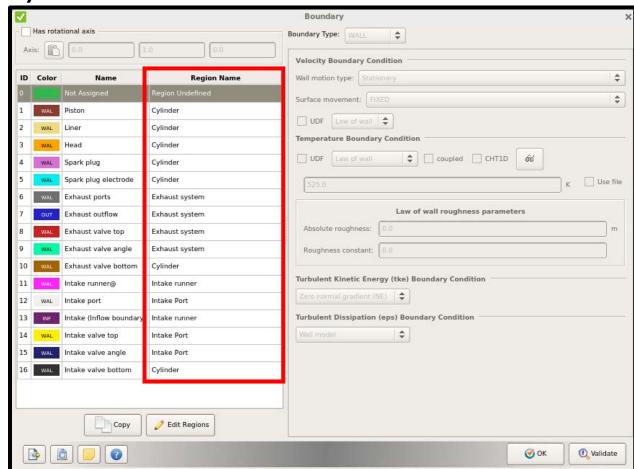
- To specify regions, you must first flag all boundaries
- Go to Case Setup > Initial Conditions
 & Events > Regions and initialization
 O Click Add to input a new region





Setting Up Regions (2/2)

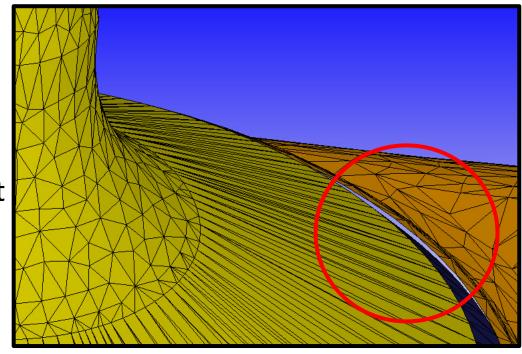
 Assign boundaries to regions
 Use the drop-down menu in the Region Name column under Case Setup > Boundary Conditions > Boundary





Disconnect Triangles (1/2)

- Recall during surface preparation that you set the valve to a minimum lift position
 - CONVERGE requires this position to avoid intersecting triangles, but in an actual engine, the port and valve touch
 - To close the valve and restrict flow, you must create disconnect triangles
- You do not create disconnect triangles in the surface geometry
 - CONVERGE adds and removes these triangles based on user-specified times ("events")





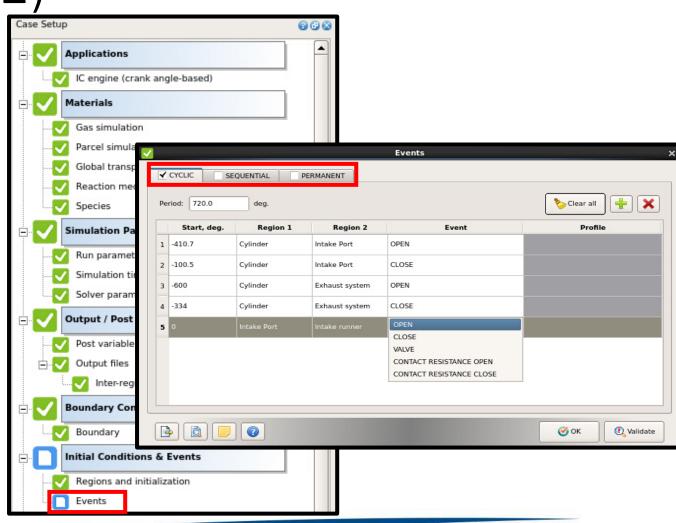
Disconnect Triangles (2/2)

- Single loop disconnect triangles are drawn at an edge that belongs to two boundaries in different regions
- Concentric circle disconnect triangles are drawn from one set of edges in one region to another set of edges in a different region
- When the disconnect triangles are activated (*i.e.*, when inter-region flow is stopped), the disconnect triangles have a symmetry boundary condition
 - Disconnect triangles are two-sided (i.e., fluid on either side)



Setting Up Events (1/2)

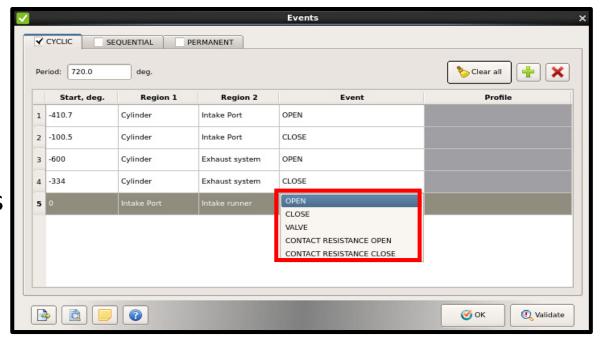
- You can set up events between regions
 - Go to Case Setup > InitialConditions > Events
- Specify the timing type as CYCLIC,
 SEQUENTIAL, and/or PERMANENT
- The events do not have to be listed in chronological order
- There must be at least one event for each pair of adjacent regions





Setting Up Events (2/2)

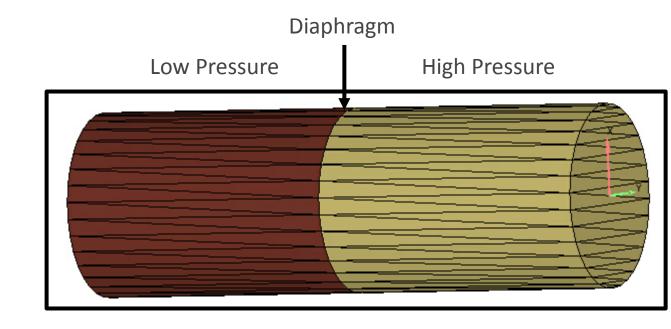
- OPEN: Allows flow between regions (*i.e.*, removes disconnect triangles)
- CLOSE: Restricts flow between regions (*i.e.*, adds disconnect triangles)
- VALVE: Removes or adds disconnect triangles based on user-provided valve lift profile
- CR OPEN: Allows flow through the Contact Resistance region
- CR CLOSE: Restricts flow through the Contact Resistance region





Disconnect Triangle for a Single Loop (1/2)

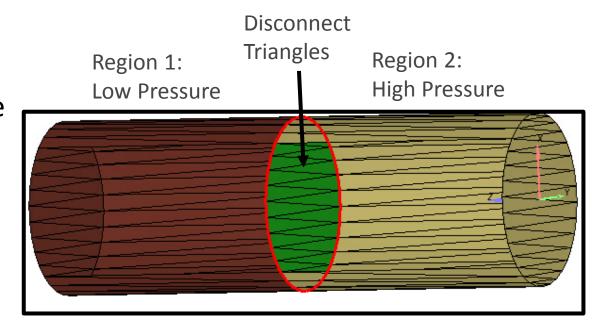
- Consider a shock tube
 - Initially high and low pressure areas are separated by a diaphragm
 - After some time, the diaphragm ruptures due to the pressure differential
- Regions can be used to set up the different pressures in the shock tube
- Events can be used to simulate the diaphragm rupture





Disconnect Triangle for a Single Loop (2/2)

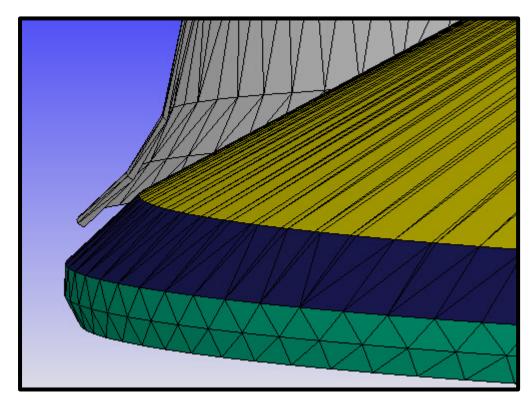
- CONVERGE automatically creates a loop of disconnect triangles between the two regions
- This is called a single loop disconnection (i.e., a circular disconnection surface at the region intersection)
- Set up an OPEN event to remove the triangles when the diaphragm breaks
 Event timing should be SEQUENTIAL





Disconnect Triangles for Two Concentric Loops (1/2)

- In an IC engine, CONVERGE uses concentric circle disconnection to control the flow between the cylinder and the port regions
 - A CLOSE event activates the disconnect triangles
 - An OPEN event deactivates the disconnect triangles When the valve opens, set the disconnect triangles to OPEN





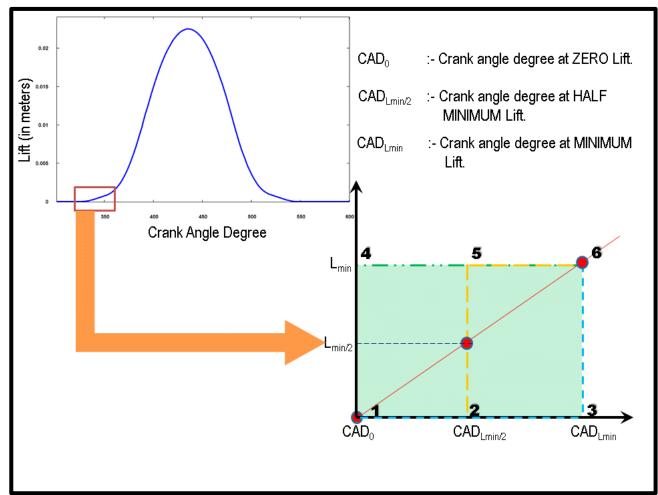
Disconnect Triangles for Two Concentric Loops (2/2)

- To model a full engine cycle, set up individual events for the valves
 - Set CLOSE events for intake valve closing (IVC) and exhaust valve closing (EVC)
 - Set OPEN events for intake valve opening (IVO) and exhaust valve opening (EVO)
- Set a CYCLIC timing type and a cycle period
 - The simulation time does not have to encompass the events timing (e.g., the simulation time can be from -360 to 360 CAD, but the events can be from 720 to 1440 CAD)



Valve Event Timings in IC Engines

- We recommend setting the valve to a minimum lift value of 0.2 mm
- Specify an OPEN event about halfway before the minimum lift position (i.e., 0.1 mm) and a CLOSE event about halfway after the minimum lift position





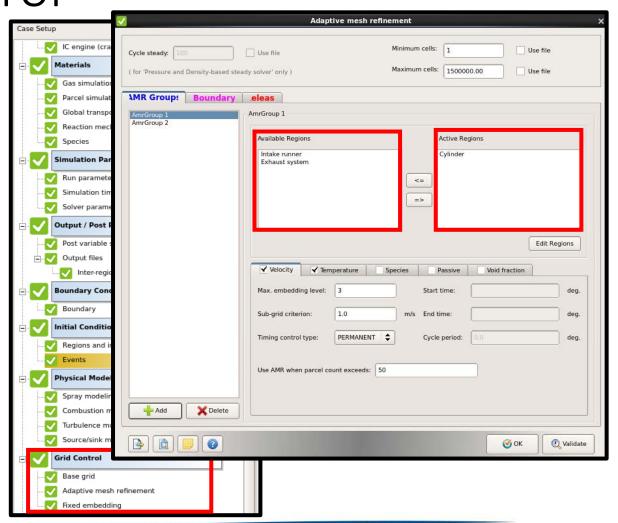
Region-Based Output

- When more than one region is present, CONVERGE generates output files for the entire domain and each specific region
- These output files are useful when you wish to plot quantities such as cylinder pressure and temperature
- For a case with two regions, three thermodynamic output files will be generated
 - o thermo.out (entire domain)
 - o thermo_region0.out (Region 0)
 - o thermo_region1.out (Region 1)



Region-Based Grid Control

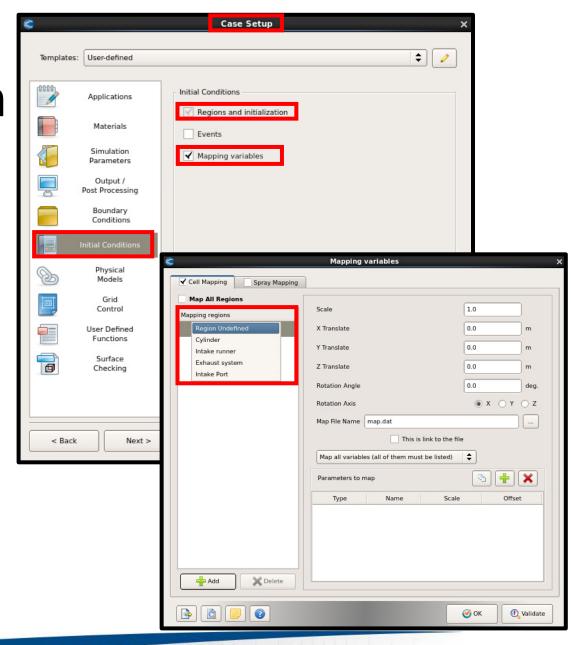
- You can apply different grid control strategies on a region-byregion basis
- To set up grid control strategies, go to Case Setup > Grid Control
- For example, you can refine the grid in the cylinder region without affecting the grid in the other regions





Region-Based Initialization

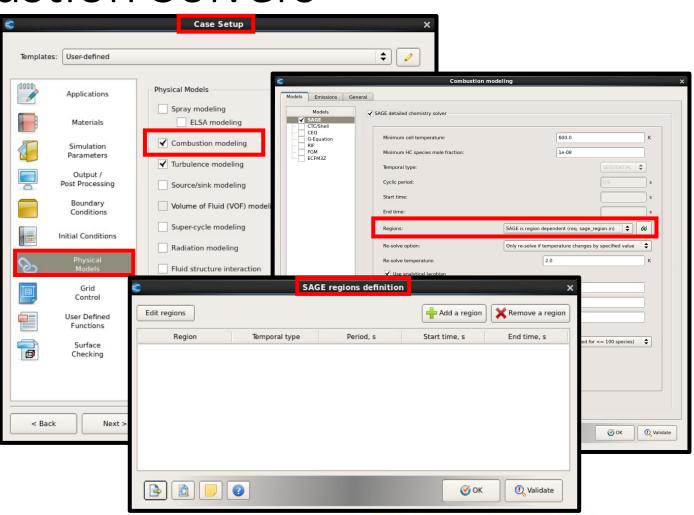
- You can initialize each region separately
 - To initialize regions, go to Case Setup >
 Initial Conditions > Regions and
 initialization
- You can also initialize regions via mapping
 - To set up mapping, go to Case Setup >
 Initial Conditions > Mapping variables





Region-Based Combustion Solvers

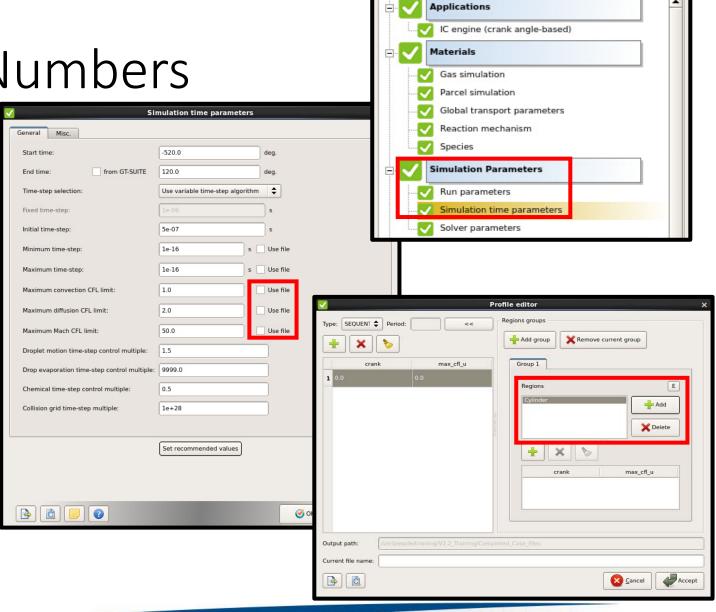
- You can set the following combustion solvers on a regionby-region basis
 - SAGE detailed chemistry
 - o CTC/Shell
 - o G-Equation
 - o ECFM/ECFM3Z





Region-Based CFL Numbers

- You can set up CFL number restrictions on a region-byregion basis
 - Go to Case Setup >
 Simulation Parameters >
 Simulation time
 parameters
 - Check the <u>Use file</u> box next to the CFL limit



Case Setup



THANK YOU! CONVERGECFD.COM







