

Surface Preparation Tools for Engine Sector Simulations



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CONVERGE Studio Workflow

- **Case Setup module**

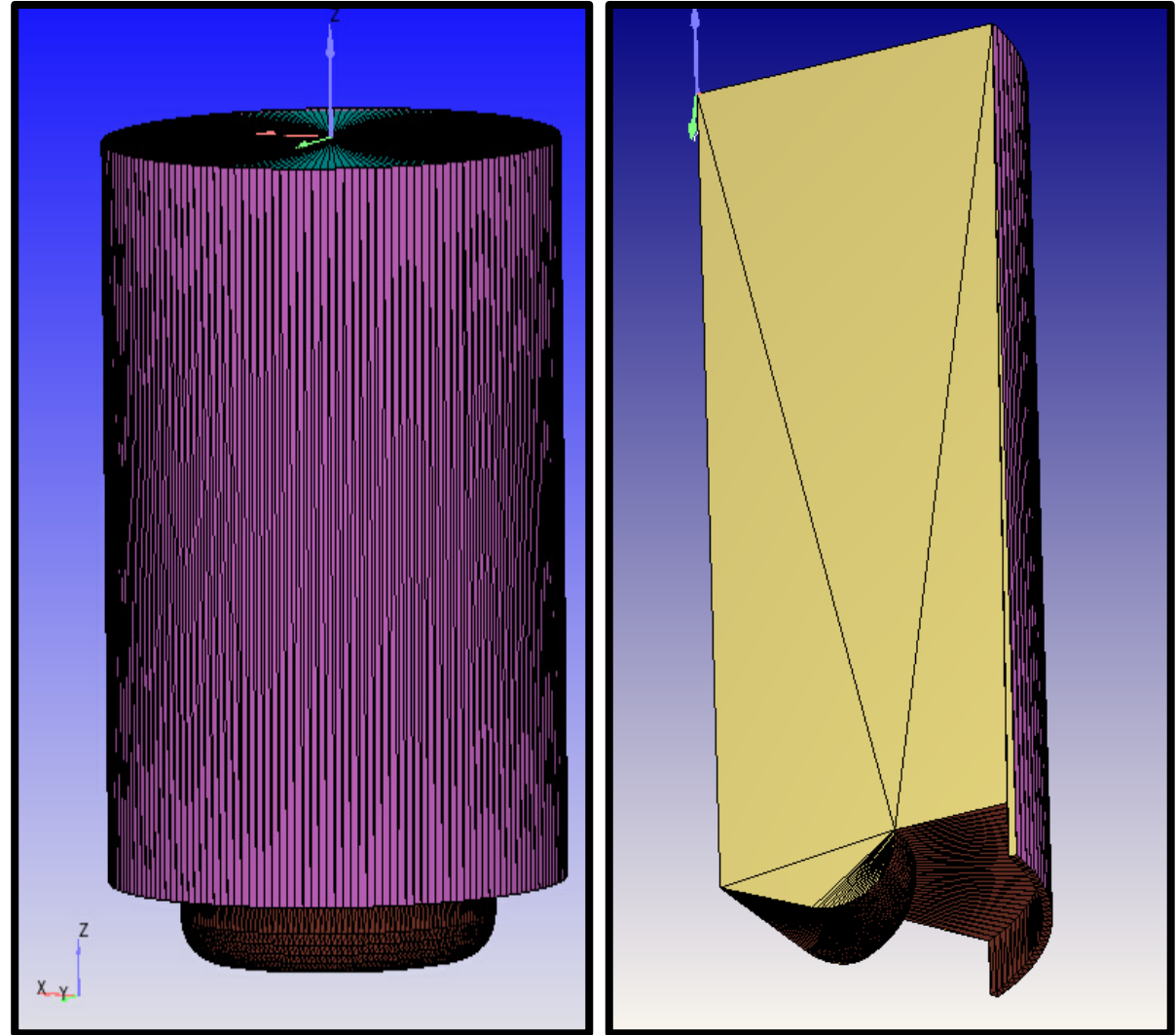
- Begin a project
- Import the surface geometry
- Prepare the surface
 - **Prepare engine sector using *Make surface* tool**
 - Prepare piston and valves for motion
- Configure case setup
- Export input and data files to the Case Directory

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

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

Motivation

- For an axisymmetric cylinder, you can reduce computational time by simulating an engine sector
- The *Make surface* tool in CONVERGE Studio automatically generates the surface geometry for an engine sector

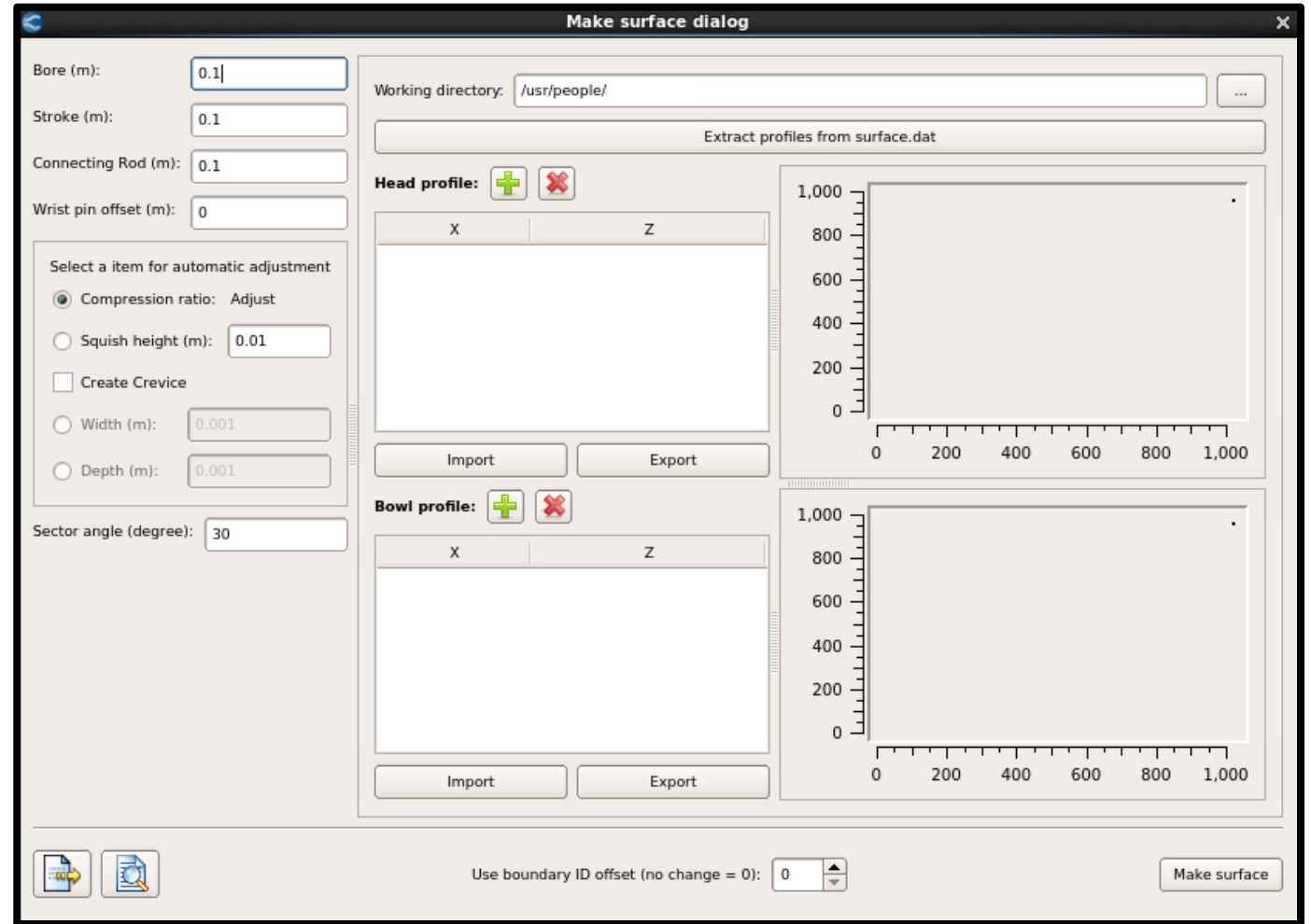
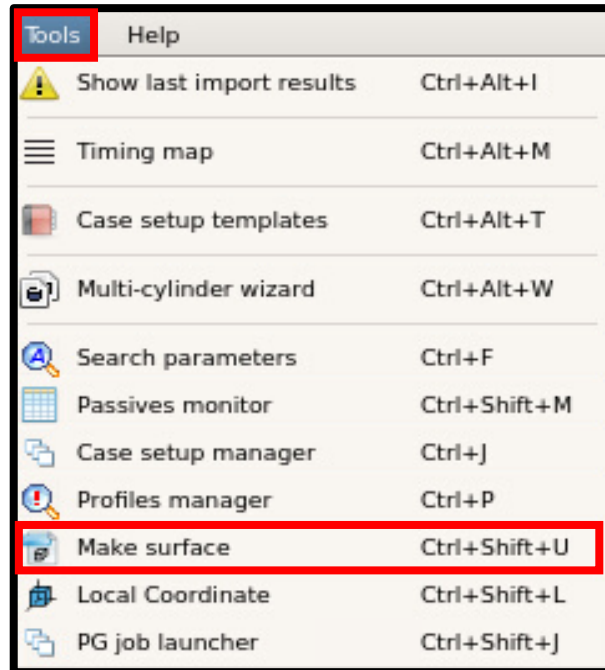


Advantages of *Make surface*

- Although you can create a sector without using the *Make surface* tool, there are several advantages to using this tool
 - Automatically generates *surface.dat* file
 - Creates a defect-free sector geometry
 - Automatically flags the liner, piston, and head boundaries
 - Automatically flags periodic boundaries
 - Perfectly matches the periodic faces in the sector and centers the geometry symmetrically around the xz plane (as required by CONVERGE)
 - Provides the correct compression ratio

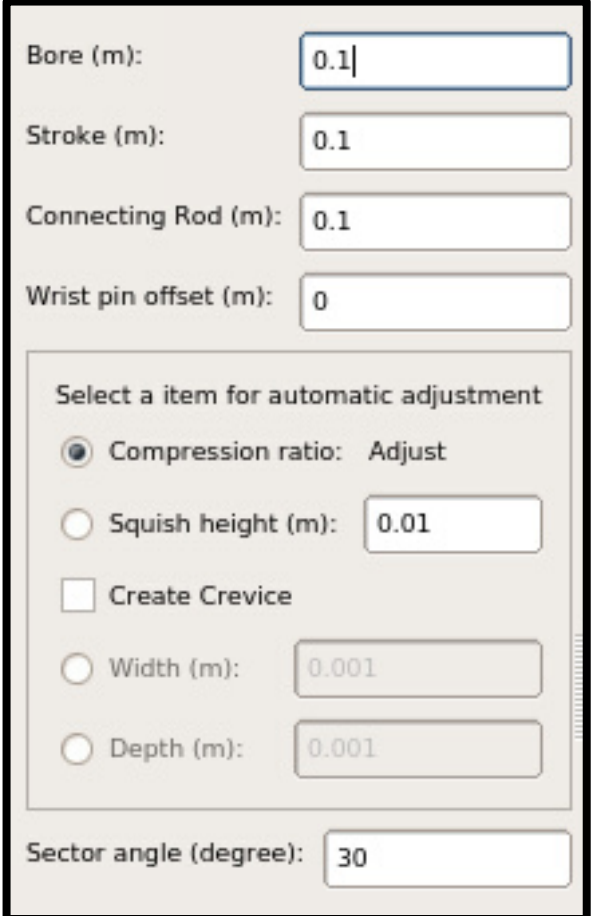
How to Access the *Make surface* Tool

- In CONVERGE Studio, go to *Tools > Make surface*



Inputs Required for *Make surface*

- Specify the following parameters
 - Bore
 - Stroke
 - Connecting Rod
 - Wrist pin offset
 - Compression ratio or squish height
 - Crevice dimensions (optional)
 - Sector angle

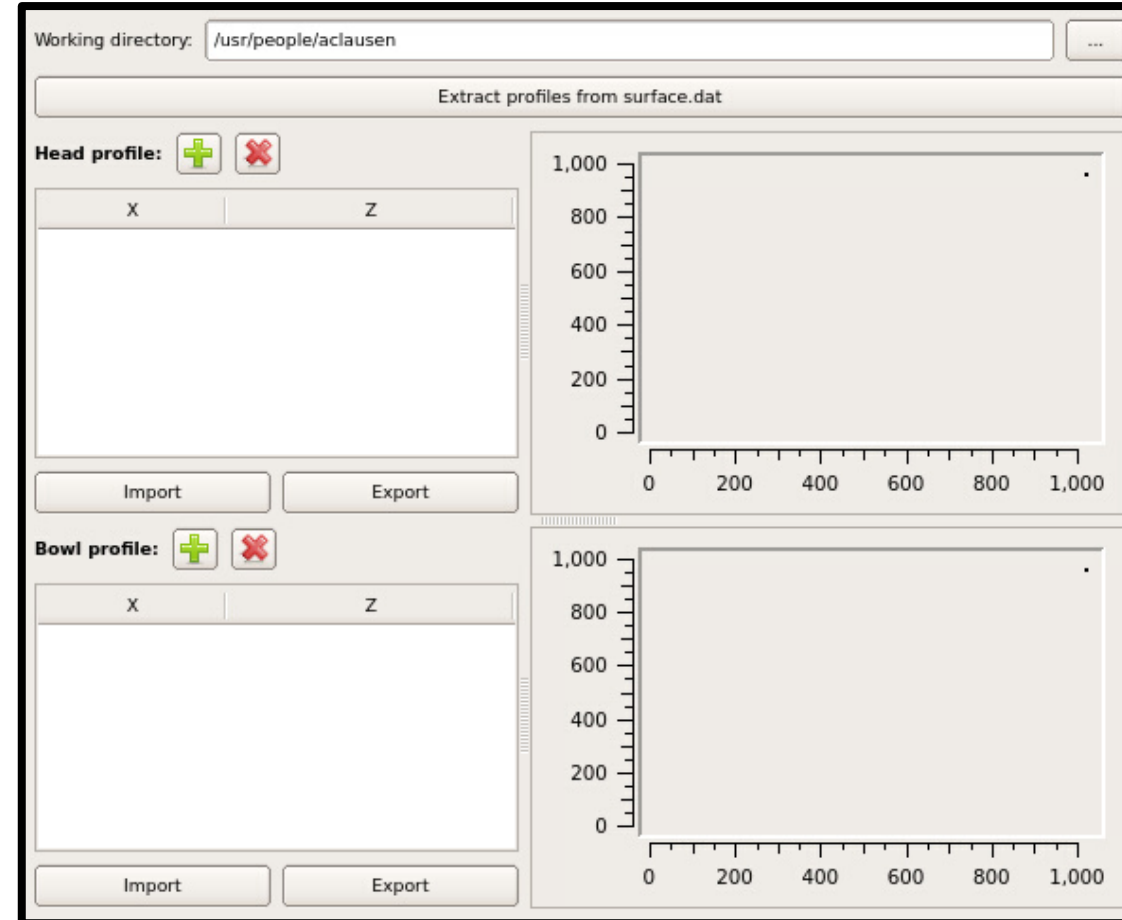


The screenshot shows a software dialog box titled "Make surface" with the following inputs:

- Bore (m): 0.1
- Stroke (m): 0.1
- Connecting Rod (m): 0.1
- Wrist pin offset (m): 0
- Select a item for automatic adjustment:
 - ☒ Compression ratio: Adjust
 - ☐ Squish height (m): 0.01
 - ☐ Create Crevice
 - ☐ Width (m): 0.001
 - ☐ Depth (m): 0.001
- Sector angle (degree): 30

Head and Bowl Profiles

- You can provide a head profile, a bowl profile, both, or neither
 - If a profile is absent, then *Make surface* will assume a flat profile
- The profiles contain x and z coordinates
 - The x coordinates are absolute in the radial direction
 - The z coordinates are relative in the axial direction
 - The *Make surface* tool adjusts these values based on stroke and squish

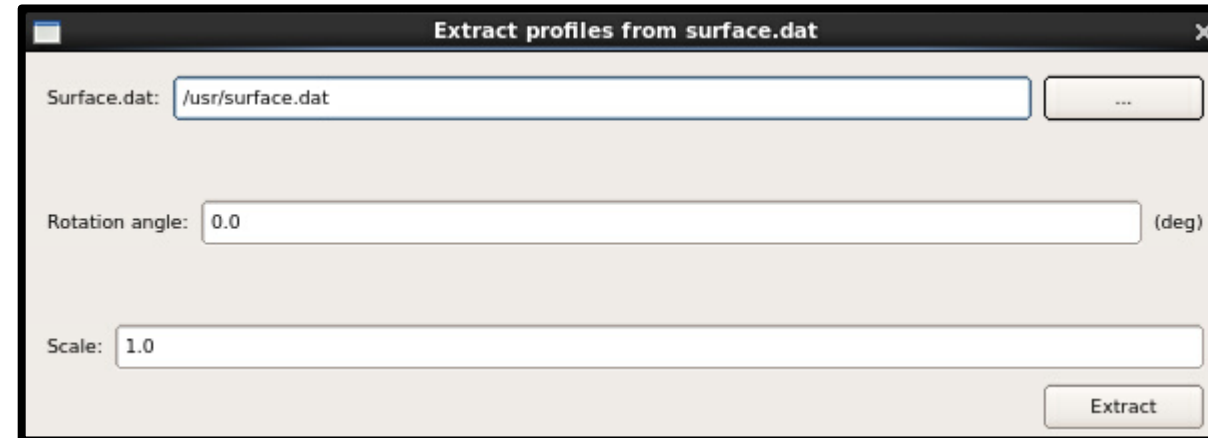


Obtaining Head and Bowl Profiles

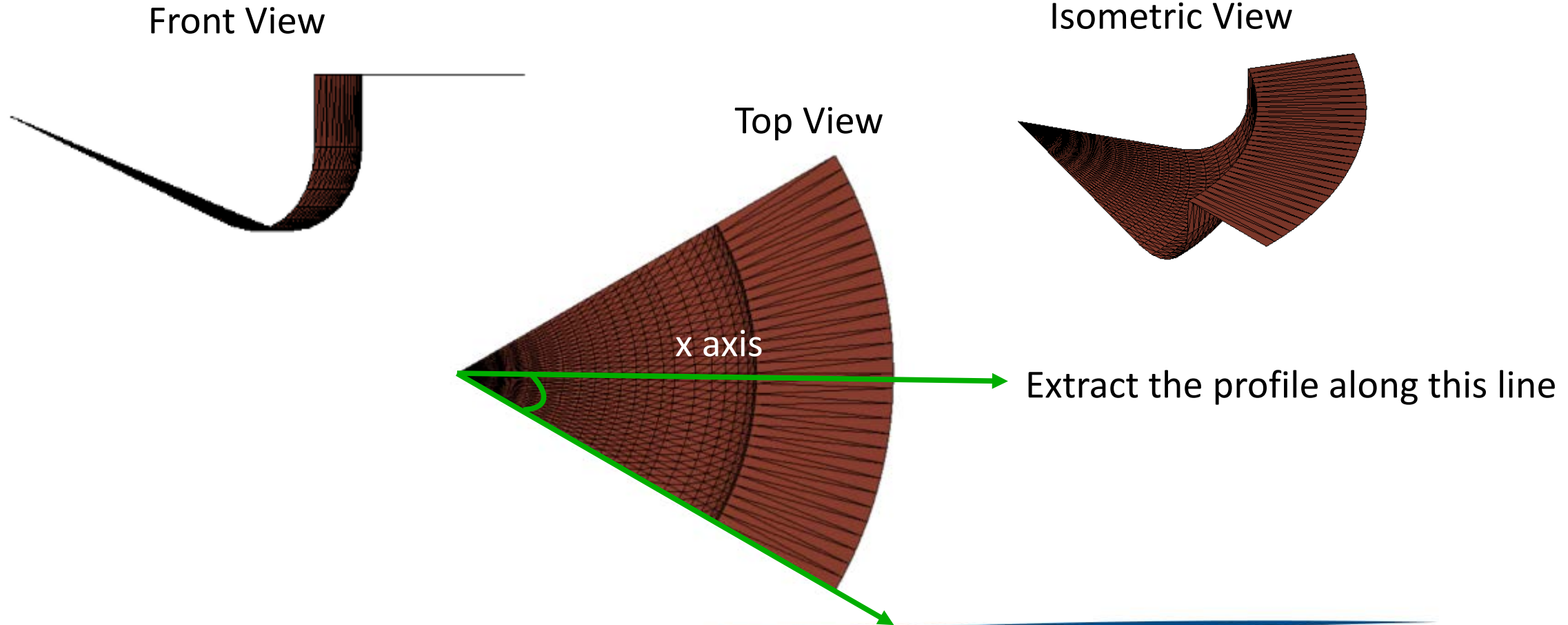
- If you do not have a head or bowl profile, there are three ways to generate a profile
 - Use the *Extract Profile* tool
 - This tool can extract a bowl or head profile from almost any engine geometry
 - This tool is available through CONVERGE Studio
 - Copy the coordinates into a file using *Create > Copy* in CONVERGE Studio
 - This method is impractical if the geometry does not have any straight radial lines along which to copy coordinates
 - Use the method of forces
 - Discussed in advanced training

Head and Bowl Profiles: *Extract Profile* (1/3)

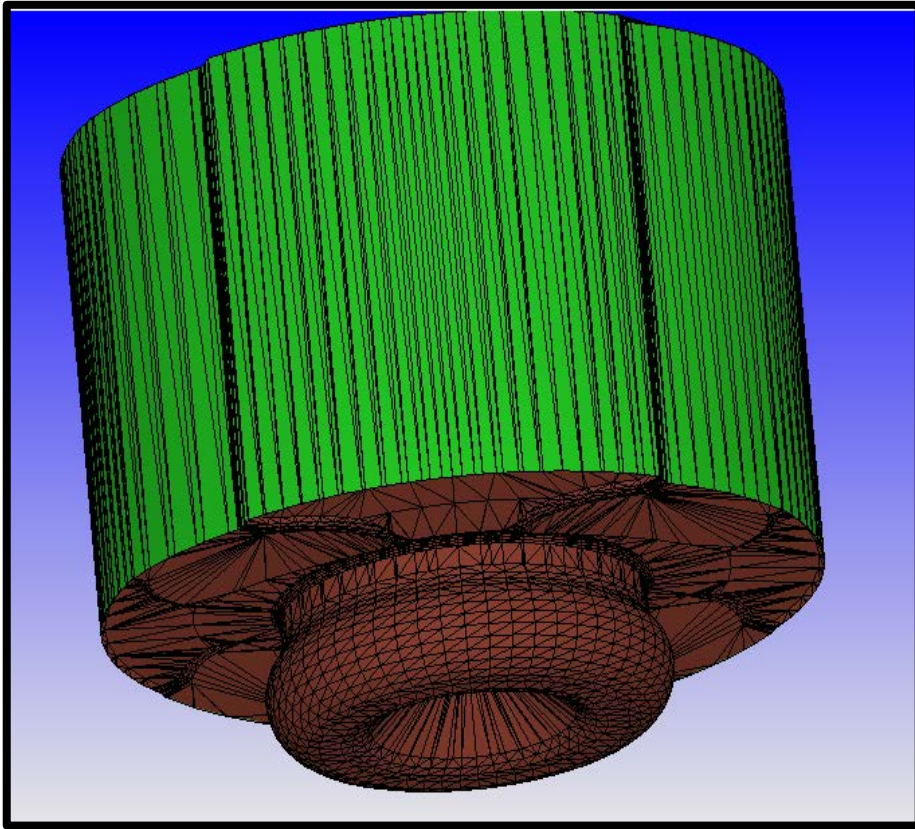
- In CONVERGE Studio, click the Extract profiles.. button
 - Supply a surface geometry file (must be *surface.dat*) for the full cylinder
 - Remove ports and valves so that the cut-plane forms a closed loop
 - The geometry must be centered along the z axis with the head at $z = 0$
 - Use *Rotation angle* to ensure the geometry crosses the xz plane
 - Use *Scale* to scale the geometry



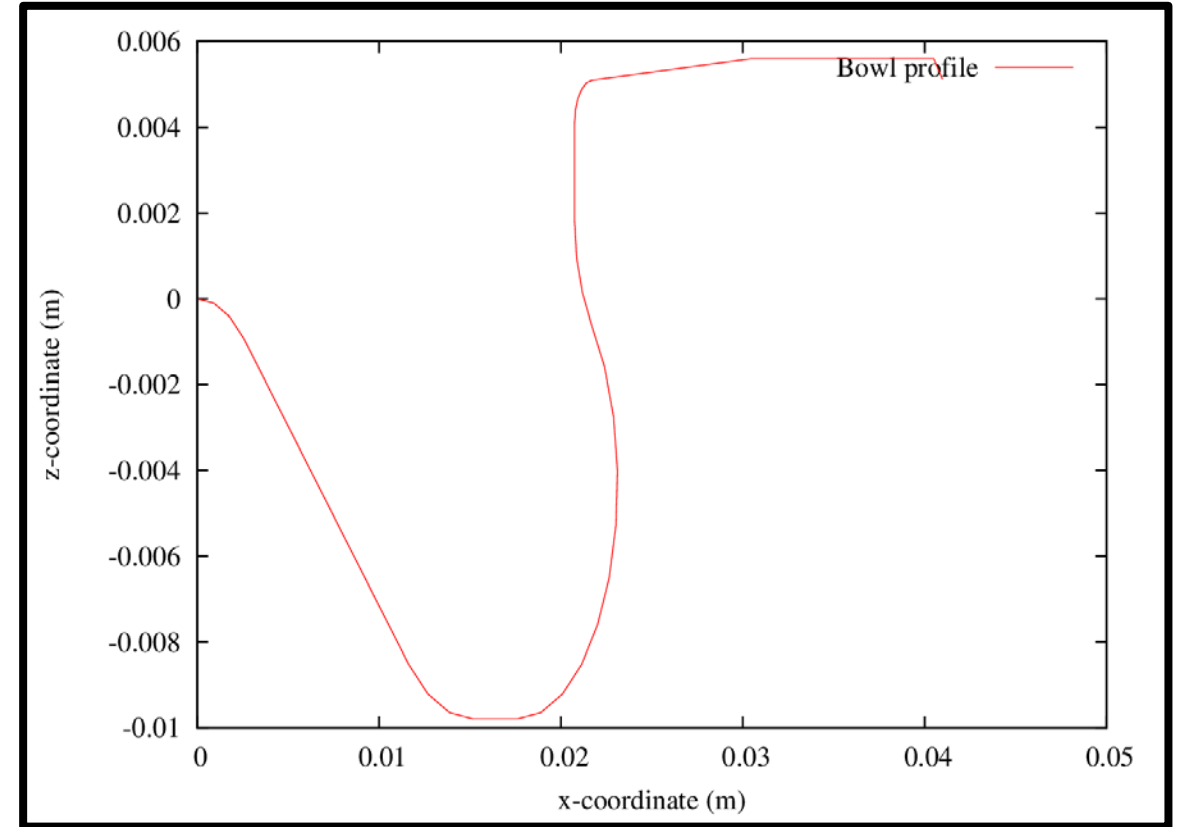
Head and Bowl Profiles: *Extract Profile* (2/3)



Head and Bowl Profiles: *Extract Profile* (3/3)



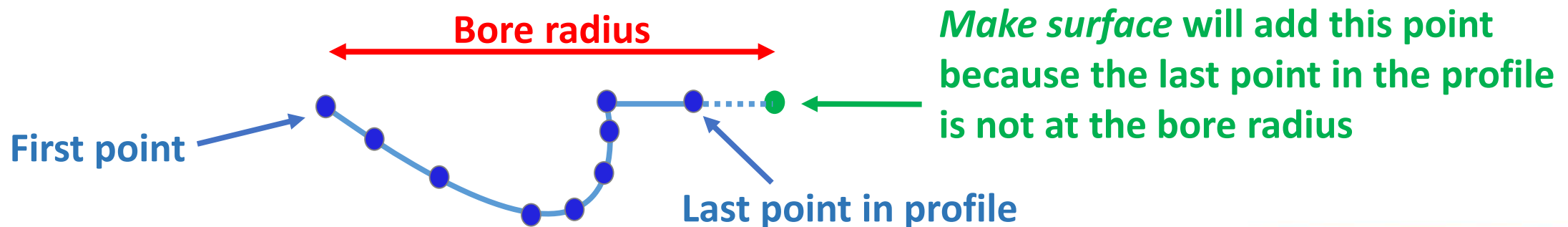
Bowl shape rendered in
CONVERGE Studio



Bowl profile drawn in the xz plane

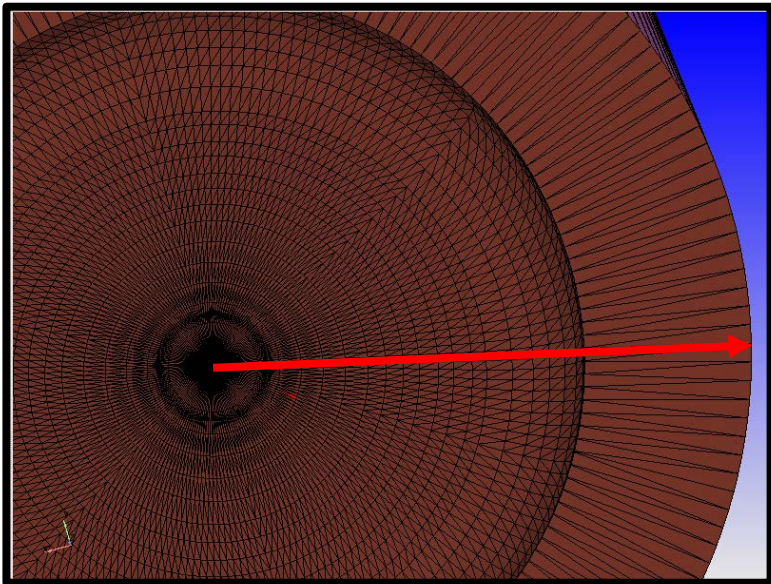
Head and Bowl Profiles: Manual Setup (1/5)

- The *Head profile* and *Bowl profile* must list the coordinates in the same order as they appear along the geometry contour
 - The first coordinate must be at the origin ($x = 0.0$ meters)
 - The last coordinate must be at the bore radius
 - If not, CONVERGE adds a coordinate at the bore radius with the same z value as the last coordinate in the profile

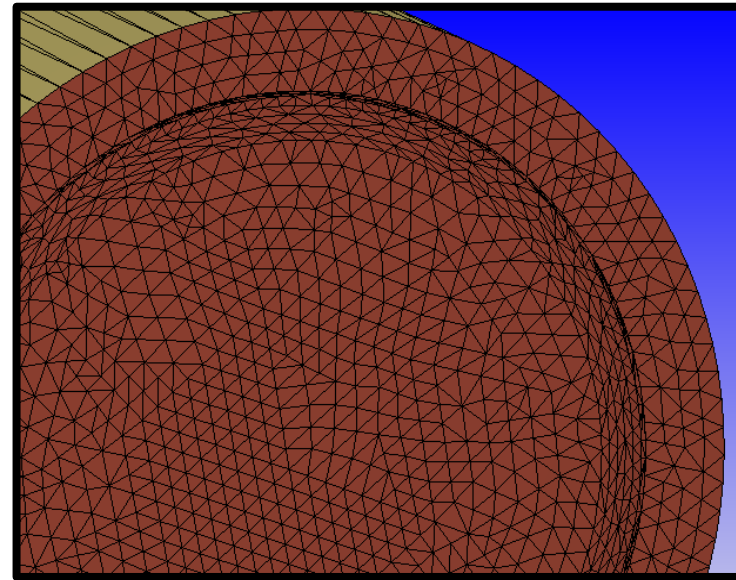


Head and Bowl Profiles: Manual Setup (2/5)

- Note that this method is impractical if there are no straight radial lines along which to select vertices



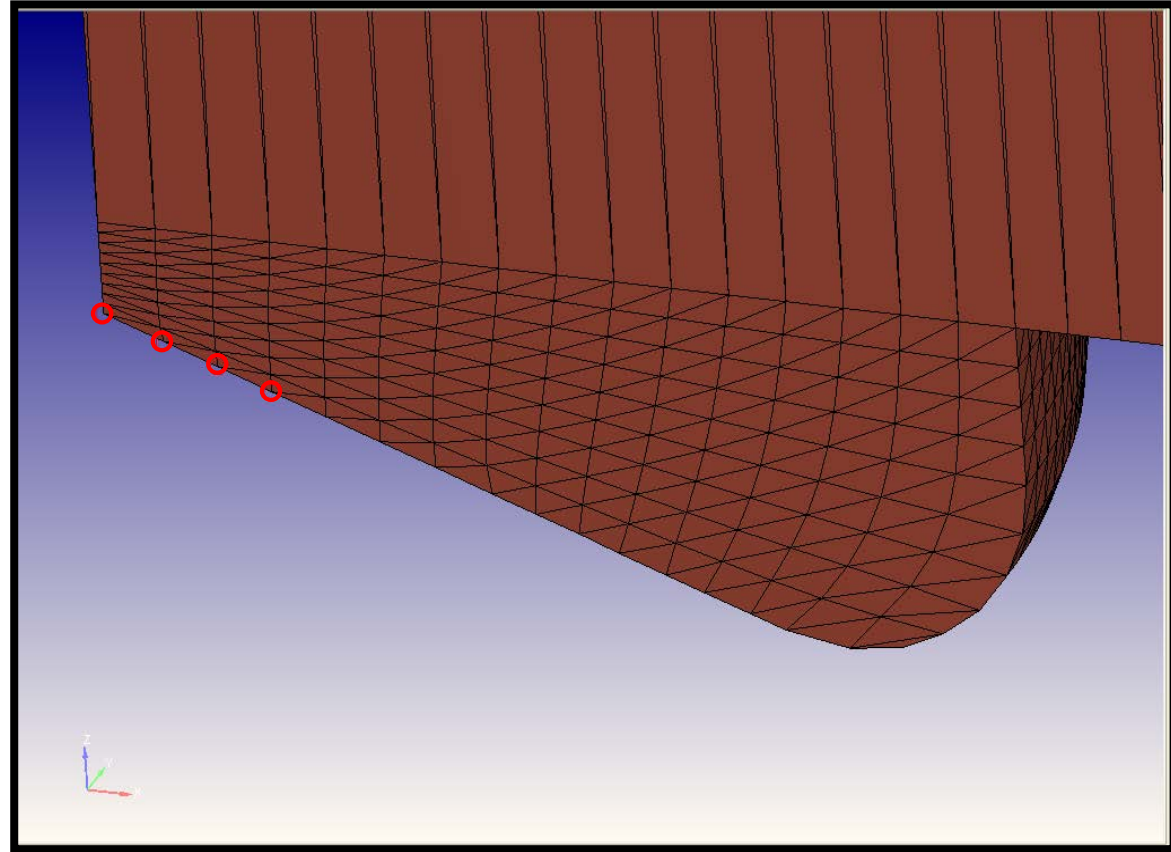
This geometry has straight radial lines



This geometry lacks straight radial lines

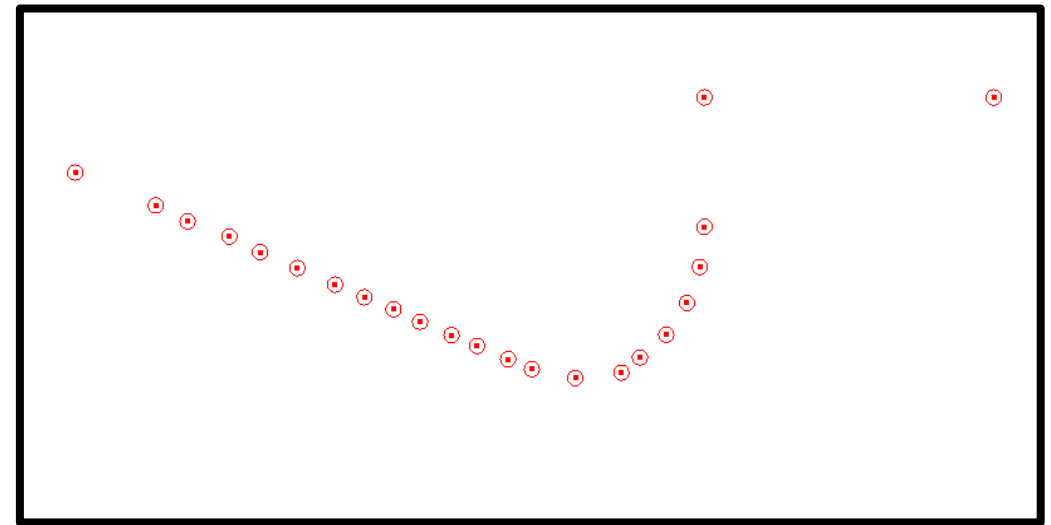
Head and Bowl Profiles: Manual Setup (3/5)

- The steps to manually create a head or bowl profile are the same
- These slides explain how to create the bowl profile
 - 1) Import the *.stl file into CONVERGE Studio
 - 2) Go to *Create > Copy* and select Vertex
 - 3) Click on vertices along the edge of the bowl
 - 4) Click Apply



Head and Bowl Profiles: Manual Setup (4/5)

- 5) Rotate the geometry so that the bowl profile lies in the xz plane
 - Go to *Transform > Rotate*, select a rotation angle of -90° , and click Apply
- 6) Go to *Repair > Delete* and select Triangle
- 7) Click on any piston surface triangle and click Apply to delete the piston boundary
 - This will leave only the copied points

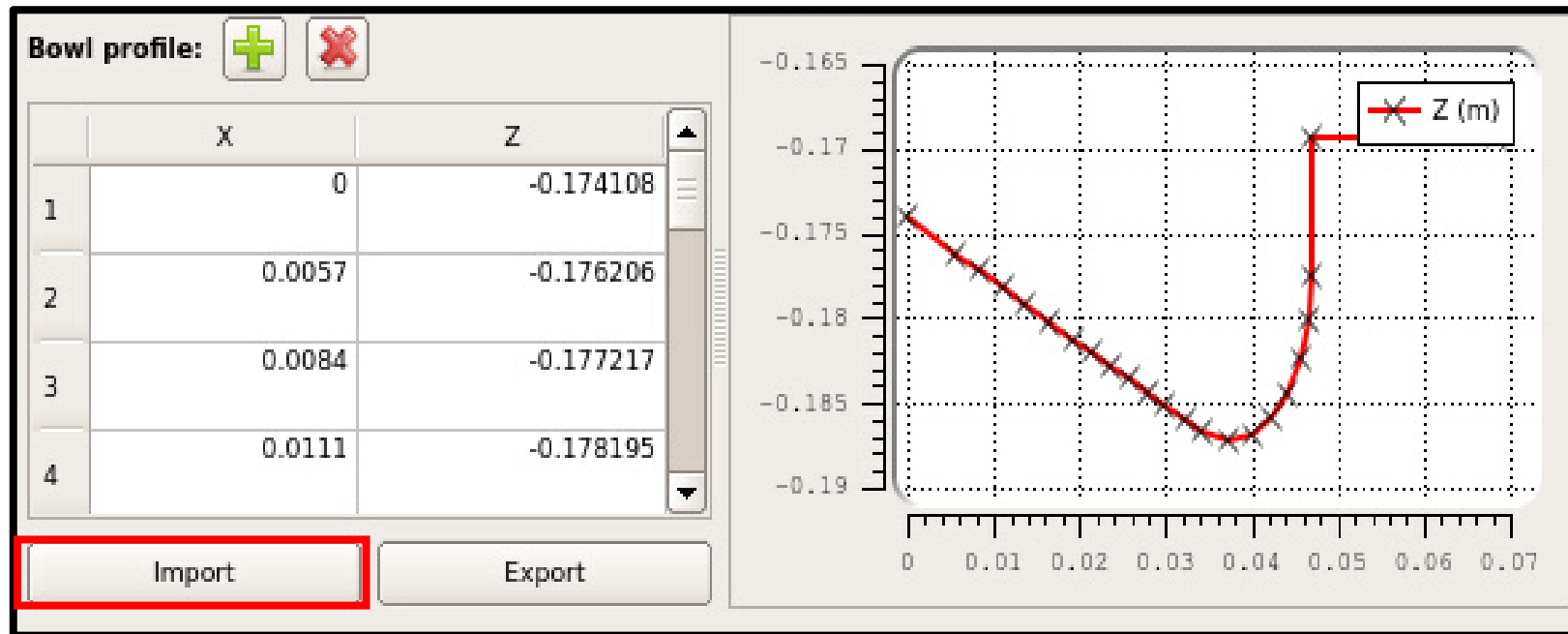


Head and Bowl Profiles: Manual Setup (5/5)

- 8) Export the profile
 - Go to *Export > Export surface file*, verify that *surface.dat* is checked, and click OK
- 9) Use a text editor to open *surface.dat*
- 10) Delete the first (vertex number) and third (y coordinate) columns of data
 - This will leave only the x and z coordinates
 - Rename this file *bowl_profile*
- 11) Repeat steps 1-10 for the head profile and rename *head_profile*

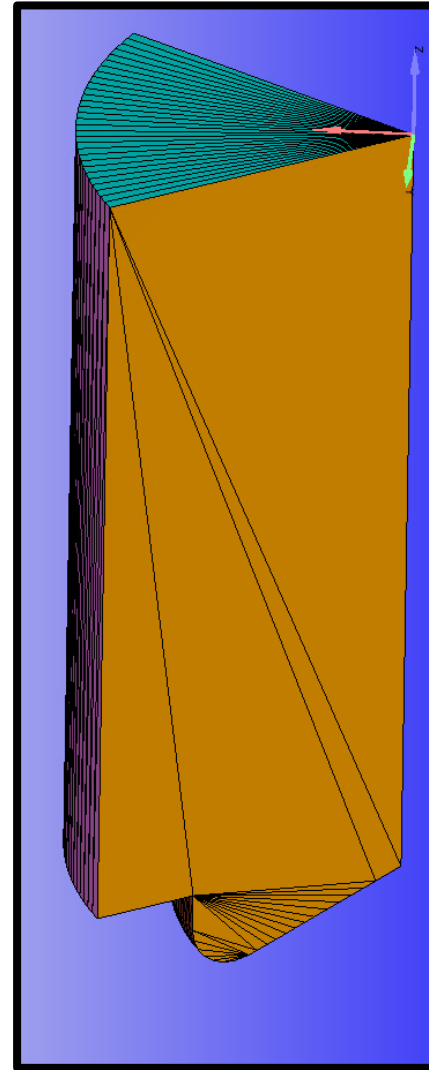
Import Head and Bowl Profiles

- Import the *head_profile* and *bowl_profile* to the *Make surface* dialog box



Engine Sector Creation

- Click Make surface to finish creating the engine sector

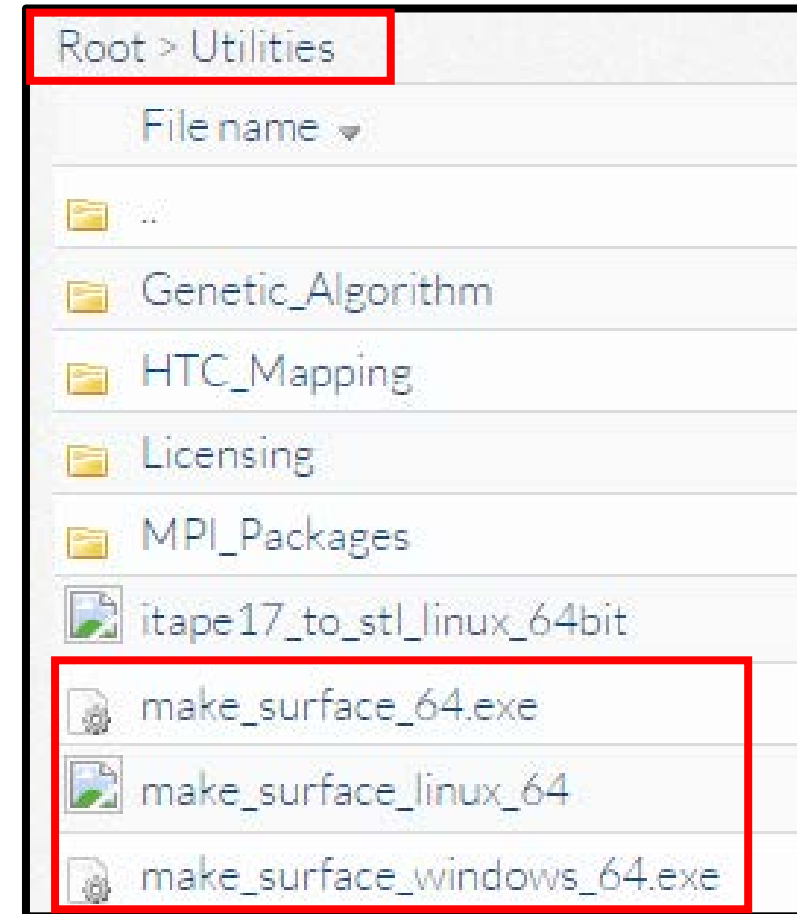


Initial Conditions for a Sector Simulation

- You must initialize the domain (pressure, temperature, velocity, species composition, turbulence) prior to starting the engine sector simulation
- We recommending the following initialization procedure for an engine sector simulation
 - Run CONVERGE with the full geometry, including valves and ports
 - Set CONVERGE to write a map output file at intake valve closing (IVC)
 - Use this file to initialize pressure, etc. for the engine sector simulation
- Session 7 contains more information on initialization

make_surface and *extract_profile* Utilities

- Instead of using the *Make surface* and *Extract Profile* tools in CONVERGE Studio, you can run the *make_surface* and *extract_profile* utilities through the command line
- Download the *make_surface* executable from **convergecf.com** (login required)
- Contact the CONVERGE Support Team (**support@convergecf.com**) for the *extract_profile* executable



THANK YOU!
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