coreform

Better simulation through better geometry

Short Course Example Problems

Problem 3: Two-part contact with plasticity, deformation on both parts and elastic recovery

Summary of changes from problem 2:

- The mesh for the disc has been refined to better capture the deformation of the disc. While smooth splines allow for coarse meshes to capture geometry, refinement is sometimes necessary to capture the correct physics.
- Yield stress has been increased from 2 to 30. This is to allow for more elastic deformation, making the elastic recovery easier to visualize
- Analysis type changed from quasistatic to implict dynamic – this to maintain a stable simulation while also respresenting springback which is a dynamic phenomenon. The timestep has also been reduced to 0.005
- Time of the simulation (and temporal functions) have been lengthened to 13 to allow for simulation of springback.

Notes:

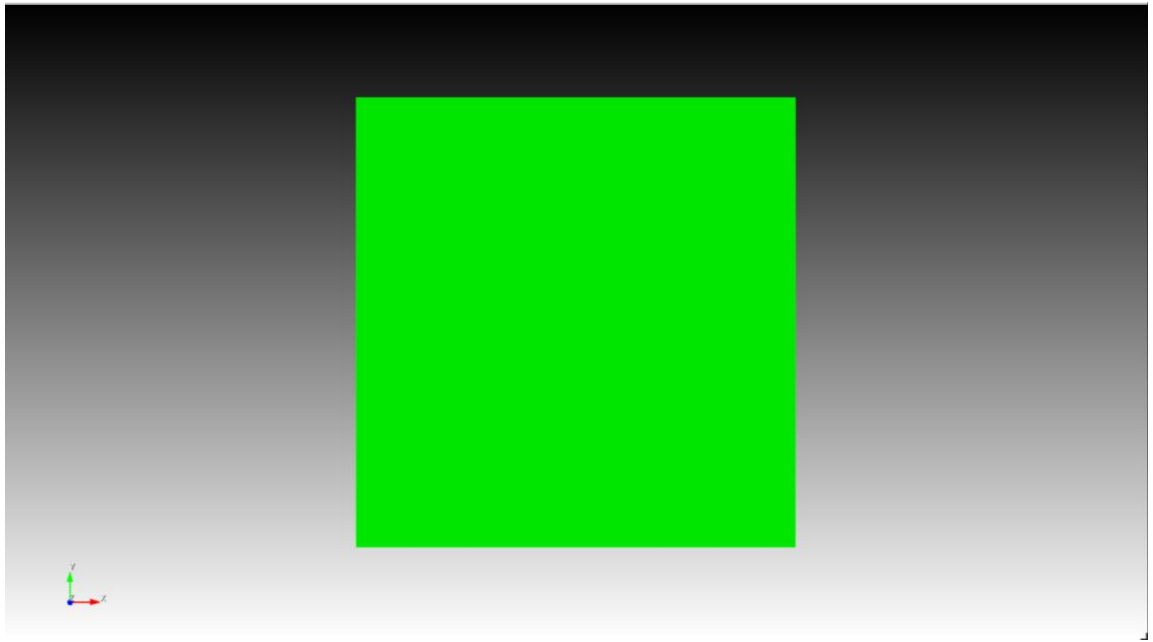
- The disc will not deform as much as the block due to its geometry.
- Lowering the yield stress (to 2 for example) will make it easier to visualize the deformation in the disc. Raising the yeild stress will produce a larger springback effect.

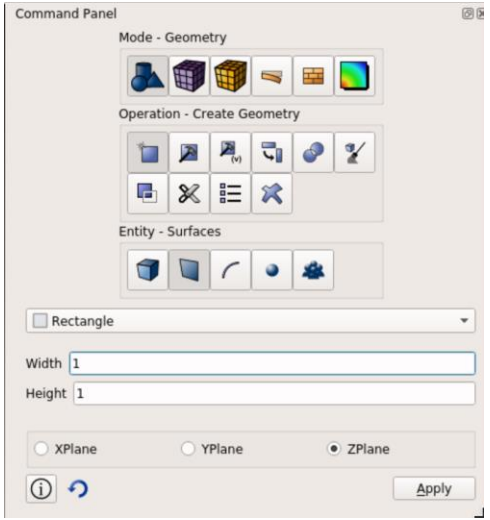
Problem 2: Learning Objectives

Tutorial participants will learn how to

- Mesh primitive geometry and create sets in Trelis
- Import Cubit file into Coreform process
- Set up simulation with multiple parts
- Impose displacement boundary conditions
- Use material model with plasticity
- Set up spline-based simulation contact definition

Create block

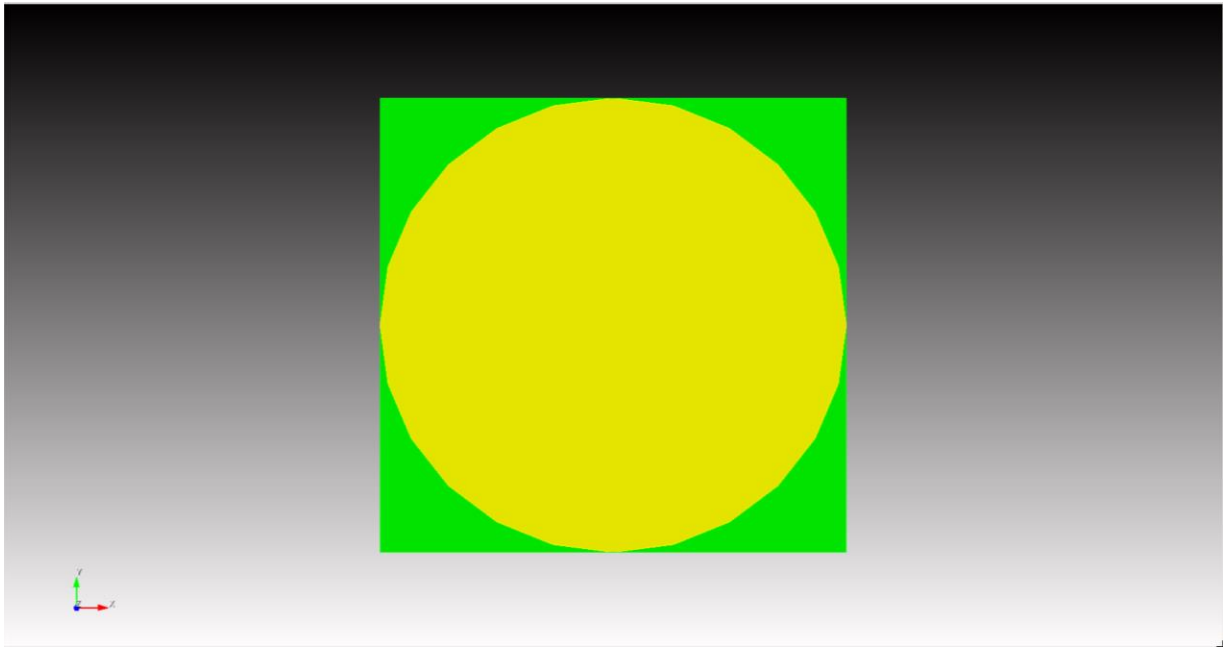


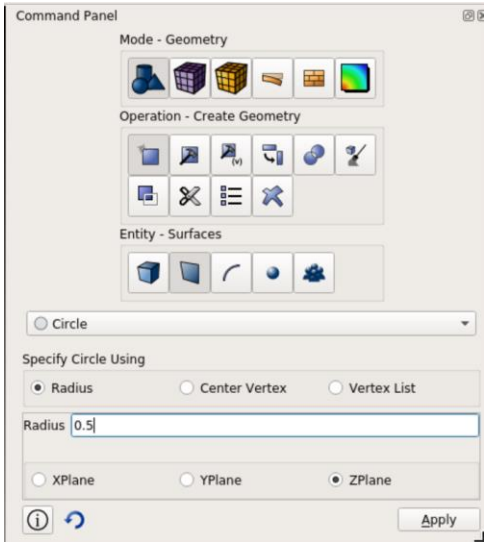


- or -

Create surface rectangle width 1 height 1 zplane

Create disc

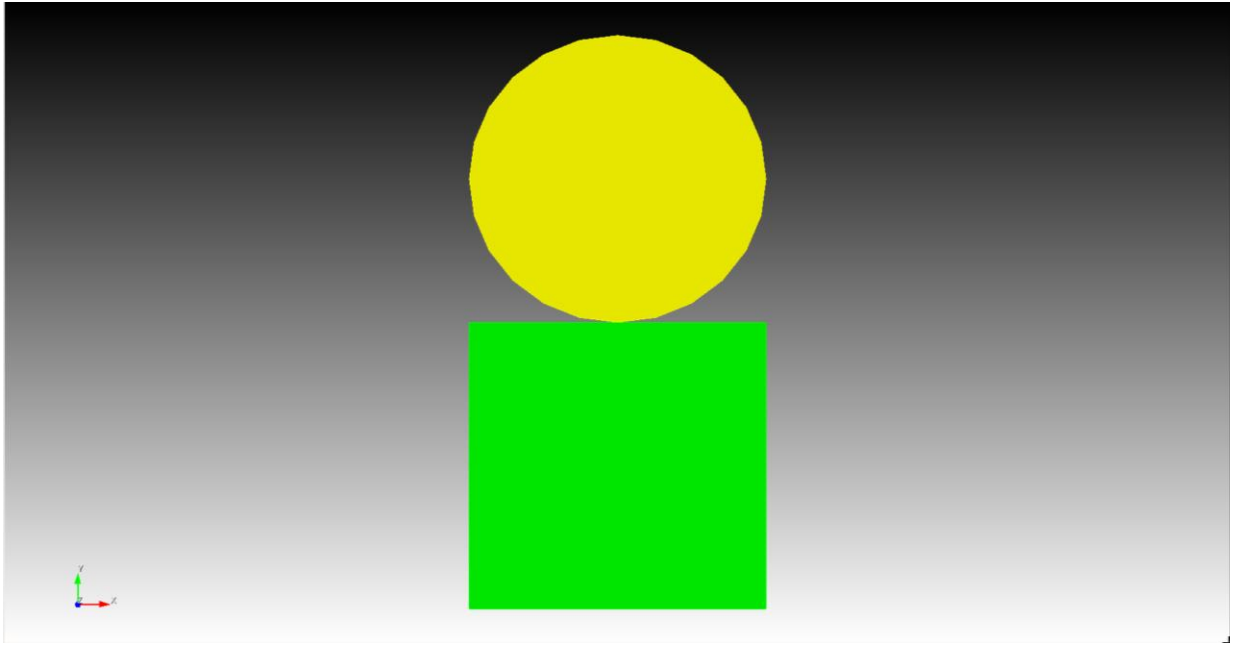


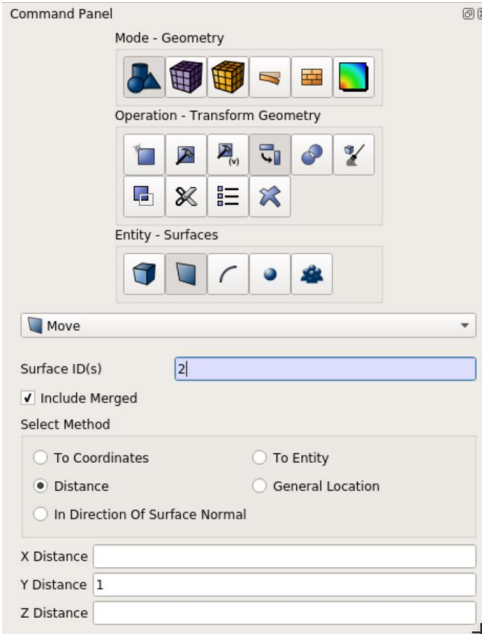


- or -

Create surface circle radius 0.5 zplane

Move disc



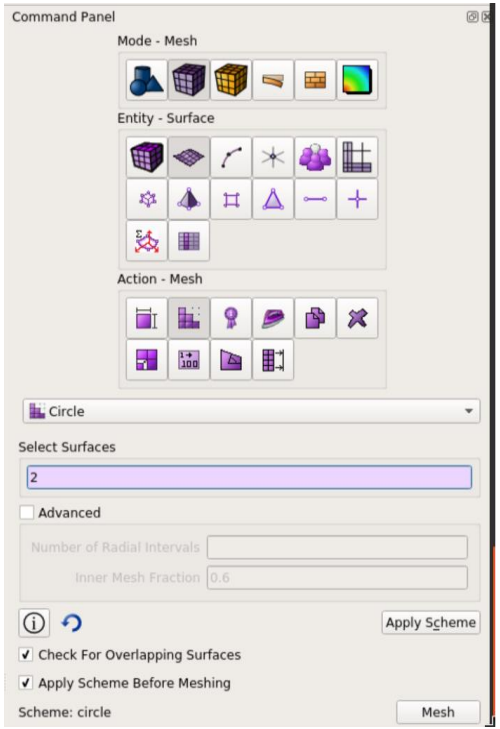


- or -

This geometry is available for download at this address:
https://coreform.com/shortcourse/deep_rolling_init.cub

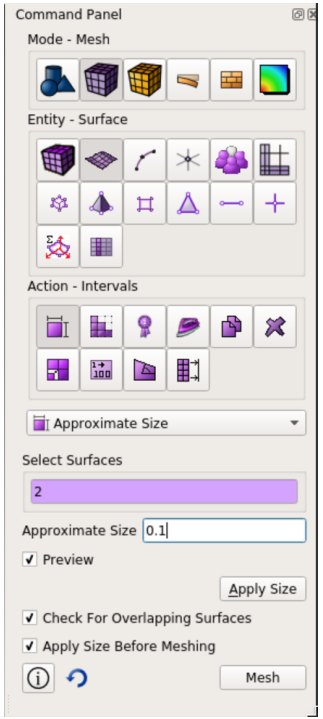
Move surface 2 y 1

Mesh disc



- or -

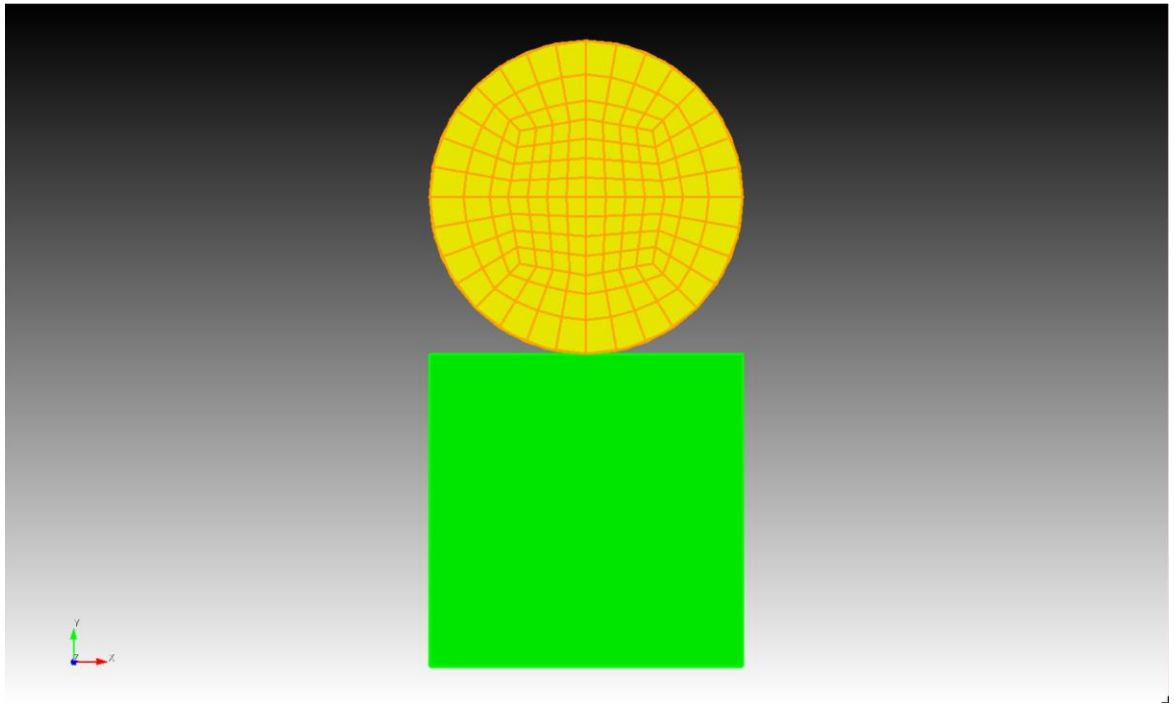
Surface 2 scheme circle



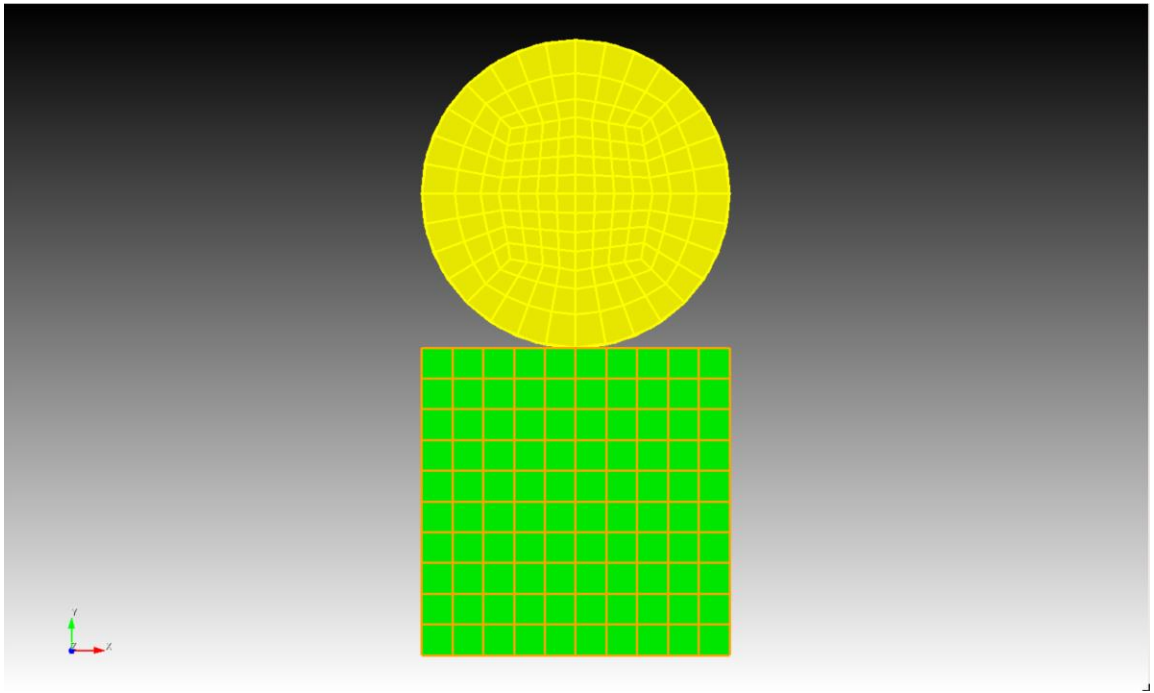
- or -

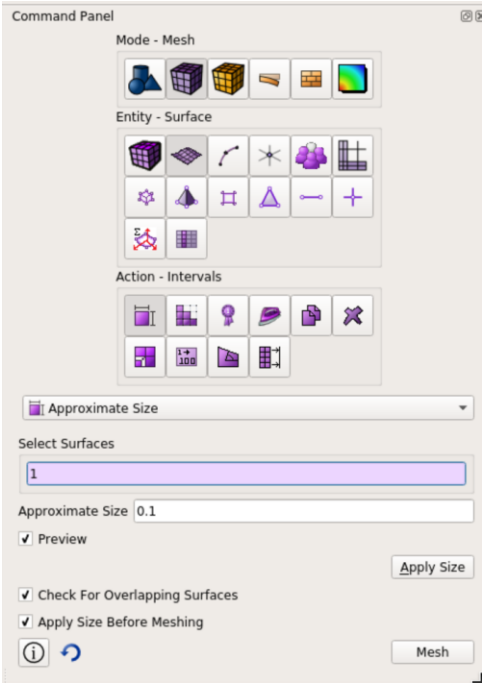
Surface 2 size 0.1
Mesh surface 2

Mesh disc



Mesh block

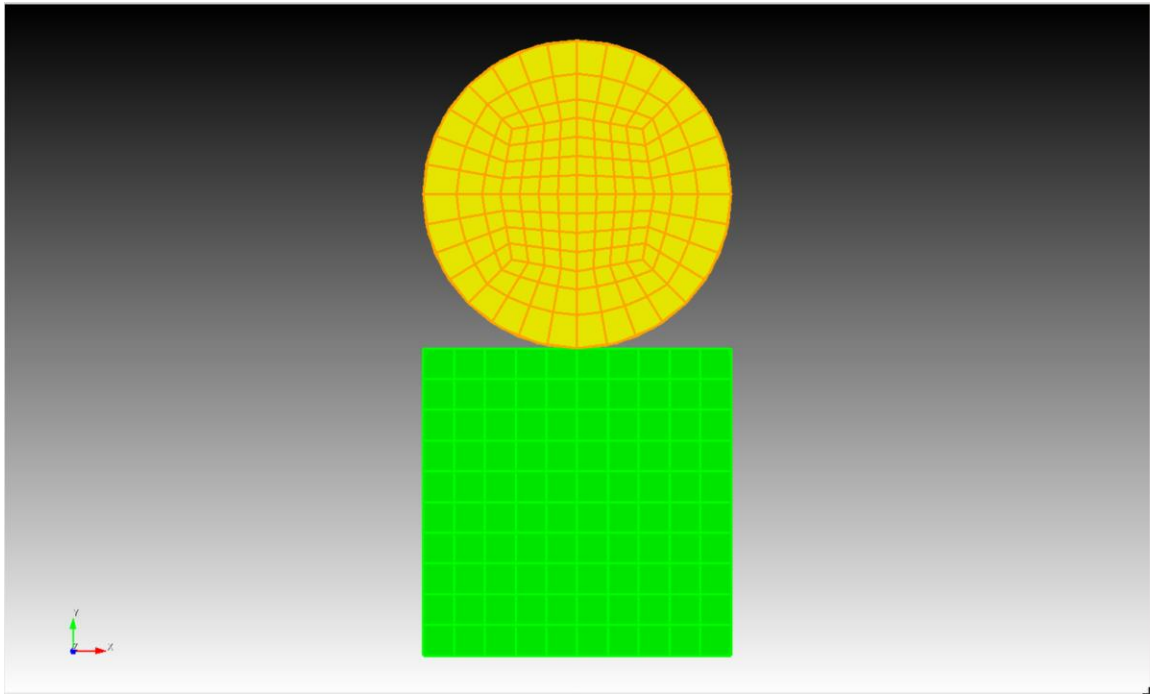


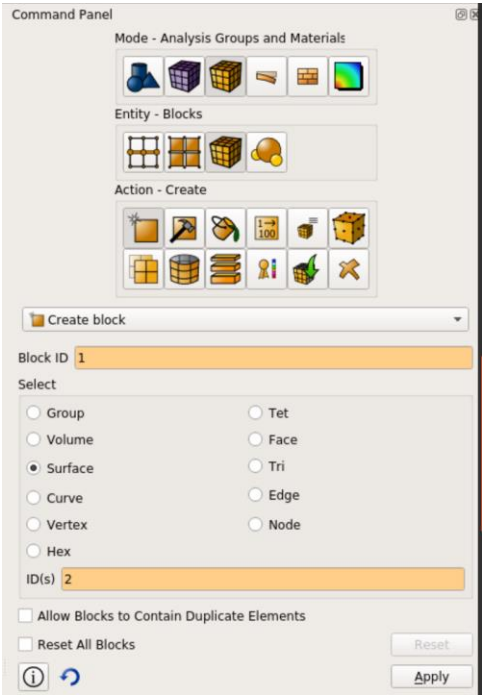


- or -

Surface 1 size 0.1
Mesh surface 1

Create block sets - disc

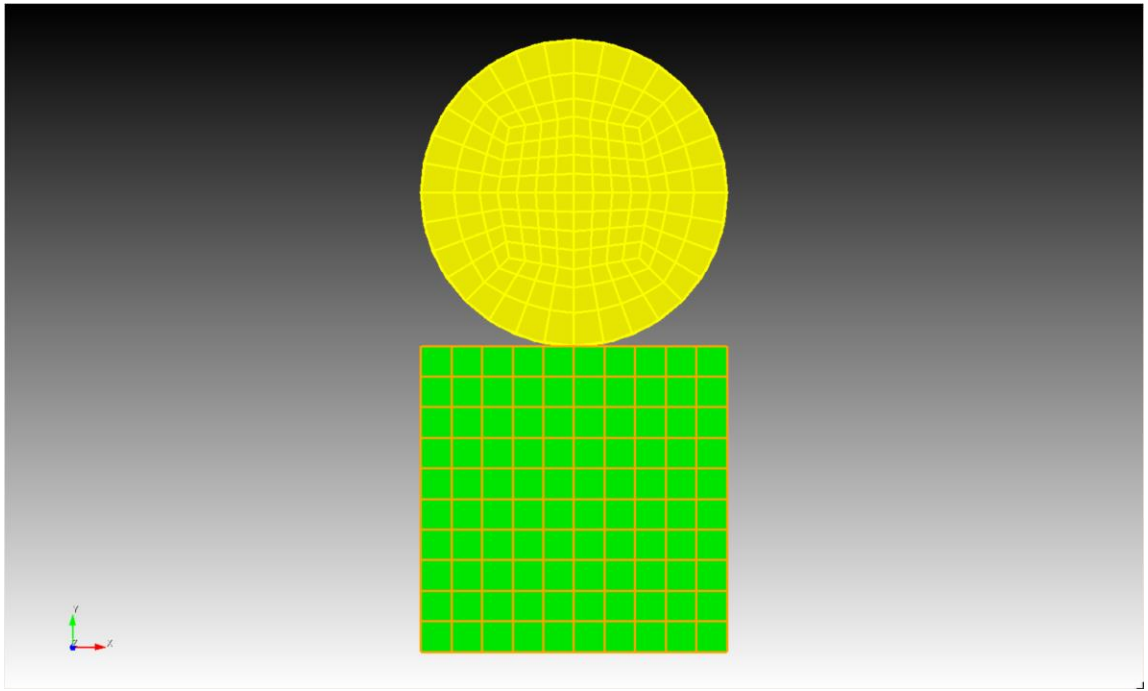


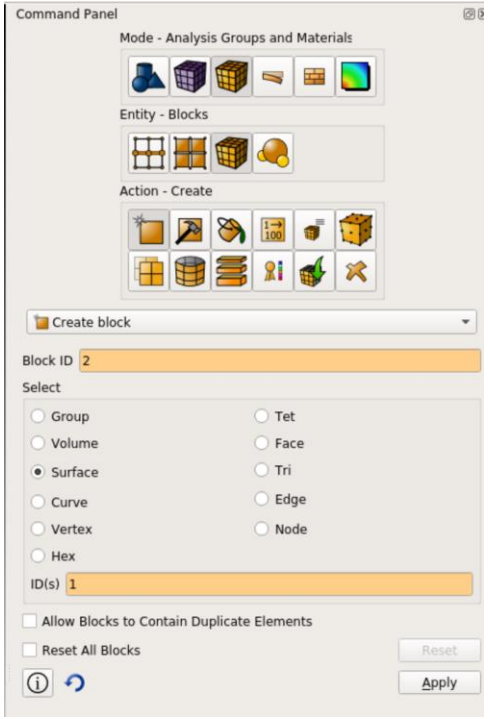


- or -

Block 1 add surface 2

Create block sets - block

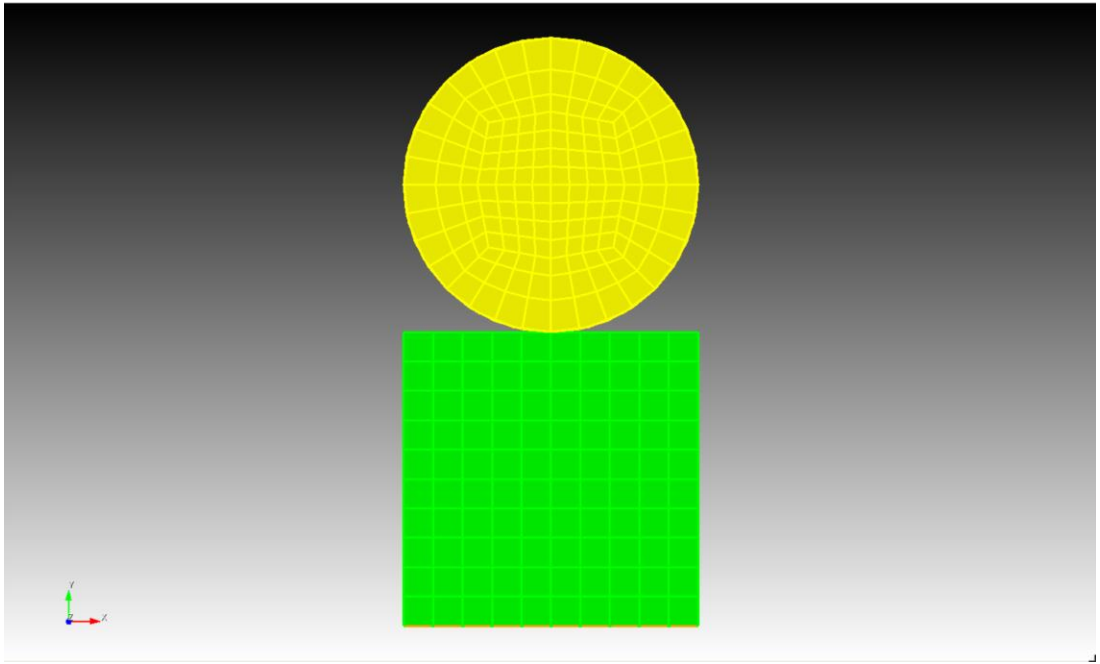


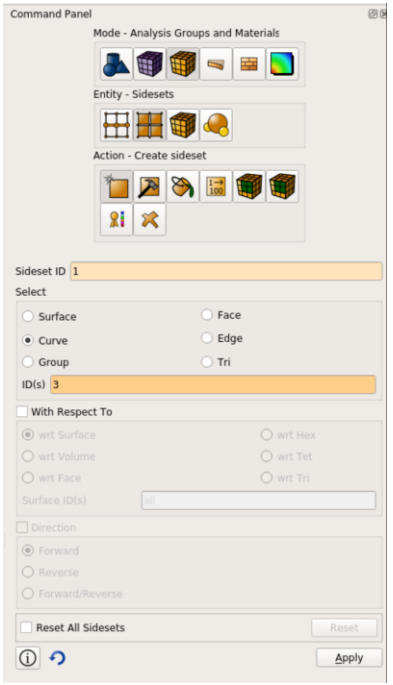


- or -

Block 2 add surface 1

Create side sets – bottom of block

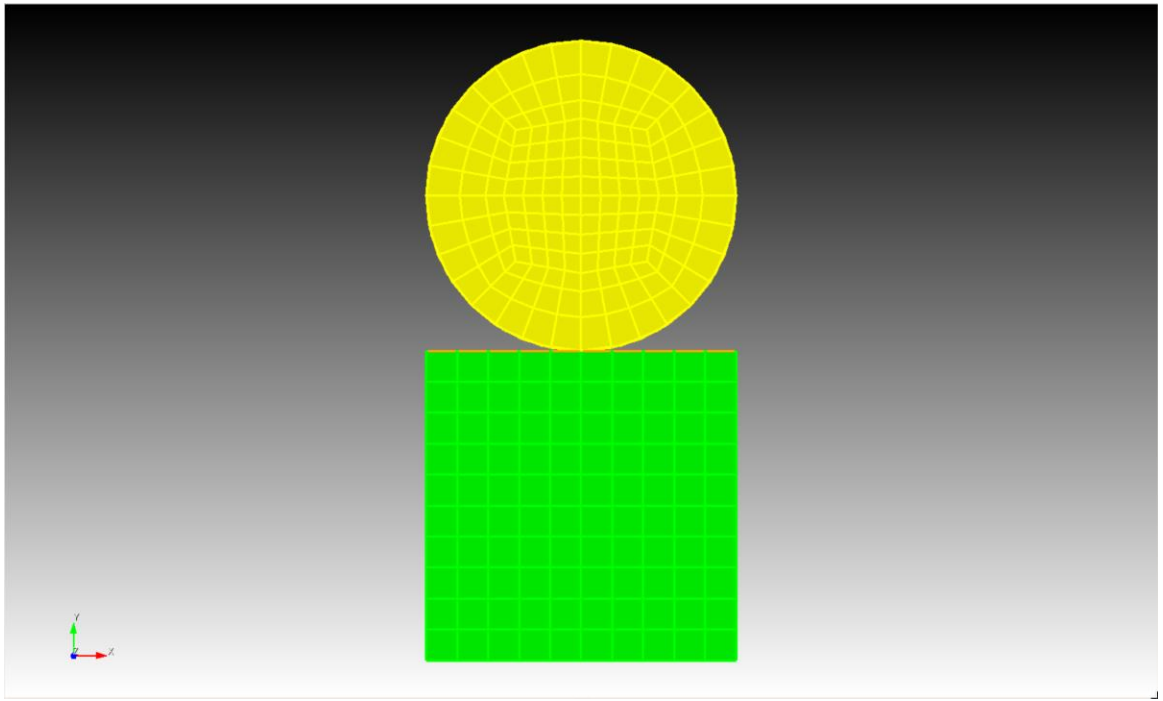


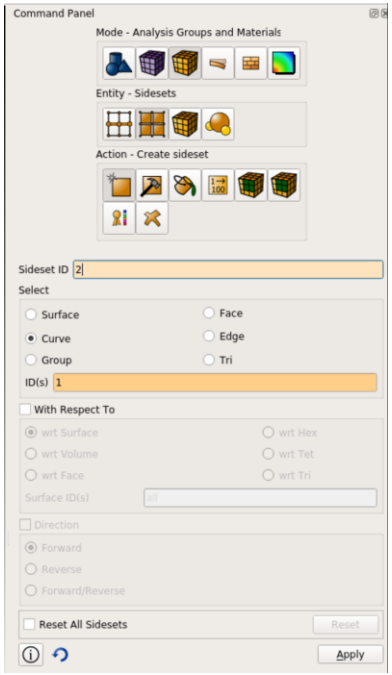


- or -

Sideset 1 add curve 3

Create side sets – top of block

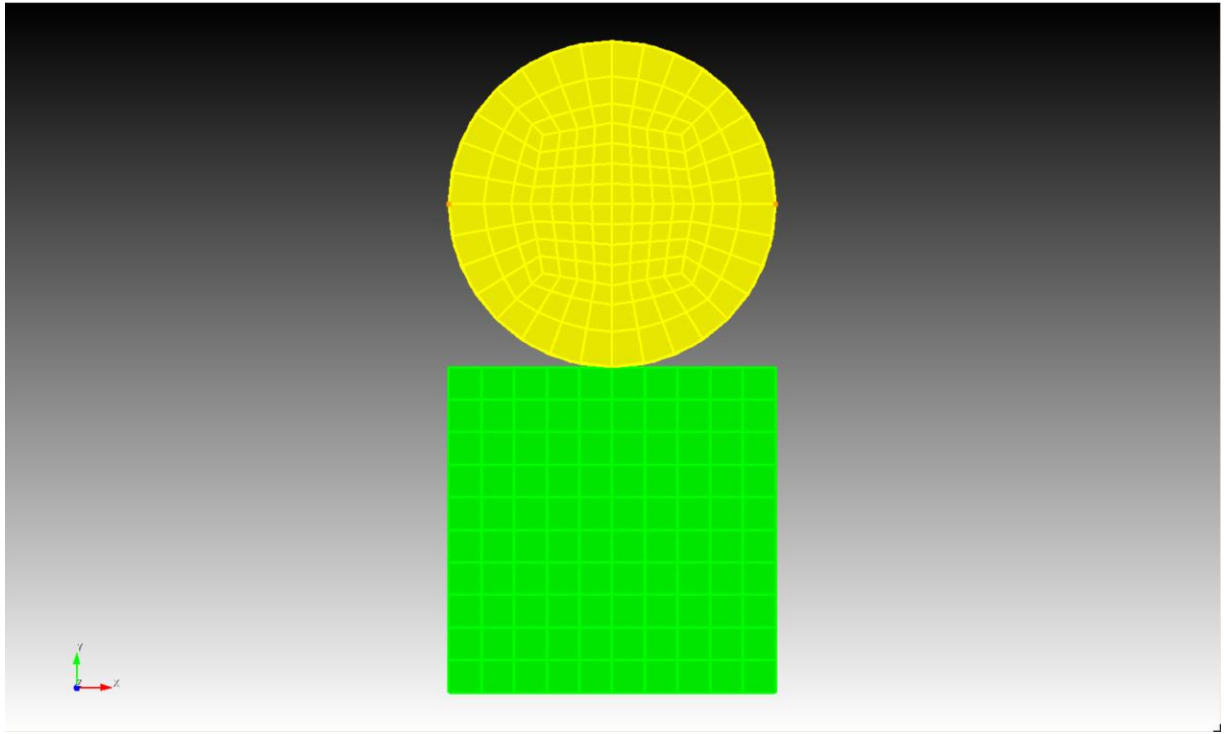




- or -

Sideset 2 add curve 1

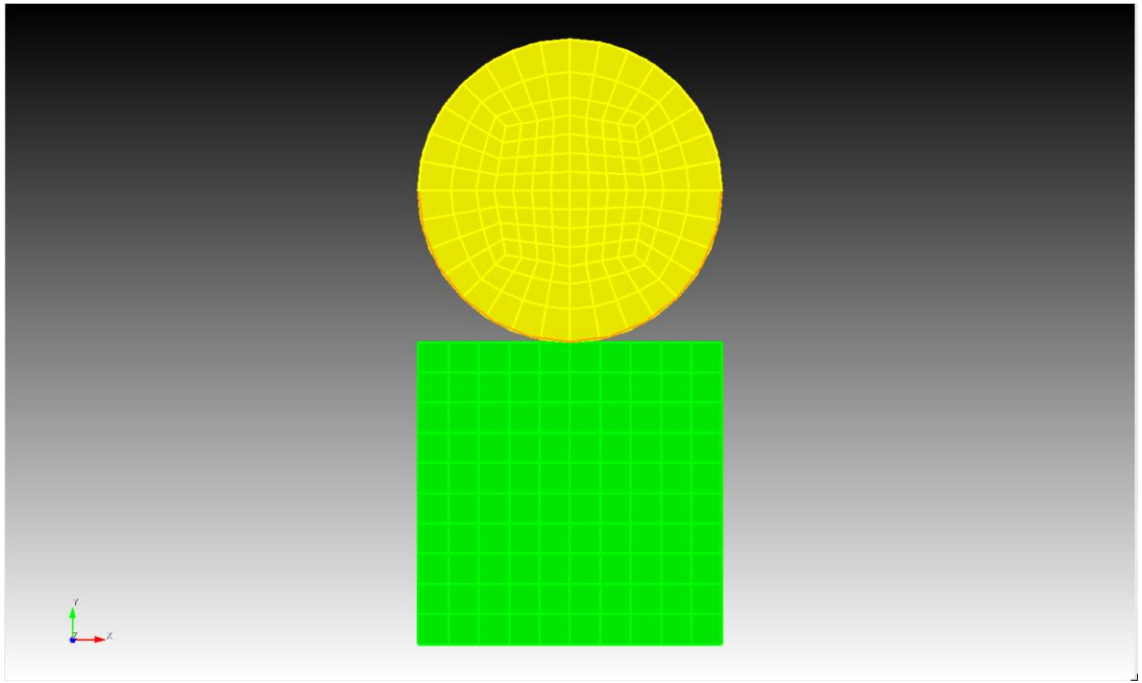
Split disc curve

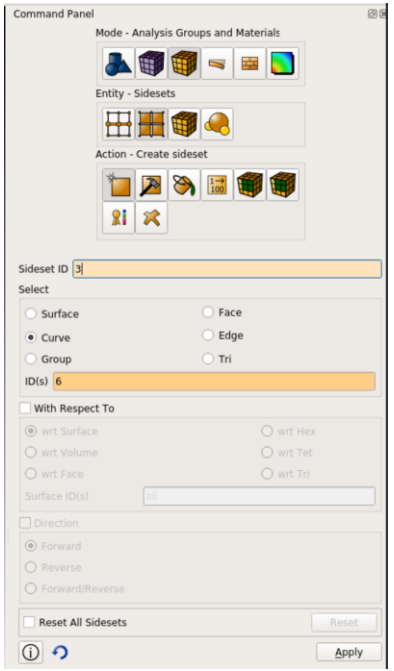


- or -

Partition create curve 5 node 1 17

Create side sets – bottom of disc

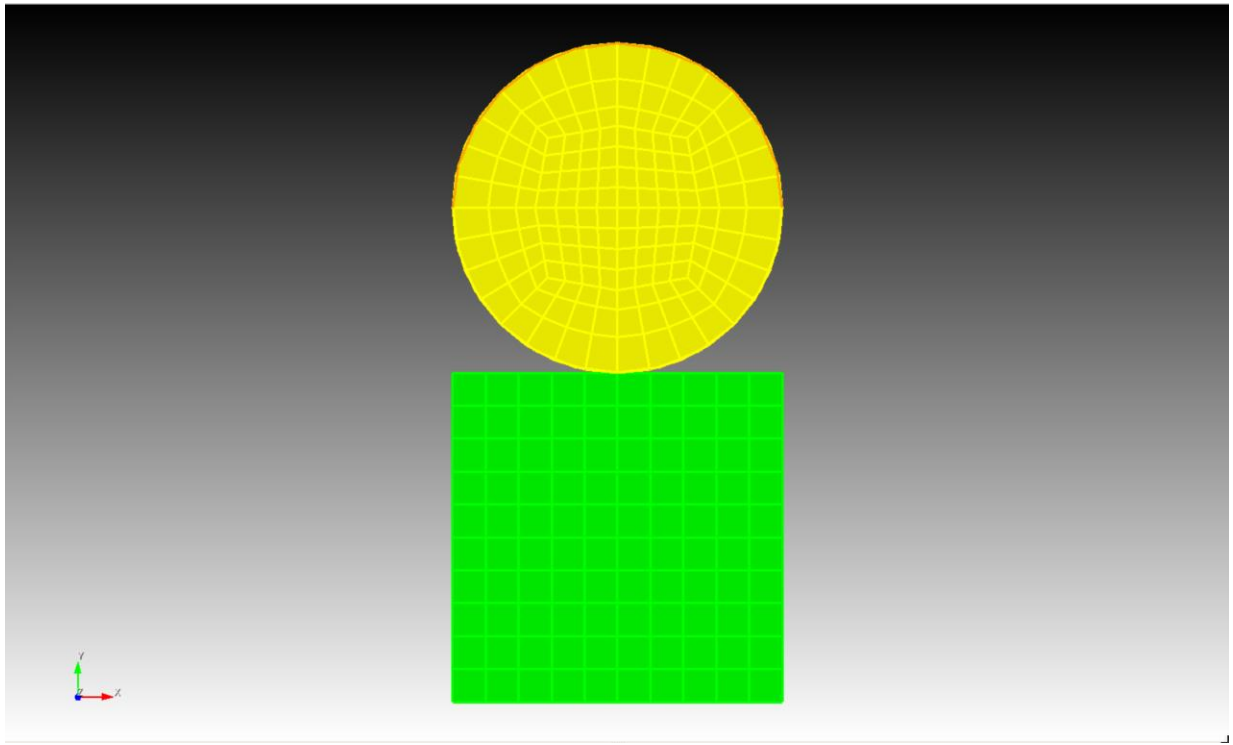


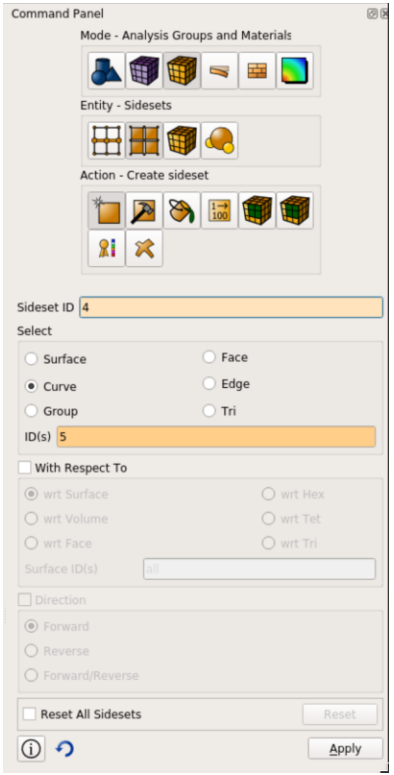


- or -

Sideset 3 add curve 6

Create side sets – top of disc

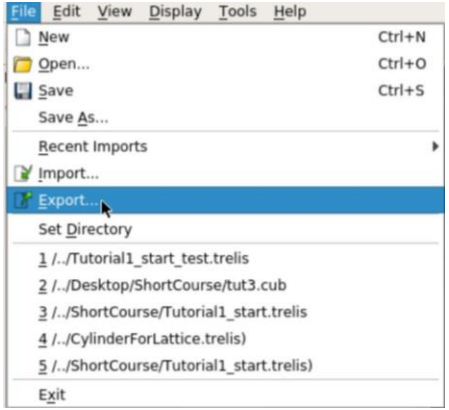


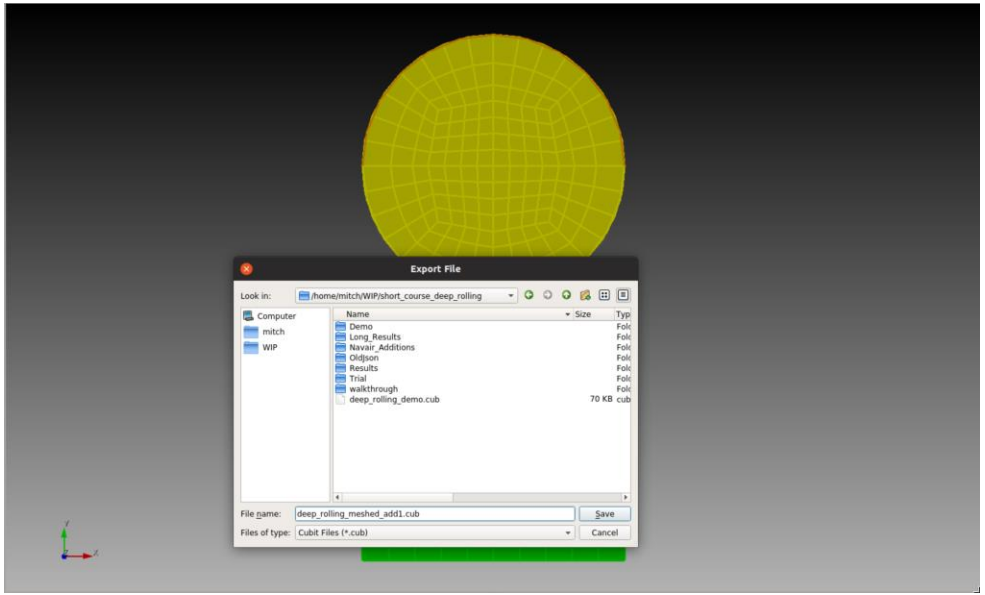


- or -

Sideset 4 add curve 5

Export .cub file



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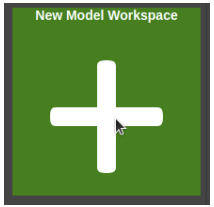
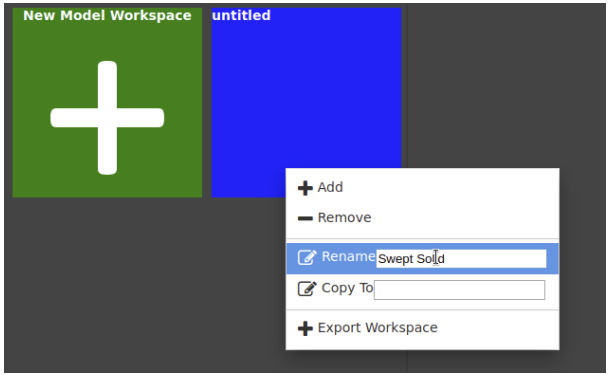
export cubit "/home/username/ShortCourse/deep_rolling_meshed_add1.cub" overwrite
```

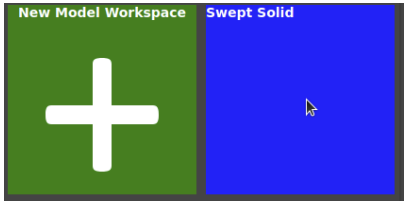
Open Coreform Process workspace



- Click "New Model Workspace"



- Right click the box labelled "untitled"
- Type "Deep Rolling" in the "Rename" box and hit Enter/Return
- Click on "Deep Rolling" to open the workspace



Import Cubit File

```
SPC - i - c
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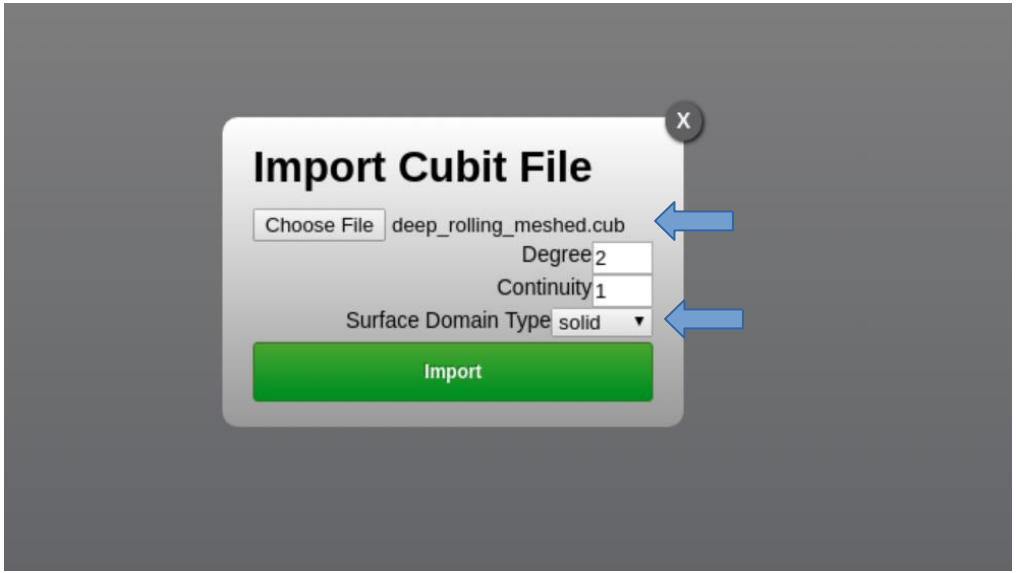
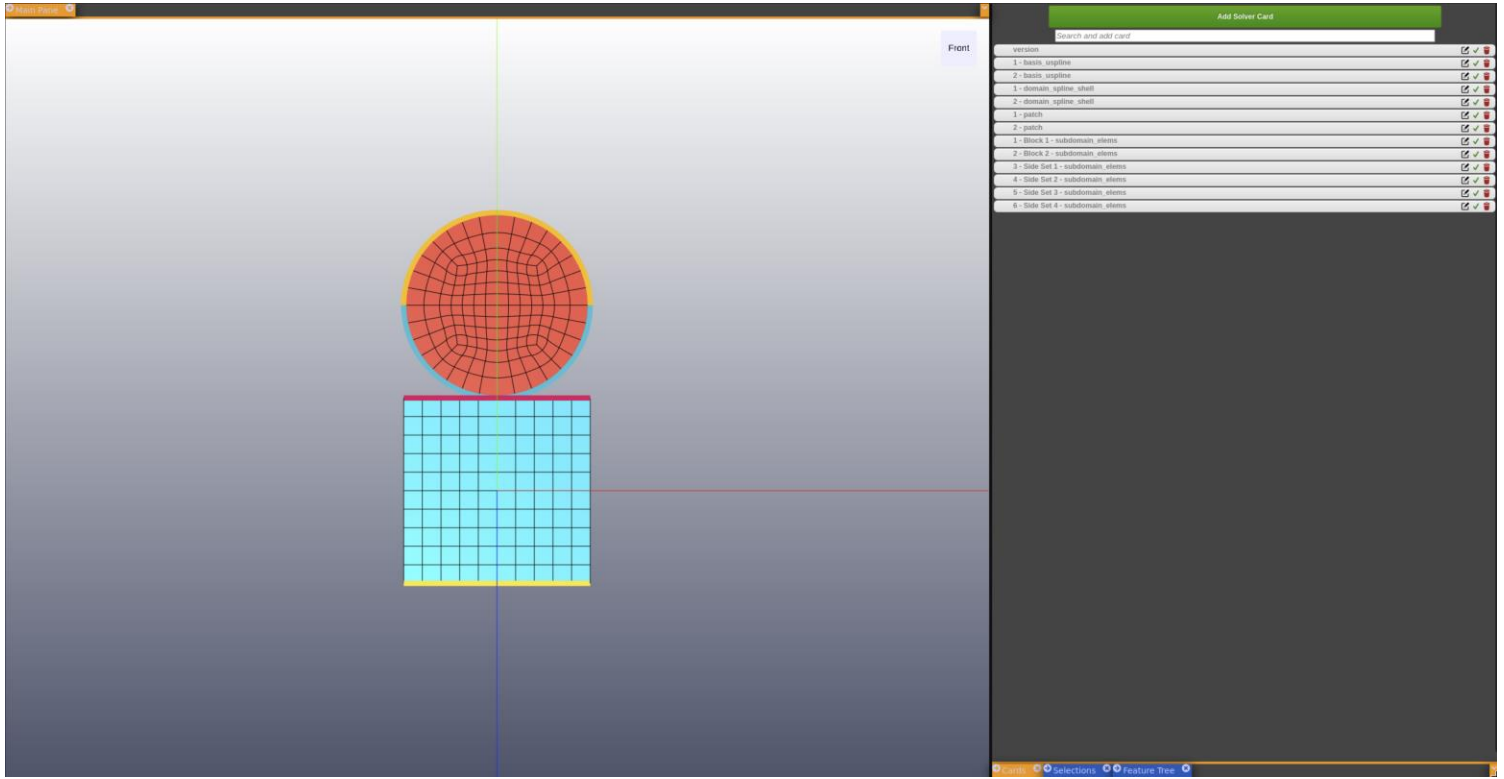
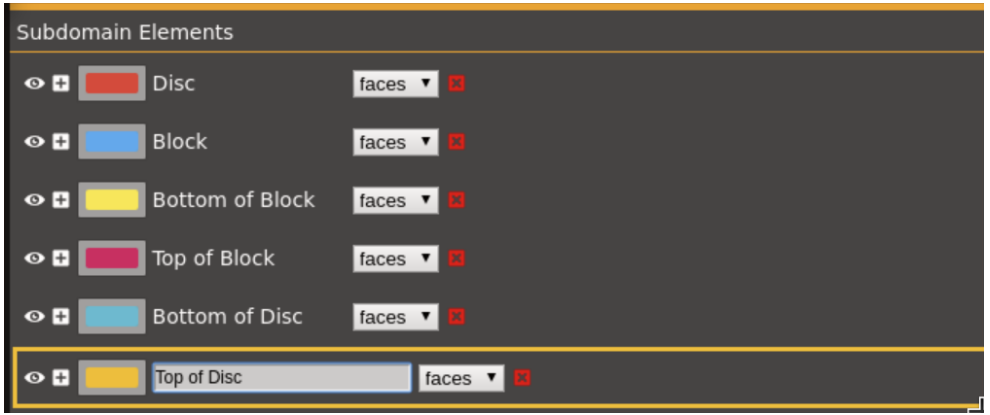


Imported Cubit File



Rename subdomians

Click on “Selections” pane



Material definition

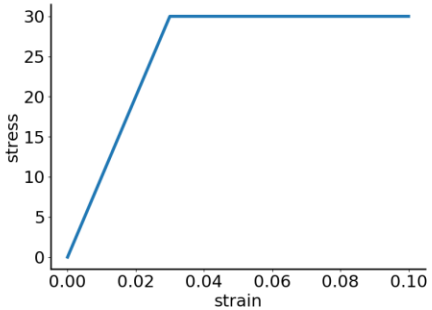
material_isotropic_elastoplastic_logarithmic

desc - optional	Material for both parts
material_id	1
E	1000
E_time_dependent_function_temporal_id	
E_temperature_dependent_function_temporal_id	
nu	0.3
rho	4e-5
material_yield_surface_properties_id	1

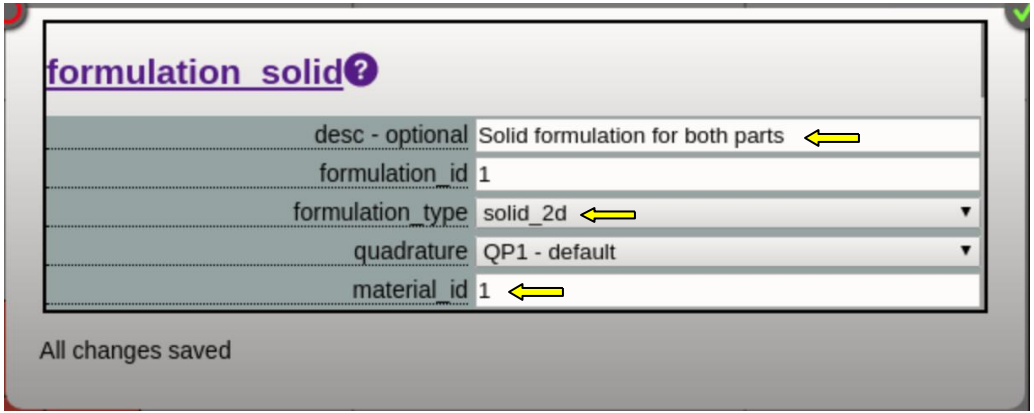
material_yield_surface_properties_von_mises

desc - optional	Material for both parts
material_yield_surface_properties_id	1
K - optional	0
yield_stress - optional	30
saturation_stress - optional	
saturation_exponent - optional	0.0

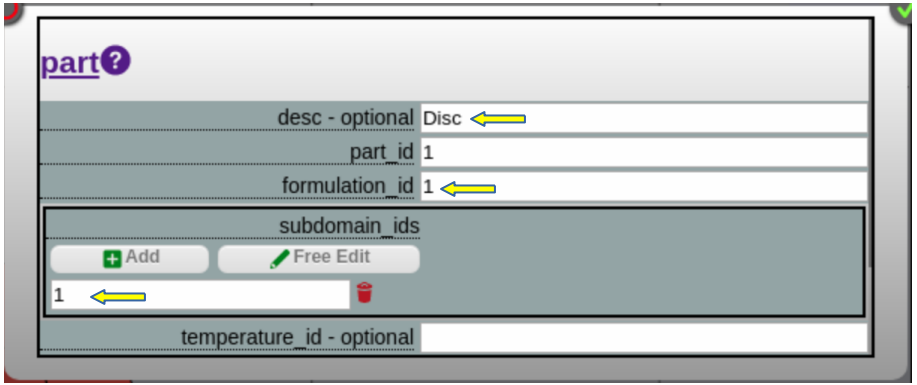
All changes saved

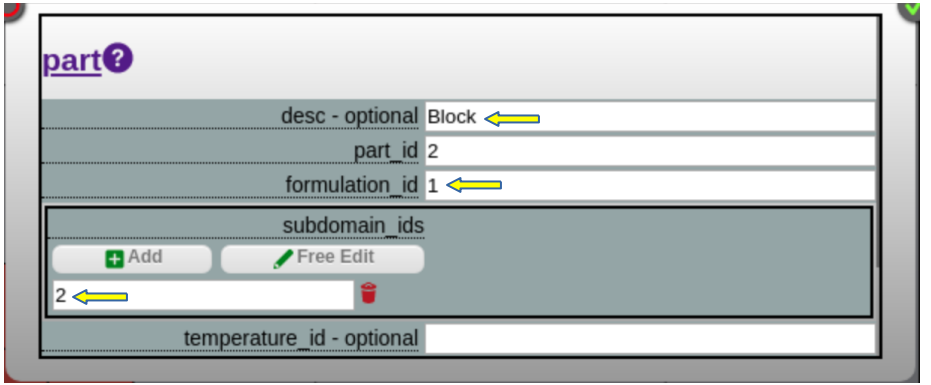


Element Formulation

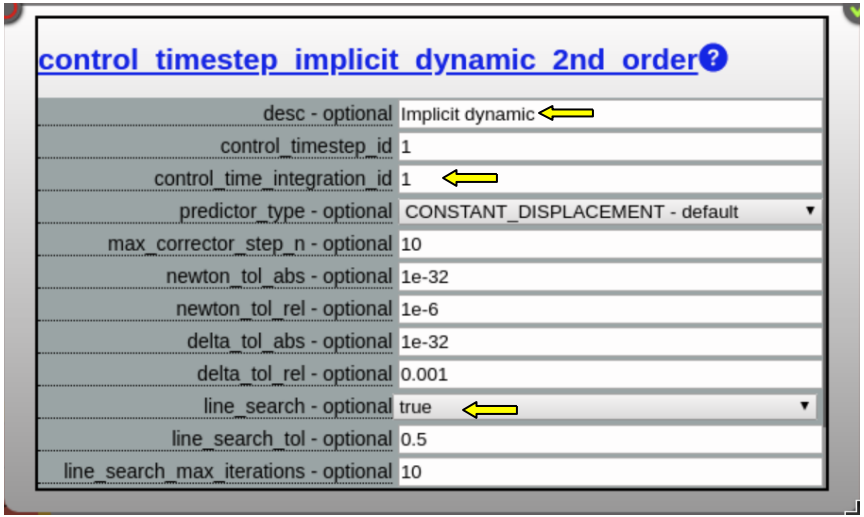


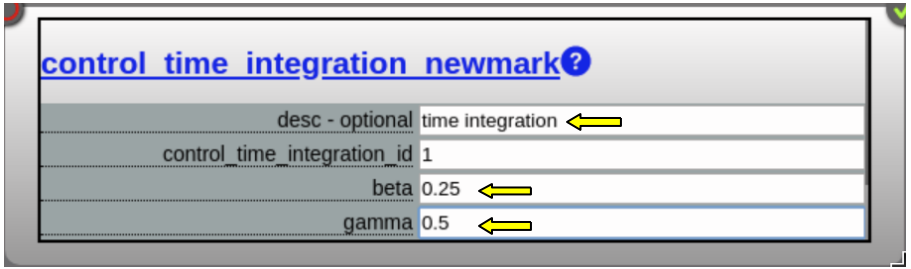
Parts


part
desc - optional
Disc
part_id
1
formulation_id
1
subdomain_ids
Add
Free Edit
1
temperature_id - optional

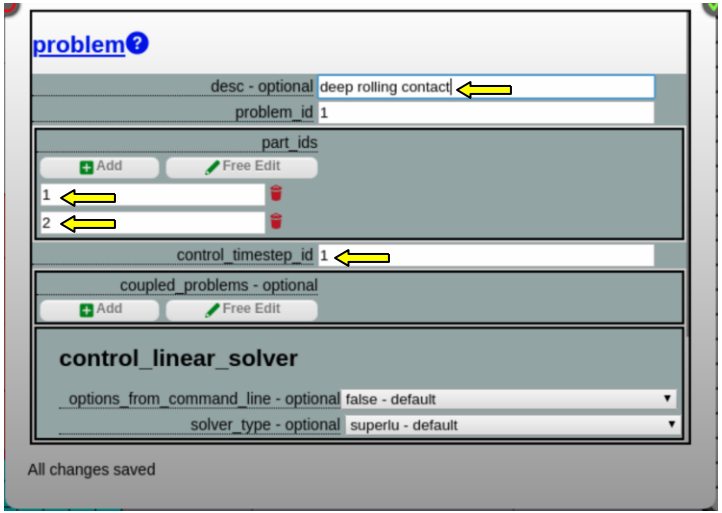

part
desc - optional
Block
part_id
2
formulation_id
1
subdomain_ids
Add
Free Edit
2
temperature_id - optional

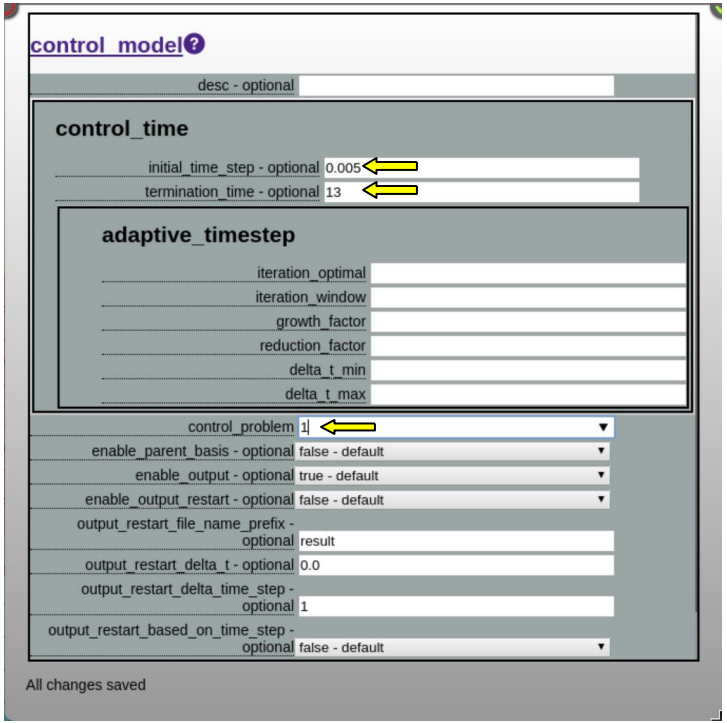
Control Timestep



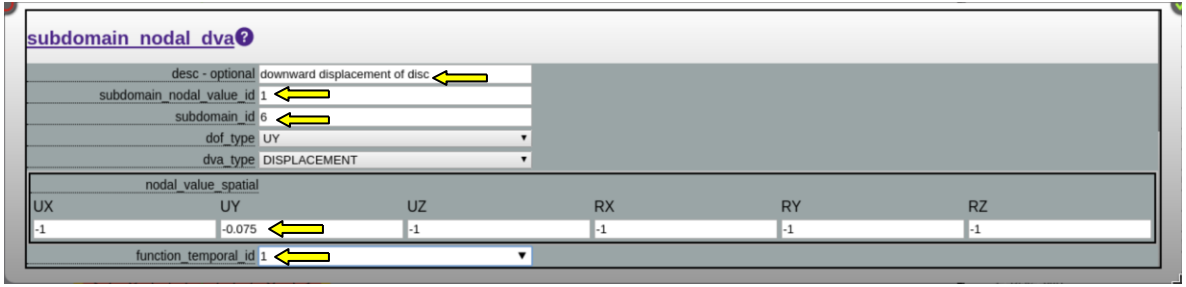


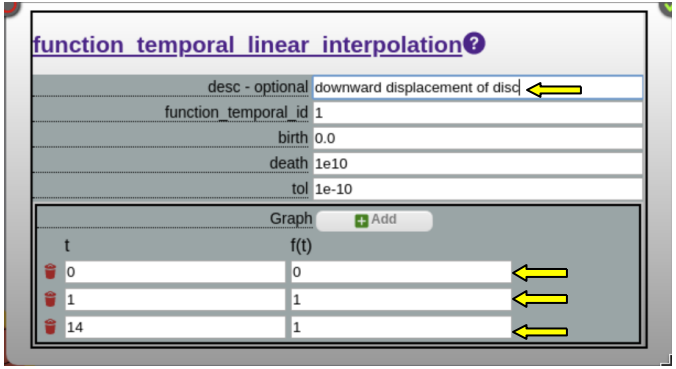
Problem and Control Model

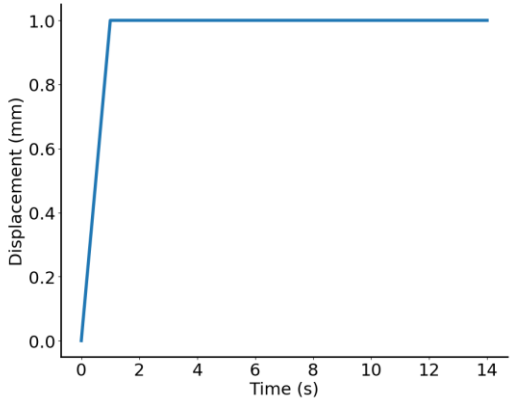




Downward displacement of disc







Right displacement of disc

subdomain_nodal_dva

desc - optional	right displacement of disc
subdomain_nodal_value_id	2
subdomain_id	6
dof_type	UX
dva_type	DISPLACEMENT

nodal_value_spatial

UX	UY	UZ	RX	RY	RZ
0.075	-1	-1	-1	-1	-1

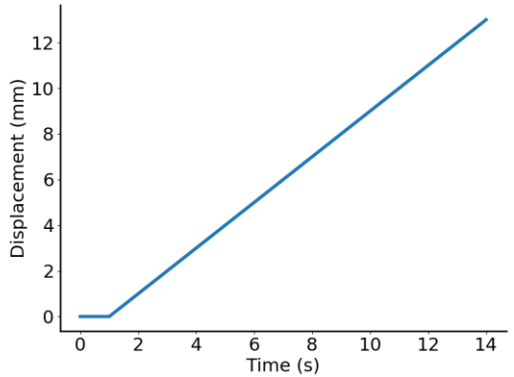
function_temporal_id 2

function_temporal_linear_interpolation

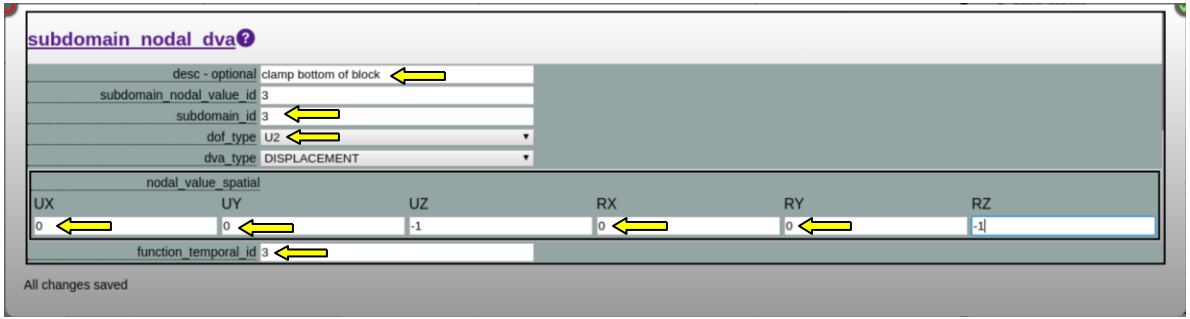
desc - optional	right displacement of disc
function_temporal_id	2
birth	0.0
death	1e10
tol	1e-10

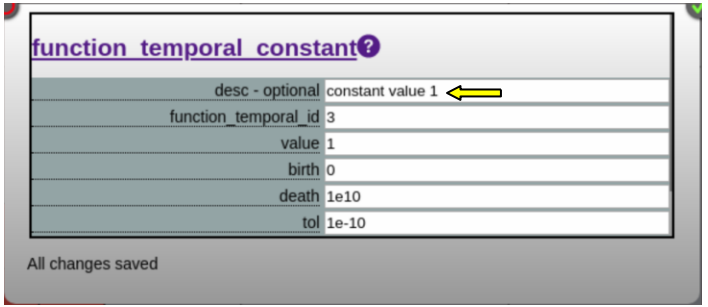
Graph Add

t	f(t)
0	0
1	0
2	1
14	13

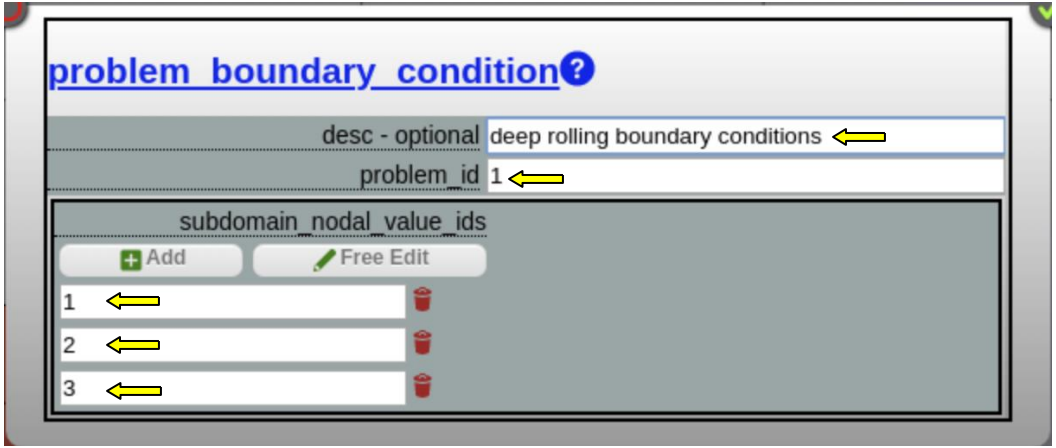


Clamp bottom of block

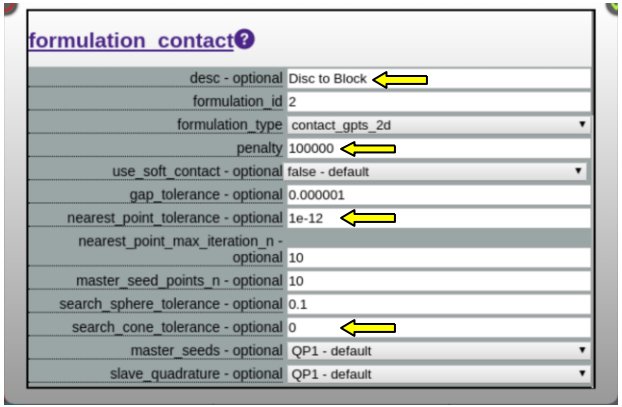


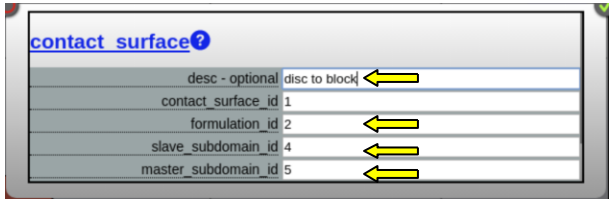


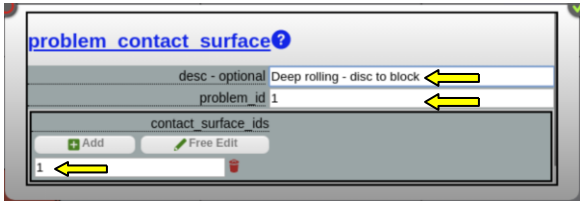
Problem boundary condition



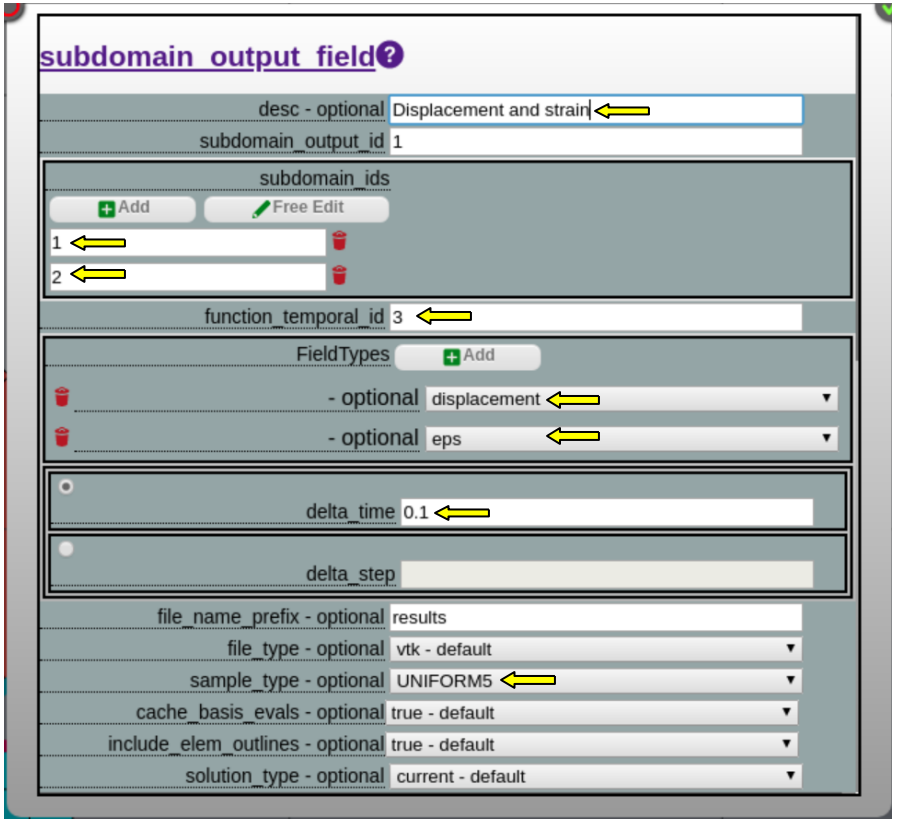
Set up contact



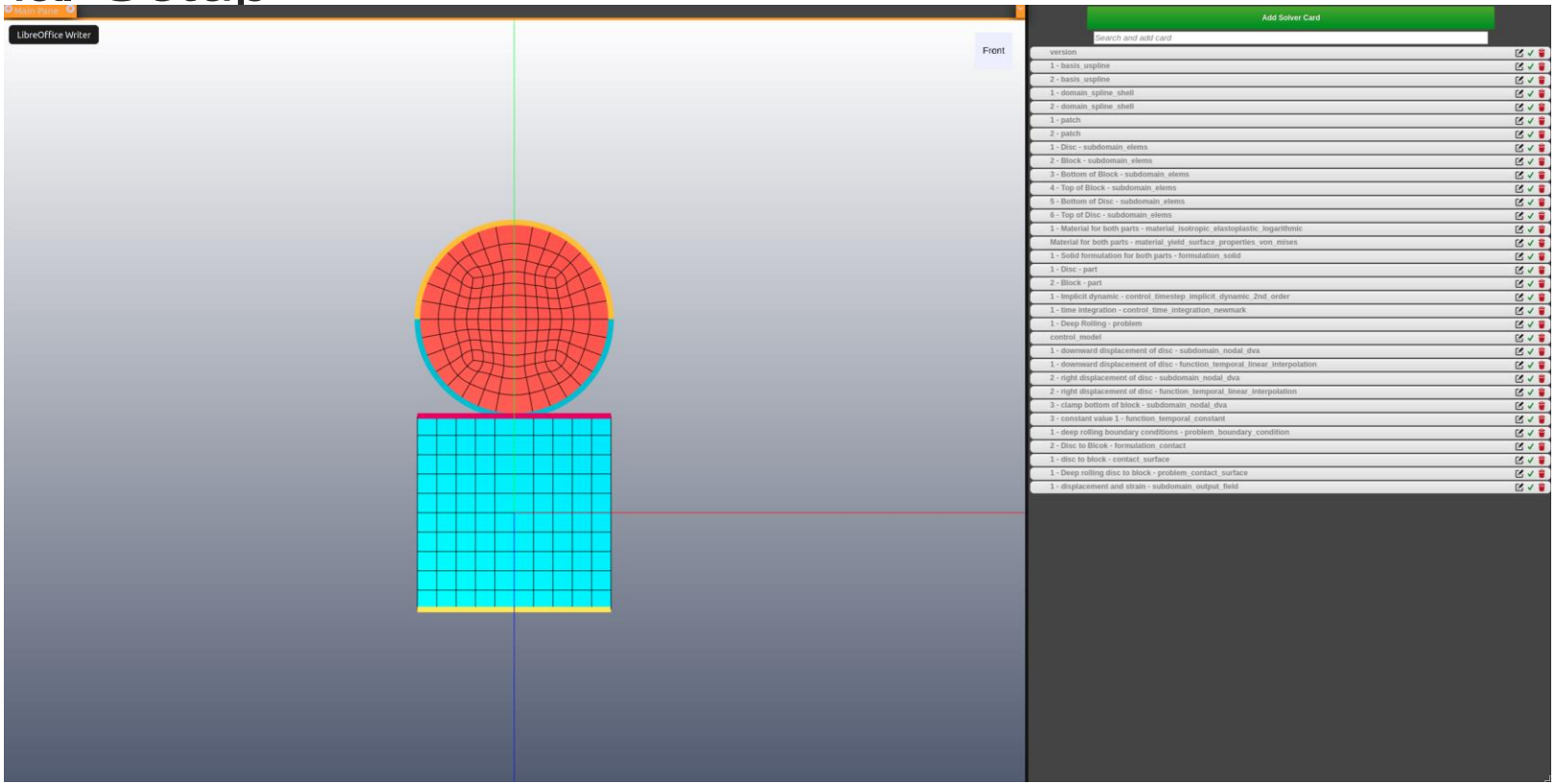




Output


subdomain_output_field
desc - optional
Displacement and strain
subdomain_output_id
1
subdomain_ids
Add
Free Edit
1
2
function_temporal_id
3
FieldTypes
Add
- optional
displacement
- optional
eps
delta_time
0.1
delta_step
file_name_prefix - optional
results
file_type - optional
vtk - default
sample_type - optional
UNIFORM5
cache_basis_evals - optional
true - default
include_elem_outlines - optional
true - default
solution_type - optional
current - default

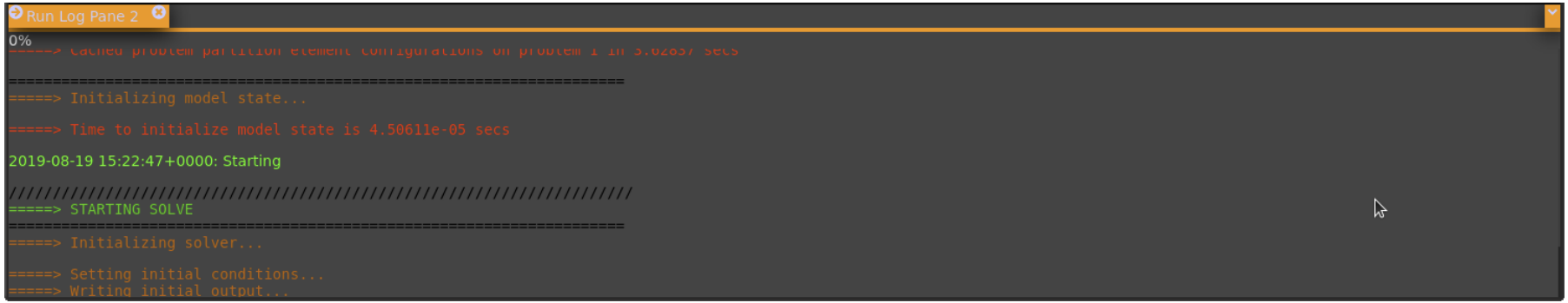
Final Setup


LibreOffice Writer
Front
Add Solver Card
Search and add card
version
1 - basis_uspline
2 - basis_uspline
1 - domain_spline_shell
2 - domain_spline_shell
1 - patch
2 - patch
1 - Disc - subdomain_elems
2 - Block - subdomain_elems
3 - Bottom of Block - subdomain_elems
4 - Top of Block - subdomain_elems
5 - Bottom of Disc - subdomain_elems
6 - Top of Disc - subdomain_elems
1 - Material for both parts - material_isotropic_elastoplastic_logarithmic
Material for both parts - material_yield_surface_properties_von_mises
1 - Solid formulation for both parts - formulation_solid
1 - Disc - part
2 - Block - part
1 - Implicit dynamic - control_timestep_implicit_dynamic_2nd_order
1 - time integration - control_time_integration_newmark
1 - Deep Rolling - problem
control_model
1 - downward displacement of disc - subdomain_nodal_dva
1 - downward displacement of disc - function_temporal_linear_interpolation
2 - right displacement of disc - subdomain_nodal_dva
2 - right displacement of disc - function_temporal_linear_interpolation
3 - clamp bottom of block - subdomain_nodal_dva
3 - constant value 1 - function_temporal_constant
1 - deep rolling boundary conditions - problem_boundary_condition
2 - Disc to Block - formulation_contact
1 - disc to block - contact_surface
1 - Deep rolling disc to block - problem_contact_surface
1 - displacement and strain - subdomain_output_field

Run simulation

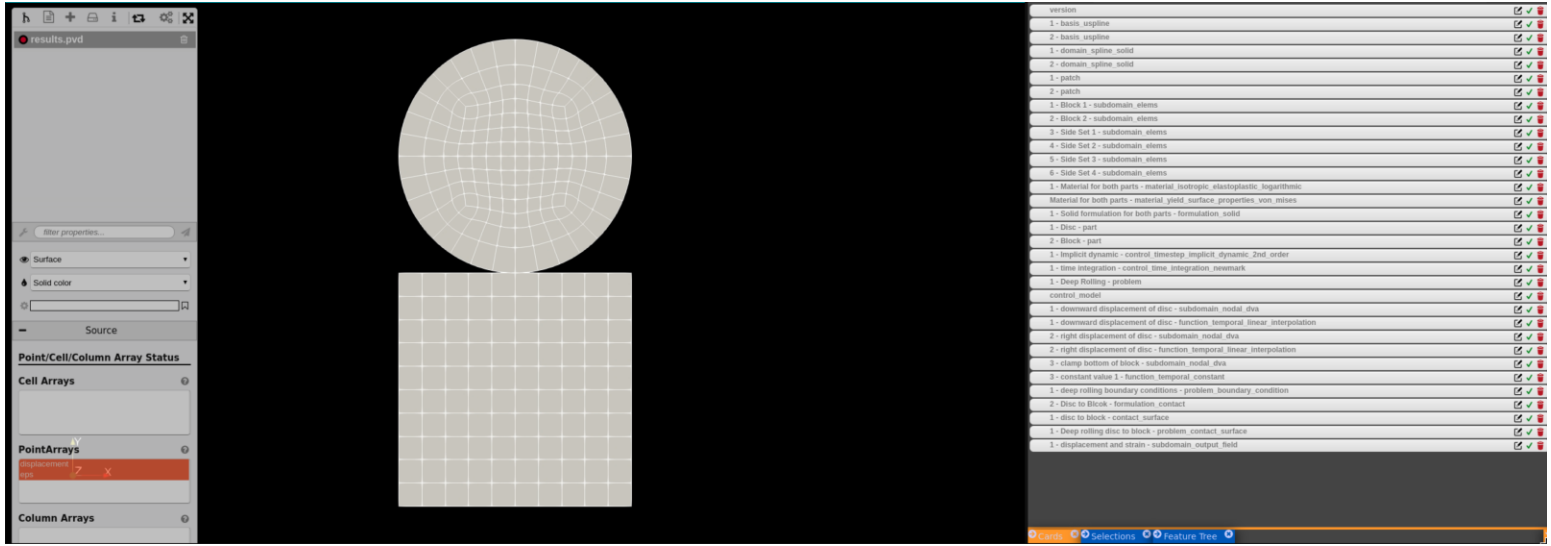
```
SPC - r - r
```

A pane will open along the bottom of the screen with information about the running simulation



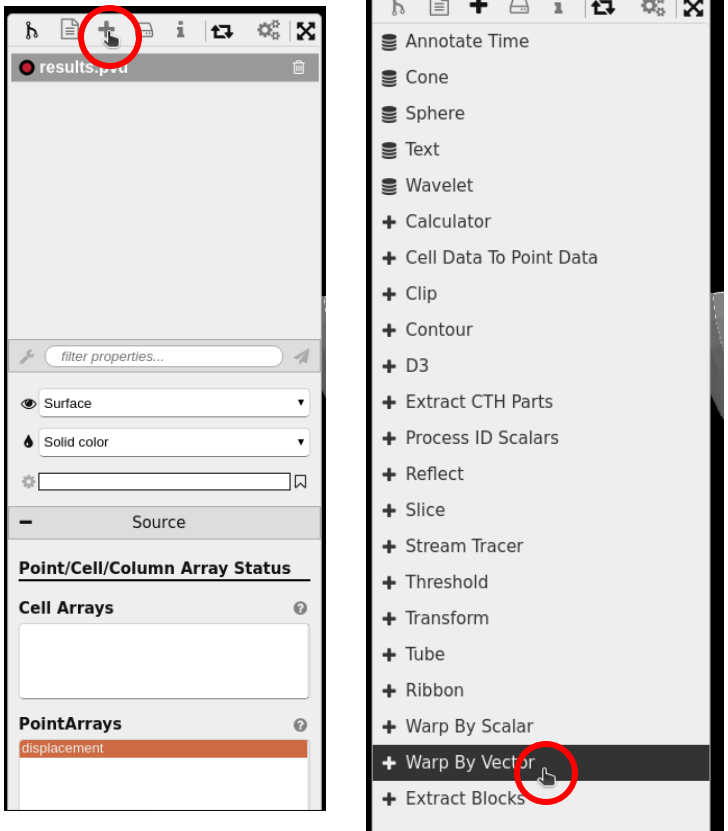
When the simulation is finished, the results will open automatically.

View Results

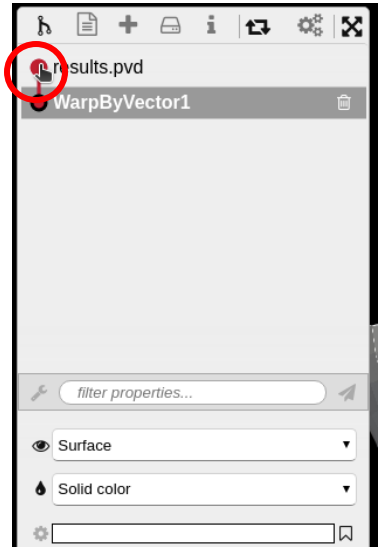


View results

Add a data visualization: Click the + button at the top of the left pane, then choose Warp By Vector



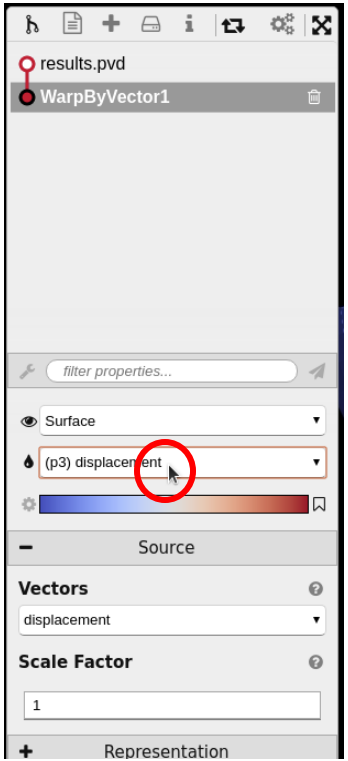
Turn off the base visualization by clicking the red circle next to results.pvd



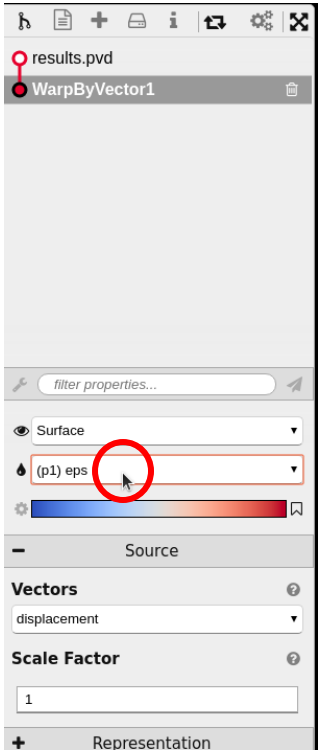
View results

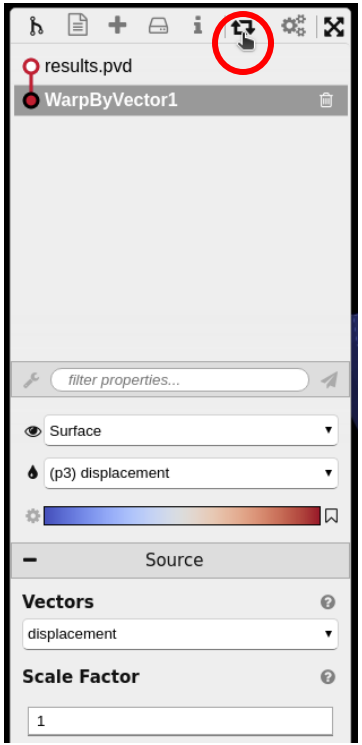
Change the coloring from Solid Color to (p3) displacement or (p1) eps.

Click the circling arrows to correctly scale the colormap.

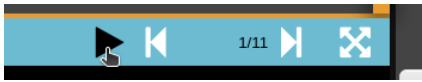


OR

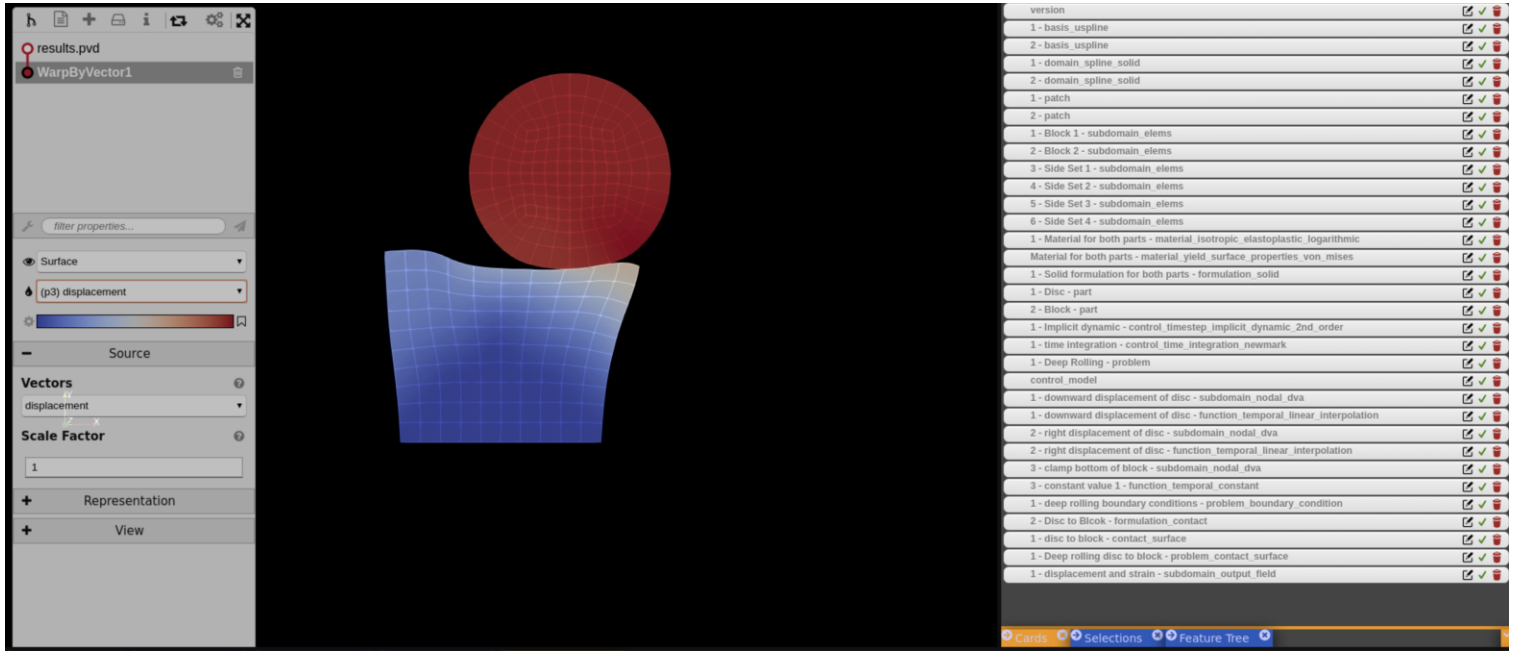




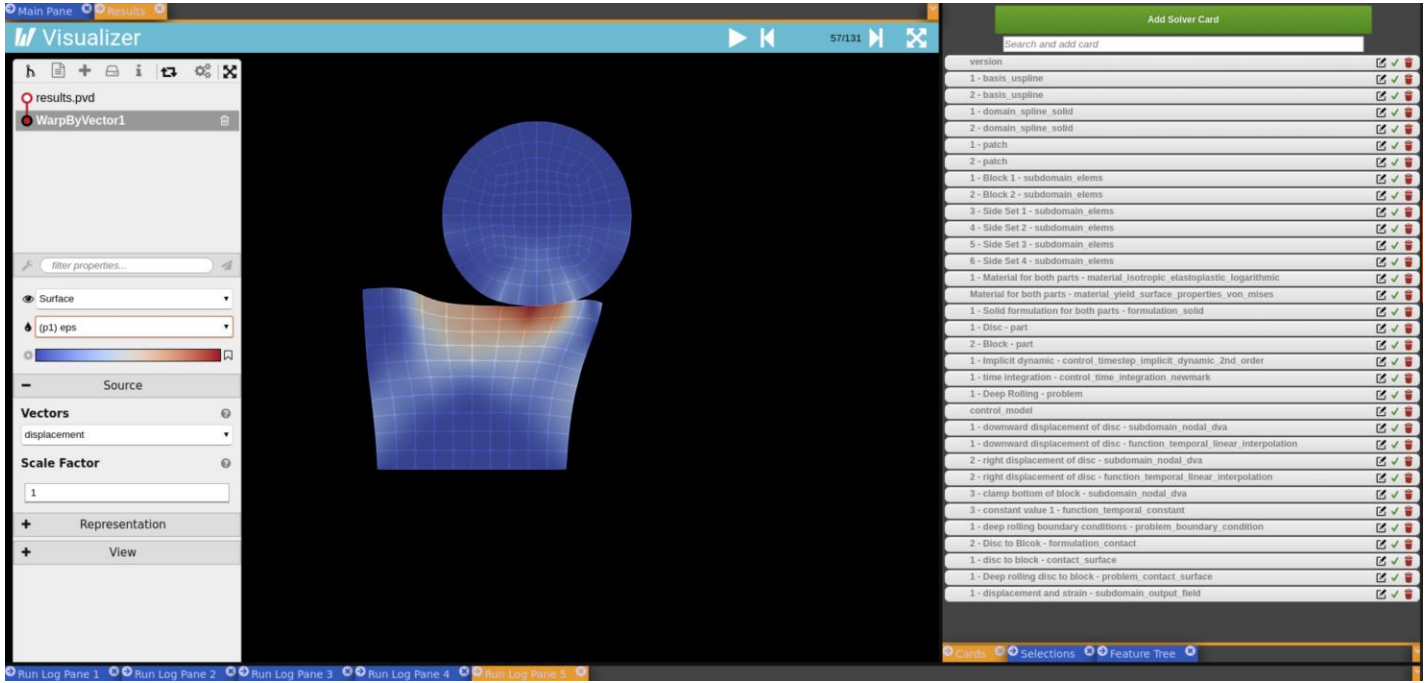
Click the play arrow in the upper right of the results pane to play the results animation.



Displacements



EPS


Main Pane
Results
Visualizer
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results.pvd
WarpByVector1
filter properties...
Surface
(p1) eps
Source
Vectors
displacement
Scale Factor
1
Representation
View
Add Solver Card
Search and add card
version
1 - basis_uspline
2 - basis_uspline
1 - domain_spline_solid
2 - domain_spline_solid
1 - patch
2 - patch
1 - Block 1 - subdomain_elems
2 - Block 2 - subdomain_elems
3 - Side Set 1 - subdomain_elems
4 - Side Set 2 - subdomain_elems
5 - Side Set 3 - subdomain_elems
6 - Side Set 4 - subdomain_elems
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1 - disc to block - contact_surface
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1 - displacement and strain - subdomain_output_field
Cards
Selections
Feature Tree
Run Log Pane 1
Run Log Pane 2
Run Log Pane 3
Run Log Pane 4
Run Log Pane 5