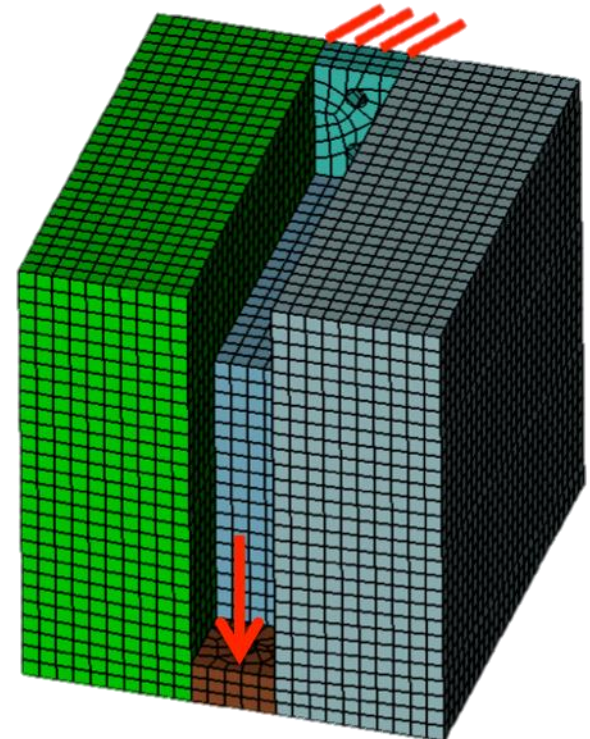


# Getting Started Tutorial

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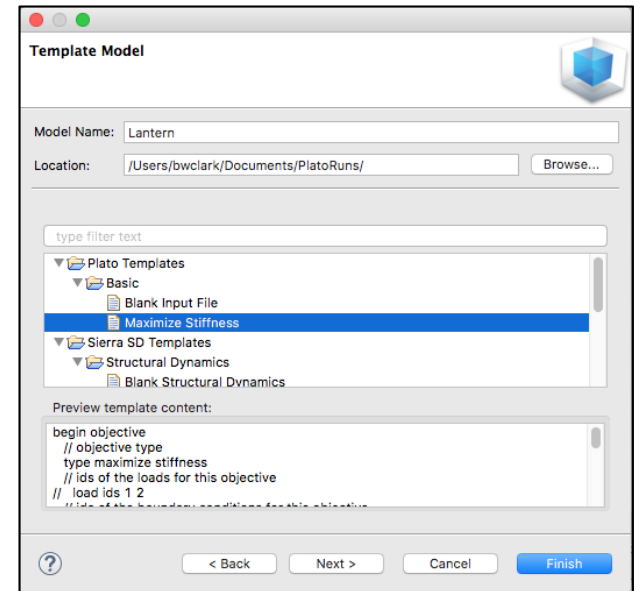
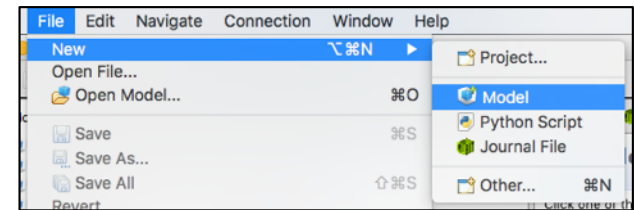
# Lantern Bracket Problem

- This tutorial will walk you through a simple topology optimization problem where we will design a bracket for mounting a lantern to a wall.
- The design domain is shown in the bottom image. The two holes at the top are where the bracket will mount to the wall and the hole where the red arrow is pointing is where the load from the weight of the lantern will be applied.



# Create a New Model

- Choose **File->New->Model** in the menu
- Choose **New Model** then **Next**
- Choose **Create From Template** then **Next**
- Enter **Lantern** as the **Model Name**
- Choose the **Plato Templates->Basic->Maximize Stiffness** template and then **Finish**



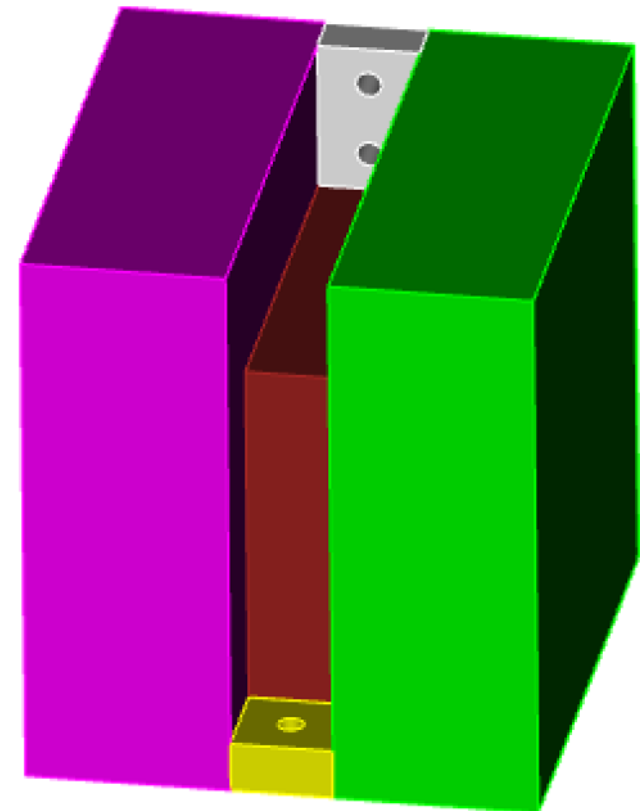
# Create the Design Domain

- At the **CUBIT**> command prompt copy and paste the following (see Hint on next slide):
  - brick x 5.5 y 5.5 z 5
  - webcut volume all with plane zplane offset .5
  - webcut volume all with plane zplane offset -.5
  - brick x 1 y 5 z 1
  - vol 4 move -2.25 .25 0
  - subtract vol 4 from vol 2
  - brick x 5.5 y 1.5 z 1
  - vol 5 move -.5 2 0
  - sub 5 from 2
  - webcut volume 2 with sheet extended from surface 48
  - webcut volume 6 with sheet extended from surface 45
  - cylinder radius .125 height 10
  - vol 8 copy rotate 90 about x
  - vol 9 move -2.25 0 0
  - sub 9 from Volume 2
  - vol 8 rotate 90 about y
  - vol 8 move 0 2.375 0
  - vol 8 copy move 0 -.75 0
  - sub 10 8 from 6
- These are CUBIT commands that create the cad model representation of the design domain in which the optimized design can exist.

```

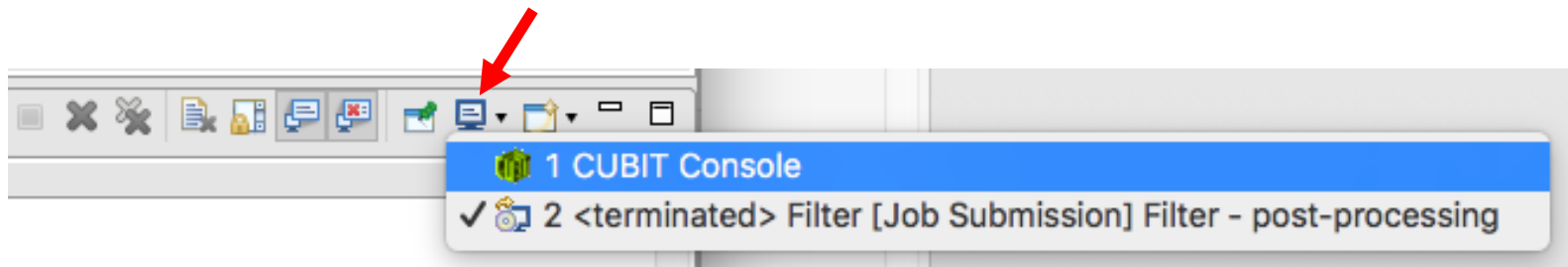
CUBIT Console
CUBIT Command History
Machines

CUBIT Console
CUBIT> brick x 5.5 y 5.5 z 5
webcut volume all with plane zplane offset .5
webcut volume all with plane zplane offset -.5
brick x 1 y 5 z 1
vol 4 move -2.25 .25 0
subtract vol 4 from vol 2
brick x 5.5 y 1.5 z 1
vol 5 move -.5 2 0
sub 5 from 2
webcut volume 2 with sheet extended from surface 48
webcut volume 6 with sheet extended from surface 45
  
```



# Hint: Cubit Console

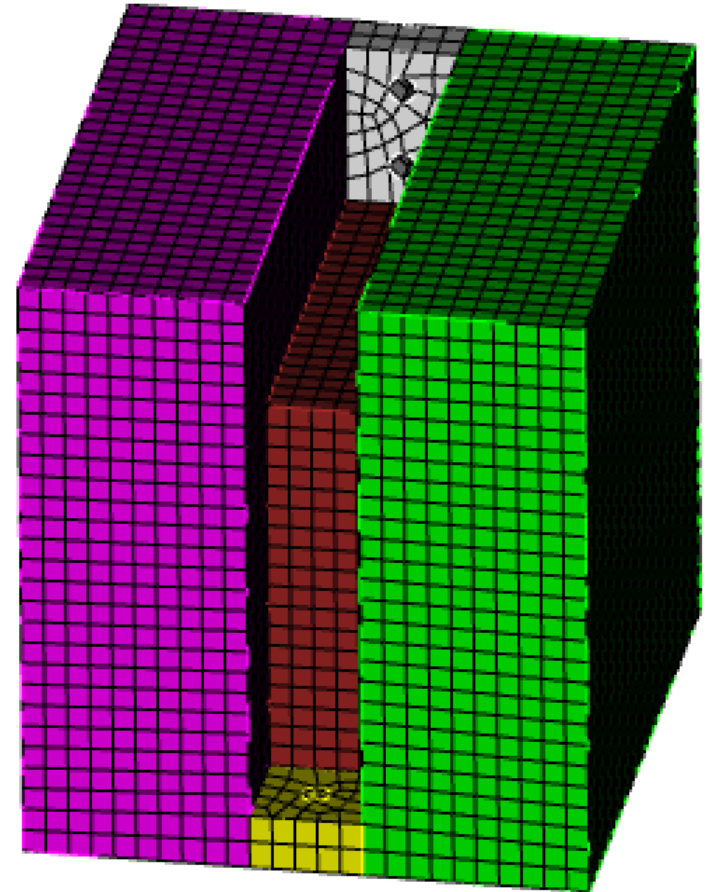
- If you don't see the **CUBIT>** prompt in the console window you are just looking at the wrong console (there may be multiple to choose from loaded in Plato that use the single console window). Click on the icon at the top right of the console window that looks like a computer screen to toggle through the different consoles that are currently loaded. Or you can click on the down arrow next to the computer screen icon to see all of the currently loaded consoles and choose one from the list.



# Create the Design Domain

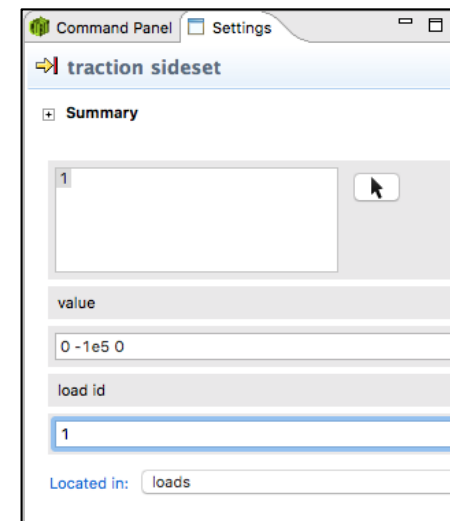
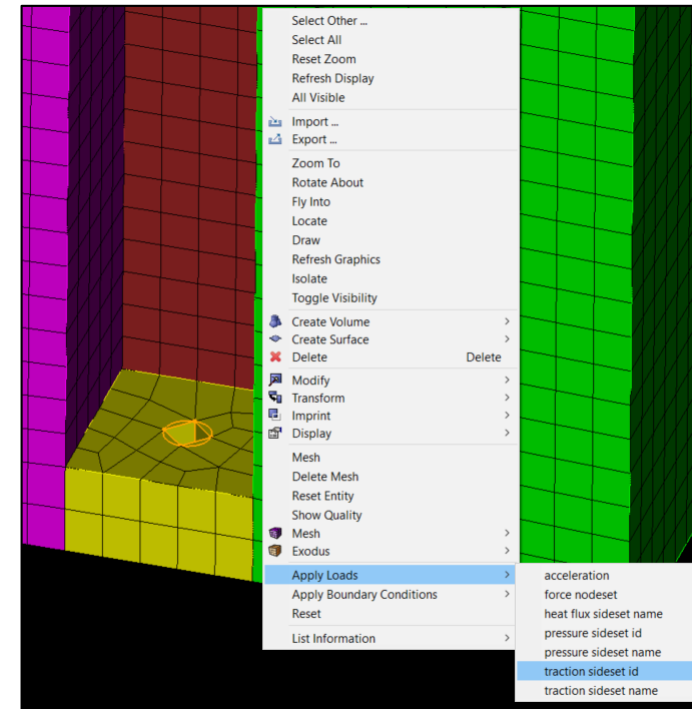
- At the **CUBIT**> command prompt copy and paste the following:  

```
imprint all
merge all
vol all size .2
mesh vol all
block 1 vol 3 7 1
block 2 vol 2 6
```
- These commands imprint the volumes onto each other and then merge the surfaces between them so that the mesh will be contiguous from volume to volume.
- Then the volumes are meshed and put in blocks based on whether they will be “fixed” or “optimizable”. In our case we will fix the volumes where the bracket attaches to the wall and where the lantern will be attached.
- See the **FixedBlocks** tutorial for more info on fixed blocks.



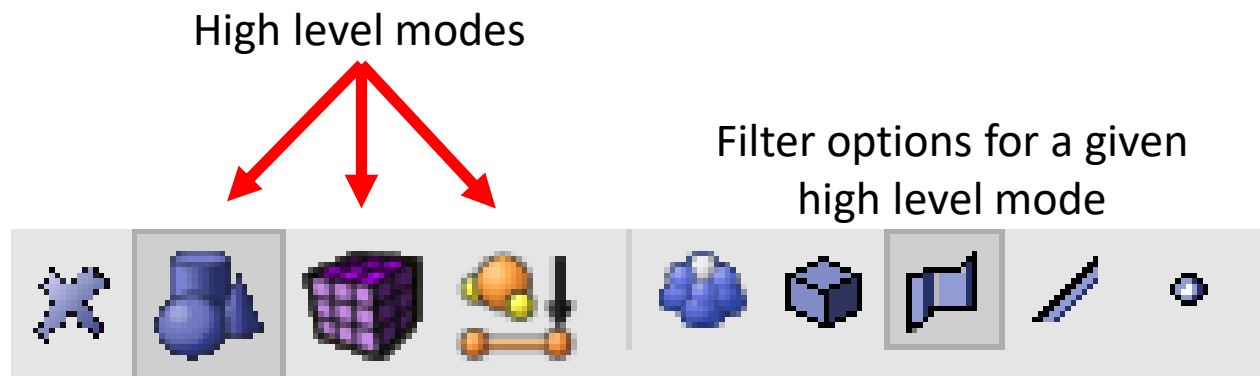
# Apply Lantern Load

- Select and right-click the inner cylindrical surface where the lantern will be attached (shown highlighted in orange) and choose **Apply Loads->traction sideset id**. (see Entity Selection Hint on next slide)
- In the **Settings** panel enter “0 -1e5 0” in the box below **value** and then enter “1” in the box below “**load id**” and hit **return**.



# Hint: Entity Selection

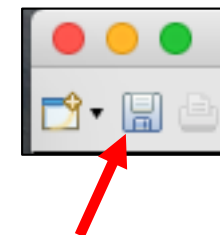
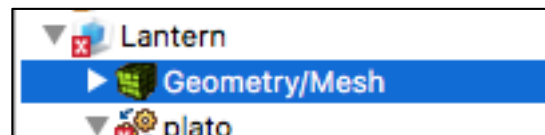
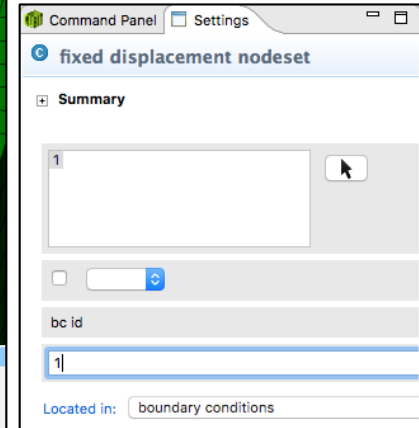
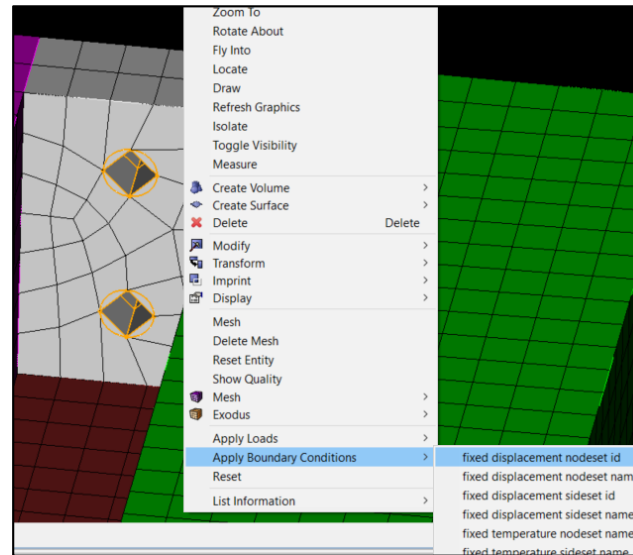
- The selection filter toolbar is at the bottom left of the graphics window.
- There are 3 high level modes: Geometry, Mesh, and Exodus
- Within each high level mode there are various options for filtering what will get selected by clicks in the graphics window.





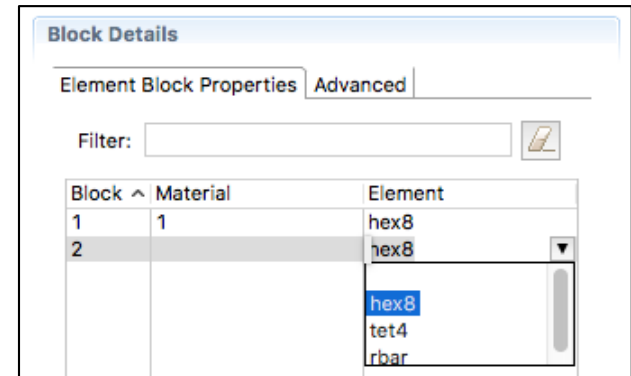
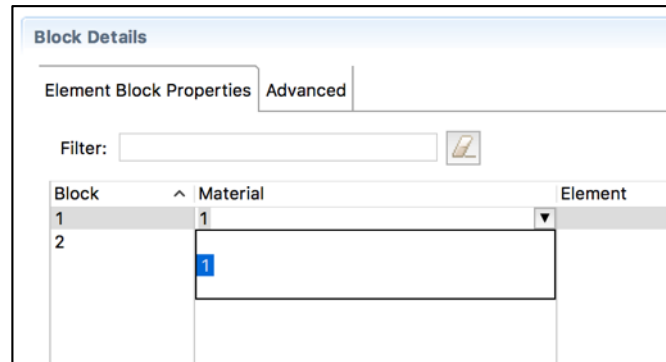
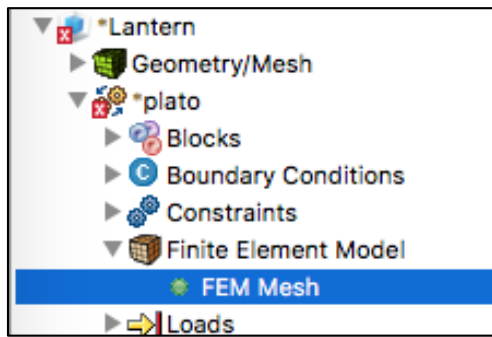
# Create a Fixed BC

- Select the two inner cylindrical surfaces where the bracket will be attached to the wall. On Windows and Linux use Ctrl-Select to select multiple surfaces and on Mac use Command-Select. After selecting the two surfaces right-click and choose **Apply Boundary Conditions->fixed displacement nodeset id**.
- In the **Settings** panel enter **"1"** in the **"bc id"** edit field and hit **return**.
- Click on **Geometry/Mesh** node in the tree and then click the **Save** icon in the toolbar to save the model



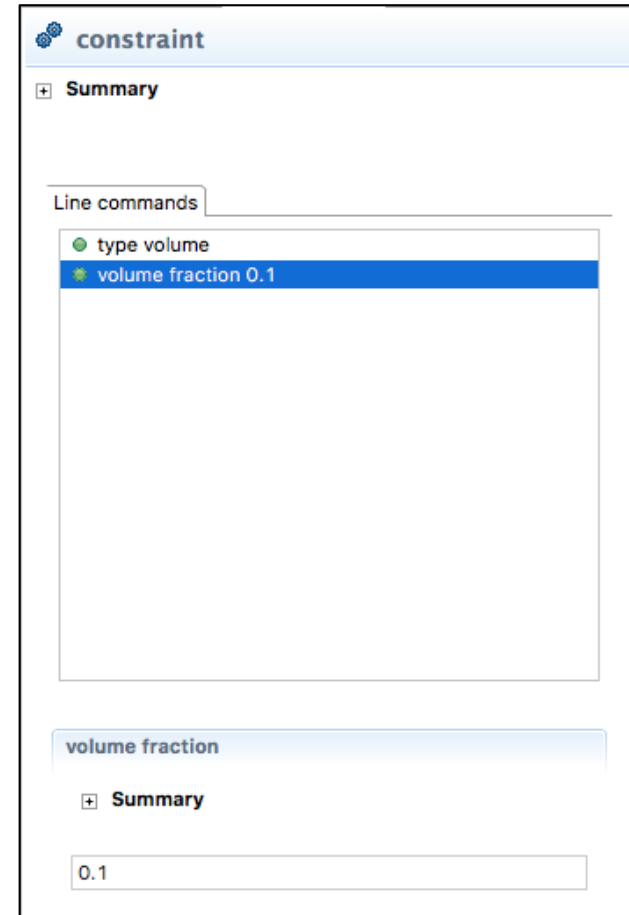
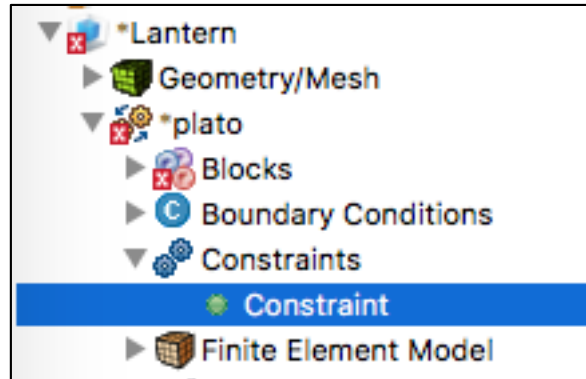
# Assign Material and Element Type

- Click on the **FEM Mesh** node in the tree under **plato** > **Finite Element Model**
- In the **Settings** panel click in the **Material** area next to Block 1 and select **1** from the dropdown list
- Then click in the **Element** area next to Block 1 and select **hex8** from the dropdown list
- Do the same for Block 2



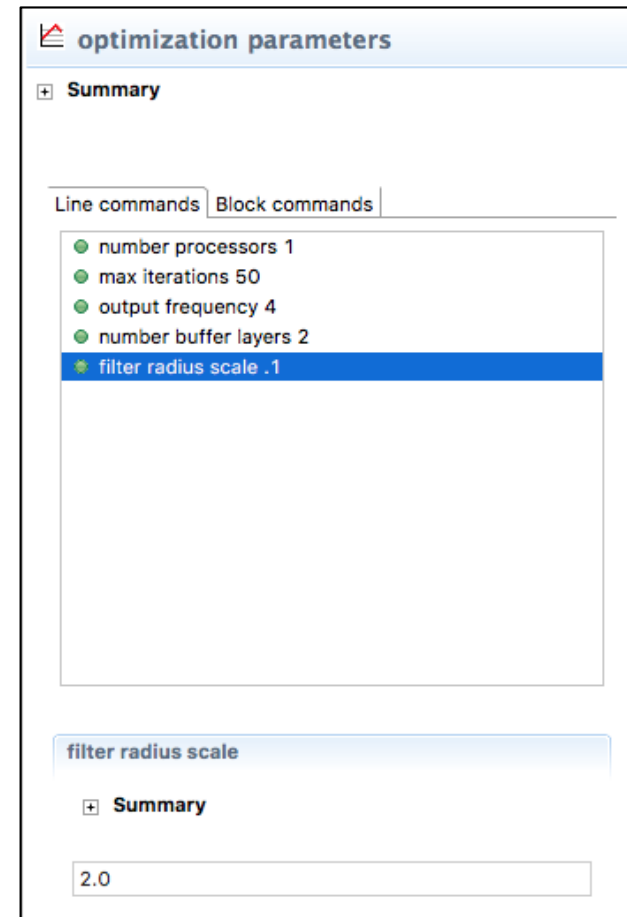
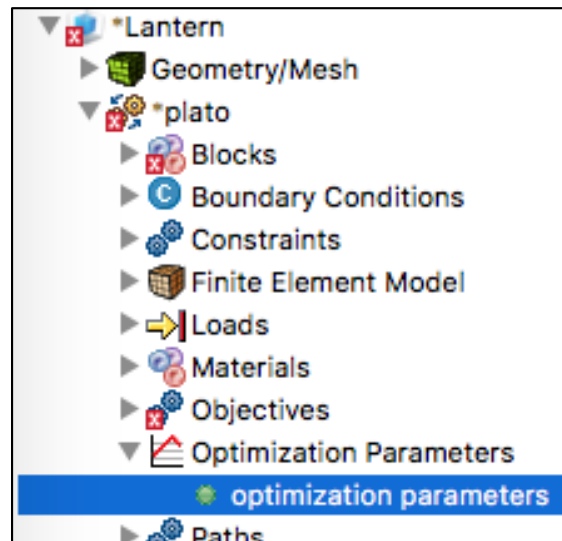
# Set the Volume Fraction

- Click on the **Constraints->Constraint** node in the tree
- In the **Settings** panel click on **volume fraction** and type in **0.1** for the value and hit the **return** key.  
This will tell Plato that we want the resulting design to only use 10% of the starting design domain volume.



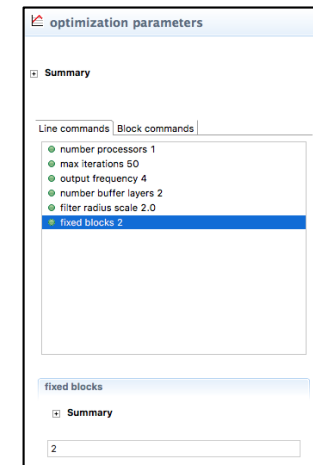
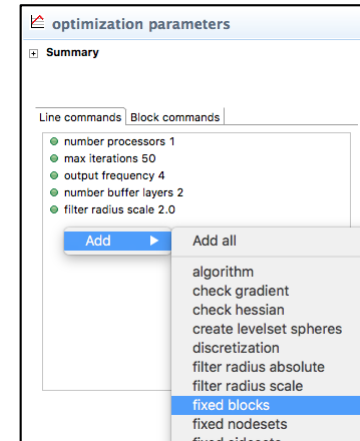
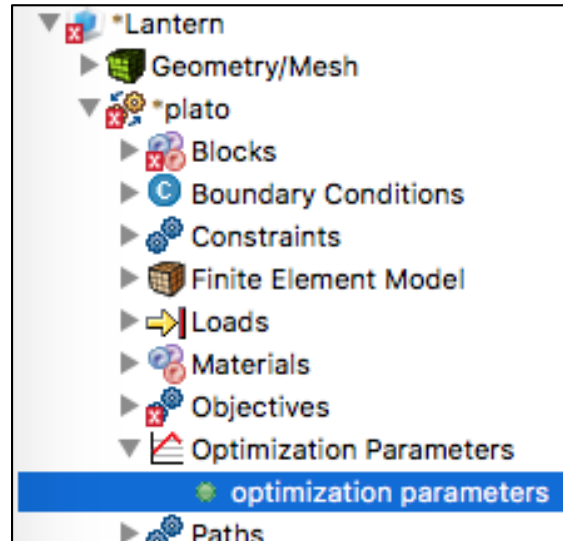
# Set the Filter Radius

- Click on the **Optimization Parameters**-> **optimization parameters** node in the tree
- In the **Settings** panel click on **filter radius scale** and type in **2.0** for the value and hit the **return** key. This will tell Plato to use a filter radius that is 2 times the average mesh edge length in the model. The filter radius will affect feature size as well as smoothness in the resulting design.



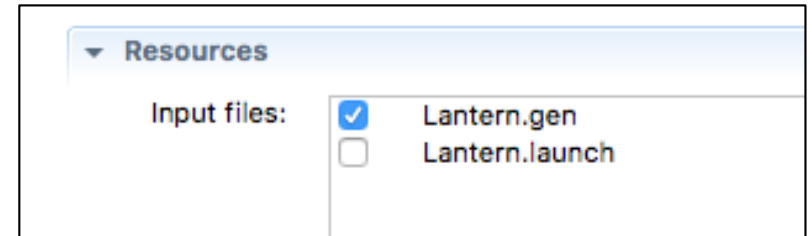
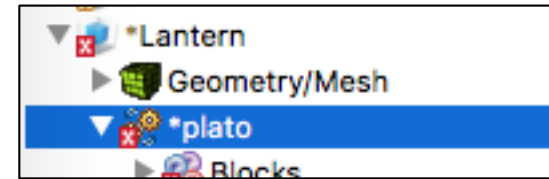
# Add a Fixed Block

- Click on the **Optimization Parameters-> optimization parameters** node in the tree
- In the **Settings** panel right-click anywhere in the Parameters area and choose **Add->fixed blocks**. Enter **2** for the fixed block id and hit the **return** key. This will tell Plato to not allow any of the material in Block 2 to be optimized away.



# Run the Optimization

- Click on the **plato** node in the tree to bring up the job submission panel in the **Settings** view
- Choose **Plato** as the code and then choose the machine and corresponding execution template. If you have a local installation of Sierra choose **local** as the machine and **Plato\_Salinas\_Local** as the execution template.



- In the **Resources** area make sure **Lantern.gen** is checked. This is the mesh file that will be used.
- In the **Prune and Refine** area make sure **Prune Mesh** is unchecked and **Number Refines** is **0**. We will not use these features in this example.
- Choose any other preferences and launch the job by clicking on **Submit Simulation Job** toward the top of the panel

# Results

- Your results should look like the image shown here.
- At this point you can try modifying parameters and resubmitting the job and each time it will just overwrite the results from the previous run.
- This tutorial should give you a general overview of the process. Try the other tutorials at [www.sandia.gov/plato3d](http://www.sandia.gov/plato3d) to learn about specific features.
- The coarseness or roughness of the result is related to mesh resolution. See the “Prune and Refine” tutorial to learn how to efficiently generate smooth results.

