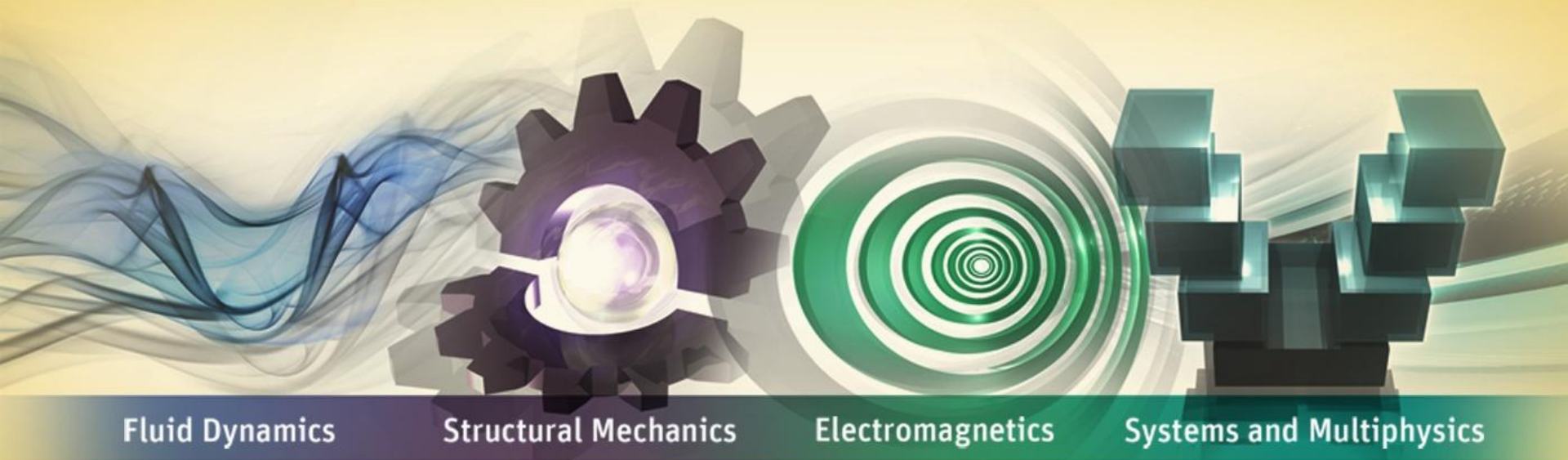
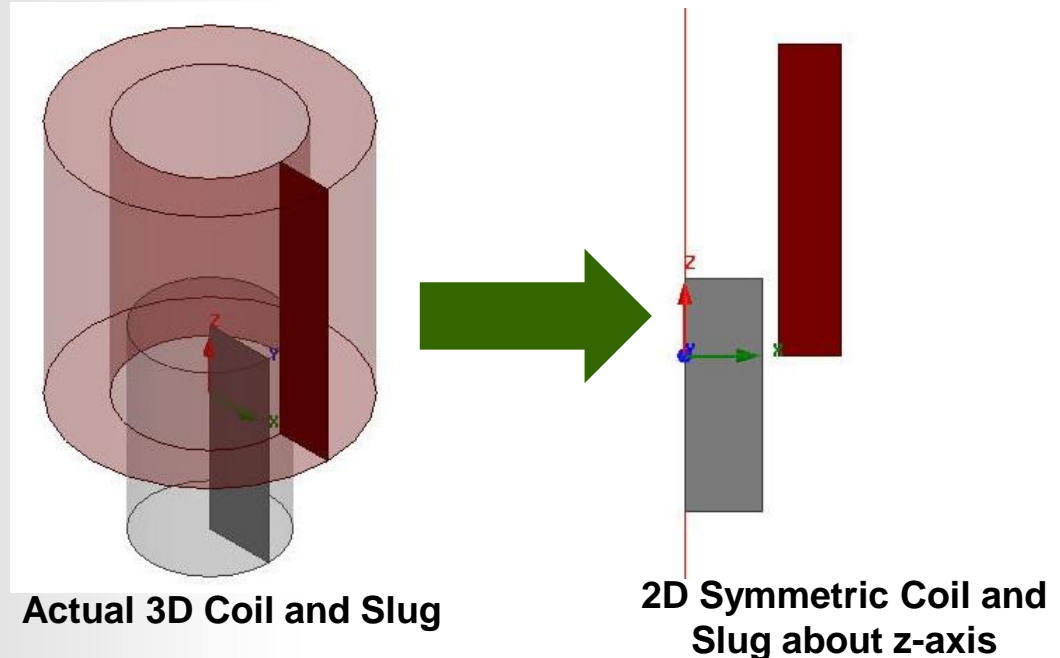


# Workshop 1: Basic Magnetostatic Analysis



## ANSYS Maxwell 2D V16

- **Force calculation in Magnetostatic Solver**
  - This workshop will discuss how to set up a force calculation in the 2D Magnetostatic Solver.
- **Problem Description**
  - As shown in the following picture, a coil and slug are drawn in a plane using RZ symmetry. The coils carry a current that exert a vertical force on the ferromagnetic slug.



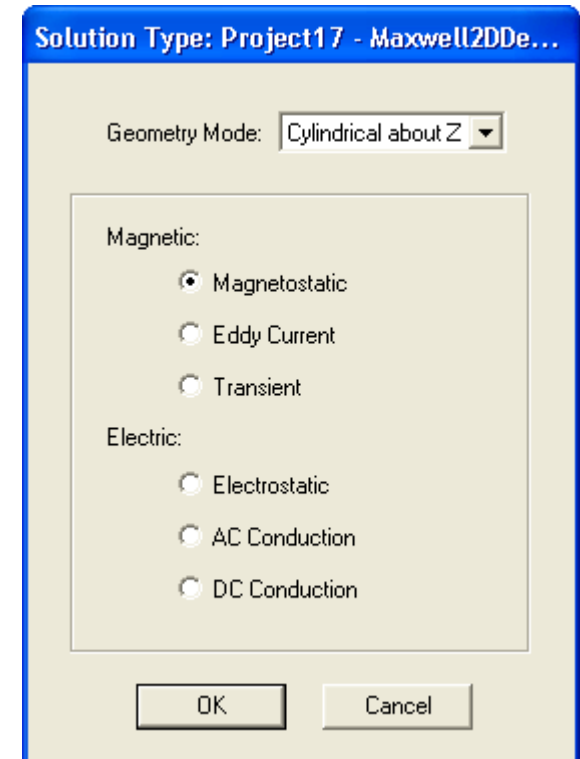
# Problem Setup

- **Create Design**

- Select the menu item **Project** → **Insert Maxwell 2D Design**, or click on the  icon

- **Set Solution Type**

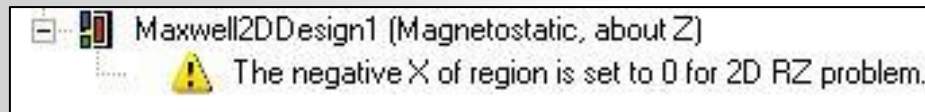
- Select the menu item **Maxwell 2D** → **Solution Type**
- Solution Type Window:
  1. Geometry Mode: **Cylindrical about Z**
  2. Choose **Magnetic > Magnetostatic**
  3. Click the **OK** button



- **Create Slug**
  - Select the menu item **Draw → Rectangle**
    1. Using the coordinate entry fields, enter the position of rectangle
      - **X: 0, Y: 0, Z: -10**, Press the **Enter** key
    2. Using the coordinate entry fields, enter the opposite corner
      - **dX: 5, dY: 0, dZ: 15**, Press the **Enter** key
  - Change the name of resulting sheet to **Slug** and color to **Gray**
  - Change the material of the sheet to **Steel\_1008**
- **Create Coil**
  - Select the menu item **Draw → Rectangle**
    1. Using the coordinate entry fields, enter the position of rectangle
      - **X: 6, Y: 0, Z: 0**, Press the **Enter** key
    2. Using the coordinate entry fields, enter the opposite corner
      - **dX: 4, dY: 0, dZ: 20**, Press the **Enter** key
  - Change the name of resulting sheet to **Coil** and color to **Brown**
  - Change the material of the sheet to **Copper**

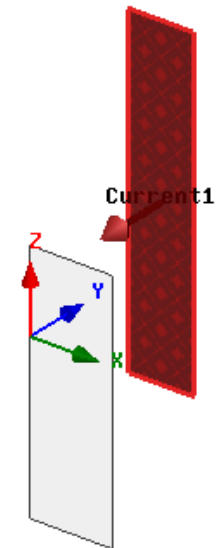
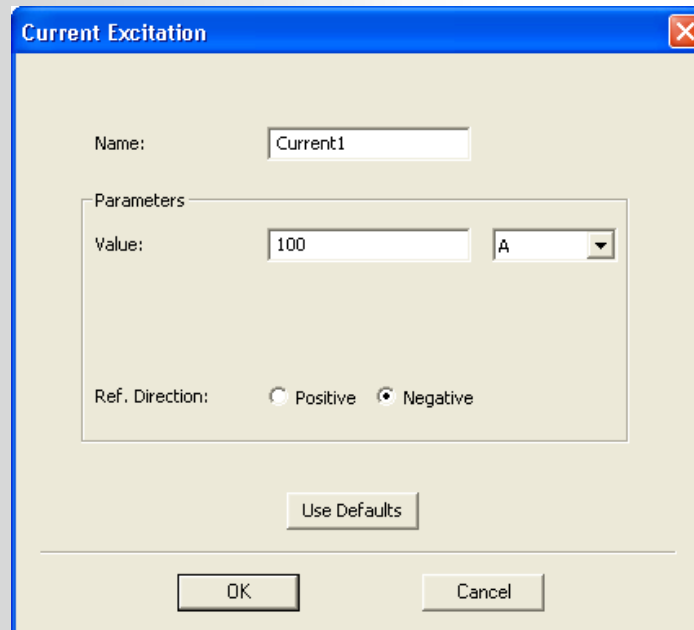
# Define Region

- **Create Simulation Region**
  - Select the menu item **Draw → Region**
  - In Region window,
    1. Pad all directions similarly: ☒ **Checked**
    2. Padding Type: **Percentage Offset**
    3. Value: **100**
    4. Press **OK**
  - You should see a message indicating that the  $-X$  direction is set to zero due to RZ-symmetry about the Z-axis.



# Assign Excitations

- **Assign Excitations**
  - Select the sheet **Coil** from history tree
  - Select the menu item **Maxwell 2D** → **Excitations** → **Assign** → **Current**
    - Name: **Current1**
    - Value: **1000**
    - Ref. Direction: **Negative** (current will be in the negative Y direction)



# Assign Boundary and Parameter

- **Assign Boundary to Region Edges**
  - Select the object Region from history tree
  - Select the menu item **Edit → Select → All Object Edges**
  - Select the menu item **Maxwell 2D → Boundaries → Assign → Balloon**
  - In Balloon Boundary window,
    - Press **OK**

*Note: On symmetry axis, “Balloon Boundary” assignment is automatically skipped, This can also be achieved by selecting the edges of region which are not on symmetry axis.*

- **Assign Force Calculation**
  - Select the object **Coil** from history tree
  - Select the menu item **Maxwell 2D → Parameters → Assign → Force**
  - In Force Setup window,
    - Press **OK**

- **Create an analysis setup:**
  - Select the menu item ***Maxwell 2D → Analysis Setup → Add Solution Setup***
  - Solution Setup Window:
    1. **General Tab**
      - Maximum Number of Passes: **15**
    2. Click the **OK** button
- **Start the solution process:**
  - Select the menu item ***Maxwell 2D → Analyze All***



- **View Solution Information**
  - Select the menu item **Maxwell 2D → Results → Solution Data**
    - To View Convergence
      - Select the **Convergence** tab

Profile	Convergence	Force	Matrix	Mesh Statistics
<div>           Number of Passes            Completed 7            Maximum 15            Minimum 2         </div> <div>           Energy Error/Delta Energy (%)            Target (1, 1)            Current (0.74774, 0.15339)         </div> <div>           View: <input checked="" type="radio"/> Table <input type="radio"/> Plot         </div> <div>Export...</div>				
Pass	Triangles	Total Energy (J)	Energy Error (%)	Delta Energy (%)
1	59	0.0036837	219.09	N/A
2	100	0.0049937	18.168	35.563
3	133	0.0050849	7.5108	1.8248
4	177	0.0051279	4.8473	0.84702
5	234	0.0051488	2.4573	0.40624
6	308	0.005159	1.556	0.19796
7	407	0.0051669	0.74774	0.15339

- To View Calculated Force Value
  - Select the **Force** tab

Profile	Convergence	Force	Matrix	Mesh Statistics
<div>           Parameter: Force1 Force Unit: newton         </div> <div>           Pass: 7         </div>				
	F(z)			
Total	-0.33974			

# Create Field Plot

- **Plot Magnetic Flux Density**
  - Expand the history tree for Planes
  - Select the plane **Global:XZ**
  - Select the menu item **Maxwell 2D → Fields → Fields → B → Mag\_B**
  - In Create Field Plot window,
    - Press **Done**

