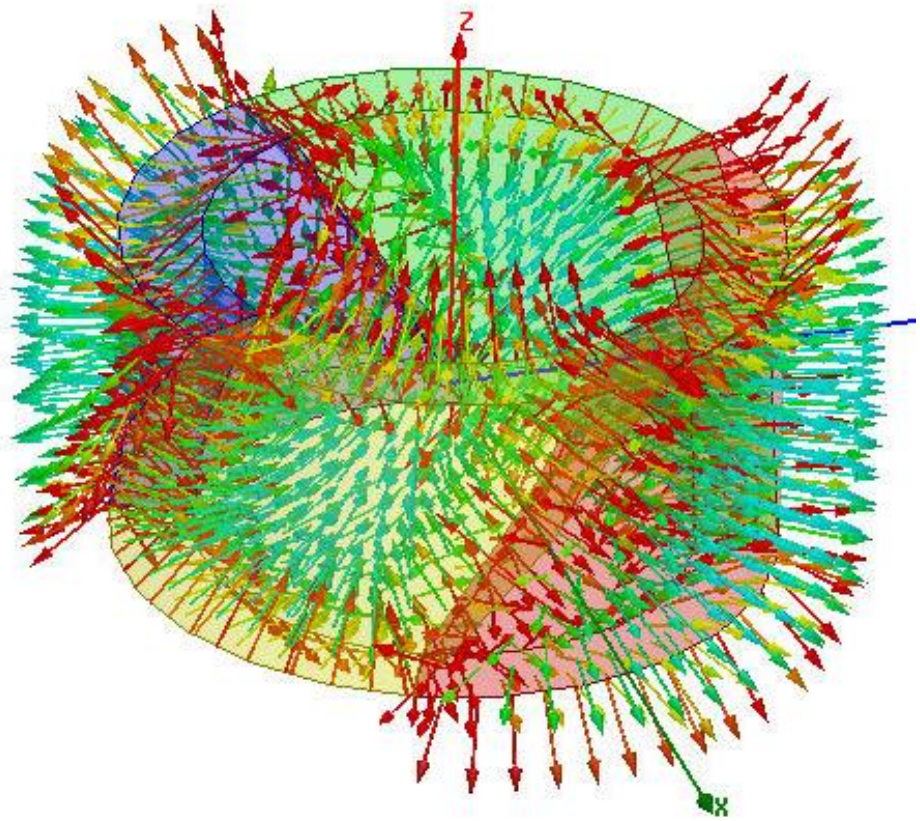
Permanent Magnet Magnetization

- Each object can have the coordinate system that is independent and is arbitrary in Maxwell. The magnetization setting can be done in an arbitrary direction for using this coordinate system.
- Moreover, since it is also possible to do the magnetization setting by using the equation and the numeric character data, the user can do a variety of magnetization settings.
- This chapter introduces the magnetization setting co-ordinate system, by equations for direction or by character data



ANSYS Maxwell Design Environment

- The following features of the Ansoft Maxwell Design Environment are used to create the models covered in this topic
  - 3D Solid Modeling
    - Primitives: **Circle, Line**
    - Modeler operations: **Sweep**
    - Boolean Operations: **Subtract**
  - Analysis
    - **Magnetostatic**
  - Field Overlays:
    - **B Vector Plots**
  - Results
    - **Calculator Expressions**
    - **Plots**

Launching Maxwell

- **To access Maxwell:**
  1. Click the Microsoft **Start** button, select **Programs**, and select **Ansoft > Maxwell 15.0** and select **Maxwell 15.0**

Setting Tool Options

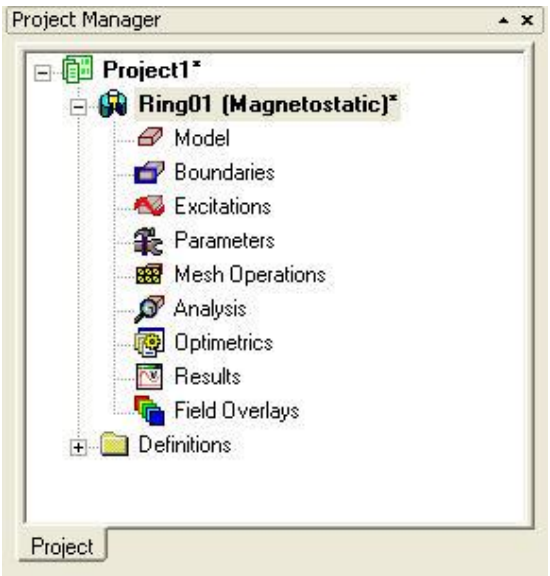
- **To set the tool options:**
  - **Note:** In order to follow the steps outlined in this example, verify that the following tool options are set :
  1. Select the menu item *Tools > Options > Maxwell 3D Options*
     - Maxwell Options Window:
       1. Click the **General Options** tab
          - Use Wizards for data input when creating new boundaries: ☑ **Checked**
          - Duplicate boundaries/mesh operations with geometry: ☑ **Checked**
       2. Click the **OK** button
  2. Select the menu item *Tools > Options > Modeler Options*.
     - Modeler Options Window:
       1. Click the **Operation** tab
          - Automatically cover closed polylines: ☑ **Checked**
       2. Click the **Display** tab
          - Default transparency = 0.8
       3. Click the **Drawing** tab
          - Edit property of new primitives: ☑ **Checked**
       4. Click the **OK** button

Opening a New Project

- **To open a new project:**
  - After launching Maxwell, a project will be automatically created. You can also create a new project using below options.
    1. In an Maxwell window, click the 🗋 On the Standard toolbar, or select the menu item ***File > New***.
  - Select the menu item ***Project > Insert Maxwell 3D Design***, or click on the  icon

Change Design name

- **To Change Design Name:**
  - Right-click **Maxwell3D Design1** at the project manager window and select **Rename.**
  - Change the Design Name to **Ring01**.

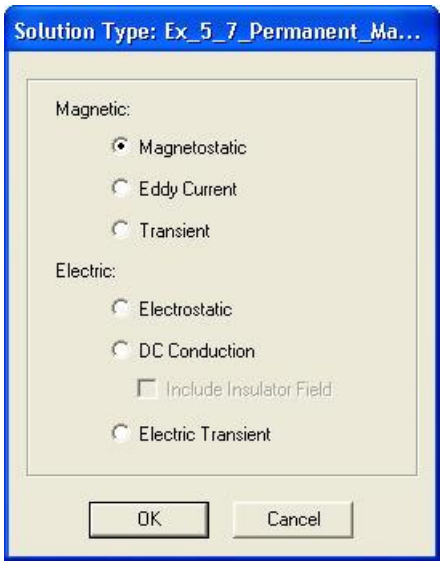


Save Project

- **To save the project:**
  1. In an Ansoft Maxwell window, select the menu item ***File > Save As***.
  2. From the **Save As** window, type the Filename: **Ex_5_7_Permanent_Magnet**
  3. Click the **Save** button

Set Solution Type

- **To set the Solution Type:**
  - Select the menu item *Maxwell 3D > Solution Type*
  - Solution Type Window:
    1. Choose **Magnetostatic**
    2. Click the **OK** button



Set Model Units

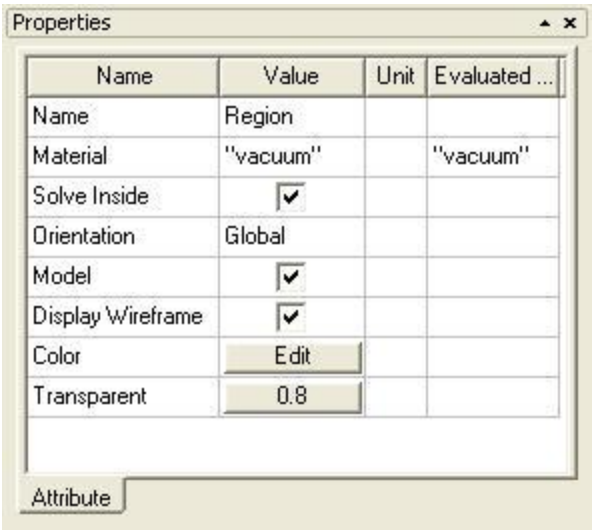
- **To Set the units:**
  - Select the menu item *Modeler > Units*
  - Set Model Units:
    1. Select Units: **mm**
    2. Click the **OK** button

Example1 : Coordinate system of object and setting for each axis

In this example, it is introduced the magnetization using Coordinate system of object.
Material : **Mag_North** and **Mag_South** is newly made in this Example.

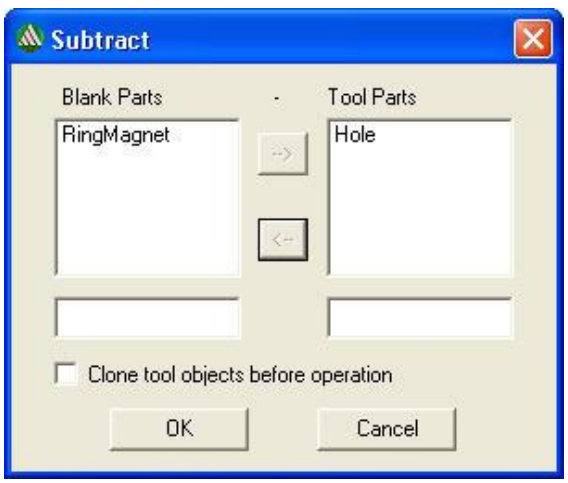
Create Region

- **Create a Box region**
  - Select the menu item ***Draw > Box*** or click on the  icon.
    1. Using the coordinate entry field, enter the box position
       - **X: -200, Y: -200, Z: -200**, Press the **Enter** key
    2. Using the coordinate entry fields, enter the opposite corner of the box:
       - **dX: 400, dY: 400, dZ: 400**, Press the **Enter** key
- **Change Attributes**
  - Select the resulting object from the tree and goto Properties window
    1. Change the name of the object to **Region**
    2. Display Wireframe: ☑ **Checked**

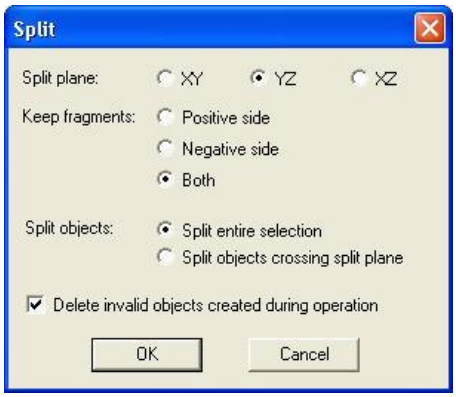


- **Hide Region**
  - Select **Region** from the history tree
  - Select the menu item ***View > Visibility > Hide Selection > Active View***

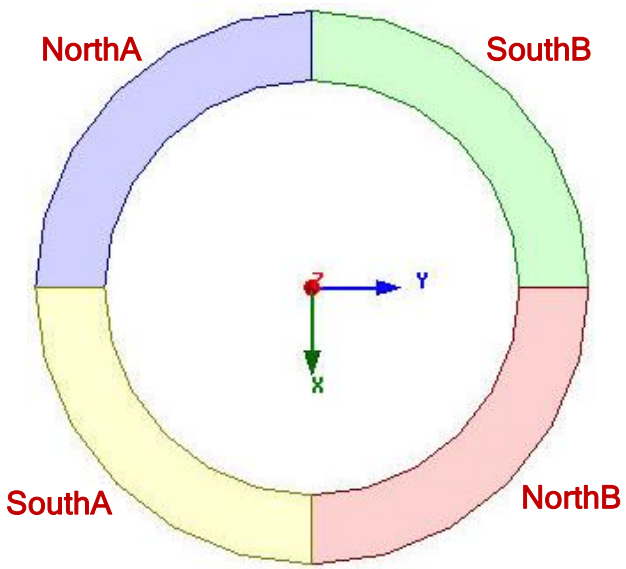
- **Create Magnets**
  - **Create Circle**
    - Goto menu item ***Draw > Circle***
      1. Using the coordinate entry field, enter the center position
         - X: **0,** Y: **0,** Z: **0**, Press the **Enter** key
      2. Using the coordinate entry field, enter the radius of circle
         - dX:**40** for radius, Press the **Enter** key
    - Select the resulting object from the tree and goto Properties window
      1. Change the name of the object to **RingMagnet**
      2. Change its color to **Blue**
  - **Draw another circle**
    - Goto menu item ***Daw > Circle***
      1. Using the coordinate entry field, enter the center position
         - X: **0,** Y: **0,** Z: **0**, Press the **Enter** key
      2. Using the coordinate entry field, enter the radius of circle
         - dX:**30** for radius, Press the **Enter** key
    - Select the resulting object from the tree and goto Properties window
      1. Change the name of the object to **Hole**
  - **Subtract Hole from RingMagnet**
    - Select **RingMagnet** and **Hole** from the history tree
    - Goto menu item ***Modeler > Boolean > Subtract***
      1. Select **RingMagnet** in Blank Parts
      2. Select **Hole** in Tool Parts
      3. Press **OK**



- **Split with YZ Plane**
  - Select **RingMagnet** from the History Tree
  - Goto menu item ***Modeler > Boolean > Split***
    1. Split Plane: Select **YZ Plane**
    2. Keep Fragments: **Both**
    3. Press **OK**

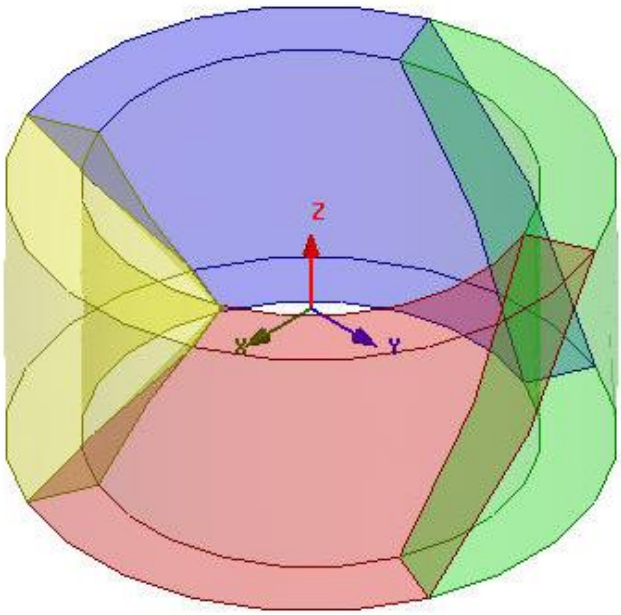


- **Split with XZ Plane**
  - Press **Ctrl** and select **RingMagnet** and **RingMagnet_Split1** from the tree
  - Goto menu item ***Modeler > Boolean > Split***
    1. Split Plane: Select **XZ Plane**
    2. Keep Fragments: **Both**
    3. Press **OK**
- **Change Attributes**
  - Change the attributes of the four objects resulted from split operation
  - RingMagnet
    1. Name: **NorthA**
    2. Color: **Blue**
  - RingMagnet_Split1
    1. Name: **SouthA**
    2. Color: **Yellow**
  - RingMagnet_Split1_Split1
    1. Name: **NorthB**
    2. Color: **Red**
  - Ringmagnet_Split2
    1. Name: **SouthB**
    2. Color: **Green**



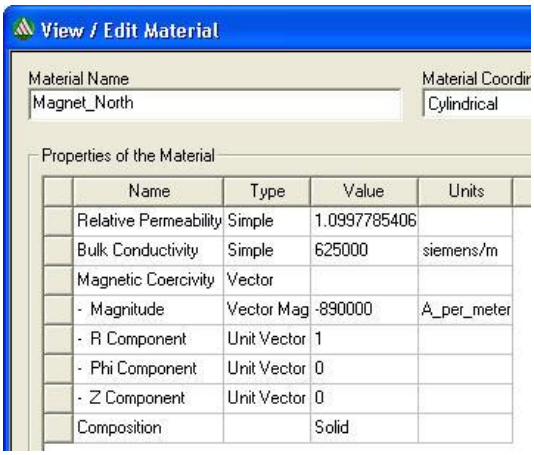
- **Create Guide for Sweep**
  - Goto menu item *Draw > Line*
    1. Using the coordinate entry field, enter first vertex positions
       - X: **0,** Y: **0,** Z: **-20**, Press the **Enter** key
    2. Using the coordinate entry field, enter second vertex positions
       - X: **0,** Y: **0,** Z:**20**, Press the **Enter** key
    3. Press **Enter** key to Exit
- **Create Sweep**
  - Select **NorthA, NorthB, SouthA, SouthB** and **Polyline1** from the History Tree
  - Goto menu item *Draw > Sweep > Along Path*
    1. Set Angle of Twist to **45 degrees**
    2. Press **OK**

  - **Note:** The 45 degree angle given in sweep command is the Skew Angle of the Magnets. This value will be give through equation in the next exercise of magnetization using equations.



Create Magnet Materials: Magnet_North, Magnet_South

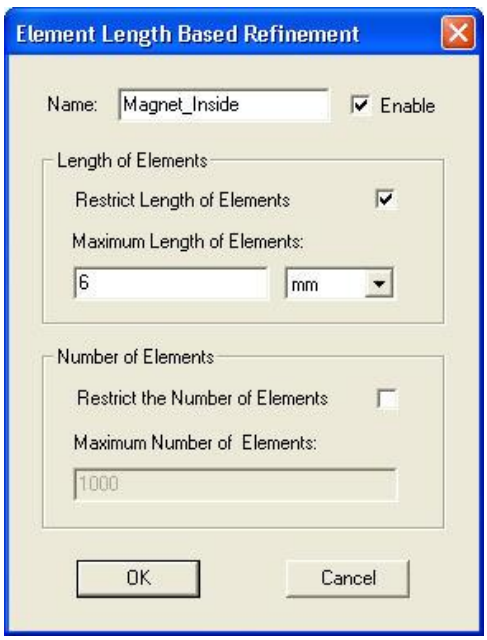
- **To Create Material Magnet_North:**
  - Select **NorthA** and **NorthB** from the history tree, right click and select **Assign Material**
  - In Select Definition window,
    1. Type **NdFe35** in the **Search by Name** field
    2. Select option **Clone Material**
    3. In View/Edit Material window
       1. Material Name : **Magnet_North**
       2. Material Coordinate System : **Cylindrical**
       3. Magnitude : **-890000**
       4. R Component : **1**
       5. Phi Component: **0**
       6. Z Component : **0**
       7. Press **OK**
    4. select **OK** to assign the material.

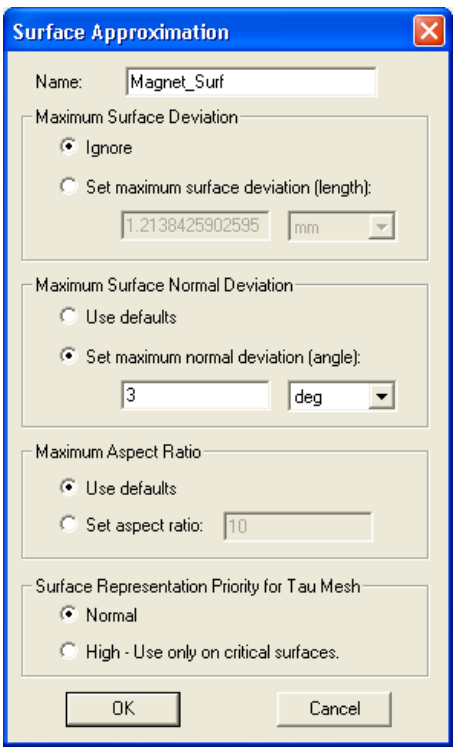


- **To Create Material Magnet_South:**
  - Select **SouthA** and **SouthB** from history tree, right click and select **Assign Material**
  - In Select Definition window,
    1. Type **NdFe35** in the **Search by Name** field
    2. Select option **Clone Material**
    3. In View/Edit Material window
       1. Material Name : **Magnet_South**
       2. Material Coordinate System : **Cylindrical**
       3. Magnitude : **-890000**
       4. R Component : **-1**
       5. Phi Component: **0**
       6. Z Component : **0**
       7. Press **OK**
    4. select **OK** to assign the material.

Apply Mesh Operations

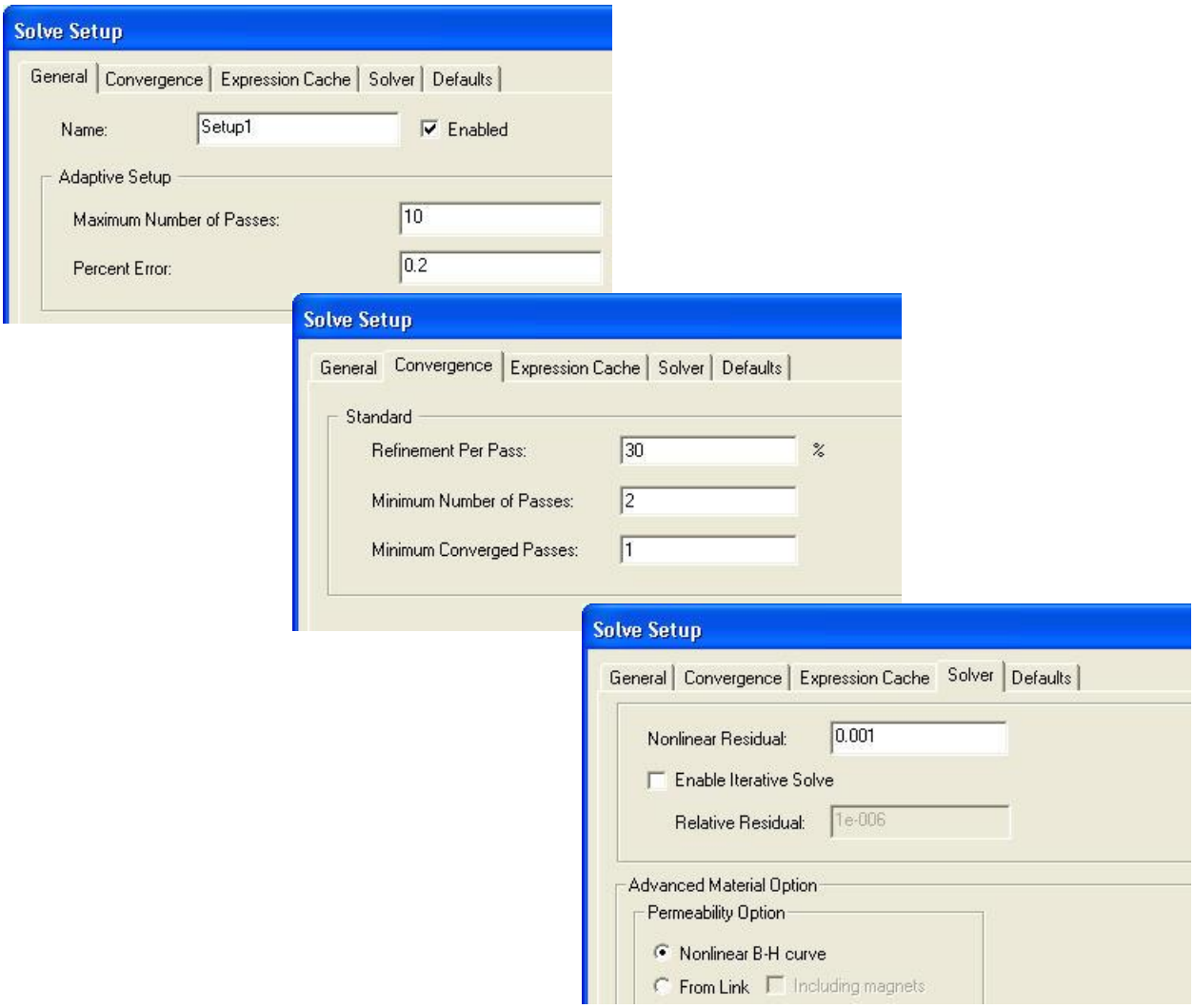
- Apply Length Based Mesh Operations
  - Select **NorthA, NorthB, SouthA** and **SouthB** from History Tree
  - Goto menu item ***Maxwell 3D > Mesh Operations >Assign > Inside Selection > Length Based…***
    1. Name: **Magnet_Inside**
    2. Restrict Length of Elements: ☑ **Checked**
    3. Maximum Length of Elements: **6mm**
    4. Press **OK**
- Apply Surface Approximation
  - Select **NorthA, NorthB, SouthA** and **SouthB** from History Tree
  - Select menu item ***Maxwell 3D > Mesh Operations > Assign > Surface Approximation***
    1. Name: **Magnet_Surf**
    2. Maximum Surface Normal Deviation
       - Set maximum normal deviation (angle): **3 deg**
    3. Press **OK**





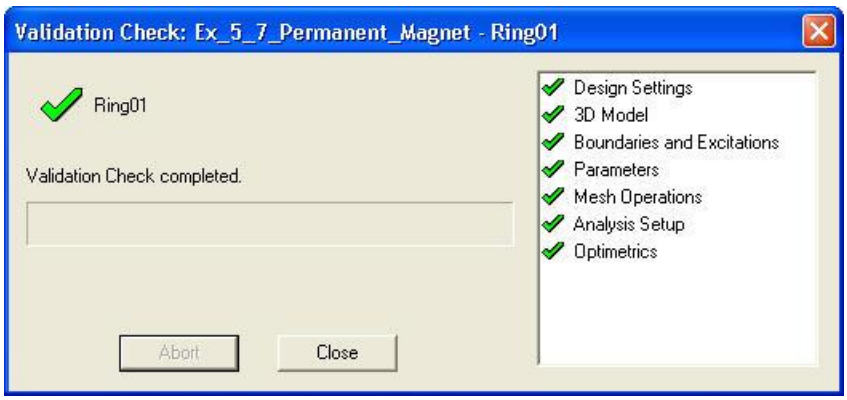
Analysis Setup

- **To create an analysis setup:**
  - Select the menu item ***Maxwell 3D > Analysis Setup > Add Solution Setup*** In Solve Setup window
    1. **General** tab
       - Percentage Error: **0.2**
    2. Press **OK**



Model Validation

- **To validate the model:**
  - Select the menu item *Maxwell 3D > Validation Check*
  - Click the **Close** button



Note: To view any errors or warning messages, use the Message Manager.

Analyze

- **To start the solution process:**
  1. Select the menu item *Maxwell 3D > Analyze All*