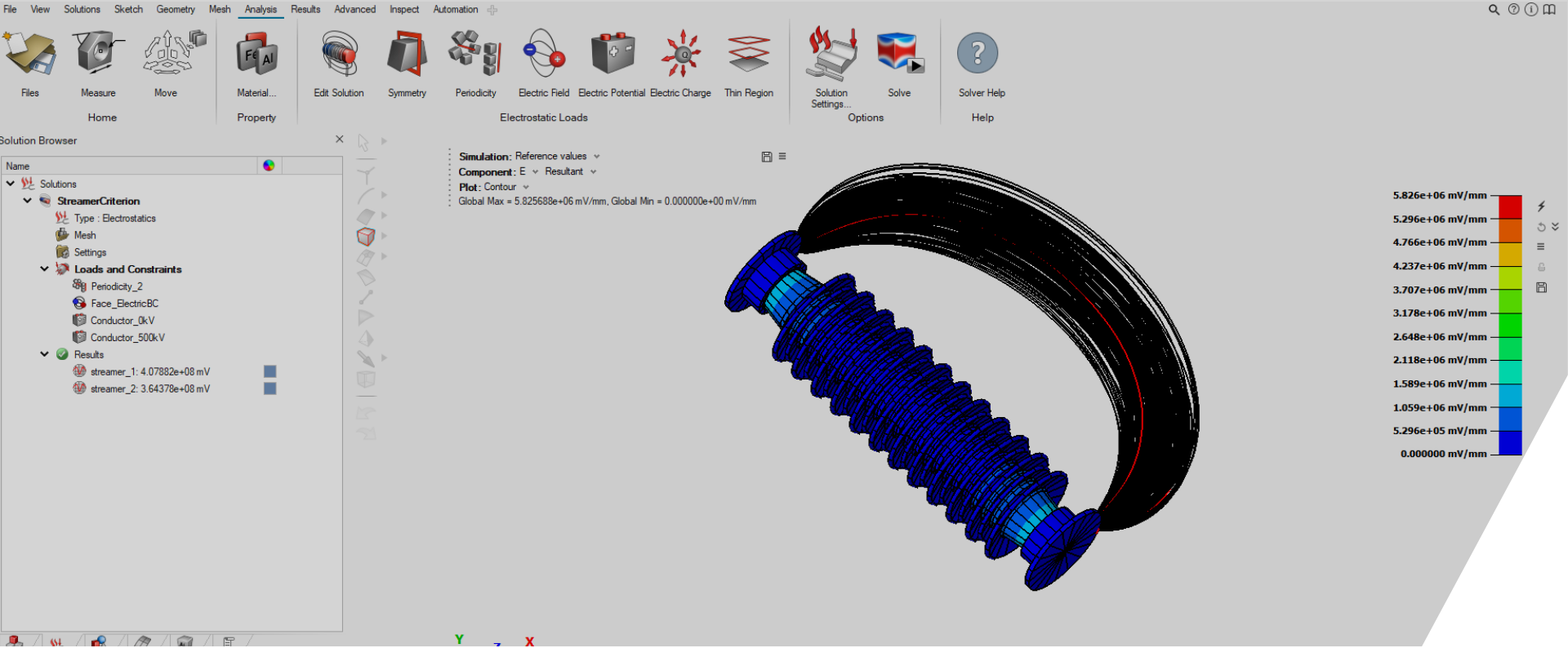

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INSULATOR: STREAMER CRITERION

ELECTROMAGNETIC APPLICATION WITH SIMLAB

October 2024, Altair Engineering Inc.

TUTORIAL OUTLINE

I. Introduction

II. 3D Electrostatic Analysis

- II.1: Solution creation
- II.2: Geometry and mesh
- II.2: Physical description
- II.3: Solving process
- II.4: Basic post-processing

III. Conclusion

INTRODUCTION

INTRODUCTION

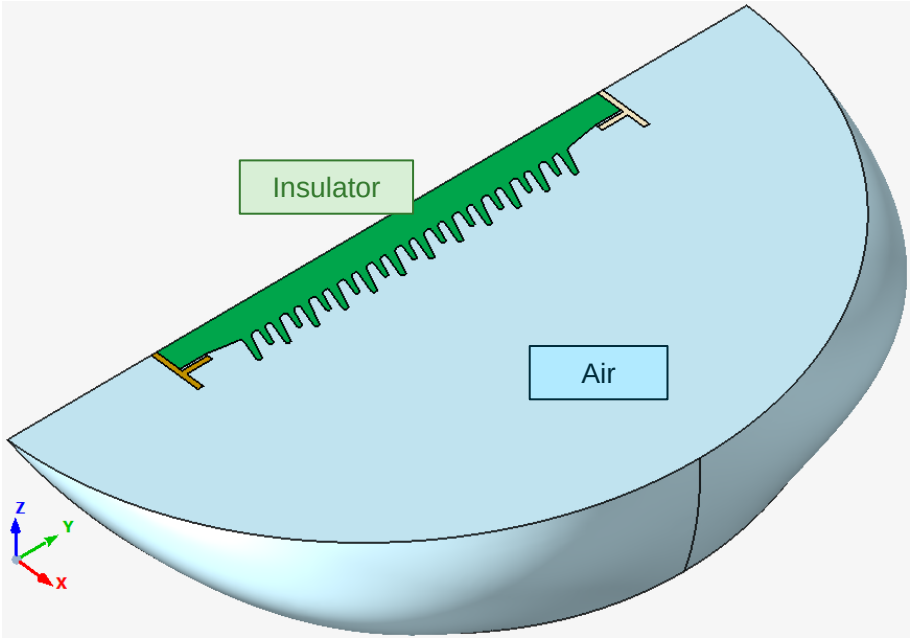
Physical Principle

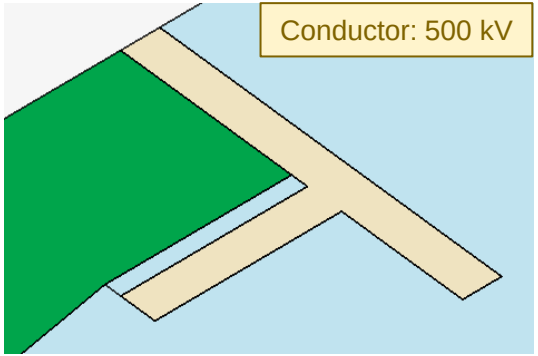
- A dielectric breakdown can occur in a dielectric gas when the applied potential difference is higher than the breakdown voltage. It is illustrated by the apparition of an electric arc in the dielectric area which can destroy definitively the device.
- The complete simulation of every physical processes yielding to an electrical discharge development is highly complex (Boltzmann equations, drift-diffusion models…), and not applicable yet to determine the breakdown voltage value in real industrial devices, due to their complexity and calculation time.
- **The streamer criterion** do not intend to be a complete simulation of the breakdown process in gases, it is only a criteria that is applied on the field obtained by an electrostatic simulation (i.e. the background field, before any discharge phenomena occurrence)*.
- This criterion gives an estimation of the threshold voltage that can trigger the electronic avalanche process leading to an electrical breakdown in the gas. This voltage is called “Streamer inception voltage”.

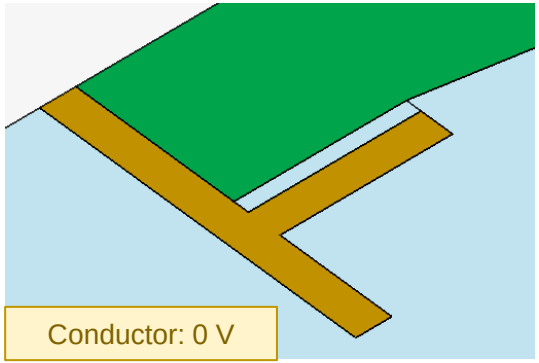
INTRODUCTION

Application Case: Insulator

- Study device: an insulator
- Analysis: 3D electrostatic







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3D ELECTROSTATICS ANALYSIS

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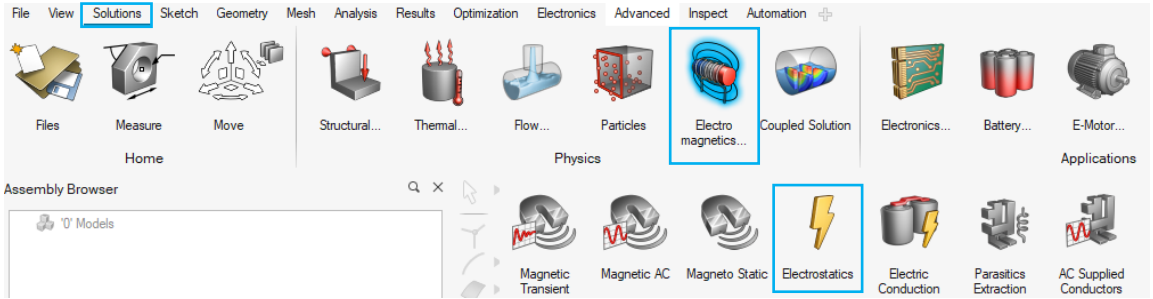
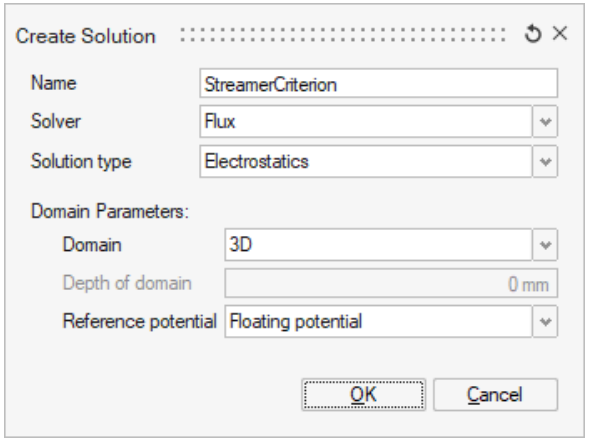
SOLUTION CREATION

3D ELECTROSTATIC ANALYSIS



- Create a SimLab solution for electromagnetic applications
  - [Solutions] – [Electromagnetics] [Electrostatics]



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GEOMETRY AND MESH

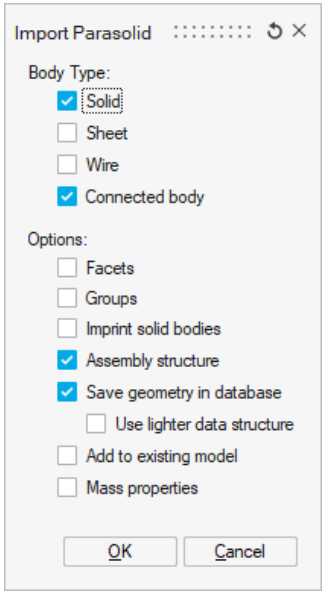
3D ELECTROSTATIC ANALYSIS

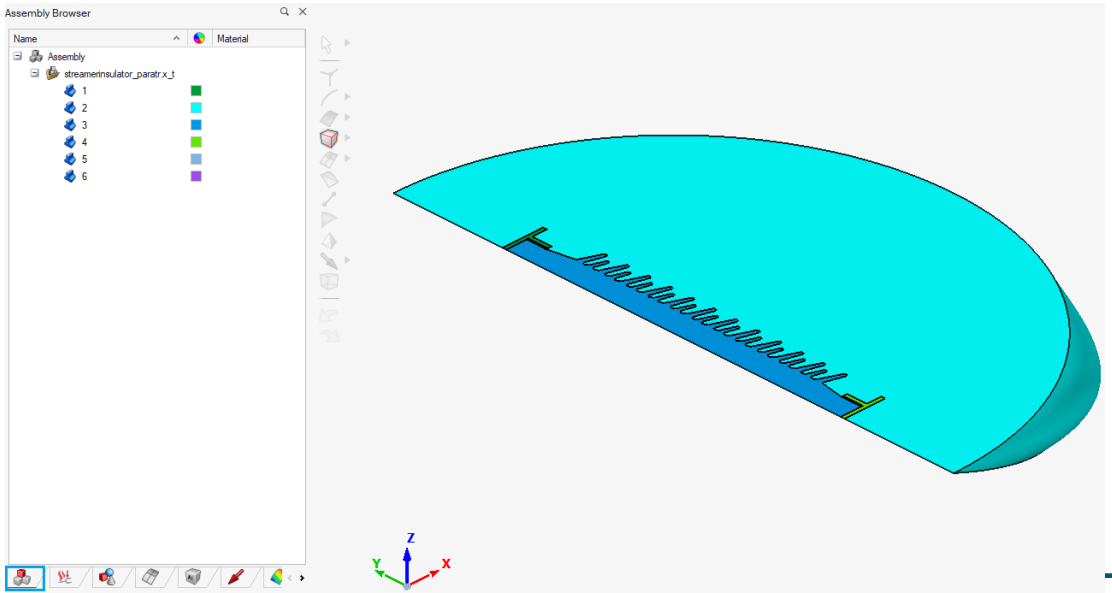
Geometry and Mesh

- Geometry import
  - [File] → [Import] → [CAD]

…\ Input \ insulator.xmt_txt

Imported insulator CAD model

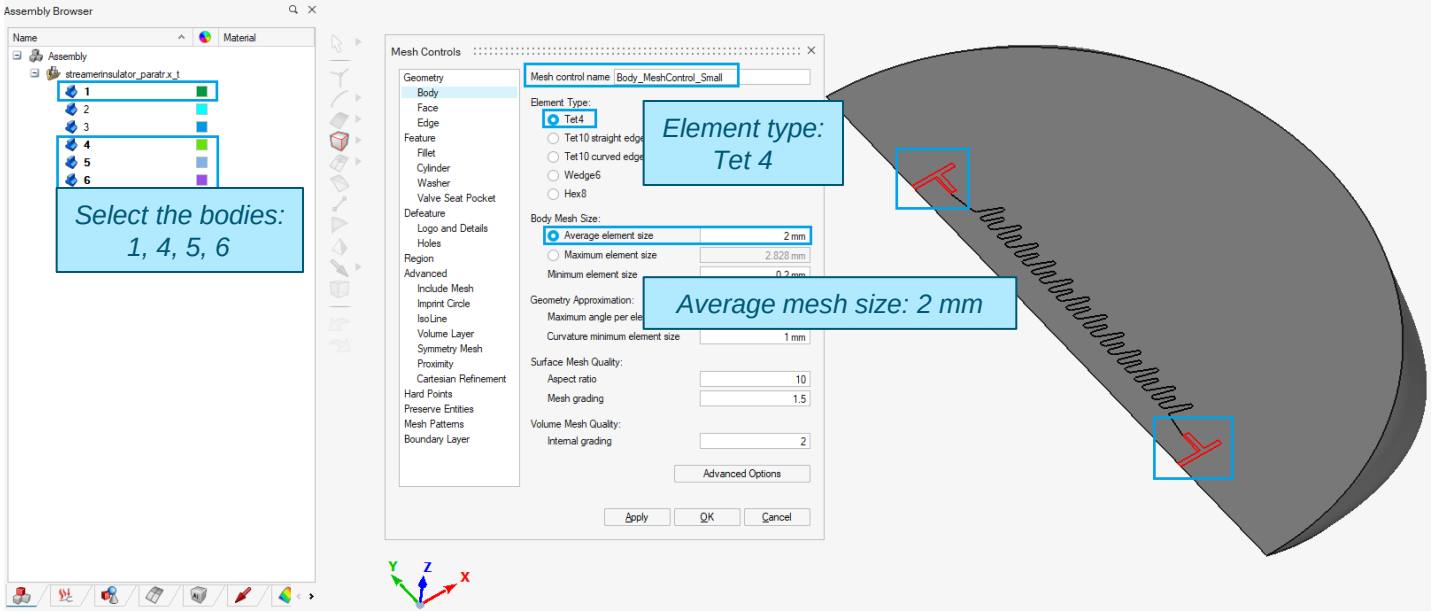




3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

- Mesh description
  - [Mesh] – [Mesh Controls]
    - Define body mesh control: small (2 mm)



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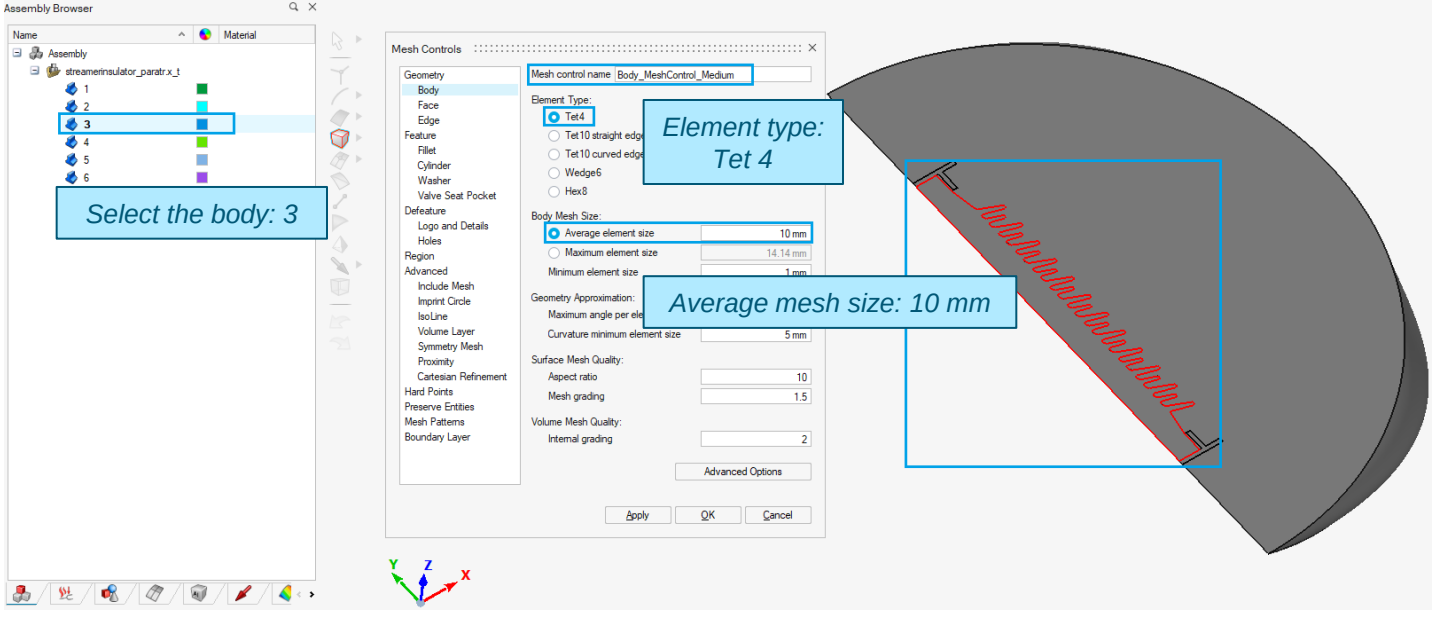
3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

- Mesh description
  - [Mesh] – [Mesh Controls]
    - Define body mesh control: medium (10 mm)



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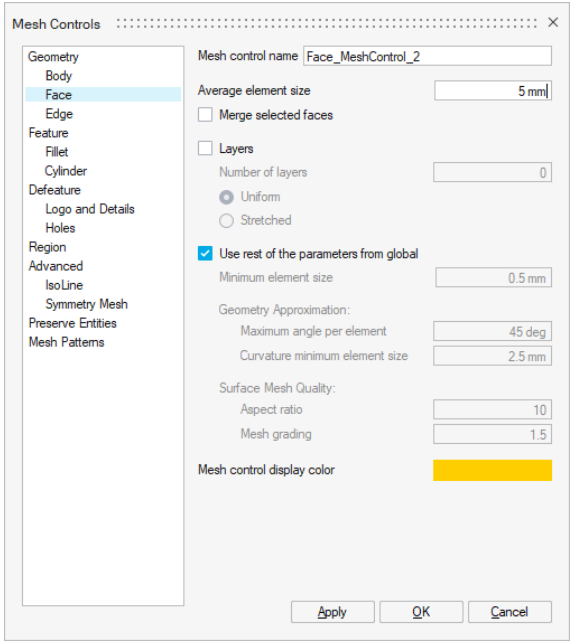
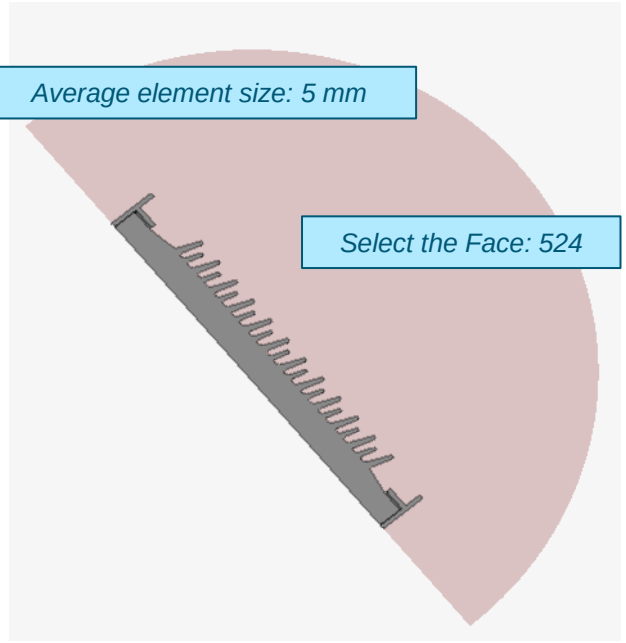
3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

- Mesh description
  - [Mesh] – [Mesh Controls]
    - Define face mesh control





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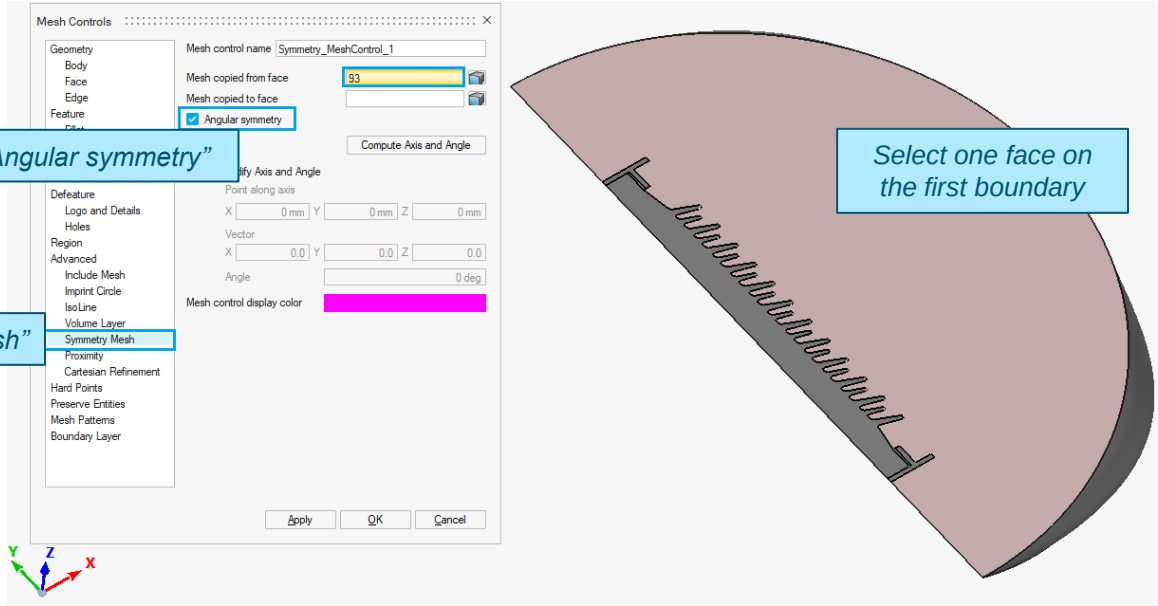
3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

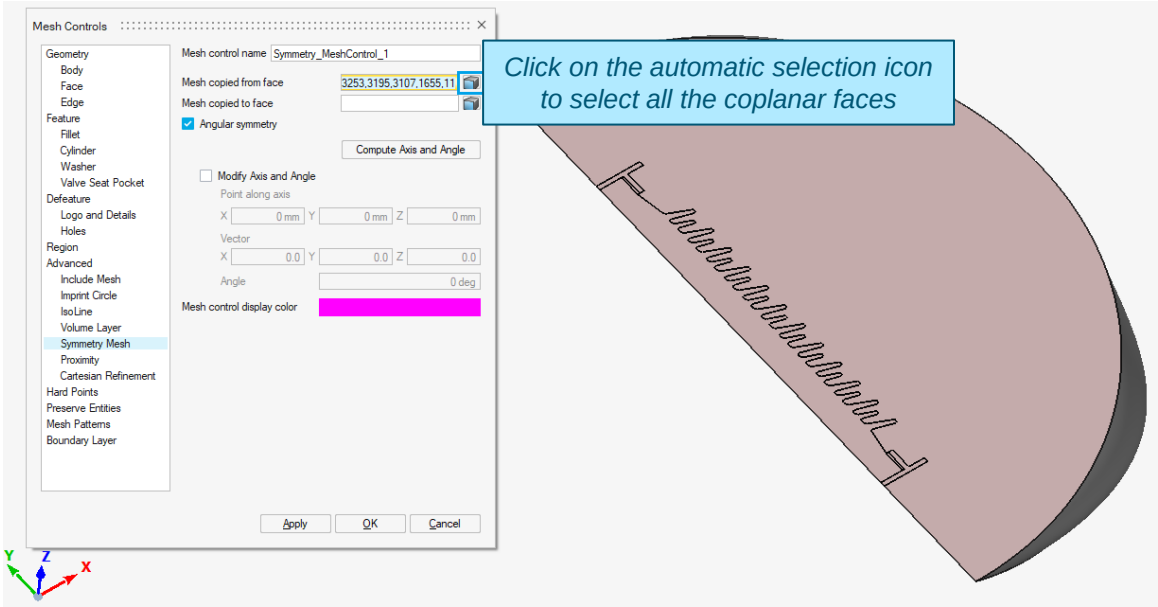
- Mesh description
  - [Mesh] – [Mesh Controls]
    - Define angular **symmetry mesh controls** for the boundary faces



3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

- Mesh description
  - [Mesh] – [Mesh Controls]
    - Define angular **symmetry mesh controls** for the boundary faces



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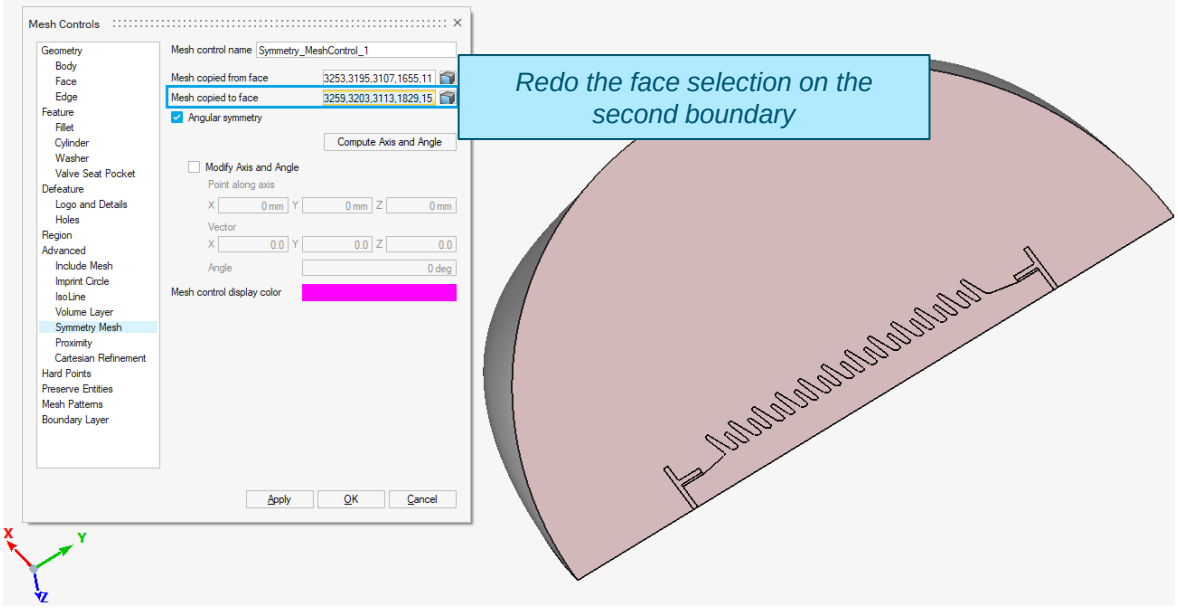
3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

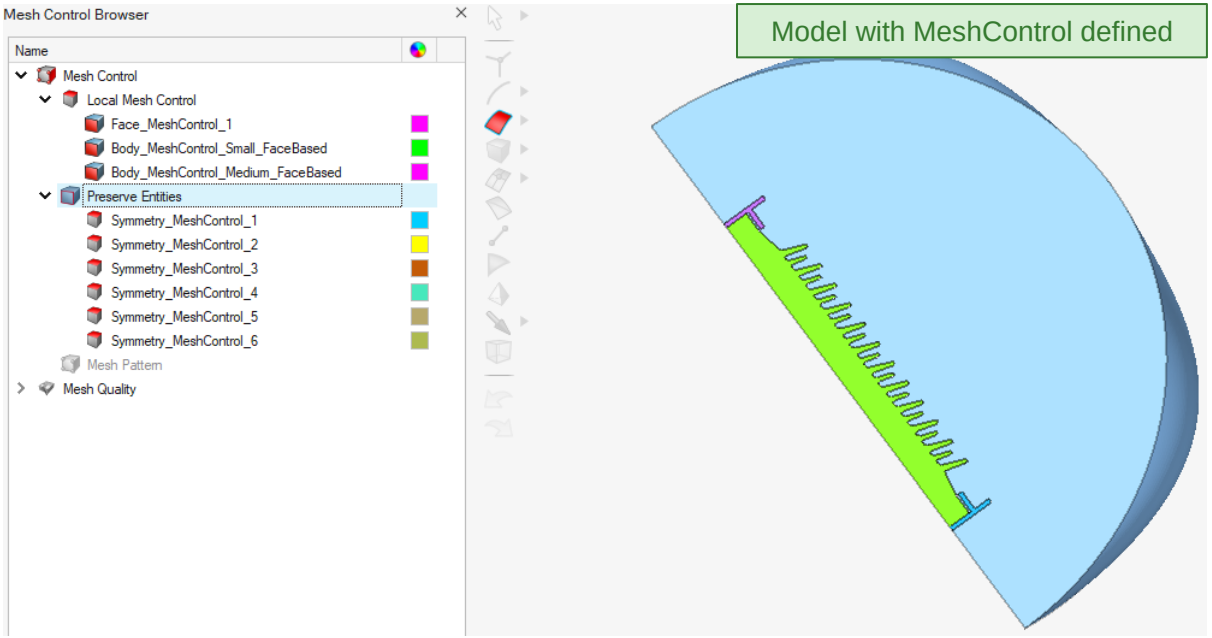
- Mesh description
  - [Mesh] – [Mesh Controls]
    - Define angular **symmetry mesh controls** for the boundary faces



3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

- Mesh description
  - Final mesh control list



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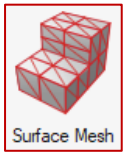
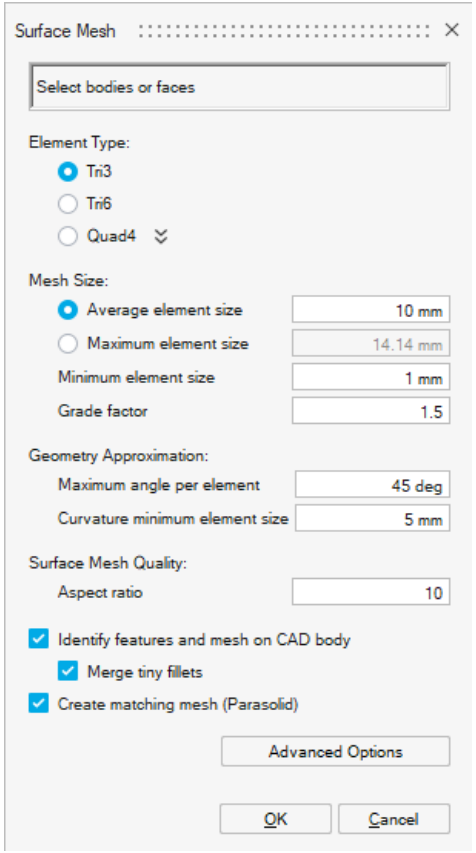
3D ELECTROSTATIC ANALYSIS

Geometry and Mesh



- Surface mesh generation
  - [Mesh] – [Surface Mesh]
    - Select All Faces
    - Fill Average element size: 10 mm
    - Validate by clicking on OK



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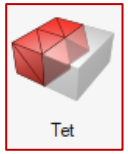
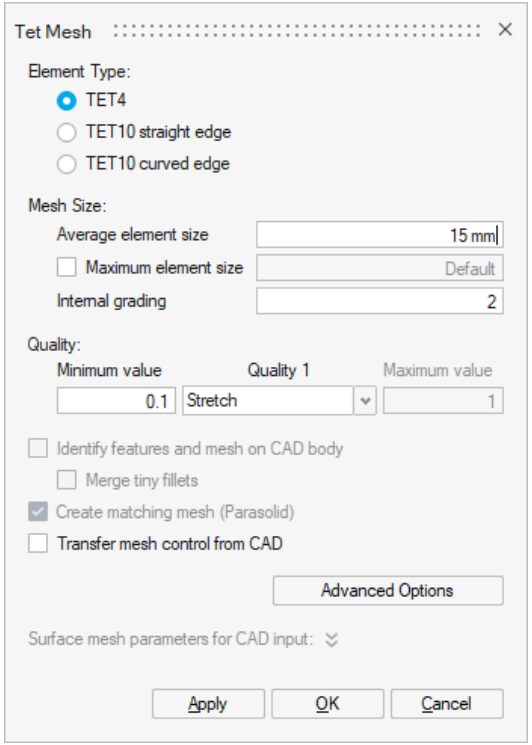
3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

- Volume mesh generation
  - [Mesh] – [Tet]
    - Select All Bodies
    - Fill Average element size: 15 mm
    - Validate by clicking on OK





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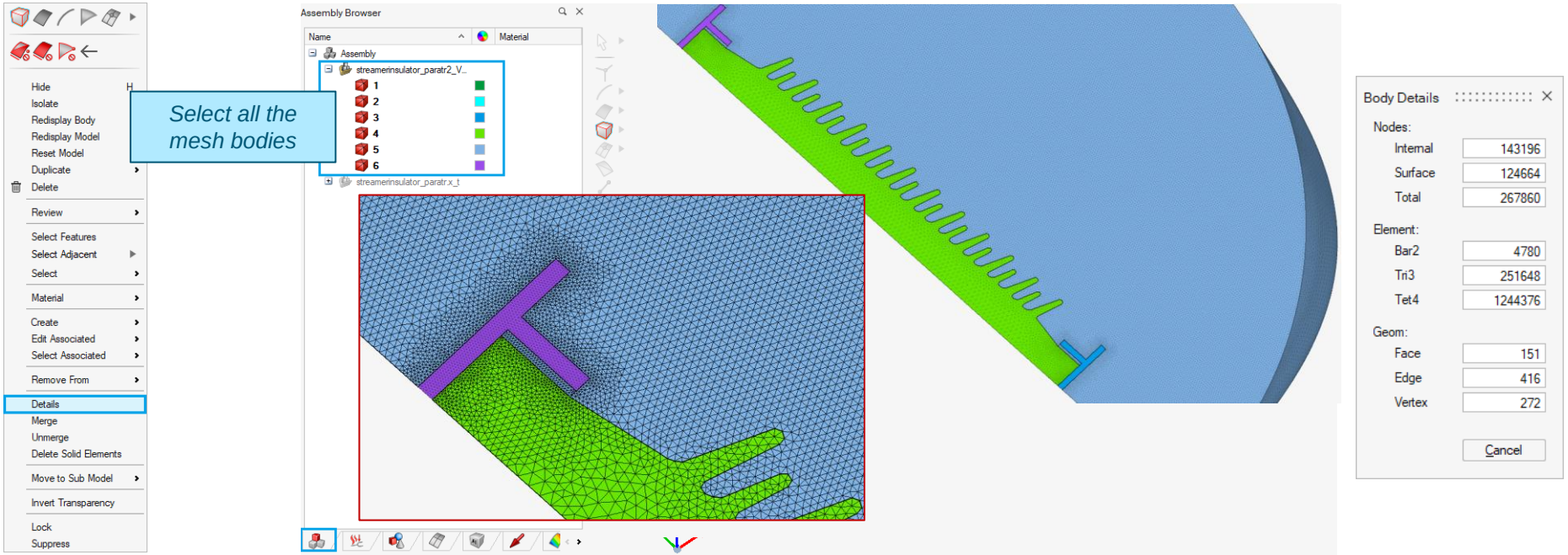
3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

- Final Mesh and Check mesh details



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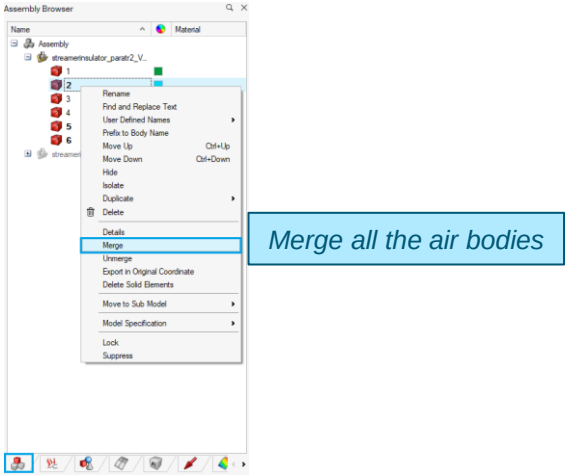
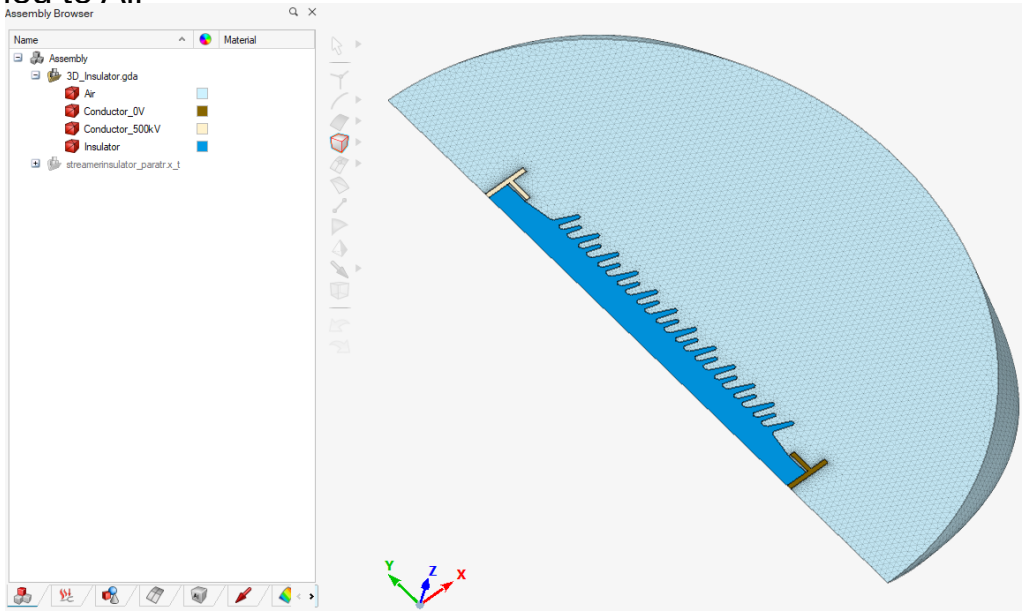
3D ELECTROSTATIC ANALYSIS

Geometry and Mesh

- Merge and rename bodies
  - Bodies 2, 5 and 6 are merged and renamed to Air
  - Body 1 is renamed to Conductor_500kV
  - Body 4 is renamed to Conductor_0kV
  - Body 3 is renamed to Insulator



Merge all the air bodies



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3D ELECTROSTATIC ANALYSIS

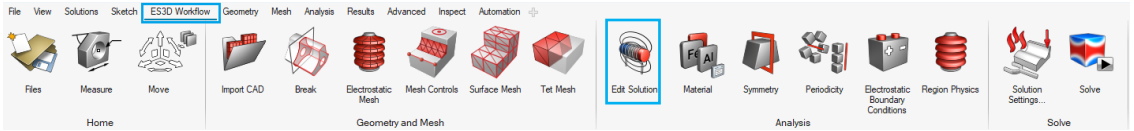
Geometry and Mesh

- Final mesh model
  - Save the project [File] – [Save As]
    - Save the project as “3D_ES_Insulator_Mesh.slb”

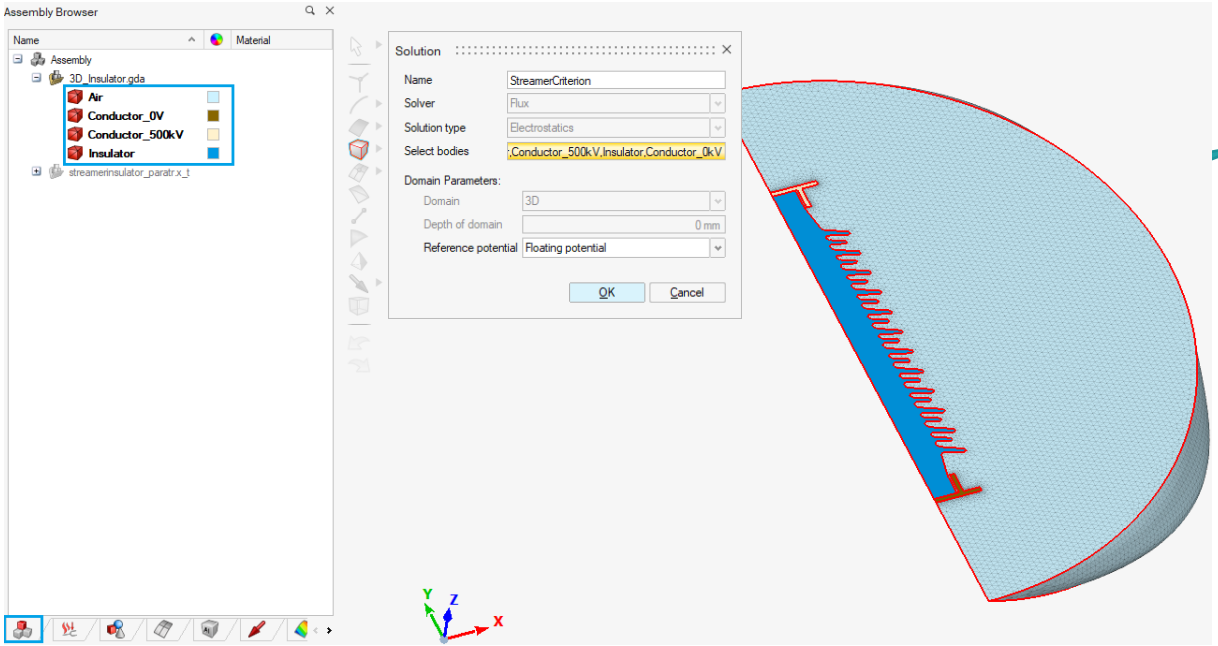
PHYSICAL DESCRIPTION

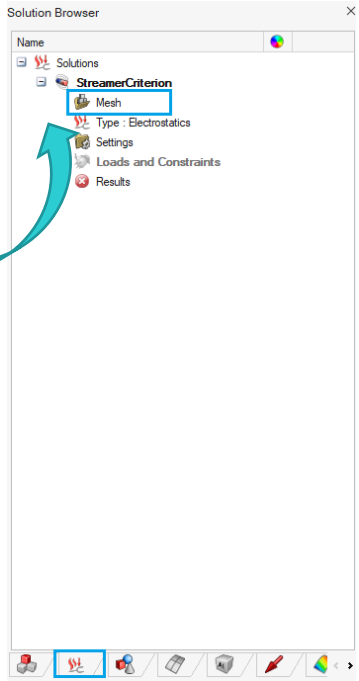
3D ELECTROSTATIC ANALYSIS

Physical Description



- Complete the **Solution** definition
  - [ES3D Workflow] – [Edit Solution]





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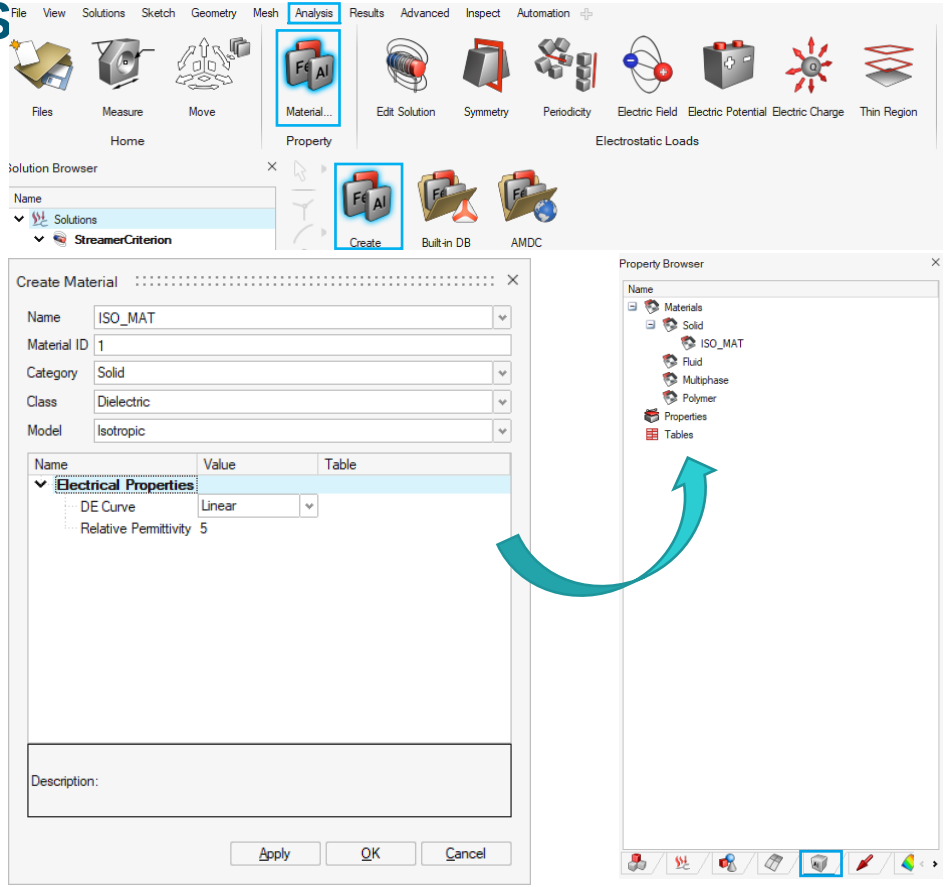
3D ELECTROSTATIC ANALYSIS

Physical Description

- Define dielectric **material**
  - [Analysis] – [Material] – [Create]

Parameter	Type / value
Name	ISO_MAT
Category	Solid
Class	Dielectric
Model	Isotropic
Dielectric relative permittivity	5



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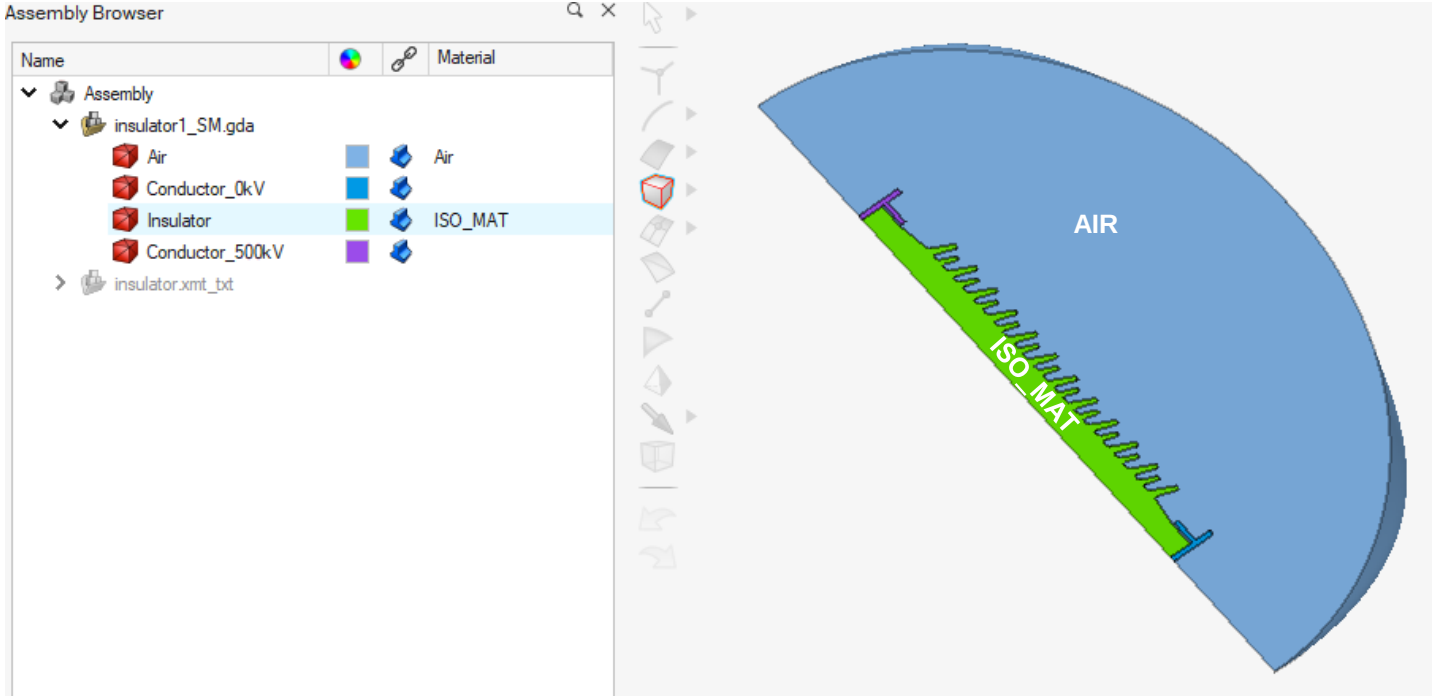
3D ELECTROSTATIC ANALYSIS

Physical Description

- Assign **materials**



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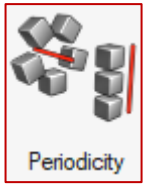
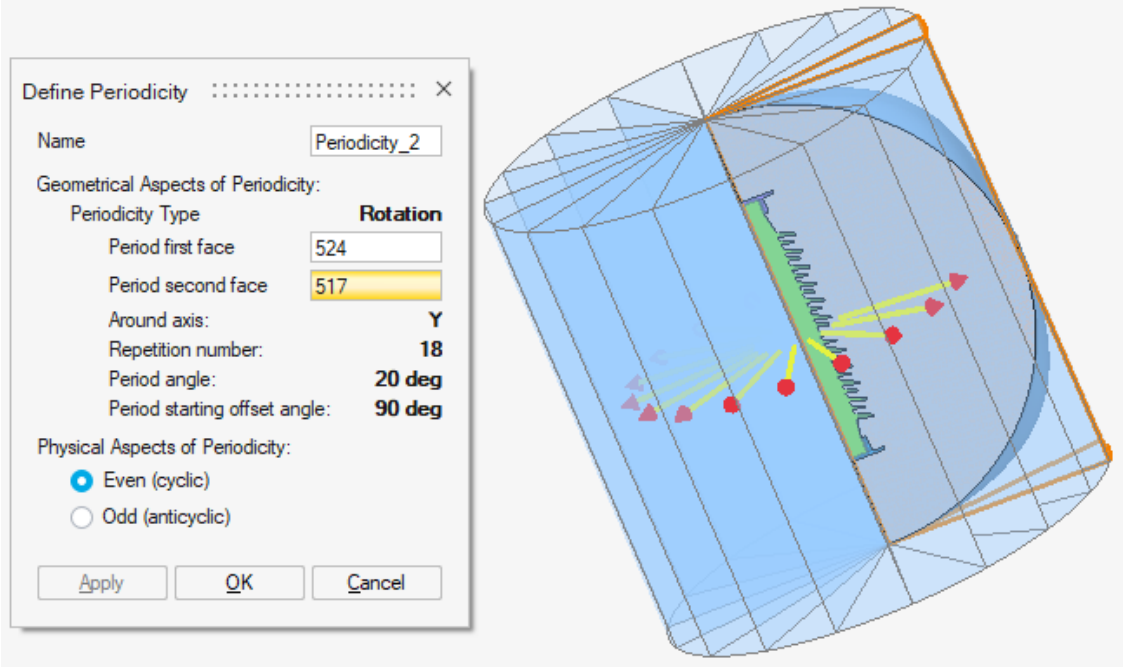
3D ELECTROSTATIC ANALYSIS

Physical Description



- Define **periodicity**
  - [Analysis] – [Periodicity]



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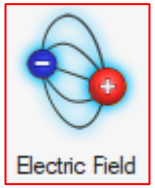
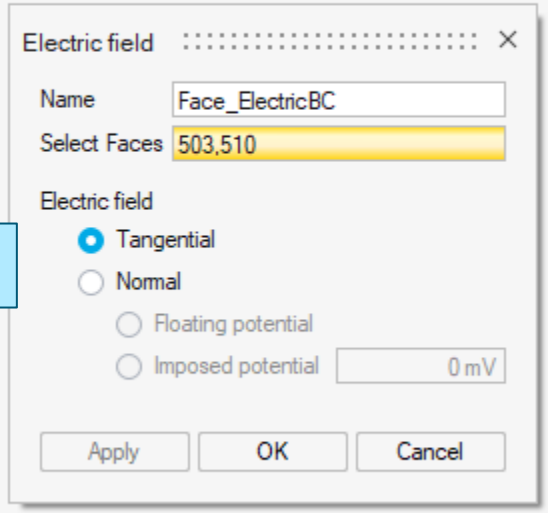
3D ELECTROSTATIC ANALYSIS

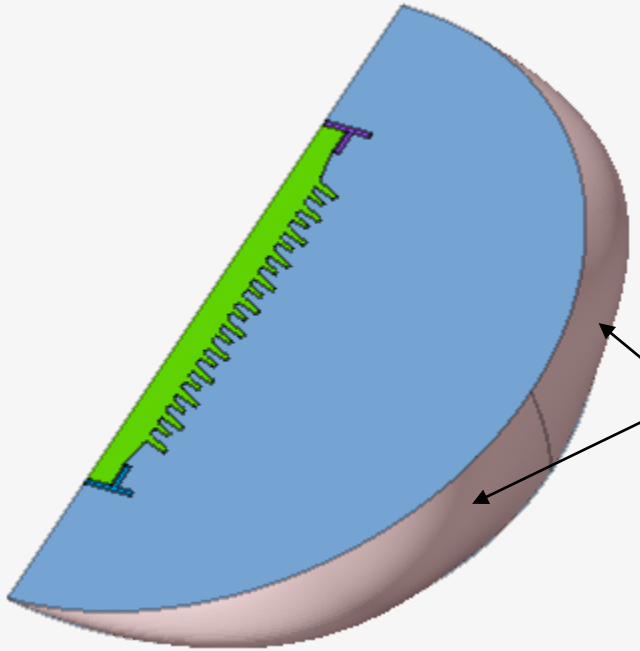
Physical Description



- Define **boundary conditions**
  - [Analysis] – [Electrostatic Field]



Boundary condition: tangential electric field



Select the two outside faces

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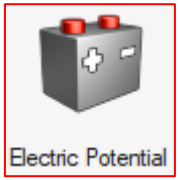
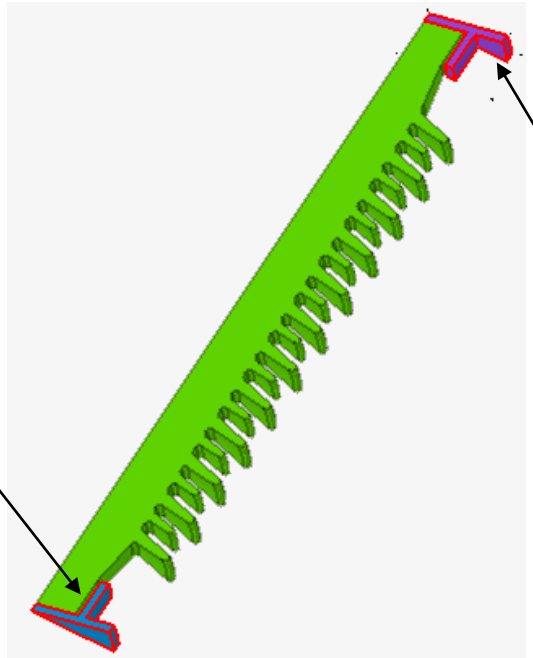
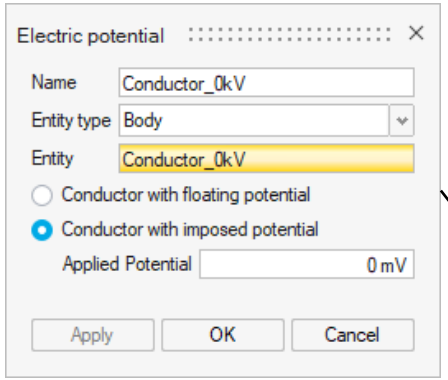
3D ELECTROSTATIC ANALYSIS

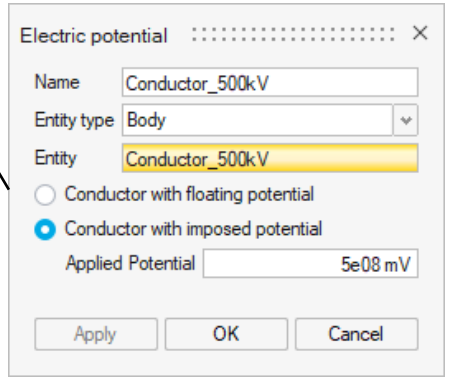
Physical Description



- Define Electric Potential
  - [Analysis] – [Electric Potential]
    - Conductor_0kV
    - Conductor_500kV







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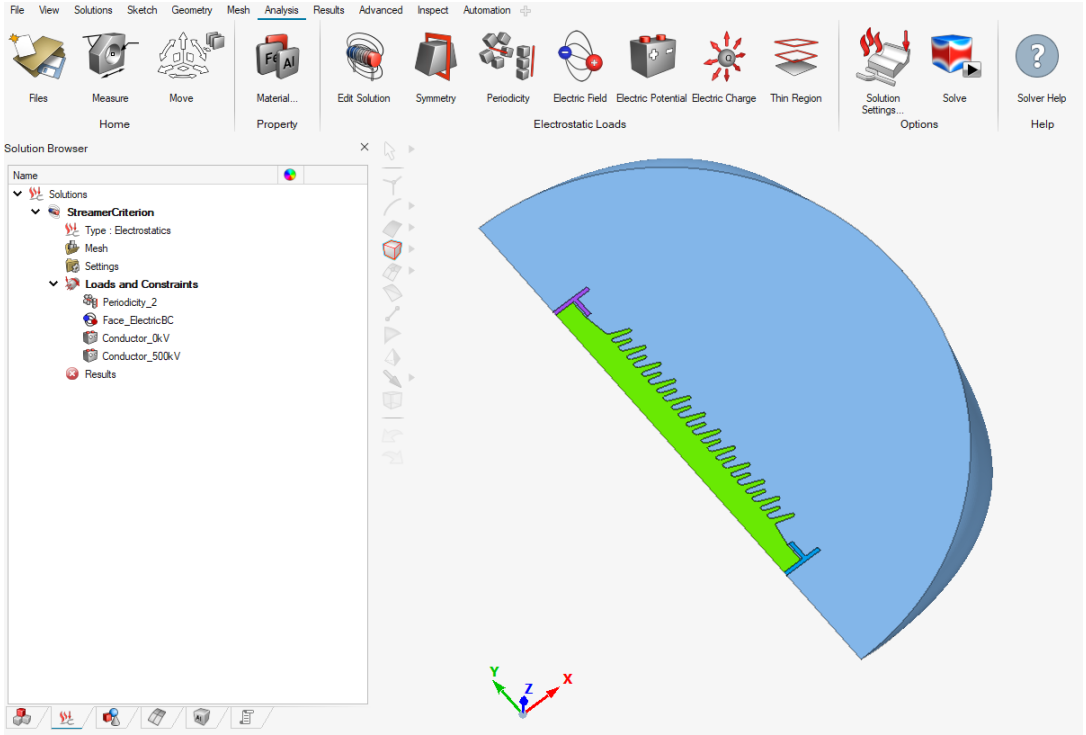
3D ELECTROSTATIC ANALYSIS

Physical Description

- Final physics-defined model



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3D ELECTROSTATIC ANALYSIS

Physical Description

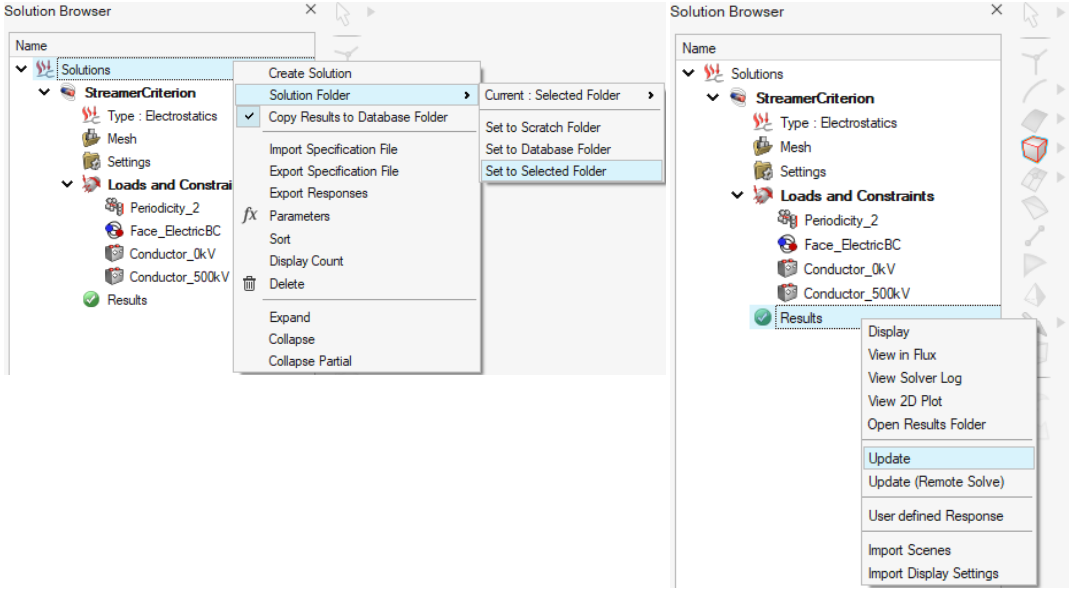
- Final physics-defined model
  - Save the project [File] – [Save As]
    - Save the project as “3D_ES_Insulator_Phys.slb”

SOLVING PROCESS

3D ELECTROSTATIC ANALYSIS

Solving Process

- Solve the electrostatic simulation project
  - Right click on the “Solutions” and select the solving folder for Flux



☞Notes:

The solving process takes about 2 min depending on the computer on which it is run.

Results means that the solving process is completed
Results means that the solving process is in progress

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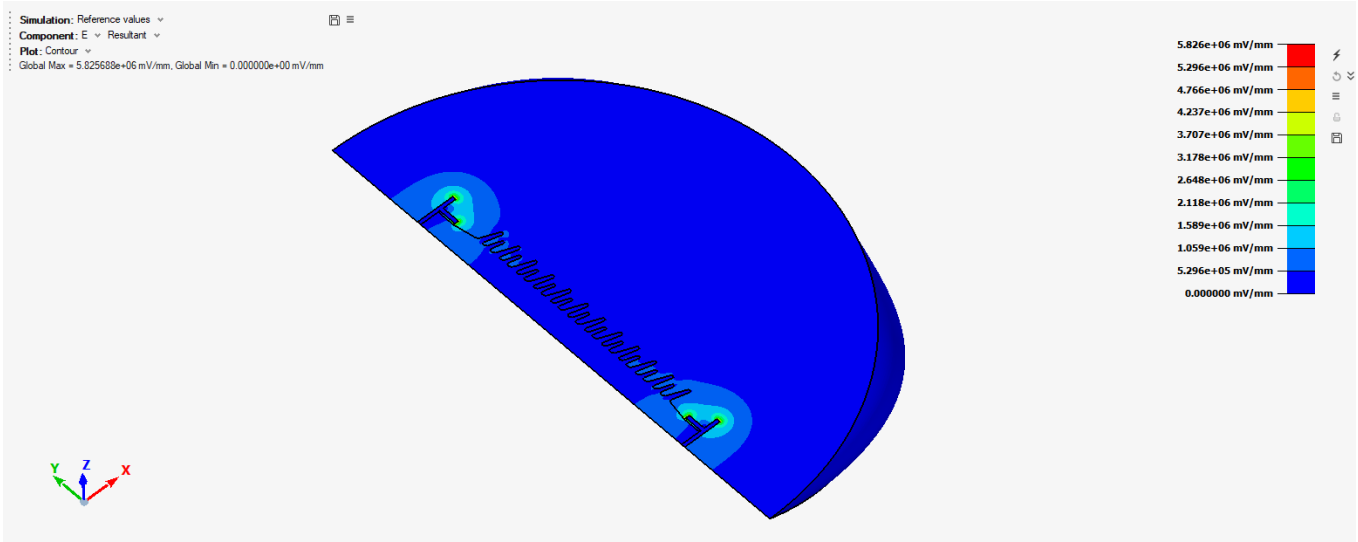
BASIC POST-PROCESSING

3D ELECTROSTATIC ANALYSIS

Basic Post-Processing

- Insulator simulation
  - Isovalues display (electric field E)



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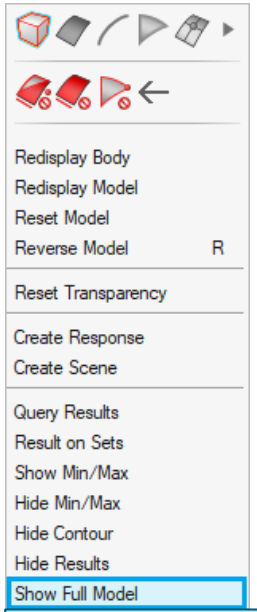
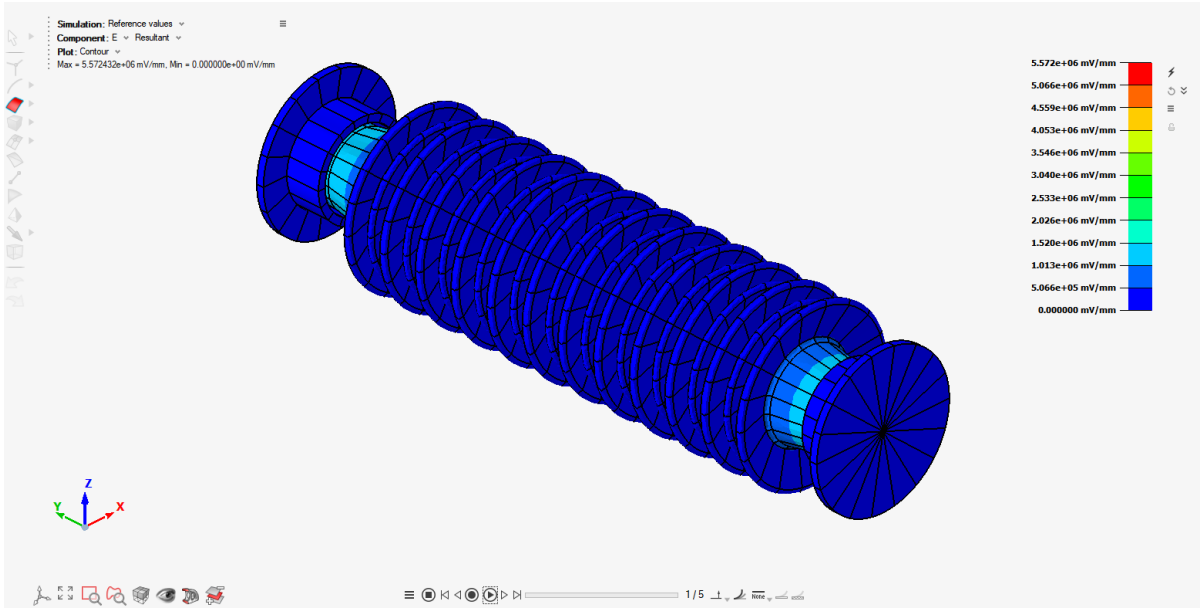
3D ELECTROSTATIC ANALYSIS

Basic Post-Processing

- Insulator simulation
  - Isovalue display (electric field E) – on full model





Click on "Show Full Model" to show the results on full motor model

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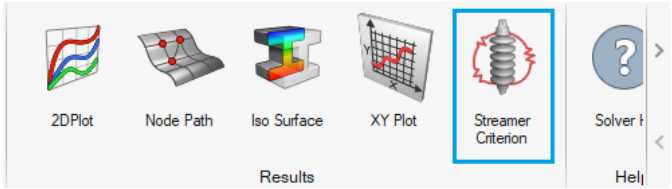
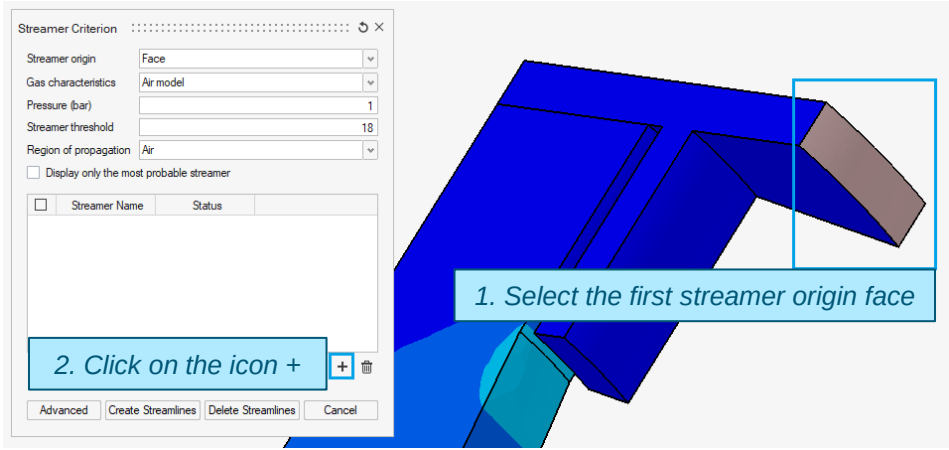
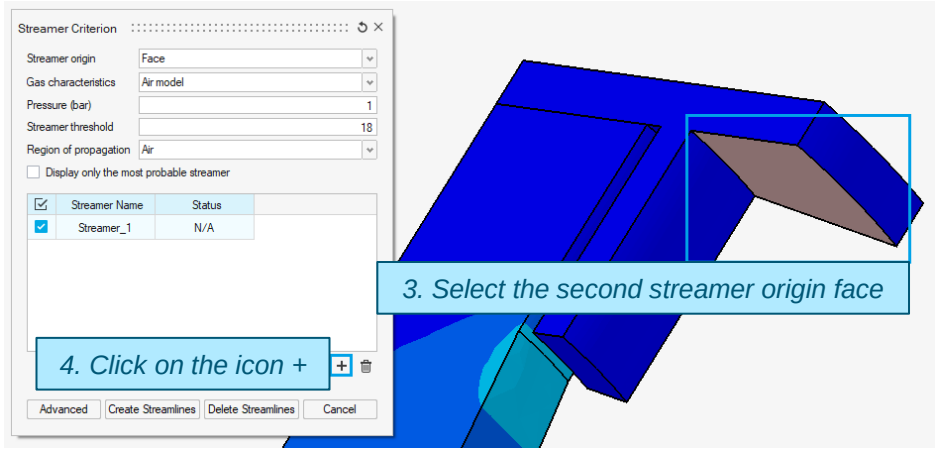
3D ELECTROSTATIC ANALYSIS

Basic Post-Processing



- Streamer criterion simulation
  - Streamer criterion display
    - Create streamer





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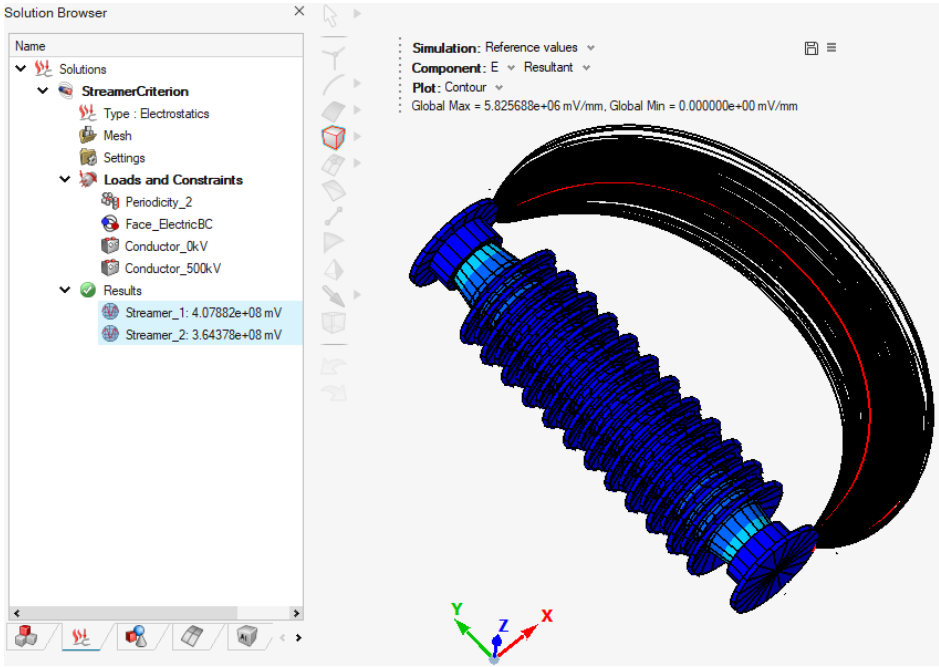
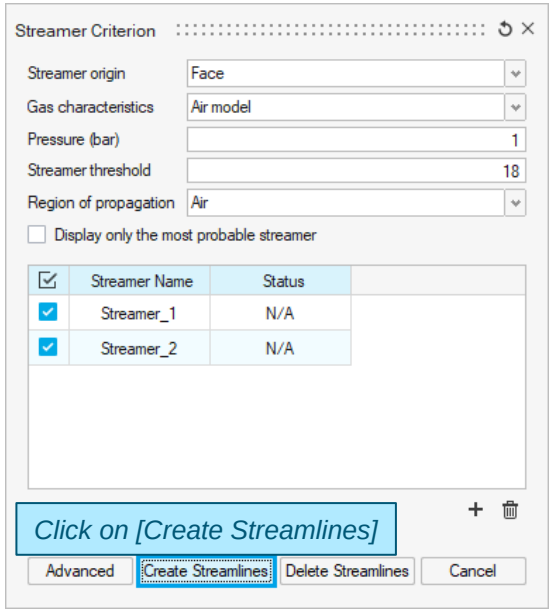
3D ELECTROSTATIC ANALYSIS

Basic Post-Processing

- Streamer criterion simulation
  - Streamer criterion display
    - Create streamlines





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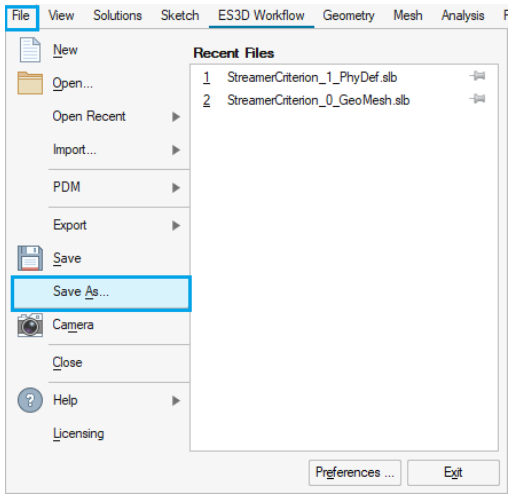
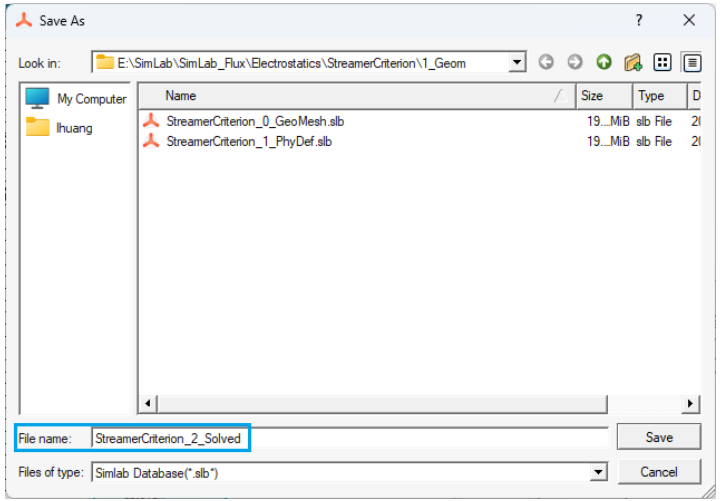
3D ELECTROSTATIC ANALYSIS

Basic Post-Processing

- Final solved model
  - Save the project [File] – [Save As]
    - Save the project as “StreamerCriterion_2_Solved”





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