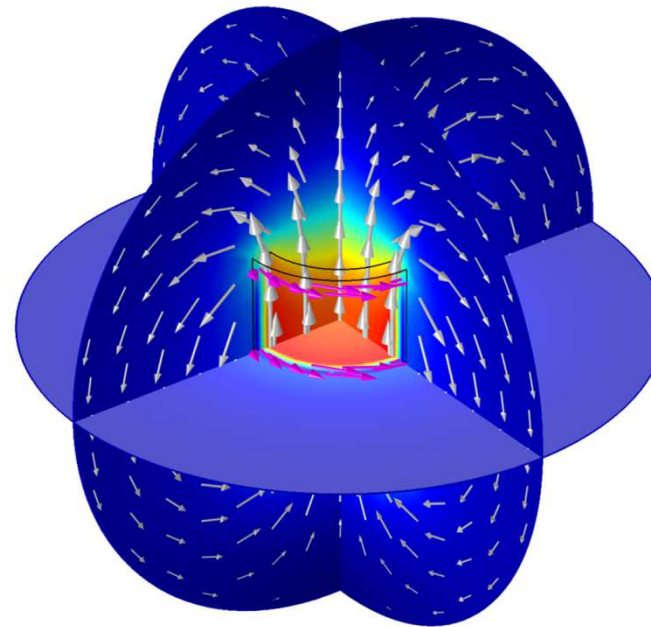
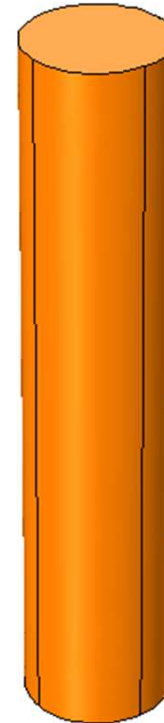


Single-turn and multi-turn coil domains in 3D



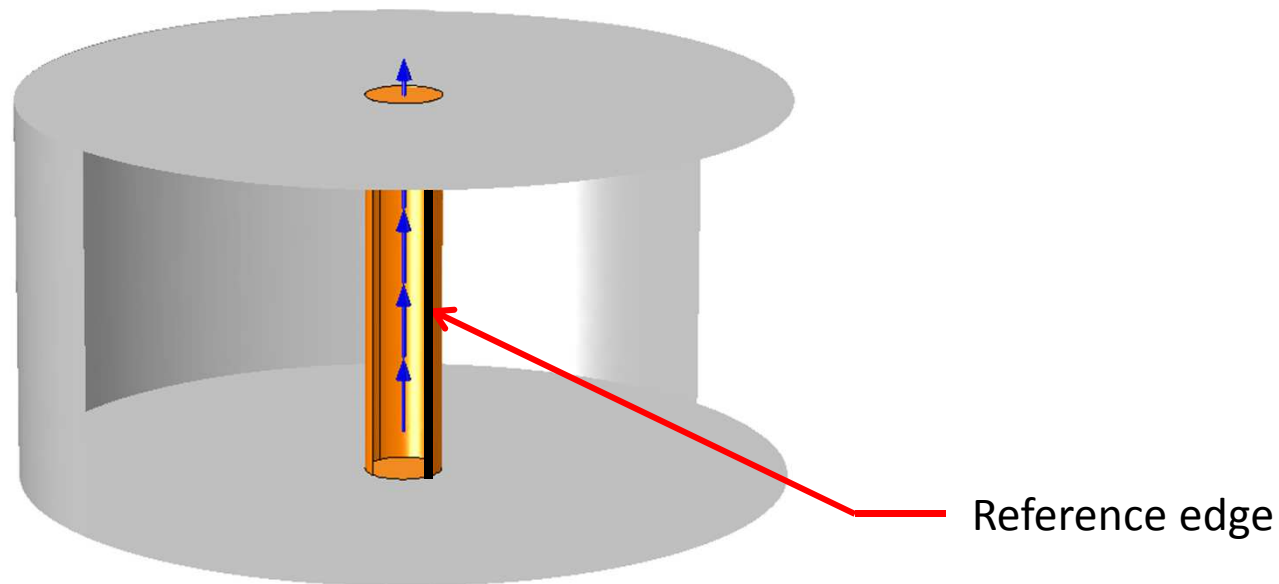
Multi-turn coil – Linear

- Multiple parallel straight wires bundled in a sleeve
- Leads are modeled
- Geometry should not form a closed loop and must have a straight longitudinal axis
- Cross section can be arbitrary



Coil excitation method

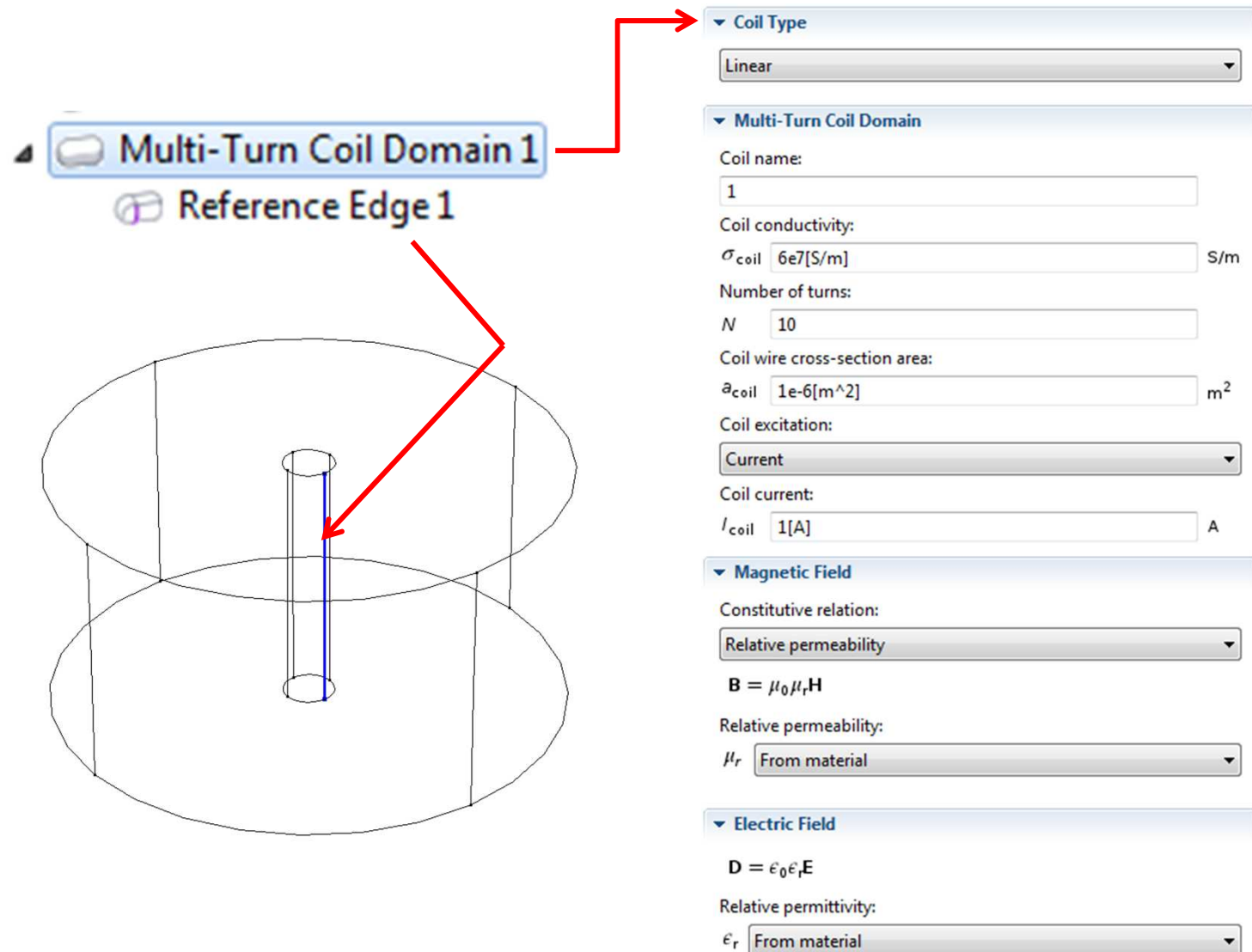
- Direction of current flow is modeled by specifying a **reference edge**
- Also the two end surfaces should touch the external walls of the air domain surrounding the conductor



Modeling in COMSOL

- For detailed modeling steps, see the following file:
 - *multi_coil_linear.mph*
- This model shows only the DC case

Using multi-turn coil domain: Linear



The image displays a 3D model of a multi-turn coil on the left and its configuration parameters on the right. The model shows a central vertical wire with 10 turns around a cylindrical core. A red arrow points from the 'Multi-Turn Coil Domain 1' label to the 'Coil Type' dropdown, and another red arrow points from the 'Reference Edge 1' label to the central wire in the model.

Multi-Turn Coil Domain 1
Reference Edge 1

Coil Type
Linear

Multi-Turn Coil Domain
Coil name: 1
Coil conductivity: σ_{coil} 6e7[S/m] S/m
Number of turns: N 10
Coil wire cross-section area: a_{coil} 1e-6[m^2] m^2
Coil excitation: Current
Coil current: I_{coil} 1[A] A

Magnetic Field
Constitutive relation: Relative permeability
 $\mathbf{B} = \mu_0 \mu_r \mathbf{H}$
Relative permeability: μ_r From material

Electric Field
 $\mathbf{D} = \epsilon_0 \epsilon_r \mathbf{E}$
Relative permittivity: ϵ_r From material

Note on coil properties

Coil Type
Linear

Multi-Turn Coil Domain
Coil name: 1
Coil conductivity: σ_{coil} 6e7[S/m] S/m
Number of turns: N 10
Coil wire cross-section area: a_{coil} 1e-6[m^2] m^2
Coil excitation: Current
Coil current: I_{coil} 1[A] A

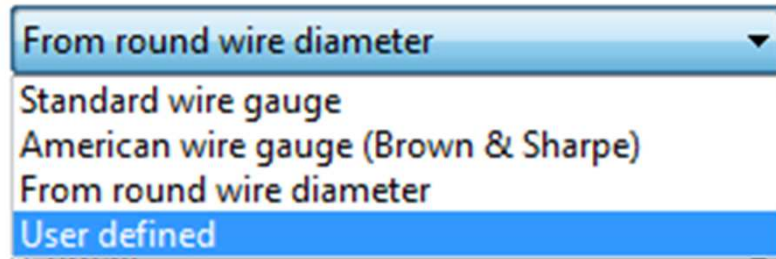
Magnetic Field
Constitutive relation: Relative permeability
 $\mathbf{B} = \mu_0 \mu_r \mathbf{H}$
Relative permeability: μ_r From material

Electric Field
 $\mathbf{D} = \epsilon_0 \epsilon_r \mathbf{E}$
Relative permittivity: ϵ_r From material

- This is the electrical conductivity of the wire material
 - This is the cross section area of each wire
 - COMSOL uses these for computing coil resistance
-
- The relative permeability and relative permittivity values are for the homogenized coil domain

Options for wire cross section

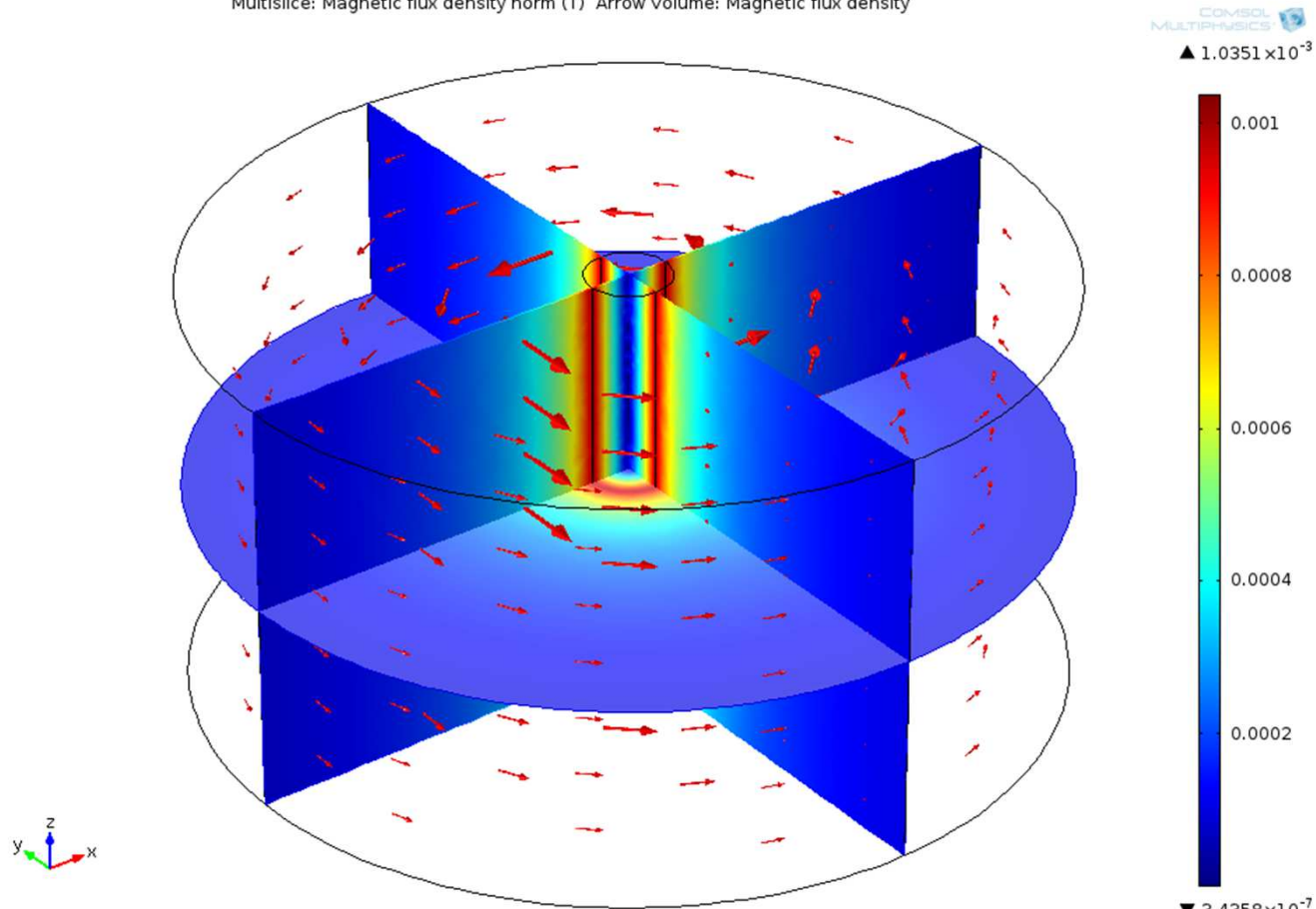
Coil wire cross-section area:



- Default is set to **User defined** cross section area
- Can specify the wire diameter of round wire
- Can also specify AWG or SWG number
- **Note:** We are still not geometrically resolving the wires

Results – Magnetic flux density

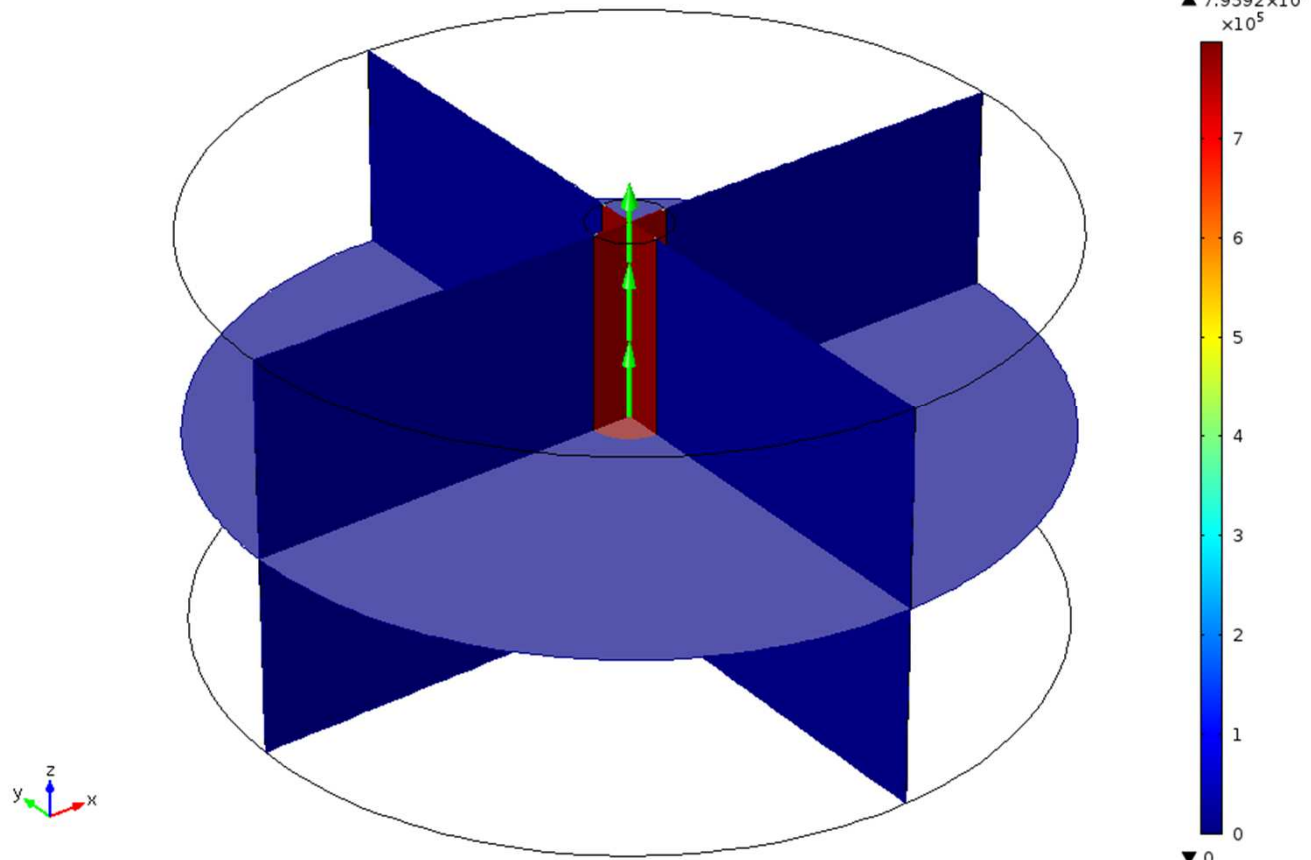
Multislice: Magnetic flux density norm (T) Arrow Volume: Magnetic flux density



Inductance = 1.02×10^{-6} H

Results – Current density

Multislice: Current density norm (A/m²) Arrow Volume: Current density



Resistance = 0.003 Ω