

Electromagnetic Simulation Software -- tutorial --

December 3, 2015

PHYS 402: E&M 2

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Login to Computer Terminal
Do NOT open FEKO

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Principle Numerical 3D EM Methods

Method of Moments (MoM)

Solves Maxwell's equations in **integral** form in the frequency domain.
(*boundary conditions included in integral*)

- For discretized volume/surface of sources, integral eq. reduces to a **matrix** eq.
- Solves matrix eq. **exactly** to get $J(r_i)$ and $\rho(r_i)$.
- Once $J(r_i)$ and $\rho(r_i)$ are known, then compute $E(r_i)$ and $B(r_i)$.

Finite Element Method (FEM)

Solves Maxwell's equations in **differential** form in the frequency domain.

- Entire solution volume is discretized, boundary cond. imposed explicitly.
- Diff. eq. become large **sparse matrix eq.**
- Solves matrix eq. **approximately** to get $E(r_i)$, and thus $B(r_i)$, $J(r_i)$, and $\rho(r_i)$.

Finite Difference Time Domain (FDTD)

Solves Maxwell's equations in differential form in the time domain.

- Staggered E and B cubic discretization lattices (MoM/FEM → triangle discr.)
- Calculate E → calculate B → time-step forward → calculate E, etc ...

Commercial 3D EM Solvers

FEKO (part of Altair Inc.)

- primary solver: MoM
- also uses FEM, FDTD, and hybrid MoM-FEM.

HFSS (part of ANSYS)

- primary solver: FEM
- also uses hybrid MoM-FEM

COMSOL Multiphysics (AC/DC and RF modules)

- primary solver: FEM

CST Microwave Studio (by CST)

- primary solver: FDTD (with some integral eq. solving also).

Open CADFEKO



CADFEKO



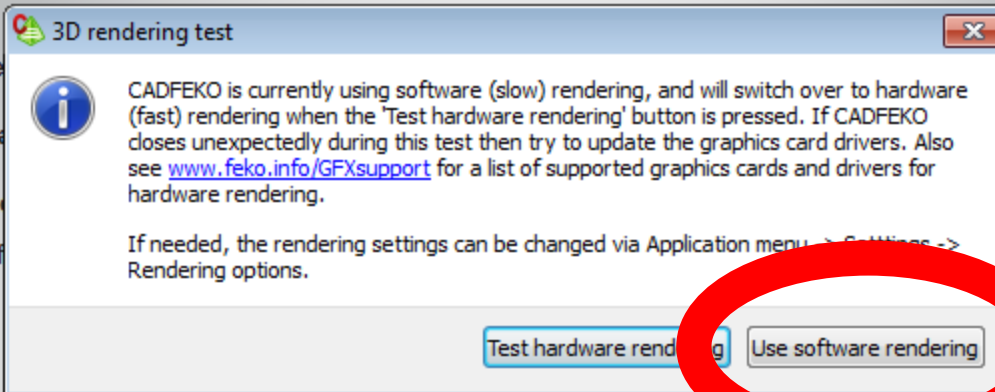
Create

Open

Recent models



startup.cf



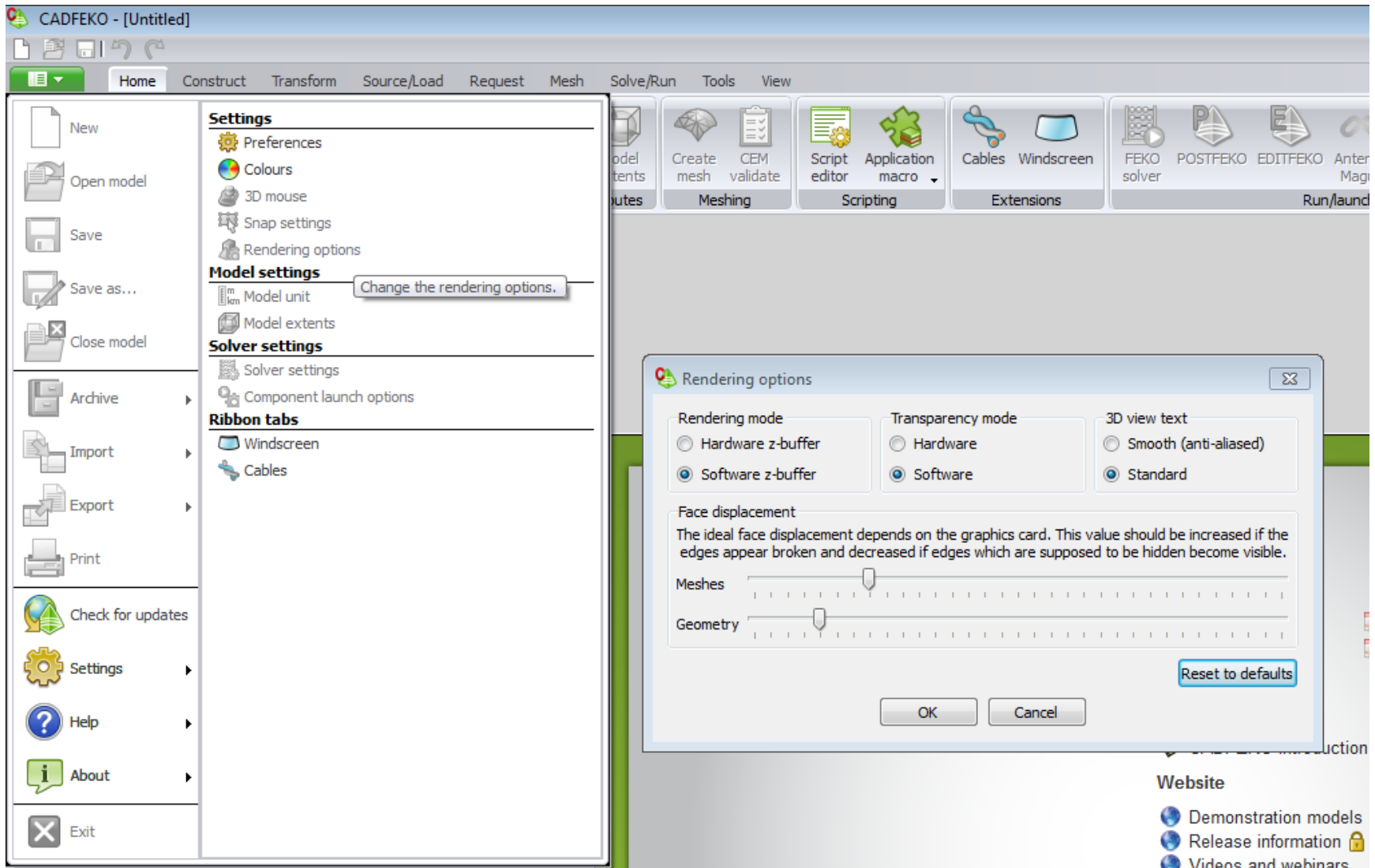
Started Guide
Notes

- Demonstration models
- Release information
- Videos and webinars
- White papers

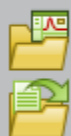
FEKO
Comprehensive Electromagnetic Solutions



Just in case: Adjusting the Rendering



POSTFEKO



Open a

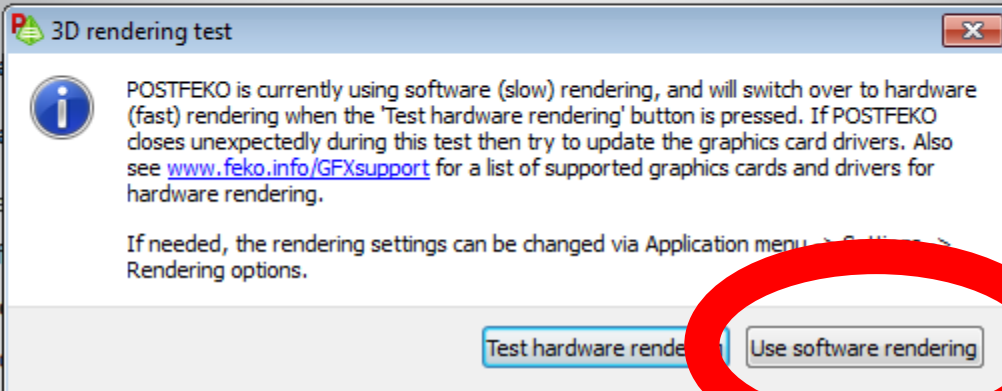
Open a

Recent projects

startup.pf

Recent models

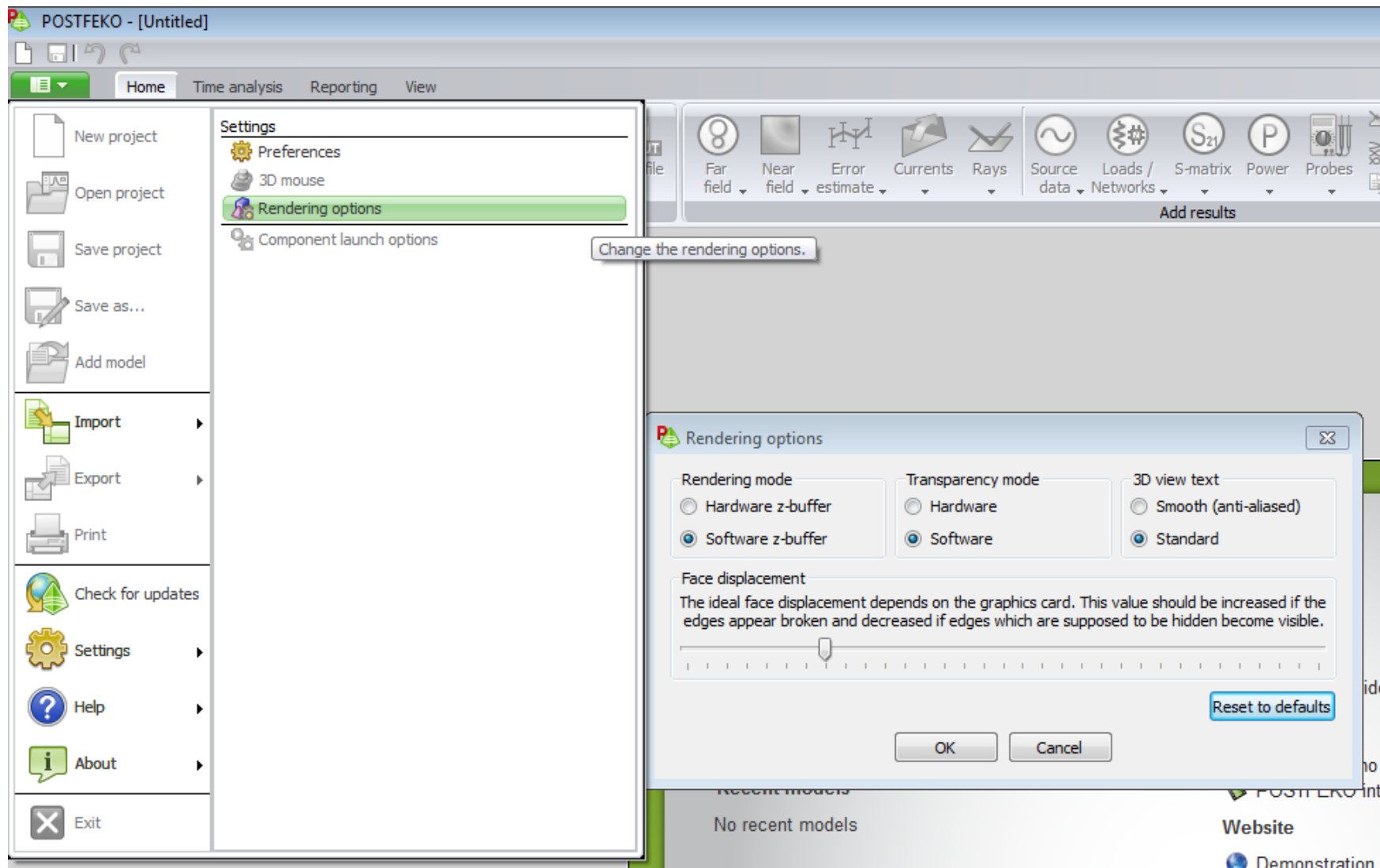
No recent models



- Demonstration models
- Release information
- Videos and webinars
- White papers

FEKO
Comprehensive Electromagnetic Solutions





FEKO workflow



Construct
model



Insert
Sources/Loads



Specify calculation
requests



Mesh
model



Solve/Run
model



FEKO workflow



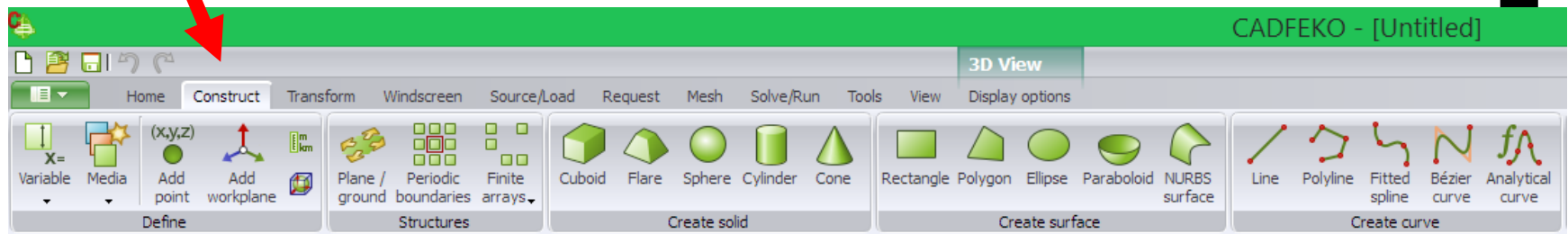
Construct
model

Insert
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Specify calculation
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Mesh
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FEKO workflow



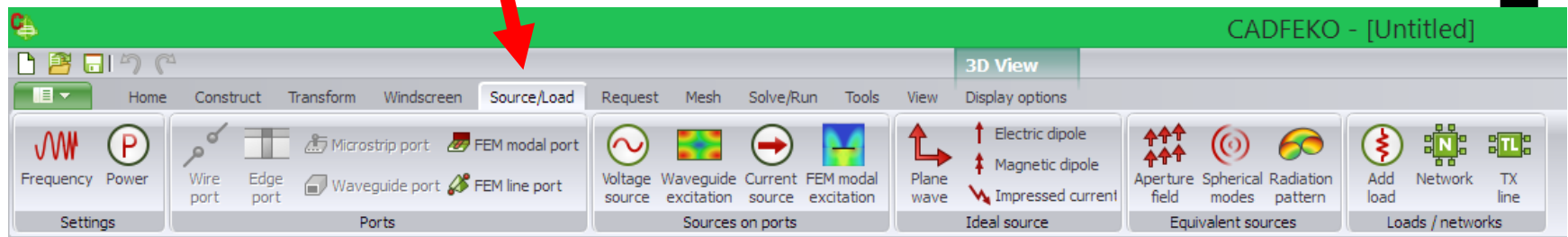
Construct
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FEKO workflow



Construct
model



Insert
Sources/Loads



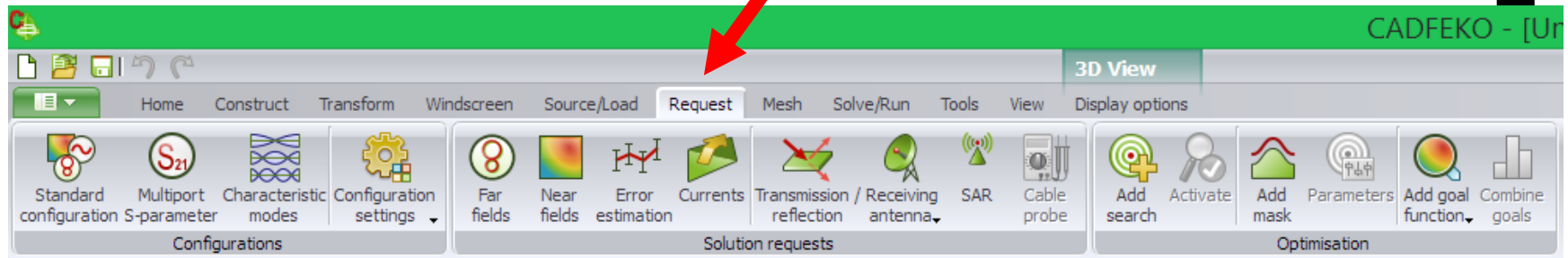
Specify calculation
requests



Mesh
model



Solve/Run
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FEKO workflow



Construct
model



Insert
Sources/Loads



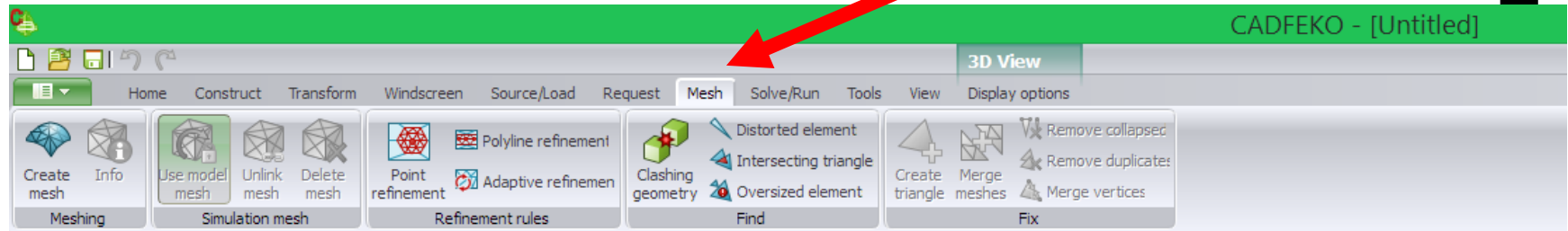
Specify calculation
requests



Mesh
model



Solve/Run
model



FEKO workflow



Construct
model



Insert
Sources/Loads



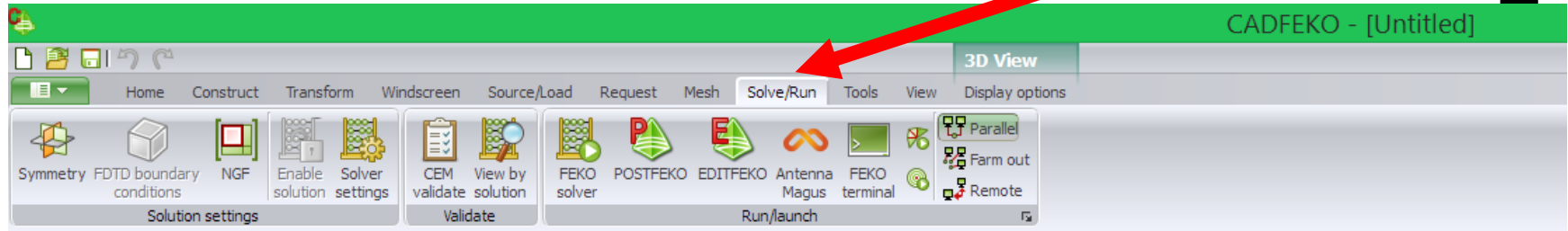
Specify calculation
requests



Mesh
model



Solve/Run
model

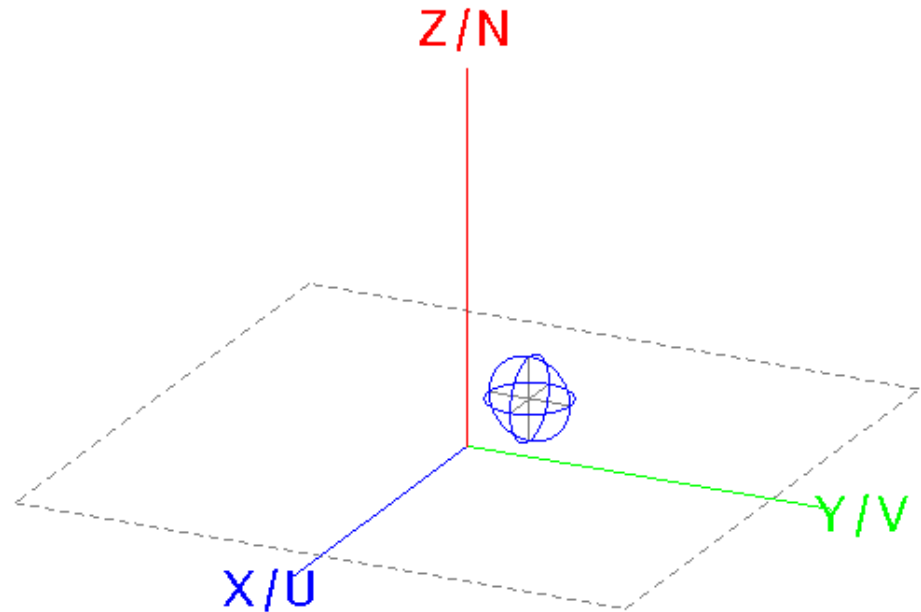


FEKO: 3D perspective navigation

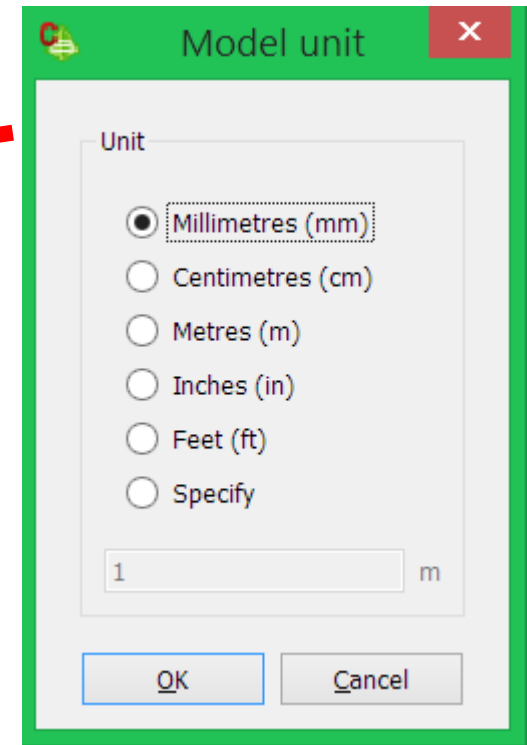
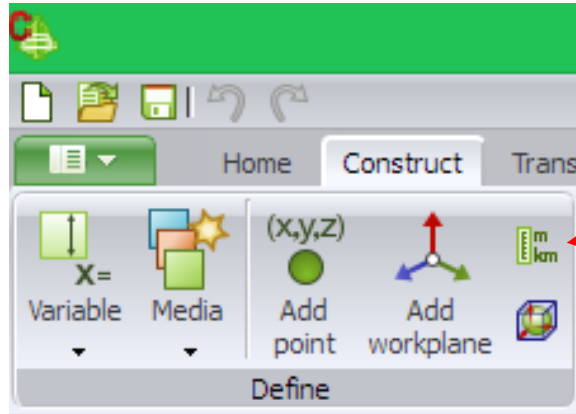
Rotation: Mouse-left-click + drag

Zoom: Shift + Mouse-left-click + drag vertical

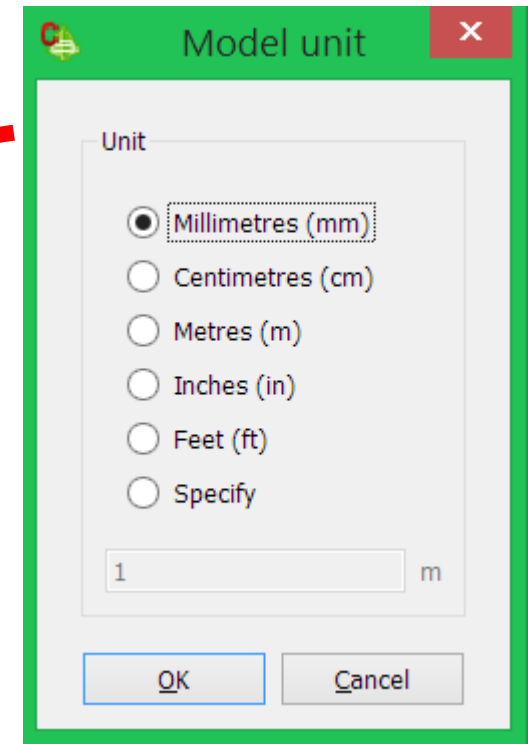
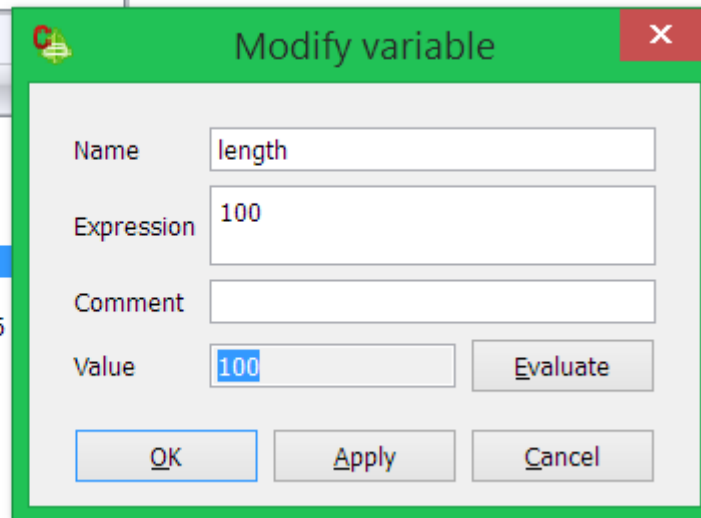
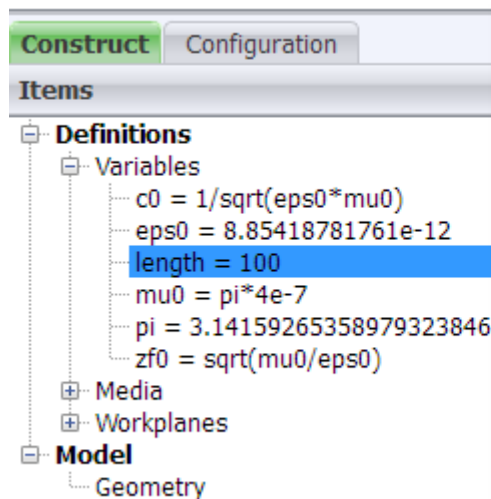
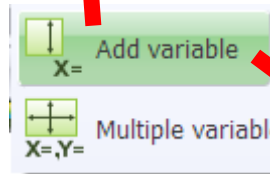
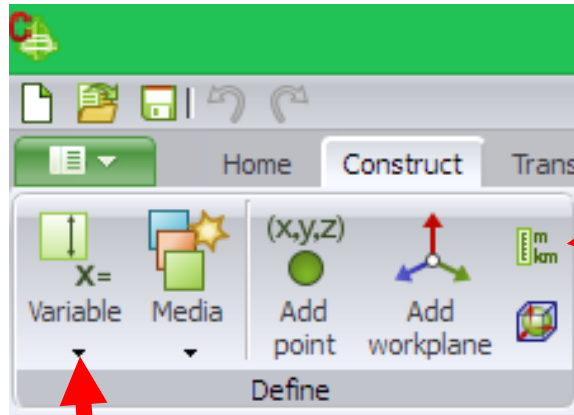
Translate: Ctrl + Mouse-left-click + drag



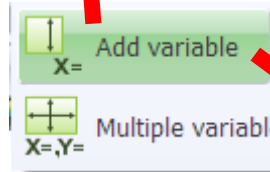
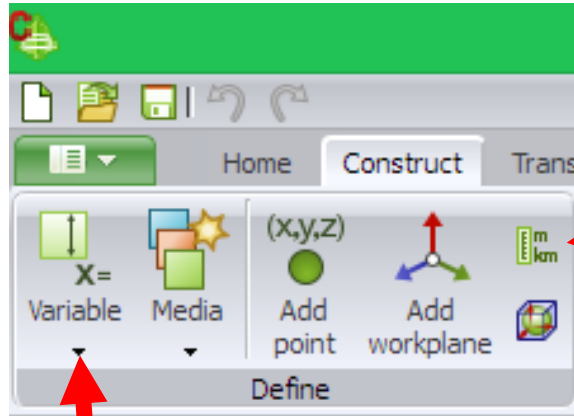
Dipole Antenna: Construction definitions



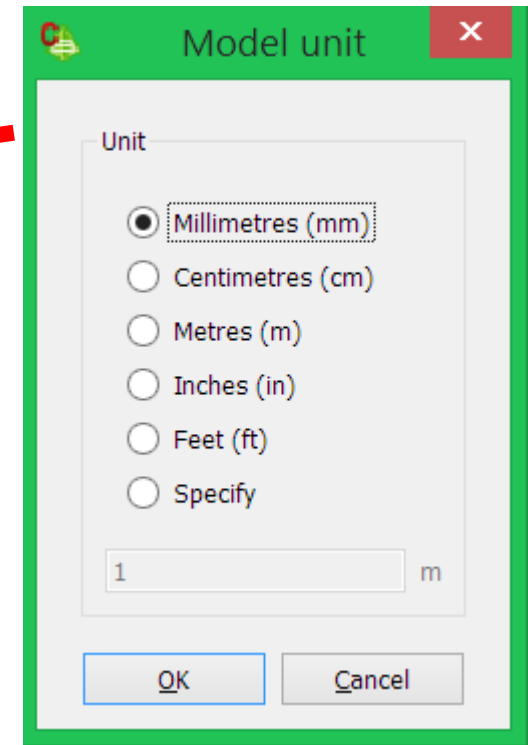
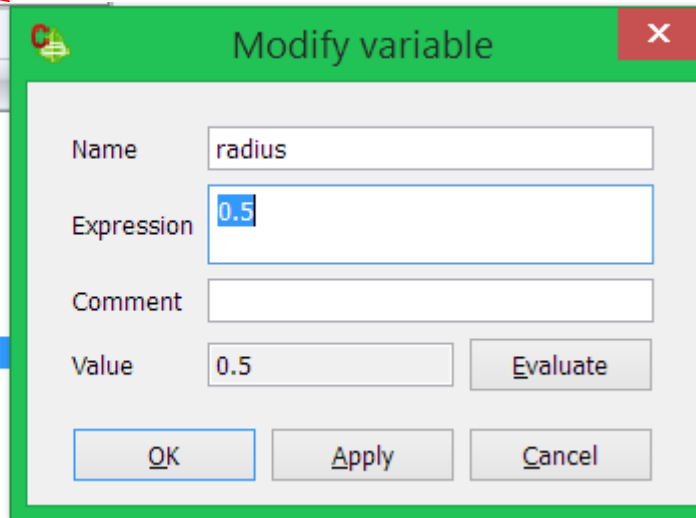
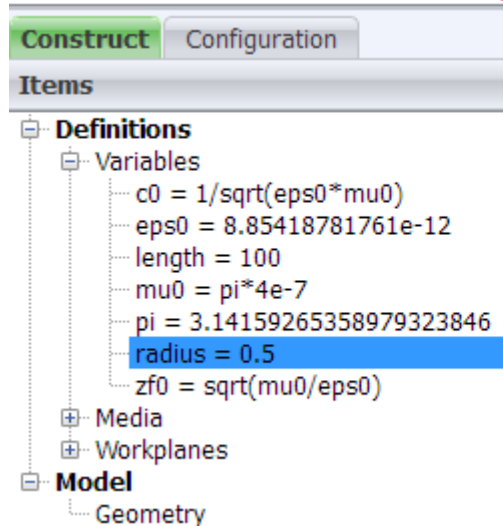
Dipole Antenna: Construction definitions



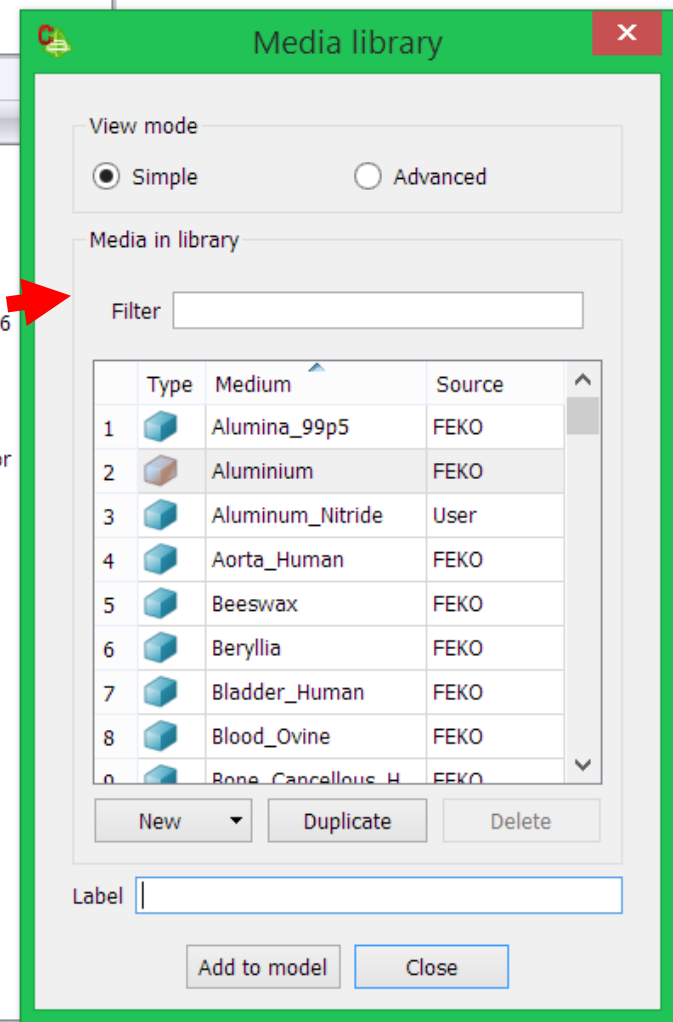
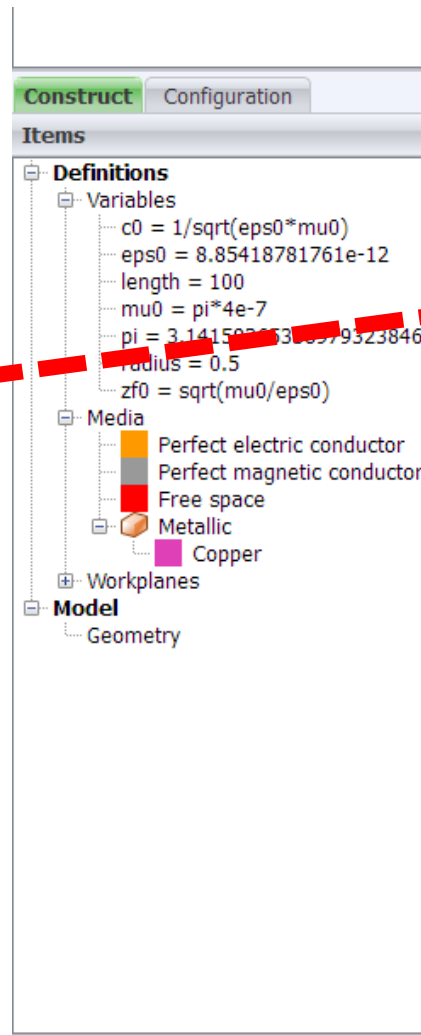
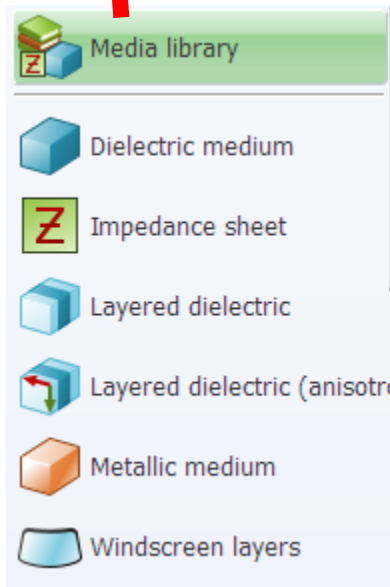
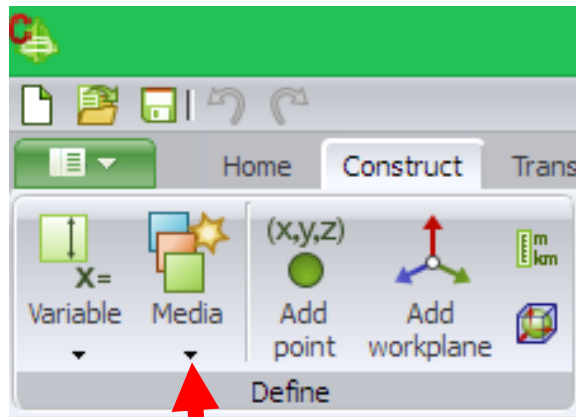
Dipole Antenna: Construction definitions



Add 2nd variable

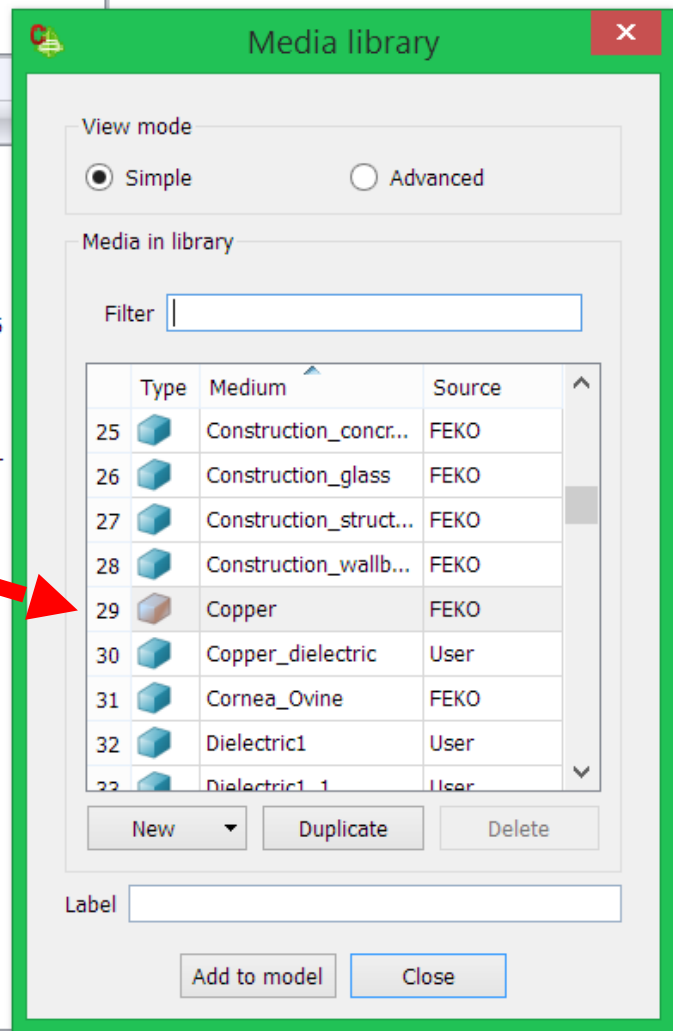
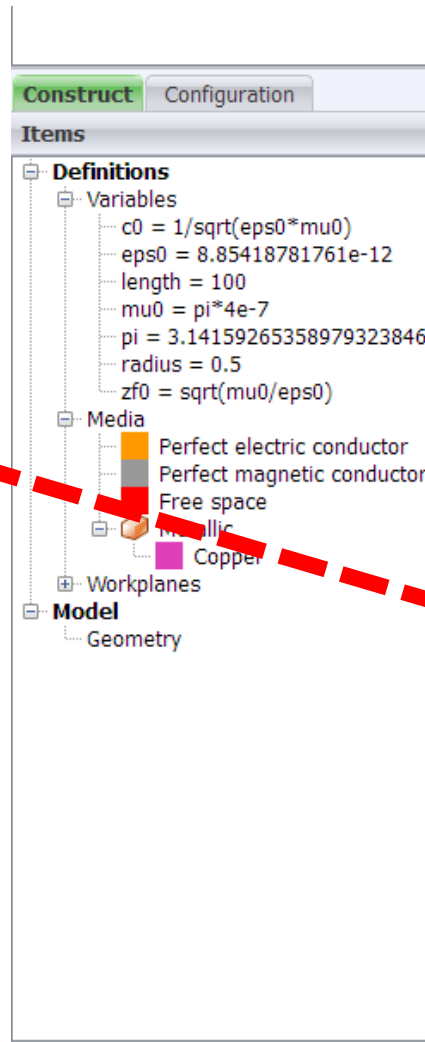
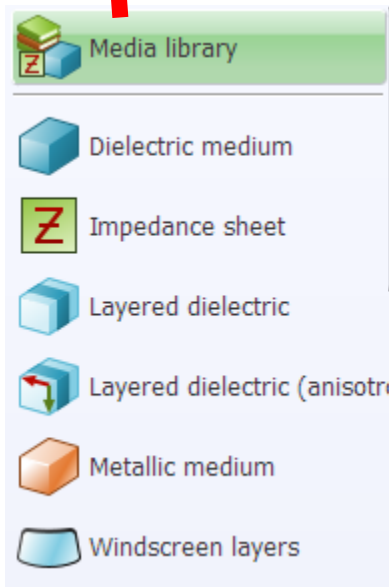
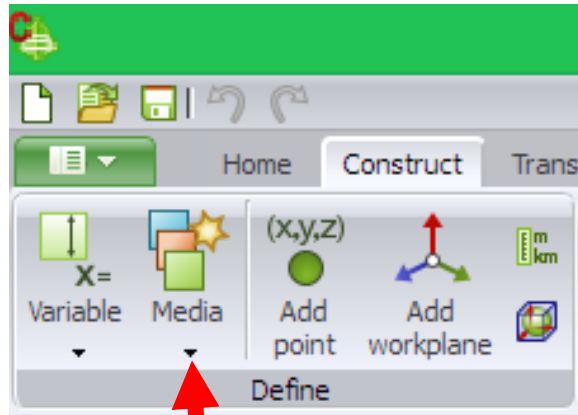


Dipole Antenna: Construction definitions

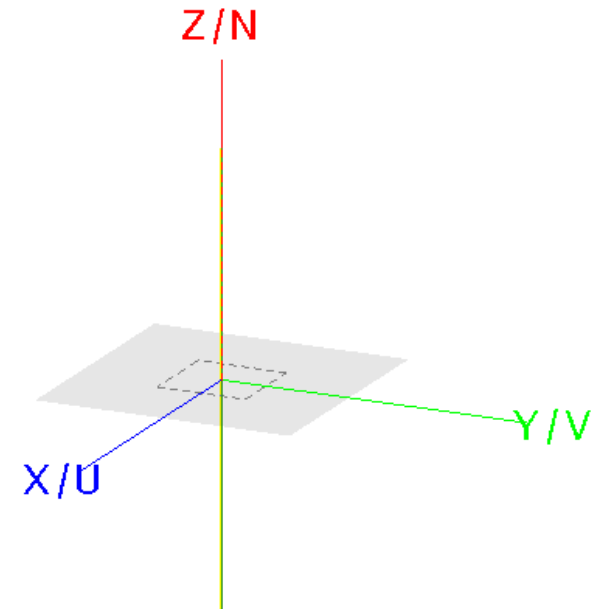
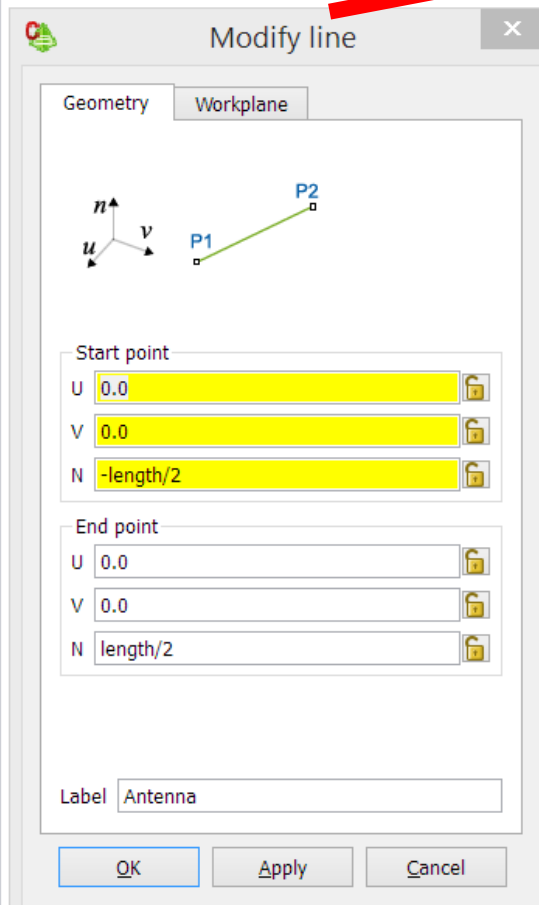
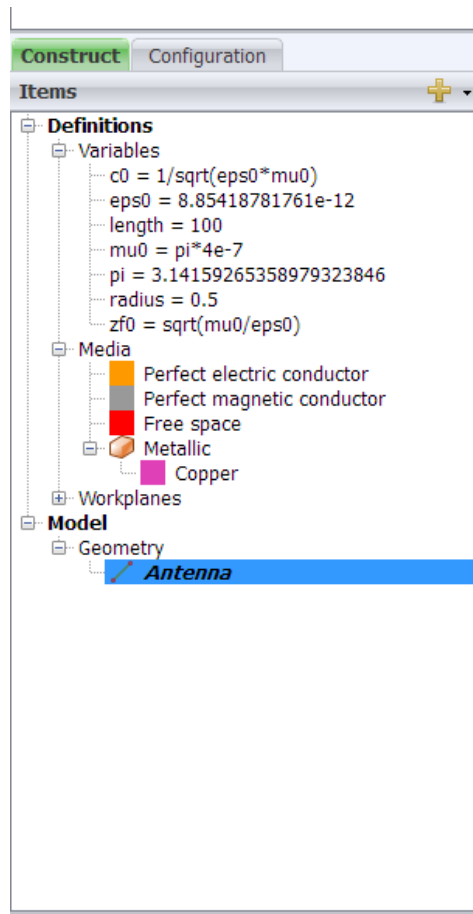
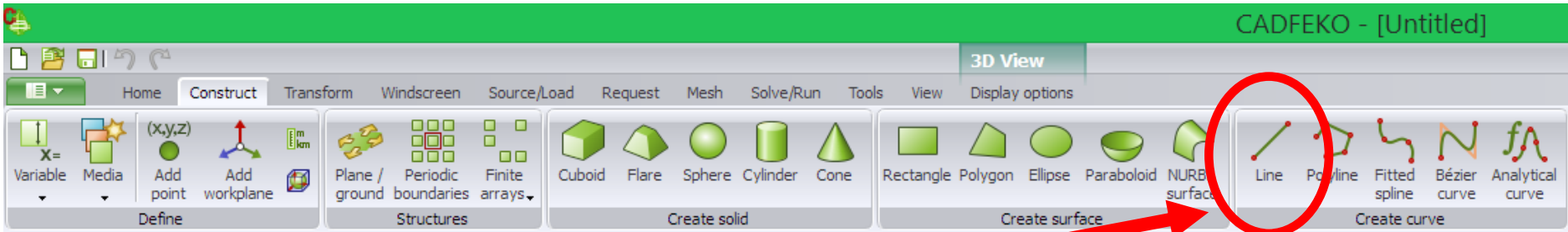


Dipole Antenna: Construction definitions

Add “Copper” to model

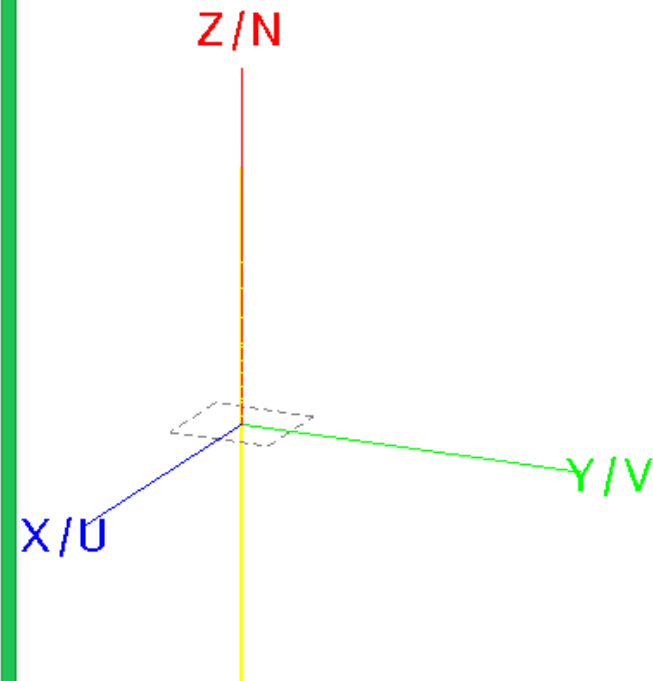
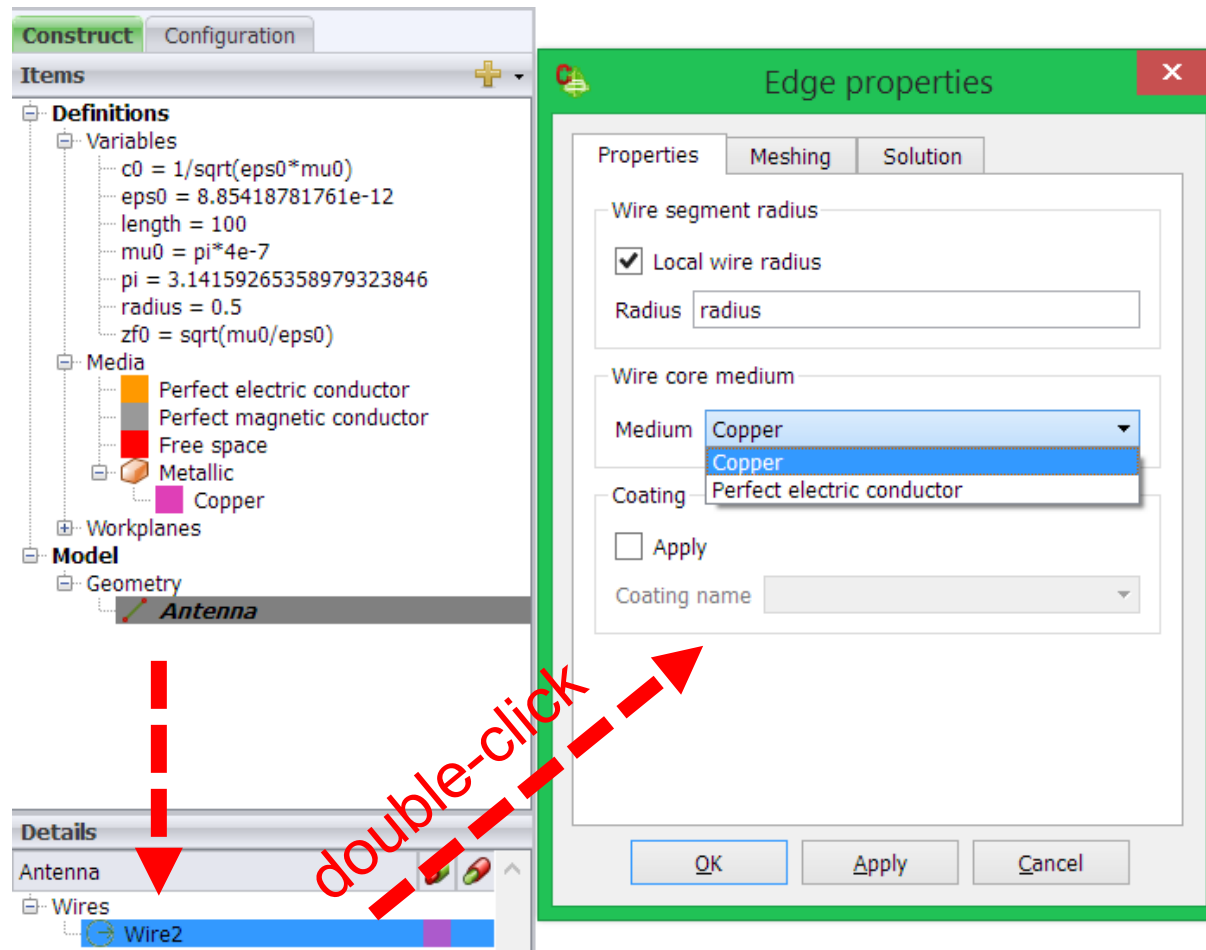


Dipole Antenna: Construct Antenna

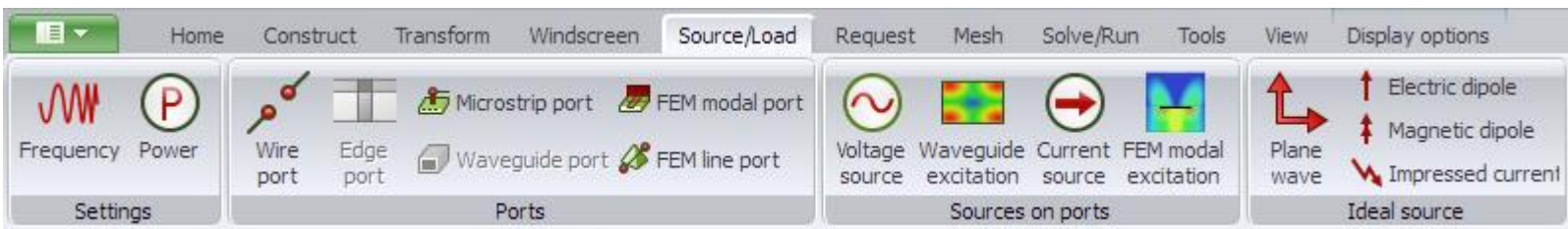


zoom out to see
full antenna

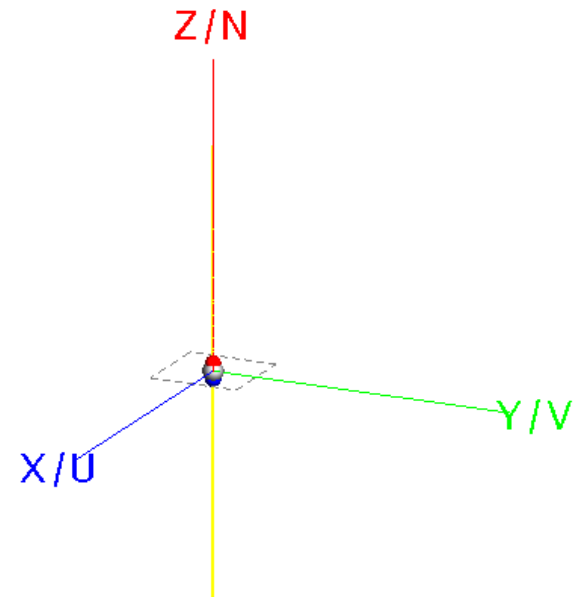
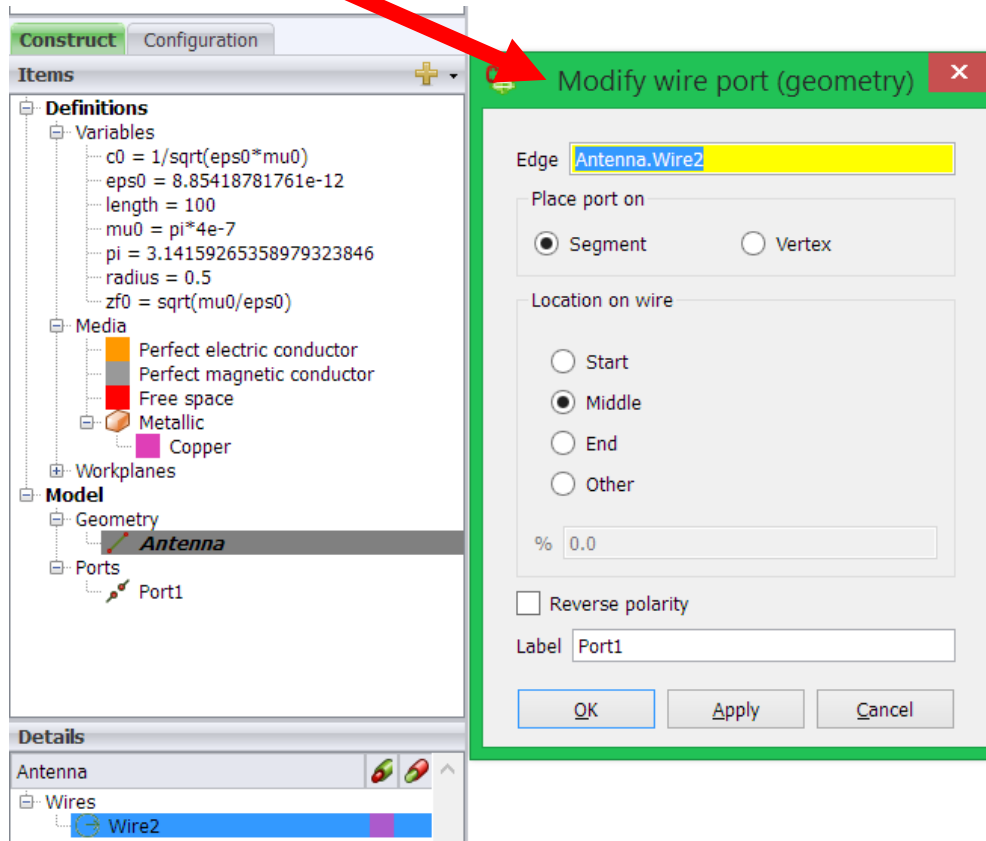
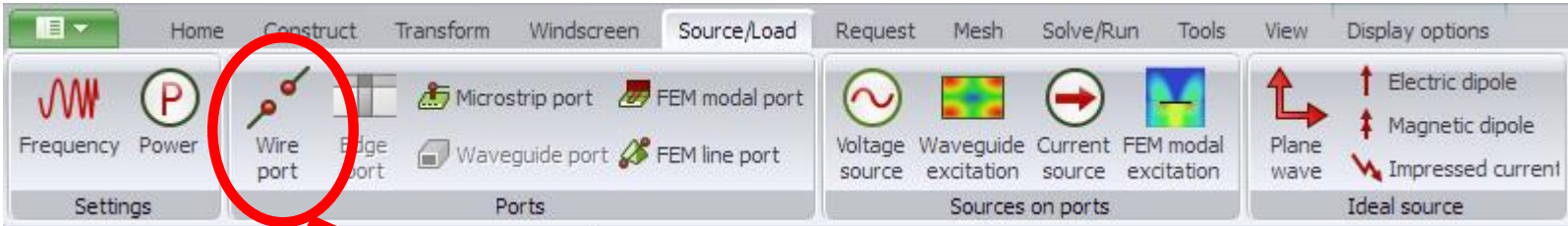
Dipole Antenna: Construct Antenna → assign material



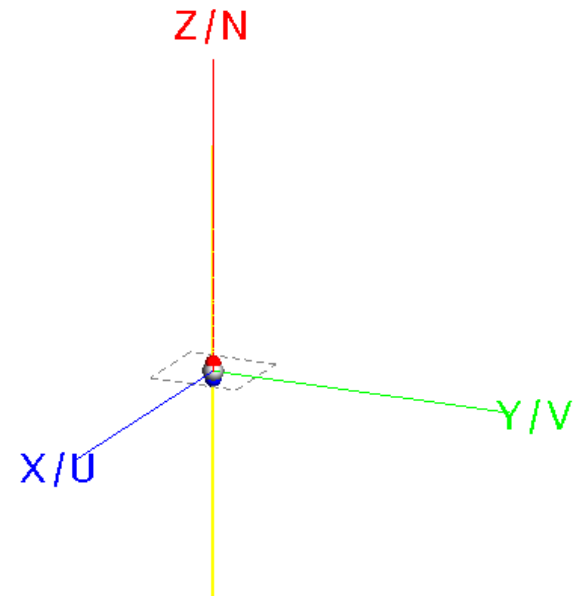
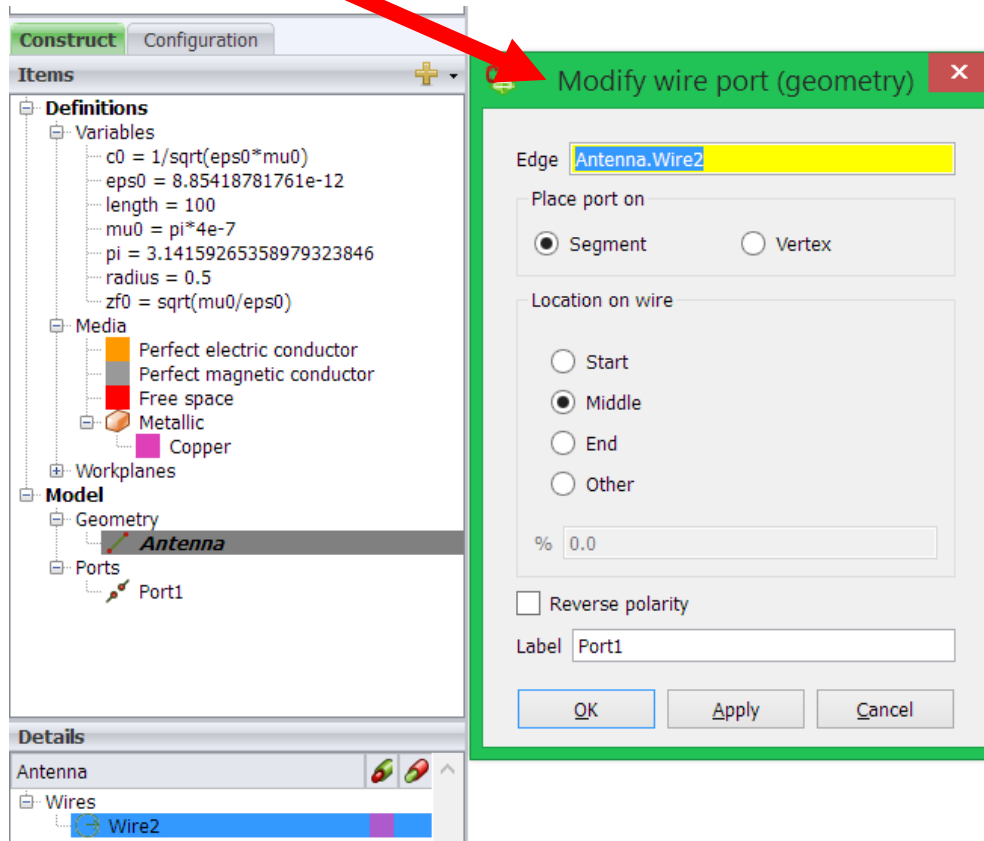
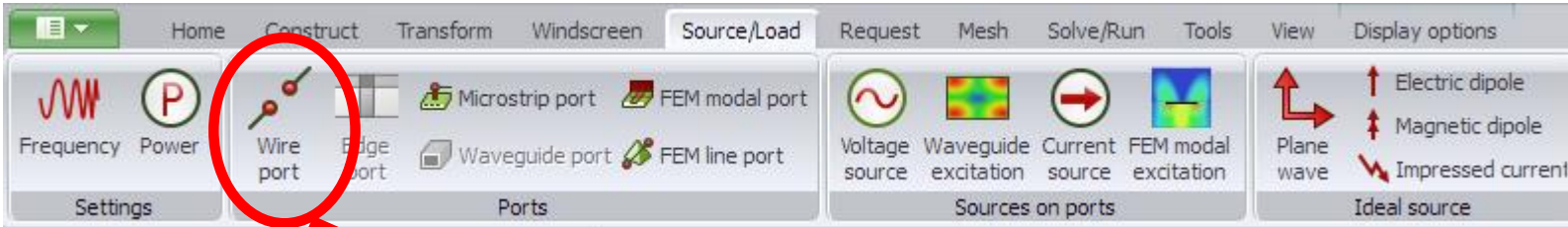
Dipole Antenna: Excitation Source



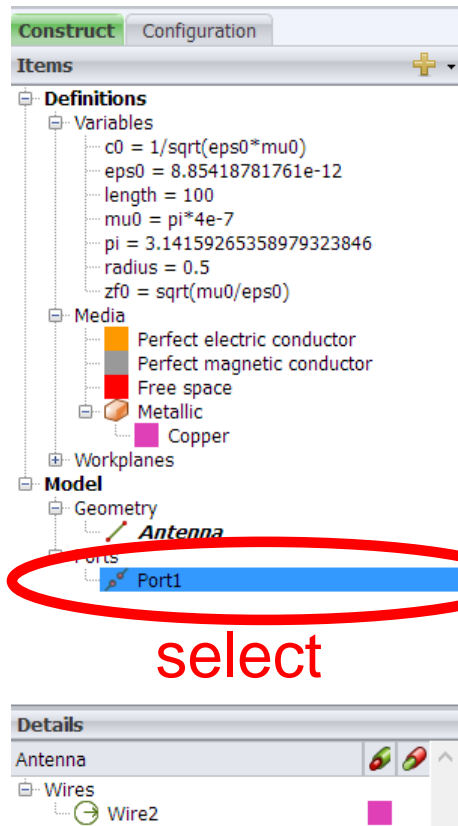
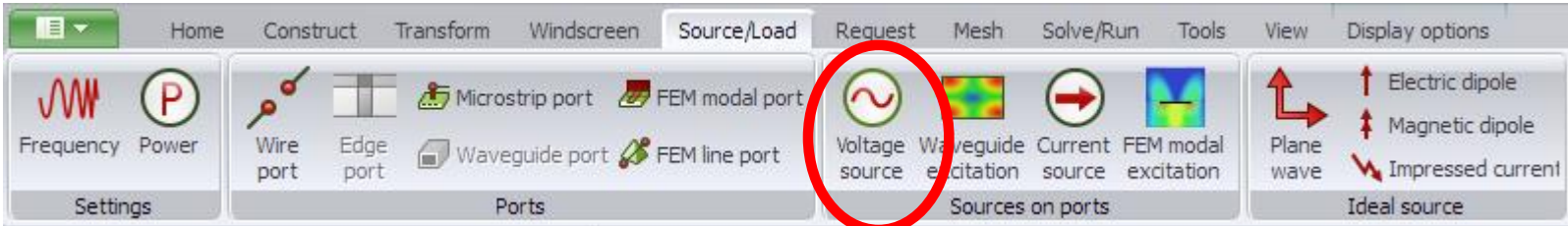
Dipole Antenna: Excitation Source



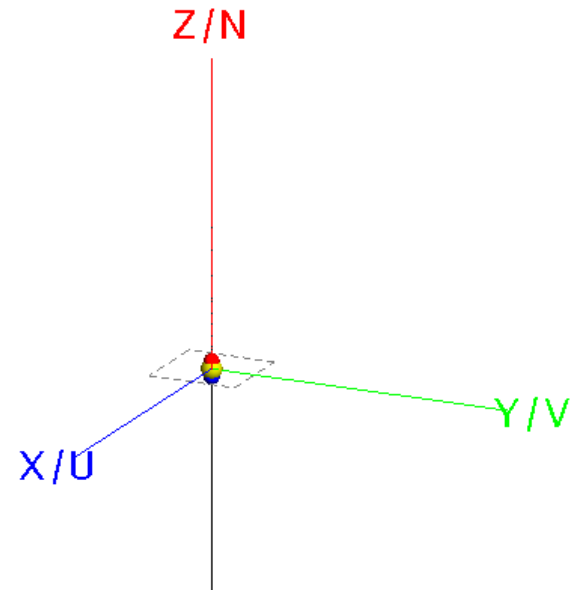
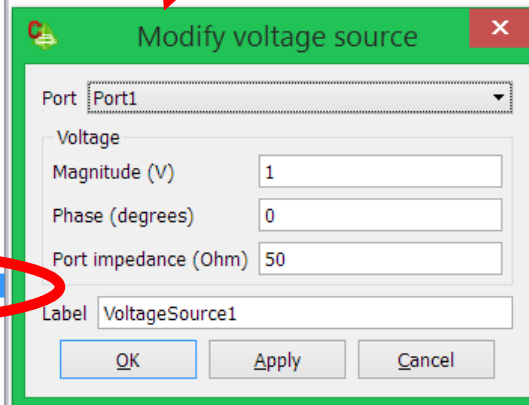
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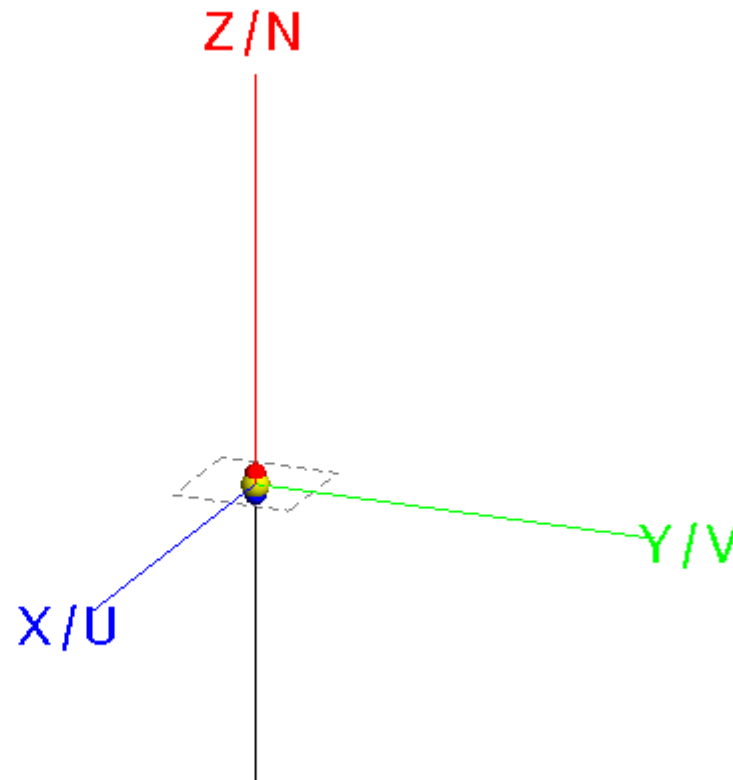
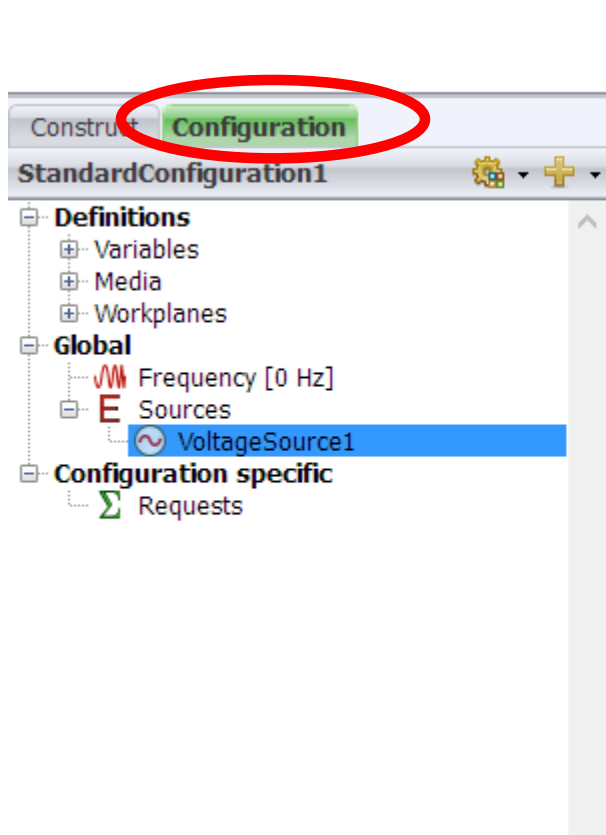
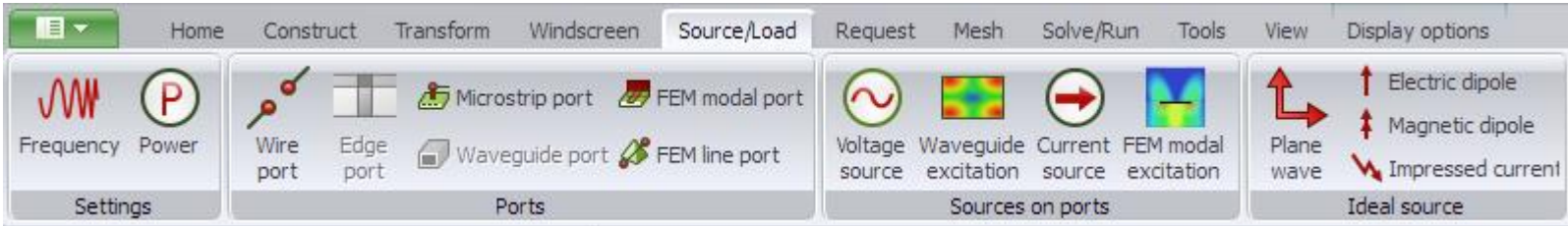
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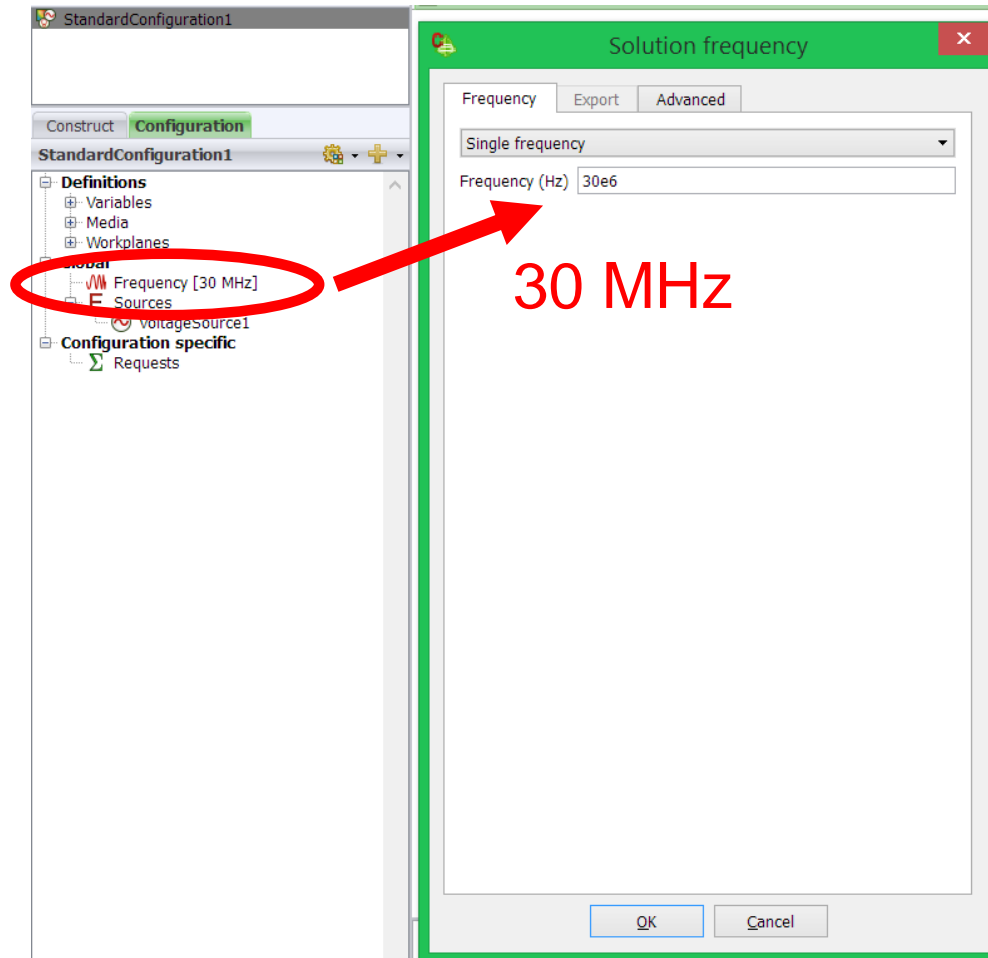
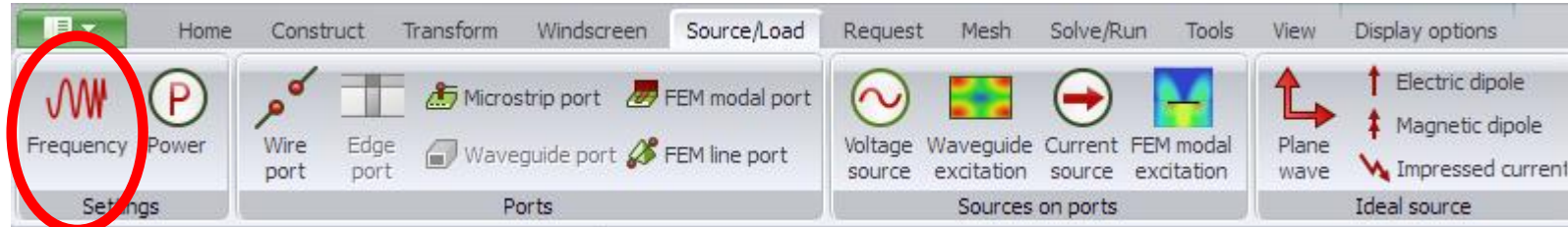
select



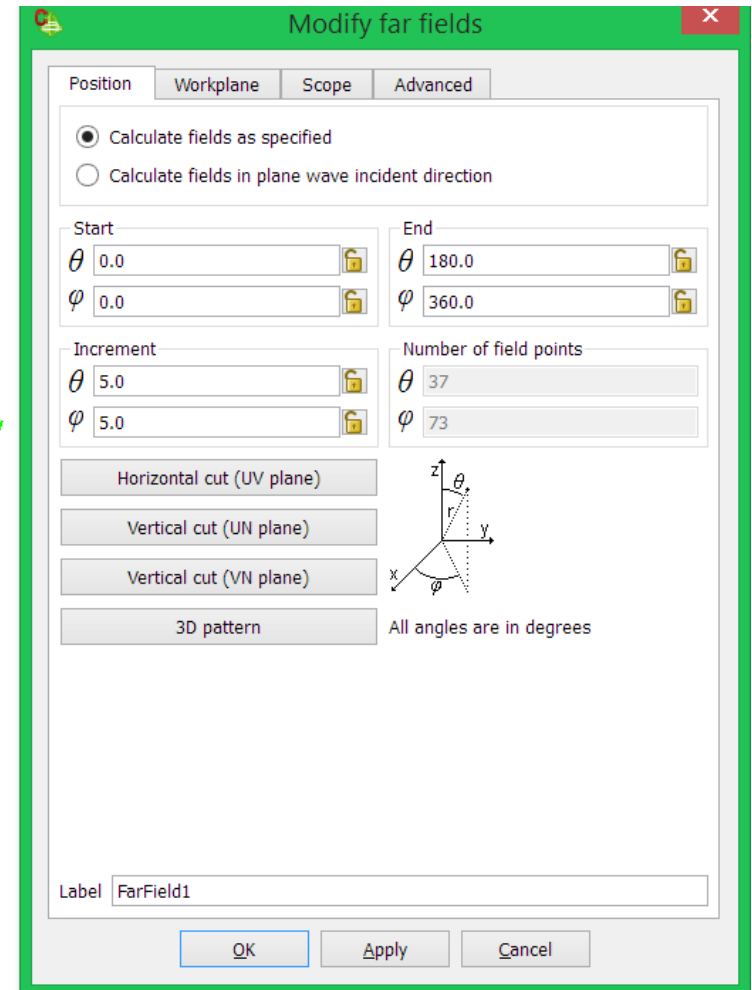
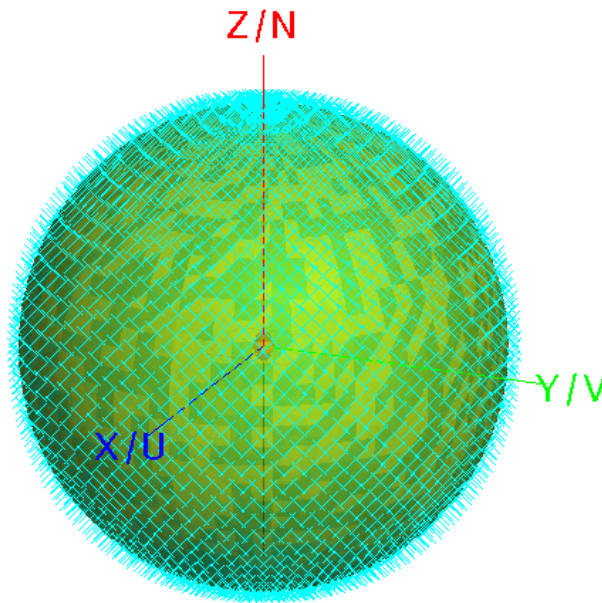
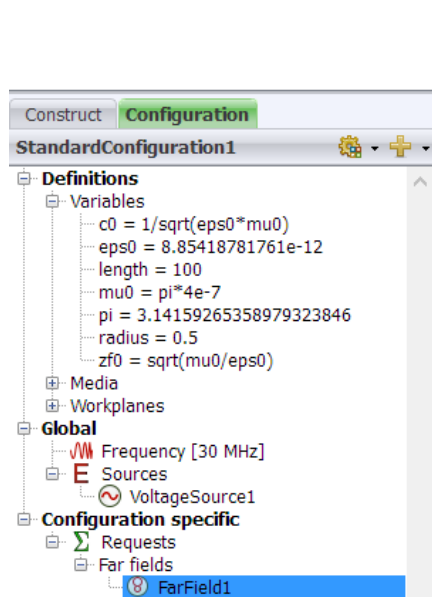
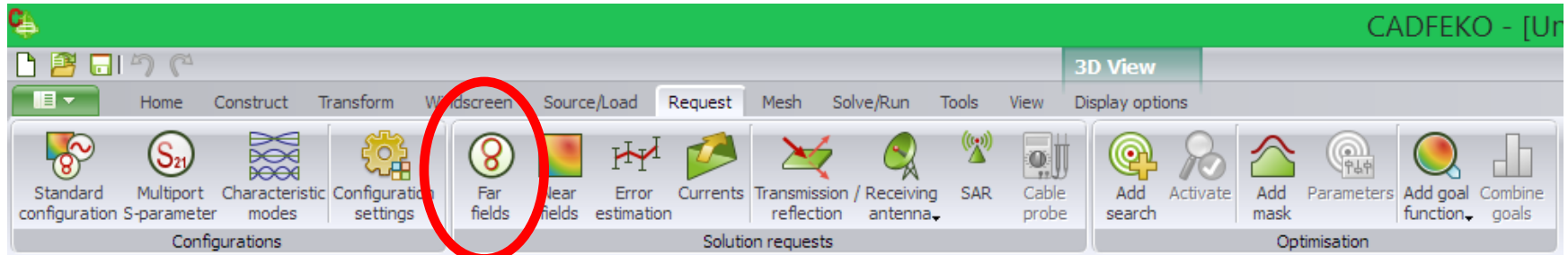
Dipole Antenna: model configuration



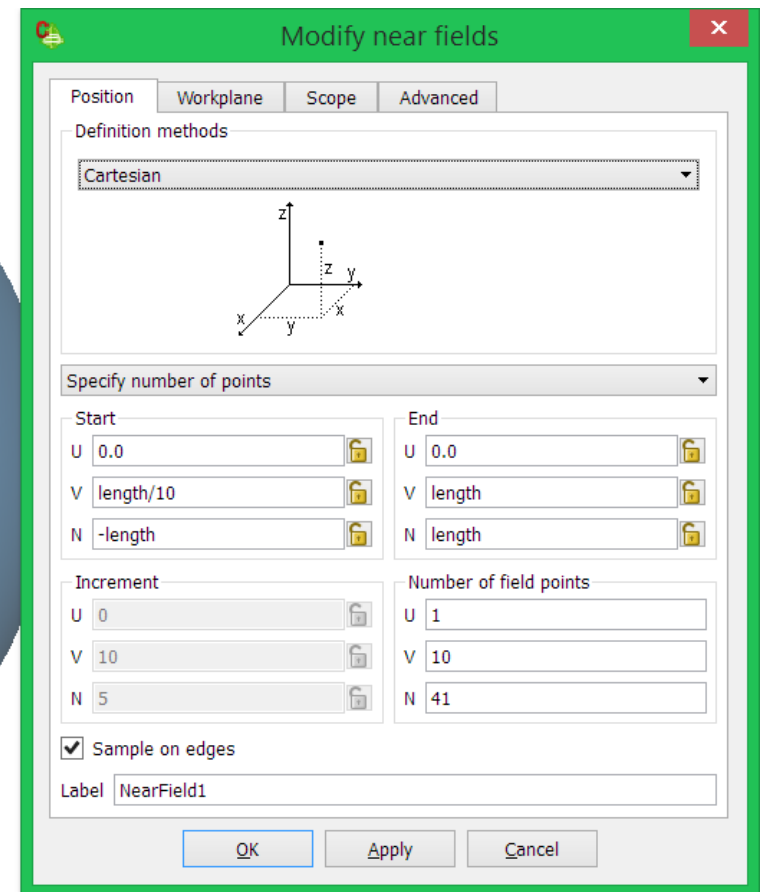
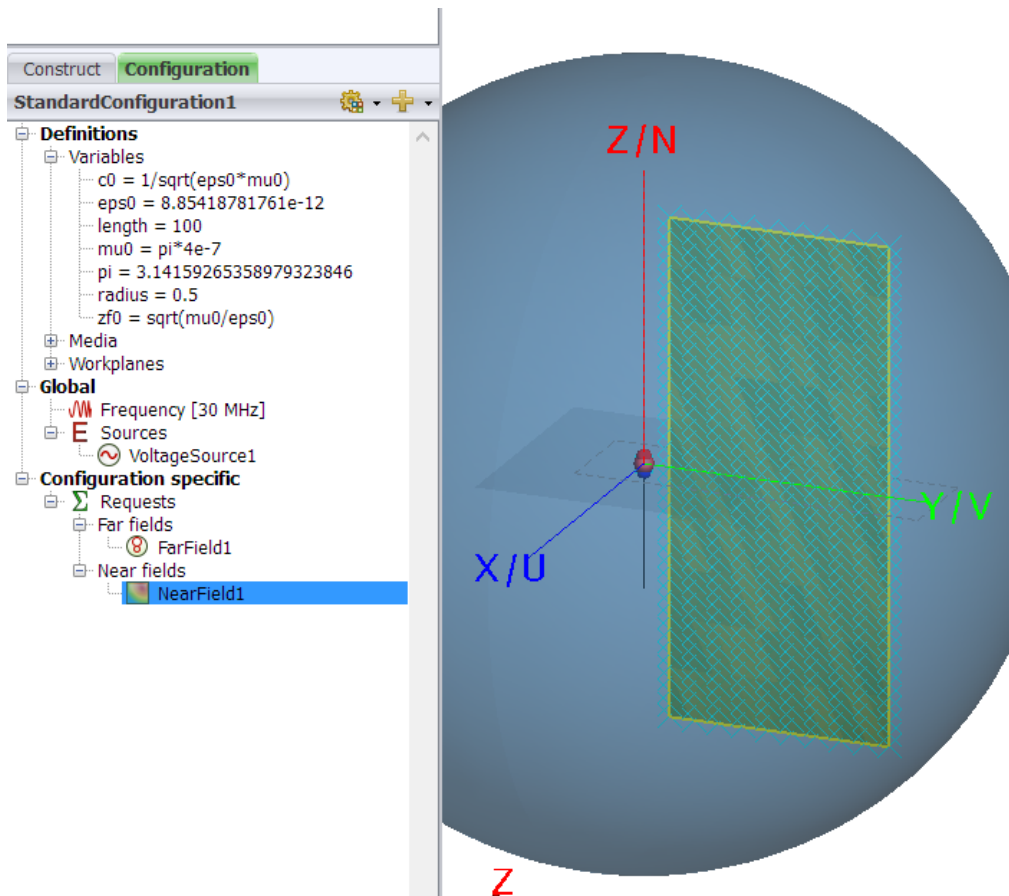
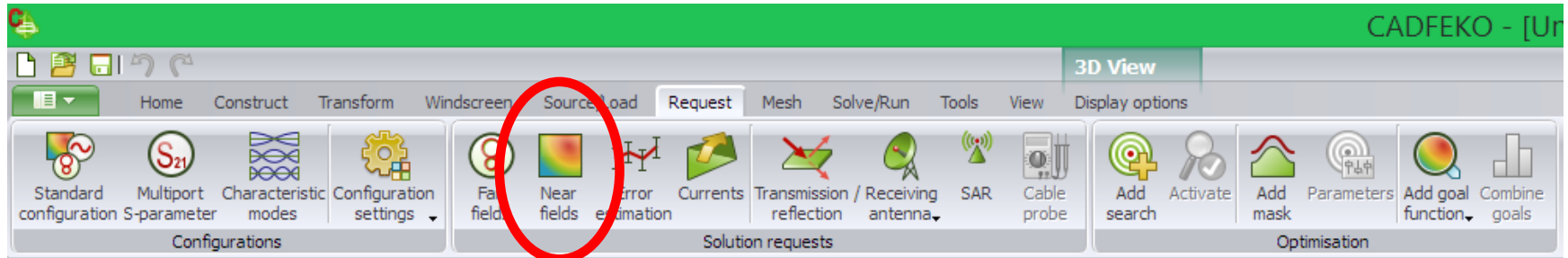
Dipole Antenna: set solution Frequency



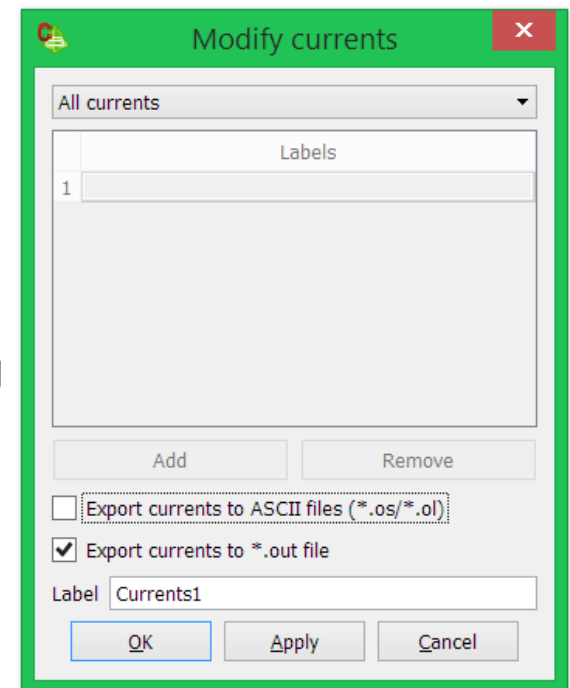
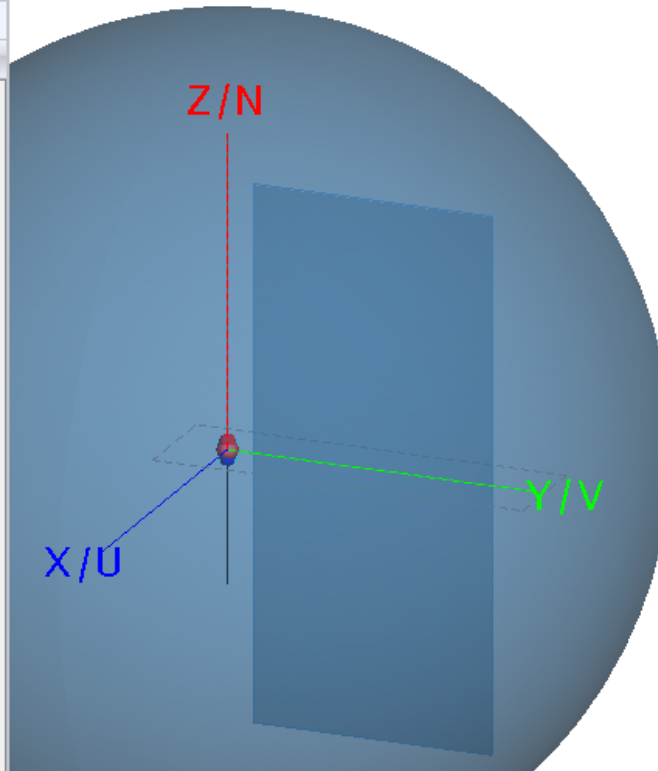
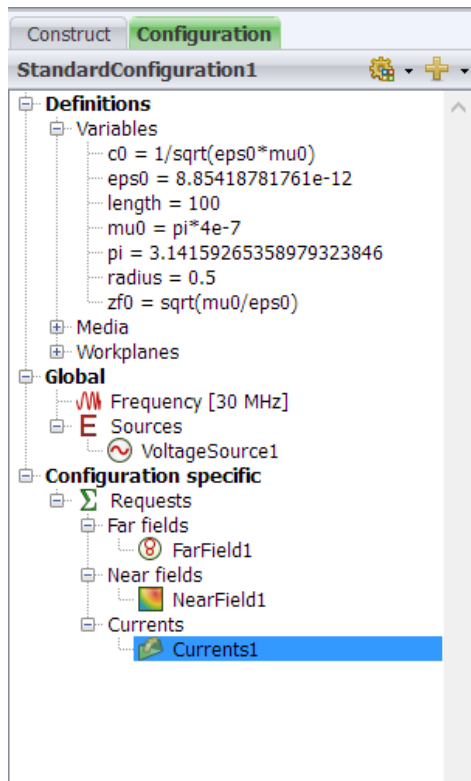
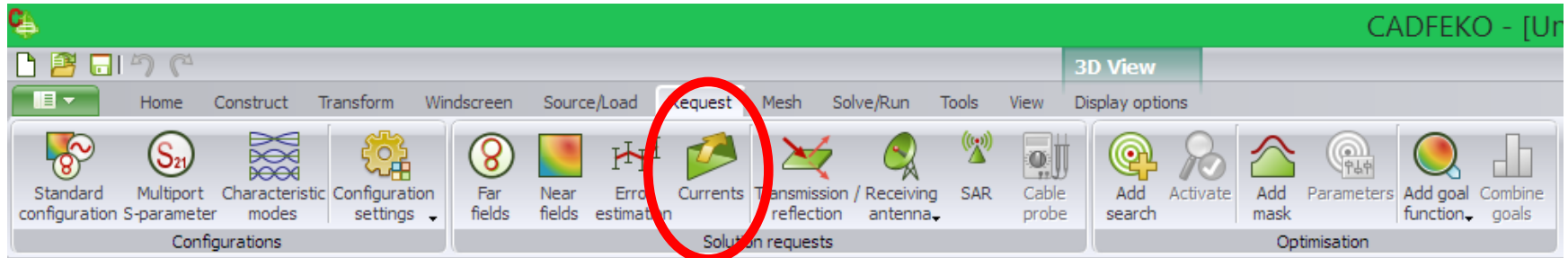
Dipole Antenna: Calculation Requests



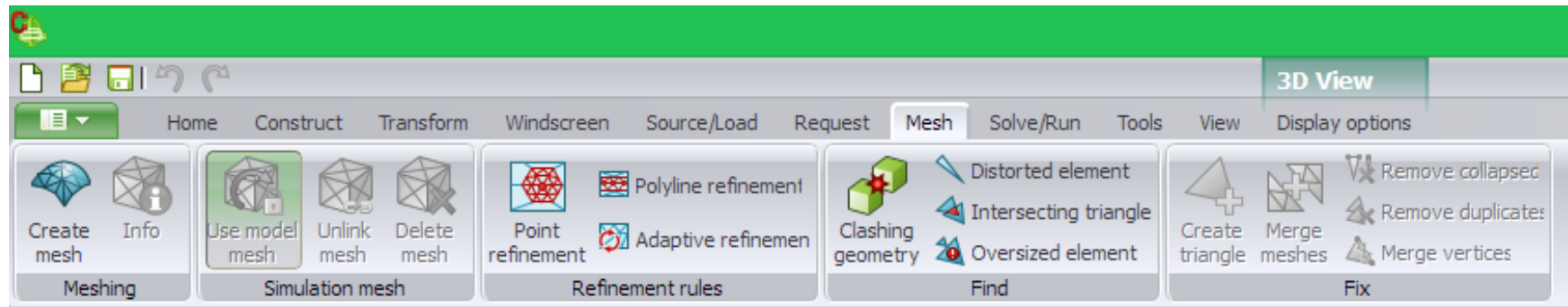
Dipole Antenna: Calculation Requests



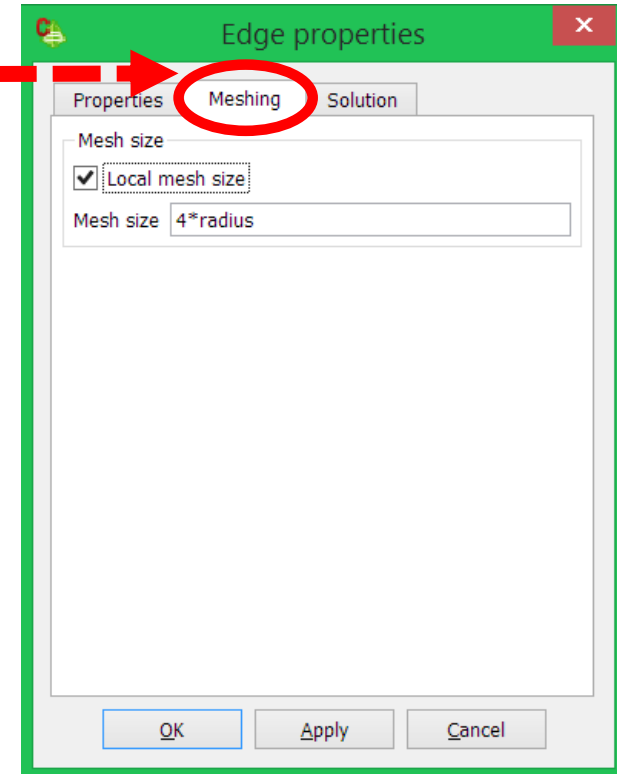
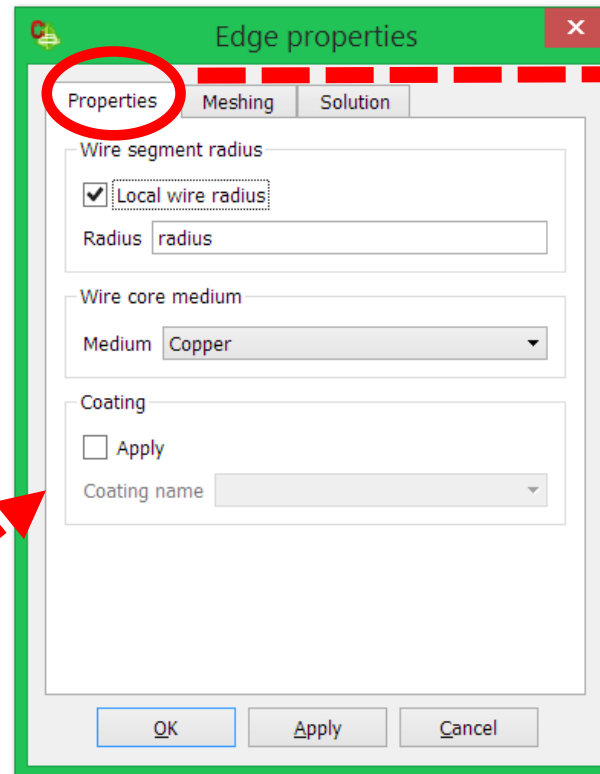
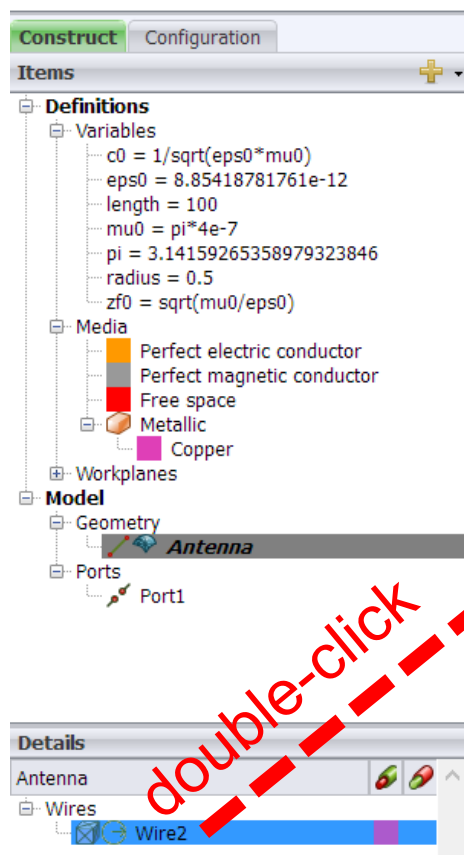
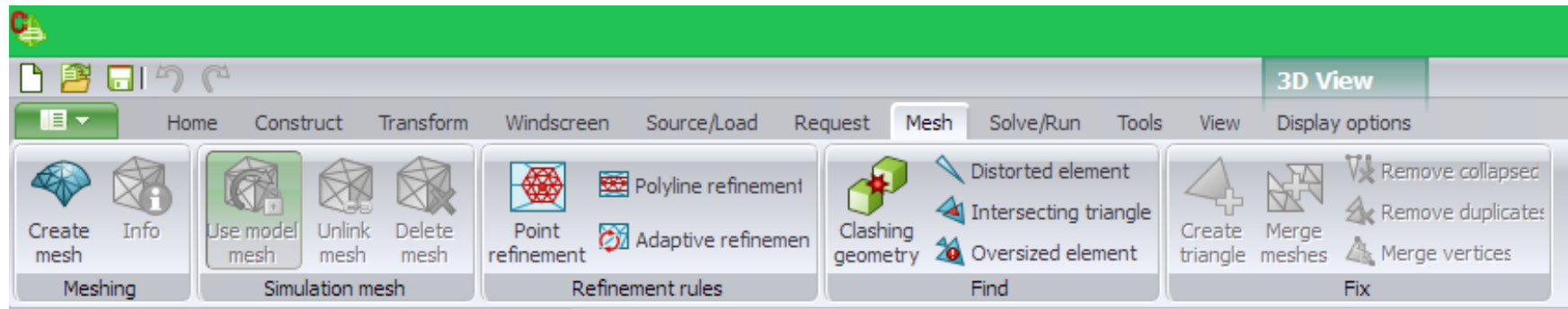
Dipole Antenna: Calculation Requests



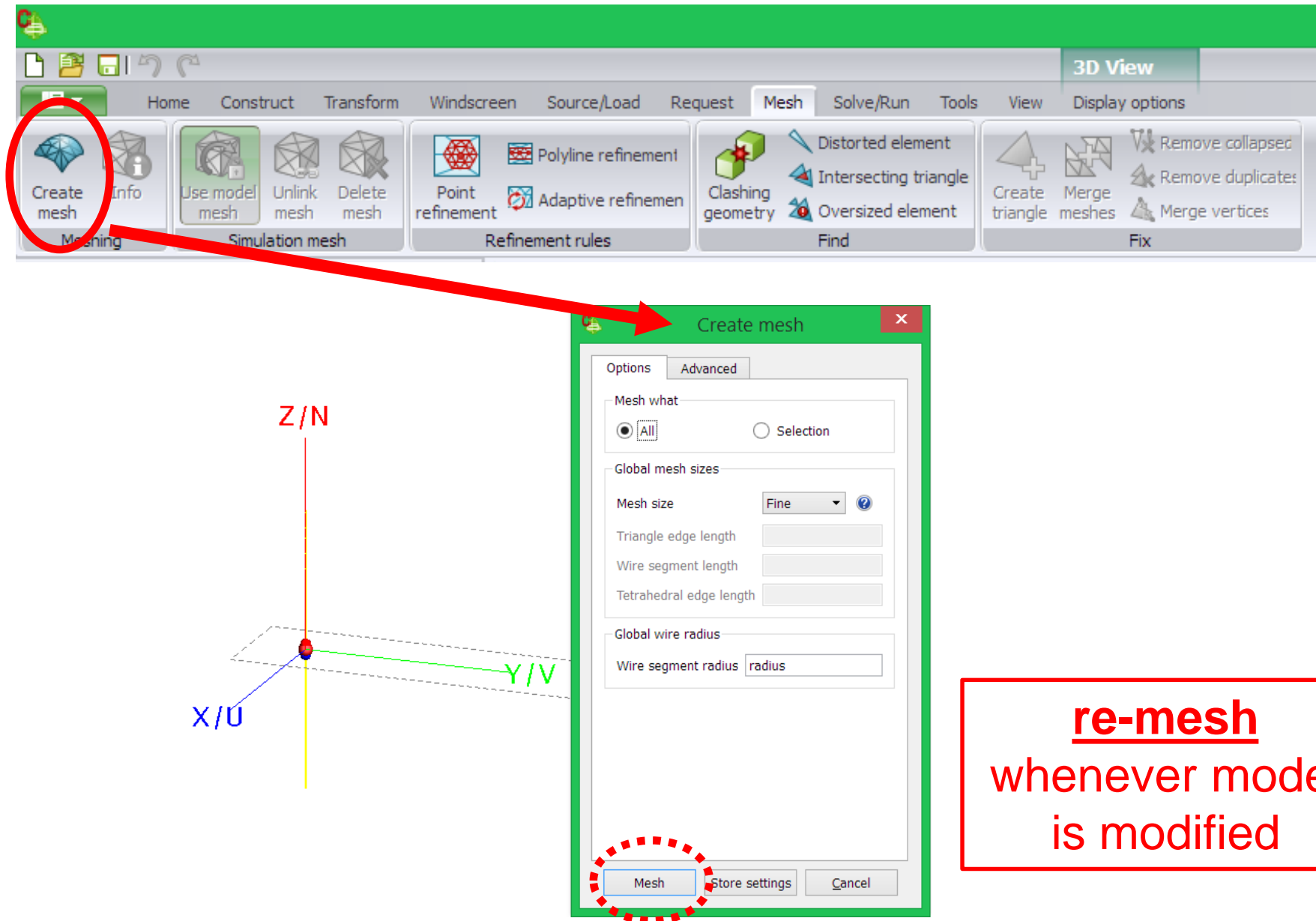
Dipole Antenna: Mesh the model



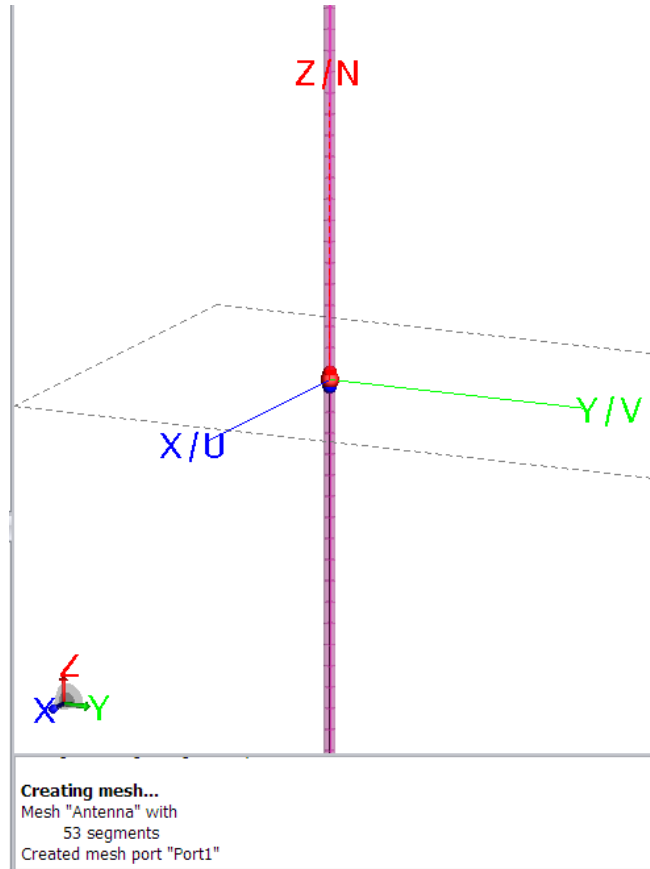
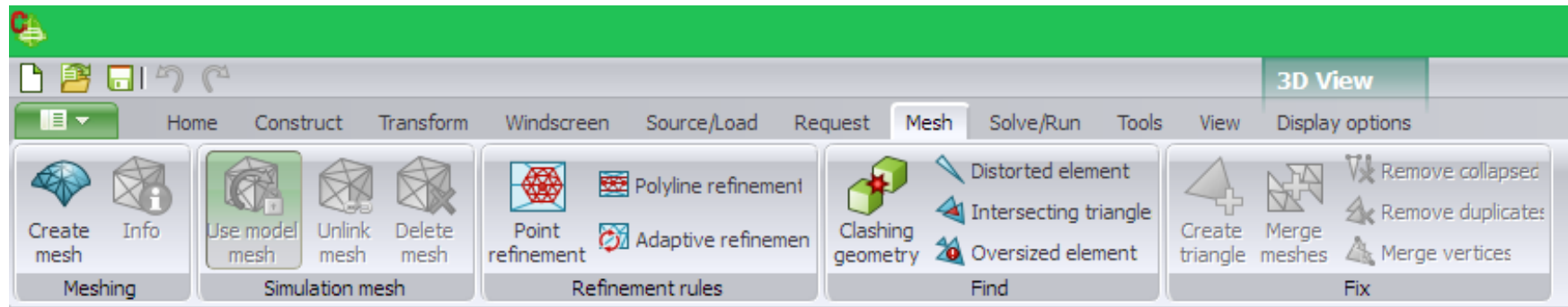
Dipole Antenna: Mesh the model



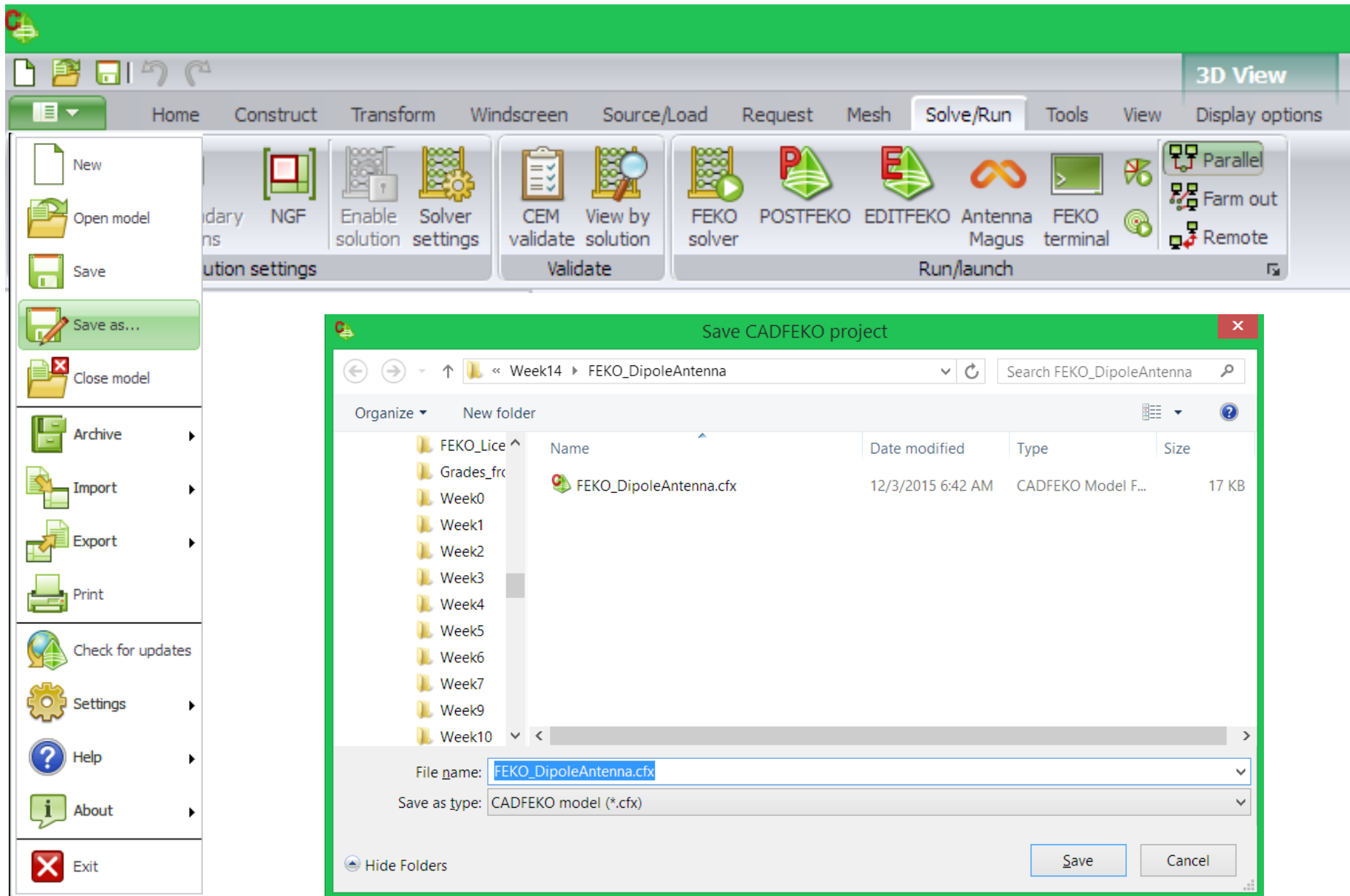
Dipole Antenna: Mesh the model



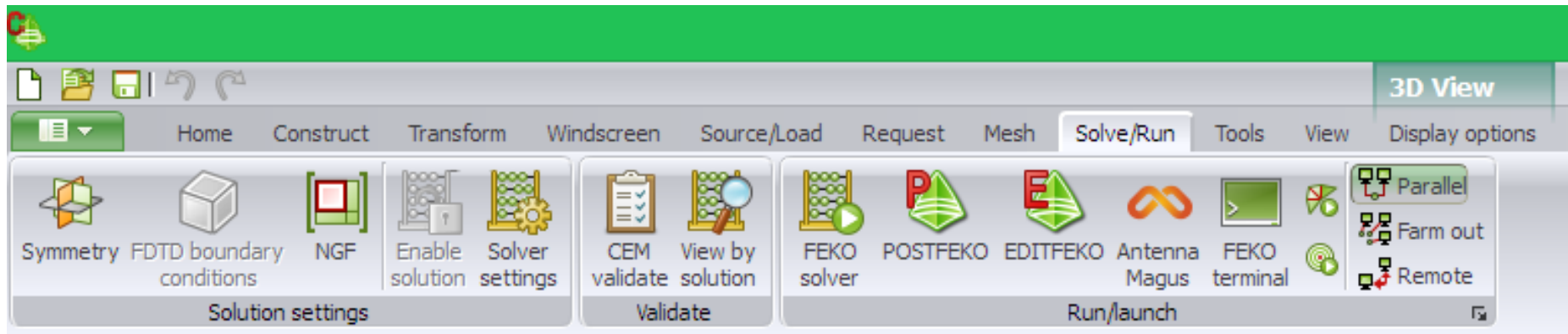
Dipole Antenna: Mesh the model



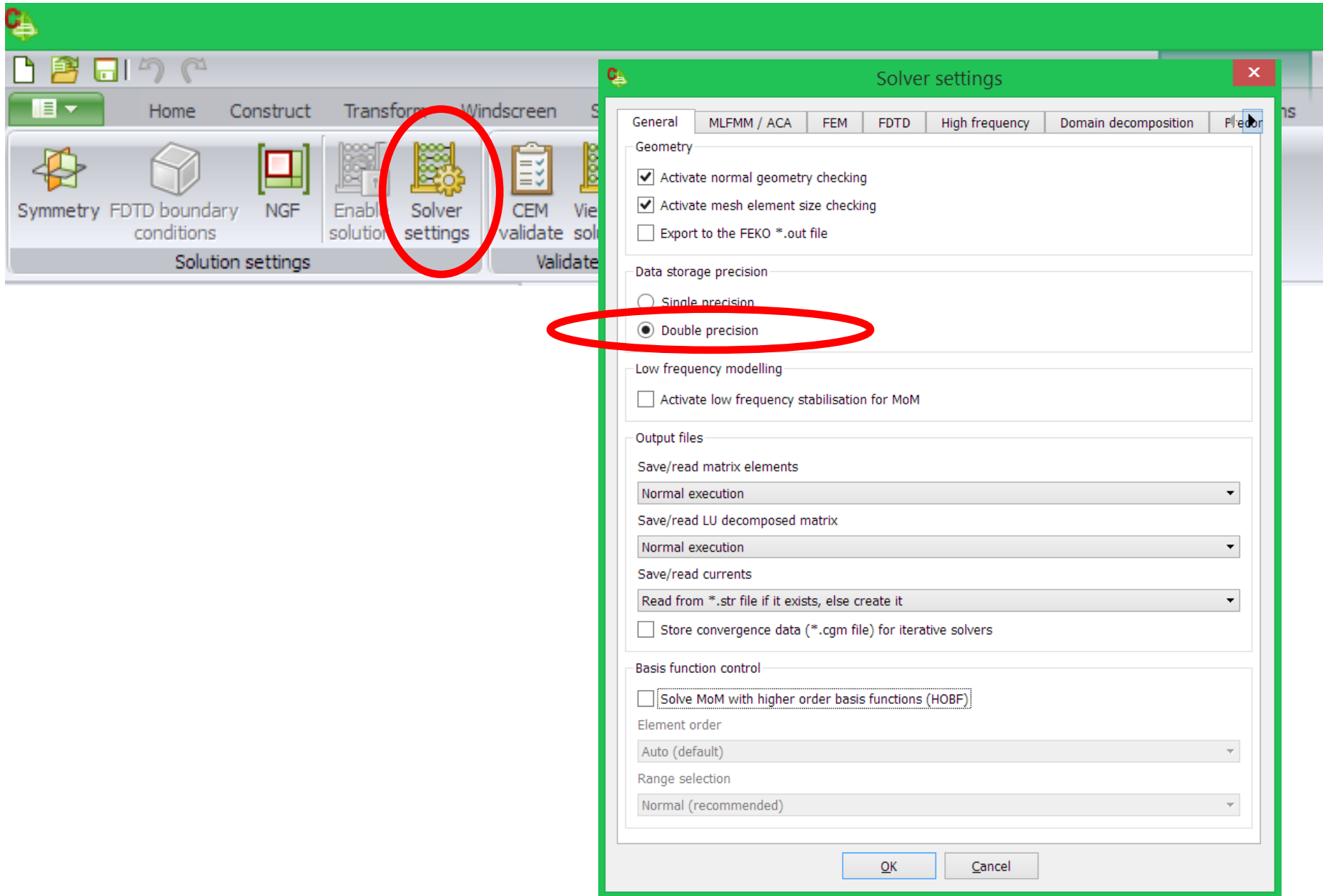
Dipole Antenna: Save the model



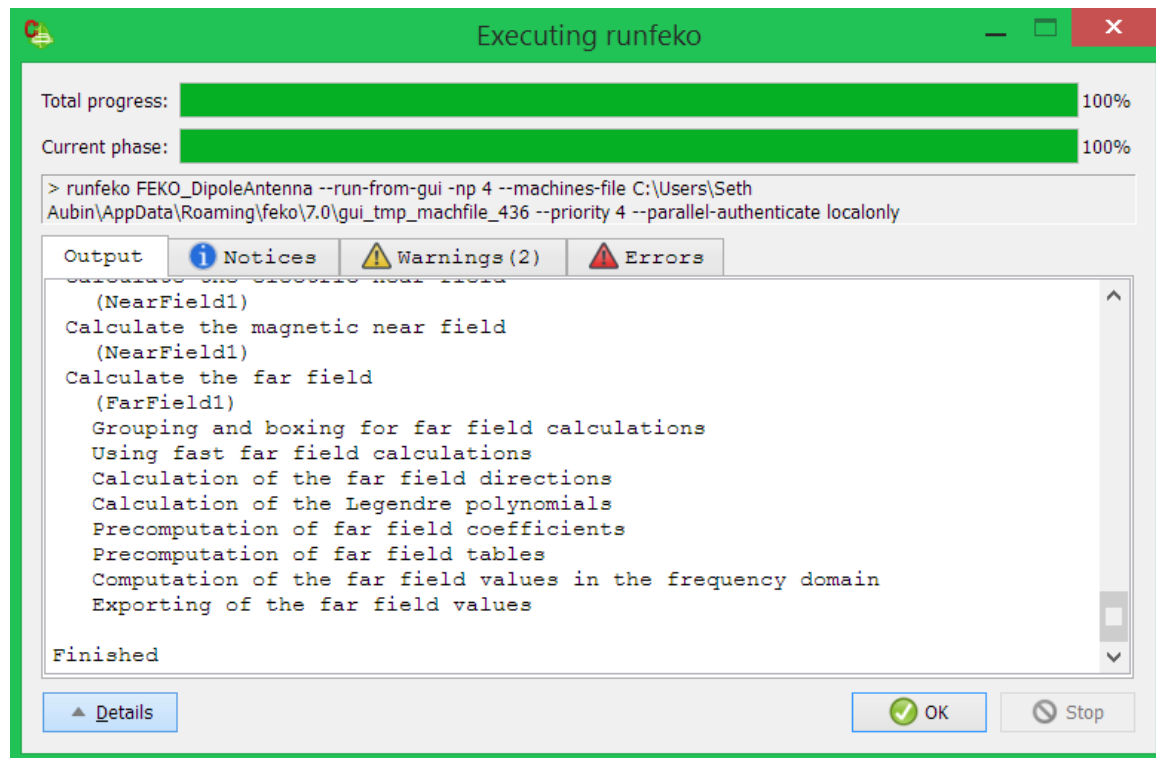
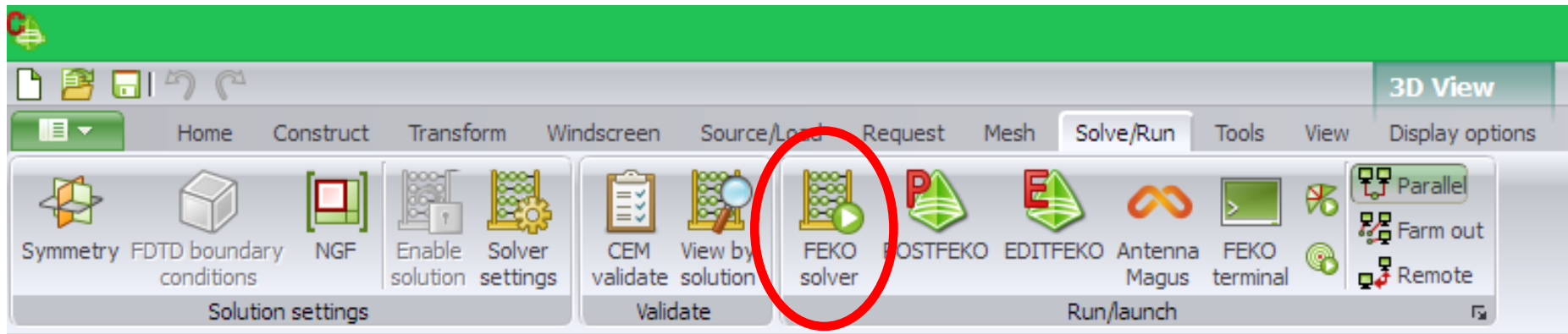
Dipole Antenna: Solve the model



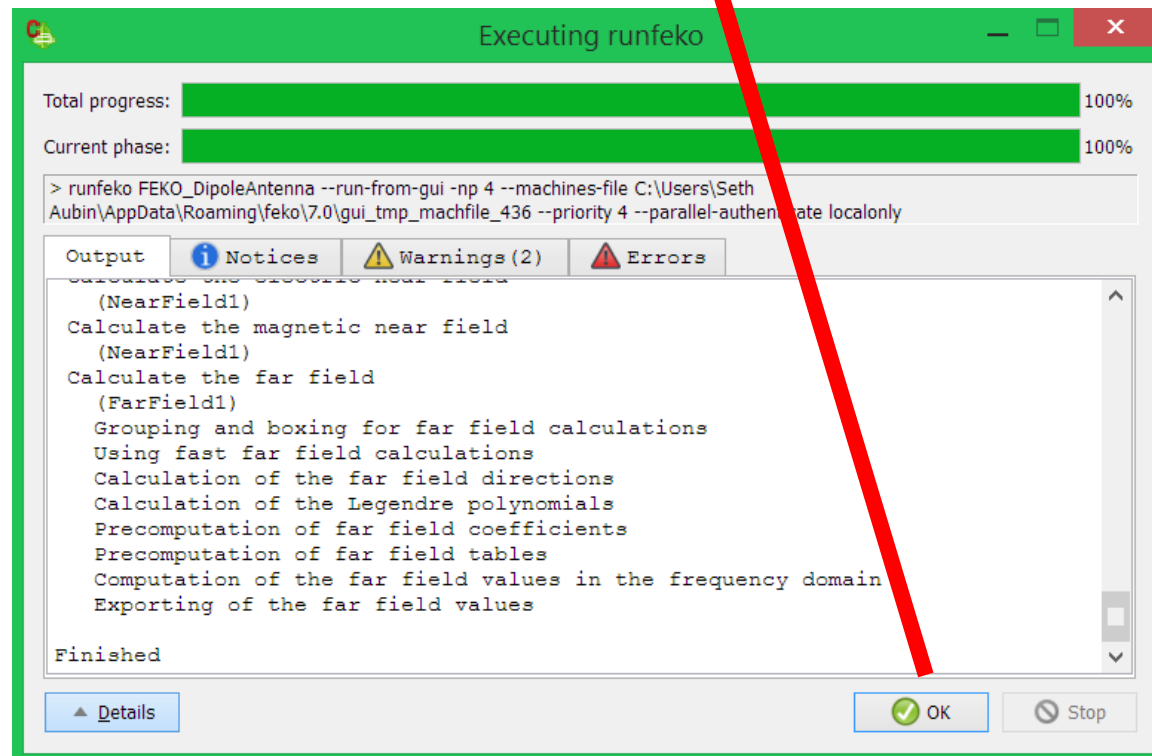
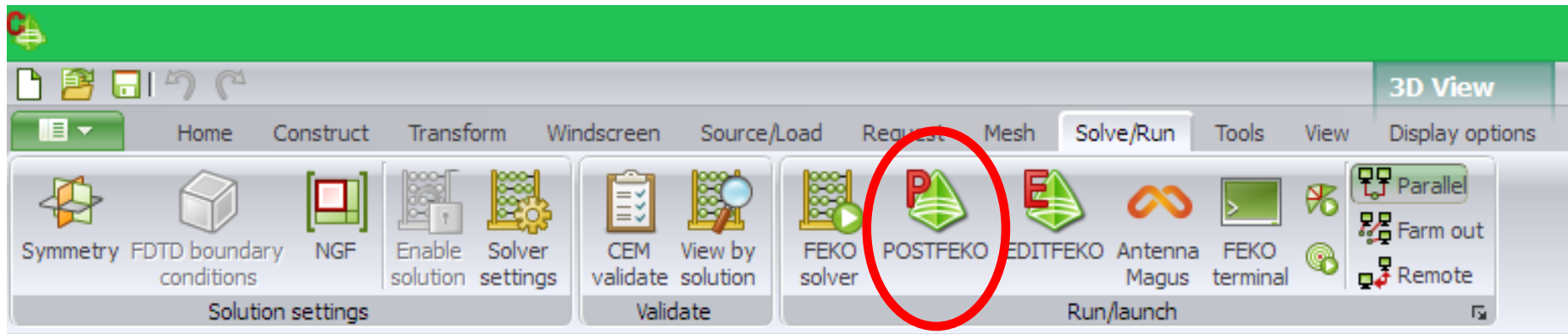
Dipole Antenna: Solve the model



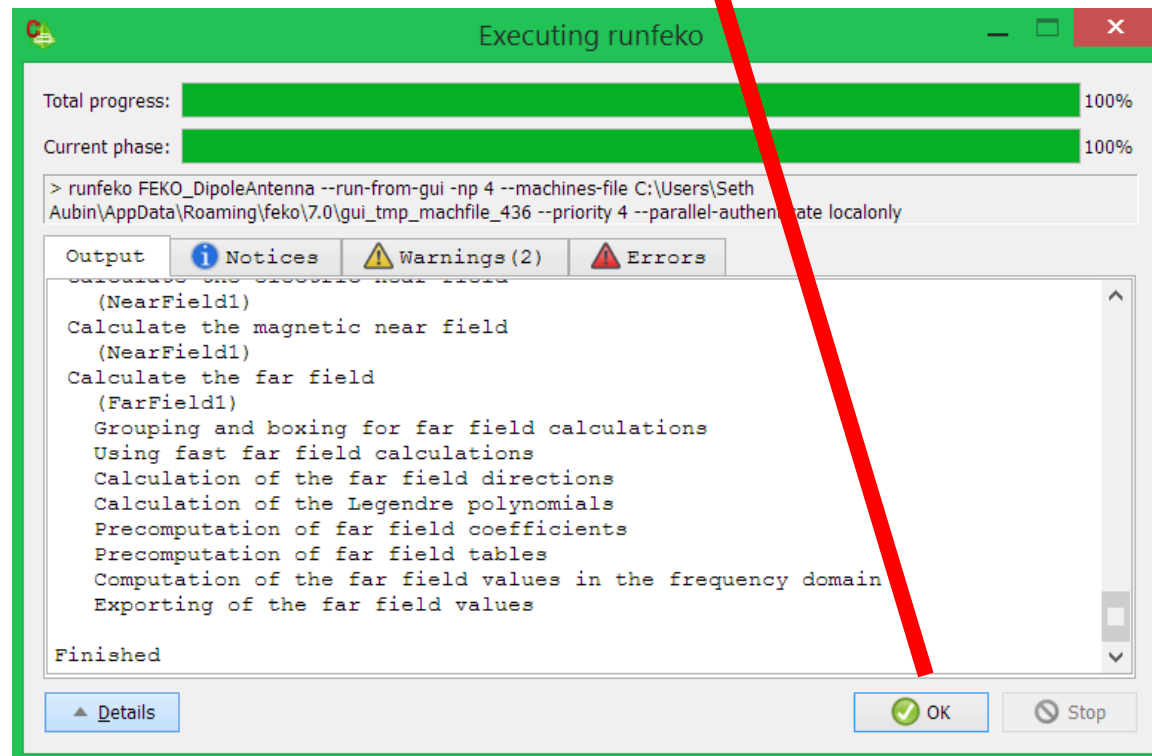
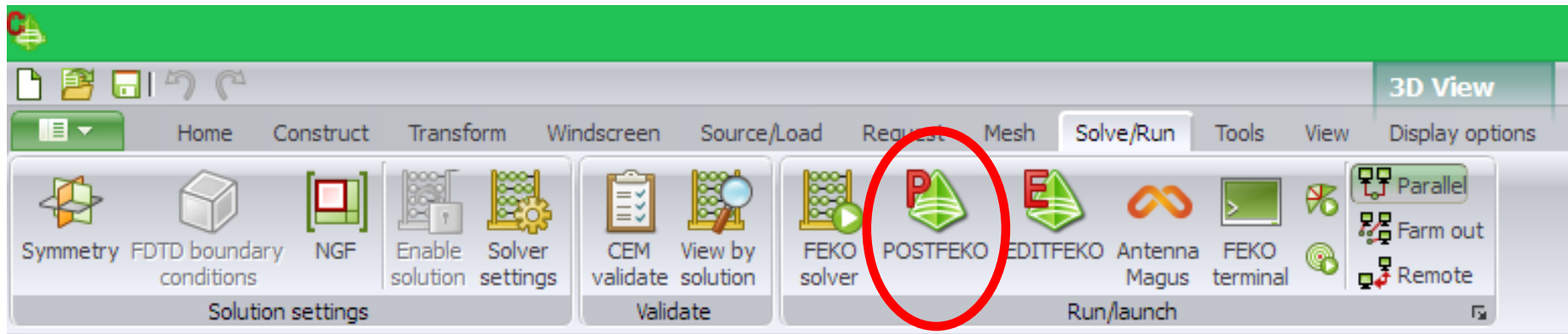
Dipole Antenna: Solve the model



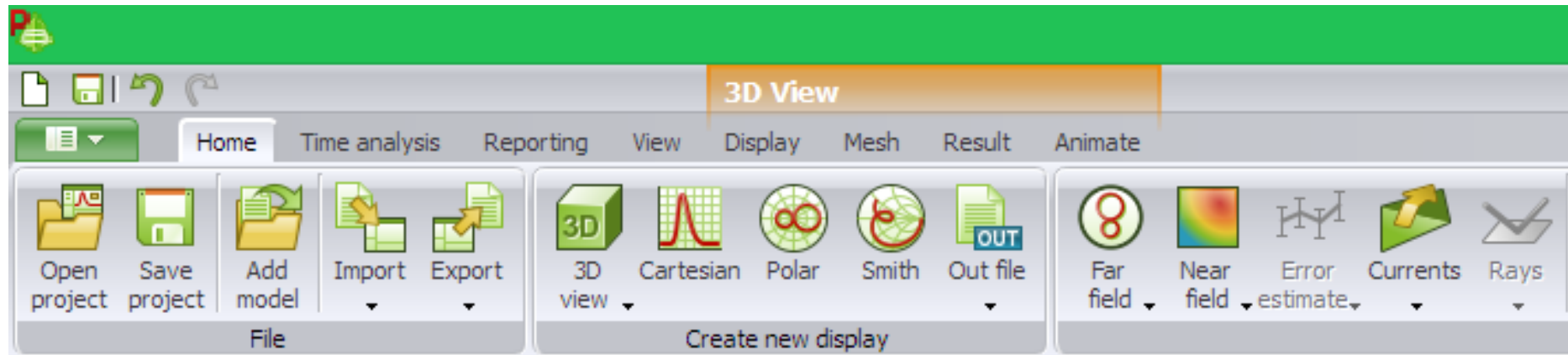
Dipole Antenna: Solve the model



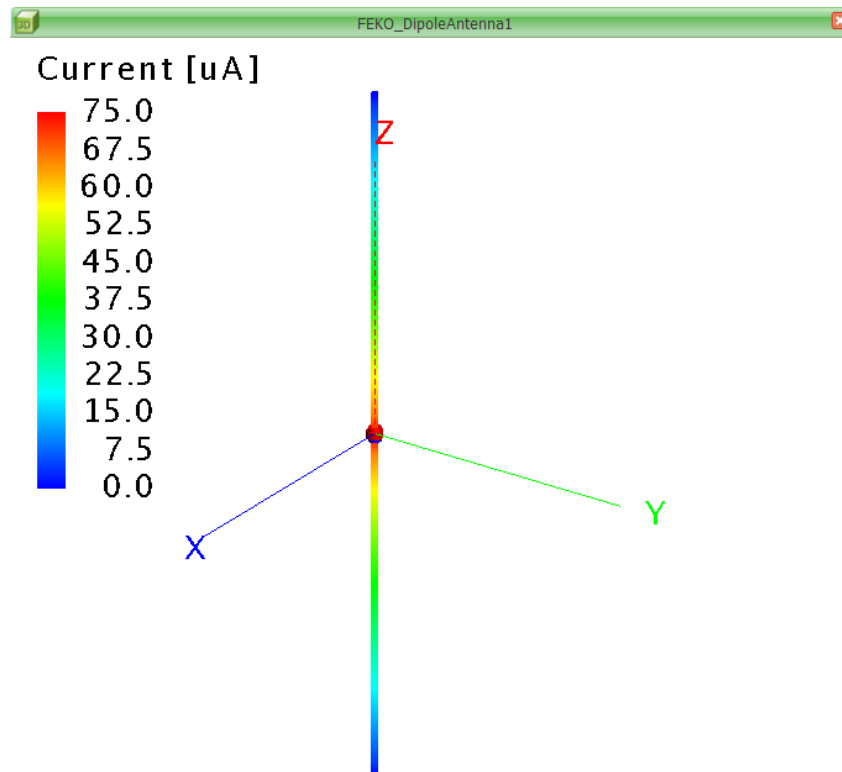
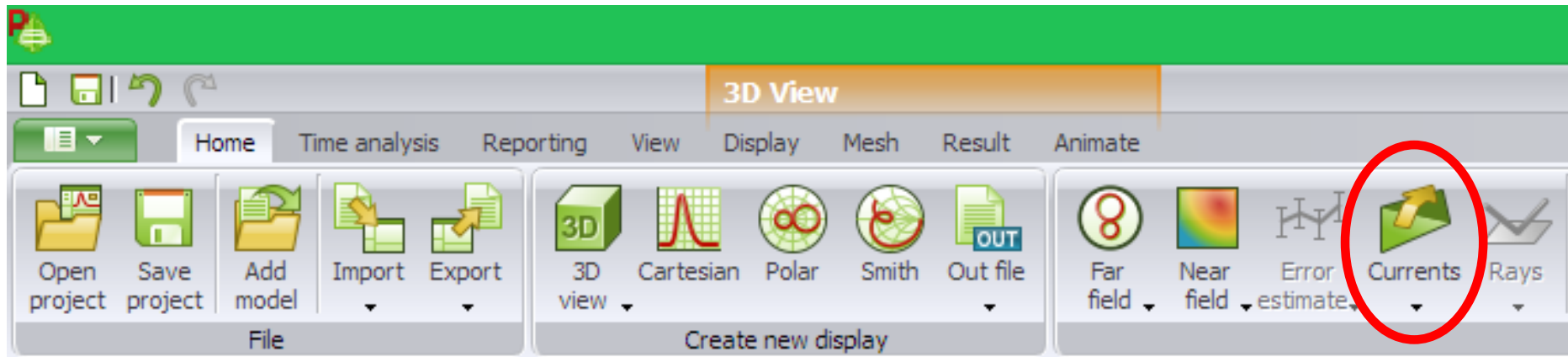
Dipole Antenna: Solve the model



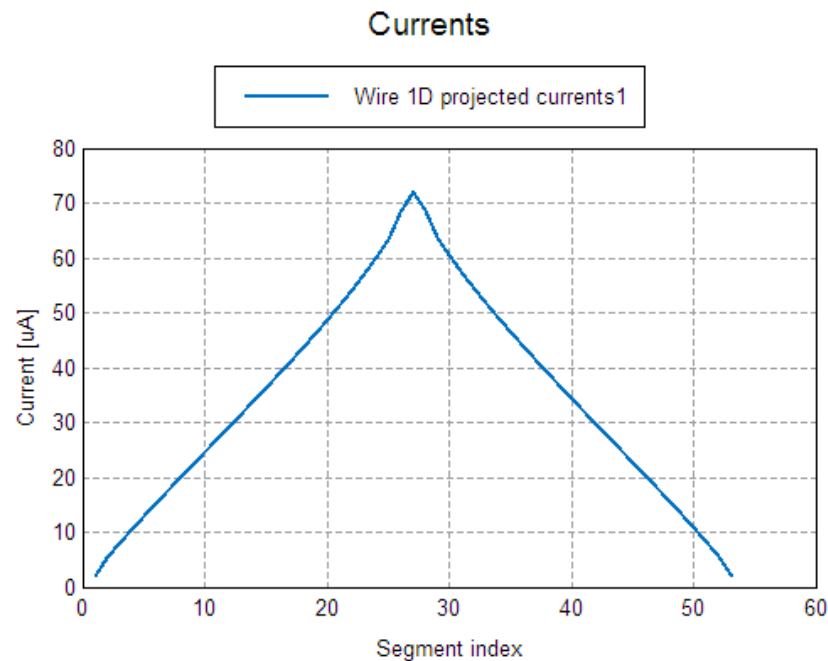
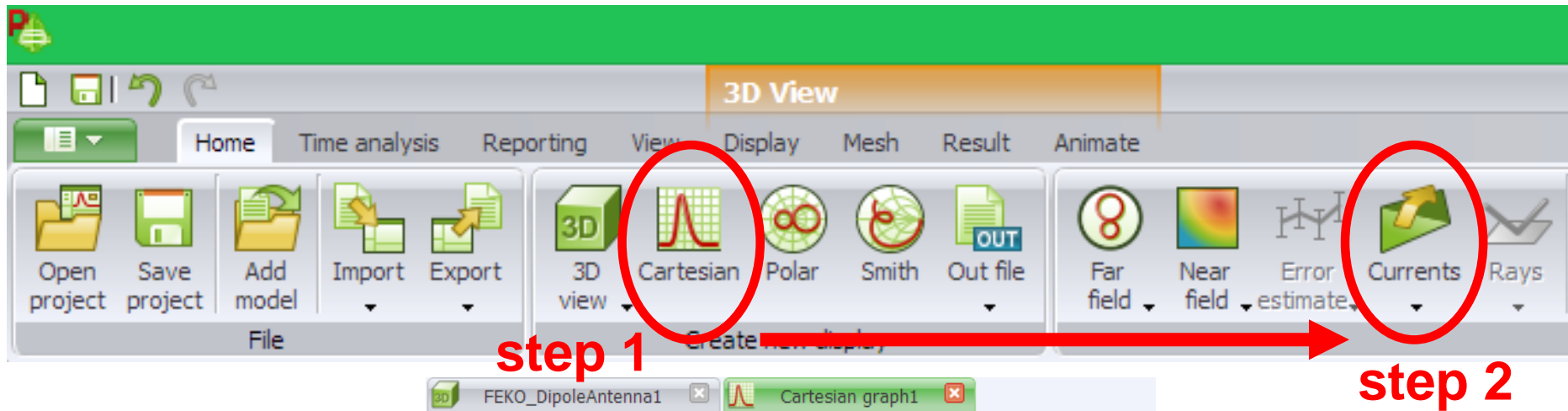
POSTFEKO: Analysis of Solutions



POSTFEKO: Analysis of Solutions

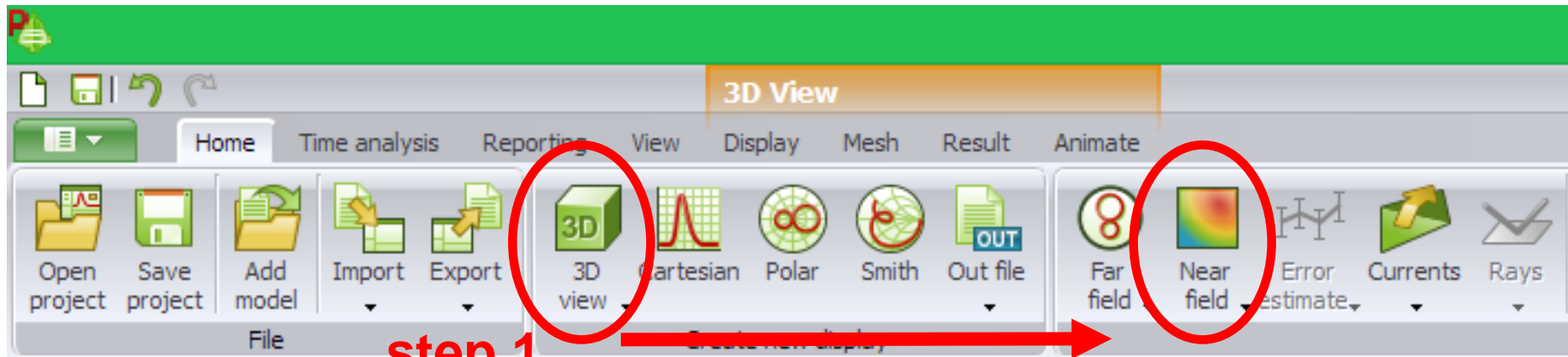


POSTFEKO: Analysis of Solutions

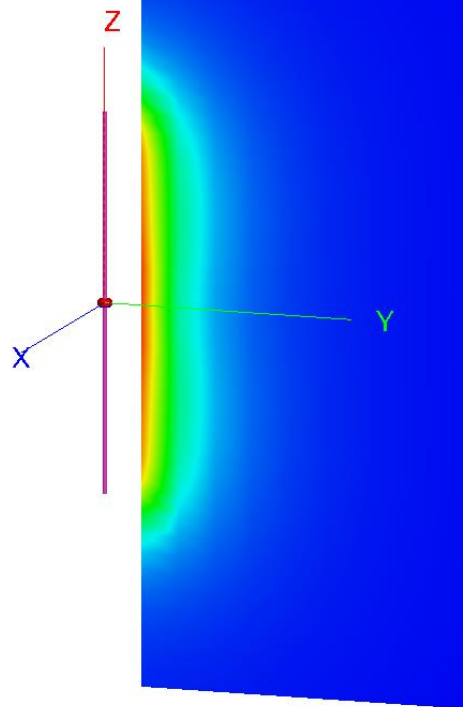
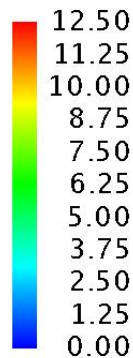


Current Magnitude [uA] (Frequency = 30 MHz) - FEKO_DipoleAntenna

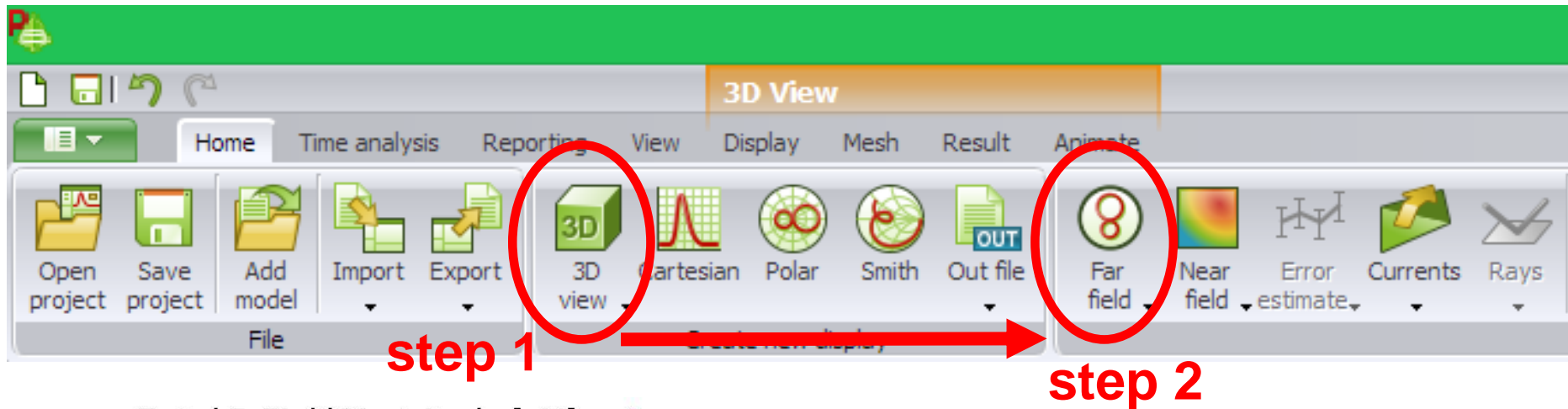
POSTFEKO: Analysis of Solutions



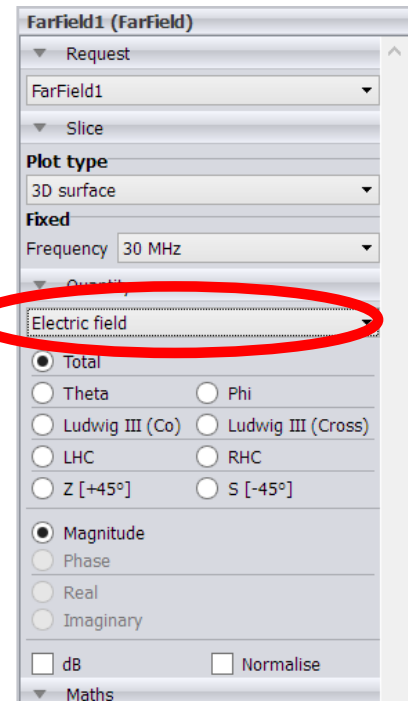
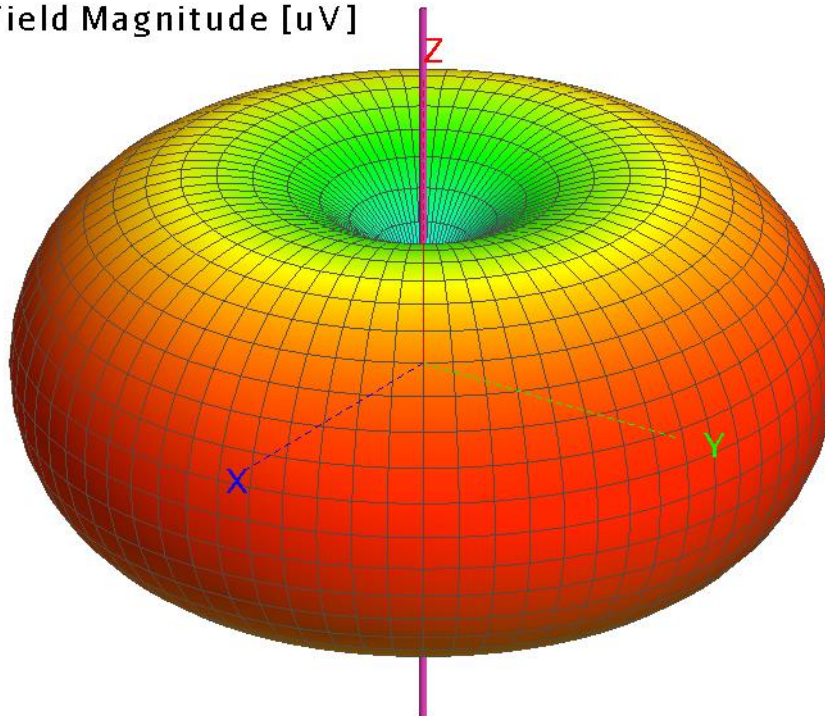
XYZ E-Field [V/m]



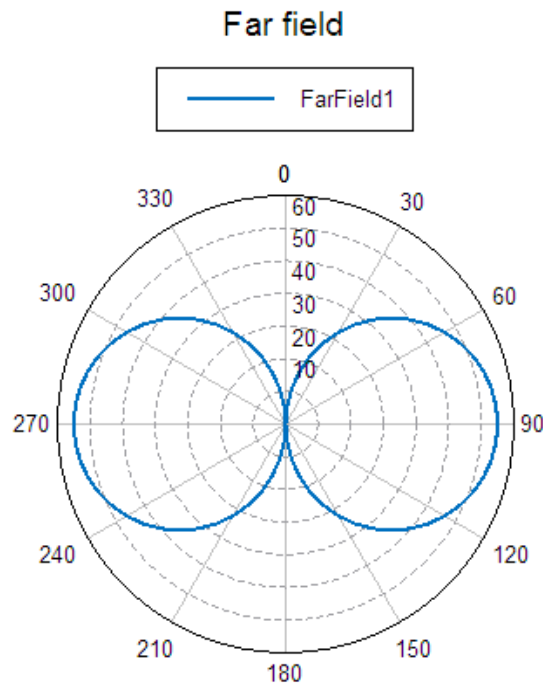
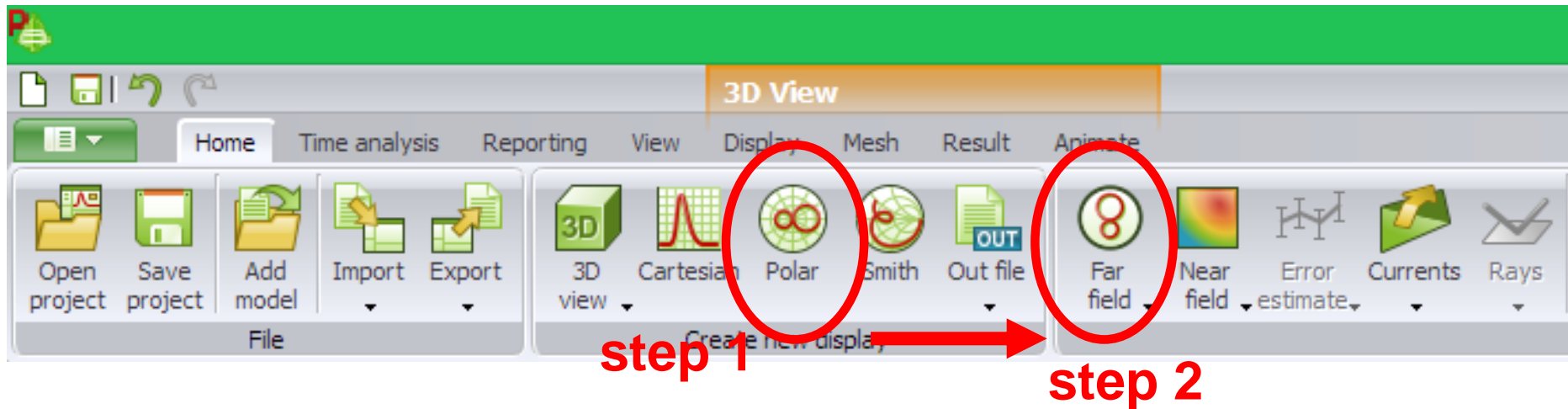
POSTFEKO: Analysis of Solutions



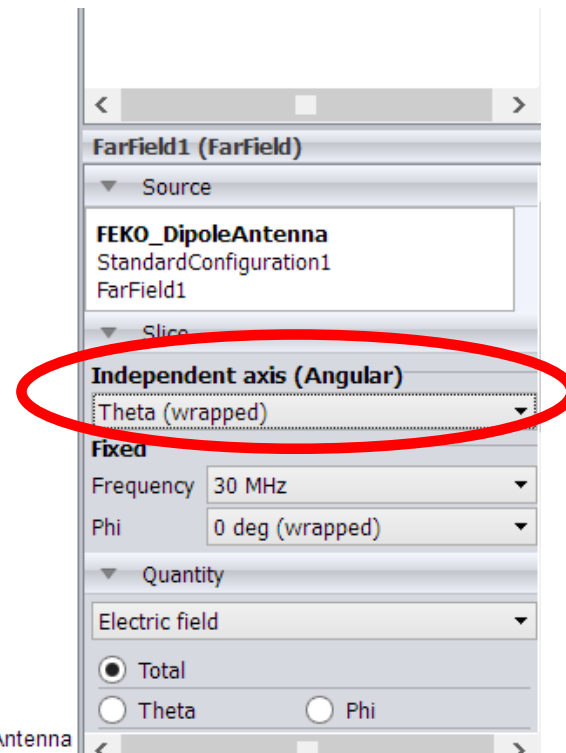
Total E-Field Magnitude [uV]



POSTFEKO: Analysis of Solutions



Total E-Field Magnitude [uV] (Frequency = 30 MHz; Phi = 0 deg) - FEKO_DipoleAntenna



Exercises

Calculate the Current and Far-Field (Gain or E-field) for the following:

1. Length = $\lambda/2$ or λ

2. Length = $3\lambda/2$, 2λ , or 5λ