



Využití Cable Studia pro EMC Simulace

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5-6-7/11/2025

CONFIDENTIAL

OBSAH

1. Úvod

- Workflow simulace kabeláže
- GUI
- Filozofie modelování

2. Modelování Kabelového Svazku

- Průřez
- Přechod do 3D

3. Nastavení Simulace

- Porty a stínění
- Solvery
- Příklady

4. Příklady

- Xtalks, vyzářené emise

5. Závěr

ÚVOD

WORKFLOW SIMULACE KABELÁŽE

Modelování Jednotlivých Kabelů

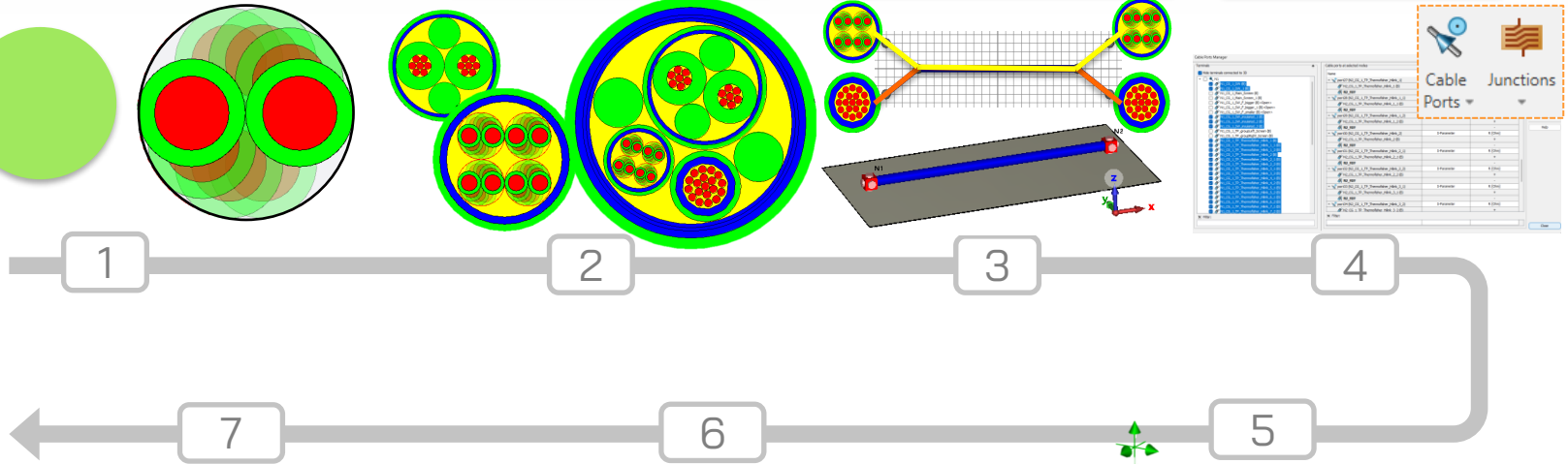
Cable Groups

Cable Bundle

Ports & Junctions

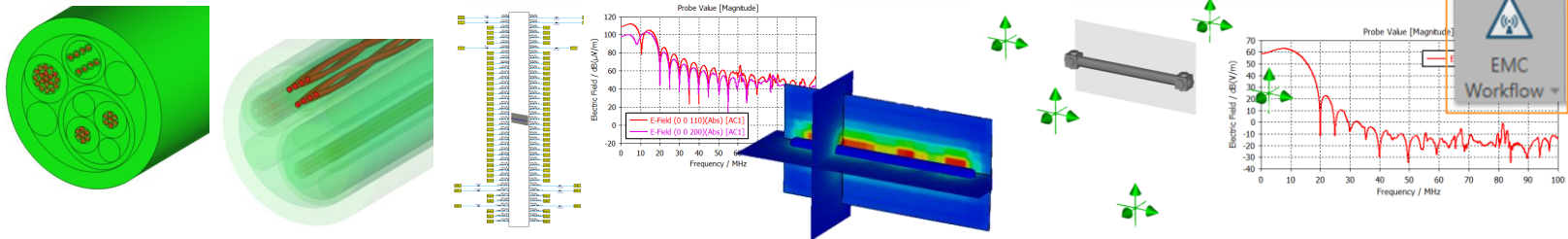
Vstup:

- Rozměry a pozice kabelů ve svazku
- Typ stínění
- Materiály



Výstup:

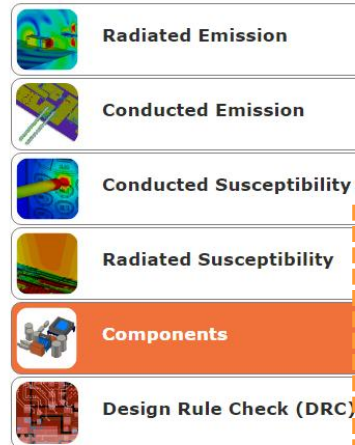
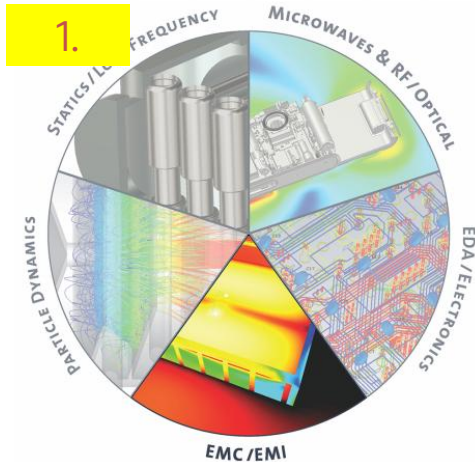
- Přeslechy (Xtalks)
- Vyzářené emise
- Imunita



- Cable Studio: specializovaný nástroj pro modelování a simulaci kabeláže
- Cable Studio lze otevřít přes šablony (templates):

Create Project Template

Choose an application area and then select one of the workflows:



Please select a workflow:

RLC Extraction

Shielding Effectiveness
of Enclosures

EMC Filters

Common Mode Chokes

Connectors

Cables

PCB

The recommended solvers for the selected workflow:



Time Domain
Specialized solver for cable modelling



Frequency Domain
Simulate cables as 3D elements



Time Domain (TLM)
Simulate cables as 3D elements

2.

3.

V2026:
Cable studio
bude možné
otevřít přímo
z MWS

Úvod GUI

File Home Modeling Cables Simulation Post-Processing View

Import Cable Harness Create 3D Cable New Node Cable Topology Cable Bundles Cable Ports Junctions Connect to 3D Connectors Signals Edit Properties Default Settings Information Curves Picks Pick Points Pick Lists Clear Picks Single Wires Twisted Cables Ribbon Cables Coaxial Cables Cable Groups 2D (TL) Modeling Impedance Calculator Logfile View Options Real Thickness Node Labels Segment Labels

Exchange Cabling Edit Cabling

Navigation Tree

- Components
- Groups
- Materials
- Faces
- Curves
- WCS
- Anchor Points
- Wires
- Voxel Data
- Dimensions
- Lumped Elements
- Plane Wave
- Farfield Sources
- Field Sources
- Ports
- Excitation Signals
- Field Monitors
- Voltage and Current Monitors
- Probes
- Mesh
- 1D Results
- 2D/3D Results
- Farfields
- Tables

Crosstalk Between Two Wire Bundles*

Postup modelování kabeláže

Cable Navigation Tree

- All Elements
- Only selected items
- Unselect All
- Cable Types
 - Single wires
 - LIFY_0qmm50
 - LIFY_1qmm50
 - Twisted cables
 - Ribbon cables
 - Coaxial cables
 - Cable groups
- Materials
- Nodes
 - N1
 - N2
 - N3
 - N4
- Segments
- Cable Bundles
 - B
 - B_1
- Junctions
- Signals
- Connectors
- Current Monitors

Select connected

Cross Section

LIFY_0qmm50

Preview průřezu

Parameter List

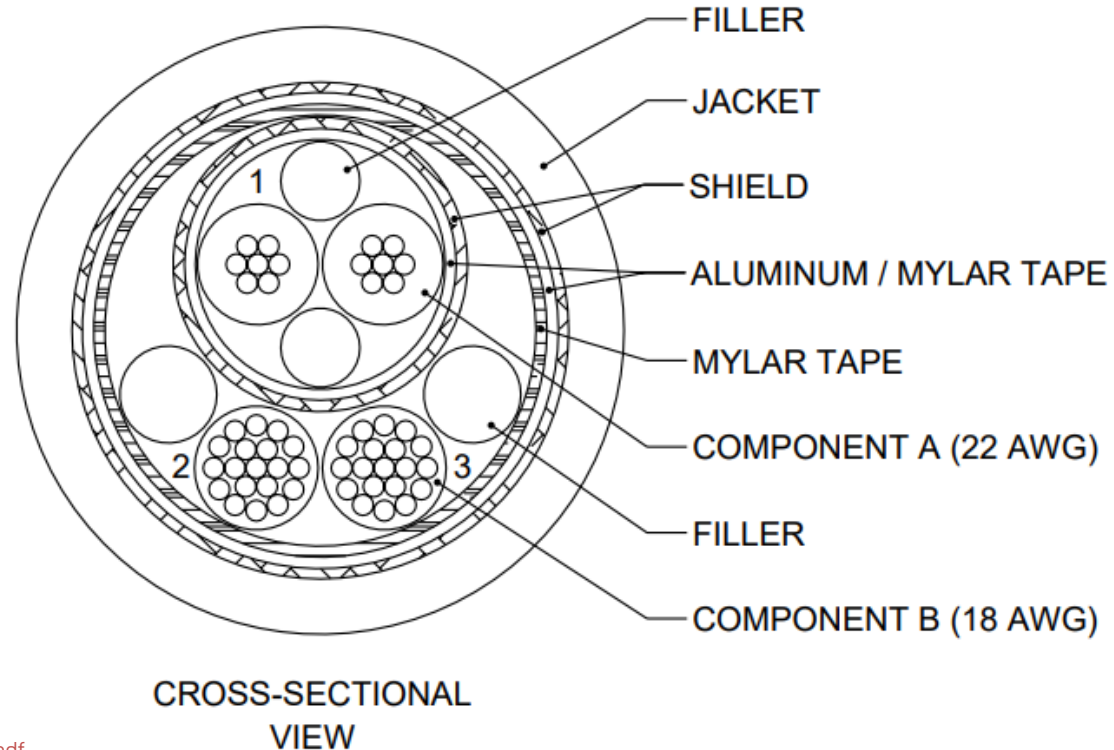
Name	Expression	Value	Description
<new parameter>			

Messages

Schematic window contains tasks in the navigation tree.

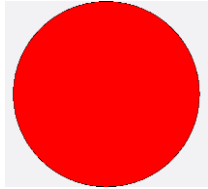
Ready Raster=200.000 | Normal | mm MHz μs °C

1. Jednotlivé typy kabelů (SW, TP, CC)
 2. Skládání kabelů do skupin
- Solid (Cu) / braid (Al) stínění
 - PE – izolace, filler
 - Cu – vodiče
 - Průměry dle datasheetu

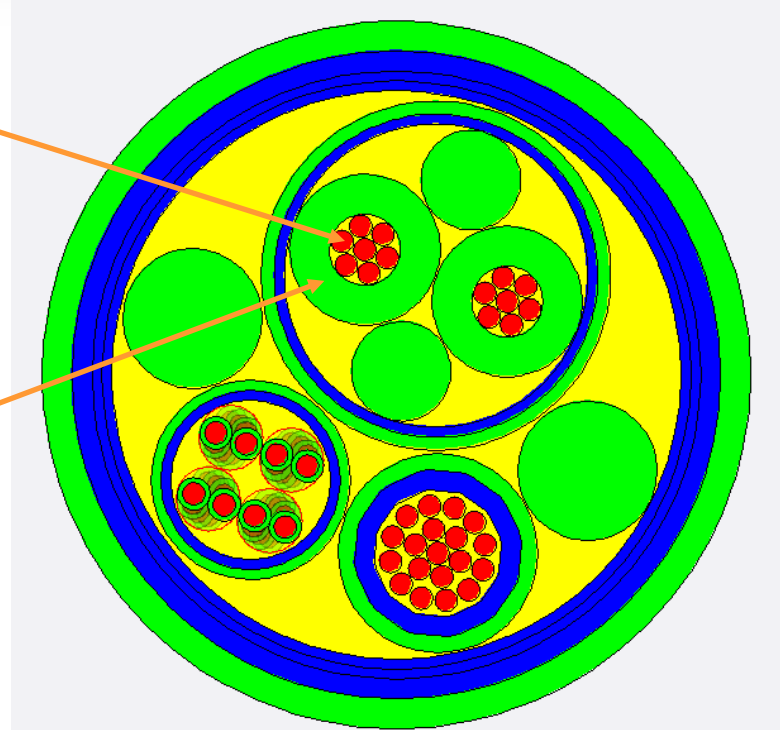
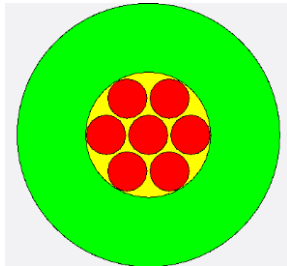


- Jak namodelovat svazek s 2x7 vodiči a 2x filler?

- Model samostatného vodič (single wire)

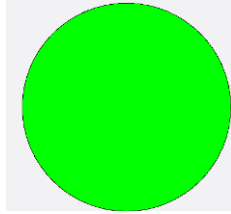


- Na základě předchozího modelu lze udělat skupinu kabelů:

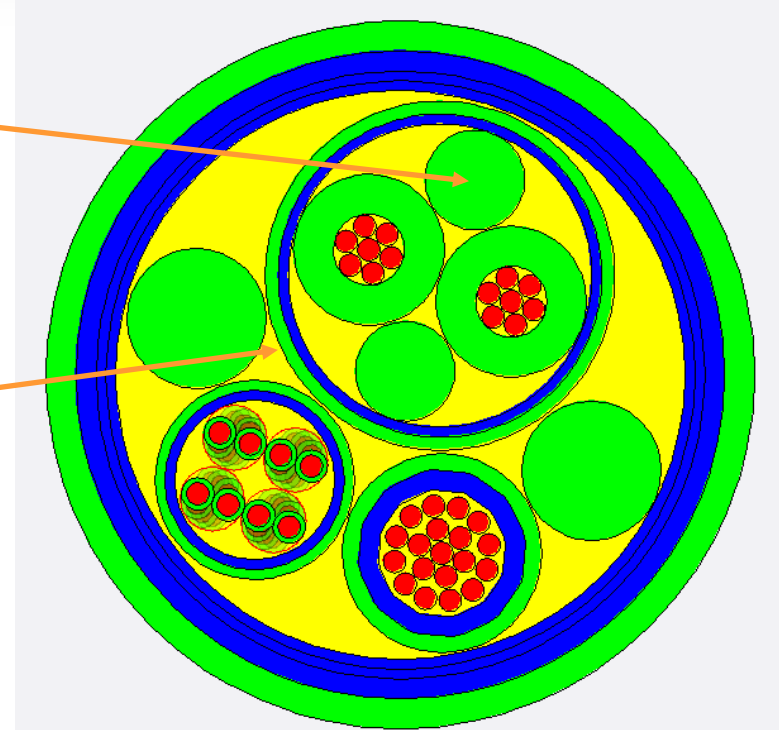
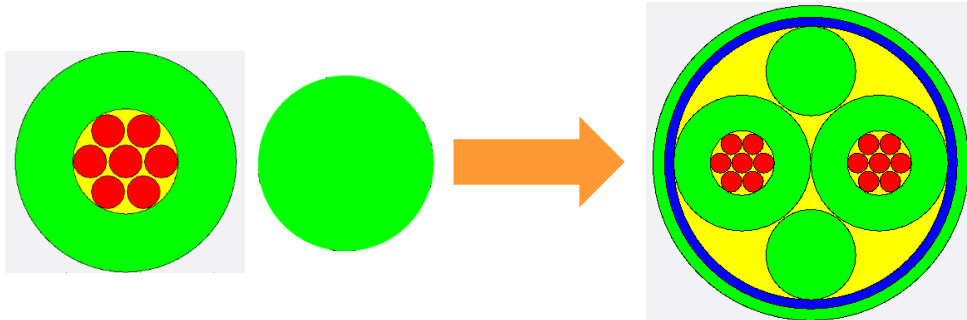


- Jak namodelovat svazek s 2x7 vodiči a 2x filler?

3. Vytvoření SW – bez vodiče



4. Ze skupiny a fillerů se vytvoří další skupina



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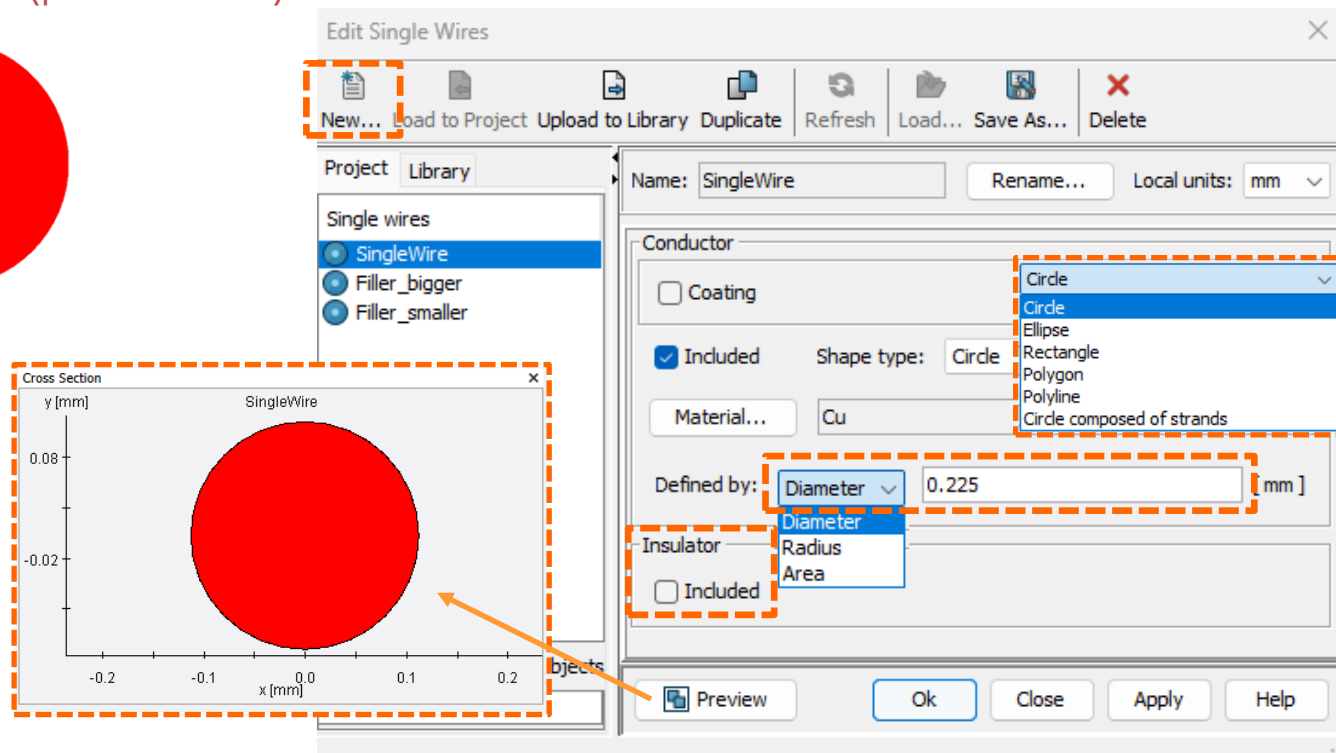
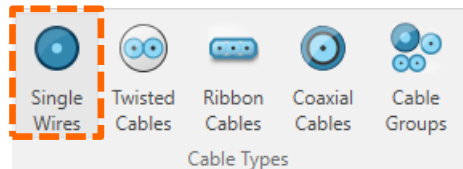
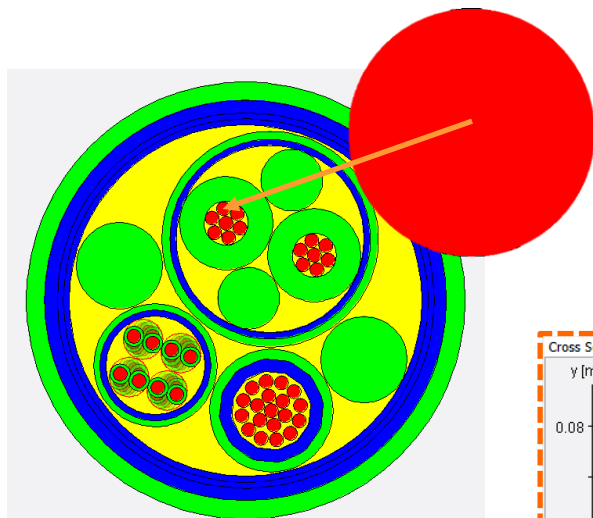
- Xtalks, vyzářené emise

5. Závěr

MODELOVÁNÍ KABELOVÉHO SVAZKU

PRŮŘEZ

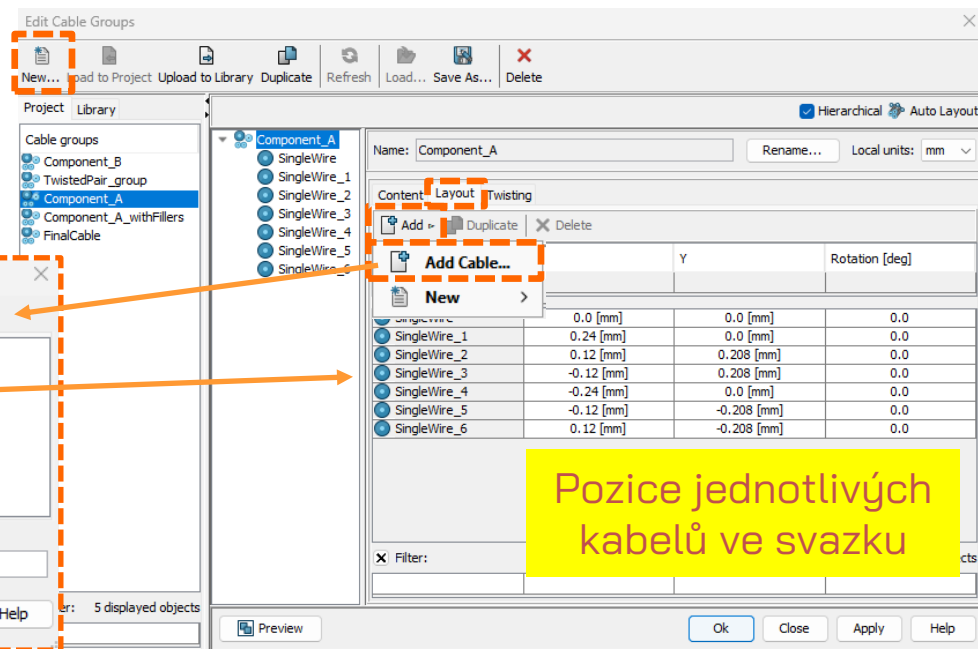
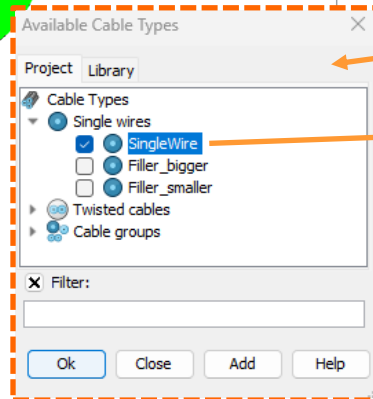
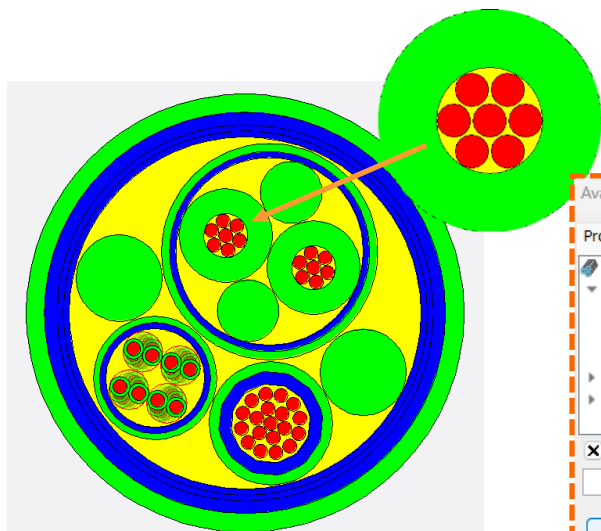
- Modelování Single Wire (pouze vodič)



MODELOVÁNÍ KABELOVÉHO SVAZKU

PRŮŘEZ

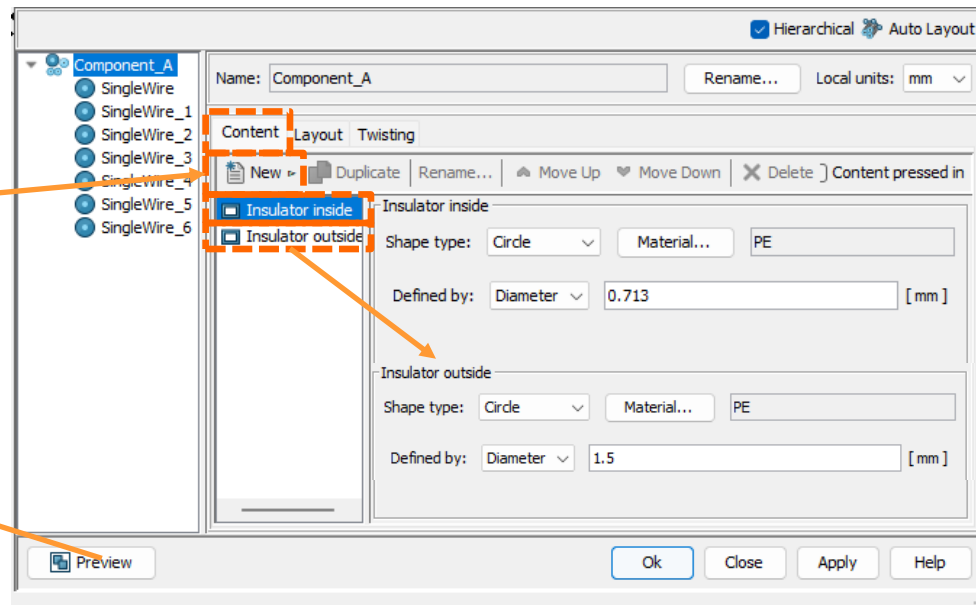
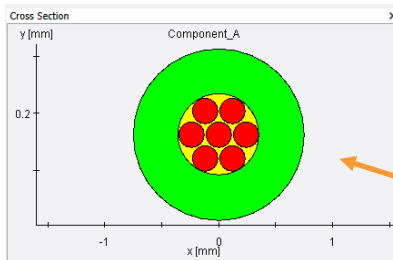
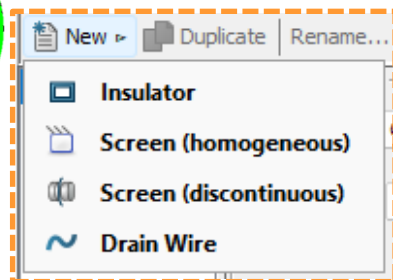
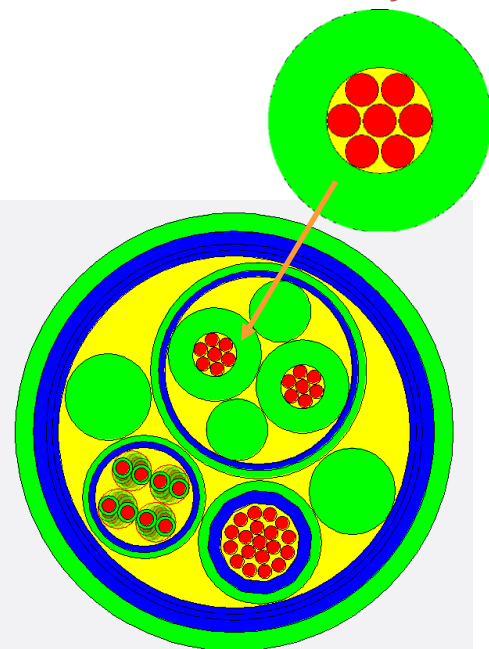
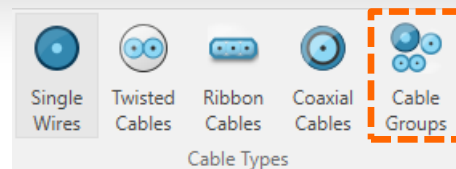
- Modelování skupiny kabelů :
 - Layout = z čeho se skupina skládá
 - Content = izolace & stínění skupiny



MODELOVÁNÍ KABELOVÉHO SVAZKU

PRŮŘEZ

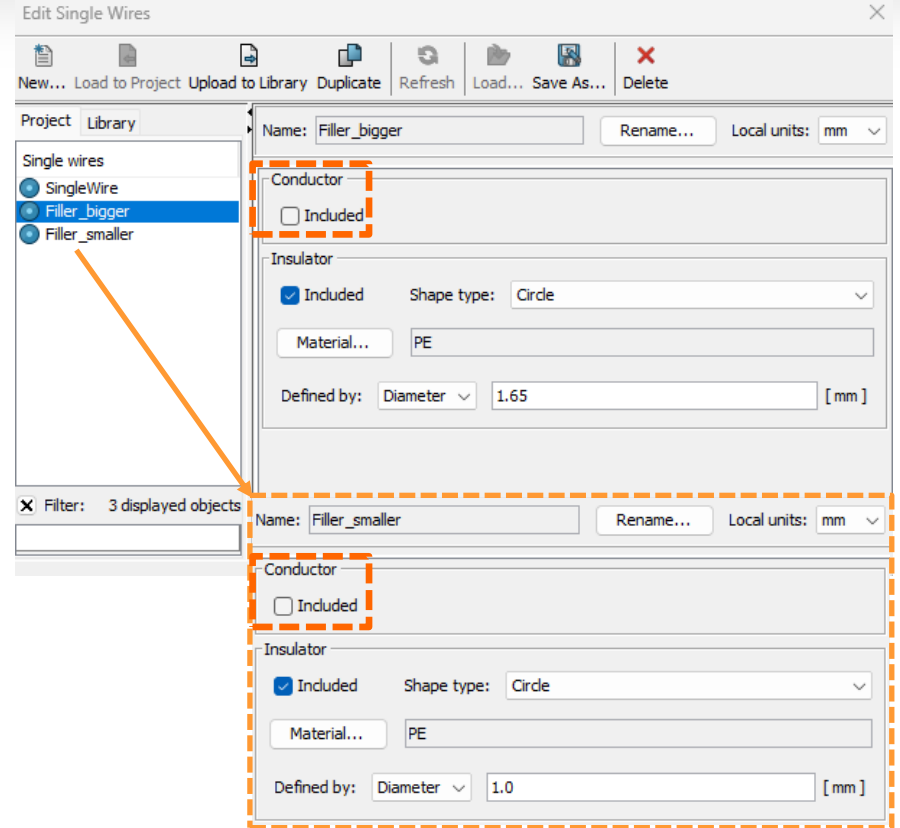
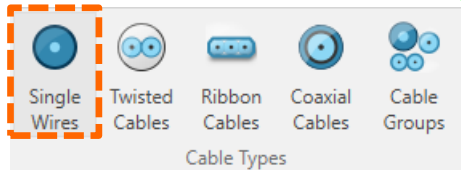
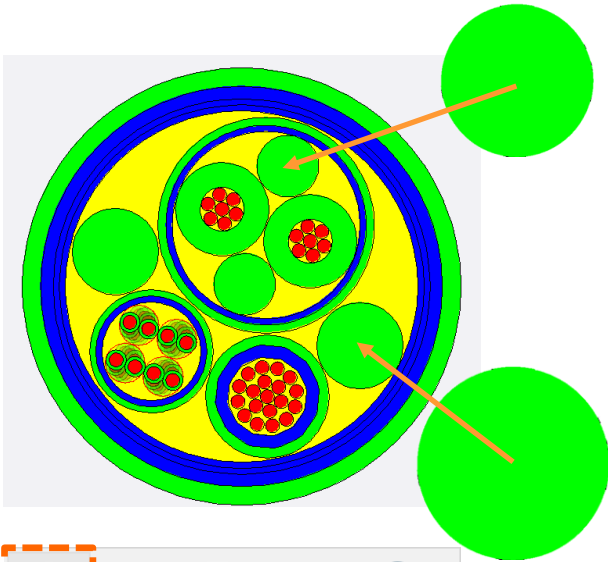
- Modelování izolace skupiny kabelů:
 - Vnitřní, vnější = PE



MODELOVÁNÍ KABELOVÉHO SVAZKU

PRŮŘEZ

- Modelování fillerů (pouze izolace)

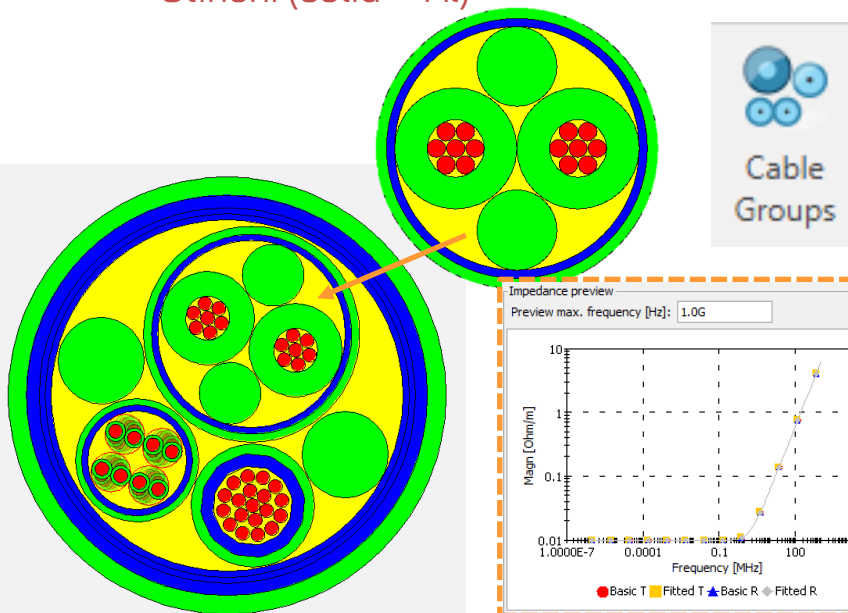


MODELOVÁNÍ KABELOVÉHO SVAZKU

PRŮŘEZ

- Modelování skupiny kabelů :

- 2×filler
- 2×skupina napájecích kabelů
- Stínění (solid – Al)



Content Layout Twisting			
Add Duplicate Delete			
Name	X	Y	Rotation [deg]
Component_A	-0.76 [mm]	0.0 [mm]	0.0
Component_A_1	0.76 [mm]	0.0 [mm]	0.0
Filler_smaller	0.0 [mm]	1.02 [mm]	0.0
Filler_smaller_1	0.0 [mm]	-1.02 [mm]	0.0

Content Layout Twisting	
New Duplicate Rename... Move Up Move Down Delete	
Insulator inside	Screen
Insulator outside	

Screen type: Simplified

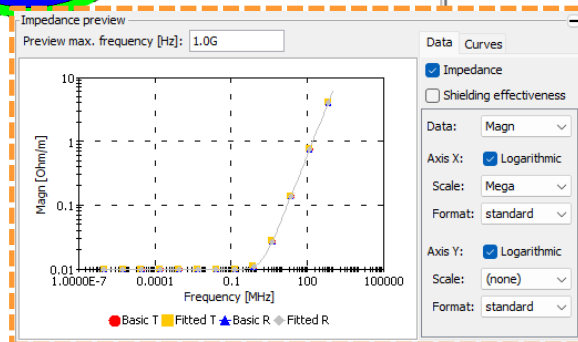
Shape type: Wrap Material: Al

Thickness: 0.2 [mm]

Model type: Analytical formula

Transfer-resistance [Ohm/m]: 0.01 Transfer-inductance [H/m]: 1.0E-9

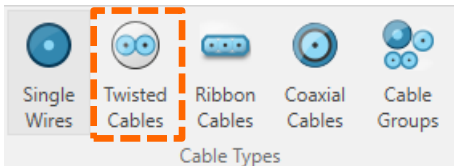
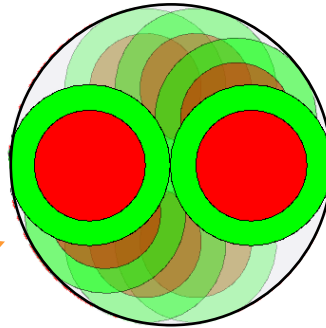
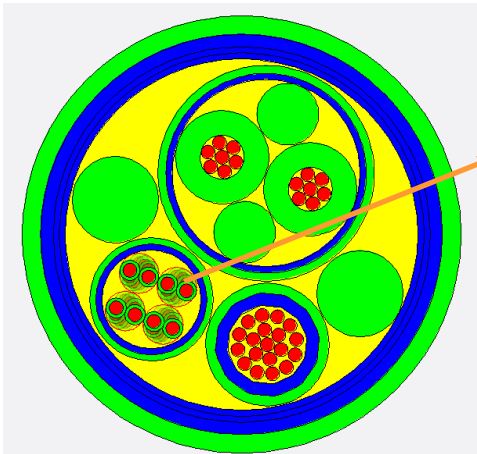
D term $\frac{H\sqrt{Hz}}{m}$: 0.0 Edge frequency [Hz]: 0.0



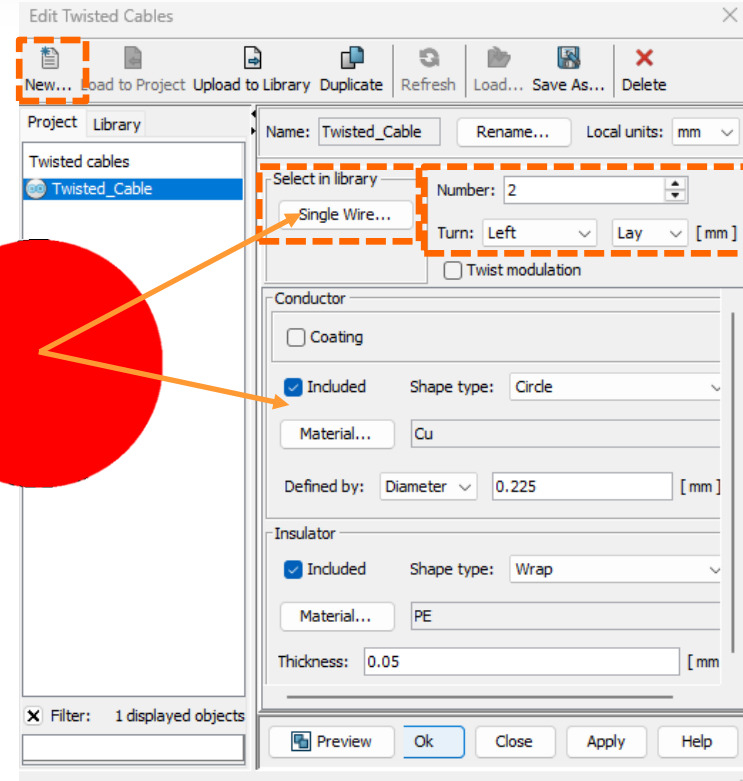
MODELOVÁNÍ KABELOVÉHO SVAZKU

PRŮŘEZ

- Kroucená dvojlinka



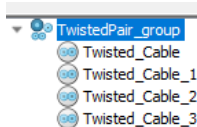
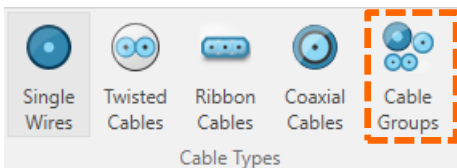
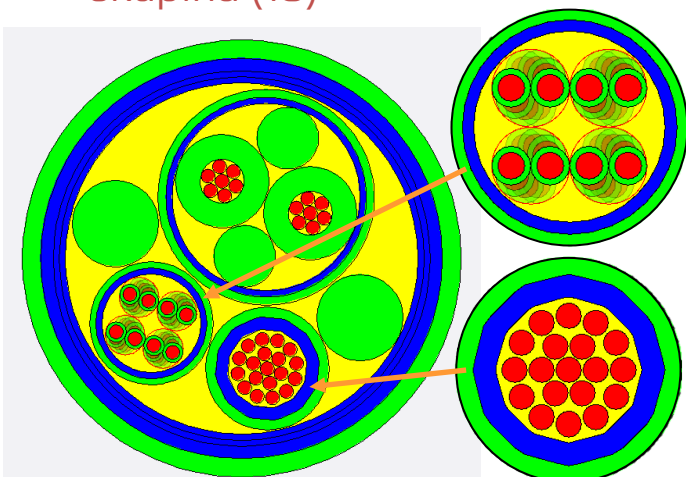
Lay = vzdálenost,
na které se
dvojlinka otočí o
360°



MODELOVÁNÍ KABELOVÉHO SVAZKU

PRŮŘEZ

- Skupina kroucených dvojlinek (4), napájecí skupina (18)



Twisted_Cable	0.325 [mm]	0.325 [mm]	0.0
Twisted_Cable_1	-0.325 [mm]	0.325 [mm]	0.0
Twisted_Cable_2	0.325 [mm]	-0.325 [mm]	0.0
Twisted_Cable_3	-0.325 [mm]	-0.325 [mm]	0.0

New Duplicate Rename... Move Up Move Down Delete Content pressed in

Insulator inside Screen Insulator outside

Shape type: Circle Material... PE

Defined by: Diameter 2.0 [mm]

SingleWire	0.0 [mm]	0.0 [mm]	0.0
SingleWire_1	0.24 [mm]	0.0 [mm]	0.0
SingleWire_2	0.12 [mm]	0.208 [mm]	0.0
SingleWire_3	-0.12 [mm]	0.208 [mm]	0.0

Content Layout Twisting

New Duplicate Rename... Move Up Move Down Delete Content pressed in

Insulator inside Screen Insulator outside

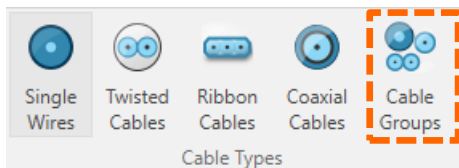
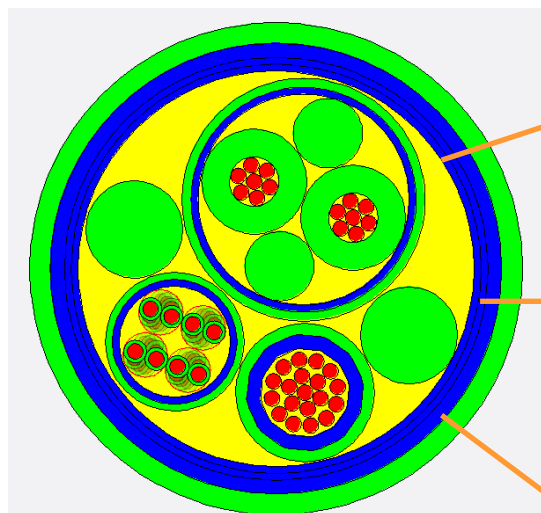
Shape type: Wrap Material... PE

Thickness: 0.05 [mm]

MODELOVÁNÍ KABELOVÉHO SVAZKU

PRŮŘEZ

- Finální kabel je složený z předchozích skupiny a fillerů.



Screen

Screen type: Solid

Shape type: Wrap Material... Al

Thickness: 0.1 [mm]

Screen_1

Screen type: Solid

Shape type: Wrap Material... Al

Thickness: 0.1 [mm]

Screen_2

Screen type: Braid Consider transfer admittance

Material... Cu Number of carriers: 16

Carrier type: Strand

Strand diameter: 0.1 [mm]

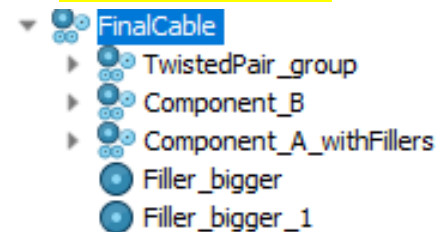
Strands in one carrier: 5

Optical coverage (0..1): 0.8749958

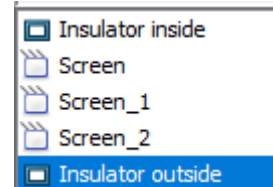
Braid angle [Deg]: 2.5000689

Picks per mm: 1.2330433

Layout



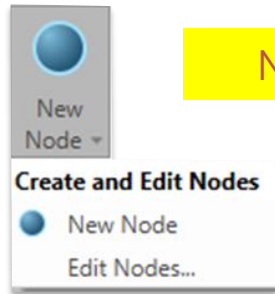
Content



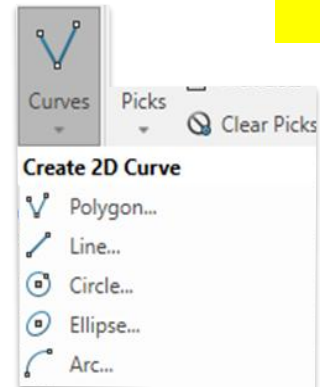
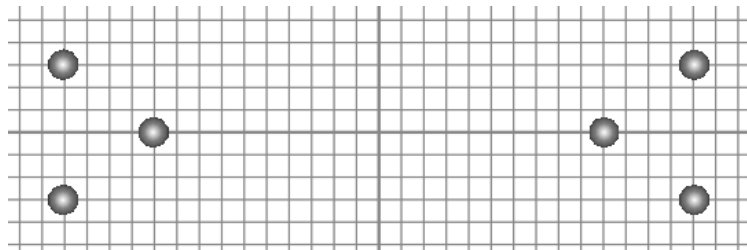
MODELOVÁNÍ

PŘECHOD DO 3D

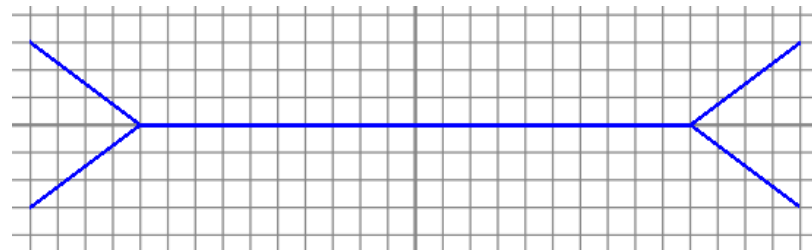
Vytvoření kabelu v prostoru lze využít:



Nodes



Curves



MODELOVÁNÍ PŘECHOD DO 3D

Nodes

1.

Create and Edit Nodes

- New Node
- Edit Nodes...

Create and Edit Cable Bundles

- Cable Bundle from Curve
- Cable Bundle from Selected Nodes
- Cable Bundle from Start and End Nodes

Edit Nodes

Available nodes

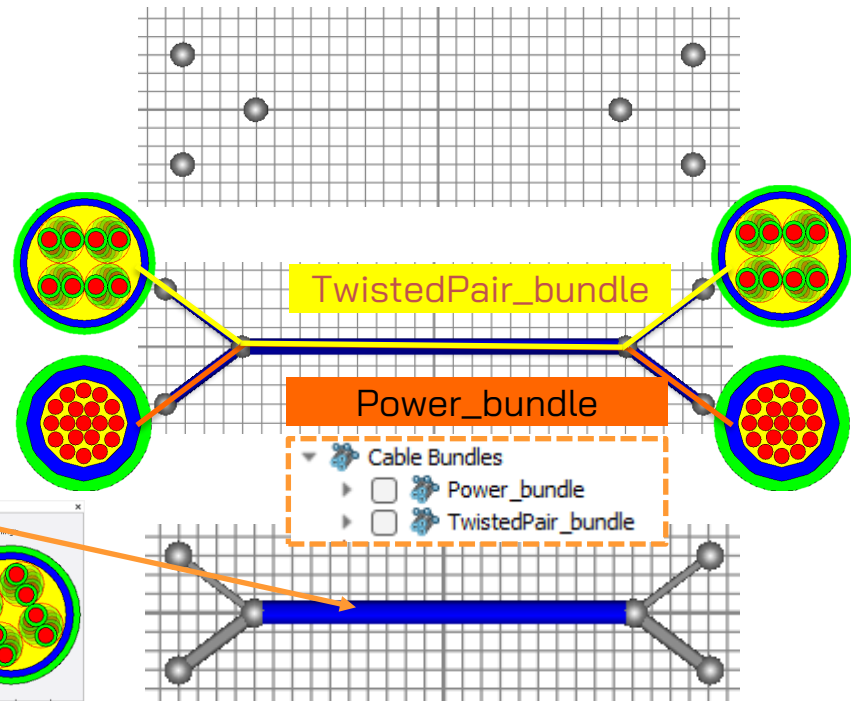
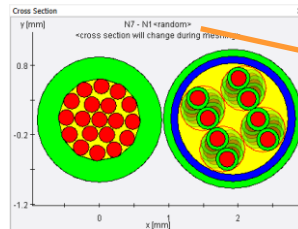
Name	X	Y	Z
N3	-700.0	150.0	100.0
N4	700.0	150.0	100.0
N5	-700.0	-150.0	100.0
N6	700.0	-150.0	100.0
N7	-500.0	0.0	100.0
N1	500.0	0.0	100.0

Units: [mm]

X Filter: 6 displayed objects

Close Help

2.



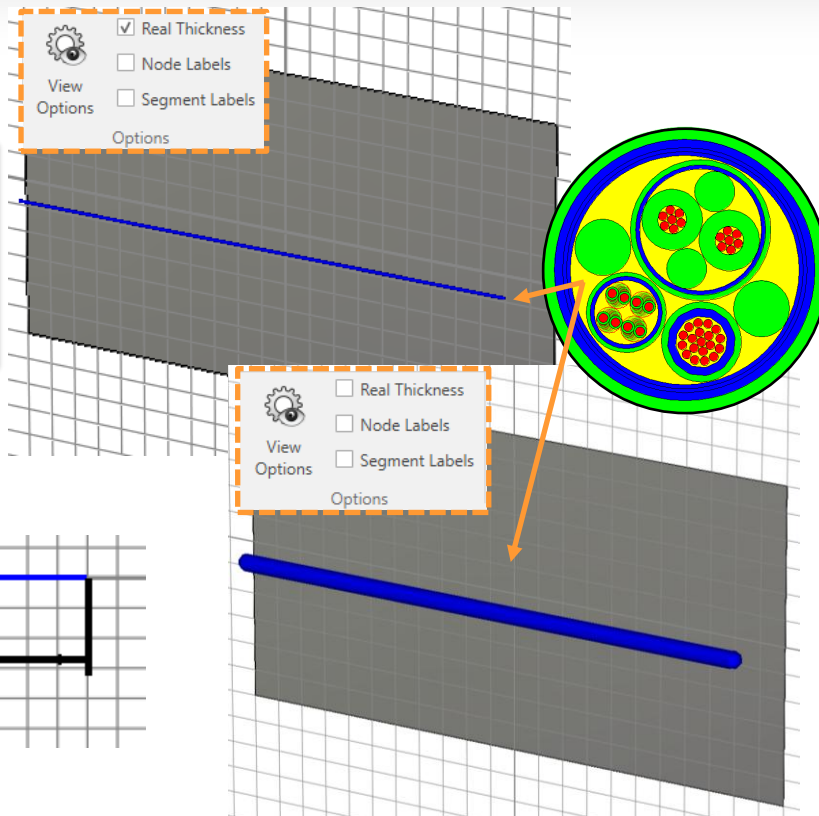
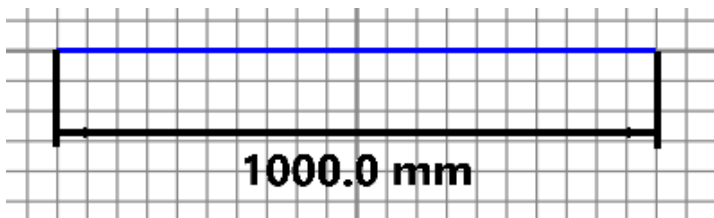
MODELOVÁNÍ PŘECHOD DO 3D

Curves

Cable Bundles

Create and Edit Cable Bundles

- Cable Bundle from Curve
- Cable Bundle from Selected Nodes
- Cable Bundle from Start and End Nodes
- Edit Cable Bundles...



Edit Cable Bundle

Available Cable Types

Project Library

- Cable Types
 - Single wires
 - Twisted cables
 - Cable groups
 - Component_B
 - TwistedPair_group
 - Component_A
 - Component_A_withFillers
 - FinalCable**

Filter:

Cable Bundle

B

Add Remove Random bundling More >>

Name	Cable Type
CG_1	FinalCable

Filter:

Preview Ok Close Apply Help

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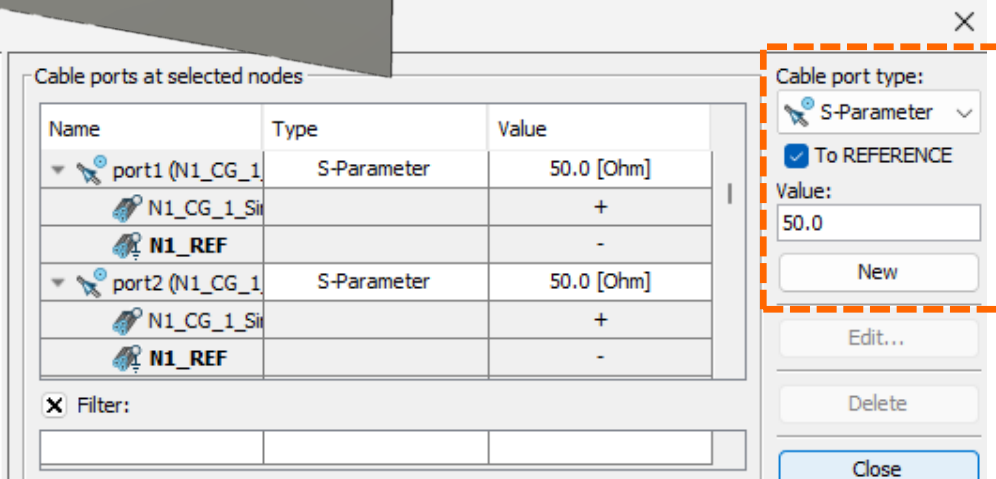
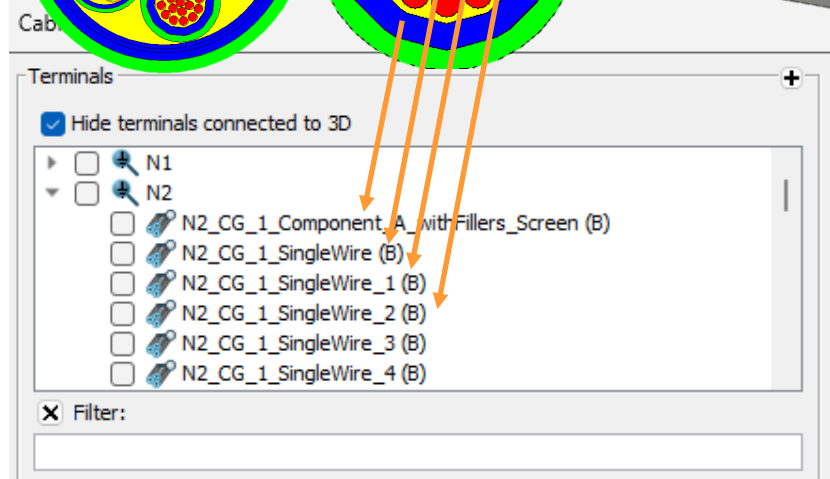
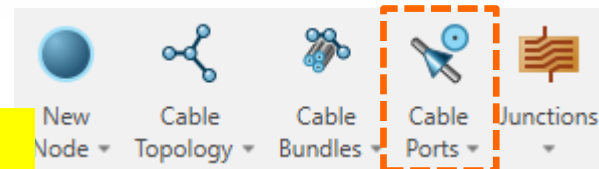
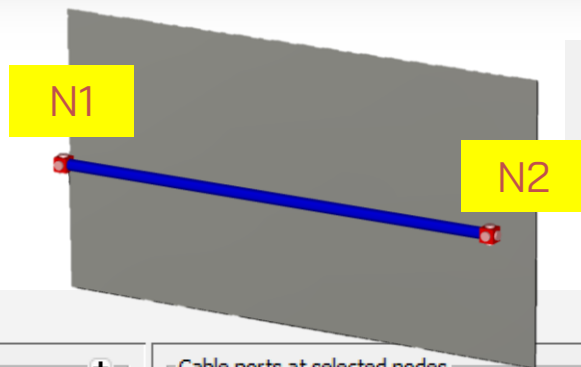
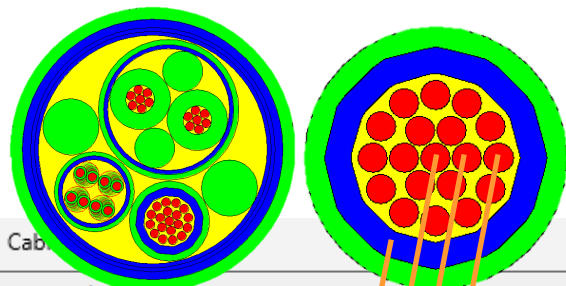
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NASTAVENÍ SIMULACE PORTY

- Single-end nebo diferenční port

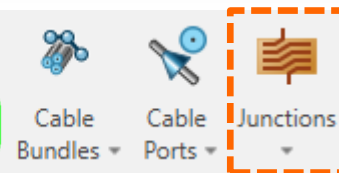
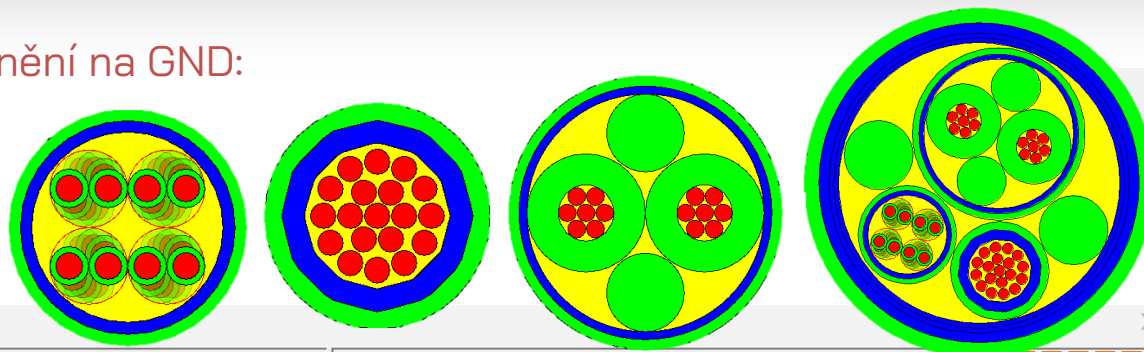


NASTAVENÍ SIMULACE

PROPOJENÍ STÍNĚNÍ S GND

- Jak připojit stínění na GND:

- Zkrat
- Odpor



Cable Junctions Manager

Terminals

☒ Hide terminals connected to 3D

- ☐ N1
 - ☐ N1_CG_1_Component_A_withFillers_Screen
 - ☐ N1_CG_1_Component_B_Screen (B)
 - ☐ N1_CG_1_FinalCable_Screen (B)
 - ☐ N1_CG_1_TwistedPair_group_Screen (B)
- ☐ N2
 - ☐ N2_CG_1_Component_A_withFillers_Screen
 - ☐ N2_CG_1_Component_B_Screen (B)
 - ☐ N2_CG_1_FinalCable_Screen (B)
 - ☐ N2_CG_1_TwistedPair_group_Screen (B)

☒ Filter: screen

Junctions at selected nodes

Name	Type	Value	Probed
<input checked="" type="checkbox"/> R	Resistor	1.0 [Ohm]	<input type="checkbox"/>
<input checked="" type="checkbox"/> N1_REF			
<input checked="" type="checkbox"/> N1_CG_1			
<input checked="" type="checkbox"/> R_1	Resistor	1.0 [Ohm]	<input type="checkbox"/>
<input checked="" type="checkbox"/> N1_REF			
<input checked="" type="checkbox"/> N1_CG_1			
<input checked="" type="checkbox"/> R_2	Resistor	1.0 [Ohm]	<input type="checkbox"/>
<input checked="" type="checkbox"/> N2_REF			

☒ Filter:

Junction type:

☒ Short

☒ To REFERENCE

Value:

New

Add

Remove

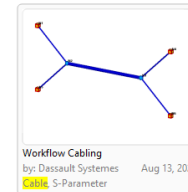
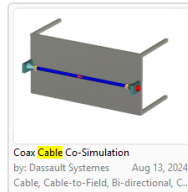
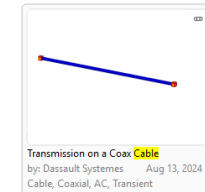
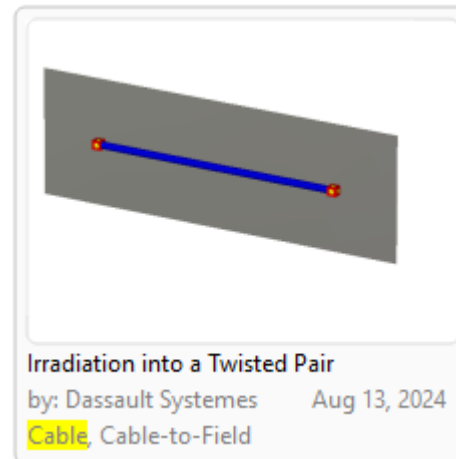
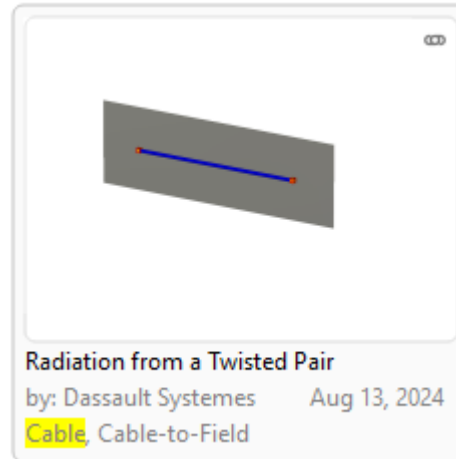
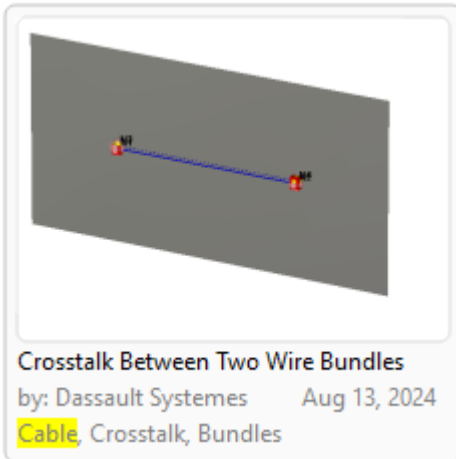
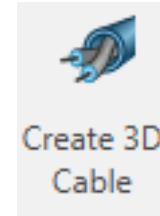
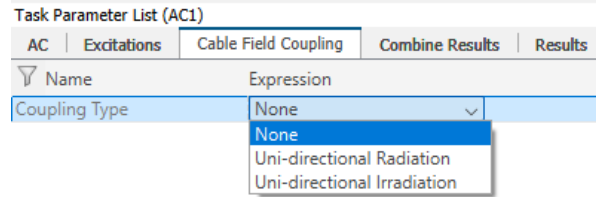
Edit...

Delete

Close

NASTAVENÍ SIMULACE SOLVERY

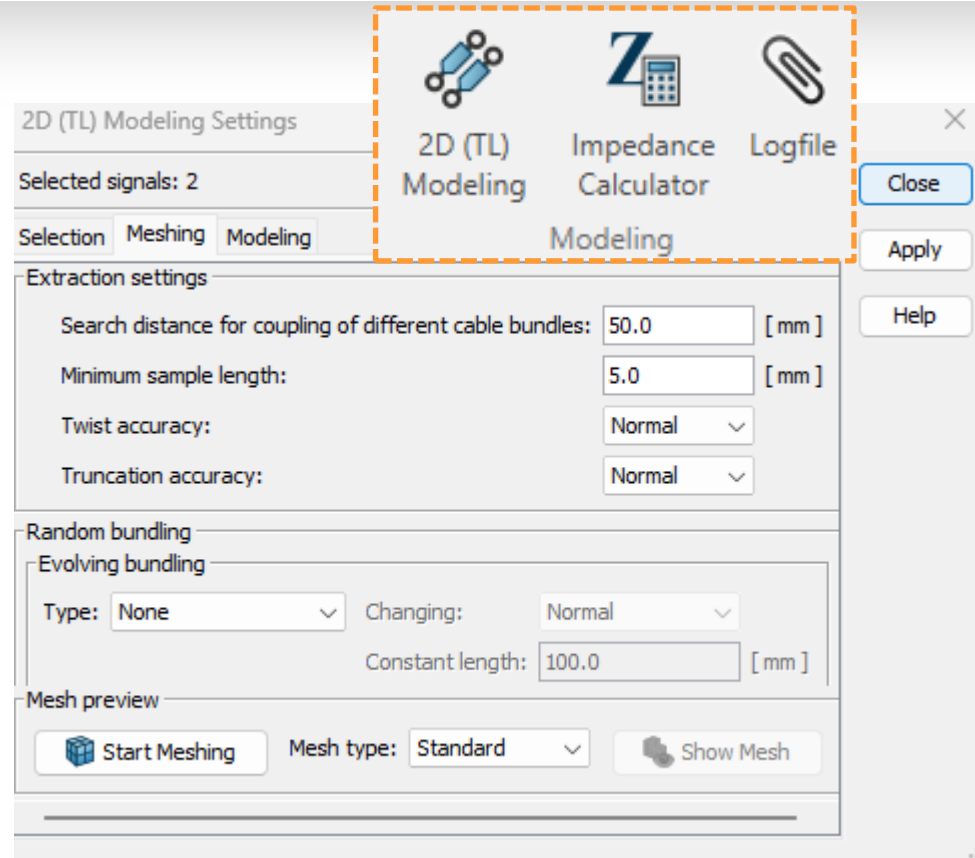
- Možnosti simulace:
 - Pouze 2D (TL)
 - 2D (TL) + 3D
 - 3D
- Kombinace 3D + schematic modulu



NASTAVENÍ SIMULACE

2D (TL) SOLVER

- Princip:
 1. Rozdělení kabelu na řezy
 2. Výpočet R,L,C,G pomocí 2D static solveru
 3. Každá sekce nahrazena za ekvivalentní obvod
 4. Spojení všech sekcí (obvodů) do jednoho, který reprezentuje celý kabel



NASTAVENÍ SIMULACE SCHEMATIC

- Postup:
 - Porty (VBA Makro)
 - Definování Tasku a vazby na 3D

The screenshot displays the Arplus Schematic software interface for configuring a simulation task. The main window shows a 3D model of a circuit board with numerous components and ports. Overlaid on this are several configuration windows and a context menu.

Task Parameter List (AC1)

AC	Excitations	Cable Field Coupling	Combine Results	Results
Name		ExpressionValue		
Circuit simulator		CST		
Local units		<input type="checkbox"/>		
Simulation settings				
Maximum frequency range		<input type="checkbox"/>		
Fmin		10	10	
Fmax		10	10	
Samples		1	1	
Logarithmic sweep		<input type="checkbox"/>		
Frequency limits				
Lower limit		0		
Upper limit		100		
Individual blocks				
Show frequency domain results		<input type="checkbox"/>		
S-parameter interpolation scheme		Magnit		
Specials		...		

Task Parameter List (AC1)

AC	Excitations	Cable Field Coupling	Combine Results	Results
Name		Unit		
1(N1_CG_1.Sin...		Voltage	100	V
Inner Resist...		0.0	0.0	Ohm
2(N1_CG_1.Sin...		Load	50.0 (Default)	Ohm
Impedance		Block Dependent	50.0 (Default)	Ohm
3(N1_CG_1.Sin...		Load	50.0 (Default)	Ohm
Impedance		Block Dependent	50.0 (Default)	Ohm

Task Parameter List (AC1)

AC	Excitations	Cable Field Coupling	Combine Results	Results
Name		Expression		
Coupling Type		Uni-directional Radiation		
		None		
		Uni-directional Radiation		
		Uni-directional Irradiation		

Context Menu (Right-click on a block):

- Add Block to all anchor points of a platform
- Add Ports to all pins of a block
- Add Termination to all open pins
- Compensate Self Inductance of Discrete Ports
- Convert Single Ended to Mixed Mode

Run Macro Menu:

- Calculate
- Construct
- File
- Report and Graphics
- Results
- Solver
- Wizard
- Edit Macro
 - Open VBA Macro Editor
 - Make VBA Macro...
 - Import VBA Macro...
 - Edit / Move / Delete VBA...

OBSAH

1. Úvod

- Workflow simulace kabeláže
- GUI
- Filozofie modelování

2. Modelování Kabelového Svazku

- Průřez
- Přejchod do 3D

3. Nastavení Simulace

- Porty a stínění
- Solvery
- Příklady

4. Příklady

- Xtalks, vyzářené emise

5. Závěr

PŘÍKLADY XTALKS

- SW1 → 100 V
- $f = 0 - 100$ MHz

Simulation settings

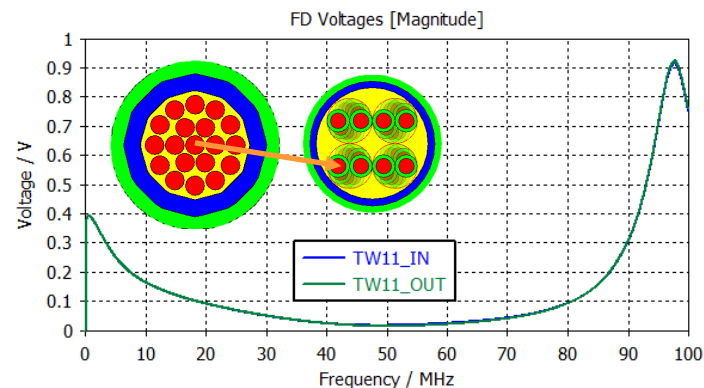
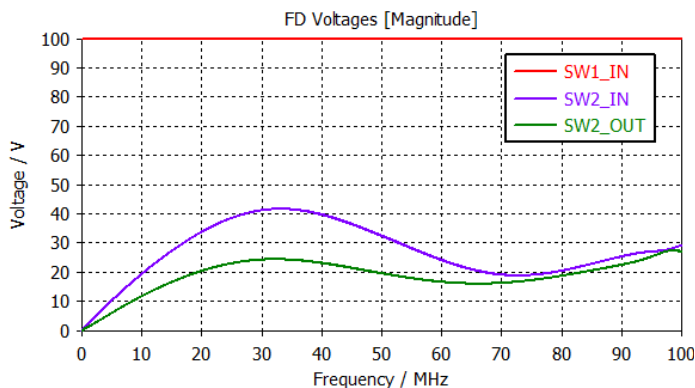
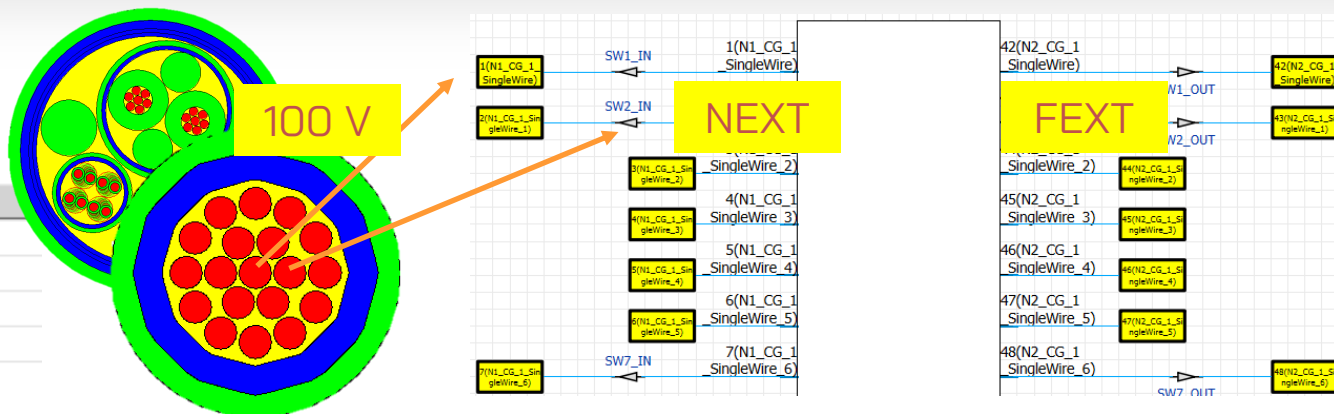
Maximum freq...	<input type="checkbox"/>	
Fmin	0	0
Fmax	100	100
Samples	1001	1001
Logarithmic sw...	<input type="checkbox"/>	

Task Parameter List (AC1)

AC	Excitations	Cable Field Coupling
Name	Unit	
1(N1...	Voltage	100 V
In...	0.0	0.0 Ohm

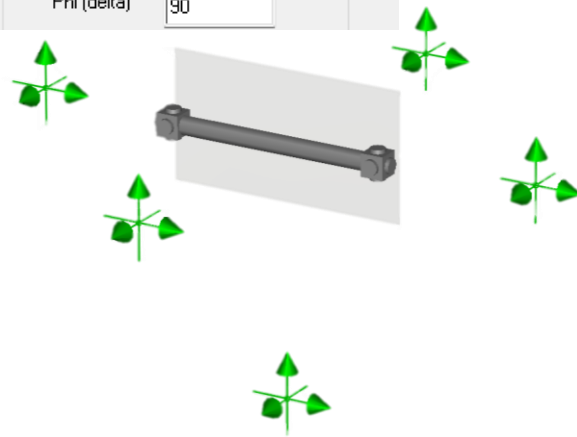
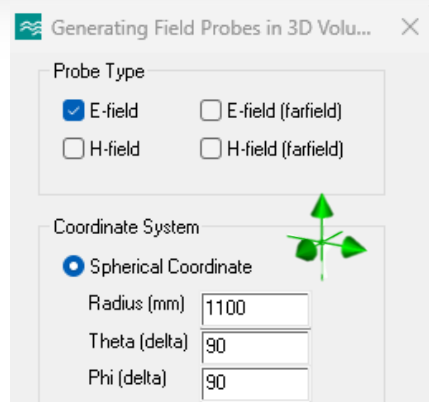
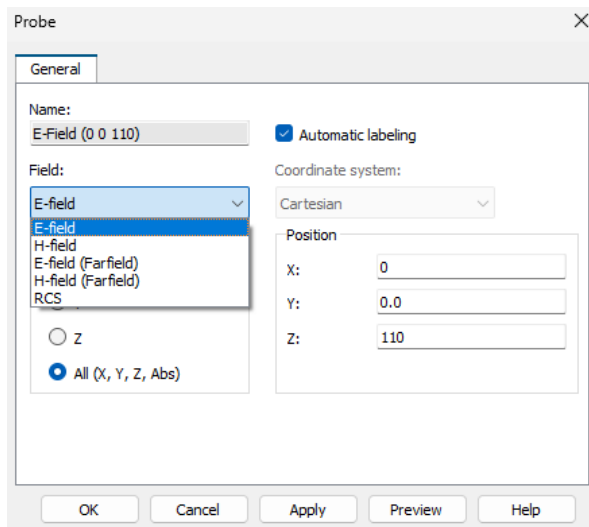
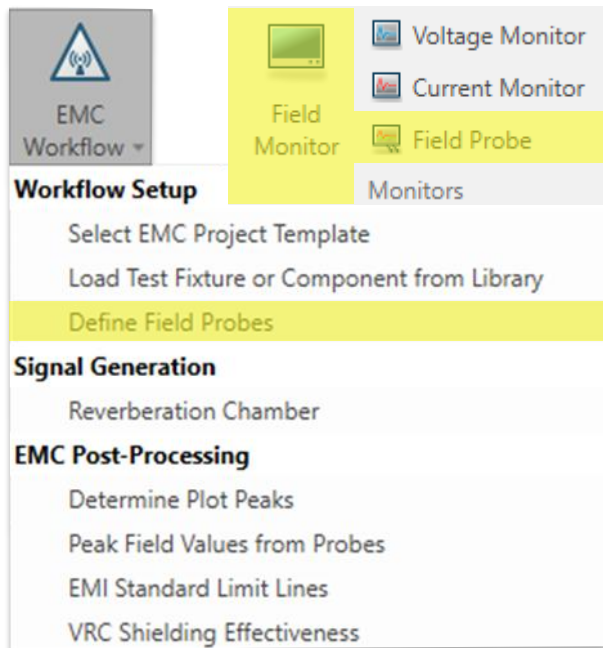
Task Parameter List (AC1)

AC	Excitations	Cable Field Coupling
Name	Expression	
Coupling Type	None	



PŘÍKLADY VYZÁŘENÉ EMISE

- Sonda: E-field v jednom bodě v závislosti na frekvenci.
- Monitor: E-field v celém prostoru pro 1 frekvenci



PŘÍKLADY VYZÁŘENÉ EMISE

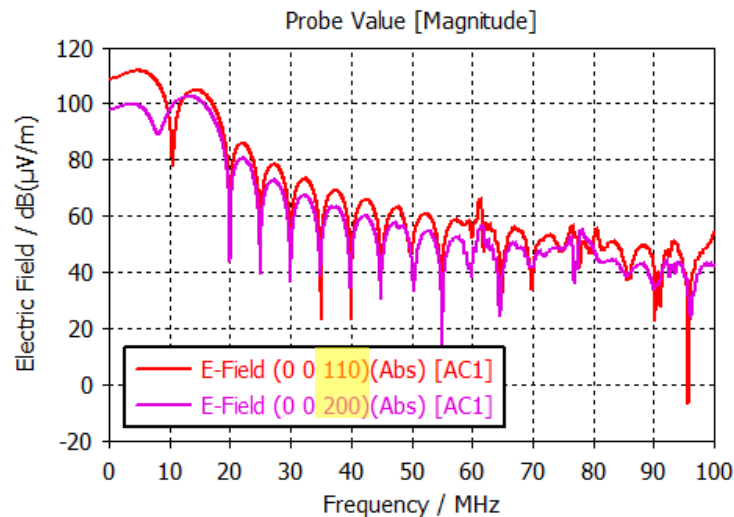
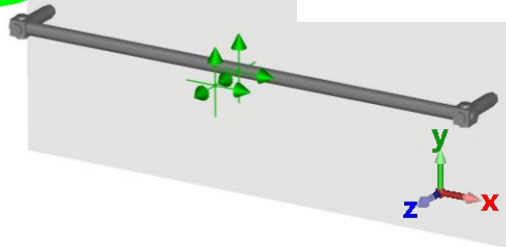
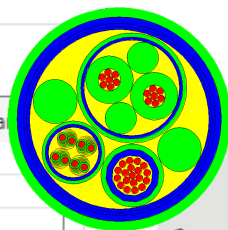
- Konvergenční kritérium pro sondy
- Vazba Uni- / Bi-directional
- Zbytek stejný jako Xtalks (AC task)

Solver → Specials

Custom stop criteria

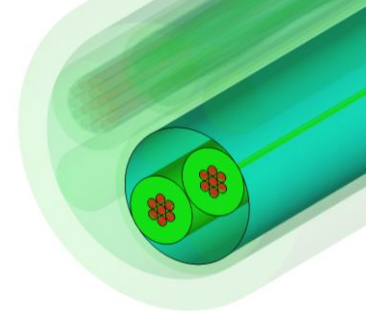
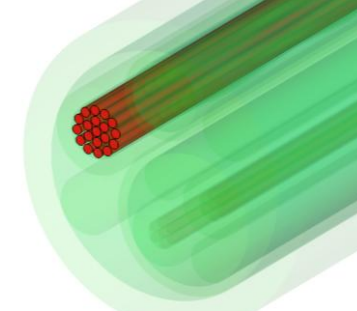
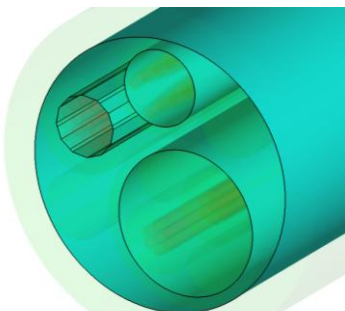
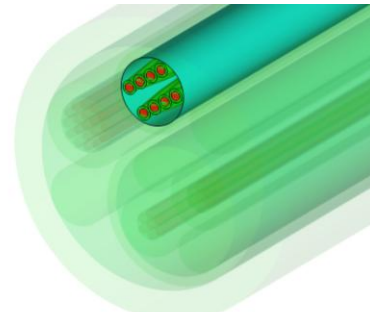
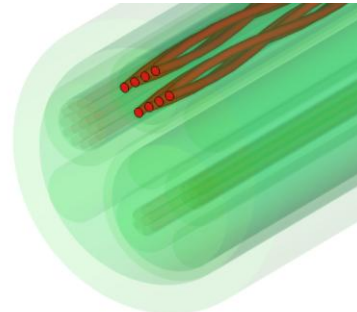
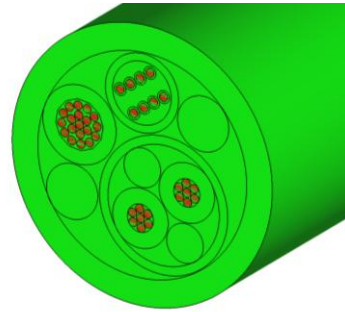
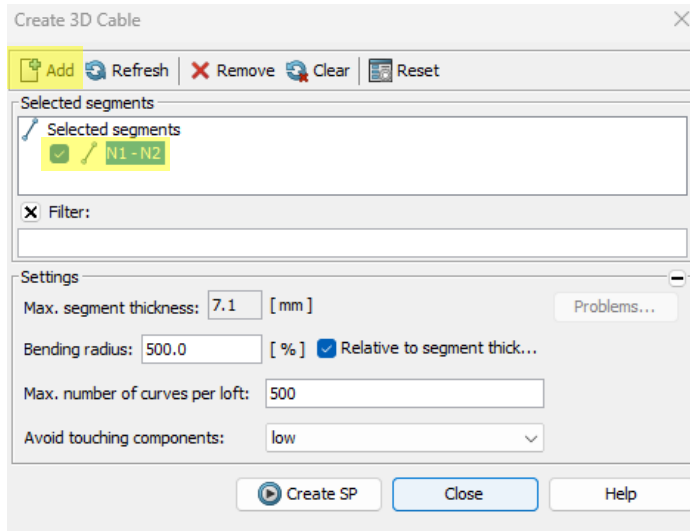
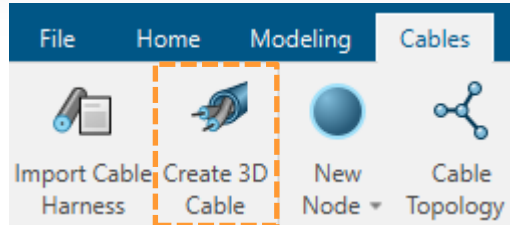
☐ Create list with excitation info

Active	Criterion	Threshold	Checks	Target freq. range
<input type="checkbox"/>	All S-Parameters	0.004	1	
<input type="checkbox"/>	Transmission S-Paramet...	0.004	1	
<input type="checkbox"/>	Reflection S-Parameters	0.004	1	
<input checked="" type="checkbox"/>	All Probes	0.02	1	
<input type="checkbox"/>	All Radiated Powers	0.004	1	
<input type="checkbox"/>	All Voltage-Current Mon...	0.004	1	
More groups...				



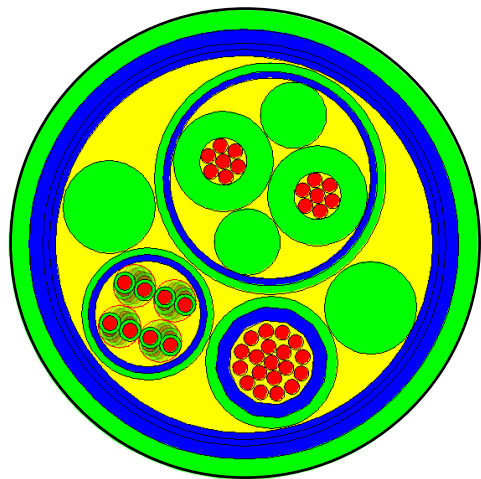
MODELOVÁNÍ

KONVERZE NA 3D MODEL



ZÁVĚR

- Cable Studio lze využít k modelování i simulaci kabeláže.
- Lze propojit s ostatními 3D solvery a schematic modulem.
- Jednoduché použití i pro složité kabelové svazky.
- Implementováno na 3DX.



CONFIDENTIAL

V případě zájmu nás kontaktujte.