

In-car communication at 60 GHz

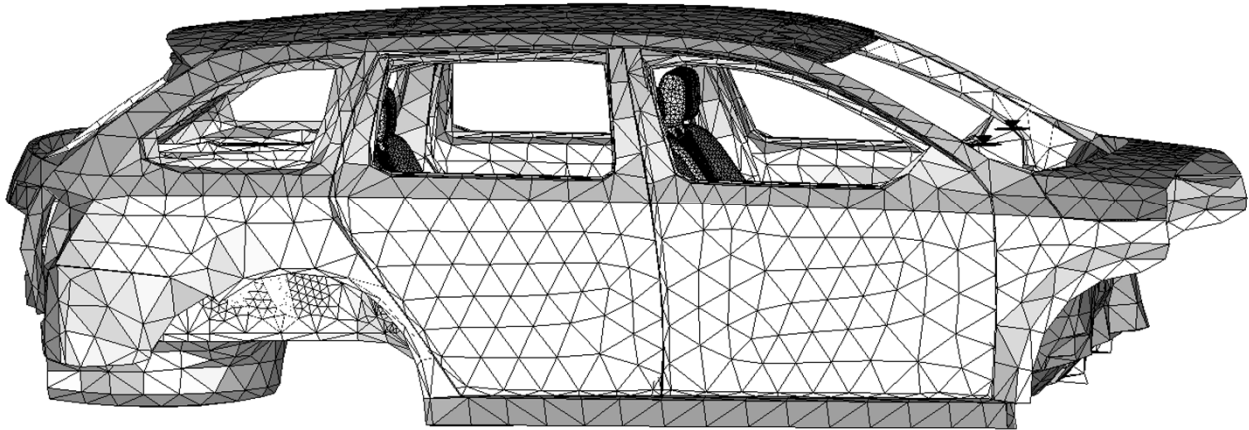
The 24th International Traveling Summer School on
Microwaves and Lightwaves

Jan Vélím

5. - 11. 7. 2014, Copenhagen, Denmark

| www.urel.feec.vutbr.cz

INTRODUCTION



1 – 10 GHz



60 GHz

MoM, MLFMM



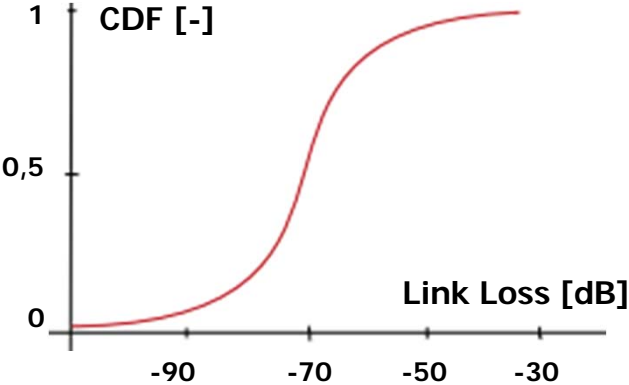
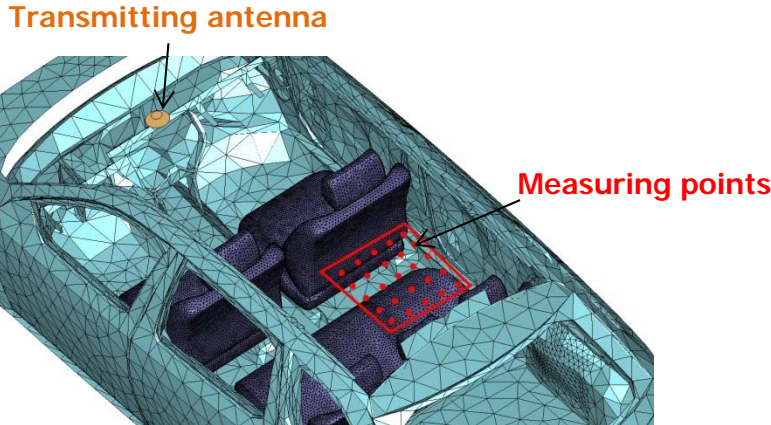
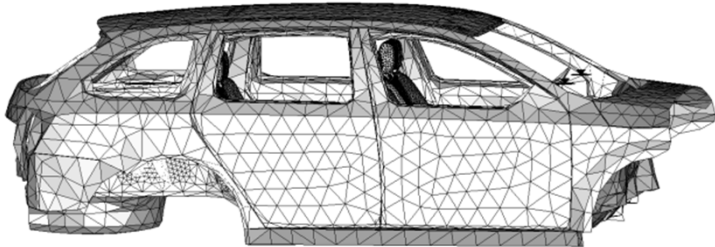
GO (Geometrical optics)

CST Microwave Studio

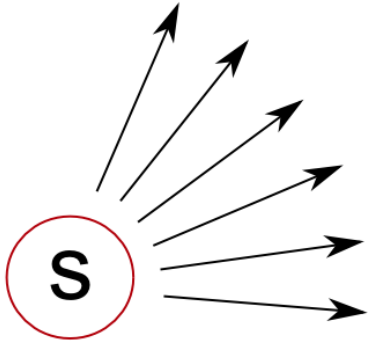
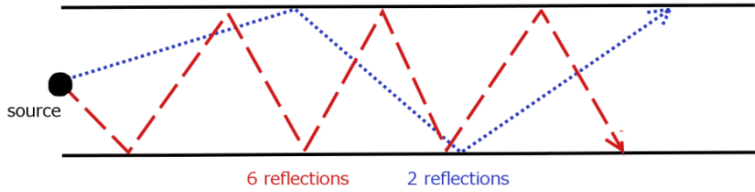
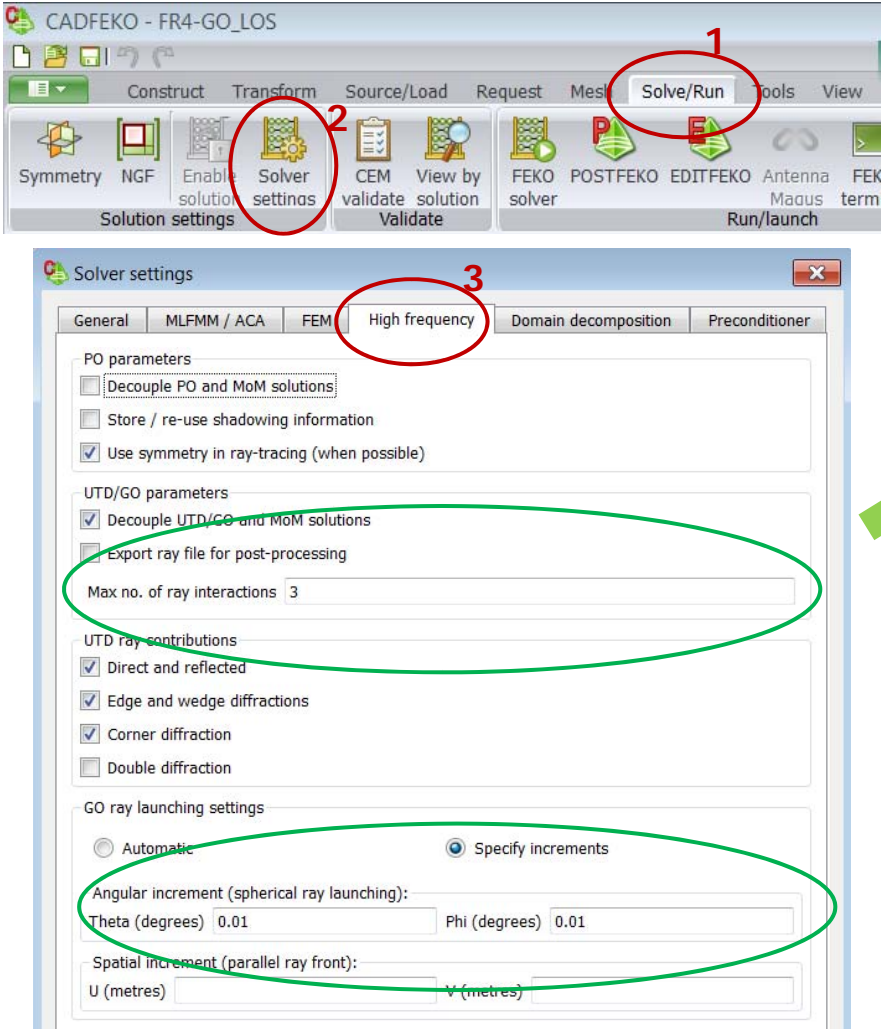


FEKO

NUMERICAL MODEL



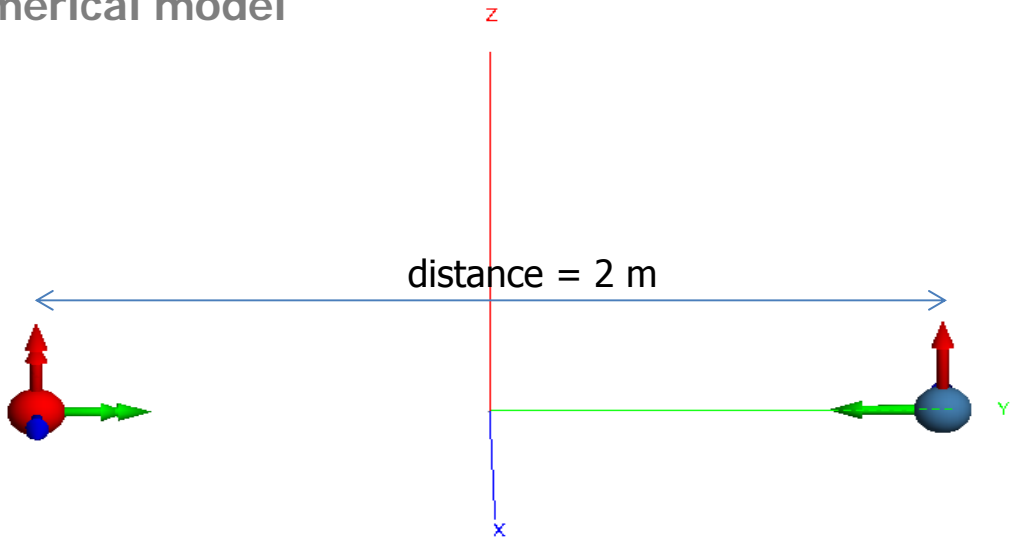
FEKO - INTRODUCTION



FEKO – VERIFICATION I.

Analytical vs. MoM

Numerical model

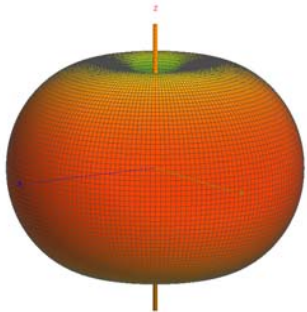


Results

	Analytical results		FEKO-MOM	
	[W]	[dBW]	[W]	[dBW]
Power on port receiving antenna	1,08E-07	-69,6502	1,08E-07	-69,6509

Details

Far-field of dipole – $\theta=\varphi=2^\circ$



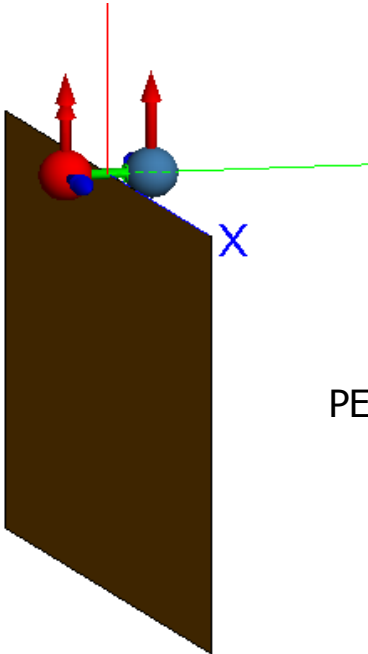
Friis equation:

$$R_p = \frac{P_t \cdot G_t \cdot G_r \cdot c^2}{(4\pi f r)^2}$$

FEKO – VERIFICATION II.

Analytical vs. GO

Numerical model



PEC half-plane obstacle – width 20 m
height 10 m

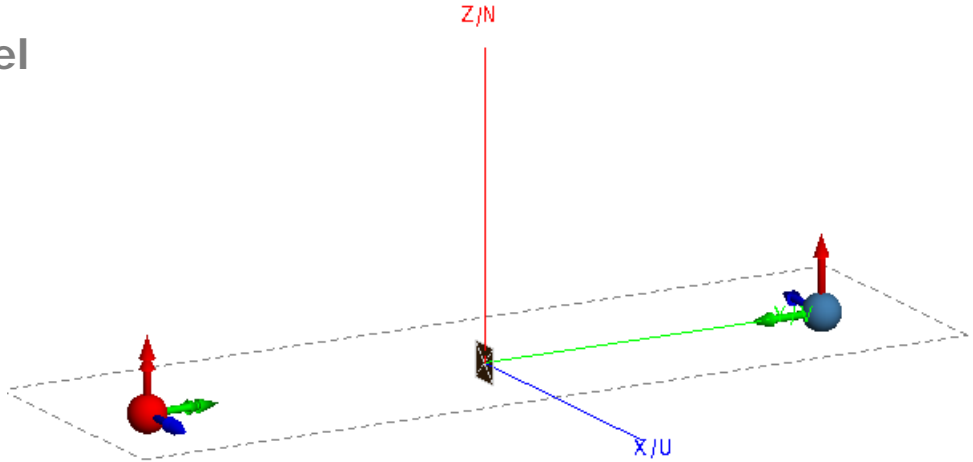
Results

	Analytical results		FEKO-GO	
	[W]	[dBW]	[W]	[dBW]
Power on port receiving antenna	2,70768E-08	-75,67	2,84000E-08	-75,47

FEKO – VERIFICATION III.

MLFMM vs. GO

Numerical model



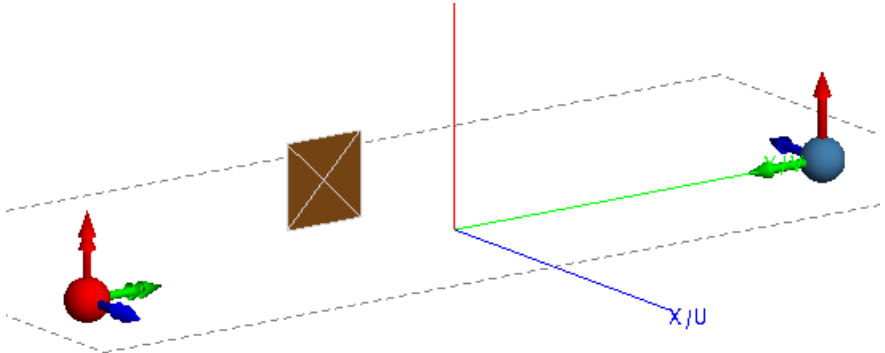
Results

Power on port receiving antenna	FEKO-MLFMM		FEKO-GO(0,1°)		FEKO-GO(0,01°)	
	[W]	[dBW]	[W]	[dBW]	[W]	[dBW]
FR4 10x10 cm	5,04E-08	-72,9775	4,86E-08	-73,1354	5,04E-08	-72,9745
FR4 20x20 cm	9,28E-09	-80,3234	9,47E-09	-80,2366	9,26E-09	-80,3358

FEKO – VERIFICATION IV.

MLFMM vs. GO

Numerical model

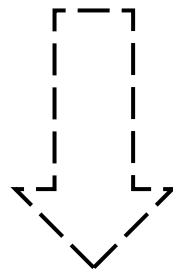


Results

Power on port receiving antenna	FEKO-MLFMM		FEKO-GO(0,1°)		FEKO-GO(0,01°)	
	[W]	[dBW]	[W]	[dBW]	[W]	[dBW]
FR4 10x10 cm	1,42E-08	-78,4792	1,06E-07	-69,7330	1,06E-07	-69,7624
FR4 20x20 cm	8,09E-08	-70,9232	1,12E-07	-69,5269	1,11E-07	-69,5481

CONCLUSIONS

- ❑ **FEKO can be used for modeling in-car wave propagation at mm-wave frequencies**



- ❑ **Testing real materials used in cars**
- ❑ **Developing more complicated numerical model of vehicle (acceptable simplifications)**



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