

# 10SPE Study Group

## Automotive Channel for Multi-Drop

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supporters

# Motivation

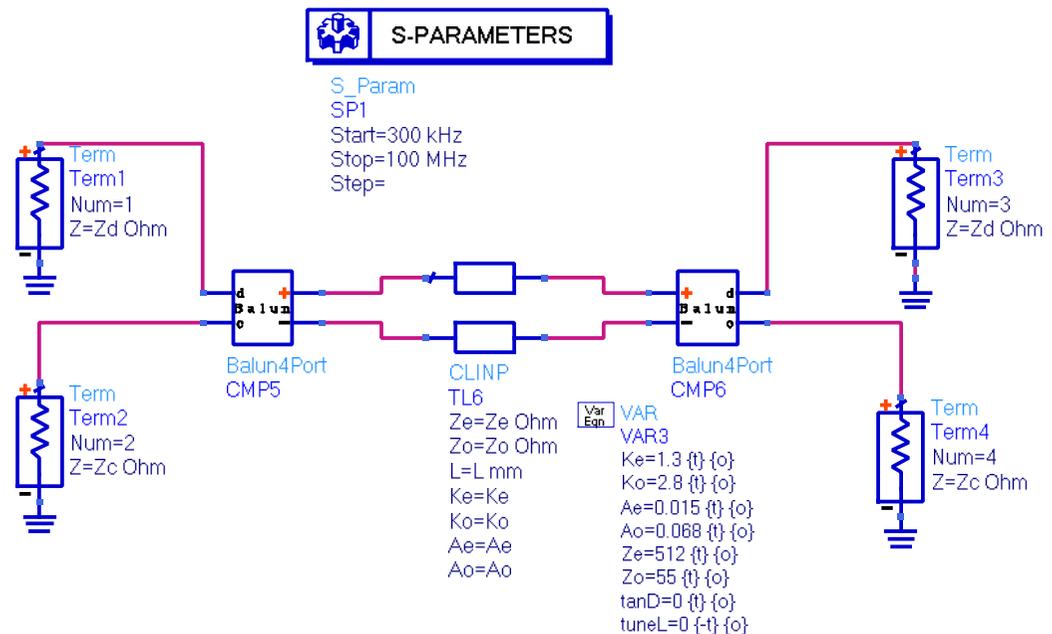
- Provide information to the 10SPE study group regarding the automotive channel for multi-drop (shared medium).
- Provide information how multi-drop (shared medium) channels could be modeled.

# methodology

- Cable modeling by ADS CLINP-model of UTP cable
- MonteCarlo Analysis (100 iterations) of length of individual topology elements to get s-Parameters for various topologies
  - Point-to-point link (15m)\* (*no MonteCarlo Simulation, just for reference*)
  - Linear topology (15m)
  - Linear topology (30m)
  - Linear topology with long stubs
  - Star topology
  - Double Star topology
- Methodology does not take into account splices, inline connectors, etc. (Assumption is their influence can be neglected for multidrop topologies)

# Cable modeling with ADS CLINP

- measurement of a „typical“ UTP cable (15m) at room temperature acc. to OPEN Alliance test specification (TC2)
- Fitting of CLINP parameters
  - $A_e = 0,015\text{dB/m@5MHz}$
  - $A_o = 0.068\text{dB/m@5MHz}$
  - $Z_e = 512\Omega$
  - $Z_o = 55\Omega$
  - $K_e = 1,3$
  - $K_o = 2,8$
  - ( $Z_d=100\Omega, Z_c=25\Omega$ )

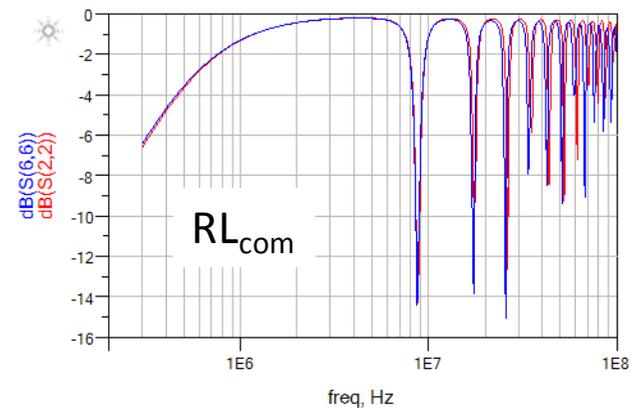
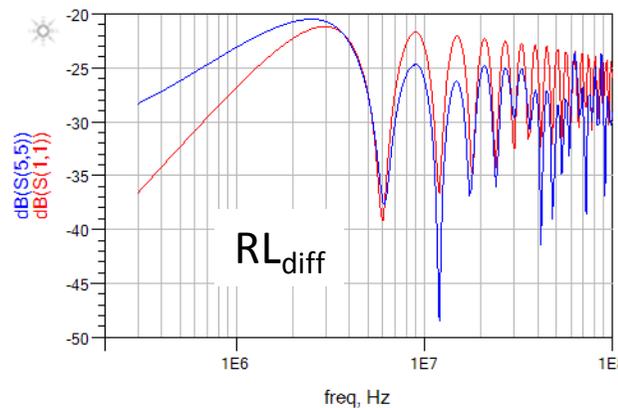
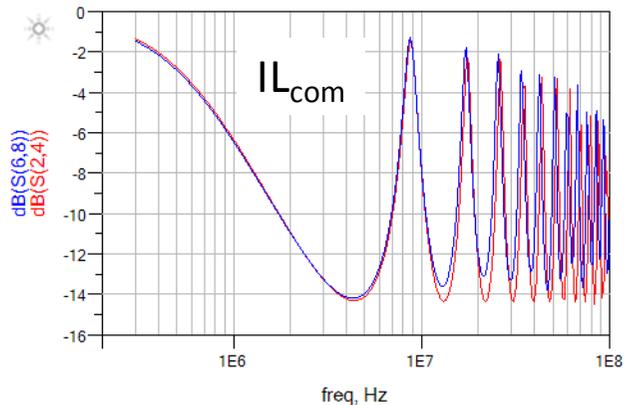
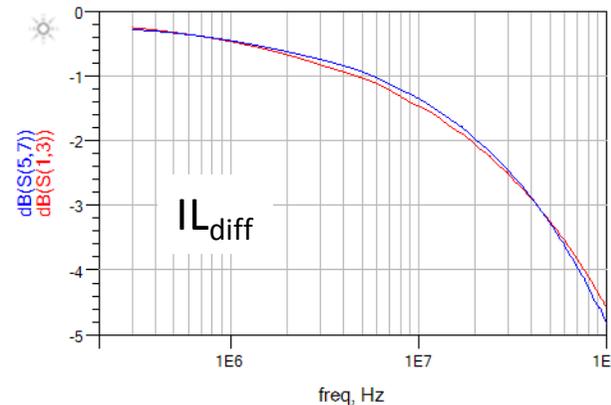
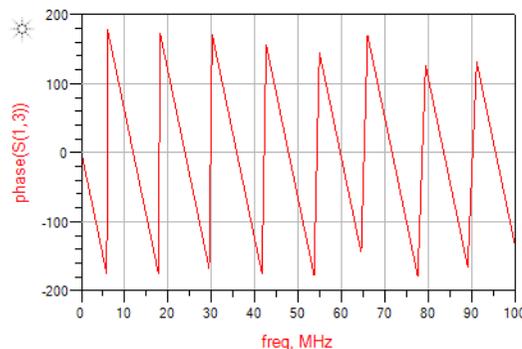


# fitting results (=15m point-to-point channel)

Measurement

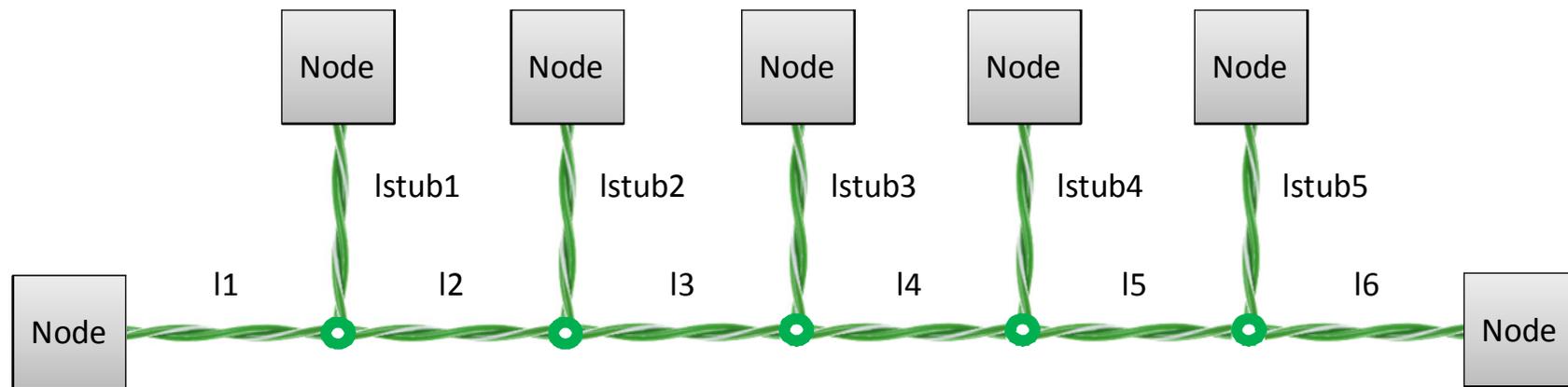
Simulation CLINP

- ~5dB attenuation at 100MHz for differential signal
- <20dB Return Loss
- Phase is constant:



# Modelling of various topologies with CLINP

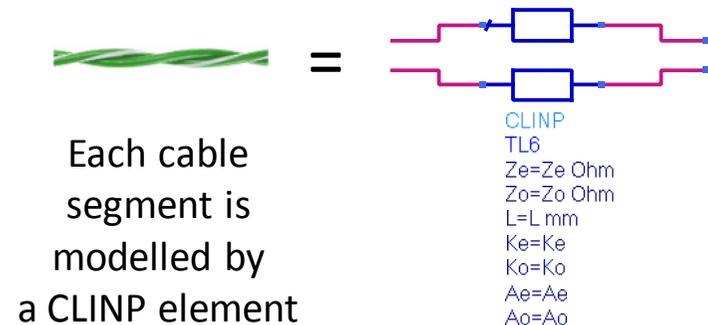
- Linear topology max. 15m:



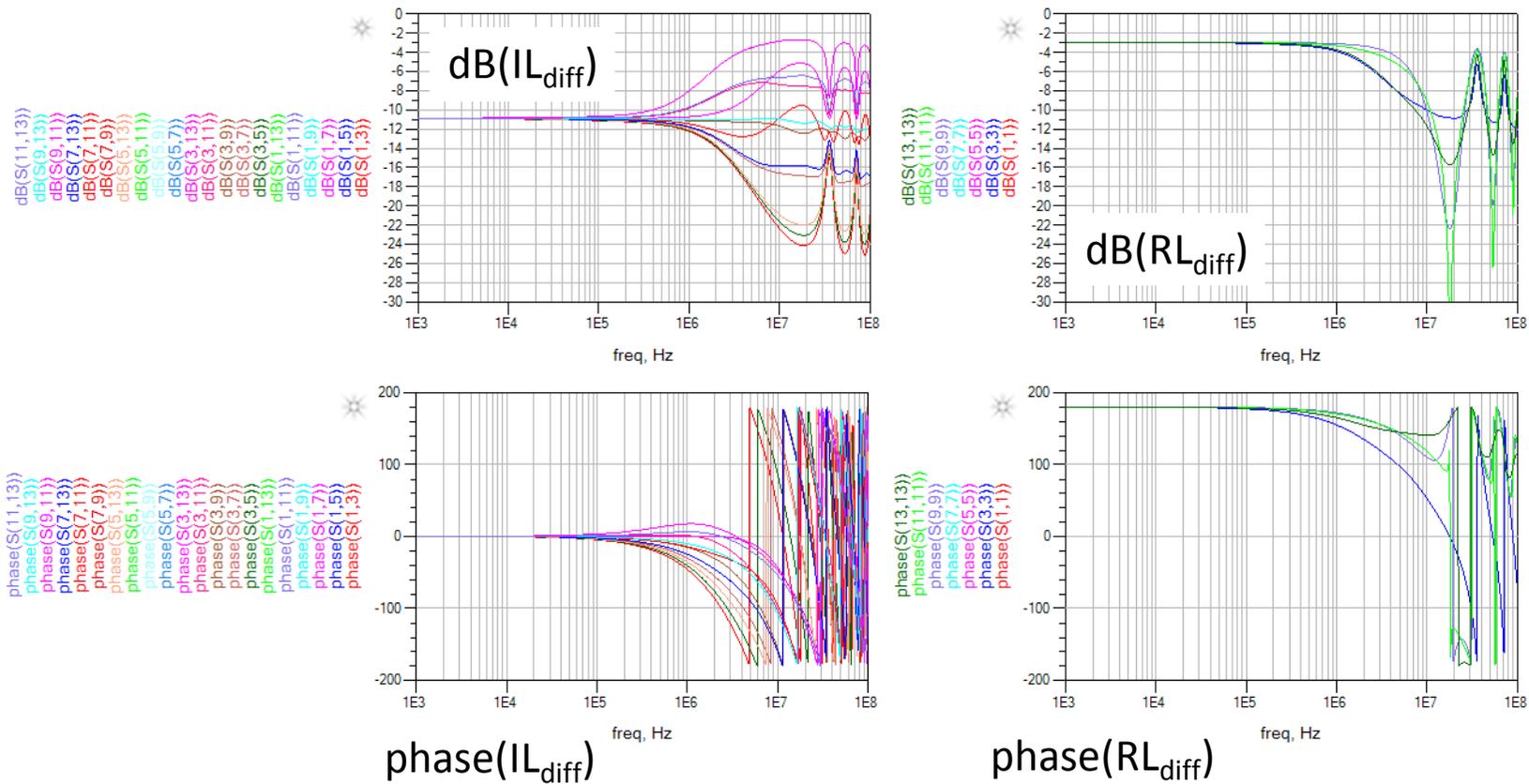
l1 to l6: [10...2500]mm  
 lstub1 to lstub5: [1...200]mm

- Overall length is limited to 15m (6x2,5m)
- Each stub is max. 20cm (~trace on PCB)

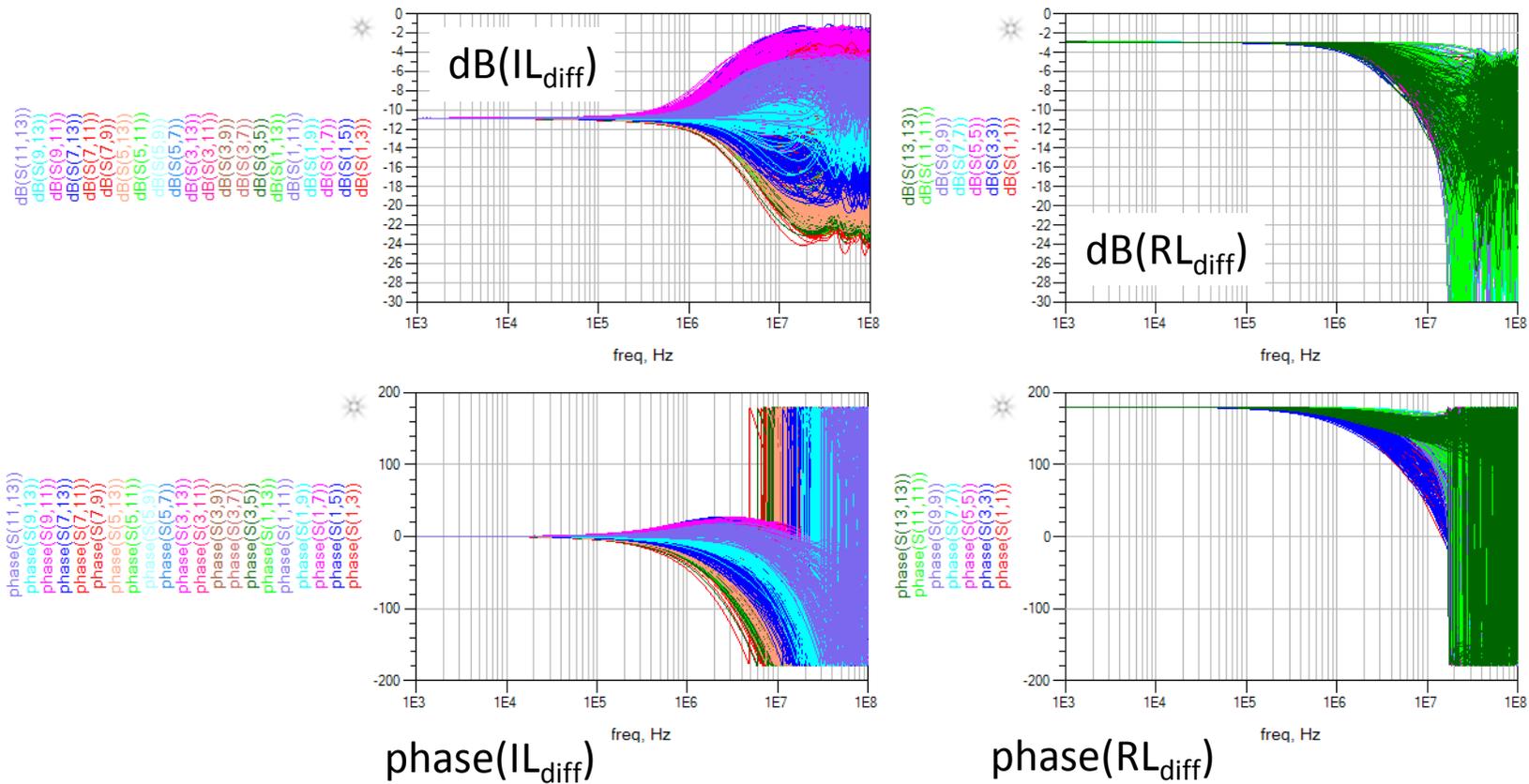
Each node is terminated with  $Z_d=100\Omega$   
 and  $Z_c=25\Omega$  in the simulation!



# Linear topology 15m (max. lengths)

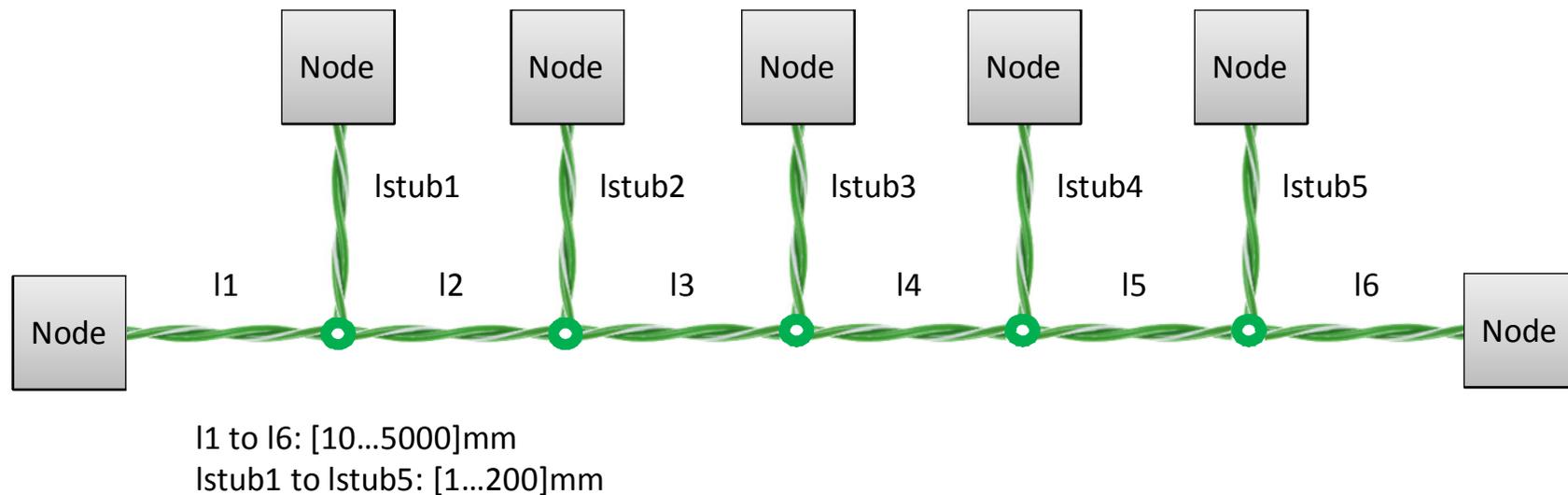


# Linear topology 15m (MonteCarlo)



# Modelling of various topologies with CLINP

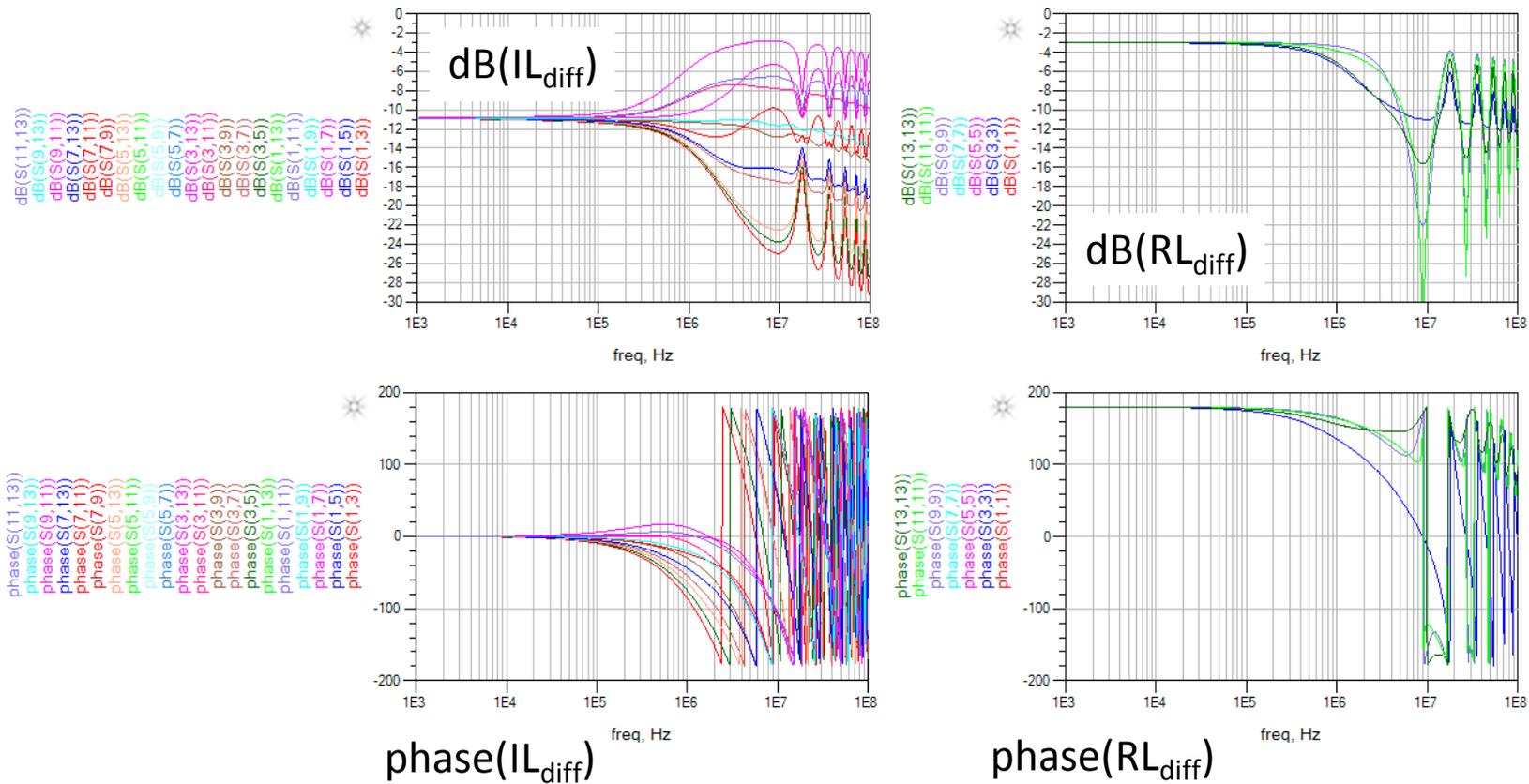
- Linear topology max 30m:



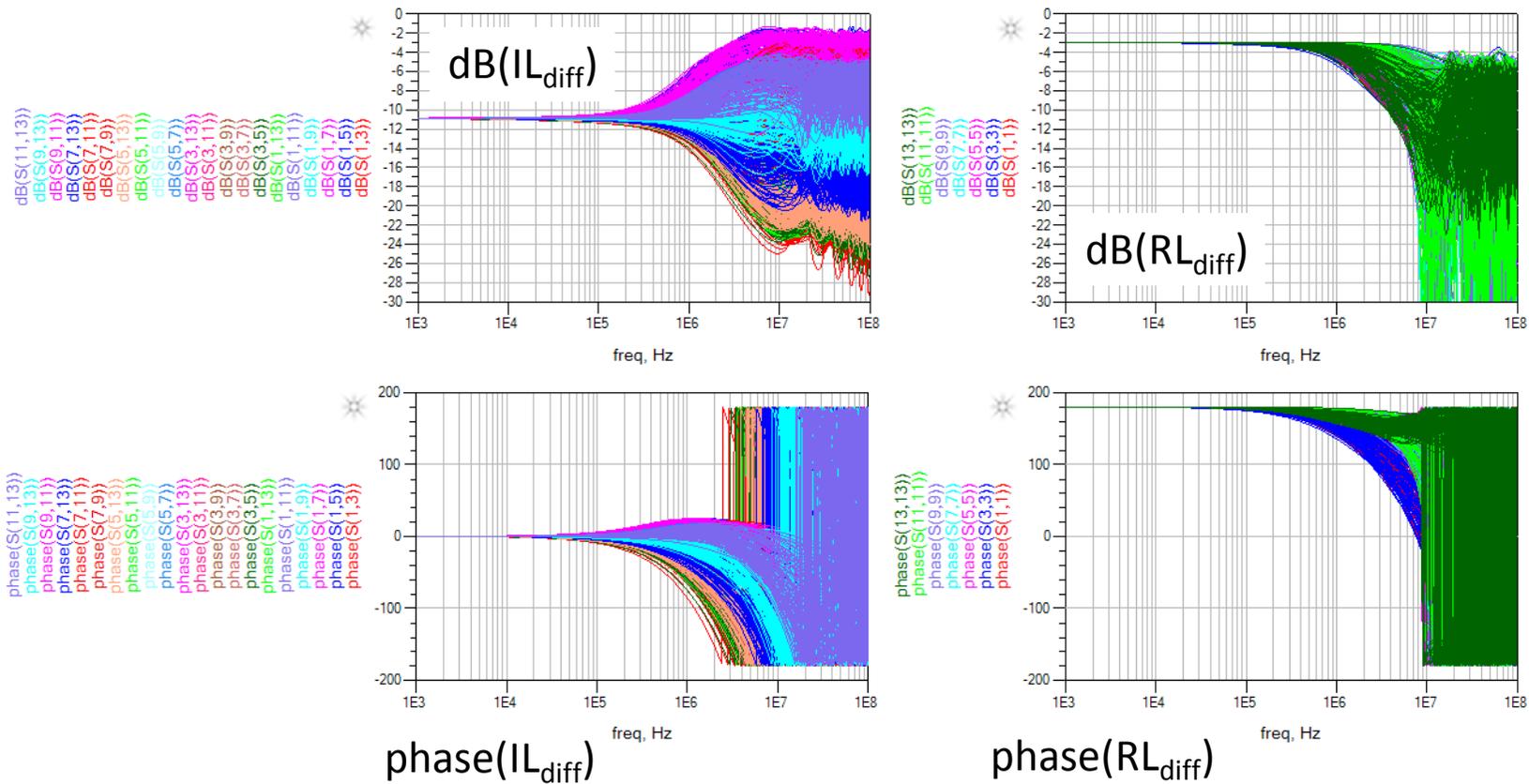
- Overall length is limited to 30m (6x5m)
- Each stub is max. 20cm (~trace on PCB)

Each node is terminated with  $Z_d=100\Omega$  and  $Z_c=25\Omega$  in the simulation!

# Linear topology 30m (max lengths)

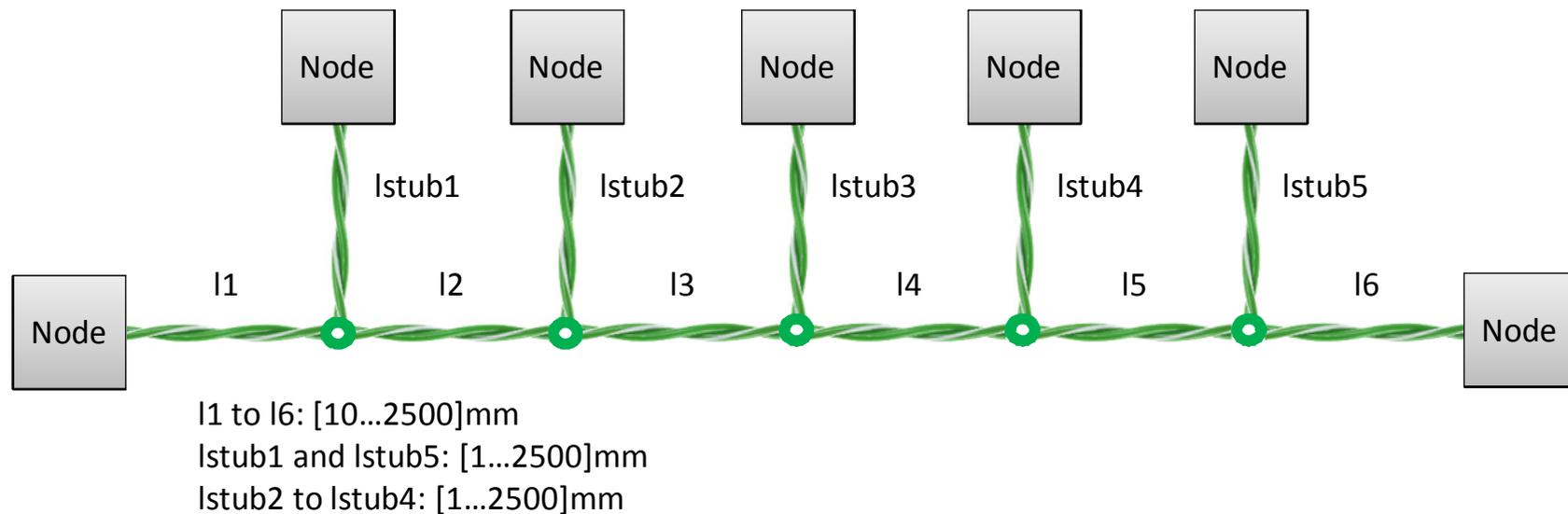


# Linear topology 30m (MonteCarlo)



# Modelling of various topologies with CLINP

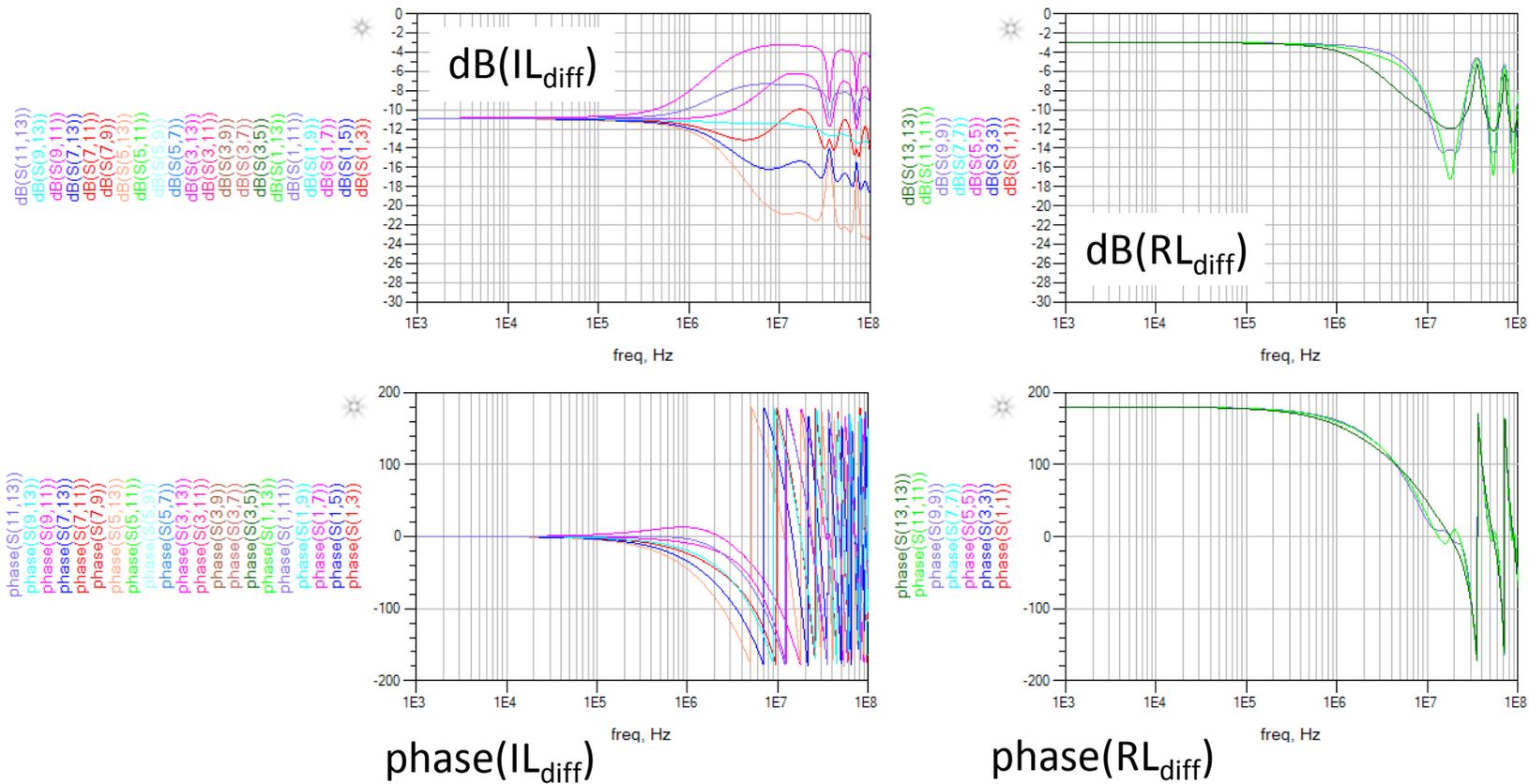
- Linear topology with stubs:



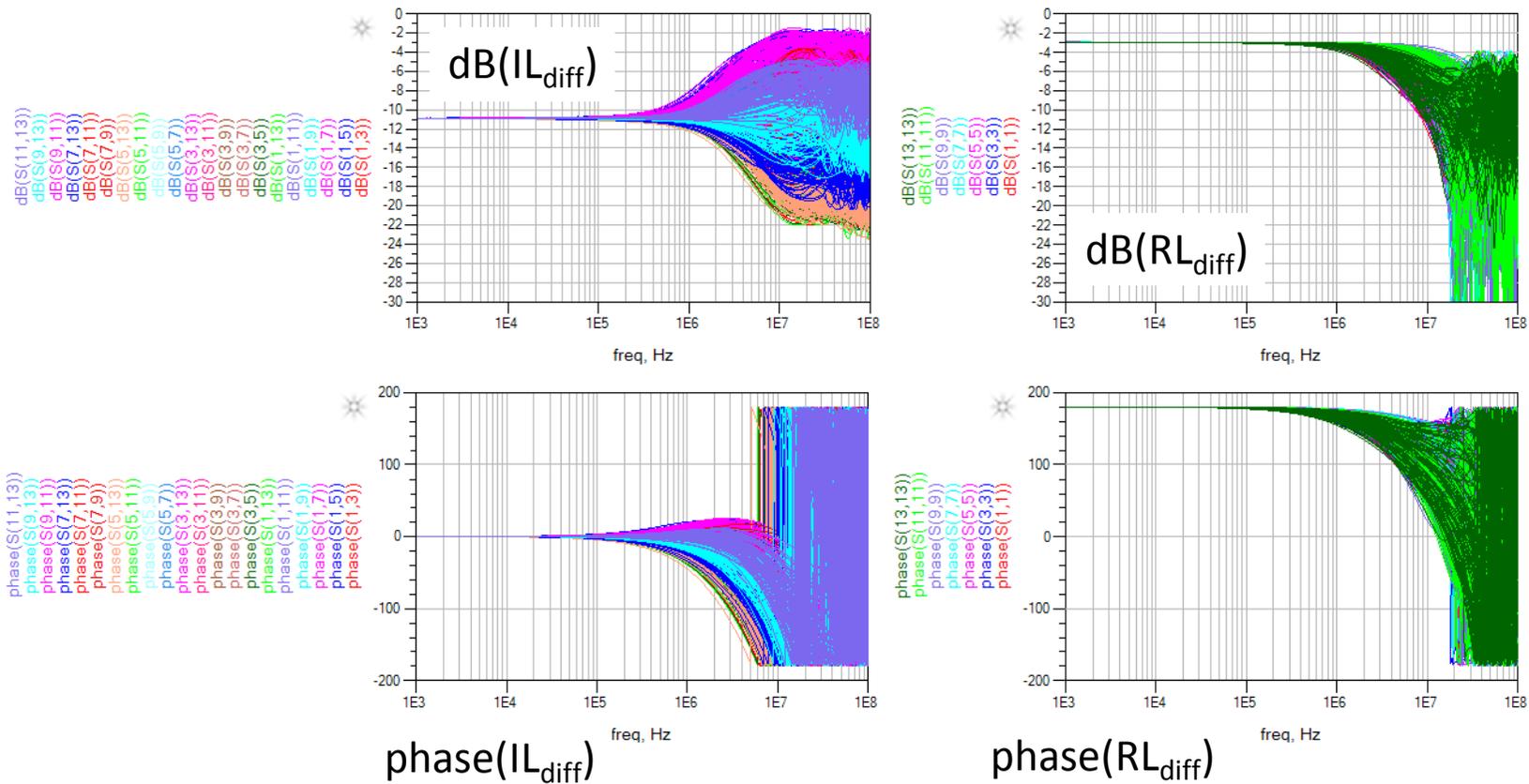
- Overall length is limited to 15m (6x2,5m)
- Each stub is max. 2,5m

Each node is terminated with  $Z_d=100\Omega$  and  $Z_c=25\Omega$  in the simulation!

# Bus with stubs max. 15m (max lengths)

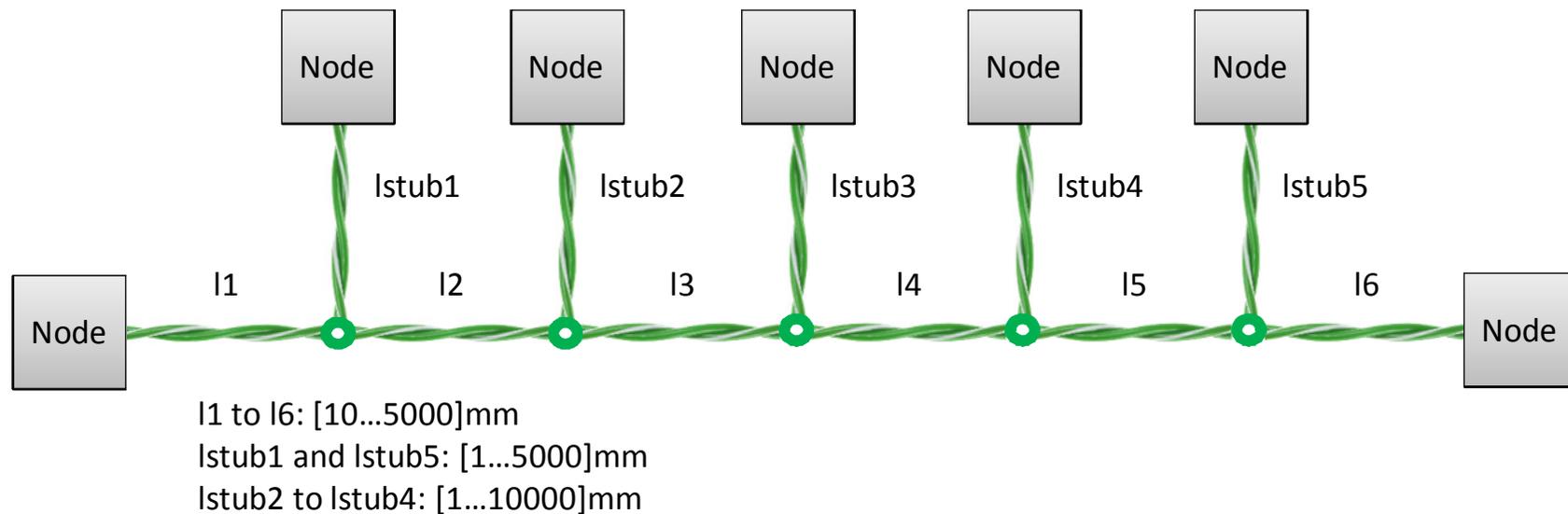


# Bus with stubs max. 15m (MonteCarlo)



# Modelling of various topologies with CLINP

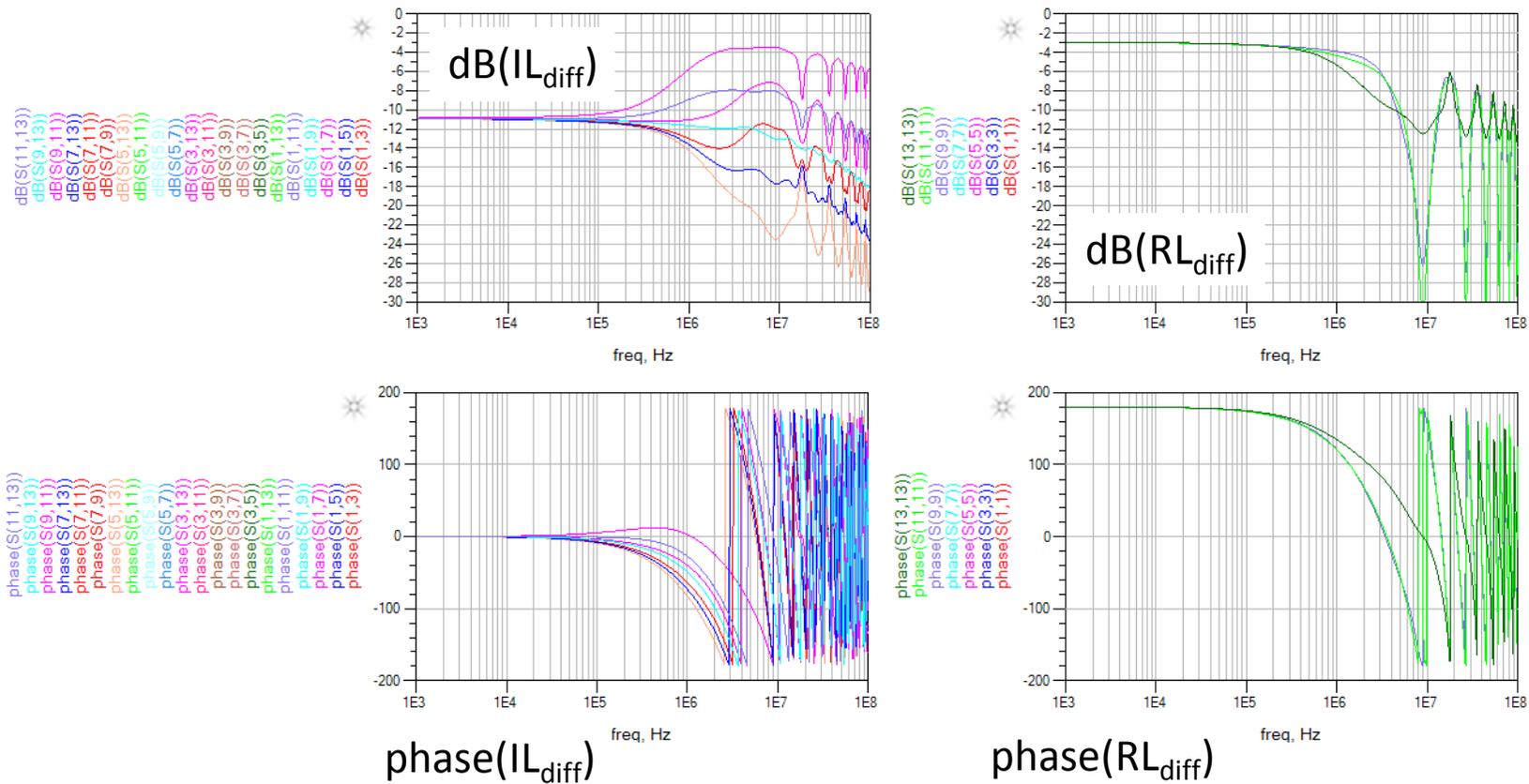
- Linear topology with long stubs:



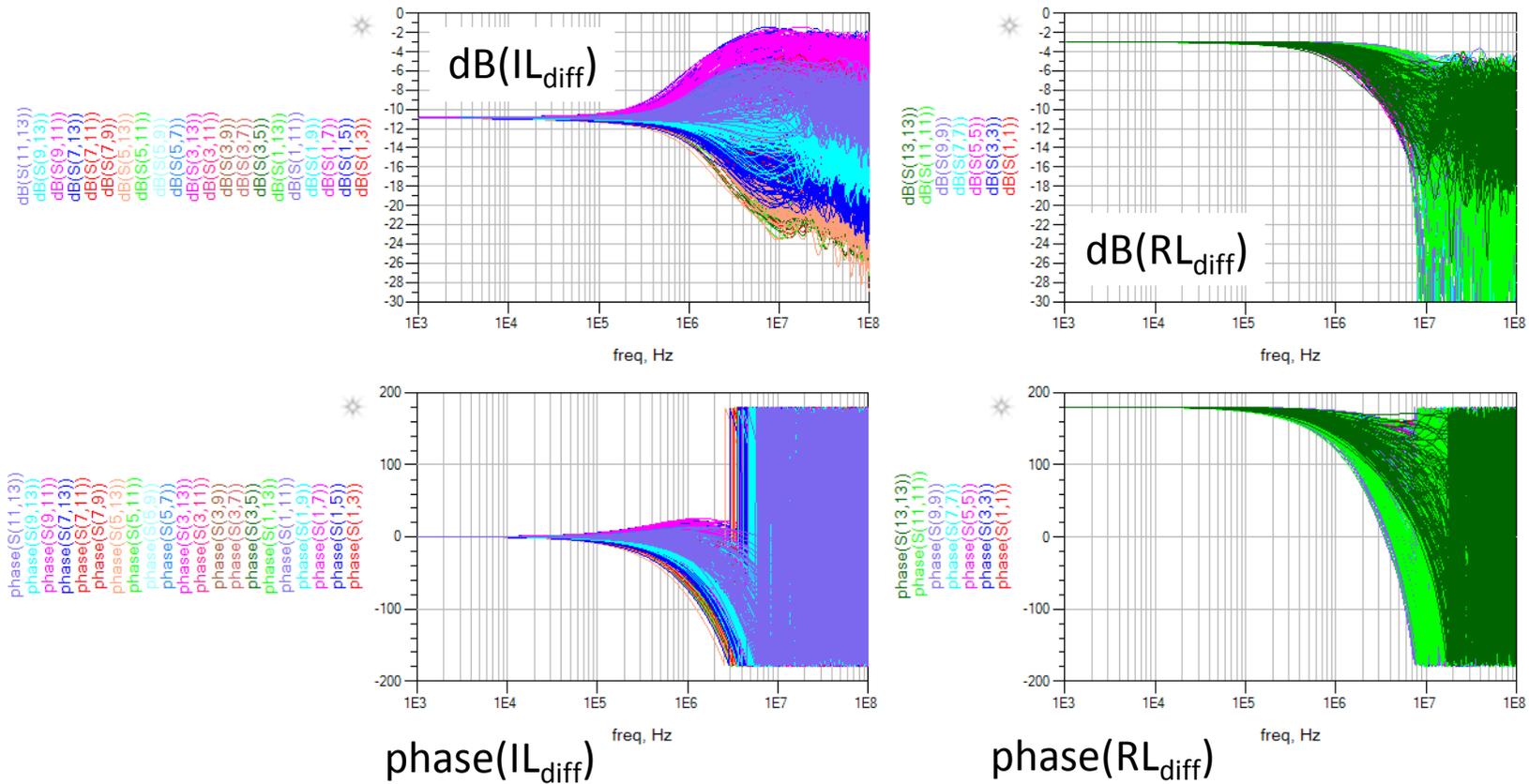
- Overall length is limited to 30m (6x5m)
- Each stub is max. 10m

Each node is terminated with  $Z_d=100\Omega$  and  $Z_c=25\Omega$  in the simulation!

# Bus with long stubs max. 30m (max length)

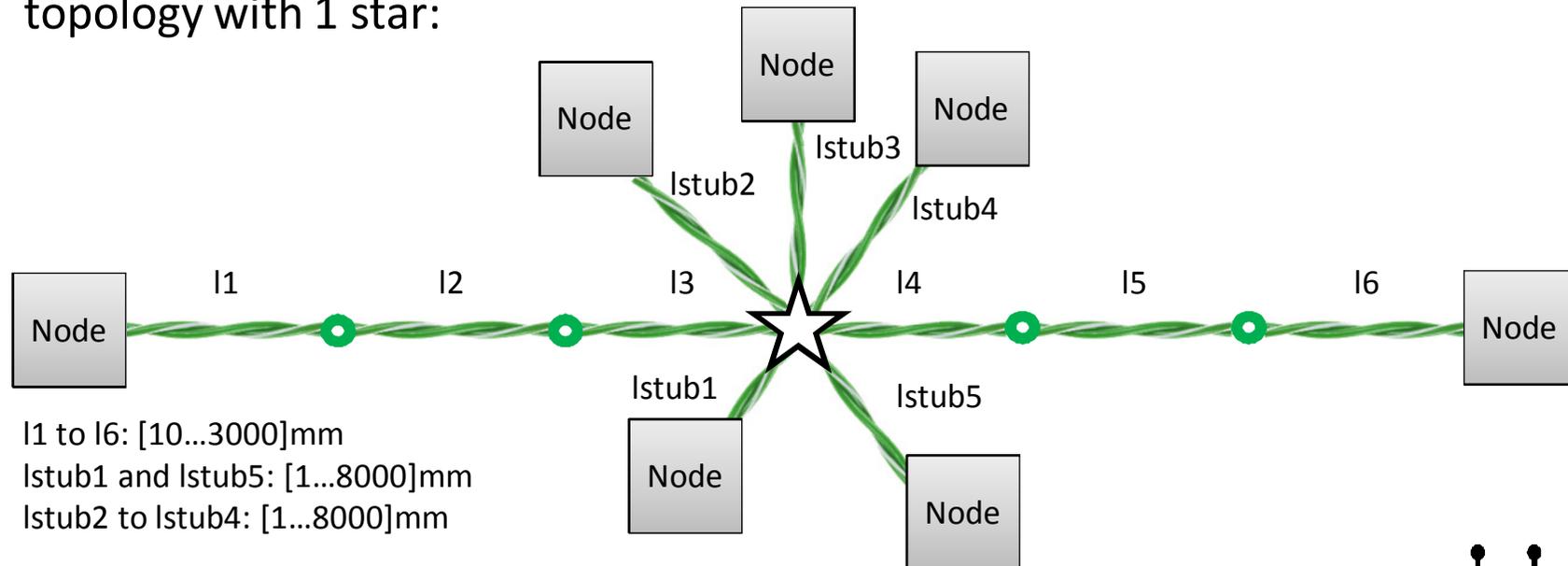


# Bus with long stubs max. 30m (MonteCarlo)



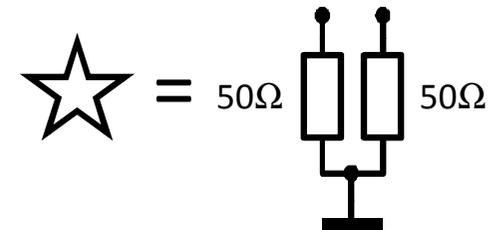
# Modelling of various topologies with CLINP

- topology with 1 star:

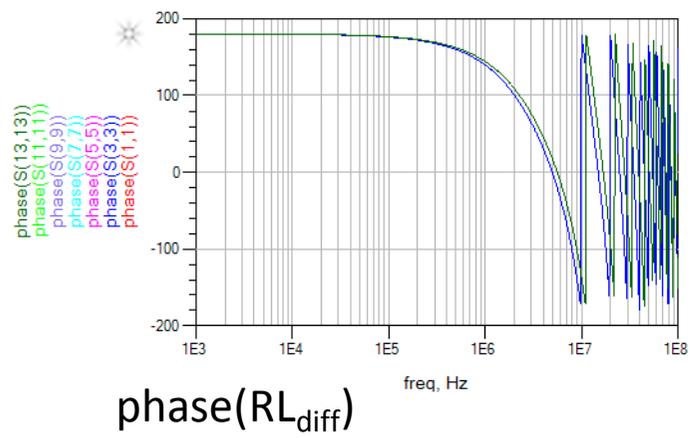
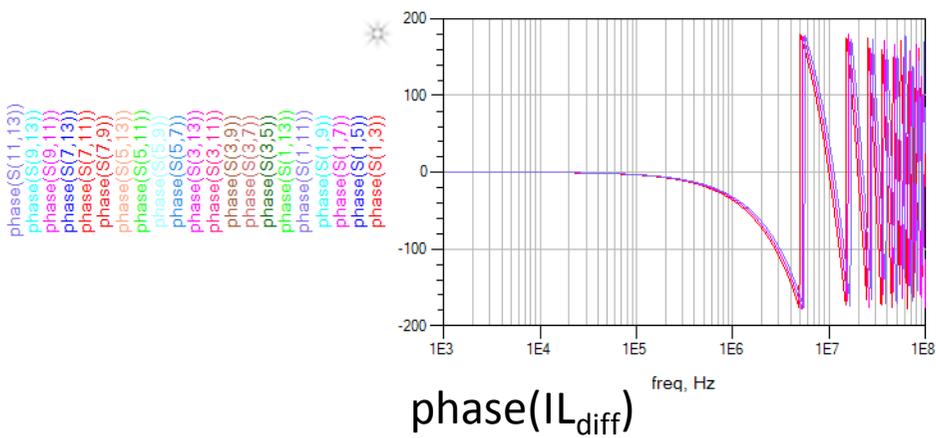
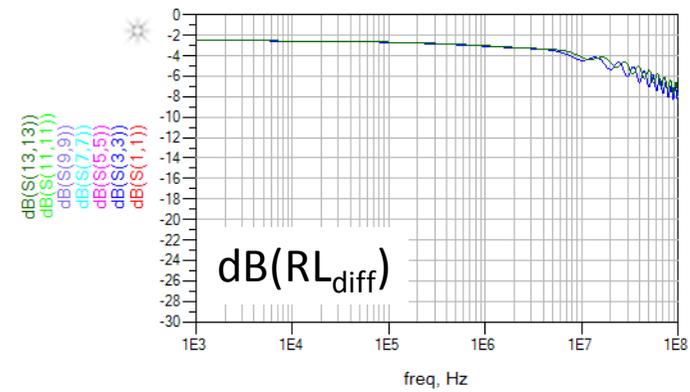
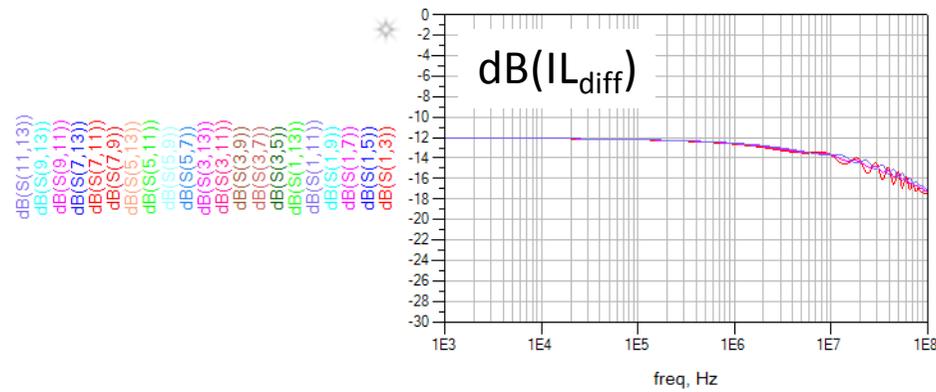


- Overall length is limited to 18m (2x9m)
- Each stub is max. 9m

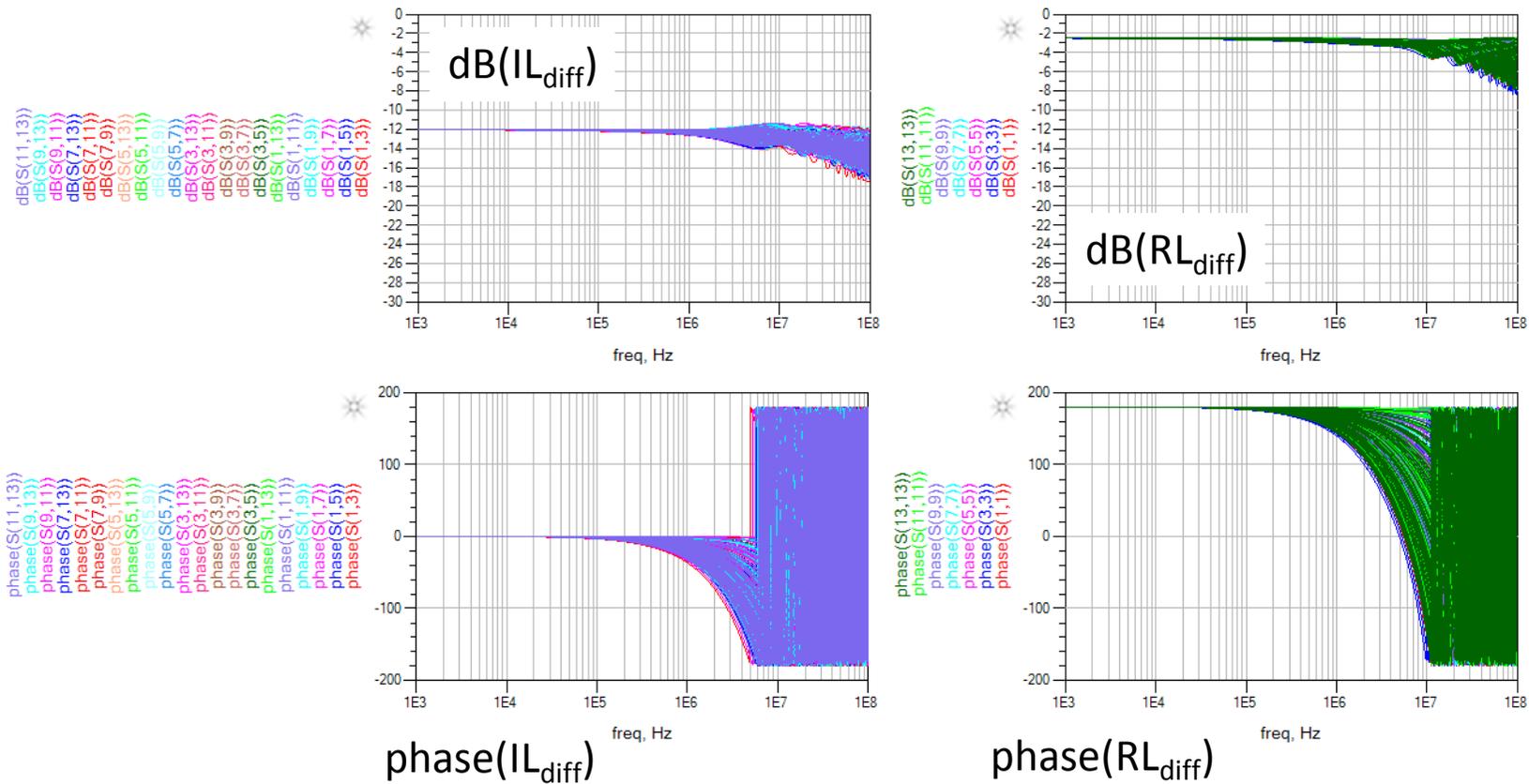
Each node is terminated with  $Z_d=100\Omega$  and  $Z_c=25\Omega$  in the simulation!



# Bus with 1 star (max length)

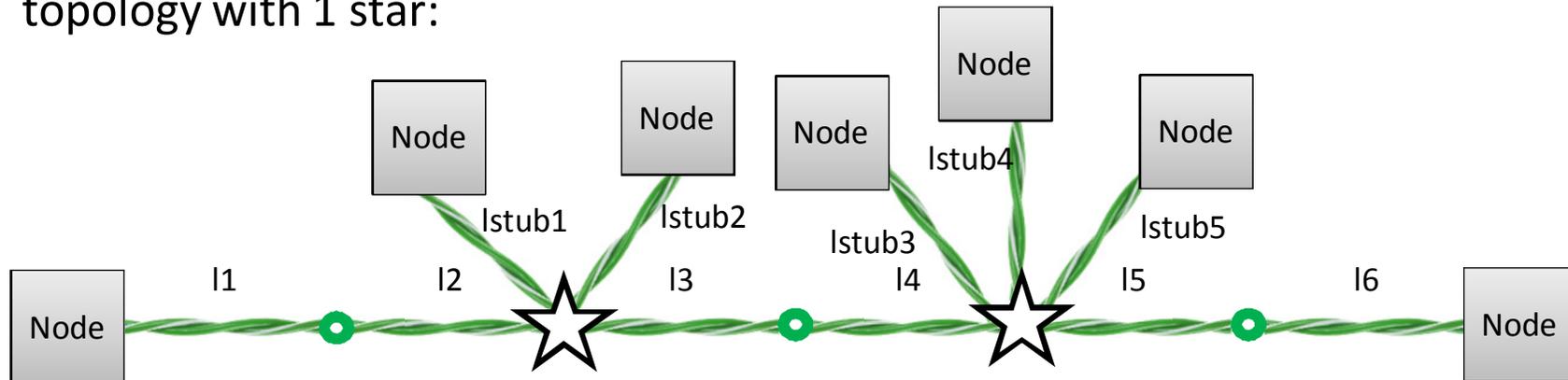


# Bus with 1 star (MonteCarlo)



# Modelling of various topologies with CLINP

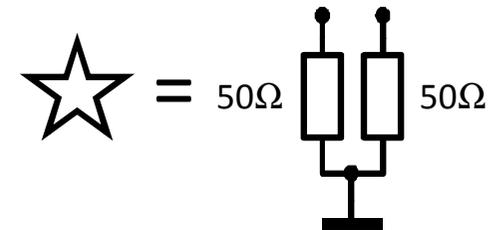
- topology with 1 star:



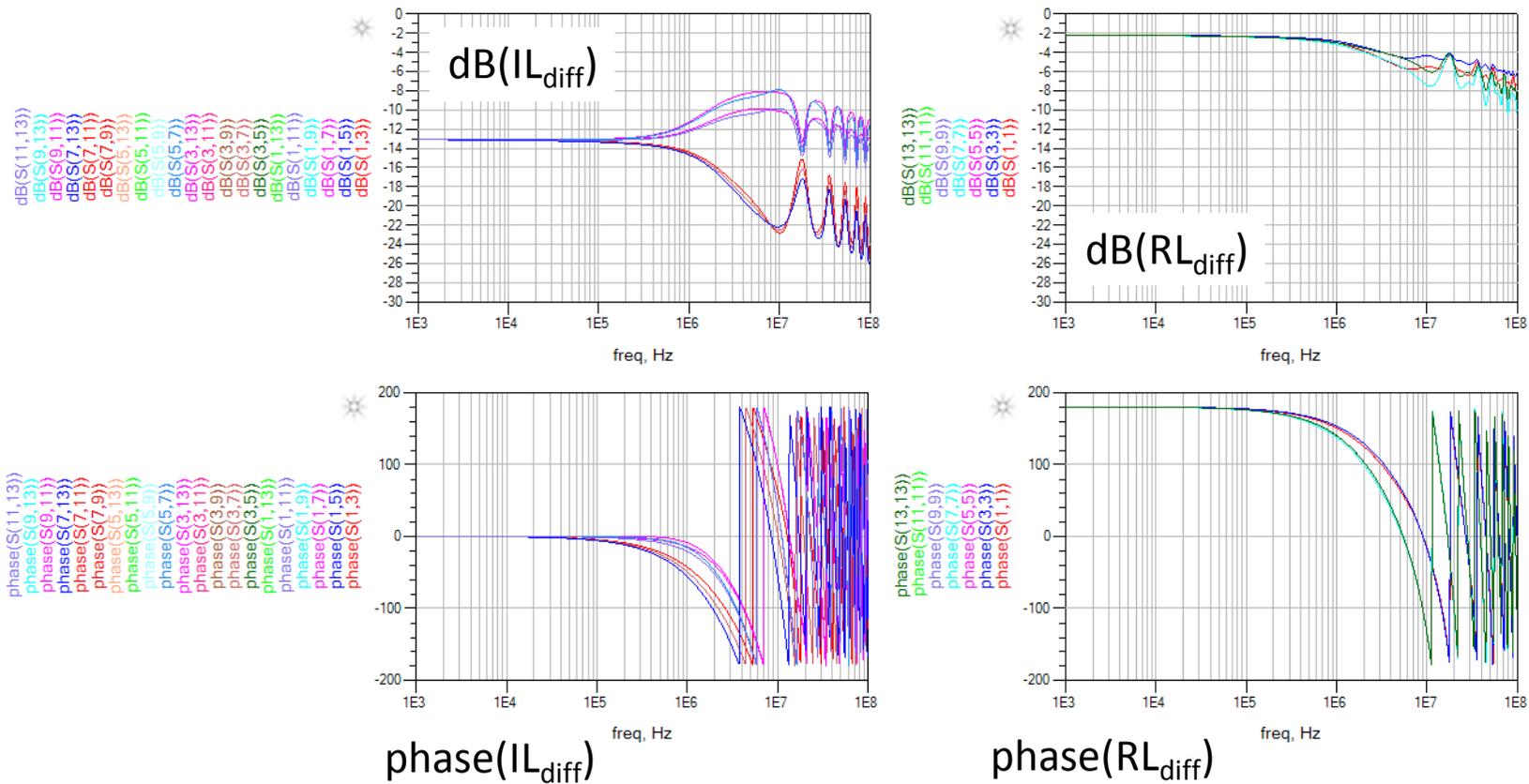
l1 to l6: [10...2500]mm  
 lstub1 and lstub5: [1...8000]mm  
 lstub2 to lstub4: [1...8000]mm

- Overall length is limited to 21m (2x8m+5m)
- Each stub is max. 8m

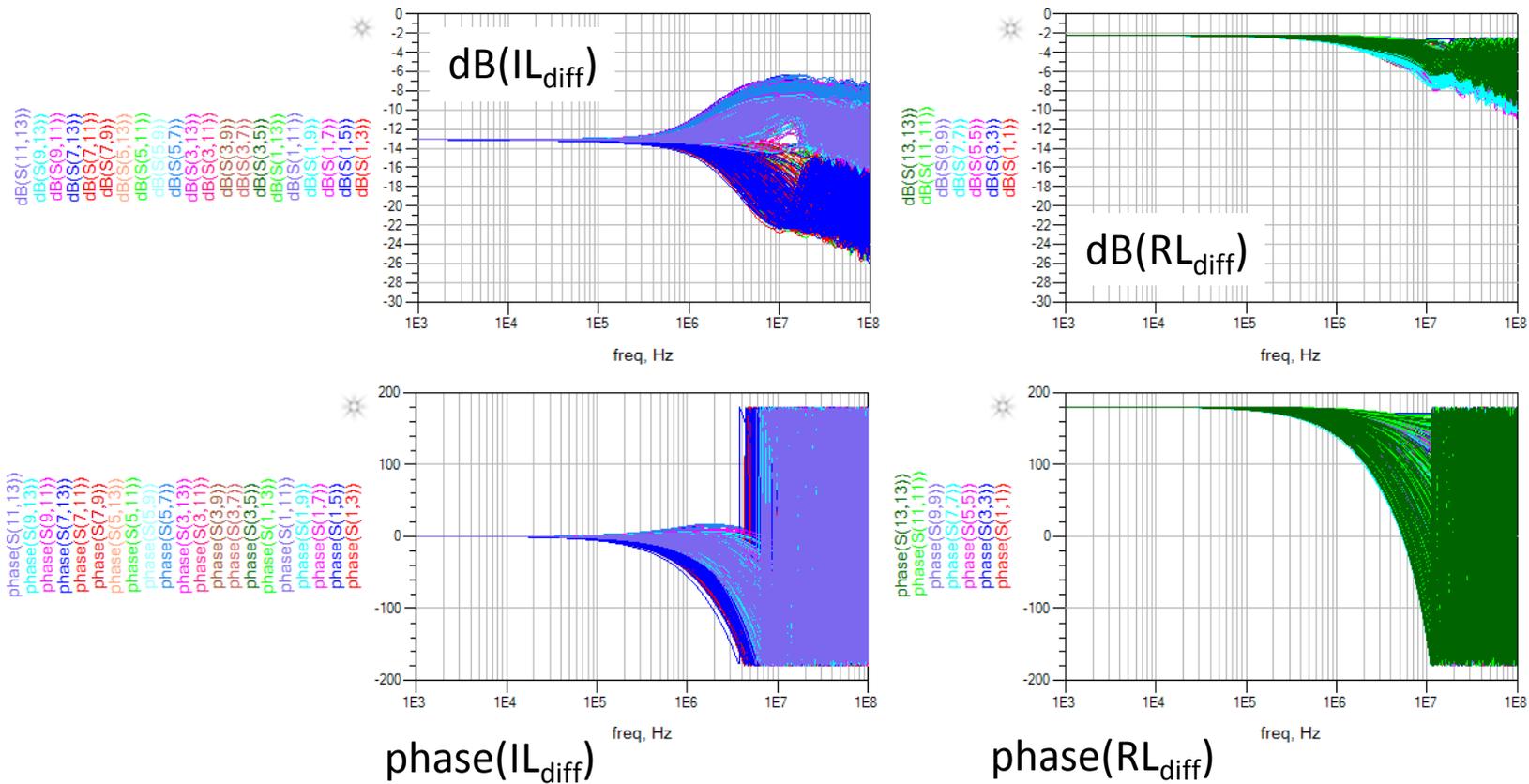
Each node is terminated with  $Z_d=100\Omega$  and  $Z_c=25\Omega$  in the simulation!



# Bus with 2 stars (max length)



# Bus with 2 stars (MonteCarlo)



# conclusion

- Methodology how to model channels has been provided.
    - Simulation terminations are  $Z_{\text{diff}}=100\Omega/Z_{\text{com}}=25\Omega$  (correlation to potential measurement setup) however real network terminations are potentially high impedance (which is preferred).
  - Various multi-drop channels and their characteristics have been shown.
  - Final channel requirements from automotive (max. length, max. nodes, max. stub length or max. # stars) have to be discussed/provided by automotive OEMs.
- This presentation shows exemplary topologies
- Potential further MonteCarlo elements (e.g. Impedance variations of topology elements) are not considered here
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