University of Zagreb

EMC Compo 2011

Raul Blečić

University of Zagreb

e-mail: raul.blecic@fer.hr

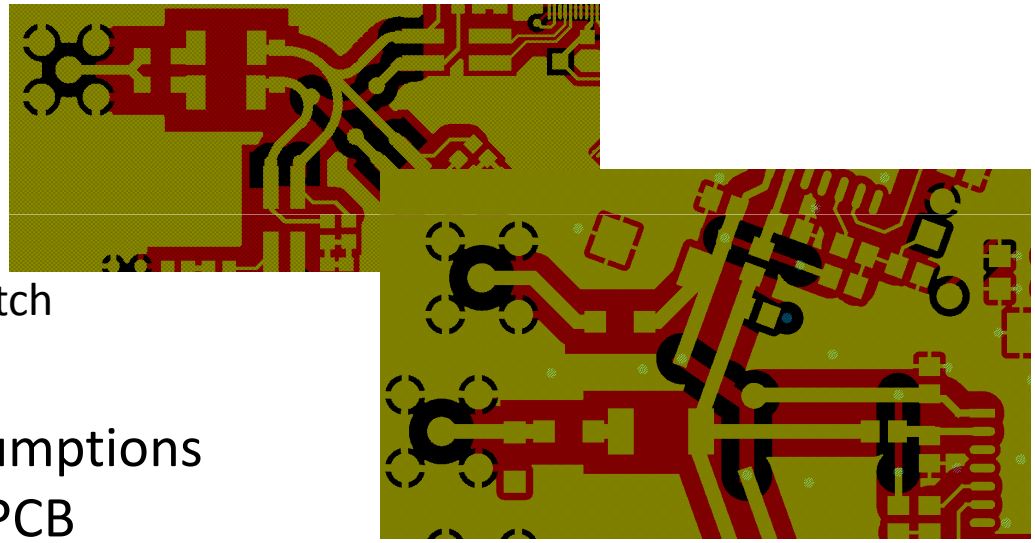
Full PCB circuit-electromagnetic simulations for high speed/RF applications

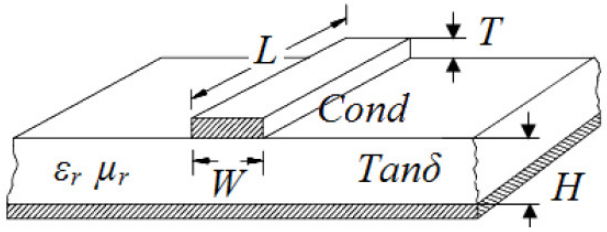
---

Industrial partner: On Semiconductor

Introduction

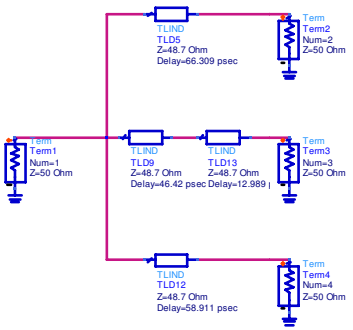
- Signal integrity and EMC are degraded in modern PCB designs because of the high operating frequencies and high density of the components present
  - Imperfect reference planes
  - Coupling
  - Bends and junctions
  - Transmission line width mismatch
  - Real passive components
- Transmission line theory assumptions are rarely satisfied on a real PCB
- Even if a PCB is designed for a lower frequencies, it still has to pass a test at 1 GHz

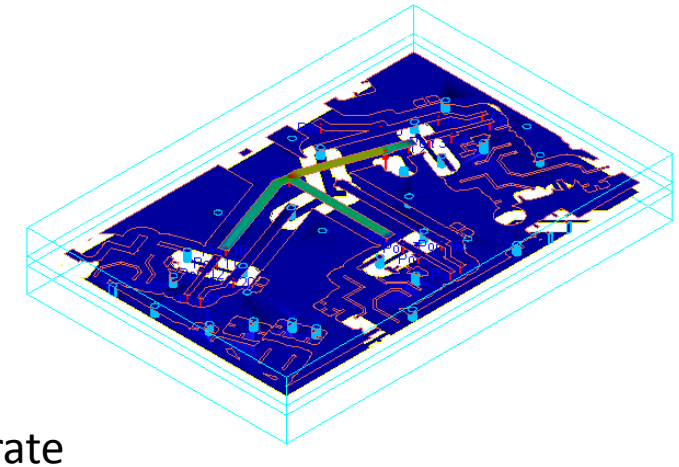




Objective

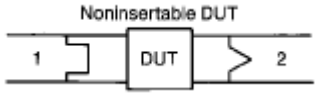
- Objective: full PCB simulations
  - Circuit simulators
    - Fast
    - But accurate only if the transmission line assumptions are valid
  - EM simulations
    - Mostly accurate
    - Slow
- Circuit vs EM simulators – what to choose?
  - Both…
- Circuit-EM co-simulation
  - Can be reasonably fast and also reasonably accurate
  - Issues like what to choose for a simulation domain in EM simulator?

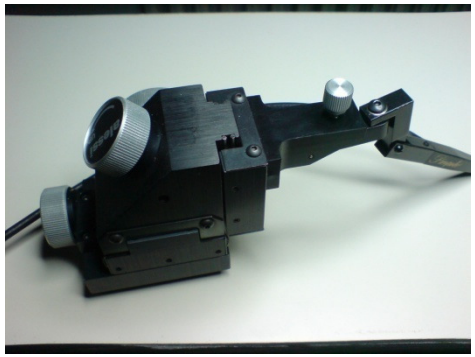




Current activities

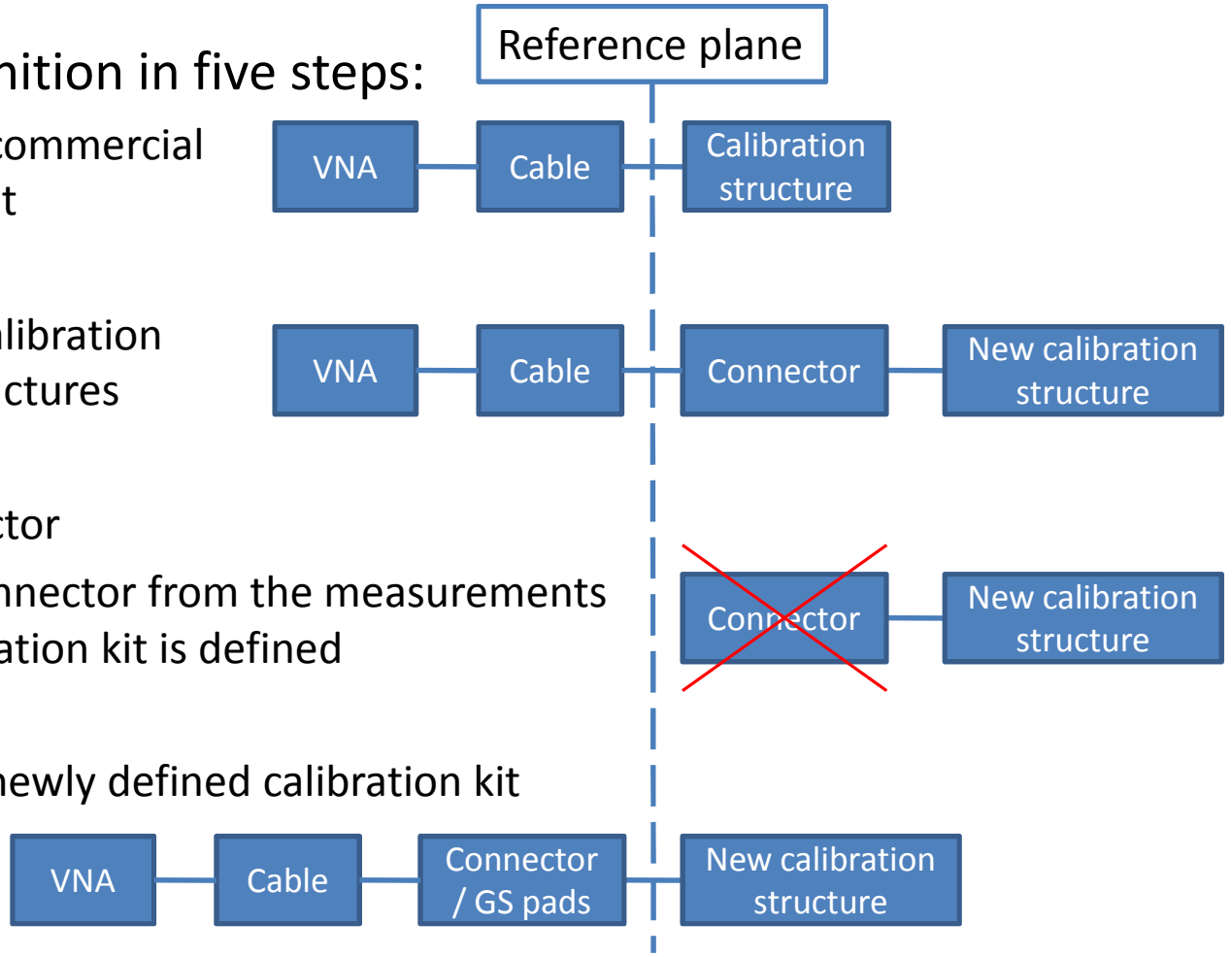
- Design of test cases for research, measuring and modelling
- Mixed-connector calibration
  - SMA coaxial connector on one port and ground-slot micro probe on the other port
  - Issue: how to define a thru?
  - Several techniques and methods exist: de-embedding, adapter removal, unknown thru
  - We have defined a calibration method for a mixed-connector environment as a hybrid between the in situ calibration and de-embedding method





Calibration PCB

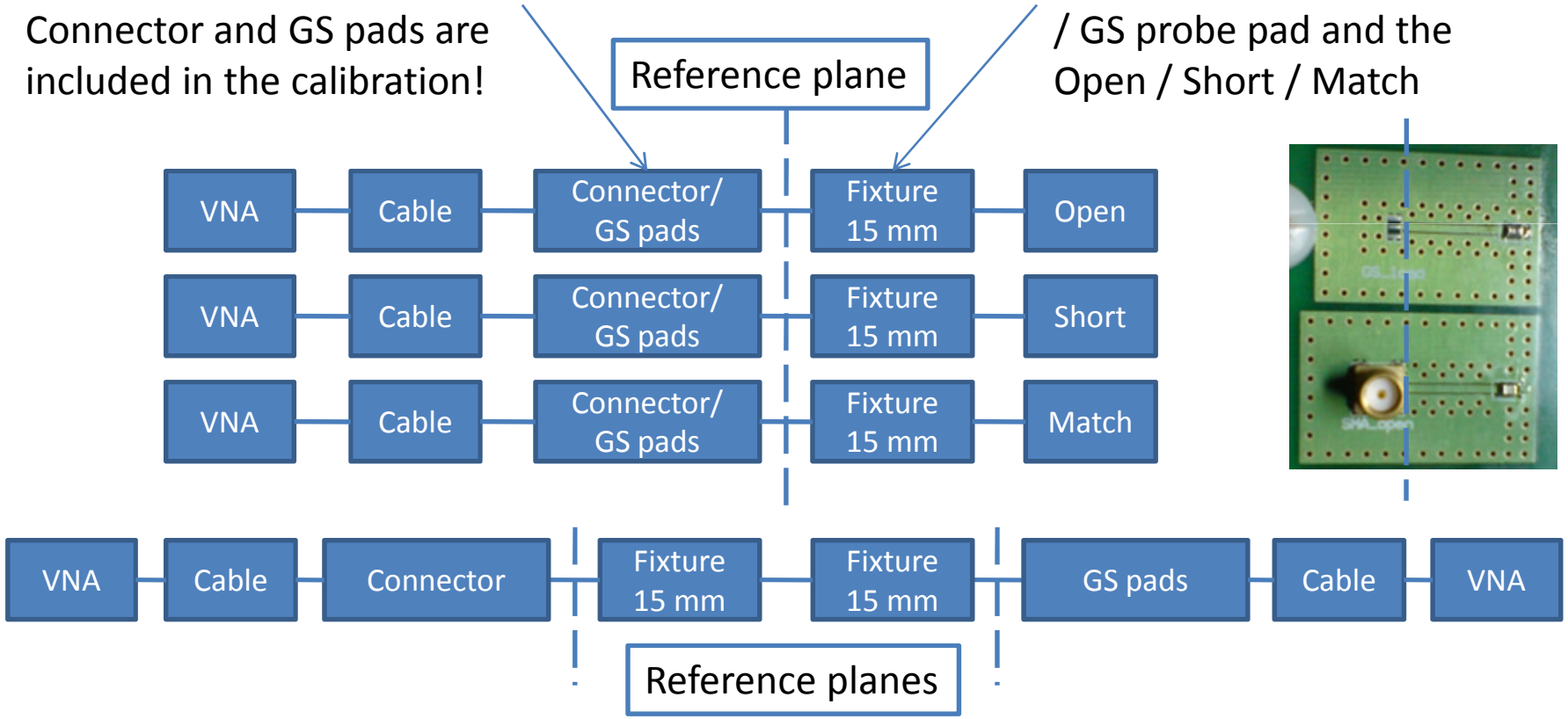
- Calibration kit definition in five steps:
  1) Calibrate using a commercial SMA calibration kit
  2) Measure a new calibration kit calibration structures
  3) Model the connector
  4) De-embed the connector from the measurements
     → The new calibration kit is defined
  5) Calibrate using a newly defined calibration kit



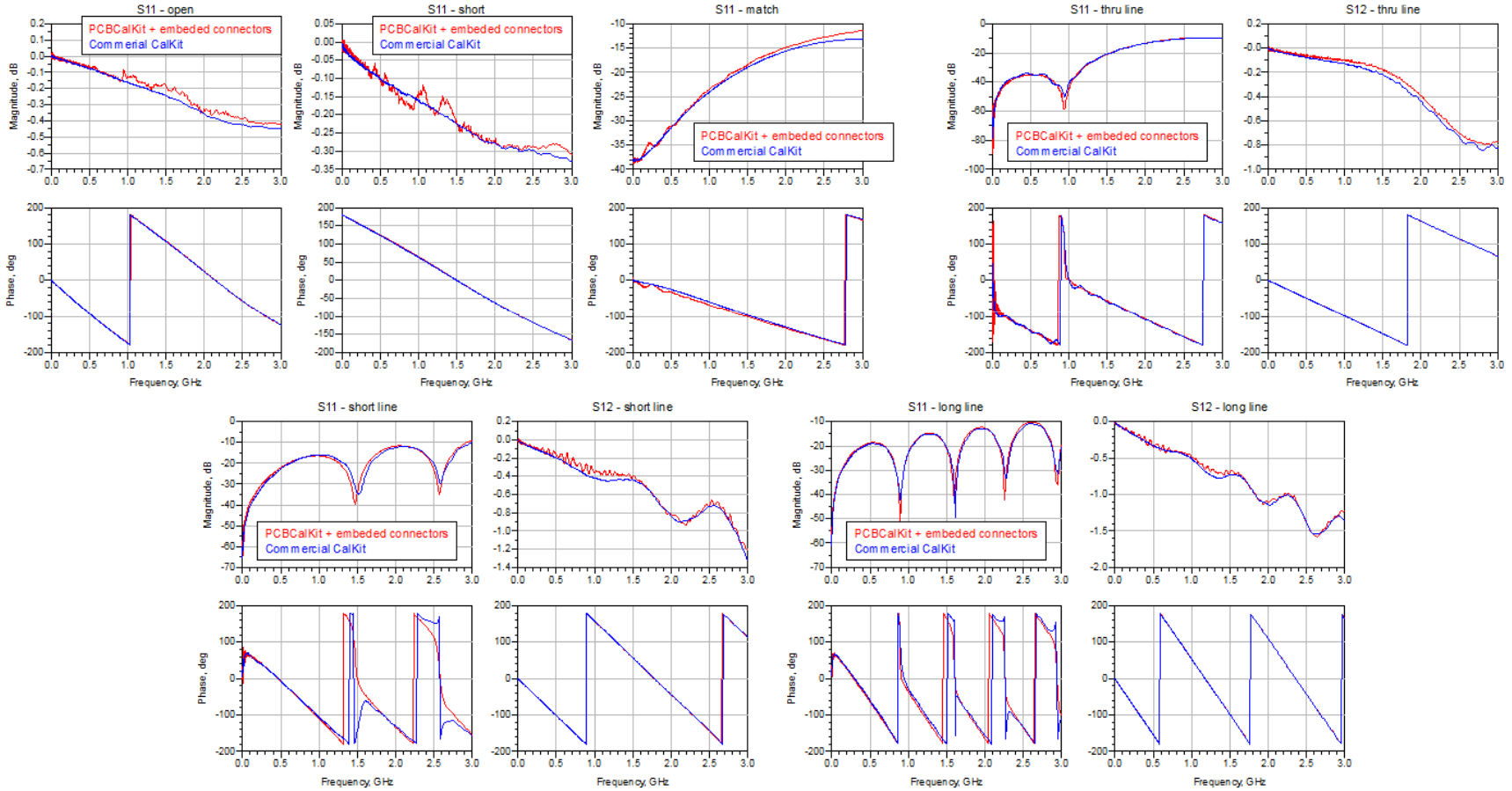
Calibration PCB

Main advantage over the commercial calibration kit: Connector and GS pads are included in the calibration!

Needs to be added to be able to connect the connector / GS probe pad and the Open / Short / Match

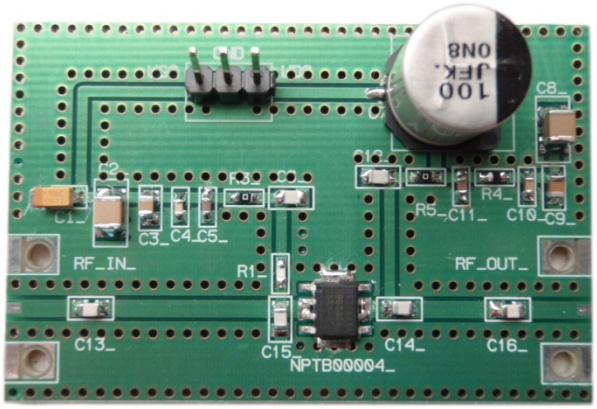


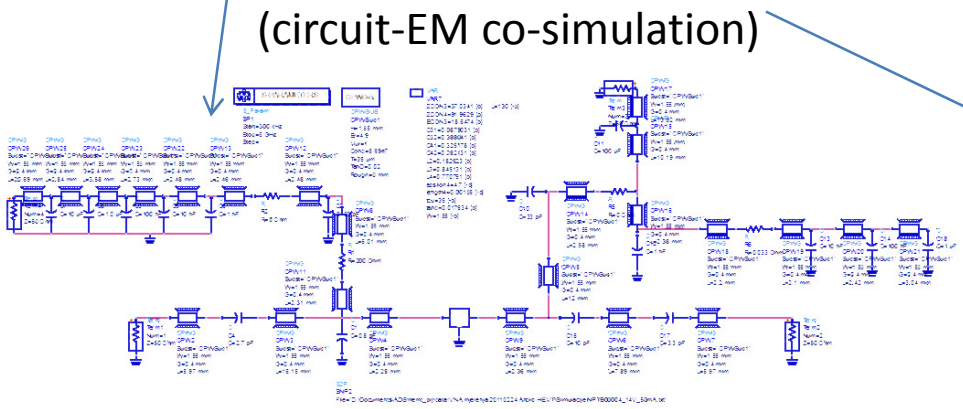
Results – Calibration PCB

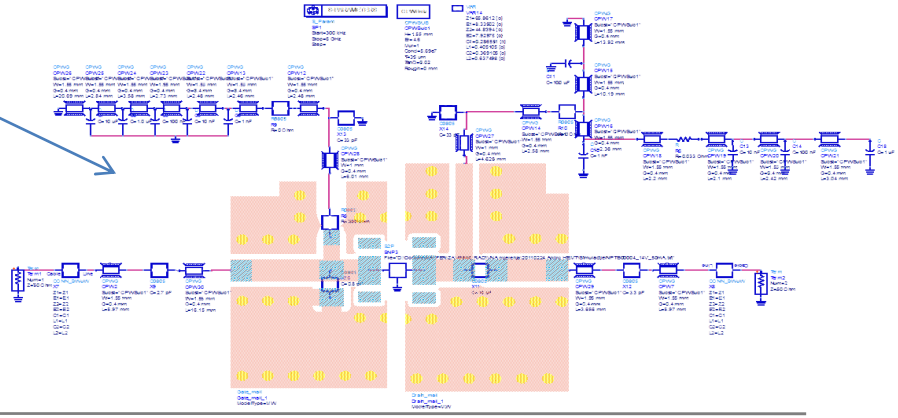


Amplifier test case

- A 2.5 GHz GaN HEMT amplifier has been simulated and compared to measurements to assess the accuracy of the simulations
- Simulations done:
  - Model 1: transmission lines and ideal components
  - Model 2: Model 1 + real component models
  - Model 3: Model 2 + connector models
  - Model 4: Model 3 + critical parts simulated in electro-magnetic simulator (circuit-EM co-simulation)

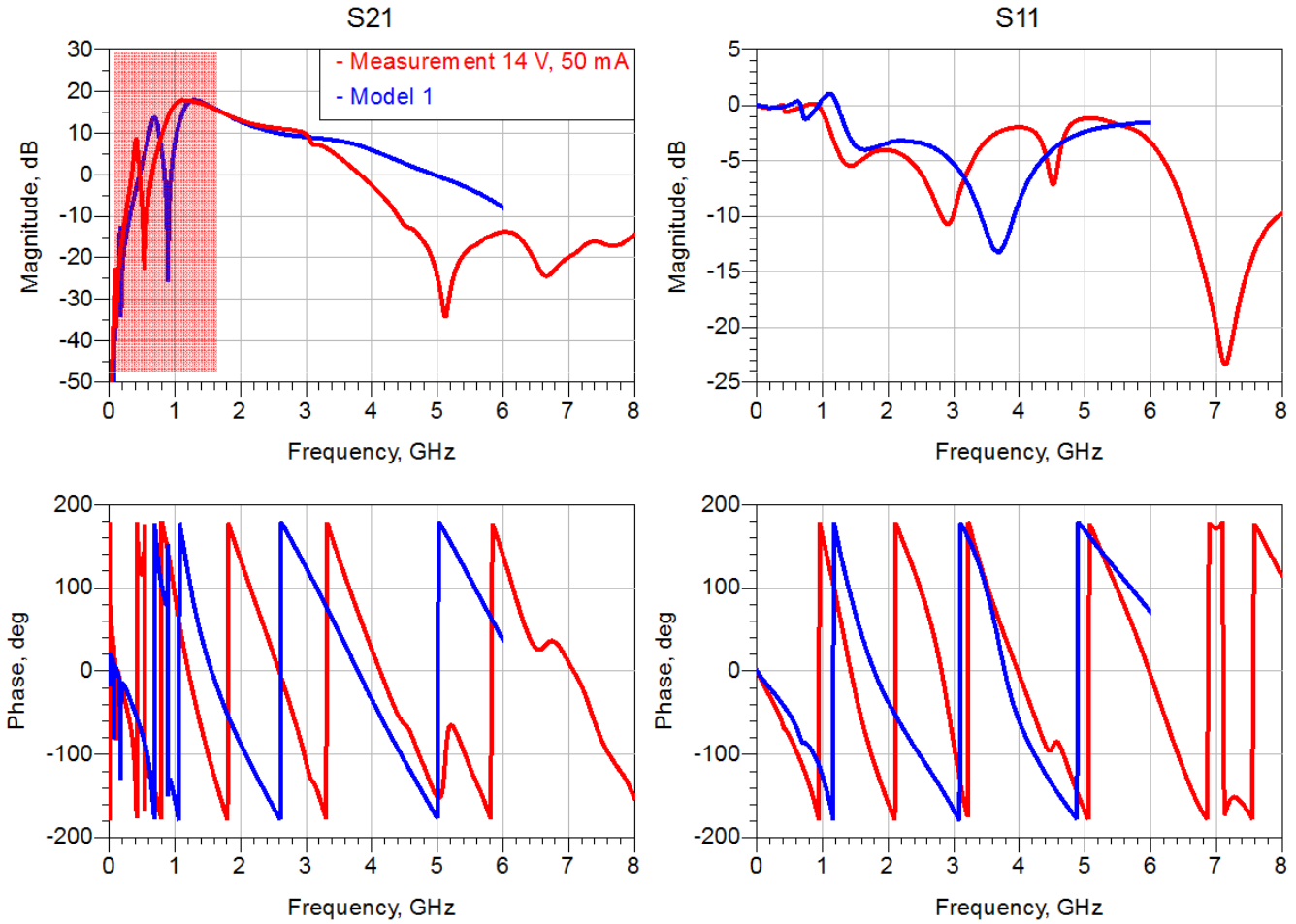






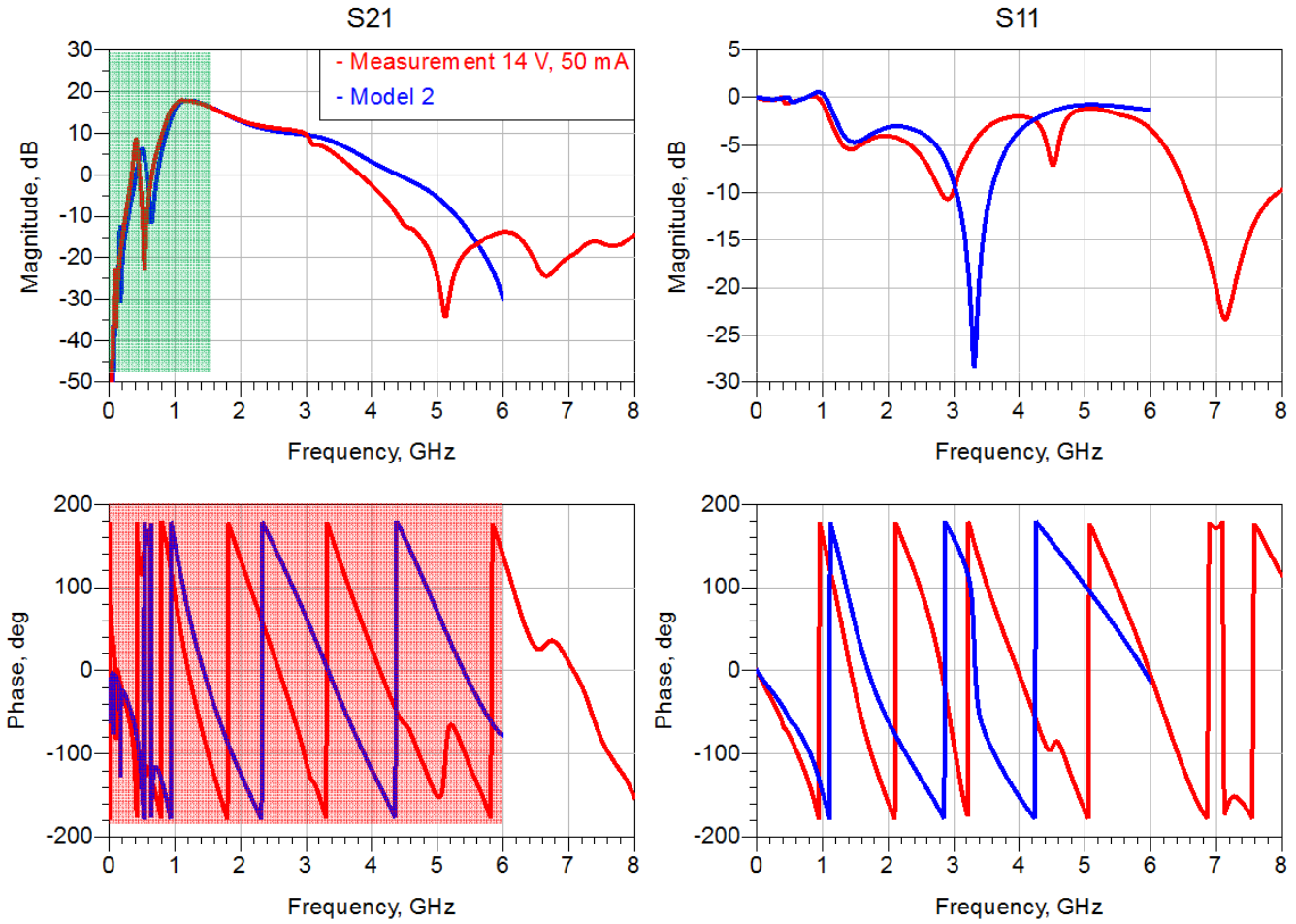
Results – model 1 vs measurements

Transmission lines and ideal passive components



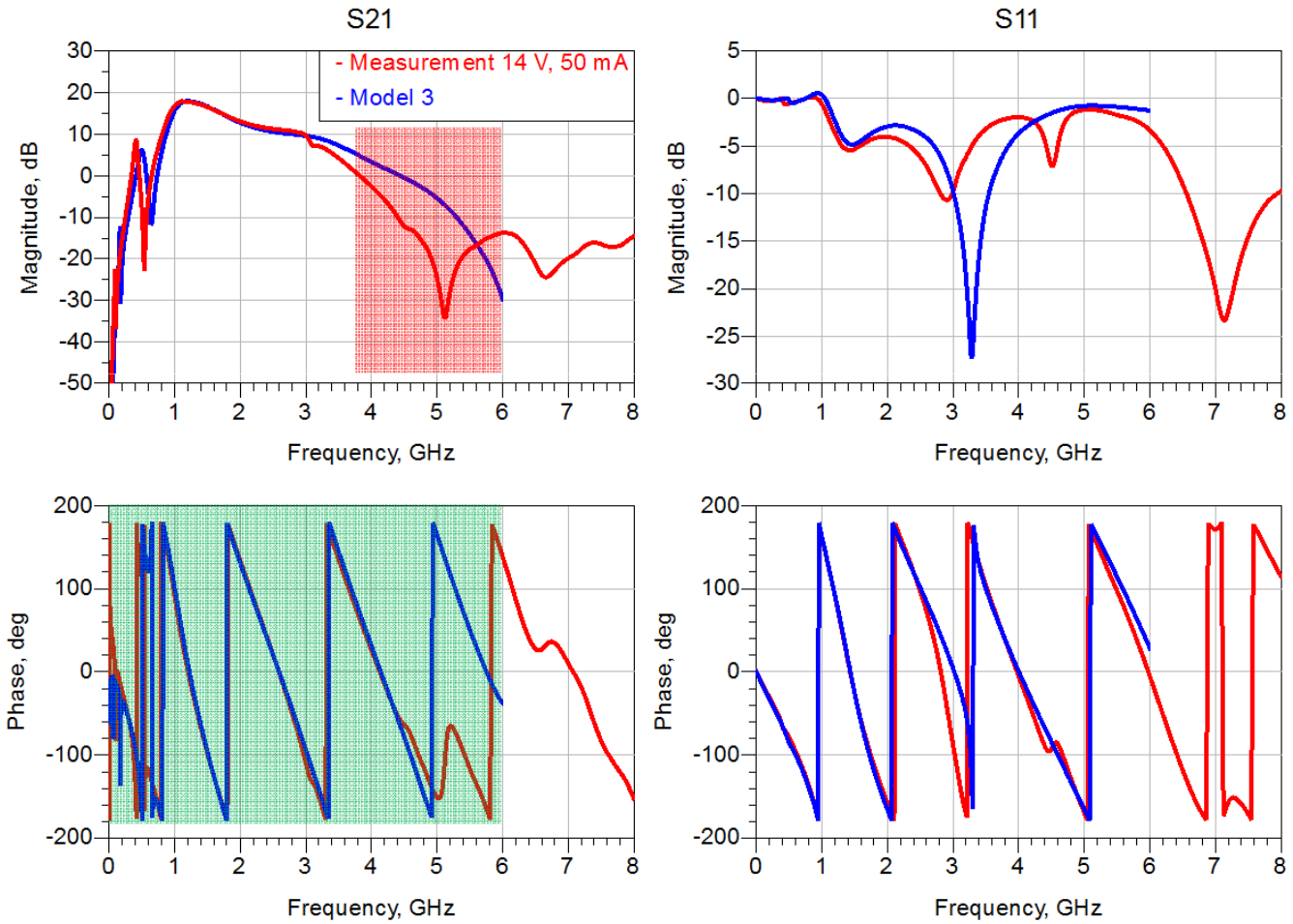
Results – model 2 vs measurements

Model 1 + real passive component models



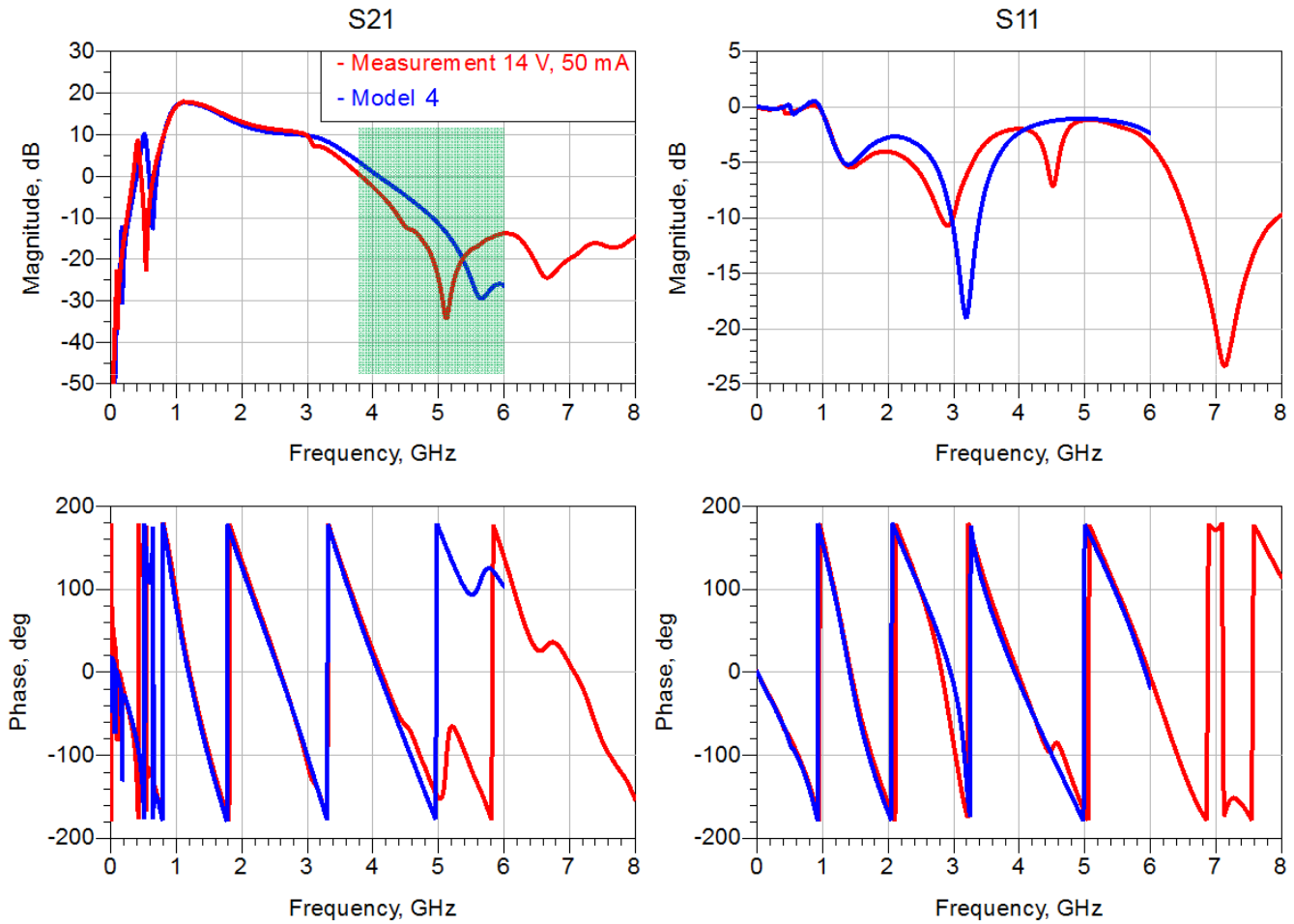
Results – model 3 vs measurements

Model 2 + connector models



Results – model 4 vs measurements

Circuit-EM co-simulation



Perspectives

- Still to do:
  - Measure several test cases on which we have been working on to validate the results of the circuit-EM co-simulation done so far
  - Compare the hybrid in situ / de-embedding calibration method with other mixed-connector calibrations
    - de-embedding method
    - unknown thru method
    - adapter removal method is not applicable for our test case
- The work shown here is a part of the project with On Semiconductor
  - Industrial environment
  - Real product PCB test cases
- A 1 year internship to KU Leuven is planned

Thank you for your attention…