The correlation of simulation to measurement for the Molex CAT 6 jack connector

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Molex Overview

- Second largest connector manufacturer in a $33 billion global marketplace
- 7.7% market share
- $2.5 billion in global sales
- 58 manufacturing facilities in 19 countries
- 26 development groups in 15 countries
- More than 100,000 products
- Over 25,000 employees

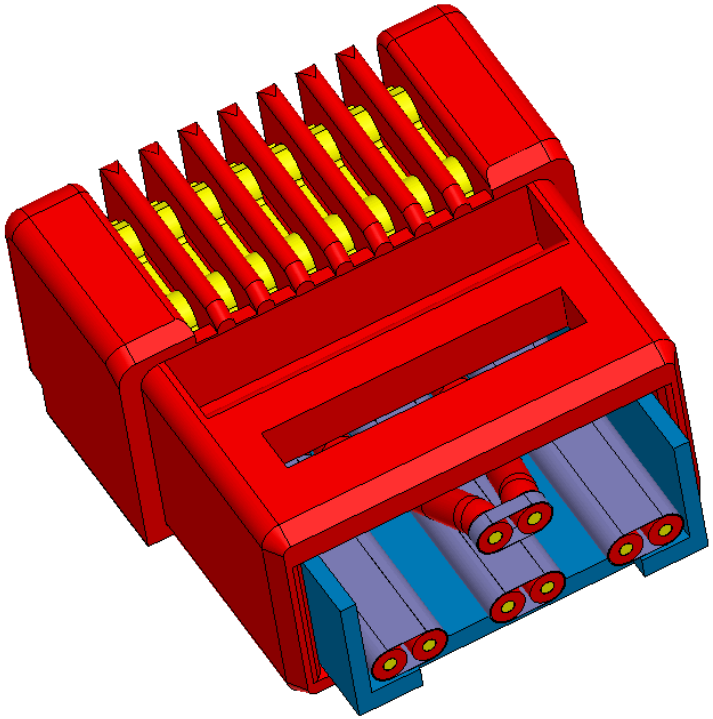
Project goals

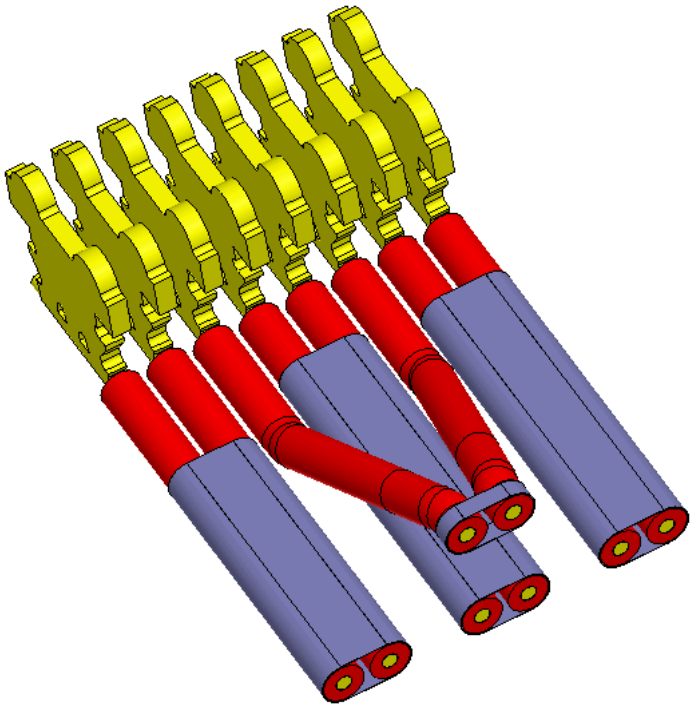
- To correlate measurement and simulation for the Molex CAT 6 Jack for Near End Crosstalk (NEXT) focusing on pair 3-6 to 4-5
- Create robust simulation methodology for current and future designs
- Reduce product design time
  - Computer system comparison

CAT 6 connector design

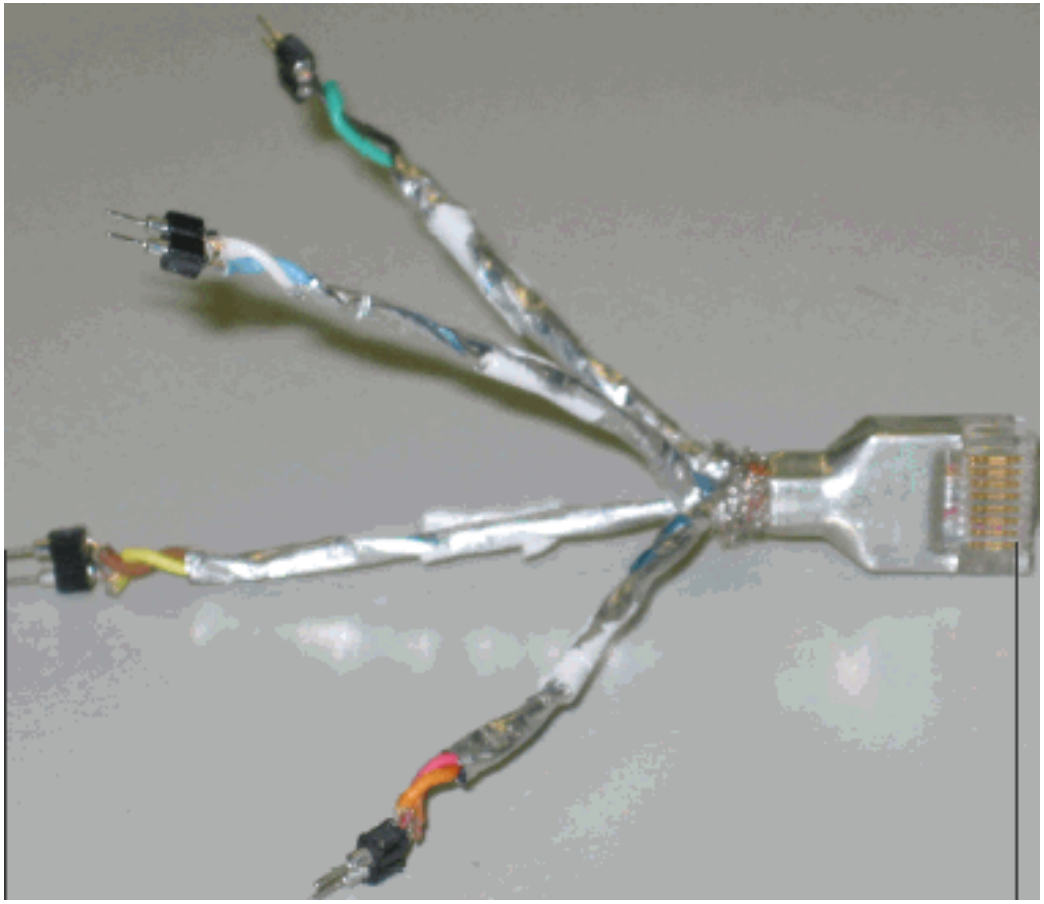
- 4 differential pairs
- Analysis from 20MHz to 1GHz
- Crosstalk control and compensation critical to meeting connector performance specification
- NEXT measured for mated plug and jack
- Current specification: 94-20log(f) dB up to 250MHz

Molex CAT 6 Plug

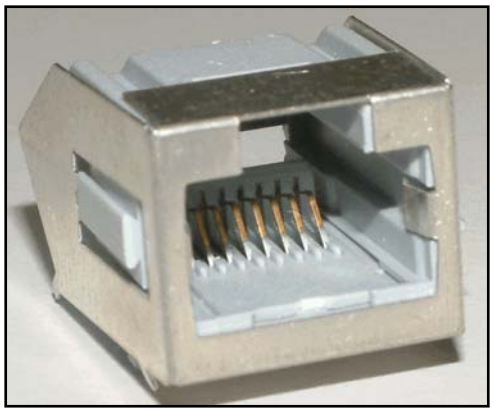


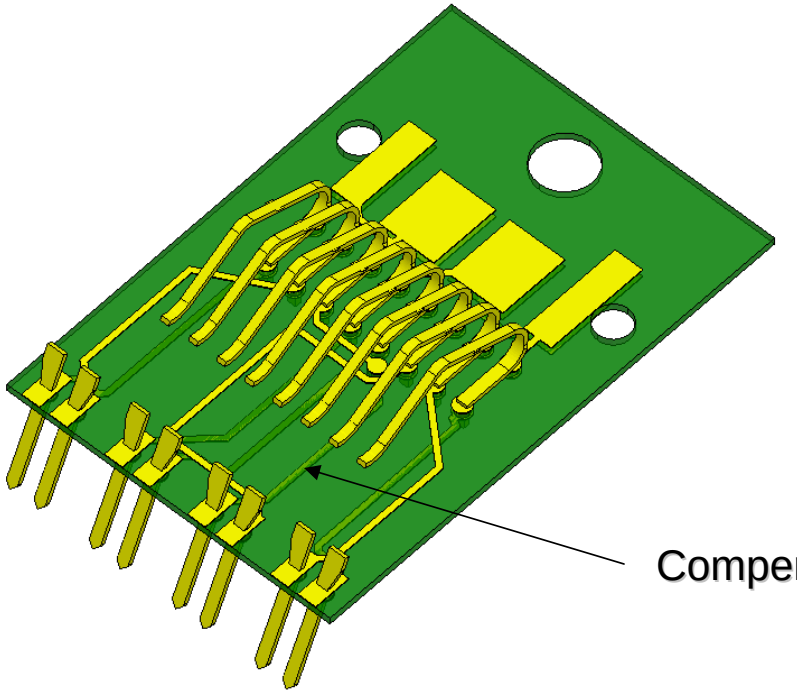


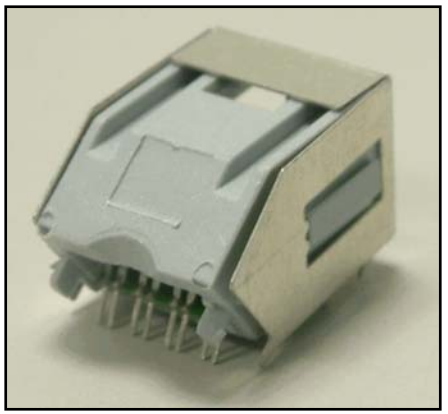
Actual plug used for measurements



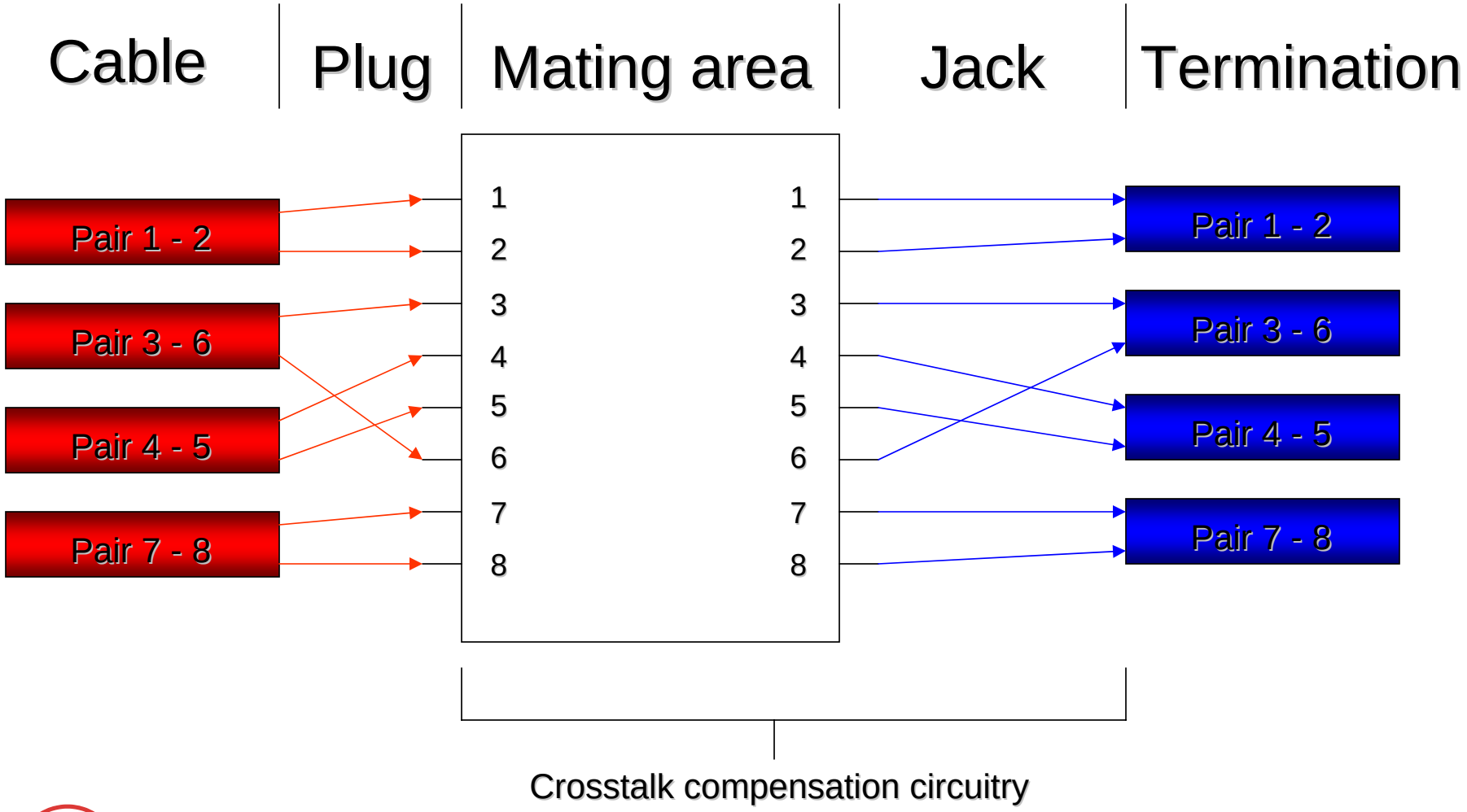
Molex CAT 6 Jack



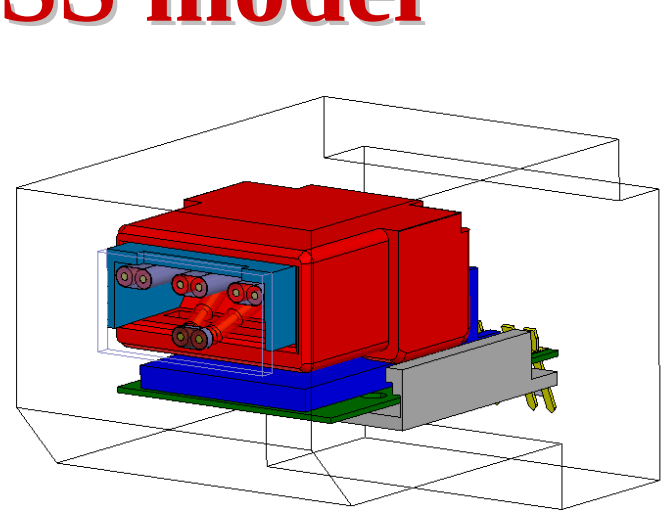


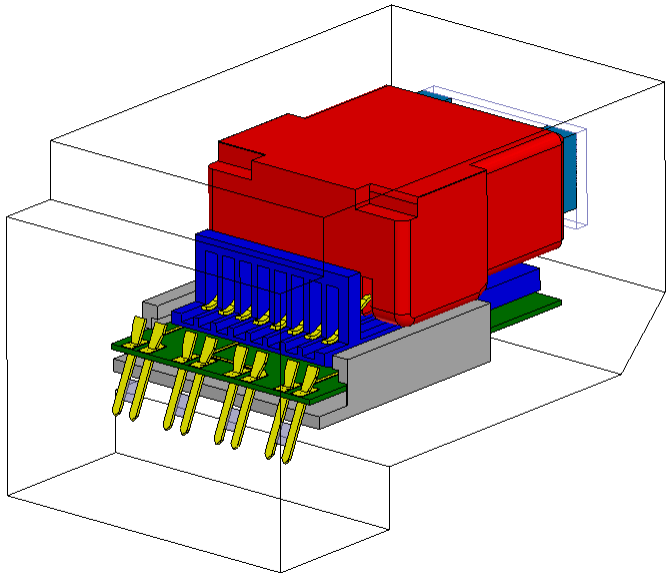


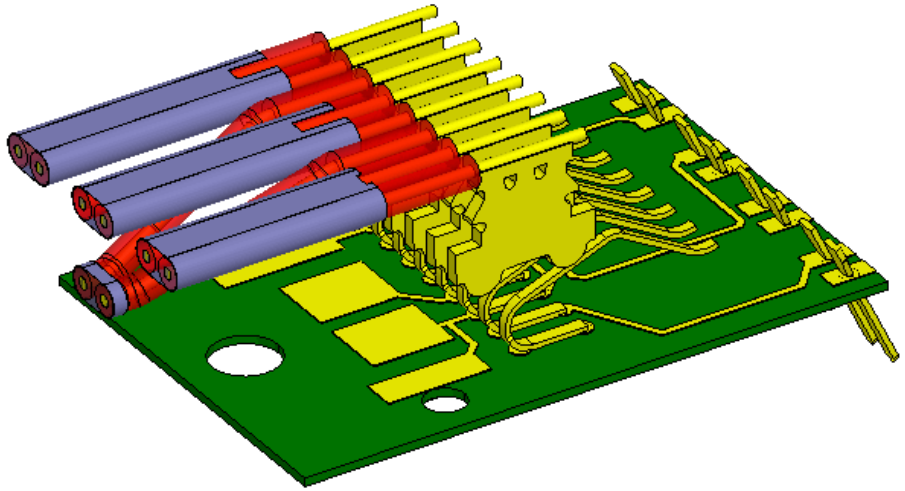
Mated connector pin layout



HFSS model







Measurement setup

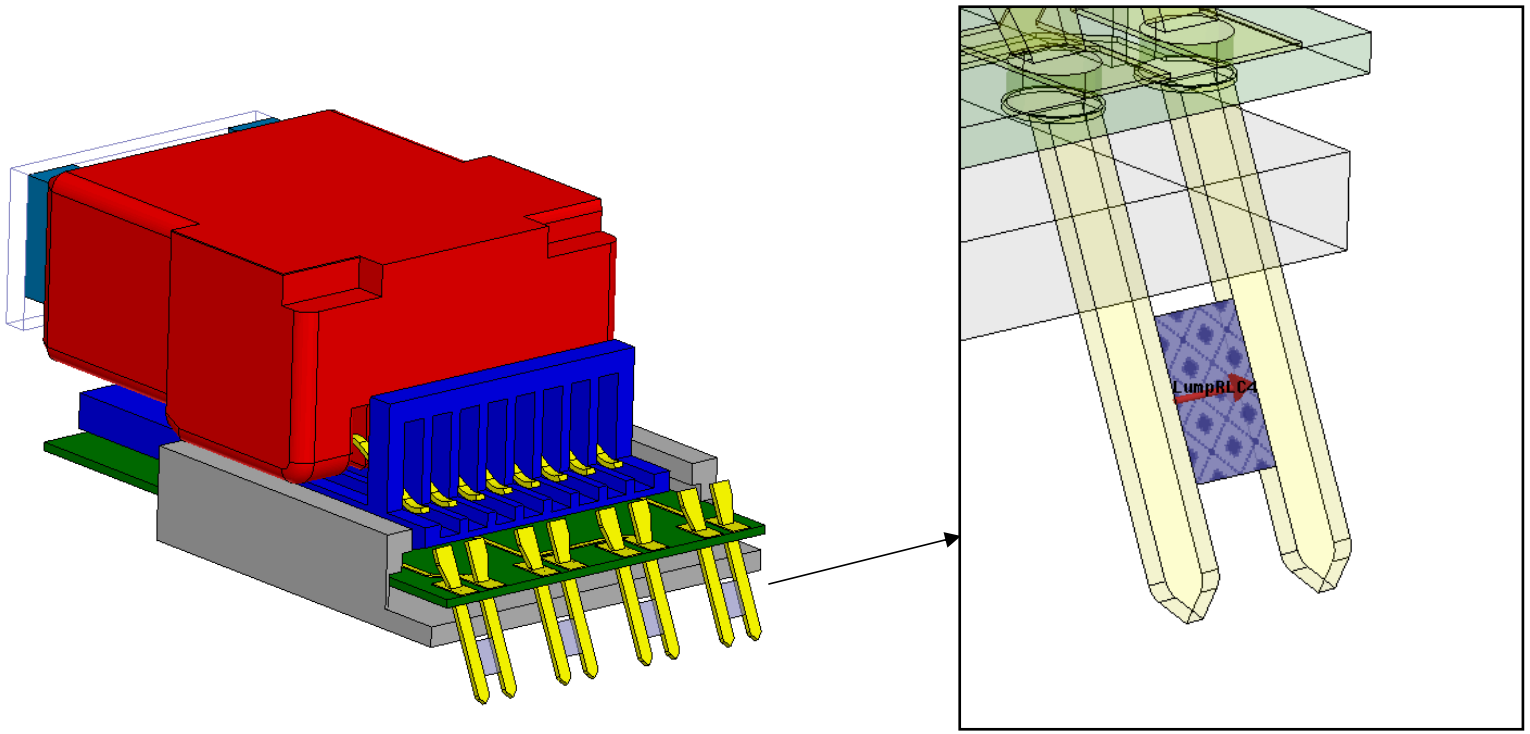
- All pairs terminated with 100Ω SMT resistors
- Measurements for NEXT as per IEC 60603-7-5
- Measurements taken for NEXT from 0 to 1GHz using a Network Analyser

Accurate 3D model creation

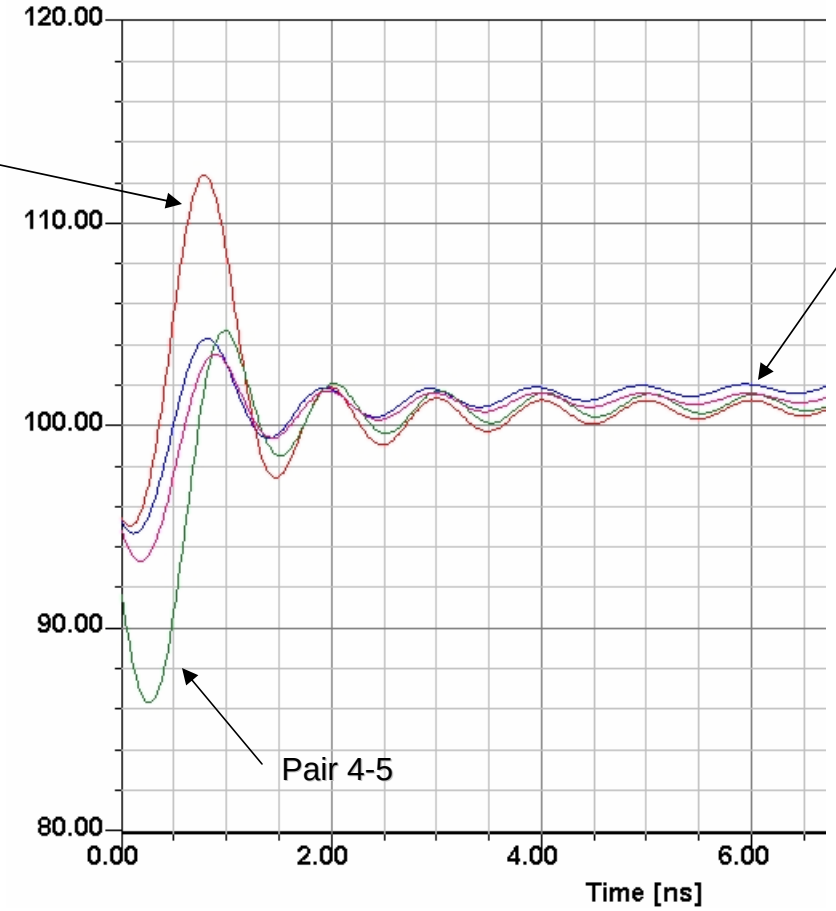
- 3D models direct from mechanical design were used
- 100Ω shielded differential cable simulated
- Jack termination method simulated
- Material data obtained from manufacturing
- Models imported using SAT format

Termination method

- 100Ω termination achieved using Lumped RLC boundaries to mimic SMT terminations



Mated connector impedance profile

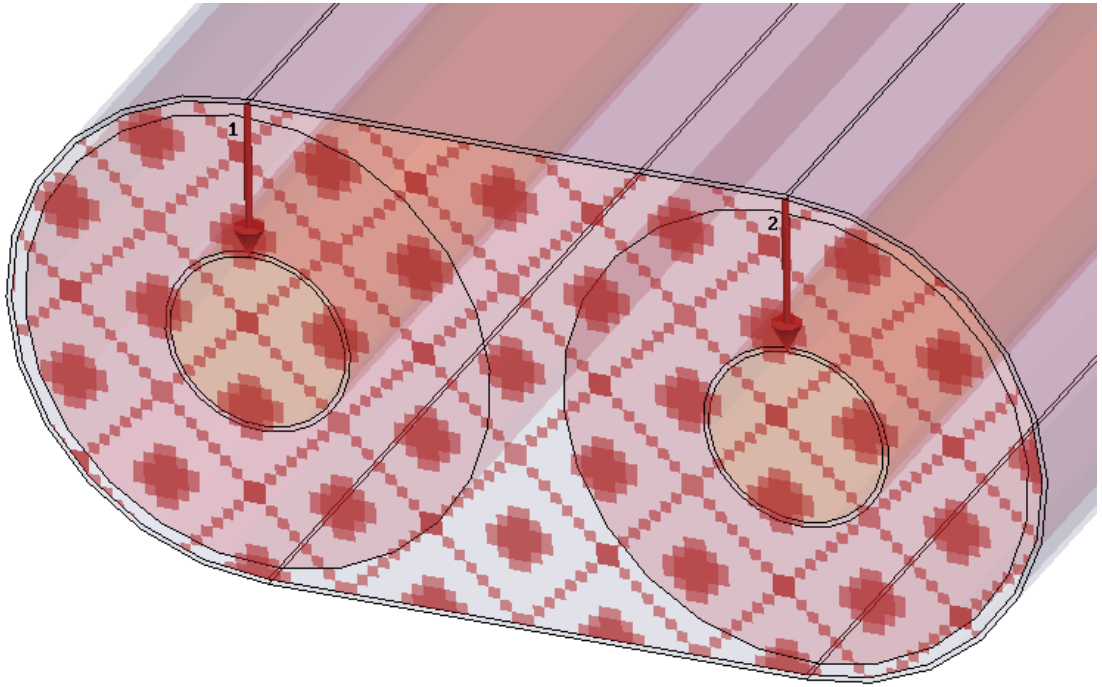


100 Ohm termination proving effective

The four differential pairs are acting in a physically realistic manner.

Waveport Setup

- Differential waveports setup on each shielded differential cable pair.



Other settings

- Model Resolution set to 0.015mm
- Surface Approximation set to 0.02mm surface deviation
- Radiation Boundary on Airbox

Adaptive & Freq sweep setup

- Adaptive solution frequency: 0.7GHz
- Low-order solution setup
  - Max delta S: 0.001
  - Max refinement per pass: 50%
  - Max number of passes: 7
  - Interpolating sweep 20MHz to 1GHz
- High-Order solution setup
  - Max delta S: 0.02
  - Max refinement per pass: 15%
  - Max number of passes: 40
  - Interpolating sweep 20MHz to 1GHz

Results

- NEXT comparison for pairs 3-6 to 4-5
  - Pair 3-6 – Aggressor
  - Pair 4-5 – Victim
- Low-Order Solution Profile
  - Number of Tetrahedra: 639,609
  - Solution Time: 3hrs:36mins
  - Max RAM used: 2.31GB
- High-Order Solution Profile
  - Number of Tetrahedra: 259,874
  - Solution Time: 4hrs:27mins
  - Max RAM used: 8.11GB

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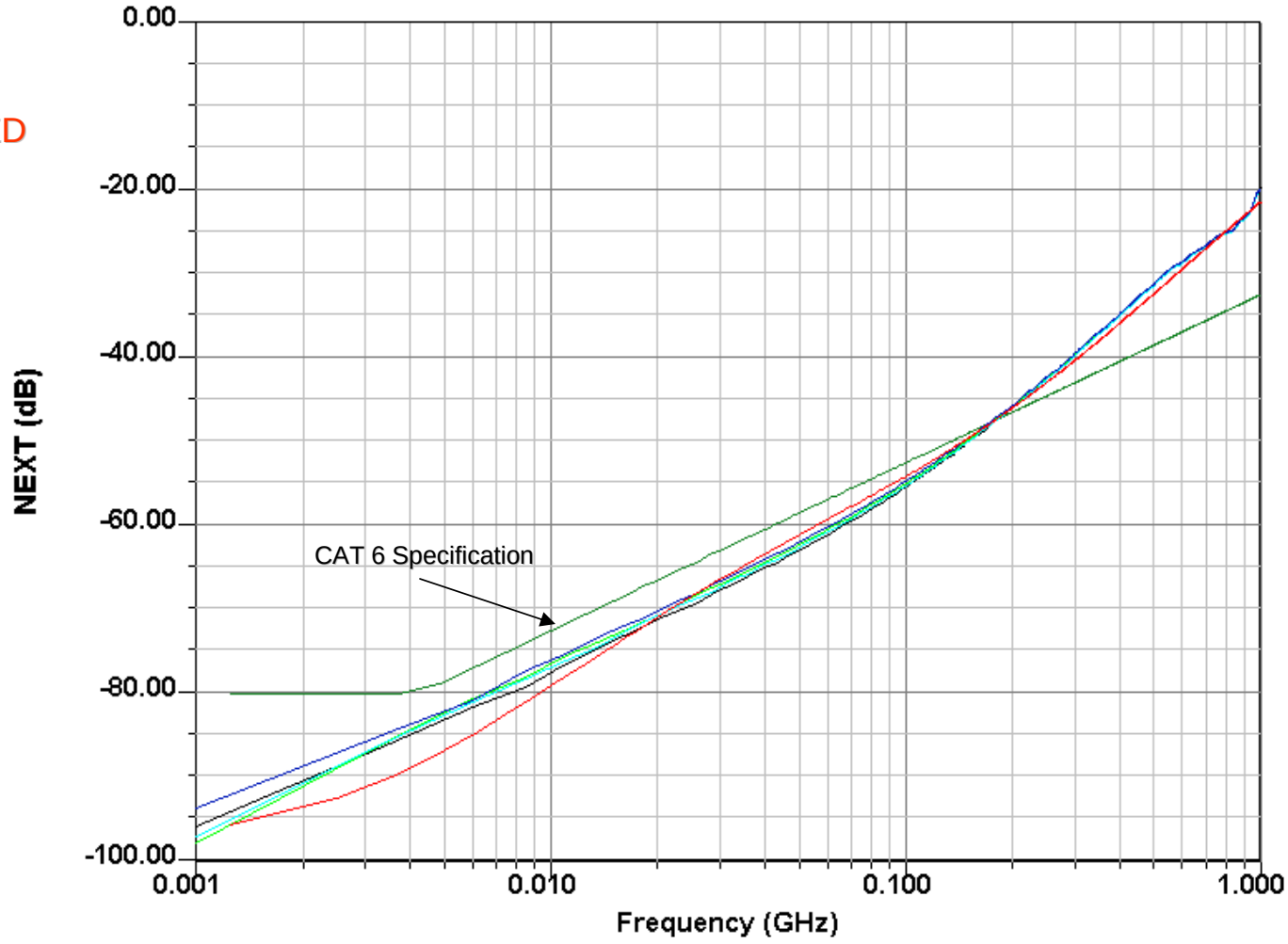
*All profiles quoted using System C

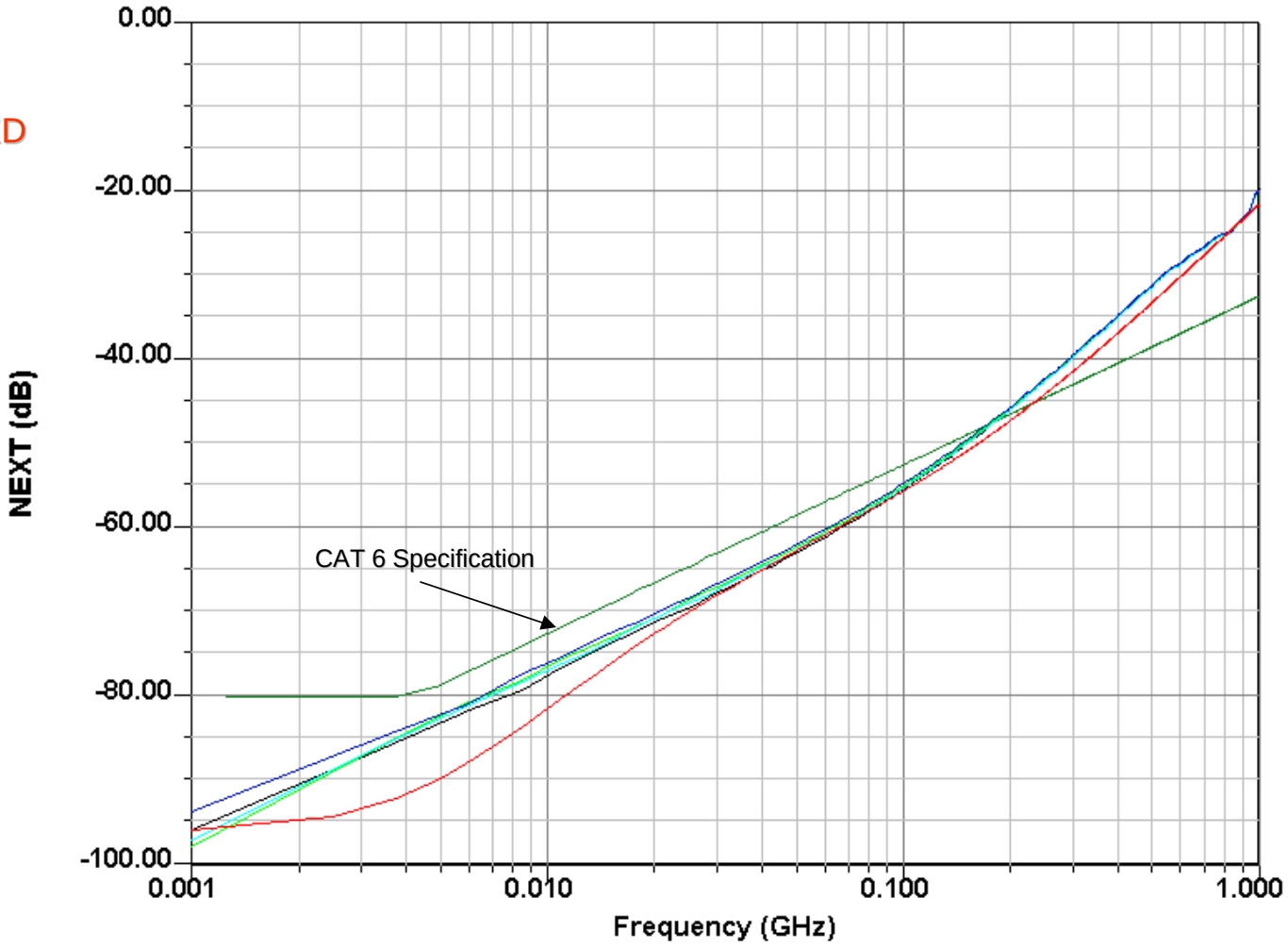
Low-Order versus measurement

Simulation in RED

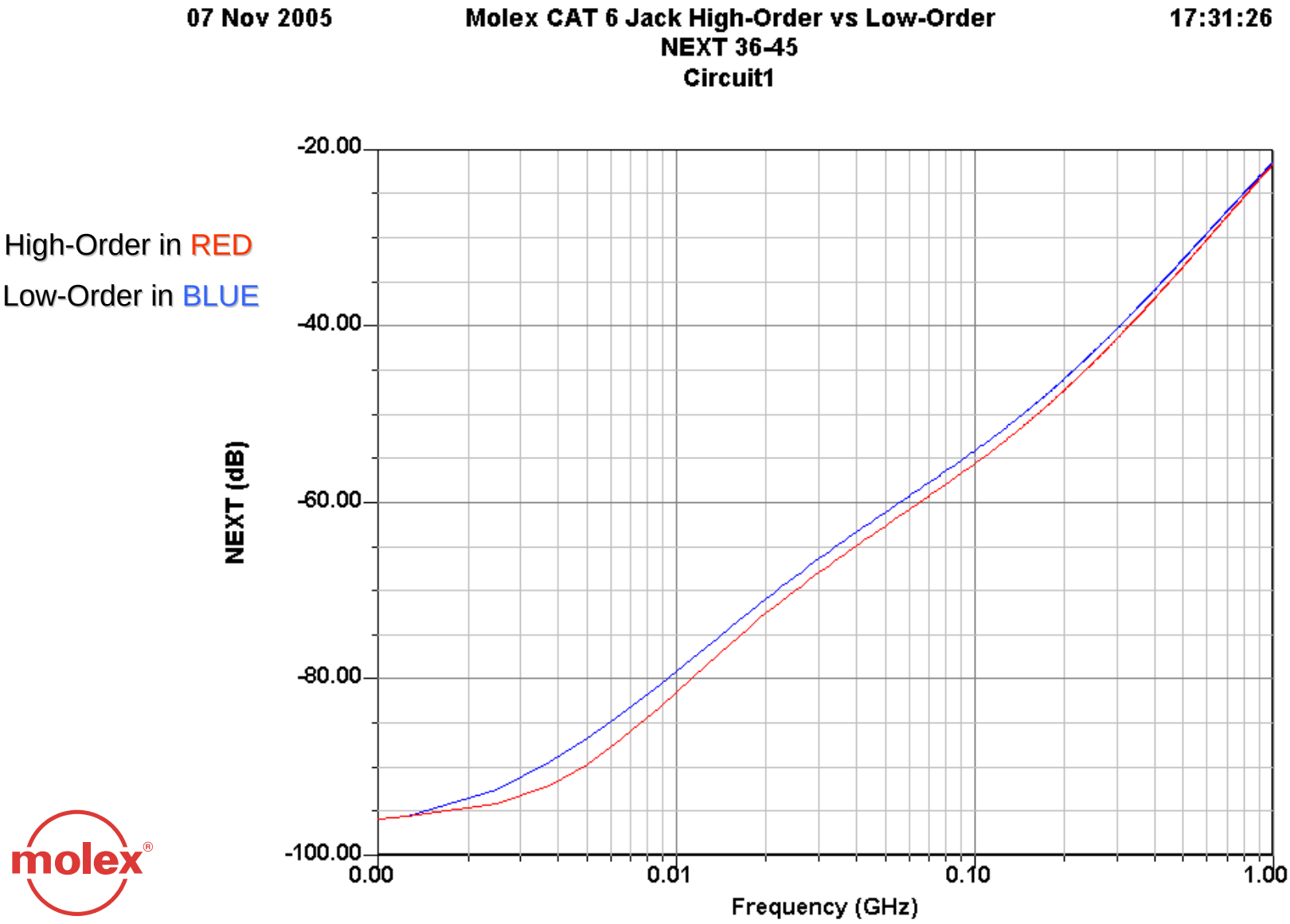


High-Order versus measurement

Simulation in RED



High-Order versus Low-Order



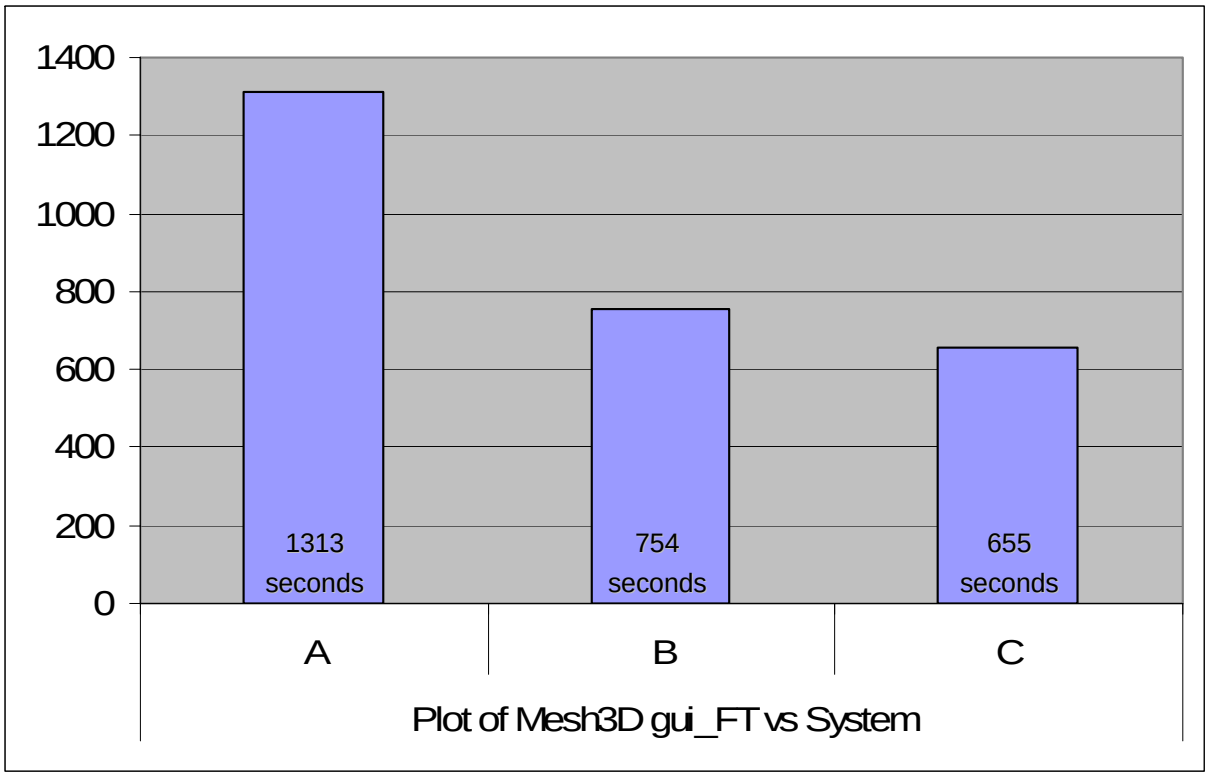
PC System Setup

- Comparison of solve time conducted with 3 computer systems
- Same HFSS model solved on each machine
- CSS and Mesh algorithms compared to view performance differences
- Multi-processor license used for CSS comparison
- HFSS V.10 used for all simulations
- 205,000 Tetrahedra in first pass
- Low-Order solution algorithm used

The systems

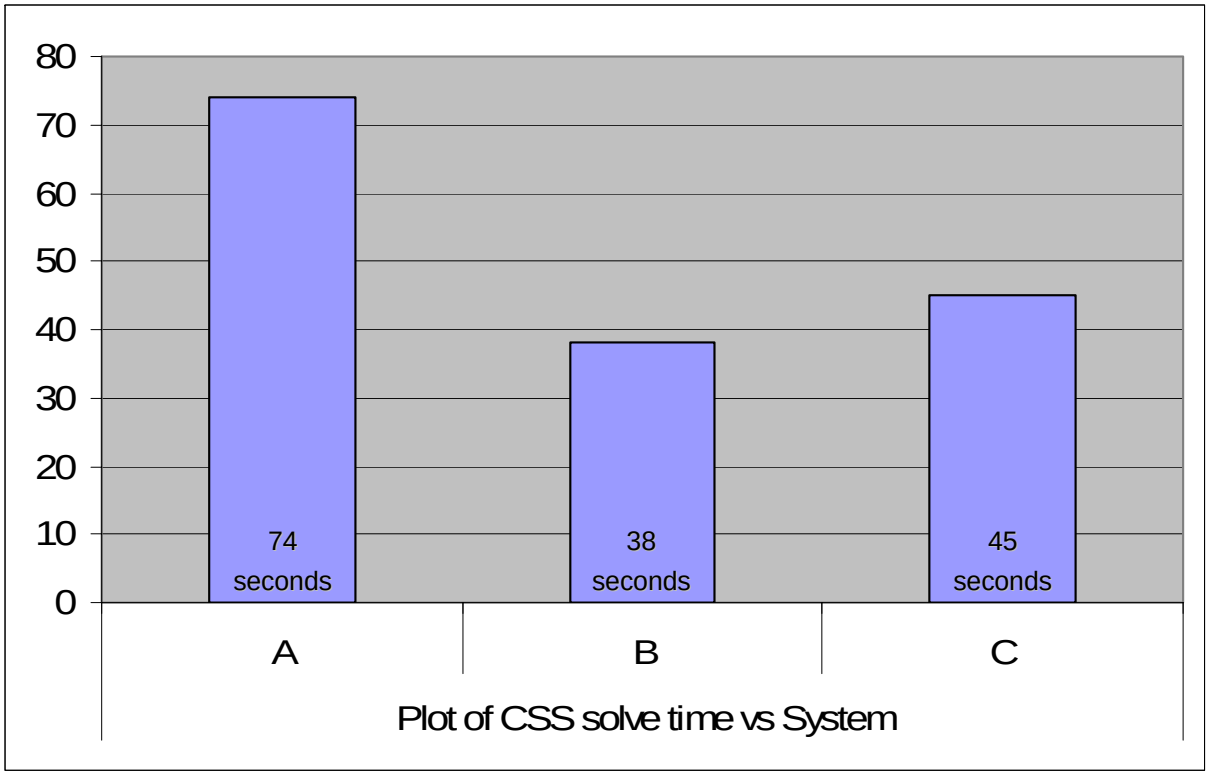
- System A
  - HP X4000 with 2 Xeon 2.2GHz processors
  - 4GB RAM
  - Win XP Pro
- System B
  - HP DL585 with 4 Opteron 846 processors (2GHz)
  - 32GB RAM
  - Win 2003 Adv. Server
- System C
  - HP XW9300 with 2 Opteron 250 processors (2.4GHz)
  - 16GB RAM
  - Win XP 64

Mesh time for each system



Time in seconds for first adaptive pass

CSS solve time for each system



Time in seconds for first adaptive pass

Questions?