Mark IV Project Report (2006-04-28)

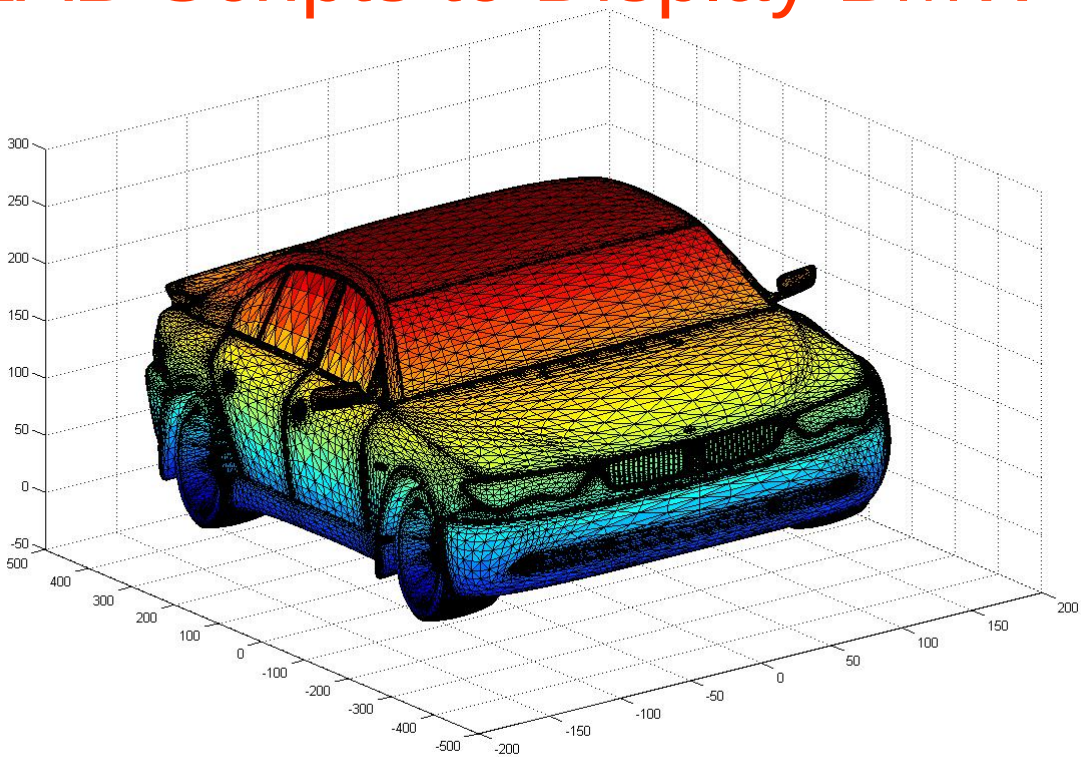
- Project supporter:
  - Mark IV Industries
- Project Leader:
  - Prof. Safavi Safavi-Naeini
  - Prof. Sujeet K. Chaudhuri
- Research Team:
  - Henghua Deng
  - Iraj Ehtezazi Alamdari
  - Gholamreza Zeinolabedin Rafi
- Research Period:
  - Jan. 2006 to Apr. 2006, University of Waterloo.

Progress Overview

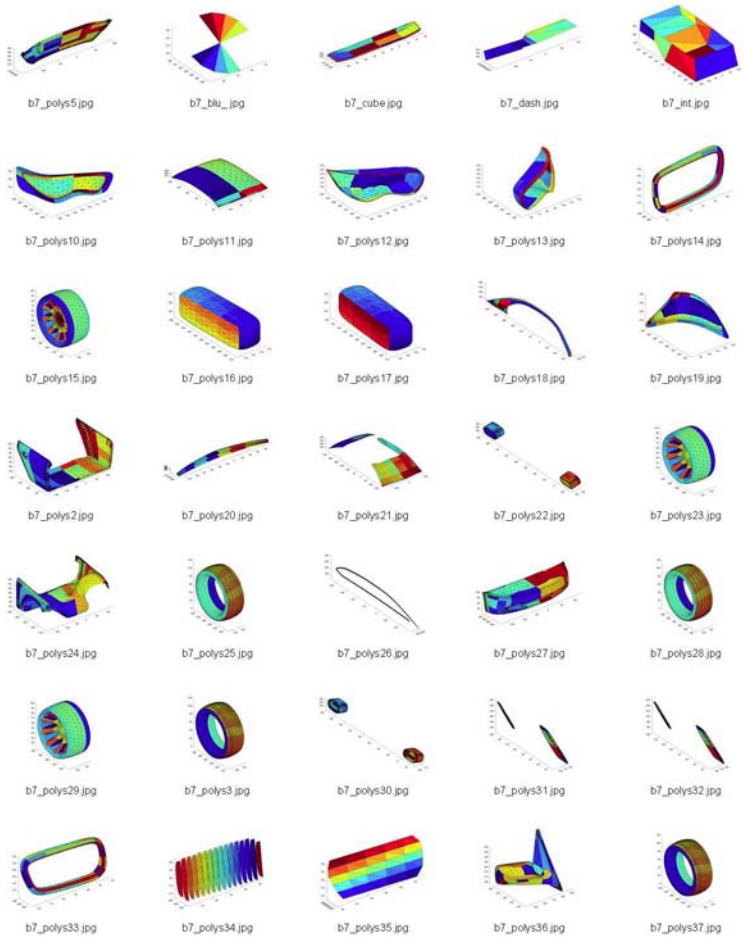
- Preparatory Work & Literature Review
  - Software Operation (HFSS, FEKO, FEMLAB, AutoCAD)
  - Ray Tracing (Thesis & Code by Ying Wang)
- Car Model Analysis
  - AutoCAD .dxf model analysis with MATLAB
  - Spartial Corp's ACIS .sat model (Ansoft 3D Modeller .sm3) with HFSS
  - To be done:
    - Stereolithography format (.stl) with CST MWS
- Antenna Inside A Car: Initial Results

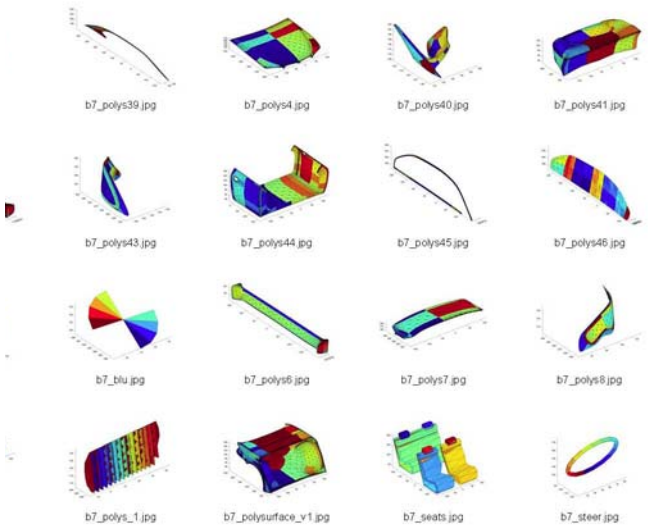
Car Model Analysis (MATLAB)

- Autodesk *.dxf format (ASCII & Binary)
- MATLAB Scripts to Display BMW 7 Car



Model Analysis and Simplification



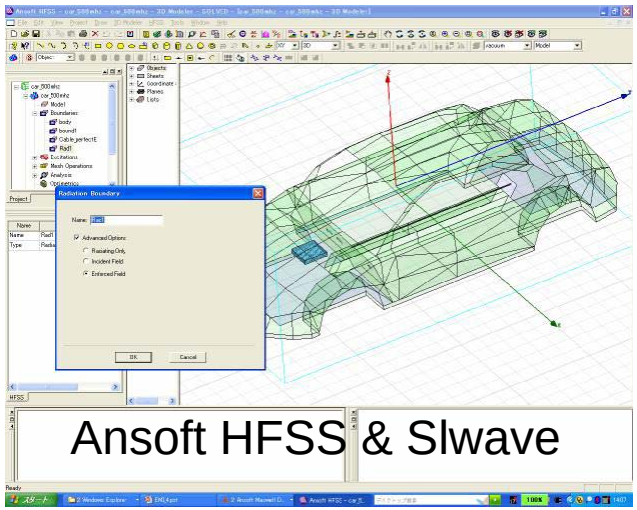


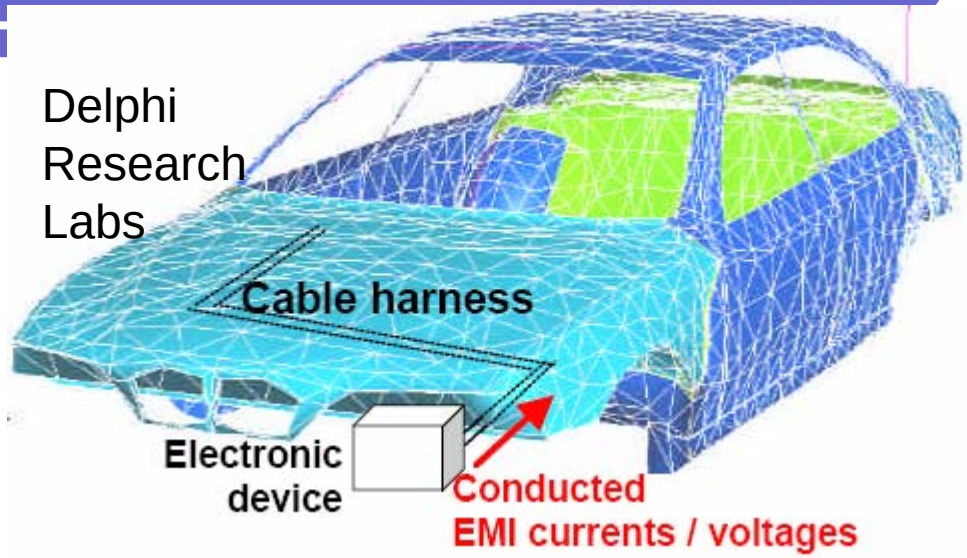
- After extracting each part of the car

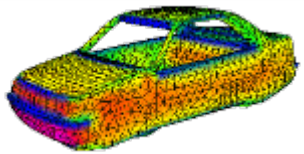
Effort to Import into HFSS & FEKO

- Importing not work for any .dxf version of the car model
  - Ansoft HFSS
    - HFSS 10 → only import this .dxf file as a long list of parameters. No geometry is drawn.
    - HFSS 9 → Failed.
    - Ansoft Support → my guess is that the objects are not closed to form solids so the software is unable to resolve the lines into solid objects.
  - FEKO (*EM Software & Systems-S.A. (Pty) Ltd*)
    - FEKO Support → Not all *.dxf files can be imported into FEKO. *.dxf file must comply with release 12, and should contain meshed or closed polylines surfaces and lines. (From)
    - →Suggest to use ACIS *.sat file,

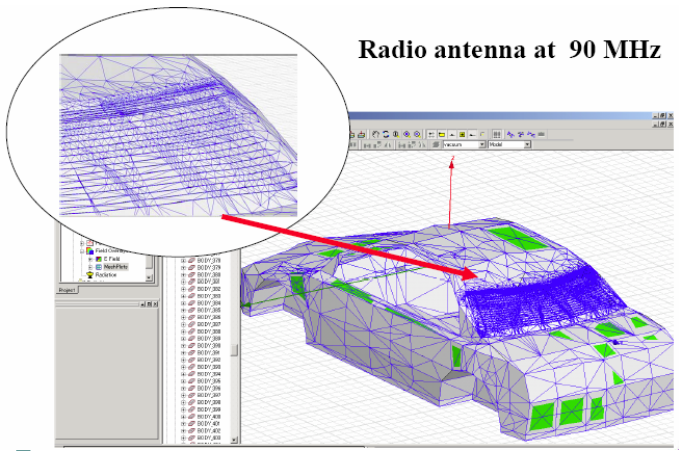
ACIS .sat format Car Models







ESI Group's
PAM-CEM Software

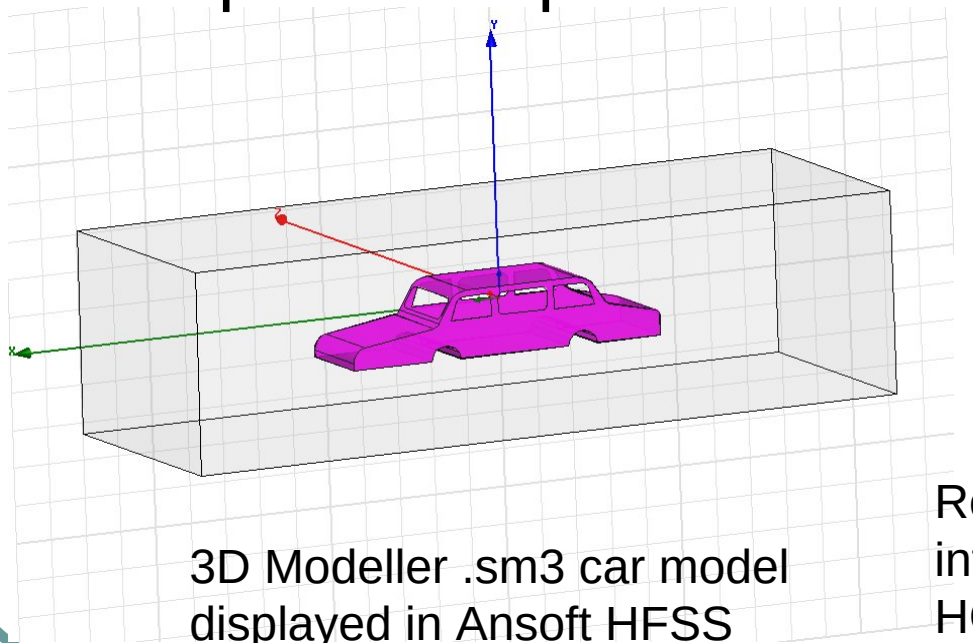


Ansoft HFSS

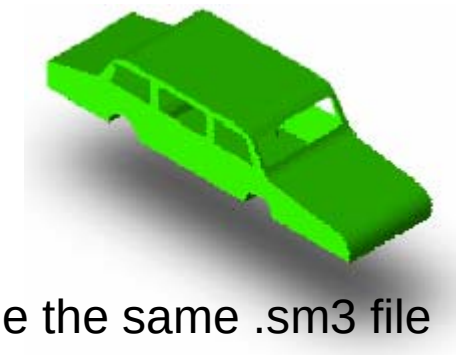
- Ansoft Support → The car designs in the presentation are generated using utilities by the car designers and then exported to DXF and STEP formats to be read into the Ansoft software. The designs are proprietary and Ansoft does not have them available for sale.

Ansoft 3D Modeller .sm3 Car Model

- With both text editor and free ACIS file viewer, we find that Ansoft 3D modeller files .sm3 are generated exactly according to Spatial Corp's ACIS .sat file format.



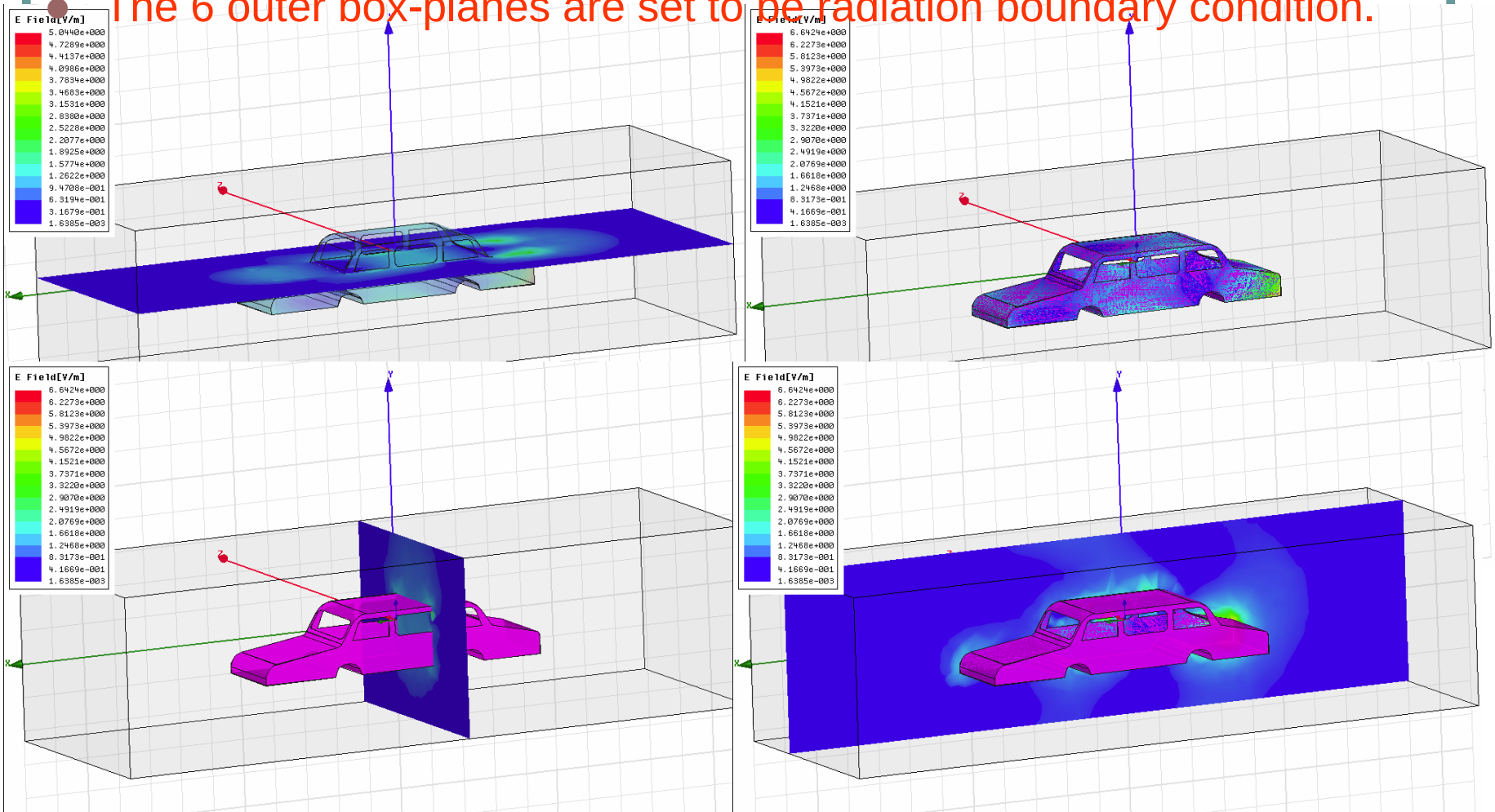
3D Modeller .sm3 car model displayed in Ansoft HFSS



Rename the same .sm3 file into .sat file and open with HOOPS 3D Part Viewer for ACIS

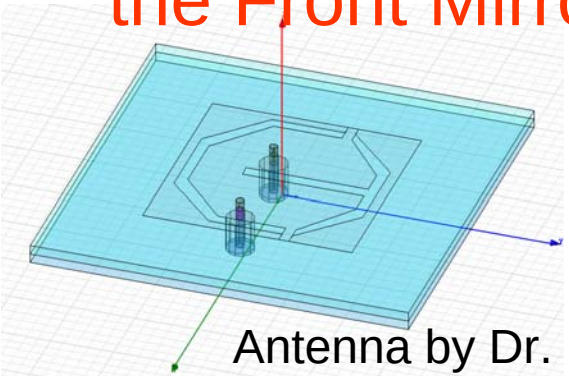
Plane Wave Simulation

- Incident plane wave at (x,y,z)=(3,3,0)m, k=(-1,-1,0)direction, Amplitude Em=(0,0,1)V/m; Frequency f=90MHz.
- The 6 outer box-planes are set to be radiation boundary condition.

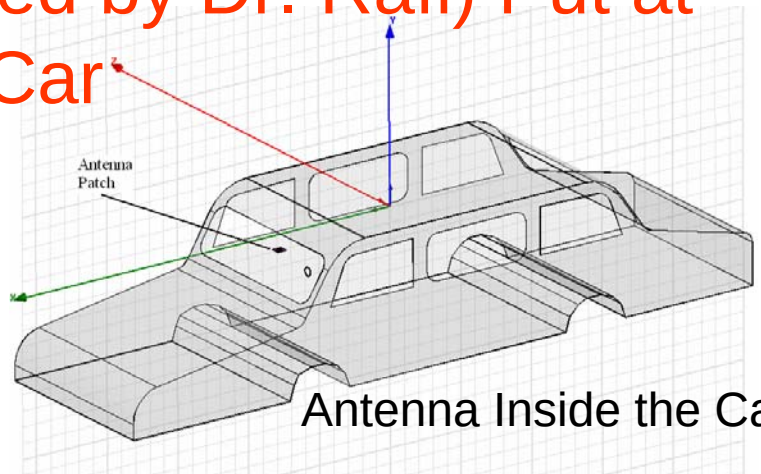


Antenna Incorporated in the Car

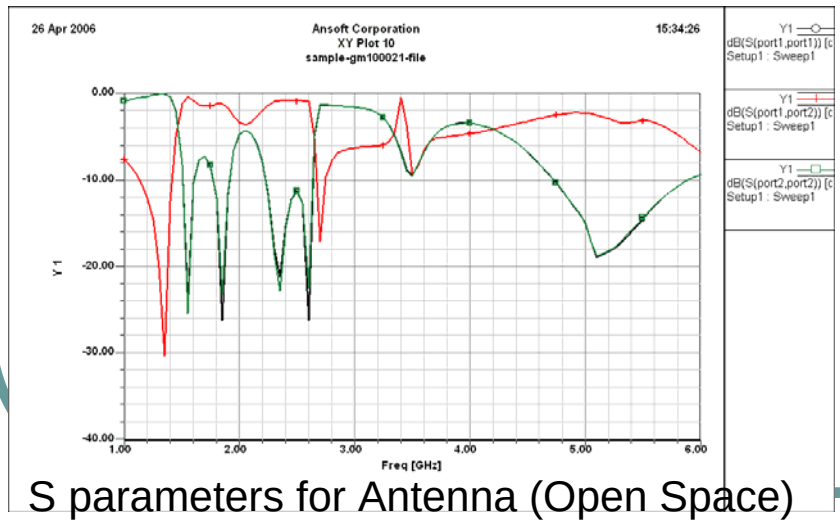
- Patch Antenna (designed by Dr. Rafi) Put at the Front Mirror of the Car



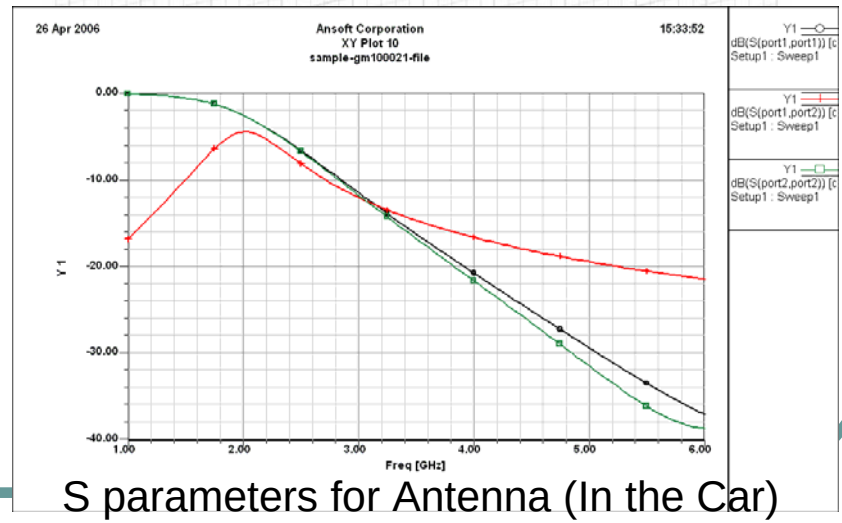
Antenna by Dr. Rafi



Antenna Inside the Car



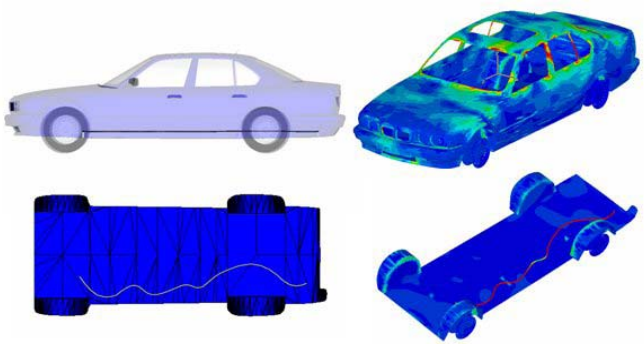
S parameters for Antenna (Open Space)

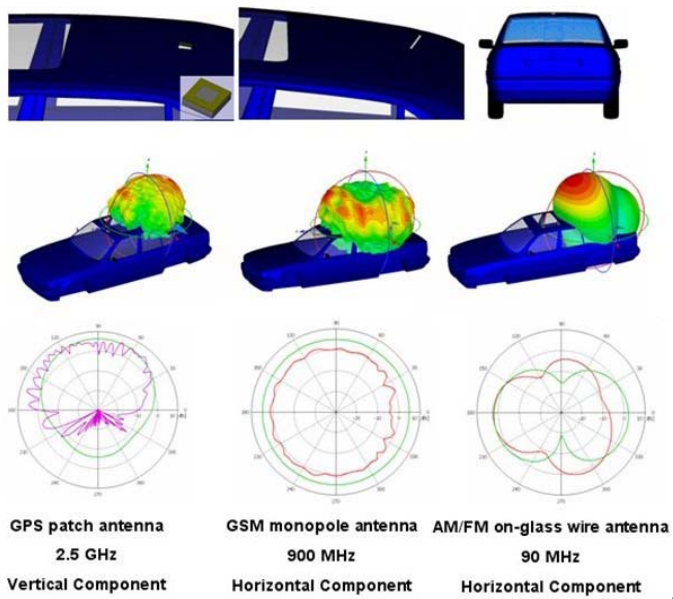


S parameters for Antenna (In the Car)

CST Microwave Studio Application

- Better CAD import/export capability
  - "renowned for its excellent CAD-data import capabilities and the sophisticated healing mechanisms."
    ”3D Import/Export: SAT, STEP, IGES, STL
    2D Import/Export: DXF”
  - Not only import structures, but also simplify and modify if necessary.
- Both Antenna and Car Models
  - Wide-bandwidth planar antenna.
  - STL interface car model





To Do at Next Step

- HFSS Simulation (FEM)
  - Combine Ray-Tracing
- CST MWS (Time Domain)
  - And/Or other tools as PAM-CEM.