Multi-Objective Optimization of Dual-Antenna Handhelds for MIMO Communications

Anders Derneryd and Anders Stjernman, Ericsson Research
Håkan Strandberg, EnginSoft Nordic
Bo Wästberg, Efield

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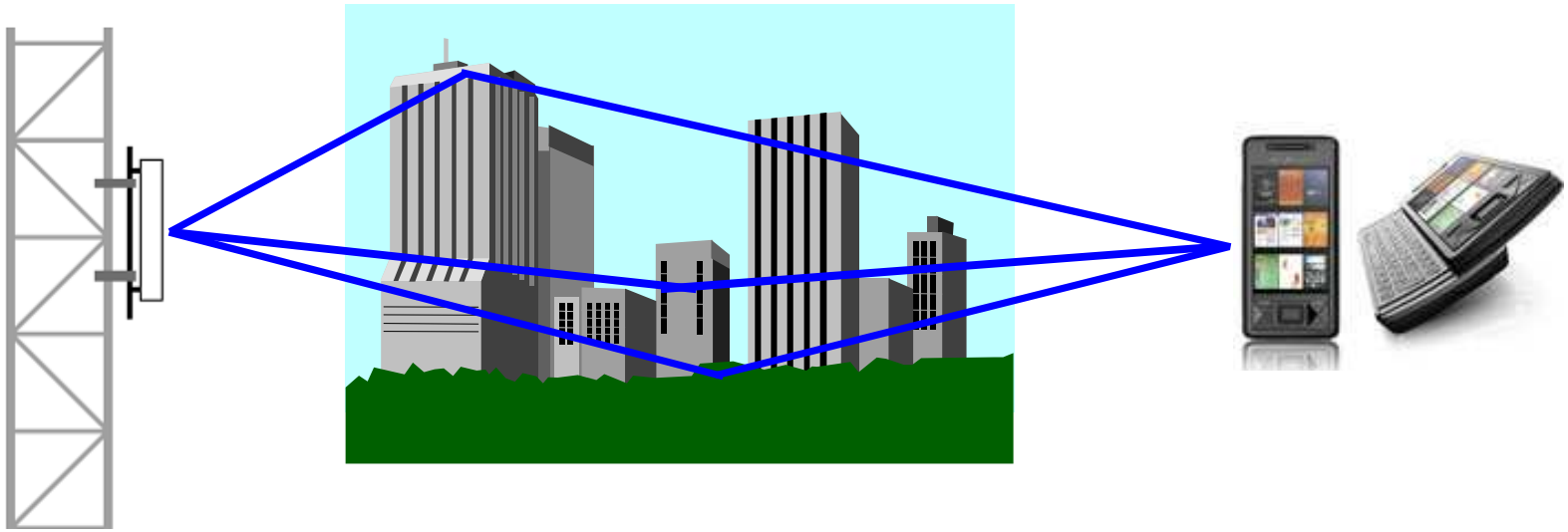
Outline

- Introduction to mobile communication
- Antenna design basics
- Analysis model
- Multi-Objective Optimization
  - Parameterization
  - Automation
  - Strategy
- Results
- Summary

Mobile Communication

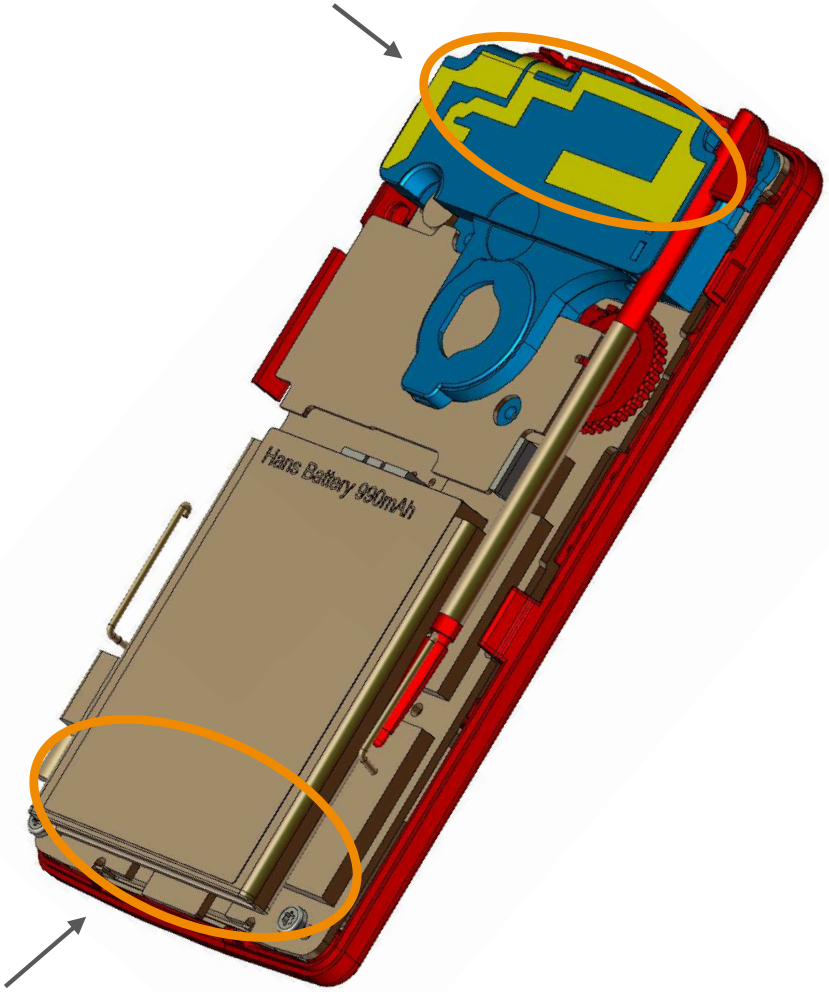
- Higher data rates
  - 4G system introduced
  - Parallel data streams
  - Multiple antennas at base station and in handhelds (MIMO)



Base Station Parallel data streams to increase capacity Handheld

Dual-Antenna Handheld

Current multi-band antenna

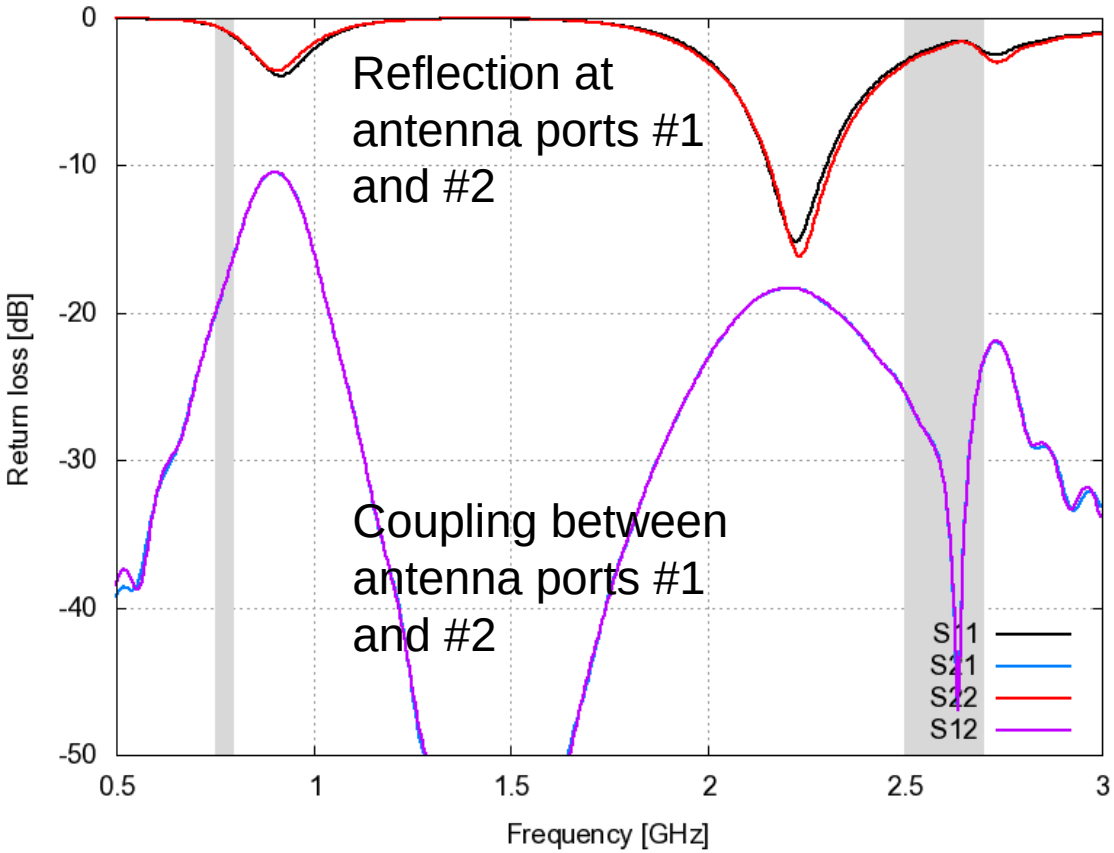


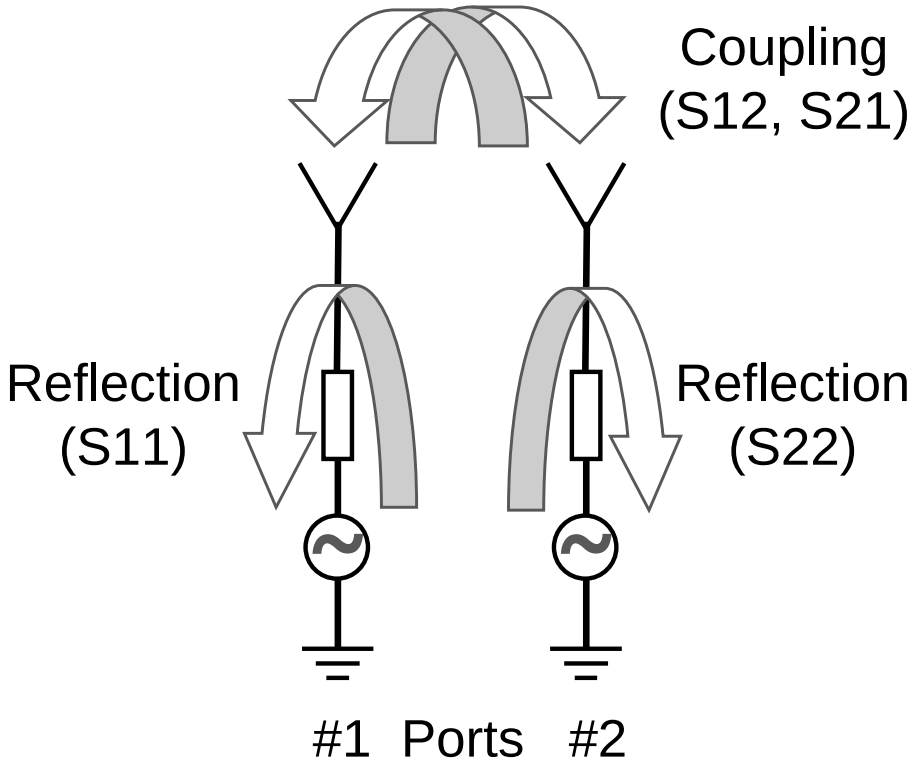
Potential second antenna location

- Small devices with a limited area
- Antennas become very closely spaced
- Cover a number of frequency bands
- Trade-off between size and performance

Most Important Performance Measures

- Signal reflection at each antenna port
- Signal coupling between antenna ports





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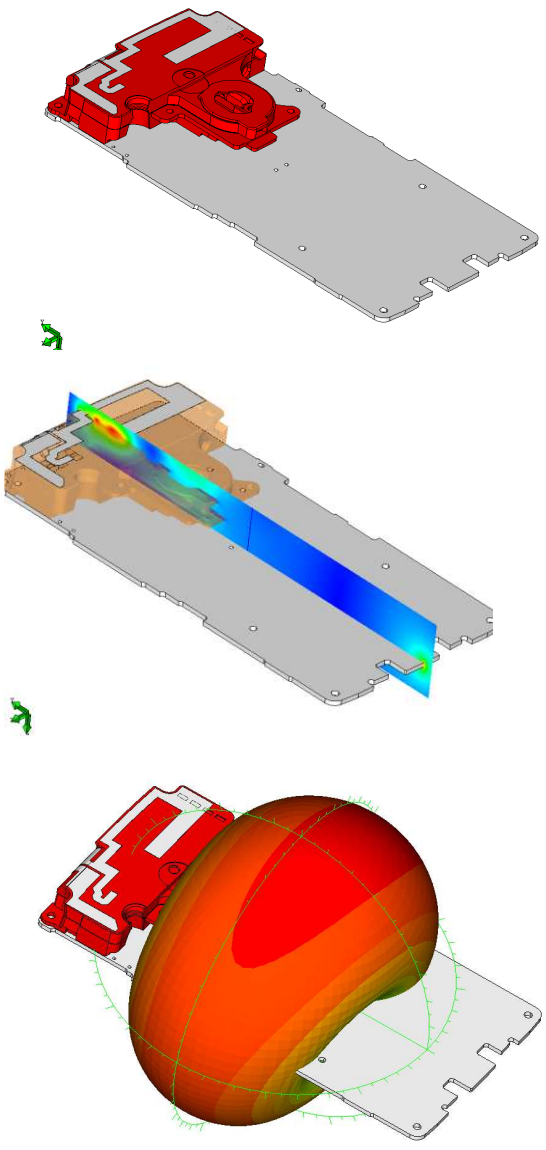
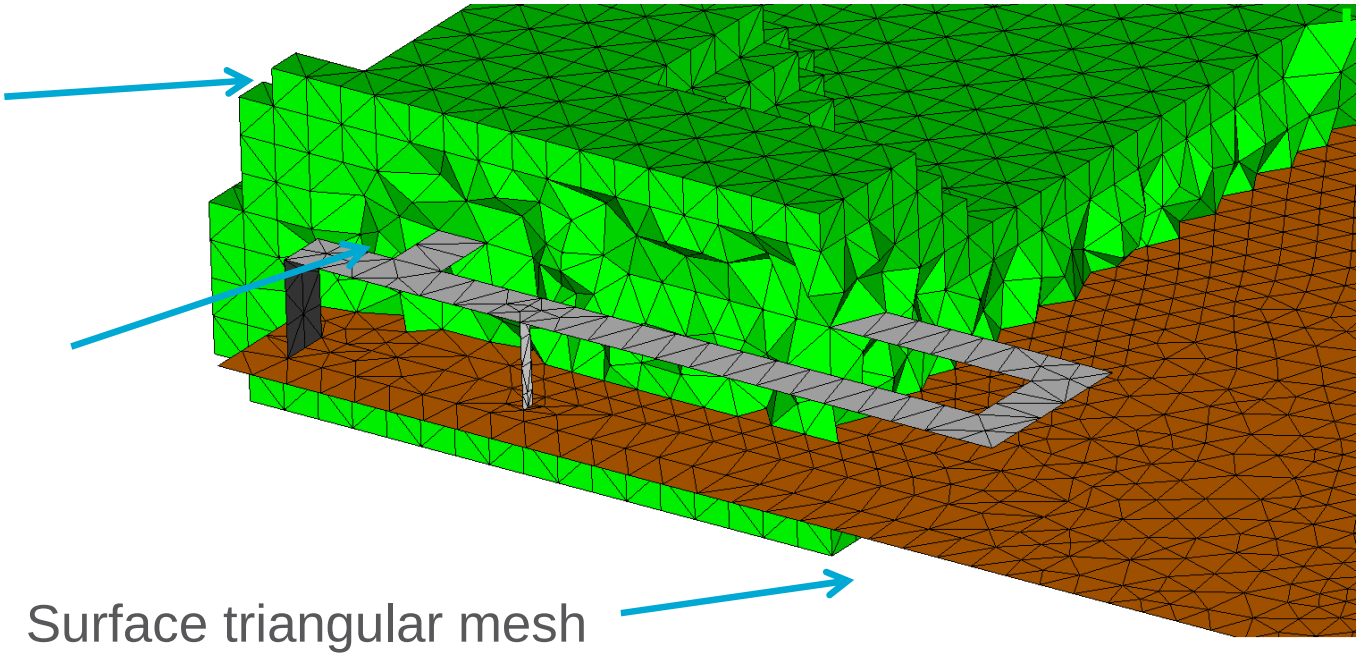


Analysis model - Efield®

- Hybrid FDTD-FEM solver
  - Time-domain simulation – good for broadband analysis
  - Local spatial refinement in FEM

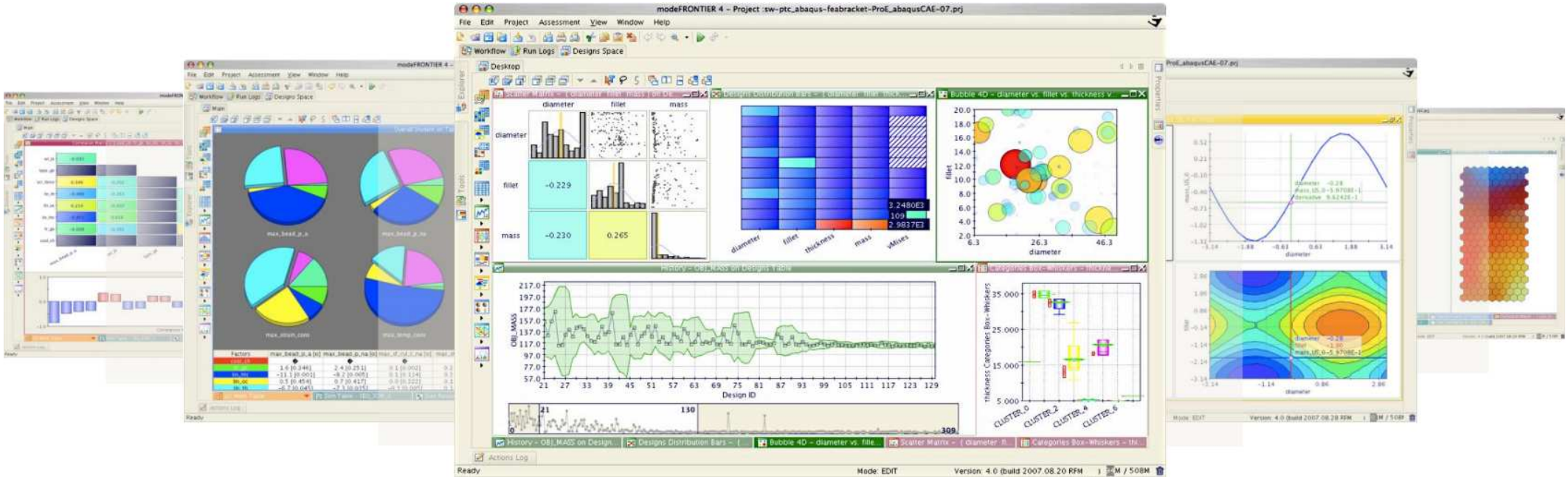
Interface to background lattice

Transition region, tetrahedral elements



Surface triangular mesh

Multi-Objective Design Environment



Using smart algorithms and automation, modeFRONTIER® helps engineers:

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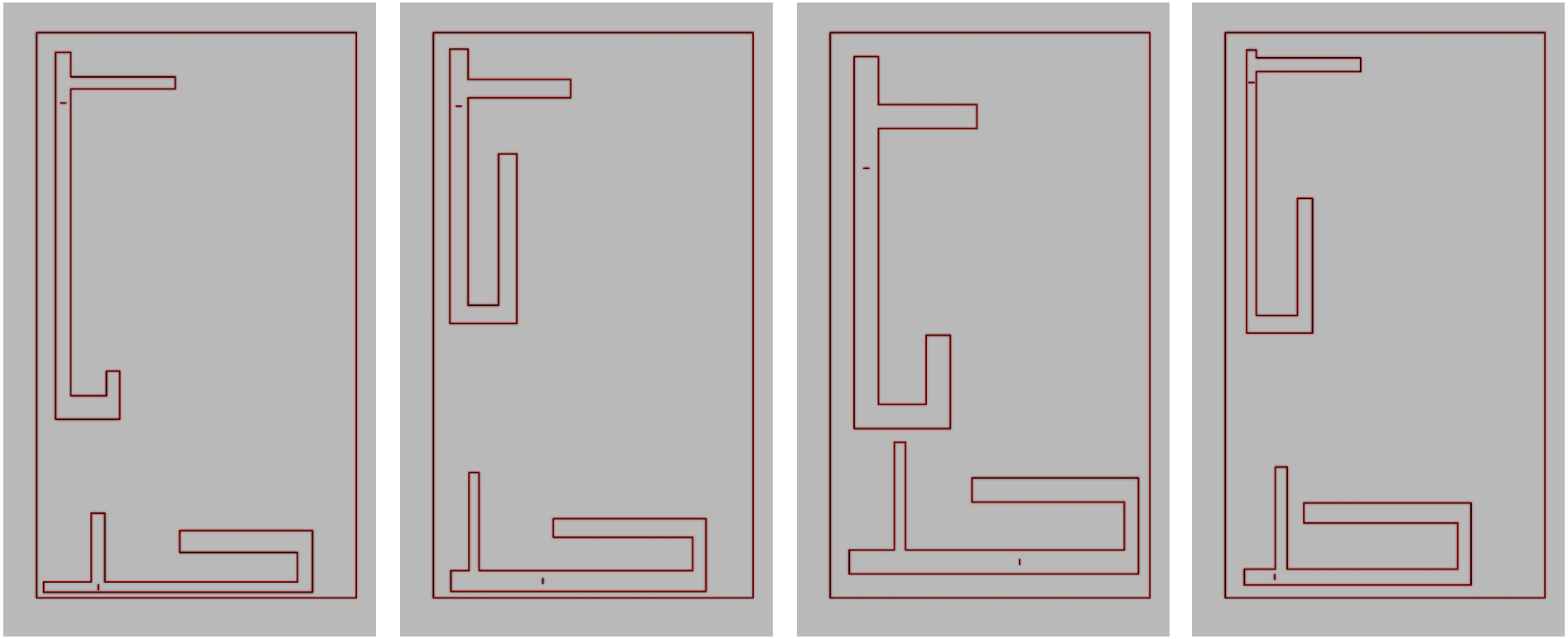
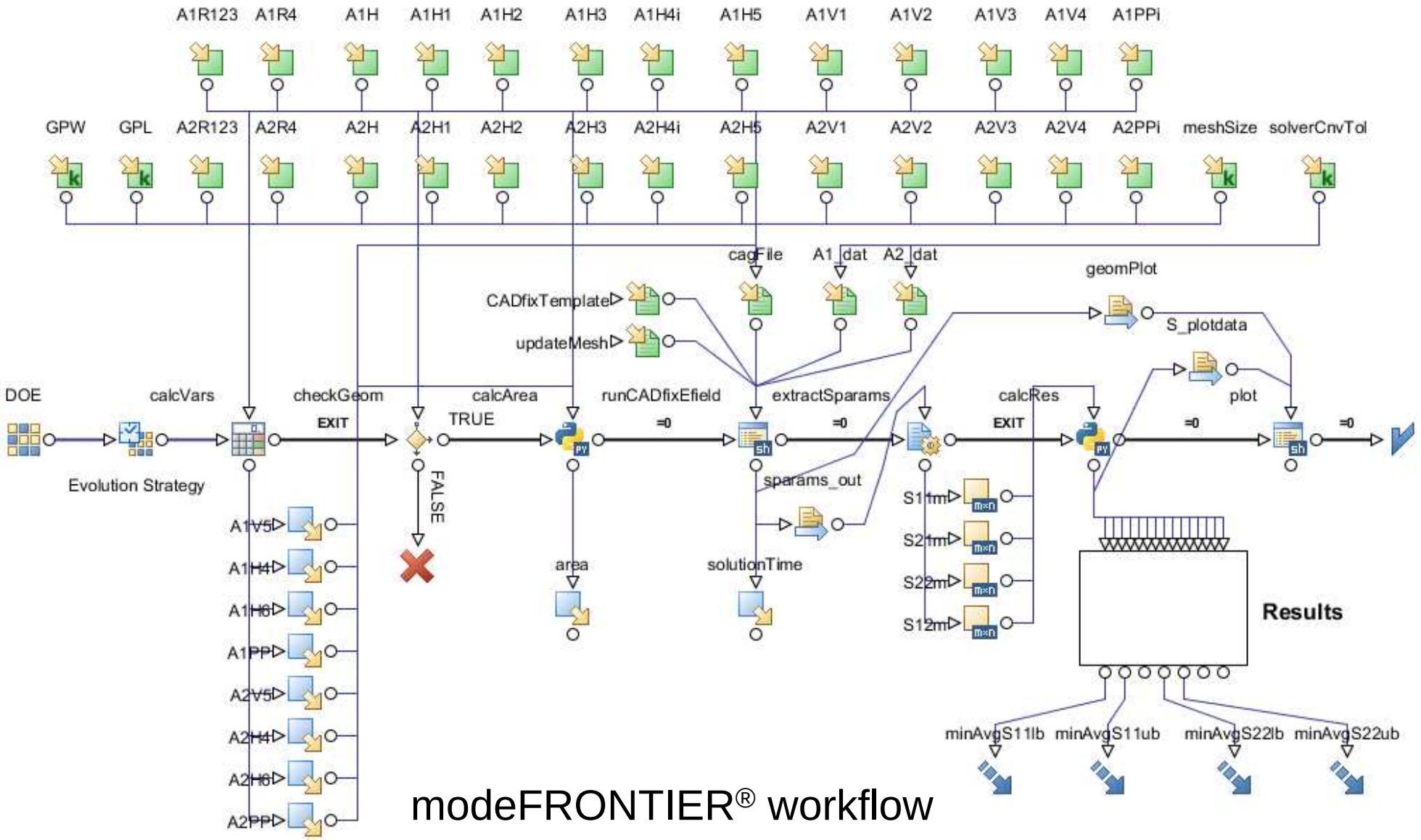
Our Design Space



- 26 geometric design variables
  - Upper and lower bound chosen from experience
  - 0.1 mm steps
- Invalid geometries can’t be avoided by “smart” parameterization
  - Logic checks avoid overlapping R123 & R4, negative V5 etc

Design Process Automation



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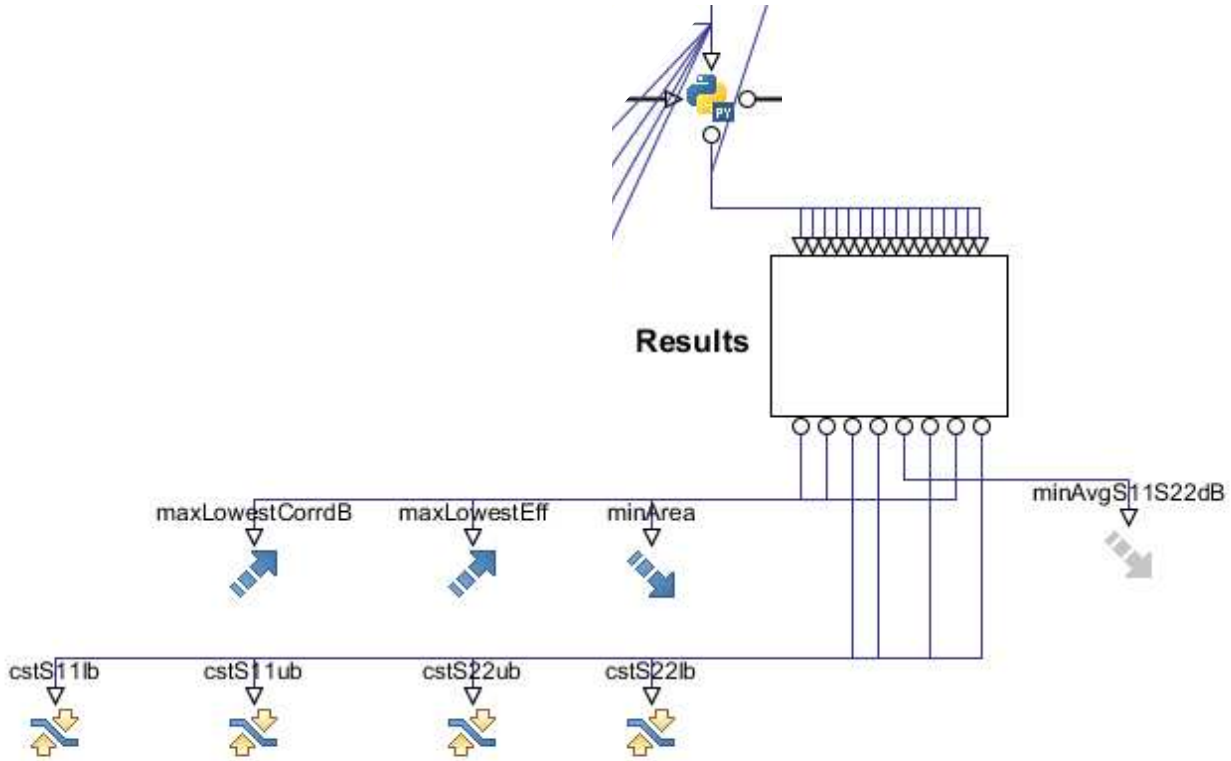
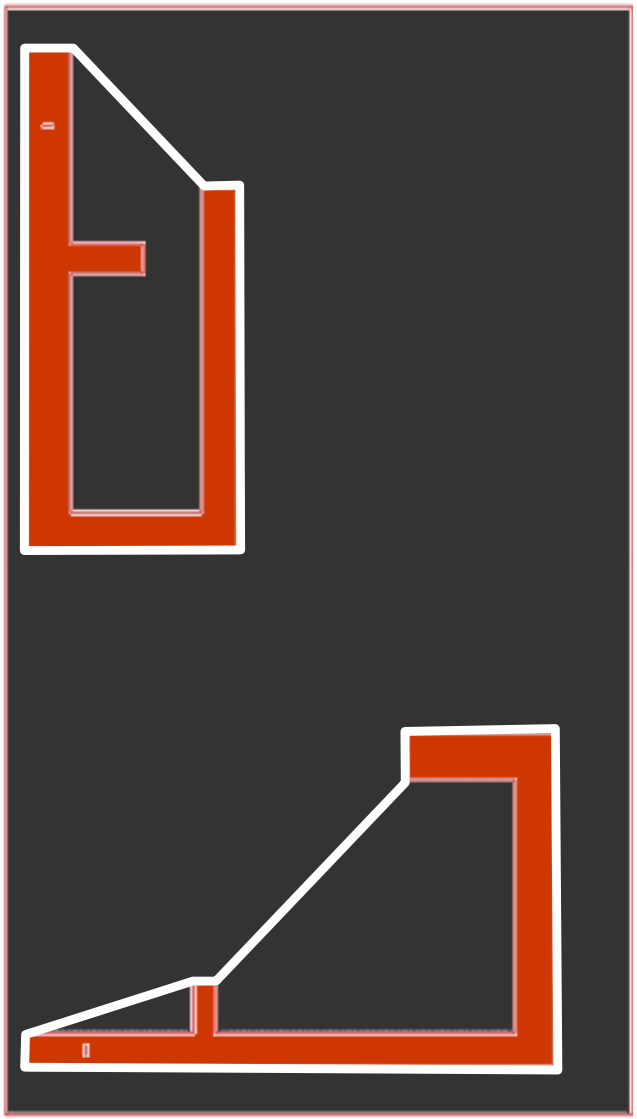
Multi-Objective Optimization

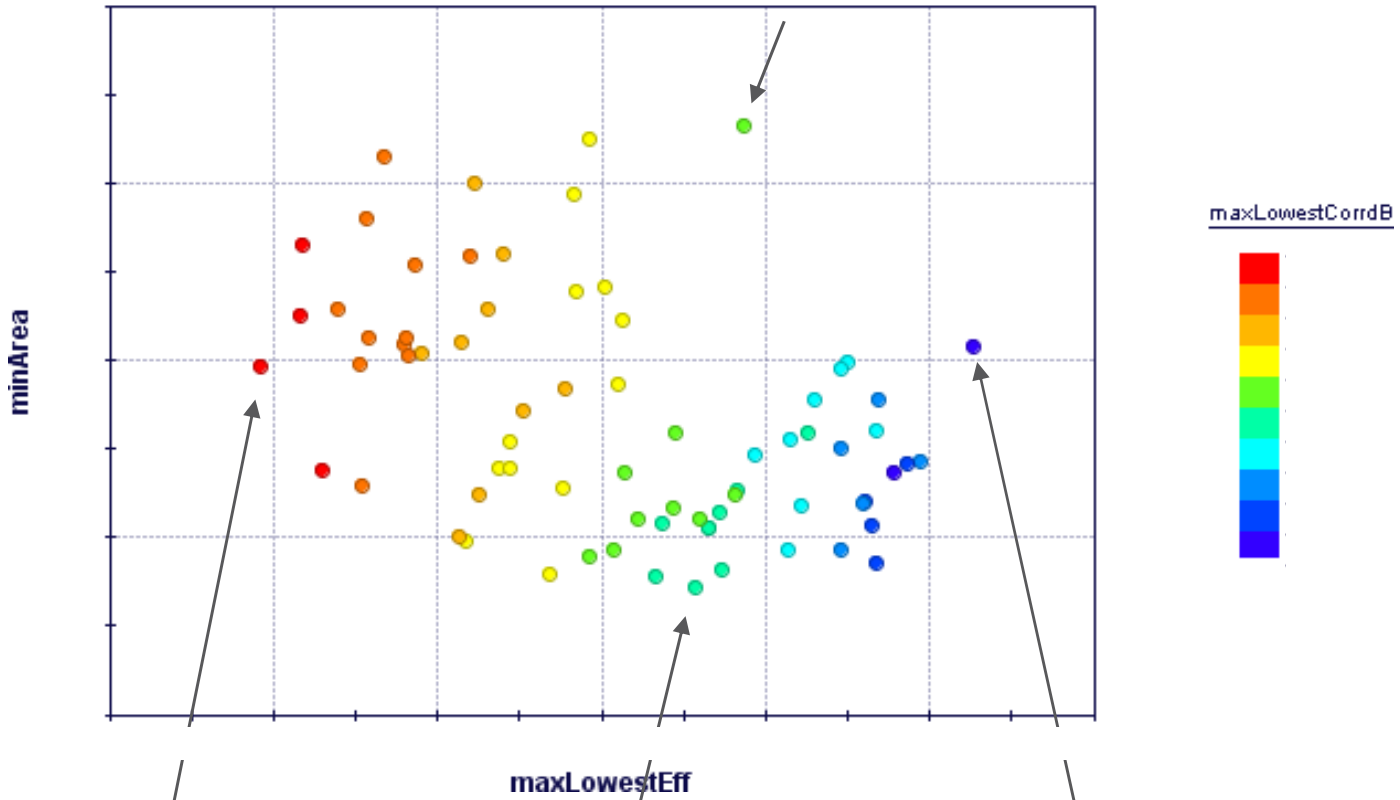
- Objectives
  - Minimize total antenna area (convex hull)
  - Maximize average efficiency
  - Maximize modified efficiency (correlation)





3 competing objectives – Pareto designs

Large area, but better corr and eff than smallest area



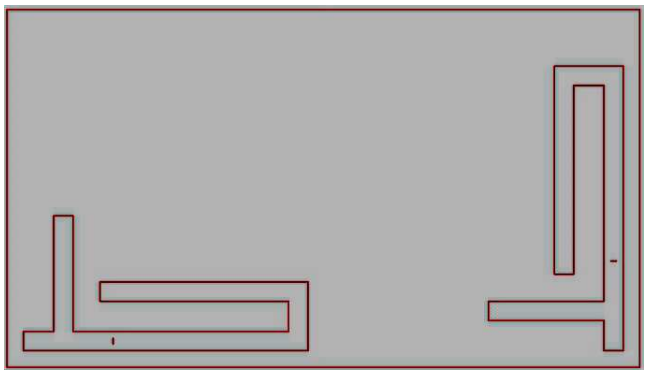
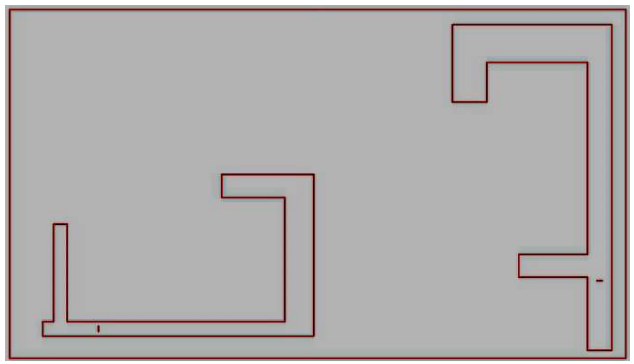
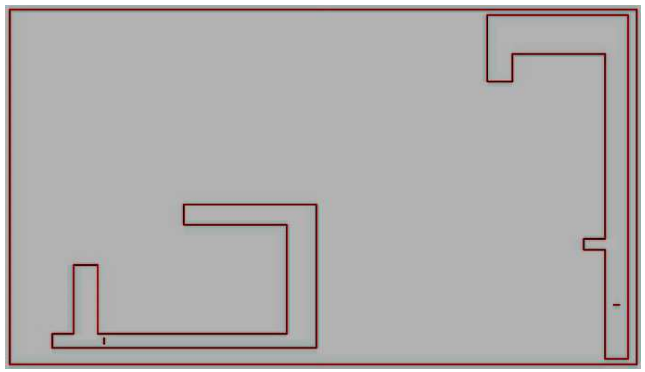
High corr, low eff

Lowest area

High eff, low corr

Summary

- It is possible to optimize antenna designs automatically
  - Sensitive resonance phenomena
  - Large design space, 26 design variables
  - Significant simulation time, 45 min
  - Multiple conflicting goals, 3
- Initial results are
  - Trade-off discussions possible
  - General & scalable process
  - Improved system knowledge

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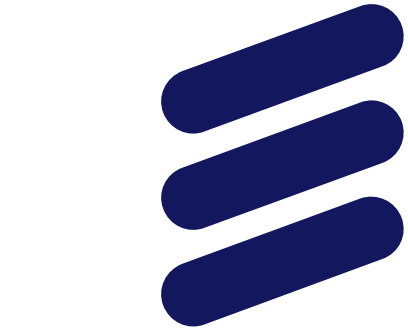

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