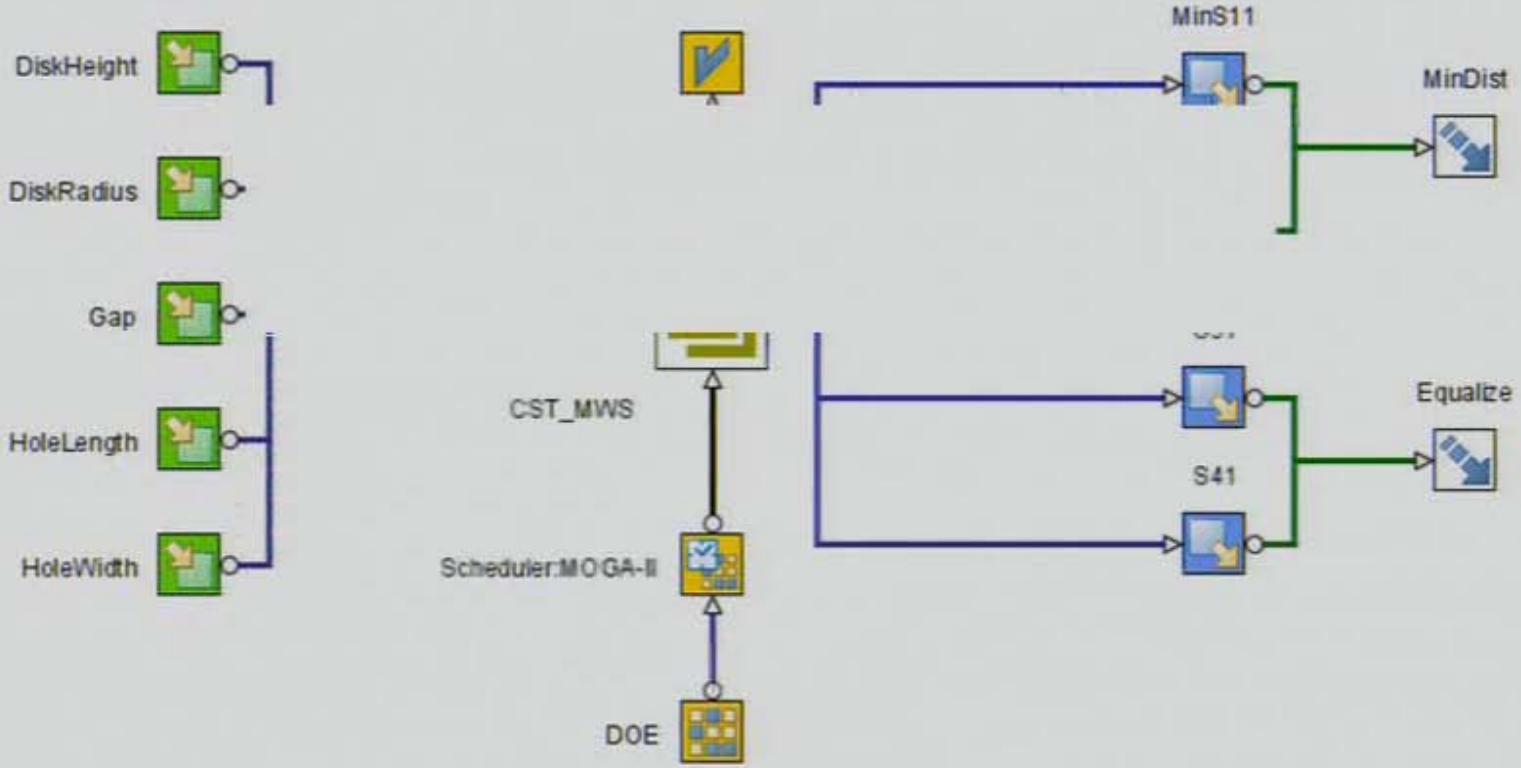
Multi-Objective Optimization of RF Components using CST MICROWAVE STUDIO® & modeFrontier®

International modeFRONTIER® Users' Meeting 2010
27th -28th May 2010 - Savoia Excelsior Palace -Trieste - Italy

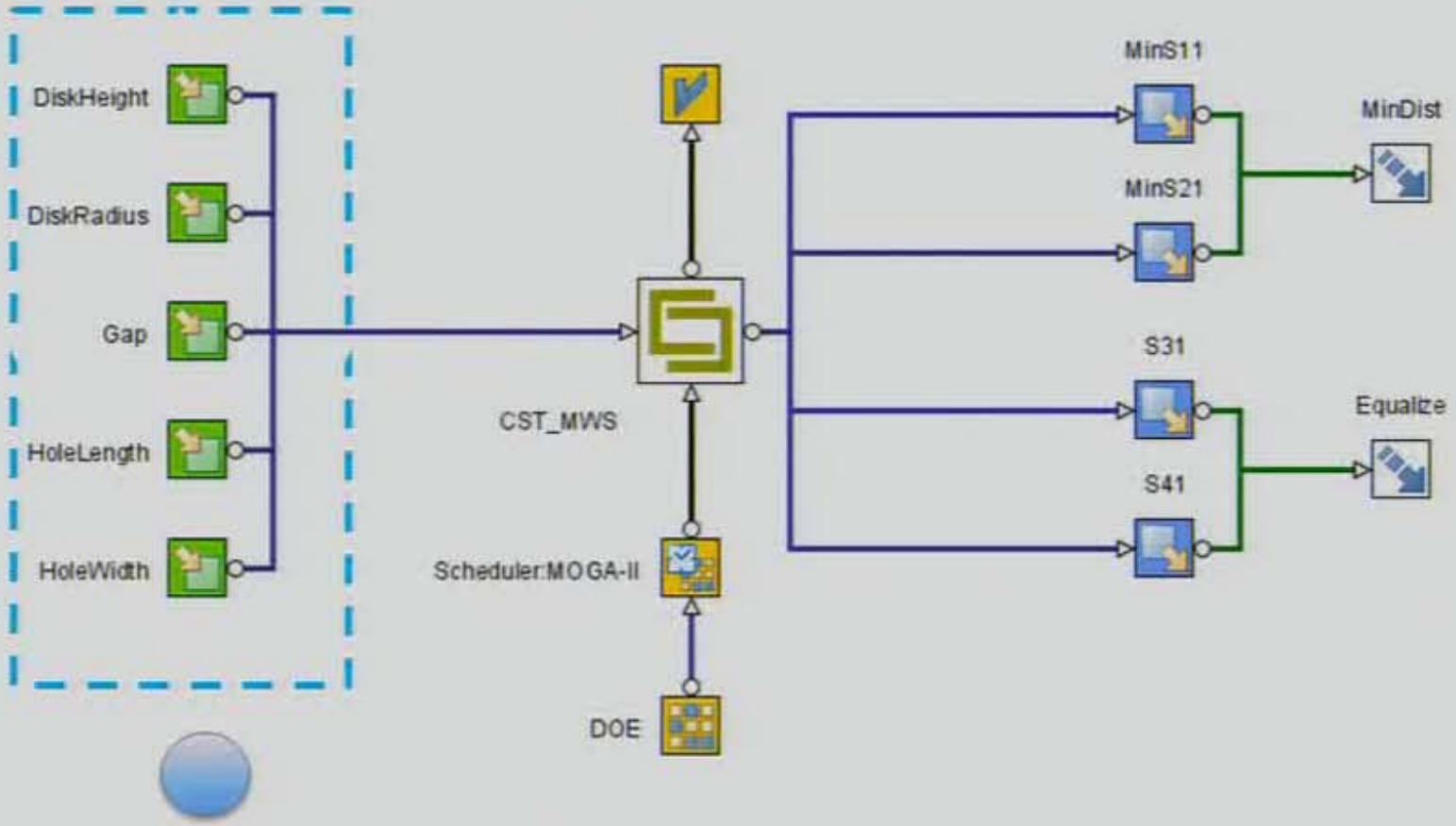
Outline

- CST STUDIO SUITE integration inside modeFrontier via direct node
- Customer case studies
  - 1 - Cavity filter
  - 2 - Isoflux Antenna
- Summary

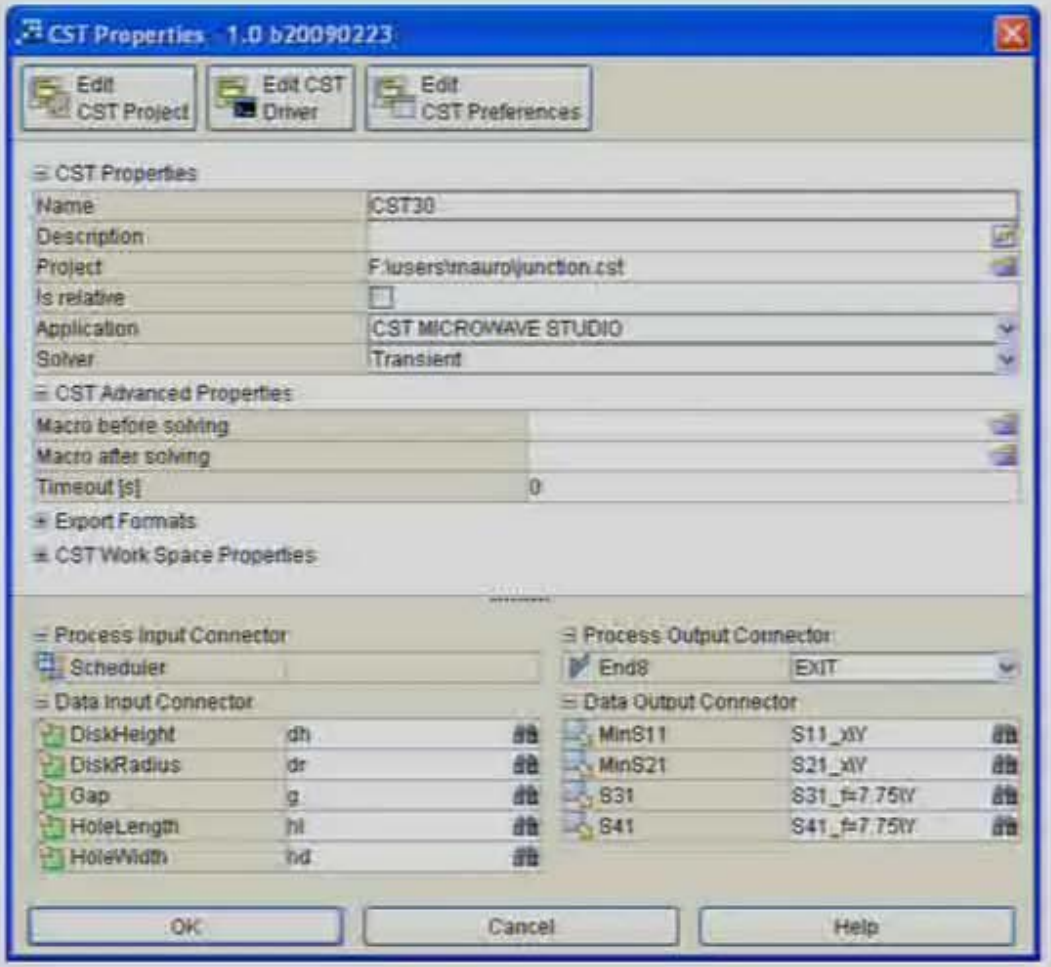
CAE Node in mF



CAE Node in mF

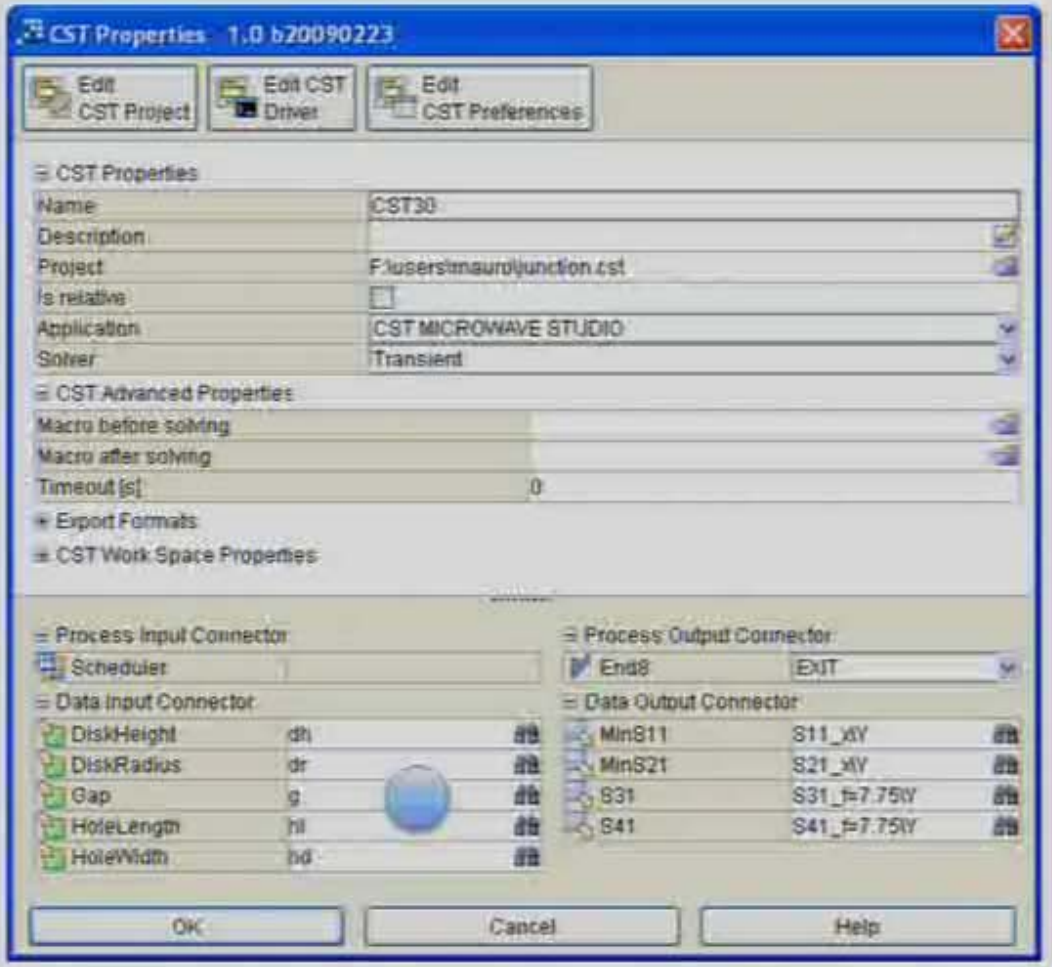


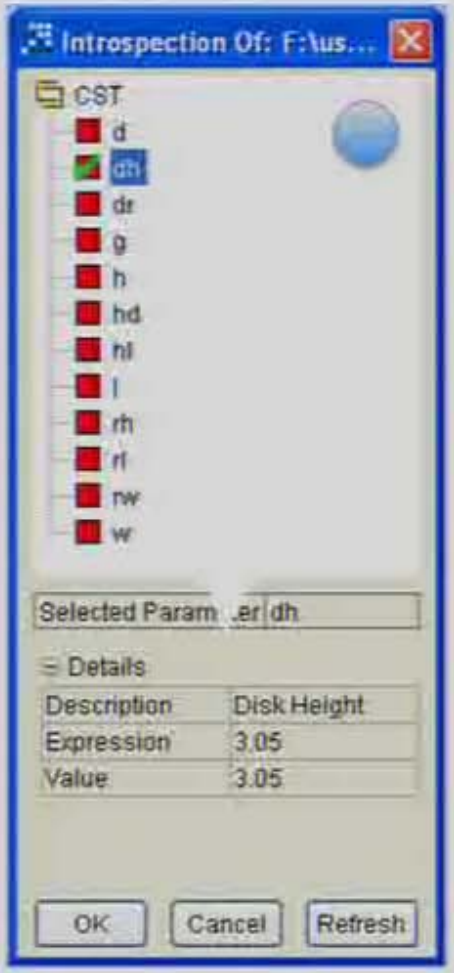
CAE Node in mF



CST Node Properties Window

CAE Node in mF

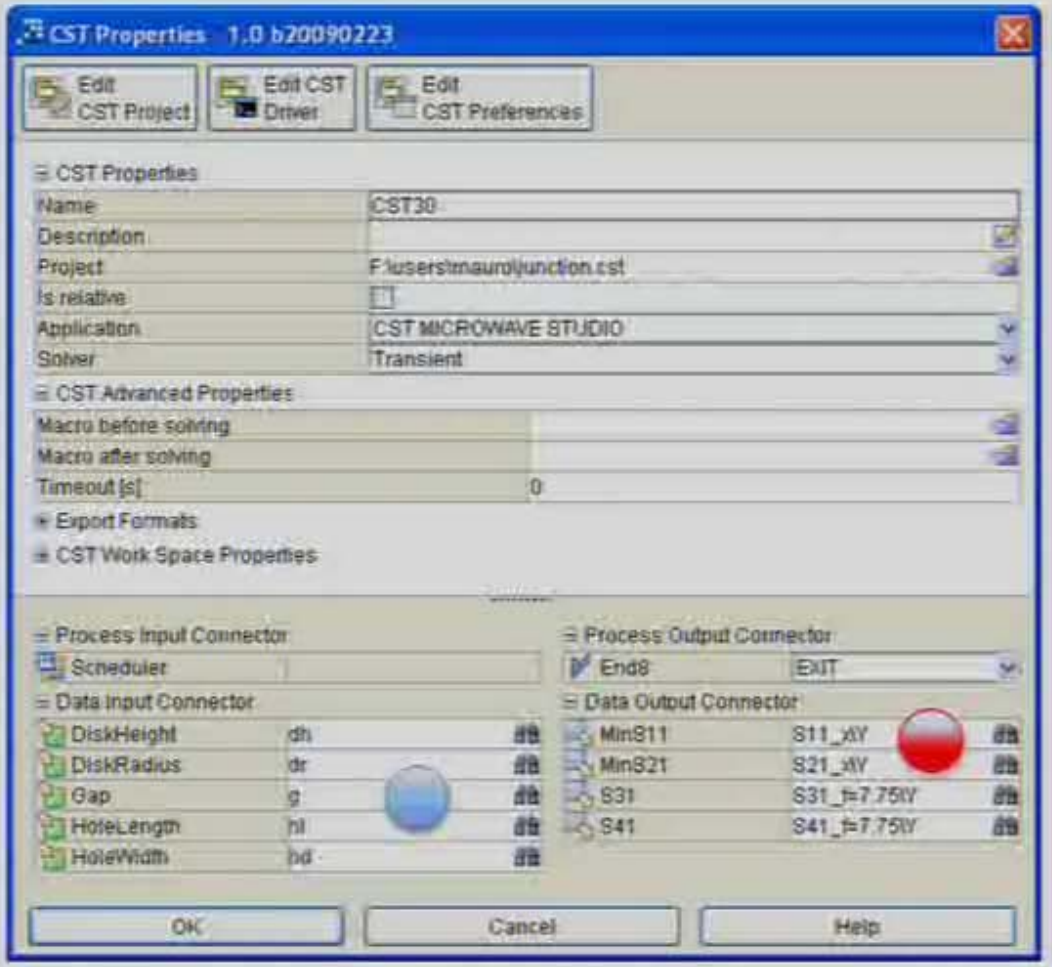


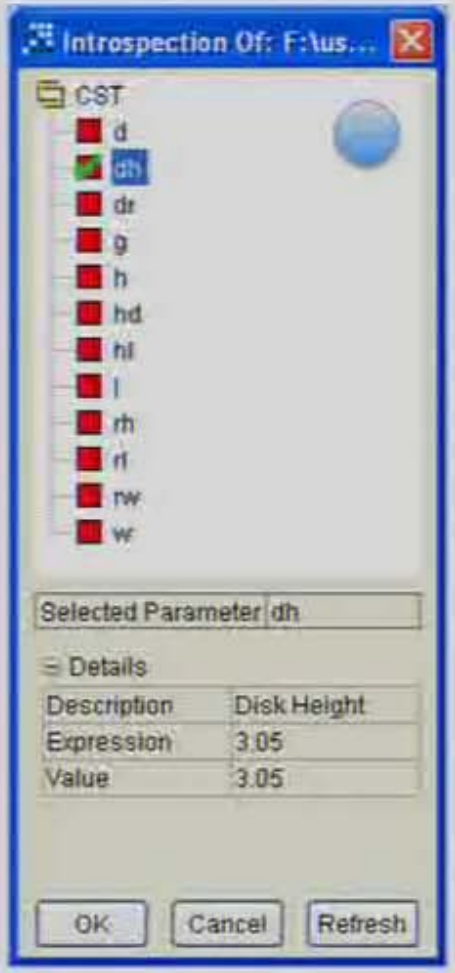


CST Node Properties Window

Input side

CAE Node in mF



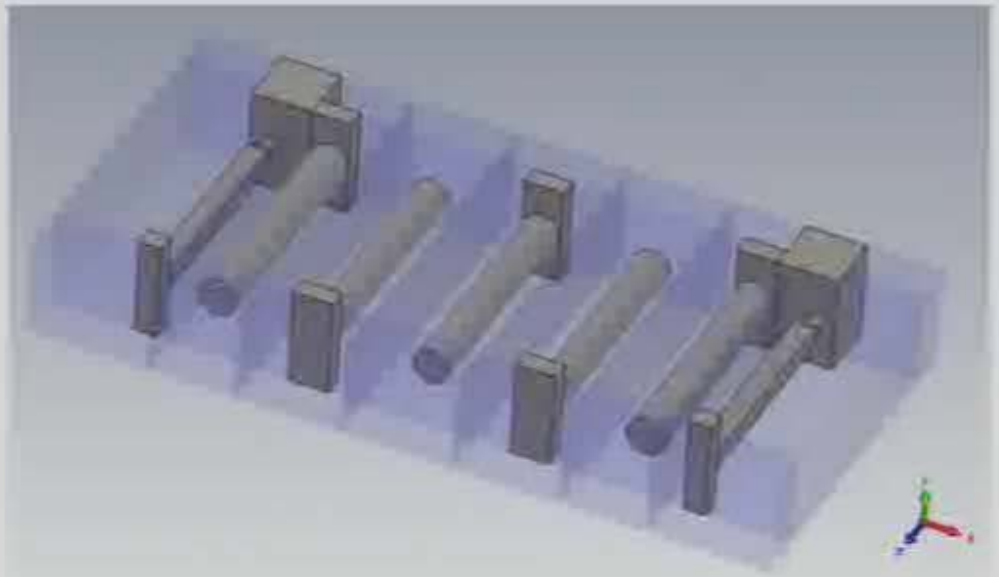


CST Node Properties Window

Input side

Outp ide

1 - Cavity filter



	Model Parameter	Description
Parameter1	Iris1tx	1st resonator length
Parameter2	Irir2tx	2nd resonator length
Parameter3	Iris3tx	3rd resonator length
Parameter4	Ittx	Length of in/out transformer
Parameter5	s01tx	Gap between the input and the 1st resonator
Parameter6	s02tx	Gap between the 1st and the 2nd resonator
Parameter7	s03tx	Gap between the 2nd and the 3rd resonator

Parameter	Value	Unit
Operative Band	250 - 270	MHz
Return Loss	< -23	dB
Isolation @ 293MHz	> 43	dB

Design targets

Courtesy of Prof. Paolo Mezzanotte, University of Perugia

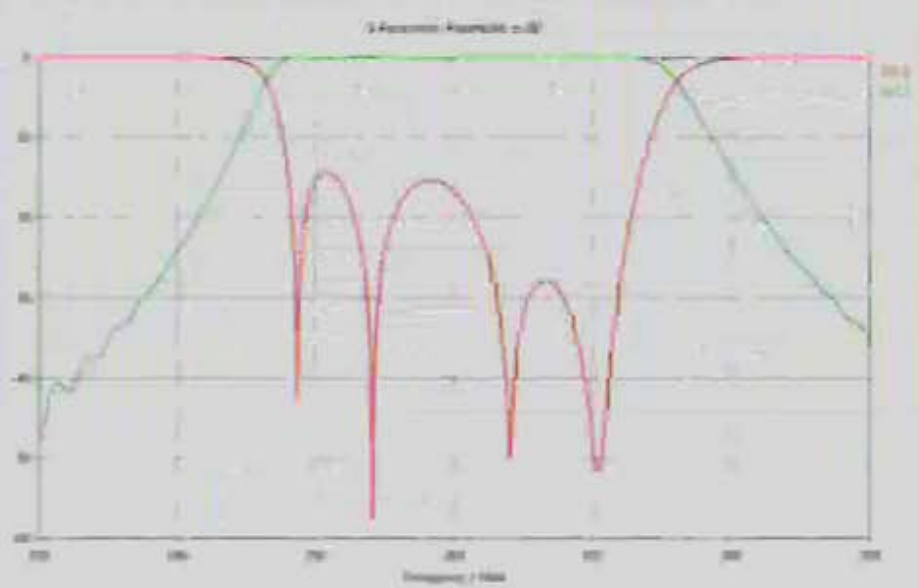
The starting point

The filter was designed using the procedure described in the following biography but it did not meet the design targets:

($|S_{11}|$ = -14.45 dB and $|S_{21}|$ = -38 dB)

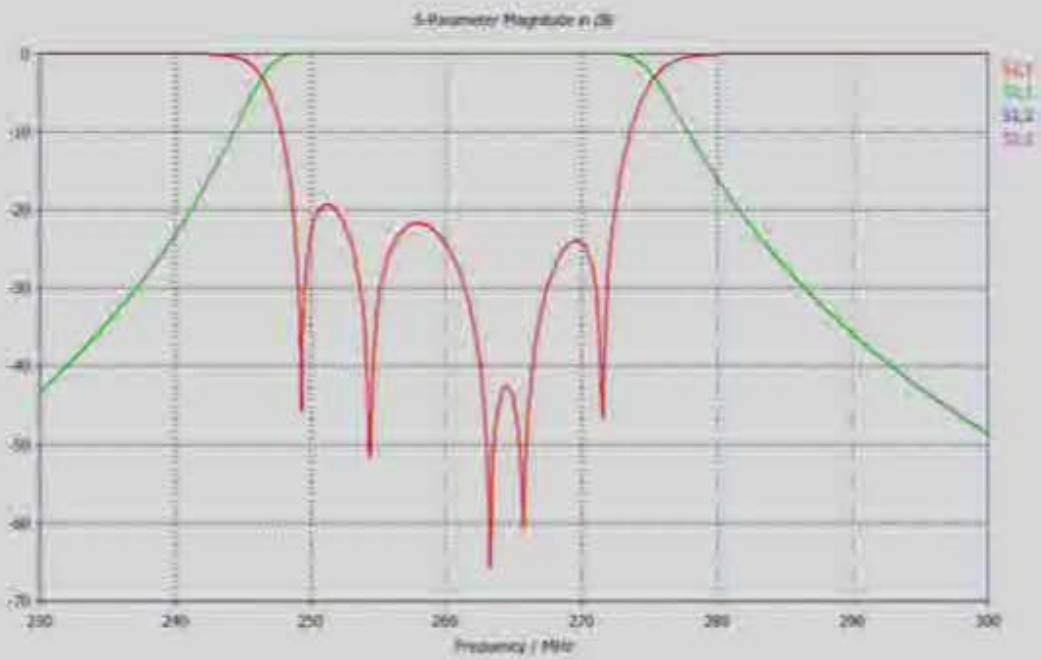
[1] G. Matthaei, L. Young, E.M.T. Jones, "Microwave Filters, Impedance-Matching Networks, and Coupling Structures", Artech House 1980.

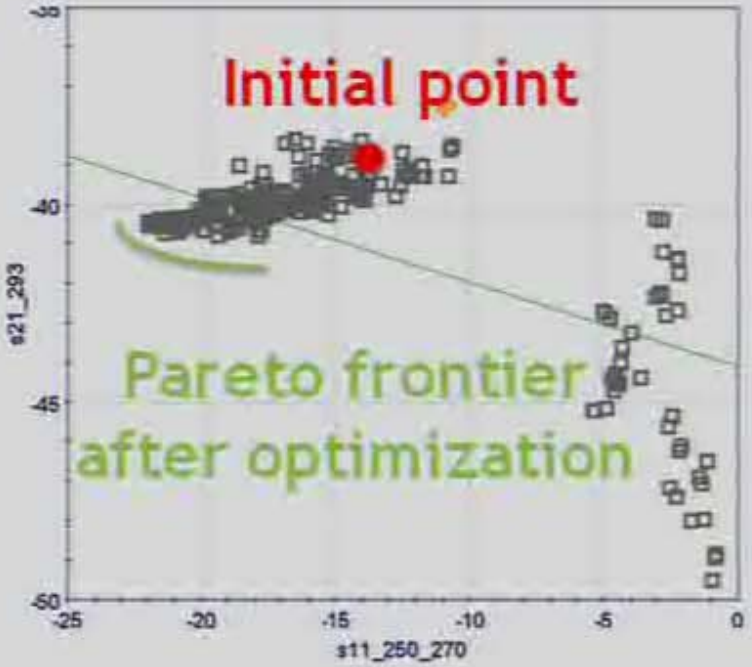
[2] E. G. Cristal, "Coupled circular cylindrical rods Between parallel ground planes", IEEE Trans. on Microwave Theory and Techniques, vol. MTT- 12, Jul 1964, pp. 428-439.



Optimization strategy

Scheduler	:	Non-Sorted Genetic Algorithm
Population size	:	16 individuals
Number of generations	:	20
CPU time per analysis	:	about 8 minutes

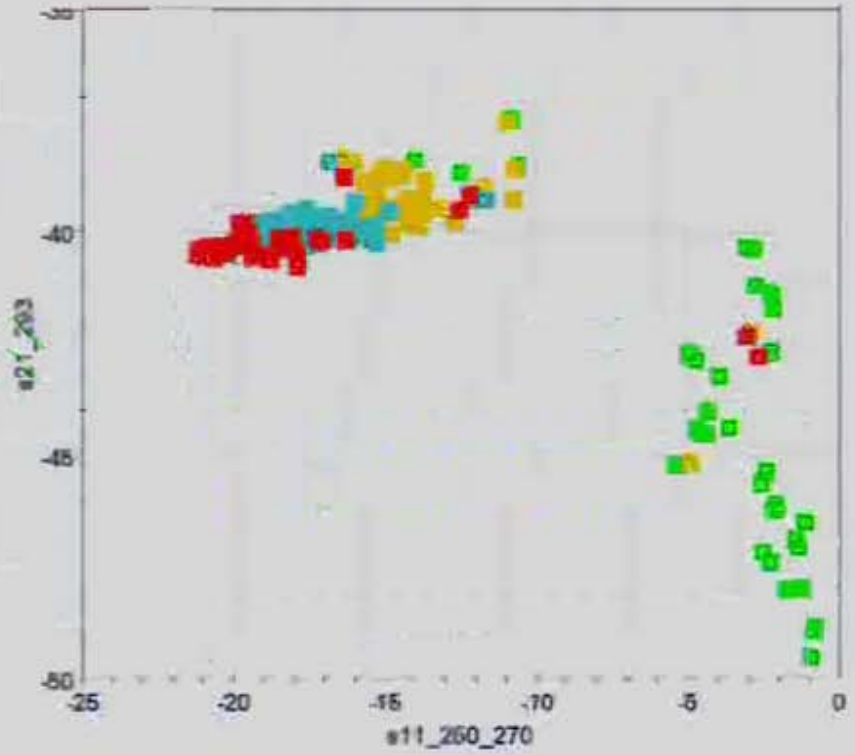




Final Result

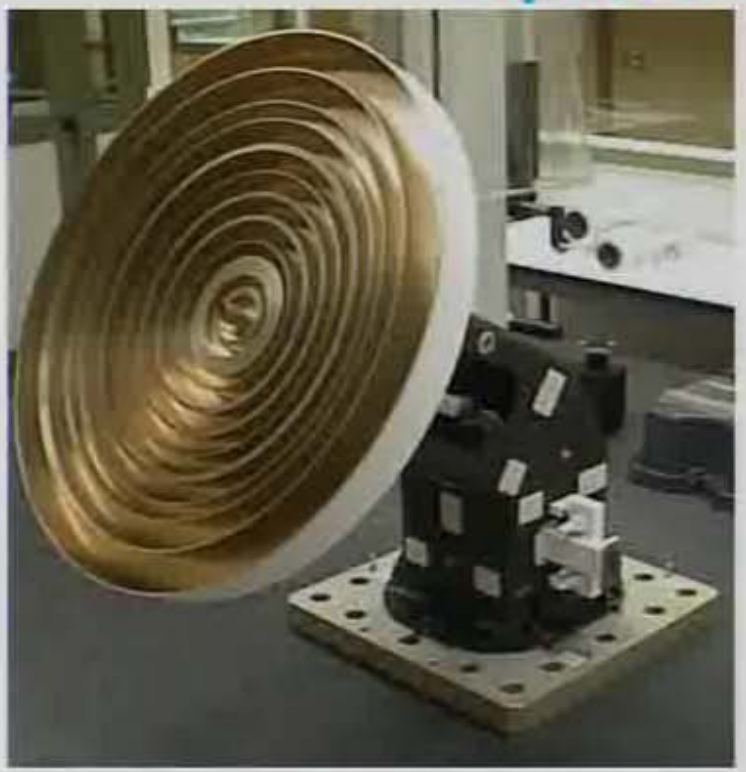
	Original	Optimized	Improvement
S11	-14.45	-19.33	33%
S21	38.02	-40.11	5%

- The full optimization took about one day and a half on a single CPU
- Good results, having sensitive improvements, are present after few generations
- Parallelization at optimization level provides a linear speed-up



2 - Isoflux Antenna

ThalesAlenia Space
A Thales / Finmeccanica Company



Multi-Objective Optimization of an Isoflux Antenna

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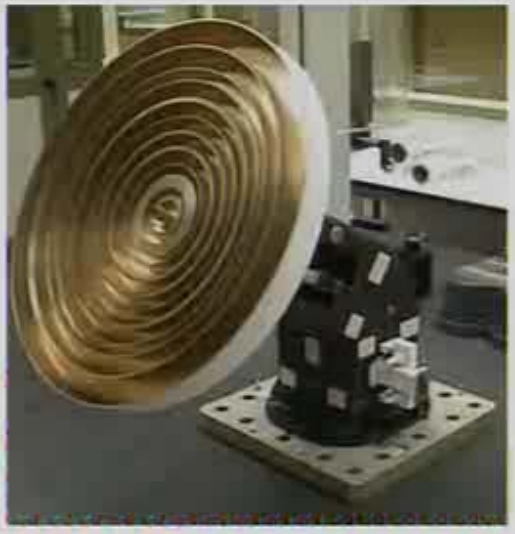
N. Baldecchi, F. Franchini, Enginsoft SpA, Firenze, Italy
C. Iannicelli, Software System Engineering SpA, Roma, Italy

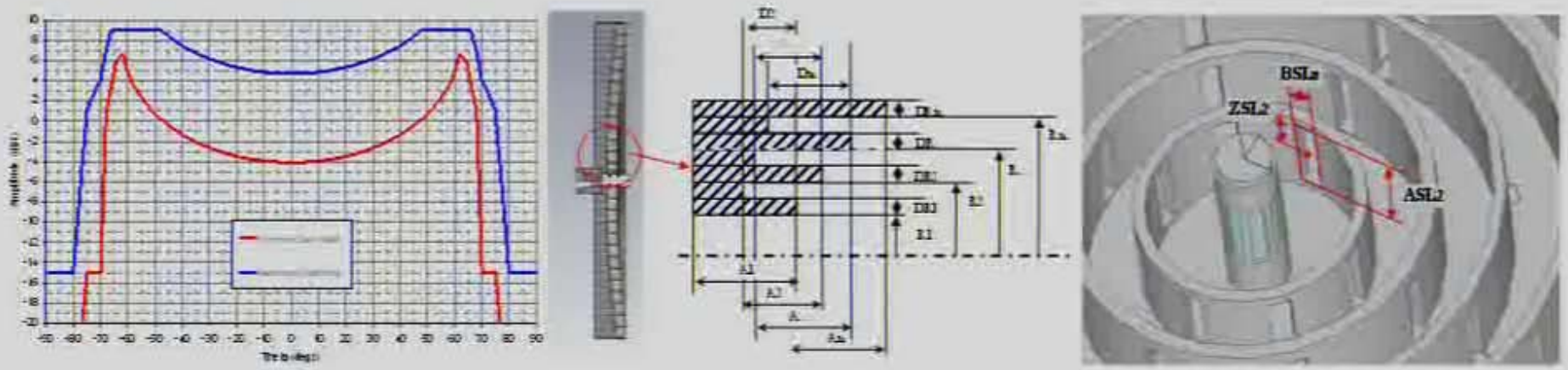
PDHT Antenna Description

Power Data Handling Antenna for Earth Observation Missions in LEO Orbits Description



- First exemplary of PDHT Antenna architecture consists of a corrugated planar surfaces with cylindrical symmetry excited by quarz loaded launcher analyzed by 2D Moment Method Modeling
- The new PDHT Antenna Structure conceived to meet new and more stringent requirements especially on XPD has sets of slots in radial direction
- 3D modeling necessary with much more computation resources to perform electromagnetic analysis

Electromagnetic Problem Formulation



Radio Frequency requirements are fixed on:

- Gain defining a Mask on elevation angular range
- Cross Polar Discrimination
- Amplitude and Phase Ripple in w.r.t. frequency
- Return Loss

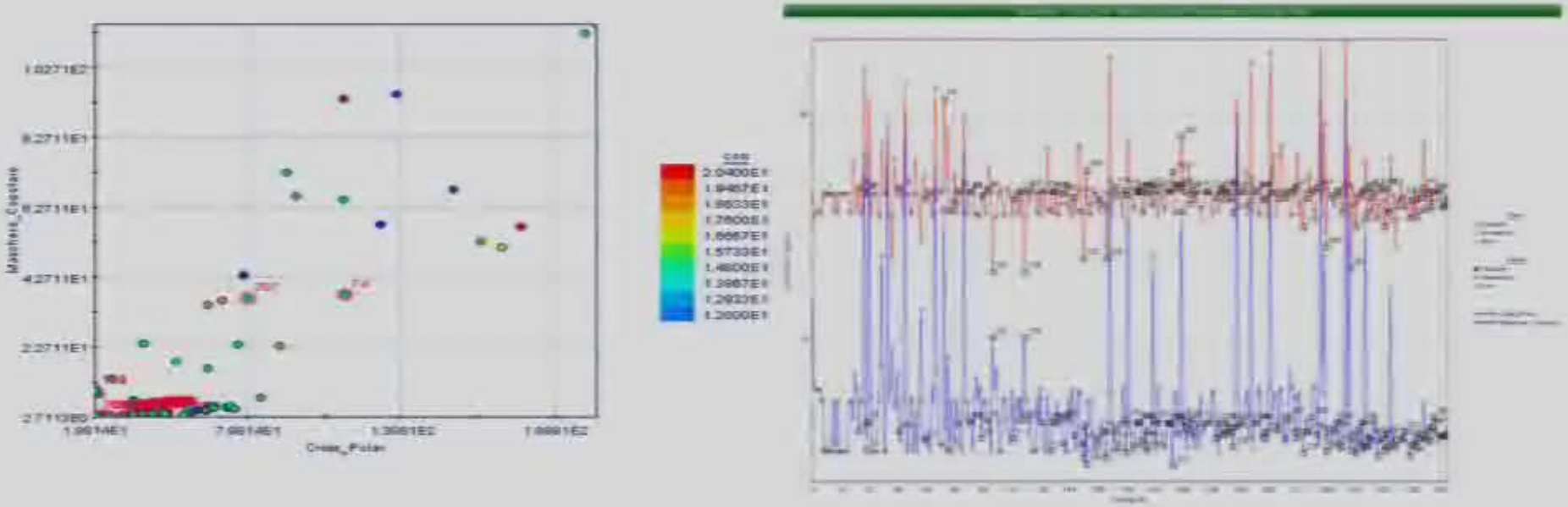
Optimization Methodology

To overtake the limitations on computation resources two ways have been followed to define the searching space of the optimal solution:

- **"minimal approach"** considers a geometrical structure profiled by an established function (polynomial function, trigonometric function) described by few variables.

- **"aimed approach"** that divides the variables in homogeneous classes and acts only on one group per time.

modeFRONTIER Optimization Process



- A first screening of search space has been implemented using Latin Square Algorithms to find most important correlation among variables (input/output)
- After first phase a Sobol-MOGA-II Optimization genetic Algorithm has been applied to search the set of optimum solutions
- A good compromise of the most important requirements (Gain and XPD) has been found