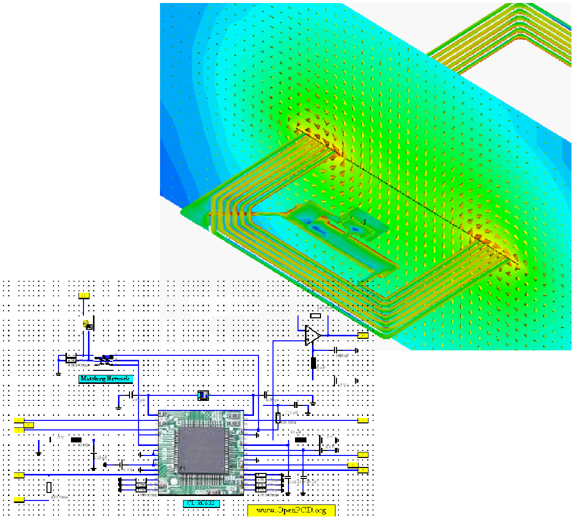
Complete Technology and RFID



- Overview
- Operating Principles
- Inductive Coupling
- Microwave Coupling
- Coupling to Circuit Simmulation
- Summary

T. Wittig

Overview

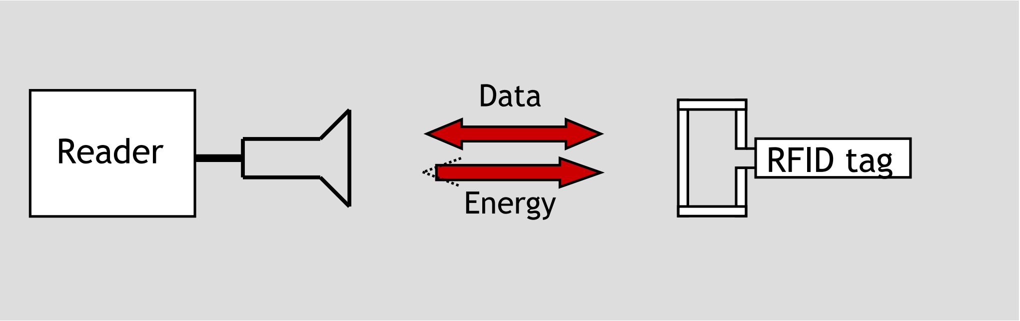
Radio Frequency IDentification

Fundamental tool for Automatic Identification: authentication, ticketing, access control, supply management, parking, payment, vending, surveillance

Advantages:

- Contains more information than e.g. Barcodes
- Can be read/write
- Contactless ID (in contrast to phone or bank cards)
- May become cheap mass product (e.g. in supermarkets)

General Principle



Typical characteristics of RFID:

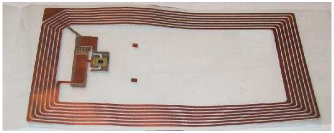
- Tag is a passive device, energy is transmitted from reader
- Distance mm to 10m (typically ~20 cm)
- Contains silicon chip, can be read only or read/write
- Responds with modulated signal
- Mostly printed (planar) structures

Frequencies

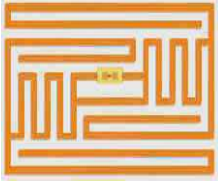
125/134 kHz	Animal identification, industrial applications, very robust, low data transmisstion (64 bit)
7.4 - 8.8 MHz	Electronic Article Surveillance (EAS)
13.56 MHz	"Smart Labels" widely used for product/article ID
868 - 928 MHz	Logistics,…
2.4 GHz	Vehicle identification, electronic toll collection
5.8 GHz	electronic toll collection in Europe

Operating Principles

- **Inductive Coupling (125 kHz - 15 MHz)**
  - Very small dimensions compared to l
  - Coupling only through magnetic field
  - Tag typically a planar coil



- **Microwave Coupling (868 MHz - 5.8 GHz)**
  - typically a regular antenna (e.g. planar folded dipole)
  - Matching network important to keep antenna small



CST

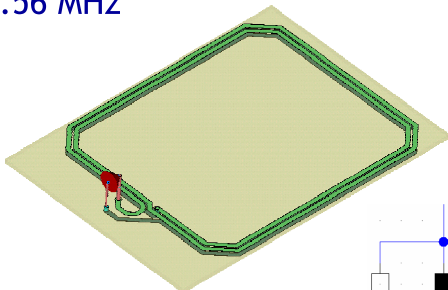
Inductive Coupling

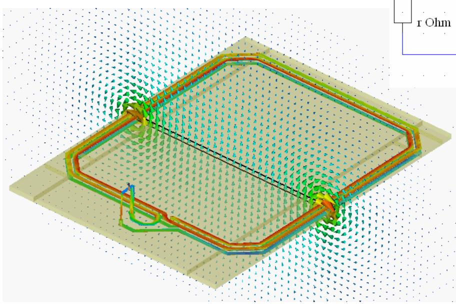
RFID tags are mostly planar coils with small dimensions compared to λ

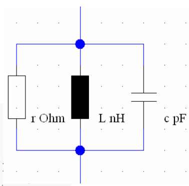
⇨ Hexahedral or tetrahedral F-Solver are typically most suited.

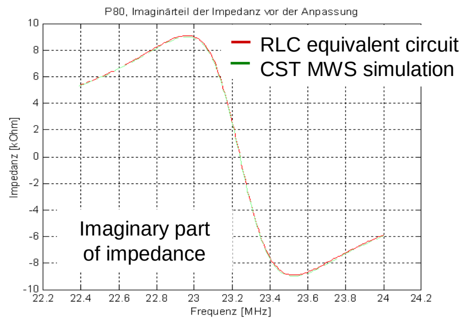
Simple Example for 13.56 MHz

At 13.56 MHz Measurement: (7.15 + 398i) Ω
Simulation: (7.0 + 334i) Ω









RLC parallel equivalent circuit fits broadband to simulation results

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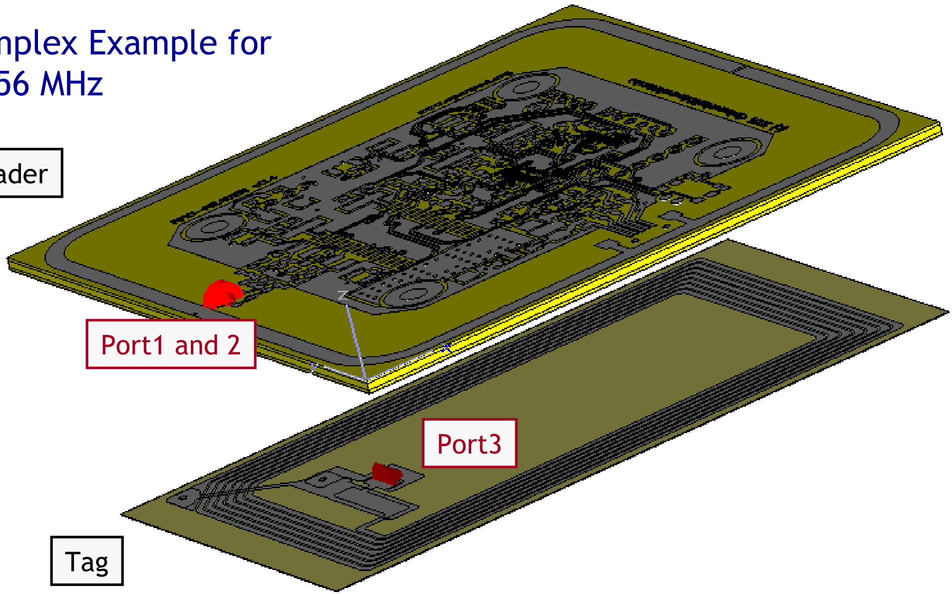
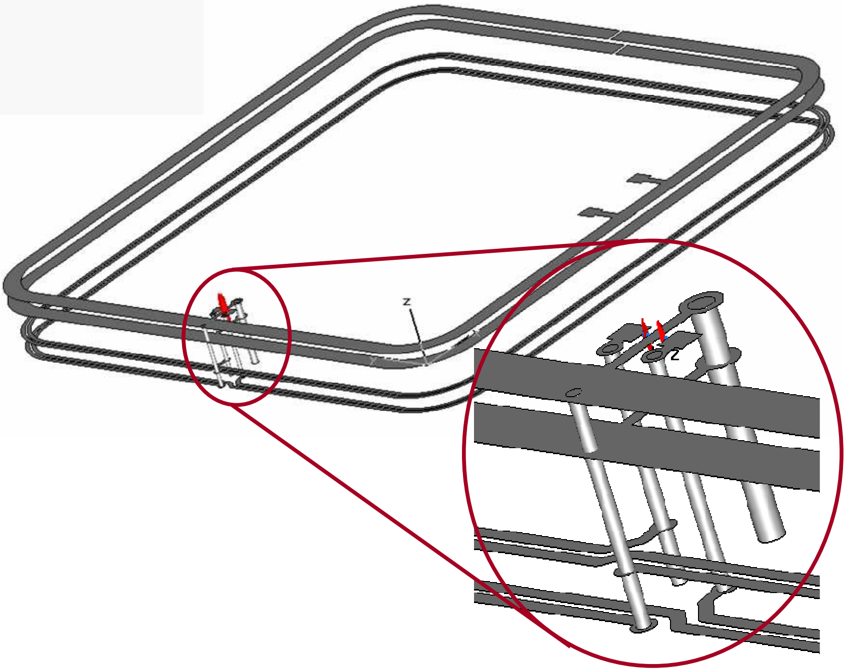
Reader &Tag

Inductive Coupling: 13.56 MHz

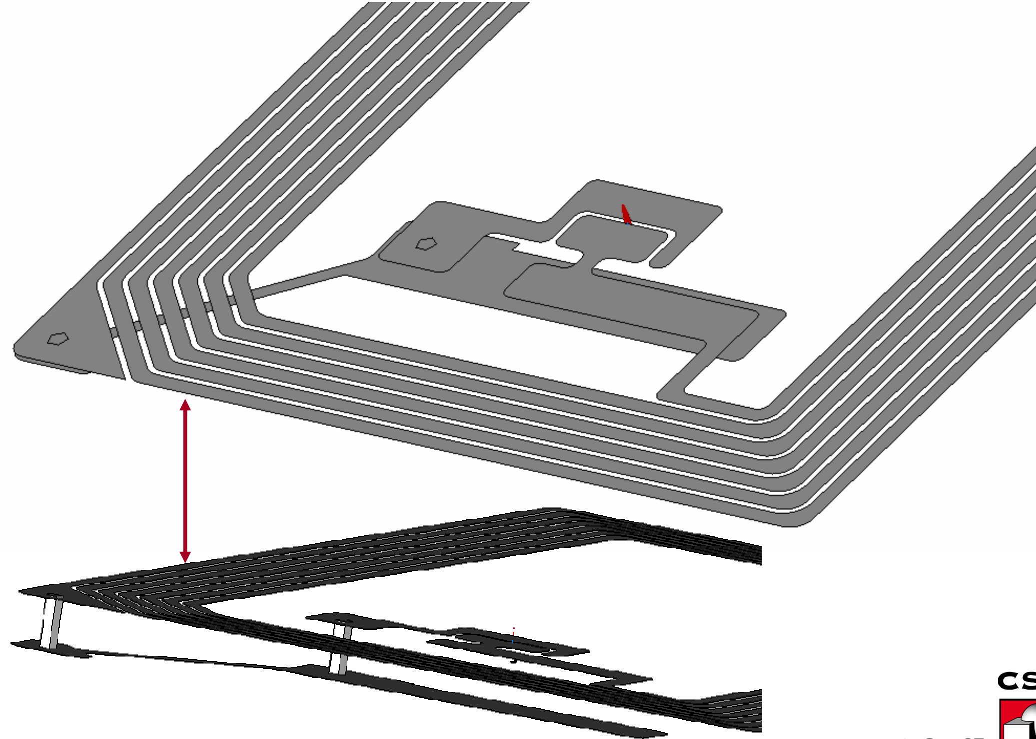
Complex Example for 13.56 MHz



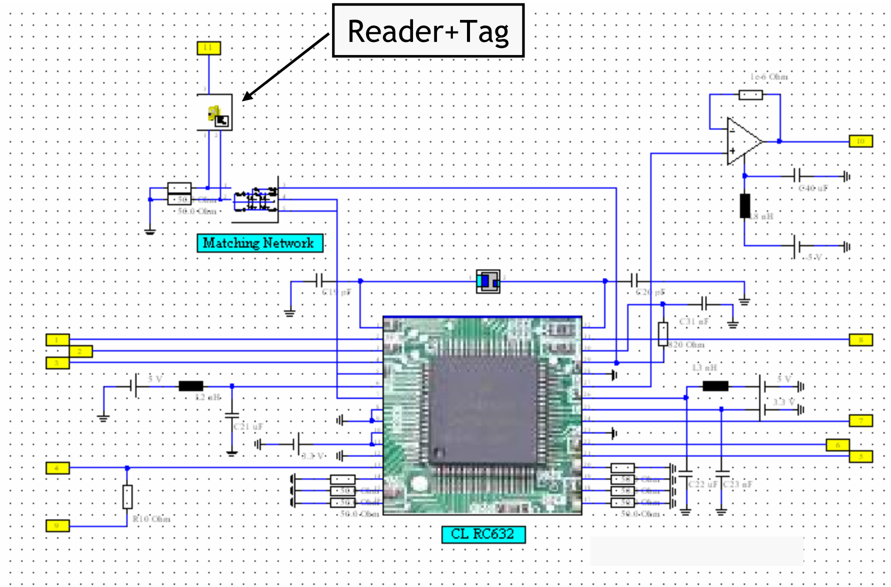
Zoom into Reader



Zoom into Tag



Circuit in CST DESIGN STUDIO

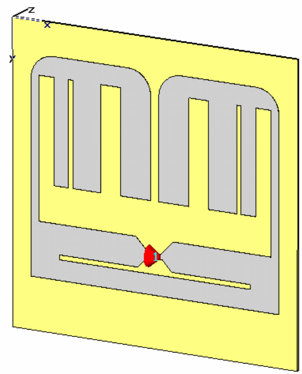


Microwave Coupling: Typical TAG

SMALL FORM FACTOR TAGS

GEN 2 1X1

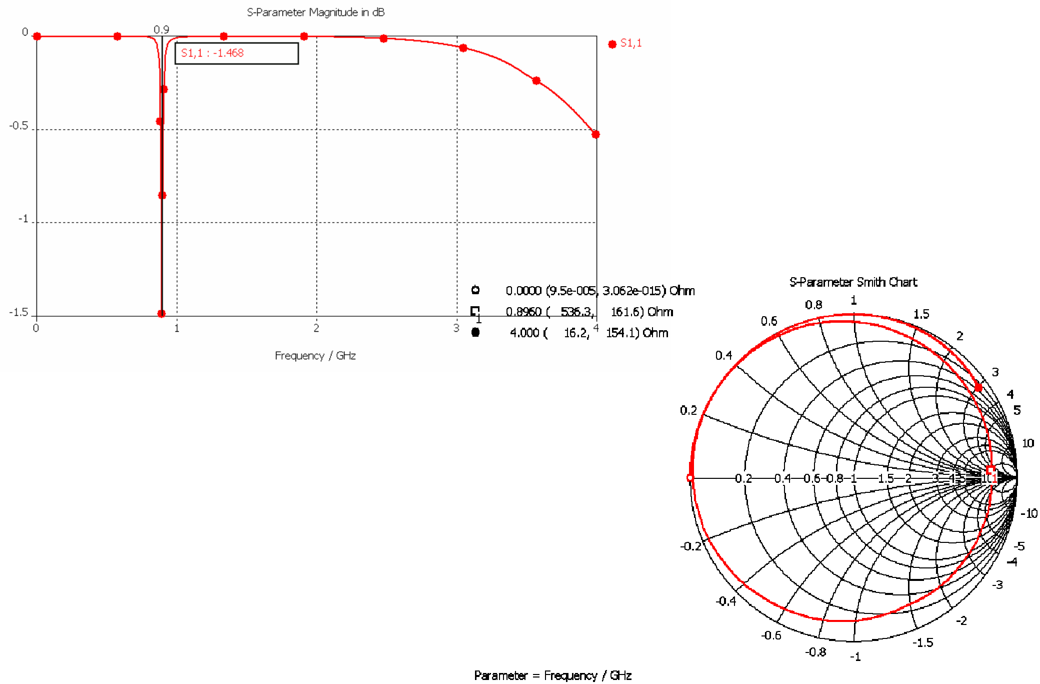
- Optimized for operation from 902 to 928 MHz
- Small form factor tag optimized for plastic packaging such as pharmaceutical pill bottles
- Near-field and far-field communication modes
- 25.4mm x 25.4mm



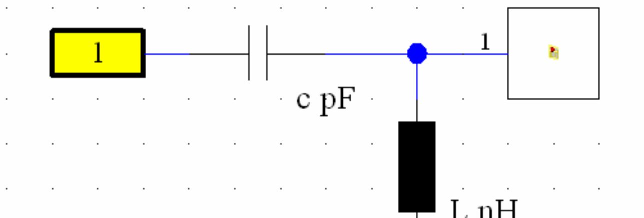
http://www.alientechnology.com/docs/Gen2_TagFam_datsht.pdf

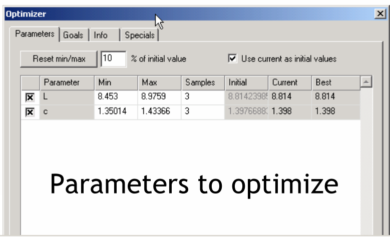
S-Parameter

$|S_{11}|$ in dB, unmatched

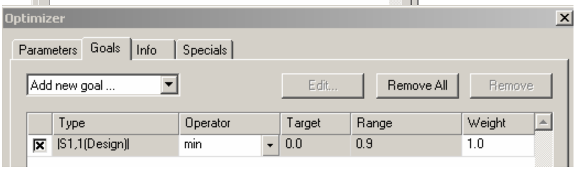


Matching Network in CST DS

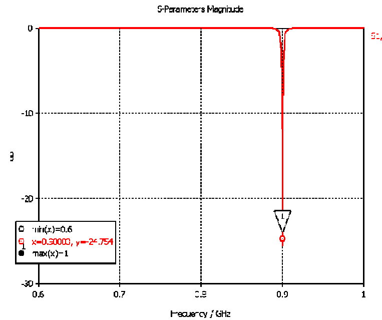


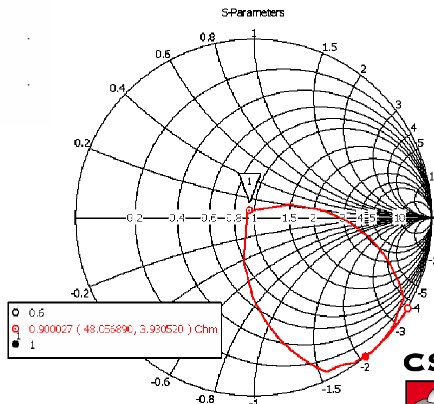


Parameters to optimize



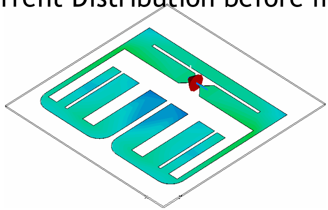
Goal definition



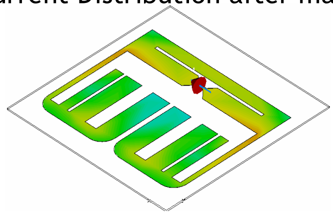


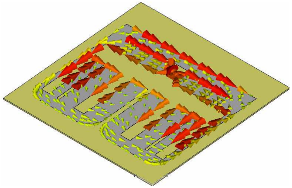
Surface-Current and Farfield
f=900 MHz

Current Distribution before matching

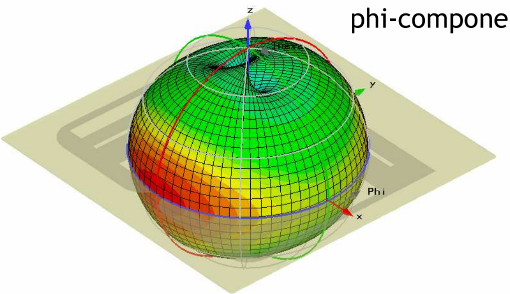


Current Distribution after matching

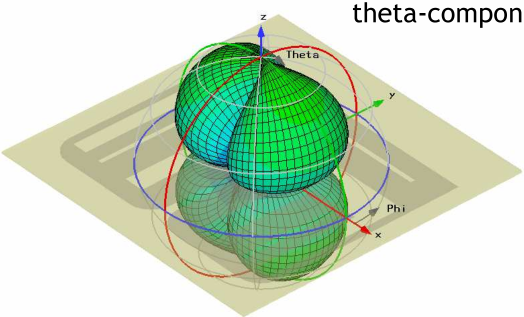




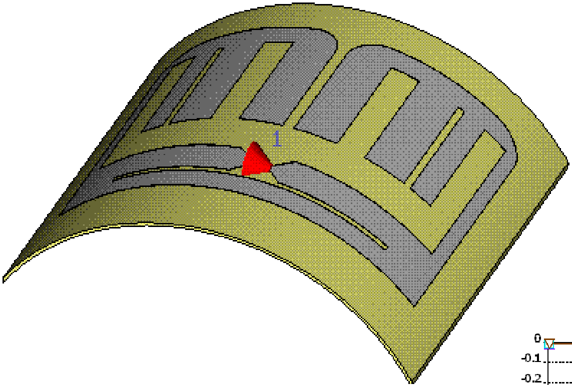
phi-component

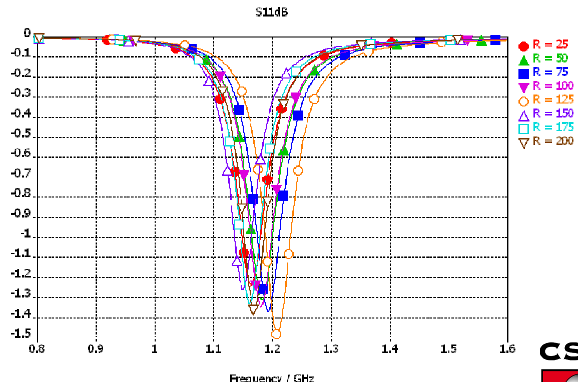


theta-component



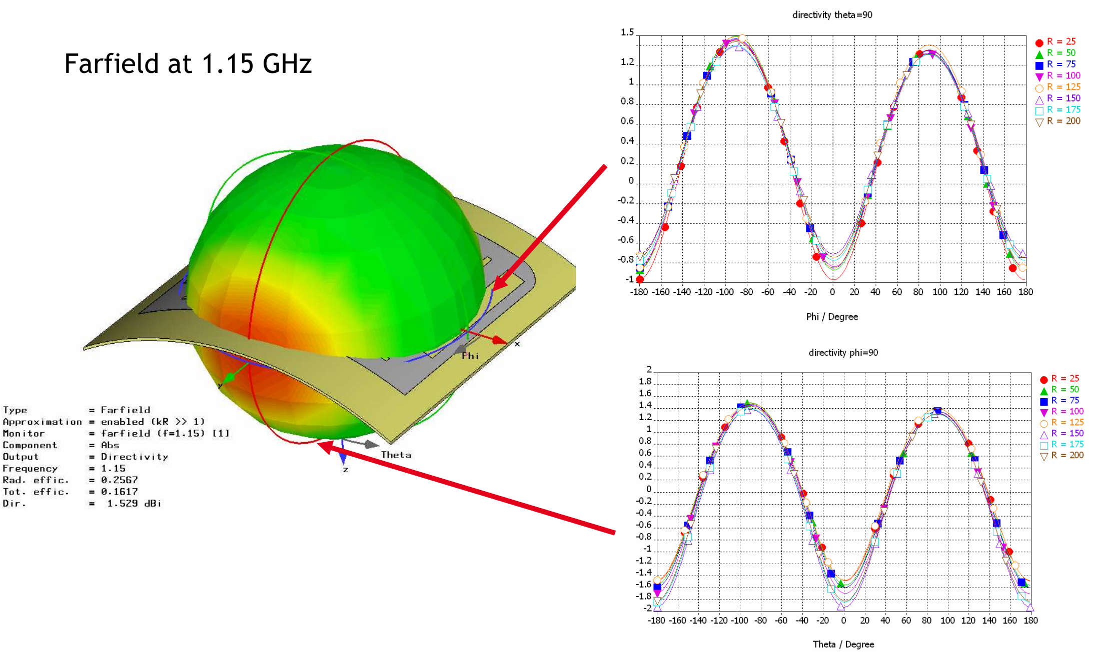
Parameter Study of a warped Tag





Parameter Study of a Warped Tag

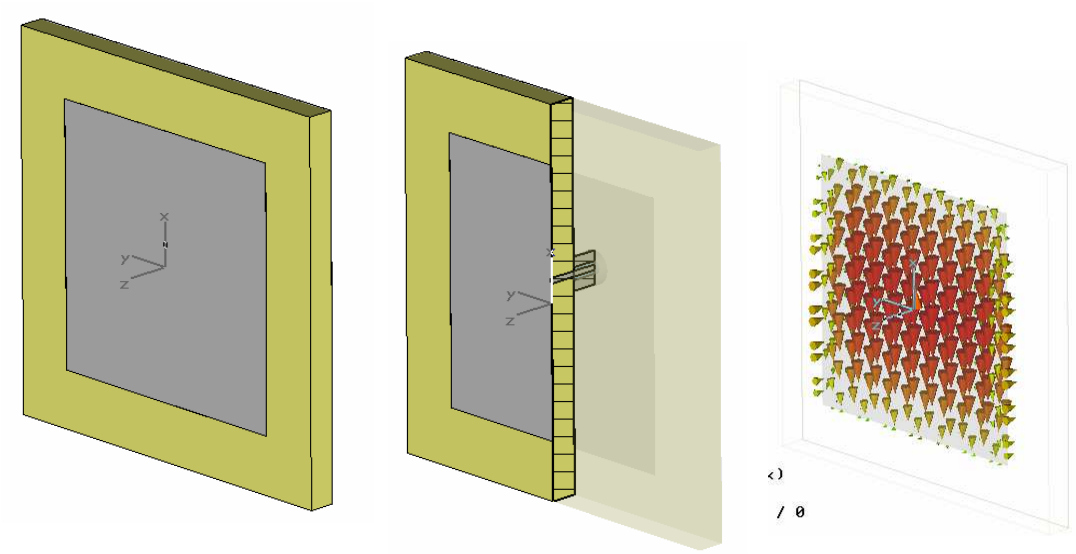
Farfield at 1.15 GHz



CST

Reader: Geometry

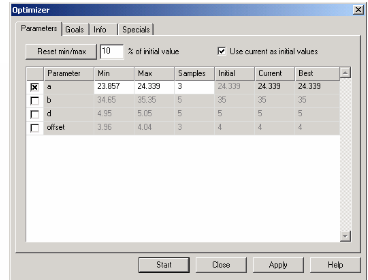
Simple, vertically polarized patch-type reader

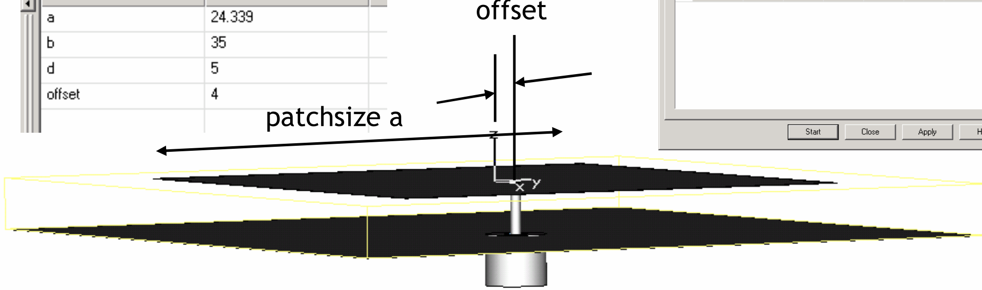


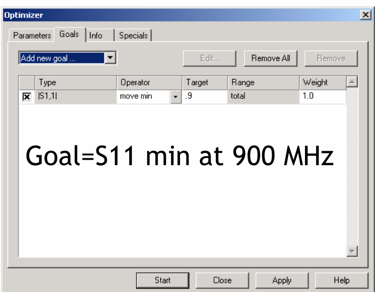
Reader: Optimization

Parametric model setup

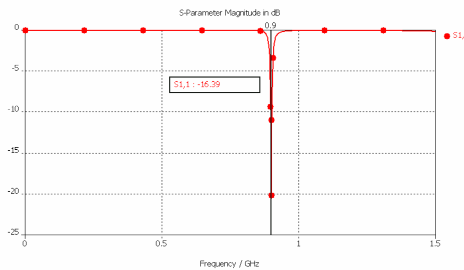
Name	Value	D
a	24.339	
b	35	
d	5	
offset	4	







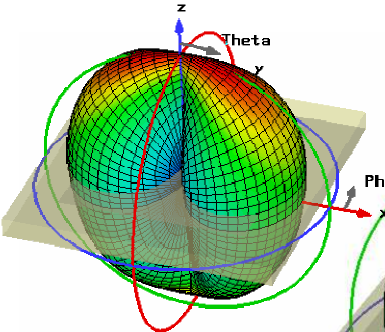
Goal=S11 min at 900 MHz

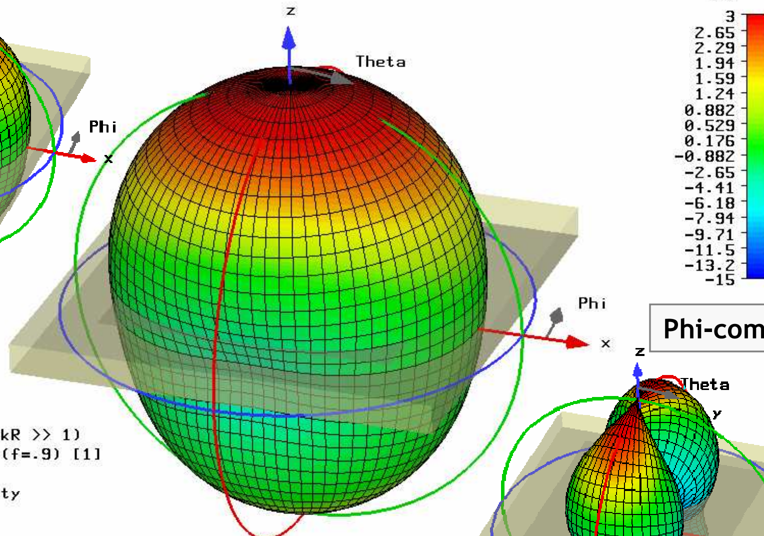


Reader: Directivity

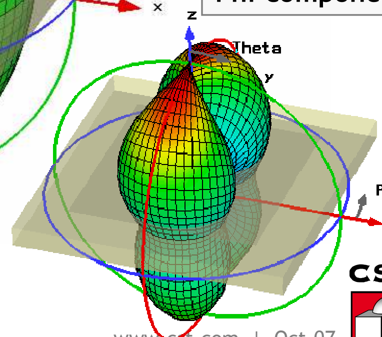
f=900 MHz

Theta-component



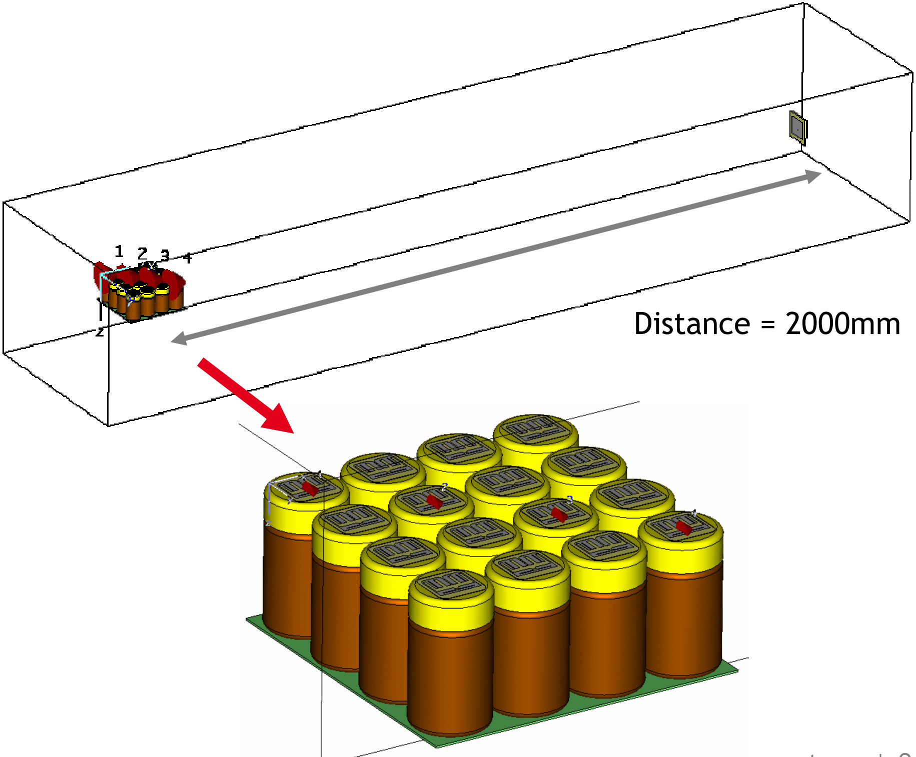


Phi-component



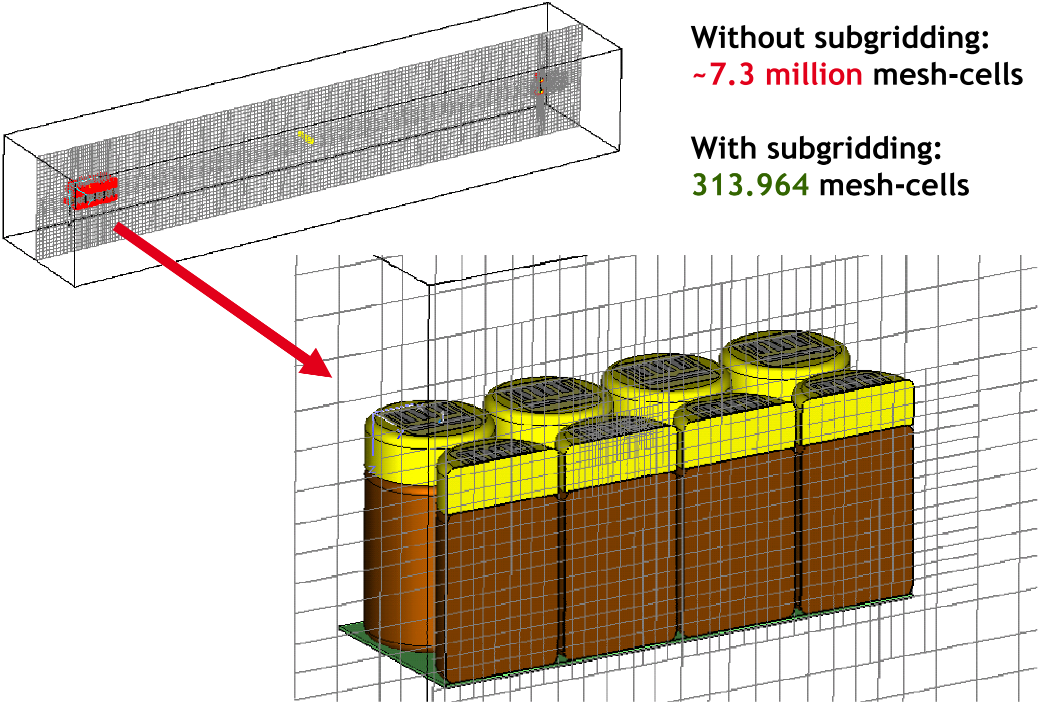

```
Type          = Farfield
Approximation = enabled (kR >> 1)
Monitor       = farfield (f=.9) [1]
Component     = Abs
Output        = Directivity
Frequency     = 0.9
Rad. effic.   = 0.9912
Tot. effic.   = 0.9628
Dir.          =  3.449 dBi
```

Tags on medical pill-boxes



Advanced Meshing

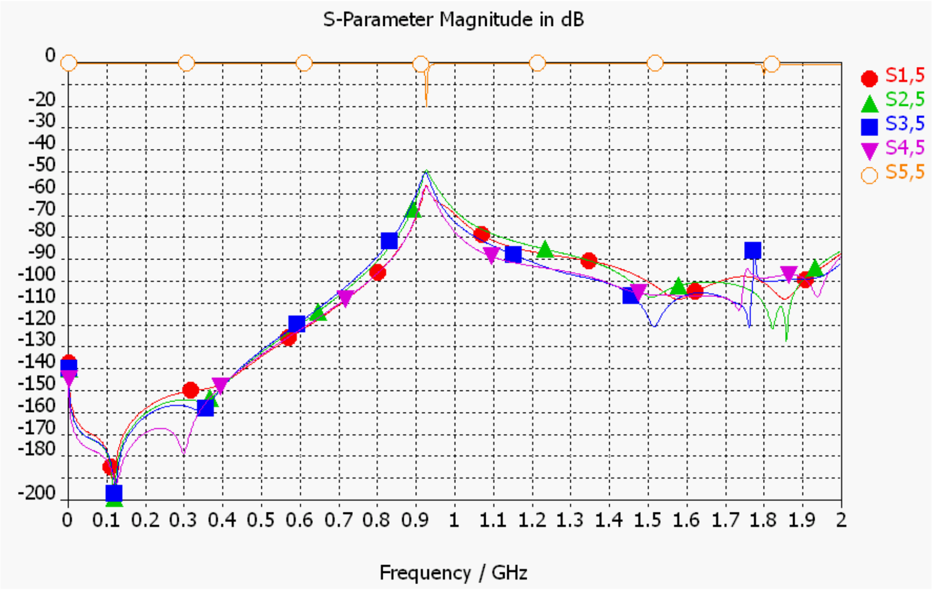
PBA + Subgrid



Without subgridding:
~7.3 million mesh-cells

With subgridding:
313.964 mesh-cells

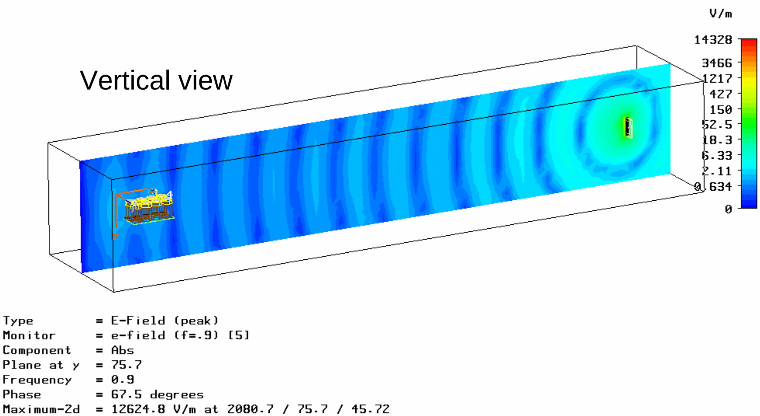
S-Parameter
|S| in dB



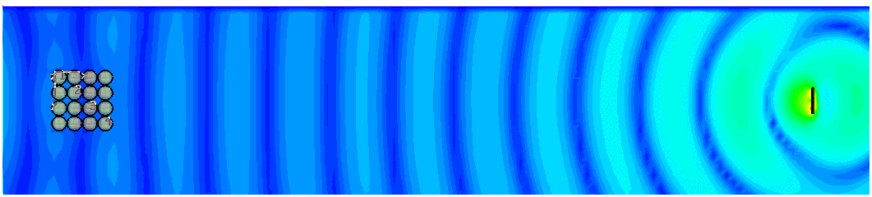
Simulation time: 2.2h on 32bit machine, 400MB

E-Field > e-field (f=900) MHz

Vertical view



Animated top view

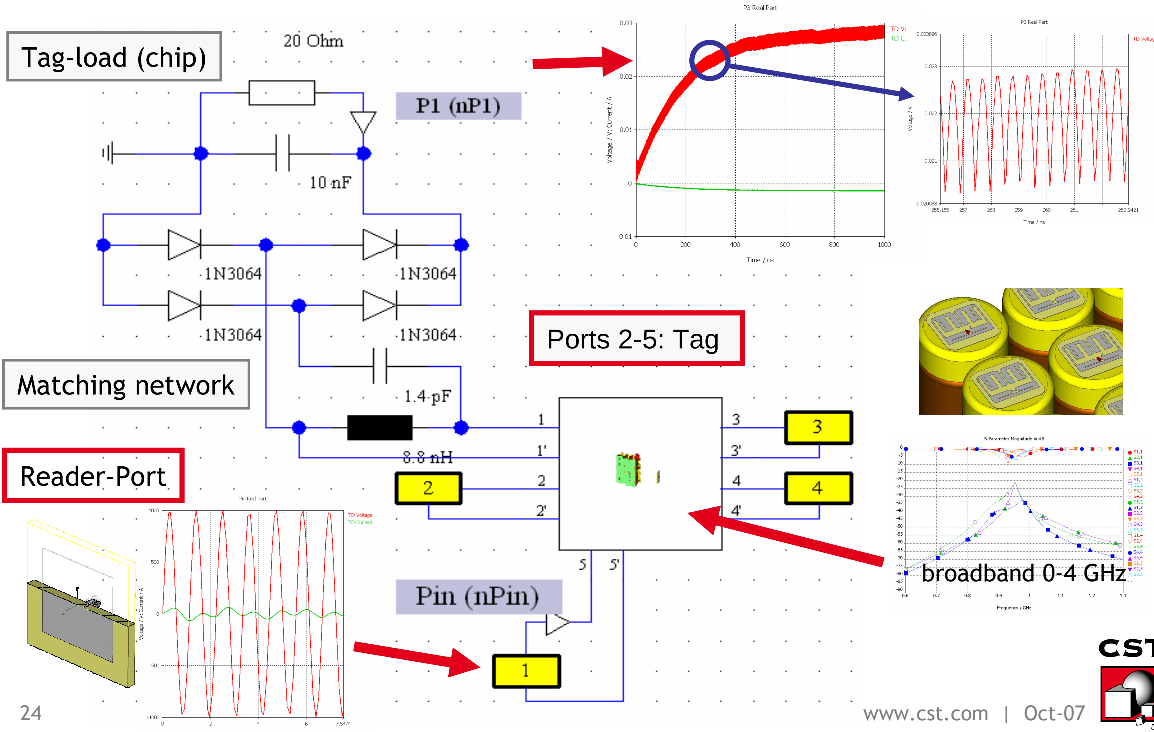


CST - Computer Simulation Technology

CST

Simulation of tags and reader

New **transient task** in CST DS



Summary

- **RFID is a general concept using different technical principals**
- **CST complete technology approach offers best solution for each case**
  - CST MWS Frequency Domain / CST EMS for inductive type
  - CST MWS Transient for microwave type
- **Coupling between CST DS and CST MWS allows easy combination of circuit and 3D EM anlysis, e.g. for**
  - Tag matching networks
  - Reader circuits (new transient solver in CST DS)