Presentation of ETS-Lindgren solutions:

- How to select right test environment: Anechoic, Reverb, GTEM
- Modular concept of RF test system: EMCenter
- Complicated EMC job can be done easy: TILE software

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ETS·LINDGREN™
An ESCO Technologies Company

Enabling Your Success

World leader: EMC-Antenna-Wireless testing

Production in: Finland, UK, USA

We operate our own laboratory!

- **In Cedar Park (Austin), Texas**
- **EMC & Wireless, ISO 17025**

NVLAP®
NVLAP LAB CODE 100286-0

Wi Fi ALLIANCE

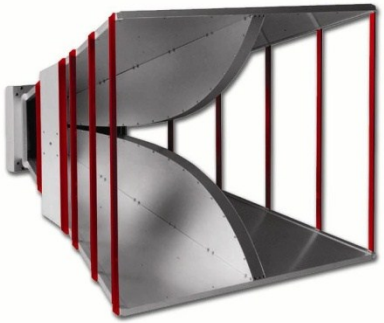
QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
ISO 9001:2000
CEDAR PARK & EURA

WiMAX FORUM
MEMBER COMPANY

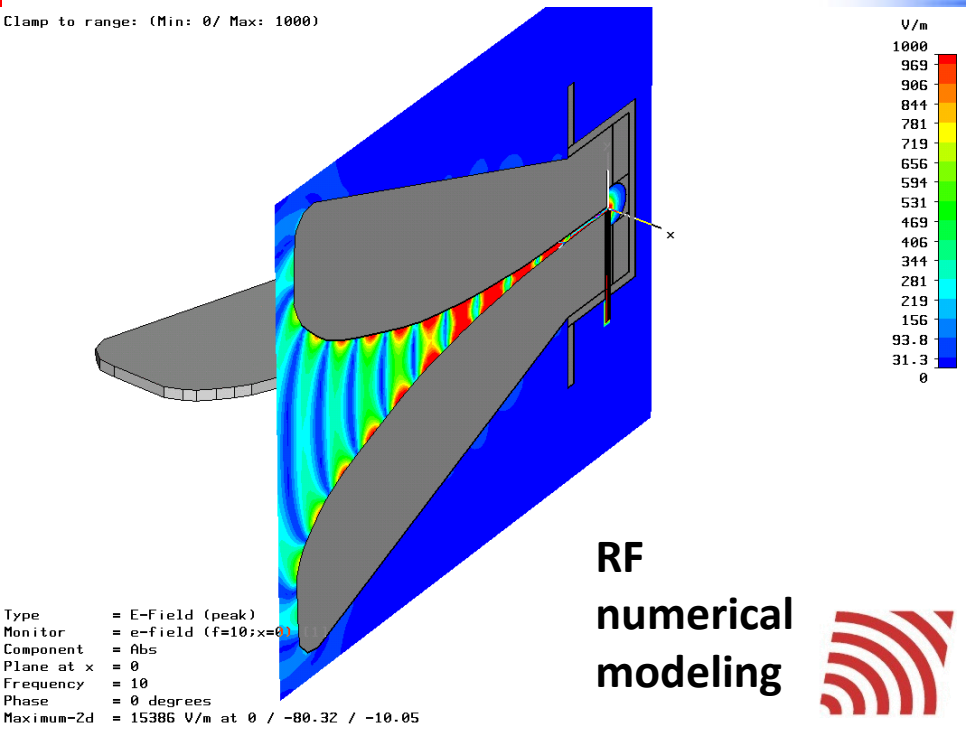
CTIA Authorized Test Lab
LAB CODE 20021212-00

A2LA
ACCREDITED
Lab Cert # 1207.01/1207.02

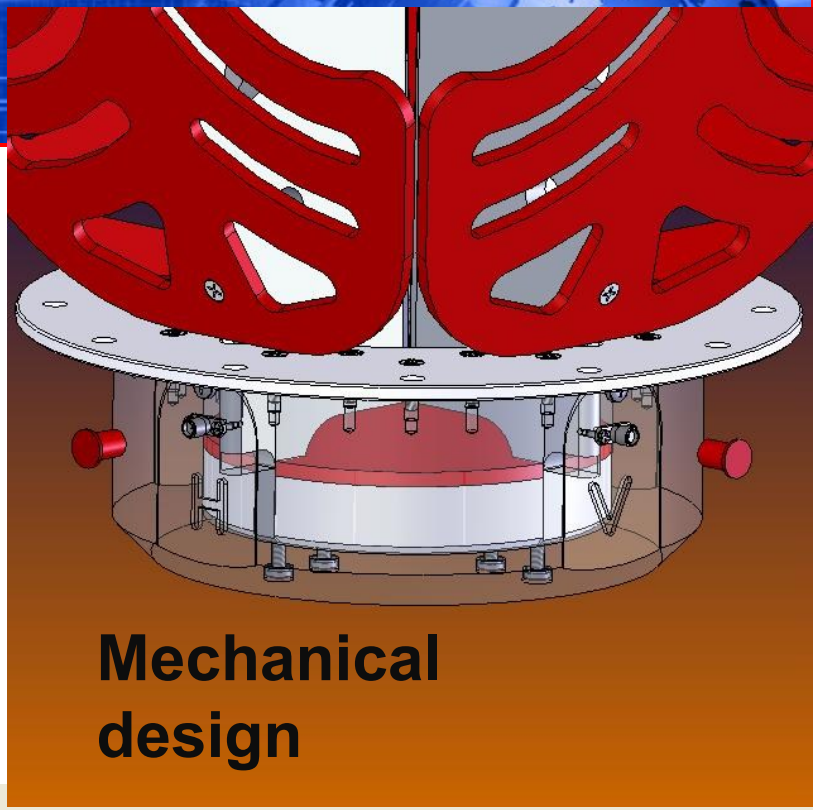
Antennas



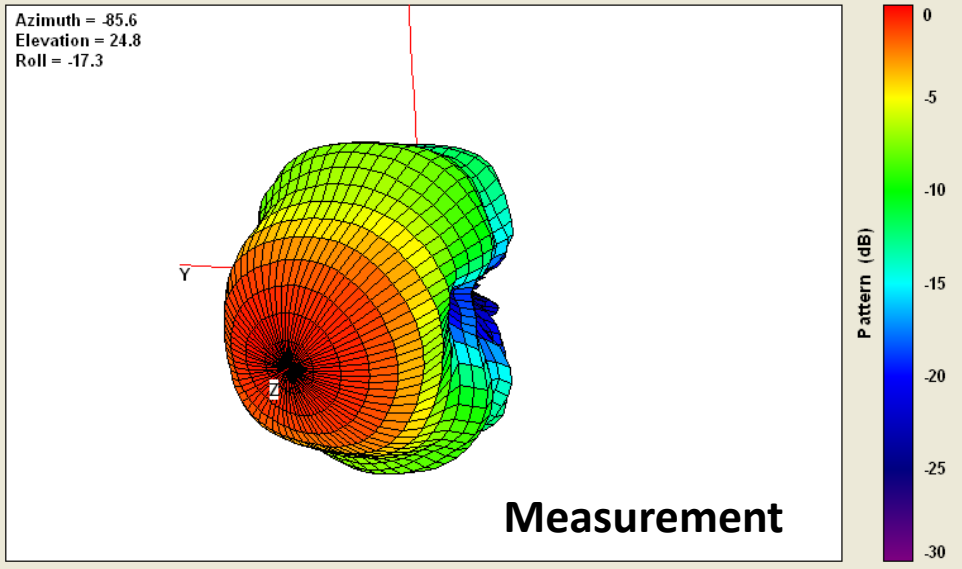



RF numerical modeling



Mechanical design

Fabrication



Measurement

Low frequency immunity horns

S81 & S101 Shielded Enclosures

EMC / OTA Positioners

EMC Field Sensors

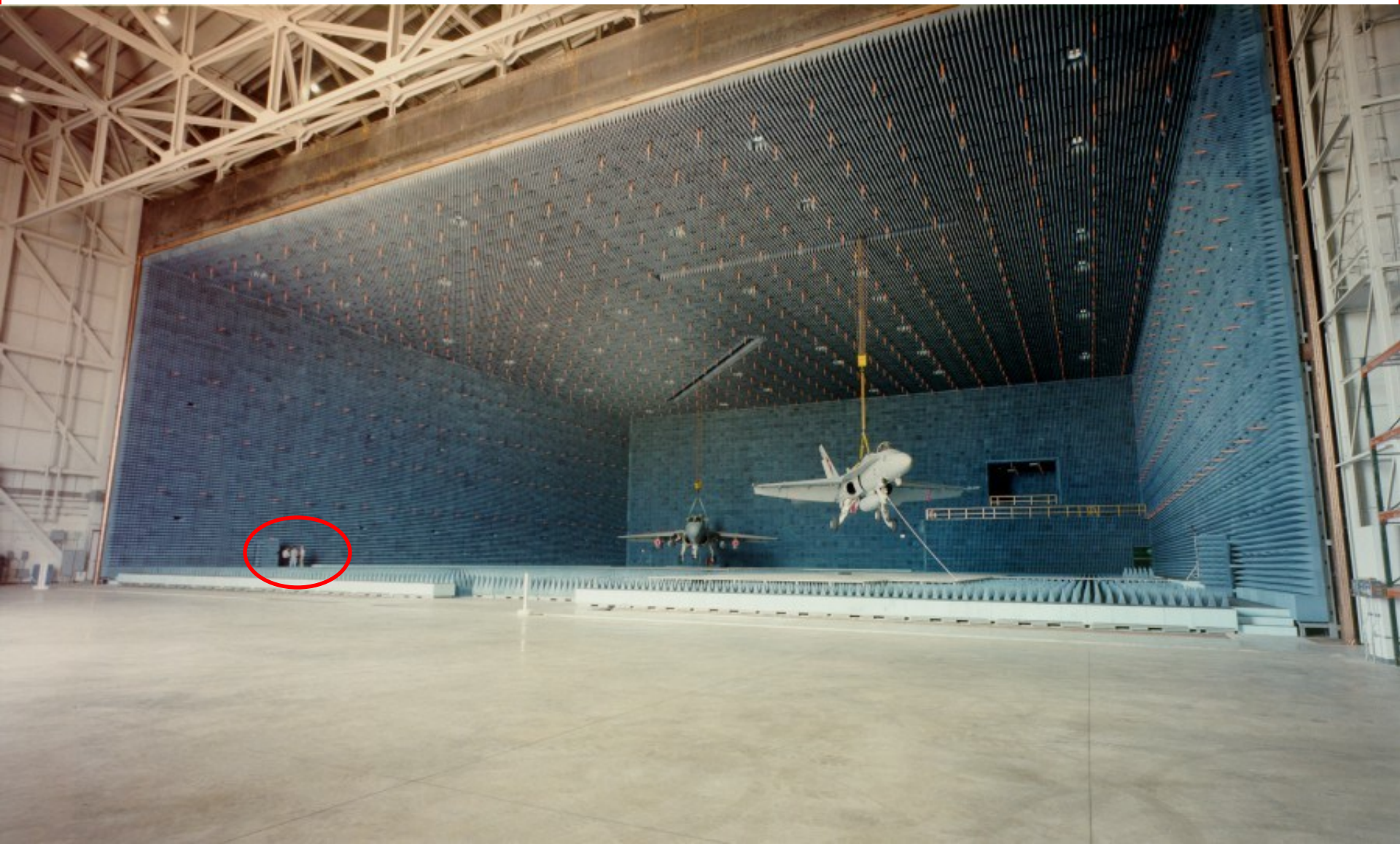
Shielded Doors, CCTV Cameras and Filters

LRX Twin Series Filters

ETS·LINDGREN™
An ESCO Technologies Company

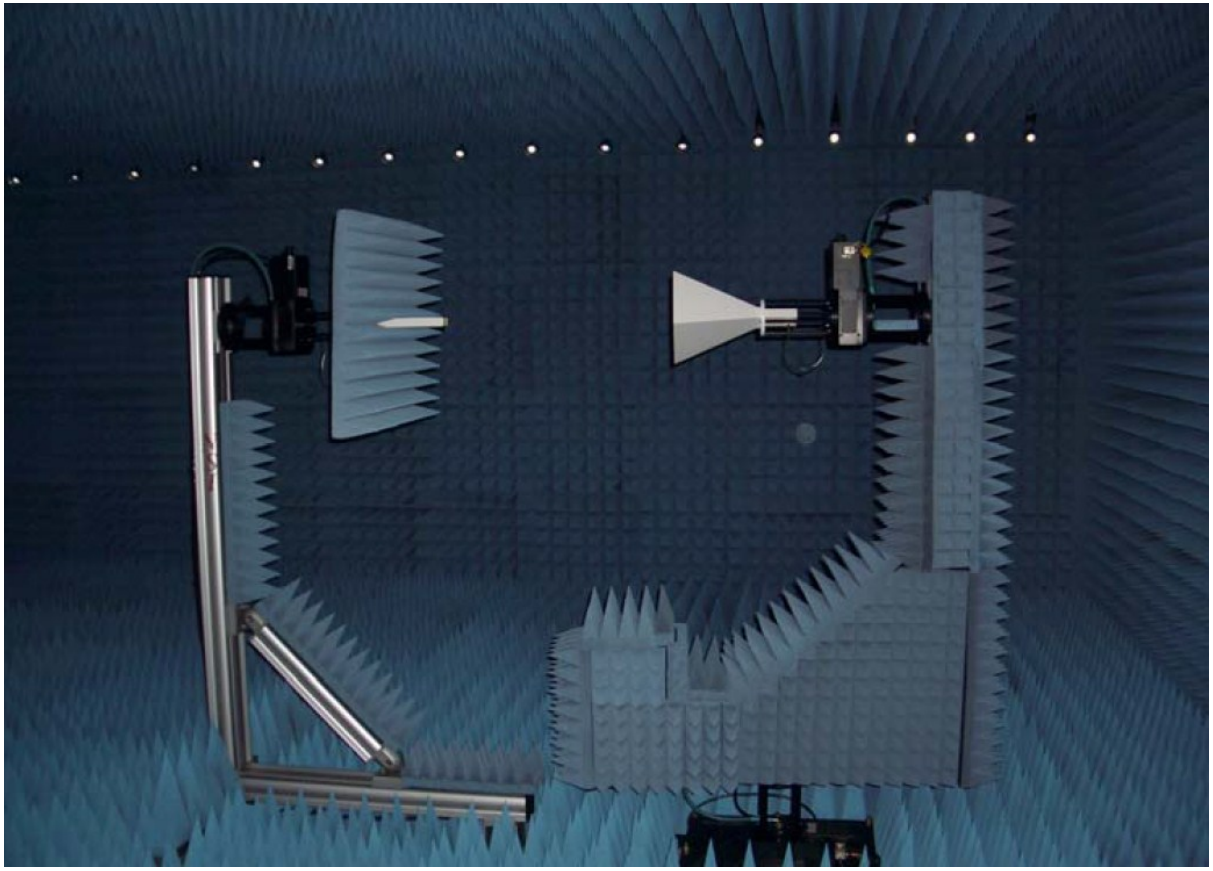
Enabling Your Success

Pax River Naval Air Warfare Center full aircraft chamber




Courtesy of OTOKAR

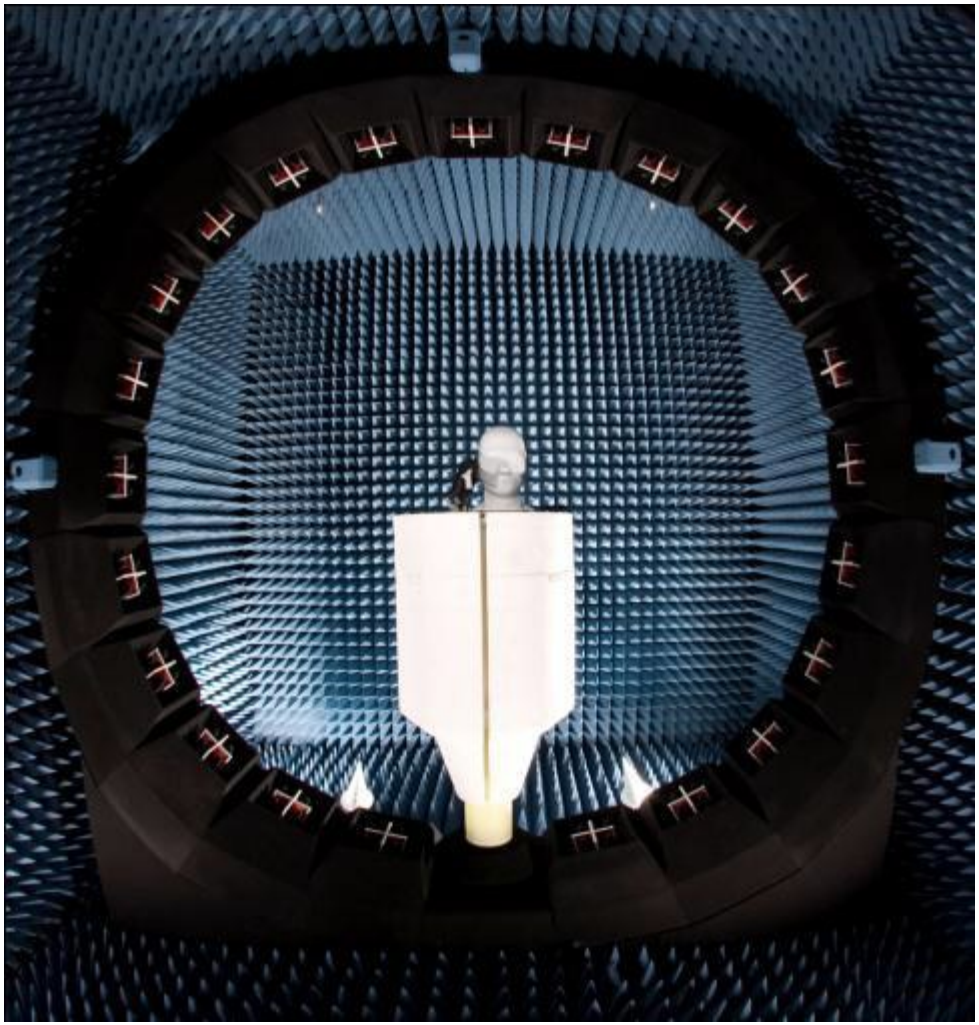
NF/FF antenna measurements with NSI



Portable chamber: passive/active antenna

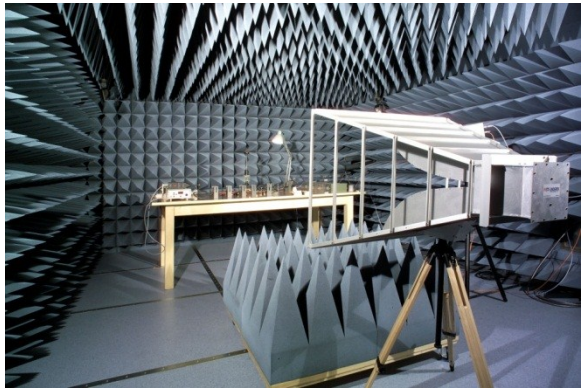
Full compliance wireless chamber

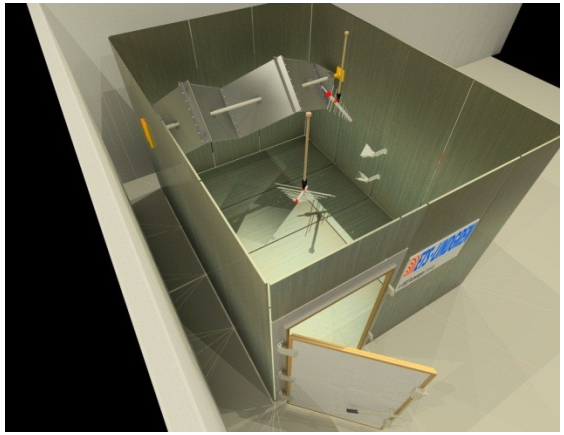
- AMS 8900
  - 2 models – 3 path lengths
  - 700 MHz – 6 GHz
  - 400 MHz Option available
  - 23 & 47 Sensor Models
  - 8923 13’ x 13’ x 14’ (4m x 4m x 4.3m)
  - 8947 16’ x 16’ x 17’ (5m x 5m x 5.3m)
  - **High Speed Active and Passive Antenna Measurements**
  - Passive Antenna Testing in <1 min per frequency
  - Fully Compliant 3 channel active measurements in < 2 min
  - Excellent correlation to conventional single antenna measurement systems



How to select right test environment

- Anechoic,





- Reverb,

- GTEM

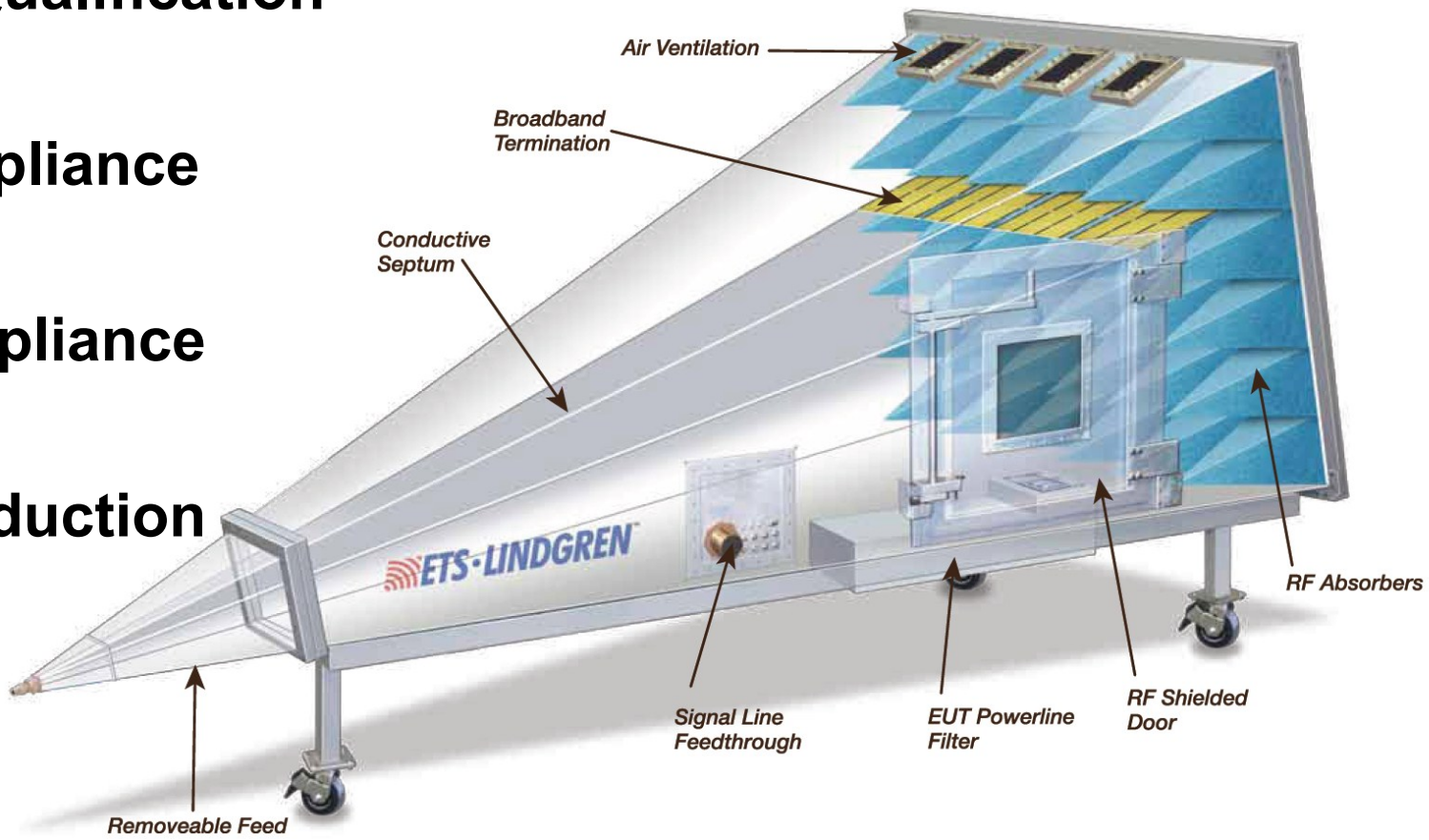
Where I can perform EMC testing:

- **OATS (weather and condition dependent, ambient noise, only for emission, if works !)**
- **Semi-Anechoic chamber (full and precompliance EMI/IMM testing for 10-5-3-1m test distance)**
- **Reverberation chamber (size of chamber related to frequency of testing, application: MIL, Automotive, Avionics,)**
- **GTEM cell (smaller EUT's, correlation software needed for emission, IMM: simple test system)**

When GTEM is my solution:

For All Phases of EMC Testing:

- **Design Qualification**
- **Pre-Compliance**
- **Full Compliance**
- **Post Production**



When GTEM is my solution:

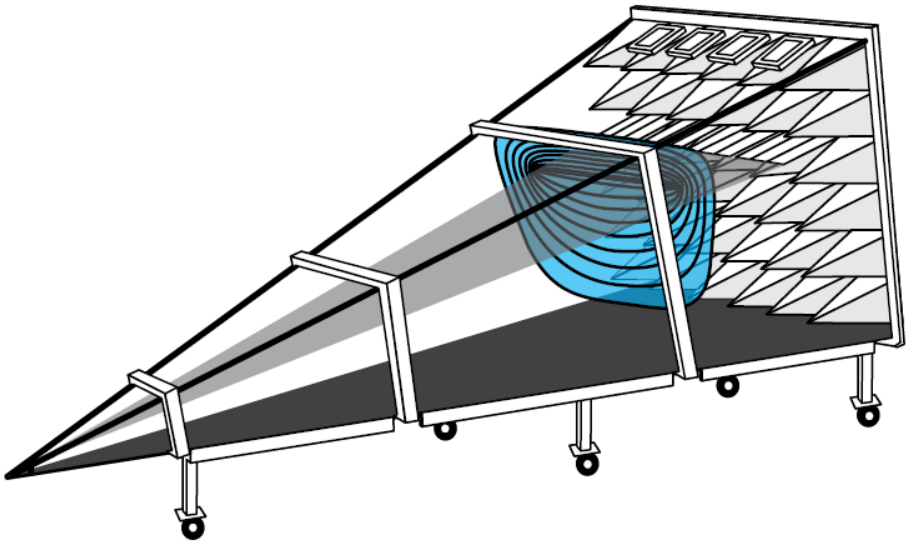
- Full compliance testing:

- IEC 61000-4-3/EN 61000-4-3,
- MIL-STD 462, ANSI C63.4,
- EN 55022 and VDE 0871

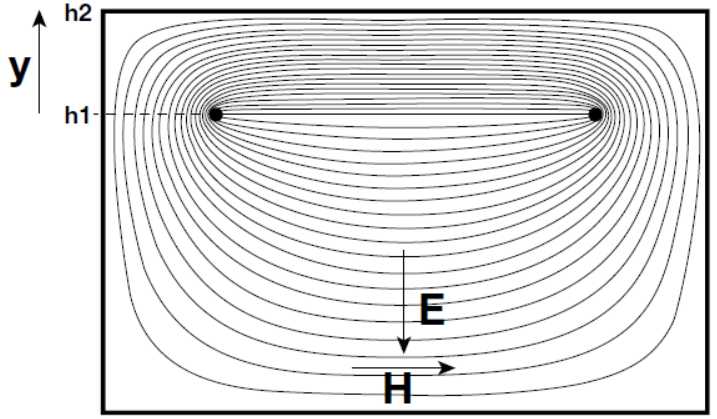
- Pre-compliance testing:

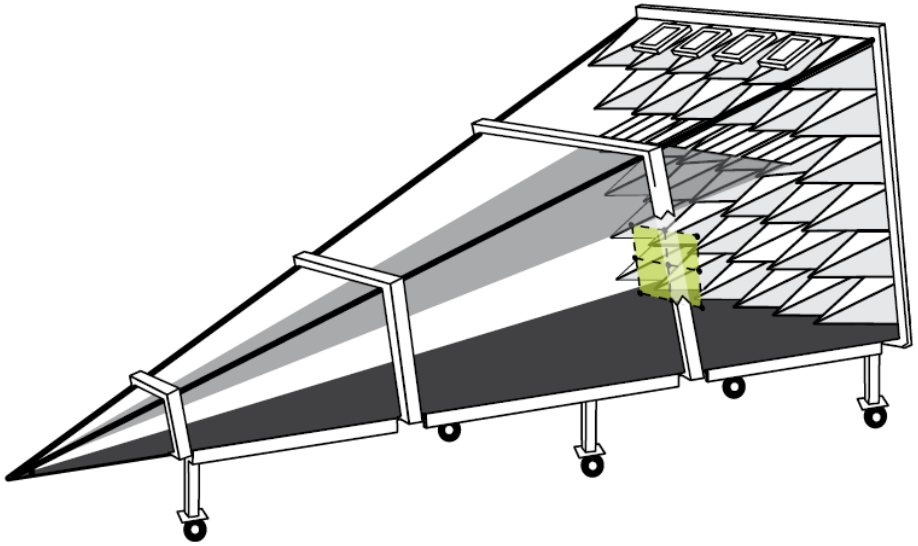
All items can be fitted inside

How does it work:

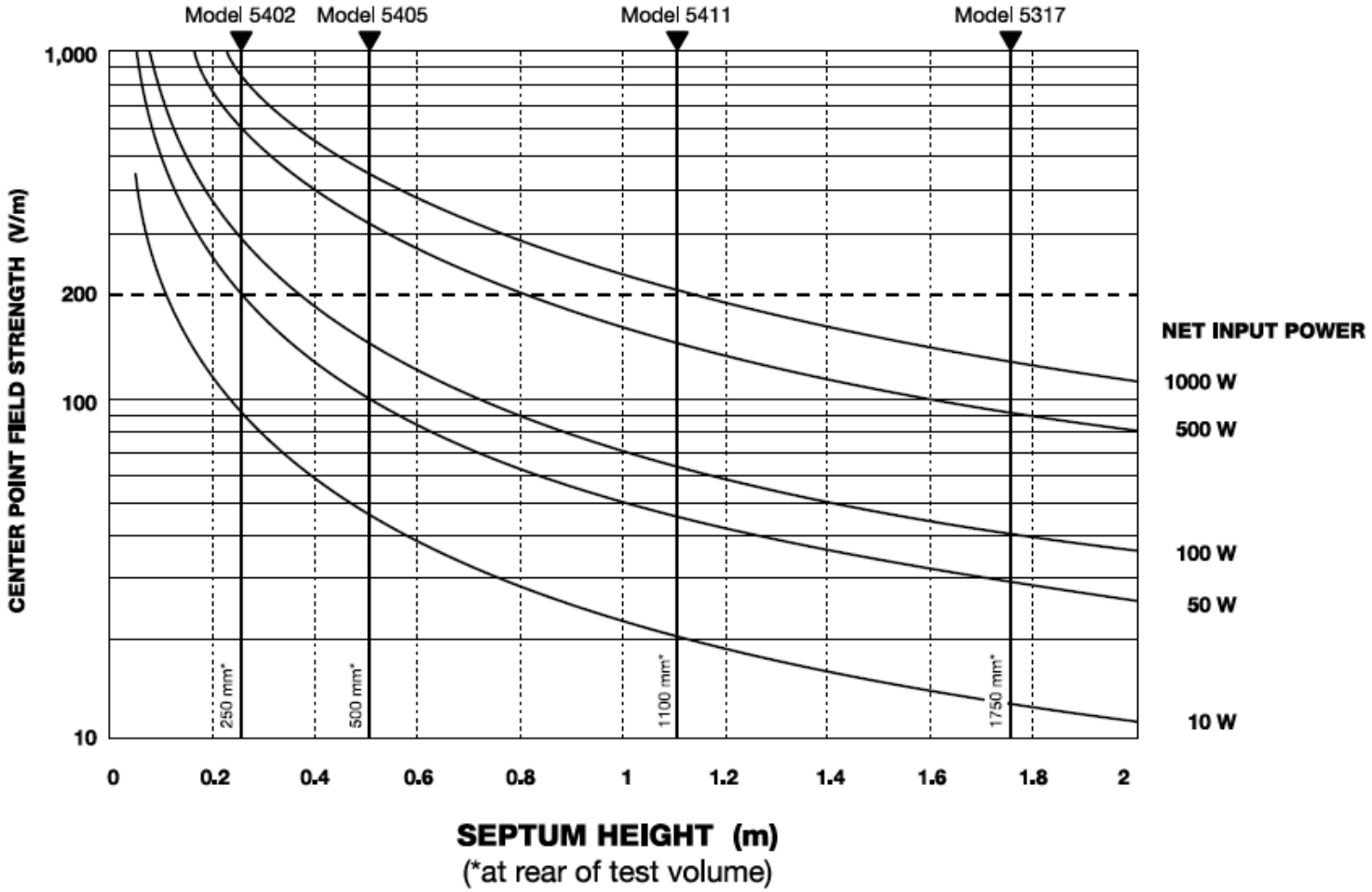


GTEM! Potentional Distribution:





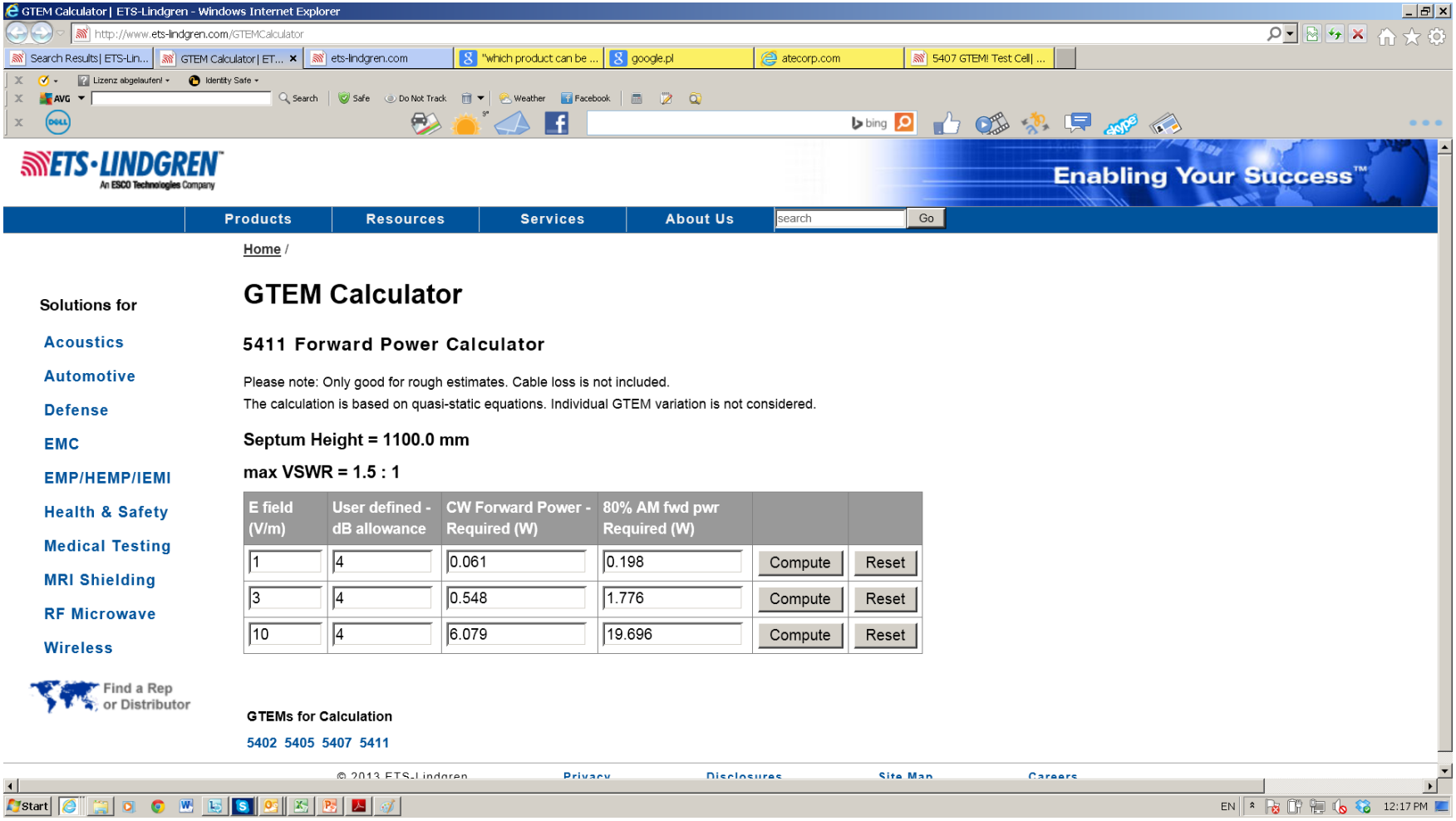
Immunity: Theoretical Field Strength:



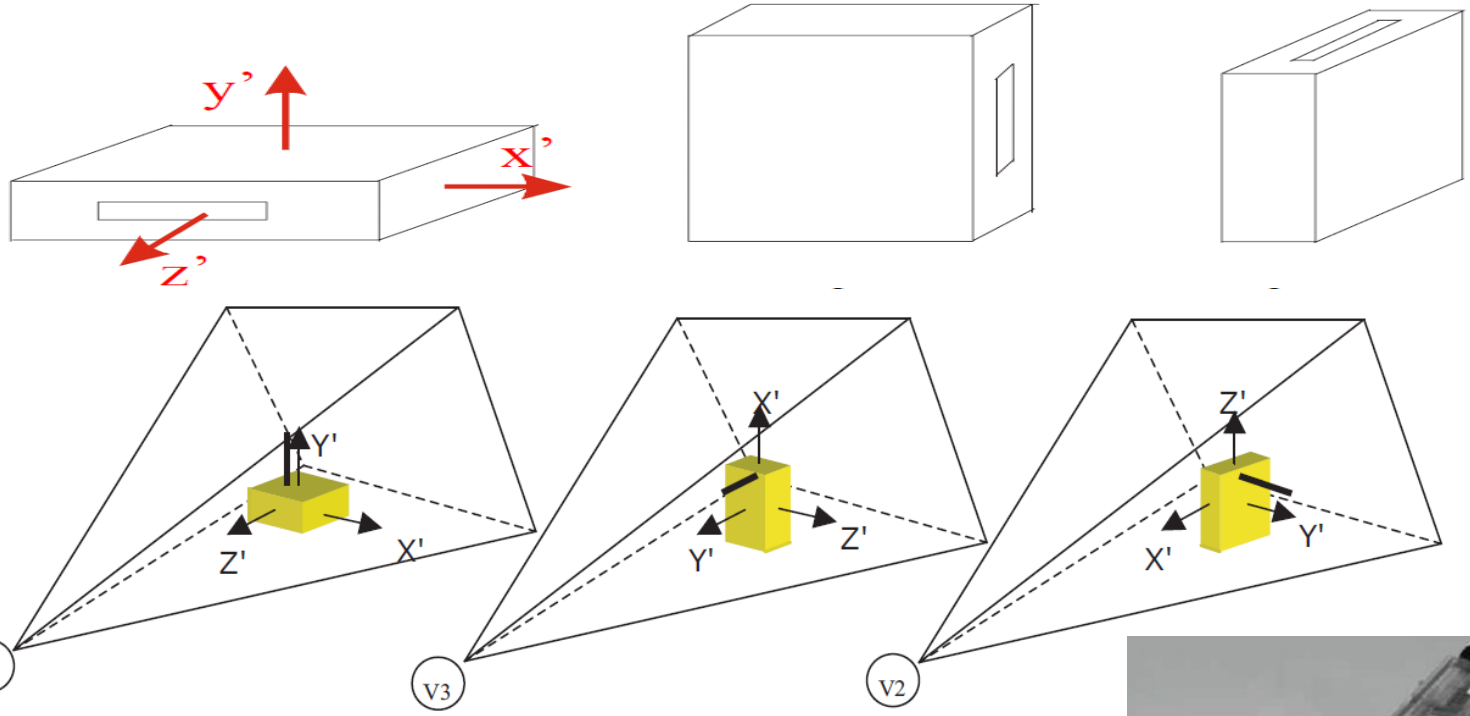
E-Field variation may be ± 3 db with respect to theoretical field strength depending on frequency and location in test volume.

Immunity: ETS-Lindgren calculator

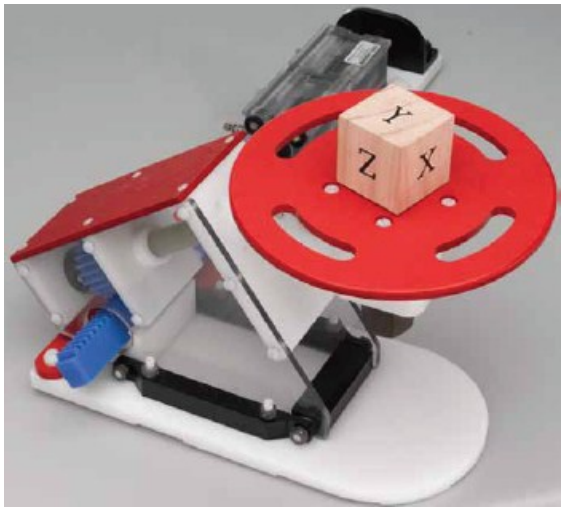
visit our page: ets-lindgren.com



Emission: correlation is a must

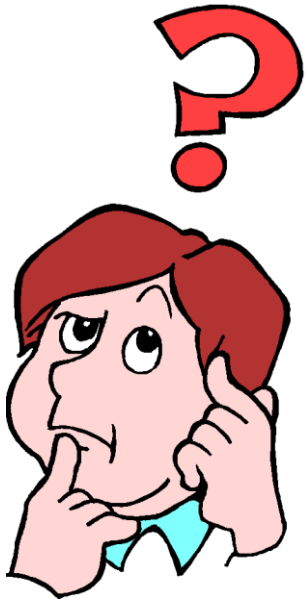


Main conclusion: 3-axis positioner is really useful



Reverb Chambers

- But, what exactly is a REVERB Chamber?



Introduction

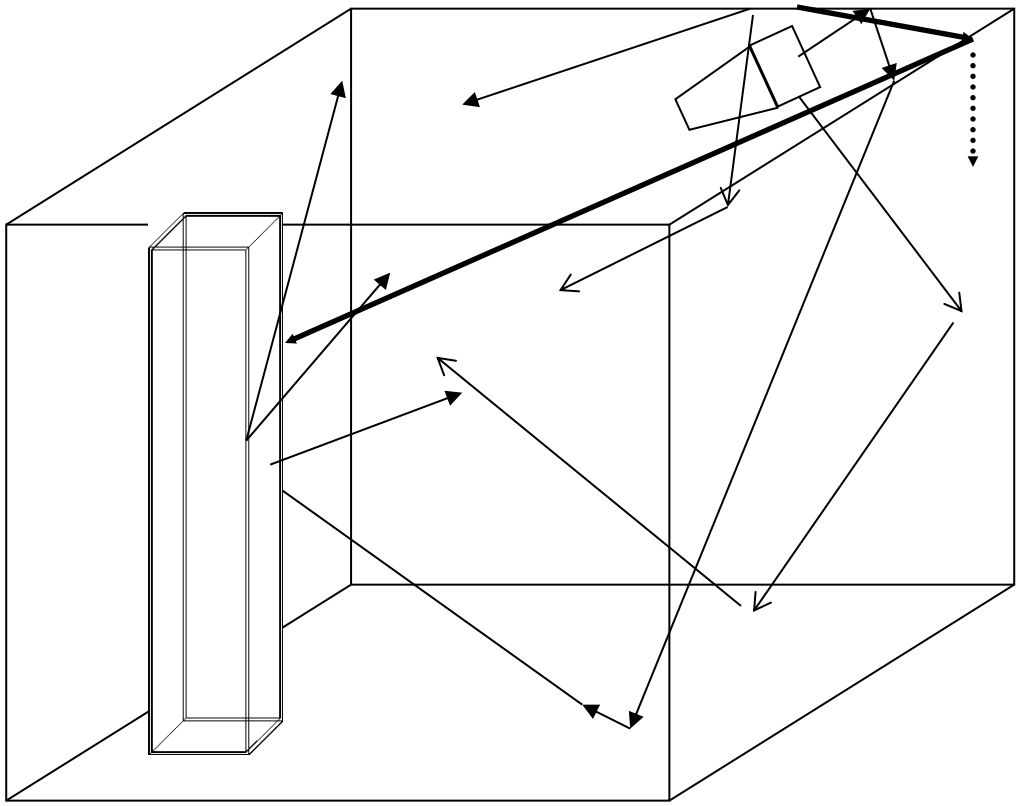
- Reverb chambers :
  - Are a specialized type of shielded enclosure.
  - Typically use mechanical reflectors (tuners) to establish a statistically uniform, isotropic and randomly polarized field in the chamber through changes in the positions of the tuners.
  - Produces a vigorous test environment for a wide range of product types….
  - Used for performing representative Immunity, Emission and shielding effectiveness tests.

REVERB CHAMBERS - in more detail

- A reverb chamber is a cavity, into which RF energy in injected,
- Through the use of boundary condition changes, a statistically uniform, homogeneous and isotropic environment is established.
- The environment is used to perform RI, RE and SE tests…

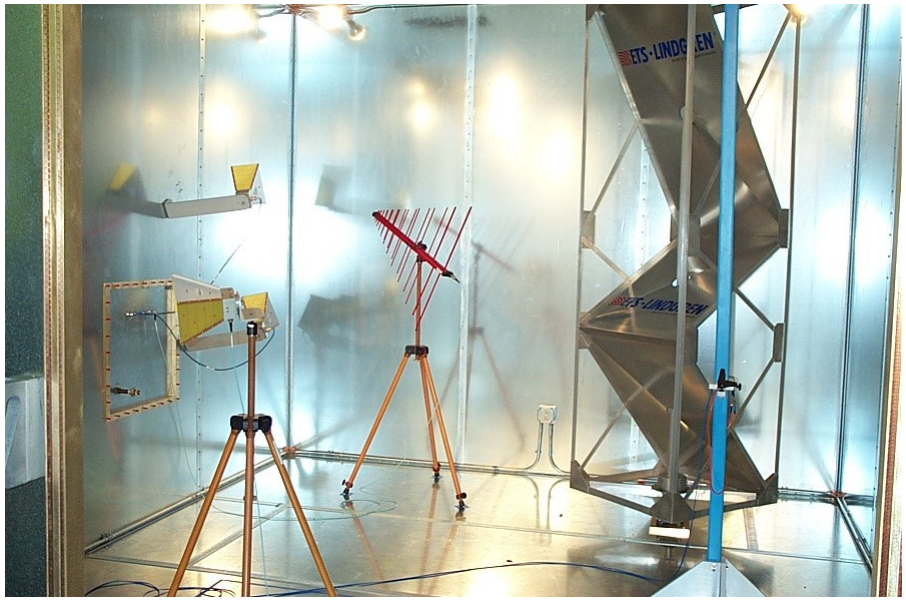
REVERB CHAMBERS - in more detail

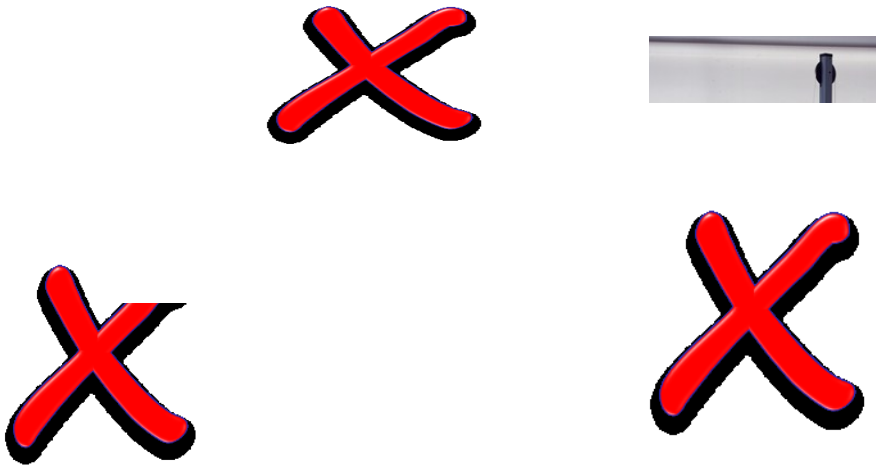
- *Reflections in cavity:*



Another point of view for reverb

- Reverb chambers :
  - Can be built to various sizes depending on customer requirements.
  - Does not typically use TT, absorbers or masts…

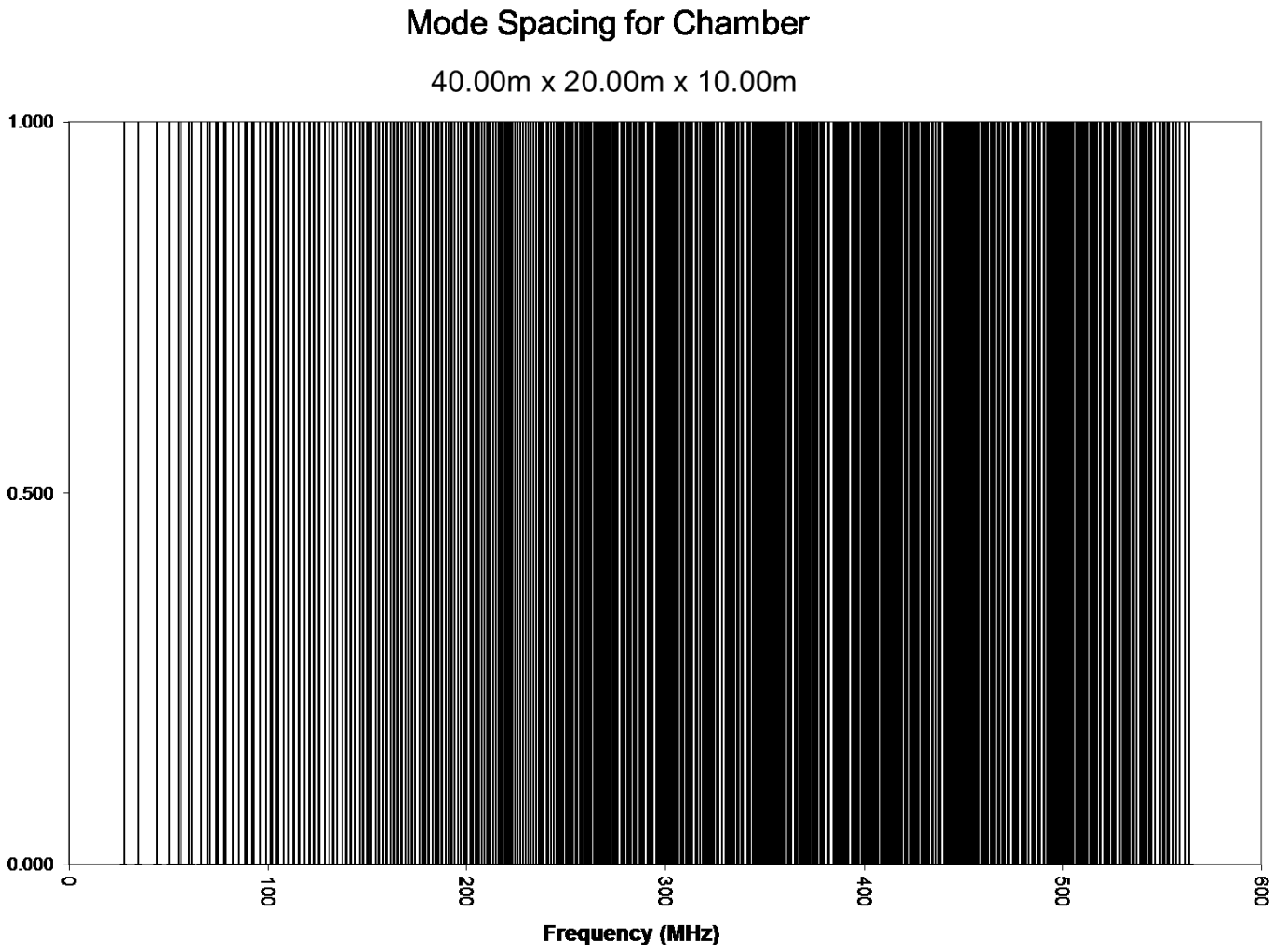




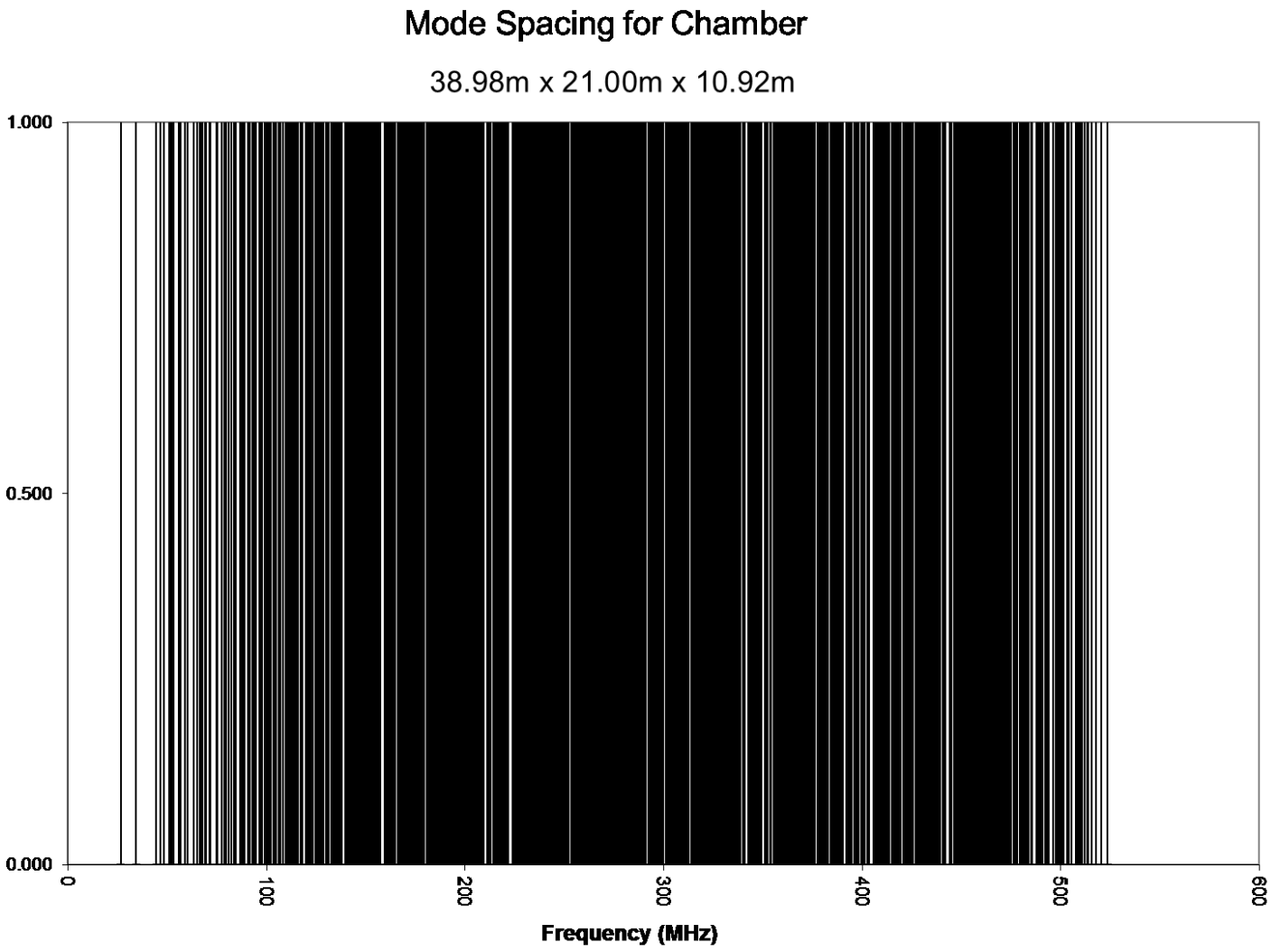
Key Differences - Reverb

- No direct illumination of the test volume…

Dimensions


Mode Spacing for Chamber
40.00m x 20.00m x 10.00m
1.000
0.500
0.000
0
100
200
300
400
500
600
Frequency (MHz)

Small change big effect !!!



REVERB CHAMBERS - in more detail

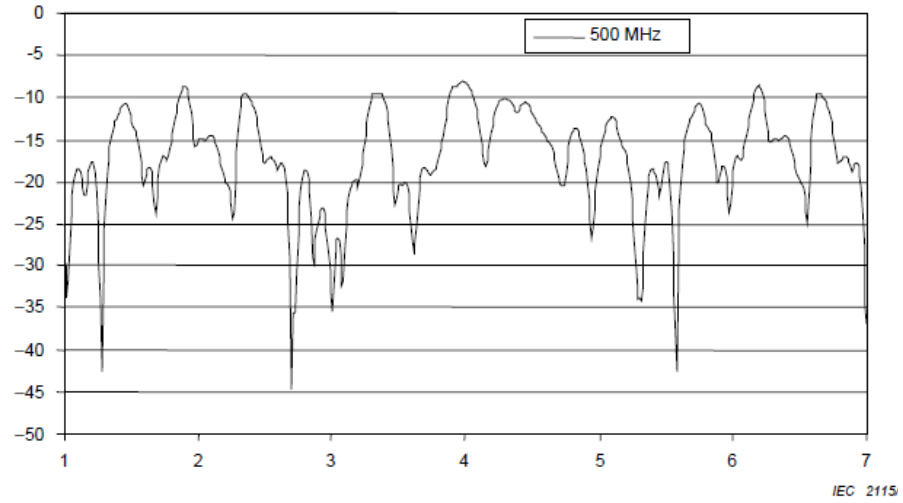


Figure C.1 – Received power (dBm) as a function of tuner rotation (s) at 500 MH

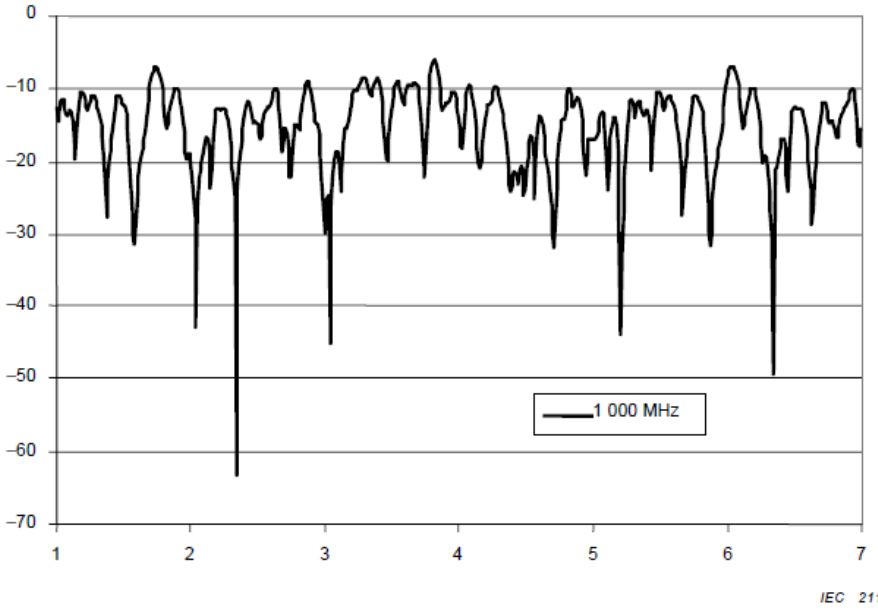
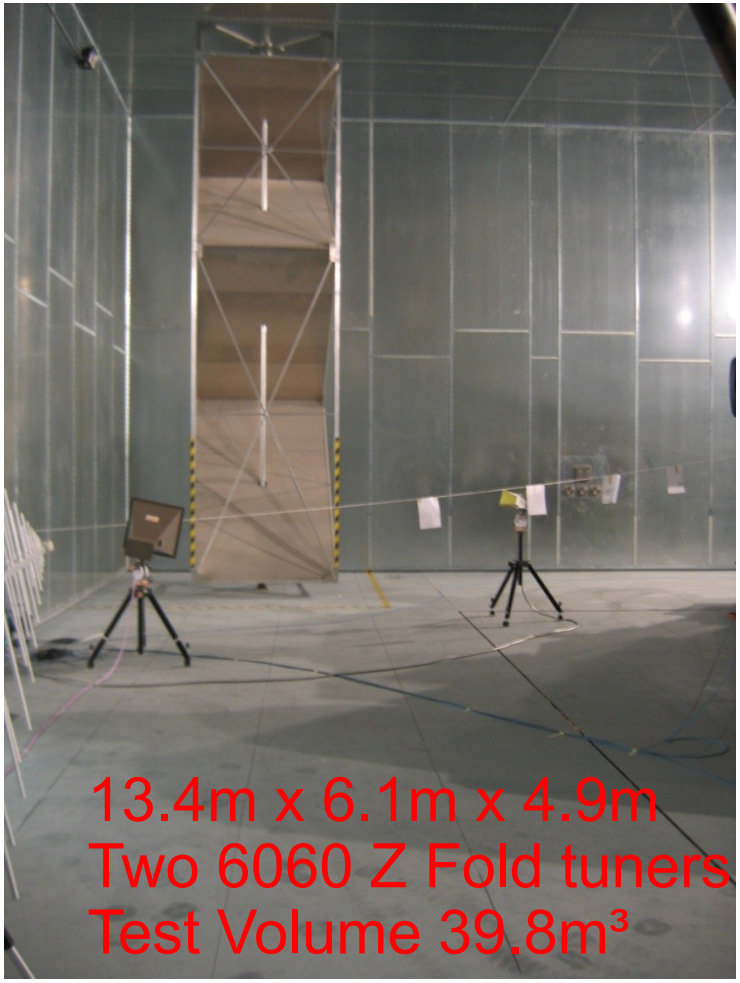
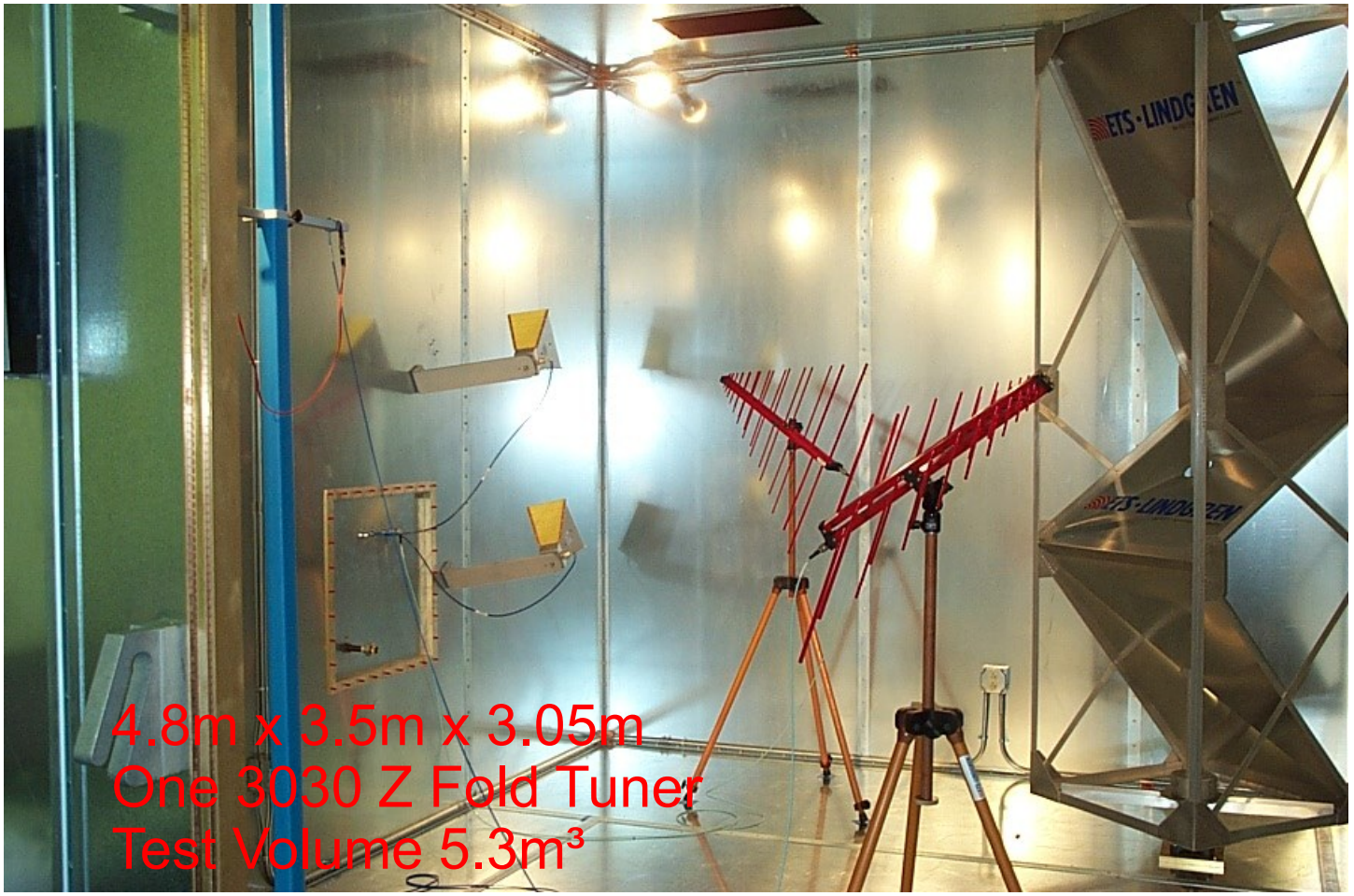


Figure C.2 – Received power (dBm) as a function of tuner rotation (s) at 1 000 MHz

Large SMART 80 CHAMBERS



Typical SMART 200 CHAMBER



Typical SMART 700 CHAMBER

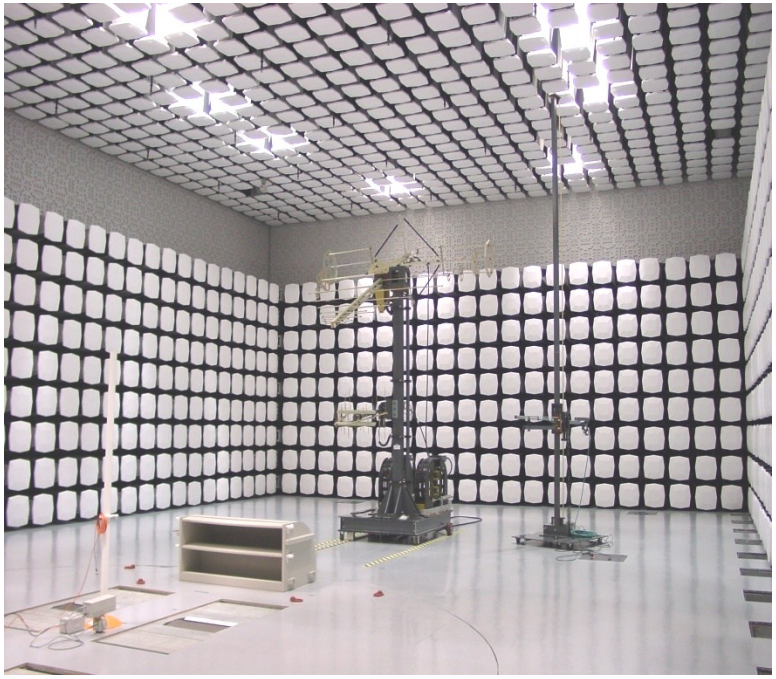
2. 0m x 1.2m x 1.5m
One 1212 'Z' Fold tuner
Test Volume 0.4m³

Advantages/disadvantages of Reverb

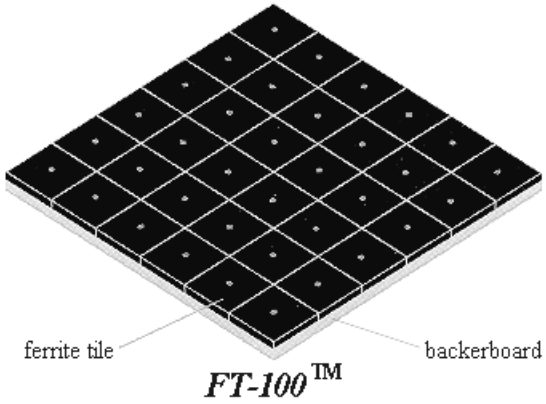
- Performance differences:-
  - Reverb Chamber – Pros
    - Immunity testing “**total EUT**”
    - Emission testing **“total EUT = TRP”**
    - Chamber volume vs. test volume <= 10:1
    - High V/m per watt
    - No turntable or scanning mast
    - Non critical EUT and cable placement
  - Reverb Chamber - Cons
    - No antenna pattern or directivity
    - No direct correlation to OATS
    - Potentially longer test time
    - Large chamber size for low LUF

EMC Semi-Anechoic Chamber

- MIL STD chamber
- CISPR 25 chamber
- SpaceSaver Model PC
- SpaceSaver Model 26H
- FACT 3 chamber
- FACT 5 chamber
- FACT 10 chamber
- FAR chamber



The Absorber Family 1



Ferrite Tile .
Magnetic Losses
Preferred technology for Low frequencies (up to 2GHz), it has low profile (7mm max).

It cannot be used for high frequencies

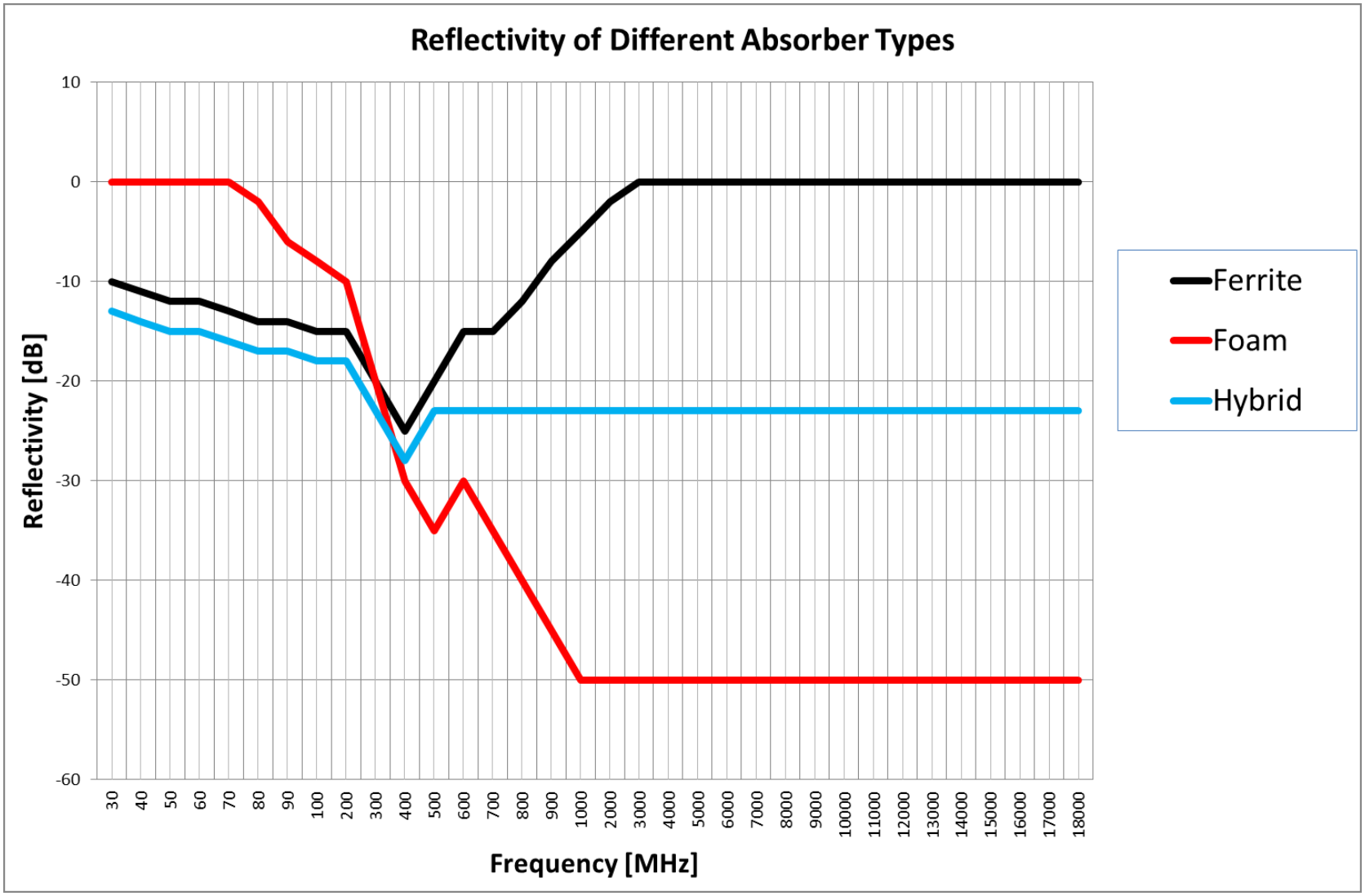
The Absorber Family 3

Hybrid Absorber .

Electric and Magnetic Losses

Preferred technology for EMC Applications. foam has to have special low carbon content for good matching with ferrite tile at the bottom.

At High frequencies its performance is not as good as MW pyramid of equal size.


Reflectivity of Different Absorber Types
Reflectivity [dB]
10
0
-10
-20
-30
-40
-50
-60
30
40
50
60
70
80
90
100
200
300
400
500
600
700
800
900
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
17000
18000
Frequency [MHz]
Ferrite
Foam
Hybrid

Anechoic Chamber

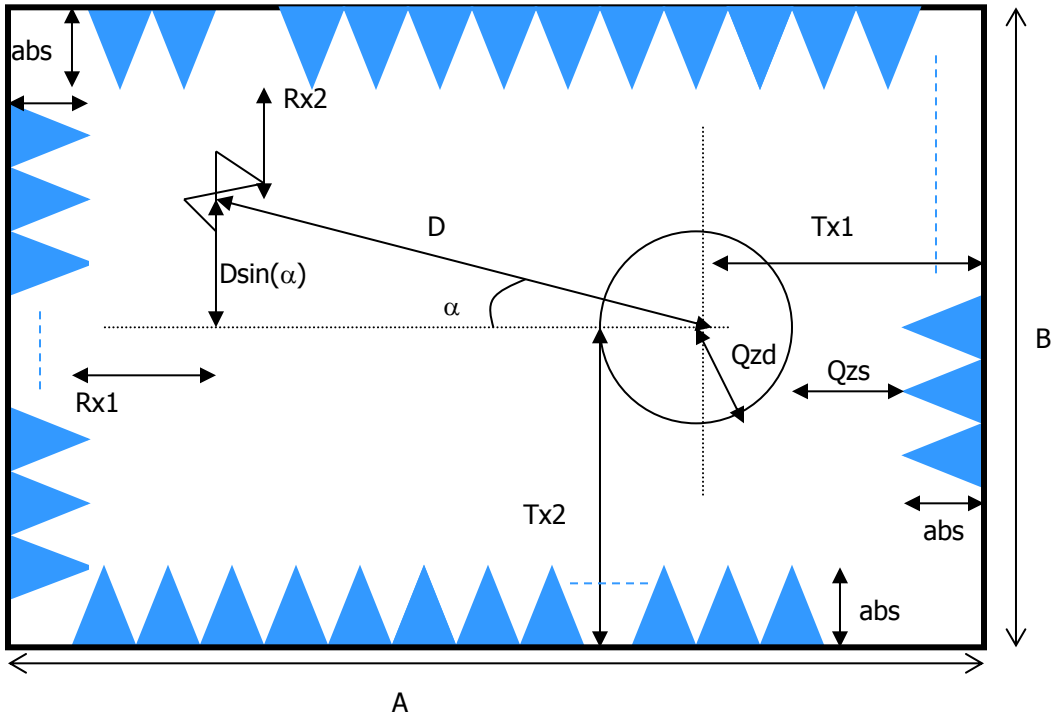
There are some rules that can be applied when sizing an EMC Chamber once the test distance and the quiet zone size are known

$$A = D + 2 \cdot Qzd + Rx1 + Qzs + 2 \cdot abs$$

$$where: \; Rx1 = 2m, \; Qzs = 1m$$

Rx1 can be a minimum of 1.5m

It is desirable that $\alpha > 0$ so that reflections from the side walls do not arrive in phase to the test area.

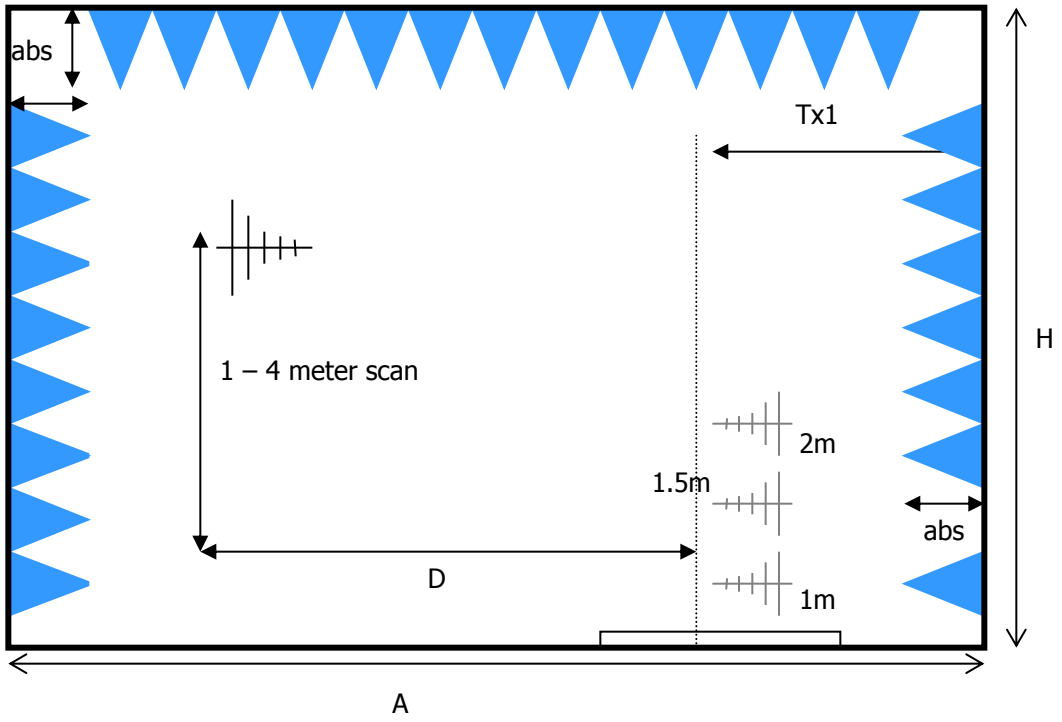


Anechoic Chamber – validation process

The FCC asks that the performance of the anechoic chamber matches that of an outdoor range.

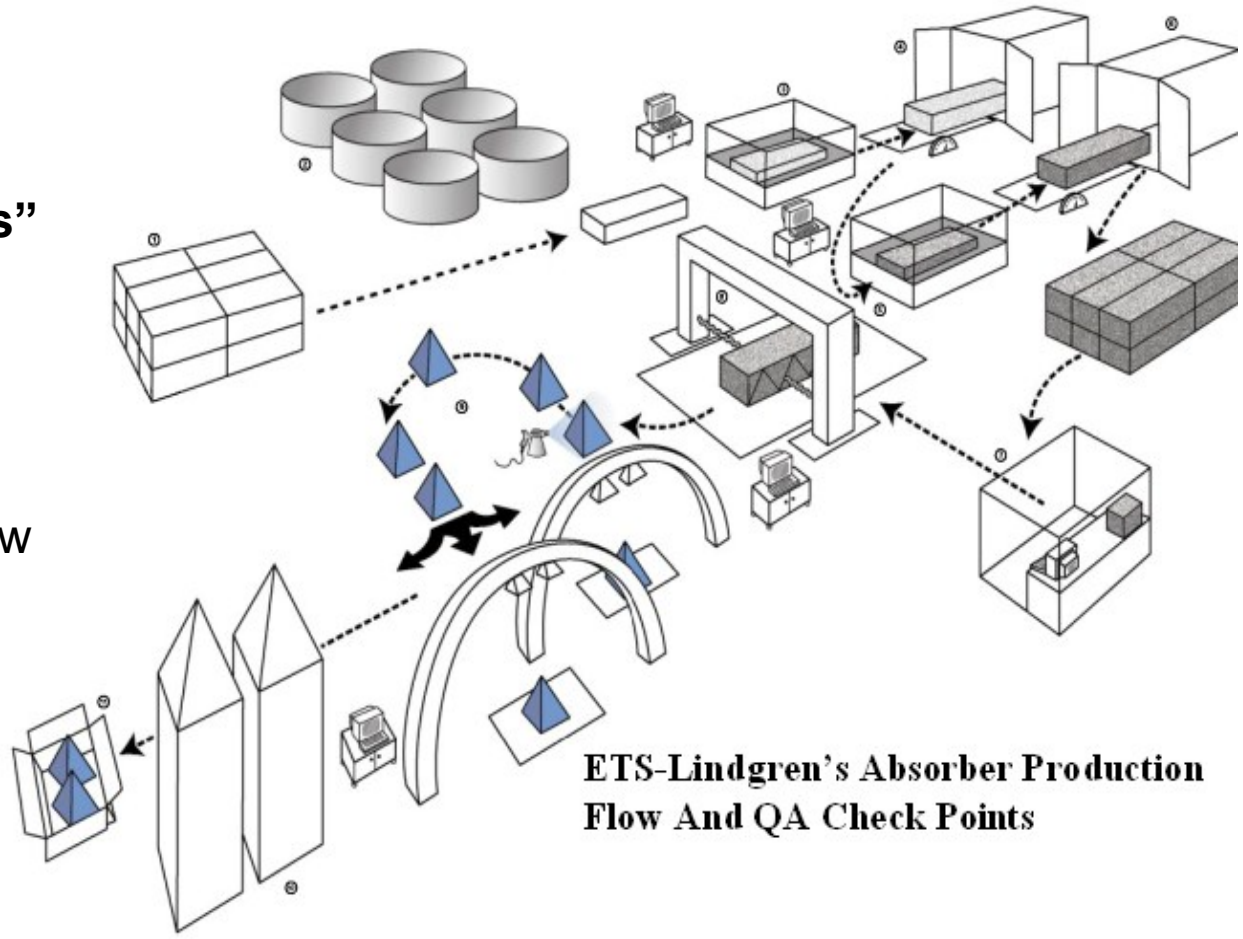
The Normalize Site Attenuation (NSA) is measured.

Another common measurement for qualification is the field uniformity (FU) measurement



Absorber Manufacturing & Quality Control

- **Two-step Impregnation Process**
- Uniform RF Performance
- Less Humidity Degradation
- **Cutting Method – "Post Impregnation Process"**
- Shape Uniformity
- Carbon Loading Uniformity
- Fire Retardant Uniformity
- Computerized Precision Saw – Greater Dimensional Accuracy



ETS-Lindgren's Absorber Production Flow And QA Check Points

Advantages/disadvantages of Anechoic

- Performance comparison:-
  - Anechoic Chamber – ***Pros***
    - Approximate antenna pattern measurement
    - Immunity testing "**per face of the EUT"**
    - Emission testing **"per face of the EUT"**
    - Direct correlation to OATS
  - Anechoic Chamber - ***Cons***
    - Immunity testing "**per face of the EUT"**
    - Emission testing **"per face of the EUT"**
    - Inefficient use of power for immunity test
    - Delicate and expensive Absorber material
    - Chamber volume vs. test volume ~ 35:1
    - Turntable and scanning mast required
    - EUT and cable placement critical

Modular concept of RF test system: EMCenter

EMC Systems are Complex

Traditional Rack Mount Systems require more space.

- Switch Controller
- Power Meter
- Signal Generator
- Positioning Controller
- Field Probe Controller
- EMC Receiver
- Amplifier
- Software Automation

EMCenter™ *is a flexible RF measurement platform consisting of an integrated microcontroller, modular chassis and plug-in card modules.*

Available Modules Include

- EMSwitch™ RF Switch Matrix up to 40 GHz
- EMPower™ USB Power Meters to 6 & 18 GHz
- EMSense™ RF Field Probe Controller
- EMControl™ Tower & Turntable Controller
- EMGen ™ RF Signal Generator
  - And more to come…

EMC Systems Simplified

Traditional Rack Mount Systems require more space.

EMCenter's compact footprint reduces size and complexity.

Benefits

- Simplified, Integrated Operation
- Reduced Cabling
- Reduced Cost
- Fewer Instrumentation Drivers to Manage
- Modular Expandability
- Global Service and Support
- Easier for User operate with system

Seven RF Instruments, One 3U Rack Space

ROOM FOR SEVEN PLUG-IN CARD MODULES

- EMPower RF Power Meter
- EMPulse RF Burst/Pulse Power Meter
- EMSwitch Coaxial RF Relay Switch
- EMLink Analog Fiber Optic Link
- EMSense Control for Battery-Powered E-field Probes
- EMControl for Positioning Devices

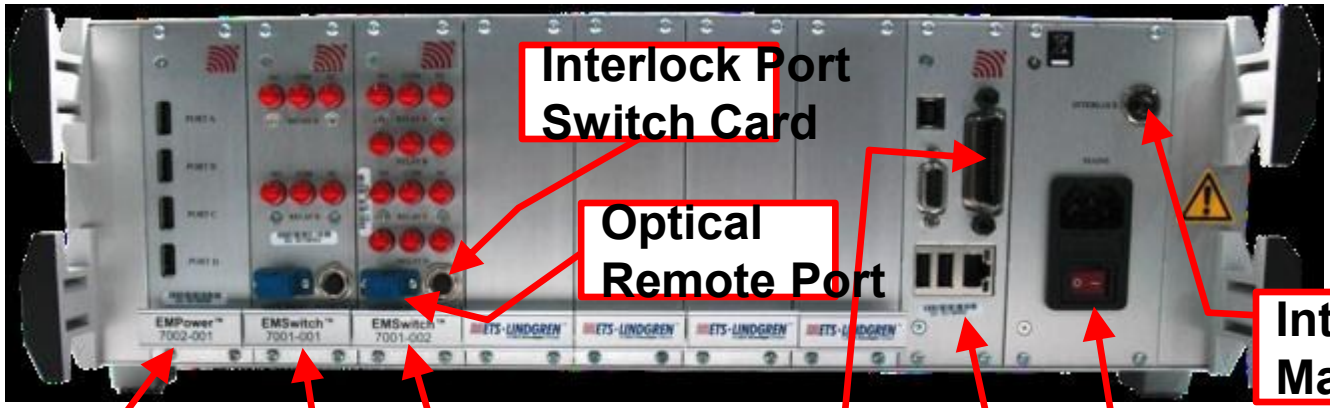
INCLUDED MODULES:

I/O Plug-in Card
- I/O Plug-in Card
- Ethernet (1)
- RS-232 (1)
- USB (3)
- IEEE-488 (Optional)

Power Module
- Safety Interlock
- IEC Power Cord Receptacle
- Power Switch

EMCenter Back Panel

Slots: 1 2 3 4 5 6 7



EMSwitch™

- Three Switch Cards Now available
  - 7001-001 2 x SPDT
  - 7001-002 4 x SPDT
  - 7001-003 2 x SP6T (Note: This card requires two slots in EMCenter)

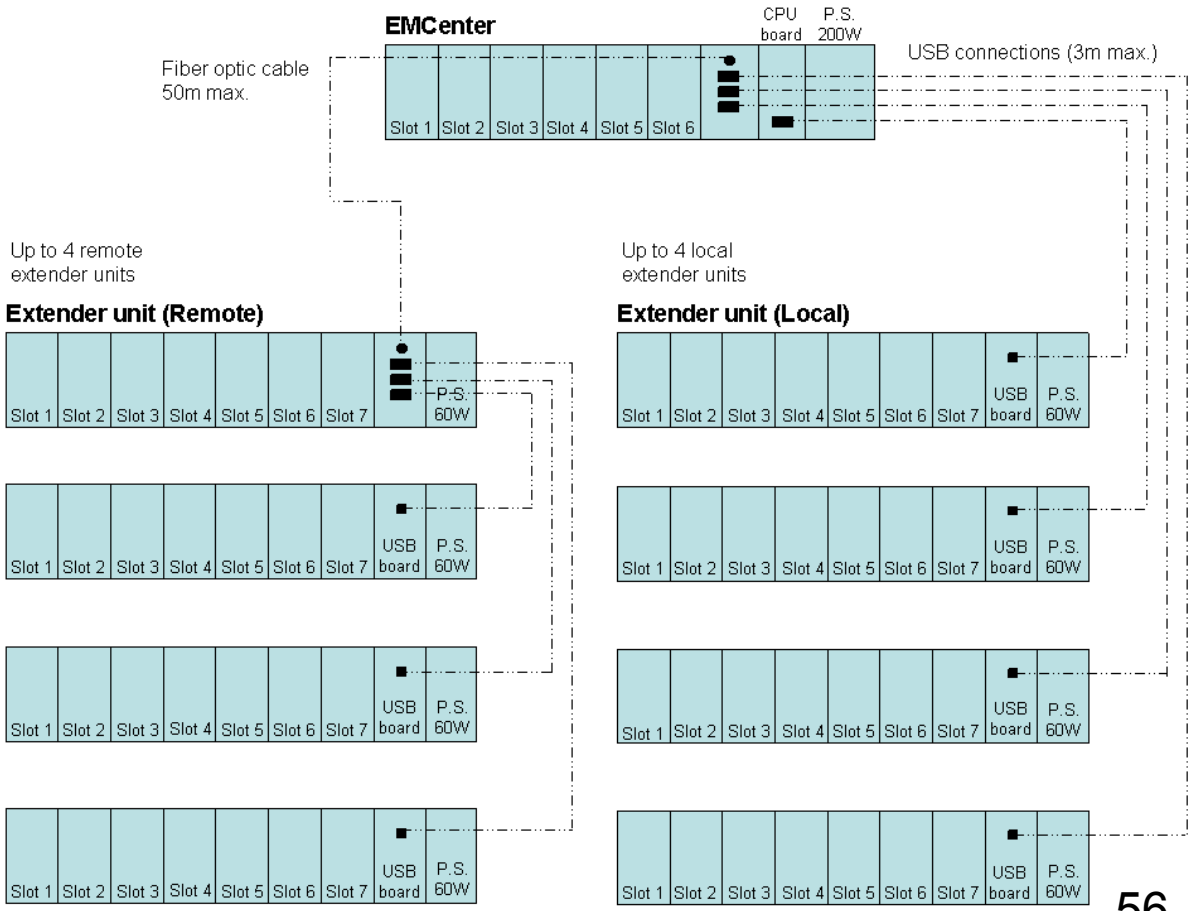
EMSwitch Specifications

- Improved Performance .. Up to 240/700 W

7001-001	2x SPDT	18 GHz	DC to 3 GHz: 240 W 3 to 8 GHz: 150 W 8 to 12.4 GHz: 120 W 12.4 to 18 GHz: 100 W
7001-002	4x SPDT		
7001-003	2x SP6T		
7001-011:	2x SPDT	40 GHz	DC to 6 GHz: 80 W 6 to 12.4 GHz: 60 W 12.4 to 18 GHz: 50 W 18 to 26.5 GHz: 20 W 26.5 to 40 GHz: 10 W
7001-012:	4x SPDT		
7001-013:	2x SP6T		DC to 6 GHz: 40 W 6 to 12.4 GHz: 30 W 12.4 to 18 GHz: 25 W 18 to 26.5 GHz: 15 W 26.5 to 40 GHz: 5 W
7001-015:	1xSP6T		
7001-021:	1x SPDT	12.4 GHz	DC to 1 GHz: 700 W 1 to 2 GHz: 500 W 2 to 3 GHz: 400 W 3 to 8 GHz: 250 W 8 to 12.4 GHz: 200 W

7001-004 Remote Extension Box

- Maximum Configuration:



EMPower™ USB Power Meters

- Four Models Available:
  - 7002-002 EMPower™ 6GHz RF Powerhead, USB
  - 7002-003 EMPower™ 6GHz **Burst/Pulse** Powerhead, USB
  - 7002-004 EMPower™ 18GHz RF Powerhead, USB
  - 7002-005 EMPower™ 18GHz **Burst/Pulse** Powerhead, USB
- Two Types:
  - Model 7002-002 and Model 7002-004: Support RMS measurements for CW signals.
  - Model 7002-003 and Model 7002-005: Measure RF bursts as short as a few microseconds.

7002-001 USB Plugin Card

- EMCenter Plugin Card allows system control of up to four power meters per card

7007-001 EMSense™ Battery Powered Probe Controller

- The ETS-Lindgren EMSense™ Battery-Powered Probe Controller Module is designed for use with the following ETS-Lindgren battery-operated field probes (sold separately).

HI-6022

HI-6053

HI-6005

Note: EMSense™ Card will work with legacy probes such as HI-4422

- Each EMSense module can support one ETS-Lindgren probe.

7006-001 EMControl™ Positioning Controller

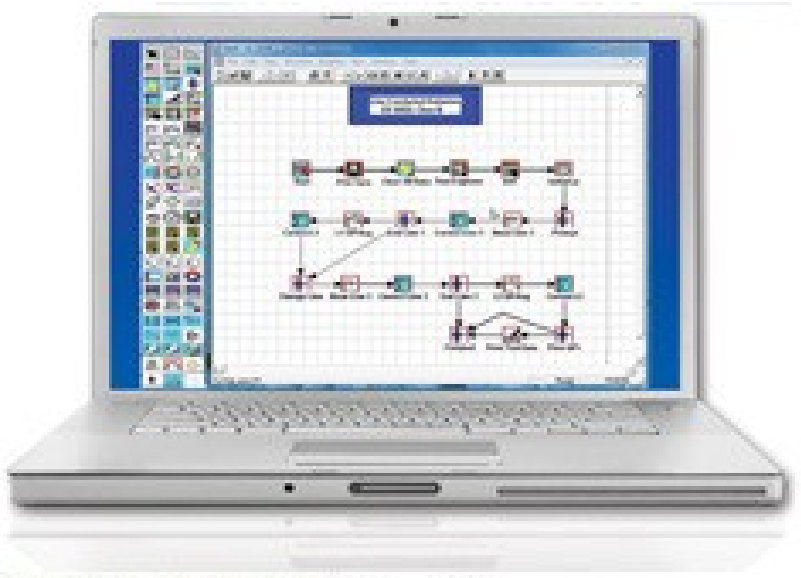
- Controls up to 2 ETS-Lindgren Positioners* Plus 2 Auxiliary Devices
  - Manual & Software Control
  - Accurate Seek & Scan
  - Variable Speed Control
  - *Compatible Command Set for ETS Model 2090 Controller

EMGen™ Specifications

Frequency Range:	9 kHz–6 GHz
Frequency Resolution:	1 Hz
Output Level:	• **Minimum:** –70 dBm • **Maximum:** +10 dBm (+4.0 dBm when using AM)
Amplitude Resolution:	0.1 dB
Amplitude Accuracy:	± 1.5 dB
Output Level Settling Time:	< 500 us
Harmonics:	< -20 dBc
Non-Harmonic Spurious:	< -50 dBc
Modulation Type:	AM and Pulse
Modulation Frequency Range:	10 Hz–100 kHz
AM Modulation Depth:	5% to 95% (usable from 0% to 100%)
Pulse Time-Range:	• **ON:** 200 ns–100 s • **OFF:** 200 ns–100 s
Pulse Modulation On/Off Ratio, Output LF:	> 60 dB (9 kHz–230 MHz)
Pulse Modulation On/Off Ratio, Output HF:	> 90 dB (80 MHz–1 GHz) > 70 dB (1 GHz–3 GHz) > 60 dB (3 GHz–6 GHz)


ETS·LINDGREN
EMCenter
Power ON
EMCenter™

Complicated EMC job can be done easy



T!™ TOTALLY INTEGRATED LAB ENVIRONMENT

Why use Software?

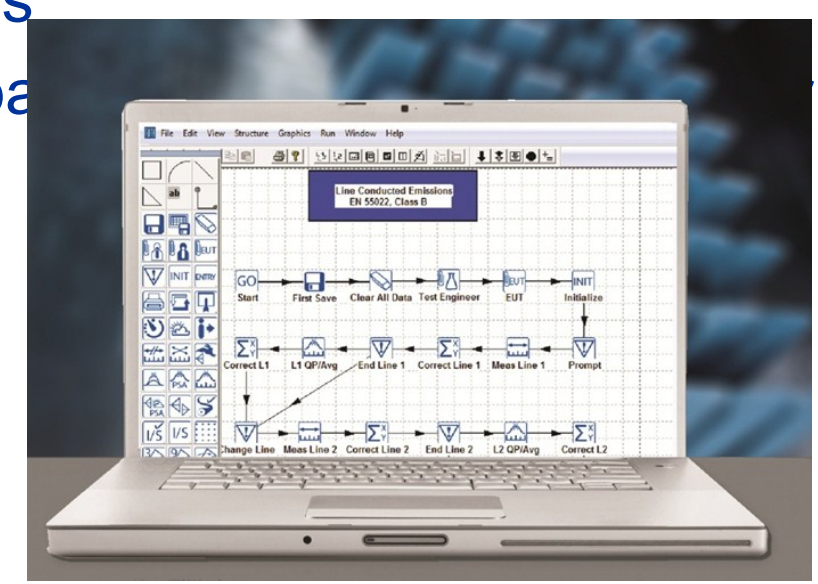
- It's easier ?
  - Only if you know the software.
  - Maybe you don't need to know the test equipment (dangerous)
- It's quicker?
  - Only if you don't hit any software problems (bugs/shut down and re-start)
- It's more reliable?
  - Possibly! (minimal human error)

What do we want from our Software?

- Straight forward User Interface?
  - Representative of the set up
  - Logical sequence
- Connectivity to ALL equipment
  - ETS-Lindgren, Agilent, R&S, AR etc
- Correction factors
  - Covering all elements of the test set up
- Results displayed clearly
  - Tables & Graphs
- Report functionality
- Would be nice to have some standard set ups for your chosen field.

TILE! Features

- How is it used?
  - TILE! provides an easy to use graphical user interface to control instruments that perform EMC testing
  - Communicates to instruments using GPIB, Ethernet, USB, or Serial Interfaces
  - Creates Windows compa
    Report Generation
  - Drag & Drop Microsoft
    Windows Interface



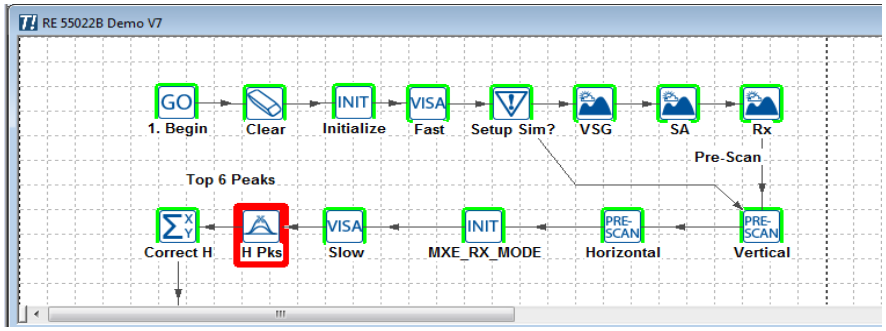
TILE Hardware

- Lab instrumentation is controlled by TILE!™ using
  - GPIB - IEEE-488-2
  - Serial - RS232
  - TCP/IP, USB

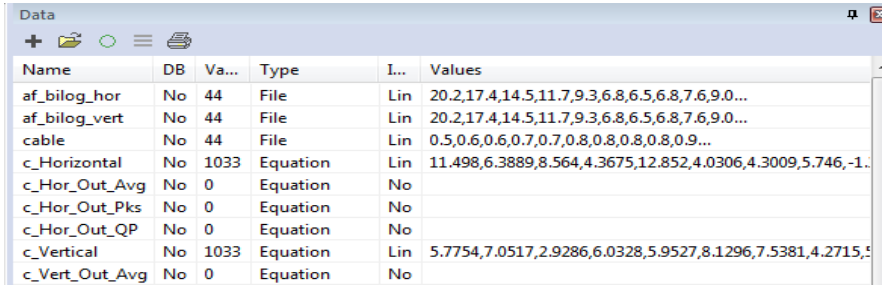
- Recommended Hardware Configuration
  - Pentium IV, 1 GHz or better
  - 1 MB RAM
  - WinXP, Windows 7
  - Available slots for GPIB cards
  - 1024 x 768 Screen Resolution.

6 Elements

- **Flowchart** – a visual display of the sequence of steps necessary to perform a test.

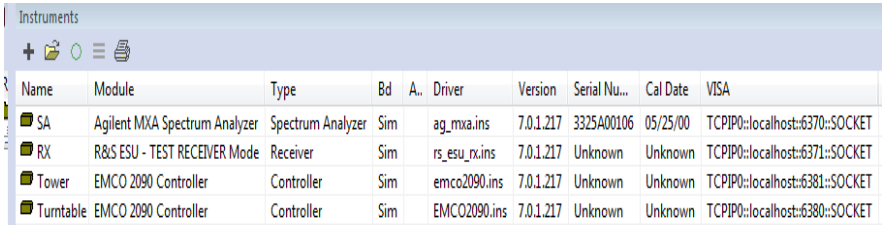


- **Data** – controls the definition of each data element used by the test.



Name	DB	Va...	Type	I...	Values
af_bilog_hor	No	44	File	Lin	20.2,17.4,14.5,11.7,9.3,6.8,6.5,6.8,7.6,9.0...
af_bilog_vert	No	44	File	Lin	20.2,17.4,14.5,11.7,9.3,6.8,6.5,6.8,7.6,9.0...
cable	No	44	File	Lin	0.5,0.6,0.6,0.7,0.7,0.8,0.8,0.8,0.8,0.9...
c_Horizontal	No	1033	Equation	Lin	11.498,6.3889,8.564,4.3675,12.852,4.0306,4.3009,5.746,-1...
c_Hor_Out_Avg	No	0	Equation	No	
c_Hor_Out_Pks	No	0	Equation	No	
c_Hor_Out_QP	No	0	Equation	No	
c_Vertical	No	1033	Equation	Lin	5.7754,7.0517,2.9286,6.0328,5.9527,8.1296,7.5381,4.2715,5
c_Vert_Out_Avg	No	0	Equation	No	

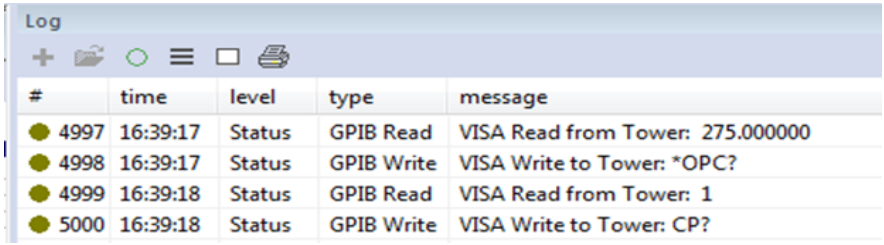
- **Instruments** - identifies the instruments that will be used during the test.



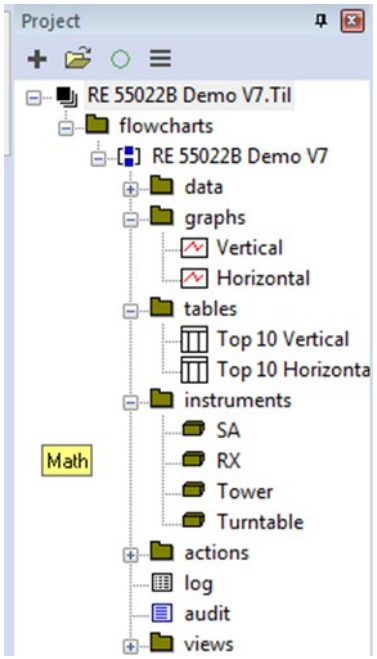
Name	Module	Type	Bd	A..	Driver	Version	Serial Nu...	Cal Date	VISA
SA	Agilent MXA Spectrum Analyzer	Spectrum Analyzer	Sim		ag_mxa.ins	7.0.1.217	3325A00106	05/25/00	TCPIP0::localhost::6370::SOCKET
RX	R&S ESU - TEST RECEIVER Mode	Receiver	Sim		rs_esu_rx.ins	7.0.1.217	Unknown	Unknown	TCPIP0::localhost::6371::SOCKET
Tower	EMCO 2090 Controller	Controller	Sim		emco2090.ins	7.0.1.217	Unknown	Unknown	TCPIP0::localhost::6381::SOCKET
Turntable	EMCO 2090 Controller	Controller	Sim		EMCO2090.ins	7.0.1.217	Unknown	Unknown	TCPIP0::localhost::6380::SOCKET

6 Elements

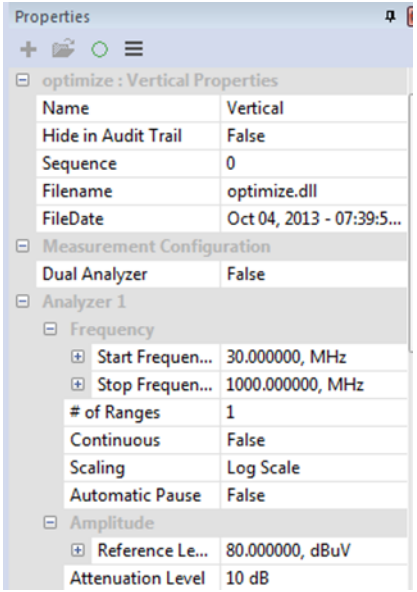
- **Log** – logs the execution of the test.



- **Project**– file structure for all elements of test

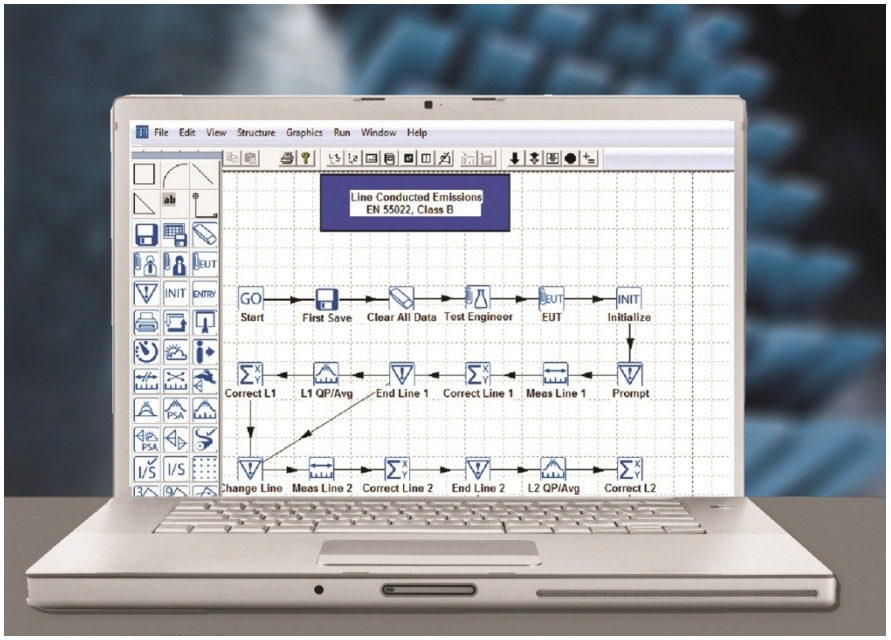


- **Properties**– lists all the changeable parameters for test equipment used during the test



Tile Features

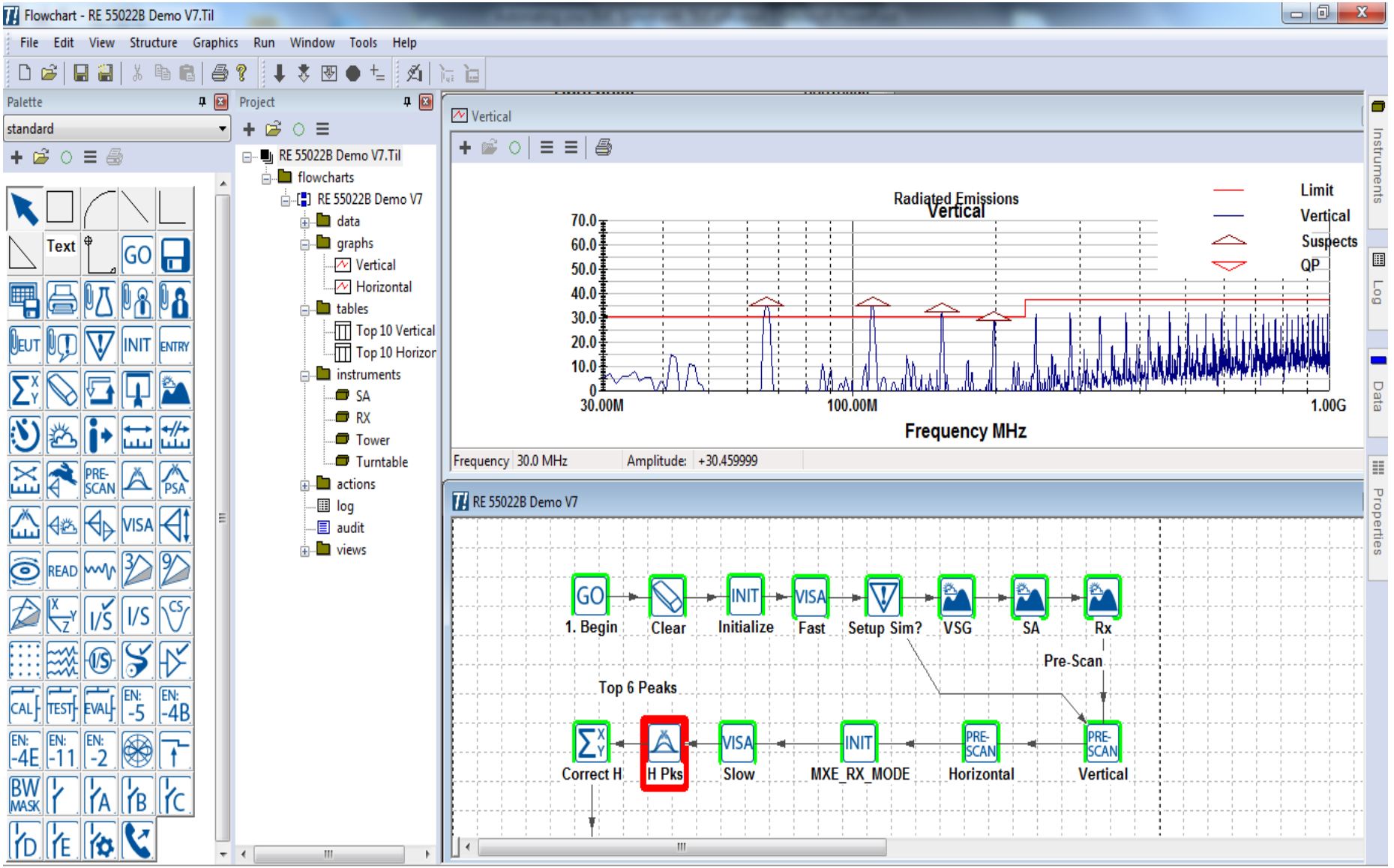
- **Automates EMC Testing**
  - Choose Ready-to-use profiles for testing to RE,CE & RI, CI Test Regulations
  - Easy design your own custom tests
- **Standard Compliant Test Methods**
- **T&M Equipment Vendor Compatible Drivers Available**
  - Over 1600 drivers
- **Drag & Drop Microsoft Windows Interface**
- **Hundreds of Field Proven Installations world wide**
- **Used in Corporate Test Facilities & in Commercial Test Labs**
- **Active user group on LinkedIn.com**



TILE! Features

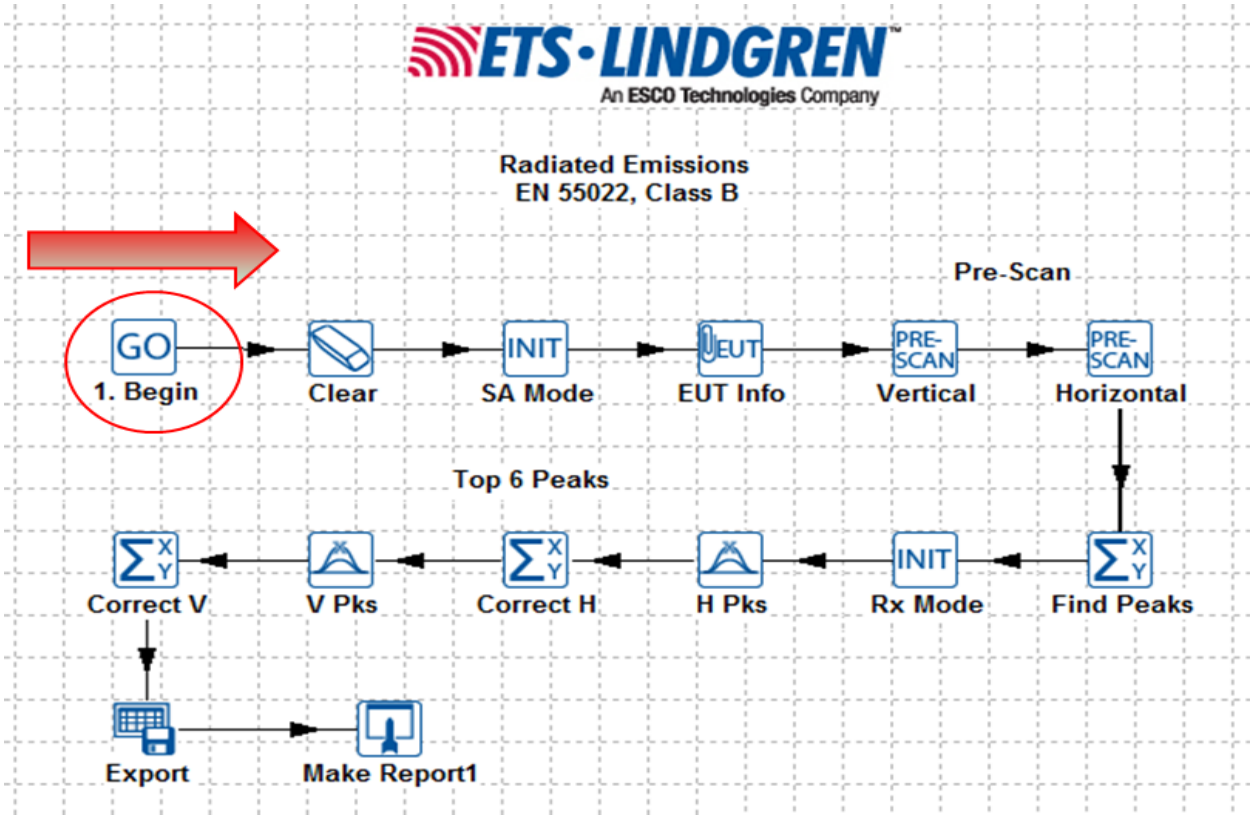
- What tests can it perform?
  - Most frequency domain EMC measurements including:
    - Radiated and Conducted Emissions
    - Radiated and Conducted Immunity / Susceptibility
  - Compatible with most EMC standards:
    - MIL-STD-461
    - EN 55022/24
    - RCTA-DO-160
    - CISPR 16,25
    - SAE
  - ISO 17025 Compatible

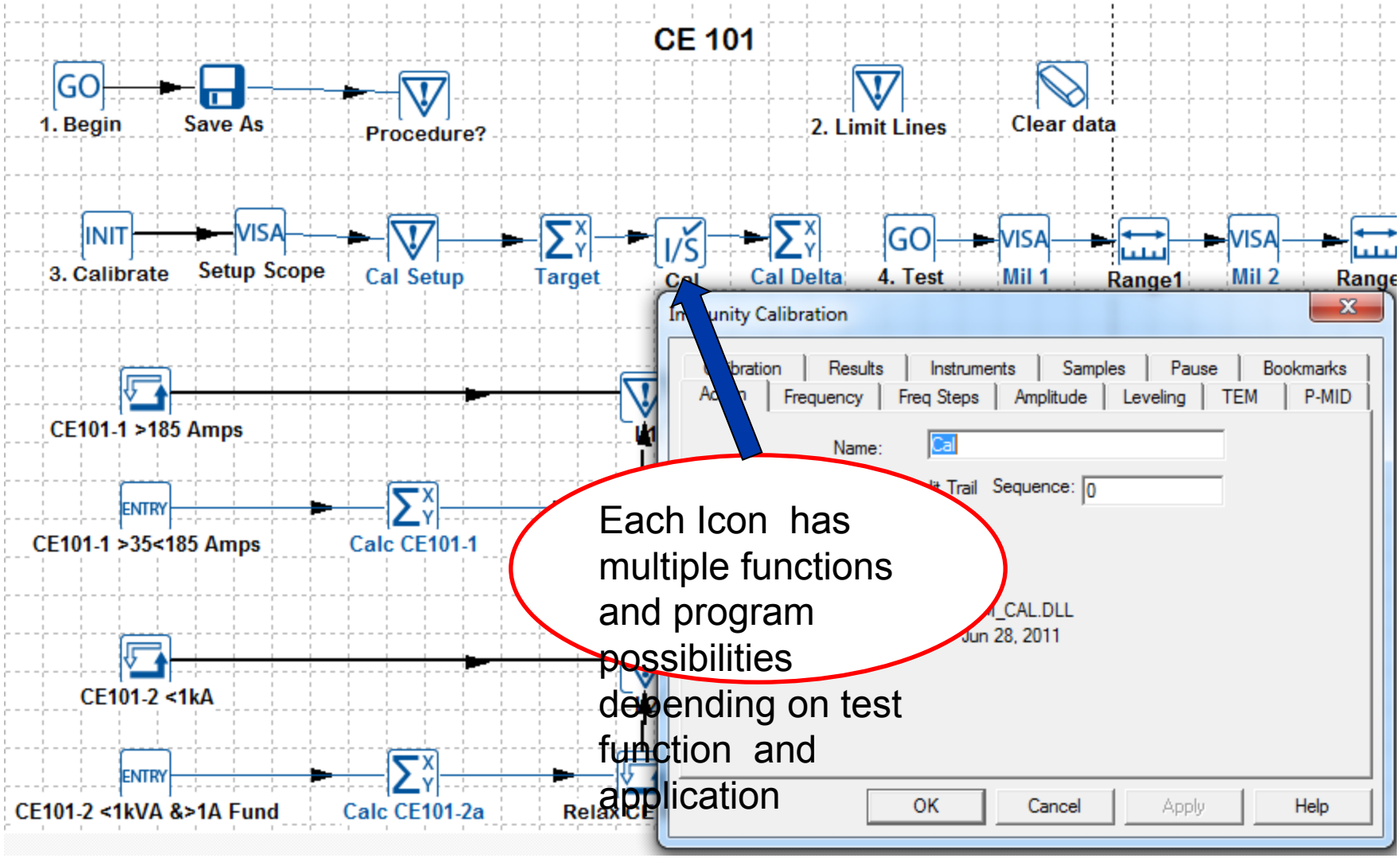
Look & Feel


Flowchart - RE 55022B Demo V7.Til
File Edit View Structure Graphics Run Window Tools Help
Palette
standard
Project
RE 55022B Demo V7.Til
flowcharts
RE 55022B Demo V7
data
graphs
Vertical
Horizontal
tables
Top 10 Vertical
Top 10 Horizor
instruments
SA
RX
Tower
Turntable
actions
log
audit
views
Vertical
Radiated Emissions
Vertical
Limit
Vertical
Suspects
QP
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
30.00M
100.00M
1.00G
Frequency MHz
Frequency 30.0 MHz
Amplitude: +30.459999
RE 55022B Demo V7
GO
1. Begin
Clear
INIT
Initialize
VISA
Fast
Setup Sim?
VSG
SA
Rx
Pre-Scan
Top 6 Peaks
Correct H
H Pks
VISA
Slow
INIT
MXE_RX_MODE
PRE-SCAN
Horizontal
PRE-SCAN
Vertical
Instruments
Log
Data
Properties

TILE! Features

- Use Flowchart to develop test procedures based on Standards or Custom Processes




CE 101
GO
1. Begin
Save As
Procedure?
2. Limit Lines
Clear data
INIT
3. Calibrate
VISA
Setup Scope
Cal Setup
Target
I/S
Cal
Cal Delta
GO
4. Test
VISA
Mil 1
Range1
VISA
Mil 2
CE101-1 >185 Amps
ENTRY
CE101-1 >35<185 Amps
Calc CE101-1
CE101-2 <1kA
ENTRY
CE101-2 <1kVA &>1A Fund
Calc CE101-2a
Results
Instruments
Samples
Pause
Bookmarks
Frequency
Freq Steps
Amplitude
Leveling
TEM
P-MID
Name:
Cal
Sequence:
0
OK
Cancel
Apply
Help
Jun 28, 2011
Each Icon has multiple functions and program possibilities depending on test function and application

Export

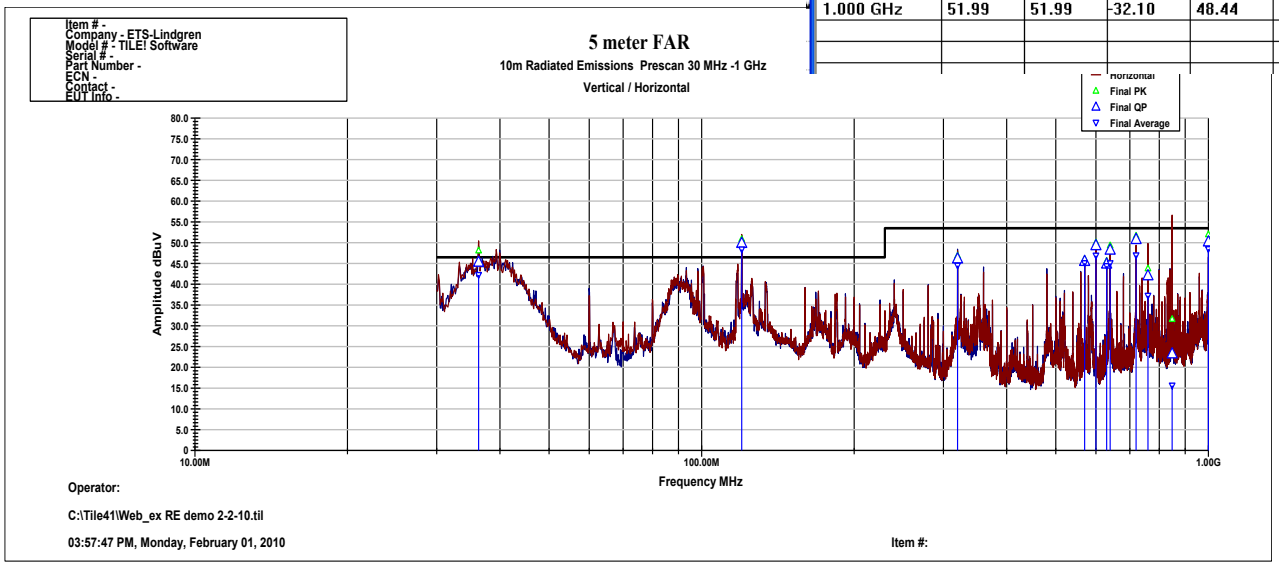
- Outputs test data to:
  - MS Word
  - MS Excel
  - Report Generator

Table:Final Radiated Emissions1

Final Radiated Emissions1

Operator:
03:57:47 PM, Monday, February 01, 2010
Item #:

	1	2	3	4	5	6	7	8	9
Frequency	Peak	QP	Correction	Average	Margin	Pol	Limit	H Az	V Az
MHz	dBuV/m	dBuV/m	dB	dBuV/m	dB		dBuV/m	deg	deg
36.305 MHz	48.11	48.11	-36.11	42.22	42.22	42.22	42.22	42.2	42.2
119.968 MHz	50.85	50.85	-28.53	48.35	48.35	48.35	48.35	48.4	48.4
320.030 MHz	46.88	46.88	-30.15	44.47	44.47	44.46	44.47	44.5	44.5
570.048 MHz	46.07	46.07	-32.14	45.05	45.05	45.05	45.05	45.0	45.0
599.996 MHz	50.05	50.05	-32.14	46.88	46.88	46.87	46.88	46.9	46.9
629.945 MHz	45.60	45.60	-32.14	44.35	44.35	44.34	44.35	44.3	44.3
640.009 MHz	49.30	49.30	-32.14	45.02	45.02	45.02	45.02	45.0	45.0
720.034 MHz	51.64	51.64	-32.13	46.92	46.92	46.92	46.92	46.9	46.9
760.046 MHz	43.81	43.81	-32.13	37.21	37.21	37.21	37.21	37.2	37.2
848.195 MHz	31.62	31.62	-32.12	15.59	15.59	15.58	15.59	15.6	15.6
1.000 GHz	51.99	51.99	-32.10	48.44	48.44	48.43	48.44	48.4	48.4



Test Launcher

- TILE! wrapped in a more attractive User Interface
  - Utilizes the new Software infrastructure
- Simple Menu Structure
  - Each Menu Button Initiates a Pre-defined Tile Profile
  - Customer not required/Able to modify profiles
  - “Locked Down” for Systems approach
- Streamlined operation
  - All the flexibility of TILE!, but hidden from user
- Now available – Profiles built and tested
- Utilizes the GUI being developed for EMQ64
  - Multi-Lingual
  - (Screen shot on next page)

Report Automation

- New Actions added to TILE to save graphs, tables and other elements in a specified Folder
- Second action launches MS Word and incorporates the saved elements
  - Basic MS Word Templates provided
  - Users can integrate their current report templates
    - (Samples on next page)

Report Generation

ETS·LINDGREN
An ESCO Technologies Company

Sample·EMC·Test·Report¶

Wednesday, January 11, 2012¶

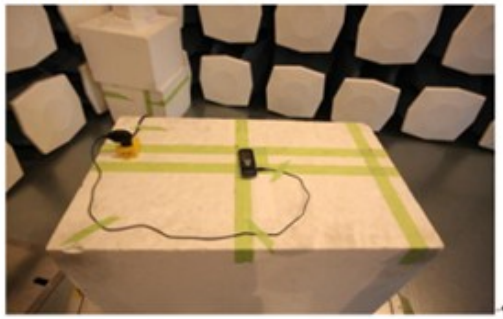
Energy takes many forms, electromagnetic, magnetic, acoustic. ↵
ETS-Lindgren provides our customers solutions with the ability to detect, measure, shield and control this energy.¶

This is a cover sheet.¶

Put whatever you want here.¶

¶

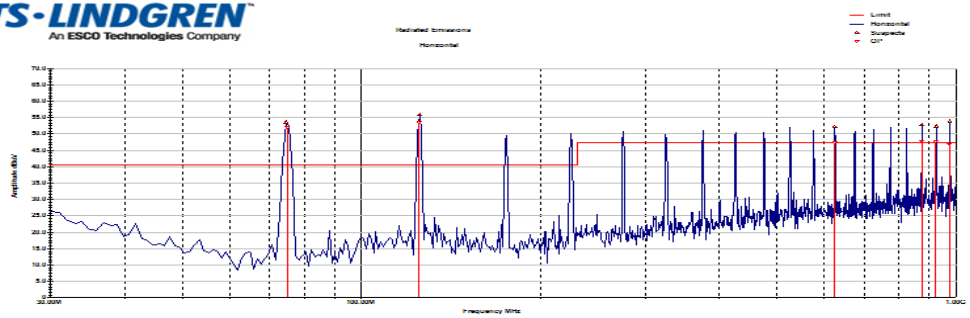
This pulls in a picture created from something. You can use any format that Word supports.¶



The energy of our company is focused on providing solutions our customers can use to be more successful in their market space.↵
ETS-Lindgren – *Enabling Your Success*™¶

Graphs and Tables

ETS·LINDGREN
An ESCO Technologies Company



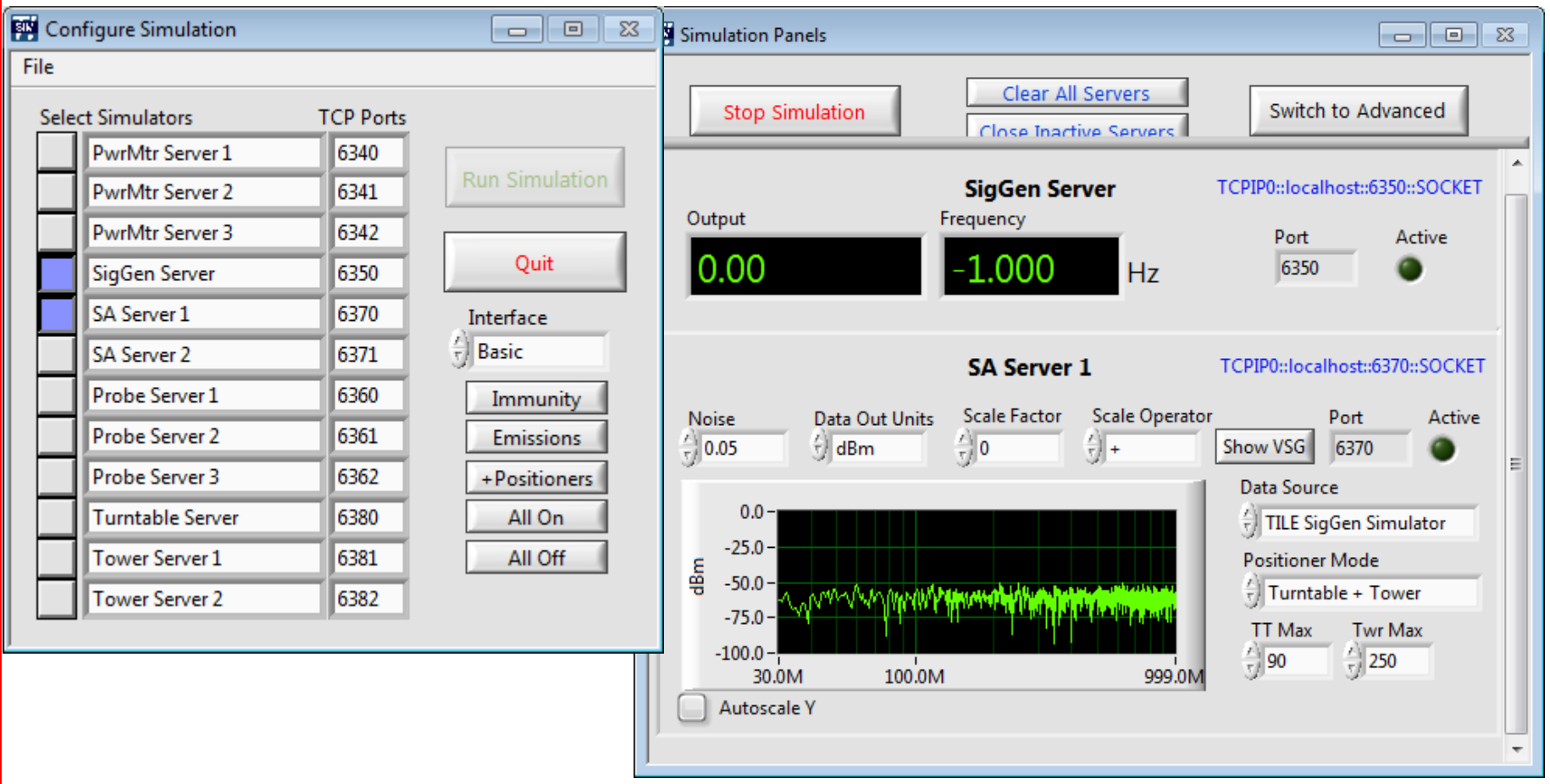
Frequency	Quasi Peak	Limit	Margin	Ant Fac	Cable Fac	AZ	HGT
MHz	dBuV/M	dBuV/m	dB	dB	dB	Deg	cm
75.00	51.93	40.46	12.73	7.20	0.80	201	225
125.00	53.44	40.46	14.23	12.72	1.13	201	225
625.00	47.37	47.46	1.91	19.70	2.80	191	220
875.00	47.74	47.46	1.46	21.65	3.40	187	210
925.00	47.81	47.46	1.53	22.05	3.50	151	214
975.00	46.78	47.46	1.41	22.40	3.65	201	216

TILE Launcher

Instrumentation Simulator

Excellent tool for performing trial runs without instrumentation

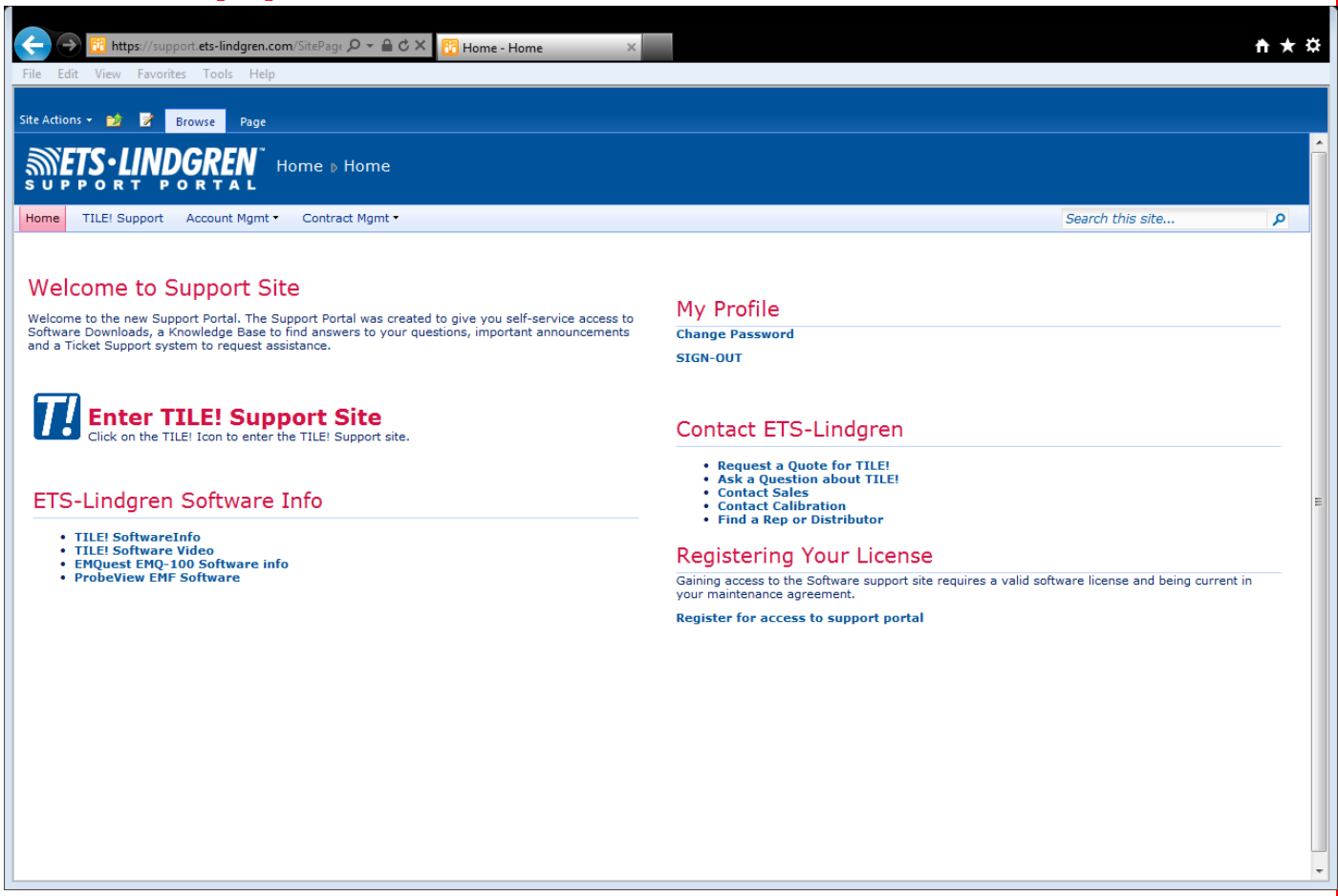
- Utilizes actual instrument drivers that can be used for debugging



TILE Support Site

Location for customers to communicate with Support:

- Check contract status
- Open and check status of tickets
- Training Videos
- Profile Templates
- FAQ's



Thanks for Your attention.
Questions please?