The How-To Guide:

Making Speaker Measurements used in Electro-Acoustic and Acoustic Simulation Programs

Introduction

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- NASA Scientist (Ames Research Center)
  1968-1971
  Acoustic & Systems Consultant 1986-2004
  Owner and Chief Scientist 2004-

Topics of Discussion

- Testing Environments
- Types of Testing Systems
- Testing Stimuli
- How Much Information is Enough?
- Who Needs It?
- What is State of the Art Testing?
- What is State of the Art Reporting?

Testing Environments

- Near Field
- Simulated Free Field
- Anechoic Chamber
- Free Field

Testing Environments

Near Field

Testing Environments

- Near Field
  - Advantages
    - Some Environmental Control
    - Eliminates Windowing to get Better Low Frequency Response.
  - Disadvantages
    - Limited Application to Single Drivers
    - Cannot be Extrapolated to a Far Field Balloon Because of Distance Between Drivers
    - More Diffractive Effects on Frequency and Phase Response.

Testing Environments

Simulated Free Field

Testing Environments

- Simulated Free Field
  - Advantages
    - Some Environmental Control
    - Able to Use Windowing to Eliminate Some Reflections.
  - Disadvantages
    - Need a VERY Large Room (at least 2 times the wavelength of the lowest frequency to be measured to any reflective surface from the DUT)
    - Limited Frequency Response

Testing Environments

Anechoic Chamber

Testing Environments

- Anechoic Chamber
  - Advantages
    - Complete Environmental Control
    - Reflection Free Environment?
    - Improved Frequency Responses
  - Disadvantages
    - Limited Distances to Wedges
    - Speaker Size Limitations
    - Reflection Free Environment?
    - COST!!!!

Testing Environments

FREE FIELD

Testing Environments

FREE FIELD

Testing Environments

- Free Field
  - Advantages
    - No Surrounding Boundaries
    - Unlimited Low End Frequency Response (within reason).
    - Closest to Reality
  - Disadvantages
    - Least Amount of Environmental Control
    - Ground Reflections
    - Speaker Handling and Mounting

Types of Testing Systems

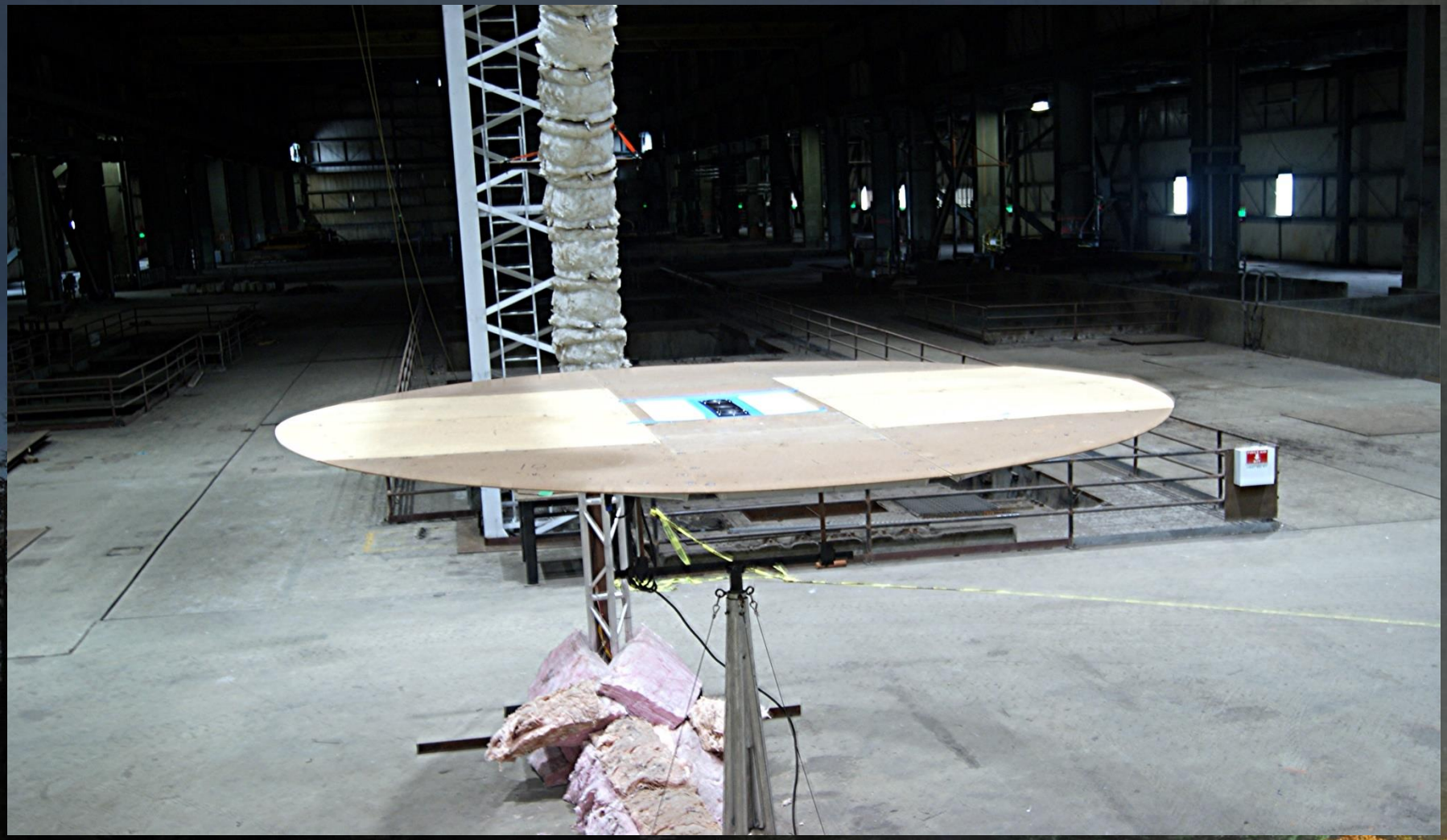
Single Microphone System

Types of Testing Systems

Microphone Array System

Types of Testing Systems

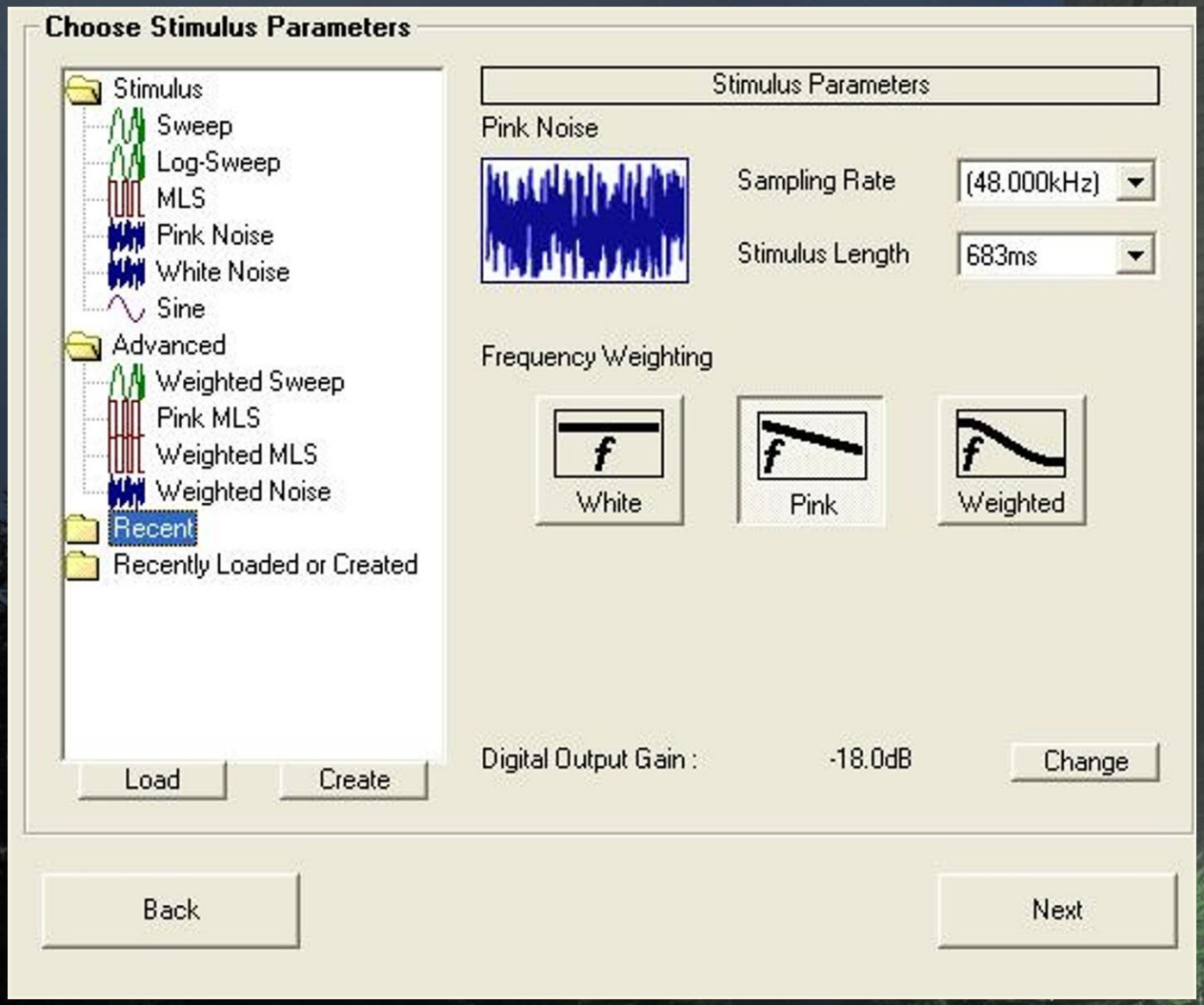
Microphone Array System



Types of Testing Systems

Computer Based Measurement System

Stimuli EASERA



Stimuli EASERA

- Multiple Types of Stimuli
  - Sweeps
    - High Immunity to Temperature Changes
  - Noise
    - Slightly Better LF Response
  - MLS
    - Less Immunity to Temperature Changes
    - Better Crest Factor
  - TDS
    - Already Windowed

Stimuli
TEF 20

How Much Information is Enough

- Who Needs It?
- How Is It To Be Used?
- Near Field or Far Field
- Grouped or Not Grouped
- Marketing

Who Needs It?

- Consultants/ Design Build Contractors
- Design Engineer
- End User

Consultants/ Design Build Contractors

- To Comply With User Specifications
- Data For Room Design Software Packages
- To Compare “Equivalent” Speakers
- Detailed Speaker Specifications

Design Engineers

- Calculate Crossover Points
- Determine Correct Delays
- Determine Coverage Patterns
- Determine Equalization Criteria
- Make Technical Information Sheets
- GLL Data

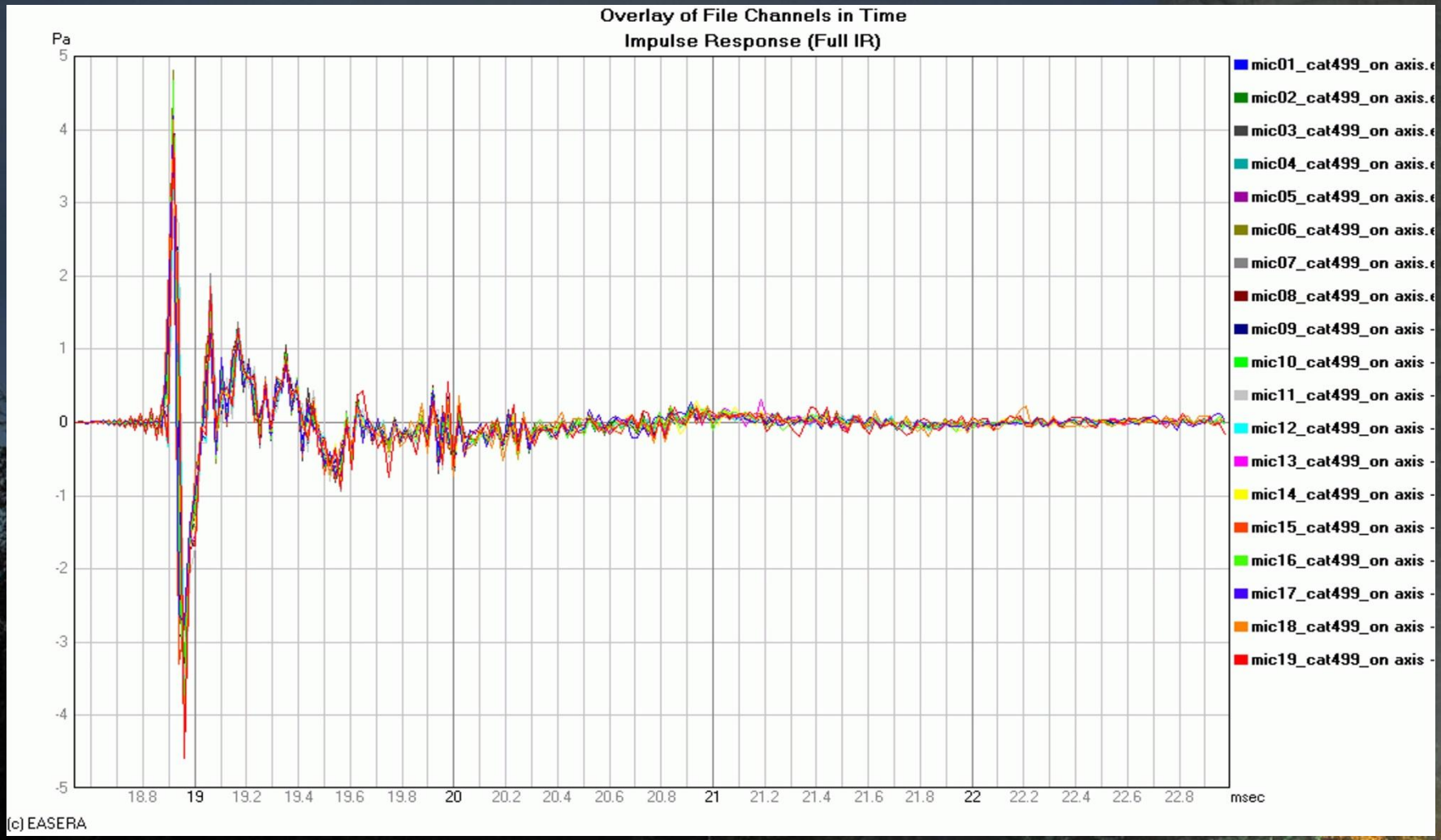
End Users

- Determine Amplifier Size
- Determine Correct Delays
- Determine Coverage Patterns
- Determine Equalization Criteria
- Allow Comparisons Between Other Speakers

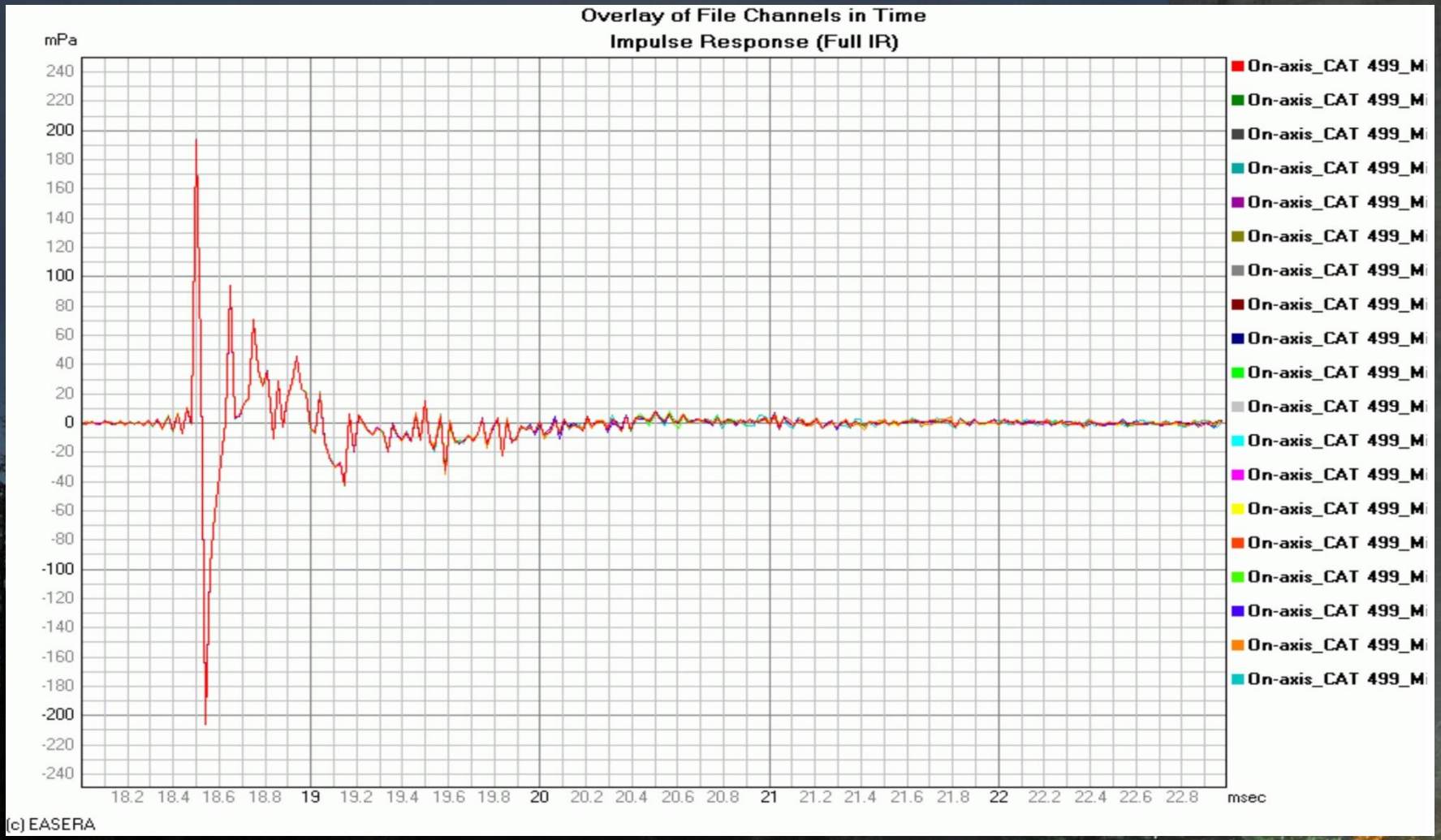
What is State of the Art Testing?

- The Use Of Complex Data
  - Magnitude +/- .125 dB
  - Phase +/- 5 Deg @ 10KHz
- Individual Directivity Balloons for Each Bandwidth
- 3dB Linear Response Max Voltage
- High Speed to Minimize Environmental Effects

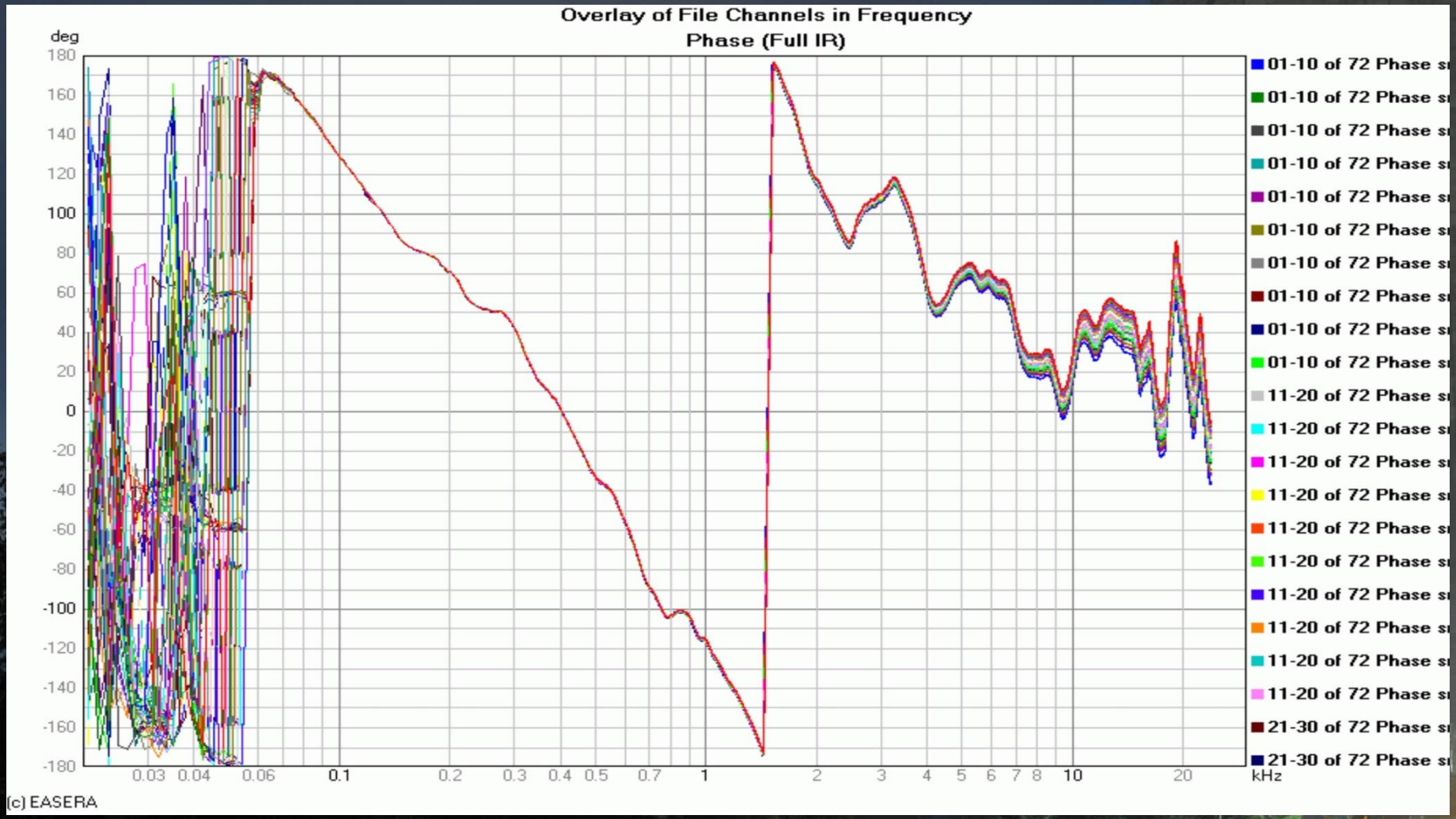
What is State of the Art Testing? (Before)



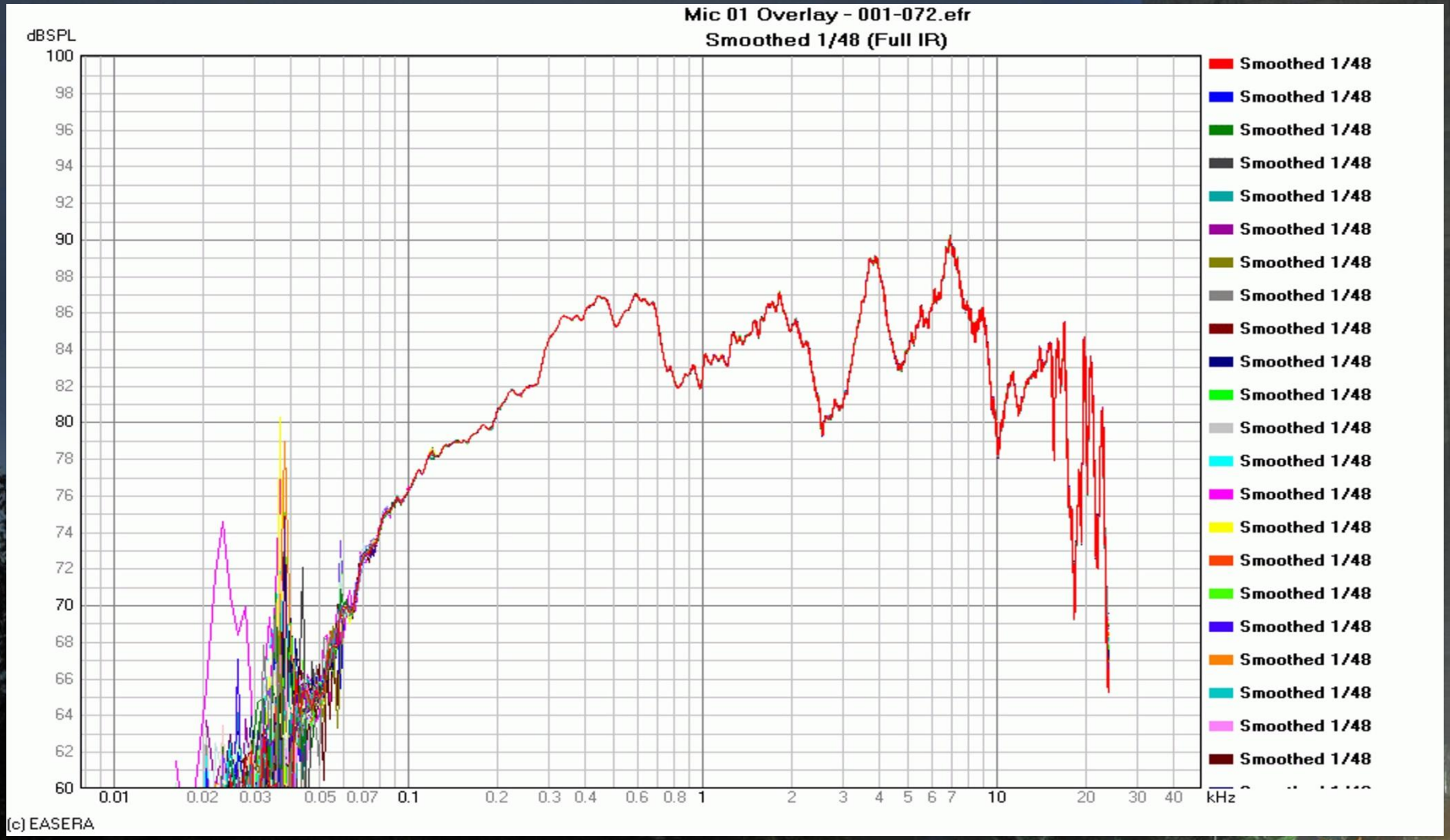
What is State of the Art Testing? (After)



What is State of the Art Testing? (Phase)



What is State of the Art Testing? (POR)

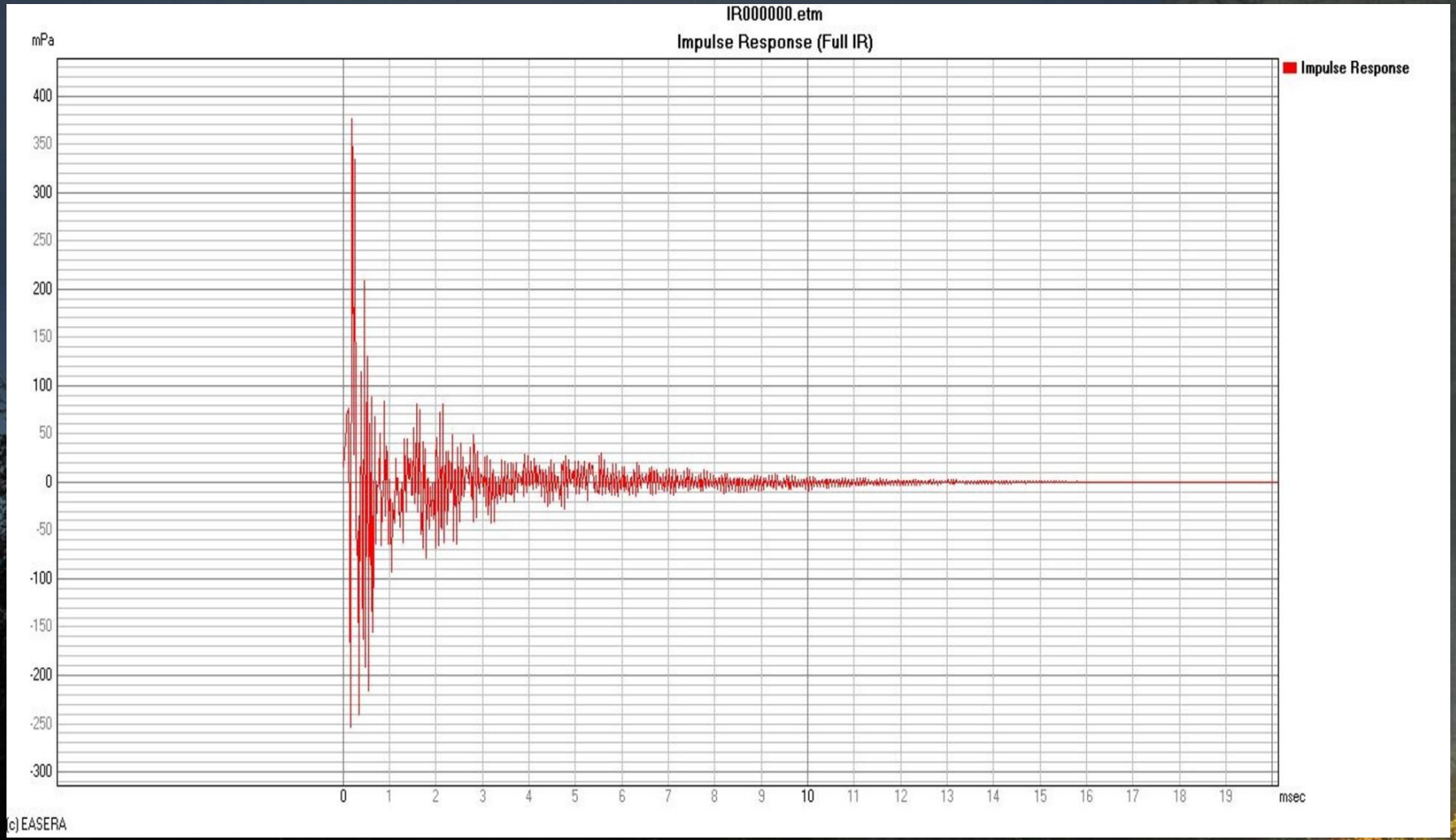


What is State of the Art Reporting?

- The Use Of Complex Data IR's to Store Speaker Data
- Directivity Balloons
- Individual Directivity Balloons for Each Bandwidth
- EASE GLL
- CLF 1 and CLF 2
- All Data Reported in 1/3 Octave but Stored in High Resolution

Complex Data. What is it?

- It Is stored as an Impulse Response

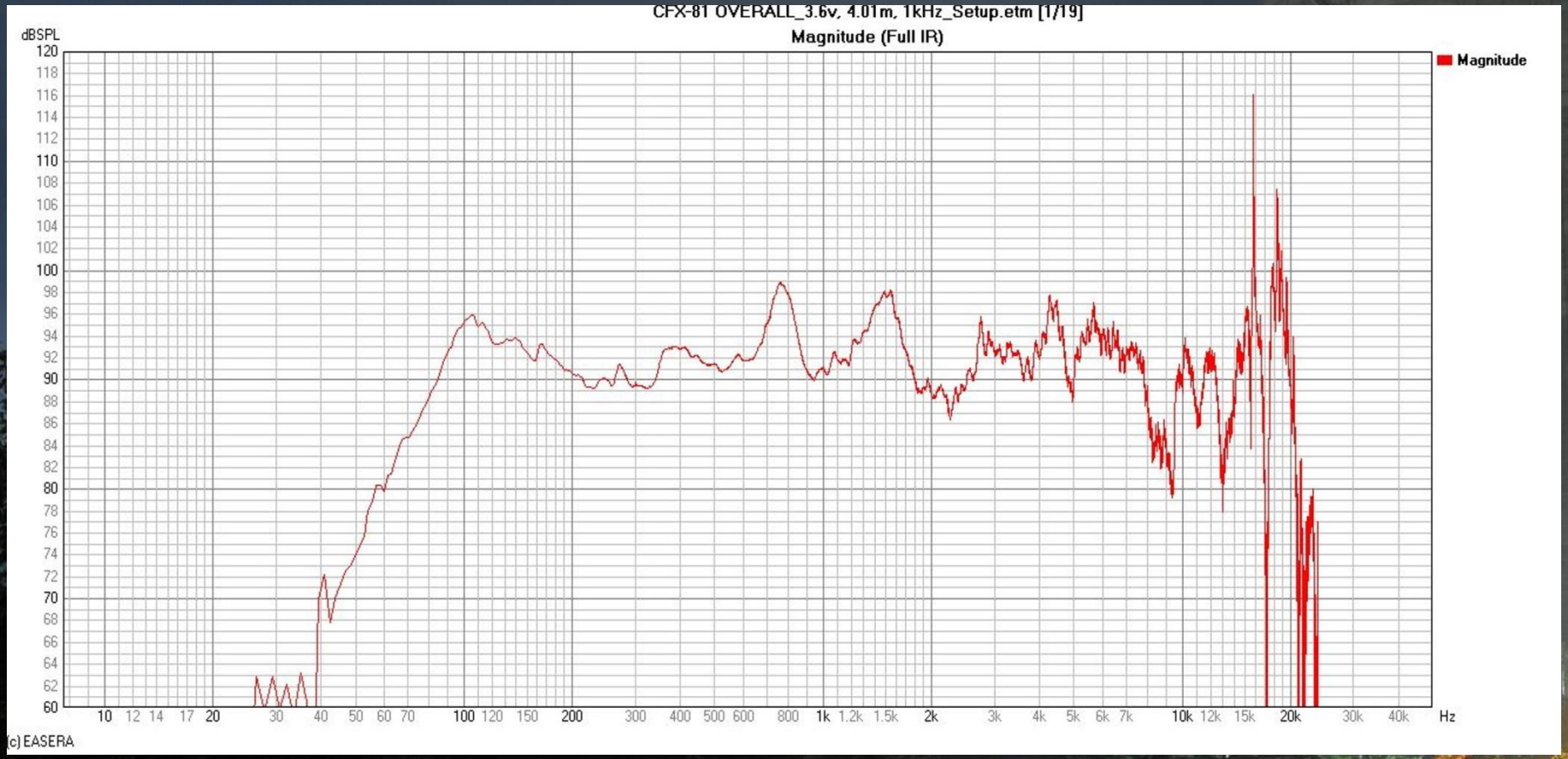


Complex Data. What is it?

- It is Stored as an Impulse Response
- It is High Resolution
- It has Magnitude Information
- It has Phase Information

Complex Data. What is it?

- It is High Resolution
- It has Magnitude Information



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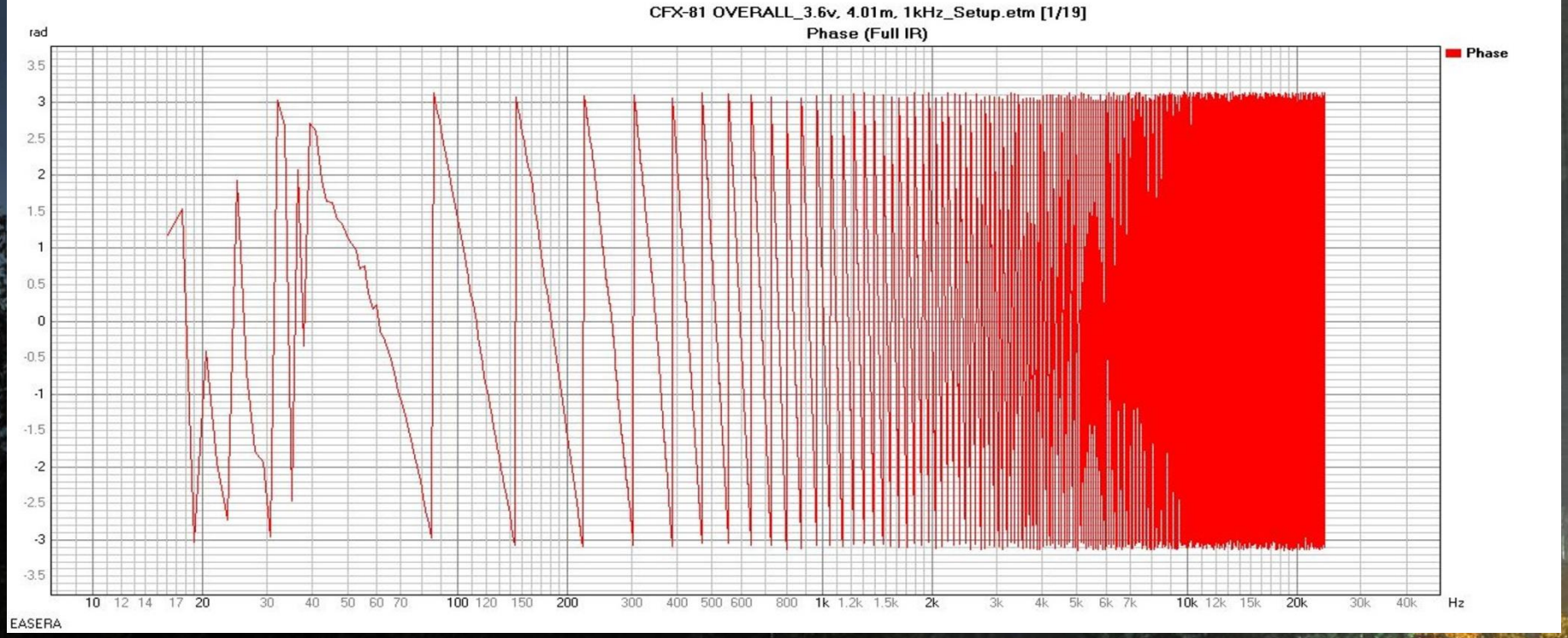
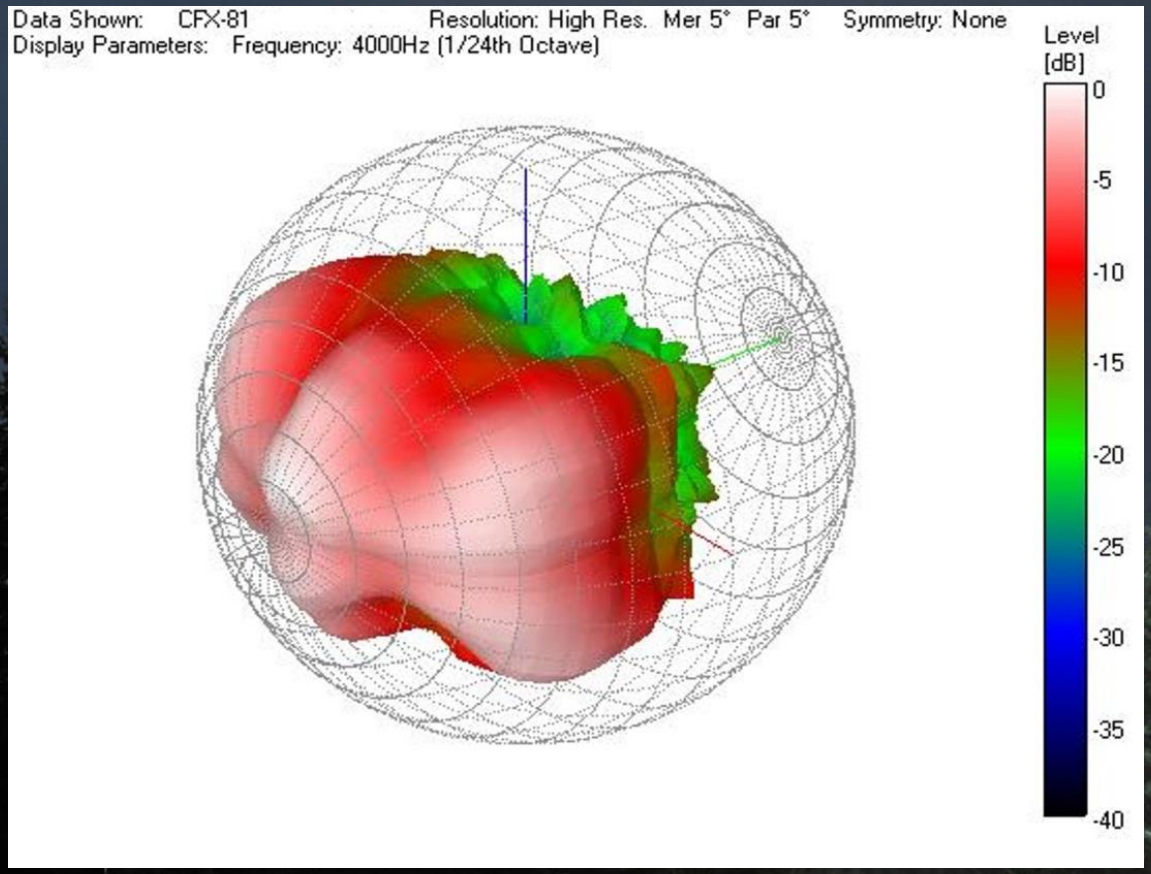


Directivity Balloon. What is it?

- It is a Series of IR's measured at set angular spacing's or resolution
- The standard as specified by AES-56 is 5º



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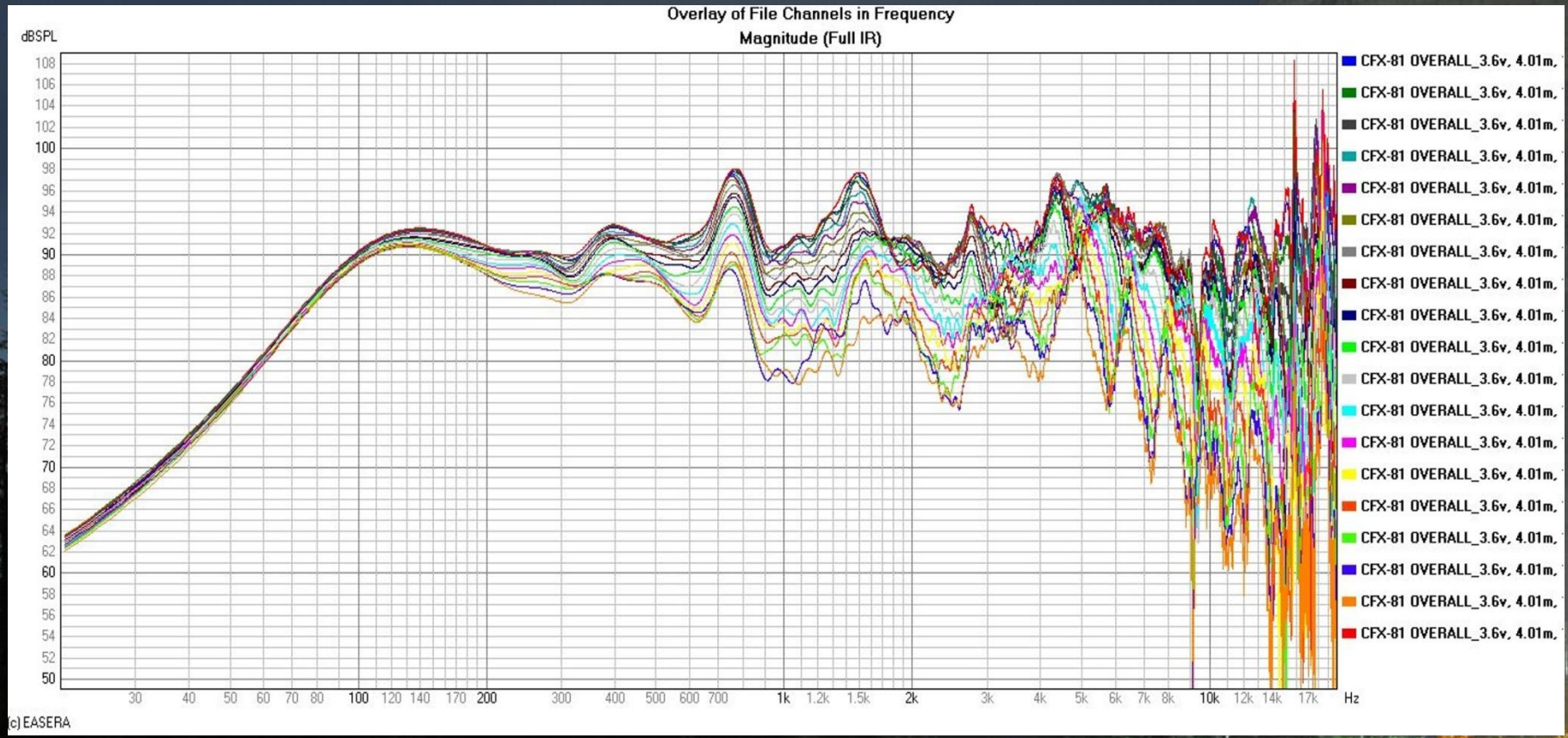

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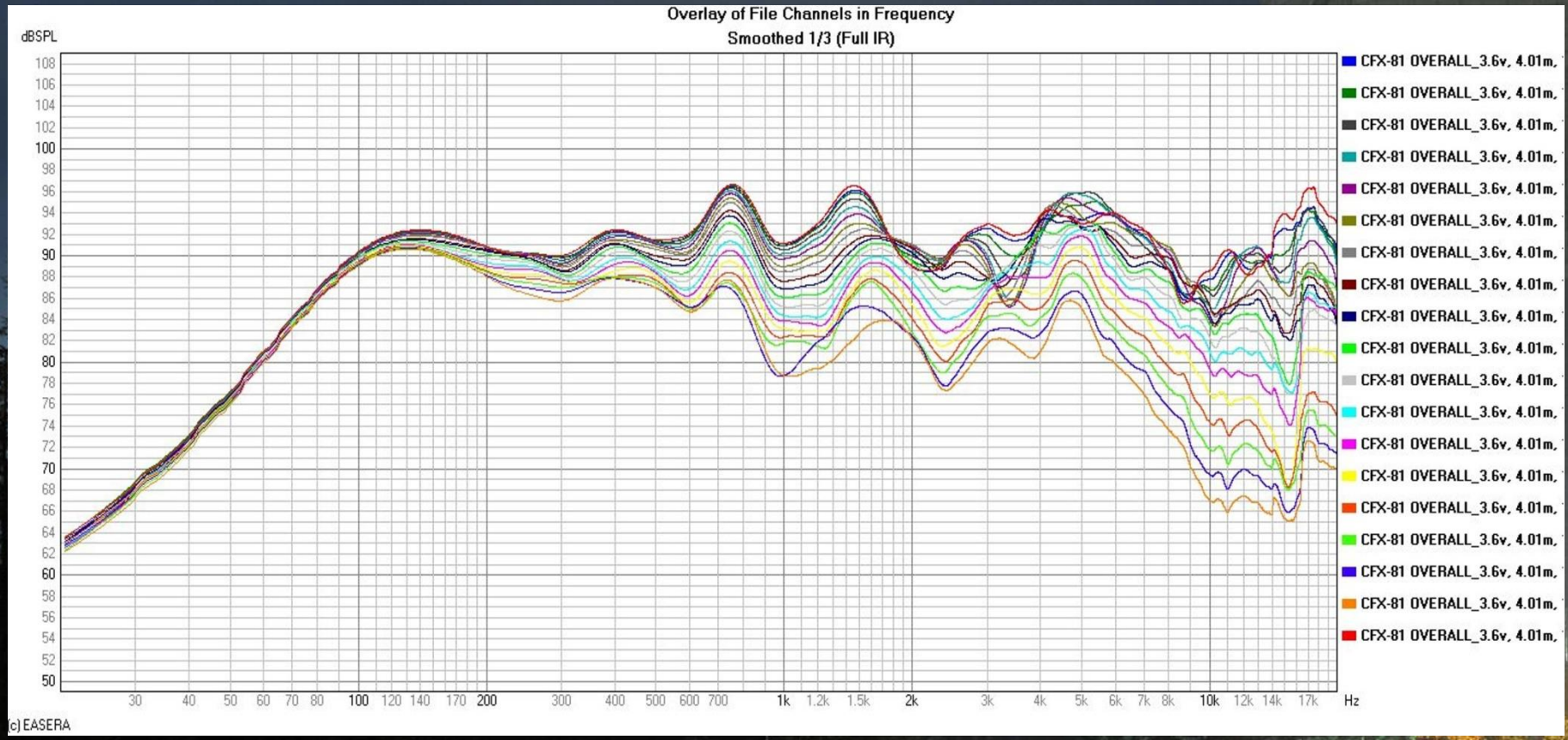
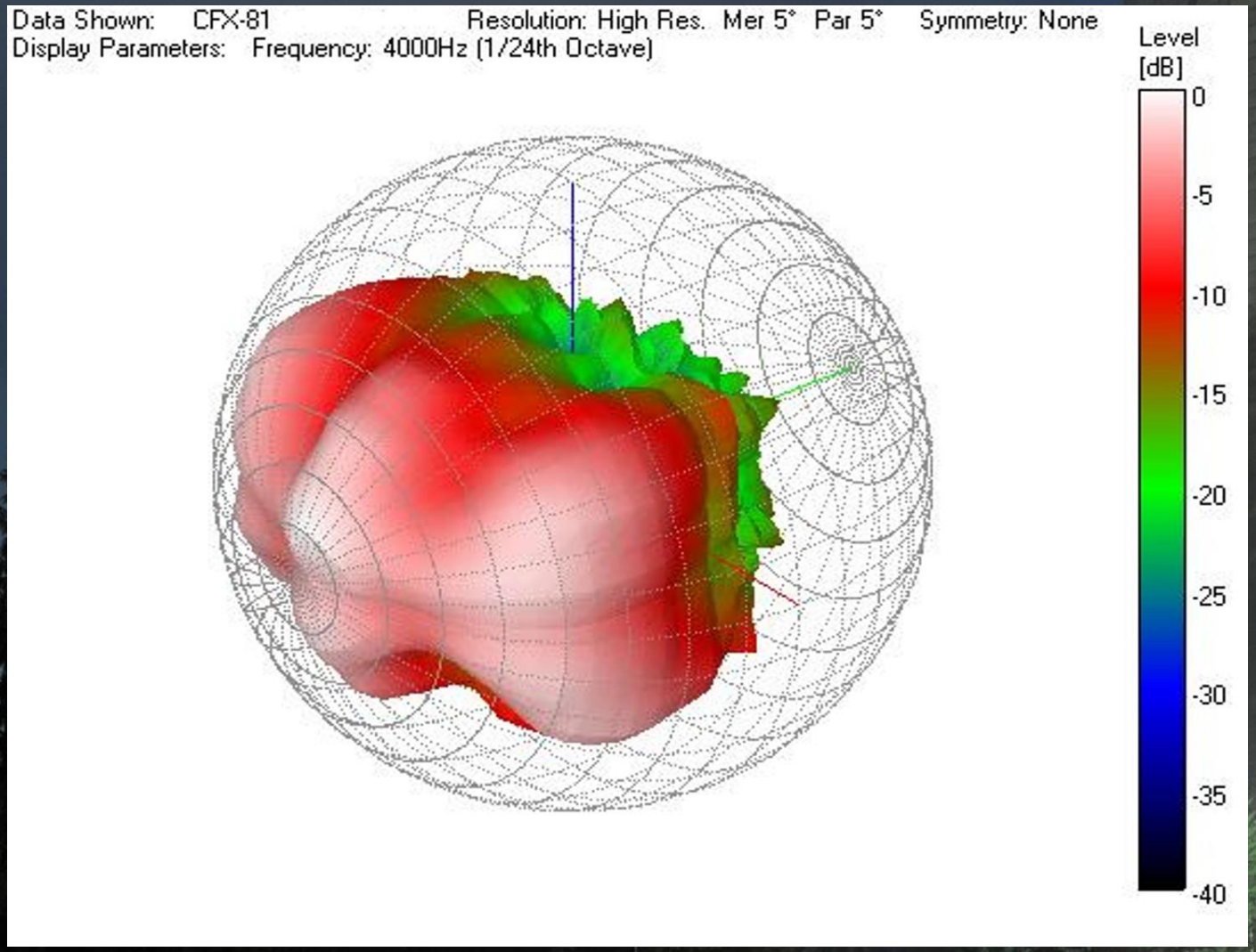


Directivity Balloon. Why is it Important?

- It is used in all system design programs



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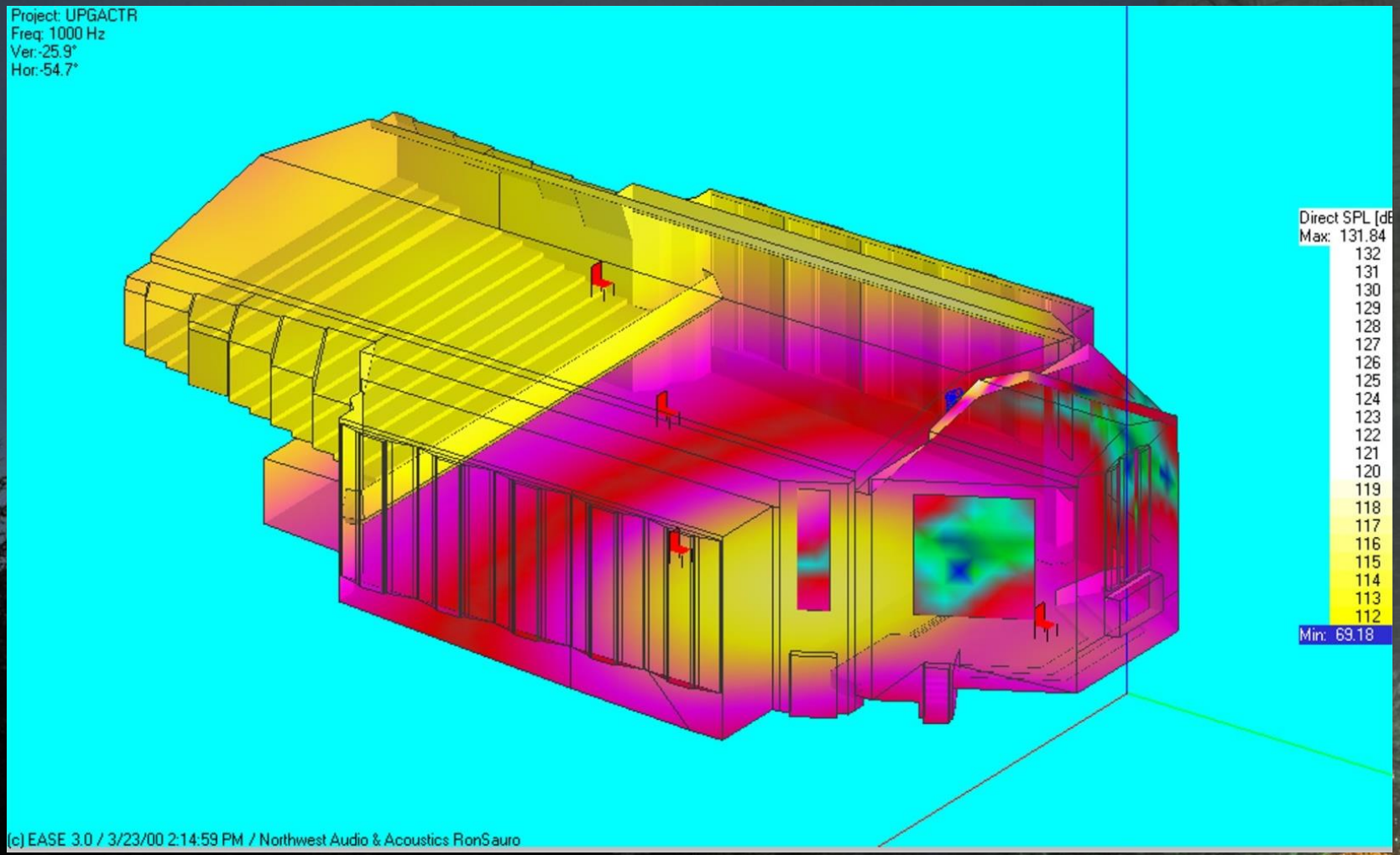
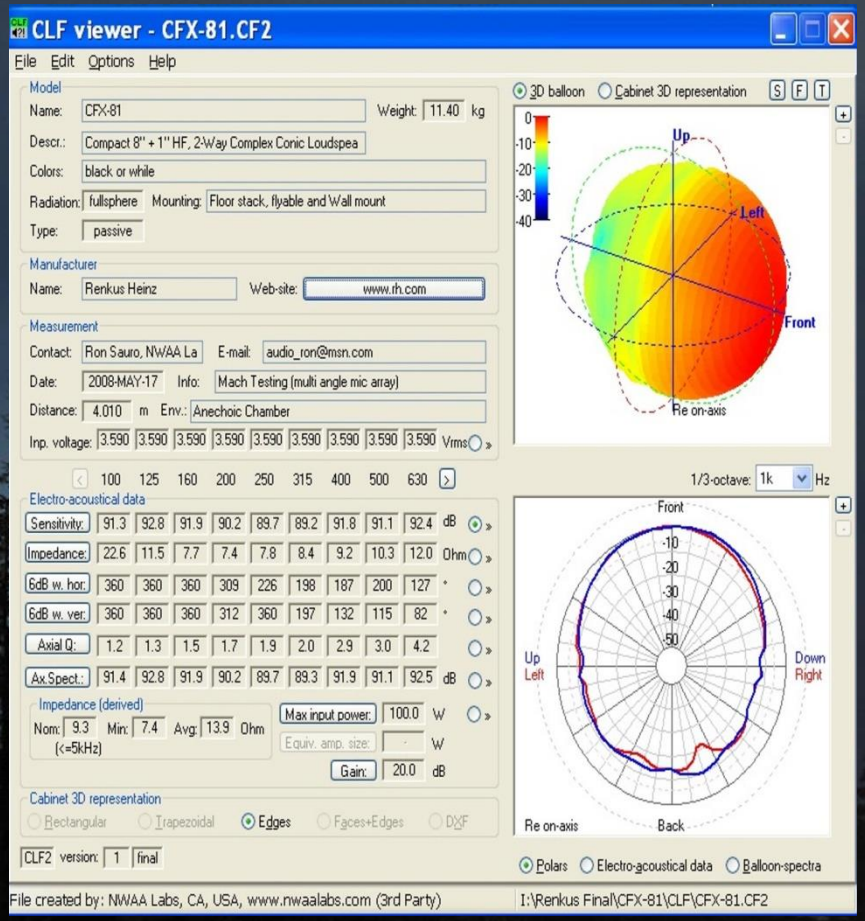
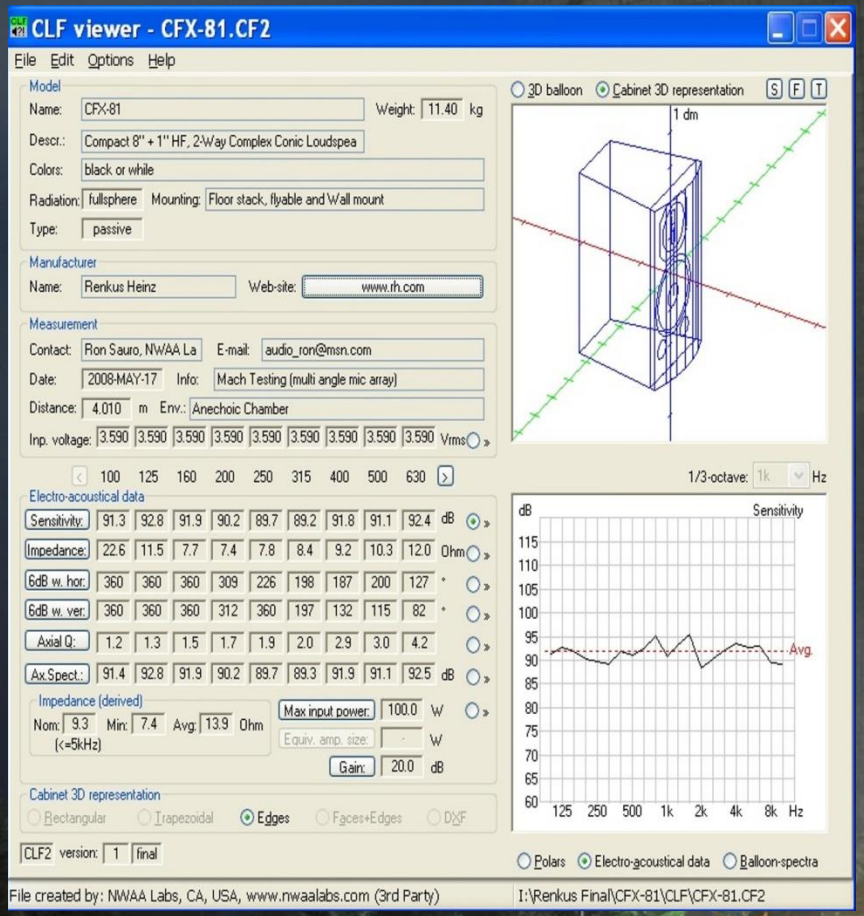


CLF1 and CLF2 Data

- It is used in the CATT Acoustic, Odeon and Ulysses system design programs



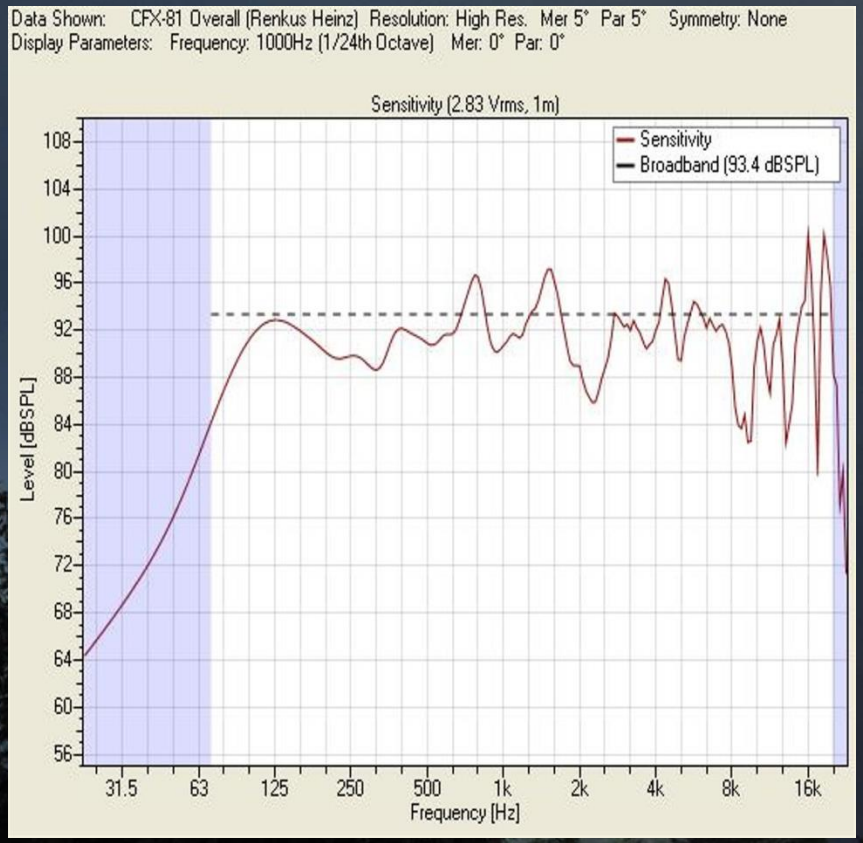


GLL Data

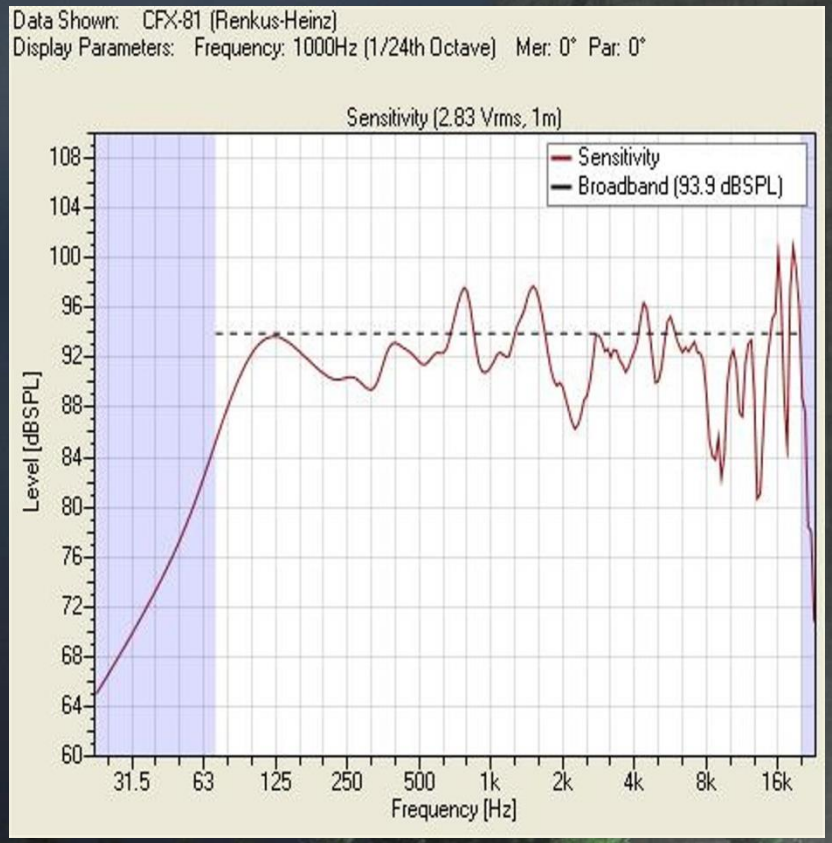
- It is used in the EASE 4X system design program
- Allows “Construction” of a Speaker System in Virtual Space.
- Allows The Speaker Designer to See What Happens When EQ, Delays or Any Type of Signal Processing is Applied to the Speaker in the Relative Near Field as Well as the Far Field
- Allows the “Arraying” of Speakers and High Accuracy Prediction of the Array Lobing
- Allows Speaker Data to be used in Both the Near Field and the Far Field for Cluster Predictions

GLL Data

- Comparisons of Point Source Measurements and GLL Predictions



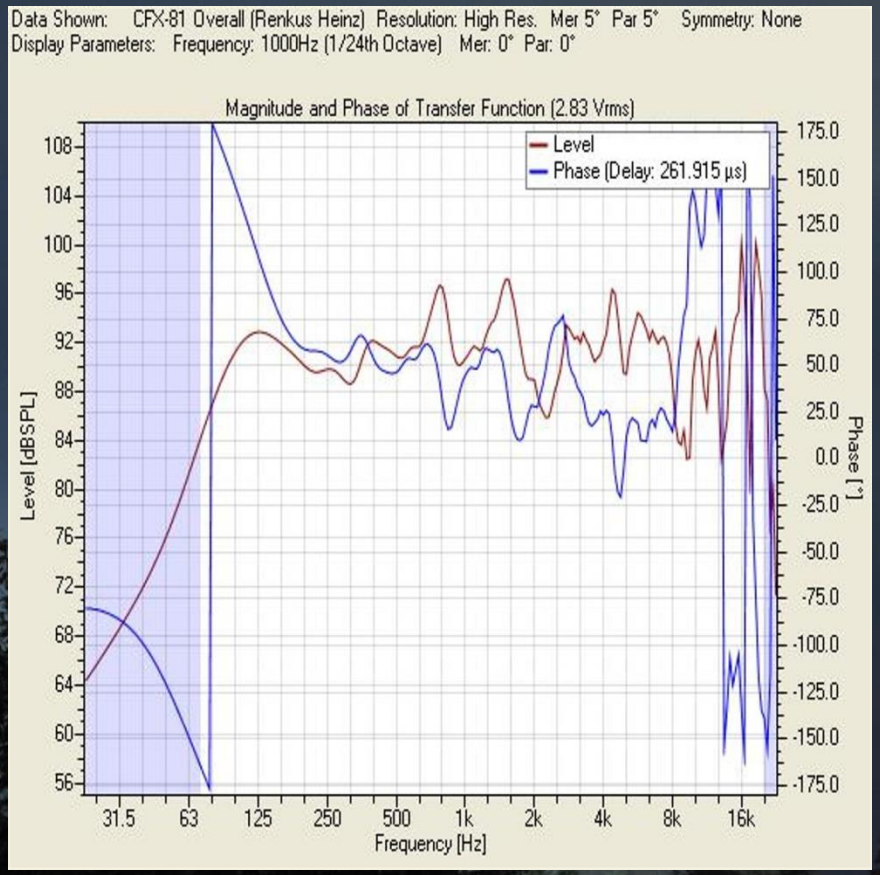
Point Source



GLL Simulation

GLL Data

- Comparisons of Point Source Measurements and GLL Predictions



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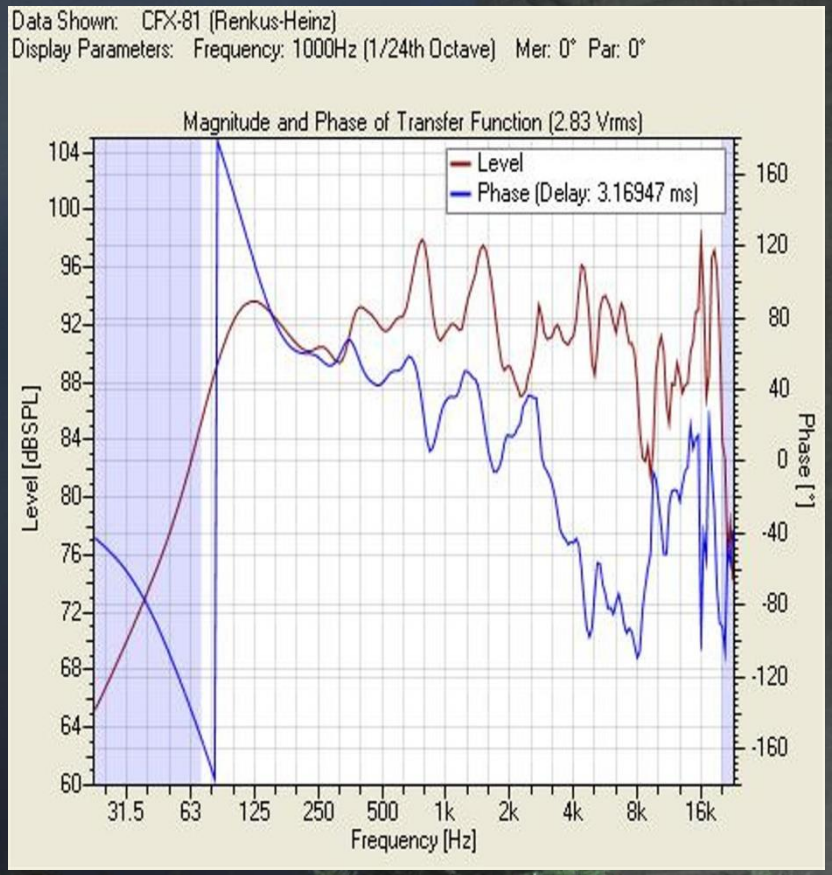

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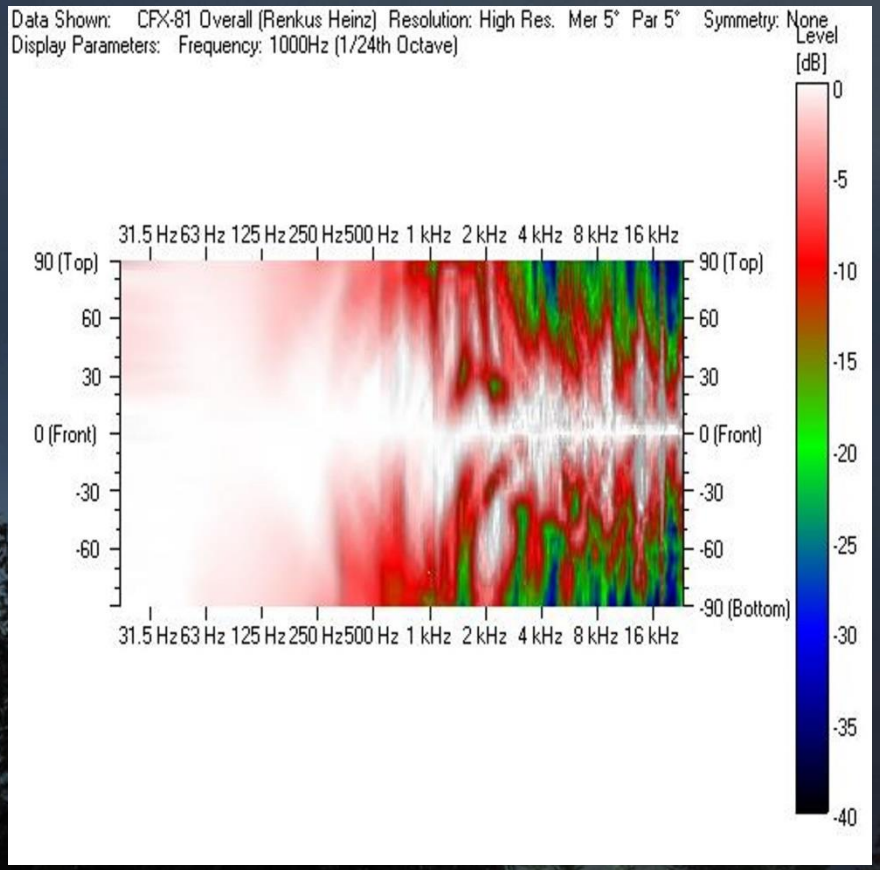

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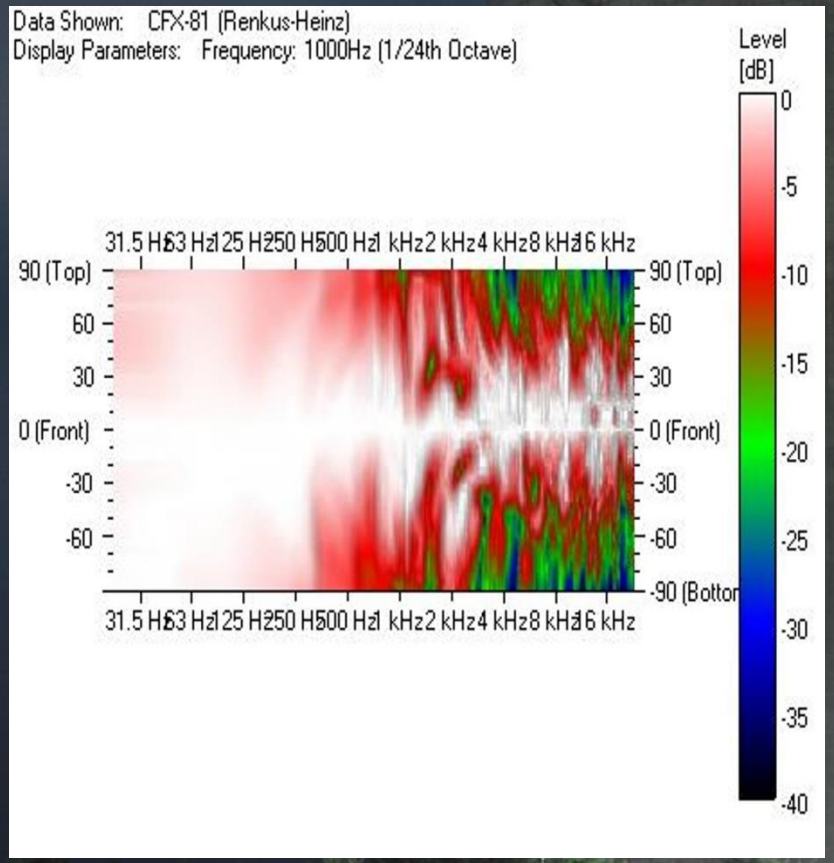

GLL Simulation

What Do You Gain with Independent Testing

- Extremely Accurate Testing
- Consistent Testing Methods
- Comparable Parameters
- Full Records and Data
- Most Consultants and End Users Perceive it to be More Believable
- A Better Understanding of the Interactions of any Modifications Done to a Speaker


Thank You For
Your Time !
Ron Sauro
NWAA Labs, Inc