DS3 Software Overview

Acoustic Qualification of Payload under SPL High-pressure Levels

DS3 software simulates the behavior of acoustic cabinets equipped with loudspeakers (the drivers) from input voltage to radiated acoustic pressure at a distance from the cabinet.

DS3 has been designed for predicting the ensemble behavior of clusters of cabinets for the **acoustic qualification of payload under SPL high-pressure levels mimicking the lift-off noise of a rocket engine**.

As SPL levels are about 150 dB, large arrays of cabinets are required.

For designing the ensemble of cabinets setup around payload for acoustic qualification purpose, the acronym DFAT for Direct Acoustic Field Transfer was referred to in many publications.

Sometimes DFAX for Direct Acoustic Field eXperiment is also found.

As the DFAT acronym is a registered trademark, an alternative acronym will design this payload test configuration. This test setup is called **DART** (**Direct Acoustic Radiation Transfer**) throughout this document.

DART has the advantage of having a meaning regarding the test setup functionality, targeted for aggressively stressing the payload structure.

When referring to test and hardware, DART acronym will be used and DS3 acronym for referring to the DS3 model simulation describing the hardware.

The acronym of DS3 software states for **Direct Sound Swarm Simulation**. DS3 will help you for designing or analyzing your own DART test system.

DS3 handles any drivers sold by audio system manufacturer so that you will be able to build your own DART from them.

Other applications can be handled by DS3 such as **audio design of cabinets** and **Active Noise Control** thanks to its inverse solve capabilities.

A DS3 model provides everything needed for designing test setup made of cabinets and loudspeakers as the total needed electric power, the motion amplitude of driver diaphragms and SPL at any distance from the cabinets.

Example of DART setup for payload acoustic qualification (ref. NASASpaceFlight.com)

DS3 predicts at any point the pressure response in the surrounding field arising from a swarm of cabinets. For this, DS3 solves the coupled problem of interaction between drivers.

Each driver generates some pressure level in the far field and as there may be hundreds of them in the vicinity, each driver diaphragm is loaded by the pressure of others, which obviously leads to less and less radiation efficiency in generating high levels by increasing the number of drivers.

The state of the system is described by a set of equilibrium equations involving the input tension, the electric current propagating with the driver coils, the mechanical motions of driver diaphragms reacting the acoustic pressure of others diaphragms.

DS3 equations are solved in two ways:

- starting from input voltage and predicting the resulting SPL at given locations with the surrounding air volume (direct DS3 solve),
- or reversely starting by SPL specification of SPL levels at some location and calculating the state of voltages and currents circulating in the drivers (inverse DS3 solve).

DS3 Software Specifications

Inputs

- either voltage spectra applied to cabinets containing the loudspeakers or
- specified acoustic pressure frequency spectra defined in rms values at set of locations (constrained pressures).
  - Fluid
  - Driver
  - Cabinet
  - Pressure
  - Floor Reflection
  - Voltage

Outputs

- Acoustic pressure spectra at any user-defined points of space
- Velocities of driver's diaphragm
- Radiated acoustic power
- Electric power consumption

Using DS3, complete DART configuration may be designed from scratch from any suitable drivers created in the DS3 database.

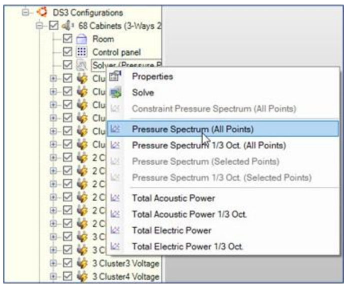
Within it, driver parameters are described by their Thiele's parameters, determined experimentally by measuring driver electric impedance or picked up from manufacturer technical sheets.

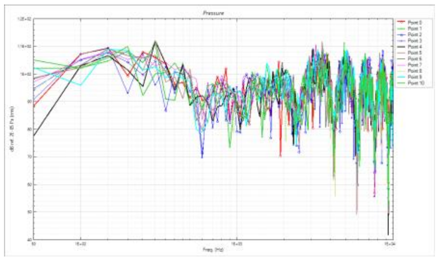
Drivers can be packed into cabinets of user-defined size and auto-organized into arrays and controlled by mapping the voltage inputs to cabinets.

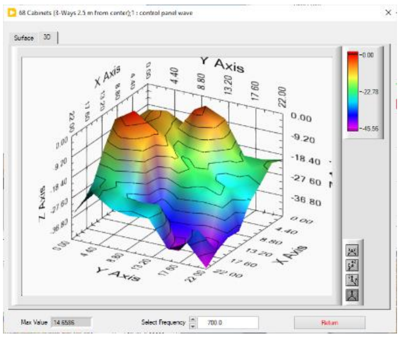
Cabinets may have internal back volumes which interact with the main frequency resonances of the drivers.

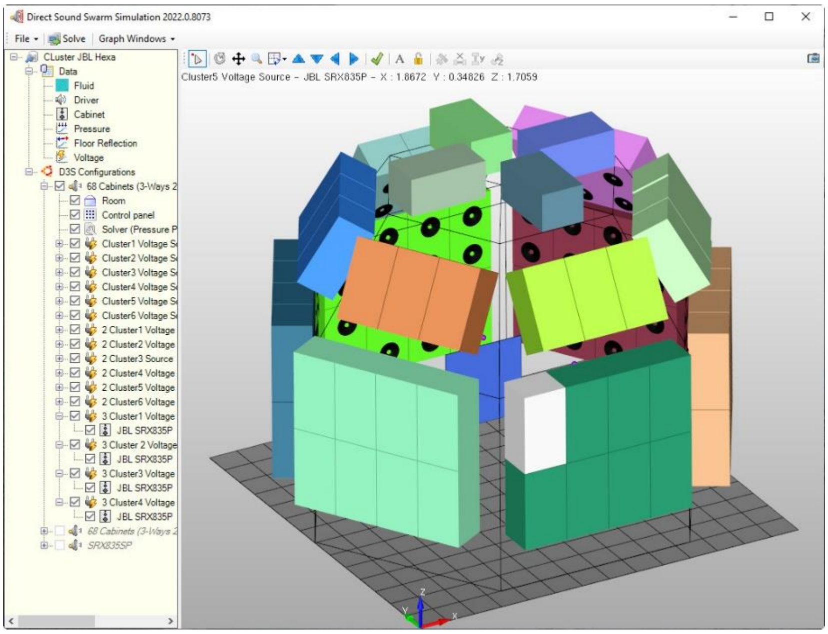
Drivers are sorted out into four types: **subwoofer, woofer, medium** and **tweeter** to cover the full audio range. Compression chamber and horn (modeled using transfer matrix method) can be added in front of the driver diaphragm to boost high frequencies and scatter their directivity pattern.

When predicting the interaction between the various driver diaphragms, diffraction corrections are introduced when the incident wave of a given driver is impinging the cabinet of another one.









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