The CabSolver

A COMPUTER BASED
CABINET & BOOTH EMULATOR
BY

Dr. CabSim

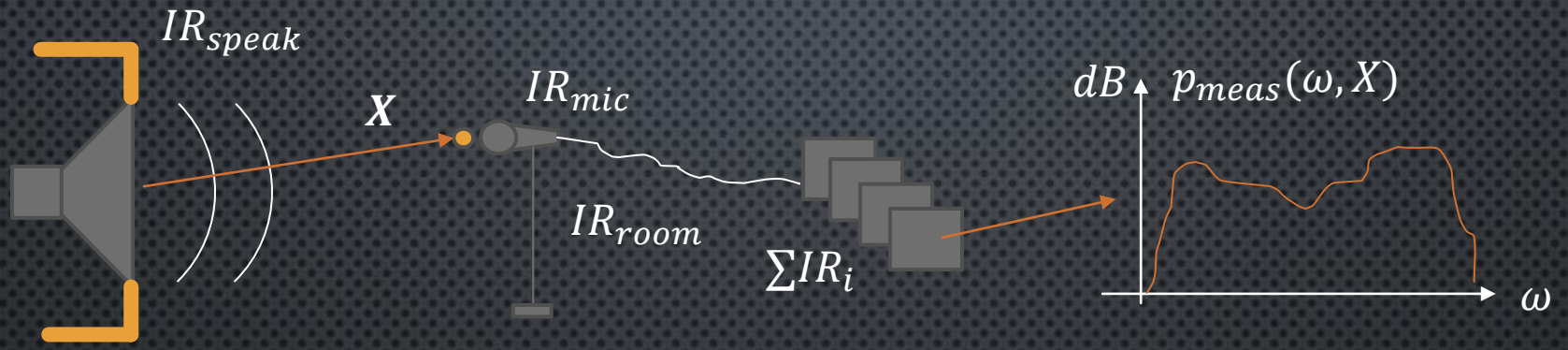
If you place a loudspeaker at an arbitrary position in a small room, is it possible to calculate how it sounds at a chosen location?

an automated computational concept has been developed (out of curiosity) to check out these virtual cabinet sounds

two, parametrized, acoustic models are today used and are here briefly presented

THE CLASSIC PLUGIN APPROACH

Most of today's speaker plugins are based on responses captured by a recording sequence



$$p_{meas}(\omega, X) = IR_{speak} + IR_{mic} + IR_{room} + \sum IR_i$$

A sequence of transfer functions

It's possible to 'isolate' the cab response using a computational model to only get IR_{speak} ?

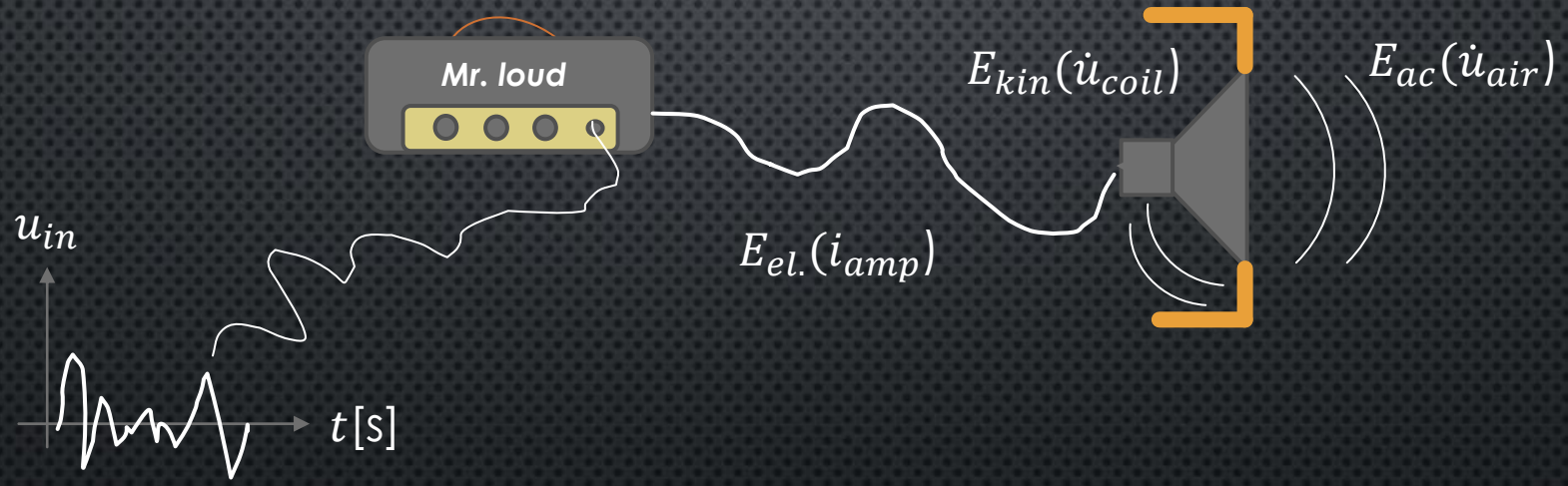
A simple band-pass filter will do the work, but a bit boring!

Speakers are, numerically, a bit tricky

Normally, in a modelling context, one (1) energy form is present (amp, stomp box etc.)

This is <u>not</u> the case concerning speakers, we are dealing with a double transducer!

- Electric ($E_{el.}$) → Kinetic (E_{kin}) → Acoustic energy (E_{ac})



Dissipation is present in the last transition, $\dot{u}_{cone} \rightarrow \dot{u}_{air}$, which is always, numerically, problematic

A speaker & cab model needs to include (to some degree) these transitions → **<u>Multi physics</u>**!

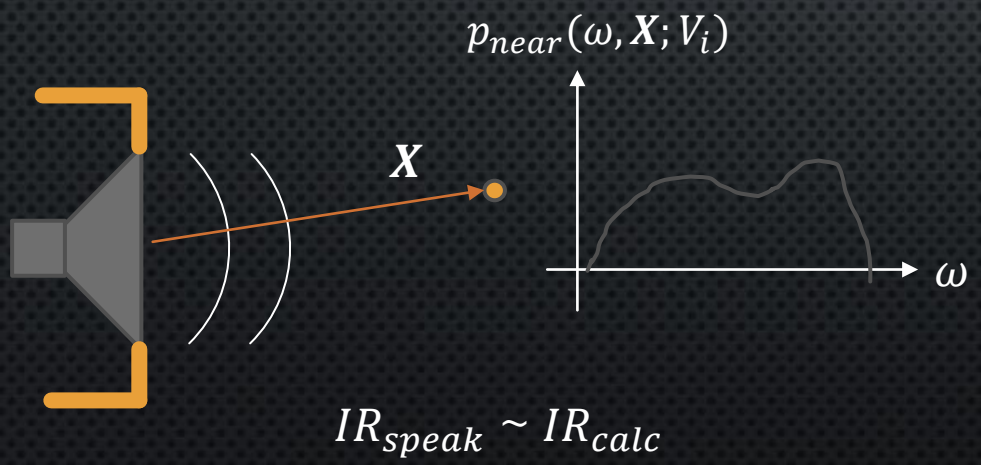
A pragmatic approach will be adopted when trying to represent these stages

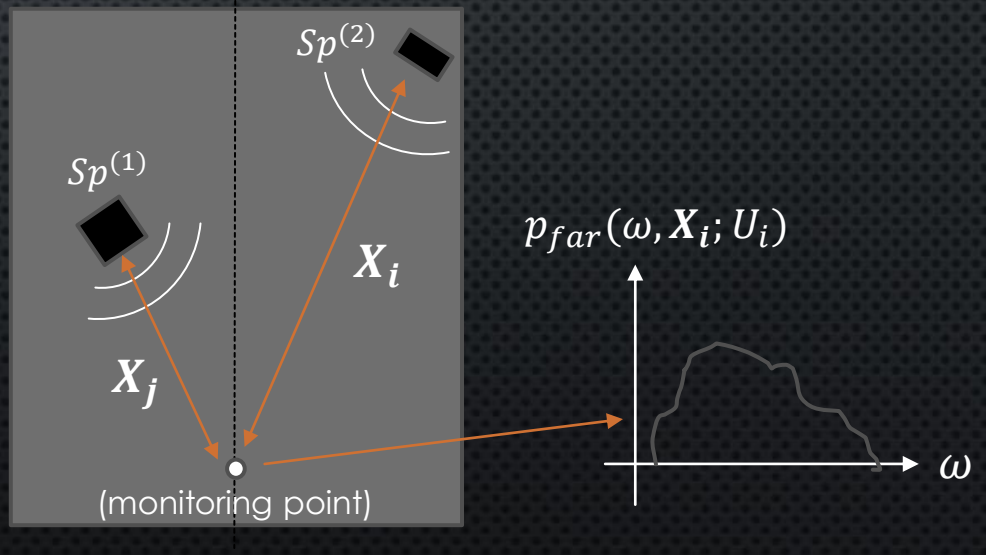
THE PROJECT PLAN

I. Develop a computational model for calculating the transfer function of speaker & cab set-up (the near field problem)

II. Look for a booth model, representing the '*cabinet in a booth*' problem, and solve the corresponding far field problem

III. Implement the results in a plugin and, simply, check the sounds!





Dr. CabSim

THE SPEAKER & CABINET MODEL

(THE NEAR FIELD PROBLEM)

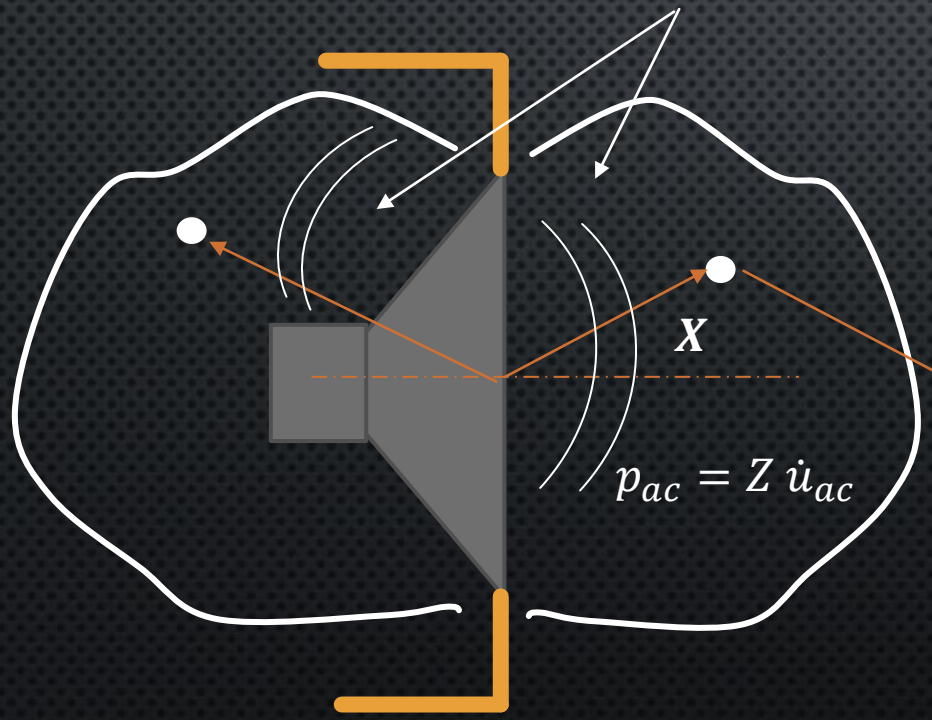
THE ACOUSTIC NEAR FIELD MODEL

Select a few speaker & cab related parameters

Figure out how to represent the axial force seen by the voice coil

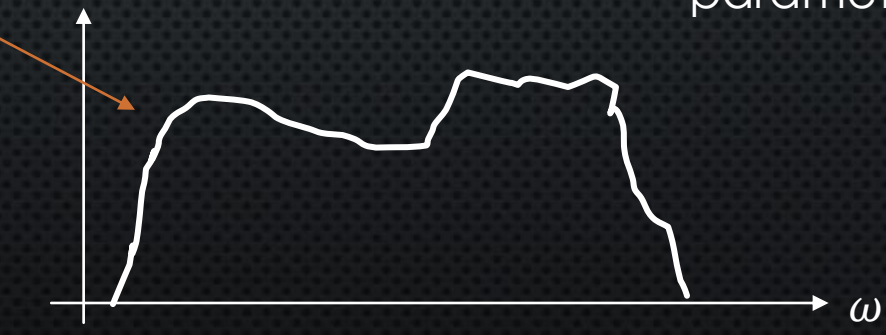
Focus, initially, on pressure solutions at a few, pre-defined, locations, X_i

The near field domains (complicated phase relation between p_{ac} and $\dot{u}_{ac}$)



$$p_{near} = p_{near}(\omega, \boldsymbol{X}; V_i)$$

speaker & cab parameters



THE SPEAKER PARAMETERS

- Speaker size (D_{sp})
- Voice Coil (d_{coil})
- Cone slope (θ_{cone})
- Material
- Force factor BL(d_{coil})

} Effecting the mechanical stiffness

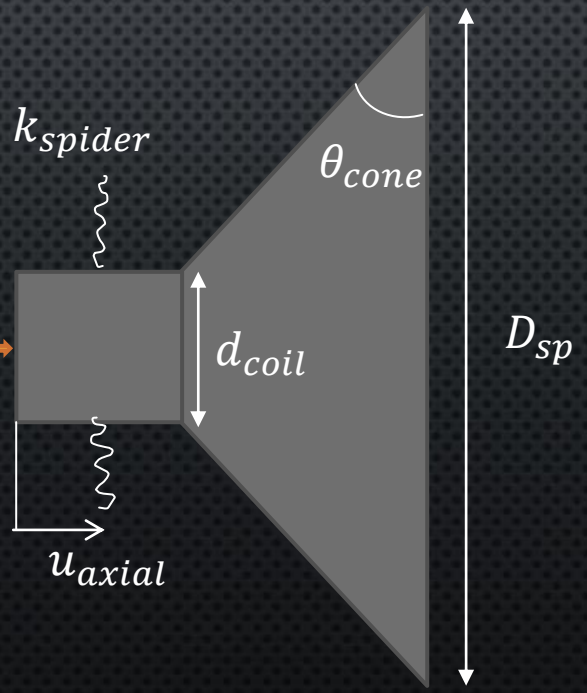
→ The 'leash' parameter (controls damping)

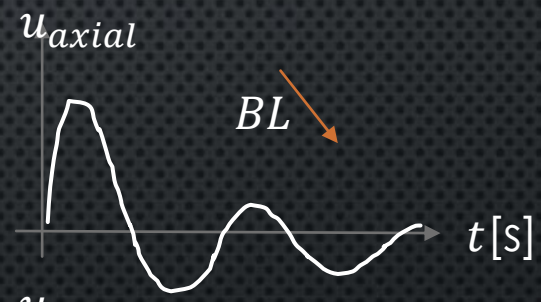
Total force 'seen' by the coil

ΔF_{ax}= f(F_i, $F_{\dot{u}}$)

$F_i \sim BL\, i_{amp}(t)$

$F_{\dot{u}} \sim BL\, \dot{u}_{cone}(t)$





A short 'leash'

THE CABINET PARAMETERS

- Cab size
- Cab type

Cab type is also, to some degree, related to the far field

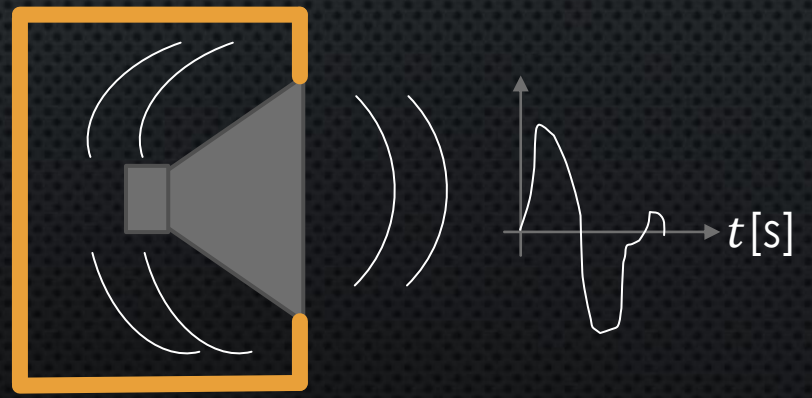
Cab size is, in this context, about baffle area

This is more of a far field parameter as the intensity is strongly related to the baffle size

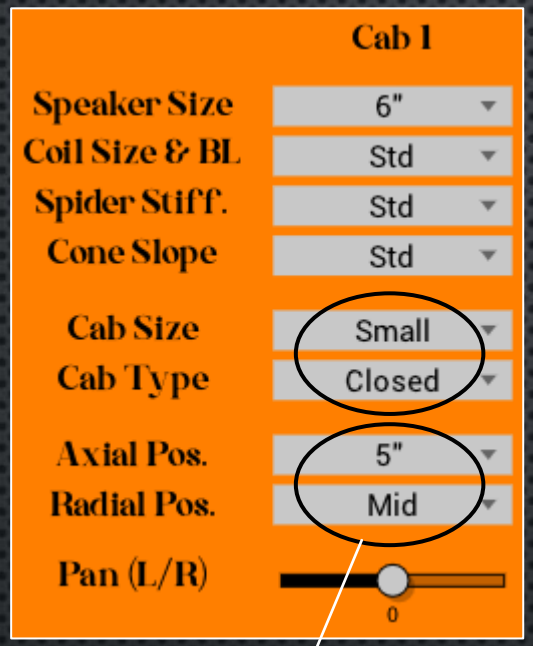
An 'infinite' baffle quadruple the acoustic intensity downstream as we are blocking the energy to not 'escape' around the corner

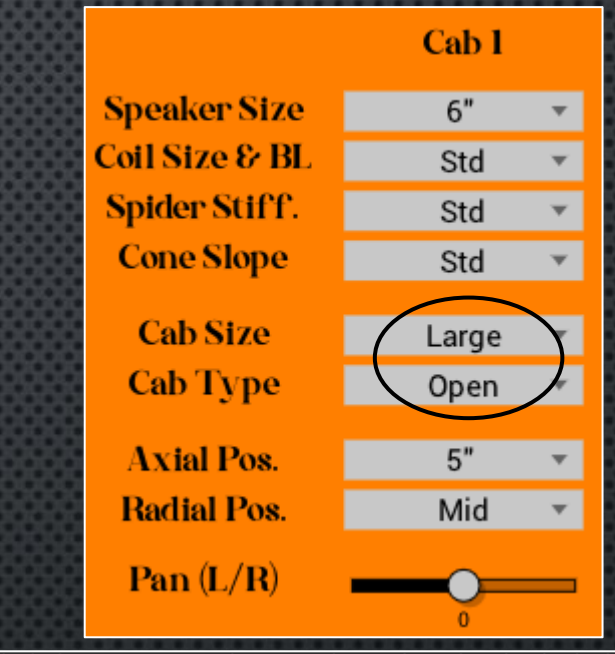
Open cabs radiate twice the energy

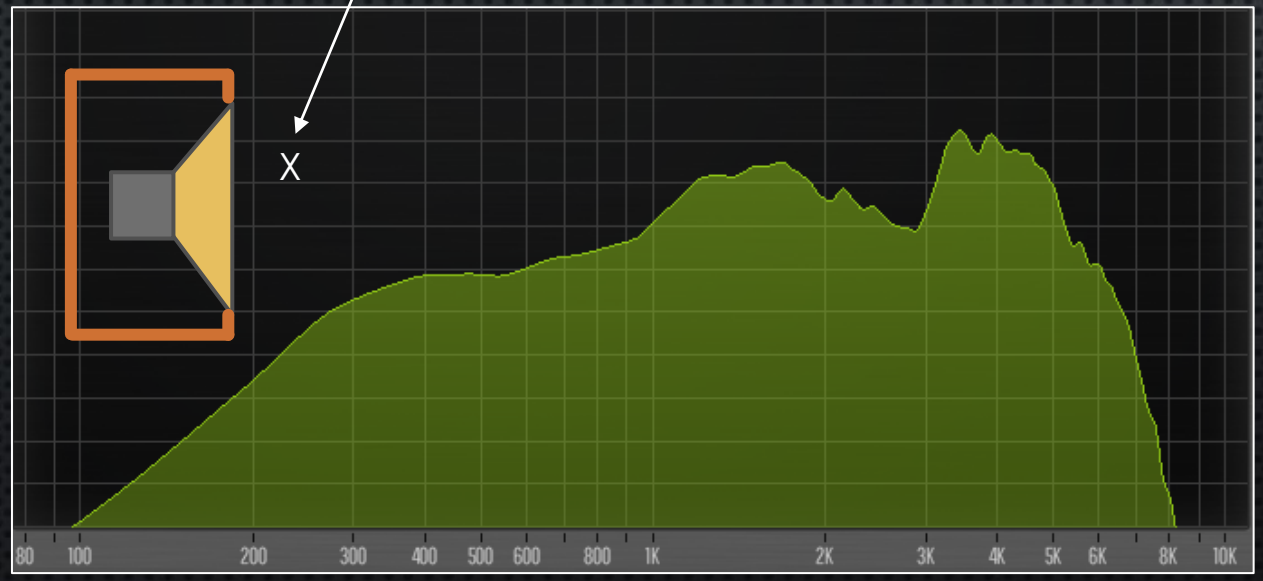
The 'trapped' air will have an impact on the resulting 'effective' speaker stiffness, especially for a small, closed, cabinet



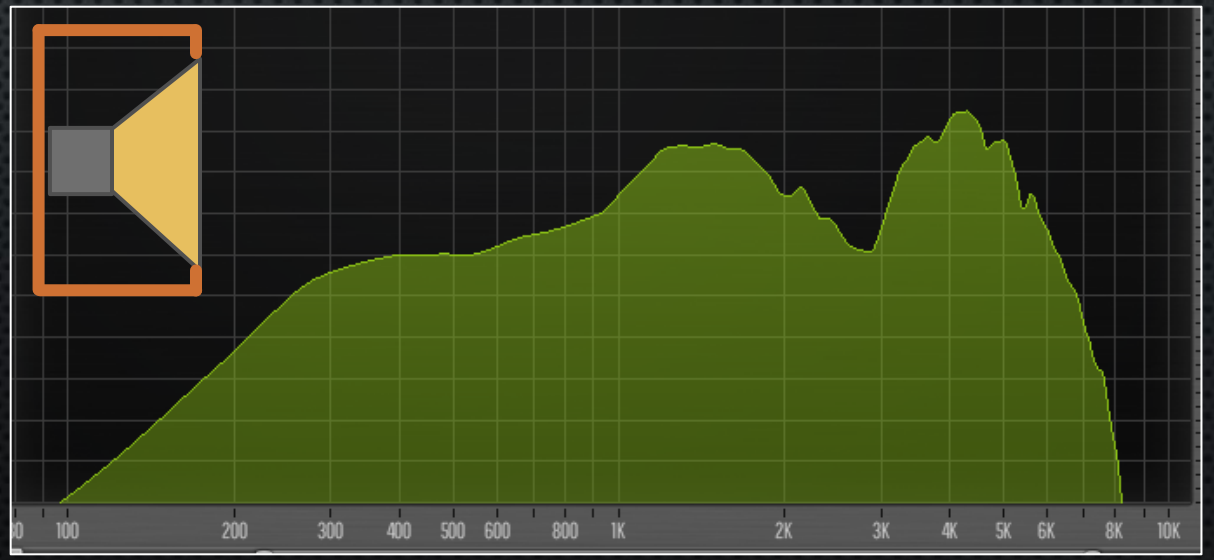
Responses (FFTs) from the near field model







...SOME ADDITIONAL GRAPHS



Part II

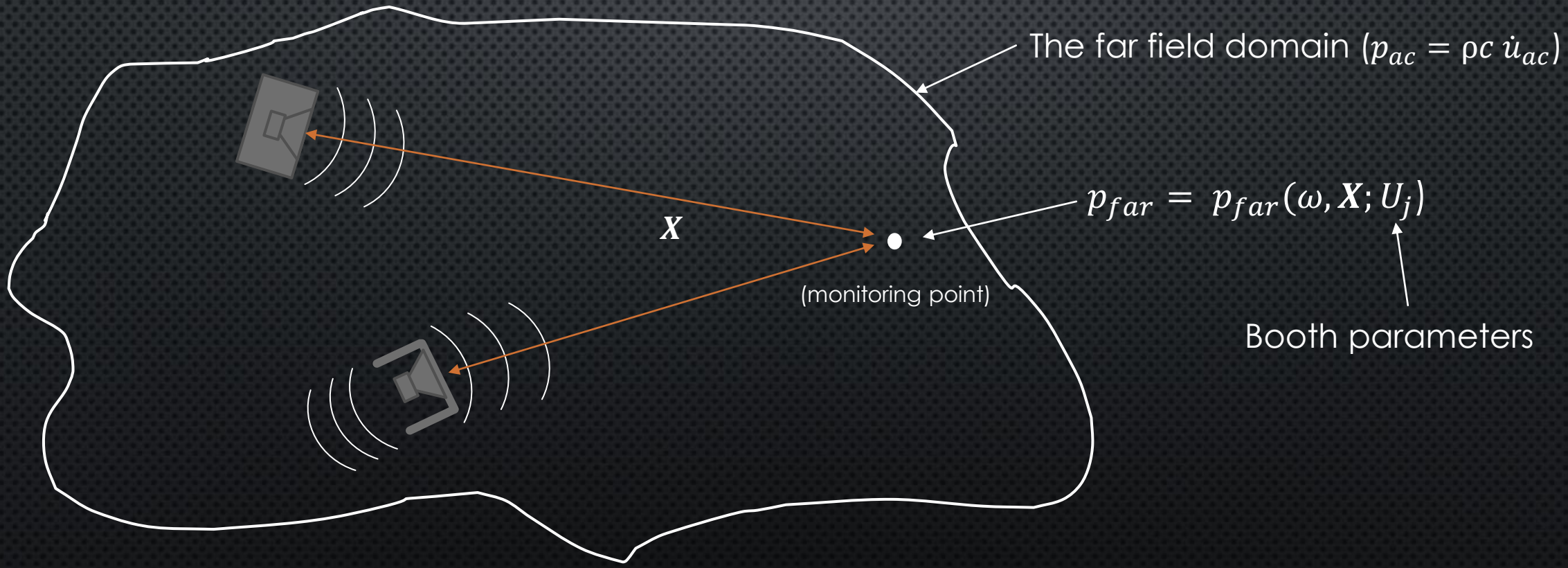
THE BOOTH MODEL
(THE FAR FIELD SOLUTION)

THE FAR FIELD MODEL

Figure out a computational model calculating the acoustic response at a given monitoring point

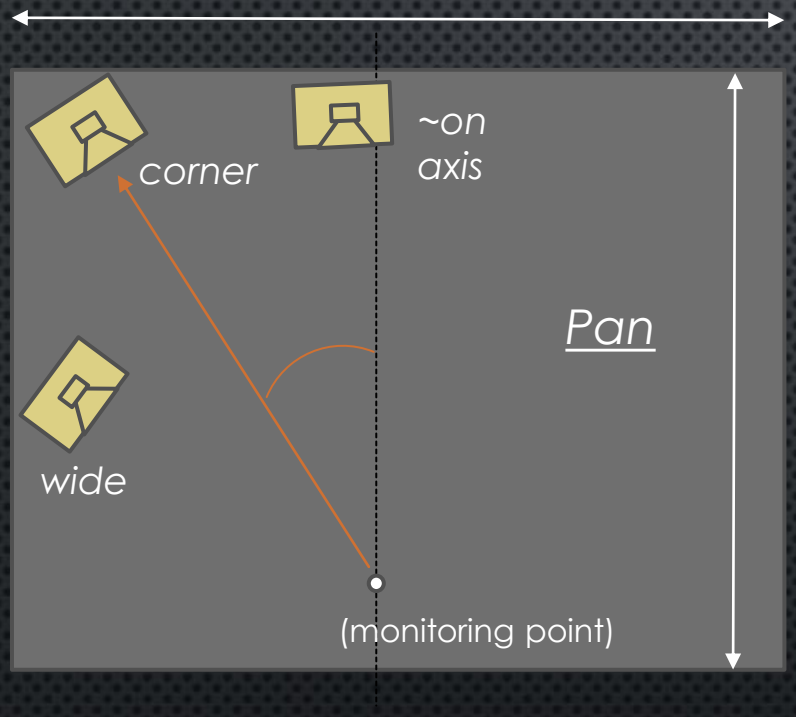
A few booth and cabinet parameters to be included

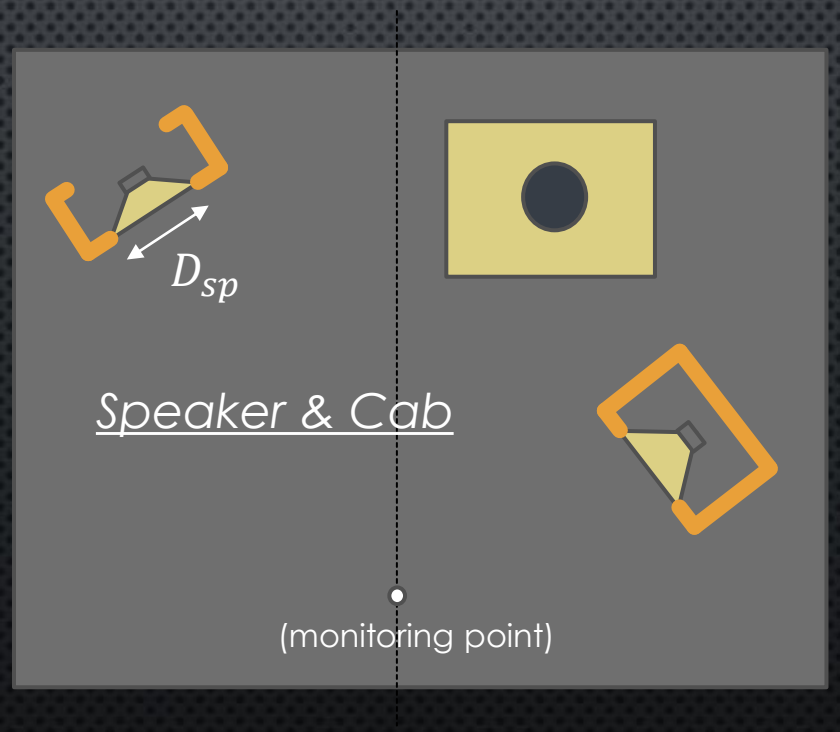
Find a strategy for blending the near- and the far field solutions for a '*cab in a booth*' sound

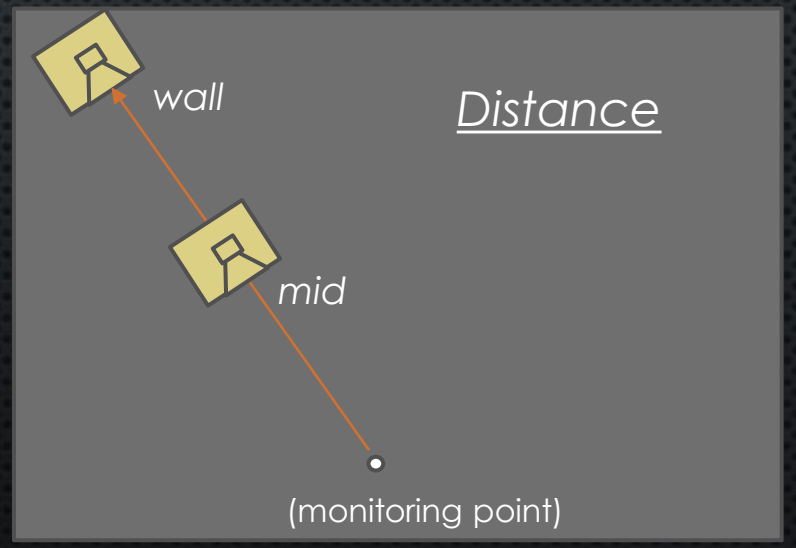


THE BOOTH PARAMETERS

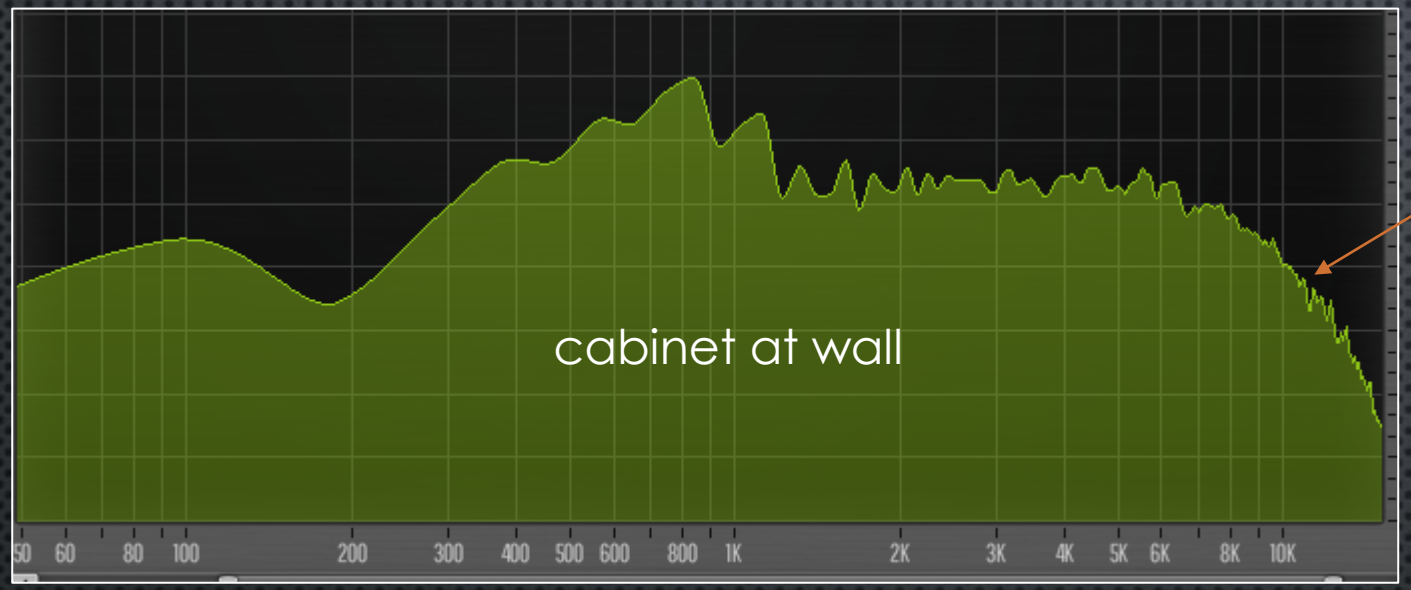
- Size of the booth (described by a ratio parameter)
- Location of the cab via *Pan & Distance*
- Reuse far field parameters from the near field set-up (speaker and cab sizes and cab type)

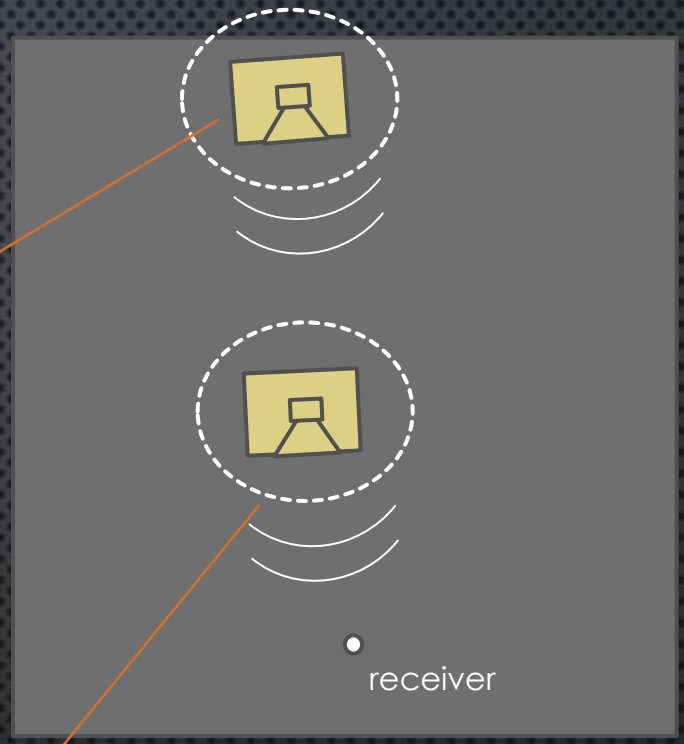


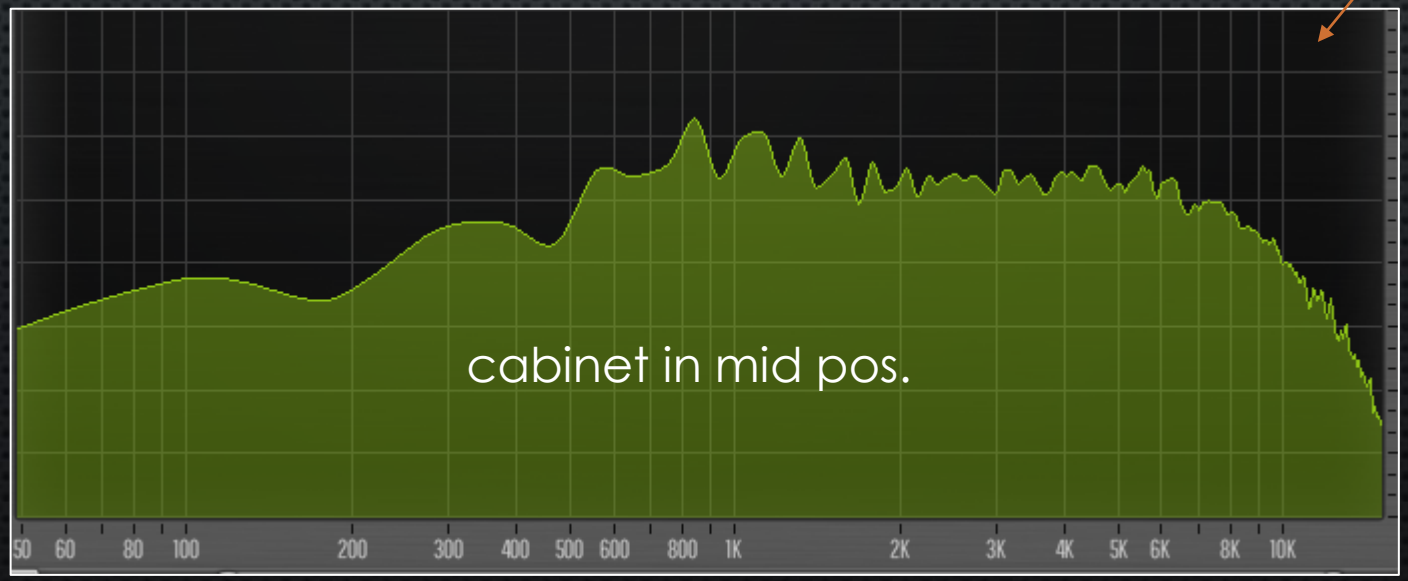




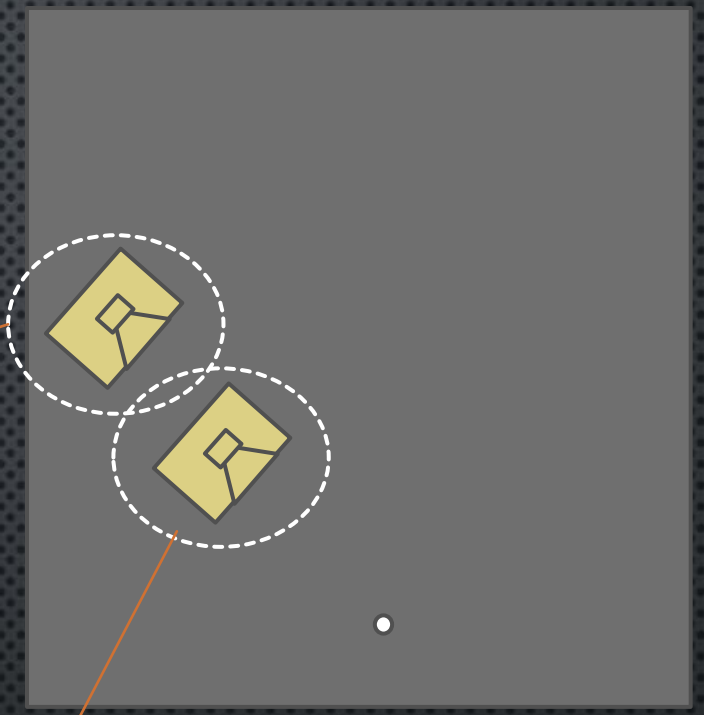
CALCULATED FAR FIELD RESPONSES

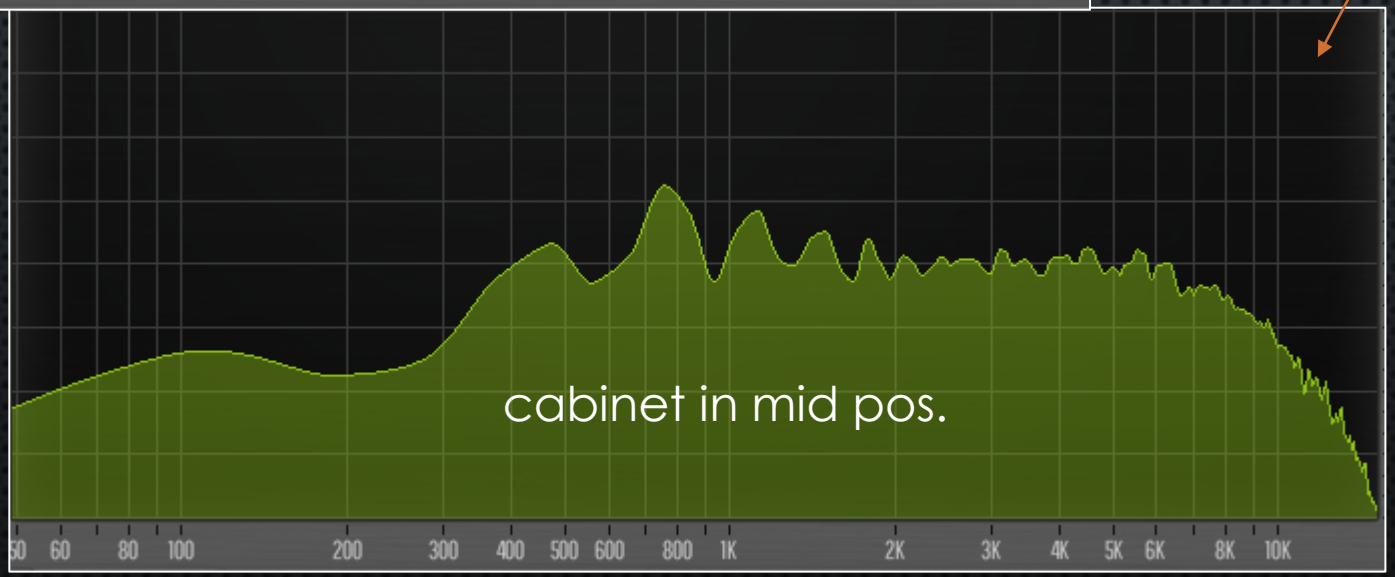






CALCULATED FAR FIELD RESPONSES





Part III

THE GUI

Dr. CabSim

THE PLUGIN

- The acoustic responses are implemented in a simple plugin

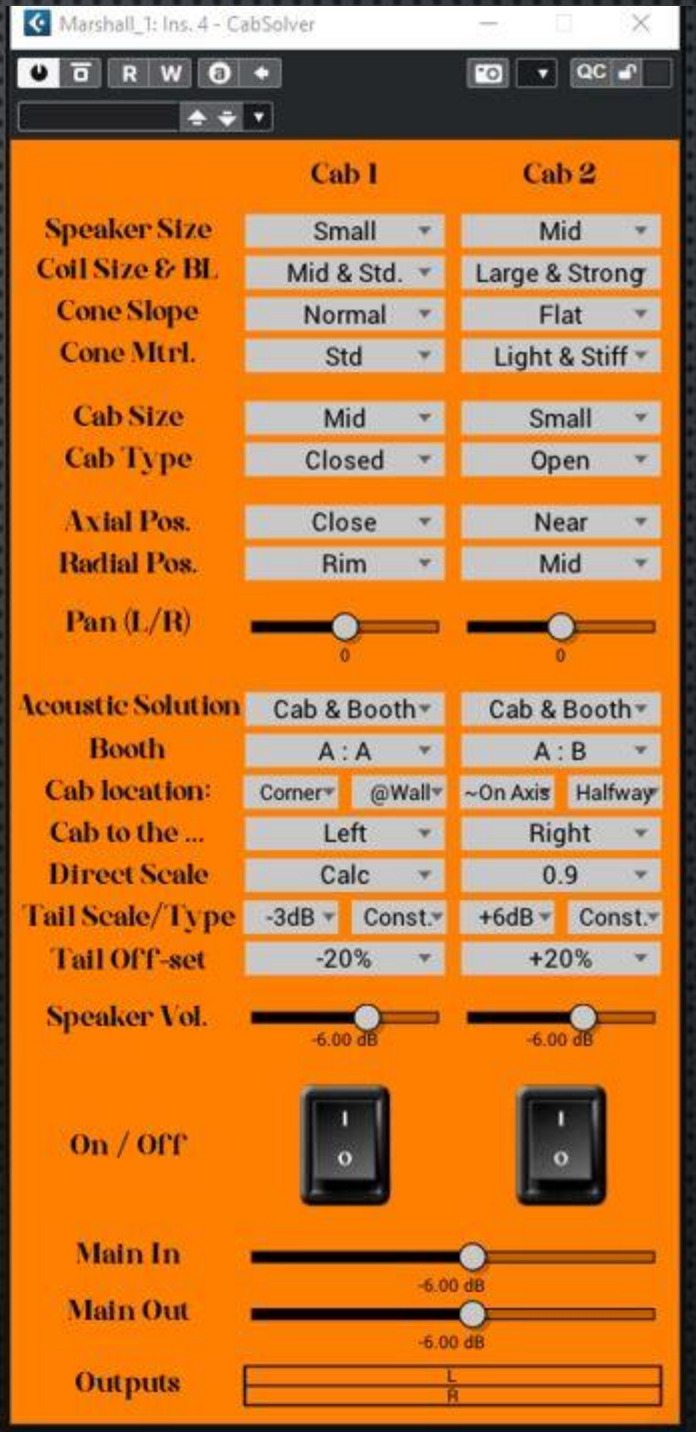
- Two different cab & booth set-ups can be used simultaneously

- Three different modes can be selected:
  - ***Just Cab***: The near field solution representing the 'mic-equivalent' sound
  - ***Cab & Booth***: The merge process of the far- and near field responses
  - ***Just Booth***: An 'ideal' cab IR (flat response) is used together with the booth solution

- Some options to elaborate the blending of the far- and near field responses
  - Scaling of the direct and the reflected sound
  - Time lag adjustment between the direct and the reflected part

CabSolver

- **Speaker size:** ***Tiny, Small, Mid*** *or* **Large**
- **Coil Size & BL**: Coil size, inductance and the force factor (***Mid & Std., Small & Weak…***)
- **Cone Slope**: Alter the overall mechanical stiffness via the cone slope (***Normal, Flat, Deep***)
- **Cone Mtrl.**: Material properties of the speaker cone (***Light & Stiff, Heavy & Soft…)***
- **Cab Size:** ***Small, Mid*** *or* ***Large***
- **Cab Type**: **Open** or **Closed**
- **Axial / Radial Pos.:** The location (z, r) of the near field solution, $p_{near}(\omega, z, r)$
- **Pan (L/R):** Panning, only valid when choosing the '**Just Cab**' solution
- **Acoustic Solution: Just Cab** → Near field solution, or the combined → '**Cab & Booth**'
- **Booth Type:** Size & shape of the booth (***A : A , A : B , B : B*** *etc.*)
- **Cab location:** Direction*(**~on axis, corner** or **wide left**), distance (**@wall** or **halfway**)*
- **Cab to the… :** ***Left*** or ***Right*** side
- **Direct Scale:** Scaling of the direct sound (**0.5 → 1.**)
- **Tail scale / Type:** Scaling of the tail & scale type (***constant, linear*** *or* ***exponential***)
- **Tail Off-set:** Elaboration with the time lag between direct and reflected sound
- **Speaker volume:** Individual adjustment of the sound level



Thanks for watching!

Dr. CabSim