SATE
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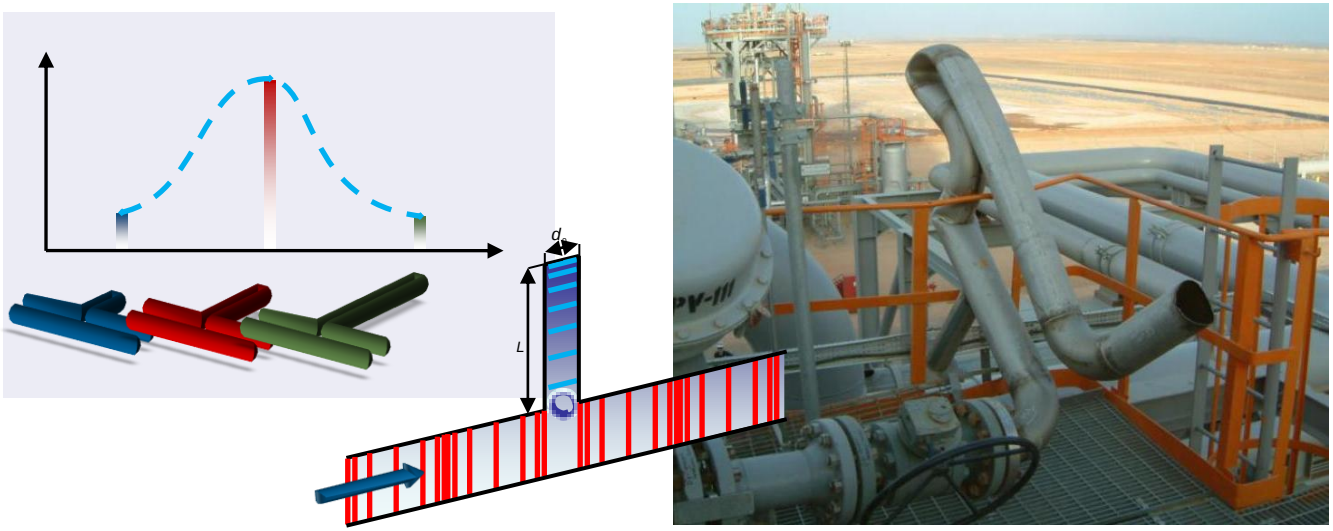
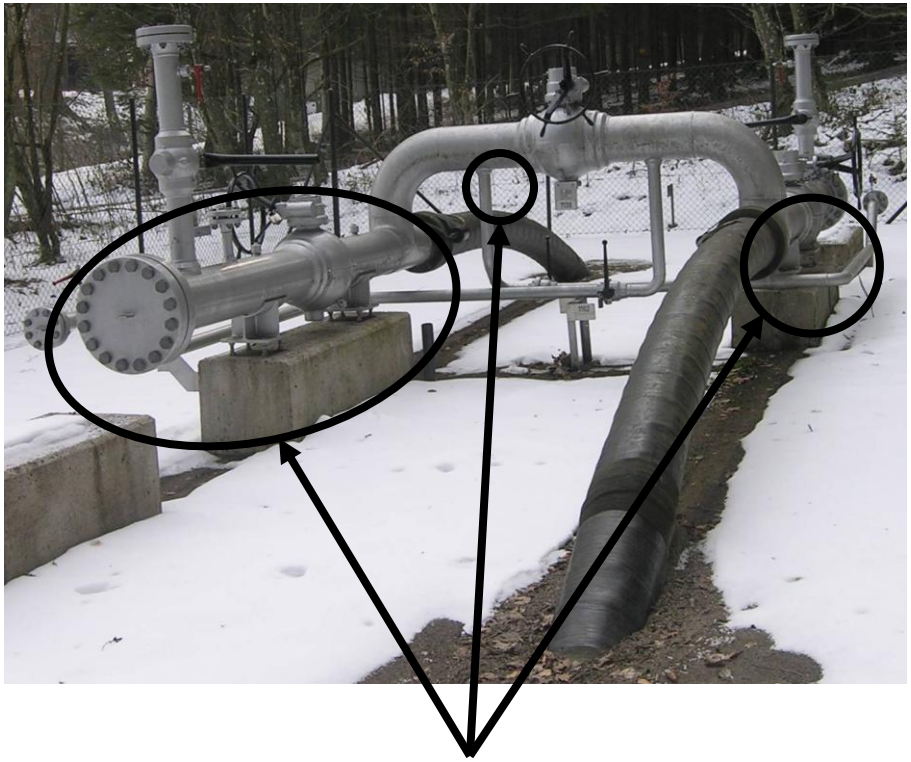
ACUSYS® & CFD TOOLS

FLOW INDUCED PULSATIONS IN PLANTS RESONANT CLOSED BRANCHES



Overview of sources



Self excited vortexes at T-joints or pipe discontinuities can induce resonant pulsations in closed branches

Flow pulsations can induce severe consequences on piping!

Involved physical phenomena

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In closed side branches dynamics
two main phenomena are involved

Fluid-dynamic vortical phenomena

- Geometric discontinuity
- Fully developed turbolent flow
- Boundary layer detaching
- Periodic vortex shedding

Mutual interaction

System acoustics

- Closed branches geometry
- Fluid properties

Involved physical phenomena

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System acoustics

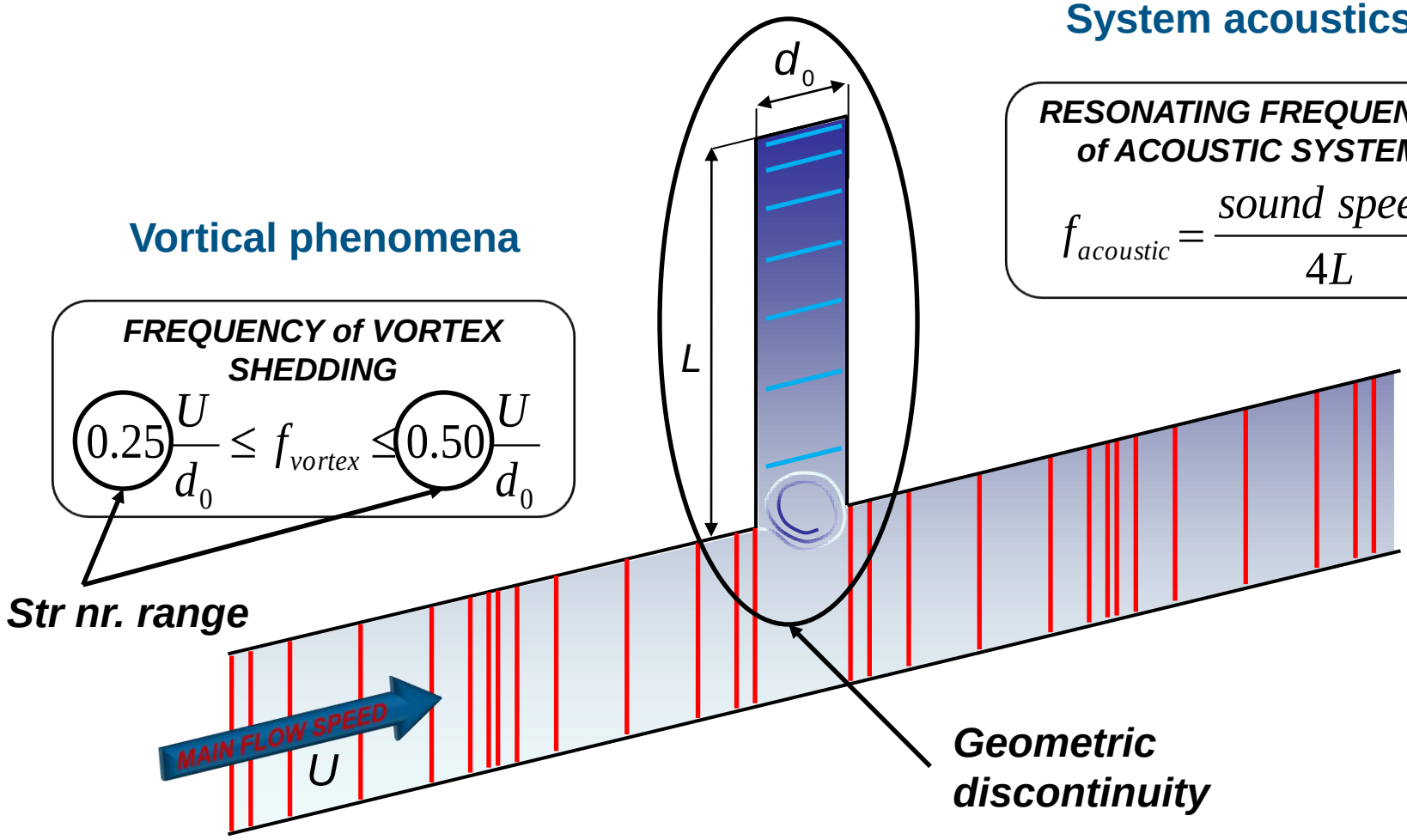
RESONATING FREQUENCY of ACOUSTIC SYSTEM

$$f_{acoustic} = \frac{sound\ speed}{4L}$$

Vortical phenomena

FREQUENCY of VORTEX SHEDDING

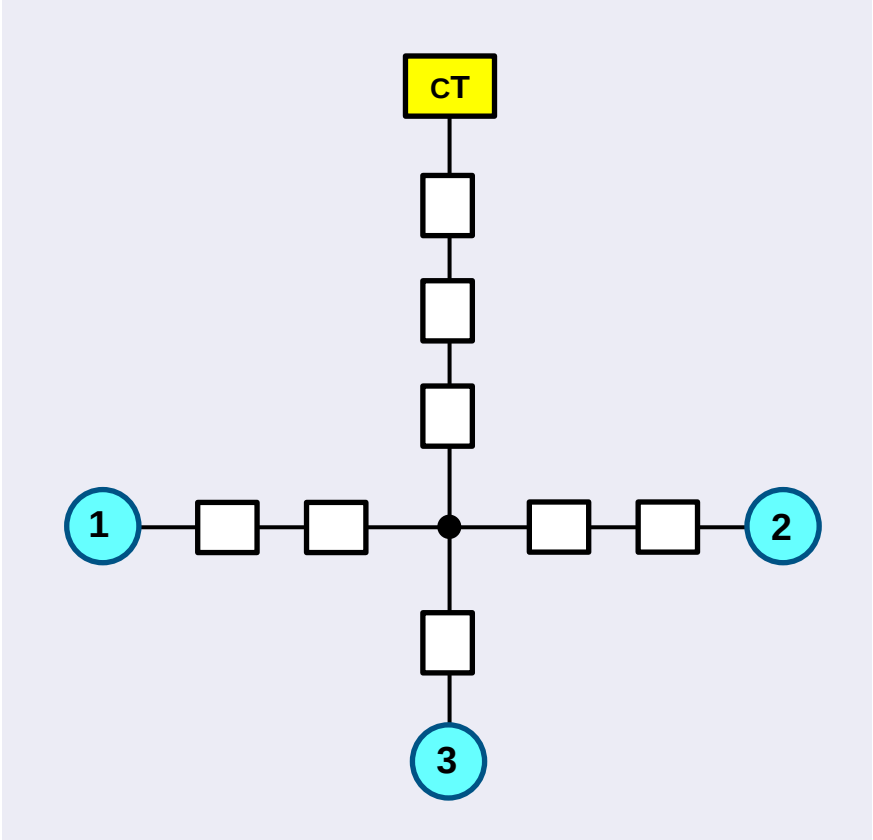
$$0.25\frac{U}{d_0} \leq f_{vortex} \leq 0.50\frac{U}{d_0}$$



Analysis Tools

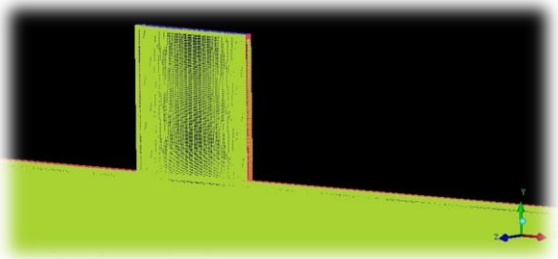
- ACUSYS® piping network model
- Pulsation sources placed at T-joints
- Source ***frequency*** explored in the 0.25-0.5 *Str* nr. range
- Sources ***strength*** calculated by converting the hydraulic energy losses into acoustic energy at the resonance.

Criterion
confirmed by dedicated CFD analysis (SATE) and experiments (literature)



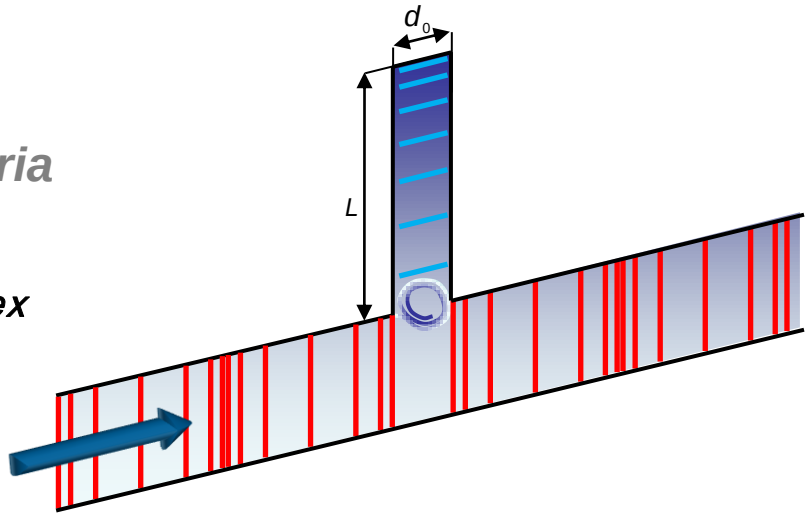
Simulated system: closed branch reference length

Vortical phenomena *System acoustic*



Interaction criteria

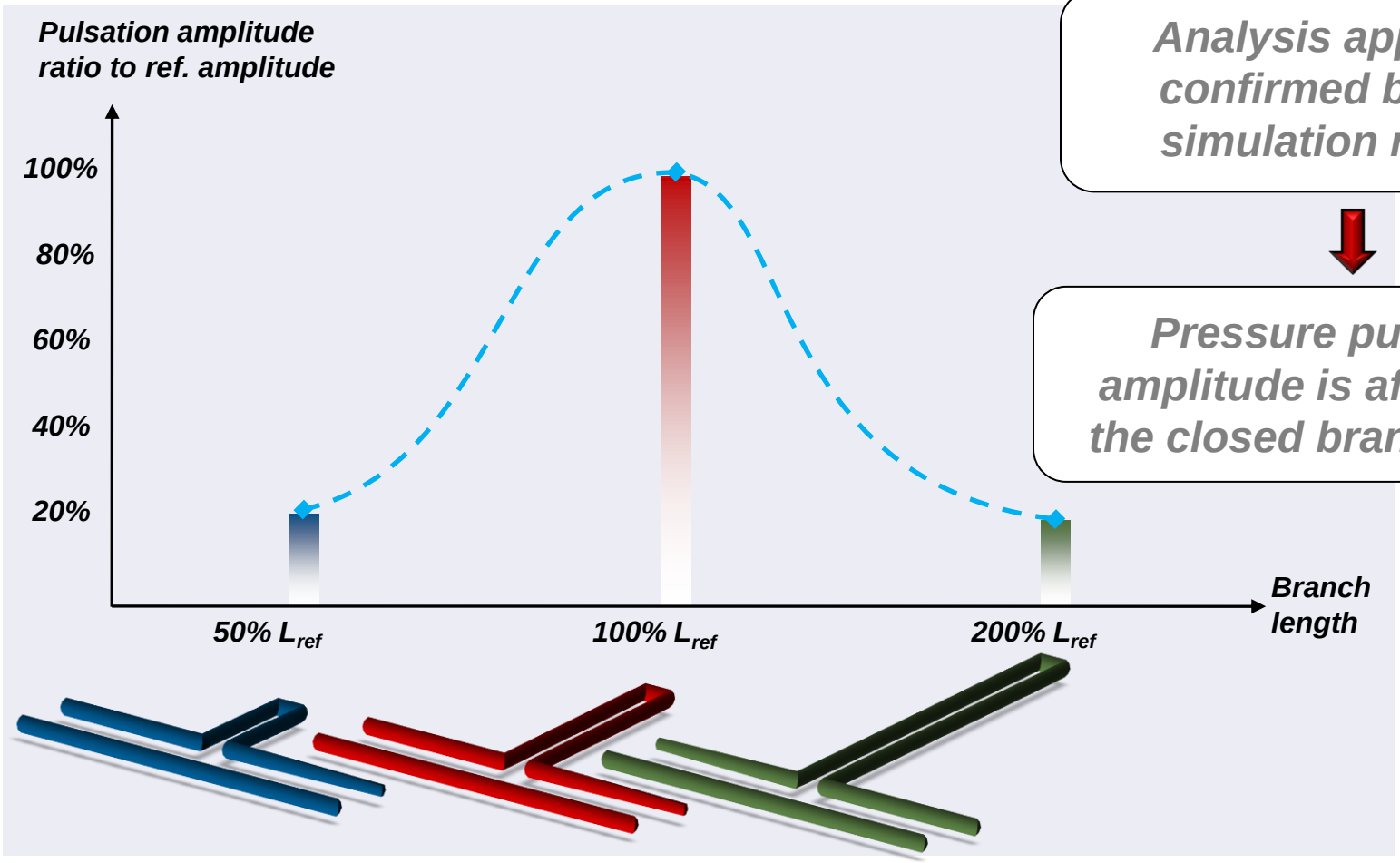
$$f_{acoustic} = f_{vortex}$$



Close branch length within resonanting conditions

$$L_{ref} = 0.25 \cdot \frac{U}{d_0} \cdot \frac{sound\ speed}{4}$$

Sensitivity test 1: vs. closed branch length



Analysis approach confirmed by CFD simulation results

Pressure pulsation amplitude is affected by the closed branch length

Sensitivity test 2: vs. main flow speed

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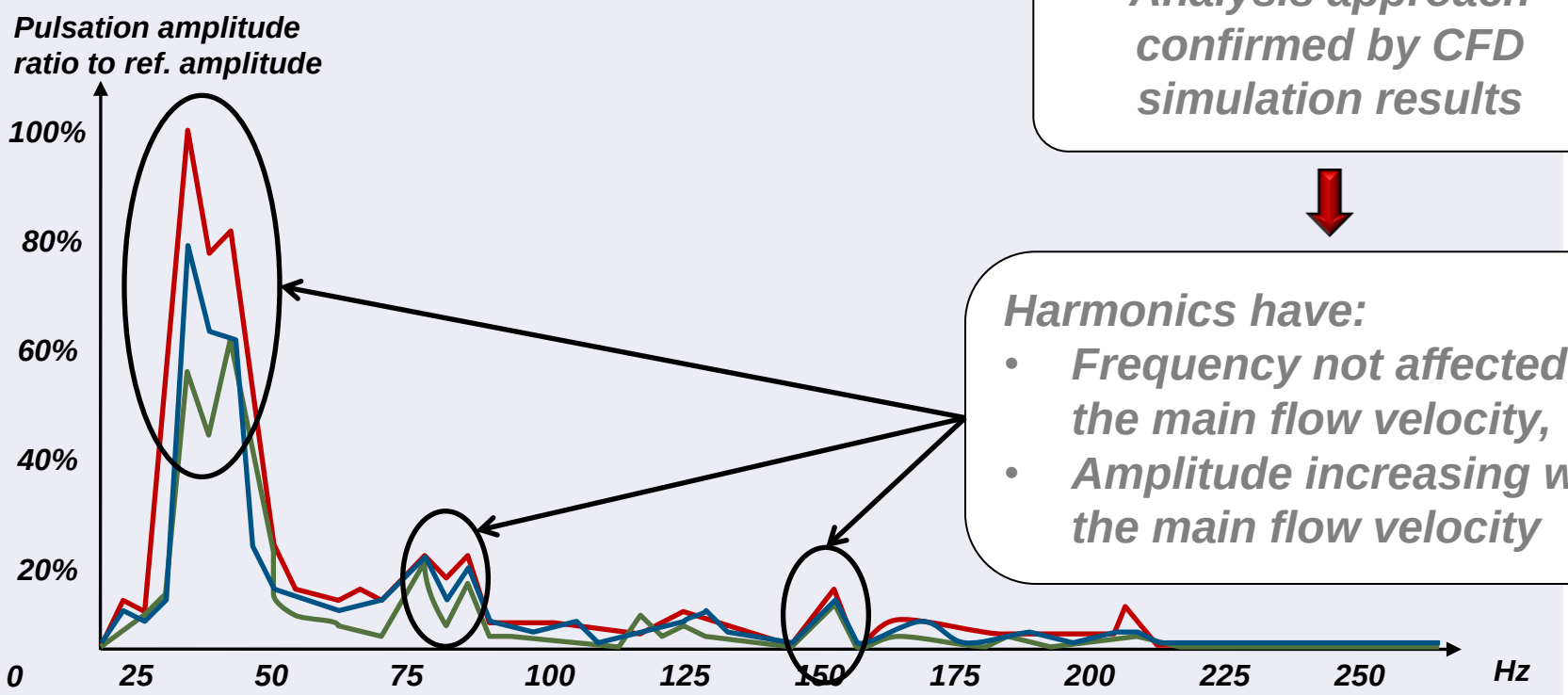


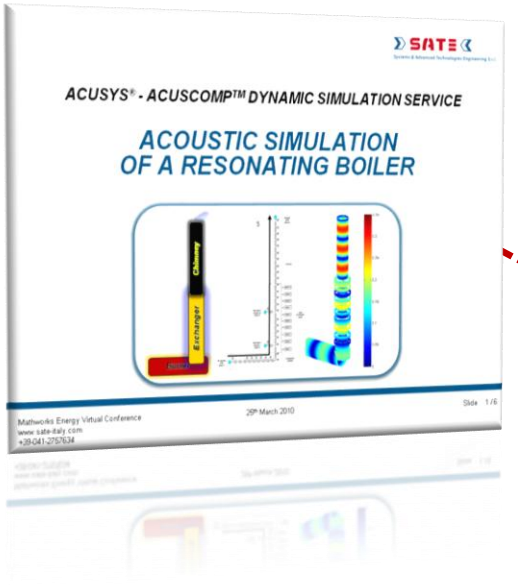
Analysis approach confirmed by CFD simulation results

Harmonics have:

- *Frequency not affected by the main flow velocity,*
- *Amplitude increasing with the main flow velocity*

Links

CLICK ON THE BUTTONS TO VIEW IN GREATER DETAILS



[MAIN PRESENTATION]

[Resonating boiler]

[Variable speed compressors]