AC/DC rocked the world, ACBC explores its nonlinear dynamics

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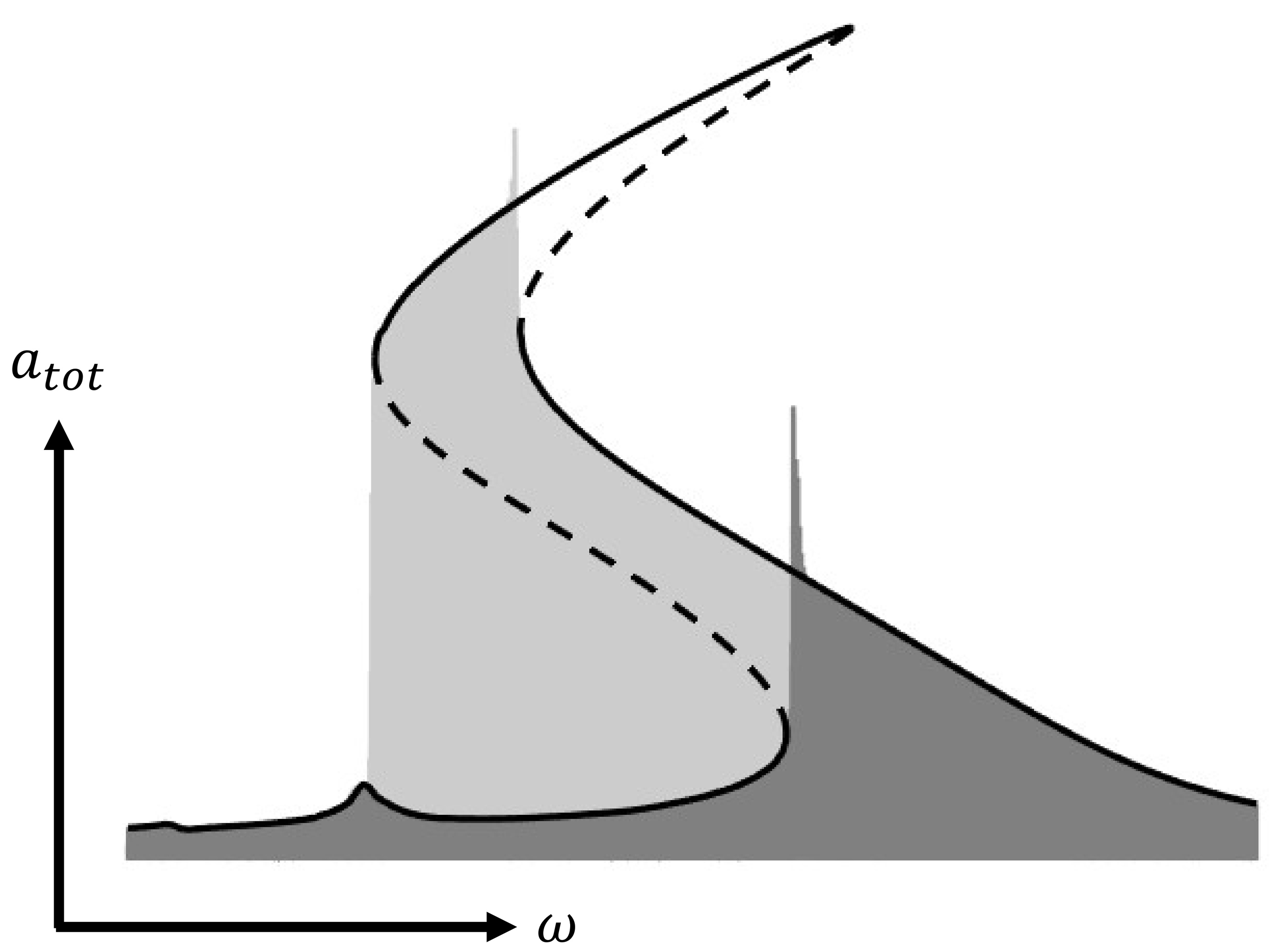
Derivative-free arclength control-based continuation (ACBC) for data-driven bifurcation analysis

Motivation

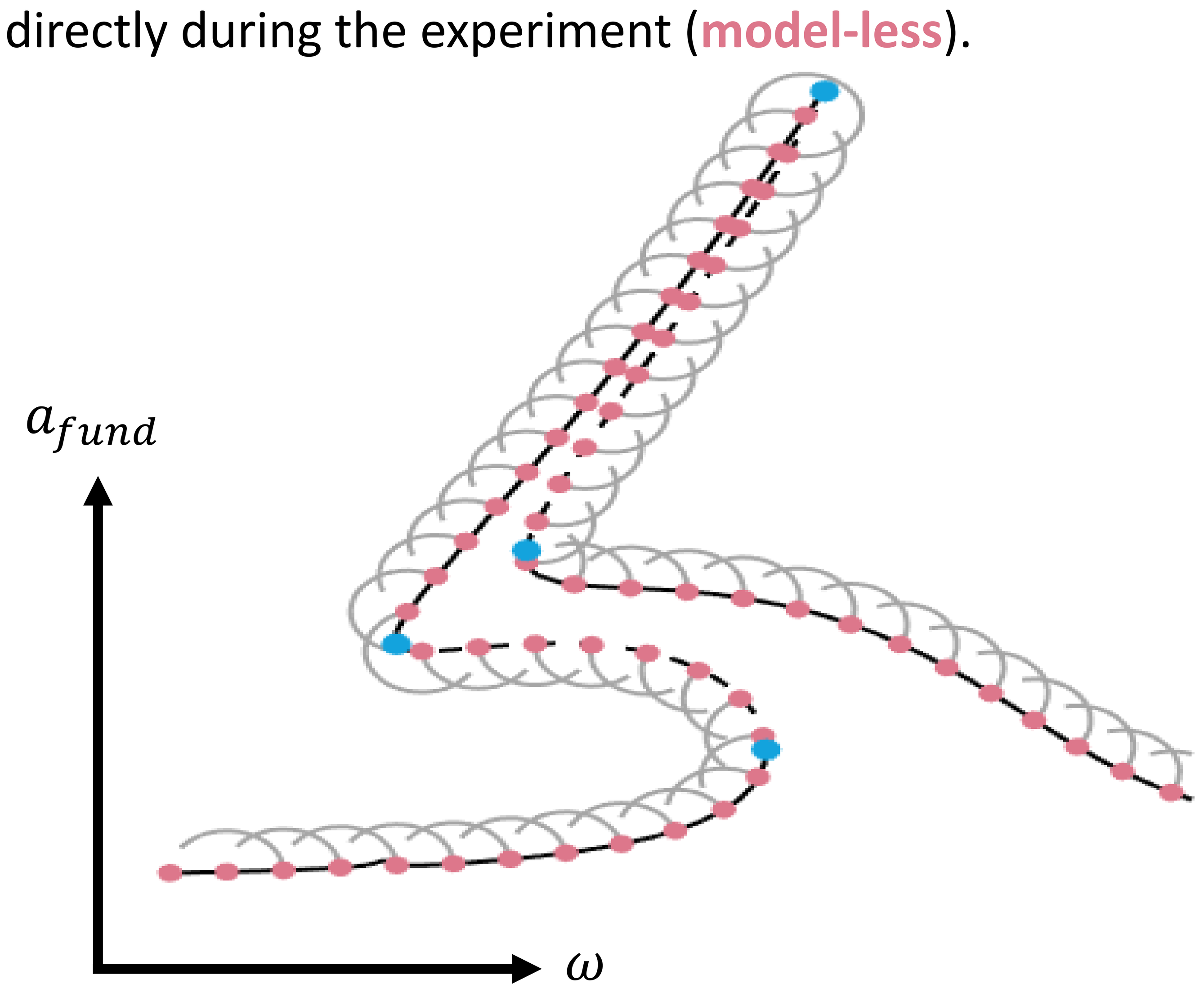
Open-loop vibration testing methods poorly capture nonlinear dynamic complexity (unstable solutions, jumps, several solutions are missed, isolated solutions).



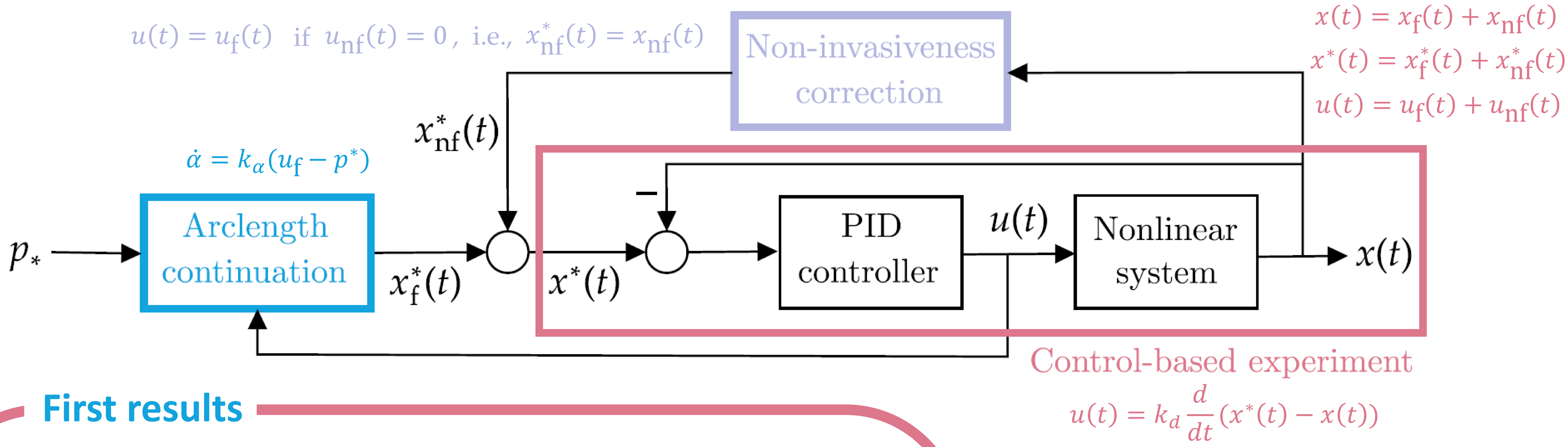
Control-based testing methods reveals full bifurcation diagrams, including unstable branches!

Method

Control-based nonlinear vibration testing combines **feedback control** to stabilize unstable orbits and **path-following techniques** to explore the dynamics of the system directly during the experiment (**model-less**).

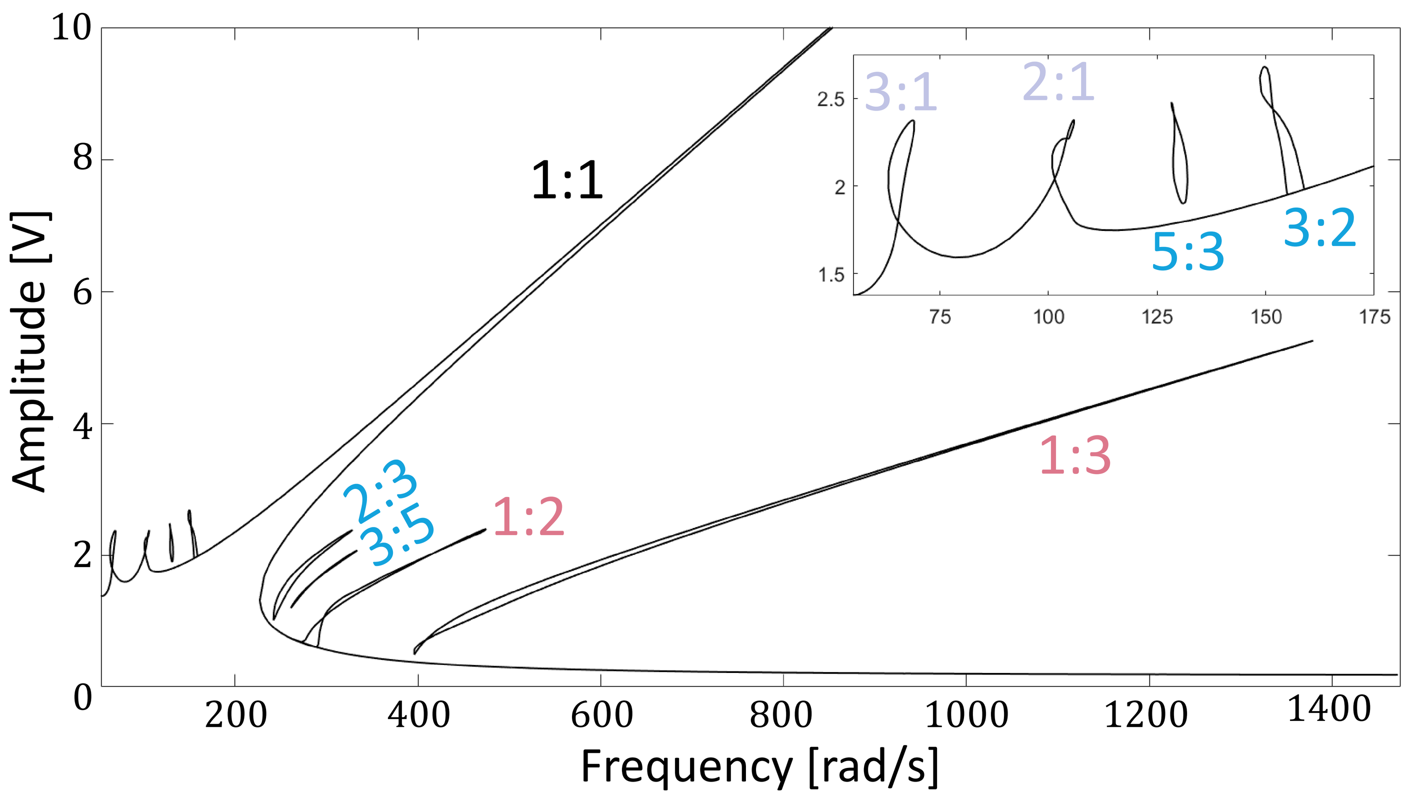


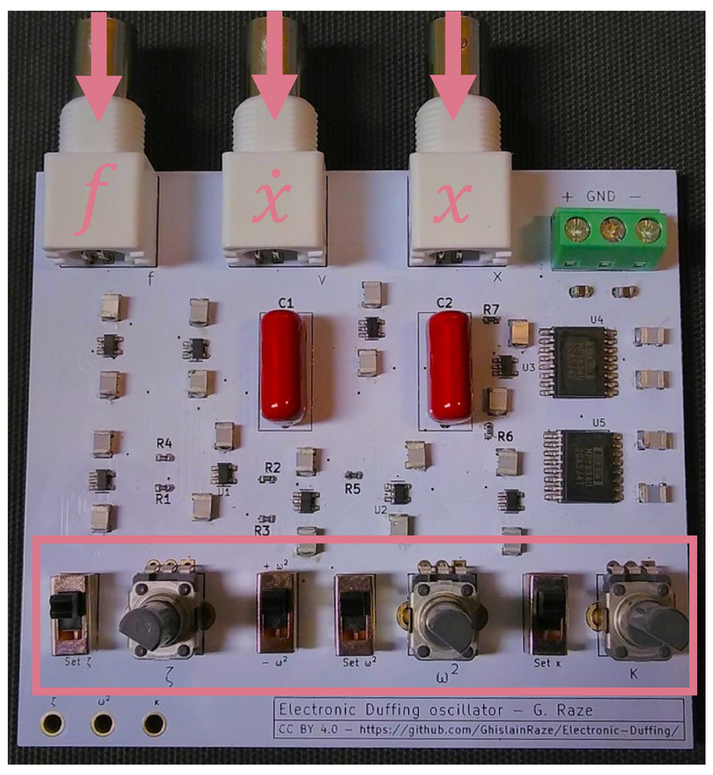
Arclength continuation goes easily through 4 fold bifurcations!



First results

A demonstration of **m-ACBC capabilities** was made with an **analog electronic circuit** that replicates the behavior of a **weakly dissipative oscillator** with **strong nonlinearity**.





The **m-ACBC** method successfully identified the **different families of resonances** at a specific forcing level, including both stable and unstable portions.

The dominant peak shifting toward higher frequencies corresponds to the **1:1 primary resonance**. This approach also identifies **superharmonic** and **(ultra-)subharmonic resonances**, whether connected or isolated from the main branch.

Goals

- Optimize and automate the selection of **ACBC parameters**.
- Apply ACBC and m-ACBC to **identify primary and secondary resonances** in **MDOF structures**.
- Apply ACBC to **track limit cycles in autonomous systems with slow-fast dynamics**.

SCAN ME!