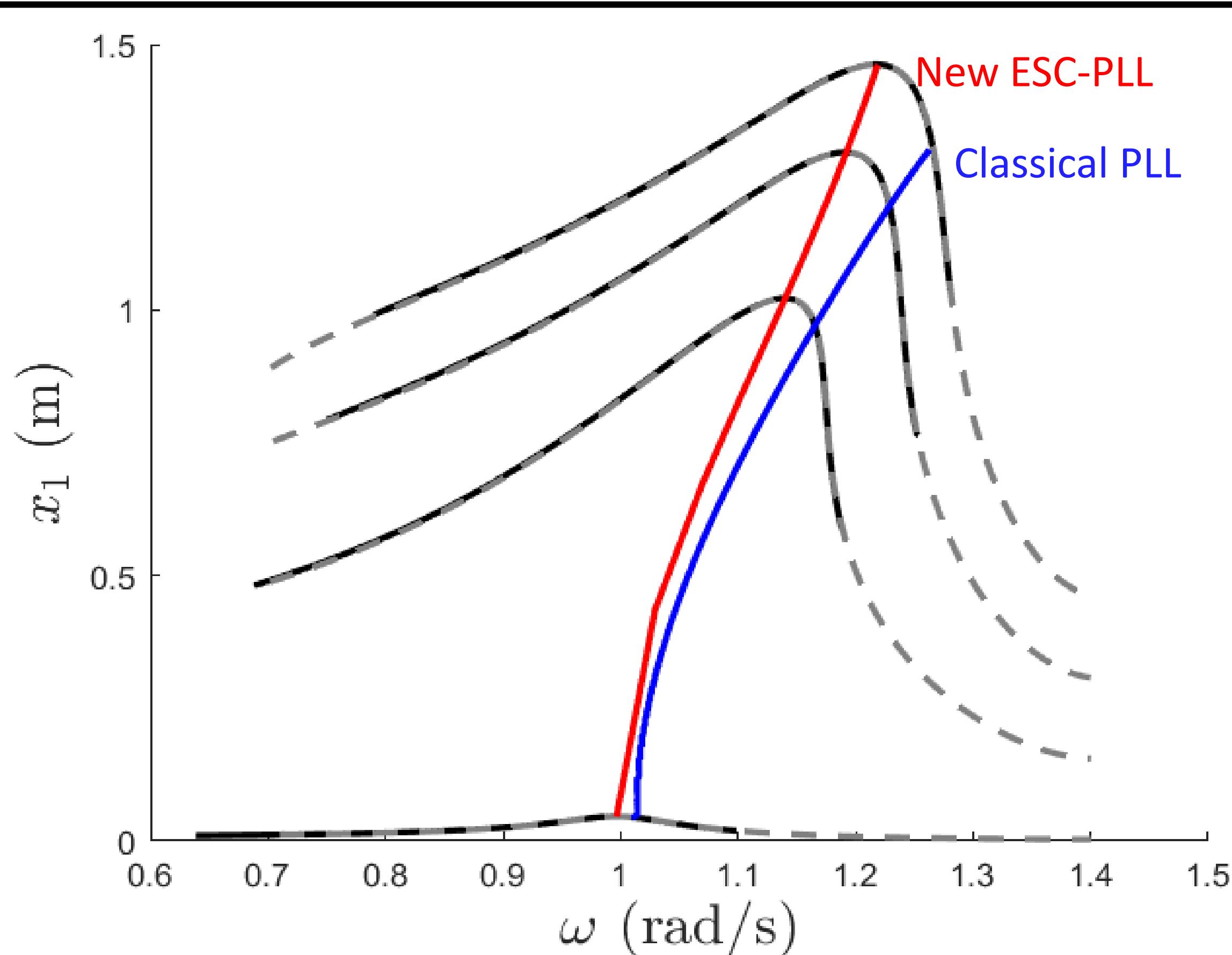


# Amplitude Resonance Tracking Using PLL and ESC for Nonlinear Systems

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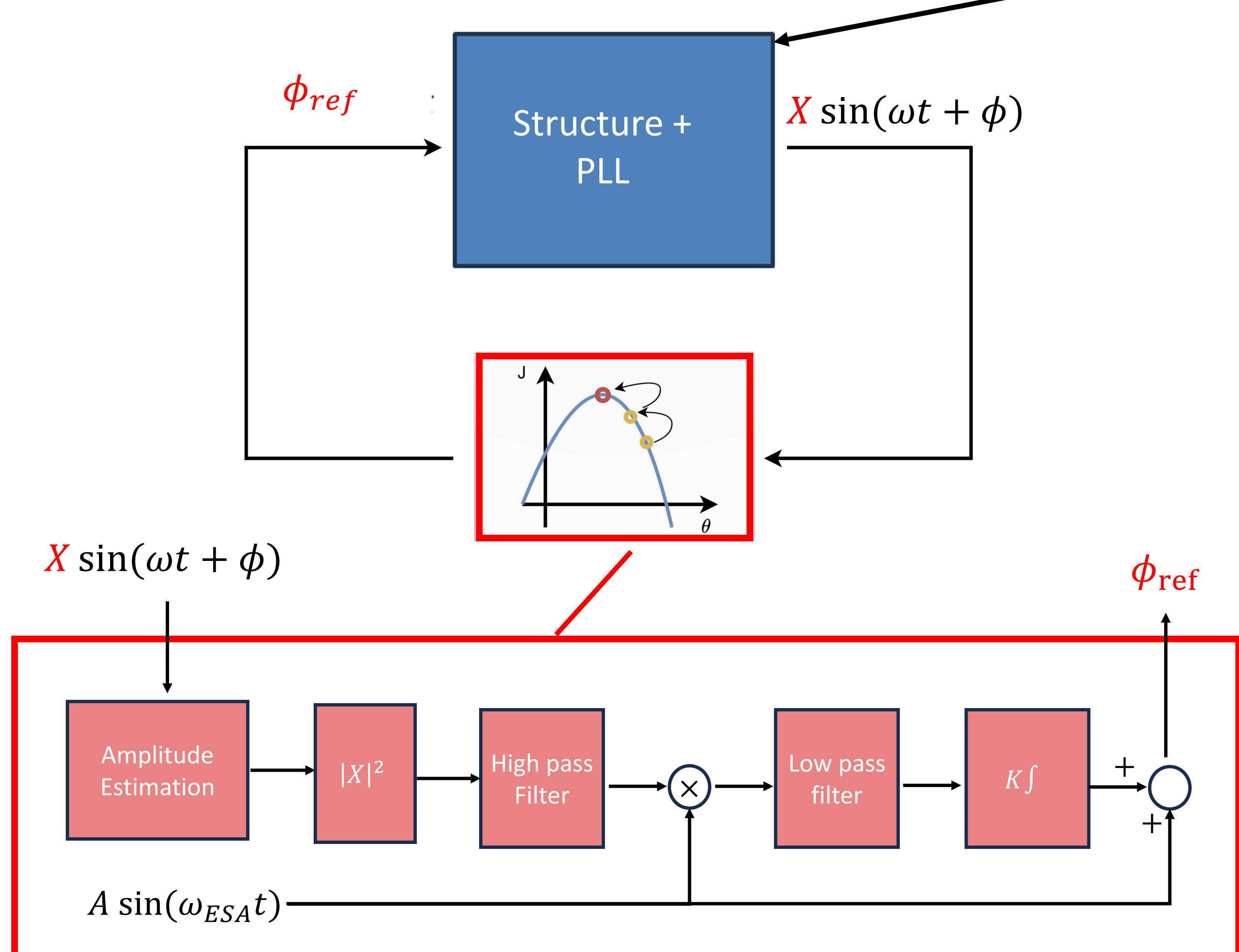
## Motivation

- Tracking maximum amplitude is often required in nonlinear dynamics and fatigue testing.
- Amplitude and phase resonance may diverge due to damping and/or closely spaced modes.
- Classical Phase-Locked Loops (PLLs) typically track phase quadrature, not the actual amplitude peak.
- As a result, amplitude resonance may be missed during testing.

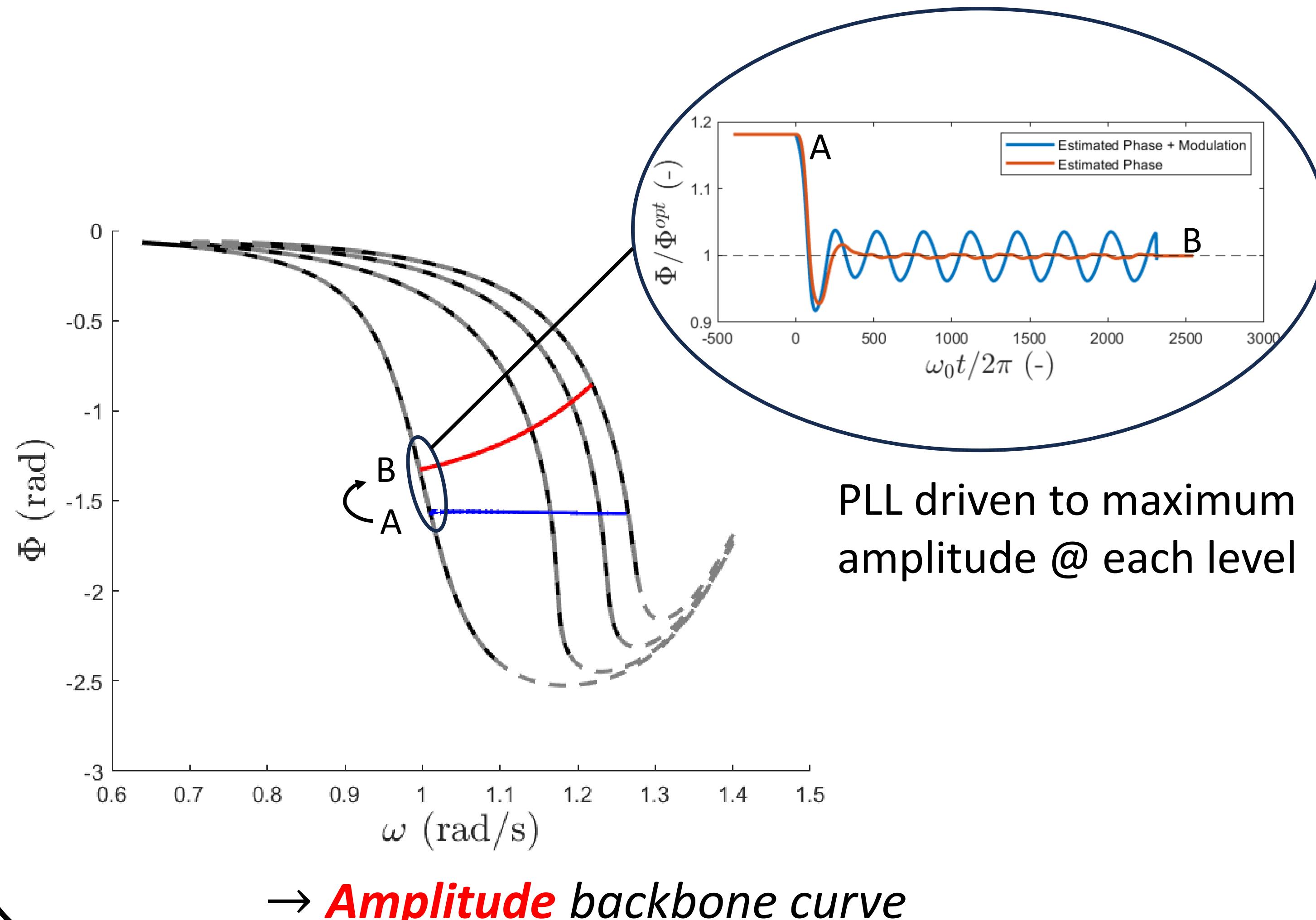


## Extremum Seeking Control driven PLL (ESC-PLL)

- New, additional layer for maximum amplitude tracking.



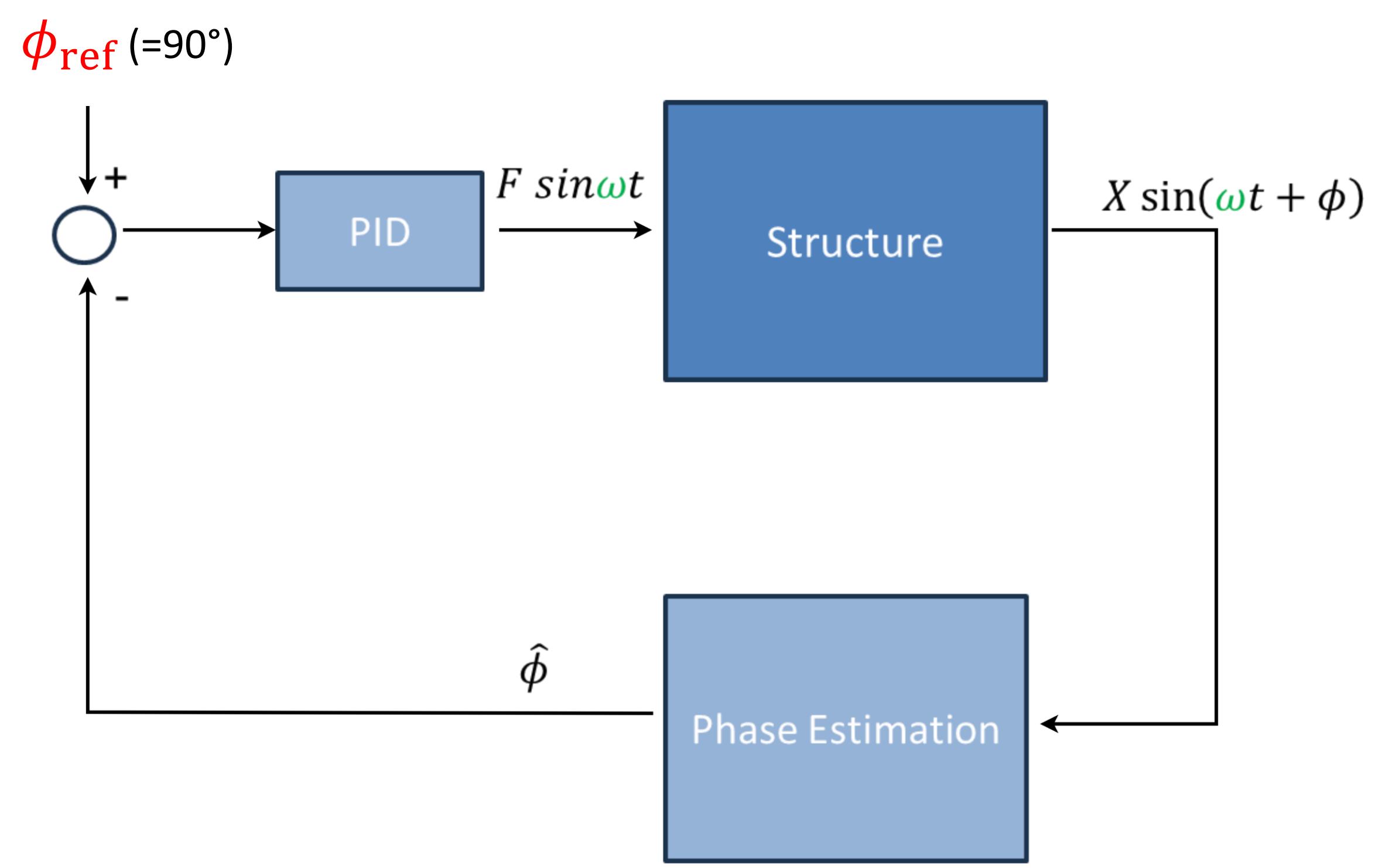
ESC: Perturbation-based *online* response amplitude maximization



→ Amplitude backbone curve

## Phase Locked Loop (PLL)

- State of the art method for resonance tracking.



- Phase quadrature enforced by PID Control.
- Backbone curve obtained by ↗ excitation level.

## What's next ?

- Robust and systematic PLL-ESC control gains selection
- New optimization schemes for *faster* optimization
- Experimental validation : phase vs amplitude backbone

## References

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- T. Zhou, G. Raze, G. Kosova, and G. Kerschen. "Experimental Nonlinear Modal Analysis of an F-16 Aircraft using Phase-locked Loop Control." *Journal of Aircraft* (2025).
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