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# Enhanced LATIN-PGD in a multi-query framework

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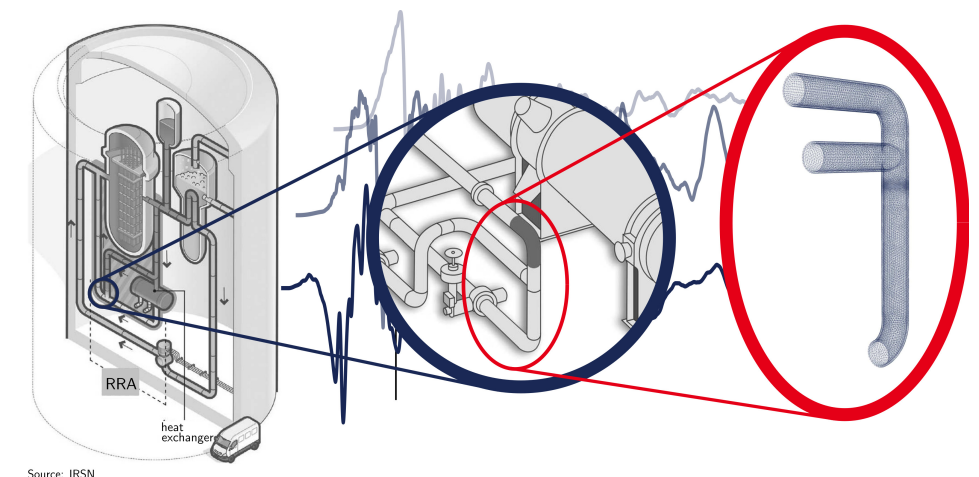
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## Seismic hazard assessment



- Efficient solver
  - ▶ Reduced-order modelling
- Multi-query capability
  - ▶ Exploits redundancy

## Proper Generalised Decomposition (PGD)

$$\mathbf{u}(\mathbf{x}, \omega) = \sum_{i=1}^m \bar{\mathbf{u}}^i(\mathbf{x}) \lambda_{\omega}^i(\omega)$$

- ▶ Spatial modes  $\bar{\mathbf{u}}^i(\mathbf{x})$
- ▶ Frequency modes  $\lambda_{\omega}^i(\omega)$

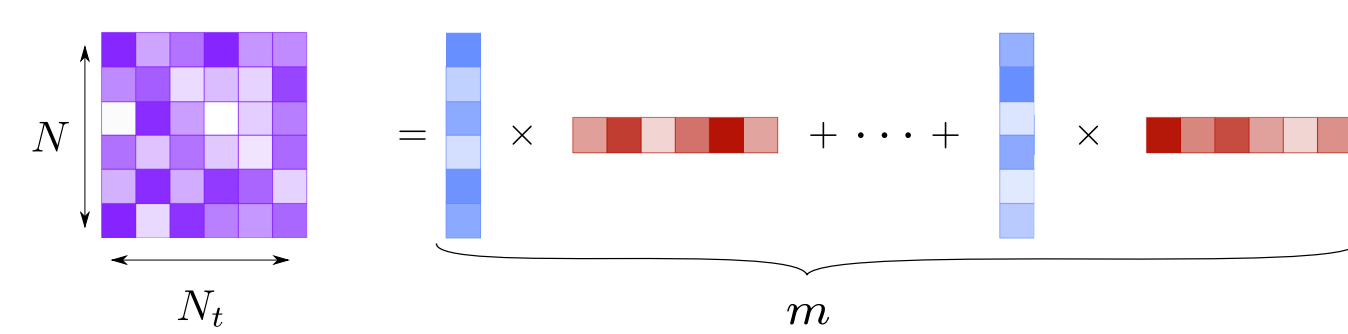
- For a given basis  $\{\bar{\mathbf{u}}^i(\mathbf{x})\}_{i \in [1, m]}$

- ▶ Galerkin projection

- Add new modes on the fly

- ▶ Greedy algorithm

- ▶ Generate modes **targeted** for the current problem



### Requirements

- Linear equations
- Global equations
- ▶ Non-incremental scheme

## Methods

### Admissibility - $\mathcal{A}_d$

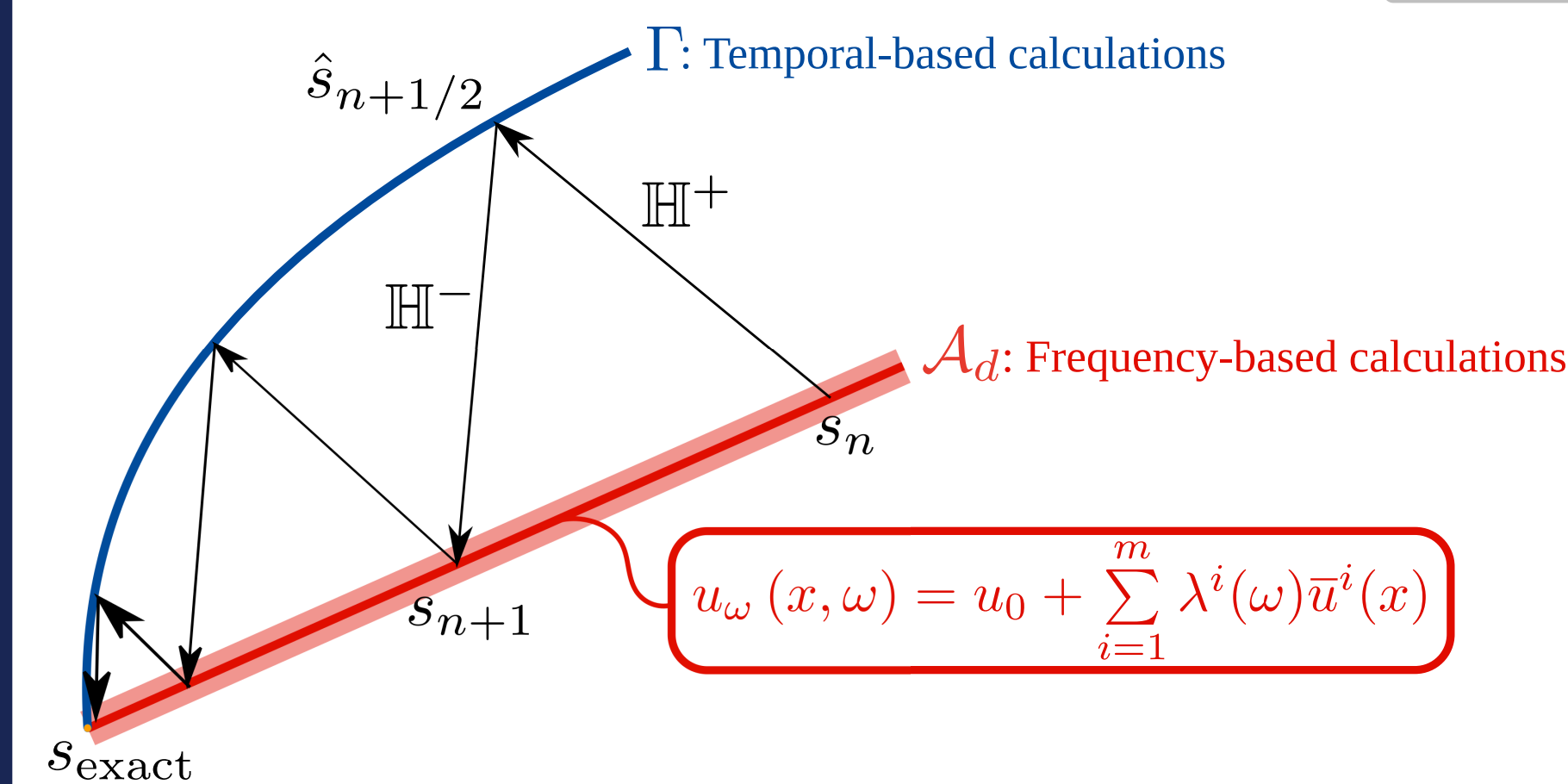
$$\nabla \cdot \boldsymbol{\sigma} + \mathbf{f}_d = \rho \ddot{\mathbf{u}}$$

Best solved in the frequency domain

### Nonlinear behaviour - $\Gamma$

$$\tilde{\boldsymbol{\sigma}} = \frac{\boldsymbol{\sigma}_D}{1-D} + \frac{\langle \boldsymbol{\sigma}_H \rangle}{1-D} \mathbf{1} - \langle -\boldsymbol{\sigma}_H \rangle \mathbf{1}$$

Temporal description



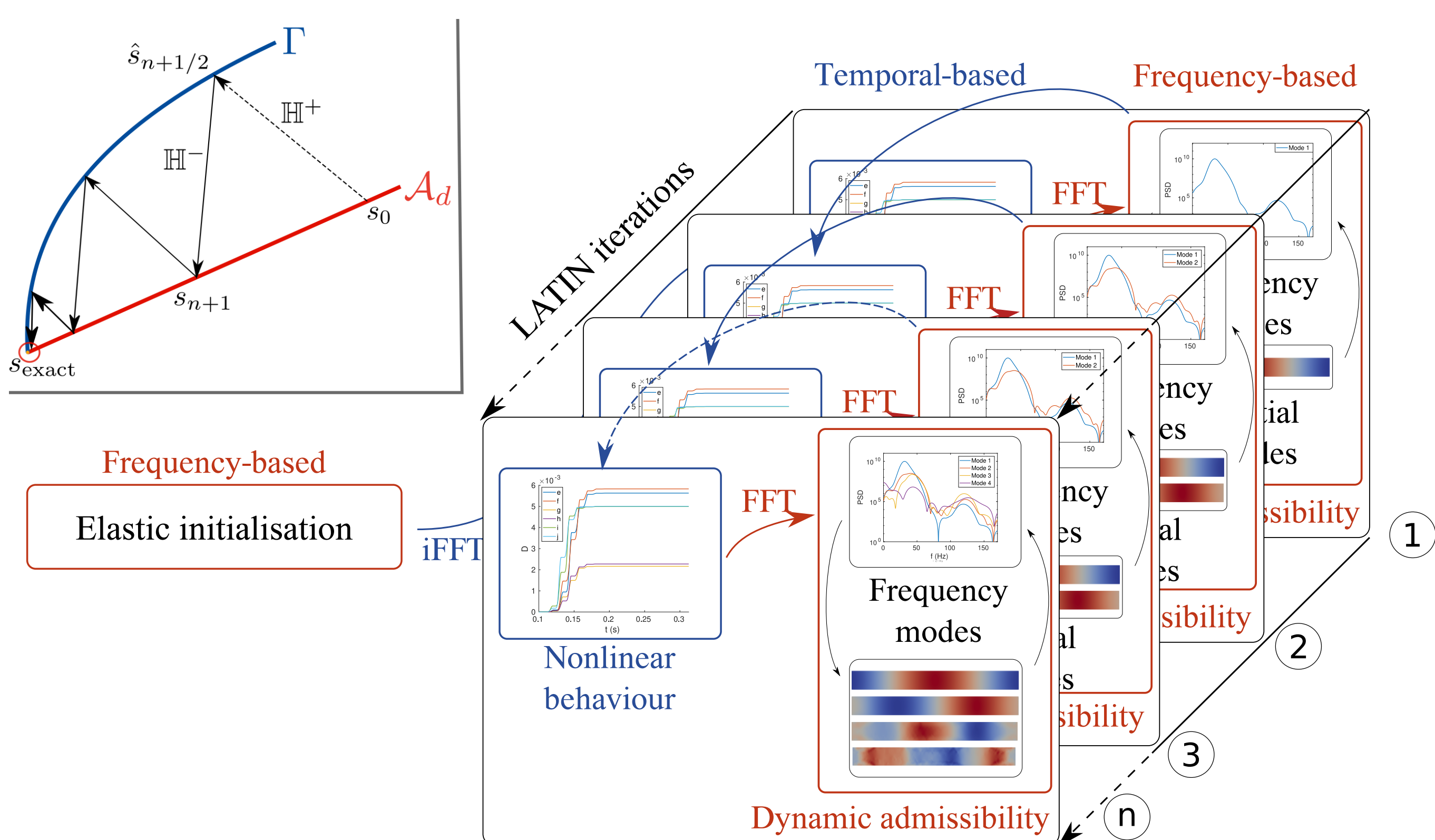
### LATIN Method:

- Non-incremental scheme
- Separation of the difficulties
- 2-alternated search directions

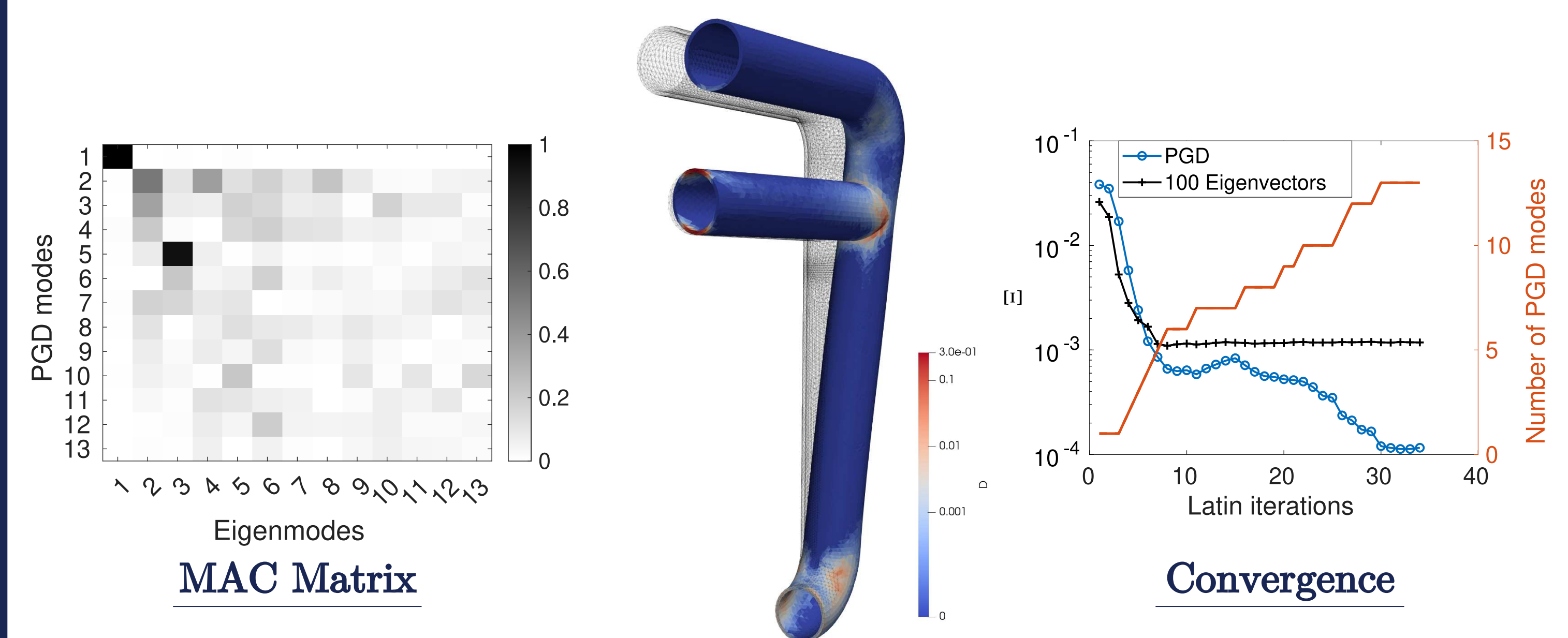
### Iterative scheme

- LATIN paradigm allows for the hybrid scheme
- Non-linear temporal computations
- Linear reduced-order model frequency computations

## Reduced-order model hybrid scheme



## Numerical results

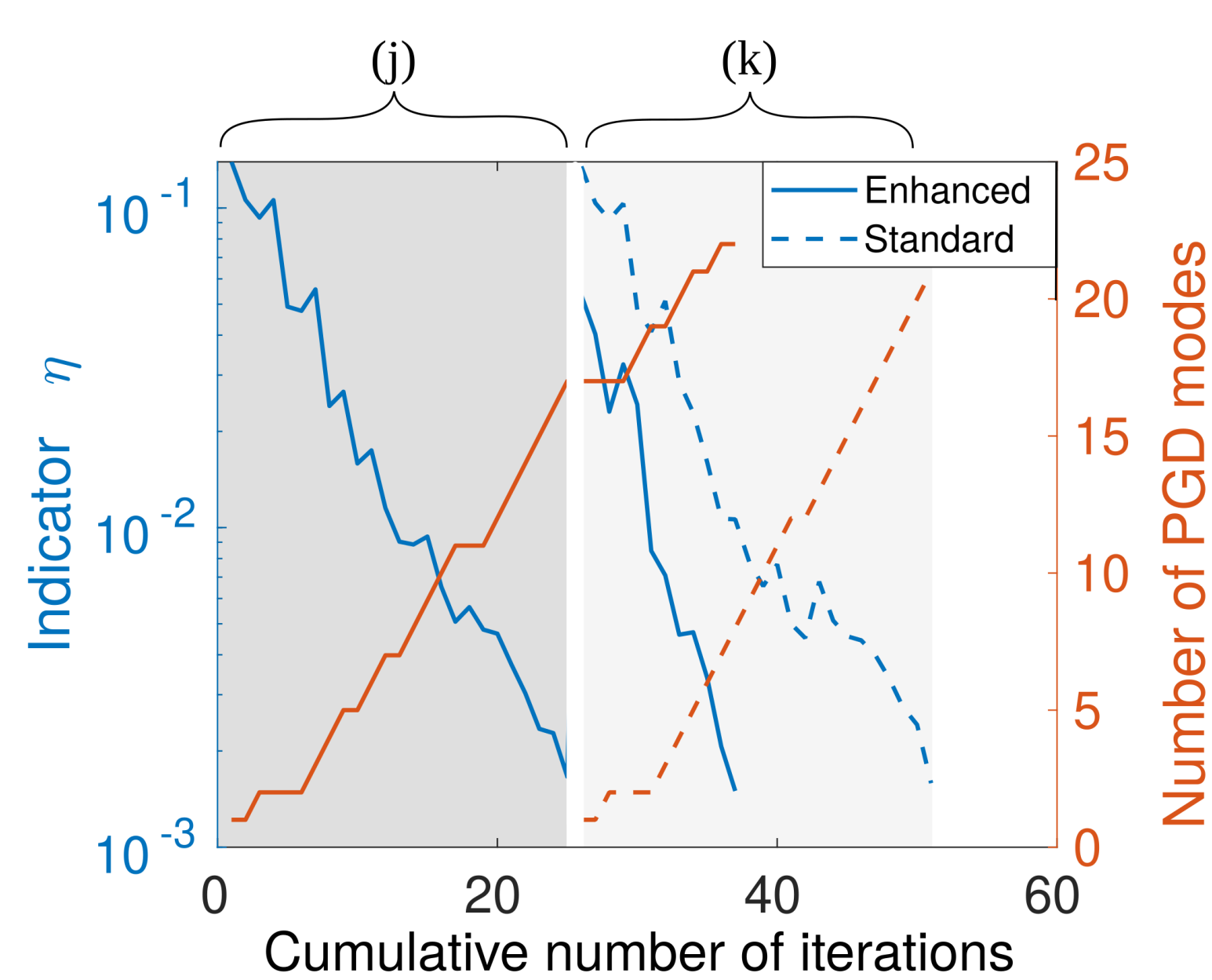


### Performances

PGD well suited to localised corrections

## Multi-query framework

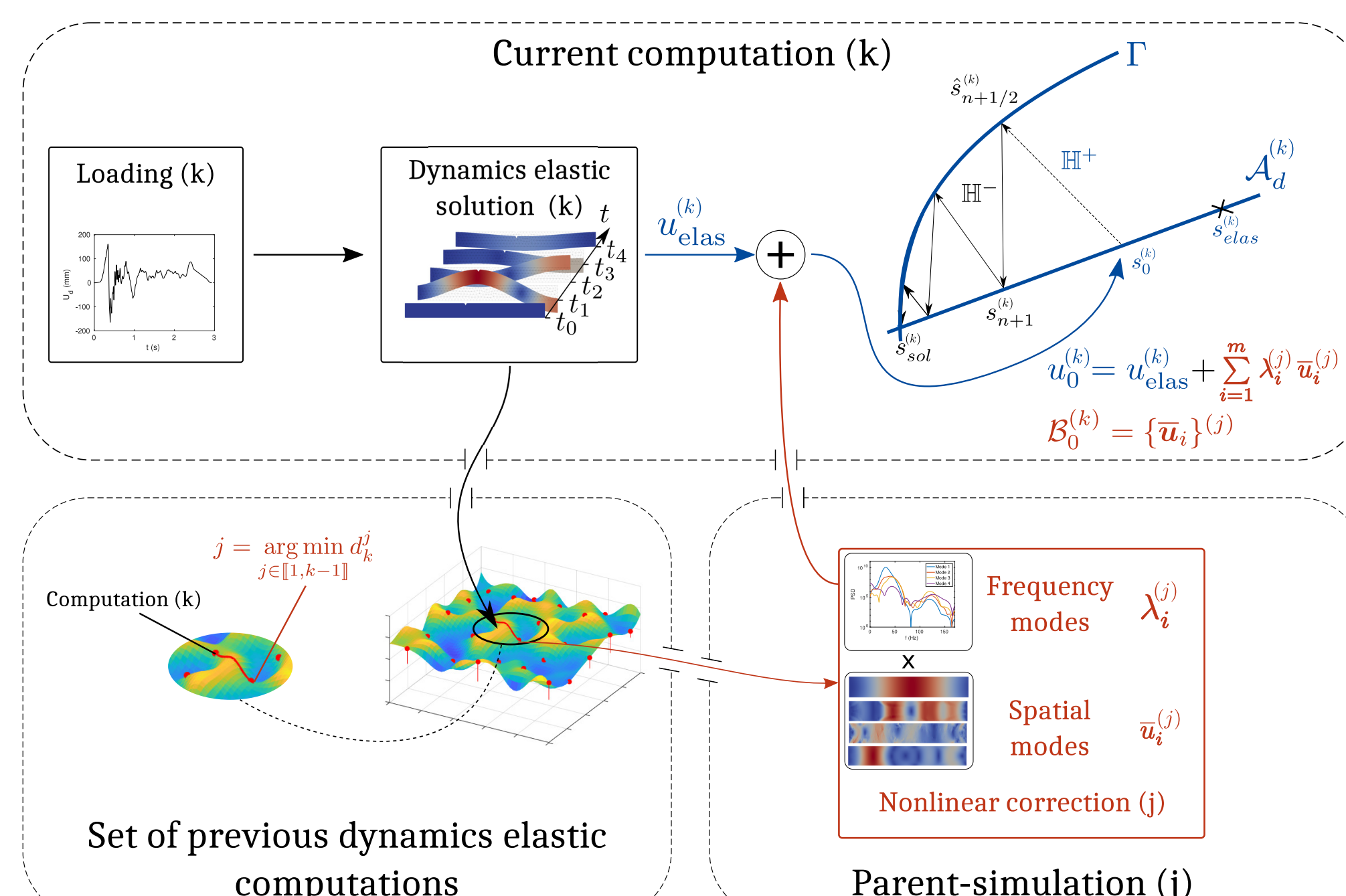
### Two computations



💡 Wise initialisation of the iterative scheme

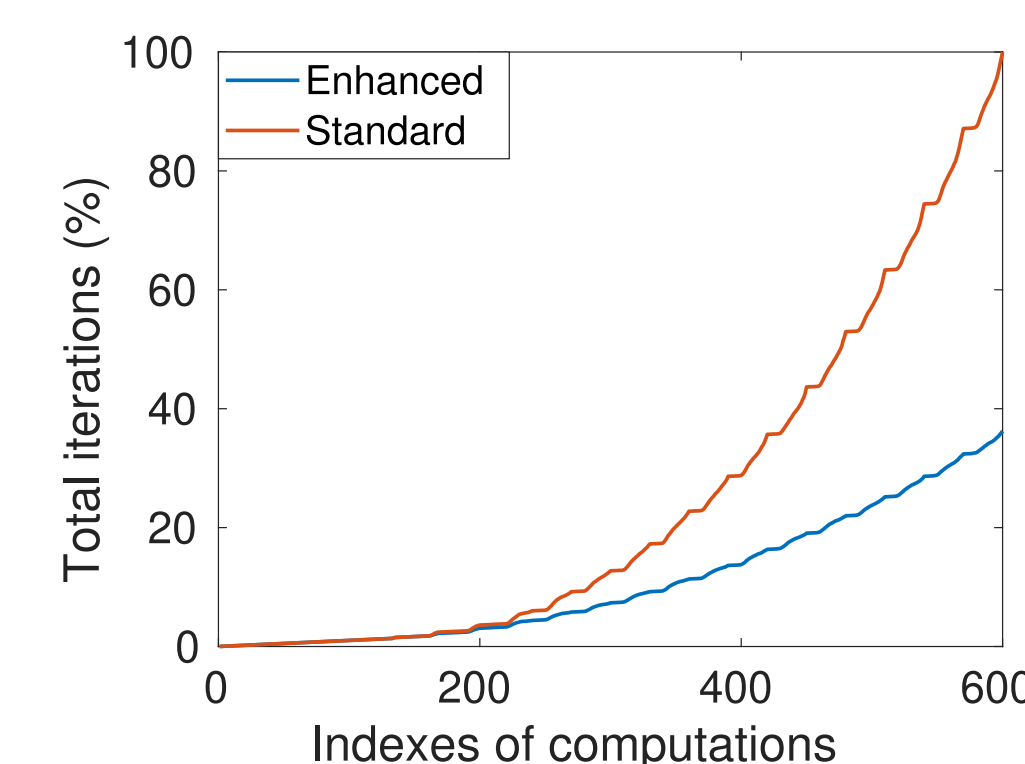
- ✔ Initial solution
- ✔ Reduced-order basis

### Many-query context

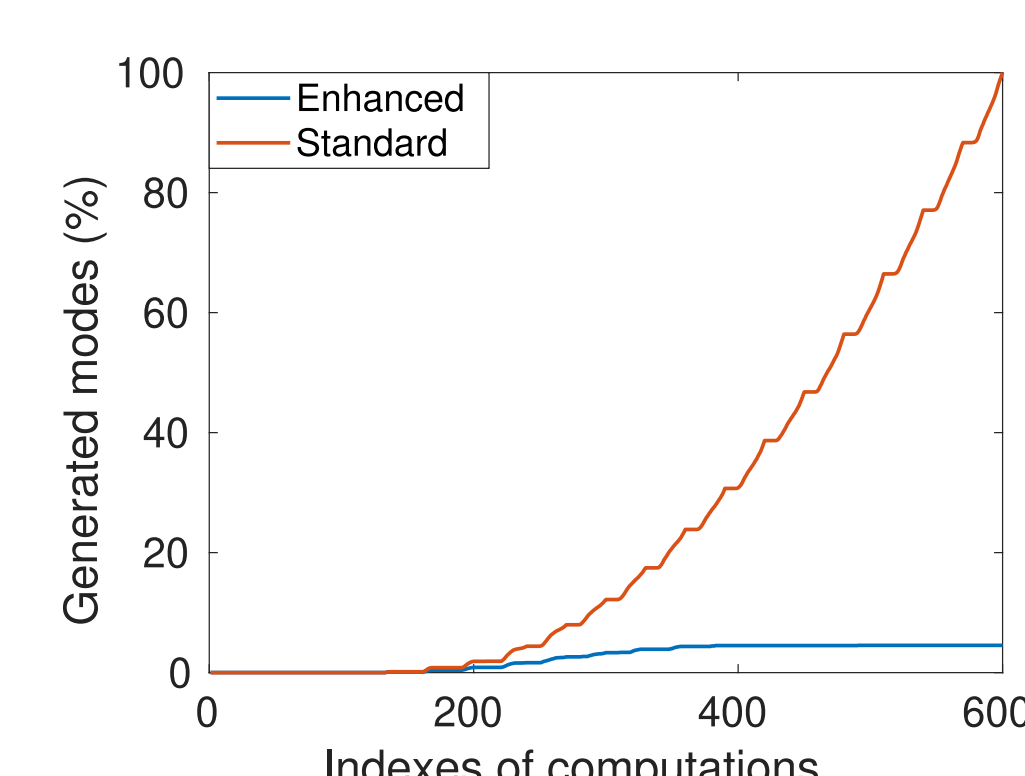


💡 Robust choice of the **parent-simulation**

💡 Well-suited distance indicator (Weighted **Grassmann distance**)



**3x fewer iterations**



**20x fewer modes**

## Conclusion

- ✔ Great reductibility with PGD
- ✔ Enhanced multi-query framework
- ✔ Robust & automatic strategy

