Automate engineering processes at scale

Heat exchange coefficient calibration

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- Proposed approach
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Presentation of the company

An international group, operating in the aircraft propulsion and equipment, space and defense markets

PROPULSION

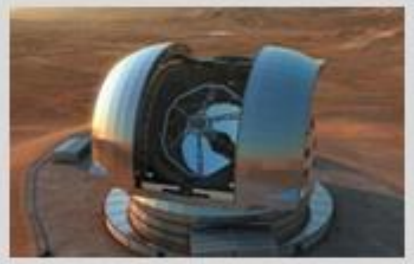
- Safran Aircraft engines
- Safran Helicopter engines
- Safran Aero Booster
- Safran Nacelles



ELECTRICITE / ELECTRONIQUE

- Safran Electronics & Defense
- Safran Electrical & Power




EQUIPEMENTS

- Safran Landing systems
- Safran cabin, Safran seats, Safran aerosystems
- Safran Transmission systems
- Safran Power unit
- Safran ventilation systems

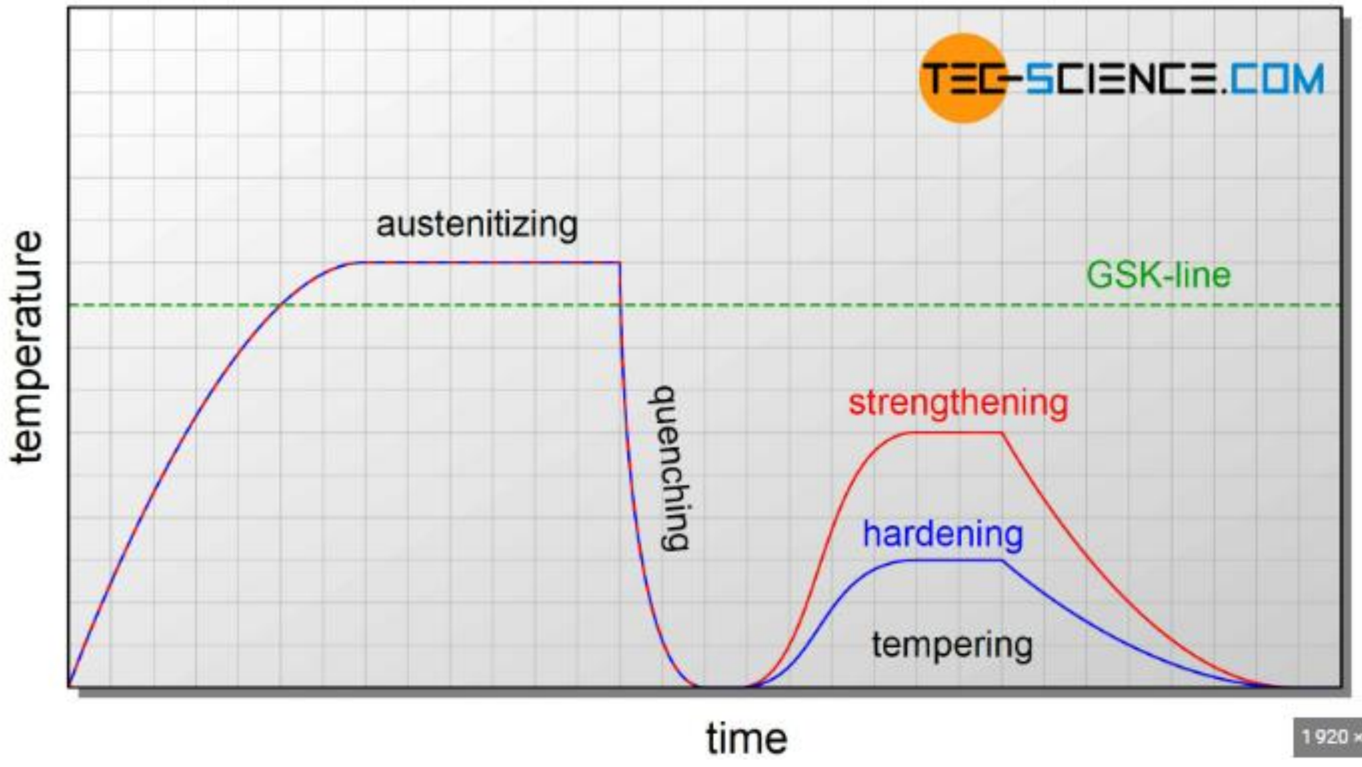


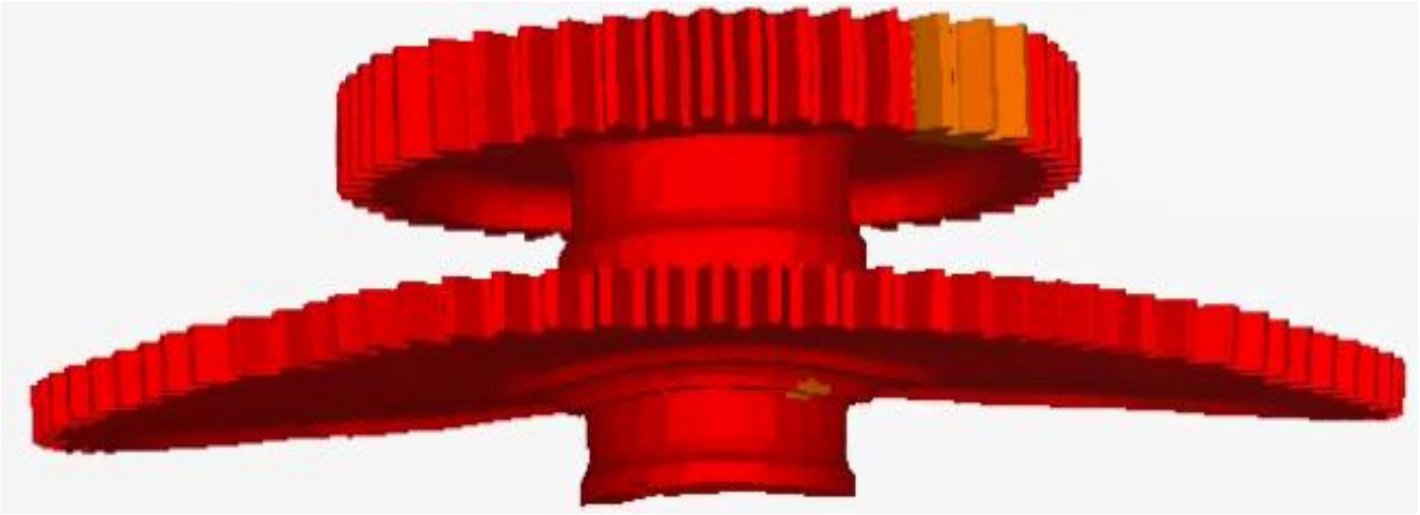




Introduction to the calibration problem

Heat treatement of gear to improve surface resistance



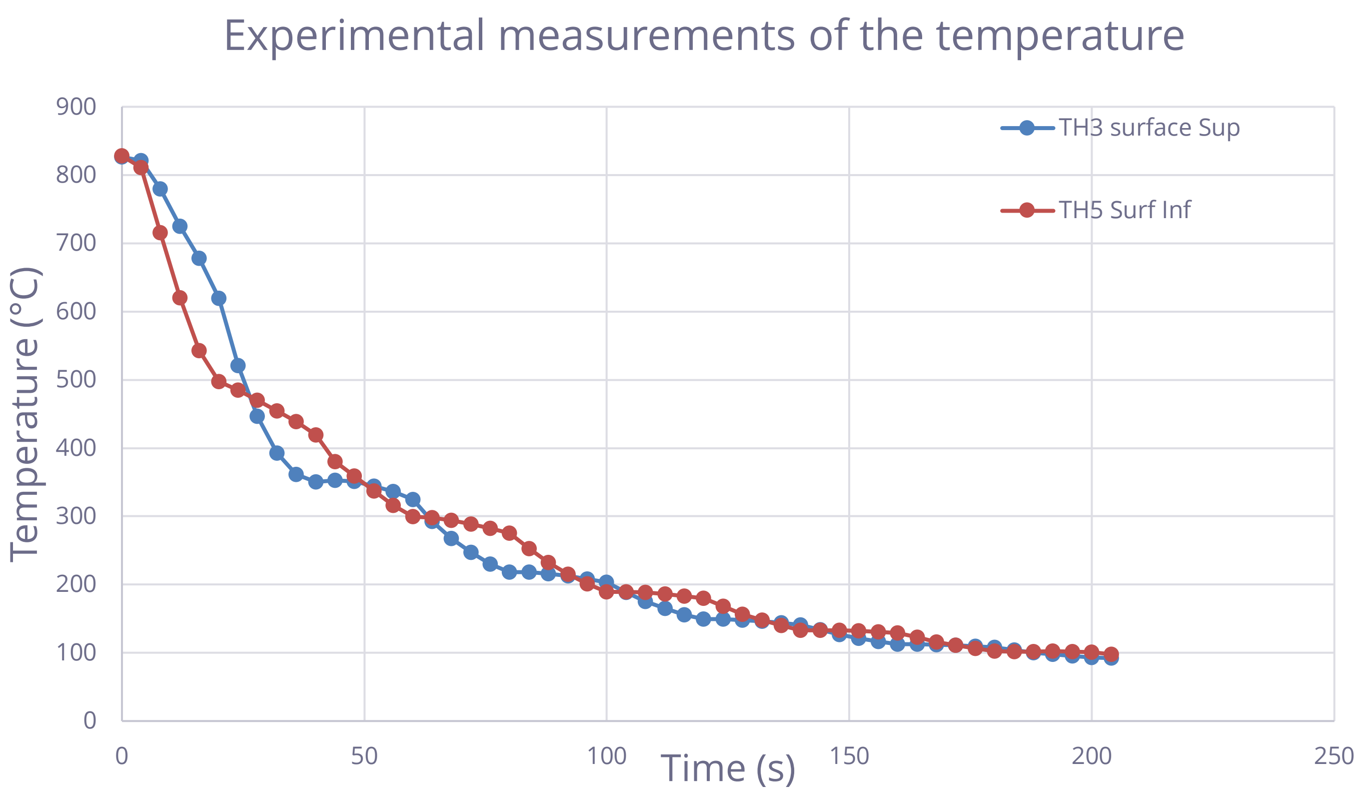


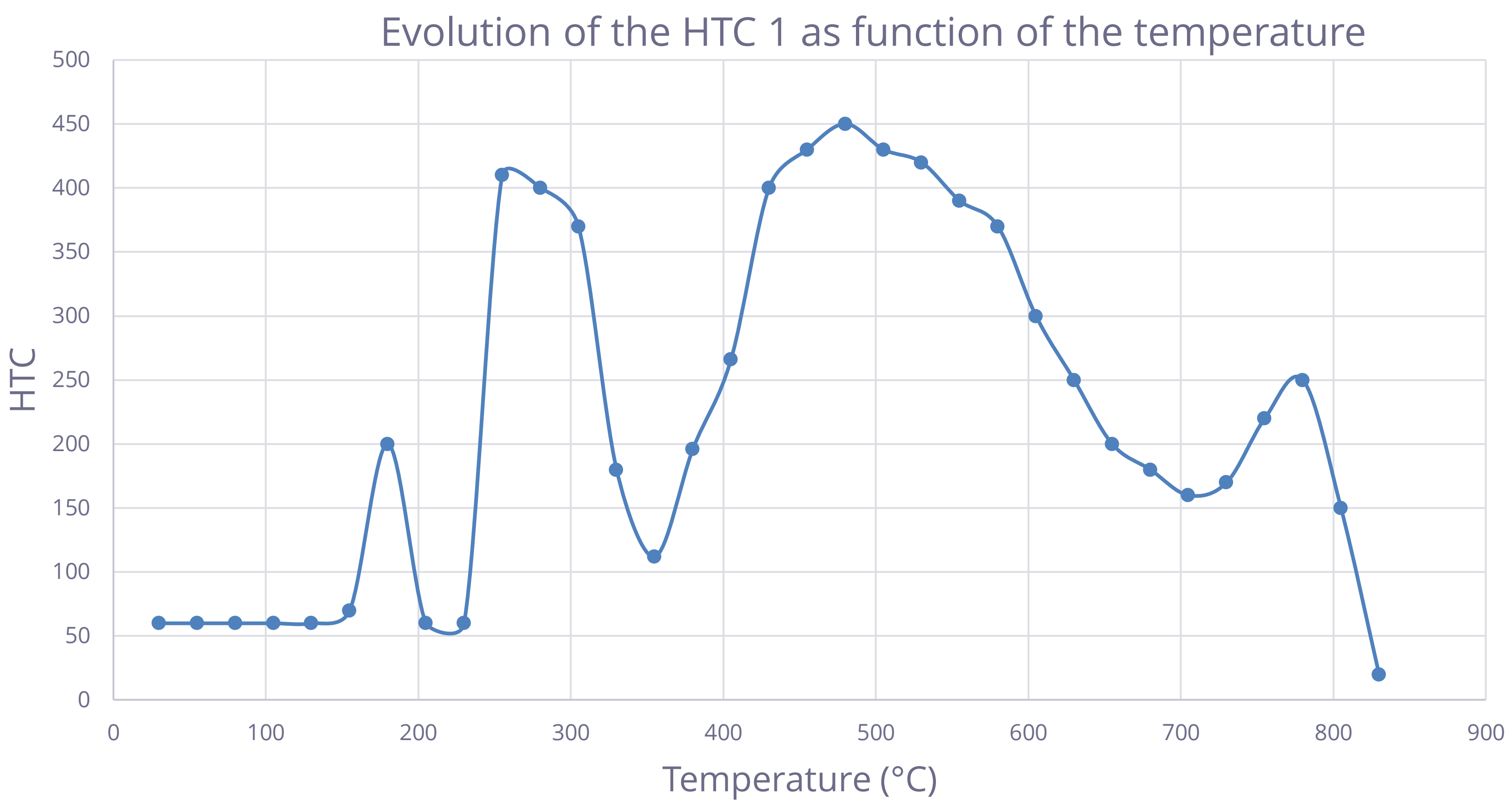
Distortion problem in Heat Treatment
(échelle×50)

Instrumentation avec Thermocouple pour identifier les conditions aux limites thermiques

Introduction to the calibration problem

- **Identification of heat exchange coefficients** (HTC) of a piece, based on **experimental temperature evolution** during cooling.
- A superior and inferior parts of the piece define two curves as experimental data. Thus, **two HTC curves** are expected.

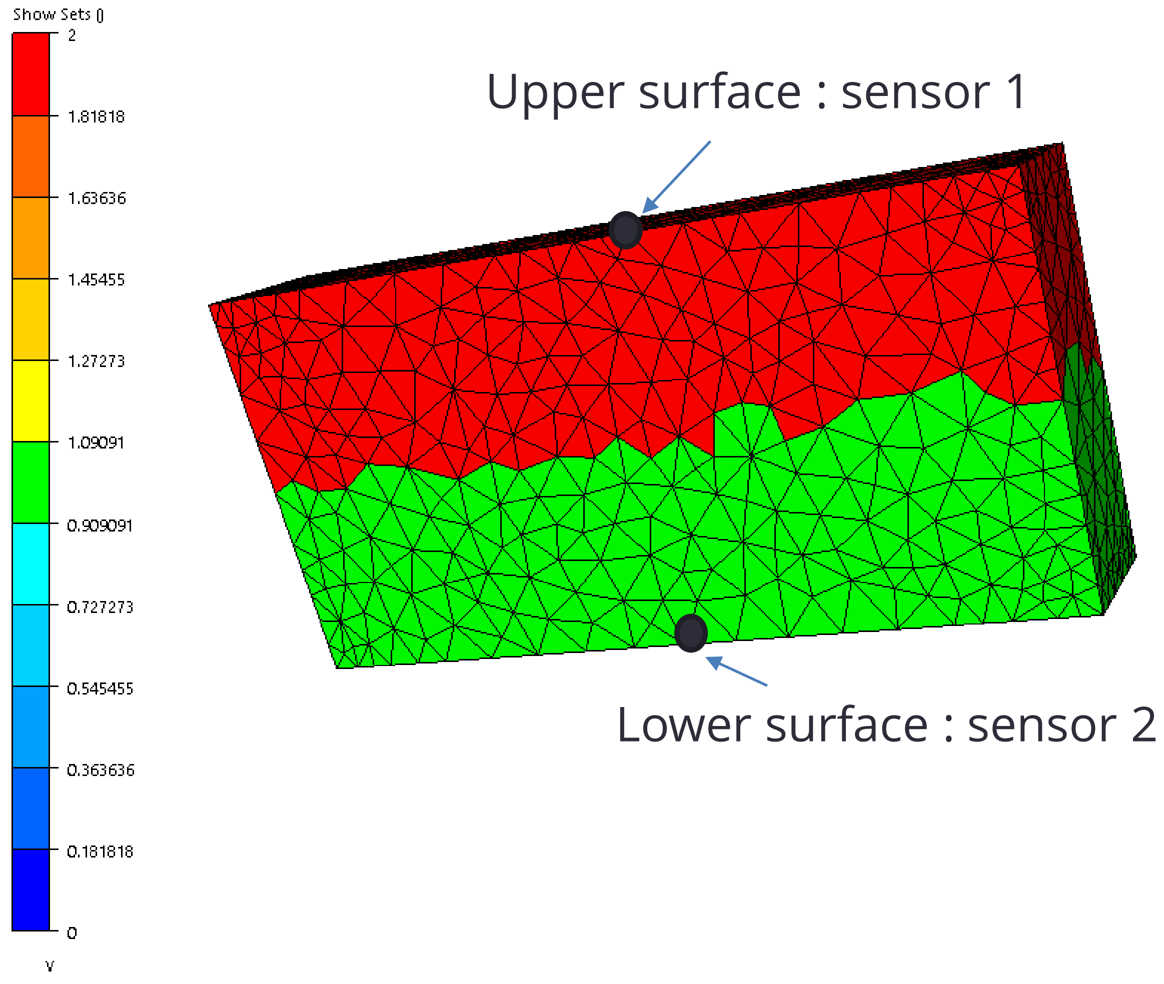




Introduction to the calibration problem

- Identification made using **Forge simulations** to match the experimental data.
- Such identification may take **several months if done by hand**, knowing that **one simulation** takes around **2 hours**.

FORGE®



Introduction to the calibration problem

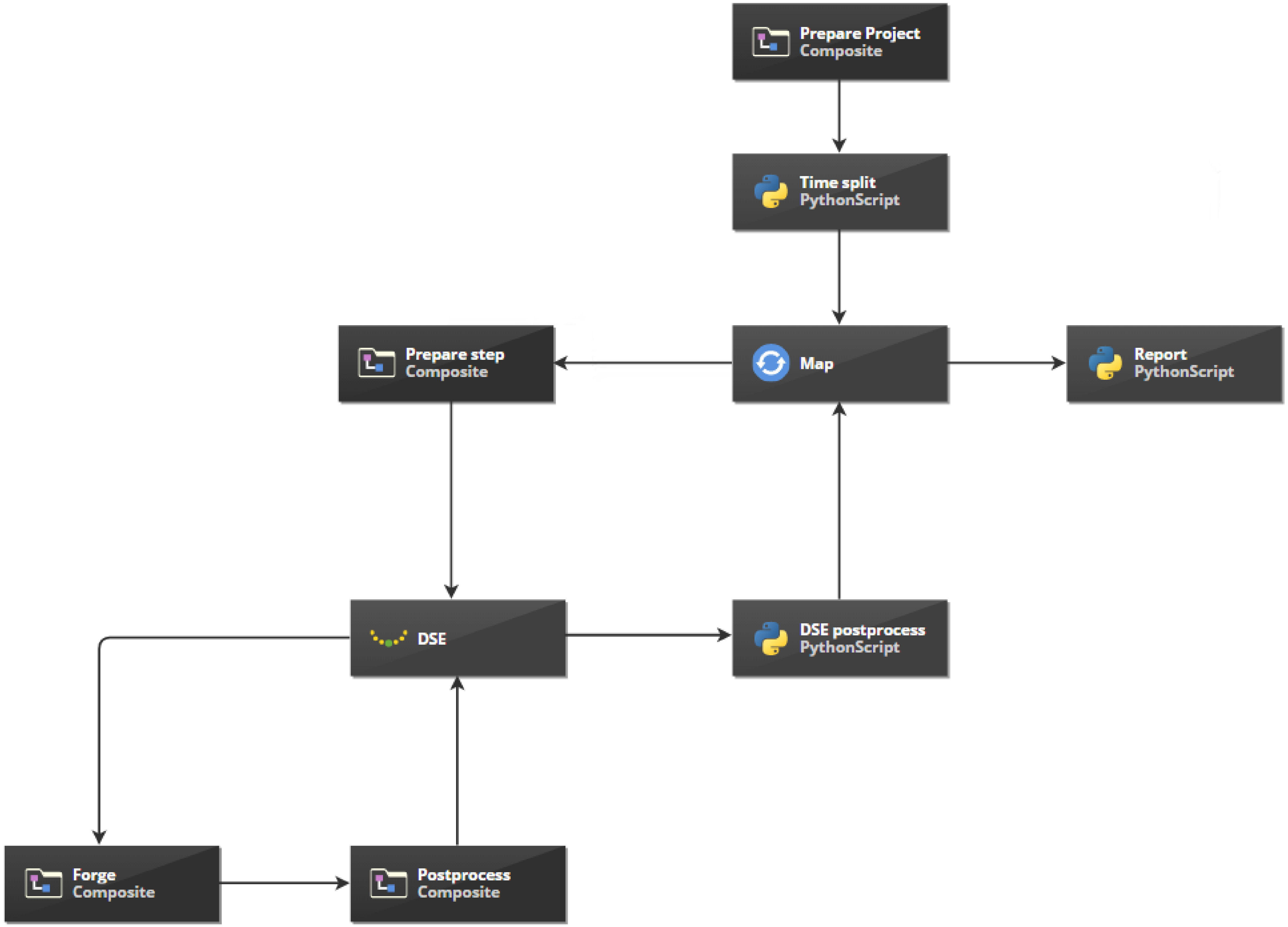
How to identify all the HTC?

- How to get **the information about the HTC** on the experimental set?
- How to **split the simulation time** to have the most accurate identification, knowing the experimental temperature evolution (and curve variation)?
- How to **integrate Forge computations** in pSeven?

Proposed approach

- **Integrate Forge** simulations through file management/parsing.
- Use **several splitting time techniques**, to be compared.
- Go through all the time steps, one by one.
- For each time step, get an **optimization campaign** of **reducing the difference in temperature** by playing on the HTC values in Forge.
- Return a report with **automated curves and data**.

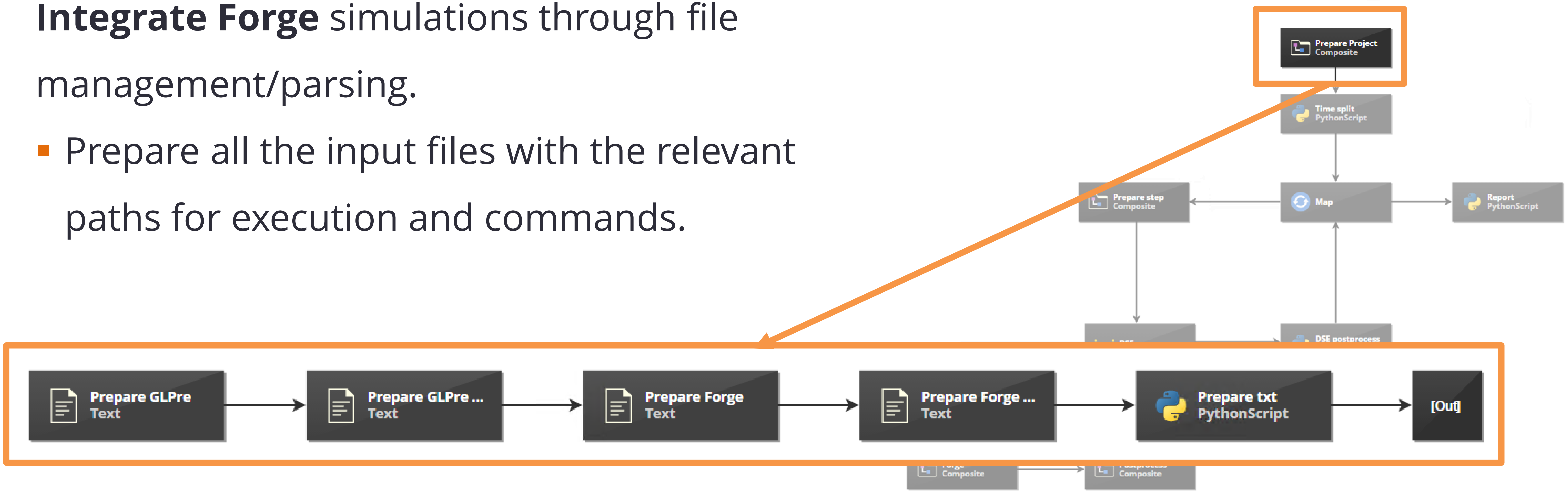
Proposed approach



Methodology

Integrate Forge simulations through file management/parsing.

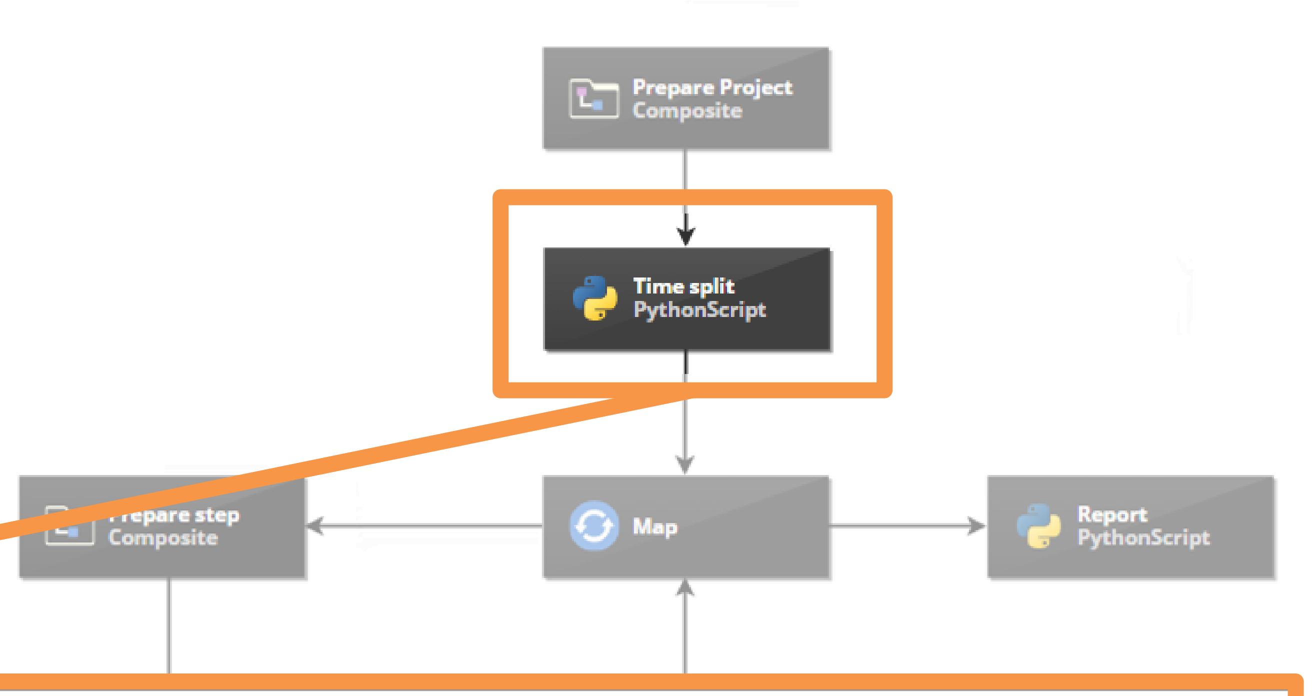
- Prepare all the input files with the relevant paths for execution and commands.

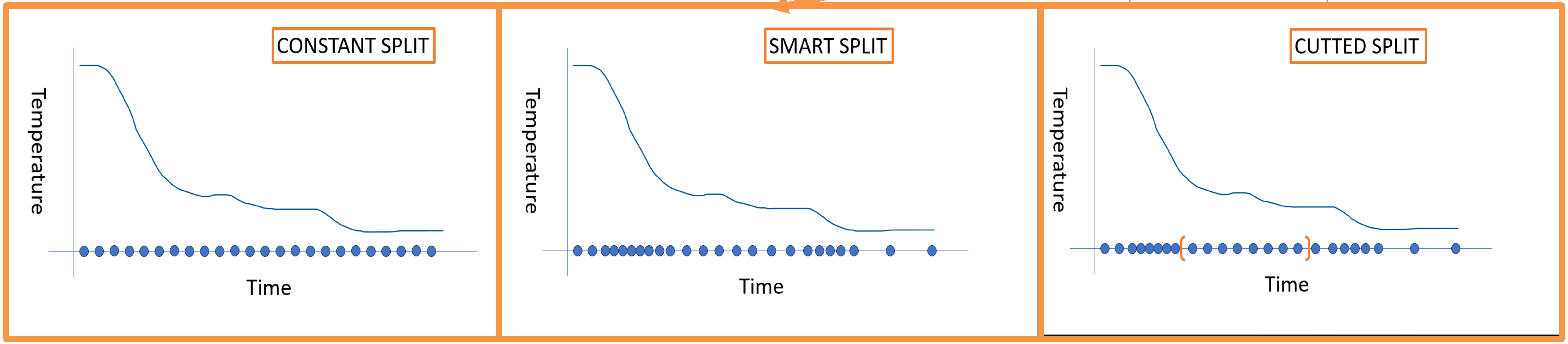


Methodology

Use **several splitting time techniques**, to be compared.

- 3 techniques : **constant, smart and cutted**.
- Selected and adjusted by the user.

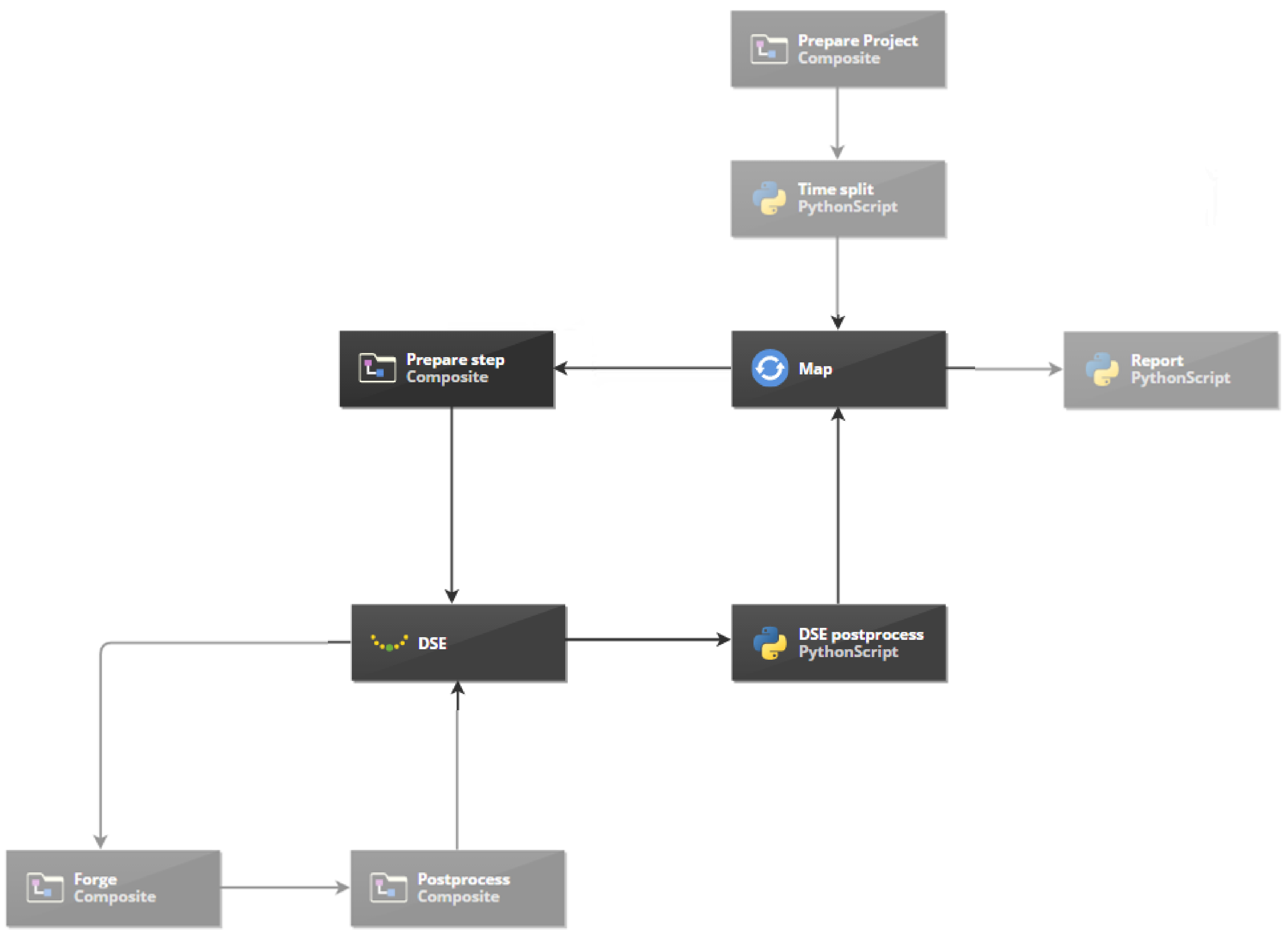




Methodology

Go through all the time steps, one by one.

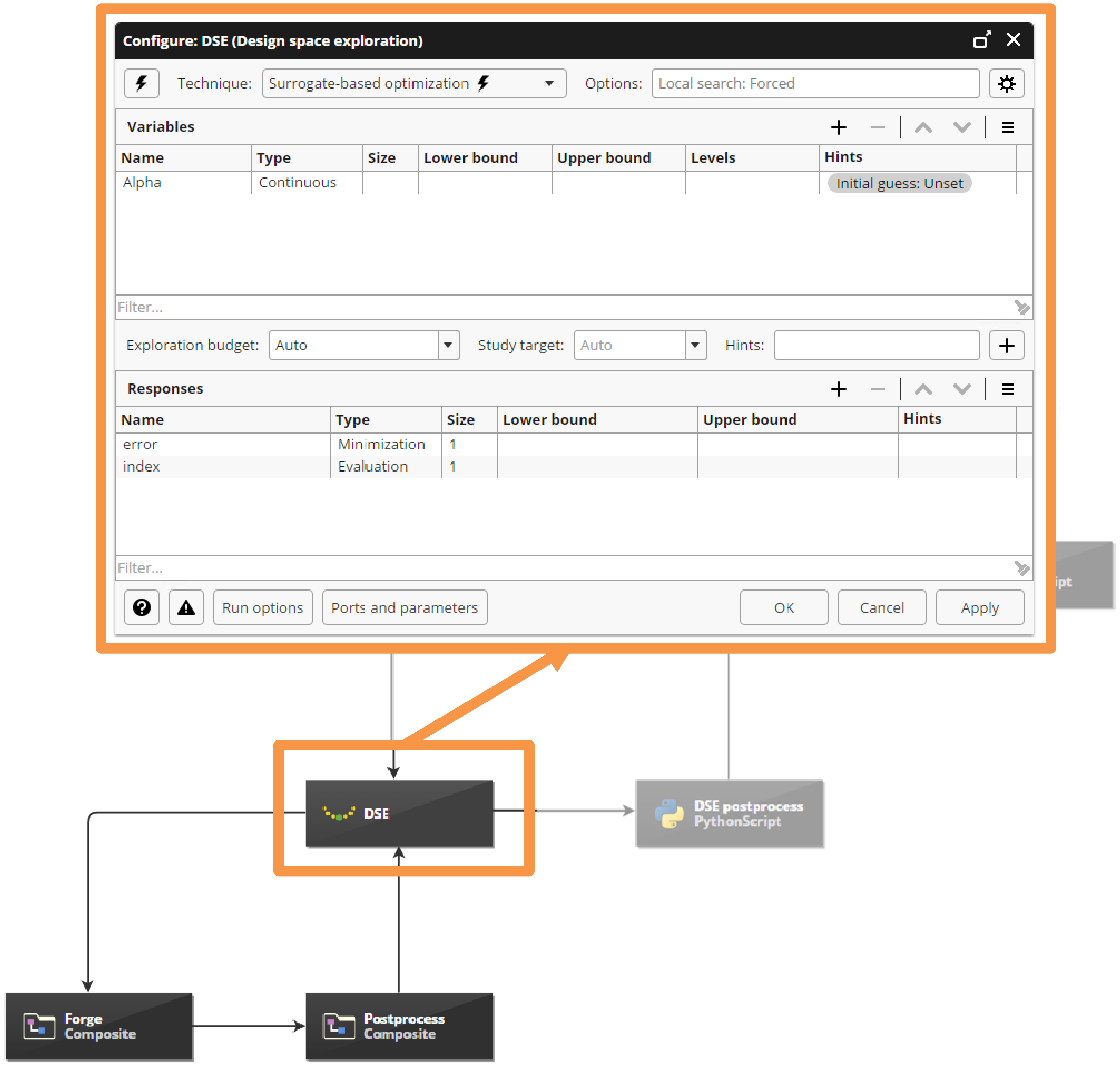
- At each step, the time interval is updated.
- After the HTC has been identified for such time step, it is saved, and the iteration continues.



Methodology

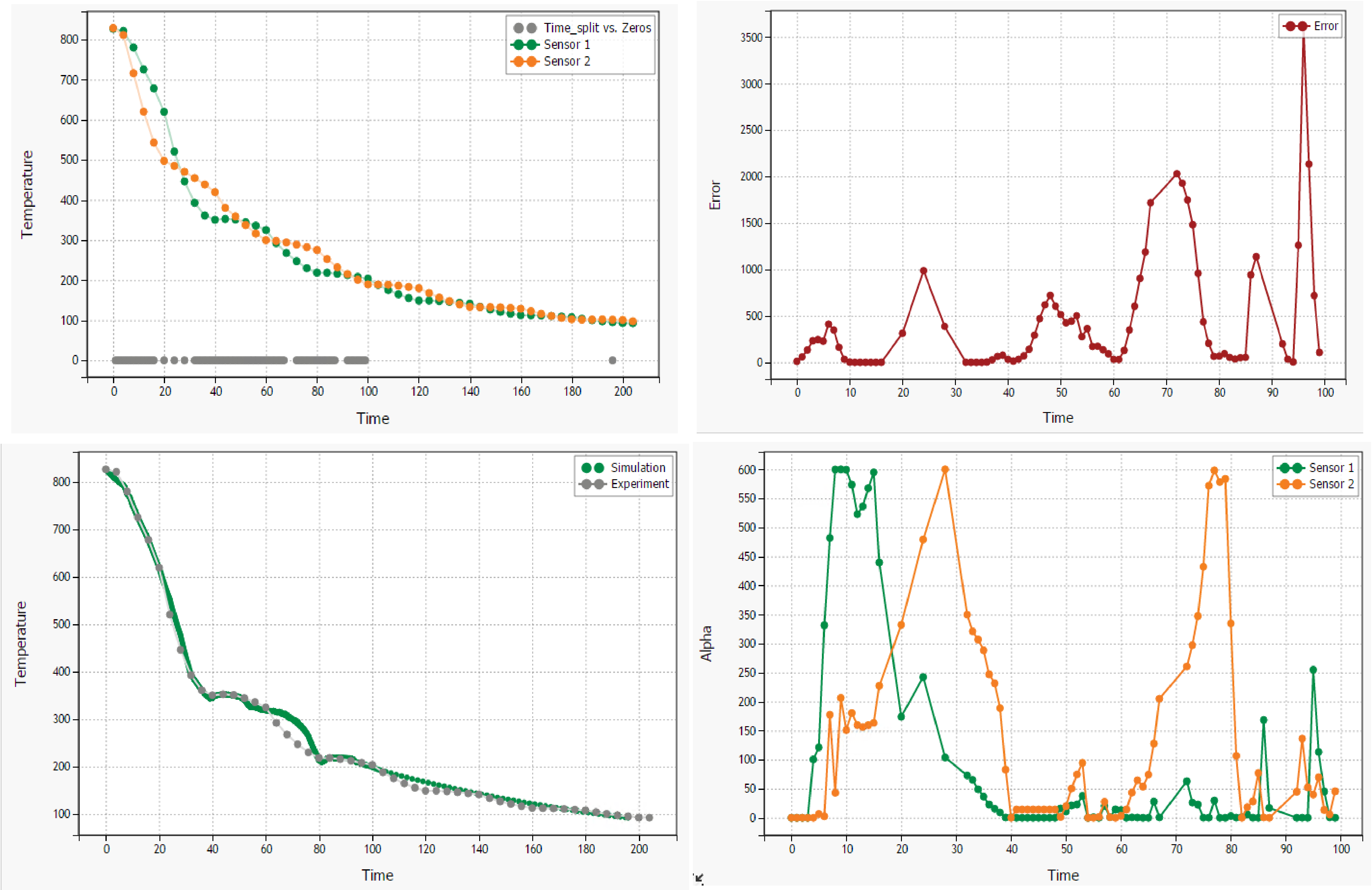
For each time step, get an **optimization campaign** of **reducing the difference in temperature** by playing on the HTC values in Forge.

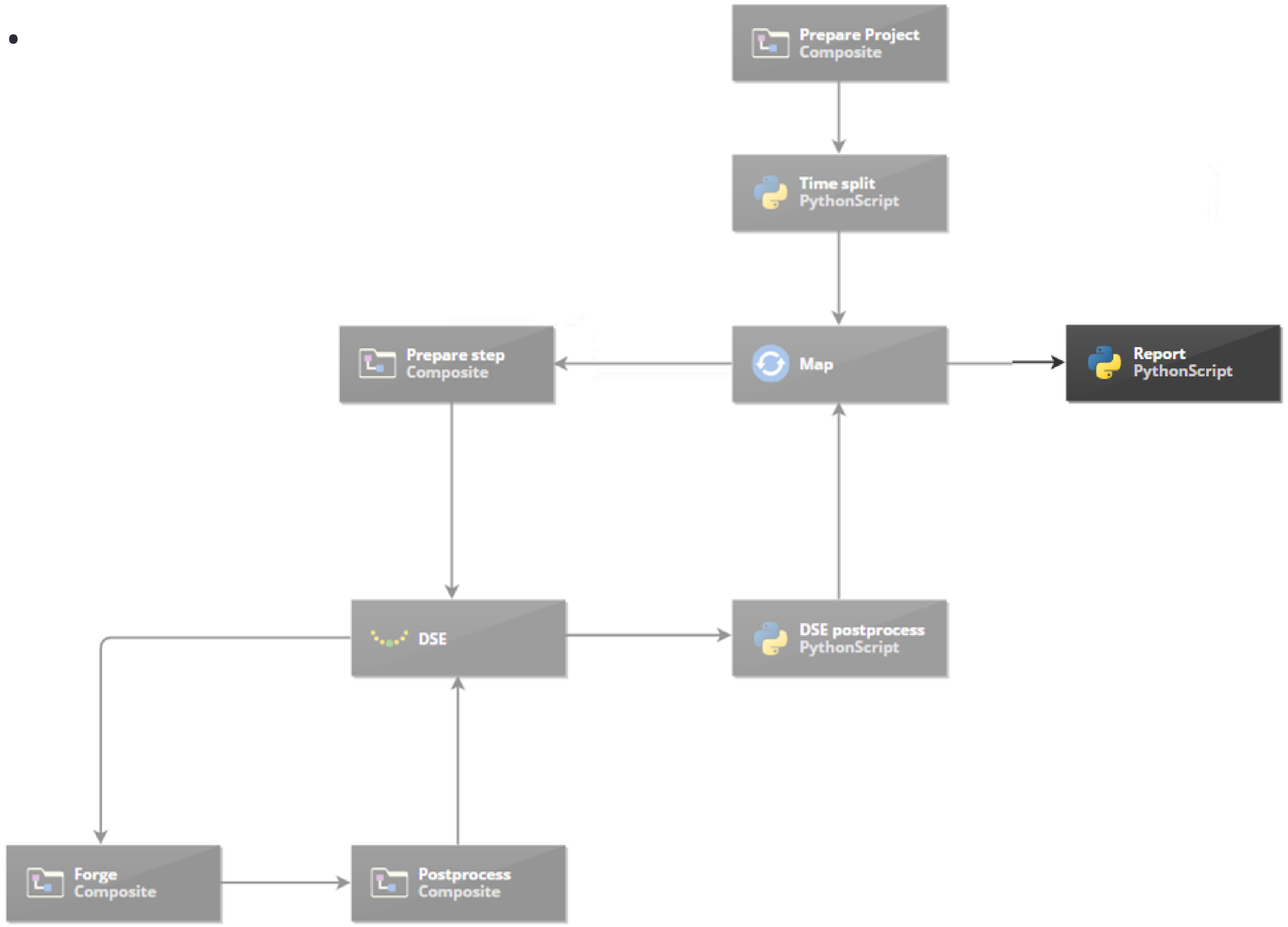
- The **Design Space Exploration block** manages automatically the optimization. It operates with the help of the **SmartSelection** algorithm.
- **GLPre and Forge** are launched using commands through the **Program block**.
- The resulting values are extracted from the output files.



Methodology

Return a report with **automated curves and data.**





Conclusion and perspectives

- An **automated approach** to allow faster identification of the HTC. The entire process takes **less than 6 hours** (compared to months of work by hand).
- **Three time splitting techniques** to allow flexibility for the research team to **explore different options**.
- **Reports** are generated for post processing and decision making. The **HTML format** allows **knowledge transfer** without the need of pSeven tool.
- **Reduced cost, complexity and time** compared to only experimental testing.
- To be applied to **other industrial parts**.

THANK YOU

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