Young Molten Salt Reactor Conference

Lecco, 06-08/06/2022

Preliminary Experimental Campaign for the Coupled DYNASTY-eDYNASTY Facility

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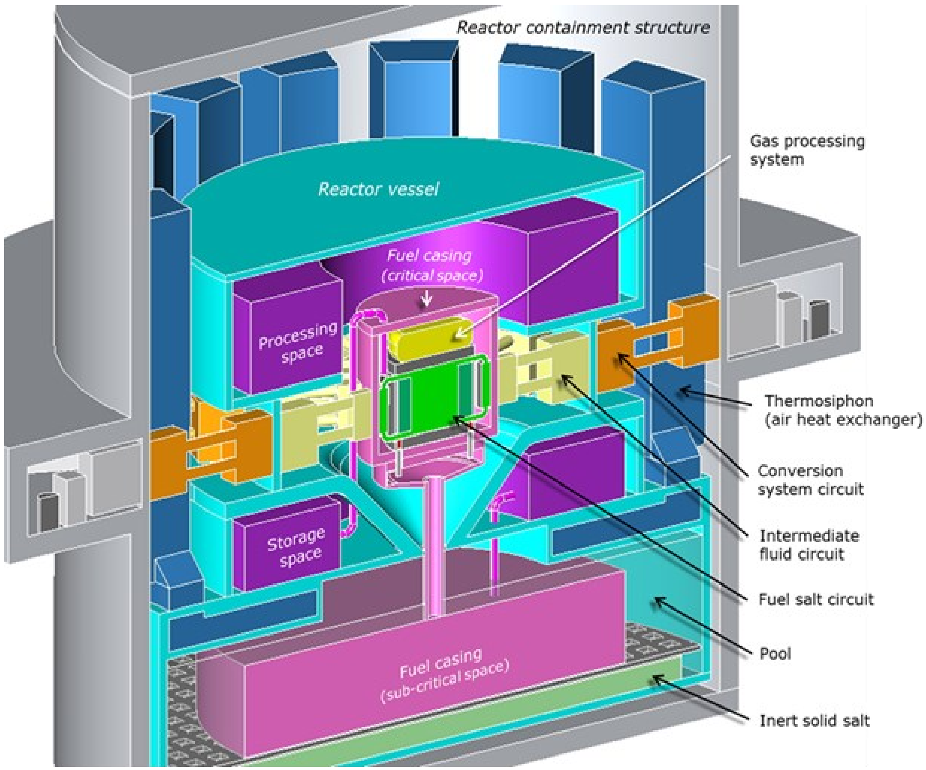
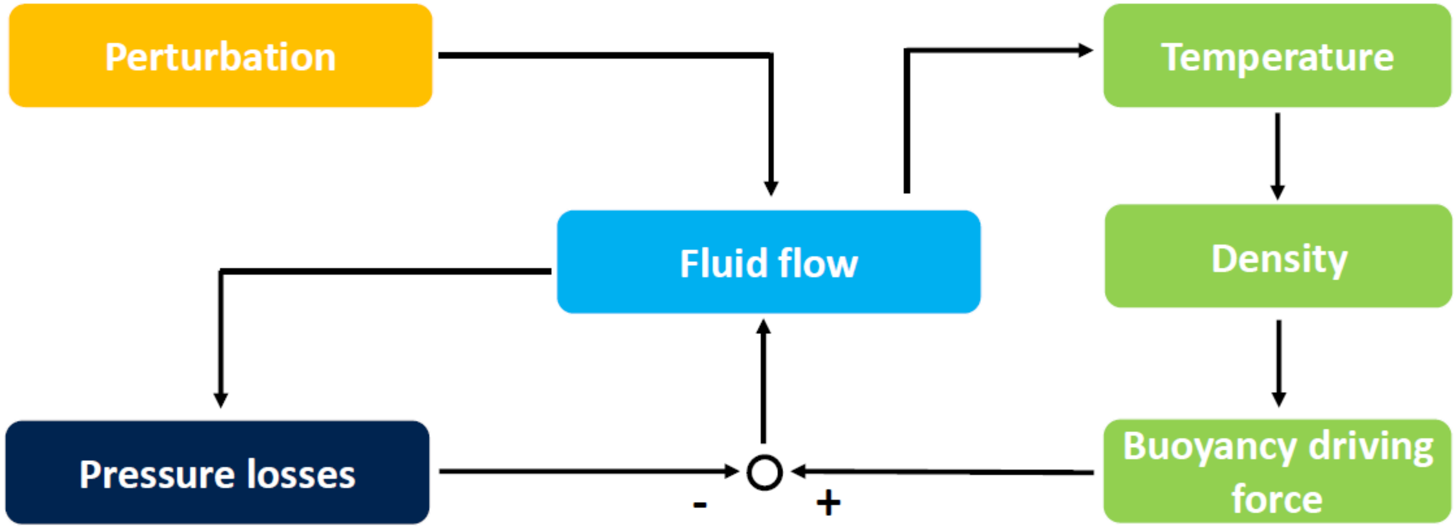
Nuclear Reactors Group

MSFR Reactor



- After shutdown, heat generation due to the decay of fission products
- Decay heat removal system (secondary loop)
- Passive operation to not compromise the reactor overall safety also in case of accidental conditions
- Natural circulation with IHG

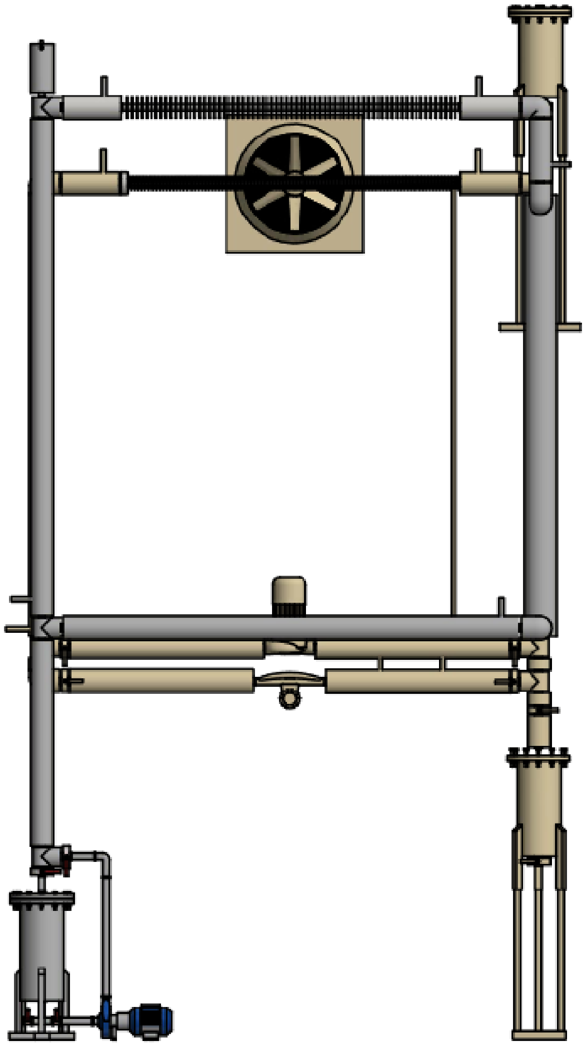
Natural Circulation Stability Problem



Natural Circulation Loops : DYNASTY

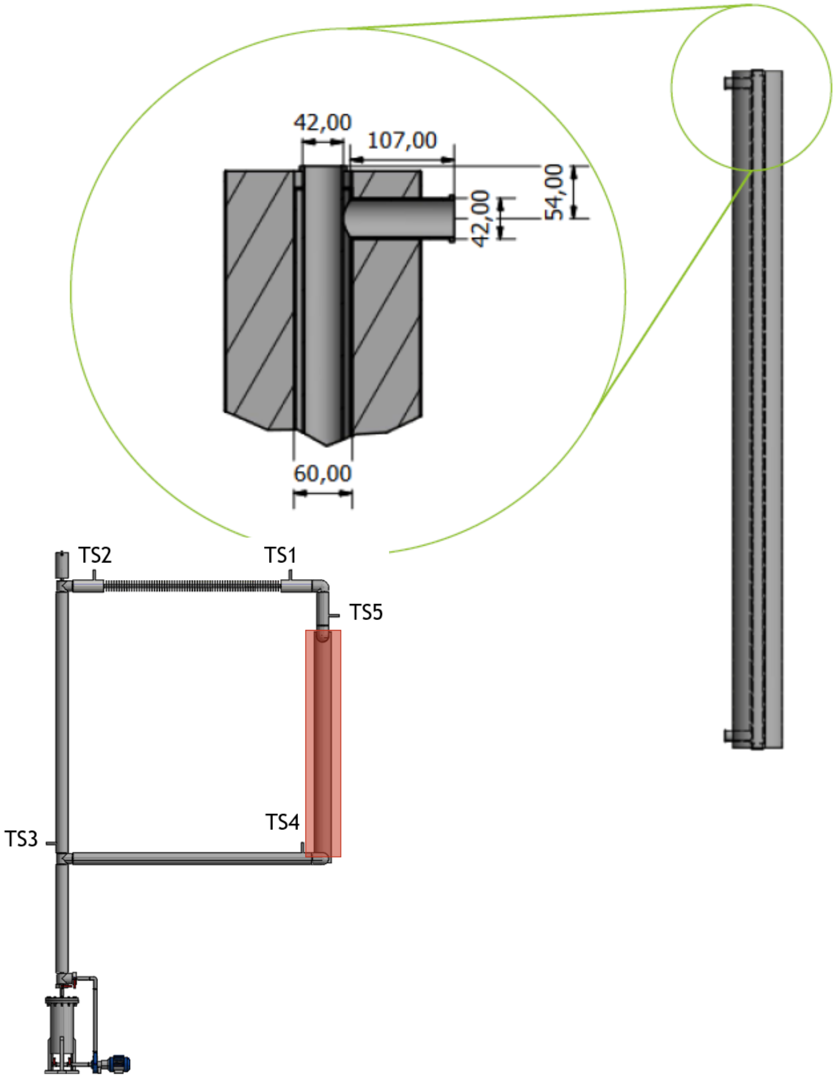
- IHG in experimental facilities is hard (nuclear / chemical reactions)
- Approximation of IHG with an EHS
- Distributed heat source (axial length greater than radial one)
- DYnamics of NAtural circulation for molten SalTs internallY heated (DYNASTY)

Secondary Coupled Loop : eDYNASTY



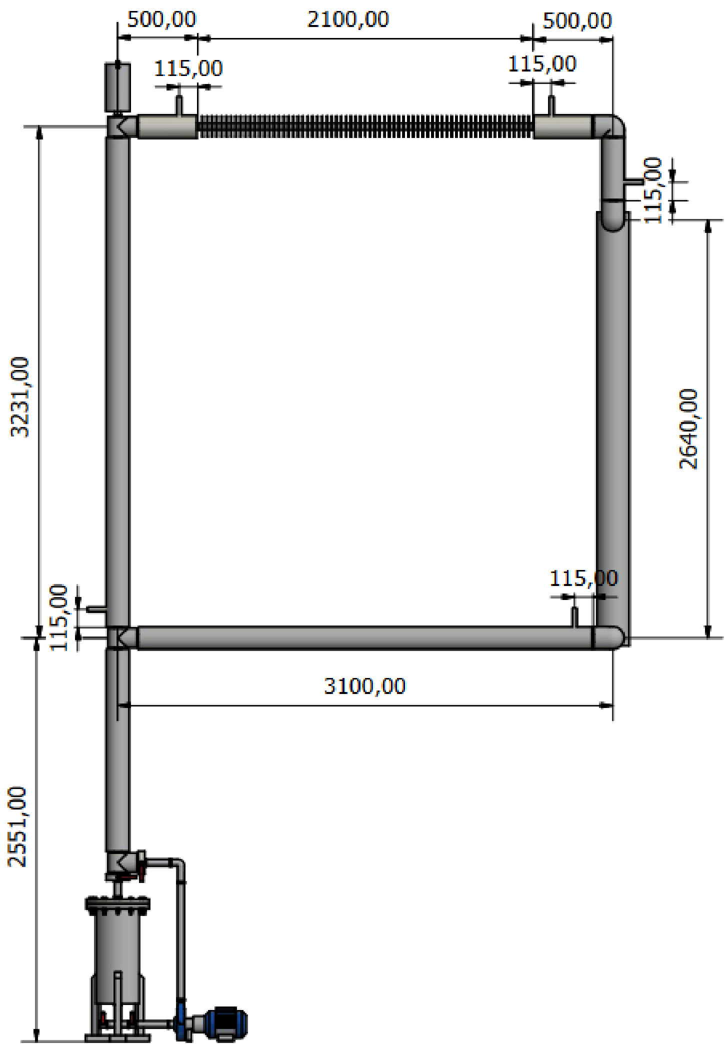
- Intermediate loop of the MSFR
- Containment between the radioactive fuel and the environment
- Decay heat removal
- eDYNASTY-DYNASTY coupled loops facility

HX Coupling

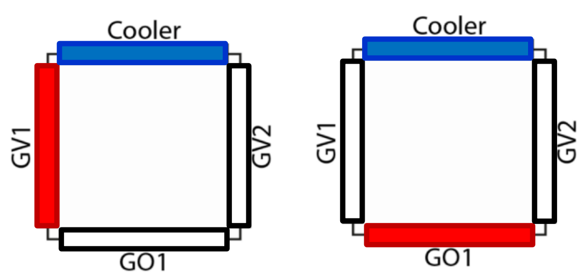


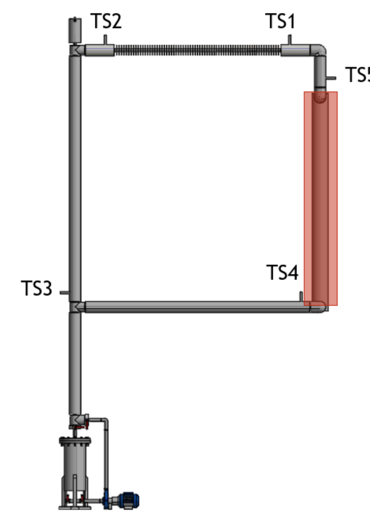
- Coupling: coaxial heat exchanger operating in natural circulation on both fluids
- Localised heat source for eDYNASTY
- DYNASTY: inner (d = 38mm)
- eDYNASTY: annulus (d = 56mm)

eDYNASTY Preliminary Experimental Analysis

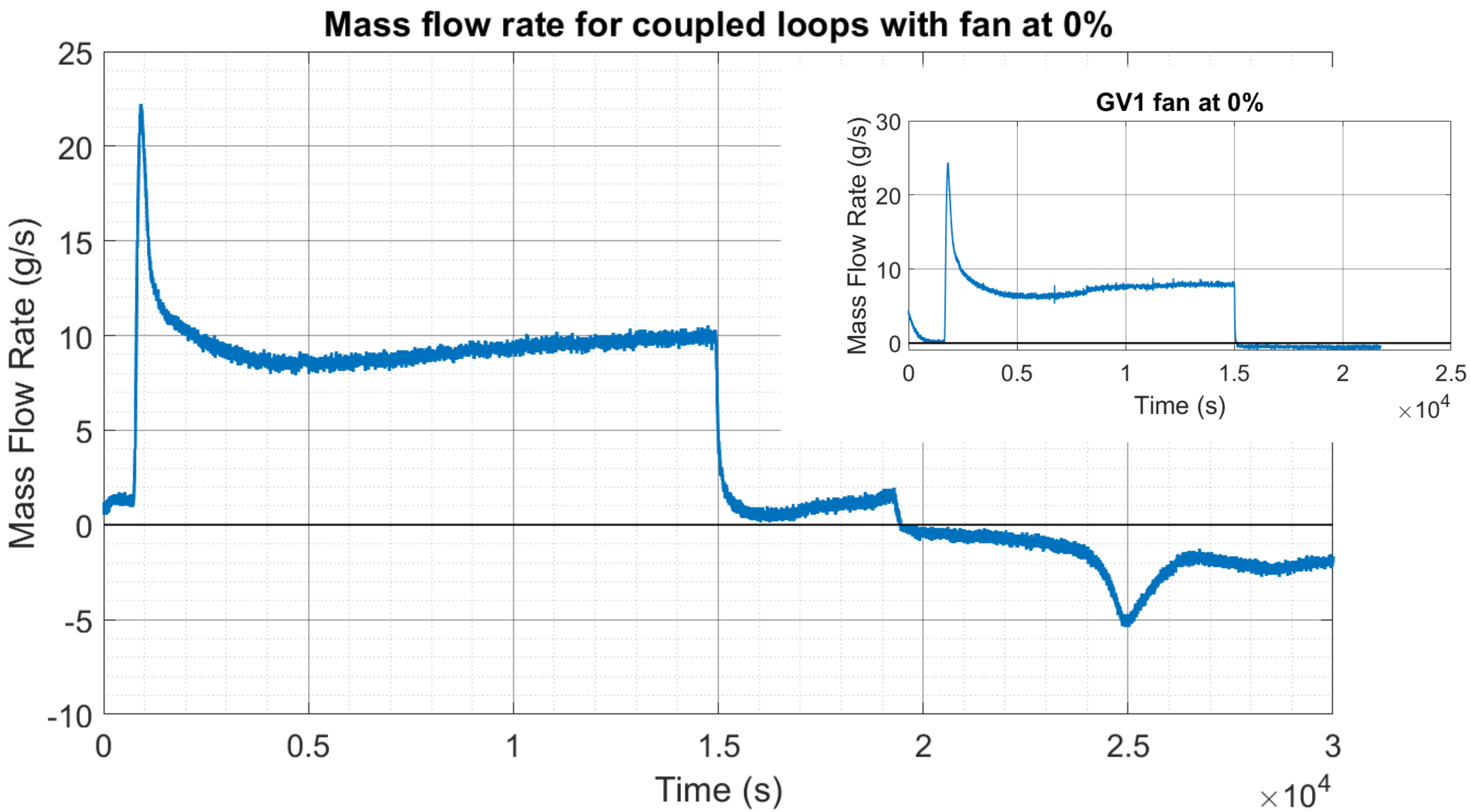


- Water as working fluid
- Maximum heating power (step input)
- No insulation (both loops)
- GV1 Case (SX DYNASTY vertical leg)
- GO1 Case (horizontal DYNASTY leg)
- Heating / cooling transient

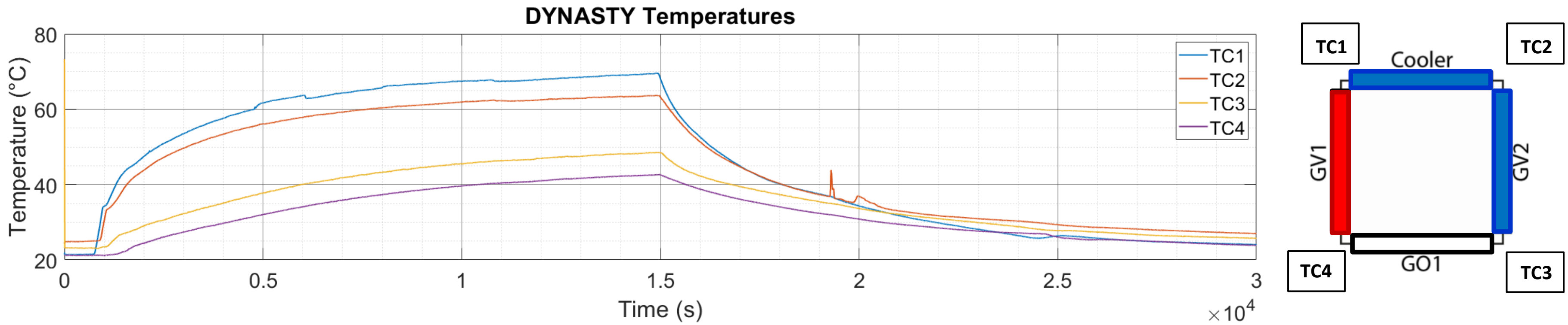


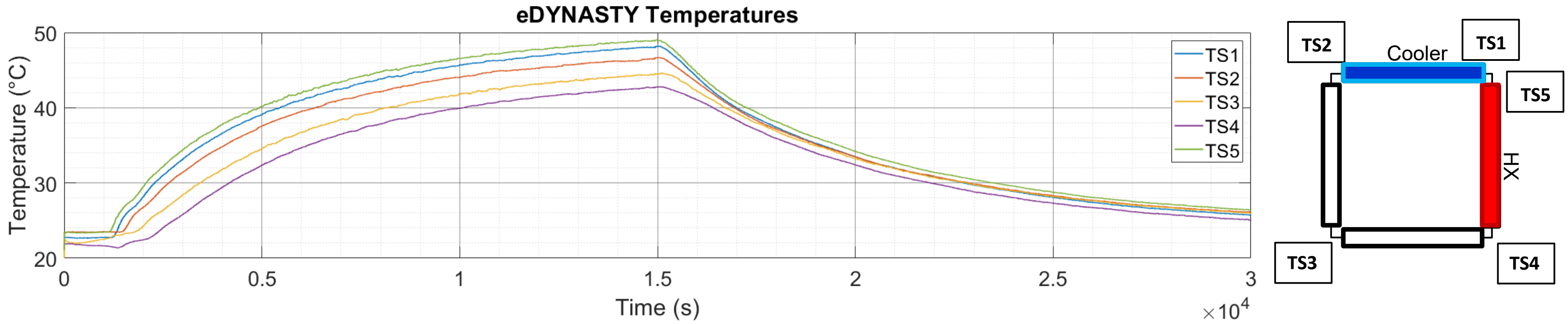


VHHC – DYNASTY Flow Rate



VHHC - Temperature

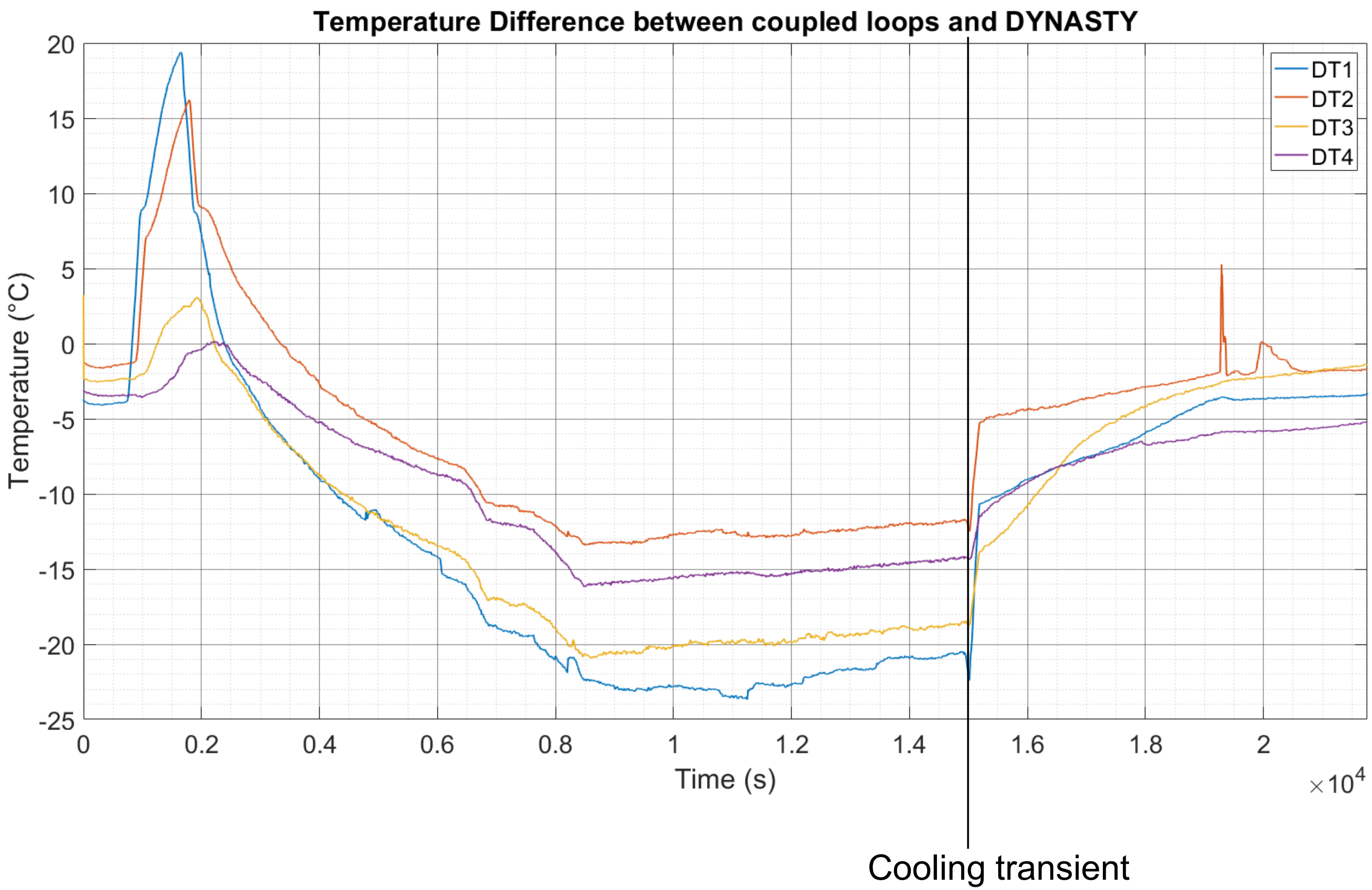




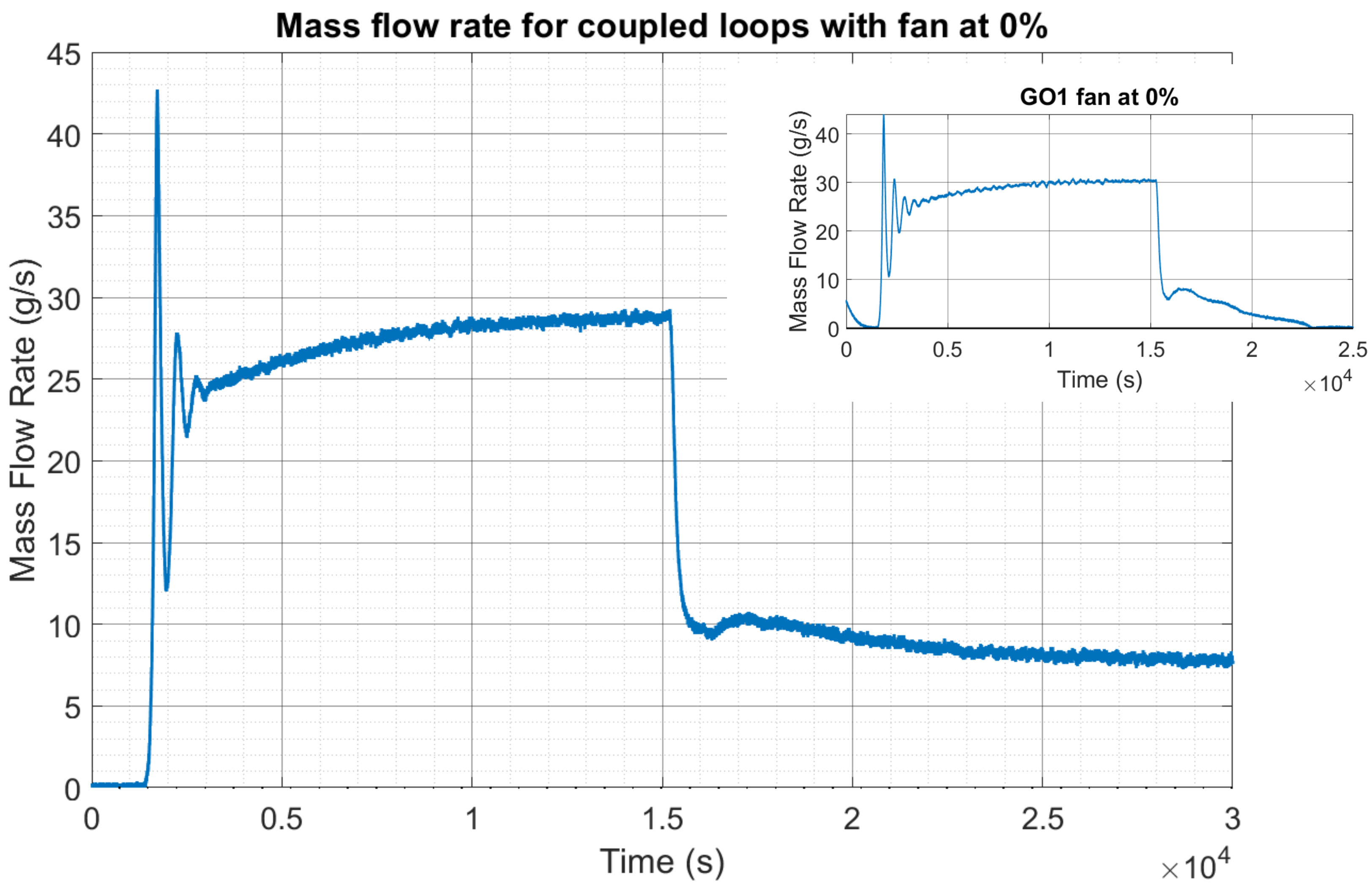
- eDYNASTY flow counter-clockwise ; DYNASTY flow clockwise
- Heat exchanger in counter-current flow configuration

VHHC – Coupled VS nonCoupled DYNASTY

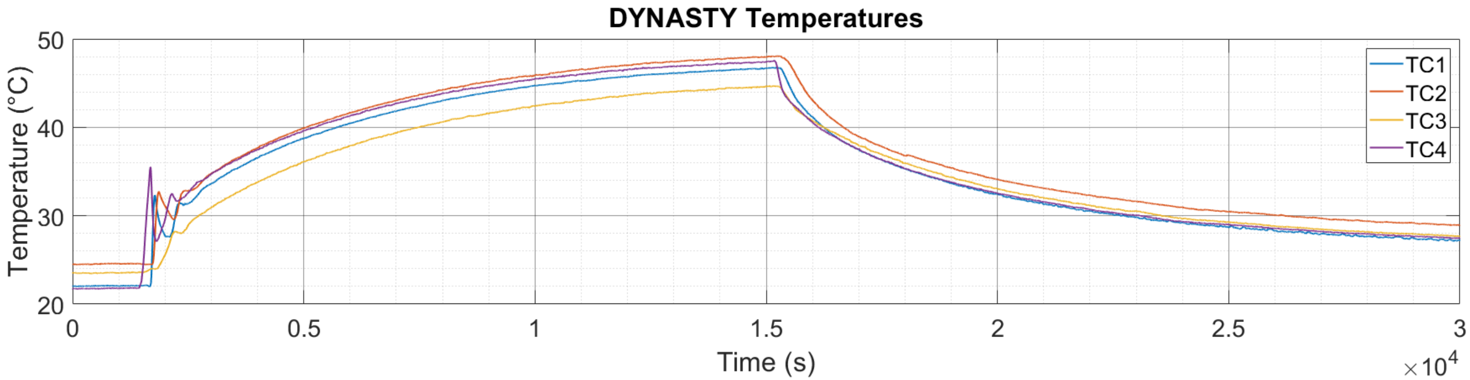
$$DT(TC_i) = TC_{i,(Coupled)} - TC_{i,(nonCoupled)}$$

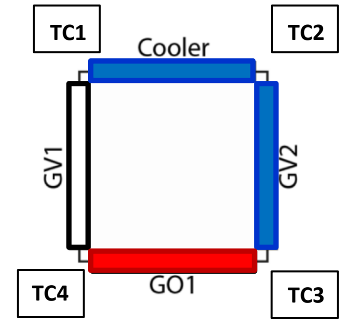


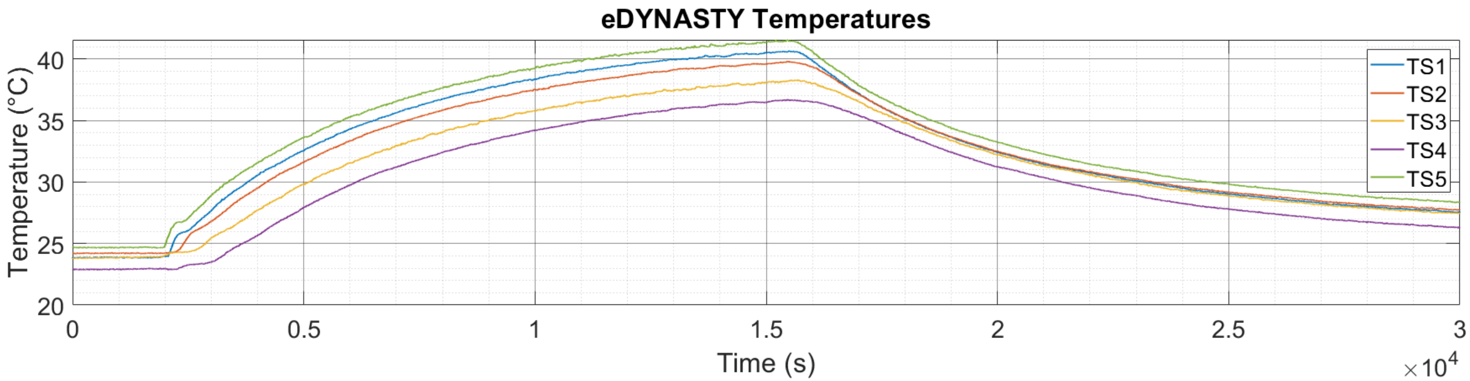
HHHC – Mass Flow

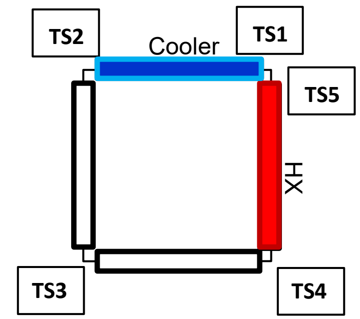


HHHC - Temperatures









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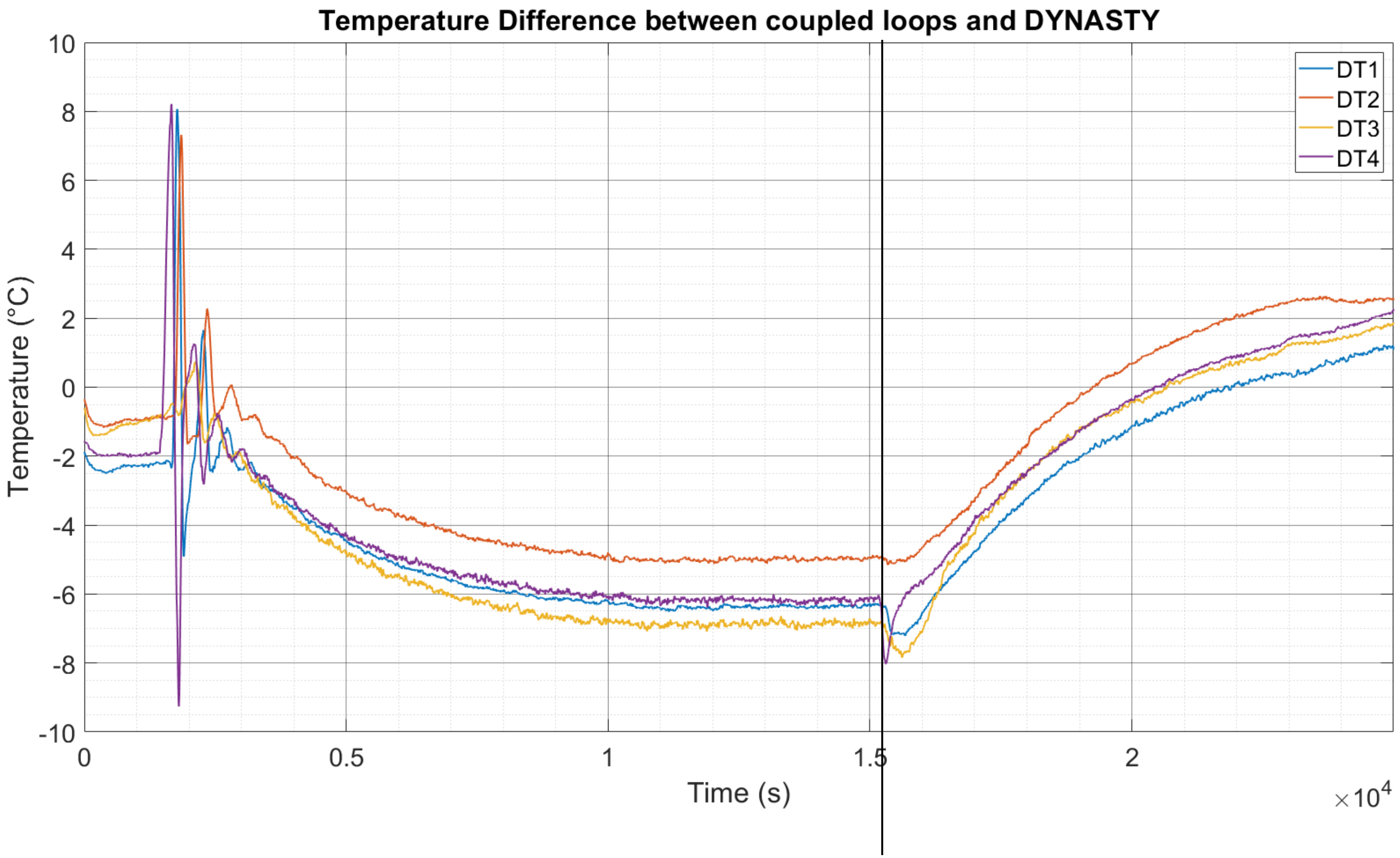

Cooling transient

Conclusions and Future Works

- Main outcomes:
  - Similarities in the mass flow rate evolution between the coupled and the uncoupled DYNASTY facility (especially for VHHC).
  - Non-negligible influence of the secondary loop on the primary loop temperatures during the heating transient (higher influence the higher the primary temperatures are -> relevant for DH!)
- Future works
  - Full experimental analysis with insulated facilities
  - Different working fluid (propylene glycol)
  - Different transient simulations (power spikes)
  - Effect of the fan on the coupled loops dynamics

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Thank you for your attention

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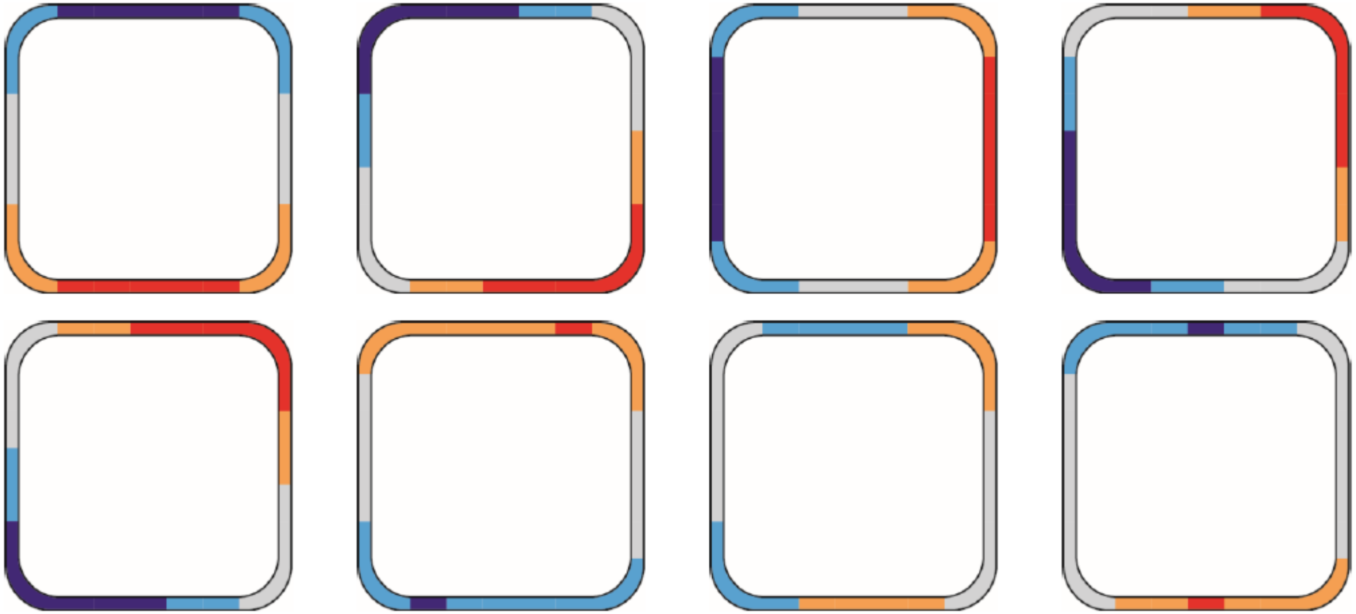
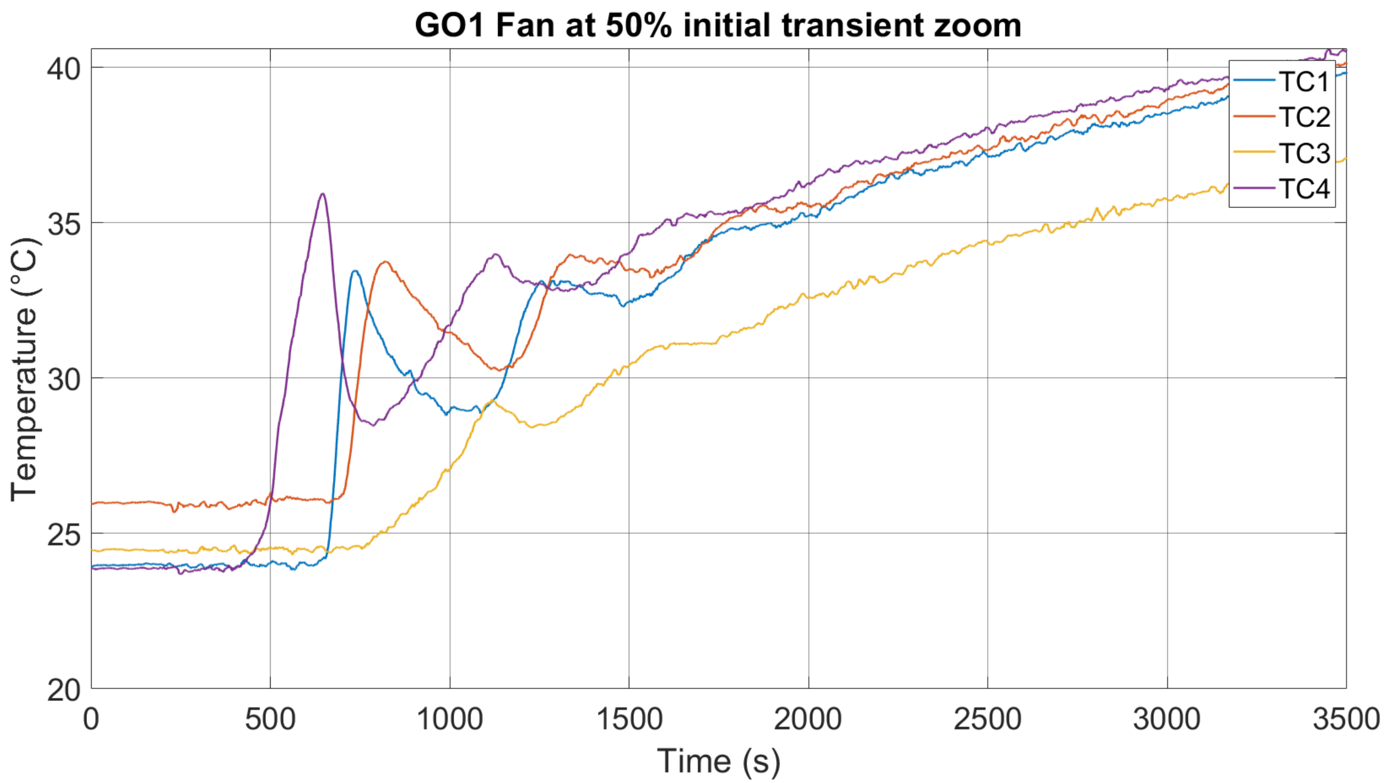
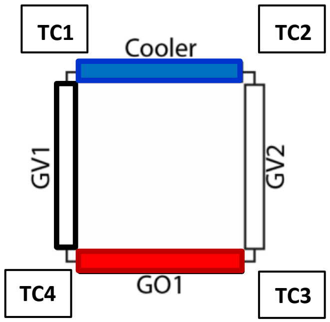
Welander Wave Packet Flow



Formation of hot and cold “fluid packets” which are amplified when passing through the heat source or the heat sink, respectively

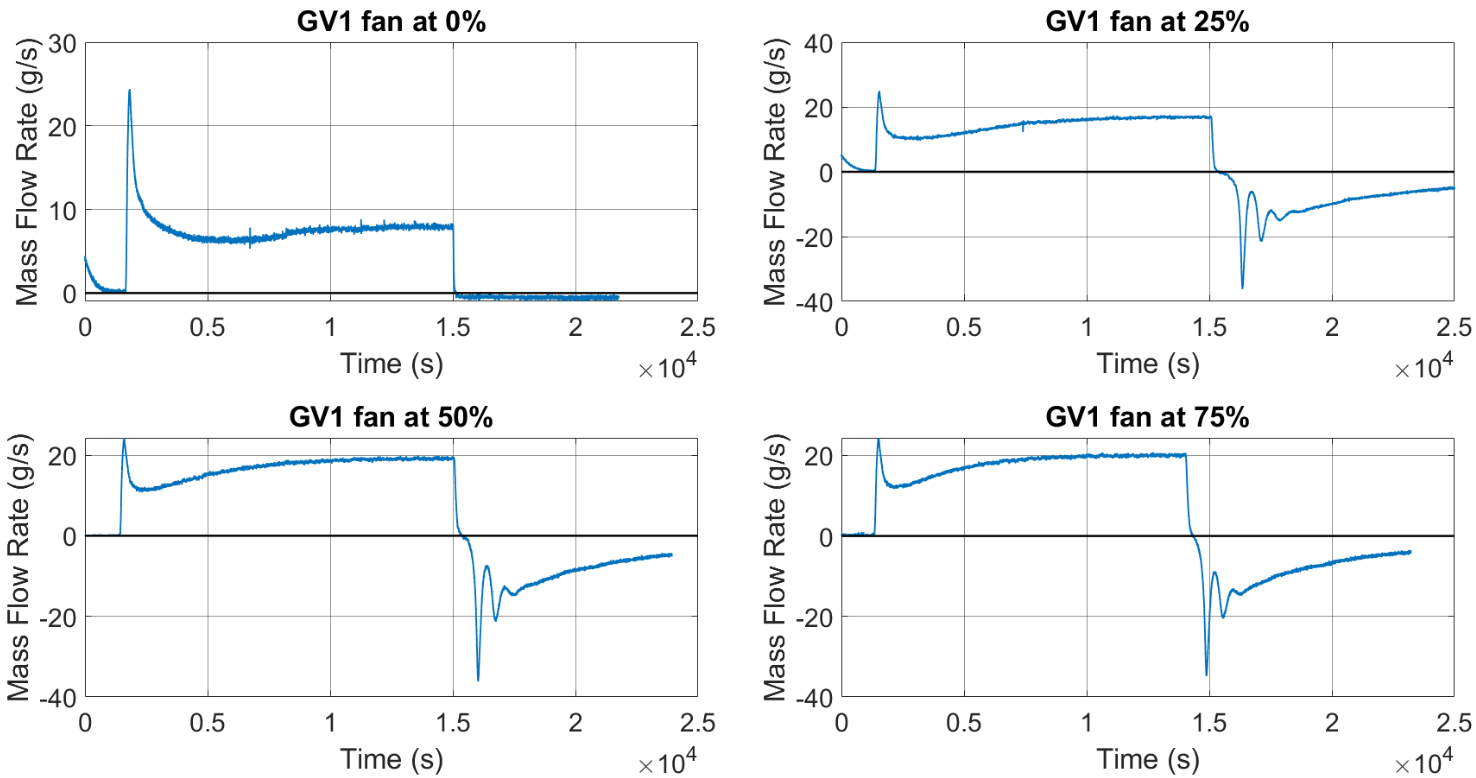
Hot Wave Packet Example (DYNASTY)

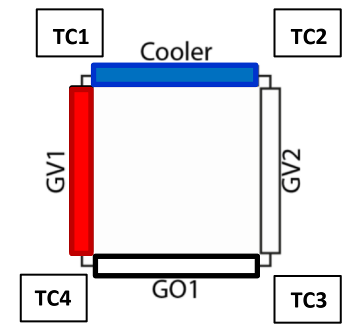




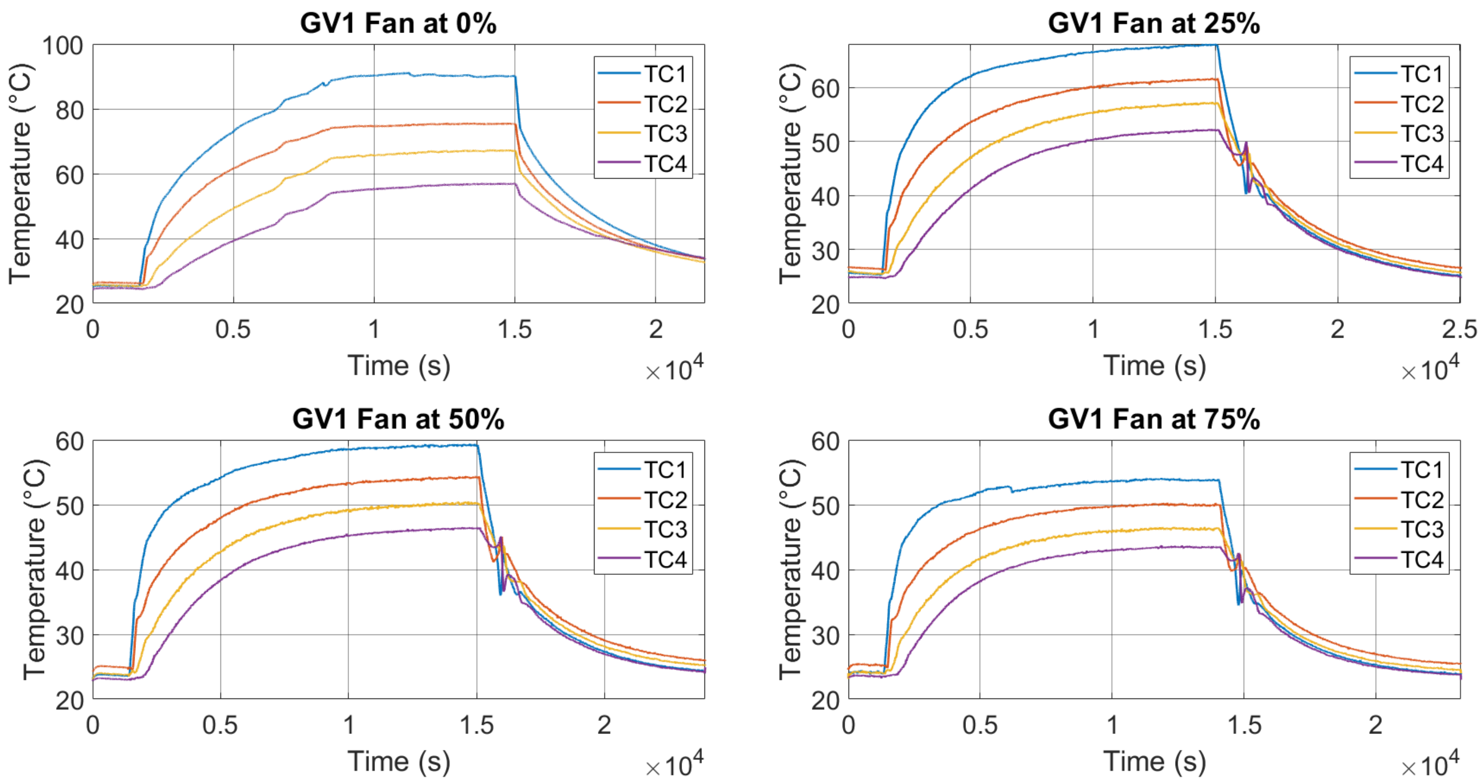
- Formation of hot wave packet when the heaters are turned on
- Motion of the hot fluid packet in the system from heater outlet (TC4) to heater inlet (TC3)

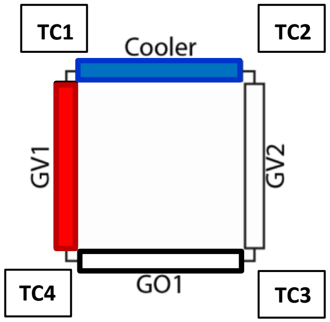
VHHC (SX) DYNASTY Only – Mass Flow



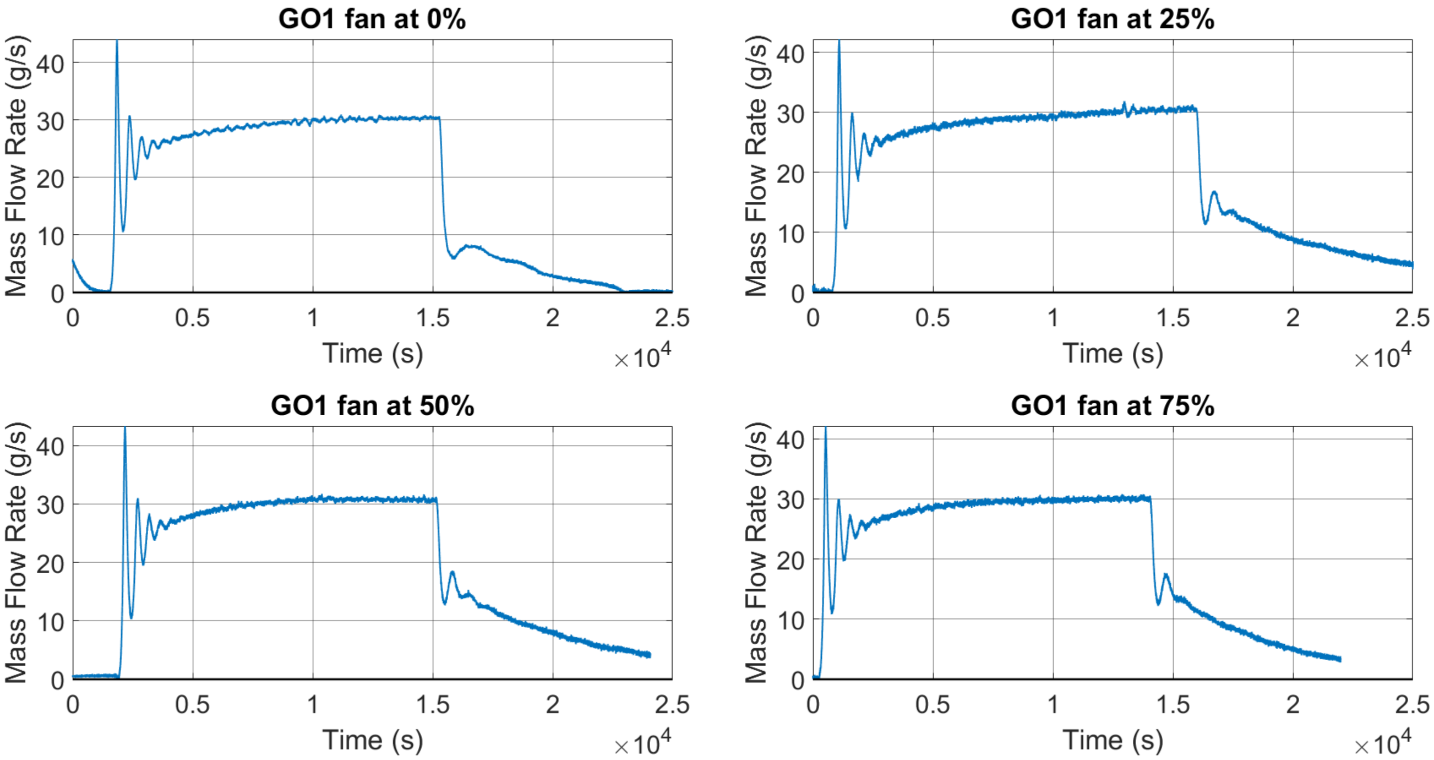


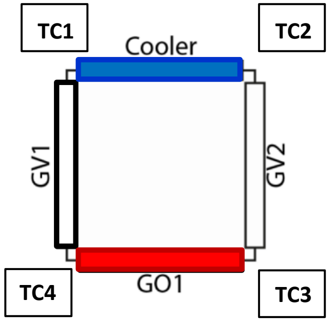
VHHC (SX) DYNASTY Only – Temperatures





HHHC DYNASTY Only – Mass Flow





HHHC DYNASTY Only - Temperatures