

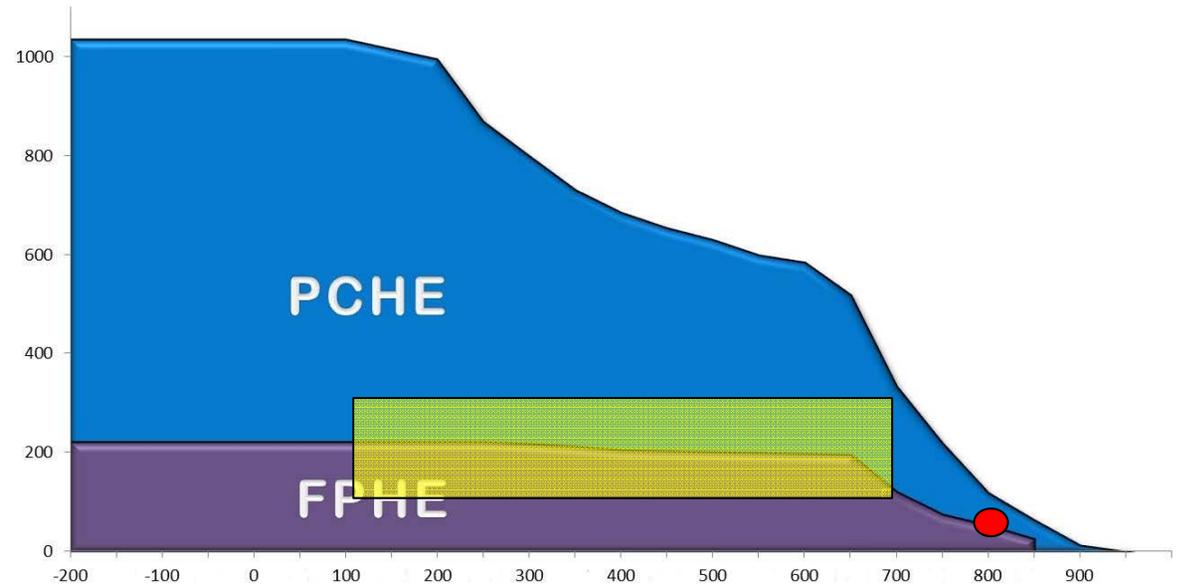
# Technology Development Needs for sCO<sub>2</sub> Heat Exchangers

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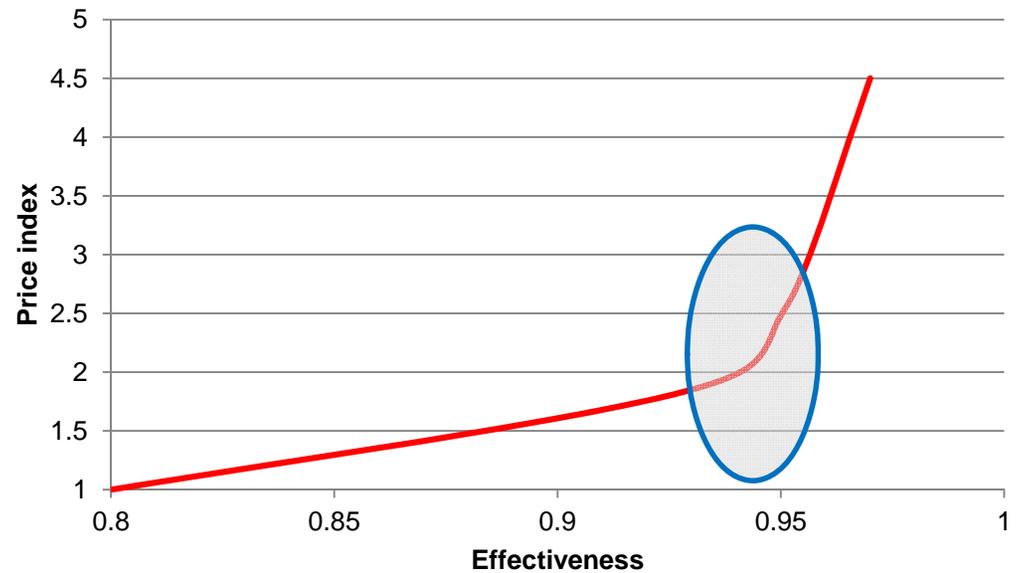
## Technical Challenges

- Heat Exchangers
- Design Pressure



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  - Temperature Approach



## Technical Challenges

### Heat Exchangers

- Design Pressure
- Temperature Approach
- Material of construction

### Existing materials

- 316L – 649°C
- >649°C – higher grade alloys (HR 120 – 617?)
- Corrosion behaviour?

### New Materials

- Must be strong, corrosion resistant, cheap and available in many product form:
- Which one?

## Technical Challenges

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  - Recuperators?



## Technical Challenges

### Heat Exchangers

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### Existing Technology

- ASME 'U' qualified
- Proven performance in sCO2 test loops since 2003 (TIT, SNL, Echogen, GE, KAERI)
- Proven performances in many other Brayton cycles (Nitrogen, Air, Helium).

## Technical Challenges

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  - Recuperators?
  - Coolers?



## Technical Challenges

### Heat Exchangers

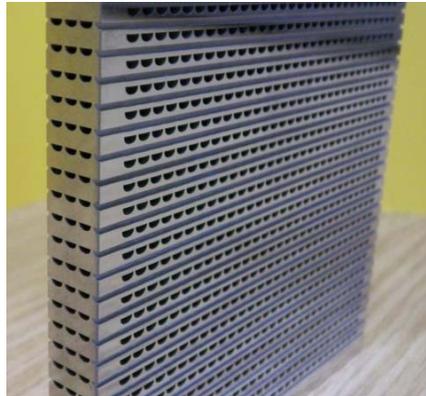
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- Temperature Approach
- Material of construction
- Recuperators?
- Coolers?

### Existing Technology

- 30 years of PCHE gas coolers
- Many units used in extremely harsh offshore environments
- Mature products
  - 2200 PCHE (<85 tons)
  - 15 FPHE (<50 tons)
- 304 / 304L / 316 / 316L / Duplex / Ti Grade 2 / 6 Moly

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  - Coolers?
  - IHX?



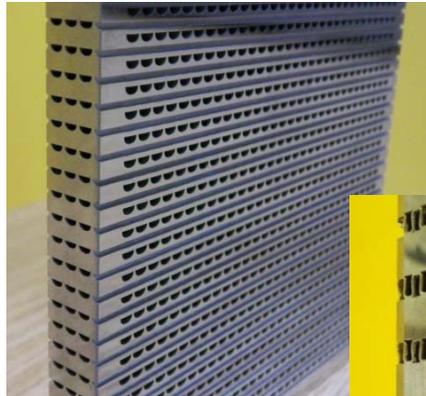
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### Heat Exchangers

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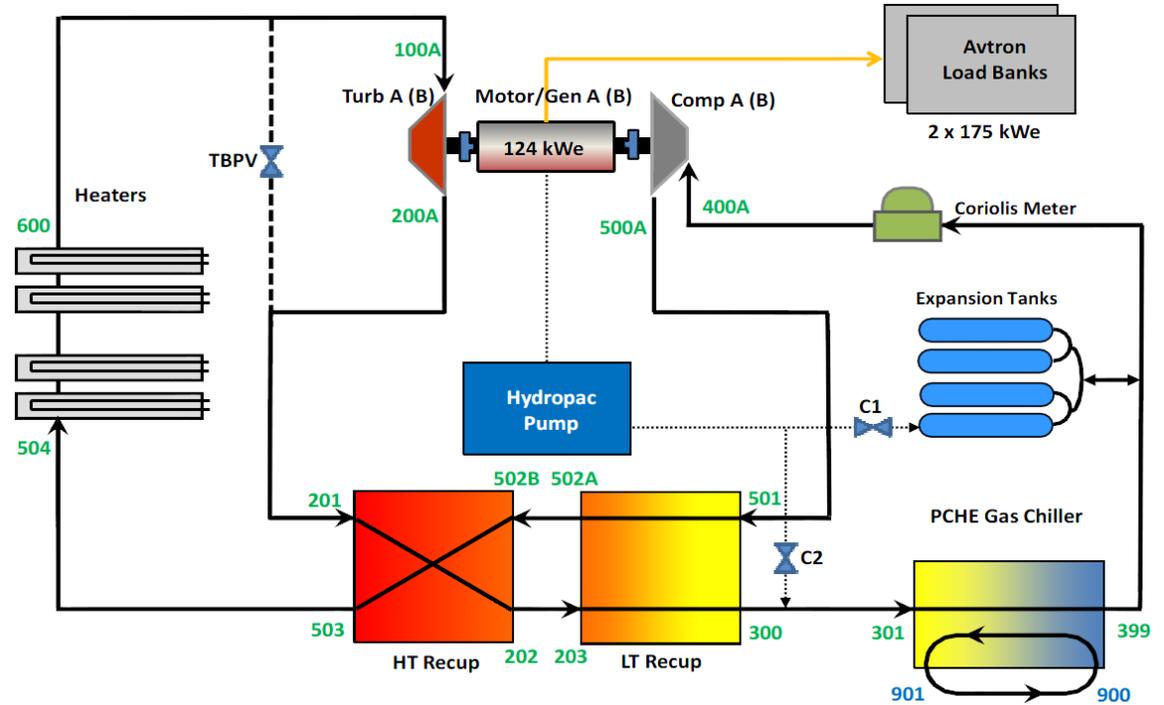
### IHX needs development

- High temperature section (material)
- Most likely hybrid to address
  - Low pressure and pressure drop on the hot side
  - High pressure on the sCO2 side



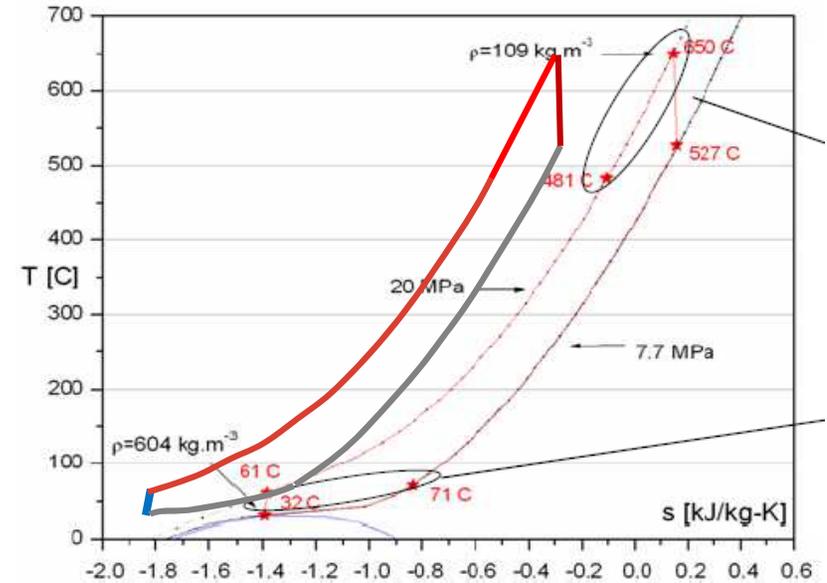
## Technical Challenges

- ▀ Test Loop overall
  - Design and components optimisation



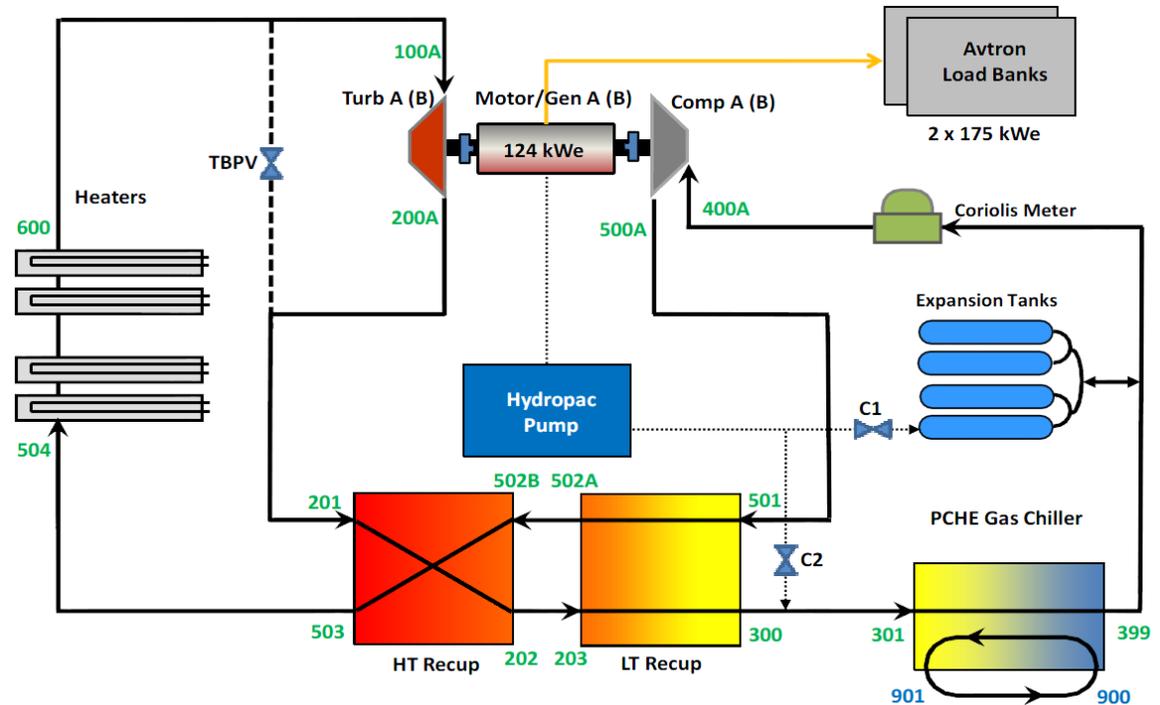
## Technical Challenges

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## Technical Challenges

- ▀ Test Loop overall
  - Design and components optimisation
  - Control (start-up, shutdown, off-design cases ...)
  - Influence off various material of construction on various components



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