EFFICIENCY
OF INDUSTRIAL
PROCESSES

SCCER EIP
WP2 Energy Efficiency (direct)

Zurich at NTB, May 6th, 2015

«Multi-Temperature Heat Pump using Turbocompressors»,

Frédéric Moix, NTB,

In cooperation with the CTI

Energy
Swiss Competence Centers for Energy Research

Schweizerische Eidgenossenschaft
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Commission for Technology and Innovation CTI

Outline

- Introduction
- Description of heat pumps
- Multi-temperature heat pumps
- Turbocompressor in heat pumps
- Project

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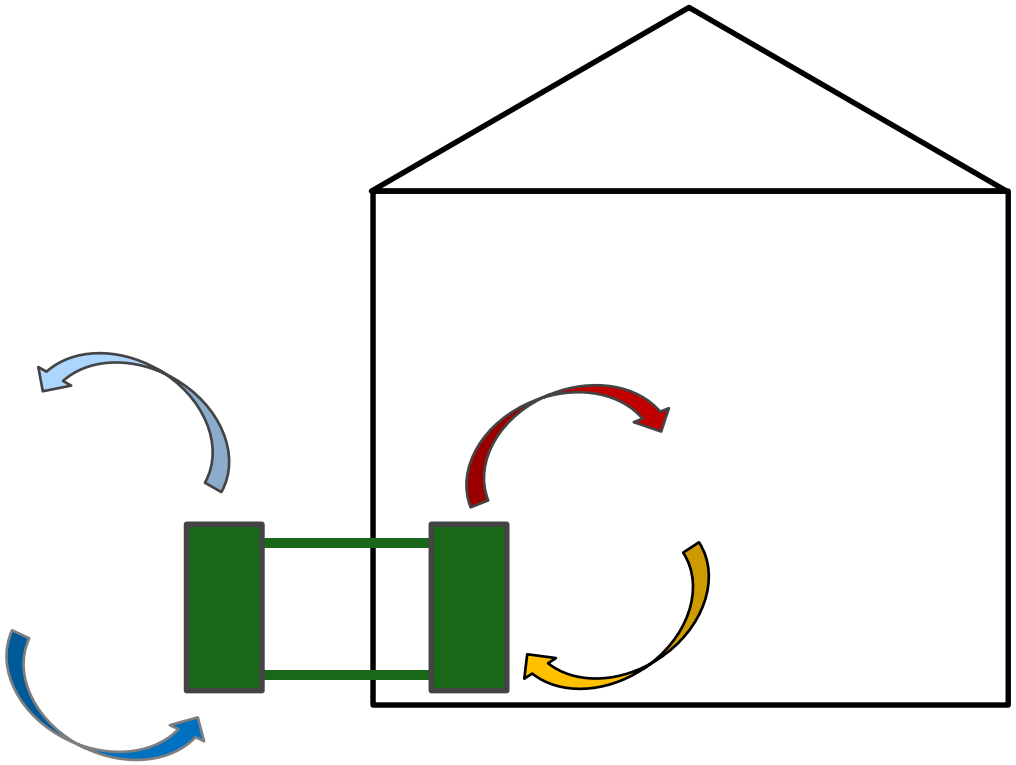
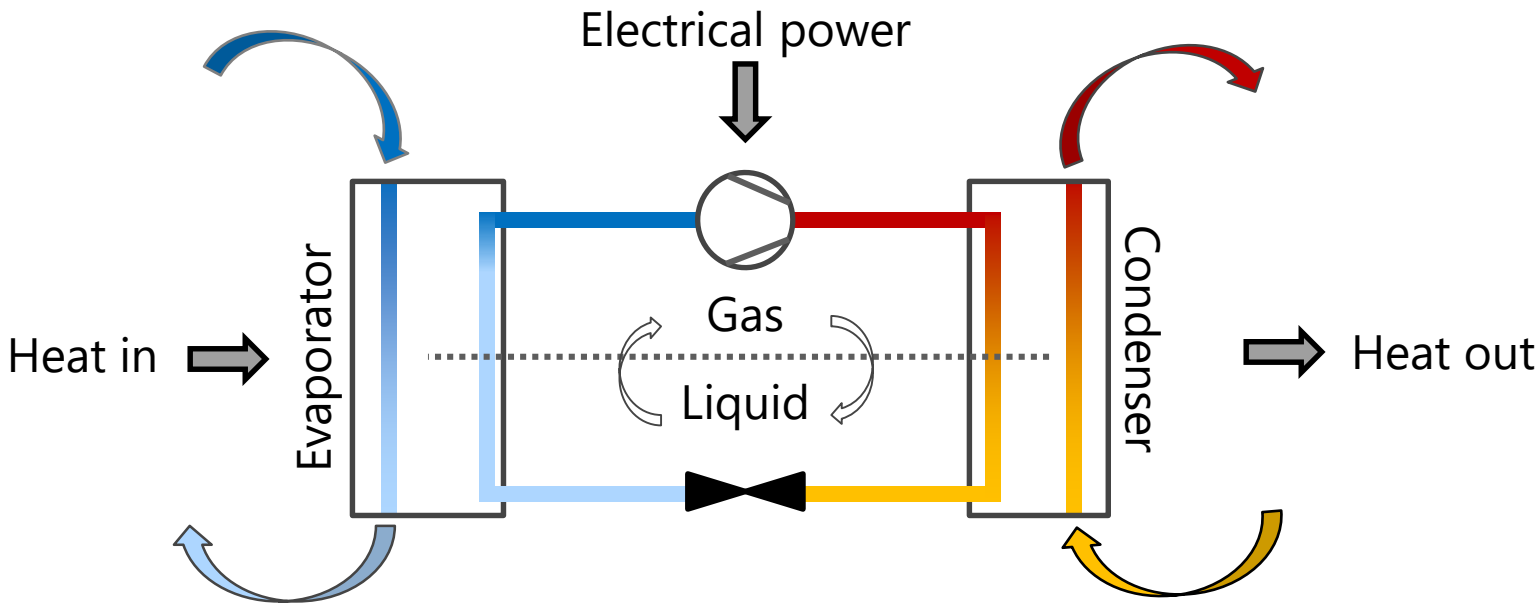
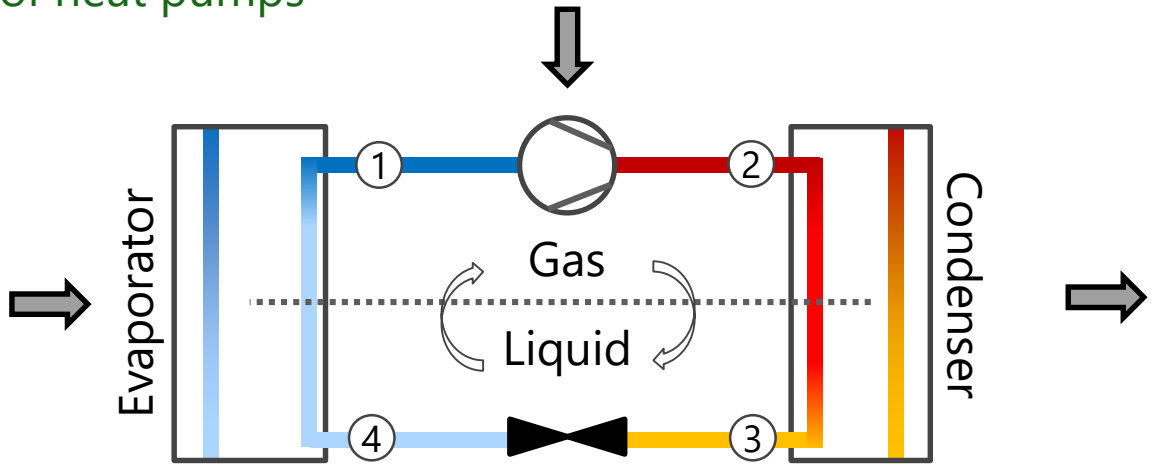
WP2: enhancement of industrial processes and production sites.

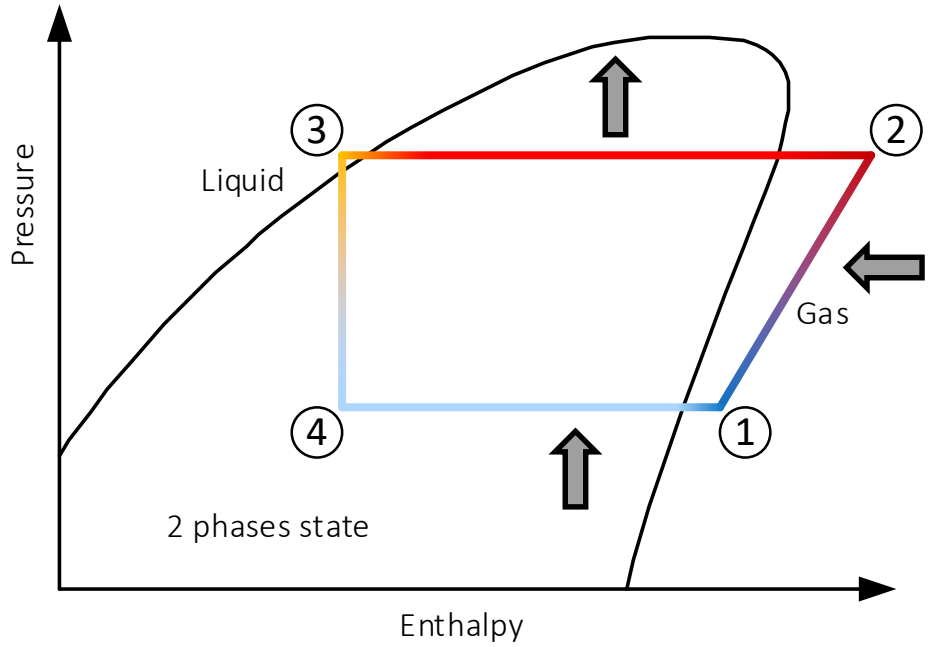
- Task1: Using **multiple temperature heat pump** (MTHP) to be able to use waste heat and reduce exergy losses.
  - NEW: Using **trubocompressors** on a recently designed **MTHP**

Winter:




Electrical power
Heat in
Evaporator
Gas
Liquid
Condenser
Heat out


Evaporator
Condenser
Gas
Liquid
1
2
3
4


Pressure
Liquid
Gas
2 phases state
Enthalpy
1
2
3
4

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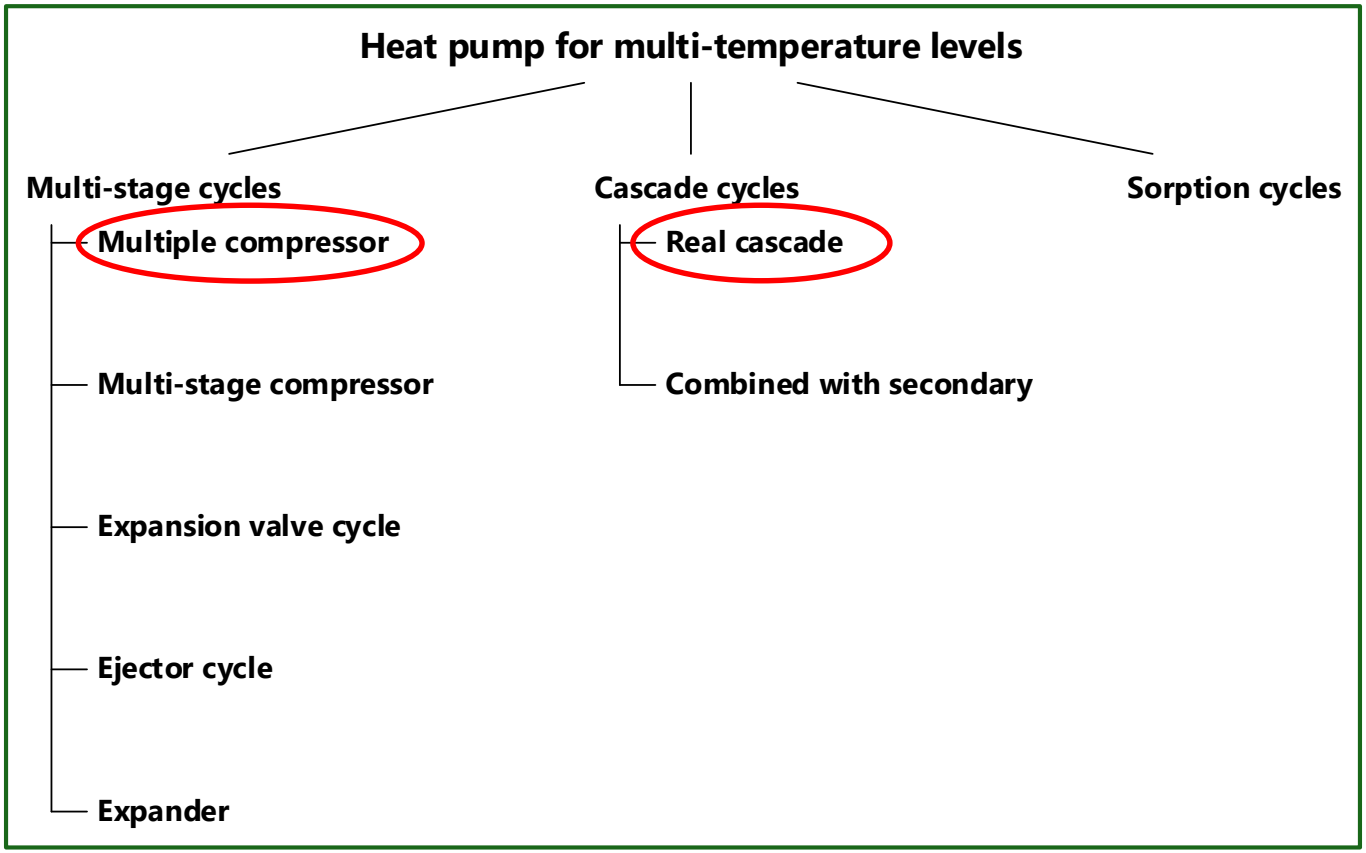
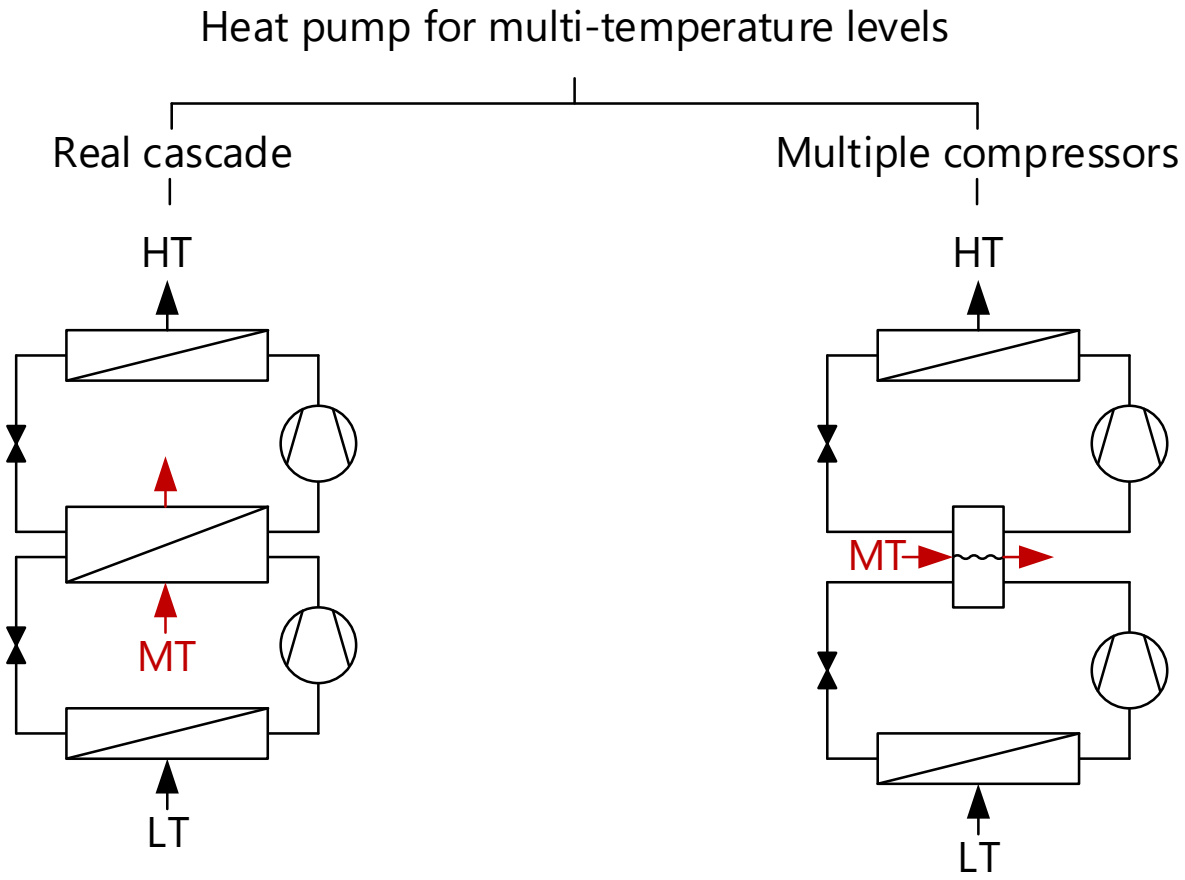
Efficiency:

Coefficient of Performance **COP**: $\frac{\mathbf{Q_{out}}}{\mathbf{Power_{in}}}$

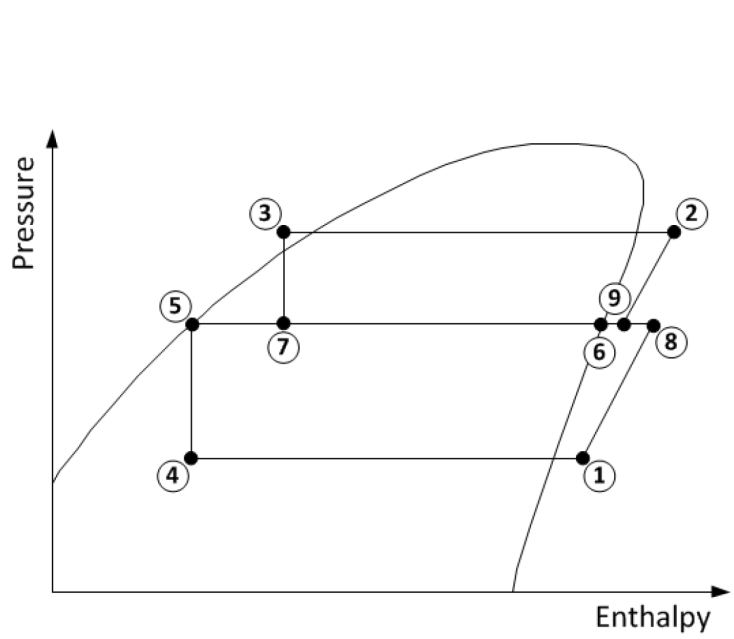
COP > 1 (more efficient than any other heating system)

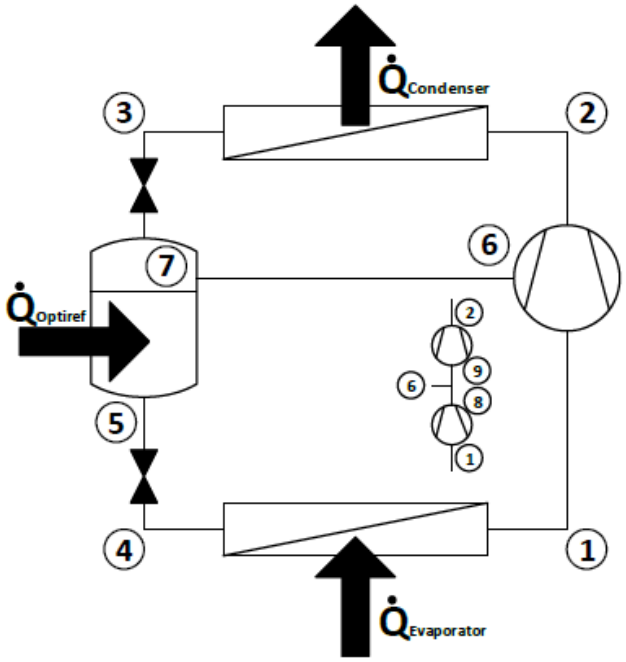
Possible heat pumps concepts for multi-temperature levels




Heat pump for multi-temperature levels
Real cascade
Multiple compressors
HT
MT
LT
HT
MT
LT

Optiref example:





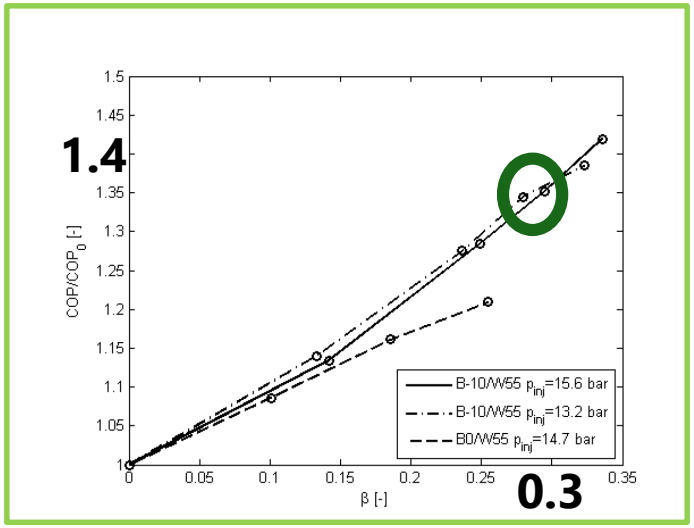
Figures: OptiRef refrigeration cycle and results, Uhlmann, M. et al.: Opti-Ref – Heat pump with two heat sources at different temperature levels, 6/2014.

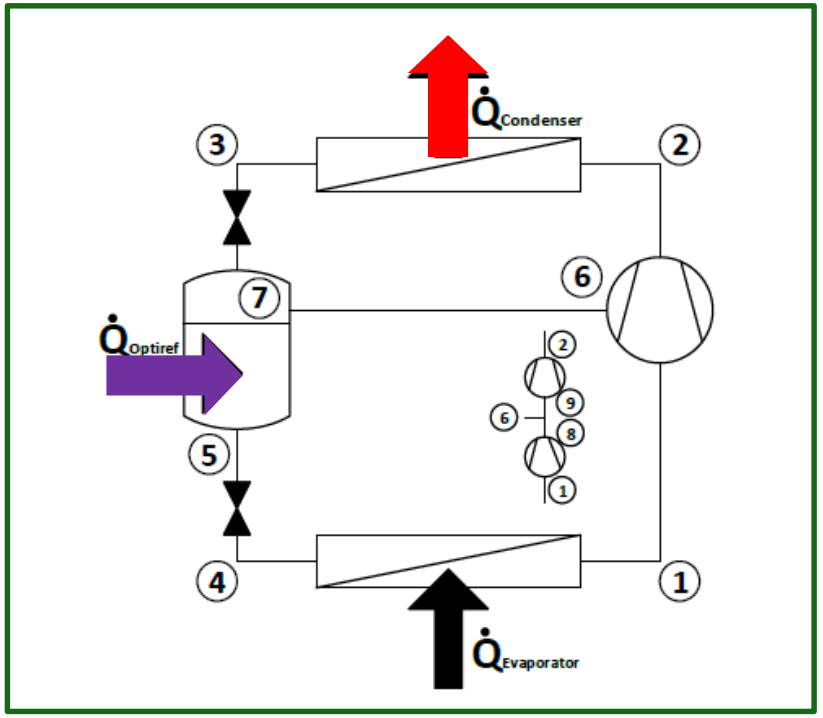
When **30%** of **required heat** (Q_{cond})

comes from **secondary source** ($Q_{optiref}$):

COP is ~ **40% higher**

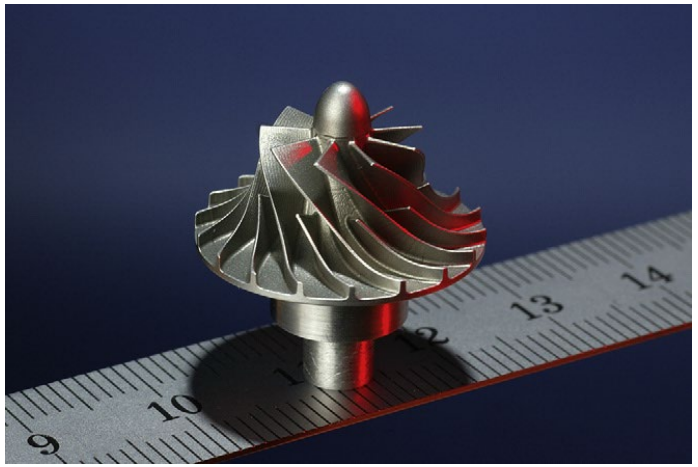
Benefit:





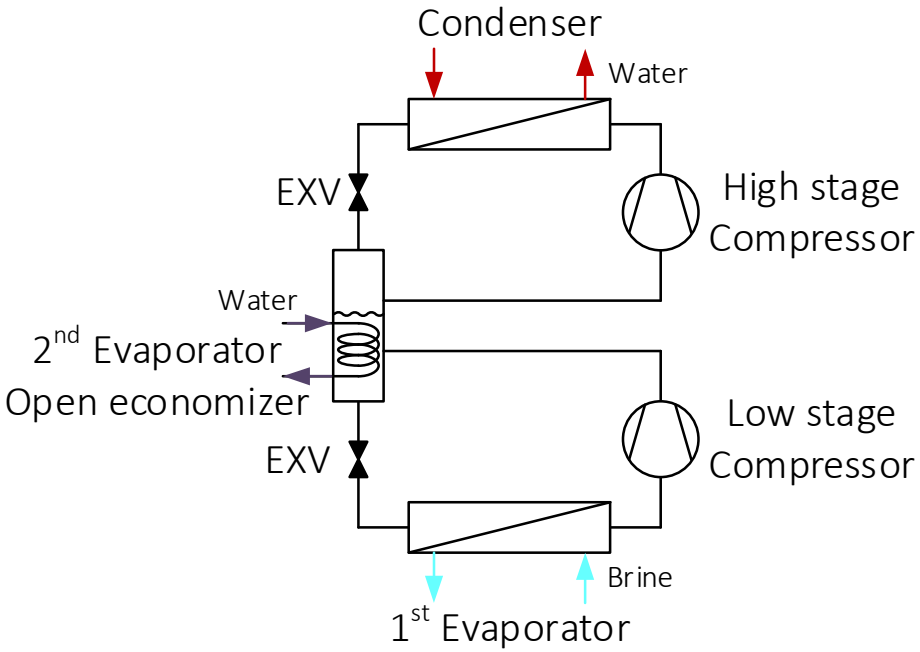
Figures: OptiRef refrigeration cycle and results, Uhlmann, M. et al.: Opti-Ref – Heat pump with two heat sources at different temperature levels, 6/2014.

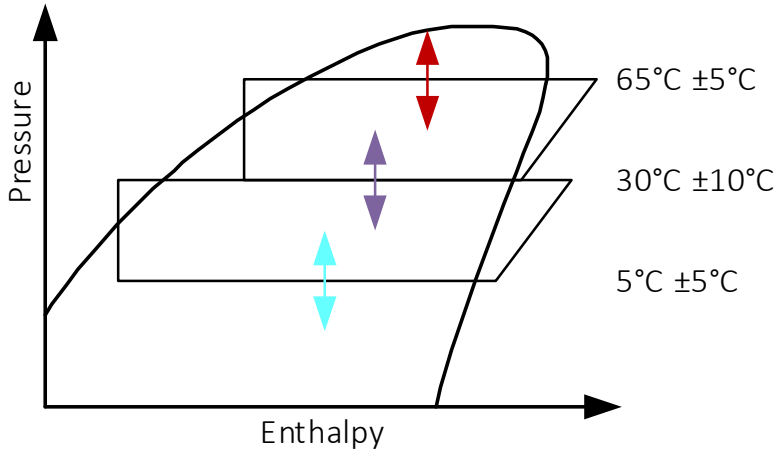
Advantage of turbocompressor in heat pumps:



- **Oil-free**
- Potential for higher **efficiency**
- Small scale oil-free turbocompressor driven heat pump has been demonstrated (Schiffmann, Favrat, 2009, International Journal of Refrigeration, 32(8), 1918-1928)

Project schematic:





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Project steps:

- **Simulation** tool for designing multi-temperature cycles (Matlab, EES)
- **System specifications** [Range (power, temperature)], number of compressors/expanders, delivery date, refrigerant, special considerations for miniature turbo compressors
- System design based on **turbocompressor**
- Building of a **test stand** to measure different multi-temperature heat pump cycles with the turbocompressor
- Build and test the **turbocompressors**
- Building a running **prototype** of the heat pump

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Thank you for your attention

I hope that you have learnt something today.

Any Question ?

NTB
Interstaatliche Hochschule
für Technik Buchs
FHO Fachhochschule Ostschweiz

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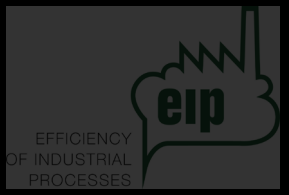
eip
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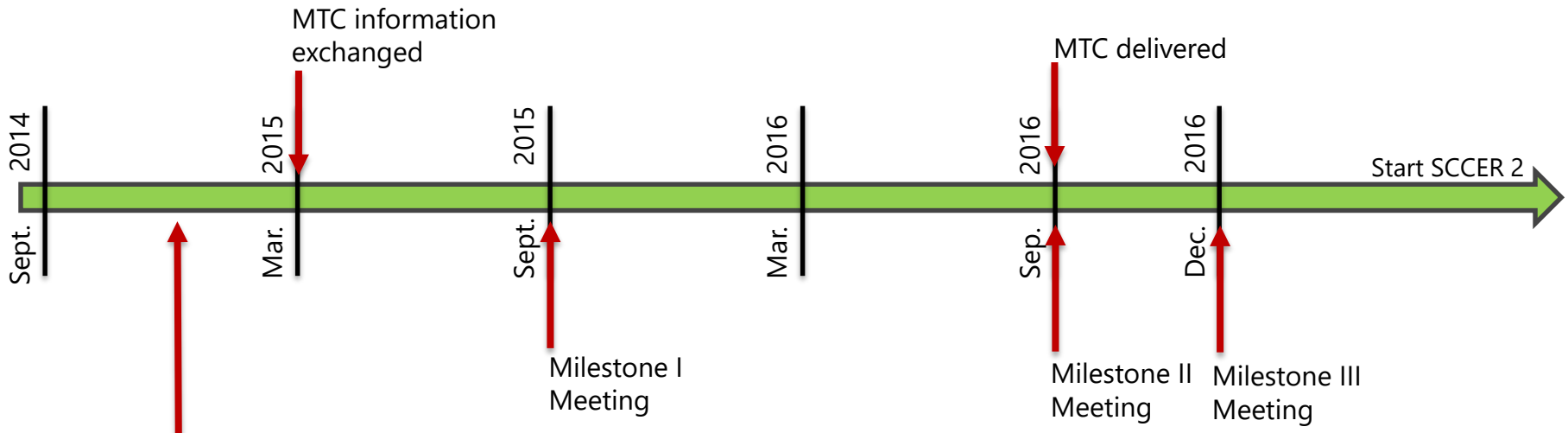
Time Schedule

Design MTC, EXP finished	Three Prototypes MTC built and tested	MTC optimized

MTC: miniature turbocompressor
EXP: Expander

EPFL



FHO-NTB

First Status Meeting,
Jan. 15, 2015, NTB
Fixed project definitions

System concept developed	Test stand/ procedure established	Prototype built and tested