

EUROPEAN HEAT PUMP SUMMIT

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CONGRESS + EXPO
NUREMBERG, 22–23.10.2019

Industrial | Commercial | Residential
Heating & Cooling | Components & Equipment

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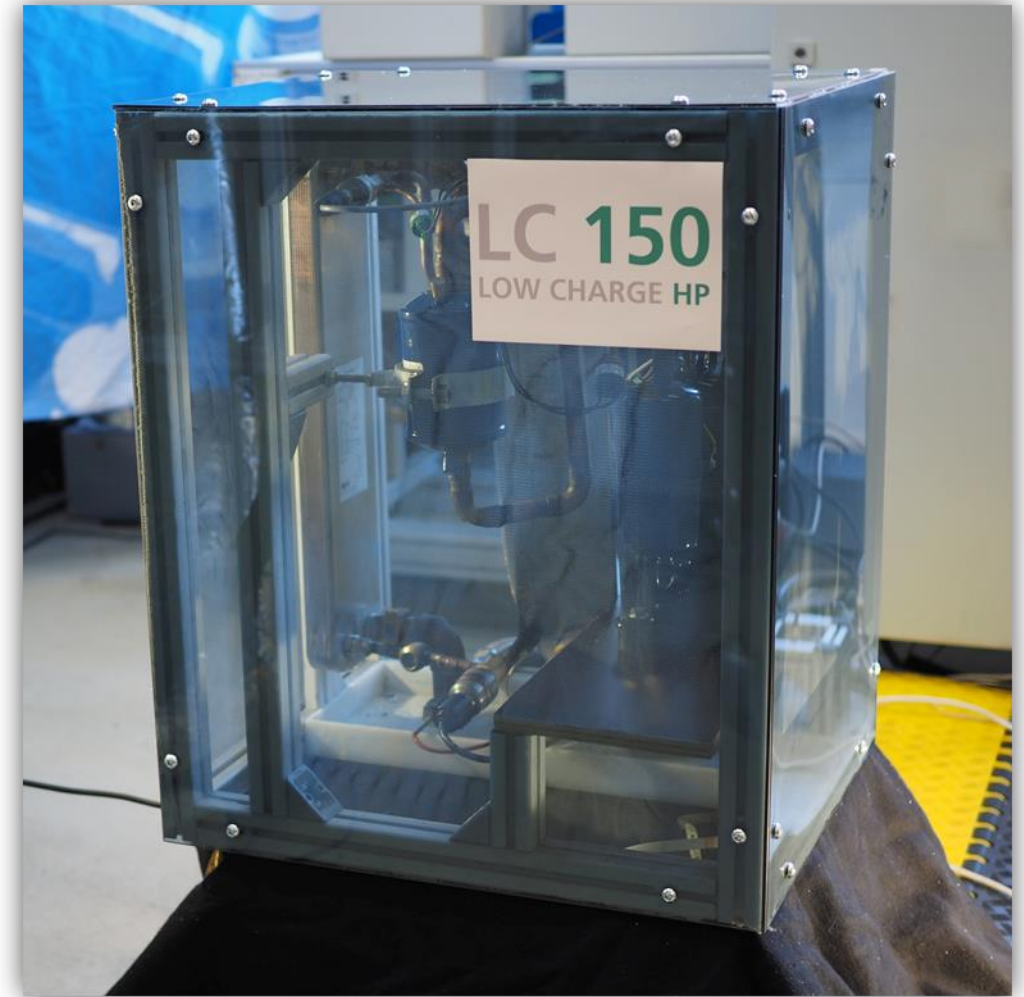
NÜRNBERG  MESSE

Low charge 150g heat pump with R-290 as refrigerant

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Heat Pump Summit 22.10.2019 – Nuremberg



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Fraunhofer Institute – Department Heating and Cooling Technologies

materials
development



components
development



systems analysis
and optimization



test and development
center for heat
transformation



field test
investigations



support of
the market



Low charge 150g heat pump with R-290 as refrigerant

Motivation

- Heat pumps are the central heating technology for a climate-friendly future
- New refrigerant solutions are needed due to F-Gas-Regulation
 - Supporting industry with sustainable, energy and cost efficient heat pumps concepts is our interest and motivation!

Low charge 150g heat pump with R-290 as refrigerant

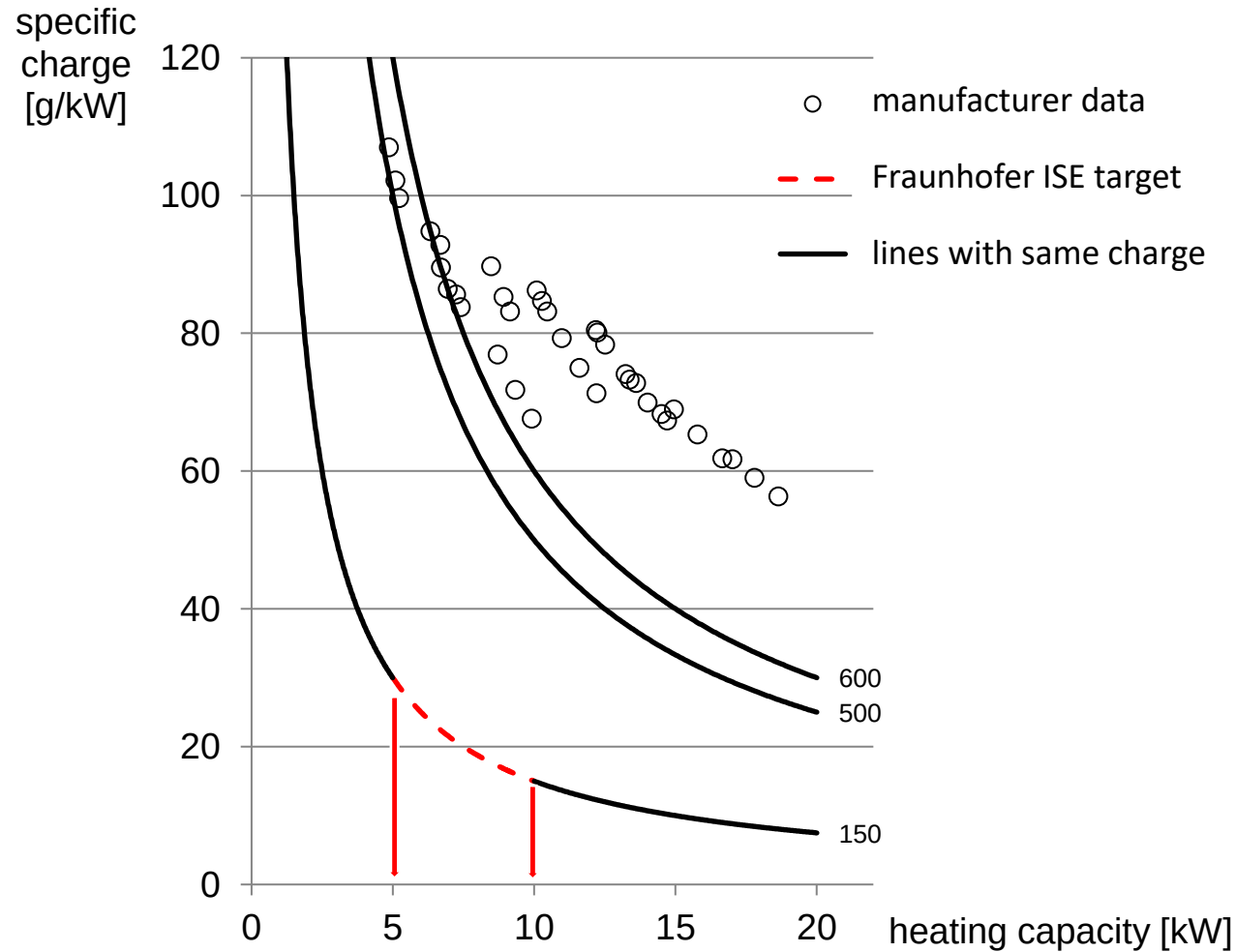
Targets

Targets for a low charge heat pump:

- Usage propane (R290) as refrigerant
- Not to use more than 150g of charge
- Providing a heating capacity between 5-10kW
- Use of market available components

Low charge 150g heat pump with R-290 as refrigerant

Targets

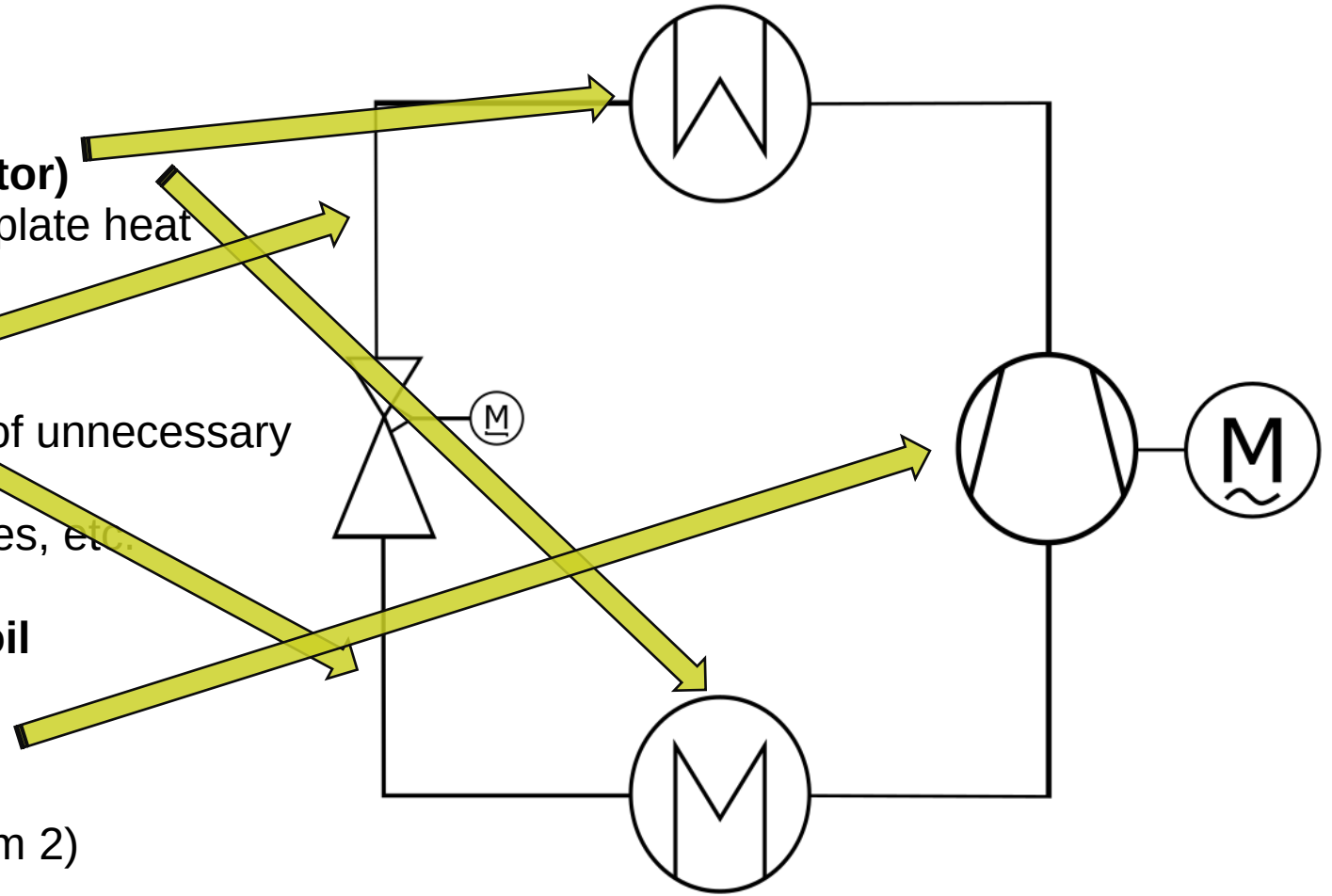


Low charge 150g heat pump with R-290 as refrigerant

Design - Concept

refrigerant intensive components

- **heat exchangers (condenser/ evaporator)**
 - reduced volume due to asymmetric plate heat exchangers
- **Diameter and length of piping**
 - Reduced volume due to avoidance of unnecessary volumes
 - Sensors, sight glasses, service valves, etc.
- **Refrigerant absorbed in compressor oil**
 - Reduction of quantity of oil
 - Two compressors tested:
 - Scroll compressor (→ system 1)
 - Twin rotary compressor (→ system 2)



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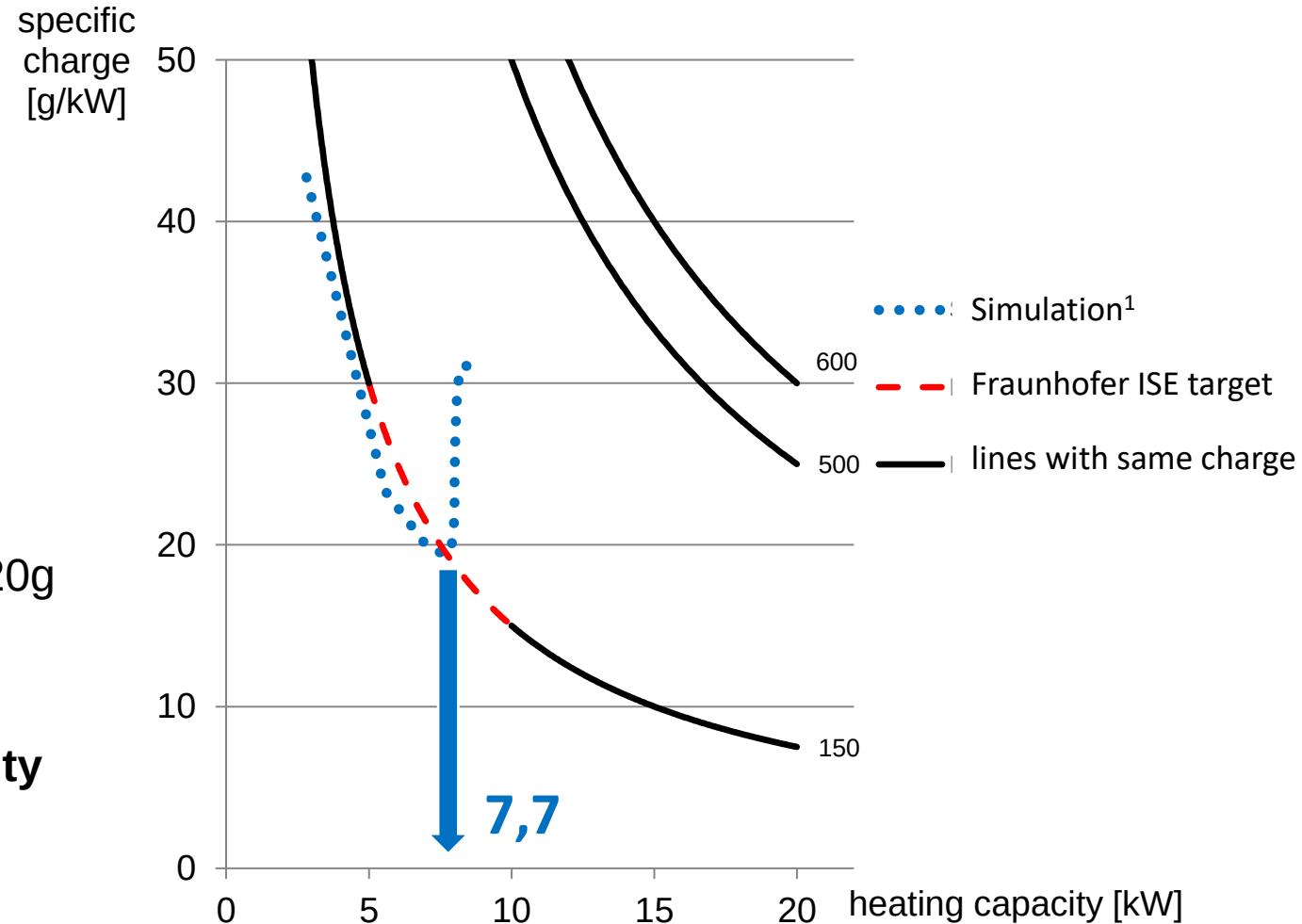
Design – Evaluation

- **Design study simulations** were made with the software IMST-ART
- **Evaluated aspects:**
 - temperature conditions
 - variation of compressor speed
 - Reduction of oil quantity
 - refrigerant mass variation between 120 to 220g

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Design – Evaluation

- **Design study simulations** were made with the software IMST-ART
- **Evaluated aspects:**
 - temperature conditions
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 - Reduction of oil quantity
 - refrigerant mass variation between 120 to 220g
- **Results for B0/W35 @120Hz, SH10K**
 - **Fixed design meets the addressed capacity range**

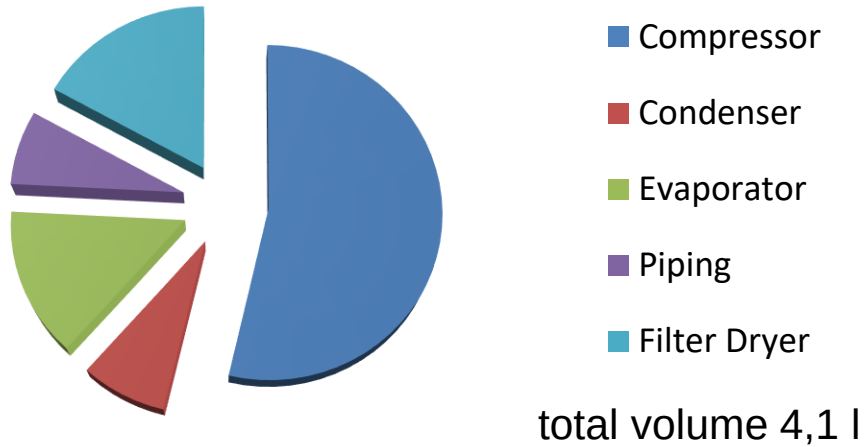


¹ B0/W35, 120Hz, SH10K

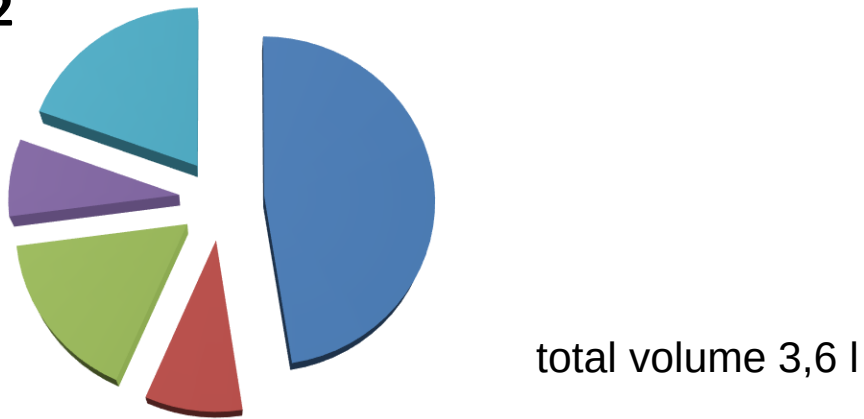
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Design

System 1



System 2



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Measurements and Results

Evaluated heat pump conditions:

	range	System 1	System 2
compressor speed	30 ... 120 Hz	✓	✓
refrigerant charge	120 ... 220 g	✓	✓
source temperature	-10 ... +10 °C	✓	
sink temperature	35 ... 65 °C	✓	
amount of oil in the system	50 ... 100 %	✓	✓
super heat	0 ... 10 K	✓	

- Results are mainly produced for system 1, comparison with system 2 for single aspects.

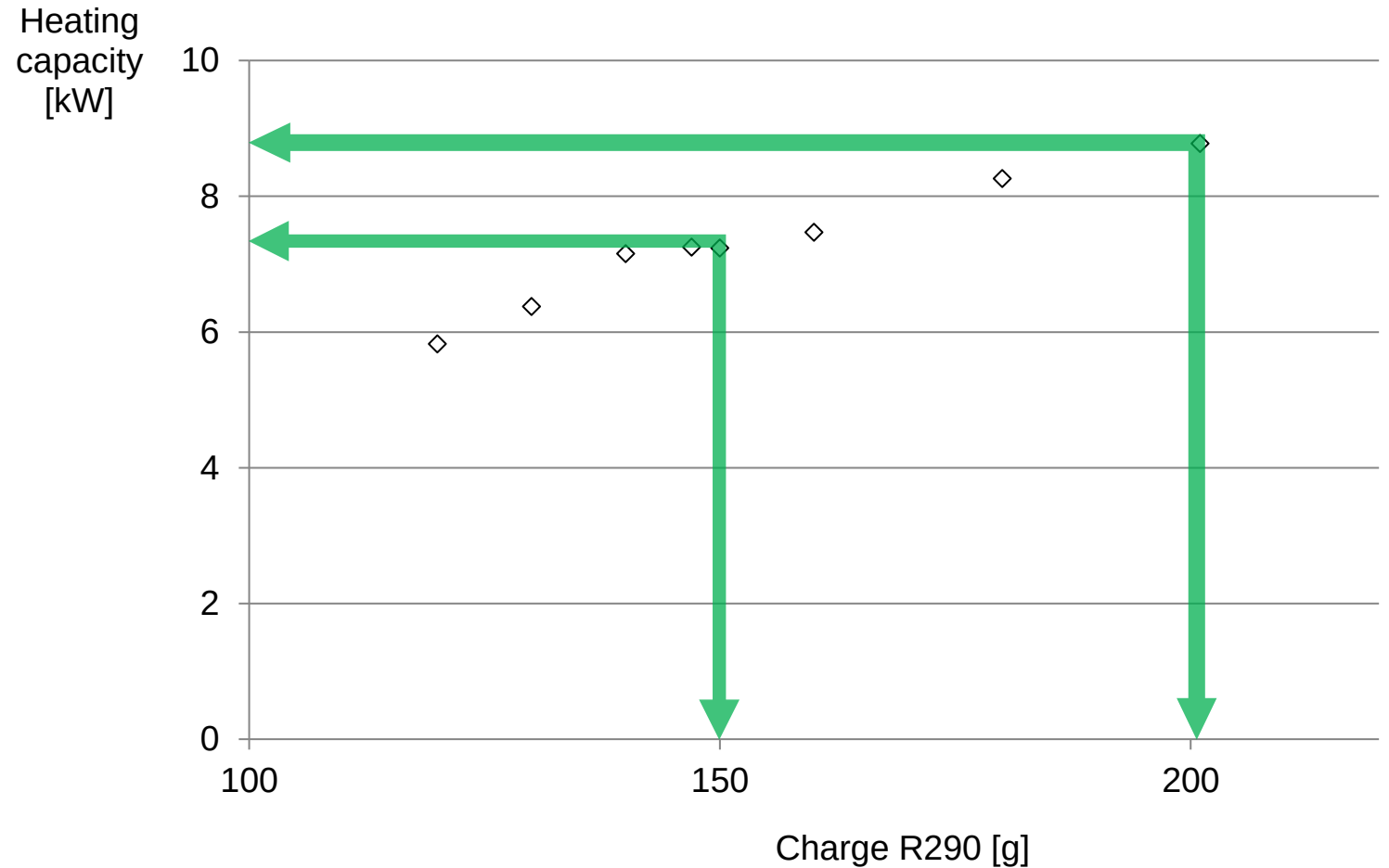
Low charge 150g heat pump with R-290 as refrigerant

Measurements and Results – System 1

■ Results for B0/W35 @120Hz, SH10K

■ Achievements

- **7,3 kW @ 150g R290**
- 8,8 kW @ 200g R290



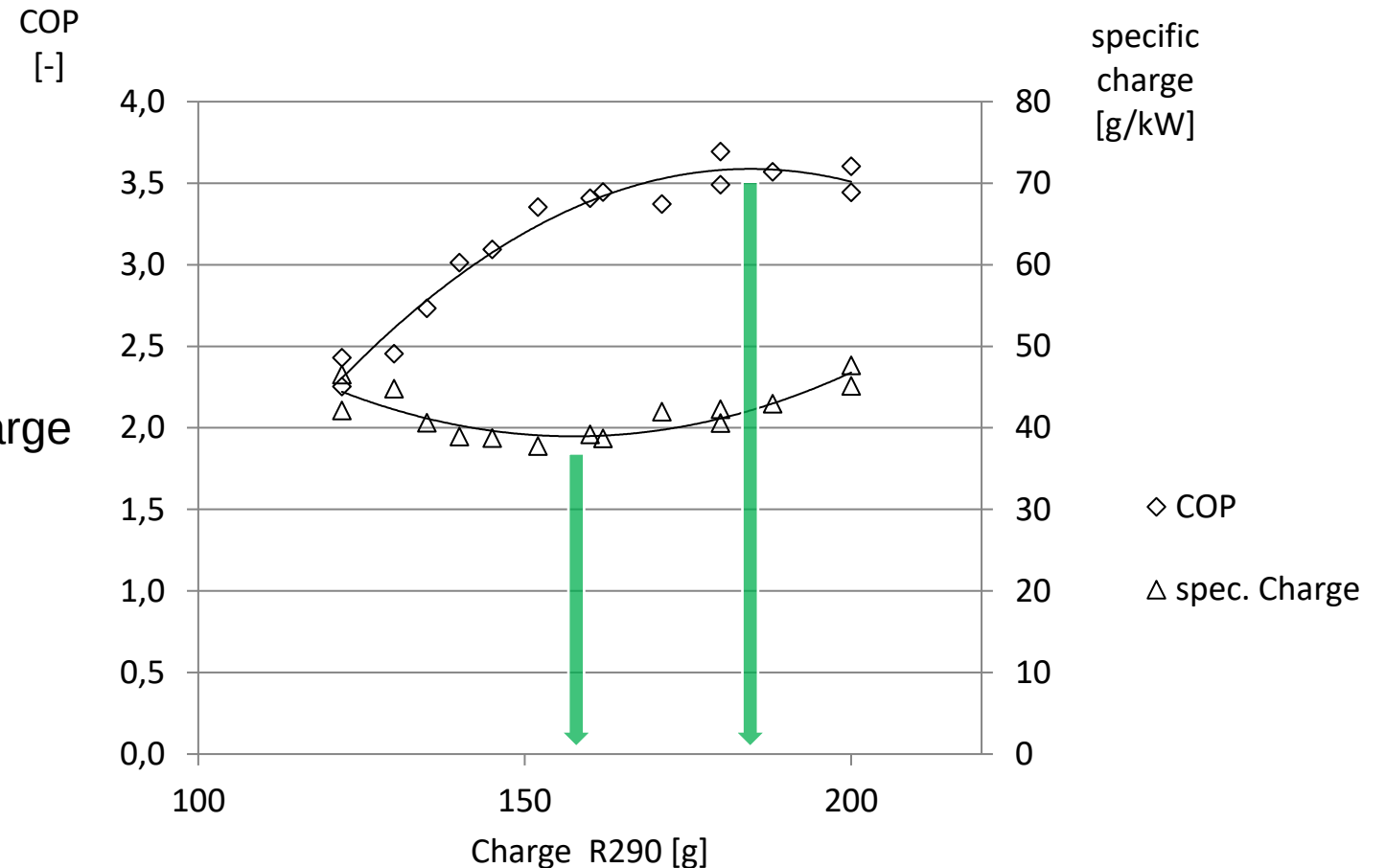
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Measurements and Results – System 1

■ Results for B0/W35 @60Hz, SH10K

■ Trade off between highest COPs and lowest specific charge

- lowest specific charge is at 160g charge
- highest COP is at 180g charge
- COP System 1 ➔ ~3,7¹
- COP System 2 ➔ ~3,9 (220g)¹



¹ Preliminary COPs (non optimized system, no insulation, ...)

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Analysis of performance

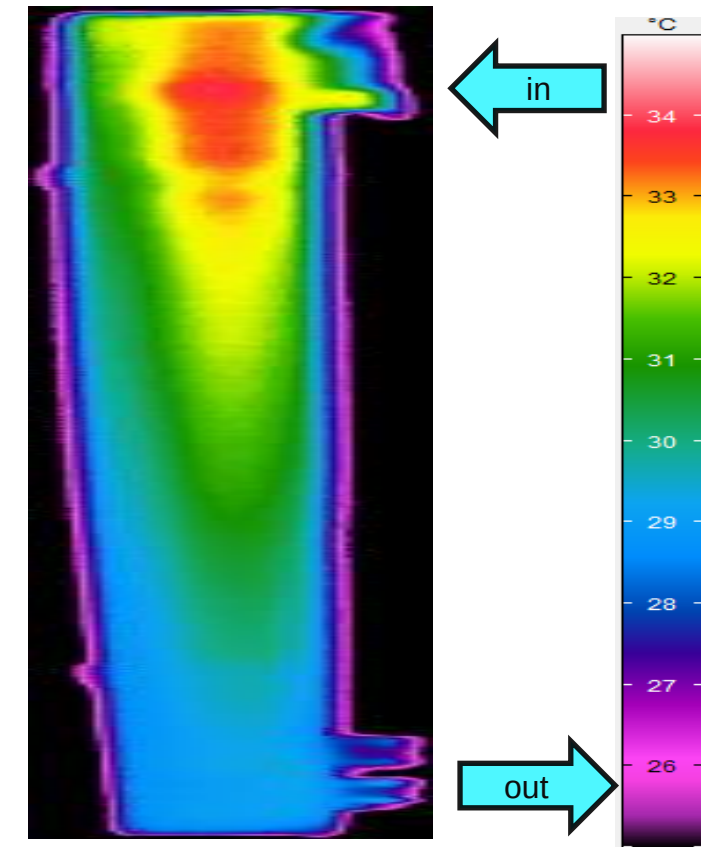
■ Pictures of ice profiles of evaporator

- → maldistribution → higher dTs → lower COPs



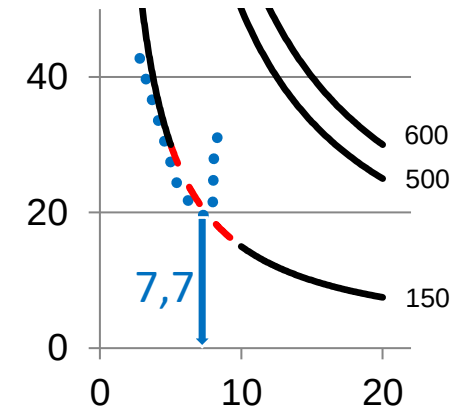
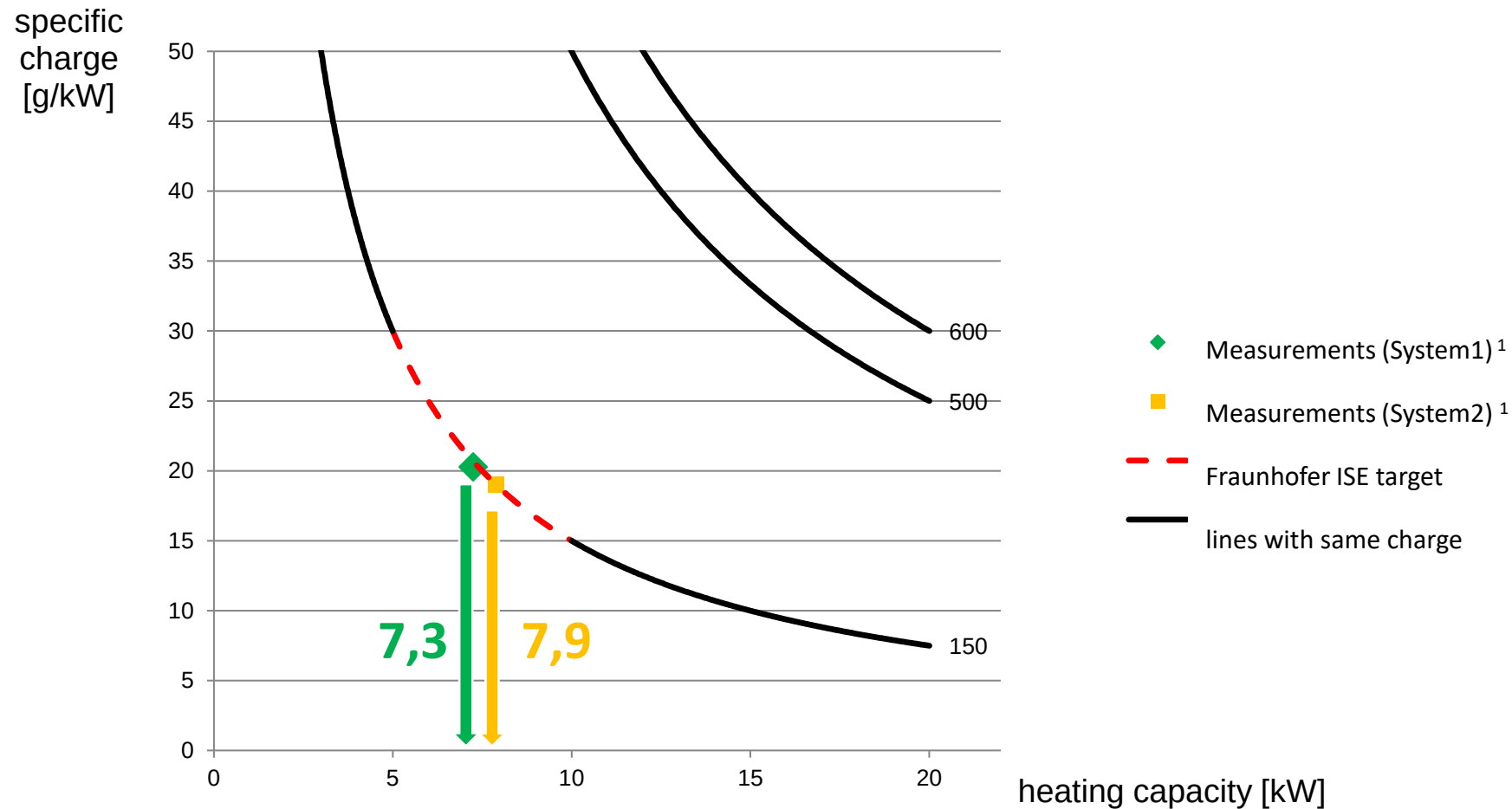
■ Thermography pictures of condenser

- → maldistribution → higher dTs → lower COPs



Low charge 150g heat pump with R-290 as refrigerant

Summary and Wrap Up



¹ B0/W35, 120Hz, SH10K

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Summary and Wrap Up

- With the **Low Charge** heat pump with **150g** propane a heating capacity of **~8kW** were achieved.
- COP needs to be improved
 - More equalized flow distribution in HEX, insulation of HEX, ...
 - Options are in discussion with experts and plate HEX manufactures.

Low charge 150g heat pump with R-290 as refrigerant

Outlook and Vision

Heat pump systems with 5-10kW using propane with 150g are feasible.

Many technical ideas to improve the system further on: addressing maldistribution, using new concepts of manufacturing, using different heat sources, etc.

■ **But how to support best the German and European heat pump manufacturer?**

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LC150 - refrigeration module platform

- Concentrating development knowledge
- Lowering manufacturing costs by mass production
- **Strengthen of the European Heat Pump industry**

Thank you for your kind attention.

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