Development of a Dry Low Frequency Linear Compressor for GM and Pulse Tube Cold Heads

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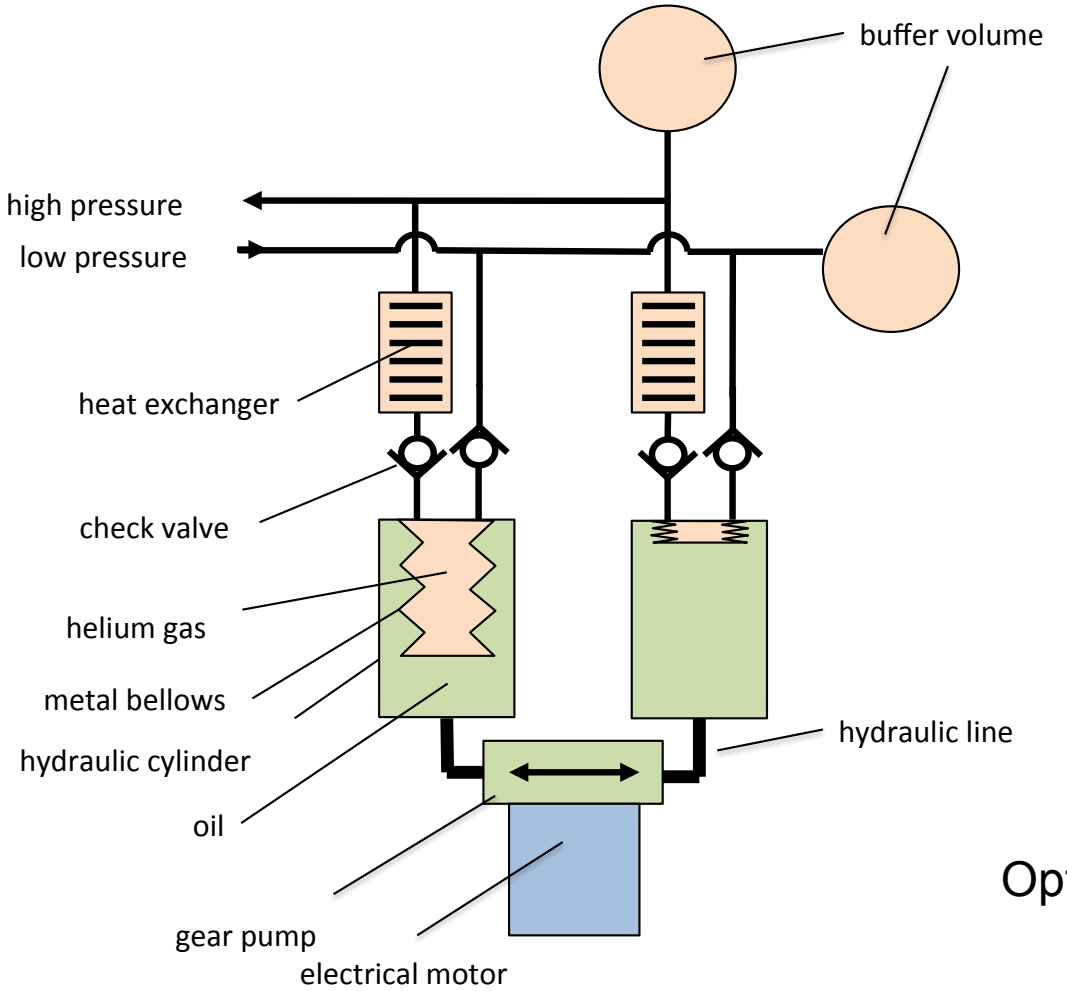
Outline

- Introduction
- Compressor
  - Set-up
  - Performance for constant flow (no cooler)
  - Performance with SRDK-101
- Reliability considerations
- Conclusions & outlook

Introduction

- Pressure Wave Systems GmbH is working on Stirling-type linear compressors for GM and pulse tube cryocoolers
  - Elimination of losses caused by the rotary valve
- This presentation is on a spin-off development of dry linear compressor
  - Substitute for any conventional scroll compressor

Metal bellows compressor

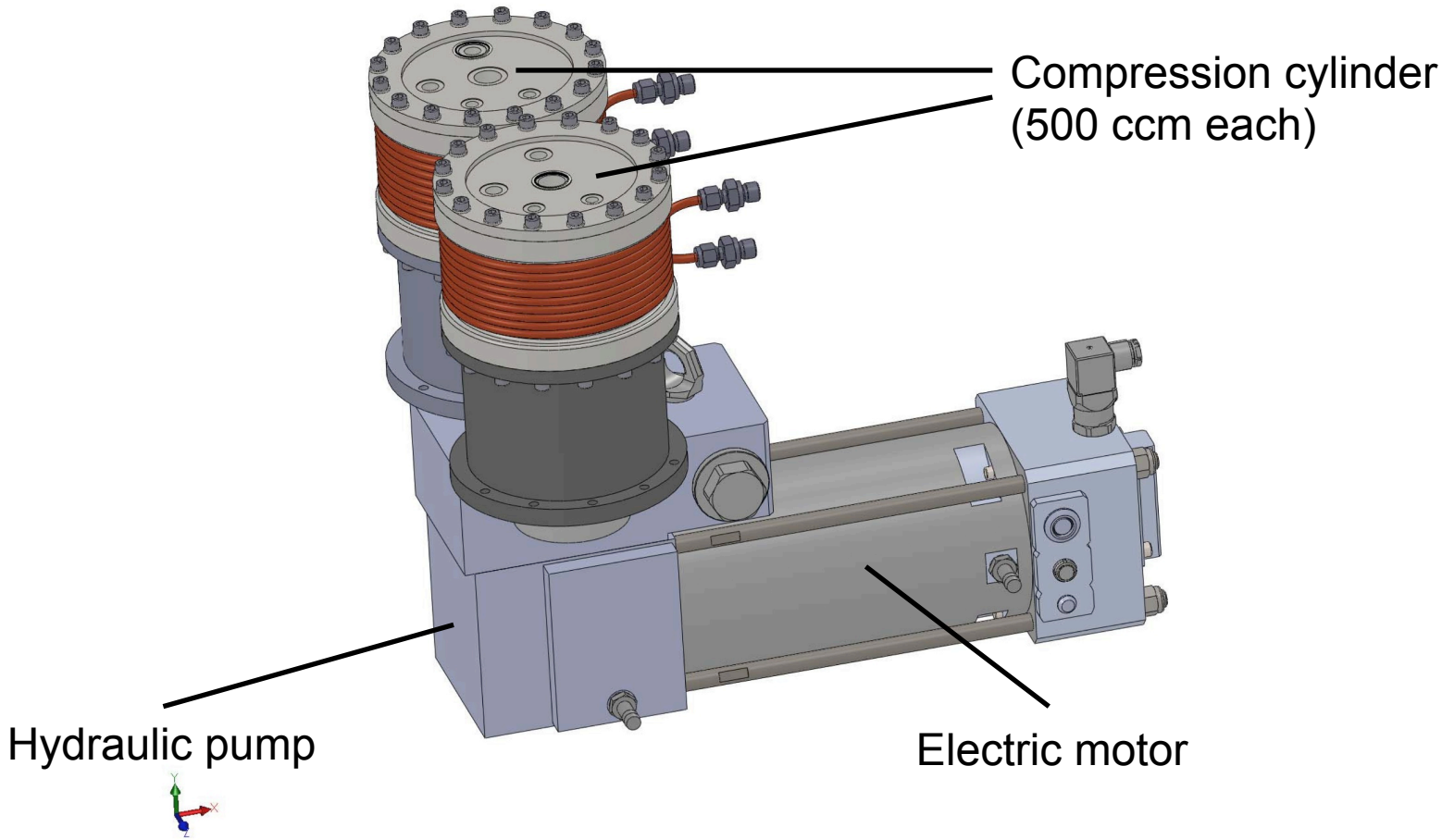


Features:

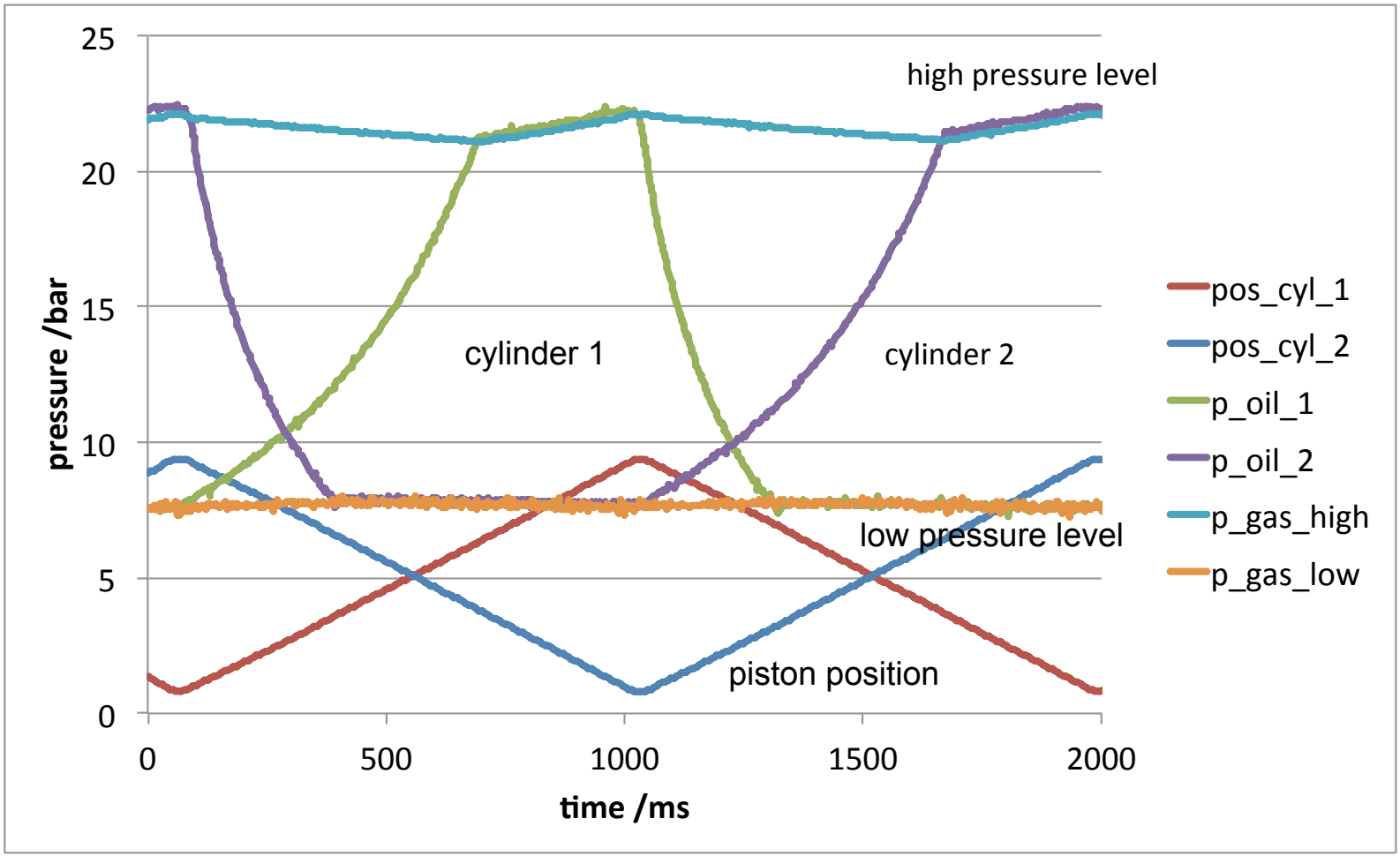
- dry
- low vibration
- variable speed
- orientation independent

Optimal frequency: 0.5 – 2 Hz

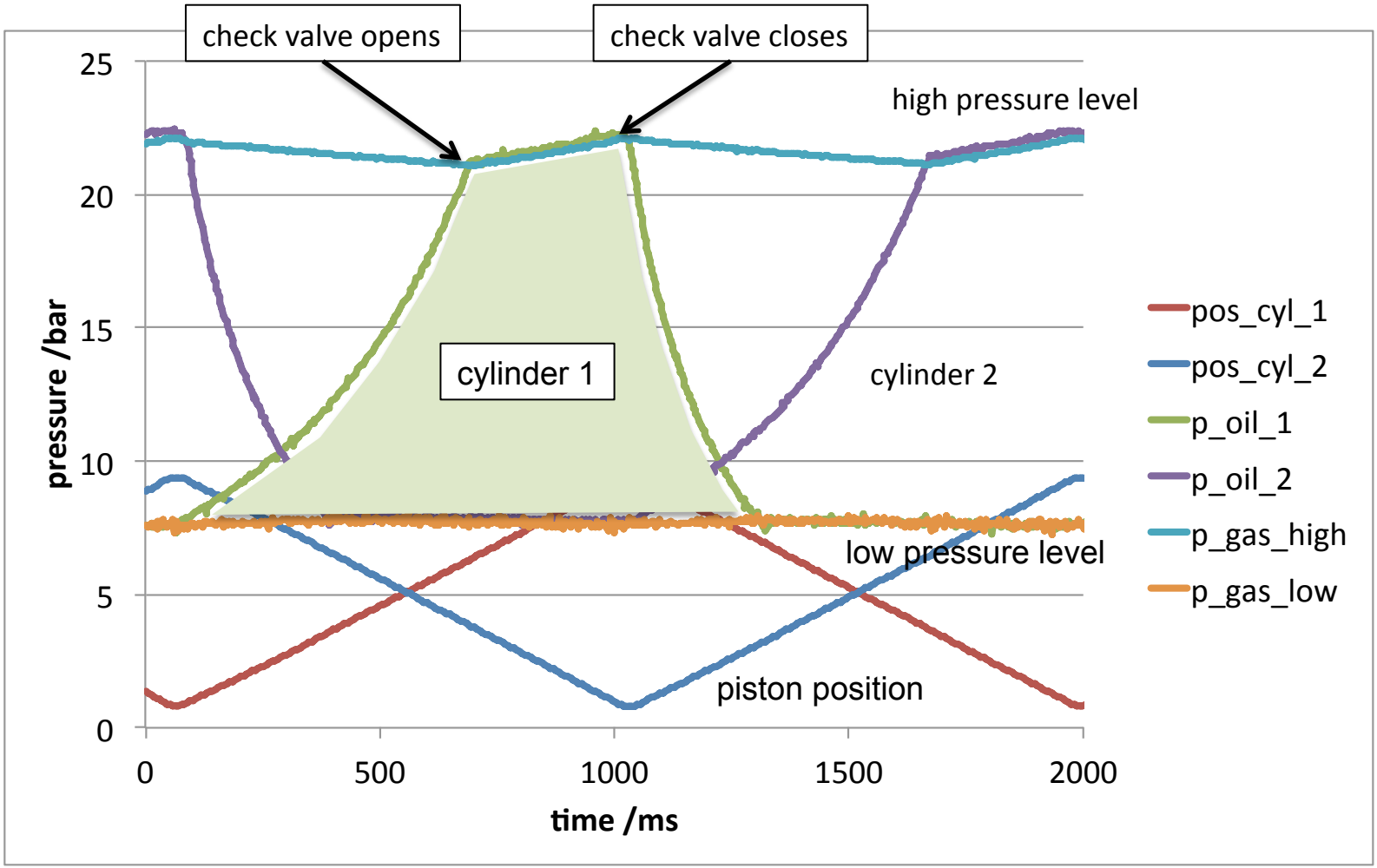
Prototype compression unit



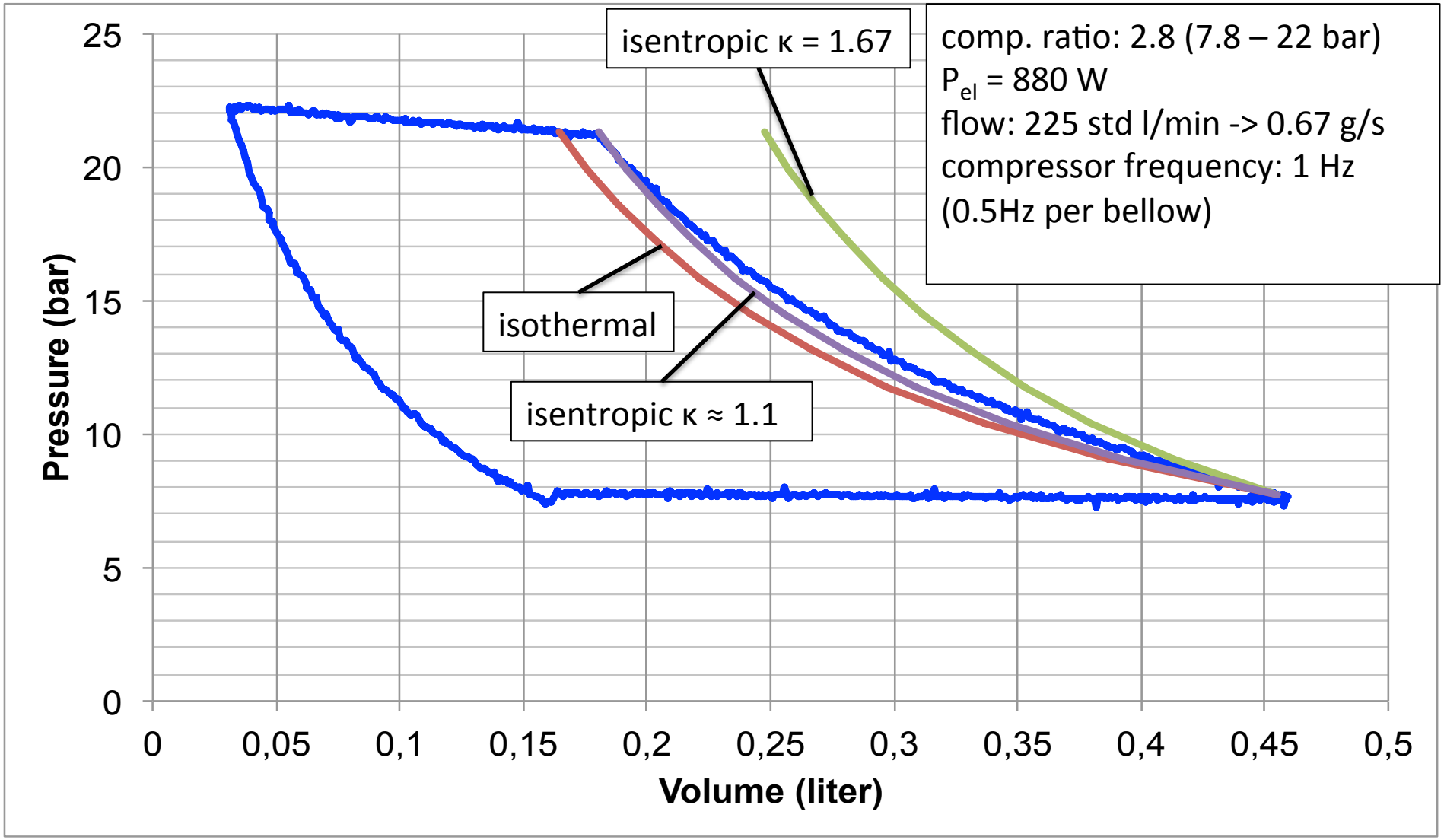
Constant flow (I)



Constant flow (II)

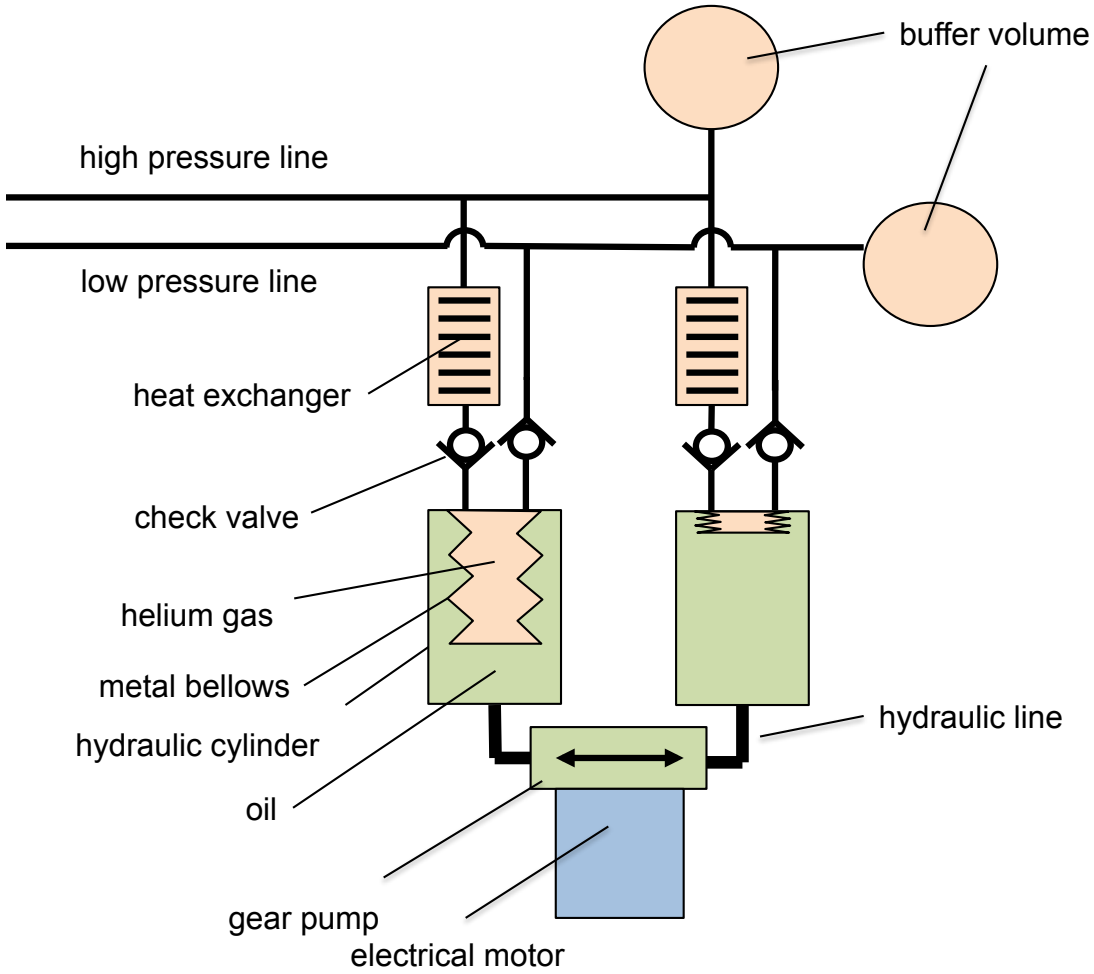


pV-diagram (compressor only)

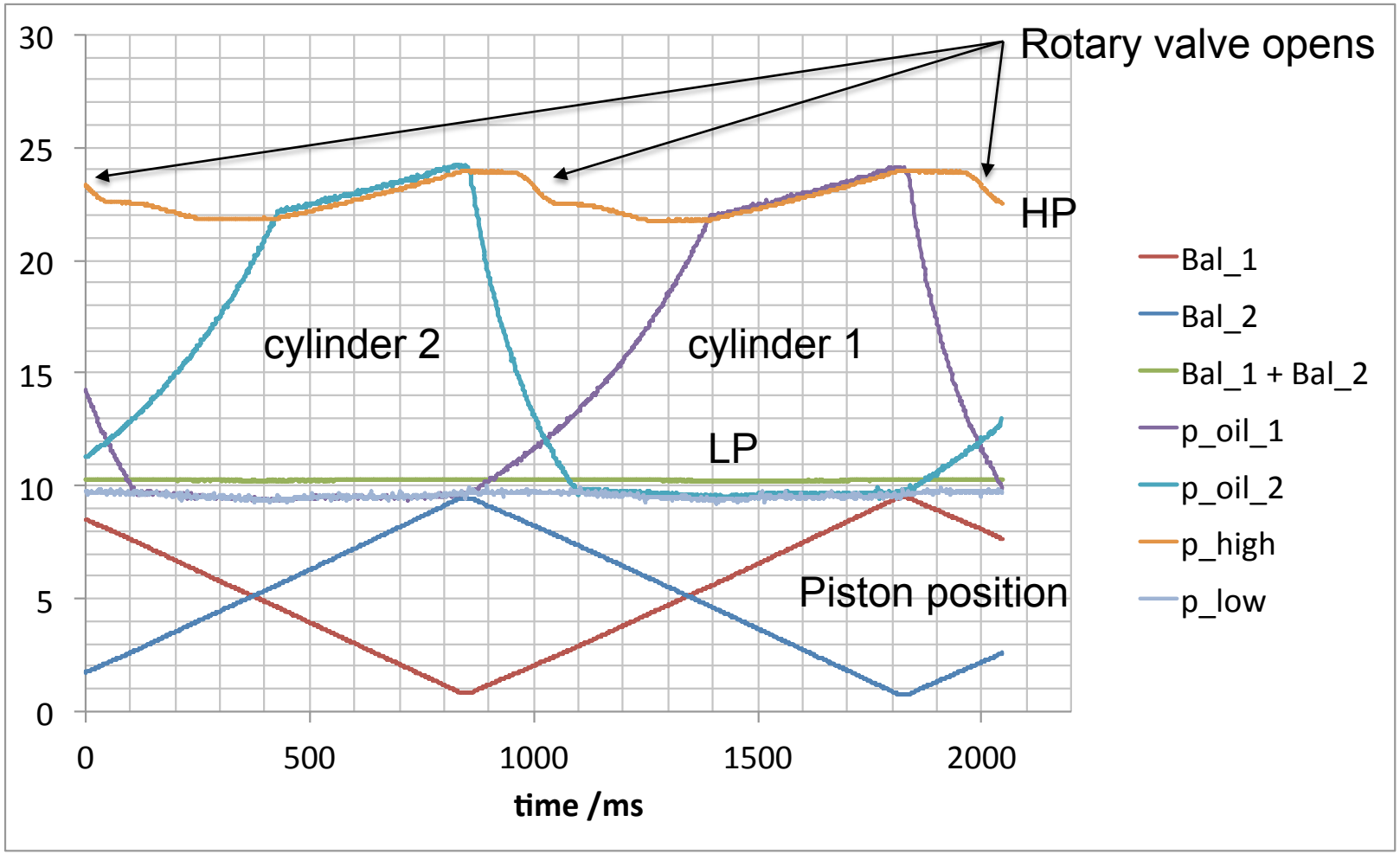


Test with SRDK-101

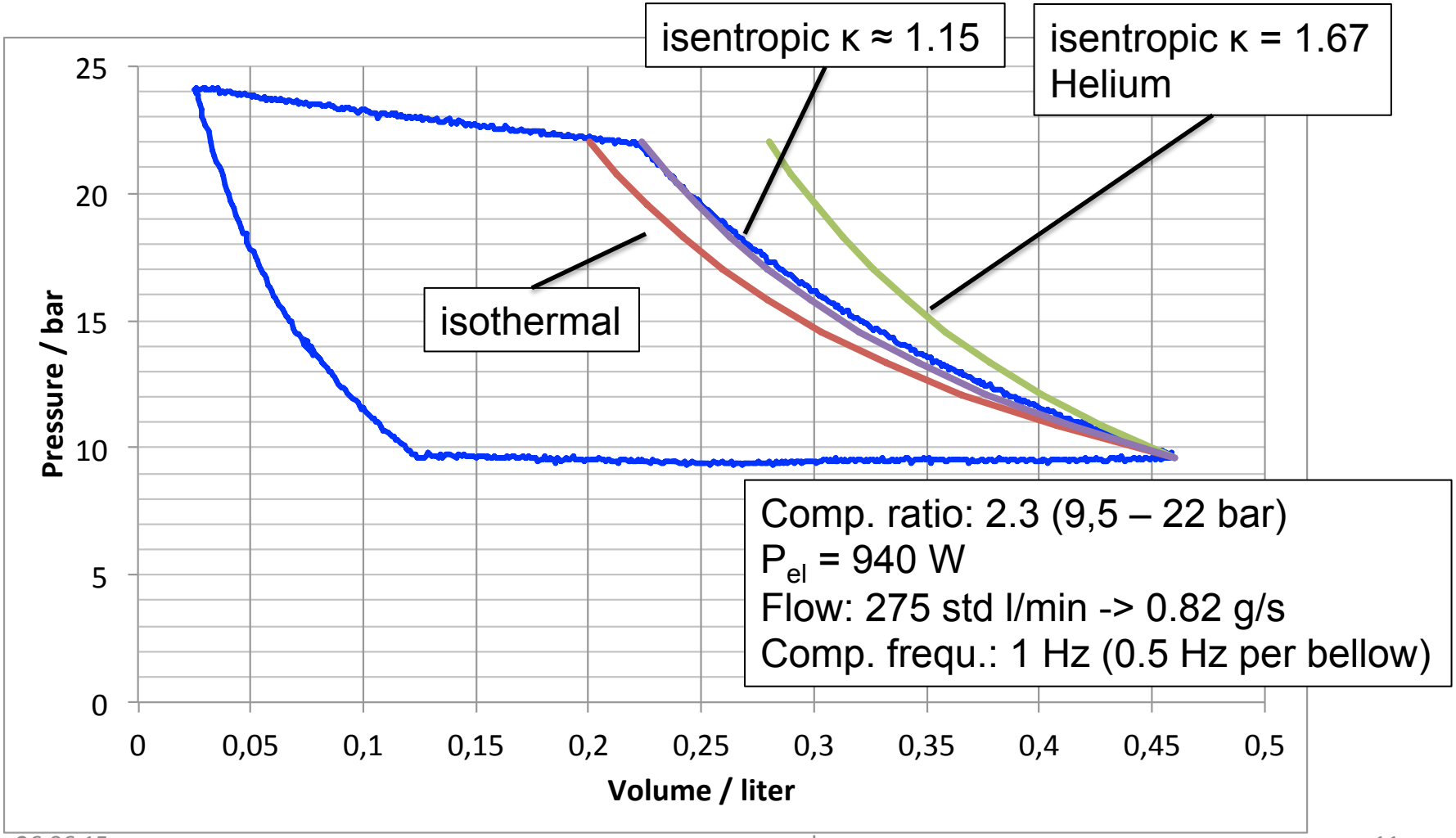
original cold head
(no modifications)



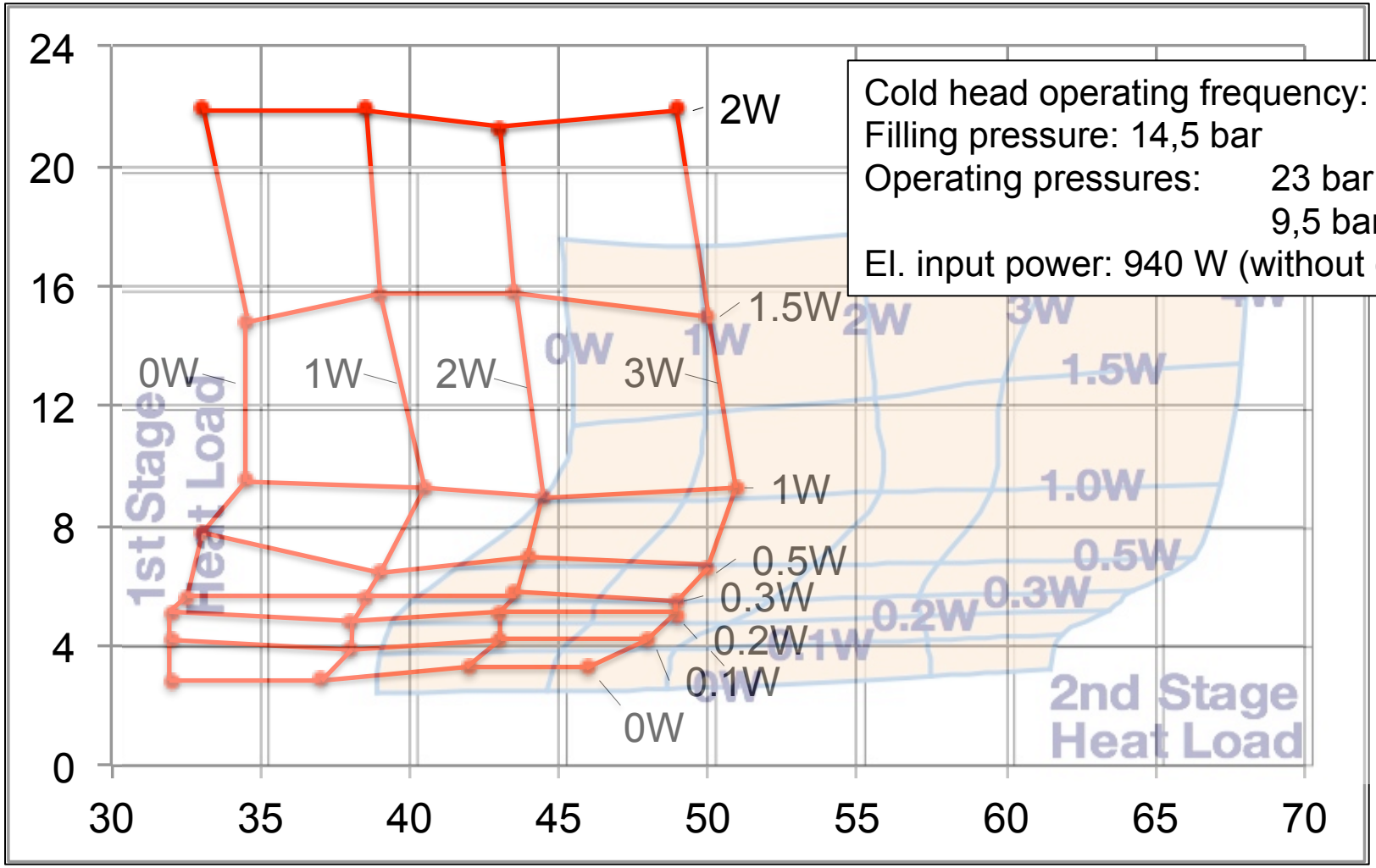
Pressure curves (with cooler)



pV – diagram with cooler



Prelim. heat load map with SRDK-101



Cold head operating frequency: 1Hz
Filling pressure: 14,5 bar
Operating pressures: 23 bar (HP)
9,5 bar (LP)
El. input power: 940 W (without cooling)

Results

- Dry linear bellows compressor
  - Delivers 225l @ 7.8 – 22 bar with 880W input power without cooler
  - Drives SRDK-101D / comparable cooling power

Reliability

- at 0.5Hz operation -> 80 Mio cycles = 5 years
- assessment ongoing
  - so far: 3.8 Mio cycles per bellow
    - guaranteed for proto: 10 Mio
    - 100 Mio cycles is possible with small modifications
  - 2.5 months of continuous running
    - About 1.5 months with SRDK-101 > absolutely stable operation
    - 0.5 Hz operation – pump is running at very low speed
  - Check valves
    - Standard valves eventually failed
    - Own development tested up to 40 Mio cycles

Conclusions and outlook

- Dry linear bellows compressor performs excellent with GM cold head
  - Should work with PT cold head as well
  - Reliability assessment ongoing
- Compressor concept is scalable
  - Larger volume bellows + larger motor > higher capacity
- Attractive alternative solution to a scroll compressor

END