

**Open loop pumps.
Noise optimization with SPU
silencer.**

Linde Hydraulics

Linde

LHY Hydraulics

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Hydraulic noise

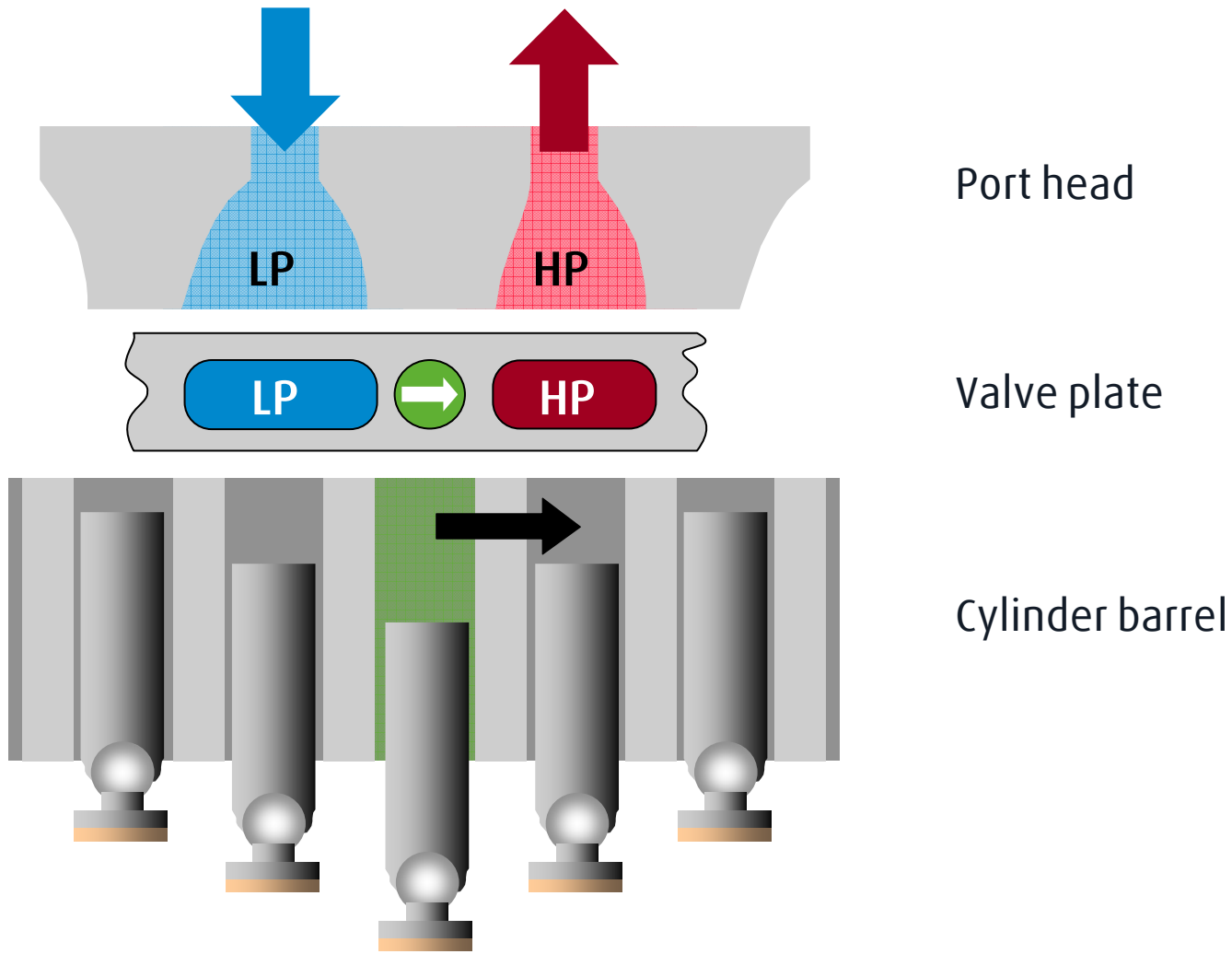
Linde Hydraulics

The Linde logo is located in the top right corner of the slide. It features the word "Linde" in a white, cursive script font, positioned over a dark red background. To the left of the word "Linde" are three white, curved lines that resemble ripples or sound waves, extending from the left edge of the red box towards the text.

Linde

- > Hydraulic systems generate noise
- > Noise bothers operators and pollutes the environment
- > Noise regulations require “silent” systems
- > Who is responsible for the noise?
- > How to make a system quiet?

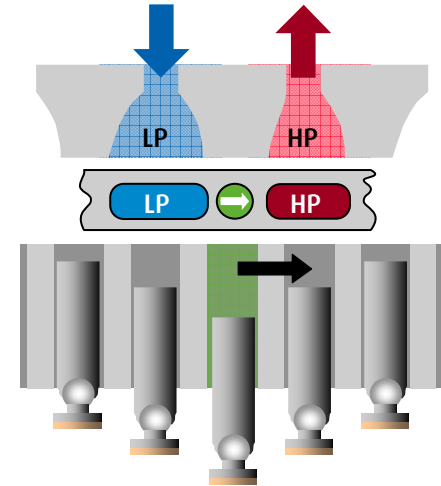
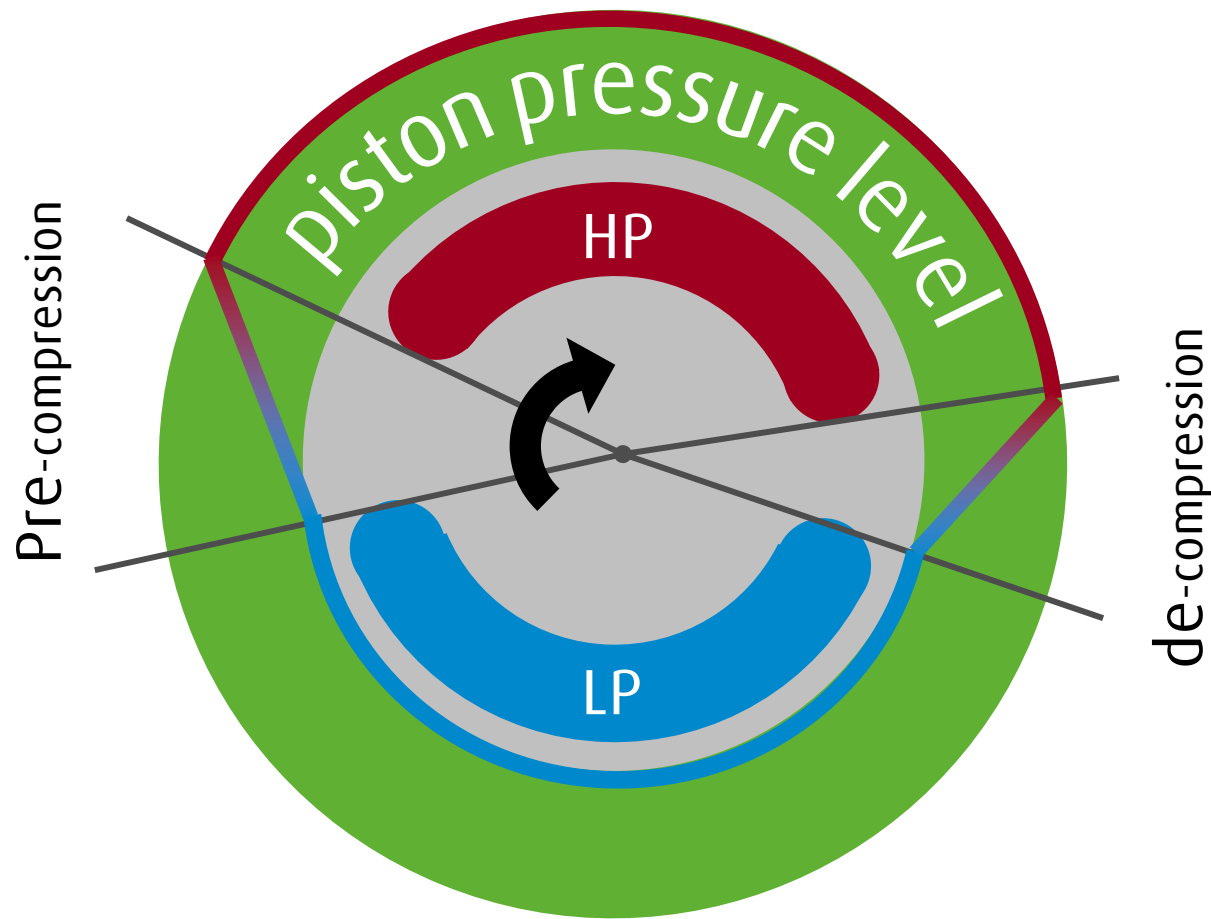
Projected cross-section of a rotating kit



Principle of pump commutation

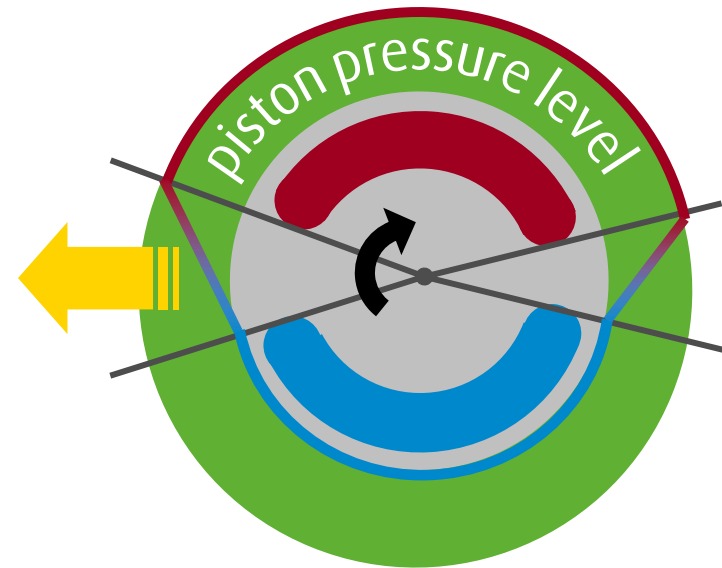
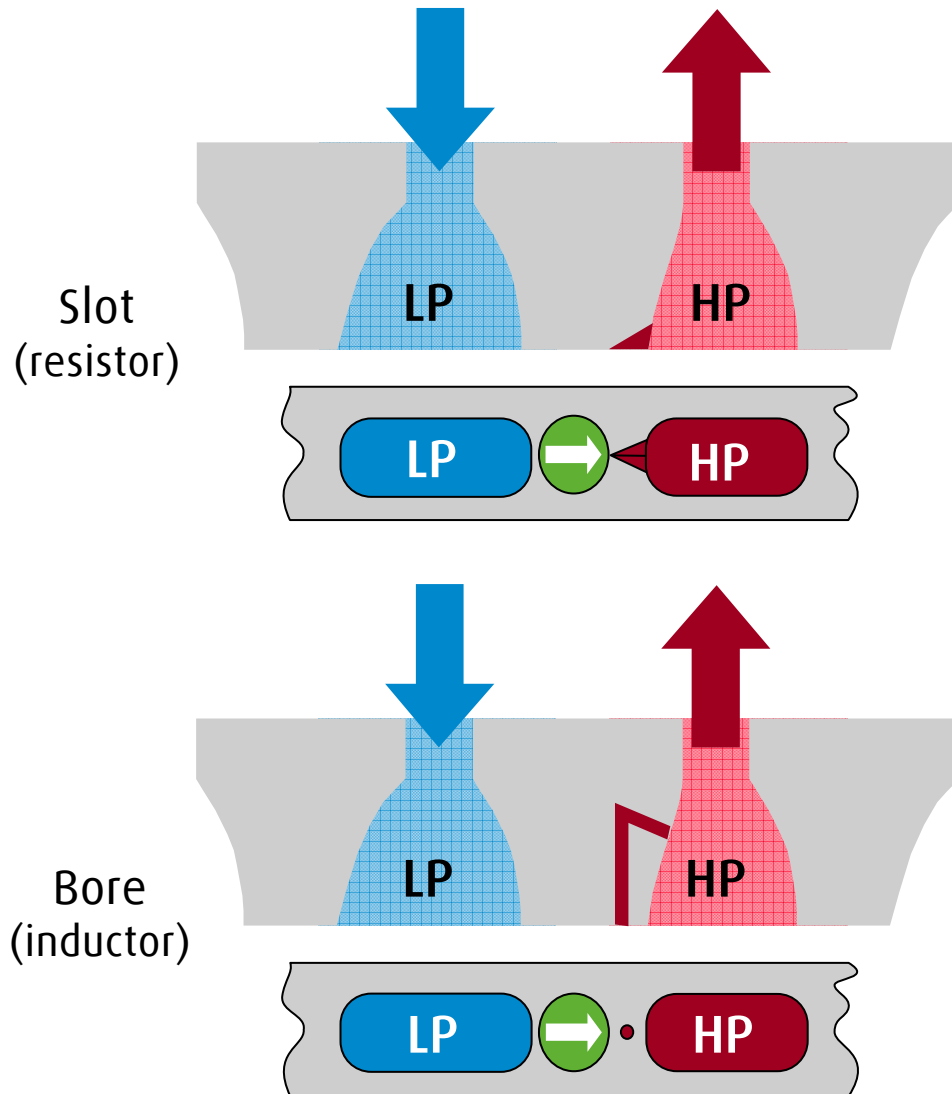
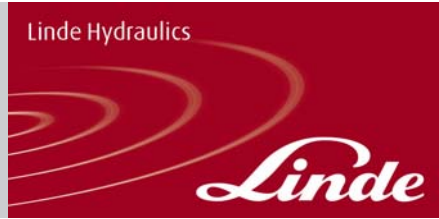
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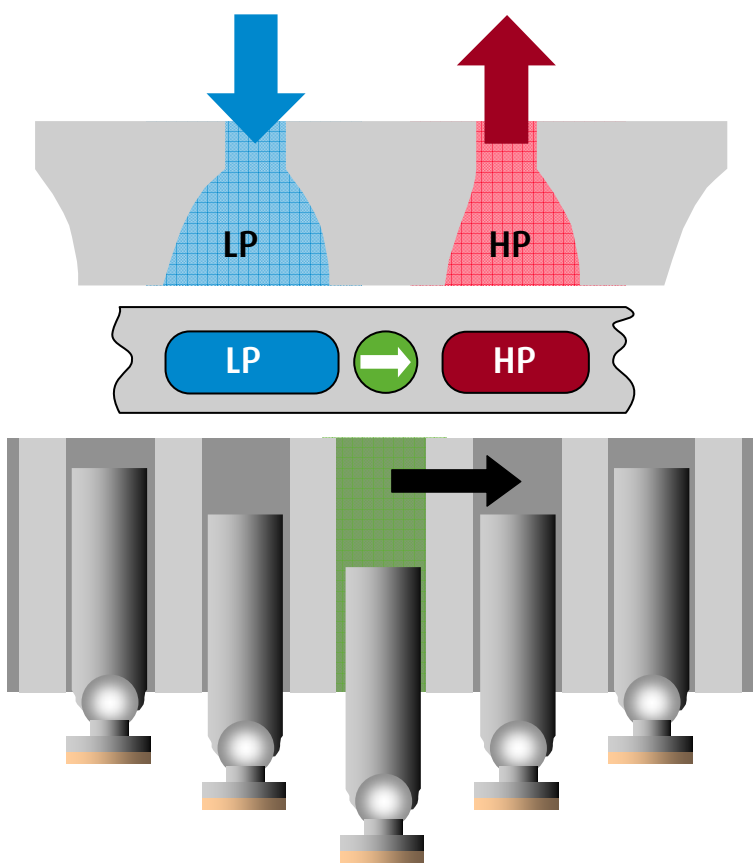
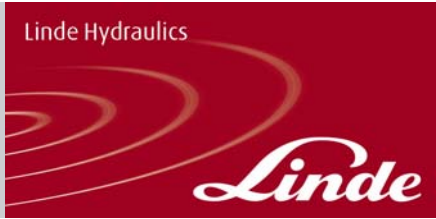


Animation

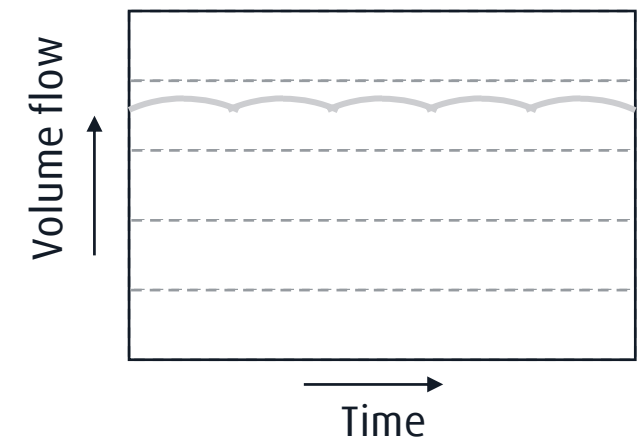
Conventional commutation methods



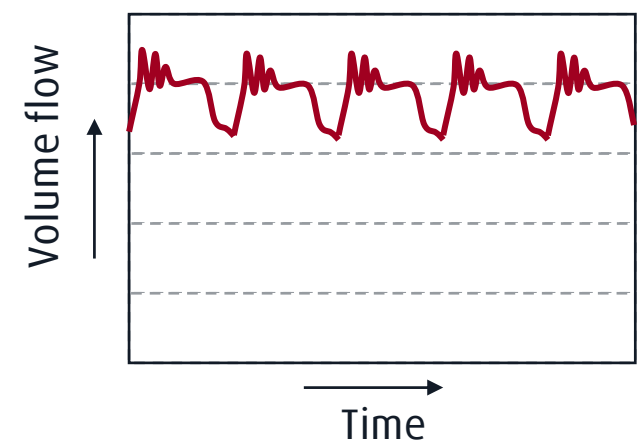
Pump commutation – ideal vs. real



Pump & fluid (ideal)



Pump & fluid (real)



The noise generation chain

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Flow ripple



Pressure ripple



Fluid borne noise



System excitation

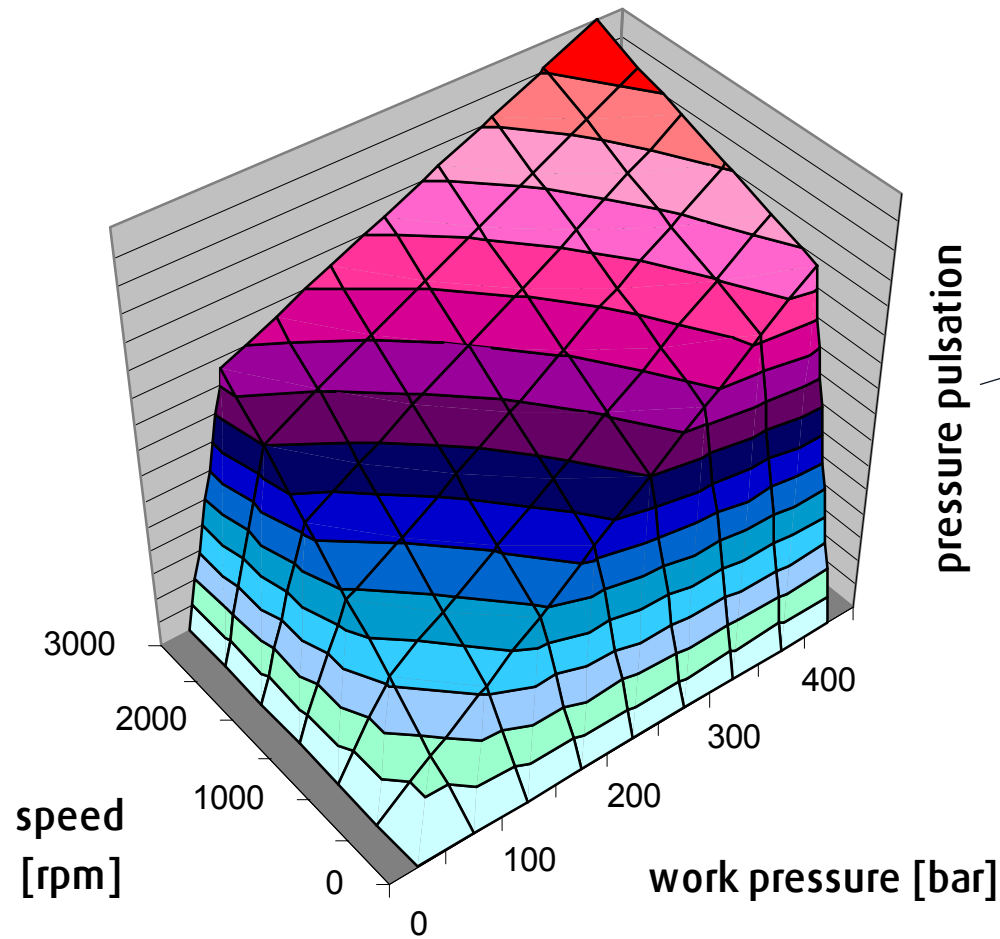


Structure borne noise



Noise radiation

Standard commutation - influence of speed and work pressure



pressure pulsation

Actual pulsation level depends on pump and system properties

Conventional commutation design

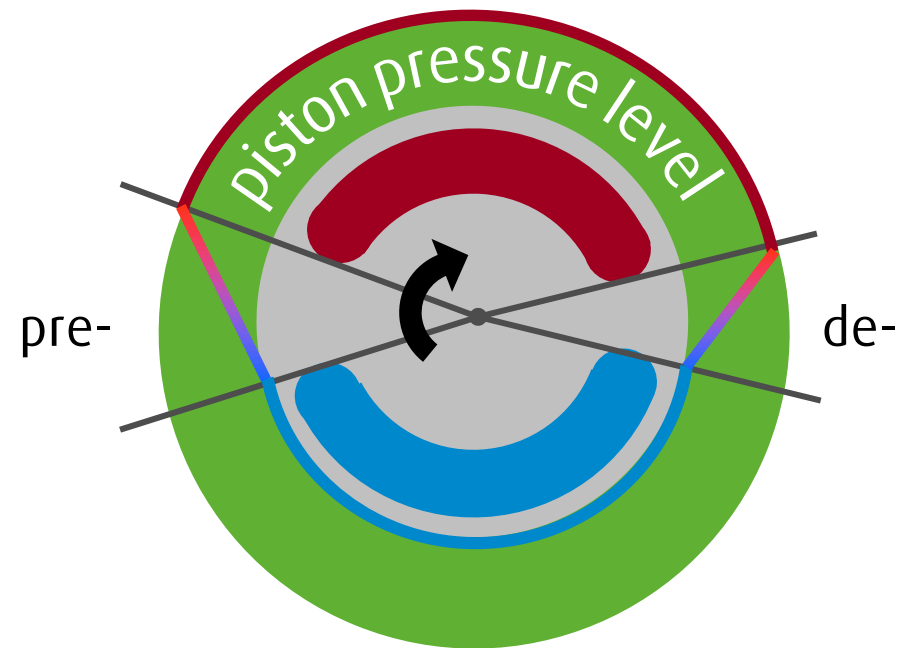
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Match pre- and de-compression
to typical operation point:

- > Pump rpm
- > High pressure level

To optimize noise behavior
under normal working conditions



Optimizing conventional commutation

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Example: HPR 160 – 01

- > Series valve plate (excavator applications):
Designed for rated speed & rated pressure

Application:

Forestry machines

Application properties:

Medium pressure, low speed engine operation

New design point:

250 bar, 1.400 - 1.600 rpm

Application optimized valve plate

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HPR 160-01

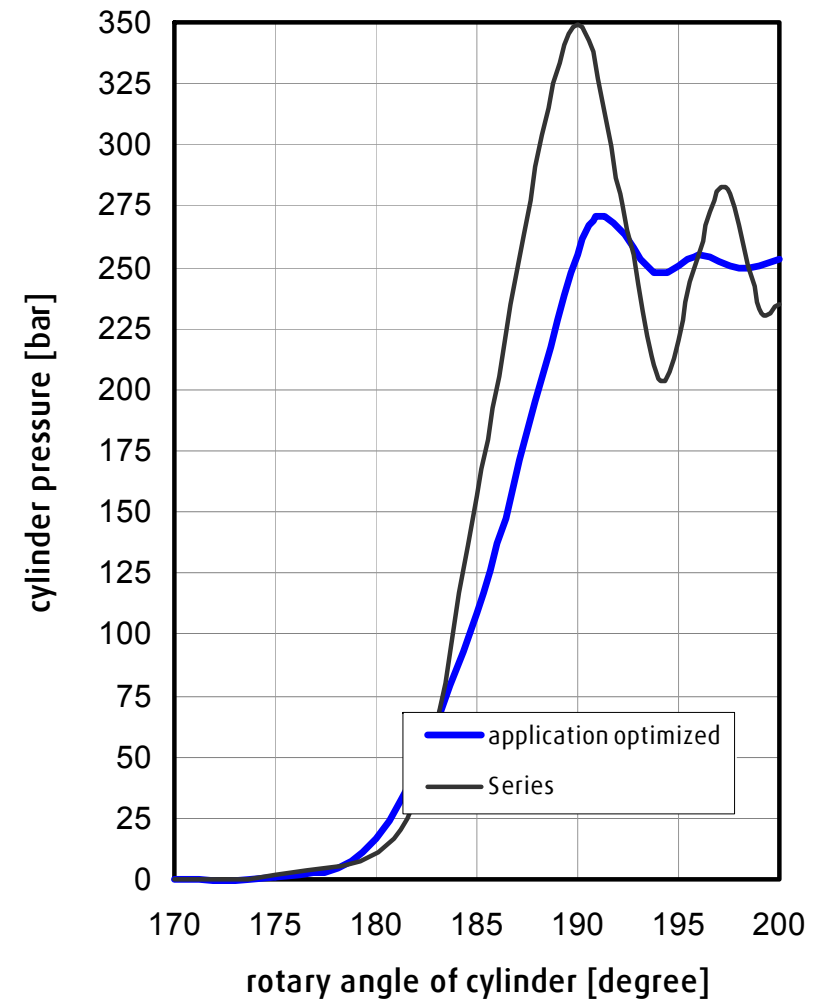
Operation point

- > Speed 1450 rpm
- > Swash angle 16 degrees
- > High pressure 250 bar

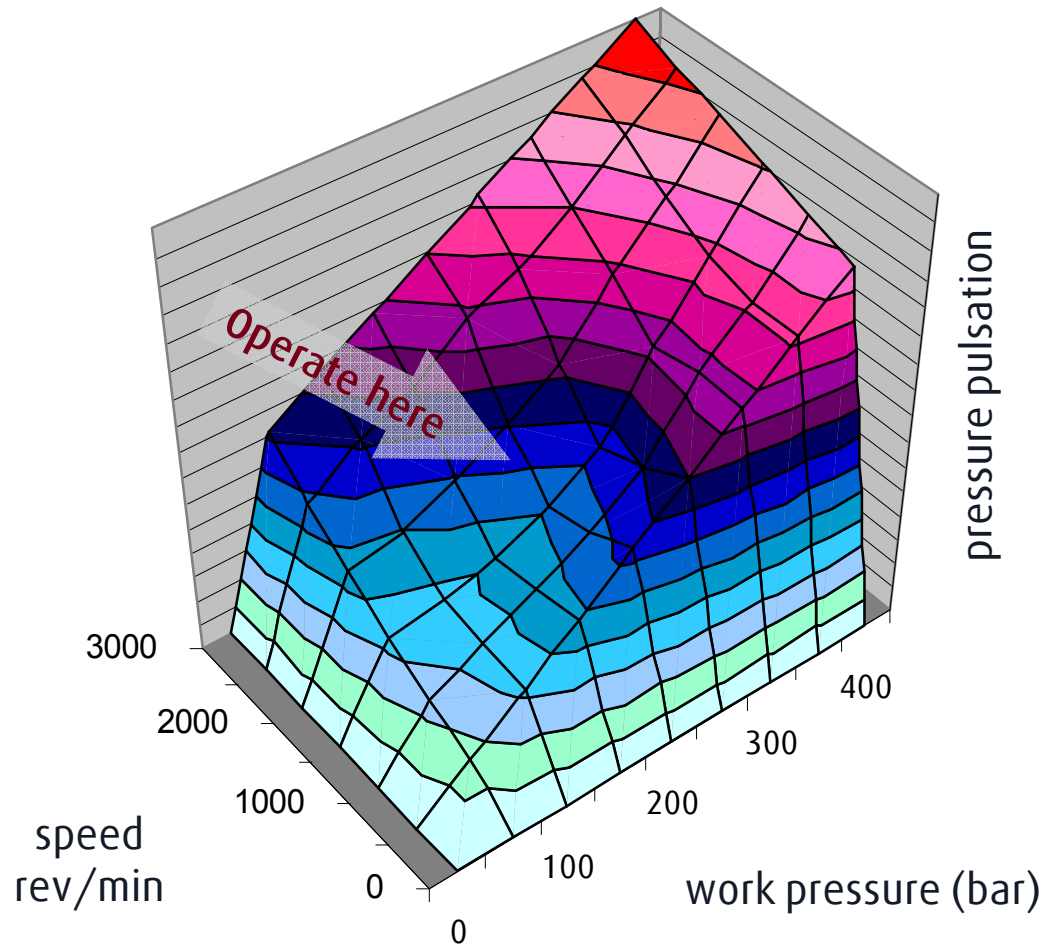
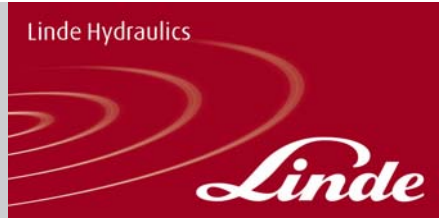
Situation:

Valve plate optimization only adapts to confined operation range

No advantage on other operation points



Principle Effect of Application Optimization



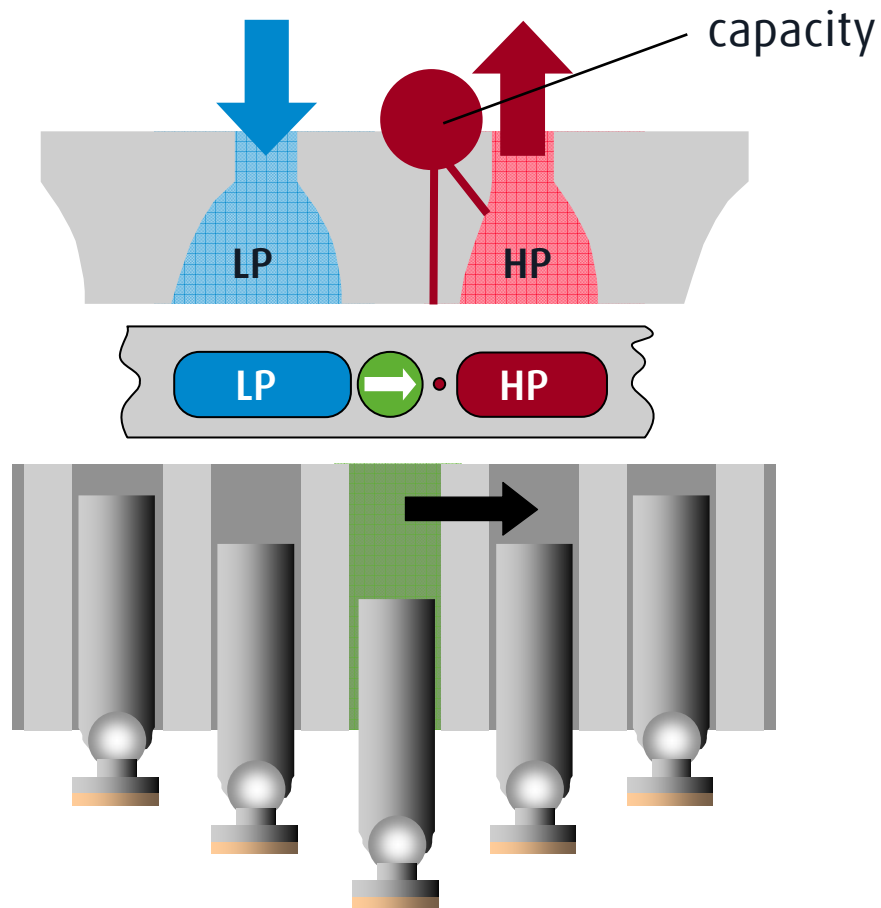
Creates „depression“
in pulsation behavior

Goal:
Broad band optimization that
adapts to changing operation
points

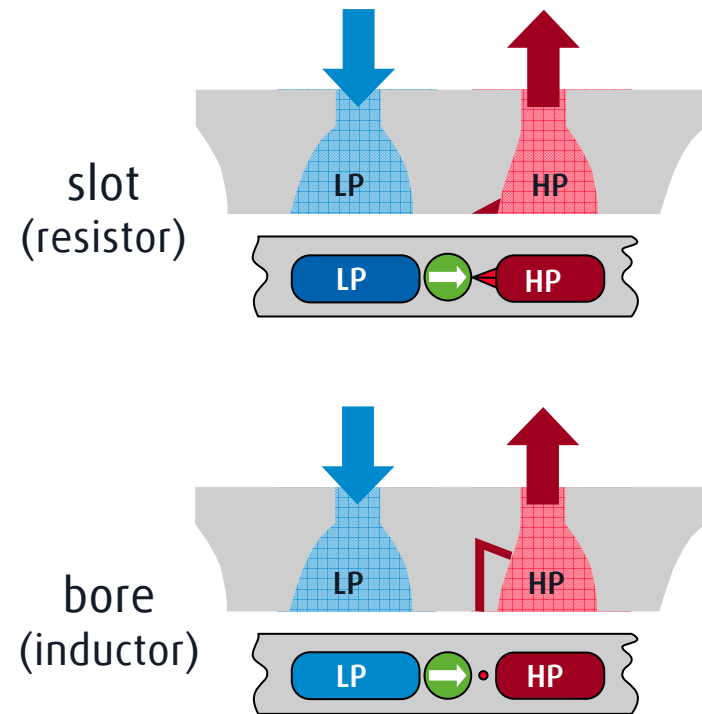
Optimized Commutation



Linde SPU

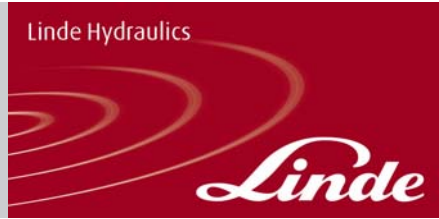


Conventional commutation

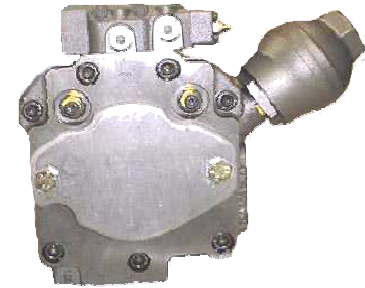


Animation

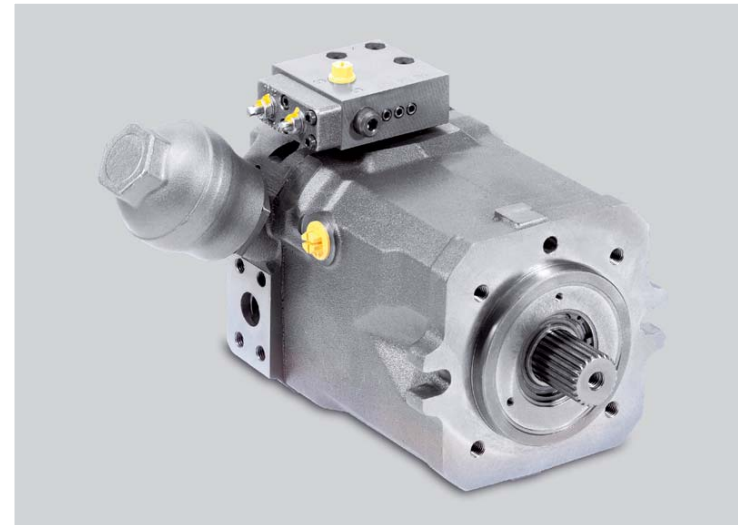
HPR .. -02 SPU execution



Rear view

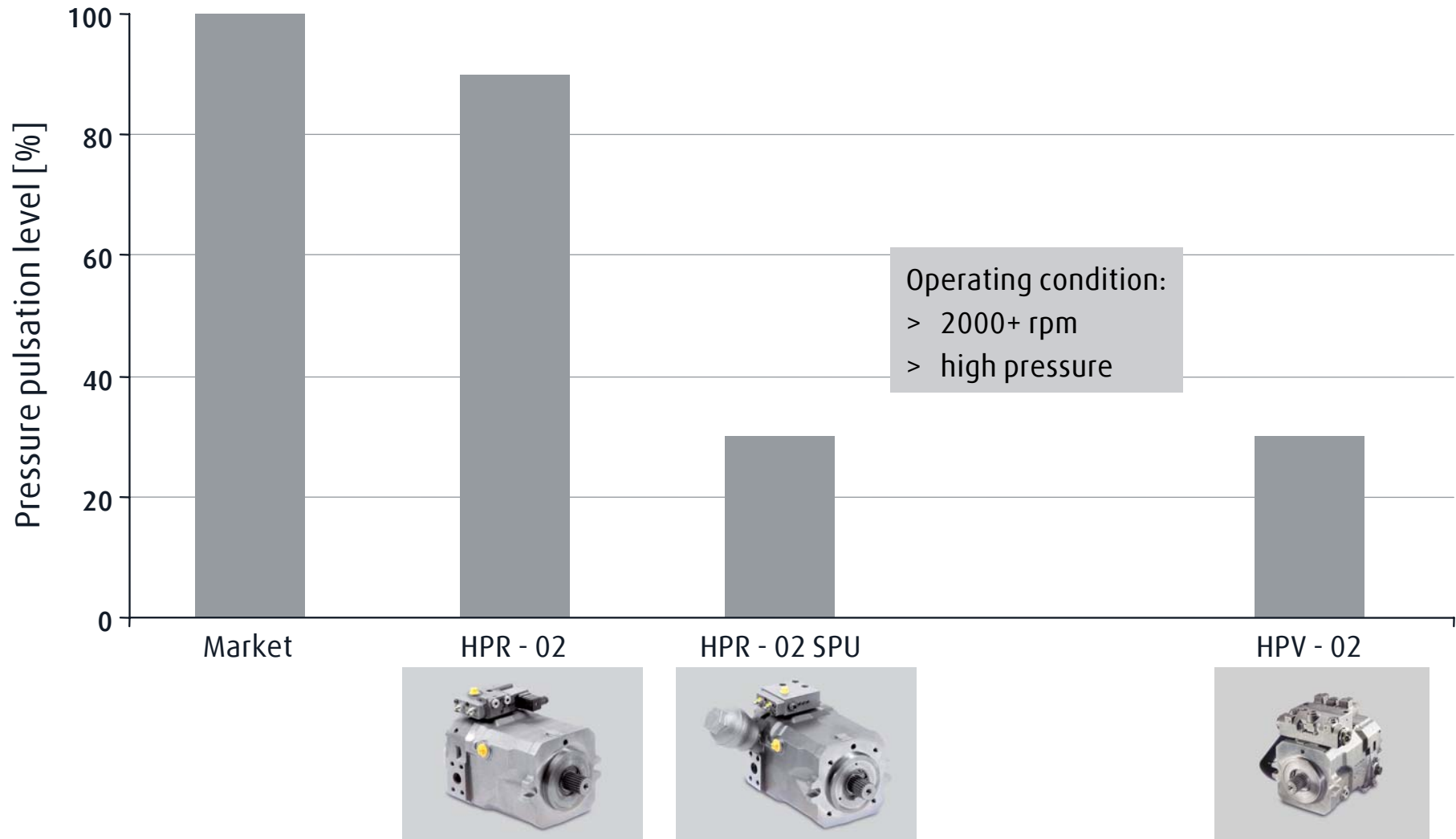


Without SPU

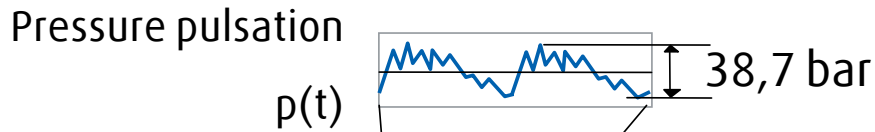


With SPU

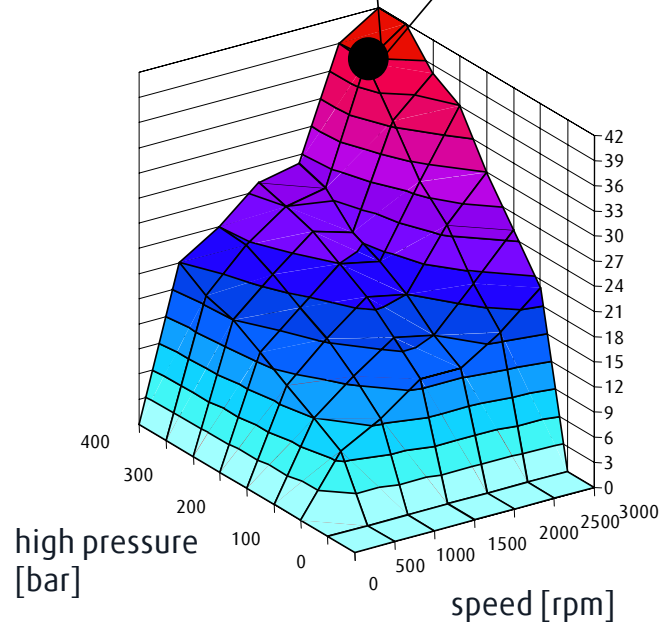
Pressure pulsation levels compared



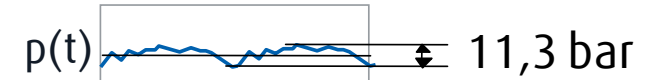
SPU Noise optimization - reduced pressure pulsation level



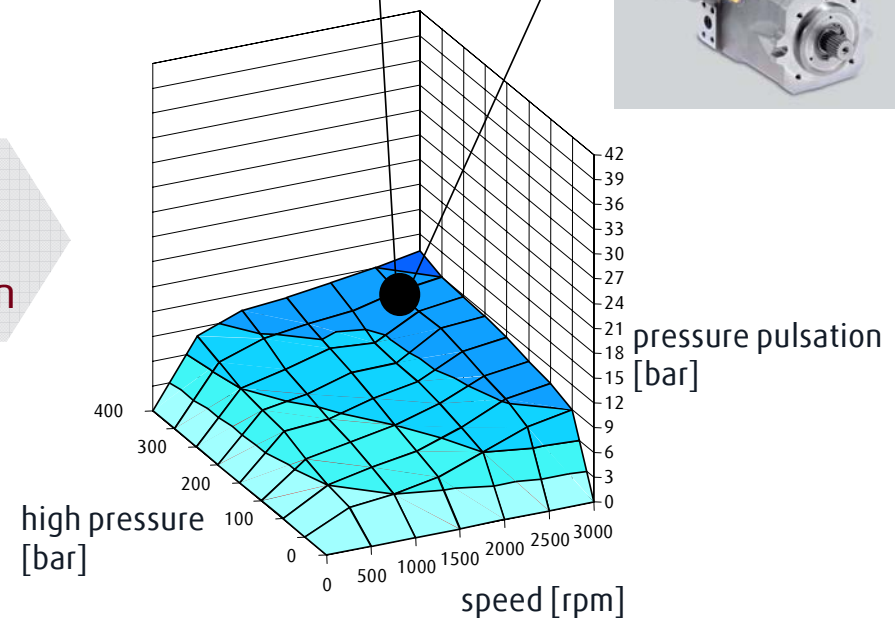
Conventional pump



up to 70% reduction



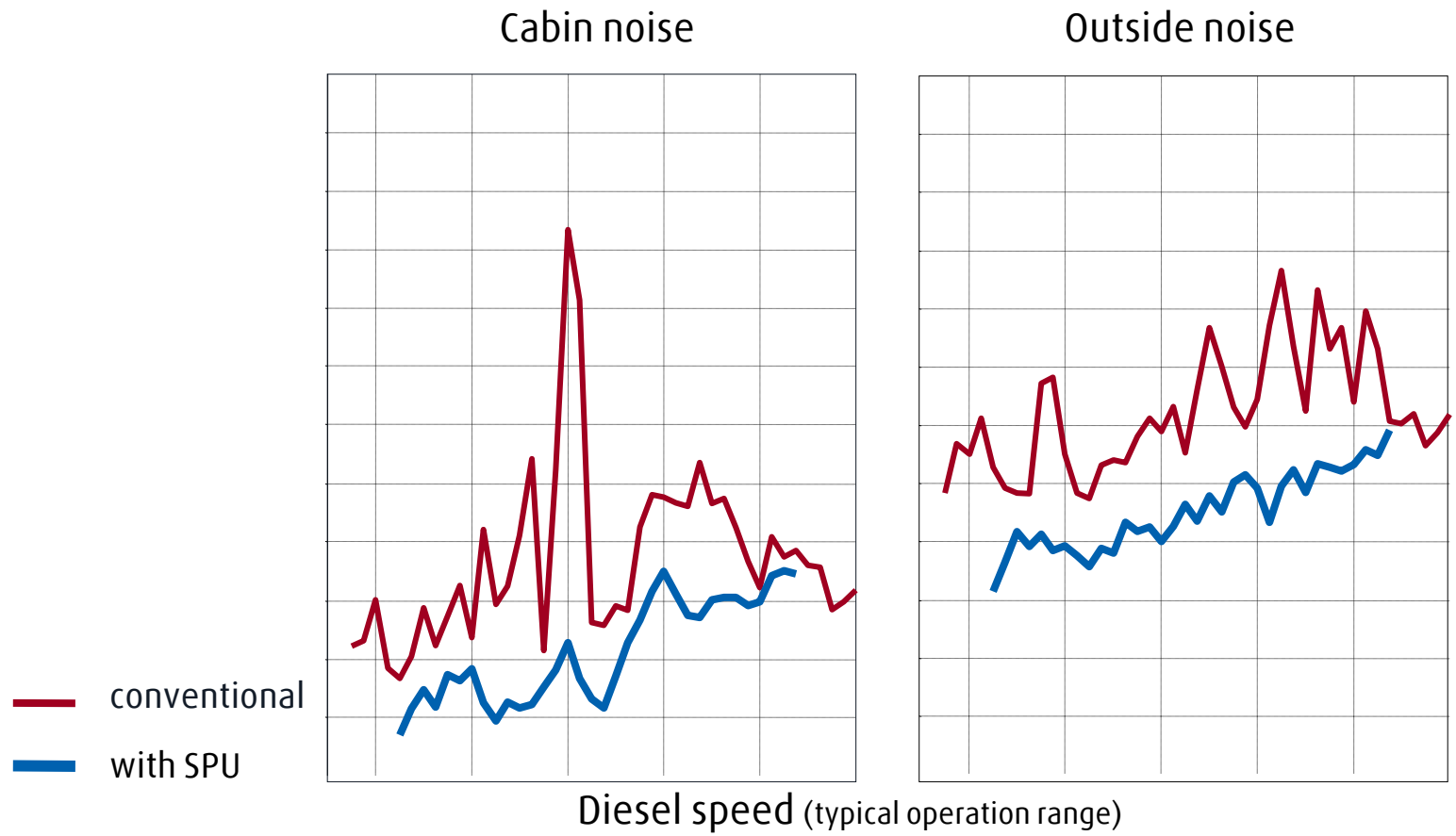
SPU pump



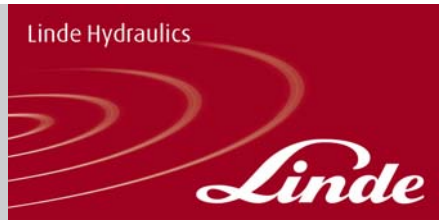
Benefit for operator – application example



Noise level in 2 dB(A) steps

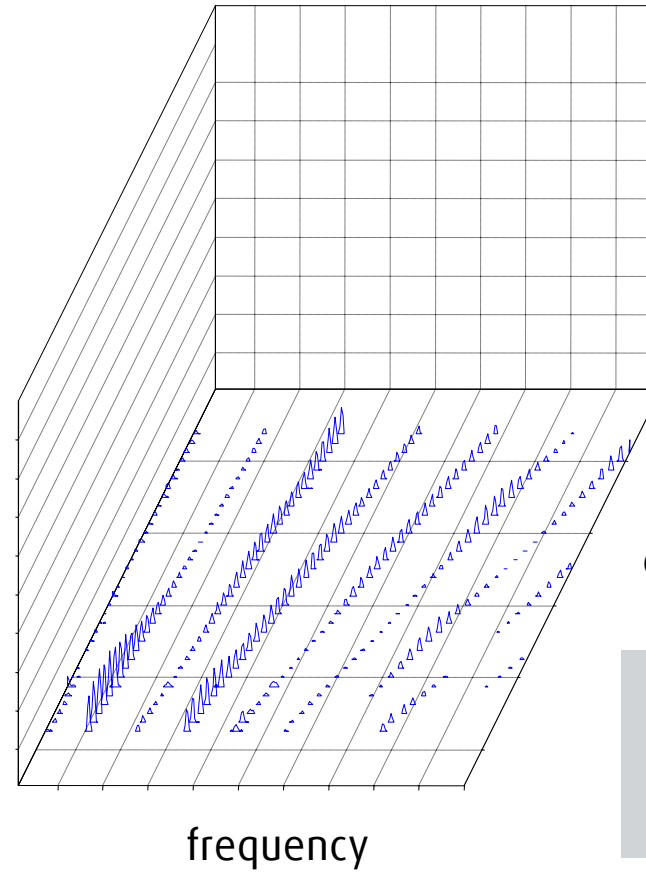
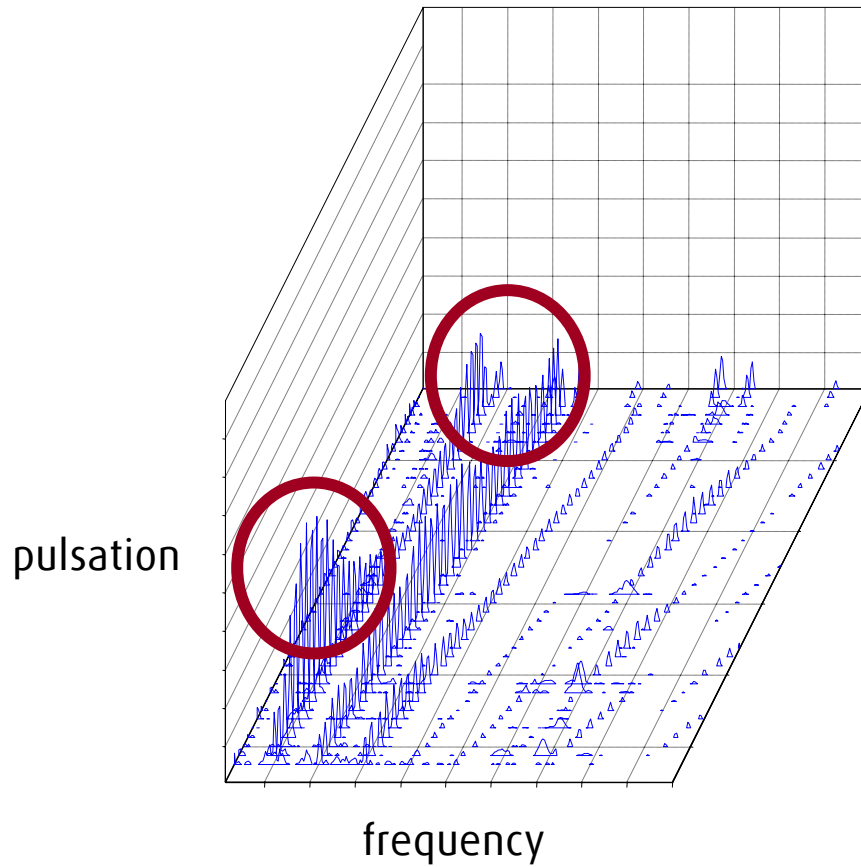


Pressure pulsation



Conventional

With SPU



diesel speed

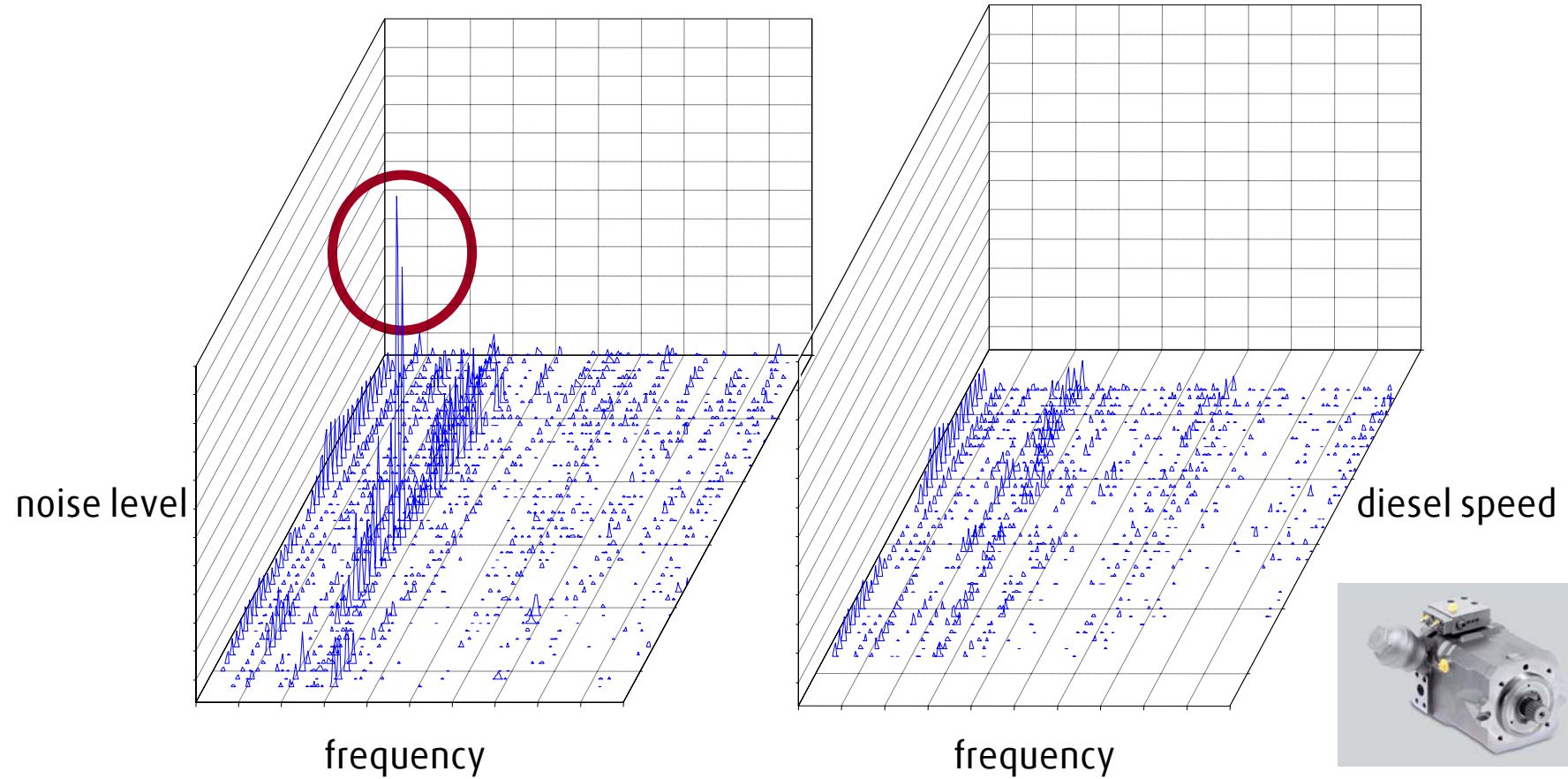


Cabin noise of wheeled excavator



Conventional

With SPU



Conclusion

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Who is responsible for the noise?

Hydraulic units create noise energy
- The system & structure respond and radiate

How to make a system quiet?

Linde pumps create minimum noise energy
- Up to 70% reduced pulsation

- The system and structure are „silent“



Thank you for your attention.



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