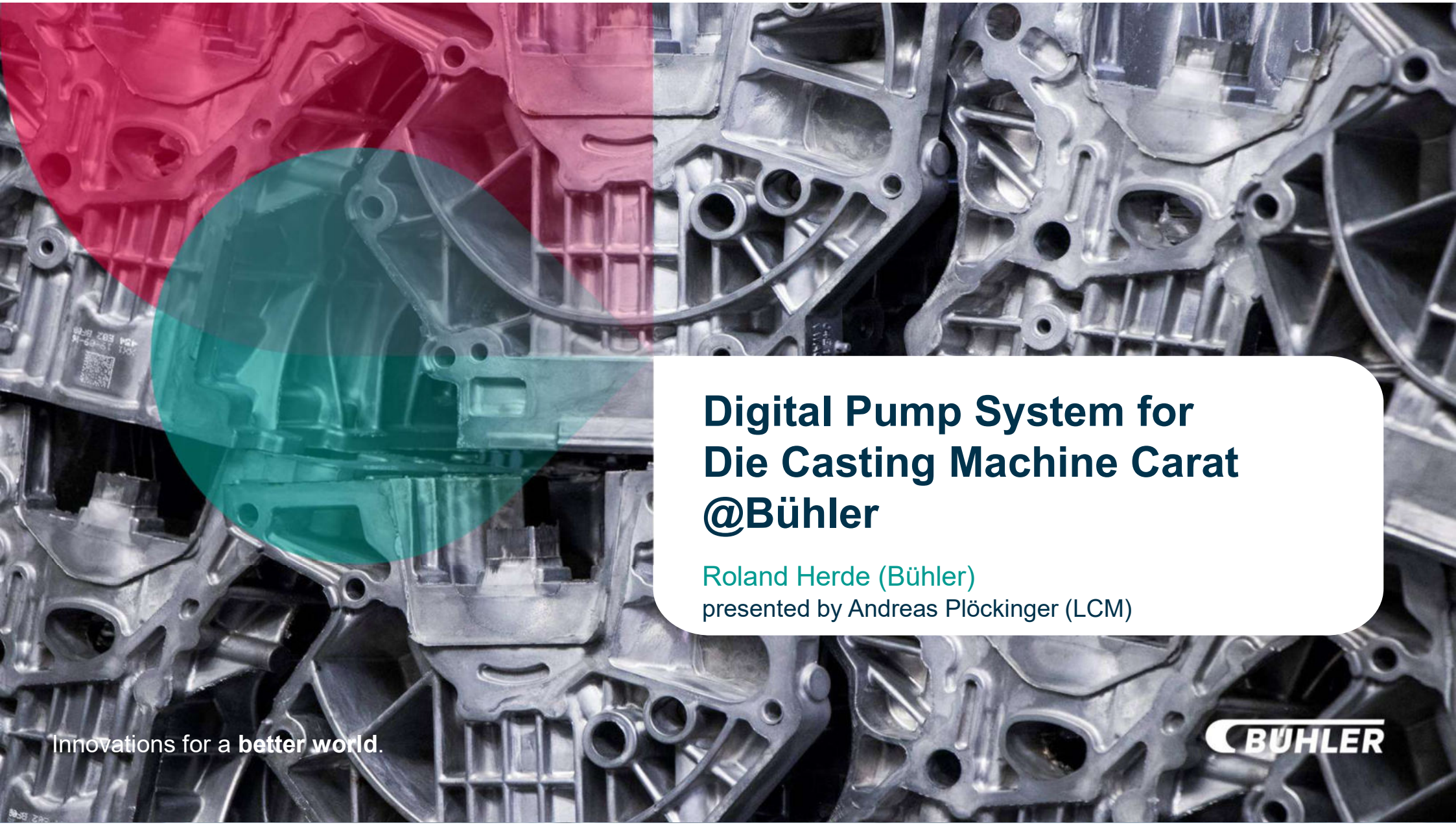


Digital Pump System for Die Casting Machine Carat @Bühler

Roland Herde (Bühler)
presented by Andreas Plöckinger (LCM)

Innovations for a **better world**.

BÜHLER

Bühler Die Casting.

Aluminum high pressure solutions for lightweight design.

Source: GF

up to 70 aluminum die casting parts in a car

Bühler Die Casting.
Our machine portfolio

7,000 die casting systems on the market.

Locking Force / Part Size

Carat
- 10,500 – 44,000 kN
- 13 sizes
- Lean, compact, extended

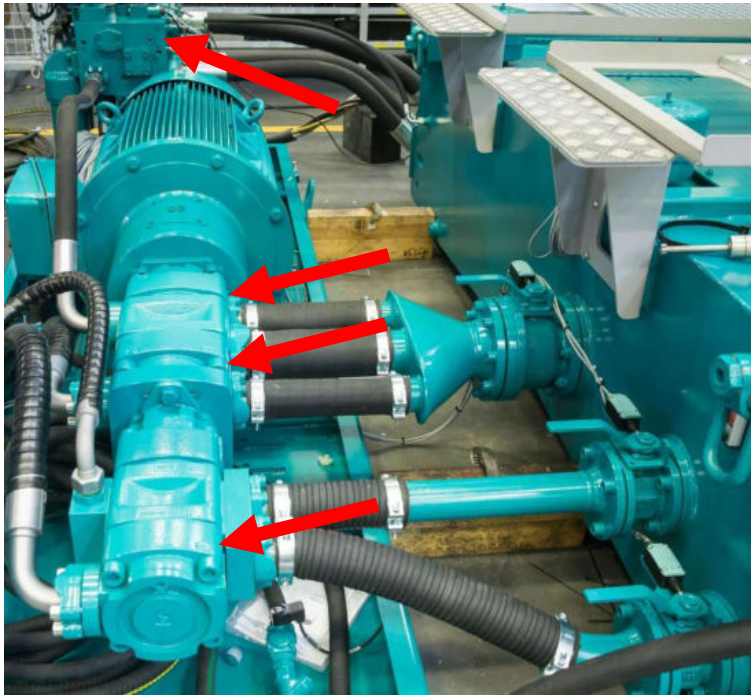
Ecoline S
- 3,400 – 8,400 kN
- 4 sizes

Evolution
- 2,600 – 9,000 kN
- 7 sizes
- Lean, compact, extended

Part Complexity / Flexibility of Production

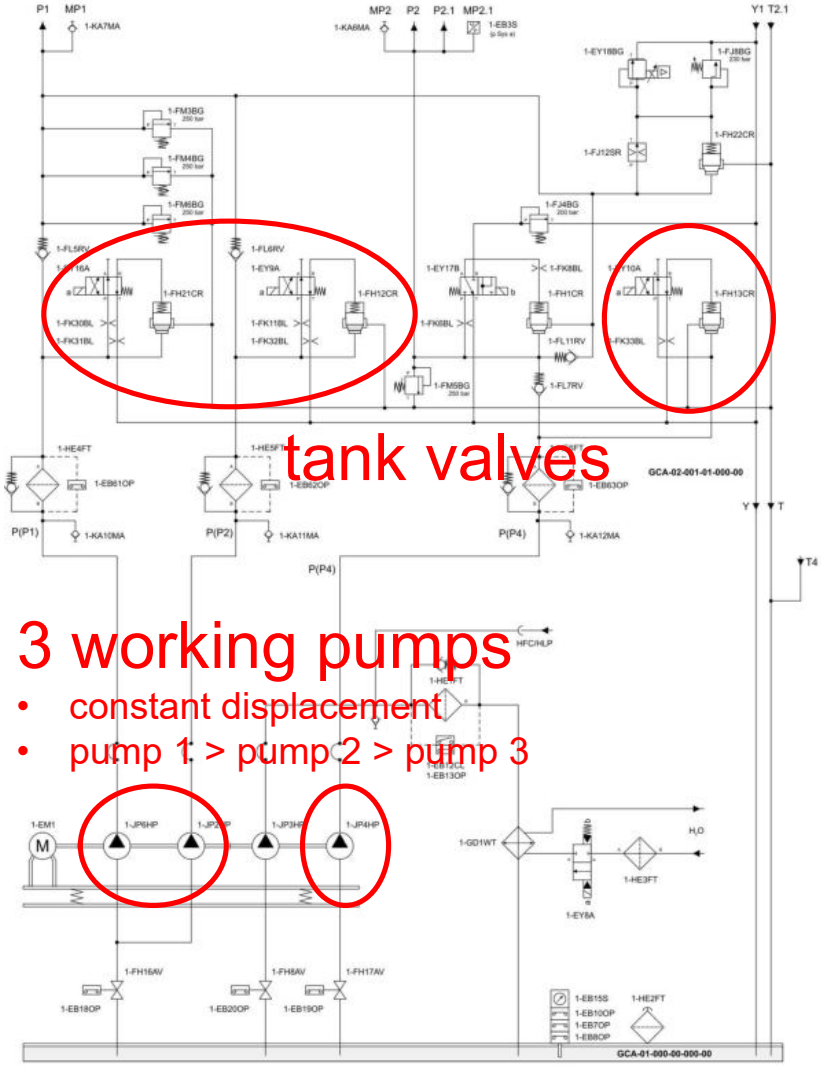
Carat: Digital Pump System

3 working pumps → 7 flow rate levels



Standard drive unit since beginning of Carat series in 2007
more than 520 machines in field

- Hydraulic fluid: mainly water glycol HFC
- Operating Pressure: 210bar

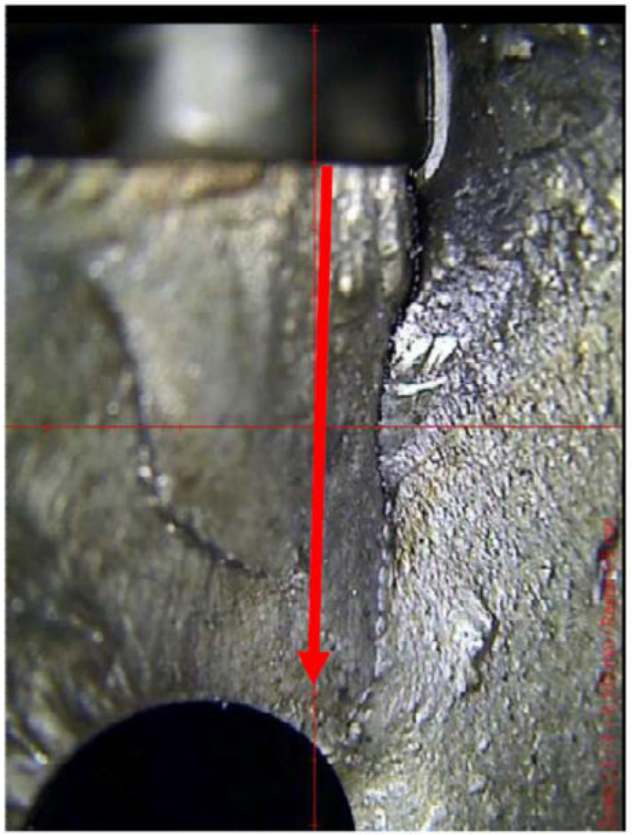


Damage Patterns

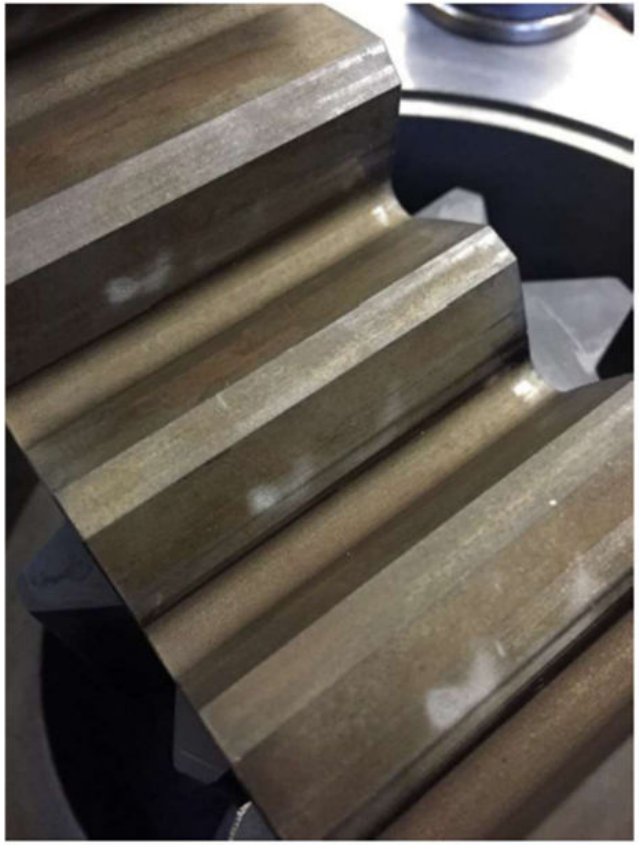
Torsionsbruch in der Pumpe

Ritzel- und Zahnkranzfresser, Gleitlager ausgebrannt.

Riss in Passfedernut Richtung Wellenmitte



Pumpe Zahnkranz: Kavitation.



Carat: Digital Pump System.
Advantages - Disadvantages

Advantages

+ Cost-effective drive unit
+ Simple control of delivery rate via tank valves

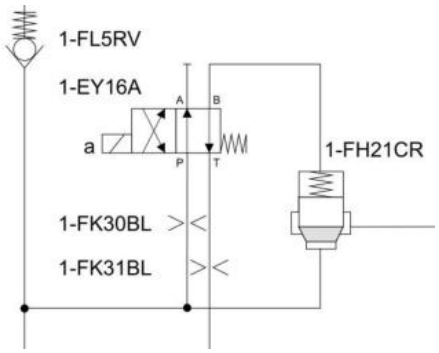
Disadvantages

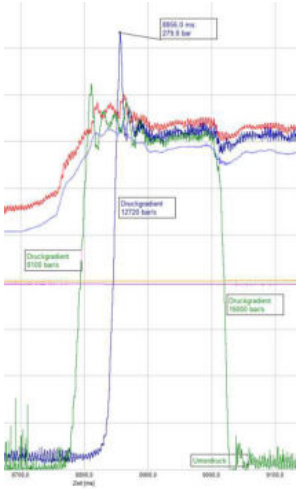
- Pressure peaks and pressure gradients
- Increased wear on hydraulic parts, e.g. pumps

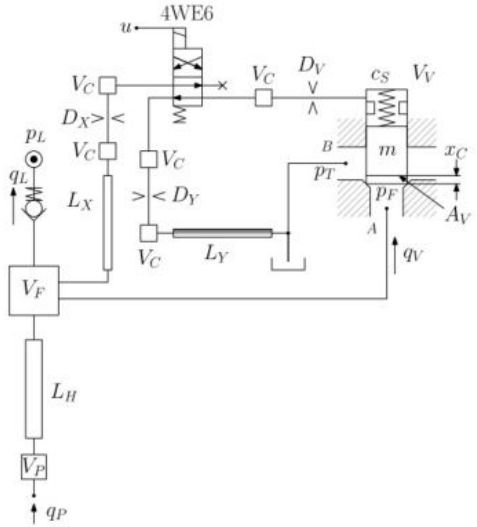
Optimization needed
Start of collaboration with LCM

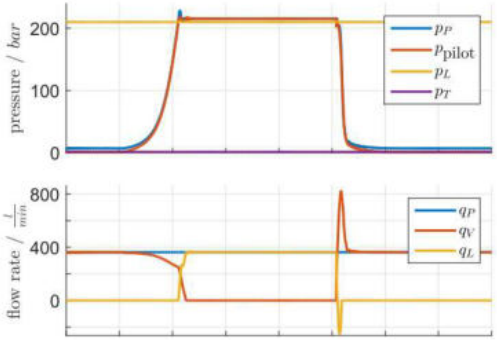
Carat: Digital Pump System.

Simulation - from real to digital world









Optimization with alternative hydraulic components

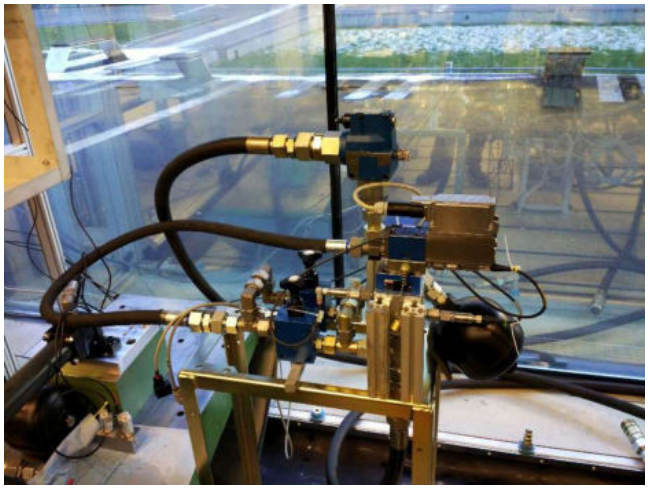
Targets:

- **Pressure peaks < 230bar**
- **Pressure gradients < 7500bar/s**
- **No cycle time extension**
- **Easy implementation needed**

Result:

5 different types of pilot valves identified as possible solution

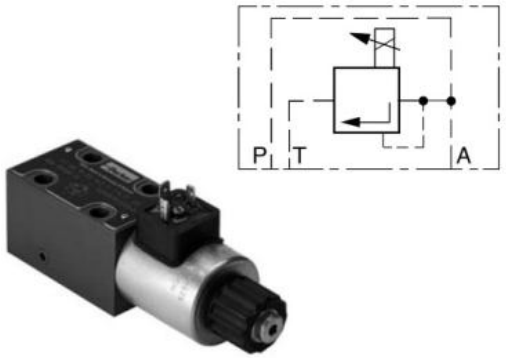
Carat: Digital Pump System.
Back from digital to real world



Test stand at LCM

Drive unit test stand at Bühler Uzwil

→ Identification of proportional pressure relief valve as optimal pilot valve.
→ Optimization of orifices in the cartridge cover.
→ Optimization of signal ramps



Carat: Digital Pump System.

Field test on three machines in a foundry in Austria

Bühler
PLC-Control

No software
changes necessary

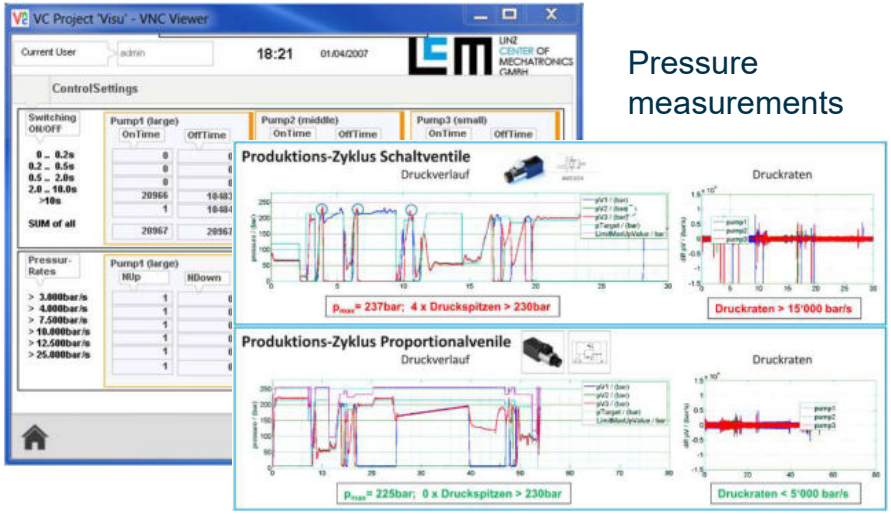
24VDC
switching signal

«LCM-PLC»

0-1.3A
analog signal

Pressure sensor
signal

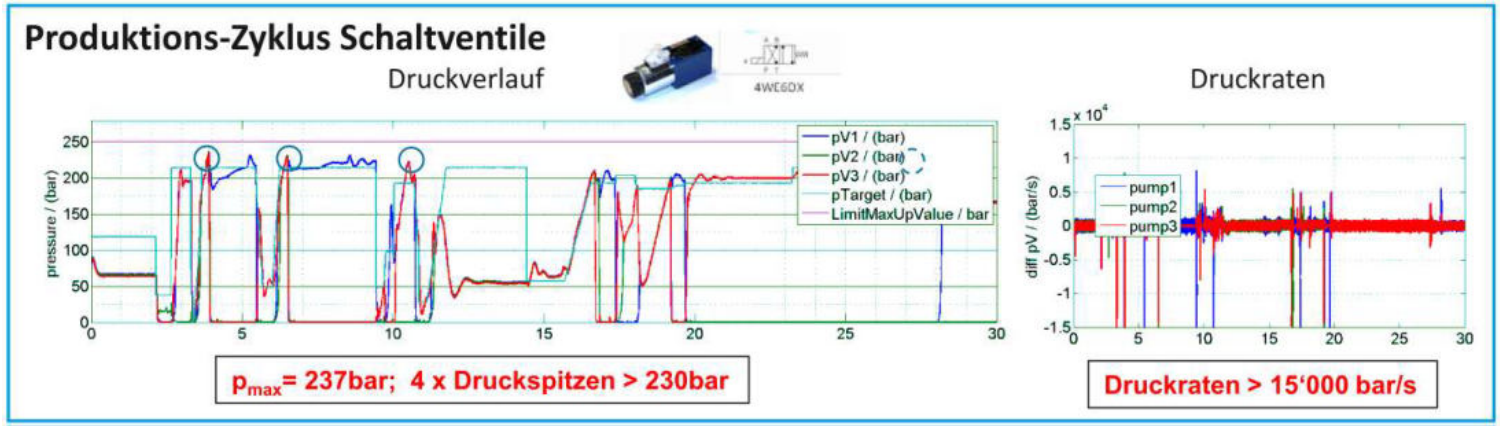
Data logging

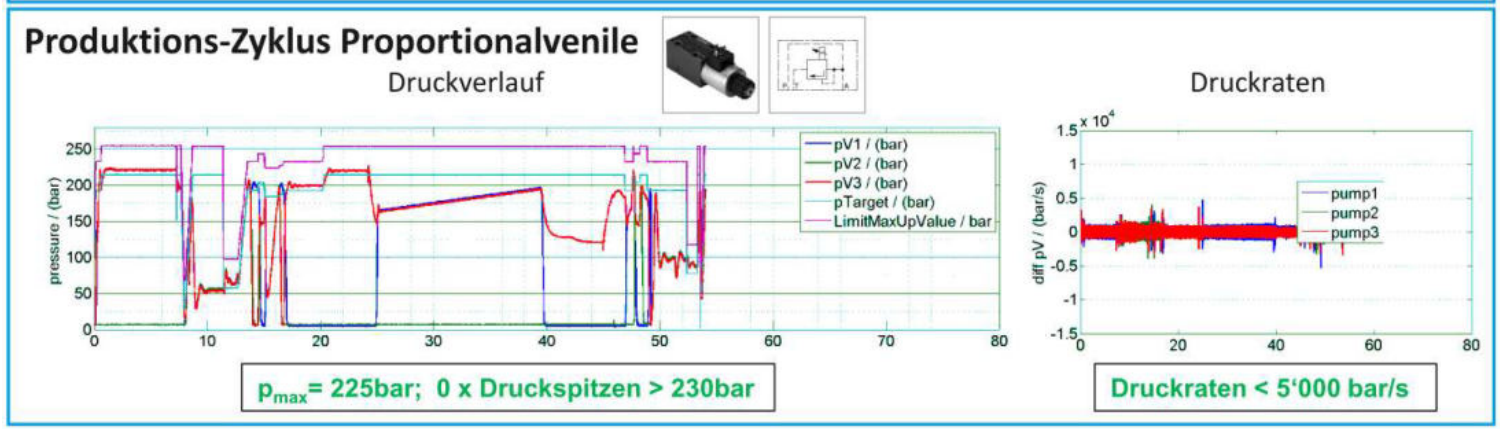


Pressure
measurements

Carat: Digital Pump System.

Field test: pressure measurements





+ no extension of the production cycle time

Carat: Digital Pump System.
Field test: data logging

Current User: admin | 08:50 | 09/13/2017 | LINZ CENTER OF MECHATRONIC GMBH

Pump# Comment

Switching ON/OFF	Pump1 (large) OnTime	Pump1 (large) OffTime	Pump2 (middle) OnTime	Pump2 (middle) OffTime	Pump3 (small) OnTime	Pump3 (small) OffTime
0 .. 0.2s	7846	29599	7100	132393	70033	34742
0.2 .. 0.5s	15571	51160	12591	70312	31180	51007
0.5 .. 2.0s	257814	185233	325690	168324	141951	280384
2.0 .. 10.0s	197891	98080	226433	76363	204988	94930
>10s	37913	152968	2999	127424	83511	70608
SUM of all	517035	517040	574813	574816	531663	531671

Pressur-Rates	Pump1 (large) NUp	Pump1 (large) NDown	Pump2 (middle) NUp	Pump2 (middle) NDown	Pump3 (small) NUp	Pump3 (small) NDown
> 2.000bar/s	297655	664296	251108	614205	512783	813468
> 3.000bar/s	265440	88825	212764	84930	331934	288333
> 4.000bar/s	248950	22663	174443	25306	140508	56186
> 7.500bar/s	0	0	0	5	0	4
> 10.000bar/s	0	0	0	0	0	[illegible]
> 25.000bar/s	0	0	0	0	0	

- Numbers of switching ON/OFF per pump are counted
- Numbers of pressure gradients over a certain value are counted
- Function integrated completely in “LCM-PLC”, no connected PC necessary

→ Data could be read out after a certain time of production

→ Immediate check if new valve control still works

Carat: Digital Pump System.
Bring the solution into the field

Series machines

All new machines delivered since April 2018 are equipped with the Smart Pump Management System

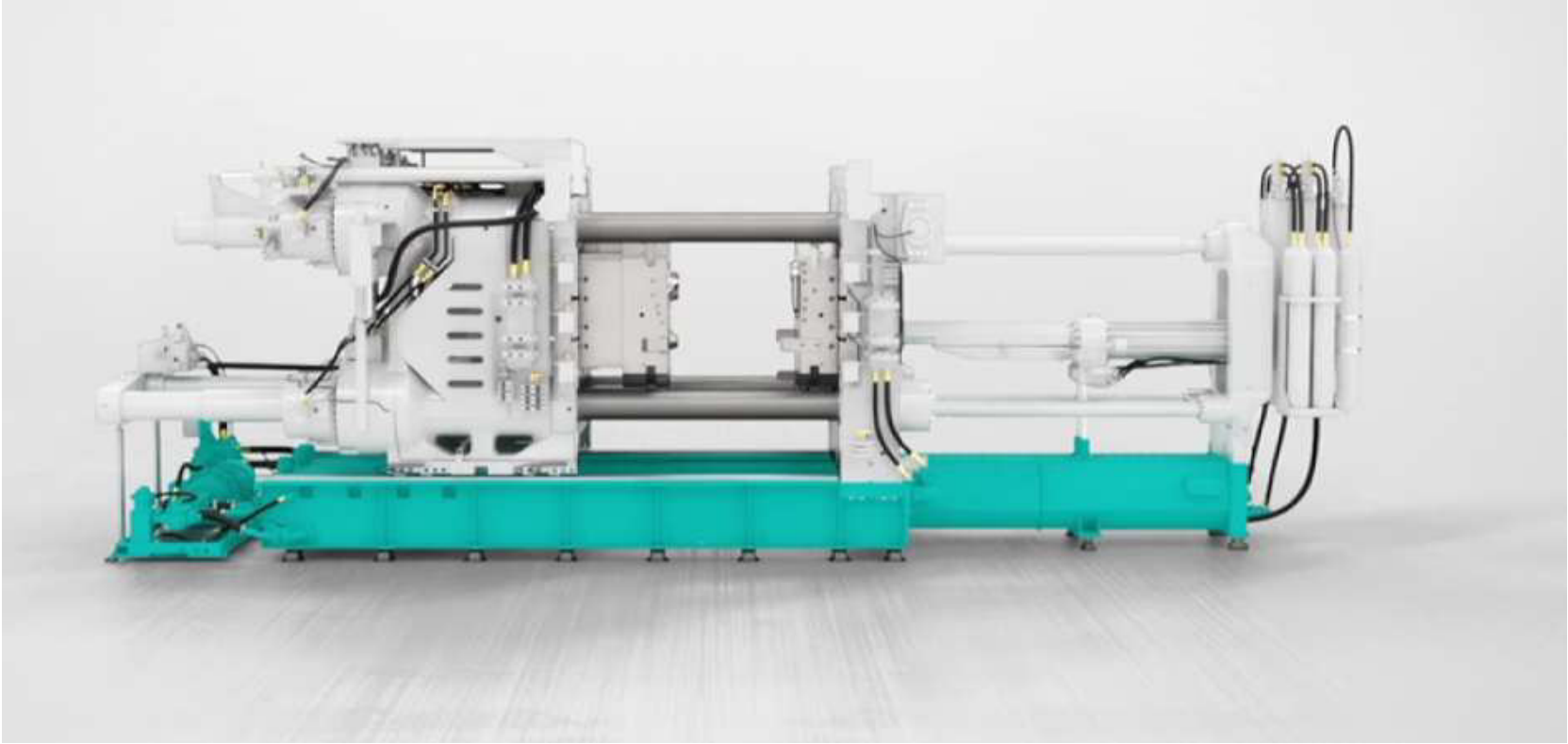
Retrofit kits

+

Software Update

More than 50 machines in field worldwide have already been retrofitted

Carat: Video
Flagship



Carat: Digital Pump System.
Conclusion

Together with LCM we achieved the targets set at the beginning of the project

→ Pressure peaks < 230bar ✓

→ Pressure gradients < 7500bar/s ✓

→ No cycle time extension ✓

→ Smart Pump Management System is now Standard ✓