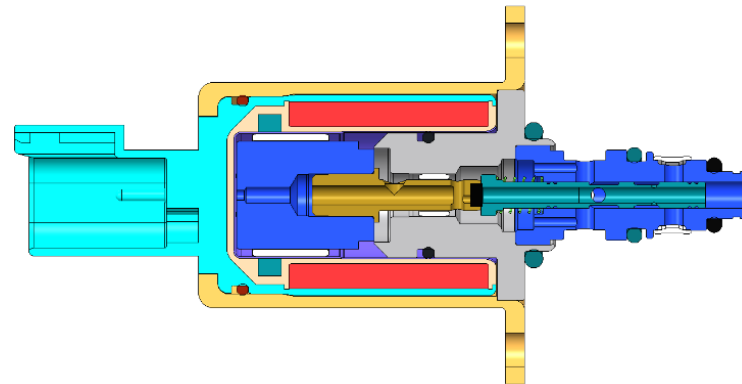


Proportional pressure reducing valves with intrinsic fail safe function

Dr. Jörg Schneider
Dr. Jens Krallmann
Daniel Ferres

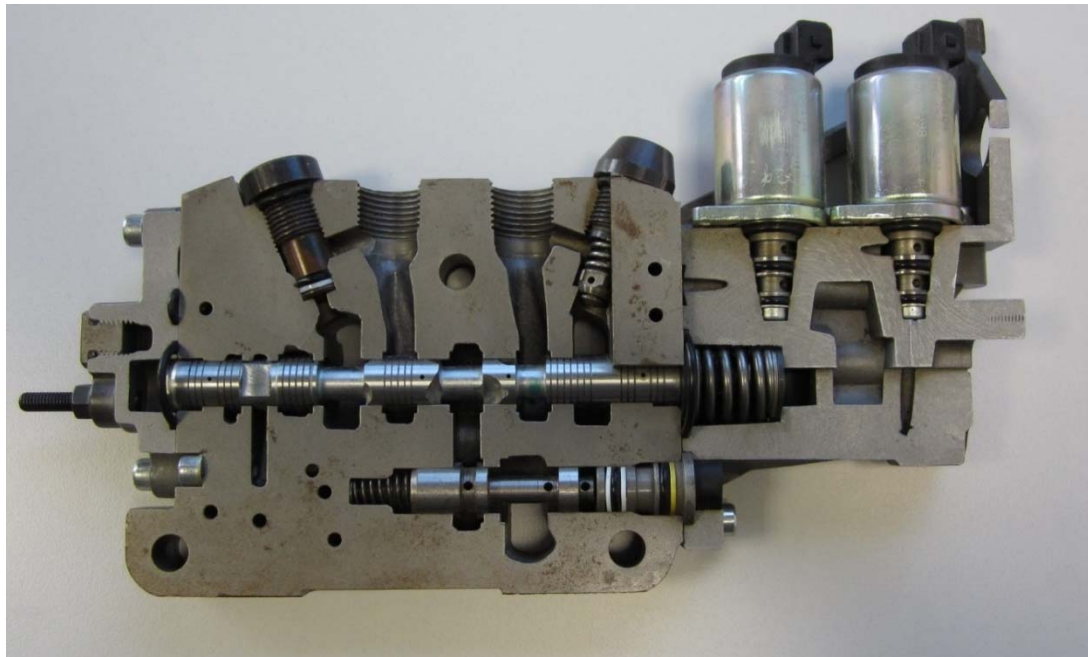


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- 1 Introduction and Motivation
 - 2 PPRVs as pilot valves for sectional valves
 - 3 Functional principle of Fail Safe versions
 - 4 Limits and Restrictions
 - 5 Influence on functional safety ratings
 - 6 Summary

THOMAS Mobilhydraulic history:

First cartridge valve development in 1996

PPRV: 3/2-way proportional pressure reducing valve



PPCD04

Proportional

Pressure

Control

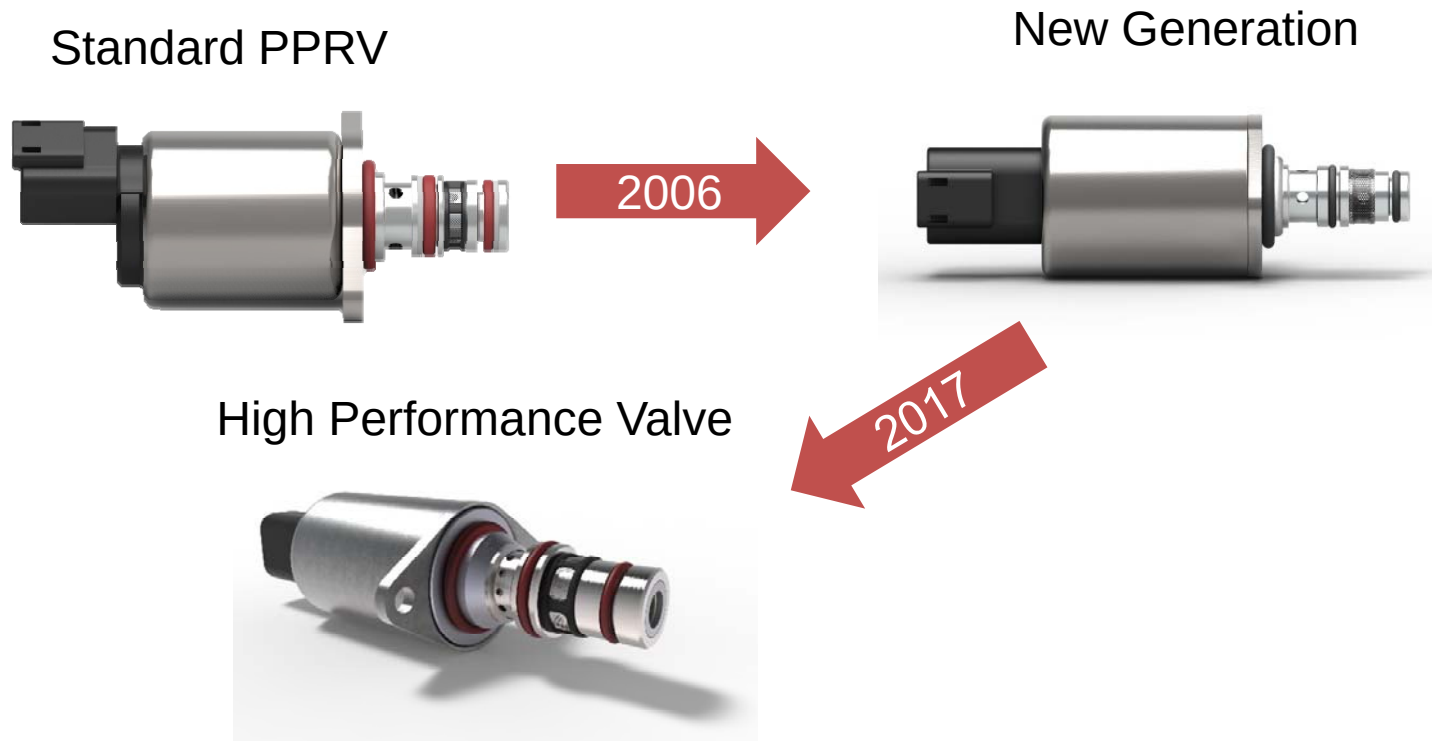
Direct operated

04 = flow capacity



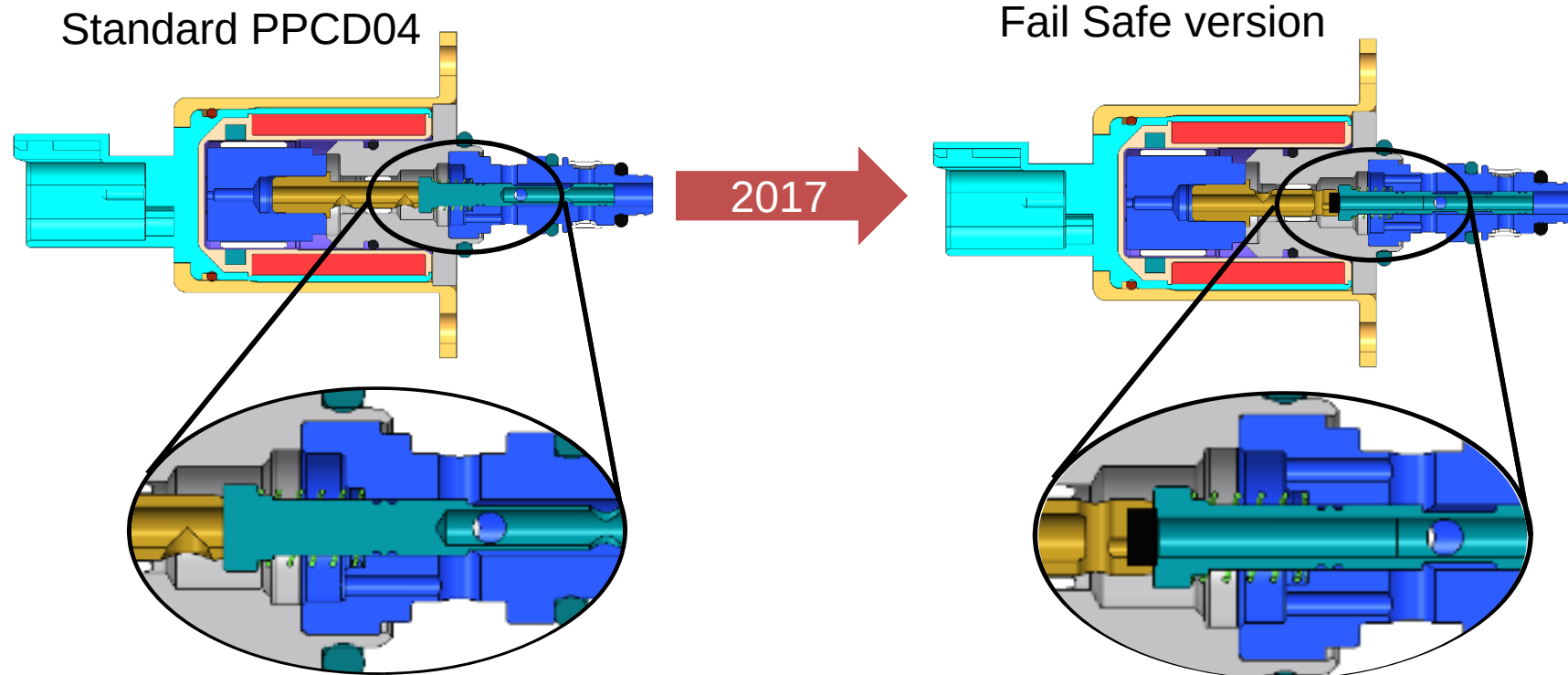
What to do for continuous improvements?

1) Higher performance and/or more compact and/or more cost efficient design



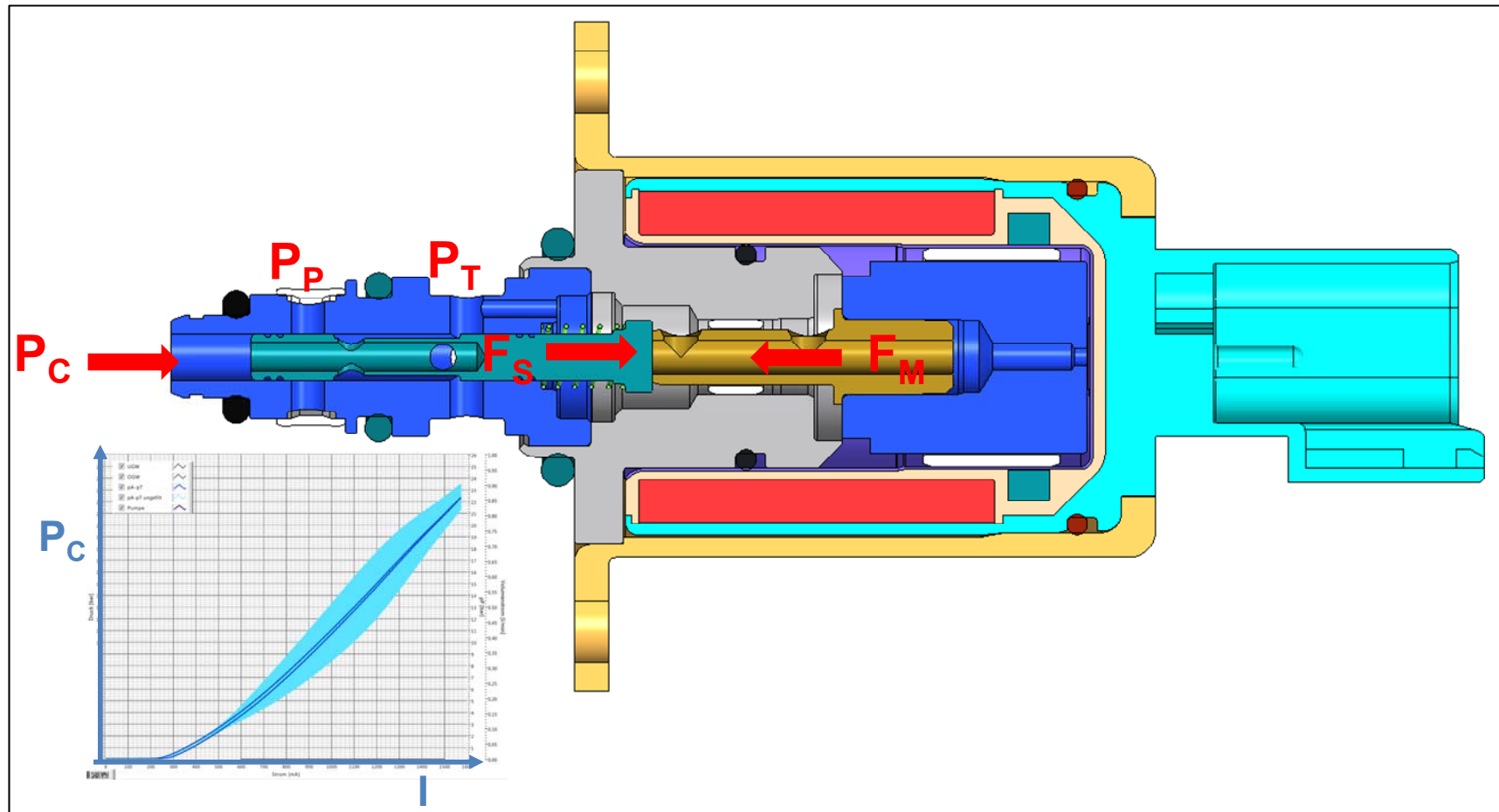
What to do for continuous improvements?

2) Integration of more functionality



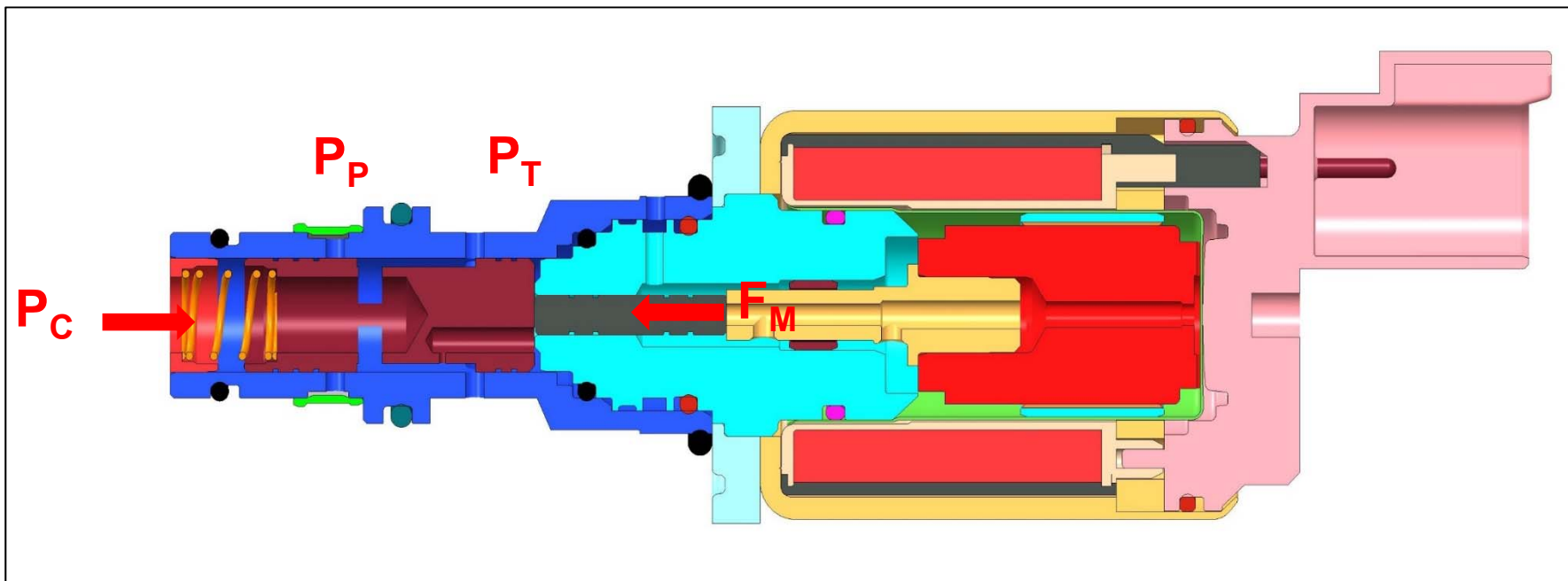
PPRVs as pilot valves for sectional valves

Functional principle of a PPCD04



PPRVs as pilot valves for sectional valves

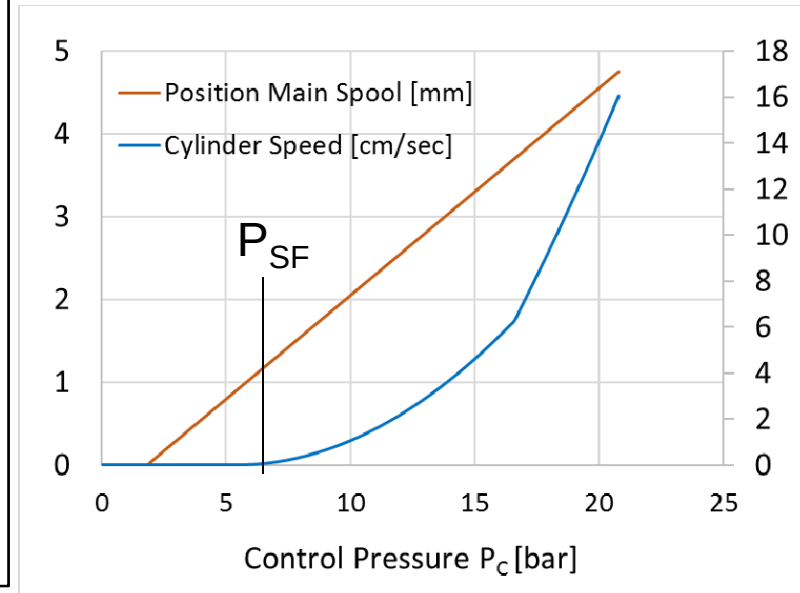
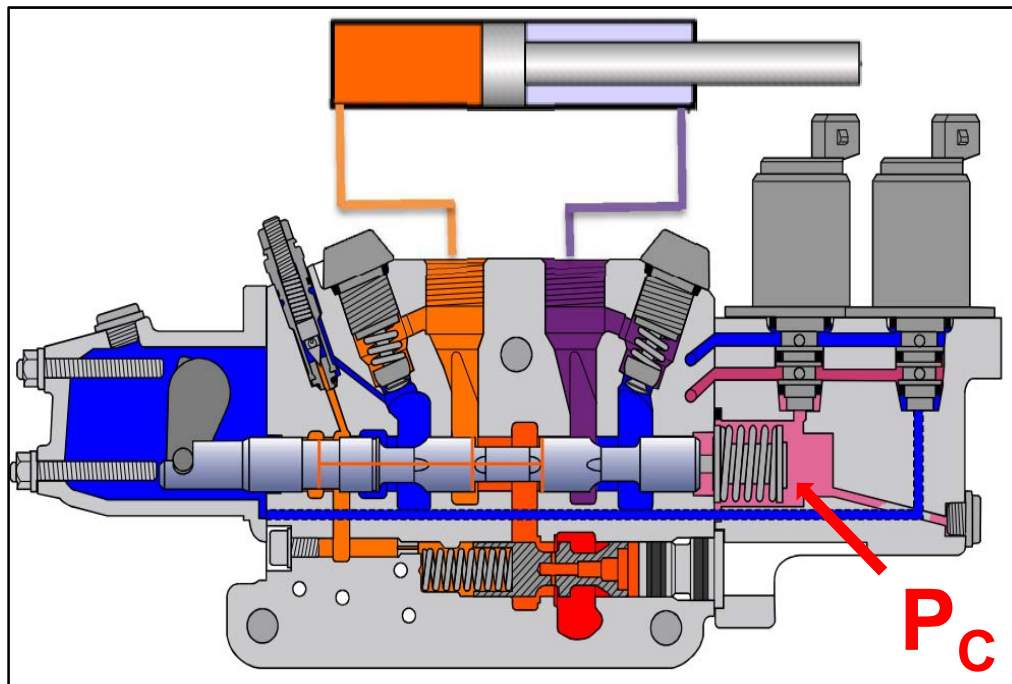
Functional principle of a PPCD06



PPRVs as pilot valves for sectional valves

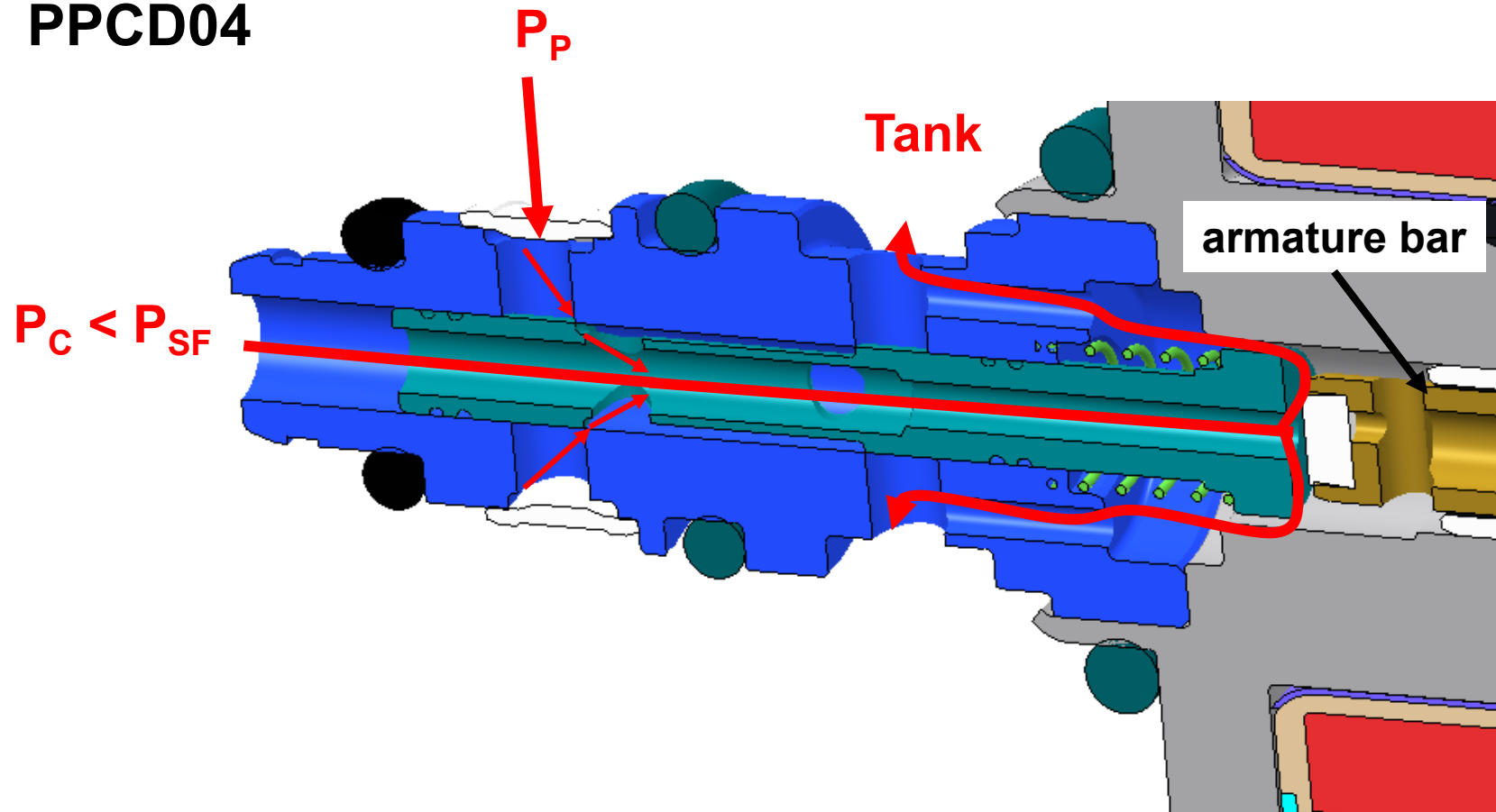
Safe situation for implement functions with electrohydraulically driven sectional valve

$P_C < P_{SF} \rightarrow$ Safe Situation

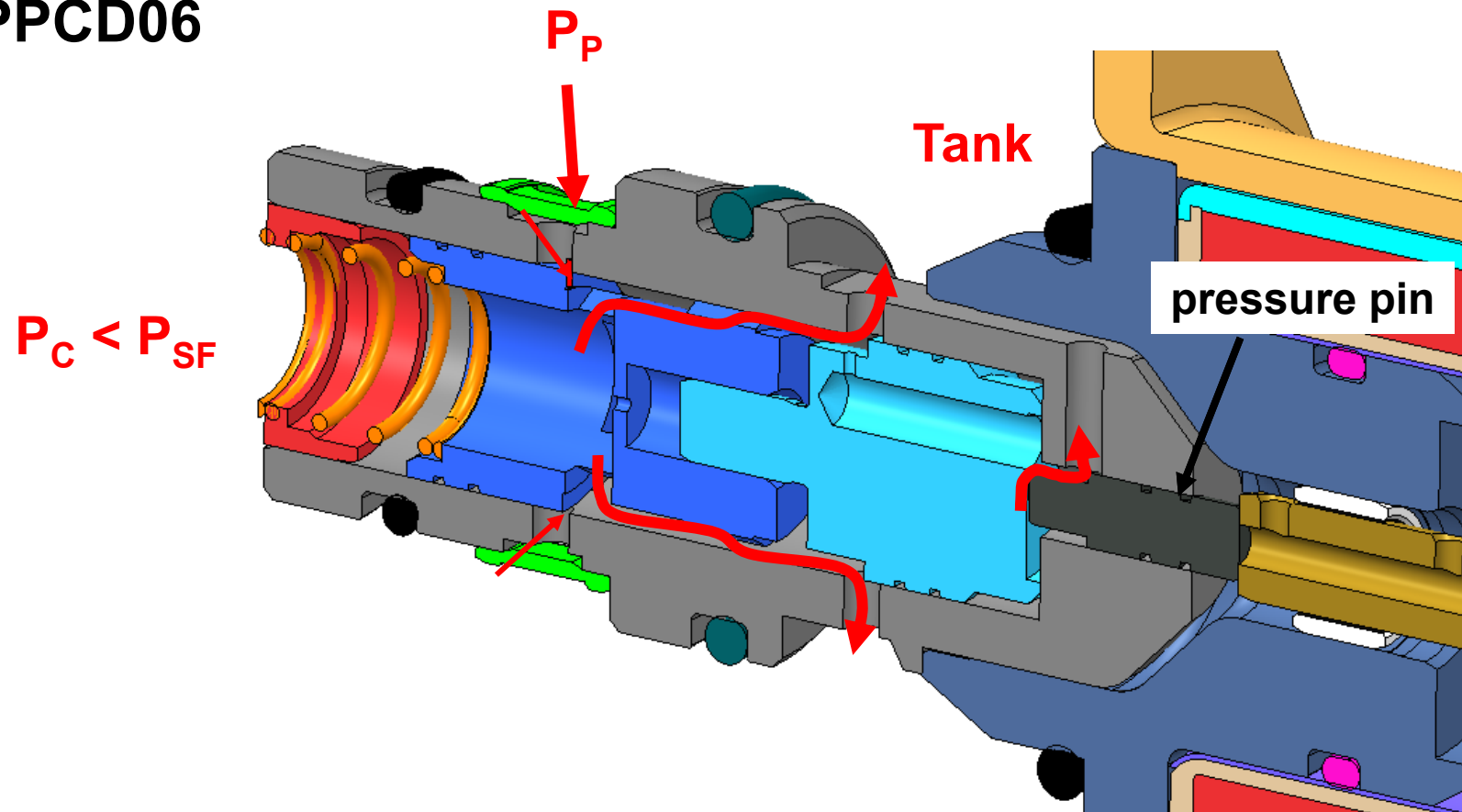


Functional principle of Fail Safe versions

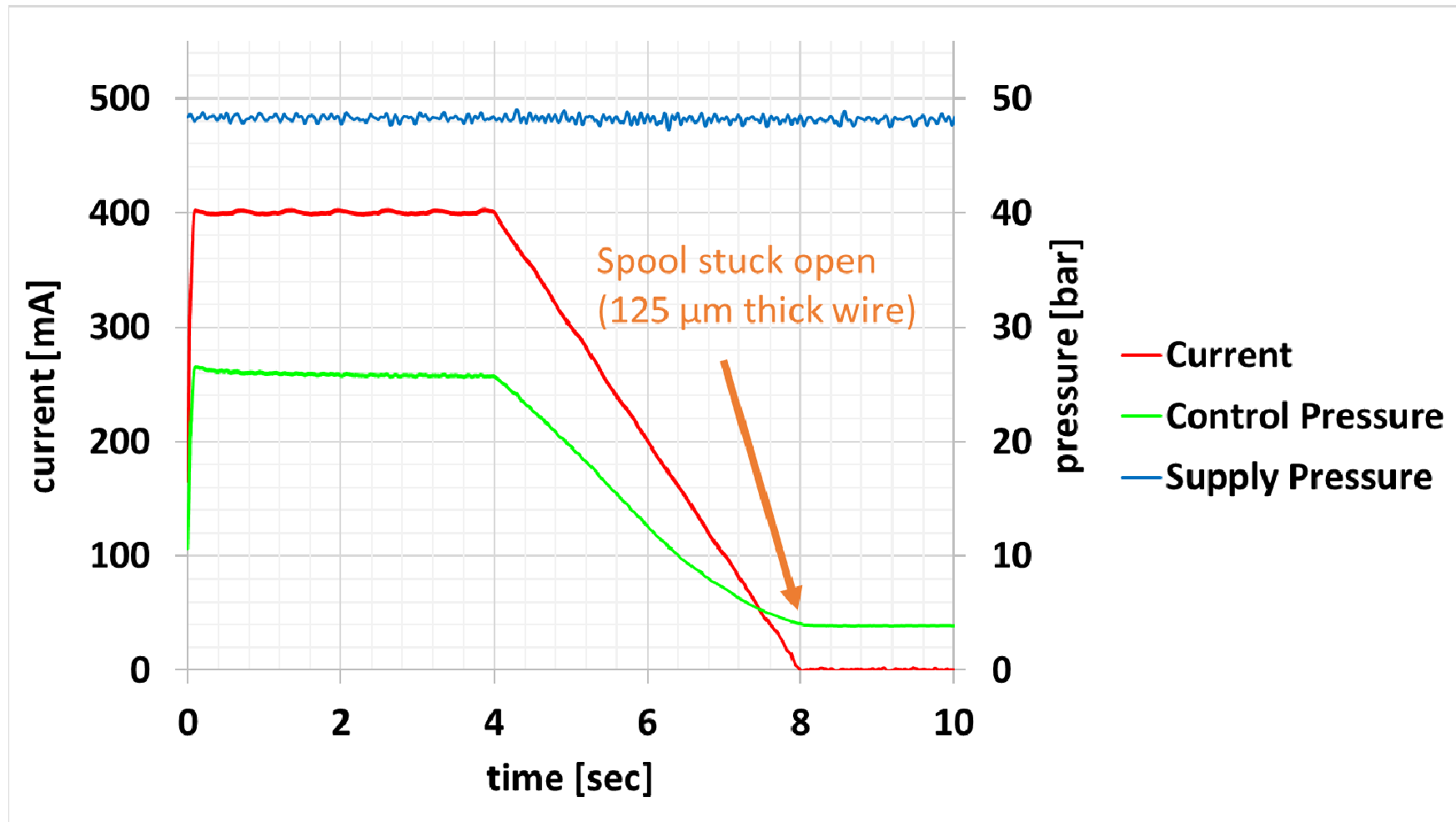
PPCD04



PPCD06

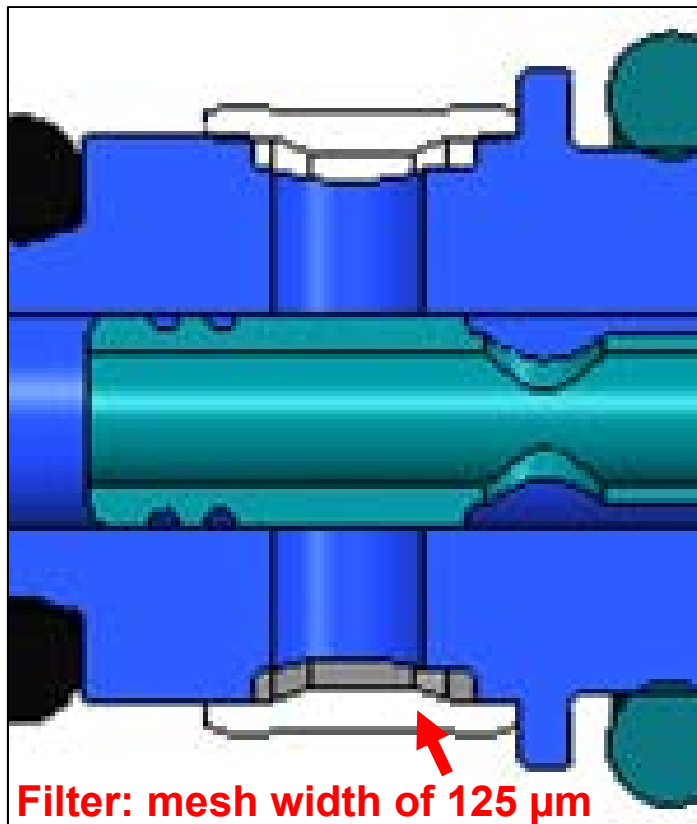


Functional principle of Fail Safe versions

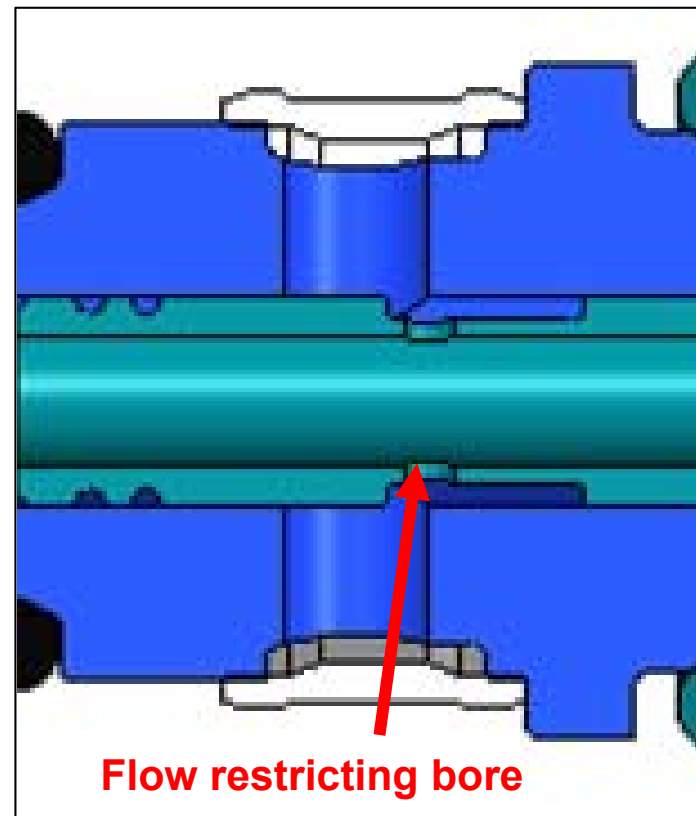


Functional principle of Fail Safe versions

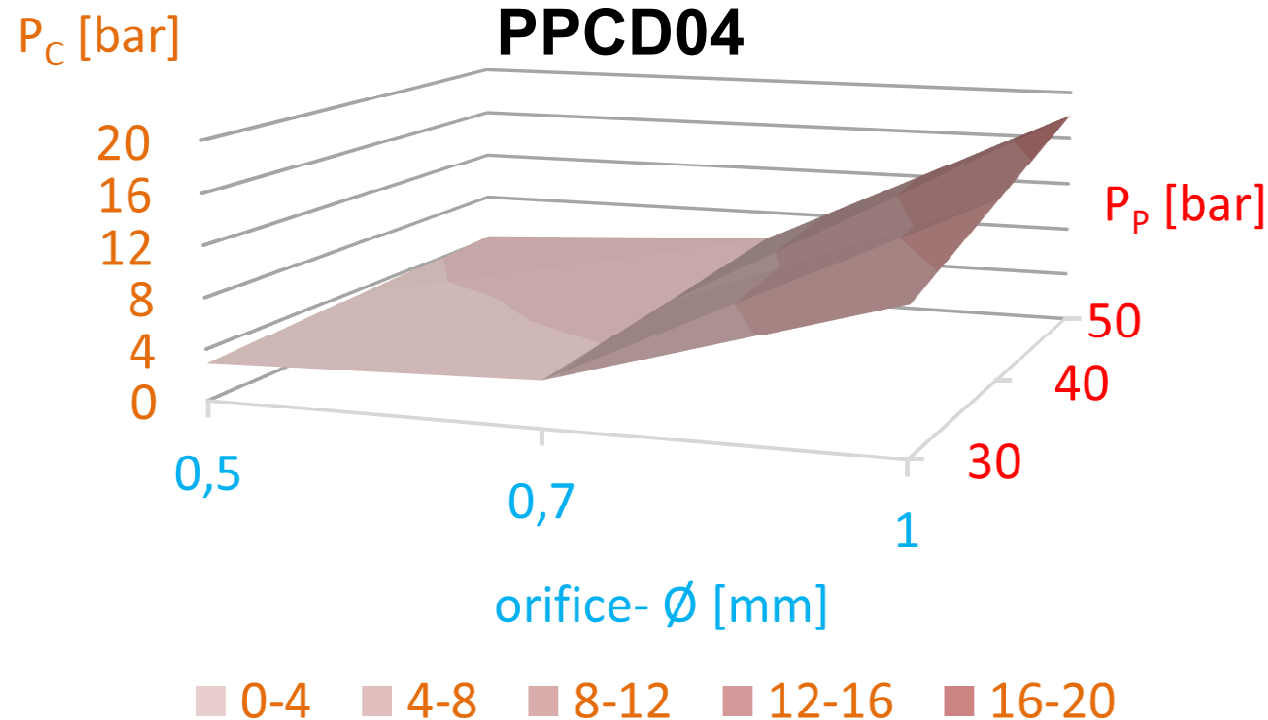
First Design

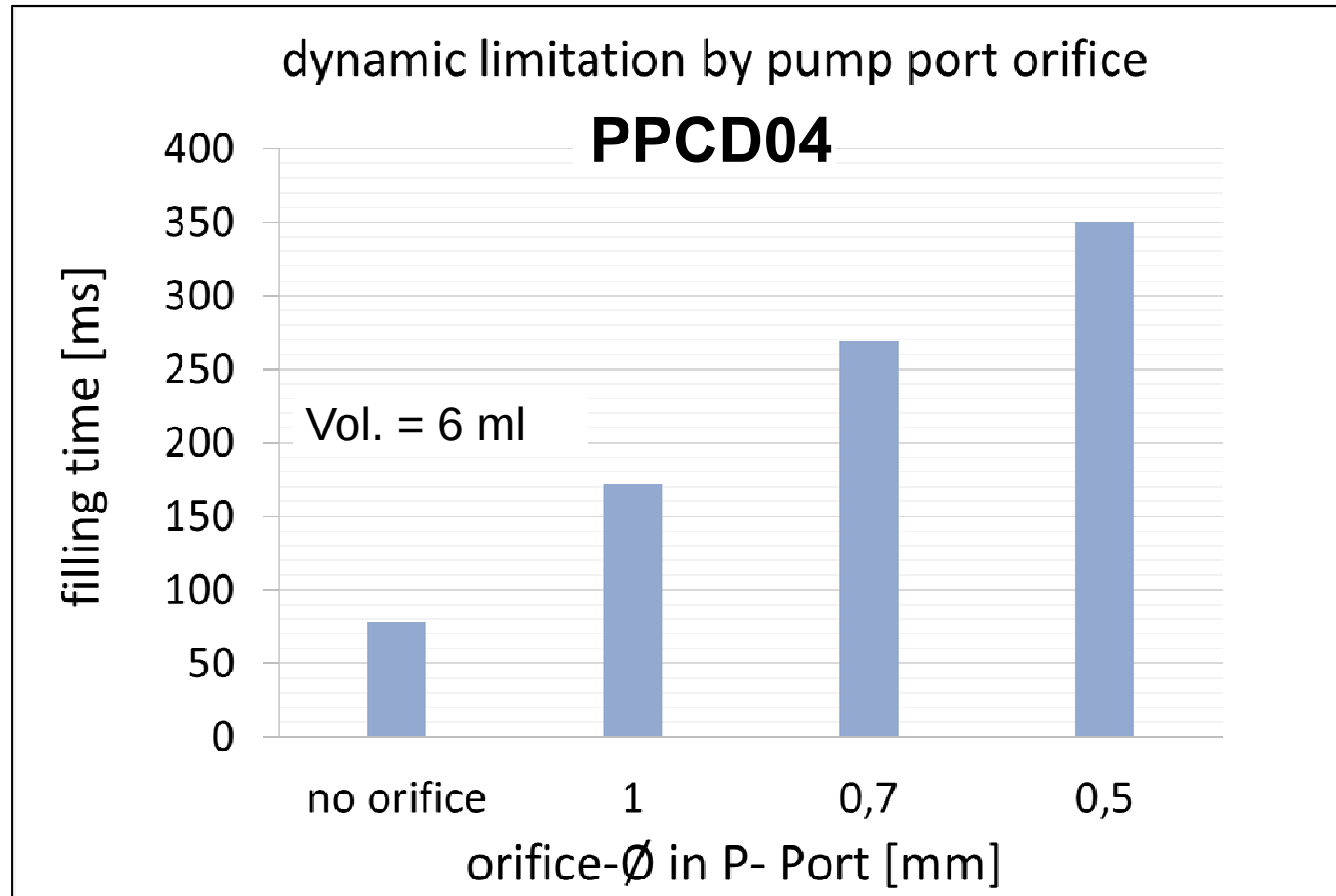


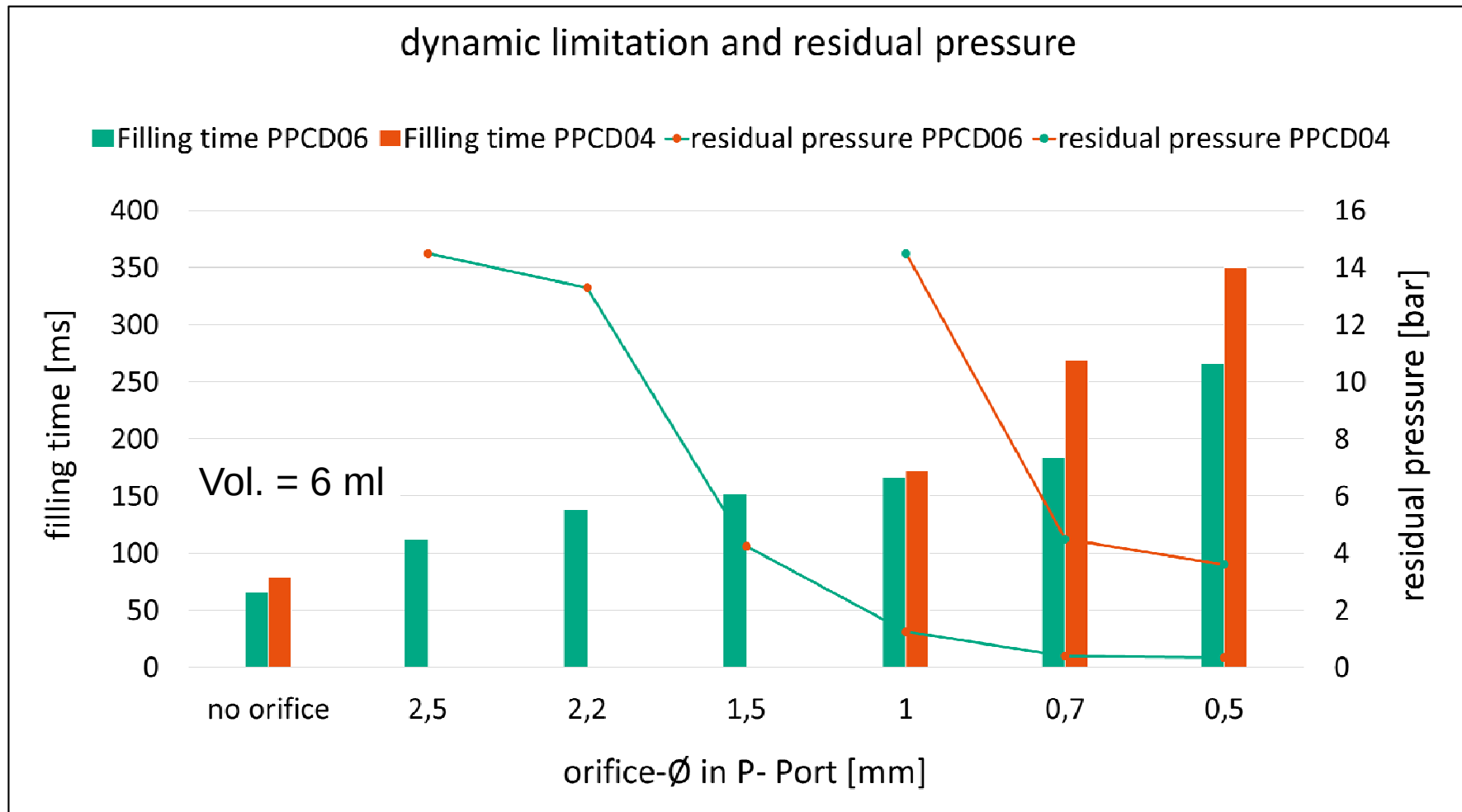
Final Design



Remaining control pressure depending
on pump pressure and orifice-Ø



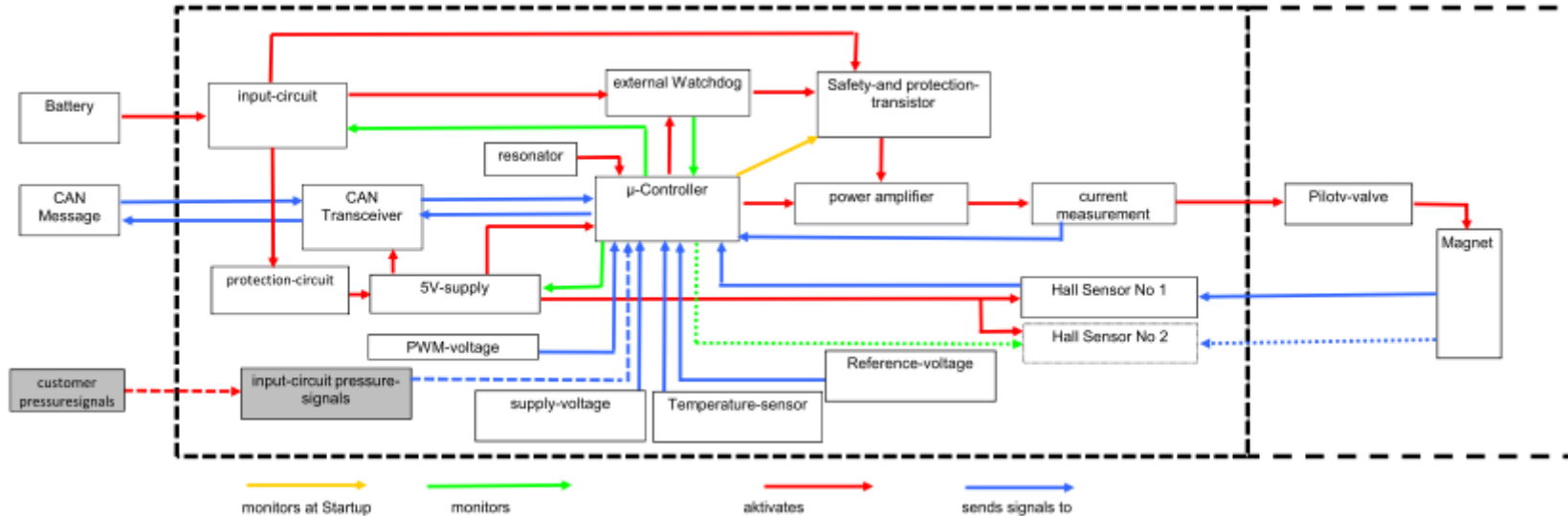
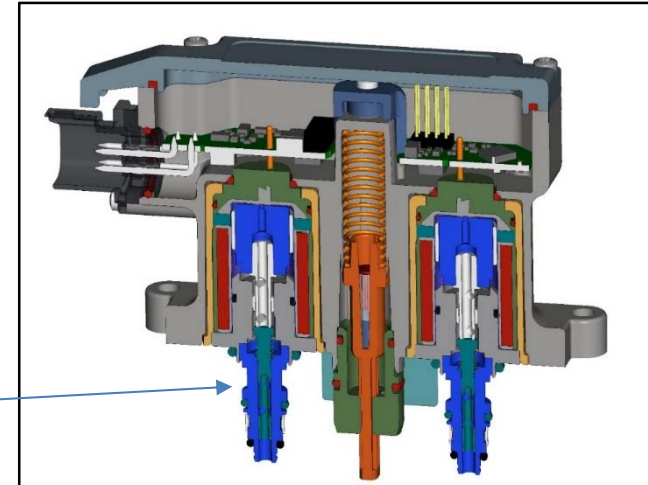




Electrohydraulic Actuator

- CAN Signal as input command
- Position feedback signal by hall sensor
- Rated according to ISO13849

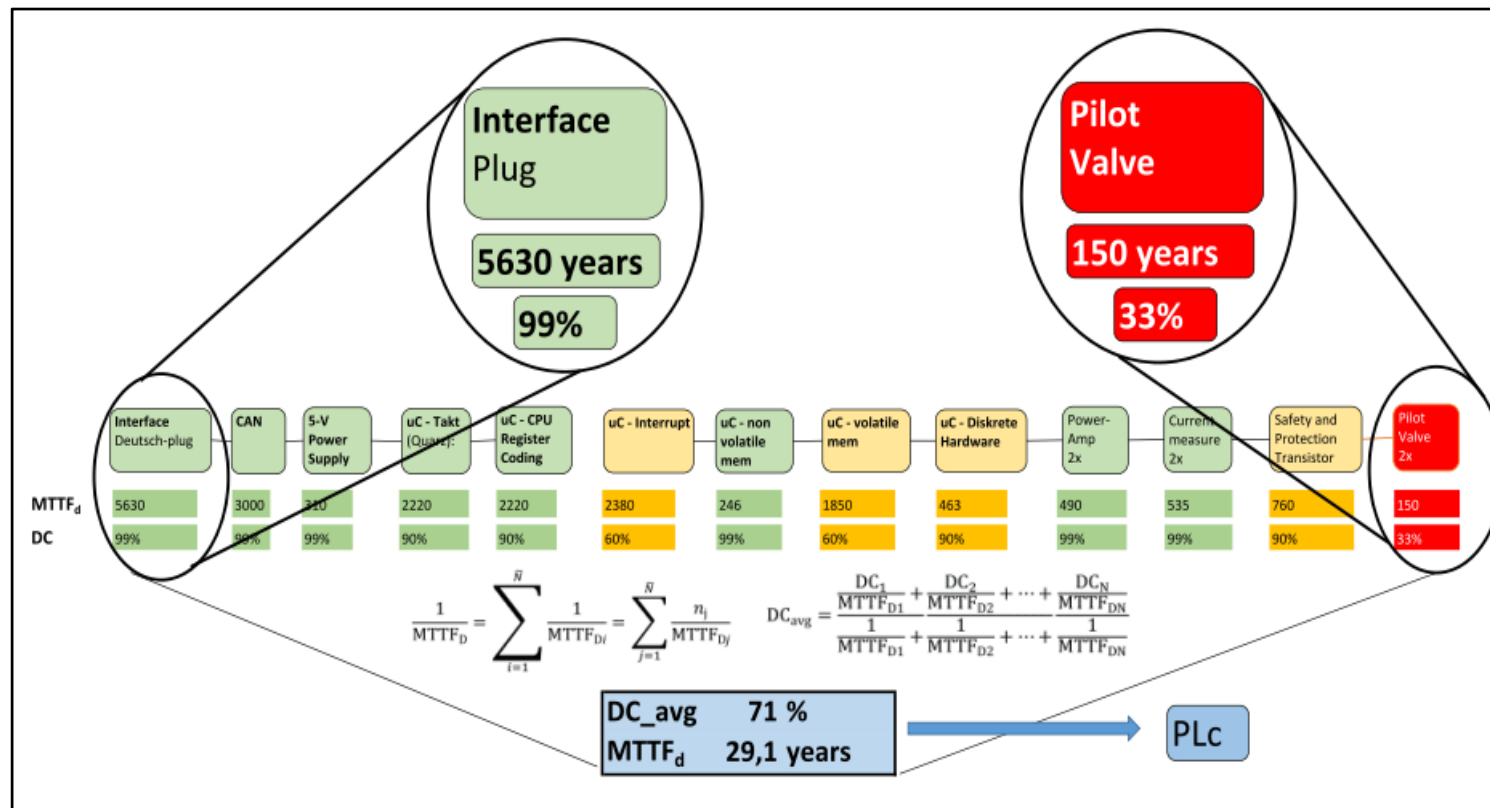
MTTFd = 150 year



Influence on functional safety ratings

Reliability model for the main Safety Function:

Both pilot valves are generating a pilot pressure below P_{SF} if neutral position is commanded

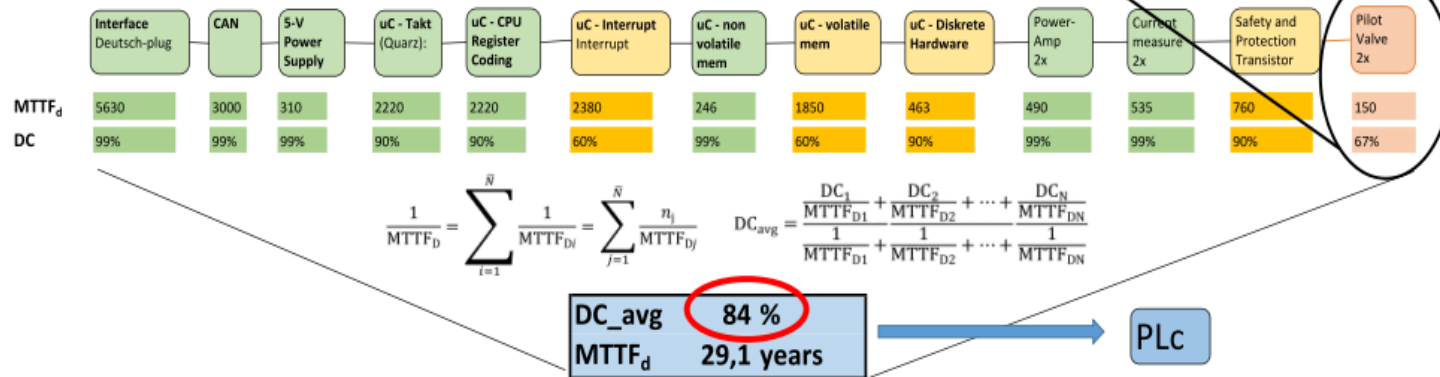


Influence on functional safety ratings

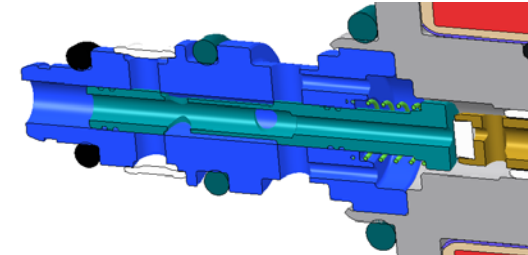
[illegible]

Detectable and EHA can be brought into safe state

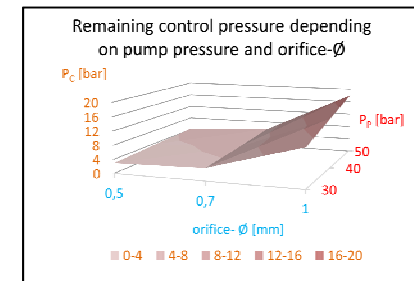
Possible failure modes due to table C.6 in ISO 13849



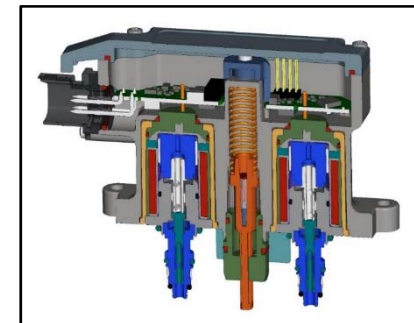
Introduction of valves with fail safe function



Discussion of limits and restrictions



Positive effects on functional rating of systems with integrated fail safe valves



Thank you for your attention!

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Email: joerg.schneider@thomas-magnete.com