

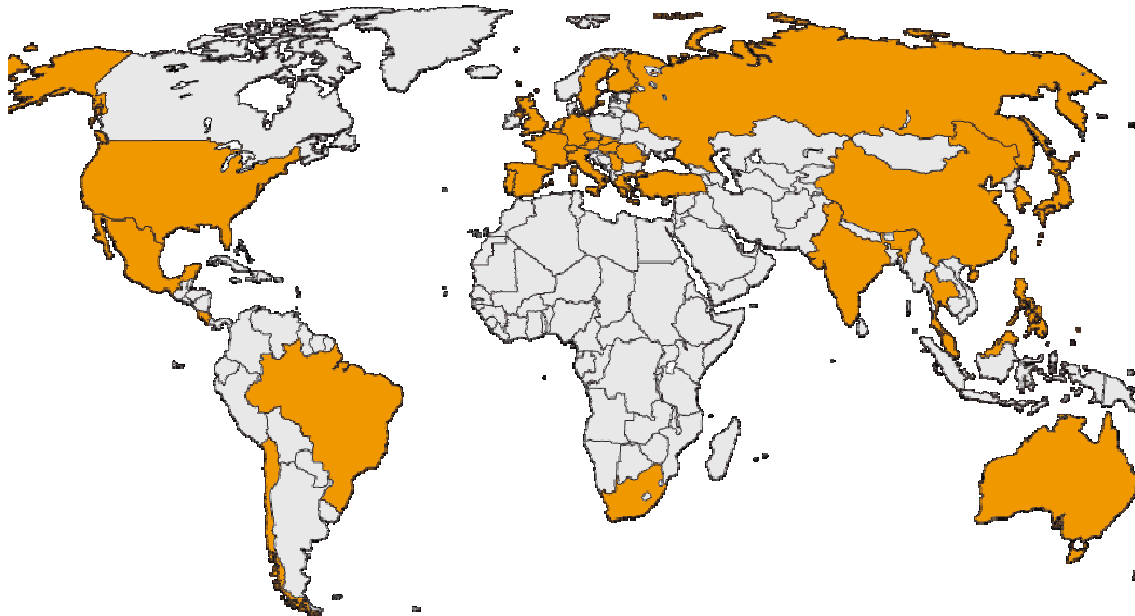


R&D department

Continental Automotive Asnières France

High pressure pump development

CONTINENTAL group

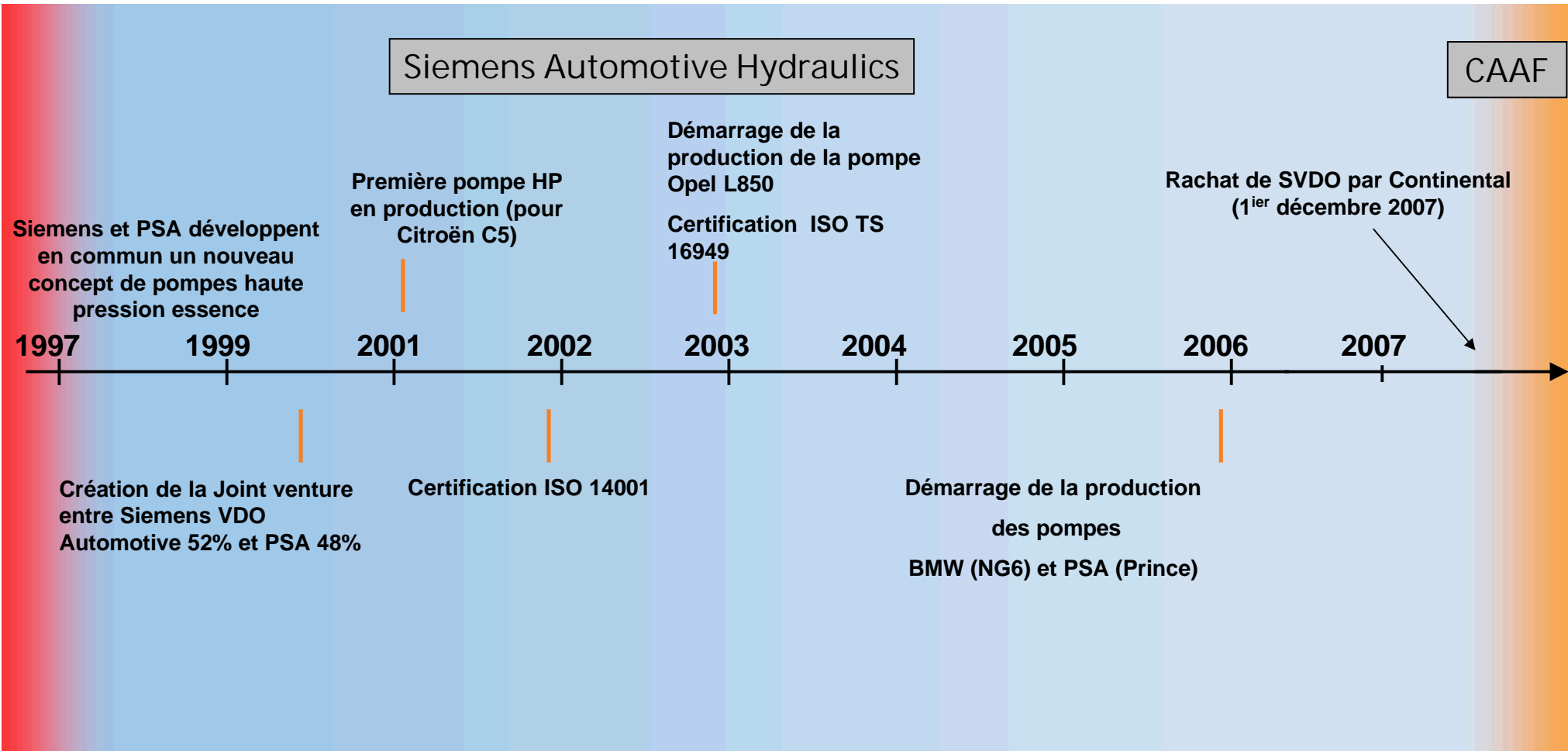


- 5th automotive supplier
- 130 000 people
- 190 R&D and manufacturing plants
- 6 divisions:
 - Chassis & Safety
 - Powertrain
 - Interior
 - Passenger & Light Truck Tires
 - Commercial Vehicle Tires
 - ContiTech

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CONTINENTAL AUTOMOTIVE ASNIERES FRANCE

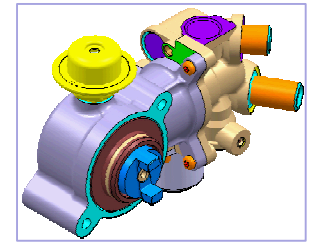
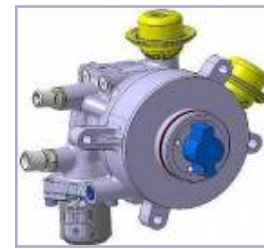
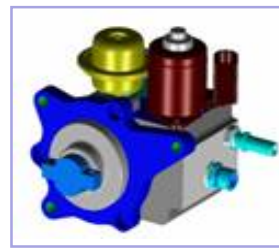
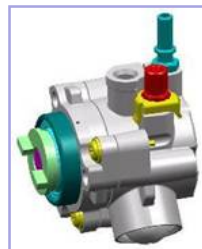


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Pompes haute pression développées et industrialisées par CAAF

Historique



C5

Pompe 3 pistons
3ME6

Signum

Pompe 3 pistons
3ME6

Série 3 / 5

Pompe 3 pistons
3FC12

207 / 307 / C3

/ mini cooper
Pompe 2 pistons
2FC9

2^{ème} génération

Boxter / Cayenne

Pompe 3 pistons
Pompe 6 pistons

C-class / E-class

Pompe mono-
pistons

1^{re} génération

1^{re} génération

3^{ème} génération

2001

2003

2005

2007

2009



PSA PEUGEOT CITROËN



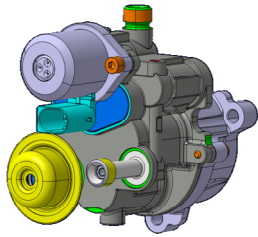
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Projets de développement chez CAAF



Pompe 3 pistons
3ME6
1^{ère} génération

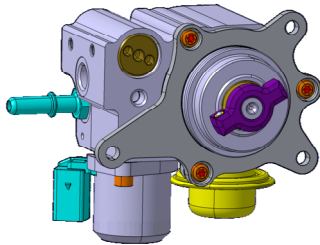


Pompe 3 pistons
3FC12

2^{ème} génération



PORSCHE



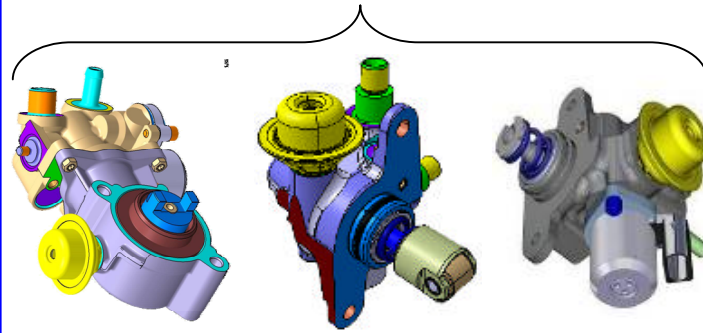
Pompe 2 pistons
2FC9
2^{ème} génération



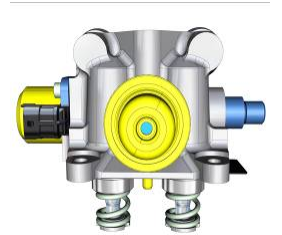
6 piston pump
6FC24
2^{ème} génération



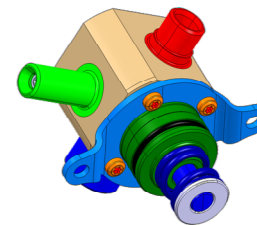
Monopistons transfert
3^{ème} génération



Pompe Twin transfert
3^{ème} génération



Monopiston std



2000

2006

2008

2009

2010

2011

2012

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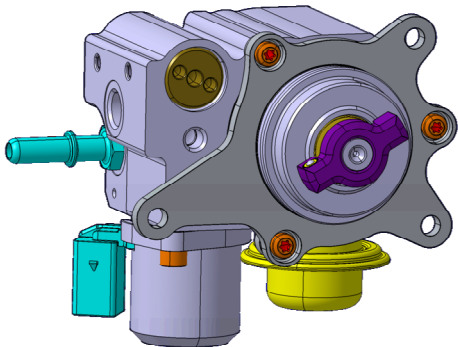


2FC9 - Prince



Technical data

- n Supply pressure : 12.0 MPa
- n Feed pressure : 0.5 +/- 0.05 MPa
- n Operating temp. : - 40...+135 °C
- n Flow control : proportional FCV
- n Drive: Camshaft driven
- n Max. flow: 0.6 cc/rev @ 12 MPa



SOP: 2006

Max volume: 200K/yr

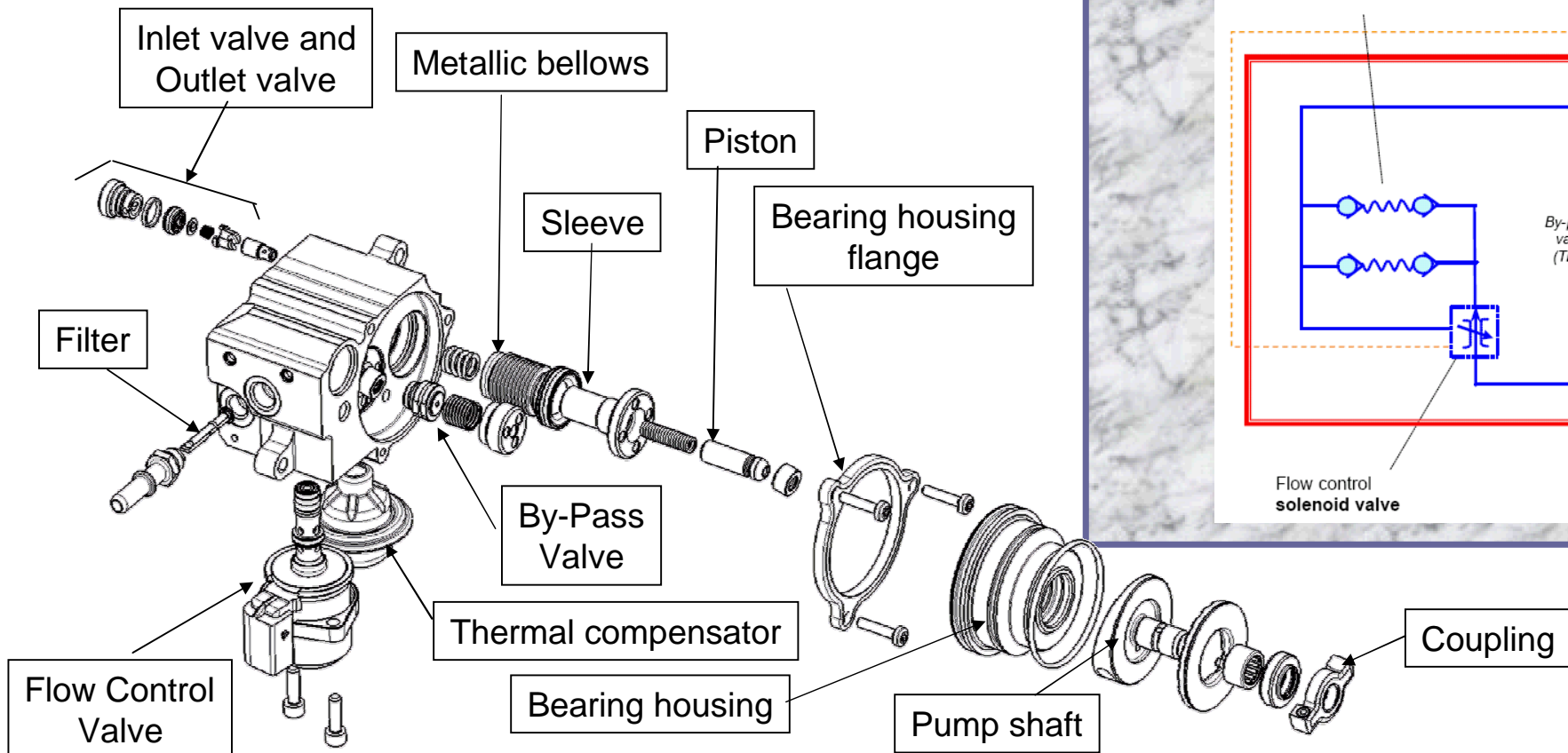
Main characteristics

- n E-85 capable
- n Flow control & pressure control
- n Long dry-running operation possible
- n Pressure relief valve integrated

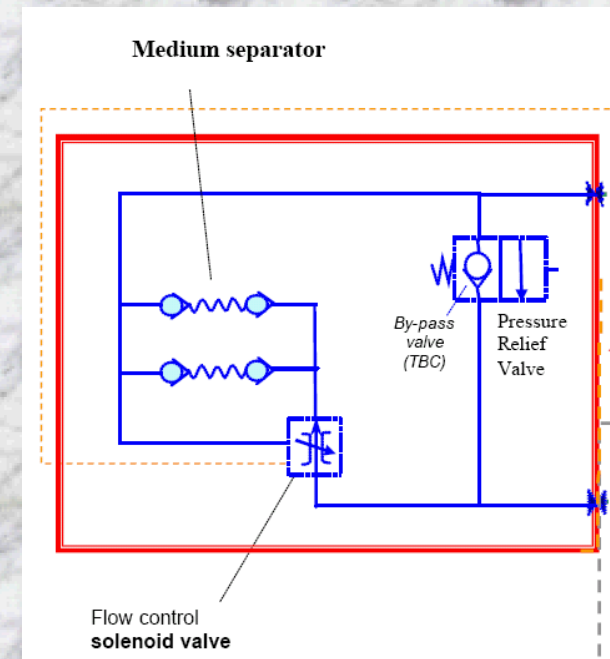
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Prince concept



Hydraulic scheme



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3FC12 - NG6

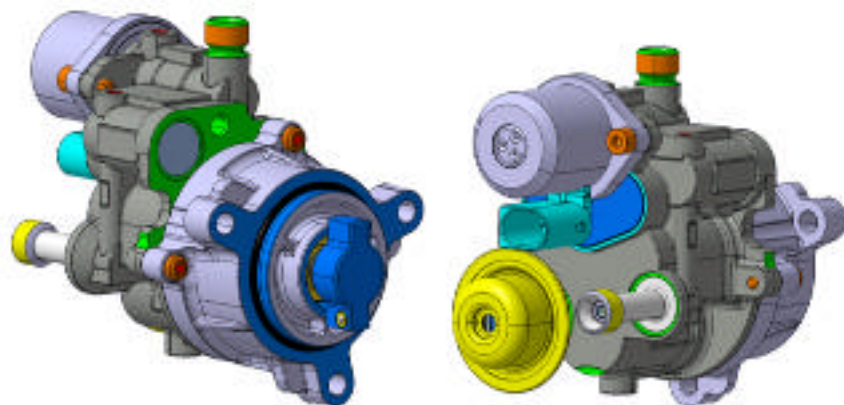
Technical data

- n Supply pressure : 20.0 MPa
- n Feed pressure : 0.45...0.6 MPa
- n Operating temp. : - 40...+140 °C
- n Flow control : proportional FCV
- n Drive: Driven by the vacuum pump
- n Max. flow: 1 cc/rev @ 20 MPa

NG6

SOP: 2006

Max volume: 200K/yr



Main characteristics

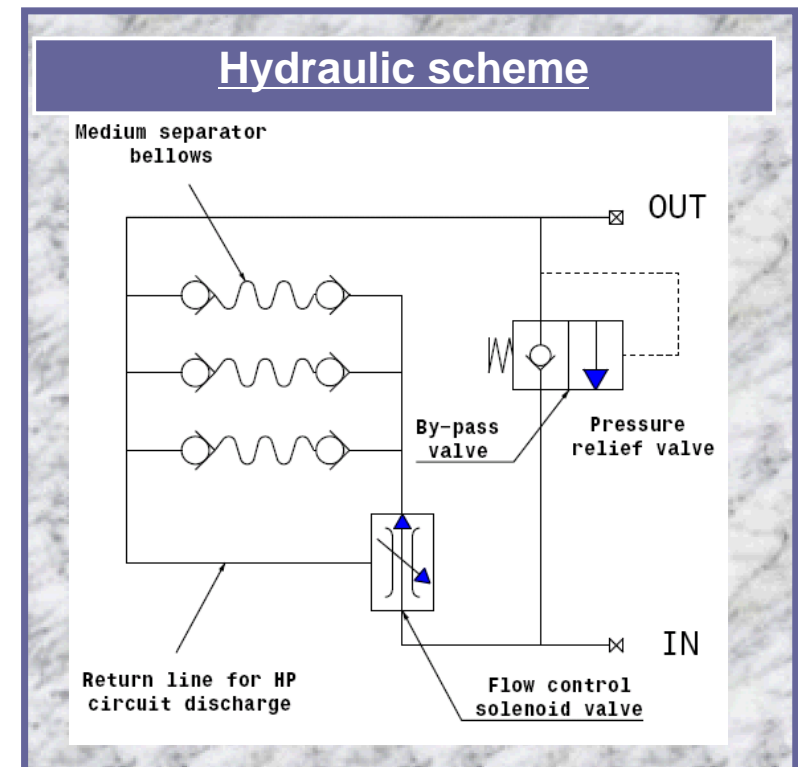
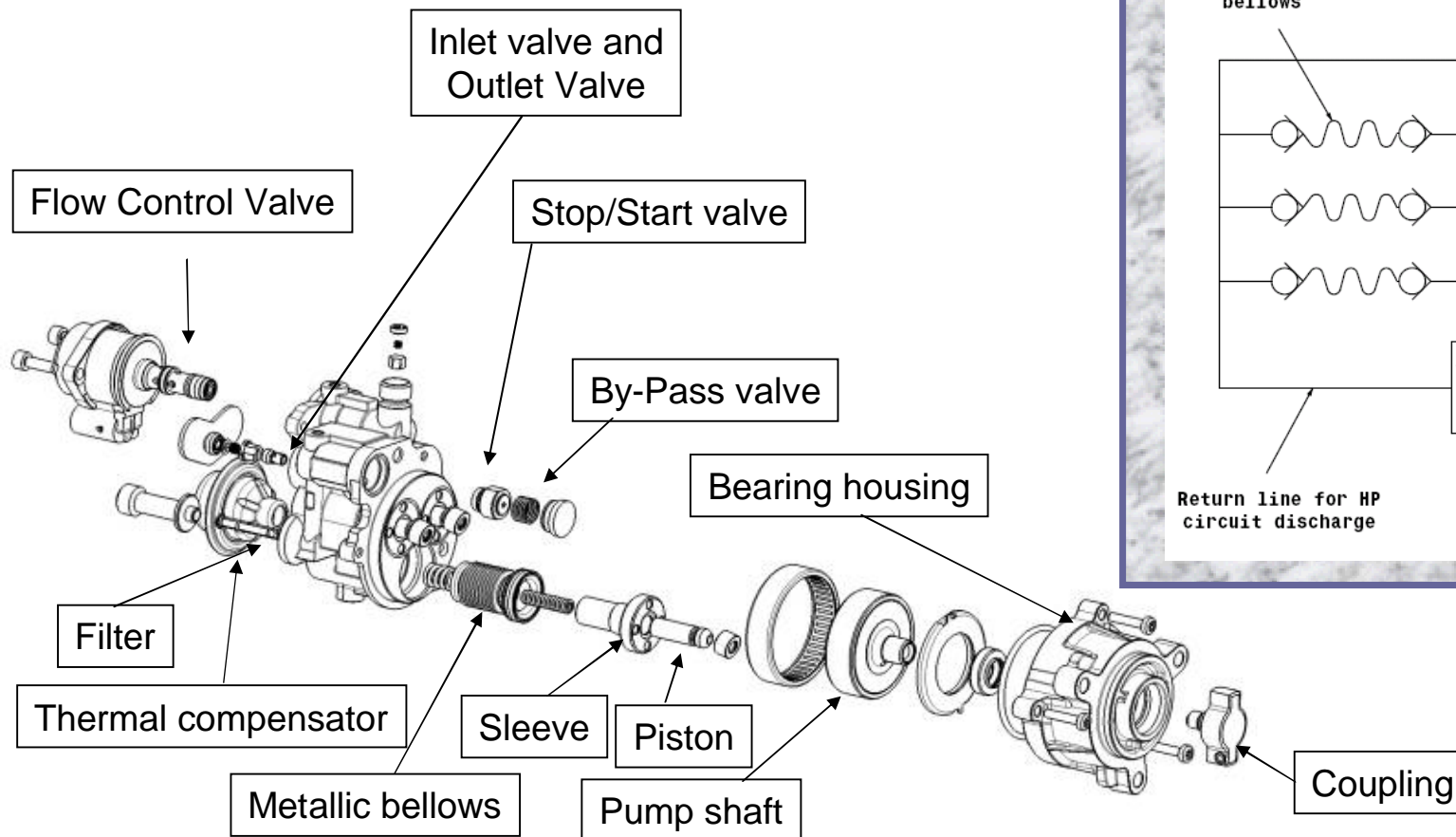
- n E-85 capable (N55)
- n Flow control & pressure control
- n Long dry-running operation possible
- n Pressure relief valve integrated
- n N55: Pressure maintained in the rail when engine is stopped

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NG6 Pump concept



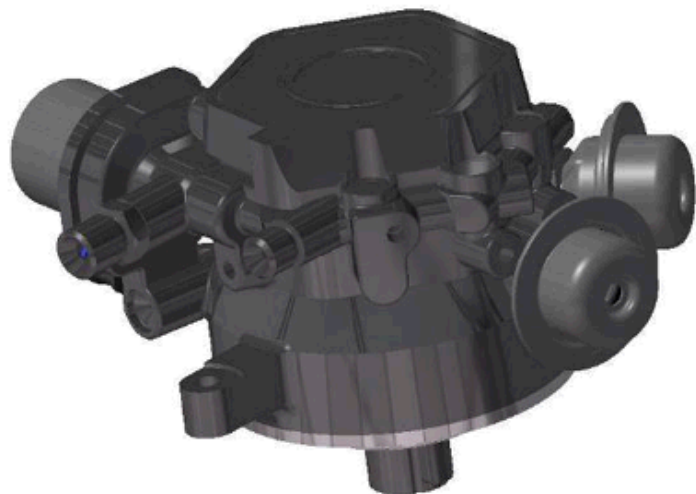
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6FC24 - PAG 6 Pistons Pump

Technical data

- n Supply pressure : 12.0 to 14,5 MPa
- n Feed pressure : 0.42 to 0.6 MPa
- n Operating temp. : - 40 to +130 °C
- n Flow control : proportional FCV
- n Drive: camshaft driven
- n Max. flow (gasoline): 1.9 cc/rev @ 12 MPa



Main characteristics

- n “Transfer” pump technology
- n E-25 capable
- n Flow control & pressure control
- n Long dry-running operation possible
- n Pressure relief valve integrated

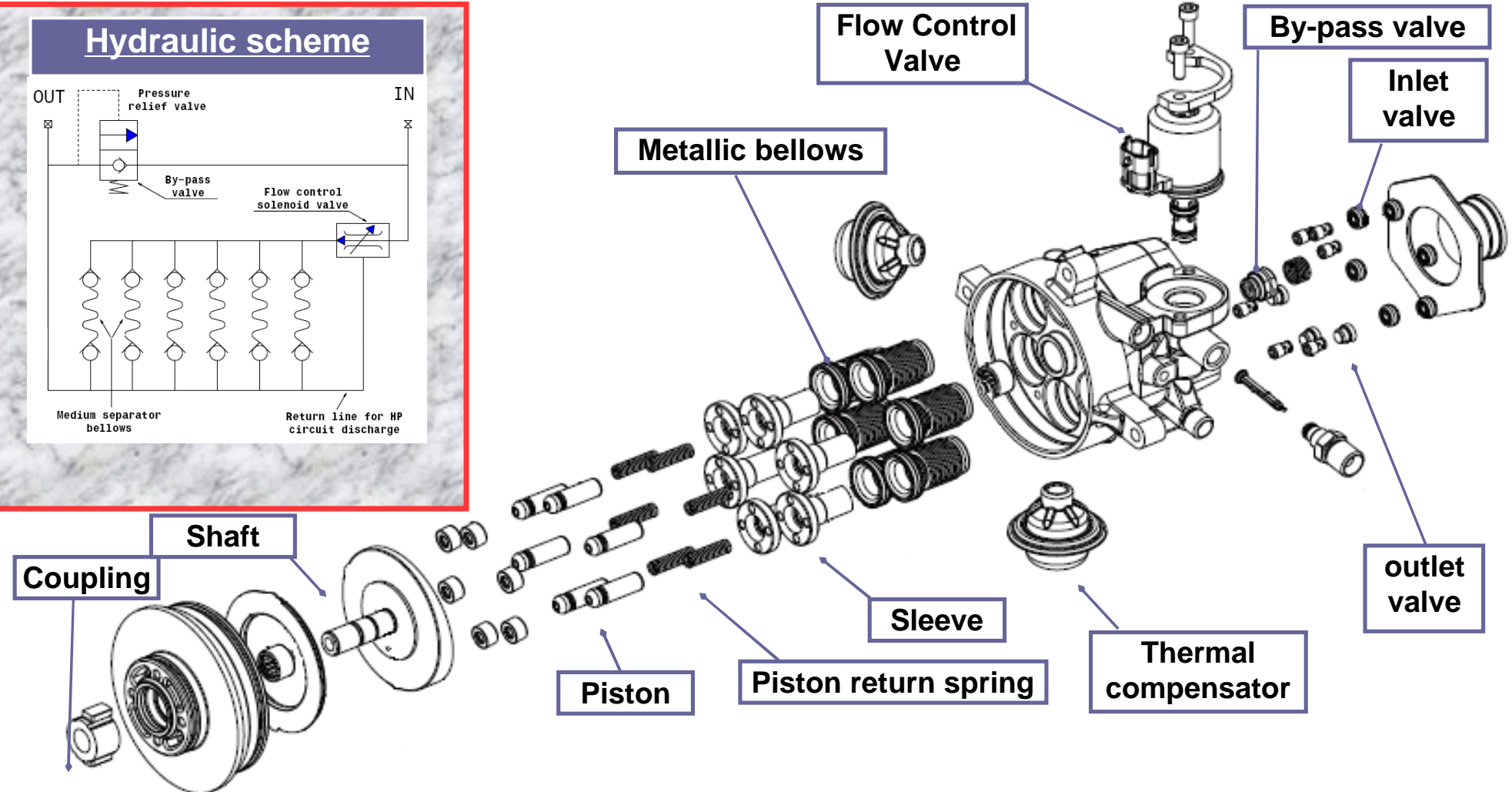
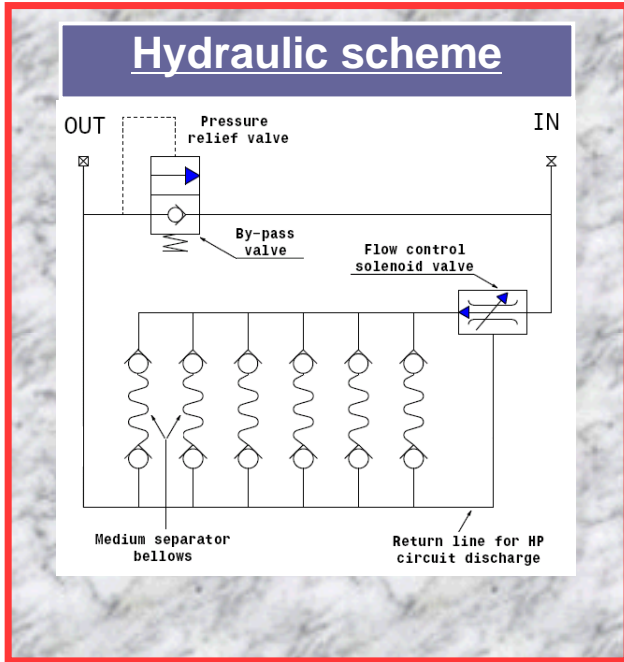
Project data

- n V8T SOP: 09/2006 – 6k/year
- n B6T SOP: 09/2009 – 5.5k/year
- n V8T Panamera SOP: 03/2009 – 3.7k/year



PORSCHE

PAG 6 Pistons Pump Concept



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M271EVO Single Piston Pump

Technical data

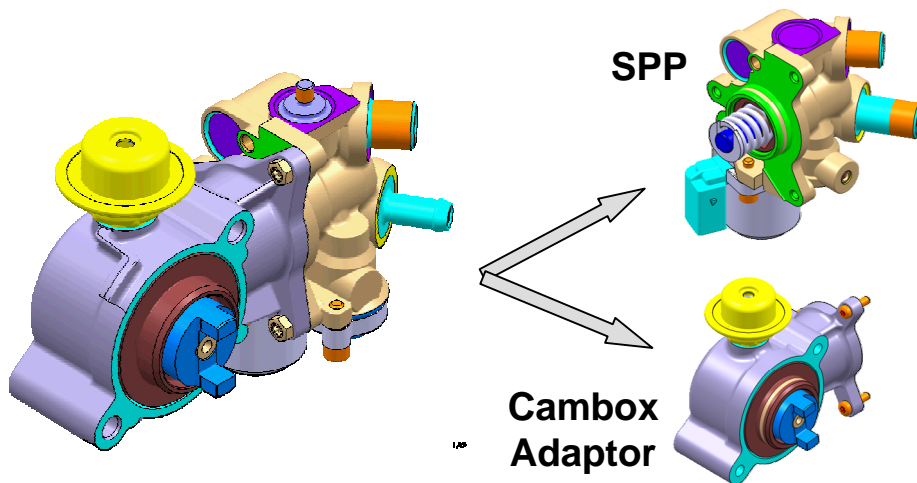
- n Supply pressure : 15.0 MPa
- n Feed pressure : 0.4...0.6 MPa
- n Operating temp. : - 40...+130 °C
- n Flow control : proportional FCV
- n Drive: cam driven stroke 3,3mm
- n Max. flow: 0,6 cc/rev @ 15.0 MPa

SOP: 2009

Max volume: 200K / yr

Main characteristics

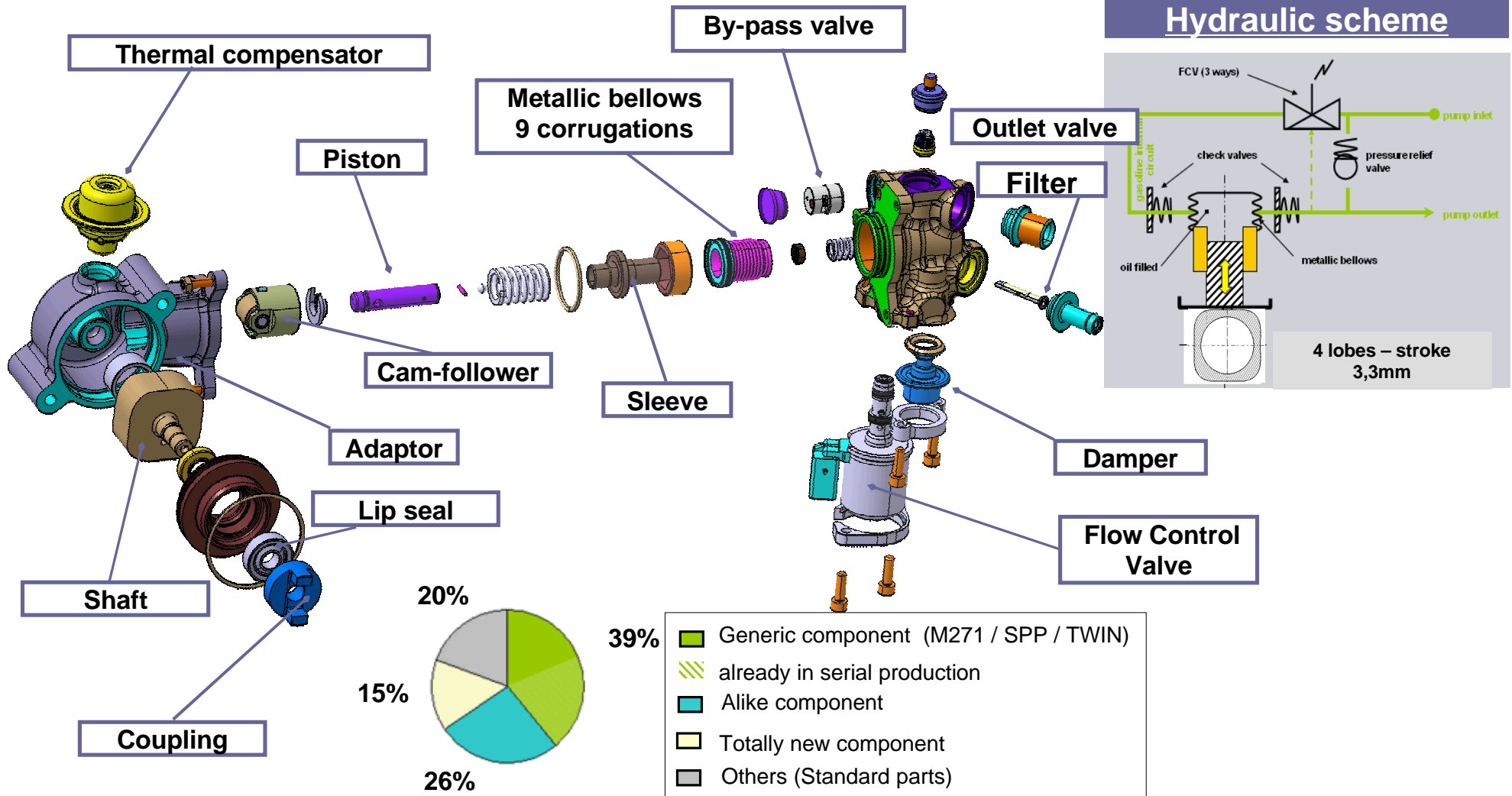
- n “transfer” pump technology
- n E-85 capable
- n Flow control & pressure control
- n Long dry-running operation possible
- n Pressure relief valve integrated
- n Stop-Start function integrated
- n LP pulsation damper integrated
- n No phasing needed with the engine (proportional FCV @ pump inlet)



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M271EVO Single Piston Pump concept



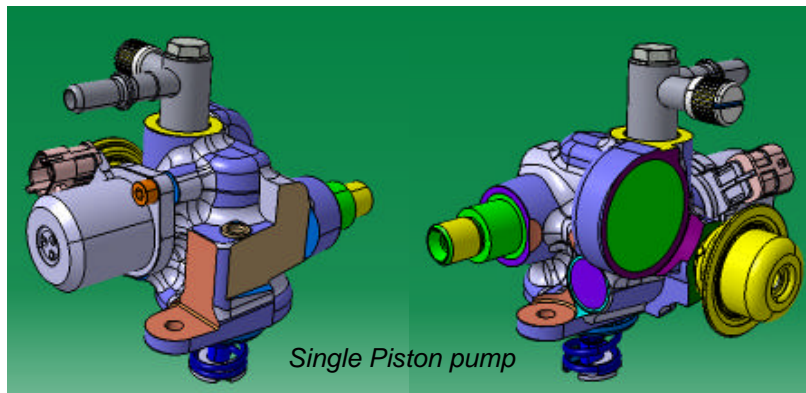
CONFIDENTIEL



Single Piston Pump

Technical data

- n Supply pressure : 20.0 MPa
- n Feed pressure : 0.4...0.55 MPa
- n Operating temp. : - 40...+130 °C
- n Flow control : proportional FCV
- n Drive: cam driven
- n Max. flow: 0.8 cc/rev @ 20 MPa

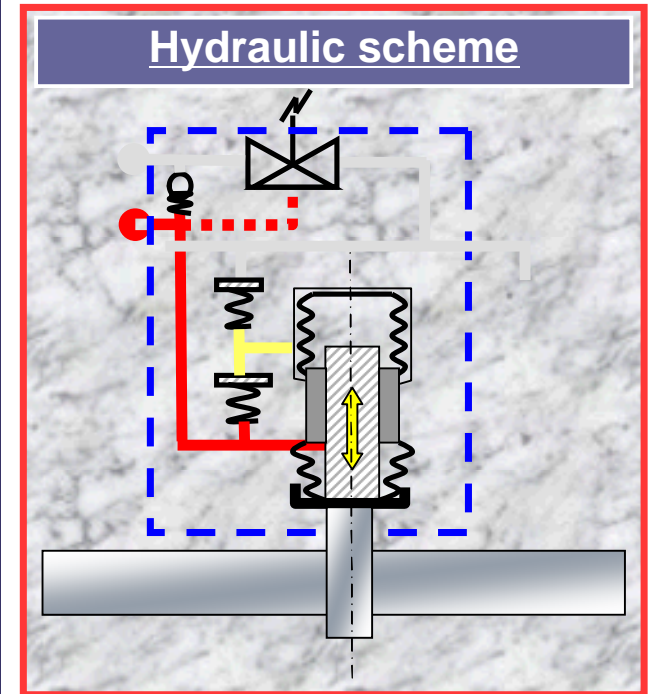
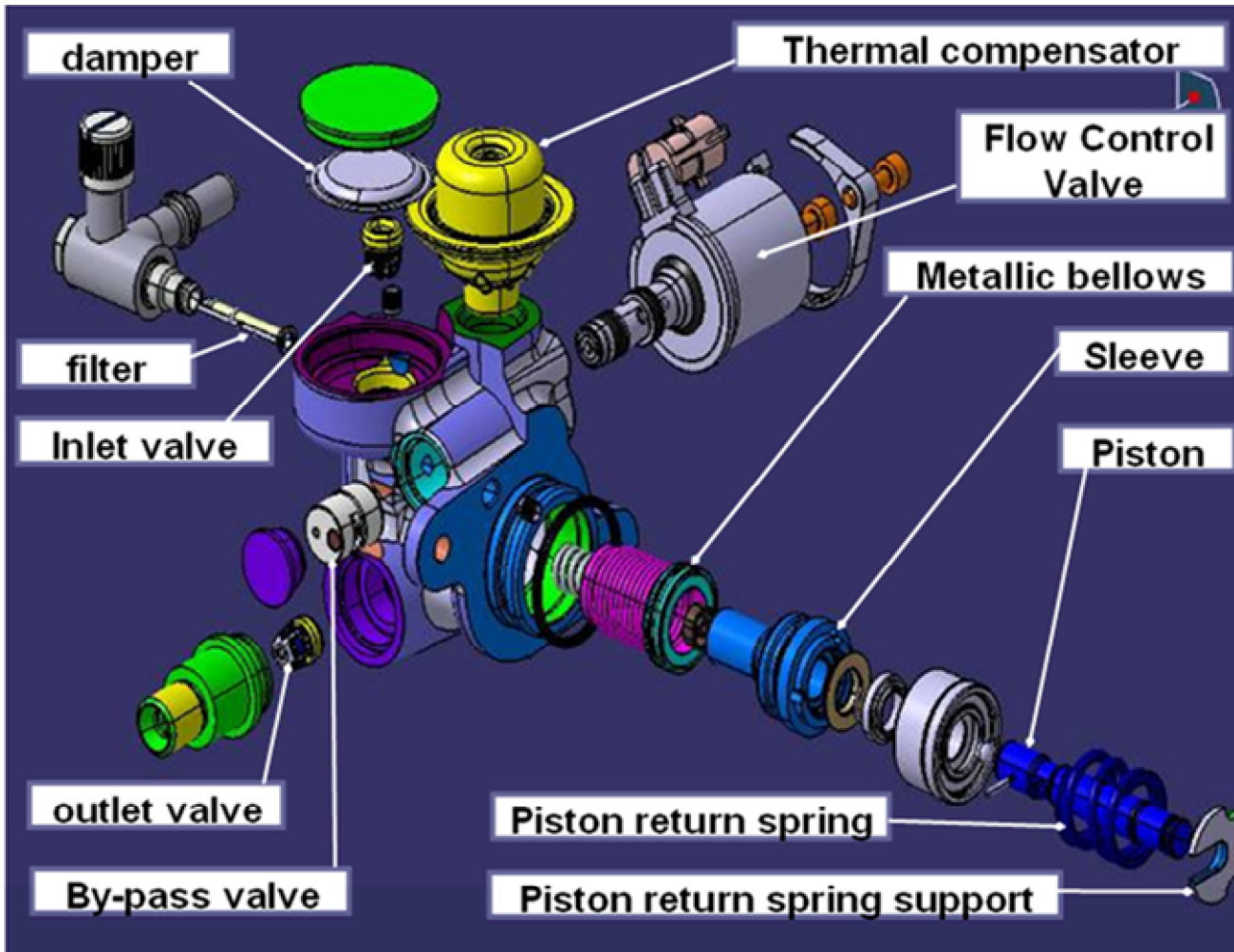


Main characteristics

- n “transfer” pump technology
- n E-85 capable
- n Flow control & pressure control
- n Long dry-running operation possible
- n Pressure relief valve integrated
- n LP pulsation damper integrated
- n No phasing needed with the engine (proportional FCV @ pump inlet)

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Single Piston Pump concept



CONFIDENTIEL

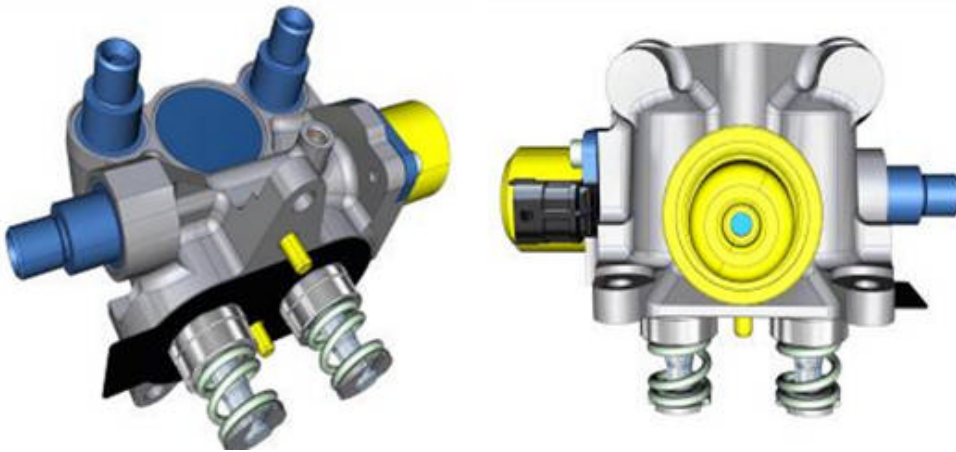
TWIN PISTONS PUMP

Technical data

- n Supply pressure : 15.0 MPa
- n Feed pressure : 0.45...0.6 MPa
- n Operating temp. : - 40...+130 °C
- n Flow control : proportional FCV
- n Drive: cam driven (up to 4 lobes)
- n Max. flow: 1.8 cc/rev @ 20 MPa

Main characteristics

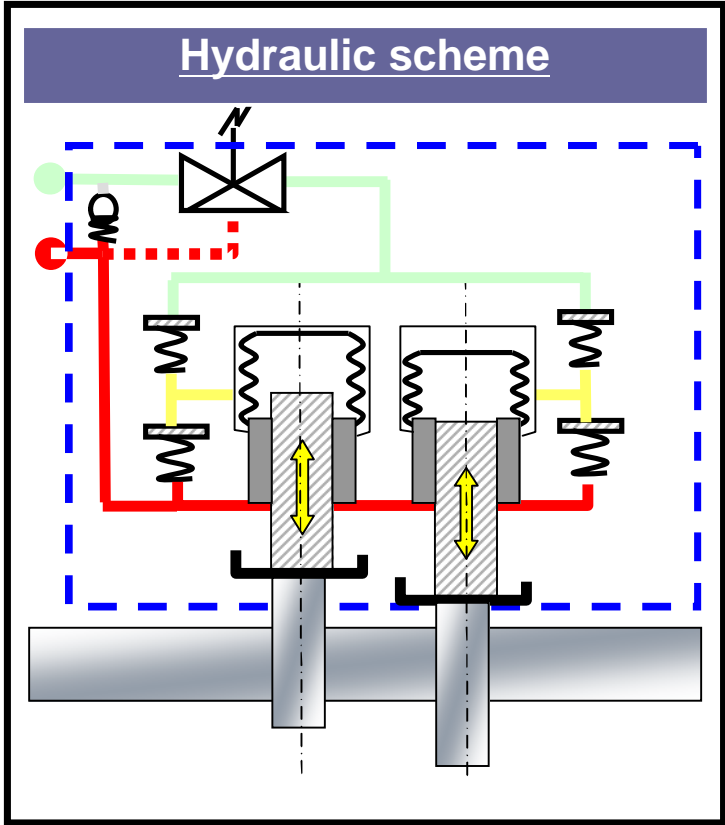
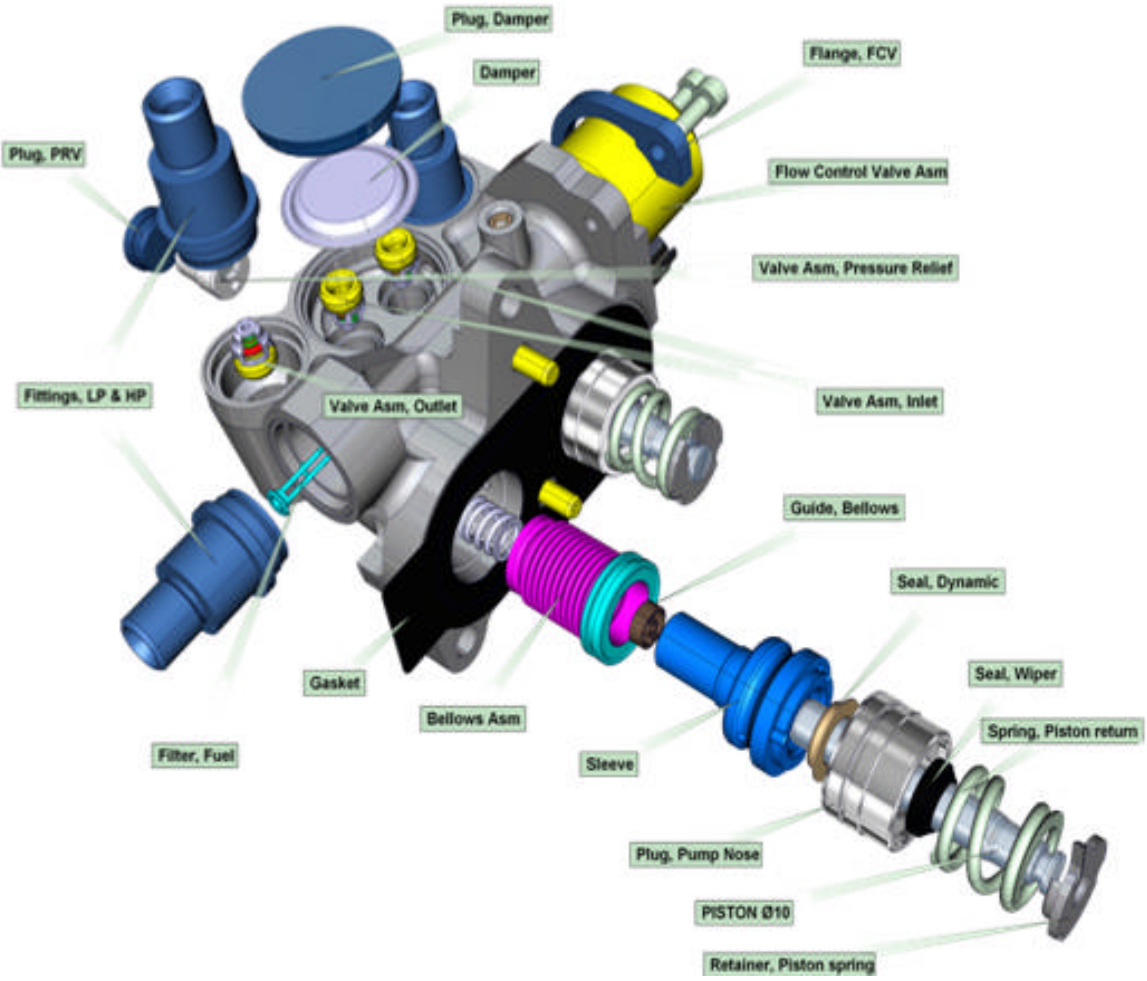
- n “transfer” pump technology
- n E-85 capable
- n Flow control & pressure control
- n Long dry-running operation possible
- n Pressure relief valve integrated
- n LP pulsation damper integrated



*TWIN Pistons Pump
"B0" design level*

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TWIN PISTONS PUMP



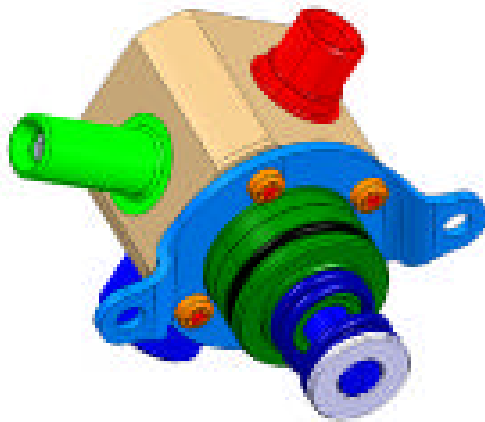
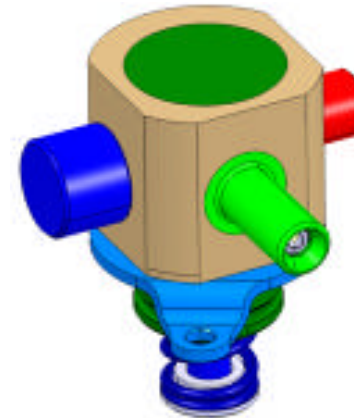
CONFIDENTIEL



CHiP3 pump – profile card

Technical data

| | | |
|---|-------------------|-------------------------|
| n | Supply pressure : | 20.0 MPa |
| n | Feed pressure : | 0.45...0.6 MPa |
| n | Operating temp. : | - 40...+130 °C |
| n | Flow control : | On-Off valve |
| n | Drive: | cam driven (2-3-4lobes) |
| n | Max. flow: | 1 cc/rev @ 20 MPa |



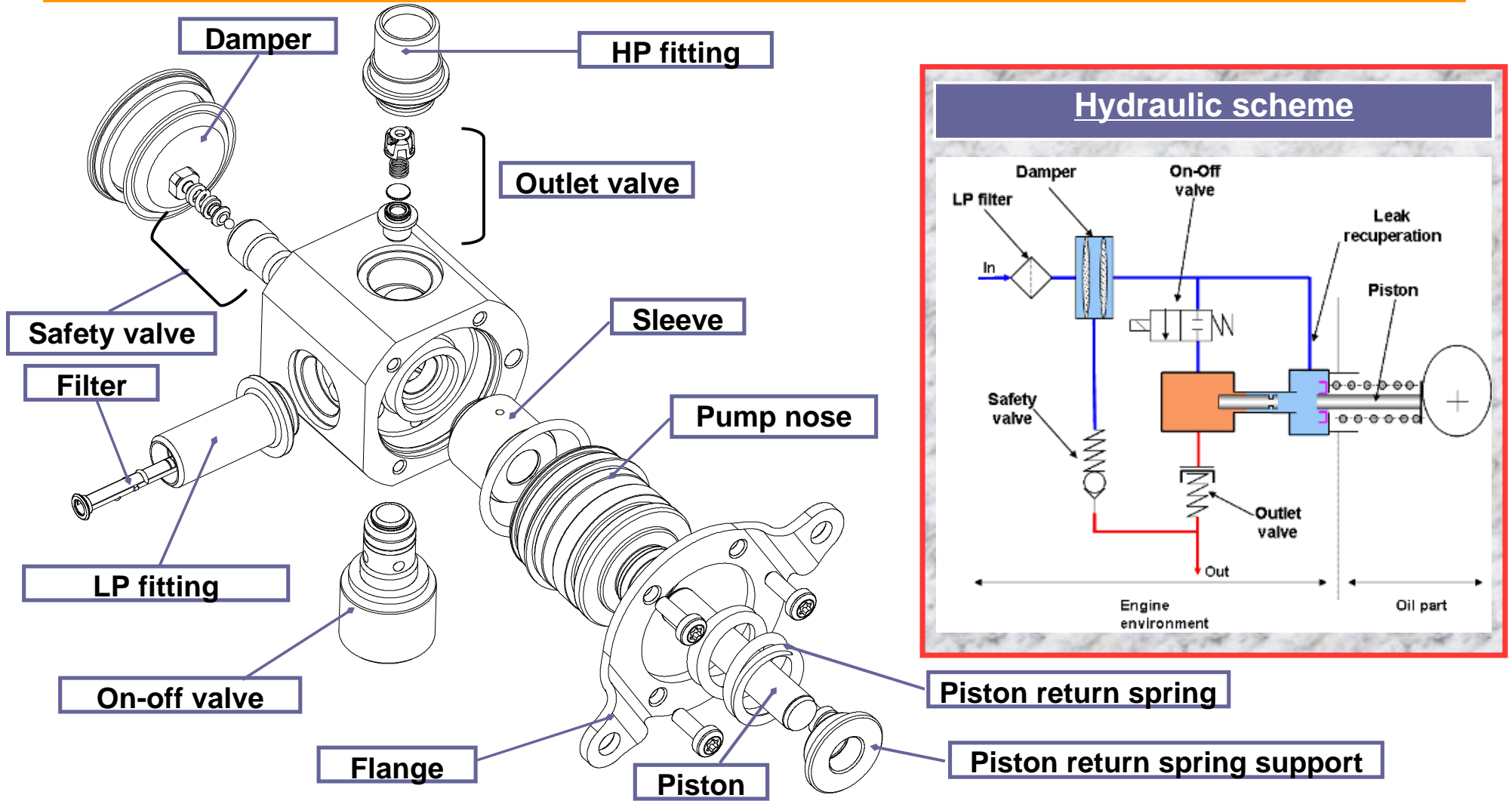
CHiP3 pump

Main characteristics

- n “un-transfer” pump technology
- n Worldwide applications including E-85
- n Flow control / Stop-start function (option)
- n Short dry-running operation possible
- n Pressure relief valve/ LP damper integrated
- n High flexibility: flange, fittings, on/off valve

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CHiP3 pump – profile card

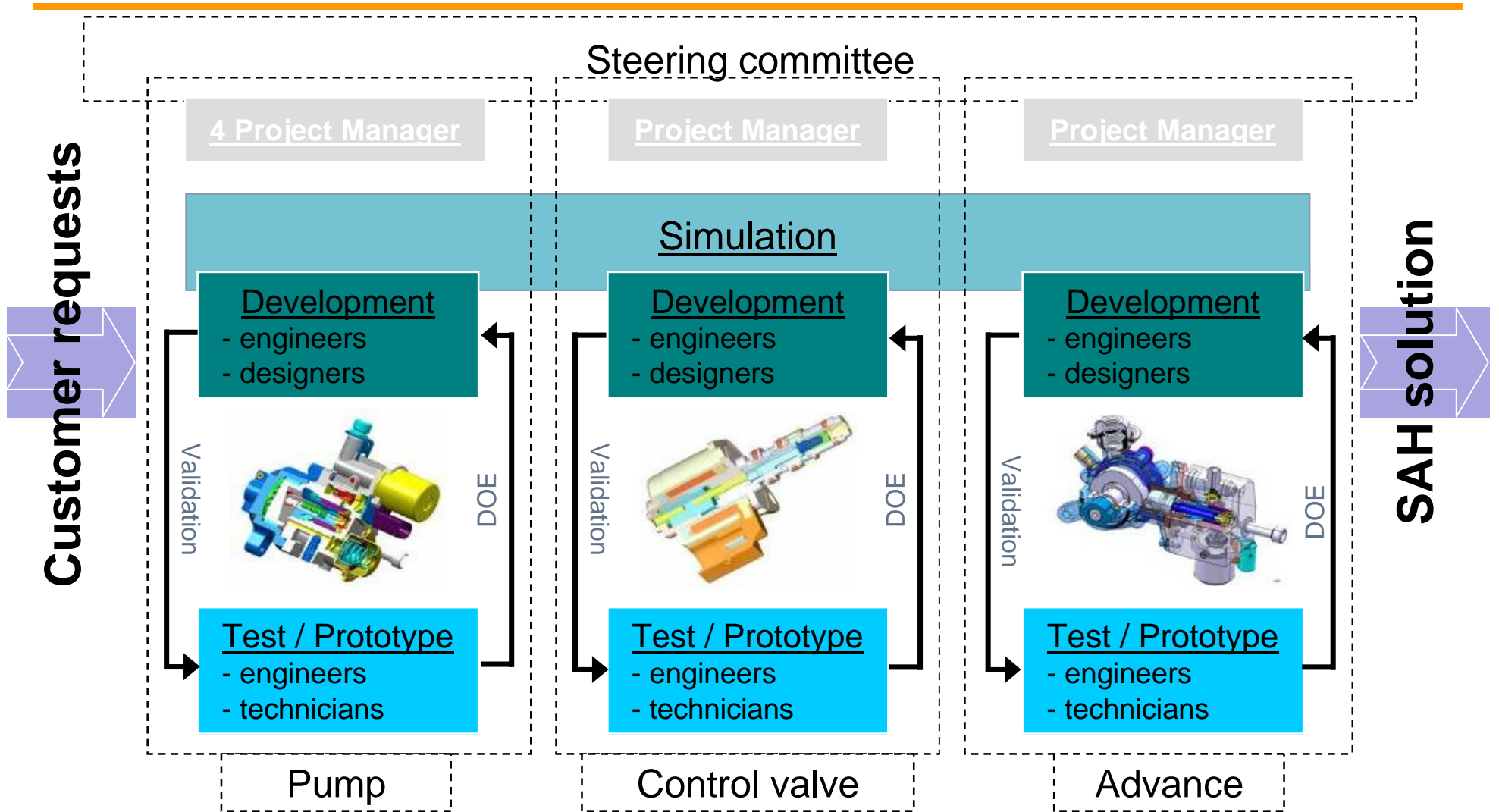


CONFIDENTIAL



R&D department

Organization



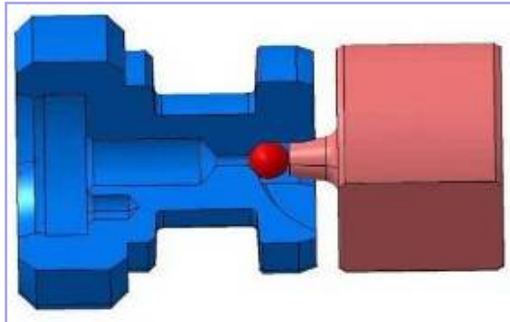
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R&D department

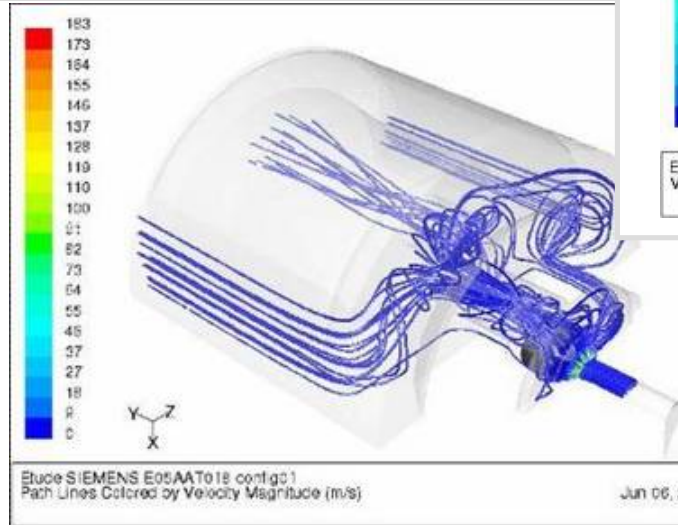
Simulation

Fluid mechanics

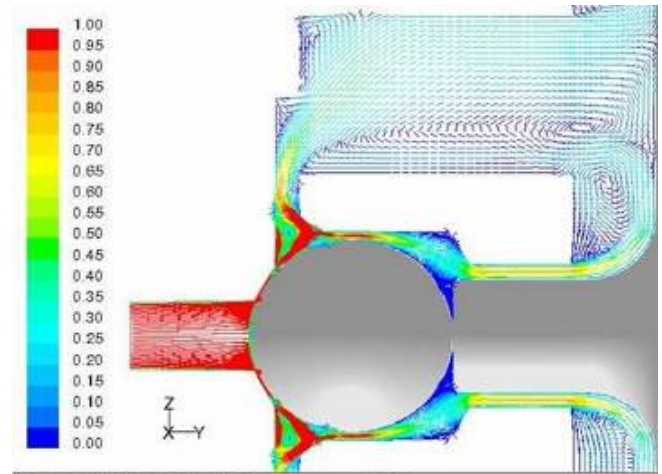
Flow optimisation
in 3rd line EV



Patch lines



Fluid velocity

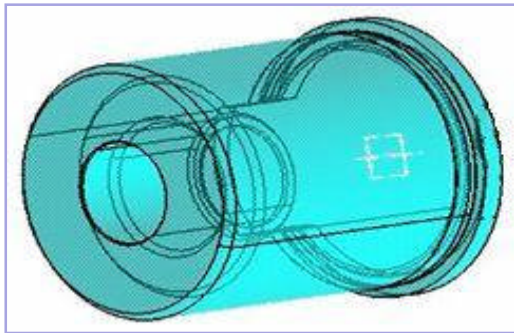


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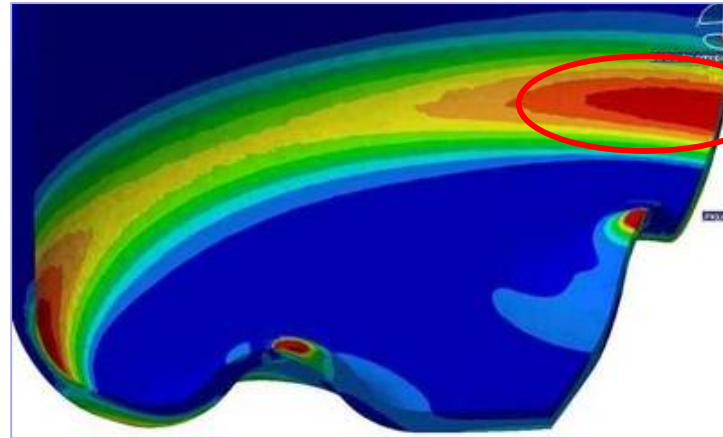
R&D department Simulation

Pressure dispersion

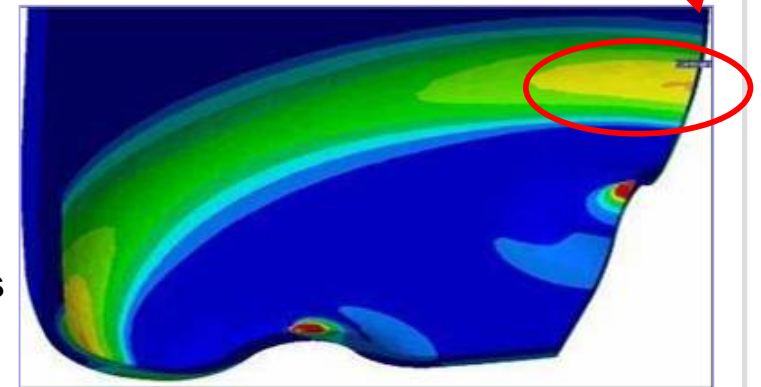
EV part
optimization



Final tube design
Find the best thickness



thickness
= 0.21 mm



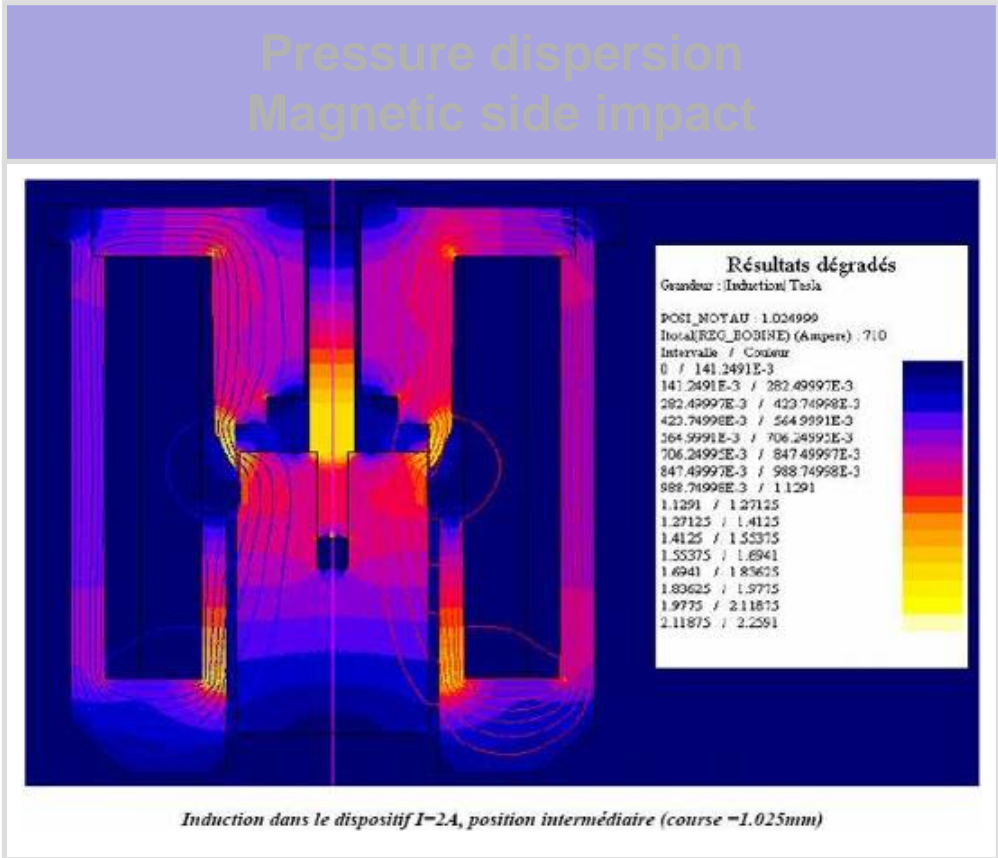
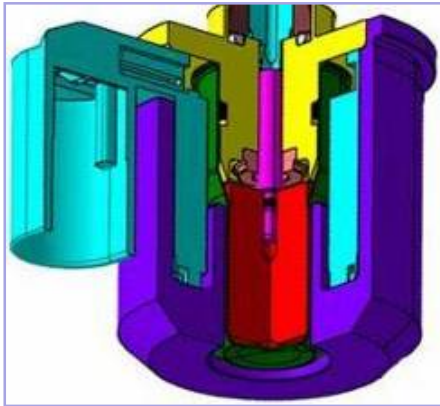
thickness
= 0.3 mm

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R&D department Simulation

Magnetic impact

Electromagnetic
part optimization



| | | |
|------------------|--------|---------|
| Stroke (mm) | 0,5 | 0,65 |
| Current (A) | 0,85 | 1,1 |
| FMax (N) | 5,06 | 7,21 |
| Fmin (N) | 4,22 | 6,2 |
| % versus nominal | ± 9,1% | ± 7,55% |

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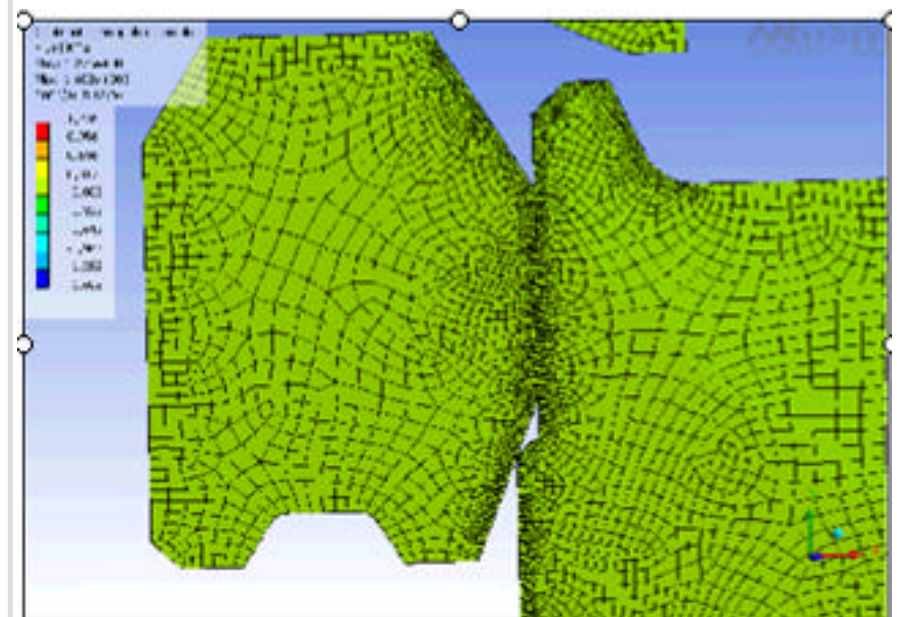
R&D department Simulation & test

Stress measurement

3 piston pump



Inlet Valve optimization : crimping



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R&D department

Validation & test

Tasks and Responsibilities

Ä Performing measurement and analysis of high pressure pump:

- Prototypes assembly for development and new concepts
- Testing support for development and new generation concept
- Failure analysis on tested feature & returned part from customer
- Support for products development & validation
- Support for production process validation
- Continuous improvement on testing equipments and analysis facilities

R&D department Validation & test

Gasoline test equipment

2 Gasoline durability test benches



2 Gasoline test benches



Pump durability test

12 Exxsol (D100) Test benches



Polyvalent test bench

Two multipurpose test bench



Other assembly & Tests equipments

Pump's oil part filling bench



Thermal chamber

PC controlled Crimping Press

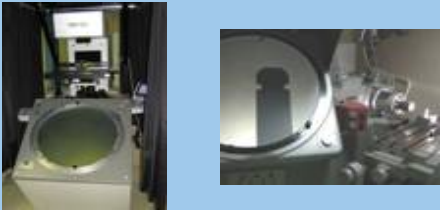


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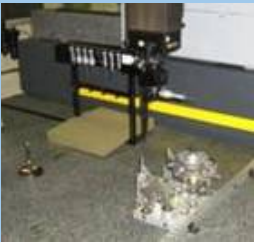
Laboratory and metrology

Measuring equipment

2 Profile projector



Three-dimensional measurement



Height Gage



Daltec



Laser



Spring test, Roundness

Roundness



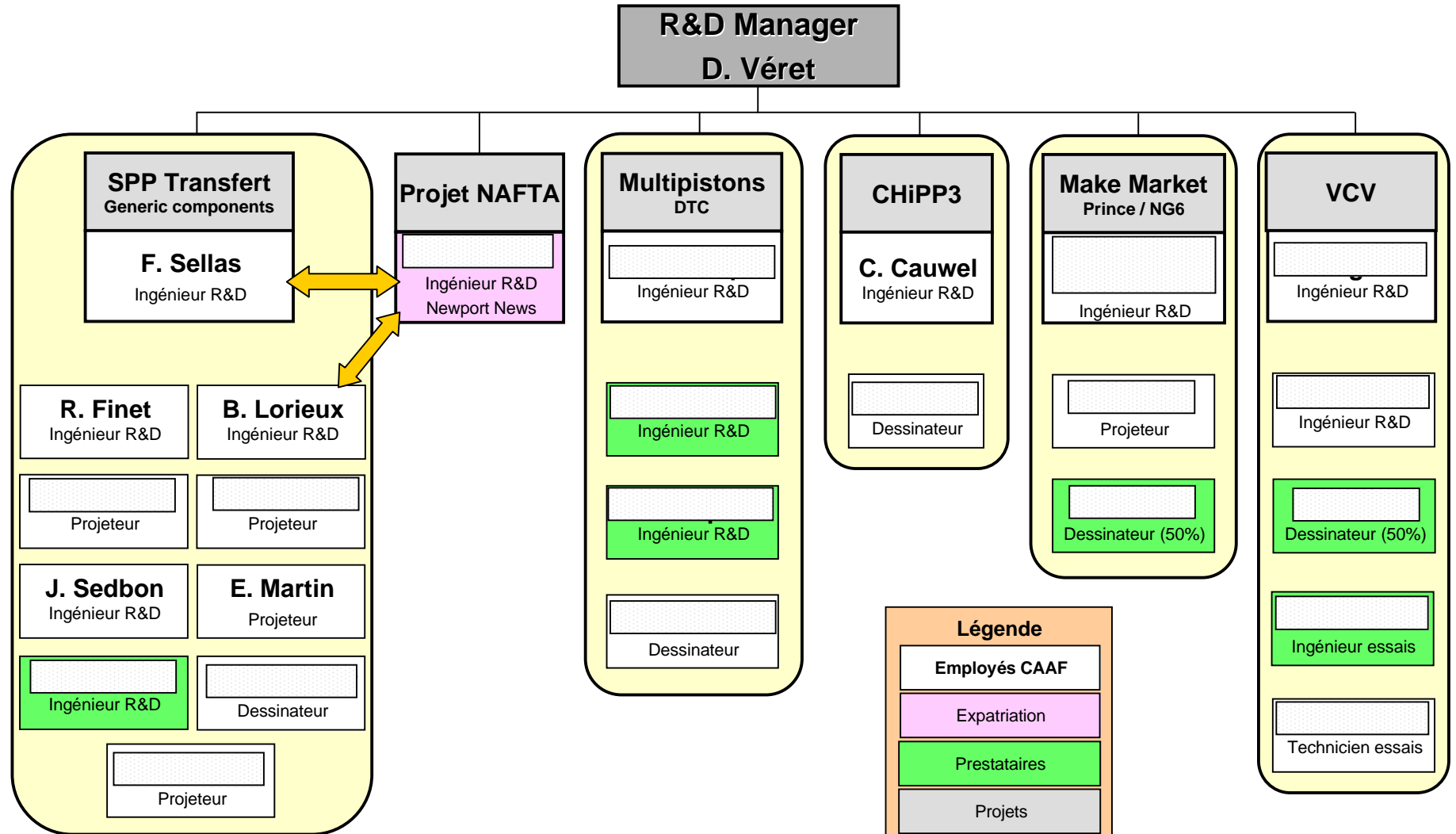
Spring test



Scanning Electron Microscopy (SEM)



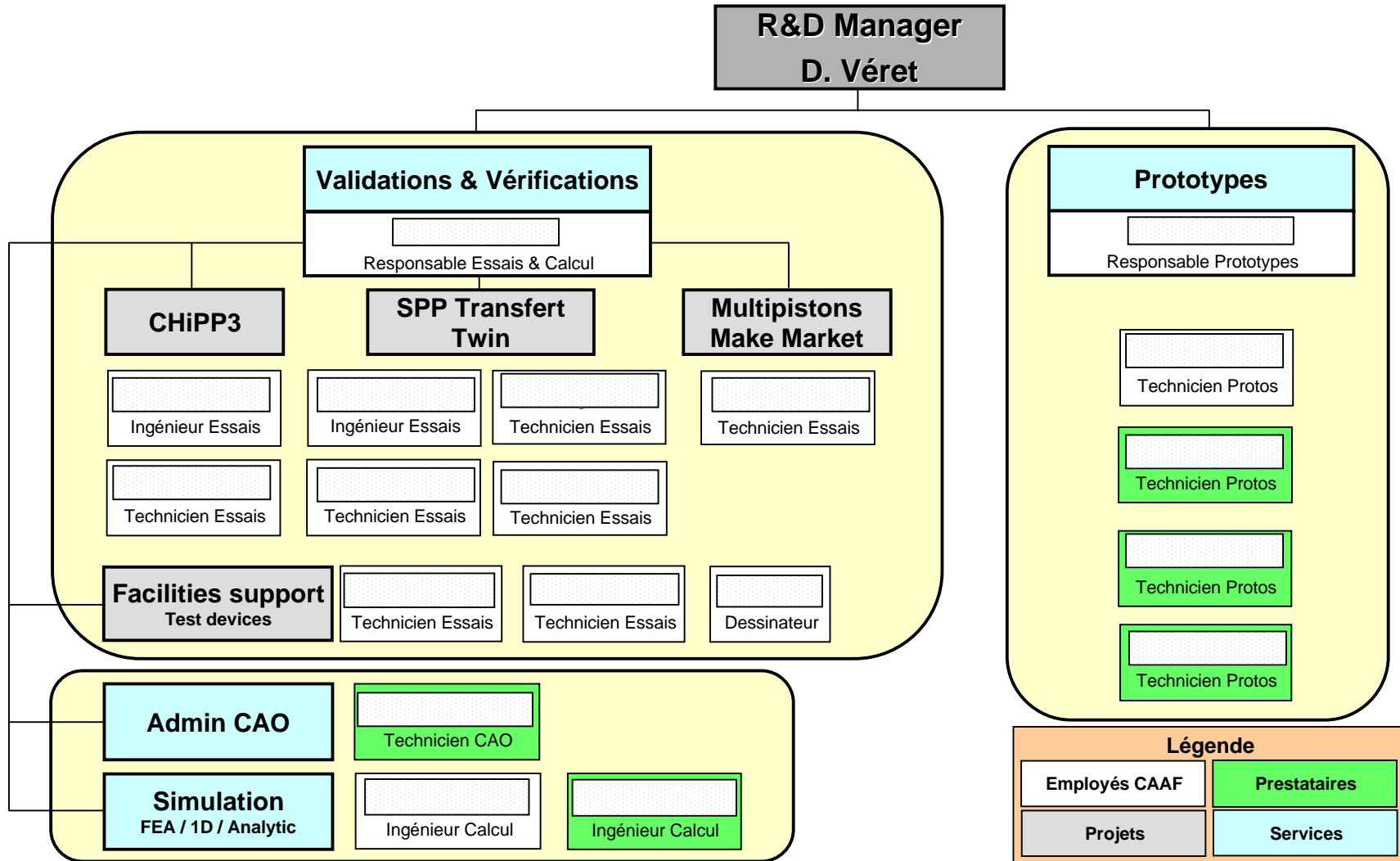
Organigramme du Bureau d'études (24 personnes)



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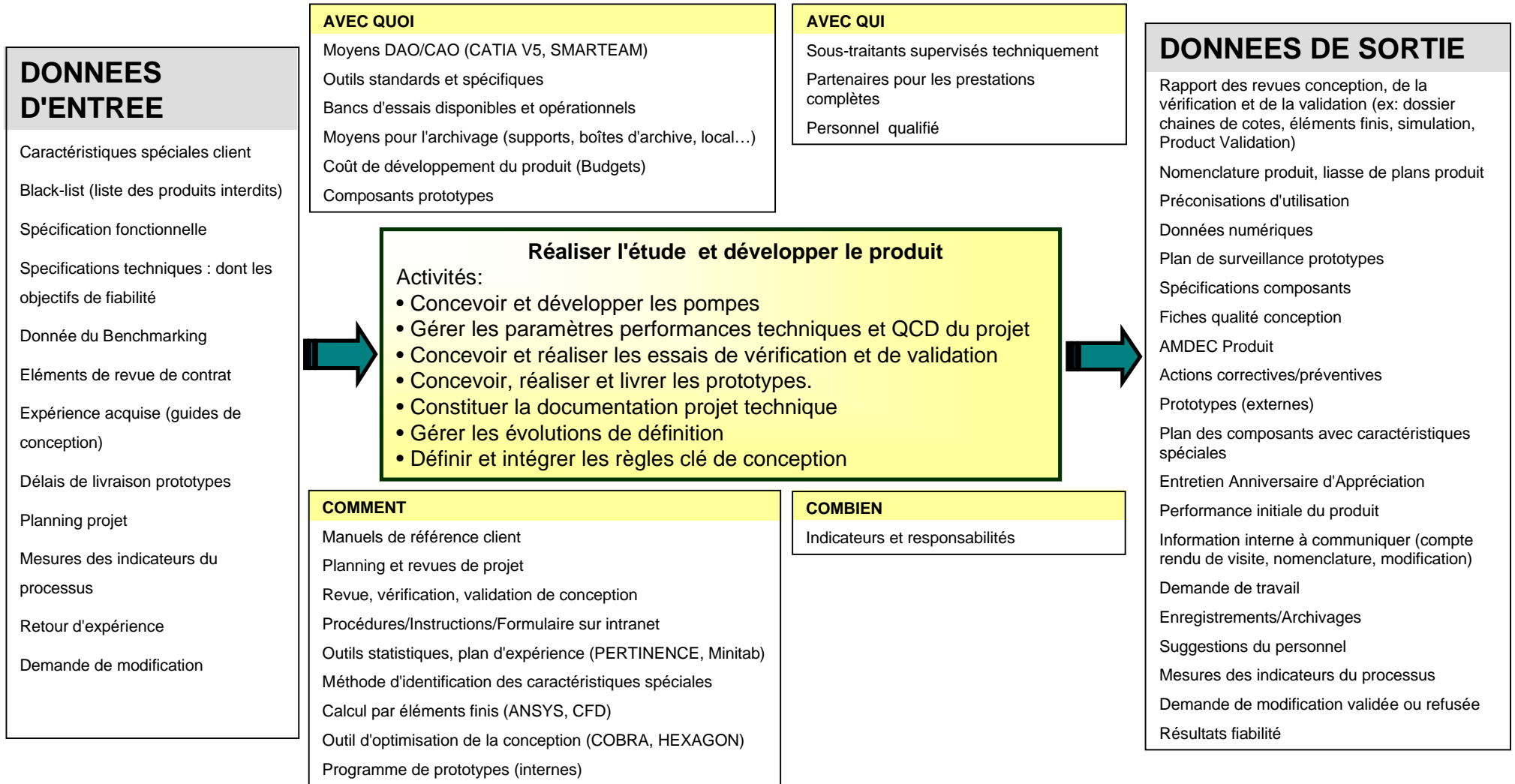


Organigramme Essais, Prototypes et Calcul (17 personnes)



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Processus de développement

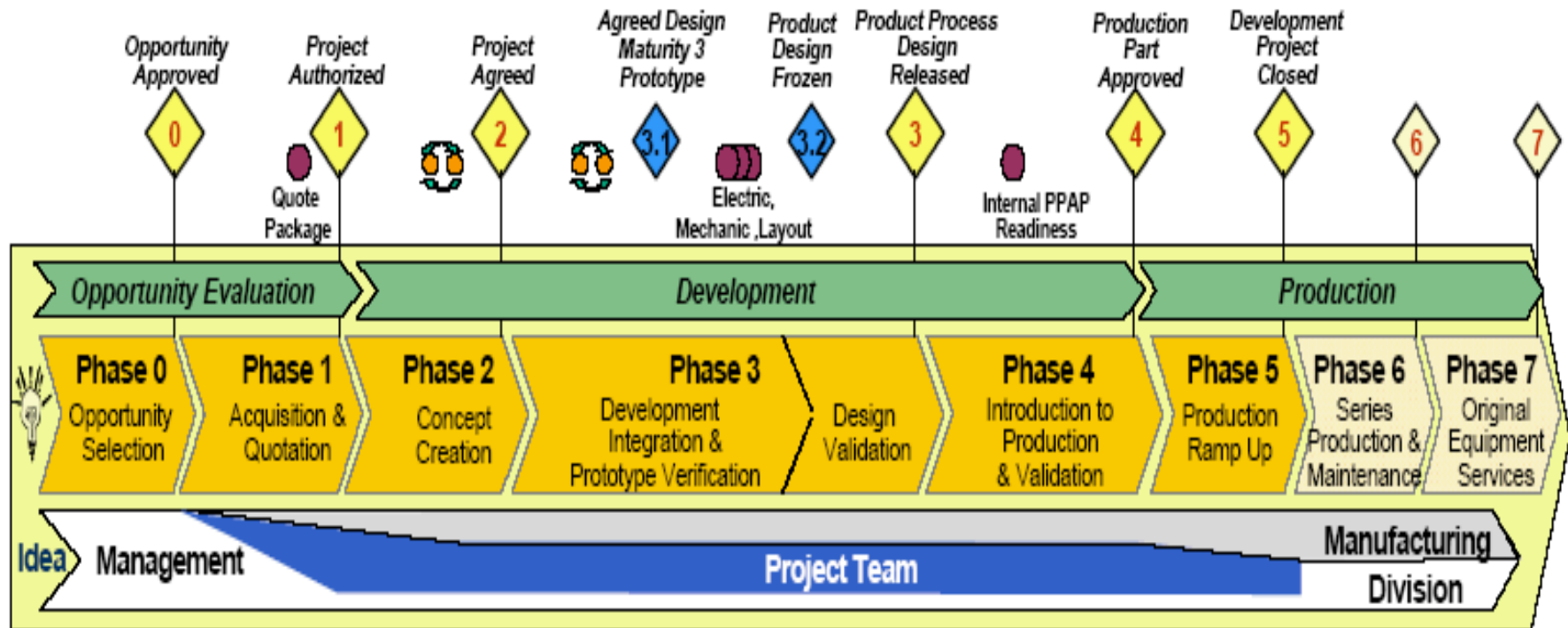


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Processus de développement projet

System Component Development & Launch Procedure (SCDLP)



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Forces et spécificités du bureau d'études CAAF

FORCES:

- Bénéficiaire du savoir-faire hydraulique de CITROEN
- Ressources et moyens de grands groupes
- Organisation en Openspace: Îlots projets (Ingénieurs R&D, projeteurs, qualité développement, méthodes, achats protos)
- Acquisition de compétences pluridisciplinaires
- Essais, laboratoire matériau, métrologie et lignes de production localisés sur site
- Valeurs fortes:
 - Satisfaction du client
 - Esprit d'équipe
 - Prise de décision
 - Responsabilité individuelle importante
 - Progression continue
 - Capacité d'innovation

RESULTATS:

- Conception, développement, industrialisation et mise en série de 6 pompes hautes pression essence (3 générations)
- ~1 000 000 pompes produites, CA ~ 62 M€/an
- Dépôts de 20 brevets,
- 4000 K€ de financement crédit impôt recherche,
- Certification TS 16949