NORGREN

流體控制在醫療器材及生化上的應用

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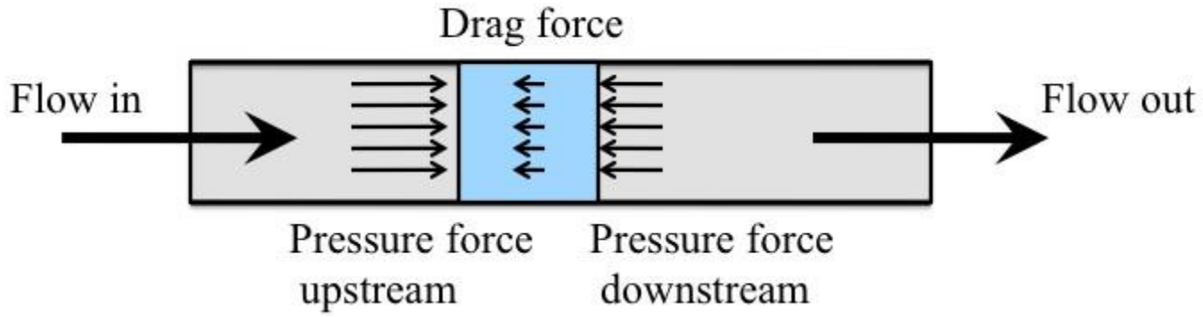
IMI

Breakthrough Engineering

流體控制元件

1. 動力源 – 幫浦 (PUMP) or 空壓機 (compressor)
   提供流體的動力

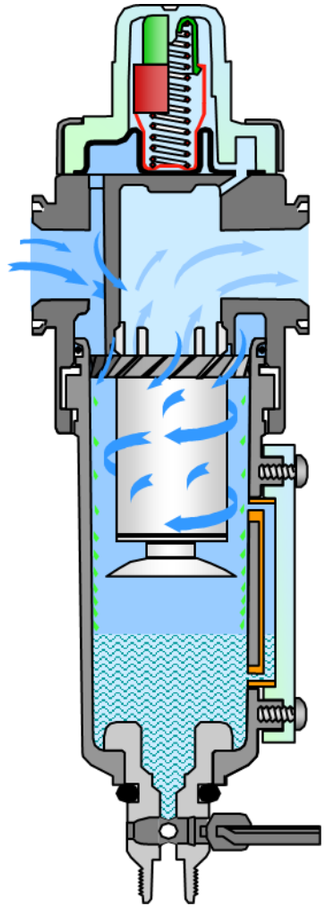


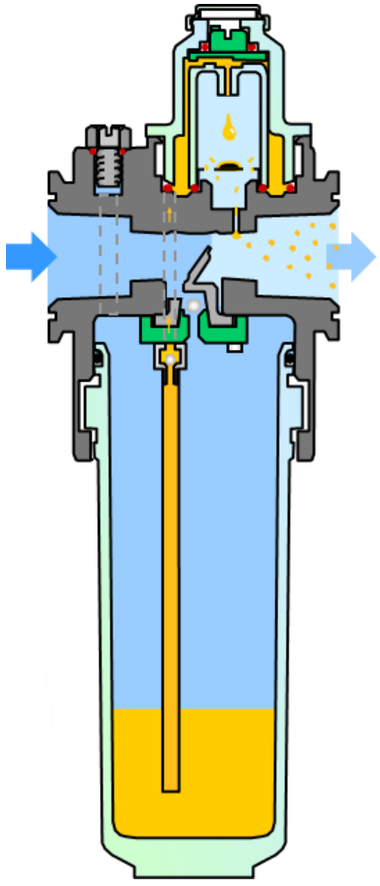
流體控制元件

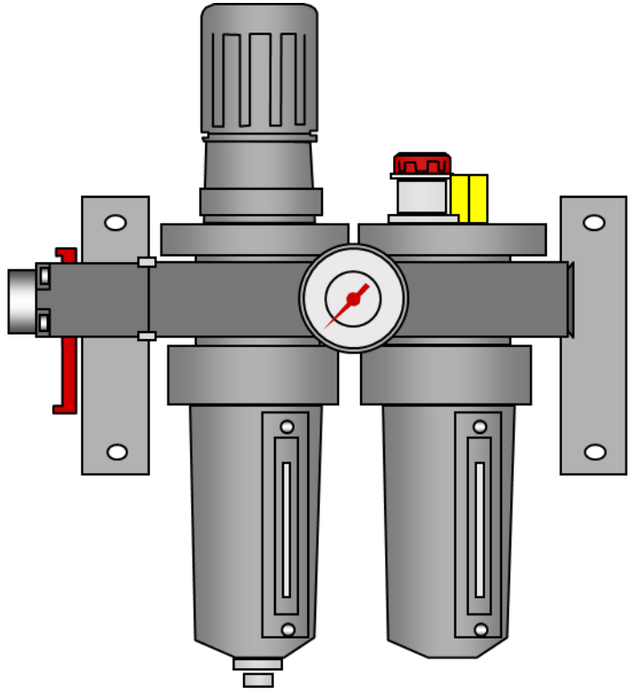
2. 處理元件 - 過濾,潤滑
   過濾很重要，常被忽略

Carl Norgren

1927

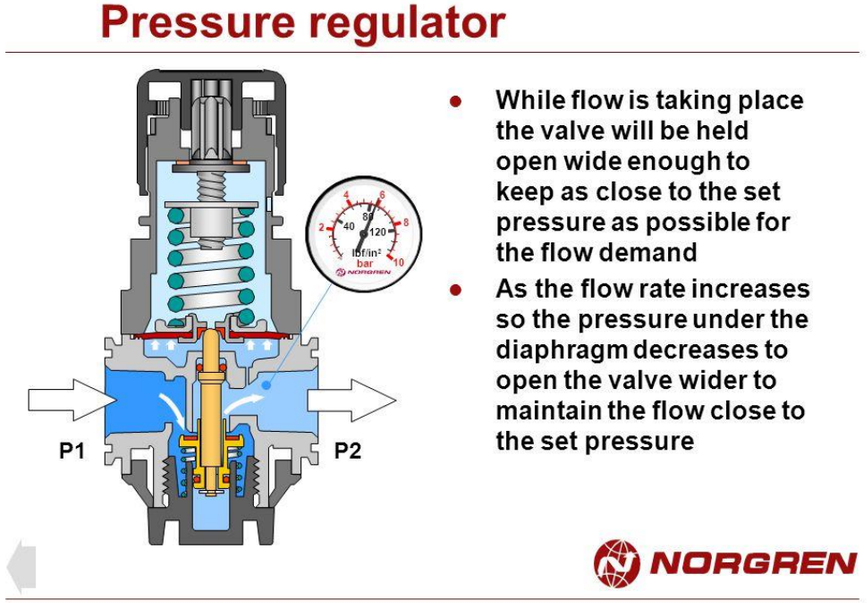




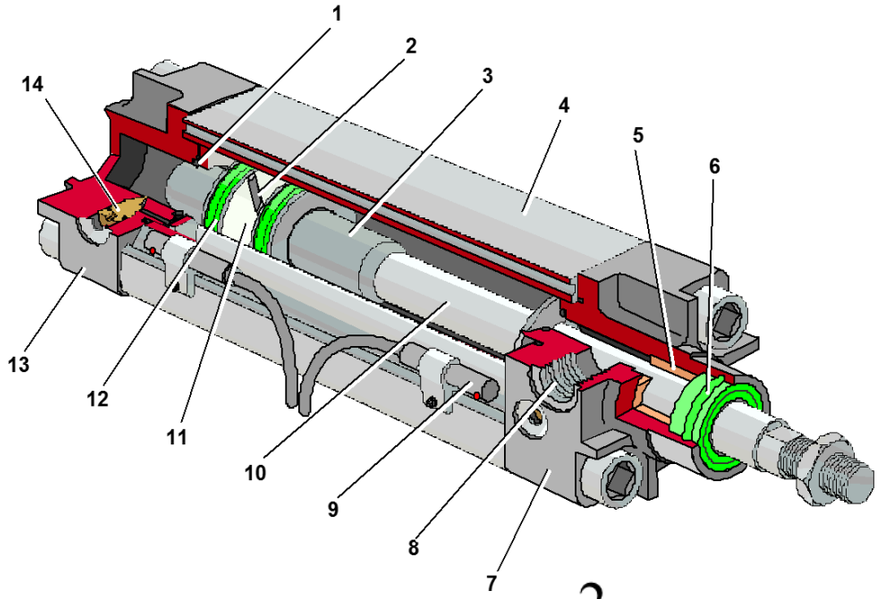


流體控制元件

2. 閥 - 開/關(ON /OFF), 改變方向,調整流量大小,調整壓力大小, 洩壓等等



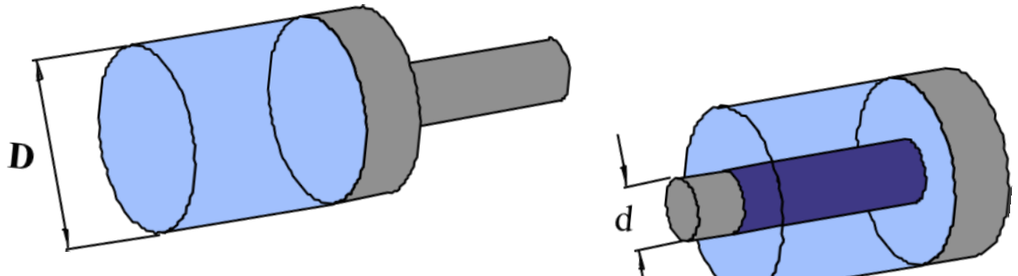
流體控制元件



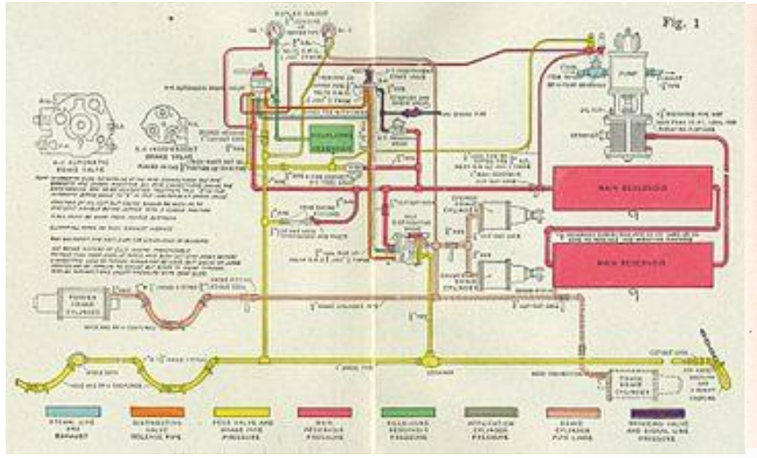
1 cushion seal
2 magnet
3 cushion sleeve
4 barrel
5 guide bush
6 rod and wiper seal
7 front end cover
8 front port
9 reed switch
10 piston rod
11 wear ring
12 piston seal
13 rear end cover
14 cushion screw

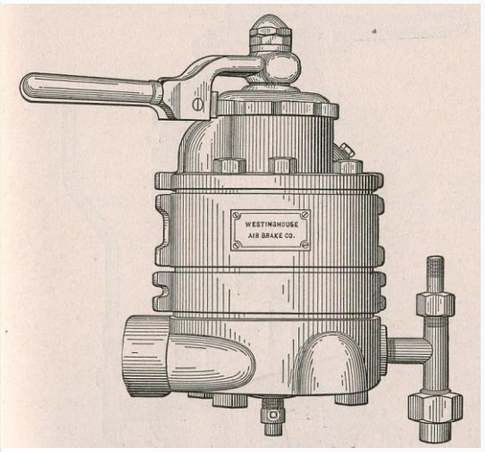
$$Thrust \quad F = \frac{\pi D^2}{4}\frac{P}{10} \quad Newtons$$

$$Pull \quad F = \frac{\pi (D^2 - d^2) P}{40} \quad Newtons$$

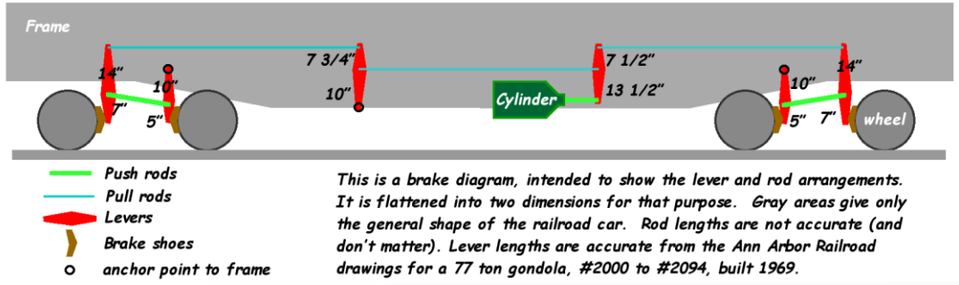


Some Pneumatic history





1909 Westinghouse airbrake system



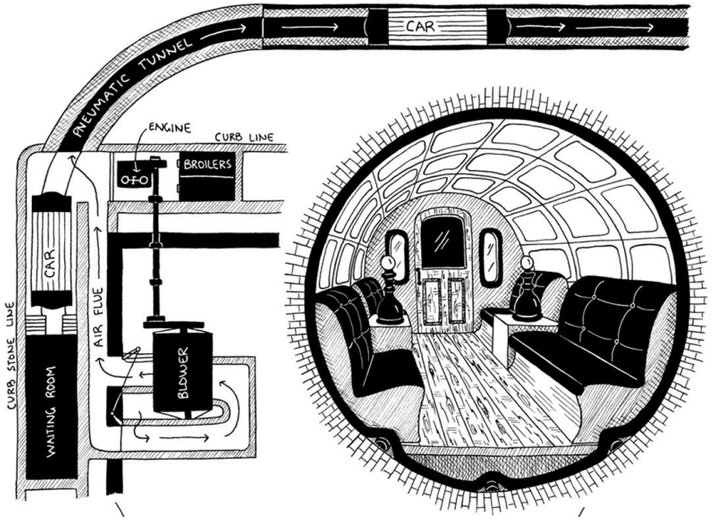
From wikipedia

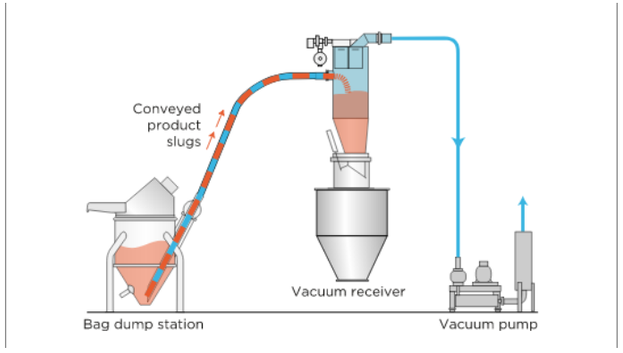
History of Pneumatic Inventions

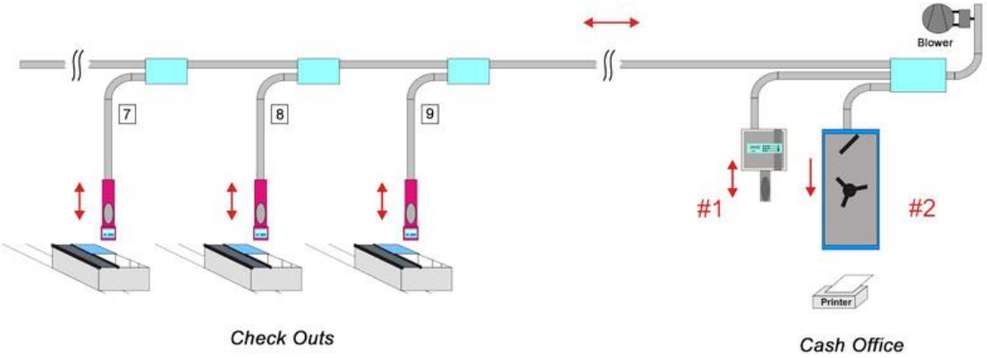
- 1870: Alfred Beach patented a pneumatic train subway in New York which used a giant pneumatic tube
- 1871: Samuel Ingersoll created the pneumatic drill

- 1887: John Dunlap used the 1st air-filled tire
- 1890: Charles Brody King created the pneumatic hammer

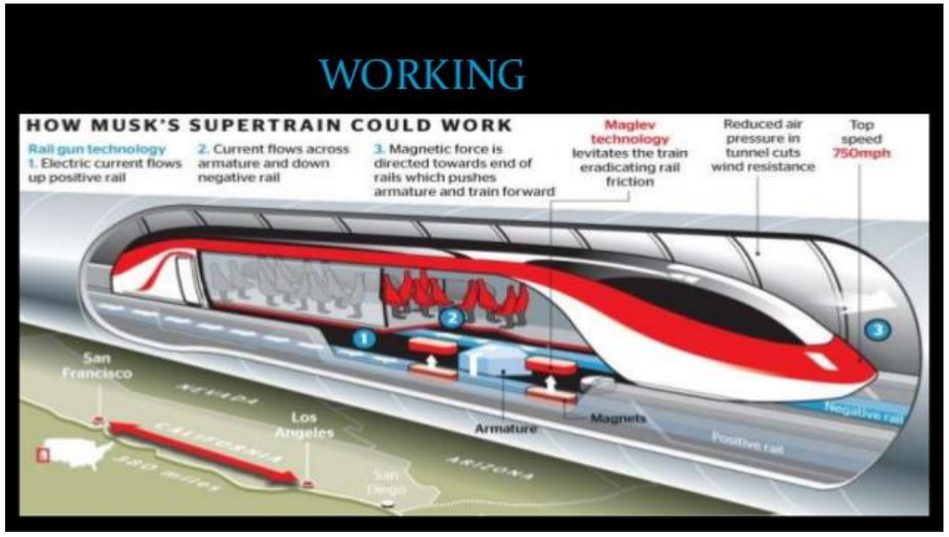
Applications later







From Air Log



NORGREN

Covid-19 Application spotlight - Ventilator

重症呼吸機

IMI

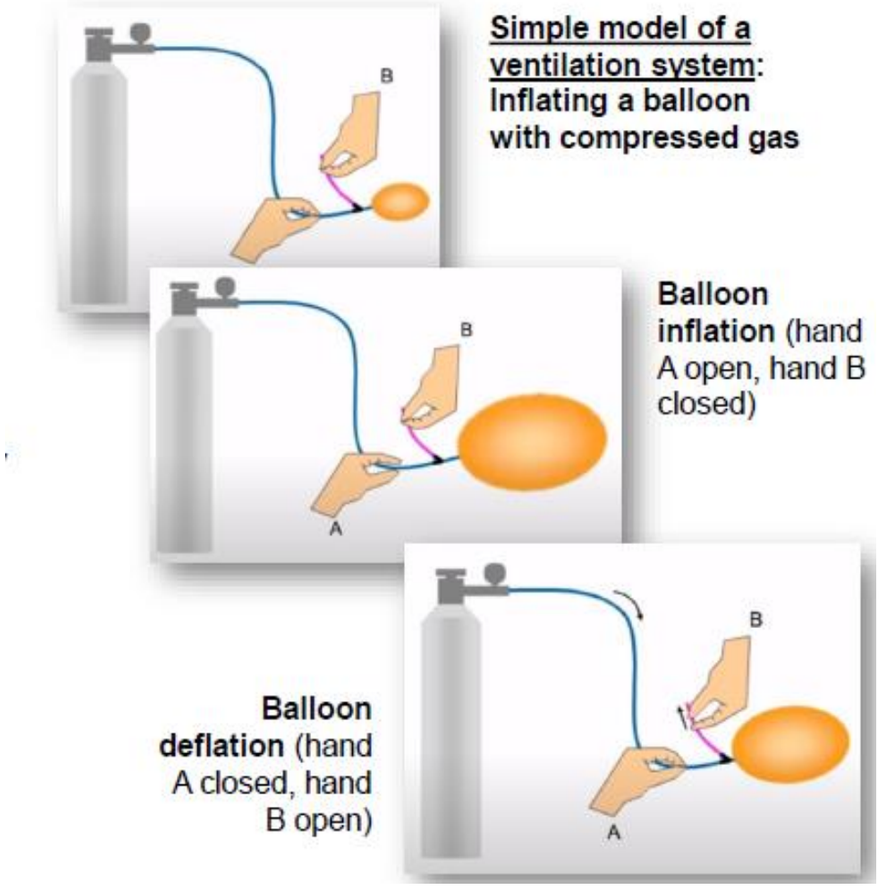
Breakthrough Engineering

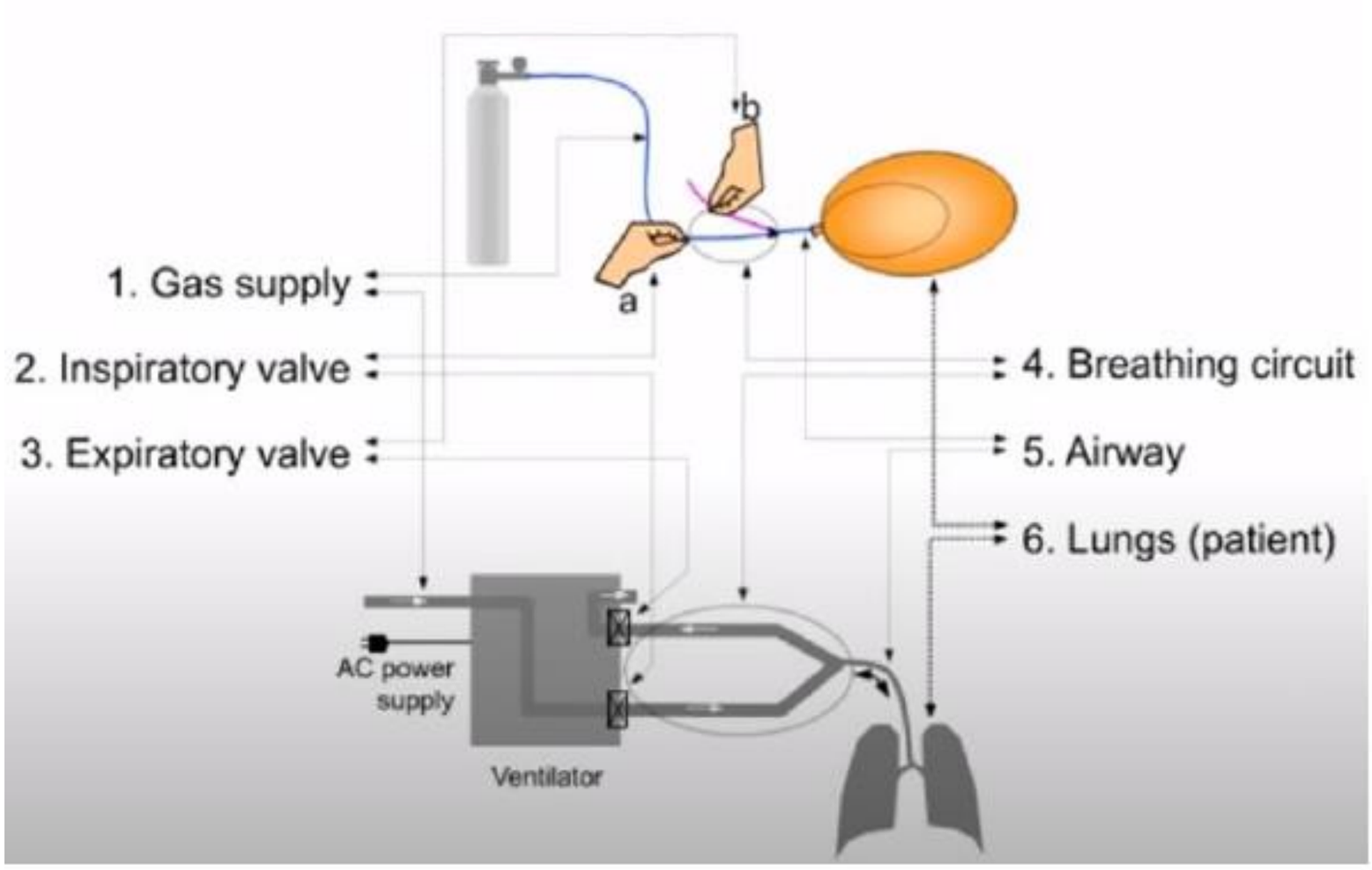
甚麼是呼吸機?

呼吸機基本上即是人工肺
用來提供氣體進出肺部的機械裝置

Ventilator / CPAP

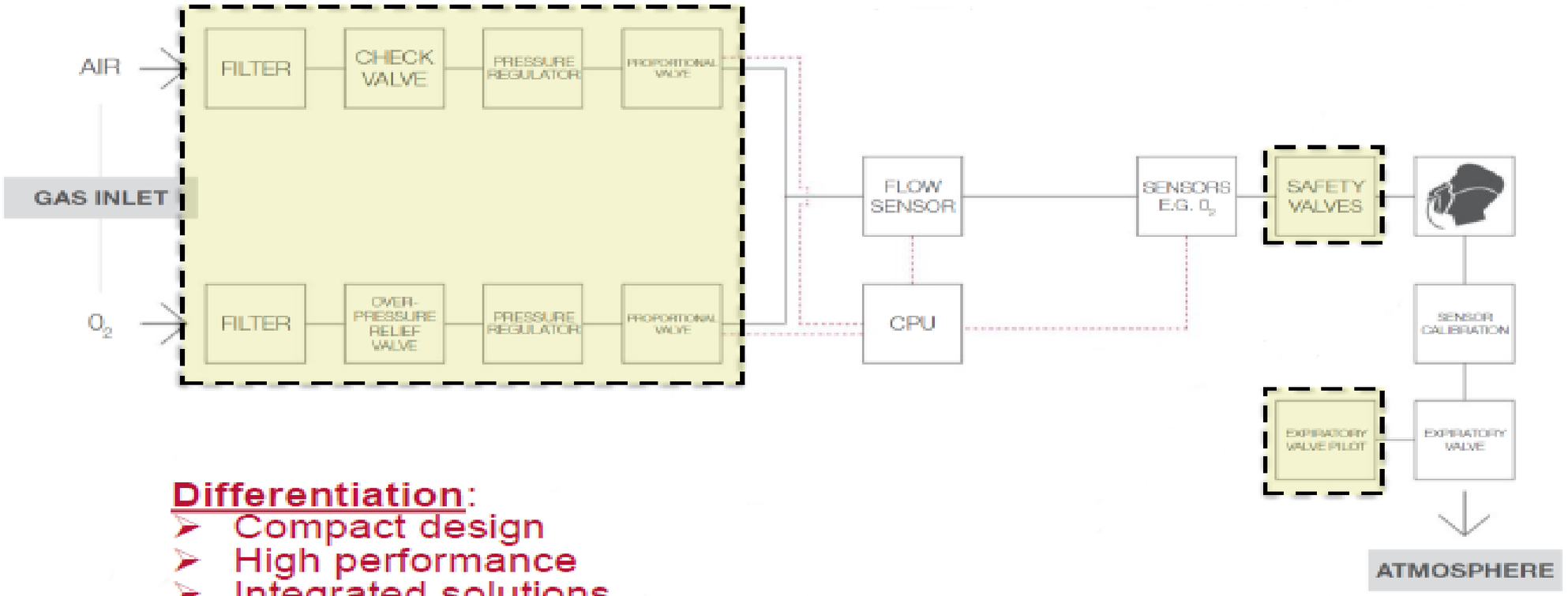
輸送氧氣，帶走二氧化碳
連續正壓輸入 – 呼吸中止症





Inspiration *(air entering the lungs, contraction of inspiratory muscles)*
Expiration *(air expelled from the lungs, relaxation of inspiratory muscles)*

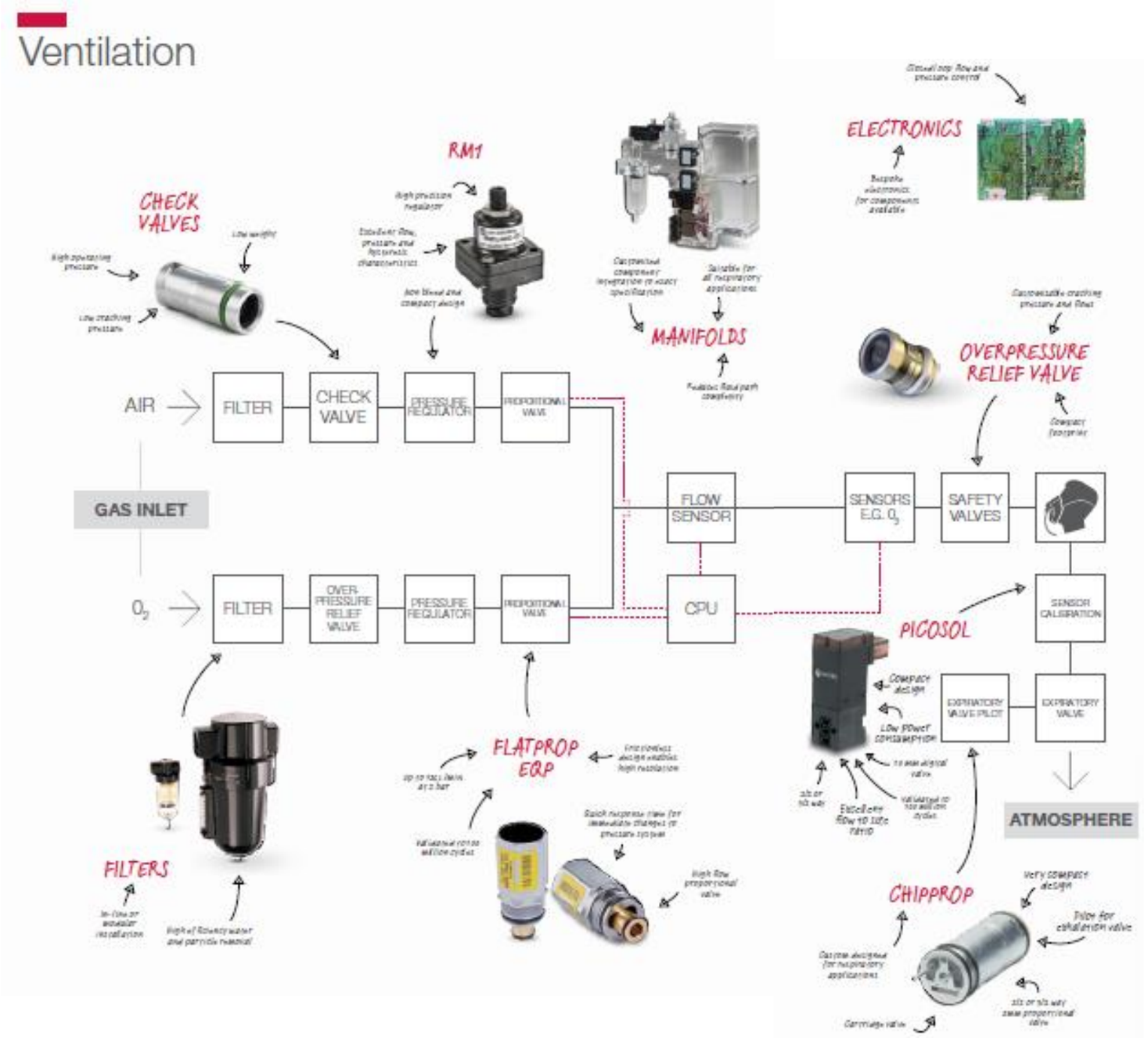
呼吸機基本架構



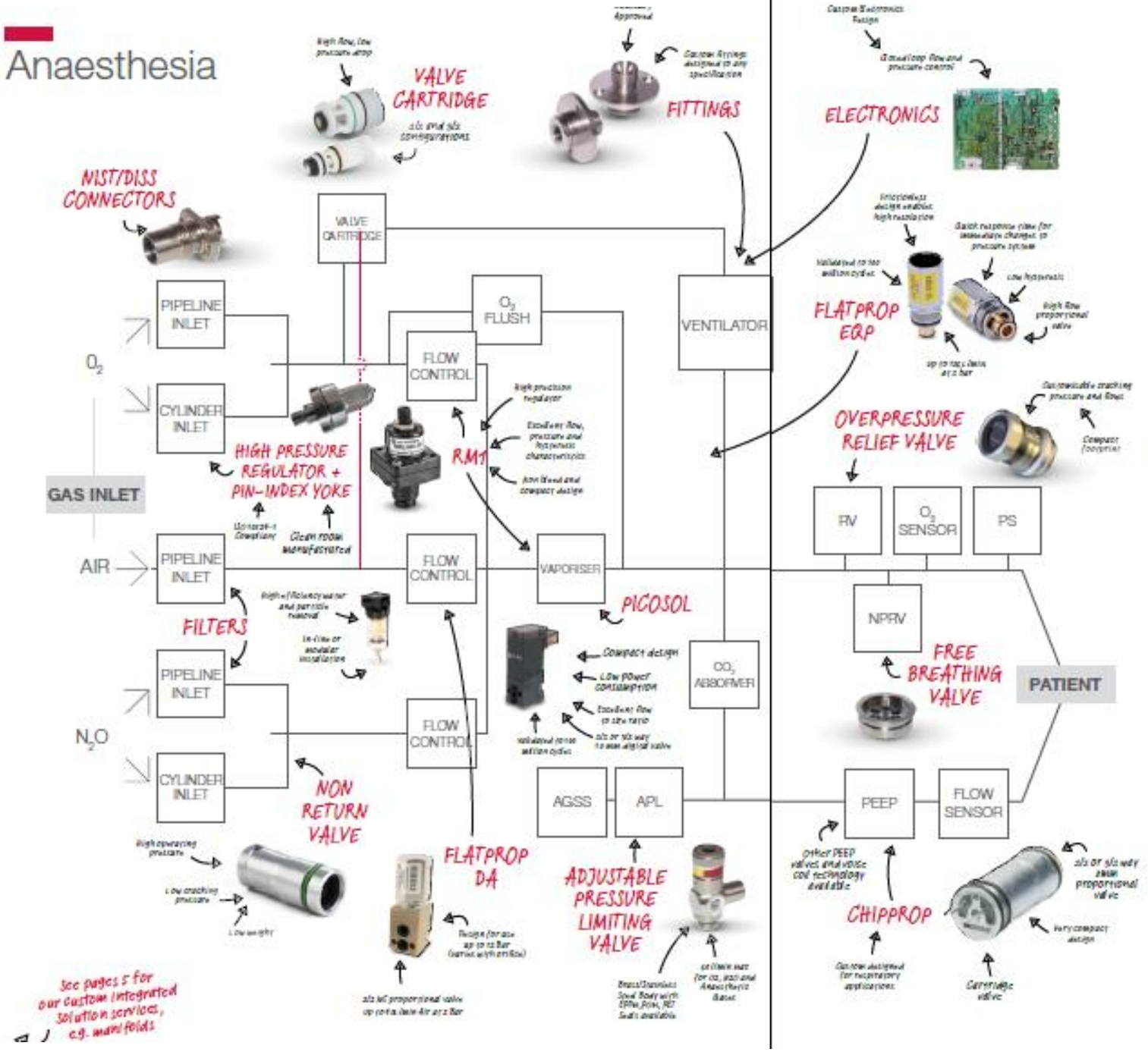
Differentiation:

- Compact design
- High performance
- Integrated solutions
- Special designed or modified products
- Application-specific expertise and experience with leading OEM's

Ventilation

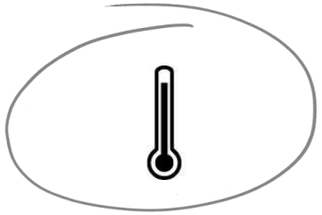


Anaesthesia

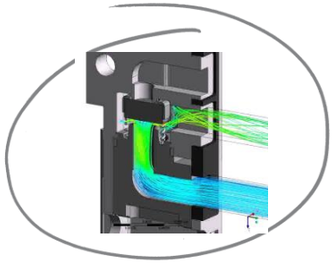


醫療器材設計的考量

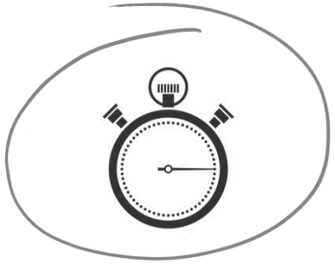
Noise



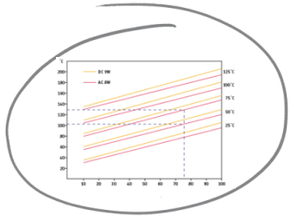
Temperature



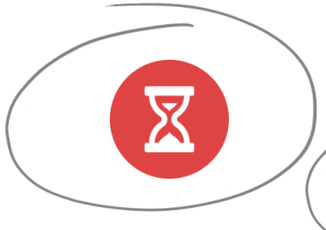
Flow



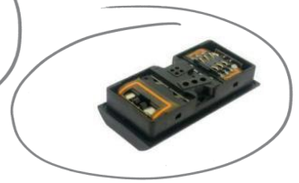
Response time



Power consumption



Life Expectancy



Integration

Customer specific solutions for critical applications

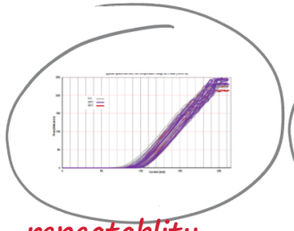
Weight

Miniaturization

Leak rate

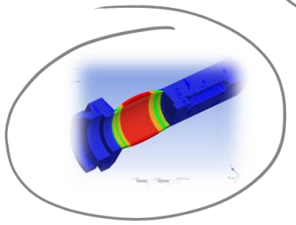
Chemical compatibility

Safety



repeatablity

Precision



Pressure

FAS valve range

On / off valves

FLEXISOL
6.5 mm

Chipsol
8 mm

Picosol
10 mm

Microsol
15 mm

Interface
Microsol

Intersol
22 mm

Minisol
22 mm

Bacosol
32 mm

Media separated valves

Chipsol
2/2 MS
8 mm

PICOSOL
2/2 MS
10 mm

PICOSOL
3/2 MS
10 mm

MICROSOL
2/2 MS
15 mm

MICROSOL
MS-E
15 mm

MICROSOL
PINCH
15 mm

MINISOL
2/2 MS
22mm

MINISOL
3/2MS
22mm

Proportional valves

Chipprop
8 mm

CHIPREG
MFC

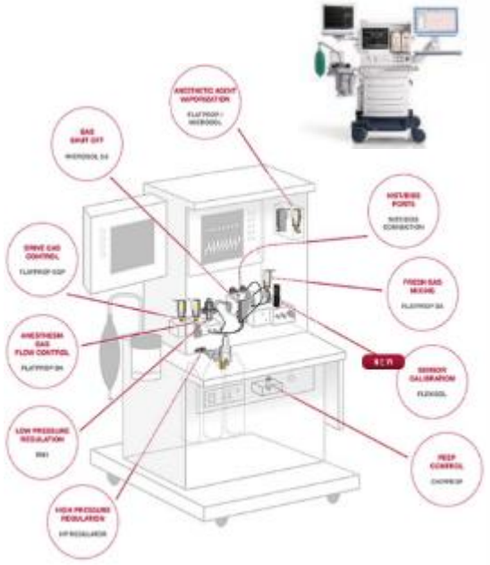
FASPROP
16 mm

Flatprop DA
16 mm

Flatprop
EQI / EQP
16 mm

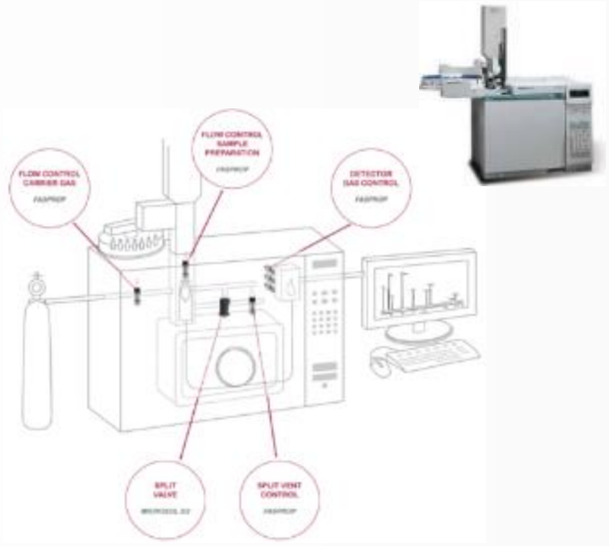
FAS applications Overview

Medical devices



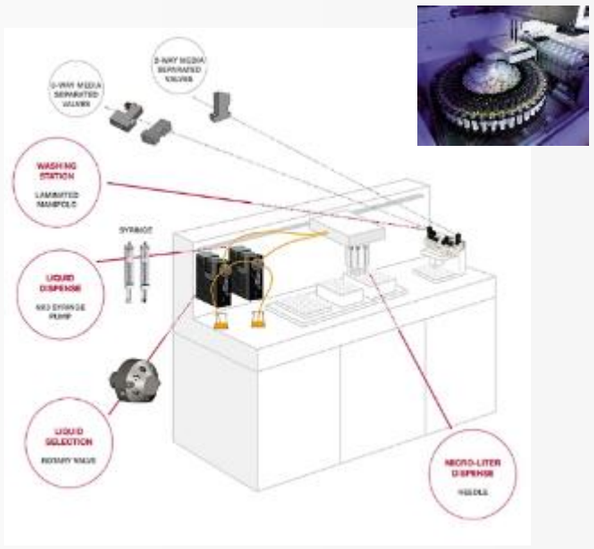
- Ventilator / Anesthesia
- Surgical equipment
- Patient monitoring

Analytical devices



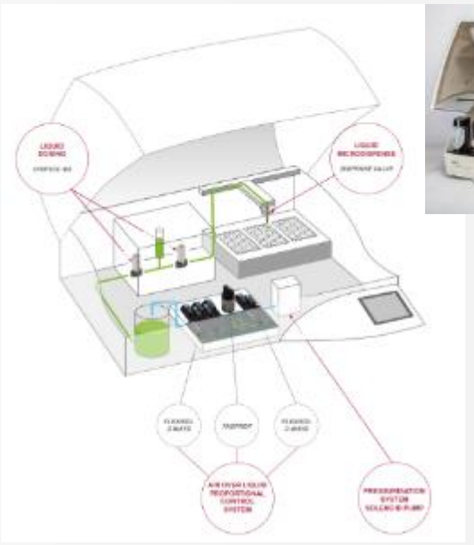
- Gas chromatograph
- Mass spectrometry
- Gas analyzers
- Water analyzers / TOC

Diagnostic Instrumentation



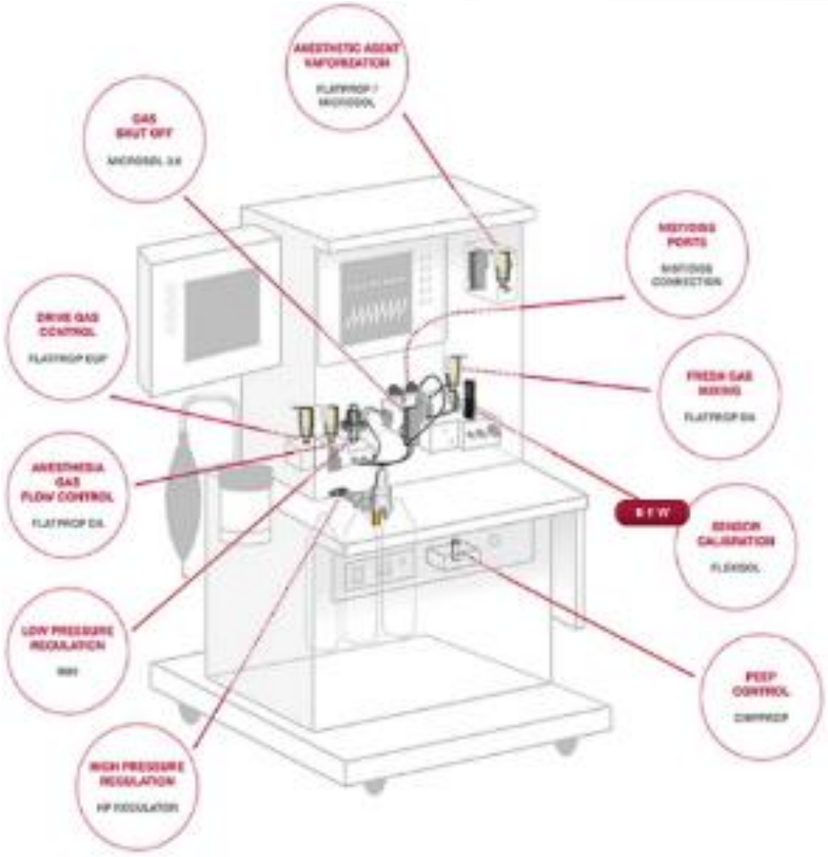
- POC / molecular diagnostics
- Hematology / Clinical chemistry

Biotechnology



- PCR
- Flow cytometry
- Peptide synthesizer
- DNA synthesizer

Medical devices
Ventilator / anesthesia machine



On / off valves

FLEXISOL 6.5 mm	Chipsol 8 mm	Picosol 10 mm	Microsol 15 mm	Interface Microsol	Bacosol 32 mm

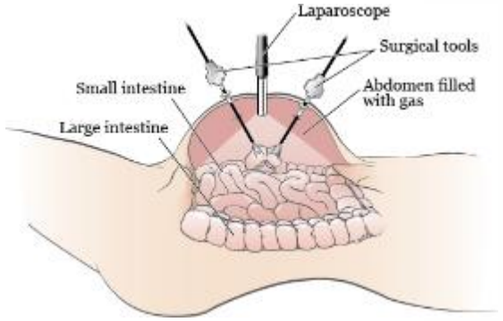
- Sensor calibration
- Flush / purge
- Nebulizer
- Gas selector

Proportional valves

Chipprop 8 mm	FASPROP 16 mm	Flatprop DA 16 mm	Flatprop EQI 16 mm	Flatprop EQP 16 mm	CHIPREG

- Exhalation pilot valve (PEEP)
- O2 /air / anesthesia gas dosing
- Drive gas flow control

Medical devices
Surgical equipment



On / off valves

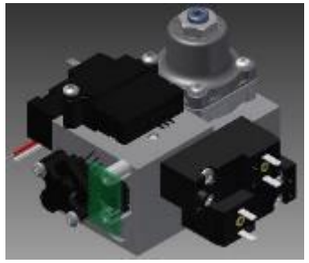
Picosol 10 mm | **Microsol 15 mm**

- Shut off
- Gas selection

Proportional valves

Flatprop DA 16 mm

Gas dosing



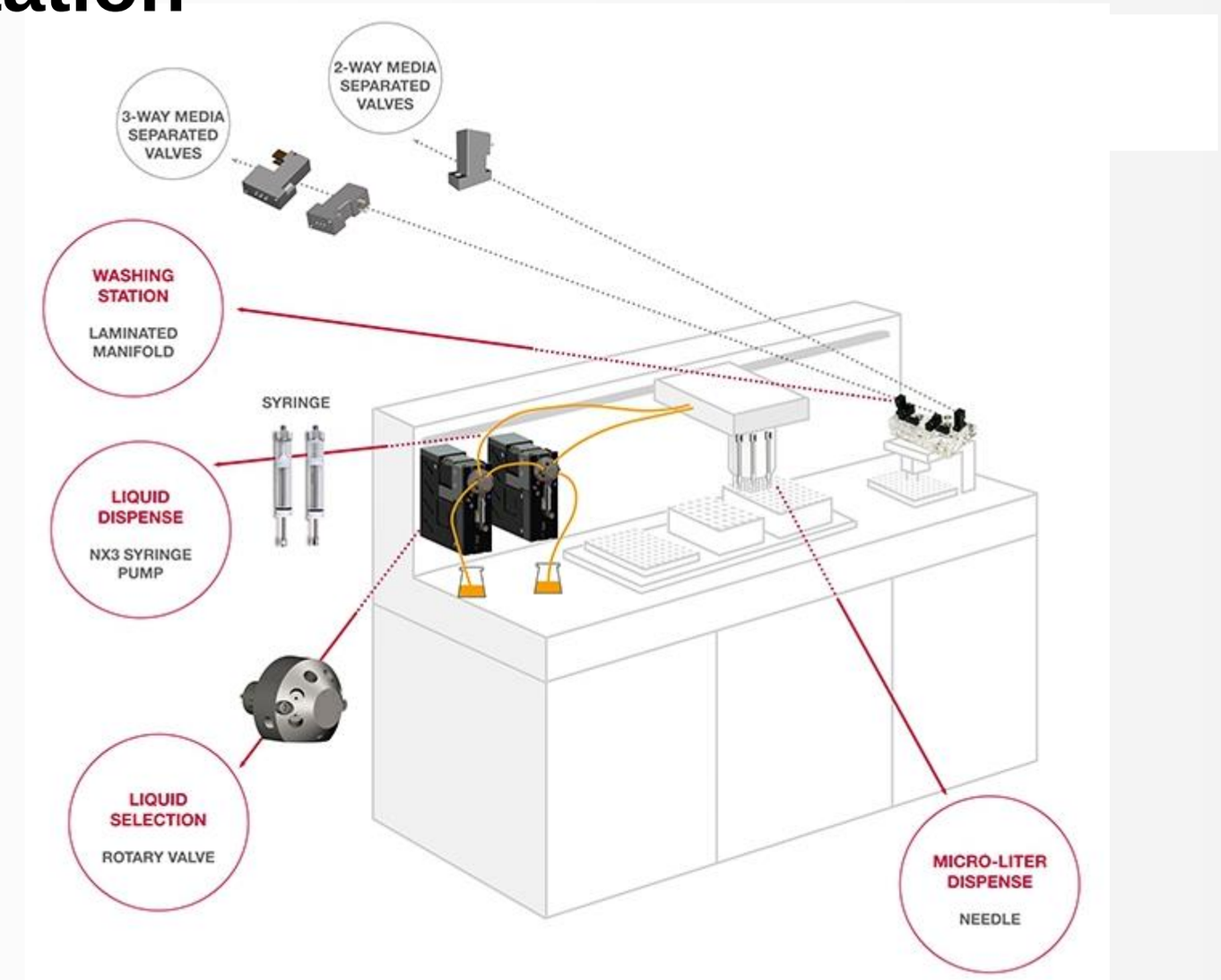
Instruments:

- CO_2 insufflator
- Laparoscope lens cleaning
- Plasma scalpel

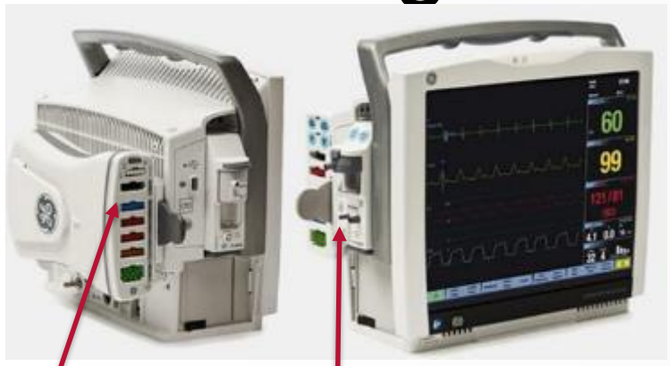
Diagnostic Instrumentation

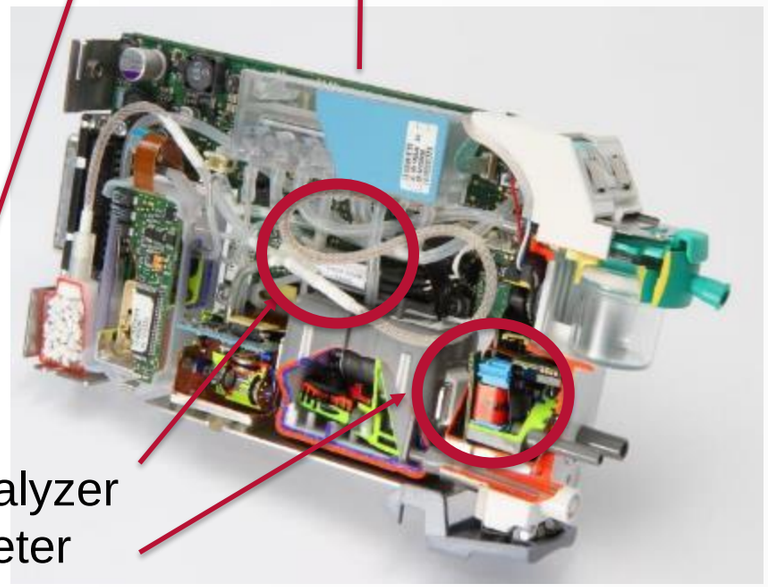
Liquid Handling Robots

- Media Separated Valves
- Rotary Valves
- Syringes
- Syringe Pumps
- Needles
- Manifolds



Medical devices
Patient monitoring





- NIBP
- Gas analyzer
- Spirometer

On / off valves

FLEXISOL 6.5 mm

Chipsol 8 mm

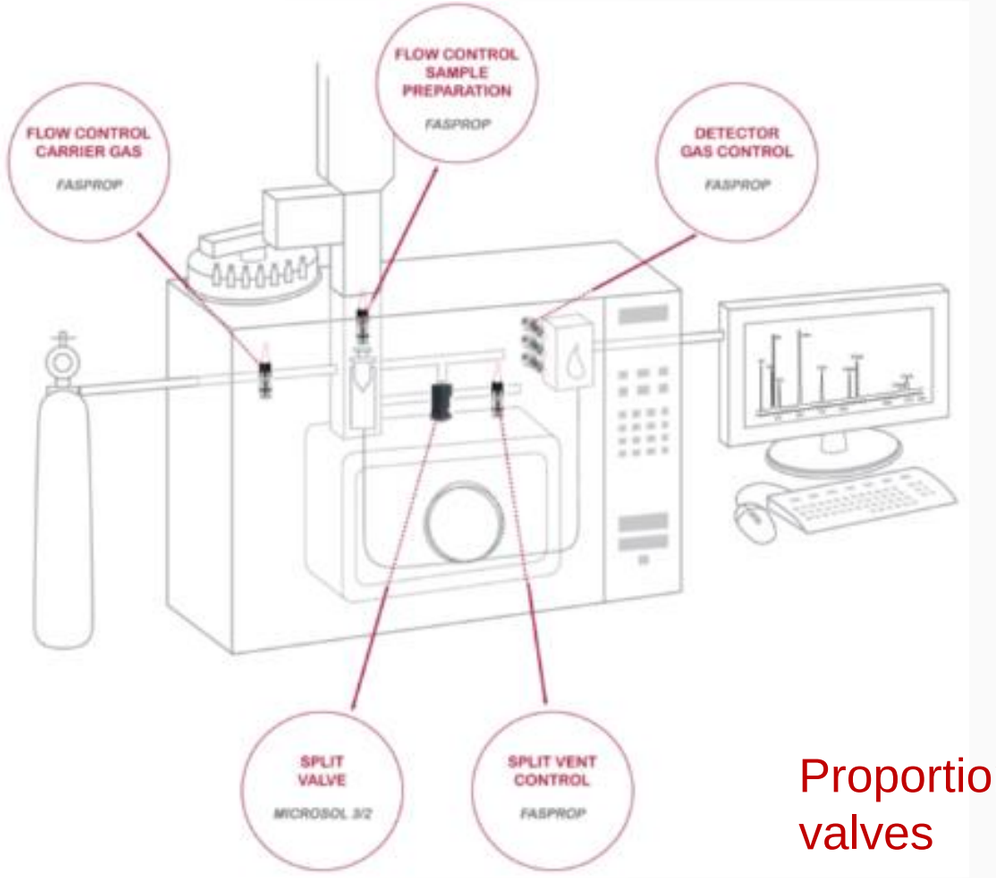
- Sensor calibration
- NIBP Cuff deflation
- Gas switching

Proportional valves

CHIPPROP 8 mm

- Controlling pressure of NIBP cuff

Analytical instruments
Gas Chromatograph

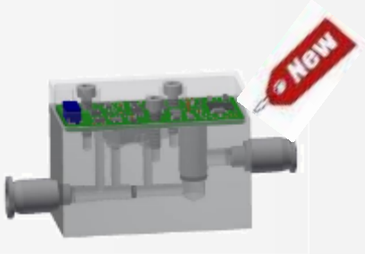


On / off valves

Picosol 10 mm | **Microsol 15 mm**

- Pilot for sample valves
- Split flow selector

Proportional valves

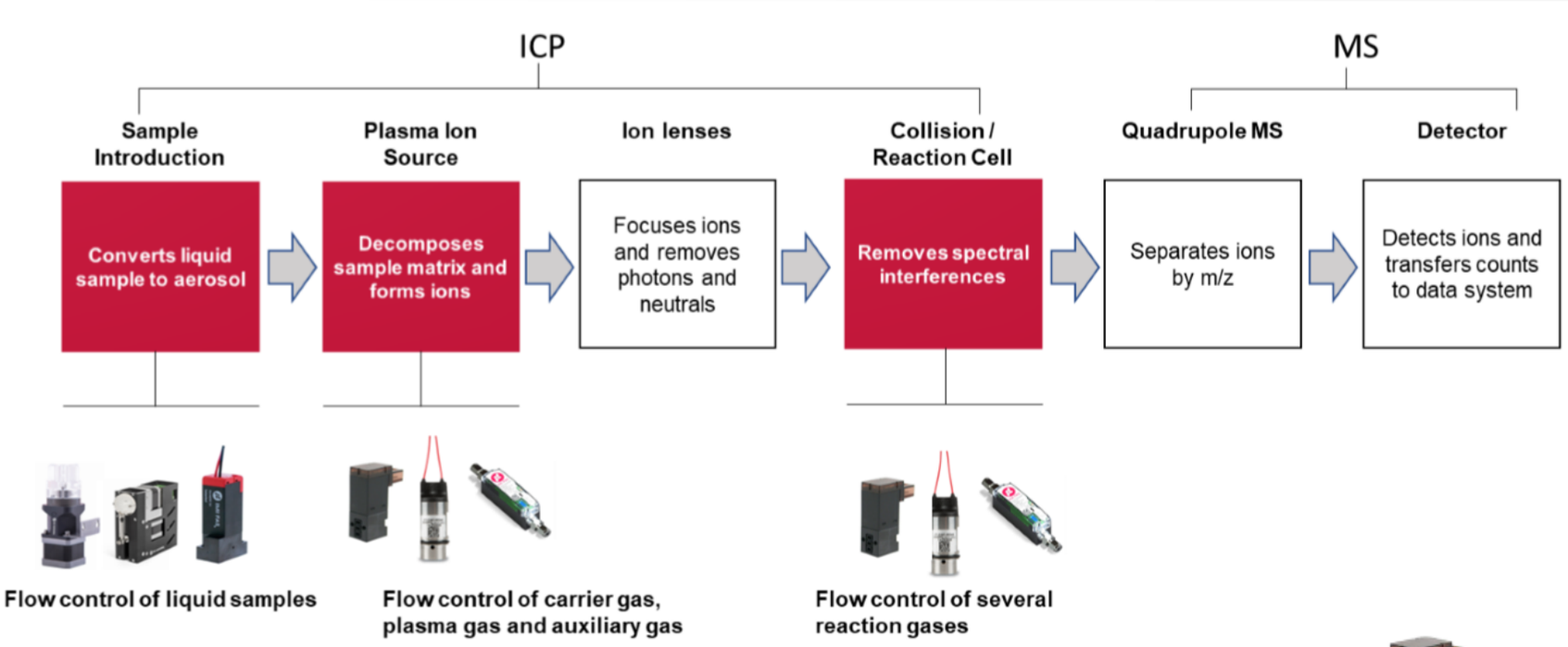


Chipprop 8 mm | **FASPROP 16 mm** | **Flatprop DA 16 mm** | **CHIPREG**

- Carrier gas flow control
- Split flow control
- Detector gas control (FID)

Analytical instruments
Mass spectrometry

Example: ICP-MS

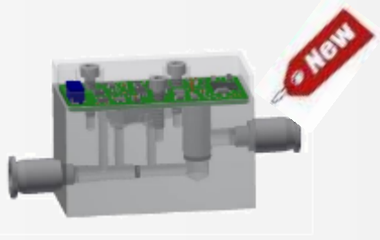


Similar needs in:

- Triple quadrupole MS
- TOF MS
- ICP-OES
- Etc…

ON/OFF valves multiple sizes

FASPROP 16mm



CHIPREG

IMI

Analytical instruments
Gas Analyzers

Examples:

- Portable gas analyzer
- Flue / exhaust gas analyzers
- Dissolved gas analyzer

On / off valves

FLEXISOL 6.5 mm	Chipsol 8 mm	Picosol 10 mm	Microsol 15 mm	Minisol 22 mm	Bacosol 32 mm

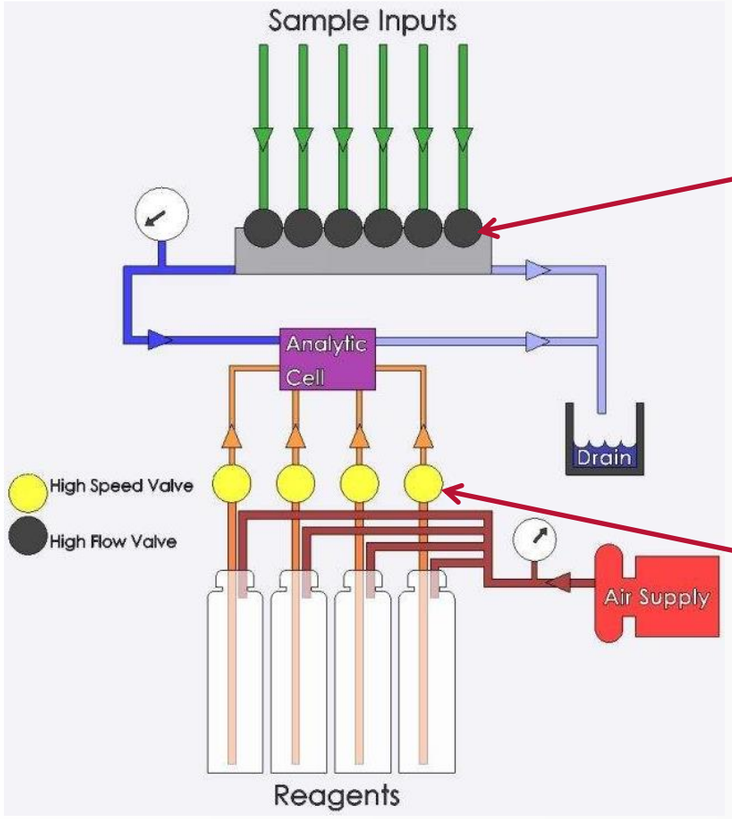
- Differential pressure sensor calibration
- Gas sensor calibration (switching between sample and atmospheric gases)
- System purge
- Gas sampling

Proportional valves

CHIPPROP 8 mm	FASPROP 16 mm	FLATPROP 16 mm	CHIPREG

- Sample dosing
- Electronic Pressure Control
- Flame Ionization Detector (FID)
- Gas mixing

Analytical Water Analysis



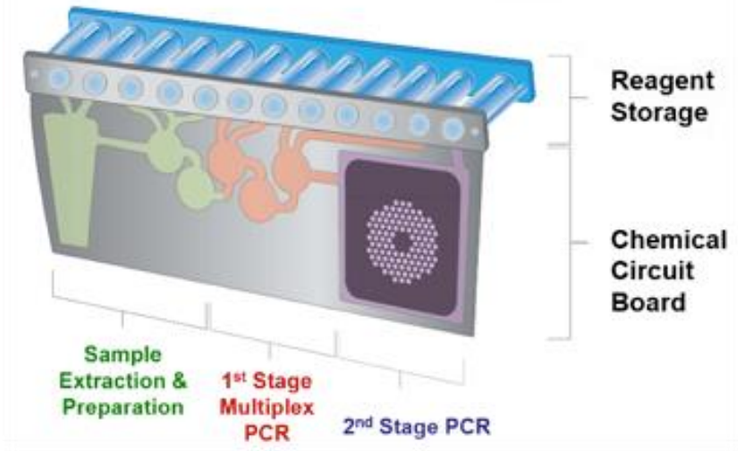
3/2 MS Valve (MICROSOL MS-E)

Sample delivery to the analytical cell **or** to the drain

2/2 MS Valve (CHIPSOL MS or MICROSOL MS)

Reagent delivery to the analytical cell

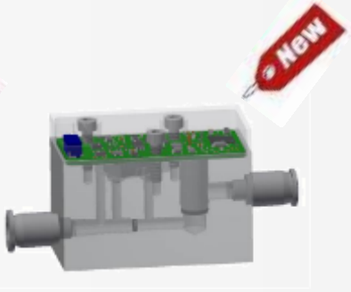
Diagnostic instruments
POC diagnostics - Air over liquid



On / off valves

FLEXISOL 6.5 mm	Chipsol 8 mm
Pressure control	Pressure control

Proportional valves



Chipprop 8 mm	CHIPREG
Pressure control	Flow control

Diagnostic instruments
Hematology and Clinical chemistry

Media-separated / pinch valves

MICROSOL MS / MS-E
15 mm, 3/2 or 2/2

PICOSOL 2/2 MS
8 mm

Pinch valve

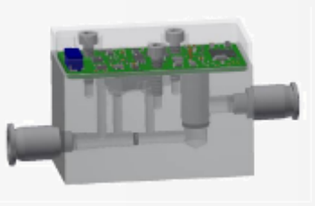
- Sample, reagents and sheath introduction and mixing
- Cleaning function (water)
- Liquid introduction in detectors
- Waste handling

Proportional valves

Chipprop
8 mm

FASPROP
16 mm

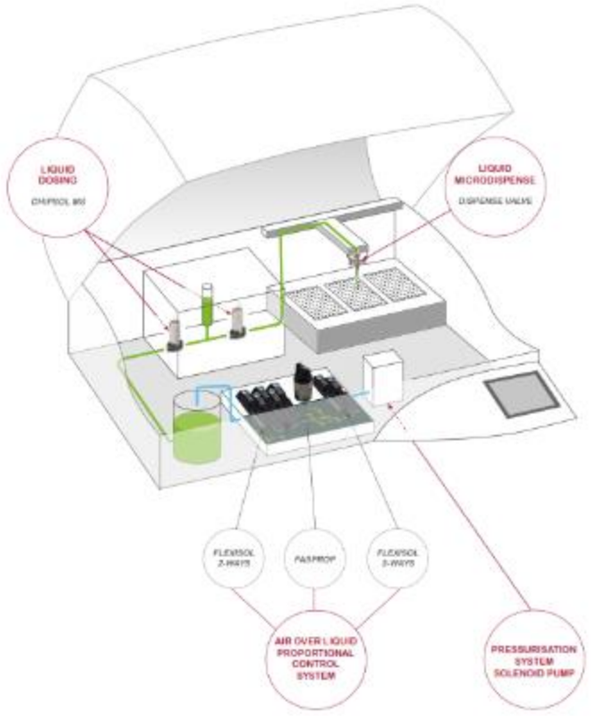
Flatprop DA
16 mm



CHIPREG

- Electronic pressure control
- Air-over-liquid control

Biotech PCR



Media-separated / pinch valves

MICROSOL MS / MS-E
15 mm, 3/2 or 2/2

PICOSOL 2/2 MS
8 mm

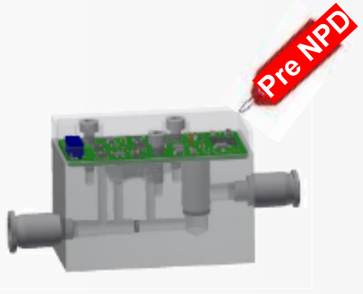
Pinch valve

- Liquid dosing and dispensing
- Reagents mixing

Proportional valves

FASPROP
16 mm

FLATPROP
16 mm



CHIPREG

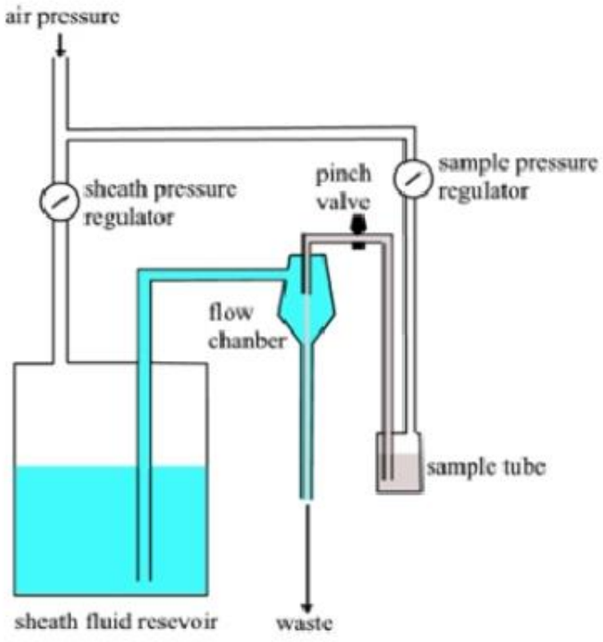
- Pressure and vacuum control

On / off valves

CHIPSOL
8mm

Gas selection
Shut off

Biotech
Flow cytometry



Media-separated / pinch valves

MICROSOL MS / MS-E
15 mm, 3/2 or 2/2

PICOSOL 2/2 MS
8 mm

Pinch valve

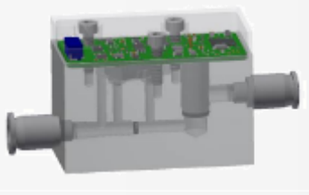
- Sample, reagents and sheath introduction and mixing
- Cleaning function (water)
- Liquid introduction in detectors
- Waste handling

Proportional valves

Chipprop
8 mm

FASPROP
16 mm

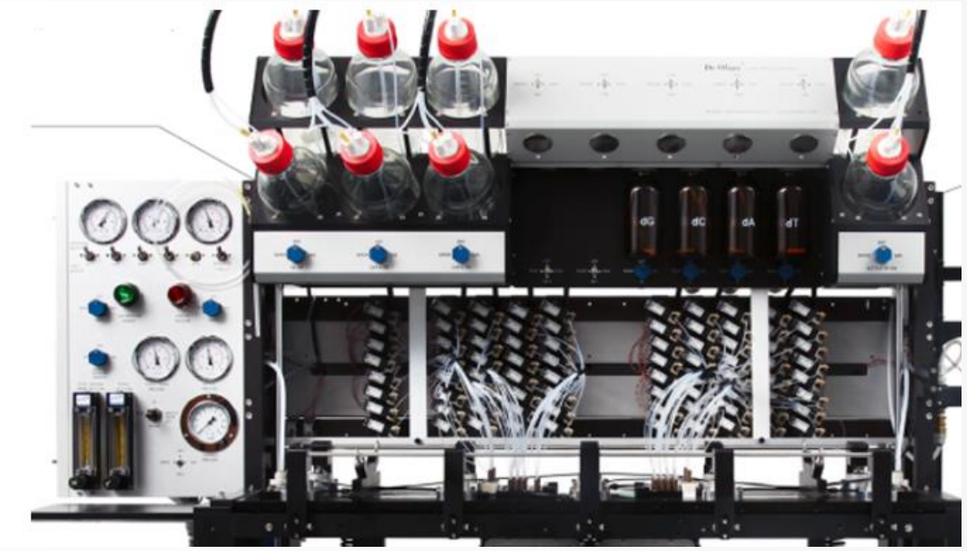
Flatprop DA
16 mm



CHIPREG

- Electronic pressure control
- Air-over-liquid control

Biotech
Other instruments



Peptide synthesizer

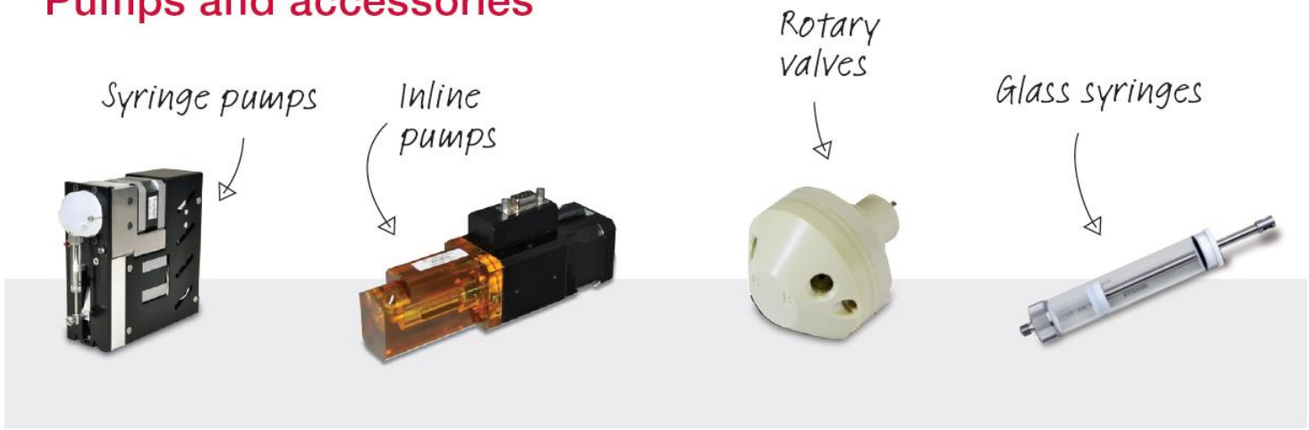
- Reagents and amino-acids mixing and dispensing
- Up to 40 media-separated valves per instrument

DNA / Oligo-nucleotide synthesizer

- Reagents delivery and mixing
- Potential for over 100 media-separated valves per instrument

IMI Precision Engineering – Life Sciences

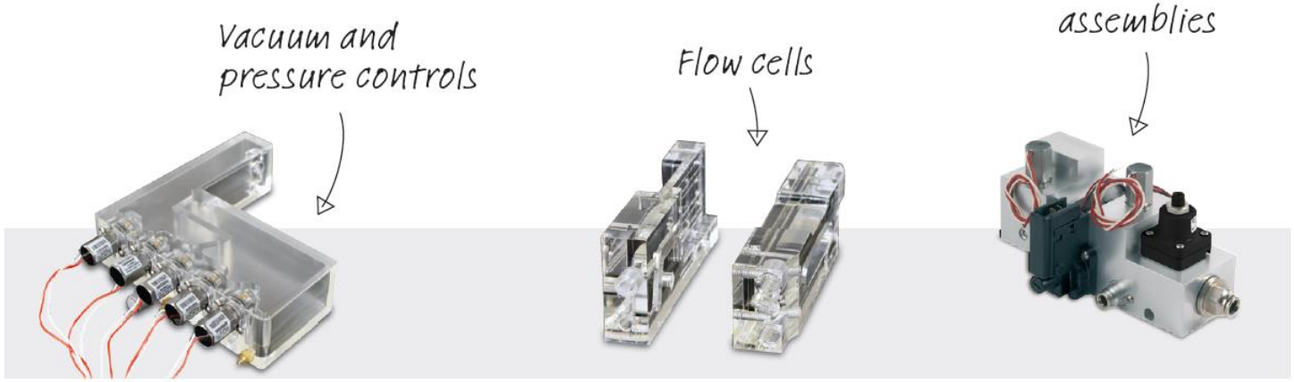
Pumps and accessories



Pumps and Accessories

- Syringe pumps for continuous flow and precise volume dispense.
- Rotary and solenoid valves for stream selection.
- Broad portfolio of syringes including zero dead volume tips.

Manifolds and assembly solutions



Manifolds and Assembly Solutions

- Multi layer, compact manifolds.
- Reduce leaks and optimize fluid paths.
- Mounted components such as valves and regulators.
- Custom assemblies shipped fully tested.

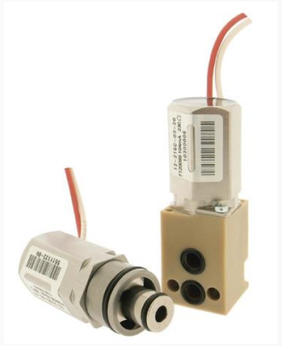
FAS Proportional Valves

8 MM VALVE

FAS CHIPPROP

16 MM VALVES

FAS FASPROP



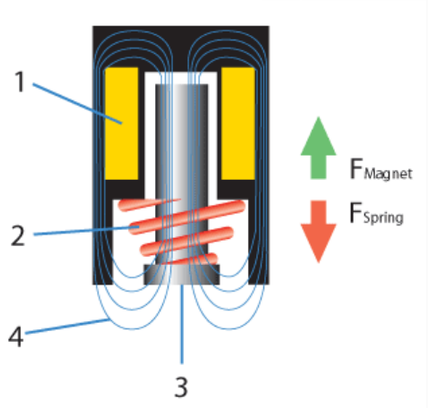
FAS FLATPROP DA

FAS FLATPROP EQI

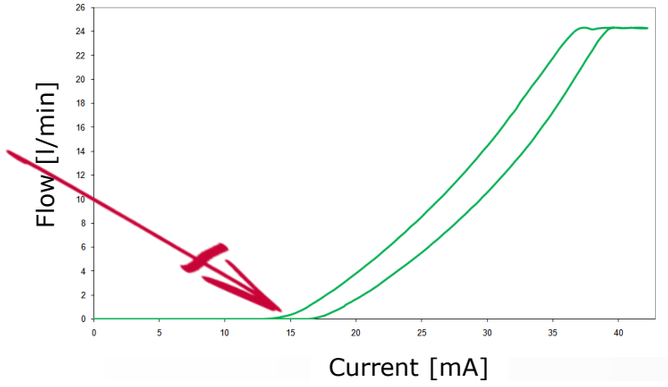
FAS FLATPROP EQP

FAS 16mm Proportional Valves

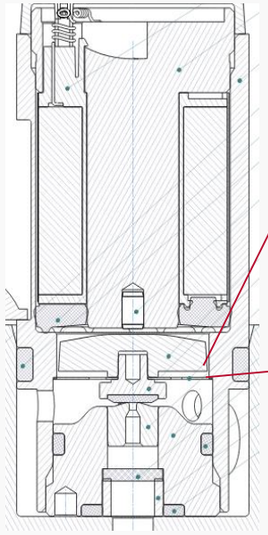
General Principle

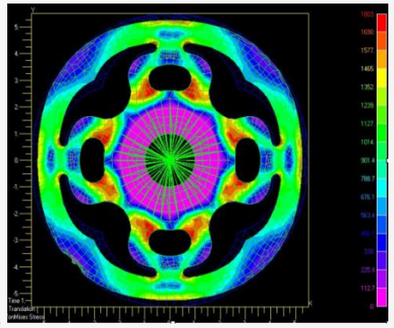


Precision: Lift Up current



FAS 16mm Proportional Valve



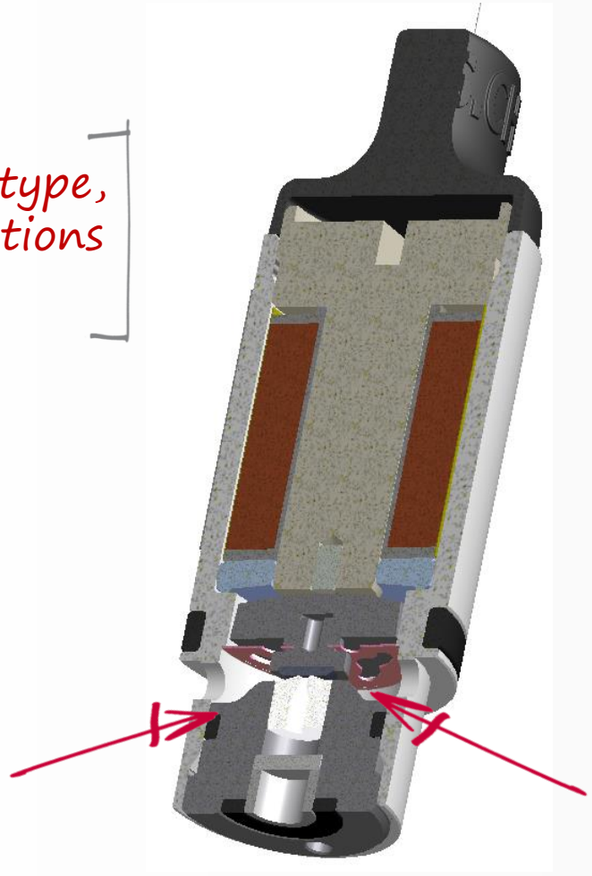


FAS patented flat spring and flat plunger

High stability in closed loop control systems

FAS 16mm Proportional Valves

Depending on the valve type, different designs and options are available



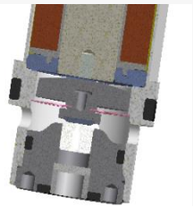
Cartridge or manifold mounting

NBR, FPM FFPM

Orifice sizes
From 0.05 to 4.6mm

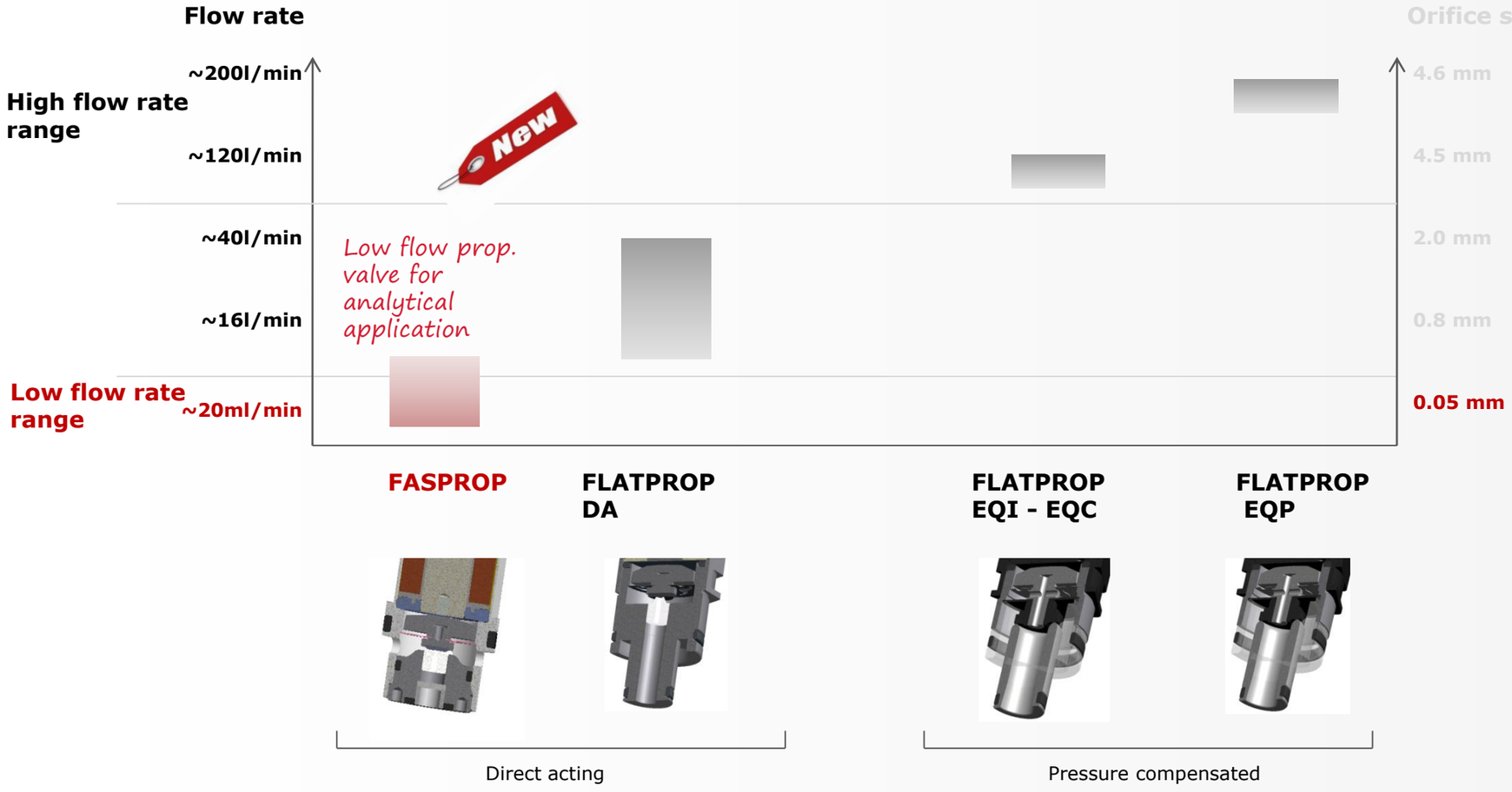
Direct Acting
or Pressure
Compensated

Direct Acting



Pressure compensated

Product Offering: 16 mm Prop. Valves



FAS 16MM FLATPROP Direct Acting

16mm Direct Acting Proportional Valve

Frictionless design enables high resolution

Lower power consumption (down to 0.5W)

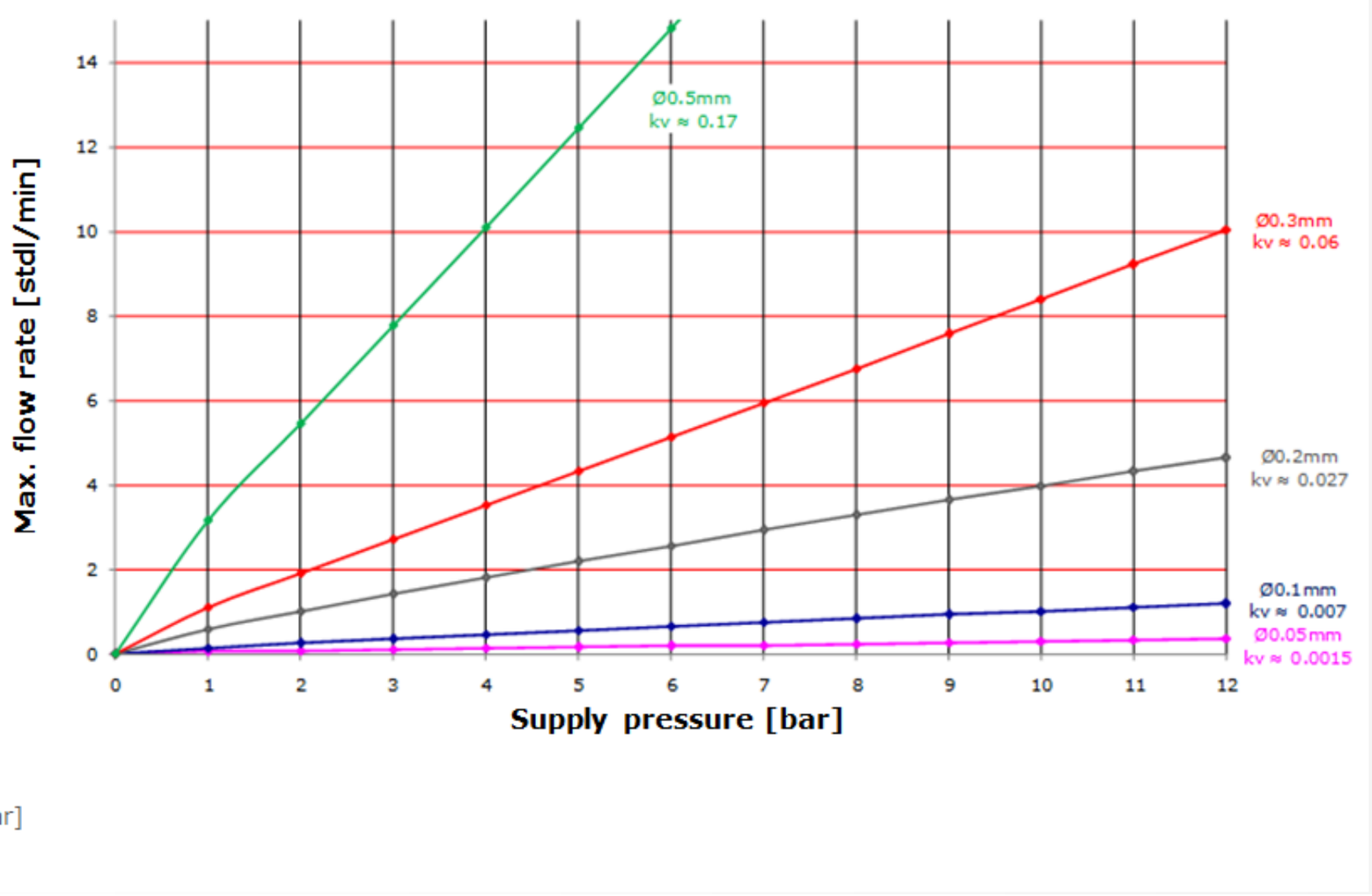
Lowest hysteresis

Validated to 100 million cycles

Cartridge or manifold

Orifice size 0.1 to 2.0 mm

Flow range



*Testing conditions:

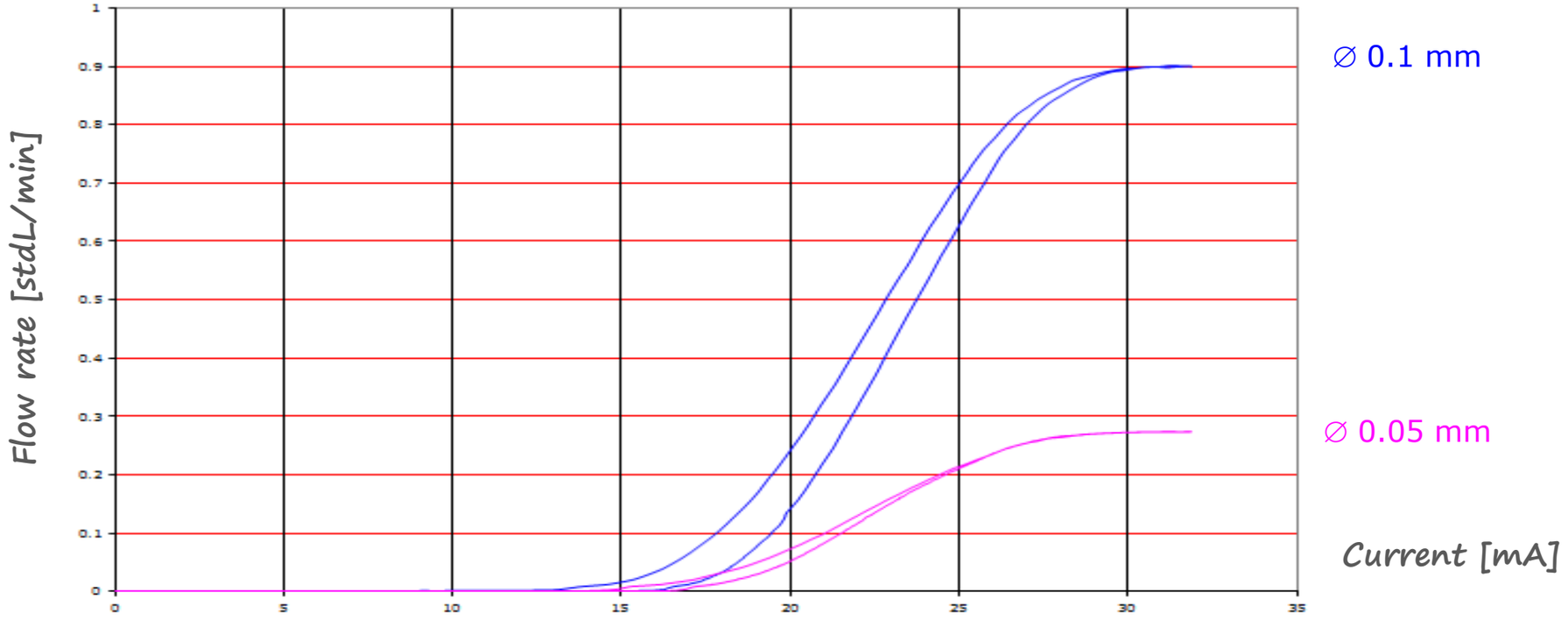
- Medium: air
- Patm: 1013 [mbar]
- T: 21.1 [°C]

FASPROP 16 MM PROPORTIONAL VALVE

IMI Precision Engineering

Linearity / Hysteresis & Repeatability

Hysteresis <10%

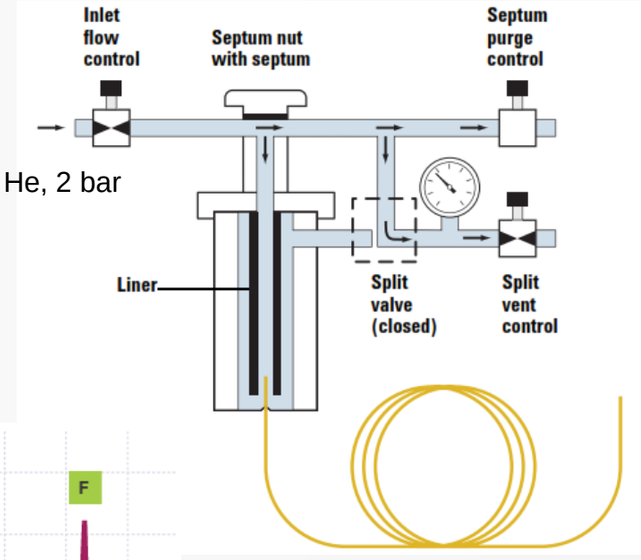


Gas chromatography

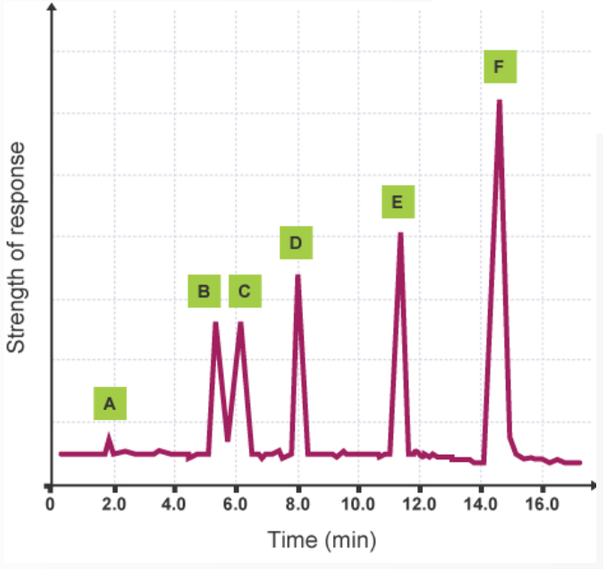
Gas chromatography is a technique used to separate volatile samples using inert gasses (He or N2).

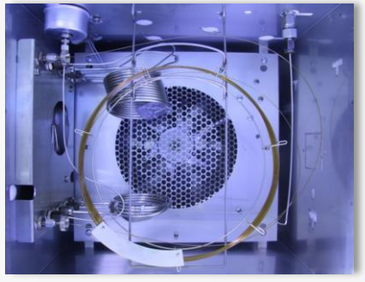
The main function of **GC inlets** is to provide accurate, reproducible, and predictable introduction of sample into the column**.**

Needs to control inlet flow from a few ml / min to more than 1250 ml / min



Column flow rate
1 ml / min

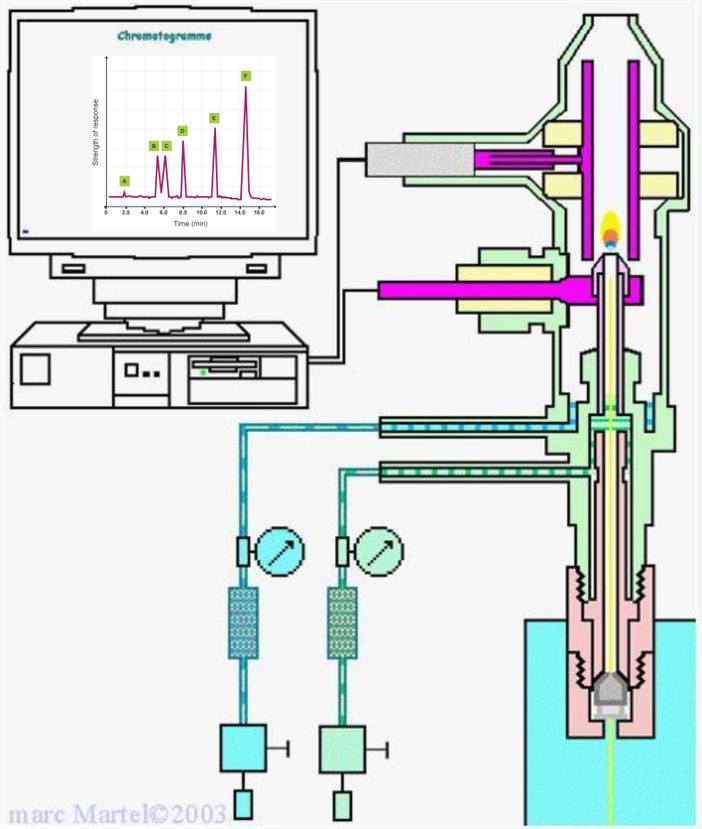




Gas chromatography

A **flame ionization detector** (FID) is an instrument that measures the concentration of organic species in a gas stream.

An air/hydrogen flame creates very few ionized particles. However, if a carbon-containing material enters the flame, ion production increases.



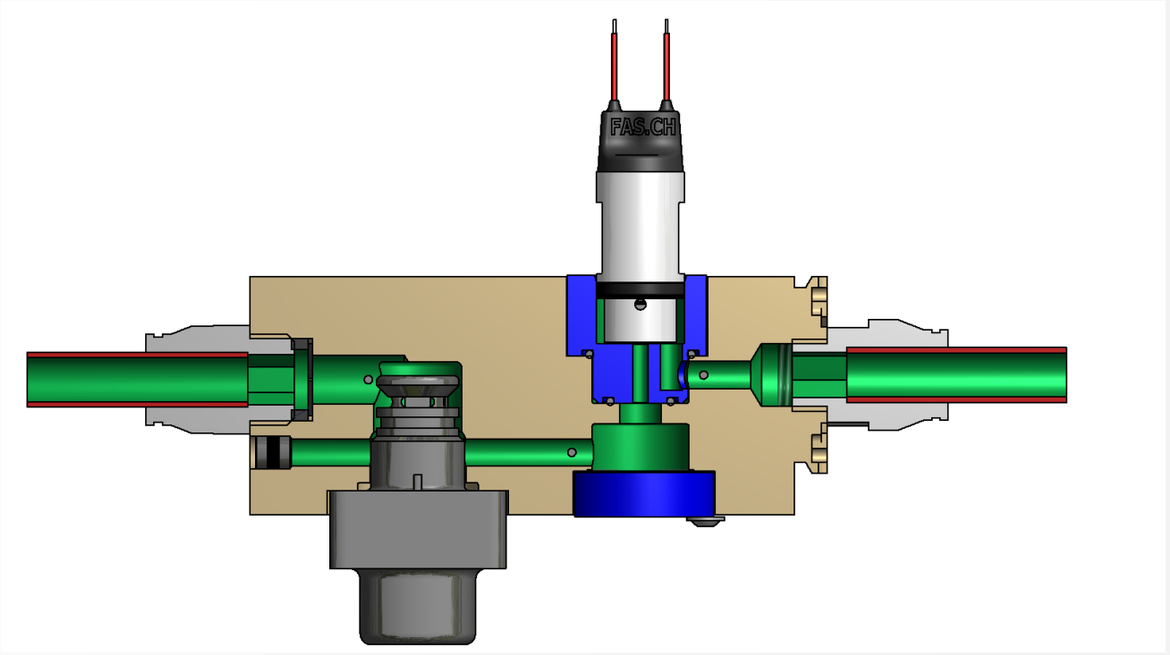
Typical flow rate

- Carrier gas 8 – 10 ml/min
- Hydrogen: 30 – 45 ml/min
- Air: 300-450 ml/min

FASPROP is suitable to **regulate flow and pressure supply** improving **stability and sensitivity.**

Mass Flow Controller

IMI FAS MFC integrated solution:



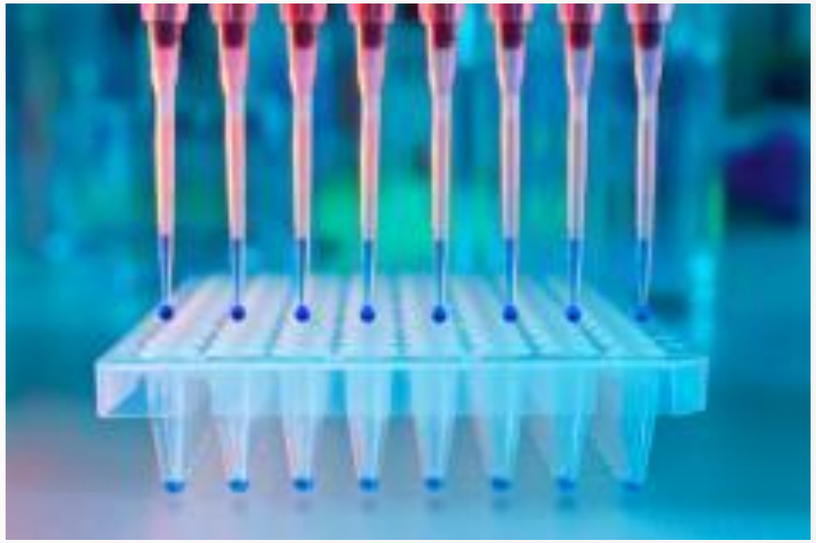
On request, multi channels MFC system is possible

Require your own device!

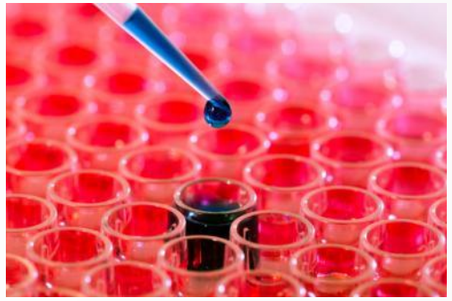
Media Separated Valves

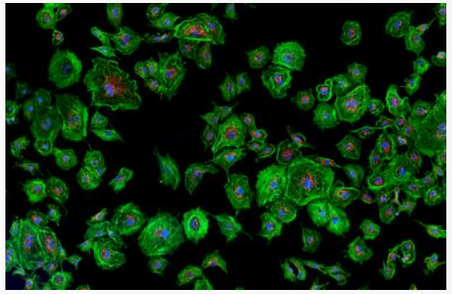
MEDIA SEPARATED VALVES

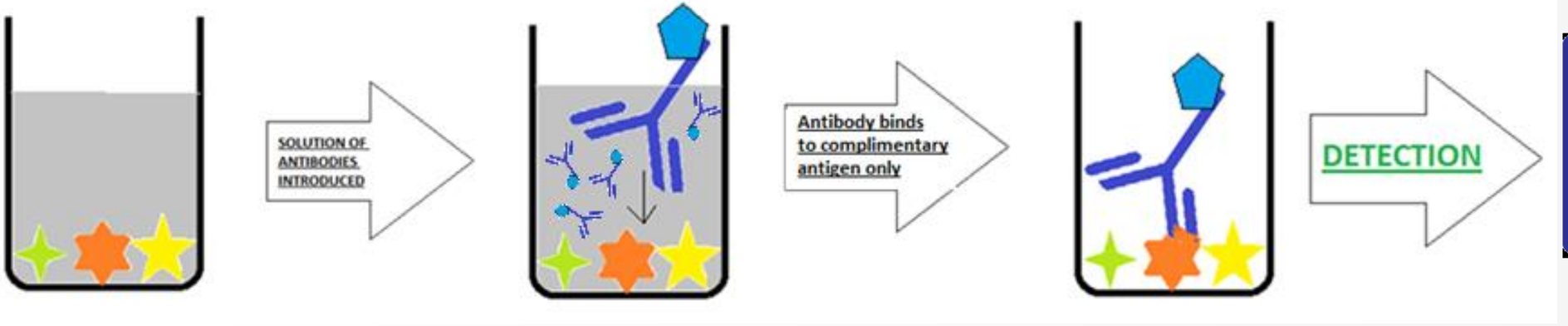
Typical Applications



In Vitro Diagnostic







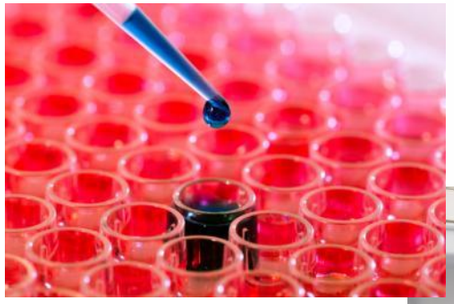
Test sample in a vial

Introduction of reagent

Reaction between sample and reagent

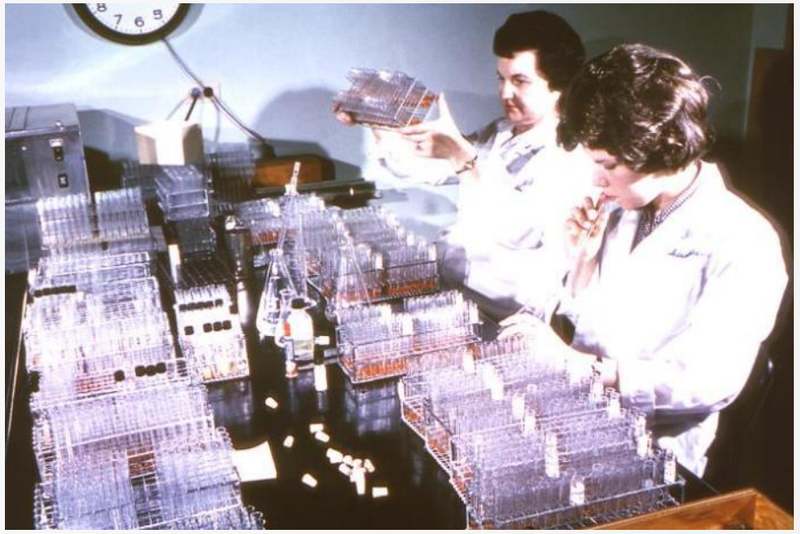
Measurement

Liquid Handing: From Manual…



Manual pipetting for a few sample…

….But, how to handle thousands of samples in the hospital???



…To Full Automated Workstation

Is there any MS valve inside this machine ???

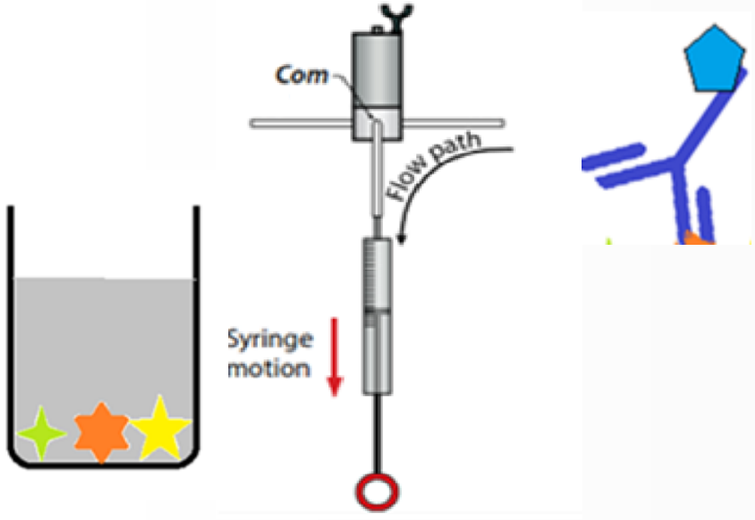
Automated Liquid Handling

Workstation

Syringe pump and valve

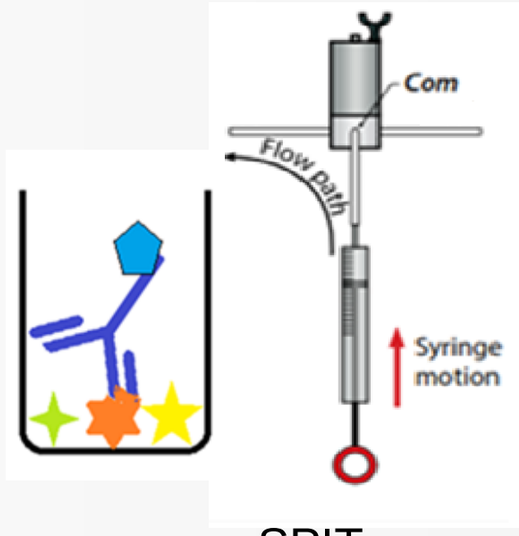
3/2 MS valve

“De-energized”



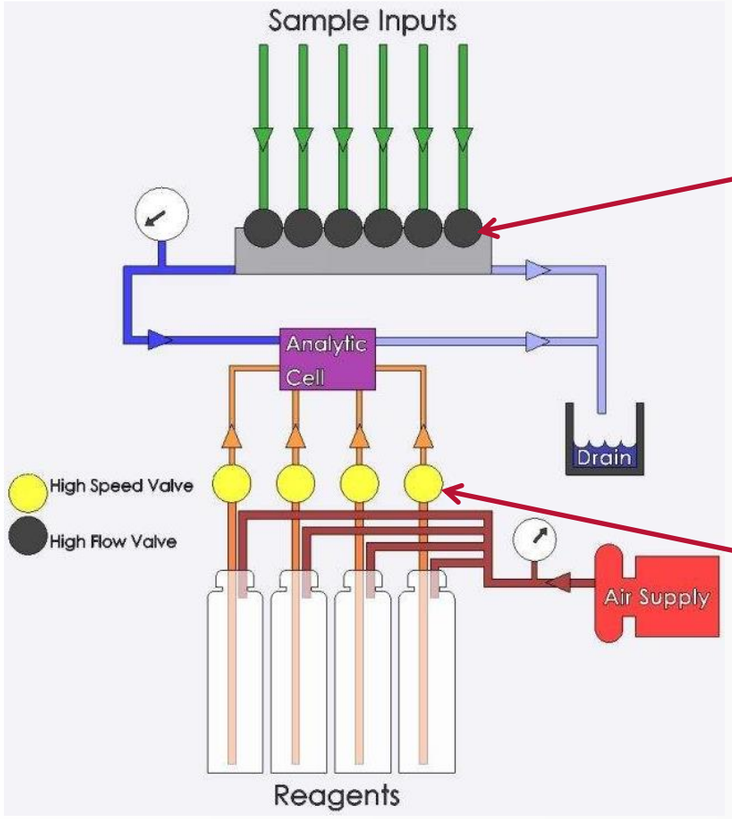
« SIP »

“Energized”



« SPIT »

Other Potential Application: Water Analysis



3/2 MS Valve

Sample delivery to the analytical cell **or** to the drain

2/2 MS Valve

Reagent delivery to the analytical cell

Where are Needs for MS Valves?

Media

Liquids, sensitive media, aggressive media, samples and reagents

> Ultra-pure water, blood, chemicals, reagents, samples…

Markets & Applications

Diagnostics, Analytical Instrumentation, Printing

> Automated liquid handling, flow cytometry…

Analytical Instrumentation

> TOC, Element Analyzer, Water analysis…

Printing

> Continuous Inkjet Printing…

Functions

Flow control, liquid dispense, drain, wash, waste

Product Offering

CHIPSOL
2/2 MS

PICOSOL
3/2 MS

MICROSOL
2/2 - 3/2 MS and Pinch

MINISOL
3/2 MS

8 mm
kv 0.1

10 mm
kv 0.65

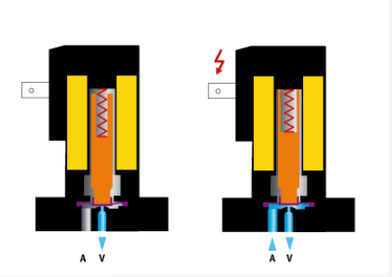
15 mm
kv 0.6-0.8

22 mm
kv 0.9-2.4

FAS Media Separated Valves

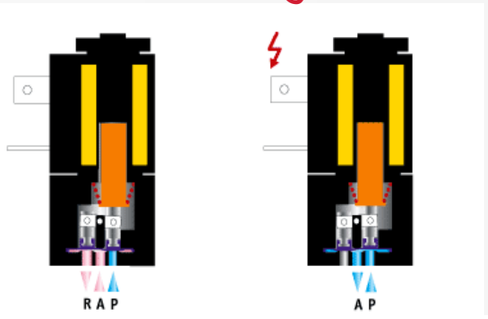
2/2-Way

- USE WITH SENSITIVE MEDIA
  - Samples or reagents
  - Ultra-pure water
  - Beverages

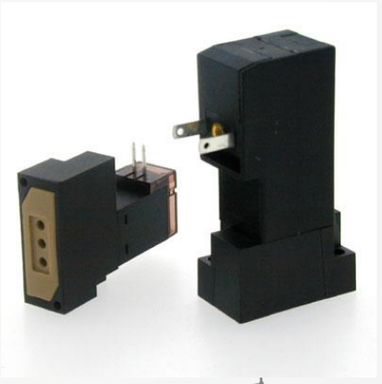


- USE WITH AGGRESSIVE MEDIA
  - Strongly acidic or basic liquids
  - Aggressive gases

3/2-Way



FAS Media Separated Valves

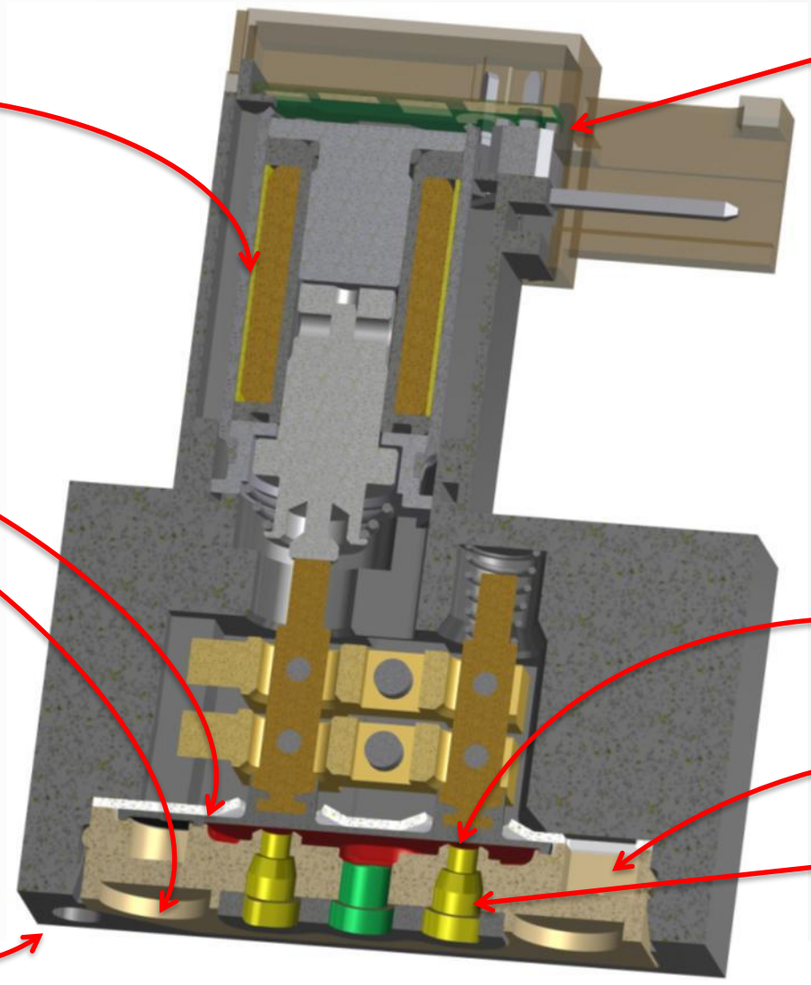


- SEAL MATERIALS:
  - FFPM: KALREZ, highest grade, resistant against most CHEMICALS, most expensive
  - FPM: VITON, more cost effective than KALREZ, resistant against many CHEMICALS
  - EPDM: minimally more cost effective than VITON, good for use with water and light bases & acids
- BODY MATERIALS:
  - PEEK: highest grade, resistant against most CHEMICALS, most expensive
  - PVDF: more cost effective than PEEK, good for use with water and light bases & acids

FFPM
FPM
EPDM

PEEK
PVDF

About PICOSOL MS



24 V bobbin

Embedded PWM

3.5 / 0.4 W

10 mm 3/2 UNI MS

Diaphragm & Seal
FFPM, EPDM

Orifice 1.2 mm, kv 0.65

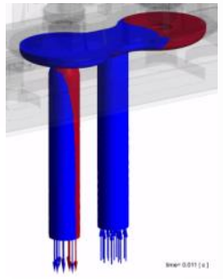
Body: PEEK

Internal volume: 72µl

2 screws, manifold mounting

Carry over / Cleanability / Internal vol

Prevent sample cross-contamination



t=0

t=0.01 [s]

t= 0.08 [s]

Already after about 0.15s, less than 1% of the initial vol is still in the valve, representing a volume of 0.72 µl

Fast and thorough cleaning of the valve

Virtually no unswept or dead volume

For your customers…

PICOSOL 3/2 MS offers

Low power consumption

Highest flow to size ratio in the industry

Universal

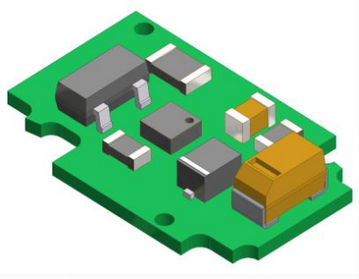
Large pressure range

Long life

Cleanability & low internal volume

FAS Embedded Electronics

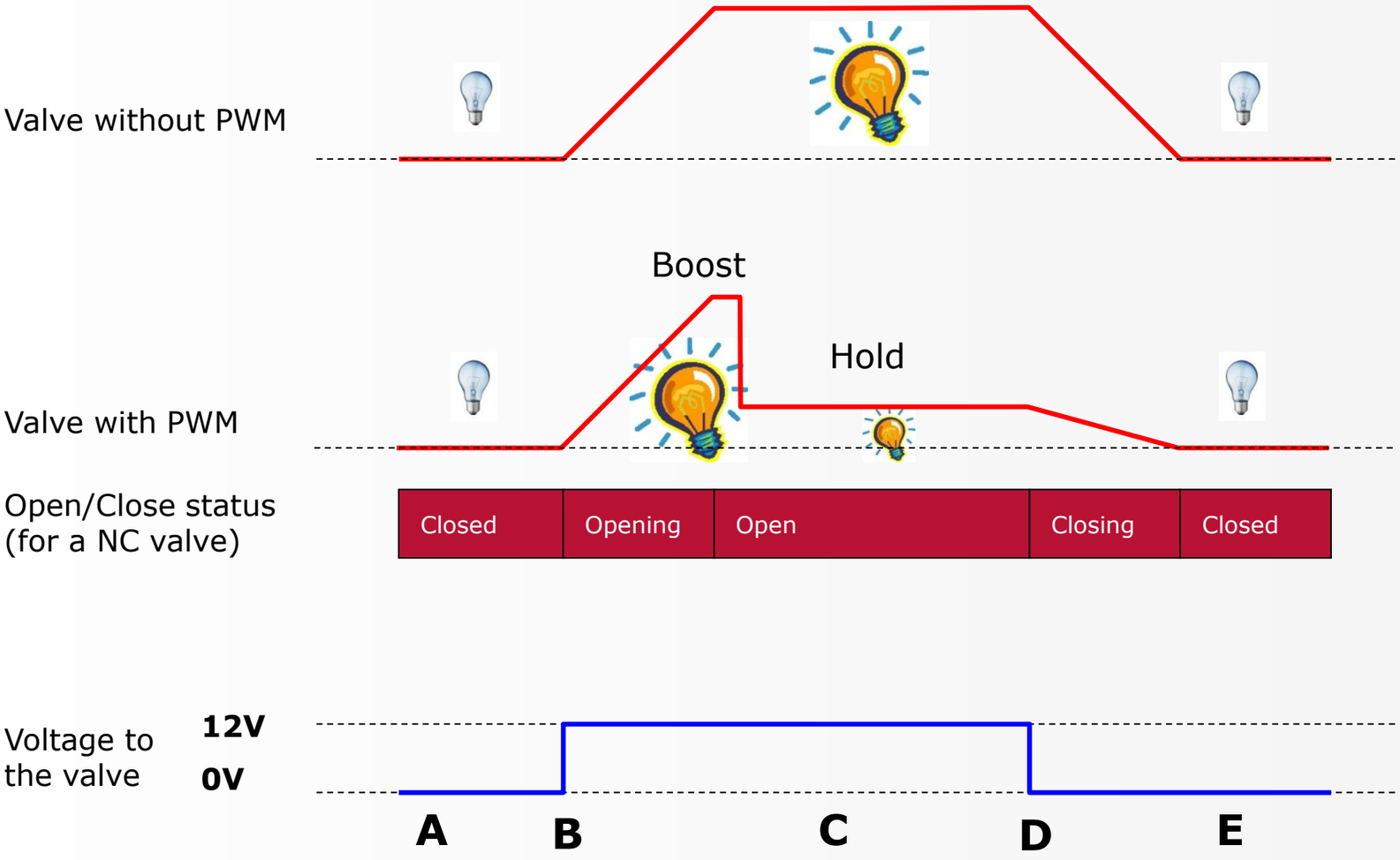
Embedded Electronics



...many options available...

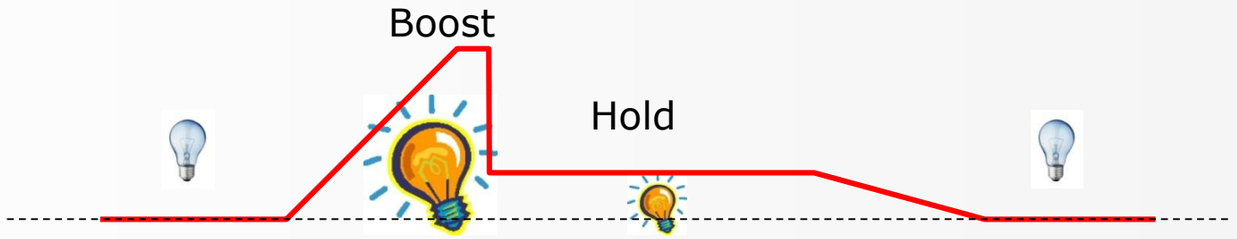
- **Integrated pulse width modulation (PWM)**
- Plunger Detection Power Adaptation (PDPA)
- Enhanced opening time repeatability
- Larger input voltage tolerances
- Faster valve closing
- Current control for improved performance over Temperature range
- Reverse polarity protection
- Led signalization

FAS Embedded Electronics: PWM



FAS Embedded Electronics: PWM

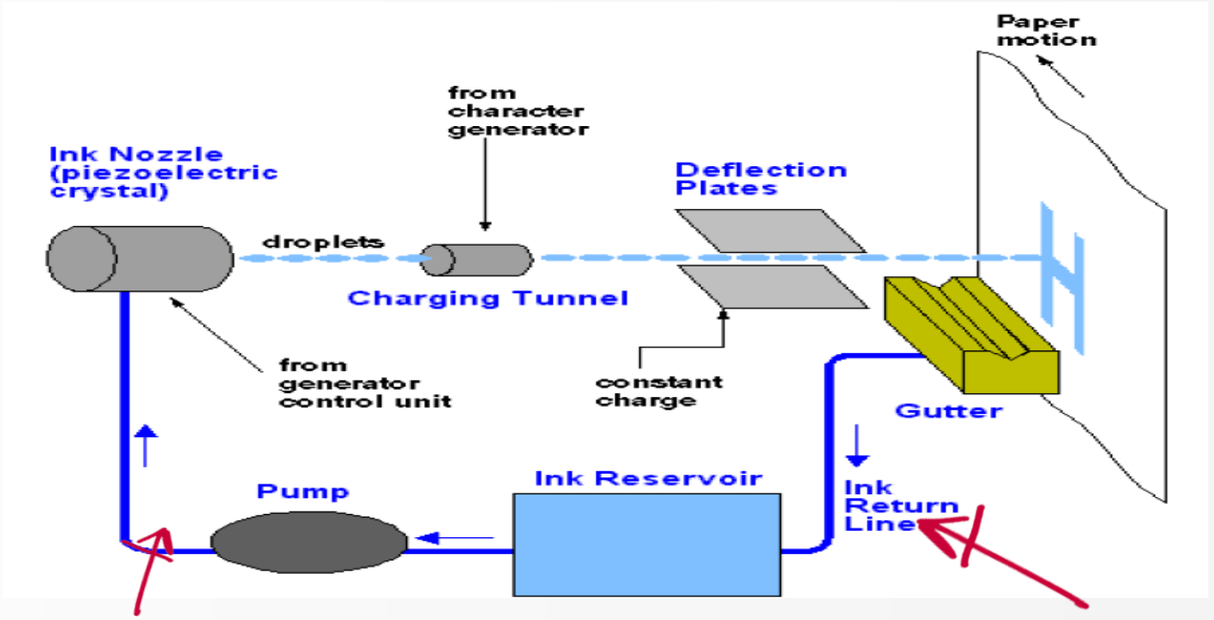
Valve with PWM



PWM is a very efficient way of providing intermediate amounts of electrical power between fully on and fully off.

PWM is energy saving and avoids the overheating of valve.

MICROSOL INKJET



HIGH FLOW VALVE

MEDIA SEPARATED VALVE

NORGREN

Thanks

IMI