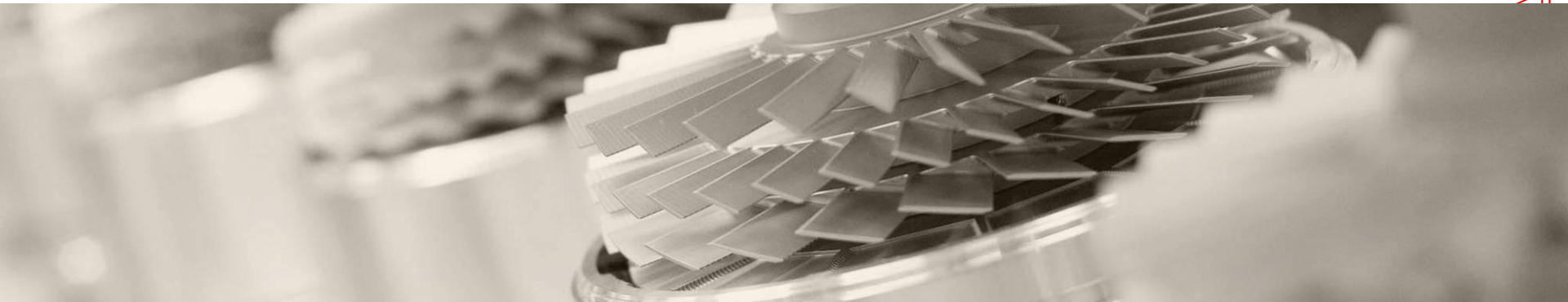


Introduction to Vacuum Pumps, Future Changes & Development Trends.

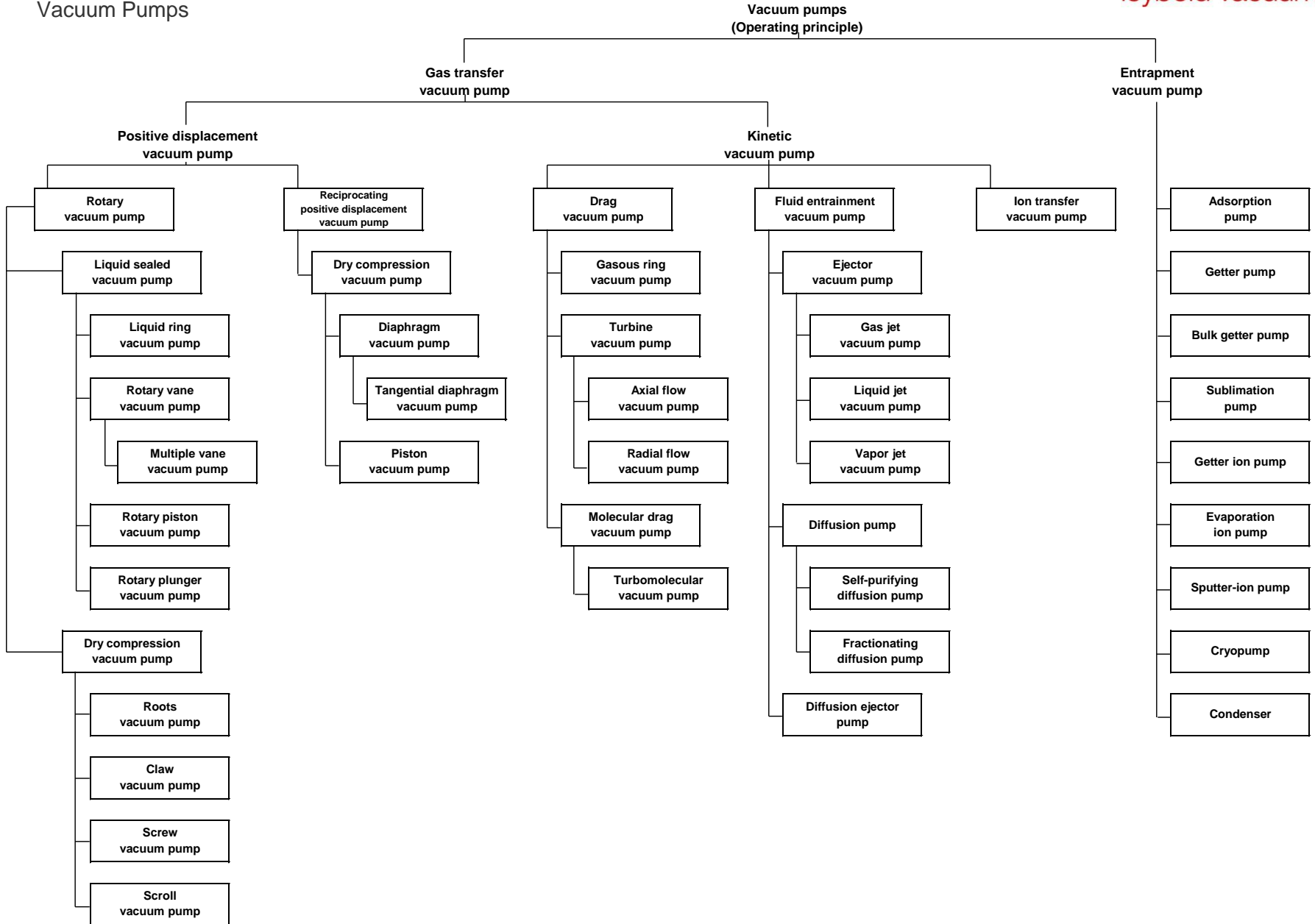
Coventry, 19th October 2011
Clive Tunna

Revised for ASPERA Workshop Darmstadt March 13, 2012
Dieter Müller



- 1 Vacuum family tree
- 2 Fore vacuum mechanisms – pressure & speed range
- 3 High vacuum mechanisms – pressure & speed range
- 4 Fore vacuum pump applications
- 5 High vacuum pump applications
- 6 Future developments

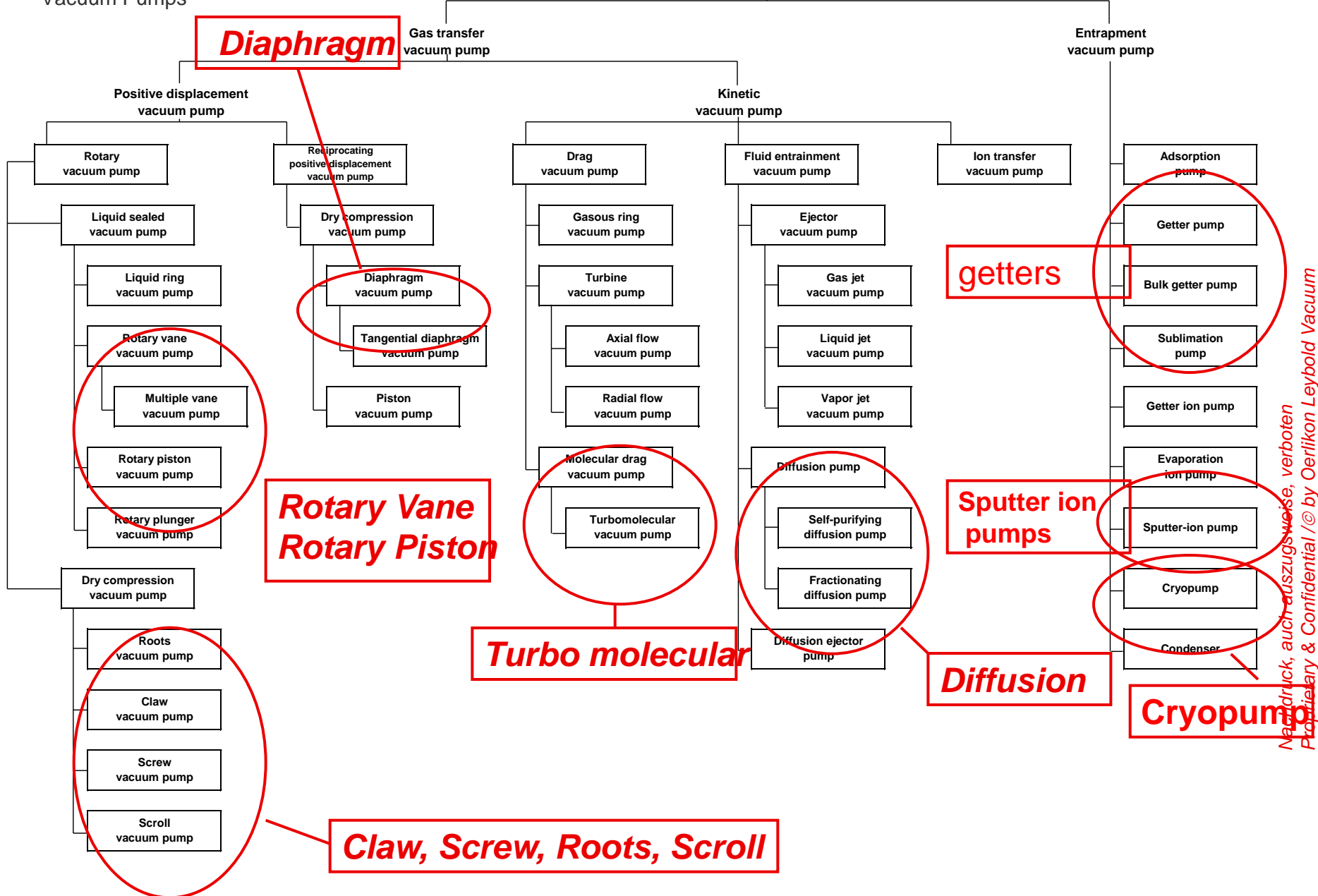
Vacuum Pumps



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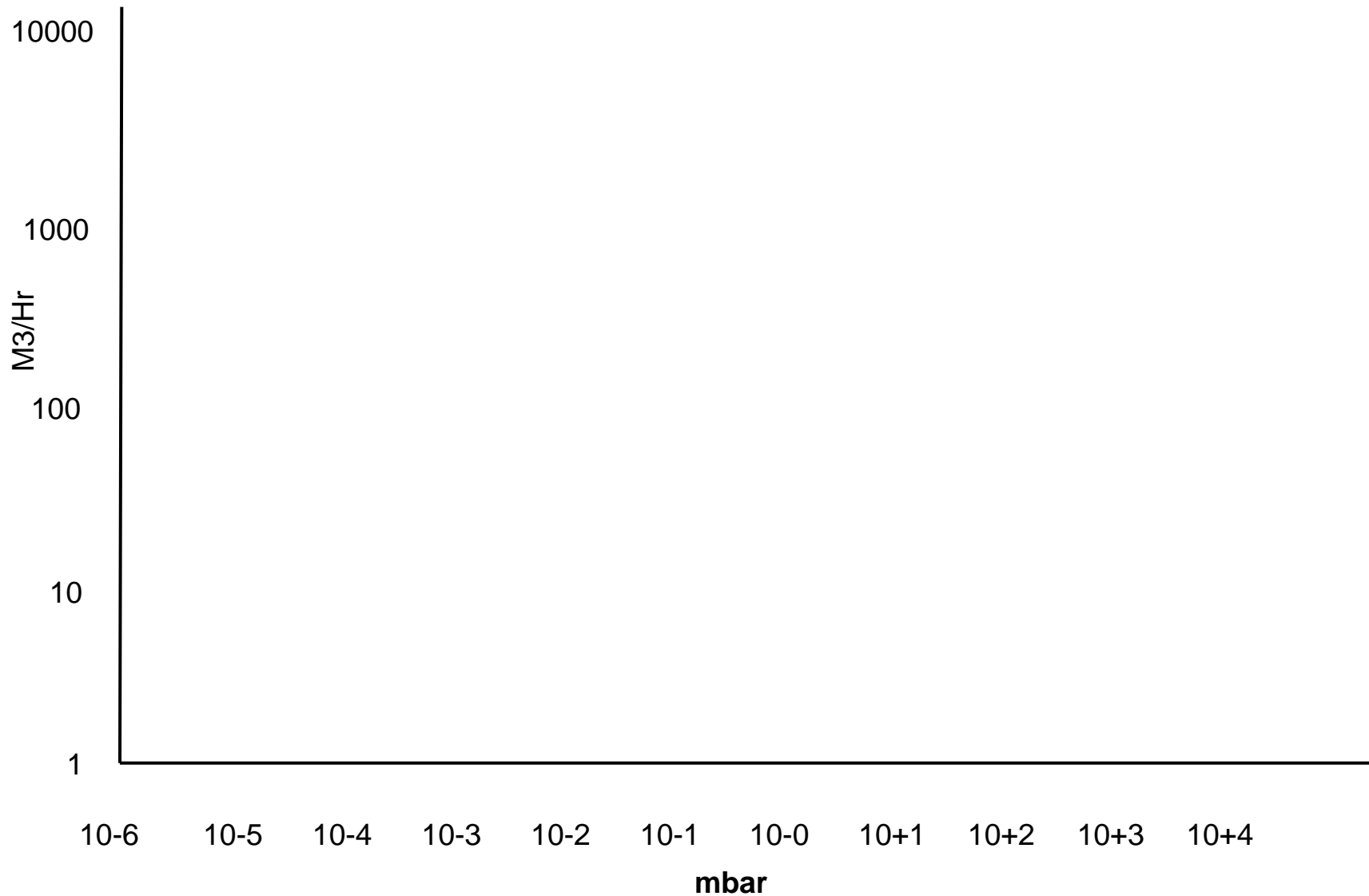
Vacuum Pumps

Vacuum pumps
(Operating principle)

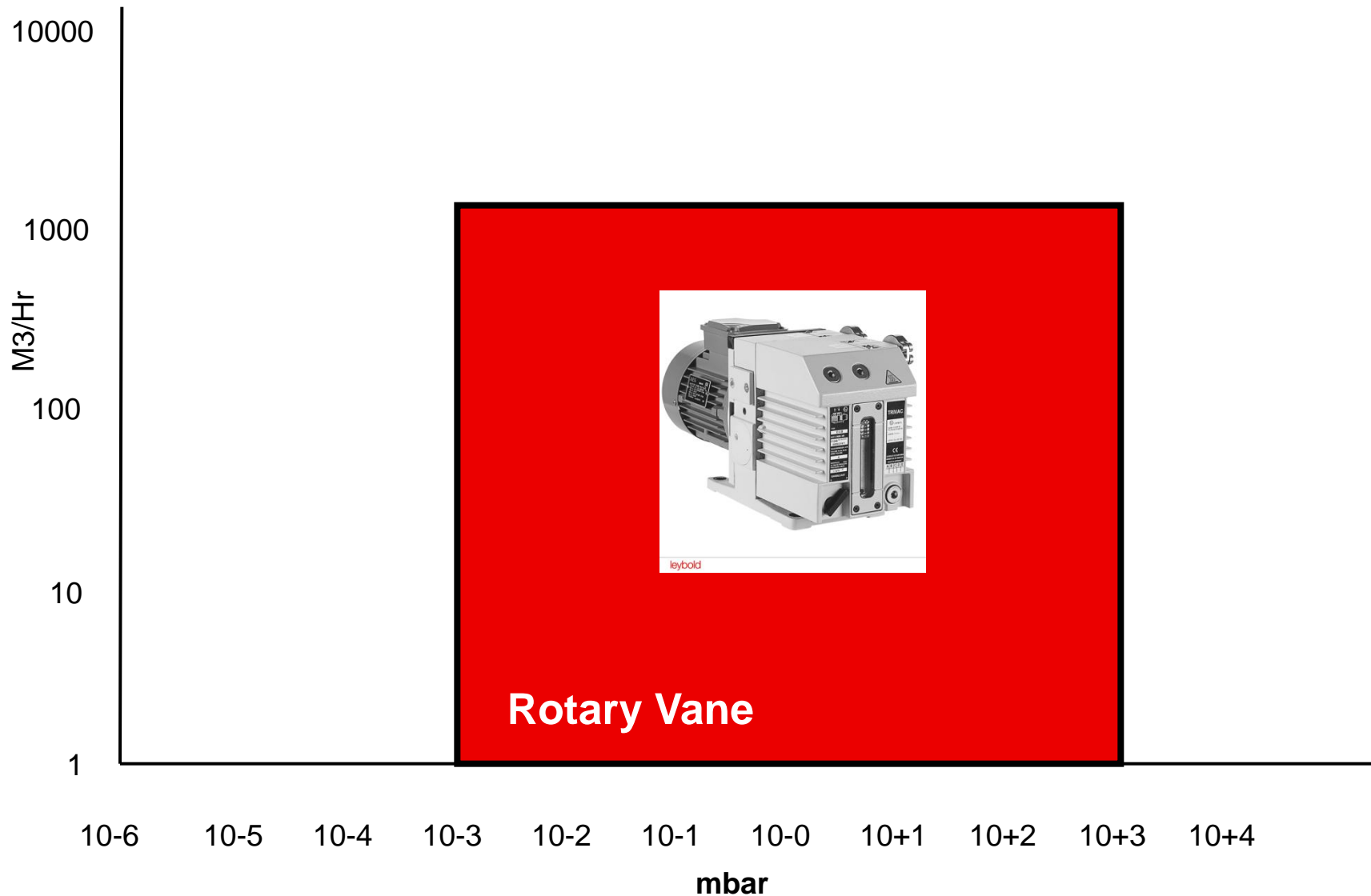


Pumping speed vs. Pressure range

Fore Vacuum pumps

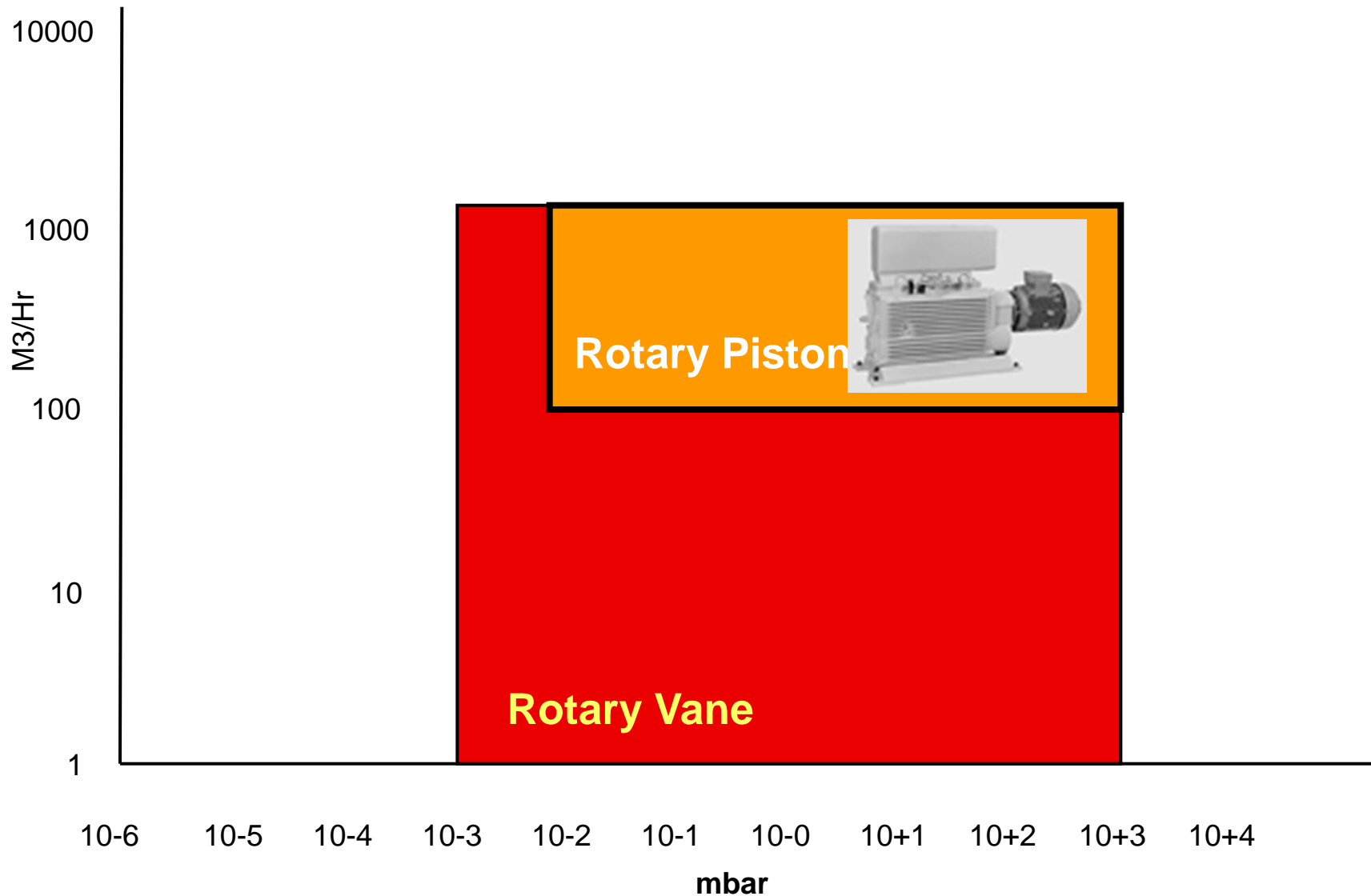


Pumping speed vs Pressure range Fore Vacuum pumps

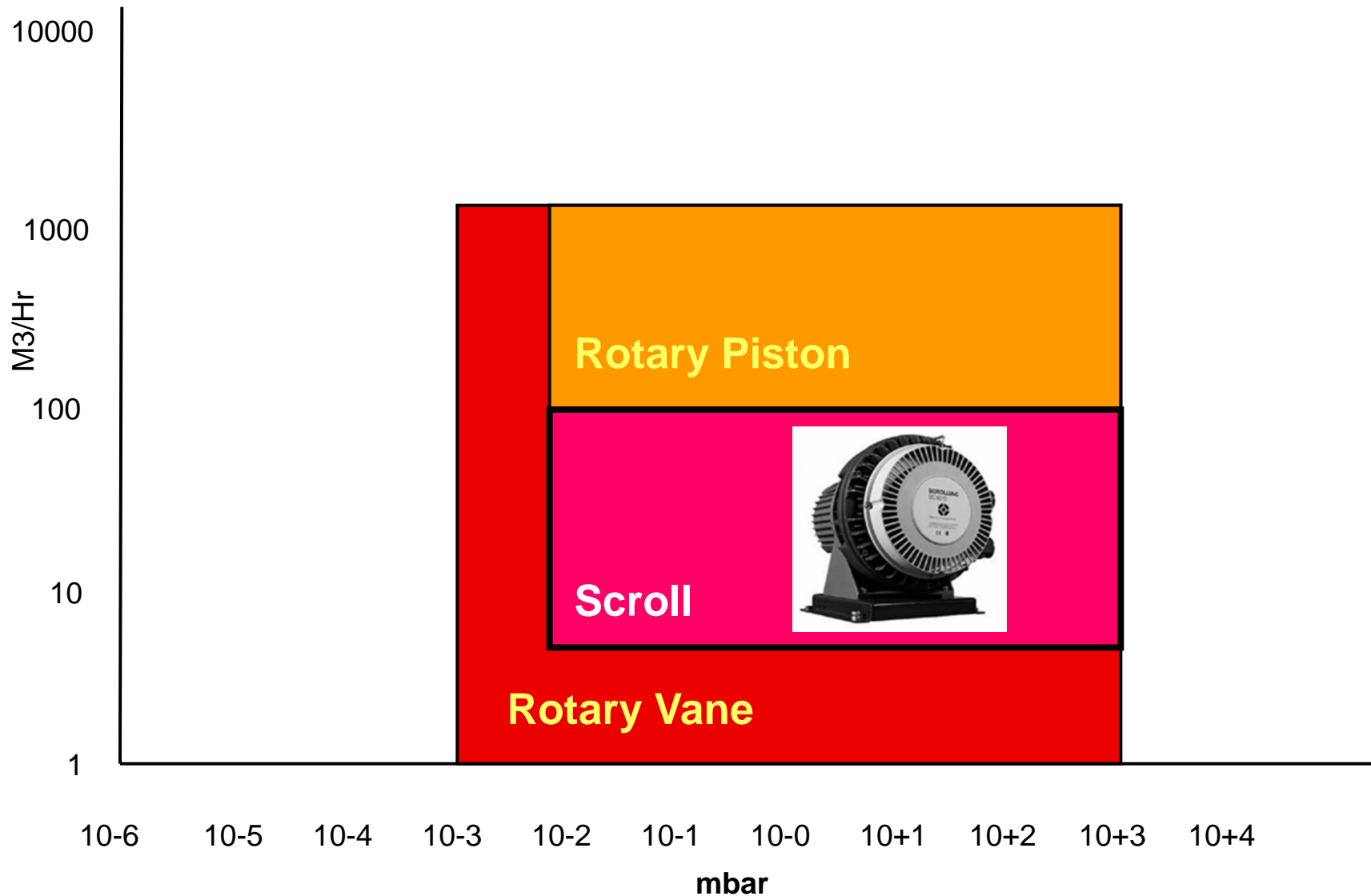


Pumping speed vs Pressure range

Fore Vacuum pumps

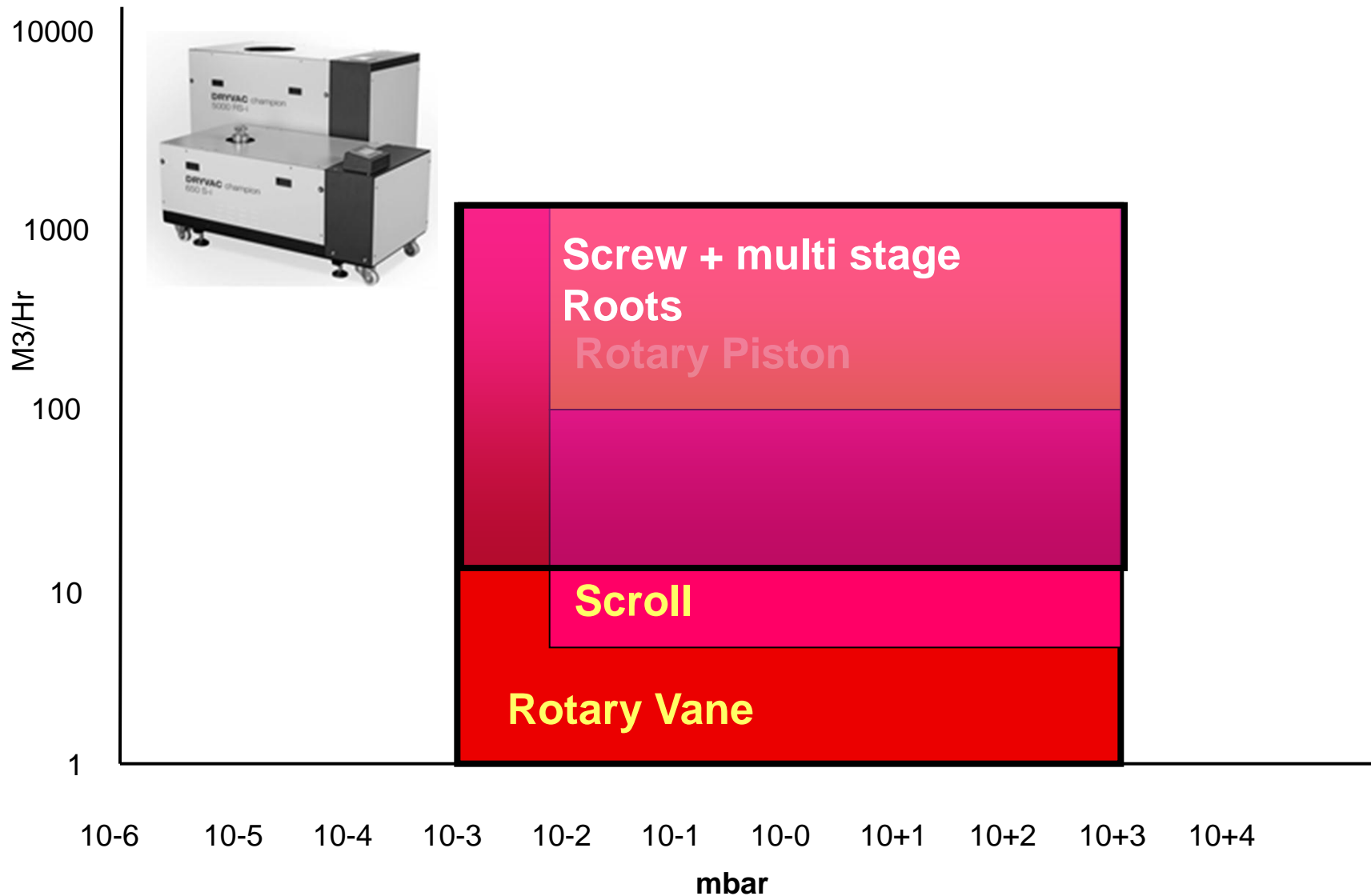


Pumping speed vs Pressure range Fore Vacuum pumps



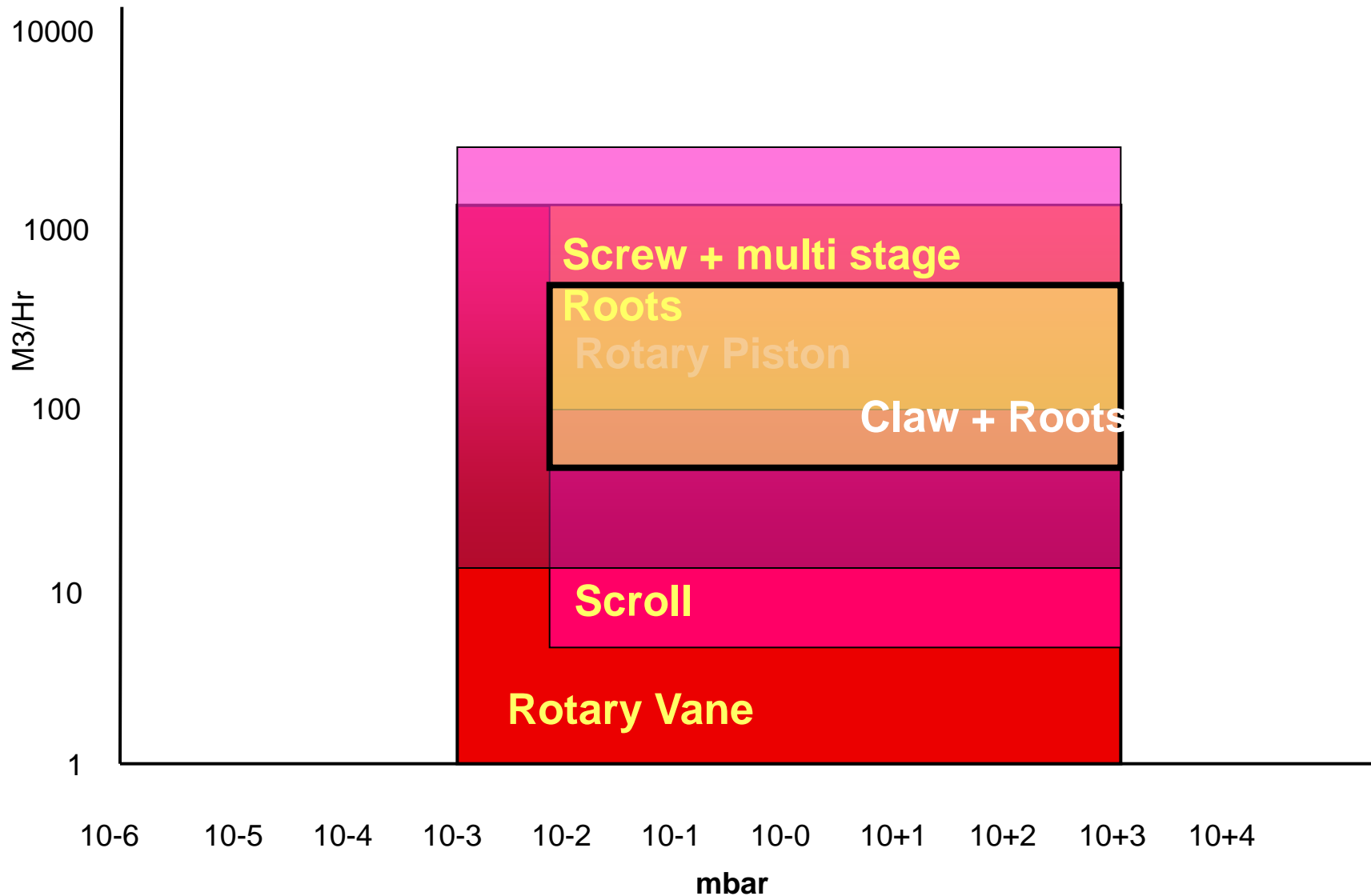
Pumping speed vs Pressure range

Fore Vacuum pumps



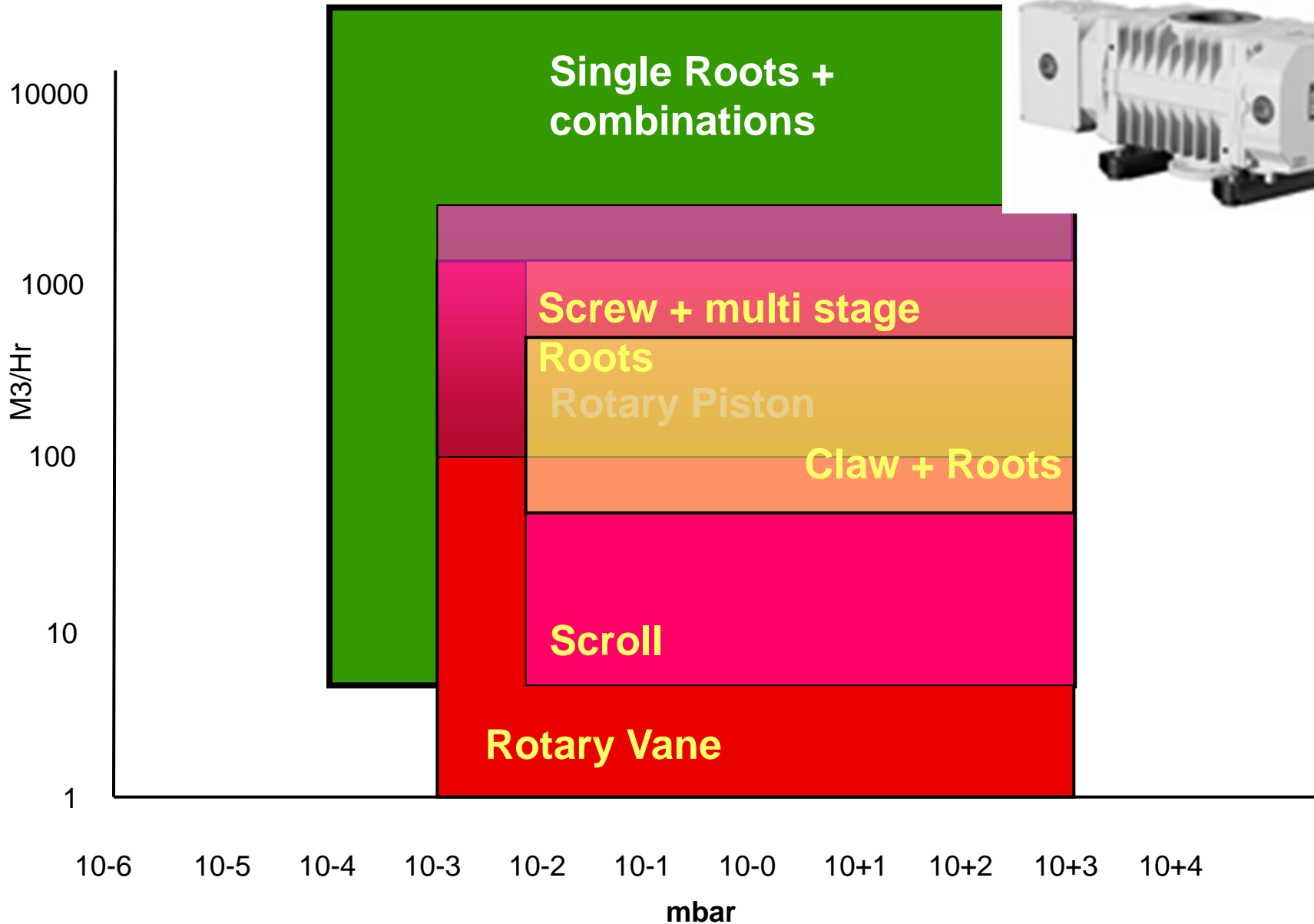
Pumping speed vs Pressure range

Fore Vacuum pumps



Pumping speed vs Pressure range

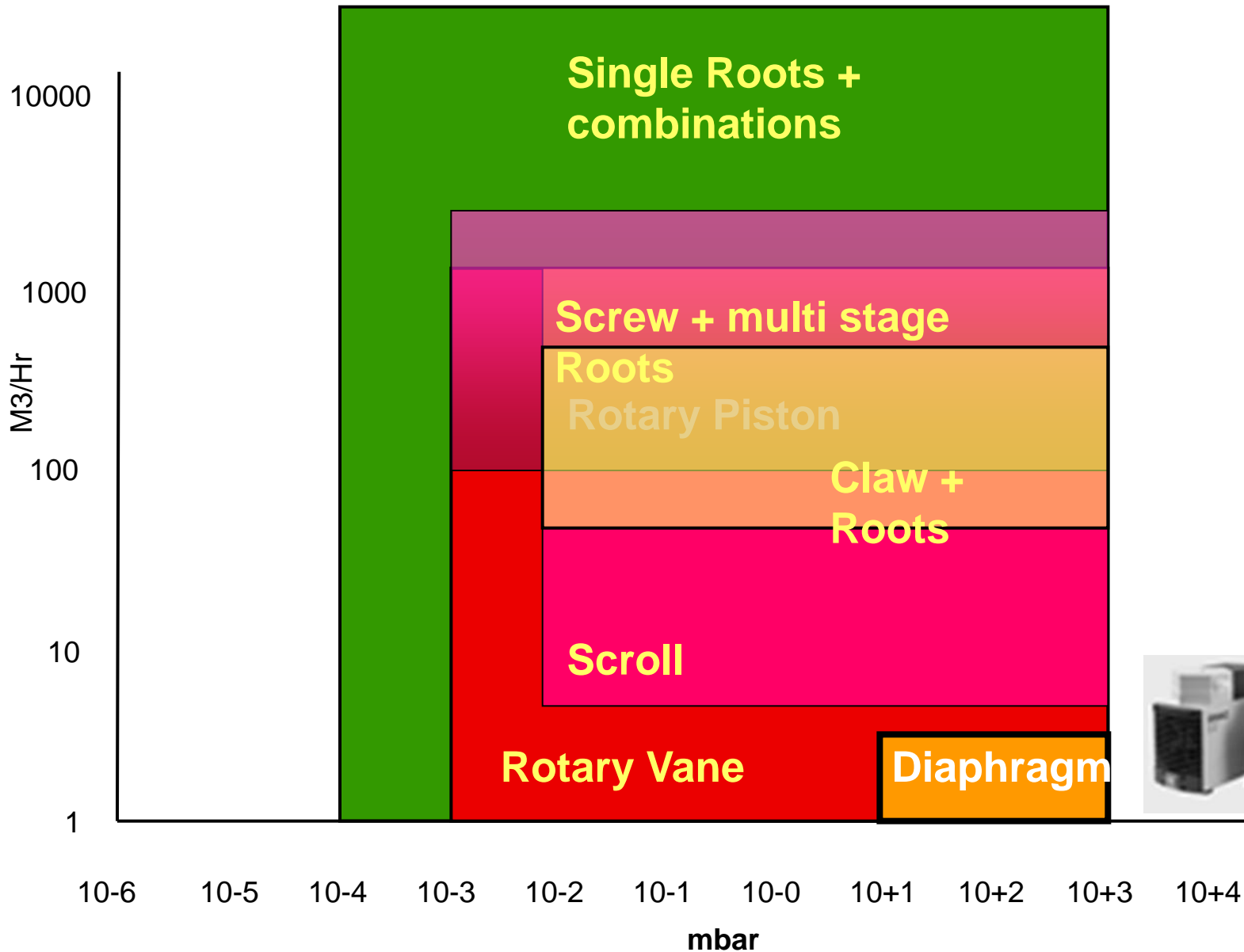
Fore Vacuum pumps



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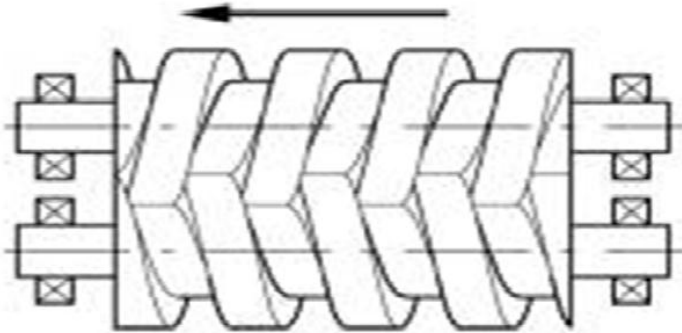
Pumping speed vs Pressure range

Fore Vacuum pumps



Screw dry pump

Gas throughput



USP: Robustness on harsh duties
Hydrocarbon free.
Low power consumption.

Cost: High

Negative: Needs seal purge gas

Pumping speed range:

100 m³/hr > 2500 m³/hr

End pressure:

10-3 mbar

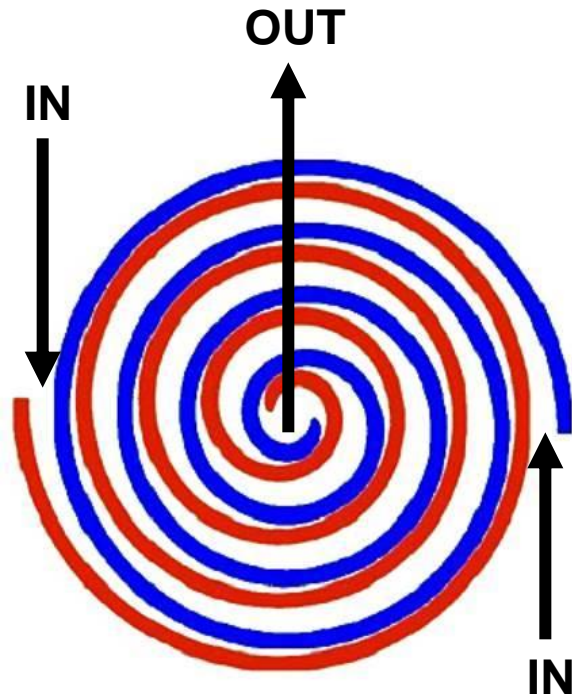
Applications:

- | | |
|-----------------------|-----|
| - Air | yes |
| - Inert gases | yes |
| - He / H ₂ | yes |
| - Flammable | yes |
| - Pyrophoric | yes |
| - Reactive | yes |
| - Radioactive | yes |
| - Toxic | yes |
| - Vapours | yes |
| - Hot gases | yes |
| - Dust | yes |
| - Sticky deposits | yes |

[with precautions]



Scroll dry pump



USP: Hydrocarbon free

Cost: High

Negative: Yearly tip seal change, produces dust

Pumping speed range:
< 5 m³/hr to > 60 m³/hr

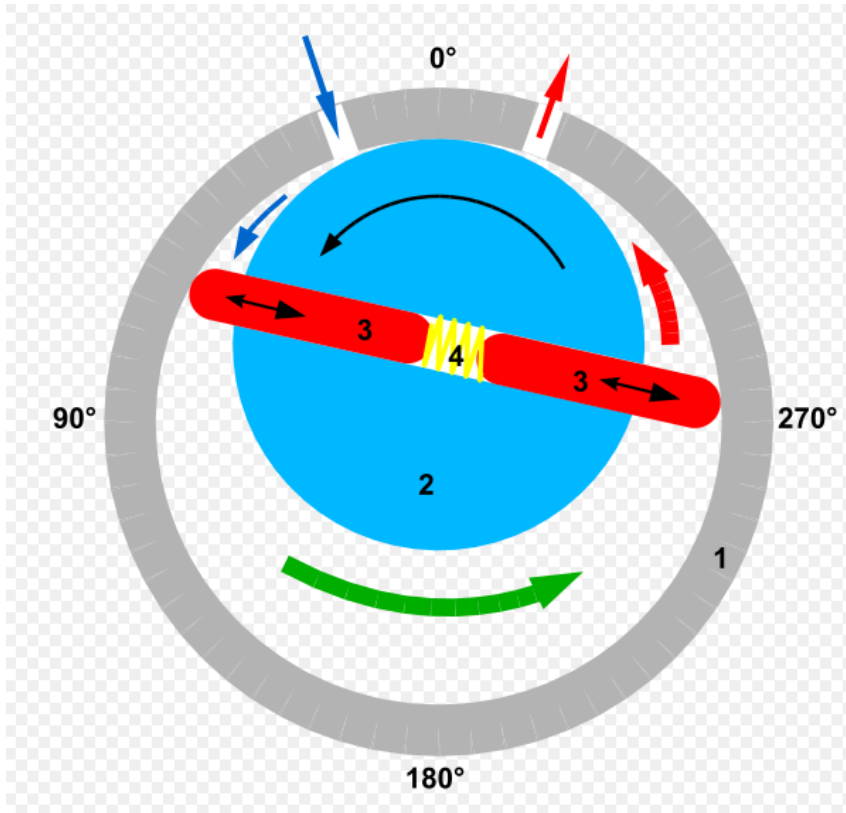
End pressure:
< 10⁻² mbar

Applications:

- | | |
|-----------------------|----------------|
| - Air | yes |
| - Inert gases | yes |
| - He / H ₂ | poor |
| - Flammable | with dilution |
| - Pyrophoric | no |
| - Reactive | no |
| - Radioactive | no |
| - [Special pump only] | |
| - Toxic | no |
| - [Special pump only] | |
| - Vapours | no condensable |
| - Hot gases | no |
| - Dust | no |
| - Sticky deposits | no |



Rotary vane wet pump



USP: Low cost high compression

Cost: Low

Negative: Oil wetted pumping chamber

Pumping speed range:
1 m³/hr > 1200 m³/hr

End pressure:
< 10⁻³ mbar



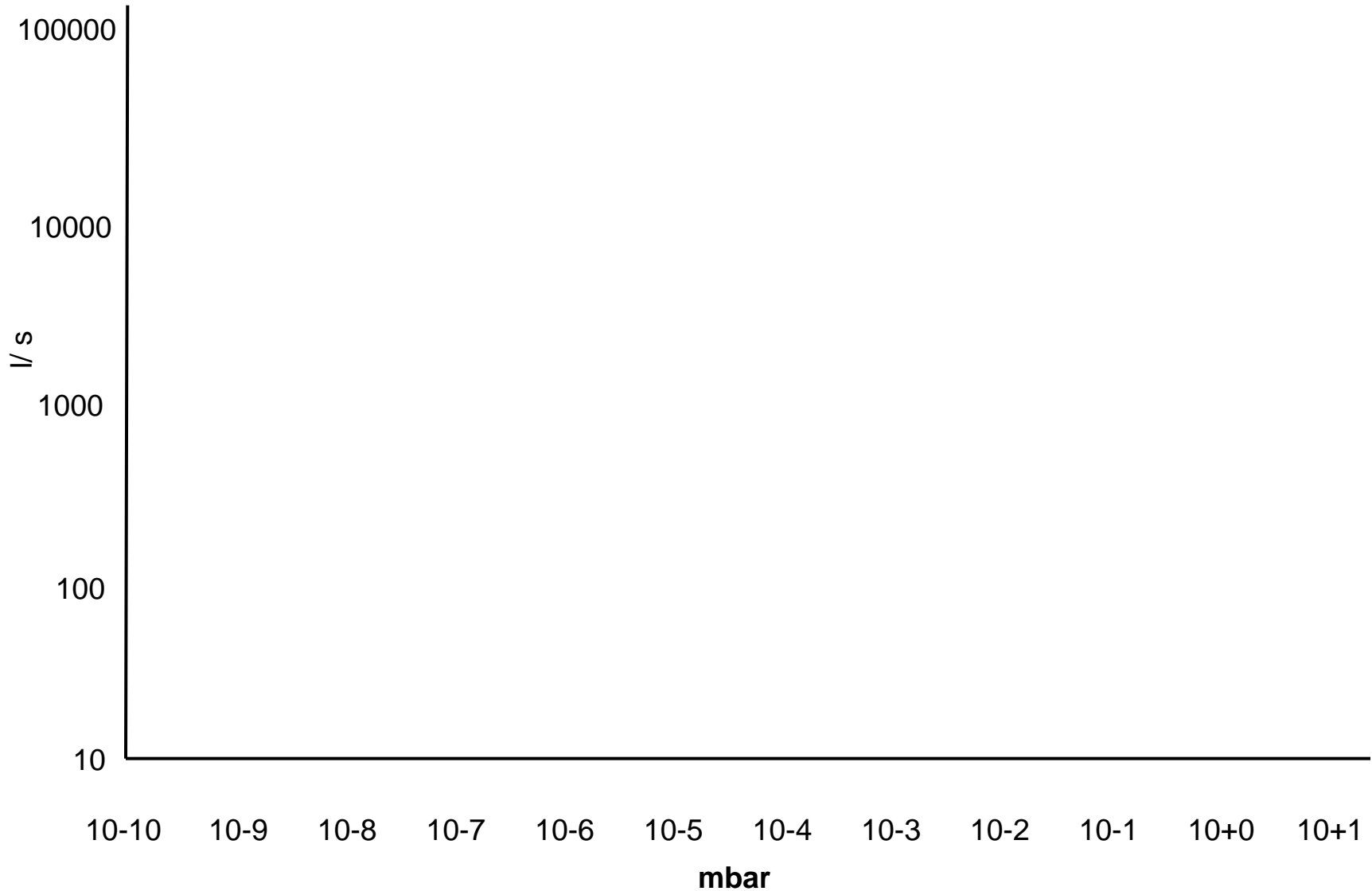
leybold

Applications: [Depending on lubricant]

- | | |
|-----------------------|---------------------|
| - Air | yes |
| - Inert gases | yes |
| - He / H ₂ | yes |
| - Flammable | yes |
| - Pyrophoric | yes |
| | [Special pump only] |
| - Reactive | yes |
| | [Special pump only] |
| - Radioactive | no |
| - Toxic | no |
| - Vapours | no condensables |
| - Hot gases | no |
| - Dust | no |
| - Sticky deposits | no |

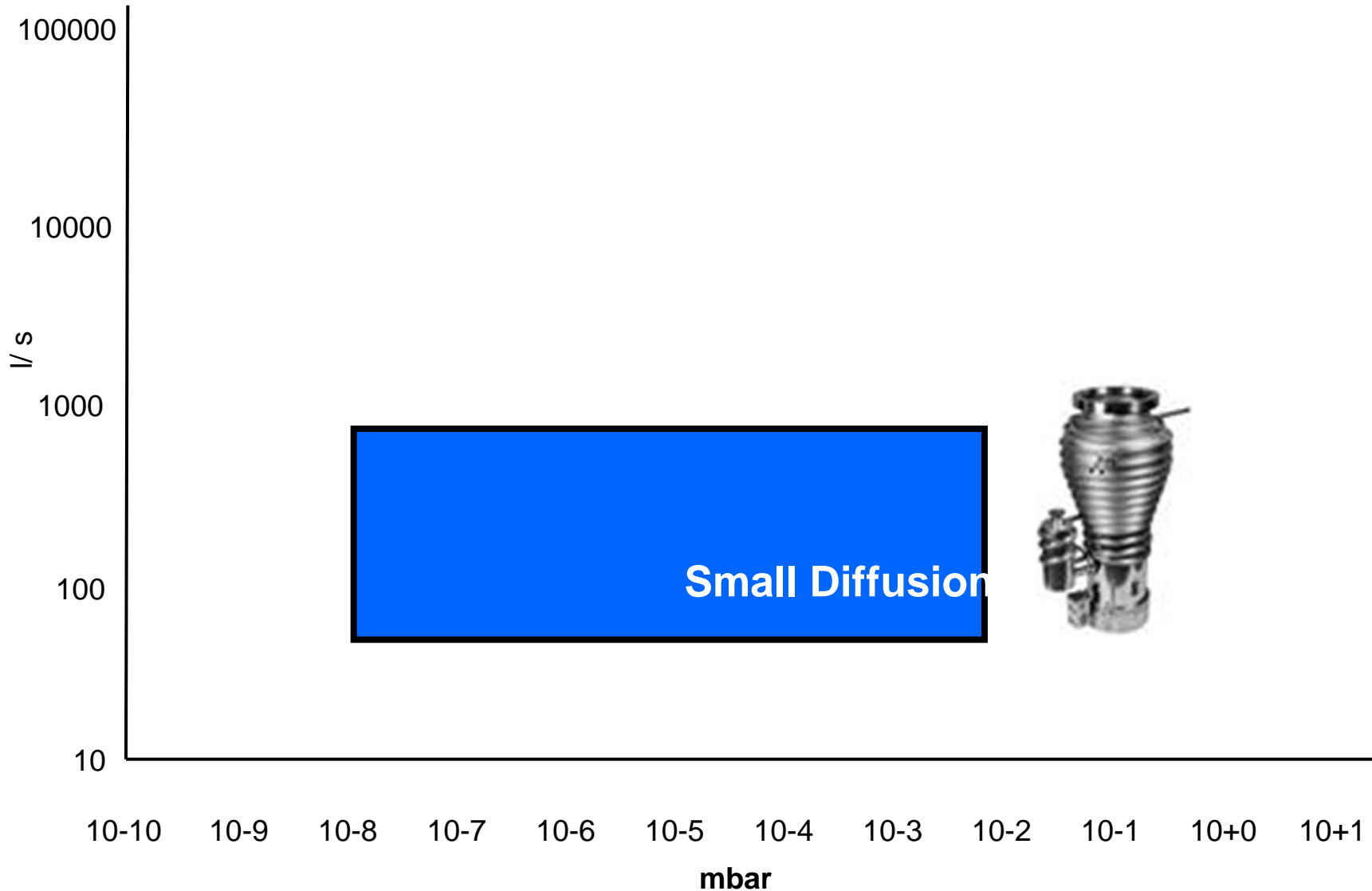
Pumping speed vs Pressure range

High Vacuum pumps



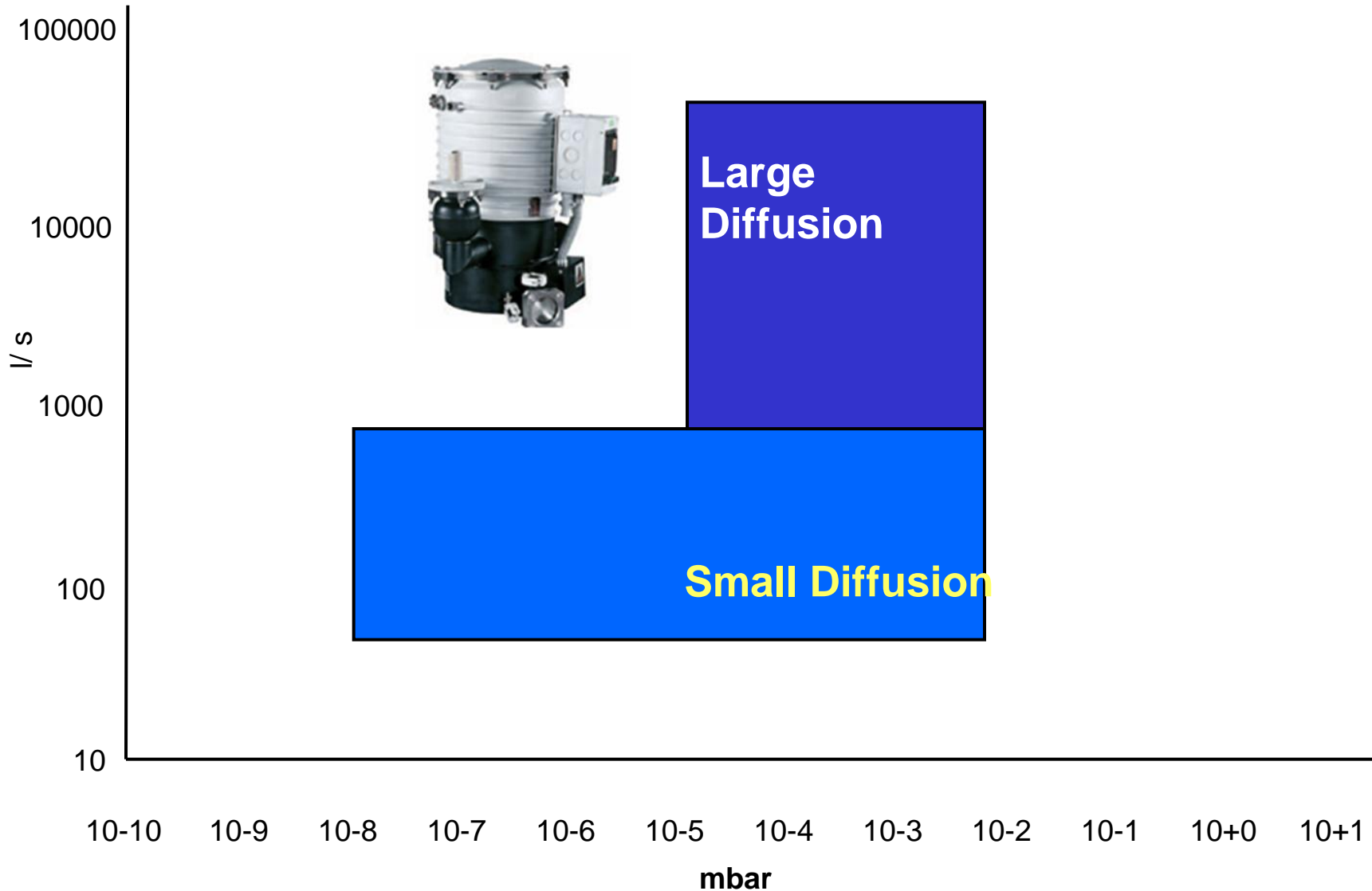
Pumping speed vs Pressure range

High Vacuum pumps



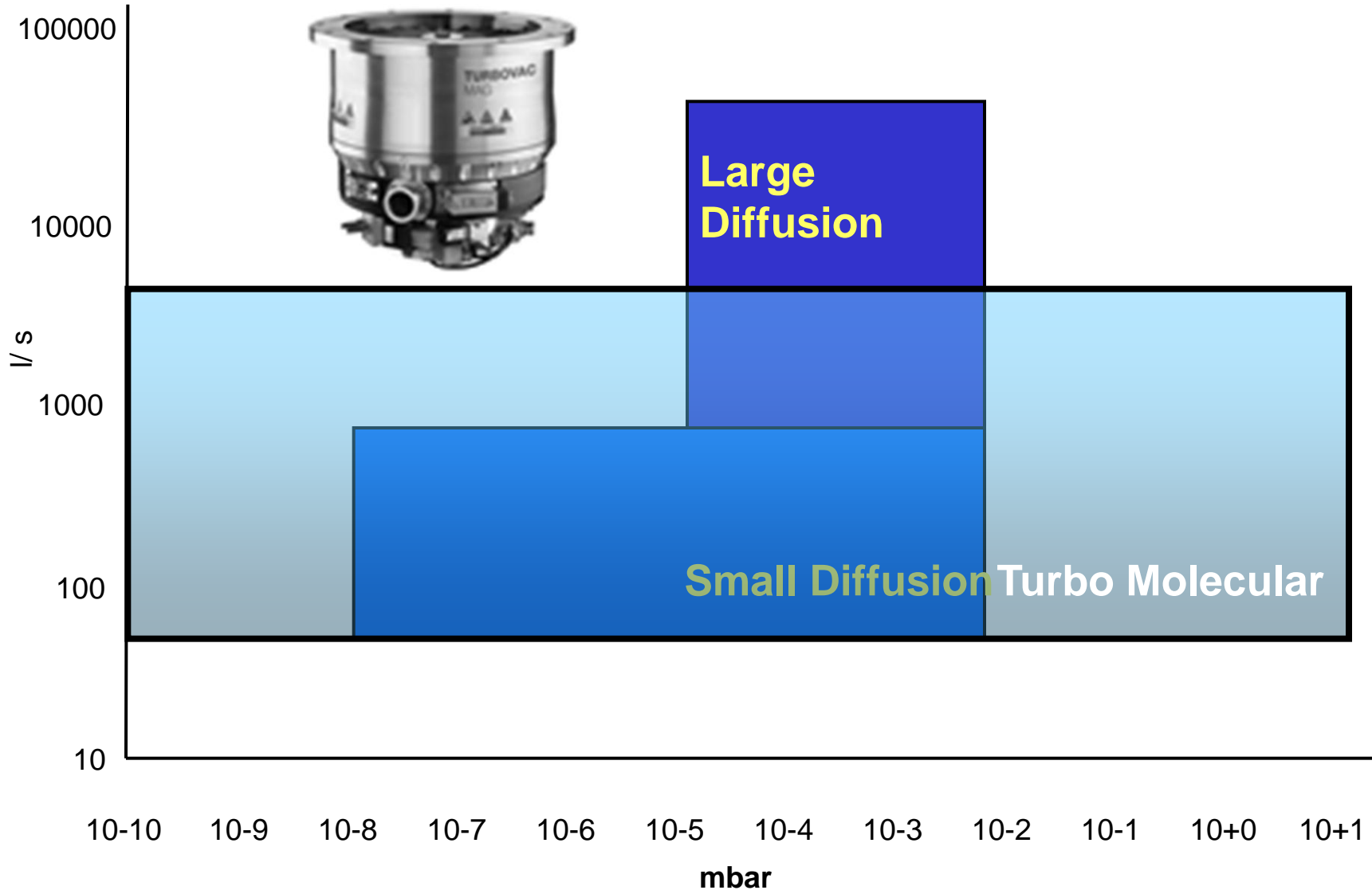
Pumping speed vs Pressure range

High Vacuum pumps



Pumping speed vs Pressure range

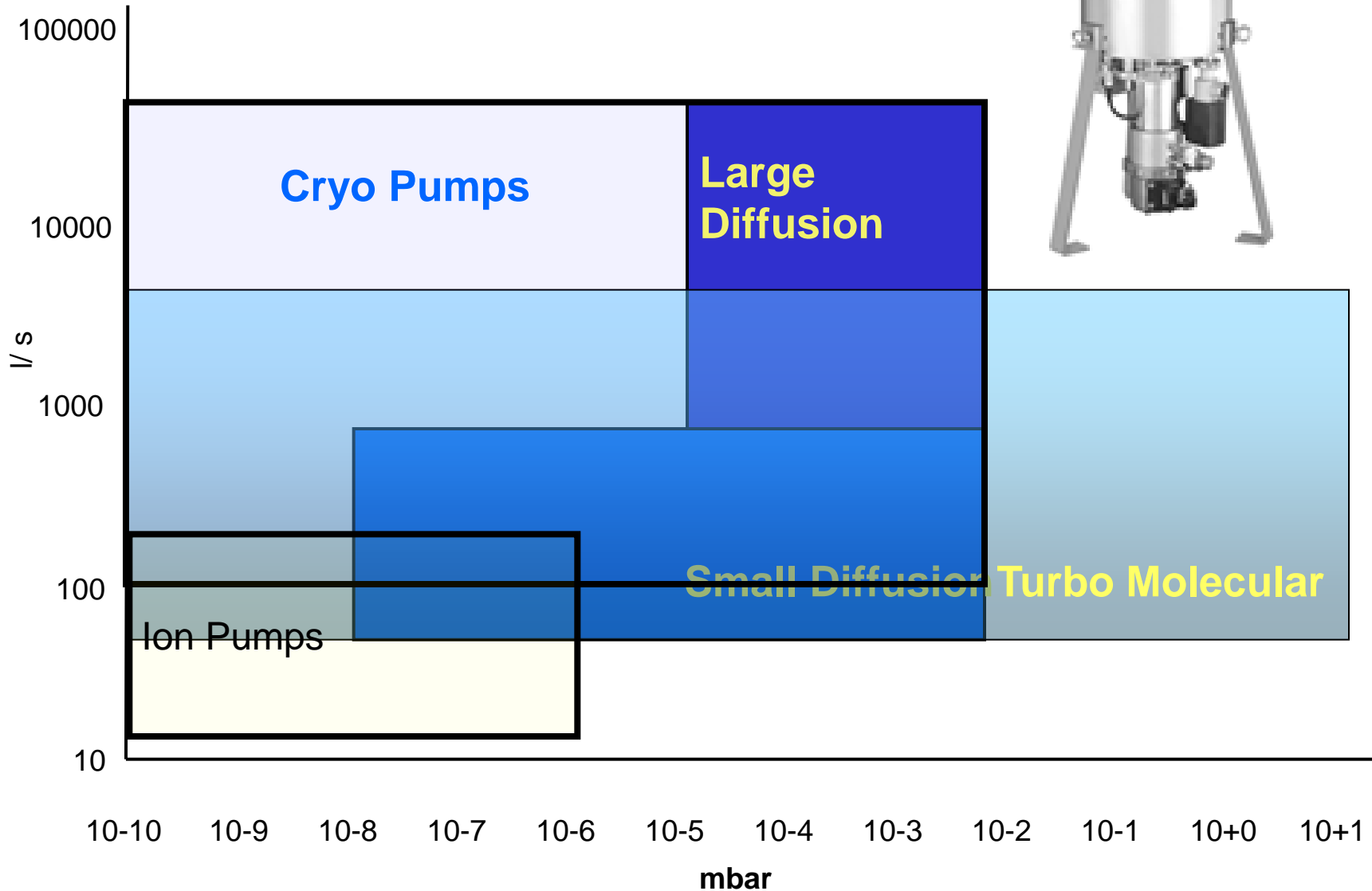
High Vacuum pumps



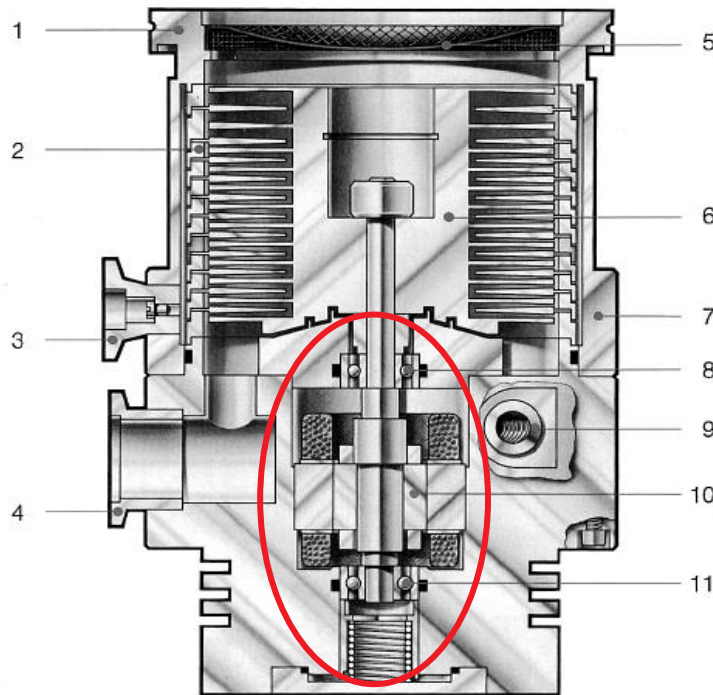
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Pumping speed vs Pressure range

High Vacuum pumps



Turbo molecular pump



- | | | |
|------------------------------|-------------------|-----------------------|
| 1 Hochvakuumanschlußflansch; | 5 Splitterschutz; | 9 Kühlwasseranschluß; |
| 2 Stator-Paket; | 6 Rotor; | 10 3-Phasen-Motor; |
| 3 Belüftungsanschlußflansch; | 7 Pumpengehäuse; | 11 Kugellager |
| 4 Vorvakuumanschlußflansch; | 8 Kugellager; | |

USP: Hydrocarbon free, low vibration.
Direct tool mounting.

Cost: Medium to High

Negative: Not tolerant to particles,
heating up in magnetic fields

Pumping speed range:
50 l/s > 5000 l/s

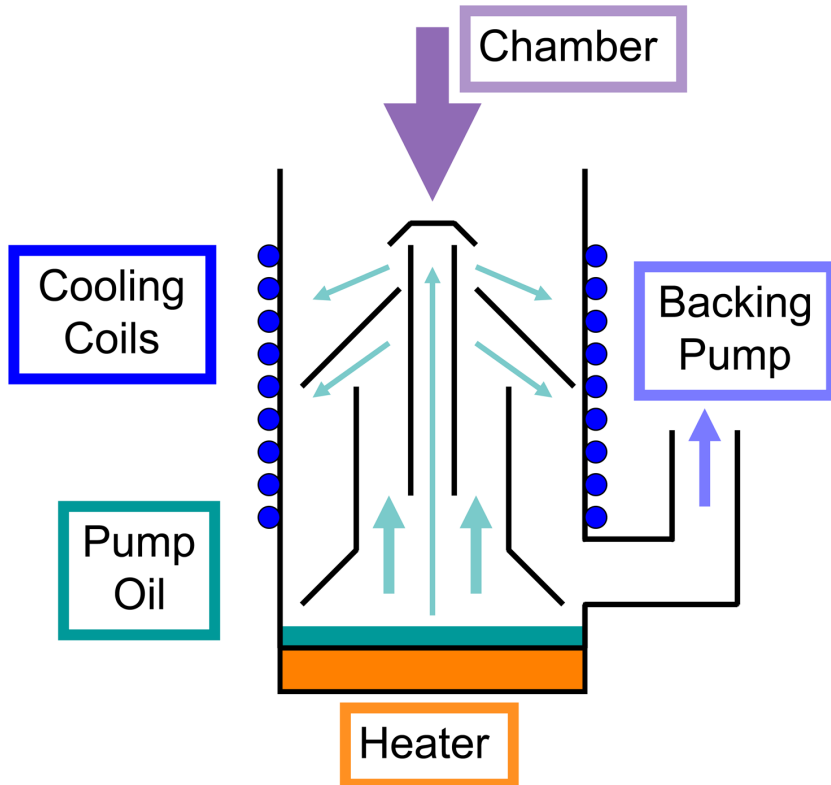
End pressure:
10-10 mbar

Applications:

- | | |
|-----------------------|---------------------------------|
| - Air | yes |
| - Inert gases | yes |
| - He / H ₂ | yes |
| | [below 10-2 mbar] |
| - Flammable | no |
| - Pyrophoric | no |
| - Reactive | no |
| - Radioactive | no |
| | [Yes if no electronics in pump] |
| - Toxic | no |
| - Vapours | yes |
| | [Heated versions] |
| - Hot gases | yes |
| | [Below 10-2 mbar] |
| - Dust | no |
| - Sticky deposits | yes |
| | [Heated versions] |



Diffusion pump



USP: Good light gas compression,
Tolerant of industrial applications,
including particles. Radiation resistant,
Works in magnetic fields

Cost: Low

Negative: Possibility of oil transfer

Pumping speed range:
50 l/s > 50000 l/s

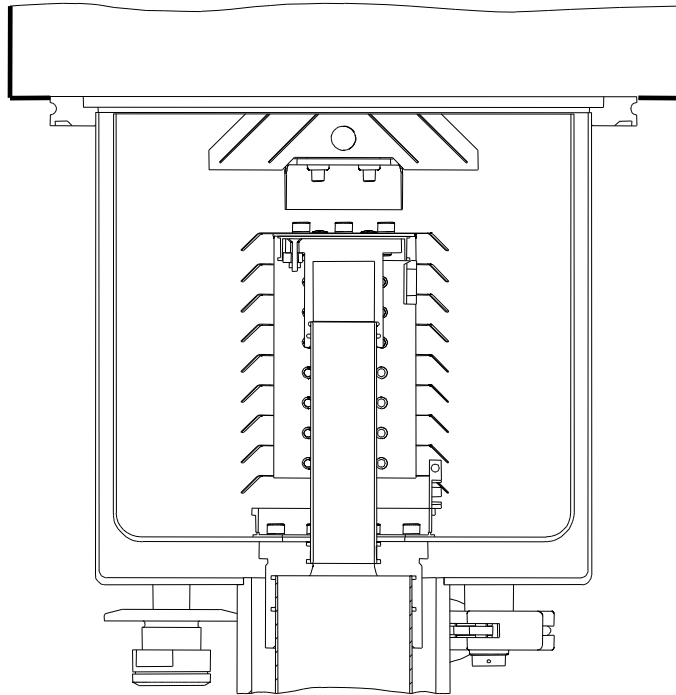
End pressure:
10⁻⁸ mbar

Applications:

- | | |
|-----------------------|-----------------|
| - Air | yes |
| - Inert gases | yes |
| - He / H ₂ | yes |
| - Flammable | no |
| - Pyrophoric | no |
| - Reactive | no |
| - Radioactive | no |
| - Toxic | yes |
| - Vapours | no condensables |
| - Hot gases | no |
| - Dust | no |
| - Sticky deposits | no |



Cryo pump



USP: hydro carbon free vacuum; high pumping speed

Cost: high

Negative: regeneration needed from time to time

Pumping speed range:
800 l/s > 60000 l/s

End pressure:
< 10⁻¹⁰ mbar

Applications:

- | | |
|-----------------------|-----------------|
| - Air | yes |
| - Inert gases | yes |
| - He / H ₂ | yes |
| - Flammable | no |
| - Pyrophoric | no |
| - Reactive | no |
| - Radioactive | no |
| - Toxic | yes |
| - Vapours | no condensables |
| - Hot gases | no |
| - Dust | no |
| - Sticky deposits | no |



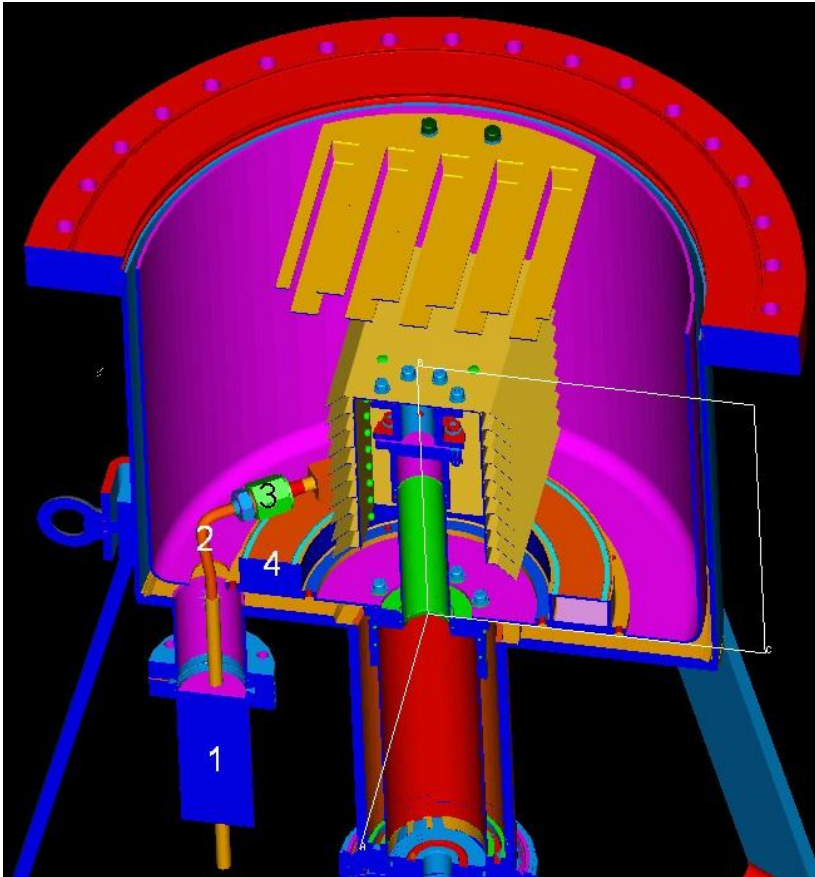
Cryo pump for XHV

Pumping speed range:
2000 l/s > 5000 l/s

ultimate pressure:
< 10-12 mbar (!)

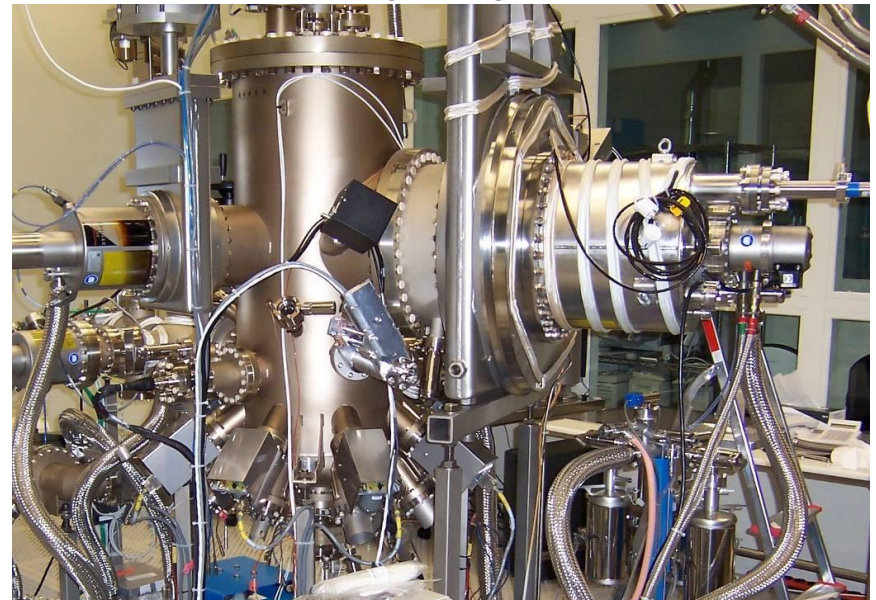
Applications:

- Large UHV vessels
- Low mobility MBE
- Surface analysis
- Storage rings



USP: hydro carbon free vacuum; fully bakeable during operation (350 C), high pumping speed for H₂O and H₂;

Cost: high, LN₂ needed during bakeout



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Where next ? 'Megatrends' in Vacuum

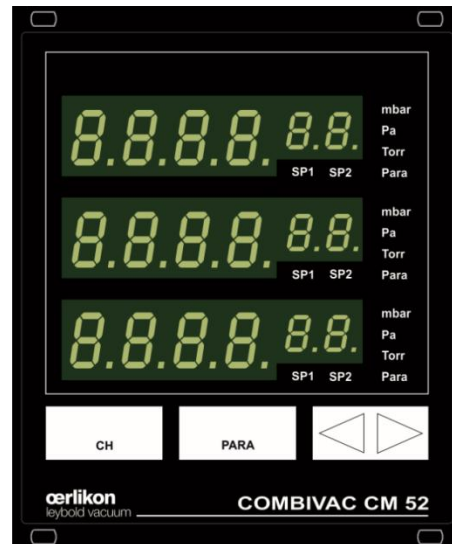
Cost reduction pressure & space limitation → integrate electronics in pump, gauge,.....
→ operate on 24 V DC (safe power supply)
→ run fore pumps faster (FC)

New motor efficiency classes → FC motors in forepumps

Remote monitoring (control) → interfaces in forepumps (FC)
→ operation software with product

Larger demand from industry → dry pumps /MAG TMPs becoming cheaper





IE 414

- Bayard-Alpert sensing system
- Measurement range to 2×10^{-11} mbar (1.5×10^{-11} Torr)
- Protection shield welded in place

IE 514

- Extractor sensing system
- Reliable to 1×10^{-12} mbar (0.75×10^{-12} Torr)
- Significant reduction of X-ray and ion desorption effects

- COMBIVAC CM 52:**
- Channel 1:** Fore-vacuum passive gauges TR 211 – TR 216 (5×10^{-4} – 1000 mbar)
 - Channel 2:** Fore-vacuum passive gauges TR 211 – TR 216 (5×10^{-4} – 1000 mbar)
 - Channel 3:** UHV / XHV passive gauges
IE 414 (1.5×10^{-11} – 1×10^{-2} mbar) or IE 514 (1×10^{-12} – 1×10^{-4} mbar)

VACVISION

- HV pump system controller
- autodetection of installed devices
- remote control via PC software or Ethernet



Cryocoolers GM

→ higher cooling power for HTSC applications

Vorstellung auf der Hannover-Messe 2012

COOLPOWER 250 MD

- einstufiger GM-Refrigerator für Hochtemperaturleiter-Anwendungen
 - Endtemperatur ~ 25 K
 - **Kälteleistung bei 80 K: ca. 200 W**



Thank you.

