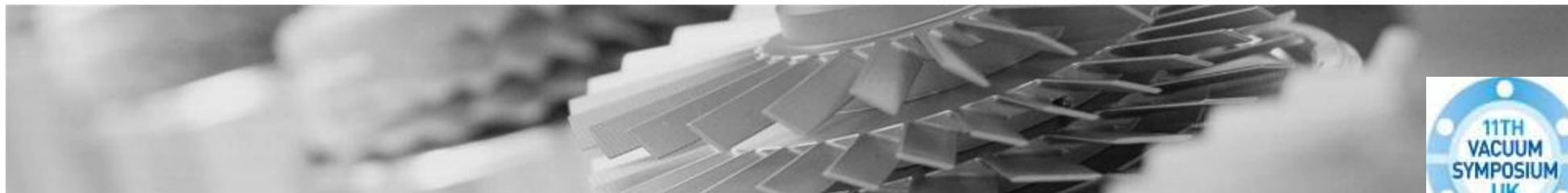


A photograph of a large industrial vacuum chamber. On the left, a silver-colored cylindrical component, likely a pump or part of the chamber's structure, is visible with various hoses and wires connected to it. On the right, a person is looking into the open chamber, which contains several small, round, metallic objects arranged on a surface. The chamber's interior is dark, and the person is wearing a dark jacket.

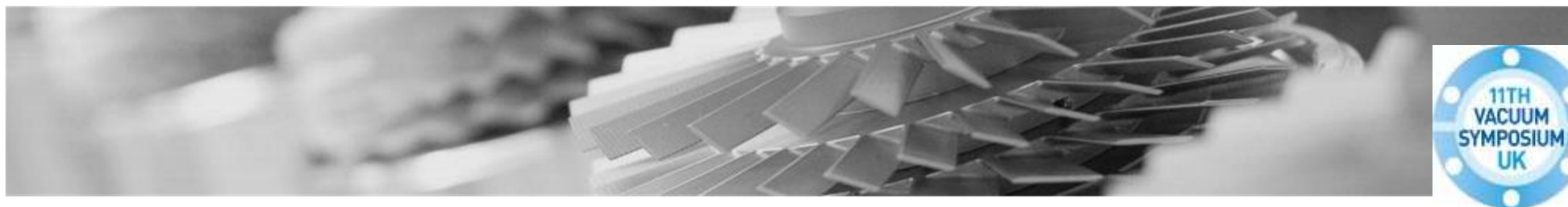
Introduction to Vacuum Pumps, Applications, Future Changes & Development Trends.

Dr Graham Rogers
June 2022

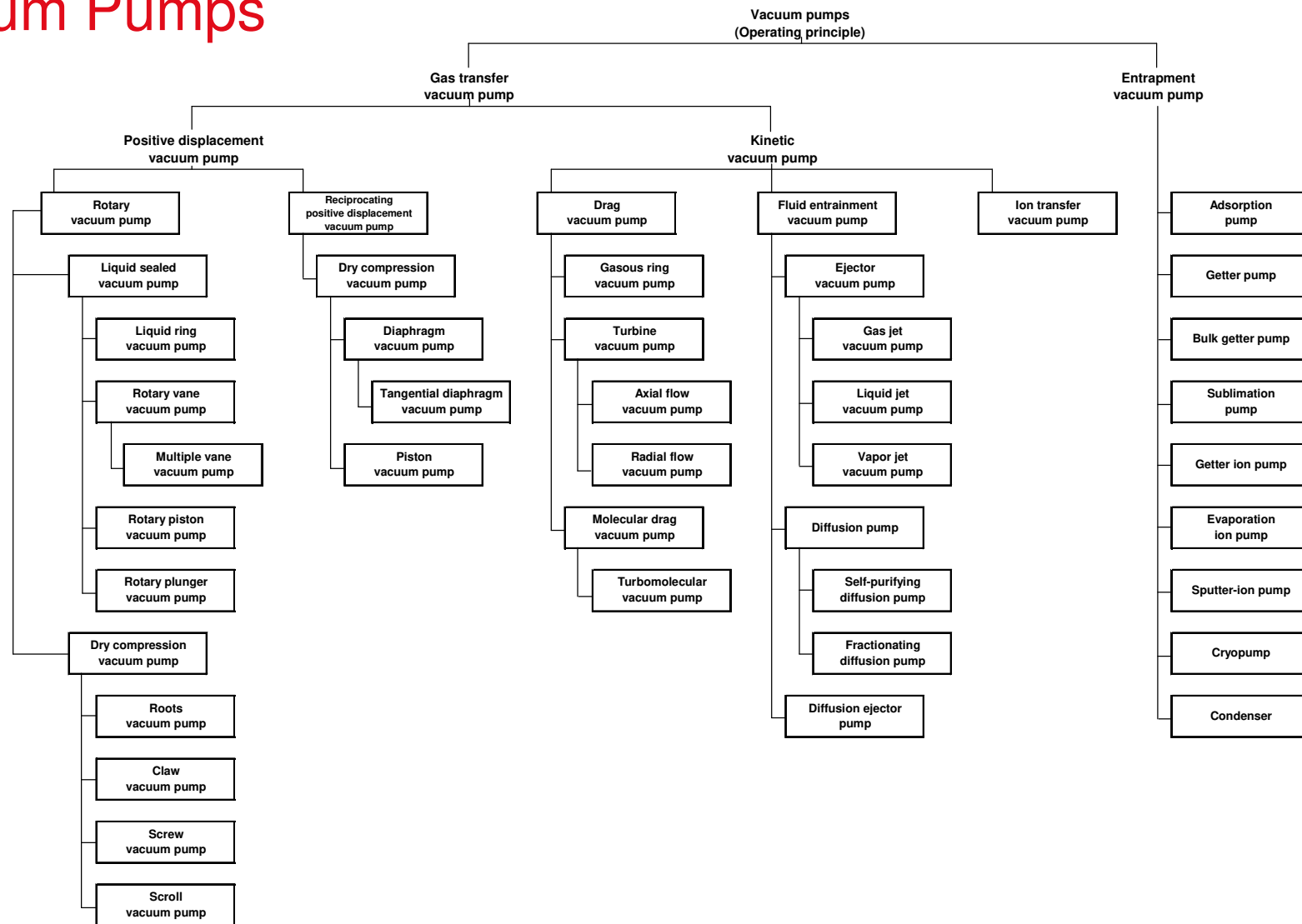
- 1 ■ Vacuum family tree
- 2 ■ Fore vacuum mechanisms – pressure & speed range
- 3 ■ High vacuum mechanisms – pressure & speed range
- 4 ■ Fore vacuum pump applications
- 5 ■ High vacuum pump applications
- 6 ■ Future Developments



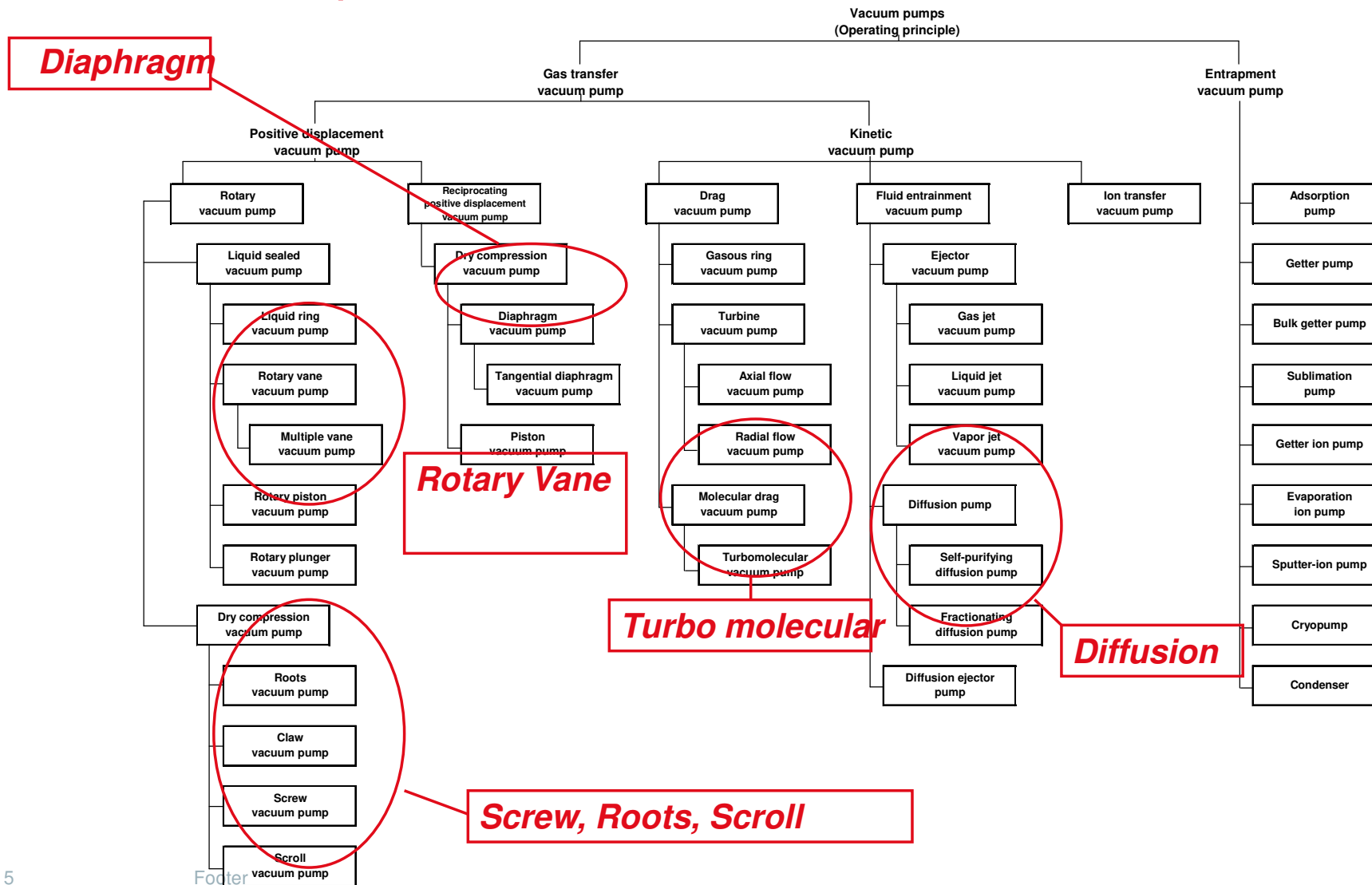
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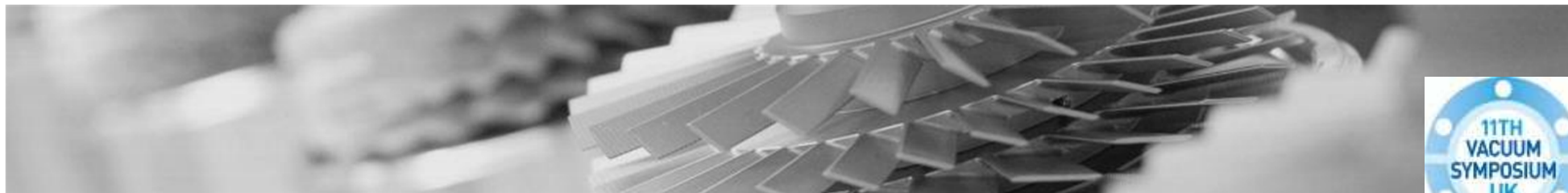
Vacuum Pumps



Vacuum Pumps

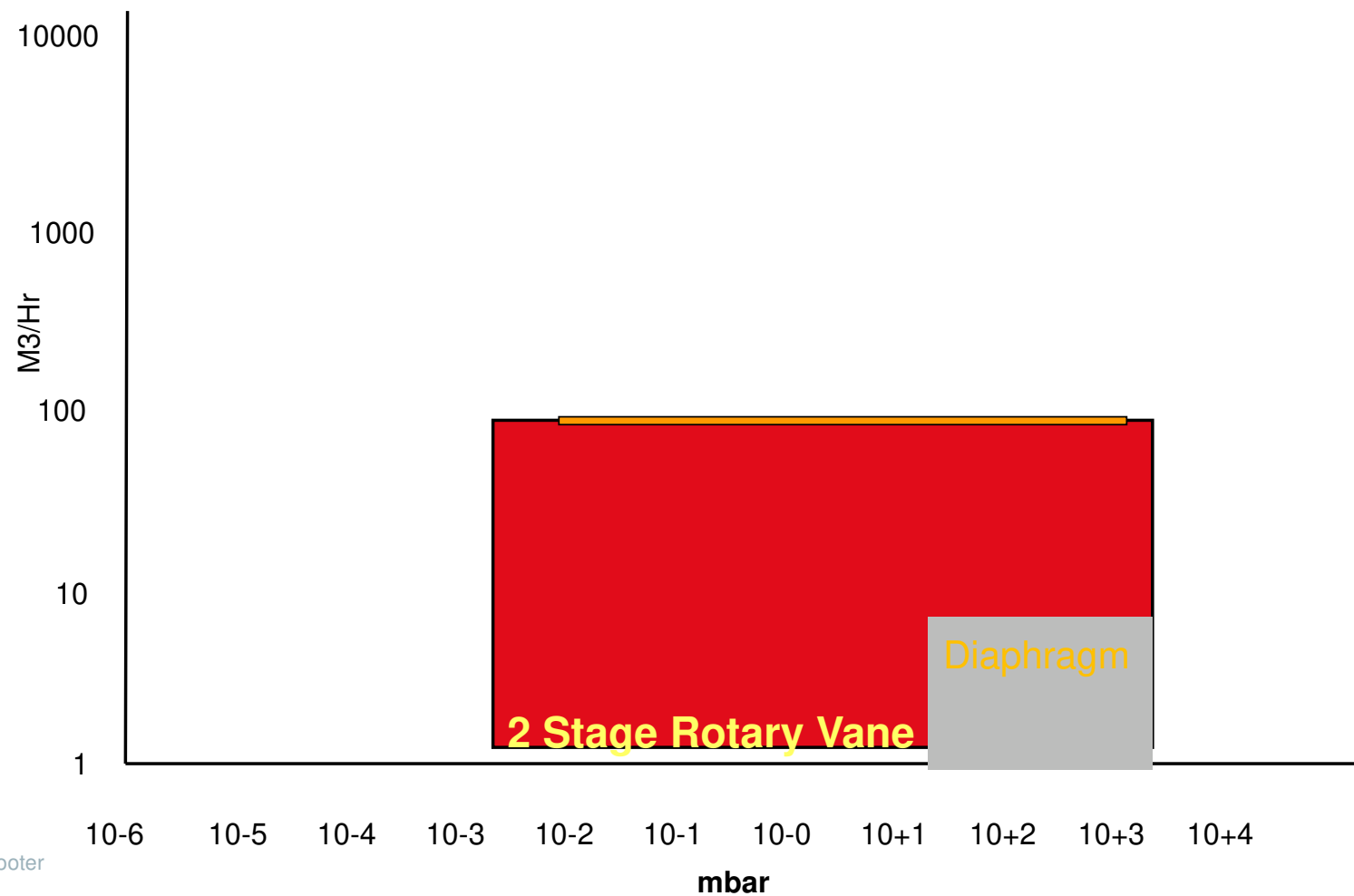


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Pumping speed vs Pressure range

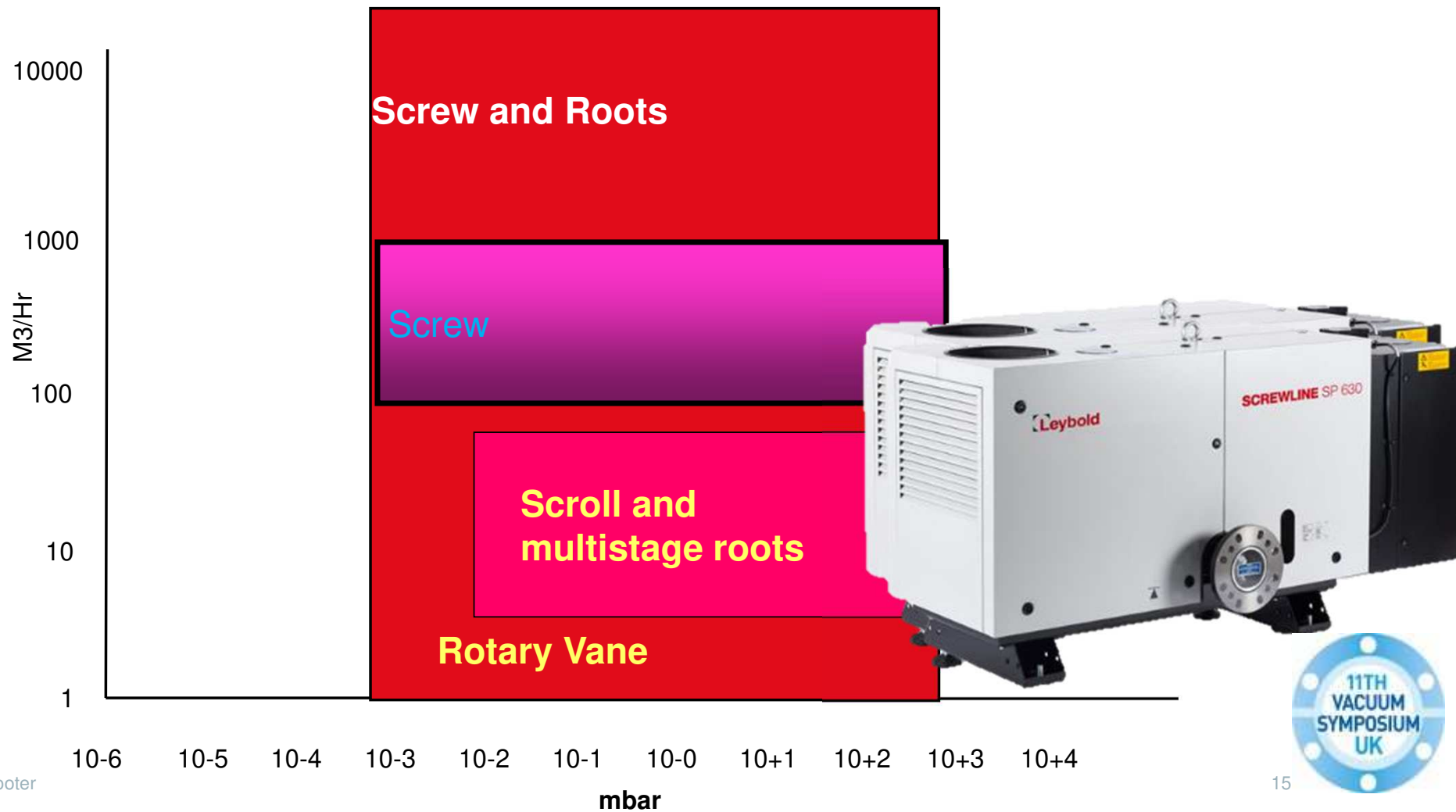
Fore vacuum pumps



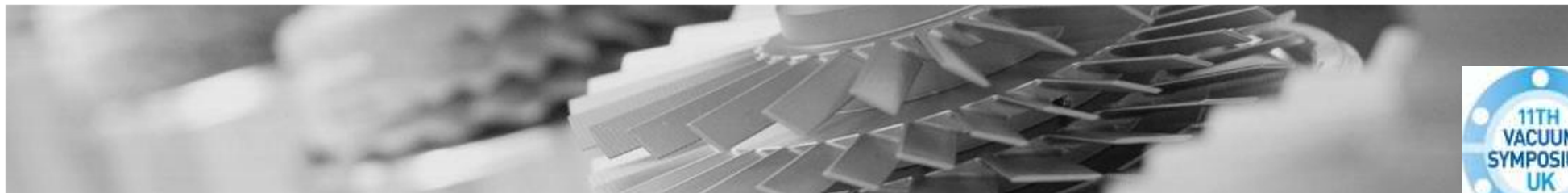
Pumping speed vs Pressure range



Fore vacuum pumps

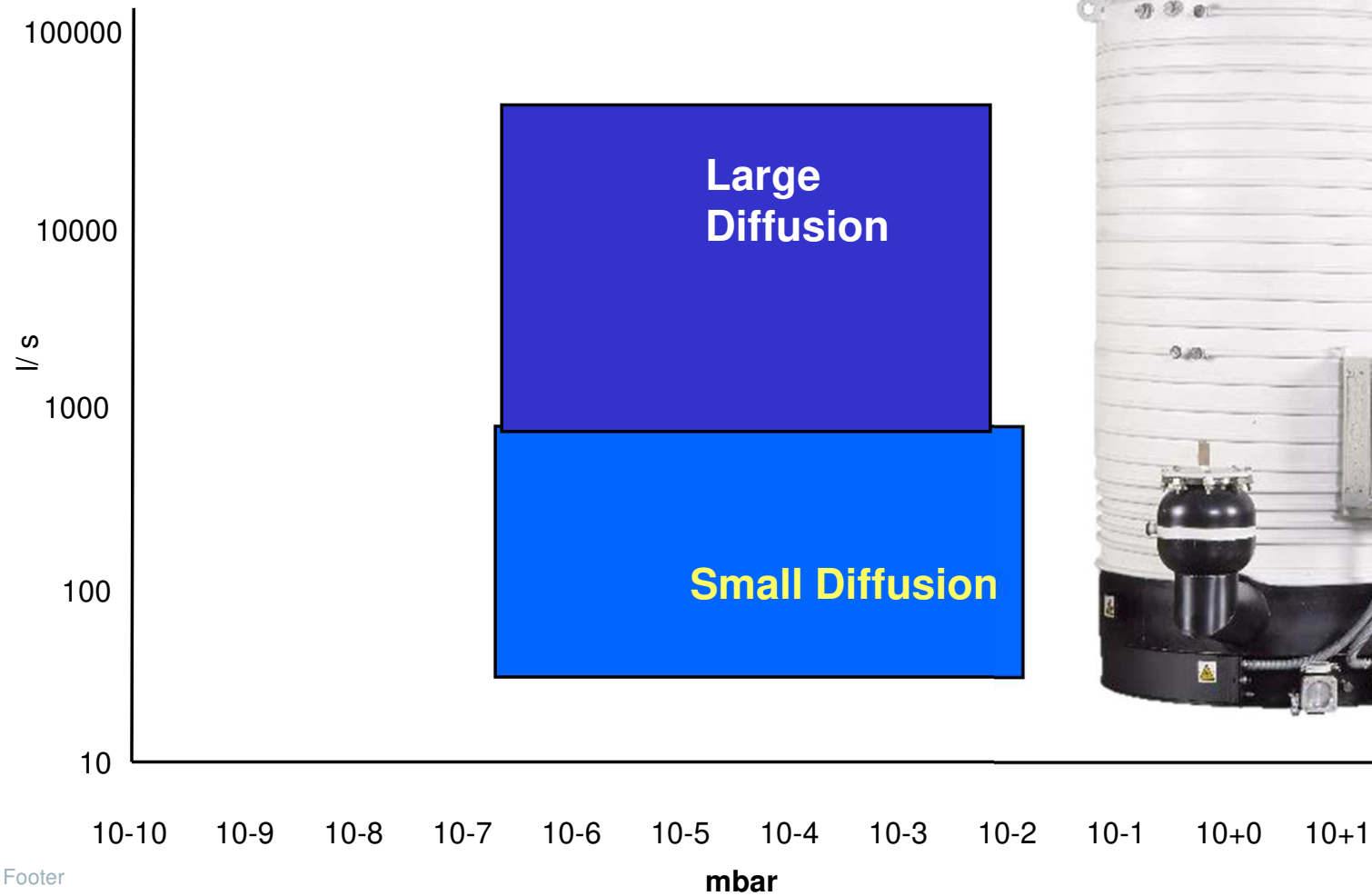


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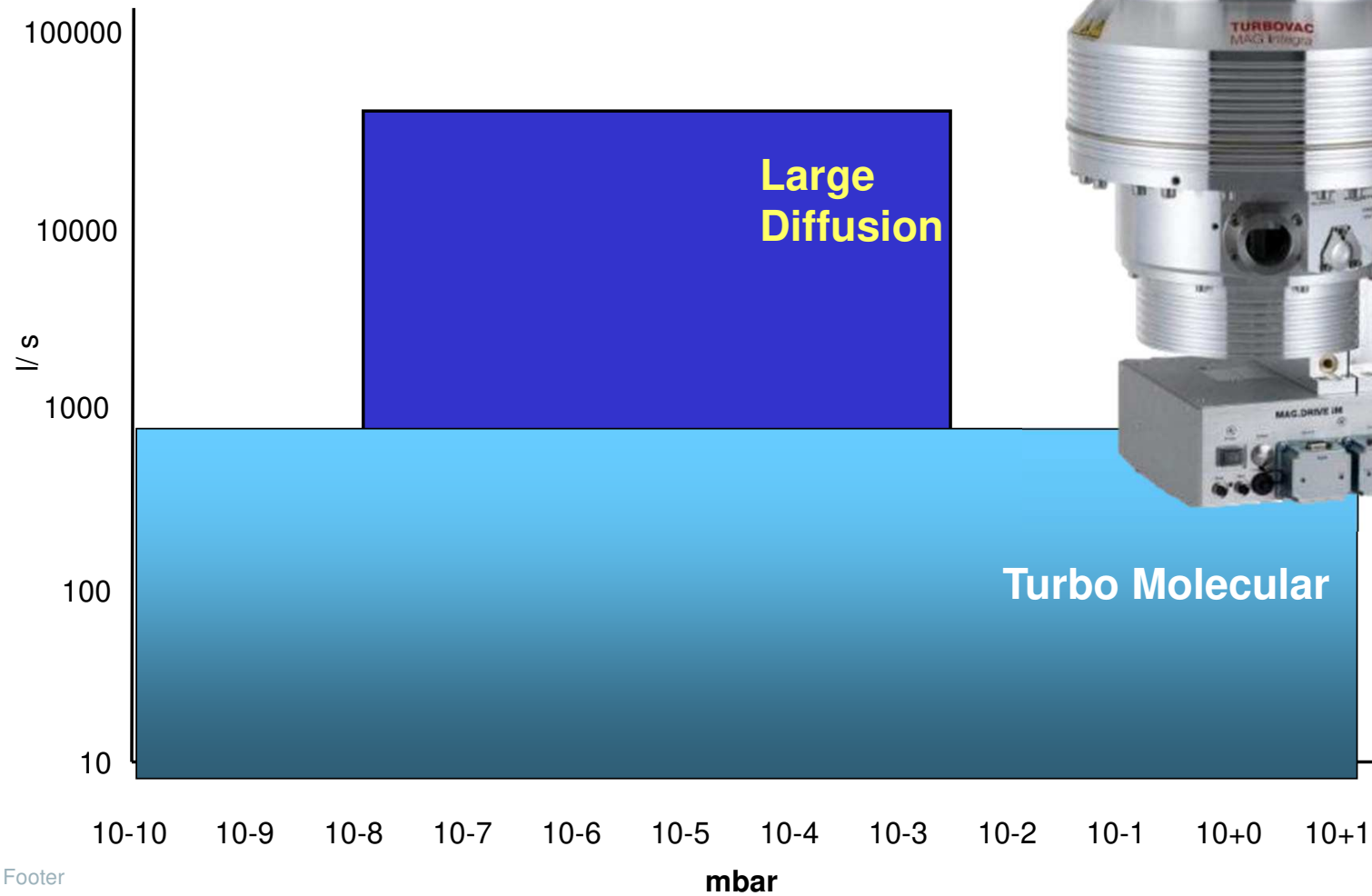
Pumping speed vs Pressure range

High vacuum pumps



Pumping speed vs Pressure range

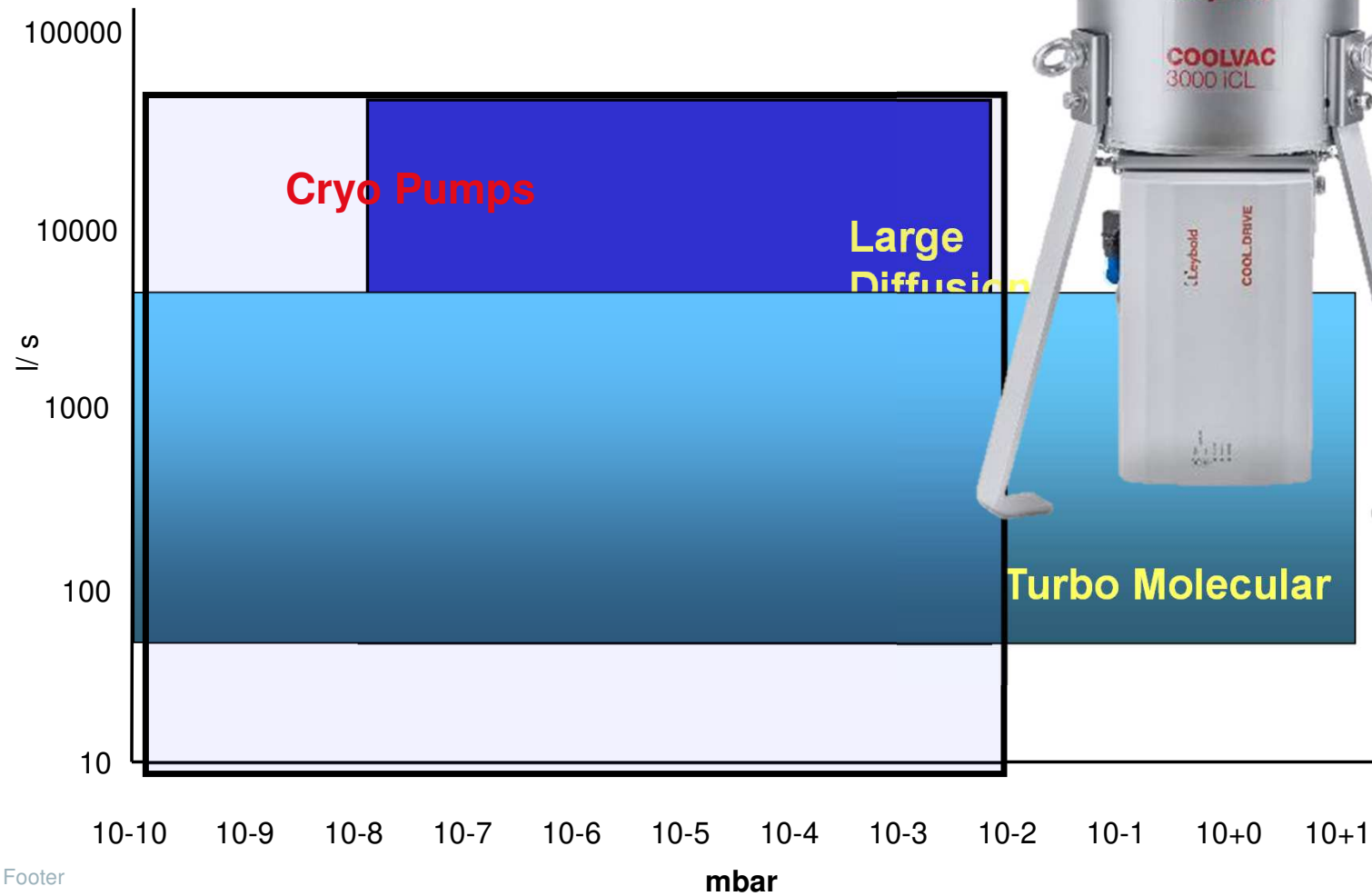
High vacuum pumps



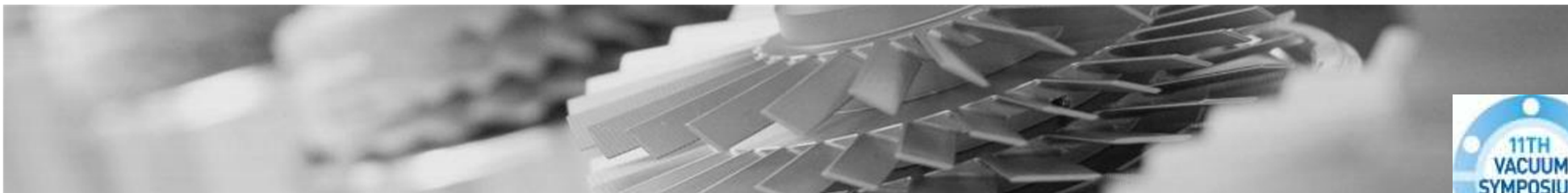
Pumping speed vs Pressure range

High vacuum pumps

Leybold



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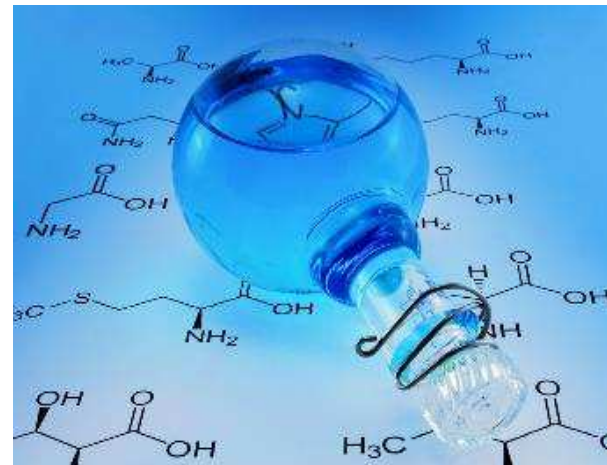
Applications – process gases

Fore Vacuum

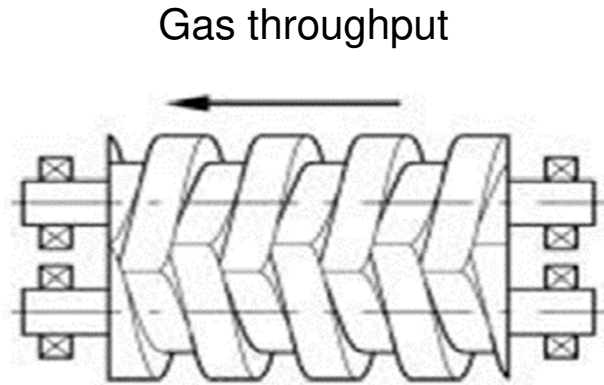
- Air
- Inert gas
- Helium / Hydrogen
- Flammables
- Corrosive
- Radioactive
- Toxic
- Vapours
- Hot gases
- Dusts
- Sticky deposits

High Vacuum

- Air
- Inert gas
- Helium / Hydrogen
- Flammables
- Corrosives
- Toxic
- Vapours



Screw dry pump



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

Cost: High

Negative: Needs seal purge gas

Pumping speed range:
100 m³/hr > 1300 m³/hr

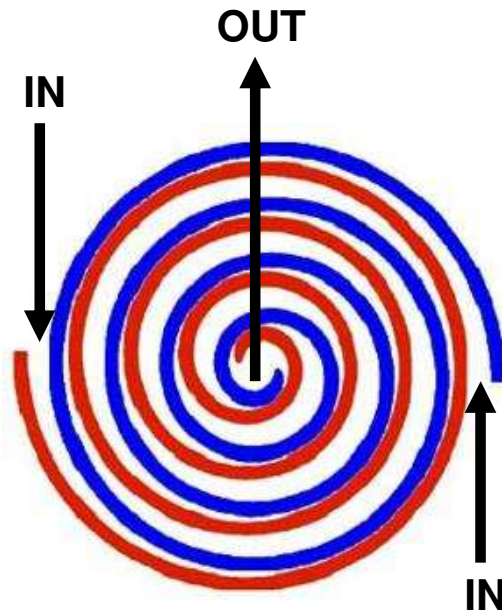
End pressure:
10⁻³ mbar

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: Medium

Negative: Yearly tip seal change

Pumping speed range:

5 m³/hr > 50 m³/hr

End pressure:

10⁻² mbar

Applications:

- Air
- Inert gases
- He / H₂
- Flammable
- Pyrophoric
- Reactive
- Radioactive
[Special pump only]
- Toxic
[Special pump only]
- Vapours
- Hot gases
- Dust
- Sticky deposits

yes

yes

poor

with dilution

no

no

no

no

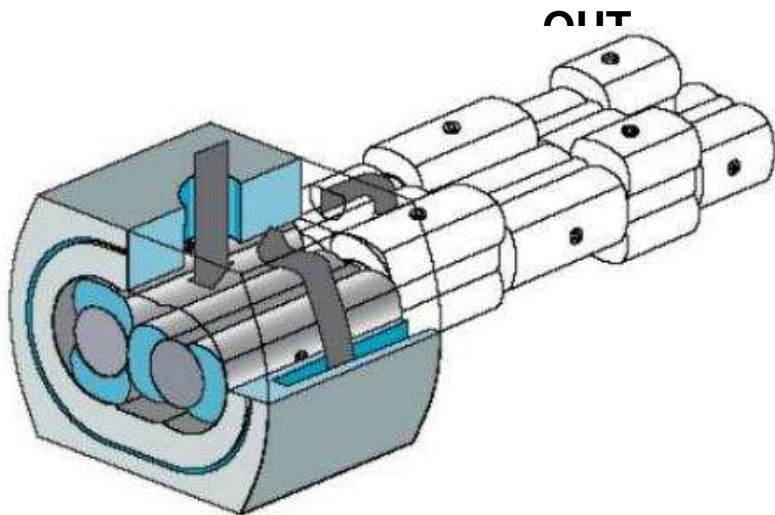
no condensables

no

no



Multi stage roots dry pump



USP: Hydrocarbon free,
Low power consumption.

Cost: Medium

Negative: Low tolerance to dust / deposits

Pumping speed range:
10 m³/hr > 100 m³/hr

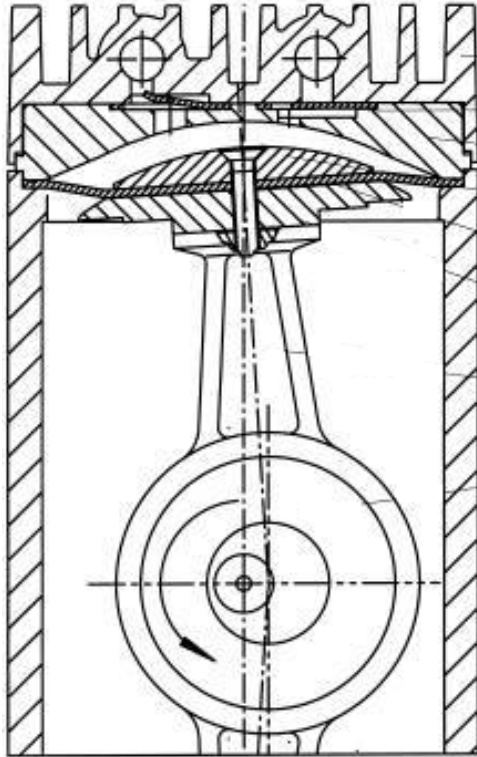
End pressure:
10⁻² mbar

Applications:

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



Diaphragm dry pump



USP: Hydrocarbon free

Cost: Low

Negative: Fatigue of diaphragm

Pumping speed range:

1 m³/hr > 20 m³/hr

End pressure:

10 mbar

Applications:

- Air
- Inert gases
- He / H₂
- Flammable
- Pyrophoric
- Reactive
- Radioactive
- Toxic

[Special pump only]

- Vapours
- Hot gases
- Dust
- Sticky deposits no

yes

yes

poor

no

no

no

no

no

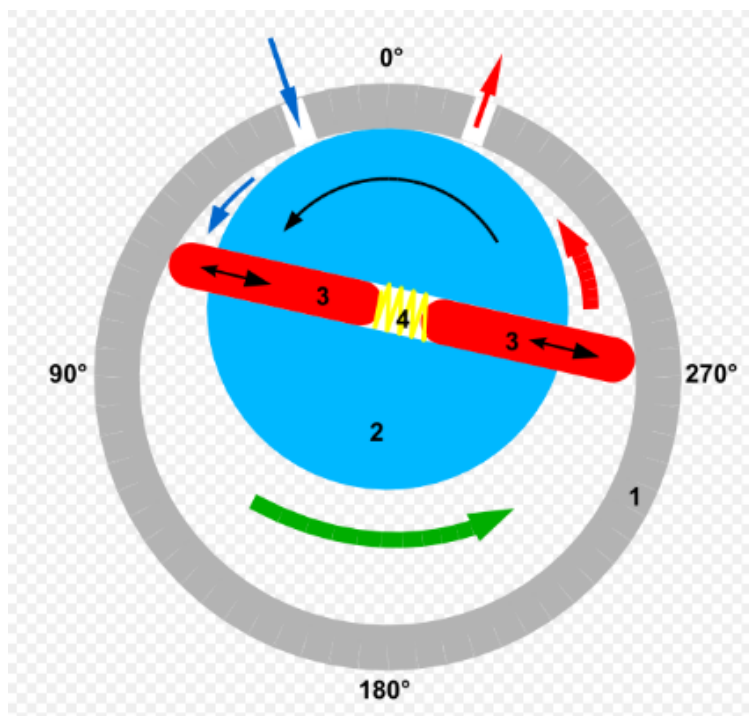
no condensables

no

no



Rotary vane wet pump



USP: Low cost high compression

Cost: Low

Negative: Oil wetted pumping chamber

Pumping speed range:

1 m³/hr > 100 m³/hr

End pressure:

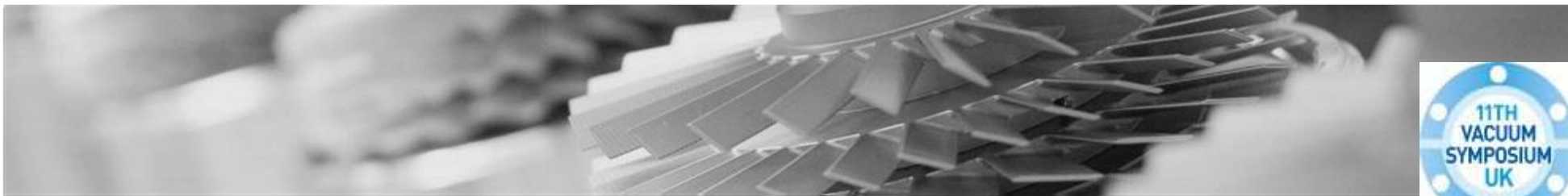
10⁻³ mbar

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 |



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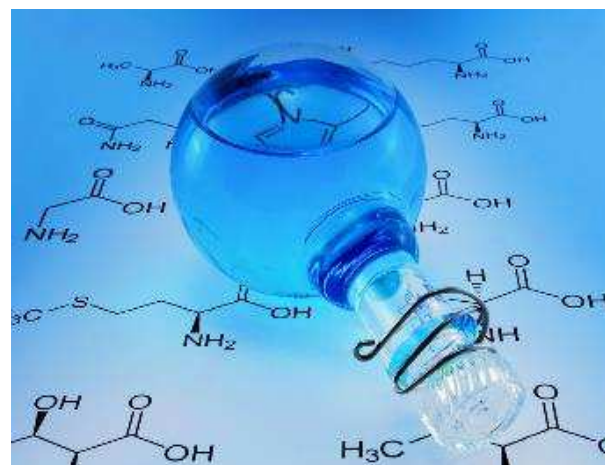
Applications – process gases

Fore Vacuum

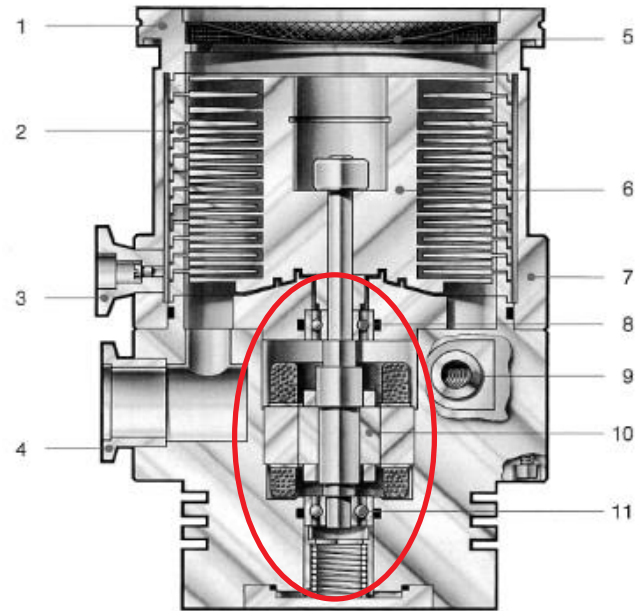
- Air
- Inert gas
- Helium / Hydrogen
- Flammables
- Corrosive
- Radioactive
- Toxic
- Vapours
- Hot gases
- Dusts
- Sticky deposits

High Vacuum

- Air
- Inert gas
- Helium / Hydrogen
- Flammables
- Corrosives
- Toxic
- Vapours



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 of particles

Pumping speed range:

50 l/s > 5000 l/s

End pressure:

10-10 mbar

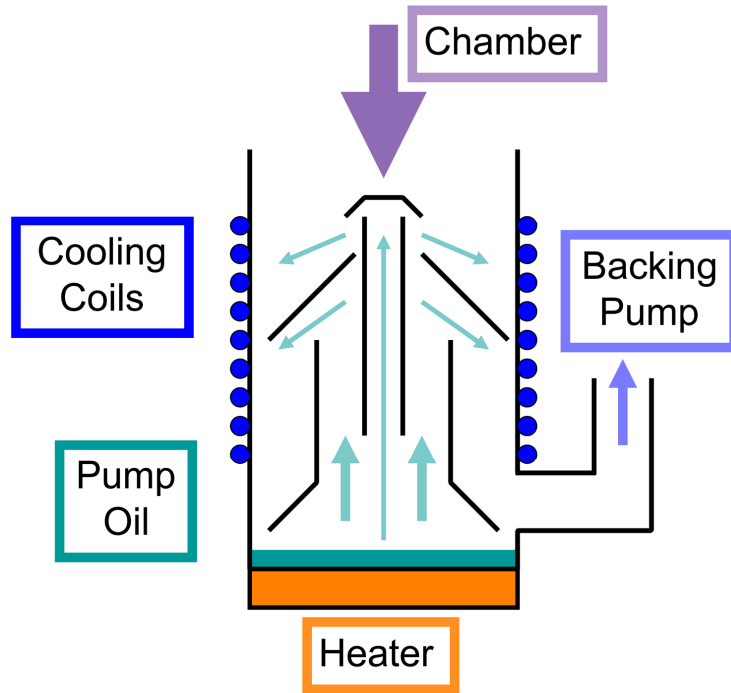
Applications:

- | | |
|---------------------------------|-----|
| ▪ 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] | |

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Diffusion pump



USP: Good light gas compression,
Tolerant of industrial applications,
including particles.

Cost: Low

Negative: Possibility of oil transfer

Pumping speed range:

50 l/s > 50000 l/s

End pressure:

10⁻⁸ mbar

Applications:

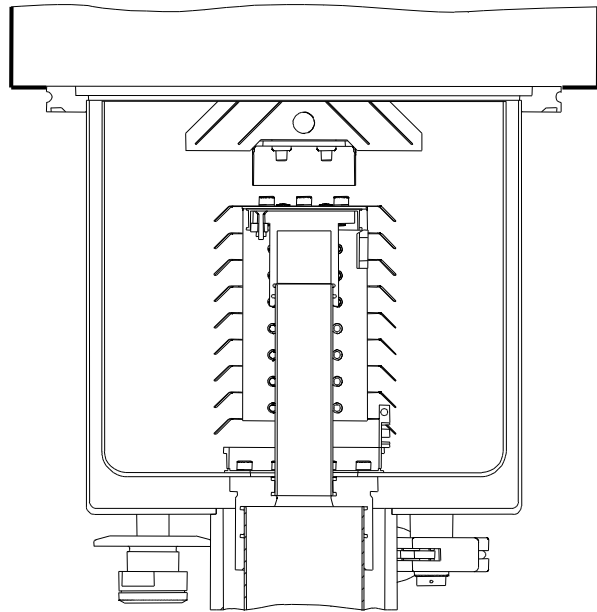
- Air
- Inert gases
- He / H₂
- Flammable
- Pyrophoric
- Reactive
- Radioactive
- Toxic
- Vapours
- Hot gases
- Dust
- Sticky deposits

yes
yes
yes
no
no
no
no
yes
no condensables
no
no

Leybold



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

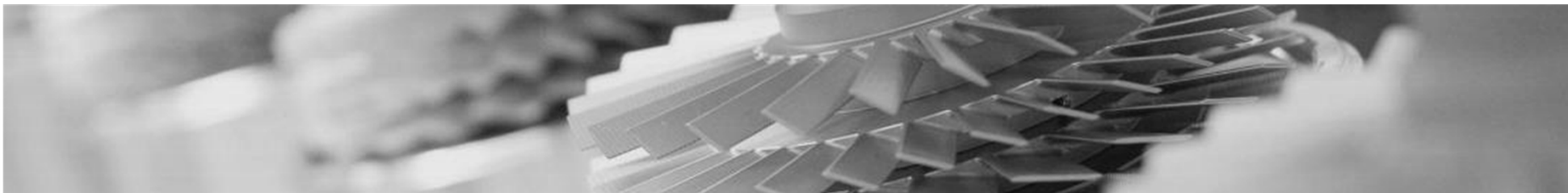
Applications:

▪ 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

 **Leybold**



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Where next - products?

Energy reductions will be key

- Focus on Diffusion pumps – reducing power in idle mode
- Minimise rotation and pumping speed at ultimate pressure
- Emphasis on the use of cryo vs diffusion pumps for specific applications EB welding, Heat Treatment

Where next - products?

- Increased service intervals for Rotary Vane pumps
- All in one device to start/stop and control pumps, Turbos, gauges and valves
- Remote monitoring of pumps via Cloud
- Focus on Cost of Ownership



Thank you

