TwisTorr molecular drag pumping technology

A new Technology for high performance Turbomolecular-Drag Pumps

Vacuum Product Division

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TwisTorr molecular drag pumping technology

Outline

Molecular drag pumps

TwisTorr technology

Today

Potential

Molecular drag pumps
Introduction

Since over 20 years axial flow TMP's

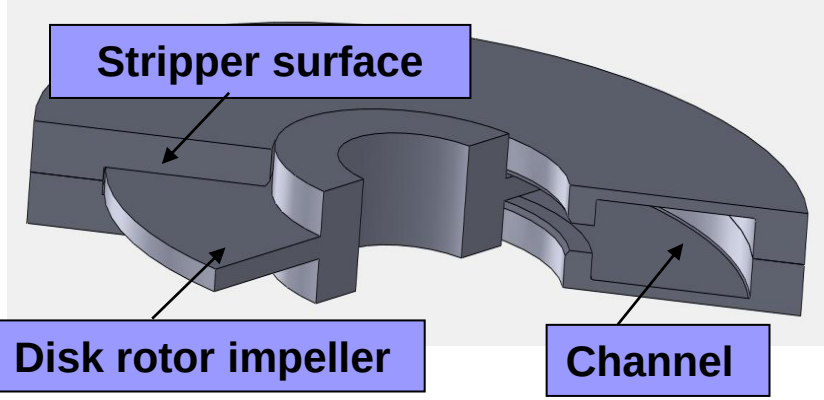
often combined with down-stream (same shaft) MDP's

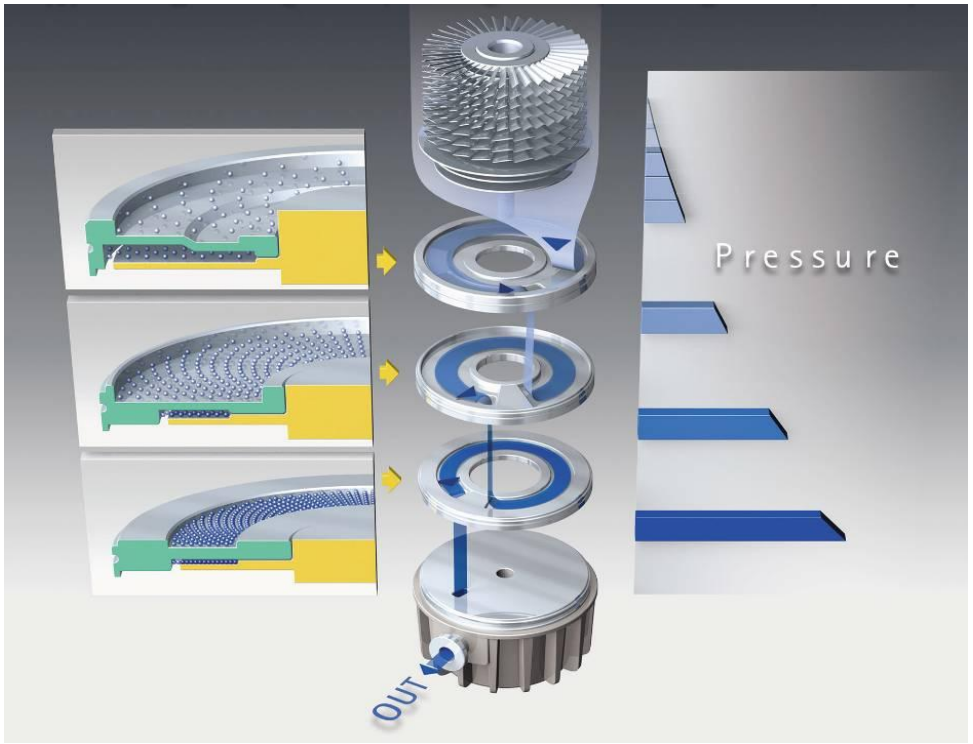
TMPDP resulting pumps improve

- Forepressure tolerance from 10 to 1000 pascal range
- Compression ratio for light gases
- Requirements for backing pumps (smaller with lower power consuption)

Molecular drag pumps

Gaede and MacroTorr (2/2)

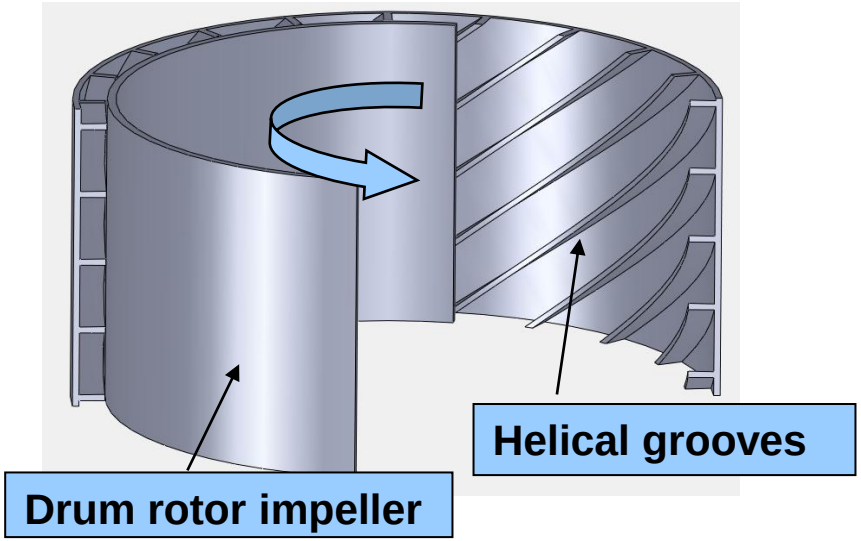


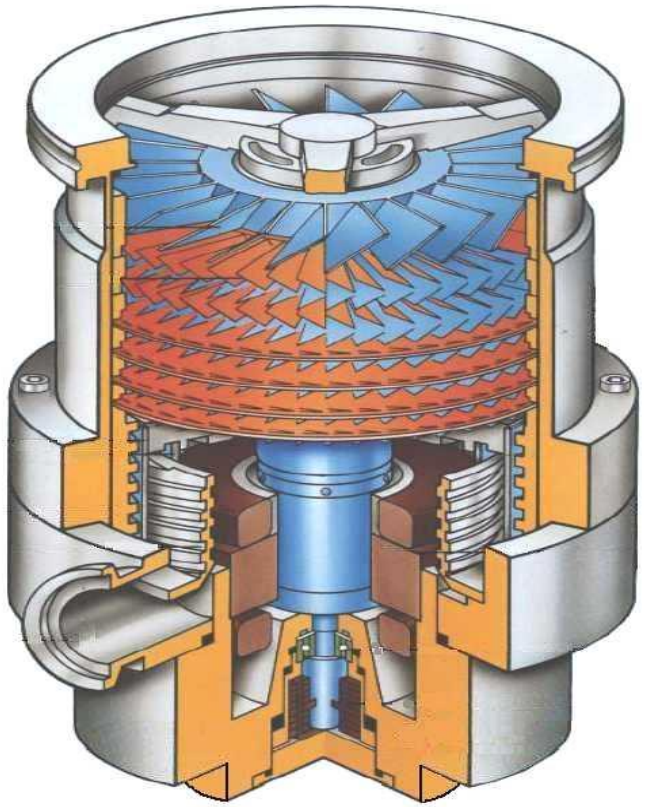


MacroTorr® (Gaede pump re-designed)

- Varian TMDP design
- , Molecular drag stages axially in series

Molecular drag pumps
Holweck (2/2)

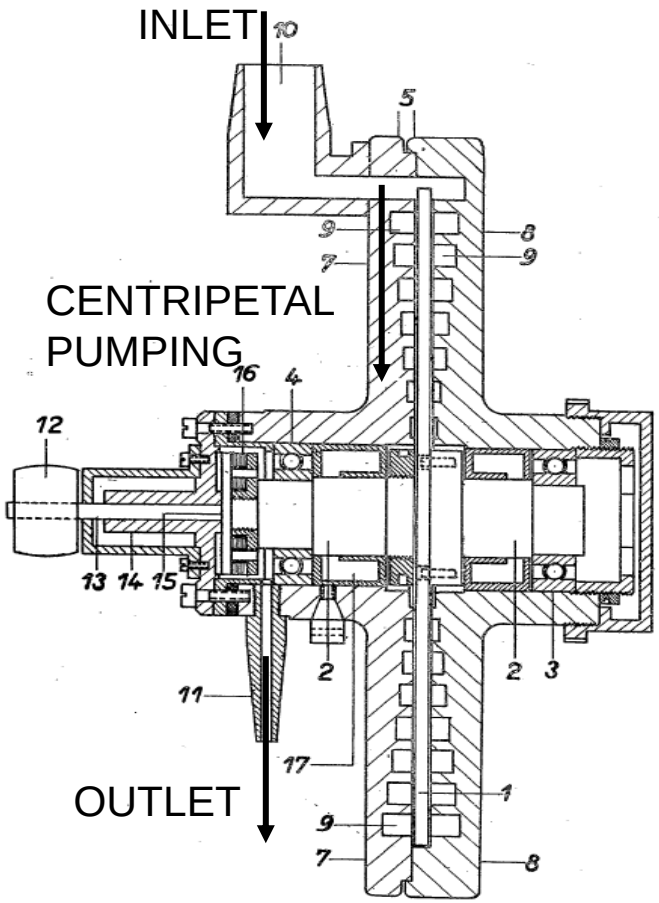




Holweck molecular drag TMDP design

- courtesy of Pfeiffer Vacuum
- with stages in series radially nested

Molecular drag pumps
Siegbahn (2/2)



Invention

• Manne Siegbahn disclosed the spiral vacuum pump invention in GB patent No. 332,879 in 1929

Working principle

• Molecular momentum transfer (“drag”, “friction”) pump, made of a smooth disk-shaped rotor with spiral grooves machined on a plane-geometry stator

- Same principle as Gaede and Howeck.
- Different geometry

TwisTorr technology
Introduction (1/2)

We have considered Siegbahn MTD since over ten years

- It perfectly fits our MacroTorr® design
- With much higher inlet conductance (potential pumping speed)

Result of tests consistently very frustrating

- Low performance
- High power consumption

TwisTorr technology
Introduction (2/2)

During the last five years

Silvio Giors with John Helmer

Performed theoretical and experimental studies on Spiral MDP

It became evident that tapered channels generate

successive compressions and re-expansions

- With waste of power
- Even worse when putting stages in series

TwisTorr technology
Constant S channels (1/2)

Constant cross section channels not enough

- At lower radius speed and S are lower

Constant local pumping speed

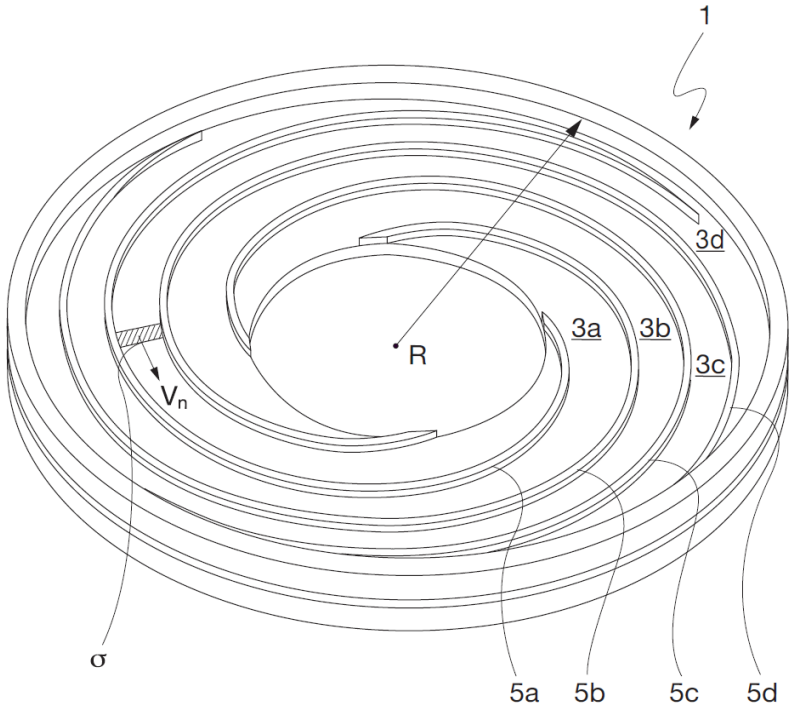
design required to prevent

- Reverse pressure gradients
- High power dissipation when stages are used in series

TwisTorr technology
Spiral MDP design (1/2)

Constant S Channel Invention (*)

- Stator spiral channel cross section area σ is increased
  from outer to inner radius
  to compensate rotor velocity reduction at smaller radius



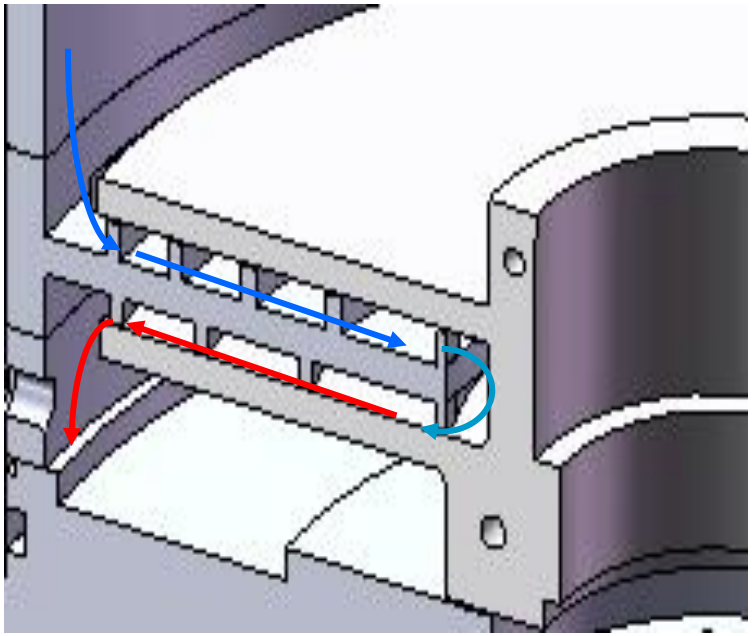
(*) Patents applications 08-44 US, 08-45 US, by J.C. Helmer and S. Giors, Dec. 2008.

TwisTorr technology

Spiral MDP design (2/2)

Rotor / Stator arrangement

- Each stator is positioned between two smooth disks
- Each disk is exploited twice in series (both surfaces)
- Fits perfectly on standard Macrotorr® design rotors

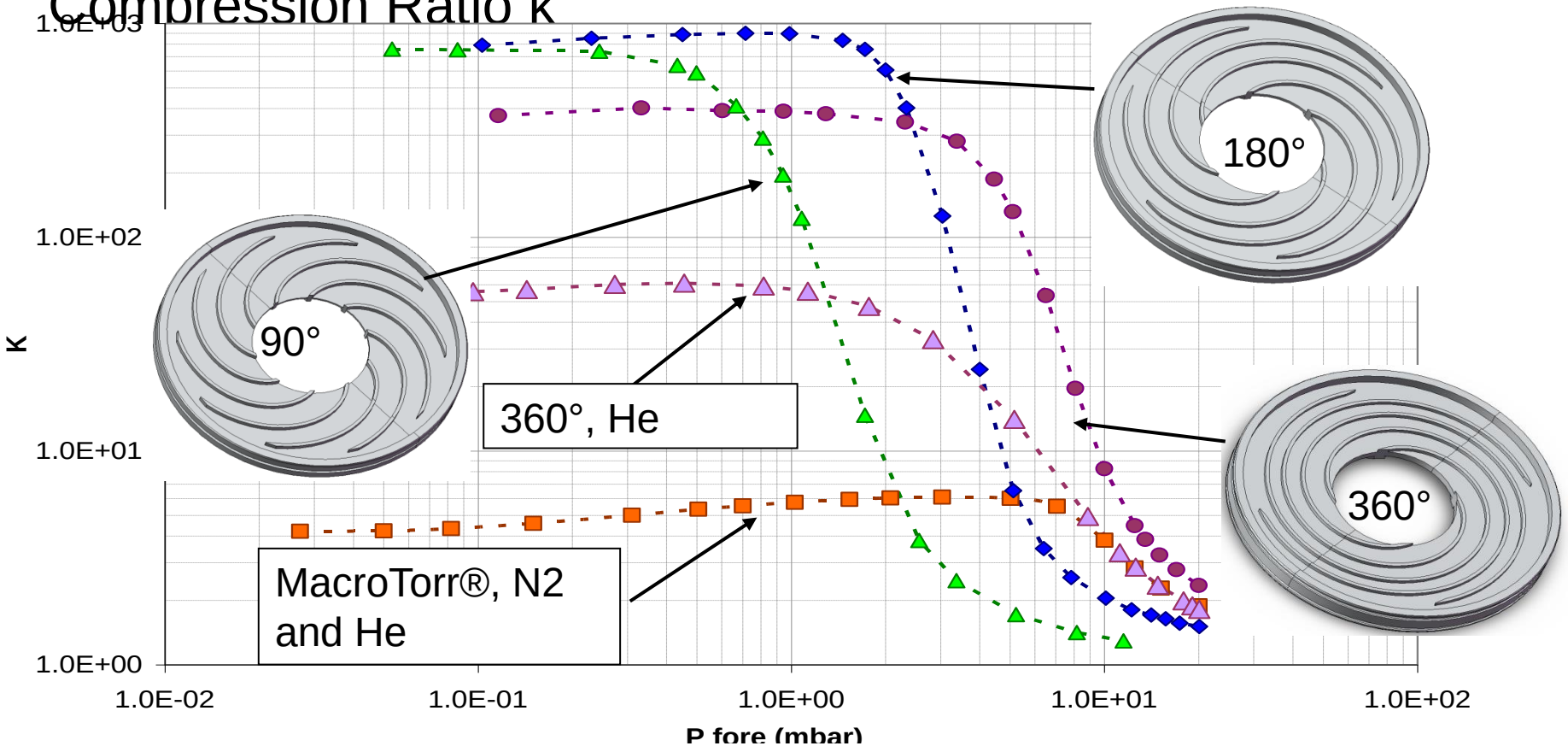


- Stators with spiral grooves on **BOTH sides.**
- **Centripetal AND Centrifugal** combined in series improve compression

TwisTorr technology

Experimental tests (3/6)

Compression Ratio k

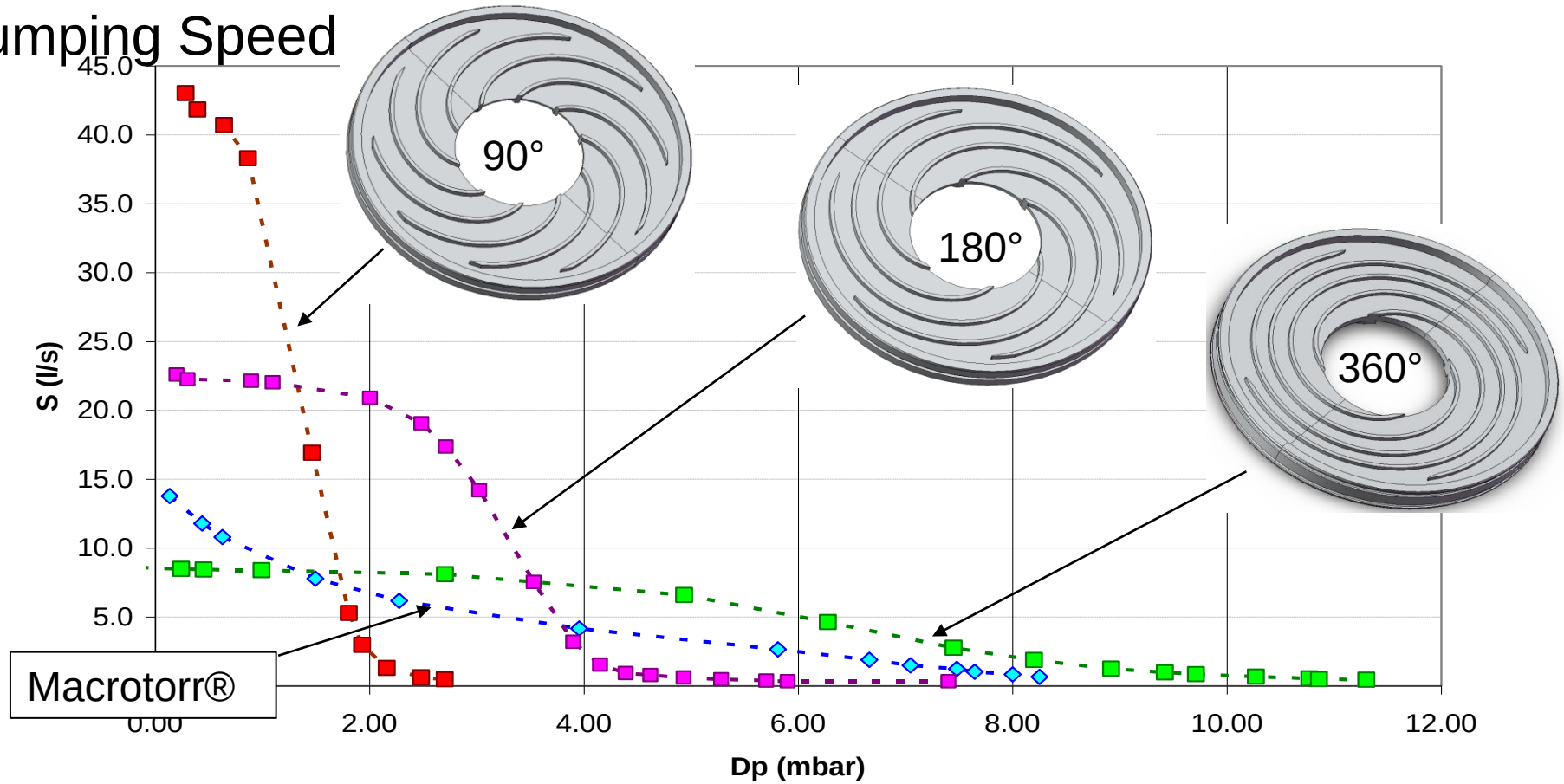


- TwisTorr increase Macrotorr® N2 compression by a factor up to 500
- TwisTorr increase Macrotorr® He and H2 compression by a factor 10+.

TwisTorr technology

Experimental tests (6/6)

Pumping Speed



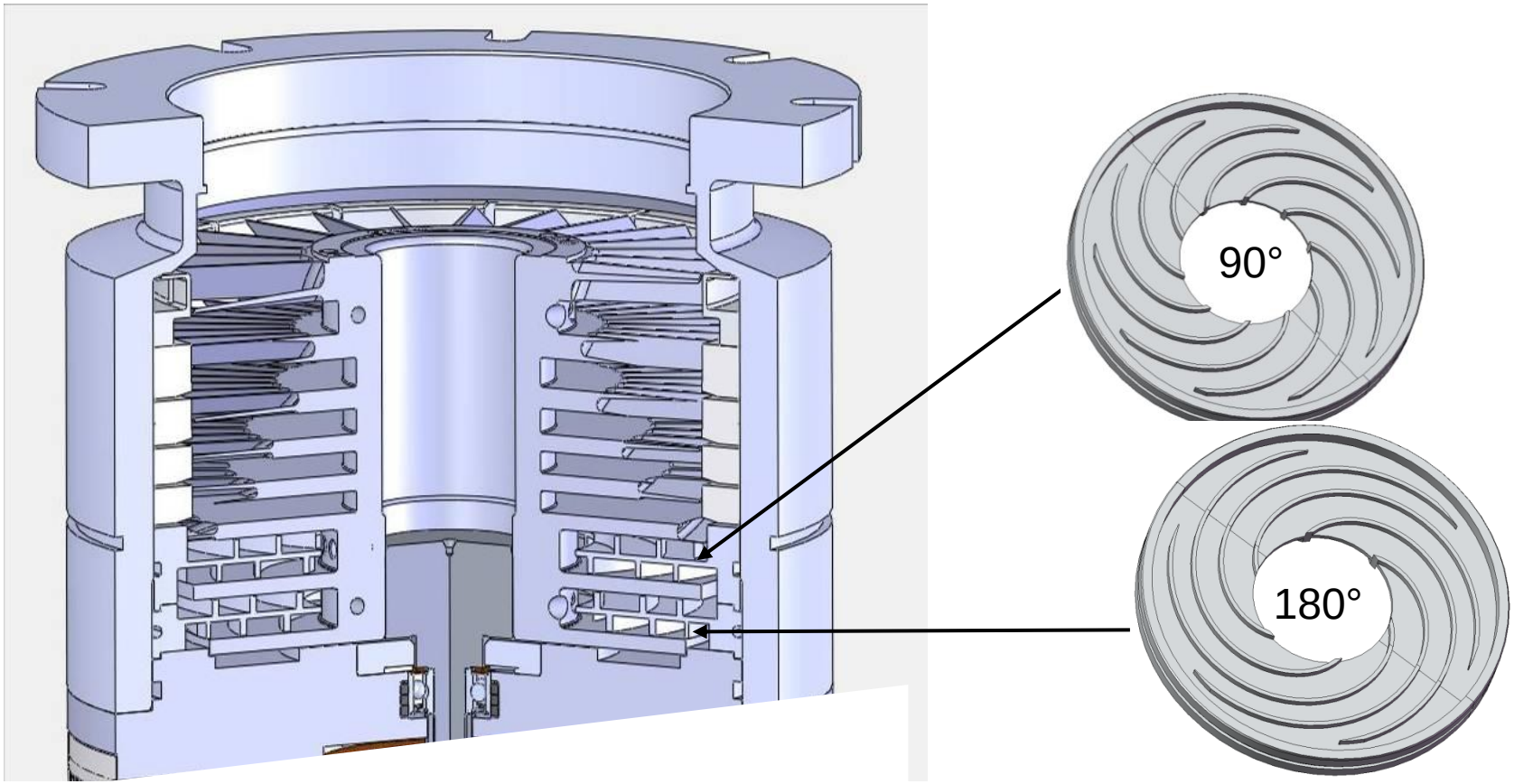
- Pumping speed up to 45 l/s is possible with an “open” 90° spiral design
- Results in agreement with channel calculations

TwisTorr technology

Feasibility test in commercial TMDP (1/3)

700l/s commercial TMDP

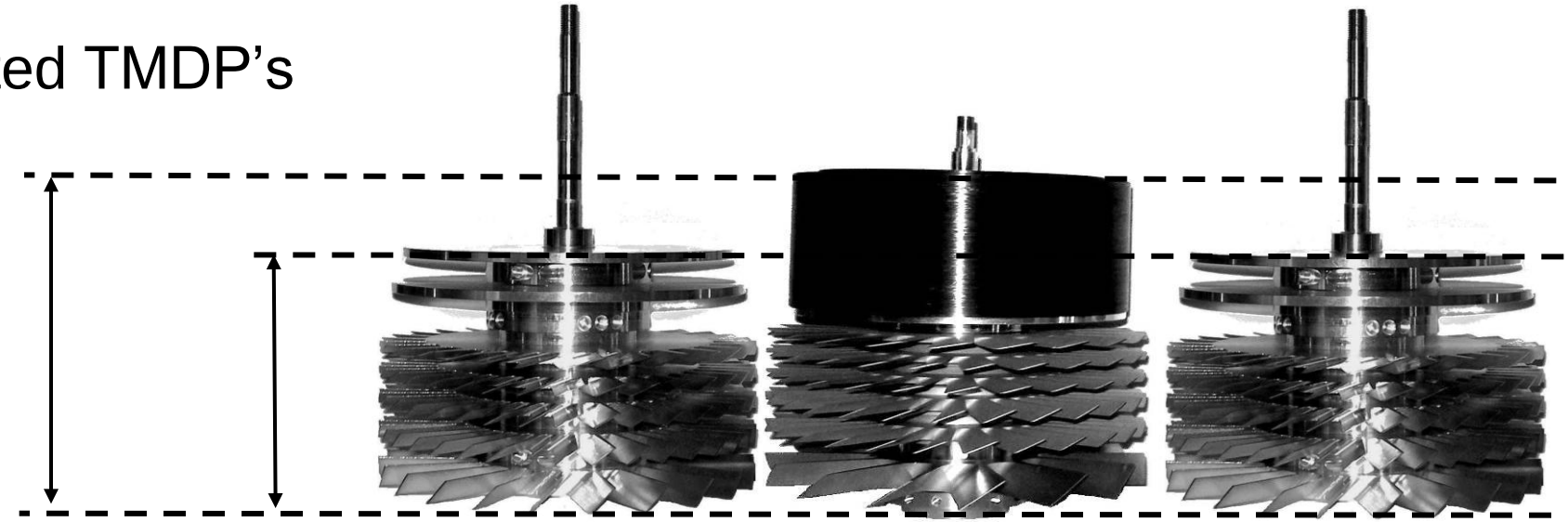
- 2 Macrotorr® stages replaced with 2 TwisTorr stages



TwisTorr technology

Feasibility test in commercial TMDP (2/3)

Tested TMDP's

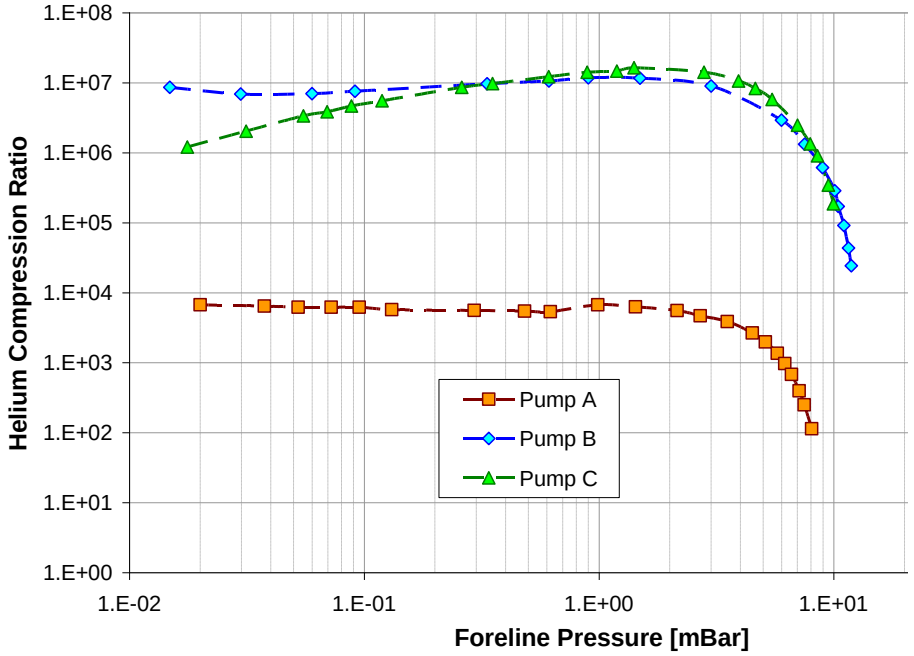


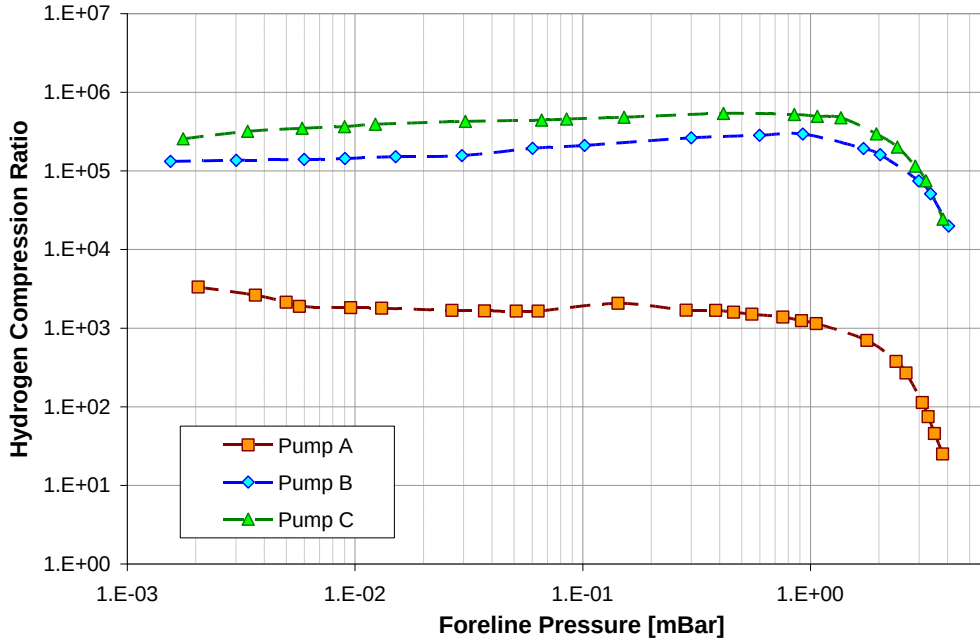
	Pump A	Pump B	Pump C
Rotational frequency	820 Hz	830 Hz	820 Hz
Rotor outer diameter	159 mm	161 mm	159 mm
Number of turbo stages	5	6	5
Drag stage technology	MacroTorr®	Holweck	SMDP
Number of drag stages	2	3	2
Drag section axial room	34 mm	60 mm	34 mm
Rotor height	100 mm	145 mm	100 mm

TwisTorr technology

Feasibility test in commercial TMDP (3/3)

Results





- TMDP equipped with TwisTorr stages largely outperform MacroTorr TMDP
- TMDP equipped with TwisTorr stages outperform longer Holweck TMDP

TwisTorr technology

Performance (1/2)

The new Spiral molecular drag pump evolved from

Siegbahn concept

- High compression ratio, including light gases
- High pumping speed
- High differential pressure

Is a very compact stage

multiple stages in series are easily integrated in TMDP

TwisTorr technology
Performance (2/2)

Compactness

- Shorter rotor
  - Smaller and lighter TMDP
  - More stable rotor to spin faster

- Same rotor
  - More pumping stages
  - High compression ratio

Today
New pumps

Based on TwisTorr technology

two TMDP's have been designed and

are being introduced

- Turbo-V750 TwisTorr platform

The technology has been used to achieve outstanding performace in competitive dimensions

- Turbo-V2300 TwisTorr platform

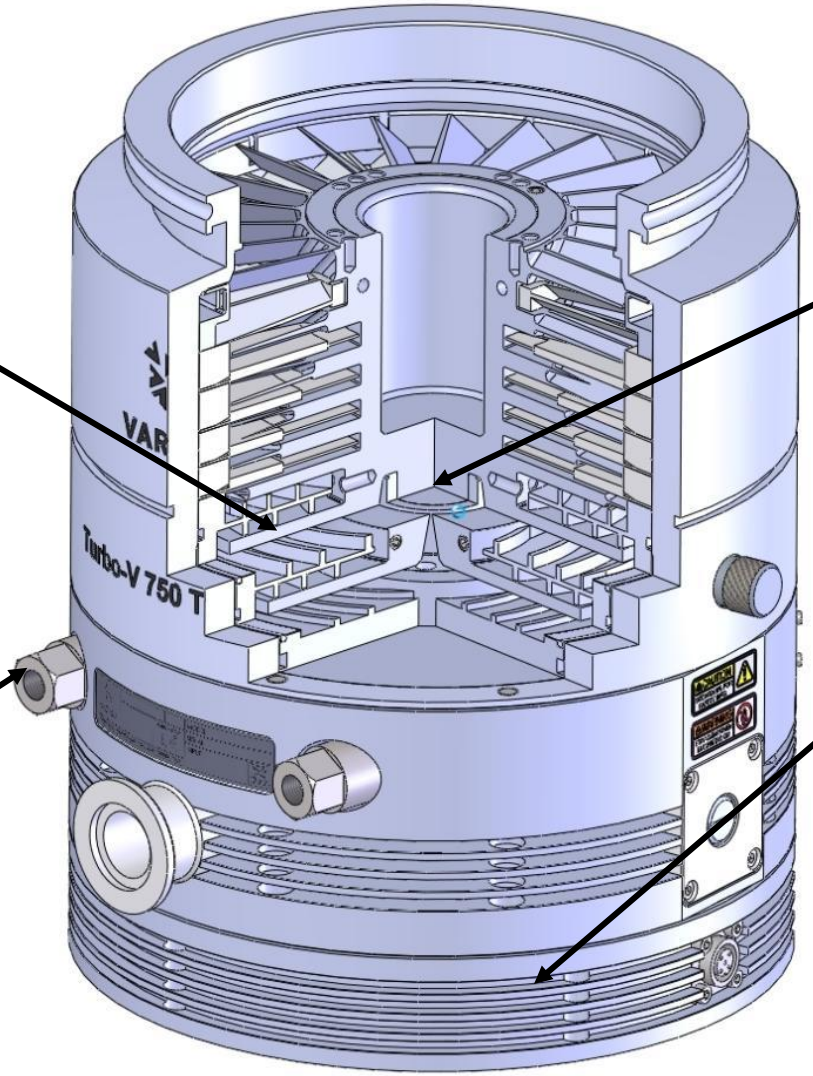
The thecnology has been used to achieve outstanding dimensions with competitive specifications

Today

New Turbo-V 750 and 850 TwisTorr (1/3)

Drag section:
New TwisTorr technology
N. 2½ TwisTorr stages
(Patent Pending)

Corrosion resistant cooling loop:
mandrel expanded SST pipe (patent pending)



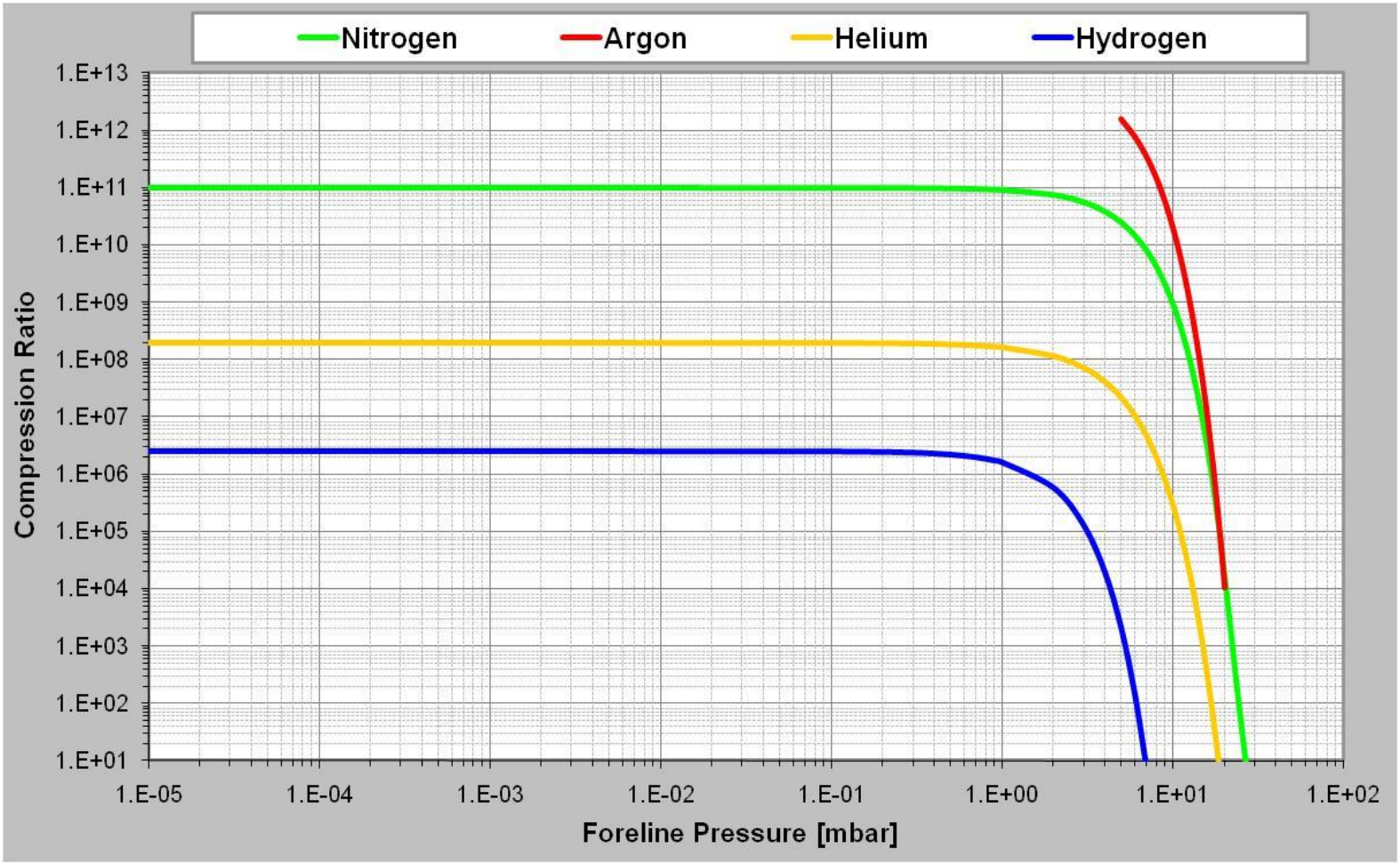
Suspension:
- Inverted fitting (patent pending)

IP54 on-board 48 Vdc integrated electronics:
- 48 V electrical motor
- Field Oriented Control of motor
- Rotational speed: 825 Hz

Today

New Turbo-V 750 and 850 TwisTorr (2/3)

Compression Ratio's



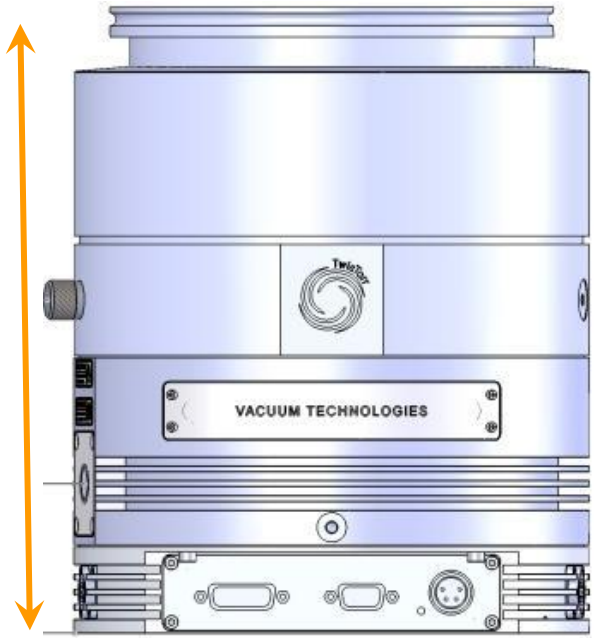
Agilent Technologies

Today

New Turbo-V 750 and 850 TwisTorr (3/3)

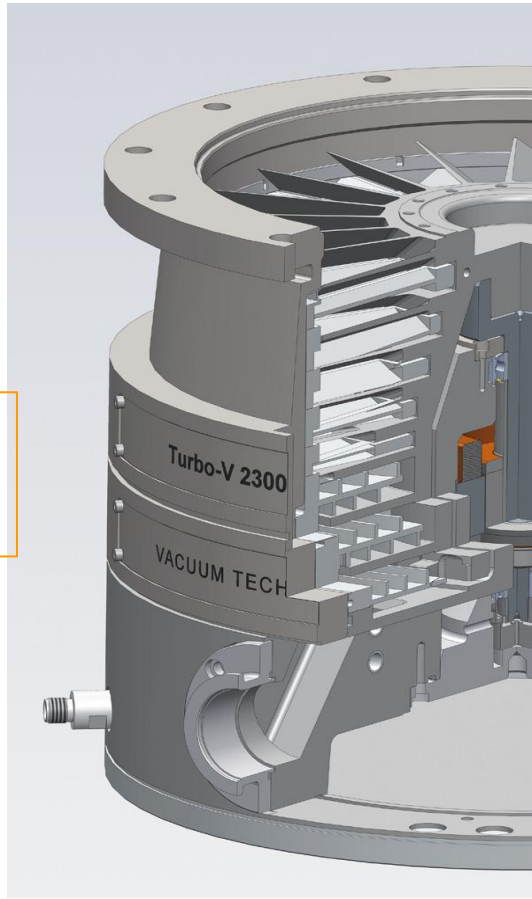
	Varian TV551 DN160	Varian New TV750 TwisTorr DN160
Speed x N2	550	700
Speed x Ar		680
Speed x He	600	680
Speed x H2	510	580
K ratio N2	1x10^9	>10^11
K ratio Ar		>10^11
K ratio He	1x10^7	2x10^8
K ratio H2	1x10^6	2.5x10^6

H = 255 mm (with integrated electronics)
(= TV 551 pump only, without Nav CNT)



Today
New Turbo-V 2300 TwisTorr (1/2)

H = 276 mm
109 mm shorter than TV 3KT pump



Today

New Turbo-V 2300 TwisTorr (2/2)

	Varian TV3KT (obsolete)	Varian New TV2300 TwisTorr
Speed x N2	2050	2050
Speed x He	2400	1800
Speed x H2	2300	1500
K ratio N2	1x10^8	8x10^8
K ratio He	1.2x10^5	8x10^5
K ratio H2	1.5x10^4	4x10^4
Max N2 Foreline	1 mbar	4 mbar
Run Up Time	<9 min.	<6 min.

Potential
Near future (1/2)

TwisTorr technology allows to build TMDP's

virtually to "any" specification

after numerical modelling

- Pumping Speed
- Thoughput
- Compression Ratio
- Foreline tolerance

Potential
Near future (2/2)

Overcome the traditional limititation in TMDP’s

- Compression ratio for light gases

Flexible design

- Interchangeable stators
- One rotor

For different applications

- Different requirements
- Different specifications