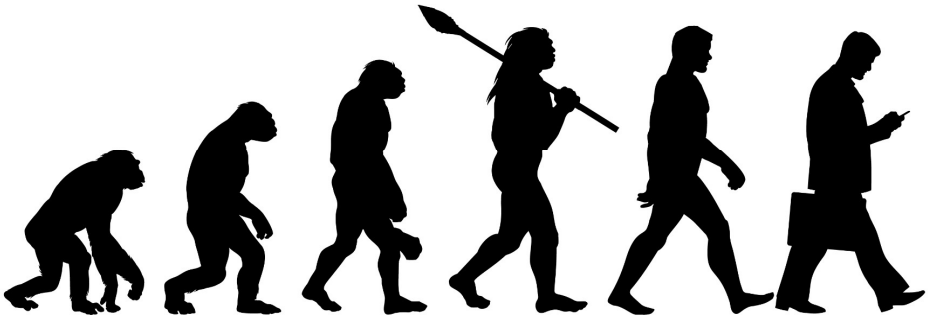
The next evolutionary step in micropump technology



John Watson
Business Development Manager – TTP Ventus

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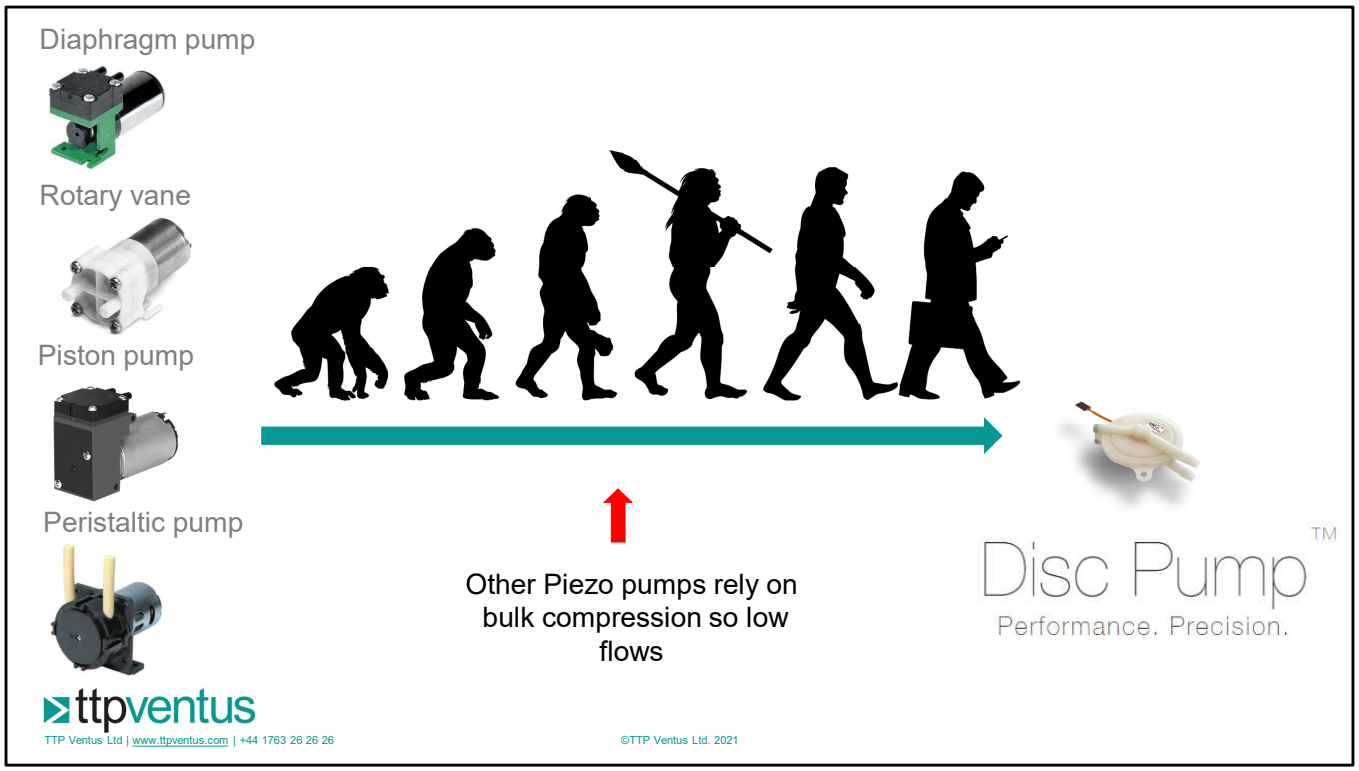
- Thanks for viewing this post event.
- I am John Watson, and head up business development at TTP Ventus, to date I have about 25 years experience in the pump industry, with about 21 of those years in the micropump sector, where I sold diaphragm, piston, rotary vane, linear, peristaltic, syringe and about any other pumping principle you can think of, as such I can speak from experience with respect to many of the problems associated with those pump technologies.
- I joined TTP Ventus back in 2018, and I am proud to be part of an amazing team who are looking to disrupt the micropump industry and enable innovation across a diverse range of industries and applications with the unique Ventus Disc Pump technology.
- So the topic of my presentation today 'The next evolutionary step in micropump technology', here, I would like to take you on a journey that looks first at some of the issues with what I am calling legacy technology, and then moves on to why I believe that the TTP Ventus Disc Pump really is the next evolutionary step in micropump technology and then some examples, that I trust justifies my claims.
- So if we take a look at what I call legacy technology.



- So what do I mean by evolution, well to emphasise the point, on the right I have just dropped in some examples of what I am terming legacy technology, and I say legacy, as this type of pump technology has been used for many years now within the micropump sector, because in essence there have been no other options.
- I say no, but this is not strictly true, as there have been advances in other pumping technologies, piezo pumps being one however, until the TTP Ventus Disc Pump came on the scene, there has been no technology that really challenges the status Quo, or had the potential to disrupt the micropump market; as you will see later, the Ventus Disc Pump is **NO** ordinary piezo pump.
- So what issues does the TTP Ventus pump address to make this evolutionary leap forward, well if start by considering some of the issues with the legacy technology, I trust all will become clear.

Main legacy micropump technology

Diaphragm pump

Rotary vane

Piston pump

Peristaltic pump

- Noise
- Flow pulsation
- Limited flow control
- Mechanical vibration
- Speed of response
- Weight
- Size
- Ambient temperature
- Lack of condition monitoring
- Pump Life
- Catastrophic failure modes

- Power consumption
- EMC
- Pump integrity
- Holding pressure *
- Dust generation *
- Intermittent operation – Sticking vanes *
- Cost
- Maintenance required
- Flow variation
- Cleaning
- MRI Compatible

* Rotary vane pumps only

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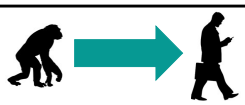
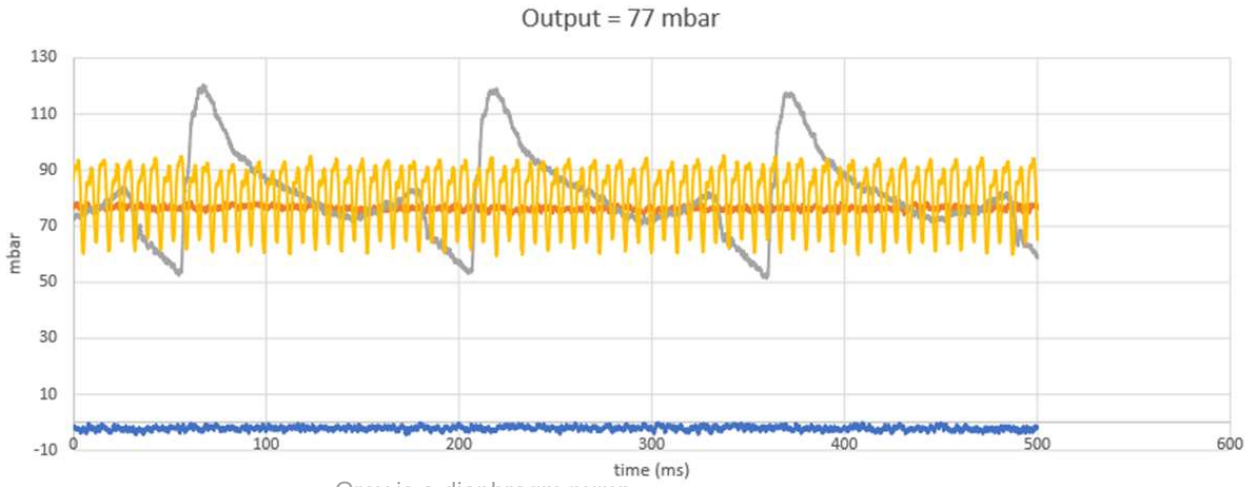
- So here I have listed some typical pumping principles and anyone who has worked with these will appreciate the following.
- So having run through many of the issues with the legacy technology, lets take a closer look at Flow pulsation for moment, why this is important and how the TTP Ventus Disc Pump is a big leap forward here.

Flow pulsation and TTP Ventus Disc Pump





- Grey is a diaphragm pump
- Yellow is a rotary vane pump (perceived as smooth running in todays market)
- Orange is a TTP Ventus Disc pump
- Blue is baseline.

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- So Flow pulsation, why is flow pulsation or should I say lack of it, so important ?
- Well, looking at a few examples, in gas analysis for instance, flow pulsation creates noise on sensors, with smooth flow you can improve the signal to noise ratio and improve measurement sensitivity.
- This Pulsation is even more critical if you look at say particle counters, where flow pulsation can cause erratic movement of the particles and double counting. Linking this for a moment, if you consider the drive in Air quality monitoring at the moment, that measure gases and particles, the TTP Ventus pump is opening up new possibilities here.
- Finally in microfluidics smooth flow is needed to set up laminar flow streams, so that fluids mix via diffusion and not turbulence, making processes more repeatable and accurate, also smooth flow limits bubble formation and entrainment.
- So having demonstrated just one aspect as to why the TTP Ventus technology is the next evolutionary step in micropump technology, I thought I would provide some background on how and why it came to be, and the origins of the technology and TTP Ventus.

TTP Ventus – a TTP Group company

TTP was founded in 1987 with a culture of freedom. The freedom to explore new technologies. The freedom to share potential new opportunities with our clients. The freedom to invest in our own business. Three decades on, the world of technology has changed but our ethos has stayed the same: from freedom comes the space to create breakthrough inventions

- Present day 310 staff
- Revenue £57.7m (2019/20)

Legacies: TTPCom acquired by Motorola (2006)

TAP acquired by Sartorius Stedm (2013)

Meteor Inkjet acquired by Global Graphics (2016)

TTP Labtech now SPT Labtech acquired by Battery Ventures (2018)

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- So, TTP Ventus is part of The TTP Group, which has a pedigree of developing new and revolutionary technologies, that as you can see here often go on to be acquired.

TTP Group - companies

Melbourn Science Park, UK

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TTP Group

TTP: The Technology Partnership
High-tech product design and engineering services

Tonejet
Industrial inkjet technology specialising in beverage can decoration

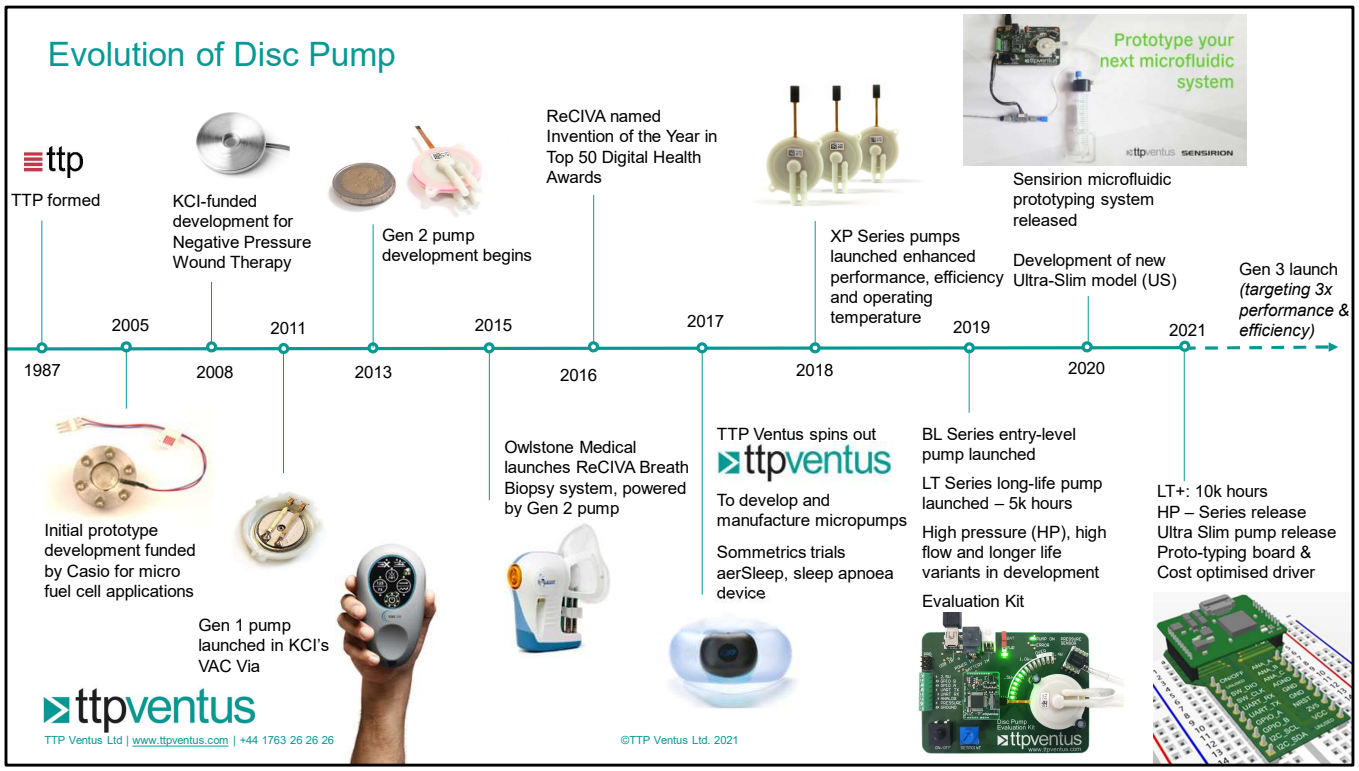
Melbourn Science Park
Estate management and property lettings

TTP Ventus
Micropump development and manufacture

Cellular Highways
High-speed cell sorting

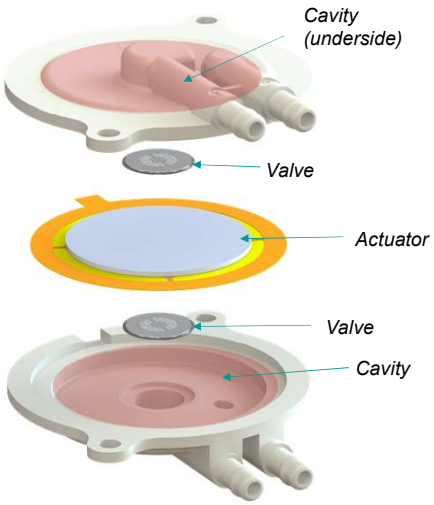
Lex Diagnostics
Molecular diagnostics

- TTP is situated just out side of Cambridge and owns the 17 acre site you can see in the top picture.
- On this site are the various sister companies, including TTP Ventus that I represent.
- So back to the history of Ventus, in the list to the right you will see TTP or ‘The Technology partnership’, which is made up of around 250 world class scientists and engineers, who many Blue chip companies turn to, to accelerate the development and integration of their products.
- In fact TTP Ventus was born out of TTP as you will note on the next slide.



- The TTP Ventus Disc Pump was born out of some work with Casio who were looking for a compact, silent, pulsation free pump with a high level of control to go inside a fuel cell, as at that time they believed that fuel cells would be powering laptops and portable electronic devices.
- Having scoured the world for a solution Casio could find nothing that fitted what they wanted so they turned to TTP for help and the Disc Pump was born some 16 years ago.
- The development with Casio did not go anywhere as Lithium Ion batteries came on the scene and squashed the demand for such compact fuel cells however, as a result TTP were left holding this unique pump technology that they could see scope for in other markets. After a few design iterations with some industry partners TTP spun out TTP Ventus back in 2017 and TTP Ventus is now a purely a pump company, focusing on developing the Disc Pump and pushing the boundaries of this evolutionary micropump technology.

What is Disc Pump?



Ultrasonic piezo electric gas pump

Most piezoelectric gas pumps rely on the movement of a piezo actuator to compress the gas in a cavity, thereby increasing its pressure. Such 'displacement' pumps have limited performance because the movement of piezo actuators is very small.

In contrast, Disc Pump does not rely on compression. Instead, it creates a high frequency, high amplitude standing wave and then rectifies that wave with an ultra-fast valve. This principle enables the Disc pump to generate much greater flows and pressures than traditional piezo pumps – and because Disc Pump operates at an ultrasonic frequency, it is completely silent.

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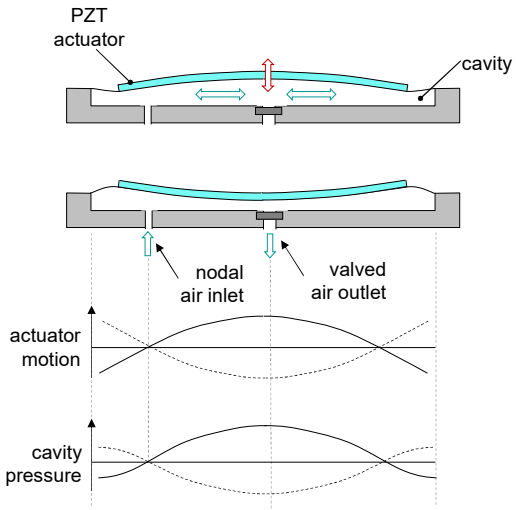
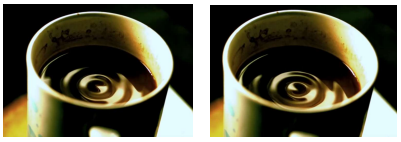
- Please read notes here, as it gives an overview as to why the TTP Ventus Disc Pump is different to other piezo pumps.

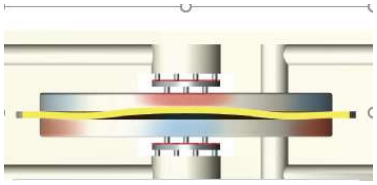
Disc Pump Principle of Operation



- Actuator flexes at its mechanical resonance
- This drives a standing pressure wave, formed between the centre of the cavity and the side wall



- Pressure builds up at the centre of the pump once per cycle
- A central, passive (i.e. undriven) valve allows airflow out of the pump
- Air flows into the pump at a nodal hole to replace the air that escapes through the valve.



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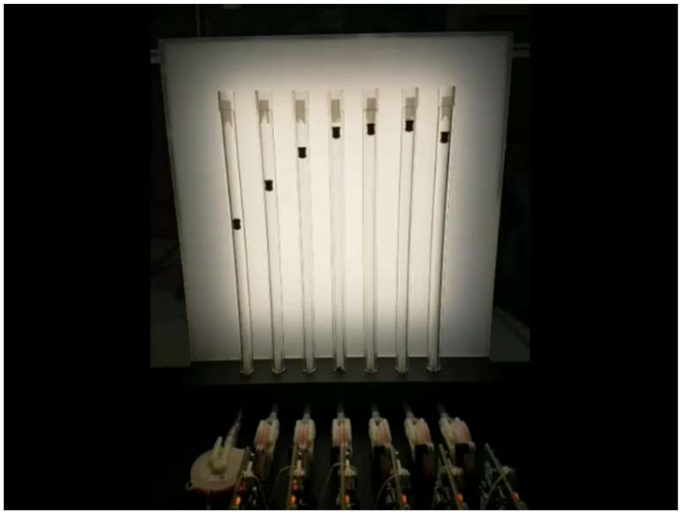
- This slide shows the pump in operation and how the standing wave produced in the pump is rectified to created driven flow.

Features

Unique feature set

- Compact form - *30 dia. X 10 mm*
- Lightweight – 5g
- Silent operation
- Pulsation & vibration free
- Millisecond response
- Near infinite turn down ratio
- Precise control
- Exceptional pressure & flow for size



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- The unique features of Disc Pump and the demonstration of 7 Disc Pumps controlling flow tubes shows many of these attributes in operation, millisecond response, precise control, near infinite turn down ratio, pulsation free flow and exceptional performance for its size.

Manufacturing

- High-volume on-site facility
- Two manufacturing lines:
  - Valve line
    - Multi-stage, panel-based processing
    - Laser welding, laser machining
    - 5 µm precision alignment over ~400 mm
  - Pump line
    - Pallet-based linear motor transport system
    - Multi-access pick & place and adhesive deposition
    - UV curing
    - Machine vision inspection throughout
    - 100% EOL test for valves and pumps

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- TTP Ventus manufacturing information.

TTP Ventus Products - summary

Line	Summary	Peak pressure	Peak flow	Peak vacuum	Life	Temp. range
BL Series	Entry level, balance between performance and cost	> 300 mbar	> 1.65 L/min	< -200 mbar	Varies depending on use case	5 to 40 C
XP Series	Highest performance, widest temp range	> 410 mbar	> 2.10 L/min	< -280 mbar	Varies depending on use case	-25 to +55 C
LT Series	Long life models	> 270 mbar	> 1.20 L/min	< -220 mbar	> 5000 hours	-25 to +40 C
HP Series	High Pressure - microfluidics	> 600 mbar	> 0.1 L/min	< -400 mbar	Varies depending on use case	-25 to 40 C
US Series	Ultra-Slim – wearable technology	> 420 mbar	> 0.95 L/min	N/A	Varies depending on use case	-25 to 40 C
Eval. Kit	Two pumps, drive electronics, PSU, accessories	N/A				
Driver boards	Postage-stamp-sized driver board for prototyping & low volume production	N/A				

In development (2021)

- Long lifetime LT series up to 10k+ hours life

New Ultra Slim design <6mm thick

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- Product Summary

Evaluation Kit

Details	
Kit contents	2 Disc Pumps Driver Board Mains PSU Accessories Kit USB drive with PC app for control, configuration, and documentation Research Licence
Control Interfaces	PC Application Rotary dial (can be configured to control pressure or power) 0-2.5 V analog in (can be configured to control pressure or power) USB-Serial interface for integration with host system
Control Modes	Power control Closed-loop pressure control (positive and negative pressure) Bang-bang pressure control

See video of operation at ***https://vimeo.com/317302083***

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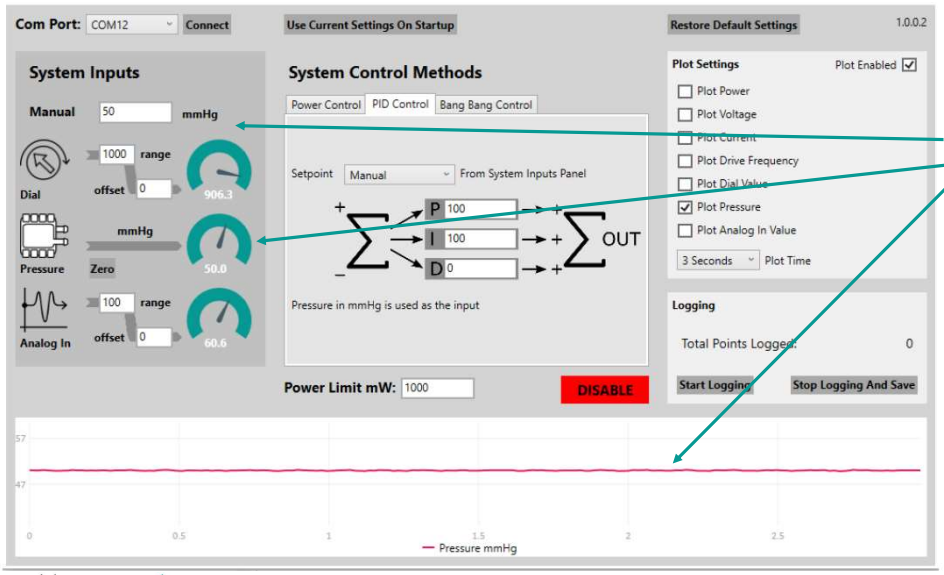
- We offer an evaluation kit for £730.00 so you can test the pump's attributes for yourself and this comes complete with two pumps of your choice, driver board, software, power supply and all the ancillaries you will need to get up and running quickly. We have designed the kit to enable you to prove principle quickly, which potentially reduces your development time/resource input. We can send over a link so that you can order this via a credit card if that is easier, however if you need an official quote so that you can raise a purchase order, please let me know your full company details and address by return, and I would be happy to send that on for you. To see the evaluation kit in action, please see link on slide.

Evaluation kit – Software and GUI



Pressure controlled to exactly 50 mmHg under PID control mode

Note: Disc Pumps' ability to maintain and follow a set pressure profile can remove the need for expensive proportional valves, reducing cost and system complexity.

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- An example of the GUI that comes with the kit, here we are demonstrating holding a target set pressure with incredible accuracy.

Markets

Medical

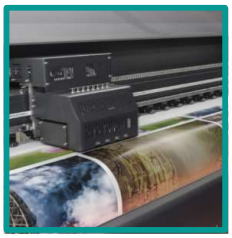
- Blood pressure monitoring
- Capnography
- Sleep therapy
- Compression therapy
- MRI compatible equipment

Life Sciences

- Medical Diagnostics
- Droplet Microfluidics
- Molecular Diagnostics
- Biomedical Engineering

Environmental

- Ion Mobility Spectroscopy
- VOC detection
- Air quality monitoring
- Particle detection
- Docking / calibration stations



Industrial

- Industrial inkjet printing
- Automotive seating
- Aerospace seating
- Automated test equipment
- Robotic arm pick and place systems
- Leak detection

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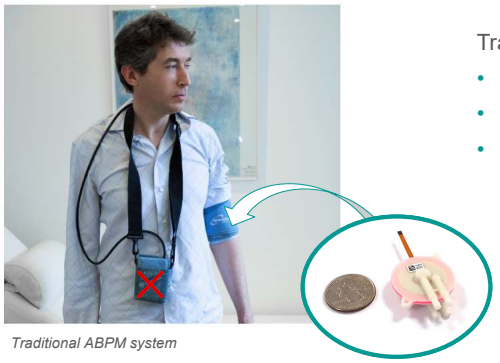
- The main markets that we operate in and some examples of applications.

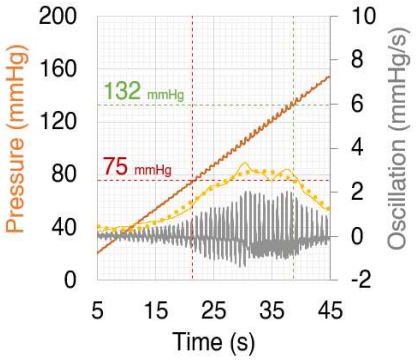
24-hour Ambulatory Blood Pressure Monitoring



Traditional ABPM system

Traditional ABPM systems

- **Bulky**
- **Noisy**
- **Measure on deflation, which is uncomfortable**
  (too much pulsation from pump to measure on inflation)



Measurement during cuff inflation and 3 mmHg/s constant inflation rate

- **Improved comfort** through silent operation and ability to carry out BP measurement on inflation.
- **Integrated pump module and cuff** through compact and lightweight form factor.
- **Enhanced measurement accuracy** through removal of hose and ability to drive adaptive inflation rates.

Learn more at: ***https://www.ttpventus.com/abpm***

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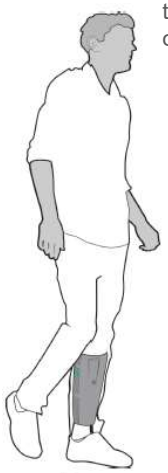
- Case study: Ambulatory Blood Pressure Monitoring

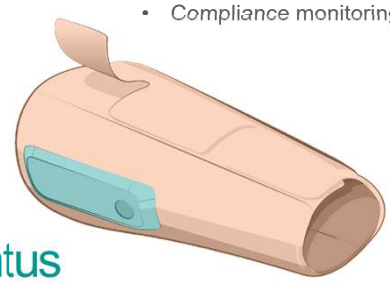
Intermittent Pneumatic Compression

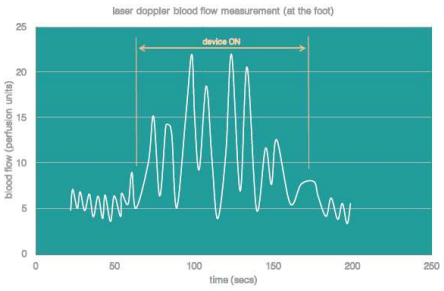
Vascular conditions are an increasing concern globally and trends towards value based care are likely to drive change. TTP Ventus has enabled a new category of IPC device which delivers a proven therapy in a radical new form-factor to improve patient adherence, outcomes and economics



Solution

- Silent, low-profile, vibration free
- Separable reusable & washable
- Smart system:
  - Adaptive control
  - Compliance monitoring





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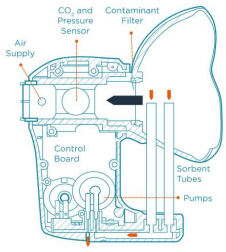
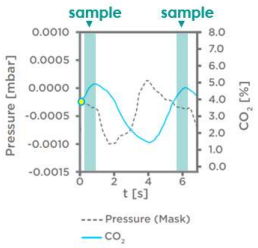
See video demonstration at: ***https://vimeo.com/301222937***

- Case study - Intermittent Pneumatic Compression

Owlstone Medical | Breath Biopsy



Breathing cycle



Background:
- Disease diagnostics via VOC biomarkers on breath
- Potential to revolutionise diagnostics as a quicker, cheaper, non-invasive, point-of-care modality.

Major challenges:
- Sampling (Repeatability, Reproducibility, Precision)
- Part-per-billion sensitivity often required

Solution:
- Sampling: Disc Pump's millisecond response and high performance allows high-precision sampling of the exact breath fraction of interest
- Sensitivity: active, selective sampling approach allows many samples to be collected in one 5 minute sitting, allowing sample preconcentration by a factor of 100

Learn more at: ***https://www.ttpventus.com/applications/owlstone-medical***

"I believe that the Breath Biopsy® technology offers a real opportunity to improve the lives of patients. *Working with TTP Ventus has enabled us to elevate this diagnostic platform further,* providing an extremely sensitive and accurate system that is also portable and user-friendly."

Billy Boyle, Founder and CEO, Owlstone Medical

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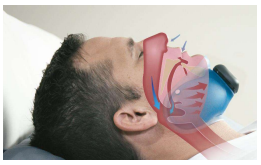
- Case study – Breathomics
- 4000 VOCs in breath
- 20 or so under investigation as biomarkers by leading researchers
- Deep lung air is needed so system tracks CO2 level and pump fires at the right point to take the sample, speed of response was critical here and this is why they have chosen Disc Pump.

Sommetrics | aerSleep™ Sleep Apnea Therapy

Sommetrics

Traditional CPAP system

- Traditional CPAP systems require face mask, long hose, and large noisy bedside pump
- CPAP systems are often uncomfortable, disruptive, and restrict movement during
- Long term compliance is poor as a result



Sommetrics' aerSleep

- Sommetrics aerSleep addresses these shortcomings
- With Disc Pump, Sommetrics has created a much less intrusive system:
  - No mask
  - No hose
  - No bedside pump
  - Silent, vibration free

✓ silent operation
✓ compact form
✓ vibration free

See video at: ***https://vimeo.com/202383258***

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"We had already developed prototypes by the time we met TTP Ventus and we knew that our technology worked. But we were still tethered to a bedside pump, and that was a problem for us. *Within minutes of introducing us to Disc Pump, I knew that our whole plan had changed.*"

Jerry Aarestad, co-founder, Sommetrics

- Case study – Sleep Apnea
- Disc Pump is silent and pulsation free so it will not disrupt sleep.

Environmental – Gas / particle sampling and detection systems

Sensitivity
Disc Pump™ moves a few nanolitres per cycle, resulting in negligible pulsation and improved signal to noise ratio.

Accuracy
Set points can be held within a fraction of a percent

Sample Response
Disc Pump has relatively little inertia. This means that it can respond to full-scale set point changes in a matter of milliseconds

Dynamic Range
Disc Pump has a near-infinite turn-down ratio on the pump speed.

Portability
Disc Pump™ weighs just 5 g (1/5 oz) and occupies a volume of 7 cm3. Also by eliminating the need for damping hardware, Disc Pump™ enables further reductions in size and complexity.

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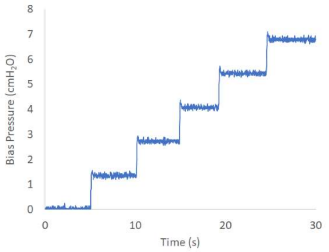
"Disc Pump's smooth flow is important to prevent noise on our sensors – the less noise the greater sensitivity we can achieve"

Peter Morris, Business Unit Manager - Sensors, Ion Science

- Case study – Gas sampling and particle detection in Air quality monitoring

Inkjet Printing | Meniscus Pressure Control



A Disc Pump controlling bias pressure within a fluid reservoir in a series of set-point steps, showing rapid response and control

Issues
- Ink wetting out / dripping at print head or air being ingested into head
- Poor print quality due to variation in droplet volume and throw (direction, velocity).

Causes
- Incorrect vacuum resulting from control challenges & single pump system across multiple heads
- Unstable vacuum resulting from pump pulsation
- Poor system reaction times resulting from slow-responding pumps.

Solutions
- Smooth flow control – pulsation-free
- Millisecond response time
- High-precision pressure control

System optimisation
- Disc pump's size and performance enables the creation of modular systems (single pump per head)

"TTP Ventus pumps work well for inkjet meniscus pressure control, enabling us to achieve improved pressure control within a compact form-factor".

Simon Kew, Managing Director of Alchemie Technology.

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- Case study – meniscus pressure control

Applications in Seating systems

Typical systems use a series of interconnecting bladders and an array of valves and a pump. The pump is normally mounted under the seat due to its size and to limit noise and vibration. It is then connected to the bladders via a complex system of pipework that is often internally reinforced to prevent kinking.

Disc Pump is silent and vibration free and can be mounted directly to the bladder, negating tubing and enabling improved system architecture.

Disc Pump weighs just 5g; minimising weight, which is critical for aircraft and vehicle seating.

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- Case study – seating systems

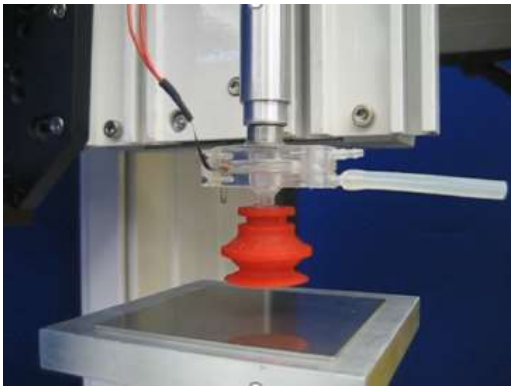
Robotic pick and place

Issues

- Running pneumatic pipe and connections to the pick and place head
- Size and weight of attachment on the robotic arm
- Speed of response on pick up

Solutions

- Disc Pump is a compact electrical vacuum source, just 5g in weight
- Millisecond response time to maximum performance
- High-precision control



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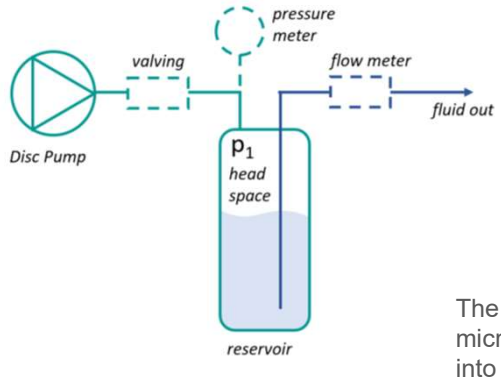
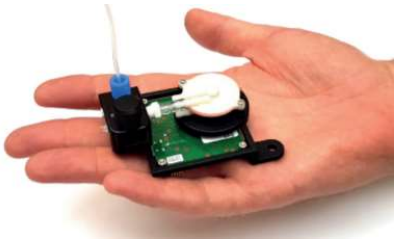
- Case study – pick and place

- We have customers developing spider bots that can climb buildings etc to check for maintenance issues, they are looking to use a pump per foot, lightweight and vacuum control are important features here.

Applications in microfluidics - Pressure Driven Flow (PDF)

Disc pump is highly controllable and moves just a few Nano-litres per cycle; this enables the pump, through a pressure driven flow system, to move fluids with a high degree of accuracy and precision with effectively no pulsation. The low inertia means it can also react to set point changes extremely rapidly.





The compact size enables high precision microfluidic handling to be tightly integrated into compact and portable systems, such as POC diagnostic systems.

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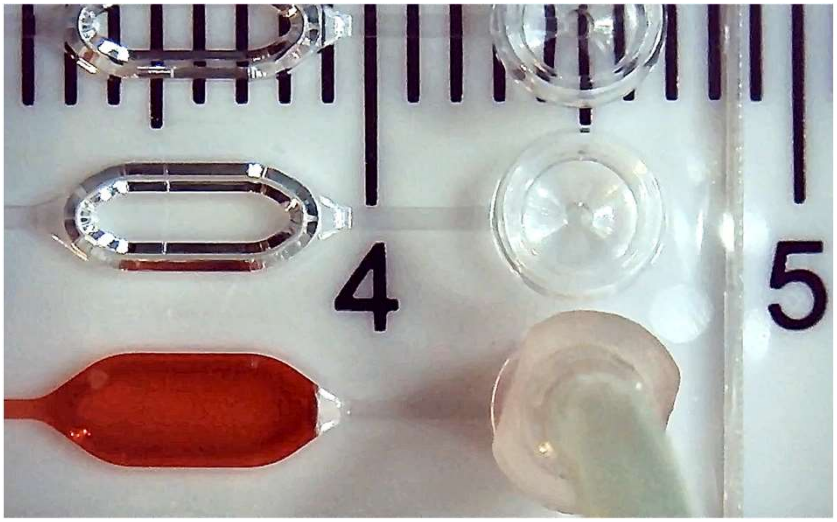
"The TTP Ventus pump was used to develop innovative reagent delivery systems for microfluidic point-of-care diagnostic devices. The pump's precision and ultra-controllability offers bubble-free and pulsation free reagent delivery and the size makes them the best solution for fluid handling in portable infectious disease diagnostic devices."

Prof. W Balachandran
Research Professor
Brunel University, London

- Another sector that is particularly suited to the attributes that the Disc Pump can offer, is microfluidics and this is a field in which Disc Pump excels when you consider the current technology and what Disc Pump can enable in terms of innovation.

- Take diagnostics as an example

Microfluidic pumping system



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- At the heart of many diagnostic devices is a microfluidic system
- Here small quantities of fluids must be moved accurately and precisely, in a way that delivers a fast and reliable result.
- Systems designers are therefore constantly looking for new and clever ways to drive the fluidic system and this is where selecting the right micropump or pumping system is critical.
- There are many pump options available to engineers and designers of however, a number of key considerations should factor in the pump selection process.

Microfluidic pump options

	Peristaltic pump	Syringe pump	Pressure driven flow
Flow stability and precision	Low	Medium	Excellent
Response time	Low	Low	Excellent
Ultra smooth flow	Low	Medium	Excellent
Direct handling of media (cross contamination)	Yes	Yes	No
Size, weight, noise	Medium	Poor	Poor
Gas injection	No	No	Yes
Injection of Nano-volume sample	Poor	Good	Medium*
Sample agitation	Possible	Not possible	Possible
Sample temperature control	Possible	Not Possible	Possible
Dynamic flow range	Good	Poor	Excellent
Fluid recirculation	Yes	No	Yes**

ttpventus * Limited only by flow sensor ** Valves needed

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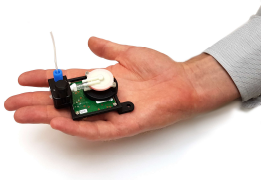
- The table shown here breaks out the advantages and disadvantages of the typical microfluidic pumps used today.
- The immediate take away from this is pressure driven flow offers many benefits over the other technologies however as it typically requires an air pump and pressure controller, the current physical size and system complexity does not lend itself to miniaturisation and POC diagnostics
- That is until Disc Pump came along, as disc pump radically simplifies the pressure driven flow set up.

Microfluidic pump options

	Pressure driven flow – Disc Pump
Flow stability and precision	Excellent
Response time	Excellent
Ultra smooth flow	Excellent
Direct handling of media (cross contamination)	No
Size, weight, noise	**Excellent**
Gas injection	Yes
Injection of Nano-volume sample	Medium*
Sample agitation	Possible
Sample temperature control	Possible
Dynamic flow range	Excellent
Fluid recirculation	Yes**



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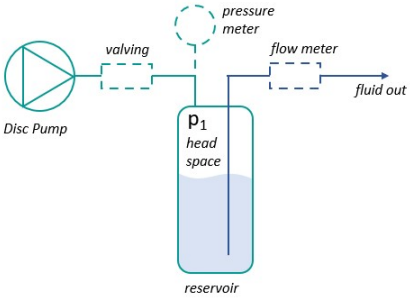
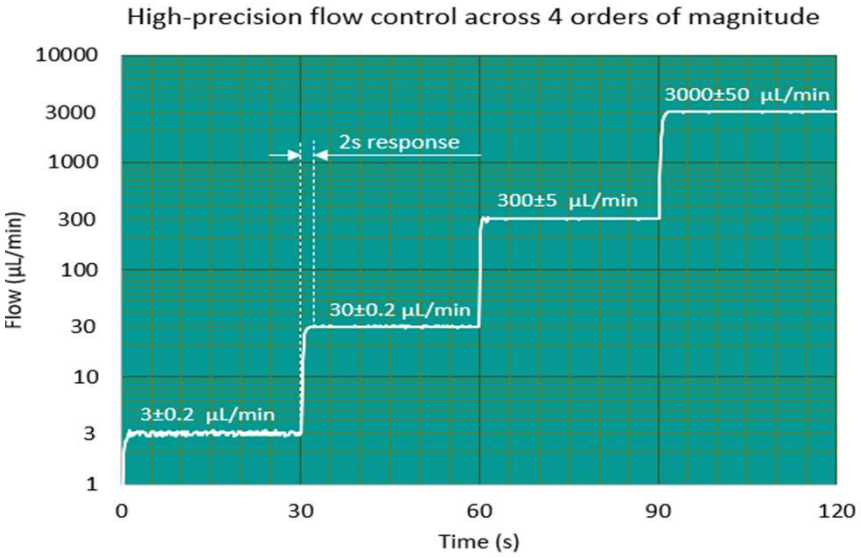
- Disc Pump weighs just 5g and has a volume of around 7 cm^3 - which supports the trend for miniaturisation and helps to enable the next generation of compact and portable POC diagnostic systems for instance.

- So miniaturisation is great but what else does disc pump have to offer microfluidics

Disc Pump – For next generation microfluidics

High precision flow control





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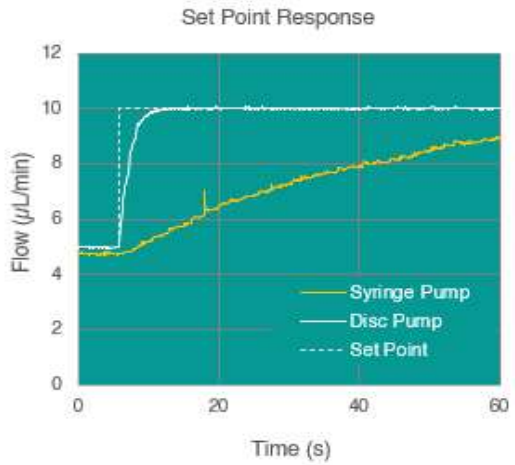
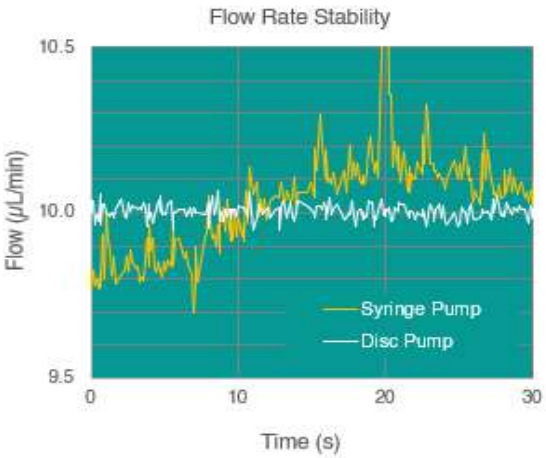
- Disc Pump offers excellent regulation of pressure and vacuum, which in turn drives stable, accurate and precise liquid flow. This makes it possible to achieve incredible accuracy across a wide performance range.

Disc Pump – For next generation microfluidics

Response speed



Flow rate stability



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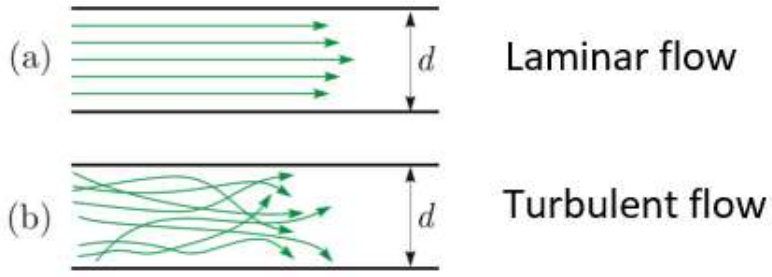
- Being Piezo, Disc pump have very little inertia and can go from zero to maximum performance in under a millisecond, this enables a rapid response to set point changes. This is good because it enables pressure gradients to be accurately followed, which helps to reduce bubble formation and entrainment and it can reduce wastage

- Due to the principle of operation, Disc Pump operates at 21K cycles per second and moves just a few nano litres of air per cycle, as such the resultant air flow is ultra smooth and this improves measurement sensitivity and flow rate accuracy. This is shown by the stable trace to the right as compared to a syringe pump, that suffers from high inertia, slow response speed and mechanical play.

Disc Pump – For next generation microfluidics

Pulsation free flow



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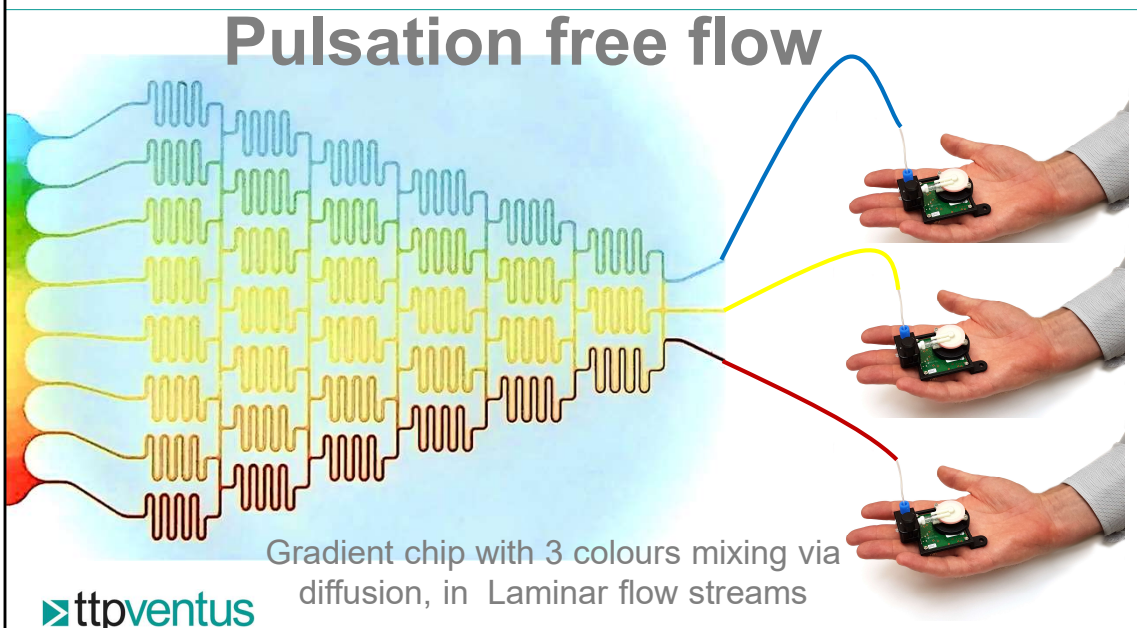
- As mentioned Disc pump moves just a few nanolitres of air per cycle, and cycles at 21K times per second, so the resultant air flow is effectively pulsation free. This allows Disc pump to create very stable pressures that can drive smooth, laminar liquid flow streams.
- This is important as this allows liquids to mix via diffusion rather than turbulence which makes the process more stable and reliable.

Disc Pump – For next generation microfluidics



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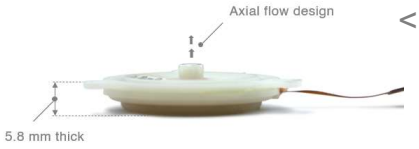
- In this example we took three Disc Pumps and a gradient chip from our friends at Microfluidic Chip shop and mixed red yellow and blue fluids in laminar flow streams to create a spectrum of stable colours and rainbow effect.
- OK so, Disc pump offers a compact solution, excellent flow control, rapid response, ultra smooth flow, so what else does it offer

Disc Pump – For next generation microfluidics

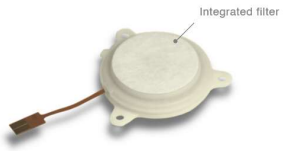
Cost

Silent operation

Size and weight



< 5g in weight



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- **Cost –** One customer told me that a £150.00 TTP Ventus Disc pump system out performed a £15K Pressure driven flow system. This company were designing a compact POC diagnostic system for Covid-19 and Disc Pump was the ideal solution for their flow control needs. They are now looking at integrating 3 pumps per device and this is still a very economical solution for them compared with alternative technology.
- **Silent operation –** Disc pump runs at a frequencies above the range of human hearing and as such is completely silent, This is like the icing on the cake for many systems, as noise pollution in the care setting is always a consideration in many POC diagnostic devices.

- **Reliability:** The pump is essentially the heart of the system
- This is actually bit of an old slide, but I like it as our pump looks a bit like the Star ship Enterprise so I have modified in red to reflect that we now have pumps that have exceeded 20K hours continuous operation in our test house, which is now over 80 cycles for every year the universe has existed.
- So having looked at micro fluidics in some depth, what does the Disc Pump enable here.

Enabling innovation – Droplet microfluidics

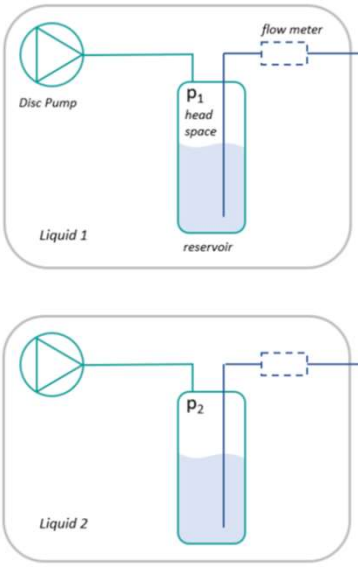
Miniaturisation

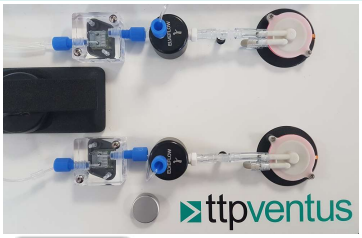
Faster processing

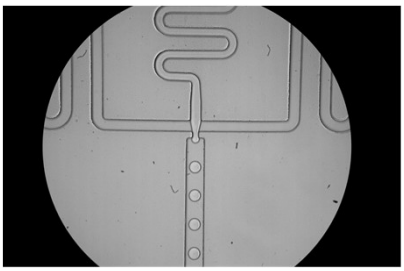
Improved STATS

Lower cost

Control & precision







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- Taking Droplet microfluidics as an example
- Traditionally, droplets are formed using bulky pressure driven or syringe pump driven flow systems.
- Disc pump changes all this for through its compact size.
- This means in theory that faster processing techniques, such as droplet-digital PCR – could be applied to compact POC diagnostic systems for example
- Also with droplet digital, as you are dealing with such small volumes it is possible to **reduce** or **speed up** steps to improve the sample turn around time or STAT- another feature POC systems are striving for
- Also as these systems deal in the nano and pico litre scale, reagent use is lower, so the cost per test can be reduced; another important factor for POC for instance.
- And finally, with droplet biology enabled by Disc pump it is possible to have very good individual control over the droplets, improving overall process control and precision

Applications in microfluidics – Organ-on-a-chip

Organ-on-a-Chip Technologies Network

cellpod system current being developed by our sister company TTP for the culture of complex cell models.

SmartPlate system for Flexible, fully automated fluid handling.

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- Here is a prototype of the cellpod system current being developed by our sister company TTP for the culture of complex cell models.
- Here they have developed a **SmartPlate** system for Flexible, fully automated fluid handling'
- In essence they are reinventing liquid handling robots in a smaller, cheaper, easier to use format, that can be used for all types of bio research and development work be that molecular or cell-based."
- The idea here is to do everything a classic liquid handling robot can from say the likes of Hamiliton but in a fraction of the size, cost and complexity.
- So once again as you can see Disc pump enables the drive towards miniaturisation and system integration.

The next evolutionary step in micropump technology

'TTP Ventus has designed the multi award-winning Disc Pump'

Unique feature set

- Compact form - *30 dia. X 10 mm*
- Lightweight – 5g
- Silent operation
- Pulsation & vibration free
- Millisecond response
- Near infinite turn down ratio
- Precise control
- Exceptional pressure & flow for size

The TTP Ventus Disc Pump is enabling cutting-edge innovation across the medical , life science , environmental and industrial sectors.

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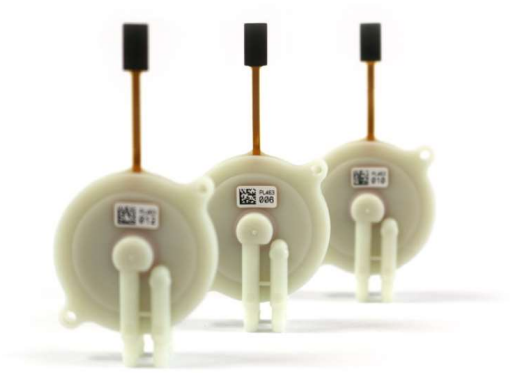
- In conclusion then, to meet the evolving demands, today's systems place increasing importance on reduced size, weight and noise, whilst remaining uncompromising on performance.
- I trust that through this presentation I have demonstrated how the TTP Ventus Disc Pump addresses those and how it really is 'the next evolutionary step in micropump technology'
- So that's about it, thanks for viewing on catch up and I hope my notes added some context to the slides.

- Thanks again, please click on to contacts.

Questions



disc pump™
performance. precision.

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