

# Revolutionizing **Single-Use-Pump**

Allow me to explain some techniques behind PumpCell



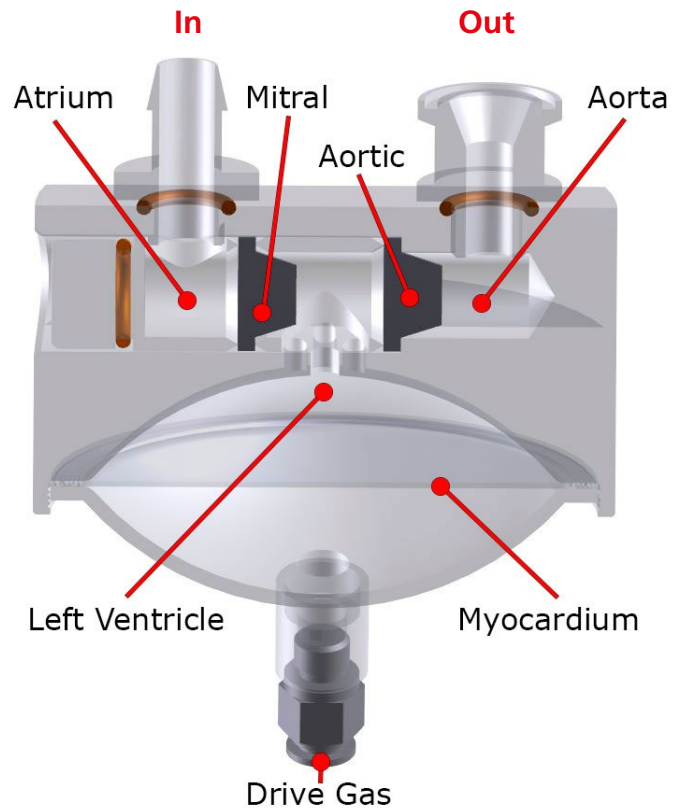
Per Stobbe



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# Single-Use-Pump

## copying the mammalian heart



Unmatched weight, unbelievable small and compact with massive opportunities for programming of any performance requirements



**Ready to use  
"right out of  
the box"**

The dynamic, untiring human heart has 4 valves, 2 inlet chambers and 2 power chambers. The two Ventricle muscle walls Myocardium contracts and force fluid through the 2 one-way valves Pulmonary, Aortic out of the heart and into the body. PumpCell copy with some limitations the human heart!

# The unique Single-Use-Pump

## – Euterpe functionality



The mammalian heart max variation in Cardiac Output (CO) = 1:10 (CO = BpM x SV)

- Beats-per-Minute (BpM) variation: 1:3
- Stroke Volume (SV) variation: 1:3

Euterpe pump cell offer 1:2.000 CO range and integrates only three moving parts:

- one Pericardium diaphragm as found on the outside of the Myocardium muscle
- two one-way cross-slit valves like Tricuspid and Pulmonary valves

Atropos drive unit integrates the Apollon PLC brain, which collects electrical signals from the Laser sensor, pressure, vacuum, and temperature sensor's. Hereby the Apollon brain calculate on-line and in real-time:

- the actual position of the Pericardium diaphragm with 1/10th of a millimetre precision

Apollon corrects the diaphragm position continuously according to changes in real-time:

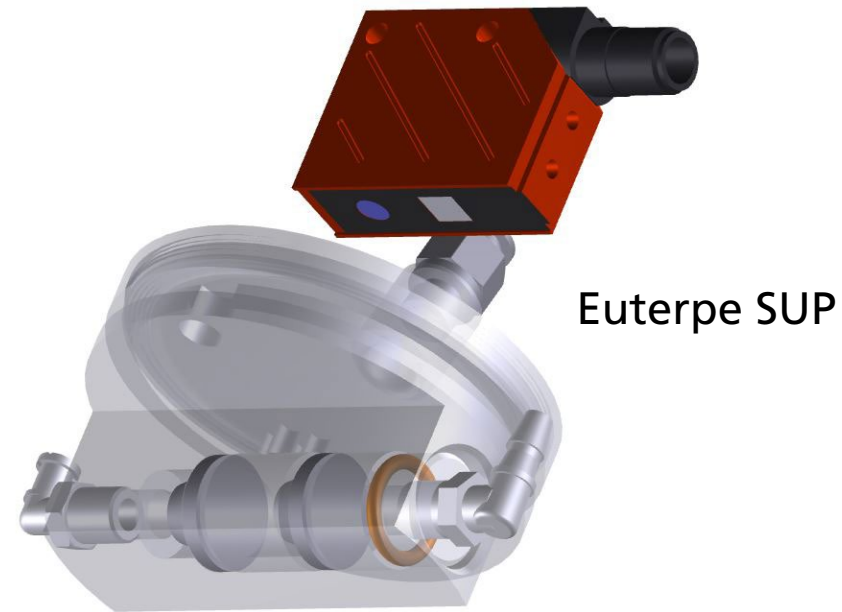
- use vacuum to contract (Systole) Pericardium diaphragm
- use pressure to expand (Diastole) Pericardium diaphragm

In Euterpe one side of the Pericardium medical grade silicone diaphragm is in contact with sterile fluid and the other side in contact with the non-sterile driving gas pressure.

# The unique Single-Use-Pump – Euterpe performance

The total volume of blood pumped by the average animal mammalian heart in a lifetime is approximately 200 million liter / kg heart

The obtainable / realistic number of human heart beats is ranging 1-2,5 billion ( $1-2,5 \times 10^{12}$ ) per lifetime – yes, all depending on how lucky we are! Euterpe Single-Use-Pump is designed for 1 mio cycles.



## Mammalian heart comparison

	Beats-per-Minute	Stroke Volume	Cardiac Output	Blod volume	Max pressure	Heart weight	Body weigth	Beat life time
<b>Abbreviation</b>	BpM	SV	CO		mm Hg x 1,3			
<b>Measures</b>		Liter	L/minute	Liter	mBar	Kilo	Ton	$\times 10^{12}$
<b>Adult human</b>	60-150	0,060-0,090	4-14	4-6	160	0,25-0,35	0,08	1-2
<b>Horse</b>	30-100	1-3	30-300	40-60	150	3-6	0,4-0,8	>1,1
<b>Elephant</b>	25-50	12	300-600	300-450	200	12-21	5-6	>1,1
<b>Blue whale</b>	6-30	>350	>2100	<6500		400-700	100-180	>1,1

# The stand-alone Single-Use-Pump – Euterpe sizes

Super compact Air-Operated-Diaphragm-Positive-Displacement (AODPD) Single-Use-Pump (SUP) offer a range of unique features unheard of in the industry

For even more compact installation the stand-alone pump cell and the Atropos Drive Unit are separated. Of course the pump cell's are all single-use, durable and of very low cost.

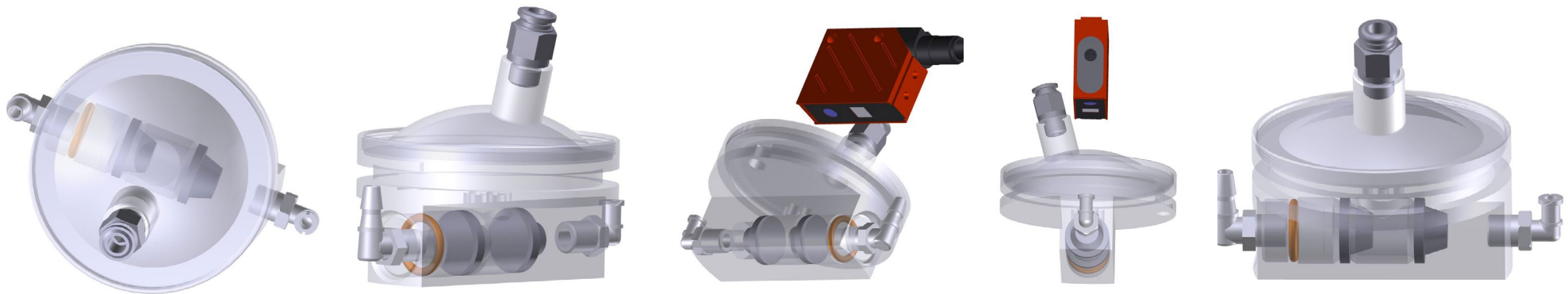


## Euterpe stand-alone pump cell's

Stand-alone product, model	Euterpe-30	Euterpe-100	Euterpe-300	Euterpe-500	Euterpe-10000
Layout, number of diaphragms	single	single	single	single	single
Cardiac Output, CO range, mL / min	0-750	0-2.000	0-3.500	0-6.000	0-10.000
SUP cell weight, grams	100	200	300	400	800

# The unique Single-Use-Pump – features of Euterpe

The here shown SUPs are all machined parts.  
In the process of being injection moulded parts.



- Euterpe SUP show on the Atropos Drive Unit display the conveyed mass-flow in real-time with 1 % accuracy
- No extra mass-flow sensor is needed
- Several fully programmable individual operating Single-Use-Pump cell's from Atropos Drive Unit
- Euterpe is self-priming and pump any mix of gas and liquid
- No tools required for exchange of pump cell
- Euterpe SUP do NOT require calibration
- Lifetime exceeds 1 million cycles at 75 % CO
- Communication with Atropos equipped with both Wi-Fi and LAN.

# The unique Single-Use-Pump – how to unpack Euterpe



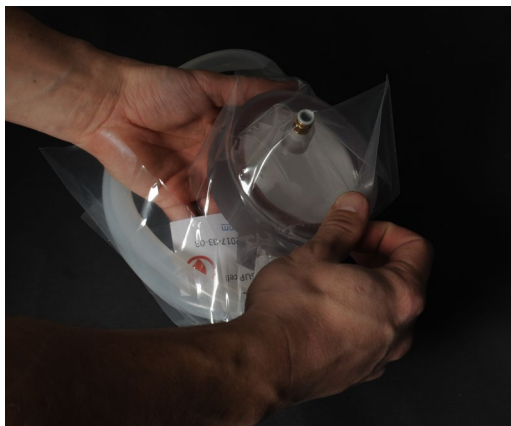
1



2



3



4



5

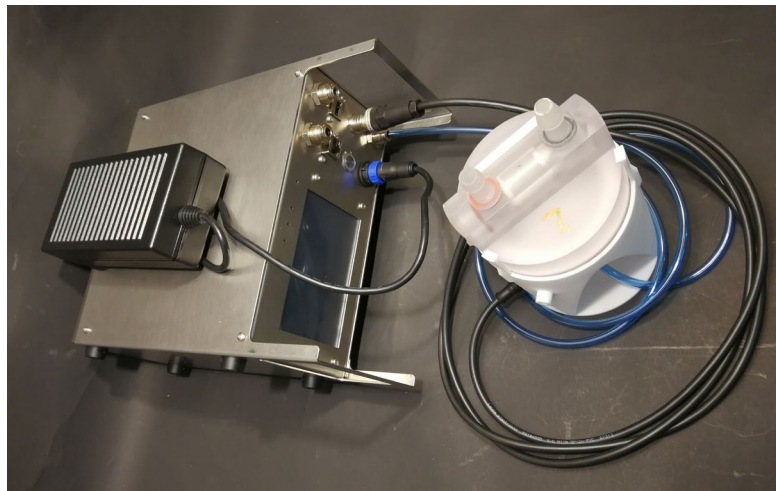
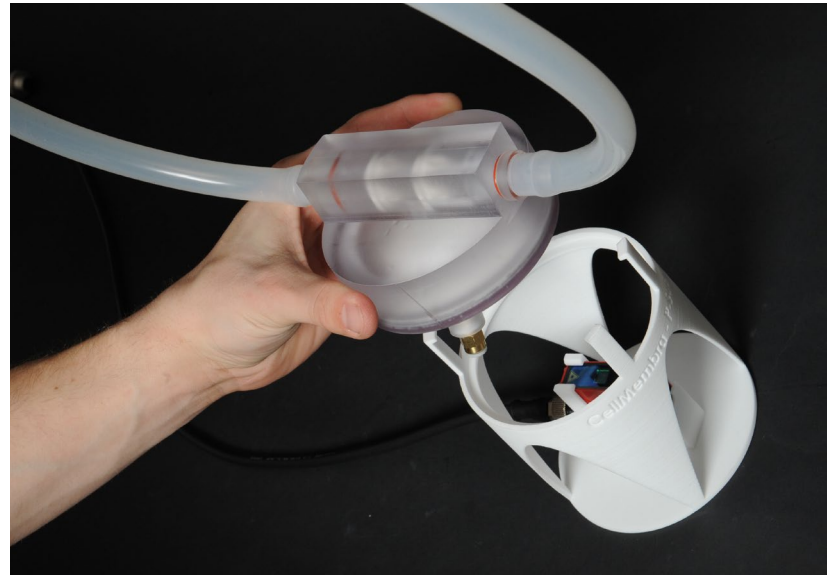


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# The unique Single-Use-Pump – how to install Euterpe

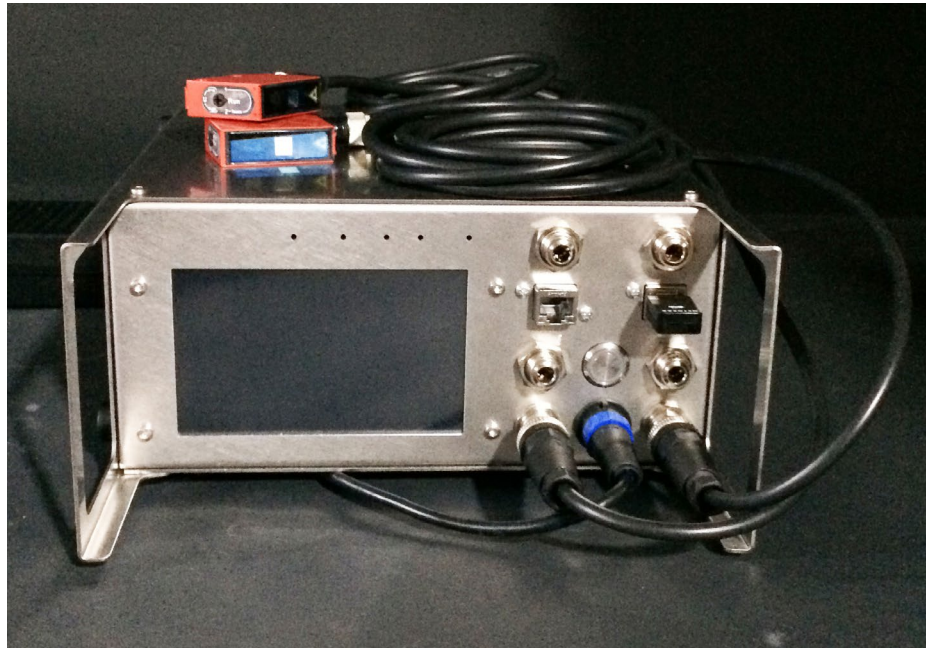
Euterpe could easily be part of a customized kit

- Euterpe-100 shown on all photos
- The shown white Laser-Foot is just one example of installation
- Euterpe operates in any position
- Only requirement is red Laser sensor positioned correct relative to the transparent dome
- Future plan is Laser foot integrated with the injection moulded dome
- The ultra compact Euterpe-100 has the weight of less than 200 grams





# The unique Single-Use-Pump hardware – the drive unit



The shown stack of 4 x Atropos-2 can drive as much as 8 x Euterpe in different size individually.

One ultra compact Atropos drive unit is only 5 liter in physical volume.



The portfolio of the Single-Use-Pump cell's are technically driven by the Apollon PLC and CODESYS software. Apollon is integrated into the very compact Atropos Drive Unit housed in the Hephaestus cabinets. One Atropos is able to drive remotely one or two Euterpe stand-alone pump cell's over distances up to 2 meter.

The re-useable red Laser sensor is a unique way of online measuring the position of the elastic diaphragm.



# The unique Single-Use-Pump – Atropos software

The most important principles behind the Drive Unit software

- Cardiac Output (CO) = total pumped volume, SUP capacity, ml/min  
(CO = BpM x SV) = depending on the specific Euterpe SUP specification
- Beats-per-Minute (BpM) = determined by the diaphragm diameter, ranging 0-25 BpM (larger decreasing)
- Stroke Volume (SV) = programmable from 10-100 % in 10 % steps.

Version A.63 Atropos-1

Year Month Day Hour Min. Sec. Time: 2017 6 29 9 36 9

Stroke length Percentage:	Cardiac Output:	Velocity calc: ID Tube	Configuration:
Percentage	0 ml/min	1.0 mm	Close

Automatic Pump control		Manual Pump control	
Run	Stop	Vacuumize	Pressurise

Configuration Time:  
Wanted: 2017 Y 6 M 29 D 9 h 30 m 45 s  
Set Time

Pump selection:  
Disabled   
Euterpe-30  
Euterpe-100  
Euterpe-300  
Euterpe-500

Pump Pressure:	Realtime-flow (filter 0.5s):	Repetitions per min:	
0.018 Bar	0.0 ml/min	0	
Sup. Pressure:	Average-flow:		
0.018 Bar	0.0 ml/min		
Vac. Pressure:	Total volume conveyed:	Total repetitions:	Total run time:
0.016 Bar	0.0 ml	0	0.0 min

Version A.64 Atropos-2

Year Month Day Hour Min. Sec. Time: 2017 7 27 9 36 19

Stroke length Percentage:	SP flow:	Velocity calc: ID Tube	Configuration:
Percentage	0 ml/min	1.0 mm	Close

Automatic Pump control		Manual Pump control	
Run	Stop	Vacuumize	Pressurise

Adjust Time:  
Wanted: 2017 Y 7 M 27 D 9 h 35 m 30 s  
Set Time

Pump selection:  
Disabled

Pump Pressure:	Realtime-flow (filter 0.5s):	Repetitions per min:	Last Harvest avg. velocity:
-0.009 Bar	0.0 ml/min	0	0.0 m/s
Sup. Pressure:	Average-flow:	Repetitions before cleaning:	Last Cleaning avg. velocity:
0.016 Bar	0.0 ml/min	999	0.0 m/s
Vac. Pressure:	Total volume moved:	Total repetitions:	Total run time:
0.009 Bar	0.0 ml	0	0.0 min

Version A.64 Atropos-2

Year Month Day Hour Min. Sec. Time: 2017 7 27 9 36 44

Stroke length Percentage:	SP flow:	Velocity calc: ID Tube	Configuration:
Percentage	0 ml/min	1.0 mm	Open

Automatic Pump control		Manual Pump control	
Run	Stop	Vacuumize	Pressurise

Pump Pressure:	Realtime-flow (filter 0.5s):	Repetitions per min:	Last Harvest avg. velocity:
-0.010 Bar	0.0 ml/min	0	0.0 m/s
Sup. Pressure:	Average-flow:	Repetitions before cleaning:	Last Cleaning avg. velocity:
0.016 Bar	0.0 ml/min	999	0.0 m/s
Vac. Pressure:	Total volume moved:	Total repetitions:	Total run time:
0.010 Bar	0.0 ml	0	0.0 min

Version A.64 Atropos-2

Year Month Day Hour Min. Sec. Time: 2017 7 27 10 19 45

Go to left side

Pump Pressure:	Total run time:
-0.002 Bar	0.0 min
Sup. Pressure:	Total repetitions:
-0.001 Bar	0
Vac. Pressure:	Total volume moved:
0.016 Bar	0.0 ml

Go to right side

Pump Pressure:	Total run time:
-0.003 Bar	0.0 min
Sup. Pressure:	Total repetitions:
-0.001 Bar	0
Vac. Pressure:	Total volume moved:
0.016 Bar	0.0 ml

# Example of use

## Perfusion SUB integrating the Single-Use-Pump

Miniature SUB for 100 cells mio/ml through perfusion cultivation in a fully single-use setup

The CellMembra-mini integrates a customized CellVessel Single-Use-Bioreactor (SUB) with the customized Single-Use-Pump (SUP), the CFF (Cross-Flow-Filter), and Single-Use-Sensor's. CellMembra is available from [www.perfusecell.com](http://www.perfusecell.com) where the SUP is named Clio and the Drive Unit is named Clotho.

### Features of CellMembra-mini

- CellMembra Single-Use-Bioreactor designed for operation in various parallel applications and demanding setup
- Supplied with Single-Use-Sensor (SUS), DO, pH, bio-mass
- Pumped volume and obtained velocity accurately measured by Clio and Drive Unit Clotho – no guessing
- The complete and pre-assembled unit packed in dual film bags and precision irradiated – forget the autoclave
- Working Volume (WV) range from 100 ml to 300 ml.



**World  
smallest  
perfusion  
SUB**



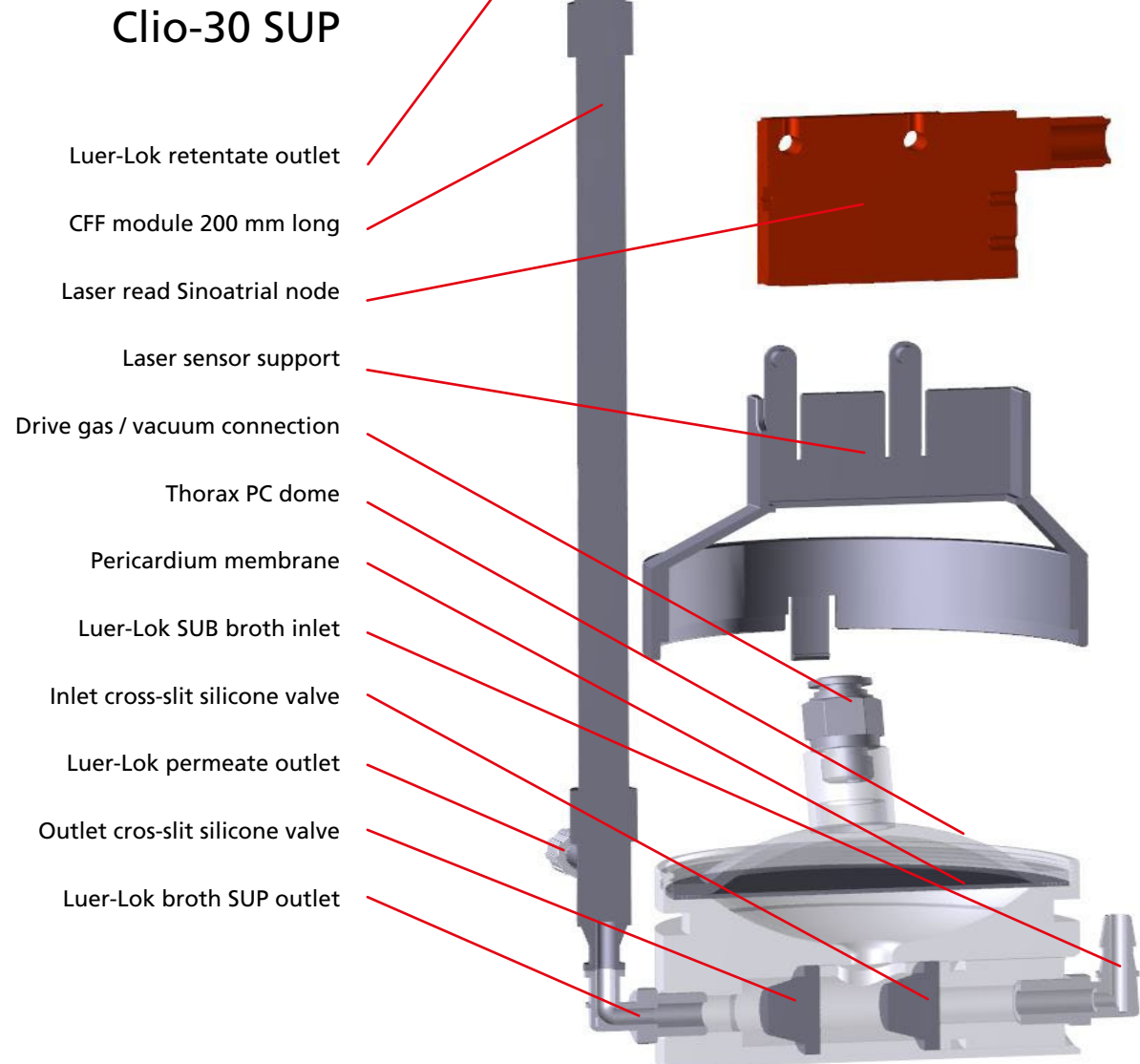
# Single-Use-Pump for perfusion offer **accurate measurement of both volume and velocity**

The SUP is arranged inside a Polycarbonate housing mounted either on desk top or integrated with the SUB.

The 1,0 mm thick elastic silicone Pericardium diaphragm separates drive gas pressure or vacuum from the broth.

The red tri-angular Laser sensor read the membrane position with 0,1 mm accuracy at any time. Pressure sensor's inside Clotho Drive Unit measures online the actual drive gas pressure. The Clotho PLC control via PWM signals proportional drive gas valves and hereby in PID loop the desired diaphragm position.

Clio can easily be programmed to convey fluid in 1:2.000 range over time. Clio is a true Positive Displacement (PD) pump where every stroke is measured accurately independent of the ever dynamic back pressure.

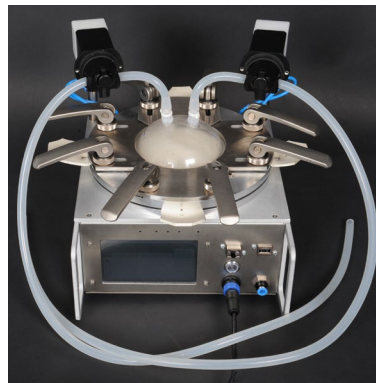


All about  
the stand-alone  
Euterpe SUP



Now to

**The integrated  
Erato SUP**

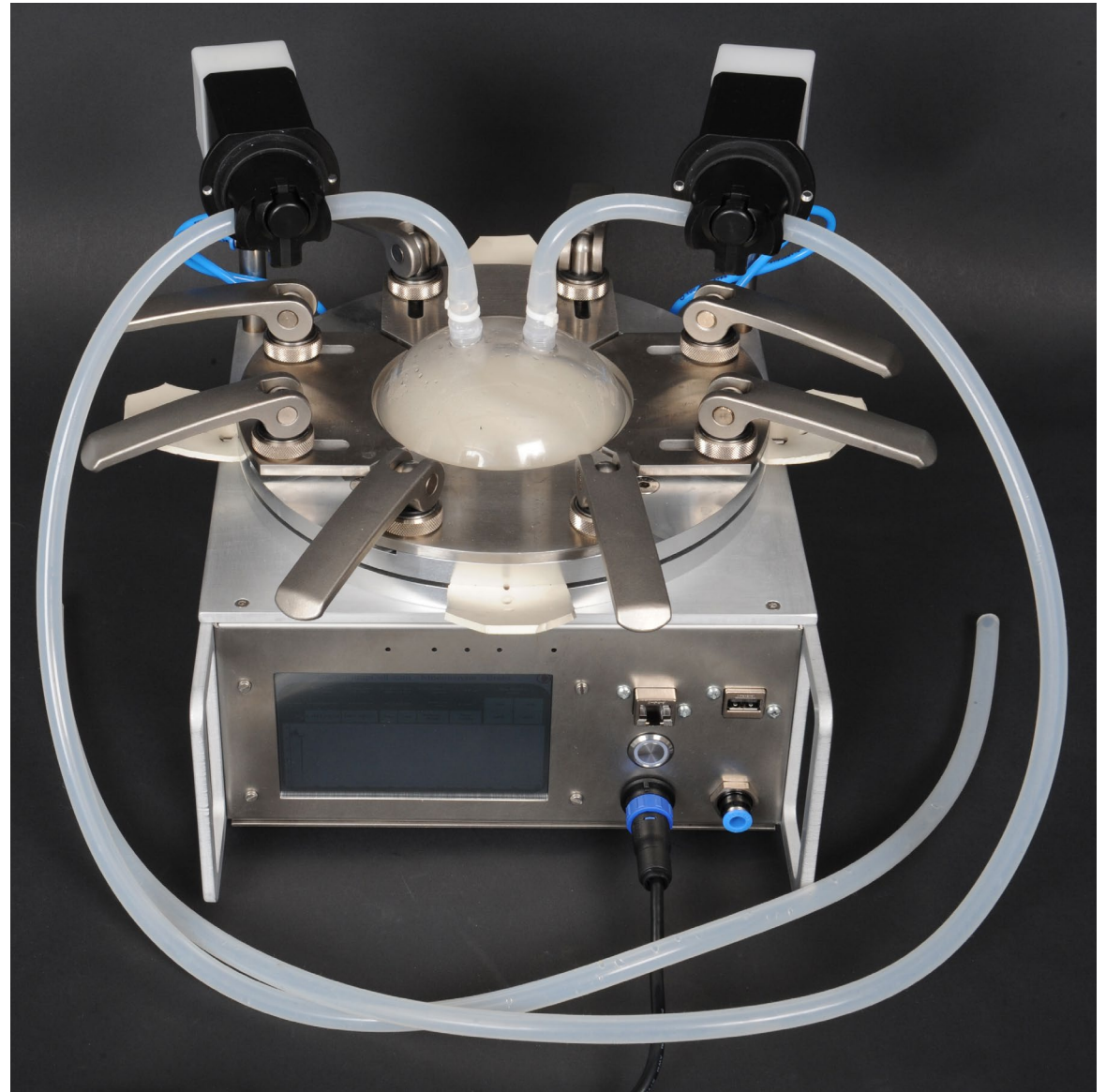


# Integrated Single-Use-Pump – Erato

Erato integrates both the SUP cell(s) and the Drive Unit in the same cabinet

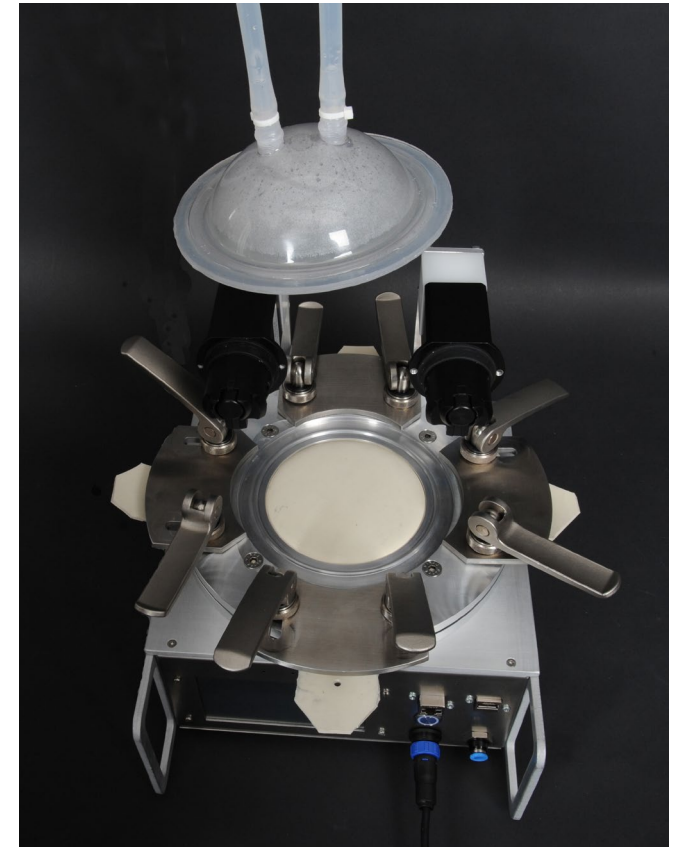
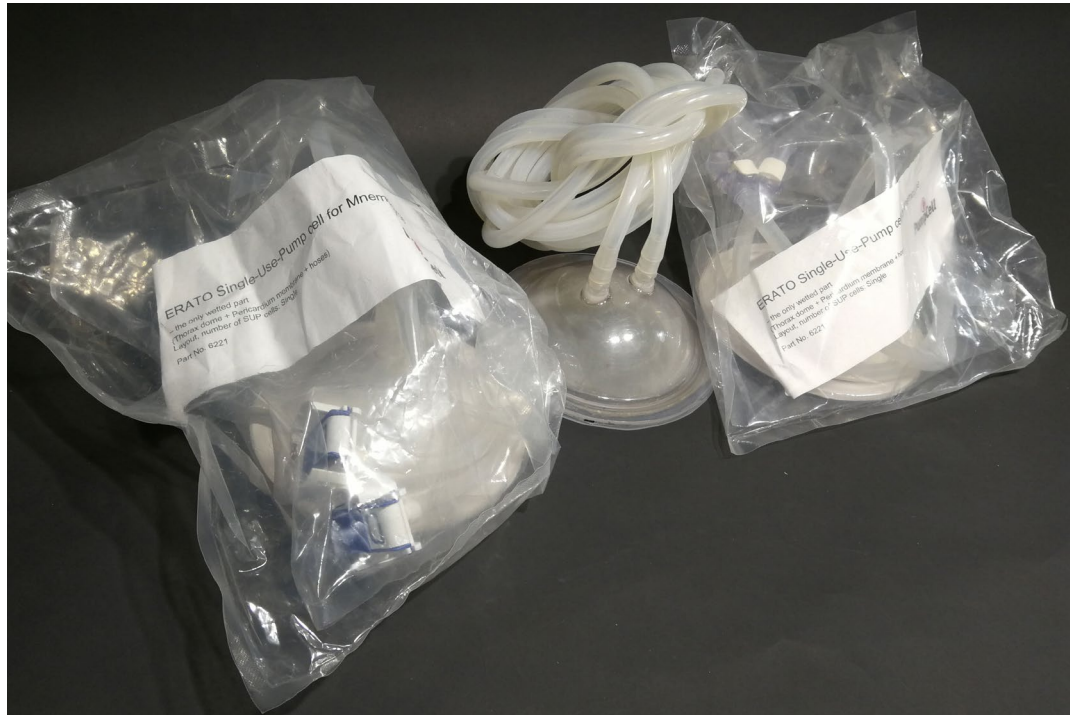
This setup offer durable SUP cell's of very low cost

- One or two individual operating SUP cell's in the same housing (one shown)
- Select freely volume, select stroke length for individual pump cell operation
- Up to 5 bar fluid pressure via controlled external pinch valves
- True fluid metering design, display in real-time the conveyed mass-flow with 1 % accuracy
- NO calibration needed
- 100 % programmable via build-in touch sensitive 5" display or Pad, Smartphone, PC
- Each SUP cell (Thorax dome + Pericardium diaphragm + hoses) is inserted into an encapsulating housing on top of the Hephaestus cabinet
- NO tools required to exchange pump cell.



# Erato Single-Use-Pump the cheapest and only high precision pump on the market!

Require only pressurized air for operation  
Erato pump from 0 to 3.000 ml/min



# Our hope is ...

This presentation gives you an idea about PumpCell's potential – at present in small scale production

That your requirement includes a customized SUP designed by PumpCell for your “pre-assembled single-use-system”

Our portfolio and outstanding technology intrigue you to dig one step further on our website

You find our Single-Use-Pump's push performance and price far beyond any pumps on the marked.





Thank you for your attention  
Much more info to be found on

[www.PumpCell.com](http://www.PumpCell.com)

