

RayDrop Platform

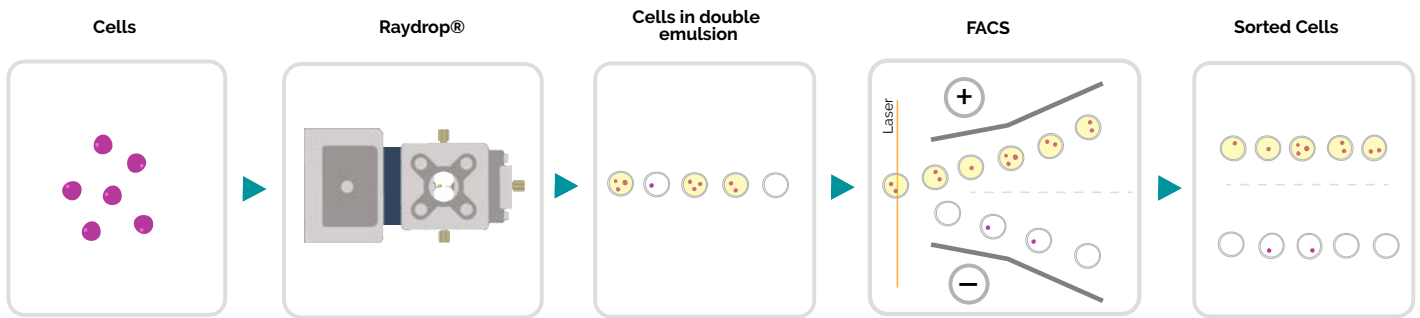
For cell encapsulation adapted to Fluorescence-Activated Cell Sorting (FACS)



Are you looking to use your FACS equipment with encapsulated cells ?

The RayDrop Platform for cell encapsulation prior to sorting in FACS equipment (Fluorescence-Activated Cell Sorting) is a specific version of the RayDrop Platform that enables biological products to be encapsulated in double emulsions (DE) made up of a thin shell of oil surrounding an aqueous core. This one step method of encapsulation is made compatible with FACS thanks to both the size of the DE down to 25 μm which fits most FACS nozzles and the use of a water/oil/water DE that is compatible with sorting based on the application of an electric field.

Moreover, this RayDrop Platform includes a comprehensive flow path with pressure controllers, filters, flowmeters, and valves to ease the start-up, shutdown and cleaning of the system. An injection loop is connected to the core phase to produce samples with limited amounts of material. Thanks to the RayDrop[®] droplet generator, double emulsions are produced in one step at high-throughput, allowing the production of about 25 samples in a half day. A suitable optical system guarantees the optimum visualization of the emulsion production process inside the RayDrop[®]. The open design of the platform allows its adaptation to the customer's needs.



RayDrop Platform

One step encapsulation of the cargo (yeast, bacteria, Human Peripheral Blood Mononuclear Cells, ...) of your choice in a water in oil in water double emulsion.

FACS

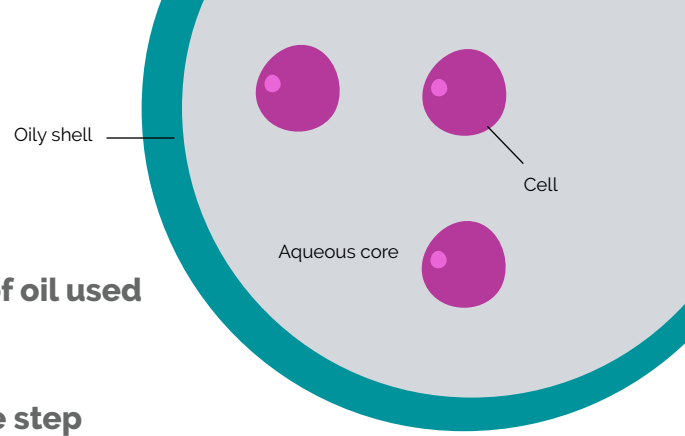
Analysis and sorting of cargo encapsulated in double emulsions, to isolate specific cell populations for further study or analysis.

Cell culture

After the sorting of cells, the growth of fluorescent cells can be used to analyze the production of a molecule of interest, or the expressions of a specific phenotype.

> Key benefits

- Double emulsion permits **to reduce the amount of oil used**
- Tunable size **compatible with FACS**
- Robust and highly monodisperse emulsions **in one step**
- **High throughput** (at least 5 000 droplets/second) allowing the production of 25 samples in 4h30 of **continuous production**
- **Quick and easy to setup**
- **Small amount of material engaged** thanks to the use of an injection loop

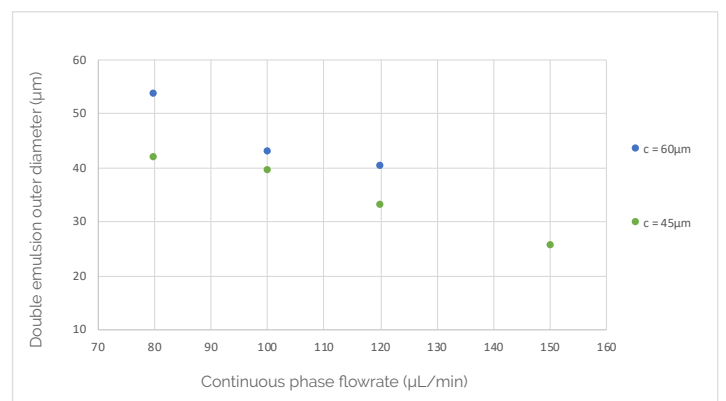
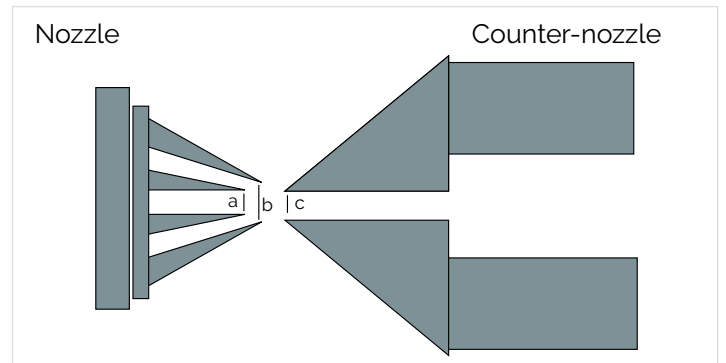


> The RayDrop® droplet generator

Moreover, this RayDrop Platform includes a comprehensive flow path with pressure controllers, filters, flowmeters, and valves to ease the start-up, shutdown and cleaning of the system. An injection loop is connected to the core phase to produce samples with limited amounts of material. Thanks to the RayDrop® double emulsion generator, the double emulsions produced are small enough for high-throughput screening and cell sorting.

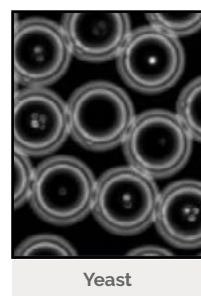
A suitable optical system guarantees the optimum visualization of the emulsion production process inside the RayDrop®. The open design of the platform allows its adaptation to the customer's needs.

Counter-nozzles with $c=45\ \mu\text{m}$ and $60\ \mu\text{m}$ are available. The smaller the counter-nozzle is, the smaller the produced double emulsion will be. By adjusting the continuous phase flowrate, double emulsions between $55\ \mu\text{m}$ and $40\ \mu\text{m}$ (resp. $40\ \mu\text{m}$ and $25\ \mu\text{m}$) can be obtained with the $60\ \mu\text{m}$ counter nozzle (resp. $45\ \mu\text{m}$).

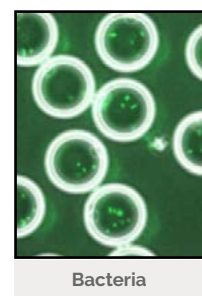


> Applications

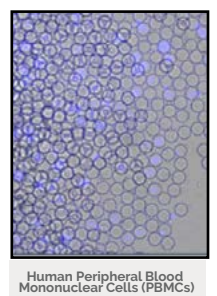
This platform has been applied to successfully encapsulate yeasts and bacteria. Human Peripheral Blood Mononuclear Cells (PBMCs) have already been encapsulated in oily shell/aqueous core double emulsions and analyzed thanks to fluorescence. It is also possible to encapsulate calibration particles for the initialization/calibration of your flow cytometer.



Yeast



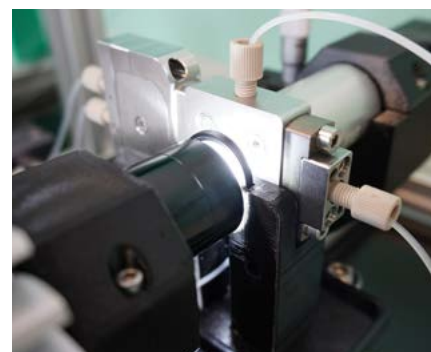
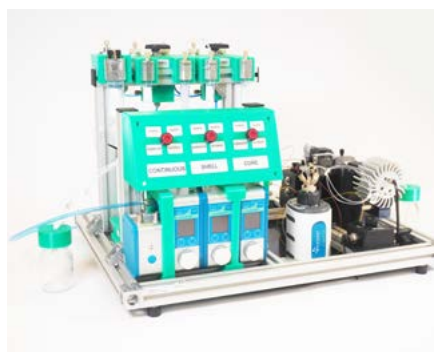
Bacteria



Human Peripheral Blood Mononuclear Cells (PBMCs)

> Formulation details

Category	Description															
Particle size* (outer diameter of the double emulsion)	<table border="1"> <tr> <td>Counter-nozzle size</td> <td>60µm</td> <td>45µm</td> </tr> <tr> <td>Range of size</td> <td>55 µm-40 µm</td> <td>40 µm-25 µm</td> </tr> </table> <p>*for water in HFE 7500 in water</p>	Counter-nozzle size	60µm	45µm	Range of size	55 µm-40 µm	40 µm-25 µm									
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Examples of formulations (water in oil in water)	<table border="1"> <thead> <tr> <th></th> <th>Continuous phase</th> <th>Shell phase</th> <th>Core phase</th> <th>Injected core</th> </tr> </thead> <tbody> <tr> <td>Example 1</td> <td>Filtered water + 1% Tween® 20</td> <td>dSurf (HFE7500 + 2% biocompatible surfactant)</td> <td>Filtered water</td> <td>PBS with cargo</td> </tr> <tr> <td>Example 2</td> <td>Filtered Mowiol® 4-88</td> <td>Filtered RAN Biotech solution (FC40 with 2% FluoroSurfactant)</td> <td>Filtered water</td> <td>PBS with cargo</td> </tr> </tbody> </table>		Continuous phase	Shell phase	Core phase	Injected core	Example 1	Filtered water + 1% Tween® 20	dSurf (HFE7500 + 2% biocompatible surfactant)	Filtered water	PBS with cargo	Example 2	Filtered Mowiol® 4-88	Filtered RAN Biotech solution (FC40 with 2% FluoroSurfactant)	Filtered water	PBS with cargo
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Biological material already tested*	<p>Yeast:</p> <ul style="list-style-type: none"> Yeast strain <i>S. Cerevisiae</i> CEN.PK 113-7D (In collaboration with TU Delft) <p>Bacteria:</p> <ul style="list-style-type: none"> Bacterial strain <i>L. cremoris</i> MG1363_GFP (In collaboration with TU Delft) <i>E. coli</i> strain expressing GFP (In collaboration with of Toulouse White Biotechnology) <p>Cells:</p> <ul style="list-style-type: none"> Human Peripheral Blood Mononuclear Cells (PBMCs) (In collaboration with ETH Zürich) <p>Calibration Beads:</p> <ul style="list-style-type: none"> Calibration particles of 2 and 3 µm in size <p>*For more information, see the application notes on our website</p>															
Screening throughput	Up to 25 samples in 4h30 of continuous production															
Droplet generation frequency	From 5 kHz up to 35 kHz, depending on droplet size															



> Technical specifications

Category	Description
Injection loop (from Fluigent)	<ul style="list-style-type: none"> • 6-port/2-position bidirectional recirculation valve • Easy to sterilize with ethanol (injection loop and each tubing in contact with the cargo)
Working volumes of cell solution	<ul style="list-style-type: none"> • Various sample loops available: 50 µL, 100 µL, 200 µL, 500 µL, 1 mL
Fluid handling system (from Fluigent)	<ul style="list-style-type: none"> • Pressure based pumps (Flow EZ 7 bar) • Injection loop on the core phase
Reservoirs	<ul style="list-style-type: none"> • Continuous phase: 1*50mL Falcon tube • Shell Phase: 2*15 mL Falcon tube • Core Phase: 2*15 mL Falcon tube
Flow meters (from Fluigent)	<ul style="list-style-type: none"> • Continuous phase: 1*Flow unit L (max 1100 µL/min in water calibration) • Shell Phase: 1* Flow unit M (max 200 µL/min in HFE calibration) • Core Phase: 1* Flow unit M (max 120 µL/min in water calibration)
Optical system	<ul style="list-style-type: none"> • LED light source • Microscope objective (10X and 5X available) • USB3 colour camera (up to 400 fps, 1 µs integration time) • XYZ translation stages
Tubing	<ul style="list-style-type: none"> • OD :1/16 and 1/32 OD • ID: 125 µm, 180 µm, 250 µm & 500 µm • Materials: PFA, PEEK
Filters	<ul style="list-style-type: none"> • 2 µm filter for all phases
Valves	<ul style="list-style-type: none"> • 3*4 way manual valves • 2*2 way manual valves
Wetted materials	<ul style="list-style-type: none"> • Platform: PEEK, PFA, PCTFE, PTFE, SS316L, Glass • Sealing: FFKM or EPDM
Unit dimensions	46 x 61 x 43 cm ³ (L x W x H)
Weight	<ul style="list-style-type: none"> • 14 kg without the protective hood • 22.2 kg with the protective hood

> Available application notes

- [Cell encapsulation in small double emulsions](#)
- [Bacteria and yeast encapsulation method in small double emulsions](#)
- [A quick and efficient double emulsion generation method for flow cytometry droplet sorting](#)