Project: SysmedPD
Status: Confidential

Basis:
Design rules

Specified by SJT last year by mail and phone (25/5/2018):

Height: 10-500µm, preferably 50-360 µm
Width: >25µm, preferably >100 µm
Length: unlimited, as long as it fits an efficient 384 well plate compatible layout.
Channel Aspect ratio (z:x): <1
Varying width: yes
Varying height: no (possible, but unpreferred for robust filling performance and optical quality)
Serpentine geometry: acceptable for in gel culture, but could be detrimental for tubular culture
Layout: preferably with inlets matching already existing designs
Iteration resolution: For the sake of these calculations, please regard a x,y,z resolution of 10 µm

As long as the design fits within a reasonable layout on a titerplate I would say the ease of changing the parameter, with the easiest on first, is: Length > Width > Varying width > Height

2.5D fabrication (stacked layers of different thickness, no overhang, no slopes)
Phaseguides at bottom, not top
1mm diameter inlets on 4.5mm grid
Min line width: 20µm
Channel aspect ratio >1:1

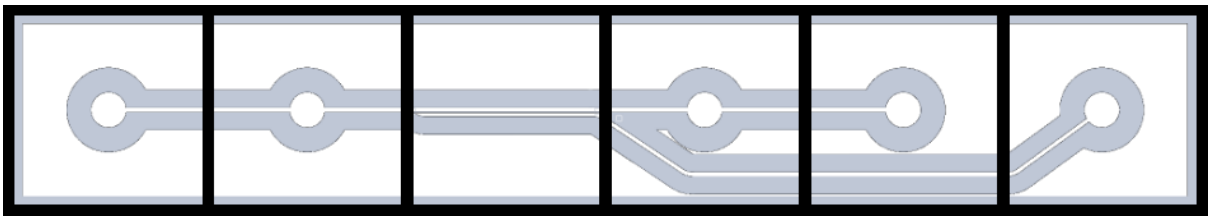
Target flow rate:
5.68mL/hr

Requested parameters based on computational modelling:
Lane width: 100µm
Lane height: 50µm
Double inlet and outlet wells to increase volume and increased media channel length to increase hydrodymanic resistance

Implementation:

The device with longer medium channel and larger medium capacity was implemented using Mimetas standard prototyping techniques. Standard titreplates, glass and other half fabricates where used.

Schematic suggestion from document microfluidicDesign_KK (20180613) was modified to ensure manufacturability and functionality resulting in the design below:



The adjacent wells on the medium in- and outlet are connected through a microfluidic channel.

Some key dimension are (w x h x l, in mm):

	Width	Height	Length	Volume ex inlets	Volume inc inlets.
Phaseguide:	0.025	0.014	4.2	n/a	n/a
Gel channel:	0.1	0.044	16.1	71nL	290nL
Perfusion channel* :	0.1	0.044	18	79nL	950nL

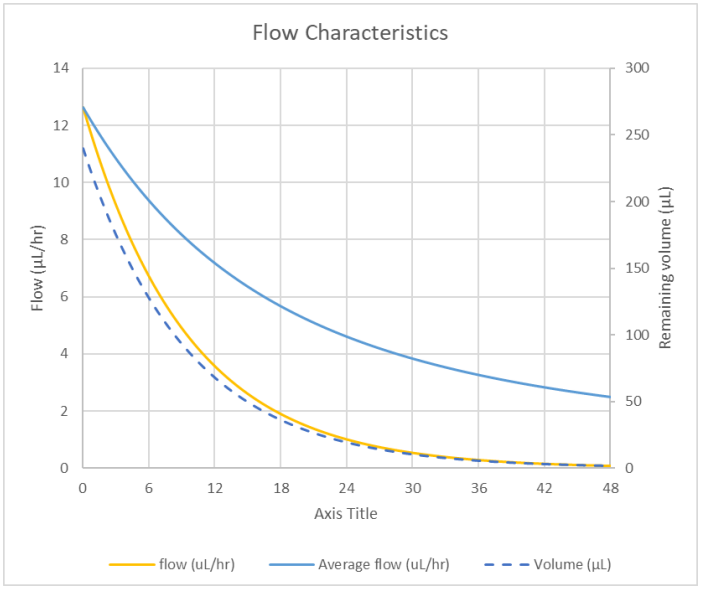
* Of which 3mm is underneath the inlets and would thus not significantly contribute to hydrodynamic resistance.

Expected performance

An approximation of the expected starting flow rate is: 12.6µL/hr based on standard flow calculation (https://www.dolomite-microfluidics.com/support/microfluidic-calculator/)

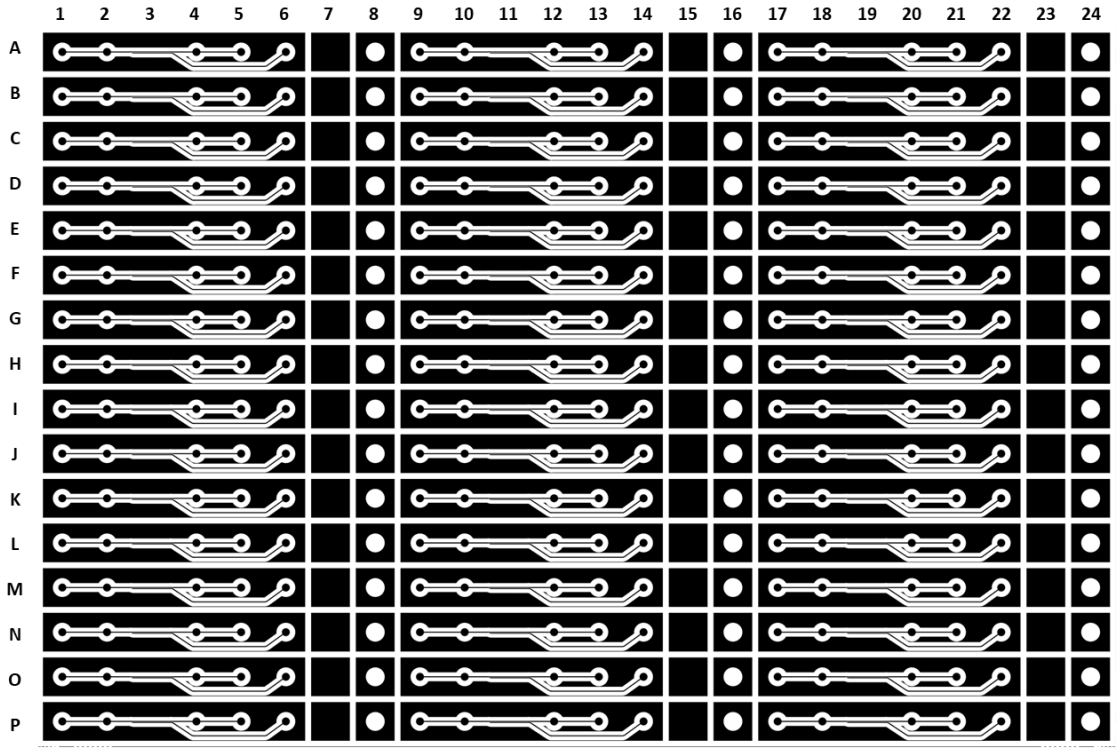
Results:		
Flow Rate:	0.210668	µL/min
Velocity:	0.000797985	m/s
Reynolds number:	0.0487657	Laminar Flow
Initial Conditions		
Channel geometry:	Rectangular	
Channel height:	44	µm
Channel width:	100	µm
Channel length:	15	mm
Fluid viscosity:	1	cP (Pa.s / 10^3)
Fluid density:	1	g/cm³ (kg/m³ × 10^3)
Pressure:	1	mbar

Assuming 240µL of medium equals approx. 1cm fluid column and 1mbar pressure simple integration of the flow rate and dropping liquid column over 24 hrs results in the flow characteristics below. Please note that this is probably an underestimation since medium in the inner two wells does not flow through the entire channel but only travels through 8 mm of channel with correspondingly reduced resistance.



Start Flow	12.6	µL/hr
End Flow	1.0	µL/hr
Average Flow	4.6	µL/hr
End Volume	19.1	µL

Plate Layout:



Instruction for use:

1. Add 50µL of PBS to well 3 to reduce evaporation
2. Add 0.5µL of ECM in well 6
    a. Note: The volume to used here should be determined by trial and error. Based on my experience with similar designs I would start at 0.5µL. As the majority of the ECM will remain on top of the inlet with such small channels, the required volume is very dependent on the droplet shape, which in its turn is very operator/pipette dependent. Please adjust the volume based on the filling performance, keeping in mind that the filling rate is related to the curvature of the droplet on the inlet, not the volume of the droplet.
    b. Note: I do not expect difficulties with filling as the reduced channel diameter will actually increase the capillary force. Extrapolating from the difference between our standard products 9603400B and 9603200B, this channel is simply one additional step in scaling down. As the 9603200B channel fills quicker in general use than the 9603400B plates, it is expected that this trend continues in this adaptation.
    c. Note: Our standard SOP is to keep the ECM on ice, but the plate at ambient temperature. I do not expect that this plate requires deviation from standard protocols as the only difference is the increased length and reduced cross-section of the channel. Increased capillarity should offset the increased length.
3. Incubate at 37°C
    a. Note: The reduced volume of gel makes it more prone to drying out. Ensure proper humidification of the environment, limit time with lid off, and keep gelation time as short as possible (e.g. 15 min)
4. Add 120µL medium to well 1
5. Check for proper filling of channel, tap plate on surface if needed before proceeding to next step
6. Add 120µL medium to well 2
7. Check for proper filling of channel, tap plate on surface if needed before proceeding to next step
8. Add 20µL medium to well 4
9. Check for proper filling of channel, tap plate on surface if needed before proceeding to next step
10. Add 20µL medium to well 5
11. Check for bubbles and tap plate on surface to dislodge them if needed