# Supporting information

## Formation and manipulation of ferrofluid droplets with magnetic fields in a microdevice: A numerical parametric study

Venoos Amiri Roodan[1], Jenifer Gómez-Pastora[2], Ioannis H. Karampelas[1], Cristina González-Fernández[3], Eugenio Bringas[3], Inmaculada Ortiz[3], Jeffrey J. Chalmers[2], Edward P. Furlani [1,4, †], Mark T. Swihart[1]

1. Department of Chemical and Biological Engineering, University at Buffalo, The State University of New York, Buffalo, NY, 14260, USA

2. William G. Lowrie Department of Chemical and Biomolecular Engineering, The Ohio State University, 315 Koffolt Laboratories, 151 West Woodruff Avenue, Columbus, OH, 43210, USA

3. Department of Chemical and Biomolecular Engineering, ETSIIT, University of Cantabria, Avda. Los Castros s/n, 39005 Santander, Spain

4. Department of Electrical Engineering, University at Buffalo, The State University of New York, Buffalo, NY, 14260, USA
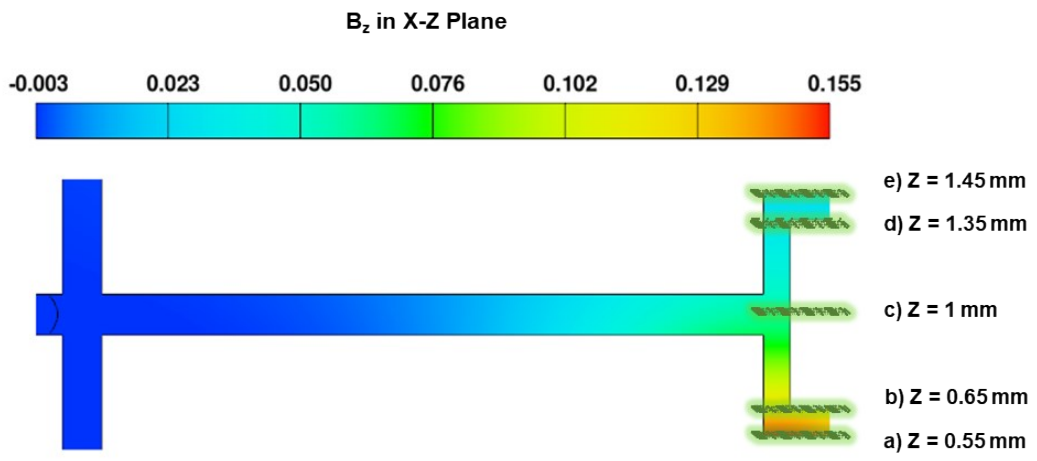
† Deceased

## Table of contents

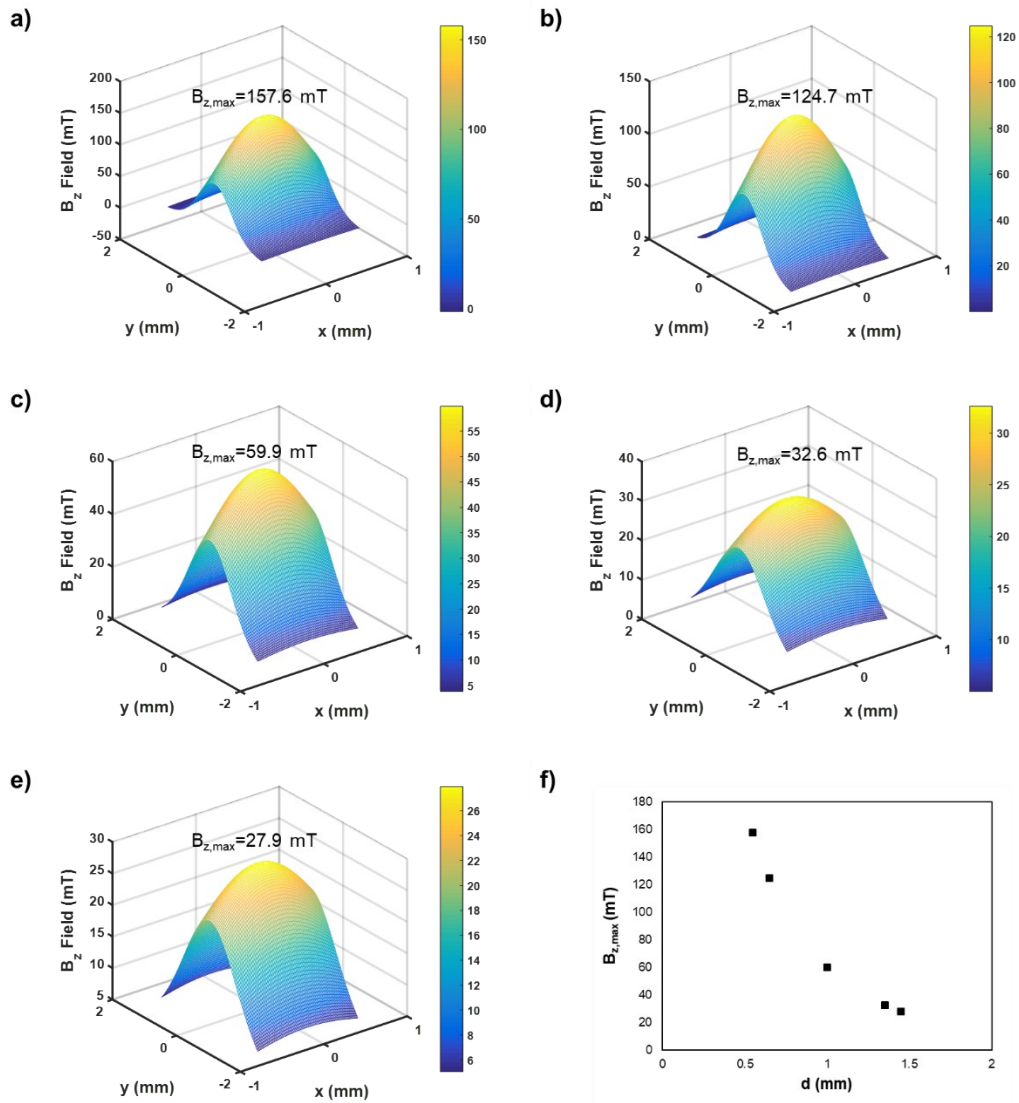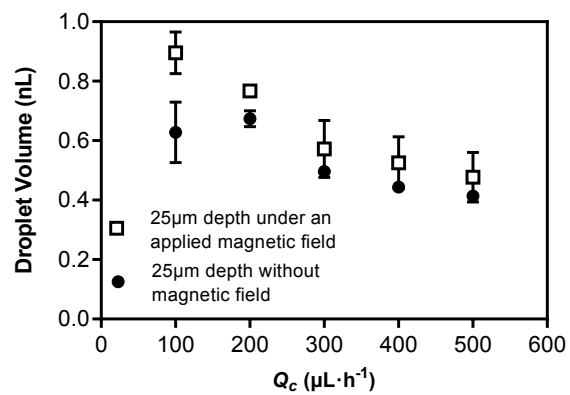**Fig. S1** Five arbitrary planes at the T-outlet

**Fig. S2** MATLAB calculation of the distribution of z-component of magnetic field for five arbitrary planes a) at z = 0.55 mm away from the magnet; b) at z = 0.65 mm; c) at z = 1 mm; d) at z = 1.35 mm; e) at z = 1.45 mm; and f) Bz,max with respect to distance

a)



b)



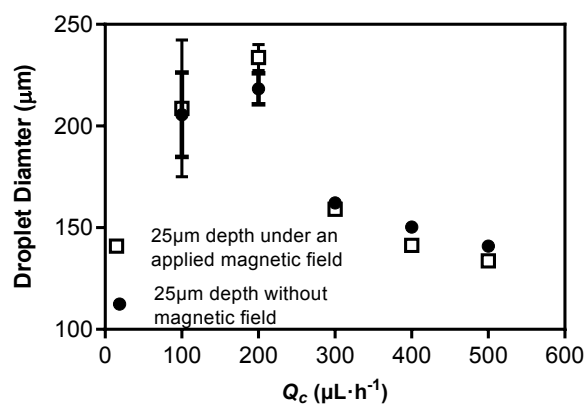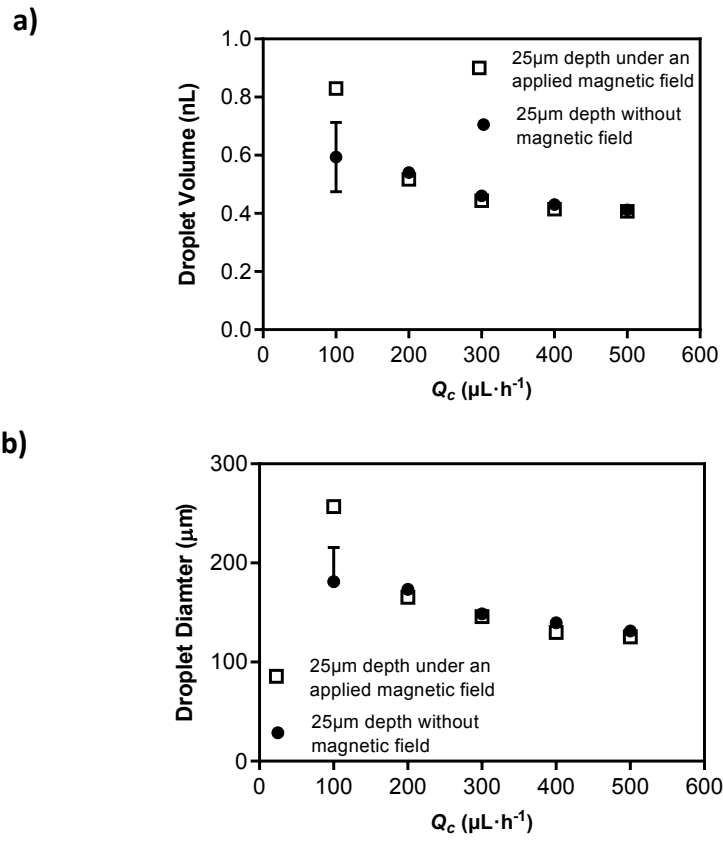**Fig. S3** Changes of volume and dimeter of 10% (v/v) ferrofluid for 25 μm depth a) volume b) diameter

a)



b)



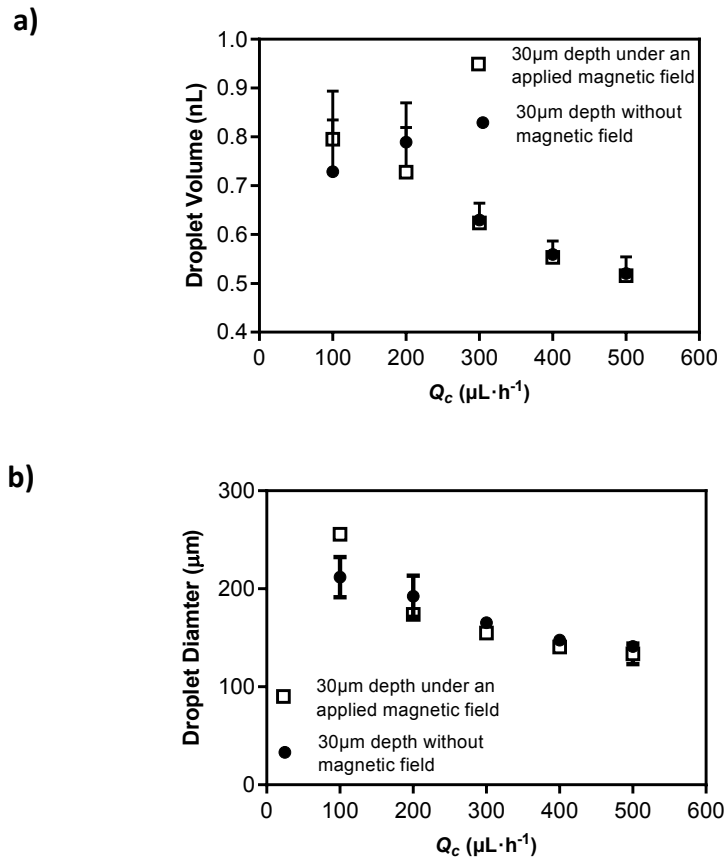**Fig. S4** Changes of volume and dimeter of 50% (v/v) ferrofluid for 25 μm depth a) volume b) diameter

**a)**



Legend:
- □ 30μm depth under an applied magnetic field
- ● 30μm depth without magnetic field

Y-axis: **Droplet Volume (nL)** (0.4 to 1.0)
X-axis: $Q_c$ (μL·h⁻¹) (0 to 600)

**b)**



Legend:
- □ 30μm depth under an applied magnetic field
- ● 30μm depth without magnetic field

Y-axis: **Droplet Diamter (μm)** (0 to 300)
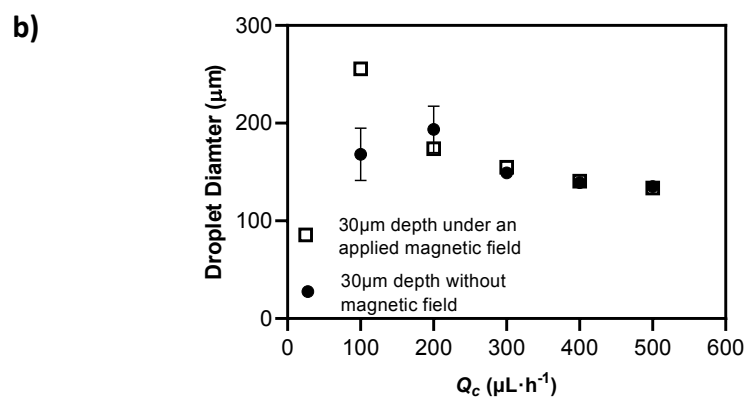X-axis: $Q_c$ (μL·h⁻¹) (0 to 600)

**Fig. S5** Changes of volume and dimeter of 10% (v/v) ferrofluid for 30 μm depth a) volume b) diameter

**a)**



**b)**



Fig. S6 Changes of volume and dimeter of 50% (v/v) ferrofluid for 30 μm depth a) volume b) diameter

a)

**Droplet Diamter (μm)**

400

300

200

100

0

□ 40μm depth under an applied magnetic field

● 40μm depth without magnet field

0    100   200   300   400   500   600

$Q_c$ (μL·h$^{-1}$)

b)

**Droplet Volume (nL)**

2.0

1.5

1.0

0.5

0.0

□ 40μm depth under an applied magnetic field

● 40μm depth without magnet field

0    100   200   300   400   500   600
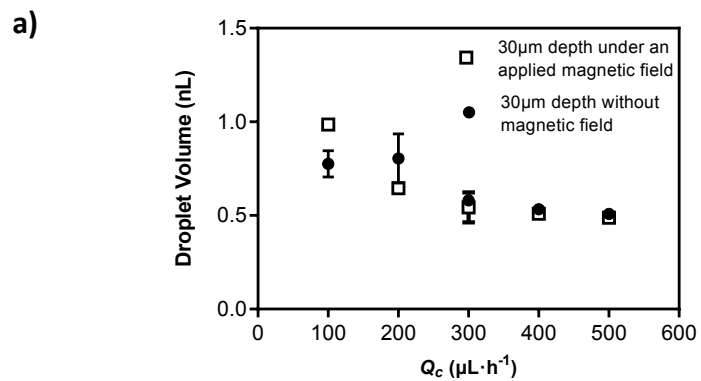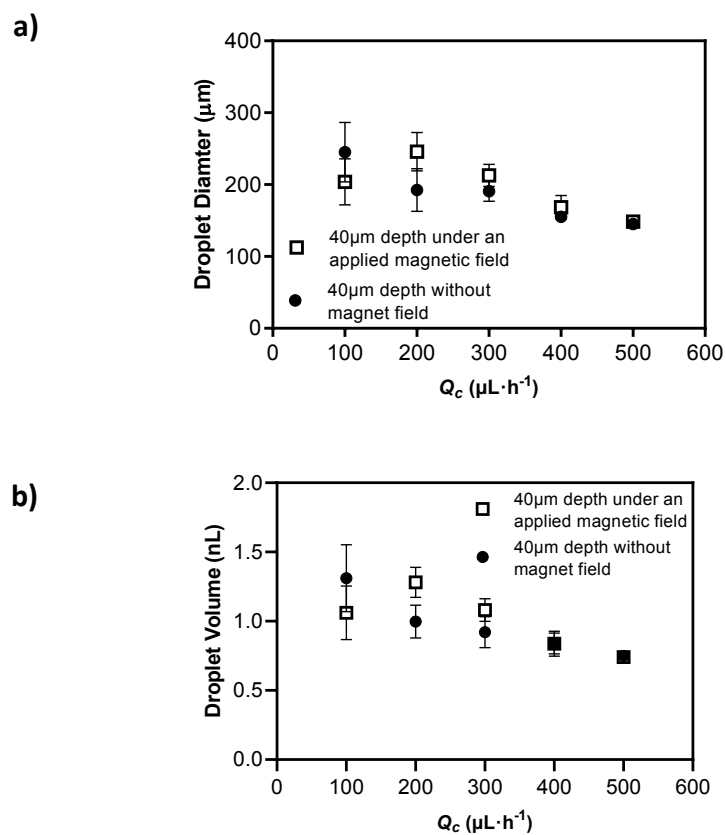
$Q_c$ (μL·h$^{-1}$)

**Fig. S7** Changes of volume and dimeter of 10% (v/v) ferrofluid for 40 μm depth a) volume b) diameter
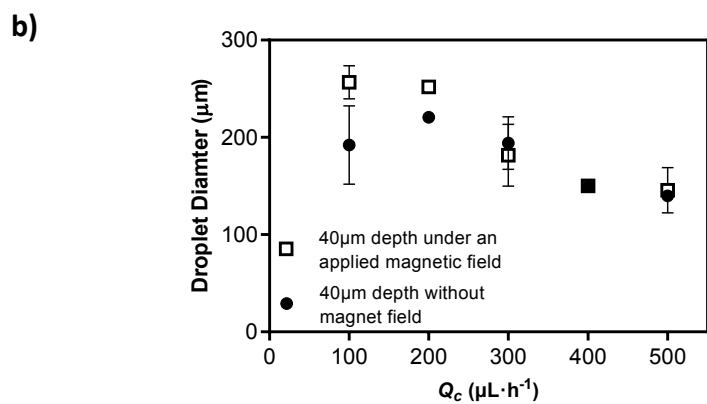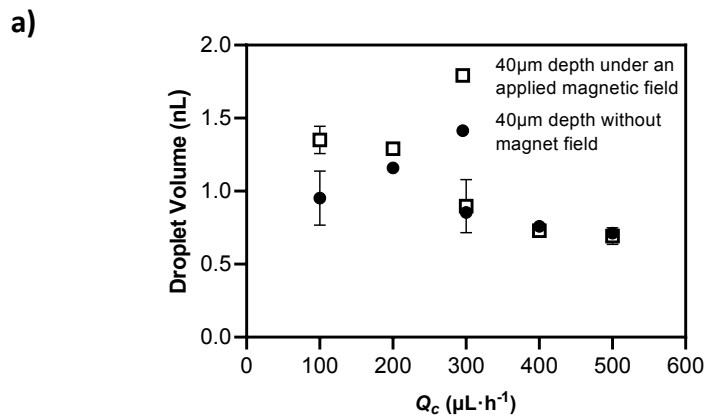
a)



b)



**Fig. S8** Changes of volume and dimeter of 50% (v/v) ferrofluid for 40 μm depth a) volume b) diameter
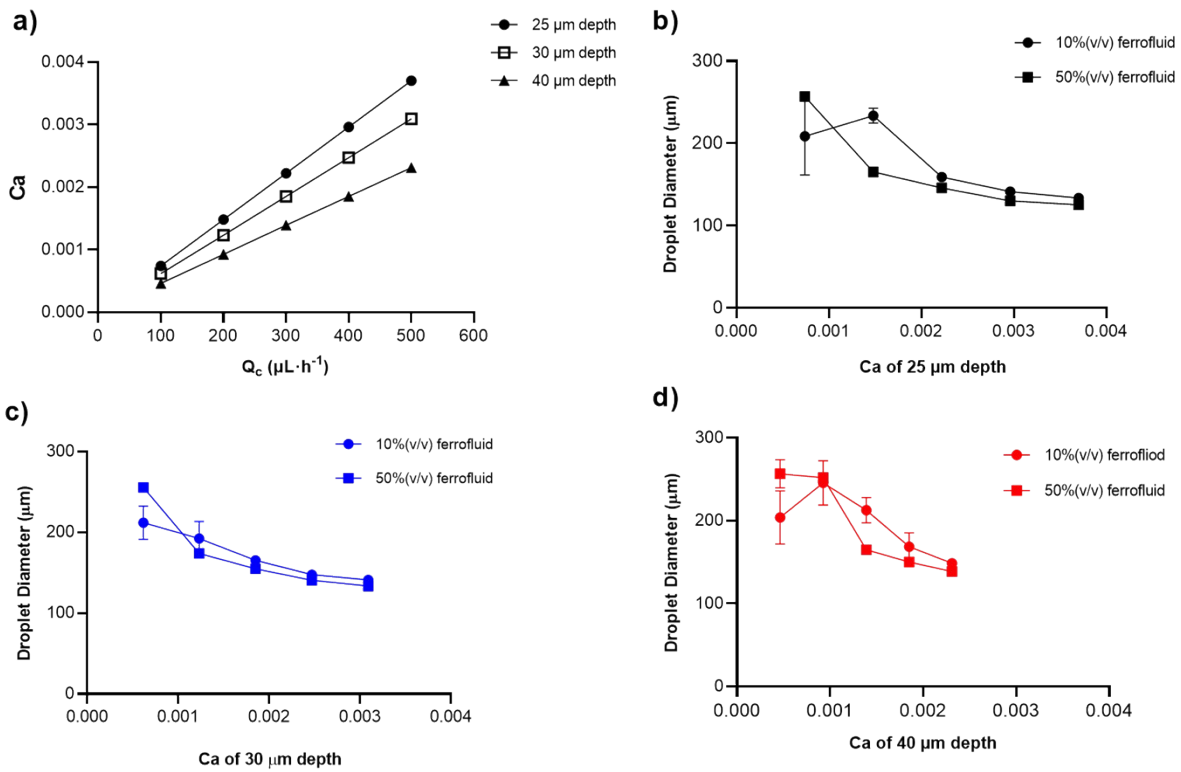
**Fig. S9** Droplet diameter after pinch off vs. capillary number ($Ca$) analysis. a) $Ca$ changes for three channel depths; b-d) droplet diameter vs. *Ca* for channel depths of b) 25 µm; c) 30 µm; and d) $Ca$ of 40 µm depth for 50% (v/v) under an applied magnetic field