PML | Plymouth Marine Laboratory

Marine Matters

Vortex bioreactors for DEWATS processing

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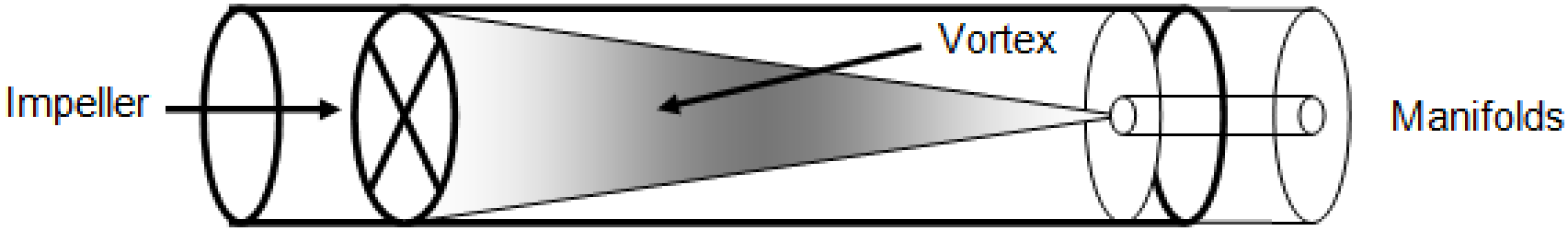
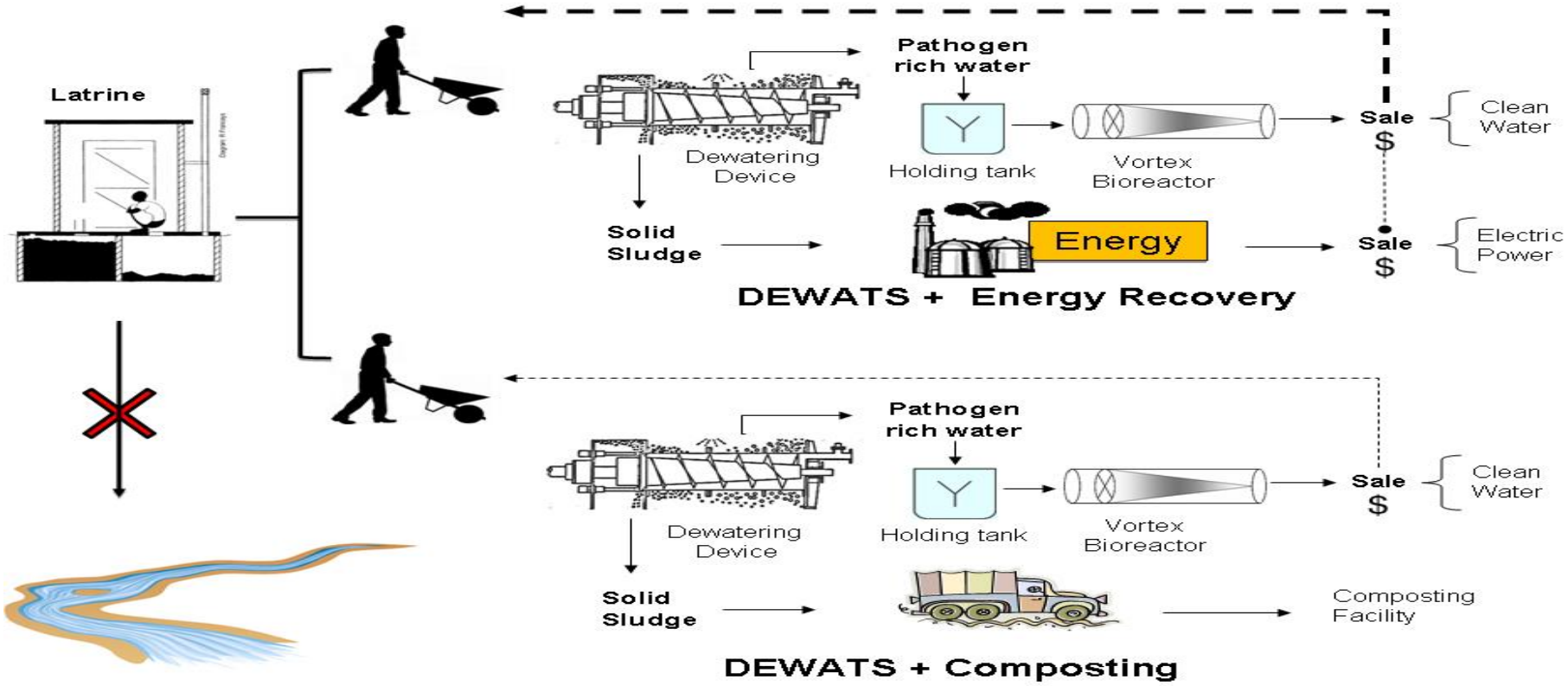
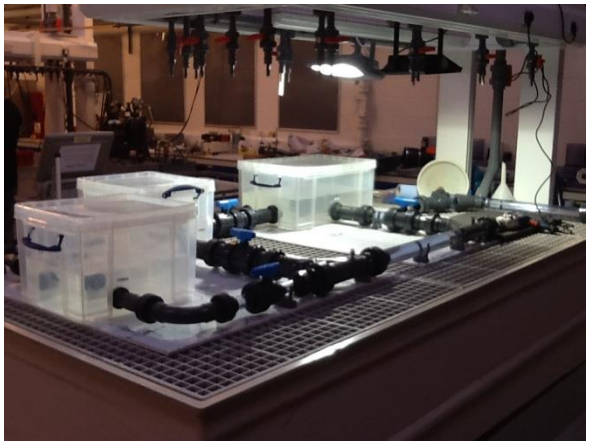
"Vortex bioreactors for the processing of fecal sludge and waste water"



"…..to develop a system which separates fecal matter from waste water and at the same time reduces the activity/viability of the pathogenic organisms in both fractions by continuous, *in situ* treatment with a low-cost formulation of biological and chemical agents".

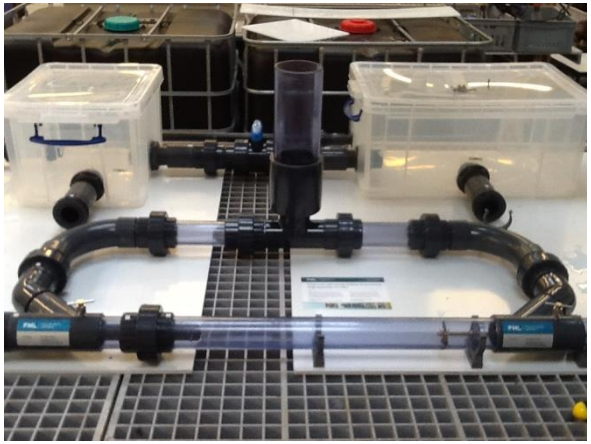
Slight change of emphasis…. focus on water sterilisation.



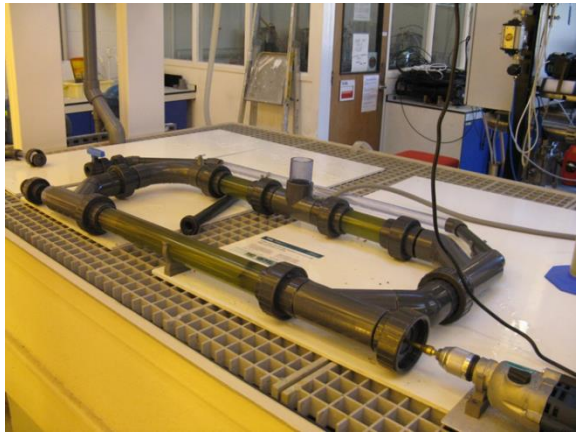


Small scale Voraxial SP2 (2 way liquid-liquid separation)

Larger scale Voraxial BD2 (3 way liquid-liquid-solid separation)



Small scale Voraxial SP3 (Closed loop design)



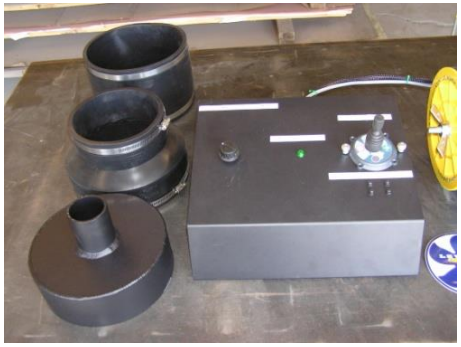
Small scale Voraxial SP2.2 in action

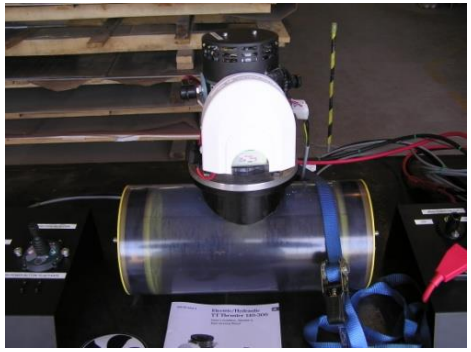
BD1

BD2.1

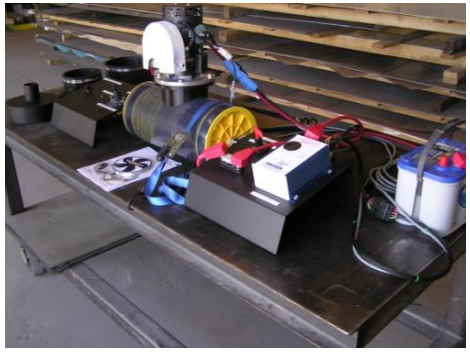
“BigDan” Prototypes

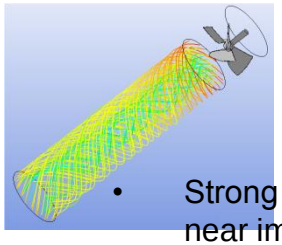
BD2.2

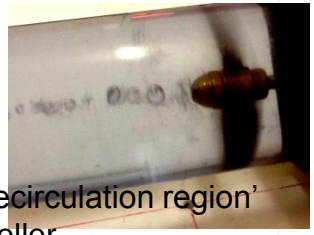


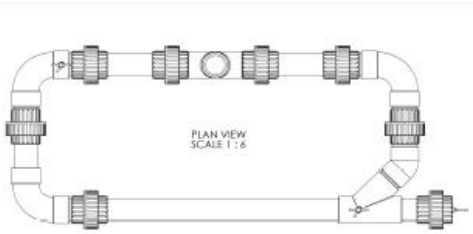


BD3.1





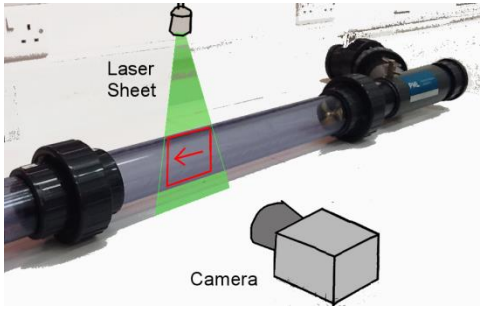




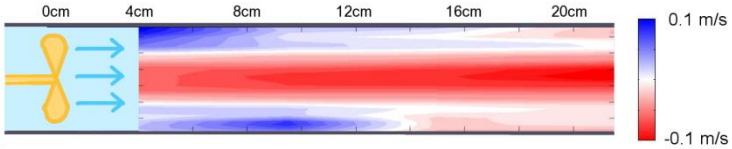
- Strong ‘recirculation region’ near impeller

Data generated in SP2-CL, ~8 litre volume

Flow Measurement (2C-PIV)

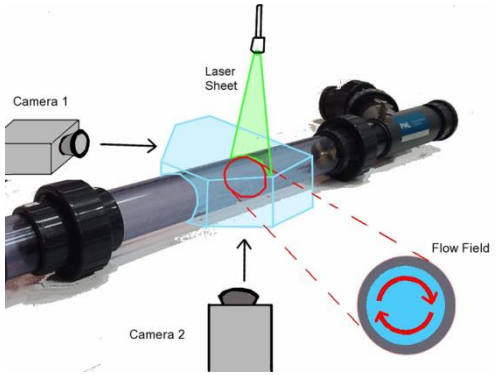


- 2-Component set-up
- Measures flow in direction of pipe
- Useful for validation of simulations

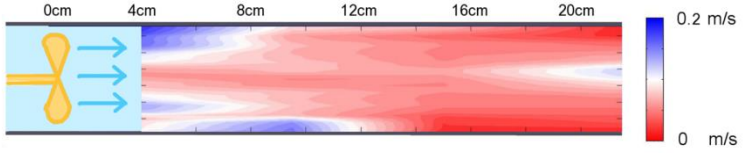


- Flow field shown for N = 716rpm
- Overall flow speeds in direction of the pipe are low (~10cm/s)
- Red regions indicate reversed flow
- Large swirling component

Flow Measurement (Stereo-PIV)



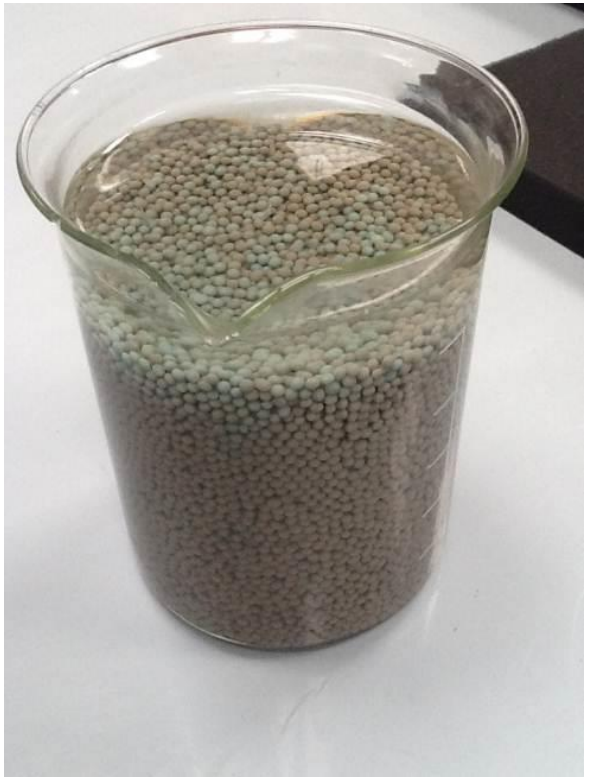
- 3-Component set-up
- Measures swirling flow in pipe
- Can be used to calculate separation forces



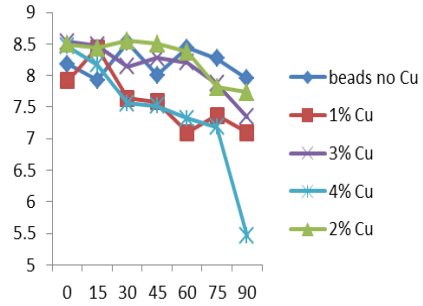
- Flow field is very turbulent
- Induces strong mixing

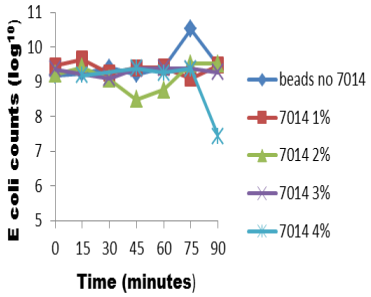
All beads have been Swiss made with precision engineering

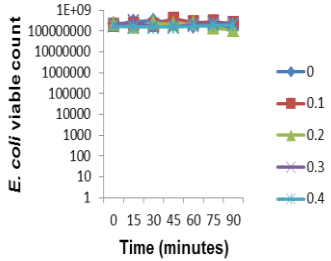
Coloured alginate beads used for visualising flow

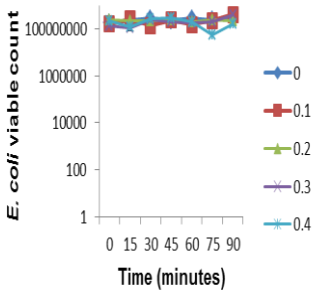


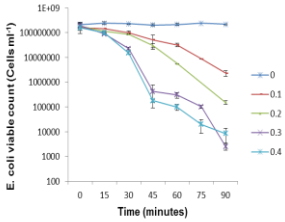
4% Copper Alginate beads

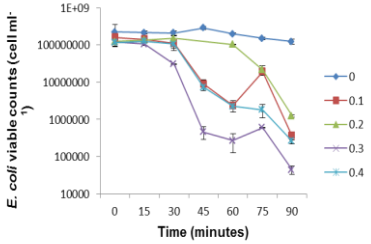


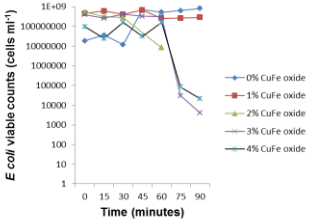






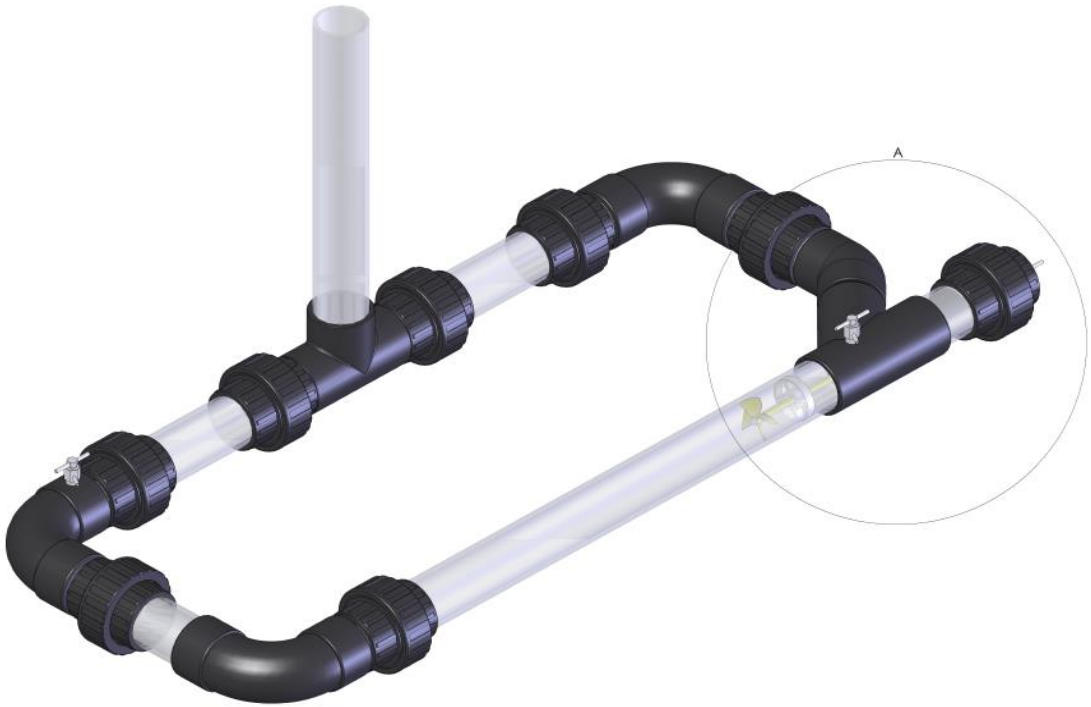


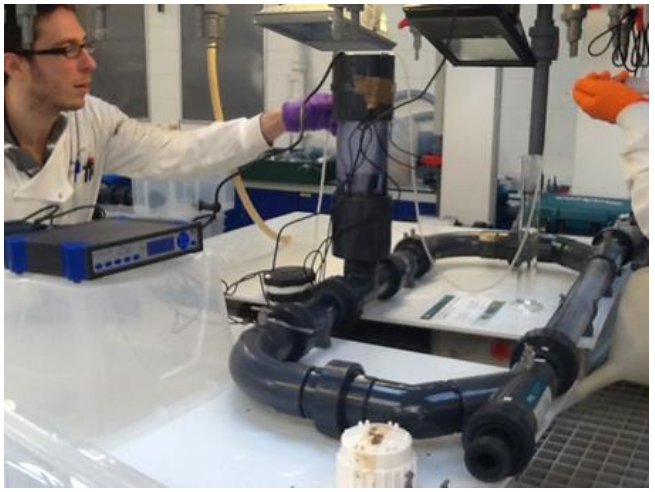




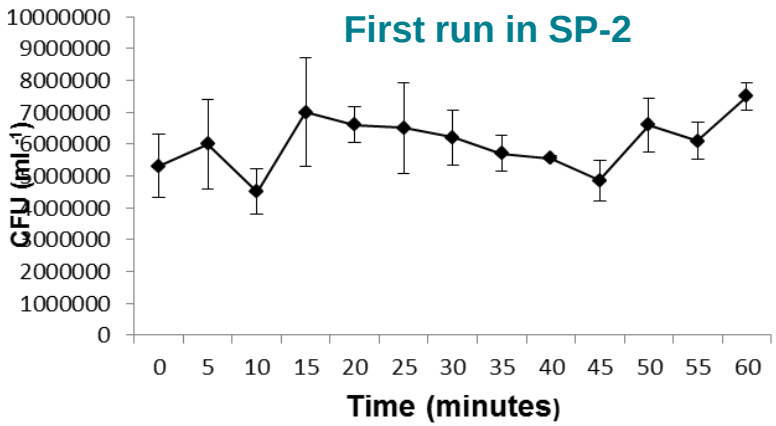
Shaking incubator flasks, ~100 ml

~4000 agar plates and >50,000 colony counts later…… ready to move into Vortex bioreactor



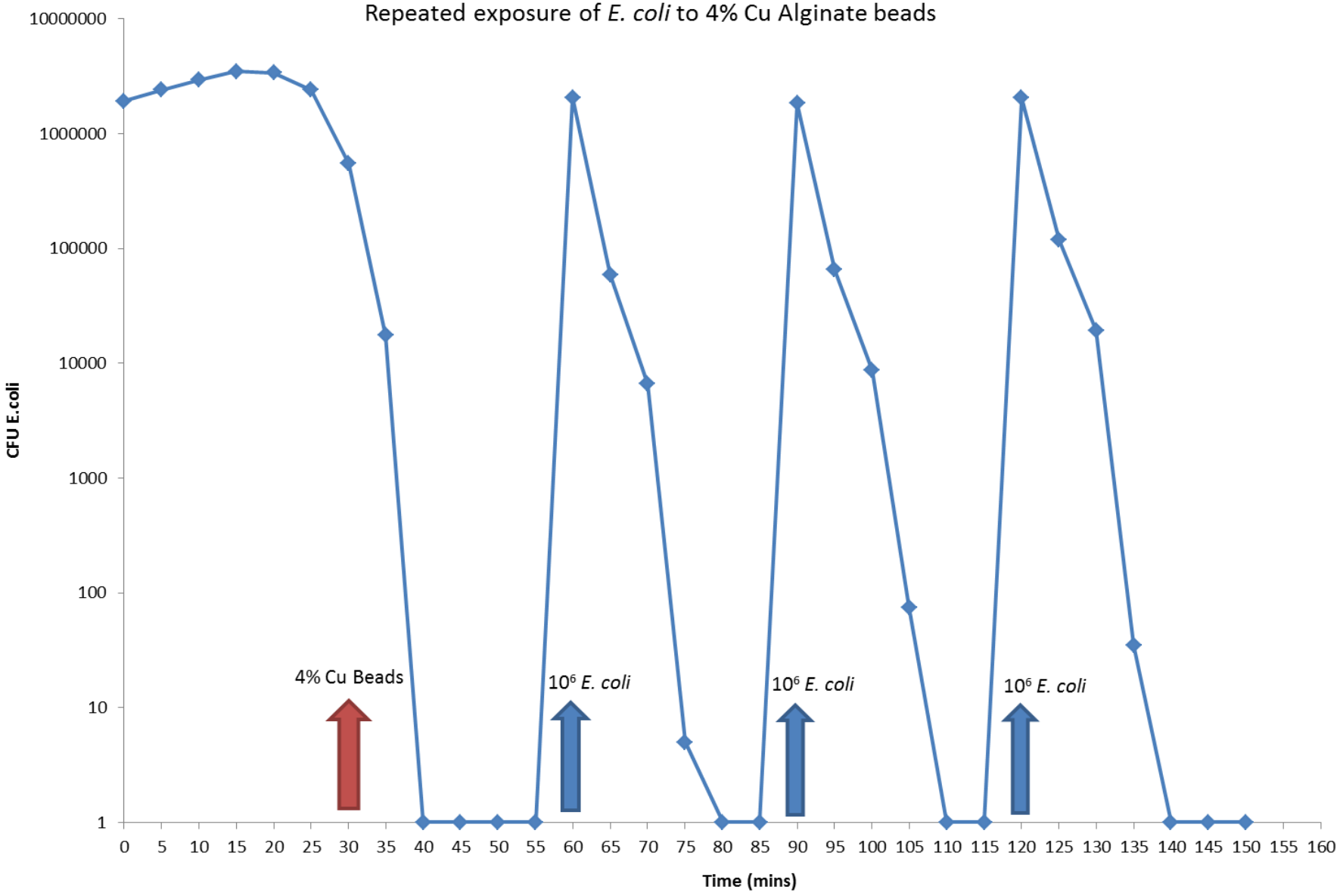


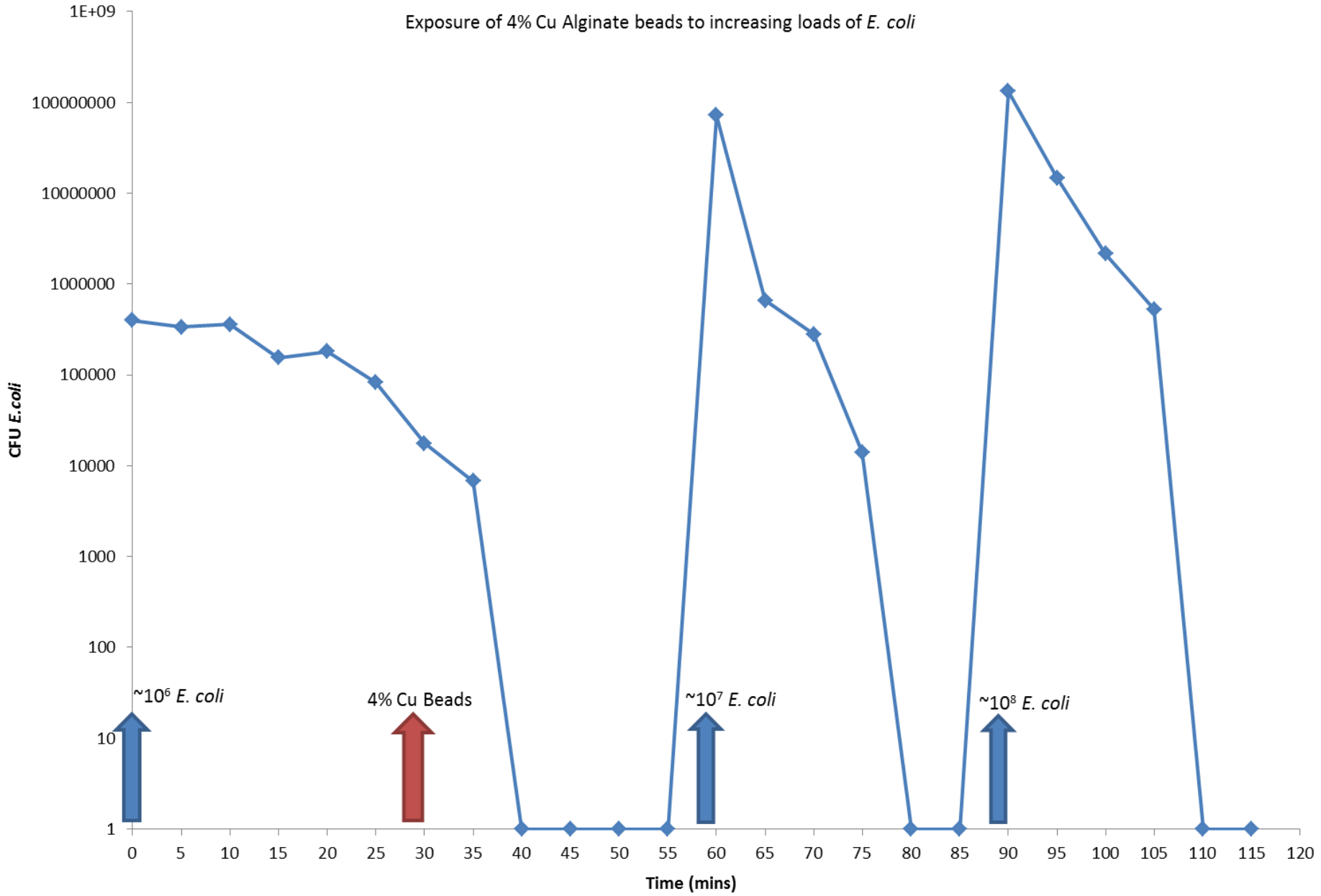
Monitor: Oxygen, Temperature, pH



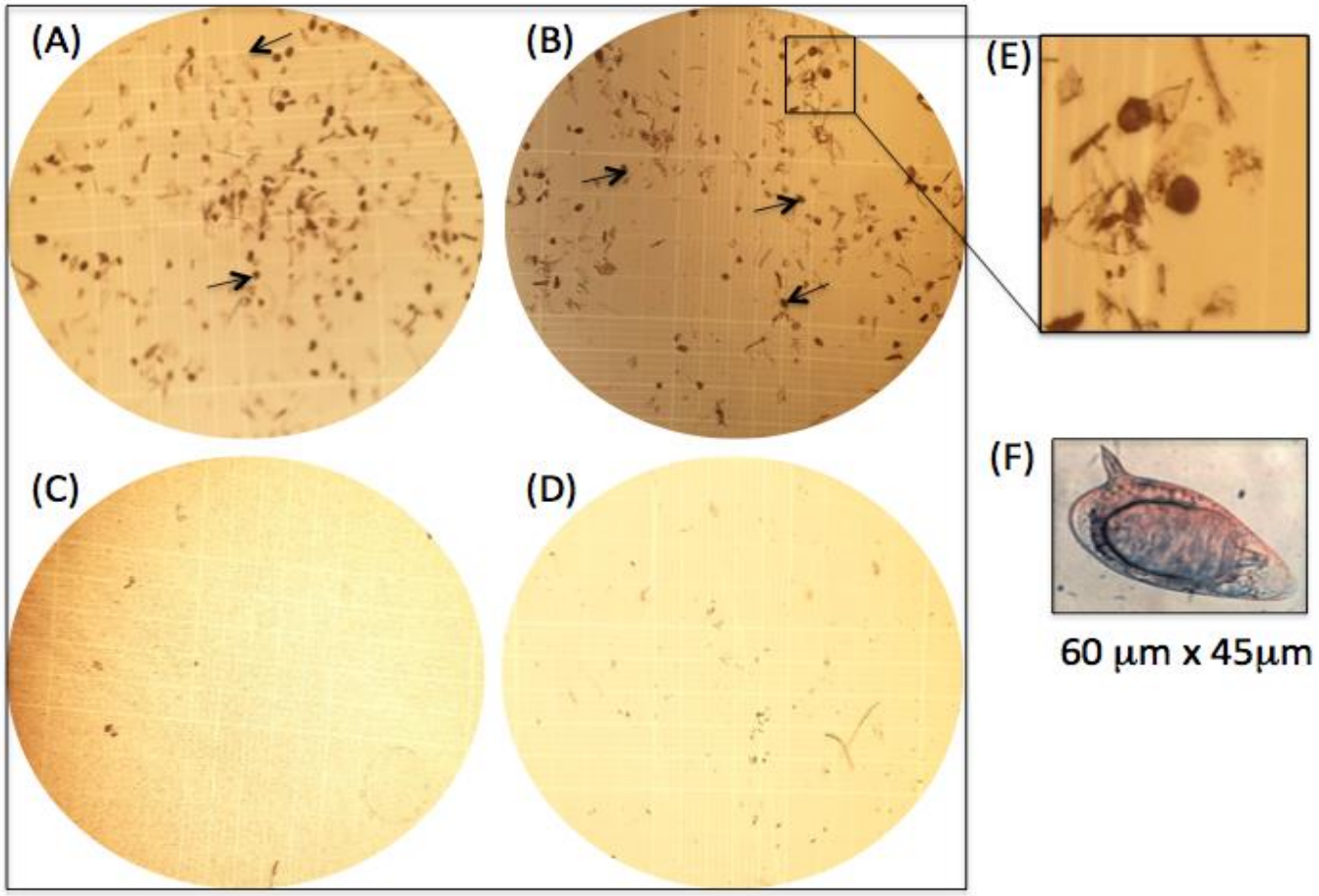
~4000 agar plates and >50,000 colony counts later……

…..very promising data


Repeated exposure of E. coli to 4% Cu Alginate beads
CFU E.coli
10000000
1000000
100000
10000
1000
100
10
1
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160
Time (mins)
4% Cu Beads
10⁶ E. coli
10⁶ E. coli
10⁶ E. coli


Exposure of 4% Cu Alginate beads to increasing loads of E. coli
CFU E.coli
1E+09
100000000
10000000
1000000
100000
10000
1000
100
10
1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
Time (mins)
~10⁶ E. coli
4% Cu Beads
~10⁷ E. coli
~10⁸ E. coli

Very early days, dealing with the helminth issue



Thanks to Team V @ PML: Simon Thomas, Paul Rooks, Sohail Ali, Fabian Rudin.

Paul Goddard, Farid Khan, Tariq Ali, Santosh Dacha, Leopoldo Herrera

Stavroula Balabani, Neil Cagney

Daniel Drumheller

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