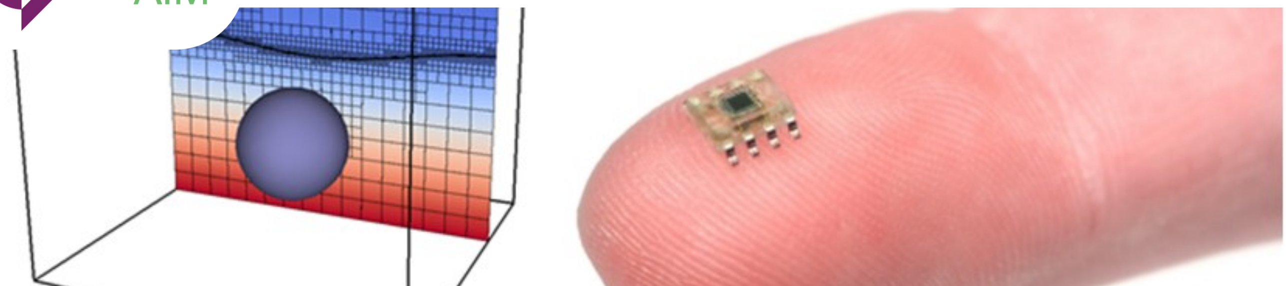
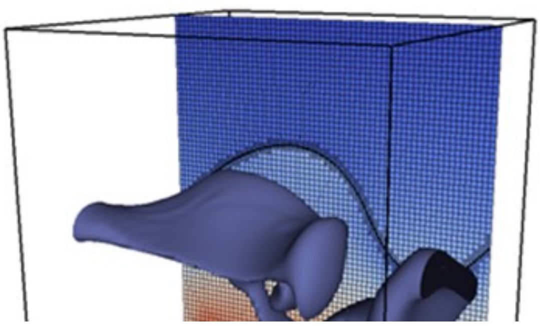
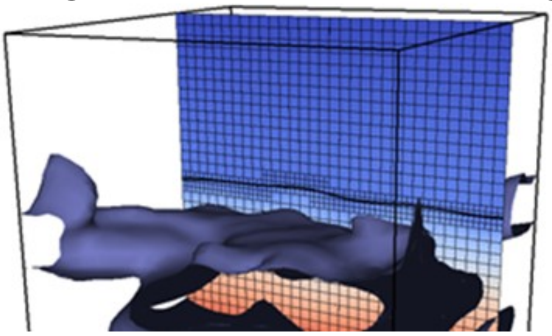
Take AIM

Smith institute
for industrial mathematics and system engineering



Harnessing Control of a Hidden World: from Microfluidic Mixing to Polymer Self-Assembly





TakeAIM Winner 2014:
Radu Cimpeanu

Institution:
Imperial College London
Department of Mathematics
South Kensington Campus
London
SW7 2AZ

Competition sponsors:

nag
AIRBUS
BT
dyson
NATIONAL NUCLEAR LABORATORY
EPSRC Engineering and Physical Sciences Research Council
CATAPULT Satellite Applications
THALES

Fluid dynamics across all scales is at the forefront of modern research. And now more than ever we can benefit from advances that lie at the tip of our fingers. With sizes not exceeding a few millimetres and usage ranging from blood sample analysis to cooling devices and tiny integrated circuit components (and far beyond), liquid systems on the microscale play an indispensable part in our lives. Their production and maintenance however is a highly sensitive and expensive process. Many classical implementations take into account intricate geometries and complex networks of channels to reach their targets. Furthermore, the presence of injected flows in such small scales is often invasive and prevents optimisation and scaling towards industrially efficient standards.

Our research focuses on eliminating these drawbacks and creating mechanisms that do not use any moving parts and do not require the presence of a incoming flow. How would the fluid move then? Electrostatic control mechanisms underpin a wide range of modern industrial processes, from lab-on-a-chip devices to microfluidic sensors for security applications.

We have developed theoretical and numerical tools that allow us to study the flow environment on the microscale in a virtual computational laboratory, thus eliminating the need for costly experiments. We use this knowledge to design electric field protocols that target microfluidic mixing, flux generation and polymer self-assembly in simple geometrical configurations where this has not been achieved before. The work is an excellent example of the fusion between state of the art mathematics, technology and high-impact high-risk applications.

The use of mathematics has profound consequences in all walks of life, but the opportunities that it opens up often go unrecognised or underexploited. The Smith Institute, enabled by the generous sponsorship of our leading corporate partners, ran the fourth annual TakeAIM competition in 2014 to make visible the crucial role that mathematics will increasingly play in all aspects of our lives. The competition was open to all undergraduate and postgraduate students working in the mathematical sciences. The author of the best entry received £1,000 of Apple vouchers as his prize, with £500 of Apple vouchers being awarded to authors of the four entries that tied for second place.