



# School of Computing University of Leeds

## Computational PDEs Unit

### Joint Research with Shell Global Solutions

Professor Martin Berzins

Professor Laurence Scales (Shell Global Solutions CIP )

Dr Roger Fairlie Senior Research fellow and Unit Manager

Dr Christopher Goodyer Research Fellow

Multidisciplinary research in computational modelling and high-performance computing applied to lubrication, combustion, biological and environmental problems

**More reliable, faster computations with better visualization leading to greater insight into challenging problems**

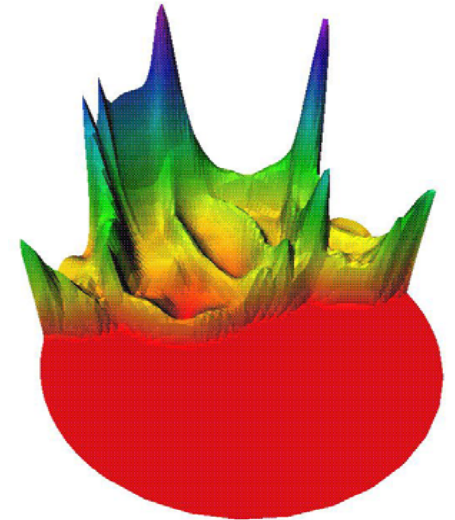
# Overview of Computational PDEs Unit Activities

1982-1992 Software written for Shell modellers

1992-2002 CPDE unit supplies expertise and software on call-off basis lubrication, combustion, soil remediation etc

Shell and EPSRC funding of £2.5M since '92

Fundamental research via 7 CASE Ph.D. students, 8 EPSRC projects, e.g. knock modelling



► Challenging problems → better algorithms, theory, software

# Elastohydrodynamic Lubrication (EHL)

Very High Loads + Small Areas

High Pressures and Temperatures

Deformation + Glass-like Lubricant

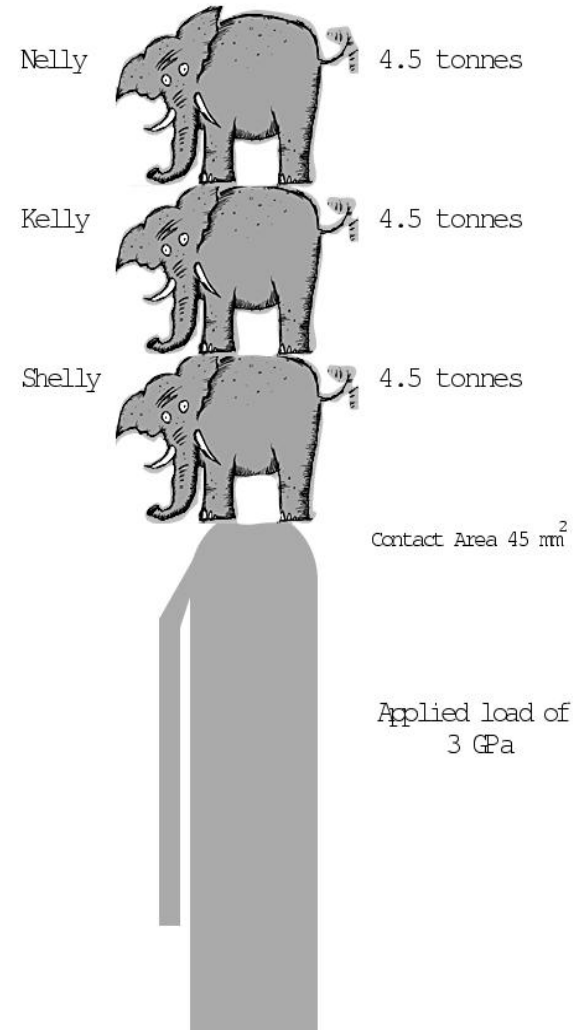
Friction + Wear

Energy Efficiency + Durability

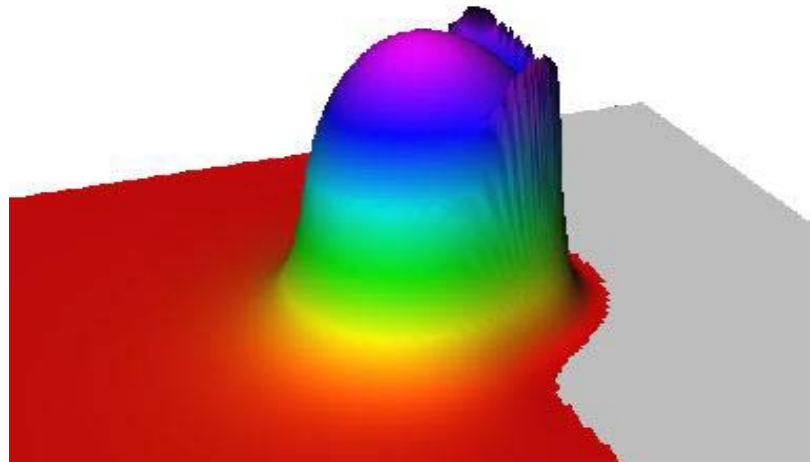
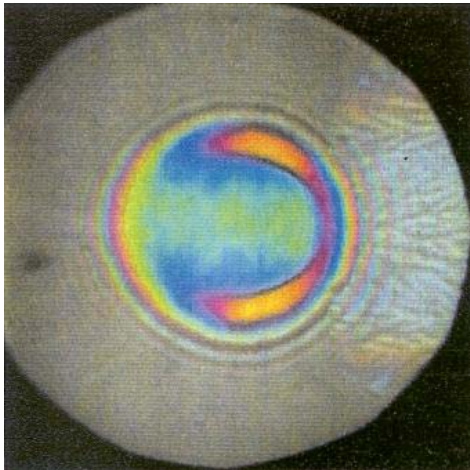
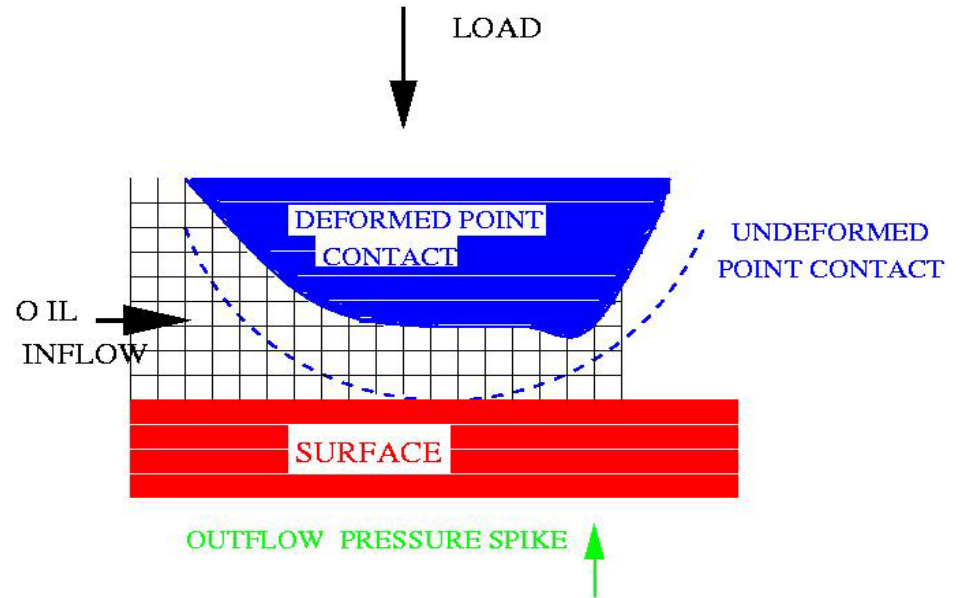
Lubricant → Experiment → Theory



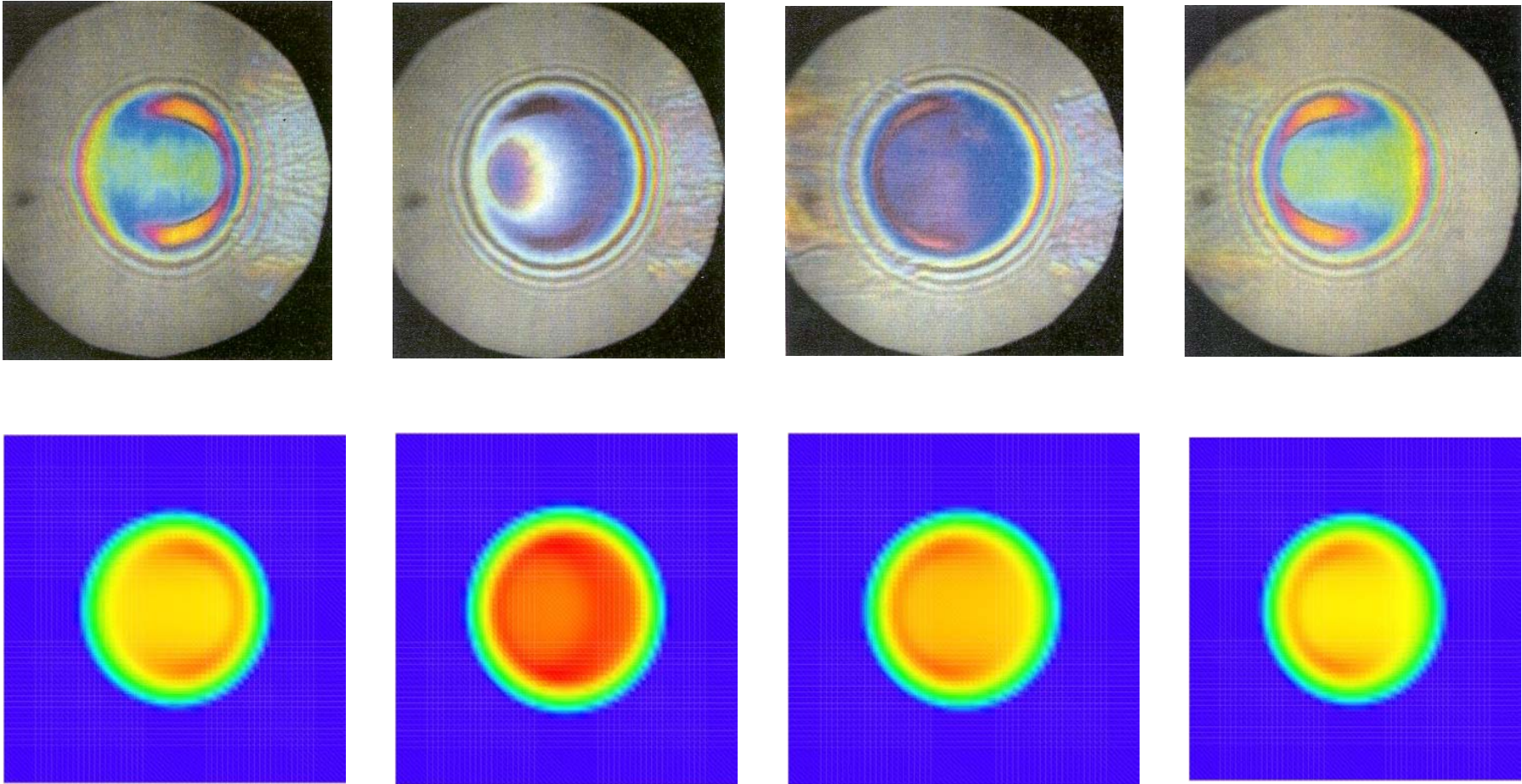
Prediction ← Computational Model



# Elastohydrodynamic Lubrication



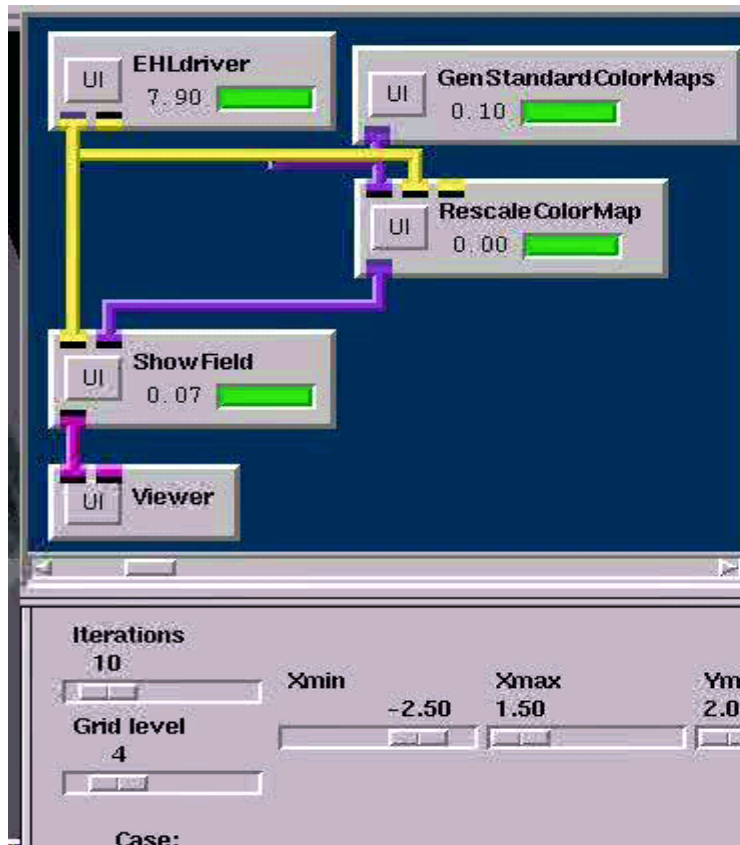
# EHL Oil Flow Reversal: Experiment and Simulation



Entrainment reversed from 5 cm/s to  $-5$ cm/s in 0.2 seconds for a point contact

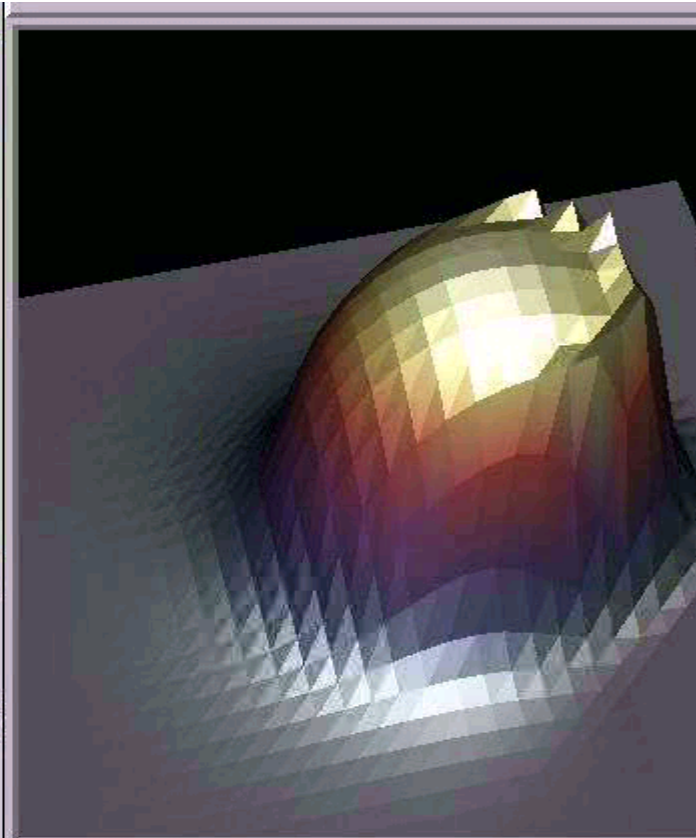
# Problem Solving Environments for EHL Simulations

Visual programming



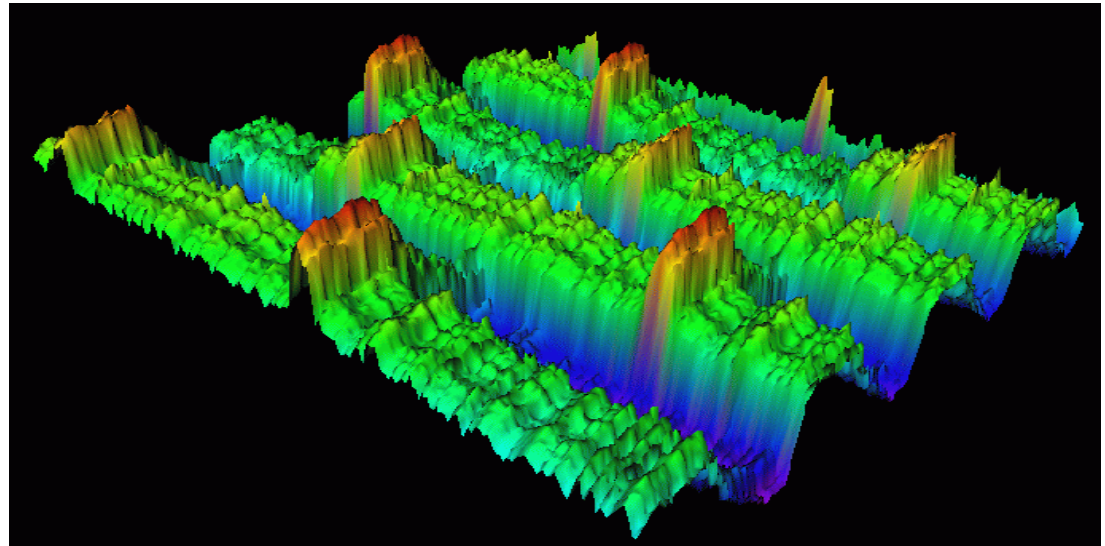
Computational steering  
for easier experimentation

Insight through visualization

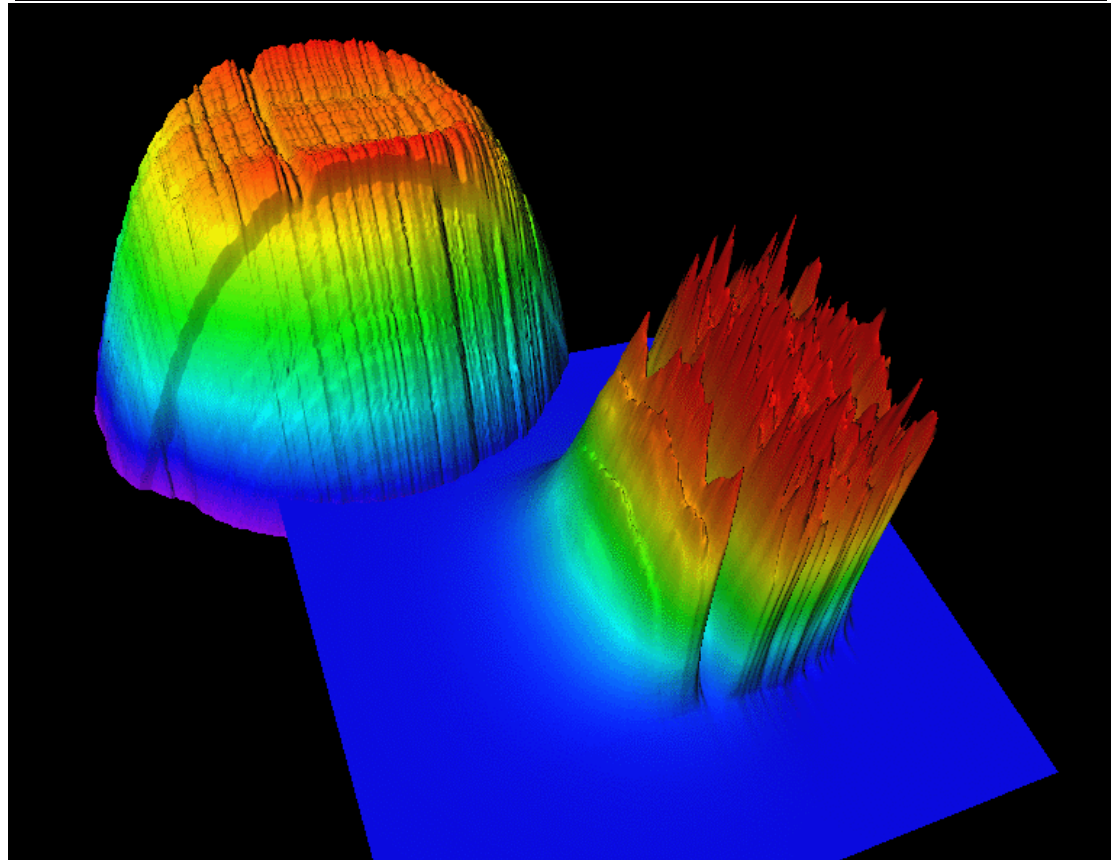


Faster (1000x) more  
reliable algorithms

Measured Surface  
Roughness



Computed  
Contact Shape



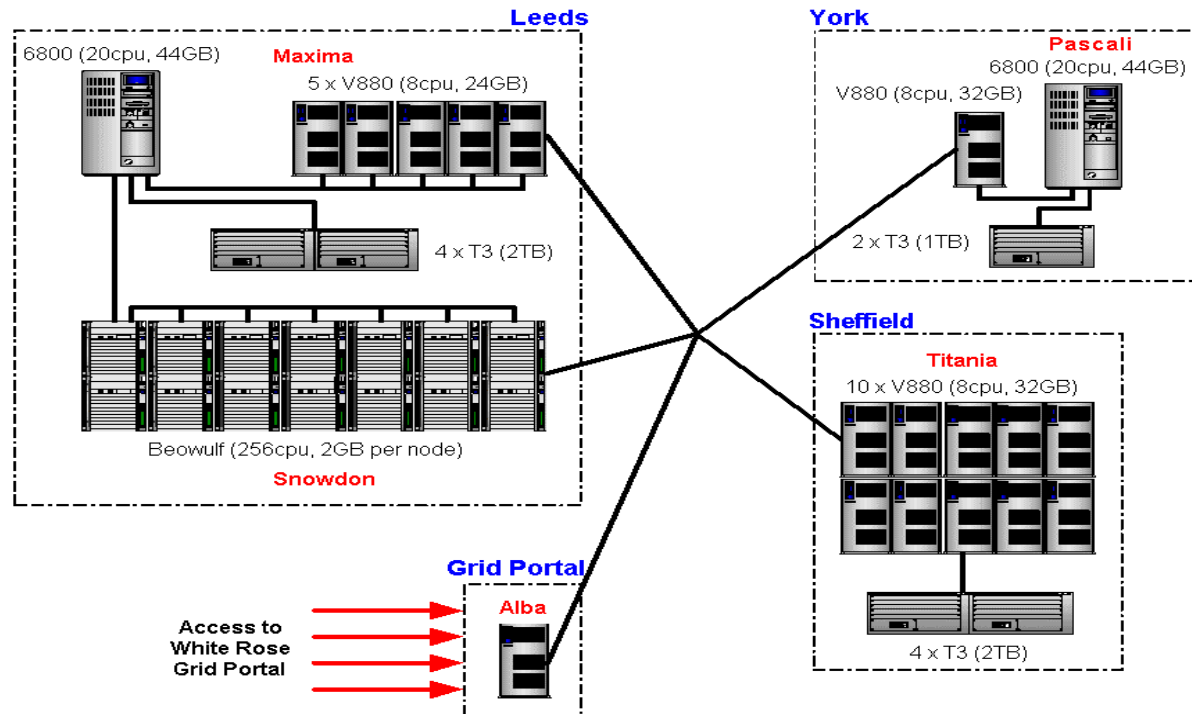
Computed pressure  
profile

# Future Research

Fully understanding and modelling lubrication with surface roughness

Multiscale models: molecular structure → rheological properties (additive films)

## White Rose Grid eScience



Virtual distributed multidisciplinary collaboration and supercomputing  
eLubes EPSRC/Shell escience project 2003