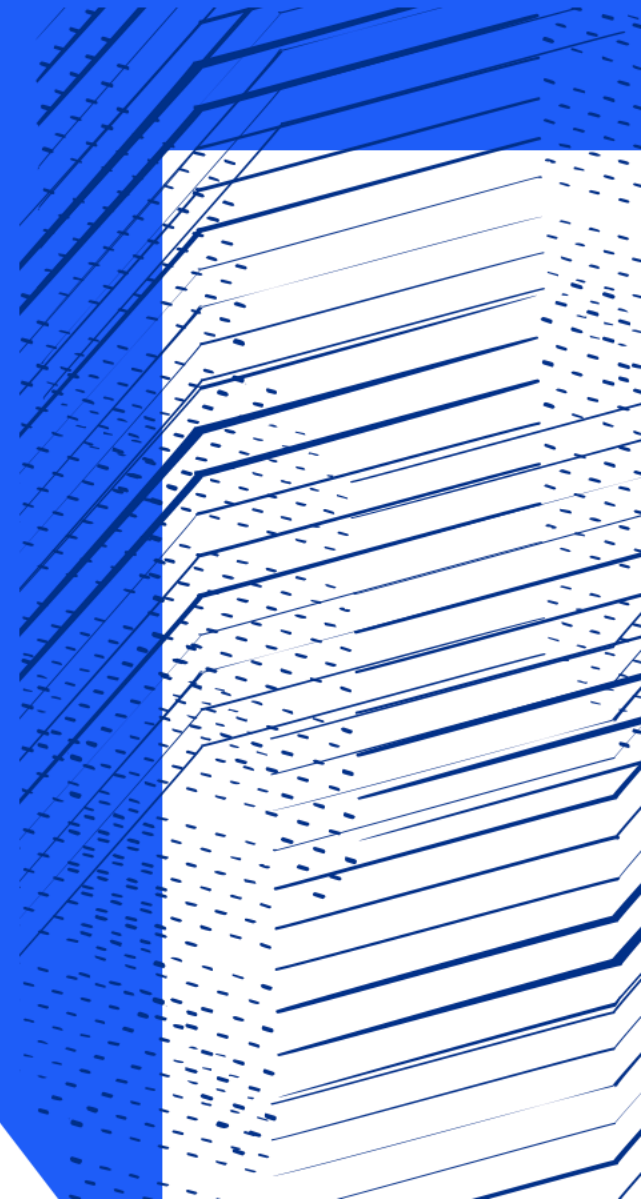




Science and  
Technology  
Facilities Council

Driving AI in BioPharma  
through a new generation of  
public/private partnerships

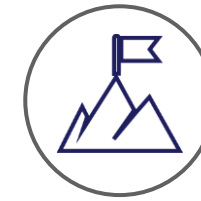
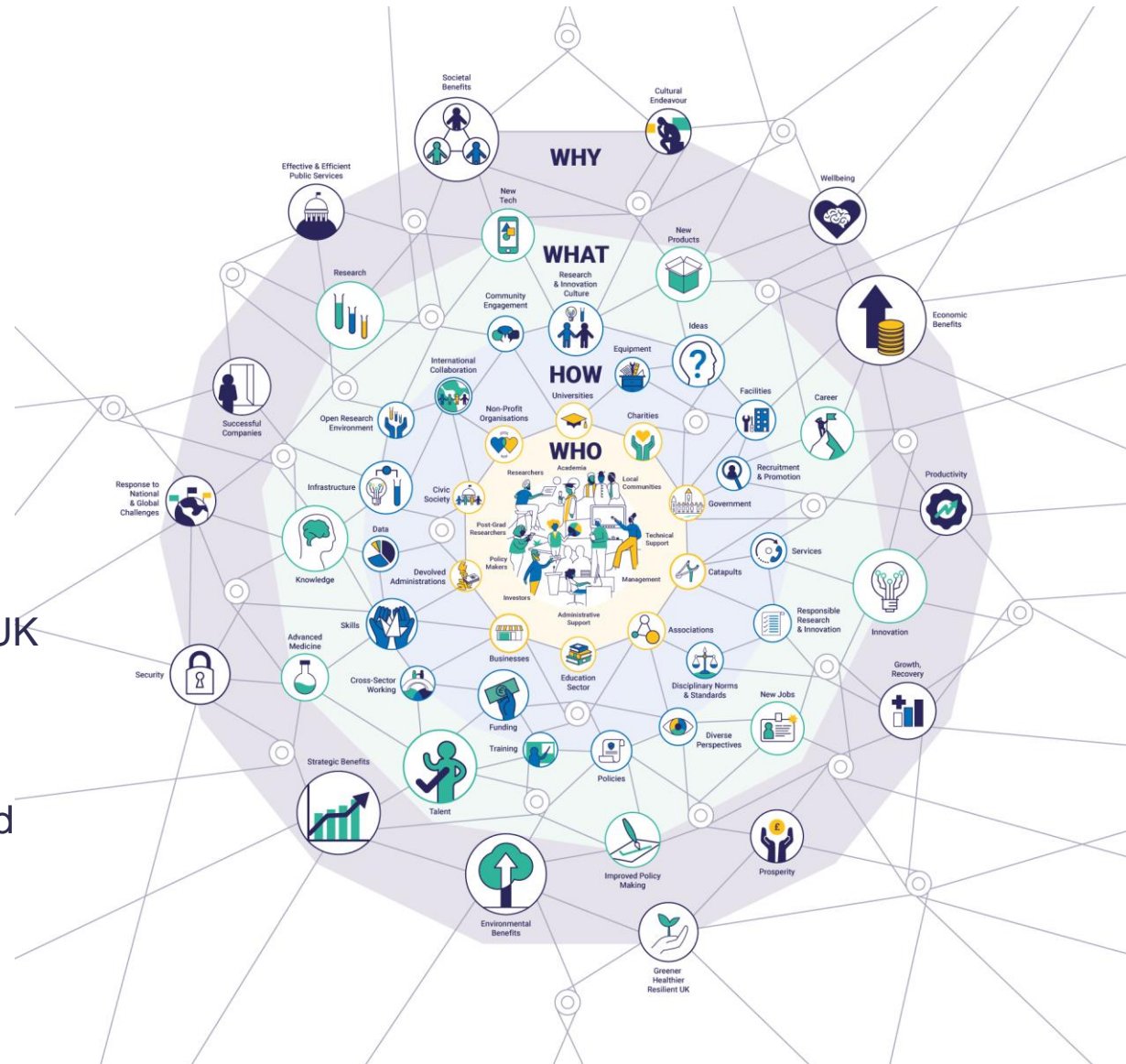
Dr Angeli Möller and  
Dr James Gebbie-Rayet



# UKRI vision and mission



Our **vision** is for an outstanding research and innovation system in the UK that gives everyone the opportunity to contribute and to benefit, enriching lives locally, nationally and internationally.



Our **mission** is to convene, catalyse and invest in close collaboration with others to build a thriving inclusive research and innovation system that connects discovery to prosperity and public good.



# STFC's mission

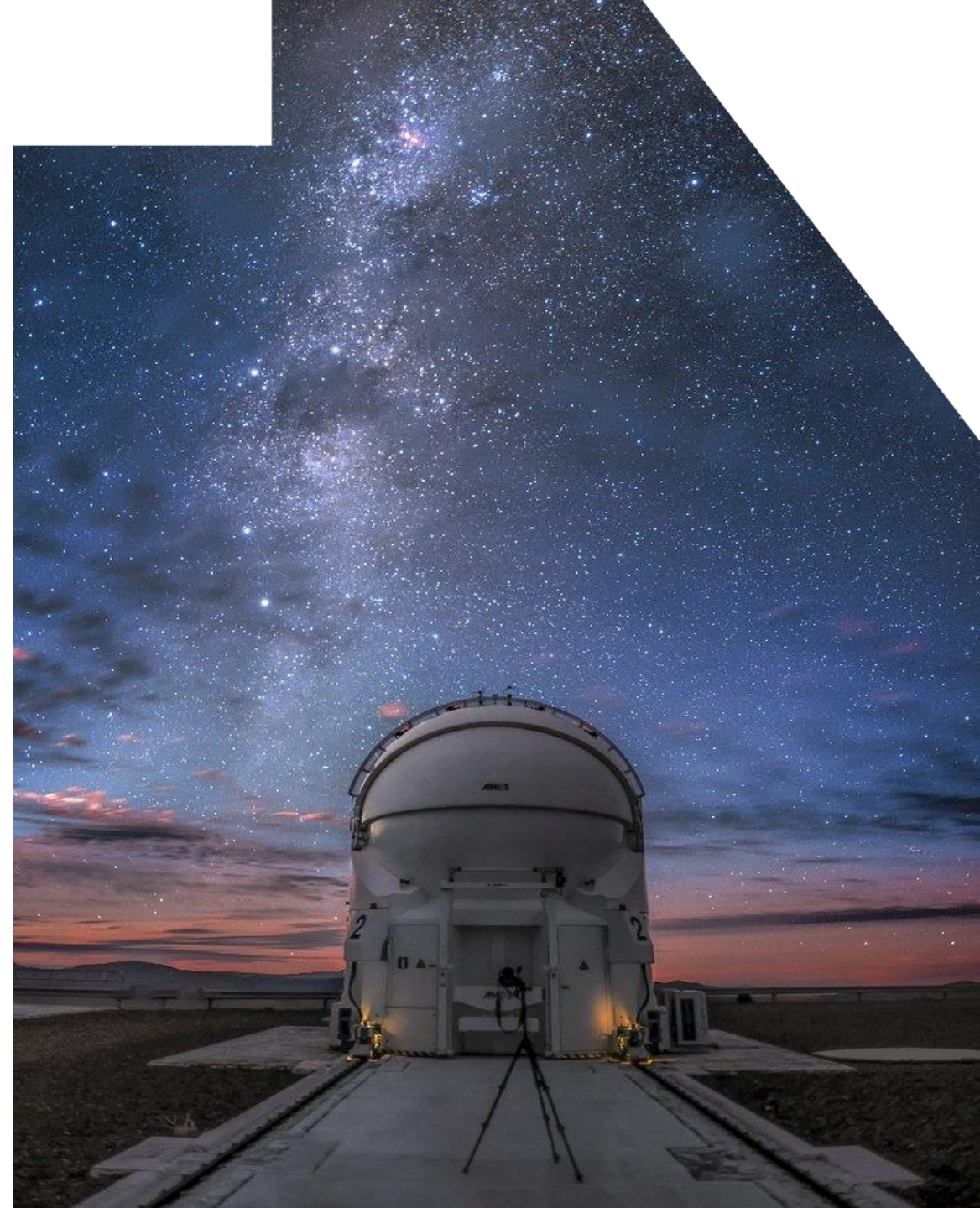
## Mission:

- Discovering the secrets of the Universe
- Developing advanced technologies
- Solving real world challenges

## Responsibilities:

- Frontier research: particle physics, astronomy, nuclear physics and space science
- **Major UK multi-disciplinary facilities**
- **Stewardship of our R&I campuses**

**Annual budget: ~£950m**



# STFC's science base

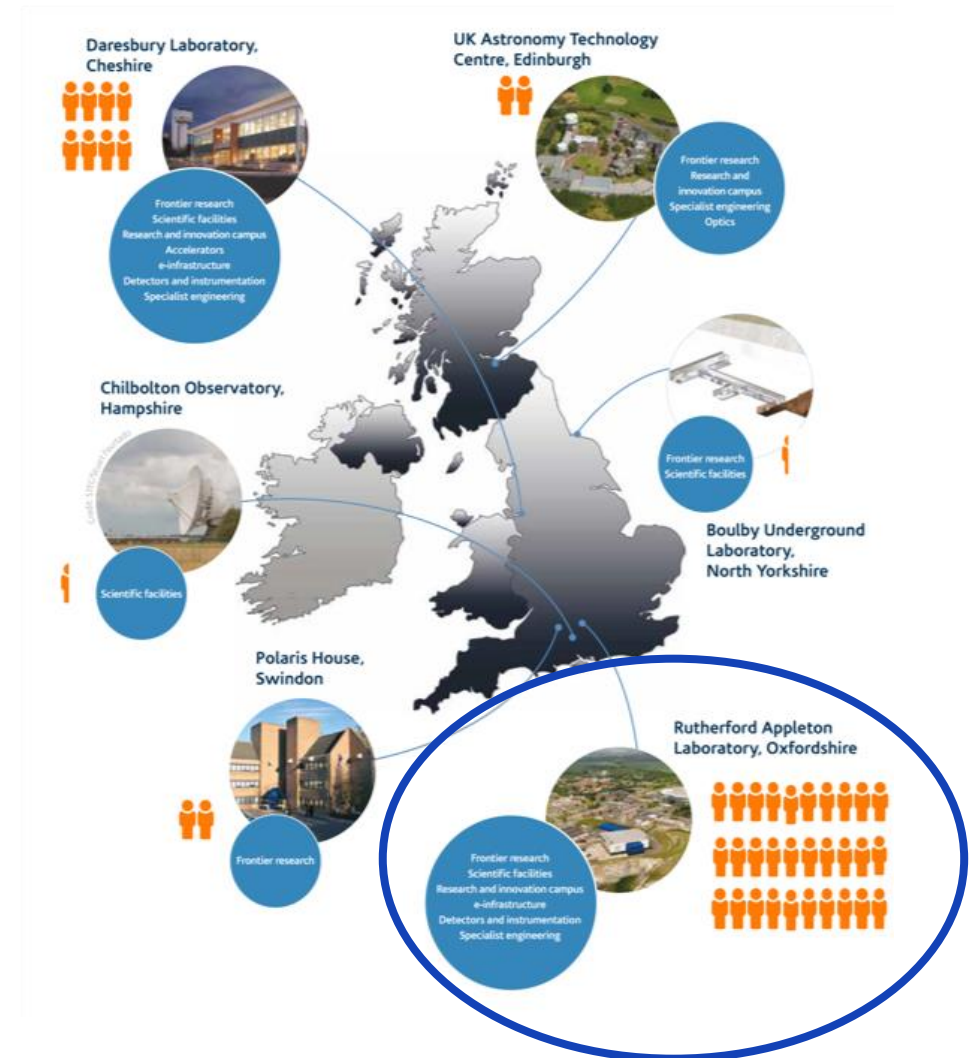
Six sites across the UK + ING in La Palma

Around 3,000 staff

- approx. 35% of UKRI staff
- >85% are scientists, engineers and technicians
- **1750** at the Rutherford Appleton Lab

## STFC National Laboratories

- STFC provides the high-tech scientific and engineering support for >10,000 industrial and academic researchers from **across all domains**





# Rutherford Appleton Laboratory

STFC provides the stewardship of UK's world-class *multi-disciplinary* facilities on the Harwell campus:

- **ISIS** neutron spallation source
  - World-leading neutron source. In terms of publications sits alongside SNS and ILL
- **Central Laser Facility (CLF)**
  - Suite of **high-power** laser facilities
  - World-class facilities and technology development
- **Diamond Light Source** synchrotron
  - 86% STFC owned/funded
  - The UK's National synchrotron



# Advanced Computing and HPC

## We have very strong computing departments

- **Scientific Computing Department ~250 people**
  - works across UK on major collaborative computing products
  - delivers and operates large-scale digital infrastructure including JASMIN for Earth Observation data and the UK “Gridpp” HTC infrastructure
- **Hartree Centre >100 staff**
  - Collaboration with IBM on industry-focused super-computing/AI: aims to demonstrate solutions to industrially relevant challenges
- **Also collaborate with external bodies, e.g. UKAEA**
  - Hartree and Scientific Computing - are supporting UKAEA's 'STEP' fusion programme (Spherical Tokamak for Energy Production)
  - Areas include exascale simulation, AI enhanced modelling, and advanced visualisation





Science and  
Technology  
Facilities Council

Scientific Computing

# Biology and Life Sciences

James Gebbie-Rayet  
Biomolecular Simulation Group Leader

# Our Capabilities

## We apply our expertise to

- Development of novel scientific research software
- A diverse programme of scientific research
- Advanced data processing technologies
- A diverse programme of modelling and simulation
- Exploitation of HPC and optimisation
- Imaging and data visualisation
- Training for UK research communities

## Domain Expertise

- Structural Biology
- Biomolecular Simulation
- Biophysics
- Biochemistry
- Bioinformatics
- Biological Imaging



# Training UK Researchers

## We develop and run training

- Training in cutting edge methods
- From fundamental computing to AI
- Cloud based scalable platform (JupyterHub)

### Several formats available

- Traditional workshop format
- Sandpit/Hackathon style follow-ups
- Materials available online

Reach of 5000 UK Researchers

12,000 training days delivered annually



Scientific Computing

## Biomolecular Simulation



[www.ccpbiosim.ac.uk](http://www.ccpbiosim.ac.uk) [www.hecbiosim.ac.uk](http://www.hecbiosim.ac.uk)

## Cryo-Electron Microscopy



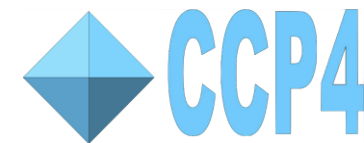
[www.ccpem.ac.uk](http://www.ccpem.ac.uk)

## Imaging and Tomography



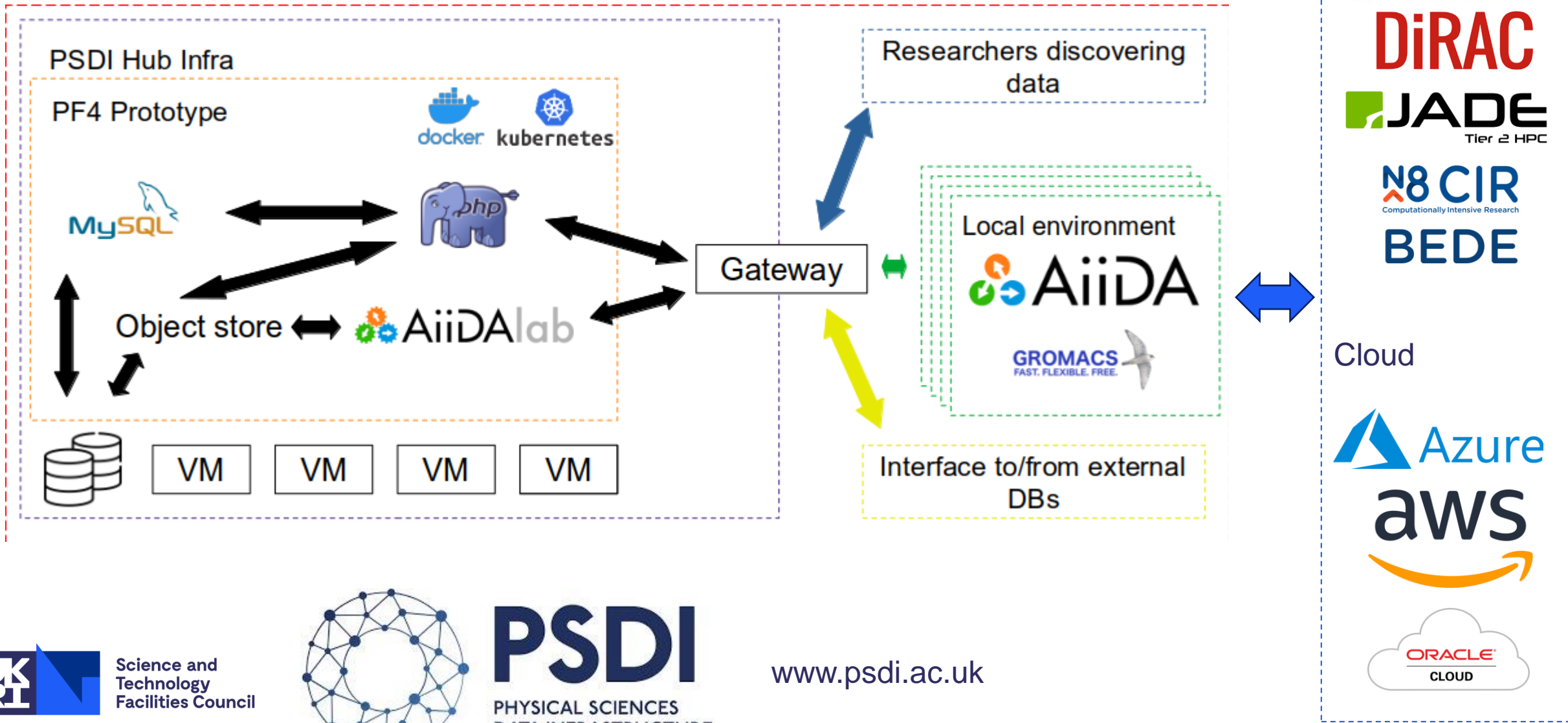
[www.ccp4.ac.uk](http://www.ccp4.ac.uk)

## Macromolecular Crystallography



[www.ccp4.ac.uk](http://www.ccp4.ac.uk)

# National Data Infrastructure

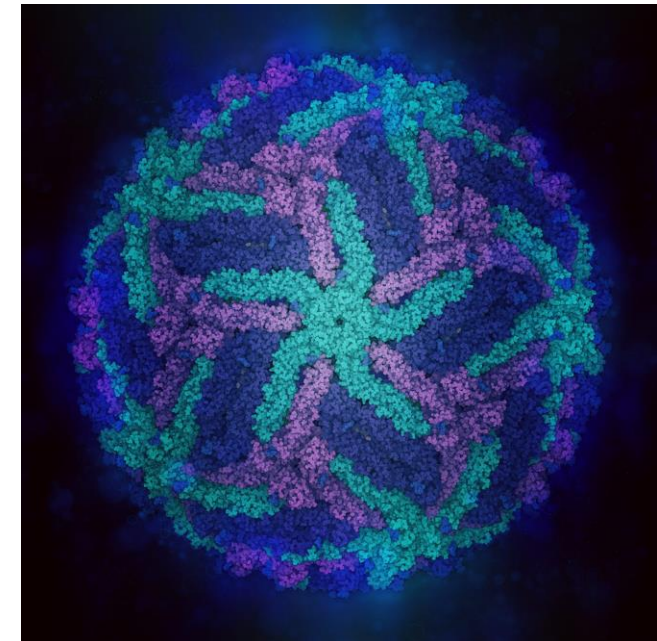
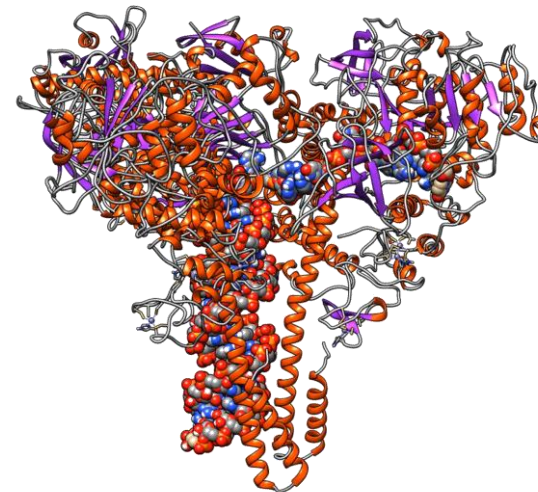


# Exploiting Exascale HPC



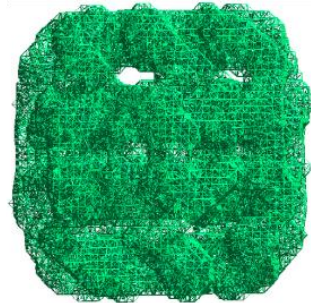
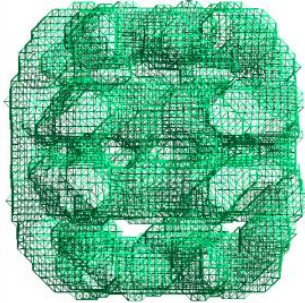
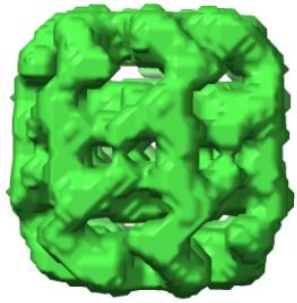
## Exabiosim is part of the UK ExCALIBUR programme

- Establish accessible routes to exascale biomolecular simulation
- Performance profiling of existing codes
- Code porting and profiling on novel testbeds
- Gathering energy data vs science output
- Developing blueprints for complex multi-scale multi-physics or multi-modal workflows





# Exploiting Exascale HPC



Cryo EM Map

Extracted Surface (stl)

Tetrahedral Mesh

EMD-24884

EMD-32272

EMD-14122

EMD-33345

EMD-13440



Mesh Res 50Å  
Nodes 35,064  
Elements 186,558  
Time to Mesh 20s

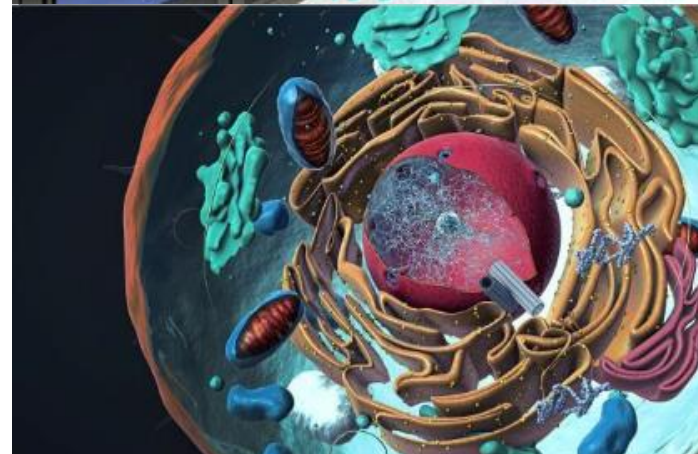
50Å  
118,289  
531,514  
40s

50Å  
158,761  
743,140  
55s

50Å  
242,791  
1,215,572  
1m22s

50Å  
376,770  
1,774,232  
2m09s

MPI Tasks	Time in Solver	Efficiency
131,072	68.959 s	100%
262,144	34.769 s	99%
524,288	18.677 s	92%



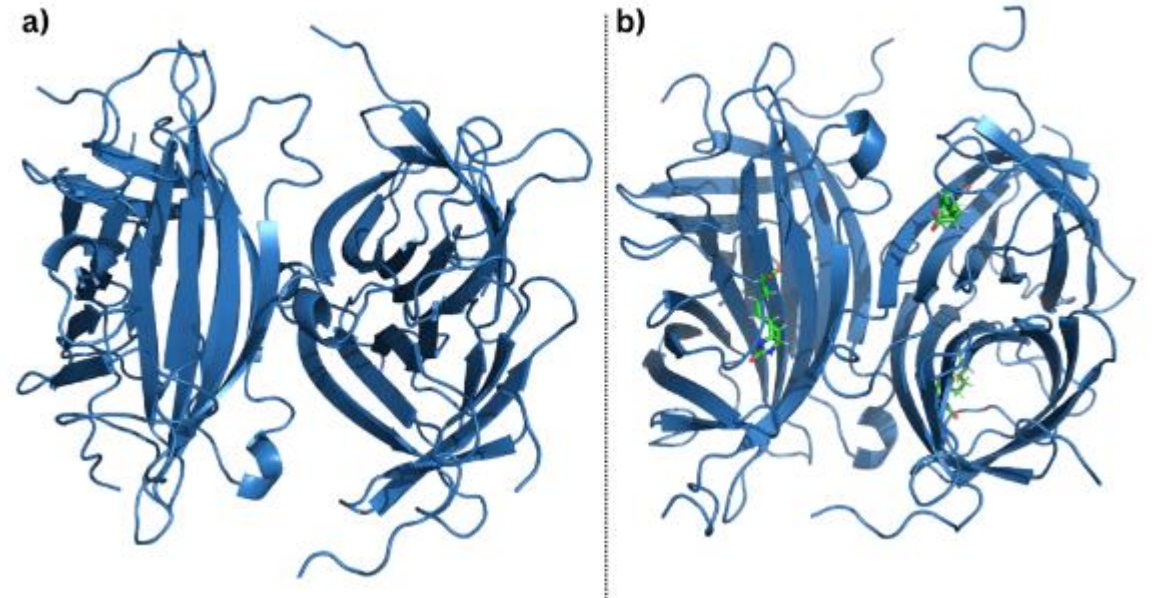


# CodeEntropy

## Novel code for entropic calculations

- Structural entropy + solution entropy
- Runs on the end of molecular simulation
- Very accurate for applications involving binding sites
- Validation against QENS

<https://github.com/CCPBioSim/CodeEntropy>



a) streptavidin tetramer. b) streptavidin-biotin complex.

# Case study (Unilever): vitamin B3 analogs amplify LL-37 activity

## Experimental observation:

Synergistic effect of niacinamide (vit. B3) > N-methylnicotinamide > isonicotinamide with naturally occurring human antimicrobial peptide LL-37 in skin conditions

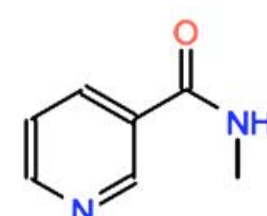


## Problem:

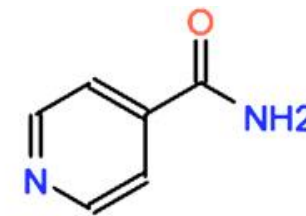
Understanding the molecular mechanism behind this co-operative effect to facilitate the design of even better potentiators of human defenses



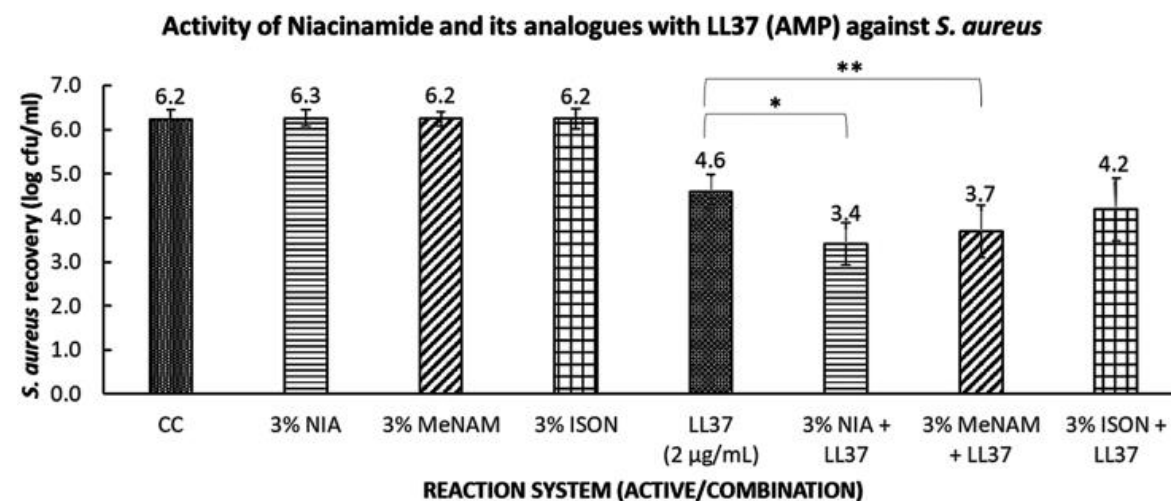
Niacinamide



N-methylnicotinamide



Isonicotinamide



## Computational solution:

Understanding the molecular mechanism behind this co-operative effect to facilitate the design of even better potentiators of human defenses

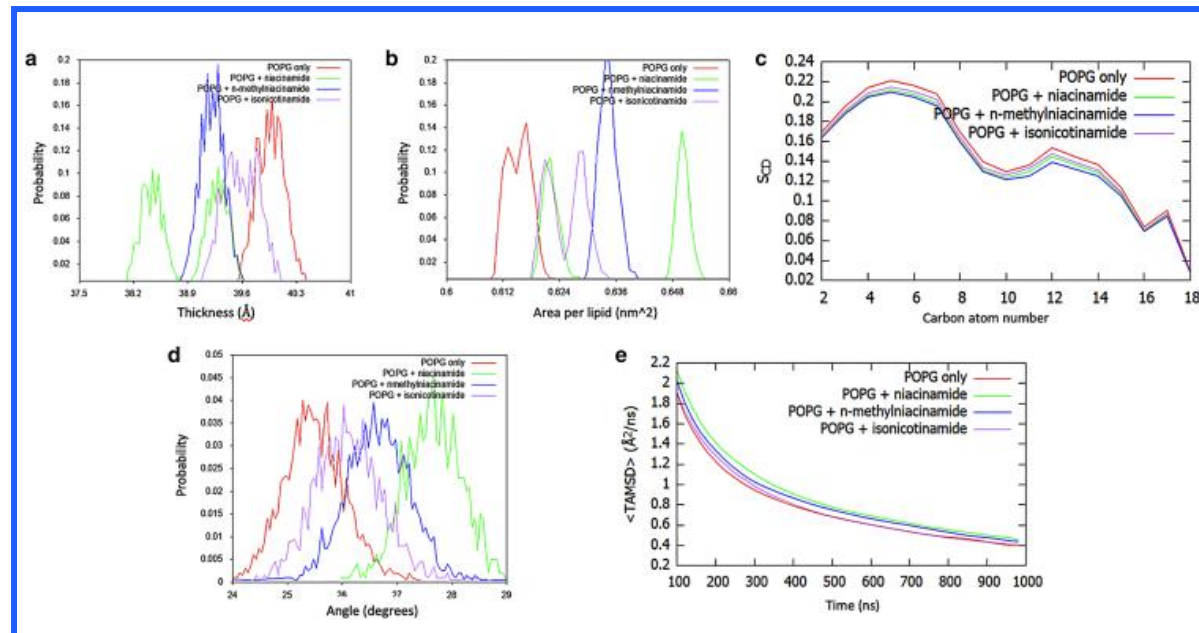


## Simulations

- ❖ Membrane only
- ❖ + LL37
- ❖ + small molecule
- ❖ + small molecule AND LL37
- ❖ Bacterial membrane
- ❖ Mammalian membrane



## Analysis of membrane properties



Understanding how subtle changes in chemical structure influence cooperativity



Novel molecules design



Science and  
Technology  
Facilities Council

# Questions?



Science and Technology Facilities Council



@STFC\_matters



Science and Technology Facilities Council





Science and  
Technology  
Facilities Council

Scientific Computing

# Thank you

[scd.stfc.ac.uk](http://scd.stfc.ac.uk)

 [@SciComp\\_STFC](https://twitter.com/SciComp_STFC)