Name of Quantum Technology

Simulation

What is the potential vision for this area?

In the next 5 years…

- Small scale analogue simulators that physicist can use to verify/test their models which are used to understand quantum materials and superconductivity – especially open system dynamics, far from equilibrium systems

- Small scale, specialised chemistry simulations (e.g. strongly correlated electron systems) using 50-100 Qubits → 5-10 years

- Solving optimisation *(image recognition, machine learning and so on) via techniques like quantum annealing – this is* already offered by D-Wave but probably >5 years to fully realise

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  Protein Folding?

In the longer term…

- General digital simulators for “software based” discovery in chemistry, materials science, drug delivery

- Applications outside physical sciences (e.g. healthcare)

Name of Quantum Technology

Simulation

What prevents this vision from being realised?

Research challenges to overcome…

- Describing strong electron correlations (more qubits {& More understanding} with 20 – 50 electrons – Find killer problem?
- Time dependence →non equalibrium physics
- Spontaneous emission (dynamically)
- Quantum emitter – Energy Transport
- Materials for solid state
- Validation of simulators
- Near ambient operation

Scientific / technological barriers…

- Trying to over define or predict what ran commercialised or what may be useful
- Compete with best classical
- experimental techniques – are not yet advanced enough
- Theory of quantum simulation is immature compared TV e.g. The Theory of General Quantum Computing – we don't have a full theory of the impacts of errors etc.
- Get suitable equipment for building internationally competitive experiments
- Shore's factoring equivalent (clear goals from a useful Q simulation)
- We don't have quantum computers!

Name of Quantum Technology
Simulation

What can the UK do to deliver this vision?

What we currently know…

- Capabilities of classical modelling using QM

What we need to know…

- Error thresholds for useful simulations
- Where “conventional” simulators fail
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  Isolating “difficult” parts
- Nature of physical system needed – how coherent?
- Control of couplings required(range, t-dependence, accuracy)
-
- Readout

Name of Quantum Technology

Simulation

What can the UK do to deliver this vision?

What should the UK do differently?

- High-quality medium-scale equipment
- Compling of quantum / classical elements in simulation
- People- complex expts need a supply of people (studentships in particular)
- Funds for thoery?
- Find the right structure for funding - international examples – Information
- Infrastructure? Different scale for different activities e.g. fab vs. characterisation