CSaP Annual Conference
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15:15 Parallel Session, Seminar 2

Challenges and Opportunities for UK Quantum Technology

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What are "Quantum Technologies"?

- Nothing new – they've been around ~70 years
  - 1st Q Revolution exploited quantisation at small scales;
  - Led to semiconductors, lasers, nuclear technologies, …;
  - … the "Information Age" and "Our Modern World";
- The 2nd Q revolution will see subtler effects exploited
  - UK National Quantum Technology Programme (NQTP) will enable a "secure, smart information age" guaranteed by quantum mechanics;
- 21st Century civilisation could not be foreseen in 1950; Civilisation in 2050 is probably unpredictable;
- Huge ($Bs/yr) global QT investment over past 5 years, UK ~ £400M
  - University-led Hubs (Comms, Comp, Imaging, Sensing & Timing: TRL 4);
  - ISCF industry led projects (TRL 5-6) & MOD Demonstrators (TRL 4-5);
- The prize – a strong, robust, flourishing economy;
- The real prize? - Guaranteed secure information networks underpinning society.

2019: UK 5 years into a 10 year programme

- UK has engineered a coordinated effort from academia + industry + government
  - Must continue, underpinned by increasing investment in science; translation and skills development as well as pull through to products;
    - £80M Hub renewal and ~£315M ISCF Wave 3 programmes now confirmed;
- UK NQTP Phase 1 focused on areas where UK had scientific world class/world leading expertise. In Phase 2 the NQTP should:
  - Achieve a self sustaining national effort within 3 – 5 years;
  - Tighten focus onto technologies where UK is at the forefront of developments;
  - Increase industry involvement, eg. industry-led innovation centres supporting electronics, manufacture, packaging, …;
  - Encourage OGDs to sponsor demonstrators;
  - Lead in setting international standards for the new technologies;
  - Continue with Responsible Research & Innovation;
- Understand failures and apply lessons learned.

Challenges during the next 5 years

- Current UK NQTP founded on decades of investment in physics
  - Must maintain the science base and create a skilled future workforce with a passion to innovate;
  - Must ensure a pipeline of new ideas to create future new technologies
  - Hub funding begins to taper from FY22/23, replaced by QT Responsive mode funding (£40M/yr from FY24/25);
    - Maintain current academia/industry/government coordination
- Deliver a strategic and coherent programme of [science + Hubs + industry] to drive the new UK quantum industry forward, including:
    - Roadmapping;
    - Increasing investment (beyond competitors? Korea, 4.55% of GDP);
- Prevent "invented in UK, made abroad syndrome"
  - UK government must create an attractive environment for research, science translation and business development;
  - Ensure skills, technologies and businesses "stick" to the UK.

Opportunities during the next 5 years

- Science: Research to enable low SWaP (handheld) technologies
  - Research for the obvious:
    - Enabling technologies: materials, novel lasers, Integrated photonics, …;
    - Sub-systems: atom chip technologies, frequency combs, …;
  - Blue-skies research
    - Interaction-free imaging, Q Zeno effect, quantum vacuum applications, …;
- Technology
  - Increased emphasis on systems engineering (Systems of Systems);
  - Maintain vigorous translational science effort;
    - Innovation centres, "UK_QT.org", … to strengthen UK industry's role;
- Manufacturing
  - Anticipate emergence of UK Q industry and create skilled workforce;
    - Not just PhDs for translational science;
  - Encourage systems integrators to engage (cf. Q Comms);
  - Develop ways to retain UK manufacturing capability and workforce;
  - Establish secure, stable, enduring and evolving supply chains.

29 July 2019

Ministry of Defence