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State-of-the-art Accelerator Technology

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HEPTech Environmental Applications of Accelerators

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Accelerators in context

- Estimated 24,000 accelerators globally
  - Only 200 used for research – less than 1%
- Used in:
  - **Healthcare** - radio-/hadron-therapy, radioisotope production, medical sterilisation
  - **Security** - threat detection, cargo screening
  - **Manufacturing** - polymer cross-linking (wires, cables, tyres etc.), ink curing, food irradiation
  - **Environment** - waste water treatment, flue gas treatment

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Accelerators in context

- Pervasive technology (more than commonly realised), **~€400bn/yr** of end products will have seen an accelerator.
- Advances in technology therefore have huge potential for impact across range of sectors.
  - We want to unlock the potential of technological advances for the benefit of UK industry

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Drivers for increased uptake

- To promote uptake in the environmental sector, we need to optimise technology solutions to commercial needs
- **Smaller** – often replacing pre-installed equipment, smaller footprint = reduced building and infrastructure costs
- **Cheaper** – reduced initial capital investment
- **More efficient** – reduced on-going resource costs
- **More reliable** – reduced Mean Time Between Failure, easier maintenance
- **(Improved) performance** – optimised to application
- **Easier to operate** – fits into standard protocols and operations
- **Repeatable** – confident that you get the same outcome every time

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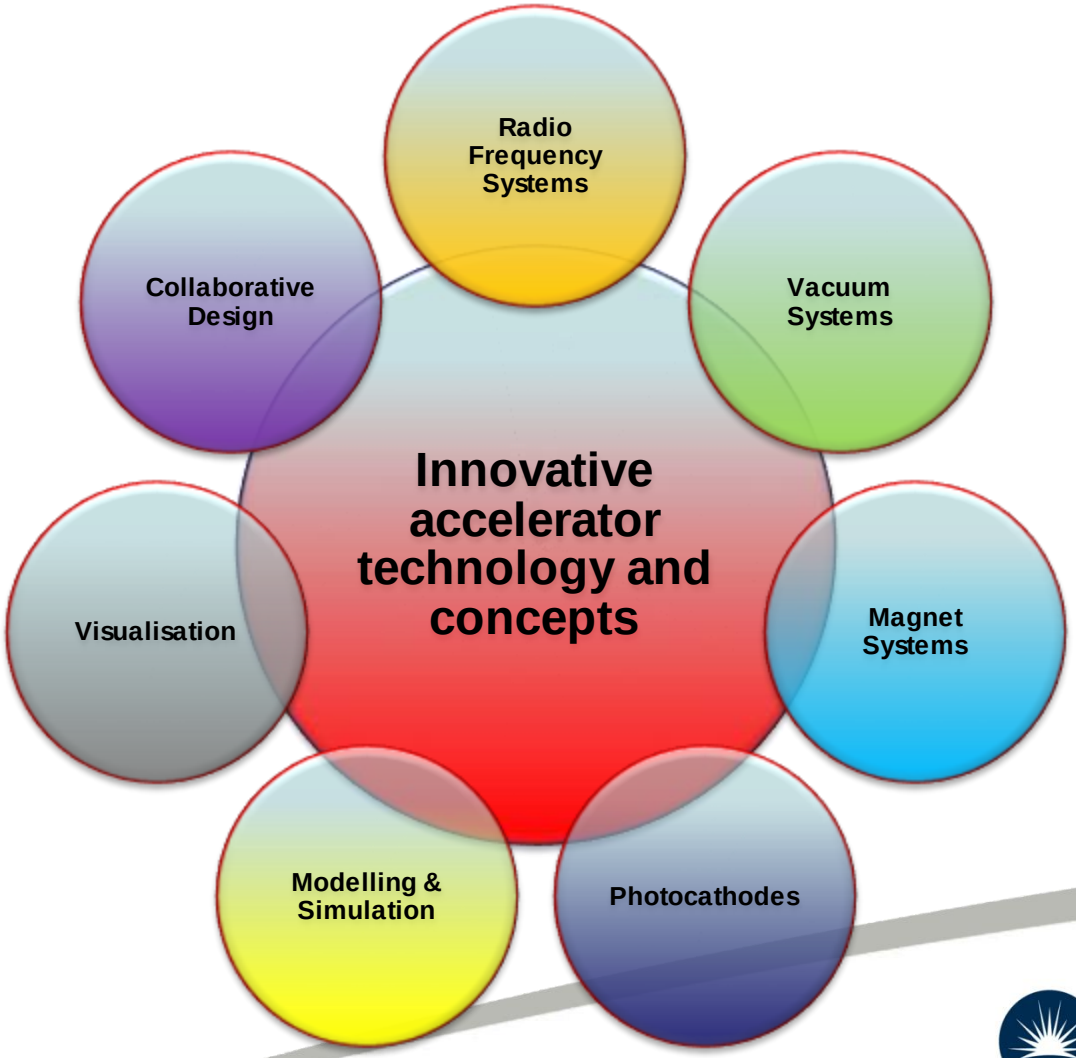
Key Technology Developments



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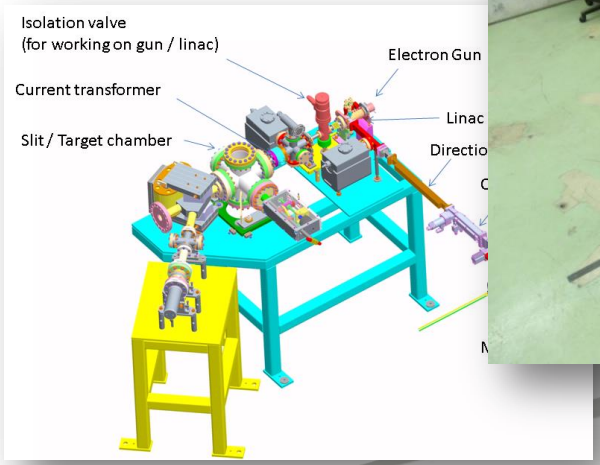
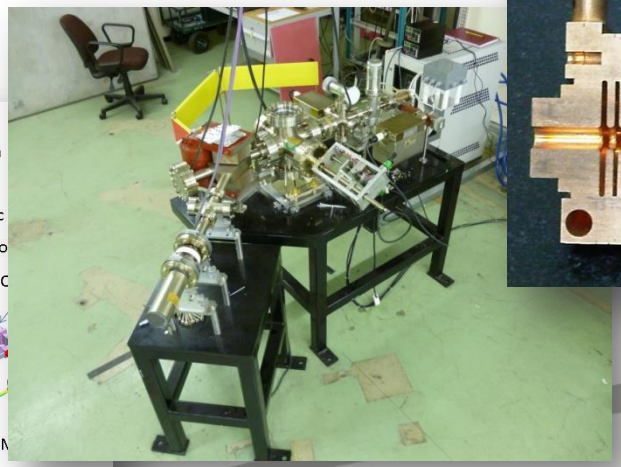
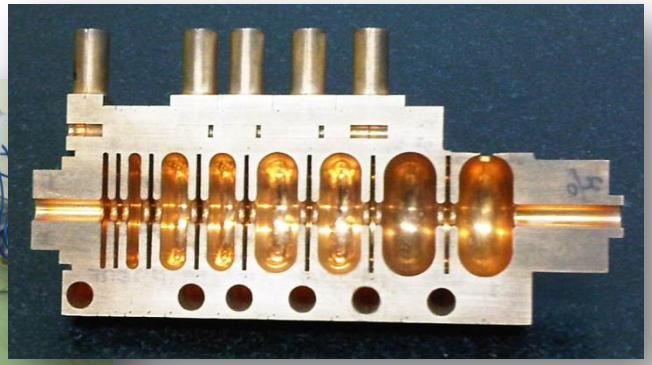
Compact Linacs

- Compact linac system demonstrated, with potential to reduce the footprint and cost of systems across a broad range of applications. Higher energy system now under development.
- Unique technology may open up the possibility of using cheaper RF power components, without degrading performance.







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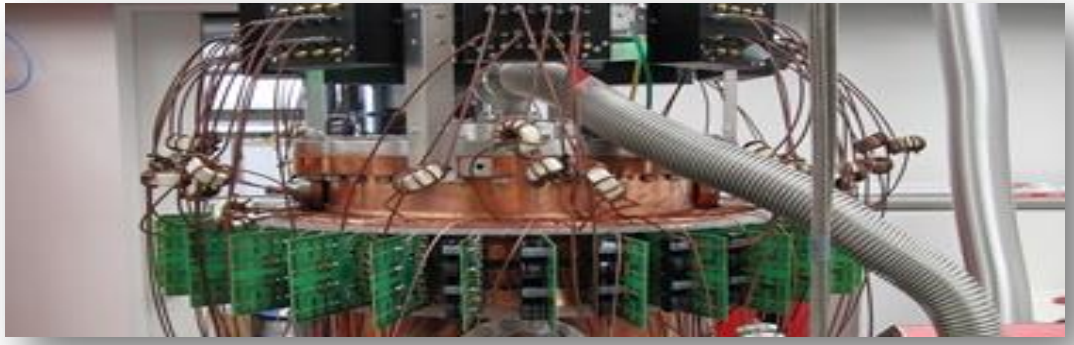
RF Power Developments

- Semiconductor amplifiers close-coupled to the cavity.
  - Possible substitute for expensive, customised klystrons (a significant proportion of the total accelerator system cost)
  - Reduces transmission losses, more electrically efficient (>70%)
  - Possible significant footprint reduction
  - Potential for user servicing and upgrades

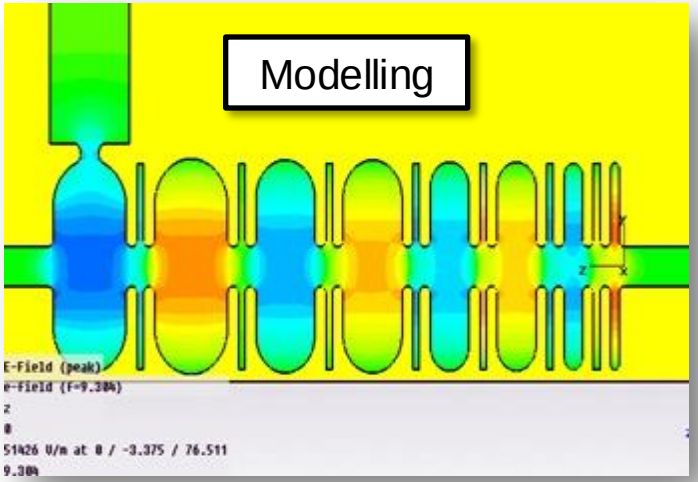


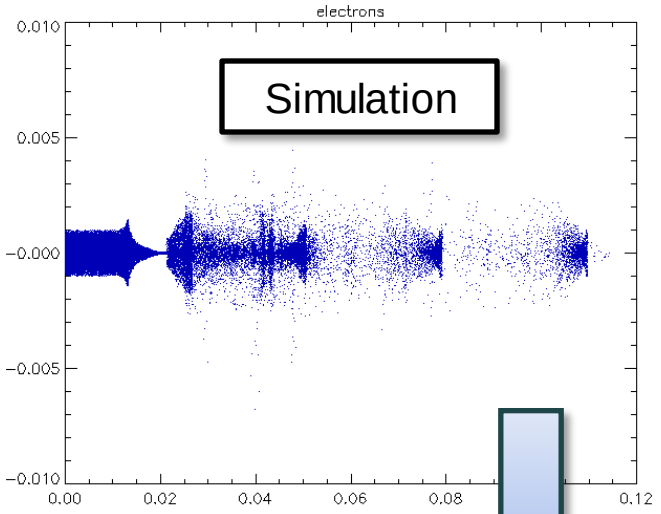
- Similarly, higher peak and average power magnetrons are opening up new opportunities to replace klystrons and deliver higher average beam currents.

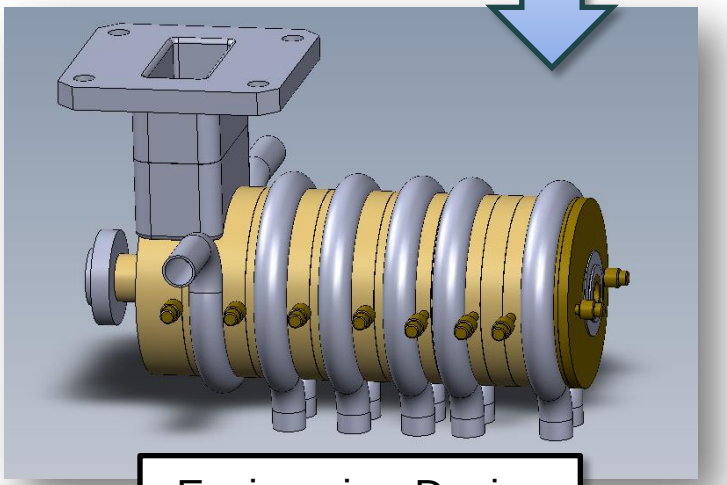
Material Developments

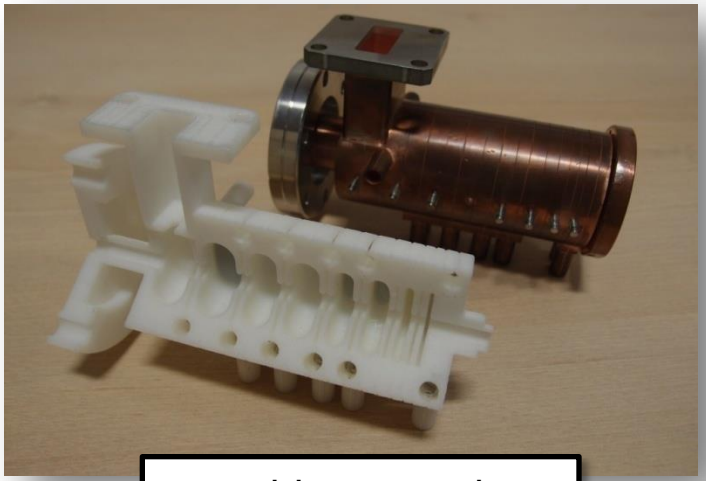
- Superconducting multilayers to supplement or replace expensive bulk material (e.g. niobium)
- High temperature superconductors may bring enhancements in the longer term
- Non-evaporable getter (NEG) coatings to enhance vacuum systems and reduce pumping system size and complexity

Fast Prototyping / Value Engineering

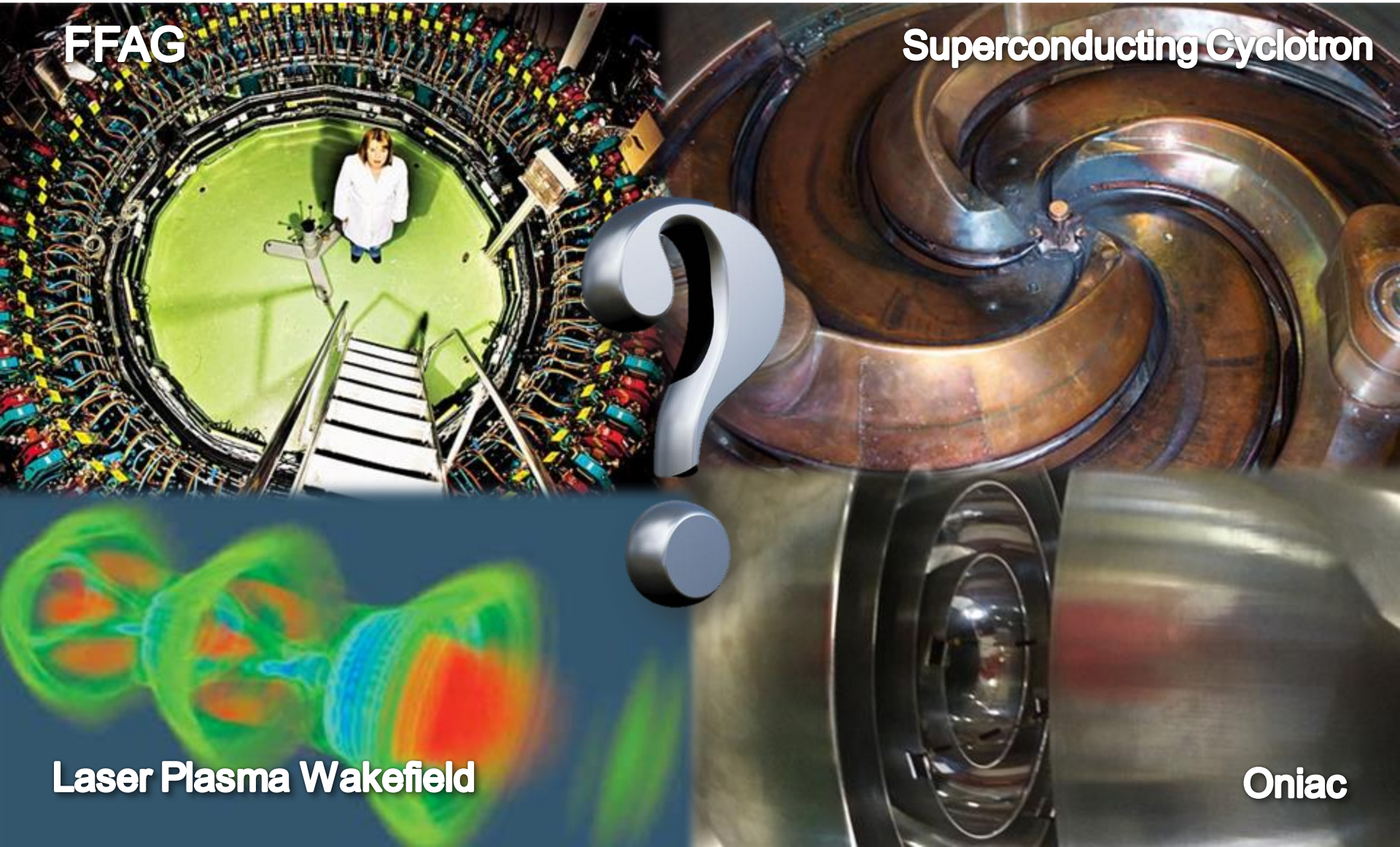








Novel Accelerators



Process Optimisation

- Significant opportunities to reduce the dose (and therefore infrastructure investment) by optimising how the accelerated beams interact with other 'conventional' techniques in the clean-up process (e.g. filtration, reduction, oxidation, aggregation, disintegration etc.)
- Therefore it is critical to promote dialogue between end users, technology suppliers and the academic base

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Summary

- Accelerators are not just big R&D tools - commercial use of accelerators is widespread in many sectors
- Technology developments are underway which will reduce the size, cost and complexity of accelerators
- The expertise exists in the UK to translate these developments into commercial systems
- Open dialogue is the key to fully identifying user needs and finding optimal solutions

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