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State-of-the-Art Accelerator Technology

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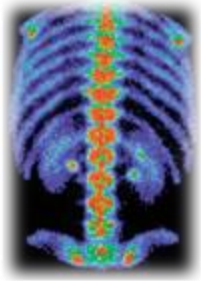
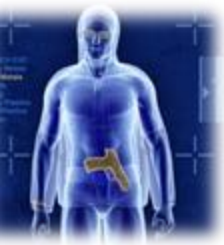
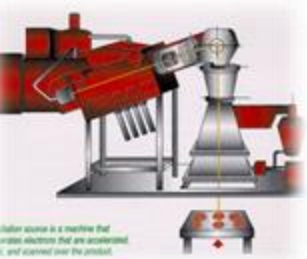
HEPTech Environmental Applications of Accelerators

9th July 2013

Accelerators Today



- Estimated >30,000 accelerators globally:
  - Only ~200 used for research – much 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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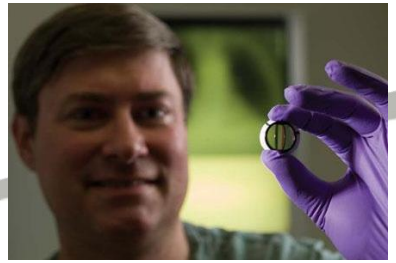
Impact of Accelerators

- 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.








Drivers for Increased Demand

- **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 operational 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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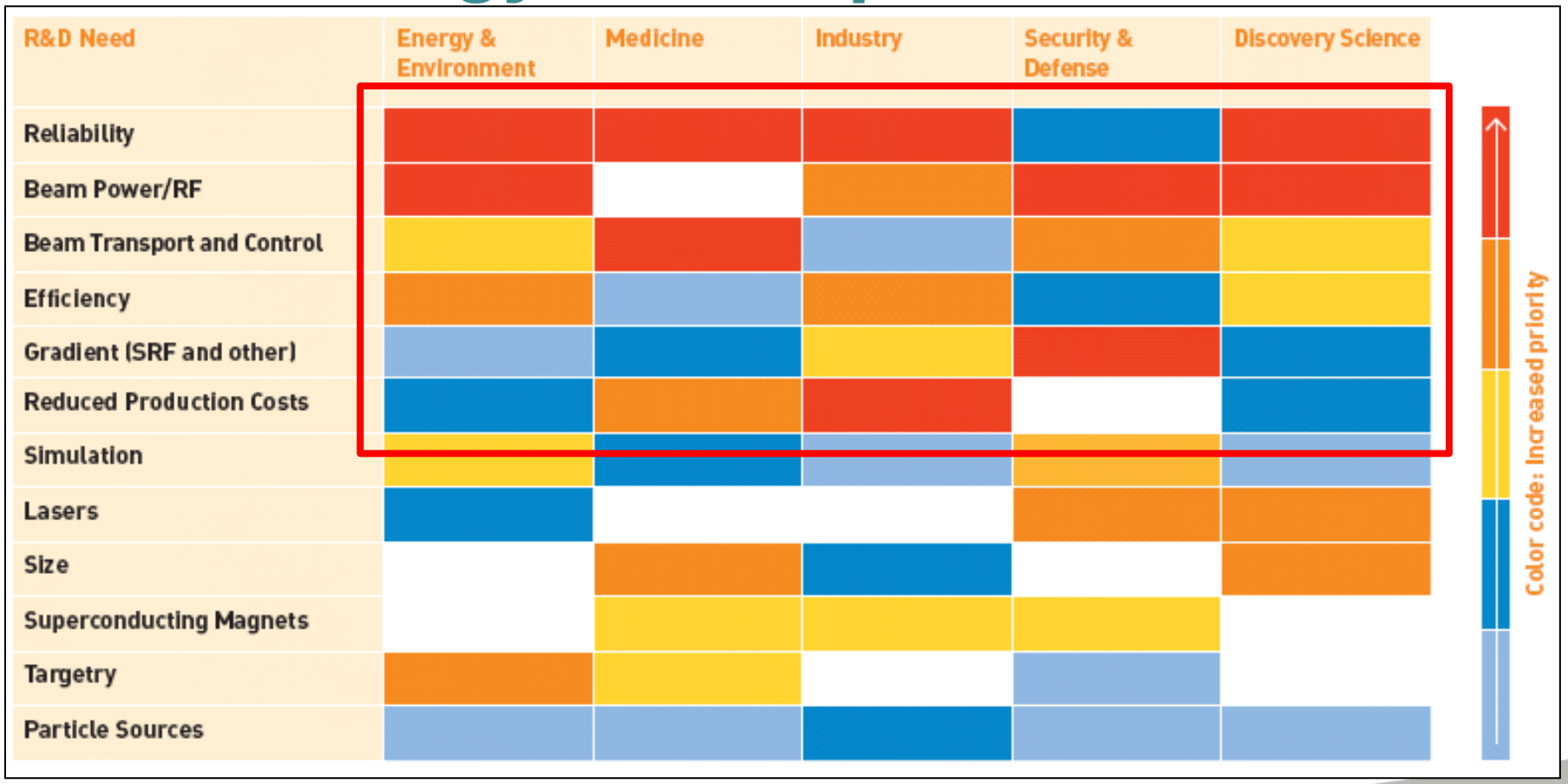
Technology Development Priorities



Ref: Accelerator for America's Future, July 2010, US DoE

Reliability, Beam Power, Transport, Efficiency, Gradient, Cost.

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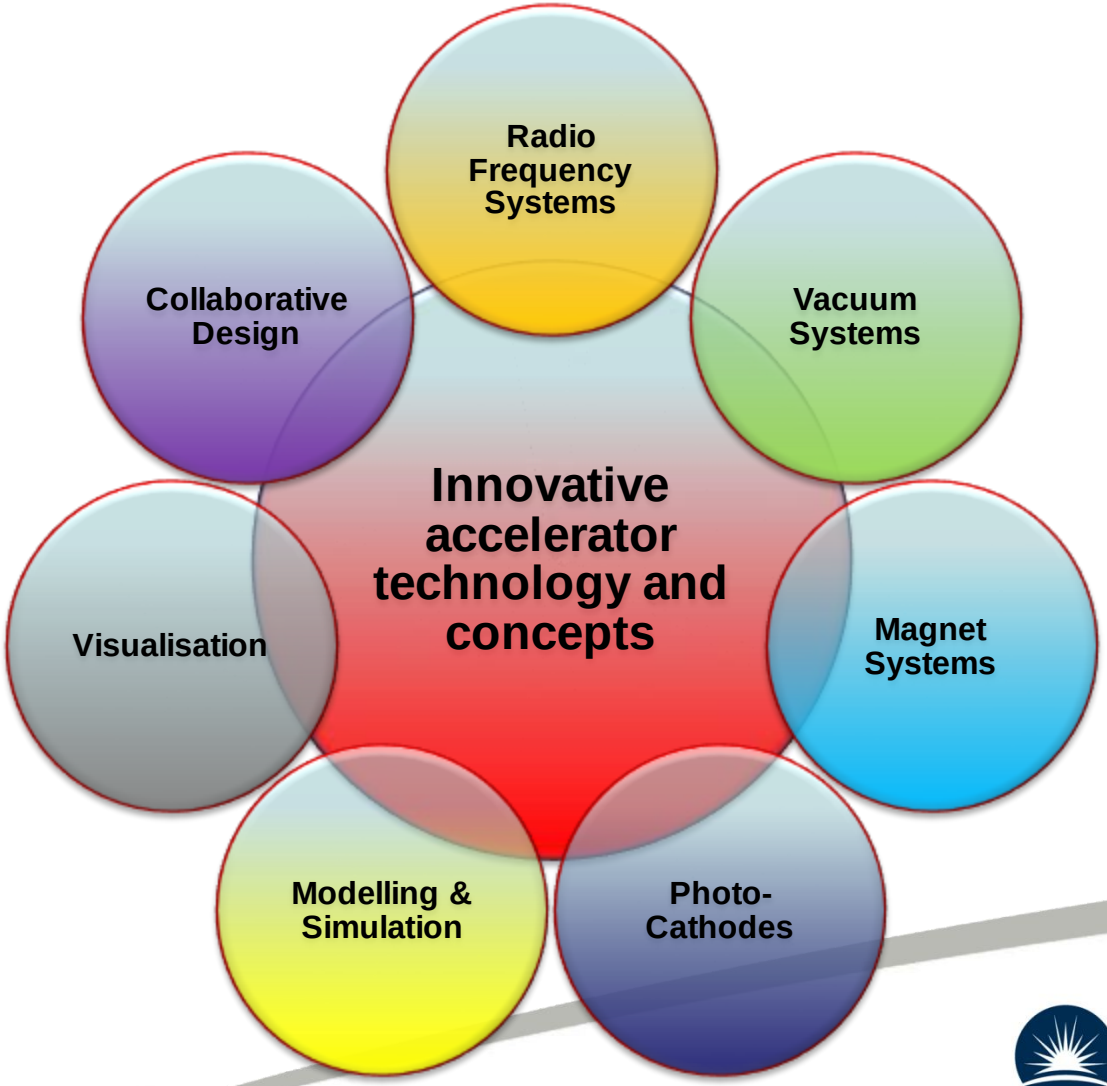
Key Technology Developments



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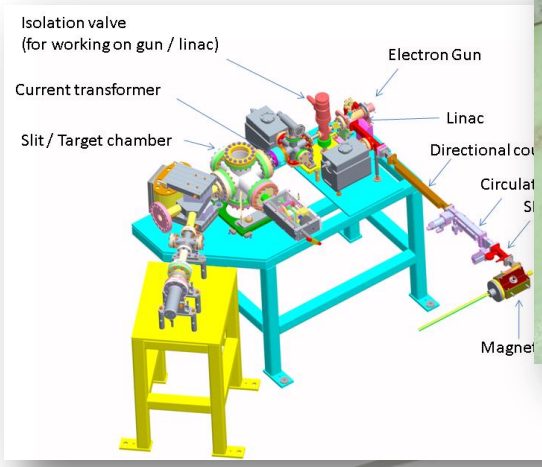
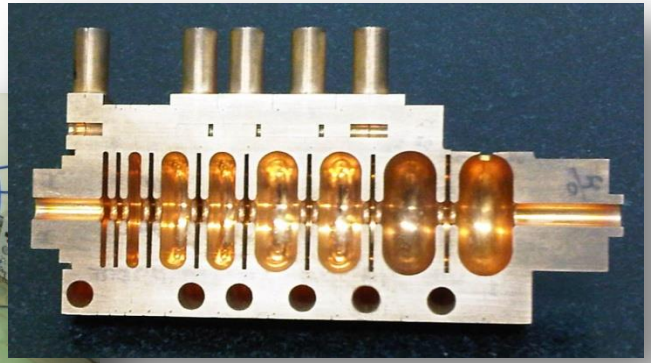
Compact Linacs

- 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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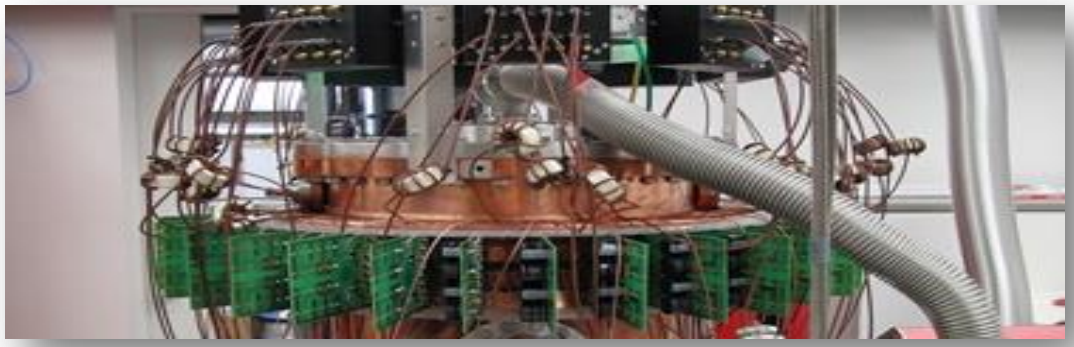
RF Power Developments

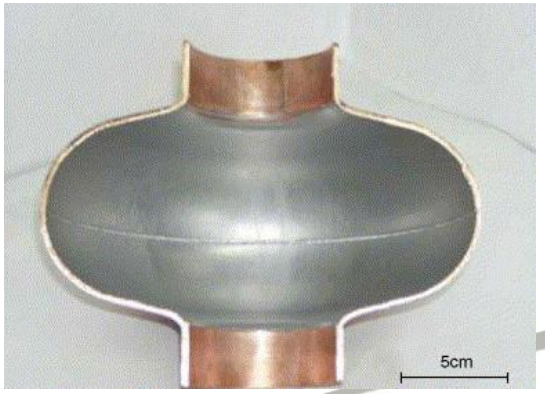
- Semiconductor amplifiers close-coupled to the cavity:
  - Possible substitute for expensive, customised klystrons (a significant proportion of the total accelerator system cost).
  - Reduces transmission losses, more electrically efficient (>70%).
  - Possible significant footprint reduction.
  - Potential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



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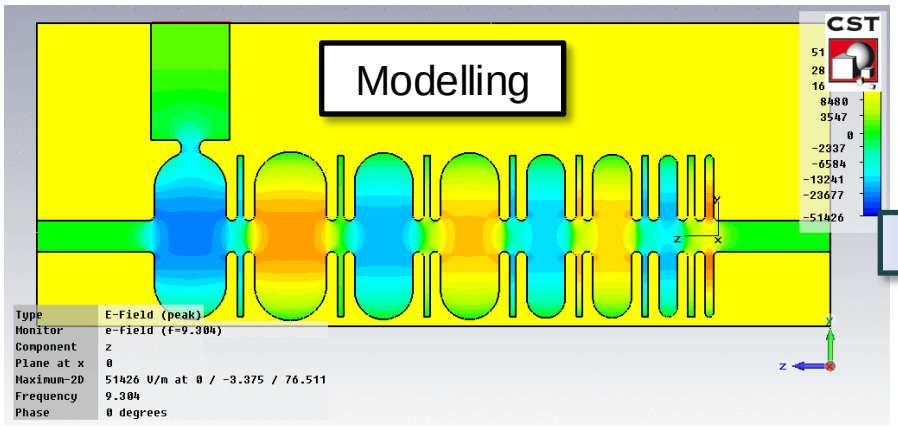
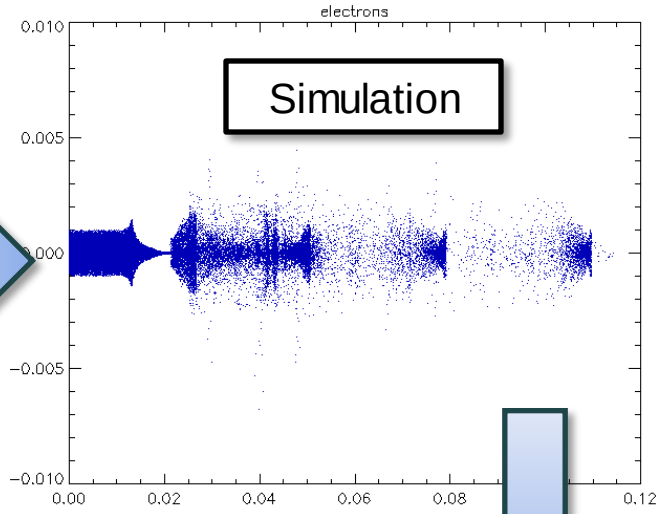
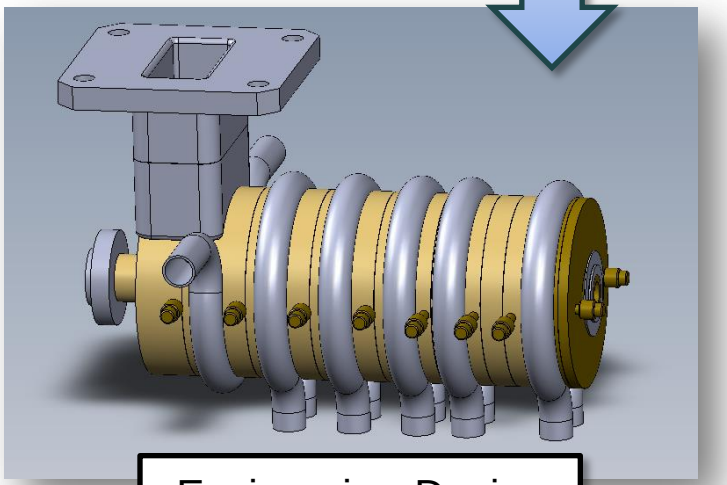
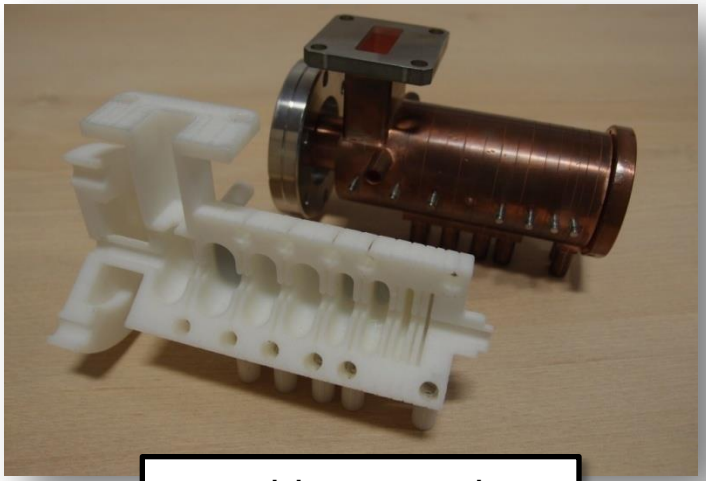
Fast Prototyping/Value Engineering

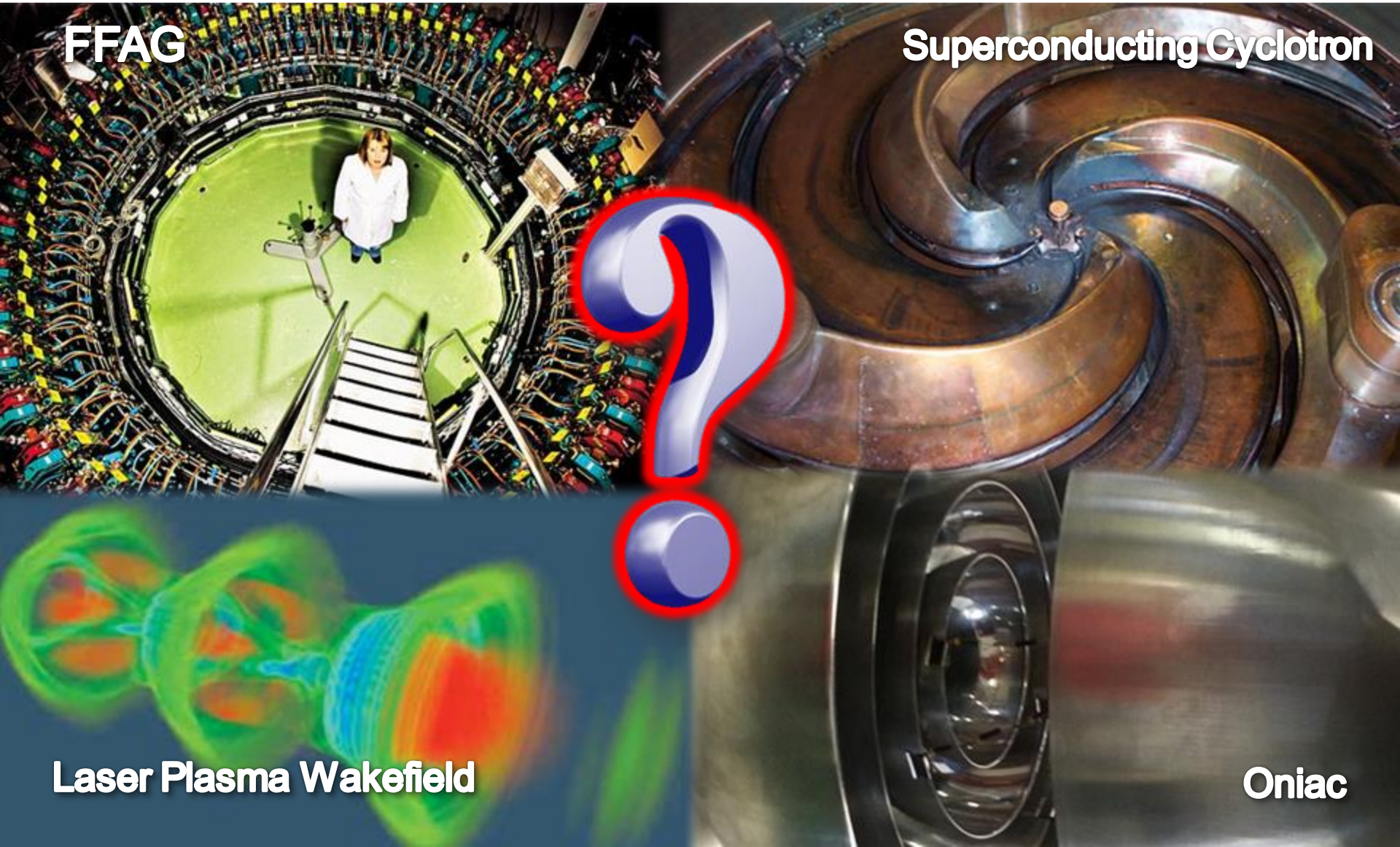








Novel Accelerators



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.