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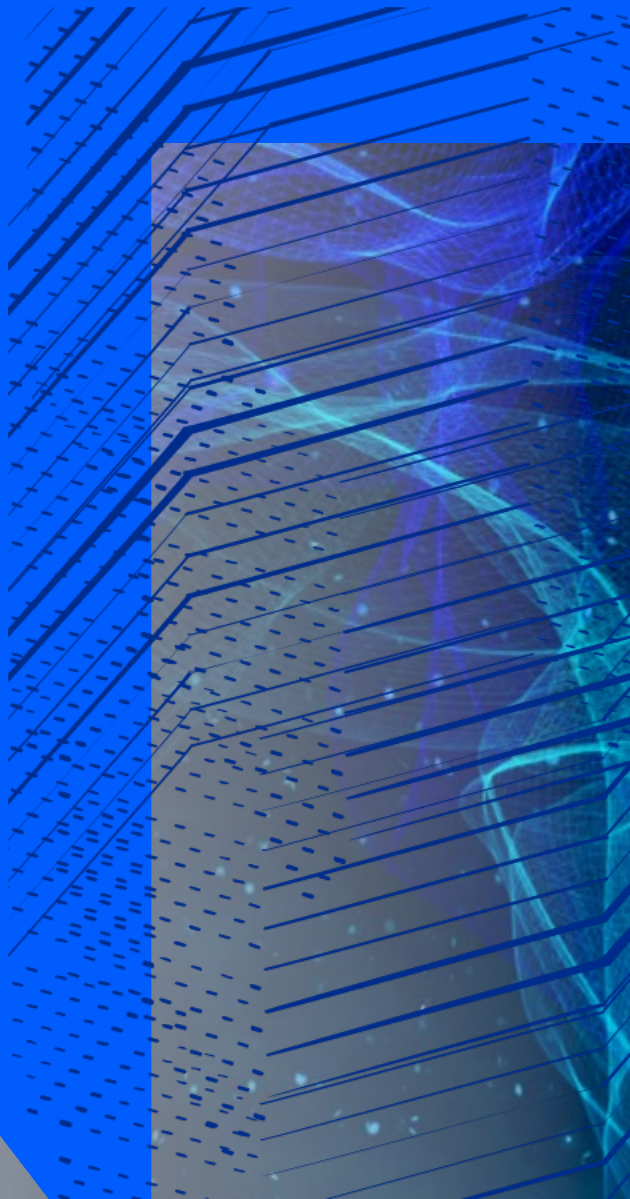
UK XFEL

An exciting opportunity for science and innovation



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The Science Case for UK XFEL 2019-2020

In the last decade XFELs have had an impressive scientific impact, but there is clearly scope to do much, much more.

Taking a long view, we looked at what kind of science we will do with an advanced XFEL operating from mid 2030's. Extrapolating current technology advances to frame what will be possible.

Science Case Objectives:

- To demonstrate scientific need
- To define a next generation XFEL capability
- To inform the technology that must be developed

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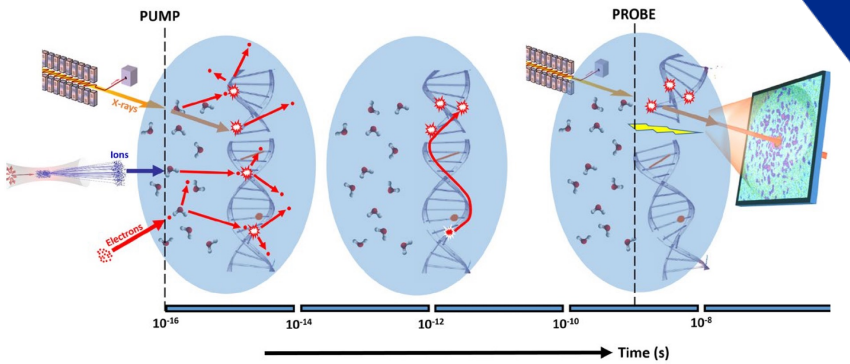
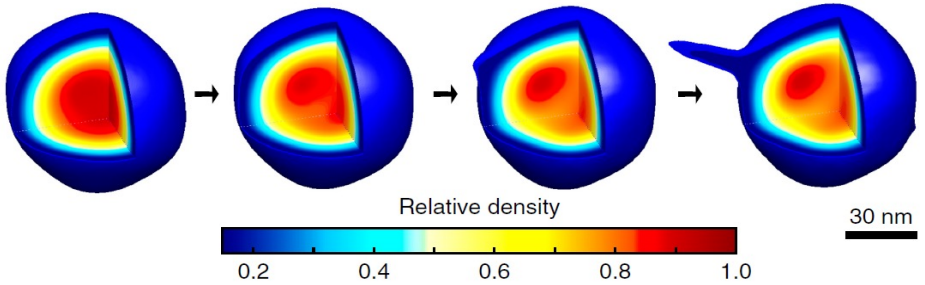
Future XFEL Science Highlights

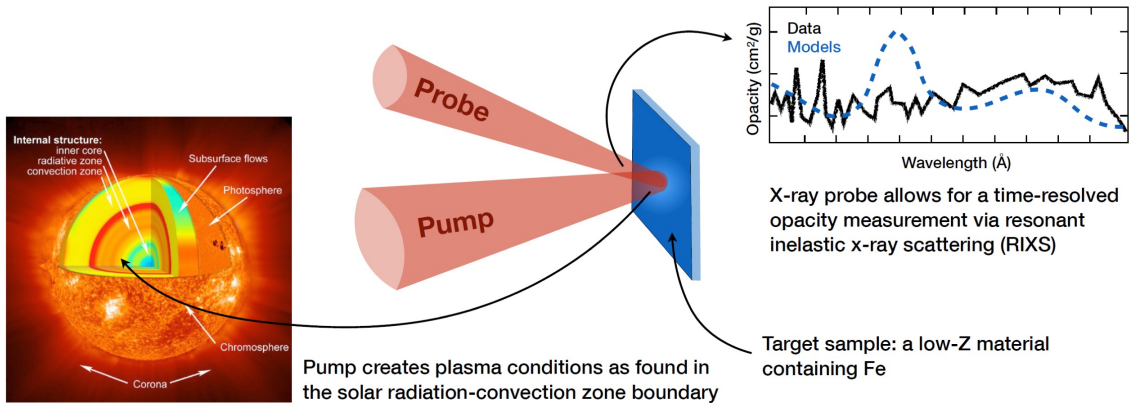
Ultrafast X-rays to probe attosecond electron dynamics, radiation interaction and damage with materials & biomolecules & elementary processes in chemical reactions



High X-ray intensity and high data rate allow exploration of fundamentals of X-ray matter interaction & new concepts in time resolved imaging at nanoscopic scale of living systems and materials in-operando



High energy/power optical lasers combined with bright X-rays access the conditions inside planets, stars and shocked materials in engineering, defence & fusion energy technologies



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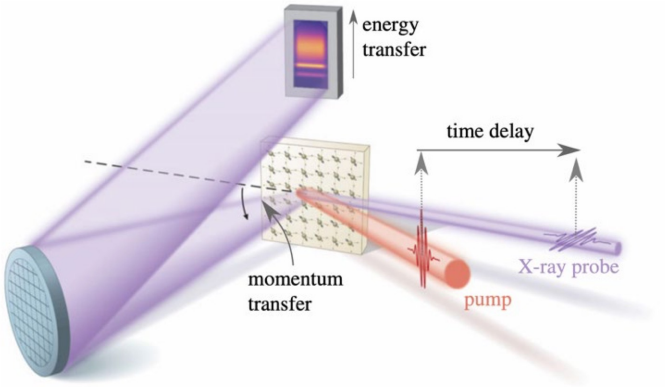
Future XFEL Science Highlights

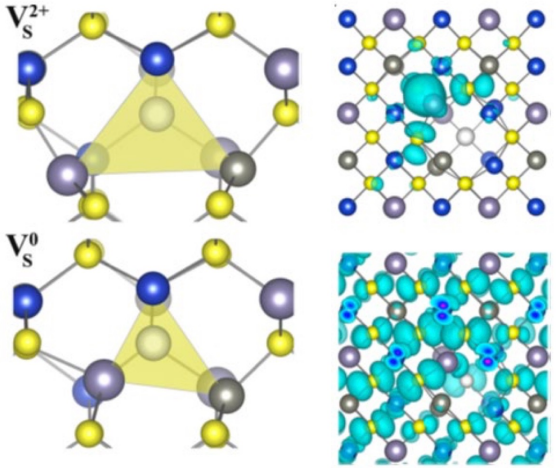
Transform limited X-rays and high data rates

enable probing and optimisation of photochemical technologies, quantum materials, ultrafast magnetisation, photodetectors & nanotechnologies



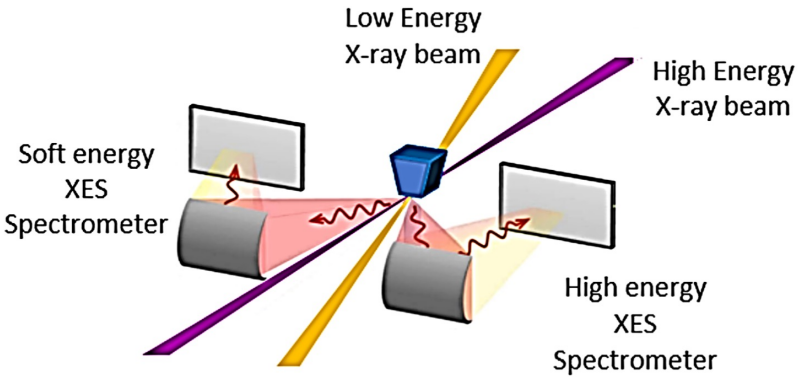
X-rays synchronized to ultrafast lasers, THz and electrons

uncover the fundamentals of chemical dynamics in the environment, space, engineering & energy materials



High rep-rate multi-colour ultrafast X-rays

provide powerful approaches to systematic advances in e.g. catalysis, MEC, biochemistry & structural materials



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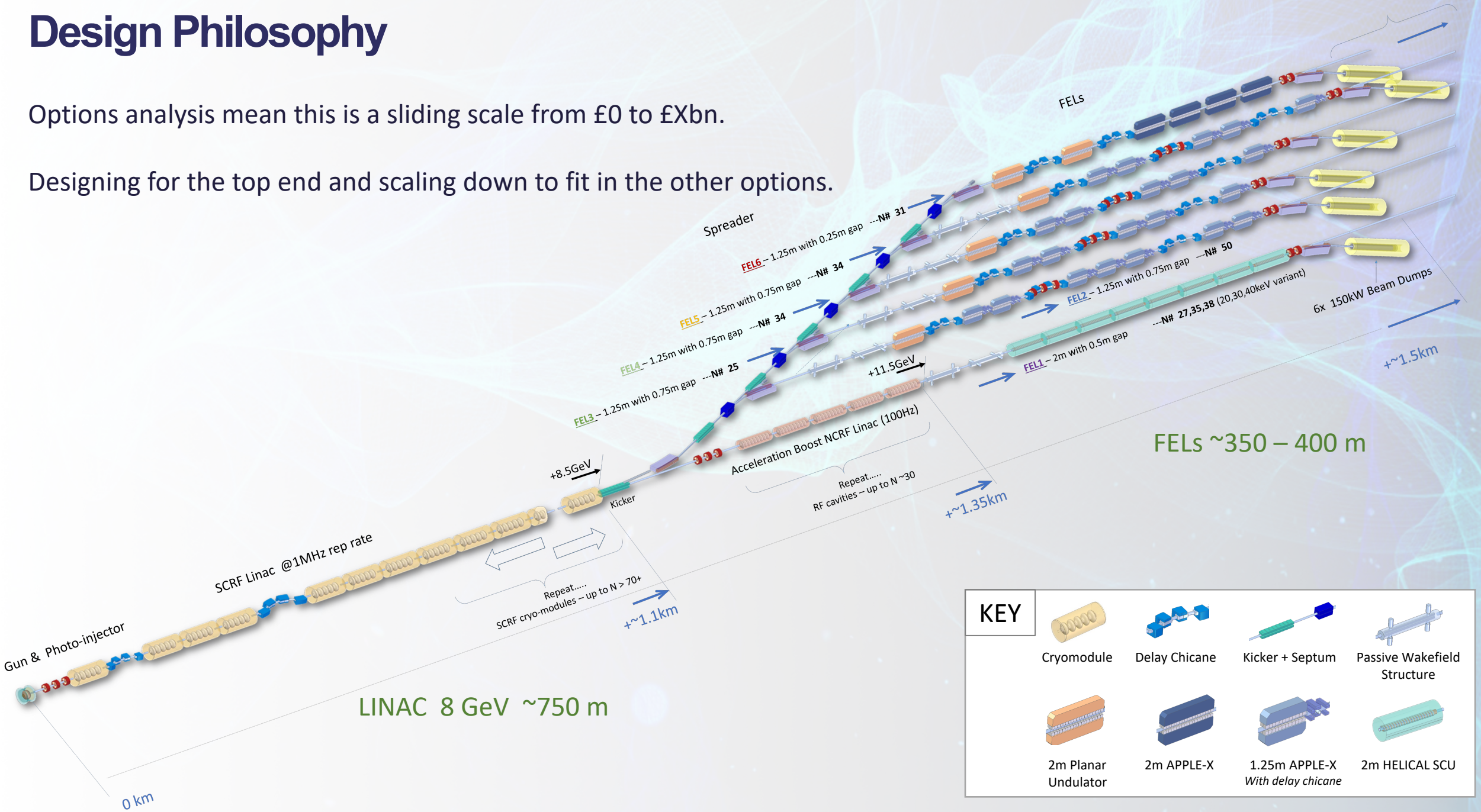
Design Philosophy

Options analysis mean this is a sliding scale from £0 to £Xbn.

Designing for the top end and scaling down to fit in the other options.



Expected timelines

Evaluate

2019 to 2021 — Science Case – Completed

Design

Currently here → Oct 2022 to Oct 2025 — Conceptual Design and Options Analysis

Oct 2025 to 2029 — Technical Design Review

Construction

2029 onwards — Civil Construction work

2030 onwards — Accelerator Construction work

Funding Bids would need to be approved before the start dates suggested. Delays in approval could cause teams and expertise to disband and lose momentum.

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Key next-generation capabilities identified in the UK XFEL Science Case:

- Transform limited operation across entire X-ray range
- High efficiency facility, with a step-change in the simultaneous operation of multiple end stations
- Evenly spaced, high-rep rate pulses to match samples & detectors
- Improved synchronisation/timing data with external lasers to < 1 fs
- Widely separated multiple colour X-rays to least one end-station
- Full array of synchronised sources:
  XUV-THz, e-beams, high power & high energy lasers at high rep-rate
- Minimise the carbon footprint and energy consumption for both operation and build.

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A next generation XFEL

By October 2025 we will have:

- mapped out how best to deliver advanced XFEL capabilities identified in the Science Case
- explored a Conceptual Design for a unique new machine that can fulfil all required capabilities
- examined other investment options and collaborations in existing XFELs
- updated the Science Case to feed into the process and inform future decisions
- held multiple Townhall Meetings around UK engaging with the user community
- investigated the socioeconomic impact of a next generation XFEL

UKRI Science and Technology Facilities Council

Project Sponsor : John Collier
Science Lead : Jon Marangos
Technical Lead : Jim Clarke
Project Manager : Paul Aden

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Contact info:

Project Manager - paul.aden@stfc.ac.uk

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