FUSION CDT

EPSRC Centre for Doctoral Training in the Science and Technology of Fusion Energy

Fusion CDT - Overview

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University of Oxford
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Fusion CDT: The need for fusion skills

- The demand for fusion skills is stretching supply
  - Strong growth in the UK, as well as internationally (e.g. China, US)
  - Driven by both government and private fusion programmes gearing up for commercialisation
  - Supply chain must also grow towards developing the future fusion industry
- If not under-pinned by strong, coherent training programmes, this growth will falter

The UKAEA fusion energy landscape
Towards commercialisation

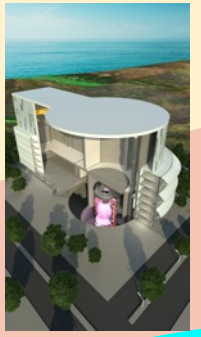
Commercialisation

3. Delivering product to market

Fusion Power Plant

EU DEMO

STEP



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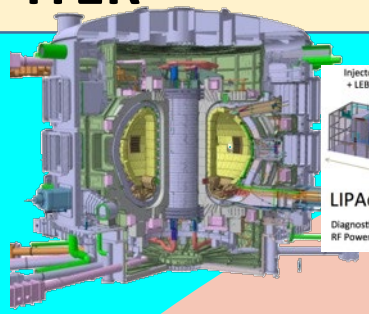

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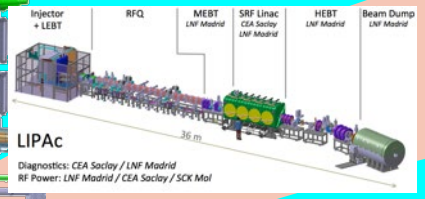
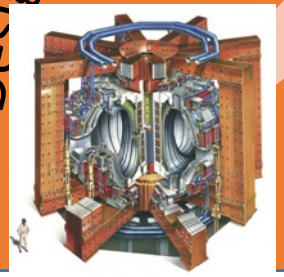


Industrialisation

2. Skills transfer, supply chain and spin-outs

R&D Design



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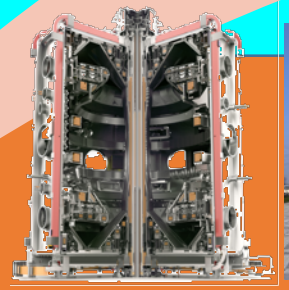


MAST-U

RACE

MRF

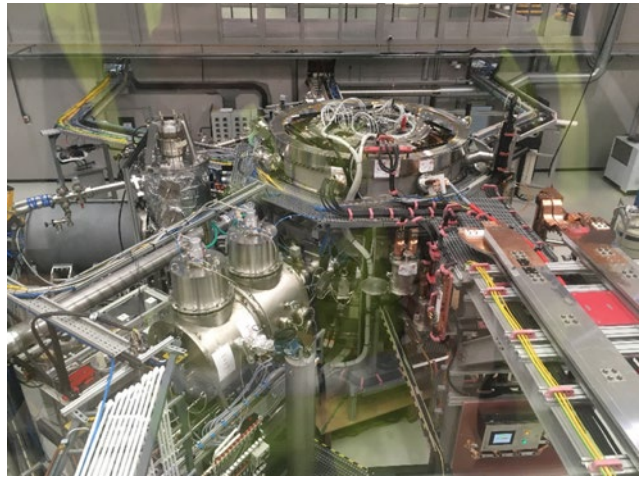
H3AT

FTF

HPC

1. UK leadership in fusion R&D

Private DT fusion companies reinforce the commercial opportunity

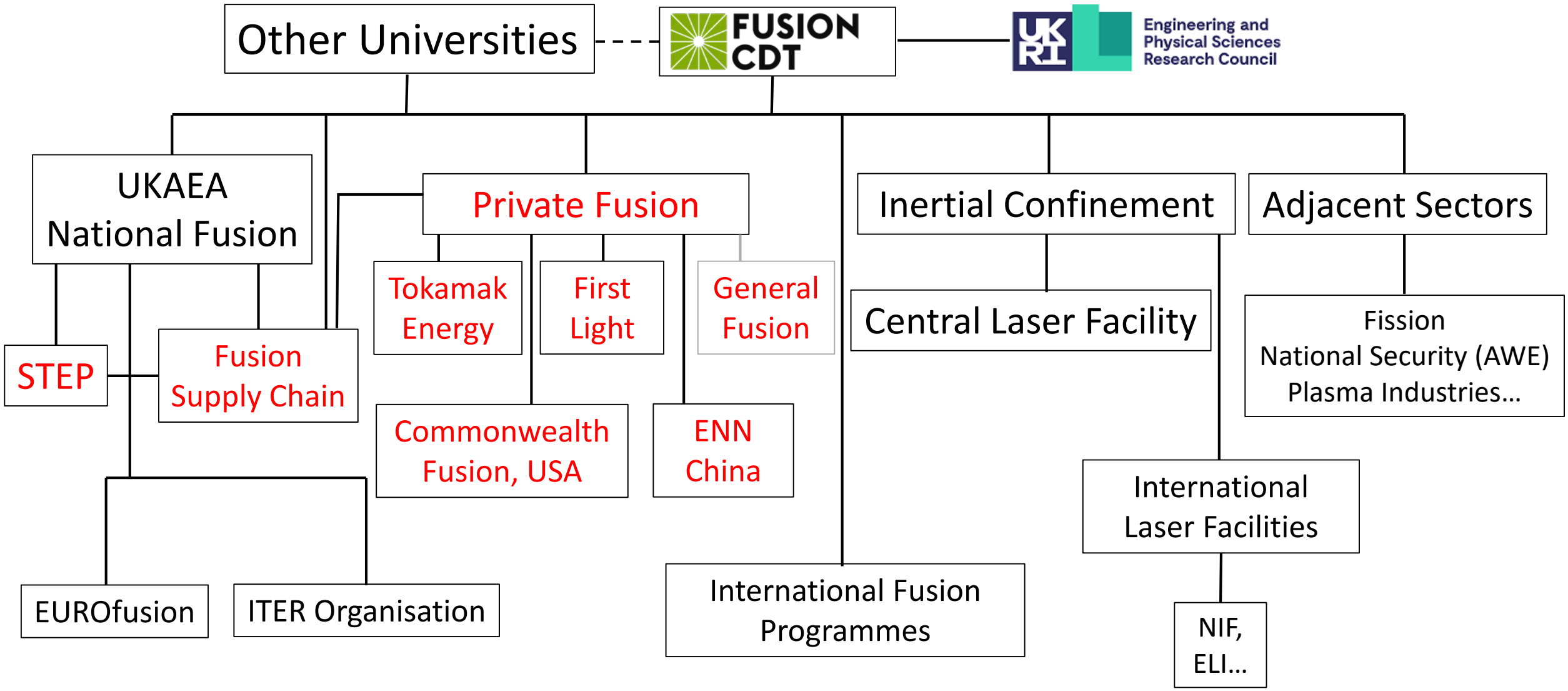


- Tokamak Energy – high field spherical tokamak with high temperature superconducting (HTS) magnets
  - ST-40 facility is operating in Oxfordshire
  - Plans for a DT device (this decade?)

- First Light Fusion – inertial confinement employing shock waves
  - Machine 3 facility operational in Oxfordshire
  - New gas gun facility commissioned this year
  - Conceptual design for gain experiment in progress

- General Fusion – magnetic confinement plus compression
  - Canadian company's recent announcement to site $400m programme at Culham

Fusion skills required across diverse organisations, in the UK and internationally



The Fusion CDT: Our Scope

- We cut across both magnetic and inertial fusion energy approaches

- Our scope covers two of the main fusion science areas and related technologies
  - Plasma Physics
  - Materials Science

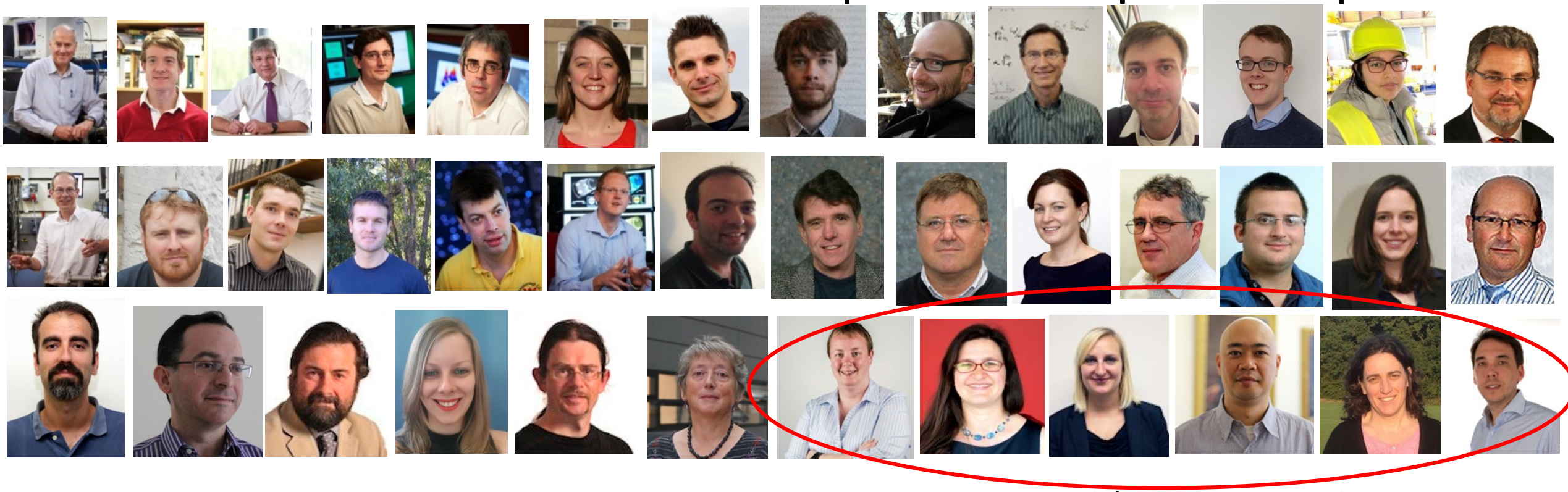
- As we advance towards building and operating fusion prototypes, we are growing our social science expertise in key areas:
  - Regulation and licensing
  - Public acceptability
  - Fusion economics

Overview of CDT structure

- A network of five universities:
  - Durham, Liverpool, Manchester, Oxford and York
- Collaborating with national and international partner laboratories
  - UKAEA, AWE, F4E, ITER, NNL, RAL, EUROfusion…
- …and industry, including private fusion companies and wider supply chain
- To train the next generation of fusion experts who will:
  - Exploit ITER, DEMO design and international laser facilities
  - Design, build and then operate STEP
  - Support private fusion endeavours
  - Support the development of the fusion industrial supply chain
  - Contribute to industries in adjacent sectors

Fusion CDT: the scale

Staff & Supervisors – past and present

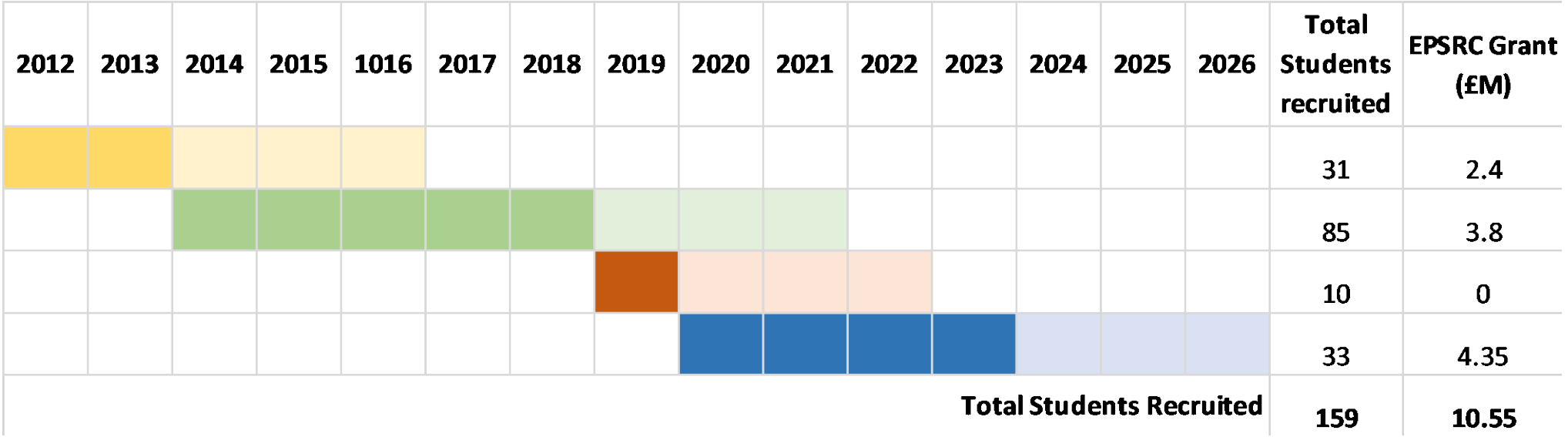


Social sciences supervisors across Environment & Geography and Politics

Admin, finance, outreach team:

Plus 70-80 PhD students in post at any time

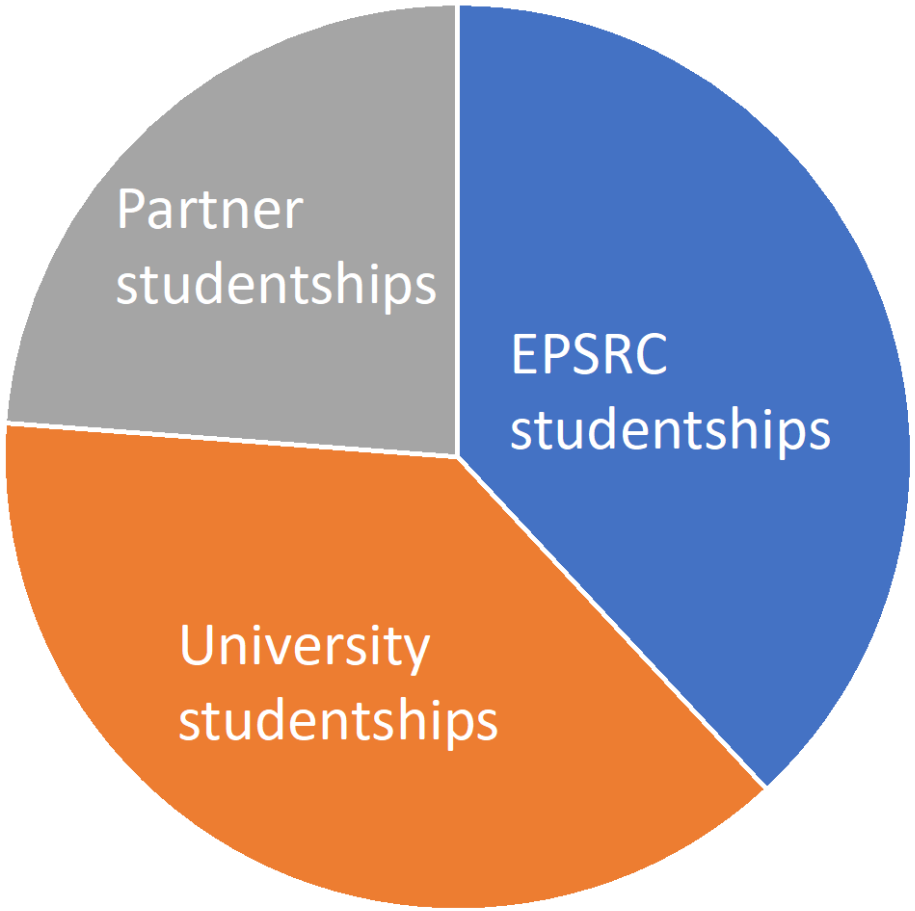
Our Funding

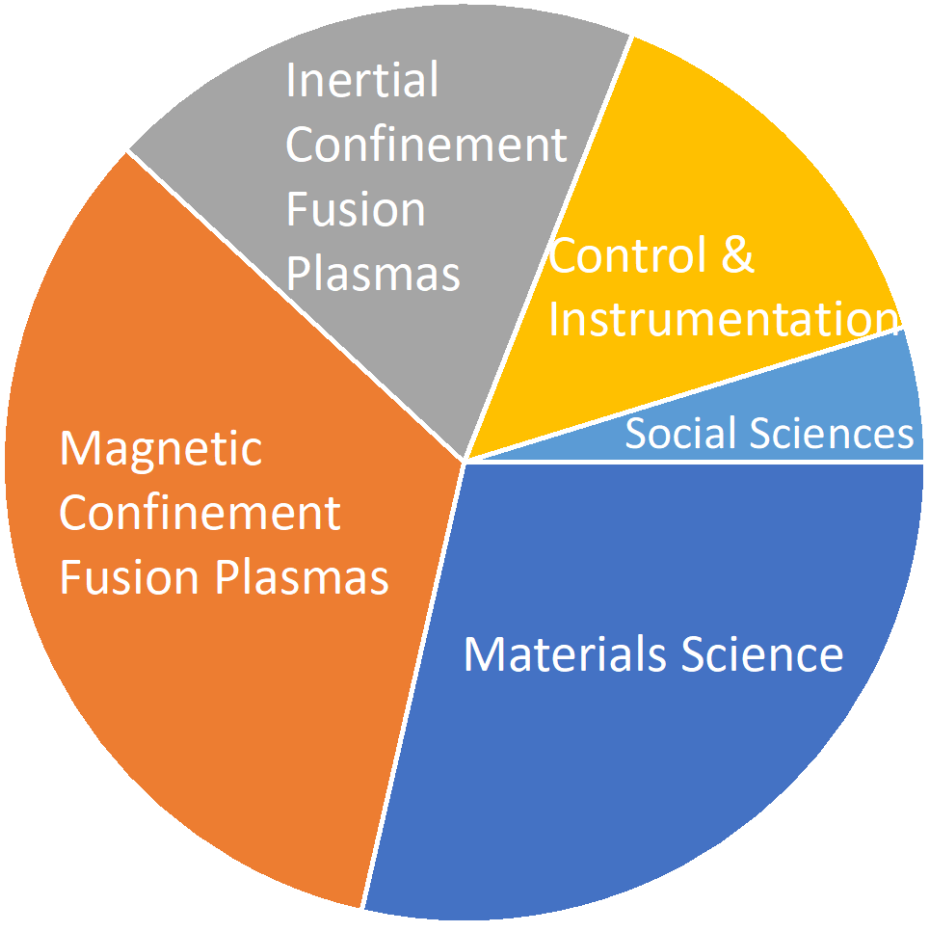


	2012	2013	2014	2015	1016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total Students recruited	EPSRC Grant (£M)
Fusion DTN																31	2.4
Fusion CDT Pt1																85	3.8
Bridging CDT																10	0
Fusion CDT Pt2																33	4.35
															Total Students Recruited	159	10.55

- EPSRC is the dominant funding organisation, matched from other sources:
  - Our partner universities (match EPSRC studentships)
  - EUROfusion
  - Partner organisations: UKAEA, AWE, CLF, First Light Fusion, Tokamak Energy, Rolls Royce, ITER Organisation, NIF, National Nuclear Lab…

Training across Disciplines: New CDT





Training Structure

- Four year cohort-based PhD programme:
  - Early group introductory modules with team-building
  - Formal taught programme in first 6 months
  - Major research project across remaining 3.5 years
- “Collaboratory” mini-project (typically during second year)
  - Tailored for social sciences (field work)
- Annual “Frontiers and Interfaces of Fusion” plus student conference
- Optional outreach programme

Fusion education into the future: Some closing personal thoughts

- Plasma physics and materials science needs will remain key into the future
- Requirements for siting, regulation and economics will drive growing activity in the social sciences (including public perception)
- Increasing needs for tritium science experts
- Accelerated fusion delivery to market will need innovative new approaches to engineering design, regulation (and construction), managing uncertainty:
  - Key role for “next generation digital engineering”
  - Requires a new breed of engineers
- As fusion penetrates into commercial organisations, there will be an increasing need for professional development of staff
  - Exploring with UKAEA and interested commercial organisations a new Fusion Industry School