UK Atomic Energy Authority

CCFE/UKAEA

UKT0 Collaboration Meeting

14th – 16th March 2018
Cosener's House

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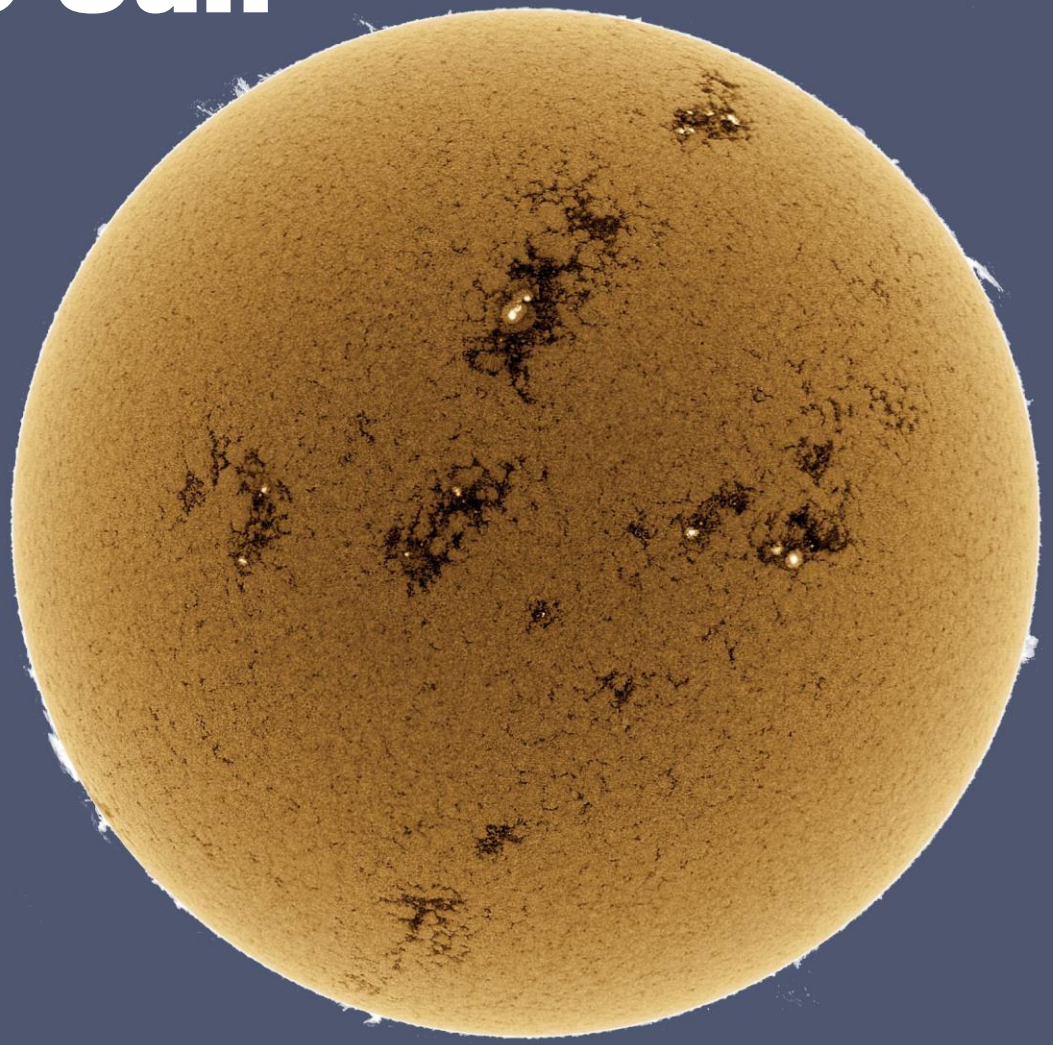
The Sun



The solar fusion cycle….

$^{1}H + {}^{1}H \rightarrow {}^{2}H + e^{+} + \nu$ (Q=1.44 MeV)

$^{2}H + {}^{1}H \rightarrow {}^{3}He + \gamma$ (Q=5.49 MeV)

$^{3}He + {}^{3}He \rightarrow {}^{4}He + 2{}^{1}H + \gamma$ (Q=12.86 MeV)

$^{3}He + {}^{4}He \rightarrow {}^{7}Be + \gamma$

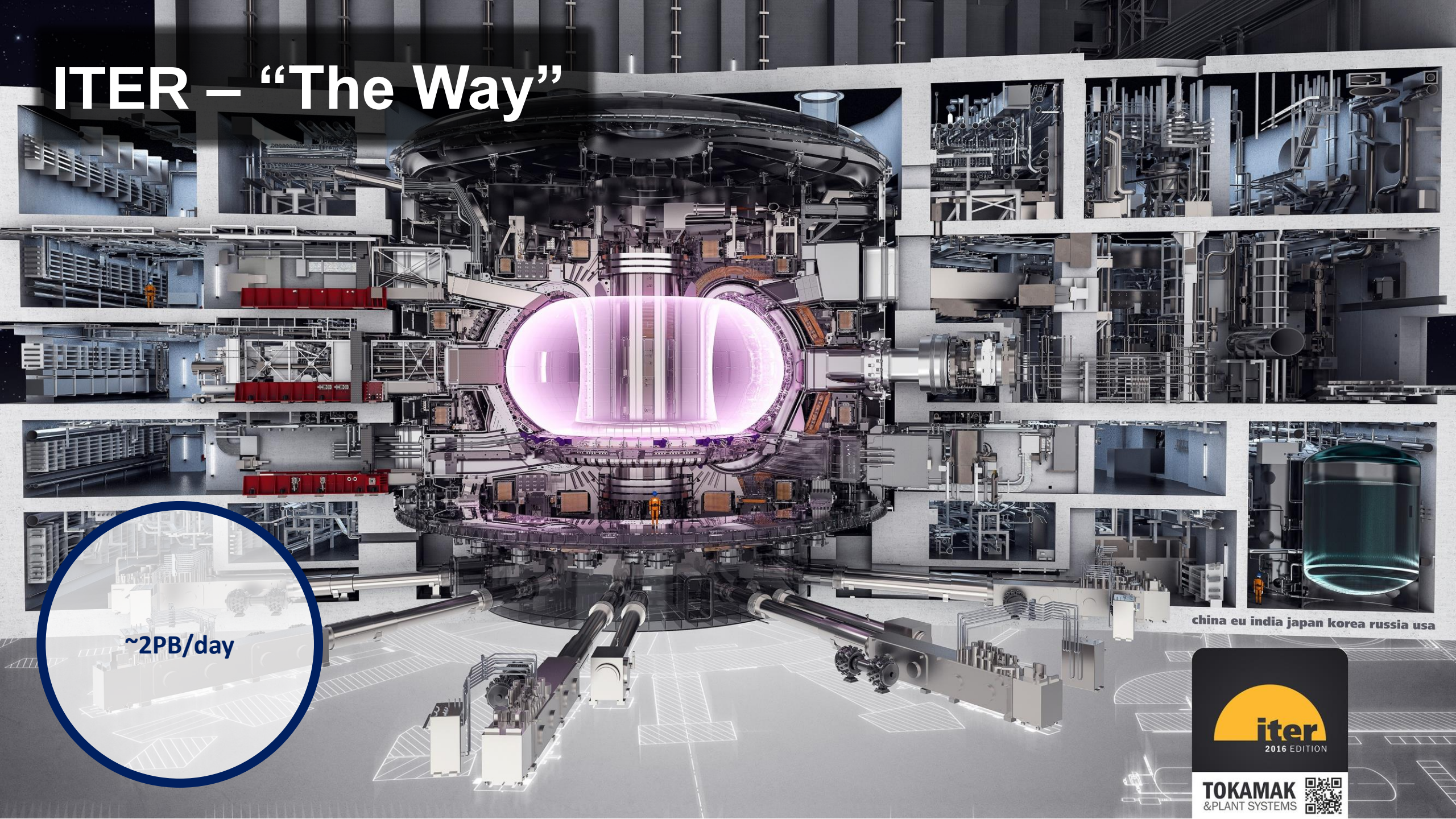
$^{7}Be + e^{-} \rightarrow {}^{7}Li + \nu$

$^{7}Li + p \rightarrow 2{}^{4}He$

CCFE hosts JET, the Joint European Torus (16MW DT fusion achieved)

~0.5PB data in 35 years, now ~1TB/day

ITER – “The Way”


~2PB/day
china eu india japan korea russia usa
iter
2016 EDITION
TOKAMAK
&PLANT SYSTEMS

ITER nuclear fusion project reaches key halfway milestone – The Guardian, Wednesday 6 December 2017

National Fusion Technology Platform (NFTP)

UK Atomic Energy Authority

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Press release

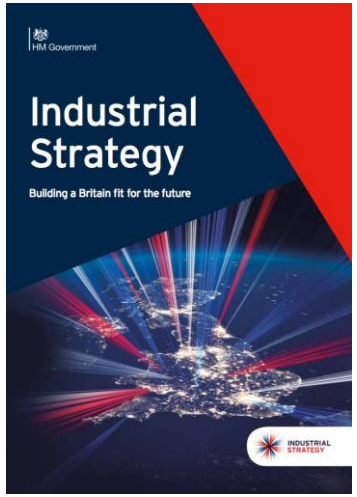
£86 million boost for UK nuclear fusion programme

UKAEA secures Industrial Strategy funding for fusion research

Published 7 December 2017
From: UK Atomic Energy Authority

Fusion Technology research

An £86 million Government investment in the UK Atomic Energy Authority's (UKAEA's) nuclear fusion research programme at Culham Science Centre has today been announced. This investment will fund the building and operation of a National Fusion Technology Platform at Culham, expected to open in 2020.



BEIS investment of £86M over next 3.5 years

Specific aims:

- Maximise commercial income from ITER (~ £1-1.9B worth of contracts to UK industry);
- Safeguard key fusion skills and experience during a period of significant uncertainty by securing a long-term future for world-class scientists and engineers currently at JET;
- Ensure the UK maintains its position as a world leader in fusion technology in the long-term and position it to exploit any fusion reactor design economy in the future.

The National Fusion Technology Platform comprises two new centres of excellence:

Hydrogen-3 Advanced Technology (H3AT) will research how to process and store tritium, one of the fuels that will power commercial fusion reactors;

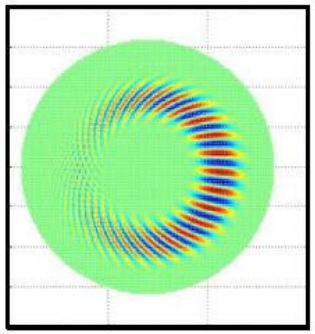
Fusion Technology Facilities (FTF) will carry out thermal, mechanical, hydraulic and electromagnetic tests on prototype components under the conditions experienced inside fusion reactors.

UK Atomic Energy Authority

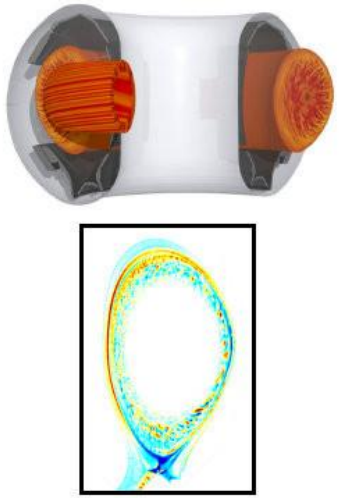
....to expedite the delivery of commercial Fusion power by exploiting advances in Big Data and Extreme Scale Computing (BDEC)....

UKAEA Advanced Computing Programme

Old way: Exascale a panacea

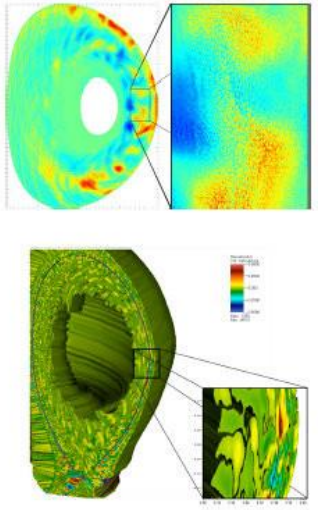


Gigaflops
Core: ion-scale electrostatic physics in simplified geometry



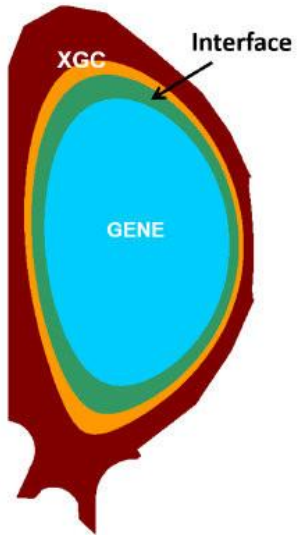
Teraflops
Core: adding kinetic electron electromagnetic physics in a torus

Edge: ion + neutral electrostatic physics in a torus

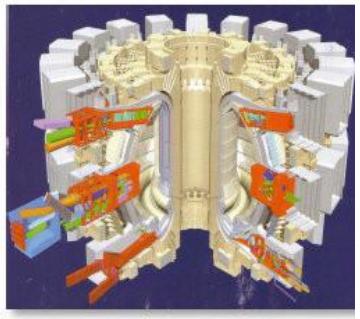


Petaflops
Core: adding electron scale physics

Edge: adding kinetic electron electrostatic physics



Exaflops
Core-edge coupled studies of whole device ITER, incl. turbulence, MHD instability, fast particles, heating and plasma wall interactions

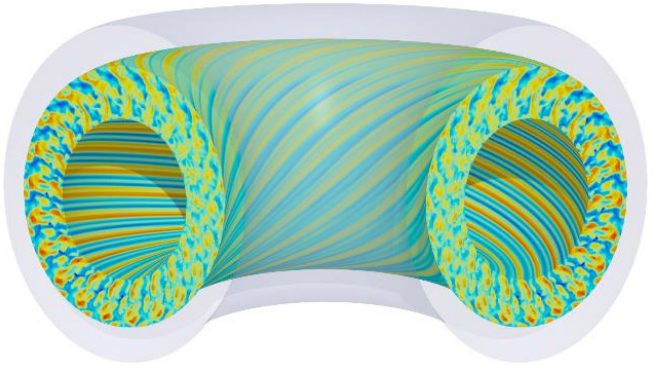


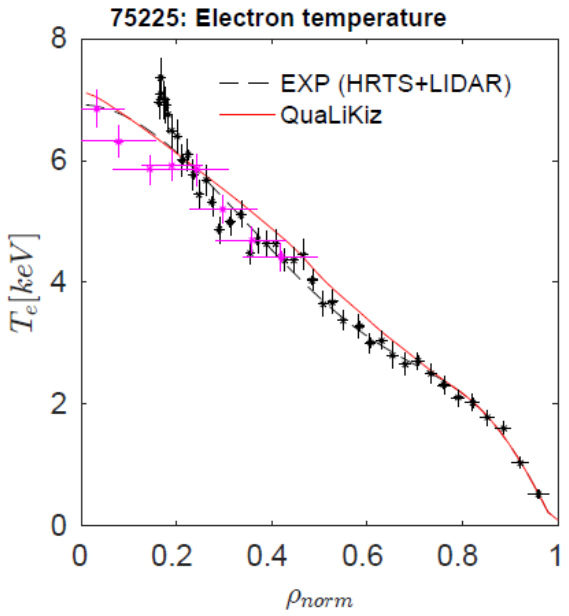
Beyond
Whole device modelling of all relevant fusion science and engineering

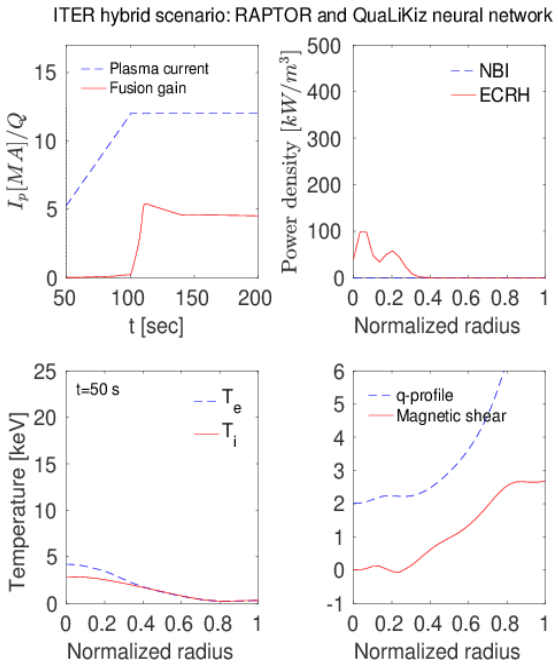
F.Jenko (IPP), EFPW 2017

New way: Multi-Fidelity modelling

(J. Citrin, DIFFER, EFPW 2017)







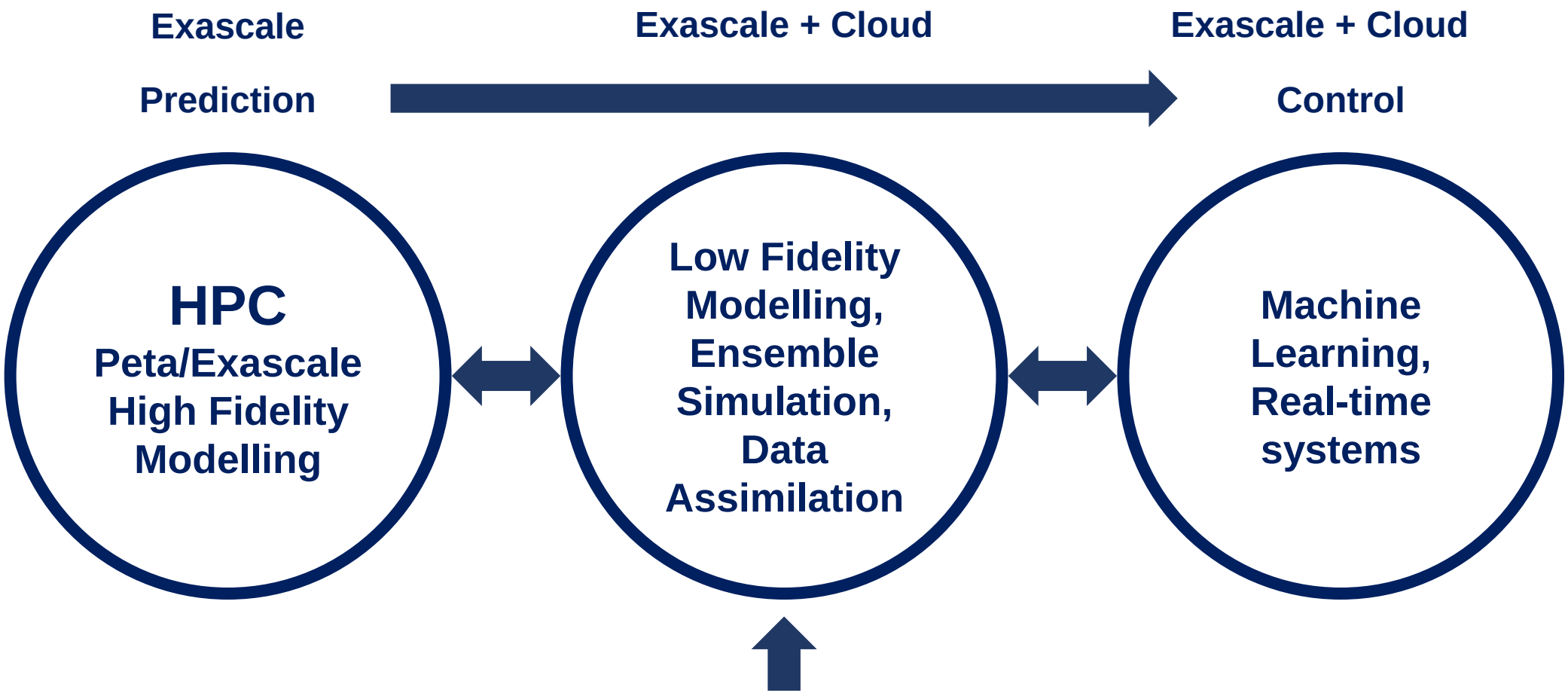
"Golden standard", e.g., with local δf nonlinear gyrokinetics (e.g. GENE)
10^8 CPUh for 1s JET-scale profile evolution

Reduced model, e.g. QuaLiKiz (Bourdelle PoP '07).
10^2 CPU hours for 1s JET-scale profile evolution

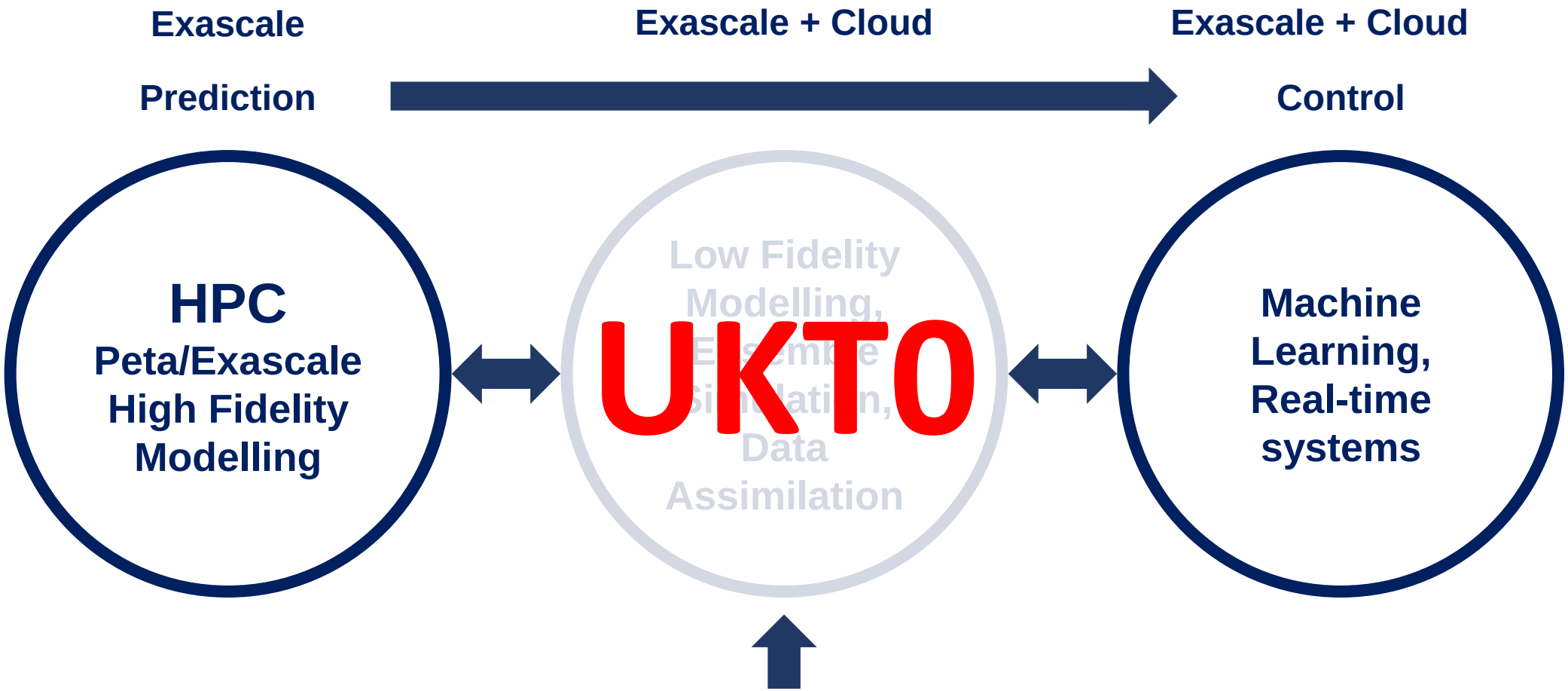
Realtime capability.
Neural Network emulation technique.
Real-time capable!

Connects: HPC + Experiments + Data Science + ML Expertise

Multi-Fidelity Modelling + Expt.



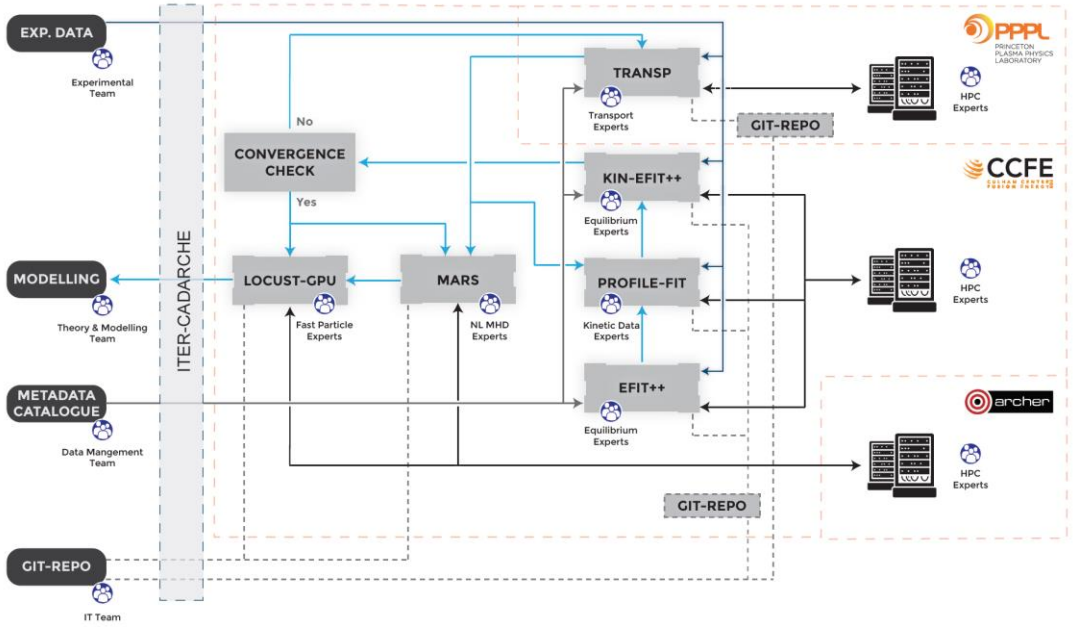
Multi-Fidelity Modelling + Expt.

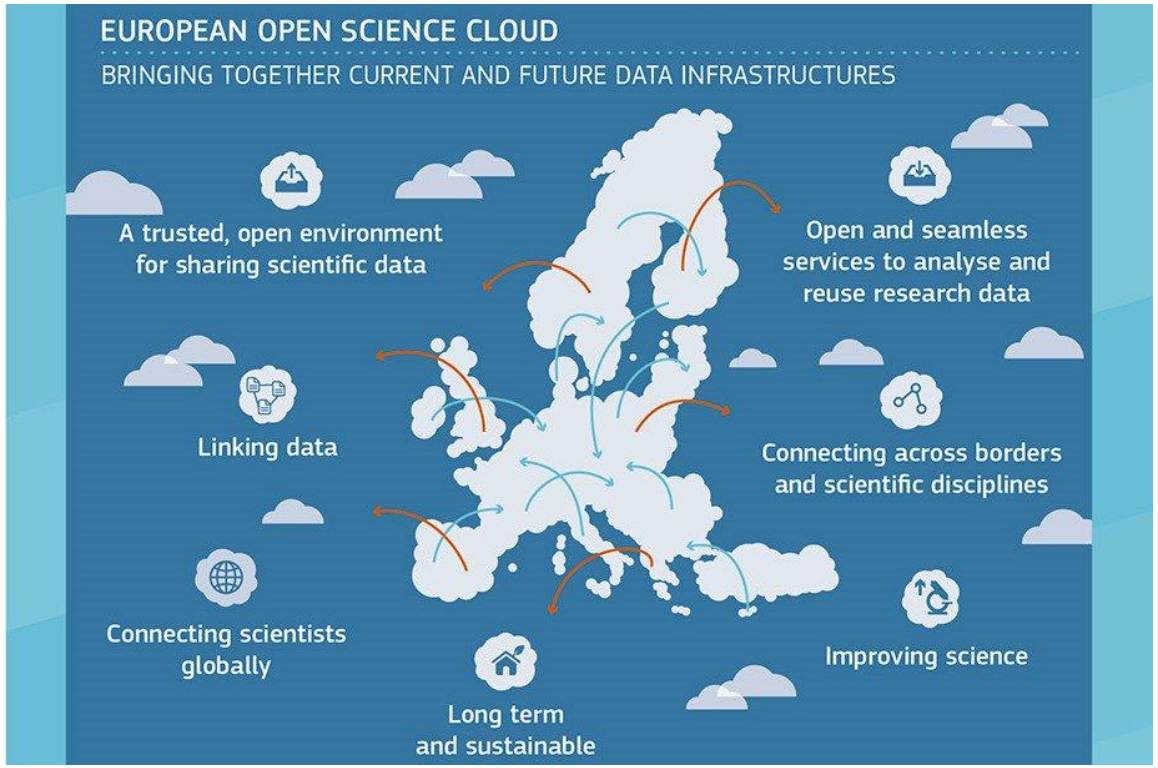


Low Fidelity modeling/data environment

Data analytics, Big Data, Ensemble simulations, UQ

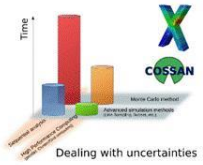
This is where “the meat” of our work resides





Stan

COSSAN



W3C PROV

UNIVERSITY OF LIVERPOOL Institute for Risk and Uncertainty

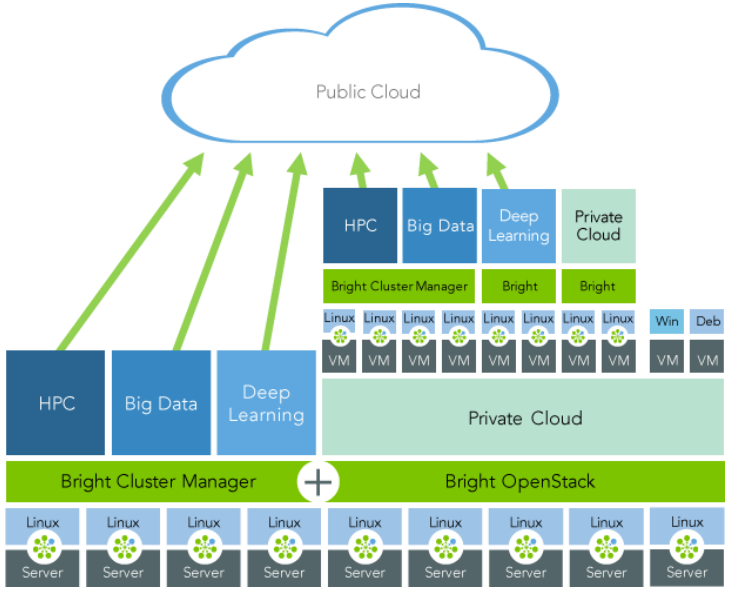
“Softening” our compute “ceiling”

Hewlett Packard Enterprise

Data centre opened by SGI/HPE CTO Eng Lim Goh, Spring 2017

1st two racks at Chippewa Falls

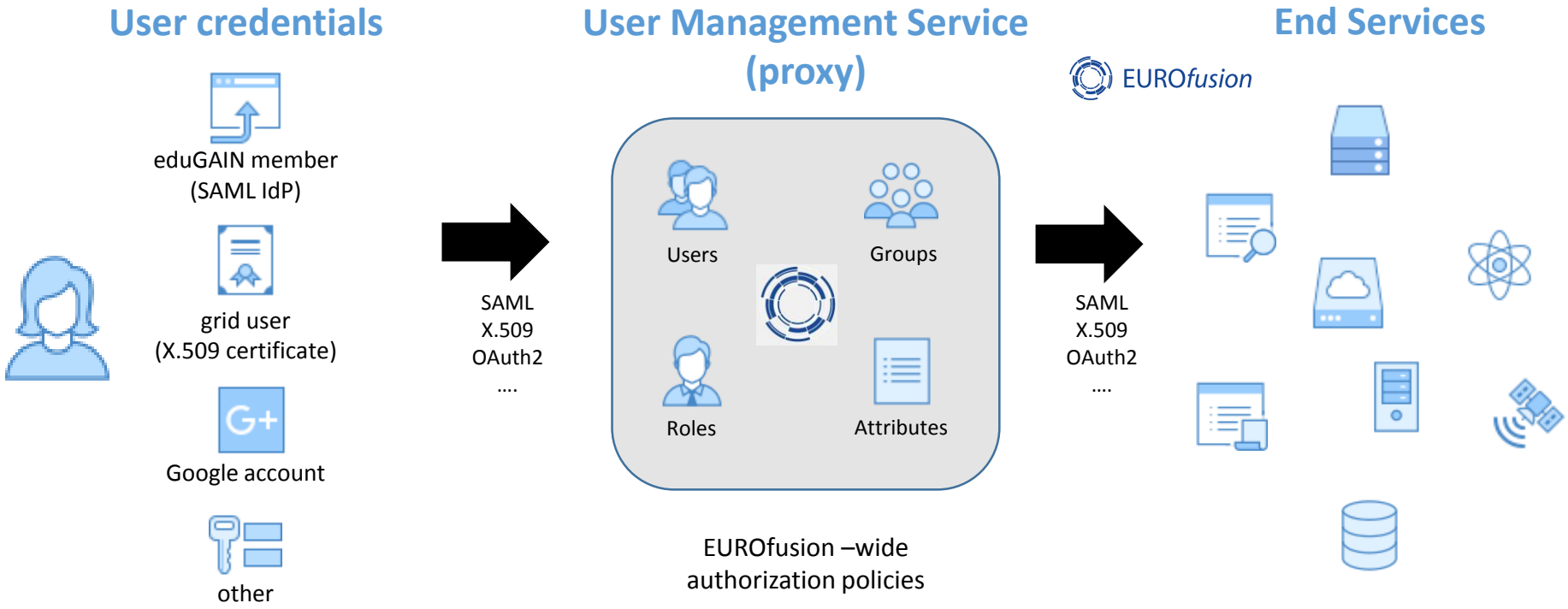
EOSC Pilot: PROMINENCE



Bright Computing

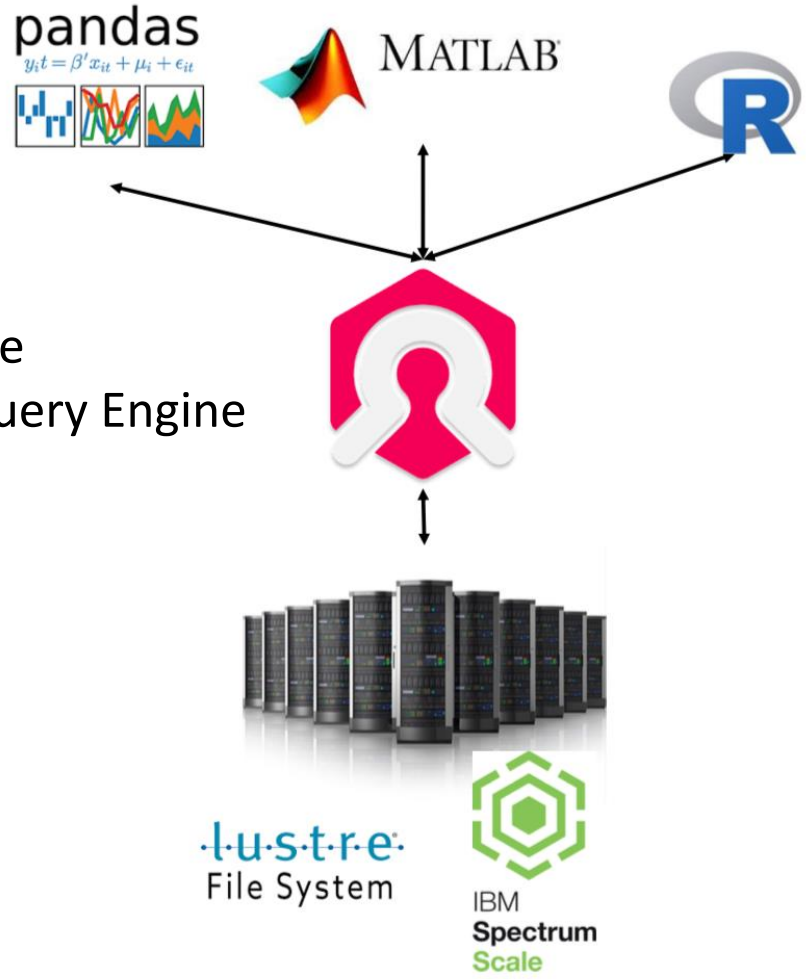
EOSCpilot
The European Open Science Cloud for Research Pilot Project

Eurofusion AAI Study



Example HPDA project: NoDB

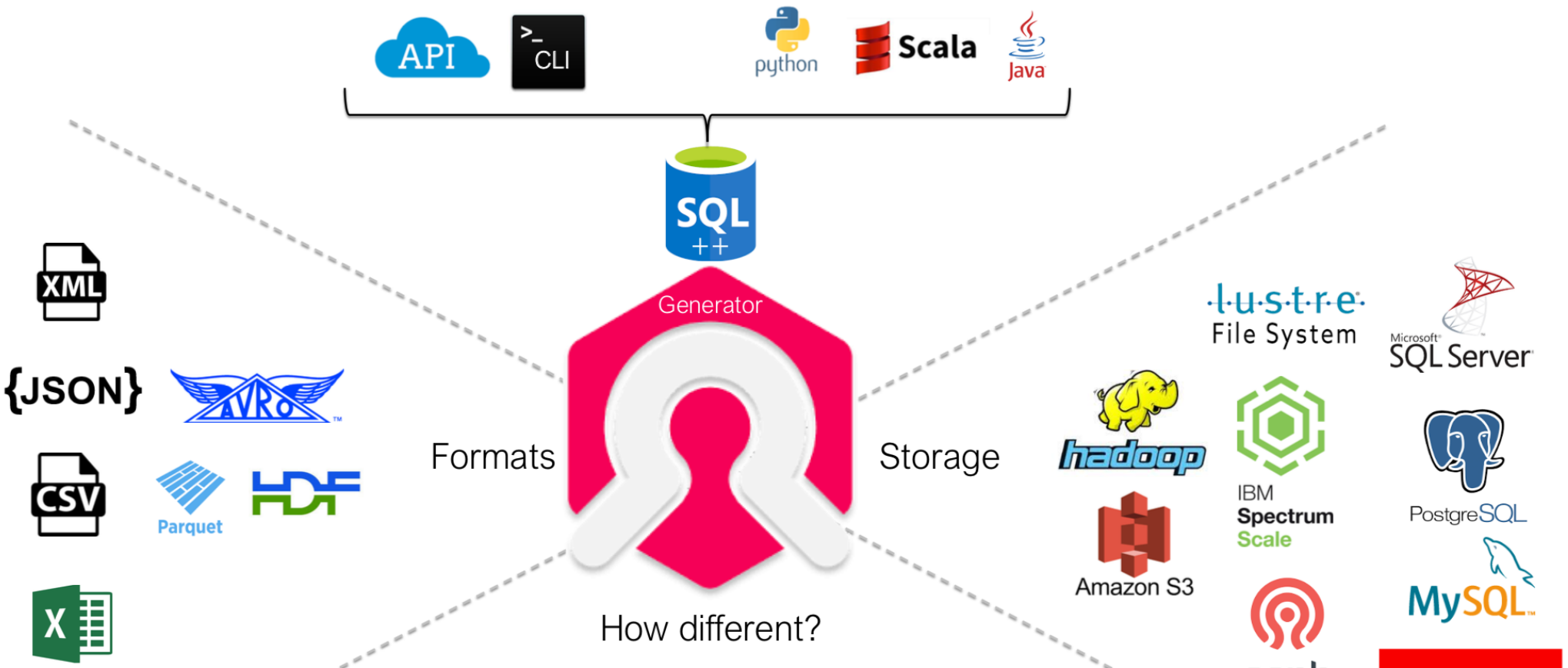
Use Case: “Database” for Piles of Files



Echo: Smart Cache
Coro: Adaptive Query Engine

- Creates the “appearance” of a database without any ingestion or ETL of data
- Query initiated through number of user languages and tools concurrently
- Particularly useful in scientific domains to bring commercial Big Data tools + frameworks to large datasets (e.g. experimental and observational)

HDF NoDB:
High-Performance Engine for Ad Hoc Analysis



How different?

- Real-time + interactive at scale
- Gets faster as it learns your queries
- Software-only platform on conventional servers + storage

- No schema required: auto-discover on query
- Not another database = NoDB (no data copies)
- No ETL

Summary

Qu: What is the UK Fusion community asking for?

Ans: Joined up Infrastructure + Software + Expertise + Collaboration with common Interfaces and transparent Access