



tokamak
energy

a faster way to fusion

**Fusion Power
Associates Meeting**

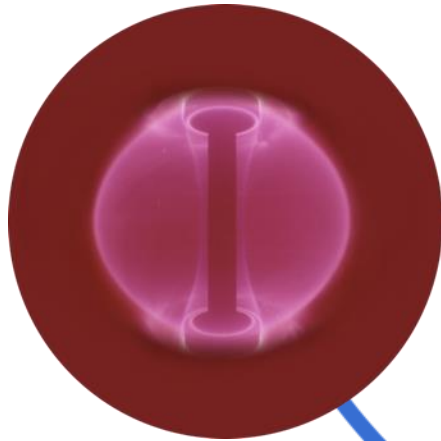
Jonathan Carling

December 2020

Two technologies unlock Commercial Fusion

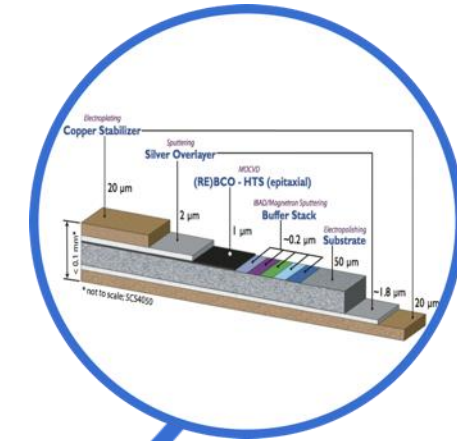
Spherical Tokamak

Squashed shape, highly efficient



High Temperature Superconductors

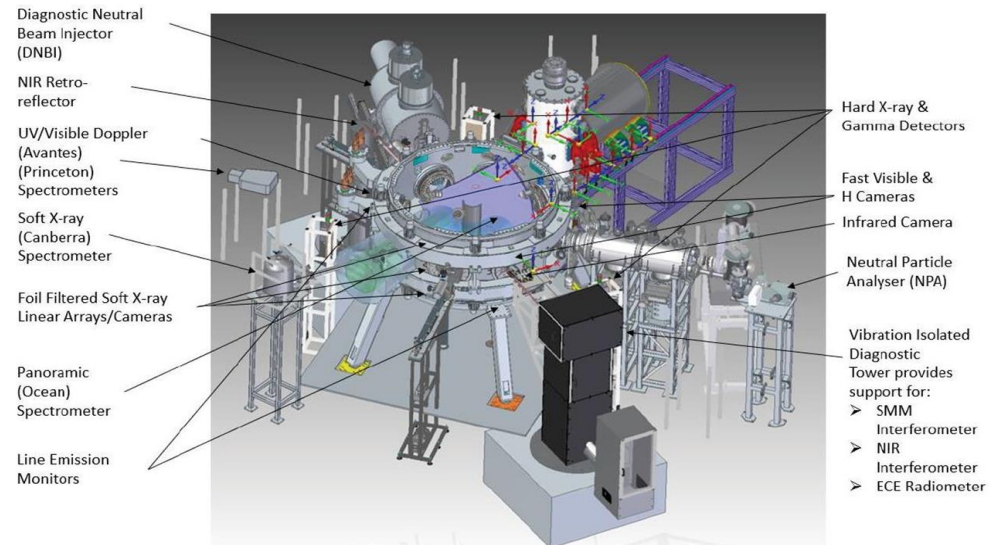
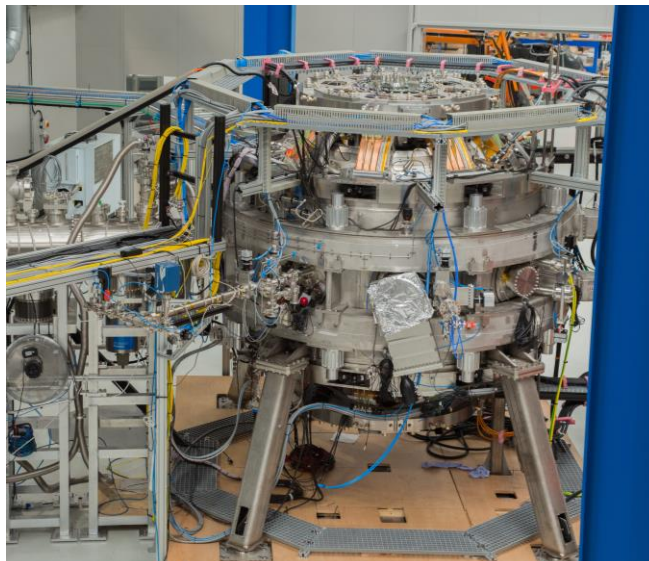
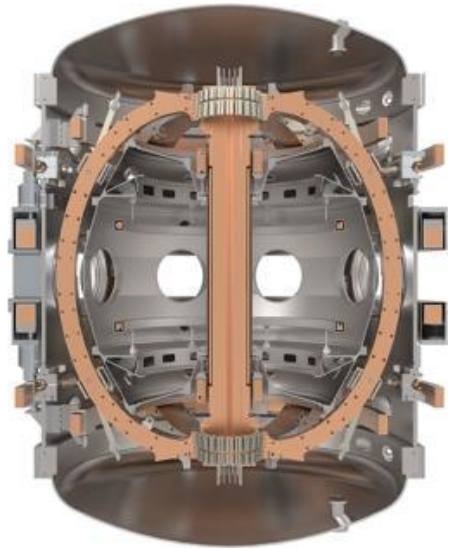
High magnetic fields



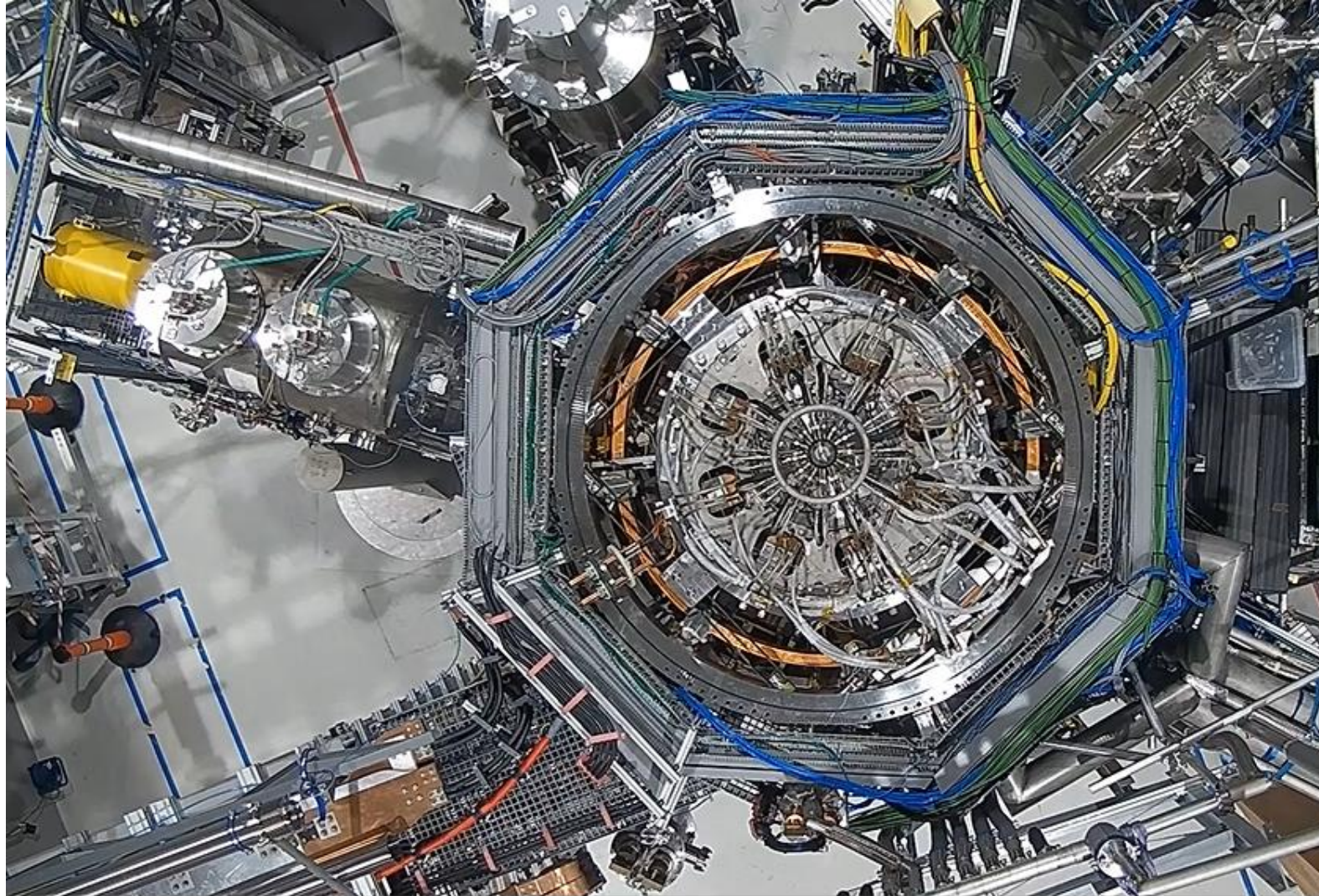
Fusion Power

Smaller, cheaper, faster..... with distinct competitive advantage

ST40 – High Field Spherical Tokamak (2019)



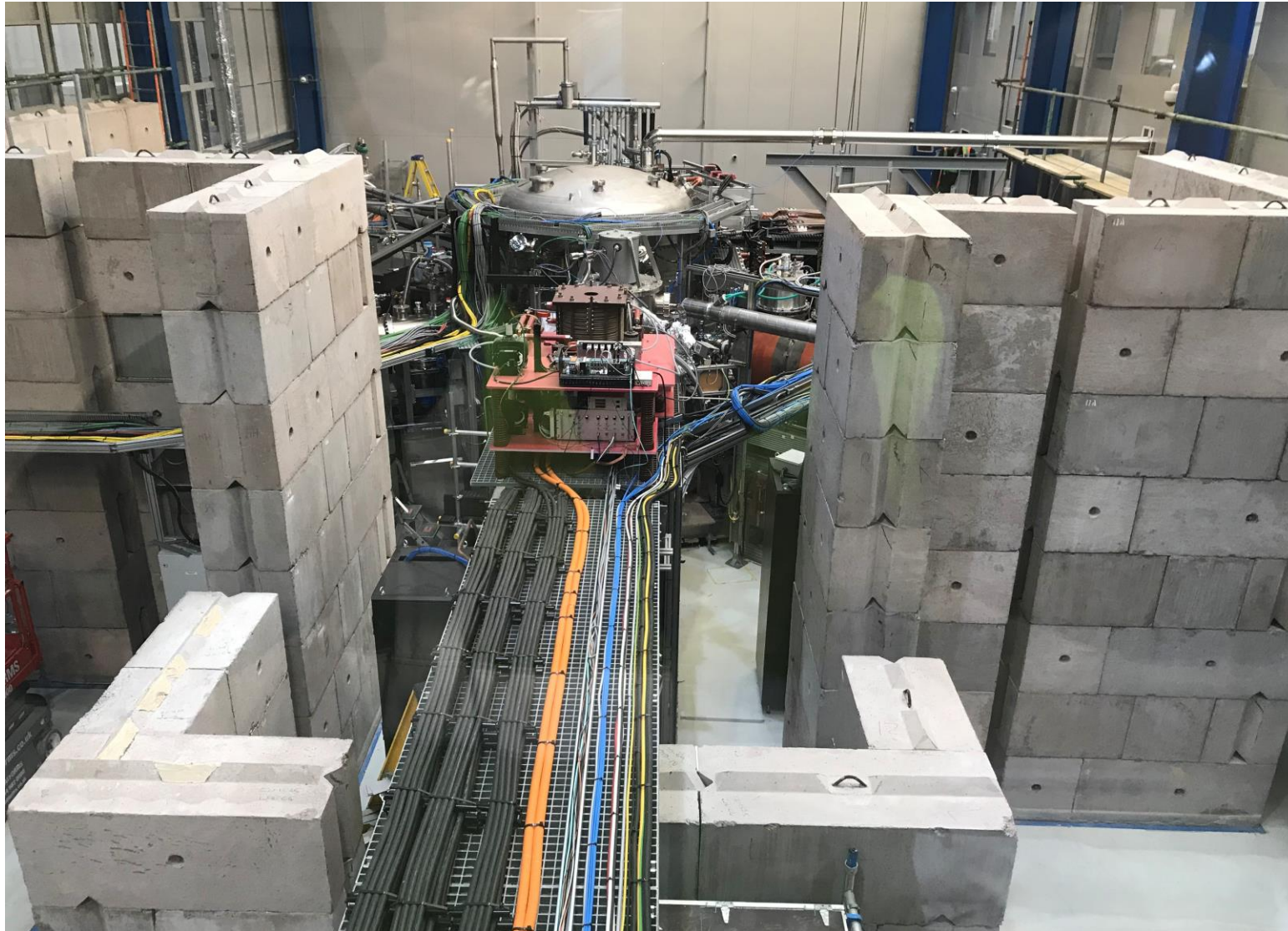
ST40 Latest Upgrade (1)



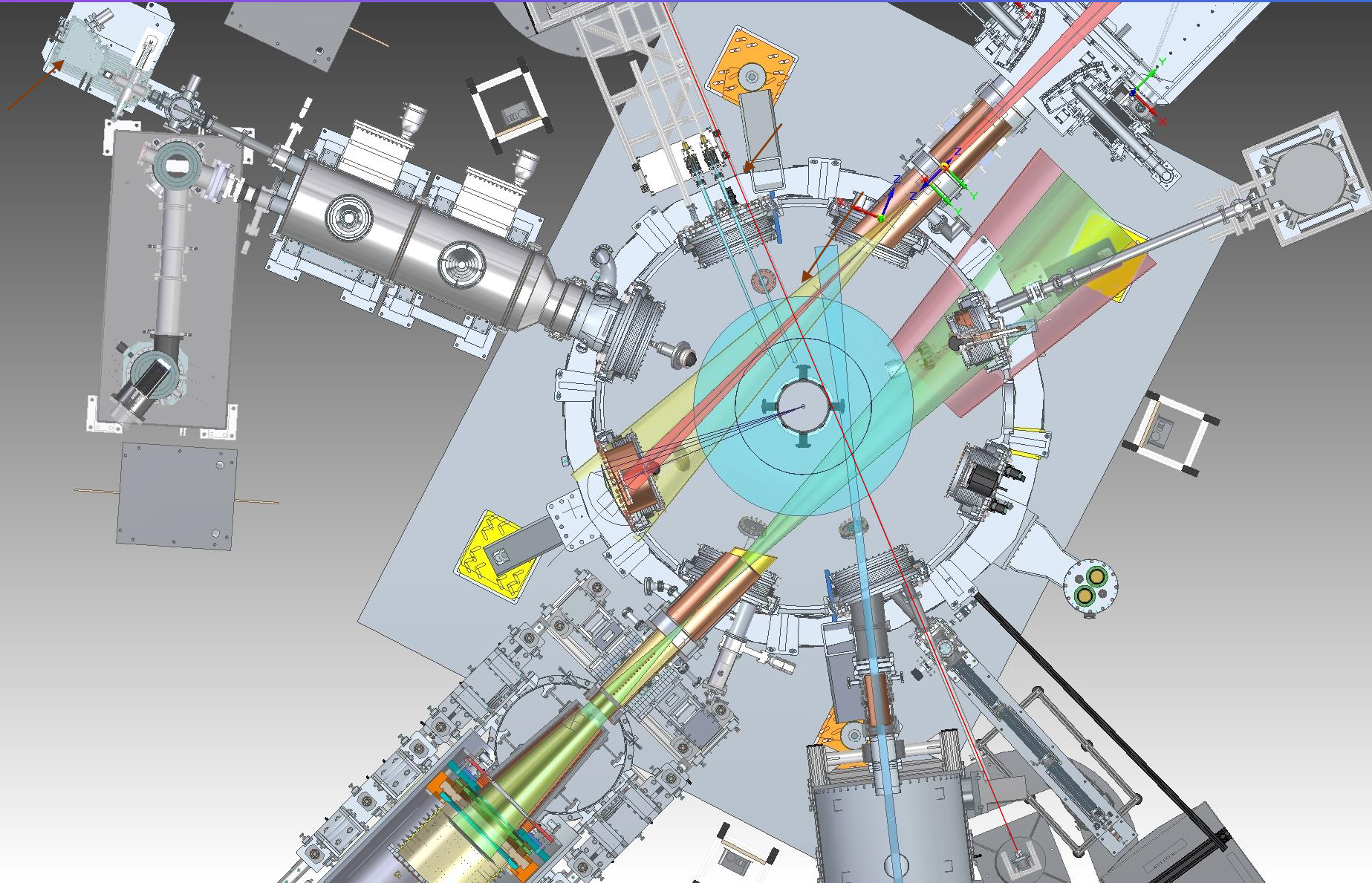
ST40 Latest Upgrade (2)



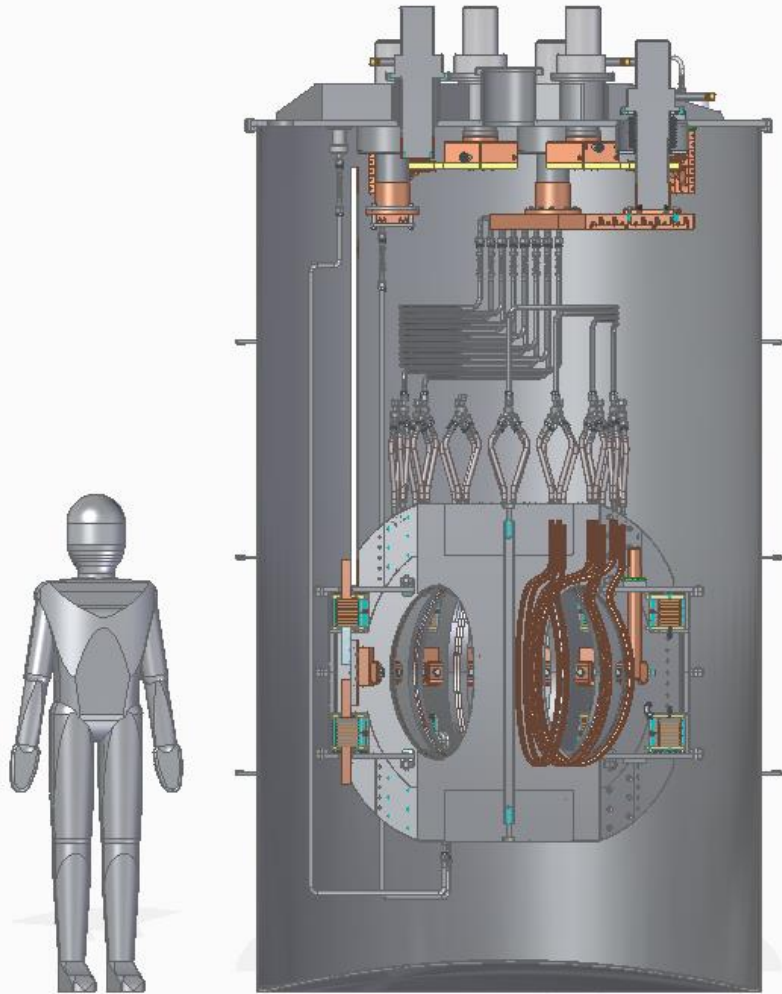
ST40 Latest Upgrade (3)



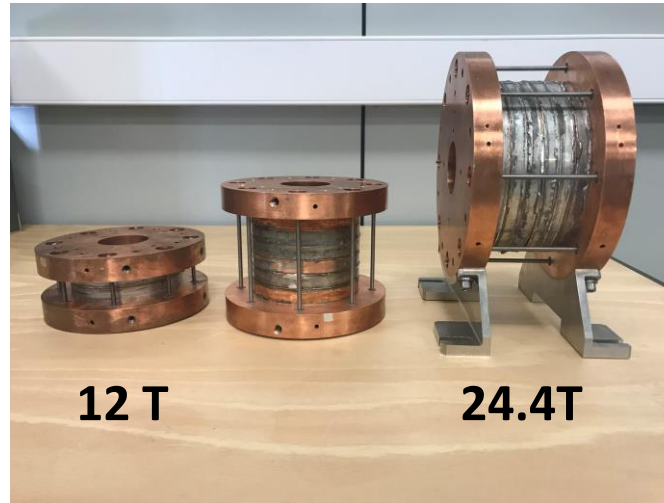
ST40 mid-plane diagnostic layout



HTS Magnet Development



“Demo4” HTS Magnet (2021)



Demo4 REBCO HTS magnet

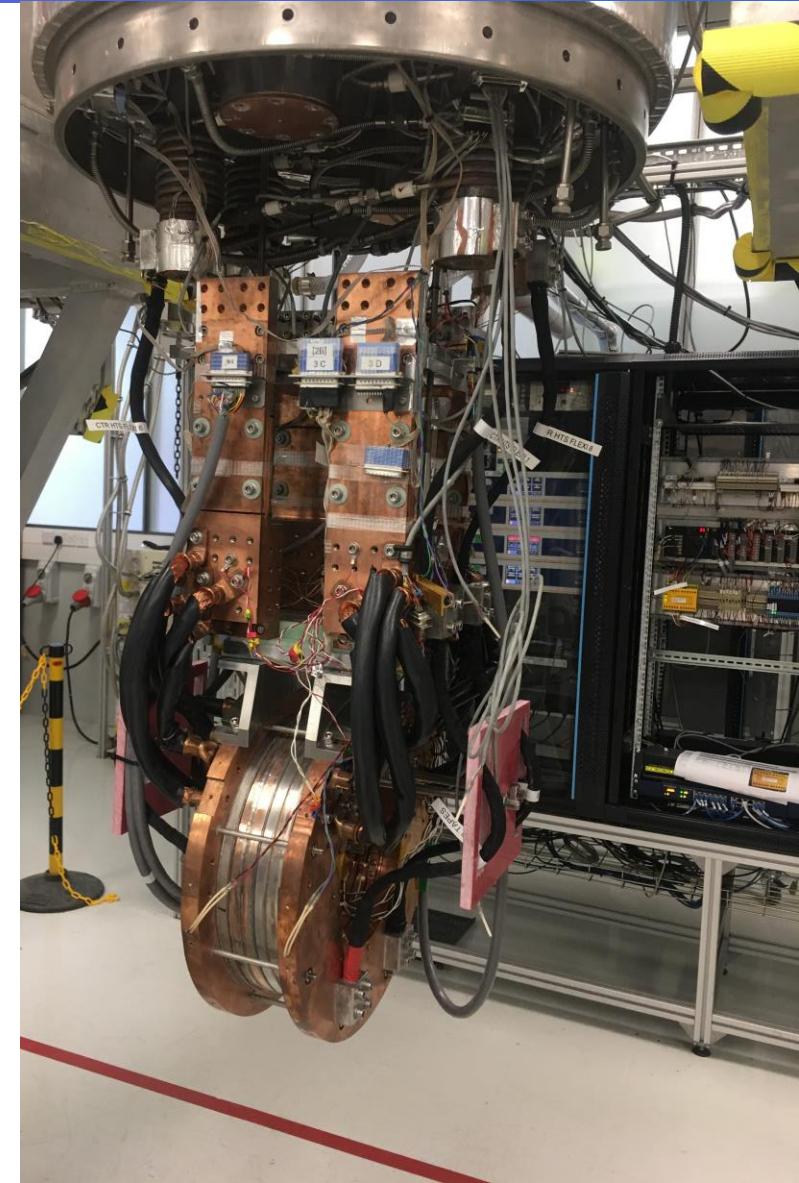
20 T on centre column

250 MPa compressive stress

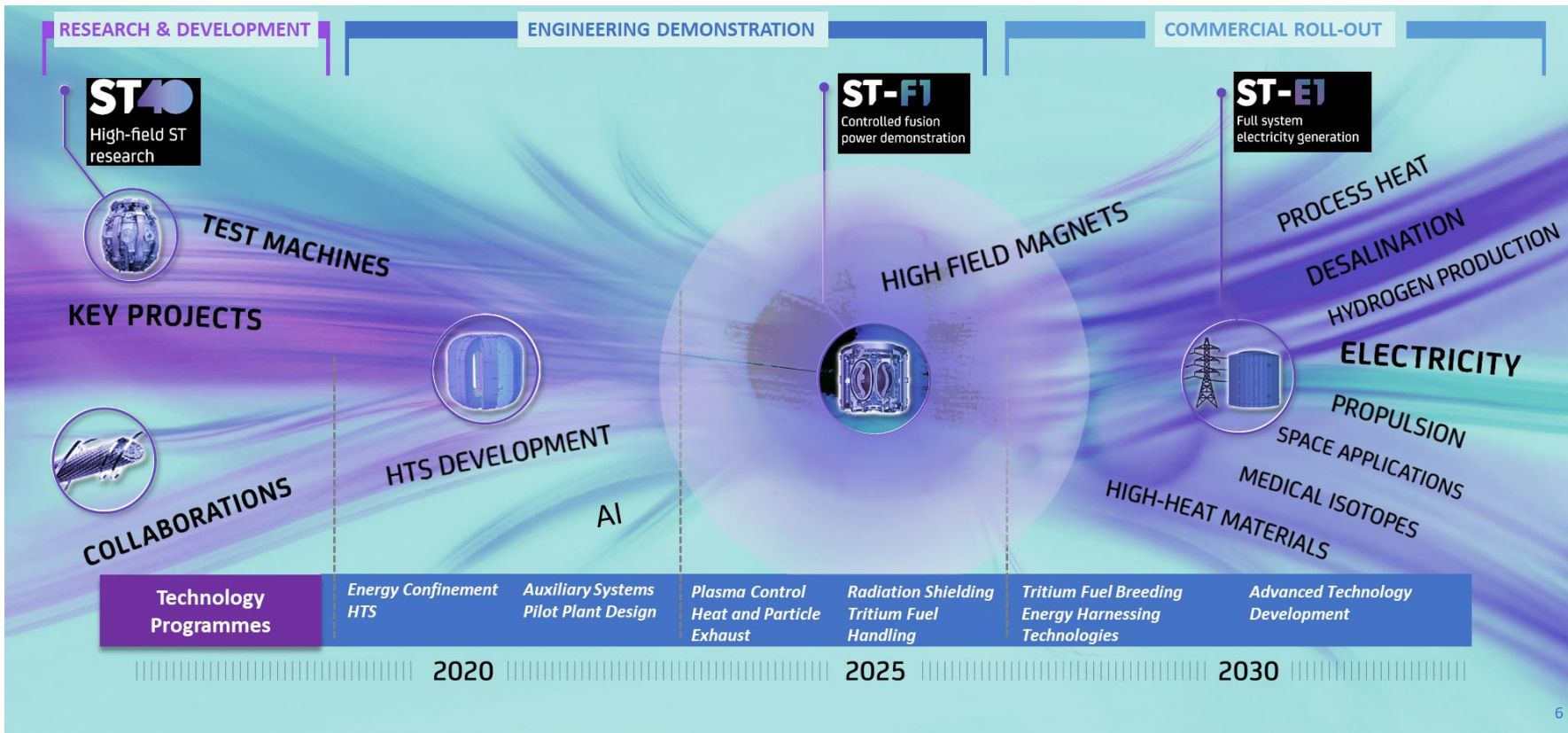
Operate @ 20 K

20 MJ stored energy

Demonstrate quench protection



Technology Roadmap for Faster Fusion



Key Technologies (FESAC 2018)

- HTS magnets
- Advanced Algorithms (Modelling/Simulation)
- Advanced Materials & Manufacturing
- Tritium fuel cycle technologies
- Fast flowing liquid metals

INFUSE collaborations

Plasma microstability (PPPL)

Plasma Scrape-off Layer Width (PPPL)

Tritium pellet injector for ST40 (ORNL)

RF antenna (ORNL)

Metal hydride neutron shielding (LANL)



PAPER

Fusion nuclear science facilities and pilot plants based on the spherical tokamak

J.E. Menard¹, T. Brown¹, L. El-Guebaly², M. Boyer¹, J. Canik³, B. Colling⁴, R. Raman⁵, Z. Wang¹, Y. Zhai¹, P. Buxton⁶ [+ Show full author list](#)

Published 16 August 2016 • © 2016 IAEA, Vienna

[Nuclear Fusion, Volume 56, Number 10](#)

Citation J.E. Menard *et al* 2016 *Nucl. Fusion* **56** 106023

On the power and size of tokamak fusion pilot plants and reactors

A.E. Costley¹, J. Hugill¹ and P.F. Buxton^{1,2}

Published 28 January 2015 • © 2015 IAEA, Vienna

[Nuclear Fusion, Volume 55, Number 3](#)

Citation A.E. Costley *et al* 2015 *Nucl. Fusion* **55** 033001

On the fusion triple product and fusion power gain of tokamak pilot plants and reactors

A.E. Costley¹

Published 27 April 2016 • © 2016 IAEA, Vienna

[Nuclear Fusion, Volume 56, Number 6](#)

Citation A.E. Costley 2016 *Nucl. Fusion* **56** 066003



ELSEVIER

Fusion Engineering and Design

Volume 122, November 2017, Pages 238-252

Original Research Article

Modular fusion power plant

V.A. Chuyanov  , M.P. Gryaznevich

Compact fusion energy based on the spherical tokamak

A. Sykes¹, A.E. Costley¹, C.G. Windsor¹, O. Asunta¹, G. Brittles¹, P. Buxton¹, V. Chuyanov¹, J.W. Connor¹, M.P. Gryaznevich¹, B. Huang¹ [+ Show full author list](#)

Published 29 November 2017 • © 2017 IAEA, Vienna

[Nuclear Fusion, Volume 58, Number 1](#)

Citation A. Sykes *et al* 2018 *Nucl. Fusion* **58** 016039

Collisionality and safety factor scalings of H-mode energy transport in the MAST spherical tokamak

M. Valovič¹, R. Akers¹, M. de Bock¹, J. McCone¹, L. Garzotti¹, C. Michael¹, G. Naylor¹, A. Patel¹, C.M. Roach¹, R. Scannell¹ [+ Show full author list](#)

Published 22 June 2011 • 2011 IAEA, Vienna

[Nuclear Fusion, Volume 51, Number 7](#)

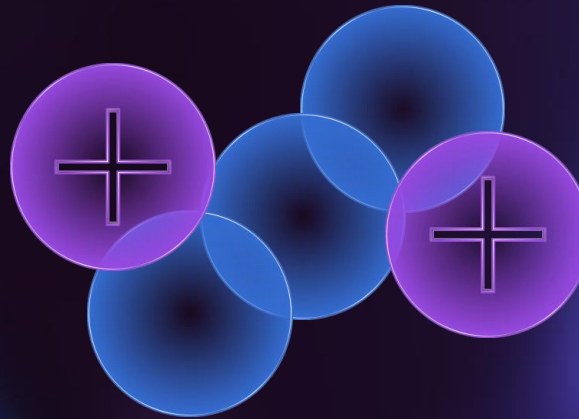
Citation M. Valovič *et al* 2011 *Nucl. Fusion* **51** 073045

Fusion Energy : A game-changer Coming sooner than You may think

- Tokamak Energy has a **unique and winning approach.**

- Established science baseline, **new technologies**, private funding, agility.

- **World-class team** : fusion, engineering and operational credentials.



- We are **serious about delivery** of economic fusion energy

- We are **generating significant IP** - well protected.

- We will **deliver fusion faster with public-private collaboration**



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A faster way to fusion