Fusion Reactor Technology II
(459.761, 3 Credits)

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Contents

Week 1. Review of Tokamak Reactor Concept

Week 2-4. Tokamak Reactor Critical Issues

Week 5. Blanket Concept

Week 6. First Wall Loading and Wall Impurity Effects

Week 7. Blanket Neutronics and Energetics

Week 9. Radioactivation

Week 10. Blanket Structure and Breeding Materials

Week 11-12. Types of Blanket in ITER and DEMO

Week 13. Plasma Facing Components

Week 14. Fuel Cycle System

Fusion Plasma Technology

Reactor Technology

Blanket and Material Technology

Safety Technology

Operation and Maintenance Technology

Advanced material and plasma wall interaction

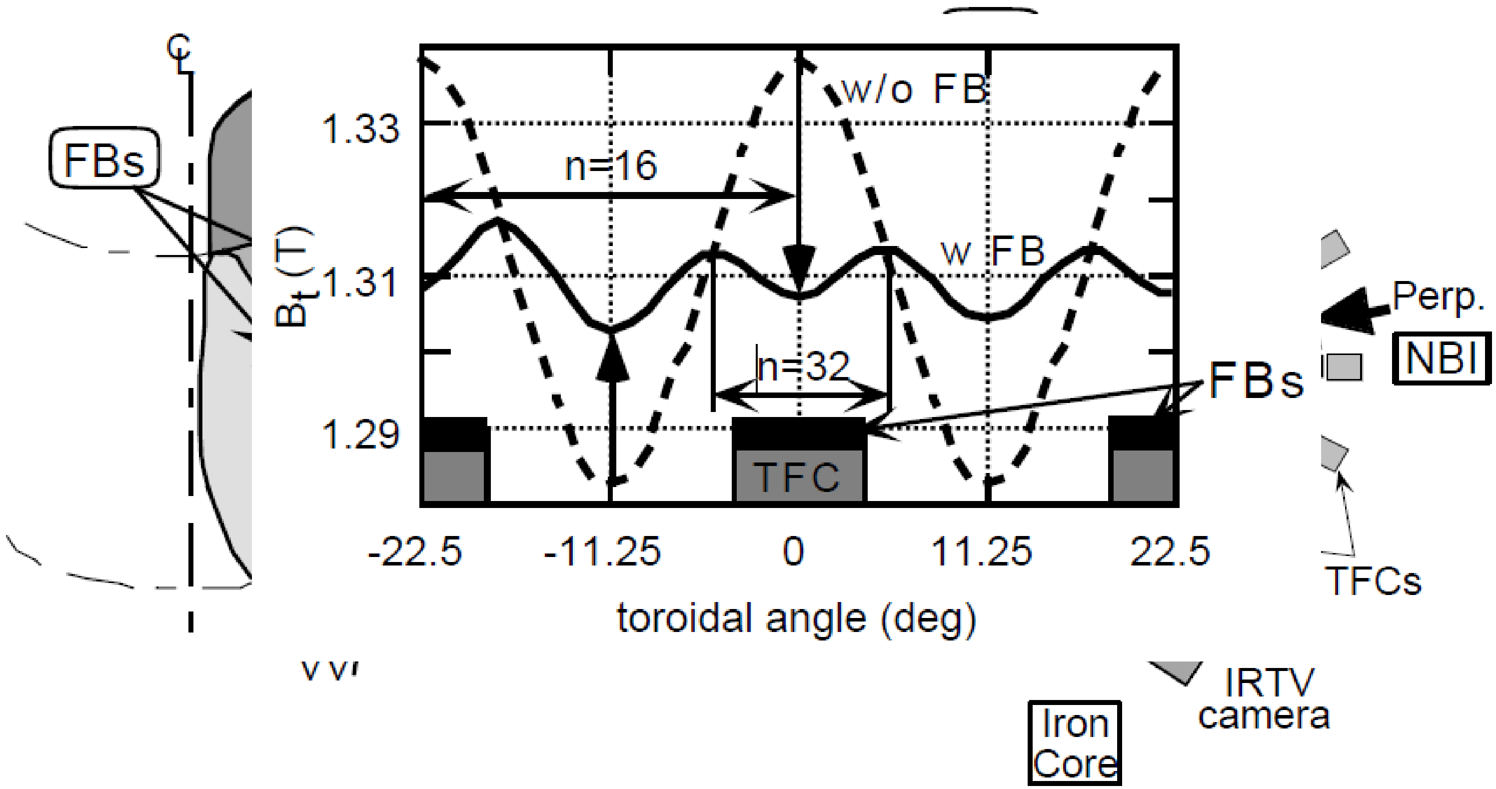
Advanced material

- Requirements
  - Low activation
  - High heat conductivity
  - Minimal swelling

- Advanced material
  - Reduced-activation ferritic steels (RAFS, RAFM)
  - Vanadium alloys
  - SiC/SiC composites

Reduced-activation ferritic steel

- Ferritic board (F83H: ferromagnetic) for ripple reduction in AMTEX(Advanced Material Tokamak Experiment) at JFT-2M



H. Kawashima et al, Nucl. Fusion ***41*** *257 (2001)*

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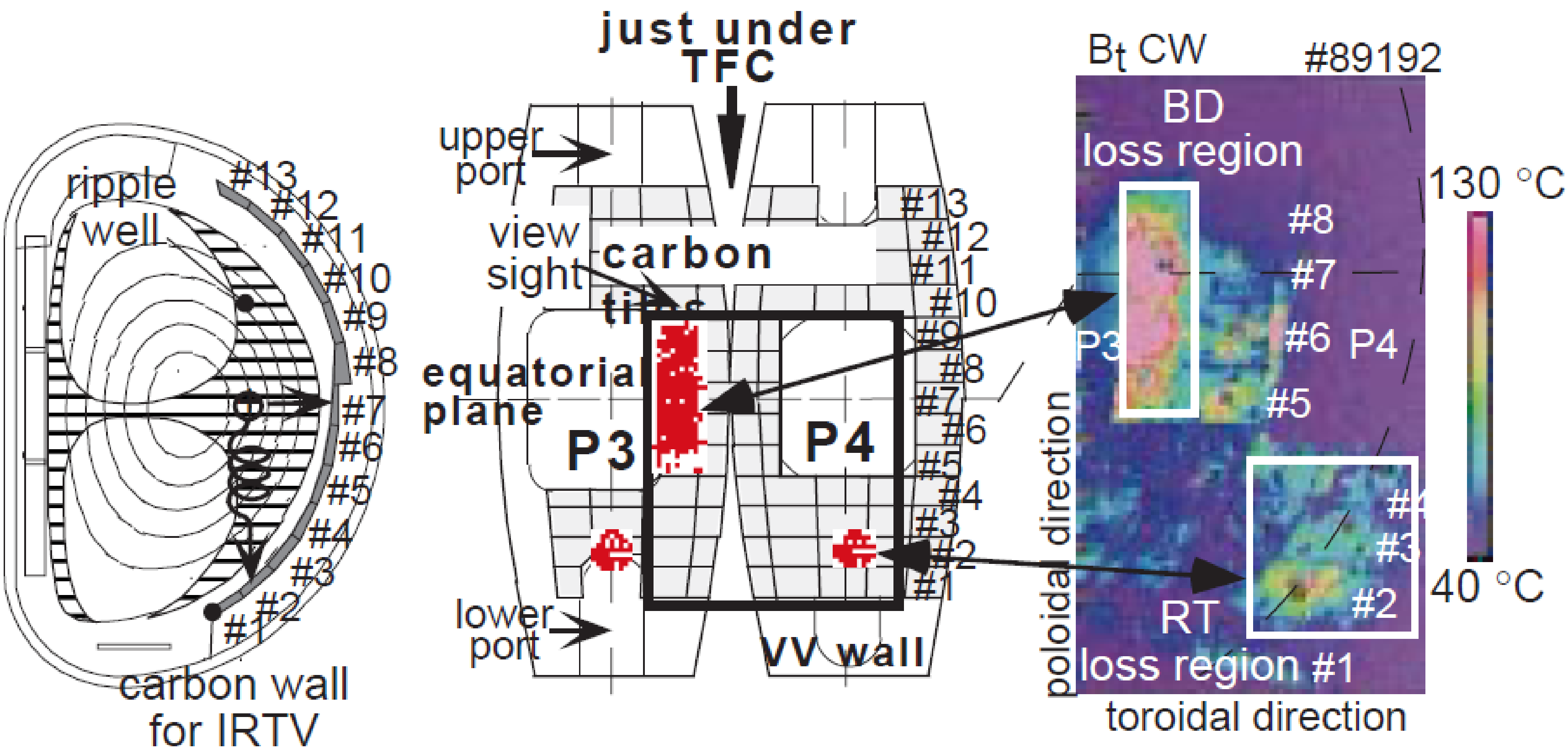

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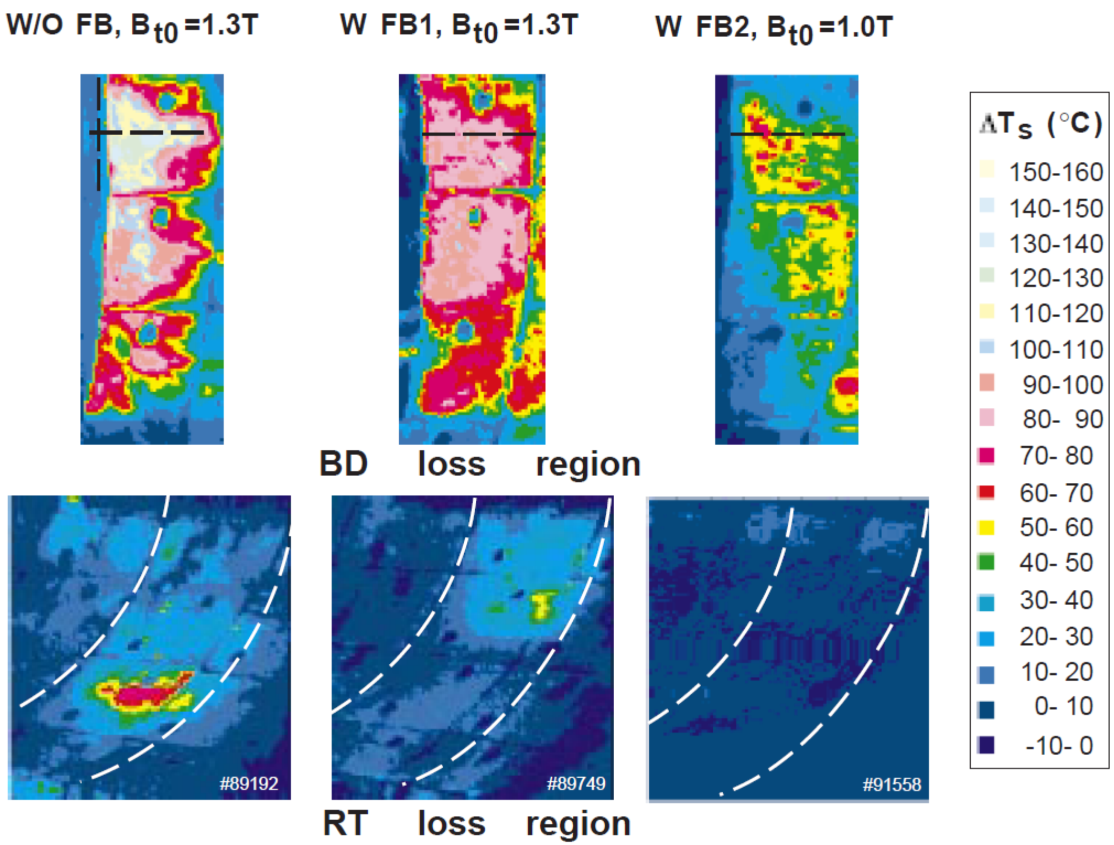


Advanced material

- Vanadium alloys

- Principal structural material of the ARIES-RS (USA)
- Embrittlement caused by the occlusion of hydrogen or helium during the tokamak operation

- SiC/SiC composites

- DREAM (JAERI), ARIES-I
- Characteristics of Plasma-wall interaction not identified

Fusion Plasma Technology

Reactor Technology

Blanket and Material Technology

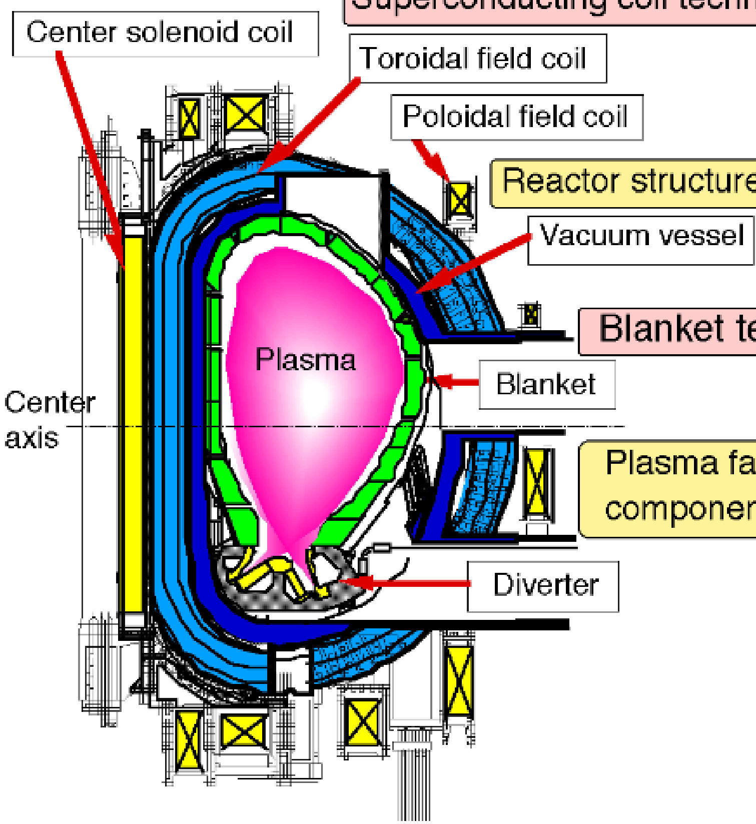
Safety Technology

Operation and Maintenance Technology

Development of component technology for tokamak type fusion reactor

Tokamak Machine Technology

- Superconducting coil technology
- Reactor structure technology
- Blanket technology
- Plasma facing components technology



Tokamak related components and system technology

- Remote maintenance technology
- Tritium engineering /safety technology
- Auxiliary heating/current drive components technology
- Plasma measurement technology
- Fuel injection and exhaust technology

- Safety standard/safety evaluation
- Demo reactor Tritium Breeding blanket R&D
- Material R&D

Development of component technology for tokamak type fusion reactor

- Technologies of tokamak component

- Blanket Technology:
  to develop the blanket that surrounds plasma and converts the kinetic energy of neutrons and other particles into heat and also shields the superconducting magnets from radiation
- Plasma Facing Components Technology:
  to develop the divertor that captures the high-energy particles and absorbs the heat load from plasma
- Reactor Structural Technology:
  to develop the vacuum vessel and support structures that will sustain the high vacuum for generation of plasma and contain the blanket and divertor
- Superconducting Magnet Technology:
  to develop the superconducting magnet that provide magnetic field to confine plasma, which is a magnetohydrodynamic fluid, and induces a current in the plasma by varying the magnetic field

Development of component technology for tokamak type fusion reactor

- Component technologies related to the tokamak

- Auxiliary Heating and Current Drive Equipment Technology:
  to heat the plasma and drive the plasma current
- Plasma Measurement Technology: to measure the temperature and
  density of plasma to form and control the plasma
- Fuel Injection and Exhaust Technology:
  to inject and exhaust fuel
- Tritium Engineering /Safety Technology:
  to recycle tritium safely, which is radioactive and
  do not exist naturally
- Remote Maintenance Technology:
  to remotely maintain and repair the components
  that are radio-activated by neutrons generated from
  the plasma. Furthermore, toward the safety review
  for licensing and the future power reactor
  development

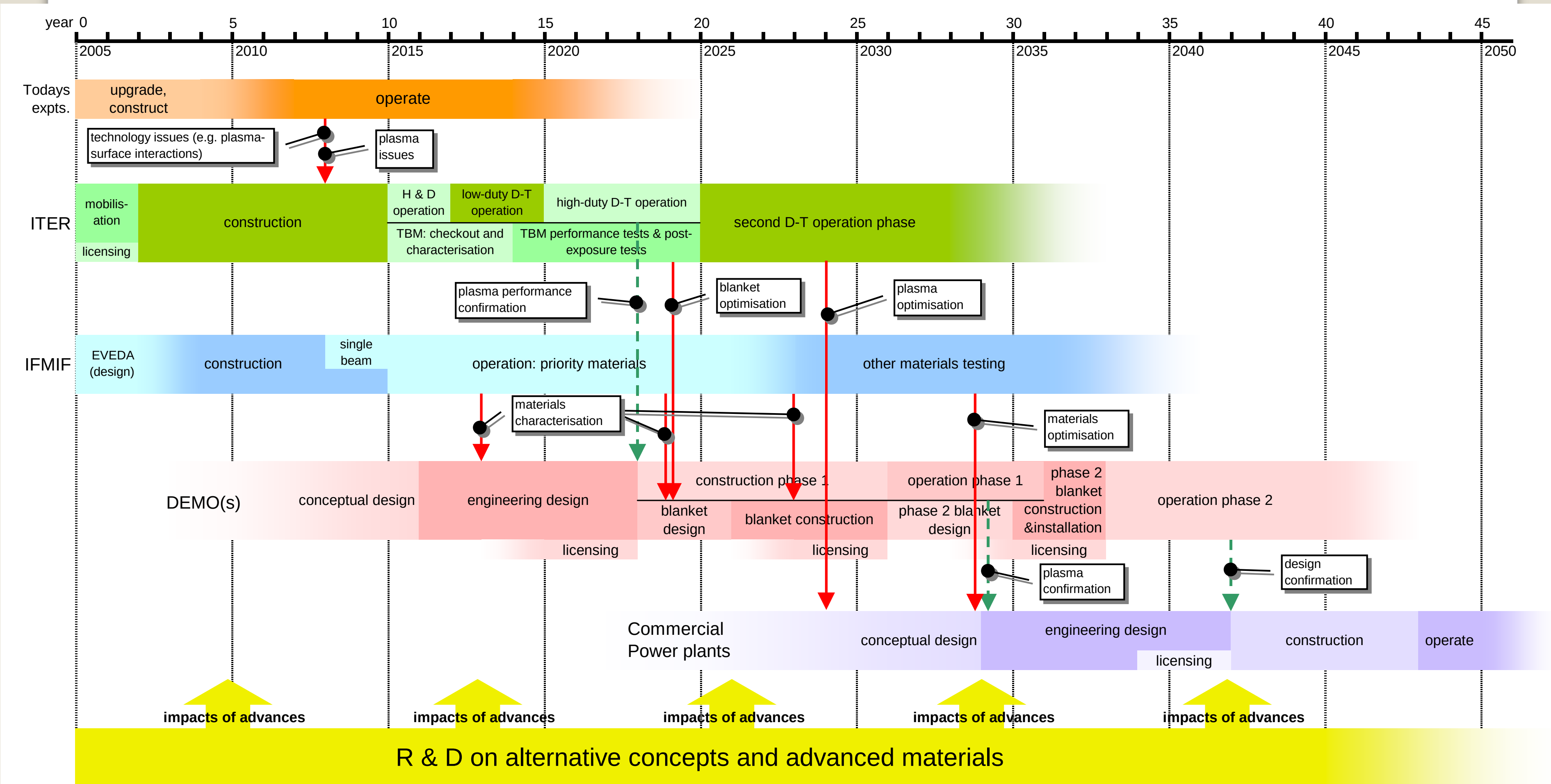
OXFORD TECHNOLOGIES

Development of component technology for tokamak type fusion reactor

- Component technologies related to the tokamak

- Preparation of safety standards required for safety review for licensing, and data and evaluation methods required for safety evaluation
- Research and development of the Tritium breeding blankets for the future power reactors
- Development of first wall materials are required.

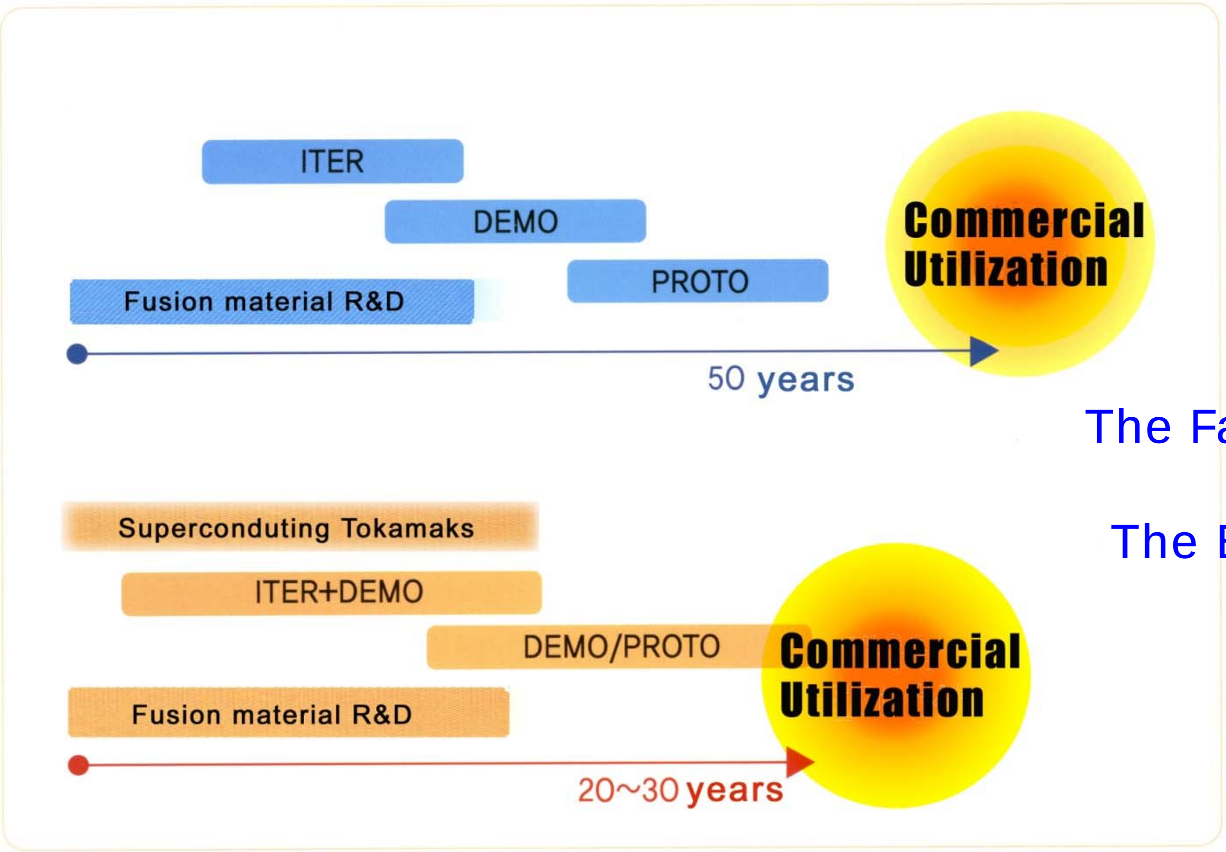
Phased integration of reactor technology development



"The Path to Fusion Power"

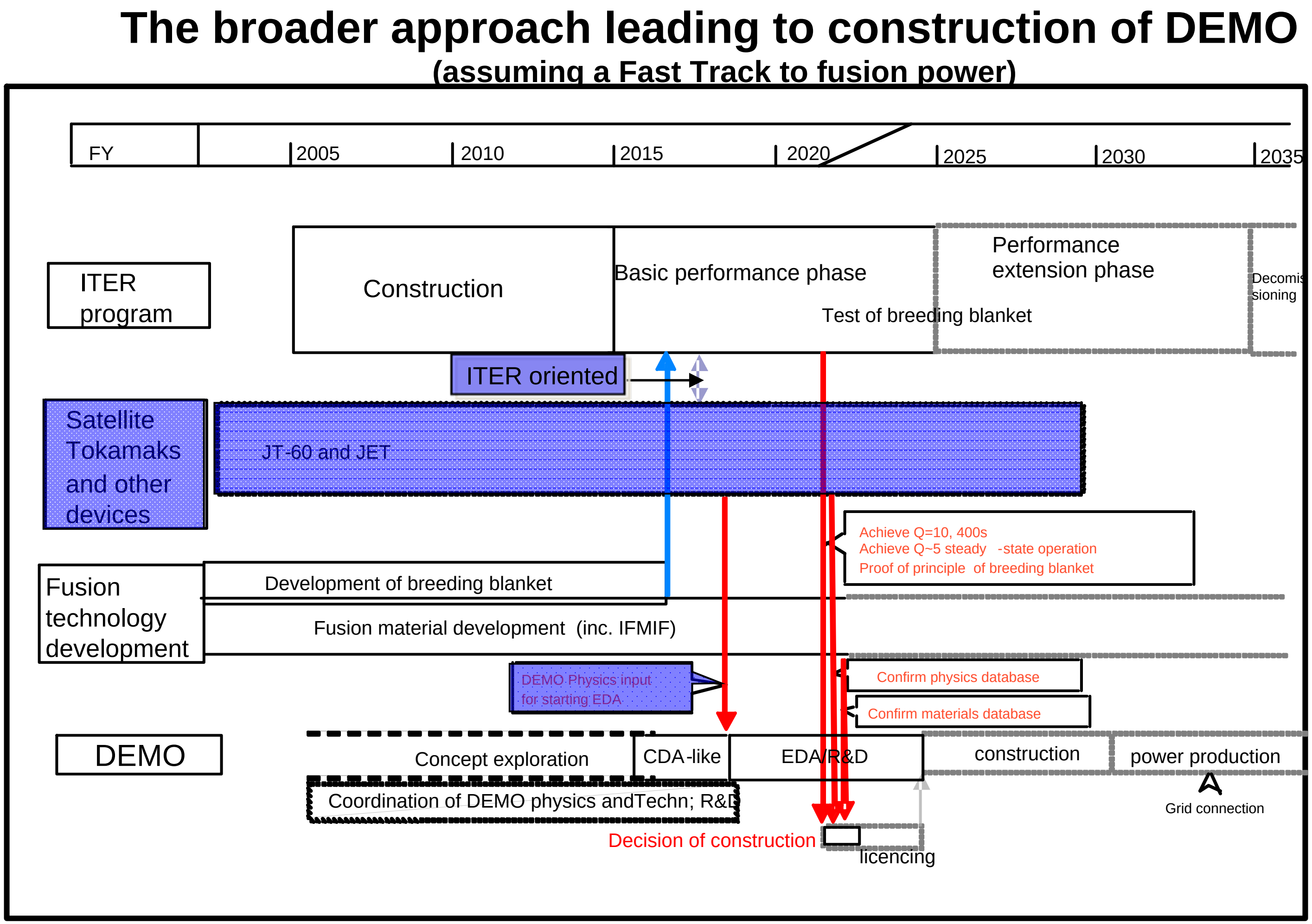
by C. L. Smith (Director, UKAEA Culham), KAST (10 October, 2006)

Phased integration of reactor technology development



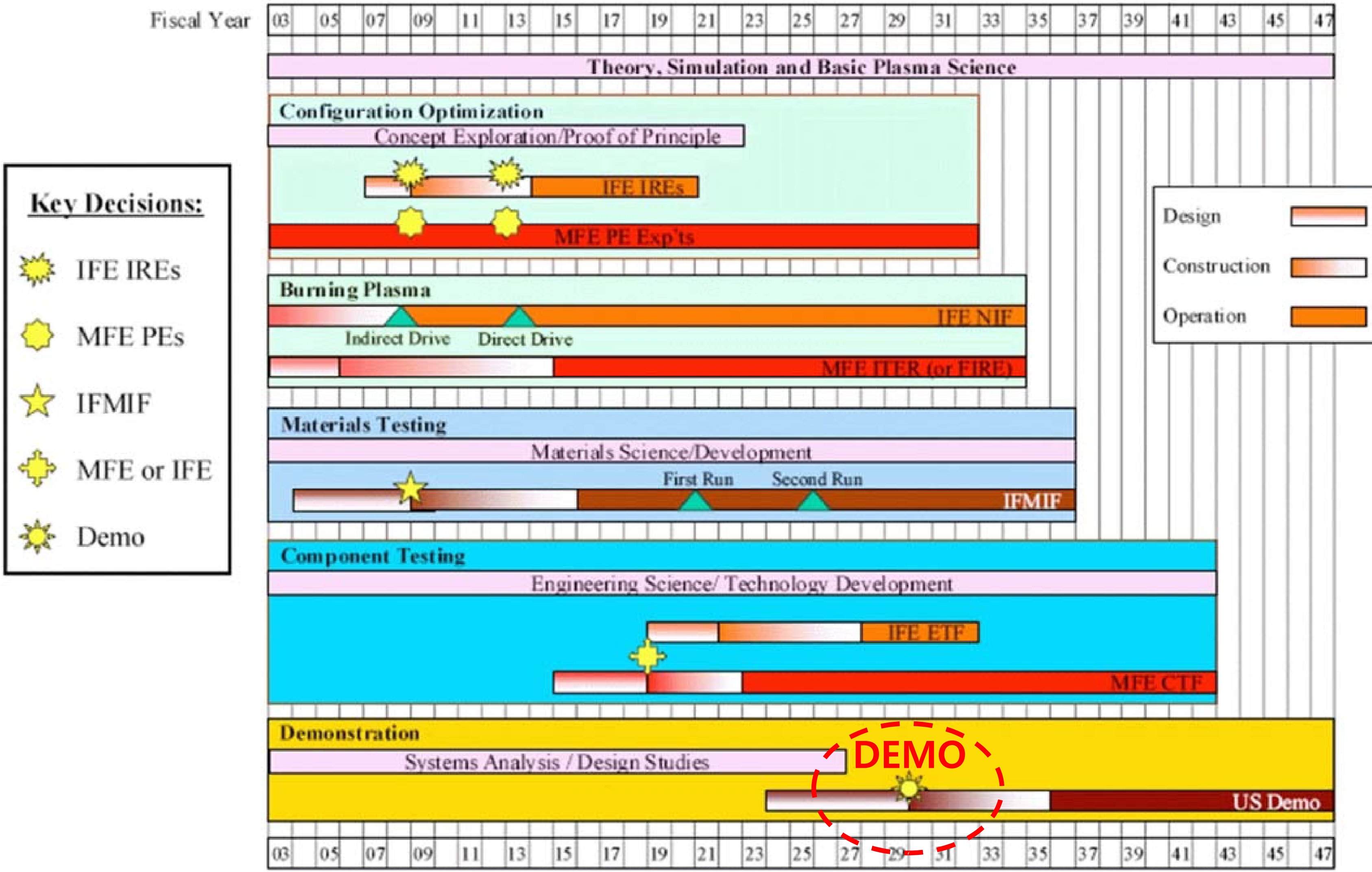
The Fast Track Approach
&
The Broader Approach

Phased integration of reactor technology development

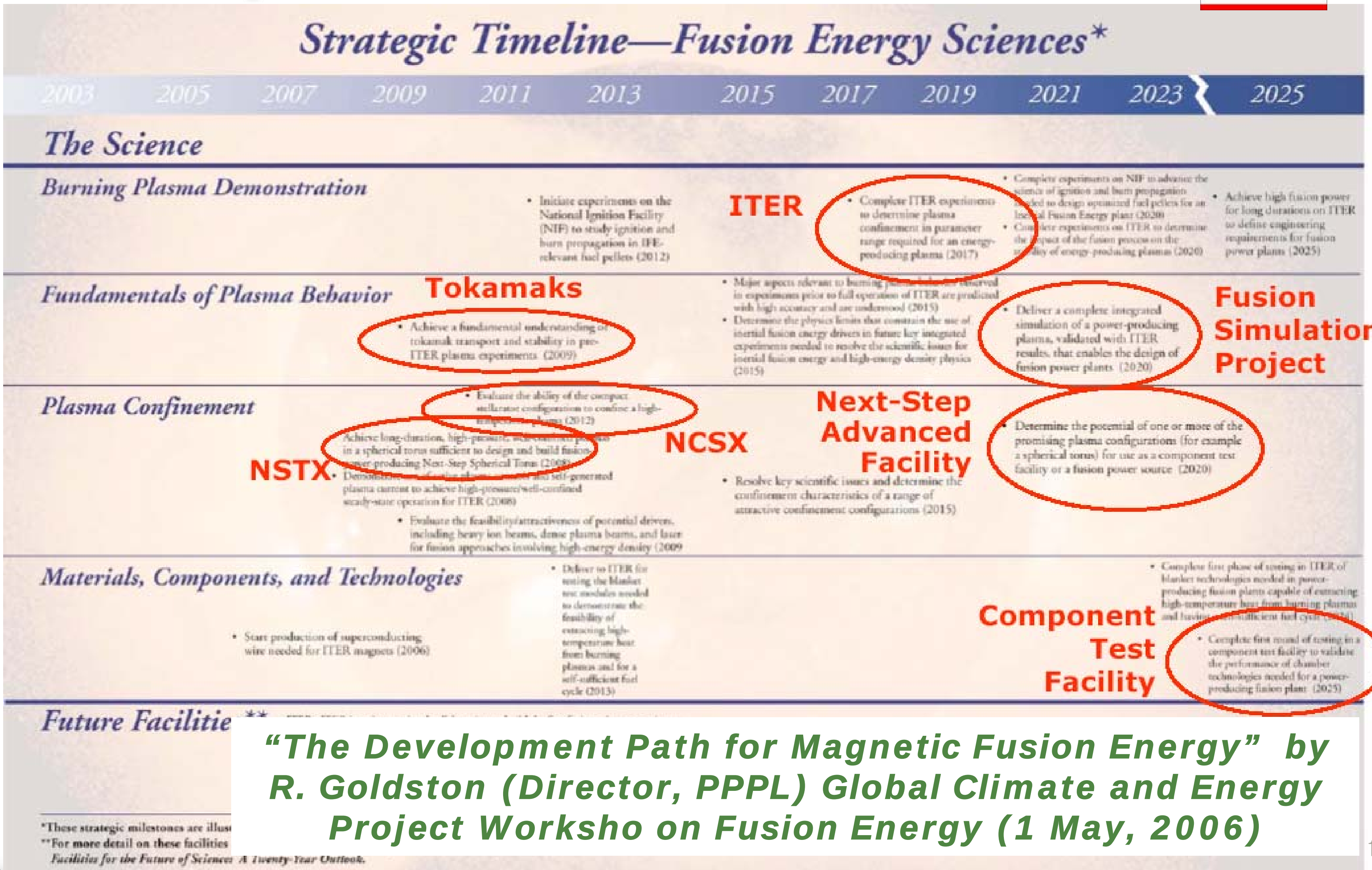


"Overview of NCT Proposal" M. Kikuchi (November 3-4, 2005)

Phased integration of reactor technology development



Phased integration of reactor technology development



"The Development Path for Magnetic Fusion Energy" by R. Goldston (Director, PPPL) Global Climate and Energy Project Worksho on Fusion Energy (1 May, 2006)