

Comments on “Modular Strategy”

Gerald Navratil

Columbia University

FESAC Development Path Panel

General Atomics, San Diego

14 January 2003

ITER vs FIRE is the wrong question...

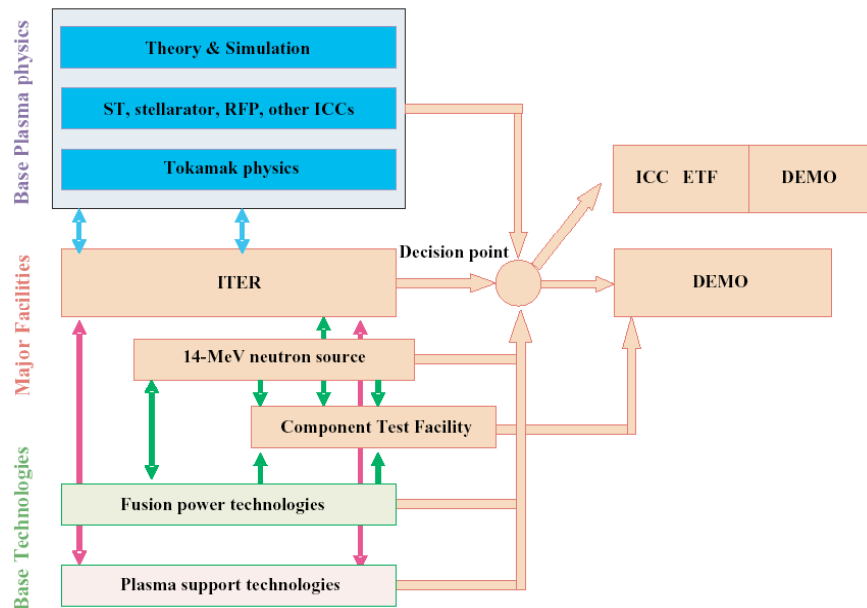
- Snowmass: both ITER and FIRE are technically credible choices to study BP physics AND give BP information leading to DEMO.
- FESAC Austin dual track strategy: try ITER first, if no-go by July 2004, proceed with FIRE.
- Goal of my remarks: **clarify development path differences between the two tracks.**

A Sound Strategy Requires Several Major Facilities Leading to DEMO

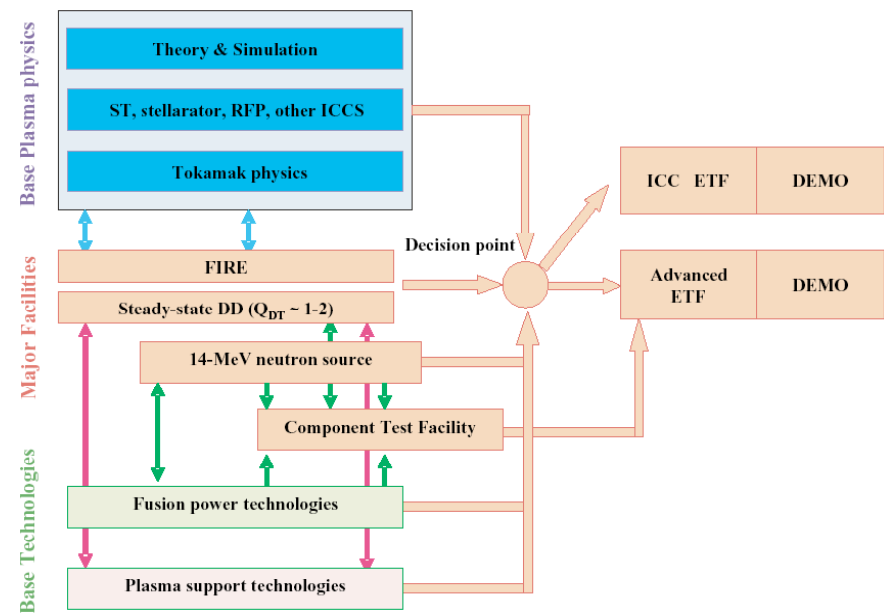
- ...must bridge the gap from present knowledge to that required to construct a DEMO.
- Attempting to cover them all in a single device will limit the domain of investigation and lead to unacceptable risk of failure...
- A single Next Step facility (ITER) is a high risk strategy in terms of physics, technology, and management, since it does not provide a sufficiently sound foundation for DEMO.

--P.-H. Rebut, Phys. Fluids B 3, 2209 (1991).

FESAC/Snowmass Plans Similar Structure, BUT With a Significant Strategic Difference

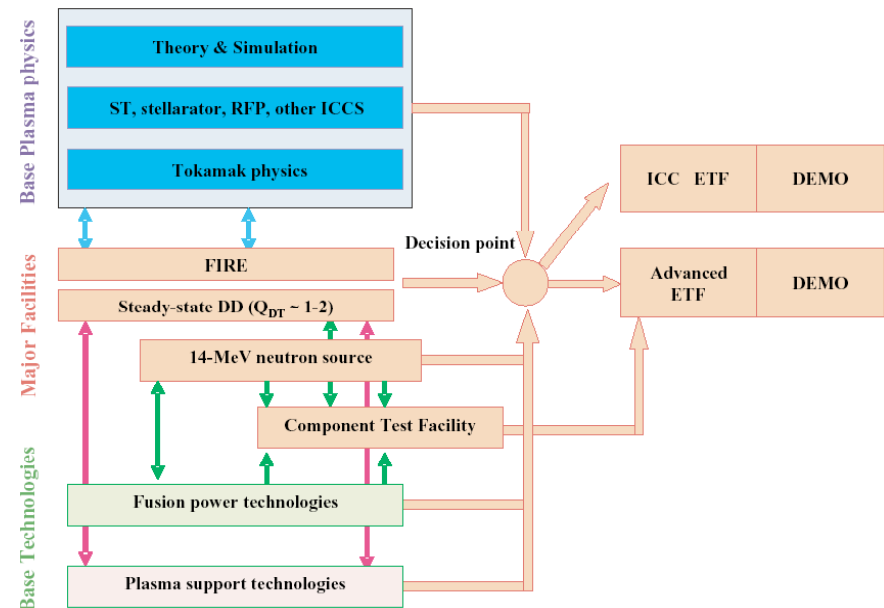
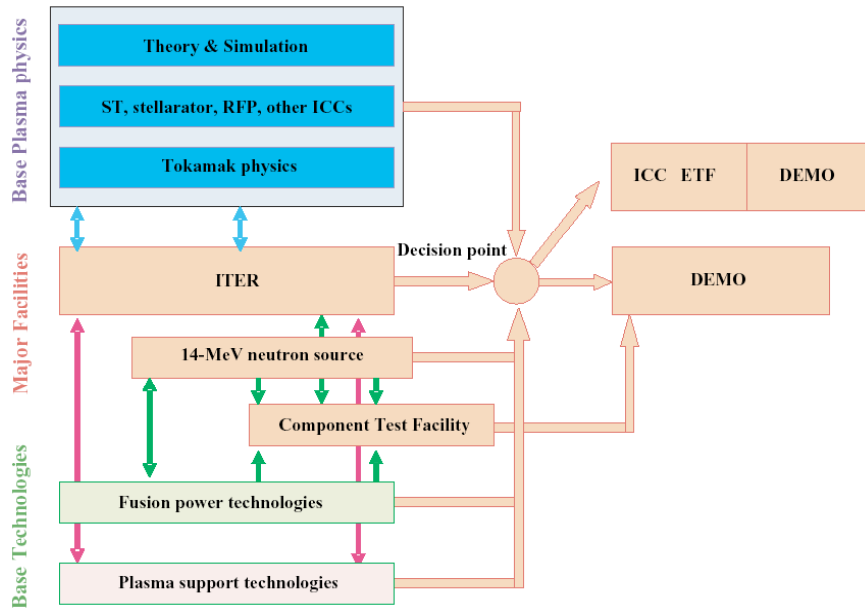


ITER Development Path
 ‘Single Machine Strategy’
 ‘One Step to DEMO’
 ‘Penultimate Step to DEMO’



FIRE Development Path
 ‘Multi-machine Strategy’
 Modular Strategy

FESAC/Snowmass Plans Similar Structure, BUT With a Significant Strategic Difference



ITER Development Path

~~'Single Machine Strategy'~~

~~'One Step to DEMO'~~

~~'Penultimate Step to DEMO'~~

Integration Now

FIRE Development Path

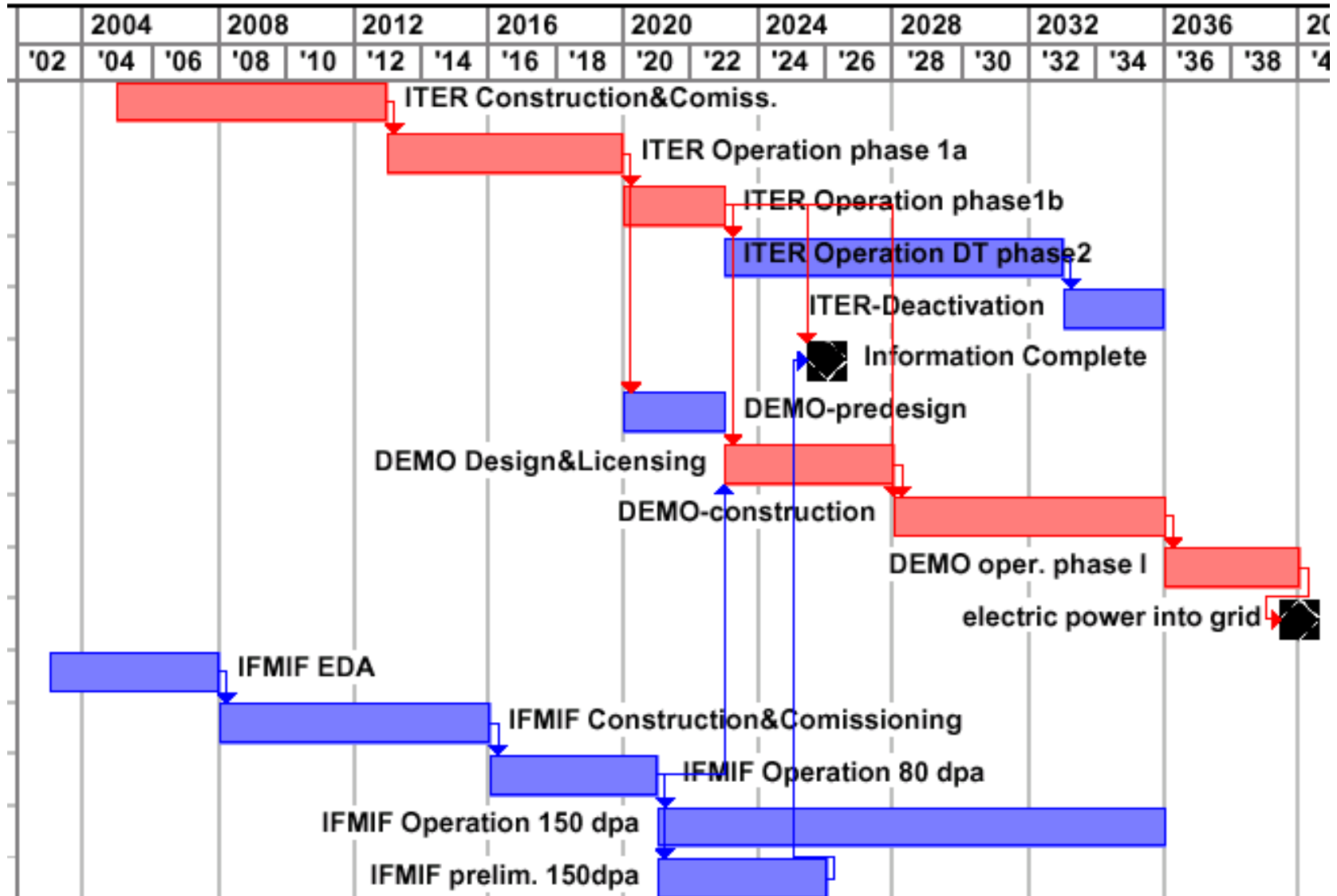
~~'Multi-machine Strategy'~~

~~Modular Strategy~~

Deferred Integration

EU Variation on Early Integration Replaces CTF with 8 yrs Blanket Development on DEMO Phase I

Roadmap to Fusion Power

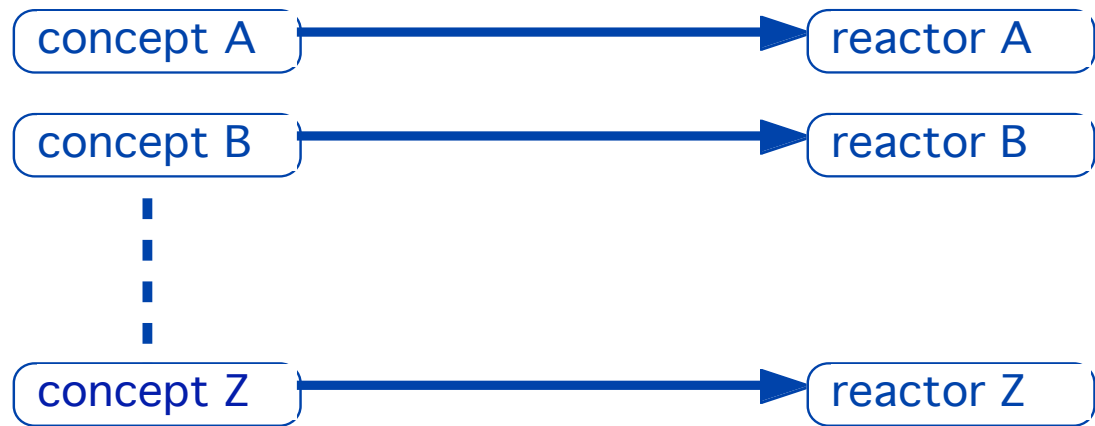


Deferred Integration [Modular Strategy] is Advantageous Technically and Financially

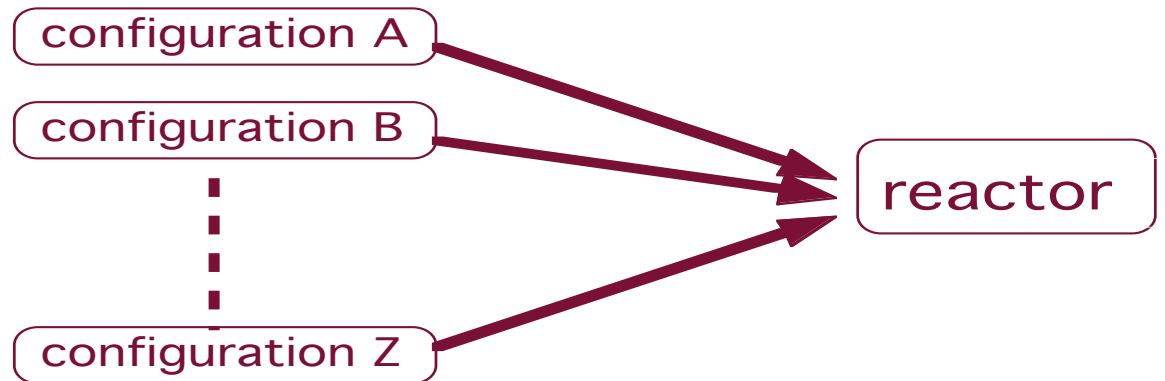
- Deferred Integration (pursuing FIRE for BP physics) is more appropriate for present pace of toroidal plasma development - target date 2020-2025 integration step:
 - o Progress in toroidal physics from PoP & PE devices [NSTX, NSST, NCSX, MST+, K-STAR, JT-60SC, LHD, W7-X...] can all be used for design of optimal BP+Technology integrated test facility: ETF
 - o BP Step (FIRE) is only a 20 year device, not 40 year as for ITER: more appropriate level of 'opportunity cost'.
- Follows paradigm used successfully by IFE Program: make progress in minimum sized parallel steps; only integrate when needed to take the next step. Premature integration drives up cost, slows schedule, & interferes with innovation.

Prager: Schematic for Concept Development

Each concept as a fusion reactor



each configuration building fusion science



Deferred Integration more compatible with Portfolio Approach to Optimal Reactor

Deferred Integration [Modular Strategy] is Advantageous Technically and Financially

- Deferred Integration approach makes full use of the CTF facility, and can incorporate developed tritium and heat removal blanket technology into a staged ETF-DEMO facility.
 - ITER technology mission drive up size and cost for little gain: IFMIF and CTF provide all nuclear & material info; W7-X, LHD, K-STAR, JT-60SC will provide basis for superconducting magnet design in ETF-DEMO facility.
- Integration Step is closer to the Commercial Plant Stage: optimal configuration for 1st generation fusion power plant emerges naturally from ETF-DEMO.

Deferred Integration [Modular Strategy] is Advantageous Technically and Financially

- Total Cost and Cash Flow are significantly reduced over next 15 to 20 years for BP element making it easier to support rapid and timely development of the essential other elements: Concept Innovation, CTF, and IFMIF.
- Deferred integration path is technically more robust against failure of AT to establish a BP compatible steady-state configuration: ICC advances will naturally be folded into choice of optimal configuration ETF-DEMO facility.
- Optimization of AT in BP requires frequent tests against stability limits: very problematic for ITER scale device.
- Deferred integration path is an opportunity for US to resume leadership of world fusion program and help to reconfigure it along a more effective path.

Both Early & Deferred Integration Are Viable Fusion Development Plans

