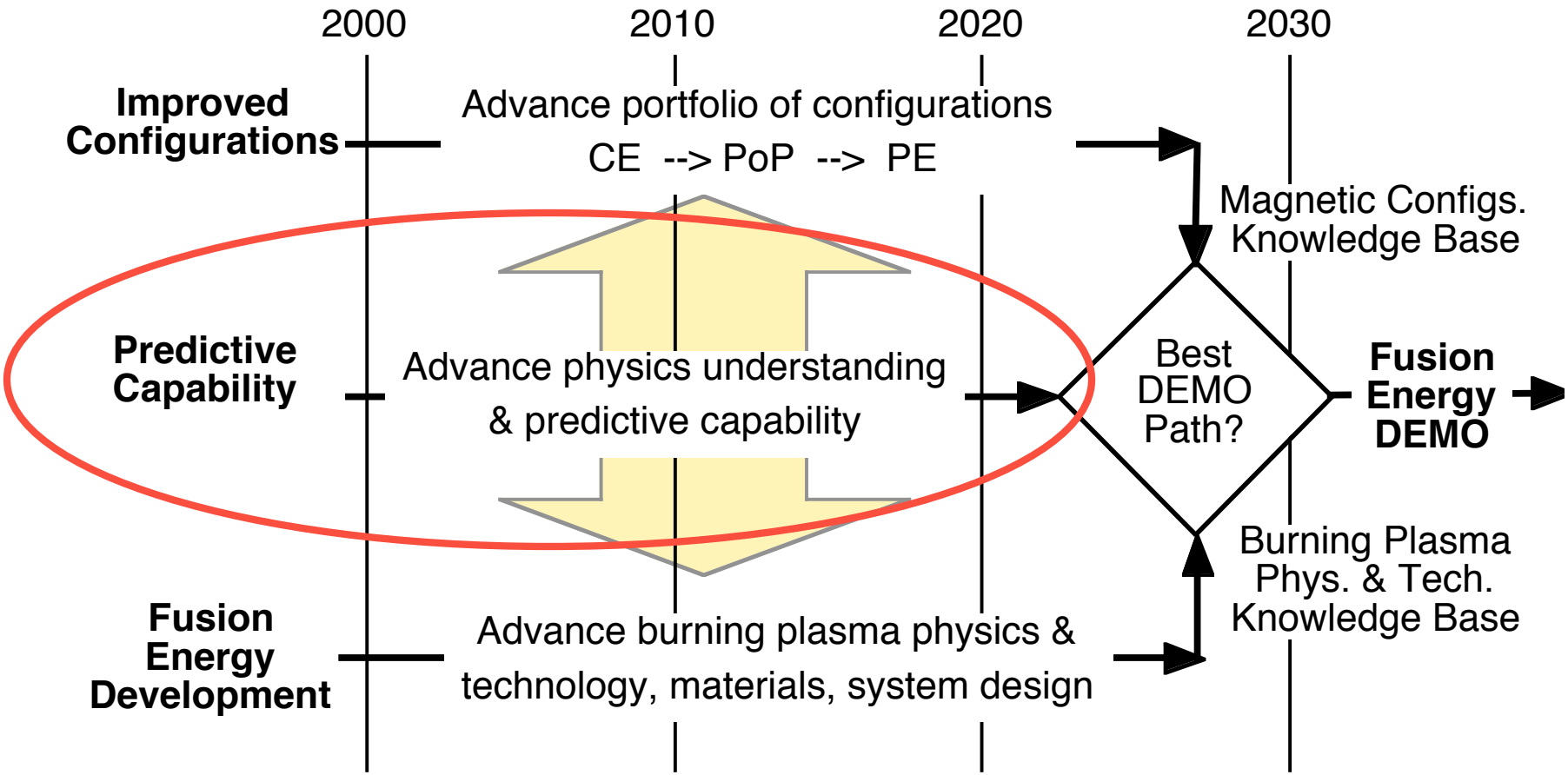
The Portfolio Approach to Predictive Capability: An MHD Example

John Sarff

ICC-BPX Connection, Session 2
Snowmass 2002

An integrated development path for fusion energy.



Some common MHD physics issues

- Wall stabilization, resistive wall modes
- Neoclassical effects on tearing modes
- Alpha-driven instabilities
- Kinetic effects
- Flow shear stabilization
- Diagnostics & computational tools
- Profile control (not strictly MHD, but related to next item)
- Coupling of transport & stability: self-consistent profiles, nonlinear effects, etc.

Resistive wall modes expected in most high beta toroidal configurations.

- Advanced Tokamak, Spherical Tokamak
  - Wall stabilization required for high β_N pressure-driven kinks
  - Flow and/or feedback stabilization solutions

- Reversed Field Pinch, Spheromak
  - Wall stabilization required for current-driven kinks ($\beta \geq 0$)
  - Flow and/or feedback stabilization solutions

- Compact Stellarator
  - No RWM, but 3D shaping analogy

Despite configuration differences, phenomena and solutions are similar.

⇒ Cross-configuration predictive capability likely.

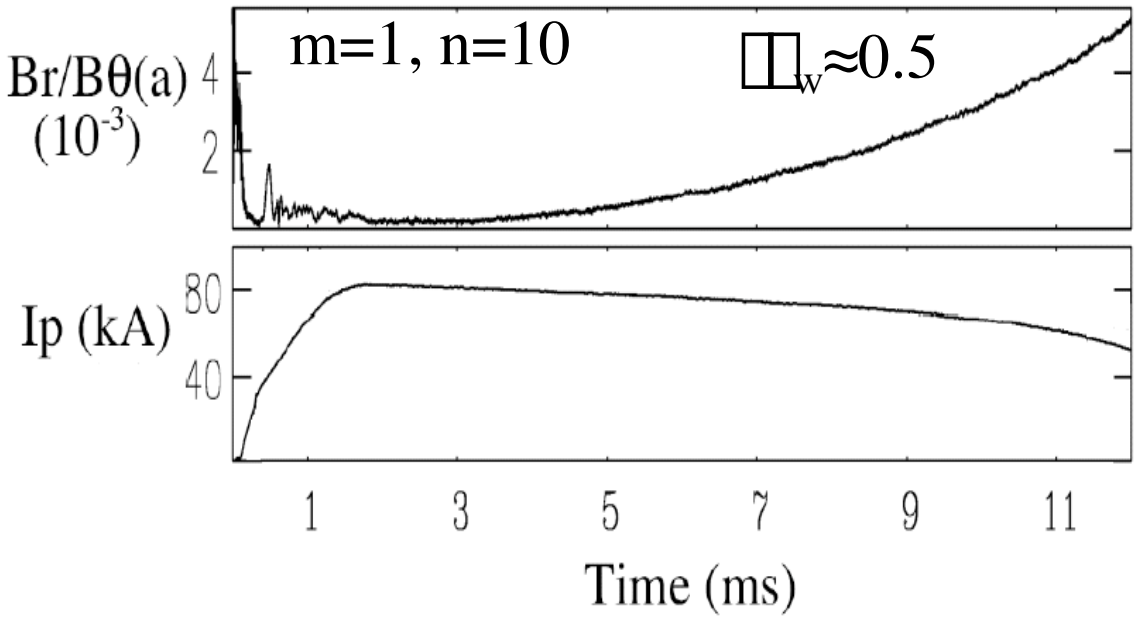
“Textbook” resistive wall mode in an RFP.

Extrap T2R

KTH-Stockholm

a = 0.18m, R = 1.24m, τ_w = 6 ms

(former OHTE)



Drake et al, EPS 2001

The ICC portfolio is more than alternate solutions.

- Experimental test bed for understanding primary configuration knobs, e.g., in toroidal confinement:
  - Aspect ratio (ST, spheromak, FRC)
  - External transform (stellarator)
  - Toroidal field strength (RFP, spheromak, FRC)

    etc...
- Cross-concept (configuration knob) predictive capability could ***define*** the optimum configuration.

Predictive science valid over a wide range of configuration space will most convincingly allow an “alternate” substitution for DEMO, even if the substitution is not very different from a present-day concept.