The Fastest Path to Commercial Fusion Power

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FNSF+ Could be the Pilot Plant for Commercial Fusion

- The smallest facility to *pilot* the route to commercial fusion – by doing fusion nuclear science, demonstrating practical operation, and making net electricity, based on
  - ITER + magnetic fusion R&D,
  - or NIF + inertial fusion R&D.

- Results from NIF + ITER well underway could trigger a common preparatory R&D program – if (and only if) we have a compelling roadmap to commercial fusion power.
A FNSF / Pilot Plant with $P_{\text{fus}} = 30\%$ of a Power Plant would Make Net Electricity

- Reduce linear dimensions to 2/3 power plant
- For fixed $\beta$, $B$, and $T$, $P_{\text{fus}}$ down by $(2/3)^3 = 30\%$
- Assume same absolute recirculating power. (!)
- For $P_{\text{fus}} = 30\%$, $Q_{\text{eng}} \equiv P_{\text{gross}}/P_{\text{recirc}} > 1 \Leftrightarrow Q_{\text{eng}}$ of power plant $> 3.33$
- Pilot plant can do FNSF mission: Neutron flux $\sim 2/3$ power plant, surface area $= 4/9$, can adjust $^6\text{Li}$ enrichment.

Obviously there are other factors (e.g., neutron m.f.p.). On the other hand $P_{\text{recirc}} = \text{constant}$ is conservative.

Initial looks at Tokamak, Stellarator, ST support 2/3 reduction
Much More Analysis is Required

• What would such an FNSF / Pilot Plant look like?
  – Advanced Tokamak (S/C for $Q_{\text{eng}} > 1$ & realistic maintenance)
  – Stellarator (Lowest recirculating power, no disruptions)
  – Spherical Torus (Cheapest, most readily maintained configuration)
  – Are there ICC game changers?

  Any design must “pilot” the power plant maintenance approach.

• What near-term program of modeling, test stands, toroidal facilities is necessary to support such an FNSF / Pilot Plant?
  – Plasma performance
  – Integrated plasma material interface
  – Neutron interactive materials

• There is much synergy between needed MFE & IFE R&D
  – An IFE pilot plant should be studied as well