Mission Statements

FIRE:

to attain, explore, understand and optimize magnetically-confined fusion-dominated plasmas.

ITER:

to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes.

Fusion Science Objectives for a Major Next Step Burning Plasma Experiment (FIRE)

Explore and understand the strong non-linear coupling that is fundamental to fusion-dominated plasma behavior (self-organization)

- Energy and particle transport (extend confinement predictability)
- Macroscopic stability (β-limit, wall stabilization, NTMs)
- Wave-particle interactions (fast alpha particle driven effects)
- Plasma boundary (density limit, power and particle flow)

- Test/Develop techniques to control and optimize fusion-dominated plasmas.
- Sustain fusion-dominated plasmas - high-power-density exhaust of plasma particles and energy, alpha ash exhaust, study effects of profile evolution due to alpha heating on macro stability, transport barriers and energetic particle modes.
- Explore and understand various advanced operating modes and configurations in fusion-dominated plasmas to provide generic knowledge for fusion and non-fusion plasma science, and to provide a foundation for attractive fusion applications.

Advanced Burning Plasma Exp't Requirements

Burning Plasma Physics (Elmy H-Mode)

Q	≥ 5, ~ 10 as target, ignition not precluded
$f_\alpha = P_\alpha/P_{heat}$	$\geq$ 50%, ~ 66% as target, up to 83% at Q = 25
TAE/EPM	stable at nominal point, able to access unstable

Advanced Toroidal Physics (Reversed Shear ITB)

$f_{bs} = I_{bs}/I_p$	$\geq$ 50% as target AT	up to 75% allowed
β_N	~ 2.5, no wall	~ 3.6, n = 1 wall stabilized

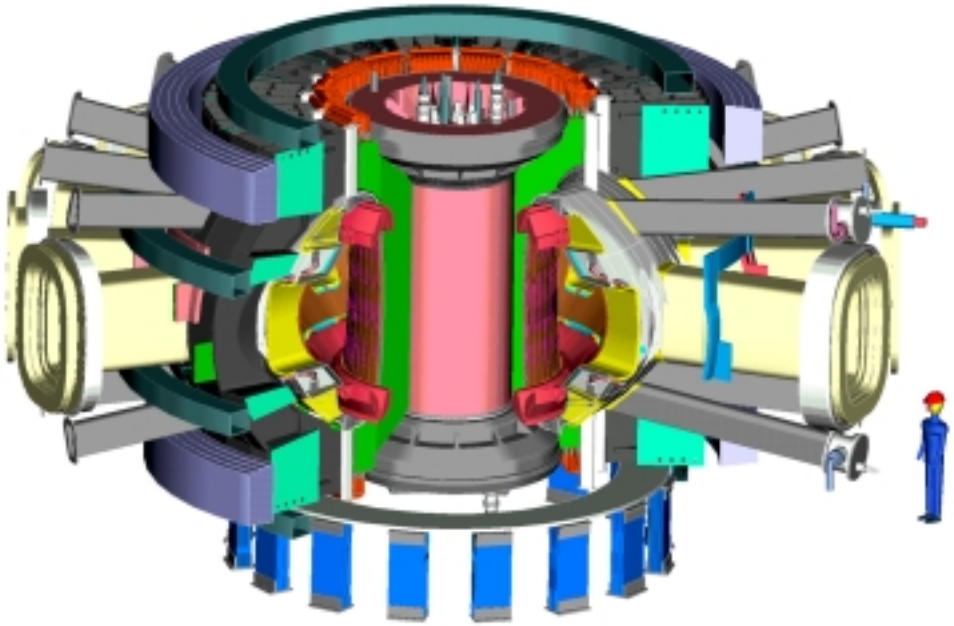
Quasi-stationary

Pressure profile evolution and burn control	> 10 τ_E
Alpha ash accumulation/pumping	> several τ_{He}
Plasma current profile evolution	1 to 3 τ_{skin}
Divertor pumping and heat removal	several $\tau_{divertor}$, $\tau_{first\ wall}$

Fusion Ignition Research Experiment

(FIRE)

http://fire.pppl.gov



Design Features

- R = 2.14 m, a = 0.595 m
- B = 10 T
- W_{mag} = 5.2 GJ
- I_p = 7.7 MA
- $P_{aux} \leq$ 20 MW
- Q $\approx$ 10, P_{fusion} ~ 150 MW
- Burn Time $\approx$ 20 s
- Tokamak Cost $\approx$ $375M (FY99)
- Total Project Cost $\approx$ $1.2B at Green Field site.