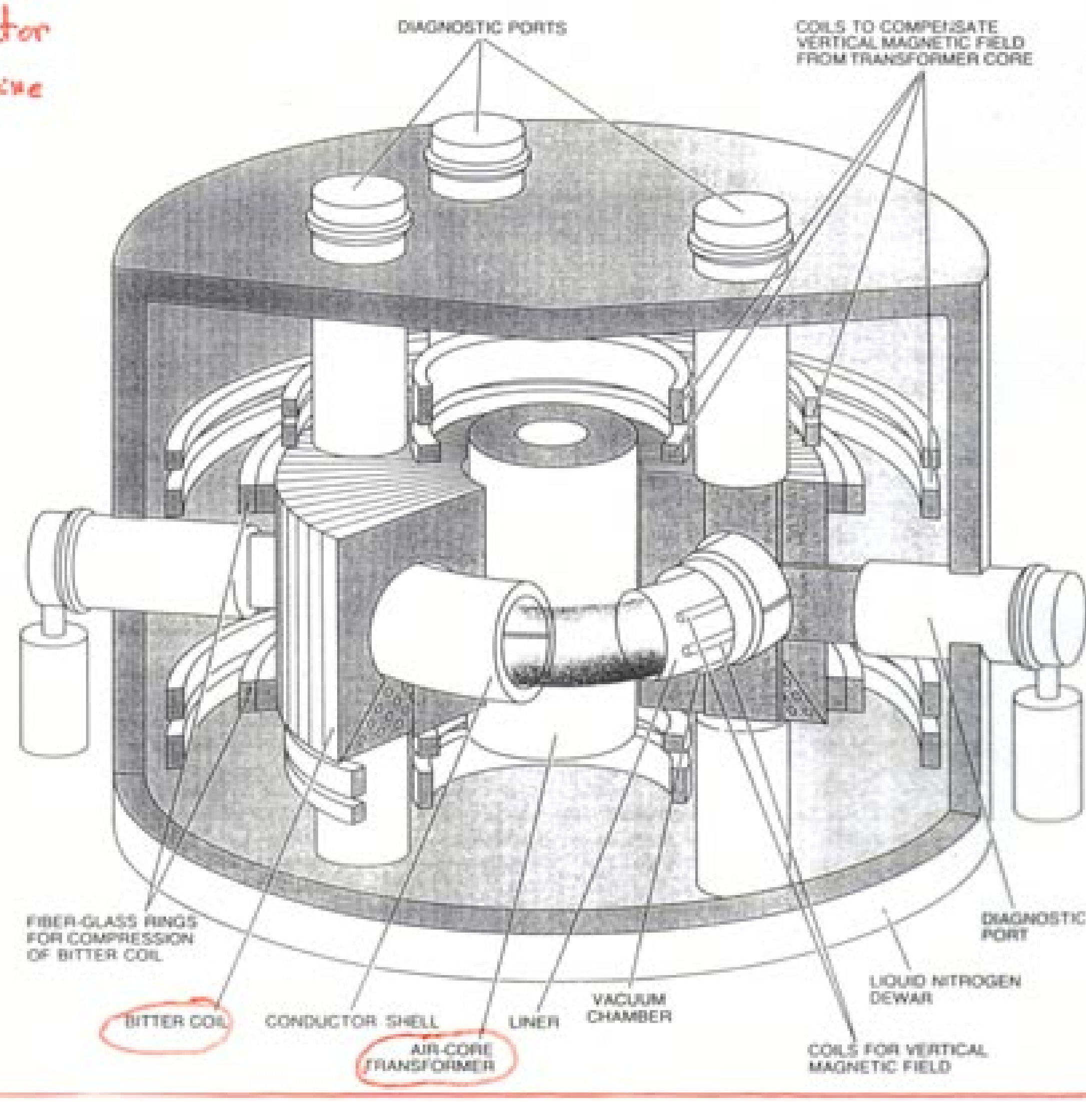
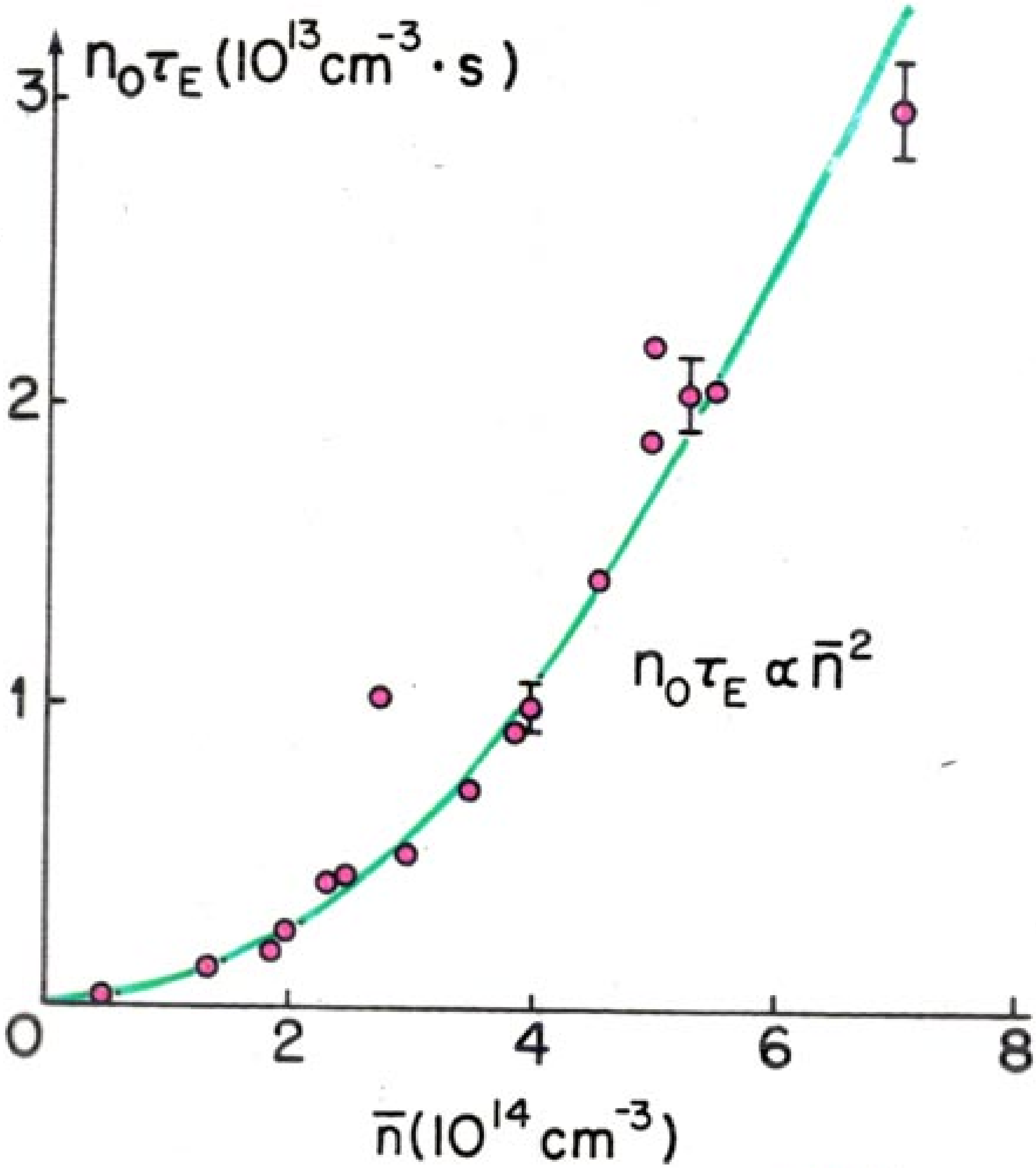
Alcator Machine

Alto Campo Torus

First machine without iron dominated magnets



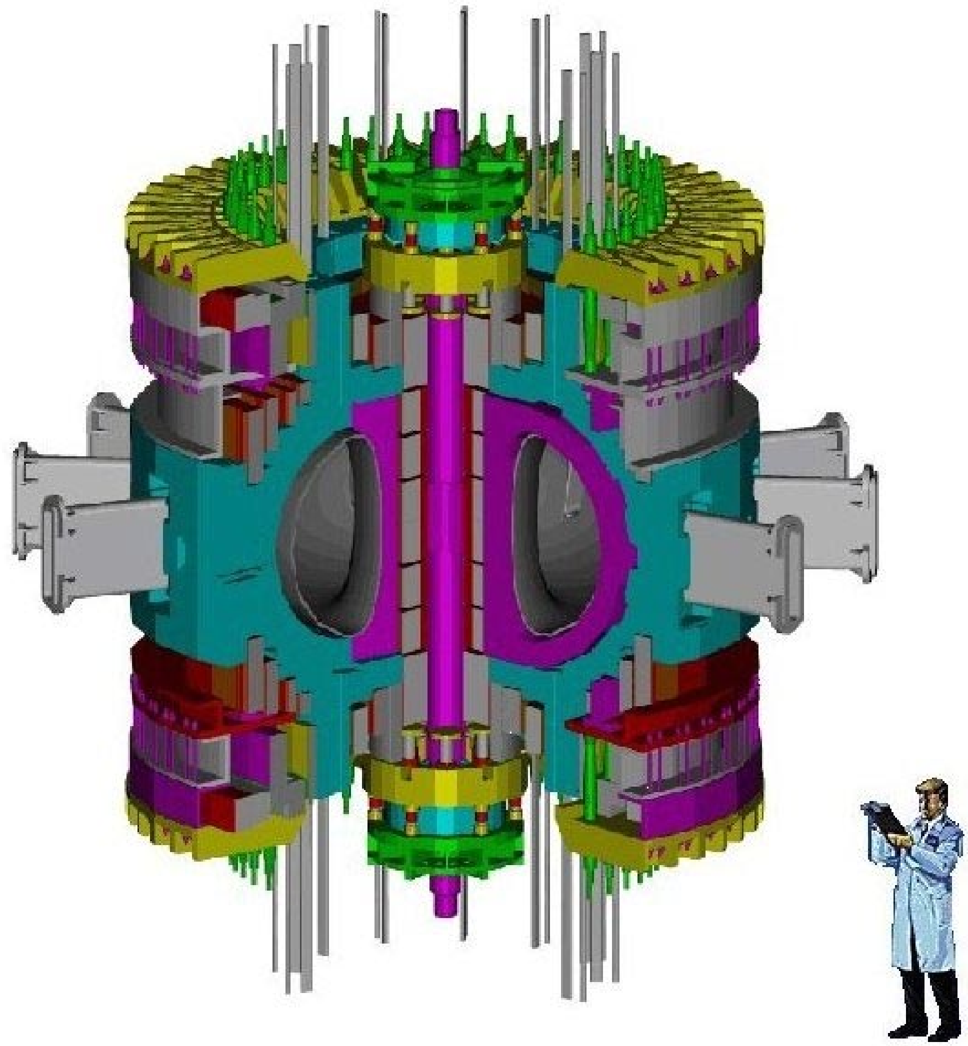


Teller
Peierls

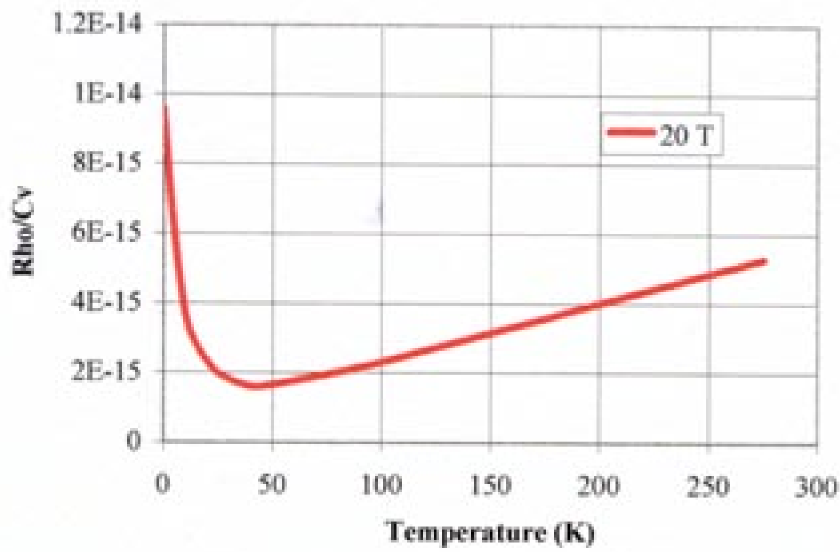
Basov

parity
isotopic effect

IGNITOR MACHINE



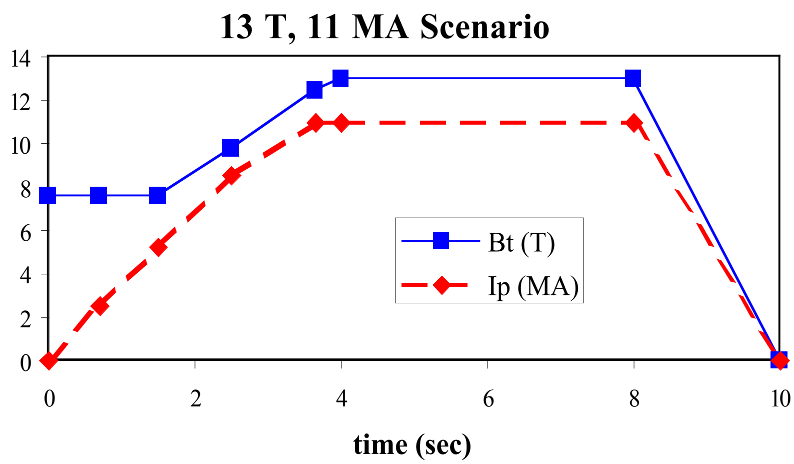
Ratio of resistivity to specific heat for the copper material adopted for the toroidal magnet



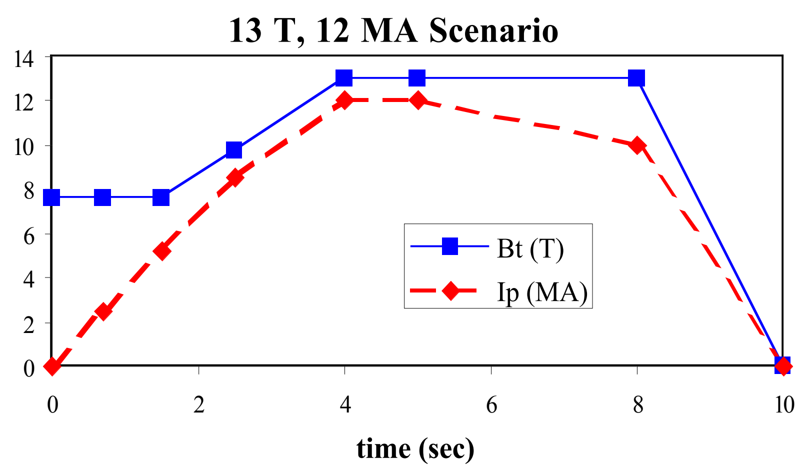
Ignitor Reference Design Parameters

major radius	R_0	1.32 m
minor radius	$a \times b$	0.47×0.86 m
aspect ratio	A	2.8
elongation	κ	1.83
triangularity	δ	0.4
toroidal field	B_T	$\lesssim$13 T
toroidal current	I_p	$\lesssim$11 MA
maximum poloidal field	$B_{p,max}$	$\lesssim$ 6.5 T
mean poloidal field	$\overline{B}_p \equiv I_p / 5\sqrt{ab}$	$\lesssim$ 3.5 T <<
poloidal current	I_θ	$\lesssim$9 MA
edge safety factor @ 11 MA	q_ψ	3.6
plasma volume	V	$\simeq$ 10 m^3
plasma surface	S	$\simeq$ 34 m^2
ICRF heating (70-140 MHz)	P_{RF}	18 – 24 MW
Optimal ICRH (115 MHz)	P_{RF}^{OP}	3–5 MW

Examples of operating scenarios



a)



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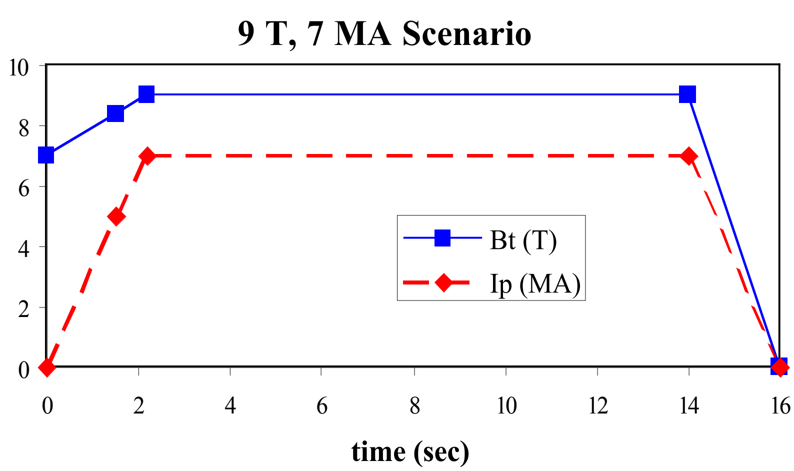
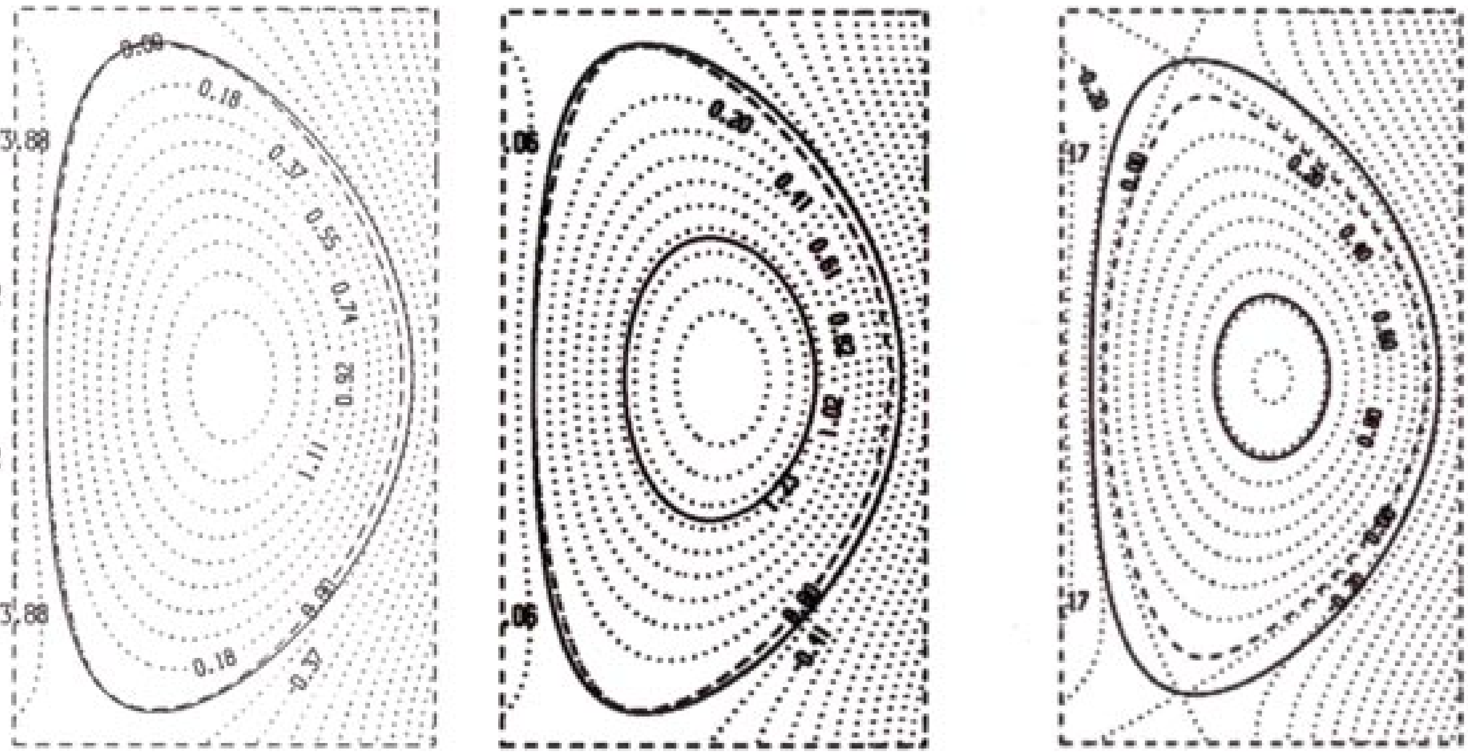


c)

Magnetic Configurations @ 13 T

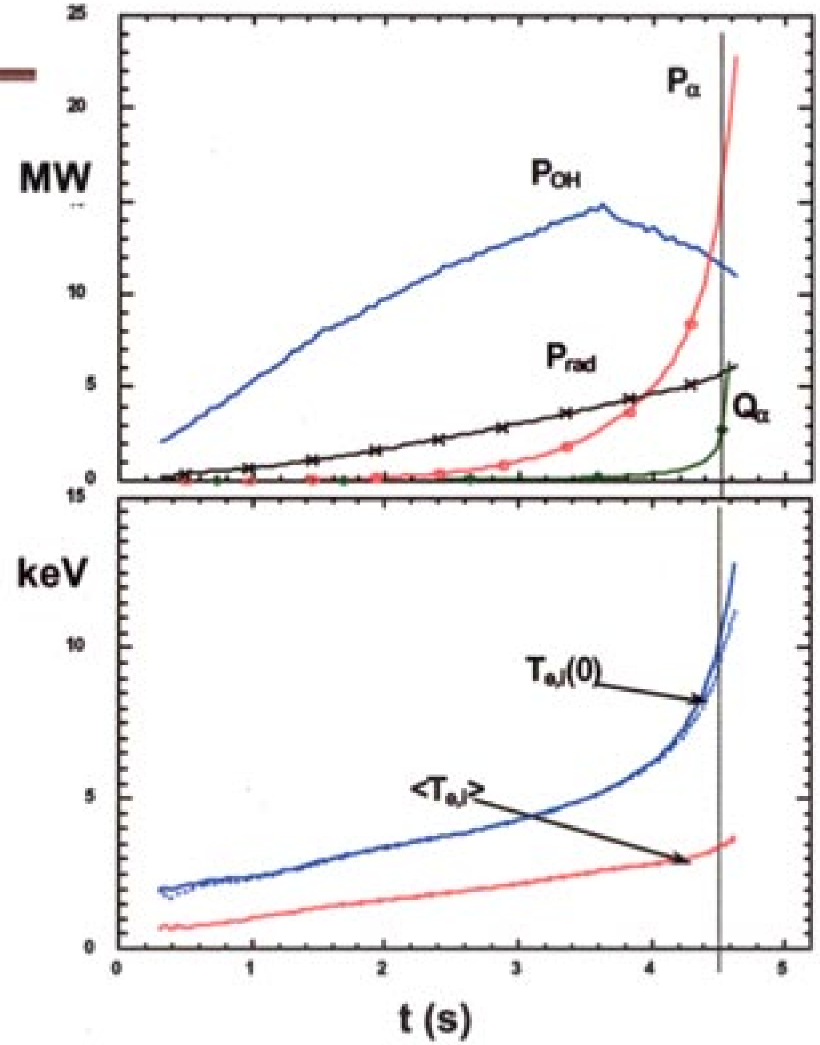


11 MA, LIMITER

9 MA, DN

JETTO Simulations

R, a	1.32, 0.47 m
κ, δ	1.83, 0.4
I_P	11 MA
B_T	13 T
T_{e0} , T_{i0}	11.5, 10.5 keV
n_{e0}	10^{21} m^{-3}
$n_{\alpha 0}$	1.2×10^{18} m^{-3}
P_α	19.2 MW
W_{pl}	11.9 MJ
$P_{OH} = dW/dt$	10.5 MW
P_{rad}	6 MW
β_{pol}, β	0.2, 1.2%
q_ψ, q_0	3.5, ~ 1.1
τ_E, τ_{sd}	0.62, 0.05 s
Z_{eff}	1.2



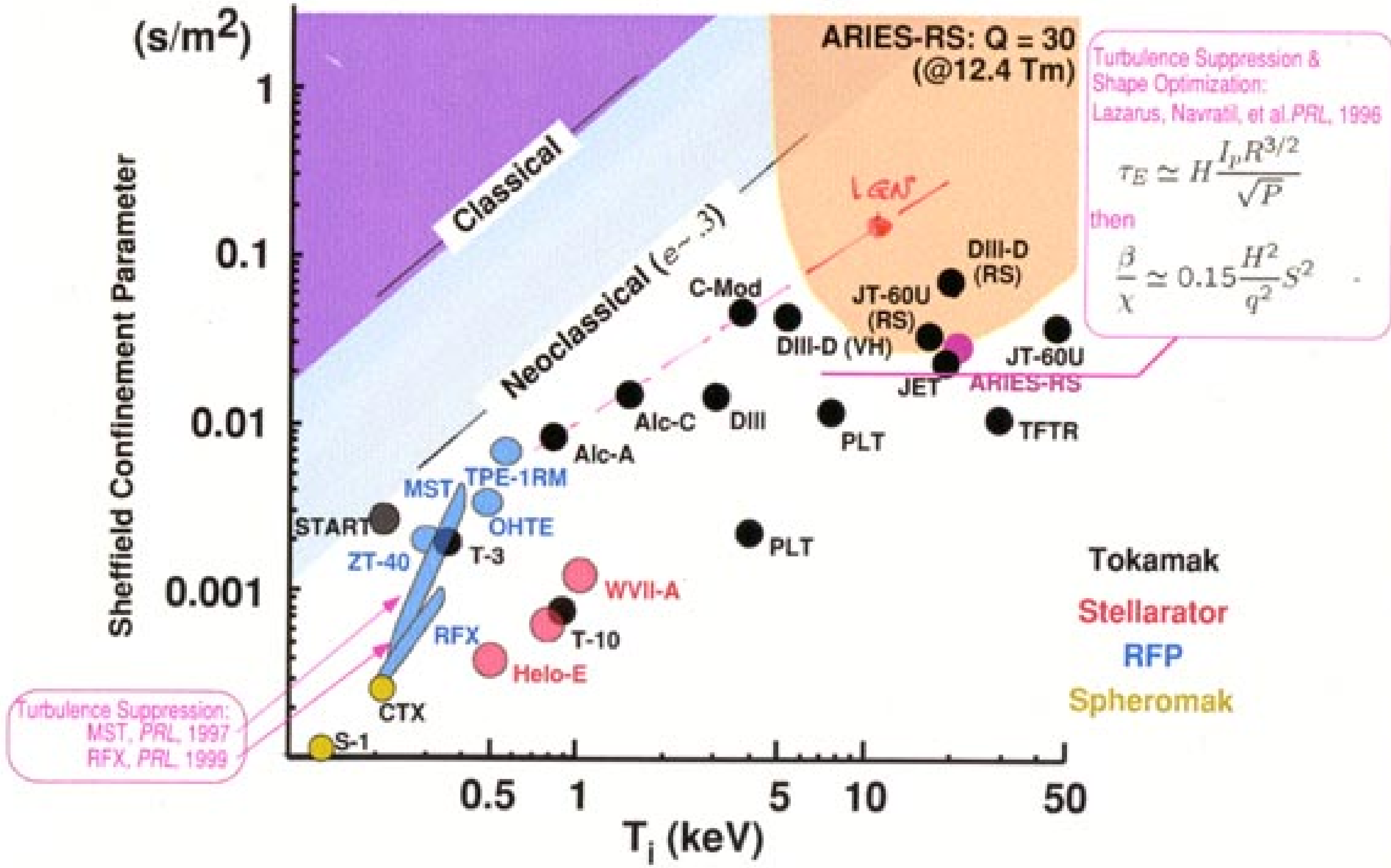
(Airoldi and Cenacchi, *Nucl. Fusion* 37,1117(1997)

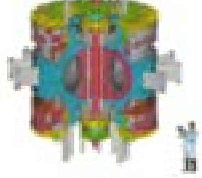
Fusion Energy Relevant Levels of β/χ have been Achieved for Short Pulses

$\beta = 8\pi \frac{\langle n(T_e+T_i)\rangle}{B^2}$

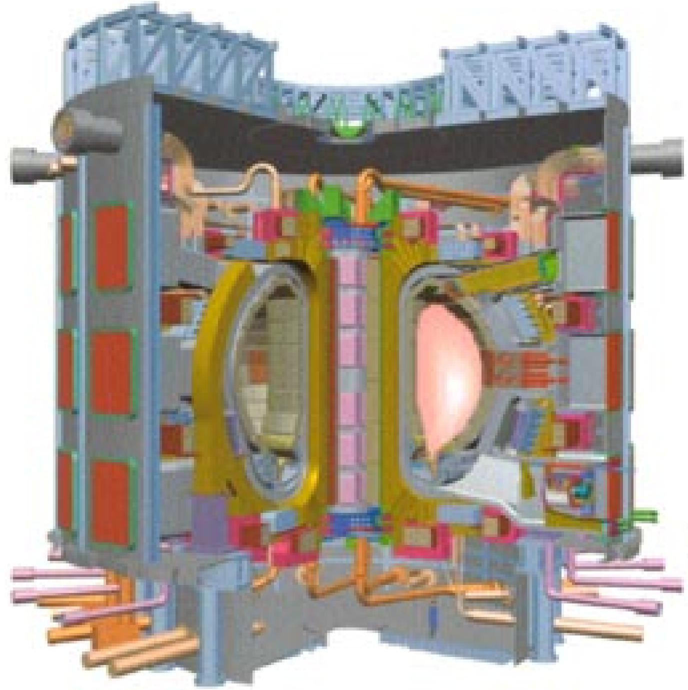
$\beta/\chi_\perp \equiv \beta\, 2\tau_E/a^2$

$\chi_\perp$ = diffusion coefficent (effective) for the plasma thermal energy

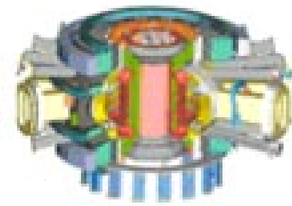




IGNITOR



ITER-FEAT



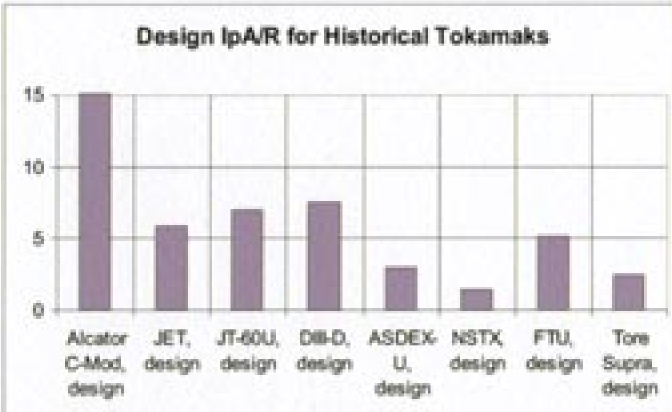
FIRE

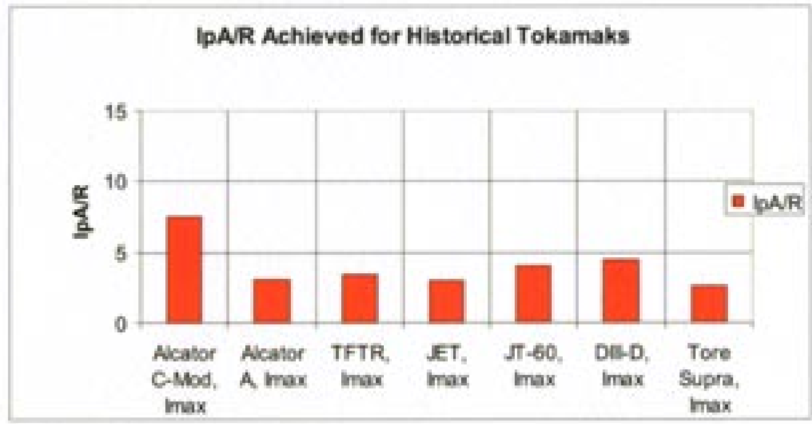
	IGNITOR	ITER-FEAT	FIRE
$q_\psi \simeq 3.5$	$\bar{\bar{B}}_p \simeq 3.5\,\mathrm{T}$	$\bar{\bar{B}}_p \simeq 1\,\mathrm{T}$	$\bar{\bar{B}}_p \simeq 1.7\,\mathrm{T}$
	$I_p \simeq 11\,\mathrm{MA}$	$I_p \simeq 12.8\,\mathrm{MA}$	$I_p \simeq 6.2\,\mathrm{MA}$
$q_\psi \simeq 3$ (lower safety factor)		$\bar{\bar{B}}_p \simeq 1.15\,\mathrm{T}$	$\bar{\bar{B}}_p \simeq 1.9\,\mathrm{T}$
		$I_p \simeq 15\,\mathrm{MA}$	$I_p \simeq 7.7\,\mathrm{MA}$

q_ψ = *safety factor for plasma stability* I_p = *plasma current* $\bar{\bar{B}}_p$ = *confining (poloidal) magnetic field*

MIT Plasma Science and Fusion Center
Fusion Technology & Engineering Division

IpA/R Historical Survey

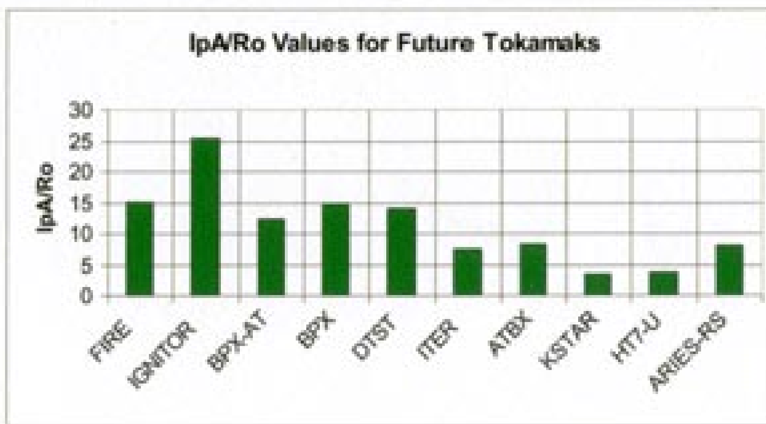


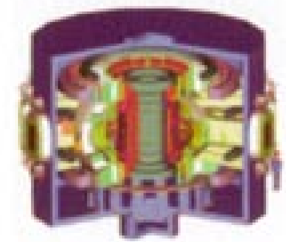


FIRE IpA/Ro 2x as high as world record

IGNITOR IpA/Ro 70% higher than other designs

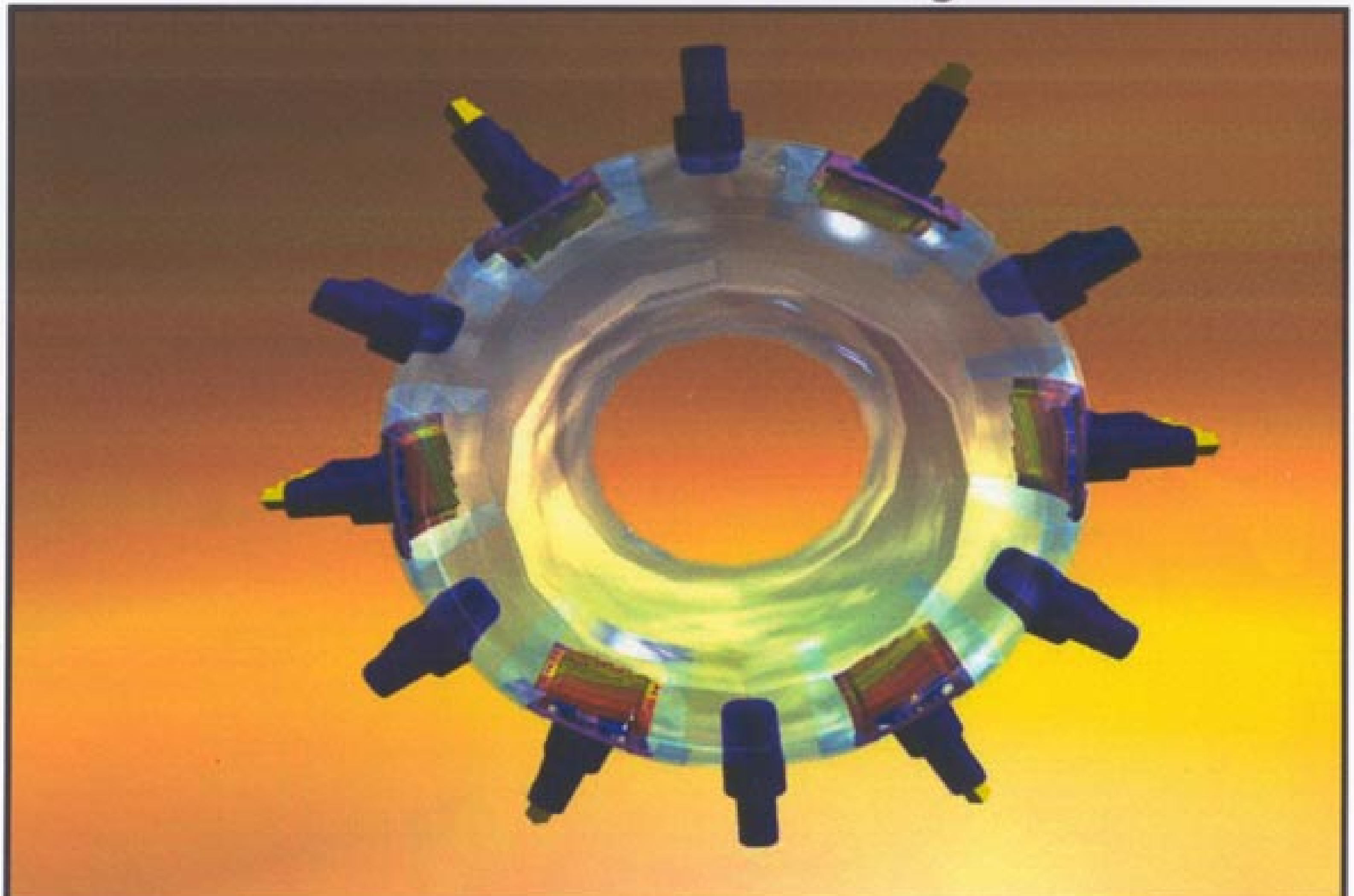
FIRE IpA/Ro 2x as high as ITER





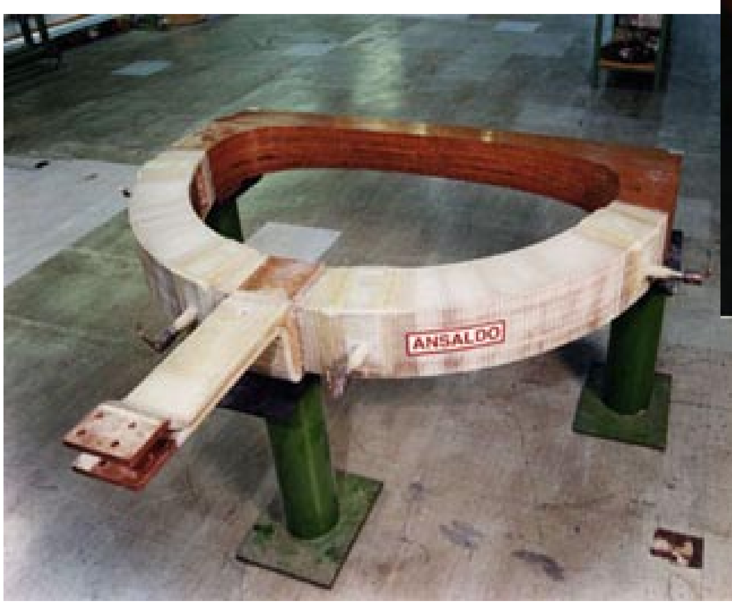
J. Schultz

Ignitor : Thermo-Mechanical analysis of the ICRH antenna system



Ignitor Project

Full size prototypes



The Italian 380 kV

Transmission Grid

C.E.S.I

ENEL Center of Rondissone (courtesy of ENEL)