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Status of Fusion Power

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INTRODUCTION

Basic Case: Do we really need Fusion Power?

The world population is increasing rapidly, the demand on electricity is also increasing, while reserves of oil and gas are reduced.

Fusion offers a ***secure, long-term*** source of electricity ***supply***, with important ***environmental advantages***, such as:

accident effect, waste, no contribution to greenhouse gases or acidic emissions, no nuclear proliferations problems, and safety.

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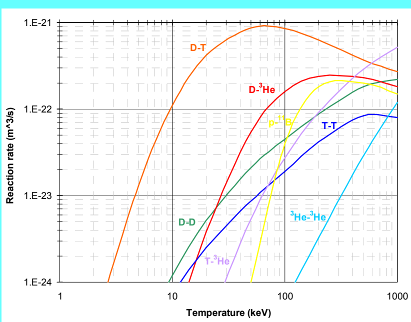
Stars Vs. Earth and Fusion Energy

IFC

MFC



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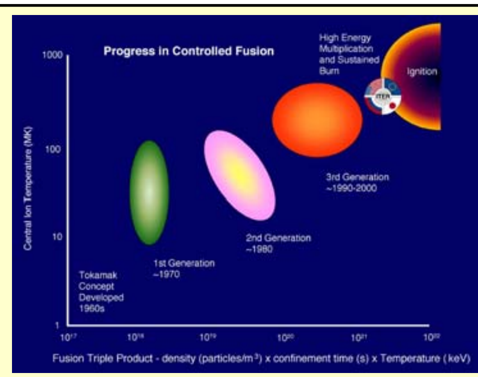

Fusion Triple Product = ntT > 5E+21 keV.s/m3

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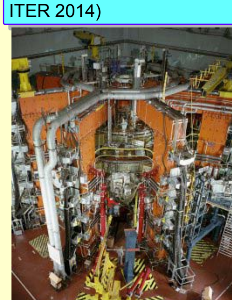
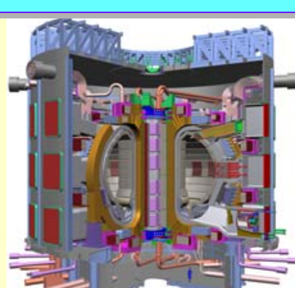
Containment Methods and Machines

Tokamak

TFTR, JET, JT-60U, C-MOD, ASDEX-U, DIII-D, KSTAR- 2004, ITER 2014)





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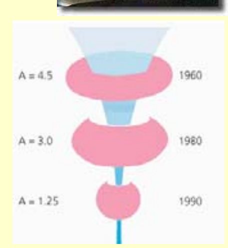
Containment Methods and Machines

Spherical Tokamak

START, MAST, COMPASS-D, SSPX, NSTX



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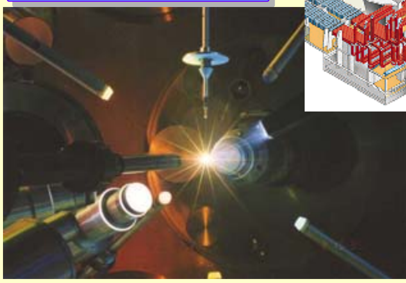
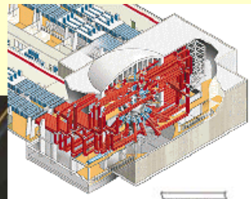
Containment Methods and Machines

ICF

NOVA, GEKKO-XII, OMEGA,
NIF *, Laser Mega Joule *





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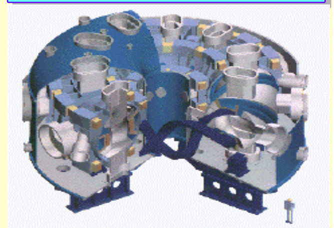
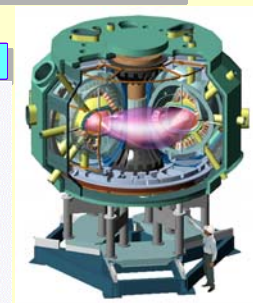
Containment Methods and Machines

Stellarator

TJ1U, HSX, CHS, WL7*, LHD, NCSX





Steady state (no transformer),
20+ years behind in technology compared to Tokamak

Machine	Country	Minor Radius a(m)	Elongation k	Major Radius R(m)	Plasma Current I (MA)	Toroidal Field B (T)	Input Power P (MW)	Start Date
ITER	Internation.	2.0	1.75	6.2	15	5.3	73+	2013**
JET	EU	1.00	1.8	2.96	7.0	3.5	42	1983
JT-60U	JAPAN	0.85	1.6	3.2	4.5	4.4	40	1991
TFTR	USA	0.85	1.0	2.50	2.7	5.6	40	(1982) Closed
TORE-SUPRA	FRANCE	0.80	1.0	2.4	2.0	4.2	22	1988
T-15	RUSSIA	0.70	1.0	2.4	2.0	4.0	-	1989
DIII-D	USA	0.67	2.5	1.67	3.0	2.1	22	1986
ASDEX-U	GERMANY	0.5	1.7	1.67	1.4	3.5	16	1991
TEXTOR-94	GERMANY	0.46	1	1.75	0.8	2.6	8	1994
FT-U	ITALY	0.31	1.0	0.92	1.2	7.5	-	1988
TCV	SWITZERLAND	0.24	3.0	0.875	1.2	1.43	4.5	1992
C-MOD	USA	0.22	1.8	0.67	1.5	8.07	4.5	1992
MAST	UK	0.5	3	0.7	2	0.63	6.5	1999
NSTX	USA	0.67	1.9	0.85	1.0	0.6	11.5	1999

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ITER vs. DT Experiments to Date (Sept. 2003)

	ITER (Pulsed)	ITER (Steady State)	TFTR (D-T)	JET (D-T)
Radius (m)	6.2	6.4	2.5	3.0
Plasma Volume(m3)	831	770	38	153
Normalized Pressure	2.8%	2.8%	1.1%	2.6%
Normalized Confinement	1.0	1.6	1.3	1.6
Pressure Driven Current Fraction	10%	48%	26%	10%
Magnetic Field Strength (T)	5.3	5.2	5.6	3.5
Fusion Power (MW)	500	360	11	16
Q	10	6	0.27	0.64

JT-60: Q (DT-eq. for pure DD fusion) = 1.25

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FUSION STATUS AND PROSPECTS

ITER

(1) Full-sized or scalable modules of key components are manufactured and tested.
(2) Scientific and technological bases to start ITER construction are established.
(3) Joint Implementation Agreement to conclude soon 2003/2004
(4) ITER operation will start in 2013

NIF

(1) Under construction and to end soon 2004
(2) World's largest laser experimental system, 10m

IFE

(1) Considerable research for IFE chambers
(2) Many challenges remain (pulsed reaction)

FPP

(1) DEMO, SSTR, A-SSTR2 are designed in Japan
(2) DEMO is the smallest and least expensive, 2030

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US DOE and A Twenty Year Outlook

Facilities for the Future of Science

Priority No. 1: ITER

Priority No. 18: Next Step Spherical Torus (NSST) Experiment

Priority No. 23: Fusion Energy Contingency

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CONCLUSIONS

- ♦ Fusion energy will be needed in the near future.

- ♦ ITER is the first fusion science experiment capable of producing a self-sustaining fusion reaction "burning-plasma." It is the next and essential step on the path toward demonstrating the scientific and technological feasibility of fusion energy.

- ♦ US Depart. of Energy (Nov. 2003) listed ITER as No.1 priority in the Facilities for the Future of Science (A 20 Year Outlook)

- ♦ Canada's federal government once again takes a short-sighted decision of passing on the ITER bid (Nov. 2003). In 1997, it closed both CFFTP and Tokamak de Varennes due to deficit reduction measures.

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Thank You

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