

Tokamak (GOLEM) - spoutání energie hvězd v pozemských podmínkách

Gaudeamus

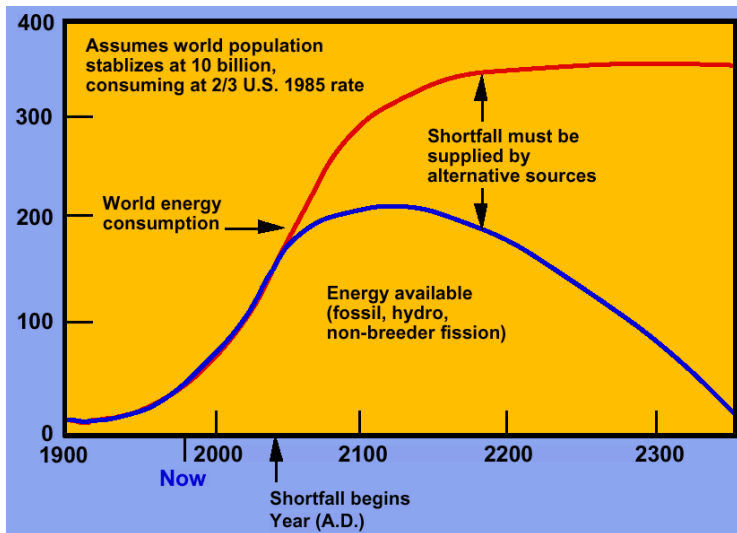
2016

Outline of the talk

- 1 Úvod
- 2 Termojaderná fúze
- 3 Konkrétní implementace - Tokamak GOLEM
- 4 Ostatní tokamaky

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Energetické potřeby lidstva



Roční spotřeba 1GW elektrárny (zhruba Praha)

Coal

250 trains



Oil

11 super tankers



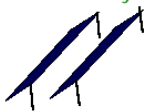
Fission

1.5 rail car load
Uranium Oxide



Solar

5000 acres of collectors
plus energy storage for
night and cloudy days

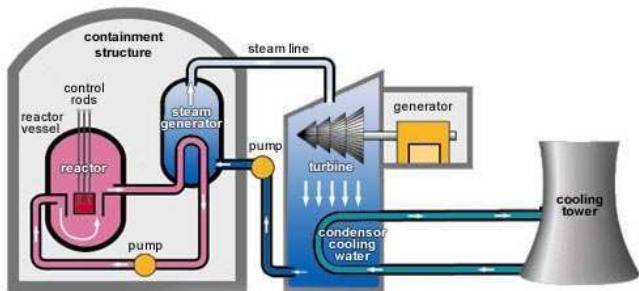


Fusion

1/2 ton pickup truck
Deuterium & Tritium



Základní princip tepelné elektrárny

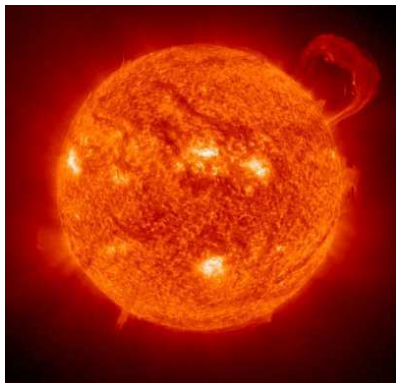


Otázka zní

?? ČÍM TOPIT ??

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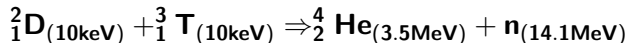
Spoutání energie hvězd



Core Burning Stages in a 25 Solar Mass Star:

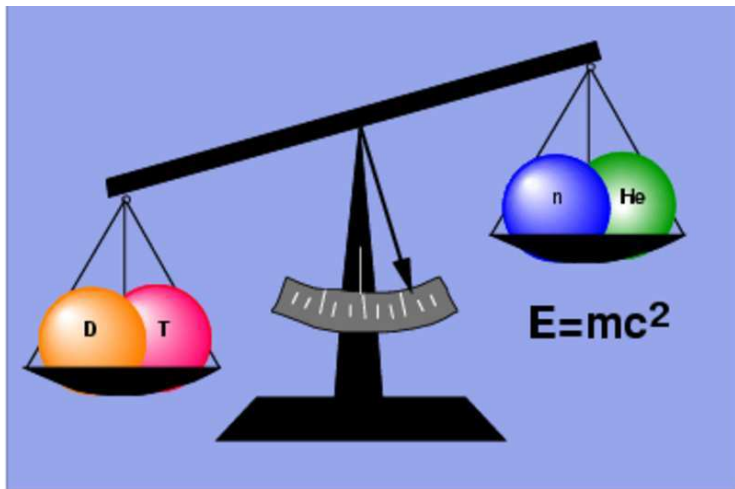
Fuel:	Products:	Temperature (K):	Minimum Mass:	Burning Period:
H	He	4×10^6	0.1	7×10^6 years
He	C, O	1.2×10^8	0.4	5×10^5 years
C	Ne, Na, Mg, O	6×10^8	4	600 years
Ne	O, Mg	1.2×10^9	~8	1 year
O	Si, S, P	1.5×10^9	~8	~0.5 years
Si	Ni - Fe	2.7×10^9	~8	~1 day

Nejvhodnější kandidát v pozemských podmínkách:

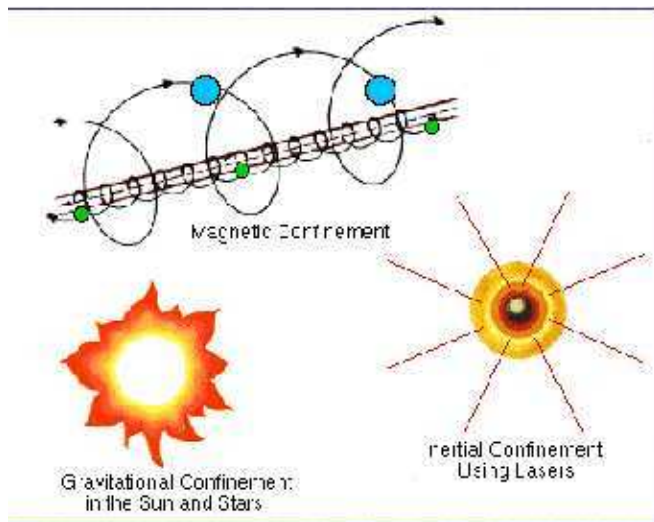


→ Udržet & Zapálit & Zahřát & Diagnostikovat ←

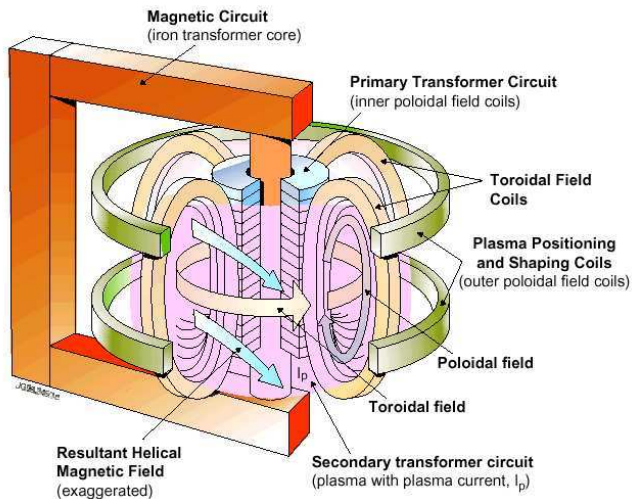
Uvolnění vazebné energie I



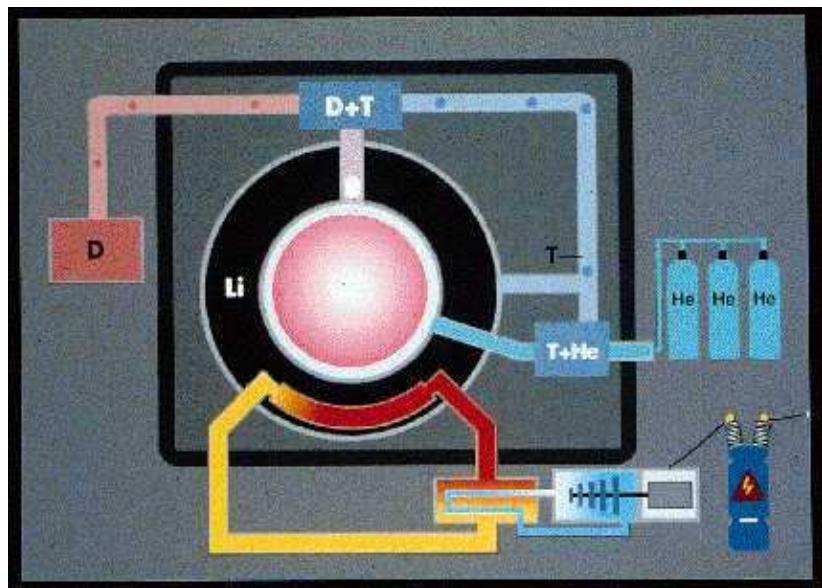
Tři způsoby udržení plazmatu



Magnetické udržení - Tokamaky



Budoucí reaktor



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Tokamak GOLEM - historie

Kurchatov Institute near Moscow,
Soviet Union
1960: **TM1-MH**



1974

Institute of Plasma Physics
Czech republic

CASTOR

COMPASS

Culham Centre for Fusion Energy
Great Britain
1989: **COMPASS-D**



2006

2006: new curricula at FNSPE:
**Physics and Technology
of Thermonuclear Fusion**

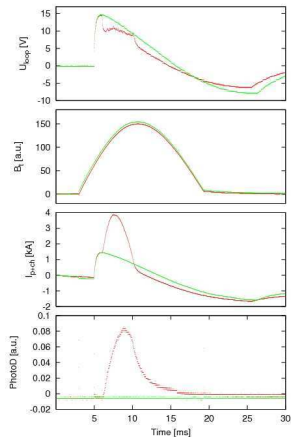
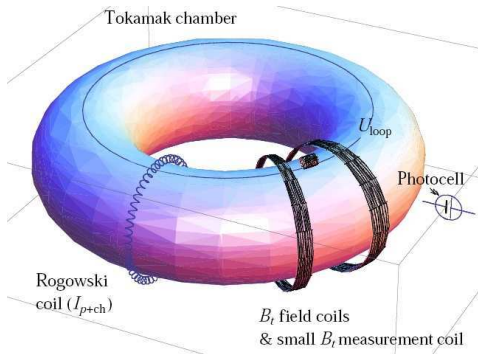
2008

Czech Technical University Prague
Czech republic

GOLEM

?virtual or real experiments?

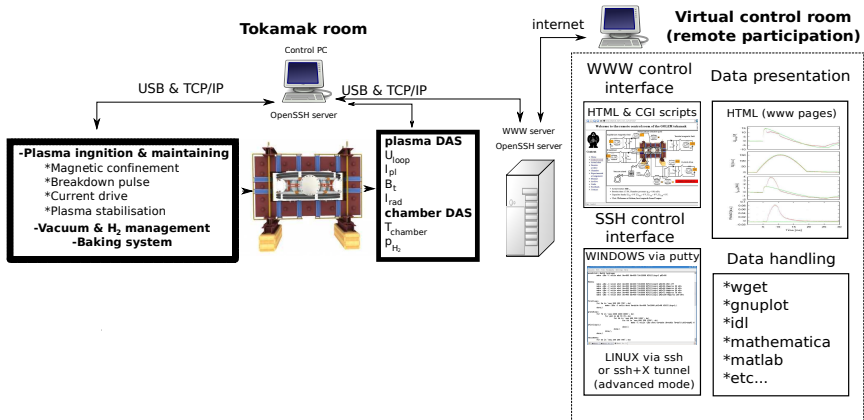
Diagnostika na tokamaku GOLEM



Diagnostika realizovaná s pomocí:



Napojení systému na internet



Virtuální velín tokamaku GOLEM

http://golem.fjfi.cvut.cz/CR/V1/events/PROMOTION/1011IBA2011/exp_L1.php

Tokamak Golem ****VIRTUALLY**** for IBA2011

Home

Control Room **L1** **L2** **L3**

Queue

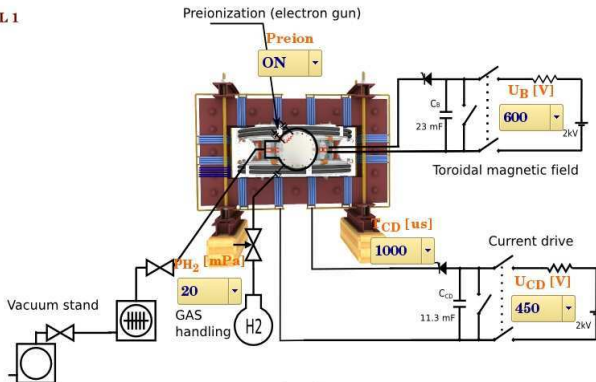
Live

Results

Manual

R

LEVEL 1

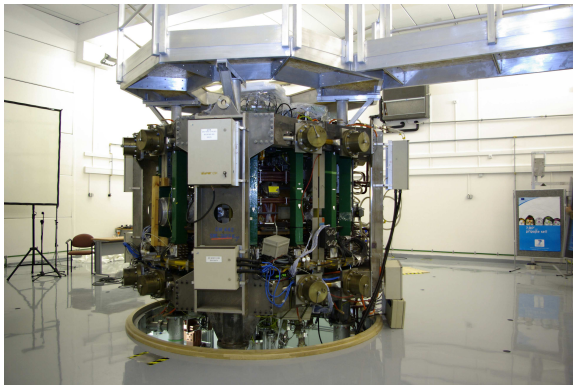


Discharge comment

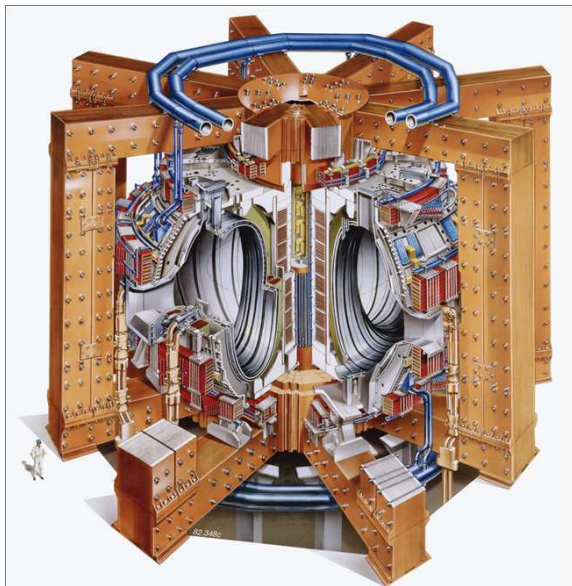
Place the discharge setup into the queue

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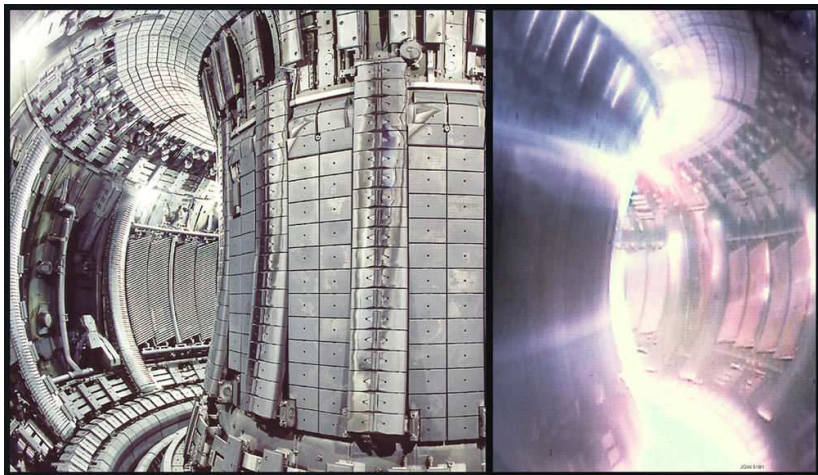
Compass



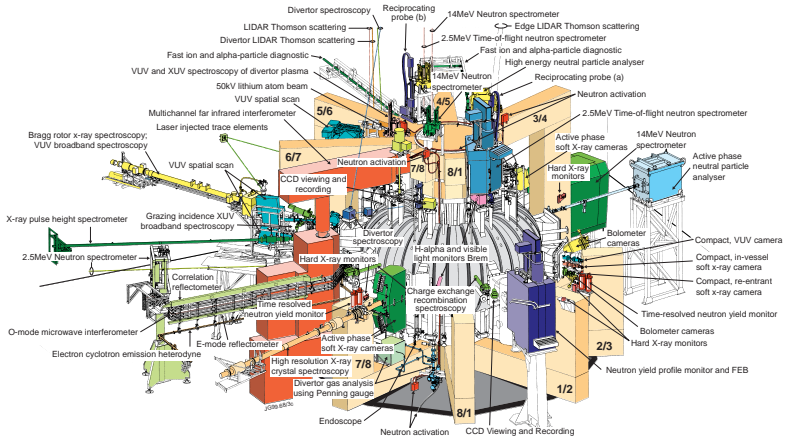
JET



Výboj v tokamaku



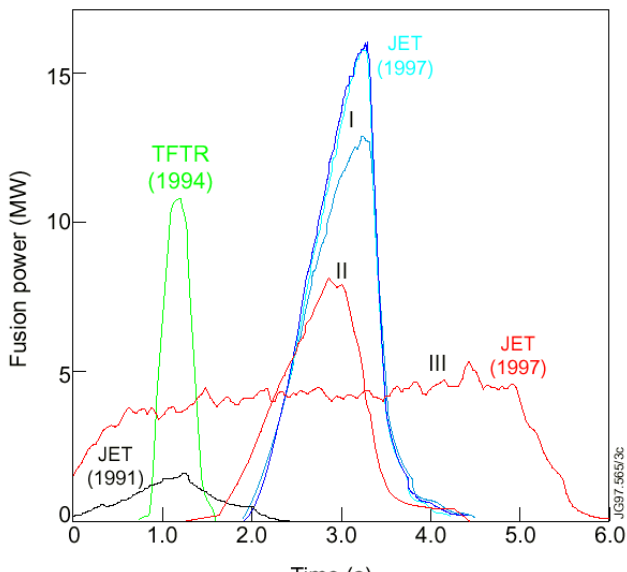
Joint European Torus (diagnostika)



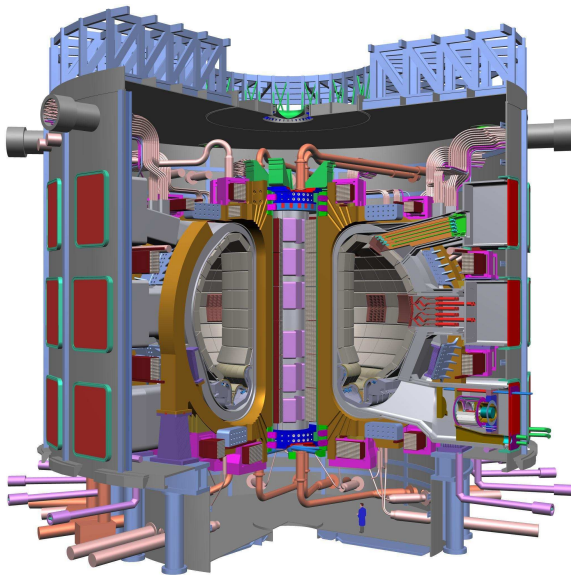
The challenge of characterising extreme conditions of nuclear fusion plasmas both spatially and temporally has inspired JET to produce an impressive array of diagnostic techniques. Drawing from fields as diverse as neutronics, spectroscopy, lasers and microwaves, JET is a leader in the art of measurement."

Andrea Murari, Task Force Leader - Diagnostics.

Fúzní výkon JETu (DT palivo)



ITER



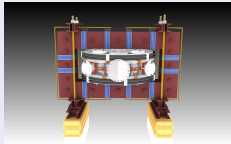
14.9.2009; ČVUT; PRAHA ...



Zimní škola fyziky plazmatu - Marianská 2011 (Tokamak, zřejmě COMPASS, s NBI)



Děkuji za pozornost



<http://golem.fjfi.cvut.cz>,
jste zváni