IAEA Activities on Plasma Physics & Nuclear Fusion Research

Richard Kamendje

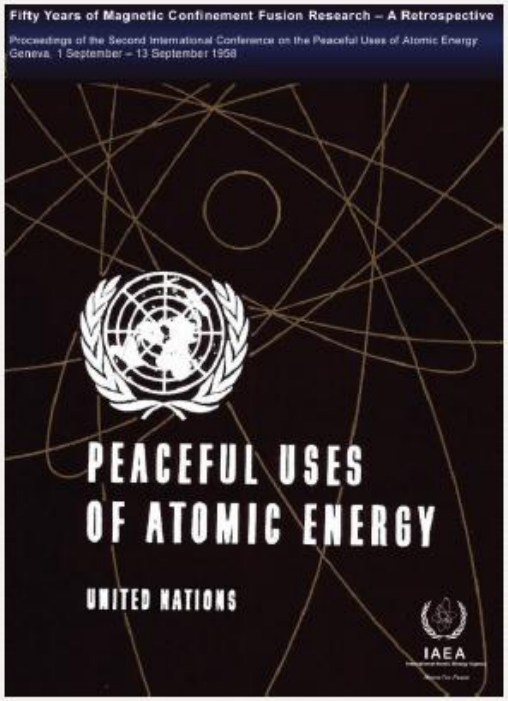
IAEA

Atoms for Peace: The First Half Century
1957–2007

April 20, 2011

Fusion History

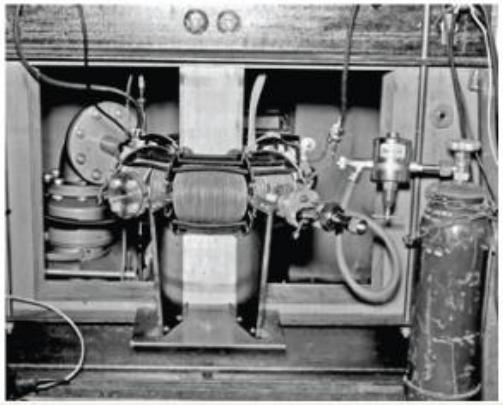
Declassification in 1958: UN Conference in Geneva with Fusion as Main Topic



Opening session of the Second Geneva Conference

I.V. Kurchatov's 1956 visit to Harwell Laboratory, where he also gave a surprising lecture in which previously classified experimental material was presented

The Aachen research group's first plasma experiment with a toroidal geometry in 1958



New York Times

SOVIET ANNOUNCES NEW ATOM METHOD

Discovery Seen as Leading to Control of Energy Released by Hydrogen

By TILLMAN DURDIN
Special to The New York Times.

HONG KONG, Aug. 22—Russian discovery of a procedure that may lead to control of the tremendous energy released by the fusion of the hydrogen atom was announced in Peiping today.

A Peiping radio dispatch received here said the new Russian method of harnessing thermonuclear reactions was reported Wednesday at a meeting at the Institute of Atomic Energy of the Chinese Academy of Sciences.

A student of Igor V. Kurchatov, director of the Institute of Atomic Energy of the Soviet Academy of Sciences, gave the report on behalf of his teacher.

The Peiping radio said "this great new scientific achievement was announced in China before it was made known in other parts of the world as a tribute to the profound friendship betwee nthe Chinese and Soviet peoples."

The new Russian approach was described as being based on use of the "ogra" unit installed at the Atomic Energy Institute in Moscow. The Hsinhua (new China) news agency summarized the new method as follows:

"Its [the ogra unit's] principle is built on the basis of the use of the adiabatic catcher. When molecular ions of hydrogen, which are accelerated to two hundred kilo-electron volts beforehand, are injected into the adiabatic catcher they are dissociated into atomic ions of hydrogen.

"Then high temperature ions vibrate between the two magnetic stoppers in the adiabatic catcher until they collide with each other and produce reaction. Because there is no large electric current going through the plasma in the adiabatic catcher the stability of the plasma is relatively high.

"Therefore it is possible along these lines to solve the question of controllable thermonuclear reaction. Moreover, this method also makes it possible to solve the question of stationary thermonuclear reaction."

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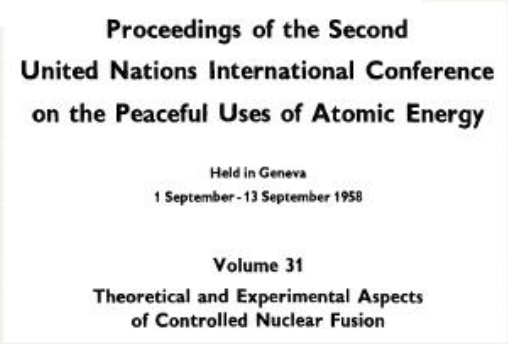
E. Teller, 1958

Peaceful Uses of Fusion

By Edward Teller *

You can operate the machine to the extent that this one surface can be cooled, the rest of the machine being at a relatively low temperature. These and other difficulties are likely to make the released energy so costly that an economic exploitation of controlled thermonuclear reactions may not turn out to be possible before the end of the 20th century.



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Outline

- Objectives fusion research within the IAEA
- Support to worldwide mainstream fusion research
- Contribution to capacity building

Objectives Fusion at IAEA

To strengthen cooperation and increased awareness amongst institutions and researchers of worldwide fusion energy endeavors

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Means of programme delivery

- Conferences
- Technical meetings & symposia
- Workshops
- Consultancies
- Coordinated research projects
- Databases
- Publications

Fusion work programme established based largely on advice from

International Fusion Research Council

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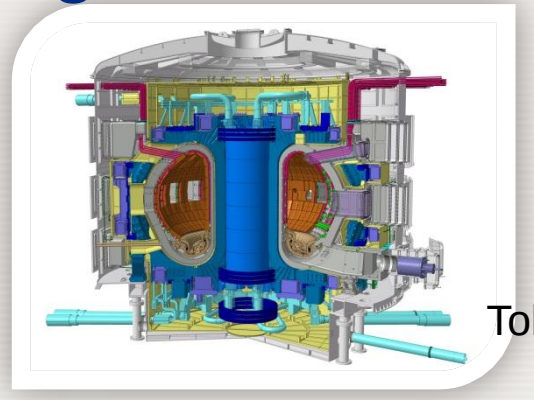
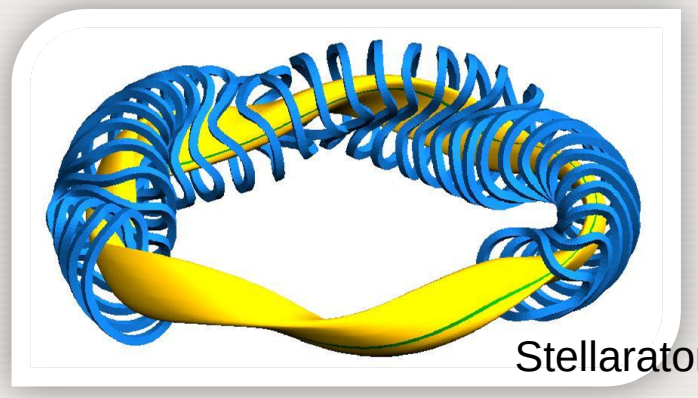
Mainstream fusion research

- Magnetic confinement fusion

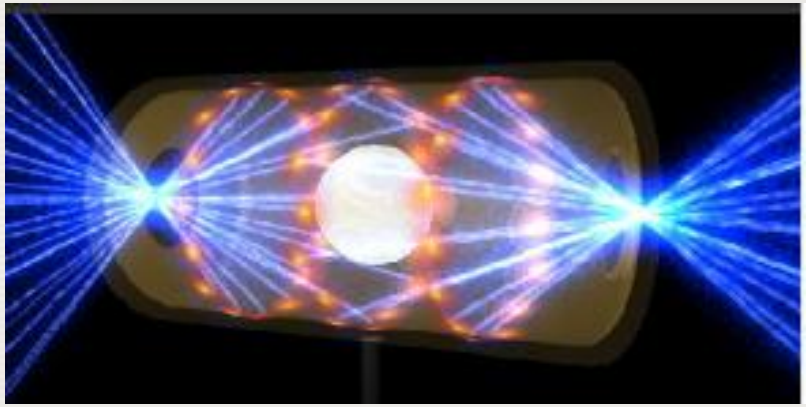


Tokamak

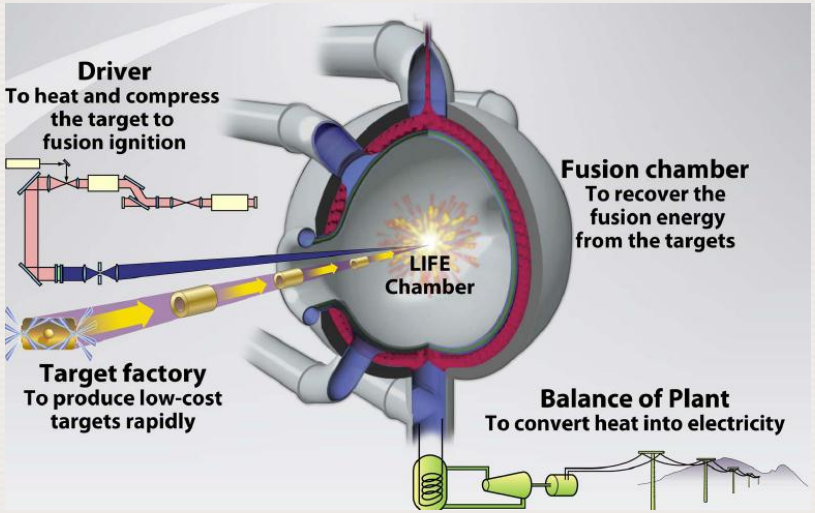


Stellarator

- Inertial confinement fusion



Target in Hohlraum in the indirect drive scheme



Short to medium term goal

Strong emphasis on substantive achievements and practical applications of plasma physics and fusion with the goal to support the next steps in fusion research in developed and developing countries.

- Magnetic Fusion (networks, applications, training, materials development, safety and security)
- Inertial Fusion (basic support, coordinated research projects)
- Plasma Physics (schools, coordinated research projects)

Cooperation with ITER

Cooperation Agreements with Intergovernmental Organizations

The conclusion of a cooperation agreement between the International Atomic Energy Agency and the ITER International Fusion Energy Organization

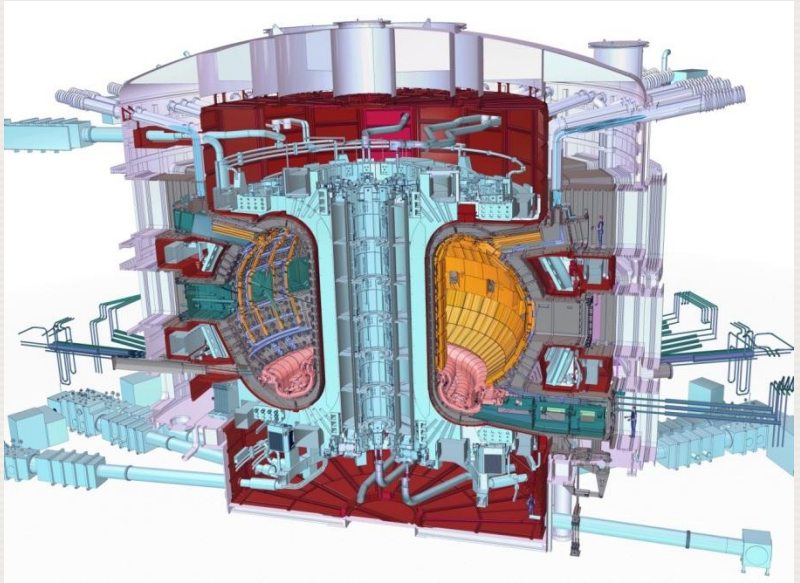
GC(52)/4
Date: 18 July 2008

- **Joint ITER-IAEA-ICTP Advanced Workshop on Fusion and Plasma Physics, 3 -14 October 2011, ICTP, Trieste, Italy**
- **2nd ITER-IAEA TM on Analysis of ITER Materials and Technologies, December 2012, India**
- **Joint ITER –IAEA publications**

1st ITER-IAEA TM on Analysis of ITER Materials and Technologies

Objectives:

contribute to the development of a knowledge base of properties, processes and technologies relevant to ITER structural and plasma-facing materials/components and energetic particles and radiation effects on ITER materials



Outcome:

Step forward in articulating ITER needs and requirements to a relevant community of material scientists and engineers

Output:

Special journal issue of Fusion Science & Technology

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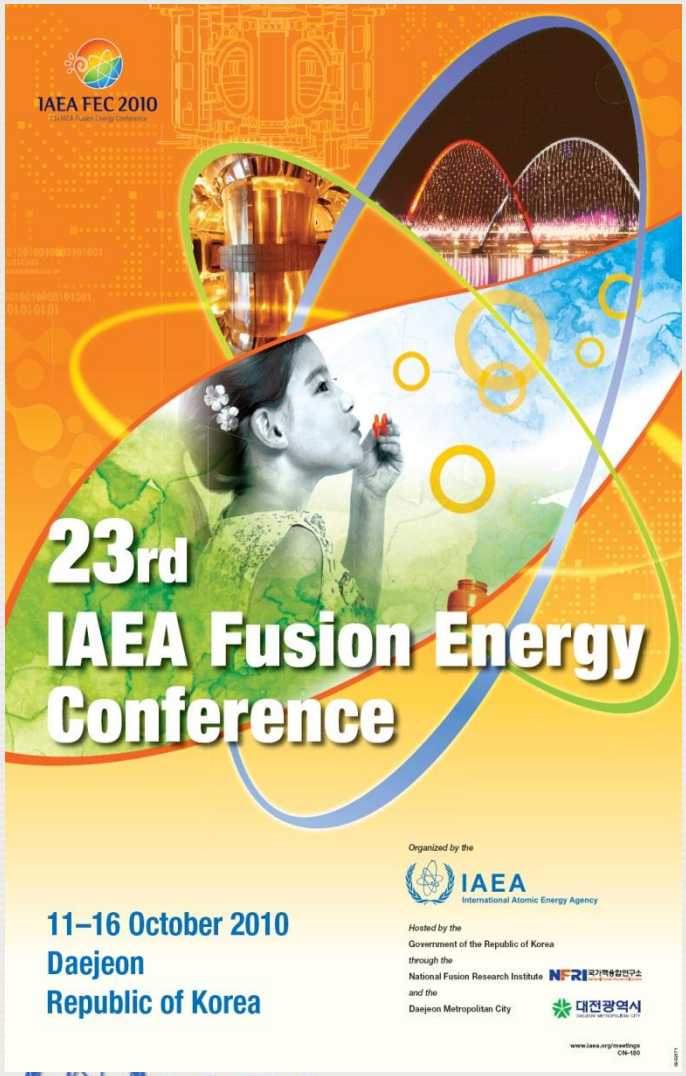
Fusion Energy Conference 2010



Biggest FEC ever with more than 1000 participants, ~600 scientific papers

International Youth Conference on Fusion Energy

In conjunction with the 23rd IAEA Fusion Energy Conference

9 and 10 October 2010

Daejeon, Republic of Korea

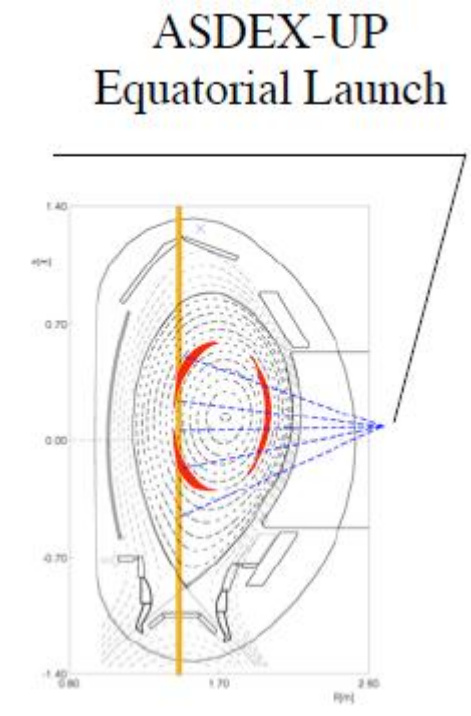
Organized by the
National Fusion Research Institute

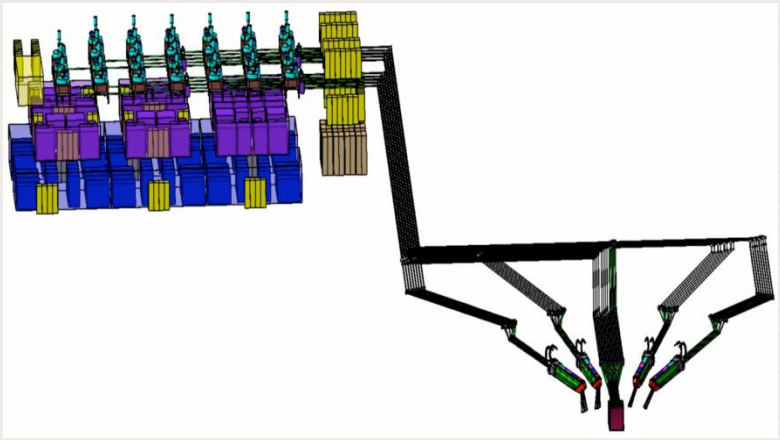
In cooperation with the
International Atomic Energy Agency

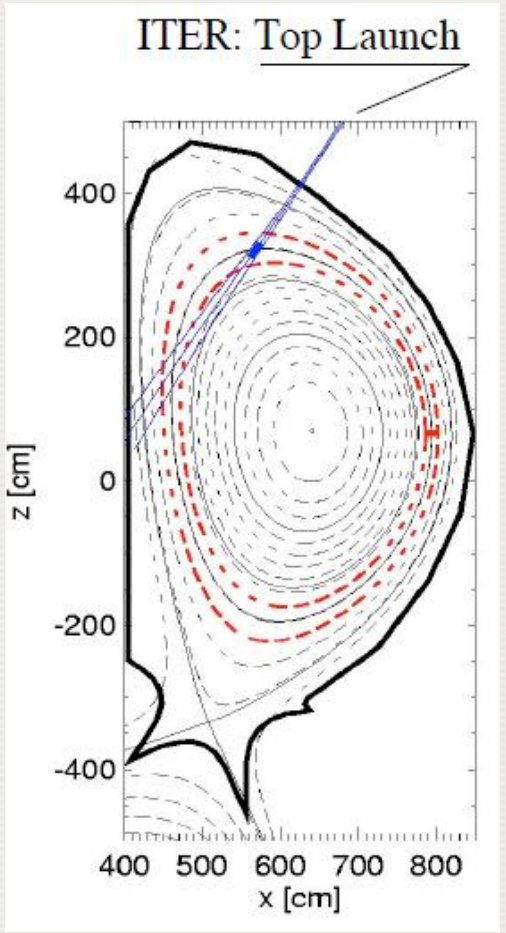
~ 150 participants

Electron Cyclotron Resonance Heating

- 6th TM on ECRH Physics and Technology for Large Fusion Device, 9 to16 July, 2011, Nizhny Novgorod, Russian Federation







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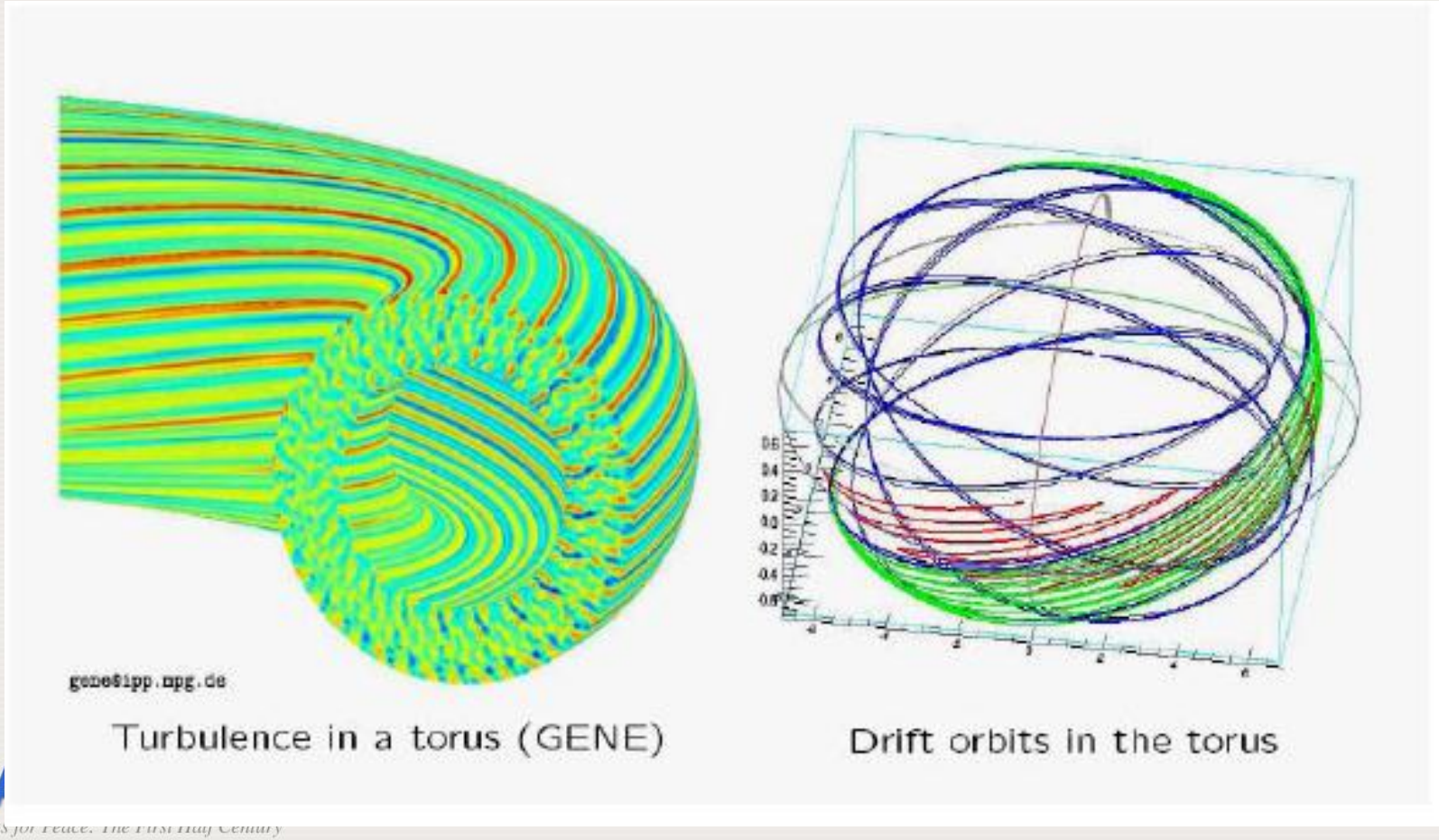
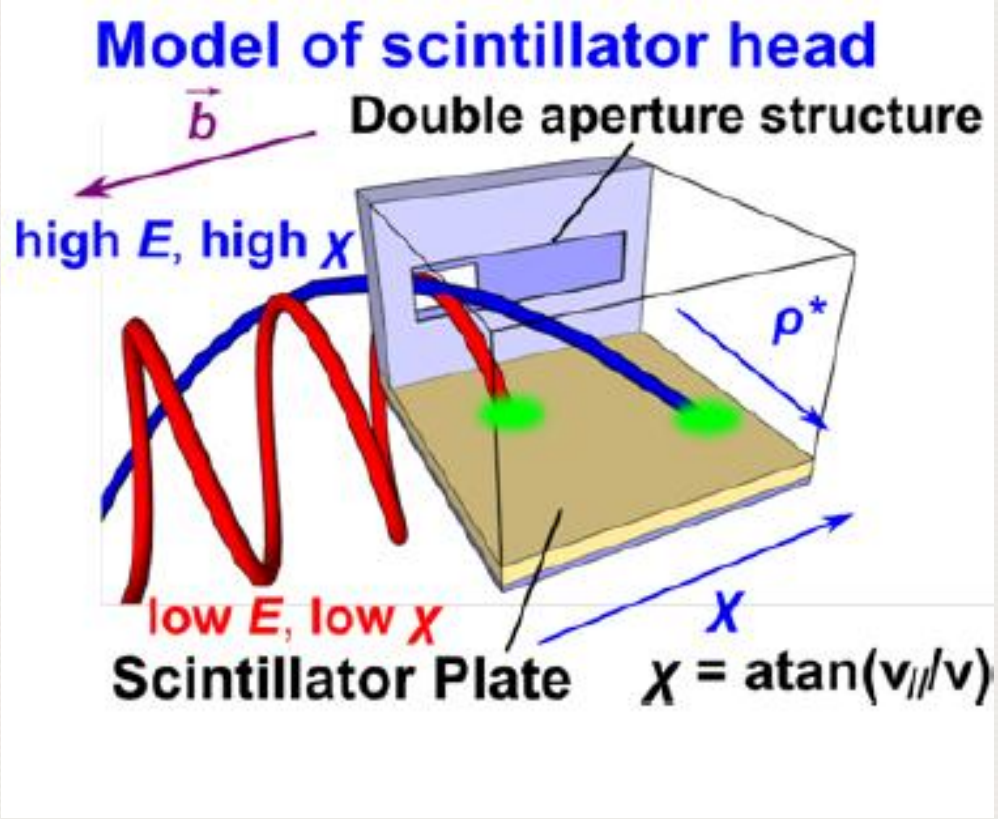
Understanding plasma instabilities

- 5th TM on Theory of Plasma Instabilities, 8 to 10 September 2011, Austin, USA



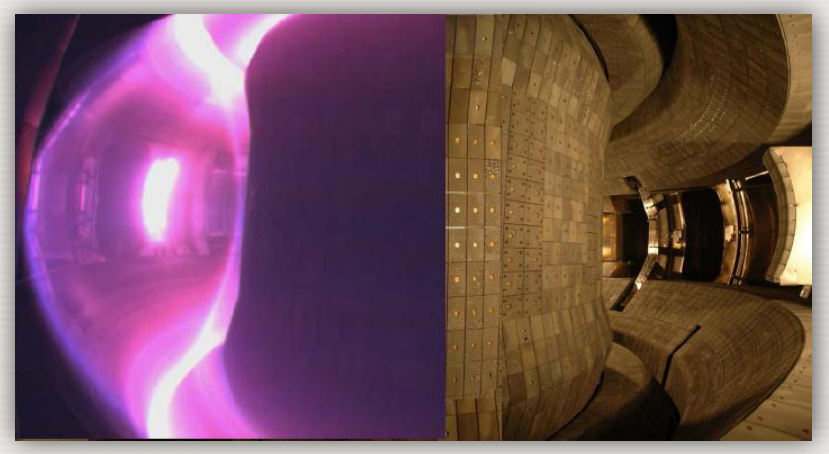
Fast particles in fusion plasmas

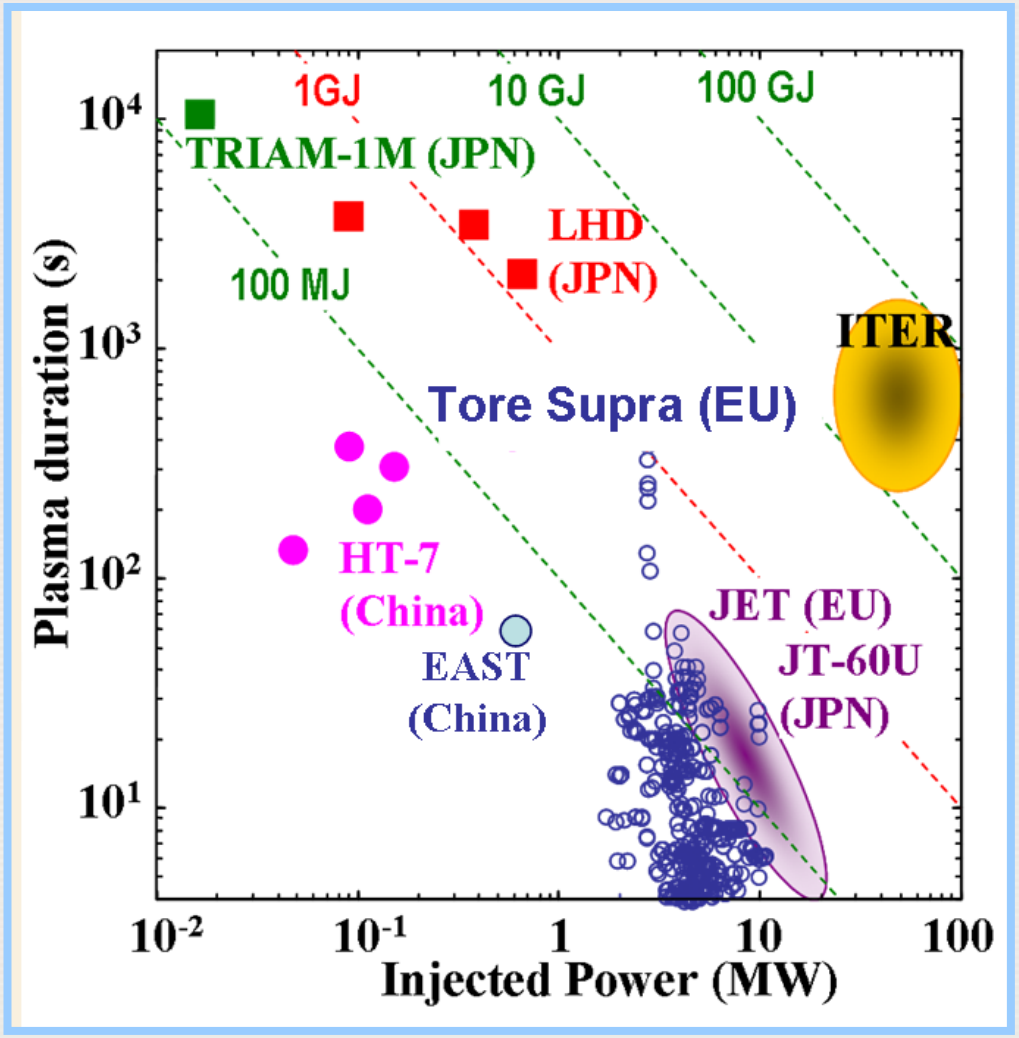
- 12th TM on Energetic Particles in Magnetic Confinement Systems, 5 to 7 September 2011, Austin, USA



Steady-state operation

- 6th TM on Steady State Operation of Magnetic Fusion Devices, Vienna, 6-8 Dec. 2010





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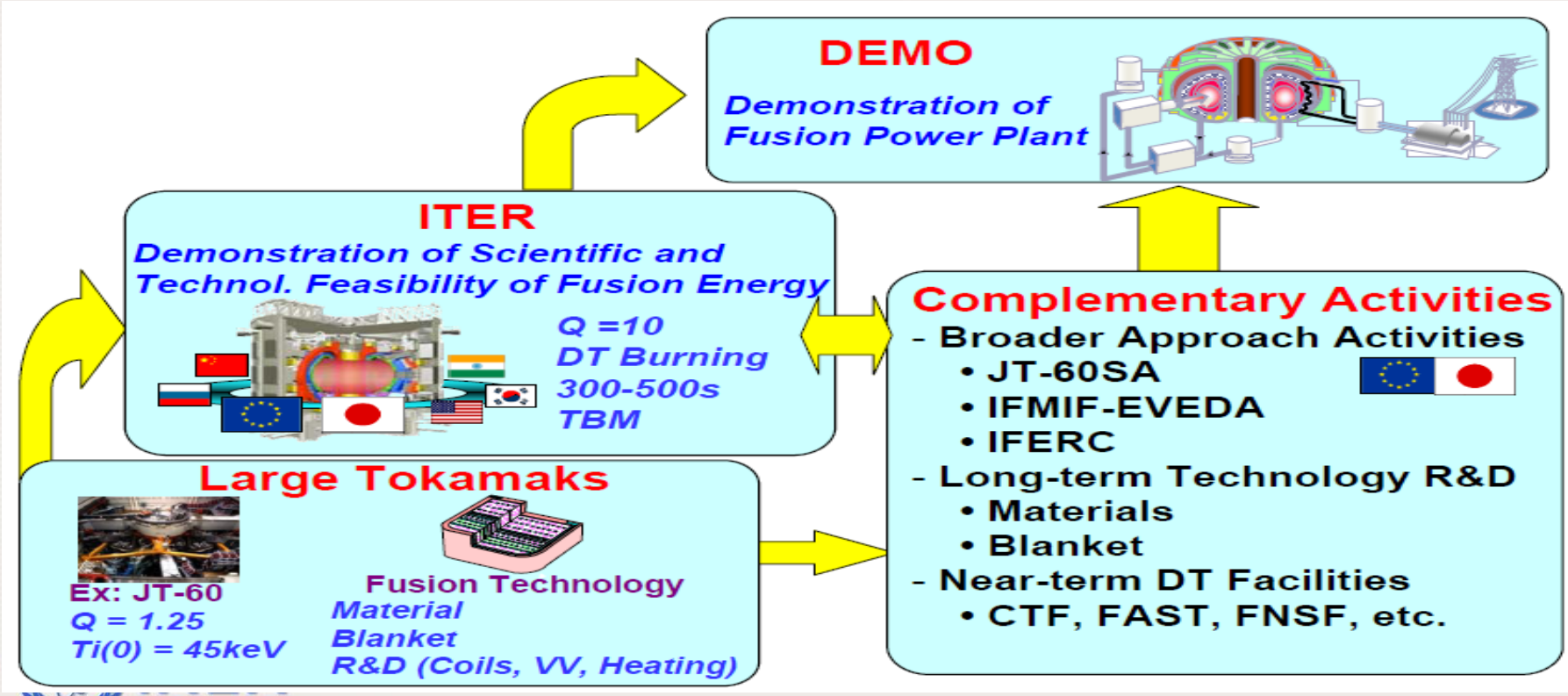
Fusion Power Plant

- 4th TM on First Generation of Fusion Power Plants - Design and Technology, 6-10 June, 2011

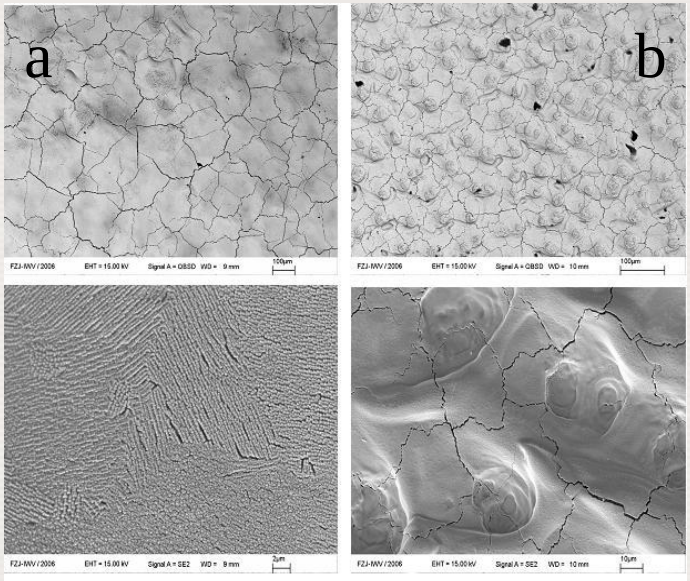


Other relevant topics

- 8th TM on Control, Data Acquisition and Remote Participation for Fusion Research, 20 – 24 June 2011, San Francisco, USA
- 1st TM on Materials under high-energy and high-intensity neutron fluxes for nuclear fusion technology, 27 June – 01 July 2011, Vienna, Austria
- 5th TM on Spherical Tori, 27 to 30 September 2011, Toki, Japan
- 20th TM on Research Using Small Fusion Devices

Fostering contribution of small devices to mainstream fusion research (1)

- CRP on “Integrated Approach to Dense Magnetized Plasma Applications in Nuclear Fusion Technology” (2007-2011)
  - ❑ 6 research contracts, 3 research agreements
  - ❑ Most research works on impact of high heat loads on ITER/DEMO-relevant first wall materials (Be, W, CFC)



Microstructure of W in W/CFC composition after irradiation at 3×10^{8} (b) and 10^{10} (a) W/cm^2.

- short response time
- high efficiency
- high signal to background counts ratio
- insensitivity to room backscatter neutrons below 1 MeV

Beryllium neutron detector assembly. A 21cm×10.6cm×0.5cm Beryllium plate is sandwiched by 2 proportional counters filled with xenon gas

Fostering contribution of small devices to mainstream fusion research (2)

- CRP on “Investigations on Materials under High Repetition Intense Fusion Pulses” (2011-2015)
  - Follow up of previous CRP to take advantage of the infrastructure and capabilities developed in various labs
  - Focus on material issues

PF-6 device

Sealed chambers suitable for DT gas mixture

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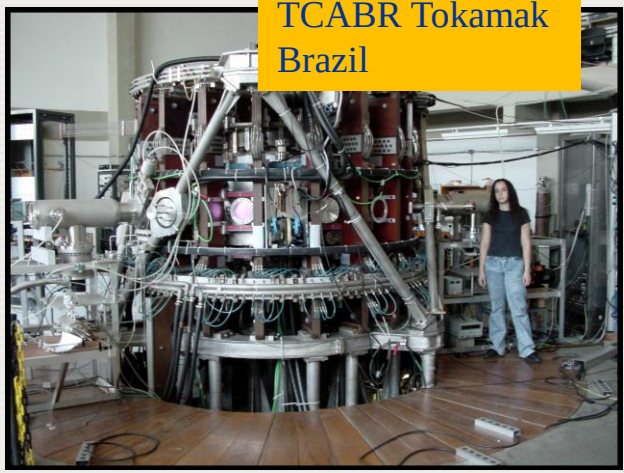
Fostering contribution of small devices to mainstream fusion research (3)

• CRP on “Utilization of the Network of Small Fusion devices for Investigations of Main Stream Fusion Topics” (2011-2015)

- Establish a network
- Organize joint experiments
- Provide training to young researchers
- Enable and coordinate exchange of scientific/technical equipment

KTM Tokamak
Kazakhstan



TCABR Tokamak
Brazil

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Nuclear Fusion Journal

- IAEA provides the forum, it owns and runs the journal. Gives assurance of impartiality and excellence of peer review
- Reports on status to IFRC
- Editorial Board drive direction. Separate from the IAEA
- Content from contributors worldwide
- No IAEA budget allocated
- Revenues from subscriptions and page charges cover costs

Contact: S. Le Masurier

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Contribution to capacity building

- College on Plasma Physics at ICTP
- Joint ITER-IAEA-ICTP Workshop on Fusion and Plasma Physics
- Book on "***Fusion Physics and Technologies***" summarizing the highlights of 50 years of international fusion research currently under preparation
- Collaboration in events such as this conference

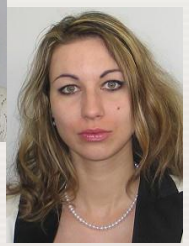
Contact partners within IAEA

Fusion staff members:

Physics Section

Mr Ralf Kaiser (Section Head)
Mr Richard Kamendje
Assistant: Ms Cecilia Devia-Torres
Consultant: Ms Barbora Gulejova

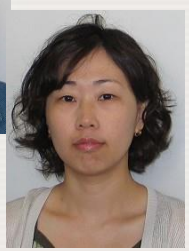


Nuclear Data Section

Mr Robin Forrest (Section Head)
Mr Bastiaan Braams
Ms Hyun Kyung Chung





Thank you for your attention