ECA auditors visited the ITER project facilities 10

By Alvaro Garrido-Lestache, principal auditor and head of task for the audit of the EU research Joint Undertakings and Richard Hardy, principal manager in Chamber IV[1]

On 20 and 21 June the ECA audit team in charge of the audit of the European Joint Undertaking for ITER and the Development of Fusion Energy visited the ITER project facilities located in Saint Paul-lez-Durance (France) together with the Joint Undertaking Audit Committee, representatives of the management of the Joint Undertaking, representatives of the Directorate General of the European Commission responsible for the ITER project (DG ENERGY), and representatives of the Internal Audit Service of the Commission (IAS).

From left to right: Richard Hardy, principal manager in Chamber IV, Alvaro Garrido-Lestache, principal auditor and head of the Joint Undertakings audit task, Marco Corradi and Santiago Fuentes, members of the ECA audit team for the European Joint Undertaking for ITER and the Development of Fusion Energy.

Introduction

Following an invitation from the Chair of the Audit Committee of the European Joint Undertaking for ITER and the Development of Fusion Energy, Brian Gray, the ECA audit team participated in the 13th meeting of the Joint Undertaking Audit Committee and were given a tour of the ITER project facilities under construction, enabling an appreciation of the current status of the works, and the scale and complexity of the project. The ECA auditors also met the ITER Organization Director General, Dr Bernard Bigot.

The ITER project "bringing the power of the sun to earth"

(Sources: ITER Organization and Fusion for Energy Joint Undertaking[3])

The ITER project is an international experimental facility, and is one of the most important and ambitious projects in the field of energy today. It is focused on the development of a secure and sustainable source of energy based on nuclear fusion. Since the idea for an international joint experiment in fusion was first launched in 1985, thousands of engineers and scientists have contributed to the design and construction of the world's first large-scale experimental thermonuclear reactor.

ITER was launched at the Geneva Superpower Summit in November 1985, when the idea of a collaborative international project to develop fusion energy for peaceful purposes was proposed by General Secretary Gorbachev of the former Soviet Union to US ex-President Reagan.

1 This article is based on information available on the websites of the ITER Organization and of the European Joint Undertaking for ITER and the Development of Fusion Energy, and at other European Union Institutions, including ECA publications.

US President Ronald Reagan and General Secretary Mihail Gorbachev of the former Soviet Union at the Geneva Superpower Summit (1985).

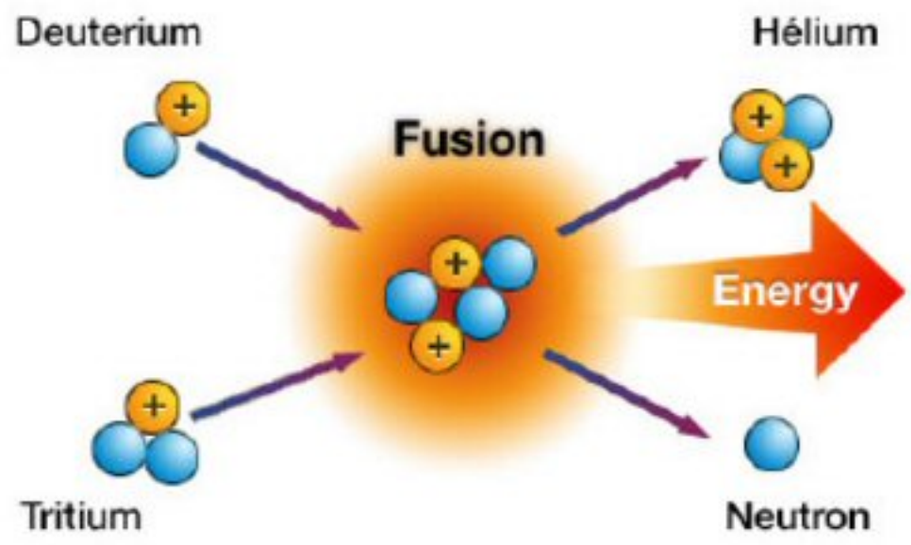
The building phase of the project started in 2007 after the signature of the ITER agreement [4] at the Elysée Palace in Paris on 21 November 2006 by Ministers from the seven ITER Members— **the European Union, China, India, Japan, South Korea, Russia and the United States.** Since then, the ITER members have been engaged in a 35-year collaboration to build and operate the ITER experimental device, which aims to demonstrate that fusion energy can be part of the solution to achieve sustainable and secure sources of energy for the future.

Ceremony hosted by French President Jacques Chirac and the President of the European Commission José Manuel Durão Barroso, on the occasion of the signature of the ITER Agreement in Paris on 21 November 2006

4 Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project of 16 December 2006. (OJ L358/62)

The fusion energy process

Fusion is the process which powers the sun. Energy is produced by the fusing together of atoms, such as hydrogen, at the extremely high pressures and temperatures which exist at the centre of the sun (15 million ºC). At these high temperatures any gas becomes plasma[5]. The fusion reaction that is easiest to accomplish is the reaction between two hydrogen isotopes: deuterium, extracted from water and tritium, produced during the fusion reaction through contact with lithium. When deuterium and tritium nuclei fuse, they form a helium nucleus, a neutron and a large amount of energy.



Two atoms, deuterium and tritium, fuse together, forming a helium nucleus, a neutron and lots of energy.

The core of the ITER project: the thermonuclear fusion reactor "Tokamak"

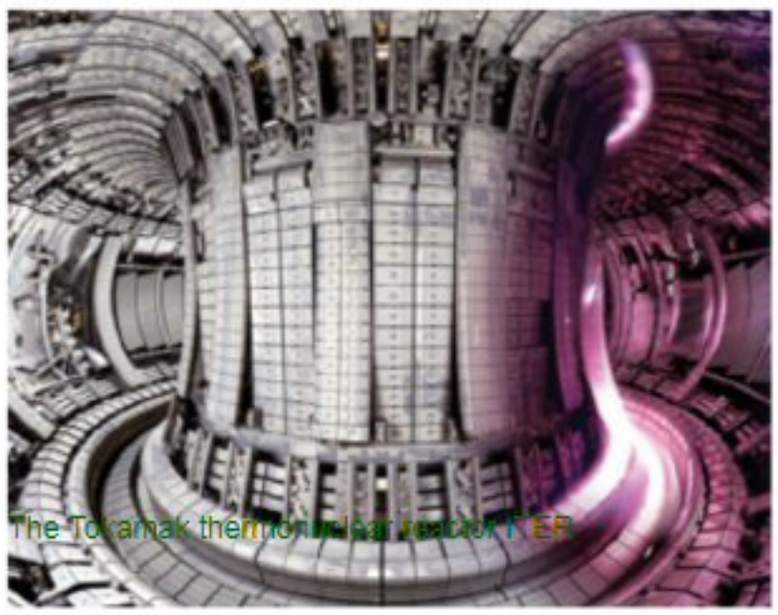
The thermonuclear reactor "Tokamak" is an experimental machine designed to harness the energy of fusion. ITER will be the world's largest thermonuclear fusion reactor, with a plasma radius (R) of 6.2 m and a plasma volume of 840 m³.

The amount of fusion energy a Tokamak is capable of producing is a direct result of the number of fusion reactions taking place in its core. Scientists

5 Plasma is the fourth state of matter (solid, liquid and gas being the other three), and is described as an 'electrically-charged gas' in which the negatively charged electrons in atoms are completely separated from the positively charged atomic nuclei (or ions). Although plasma is rarely found on earth, it is estimated that more than 99% of the universe exists as plasma (Source: Fusion for Energy Joint Undertaking website)

ECA auditors visited the ITER project facilities *continued*

state that the larger the vessel, the larger the volume of the plasma, and therefore the greater the potential for fusion energy. While previous Tokamak experiments such as JET[6] succeeded in producing significant amounts of fusion power for short periods, none so far was capable of demonstrating fusion on a scale needed to allow it to generate part of its own fuel and produce power on a continuous basis. The Tokamak ITER is designed to achieve this objective, as a unique experimental tool, capable of longer plasmas and better confinement. The machine has been designed specifically to reach the goals shown in the following table:



The Tokamak thermonuclear reactor ITER

ITER's goals[7]

1) Produce 500 MW of fusion power
The world record for fusion power is held by the European tokamak JET. In 1997, JET produced 16 MW of fusion power from a total input power of 24 MW (Q=0.67). ITER is designed to produce a ten-fold return on energy (Q=10), or **500 MW** of fusion power from 50 MW of input power. ITER will not capture the energy it produces as electricity, but—as the first of all fusion experiments in history to produce net energy gain—it will prepare the way for the machine that can.

2) Demonstrate the integrated operation of technologies for a fusion power plant
ITER will bridge the gap between today's smaller-scale experimental fusion devices and the demonstration fusion power plants of the future. Scientists will be able to study plasmas under conditions similar to those expected in a future power plant and test technologies such as heating, control, diagnostics, cryogenics and remote maintenance.

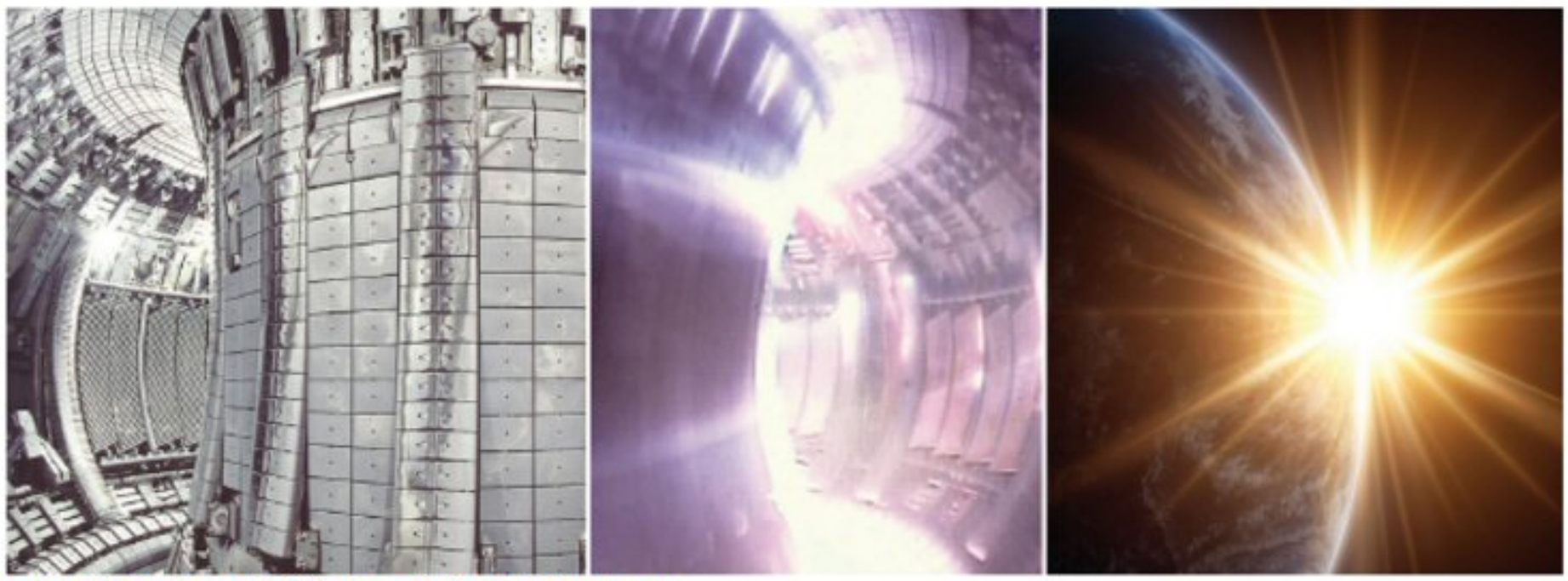
3) Achieve a deuterium-tritium plasma in which the reaction is sustained through internal heating
Fusion research today is at the threshold of exploring a "burning plasma"—one in which the heat from the fusion reaction is confined within the plasma efficiently enough for the reaction to be sustained for a long duration. Scientists are confident that the plasmas in ITER will not only produce much more fusion energy, but will remain stable for longer periods of time.

4) Test tritium breeding
One of the missions for the later stages of ITER operation is to demonstrate the feasibility of producing tritium within the vacuum vessel. The world supply of tritium (used with deuterium to fuel the fusion reaction) is not sufficient to cover the needs of future power plants. ITER will provide a unique opportunity to test mockup in-vessel tritium breeding blankets in a real fusion environment.

5) Demonstrate the safety characteristics of a fusion device
ITER achieved an important landmark in fusion history when, in 2012, the ITER International Organization was licensed as a nuclear operator in France based on the rigorous and impartial examination of its safety files. One of the primary goals of ITER operation is to demonstrate the control of the plasma and the fusion reactions with negligible consequences for the environment.

6 Joint European Torus (JET), the world's leading fusion device located in the Culham Centre for Fusion Energy in Oxfordshire, UK, is now under the umbrella of the EUROfusion consortium agreement (formerly the European Fusion Development Agreement (EFDA).

7 Source: https://www.iter.org; and http://fusionforenergy.europa.eu



Inside of the Tokamak ITER where fusion is to take place.

The ITER Organization

The ITER Organization is the international body set up to run the ITER project. It is managed by a Director General, under the supervision of the ITER Council, the highest Governing Board of the organization where its seven parties are represented. The Chair of the ITER Council since 1 January 2016 is Professor Emeritus Won Namkung. The Director General of the ITER organization since 5 March 2015 is Dr. Bernard Bigot. The ITER Organization is staffed by men and women from the seven ITER Members. Approximately 7000 directly employed staff and 500 external contractors work for the ITER Project in its installations at the CEA[8] Reseach Center of Cadarache, Saint Paul-lez-Durance, France. The accounts of the ITER Organization are audited by a Financial Audit Board made up of independent representatives from each ITER Member, and which provides an annual audit report that is included in the Annual Financial Report of the ITER Organization[9].

The European Joint Undertaking for ITER and the Development of Fusion Energy

The European Joint Undertaking for ITER and the Development of Fusion Energy (F4E Joint Undertaking) was set up by Council Decision 2007/198/Euratom of 27 March 2007 for a period of 35 years. While the main fusion facilities of the ITER project are in Cadarache, France, the European Joint Undertaking is located in Barcelona. The main task of the F4E Joint Undertaking is to provide the EU contribution to the ITER Organization under the ITER International Agreement. Other tasks of the Joint Undertaking are to provide the contribution of Euratom to 'Broader Approach' (complementary joint fusion research) activities with Japan for the rapid development of fusion energy; and to prepare and coordinate a programme for the construction of fusion reactors. The Chair of the Governing Board of F4E Joint Undertaking since 2 December 2015 is Dr. Joaquín Sanchez. The Director General of the Joint Undertaking since 1 January 2016 is Johannes Schwemmer. As of 31 December 2015, the total number of staff at the Joint Undertaking was 434, of which 252 EU Officials and Temporary Agents, 167 Contract Agents, and 15 interim staff. The accounts of the F4E Joint Undertaking are audited by the ECA, which has produced a Specific Annual Report on the accounts of the Joint Undertaking since the 2008 financial year.

The members' contributions to the ITER project: *"in-kind contributions"*

The seven parties of the ITER project have committed themselves through the signature of the ITER International Agreement to contribute to the project mainly with "in-kind contributions". Around 90% of the ITER project is based on in-kind contributions.

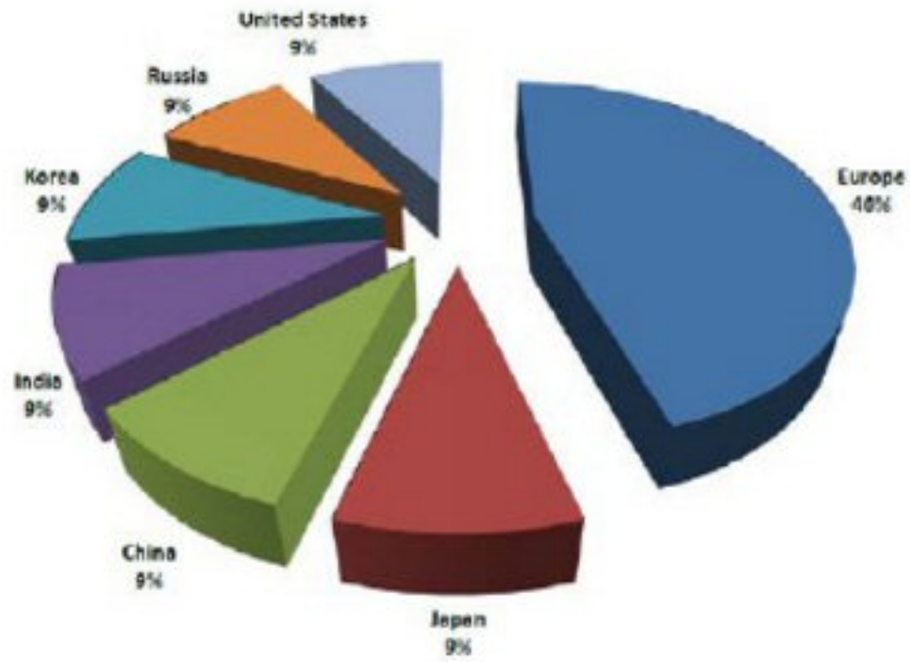
8 The French Alternative Energies and Atomic Energy Commission (CEA).

9 https://www.iter.org/doc/www/content/com/Lists/list_items/Attachments/625/2014_iter_financial_statements.pdf.

ECA auditors visited the ITER project facilities *continued*

To this end, the components that make up the ITER facility have been divided into 85 procurement "packages" distributed among the seven parties to the ITER Agreement. To value the "in-kind contributions" of each party to the project, the ITER Organization has set up its own ITER Unit of Account (IUA).

Europe, as the host party, and France, as the host state, have special responsibilities for the success of the project. Europe supports 46% of the construction cost and 34% of the cost of operation, deactivation and decommissioning of the facility, as well as the preparation of the site.



Sharing of the contributions to the construction cost of ITER by each of the ITER Parties (Fusion for Energy 2015 Annual Activity Report)

View of the construction of the ITER Tokamak in Cadarache- March 2016

The role of the ECA

The ECA is the external auditor of the F4E Joint Undertaking but does not have any audit mandate for the ITER Organization accounts, which are audited by its Financial Audit Board.

The first work of the ECA in relation to the F4E Joint Undertaking was the formulation of Opinion 4/2008 of 6 October 2008 on the Joint Undertaking's Financial Regulation. This Opinion contained 50 recommendations which were broadly accepted by the F4E Joint Undertaking's Governing Board and introduced in its Financial Rules [10]. Of significant value in order to strengthen the financial control framework of the Joint Undertaking was the ECA recommendation to allow for the same powers for the Internal Audit Service of the Commission (IAS) over F4E JU as it exercised in respect of other EU bodies. That has proved to be a very important instrument within the internal control framework of the Joint Undertaking. Other important recommendations were to further develop the conditions under which exceptions to the budgetary principles of the Framework Financial Regulation could be applied and, in view of the size of the budget and the complexity of the tasks to be performed by the Joint Undertaking, to set up an Audit Committee, which was created by Decision of the Governing Board on 10 June 2010.

The ECA issued its first Specific Annual Report on the accounts of the F4E Joint Undertaking in relation to the 2008 financial year [11]. Since then, and for seven consecutive financial exercises, the ECA's audit opinions on the reliability of the accounts and the legality and regularity of the transactions underlying the accounts of the Joint Undertaking have been positive. Without calling the audit opinions into question, as a result of its audits, the ECA has raised numerous observations and recommendations which have contributed to reinforcing the internal control systems of the F4E Joint Undertaking in different areas: ex ante and ex post controls, the legal framework for the operational tendering procedures launched for the components to be provided in kind to the ITER project, the Joint Undertaking's industrial policy

10 www.eca.europa.eu/Lists/ECADocuments/.../OP08_04_EN.PDF

11 Last one referred to the financial year 2014. The Specific Audit Report on the 2015 Joint Undertaking Accounts will be made available on 15 November 2016.

and rules for the protection and dissemination of intellectual property rights, anti-fraud strategy and rules on the management of the prevention of conflicts of interest, as well as the control and monitoring of the operational procurement contracts and grants launched by the F4E Joint Undertaking for the implementation of its activities. In performing the task, the ECA auditors have maintained very close and productive cooperation with the management and staff of the Joint Undertaking, the IAS, the Internal Audit Capability of the Joint Undertaking, the private audit firms performing the audit of the reliability of the financial statements of the F4E Joint Undertaking since the 2014 financial year, and other auditing and consulting firms which have carried out evaluations of the performance of the Joint Undertaking over the years[12].

A major concern for the European Union: "The cost of the EU contribution to the ITER project"

One of the main concerns of the EU budgetary authority has been the cost of the EU contribution to the ITER project. The EU is the main contributor to the construction phase of ITER. In view of its complexity, the progress of ITER has been the subject of numerous debates in the Budgetary Control Committee of the European Parliament, which takes a particular interest in the development of the project.

Article 4 (3) of the Council Decision setting up the European Joint Undertaking for ITER and the Development of Fusion Energy [13] refers to €9 653 million in 2008 values as the indicative total resources deemed necessary for the Joint Undertaking to carry out its tasks under the timeframe of 35 years for which it was set up. Already in July 2010, the Council agreed a revised budget estimate for the EU contribution to the first phase of the project, "the construction phase", initially targeted to be finalised in 2020, from the initial estimate of €2.7 billion euro to €6.6 billion (2008 value)[14]. This figure, which doubled the initial budgeted costs for this phase of the project, did not include €663 million proposed by the European Commission in 2010 to cover potential contingencies [15].

ECA has been reporting since 2010 that the complexity of ITER activities implies that the amount of the F4E Joint Undertaking's contribution to the construction phase of the project is exposed to significant risks of increase, mainly as a result of changes in the scope of the project deliverables and delays in the schedule. At the time of the publication of the last Specific Annual Report, on the 2014 accounts of the F4E Joint Undertaking, the Joint Undertaking was working together with the ITER Organization on a revised estimate for the cost of the EU contribution to the construction phase of the ITER project. These two issues concerning the cost and schedule of the project have been the subject of an emphasis of matter in the ECA audit reports on the accounts of the F4E Joint Undertaking since 2013 [16].

Current status of the ITER project: the road to "First Plasma"

As a result of a two-year exercise carried out by the ITER Organization and its seven members to establish a new baseline schedule, the ITER Council endorsed in its meeting of 15-16 June 2016 [17], an updated Integrated Schedule for the ITER Project, which identifies the date of achievement of "First Plasma" as December 2025. The updated integrated schedule proposed by ITER is the following:

12 See for example "`Potential for Reorganization within the ITER project' of 2013, carried out by Ernst & Young upon request of the European Parliament,

13 Council Decision 2007/198/Euratom of 27 March 2007 establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it (OJ L 90, 30.3.2007, p. 58), amended by Council Decision 2013/791/Euratom of 13 December 2013 (OJ L 349, 21.12.2013, p. 100) and Council Decision (Euratom) 2015/224 of 10 February 2015 (OJ L 37, 13.2.2015, p. 8).

14 Council conclusions on ITER status of 7 July 2010 (Ref. 11902/10).

15 Communication from the Commission to the European Parliament and the Council of 4 May 2010 on ITER status and possible way forward (COM(2010) 226 final).

16 See Specific Annual Reports on the annual accounts of the F4E Joint Undertaking for 2013 and 2014 at www.eca.europa.eu. EU Oficial Journal at http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:C:2015:422:FULL&from=EN

17 https://www.iter.org/org/team/odg/comm/pressreleases

ITER Timeline to achieve first plasma[18]

2005 Decision to site the project in France
2007 Formal creation of the ITER Organization
2007-2009 Land clearing and levelling
2010-2014 Ground support structure and seismic foundations or the Tokamak
2012 Nuclear licensing milestone: ITER becomes a Basic Nuclear Installation under French law
2014-2021* Construction of the Tokamak Building (access for assembly activities in 2019)
2010-2021* Construction of the ITER plant and auxiliary buildings for First Plasma
2008-2021* Manufacturing of principal First Plasma components
2015-2021* Largest components are transported along the ITER Itinerary
2018-2025* Assembly phase I
2024-2025* Integrated commissioning phase (commissioning by system starts several years earlier)
Dec 2025* First Plasma

According to the ITER Council conclusions of 15-16 June 2016, the updated schedule is challenging but technically achievable, and will have now to be duly validated with a thorough and comprehensive review by the independent ITER Council Review Group[19].

Further information on the ITER project, the European Joint Undertaking for ITER and the development of Fusion Energy and the reports by the ECA can be found at:

www.iter.org/
http://fusionforenergy.europa.eu/
http://www.eca.europa.eu

ITER work site-April 2016

18 Source: ITER Organization https://www.iter.org/proj/inafewlines

19 The ITER Council Review Group provides external validation of ITER Project progress.