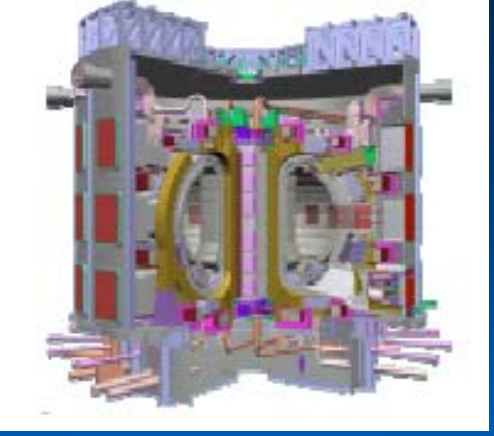


State Atomic Energy Corporation “Rosatom”
Department of scientific policy

Alexey Kalashnikov

Project management and participation of Russian Federation in the ITER international fusion energy organization

ITER Historical Background

ITER (meaning "the way" in Latin) is an international collaborative project undertaken jointly by the world's leading fusion energy programmes with the objective of demonstrating the scientific and technological feasibility of fusion energy for peaceful purposes.

November 1985 - At the Geneva Superpower Summit Meeting in, a proposal was made by the then Soviet Union to build a next generation tokamak experiment on a collaborative basis involving the world's four major fusion programmes in Europe, Japan, the Soviet Union, and the United States of America (the "Parties").

This led to the establishment of a collaboration under the auspices of the International Atomic Energy Agency (IAEA), and the start of Conceptual Design Activities (CDA) for ITER in April 1988 which were successfully completed in December 1990.

Main ITER project stages

The CDA (1988 – 1990) helped to bring about a convergence of the Parties' views on the overall programmatic and technical objectives for a next step machine, and gave them confidence that it could be achieved through international collaboration. Common understandings were reached on the choice of the tokamak confinement concept and on the technology R&D that needed to be carried out.

In July 1992, the four Parties (now with the Russian Federation replacing the Soviet Union) entered into an intergovernmental agreement to begin the Engineering Design Activities (EDA) of ITER. Canada and Kazakhstan became involved in the Project by association with Euratom and the Russian Federation respectively.

Main ITER project stages

The EDA (1992 – 1998) was defined initially for a six-year period during which the Parties agreed jointly (and on a basis of equality) to produce a detailed, complete and fully integrated engineering design and all technical data necessary for future decisions on the construction of ITER. Six years of international collaborative work culminated in the approval by the ITER Council in June 1998 of the ITER Final Design Report, Cost Review and Safety Analysis. This report provided the first comprehensive design of a fusion reactor based on well-established physics and technology.

The EDA was extended by 3-years to allow the details of such a design to be worked out, and to undertake other work aimed at enabling a possible future construction decision. The US committed itself unilaterally to one year only, and withdrew in 1999. The revised design was finalised, documented in the ITER Final Design Report (FDR), and approved by the remaining Parties at the end of the EDA in July 2001. The technical basis was established on which to start the ITER construction phase

Negotiations on establishment of the ITER international fusion energy Organization for the join implementation of ITER project.

Quadripartite meetings on Negotiations on the Joint Implementation of ITER began in mid-2001. The initial "Participants" were Euratom, Japan and the Russian Federation, plus Canada, which made a government-backed site offer. In February 2003 they were joined by the People's Republic of China and the United States of America, and in May 2003 by the Republic of Korea. The Negotiators should draft the ITER Joint Implementation Agreement on Construction, Operation and Decommissioning, examine proposals for the ITER construction site (there are four proposals - Cadarache, Clarington, Rokkasho-mura, and Vandellos), agree on the procurement rules and management, who will provide the various ITER components/systems and how the costs will be shared, and identify the Director General for the ITER Legal Entity (ILE), and the organisation for its work.

Negotiations on establishment of the ITER international fusion energy Organization for the join implementation of ITER project.

The Negotiators were supported on technical aspects by Coordinated Technical Activities (CTA), between July 2001 and the end of 2002, and subsequently are supported by ITER Transitional Arrangements (ITA) in the run-up to construction. These maintain the integrity of the project so as to prepare for joint construction and operation. The work of the Participant and International Teams during the CTA/ITA involves preparation for an efficient start of construction, including design adaptations to potential sites and their regulatory environment, and formal review and modification to ensure design completeness, preparation of licensing applications by close dialogue with potential host regulators, exploitation of manufacturing R&D, and of physics R&D to take advantage of latest experimental results, and preparation of technical specifications for procurements which need to be launched early.

The timescale for the Negotiations foresees that the Joint Implementation Agreement should be initialled during 2003. Formal signature (and/or ratification) should take place in early 2004, leading to the establishment of the ITER International Fusion Energy Organisation (IIFEO), the organisation which will build ITER, shortly thereafter.

Choice of ITER site for construction at Cadarache, FRANCE.

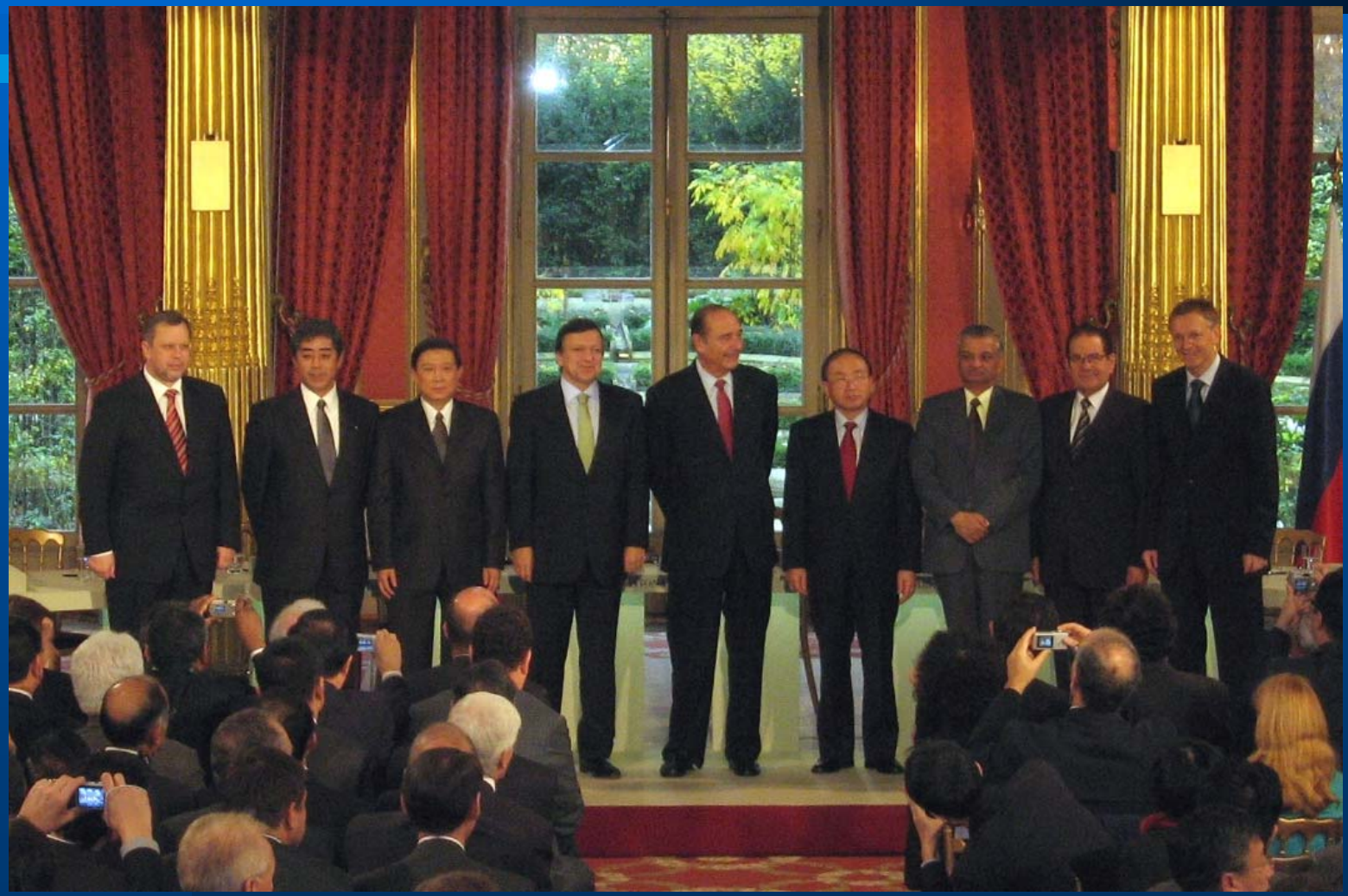
Moscow –MM2, 28 June 2005

Joint Declaration by the Representatives of the Parties to the ITER Negotiations, on the Occassion of the Ministerial Meeting for ITER, Moscow, 28th June 2005

The Representatives of the European Atomic Energy Community (Euratom), the Government of the People's Republic of China, the Government of Japan, the Government of the Republic of Korea, the Government of the Russian Federation and the Government of the United States of America, sharing the common understandings that:

- ITER should be implemented by an international organization (the ITER Organization) to be established and supported by the Parties, to the Agreement (hereinafter “the Parties”) with the possibility of accession by any state or international organization subject to unanimous agreement of the Parties;
- ITER shall be sited at Cadarache, France; and so the Host and the non-Host in the attached Joint Paper will be respectively EURATOM and Japan;
- the sharing of costs and the allocations among the Parties of procurements of the components of ITER should follow the consensus on these matters that has been reached in the frame of ITER negotiations to date,
- the Broader Approach activities that will be implemented through bilateral cooperation between EURATOM and the Government of Japan will be open to other Parties for their participations in Broader Approach research activities.

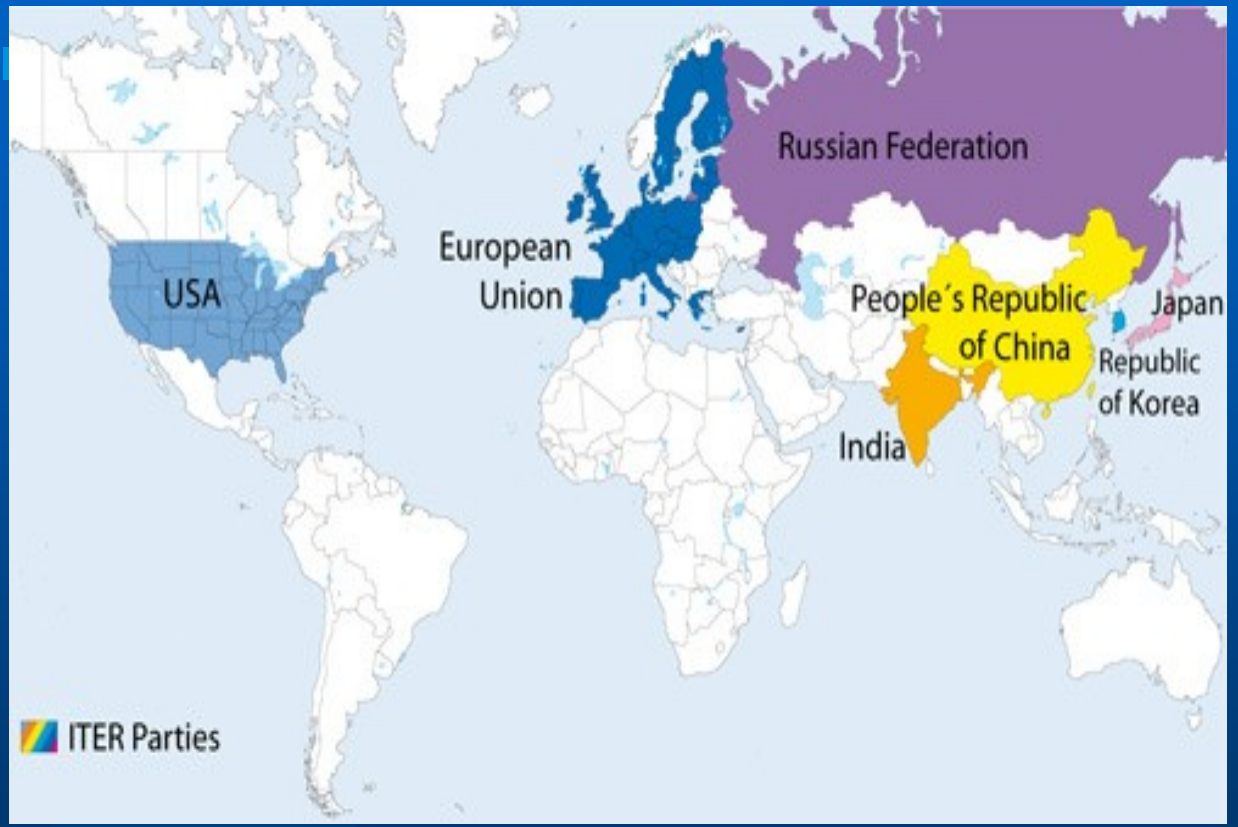
Ceremony of ITER Agreement Signature, Elysee Palace, 21 November 2006



ITER Project development

Over the years of the EDA, a large number of scientists and engineers from Europe, Japan, Russia and the United States worked together on this unprecedented international collaboration (see attachments). The Director, reporting to the ITER Council (itself supported by Management and Technical Advisory Committees), led a Joint Central Team of approximately 150 professional staff formed by the Parties to develop and coordinate the design, define R&D tasks carried out by "Home Teams" of each Party (the Home Team is defined to include all those people and organisations working on ITER tasks) and credited to its contribution. The Joint Central Team was located at three (later two) Joint Work Sites at Garching, Naka, and formerly in San Diego. The Home Team tasks involved companies and organisations distributed throughout the territories of the participants. Over the EDA, the Joint Central Team and the Home Teams dedicated nearly 2000 professional person years of effort, and the Home Teams spent $660M (1989 values) on supporting R&D. The total cost of the design phase has therefore been in the region of $1B.

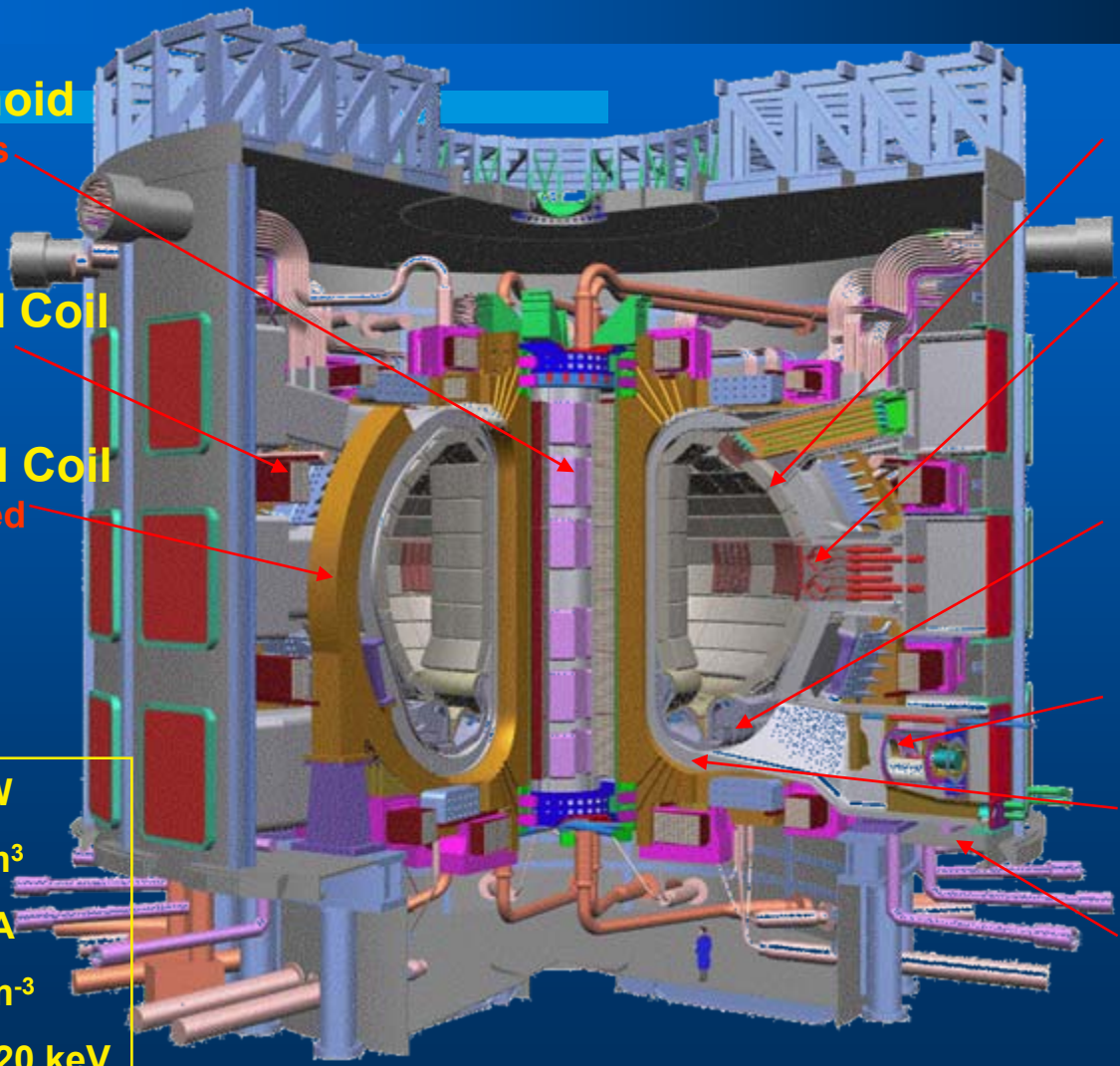
ITER Collaboration



For its size and cost and the involvement of virtually all the most developed countries, representing over half of today world's population ITER will become a new reference term for big science projects.

The ITER project is one of the world's biggest scientific collaboration.

Detailed Design Has Been Developed



Central Solenoid
Nb_3Sn, 6 modules

Poloidal Field Coil
Nb-Ti, 6

Toroidal Field Coil
Nb_3Sn, 18, wedged

Blanket Module
440 modules

Port Plug
heating/current drive
test blankets
limiters/RH
diagnostics

Divertor
54 cassettes

Torus Cryopump
8 units

Vacuum Vessel
9 sectors

Cryostat
24 m high x 28 m dia

Fusion Power: 500 MW

Plasma Volume: 840 m^3

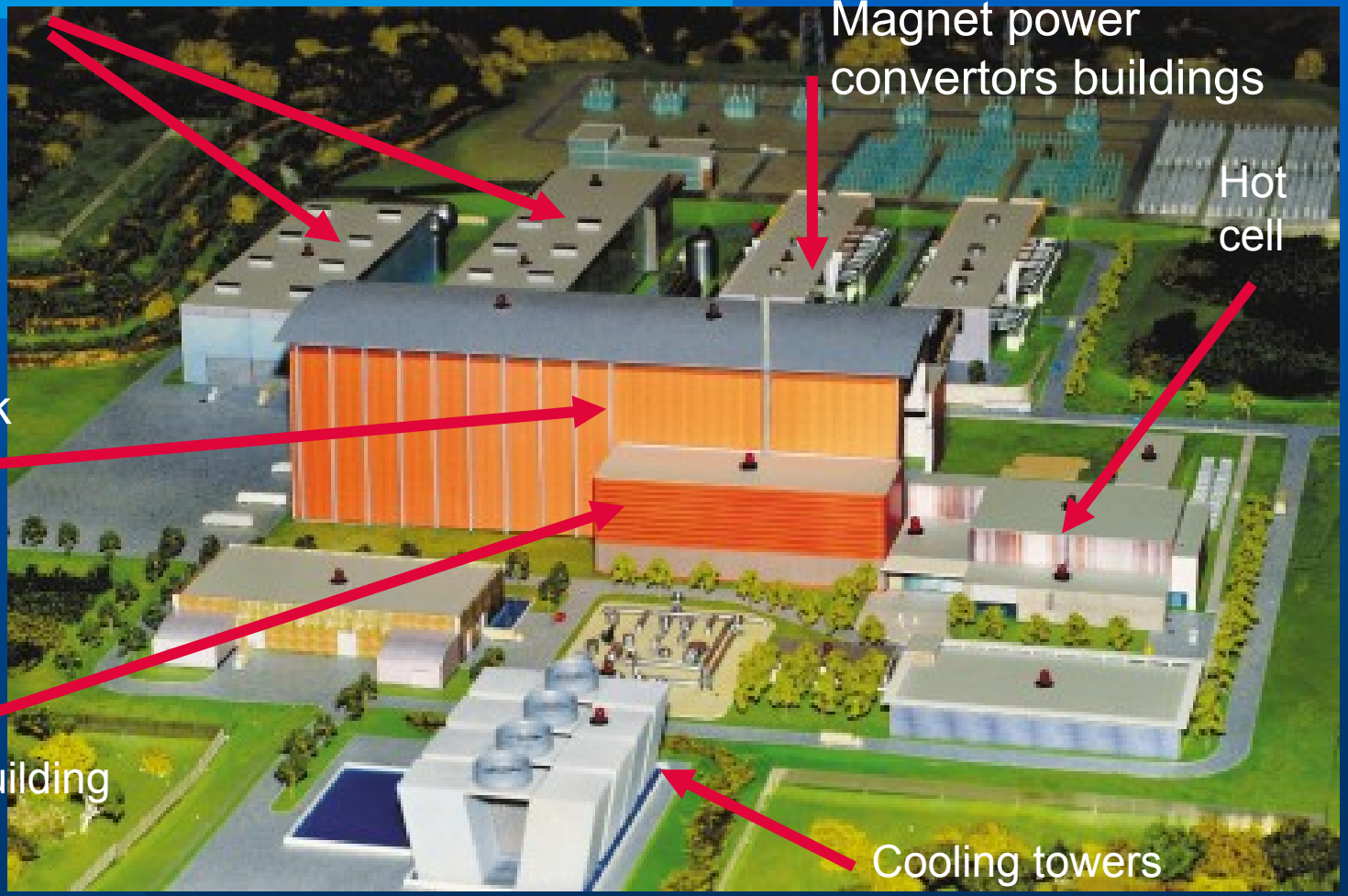
Plasma Current: 15 MA

Typical Density: 10^{20} m^{-3}

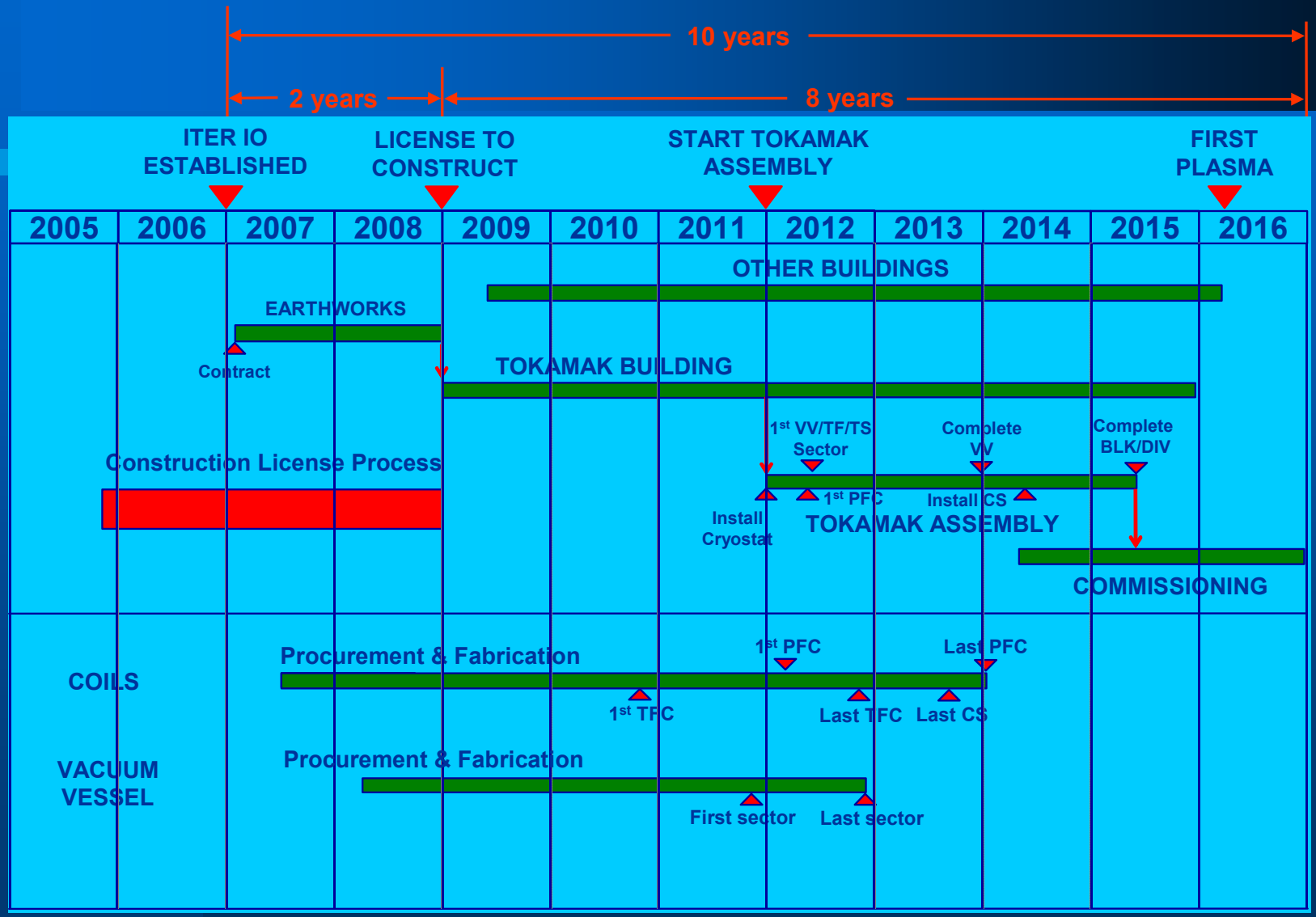
Typical Temperature: 20 keV

The ITER Site

•Will cover an area of about 60 ha, large buildings up to 170 m long, large number of systems



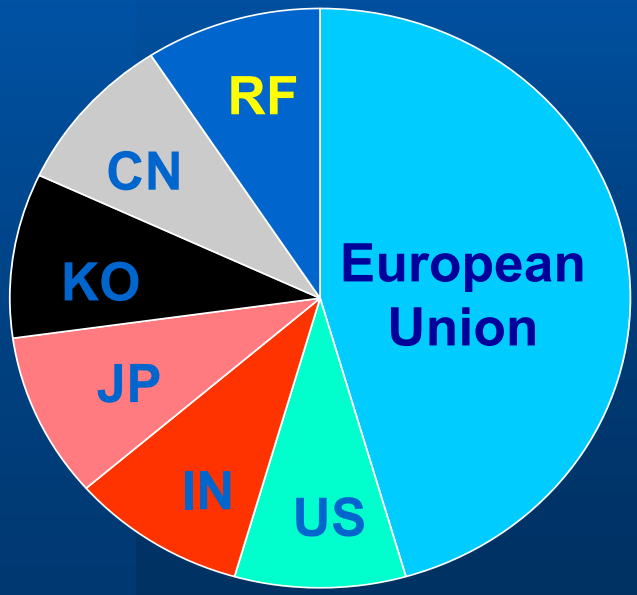
Integrated Project Schedule Top Down



Construction Cost Sharing

Overall sharing:

EU 5/11, other six parties 1/11 each. Overall contingency of 10% of total. Total amount: 3577 kIUA (5079 Euro-2007)



Total procurement value : 3021

Staff: 477

R&D: 80

Total kIUA: 3577

Procurement Sharing (example for Magnet)

PACKAGE			kIUA	ALLOCATION	REMARKS
1.1 Magnet	Toroidal Field Magnet Windings	1A	85.2	EU=100%	1A for 10 TF (including 1 prototype) and 1B for 9 TF (including 2.5 kIUA for fabrication verification)
		1B	82.3	JA=100%	
	Toroidal Field Magnet Structures	2A	51.4	EU=10%, JA=90%	Fabrication of whole structures by JA and Pre-compression ring (0.6 kIUA) by EU. Final assembly of 10 TF coil cases by EU (10%)
		2B	47.7	JA=100%	
	Magnet Supports	2C	22.85	CN=100%	
	Poloidal Field Magnet 1 & 6	3A	13.6	EU=50%, RF=50%	PF1 by RF and PF6 by EU
	Poloidal Field Magnet 2 to 5	3B	33.6	EU=100%	
	Correction Coils	3C	2.6	CN=100%	
	Central Solenoid Magnet	4A+4 B	39.6	US=100%	
	Feeders	5A	26.15	CN=100%	
	Feeders Sensors	5B	18.05	FUND=100%	
	Toroidal Field Magnet Conductors	6A	215	EU=20%, JA=25%, RF=20%, CN=7%, KO=20%, US=8%	See Note-1
	Central Solenoid Magnet Conductors	6B	90	JA=100%	

Copy from the “Common understanding of procurement sharing”

Construction Cost Sharing

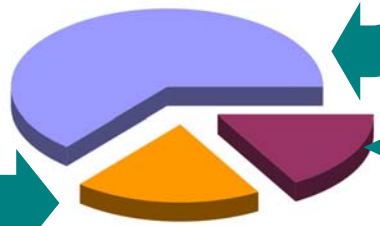
C

"Contributions in Kind"
Major systems provided

directly by Parties

A

Systems suited only to Host Party industry
- **Buildings**
- **Machine assembly**
- **System installation**
- **Piping, wiring, etc.**
- **Assembly/installation labour**

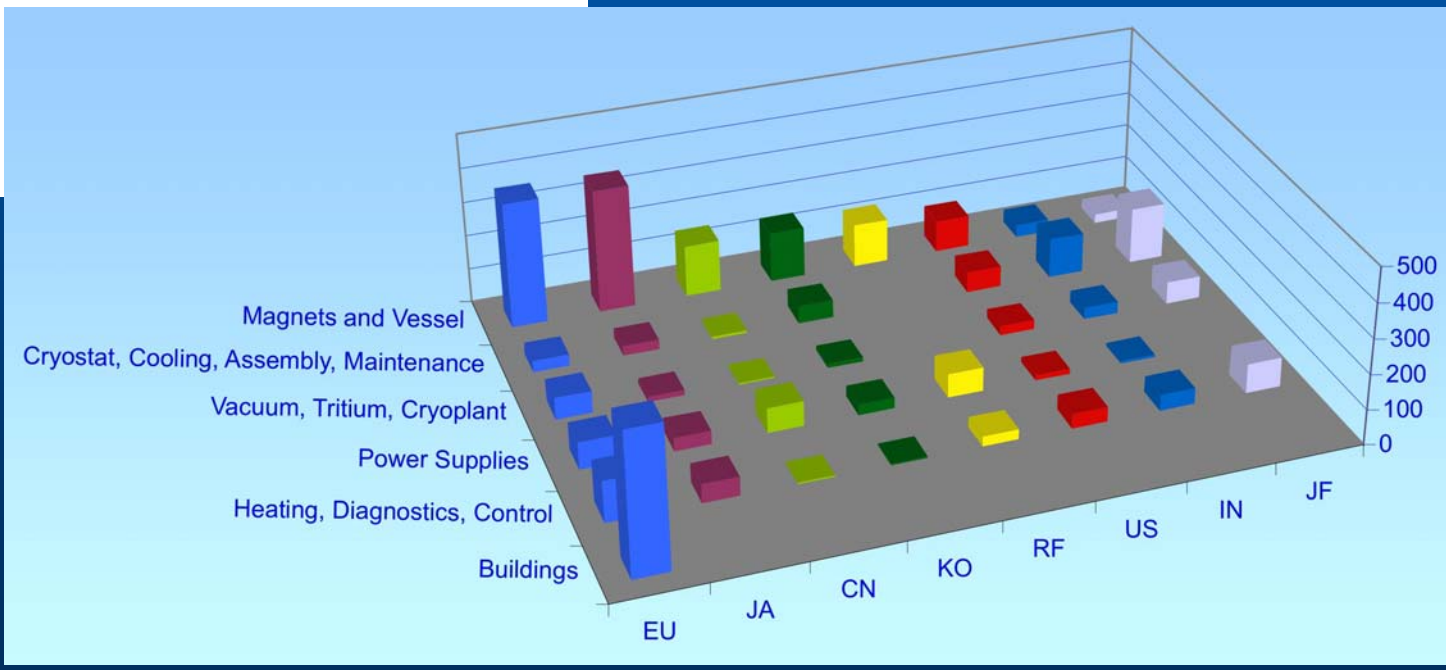


Overall cost sharing:
EU 5/11, Others 6 Parties 1/11 each,
Overall contingency up to 10% of total.

B

Residue of systems, jointly funded, purchased by ITER Project Team

Overall costs shared according to agreed evaluation of A+B+C



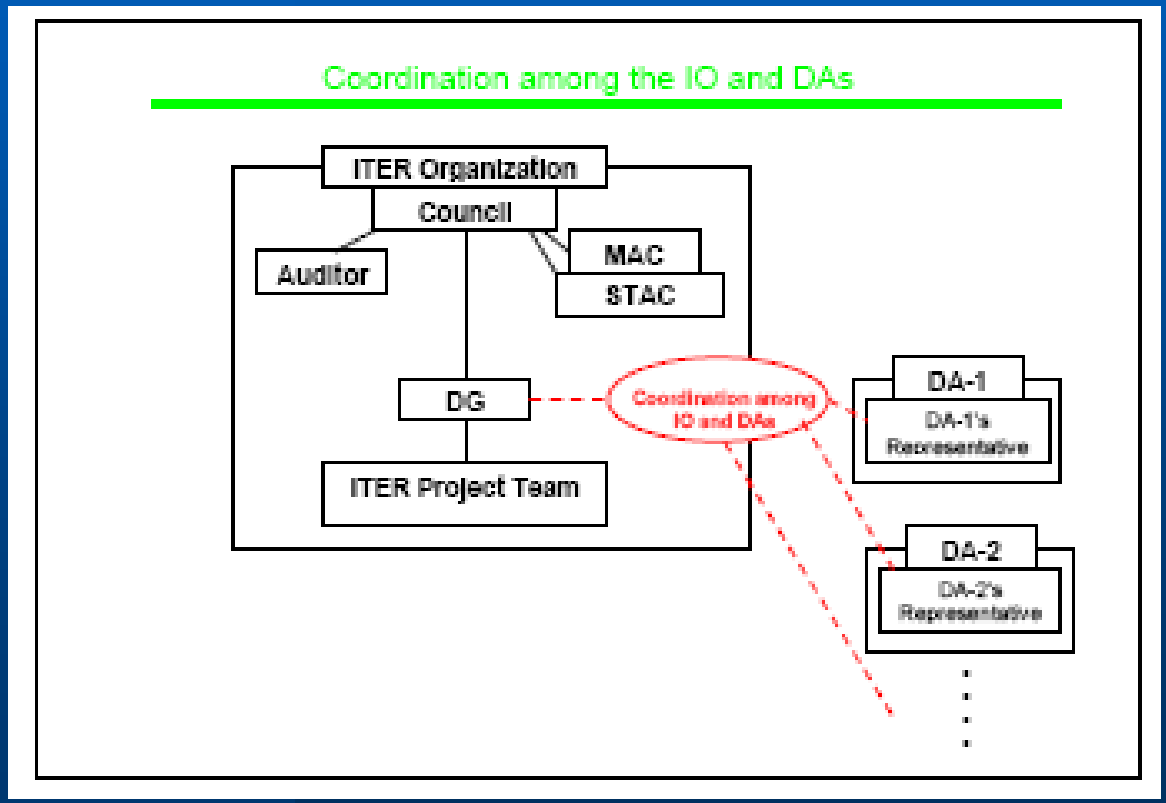
Roles and Responsibilities for Construction

ITER Organization	Seven Parties
• **Planning / Design** • **Integration / QA / Safety / Licensing / Schedule** • **Installation** • **Testing + Commissioning** • **Operation**	• **Detailing / Designing** • **Procuring** • **Delivering** • **Supporting installation** • **Conformance**

IO – DA Coordination Proposed

Very good communication on the technical level !

- **Coordination for project execution between IO and DAs:**
  - **Integrated Project Schedule, procurement schedule**
  - **Procurement arrangements, task agreements**
  - **Technical interfaces, design review/design changes, test facilities, etc.**



Coordination Group (current Leaders meeting): DG, DA Leaders or persons designated

DG or the person designated by DG shall report to the IC, and submit proposals to Council where necessary.

ITER Council

The ITER Council is the principal organ of the ITER Organization composed of Representatives of the ITER Agreement Members.

Each Member shall appoint up to four Representatives to the Council.

The Council shall meet twice a year, unless it decides otherwise. The Council may decide to hold an extraordinary session at the request of a Member or of the Director-General. Sessions of the Council shall take place at the Headquarters, unless the Council decides otherwise.

The Council shall be responsible, for the promotion, overall direction and supervision of the activities of the ITER Organization in pursuit of its purpose.

The Council may take decisions and make recommendations on any questions, matters or issues in accordance with this Agreement.

Advisory Committees and Auditor

The ITER Council have two main advisory committees:

Science and Technology Advisory Committee (STAC).

This would advise the Council on science and technology issues arising during the course of ITER construction and operation. Members of the committee will be chosen for their outstanding technical qualifications and experience, rather than on a quota basis.

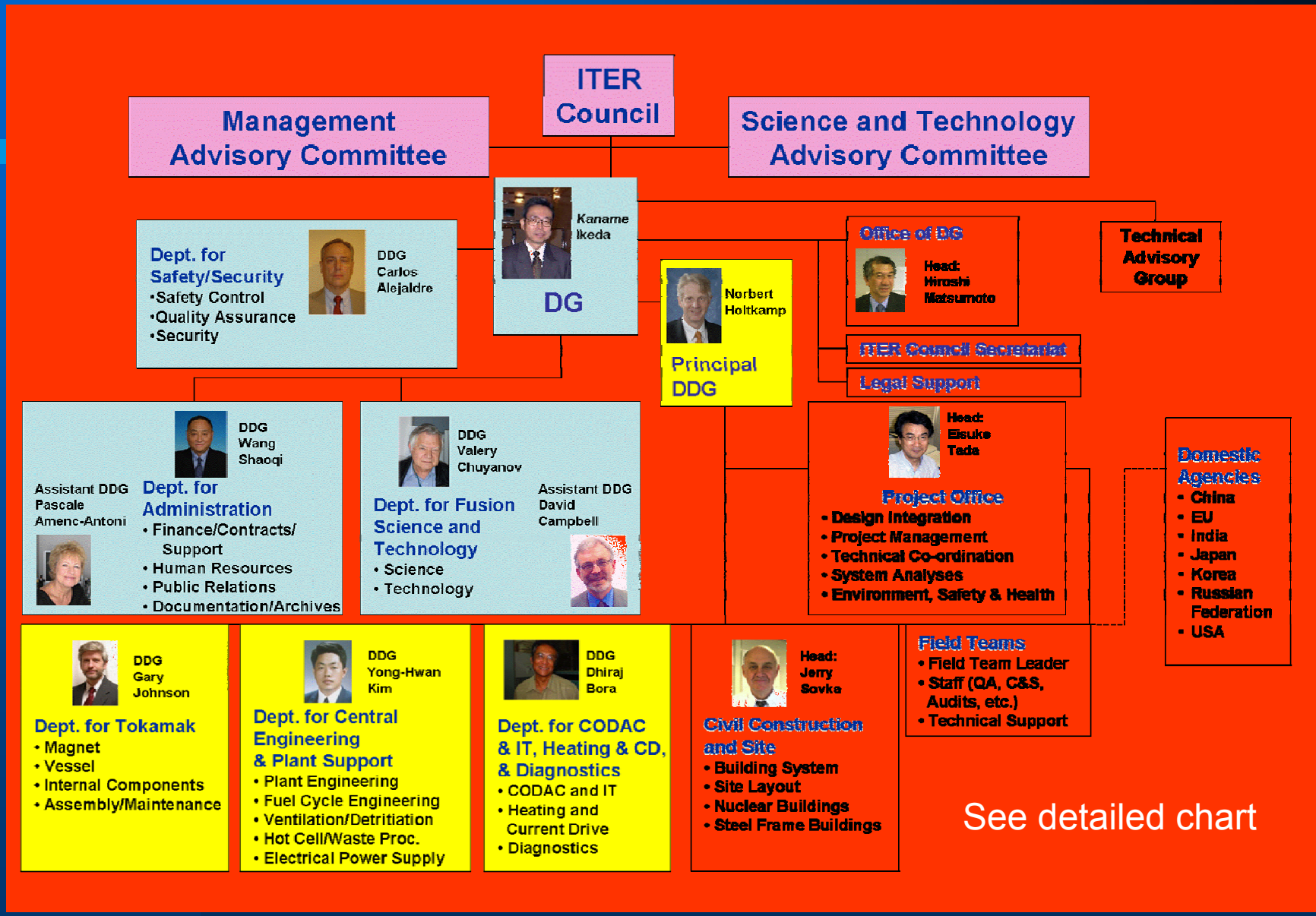
Management Advisory Committee (MAC).

This would advise the Council on management issues arising during the development of the ITER Project, such as budget allocations, the effective application of privileges and immunities to the organization and the project staff, and recommend such other administrative actions where the Parties can facilitate the work of the project.

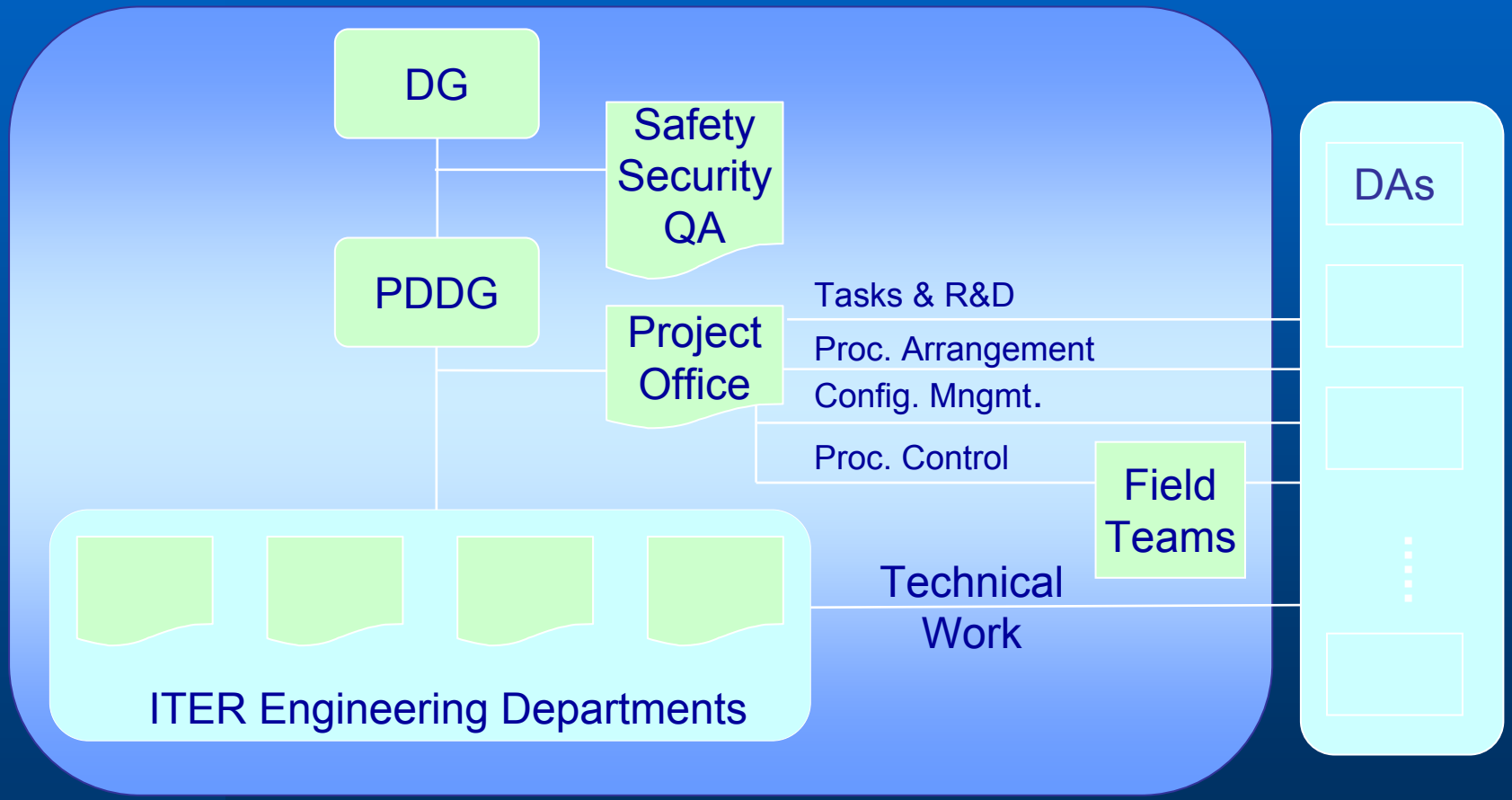
Financial Audit

This would advise the Council to undertake the audit of the annual accounts of the ITER Organization in accordance the Project Resource Management Regulations.

Main Management Structure of the ITER IO

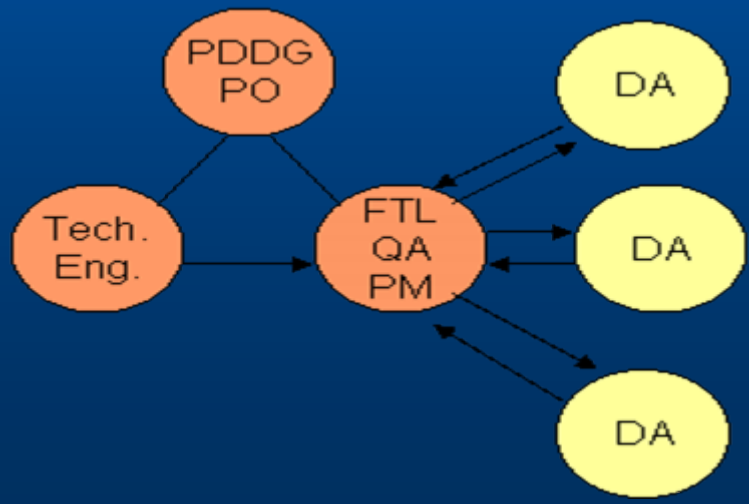


IO – DAs collaboration scheme

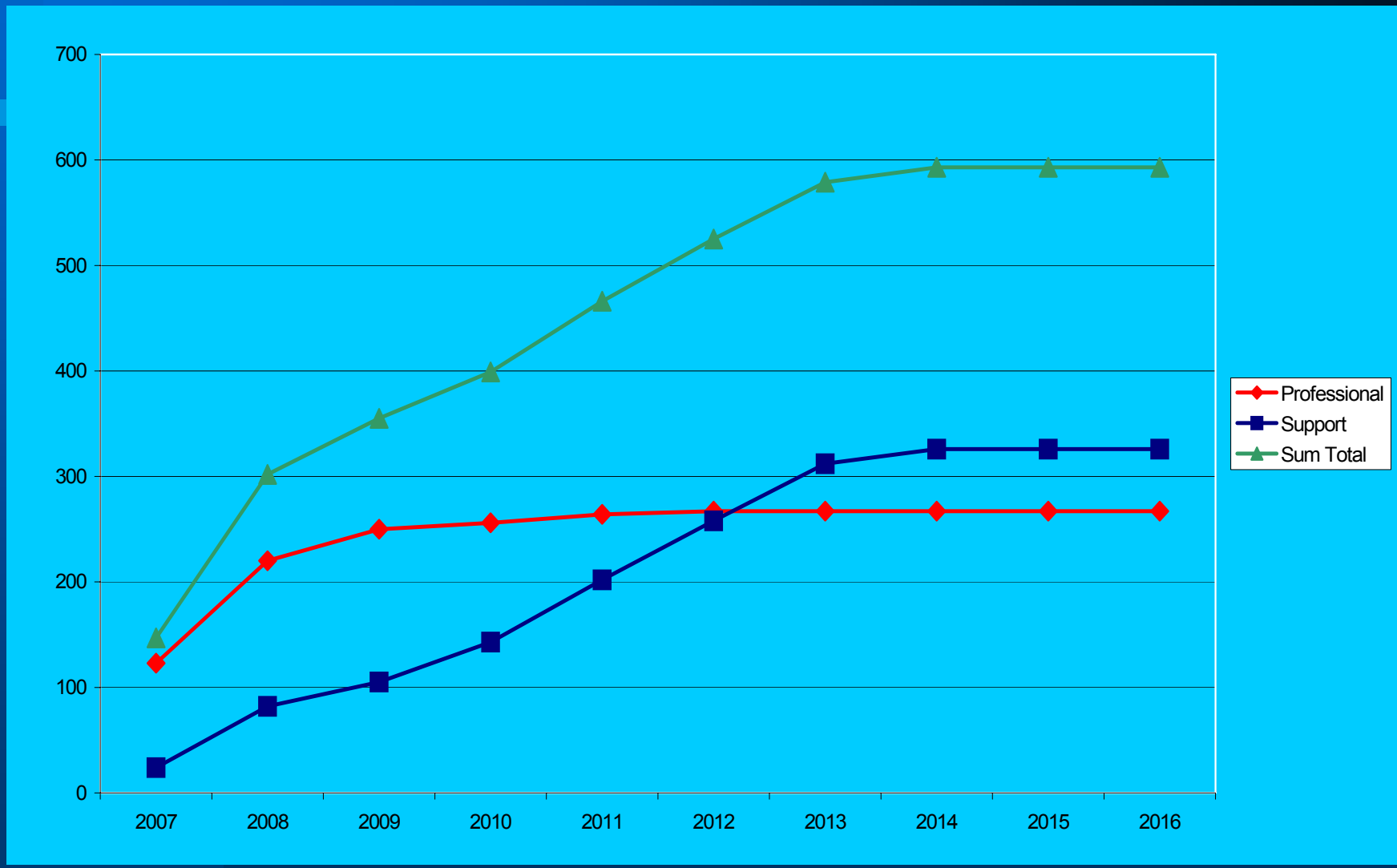


Field Teams

- The Field Teams (FT) are employees of the IO and act as agents on behalf of the ITER Organization (IO), providing the information flow between the Domestic Agency (DA) and the IO.
- The main interface of the FT on the IO side will be the Project Office (PRO), receiving cost, schedule and performance information through the FT from the DA.
- The FT will be responsible for the implementation of the IO's Quality Assurance program within the DA.
- FT are minimally staffed (1+ …)

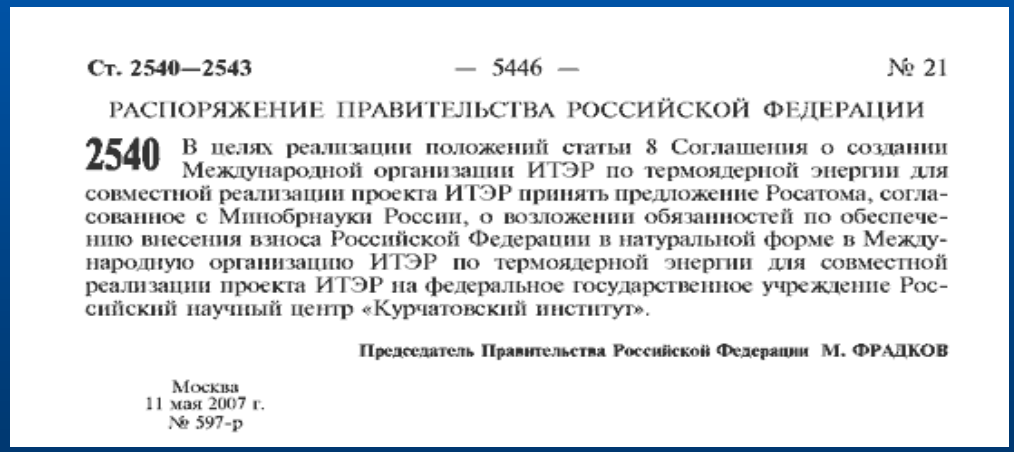


Staff build-up during the construction



Domestic Agencies

Each Member shall provide its contributions to the ITER Organization through an appropriate legal entity, hereinafter «the Domestic Agency» of that Member, except where otherwise agreed by the Council. The approval of the Council shall not be required for Members to provide cash contributions directly to the ITER Organization.



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РАСПОРЯЖЕНИЕ ПРАВИТЕЛЬСТВА РОССИЙСКОЙ ФЕДЕРАЦИИ

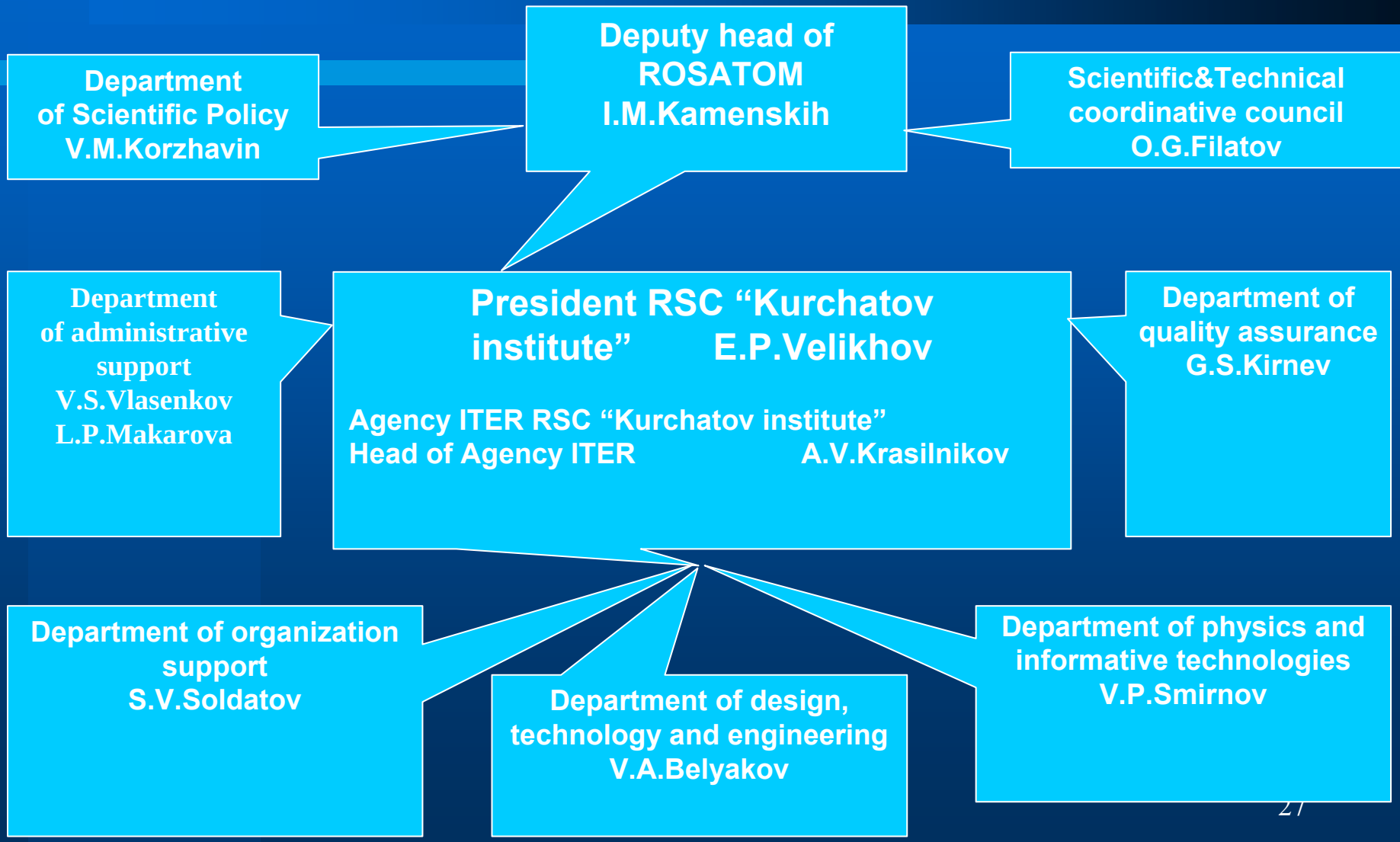
2540 В целях реализации положений статьи 8 Соглашения о создании Международной организации ИТЭР по термоядерной энергии для совместной реализации проекта ИТЭР принять предложение Росатома, согласованное с Минобрнауки России, о возложении обязанностей по обеспечению внесения взноса Российской Федерации в натуральной форме в Международную организацию ИТЭР по термоядерной энергии для совместной реализации проекта ИТЭР на федеральное государственное учреждение Российский научный центр «Курчатовский институт».

Председатель Правительства Российской Федерации М. ФРАДКОВ

Москва
11 мая 2007 г.
№ 597-р

According the Government Decision the Russian Federation represented by the ITER Domestic Agency of Russia - Russian Research Center «Kurchatov Institute», undertakes to manufacture, deliver to the destination and test the equipment (contribution in-kind).

Management of Russian domestic agency
Structure and functions



Department of organization support

Functions :

1.Procurement planning preparation and arrangement. Tender preparation. Marketing and prices.

2. Preparation and signing international and internal contracts.

3. Arrangement of supervising of the manufacture and procurement.

4. Loire expertise and support of agency activity.

5. Provision execution, logistics, insurance, custom issues.

Department of design, technology and engineering V.A.Belyakov (coordinator)

Functions :
Management of activities in design, technology and engineering.
Monitoring of technologies and manufacture.
Development and support of codes and standards.
Documents and drawings development and unification.

Structure:
Sector of technology systems (super conductor, Be, magnetic system, vacuum chamber, first wall and divertor, power supply, blanket).
Sector of codes and standards.
Sector of drawings and technology documentation .

Department of physics and informative technologies V.P.Smirnov (coordinator)

Functions :

Analysis and modeling of plasma regimes and physical processes in ITER.

Arrangement and monitoring of the development of ITER diagnostics.

Arrangement and monitoring of the development of methods, equipment and regimes of ITER plasma additional heating.

Arrangement of IT nets, remote participation in experiments and video conferences.

Intellectual property data base management.

Participation in CODAC system and its component development

Analysis of the future perspective projects.

Structure and staff:

Sector of experiment planning and simulators - S.Konovalov (7 spec.)

Sector of diagnostics and fusion technologies – (9 spec.)

Sector CODAC and remote participation – I.B.Semenov (5 spec.)

Department of quality assurance
G.S.Kirnev

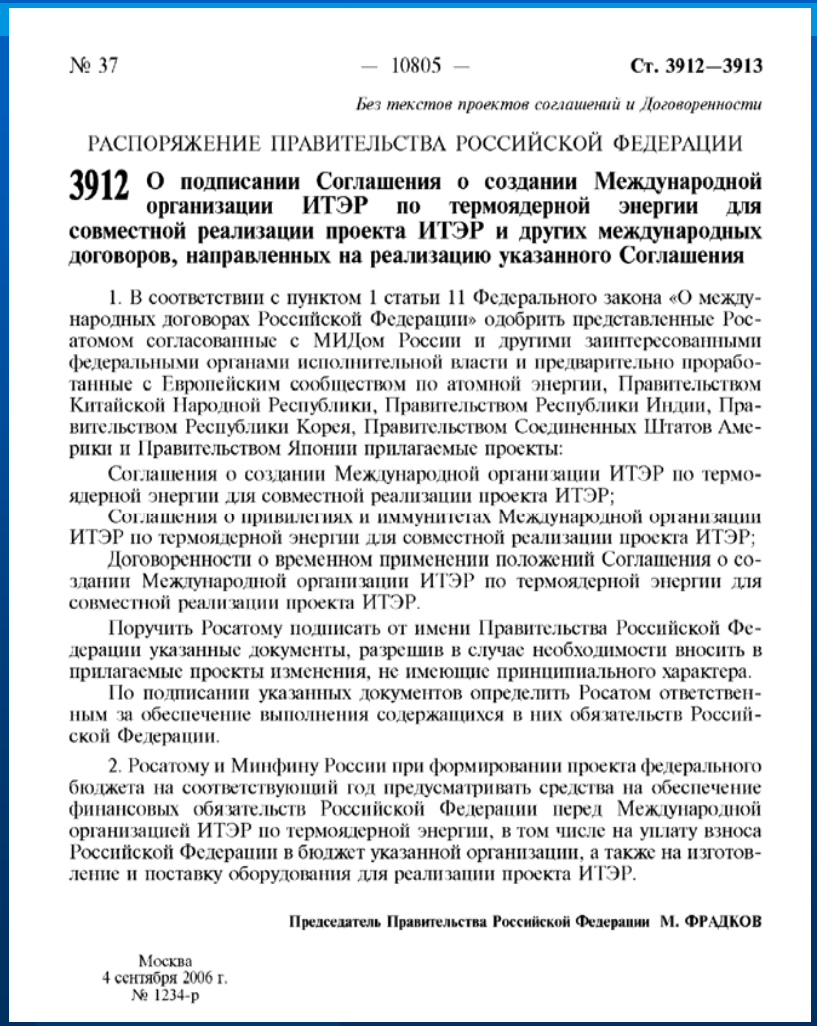
Functions:
1. Quality monitoring of manufacturing in Russia ITER systems.
2. Monitoring of the manufacture arrangement.
3. Monitoring of the quality of design, technology development and engineering

Department of administrative support
V.S.Vlasenkov, L.P.Makarova

Functions :
1. Providing of the interaction with IO.
2. Providing of the arrangement of international cooperation with partners.
3. Arrangement of the agency workshops, meetings etc.
4. Paperwork
5. Information
6. Work with society and press

Office management

Maintenance of obligations of Russian Federation contained in the ITER Agreement



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Без текстов проектов соглашений и Договоренности

РАСПОРЯЖЕНИЕ ПРАВИТЕЛЬСТВА РОССИЙСКОЙ ФЕДЕРАЦИИ

3912 О подписании Соглашения о создании Международной организации ИТЭР по термоядерной энергии для совместной реализации проекта ИТЭР и других международных договоров, направленных на реализацию указанного Соглашения

1. В соответствии с пунктом 1 статьи 11 Федерального закона «О международных договорах Российской Федерации» одобрить представленные Росатомом согласованные с МИДом России и другими заинтересованными федеральными органами исполнительной власти и предварительно проработанные с Европейским сообществом по атомной энергии, Правительством Китайской Народной Республики, Правительством Республики Индии, Правительством Республики Корея, Правительством Соединенных Штатов Америки и Правительством Японии прилагаемые проекты:

Соглашения о создании Международной организации ИТЭР по термоядерной энергии для совместной реализации проекта ИТЭР;

Соглашения о привилегиях и иммунитетах Международной организации ИТЭР по термоядерной энергии для совместной реализации проекта ИТЭР;

Договоренности о временном применении положений Соглашения о создании Международной организации ИТЭР по термоядерной энергии для совместной реализации проекта ИТЭР.

Поручить Росатому подписать от имени Правительства Российской Федерации указанные документы, разрешив в случае необходимости вносить в прилагаемые проекты изменения, не имеющие принципиального характера.

По подписании указанных документов определить Росатом ответственным за обеспечение выполнения содержащихся в них обязательств Российской Федерации.

2. Росатому и Минфину России при формировании проекта федерального бюджета на соответствующий год предусматривать средства на обеспечение финансовых обязательств Российской Федерации перед Международной организацией ИТЭР по термоядерной энергии, в том числе на уплату взноса Российской Федерации в бюджет указанной организации, а также на изготовление и поставку оборудования для реализации проекта ИТЭР.

Председатель Правительства Российской Федерации М. ФРАДКОВ

Москва
4 сентября 2006 г.
№ 1234-р

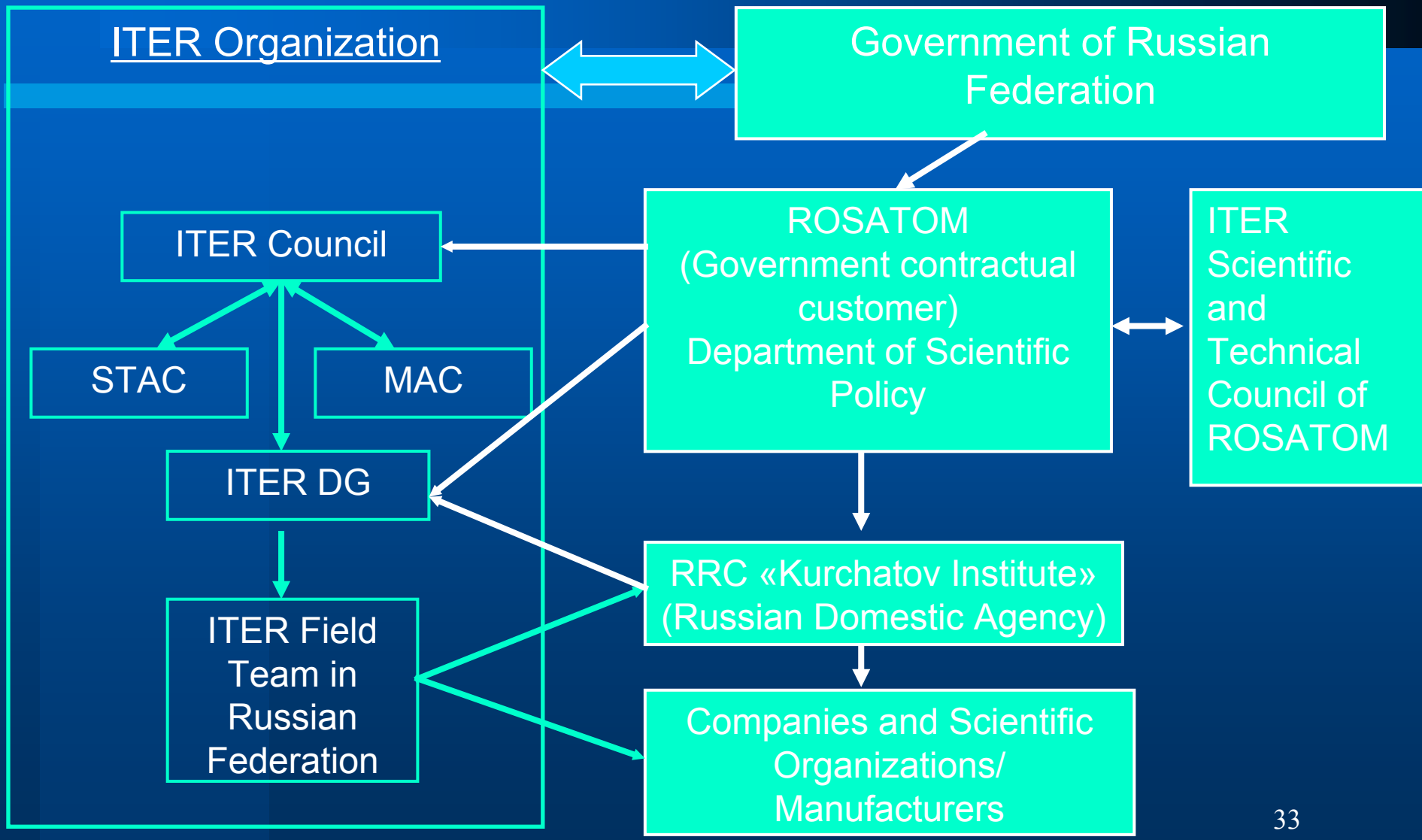
Russian Government Decision:

«…. To define the ROSATOM as responsible organization for maintenance of obligations of Russian Federation contained in the ITER Agreement.»

ROSATOM:

Government customer for procurement to ITER Organization in kind. Contribution to ITER Organization in cash.

Maintenance of obligations of Russian Federation contained in the ITER Agreement



RF ITER Procurements

Magnets

1.1.3A PF COIL 1

1.1.6A CONDUCTOR FOR TF COILS

1.1.6C CONDUCTOR FOR PF COILS

Vacuum Vessel

1.5.2B UPPER PORTS

Blanket System

1.6.1A FIRST WALL

1.6.1B BLANKET SHIELD

1.6.3 BLANKET MODULE STRUCTURAL SUPPORT

DIVERTOR

1.7.2C DOME LINER

1.7.2D HIGH HEAT FLUX TEST of PLASMA FACING COMPONENTS

POWER SUPPLY SYSTEM

4.1.3 SWITCHING NETWORKS & FAST DISCHARGE CIRCUITS

ELECTRON CYCLOTRON HEATING

5.2.3 EC H&CD GYROTRON SOURCES

DIAGNOSTICS

Neutron Systems

5.5.B.02 Vertical Neutron Camera

Optical Systems

5.5.C.03 Thomson Scattering (X-point)

Spectroscopic

5.5.E.02 H Alpha

5.5.E.08 Neutral Particle Analyser (NPA)

5.5.E.12 CXRS Based On DNB (Edge)

Microwave

5.5.F.02 Reflectometer (Main Plasma, LFS)

Russian Domestic Agency Activity

The first Procurement Agreement between the ITER Organization and the Domestic Agency of the Russian Federation was signed on 12th February, 2008 by ITER PDDG Norbert Holtkamp and Academician Evgeny P. Velikhov in the Kurchatov Institute , Moscow.

Russian Domestic Agency Activity

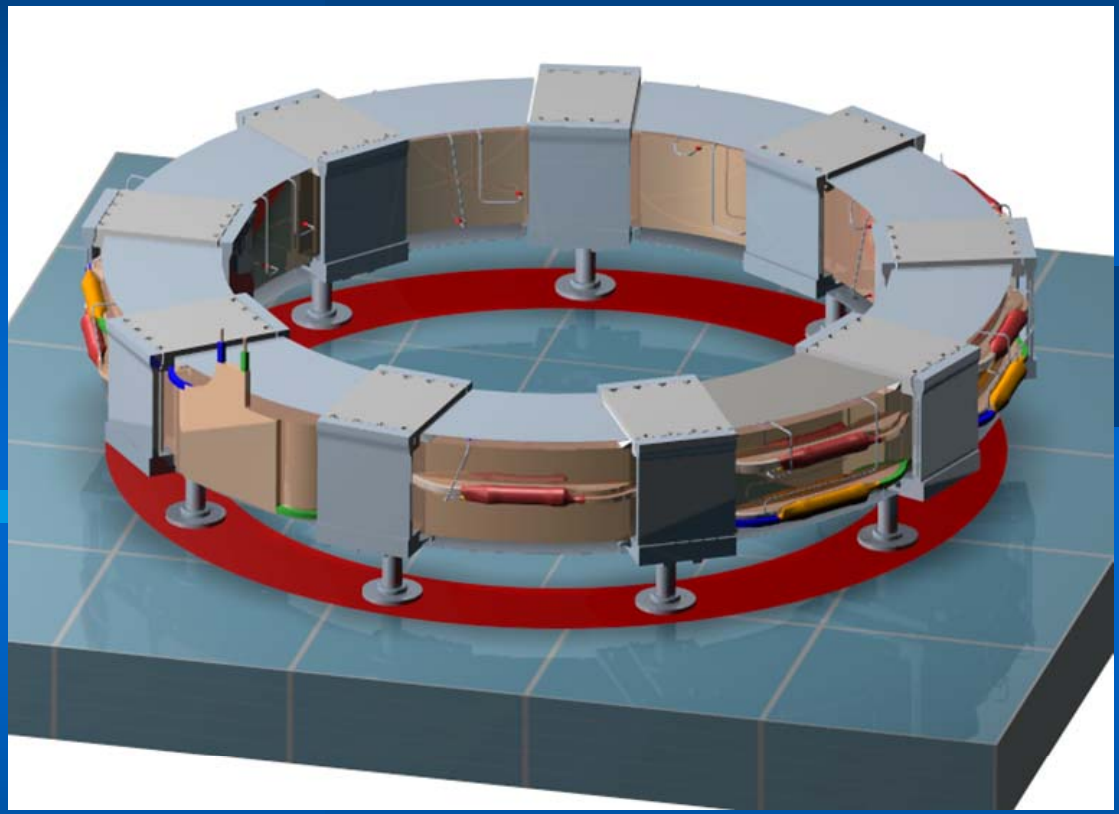
This Procurement Arrangement is for part of the conductor for the Toroidal Field Coils that will confine the plasma within the ITER machine and is an important step forward in work being undertaken by the Russian Party for the ITER project. It is the first of the baseline Agreements by which the Russian Federation will make their in-kind contributions to the ITER Project.

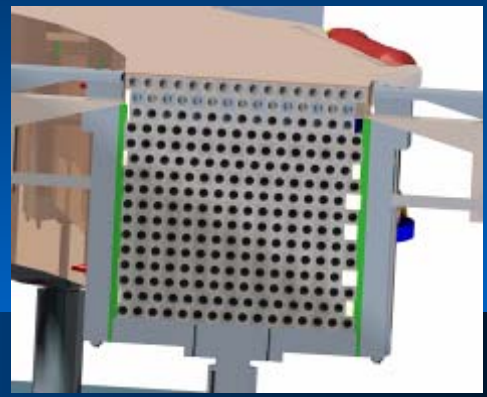
"I am convinced, that Russia is both technically and financially completely able to qualitatively and in time fulfil its obligations under this Agreement", Academician Velikhov said.

Norbert Holtkamp expressed his confidence in further successful collaborations with the Russian Federation and underlined that "Russia has been making significant contribution to the ITER Project development for a long time".

Production line for ITER-related superconductors is under development at Chepetsk Mechanical Plant.

Magnets - Coil PF-1





Start of manufacturing –

May 2012

Supply to ITER –

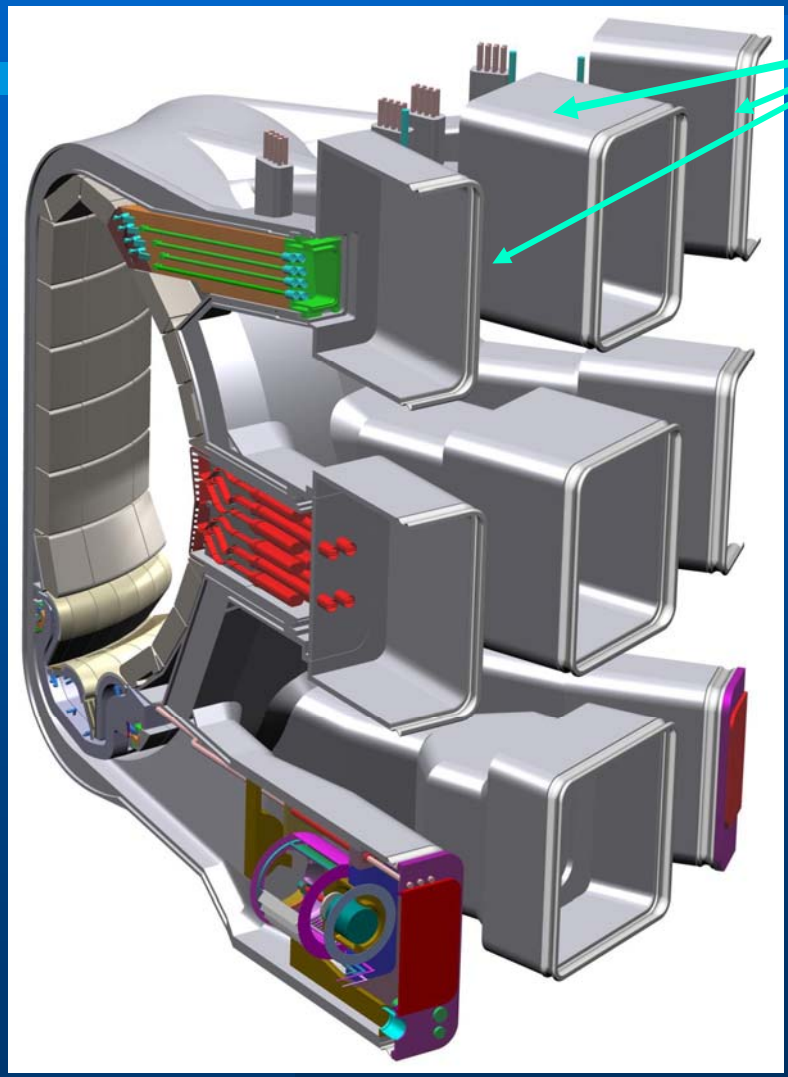
November 2014

Installation – January 2015

Coil	Outer diametr, м	Weight, т	Length of supercoductors strand, м
PF-1	9	225	6260

RF ITER Procurements

Vacuum Vessel - UPPER PORTS



Upper ports

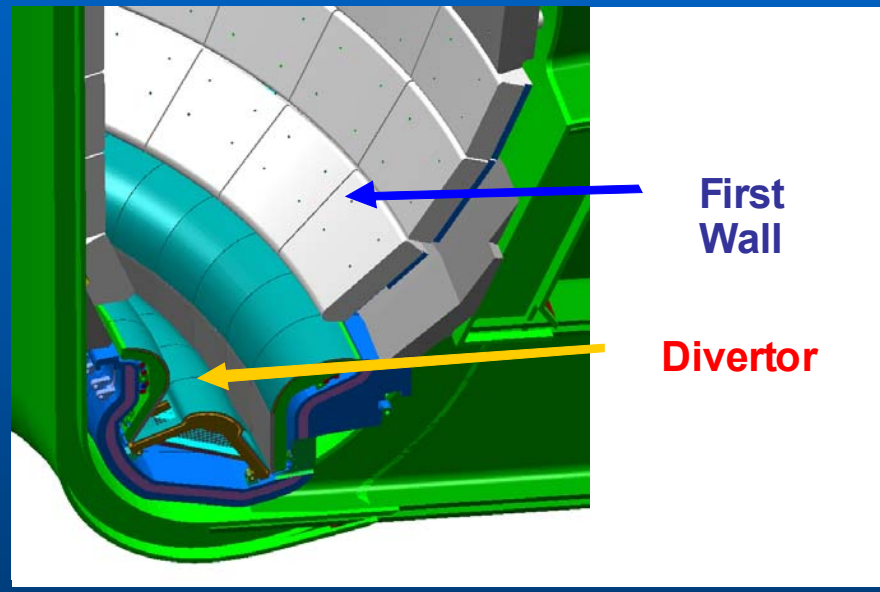
outer dimensions (length, breadth, height)	4.6м/2.5м/3.5м
amount	18
weight	23.5 т
Total weight	423 т

Blanket system - First Wall, Divertor Dome liner, High heat flux test of plasma facing components

1. First wall panels
360 (20% of total amount);

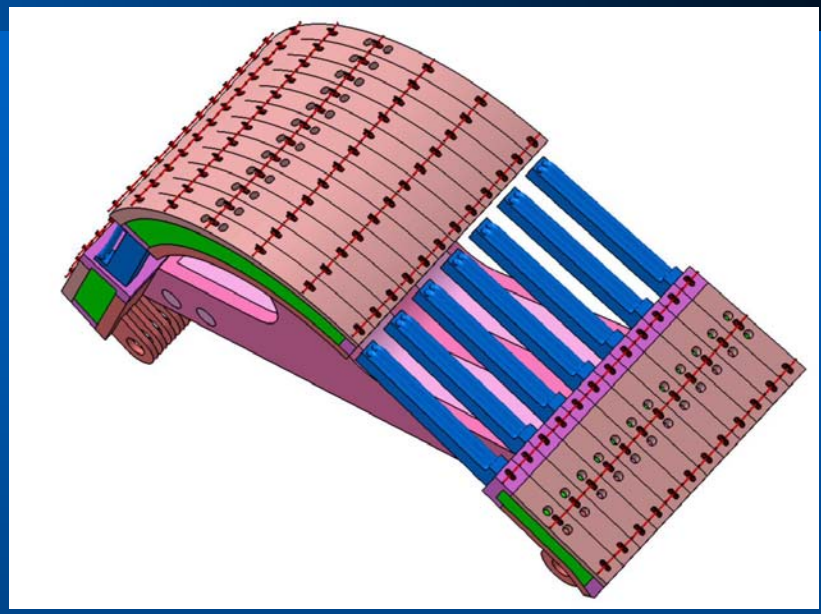
2. Central assembly of divertor
60 (100%);

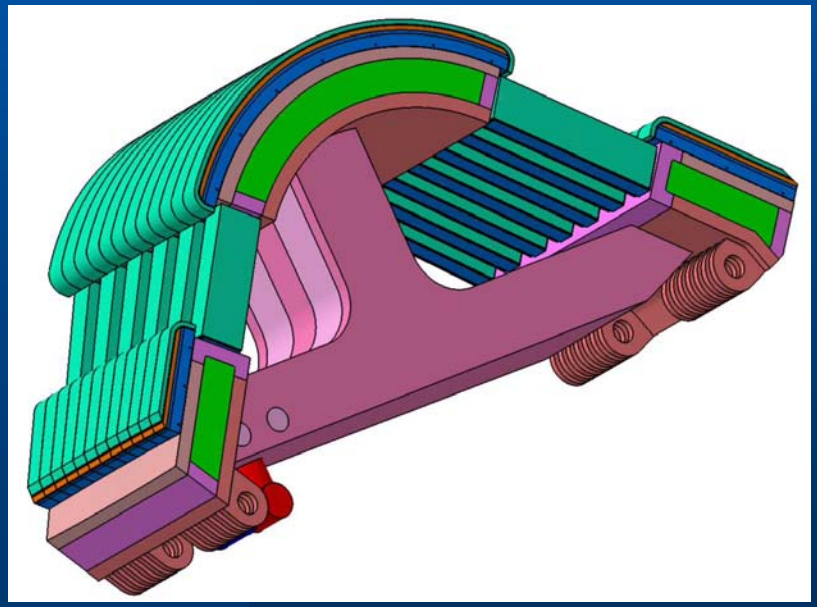
3. Heat test
~700 pipes elements (100 %).



Blanket system - Divertor Dome liner

- 54 central assembles + 6 spare units;
- dimension: 2 x 1x 0.7 м
- weight of unit ~ 2 т;
- Design load< 3 MW/м²;
- Facing: W - 10 мм thickness

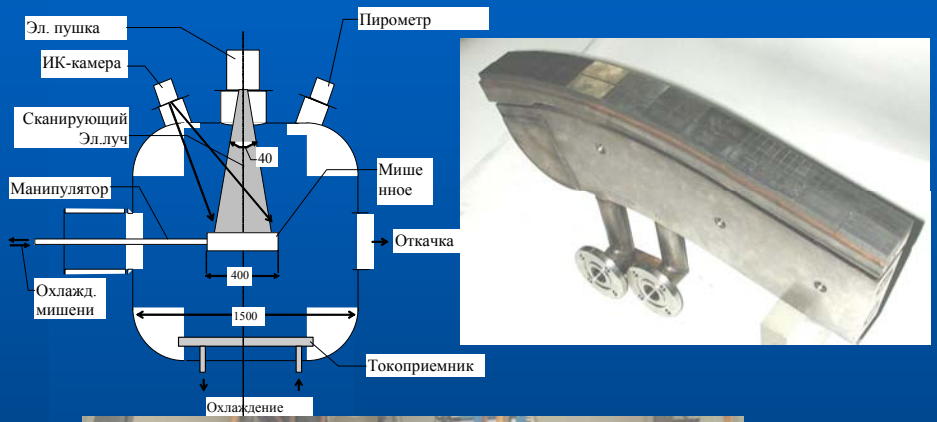


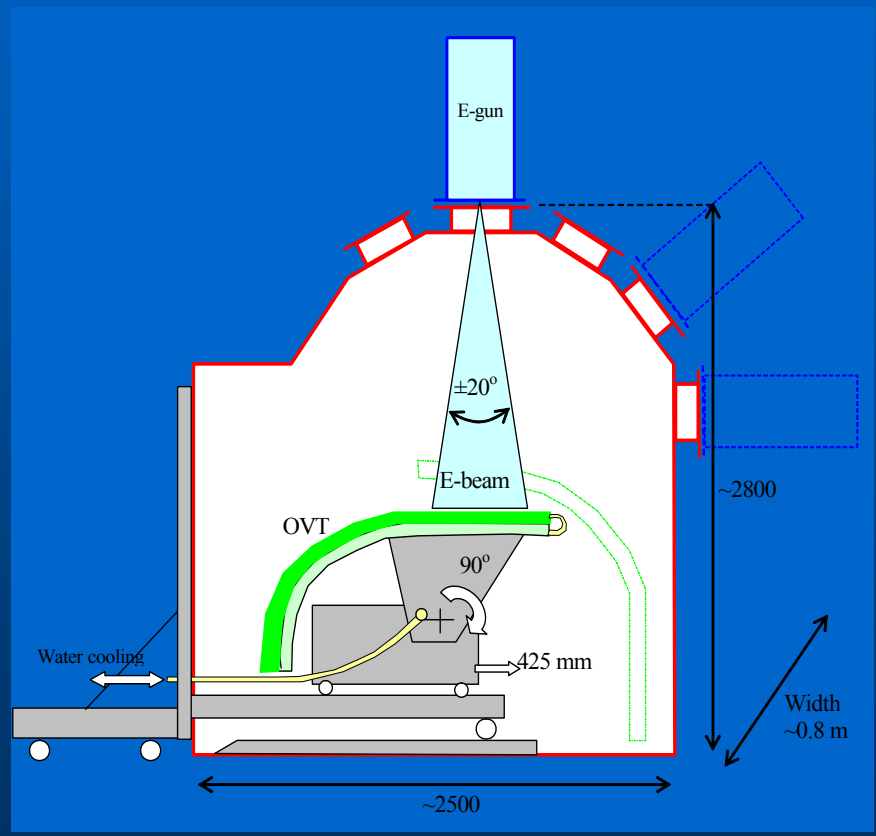


High heat flux test of plasma facing components on Tsefey-1,2

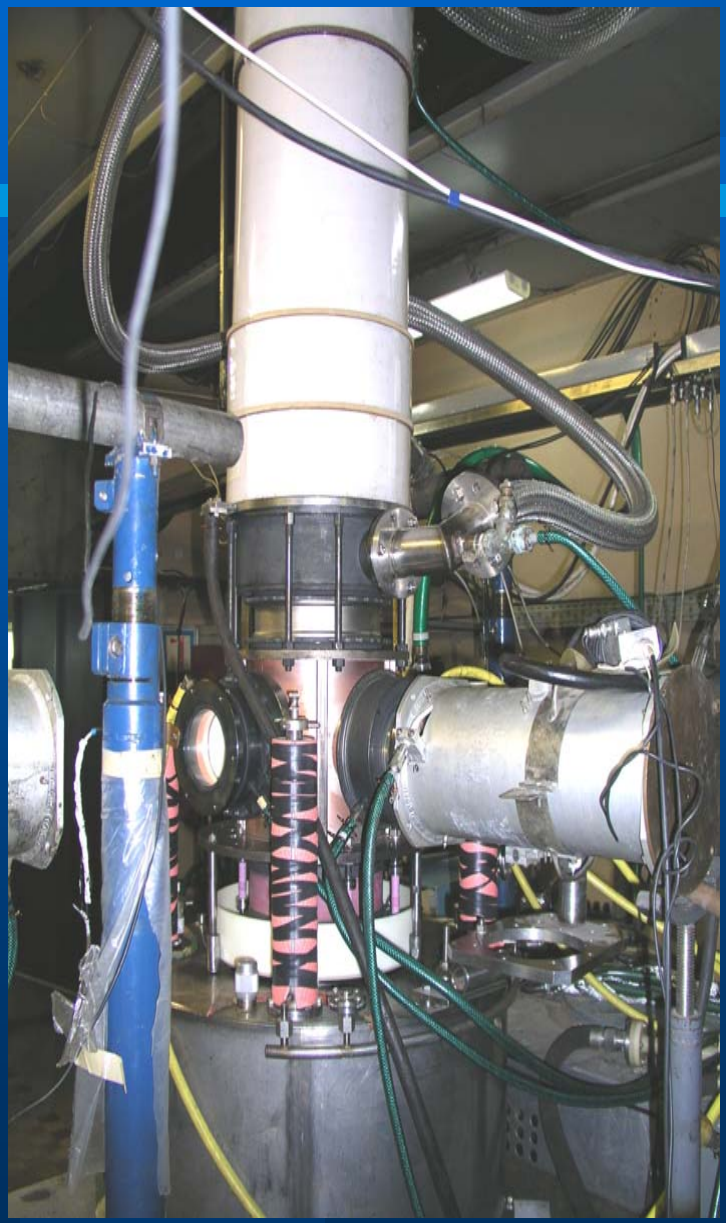
Testing of middle scale (l~0.5 м and up to 1.7 м) prototypes (about ten pieces) on Tsefey-1 (200 кВт)

Testing of full scale prototypes on Tsefey-2 (~ 600 pices)





ELECTRON CYCLOTRON HEATING - EC H&CD GYROTRON SOURCES



Parameter	Value
frequency	170 GHz
pulse duration	1000 (3600) s
window	CVD diamond, ∅80-mm
efficiency	50 %
weight	270 kg
dimension	0.5 × 0.5 × 2.7 m