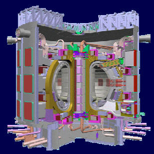
ITER an unprecedented international collaboration in energy research

Carlos Alejaldre (MEC, Spain)
for the ITER International and Participant Teams



European Conference on Infrastructures (ESFRI)
Nottingham, 6 December 2005

Outline

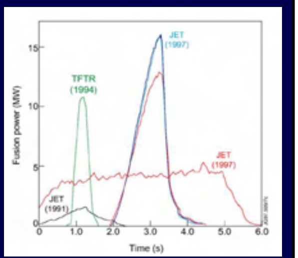
- Introduction: Fusion Results
- Technical and Organisational Preparations
- Negotiations Status
- Risk Assessment
- Conclusions

Acknowledgements

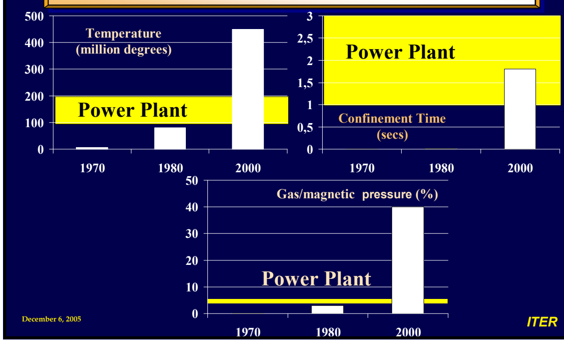
S. Shimomura, B. Spears, P. Barabaschi and ITER team
J. Doncel (MEC)

Fusion Power Results

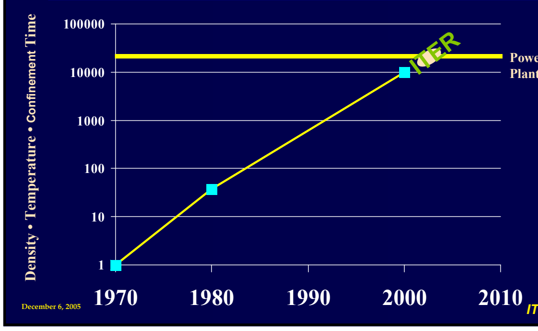
- Experiments in JET and TFTR have initiated the study of DT plasmas with significant fusion power: best JET results correspond to a fusion power production of 16MW
- α-particle heating amounted to ~15% of the input power to the plasma



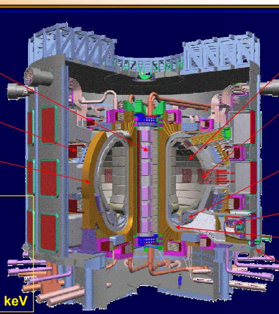
Fusion Results



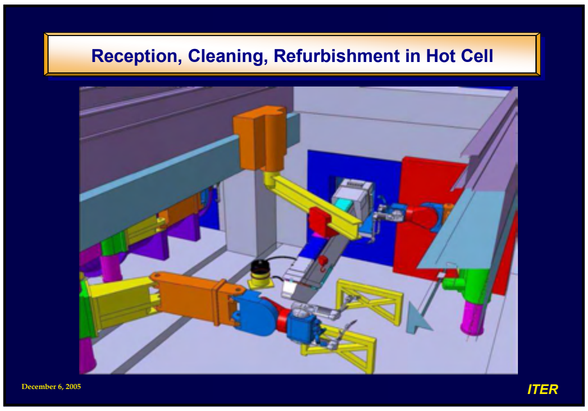
Globally

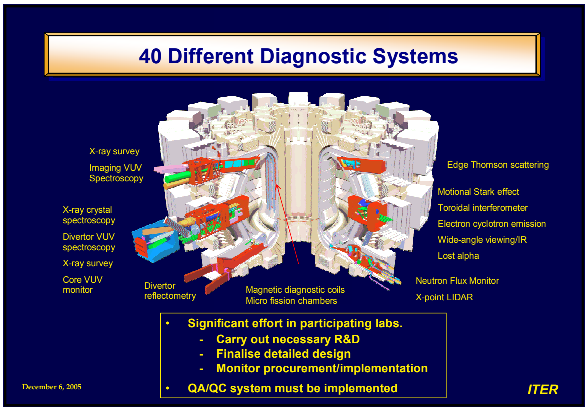


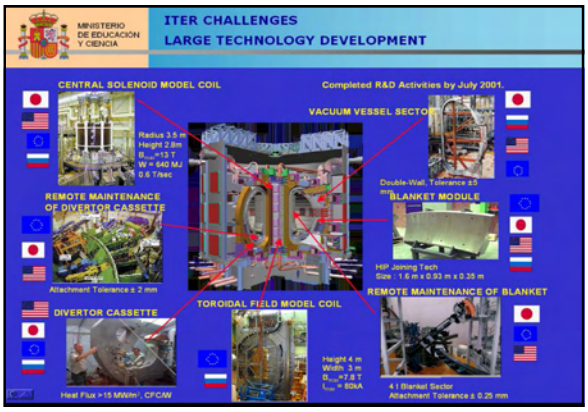
Detailed Design Has Been Developed



Fusion Power: 500 MW
Plasma Volume: 840 m^3
Plasma Current: 15 MA
Typical Density: 10^{20} m^{-3}
Typical Temperature: 20 keV








"All the News That's Fit to Print"

The New York Times

Late Edition

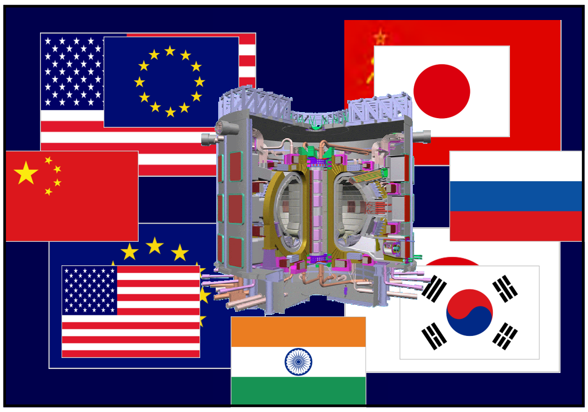
Weather: Rain likely today, strong easterly winds; rain ending late tonight. Partly cloudy and warmer tomorrow. Temperatures: today 43-47, tonight 40-45; yesterday 38-62. Details, page C30.

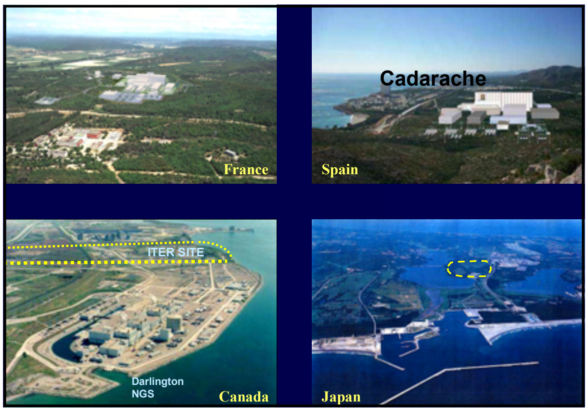
VOL.CXXXV . . No. 46,601 — NEW YORK, FRIDAY, NOVEMBER 22, 1985 — 30 CENTS

...xt of the Joint U.S.-Soviet Statement: 'Greater Understanding Achieved'

Fusion Research

The two leaders emphasized the potential importance of the work aimed at utilizing controlled thermonuclear fusion for peaceful purposes and, in this connection, advocated the widest practicable development of international cooperation in obtaining this source of energy, which is essentialy inexhaustible, for the benefit for all mankind.





Broadening the Scope of ITER

- Suggested initially to resolve ITER siting problem.
- Includes:
  - Remote experimental control centre as focus for interaction with ITER.
  - Virtual plasma modelling laboratory, to bring together models for plasma behaviour on ITER and to make predictions, feeding back information subsequently from ITER operation.
  - "Satellite" tokamak providing support (and ability to rapidly evaluate new ideas) during ITER construction and operation.
  - DEMO design team.
  - DEMO materials test/qualification facility (IFMIF).
- Implementation details now being discussed between Europe and Japan.

Negotiations

- Began in July 2001 with the following aims:
  - draft Joint Implementation Agreement
    agree how the procurement and costs will be shared
    define how the project will be managed
    - ⇒ Schedule foresees Agreement initialling in January-March 2006.
    - ⇒ India possibly joining adds further complexity.
    - ⇒ Signature/ratification by end of 2006 foreseen.
  - select ITER construction site
    - ⇒ Cadarache site chosen in June 2005.
    - ⇒ Cadarache Joint Work Site starts January 2006.
  - identify the Director General and senior staff.
    - ⇒ Kaname Ikeda chosen as DG in November 2005.
    - ⇒ Principal Deputy to be chosen by Europe soon.
    - ⇒ DG + PD to draft Project Team details.

Construction Cost Sharing

		ITER Construction	Complementary Programme
CN/KO/RF/US		10% each 40% total	?
EU + JA	Host of ITER Facility	≤ 50%	≤ 8%
EU + JA	Host of Complementary Programme	≥ 10%	≤ 8%
Sum		100%*	≤ 16% + ?

*90% in kind, 10% in cash from shared funds;

*Allocation of 80% of procurements have already been tentatively agreed.

*Situation prior to interest of India to participate.

- CN: magnet support, feeders, correction coils, conductors, blanket (0.2), cryostat, gas injection, casks (0.5), HV substation, AC/DC (0.35), diag.
- EU: TF(0.5), conductors, cassette and outer target, vac.pumps, div. RH, casks (0.5), isotope sep., IC, EC, diag.
- JA: TF(0.5), conductors, inner target, blanket RH, EC, diag.
- KO: conductors, vessel ports (0.67), blanket (0.2), assembly tools, thermal shield, T storage, AC/DC (0.65), diag.
- RF: PF1, conductors, vessel ports (0.33), blanket (0.2), port limiters, flexibles, dome and PFC tests, Discharge circuits, EC, diag.
- US: CS(0.5), conductors, blanket (0.1), vac.pumps, pellet inj., vessel/in-vessel cooling, tok exh. proc., IC, EC, diag.

Risk Management - The Problem

- 90% of items will be provided in kind from the 6 Parties and sharing amongst them has not been optimised especially to minimise risk.
- Such an experiment cannot be built without some changes during construction which may affect suppliers in several Parties.
- Unlike normal centrally-funded projects, any margins actually realised will not be seen by the project for items provided in kind.
- The project therefore has no "cushion" for overcost items or failed/delayed deliveries.
- Very long time scale of the project and lack of experts.

Large Number of Specific Very High Quality Components

500 t of Nb_3Sn, 2000 first wall panels and 2000 divertor elements

- Risks:
  - Too low production/acceptance rate.
  - Too high costs.
- Minimisation of risks:
  - R&D including QA.
  - Qualification of potential vendors before call for tender.
    - (Nb_3Sn strand: Trial production and tests ongoing with 15 vendors)
    - (First wall panel: Trial production and tests will start soon)
  - Fixed price contracts with multiple vendors with demonstrated capability.
  - Staged production and "holding" of cash contingency.
- Mitigation of consequences:
  - Transfer of remaining production to other vendors demonstrating adequate production quality. A solution is needed for funds transfer from the defaulting to the compensating Party.

Large and Complex Tokamak Core Components

- Risks:
  - Unacceptable delays.
  - Inability to maintain quality in series production.
  - Design changes.
  - Too high costs.
- Minimisation of risks:
  - R&D (7 Large Projects), detailed fabrication and QA (in progress).
  - Very good preparation esp. specification and planning (underway).
  - Firm and fixed price contracts for reasonably large packages of work.
  - Prime- - subcontractor relationship between multiple Parties' vendors.
  - Very good direct relationship between ITER International Organisation and vendors.
- Mitigation of consequences:
  - ITER International Organisation must minimise cost impact of changes.
  - ITER International Organisation must seek compensating cost savings within the contract, or with other contracts.
  - Access to a general reserve fund as a last resort.

Complex Organization and Lack of Experts

- **Risks**
  - Lack of specialists.
  - Lack of technical continuity due to long time scale
    - retirement of senior staff in IT, PTs and Industry who actively participated from the beginning of the ITER Engineering Design Activities in the early 1990s.
  - Inefficiency of complex international structure.

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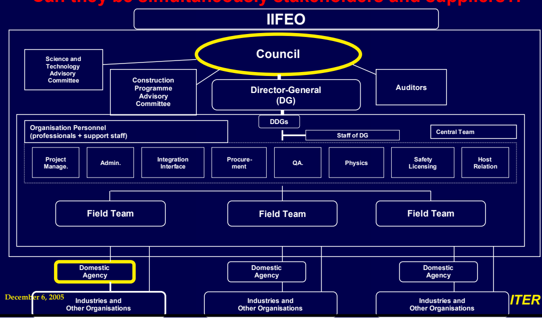
Roles and Responsibilities: The Parties

Can they be simultaneously stakeholders and suppliers?.



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Simple Relation between ITER Organization (via Branch Office) &Supplier

Parties' Agencies must play a supporting rather than a leading role.

•Component procured by Party A

ITER International Organization — Prime Contractor Industry in A — Subcontractor (s)

For a specific component, a prime contractor could be an institute or an association, which will have to implement QA/QC system. (pellet injector, diagnostics, etc.)

•Component shared by Party A and Party B

ITER International Organization — Prime Contractor Industry in A — Subcontractor(s); Subcontractor Industry in B

•Extremely inefficient arrangement for a core component shared by multi Parties.

ITER International Organization — A-Party's Agency — Industry in A; B-Party's Agency — Industry in B

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Example Solution to Risk Sharing Between Project and Parties

In-kind contribution, before contract placement

ITER International Organization — A-Party's Agency — Industry in A; B-Party's Agency — Industry in B

Supplier Selection / Supplier Selection

After contract placement

ITER International Organization

A-Party's Agency / B-Party's Agency

Technical responsibility / Financial responsibility for scope changes

Industry in A / Industry in B

Financial responsibility for original scope / Financial responsibility for original scope

(separate, leader-follower, or consortium)

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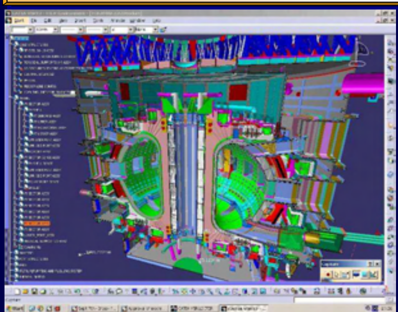
Improvement of Configuration Management Tools



- Complexity, clash detection, utility routing, collaborative design with Participants, need better tools.
- ITER needs "Virtual product data manage-ment" software for 3D digital mockup. Imple-mented in 2004, upgraded at end of 2005.
- Complete switch to CATIA V5 at end of 2004.

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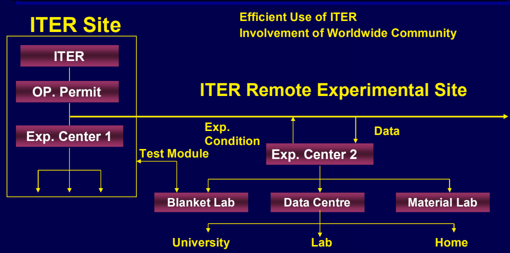
Remote Participation in ITER Experimentation



Example: 3 shift/day on site (night shift for monitoring and support of remote experiment)
1 or 2 shift(s)/day on remote experimental sites

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Conclusions

- The ITER Transitional Arrangements are being used at the project technical level to get many things ready that will ease the path once the negotiations are successfully completed.
- Further careful considerations and preparations are required, especially in the Project Organization, Staffing, Procurement System, and the relationship among the ITER International Organization, Domestic Agencies and suppliers.
- Joint Implementation Agreement should leave enough flexibility for the Project's Director-General.
- Following the site decision, progress now being made on all fronts, with ITER and Broader Approach items. Lack of decision on the site has set the date of first plasma back 2 years, to 2016.
- The success of ITER will require the strongest commitment of all the Parties and their industries to provide the specified components at the required quality level and on schedule.

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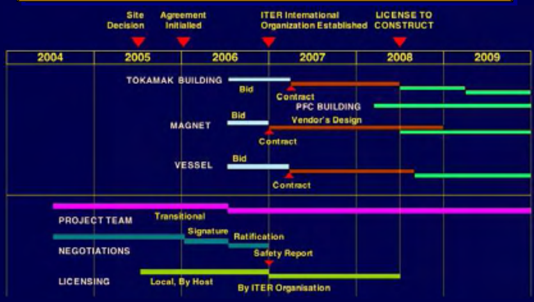
Immediate Schedule



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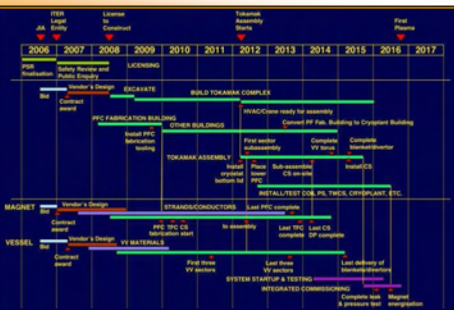
Construction Schedule



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