

23 June 2008 P.H.Rebut

FIRST JET PLASMA 25th ANNIVERSARY 1983-2008

I am pleased to be again in a place where I have spent so much of my life and I thank your leader Dr Romanelli for inviting me to-day for the 25th anniversary of the JET first plasma. This date was a turning point between the JET construction and operation.

From the JET conception to the first plasma :

The JET saga started by the Enriques Report in 1973 recommending that a tokamak should be constructed by Euratom and the associations with a 3 MA plasma needed to confine alpha particles.

This proposal was accepted and I was sent to Culham in May 1973 to form a design team that had to study such a machine. In September a JET design team started to work, hosted by the UKAEA.

Two years later, in 1975, the project was defined in the report R5: The four objectives of the machine were :

- confinement,
- plasma wall interaction,
- heating,
- tritium and alpha particles.

The guiding principles of JET conception were simplicity and sturdiness in order to keep the cost minimal and to provide a long life to the experiment. In order to be able to adapt to the experimental program, the machine was built with margins to face the unknown physics. These margins have allowed 4 T, the doubling of the flux, 7 MA, the installation of a divertor....

The JET had new features : first its size, 100 m³ against 1 m³ previously, 3 MA against 300 KA. Secondly its size, its D shape cross section which generated heated discussions as no previous experiment was existing in this field. The D-shape provided an increase in plasma current from 3 to 5 MA as it was recognized in R5 that the plasma current was the key parameter for confinement. The stability and beta limits were properly calculated.

Production of α particles also was a major objective of a novel nature for a fusion experiment. it required shielding, hot cells and remote handling maintenance. From the beginning, remote handling was included in the design ; a remote handling manual defining how to implement basic operations (bolting, welding, cutting, etc.) was developed.

In the fusion world, JET performances predictions were very largely spread from the coldest plasma in the world up to ignition. The experimental results obtained were not the best which could be expected, but reasonably good.

The work of the design team was accepted by Euratom and the Associations and proposed to the council of ministers. We must thank Donato Palumbo for his strong support.

Three long years of political fight about the choice of the site ended in the last months of 1977 by the choice of Culham for the construction.

The 1st June 78 JET, a Joint Undertaking was created with Hans Otto Wuster as Director and the construction started.

On the 23rd of June 1983, 5 years after the JET Undertaking creation, the first plasma was obtained. The plasma current was low but, nevertheless, it marked the end of the construction phase and the beginning of the JET operation.

A few months later 1 MA was obtained for 2 seconds before TFTR in Princeton achieved it and we won the bet: meals and wine, the wrong way round. We drank Californian wine in an English pub.

The foreseen construction schedule was 5 years and the machine was constructed in time and within cost according to the R5 report.

The official inauguration of JET was held on the 9th of April 1984 by the Queen Elizabeth II and President Mitterand.

After the first plasma

After the initial plasmas, JET raises its performances. It achieved plasmas up to 7 MA with limiters and later on plasma with X points and divertor in the H mode and ELMy H mode regimes allowing to establish the scaling laws for ITER.

Beryllium was introduced as a first wall material.

During this time, an astonishing news reached us : cold fusion.

I was asked by a journalist when JET will stopped and when our un-useful team will be disbanded.

In order to answer to some of the laboratories. I must confess that we made measurements with our very sensitive and precise instruments to detect neutron flux which could be emitted from a cryogenic palladium loaded with deuterium. The result was null.

The first experiment in the world with tritium took place on the 9th November 1991 : PTE : 1 MW of fusion power during 1 second was produced. This made the news around the world as journalists have witnessed it in the control room and seen the tension first and after the exitationof the team

In the campaign of 1997 JET achieved 16 MW with a Q approaching 1 under Martin Keilhacker leadership.

The Preliminary Tritium Experiment, PTE, was a landmark in fusion research: It was the first production of controlled fusion power of a significant amount.

It also demonstrated the safe use of tritium and allowed to gain a valuable experience on the retention of tritium in the first wall and to check the effectiveness of cleaning techniques (mainly discharge cleaning) to remove it.

JET organisation

I now would like to stress some aspects of the JET organisation that contributed to its success.

The JET Undertaking was a legal entity formally independent from the national laboratories and the associations that were present at the JET council;

JET had the resources required at his disposal, staff and money. This allowed to arbitrate between the different machine aspects. It could control the schedule and the cost, have fast reactions when problems raised and provide a global optimisation to the project.

The contingency, 20% of the project cost, was mainly required for the buildings and the piping.

The relations with Industry were good as our objective was not to load the industry with legal requirements but to obtain the components of the project in time and manufactured with a high quality.

When a problem raised, we could put some appropriate members of the JET team to help the industry to resolve it. Among the problems solved, I would mention the toroidal conductor brazing and the instability of the fly-wheel generator which destroyed one bearing.

The problem of the Joint Undertaking was due to the fact than two different statuses for staff employment were imposed depending to the staff origin, UKAEA or Euratom. The JET staff statuses were almost the only point which was not under the Jet Undertaking

control. This problem was used to terminate the Joint Undertaking that had shown its efficiency.

Despite this problem, the JET results could not have been obtained without the dedication of the team who worked on the project. They fully gave it their interest and their time accepting to work in three shifts, day and night.

JET has fulfilled its program and allowed the existence of ITER; it is now the only machine that could work with tritium before ITER operates.

The absolute performances are for me the only valid proof of a progress as plasma behaviours are largely non-linear : if a better control and understanding of the plasma appears, better performances must to be achieved; in this respect it seems to me that 30 MW and 100 MJ of fusion power could be the present JET objectives to demonstrate the advances made in this field.