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ABSTRACT

European fusion research is oriented on magnetic confinement nuclear fusion as a potential large-scale, emission-free power source. This defines the main scope for Public Information (PI) activities in the field. Opinion polls indicate that the public is not adequately informed about fusion research. The limited resources available for PI require a sound communication strategy and hence, a careful definition of PI target groups is essential. Based on this, suitable PI methods applicable in fusion are selected and their challenges discussed. It is argued that trends in communication inside the fusion community will play a critical role in further PI developments. Furthermore, key significance of communication feedback is demonstrated, although at present it is limited to personal contacts and web statistics. In the present fusion PI practice, the itinerant exhibition Fusion Expo is a valuable source of experience and feedback. Based on the achieved level of fusion PI expertise it is concluded that further work have to concentrate on designing effective messages with comprehensive terminology, on emotional impact of the PI work and on broader division of professional roles within the fusion PI activities.

1. INTRODUCTION

Magnetic confinement fusion research in Europe is aimed at demonstrating that nuclear fusion is a viable future energy option. Achieving this aim requires a sustained, long-term and large scale effort and investment, including expertise in a wide range of disciplines. That is why all European Union (EU) Member states collaborate in a European programme [1], supported under the EURATOM Framework Programmes. It has a unique organizational structure: long-term "Contracts of Association" between the European Commission (for EURATOM) and fusion research organizations in the EU Member States have allowed the development of a programme which is integrated and co-ordinated at European level. In 1999, the European Fusion Development Agreement (EFDA) [2] was created to provide a framework for national fusion research parties (known as Associations, see Fig.1) to participate in collective activities. This includes the scientific exploitation of the Joint European Torus (JET), the world largest tokamak (Fig.2).

The European dedication to the fusion research has allowed for significant achievements in the field [3]. For example, in 80s the high confinement mode (H-mode) was discovered on ASDEX tokamak in Germany, in 90s JET demonstrated the deuterium-tritium operation including the present world record of 16 MW released fusion power (1997), and recently Tore Supra in France achieved long-duration tokamak discharges (>6min) with more than 1GJ energy input. On 28th June 2005, six parties4 to the international fusion project ITER [4] agreed to go ahead with the construction of the facility at the EU candidate site in France, next to the CEA fusion research centre at Cadarache, see Figs.1 and 2.

The above conditions clearly define the scope for the evolving Public Information (PI) activities in fusion. In brief, the EFDA PI activities present fusion as a promising energy source for the future and cover the ongoing fusion research activities including its international dimension with ITER in focus.

In pursuing this task, the fusion community can profit from the overall public support to R/D activities, to peaceful international collaboration and to the environmental assets of the project. The main challenge is to develop, within limited resources and experience, an efficient PI practice capable to respond correctly and remarkably to public concern about nuclear power and centralised projects in general.

This paper outlines the Public Information policy of the European fusion community on the background of the current situation in public understanding of fusion. As part of an efficient information and communication strategy, the main PI target groups will be discussed, including their specific profiles. Corresponding methods of PI will be overviewed, with brief discussion of their challenges and potentials for further development. A separate paragraph will be devoted to internal communication as a key part to successful PI. Feedback to fusion communication activities, namely personal contacts and web statistics, will be mentioned. In the second part, a case study of the Fusion Expo exhibition will be presented. A recommended strategy for the expected growth of fusion PI will conclude the article.

2. METHODS AND CHALLENGES IN FUSION PUBLIC INFORMATION

In general, any public information activities should be launched as an open two way communication between two equally respected groups, the experts (scientist and communicators) and the target group (see section 2.2). A sound communication strategy has to be prepared in advance by the experts to cover both planned PI campaigns and unplanned events. Their group can be pro-active in delivering its information ("push", e.g. in a press conference) or passive by making it available ("pull", e.g. via a website) or highly flexible to cope with unforeseen situations. It is to be noted here that both rational and emotional messages are always present in any communication, so that no responsible PI work can rely on technical expertise alone.

Communication work should start with planning based on a detailed audit of available resources and a clear specification of the target group, including a research into its knowledge and opinion (a poll). Based on this plan, realistic objectives should be set and a most efficient information method should be selected and adapted. Following the PI campaign, its impact should be evaluated using a wide feedback from the target group, preferably by repeating the opinion poll. In practice, due to many parallel communication activities and limited resources, strict application of this scheme can be difficult to achieve and thus counterproductive. Its framework is, however, quite useful and worth following.

2.1. PUBLIC OPINION ON FUSION

A proper research into knowledge and opinion of any large group, and of general public in particular, is a very demanding task. Some members of the group can be easily omitted (e.g. the non-responsive ones), and some of the questions can be biased (e.g. carry emotional messages). It is therefore recommended that only highly professional surveys are trusted. In fusion, a very valuable resource of information on public opinion is the 2002 Eurobarometer on Energy [5]. According to its findings, the European public is badly informed about nuclear fusion research in the EU (~3% informed) and about

the EU energy-related research in general (~15%). Therefore, for general public the challenge of producing energy from nuclear fusion is quite abstract. It turns out that the level of education and social background tend to play a major role in awareness of nuclear fusion as future energy source. As far as energy-related research in the EU is concerned, nuclear fusion appears to be at the third position on the priority list of those areas where people would like the EU to do more, with 21% of support, well far behind renewable energy sources for instance (69%). Furthermore, there are significant concerns regarding the capability of nuclear fusion power to meet the public safety and environmental requirements: almost 35% believe it won't be safe, will produce long-term nuclear waste and will contribute to global warming. These negative opinions are remarkable namely in relation to very low public awareness of fusion, which contradiction can be clearly ascribed to the prejudices associated with the tag "nuclear". Nuclear fusion is also viewed as the second most efficient potential energy source (22%) and it is believed (59%) that it needs much more research to confirm its potential.
Since 1997 the EU fusion programme has been pursuing a broad Socio-Economic Research on Fusion (SERF) [6]. Namely the SERF part on Social Acceptability of Fusion give very strong incentives for further developments of fusion communications based on rigorous social research. For example, it concluded that "broad public involvement is now universally seen as a requirement for any decision process concerning major new technology developments," and set framework guidelines for future public debates, based on energy industry experience and feedback (see part 2.5).

2.2.TARGET GROUPS IN FUSION PUBLIC INFORMATION

In an efficient communication strategy, methods, contents and specific target groups of PI are strongly interconnected. Fusion communicators have been focussed on the following main target groups, on their interests, knowledge and opinions:

- **Decision makers:** due to direct link between the EU energy policy and the European fusion research this group needs to be informed on both European and national levels about the mission progress. The group consists of judicious, motivated, busy people.
- **Media:** as a key intermediate to pro-active communication with general public, media (TV, radio, newspapers, journalsÖ) deserve high priority PI, namely personal relations. In fusion, media relations are established, as a rule, on national levels.
- **Schools & Universities:** Teachers act as efficient intermediates to young people who will probably decide about the industrial future of fusion. Even before, fusion R&D will need a supply of new determined experts. Notice that fusion has relatively sparse professional links to Universities compared to other major research projects.
- **Interested Public:** Although fusion cannot hope for a major pro-active influence of general public, any of those who are interested and request information must feel free to obtain it, hence the passive PI must be very broad and highly responsive.
- **Industry:** Nowadays, the main topics in fusion research have expanded from basic plasma physics towards more technological tasks, e.g. to material research, which calls for direct

involvement of different industries including their R&D. PI activities have to follow these developments and promote the opportunities.

- **Fusion Community:** Due to international dimension of the research it is vital to foster good relations among fusion centres, calling for broad communications.
- **Scientific Community:** support from the influential category of "other scientists" can be expected only if fusion community manages to inform them properly about the fusion research, its mission, results and strategy, as well as about joint interests.

When setting priorities for the available PI resources, the potential target groups are further subdivided and then classified according to, for example, their influence, legitimacy and/or urgency. A group that appears in several classes calls for a higher priority, namely for a pro-active communication.

The international character of EFDA is an important feature that strongly affects the targeting: Language barriers as well as certain cultural differences (e.g. acceptability of nuclear power) need to be taken into account. In order to cope with these, and also in order to share experience, an informal network of PI experts from all fusion Associations was established, with a clear potential to mature into a more formal collaboration. Of course, the individual Associations pursue in parallel their own PI programmes adapted to their sizes and specific needs (for instance, in case of JET there are important links to local community).

2.3.METHODS OF PUBLIC INFORMATION

The methods and contents of PI should depend strongly on the selected target group, on its interests, knowledge and current opinion. However, to keep fusion communications as efficient as possible it is often decided to address several groups with identical message.

As a general rule, personal contacts are strongly preferred. Decision makers, media and industry representatives, scientists and other professionals are encouraged to visit fusion facilities and meet fusion experts on individual basis. Group excursions are organised for schools and interested public along numerous other events like, for example, open days, lectures and exhibitions. The unique experience of Fusion Expo, the EU travelling exhibition, will be presented in a case study in Part 3. Very popular, on international level, is also the "Fusion Roadshow" by the EURATOM-FOM Association (the Netherlands), an entertaining demonstration of a few experiments combined with key facts about fusion and energy.

The European Commission (EC), as the body which co-ordinates and manages the fusion programme within the EURATOM Framework Programme, has a particular role to play in communication activities. The Directorate General for Research has a dedicated team for public information and communication which works closely with the professional staff responsible for fusion within the EC. A wide range of information and communication activities are covered, from producing publications, maintaining a dedicated web site and organising events, right up to drafting media releases and articles for the press and writing speeches for Commissioners. As well as needing to meet exacting standards, the materials

produced must be suitable for a very broad range of audiences and conform to the political context of general EU policies, and energy research policy in particular. The global perspective of the EC's communication activities therefore complements the more fusion-oriented approach of the work done by EFDA and the Associations.

In order to maintain a current and pro-active information flow to decision makers and other experts – including fusion community itself – EFDA issues two periodicals, EFDA Newsletter and JET Bulletin. This represents a repetitive exercise in the internal communication (see part 2.4), namely in searching for suitable topics and authors. Importantly, the periodicals also require maintenance of relevant, up-to date distribution lists. EFDA and/or its Associates have also issued several PI brochures as well as other information materials (calendar, interactive CD-ROM, movies). All the brochures can be downloaded from the EFDA websites [2]. Due to a concerted effort of the EFDA PI network, selected printed materials appear step by step in different languages.

The fusion public websites act as a key tool in the passive communication, although their impact is still underestimated by many experts when compared, for example, to printed materials. Notice that from the web statistics it follows that hundreds of visitors browse the JET public pages daily (see part 2.5). At JET, the public webpages aim to enhance understanding of current fusion research, with particular accent on simplicity, illustration and topicality – thus, again, relying on an efficient internal communication. This year, being the World Year of Physics, the JET website furthermore features monthly articles on fusion history. In near future the interactivity of the webpages is to be increased, including, for example, a "treasure hunt" with incentives. It is expected that the interactivity shall not only attract more visitors to the JET website, but also enhance its role as a precious source of feedback (see part 2.5).

A significant challenge for the fusion community, in both printed and online materials, is the graphical representation and form of information. Capabilities to implement creative graphics are rather underdeveloped in science, due to its rigorous background, and in most cases there are very limited opportunities to call for external graphic services. However, the strength of visual information has been clearly recognised in the fusion community so that there is increasing determination to improve the situation. For instance, after a successful launch of the JET web database of figures, a similar web database of photographs is to be implemented. At the same time, the need for new illustrations and photographs is being pushed through internally, with accent on artistic and human aspects of the visual information (see fig.3)

It is to be noted here that the key actions of the fusion PI are co-ordinated on broad international platform and as such they are subject to collective control including a rigorous clearance procedure for all printed materials. This insures high standards of information in terms of scientific and political correctness, but hampers flexibility. In this sense, the key areas to develop common standards are risk communication (e.g. on conceivable fusion accidents) and unplanned PI, namely crisis communication (response to "media panic"). The corresponding efforts will be based on working experience in individual Associations, for instance, the Association EURATOM-UKAEA had a relevant media training recently.

On the other hand, a high degree of international collaboration permits for major projects in support of PI. Fusion Expo, which will be detailed in part†3, has been already mentioned as well as the SERF studies. Furthermore, EFDA JET is a founding member of EIROforum, a collaboration between seven European Intergovernmental Scientific Research Organisations (CERN, EFDA, EMBL, ESA, ESO, ESRF and ILL) that allows for joint PI actions targeting in particular decision makers, teachers and the scientific community [7].

To illustrate the public information work, let us present methods in which fusion community supports the education system (i.e. the Public Outreach activities). Many Associations maintain close relations with local schools (some involve even pre-schools), offering excursions on site, lectures at schools, hands-on experiences, teaching kits etc. EFDA also initiates international contacts among Associations and schools not only to demonstrate the European dimension of the fusion research, but also in order to obtain a valuable feedback on cross-cultural perception of fusion. Fusion websites provide well adapted information to pupils and students, and allow them to contact experts directly. Science teachers can meet to exchange ideas and learn about research progress at national and European levels of the Science on Stage teaching festival, organised and sponsored by EIROforum [7]. For university students, a variety of summer schools is organised – a bridge between public information and rigorous science communication.

2.4.SUPPORT OF SCIENTISTS

A complete, prompt and trustful public information can only be based on a well-developed communication within the expert group. Although this condition looks simple to fulfil, every PI team would confirm that fostering the internal communication is perhaps the most challenging part in their responsibility. In science there is an advantage of quite informal relations, on the other hand the "rational" mindset often proves to be rather rigid. In respect to PI this may lead to overexpectations and misgivings associated to the busy world of information market. As an example, a recent quote from a leading fusion scientist: *"At least, they [BBC] should have screened the programme in front of others first and give us a chance to comment"*. It has been shown by different groups that communication and media training of scientists can significantly improve their understanding of the PI [8] which claim is, based on experience in fusion, worth a strong promotion.

Enthusiast and knowledgeable staff is the main resource for communication of science. High workload of experts thus present another significant challenge. Although in principle scientists declare their support to PI activities, their actual duties do not allow them enough flexibility for communication work. In some cases, too narrow contacts with public can be even perceived as a hindrance for scientific careers [8]. Young scientists are much more positive and open for communication, thus more valuable for PI – but also more vulnerable to the criticism that they're using it in order to increase their visibility. As a consequence, even talented communicators can become reluctant to give public presentations, or to write articles for newsletters or webpages. As another consequence, in a large scientific team it proves very difficult to maintain and prioritise a survey of news, usually forcing the PI responsibles to

read and understand the latest scientific reports themselves. In fusion research, due to its imminent progress into fields of applied research and technology, there is an urgent demand to change this situation. Efforts need to be invested in order to carry through a new management practice, in which researcher's time devoted to communication tasks would get similar recognition as time devoted, for instance, to administrative work.

At the same time, the fusion community witnesses a remarkable progress in the internal communication due to new media, namely due to the internet and phone- and video-conferencing facilities. For example, EFDA JET maintains not only local "intranet" webpages, but also "users" webpages with scientific and administrative contents accessible to all EFDA parties. In most cases, these webpages are spontaneously maintained by scientific leaders. Thanks to investments to videoconferencing facilities, the scientific and managerial meetings can be followed in remote, saving time and travel expenses. Based on this success, the necessary hardware has been recently installed in the JET Control Room which will allow for real time "Remote Participation" during experiments. On several occasions, these tools allowed for direct and attractive PI events, e.g. in July 2005 JET took part in the EIROforum discussion with public attending the World Year of Physics EPS-13 conference in Bern.

2.5. FEEDBACK AND EVALUATION

So much as it is important to evaluate the efficiency and impact of the fusion PI, it is very difficult to quantify it, as the available feedback is mostly limited to personal contacts that do not render completely correct sampling of the target audiences. Still these contacts provide valuable benchmarks and arguments for ongoing discussions on further strategy.

The rigorous SERF studies (see part 2.1) present an important exception to this, and that is why their findings are considered to be a reference for the EFDA policies. In 2004 the SERF studies served as a basis for a critical discussion with a broad spectrum of industry experts, energy policy makers, politicians and non-governmental organisations (NGO's) [9]. From these discussions, it emerged that further studies will be needed on how much investment would be required to accelerate the development of fusion power, on tritium risks, and on spin-offs from the research. The feedback from these key target groups therefore shows increasing demand for professional communication services.

Some examples of personal feedback from general public can be found in Part 3 of this article. As another interesting instance, several *science communicators* were asked the peremptory question: "What emphasis should be given to the world *nuclear* in fusion public information activities?" Surprisingly, while *within* the fusion community the respondents were rather in support of using the adjective ("not mentioning nuclear would be perceived as hiding nuclear"), the answers coming from *outside* the fusion community were usually opposite ("a word which evokes hostility is not helpful to inform people").

Public webpages offer yet another significant tool that permits to feedback and evaluate fusion PI activities - namely the web interactivity and the web statistics. Although at present the interactive

features of JET public webpage are limited to the “ask a question” feature, the corresponding return gives some background concerning who and why is interested in fusion. About two questions per week are addressed to the JET webserver, plus approximately similar amount of requests for a site excursion. The questions are asked usually either by high-school students working on a project, or by interested engineers. In future, the interactivity of the public webpage will be increased, see part 2.3.

As for the web statistics, it unveils significant effects, although the computer experts warn of important data errors due to cache servers, search robots etc. The main, repeatedly observed effect is a strong synergy between “push” fusion coverage in media and corresponding “pull” request for information on JET website. The recent example of this synergy occurred on 28th June in response to ITER siting in France. This news was broadcast by all major news agencies, and as a consequence the number of different IP addresses requesting information from the JET web server (“visits”) boosted by a factor of six above average (see fig. 4). Immediately the day after the number of visits started to fall down, although it kept an above-average value for almost two weeks. Based on past experience, this evolution of response was well anticipated. The contents of the JET webpage reacted immediately to the ITER-siting news by publishing two ITER-relevant articles that had been prepared in advance. This may have contributed to the fact that the ratio of the hits (reflecting the number of mouse clicks) to visits increased by about 50% for a few days, demonstrating that not only the amount of people who browsed JET webpages spiralled up, but also that the visitors were spending more time on the JET website than usual.

Both the web statistics and the most frequent terms looked for using the JET website “Search” facility clearly indicate that a large part of the web audience is interested in fusion basics. This feedback gives an evidence that public wants to understand principles of fusion, and leads to a conclusion that contents of the relevant chapter deserve priority editing work.

3. CASE STUDY: FUSION EXPO

The Fusion Expo is a traveling exhibition produced by the European Commission with support of EFDA, originally conceived and set up by the Association EURATOM-ConfÈdÈration Suisse (CRPP EPFL Lausanne), with some support from CERN, in 1993. Currently it is being administered by the Italian Association EURATOM-ENEA (Consorzio RFX, Padova). The exhibition was designed as a mean of communicating fusion research, both in its scientific and technological aspects, to a wide range of target audience: the general public, students, scientific community, local politicians and local media. Being itinerant, the Fusion Expo has been facing a variety of logistics and socio-political constraints which require a good adaptability of both its layout and the message presented, with low hosting costs and a high hardware flexibility and handiness of material.

The Fusion Expo has been displayed in almost all European countries - in the last two years, many of its installations have been realised in the new or accessing EU countries. The exhibition enjoys a high demand and it has proven to be an effective tool for bringing fusion to the attention of the large public. Furthermore, it provides an important feedback: It clearly demonstrates that fusion is an

extraordinary theme for public debate, for it is complex to grasp and at the same time highly emotional. Many questions concerning the relation between fission and fusion often occur, and in most cases these are not linked to any a-priori fear of nuclear energy. However, any missing piece of information can cause doubts, skepticism and loss of confidence. Direct and varied experience with the exhibition led the fusion community to a number of considerations on how to enhance the impact of the public presentations, and triggered current major redesign and modernisation of the exhibition

First, the chosen linguistic approach has to be progressively reoriented in order to come closer to public understanding. It is known that science relies on the use of well defined technical terminology to avoid ambiguities. Having said this, it must be pointed out that many scientific terms have been adapted from everyday vocabulary in order to denote phenomena that are completely beyond daily experience. Therefore, scientific language can be very abstract. At Fusion Expo fusion community learned that linguistic comprehension of science is extremely difficult for those who are not scientists and who, therefore, cannot clearly distinguish between the literary and the figurative sense of the scientific terminology. Terms like *pinch*, *velocity shear*, *hollow profile* or *high-field side* have immediate and well-defined meaning to tokamak fusion experts, but they prove to be confusing and misleading in the fusion public presentations. Still, the Fusion Expo visitors wish to understand, and, therefore, a lot of effort was already dedicated to keeping the language both rigorous and comprehensive. Not only the written information, but also the exhibition guides have to be well prepared to be versatile in this respect: sometimes visitors become to be very involved only when the vocabulary of their proper daily work emerges, for example, when a parallel between fusion and home appliances is presented to householders. This is even more complicated by the fact that Fusion Expo is presented in many different countries, with many different languages that do not always use words in an identical way. A lot of effort has been spent by many Associations in order to cope with this challenge, but still more is to be done.Second, being oriented in particular to young audience, the Fusion Expo needs not only to carry interesting messages, but also to feature a modern and attractive look. This is achieved by aiming at a rather dynamic layout and by presenting a quick sequence of concise key messages. These are followed by in-depth graphical information supported by multimedia presentations (computers and DVD projections). Appropriate combinations of light, colours and shades, thoughtfully adapted to the exhibition room, may have impressive impact. As a general rule, visitors don't like a passive role, so that the exposition cannot be limited to information panels. Hands-on interactive exhibits, encouraging people to active participation, play a central role: Models, experiments and small tasks are not only highly appreciated, but prove to be more efficient in passing messages and inspiring discussions.

Yet, the experience of Fusion Expo demonstrates how difficult it is to get fusion into the public view, to gain public support and/or to motivate people for further learning. This claim, however, must not play down fusion PI. Experience from other science fields, e.g. biotechnology [10] shows that public opinion is formed by many information sources and that it is the official science that tends to underestimate the risks of underdeveloped communication abilities. In this respect, the Fusion Expo

has shown that safety, environmental and social aspects of fusion are the elements that can win broad public attention and that can stimulate further public interest.

CONCLUSIONS

Thanks to collective effort of EFDA, the fusion Associations and the European Commission the fusion Public Information in Europe matured from a part-time activity of enthusiasts to a very broad, dedicated and internationally networked programme. As shown above, the Public Information achievements and challenges can be clearly identified and some strategic advice formulated. In particular, the three domains that need concentrated efforts in communicating fusion research to public are as follows:

- **Clear messages**: Key messages need to be simple and easy to find. Moreover, the communication has to be comprehensible and adapted to the target group, avoiding specialised terminology without compromising on the message contents. The requirements for reliable translations and interpreters call for considerable involvement of individual Associations in this respect.
- **Empathy**: The form in which information is presented (including its emotional impacts) needs to be thoroughly appreciated. In particular, application of professional graphics has to be encouraged. Use of illustrations, photographs and videos beyond technical documentation should become routine
- **Division of responsibilities**: In the new era of fusion, with many different world cultures working together on extraordinarily broad technological projects like ITER, it will be beyond capacity of scientists alone to assume all aspects of communication.

Implementation of these three recommendations will put strain namely on *internal communication,* for scientists - with their specific professional background and perceptions - may feel that the above efforts are not a high priority activity. Anyway, in near future this will represent just one of many similar challenges for fusion scientists, who will find themselves among industrial engineers, nuclear regulators, managers from different countries etc. Highly professional communication team, combined with good communication training for a sufficient number of managers, scientists and engineers, can actually relief many of these strains while concentrating on the primordial objective, the improvement of public understanding of fusion.

DISCLAIMER:

This paper represents the opinions of the author. Neither the European Commission nor persons acting on their behalf are responsible for consequences of using this information.

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Figure 1. Fusion research in Europe, showing the location of the fusion Associations, and the JET and ITER sites

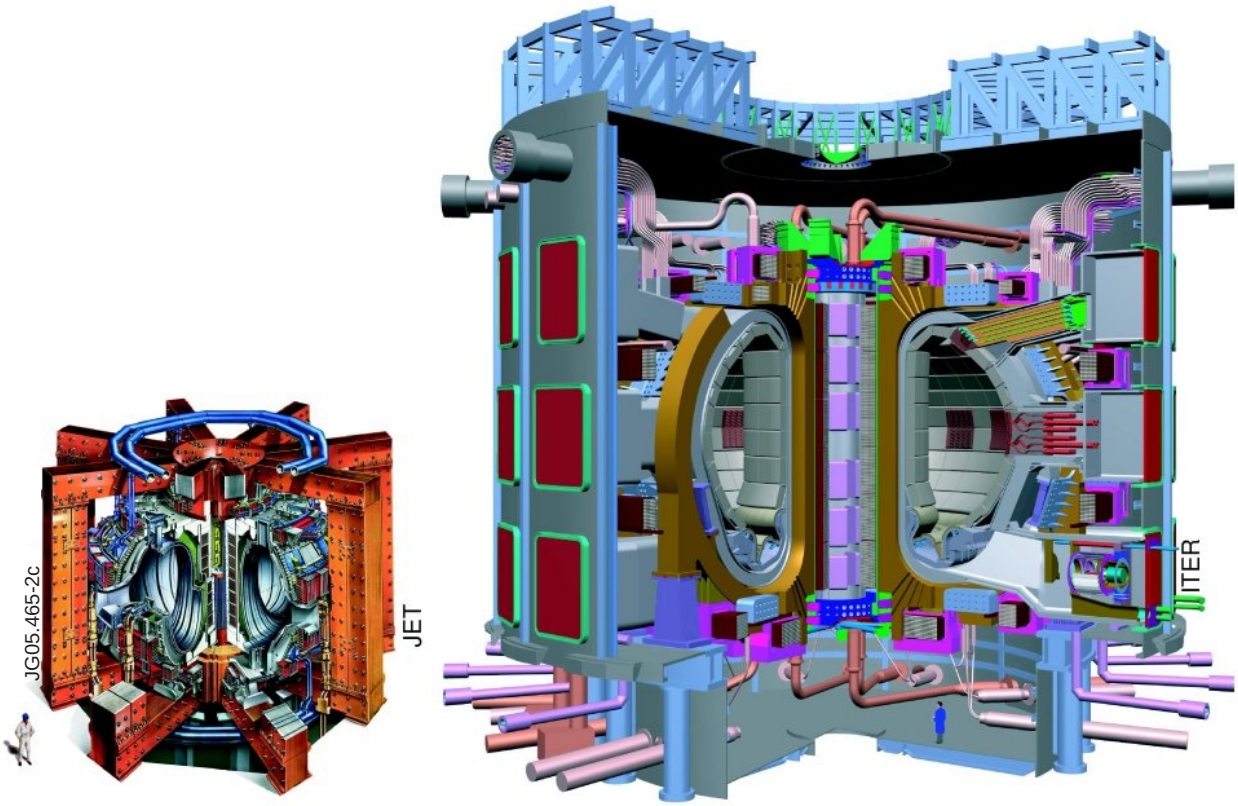

Figure 2. Cutaway diagram of the JET and ITER tokamaks (in scale)

Figure 3. Three different types of JET PI photos: (from left to right): technical, human element, artistic.

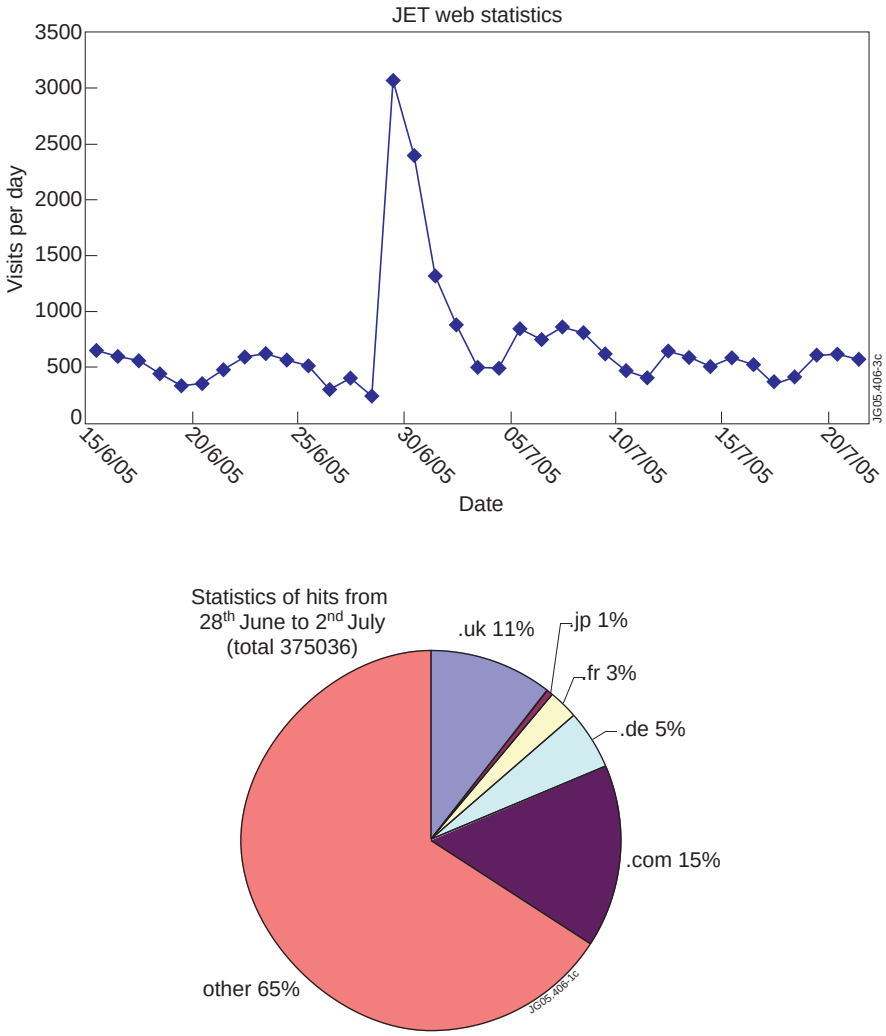

Figure 4. Statistics of visits to the JET website before and after the ITER siting decision.

Figure 5. Snapshots from Fusion Expo presentation in Sofia, Bulgaria.