ASDEX Upgrade Letter

No. 2/June 2002

Foreword

With this edition of the ASDEX Upgrade Letter, we report on recent progress at IPP in enhancing the possibilities for remote participation in ASDEX Upgrade experiments. This is an important development in the framework of our increased effort to open up the ASDEX Upgrade experimental facility to the European Fusion Programme. It will also become important in the future when Wendelstein 7-X starts operation as a European Fusion Facility. We strongly rely on the feedback from our remote users and I hope that you make use of the possibilities described here. Please let us know your comments and suggestions for improvement.

Recent experience in the use of video conferencing has been gained on the occasion of a review of our experimental programme. Five EURATOM associates from our international programme committee participated in this review via video conferencing.

On the scientific side, we have had a very fruitful campaign that has produced a variety of interesting results including the first pulses with ten seconds flattop - yielding a unique pulse length with respect to the current diffusion time - as well as record temperatures in excess of 20 keV in ITB discharges with H-mode edge.

Last but not least, we have had also seen the first successful joint experiments under the new structure in the fields of sawtooth stabilisation and transient electron heat transport. These successful experimental efforts will be described in the near future as ‘highlights’ in this Letter, reflecting the benefit that the world-wide fusion programme can gain from joining forces.

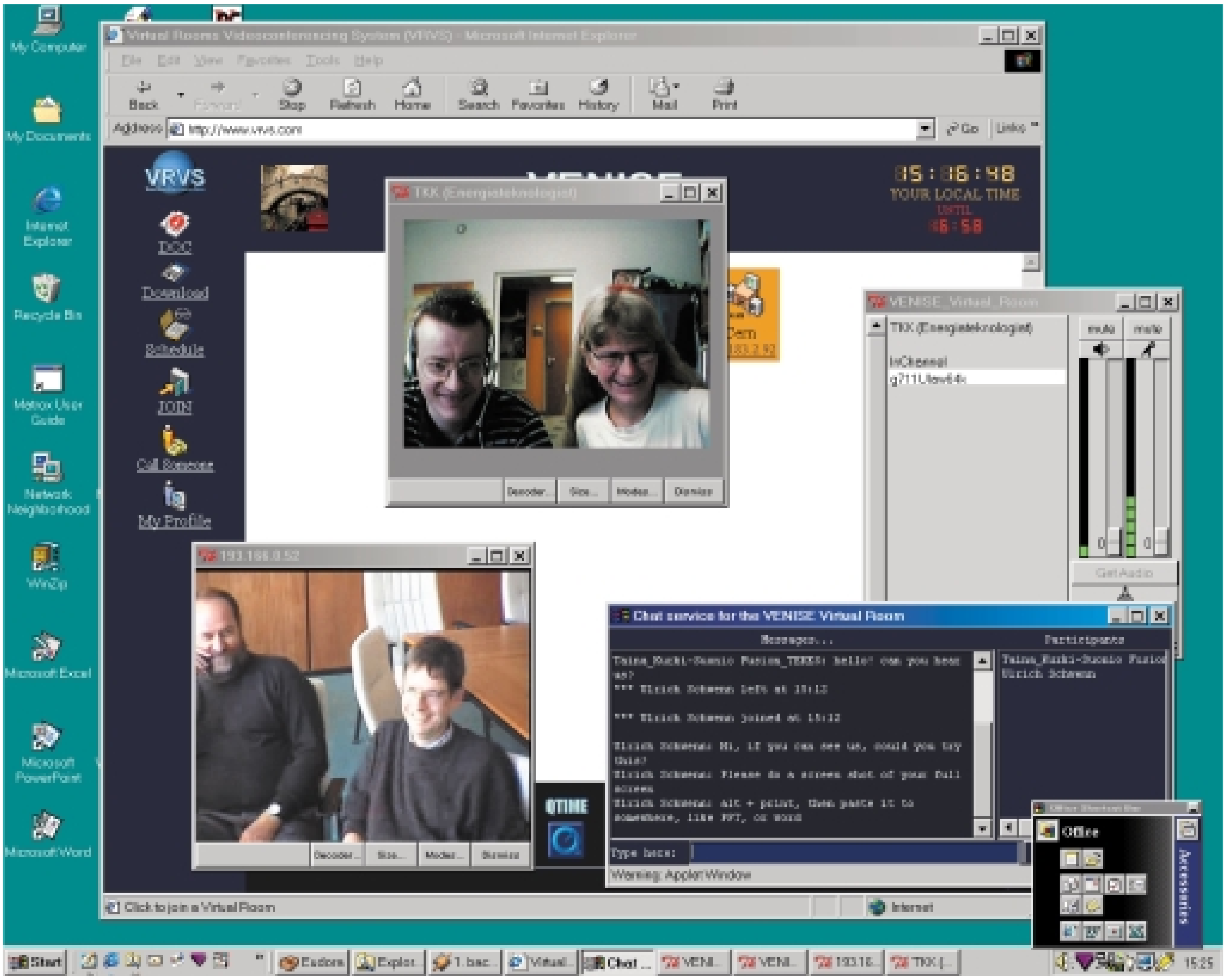
H. Zohm

Improved Tools for Remote Participation

Cooperation of geographically separated workgroups on a single large-scale experiment is a challenge for effective communications and coordination. At IPP a variety of technologies are now in place for remote participation in the planning, organisation, execution and analysis of experiments at the ASDEX Upgrade fusion facility. This effort is guided by the goal to make joint work more efficient or even possible in case of prohibitive financial constraints for travelling. Main progress has been made in several areas, mainly remote data analysis, documentation and teleconferencing. This article will introduce the main elements of remote participation at IPP.

Video Conferencing Tools

Cooperative experiment planning and analysis is supported by video conference and shared application facilities. Due to the fact that IPP also has a branch in Greifswald, where the Wendelstein 7-X stellarator is being built, years of experience have been gained with broadcast of large seminars from the central campus auditorium as well as video conferenced smaller meetings. Currently, the ASDEX Upgrade main seminar room in Garching (max. ~ 60 participants) is being equipped with a multi-channel audio system with several wireless microphones for presentations and teleconferenced discussions, overhead video projection, video camera and a computer desk for the presenting speaker. A smaller seminar room (~ 20 participants) is currently equipped with a workstation for audio transmission. A full videoconferencing system for this room is planned. The H.323 industry standard is used for video and audio broadcasts. This choice is motivated by an extensive variety of end user equipment available commercially, ranging from inexpensive (~500 Euro) single



Snapshot from a video conference between Helsinki University of Technology, Finland, and IPP Garching during a compatibility test between H.323 and VRVS.

user stations to high quality seminar room and auditorium systems. A Multipoint Control Unit (MCU) is installed at IPP for up to four participating stations, a larger number of participants can connect via relay MCUs at Deutsches Forschungsnetz (DFN). A gateway to VRVS reflectors is provided by CERN and can be used to connect with public domain M-Bone software, which is regularly used for video conferences with JET. Viewgraph presentations and live computer applications are broadcast with AT&Ts vnc (virtual network computing) software which also allows two-way interaction on a shared desktop.

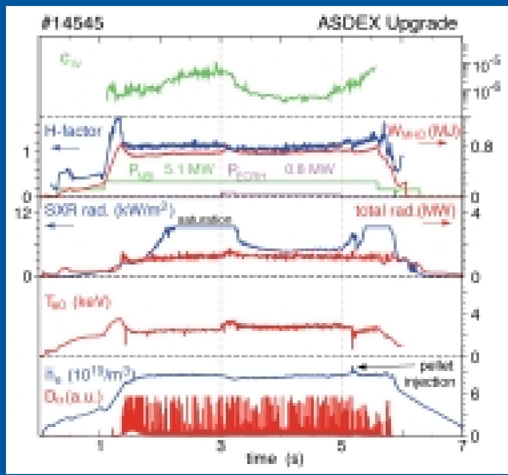
Remote Data Access by MDSplus

Two basic techniques for remote data analysis are open to collaborators: Remote Computer Access (RCA) to a cluster of three gateway computers from which all computing facilities at ASDEX Upgrade can be reached. In this manner IPP computers can be used for data processing under remote control. As an alternative, diagnostics data can be downloaded and processed by computer programs running at locations outside IPP (Remote Data Access, RDA). For easy diagnostics data access, an MDSplus server has been installed which allows reading arbitrary signals from the ASDEX Upgrade shot file archive and provides access to the ASDEX Upgrade equilibrium toolbox, e.g. for flux coordinate mapping (MDSplus is a freeware package for handling large experimental data sets from big experiments developed within the fusion community at MIT and other institutions). This allows the use of standardised MDSplus tools that are used by a growing part of the fusion community. All computer files are stored in the IPP

Highlights from recent ASDEX Upgrade experiments

Tungsten as an Option for the Reactor First Wall

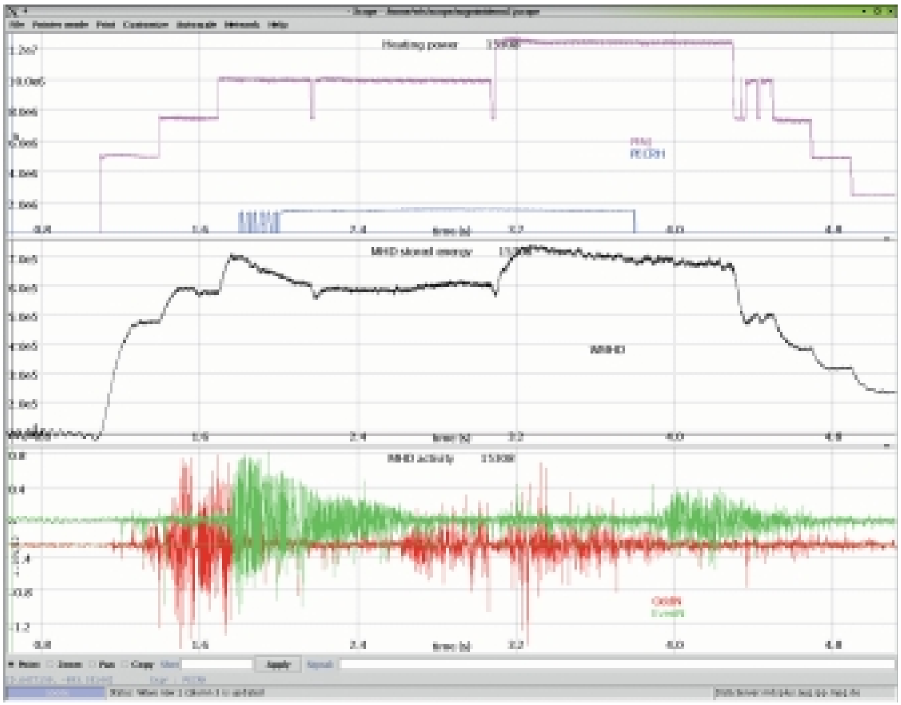
To avoid excessive co-deposition of tritium with carbon, ITER will start operation with beryllium as the first wall material in the main chamber. However, in a later phase of ITER or in a DEMO reactor, tungsten seems to be the only material at hand to stand the fluence with acceptable erosion. The feasibility of tungsten is being addressed in ASDEX Upgrade by coating the central column with tungsten in a step-by-step approach, starting with the experimental campaign 1999/2000. In the 2001, the tungsten coverage was extended to the entire central column with the exception of regions that may be hit directly by the shine-through of the neutral beam injection (NBI) system.



Plasma parameters during an H-mode discharge at I_p=1 MA, B_t=2.5 T, δ=0.4, showing enhanced tungsten concentration c_W with NBI heating alone but a strong reduction of c_W during additional central ECRH

Recent experiments show that the operational space is somewhat more restricted than for a device having only low-Z Plasma Facing Components. On the other hand, the plasma carbon content seems to be reduced by about 30-50%. W-influx measurements give effective sputtering yields of about 10^{-3}, suggesting that intrinsic light impurities make a large contribution to the W sputtering. Only in the order of 1% of these eroded W-atoms reach the confined plasma so that tungsten concentrations range from below 10^{-6} to 10^{-5} in discharge scenarios without wall contact. Generally, in discharges with improved core confinement and therefore increased density peaking, a tendency for increased tungsten concentrations or even accumulation is observed.

Central heating, primarily by ECRH, leads to a strong reduction of the central impurity content, accompanied by a very modest reduction of the energy confinement, thus providing an excellent tool to control the central impurity content (see figure). This impurity behaviour can be explained by the combined effect of increasing the anomalous transport at higher heat flux levels (profile stiffness) and a decrease of the neoclassical inward drift due to reduced density peaking.



Remote Data Access by MDSplus: Screen shot of an MDSplus plot showing diagnostic signals of a typical ASDEX Upgrade discharge (NTM stabilisation experiment).

cell of the world-wide accessible Andrew File System (AFS) and can be transparently accessed from other AFS cells or stand-alone AFS clients connecting to the IPP cell. All services use secure protocols such as Secure Shell and encrypted authentication. Further information is available on the ASDEX Upgrade Intranet.

Documentation in the ASDEX Upgrade Intranet

For a large experimental facility such as ASDEX Upgrade, an enormous amount of information about the machine and its technical possibilities, the available diagnostics and the access to the experimental data exists. This information is vital for the planning, execution and analysis of experiments at ASDEX Upgrade. In the past six months, we have substantially restructured the ASDEX Upgrade Intranet (http://www.aug.ipp.mpg.de) to help remote participants learn about these points from abroad. In addition, the Intranet now contains comprehensive information about the scientific programme, also through a collection of publications of ASDEX Upgrade results including recent pre-prints. For full information, a password is required to access the 'internal' link on the entry page. ASDEX Upgrade users with an account in the ASDEX Upgrade computer system can use their AFS password; interested visitors without password can request one (mail to annedore.buhler@ipp.mpg.de).

Comments and suggestions to make these pages even more useful are very welcome!

Future Applications of Improved Tools

All these techniques are now open for all collaborators with the ASDEX Upgrade program. Although significant experience has been gained from previous work at ASDEX Upgrade and JET, one can expect that new lessons will be learned when remote participation tools are used more regularly in the various stages of experimenting. Program planning begins at an early stage with discussion in ASDEX Upgrade Task Forces and working groups that can be accessed by video conferencing. Actual implementation and time allocation of plasma discharges is discussed in the operations meeting on Monday morning which will be broadcast in the future. If scientific coordinators cannot attend their own experiment in person, close contact should be held with session leaders and diagnostics specialists.

The success of each experimental proposal depends on good communication between all those who contribute. The new facilities for remote participation are intended to help this process and all fellow researchers are cordially invited to exploit and improve these new possibilities together with the ASDEX Upgrade team for the benefit of the fusion research program.

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