HTML ABSTRACT + LINKS

Recent Activities on the Experimental Research Programme Using Small Tokamaks

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Abstract. A new concept of interactive co-ordinated research using small tokamaks in the mainstream fusion science areas, in testing of new diagnostics, materials and technologies as well as in education, training and broadening of the geography of fusion research in the scope of the IAEA Co-ordinated Research Project (CRP) is discussed in this paper. Besides the presentation of the recent activities on the experimental research programme using small tokamaks and scientific results achieved at the participating laboratories, information is provided about the organisation of the co-ordinated research project. Future plans of the co-ordinated activities within the CRP are discussed.

Keywords: Fusion Research, Small Tokamaks, IAEA CRP.
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INTRODUCTION

Significant progress has been achieved in fusion research during last decade, which resulted in the beginning of the construction of ITER. However, as in the past [1], small tokamaks continue to play an important role in fusion research. 40 small tokamaks are operational at present in 15 countries. Table 1 presents the updated table of operating small tokamaks (or those operated during last two years) and projects under construction (in bold). The database only includes information, which was supplied to the authors or available in publications. Information in italic is provisional.

TABLE 1. Small Tokamak Database.

	name	organisation	R,m	a,m	elon	Ip, kA	Bt, T	Config	τ_{pulse}, ms	Aux. Heating, MW	start, status
	EUROPE										
1	Globus-M	Ioffe, St Petersburg, RF	0.36	0.24	1.6/ 2.2	350/ 500	0.5/ 0.62	DND, SND, L	300/ 500	NB 1.5/0.8; ICRH 1	2002
2	TUMAN-3M	Ioffe, St Petersburg, RF	0.55	0.24	1.0	180	1.0/ 3.0	L	150	NB 0.5; ICRH 0.4/1.0	1985
3	FT2	Ioffe, St Petersburg, RF	0.55	0.08	1.0	22	2.5	L	60	LH 0.3	1979
4	T-11M	TRINITY, Troitsk, RF	0.7	0.2	1.0	150	1.2	L	250	ICRH 1.0	1996
5	GUTTA	St Pet.Univ, St. Petersburg, RF	0.16	0.084	2	150	1.5	L	10	no	1984 re-started 2002
6	T-10	RRC"Kurchatov Inst.", Moscow, RF	1.5	0.36	1.0	400/ 820	2.5/ 5.0	L	1 s	ECRH 3.4	1975
7	CASTOR	IPP Praha, Czech Rep.	0.4	0.085	1.0	20	1.5	L	50	LH	1985
8	ISTTOK	Lisbon, Portugal	0.46	0.078	1.0	8	0.6	L	70	no	1992
9	**Proto-Sphera /START**	**Frascati, Italy**	**0.18**	**0.14**		**240**	**0.6**	**DND**	**-**	**no**	**Under constr**
	ASIA										

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10	TST-2	Univ. of Tokyo, Tokyo, Japan	0.38	0.25	1.8	120/ 200	0.3/ 0.4	DND, L	200	EBW 0.2	1999
11	**UTST**	**Univ. of Tokyo, Tokyo, Japan**								**EBW, NBI**	**2005**
12	**QUEST**	**Kyushu Univ, Fukuoka, Japan**	**0.64**	**0.36**	**2.5**	**500**	**0.5**	**SN, DND**	**ss**	**ECR, NBI 3.0**	**Under constr**
13	CPD	Kyushu Univ, Fukuoka, Japan	0.3	0.2	2.5	150	0.25	DND, L		EBW 0.2	2005
14	LATE	Kyoto Univ., Kyoto, Japan	0.25	0.2	1.34	4	0.12	L	4.5s	ECRH 0.2	2000
15	HIST	Univ. of Hyogo, Himeji, Japan	0.3	0.24	2	100	0.2	L	5	no	1998
16	TS4	Univ. of Tokyo, Tokyo, Japan	0.55	0.45	3.0	300	0.5	L	5	no	2000
17	TS3	Univ. of Tokyo, Tokyo, Japan	0.2	0.14	2.0	80	0.2	L	0.05	no	1986
18	*CSTN-IV*	*Nagoya Univ., Nagoya, Japan*	*0.4*	*0.1*	*1.0*	*1*	*0.12*	*L*	*20*	*no*	*1998*
19	*HYBTOK-II*	*Nagoya Univ., Nagoya, Japan*	*0.4*	*0.11*	*1.0*	*15*	*1.5*	*L*	*15*	*no*	*1991*
20	*NUCTE-ST*	*Nihon Univ., Nihon, Japan*	*0.062*	*0.052*	*10.0*	*340*	*0.45*	*L*	*0.12*	*no*	*1998*
21	*TODOROKI-1*	*Tokyo Inst. Of Tech, Tokyo, Japan*	*0.4*		*1.0*	*10*	*1.0*	*L*	*4*	*no*	*1995*
22	HT-6M	ACIPP, Hefei, China	0.65	0.2	1.0	150	1.5	L	60	ICRH, LH	1985
23	HT-7	ACIPP, Hefei, China	1.22	0.35	1.0	400/ 350	3/2.5	L	4 min	ICRH 1.0/0.5, LHCD 1.0	1995
24	SUNIST	SUNIST Lab., Beijing, China	0.3	0.22	1.6	50	0.08/ 0.15	DND, L	13	EBW 0.1, HHFW	2003
25	HL-2A	SWIP, Chengdu, China	1.64	0.4	1.6	480	2.8	SND, DND	750	NBI 10, LHCD 3, ECRH 1, ICRH 3	2002
26	*KT5D*	*USTC, Hefei, China*	*0.325*	*0.125*	*1.0*		*0.6*	*L*	*../ss*	*ECR*	*2005*
27	ACST	SNU, Korea	0.05	0.025	2	0.6	0.02	L	ac	No	
28	*KT-1*	*KAERI, Daejeon, Korea*	*0.27*	*0.05*	*1.0*	*15*	*1.5*	*L*	*20*		*1988*
29	ADITYA	IPR, Bhat, India	0.75	0.25	1.0	100	1.2	L	120	ICRH 0.2, ECRH 0.2	1992
30	SINP	SAHA, Kolkata, India	0.3	0.075	1.0	75	2	L	20	no	1987
31	STPC-EX	TAEA, Ankara, Turkey	0.084	0.056	4.0	6.5	0.12	L	9.5	no	1992
32	**KTM**	**Kazakhstan**	**0.9**	**0.45**	**1.7**	**750**	**1**	**SND**	**4 s**	**RF 7.0**	**Under constr**
33	DAMAVAND	PPL,Tehran, Iran	0.36	0.07	2.8	35/40	1.0/ 1.2	DND	25/ 50	no	1995
34	IR-T1	PPRC IA University, Teheran, Iran	0.45	0.125	1.0	40	1.2	L	25/10	no	1994
	AMERICA										
35	CDX-U/LTX	PPPL, Princeton, USA	0.335	0.225	1.7	70	0.23	DND, L	25	FW	1993
36	Pegasus	Un. of Wisconsin, Madison, USA	0.45	0.41	3.7	160/ 300	0.15	DND, L	50	EBW, HHFW	1996
37	ET	UCLA, USA	5	1	2.0	40/100	0.25	L	5 s	ICRH 5.0, NB 1.0	1999
38	HBT-EP	Columbia University, New York, USA	0.92	0.15	1.0	30/40	0.35/ 0.5	L		ICRF 5.0	1993
39	ETE	INPE, SP, Brazil	0.3	0.2	1.8	60/400	0.4/ 0.8	L	10.0/ 25.0	no	2000
40	TCABR	Univ. of São Paulo, SP, Brazil	0.61	0.18	1.0	110	1.1	L	100/ 120	Alfven 1.0	1999

41	NOVA	Univ. of Campinas, SP, Brazil	0.30	0.06	1.0	10.0	0.8/ 1.5	L	12.0	no	1998
42	NOVILLO Tokamak	ININ, Mexico City, Mexico	0.23	0.06	1.0	12	0.47	L	5	no	1983
43	STOR-M	PPL Un. of Saskat-chewan, Canada	0.46	0.12	1.0	30	0.7	L	ac	no	1984
	AFRICA										
44	EGYPTOR	NRC, EAEA, Cairo, Egypt	0.3	0.1	1.25	45/100	1.2	L	60/ 45	no	2002

Research on small tokamaks has created a scientific basis for the scaling-up to larger tokamaks. Well-known scientific and engineering schools, which are now determining the main directions of fusion science and technology, have been established through research on small tokamaks. Many experimental tools and diagnostics have been developed on small tokamaks and these activities are carried on. Combined efforts within a network of small and medium size tokamaks will provide further contribution of small tokamaks to the fusion research. An interactive co-ordinated research using small tokamaks in the mainstream fusion science areas, in testing of new diagnostics, materials and technologies as well as in education, training and broadening of the geography of fusion research in the scope of the IAEA Co-ordinated Research Project has started in 2004 [2]. In this paper we present results of the recent activities on the experimental research programme using small tokamaks and overview scientific results achieved at the participating laboratories. Information is also provided about the present organisation of the co-ordinated research project. A brief report is given on the results of the 1st Joint (Host Laboratory) Experiment on characterization of the edge plasma in a tokamak. Other activities under the CRP Working plan and future plans of the co-ordinated activities within the CRP are discussed.

RESULTS OF THE RECENT ACTIVITIES ON THE EXPERIMENTAL RESEARCH PROGRAMME USING SMALL TOKAMAKS

Nine small tokamaks participated in the CRP project in 2004-05: T-10, ISTTOK, STOR-M, CASTOR, TCABR, GUTTA, SUNIST, ETE and EGYPTOR. During the first Research Coordination Meeting at Lisbon, 7-10 November 2004, the status of all on-going activities on these tokamaks was presented and the proposed list of activities was summarised in the classification table of the CRP research topics, which was formatted based on the ITPA classification scheme (Table 2 in [2]). The list of currently proposed CRP research topics has been classified accordingly and presented in the individual activity matrix (Table 2) for each participating tokamak reflecting activities of the individual

TABLE 2. CRP Individual Activity Matrix (IAM) for 2005. Here exp: experiment, th: theory. The cell numbers (sub-topics) are described along the paper.

Tokamak	1.Core transport and turbulence		2. Edge physics, PSI and technology		3. Heating CD and plasma formation		4. MHD and control		5. Diagnostics development		6. Control, data acquisition, remote participation		7. Excellency education, knowledge transfer, capacity building	8. Expertise exchange
T-10	1.2, 1.3, 1.7	1.3	2.1, 2.5, 2.8	2.1			4.5		5.1, 5.4					8.1, 8.2
GUTTA					3.3, 3.5						6.1, 6.2	6.1	7.2, 7.3	8.1
SUNIST					3.3, 3.5									
EGYPTOR			2.8		3.5									8.1

ETE		1.4	2.8		3.1, 3.5	3.1 3.5			5.2, 5.3	5.3			7.2	8.1
TCABR	1.1		2.2				4.5, 4.8	4.5	5.2				7.2, 7.3	8.1
ISTTOK			2.2, 2.6								6.1, 6.2		7.2, 7.3	8.1, 8.2
CASTOR	1.7		2.1, 2.2						5.2	5.2			7.1, 7.2	8.1, 8.2
STOR-M			2.1, 2.2, 2.8		3.3, 3.5				5.1, 5.2				7.3	8.1
	exp	th	exp	th	exp	th	exp	th	exp	th	exp	th		

proposals. In addition, joint activities were identified from the working matrix and a joint activity matrix was established for the first year of the CRP project. The Joint Activity Matrix of the co-ordinated research is presented in Table 3.

TABLE 3. CRP Joint Activity Matrix (JAM) for 2005.

topics	sub-topics	T-10	GUTTA	SUNIST	EGYPTOR	ETE	TCABR	ISTTOK	CASTOR	STOR_M	activity description
1. Core transport and turbulence	1.4										
	1.7	●							●		Joint studies of impurity transport in CASTOR and T-10
2. Edge physics, PSI and technology	2.1	●					●	●	●	●	Joint studies of edge turbulence in different tokamaks
	2.2						●	●	●	●	Joint studies of the effects of biasing induced electric field on plasma performance
	2.8				●	●				●	Optimization of discharge parameters by fuelling and wall conditioning in small tokamaks
3. Heating, CD and plasma formation	3.3		●	●						●	Comparative studies and development of different non solenoid plasma formation methods
	3.5		●	●	●	●				●	Modelling and experimental studies of start-up in tokamaks
4. MHD and control	4.5	●					●				Theoretical and experimental investigations of runaway and disruptive discharges in tokamaks
	4.8						●	●		●	Theoretical and experimental investigations of the influence of edge biasing on MHD activity
5. Diagnostics improvement and development	5.1					●	●	●		●	Colaboration on development and improvement of core diagnostics
	5.2					●		●	●	●	Colaboration on development and improvement of edge diagnostics
	5.3				●	●					Improved methods of equilibrium reconstruction and plasma position determination using magnetic diagnostics
6. Control, data acquisition, remote participation	6.2		●					●		●	New approaches for real time plasma position control
7. Excellency Education, Knowledge transfer, capacity building	7.2		●					●	●		Participation of CRP members PhD students in joint studies
	7.3		●					●			Participation of CRP members undergraduate students in joint studies

The numbers in Table 2 and 3 correspond to the CRP activities classification and are described below. The final working plan was composed of joint and individual activities, which will be carried out under the framework of the CRP.

Research activities on T-10 tokamak

Research activities on T-10 machine were developed in accordance with the Work Plan and presented below in accordance with the CRP classification.

Experimental investigation and analysis of electron transport during auxiliary heating and in ohmic discharges was continued. Under Topic 1.2 "ITB formation and control", experimental investigation of electron transport were carried out in ohmic discharges and in the ECR heated L-mode plasmas and in regimes with improved confinement due to electron internal transport barrier (eITB) formation in the reversed shear discharges. This result together with the previously obtained data allowed investigating effect of the negative central shear on plasma transport.

Under Topics 1.7 "Impurity and particle transport", 1.3 "Non-local transport (transient phenomena)", and 2.8 "Fuelling, recycling, wall conditioning", a new pellet injection system was developed and tested. Both carbon and deuterium pellet injectors are now installed on T-10, that sufficiently broadens experimental possibility of investigation of the plasma transport. A new high-field side reflectometer was installed and tested, Topic 5.1 "Core diagnostics". Under the same Topic and also under 2.5 "Plasma facing components and materials, dust" and 5.4 "Calibration, test-bed, methodology, burning plasma diagnostic R&D", a new diagnostic system based on the scanning probe microscope (STM-AFM) was developed and applied for analysis. The detailed information is presented in the EPS papers and presentation at the meeting "Dust in Fusion Plasma" [3-11].

Under Topic 8.1 "Joint Experiments and projects with other small tokamaks", Joint Experiments were performed on CASTOR (investigation of periphery plasma behaviour and plasma-wall interaction, development of remote control and data acquisition system). Joint activity with TEXTOR (FZJ, EU), JET (UK), Tore-Supra (France) and ISTTOK (Portugal) has initiated a joint INTAS 2005 proposal on the runaway electrons study. Joint project with the Kazakhstan tokamak KTM on "Dust on tokamaks problem" has been started in 2005. Participation of T-10 scientists in the EGYPTOR tokamak experiments is foreseen in the end of 2005.

Research Activities on CASTOR Tokamak

Analysis of the poloidal structure of the edge turbulence has been performed on CASTOR tokamak (Topics 2.1 "Edge turbulence" and 2.2 "Biasing"). The poloidal structure of the edge turbulence in the SOL was studied with full-poloidal rings of Langmuir probes and planar electrodes in ohmic and biased discharges. The obtained results are reported in [12-14]. The behaviour of the plasma column at high biasing voltages (> 300 V) was studied, as described in [15]. These biasing experiments have shown an effective triggering of an improved confinement, characterized by the rise of the transport barrier at the edge through steeper density and radial electric field gradients. The influence of the biasing electrode material on the discharge parameters, particle and energy transport was studied. The graphite, bulk tungsten, plasma-sprayed tungsten, copper-tungsten composite and solid copper were tested. These experiments have shown that the electrode material strongly influences the overall plasma behaviour [16].

Under Topic 5.2 "Edge diagnostics development", a ball-pen probe was envisaged as a simple and robust diagnostic tool for the direct plasma potential measurements and compared with the emissive probes [17,18]. Systematic measurements with the tunnel probe have been performed and results were compared with results obtained from a radial array of Langmuir probes, to which a swept voltage was applied [19]. Numerical simulations (PIC code) were performed in order to calibrate segmented tunnel probe, a modification of the tunnel probe that allows determination of the ion temperature [20]. In studies under Topic 1.7, recently obtained data illustrate the possibility to analyse the spatial (radial) image of the line emission spectrum created by a VUV Imaging Spectrometer & 2D Fast Detection System. The shape of the radial profile of the chord-integrated intensity of the OVI (103.2 nm) and Ly_{α} H I (121.6 nm) lines was obtained. The data was used for quantifying the influence of the transport phenomena on the ionisation equilibrium of light impurities [21].

All the reported results were obtained in a broad international collaboration, both within and outside the CRP partners. Furthermore, here should be noted participation of the CASTOR group members in the ISTTOK emissive electrode biasing experiments and the use of the CASTOR Gundestrup probe design on the STOR-M tokamak. The CASTOR team hosted the 1st Joint (Host Laboratory) experiment on characterization of the edge plasma in a tokamak, as described below.

Research Activities on TCABR Tokamak

Improved plasma confinement regimes were investigated in ohmic-heated regime using the electrode biasing technique, Topics 1.1 “H-mode studies, L/H transition, improved confinement” and 2.2. Experiments using biased electrodes show confinement improvement and formation of a transient transport barrier. The edge plasma parameters have been measured with the installed ECE radiometer and interferometer diagnostics, Topic 5.2 [22]. MHD mode identification and studies of their properties (localisation, structure, rotation) have been performed with Mirnov coils, ECE and other diagnostics (Topic 4.8, “MHD instabilities”). Results have been published in [23]. Studies of the conventional Dreicer and a detached runaway regimes have been performed, Topic 4.5 ”Runaway studies and mitigation” [24]. Some of these studies have been performed in collaboration with T-10 group, and in 2005 joint experiments using biased electrode were initiated with ISTTOK group.

Research Activities on ISTTOK Tokamak

Emissive electrode biasing experiments have been performed (Topic 2.2) and detailed comparison of the modification induced by the biasing to the radial electric field and flow have been done. In the SOL plasma the turbulent transport was strongly reduced by biasing of both polarities, however, MHD activity was not strongly influenced by the biasing. A new Gundestrup probe incorporating advanced materials has been developed provided information on the radial and parallel flows. A liquid Galium metal loop experimental rig has been commissioned, Topic 2.6 “Liquid wall, liquid limiter”. Under Topics 6.1 “Control and data acquisition” and 6.2 “Real time processing and control”, a fast feedback plasma position control with a PCI Hybrid DCP/FPGA board and a generic remote method invocation for intensive data processing have been developed [25,26]. Efforts are being developed to define and implement a standard interface to access the databases of different devices, for data retrieval and for data input for remote operation.

Research Activities on SUNIST Tokamak

Plasma current start-up with the electrode assistance studies have been started, Topics 3.5 “Start-up and breakdown studies” and 3.3 “Non-solenoid plasma formation”. The ECR magnetron (2.45GHz, 100kW, 30msec), electrodes for electrode-assistant start-up and several necessary basic diagnostics have been installed and experiments on ECR start-up have been performed. Significant increase in the initial plasma current in the electrode assisted breakdown compared to a pure ECR breakdown have been demonstrated enhanced by an optimised vertical field. Dependence of the plasma current on the background pressure has been studied. Preliminary results are presented in [27].

Research Activities on ETE Tokamak

Improvements of the ETE wall conditioning have been achieved by increasing the baking temperature and optimization of the glow discharge operation accompanied by a systematic study of effects on plasma temperature and impurity emission, Topic 2.8. Design and construction of a high-power 6.7 GHz monotron and studies of advanced concepts of corrugated waveguides and cavity resonators were carried out, looking for plasma heating applications in the future, Topic 3.1 “Heating power source development” [28]. A single-channel optical detection system of the fast neutral lithium beam probe allows measurements of the density and its fluctuations at the edge, with good spatial and temporal resolutions, of the order of 1.5 cm and a few nanoseconds, respectively (Topic 5.2). After successful measurements of the temporal evolution of the plasma density in discharges of the ETE tokamak with a fast neutral lithium beam probe, an upgrade of the system has being performed. The main modification includes replacement of the old one-channel optical detection system by a new eight-channel system. The IAEA Coordinated Research Project on “Joint Research Using Small Tokamaks” has reinforced the mutual cooperation agreement with the Centro de Fusão Nuclear – CFN, of the Instituto Superior Técnico in Portugal. Within the scope of this collaboration a data acquisition system will be implemented on the ETE spherical tokamak.

A model to calculate eddy currents in the vacuum vessel due to poloidal coils current has been developed as a first step for simulating the startup conditions in ETE, Topics 3.5 and 5.3 “Magnetic diagnostics and equilibrium reconstruction” [29]. Theoretical studies have been undertaken in the formulation of edge plasma models, particularly looking into effects of plasma viscosity at the boundary, Topic 1.4, and detailed studies of the bootstrap current fraction and bootstrap current profile have been carried out [30].

Research Activities on GUTTA Tokamak

Under Topics 6.1, 6.2 “Real time processing and control”, models of the plasma control were adapted using GUTTA plasma parameters [31]. A fast interface between magnetic diagnostics and data computer has been developed. The data acquisition system for collection and processing signals from magnetic sensors is under commissioning. A transistor amplifier for the fast control of the current in radial equilibrium coils is manufactured (maximum current 0.5kA, maximum voltage 600V). This amplifier could be controlled digitally by a PC or using an analog system. A 3mm interferometer for plasma density measurements was manufactured and installed (Topic 5.1).

ECR breakdown studies were performed in collaboration with the MAST tokamak (Topics 3.3, 3.5). A 9.4 GHz magnetron with 20 kW power and 0.5ms pulse was used for the low field side RF power launch. The toroidal field was reduced to 0.3 T to provide fundamental resonance near the inner wall of the vacuum vessel. The breakdown delay dependence on filling pressure, RF power and vertical magnetic field was studied. Maximum delay was about 0.1-0.3 ms at zero vertical magnetic field decreasing with increasing vertical field [32].

On topic 7, PhD and postgraduate students participate in development of the plasma position control model, designing of control algorithms, data acquisition and analysis and in experimental work. Laboratory work for undergraduate students, “Plasma equilibrium control in a tokamak”, was prepared and will be implemented this academic year.

Research Activities on EGYPTOR Tokamak

Studies of the breakdown assistance using a hot filament and of the current ramp-up have been performed under Topic 3.5. The 0.6A 600V glow discharge cleaning in Ar, H and He is under commissioning, Topic 2.8. Calibration of magnetic diagnostics and measurements of the internal magnetic field have been performed in collaboration with the CASTOR team [33].

Research Activities on STOR-M Tokamak

Measurements of the poloidal and toroidal components of the velocity of the plasma ions in different operating regimes with the Mach probe have been performed, Topics 2.1, 5.2. The evolution and modification of the velocity profiles during discharges characterized by the appearance of an enhanced confinement is crucial in understanding the physical mechanisms responsible for the generation of the high confinement mode. The Compact Torus (CT) injection for fueling, pressure profile control (Topic 2.8) and for the start-up assistance (Topics 3.3, 3.5) is under investigation [34]. In order to investigate the feasibility of the vertical CT injection, the USCTI injector has been modified to allow vertical injection. CT injection can also trigger transition to improved confinement regimes (Topic 1.1) and characteristics of the H-mode induced by the CT injection have been studied [35]. Effects of the edge biasing (including transition to the H-mode) are also under investigation (Topics 2.1, 2.2). Scattering of 2 mm microwave by short wavelength modes has been investigated. It has been found that active density fluctuations exist in the wavelength regime much shorter than the ion Larmor radius where the drift type modes are expected to be stable. Computer simulations and analytic studies are underway to clarify the nature of transport by the ITG and ETG modes. For example, both ion and electron thermal diffusivities in tokamaks have been shown to be proportional to the safety factor [36].

THE 1ST JOINT (HOST LABORATORY) EXPERIMENT

The 1st Joint (Host Laboratory) Experiment on “Joint Research Using Small Tokamaks” has been carried out using the IPP Prague experimental facility "CASTOR Tokamak" and was organized jointly by IPP Prague and KFKI Budapest. It included two week of experiments between 28th of August and 9th of September 2005. 19 scientists from 7 countries participated in this experiment. The main experimental programme was aimed to characterise the edge plasma in a tokamak by using different advanced diagnostics. It is widely recognized that characterisation of phenomena occurring at the plasma edge is essential for understanding of the plasma confinement in a tokamak. The edge plasma studies have a long tradition on CASTOR (appropriate equipment, large amount of expertise, etc). The edge plasma in small and large scale experiments has many similar features, and the results obtained through detailed measurements in a small flexible devices like CASTOR are in many aspects still relevant to those in large tokamaks (like JET, Tore-Supra, DIII-D, ASDEX-Upgrade and JT-60). Therefore, it is expected that results of this joint experiment will have a general validity.

Main topics of the joint experiment were as follows:

- Measurements of the edge turbulence with electric probe arrays (radial and poloidal)
- Measurements of magnetic fluctuations with poloidal array of magnetic sensors (coils/Hall detectors)
- Edge plasma polarization by means of the electrode biasing
- Directional flows measurements using oriented probes
- Edge temperature measurements using a tunnel probe
- PIC modeling of the electrical probes data
- Bolometric measurements (tomography)

6 experimental days have been dedicated to these studies, followed by the data analysis and discussions sessions. Four joint publications based on these results in comparison with results achieved on other CRP tokamaks are in preparation. Details of the experiment are discussed in [37].

OTHER ACTIVITIES UNDER THE CRP AND FUTURE PLANS

In addition to the 1st Joint (Host Laboratory) experiment on characterization of the edge plasma in a tokamak, number of collaborative experiments have been performed, as was described above. As a result of independent and collaborative activities of the CRP members, more than 30 Journal publications and presentations at International Meetings and Conferences have been published, submitted or presented in 2005. The 2nd Joint (Host Laboratory) experiment will be held in September – October 2006 on T-10 tokamak at RRC "Kurchatov Institute", Moscow, Russian Federation. It is expected that the scientific scope of this experiment will be broadened compared with the CASTOR Joint experiment.

Important tools are being developed to promote data exchange among CRP members (www.fusion.org.uk/iaeacrp). These are web based interfaces with public and restricted access areas that contain the general information regarding the CRP activities, updated tokamak database and allow for upload/download of results of recent experiments (graphical and/or tables) and reports on interpretation of results (documents containing data analysis). Included is a standard interface (in improvement) for retrieving data from different devices regarding a particular set of experiments and diagnostic measurements. These tools provide on-line data availability allowing for more participative discussions and a better coordination in the planning of further experiments.

The Secretariat of the International Atomic Energy Agency is planning to hold the 2nd Research Coordination Meeting on the CRP on Joint Research Using Small Tokamaks from 23 to 26 October 2006 at the campus of the Tsinghua University, Beijing, People's Republic of China. This meeting will be a satellite meeting to the 21st Fusion Energy Conference which will be hold in Chengdu city from 16 to 22 October 2006. The purpose of the meeting is to present the reports on the work performed during the last two years in the frame work of the CRP and to plan further activities for the next two years. Representatives of all CRP members and the IAEA Scientific Secretary will participate in the meeting.

In conclusion, the first year of CRP activities resulted in increase in the number of joint publications from small tokamaks and joint experiments. 4 new applications for Research Agreements have been submitted and 7 more tokamaks are considering joining the Agreement. This will cover more than 50% of operating small tokamaks. More information about the past, present and future activities within the CRP can be found in the CRP web page, www.fusion.org.uk/iaeacrp.

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