SST-1 Update - Long Pulse Discharges With LHCD

In the recently completed campaign (XXIV) of the Steady-state Superconducting Tokamak-1 (SST1), held in April-2019, a new milestone of the longest plasma discharge of ~650 millisecond was achieved. The plasma current was sustained non-inductively and assisted by lower hybrid waves (LHWs) launched from lower hybrid current drive (LHCD) system.

This achievement surpassed the earlier long pulse plasma shot of ~480 ms obtained in 2015, assisted by the LHCD system. The two pulses are shown below for easy comparison and displays distinguished features which are discussed below.

As can be inferred from the figure, the LH coupling was obtained at higher plasma current (~75kA), compared to earlier campaign (~25kA). As plasma density was also high in this campaign, it provided better edge plasma conditions for efficient coupling of LHWs from the launcher to the plasma. Also, in the present campaign, the entire loop voltage could be utilized and nearly zero loop voltage conditions were obtained in the shots which was not the case in earlier campaigns.

Earlier, (in 2015 campaign), the target plasma was formed with the help of Ohmic system and the electron cyclotron resonance heating (ECRH) system (used for pre-ionization) simultaneously. To sustain the plasma current non-inductively, the LH pulse of 150ms was injected, immediately after the ECRH pulse. It is worth noting that in the present campaign, a very short pulse of ECRH could pre-ionize the plasma and later Ohmic power supported the formation of target plasma. Once a good target plasma was formed, the LHCD pulse was injected after sufficient delay of 200ms.

These improved conditions provided encouraging results in the present campaign and will help in planning the next campaign.

(Top) The record long pulse discharge in SST1 for ~650msec, obtained in the 24th experimental campaign (Bottom) Earlier long pulse discharge with LHCD in SST1 machine from a campaign in 2015
Inauguration of Vigyan Samagam

The Vigyan Samagam, India’s first mega science exhibition kicked off on 7th May, 2019 at the Nehru Science Center, Mumbai. The exhibition was inaugurated by Dr. Vijay Kumar Saraswat, Member, Niti Aayog. The exhibition was also thrown open to public. On 7th and 8th May, speakers from all of the mega projects gave presentations. From IPR, Dr. Shashank Charurvedi, Director, gave a talk on “India’s Plasma Science & Technology Program and Spin-offs”, Dr. Laban Coblentz, Head, Communications, ITER, France, gave a talk on “The ITER Project: the way to new energy” and Shri Ujjwal Baruah, Project Director, ITER-India gave a talk on “India’s participation in ITER – Technology challenges and Industry response”. For LIGO India, Prof. S. Mukherjee gave a talk on “LIGO India - opportunities for the industry”.

This was followed by a Panel Discussion on “Leveraging collaboration for Indian science and industry”, which was moderated by Shri Arun Chakraborty of ITER India. The participants of this discussion were Dr. K., Balasubramanian (Director, NFTDC, Hyderabad), Prof. Rajiv Dusane (P. K. Keikar Chair Professor in Nanotechnology, IIT Bombay), and Mr. Rajkumar Panjwani (President, Cryo Scientific Division, INOX India Pvt. Ltd).

This exhibition will be open to public at Mumbai till 7 July, 2019. IPR / ITER-India week at this exhibition will be from 20-26 May, 2019.

(Top) Dr. V. K Saraswat inaugurating the Vigyan Samagam (Middle) Releasing the exhibition booklet (Bottom) ITER stall at the exhibition
Vigyan Samagam - Mumbai

(L-R) Dr. Shashank Chaturvedi, Shri Ujjwal Baruah and Prof. S Mukherjee delivering their talks

(L) Dr. Shashank Chaturvedi interacting with Dr. Anil Kakodkar, Dr. Laban Coblentz and Shri Vithal Nadkarni (R) ITER Stall

(L) Shri Arun Chakraborty conducting the panel discussion. (R) Children interacting with the exhibits at the ITER stall

Children at the ITER exhibition

(L) Dr. Shashank Chaturvedi interacting with Dr. Anil Kakodkar, Dr. Laban Coblentz and Shri Vithal Nadkarni (R) ITER Stall
श्री रितेश सुगंधी
SYSLOG का परिचय /Introduction to SYSLOG

श्रीमती ज्योति अगरवाल
डाइएलेक्ट्रिक बैरियर डिस्चार्ज प्लाज्मा और इसके उपयोग / Dielectric barrier discharge plasma and its application

श्री राजीव शर्मा
ई सी आरएच /ECRH System

श्री देवेंद्र मोदी
आप कार्यस्थल पर कितने सुरक्षित है? / How safe are you at the workplace?

श्री सुश्री यशश्री पाहि
र्डूट्वीय संलयन ऊर्जा और उसका विकास / Inertial fusion energy and its development

श्री राजीव शर्मा
वैक्सूज जेकेटेड पॉलारिसेबल कार्यान्वेणी ट्रस्फर लाइन का स्वदेशी विकास / In-house development of vacuum jacketed flexible cryogenic transfer line

श्री प्राचीन कार्यालय
आईपीआइ की आउटरन सेडम जनाउंड का आयोर्न डकया गया। सेडम जनाउंड के दूसरे सत्र के समापन के बाद राजसिंह, उपाध्यक्ष, राजभाषा ने सभी प्रतिभागियों को तकनीकी विषय को सही और साथ ही भविष्य में इस प्रकार के आयोजन में तकनीकी विषय को सही हिंदी भाषा में अभिव्यक्त करने हेतु उन्हें भाषा को प्रोत्साहित किया।

श्री गड्डू रमेश
इलेक्ट्रॉमेट्रिक्स के कारण बुधवार क्षेत्र के लिए एक कोड / A code for magnetic field due to arbitrary electromagnets

श्रीप्राचीन सुतापा रंजन
कृण्तिर बुध नामव बुध / Artificial intelligence vs human intelligence

श्री दीक्षित कृष्णचन्द्र
रोजमर्रा के काम में विद्युत उर्जा / Electrical safety in everyday work

श्री सुश्री यशश्री पाहि
र्डूट्वीय संलयन ऊर्जा और उसका विकास / Inertial fusion energy and its development

श्री रक्षक कार्यालय
आईपीआइ की आउटरन सेडम जनाउंड का आयोर्न डकया गया। सेडम जनाउंड के दूसरे सत्र के समापन के बाद राजसिंह, उपाध्यक्ष, राजभाषा ने सभी प्रतिभागियों को तकनीकी विषय को सही और साथ ही भविष्य में इस प्रकार के आयोजन में तकनीकी विषय को सही हिंदी भाषा में अभिव्यक्त करने हेतु उन्हें साथ ही भविष्य में इस प्रकार के आयोजन में तकनीकी विषय को सही हिंदी भाषा में अभिव्यक्त करने हेतु उन्हें भाषा को प्रोत्साहित किया।

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Fire Service Week is observed every year to enhance general public awareness about the necessity of minimizing losses due to fire. 14th April is also observed as the “Martyrs Day” in homage to those brave firefighters who sacrificed their lives while discharging their duties. The Ministry of Home Affairs, Govt. of India, had decided the theme of “Fire Prevention is better than Fire Fighting” for this year. In view of this, IPR observed the “Fire Service Week” by conducting short briefing session at various work areas on “how to prevent fire and how to operate fire extinguishers”. Furthermore, practical demonstration of operation of fire extinguishers was conducted for the workshop team members, employees, security personnel, guest house staff, etc. The security personnel at ITER-india laboratory building were also shown the demonstration of fire hydrant system.
The school students from the north and western regions of India, selected for ISRO’s "Young Scientist Programme" "YUva Vgyani KAranyakram" visited IPR on 15 May 2019, in tune with the Government's vision "Jai Vigyan, Jai Anusandhan". The program is aimed at creating awareness amongst the youngsters who are the future building blocks of our Nation. ISRO has chalked out this programme to "Catch them young". Thirty three of the 128 students selected this year visited IPR as part of the programme.

Director IPR addressed the participants of the programme and gave a popular talk on IPR activities, with emphasis on societal applications of plasma. Outreach Division had also arranged interactive plasma experiments for the visiting students. The students were also taken to see Aditya and SST-1 machines.
राजभाषा के क्षेत्र में उपलब्धि

नगर राजभाषा कार्यान्वयन समिति की बारहवीं छमाही बैठक 26 अप्रैल, 2019 को बड़ोंदा एपेक्स अकादमी, गांधीनगर में आयोजित की गई, जिसमें श्री पंकज जानी, नरकास अध्यक्ष एवं प्रमुख, बड़ोंदा एपेक्स अकादमी, श्रीमती सुनीता यादव, उपनिदेशक, क्षेत्रीय कार्यान्वयन कार्यालय, मुबई एवं गांधीनगर स्थित केंद्र सरकारी कार्यालयों/उपक्रमों/बैंकों/संस्थाओं के प्रमुख एवं प्रतिनिधि उपस्थित थे। इस बैठक में राजभाषा के क्षेत्र में श्रेष्ठ कार्यान्वयन हेतु वर्ष 2018 के लिए लाज्मा अनुसंधान संस्थान की प्रथम पुरस्कार के रूप में शील्ड और प्रमाणपत्र प्रदान किया गया। लाज्मा अनुसंधान संस्थान की ओर से उपस्थित आईपीआई के सदस्यों ने यह पुरस्कार ग्रहण किया।

पुरस्कृत कार्यालयों में राजभाषा संबंधी कार्यों से जुड़े कर्मचारियों को उनके उल्लेखनीय योगदान के लिए पुरस्कार दिया गया। डॉ. संध्या देवी का कार्यालय में राजभाषा कार्यान्वयन में उल्लेखनीय योगदान के लिए प्रथम पुरस्कार के रूप में शील्ड और प्रमाणपत्र प्रदान किया गया।

नरकास(TOLIC) के तलावधान में निफ्ट(NIFT), गांधीनगर द्वारा आयोजित निबंध प्रतियोगिता के लिए संस्थान की सुश्री प्रतिभा गुप्ता, वैज्ञानिक अधिकारी – एफ की प्रथम पुरस्कार के रूप में 5,000 रुपये एवं सुश्री शिल्पा खंडकर, वैज्ञानिक सहायक – डी की द्वितीय पुरस्कार के रूप में 2,500 रुपये प्रमाण पत्र सहित प्रदान किये गये। उनके द्वारा लिखित निबंध का विषय था - जलवायु परिवर्तन का भारतीय अर्थव्यवस्था पर असर एवं भारतीय अर्थव्यवस्था का वैश्विक विकास में योगदान।

जनगणना कार्यक्षेत्र में गांधीनगर द्वारा आयोजित समायोजन प्रतियोगिता के लिए श्री श्रीपक मेहता, वैज्ञानिक अधिकारी-डी की द्वितीय पुरस्कार के रूप में 600 रुपये एवं श्री हिमांशु लागी, वैज्ञानिक अधिकारी-डी की प्रथम पुरस्कार के रूप में 300 रुपये प्रमाण पत्र सहित प्रदान किये गये।
MDSplus is an open source data acquisition and analysis software library developed by MIT. It provides direct and uniform access to different data types irrespective of their format, source and location. It stores data in a hierarchical tree format that provides context for data, relationship between them and easy browsing of shot data.

To adapt MDSplus for SST-1’s experimental data, MDSplus Python module along with MDSplus objects libraries are used. For continuous data acquisition, the MDSplus datafile is being stored incrementally in a linked list of data segments. An index of these data segments is maintained in such a way that retrieval of subsets of the data can be performed properly and efficiently using start, end and optionally a delta time using provided libraries.

To access the SST-1 experimental data over the web, WebScope is configured, which is based on http protocol using Asynchronous JavaScript and XML (AJAX) technology. Web based data access configuration has been implemented using available Python module via Web Server Gateway Interface (WSGI). Python interface and WSGI implementation allows the requested experimental data access inside any modern browser with JavaScript API.

![Video data file played from jScope](L)  ![SST-1 Shot overview plot for shot#9182 on Web Browser using WebScope](R)

**Prevention of Liquid Nitrogen Fluid Losses of 80 K Distribution System of SST-1**

In SST-1, sub-cooled LN2 fluid is used in various sub-systems of 80 K distribution for cooling to reduce the heat load. The LN2 returns from all 80 K applications via the phase separator to the sub-cooler vessel by gas and liquid separation process. During past experimental campaigns of SST-1, frequent dripping of LN2 was observed in the main vent line which was not safe for persons working there and also was having cost implications due to wastage of LN2.

Various in-house solutions were tested out, namely, problem analysis and heat load calculation, re-routing of return cryo transfer lines to the phase separator, replacement of the phase separator supply valve, re-routing of the venturing piping and dis-assembly and re-fabrication of the inner process pipe, vacuum barrier at 80 K etc.

In the present SST-1 campaign, no LN2 fluid was seen to be dripping out from the vent line and the fluid consumption was seen to have reduced from 1400 l/hr to 1000 L/hr, which resulted in cost saving. [Rajiv Sharma, SST-1 Cryogenic Division]

![Valve installation in LN2 Phase Separator](L)  ![Return LN2 from 80 K Applications](R)
Dr. Sudhir Nema gave an invited talk entitled “Non-thermal atmospheric pressure plasma technologies for societal benefits” at the 9th International Conference on Frontiers Of Plasma Physics And Technology (FPPT-9) 8-12 April 2019, Colombo area, Sri Lanka. He also chaired a session at this conference. In the same conference, Mr. Amit Kr. Patel, Research Scholar gave a poster presentation entitled “On the characteristics of argon plasma in a multi-pole line-cusp variable magnetic field”. He received the “Best Poster” award for this presentation.

Visit of Dr. Banerjee to IPR

Dr. Srikumar Banerjee, Chancellor, Kashmir University and past Chairman, AEC and Secretary DAE, visited IPR on 6 May, 2019. He visited the SST-1 Tokamak and interacted with the scientists.
Mr. Yogesh Sharma, Banaras Hindu University, Varanasi, gave a talk on "Studies on Dispersion Characteristics of Electromagnetic Waves in Magnetized One Dimensional Ferrite Photonic Crystals" on 10th May 2019.