SRESA Newsletter

Apr-Jun-2021 Issue

A quarterly publication of Society for Reliability and Safety [Reg. No. 3141/2010/G.B.B.S.D.], Mumbai

New SRESA-IIRR in Association with IIT Madras organizing a Webinar on 'Reliability and Safety of Complex Systems' on 29/05/2021 – SRESA invites early registration

SRESA Mission

Development, maintenance and application of required national codes, standard and guides, is one of the attributes, for a nation to be called as Advanced Nation.
SRESA has in its charter - the development of codes, standards and guides in the area of Risk and Reliability, keeping in view national requirements. The codes, standards and guides developed by SRESA will be submitted to Government agencies for their approval, to facilitate their use in government, industrial and societal sectors.

From the President's Desk ....

I am happy to share with you, certain initiatives that SRESA has been working on. First, I bring to your kind notice that SRESA has been working on, to open its fifth Chapter in Indore and related activities are at advanced stages on this subject.

The second and very important - SRESA managing committee has discussed a proposal to set up a world class institution – *Indian Institute of Risk and Reliability (IIRR)*. The proposal was approved, in principle, by the SRESA managing committee. Considering the financial, academic, infrastructural and other resources required for this project, no doubt this initiative appears to be very ambitious one. However, SRESA has taken up this project as a challenge and going ahead with the strength of over 220 members and our experience of over 10 years, that speaks for itself. IIRR in association with IIT, Madras, is organizing a Webinar on 29th May 2021 on *Reliability and Safety of Complex Engineering Systems*. Prof. Neelesh Kumar, Honorable Director, IIT, Indore will be the Chief and Honorable Prof. Oliver Straeter, University of Kassel, Germany, the Guest of Honor, for this webinar.

I am also happy to share that the recently launched project on development of Safety Critical systems Lab at IIT Madras, in collaboration with SRESA has been progressing well. SRESA has started working on developing the codes and standards. I take this opportunity to thank SRESA managing committee and SRESA members for their contributions to SRESA activities.

Prabhakar V Varde

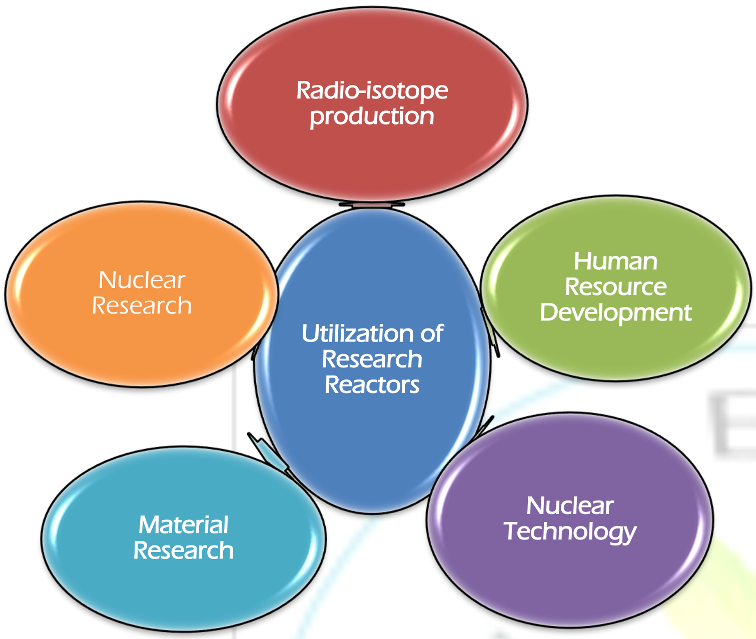
In this issue ....

Utilization of Research Reactors at Bhabha Atomic Research Centre, Mumbai

Tanay Mazumdar[1], Tej Singh[1,*] and Kunal Chakrabarty[2]
[1]Research Reactor Services Division, Bhabha Atomic Research Centre, Mumbai
[2]Reactor Operations Division, Bhabha Atomic Research Centre, Mumbai
*E-mail: t_singh@barc.gov.in

1. Introduction

Research reactors (RRs) primarily function as a source of neutrons, which can be utilized for several applications like production of radioisotopes for medical, industrial and agricultural uses, neutron beam research, material characterization, imaging etc. For more than 60 years, RRs are the epicenter of our research on safety and technology of existing nuclear power reactors, optimization of the fuel cycle and material research for new reactor types and nuclear fusion. Being flexible, RRs are best suited for testing nuclear fuels of various reactor types. Current trend of research is mainly focusing on studying the safety margins for nuclear fuel for existing and future reactors and developing accident tolerant and proliferation resistant fuel for future reactors. Due to the rapid technological advances in Nuclear Medicine, it is difficult to imagine today's medicine industry without radioisotopes.



Research Reactors are most suitable to produce radioisotopes for diagnosis and therapeutic applications in nuclear medicine as well as for industry, agriculture and high quality neutron transmutation doping of semiconductor materials for manufacturing nano-chips/micro-chips. RRs are important platforms for supporting research pertaining to material characterization using neutron beam tube, testing and qualification of reactor materials and related components under neutron flux environment, manpower training. There are 2 research reactors, namely Dhruva (100 MW rated power with thermal and fast neutron fluxes 2.2×10^{14} and 2.8×10^{12} n/cm^2/s, respectively) and Apsara-U (2 MW rated power with thermal and fast neutron fluxes 6.1×10^{13} and 1.5×10^{13} n/cm^2/s, respectively), currently under operation at BARC, Trombay.

1. Radioisotope Production and its application

Use of Dhruva/Apsara-U research reactors for the production of radioisotopes for different applications constitutes an important program in India. Radioisotopes such as ^{60}Co, ^{192}Ir, ^{137}Cs, ^{103}Pd, ^{125}I, ^{32}P, ^{198}Au, ^{32}P, ^{131}I, ^{90}Y, ^{153}Sm, ^{177}Lu, ^{186}Re, ^{166}Ho, ^{125}I, ^{99m}Tc, ^{64}Cu etc. are used in diagnostic and therapeutic applications. At present there are about 300 licensed nuclear medicine centres across India, majority of which utilize radioisotope produced at Dhruva for human healthcare, either diagnosis or treatment. ^{60}Co, ^{192}Ir, ^{137}Cs, ^{82}Br, ^{131}I, ^{99m}Tc, ^{140}La, ^{46}Sc, ^{198}Au, ^{56}Co, ^{24}Na, ^{79}Kr, ^{41}Ar etc. are used in level gauging, density monitoring, thickness gauging, radiometric scanning, gamma radiography, tomography, blockage detection, leak detection in pipelines and heat exchangers, flow rate measurements, residence time distribution (RTD) measurements, mixing time measurement, wear and corrosion measurements, sediment transport investigations in Ports, effluent dispersion in water bodies, particle tracking and fluid flow tracing in oil fields etc. Radioisotopes (^{60}Co, ^{32}P, ^{35}S, ^{54}Mn, ^{57}Co) used for radiation processing in agriculture to obtain desired results like sprout inhibition (potatoes, onions, etc.), hygienization (spices, meat, fish etc.), shelf life extension (meat, fish, cut vegetables, fruits, flowers, etc.), quarantine (fruits, etc.), insect disinfestations (cereals, pulses, dry fruits, etc.) and sterilization of food.

2. Nuclear Research

2.1 Neutron scattering activities and other applications in beam tubes

Neutrons are used as an important and complementary probe to x-rays and electrons in the study of various physical phenomena in condensed matter physics. Several neutron scattering facilities (under the National Facility for Neutron Beam Research) have been set up at Dhruva/Apsara-U beam tubes. Primarily they are being used to study arrangement of atoms and nature of bonding in crystalline materials, locating position of light atoms, arrangement of spins in magnetic systems through Neutron Diffraction (ND), short range ordering in glasses, liquids and disordered systems through ND, magnetic correlations through Polarized neutron scattering (PNS), large scale structures in soft matter, biology and porous materials using Small Angle Neutron Scattering (SANS), excitations through Inelastic Neutron Scattering (INS), diffusion of atoms / molecules in confined geometry and in soft condensed matter through Quasi Elastic Neutron Scattering (QENS), morphology and interfaces in thin films and multilayers through Neutron Reflectivity (NR), residual stress measurement of materials by neutron diffraction imaging, neutron depth profiling of ^{6}Li, ^{10}B etc. by thermal neutron absorption at the surface, neutron cross section measurements etc.

2.2. Prompt γ ray coincidence spectroscopy

A unique radial beam tube facility has been developed for high resolution prompt γ-ray coincidence spectroscopic measurements. This facility consists of a high energy-resolution gamma detector array, comprising of 8 HpGe Clover detectors with BGO anti-Compton shields and 11 $LaBr_3$(Ce) scintillation detectors of fast timing capability, coupled to a state of art digital data acquisition system. The mechanical frame of the array enables positioning of the detectors at predetermined complimentary angles with respect to the beam direction. Beam spot size at the target position is ~ 12 mm and the neutron flux at the target position is ~ 1.0×10^{8} n/cm^2/sec. High resolution data obtained in the facility are important to understand the nuclear structure and exotic excitation modes, physics of nuclear fission process and the r-process nucleosynthesis of translead nuclei.

2.3 Reactor Physics Experiments

Apart from Dhruva and Apsara-U, there is a low power AHWR/PHWR-Critical Facility (CF) at Trombay, which has been designed with in-built flexibility for conducting lattice physics experiments as per the design objectives of AHWR and 500 MWe PHWR. Various reactor physics experiments like measurements of flux spectra at beam tubes and thermal columns, reactor kinetics parameters, subcritical multiplication and shutdown margin during the approach to criticality, excess reactivity, reactor period, temperature and void coefficients of reactivity, absorber reactivity worth, calibration of control rod, nuclear instrument etc. are carried out at Dhruva / Apsara-U / CF for AHWR and Advanced PHWRs.

3. Material Research

3.1 Neutron Activation Analysis (NAA) for Chemical characterization of materials

Neutron Activation Analysis (NAA) is a nuclear analytical technique for simultaneous multi-element determination of elements at major, minor and trace concentration levels in samples of diverse matrices. This involves measurement of neutron capture prompt gamma-rays (Prompt Gamma-ray NAA or PGNAA) or delayed gamma-rays (Conventional NAA) from activation products. PGNAA is useful for compositional characterization of materials as well as determination of elements like H, B, Cd, Hg, Eu, Sm and Gd, which are not suitable in conventional NAA. Pneumatic Carrier Facility (PCF) and Self-serve facilities of Dhruva and Apsara-U research reactors are routinely used for multi-elements (Na to U) by NAA of various samples for R&D, material characterization and preparation of radiotracers for analytical applications.

3.2 Geochronology

Use of research reactors for geochronology (dating) is a more specialized application. There are two geochronology methods. (i) Fission track geochronology is a method for dating minerals containing uranium, particularly apatite and zircon by counting fission tracks in the material from spontaneous fission of ^{238}U. (ii) Argon geochronology is another dating method whereby the age of small quantities (~mg) of minerals/rocks can be determined based on the radioactive decay of 40K into ^{40}Ar. Samples as young as 2000 years and as old as the earth itself (about 4.6 billion years) can be dated, depending on the nature of the sample. The requirement can range from a fast neutron fluence of about 2×10^{15} n/cm^2 for young rocks up to 10^{18} n/cm^2 for very old rocks.

3.3. Irradiation Damage study of Materials

Fast neutrons cause damage in material structure by displacement of atoms. Depending on the composition and characteristics of materials, they become fragile, or hardened, and can swell, crumble, change their composition, release gas, etc. Each alloy, ceramic, and plastic has its own behavior, which can be verified only by irradiation experiments in research reactors.

4. Nuclear Technology

4.1 Testing of shielding material at Shielding Corner of Apsara-U

Evaluation / qualifying of radiation shielding in any reactor project is a challenging exercise because it involves large attenuation, flux anisotropy, complicated geometry and wide energy range for both neutrons and gammas. Theoretical estimates are considered to be accurate within an error bound, which depends on uncertainties due to modeling approximations and nuclear data. These uncertainties are taken care of by using suitable bias factors (BF) obtained from experimental measurements. The BFs are used as multipliers in the theoretically estimated exit flux from a shielding set up. Over conservation of BF leads to cost penalties and under estimation may result in serious radiological problems. Hence, mock-up experiments need to be carried out prior to detailed shield design, to obtain BF and to optimize the shield. A shielding corner facility has been designed at Apsara-U in order to carry out extensive experiments for the shielding design of new reactors and validating the computer codes used in shielding calculations.

4.2. Development & Testing of Detectors

Research reactors are utilized for testing and calibration of ionization chambers, fission detectors, ^{10}B lined proportional counters, ^{10}B lined gamma uncompensated / compensated ionization chambers, calibration of variety of miniature neutron detectors, neutronic channels viz. Start-up, Campbell and Power range, measurement of neutron sensitivity of Cobalt, Platinum, Vanadium Self Powered Neutron Detectors (SPNDs), SPND amplifiers for reactors, ^{3}He and BF_3 gas detectors for neutron scattering experiments, solid state nuclear track detectors and its applications etc.

4.3 Neutron Imaging and its applications

Neutron imaging as a non-destructive testing method that can be used for a broad spectrum of industrial/scientific applications. It provides similar capabilities as industrial X-ray i.e. radiographic images or 3D topographic views of samples with a size of a few centimetres up to tens of centimetres. The neutron imaging technique finds application in fault detection in the engineering components, distribution of hydrogen, boron and cadmium in metals, water transport in soil/plant/fuel cell, study of cultural artefacts for preservation and restoration, real time neutron radiography for flow visualization and kinetics etc.

4.4 Neutron Transmutation Doping (NTD)-Si

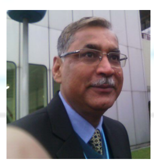
NTD-Si is the process of creating non-radioactive dopant atom from the host Si atoms by thermal neutron irradiation and its subsequent radioactive decay. It has been used extensively in manufacturing of high power semiconductor devices. The quality of NTD-Si, both from the viewpoints of dopant concentration and homogeneity has been found superior to the quality of doped silicon produced by conventional methods. Maintaining homogeneous dopant concentration, while irradiating the Si ingot inside a reactor, is a challenging job. During irradiation, adequate cooling is provided to the ingot to remove the nuclear heat, produced by gammas and neutrons. After the irradiation, Si resistivity remains > 10^5 ohm-cm due to the radiation damage, which can be repaired to a level of desired satisfaction (25-500 ohm-cm) by adopting a suitable annealing process.

12. Human Resource Development

Research reactors are used in human resource development by giving exposure to the teachers & students from various academic institutions, nuclear power plant operators, operational health physicists and regulators. Apart from this, there is a full scale research reactor simulator in Dhruva, which is very helpful for gaining hand-on experience pertaining to safe and smooth operation of the research reactors.

Authors

Dr. TanayMazumdar, a Phd from HomiBhabha National Institute, Mumbai, joined Research Reactor Services Division (RRSD), Reactor Group, BARC after completion of one-year orientation course from 3rdbatch of BARC Training School at IGCAR, Kalpakkam. His areas of expertise are nuclear reactor physics and computational physics.



Dr. Tej Singh, a Ph.D. from Mumbai University, joined Research Reactor Services Division (RRSD), Reactor Group, BARC after completion of one-year orientation course from 33rd batch of BARC Training School at BARC, Mumbai. At present, he is heading Reactor Physics and Nuclear Engineering Section, RRSD. His areas of expertise are reactor physics and safety of present and upcoming research reactors. He has developed computer codes using nodal expansion methods for reactor physics design, shielding and reactivity initiated transients / safety analysis of nuclear reactors.

Shri Kunal Chakrabarty, a B.Tech. in Chemical Engineering, joined Reactor Operations Division (ROD), Reactor Group, BARC after completing one-year orientation course from 32ndbatch of BARC Training School at BARC, Mumbai. After serving as Reactor Superintendent, Dhruva, he is currently Heading Reactor Operations Divisio. His areas of expertise are reactor operation, reactor fueling, safety review of research and power reactors.

Development of an intelligent approach for operational improvements in Mega Advanced Research Machines – Application on 200 mA and 2.5 GeV Accelerator – INDUS-2, at RRCAT, Indore

Surendra Yadav [a,b]*, T. A. Puntambekar[a] and P. V. Varde [b]
[a] Raja Ramanna Centre for Advanced Technology, Indore, India, 452 013
[b] Homi Bhabha National Institute, Anushakti Nagar, Mumbai, India, 400 094

1. Introduction

Man-machine interaction is critical to complex system operation, particularly in respect of performance optimization and safety assurance. As the system becomes complex, expert skills and judgement is required to tune the system. However, this process of manual tuning becomes inadequate and cumbersome as the number of combinations of system parameters increases. It is recognized that procedures requiring manual operator actions pose a limit and automated provision are required to tap the full potential of the system.

An electron synchrotron radiation source (SRS) is an example of a complex system wherein the electron beam is accelerated, stored and bent to emit wideband synchrotron radiation (SR) which is used in various areas of science and technology such as Life Sciences, Engineering, Environmental Sciences, Material Science, Cultural Heritage, etc [1]. The synchrotron radiation source (SRS) poses operational challenges when it comes to improving the performance of the machine which critically depends on a manual process for fine-tuning of machine parameters. In SRS, the problem of transverse coupled bunch instabilities (TCBI) is one of the major challenges that limit the beam current operation at higher level at ~ 200 mA, [1].

In the presence of TCBI, electron bunches undergo the transverse oscillations with growing amplitude. There is a phase difference between the oscillations of two consecutive bunches, which is specified in terms of the transverse coupled bunch mode (TCBM) number [2]. The amplitude of the oscillation due to the excitation of a TCBM is termed as TCBM level. The TCBI causes saturation of accumulated beam current or partial beam loss during the beam current accumulation.

2. Challenges of TCBI at Indian SRS: Indus-2

Indus-2 is a synchrotron radiation source at Raja Ramanna Centre for Advanced Technology, Indore, which has rated beam current of 200 mA and beam energy 2.5 GeV [3]. In Indus-2, strong excitation of TCBM at high beam current, the system experiences instabilities and this leads to degradation in beam quality. The overall concern due to this is, it is not possible to ramp the accelerator current to its rated capacity of 200mA. The typical beam operations profile in 2019 for high beam current accumulation in Indus-2 are depicted in Fig. 1.

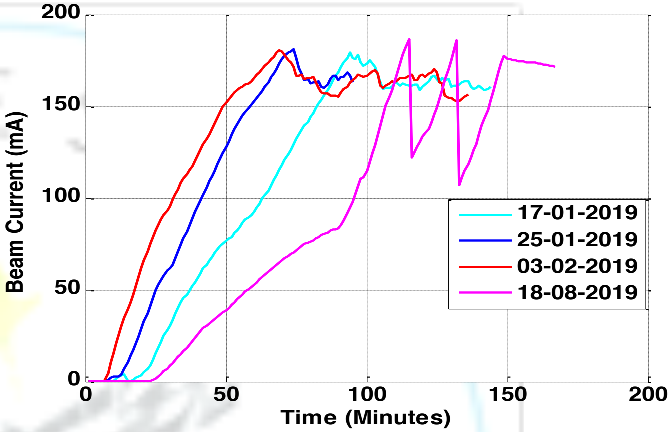


Figure 1: Typical degradation of beam accumulations in Indus-2 due to excitation of TCBM

From Fig. 1, it can be seen that a rated value of 200 mA could not be achieved due to excitation of TCBI in absence of any active feedback system.

3. Mitigation of TCBI using Intelligent Approach

A novel approach involving the adaptive variable boundary based real coded genetic algorithm (AVB-RCGA) has been developed to identify the near-optimal value of the operating parameters of the accelerator. Accelerator parameters, namely quadrupole magnet strengths and sextupole magnet strengths are used as input to minimize the TCBI. The real-time data obtained from the Indus-2 synchrotron radiation source (SRS), in this case, were used for online optimization of system parameters.

The parameter settings used in the optimization are real numbers and their boundaries were also adaptively modified during the optimization. Hence this variant of genetic algorithm was termed as Adaptive Variable Boundary based Real Coded Genetic Algorithm (AVB-RCGA). In this algorithm, two lower boundaries and two upper boundaries for each variable were used during the optimization. The first boundary is called as ultimate boundary and the second one is known as the working boundary [4]. The ultimate boundaries of variables are governed by system safety limits and working boundaries were specified by experience gained with previous beam operations.

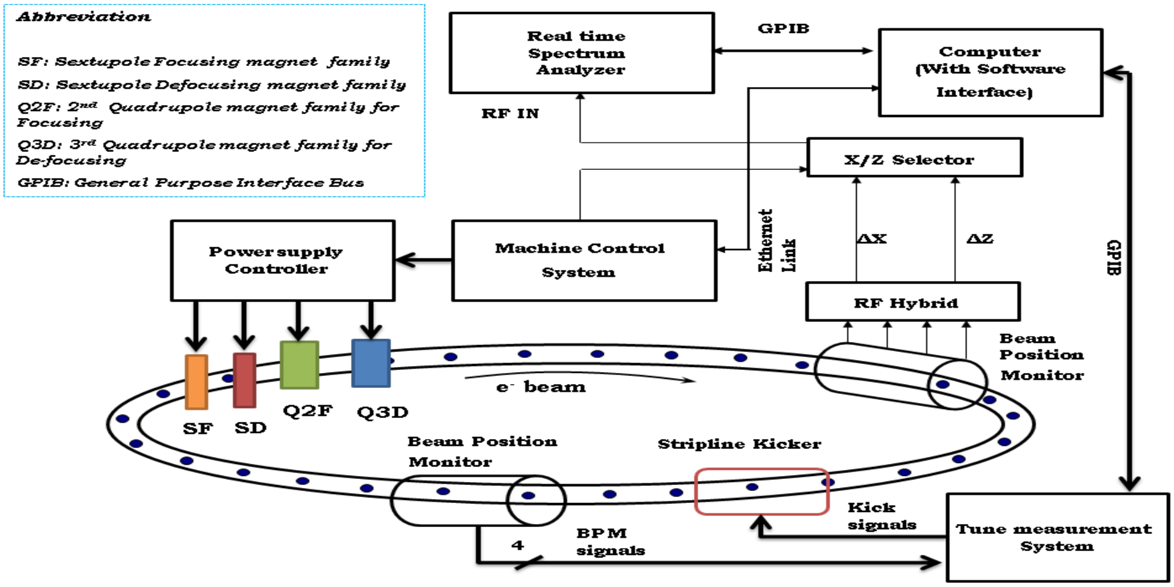


Figure 2: Hardware setup for minimization of averaged TCBM level in Indus-2 [5]

4. System Description

The description of the system for AVB-RCGA based optimization and results of beam experiments are discussed below.:

The scheme of online optimization of quadrupole magnet and sextupole strength for suppression of TCBI is shown in Fig. 2. A system has been developed for TCBM measurement using spectral analysis of beam position signal and measuring the amplitude at a frequency of each TCBM. This system was augmented for measurement and correction of machine parameters, Betatron tune and chromaticity, by applying suitable quadrupole (Q2F and Q3D) and sextupole (SF and SD) magnets power supplies current settings [5]. The optimization algorithm runs on the computer which interfaces with the machine control system and these measurement systems. Software sets the current settings of quadrupole and sextupole magnet power supplies for optimization. The performance indices are based on the average of the measured level of all transverse coupled bunch modes.

With the conventional approach, quadrupole and sextupole magnet strengths were optimized manually to reduce the excitation level of transverse coupled bunch mode (TCBM) at high beam current operation in SRS. A lot of efforts have to be done by the machine operator to get the optimum value due to the small step size and large time consumption for a large number of combinations. Automated optimization eliminates these problems.

The objective function f_{GA} of the AVB-RCGA based optimization is given below

$$f_{GA} = \sum_{n=0}^{M-1} CBM_{APx} + CBM_{APz}$$

Where, CBMAPx and CBMAPz are average power of horizontal and vertical position signal for frequencies corresponding to coupled bunch modes. M is the harmonic number of accelerator which is 291 for Indus-2.

The two sextupole magnet families (namely sextupole focusing (SF) & sextupole defocusing (SD)) and two quadrupole families (namely Q2F and Q3D) are optimized to reduce the objective function (also called as fitness function) as given above.

5. Experiment and Results

The following parameters / conditions are set during the beam experiment:
Beam Energy: 546 MeV. This is the injection energy at which chance of higher excitation of TCBM. Beam Current: 130 mA to 150 mA. This current range allows measurement of the level of excitation before TCBI occurs. Bunch filling pattern: 160 Bunches filled out of 291 Bunches. This is an optimized bunch filling pattern for Indus-2 concerning beam injection efficiency and ion-based beam instability. Quadrupole and Sextupole strength are at nominal optimized settings.

Parameters of AVB-RCGA

No. of variables: 4 [P/s Current of Q2F, P/s Current of Q3D, P/s Current of SF, P/s Current of SD].

Population size: 10.

No. of iteration: 8.

Lower bound of variable LB1 =[28.140 30.950 11.40 8.00].

Upper bound of variable UB1=[28.180 31.950 12.50 9.50].

Lower bound of variable LB2 =[28.155 30.960 11.60 8.20].

Upper bound of variable UB2=[28.175 31.000 12.10 8.50].

The working boundaries, LB1 and UB1, are adaptively changed throughout the optimization while ultimate boundaries, LB2 and UB2 are steady. The working boundaries are modified after a number of iterations and they shift towards the best solution of the previous iterations. The mean fitness value reduction with the number of iterations is shown in the figure given below.

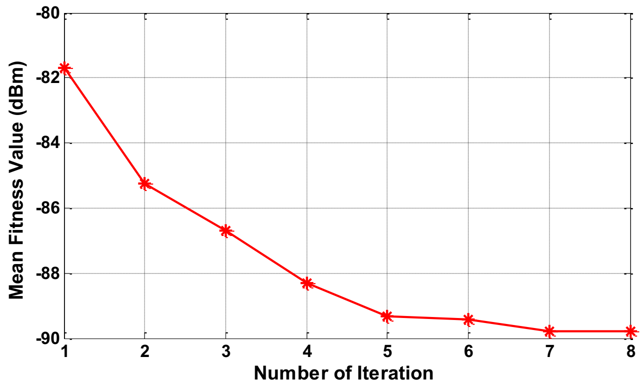


Figure 3: Convergence curve for optimization of magnets strengths using AVB-RCGA

Average TCBM level got reduced by ~ 8 dB in 8 nos. of iteration. Optimization is terminated when the optimum value (-89.8 dBm) approaches -90 dBm (Noise floor of measuring instrument). The TCBM levels of all 290 modes at nominal optimum settings are depicted in figure 4. From the above figure, it is noticed that levels of horizontal CBM are significant as compared to the vertical CBM. The TCBM level after optimization is shown in Fig. 5.

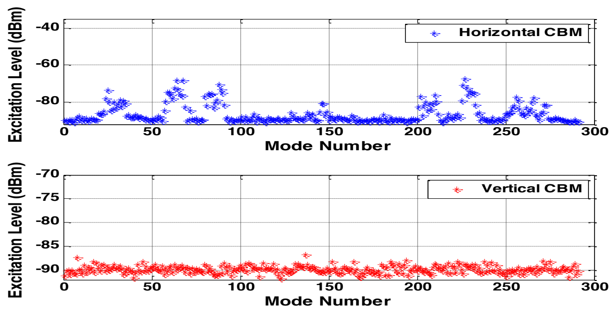


Figure 4: Horizontal and vertical CBM levels at nominal settings

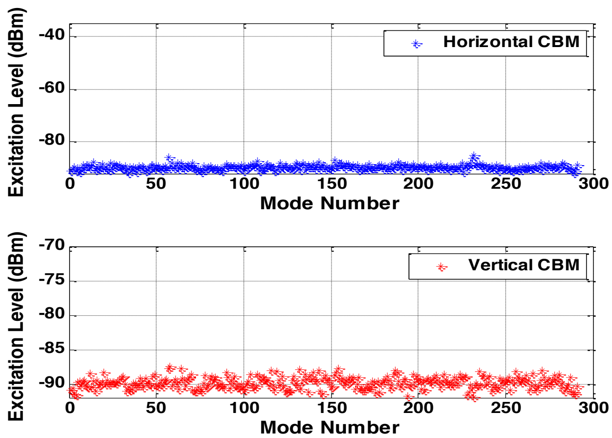


Figure 5: Horizontal and vertical CBM levels after optimization

From Fig. 5, it is found that all the coupled bunch modes are suppressed at optimized settings. The optimized results are summarized in Table 1: That shows measurement results and parameters settings before and after optimization

Table 1

S. No.	Parameter	Before optimizn.	After optimizn
1	Quadrupole focusing (Q2F) magnet power supplies current	28.171 A	28.156 A
2	Quadrupole defocusing (Q3D) magnet power supplies current	30.968 A	30.931 A
3	Sextupole focusing (SF) magnet power supplies current	11.70 A	12.06 A
4	Quadrupole defocusing (Q3D) magnet power supplies current	8.24 A	8.62 A
5	Average TCBM level in x plane (CBMAPx)	-85.31 dBm	-89.73 dBm
6	Average TCBM level in z plane (CBMAPz)	-88.24 dBm	-89.89 dBm

This experiment demonstrates the utility of on-line AVB-RCGA to identify the optimal value of magnetic strengths for minimum TCBM levels. Using this optimization, the average TCBM level got decreased by ~ 4.5 dB with respect to the nominal settings. A typical graph for beam accumulation with and without optimization is shown in Fig. 6.

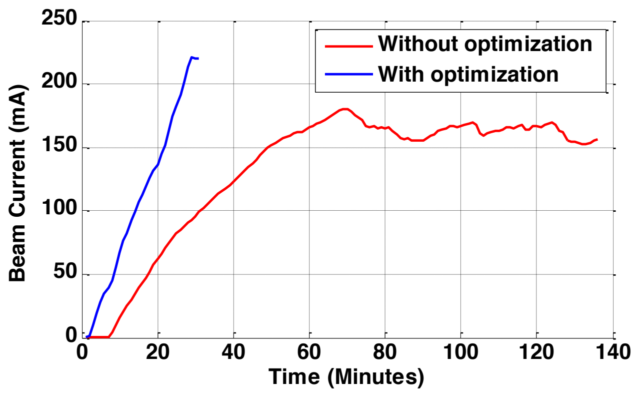


Figure 6: Typical beam accumulations in Indus-2 with and without optimization through AVB-RCGA.

The concept of adaptive boundary makes this algorithm useful for the online tuning of accelerators. Each iteration in this algorithm is followed by a shrink in the boundary span (=UB2-LB2) due to which this algorithm identifies the global minima and then tracks this minimum according to the dynamic change in the system.

From Fig. 6, it is observed that with optimum settings, the maximum accumulated beam current of Indus-2 increases from a limit of ~170 mA to more than ~210 mA at the beam energy of 546 MeV.

6. Conclusion

The scheme presented in this article is based on the measured data of a real-time system and it does not require an actual model of the machine. This novel approach of AVB-RCGA is capable of optimizing dynamic systems due to adaptive change in search space. This project was challenging as the system characteristics were non-linear from the operational point of view due to complex set of inputs. Being a mega machine that has duty cycles heavily loaded for beam experiments, testing and understanding intelligent algorithm response was formed a considerable task. In spite of these challenges, it was demonstrated that the developed intelligent system could successfully ramp up the machine to more than its rated capacity i.e. at the level of 220 mA.

References

1. Herman Winick, Synchrotron radiation sources A primer, World Scientific Publishing, 1994
2. Chao, Physics of Collective Beam Instabilities in High Energy Accelerators, New York: Wiley, 1993.
3. www.rrcat.gov.in/technology/accel/index.html
4. S. Yadav, T. A. Puntambekar, P. V. Varde, Development of Adaptive Variable Boundary based Real Coded Genetic Algorithm for online optimization of beam excitation level for Indus-2 tune measurement system, Journal of Instrumentation (JINST), 13 P07028 ,2018. DOI: https://doi.org/10.1088/1748-221/13/07/P07028
5. Surendra Yadav, T. A. Puntambekar, P. V. Varde, Modelling and Control of Transverse Coupled Bunch Mode Levels in Indus-2 using Artificial Neural Network, Review of Scientific Instruments 92, 033304 (2021); https://doi.org/10.1063/5.0016339

Authors Profile

Mr Surendra Yadav has received the degree of Bachelor of Engineering in 2003. Since 2004, He is working as a scientific officer in Raja Ramanna Centre for Advanced Technology, Indore, India. He is involved in design, and development, of various beam diagnostics systems for Indus Accelerator. The research results presented in this article are part of Mr Yadav's Ph.D. project.

Mr. T. A. Puntambekar received B.E. (Electronics) degree in 1986 from Devi Ahilya Vishwavidyalaya, Indore, Madhya Pradesh, India. He joined Raja Ramanna Centre for Advanced Technology, a premier R & D organization of Department of Atomic Energy in 1988, after graduating from BARC Training School (31st batch). He was involved in design, development, installation and operation of various beam diagnostics devices for Indus Accelerator Programme. Presently, he is leading the Electron Accelerator Group, RRCAT as Group Director and also working as Head of Beam Diagnostics & Coolant Systems Division.

Prof. P. V. Varde, is Former-Associate Director & Outstanding Scientist, Reactor Group, and Senior Professor of Homi Bhabha National Institute, Bhabha Atomic Research Centre, Mumbai (India) .

Dr. Varde received B. Tech. (Mechanical Engineering) in 1983 from APS University, Rewa and Ph.D. (Reliability & Safety) in 1996 from IIT Bombay. He has expertise in Nuclear Plant Operational Safety and Probabilistic Safety Assessment. He has more than 30 years of Experience on development of PSA for nuclear plants and its applications. He has over 250 publications at national and international levels that include 17 books / book chapters/ conference proceedings, authored or edited by him.

Presently he is a Raja Ramanna Fellow at BARC, Department of Atomic Energy. He is also, President of Society for Reliability and Safety (SRESA), India. He is also Ph.D. Guide for Shri Surendra Yadav.

SRESA Welcomes New Member

Shri A S Joshi after his post-graduation from IIT, Bombay joined the 27 batch of training school at Bhabha Atomic Research Centre (BARC), Mumbai. He joined the Laser Division, BARC on completion of the training. He worked in the field of development of optics and Nd doped laser glass for high energy, high power lasers on joining Raja Ramanna Centre for Advanced Technology(RRCAT), Indore. His special interest has been in the area of laser induced damage of large sized optics and laser glasses and their safety from the damage. He had published 26 papers in the journals and more than 100 papers in the symposia. He was awarded two group achievement awards.

Presently, he has retired as Head, Advanced Lasers and OpticsDivision(ALOD), RRCAT. and contributed to many laser projects and programmes in the country. .

Invitation for the SRESA Webinar on Reliability and Risk of Complex Engineering System

SRESA since its inception in 2010, has been organizing International and national events in the area of risk and reliability. In fact. SRESA has organized 4 International and National Conferences,

During COVID times it is not possible to have the traditional approach to seminar where the dignitaries and participants present themselves face to face and discuss the subject and exchange programs. In December 26, 2020 SRESA celebrated 10th Anniversay by organizing a webinar. The experience was good, even though you miss the one to one exchange and discussions, there is a general feeing that there are some positive side of the webinar, e.g., time and resources saved in saved on travelling, boarding and lodging, absence from office or headquarter is not required and still you have advantages of lectures and virtual technical exchange, etc.

Encouraged by the advantages of Webinar mode that offers a virtual common platform, SRESA is organizing its second Webinar on Reliability and Safety of Complex Engineering Systems, on May 29, 2021. Prof. Neelesh Kumar Jain, Director (Officiating) has consented to be the Chief Guest for this event.

Prof. Oliver Straeter, University of Kaeel, Germany will be the Guest of honor and deliver his talk on *'Human reliability assessment in automated systems and implications for an integrated system design'.* It is heartening that this webinar is essentially being organized by SRESA-Indore Team and Shri N.S. Joshi, Ex-RRCAT, Indore, is the Webinar Direcor. Launching of the SRESA -INDORE Chapter will be one of the major highlights of the programme.

SRESA Executive Committee invites you all to join the Webinar 29th May 2021 from 1000 hrs to 1330 Hrs. Programme details are given below. For more details on the webinar registration please contact sresa-web-site: www.sresa.org.in

SRESA's Indian Institute of Risk and Reliability (IIRR)

In association with

Safety Critical Systems Lab, IIT MADRAS

Invite you for the

WEBINAR on

RELIABILITY AND SAFETY OF COMPLEX ENGINEERING SYSTEMS

On 29th May 2021 10:00-13:30

Prof. Neelesh Kumar Jain

Director (Officiating), Indian Institute of Technology, Indore

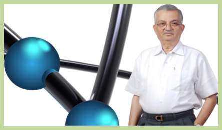
has kindly consented to be the

Chief Guest

for the program and grace the occasion.

(Please see the detailed program overleaf.)

SRESA Editorial team sent a copy of the SRESA Newsletter that contained an article on 10th Anniversary of SRESA. I am delighted to share with you the compliments and congratulatory message from Dr. Anil Kakodkar Former-Chairman, AEC and Secretary Dept. of Atomic Energy, India



Dear Prof. Varde,
Thank you for your mail and the copy of SRESA newsletter. I am delighted to note the steady work and progress you and your colleagues have made in this crucial field. Congratulations!

Warm Regards,
Anil Kakodkar
Chairman, Rajiv Gandhi Science & Technology Commission
Former Chairman, Atomic Energy Commission

Invitation for Contribution to the Newsletter

SRESA Newsletter published Articles under the following major categories:

1. Brief technical article up to four pages (Max.) discussing a new idea, design, achievement in operational performance, major result(s)/finding(s) of a study or experiment, and review.
2. Insights and experiences of collaborative research, development and applied research work, visiting position and postdoctoral research, academic achievements,
3. Book review particularly, review of book written by SRESA members.
4. Announcement of upcoming conferences of having relevance to SRESA members.
5. Major events organized and activities by SRESA chapters
6. Information on publications in the form of extended abstracts by SRESA members for wider publicity

For submission of article editor on contact: newsletter@sresa.org.in, editor@sresa.org.in

SRESA invites the engineering professionals to become member of the Society. The SRESA membership forms duly filled and signed along with applicable membership fee, as per the guidance provided at the bottom of the membership form, should be sent to the Hon Secretary SRESA at secretary@sresa.org.in. Once the SRESA executive committee approves the membership, the same will be communicated by email along with the membership Certificate. For details visit SRESA web-site: www.sresa.org.in

Society for Reliability & Safety (SRESA)

(REG. NO. :F-43051 (Mumbai))
SRESA COORDINATOR, SHRI S.J. RAUT, 64-VIBHA, R. PARAMHANS MARG
OPP. CARDINAL GRACIOUS HIGH SCHOOL; BANDRA(E) MUMBAI - 400051
Web Site: www.sresa.org.in (PHONE ; +91-22-25596206)

MEMBERSHIP APPLICATION FORM. **MEMBERSHIP NO*.**

1.	Name of applicant		Photograph
2.	Qualification		
3.	Affiliation		
4.	Position held		
5.	Specialization		(Affix passport size photograph above and send one additional softcopy with email)
6.	Official address ☐ Residential Address ☐ (Please tick the address to be used for official communication)		
7.	Cell phone number(s)		
8.	Email		
9.	Date of birth (DD/MM/YY)		
10.	Type of membership (Tick applicable category)	Life membership : Rs. 2,200/- Corporate membership : Rs 50,000/- Annual student membership : Rs 500/- (Please tick the applicable category)	☐ ☐ ☐
11.	Payment mode: i) Cheque ☐ ii) Demand draft ☐ iii) On-line transfer: ☐ Cheque /DD/online transfer details :……………………..Date: ………………. Amount: ……………………… Name of the Bank:……………………Account number…………ISFC code		
12	Applicant's Signature:		

- Kindly send the scanned copy of the form duly signed by email to Secretary, SRES along with a soft copy of the passport size photograph at secretary@sresa.org.in
- SRESA account details are as follow : Money to be transferred in favour of 'Society for Reliability and Safety', Bank Name: State Bank of India, Account number : 31110442604, Swift Code SBININBB508, Branch: BARC, Mumbai-400085.
- *will be allotted by SRESA Office.