GOVERNMENT OF INDIA
DEPARTMENT OF ATOMIC ENERGY
LOK SABHA
UNSTARRED QUESTION NO.1639
TO BE ANSWERED ON 21.09.2020

R&D CENTRES

1639. SHRI BHOLA SINGH:
SHRIMATI SANGEETA KUMARI SINGH DEO:
DR. JAYANTA KUMAR ROY:
SHRI RAJA AMARESHWARA NAIK:
SHRI VINOD KUMAR SONKAR:
DR. SUKANTA MAJUMDAR:

Will the PRIME MINISTER be pleased to state:

(a) whether the Government has set up Raja Ramanna Centre for Advanced Technology for Research and Development (R&D) in non-nuclear front line research areas of Lasers, Particle Accelerators & related technologies;

(b) if so, the details thereof along with its achievements in terms of research output since its inception;

(c) whether the Government is planning to open more such R&D centres across the country;

(d) if so, the details thereof; and

(e) the other steps being taken by the Government for promotion of R&D in the areas of Lasers, Particle Accelerators and related technologies in India during the last five years?

ANSWER

THE MINISTER OF STATE FOR PERSONNEL, PUBLIC GRIEVANCES & PENSIONS AND PRIME MINISTER'S OFFICE (Dr. JITENDRA SINGH):

(a) Yes, Sir.

(b) Raja Ramanna Centre for Advanced Technology(RRCAT)was established by the Department of Atomic Energy (DAE) in June 1986, India to expand its activities in two frontline areas of science and technology namely Lasers and Accelerators.

Major activities being pursued at RRCAT are as follows:

i) Synchrotron radiation sources (Indus-1 & 2), Advanced light sources using insertion devices, and Free electron lasers.

ii) High intensity superconducting proton accelerator: design studies and technology development for future projects.

iii) Electron accelerators for societal applications.

iv) Development of lasers of different types and their applications.

v) R&D in materials, cryogenics, superconductivity etc.

vi) Participation in international collaborations / mega-projects: Centre has participated in various international projects, wherein it has been the nodal agency for collaboration with CERN, Geneva for the LHC project and other associated activities. The Centre is one of the major participants in the Indian Institutions Fermilab Collaboration (IIFC).

vii) Presently, the Centre is the nodal agency for the setting up of the LIGO project in India.

Major achievements of RRCAT are as follows:

a) Indus Synchrotron Radiation facility, established by RRCAT, is being extensively used as a National Facility. The indigenously developed Indus Synchrotron Sources at RRCAT, Indus-1 (450 MeV, 100 mA) and Indus-2 (2.5 GeV, 200 mA), have been operating round-the-clock since February, 2010.

b) Sixteen beamlines on Indus-2 and six beamlines on Indus-1 are currently operational. Out of these sixteen beamlines, three beamlines, namely: Engineering applications beamline, Small and wide angle x-ray scattering beamline and Grazing incidence x-ray scattering beamline, were commissioned in the year 2018-19. Researchers from nearly 150 institutes and national laboratories from all over India are using these beamlines for their research activities. During the calendar year 2019, a total number of 945 user experiments were carried out at the different Indus beamlines and 175 publications were made in peer-reviewed journals. In the recent past, there has also been an increase in the usage of the Indus beamline facilities by the R&D sector of private pharmaceutical industries. Five more beamlines are in various stages of completion, which include two bending magnet beamlines and three insertion device (ID) based beamlines.

c) An Infra-Red Free Electron Laser (IR-FEL) has been built at RRCAT and saturation of lasing has been achieved with an out-coupled CW average power of 5 - 7 mW and peak power ~ 4 MW in 10 picosecond long pulses at a wavelength of 28 micrometers. The IR-FEL is designed to lase in the 12.5 - 50 micrometers wavelength region with an electron beam of 15 - 25 MeV and a 2.5 m long, pure permanent magnet undulator. A commensurate

user facility has been developed to use the infra-red radiation from the IR-FEL for the spectroscopy of materials under low temperature (down to 5 K) and high magnetic field (up to 7 Tesla) environments.

d) RRCAT has established an *Agricultural Radiation Processing Facility* (ARPF) at Devi AhilyaBaiHolkar Fruit and Vegetable Mandi, Indore for societal applications of electron beam processing. The heart of this facility are two 10 MeV energy, 5 kW power linear accelerators, developed indigenously at RRCAT. On January 25, 2019, the processing facility obtained required licence from Atomic Energy Regulatory Board (AERB) for running as a facility. The electron beam radiation processing of various products is being carried out by Bhabha Atomic Research Centre (BARC) as well as by various ICAR institutes, universities and industries on regular basis to demonstrate usefulness of the electron beam technology for a variety of social applications. Some of the major applications already demonstrated include mutation breeding of new crop varieties (pulses, wheat, rice, millets, etc.), microbial decontamination of dehydrated food products and phytosanitary treatment of rice seeds,improvement in functional properties of semiconductors switching devices, colour modification of gems, preservation of food products including spices, sterilization of medical devices, damage assessment of solar cells and other sensors for research in space applications. RRCAT is in the process of obtaining FDA license for sterilization of Risk Class-A medical devices by electron beam radiation processing at the facility.

e) RRCAT has built facilities and expertise to develop almost all the sub-systems required for accelerators, including RF technology, magnets, vacuum, beam diagnostics, precision mechanical positioning and alignment, control system, superconducting radio frequency cavities etc. The R&D in accelerator technology has also led to several spin-offs for societal benefits.

f) In the area of lasers, several lasers like lamp pumped and diode pumped solid state lasers, copper vapor lasers, fiber lasers, semiconductor diode lasers and laser based systems have been developed for industrial, medical, nuclear and research applications. An important aspect of the R&D in lasers and associated technologies is the successful deployment of several lasers and optics based tools and processes developed in-house for the maintenance, refurbishing, diagnostics,medical and metrology related

applications in nuclear reactors and other nuclear installations. It has helped in saving precious man-days, saving associated costs and in minimizing manrem consumption and shutdown time. These include remotely operable fiber coupled lasers with customized tools, which have been deployed for cutting operations in the high radiation environment of nuclear reactors and in narrowconstrained regions, which are otherwise not possible with conventional mechanical methods.

g) Several laser based instruments have been developed for various DAE applications and also for societal applications. A portable version of Raman optical fiber distributed temperature sensor (ROFDTS) system using a 532 nm pulsed laser and 200/220 µm sized, 150 m long multimode sensing fiber has been developed and demonstrated. The developed ROFDTS was installed for temperature monitoring of a vacuum section of a beam line in Indus-2. An FBG based temperature sensor set-up has been developed and deployed at the Advanced Fuel Fabrication Facility (AFFF), BARC, Tarapur, to monitor the temperature of microwave heated nuclear fuel processing chamber.RRCAT has developed two optical technology based, easy-to-use, portable and low cost health-care instruments, a “TuBerculoScope” and an “OncoDiagnoScope”. The “TuBerculoScope” is an easy-to-use, compact and portable optical device for rapid detection of TB while “OncoDiagnoScope” is intended for instant, non-invasive screening of oral cavity cancer. Both these systems have undergone validation through various clinical studies in hospital settings. Units of these instruments have been handed over to various hospitals including HomiBhabha Cancer Hospital, Varanasi, Institute of Medical Sciences, BHU, Varanasi and HomiBhabha Cancer Hospital, Sangrur for their further clinical validation over large number of patients. Data generated from these instruments will help develop more robust instruments for large scale deployment of these instruments. The technology of "TuberculoScope” has been successfully transferred to an Indian industry.Further, the technology of a hand-held Raman probe, developed at RRCAT, which is capable of generating good quality Raman spectra from low Raman active materials like biological tissues has also been transferred to an Indian industry.

h) RRCAT has designed a UV-C light based mobile sanitization device (called “NeelBhasmi”) intended for remote sanitization of air as well as the surfaces of various objects (including glass, plastic, cloth etc.) inside a room. The technology of NeelBhasmi has been transferred to four Indian industries.

i) Based on in-house developed technologies, sixteenpatents have been granted to the center while fifteen technologies have been transferred to the industry.

j) Based on the research work carried out in the center, 3713 research papers have been published (since 1987) in various national and international journals.

(c) DAE does not have any specific plans to set up research centres like RRCAT.

(d) Not applicable.

(e) DAE has developed a long-term roadmap for accelerator technologies. In the first phase, a Low Energy High Intensity Proton Accelerator (LEHIPA), with energy of 20 MeV and intensity of 10 mA was taken up by BARC. In second phase it is planned to develop Medium Energy High Intensity Proton Accelerator (MEHIPA) and then High Intensity Superconducting Proton Accelerators (HISPA).

Some of the R&D activities undertaken with respect to accelerator technologies are:-

i. Acceleration up to 3 MeV has been demonstrated in LEHIPA project.

ii. Indigenous development of a Radio Frequency Quadrupole (RFQ) was done.

iii. India has already made and supplied superconducting cavities, power amplifiers, magnets and controls for (Proton Injector Project) PIP-II project which was tested and accepted at Fermilab.

iv. 10 MeV electron accelerator has been developed and utilised for diverse societal applications such as irradiation of chitosan (a bio stimulator used in agriculture) to enhance sugar cane production and various other R&D studies.

v. Development of electron accelerators such as 1 MeV (for environmental applications) and dual energy (for security) LINAC was initiated.

vi. Research to explore newer techniques of selective excitation in molecules, development and application of lasers for improvingbiomaterial properties and conducting studies on laser-surface interaction. Laser based security system and instrumentations were developed and some of these technologies were transferred to private entrepreneurs.

Some of R&D activities undertaken the area of related Plasma technologies are:-

a) Work in the area of thermal plasma for non-nuclear applicationslike high temperature thermal barrier and corrosion resistantcoating of refractory materials (like yttrium oxide, aluminiumoxide etc.) was initiated.

b) A totally indigenous 30 kW Hafnium cathode based DC Air plasma torch has been developed. The torches are being deployed for management of municipal solid wastes in an environment friendly manner.

c) Work undertaken for nitrogen functionalization of multiwall carbon nano-tubes using Cold Atmospheric Plasma (CAP) toenhance hydrophilicity of nano-tubes for assisting process requirementin manufacturing of 'BhabhaKavach'.

Variable Energy Cyclotron Centre (VECC), Kolkata a unit of DAE,has carried out the following R&D activities during last five years, in the related areas of Particle Accelerators and related technologies:-

i. Design and development of 650 MHz, low beta Superconducting Radio Frequency(SRF) cavity has been carried out, as part of R&D activities on SRF and associated technologies under Indian Institutions and Fermilab Collaboration (IIFC). Fabricationand testing of prototype cavity of 650 MHz, beta=0.61 superconducting RF linac cavity has been successfully carried out. Development of 5-cell SRF cavity is in progress.

ii. The high intensity proton beam acceleration at the Medical Cyclotron facility of VECC has been installed, commissioned and production of radioisotopes/radiopharmaceuticalsand also R&D activities on Material Science have been started.

iii. The beam from K-500 Superconducting cyclotron have been accelerated, extracted and transported to the scattering chamber of user beam line.

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