

A CONCEPTUAL STUDY ON THE UPCOMING APPROACH OF LASER TECHNOLOGY IN INDIA

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Abstract: *The provision for laser automation at foundations and laboratories in India supplyextensivemoment to the scientists and study scholars affected in the area of gas laser, free electron lasers, solid form lasers, semiconductor lasers, laser concerned substances/crystal and features etc. The strain work in the area of ocularstudyutilizing laser composes of holography, ocularfacts/signal/data storage, prepare, communication and computing, etc. by educational and R & D foundations shows exceptionalachievement. The laser spectroscopic actions develop laser culture in the laboratories. For the growth of ocularunified circuit, and expectedocular communication systems with culturedprovisions, it is important to make nativelycreated lasers. Keeping in mind the consequence of cultivateutilizations of laser, a liking up of foundations and industry is suggested. In this article, an endeavour has been made to highpoint the calculated of success that has been achieved by educational and R & D foundations around the country.*

I. INTRODUCTION

The laser (light elaboration by aroused emission of radiation) is a light origin that disperformsccommonfeatures of monochromaticity, directionality and coherence. The elemental a procedure called aroused emission. A laser elementallycompose of three parts: a resonant ocularcrater (ocular resonator), a laser achieveaverage (active laser average) and a pump origin to inspire the molecules in the achieveaverage. The ocularresonator composes of at least two mirrors among which the light rebound up and down resonantly. One of the end mirrors is commonlylightlysedate called the output coupler. The laser workneedsanachieveaverage in the resonator, which intensify light. Lasers are classified by the different of achieveaverage they worker (gas laser, solid-form laser, dye laser, semiconductor laser, etc). The activemolecules in the laser achieveaveragerequirement to be in a form of reversal for the laser to function. To extend this formpushingprocedure is needed, which raise them into the needed energy form.

In fact, lasers are used in thousands of utilizations in every stage of modern society, containing consumer electronics, facts and communications automation, entertainment, science and industry, the medical area and defence. Modern laser studyaffects principal laser physics, imaginativegrowth of unique laser theory and developedexploratorylabour and conclusion. All this can guide to the growth of new lasers, which will fulfil the necessities of recent and expectedordered in science and industry.

II. LASER AUTOMATION

In last two eras laser automation has in its wavelength and has been squirmed in its time province. It has extended CW power stage of closely a million watts in a short rupture and a wavelength near the X-ray region. Most copyrightspermitted are concerned to the automation of laser with power above 1000W. Thesignificance is on higher and higher power, prolonged life in the case of well-attempt lasers, denseness and tightness for area use and the invention of superior is: preparesubstances, producing plasmas, isolating isotopes, etc. The labourhorse of industry residues the CO₂, the significance is on high frequency appliances to improve bindachievement. The interest in waveguide CO₂ is due to its denseness and small power which makes it ideal for medical use.

A high power laser alone does not draw aim of producer/labourers. The metal vapor laser (e.g. Copper vapor laser, gold vapor lasers, Manganese vapor laser, etc.), semiconductor lasers (e.g. GaN, InGaN, and AlGaas etc.), nuclearanimated laser, and N₂-animated dye laser, Nd: YAG- animated dye laser etc. are also gainingfunction in high power laser labouredfor CO₂ laser. When laser beams are applied to the human body the authority of power and of the focal pointposition become valuable.

III. LASER CONCERNEDSUBSTANCES AND FEATURES

Laser substances and features could be designated as (i) those needed for the generation of laser radiation (ii) those needed for the disclosure of laser radiation (iii) those needed for the alteration of laser radiation. The pointlight at current is on the preparedisclosure and alteration. New substances being developed are alexandrite for solid form lasers. The electro optic substances are LiNbO₃, MgO: LiNbO₃, Fe: LiNbO₃KNbO₃, AggaS₂, and AgGeSe₂. Among justifiable laser most substances being developed are Cr: GSGG, Cr: GGG, Cr: BeAl₂O₄, Nd: Cr: GSGG and variant of yttrium aluminium garnet (YAG) and gadolinium scandium gallium garnet (GSGG) doped with Er, Tb, and Nd. These are used in block as rigidcrusting, high tough dielectrics, semiconductors, ceramics, superioractivemeansresumeto be developed. The crystal/substancesNd:YAG, Nd:KGW, Nd:YAP, Nd:Cr:GSGG, LiNbO₃, Fe:LiNbO₃, Gadolinium gallium garnet(GGG), Potassium dihydrogen phosphate(KDP), ADP, BiSiO₁₂(BSO), HgCdTe are developed at SSPL, BARC, IISc, DSC, and IITK. Flash lamp for pushing ruby, Nd: YAG, Nd: glass laser have been developed by BARC. Paper capacitors have been developed by BARC, and by private manufactures.Ceramic capacitors are manufactured regimely by BEL. Thyratrons are

important for functioning many vibrated lasers (such as N₂, CVL, and excimer). Krypton, which are cold-cathode thyatons and are used for Q-switching, solid form lasers requirement to be developed. The ocular features like, prisms, lenses, laser mirrors, windows, and specific girding etc., are accessible in the country through trading and organizational mode. The dielectric mirrors have been made in BARC, CSIO, DSC, IISc, and NPL. Commonly, all laboratories acquire dielectric mirrors from origin foreign. The labour for cultivate ZnSe/ge or coated mirrors for CO₂ has been accepted in India. Holographic gridding for laser labour (i.e. for tuning) are comprehensively transported out at IITM, CSIO, IISc, IITD, IITK, IRDE etc. The latest kind of mirrors viz, stage-fuse mirrors requirement to be developed. For assortment of lasers-in specific, Ar⁺, Kr⁺ and CVL lasers-critical features needed are beryllium and alminatunned.

IV. POSITION OF LASER PROVISION

Indian institute of Automation, Delhi (IITD) have ocular fibre braiding and characterization set-up, high power lasers, ocular fibre blend provision, diode animated Nd: YAG laser, provision for ocular stage association with photorefractive, OTF counter, active holographic writing set-up, thermoplastic photoconductor holocamera, image prepare system, real-time spectroscopy system, excimer lasers, liquid helium relativeseries cryogenic labour, spatial light coordinator, polarizing microscope, ocular multichannel analyser, titanium sapphire laser etc. Indian institute of automation, Kharagpur (IITKGP) has fibre optics lab, high power semiconductor lasers, unified optics lab, etc. Tools Study & Growth Establishment (IRDE), Dehradun, is a launching institution in the sector of laser dimensions finders, laser dimension sensors, laser warning systems, photonics and holographic products, and fibre optics systems, software for micro-machining. Laser interferometer, etc. International School of Photonics (ISP), Cochin have provision like ultra-fast Ti-sapphire laser, ultra-fast T-sapphire recorder, 5 watt CW DPSS laser, Q-shifted Nd: YLF green laser, ocular parametric oscillator, Nd: YAG lasers, ring-dye laser, vibrated dye laser, helium-cadmium laser, Nd: glass laser, carbon dioxide laser, nitrogen laser, semiconductor diode lasers, He-Ne lasers etc. Indian Institute of Automation, Guwahati (IITG) has Q shifted high power Nd: YAG laser, laser ablation set-up, multiple beam interferometry set-ups, fibre optics communication set-up etc. Raman Study Institute, Bangalore supply femtosecond laser with recorder, producing 100fs laser pulses, frequency paired and Tripler, and isolate crack autocorrelator, nanosecond Nd: YAG laser with second harmonic output, UV-VIS spectrophotometer, monochromator, fibre optic spectrometer, laser beam mark, ultra high vacuum chamber (300 its volume), 10W, NdVO₄ pump laser, vibrated at a rate of 10 pulses per second. The principal IR radiation has energy of 850mJ per pulse, frequency paired green 450mJ and the frequency tripled UV 200mJ. University of Pune, Pune supplies Zeiss Axiovert microscope (Inverted) with laser link + CCD + monitor, excimer lasers, Nd: YAG (oscillator + recorder), ruby laser (oscillator + recorder), CO₂ laser (CW), ocular multichannel

supplies He-Ne and diode lasers, ocular fibres, and ocular fibre kits. In Laser Science & Automation Centre, Delhi (LASTEC) the provisions affect high power lasers viz., burning manage high power gas active laser, chemical oxygen-Iodine laser, low energy solid form lasers, Nd-YAG laser nominator cum dimensions finder, beam authority technologies, electro-optic counter calculated, laser substances, laser-concerned Optica, thin film crusting, laser crystal/ glass substances.

V. LASER IN COMPOSES STUDY

An optic study utilizing laser composes of holography, ocular data storage, prepares communication and computing, unified optics and speckle occurrence, metrology, etc. There has been extensive action in the sector of non-classical forms of light utilizing nonlinear ocular occurrence. The main conceptual groups in the area at BARC, IITD and University of Hyderabad have been assortment active in the esoteric subjects of nonclassical light, measure variations, six-wave variations, non-equilibrium stage conversions in the existence of non-classical light, stage association, crushed forms etc. Less esoteric and somewhat laboratory aligned study in non-linear optics is pursued at BARC, CAT, IACS, IITK, TIFR and the universities of Burdwan, Cochin, etc. Laser and photonics concerned actions, opto-electronics and ocular-communication is a study programme being current by IIT Delhi. The study sectors affect fibre-optics, laser electron acceleration in dense plasmas, real-time ocular prepare, laser Raman and photoluminescence, spectroscopy, non-linear unified ocular appliances, millimetre wave free electron laser, photon persuaded link alteration. Shri G.S. Institute of Automation & Science, Indore (SGSITS) run programme in optoelectronics with specification in ocular communication. At current, the department has mobilized its highest study actions in the sectors of laser physics, of Plasma study, Gandhinagar, Gujarat affected in study in contradictory condition of plasma science containing free electron laser, dusty plasma and other nonlinear occurrence. Labour is bustling on in the sector atomic spectroscopy (like co-work of severe laser sector with atomic systems, wave variations, spectroscopy of ions and short lived isotopes.), molecular spectroscopy (reverberation and time conclude Raman spectroscopy, active of inspired forms, laser photoelectron spectroscopy), laser examining spectroscopy (disclosure trace & ultra-trace bulk of elements, utilizations to cosmology, nuclear physics, hydrology, biomedical sciences, oceanology, geoscience etc. search of photo ionizations in the atmosphere by high power lasers and syncyclotron radiation origins. The laser spectroscopic actions in Bhabha Atomic Study Centre (BARC) affect programmes like high-resolution atomic spectroscopy, laser optogalvanic spectroscopy multiphoton ionization spectroscopy, high resolution infrared diode laser spectroscopy of polyatomic molecules, laser Raman spectroscopic search on biological molecules, semiconductors, stage conversions, laser optoacoustic and laser-persuaded fluorescent spectroscopy, laser spectroscopy techniques for trace search, spectroscopic search on supersonic nozzle beams, concept search on co-work of

laser radiation with atomic systems, spectroscopy and chemistry of laser photo detachment products, laser products plasmas etc. The labour at IITK is in multiphoton prepared, Doppler free cultivating, optogalvanic spectroscopy, photochemical reactions, laser Raman spectroscopy, solid form spectroscopy, laser-persuaded fluorescence, spectroscopy of high temperature superconductors etc. In IRDE, laser and photonics concerned actions are being pursued in Doppler free cultivating, optogalvanic spectroscopy, photochemical reaction, laser Raman spectroscopy, solid form spectroscopy, laser-persuaded fluorescence, solid form spectroscopy of high temperature superconductors etc. In IRDE, laser and photonics concerned actions are being pursued in departments. The sectors of study affect ocular netlabours fibre optics, fibre-optic communication, photonics, laser physics, non-linear optics etc. In IITG, the main point light of study in the department is in the following sectors lasers and photonics, laser matter co work, plasma disease, ocular interferometry, optoelectronics, unified optics, etc. in Raman Study institute, Bangalore the interests have broaden to affect laser cooling and catch of atoms, study of ultrafast prepared and severe laser-matter co works. The sectors currently under study affect haphazard lasers, non-linear optics, laser cooling and catch of atoms, severe laser matter co works. In Physical Study Laboratory (PRL), the study actions affect measure computation & measure facts, measure optics, ocular resonators and ocular fibres. In International School of Photonics (ISP) the study sectors affect laser persuaded plasma spectroscopy, fibre optic sensors, photo-acoustic search, non-linear optics like non-linear optics substances, holography, fibre optic sensors, laser utilizations etc. Raja Ramanna Centre for Developed Automation, Indore (RRCAT) engaged in R & D in non-nuclear front line study sectors containing contradictory different of lasers, laser concerned features and laser-based tools. Trading ruby lasers were being used for the study of He-Ne, Ar-ion, carbon dioxide, nitrogen, nitrogen laser animated dye, Cu-Vapor, Ar-ion animated dye and Cd-plasma recombination lasers are some of the lasers developed at IIT Kanpur. The main study actions affect high resolution laser spectroscopy, non-linear optics, laser plasma search, laser Raman search, medical utilizations of lasers, photonic appliances, electro-optic substances and appliances. The laser spectroscopic labour at BHU affects unique laser based techniques of photo acoustic, opt galvanic, melting capture and photo ionization spectroscopy etc. At IITM labour has been done in laser Raman spectroscopy, aroused Raman scattering, photoacoustic spectroscopy, achieve spectroscopy, photo isomerism search etc. Pico second and femto second spectroscopy has importantly been possible due to short vibrated lasers and exciting growth in disclosure electronics and sensors. The Physics Department at IIT, Bombay has a live study program with labour bustling on in boundary sectors of optics and laser spectroscopy. The sectors under laser and optics being pursued affect non-linear ocular prepared and ultrafast ocular switching, holographic interferometry and laser spectroscopy. The action at Tata Institute of Principal Study (TIFR) laboratory affects time-

conclude chemical and origins. Lasers and heavy ion beams from an accelerator are being progressively used to understand the prepared which occur in astrophysical and plasma environments. Ultra short (femtosecond) laser producing very high crest powers are being used to explosively ionize matter and study its behaviour at these forceful, "consonant" excitation conditions. Nonlinear ocular features of develop and unique substances are being studied to understand how prepare structure influences its ocular response. The study sectors at Department of Nuclear and Atomic Physics affect Co work of electrons, ions and neutrals with laser inspired molecules, Co work of matter in severe laser sector, Non-linear optics, and measure computing and ocular communications. The main objective of Centre of Superiority in Laser & Optoelectronic Sciences (CELOS) is to establish study actions in the area of laser & optoelectronic sciences and to frame them to a level of competence comparable with international standards. The core sectors of study at this centre affect laser automation, non-linear optics, laser-matter neural netlabour, photonic substances growth, and optoelectronic appliances. The department of Physics at IIT, Madras carries out study in many boundary sectors, ocular and laser physics, ultrafast lasers and ocular recorders. The first semiconductor laser in India was developed at BARC in 1965. Centre for developed Automation (CAT) built first copper vapor laser. It is the most powerful laser diffuses visible light. Copper vapor lasers efficient of producing up to 40 Watt average power had been developed at CAT. These lasers are also used to pump justifiable dye lasers whose wavelengths can be alternate. Another valuable laser developed technologies of many different of CO₂ lasers namely, low power slow flow CO₂ laser, high power fast flow CO₂ laser, justifiable CO₂ laser and high pressure vibrated CO₂ laser and is also ensuing utilizations of these CO₂ lasers in medicine and industry.

VI. BIOMEDICAL UTILIZATION OF LASERS

The most subversive utilizations of lasers in medical science are in dermatologic surgery, neuro surgery, oncological surgery, ophthalmologic surgery, oral surgery and so on. Laser surgery discards surplus prostrate tissue by ablation and enucleation. For smooth hair free skin, laser medication labours on hair root beyond harming encircling skin. CAT has been cultivating CO₂ lasers for surgery and nitrogen laser for medication of tuberculosis. The medication compose of put a tease from the behind of the patient into the crater and then illuminate the crater with the nitrogen laser beam which is transmitted through an ocular fibre introduced through the tease into the crater. Exposure of the burn wounds to nitrogen laser results in total restorative of the wounds. CAT has taken up growth of examining tools laser fluorimeter for disclosure of low concentration of uranium in water samples. This instruction of low concentration of uranium in water samples. This tool uses a nitrogen laser to inspire fluorescence in uranium origin. The passion of this florescence's a direct indication of the concentration of uranium in water. In IITD, the quasi elastic laser light scattering and laser Doppler velocimetry are used

to get facts about the size and movement of the microorganisms, cells organelles, and molecules. These search are concerned to the diffusive motion, self-propelled motion (e.g. of sperms) and motion in electric sector. The effect of time, dilution and certain cations (e.g. K^+ , Ca^{2+}) on the velocity position of human sperms has also been examined. Electrophoretic light scattering technique is being used to comprehend electro kinetically diseased blood cells. In IITM labour has been proposed on monitoring chest movements by holographic and speckle interferometry with a view to get diagnostic facts and cardiac displacements or mal functions. Reluctance of tissues and blood samples for HeNe light is also being studied. In IITK labour on the contradictorily fluorescence spectra of diseased samples of tissues and body fluids has proposed. Laser as well as common spectroscopic search of the lens and gall bladder stones has been done in BHU. Lasers are finding wide ranging utilizations in medicine and have already revolutionized the medication of contradictory disorders, ranging from retina to angioplasty. Modern sectors should be taken up are investigations of cowork of laser beams of contradictory wavelengths with contradictory tissues of the human body and laser based techniques for conclusion. Laser surgery has many advantages over common surgery. In laser surgery there is elementally no bleeding, far less trauma to the patients and restorative is faster. CAT therefore decided to develop a surgical laser based on a 60W CO₂. This surgical laser has an enunciate arm with seven elbows to allow the surgeon to guide the laser beam.

VII. LASERS IN PREPARE

The main utilization of adequately high mechanized lasers (CO₂, Nd: YAG/Glass) in industry is in prepare. Many producers in our country have installed high power lasers (CO₂, CW, 2kW) for laser train, profile cutting, bind and surface medication of metals. CAT has also developed a fast glow high power CO₂ laser efficient of producing up to 5 KW power frequently. This laser can efficiently cut steel sheets more than one cm thick.

Laser bind is suitable for bind contradictory metals. Utilizing the 4KW high power CO₂ laser, CAT scientists have successfully gladdedeven rigid substances on the blades. Similarly, a technique was developed to improve ceramic coating to turbine blades by laser varnish. In the sector of surface alteration of substances by high power laser, study and growth labour is being transported out at Defence Metallurgical Study Laboratory (DMRL). Utilizing a 5kW CO₂ laser, assortment of prepared such as regimenting, alloying and melting of steels, Ti alloys, Al alloys and ceramics are being developed to forestall from erosion and corrosion. In IITM grinding wheels of SiC/Al₂O₃ have been dressed utilizing Nd: YAG laser radiation. In BARC assortment of specific problems of nuclear reactor automation are being managed by laser substances prepare. Labour on surface rigidness augmentation of aluminium alloys and on erosion of polymers has been proposed in IITK.

VIII. RECOMMENDATIONS

The labour on laser metrological tools, laser spectroscopy tools for trace search, mineral examination, forensic science, pollution monitoring, medical conclusion etc. should be given priority. The growth of micro channel plate, diamond turning lathe for ocular features, production automation of holographic girding should be heartened. The automation of holographic element containing girding, computer-generated holograms and ocular facts prepare should be made accessible to foundations. Laboratory and institution should systematize labour shop and study training program every year on laser automation, holography & optics, laser prepare, laser in industry, laser crystals, engineering optics, fibre optics communication, laser spectroscopy etc. to encourage cowork among labouring scientists. Normal programmes to train technicians should be taken up. Expected necessity of laser specificity in R&D foundations, industries and hospitals requirements specific aim. Laser physics and automation is already being instructed in many educational foundations. This should be heightening by providing more laboratory provisions to foundations. The establishment of national provision for growing laser, nonlinear ocular and ocular crystals/ substances is suggested. Encouragement to multi organizational, multidisciplinary programmes with time bound target for biomedicine, laser substances prepare and ocular computing are needed.

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