Raja Ramanna Centre for Advanced Technology, Indore

Scientific Accomplishments of the Last Year

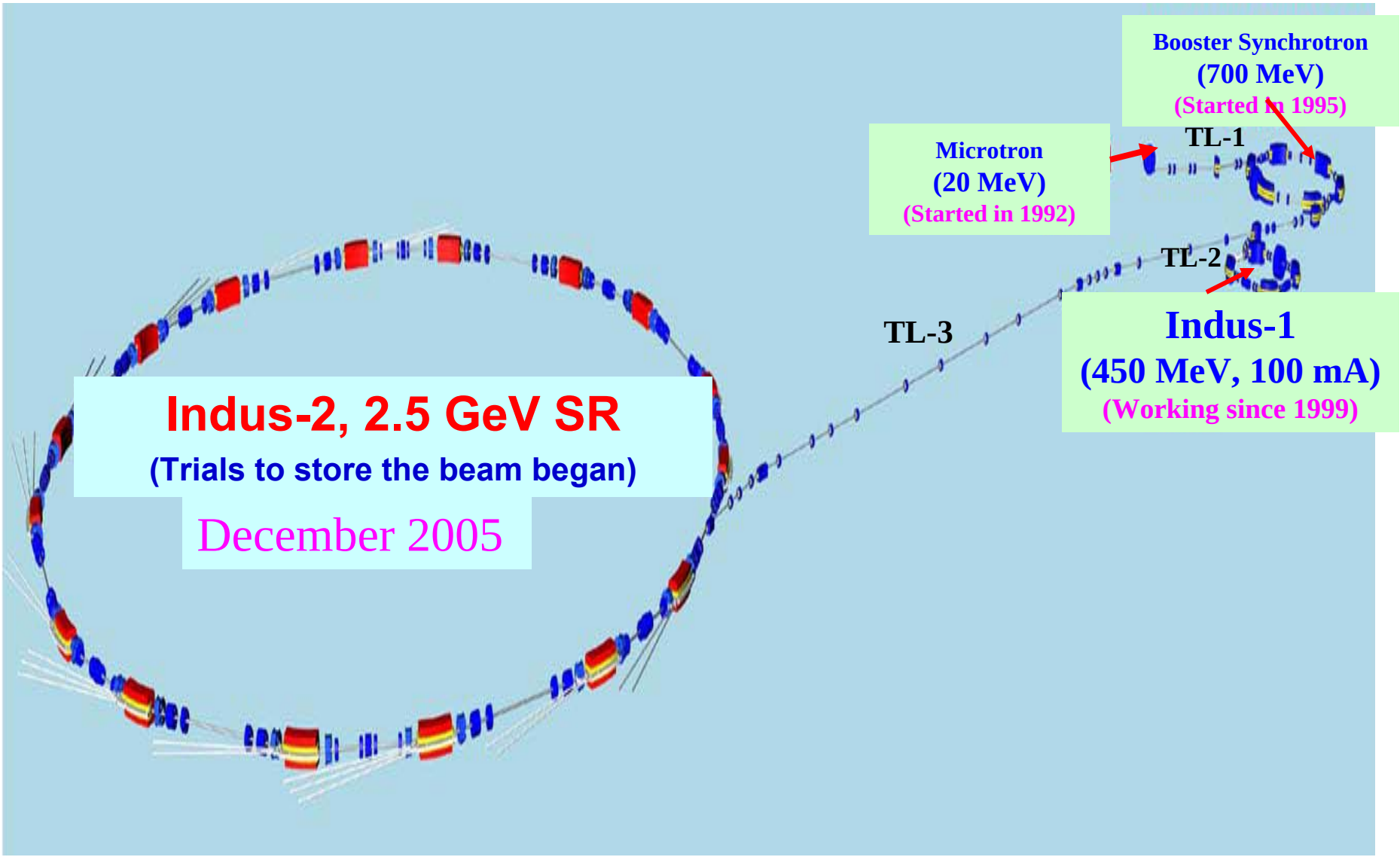
Inauguration of CAT by President Giani Zail Singh. Seen along with him (L to R) are—Dr. R. Ramanna, Chairman, Atomic Energy Commission: Shri P.C. Sethi, Union Home Minister; Shri Arjun Singh, Chief Minister of M.P.; Shri Bhagawat Dayal Sharma, Governor of M.P.; Shri Shivraj Patil, Union Minister for Energy; Shri Rajendra Dharkar, Mayor, Indore Municipal Corporation & Shri C. Ambasankaran, Chairman, P&IC, CAT.

Our Centre's Foundation Stone was laid on 19th February 1984

A Very Warm Welcome to
Prof. P. Balaram, Director, IISc, Bangalore
on his visit to our Centre

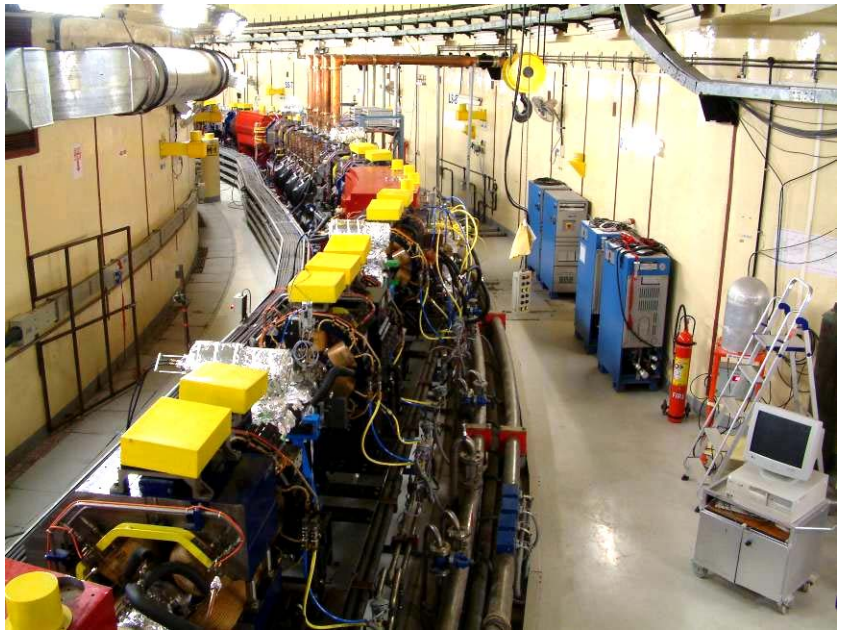
RRCAT FOUNDATION DAY FUNCTION
February 19, 2007

SCHEMATIC VIEW OF INDUS COMPLEX



Status:Indus-2, TL-3 Fully Integrated;~38mA accumulated.
Injection @550MeV, beam energy ramped up to 2.4 GeV.

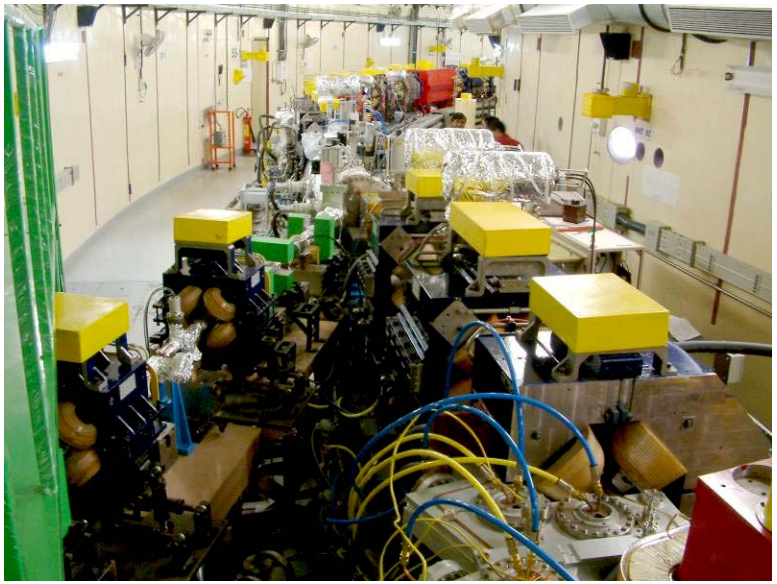
Assembly of Indus-2 Ring in the Tunnel



RF Cavities installed in Indus-2 Ring

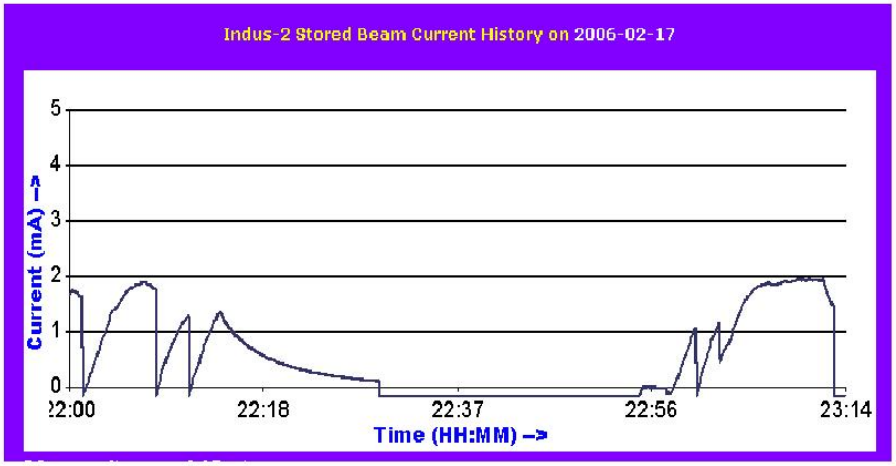
Long Straight Section LS-6 Assembly

Transport Line-3 Joining on to Indus-2

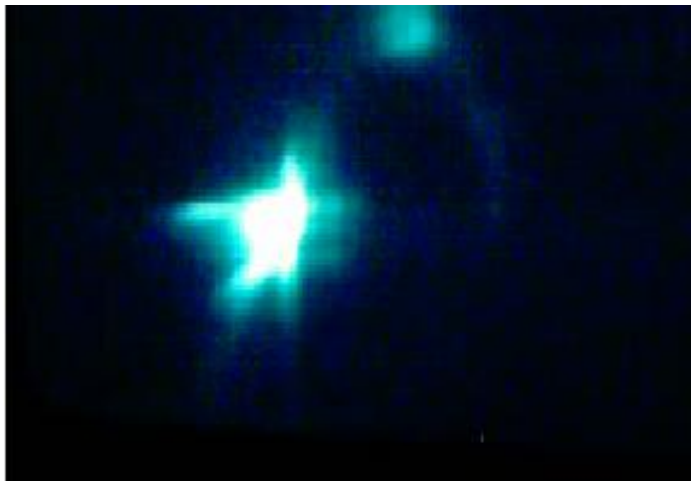


Major Events in 2006 (I)

First current accumulation in Indus-2 seen using DC Current Transformer) (17 Feb 2006)

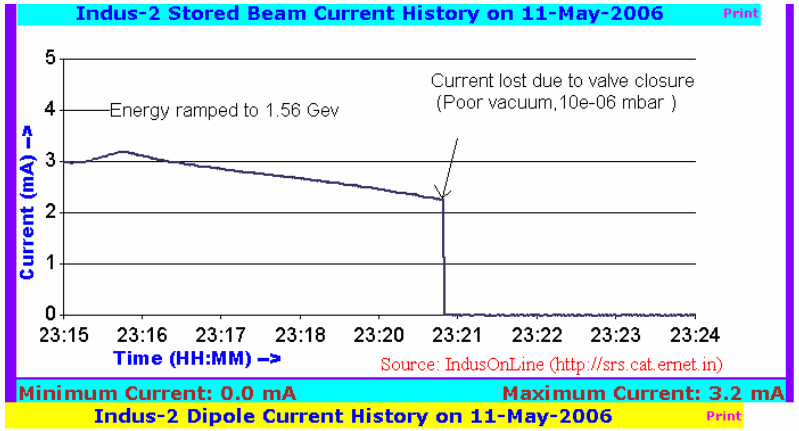


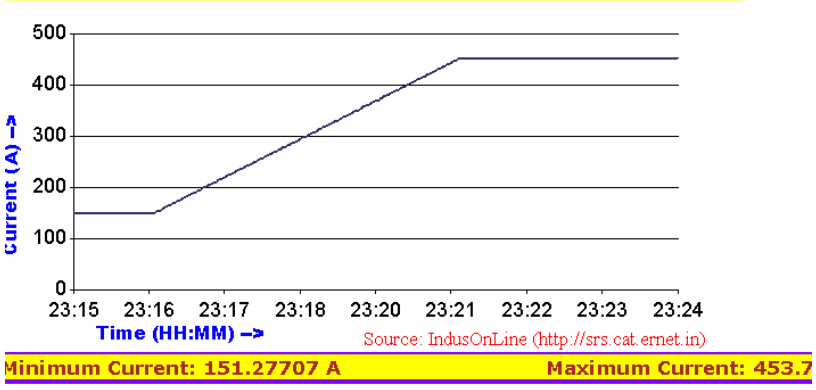
Maximum Current= 2.1 mA



Synchrotron Light at 2mA Beam as seen by CCD onsighting beamline on Feb 17, 2006

Successful energy ramping >1.5 GeV (May 11,2006) in Indus-2: Upper trace shows current in Indus-2; lower trace shows current in the dipole magnets. 150 Amps corresponds to 543 MeV ~450 Amps corresponds to 1.56 GeV.



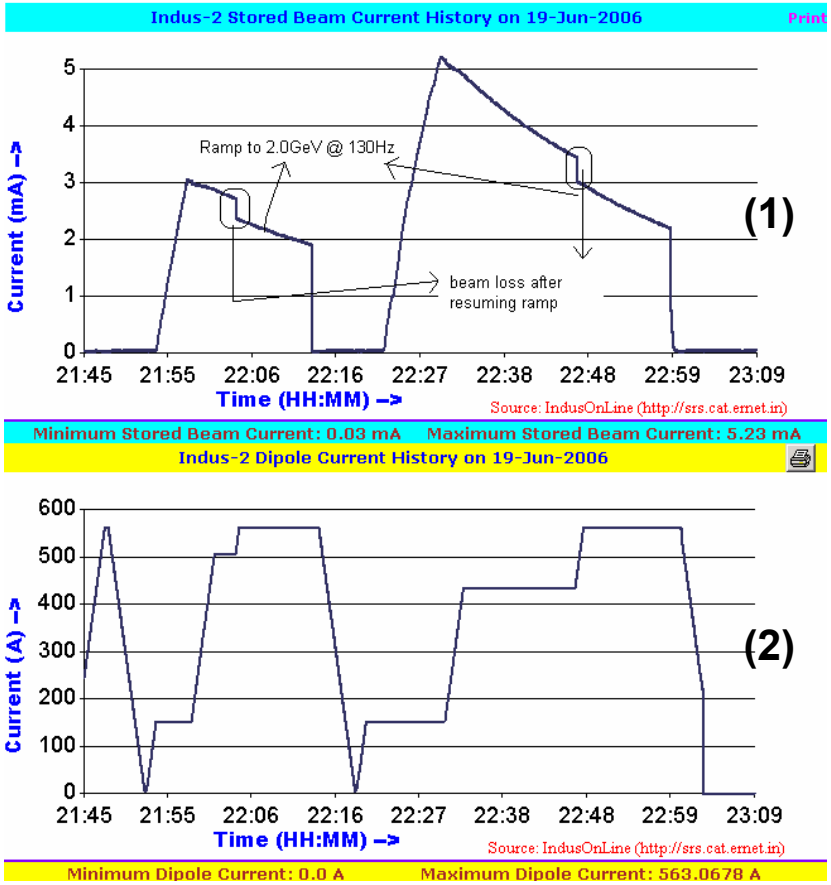


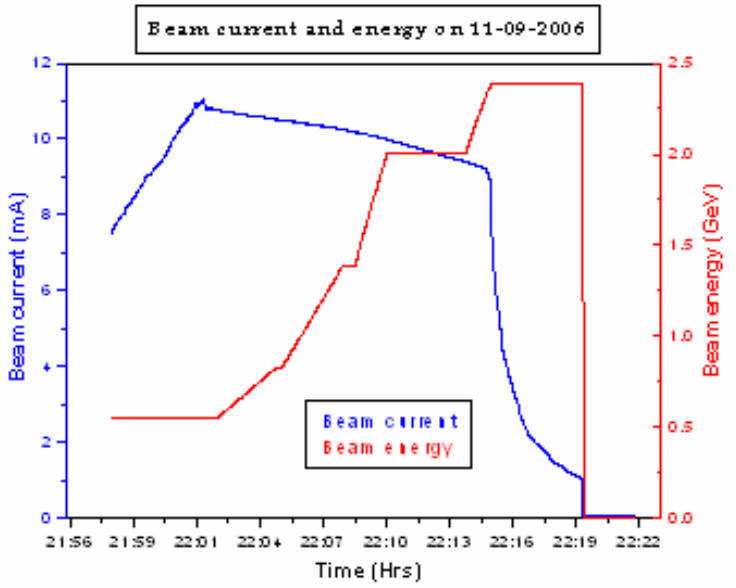
Major Events in 2006 (II)

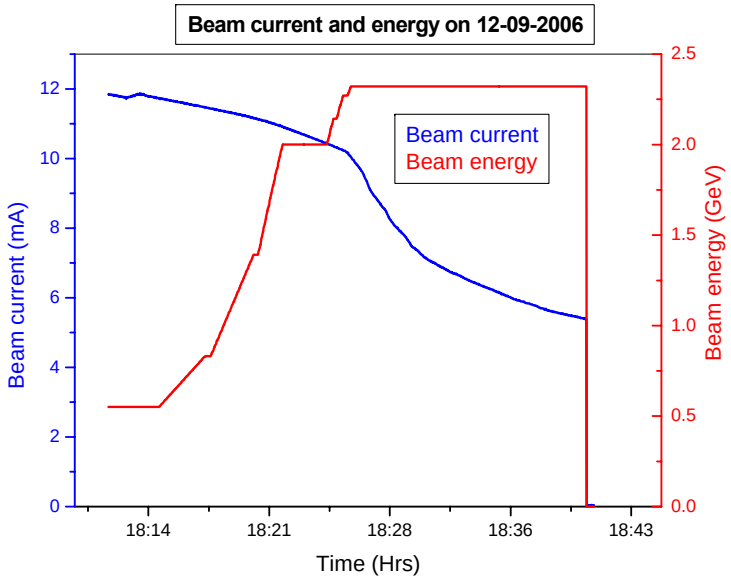
Energy ramped to 2 GeV (19/6/ 2006).

(1) shows current in Indus-2;

(2) shows current in the dipole magnets. 150 Amps corresponds to 543 MeV; ~550 Amps corresponds to ~2 GeV.







Beam-lines being built/designed/planned (updated 10-2-06)

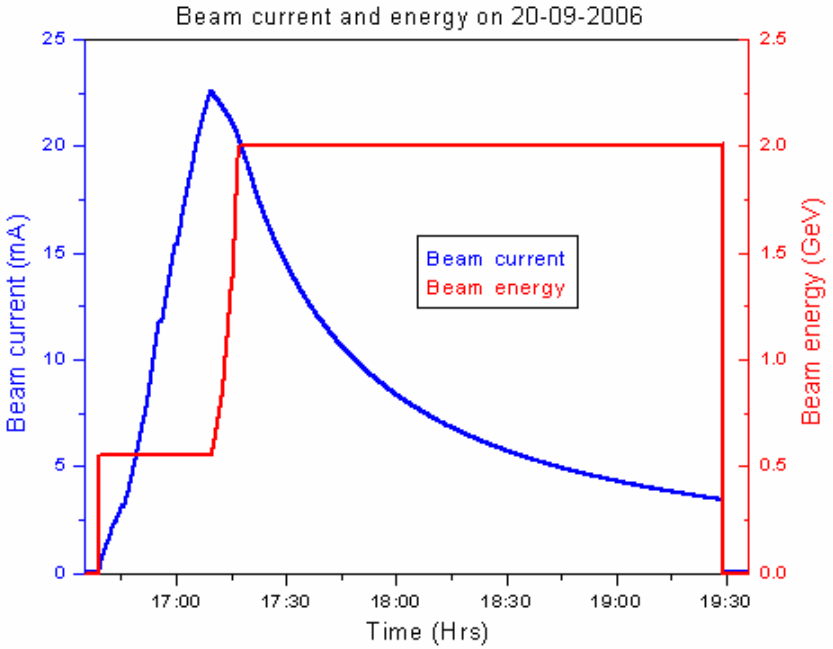
	Range (KeV)	Groups
Being built		
XRD powder diffraction (Installed)	5 – 25	RRAT
XRF-microprobe	2 – 20	RRCAT
Energy Dispersive – XRD	10 – 70	BARC
EXAFS (Installed)	5 – 20	BARC
Grazing incidence mag scattering	5 – 15	SINP, Kolkatta
PES (With high resolution at ~6keV)	.8 - 15	BARC
Small angle X-ray scattering (SAXS)	8 - 16	BARC + IGCAR
Being designed		
Protein Crystallography	6 – 25	BARC + UGC-DAE-CSR
White-beam lithography	1 – 10	RRCAT
MCD/PES on bending magnet	0.03 – 4	UGC-DAE-CSR
Medical imaging beam-line	10 – 35	BARC + UGC-DAE-CSR
Planned		
IR-beam-line	2 – 100 μm	BARC
Undulator-MCD	0.1 – 1.5	RRCAT
X-ray beam diagnostics	6.2	RRCAT
Visible beam diagnostics	Visible	RRCAT

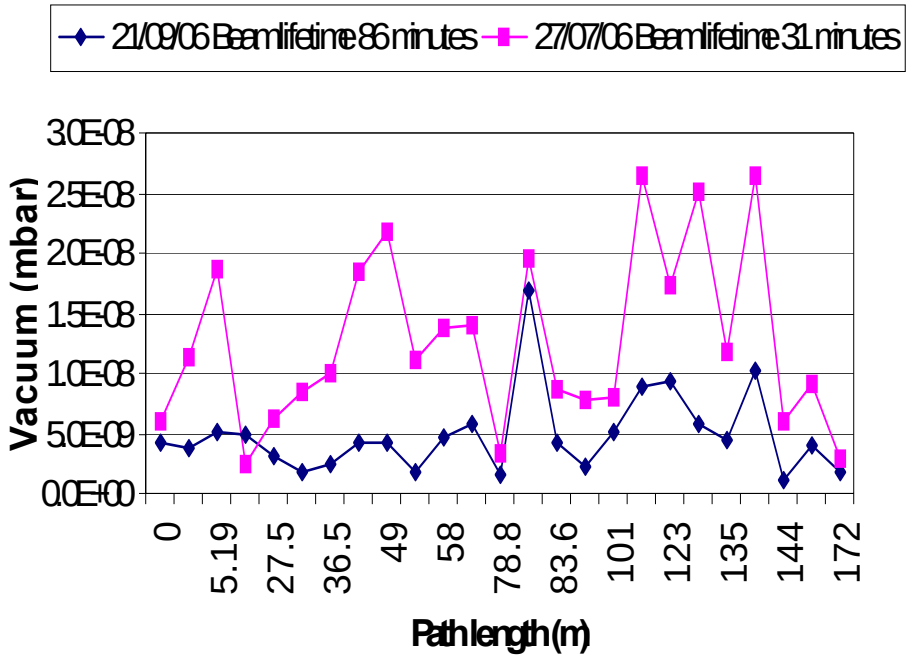
Major Events in 2006 (III)

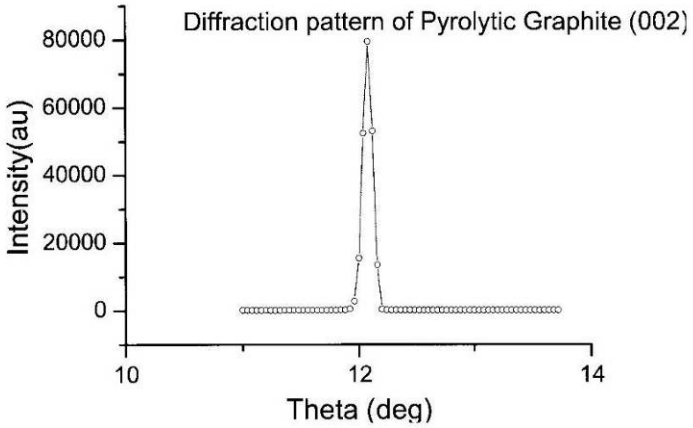
Prototype Front-end of Indus-2 Beam-line Built

First front end on XRD BL Indus-2 installed

Major Events in 2006 (IV)







First x-ray diffraction record with SR from Indus-2 using XRD BL12 on Sept 28, 2006; Indus-2 beam energy was 2 GeV & current ~4 mA.DCM aligned to get monochromatic SR out but calibration was still on.

simomura osamu <simomura@post.kek.jp>

Thursday, October 05, 2006 5:22 AM

Dear Dr. Sahni, Dr. Kotaiah and Dr. Nandedkar,

On behalf of the Japanese Society of Synchrotron Radiation Research, and also on behalf of the Photon Factory, I would like to express my sincere congratulation to you and your colleagues on the success of hard X-ray diffraction at INDUS-II. When I visited INDUS about 10 years ago, INDUS-I was just in operation and the place for INDUS-II was digging out. Since then, you have made a tremendous effort to this great milestone. I much appreciate your enthusiasm to construct SR facility in India. I expect you will present your excellent result at the first workshop of Asia-Oceania Forum held at KEK, Tsukuba in this November,
It is my pleasure to look at the new activity at INDUS-II next week.

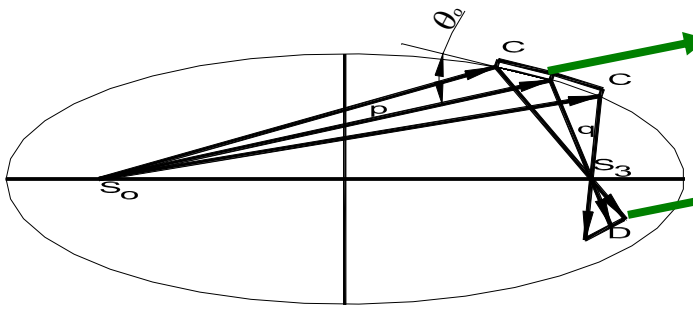
Best wishes,
Osamu Shimomura
President, Japanese Society of Synchrotron Radiation Research,
Director, Institute of Materials Science Structure, KEK

Multi Channel EXAFS Beamline for INDUS-2 Synchrotron Source

Being developed by Spectroscopy Division, B.A.R.C.

It involves measuring the x-ray attenuation coefficient in a material just above the absorption edge of a particular atom using Energy Dispersive Mode

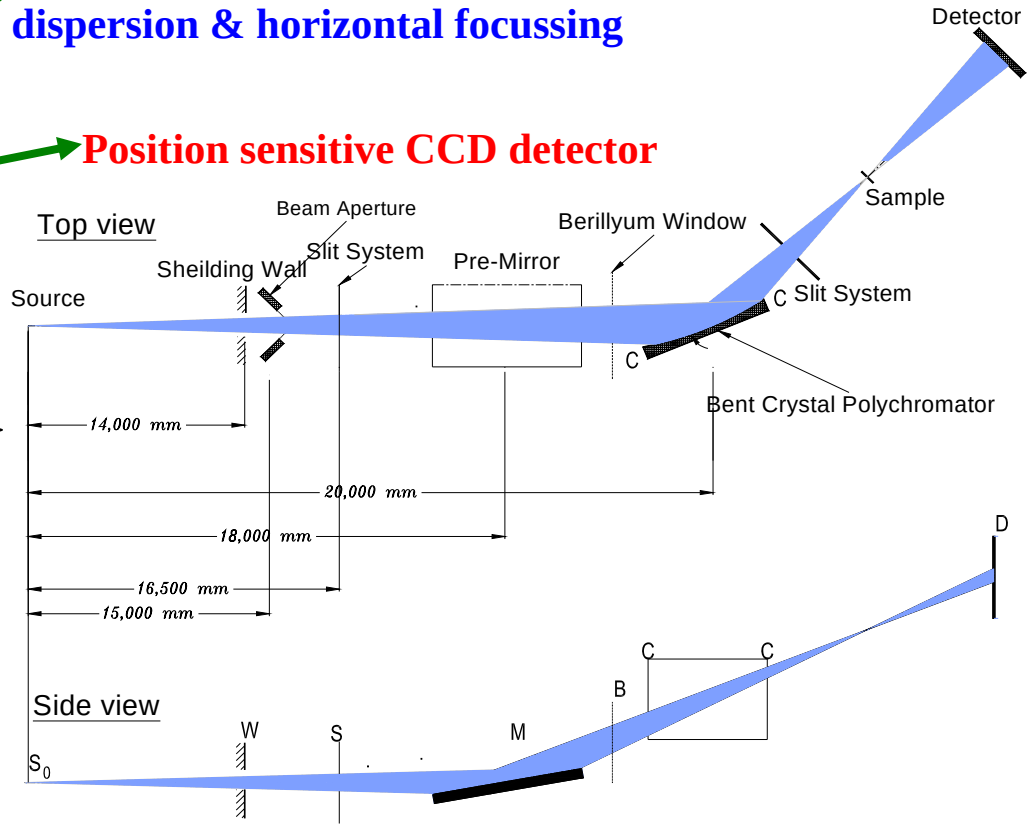
Fast Technique → **Average data acquisition time : 300 msec**
Suitable for in-situ, fast and time-resolved processes



Elliptically bent Si (111) crystal for dispersion & horizontal focussing

Position sensitive CCD detector

Optical Layout →



Specifications

Energy Range: 5-20 keV

Bandwidth : 1 keV @ 10keV

Resolution (E/ΔE): 10^4

Parameters of 2-3 GeV Synchrotron Light Sources

Source	Country	Energy (GeV)	Circumference (m)	Beam current (mA)	Emittance (nm.rad)	λc (Å)
Indus-2	India	2.5	172.5	300	58	2
ALBA	Spain	3	268.8	400	4.3	1.5
SESAME	Jordan	2.5	129.0	400	26	2.0
SOLEIL	France	2.75	354.1	500	3.7	0.8
Australian LS	Australia	3.0	216.0	200	16	1.6
Diamond	U.K.	3.0	561.6	300	2.7	0.8
SPEAR-3	U.S.A.	3	234.1	500	18.6	1.6
ANKA	Germany	2.5	110.4	400	90	2.0
CLS	Canada	2.9	170.9	200	18	1.6
SLS	Switzerland	2.4	288.0	400	4.8	2.3
Siberia-2	Russia	2.5	124.1	150	98	1.1
Elletra	Italy	2.4	259.2	140	10	1.3
PLS	S. Korea	2.0	280.6	150	19	2.2
ALS	U.S.A.	1.9	196.8	400	6.3	4.1

Parameters of 2-3 GeV Synchrotron Light Sources *(contd..)*

Source	Country	Circum. (m)	No. of BM†	Cost of source (Crores of Rs)	Schedule (Start)	Schedule (Source commissioning)	No. of total beam lines	Beam lines from BM †
Indus-2	India	172.5	16	100	1998	2006	32	27
ALBA	Spain	268.8	32	1100 (187M€)	2003	2010	10 *	1*
SESAME	Jordan	129.0	16	-------	2003	2009	12*	3*
SOLEIL	France	354.1	32	-------	2004	2007	43	22
Australian LS	Australia	216.0	28	925 (206.3M$)	2001	2007	30	13
Diamond	U.K.	561.6	48	1980 (235M£)	1998	2007	42	20
SPEAR-3	U.S.A.	234.1	18	--------	--------	2004	11 *	4*
ANKA	Germany	110.4	16	-------	1997	2003	16	13
CLS	Canada	170.9	24	730 (174M$)	-------	2001	32	24
SLS	Switzerland	288.0	36	-------	--------	2001	24	16
Siberia-2	Russia	124.1	12	-------	--------	1999	13	9
Elletra	Italy	259.2	24	-------	--------	1997	26	12
PLS	S.Korea	280.6	36	920 (200M$)	1988	1994	33	18
ALS	U.S.A.	196.8	36	500 (99.5M$)	1987	1994	46	21

* In the initial phase

† Bending Magnet

Plans ahead for Indus-2

- **Enhance beam energy. Will need more power. MPSEB (the utility company) has been approached.**
- **Bring down closed orbit deviations.**
- **For stable performance of ring, power conditioning system would be added. Power trips cause dipole current to plummet rapidly, resulting in large force on dipole vacuum chambers. Some of the connecting bellows have been damaged.**
- **Give thrust to developing beam line components: DCM, mirrors & their movement systems, slits, mirror bender, beam position monitor etc.**
- **Build or acquire IDs and install as per users' interests.**

HV GENERATOR FOR 750 keV DC ACCELERATOR

Performance tests of HVG completed Feb 07

DC accelerator has been operating since 2003 at 550 keV & 5 kW. To up grade it for 750 keV operation a HVG has been built. Tests of HVG were carried out with a mixture of N2-CO2 & SF6 gas at 5.5 bars.

High voltage achieved: 760 kV

Lower deck voltage : 80 kV

Earlier single deck testing was done

Rating of single deck : 120 kV

Deck tested for voltage : 90 kV

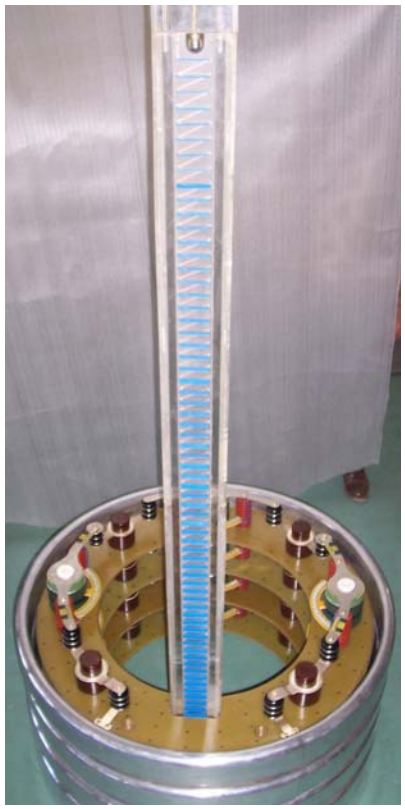
Tests show that operation of HVG @ 25 mA rated current will give a DC voltage drop of 100 kV and accelerating terminal voltage of 755 kV. **Hence the rated power of the accelerator will be achieved.**

Component That Required Special Efforts

New design of HV bushing that sustained 45 kV

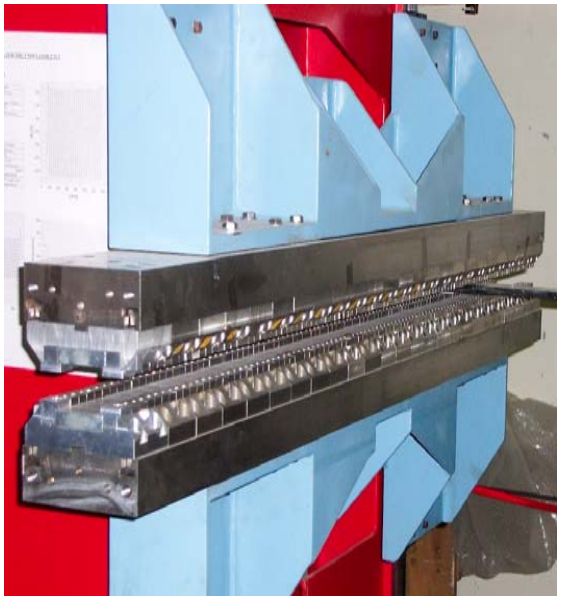
HV Bushing That Failed at 30 kV

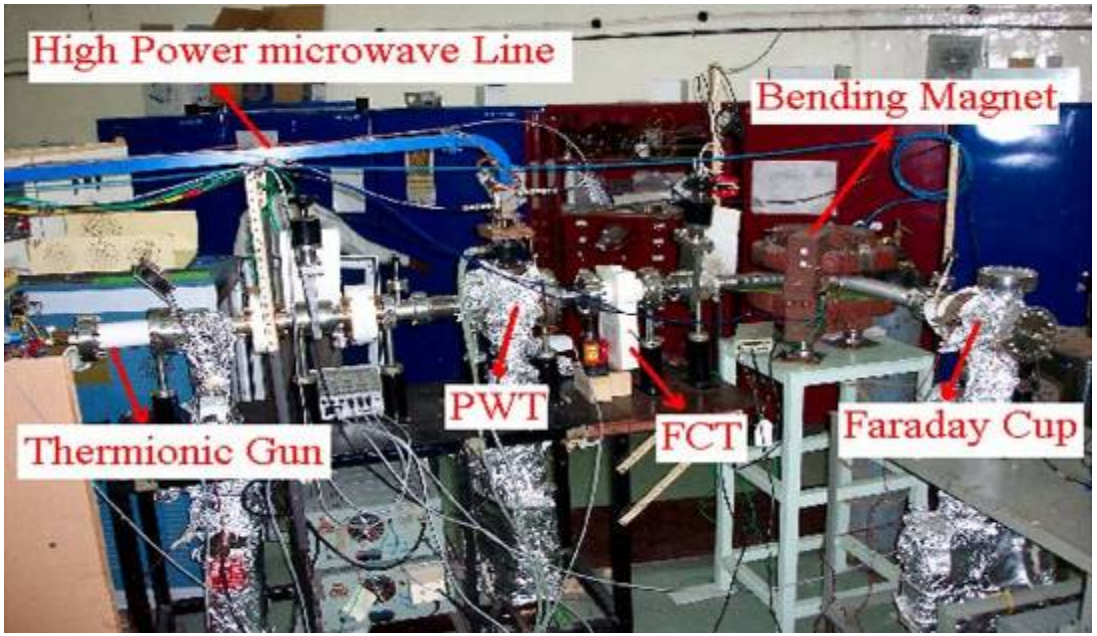
Multiplier Deck Assembly & HV Divider



Parts of PWT Linac for THz Source

Variable Gap PM Undulator

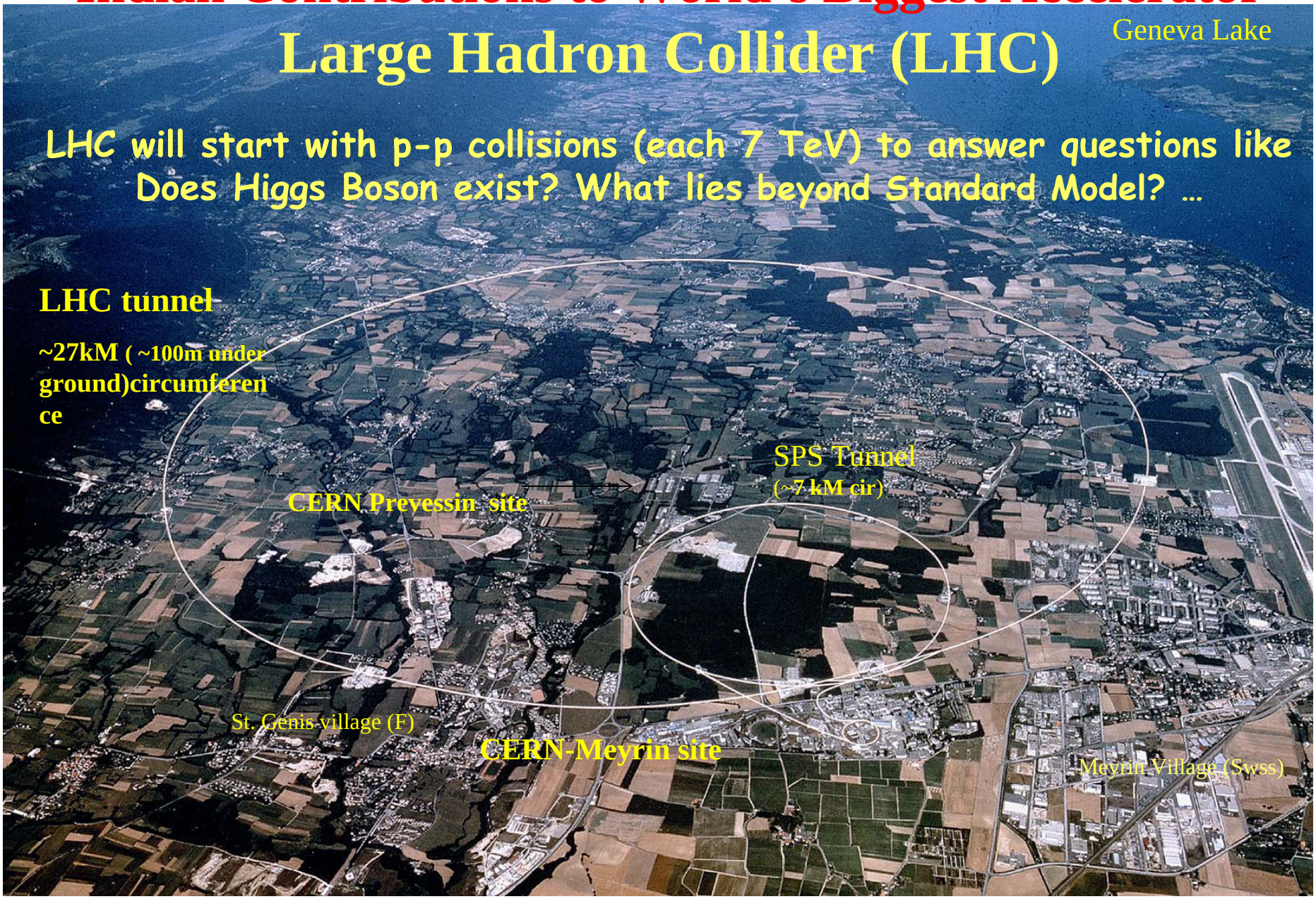




Status (as of Nov 06):

PWT has been built; beam accelerated and passed through undulator, producing first THz radiation signal @ ~500μ.

Indian Contributions to World's Biggest Accelerator



7080 Nos. Precision Mag
Positioning System (PMPS)

MCS (1146 Units) &
MCDO (616 Units)

Magnetic measurements
teams- ~100 Man-years

5500 Nos. Quench Heater
Power supplies(QHPS)

1435 Nos. Local
Protection Units

A part of DAE's contributions
installed in LHC Tunnel at CERN

Precision alignment JACKS for LHC cryomagnets (weighing 32 Tons)
6800 PMPS Jacks + 280 Motorizable & Higher Precision-All delivered
Test Set-up to demonstrate setting resolution of 0.02 mm

Indian made PMPS Jacks being installed in LHC

From: Vittorio Parma
Sent: Tuesday, April 18, 2006 5:23 PM
To: vcsahni@cat.ernet.in; Lyn Evans; Philip Bryant; Philippe Lebrun
Cc: hcsoni@cat.ernet.in; jishnu@cat.ernet.in; Alain Poncet

Subject: Last batch of LHC jacks arrives at CERN

Dear colleagues,

I have the pleasure to inform you that the last container with 126 jacks, has reached CERN on the 10th April last.

This last delivery **completes the supply of 7080 jacks for the LHC, designed/produced under the collaboration agreement CERN/DAE** Add.F2 and amendment 1.

My personal congratulations for the excellent work done by the project team at CAT.

Regards,

Vittorio

Success of LHC partnership led DAE & CERN to a new cooperation on **Novel Accelerator Technologies**

DAE agreed to join CERN's Novel Projects :

- **SPL, especially LINAC-4, the front end of SPL.**
- **Compact Linear Collider (CLIC) Test Facility CTF3.**

CERN consented to help DAE's upcoming projects

- **Spallation Neutron Source (SNS) at RRCAT, Indore**
- **Accelerator Driven System (ADS) at BARC**

From: Purushottam Shrivastava [mailto:purushri@cat.ernet.in]

Sent: Friday, October 21, 2005 12:04 AM

To: Carlo Rossi; Carlos De Almeida Martins; Gilles Simonet; Gilbert Pecheur; Maurizio Vretenar; vcsahni@cat.ernet.in

Cc: Roland Garoby; Frederick Bordry; vcsahni@magnum.barc.ernet.in; Jean-Pierre Royer

Subject: Pre-design report draft 1 for LEP klystron modulator

Dear Colleagues,

Seasons greetings. Please find enclosed the awaited predesign report from CAT. This may further be circulated to all concerned. For simplicity solid state switches from BEHELKE, Germany are taken in this design but Eupec and ABB switches are seriously considered to be useful. The exact part numbers will be evolved for switches from these manufacturers. More detailed simulations are planned at CAT and will be sent to you separately. More rigorous discussions are required on several parts of the predesign, so kindly unzip the document and please send the comments, views and valuable suggestions.

With best regards,

****

Purushottam Shrivastava Scientific Officer G

Member Secretary DAE-CERN Coordination Committee

Accelerator Program Centre for Advanced Technology

PO CAT Indore 452013 INDIA fax 91-731-2488000 Office ph. 91-731-2488015

Home: 91-731-2487324 email purushri@cat.ernet.in

Pre-design Technical report
on
700 MICROSEC LEP KLYSTRON PULSE MODULATOR FOR RFQ TEST STAND OF LINAC 4 PROJECT AT CERN

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A DAE-CERN COLLOBORATION PROJECT

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September 2005

Center for Advanced Technology,
CAT, Indore India

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-
-

Subject: RE: Pre-design report draft 1 for LEP klystron modulator

From: "Carlos De Almeida Martins" <Carlos.Martins@cern.ch>

Date: Tue, November 22, 2005 10:12 pm

To: purushri@cat.ernet.in (more)

Cc: "Jean-Pierre Royer" <Jean-Pierre.Royer@cern.ch> (more)

Dear Purushotava,

Please find below the comments we have prepared for your preliminary technical design. They were prepared in collaboration with Carlo Rossi (AB/RF).

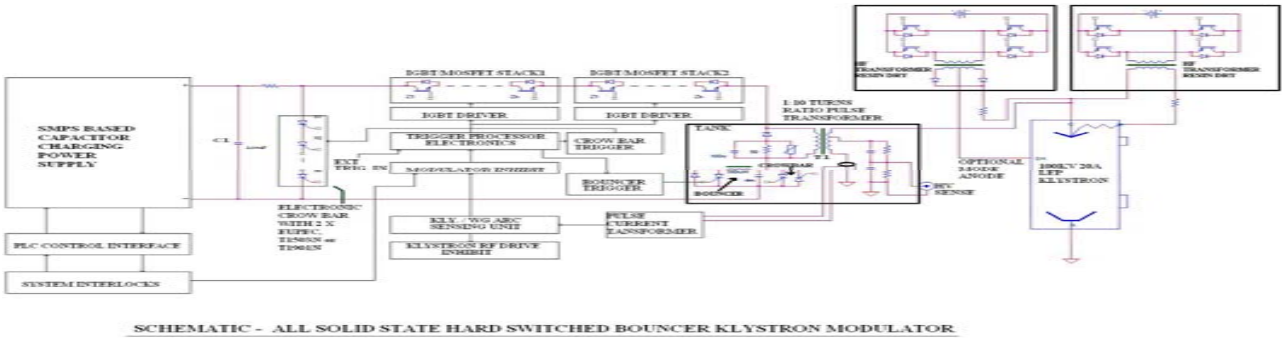
We would like to thank you for your valuable work in the preparation of this pre-design report. It presents a good description of the several technical approaches discussed so far and it gives detailed technical characteristics and ratings for the main components and sub-systems. In general, we think the preferred technical solution goes well in the sense we have been discussing mutually before. Concerning the procurement of the components and sub-systems listed in point 4.8, we consider this not as only a technical problem and so it shall be analysed later on in the framework of the collaboration. We will consider the proposed components and sub-systems on the technical point of view only. Please feel free to argue on the comments below in order to continue converging towards the best solution.

With the best regards,

Carlos A. Martins.

Comments and remarks on the technical aspects of the pre-design study

Solid State Hard switched Bouncer Modulator Tests

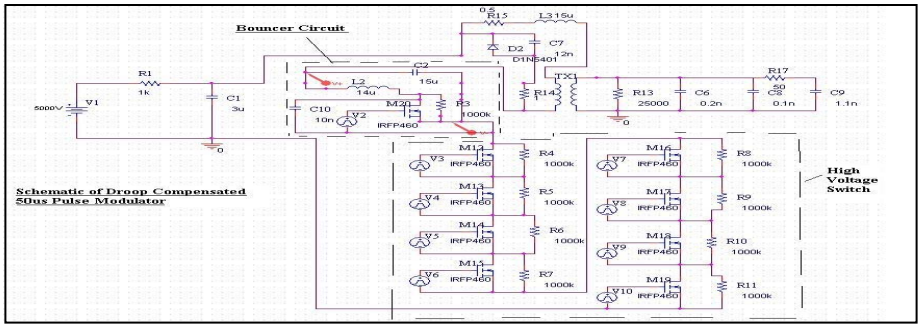


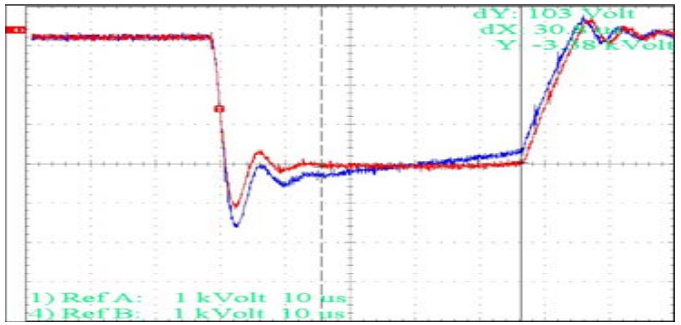
SCHEMATIC - ALL SOLID STATE HARD SWITCHED BOUNCER KLYSTRON MODULATOR

Features of Bouncer Klystron Modulator

- **Droop Compensation up to <1% with very Low energy Loss**
- **No External Charging required for Bouncer Capacitor with programmable timing of Bouncer switch**
- **Size of Energy Storage Capacitor reduces very much**
- **Impedance of Bouncer circuit has to kept very low to be effective**

Droop Compensated Modulator Test Setup and Results





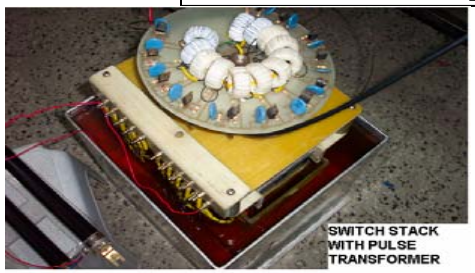
- Output without Bouncer circuit
- Output with Bouncer circuit

Specifications Of Modulator Test Setup Components

High Voltage Switch	
Max. Voltage	6kV
Peak Pulse Current	80A
Max. Pulse Width	50us
Rise Time	100ns
High Voltage Pulse Transformer	
Max. Pulse Voltage	50kV
Pulse Width	60us
Turns ratio	1 : 10
Rise Time	1.5us
Bouncer Circuit	
Bouncer Switch	500V, 160A
Bouncer Capacitor	7uF, 1000V
Bouncer inductor	45uH, Air Core
*Energy Storage Capacitor	3uF, 8kV

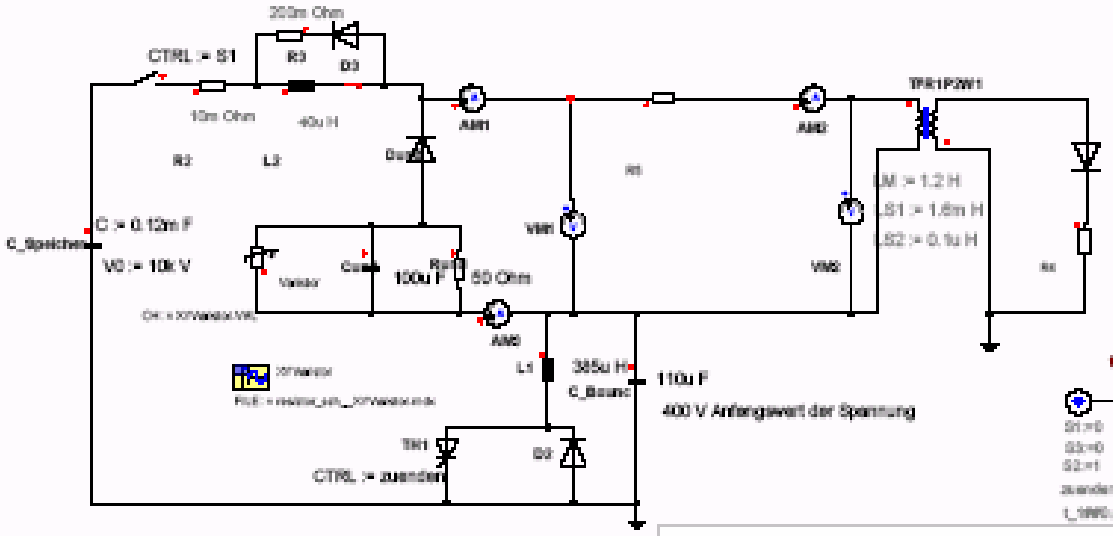
Droop Compensated Modulator Test Setup Results

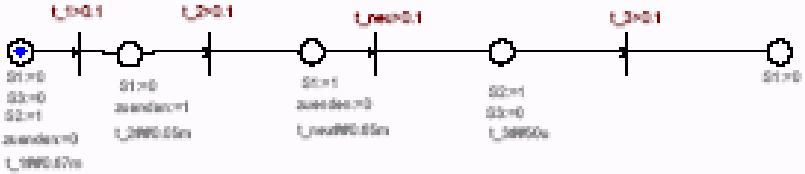
Output Pulse Voltage	**12kV**
Output Pulse Current	**500mA**
Pulse Width	**50us**
Droop with Bouncer circuit	**~1%**
Droop without Bouncer circuit	**~20%**

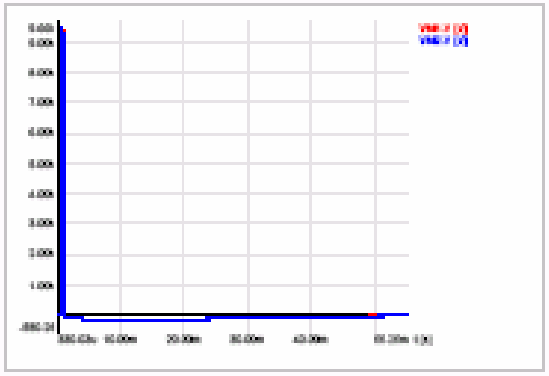


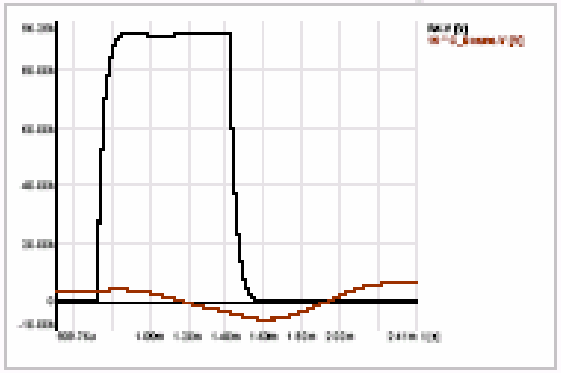
RRCAT, Indore, India

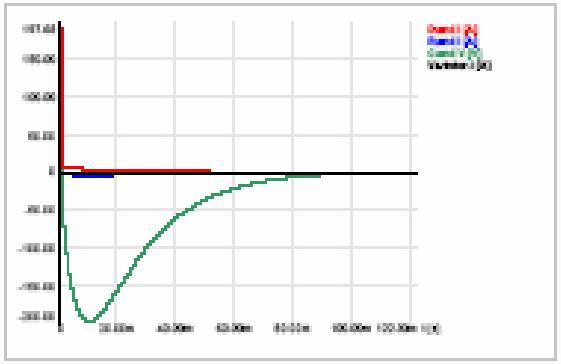
10kV Modulator kabel Primär + Klystron 1,7 im Fehlerfall

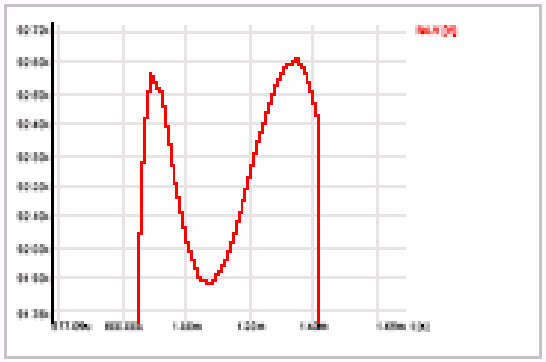


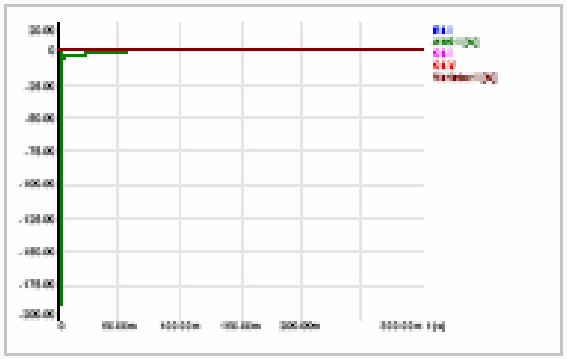


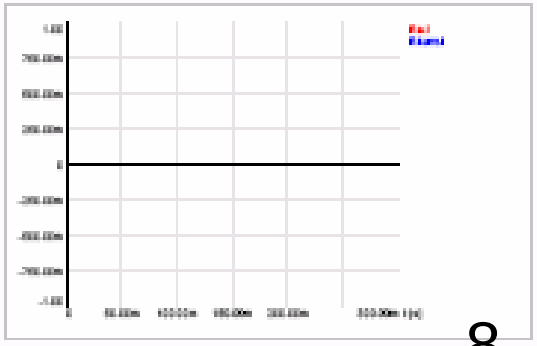








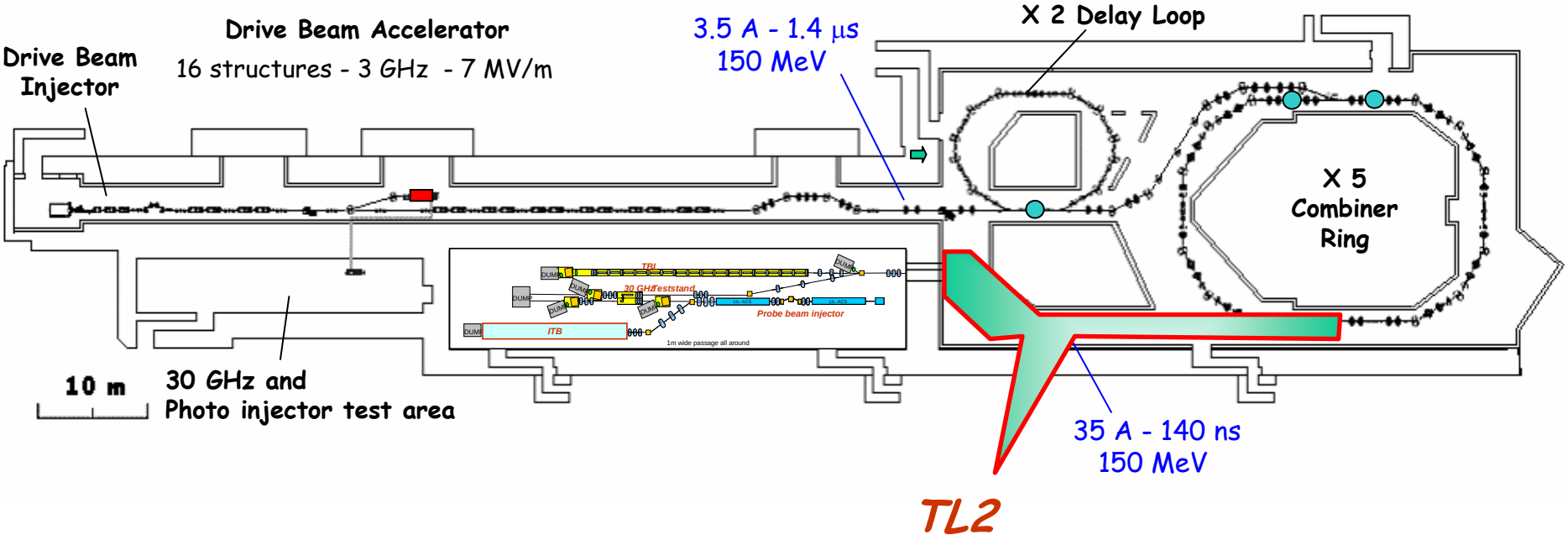




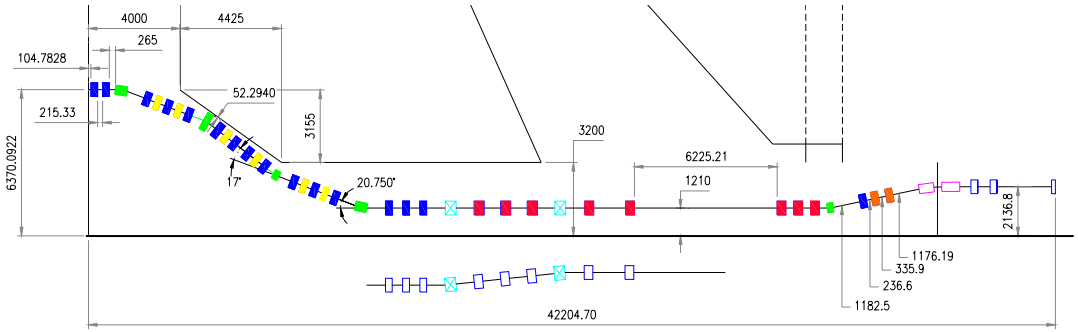
Layout of CLIC TEST FACILITY3 (CTF3) at CERN

*RRCAT is involved in the **Design & Fabrication of TL2.***

(Aim of CLIC: Establish the principle of a 3-5 TeV e^+-e^- Collider using the idea of (1) a "drive beam" creating an "in situ" 30 GHz RF (2) extracting RF power via PETS & (3) deploying this RF power to accelerate the electron & positron beams that will collide.)



Complete optics design & layout of TL-2 along with fabrication of the vacuum chambers & magnets etc is being done by RRCAT



STATUS

Optics design in linear zone done for the R_{56} from -0.35m to +0.35m.

T_{566} correction studies in progress and preliminary results of R_{56} = 0.00 and -0.35 obtained.

β-functions higher in module-2 beginning and can be lowered with one more quadrupole in Module-1.

Beam parameters

Parameters	@ Input	Requirement @ Output
Nominal energy	150 MeV	150 MeV
Maximum energy	300 MeV	300 MeV
β_x , β_y (m)	8.1, 3.5	4 - 5
α_x , α_y	0.12, 0.31	0.0, 0.0
η	0.0	0.0
η'	0.0	0.0
dp/p (%)	1%	1%
σz (rms)	8.3 ps	1.3 ps
Height above ground	1.35 m	0.85 m

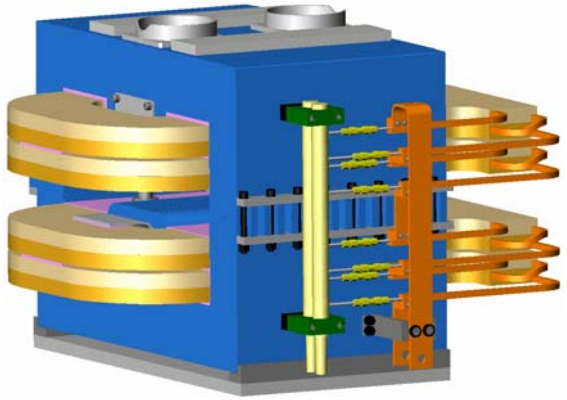
DIPOLE VACUUM CHAMBERS FOR TL-2

Length 945 mm
Width 250 mm
Material Al Alloy
machined in
CNC-VMC

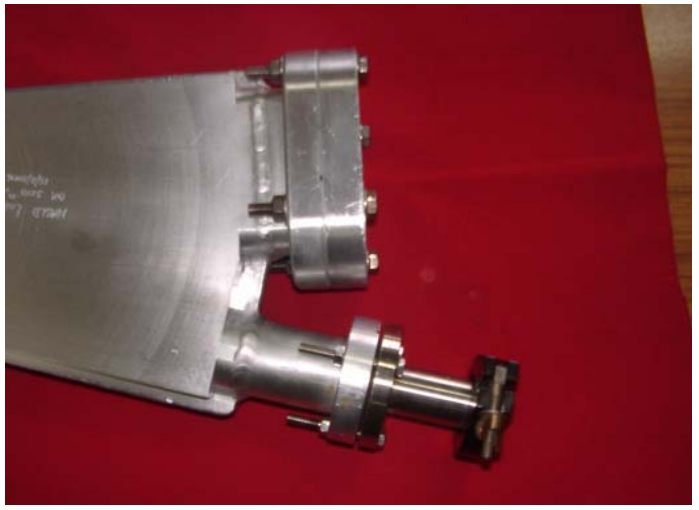
Machined & Welded Prototype Chamber

DIPOLE MAGNET ASSEMBLY

Magnet height	**640 mm**
Magnet Width	**1000 mm**
Magnet Length	**910 mm**
Magnet total weight	**2200 kg**



Initial Trial



Final Trial

FIRST ADDENDUM ON MANPOWER SUPPORT FOR THE COMMISSIONING AND OPERATION OF CONTROL SYSTEM OF CTF 3

P074/LHC/CTF-3/M.1

ADDENDUM No. CTF-3/M.1

to

THE PROTOCOL DATED 15 February 2006,

to

THE 1991 CO-OPERATION AGREEMENT, AS EXTENDED IN 2001

between

THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

and

THE DEPARTMENT OF ATOMIC ENERGY (DAE) OF THE GOVERNMENT OF INDIA

concerning

JOINT PARTICIPATION IN CTF-3 UNDER THE NOVEL ACCELERATOR TECHNOLOGIES PROJECT (NAT)

This Addendum defines the collaboration between CERN and the Department of Atomic Energy (DAE) of the Government of India for the provision of expert support for the commissioning and operation of CTF3 at CERN.

September 2006

Article VIII
Final Provisions

This Addendum shall form an integral part of the 2006 Protocol to the 1991 Co-operation Agreement, as extended in 2001.

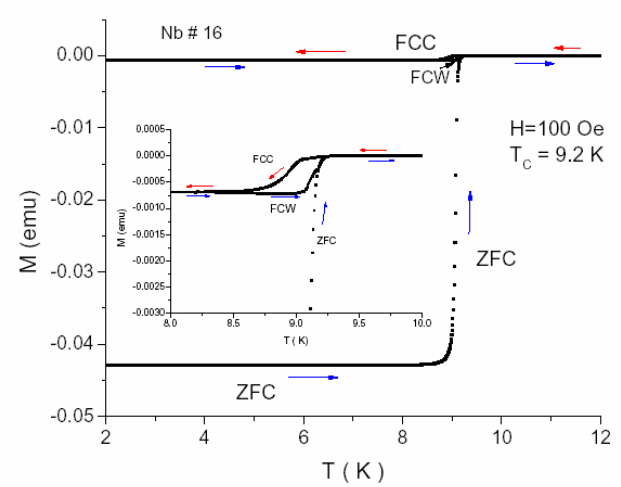
Done at Indore/Geneva on Oct. 5, 2006, in two copies in the English language.

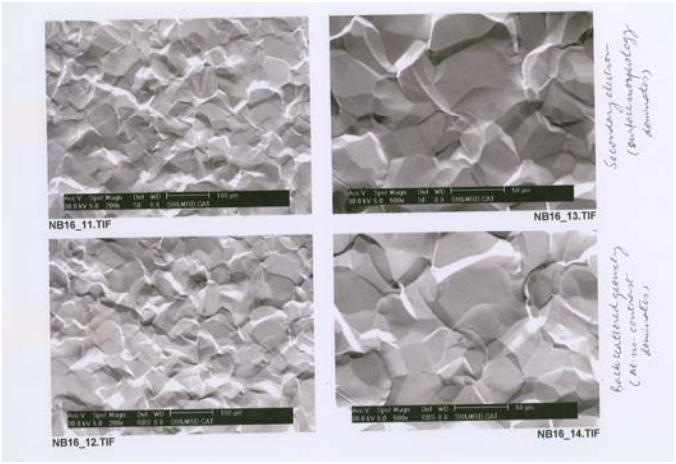
For the Department of Atomic Energy (DAE) of the Government of India	For the European Organization for Nuclear Research (CERN)
.....	.....
Dr. V.C. Sahni Co-Chairman, DAE-CERN Joint Coordination Committee for Collaboration with CERN in the LHC Project and Director, RRCAT	Dr. R. Aymar Director General

R&D on Superconducting Materials at RRCAT Relevant for Advanced Accelerators

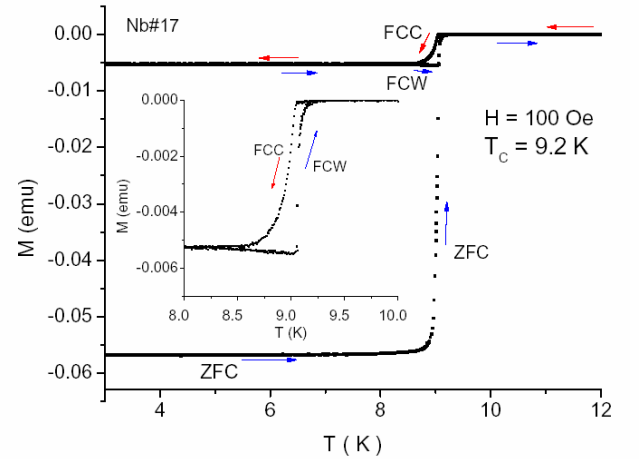
Results on BCP samples of Nb from Fermi Lab, USA

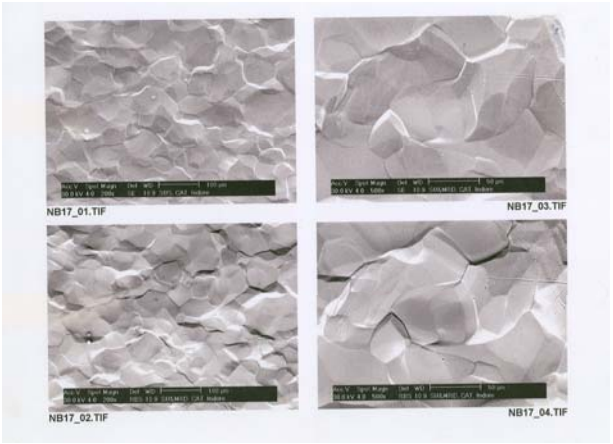
Sample # 16
Avg grain size
~ 30-35 Micron





Sample # 17
Avg grain size
~ 40-45 micron





Large grain Nb samples from Jlab have also been studied

Invitation to join ILC Accelerator R&D Efforts

Directors of SLAC, Fermilab, DESY & GDE had visited RRCAT on March 6, BARC on March 7 & met Chairman, AEC on March 8, 2006.

They visited Indus-2 & proposed that we can work together on ILC R&D activities. Few areas we have identified of common interest are: damping ring magnets, superconducting accelerator cryo-module development, vacuum design etc.

We are now working on the infrastructure needed for us to participate. Dialogue has just started.

Raja Ramanna Centre For Advanced Technology

6-March-06

We are thrilled to see your impressive facility built with intelligence, skill and Indian know-how.

We look forward to working with you as partners to build the dream of particle physics – The International Linear Collider.

Best of luck,

Barry Barish
ILC / GDE Director
(Caltech)

Raja Ramanna Centre For Advanced Technology

6 March 2006

It has been a great pleasure and priveledge to visit CAT. It has been a most interesting and exhilarating day. I am most impressed by all that I've saw - you have implemented INDUS-2 with great skill and forthought. It was especially impressive talking with the INDUS-2 technical experts.

I look forward to opening up opportunities for meaningful collaboration both with SLAC and US institutions in general. Given my long held vision of global cooperation in accelerator-based science, I see India as having many ways to join and take leadership.

Thank you all for your warm hospitality

Jonathan Dorfan
SLAC Director

Raja Ramanna Centre For Advanced Technology

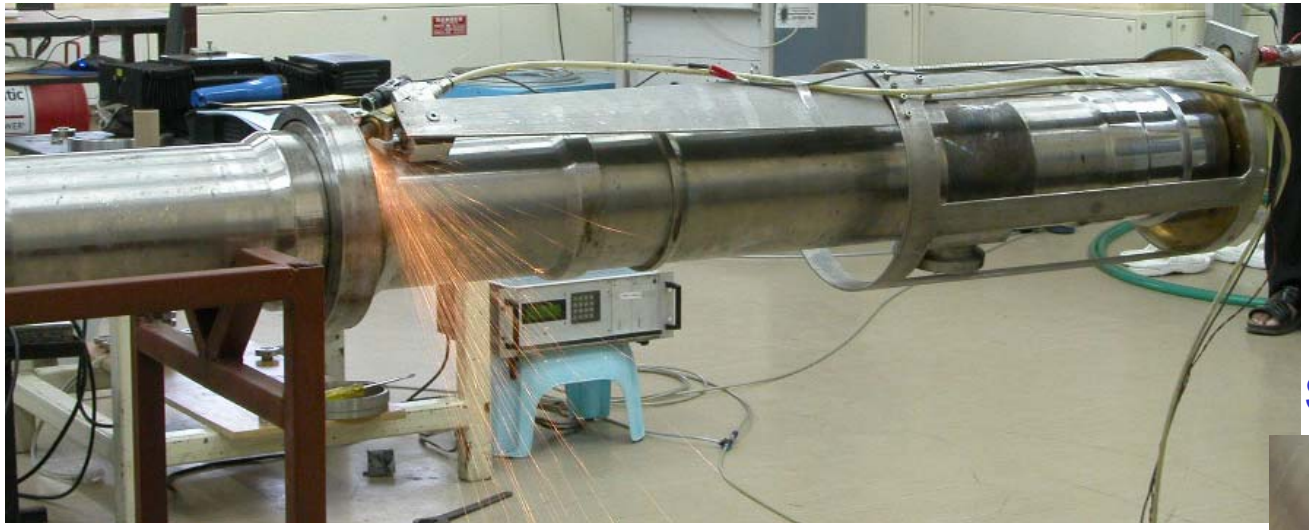
It has been a great pleasure to visit your facility and to learn about your laboratory and your many skills. The light source INDUS/2 is truly impressive and the spirit of being in command of all aspects of accelerator technology is commendable. The many young people we saw in our tour also tells us that the future will be bright. Your spirit of international collaboration opens up many opportunities for us to work together.

I will now look forward to work on specific areas of collaboration between Fermilab and CAT and together open up new opportunities for the future. A special thanks to your hospitality, especially to Professor Sahni!

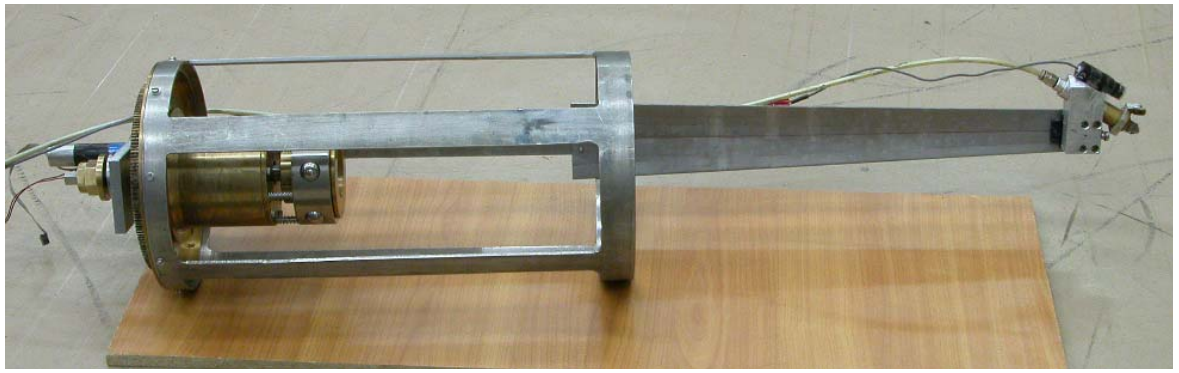
Pier Oddone
3/6/06

Laser & Materials Related Activities

Nd:YAG Laser based bellow-lips cutting & welding set up for use in PHWRs. (4 systems given to & used at NAPS)



Laser cutting mock-up for bellow lip



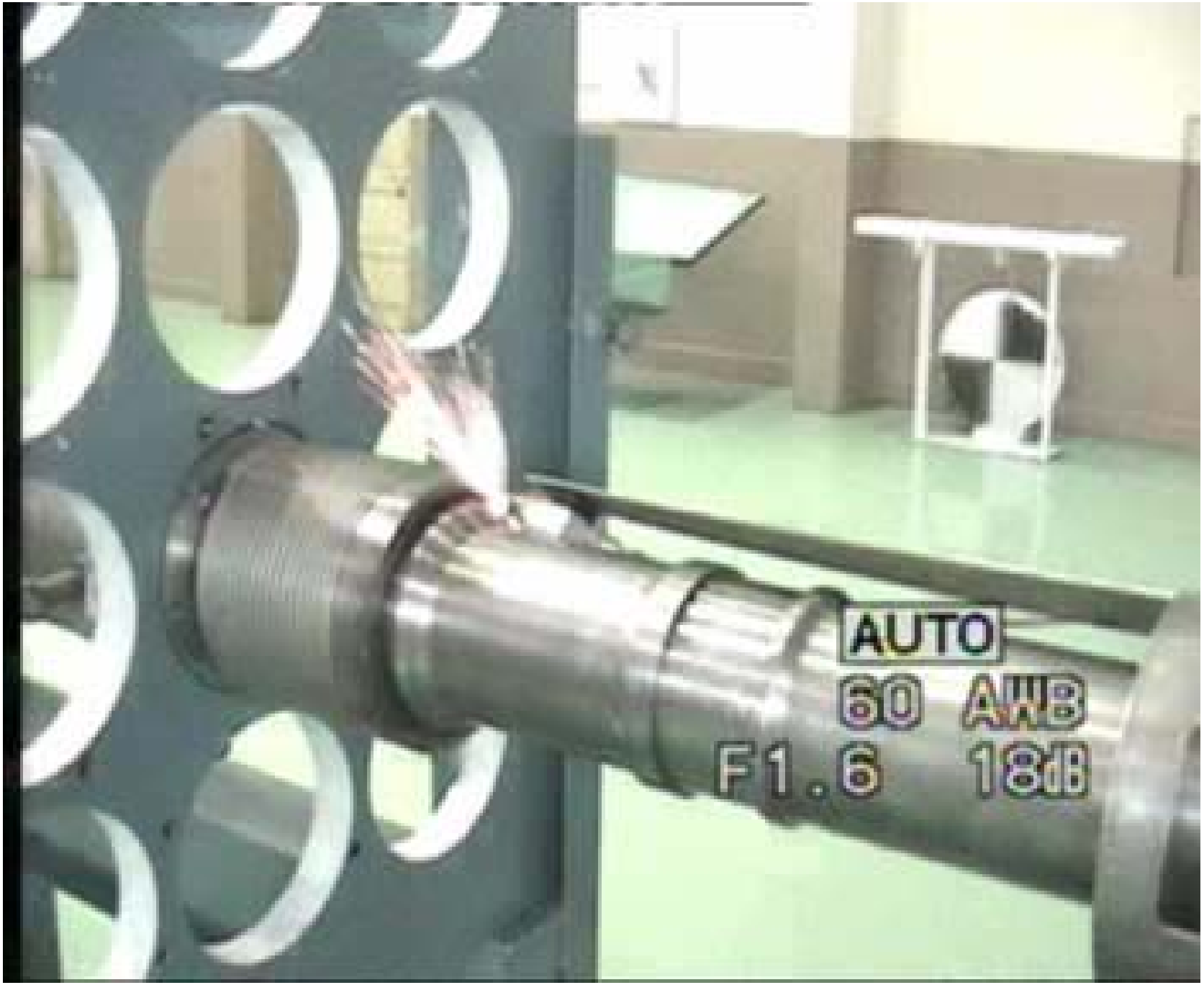
Bellow lip cutting fixture

Salient features

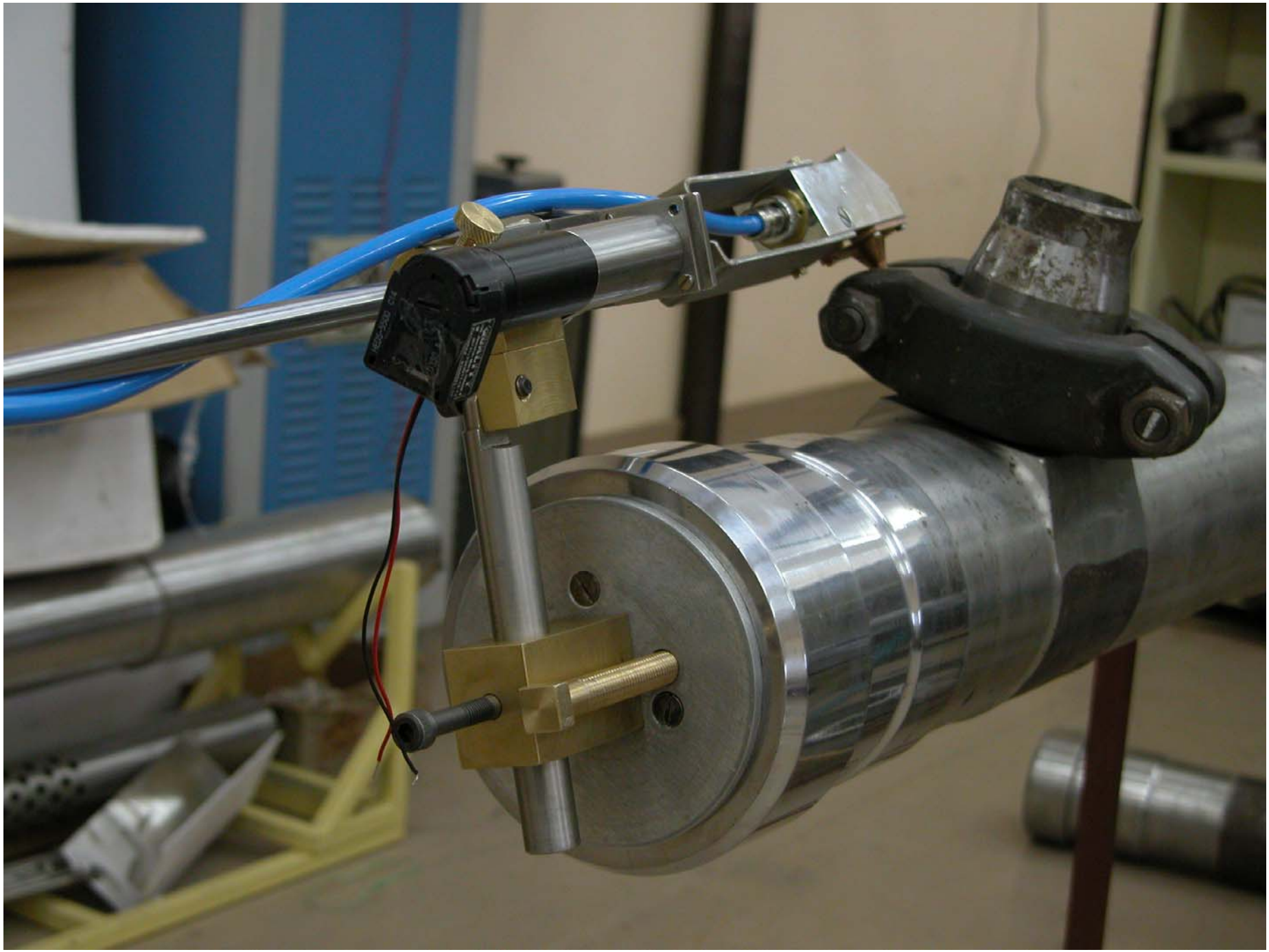
- MANREM reduction
- Ease in system handling
- Time saving
- Reliable operation

Separated bellow lip

Welded bellow lip


AUTO
60 AWB
F1.6 18dB


2006/05/31



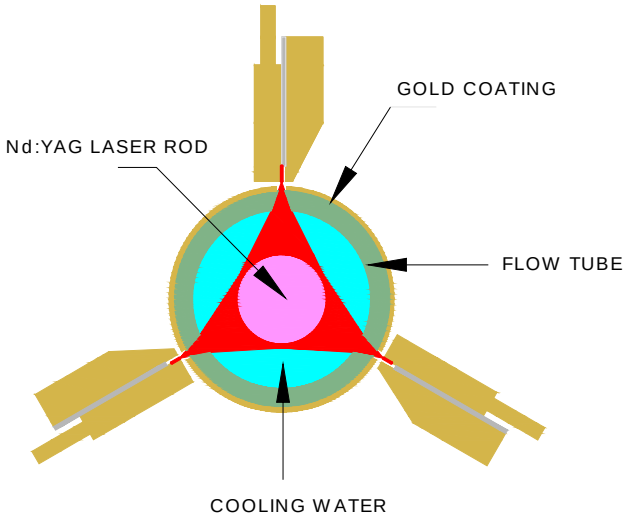
Diode-pumped High Power CW Nd:YAG Laser

System Specifications:

Geometry – Gold-coated Flow tube

Diode stacks – Linear, 6x40W

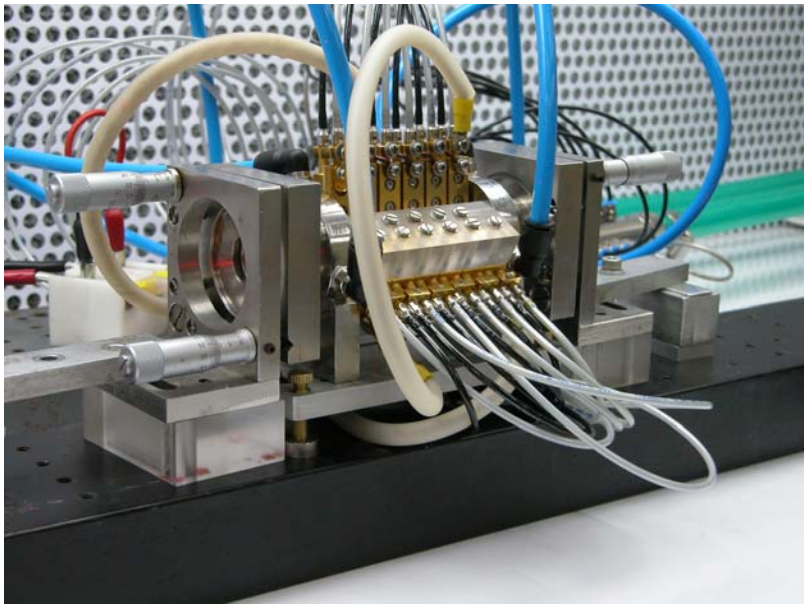
Pump Module – 3x Diode stacks - 120 °



Max. laser output power - 375W (M^2 ~ 60)

Optical-to-optical efficiency - 50%

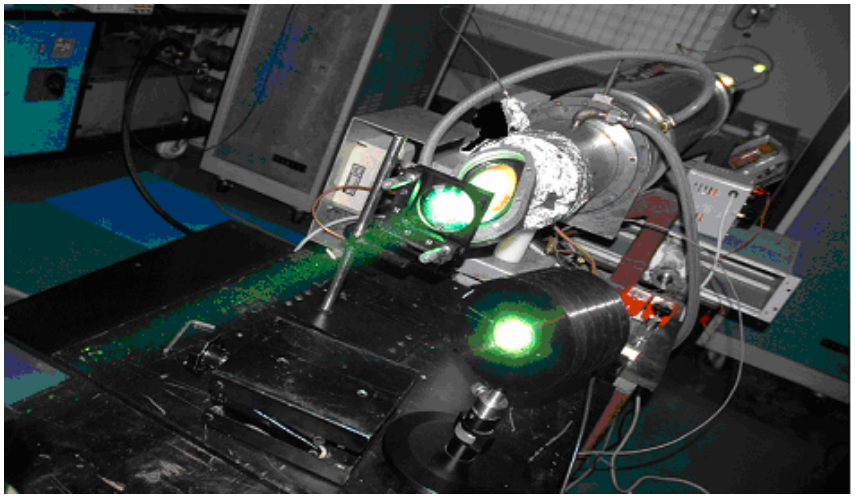
Electrical-to-optical efficiency - 25%

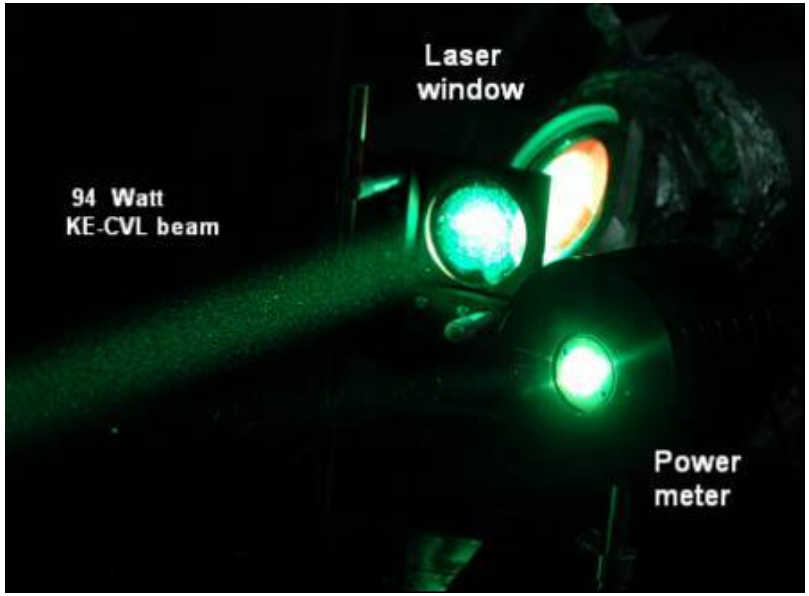


Applications: R&D, Medical & Industrial

Development of Copper Vapor Lasers

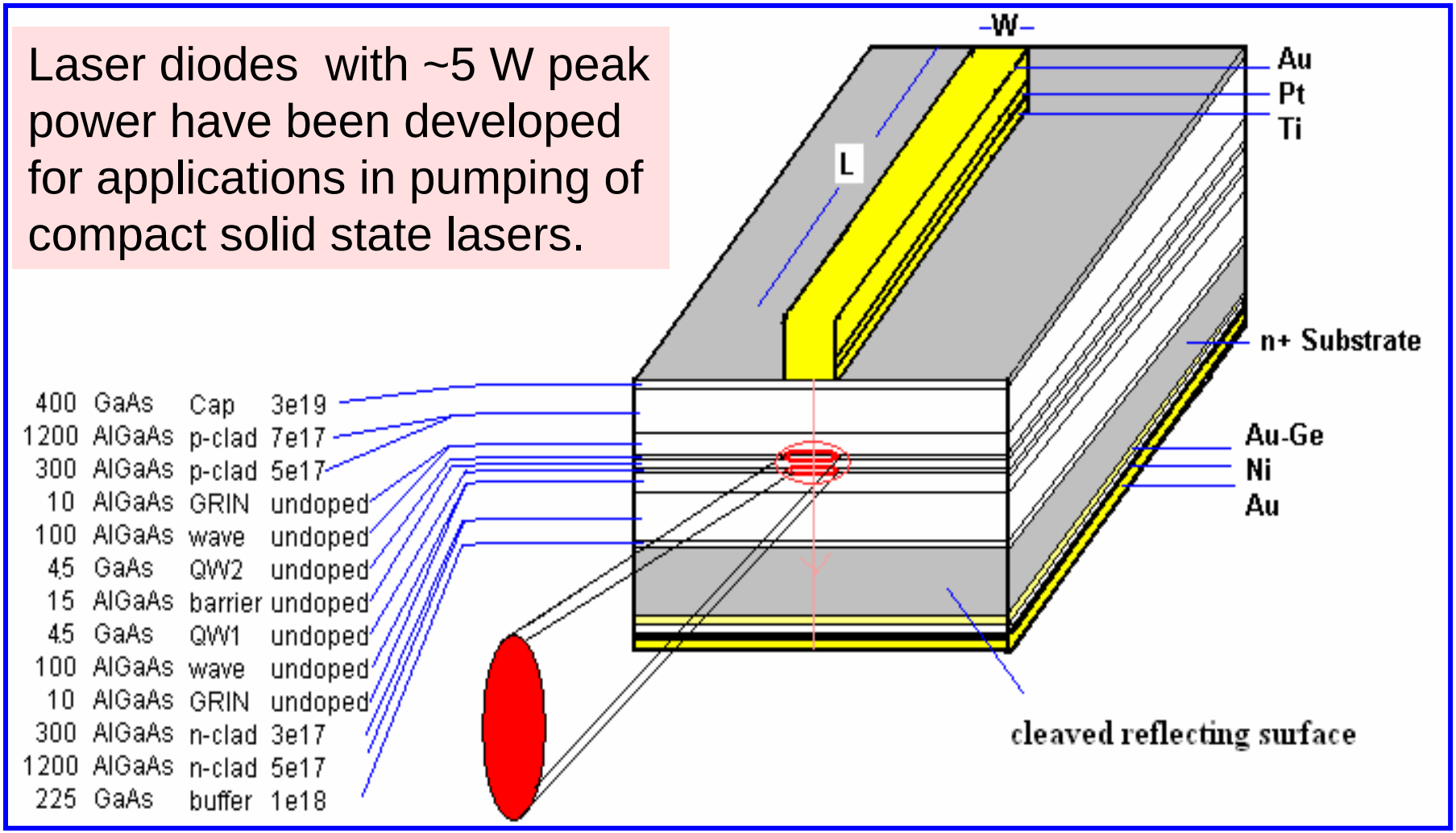
Technology of making copper vapor lasers and their kinetically enhanced version is established.



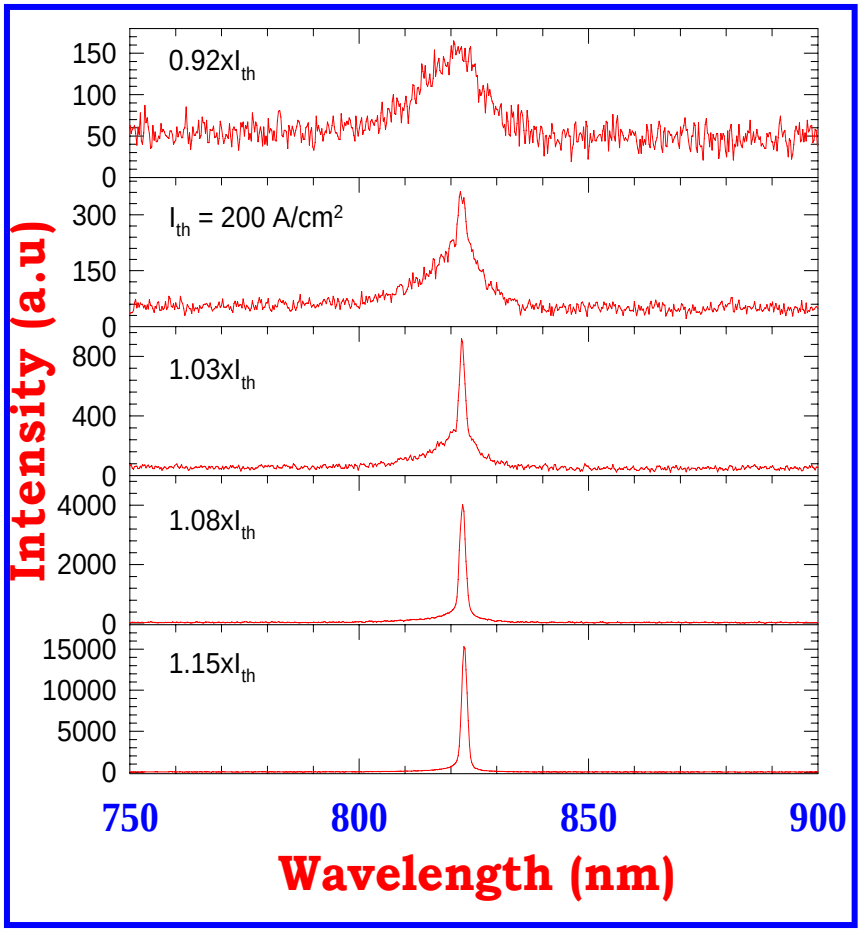


Development of Laser Diodes

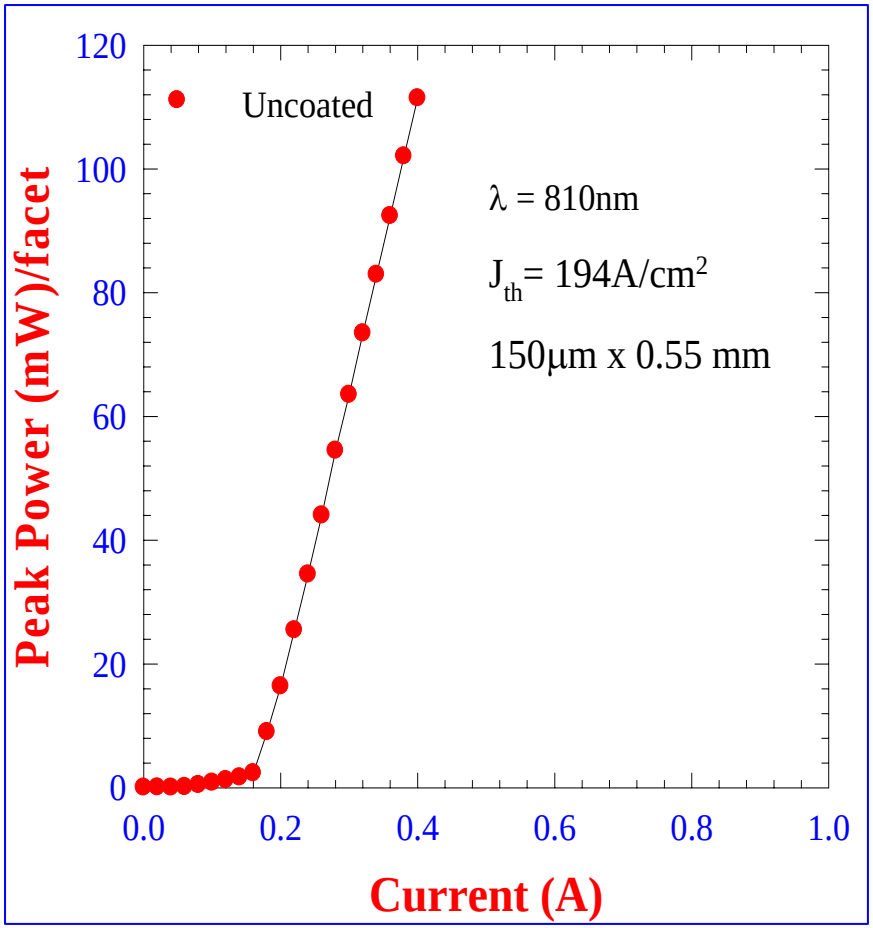
Laser diodes with ~5 W peak power have been developed for applications in pumping of compact solid state lasers.



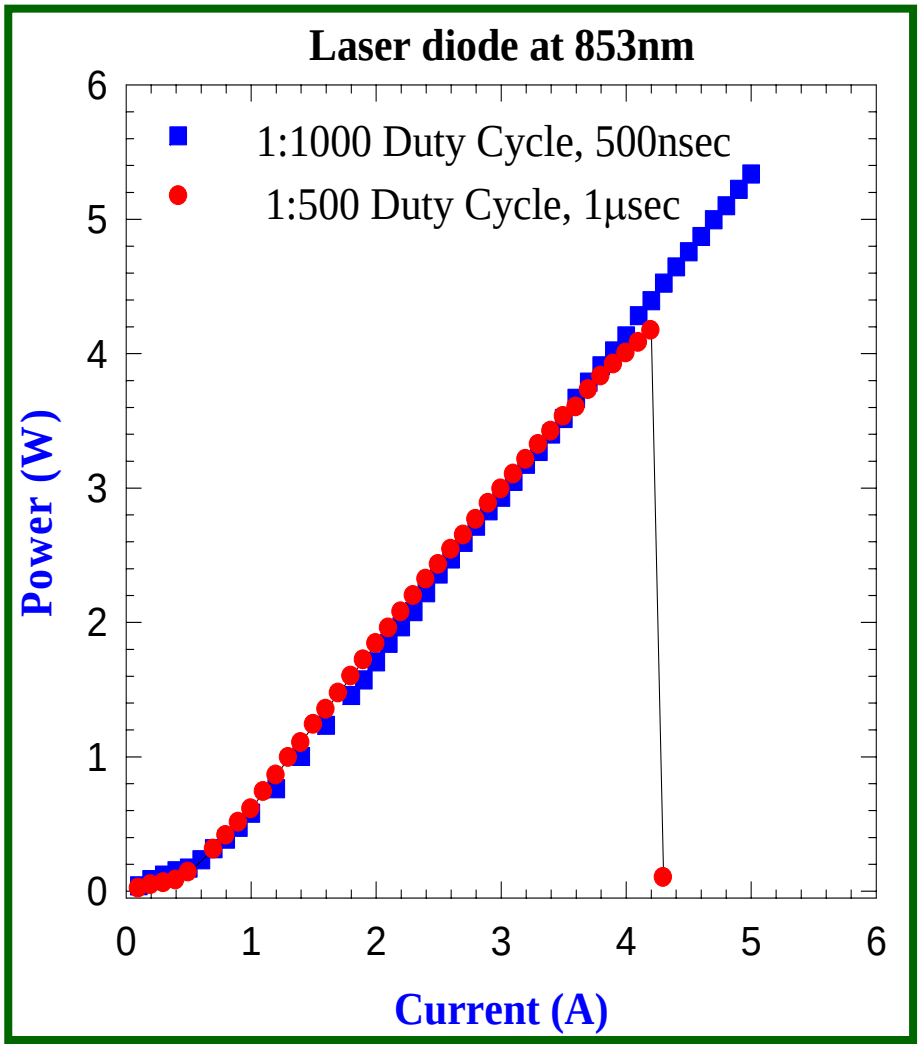
Lasing spectrum of a Laser Diode



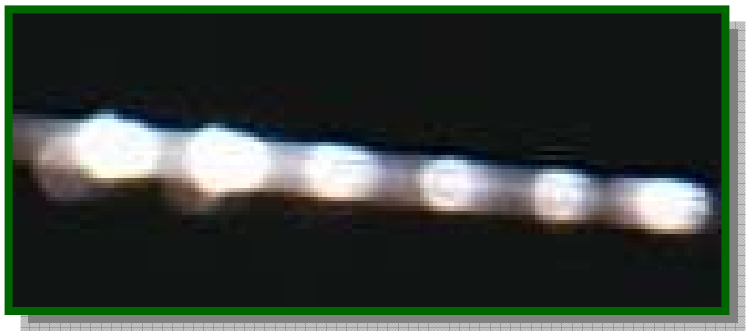
Lasing observed for a DQW Laser Diode



High power Laser Diode



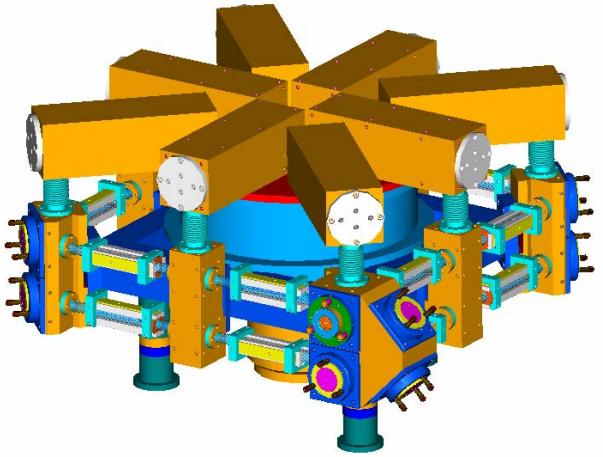
Laser Bar



Highlights of work with high power CO_2 lasers:

Partnering various institutions to promote applications:

MoU with M/s Protec System , Chennai to set up a 3kW Fast Axial Flow CW CO_2 Laser for cutting applications

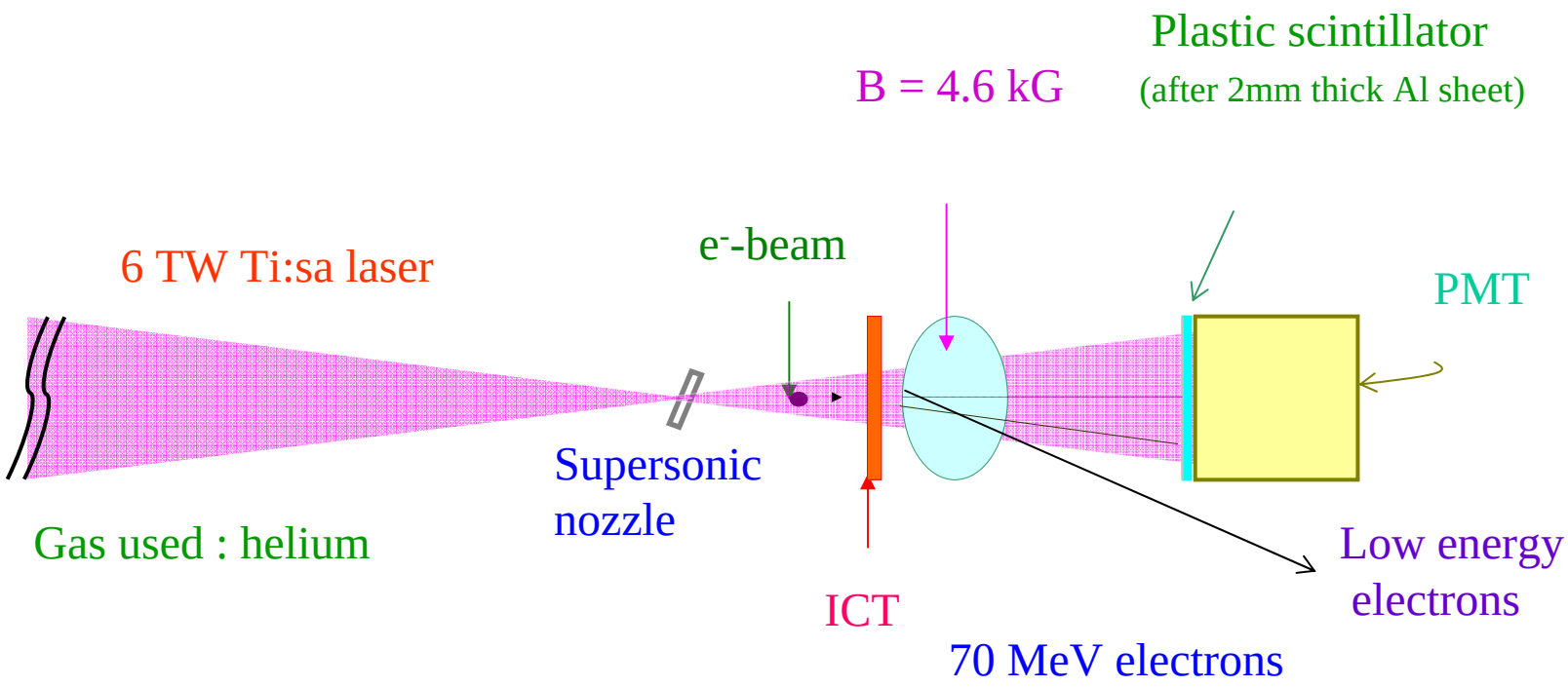


Typical work station

MoU with LASTECH, Delhi to make a high-rep rate, line tunable TEA CO_2 Laser for LIDAR applications

MoU with M/s Mahindra & Mahindra for building a 5kW Transverse-Flow CW CO_2 Laser to weld automotive components

Laser Based Electron Acceleration

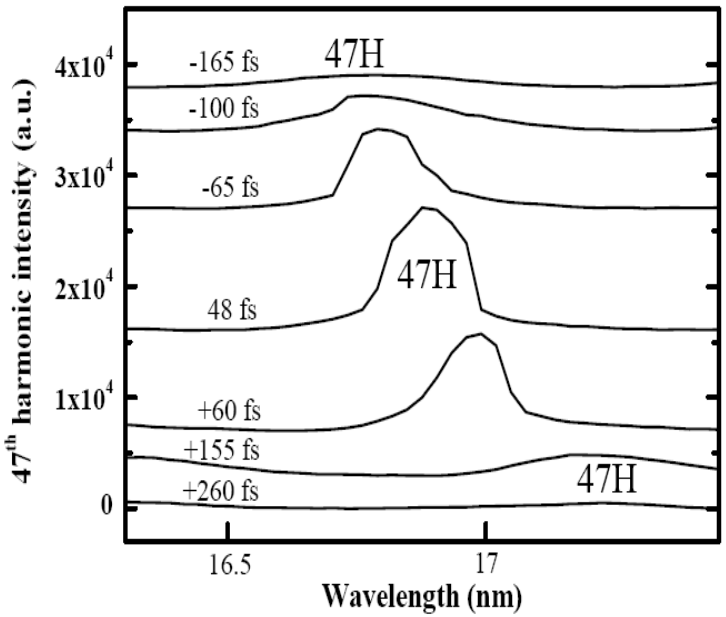


In experiments using Ti:Sapphire laser irradiation of high pressure helium gas jet, electrons have been accelerated to energy exceeding 70 MeV. Number of accelerated electrons per pulse ~ 1.7 x 10^{10}

Intensity Enhancement through Harmonic Tuning

(Effect of chirp variation)

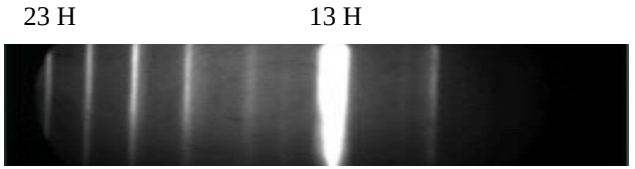
Harmonics Tuning: Silver Plasma



Tuning range upto 0.8 nm

Physical Rev. A 74, 063824, 2006

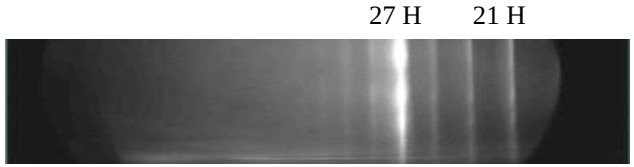
Indium Plasma Harmonics



13^{th} harmonic: 200 X

Optics Letters 32, 65, 2007

GaAs Plasma Harmonics

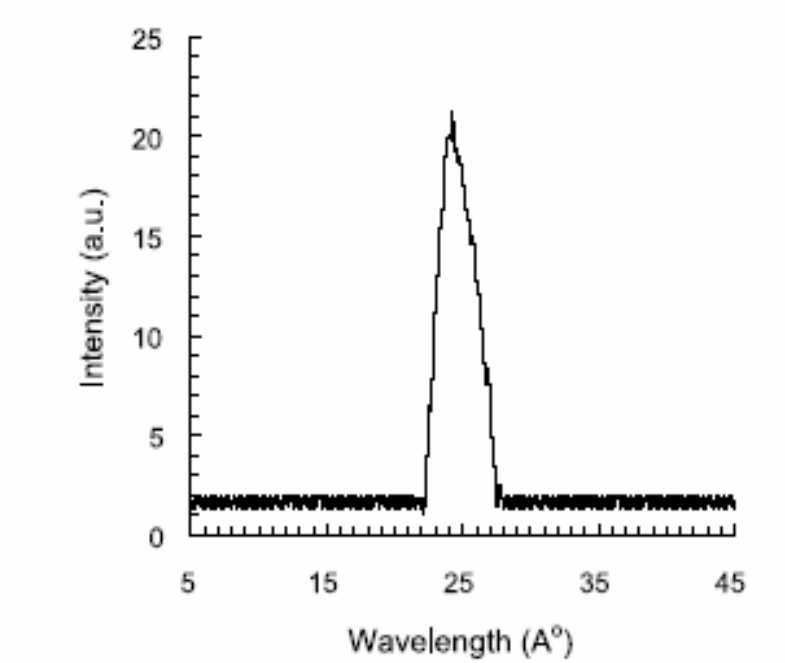


27^{th} harmonic: 6 X

J Opt Soc. Am B 23, 2535, 2006

Narrow-Band Water Window X-ray Emission from Mix-Z Plasma

Transmitted x- ray spectrum of gold-copper mix-z plasma



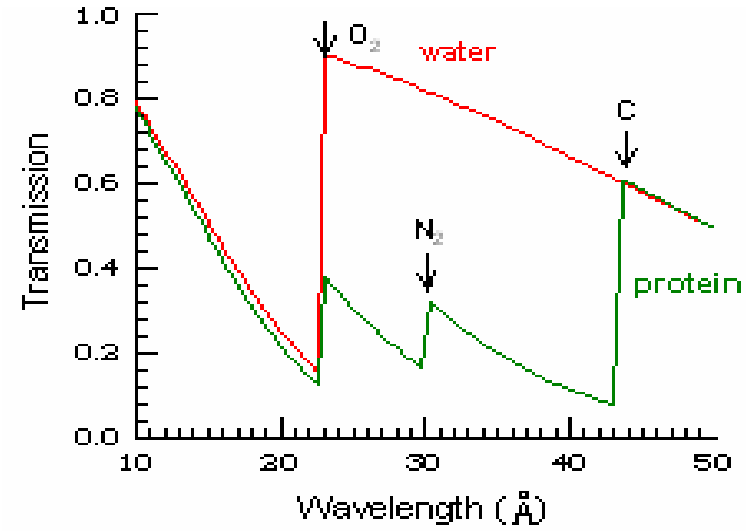
Narrow band (24 – 26 A) source

J. Appl. Phys. 100, 33306 (2006)

Appl. Phys. B. (2007) In Press

Possible use of source for live bio-molecule imaging in the Water-window region

23 Å - 44 Å

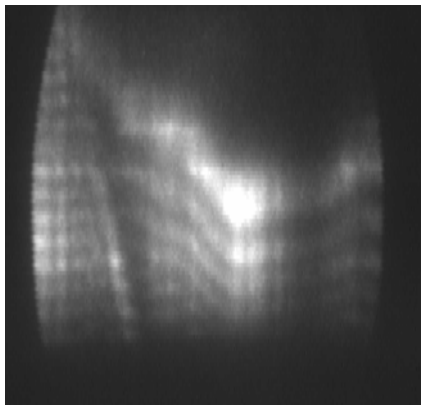


Optical Streak Cameras & Time Resolved Shear Interferometer

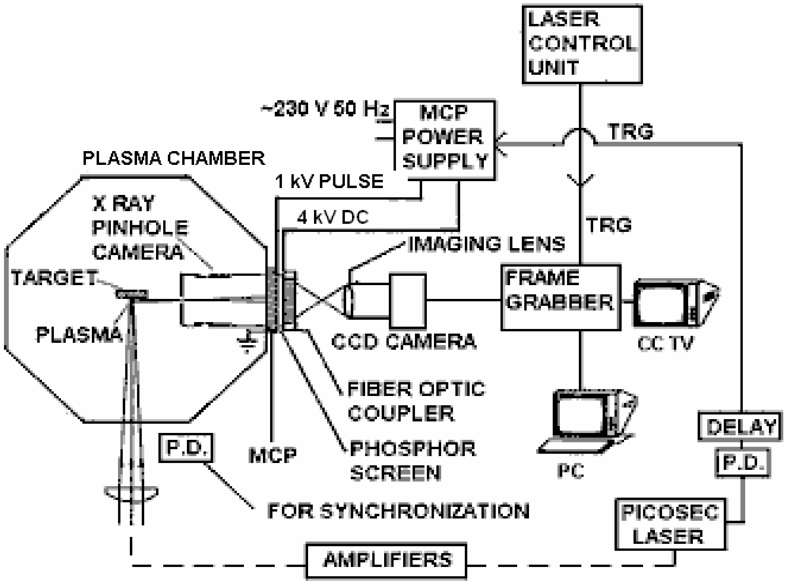
S-20 Optical streak camera

Temporal resolution = 8 ps

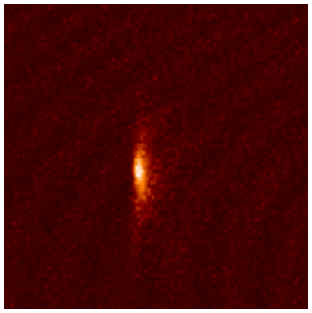
Interferogram of LPP

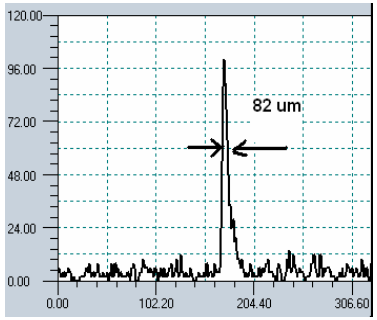


X-ray Framing Camera



Filtered x-ray pin-hole camera with fast gated MCP detector





Typical X-ray frame

Development of Fiber Optic Temperature Radar

Temperature range :
25^0C – 500^0C
Accuracy : ± 2^0C

Simultaneous measurement possible at many points over a length of 500 m

A prototype system has been developed for monitoring of sodium circuits and steam generators of FBR and it will be soon delivered to IGCAR.

Ophthalmic Green Laser

Diode-pumped frequency doubled Nd:YVO_4 system

- **Diabetic retinopathy**

Power : 0-1000mW in steps of 10mW

Wavelength : Green 532nm

Mode : True CW / Foot-switch operated

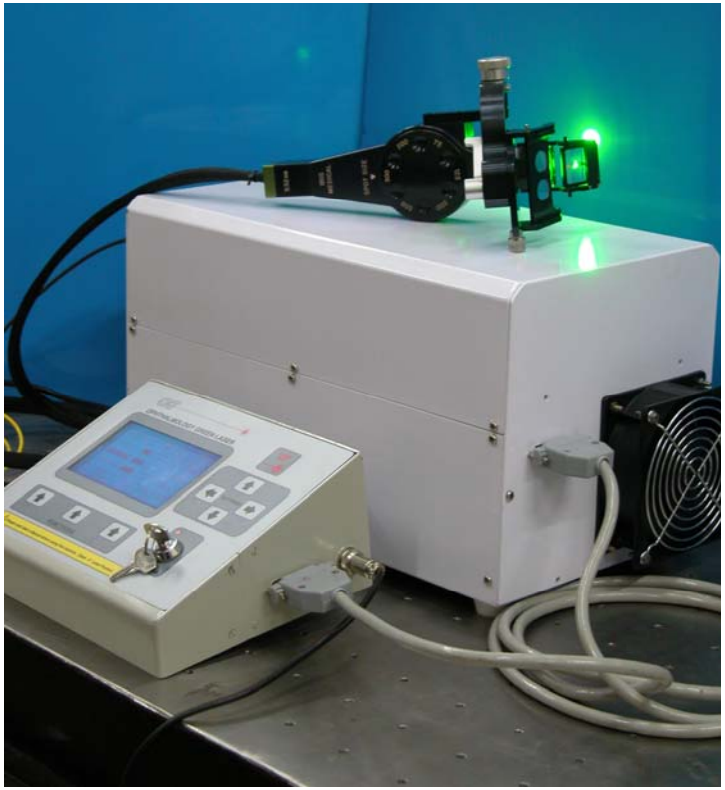
Pulse duration : 50ms to 1000ms

Repeat interval : Variable (<50% duty)

Cooling : Forced air

Aiming Laser : 650nm, diode laser, <1mW

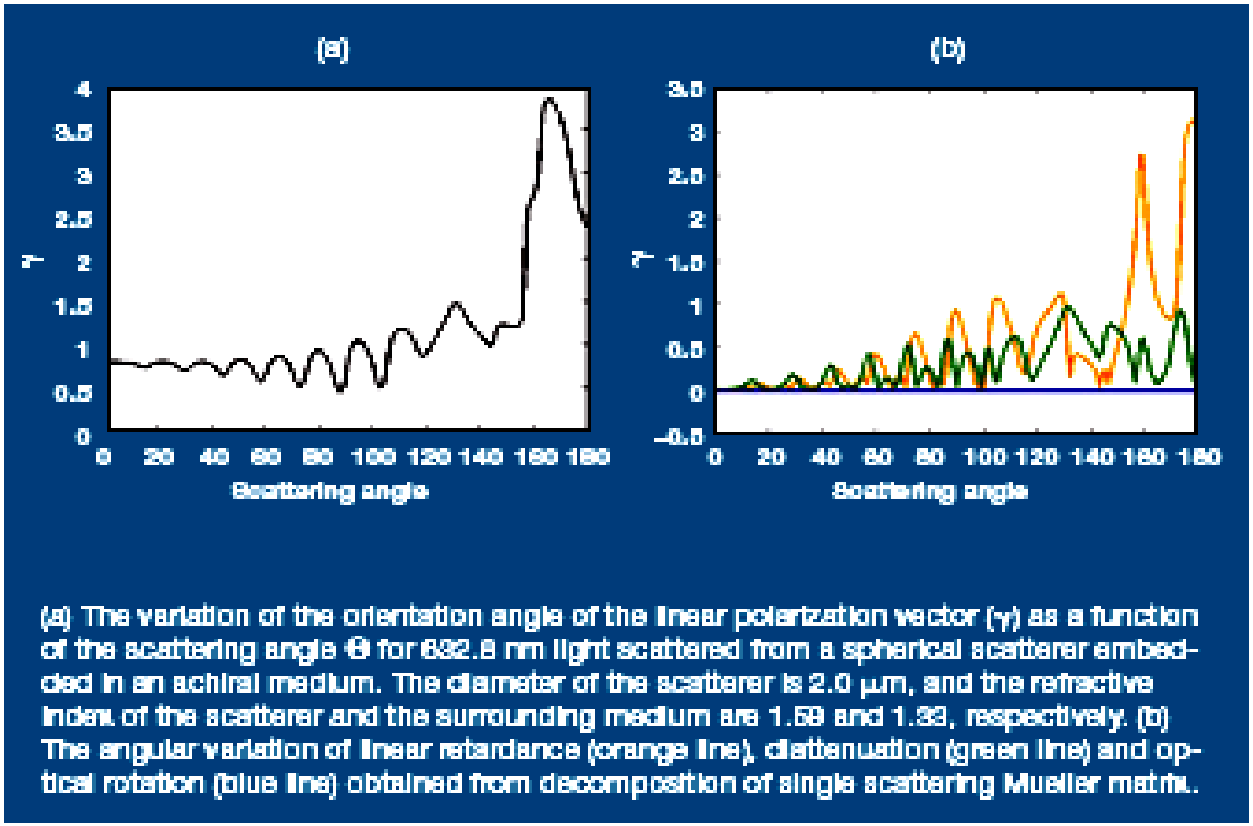
Display : Graphical LCD screen, Portable



In Sept 2005, one Prototype unit was supplied to M/S Aravind Eye Hospitals, Madurai, under an MoU signed between us. After clinical trials a "mark 2" unit has been built & will be supplied after user checks out its functioning at our place in the coming months.

Activities at Laser Biomedical Applications & Instrumentation Division

Meuller Matrix Approach for Discriminating Optical Rotation



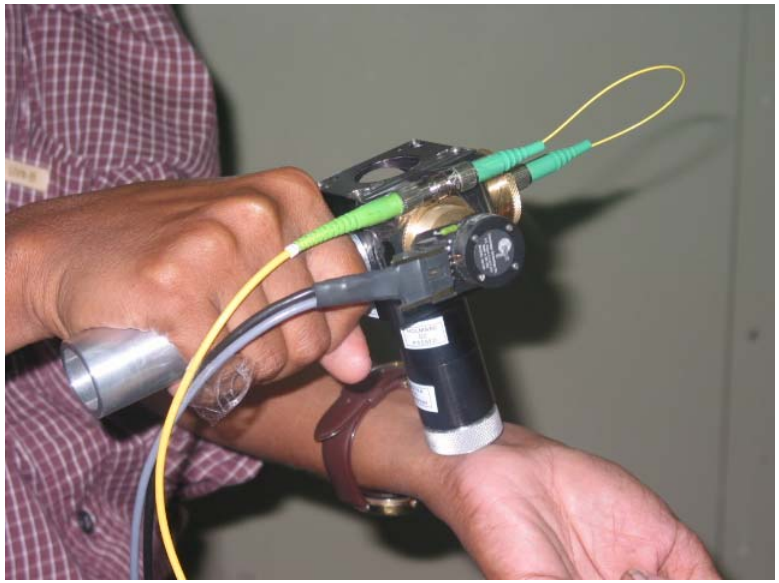
(a) The variation of the orientation angle of the linear polarization vector (γ) as a function of the scattering angle Θ for 632.8 nm light scattered from a spherical scatterer embedded in an achiral medium. The diameter of the scatterer is 2.0 μm, and the refractive index of the scatterer and the surrounding medium are 1.59 and 1.33, respectively. (b) The angular variation of linear retardance (orange line), diattenuation (green line) and optical rotation (blue line) obtained from decomposition of single scattering Mueller matrix.

RRCAT has developed a method to decouple the rotation of the angle of the polarization vector arising due to chirality of the turbid medium from that due to scattering. This may find application in non-invasive determination of optically active substances in turbid media, like for example glucose in human tissue, that is required to manage diabetes.

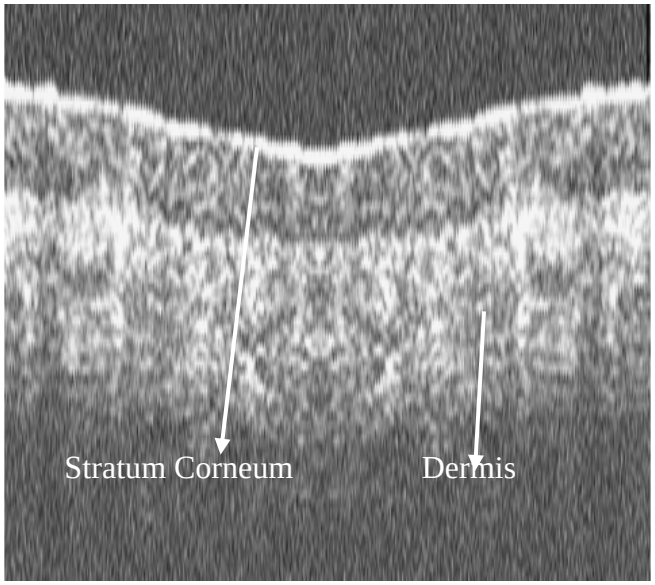
Optics and Photonics News, December 2006 Special issue 'Optics in 2006".

Activities at Laser Biomedical Applications & Instrumentation Division (contd)

Optical Coherence Tomography



Handheld probe for real time imaging (8 frames per second)

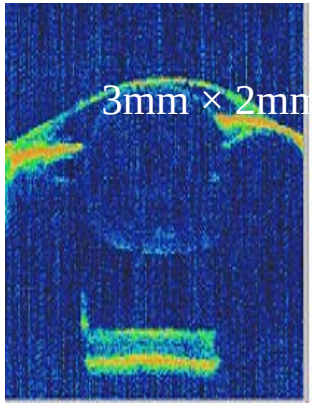


Axial and lateral resolution ~18μm

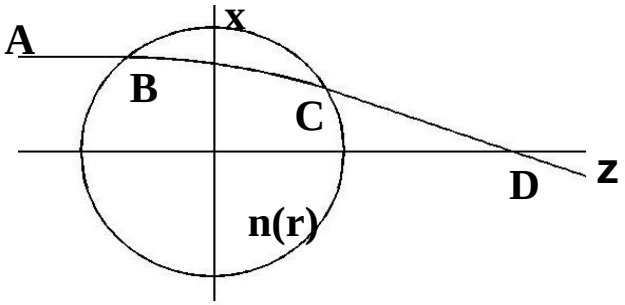
Activities at Laser Biomedical Applications & Instrumentation Division (contd)

GRADIENT REFRACTIVE INDEX PROFILE OF FISH EYE

Comparison of Gradient refractive index profile retrieved by iterative fitting of optical path measured using OCT images with that calculated by ray tracing method.

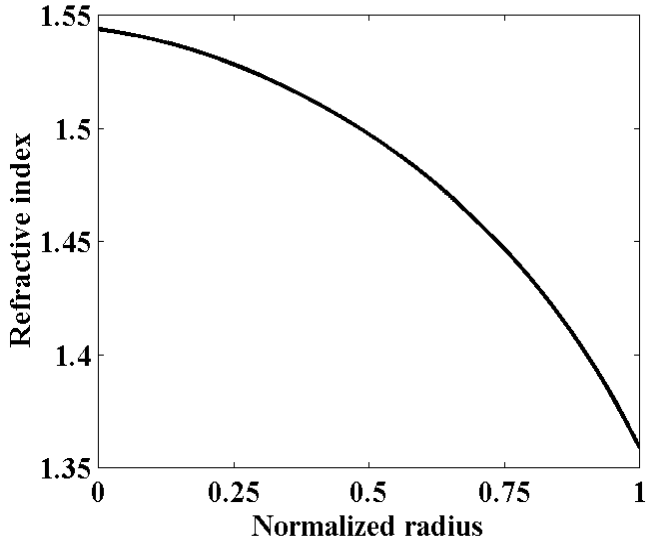


In-vivo OCT image of Zebrafish eye



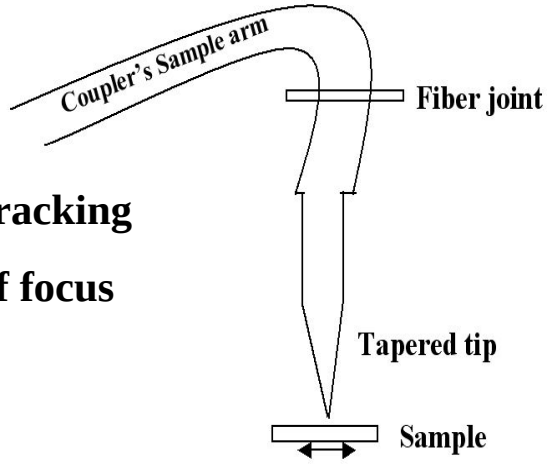
$n(r) = a_0 + a_1 r^2 + a_2 r^4 + a_3 r^6$

Optical path BC $= \int_B^C n(r)\,dr$



Activities at Laser Biomedical Applications & Instrumentation Division (contd)

Lateral resolution enhancement using of tapered fiber tip



No need of focus tracking

Improved depth of focus

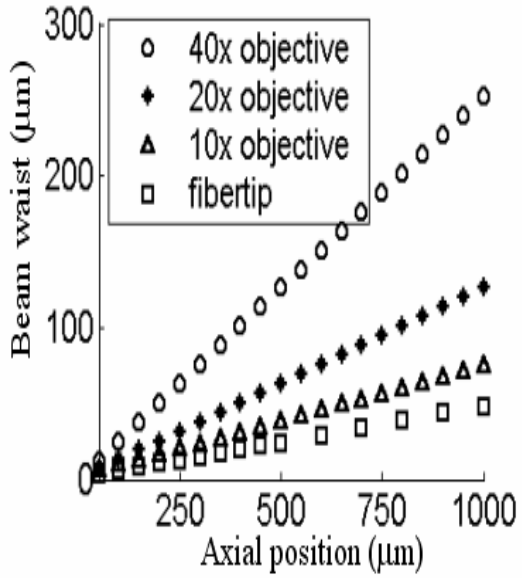
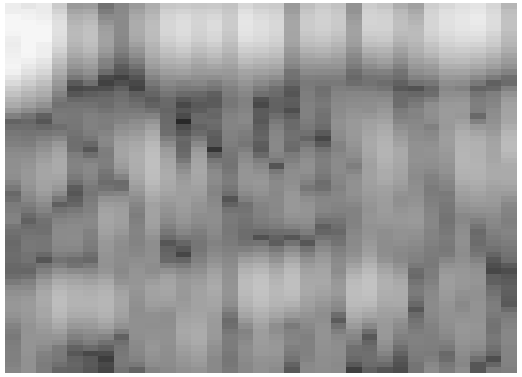
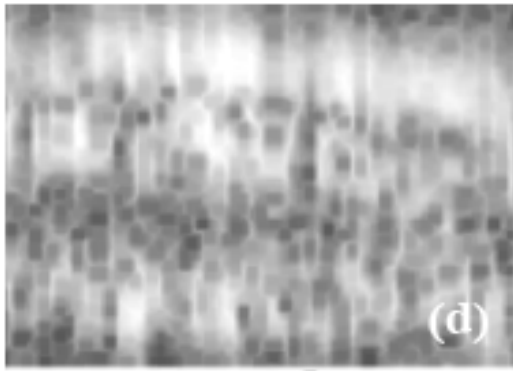


Image of *Elodea densa* leaf section



Normal OCT image



Fibertip based OCT image

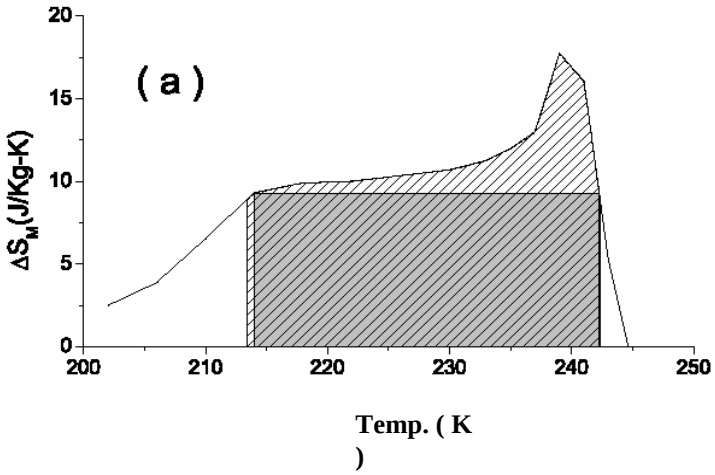
Growth of Optical Crystals and IR-transparent free-standing ZnS dome

Automatic diameter control pull head has been successfully interfaced with a resistive heating furnace to grow crystals with melting point up to 1300 ^{0}C

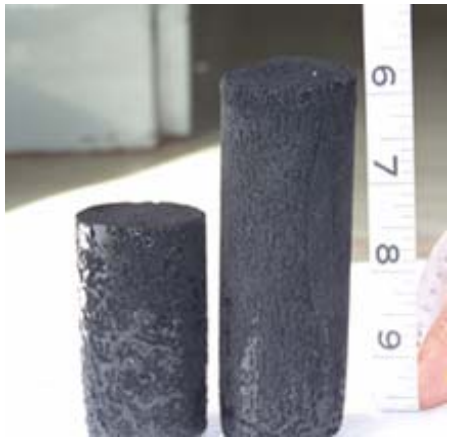
Congruent LN crystals; (a) without doping, (b) with Er (0.25, 0.5 and 1 mol%) and (c) with Zn (2 and 4 mol%) doping grown with the automated system.

Magnetic-Cooling in Ternary Alloys NiMnIn

Recent studies at RRCAT have revealed occurrence of large magnetocaloric effect in $Ni_{50}Mn_{13}In_{16}$ alloy in the temperature regime around 250K. Such materials are of potential interest in producing energy efficient and environment friendly cooling.



Development and utilization of Carbon aerogels of different morphologies



Pt-Loaded Carbon –silica composite cylinders and disc

Carbon Foam Electrode (125 x 80 mm)

Use of carbon aerogels of different morphologies (monoliths, thin large sheets, cylinders and rasching ring etc) for different applications (separation of hydrogen isotopes in liquid catalytic exchange process) are being pursued.

RRCAT was the host for

APAC2007

(where of ~360 participants about ~160 were from overseas)

NLS-2006

(with ~400 attendees)

& other smaller meetings

Ground Water Recharging at RRCAT

BACKGROUND:

INDORE CITY EXPANSION HAS LED TO CUT IN WATER SUPPLY TO RRCAT.

SO WE NEED TO IMPROVISE WAYS TO AUGMENT OUR WATER SUPPLY.

POSSIBLE SOLUTION IS BOREWELLS; BUT WE MUST ENSURE GROUND WATER RECHARGE.

FACTS TO CONTEND WITH ARE: REDUCTION IN CAPACITY OF SUKHNIWAS LAKE DUE TO SILTING & DIVISION OF LAKE DUE TO THE MAIN ROAD

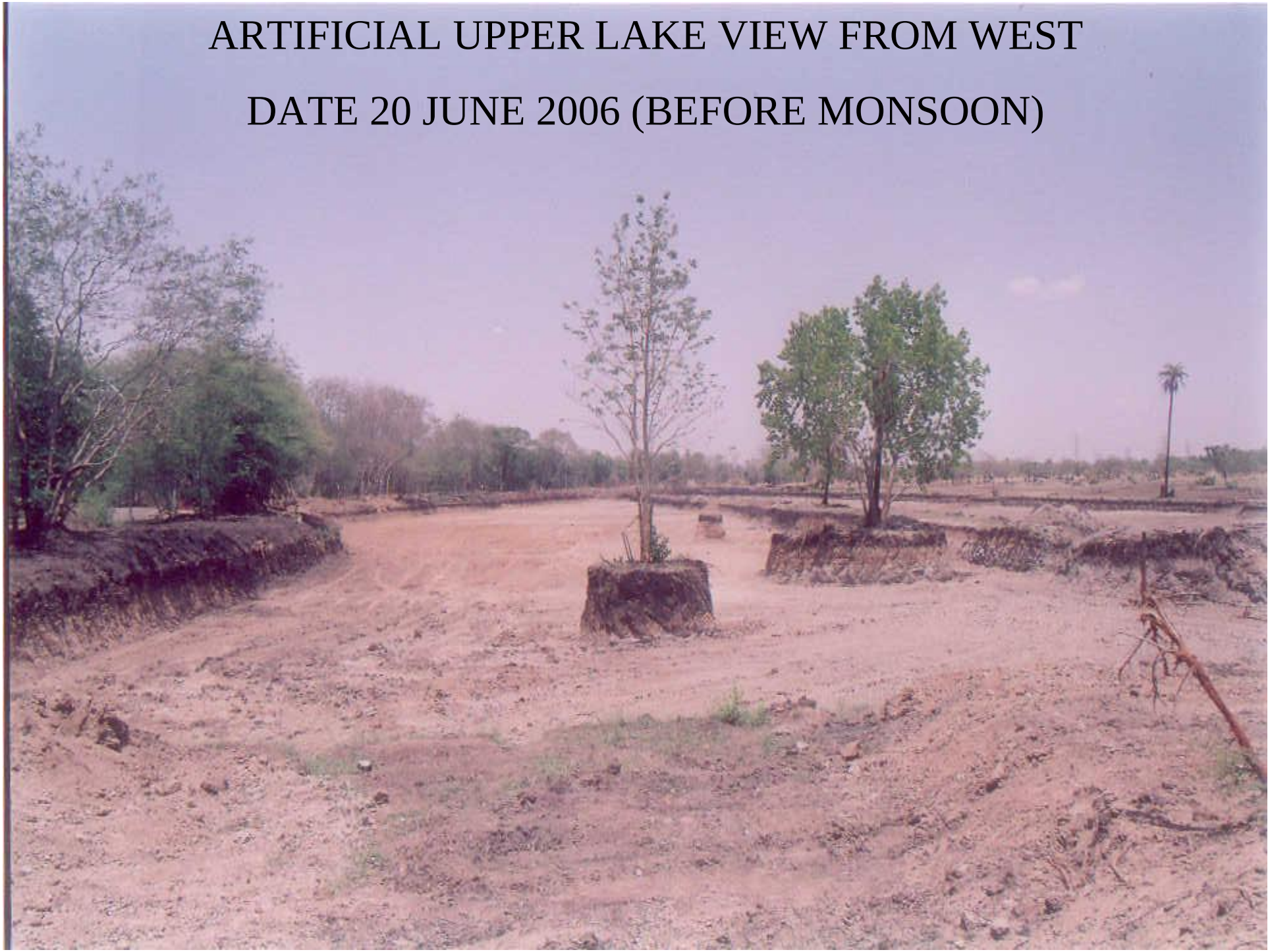
PLAN:

ENHANCE CAPACITY OF EXISTING SUKHNIWAS LAKE BY DE-SILTING. CONSTRUCT UP-STREAM LAKE. CHANNELISE WATER INTO SUKHNIWAS LAKE


CAT Indore
© 2006 Europa Technologies
Image © 2006 DigitalGlobe
©2006 Google
1412 ft
Pointer 22°39'55.40" N 75°47'47.87" E elev 1896 ft
Streaming 100%
Eye alt 6822 ft

ARTIFICIAL UPPER LAKE VIEW FROM WEST

DATE 20 JUNE 2006 (BEFORE MONSOON)



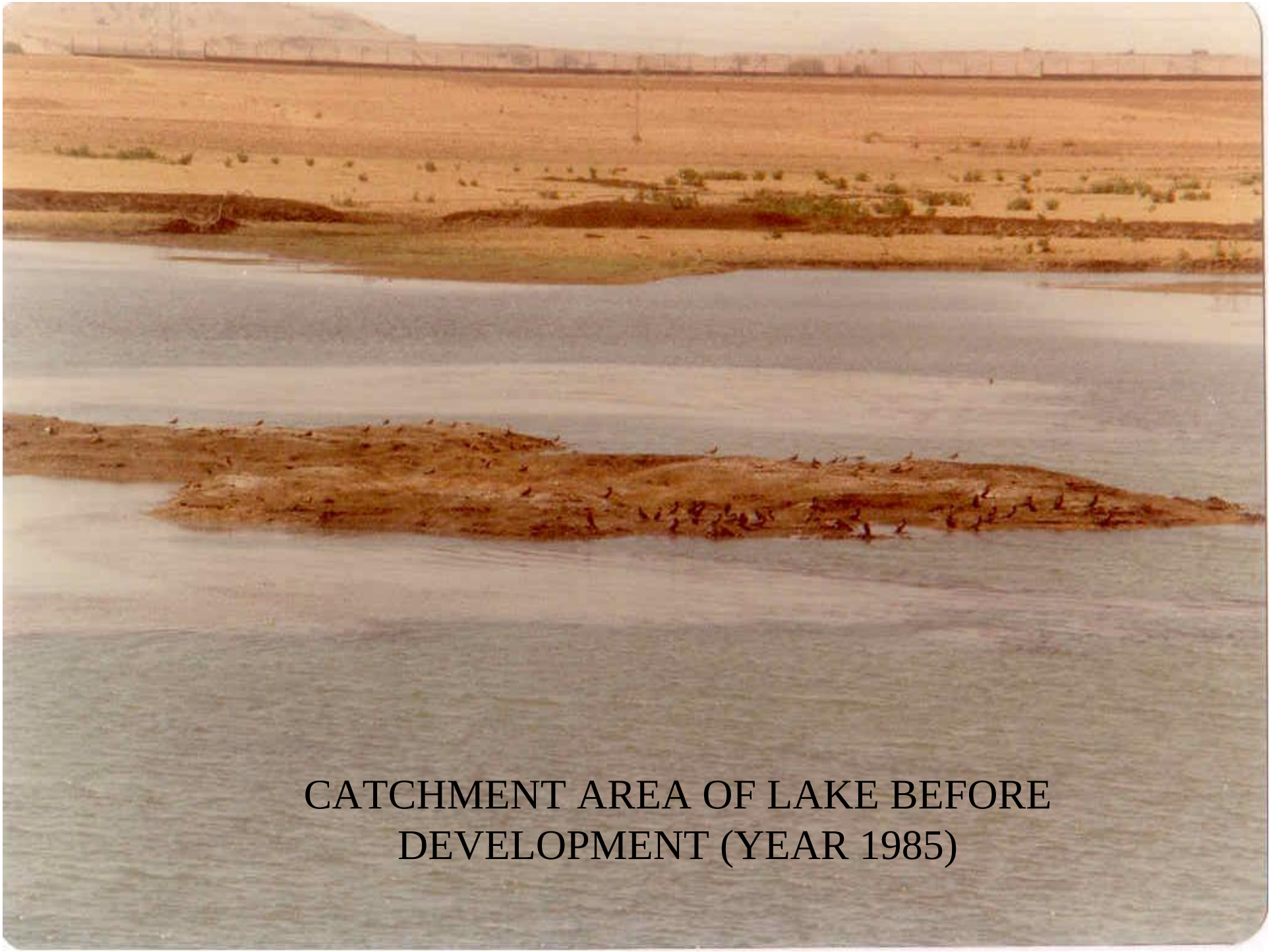
ARTIFICIAL UPPER LAKE VIEW FROM EAST

DATE 20 JUNE 2006 (BEFORE MONSOON)


ARTIFICIAL UPPER LAKE VIEW FROM WEST
DATE 21 JULY 2006 (RAIN FALL 225mm)

ARTIFICIAL UPPER LAKE VIEW FROM SOUTH

DATE 21 JULY 2006 (RAIN FALL 225mm)



CATCHMENT AREA OF LAKE BEFORE DEVELOPMENT (YEAR 1985)

DELIVERABLES OF PHASE-I

1. 430 LAKH LTR ADDITIONAL CAPACITY
2. BETTER COLLECTION FROM CATCHMENT AREA
3. PREVENT WATER MOVEMENT INTO OTHER AREAS
4. IMPROVEMENT IN GROUND WATER TABLE DUE TO STORED WATER
5. REUSED EXCAVATED MATERIAL TO FILL LOW LYING AREAS IN NEW COLONY
6. SAVED ABOUT RS 40 LAKH

Thank You