Raja Ramanna Centre for Advanced Technology, Indore

FOUNDATION DAY FUNCTION 2009

A Warm Welcome from the Entire Staff of RRCAT

to

Prof. B. V. Sreekantan, Former Director, TIFR

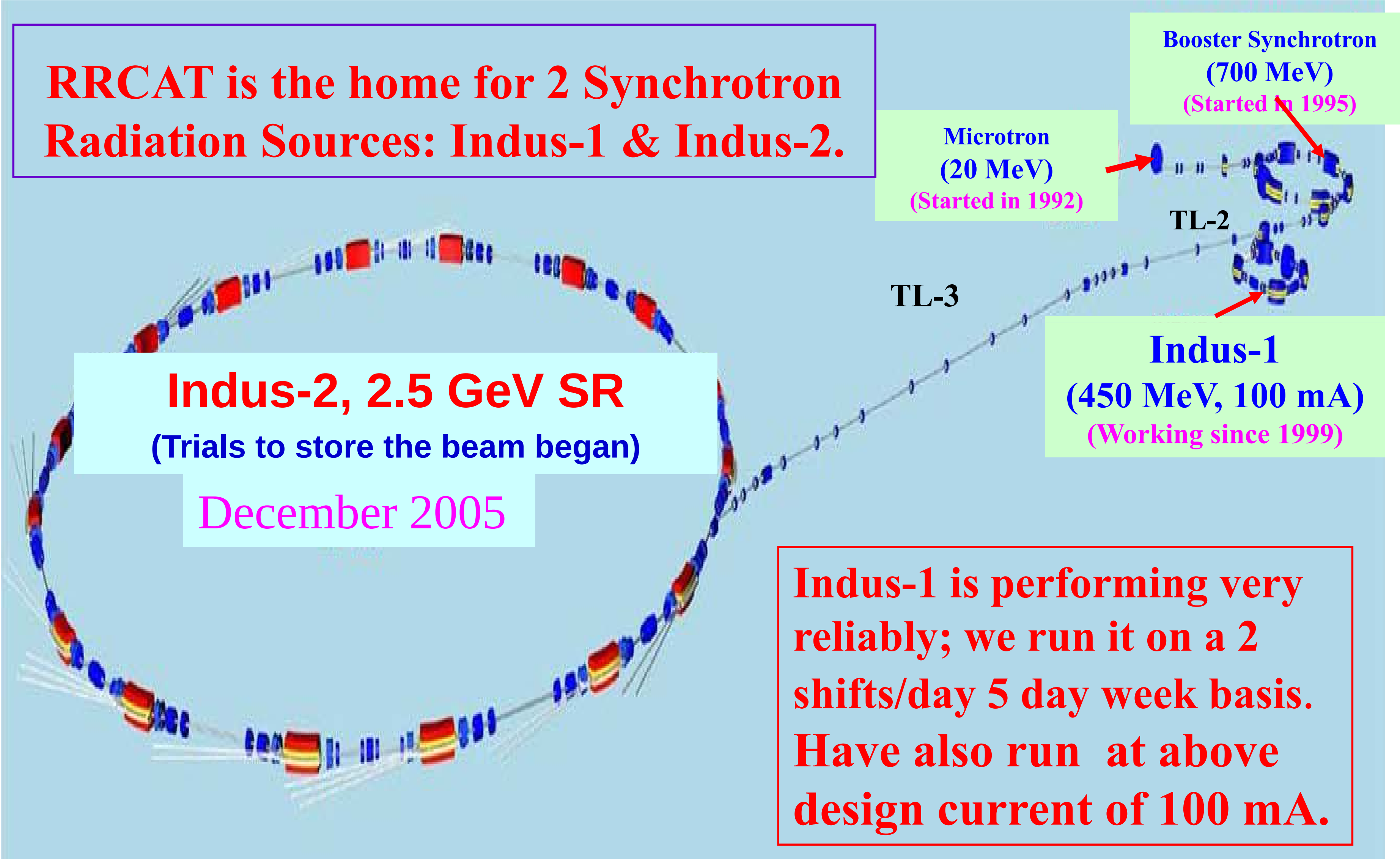
Scientific Accomplishments of the Last Year

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.

Photograph when Foundation Stone of (RR)CAT was laid on 19th Feb 1984, by the then President of India

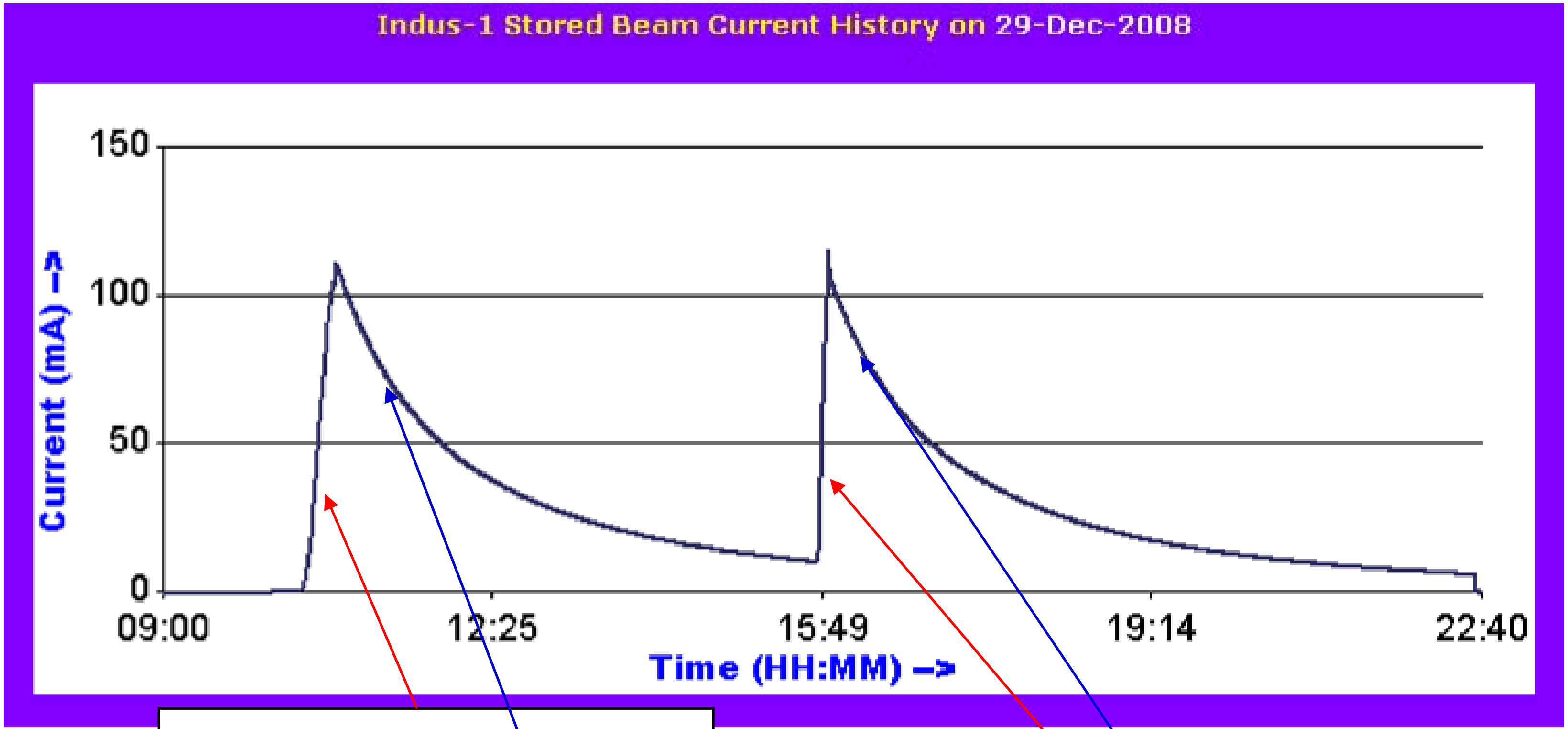
Photograph taken on 17th Dec.2005 when the Prime Minister Dr. Manmohan Singh renamed CAT as RRCAT.

Indus-2 Status: ~135mA accumulated@ injection energy ~550MeV.
Being operated @50 mA;2/2.5GeV; 3 SR beam lines operational.



SCHEMATIC VIEW OF INDUS COMPLEX

Typical Indus-1 operation working 5 days/week and 2 shifts/day

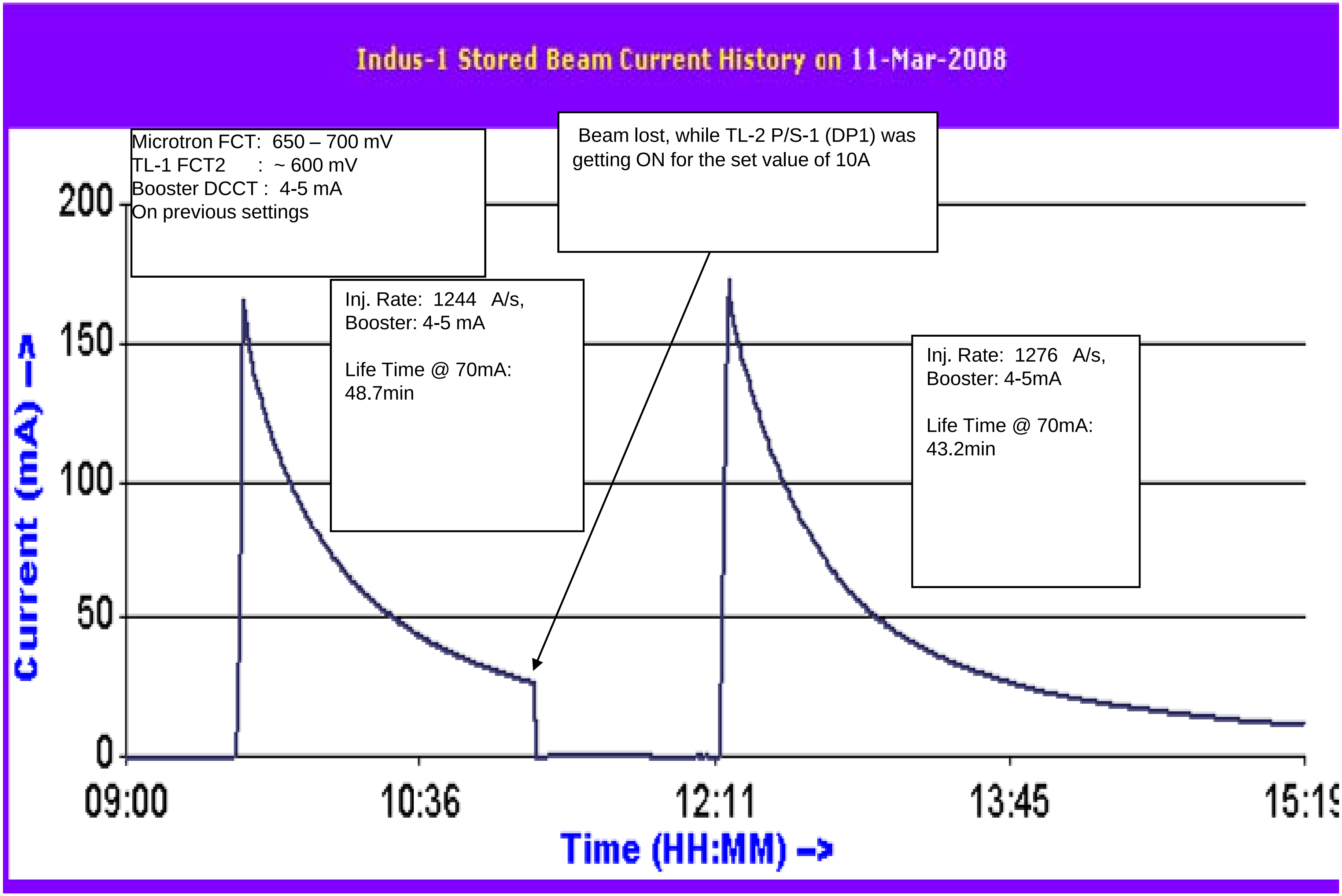


Accumulation rate= 100µA/s
Booster current: ~1-2mA

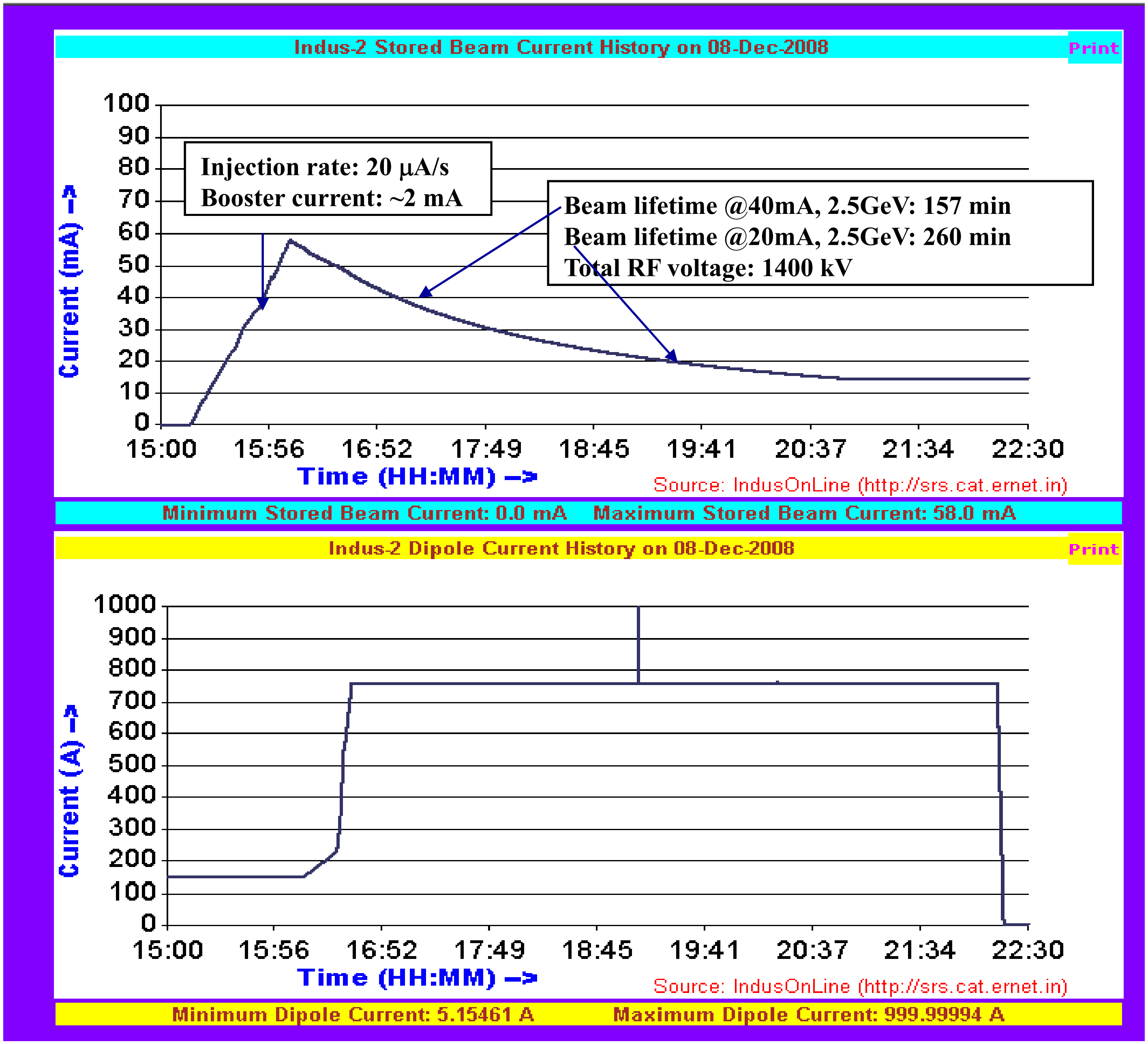
Lifetime @100mA=73minutes
Lifetime @ 70mA=84minutes

Accumulation rate=285µA/s
Booster current: ~2-3mA

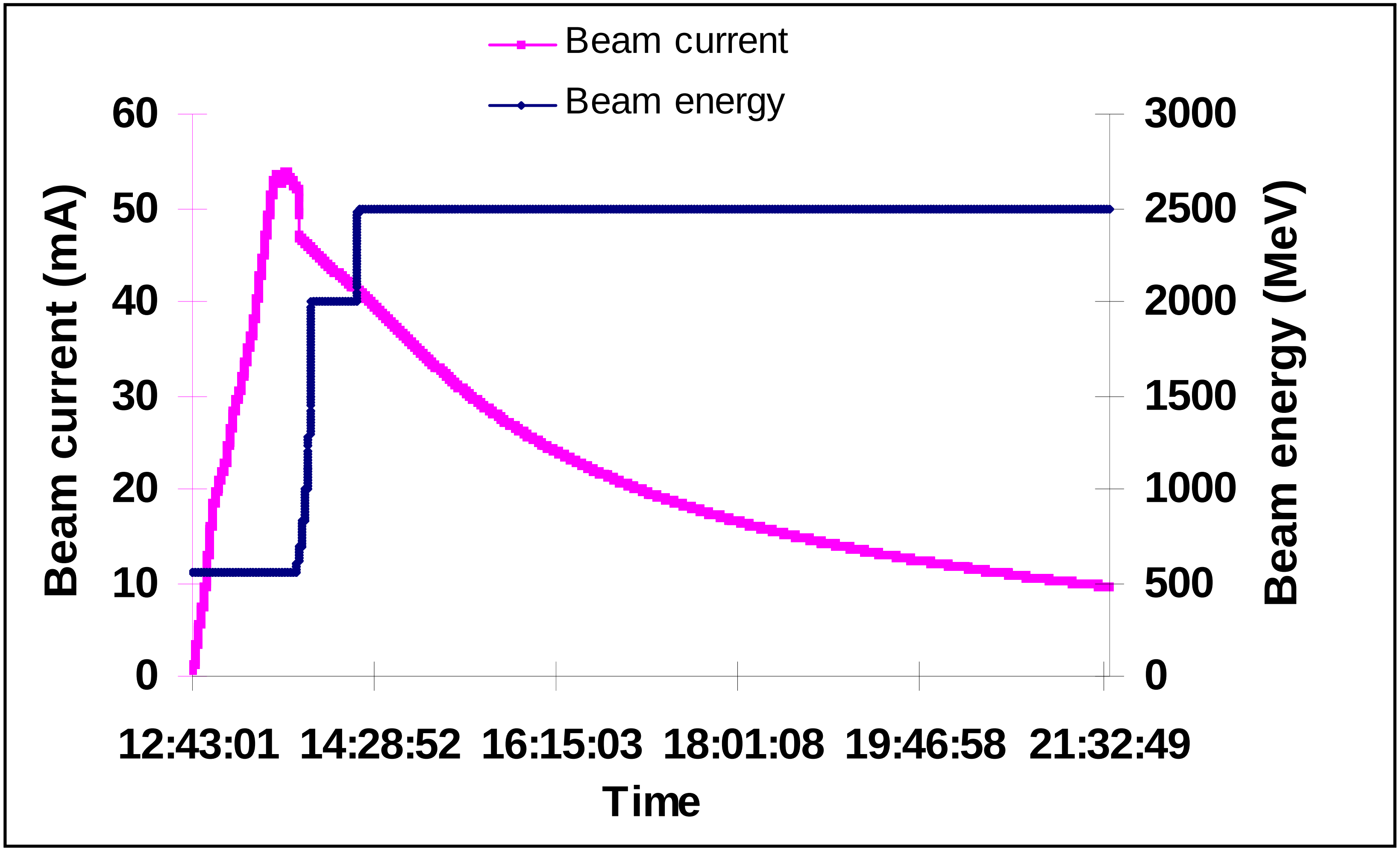
Lifetime @100mA=75minutes
Lifetime @ 70mA=88minutes


Indus-1 Stored Beam Current History on 11-Mar-2008
Microtron FCT: 650 – 700 mV
TL-1 FCT2 : ~ 600 mV
Booster DCCT : 4-5 mA
On previous settings
Beam lost, while TL-2 P/S-1 (DP1) was getting ON for the set value of 10A
Inj. Rate: 1244 A/s,
Booster: 4-5 mA
Life Time @ 70mA: 48.7min
Inj. Rate: 1276 A/s,
Booster: 4-5mA
Life Time @ 70mA: 43.2min
Current (mA) --->
200
150
100
50
0
09:00
10:36
12:11
13:45
15:19
Time (HH:MM) -->

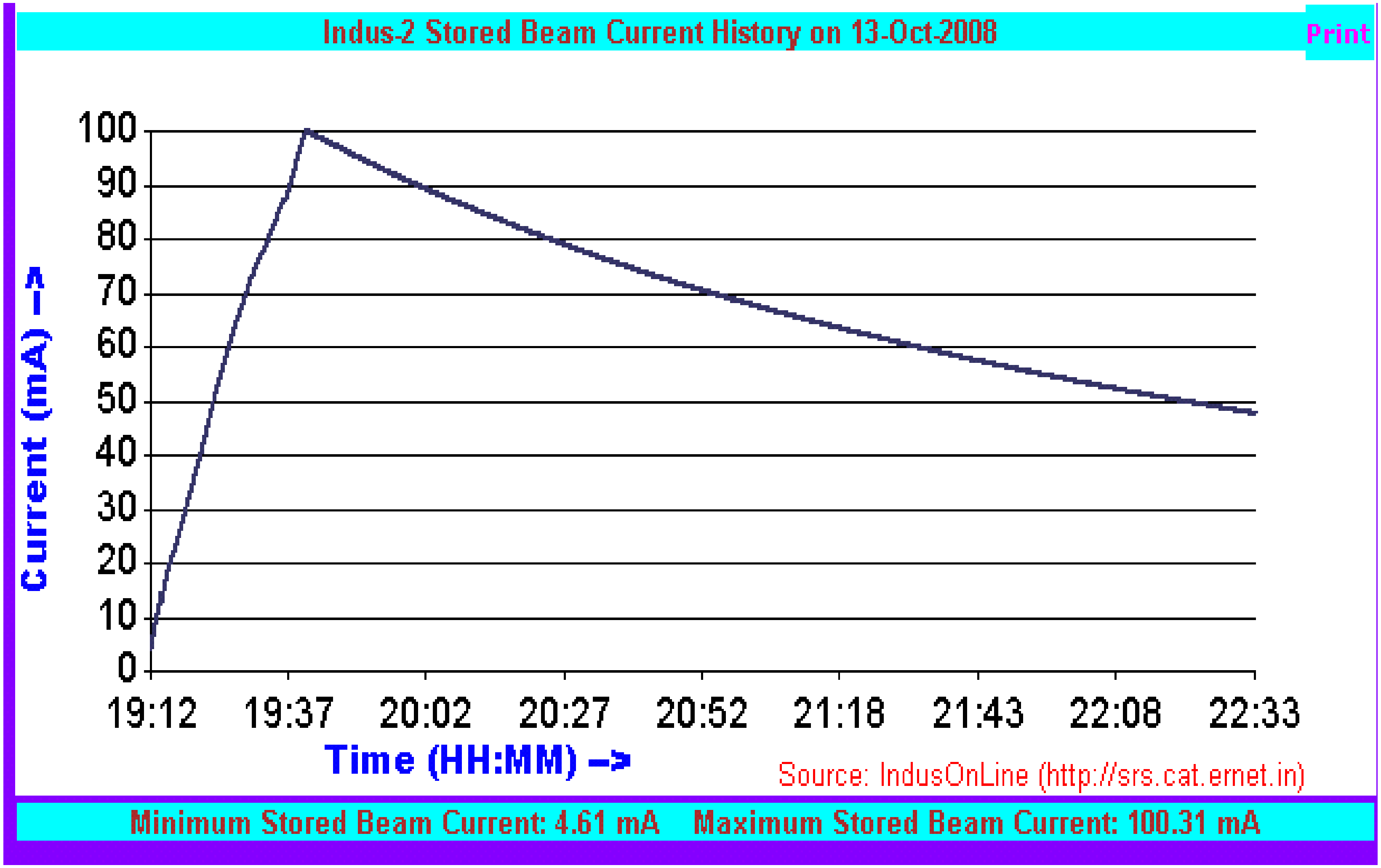
June 2008 : AERB permitted 2.5 GeV 50 mA operation. Daily run on 2 shift basis



Beam current and beam energy on 07-01-2009



Beam current at injection energy on 13-10-08

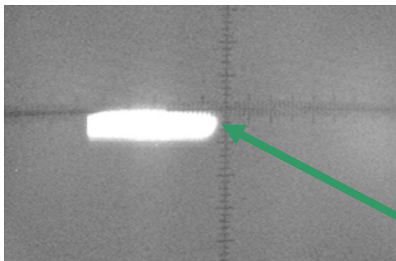


Beam-lines Status (As of January 2009)

Purpose of beam line	Range (KeV)	Institutions involved
Already set up		
Sighting beam line (Installed)	Uses a CCD	RRCAT
EXAFS (Installed)	5 – 20	BARC
Energy Dispersive – XRD (Installed)	10 – 70	BARC
High resolution XRD (Installed)	5 – 25	RRAT
Under construction/partially installed		
XRF-microprobe	2 – 20	RRCAT
Grazing incidence magnetic scattering	5 – 15	SINP, Kolkatta
PES (With high resolution at ~6keV)	0.8 - 15	BARC
White-beam lithography	1 – 10	RRCAT
Protein Crystallography	6 – 25	BARC
Being designed		
Small angle X-ray scattering (SAXS)	8 - 16	BARC
MCD/PES on bending magnet	0.03 – 4	UGC-DAE-CSR
Medical imaging beam-line	10 – 35	BARC + UGC-DAE-CSR
Planned		
Undulator-MCD	0.1 – 1.5	RRCAT
X-ray beam diagnostics	6.2	RRCAT
Visible beam diagnostics	Visible	RRCAT

Pictures of PSD-EXAFS Beam-line

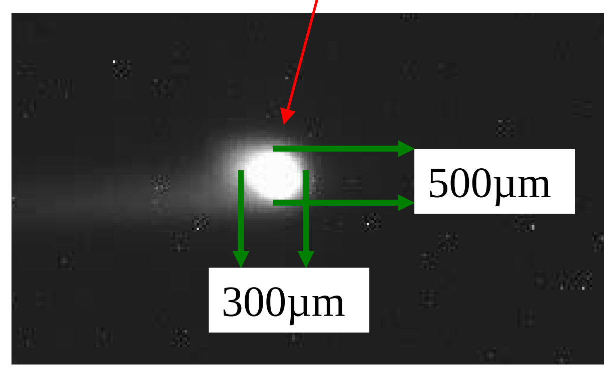
SR beam footprint at beam viewer-1 (before pre-mirror) on EXAFS BL-8. @5mA/2 GeV e- beam from Indus-2



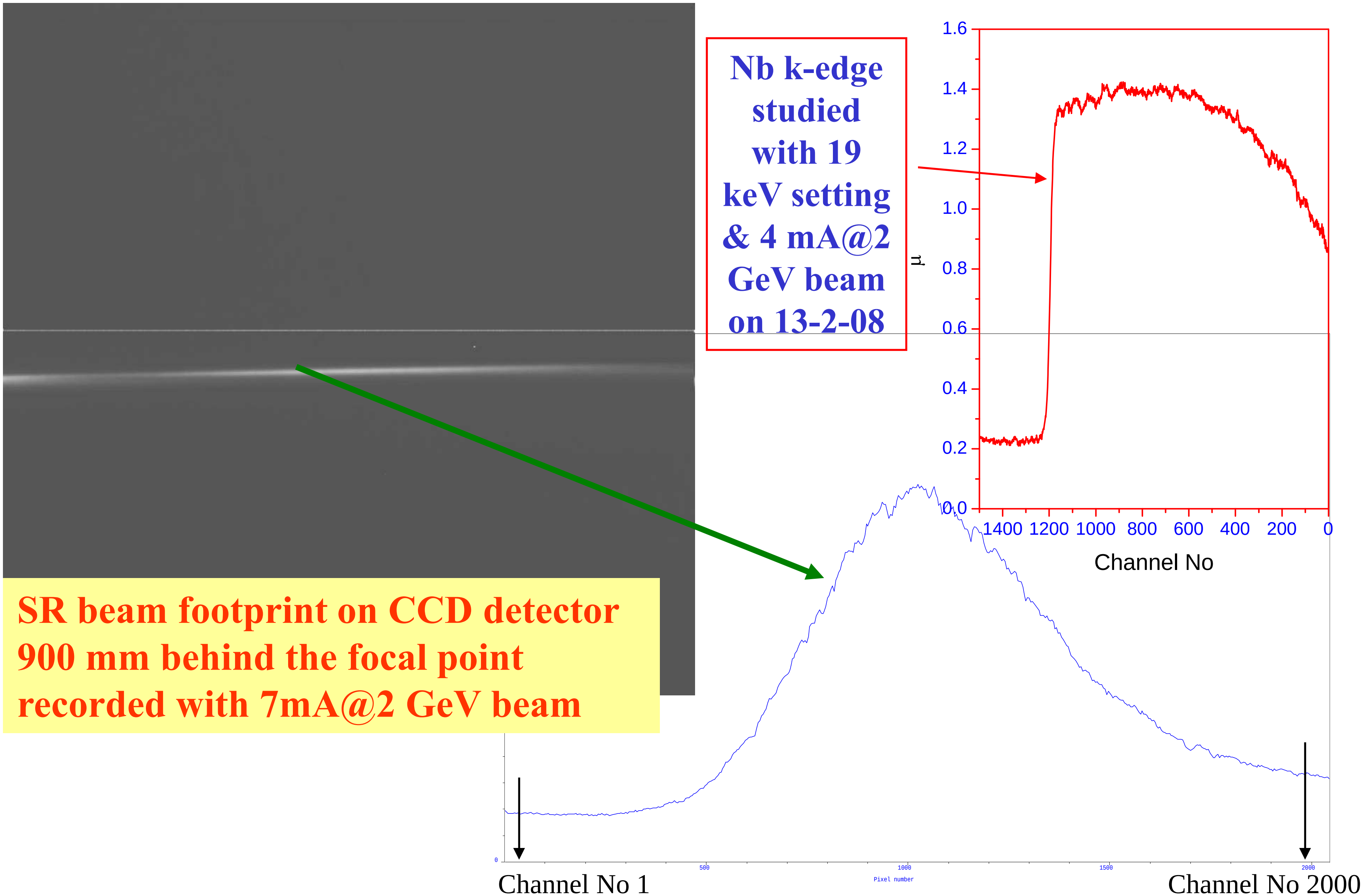
Pic taken on 22.11.2007

<u>Focussed beam at the sample position</u>

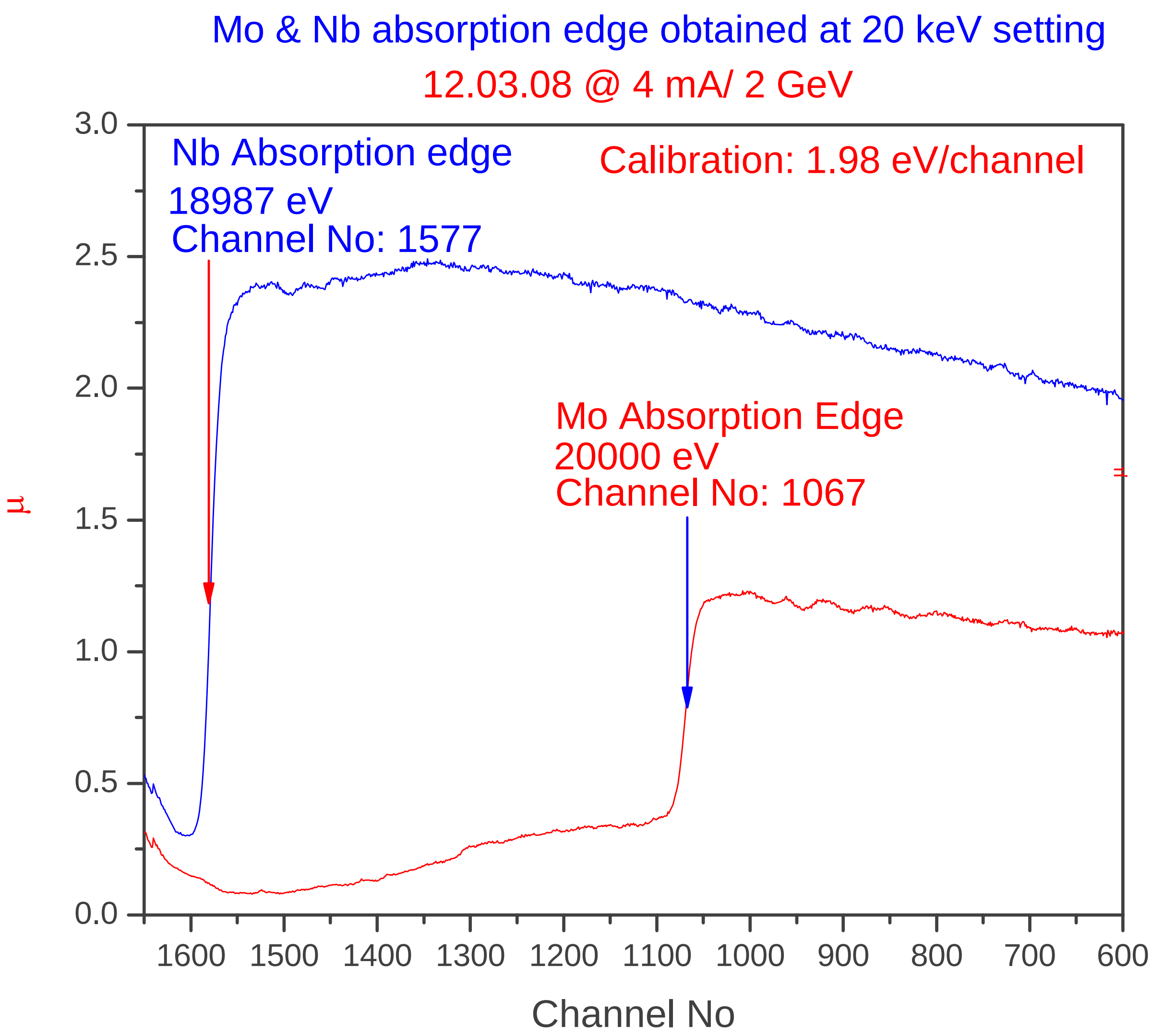
after horizontal focusing by bent Si(111) crystal & vertical focusing by Rh–coated mirror recorded with 7mA@2 GeV beam on 8-2-08 at BL-8 on Indus-2

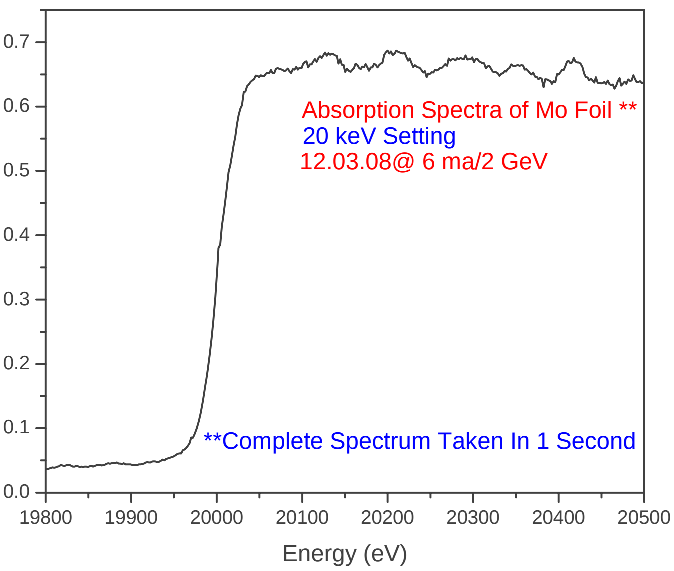


Pic of Mirror bender made at BARC for EXAFS station


Nb k-edge studied with 19 keV setting & 4 mA@2 GeV beam on 13-2-08
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1400 1200 1000 800 600 400 200 0
Channel No
SR beam footprint on CCD detector 900 mm behind the focal point recorded with 7mA@2 GeV beam
Channel No 1
Channel No 2000

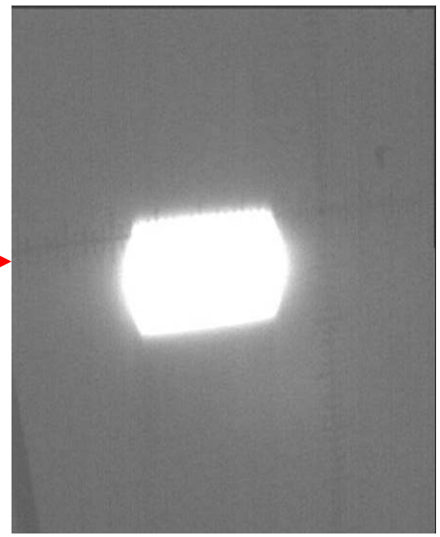
Data to illustrate of the performance of EXAFS beam line

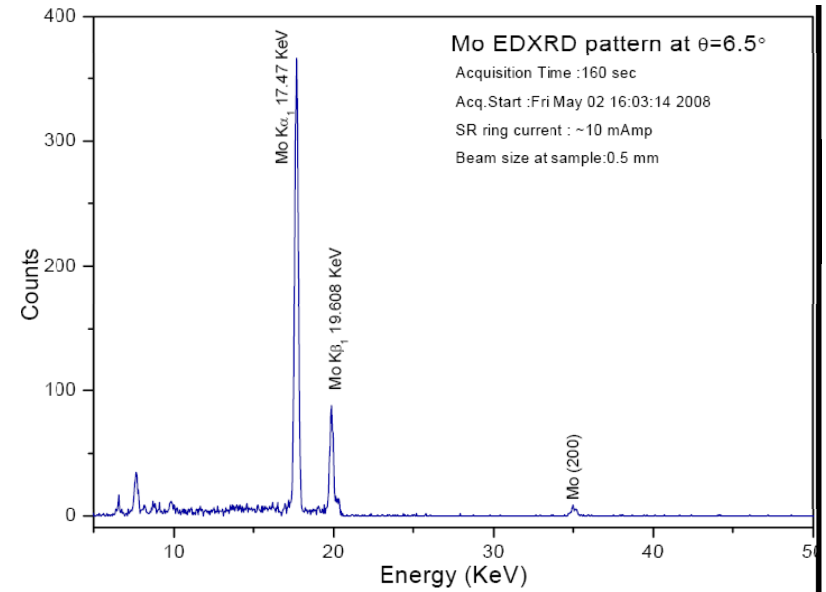


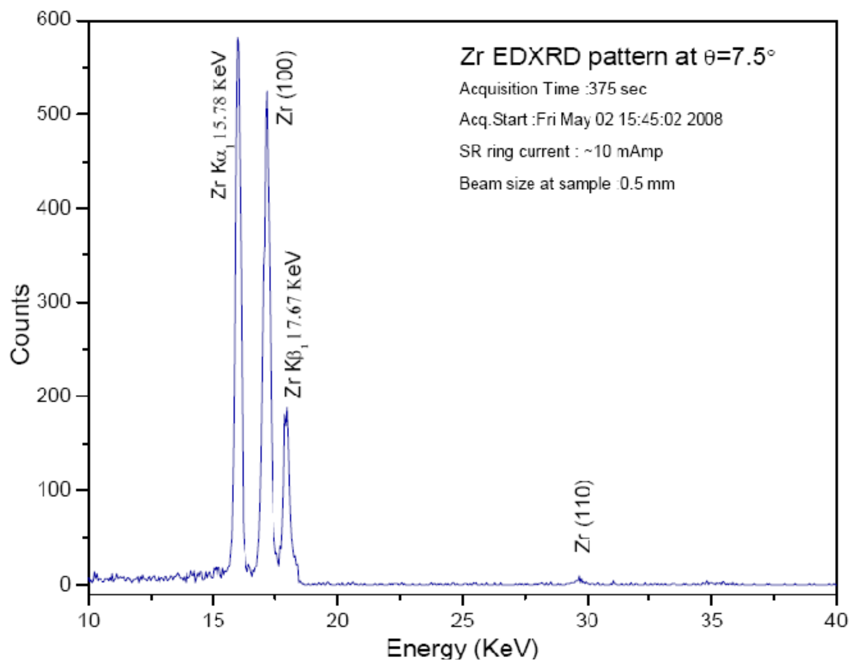


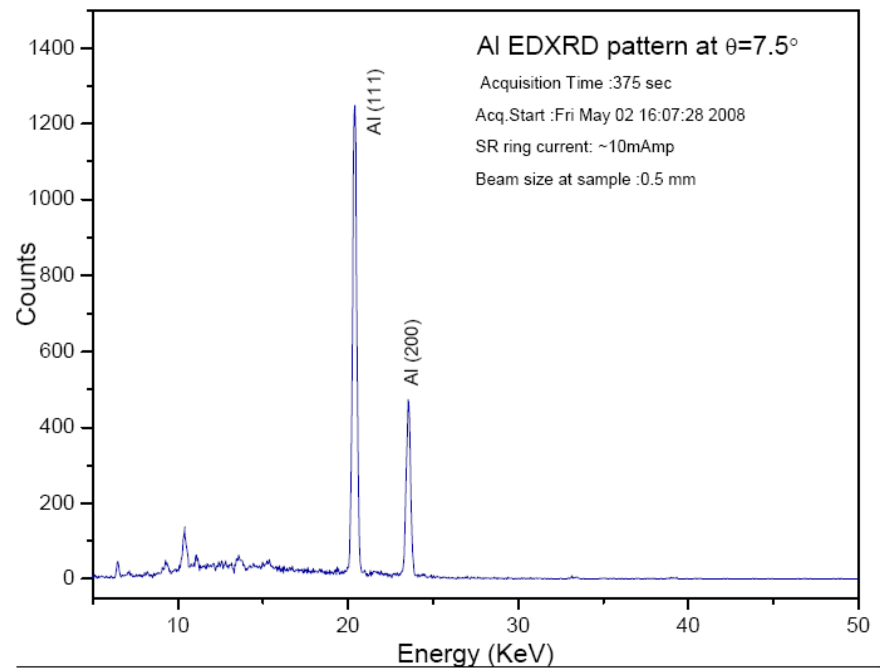
Data to illustrate of the performance of EDXRD beam line

SR as seen on the Be window of the EDXRD beam line (BL11).

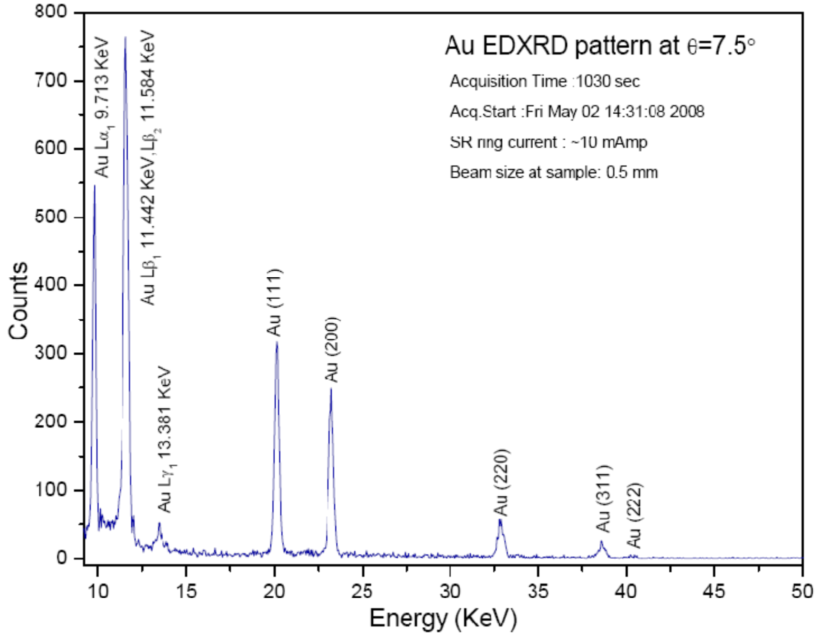


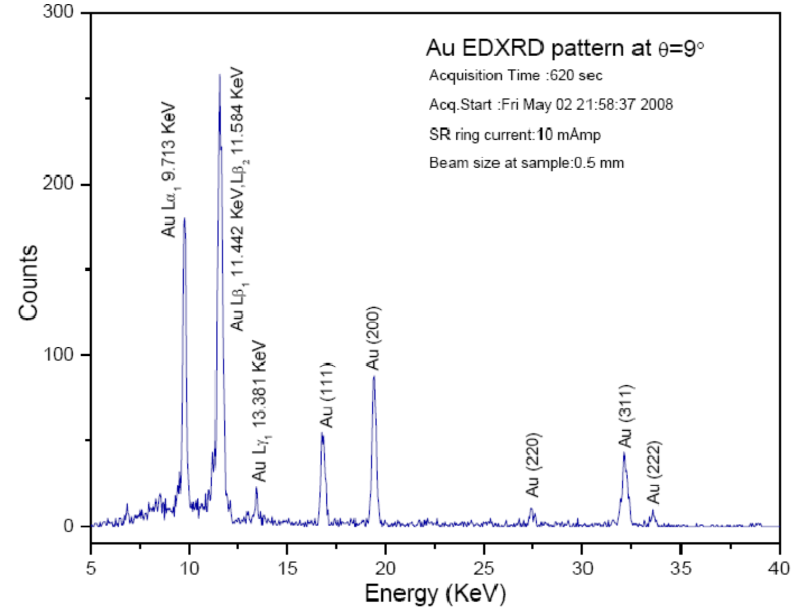


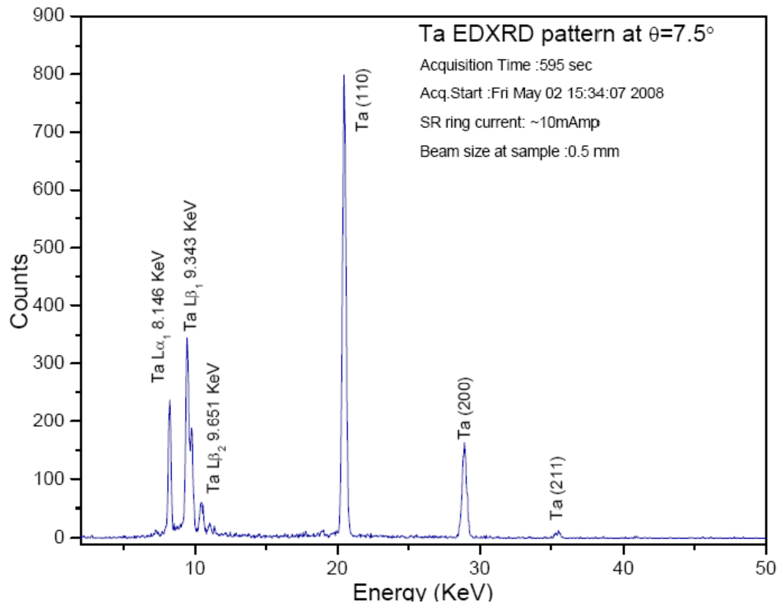


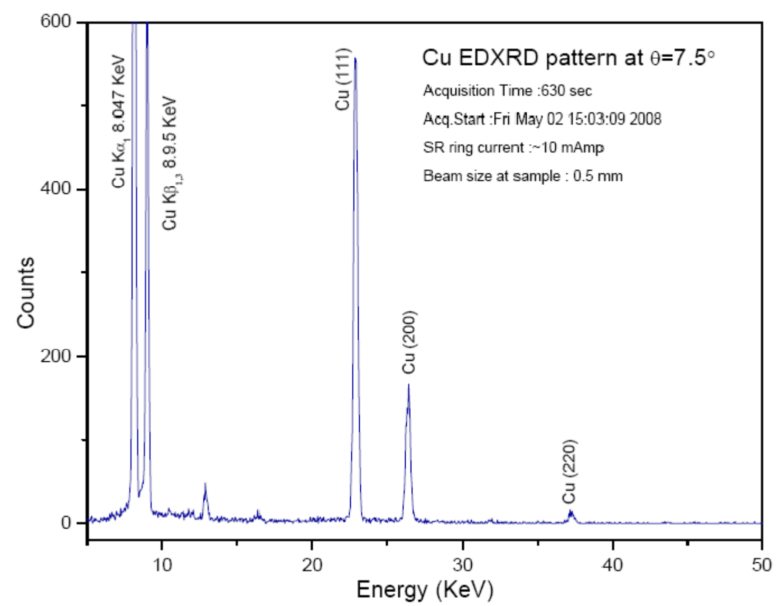


Data to illustrate of the performance of EDXRD beam line









Accelerators for Radiation Processing Applications: Steps initiated to set up ARPF at DAH Mandi, Indore.

750 keV DC Accelerator was operated up to 12 mA current

Building designed to house two accelerators in the Agricultural Radiation Processing Facility at DAH Mandi Complex, Indore. 2.25 acres land for this facility allotted by MP State Government.

Goal is: Reliable operations of the accelerators at this complex.

DAE- CERN Collaboration in Particle Accelerators

DAE-CERN Collaboration : LHC & Beyond

(RRCAT is the Nodal DAE Institute for this Collaboration)

DAE has given subsystems & skilled manpower support of 44 MCHF for LHC @ CERN; ***India is an Observer State.***

We continued helping CERN in LHC commissioning and

Participated in CERN's Novel Accelerator Projects :

*** Compact Linear Collider (CLIC)Test Facility CTF3.**

***Linac-4, front end of Superconducting Proton Linac.**

Reciprocally CERN has given hardware for our projects: One Klystron, one circulator for our use has already reached us. We had earlier received wave guide components.

 # Have made good progress in all collaborative programs during the last year.

Precision Magnet Positioning System (PMPS) Jacks

MCS & MCDO

Magnetic measurements teams- ~100 Man-years

To mark DAE's contributions, CERN Gifted a Memento to Director, RRCAT on 20/3/07

Quench Heater Power Supplies(QHPS)

Local Protection Units

DAE's contributions installed i LHC Tunnel at CERN

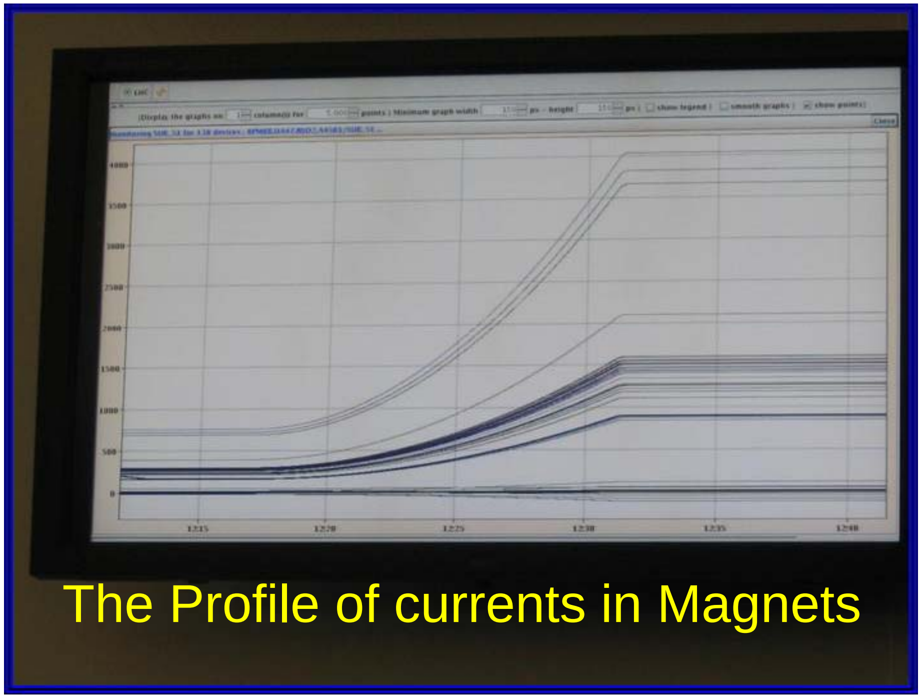
H/W Commissioning in LHC Tunnel

- Participation in
  - Hardware installation for quench protection systems
  - Test setup installations
  - Cooling stations' adjustments
  - Attending to faulty components

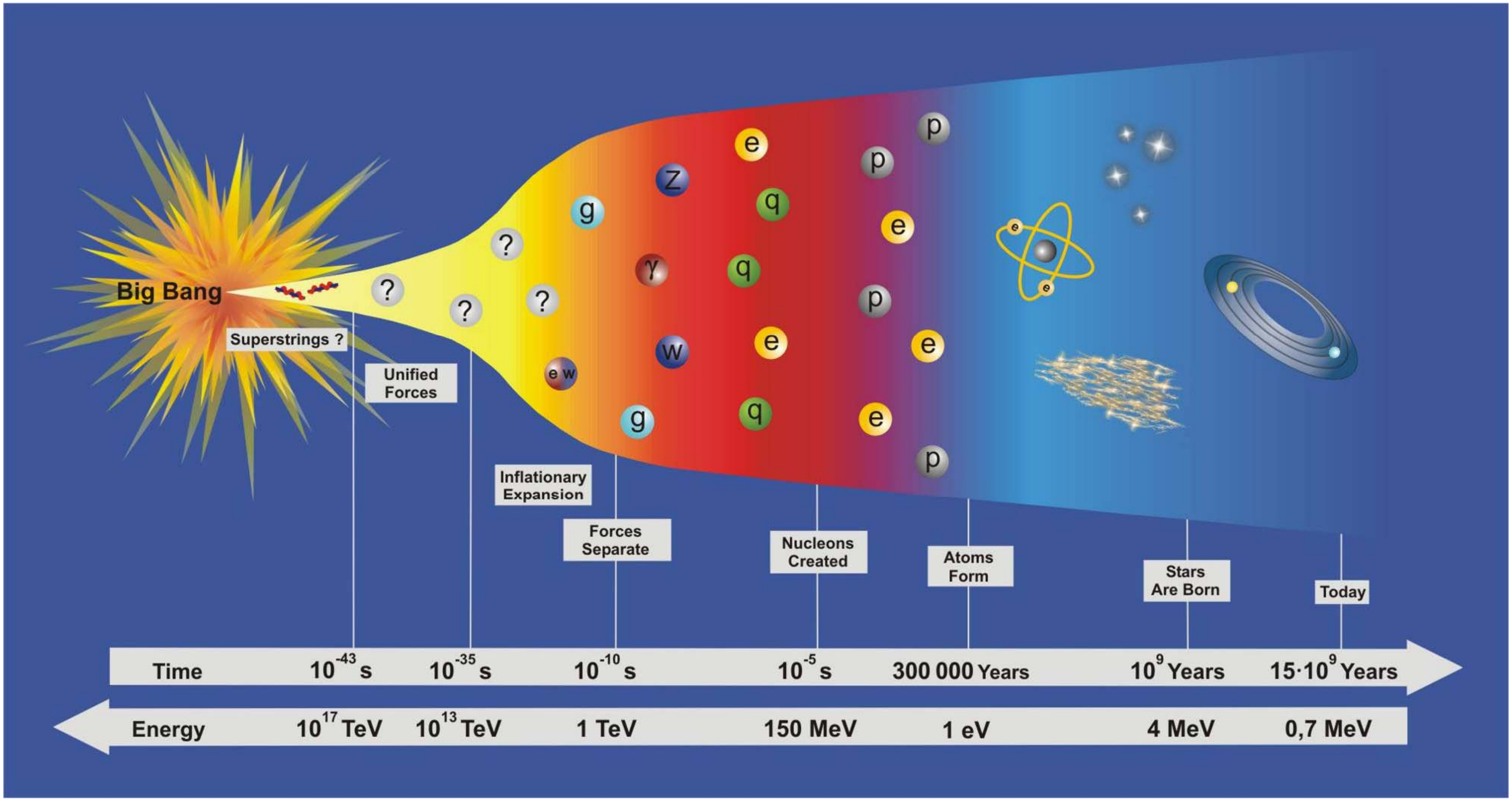
Hardware Commissioning in the CERN Control Centre

Participation in powering tests for all the sectors of LHC

Powering of a group of supplies in sector 4-5



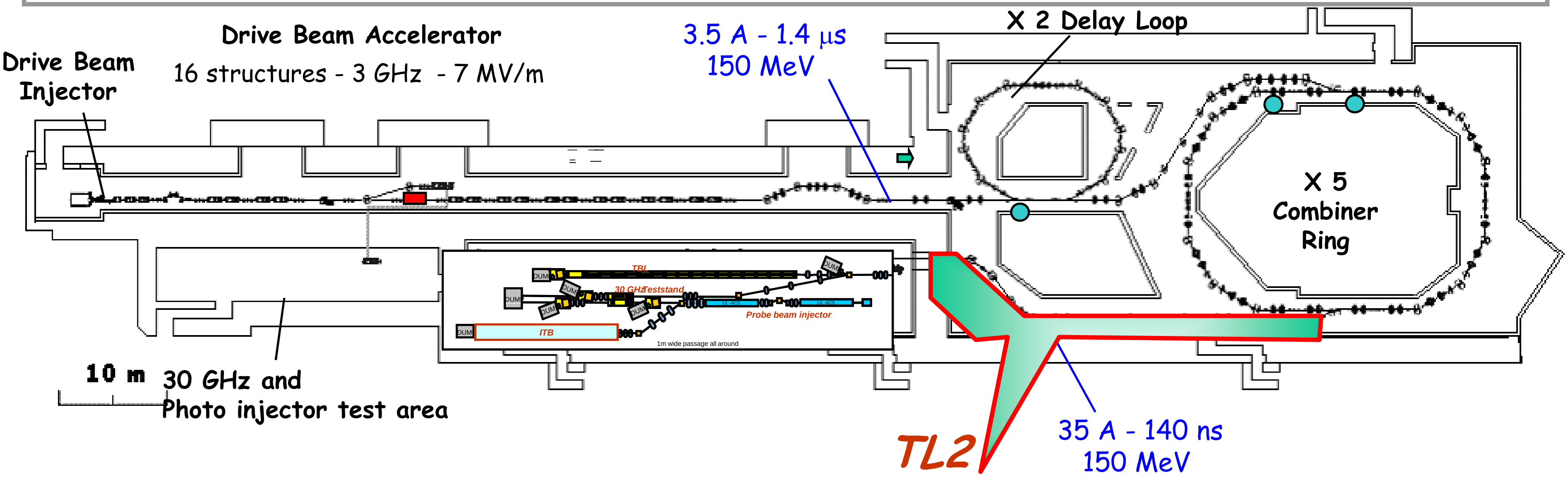
History of Universe



LHC (in future possibly *ILC/CLIC*) will probe early universe and new energy frontiers in Elementary Particle Physics

DAE-CERN Joint Coordination Committee Meeting-March5, 08

CLIC TEST FACILITY3 @ CERN *Aim: Establish principle of a 3-5 TeV e^+-e^- Collider using (1) A "drive beam" to create 12 GHz RF source",(2) Extract RF power via PETS & (3) Use RF power to accelerate e+-e- beams that will collide.*

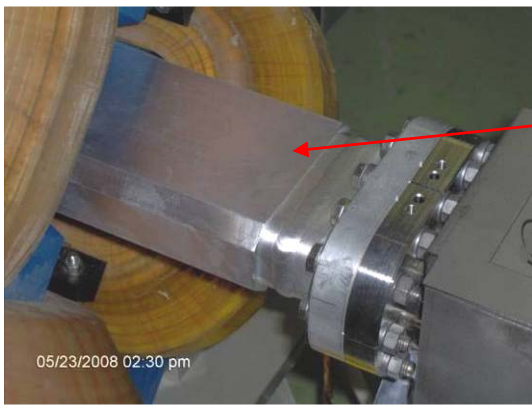


CTF3 Hardware Designed & Made at RRCAT & Shipped to CERN

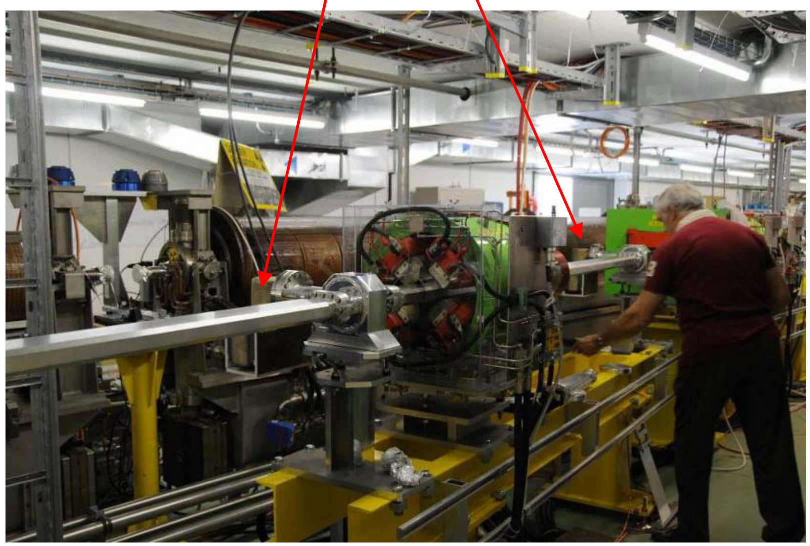
Team with vacuum chambers

1/5 magnets for CTF3:Pic at RRCAT & CERN

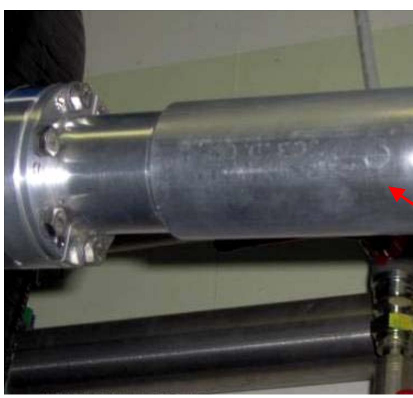
Vacuum Chambers installed in TL2 of CTF 3 at CERN



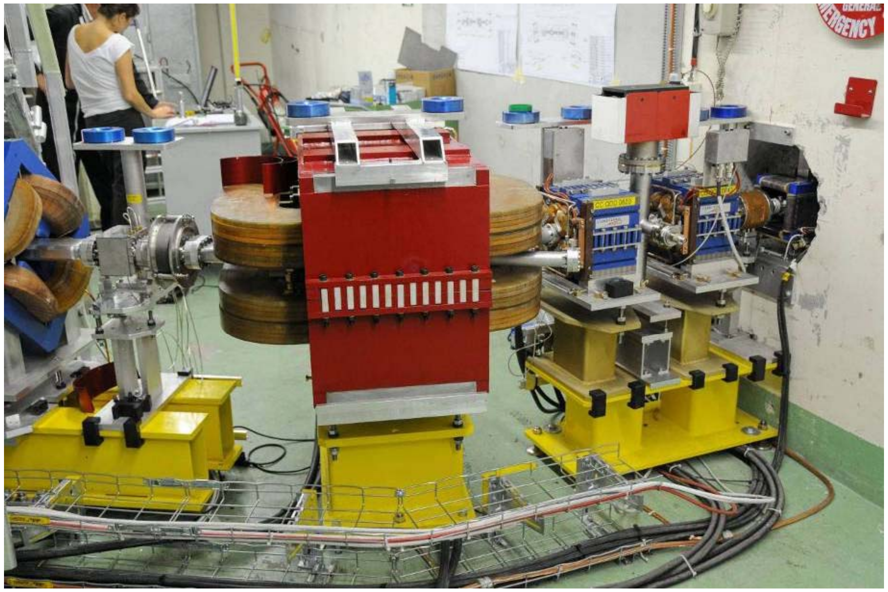
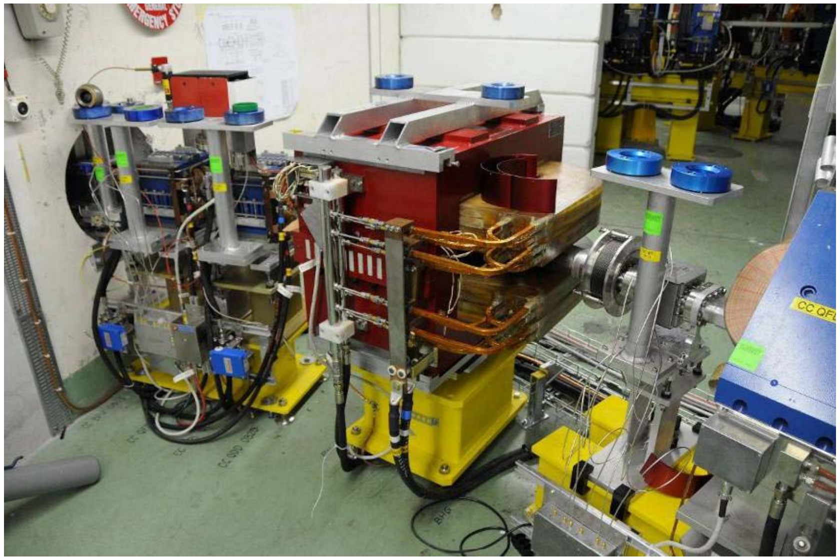
Race Track Profile Vacuum Chambers installed



End part of TL2 entering TL2' in CLEX area at CERN CTF3 Site

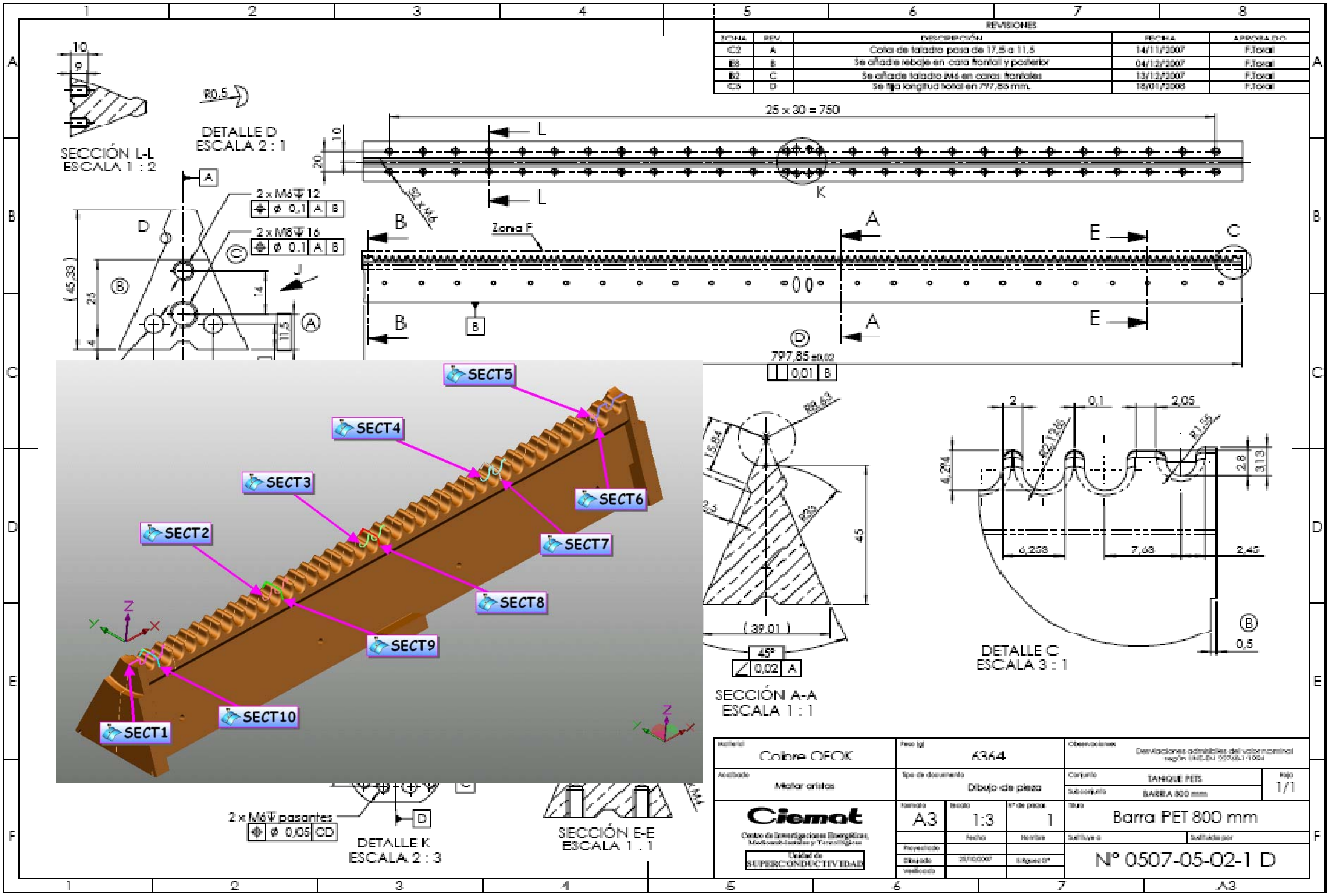


Circular Profile Vacuum Chambers installed


More pictures of RRCAT built CTF3 hardware installed @CERN

Power Extraction & Transfer Structure (PETS) bar



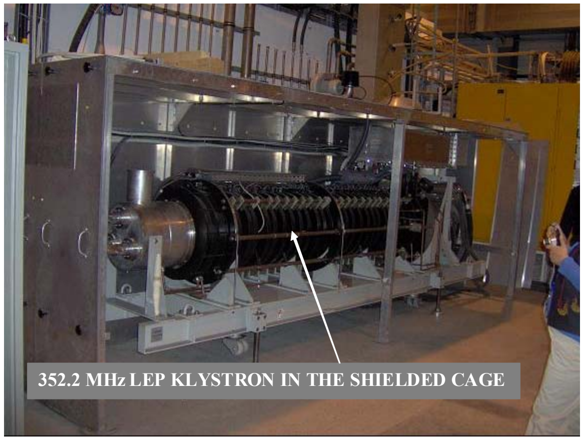
Benefits from CERN Collaboration for Our Programs

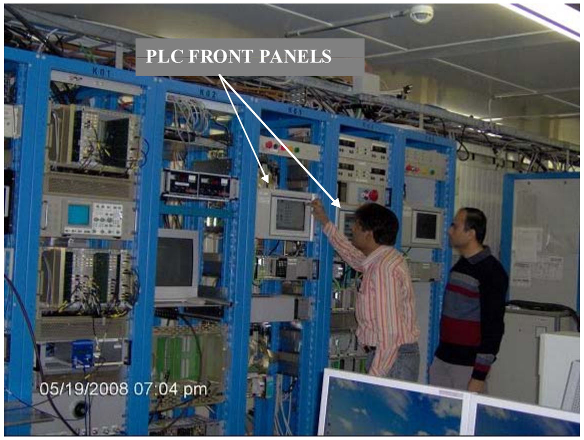
1) Exposure for our staff at forefront of accelerator technology

2) Receiveing hardware for our programs

One klystron tested by CERN & Indian Team at SM18 in May 2008.

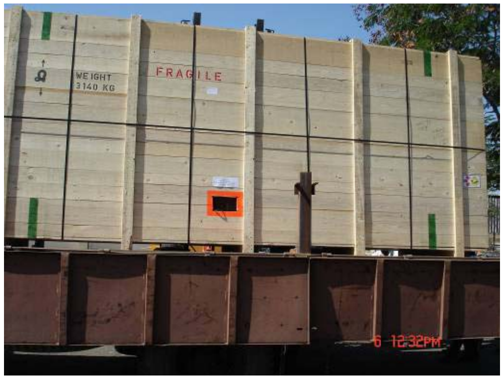
3 more klystrons tested by CERN team. 1 klystron & one circulator shipped by CERN & received at RRCAT. It will be used to test the modulator built at RRCAT.





Tests/dispatch of LEP equipment for use @RRCAT

LEP Klystron from CERN to India



As received

Shifting to truck

Receipt & unloading of klystron at RRCAT

Shock detectors are intact; klystron is safely received

First LEP klystron & circulator from CERN have been received. Items are under installation in high power test stand set up at RRCAT to test these as well as the Solid State Bouncer modulator for LINAC 4 and the components developed at RRCAT.

Towards LHC's luminosity increase: Modulator for Linac 4 at CERN

DEVELOPMENT OF ALL SOLID STATE BOUNCER COMPENSATED LONG PULSE MODULATORS FOR LEP 1MW KLYSTRONS TO BE USED FOR LINAC4 PROJECT AT CERN*

Purushottam Shrivastava[#], J. Mulchandani, V.C. Sahni
Raja Ramanna Centre for Advanced Technology, Indore, India
Carlos A. Martins, Carlo Rossi, Frédérick Bordry, CERN, Switzerland.

Abstract

CERN is building a 352.21 MHz 3 MeV RFQ based test stand as first part of LINAC 4. Extending its earlier collaboration with RRCAT, India, CERN had approached it to design and develop a high voltage pulsed modulator for 1 MW LEP klystrons, planning their reuse. RRCAT proposed three design schemes out of which an all solid state bouncer compensated modulator was chosen for follow up development work. The main considerations for the design were to avoid gas tube crowbar on the HV side, to have low rise and fall times and to realize high voltage stability of the flat top. The output voltage and current are rated up to 110kV/24A, with pulse duration 800µs, repetition rate of 2Hz, <1% droop and <0.1% ripple on pulse top with energy restricted to 10J in case of klystron arc. Based on these principles, a modulator has been developed and constructed at CERN and is currently undergoing tests with a klystron while another one with similar development is in the final stages of integration/evaluation at RRCAT. The present paper describes the topology, simulation results, protection strategy and briefly summarizes the results achieved.

INTRODUCTION

The 3MeV test stand will enable to explore the beam dynamics issues at the low energy end and comprises of 352.21 MHz, 3 MeV, 3-meter long RFQ, (part of SPL Front End) as the first part of the Linac4 [1], a new PS Booster injector proposed to improve the proton beam quality and availability for CERN users in the LHC era.

LEP 352.21 MHZ, 1 MW CW klystrons will be operated in pulsed mode with maximum average power up to 2 kW, to feed the RF sections of the linear accelerators. This requirement necessitated the development of new high voltage pulsed modulators tailored for operation at duty cycle of 0.1%.

Design considerations

The following issues were considered in the design:

- Crow-bar-less (no ignitron or thyratron) protection of klystron against arcing. The protection is assured by a) switching-off the main series switch very swiftly b) absorbing and dissipating the maximum of energy stored in the parasitic elements (stray capacitances, inductances, etc) inside the damping networks
- Low rise and fall time to limit the amount of wasted power
- High voltage stability of the flat top to assure the necessary phase stability of the RF output
- High reliability, minimum maintenance efforts and high lifetime due to solid-state construction.
- Modular structure to facilitate higher repetition rate up to 15 % duty at a later stage.
- The power supply interlock system able to be integrated into the CERN control and interlock system

purushri@rrcat.gov.in

* work supported by DAE of India under aegis of DAE CERN NAT Protocol___

TECHNICAL SPECIFICATIONS

The major requirements are listed in table 1.

Table 1 – List of modulator main parameters

Parameter	Design Targets
Klystron modulator type	Bouncer
High Voltage pulse amplitude	-10 kV to -110 kV
High Voltage pulse width measured at 70% to 70 % of peak.	800 µsec
Minimum Flat top available	600 µsec
Maximum current during pulse	24 A
Pulse repetition rate	2 Hz
Acceptable voltage drop	≤ 1.0 %
Allowed ripple on flat top (≥ 10 kHz)	≤ 0.1 %
Rise time/fall time	<100 µsec
Energy dissipated in klystron during klystron arc	<10 J

TOPOLOGIES CONSIDERED

At RRCAT we have designed and commissioned several modulators for klystrons based on the PFN topologies with step up pulse transformers, which have peak pulse power up to 15MW and mean power up to 90kW[2]. Few solid state switched modulators were also developed using RRCAT built stacked MOSFET/IGBT solid state switches, operating at 5kV/0.5A@10µsec/1Hz and 50kV/2A@10µsec/300Hz for pulsing driver klystrons and LINAC electron guns respectively. Looking into large reservoir of experience gathered on various topologies RRCAT took up the present project for CERN. Out of several schemes three options were found to be suitable and therefore an initial evaluation was restricted to: 1) Hard switched klystron modulator with high voltage programmable power supply for droop correction (active

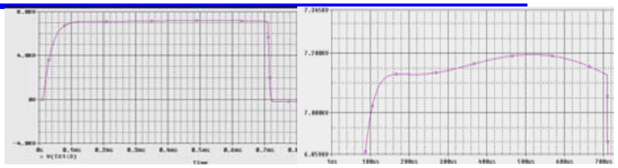


Figure 2 – Simulated waveforms (referred to primary) left: full pulse and, right: Zoomed at flat-top.

Figure 3. Photo on left: Charging/Filament Supplies photo on right: trigger, controls and interlock system of modulator at RRCAT.

Figure 4 left: resistive load in oil tank (@110kv) connected to modulator; right: bouncer circuit elements pictures at RRCAT

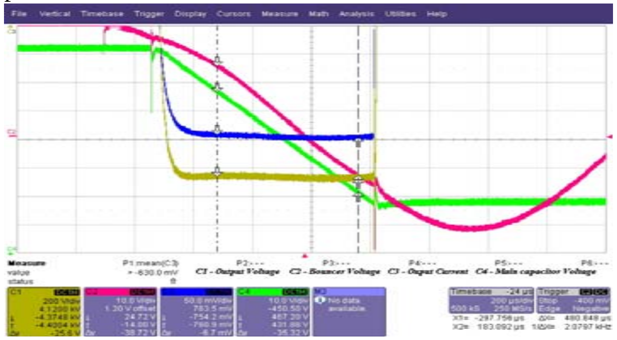
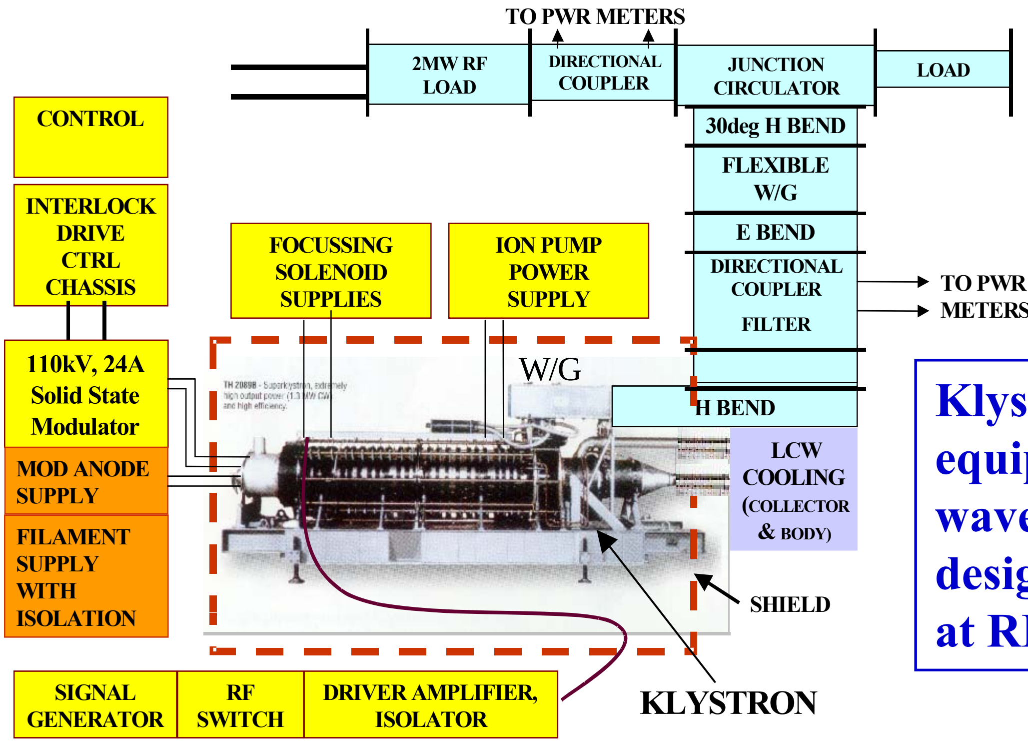


Figure 5 – Obtained output during initial run, at resistive load, representing klystron impedance. Waveforms represent C1:Output voltage C2: Bouncer voltage C3: Output Load current C4: Main Capacitor voltage



Schematic of 1.3 MW 352.2 MHz Test Stand at RRCAT

Klystron handling equipment & WR 2300 waveguide components designed and developed at RRCAT

Modulator that has been designed (& will be tested for CERN) would also serve our own proton accelerator development program.

LEP Klystron and circulatorr received from CERN being integrated with test stand at RRCAT

DAE-Fermilab Collaboration :R&D relating to ILC/Project-X CM + Useful for 4th Gen LS

- Collaboration focus: Value Addition to SC cavity & CM designs, reduce costs & enhance functionality.
- Some ideas have been developed & prototyping is on at Machine Shops in Indore.
- At present we are working on 1.3 GHz SC cavities & plan to put up facilities for making single and multi cell Nb cavities and test their performance.
- We intend to explore spin offs of this technology, eg, SC cavity for high current operation of Indus-2.
- We are partnering other labs in India and USA in this regard.

Memorandum of Understanding
between
US Universities & Accelerator Laboratories
and
Indian Universities & Accelerator Laboratories
concerning
Collaboration on R&D for Various Accelerator Physics and High Energy Physics Projects

January 9, 2006

1. Introduction

1.1 General Description

This Memorandum of Understanding (MOU) establishes a collaboration framework between various US and Indian Accelerator Laboratories and

4.2 Approvals

The following concur in the terms of this Memorandum of Understanding:

Piermaria Oddone, Director, FNAL	Vinod C. Sahni, Director, RRCAT
Date 1/9/05	Date March 8, 2006
Jonathon Dorfan, Director, SLAC	Bikash Sinha, Director, VECC
Date 1/23/06	Date March 9, 2006
Christoph Leemann, Director, TJNAJ	Amit Roy, Director, IUAC
Date 1/18/06	Date March 9, 2006.
Maury Tigner, Director, Newman Lab	S. Bhattacharya, Director, TIFR
Date	Date April 17, 2006
	S. Banerjee, Director, BARC
Date	Date March 14, 2006
	Deepak ~~Pental~~, Vice Chancellor, DU
Date	Date April 10, 2006

ADDENDUM

to the

Memorandum of Understanding
between
US Universities & Accelerator Laboratories
and
Indian Universities & Accelerator Laboratories
concerning
Collaboration on R&D for Accelerator Physics and High Energy Physics Projects

Addendum I: "Fermilab, RRCAT, BARC, IUAC and VECC Collaboration on ILC Main Linac SRF Accelerator Technology R&D"

October 2, 2007

1. Introduction

The work detailed in this document falls within the scope of the Memorandum of Understanding (MOU) between US and Indian Institutions dated January 9, 2006. It

7 Management and Approval:

The work under this MOU will be jointly managed by Dr. Shekhar Mishra, Fermilab and Dr. Vinod C. Sahni, India. They represent the institutions in the respective countries and serve as a single point of contact.

The following concur on the terms of this Memorandum of Understanding:

Dr Vinod C. Sahni, Director, RRCAT	Dr. Piermaria Oddone, Director, FNAL
Oct 2, 2007 Date	10/2/07 Date
	Dr. Shekhar Mishra, Deputy ILC Program Director, FNAL
	10/2/07 Date

Cavity Tooling, Forming and Half cell Machining at RRCAT

Forming tooling

Deep Drawing

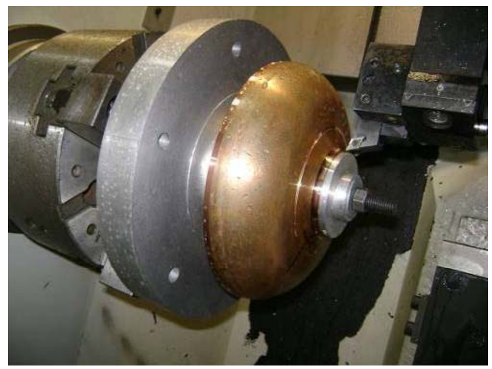
Formed half cell

- Manufactured and qualified one complete set of forming tooling (center cell, Long end cell, short end cell) for TTF cavity.

- Formed, machined, inspected (Profile inspection on CMM) several Aluminum & OFE copper half cells. Formed, Machined and inspected one niobium half cell.

- One Center cell forming tooling transported to Fermilab.

- Cavity cell tuner under manufacturing



Half cell machining

CMM inspection

Parameter	Target Value	Obtained Value
Profile tolerance, mm	± 0.2	± 0.2
Parallelism of equator and iris faces, mm	0.02	0.03
Roundness of equator ID, mm	0.05	0.03
Roundness of iris OD, mm	0.05	0.01

E-beam welding of "Single Cell Prototype Cavity"; Material : Al
Facility used :Techmeta 6 kW (60kV-100 mA) at Coimbatore

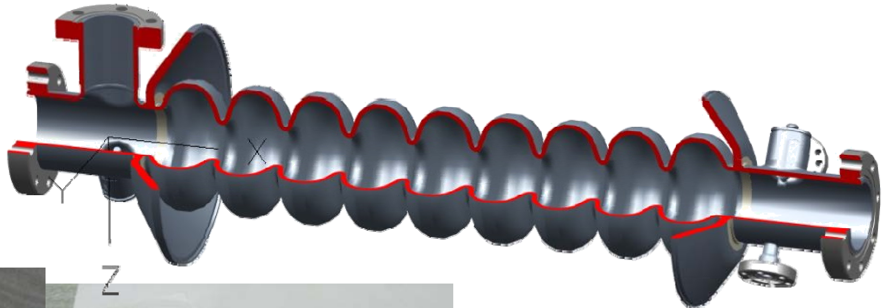
E beam welding trails on 1.3 GHz Single Cell;Material High RRR Nb Facility of IUAC, New Delhi EBW M/c:Techmeta Make 15 kW

Welding of Beam pipe to Half Cell

Welding of Beam pipe to Flange

Progress towards economic manufacture of SC cavities

Alternate way to make the cavity “end groups”



M/S CRISP,Bhopal

Approach

- Machine entire end group from a single cylindrical block. Use EDM wire cut process. Solid part will be used to make other components like form teil housing.
- Extensive prototyping and testing.

Status

- Prototypes in Copper and Low RRR niobium block completed.

ADDENDUM

to the

Memorandum of Understanding

between

US Universities & Accelerator Laboratories

and

Indian Universities & Accelerator Laboratories

concerning

Collaboration on R&D for Accelerator Physics and High Energy Physics Projects

Addendum III: "Fermilab and Indian Accelerator Laboratories Collaboration on High Intensity Proton Accelerator and SRF Infrastructure Development"

Feb 10, 2009

1. Authority and Limitations

Pursuant to the Memorandum of Understanding ("MOU") between the U.S. Universities & Accelerator Laboratories and Indian Universities & Accelerator Laboratories dated January 9, 2006, Fermilab and Indian Accelerator Laboratories (the "Parties") intend to undertake the work described in this Addendum III. The Parties acknowledge that their intended work shall be consistent with the terms and conditions of the MOU, the terms and conditions of their respective contracts and programs, and subject to the availability of appropriated funds as provided to them. The Parties further acknowledge and understand that their agreement with and signature to Addendum III does not create a legal, contractual obligation for either Party nor may form the basis of a claim for reliance thereon. The Parties agree to comport their activities under Addendum III in conformance with all applicable U.S. and Indian laws and regulations, including those related to export control.

2. Introduction

The work detailed in this document falls within the scope of the MOU cited above. It addresses in some detail the two key areas of collaboration mentioned in the main MOU, which are (i) Superconducting Radio Frequency (SRF) Acceleration Science and Technology, including setting up test facilities and a high current proton driver, and (ii)

Mishra, Fermilab and Dr. Vinod C. Sahni, India serve as the Collaboration Coordinators.

The Fermilab Associate Director Accelerators and the ILC/SRF Program Director in consultation with the appropriate Fermilab Division Head and the Fermilab Collaboration Coordinator will appoint a Project Manager for each of the projects described in this Addendum. Indian Institutions will also appoint a Project Manager in consultation with the Indian Collaboration Coordinator and assign a lead laboratory for each project to help coordinate the work.

The Project Managers have the responsibilities of developing and managing the technical design, budget and schedule of the project. They will provide technical leadership, negotiate for required labor, conduct project reviews, prepare needed safety documents, and get necessary safety approvals and certifications in order to carry out the work. Project Managers are also expected to manage the daily aspects of their projects and keep the respective Institutional Management and Collaboration Coordinators informed of progress.

The Collaboration Coordinator in consultant with the Project Managers will call for periodic reviews of the project. They, in consultation with their respective Institutional Management will approve the plans developed by the Project Managers and decide on future direction of a project.

The following concur on the terms of this Memorandum of Understanding Addendum:

10.2.2009	Feb 10, 2009		2/10/2009
Dr Vinod C. Sahni, Director, RRCAT	Date	Dr. Piermaria Oddone, Director, FNAL	Date
	Feb 11, 2009		Feb 11, 2009
Dr Srikumar Banerjee, Director, BARC	Date	Dr Amit Roy, Director, IUAC	Date
Dr Bikash Sinha, Director, VECC	Date		


Dr. Shekhar Mishra
Dr. Anil Kakodkar
Dr.Piermaria Oddone
Dr. V. C. Sahni
Dr. R. K. Bhandari
Sh. C. K. Pithawa

Benefits we expect will accrue from SCRF collaboration

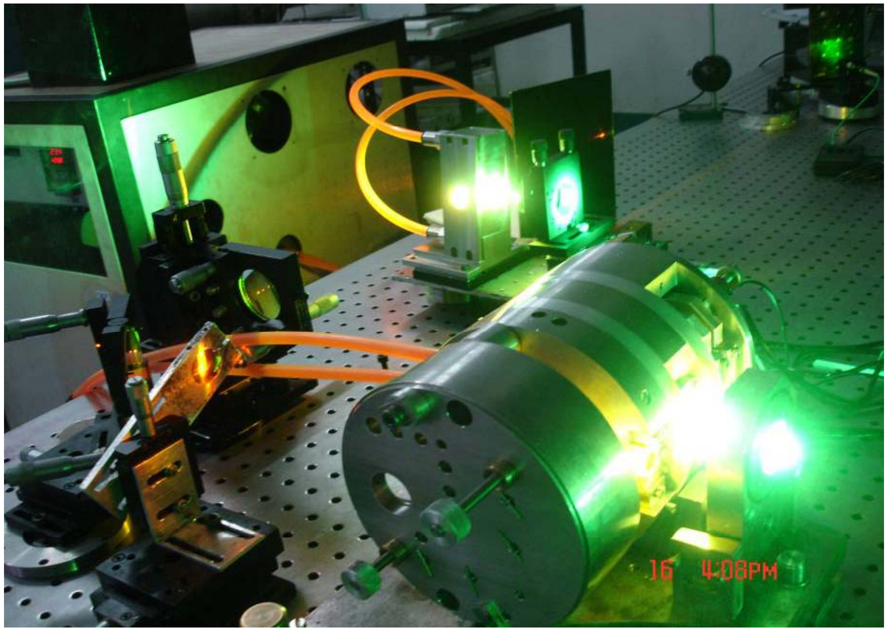
- ✓ Technology development and setting up of an infrastructure for the SCRF cavity fabrication, chemical processing, cleaning, assembly & test at required accelerating gradient for accelerator applications like XFEL, SNS, ERLs etc.
- ✓ Establish Cryogenic Infrastructure to operate large systems.
- ✓ Experimental research in bulk & thin film superconducting materials from the point of building accelerating cavities with high gradient and high quality factor.
- ✓ Exploit SCRF technology for building an infrared source providing coherent radiation at wavelengths down to around 30 microns, using superconducting post-accelerator and we will create a solid base for ADS program of DAE.

Report the progress related to

Developments in the area of lasers.

Development of Tunable Narrow Line Width Dye Laser

Dye laser oscillator - amplifier system developed at RRCAT



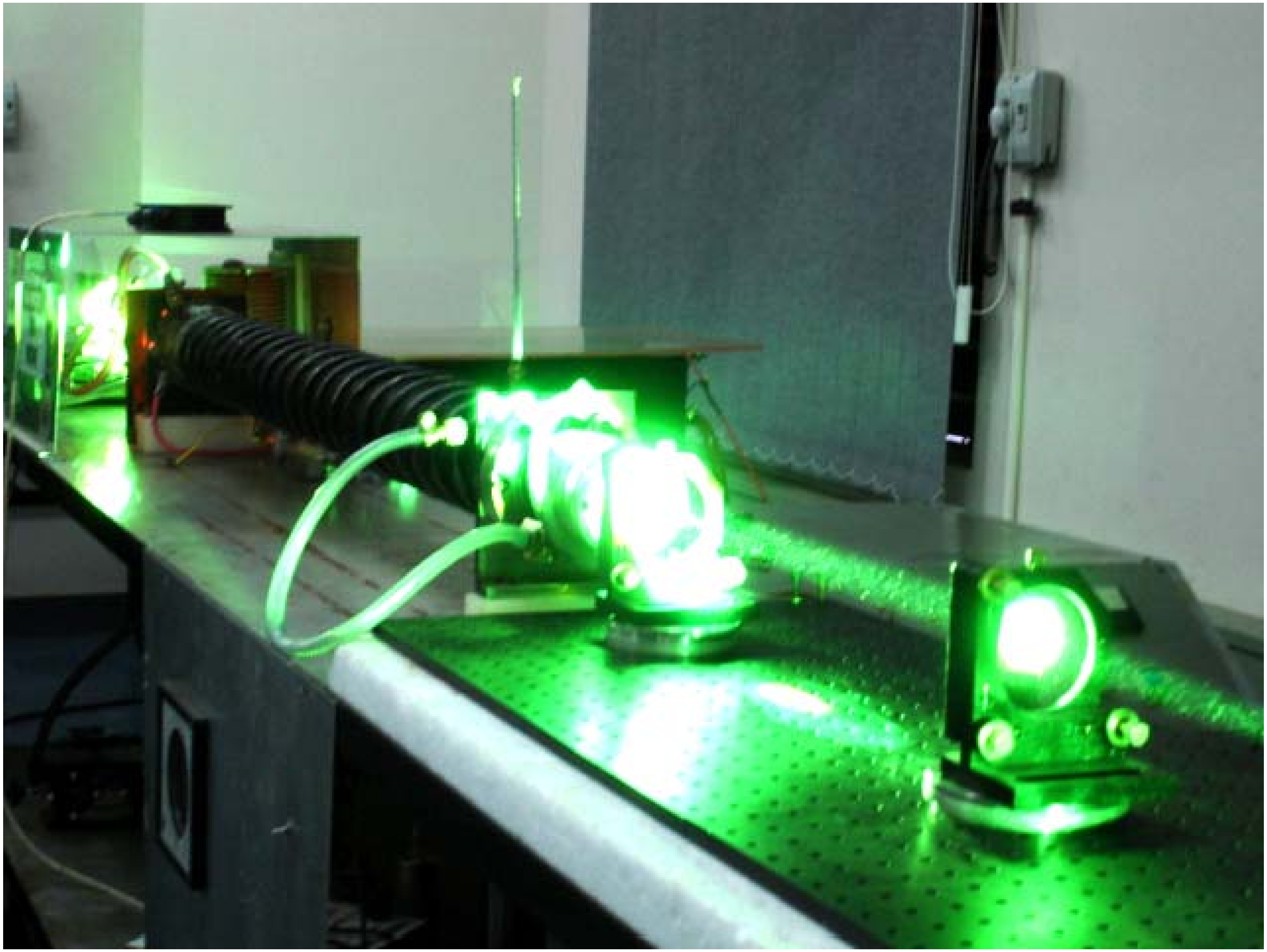
The laser system is pumped by in-house developed copper vapor lasers.
It provides tunable laser of average output power of 1 W with line width ~200 MHz.

Output power of above laser will be increased to 5 W. Two such systems will be made for application in laser isotope separation.

Recent Developments of More Powerful Laser Systems

A view of 880 W cw Nd:YAG laser

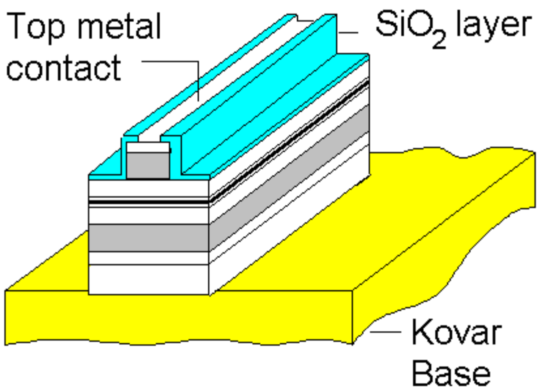
High repetition rate, high pulse energy line tunable TEA CO2 laser



A 60 W prototype version CuHyBrID laser

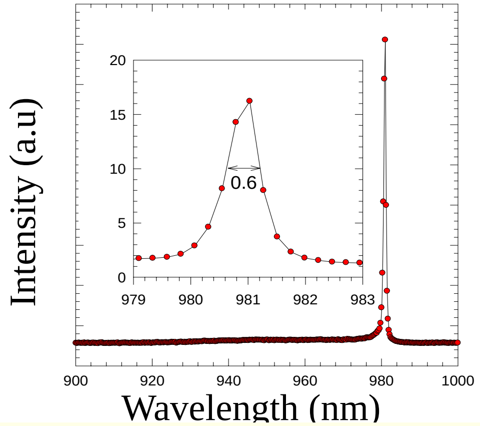
Development of CW Semiconductor Diode Lasers

CW semiconductor diode lasers have been demonstrated at RRCAT with output power of 250mW at ~981nm.



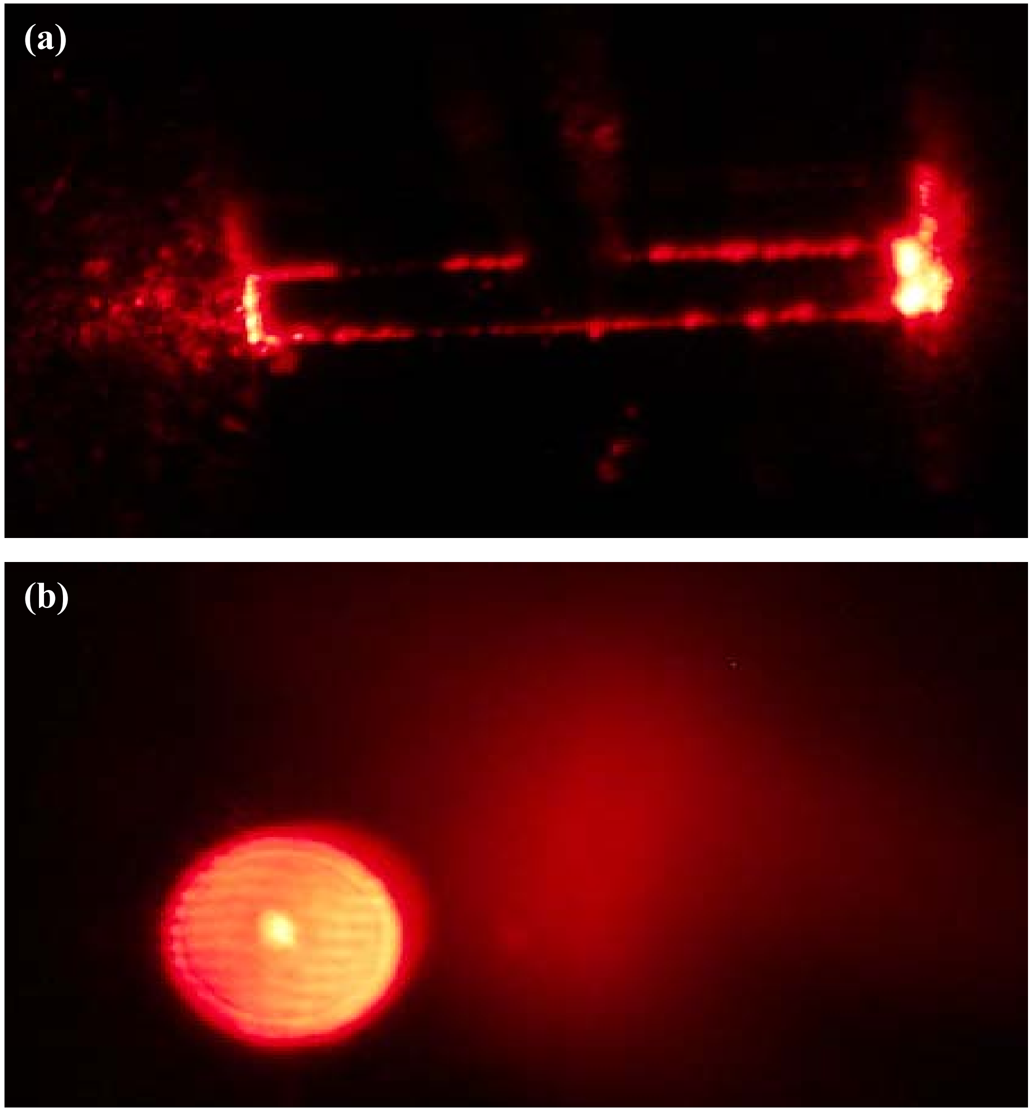
Schematic of the laser diode

Beam profile



Output spectrum

Next target :CW output power ~ 500-1000 mW. Facet coating/wire bonding of these devices is planned for making usable CW operating devices.



Photographs of red laser diode (a) showing emitting light from both facets. (b) photograph of laser diode beam

Nd:YAG Laser based bellow-lips cutting & welding set up for use in PHWRs. (Successfully used at NAPS will be deployed at KAPS)

Laser cutting mock-up for bellow lip

Salient features

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

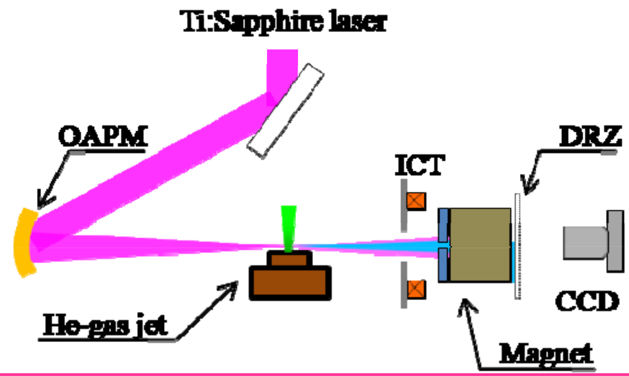
Separated bellow lip

Bellow lip cutting fixture

Welded bellow lip

Ti:Sapphire laser system for laser-plasma acceleration experiments.

- ❑ Laser : 10 TW, 45 fs
  - $I_L \approx 1.8 \times 10^{18}$ W/cm^2
- ❑ Slit-type supersonic nozzle
  - Helium gas jet 2 ms duration

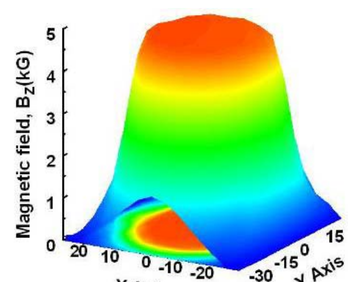


Diagnostics for electron beam characterization

ICT

for measuring e^- beam charge

Magnetic energy spectrograph



Permanent magnet 0.46 T

Electron beam profiler

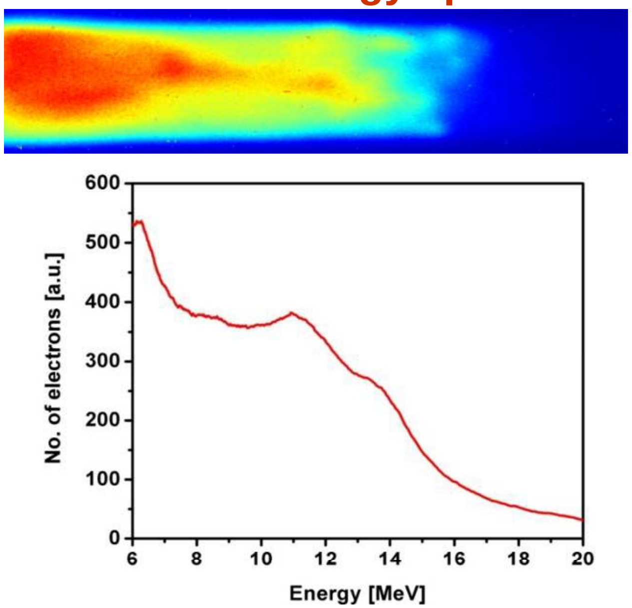
DRZ-phosphor and CCD camera

Laser plasma electron acceleration experiments @RRCAT

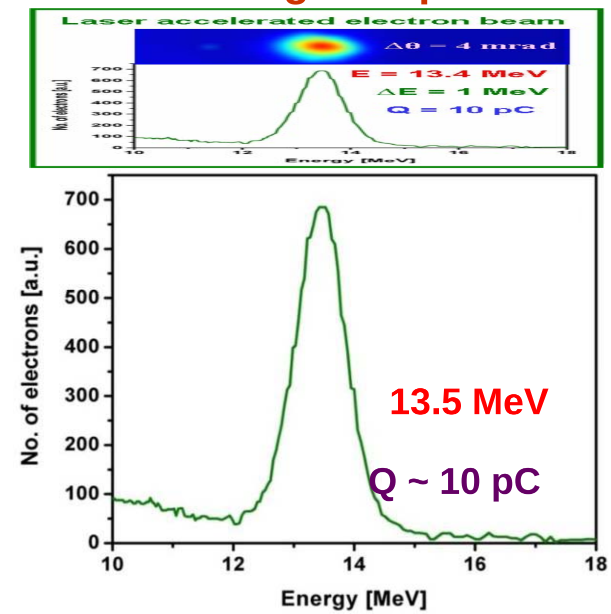
Energy spectrum of electron beam

Electron energy spectrograph : Energy range : 6 – 50 MeV

Continuous energy spectrum



Monoenergetic spectrum



Monoenergetic beam at $n_e \sim 8.5 \times 10^{19}$ cm^{-3} (~ 20 % of shots)

Peak energy (E): ~ 10 – 20 MeV; Energy spread (ΔE/E) : ~ 4 – 8 %

Divergence (2θ) : ~ 4 – 7 mrad; Beam charge : ~ 10 – 60 pC

Geometric emittance : ~ 0.02 – 0.03 π mm.mrad

Spin offs of Plan Projects : Laser based systems developed by RRCAT for societal needs & local industry

Fibre coupled Nitrogen laser developed for MY Hospital, Indore for treatment of TB of lymph nodes

A compact fiber coupled nitrogen laser has been developed for use in the treatment of tuberculosis of the lymph node, and delivered to MY Hospital, Indore for clinical trials. Transfer of technology for manufacture of this system is on course.

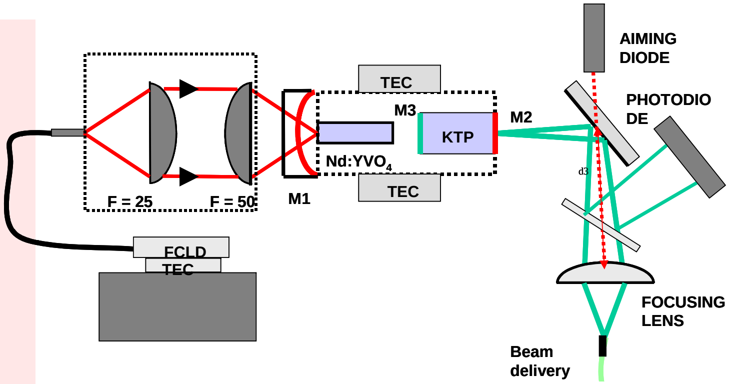
Green laser photocoagulator with advanced features (Unit-II) developed for diabetic retinopathy for M/s Aurolab, Madurai.

Output power >1 W

Sealed laser cavity

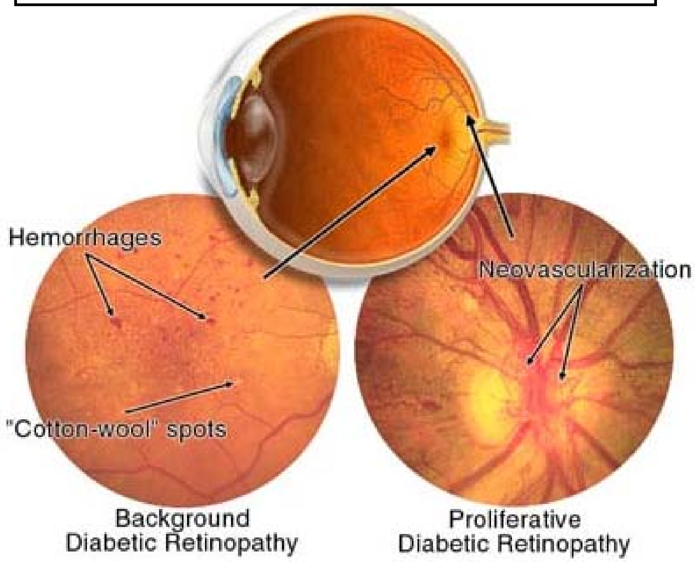
Delivery probe identification

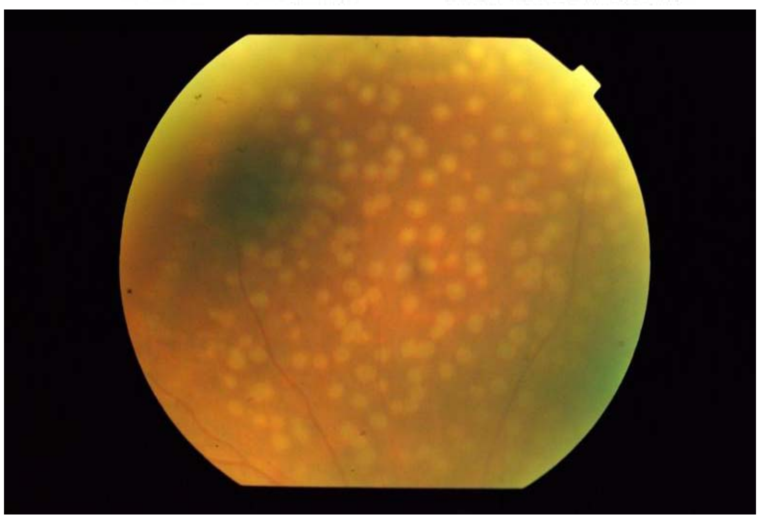
On-line power monitoring



Green laser photo-coagulator Mark II developed to treat Diabetic Retinopathy

Retina affected due to diabetic retinopathy

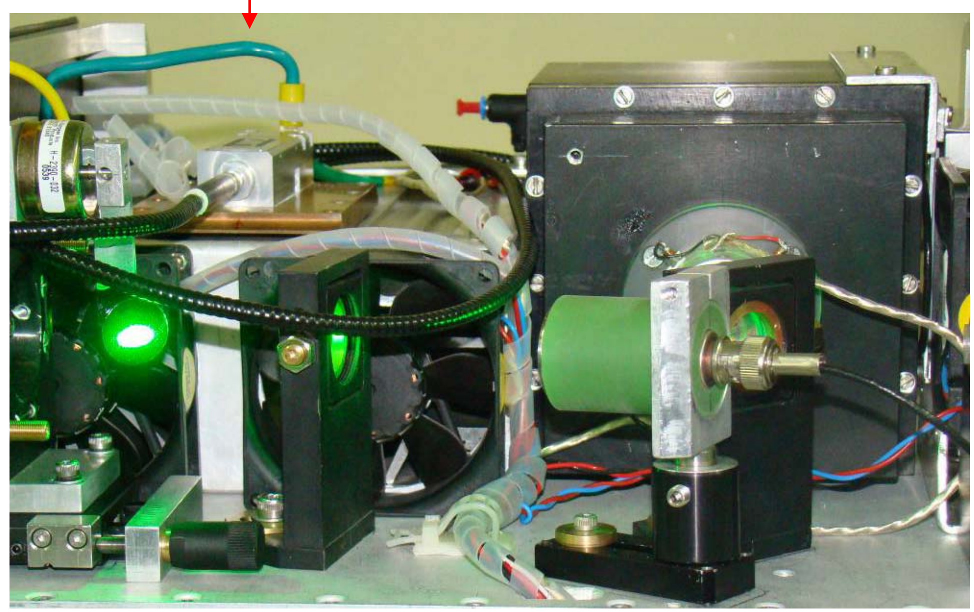




Treated retina with unit made at RRCAT. Photo by Aravind Eye Hospital, Madurai.

Complete system with output beam.

A view of internal assembly of full system with beam transferring optics.



RETINA & VITREOUS CLINIC

MEDICAL OFFICERS:
Dr. P. Namperumalsamy, MS, FAMS
Dr. R. Kim, Dip. NB
Dr. Dhananjay Shukla, MS
Dr. Naresh Babu, MS, FNB
Dr. Anand Rajendran, Dip.N.B, FRCS
Dr. Umesh Chandra Behera, MS
Dr. Somnath Chakraborty, MS
Dr. T.P. Vignesh, MS
Dr. Jay Kalliath, MS

ARAVIND EYE HOSPITALS
& POSTGRADUATE INSTITUTE OF OPHTHALMOLOGY
Run by Govel Trust
Affiliated to
Dr. MGR Medical University
World Health Organization
Collaborating Centre
For Prevention of Blindness
1, Anna Nagar, Madurai 625 020, Tamil Nadu, India
Phone: (0452)-435 6100; Fax: 91-452-253 0984
Email: aravind@aravind.org; www.aravind.org

SURGEON'S OPINION ABOUT LASER SYSTEM

Our surgeons in Retina clinic have performed the testing of RRCAT Green Laser II; treatment was given to around 30 patients. They have used the system for Panretinal Photocoagulation (PRP) Diabetic Retinopathy, Peripheral Iridectomy in glaucoma and are satisfied with the performance of laser. The burn reaction is good even with lower set powers of the laser. Burn characteristics are good, studying the uniformity of burn in central and peripheral area. This could be due to better beam quality; beam profile could be near Gaussian.

With regard to pain perceived by the patients, laser scar progression and laser parameters required to achieve the optimal retinal treatment, the present unit is better than the previous one developed by RRCAT.

The changes we would like to have in the present unit are;

1. It will be more user friendly if the laser parameter adjustments menus can be included in **Treat mode** also rather than in **Standby mode** alone.
2. If the size can be reduced by around 25% of the existing size, the product will be more appealing.

Signature with Date:

Dr. Naresh Babu
Medical Consultant
Vitreo retinal Services
Aravind Eye Hospital
Madurai, India

RRCAT Built Systems for Inspection & Metrology Purpose

Mixed Carbide Fuel Metrology

Range: 10mm

Resolution: 1µm

Accuracy: ±2µm

This instrument has been installed at RMD BARC for the metrology of mixed carbide fuel pellets

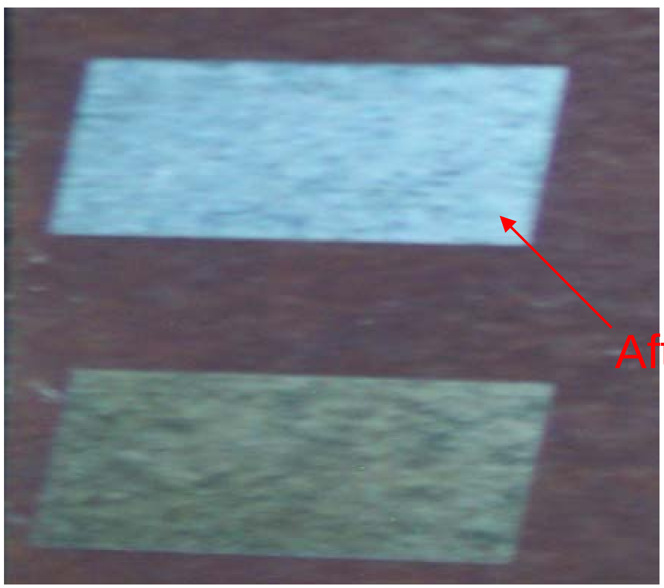
Nd:YAG laser system for decontamination built @RRCAT

Fluence :100mJ-1J/cm2

Pulse duration range :10ns-200µs

Rep. rate : 1Hz-50Hz or higher

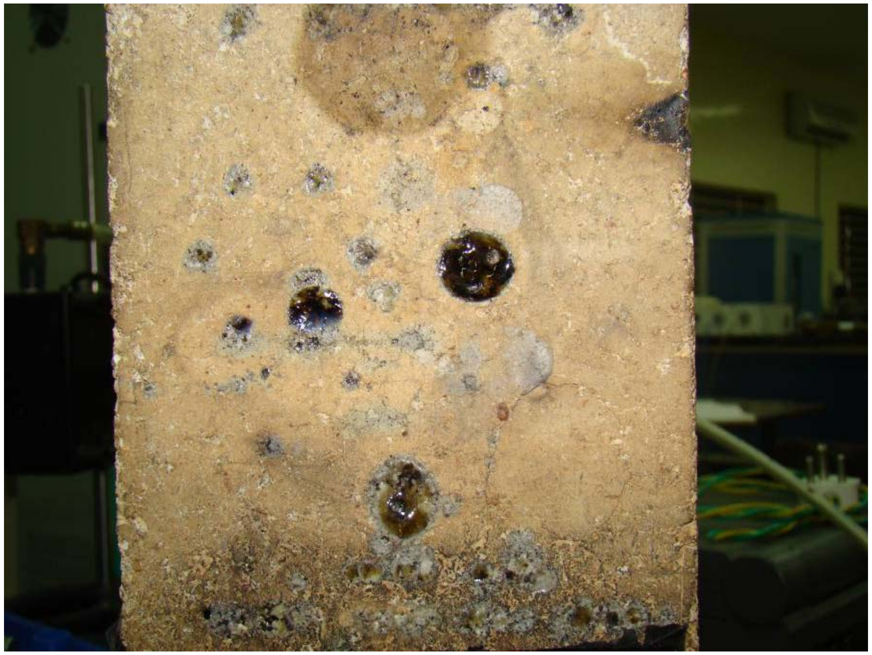
Free running and Q-switched fiber based resonator



Rust layer cleaning with RRCAT pulsed Nd:YAG laser

On way to development of lasers for decommissioning (ctd)

Trial runs to study how the 880 W laser affects a RCC brick

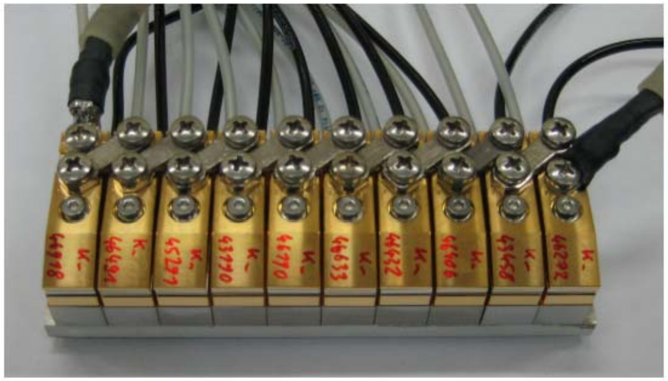


(Sample brick supplied by H. S. Bhambra
R&D Nuclear Systems, NPCIL)

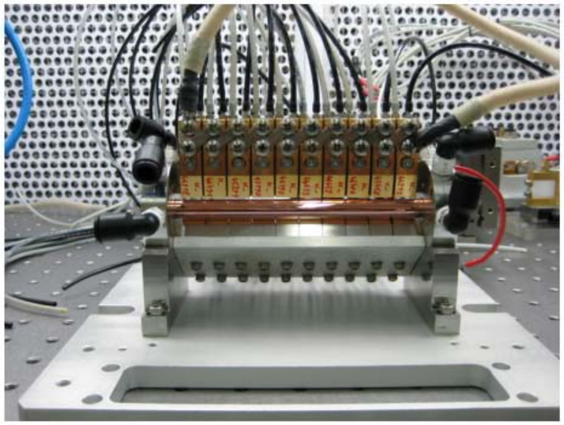
On way to development of DP lasers for decommissioning

Assembly of High Power Diode-pumped CW Nd:YAG Rod Laser

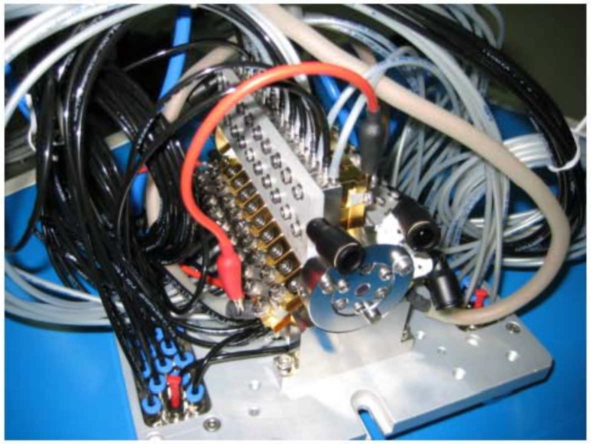
Base Plate with water manifold



Diode pump module



Laser head with two pump module



Complete assembly

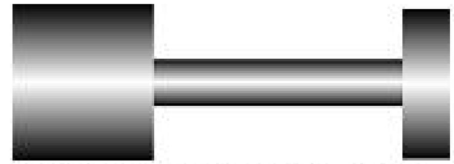
Laser Rapid Manufacturing of Colmonoy Bushes

* Colmonoy bushes are used as guide materials in Control Rod Drive Mechanism (CRDM) & Diverse Safety Rod Drive Mechansim (DSRDM) of PFBR.

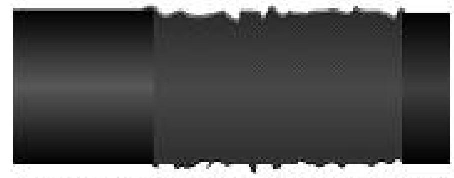
* Imported cast colmonoy bushes are very expensive.

* **Existing methodology for fabrication of Colmonoy bushes:** GTAW-assisted deposition of Colmonoy on SS rods followed by precision machining ***(Fab time ~ 70 hr)***

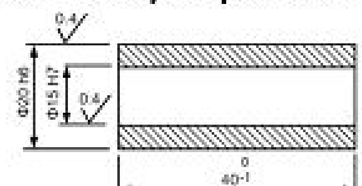
* LRM offers a faster and economical fabrication route for Colmonoy bushes. ***(Fab time ~ 32 hr)***



Machined SS substrate



Colmonoy-deposited substrate



Machined Colmonoy bush

Laser Rapid Manufacturing of Bimetallic Components

Bimetallic tubular bush: Outside surface - Type 316L SS;

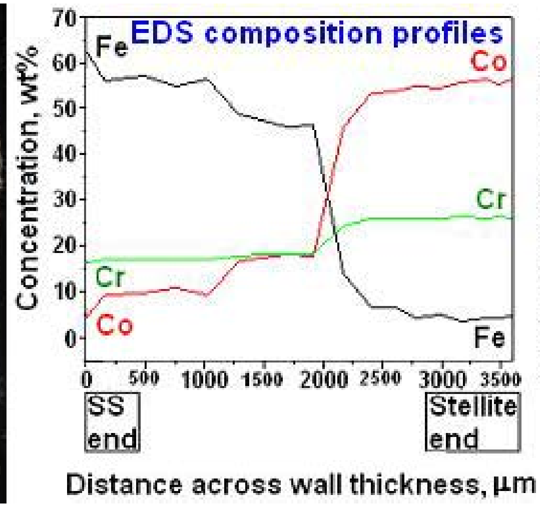
Inside surface - Stellite21 (Wear-resistant Co-base super alloy)

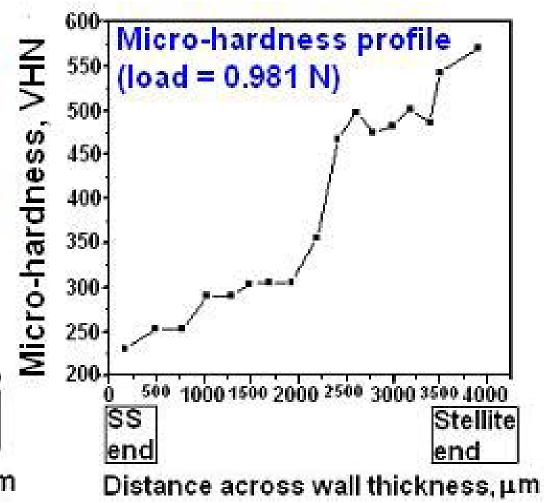
Laser used:

3.5 kW CO_2

OD: 32.5 mm

ID: 25 mm



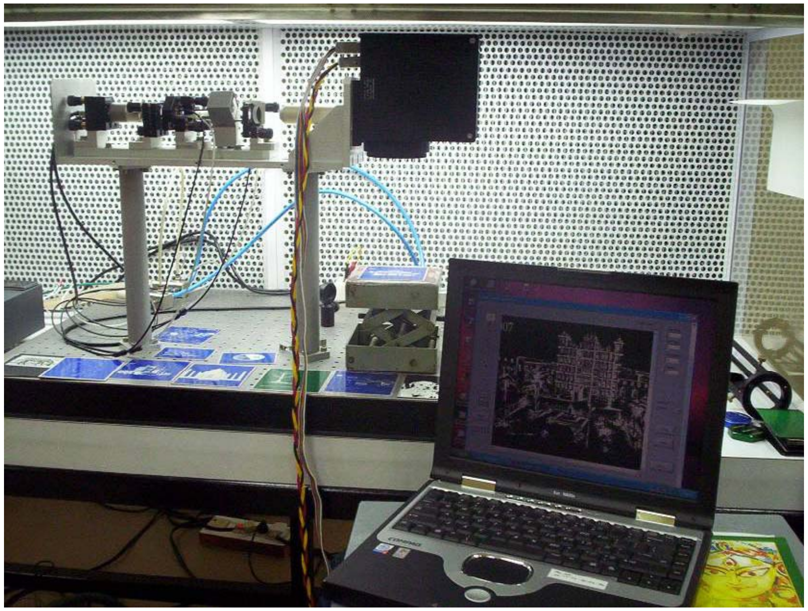


Stainless tube with internal step of Stellite 21

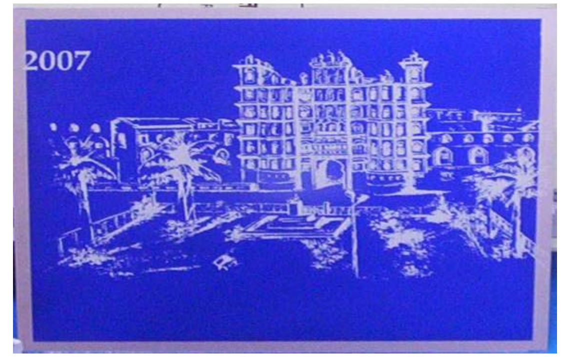
OD: 38 mm; ID: 34 mm; Step thickness: 1.5 mm;

Step width: 8 mm

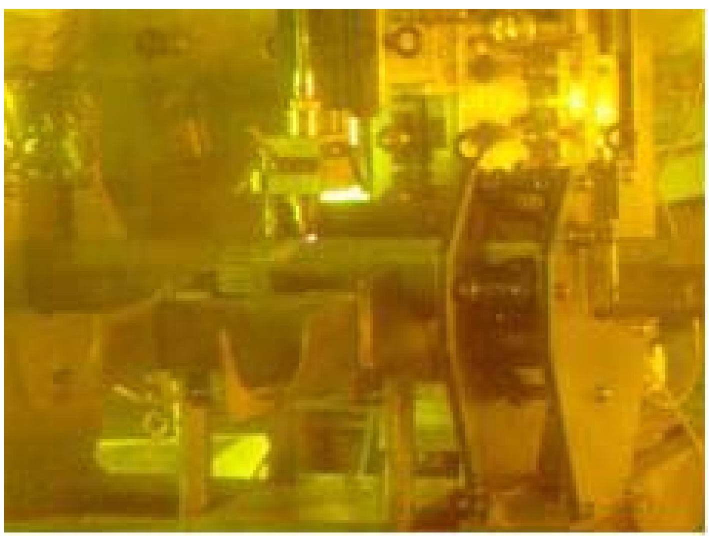
This kind of insert may find application as an insert for Grid Plate Sleeve in FBR.



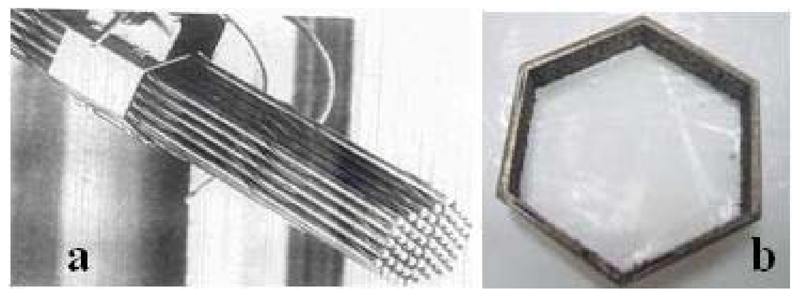
A general view of laser marker



Samples of picture transferred to metal plates using laser marker



Laser cutting of FBTR fuel subassembly in a hot cell at IGCAR

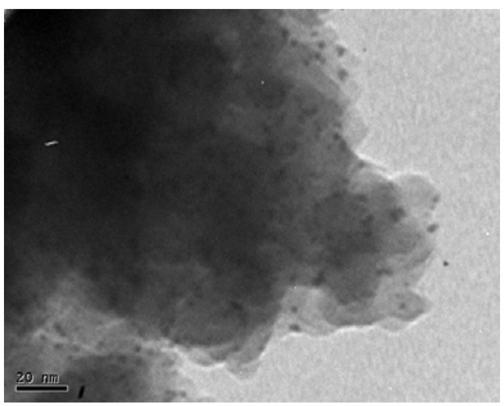


a) A fuel pin bundle being extracted from a fuel subassembly; b) A cut sample of the hexagonal fuel subassembly

New Pt loaded carbon aerogels developed for very efficient H/D isotopic reactions – Could prove useful for a good route to making heavy water

Pt-Loaded Carbon –silica composite cylinders and disc

Carbon Foam Electrode (125 x 80 mm)



TEM of Pt loaded Carbon Foam showing 2-3 nm clusters of Platinum

Raschig Ring Morphs of Pt-Carbon Composite Catalyst.

Other activities & photo gallery

 # We organized BRNS supported 4th Indian Particle Accelerator Conference, InPAC2009. 400 persons attended the meeting. Inaugural session was presided over by Dr. A Kakodkar and Key Note talk was delivered by Pier Oddone, Director, FNAL.

 # On National Science Day neighborhood school students were given tour of labs.

 # Scientific staff continued giving help to many national labs/agencies for laser & accelerator based programs. Dr. K. Kasturirangan & Prof P. Rama Rao were amongst the distinguished visitors to have visited our Centre this year.

Thank You