A Perspective on BARC's Accelerator Related Activities and Proposal to Join TTC

P. Singh and V.C. Sahni
Bhabha Atomic Research Centre
Mumbai-400085, India

Plan of the Talk:

- About BARC
- Accelerator related activities
- Major facilities available at CDM
- International collaborations
- Proposal for joining TTC

BARC

✓**BARC is the biggest R & D Centre in India, with ~5000 Scientists and Engineers working in different disciplines (Physics, Chemistry, Biology, Electronics & Instrumentation, Reactor Physics, Technology …).**

✓**BARC is made up of "Groups" covering different disciplines.**

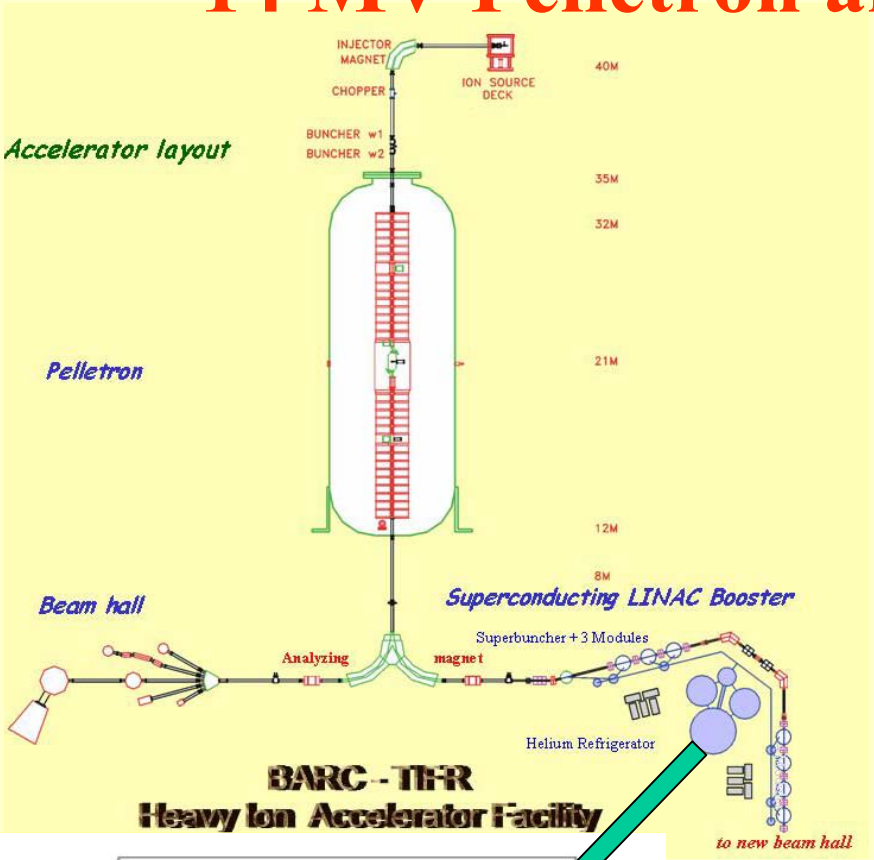
✓**Physics Group, has ~700 Scientists & Engineers, working in many areas: Nuclear Physics, Condensed Matter Physics, Spectroscopy, Astrophysics, Vacuum Physics & Instrumentation …etc.**

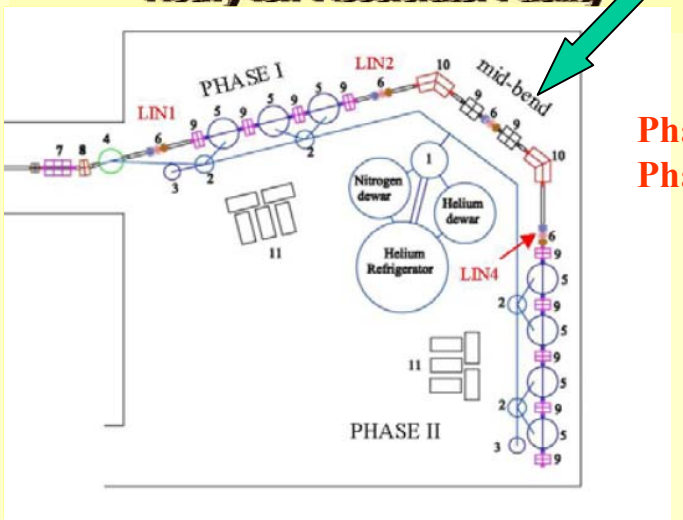
✓**NP research is done with 14 MV Pelletron + SC Linac Booster.**

✓**A 20 MeV high intensity proton injector (for a 1 GeV Linac) is being built for waste transmutation studies.**

✓**Strong base exists to make large subsystems at our Centre for Design and Manufacturing (CDM). Small prototypes can be made at other workshops.**

14 MV Pelletron and SC LINAC Booster





Phase I: 12 QWR
Phase II: 16 QWR

Quarter Wave Resonator

RF sub-systems for BARC-TIFR Super-conducting Linac

150 MHz, QWR, Lead on Copper

◆**RF Electronics for the SC Resonators**

a) Resonator Controller : Based on Self-excited-Loop architecture.

b) Solid state RF Power Amplifiers (150W)

◆ **RF Electronics for the NC Resonators**

a) Dynamic Phase Reference Generation

b) Resonator Controller

Resonator Controller

RF Multiplexer

Off-shoot: RF control electronics for the SC resonators of two more heavy ion LINACs

1. **Inter-University Accelerator Centre, New Delhi (97 MHz, Quarter wave, Bulk Nb)**
2. **Australian National University, Canberra (150 MHz, Split-loop, Pb on copper)**

Scheme for Accelerator Development for ADS

Normal Conducting

High current injector 20 MeV, 30 mA

Proton IS 50 keV → **RFQ 3 MeV** → **DTL 20 MeV**

DTL 20 MeV → **DTL/ CCDTL**

DTL 20 MeV → **Super-conducting**

DTL/ CCDTL and **Super-conducting** → **100 MeV** → **SC Linac**

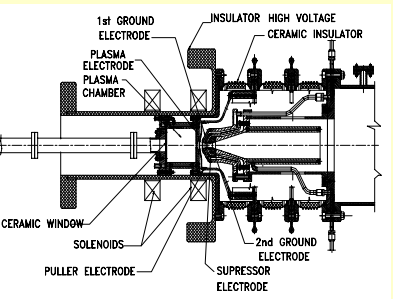
SC Linac → **1 GeV**

Proton beam from high power accelerator

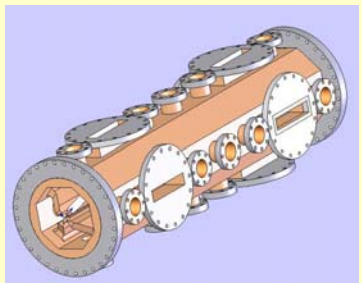
⇩

Design completed and fabrication is in progress

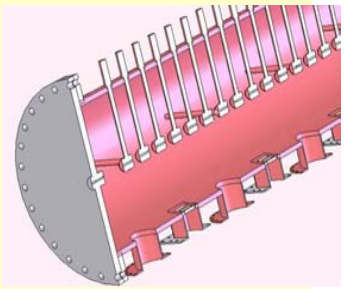
ECR Ion Source



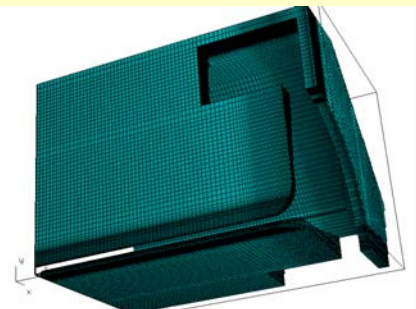
RFQ



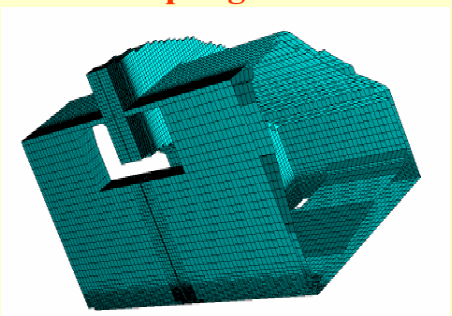
DTL



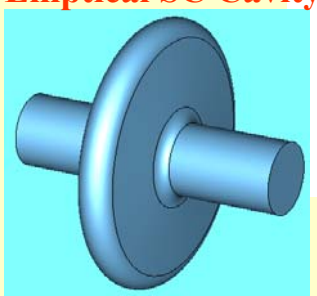
Beginning Cell

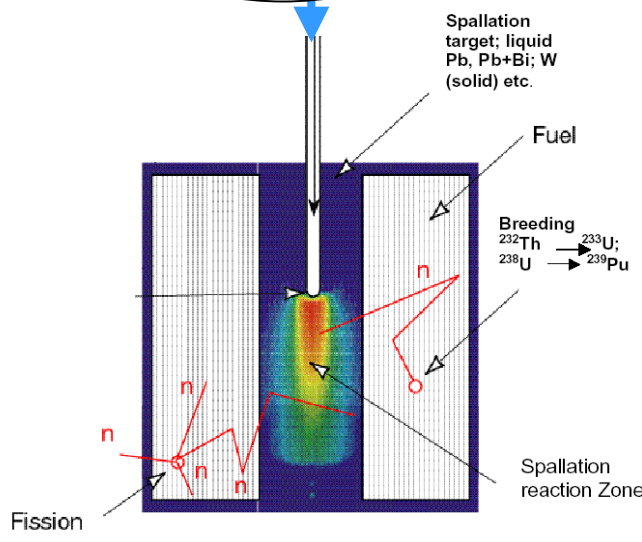


Coupling Cell



Elliptical SC Cavity





Parameters of RFQ, DTL, CCDTL and SC Linac

RFQ

Frequency	352.21 MHz
Energy	50 keV/ 3 MeV
Input current	30 mA
Vane voltage	82-111.58 kV
Avg. Aperture R_0	3.63-4.53 mm
Length	3.45 m
Total RF power	500 kW
Transmission	97 %

DTL CCDTL

Energy Range (MeV)	3-50	50-98.6
Frequency (MHz)	352.21	704.42
Current (mA)	29.3	29.3
Focusing Lattice	FODO	FODO
Quadrupole Gradient (T/m)	100	58.2-19.6
Avg. Acc. Gradient (MV/m)	2.58	1.6
Total Length (m)	28	75
Norm. Trans. Emitt. (πcm-mrad) ε_x ε_y	0.022-0.023 0.022-0.023	0.023-0.024 0.023-0.024

SC Linac

Parameter	**β_G= 0.47**	**β_G= 0.62**	**β_G= 0.80**
Energy Range (MeV)	98.6-198.3	198.3-498.3	498.3-1008.3
Frequency (MHz)	704.42	704.42	704.42
Current (mA)	29.3	29.3	29.3
Trans. Focusing lattice	Doublet	Doublet	Doublet
Lattice Period (cm)	300.1	608.0	810.7
Quadrupole gradient (T/m)	5.8-5.37	4.5	4.4
Eff. Length of Quad (cm)	35	40	45
Synch. Phase (degrees)	-30	-23.44	-23.44
Cavities/cryomodule	2	3	4
No. of Cryomodules	35	40	51
Aperture Radius (cm)	4.0	4.0	4.0
Total length (m)	105.04	243.2	413.46
Norm. Trans. Emitt. (πcm-mrad) ε_x ε_y	0.024-0.025 0.024-0.025	0.025-0.029 0.025-0.028	0.029-0.03 0.028-0.027
Norm. Long. Emitt. (MeV-deg)	0.327-0.444	0.444-0.482	0.482-0.499

Capabilities of CDM, BARC

- **Design, modelling, simulation & analysis using state-of-the-art CAD tools.**
- **Maintaining the high standard in fabrication of components & equipments**
- **Standards of precision and quality control – are most stringent.**
- **Capability to manufacture sophisticated equipments of varied nature with perfection.**

- **(Engineers:70; Technical Staff: 300)**

Major Facilities Available at CDM, BARC

UPMC-850 CARAT S-ACCURATE CNC
Range X: 850 mm Y: 1150 mm Z: 600 mm

LENGTH: 510 mm , ACCURACY: 0.004 mm

CNC Universal Boring And Milling Machine
Table Area : 900X530 mm, Accuracy: 0.010 mm

CNC 5 AXES BORING & MILLING MACHINE
Table Area: 600X600 mm, Positional Accuracy:0.01 mm

CNC VERTICAL BORING & MILLING CENTRE ,
Table Area:900X720 mm, Accuracy :0.005mm

CNC Wire-Cut EDM Machine Super Cut 734
X: 250 mm, Y : 350, U&V : 73, Accuracy :0.010 mm

CNC, Ultra Precision, Slant Bed Lathe, Length : 400 mm
Accuracy : 0.002 mm

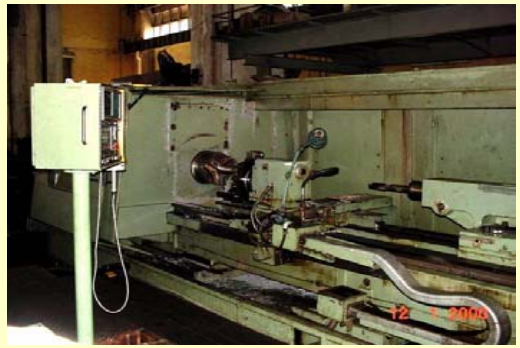
3 Axis Coordinate Measuring Machine

NIKON MEASUROSCOPE
MAGNIFICATION 1000 X

Major Facilities …

CNC Heavy Duty Spindle,BECO Lathe
Turning Length: 3200 mm, Accuracy:0.010mm

CNC BED TYPE VERTICAL MILLING VMC 800 MACHINE (M/S HMT), Table Area: 800X500 mm, Accuracy: 0.015 mm



CNCB32 Lathe (M/s HMT, Bangalore
Turning Length: 3000 mm, Accuracy:0.010mm

POWDER COATING FACILITY

SCANNER FOR UT (M/S INTEGRATED)
Size:5215X1505X1483 mm.

INDUSTRIAL X-RAY, 420 KV HIGH FREQUENCY, SYSTEM

CNC LATHE WITH INCLINED & HYDRAULICALLY OPERATED CHUCK, LT-20

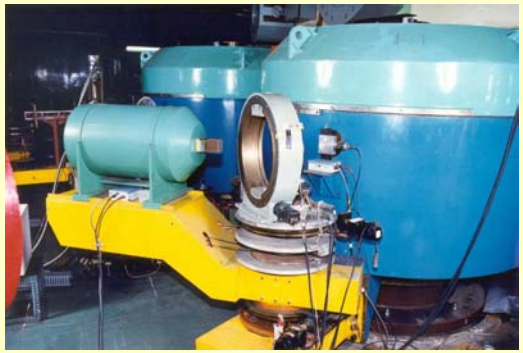
NIKON PROFILE PROJECTOR
MAGNIFICATION 500 X

GUIDE SLEEVE & SENSOR TIPS CUTTING MACHINE FOR 230 MWe PHWR

Subsystems Built by CDM for Home Programs

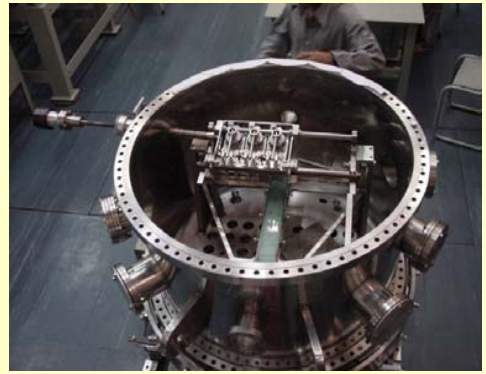
6.65m Off Plane Eagle Mount Spectrometer, CAT-INDUS-I,Wavelength Resolution 0.01 Aº.

Neutron Scattering facility at DHRUVA



Single Crystal Diffractometer

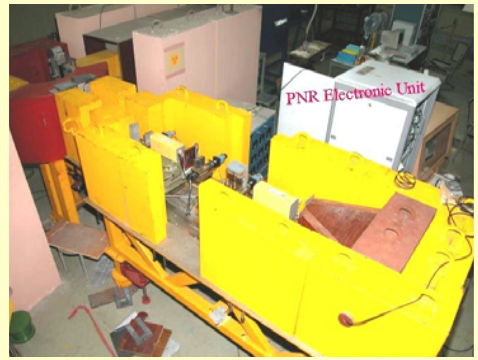
Triple Axis Spectrometer



Plane Grating Monochromator

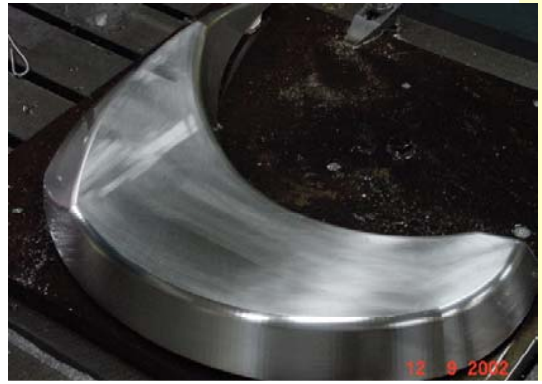
Experimental Station For EXAFS Synchrotron Beam Line (Indus-II)

Elliptical Crystal Bender



Polarised Neutron Reflectometer

RF AMPLIFIER COMPONENTS FOR SC CYCLOTRON, VECC



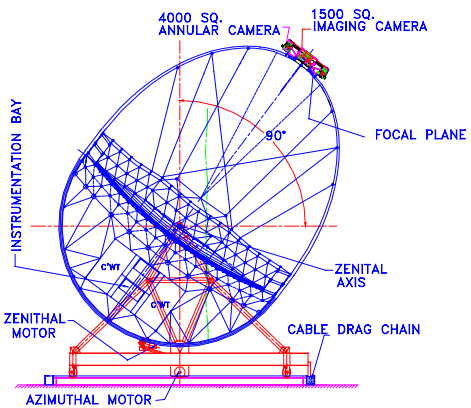
DEE Former, VECC Super Conducting Cyclotron

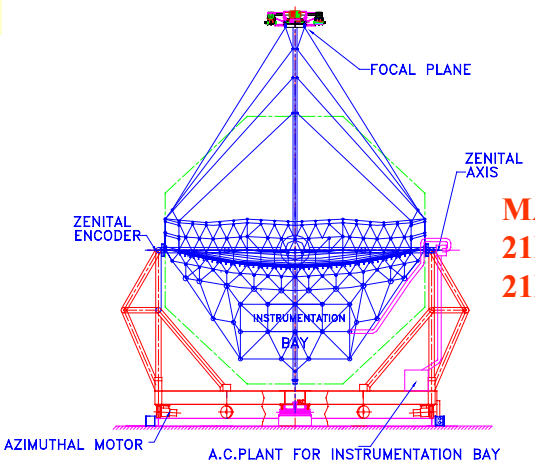
GAMMA RAY TELESCOPE, NRL/HARL, MT. ABU

TACTIC TELESCOPE

4M X 4M MIRROR BASKET 4M FOCAL LENGTH

TEST ACTIVE TILT MIRROR PANEL





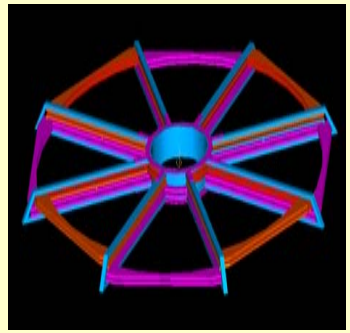
MACE TELESCOPE
21M X 21M MIRROR BASKET
21M FOCAL LENGTH

Proposed site: Hanley, Ladakh, India

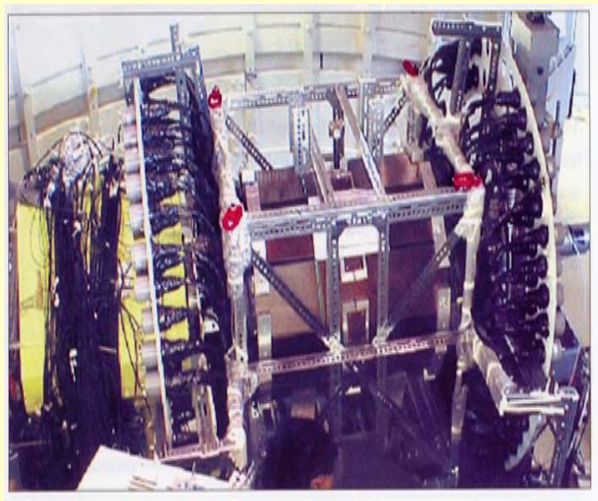
International Collaborations

BNL(USA), FAIR (Germany), LHC (CERN), KEK (Japan), LEGNARO (Italy), COSY (Germany), RAL (UK), Korea

- Hadron Calorimeter (Fermilab) U.S.A.
- Grid Frame for Phenix Project U.S.A.
- Scintillator Tiles Fermilab U.S.A.
- Triple axes Neutron Spectrometer Korea
- OSIRIS beam line RAL U.K.
- ENSTAR Detector Germany

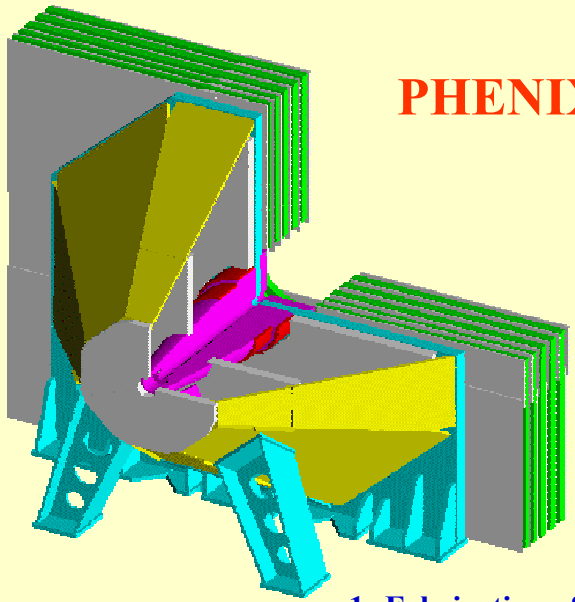


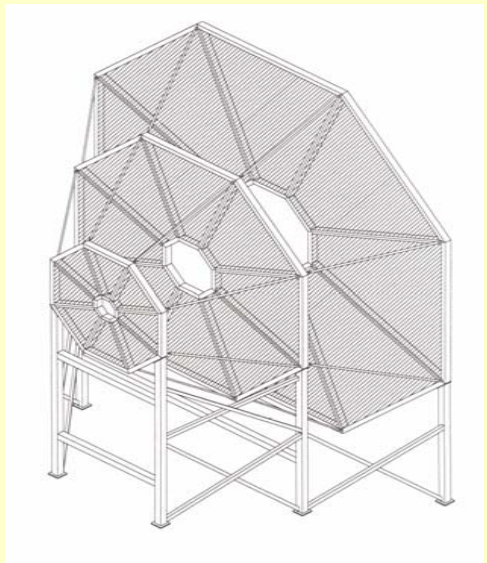
Grid frame



ENSTAR

PHENIX





1. **Fabrication of Muon Tracking Stations**
2. **Simulation and Reconstruction Software**

BARC @ LHC

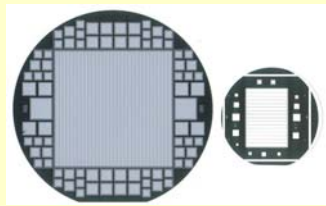
India has "observer status" at CERN

Some of the contributions:

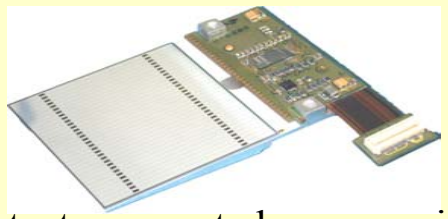
- Quench Heater Power Supplies (5500 Nos.) for LHC
- Si Strip and Scintillator Detectors for CMS
- Grid Operations Centre software
- Man Power support to evaluate LHC magnets (70 man-years)
- Vacuum systems
- Engineering Analysis and simulation studies

5500 Nos. Quench Heater Power supplies(QHPS

Magnetic measurements teams- ~100 Man-years



Si strip detectors



Detector mounted on ceramic & Al tile

Proposal to join TTC

Main Interest to Join TTC

- To augment our capability in SC Technology.
  - Have experience in Building QWR for SC Linac booster.
  - Built RF Controls Systems.
  - Successful collaborations in International Projects.
  - BARC has good designing & manufacturing facilities.
- Exploit this added capability for developments pertaining to ILC ….
  - Design and fabrication of cryomodules, tuners etc
- Also utilize it for new home programs.

BARC wishes to join TTC


Thank You