Indian Collaborations to CERN and Industry participation

Session: Mega Science and Industry

November 05,2019.

Science City, J.B.S. Haldane Avenue, Kolkata, 700046.

DEBASHIS DAS

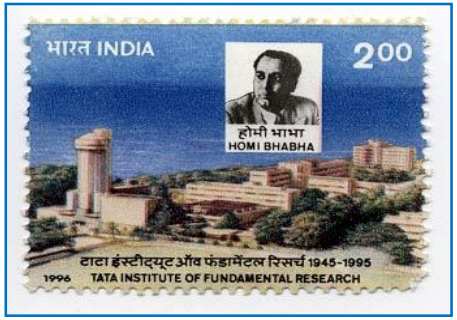
Raja Ramanna Centre for Advanced Technology (RRCAT)

Indore

Participating Institutions – non industrial

Major DAE R&D Centres in CERN Program

BARC, Mumbai



TIFR, Mumbai

VECC, Kolkata

RRCAT, Indore: Nodal Institute

IOP, Bhuvaneshwar

SINP, Kolkata

Indus Accelerator Complex - RRCAT

Indus–1 and Indus-2, the Indigenous synchrotron radiation sources are the national facilities.

Operational beamlines (16)

1. Soft X-ray Absorption Spect. (BL-01) [DAE-CSR]
2. Soft X-ray Reflectivity (BL-03) [RRCAT]
3. X-ray Imaging (BL-04) [BARC]
4. X-ray Lithography (BL-07) [RRCAT]
5. Dispersive EXAFS (BL-08) [BARC]
6. Scanning EXAFS (BL-09) [BARC]
7. Extreme Conditions AD/ED XRD (BL-11) [BARC]
8. Angle Dispersive XRD (BL-12) [RRCAT]
9. X-ray Photo-Electron Spect. (BL-14) [BARC]
10. X-ray Fluorescence Microprobe (BL-16) [RRCAT]
11. Protein Crystallography (BL-21) [BARC]
12. Visible Diagnostic (BL-23) [RRCAT]
13. X-ray Diagnostic (BL-24) [RRCAT]
14. Grazing Incidence X-ray Scatt. (BL-13) [SINP]
15. Engg. Appl. beamline (BL-02) [RRCAT]
16. Small and Wide Angle X-ray Scatt. (BL-18) [BARC]

Ready for commissioning (1): Commissioning by Dec'19

1. ARPES beamline on U-2 (BL-10) [RRCAT]

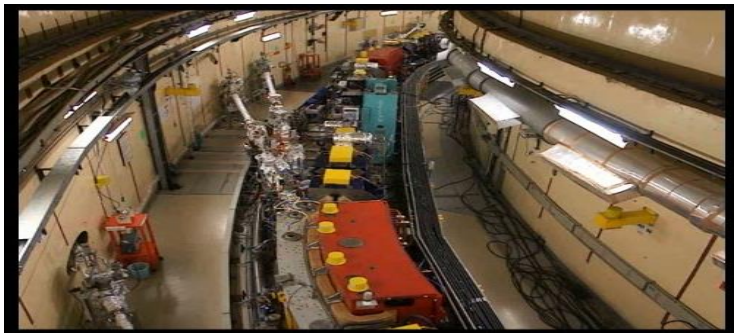
Installation and Commissioning (2): Commissioning by Sep'20

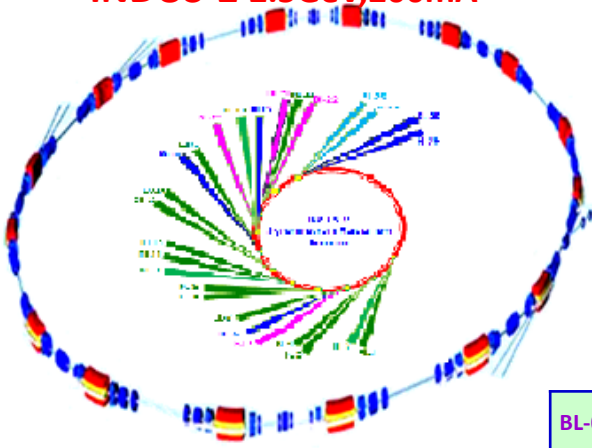
1. Photo-Emission Ele. Microscopy (BL-22) [BARC]
2. X-ray Mag. Circ. Dichr. on U-3 (BL-20) [RRCAT]

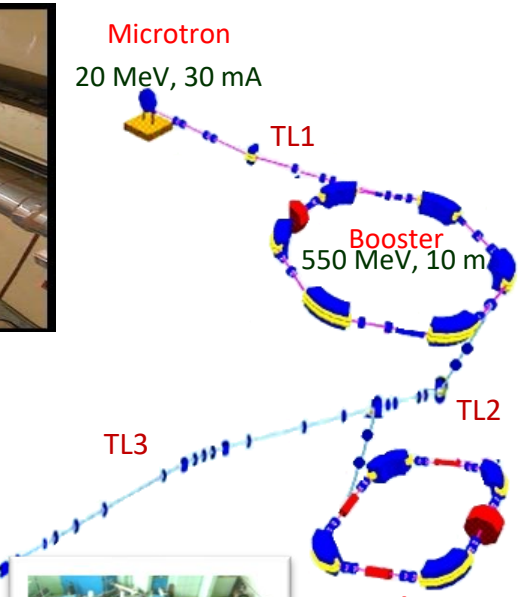
Under construction (2)

- AMOS beamline on U-1 (BL-05) [BARC]
- BL for Radiological Safety Studies (BL-17) [BARC]

Researchers from more than 150 institutes all over India are using this facility







BL-01	AMPD, BARC	High Resolution VUV Spectroscopy beamline
BL-02	UGC-DAE-CSR	Angle Integrated Photo-Electron Spectroscopy beamline
BL-03	AMPD, BARC	Angle Resolved Photo-Electron Spectroscopy beamline
BL-04	SUS-RRCAT	Soft-X-ray Reflectivity beamline
BL-05	AMPD, BARC	Photo-Physics beamline
BL-06	HPSRPD, BARC	Infra-Red beamline
BL-07*	TPD-BARC	Photo-Absorption Spectroscopy Studies beamline (To be commissioned)

Both Indus–1 and Indus-2 are operated in round-the-clock since February 2010.

India CERN Collaboration Activities

Accelerator activities:

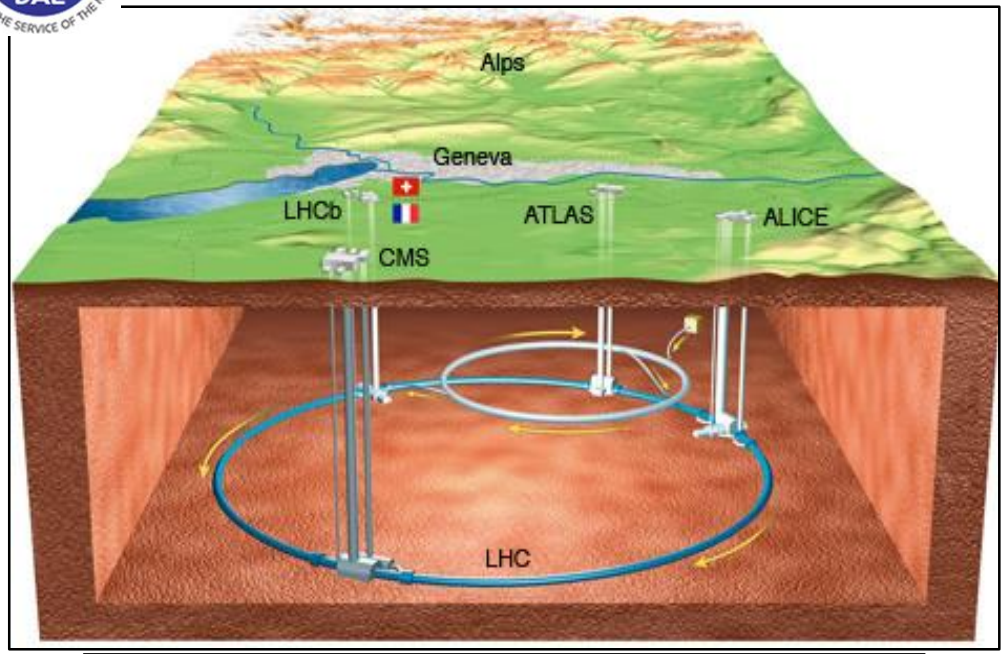
1. **Participation in Construction of Large Hadron Collider (LHC)**
   - Hardware contributions for construction of LHC
   - Participation in commissioning
   - Software development
2. **Beyond LHC: Novel Accelerator Technology (NAT)**
   - Compact Liner Collider (CLIC)- Starting with CLIC Test Facility (CTF3)
   - Superconducting Proton LINAC (SPL) front end-LINAC-4

Collaboration in High Energy Physics Experiments:

Detectors: Compact Muon Solenoid (CMS), A Large Ion Collider Experiment (ALICE) - Muon and PMD; Construction, commissioning and operation.

GRID Collaboration

Large Hadron Collider (LHC) at CERN, Geneva



- **"Large" :** ~27 km in circumference.
- **"Hadron" :** Accelerates protons or ions, to near the speed of light.
- **"Collider":** Two particle beams travelling in opposite directions collide head-on, at four different points **(ALICE, CMS, ATLAS, LHCb)** around the machine.

Objectives of LHC

Recreate Big-Bang like conditions to probe nature's deepest secrets such as:

- Origin of mass (ATLAS & CMS)
- Dark matter and dark energy (ATLAS & CMS)
- Quark-Gluon plasma give rise to the particles that constitute the matter of our Universe (ALICE)
- More matter than anti matter (LHCb)

Indian contribution so far in LHC

- Supply of Super conducting magnet (building of LHC)
- Development of Silicon strip detector (CMS Preshower detector)
- Building of Photon Multiplicity Detector (PMD) (ALICE sub detector)
- Building of Muon Chamber (MCH) (ALICE sub detector)
- Worldwide LHC Computing Grid (WLCG)
- Data analysis

Courtesy: Dr. V.B.Chandratre

Table 1: Participation in LHC protocol for accelerator construction/commissioning - 1996

Sr.	Description	Qty
1	Liquid Nitrogen tanks 50000 litres capacity	2
2	Superconducting corrector magnets : Sextupole, Decapole and Octupole	1146 616
3	Precision Magnet Positioning System (PMPS) Jacks	7080
4	Quench Heater Power Supplies (QHPS)	5500
5	Integration of QHPS units into racks	6200
6	Control electronics for circuit breakers of energy extraction system	70
7	Local protection units (LPU)	1435
8	SC Dipole magnet measurements, expert support. Equ. man-years	100
9	LHC commissioning: Cryogenics, Controls, Converters, protections, man-years	20
10	Software development for LHC subsystems, equ. man-years	41

Table 2:Participation in NAT protocol - construction of CLIC (CTF3)/SPL (LINAC4)-2006

1	Design, development, magnetic tests of dipole magnets for TL2 of CTF 3	5
2	Design, Development, vacuum tests of vacuum chambers, for CTF3 + spares	64+62
3	Optics design, simulations, analysis and results for TL 2 of CTF 3, eq man months	9
4	Expert support for commissioning, operation of controls for CTF3, man months	41
5	Expert support for the commissioning of the subsystems of Linac 4, man months	25
6	100kV, 20A solid state modulator for CERN LINAC 4	1
7	20kW Broad Band solid state amplifier for harmonic buncher for CLIC linac	1
8	Development, supply of prototype components for Linac 4	6
9	Development, supply of copper coated SS power couplers for DTL for Linac 4	4
10	Tests and supply by CERN: 1MW CW 352.2 MHz klystrons, 1MW CW circulators, waveguide hardware LEP useful for DAE's SNS/ADS program.	4 sets

Major DAE Contributions to LHC machine

Corrector Magnets
(616 MCDO & 1146 MCS)

Quench Heater Power Supply
(QHPS) HDS units 5500

Local protection units
(LPU) 1435

Precision Magnet Positioning System
7080

Installation of dipoles on Indian jacks

Expert support for SC Dipole measurements 100 Man years,
Support for LHC hardware commissioning ~18 Man years

Tests and Qualification of the LHC Superconducting Dipoles & Commissioning of LHC Hardware Subsystems

DAE engineers worked at SM18 Hall at CERN and completed crucial performance tests and qualification of all the LHC superconducting dipole magnets. H.E. Dr. A. P. J. Abdul Kalam the President of India at SM 18 Hall of CERN with DAE's engineers on May 25, 2005.

High voltage test set-up for nQHPS

nQPSRacks ready for installation

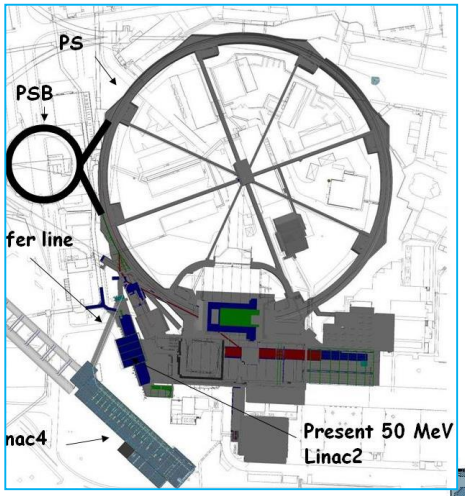
Determination of excessive frosting in cryogenic subsystem & re-evaluation of safety valve size etc.

Indian experts participated in the commissioning of new Quench Heater Protection Systems, Cryogenic Systems, Power Converters Systems. Total support of ~18 man years.

Collaboration with CERN beyond LHC

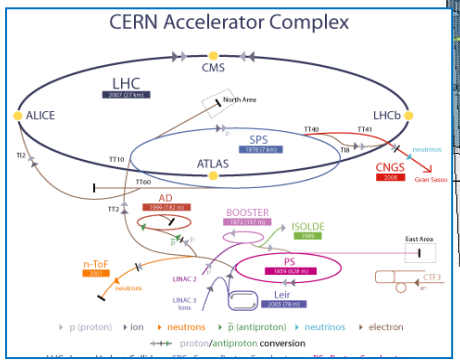
SPL/Linac4 and CLIC/CTF3

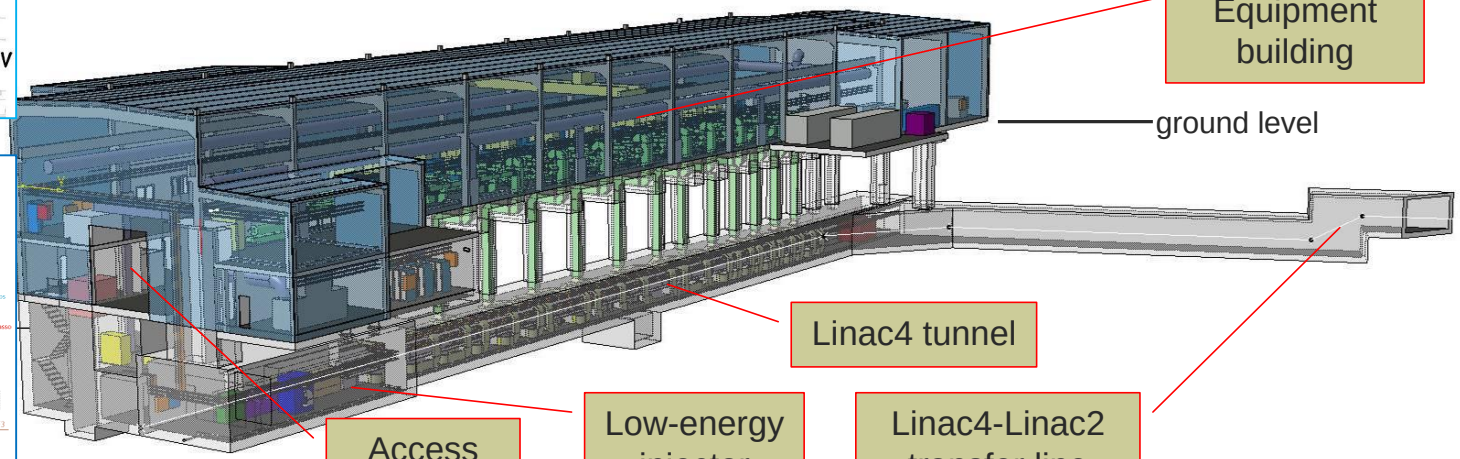
Linac-4 (LHC Luminosity Upgrade)

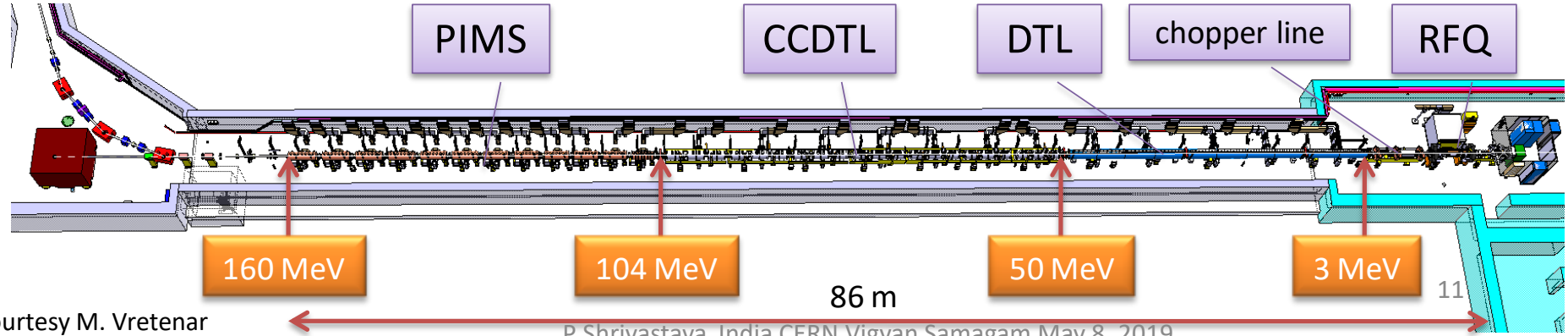


***Linac-4** is a **160 MeV H-** linac built at CERN to increase the injection energy into the PS Booster and to allow **higher intensities** from the LHC injector chain, in view of an upgrade of **LHC Luminosity**.*

(Linac-4 because 4th linac to be built at CERN)





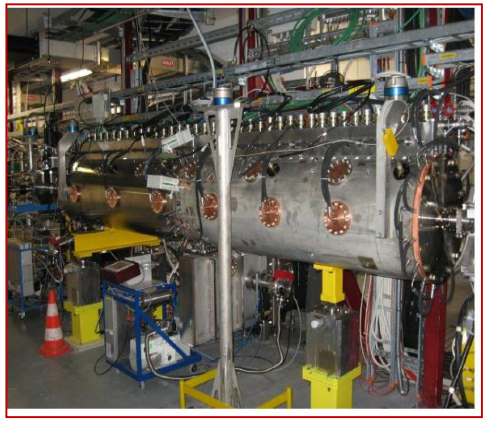


Courtesy M. Vretenar

Collaboration: NAT Protocol LINAC 4 project

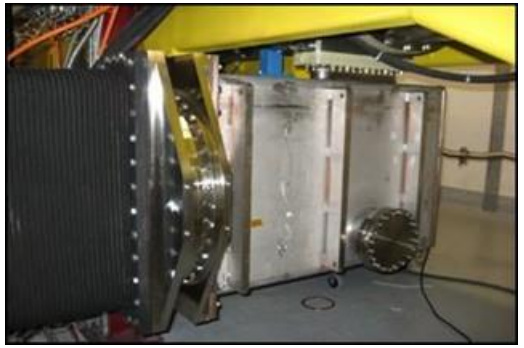
- 100kV state of the art prototype solid state bouncer modulator for LINAC4
- WR 2300 waveguide components, power couplers for LINAC4
- Participation in commissioning of the LINAC4 subsystems.
- India received four 352.21 MHz, 1MW CW klystrons and circulators along with RF waveguide components for our projects on SNS at RRCAT and ADS/LEHIPA at BARC.

100kV solid state modulator designed, developed and commissioned by RRCAT, Indore, for LINAC 4 cavity tests.



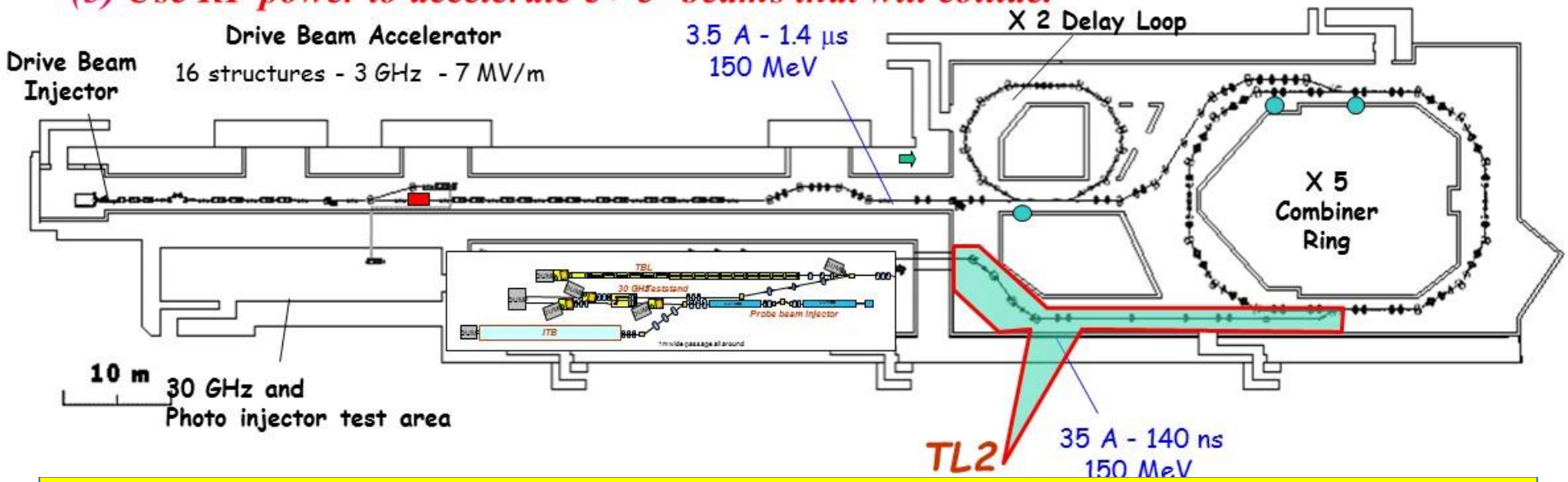
CERN klystron and circulator tested at 1MW peak power at RRCAT test stand.

Two Cu coated SS WR 2300 waveguide power couplers installed in the DTL/CCDTL in LINAC 4 tunnel at CERN



(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.



Optics design of TL2, 5 dipole magnets, 62 Vacuum chambers, Software development for controls for CTF3, Components of Power extraction and Transfer Structure (PETS), 20 kW Wide Band Solid State RF Amplifier for sub-harmonic buncher for CLIC

Vacuum chambers of various profiles for TL2 of CTF3

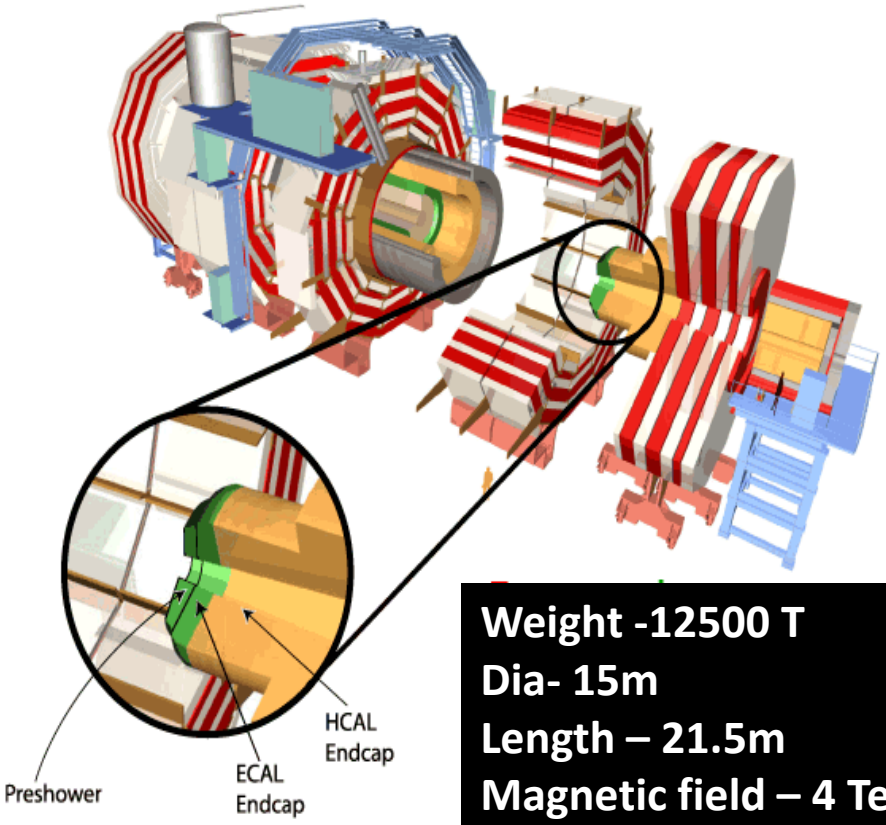
20kW Broardband SSPA for CLIC

Indian Contributions in the CERN experiments: CMS & ALICE detectors

Brajesh Chandra Choudhary,
Spokesperson, CMS-India collaboration , Delhi University, Delhi
Subhasis Chattopadhyay,
Spokesperson, ALICE-India Collaboration,
Variable Energy Cyclotron Centre, Kolkata

CMS Si Preshower Detector (DAE-CERN)

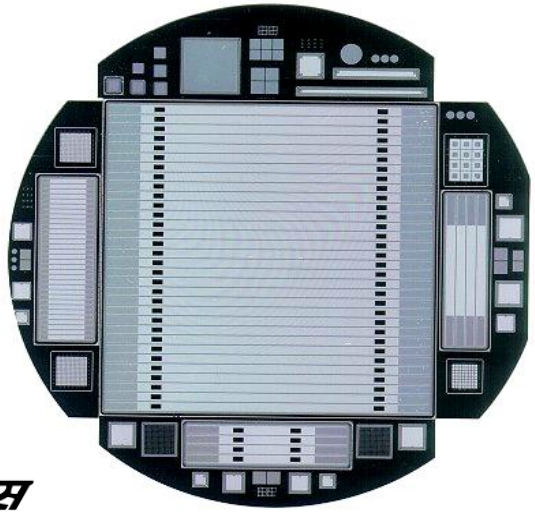
Pb –Si sandwich sampling Calorimeter

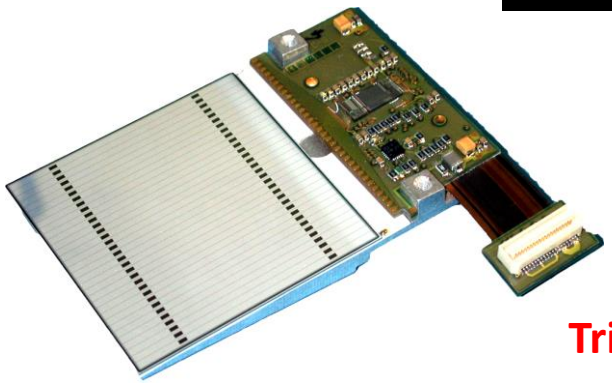


BARC delivered 4800 detector modules forthe CMS preshower

End caps of CMS detector INDIA supplied silicon strip detectors covering area of about +17 m^2 (BEL,India)

Weight -12500 T
Dia- 15m
Length – 21.5m
Magnetic field – 4 Tesla



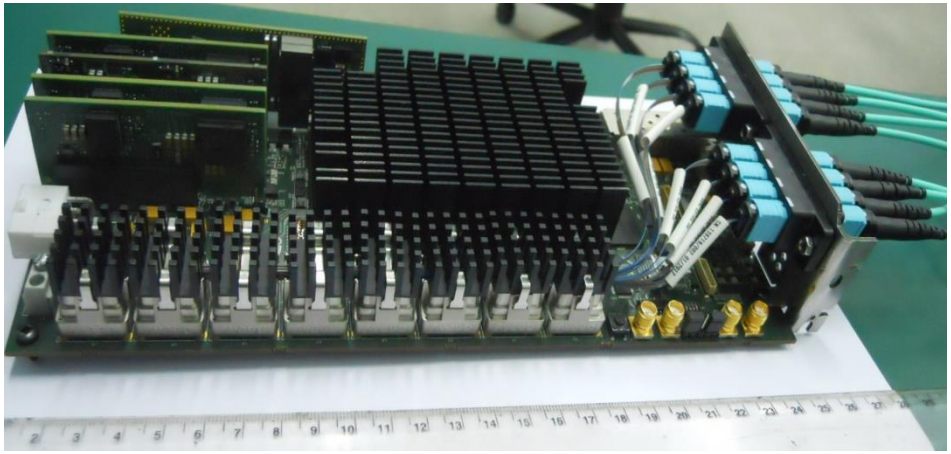


भारत इलेक्ट्रॉनिक्स
BHARAT ELECTRONICS
QUALITY. TECHNOLOGY. INNOVATION.

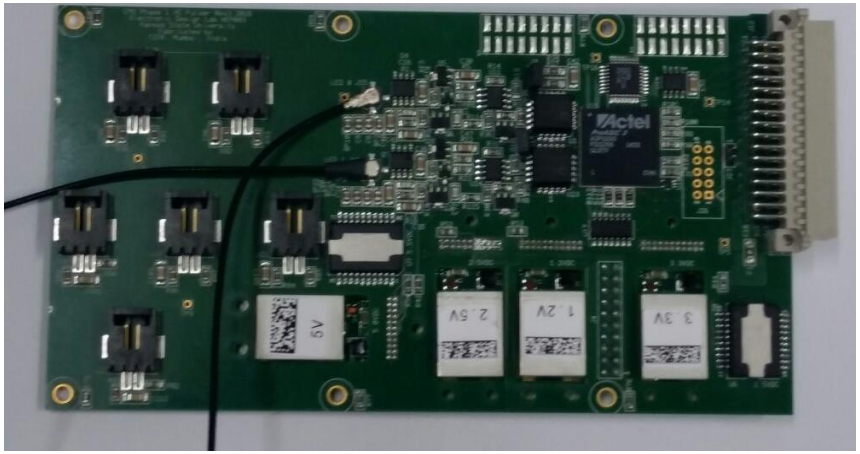
Tribute : late Dr S K Kataria

FPGA based data Acquisition system facility for ALICE & CMS

ALICE CRU



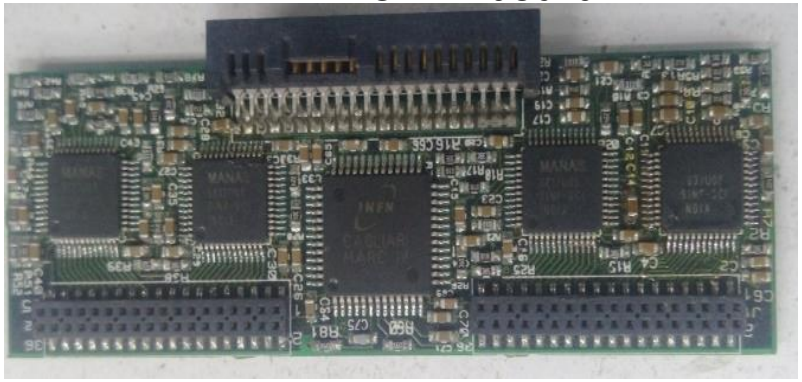
48-channel Si-PM control board



MANAS ASIC

MANAS: 16 channel Amplifier, shaper, track and hold for ALICE

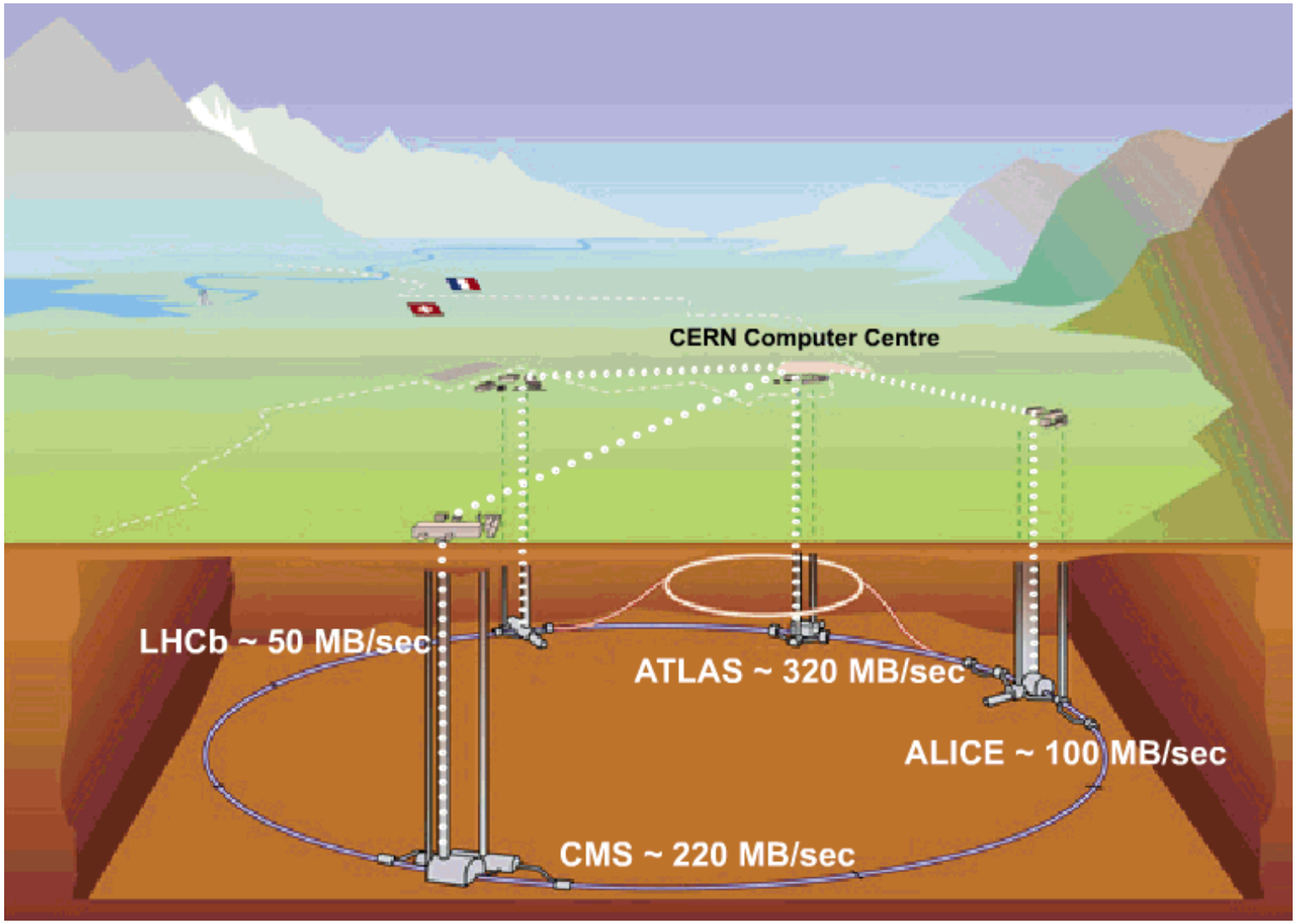
MANAS FEE board



VECC, SINP, BI, SCL, TIFR, PU,DU

DAE's contributions towards LHC GRID computing

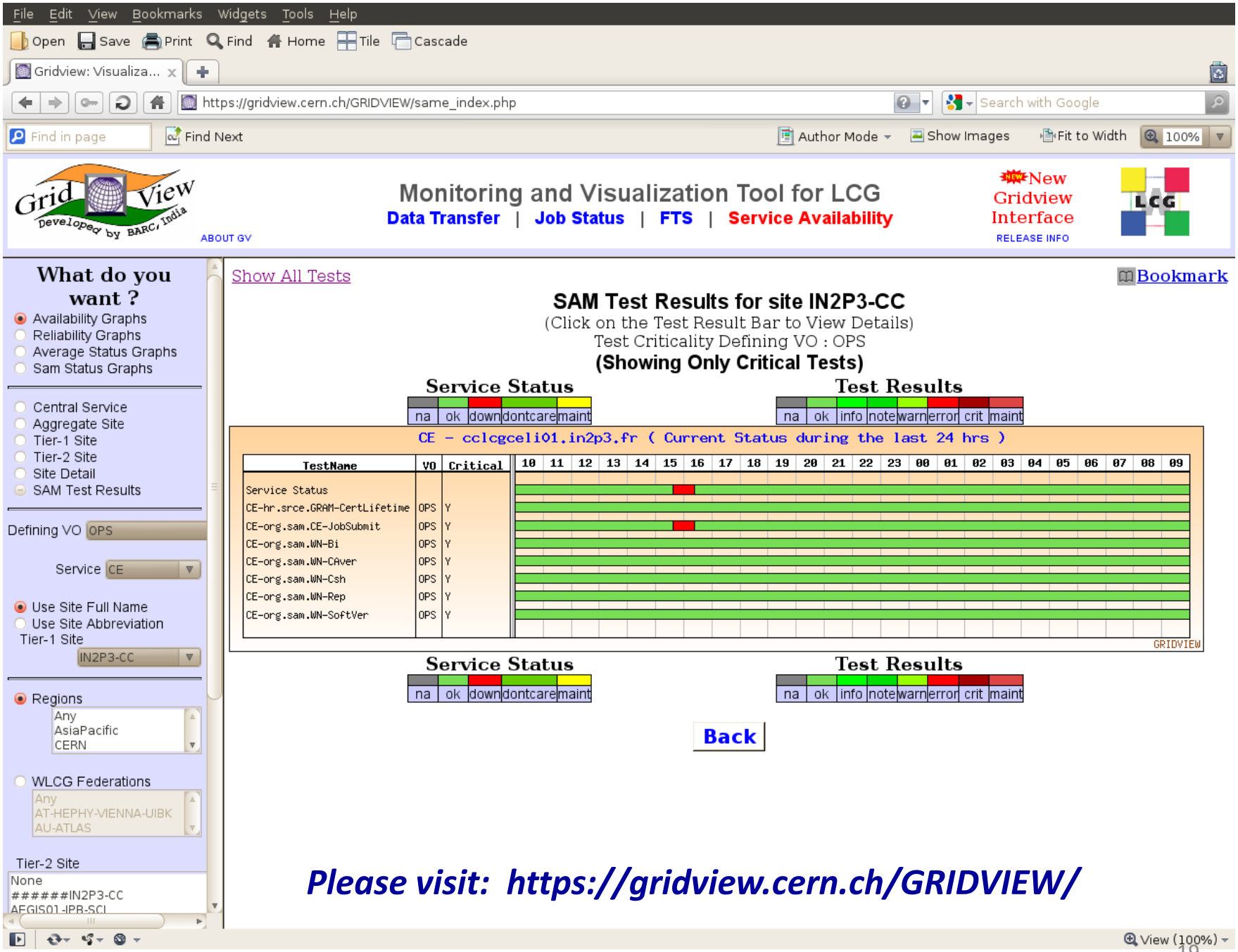
Tier 0 at CERN: Acquisition, First pass processing Storage & Distribution



Courtsey : Mr. B.S. JAGADEESH, BARC, TROMBAY, MUMBAI – 400 085

LHC Computing

- LHC (Large Hadron Collider) Data rates per experiment of >100 bytes/sec.
- >1 Pbytes/year of storage for raw data per experiment.
- Computationally problem is so large that can not be solved by a single computer centre
- World-wide collaborations and analysis.
    - Desirable to share computing and analysis throughout the world.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https://gridview.cern.ch/GRIDVIEW/same_index.php
Search with Google
Find in page
Find Next
Author Mode
Show Images
Fit to Width
100%
Grid View
Developed by BARC, India
ABOUT GV
Monitoring and Visualization Tool for LCG
Data Transfer | Job Status | FTS | Service Availability
New Gridview Interface
RELEASE INFO
LCG
What do you want ?
Availability Graphs
Reliability Graphs
Average Status Graphs
Sam Status Graphs
Central Service
Aggregate Site
Tier-1 Site
Tier-2 Site
Site Detail
SAM Test Results
Defining VO OPS
Service CE
Use Site Full Name
Use Site Abbreviation
Tier-1 Site
IN2P3-CC
Regions
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AsiaPacific
CERN
WLCG Federations
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AU-ATLAS
Tier-2 Site
None
######IN2P3-CC
AEGIS01-IPB-SCI
Show All Tests
Bookmark
SAM Test Results for site IN2P3-CC
(Click on the Test Result Bar to View Details)
Test Criticality Defining VO : OPS
(Showing Only Critical Tests)
Service Status
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CE-org.sam.CE-JobSubmit OPS Y
CE-org.sam.WN-Bi OPS Y
CE-org.sam.WN-CAver OPS Y
CE-org.sam.WN-Csh OPS Y
CE-org.sam.WN-Rep OPS Y
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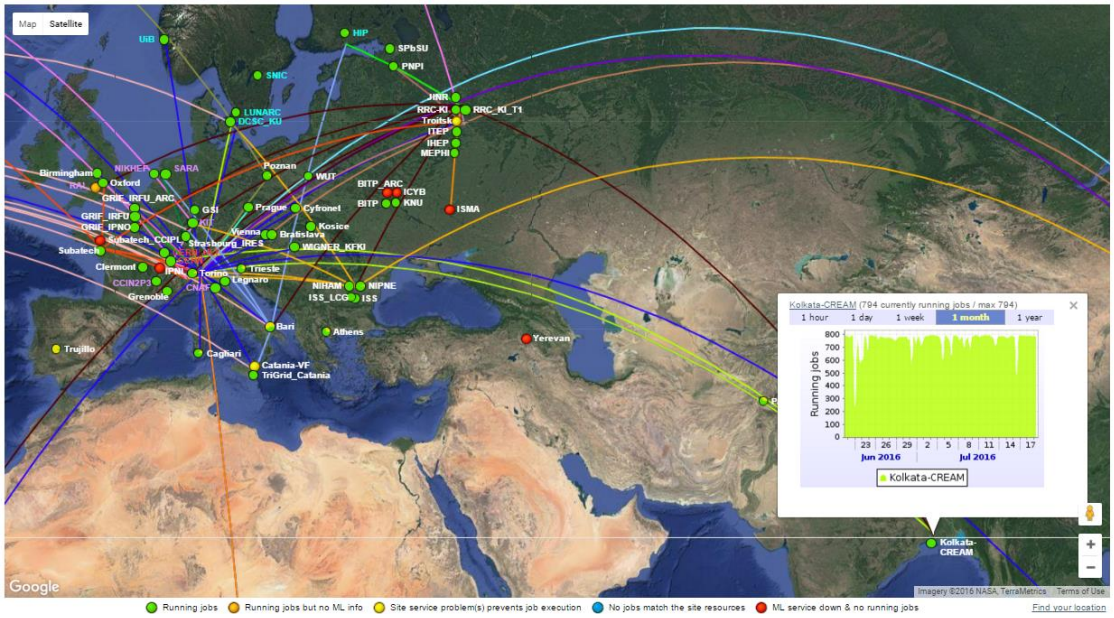
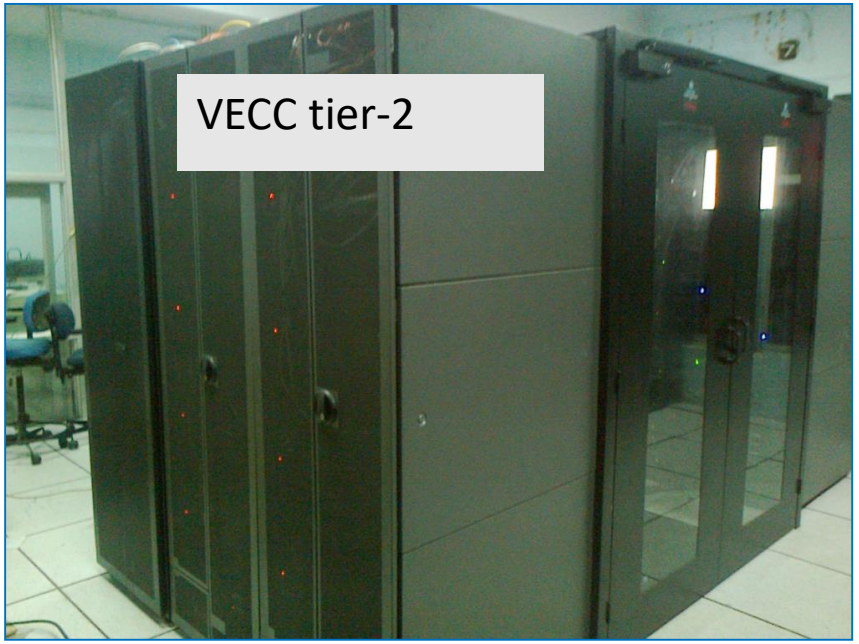
Tier-2 GRID Computing Facilities in India

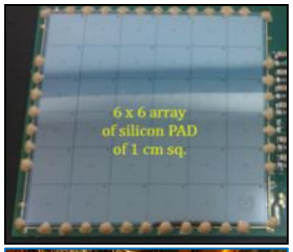


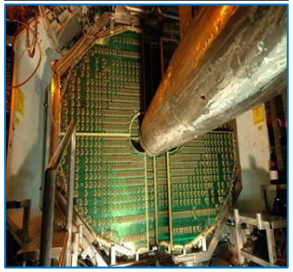
Computing grid being used heavily for LHC Computing

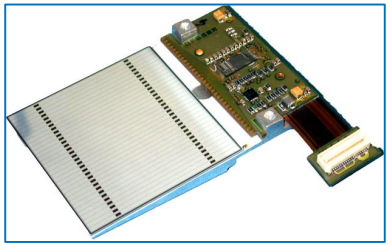
- Tier-2: VECC, TIFR
- Tier-3: collaborating institutes
- Connected via NKN



Participation of Indian Industries and further Business Opportunities with CERN







Courtesy: Shri Suman Sarkar et.al.

Table 1: Participation in LHC protocol for LHC accelerator construction/commissioning

Sr. No.	Description	Qty	Indian Participation
1	Liquid Nitrogen tanks 50000 litres capacity	2	INOX, India
2	Superconducting corrector magnets (SCM): Sextupole SCM: Decapole and Octupole	1146 616	Kirloskar Electric Co. Ltd, Bangalore
3	Precision Magnet Positioning System (PMPS) Jacks	7080	Avasarala, Bangalore IGTR, Indore
4	Quench Heater Power Supplies, QHPS	5500	ECIL, Hyderabad
5	Integration of QHPS units into racks	6200	ECIL, Hyderabad
6	Control electronics for circuit breakers of energy extraction system	70	ECIL, Hyderabad
7	Local protection units (LPU)	1435	ECIL, Hyderabad
8	SC Dipole magnet measurements, expert support. Eq. man-years	100	
9	LHC commissioning: Cryogenics, Controls, Converters, protections, man-years	20	
10	Software development for LHC subsystems, eq. man-years	41	

- Courtesy: Shri Suman Sarkar et.al.

Table 2:Joint Participation in NAT protocol for construction of CLIC(CTF3)/SPL(LINAC4)

Sr. No	Description	Qty	Indian Participation
1	Design, development and magnetic tests of dipole magnets for TL2 of CTF 3	5	IGTR, Indore
2	Design, Development and vacuum tests of vacuum chambers, for CTF3 + spares	64+62	Mann Aluminium + IGTR,Indore
3	Development & supply of copper coated SS power couplers for DTL for Linac 4	4	IGTR, Indore
4	Optics design, simulations, analysis and results for TL 2 of CTF 3, eq man months	9	
5	20kW Broad Band solid state amplifier for harmonic buncher for CLIC linac	1	
6	Development & supply of prototype Waveguide components for Linac 4	6	
7	100kV, 20A solid state modulator for CERN LINAC 4	1	
8	Expert support for commissioning & operation of controls for CTF3, man months	41	
9	Expert support for the commissioning of the subsystems of Linac 4, man months	25	

• Courtesy: Shri Suman Sarkar et.al.

Indian Industries……

- ✓ ECIL, Hyderabad,
- ✓ Bharat Electronics Limited (BEL), Bangalore
- ✓ Semi-Conductor Laboratory, Chandigarh
- ✓ IGTR, Indore
- ✓ Avasarala, Bangalore
- ✓ MSME Indo-German Tool Room, Indore
- ✓ Mann aluminium, Pithampur, Indore
- ✓ Kirloskar Electric Company Ltd, Bangalore
- ✓ Crompton Greaves, Bhopal
- ✓ Smile Electronics Limited, Bengaluru
- ✓ Central Tool Room, Ludhiana
- ✓ Hi-Tech Industries, Mumbai
- ✓ Micropack, Bangalore
- ✓ HiQ Electronics

- ✓ Micro-Epsilon India Private Limited, Bangalore
- ✓ KAF International, New Delhi
- ✓ Ameliorate Solutions, Bangalore
- ✓ Nordson-EFD, Bangalore
- ✓ HDR Holding India Pvt. Ltd, Kolkata
- ✓ Peninsula Electronics, Bangalore
- ✓ Eata Plast Fabrics, Rabale, Mumbai
- ✓ Alpha Pneumatics, Mumbai
- ✓ PDR Videotronics, Mumbai
- ✓ Amit Electronics
- ✓ IDEMI,Mumbai

- **Courtesy: Shri Suman Sarkar et.al.**

CERN: Tender Framework

Announcement (for interest) → Market Survey (Vendor Qual.) → Invitation to Tender - Contract Award

- **All public announcement of tenders and market surveys are published in web-link:** https://found.cern.ch/java-ext/found/CFTSearch.do
- **It is very important for companies to register themselves in CERN supplier database to receive online intimation about new announcements and market surveys. For registration see web-link:** https://procurement.cern.ch/aspx/Registration

Current Opportunities	Upcoming Opportunities
• Supply of PXIe High Availability Chassis for the LHC	• Mechanical Switches for Energy Extraction Systems
• Supply of metallized polypropylene capacitor	• Electronics for beam instrumentation
• Supply of vacuum vessels, jumpers and end covers	• Supply and installation of X-ray diffractometer (XRD)
• Design and supply of flexible cryostats, stainless steel cryostats, metallic bellows etc.	• Supply and installation of site surveillance (SUSI) access control and video surveillance system
• Supply of Air Handling Units	• Cabinets equipped with electrical and electronic comp
• Supply of centrifugal water pumps	• Supply of cooling Systems on the CERN Sites

- Courtesy: Shri Suman Sarkar et.al.

CERN: Type of Enquiry

"Price Enquiry" (DO)	"Invitation-to-Tender" (IT)
1. Enquiries < 10'000 CHF (INR 7 Lakhs)	3. Enquiries ≥ 200'000 CHF
2. 10'000 CHF ≤ Enquiries < 200'000 CHF (INR 1.4 Crore)	(INR 1.4 Crore)

Enquiries < 10'000 CHF (INR 7 Lakhs)

"Price Enquiry" (DO):

- Price enquiry by Technical Officer or Procurement Officer
- Minimum of 3 bids requested;
- Purchase Order (PO) made to the lowest compliant bidder

10'000 CHF (INR 7 Lakhs) ≤ Enquiries < 200'000 CHF (INR 1.4 Crore)

- Price Enquiry prepared / managed by Procurement Officer; Technical specification prepared by Technical Officer; Submission deadline: 4 weeks from date of dispatch.
- Minimum of 3 bids requested. PO made to the lowest compliant bidder.
- All price enquiries above 50'000 CHF (INR 35 Lakhs) are sent to the Industrial Liaison Officers (ILOs) for information.

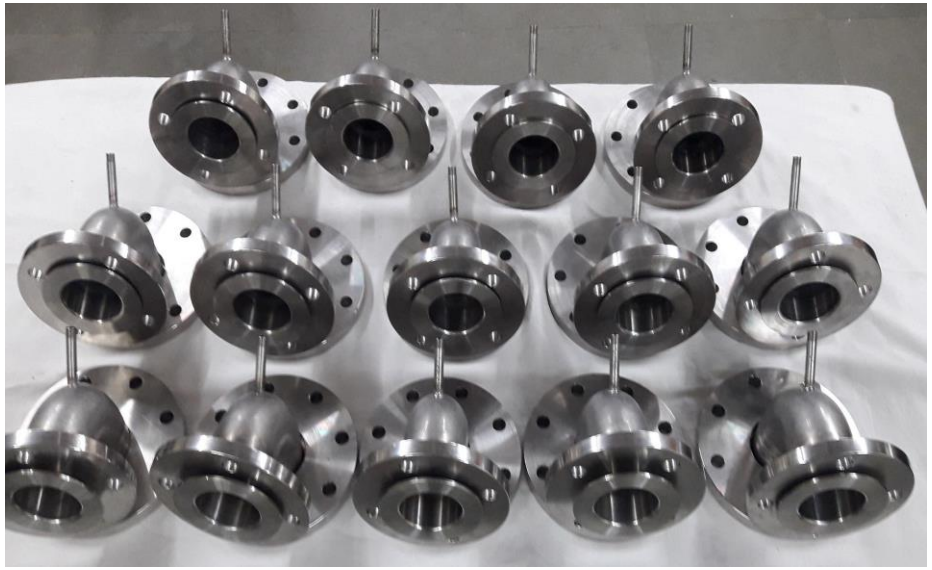
- Courtesy: Shri Suman Sarkar et.al.

CERN: Type of Enquiry ..Contd.

Enquiries ≥ 200'000 CHF (INR 1.4 Crore)
• Departmental Request followed by internal Start-up Meeting at CERN
• Prior announcement in CERN's procurement website & communication to ILOs.
• At this stage, interested firms are encouraged to contact CERN in order to have a clear understanding of the requirement, allowing them to prepare their organization ahead of the tendering process.
• "Market Survey" (MS) includes : "Technical Description" and "Qualification Questionnaire" (financial and technical) which is vetted by a Specification Committee at CERN.
• Submission deadline: 4 weeks, or more if the MS is still online.
• MS Results is followed by "Invitation-to-Tender" that includes : Tender Form, Technical Specification and all Annexes vetted by Specification Committee. These are sent to qualified and selected firms only & ILOs for information.
• Submission deadline: 4 weeks from date of dispatch (with a longer period for more complex requirements); Bidders Conference is organized if required.
• Clarification Process: Firms may ask questions in writing to understand all requirements and prepare a bid that best matches CERN's needs & submit the bids online.
• Opening & Evaluation of the bids followed by CONTRACT.

- Courtesy: Shri Suman Sarkar et.al.

CERN: Recent Supplies by Indian Industries



SPSACTMC0300 Elbow with Flange for SPS Caivites
(supplied by M/s IDEMI, Mumbai)

SPSACTMC0301 Sleeve Outlet for SPS Cavities
(supplied by M/s IDEMI, Mumbai)

Contact

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Email : ssarkar@barc.gov.in

Thank you all.