A WARM WELCOME

TO

HIS EXCELLENCY

THE PRESIDENT OF INDIA

DR. A.P.J. ABDUL KALAM

ON HIS VISIT TO

SM18 MAGNET TEST FACILITY

AT CERN, GENEVA

ON 25TH MAY 2005

FROM

ENGINEERS AND SCIENTISTS OF DEPARTMENT OF ATOMIC ENERGY, INDIA, AT SM18

Testing of superconducting cryo-magnets for LHC

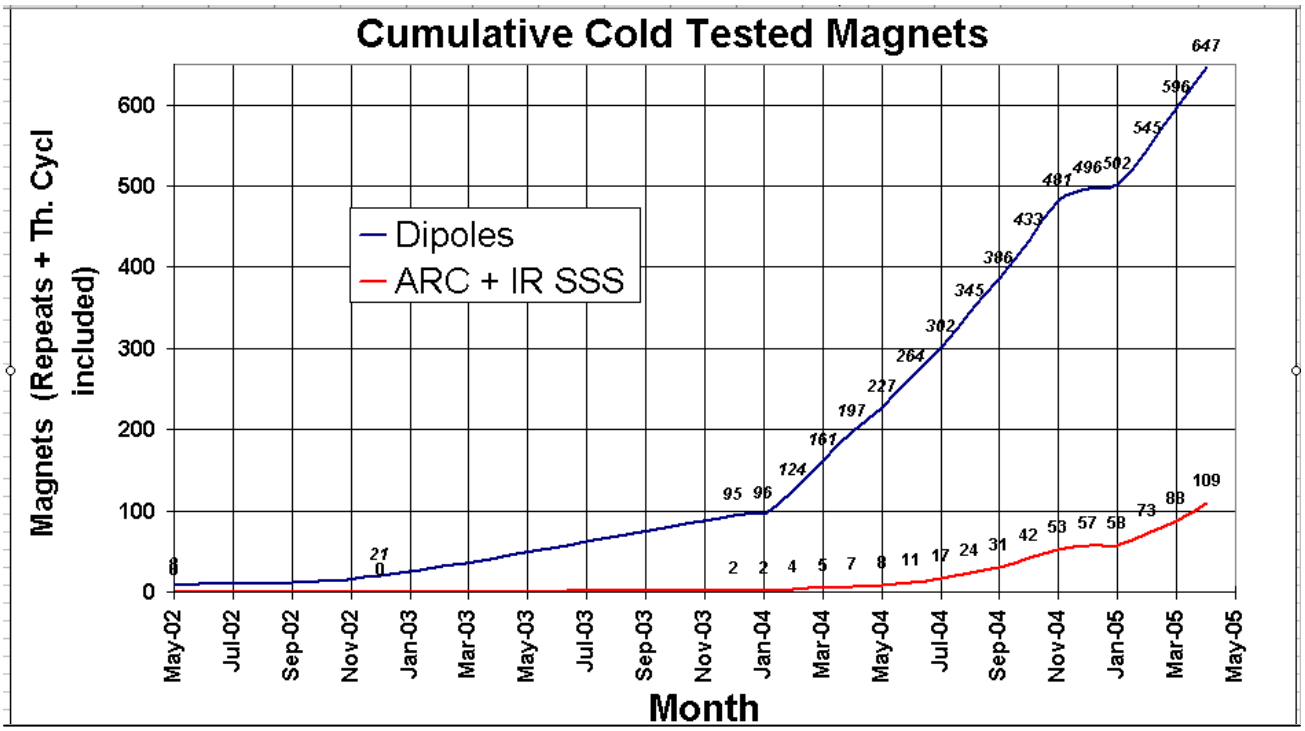
The Large Hadron Collider (LHC) under construction at CERN requires around 1900 superconducting cryo-magnets. Testing of the magnets under cryogenic conditions at CERN posed a formidable challenge to CERN in view of time and resource constraints. In 2001, CERN and Department of Atomic Energy (DAE)-India entered into an agreement to collaborate in the testing of these magnets.

The magnets are tested under cryogenic conditions in this facility called SM18, which provides infrastructure for testing the Dipole and the Quadrupole magnets. A defined sequence of tests is performed on each magnet to validate their quality with respect to their electrical and magnetic performance. The magnets are trained to the designed magnetic field (the magnets are normally expected to have memory meaning that they maintain their performance after testing & storage) before installing them in the LHC tunnel. The SM18 allows simultaneous testing of up to 12 cryo-magnets arranged in clusters of test benches sharing common resources like power, water, electronics and cryogenics.

A dedicated operation team comprising mainly of Indian collaborators drawn from various DAE institutes and a few CERN Accelerator operation staff operates this test facility on a round-the-clock basis. The operation team has been instrumental in developing various operational tools that were necessary for improving the efficiency and throughput. These include web-based test management and information system, development of precisely defined list of test sequences, electronic logbooks and well-documented test procedures. The operation team also maintains the magnet test statistics, updates the CERN LHC magnet database and helps in magnet performance analysis.

The tools and techniques implemented by the collaborating teams have helped immensely in reducing the mean testing time of the magnet and thereby the test-bench occupancy time. This has increased the testing rate with 72 magnets being tested in the month of April 2005. At this rate, it is expected that the testing of the magnets required for LHC would be completed well before the projected schedule of LHC commissioning in 2007.

This is a shining example of a successful international collaboration for the advancement of science.


Cumulative Cold Tested Magnets
Magnets (Repeats + Th. Cycl included)
Dipoles
ARC + IR SSS
Month
0
100
200
300
400
500
600
May-02
Jul-02
Sep-02
Nov-02
Jan-03
Mar-03
May-03
Jul-03
Sep-03
Nov-03
Jan-04
Mar-04
May-04
Jul-04
Sep-04
Nov-04
Jan-05
Mar-05
May-05
8
21
95
96
124
161
197
227
264
302
345
386
433
481
496
502
545
596
647
2
2
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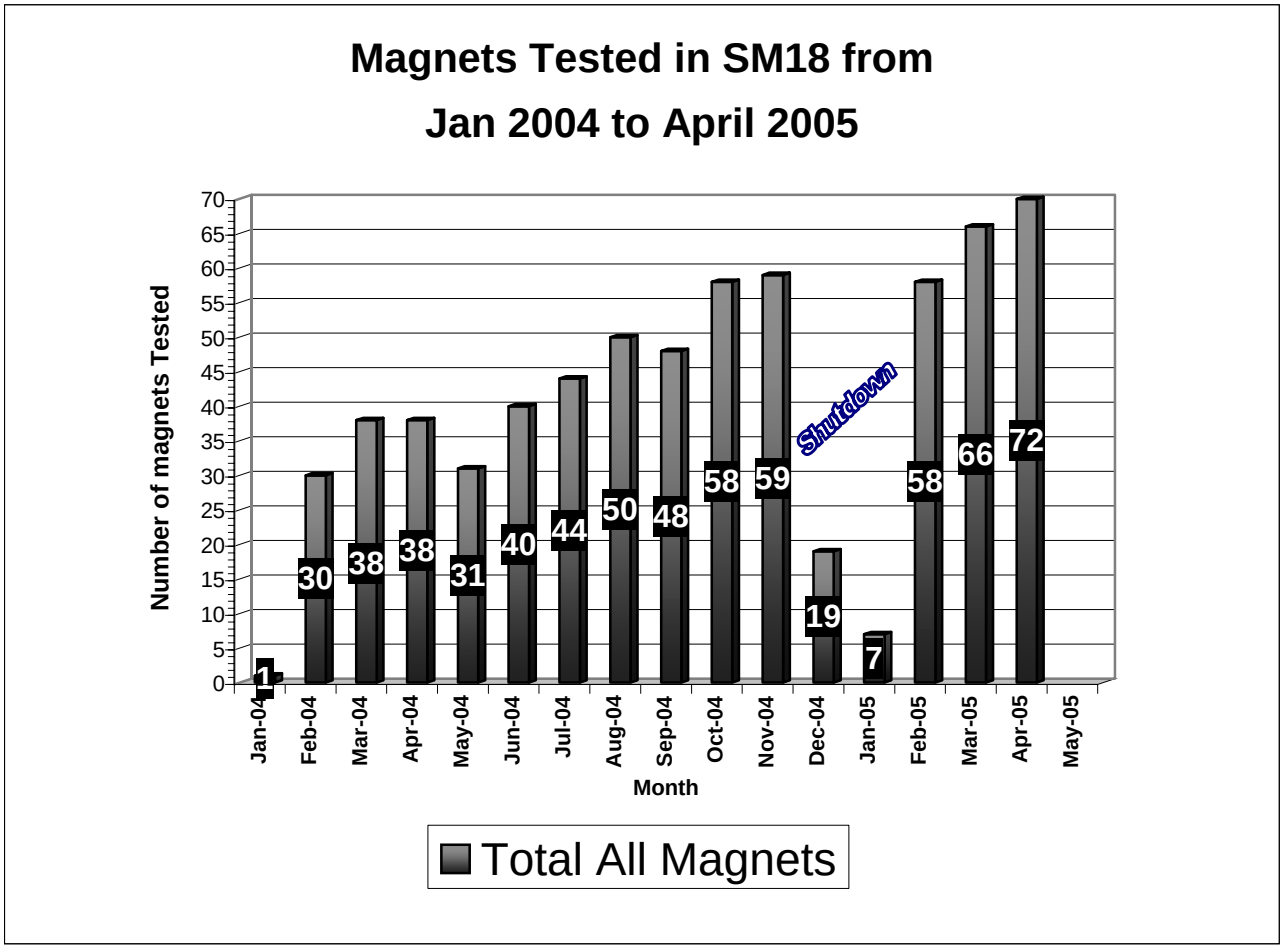
7
8
11
17
24
31
42
53
57
58
73
88
109


Magnets Tested in SM18 from
Jan 2004 to April 2005
Number of magnets Tested
Month
Shutdown
Total All Magnets
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
Aug-04
Sep-04
Oct-04
Nov-04
Dec-04
Jan-05
Feb-05
Mar-05
Apr-05
May-05
1
30
38
38
31
40
44
50
48
58
59
19
7
58
66
72

TYPICAL SUPERCONDUCTING MAGNET TEST SEQUENCE

New Magnet

PREPARATORY TESTS AT ROOM TEMPERATURE

- **Lyre Test: Simulate Effect of Thermal Contraction in Cold condition**
- **Check Functioning of Quench Heaters and Voltage Taps. Measure Heater resistances and perform High Voltage Insulation Test**

Magnet Cool Down to 1.9 K

COLD TESTS

- **High Voltage Insulation Test: Before Magnet Powering**
- **Slow Power Abort Test: Power the Magnet upto 1000 A and then back to Zero with Controlled Ramp Rate to check the power converter operation**
- **Provoked Quench Tests: Power the Magnet up to 1500 A and check Quench-Heaters' protection by provoking a Quench by triggering the heaters.**
- **TRAINING of Magnet: Feed the Magnet with Repetitive Current Ramp cycles until it gets "TRAINED" (Reaches the Ultimate Designed Current Value of 12850 A)**

MAGNETIC MEASUREMENTS

Measurement of Field profile, Harmonics etc. by rotating a coil in the magnet aperture

- **HV Insulation Test: After Completion of Magnet Power Tests**
- **Minimum Energy Quench: Provoke a Quench by Firing one LF Heater at minimum required Heater-Voltage**

Magnet Warmed up to 300 K

FINAL TESTS AT WARM

- **Final Check for Electrical Integrity of Voltage Taps and Temperature Sensor after completion of Power Tests at cold**
- **Final Resistance Measurement at Room temperature of Quench Heaters, Voltage Taps, Temperature sensor etc.**

Current Indian Collaborators at CERN (May 2005) seen here with Dr. Vinod Chohan, Leader – Operation for Magnet tests, CERN

Sitting (L to R) : Vasudevan Kakkat (BARC), Prakash Kashyap (BARC), Sanjeev Sharma (BARC), Surajit Sen (BARC), Jayanta Debnath (VECC), Dr. Vinod Chohan (CERN), Sanjeev Kane (CAT), Ajay Kasbekar (BARC), Akhilesh Jain (CAT)
Standing (L to R) : Jacob John (BARC), Anand Pagare (CAT), Sashidhar Rao (IGCAR), Adibabu Pallapothu (BARC), Dhruva Bhattacharjee (BARC), Yashpal Singh (CAT), Jaydeep Gore (BARC), Sudheer Singh (BARC), Debabrata Roy (BARC), Jitendra Mishra (BARC), Kapildeo Ambastha (BARC), Yashvant Chaudhari (BARC), Naushad Ali (BARC)
Others (not in photo) : Paresh Motiwala (BARC), Mandar Joshi (CAT), Shradha Palod (CAT)

Earlier Indian collaborators (2001 – 2004)

Pradhan Jedidiah (VECC), Tamal Bhattacharyya (VECC), Clement Verghese (BARC), Premakumar Kavalan (BARC), T.S.Selvakumaran (IGCAR), Ramalingam Dhandapani (IGCAR), Anand Laddha (BARC), Beachai Maurya (BARC), Manoj Gandhi (CAT), Ravindra Marathe (CAT), Sandip Pal (VECC), Madhusudan Jathar (CAT), Pramod Radheshyam (CAT), Govindan Aravanmuthan (BARC), Sanjay Malhotra (BARC), Rajendra Bhole (VECC), Uttam Bhunia (VECC), Praveen Behere (BARC), Narayanan Ramkumar (BARC), P. Daniel Babu (BARC), Satish Shetty (BARC), Kuppusamy Palanisami (IGCAR), S. Sridhar (IGCAR), Vimal Bhatnagar (CAT), Apollo Kasliwal (CAT), Krishna Mohan Khare (CAT), Prashant Pareek (CAT), Bangalore Arunkumar (BARC), Kesavan Nair (BARC), Prashant Awale (BARC), Mahesh Patil (BARC), Krishna Dubey (BARC), Amitava Roy (BARC), Sivasankaran Gomu (BARC), Rakesh Kumar Gupta (BARC), Martin Mascarenhas (BARC), Puthiyedath Surendran (BARC), T V Shyam (BARC)

CERN & Indian Collaborators at work & play …….