


Assembly and Testing of CMS RPCs for low η regions

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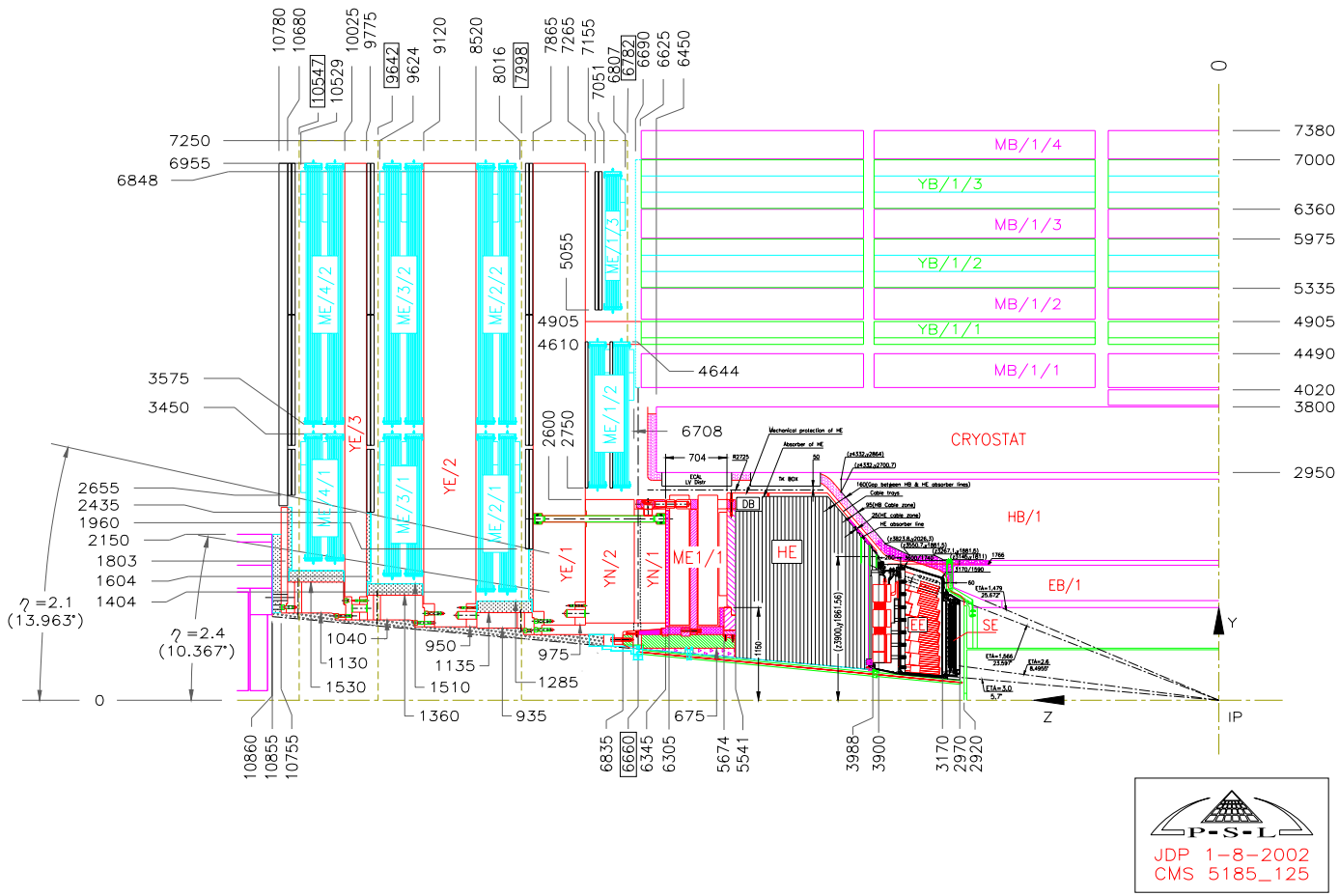
Workshop on Physics at LHC 16. 12. 2004

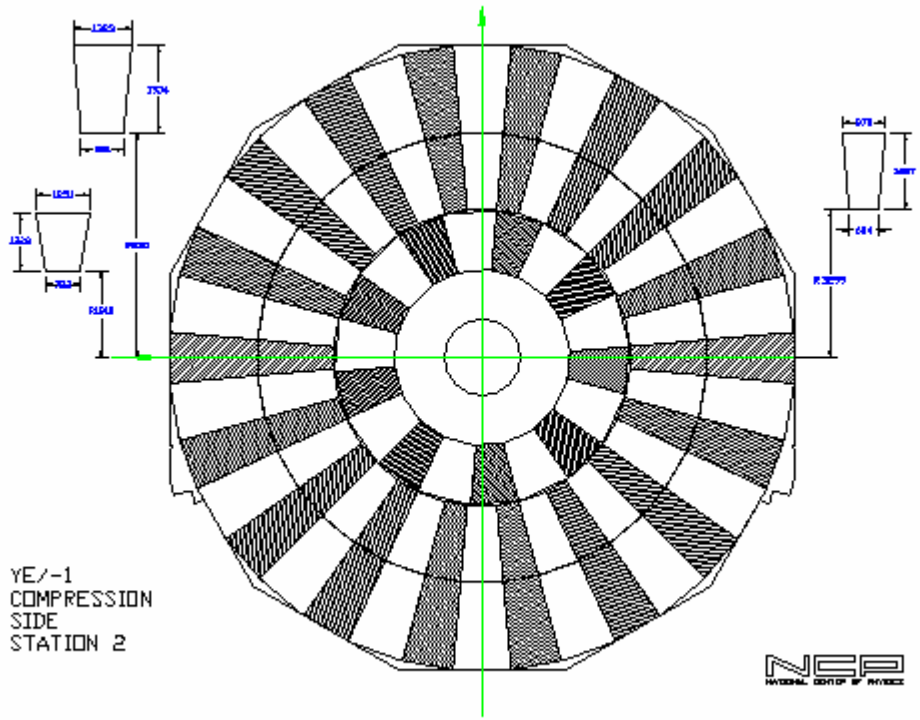
Talk outline

- Introduction and functions of RPCs in CMS experiment
- CMS Chamber parameters
- Beam test results
- Task List assigned to Pakistan
- Chamber assembly facility & its functional status
- Assembly Procedure pictures
- Status of test facilities for gaps & chambers
- Realistic time estimates for production
- Summary



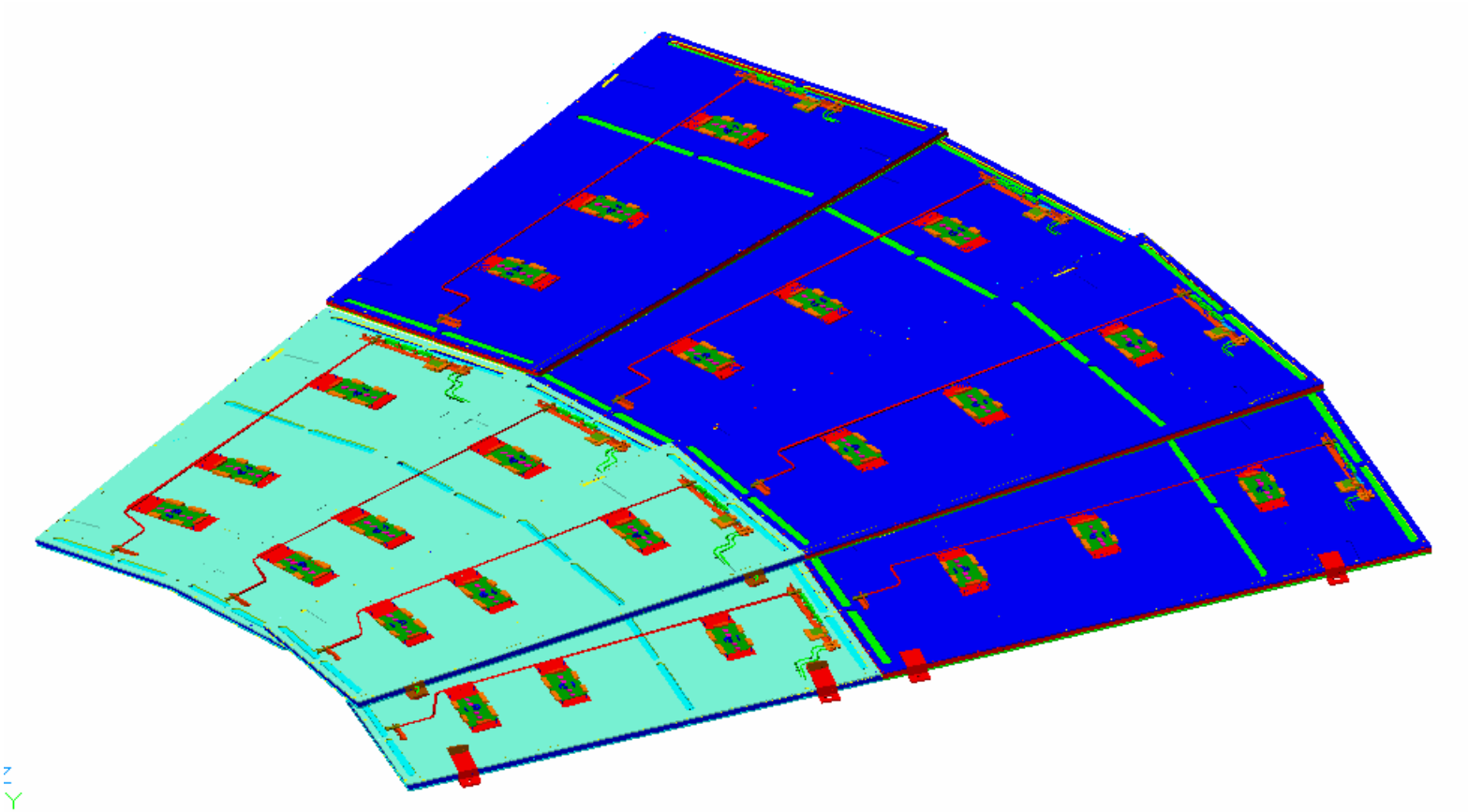
CMS η SEGMENTATION

Assembly and Testing of RPCs



Station 2 YE/-1

40 ° sector of station 2, 3 & 4



Functions of RPC trigger

To study the decay of 150 GeV Higgs boson into Z-Z or Z-Z* which in turn decays into four charged leptons

- Identify candidate muon tracks
- Assign a bunch crossing to the candidate tracks
- Estimate their transverse momenta

CMS Chamber parameters (TDR-1997)

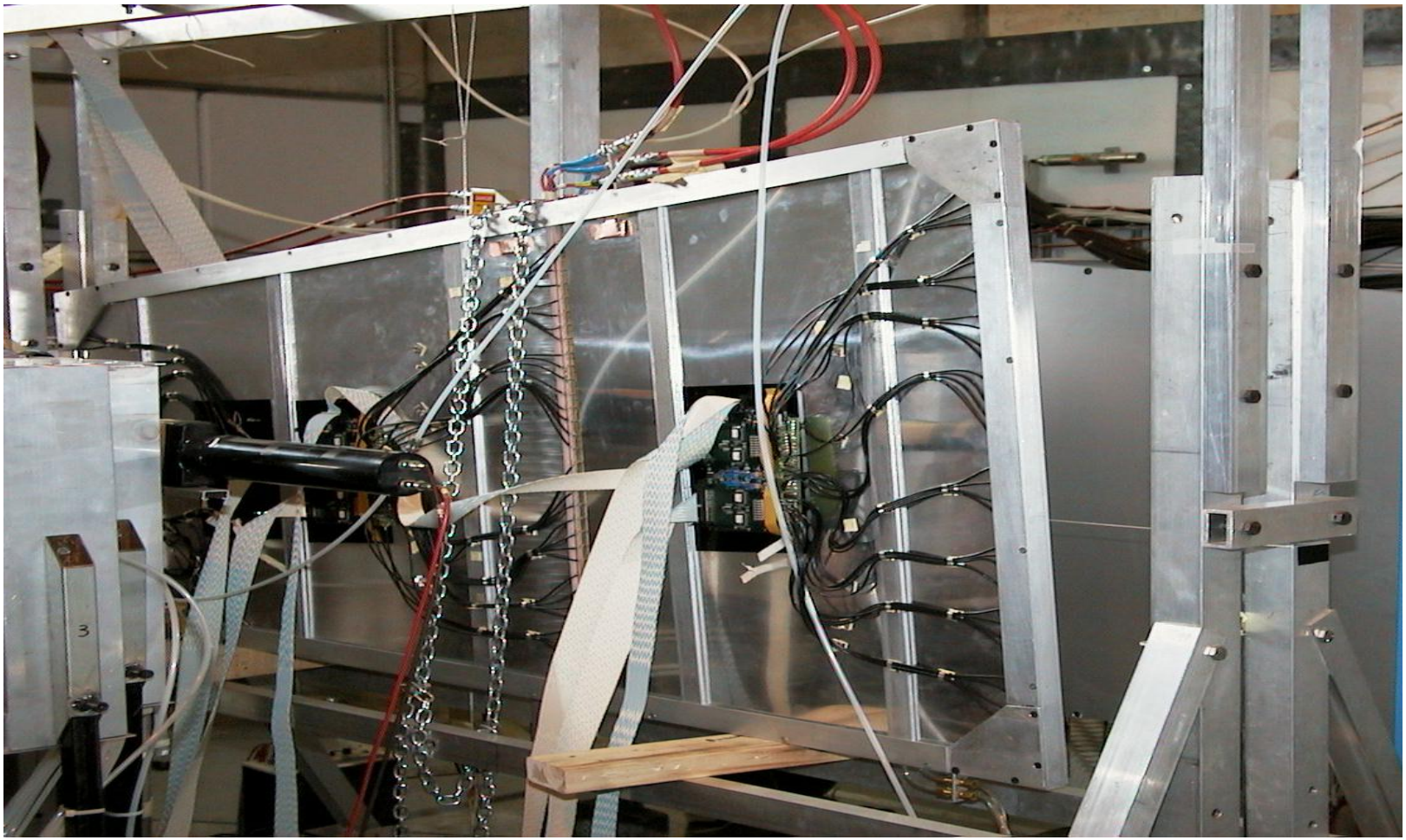
- Graphite Coated parallel plate double 2 mm gas gap (Non Oiled) configuration, operated in avalaunche mode
  - **Time resolution < 3ns**
  - **Efficiency > 95%**
  - **Cluster size ≤ 2 strips**
  - **Rate capability ≥ 1 KHz/cm^2**
  - **Operational Plateau > 300 V**
  - **# Streamers < 10 %**

Revisions in base line chamber parameters

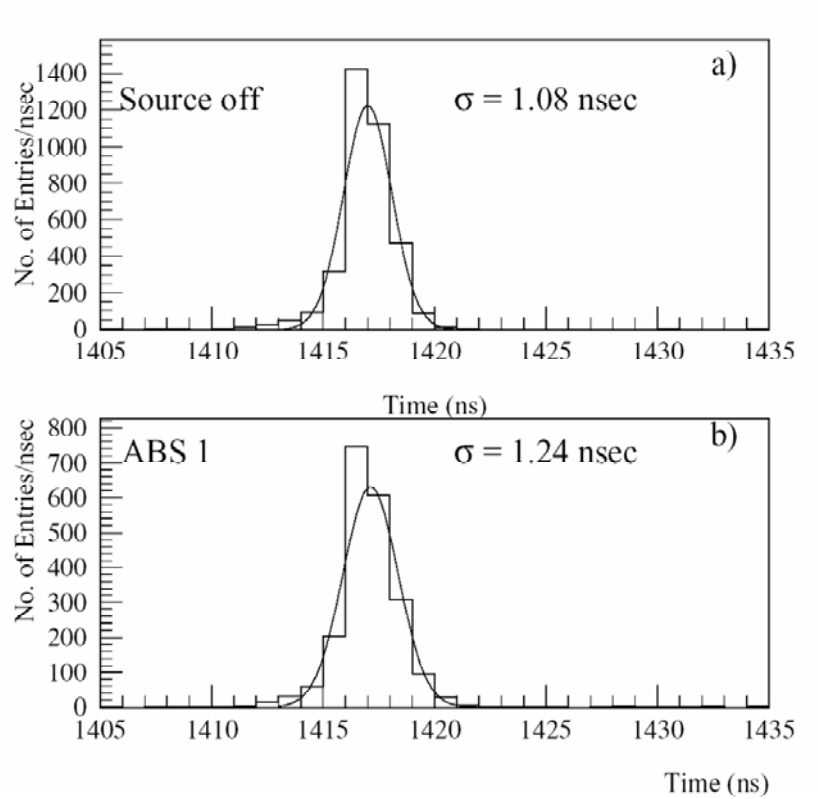
- By 2002, after beam tests and studies by many groups it was discovered that it was not possible to bring the intrinsic noise rate of RPCs below 30 Hz/cm^2 on strips for non-oiled chambers. This posed a serious problem for the CMS trigger. All other parameters were O.K by that time.

- It was decided to Oil the the gas gaps and the intrinsic noise rate falls down to $\leq$ 5 Hz/cm^2.

RE 2/2 chamber under test at CERN



Beam test Results -I



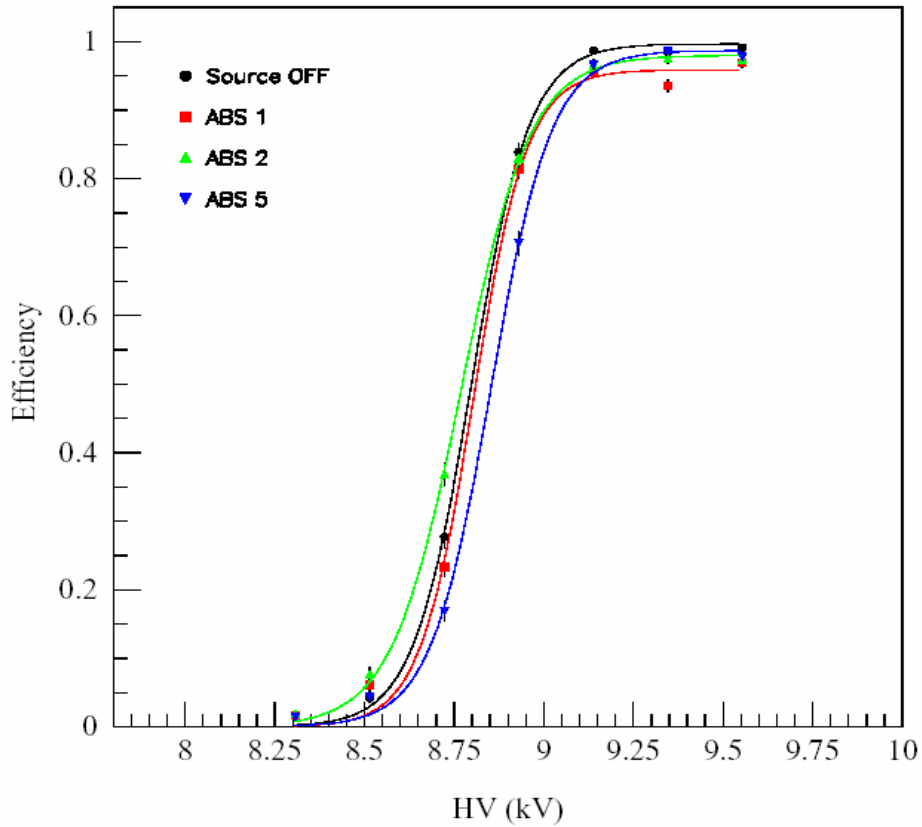
RPC Time resolution

a) No Exposure to photon flux

b) Exposed 20 m Ci γ ray flux

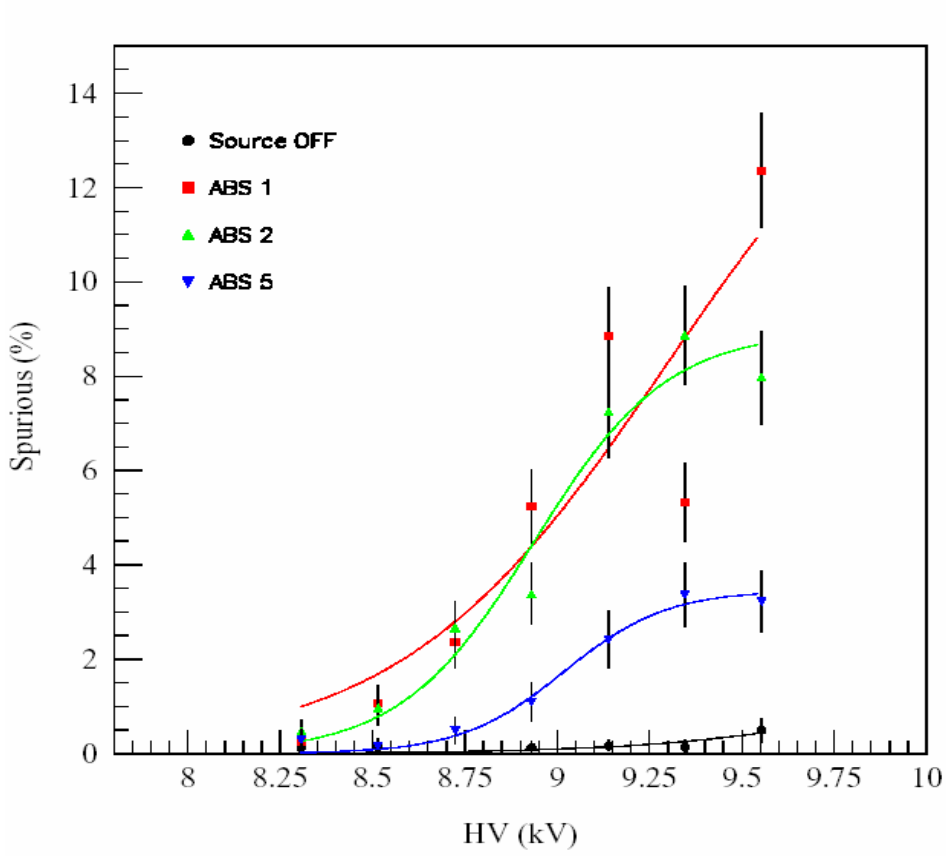
Assembly and Testing of RPCs

Beam test results-II



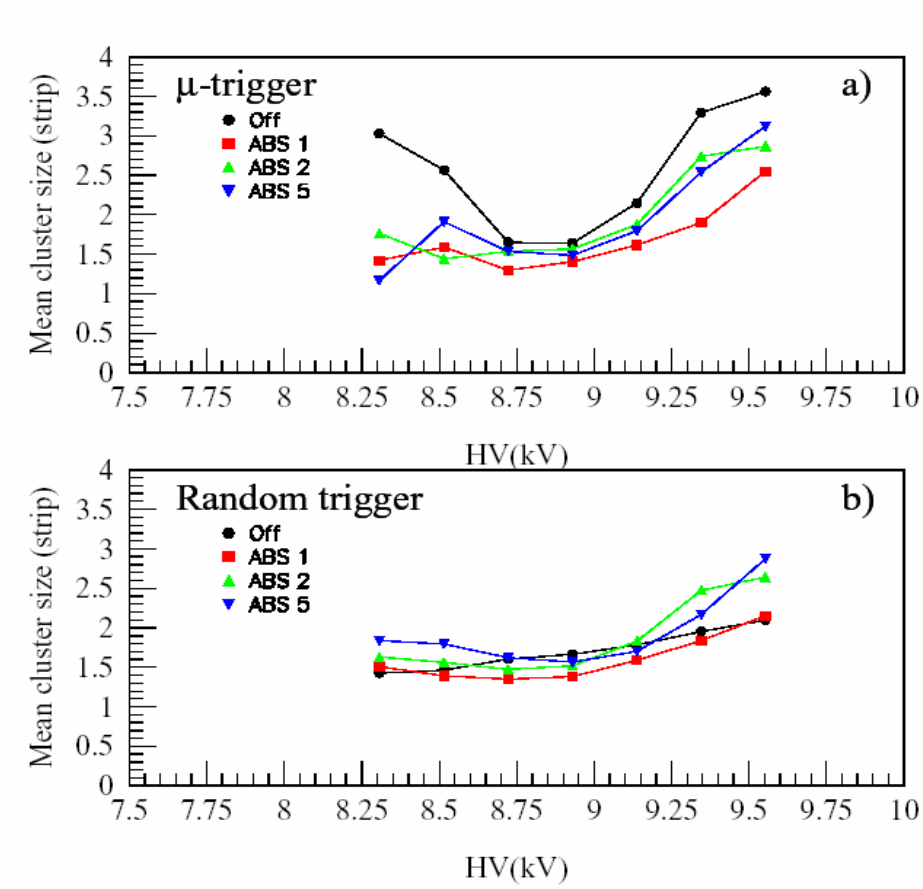
RPC Efficiency plots at different source exposure levels rates

Beam test results-III



Percentage of Spurious hits at different photon flux intensities

Beam test results-IV



Cluster size at different photon flux intensities

Task list

- **According to signed MOU (May 16,2000)**
  - Fabrication, testing & installation of 432 chambers
  - Fabrication & testing of 3000 FEBs
  - Detector monitoring
  - Services cooling and gas etc
- **Revised/proposed by CERN & accepted by NCP (EDR – October 10, 2002)**
  - Fabrication, testing & installation of 288 chambers
  - Production of about 1600 FEBs
  - Provision of H.V & L.V system for all Pakistan built chambers
  - Detector monitoring
  - Services cooling and gas etc

Accomplished Tasks by Pakistan

- Our chamber design has been approved by the EDR committee at CERN

- Four successful beam tests have been conducted on the chambers built in Pakistan

- Pakistan team contributed in the engineering design of CMS Endcap RPC station

- Contribution in the development of integration & maintenance scenario

- Development of local RPC R&D facilities

Available manpower & space

- **Manpower:**
  - Physicists: 08 (All are not full time)
  - Engineers 03
  - Technicians 08

- **Space:**
  - Data analysis Lab. (NCP) 600 sq. ft
  - Chamber testing Lab (NCP) 1000 sq. ft
  - Mechanical assembly Facility (PAEC) 4000 sq. ft

Total available space for RPC 5600 sq.ft (600 sq. m)

Chamber Assembly facility

Available Rooms:

- Storage Room
- Workshop
- Gap Testing Facility
- Chamber Assembly
- Meeting Room
- Office

Gap Testing Area	Office	Meeting Room	Storage Area
Networking Facility For the Complex	Chamber Assembly Room		Workshop

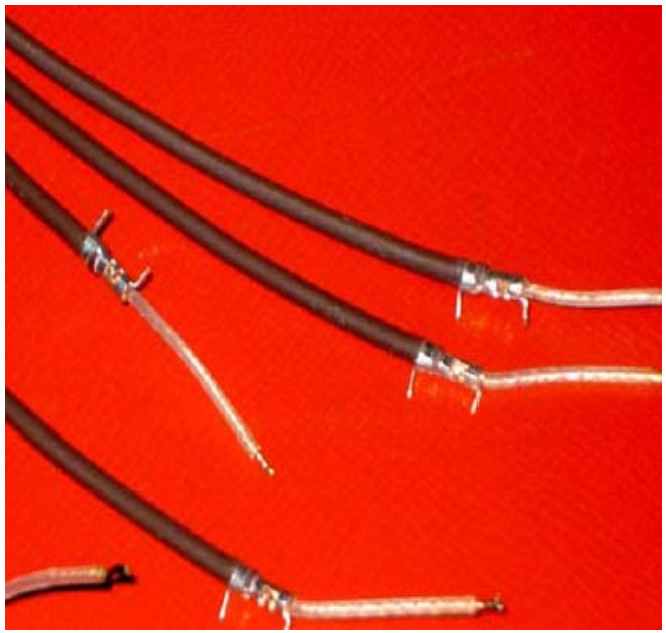
Production status

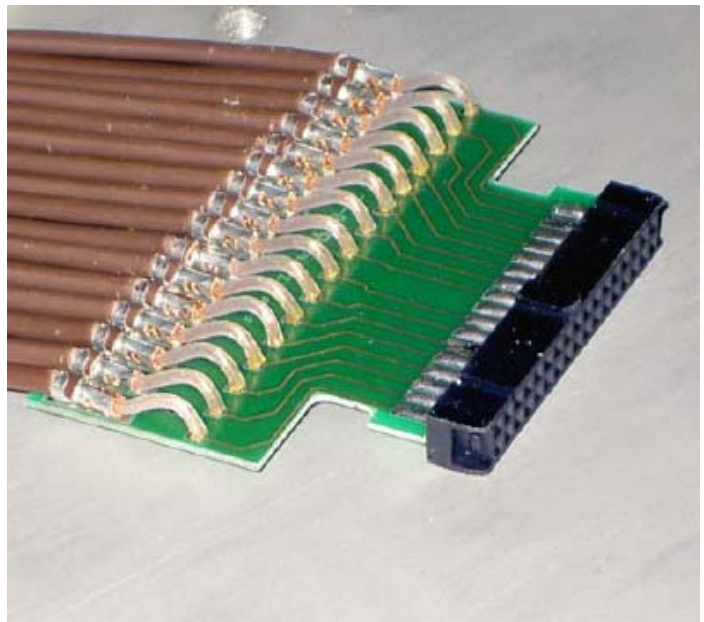
- Assembly not started yet. Only chambers for test beams and a few mock-ups have been produced so far.
- Switch over to honey comb panel is a major change. Delivery of panels is still awaited from China.
- Gaps for 40 RE 2/2 chambers have been received from South Korea.
- Front end boards have been dispatched from Italy. The RPC control boards for Pakistani chambers are still to be ordered.
- Material and components for production of 30 chambers is available in our stores, the missing items/components are being ordered.
- The manpower is being trained on preparation of components and assembly procedures.

Main RPC materials for each RE */2, */3 chamber

1) Pet insulation sheet 250 micron	05
2) Copper sheets 180 micron	02
3) Fr4 sheet for strips 200 micron	01
4) Bakelite gaps	03
5) Al foil 100 micron (Purchased, not used in HCP design)	01
6) Signal cables	50 meter roll
7) Front end boards	03
8) Gas connectors (6 mm internal dia.)	04
9) Aluminum Honey comb panel box	01
10) Multi pole HV connector	01
11) Al Shielding cover	01
12) Al angles, Screws, internal gas pipes, HV and ground cables etc.	

Pre Assembly tasks (Pictures)





Signal & Twisted pair cable Preparation

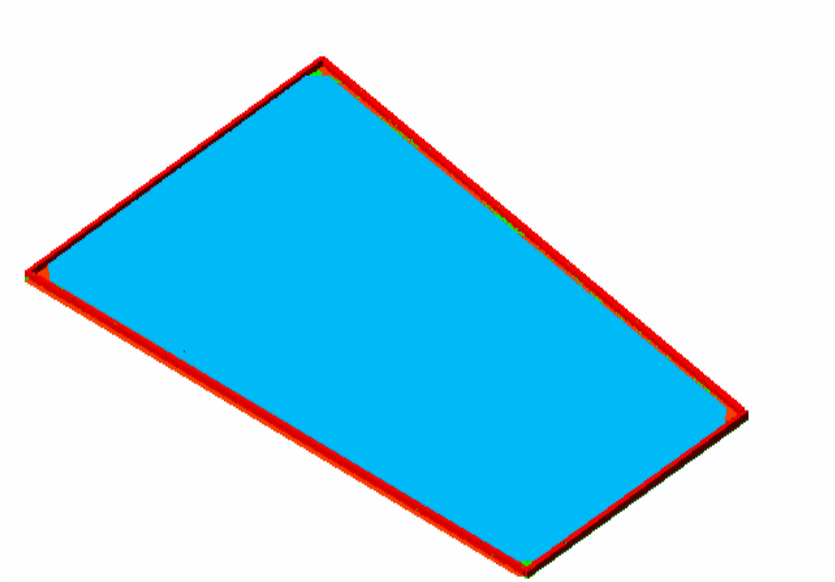
Assembly and Testing of RPCs

Pre-assembly tasks (Pictures)

Gas block pieces

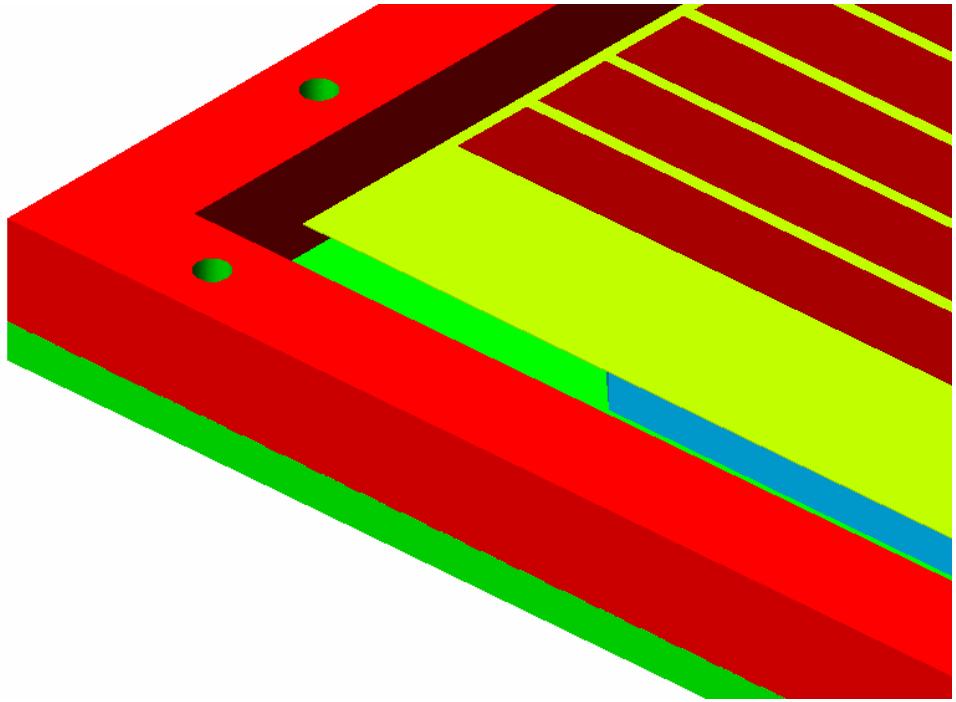
FEB mounting & Cooling circuit

Assembly Procedure (Pictures)



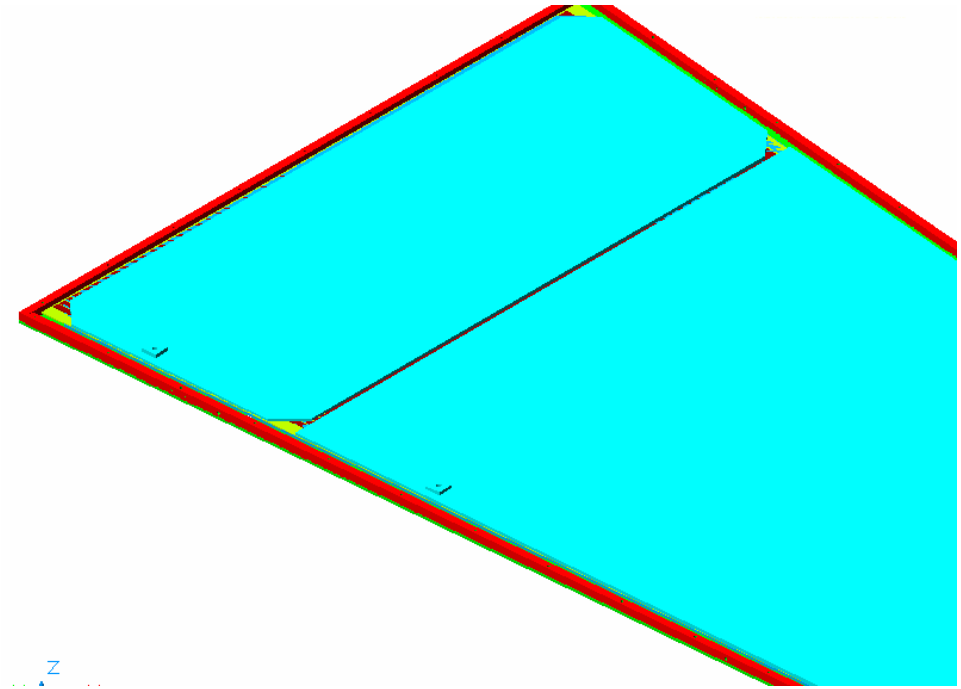
Bottom gap placed in the assembly

Assembly Procedure (Pictures)



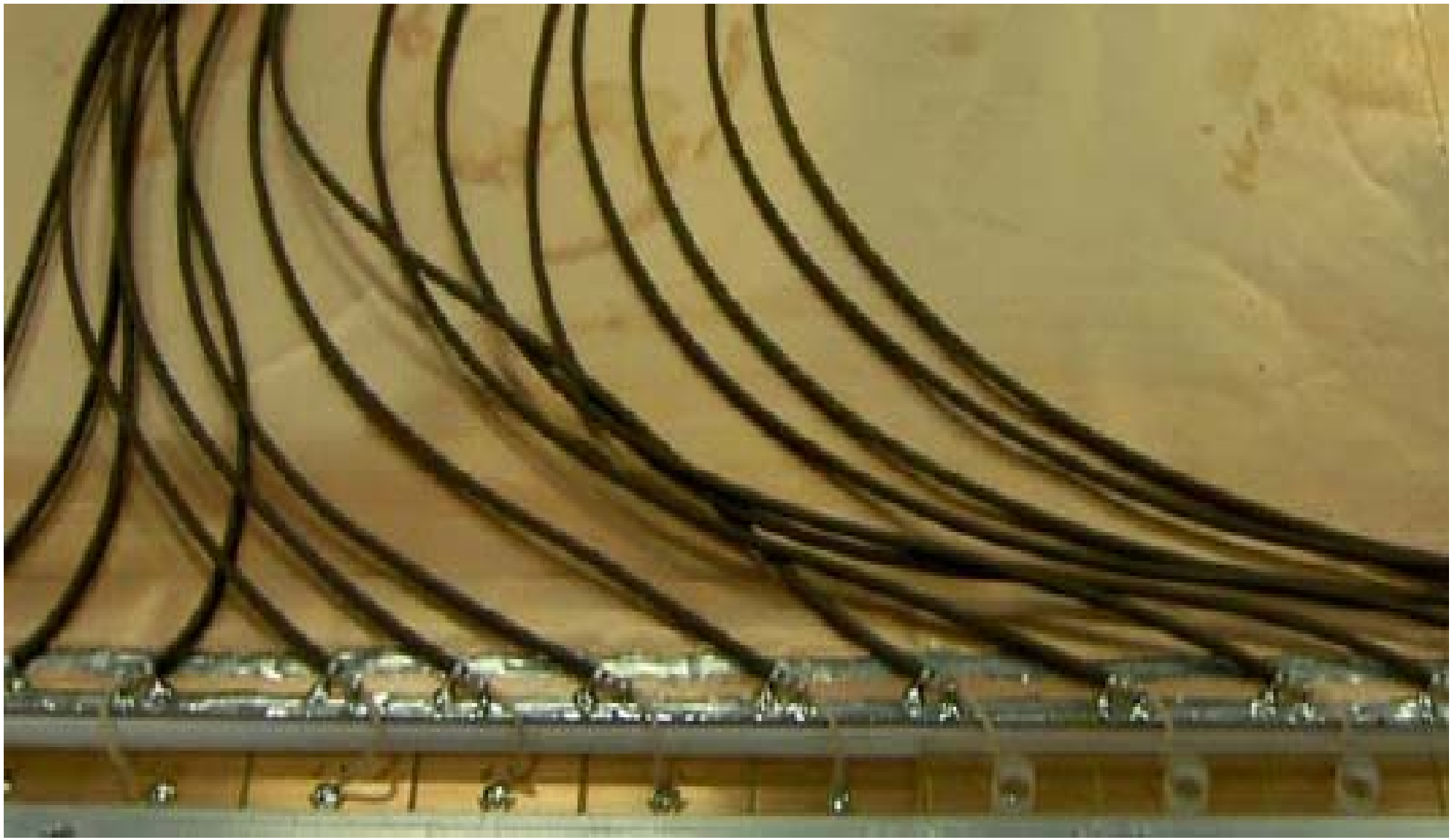
Strip sheet placed on the assembly

Assembly Procedure (Pictures)

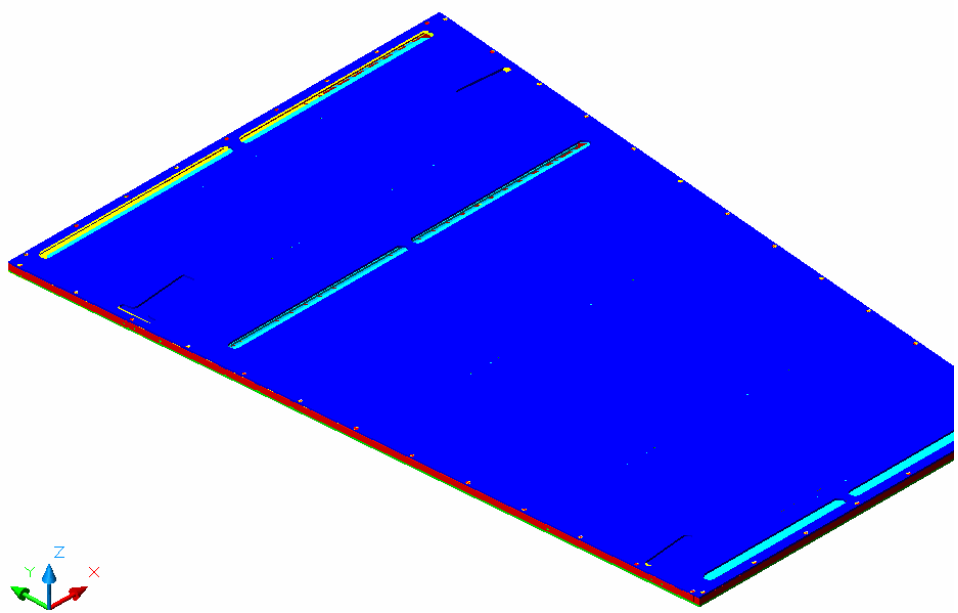


Cut gaps placed on the assembly

Signal cable Connections

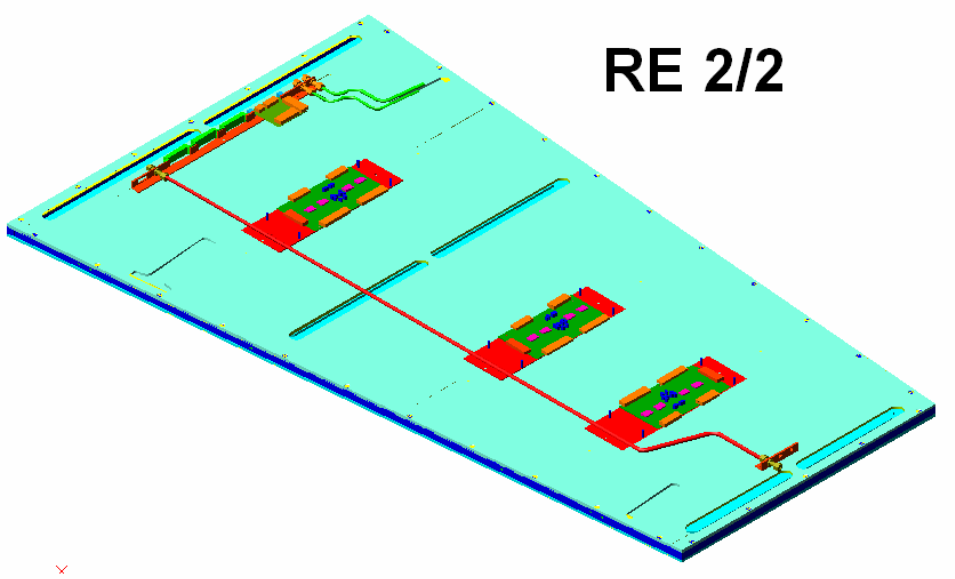


Assembly Procedure (Pictures)



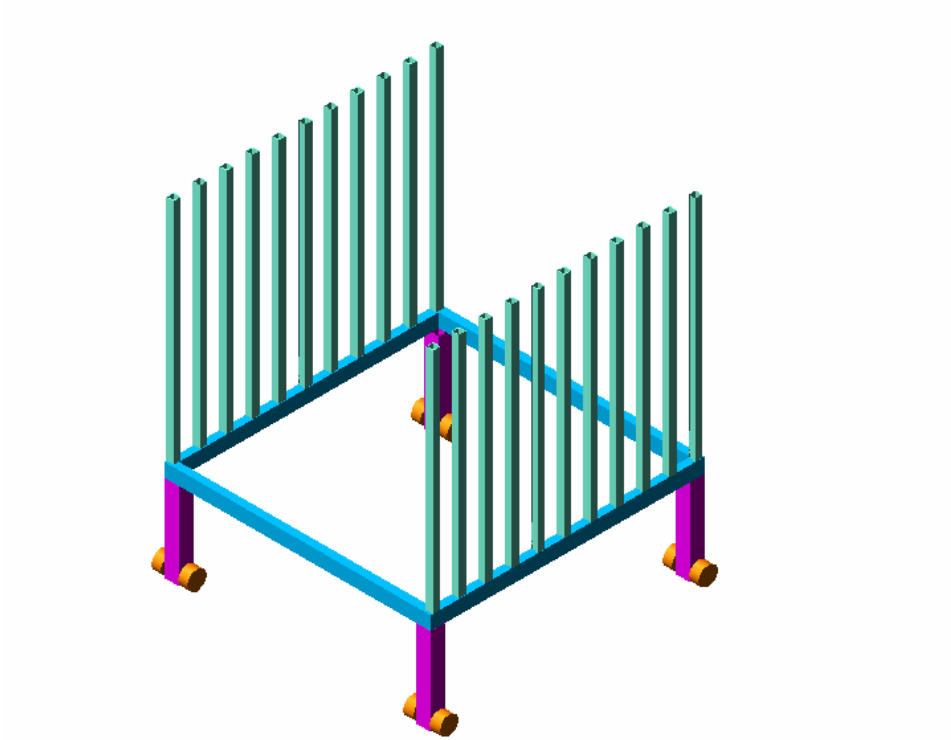
Top panel placed on the assembly

Assembly Procedure (Pictures)



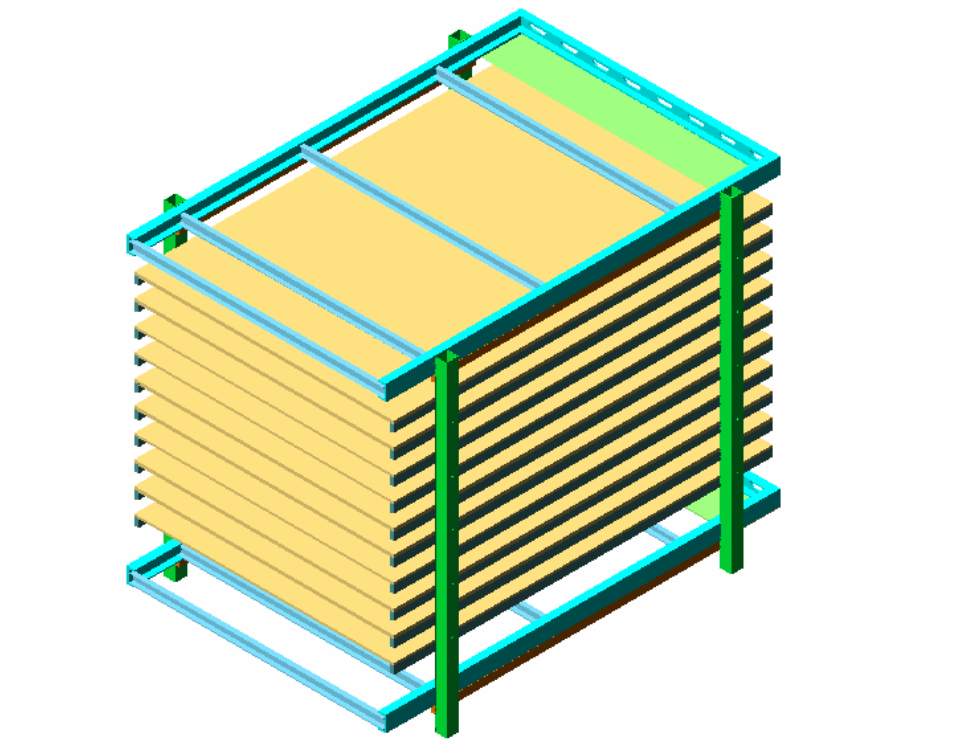
RE 2/2 chamber without Shielding cover

Assembly Line (Pictures)



Rack for Chamber storage

Assembly Line (Pictures)



Cosmic ray Test Stand

Q. A. & Proposed Chamber Tests

Tests on gaps → **Gas leakage test** → **Current vs HV of gaps before assembly**

Tests for Chamber

- **Gas Flow and leakage Test**
- **Current vs HV**
- **Singles rate**
- **Cosmic Ray test**

Status of Gap & chamber test facilities

Tests on gaps:

Leak test: Ready (20 mbar overpressure)

Current test : Ready

Test on Chambers:

Cosmic ray test facility: Being set up at NCP, QAU

(Not Operational)

Production Schedule

- Assembly & testing of 40 chambers for station RE2+
  Feb., 2005 – July 2005
- Installation & testing of 40 chambers at CERN
  Aug. – Sep. 2005
- The remaining chambers have to be built, tested and installed during 2005-2006

Summary

- The production and testing facilities are ready for mass scale production.
- Due to delays like receipt of gaps from S. korea, frequent design changes after EDR approval, it is feared that assembly of 300 chambers may be delayed till Oct., 2006. However utmost effort will be made to complete the task by June,2006.