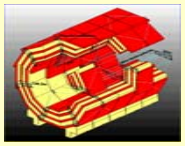

Integration study and first test results of the CMS Muon Barrel Alignment system

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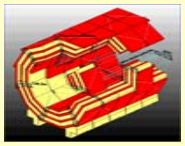
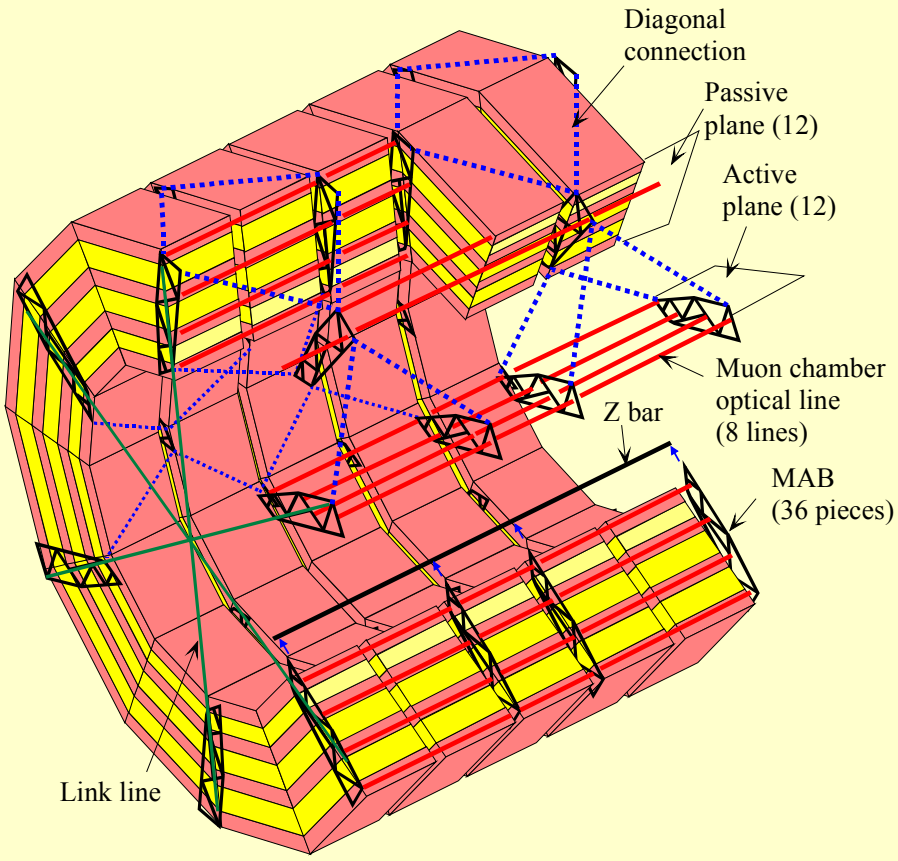
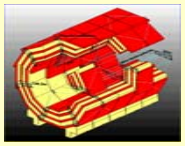


Muon Barrel Alignment System



Basic elements of the system

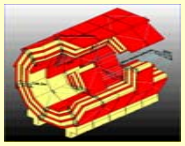
- Rigid structures (MABs, z-bars)
- Video-camera boxes (on the MABs)
- LED holders (on thechambers)
- Diagonal and Z-LED holders (on the MABs and Z-bars)
- Board computers (on the MABs)



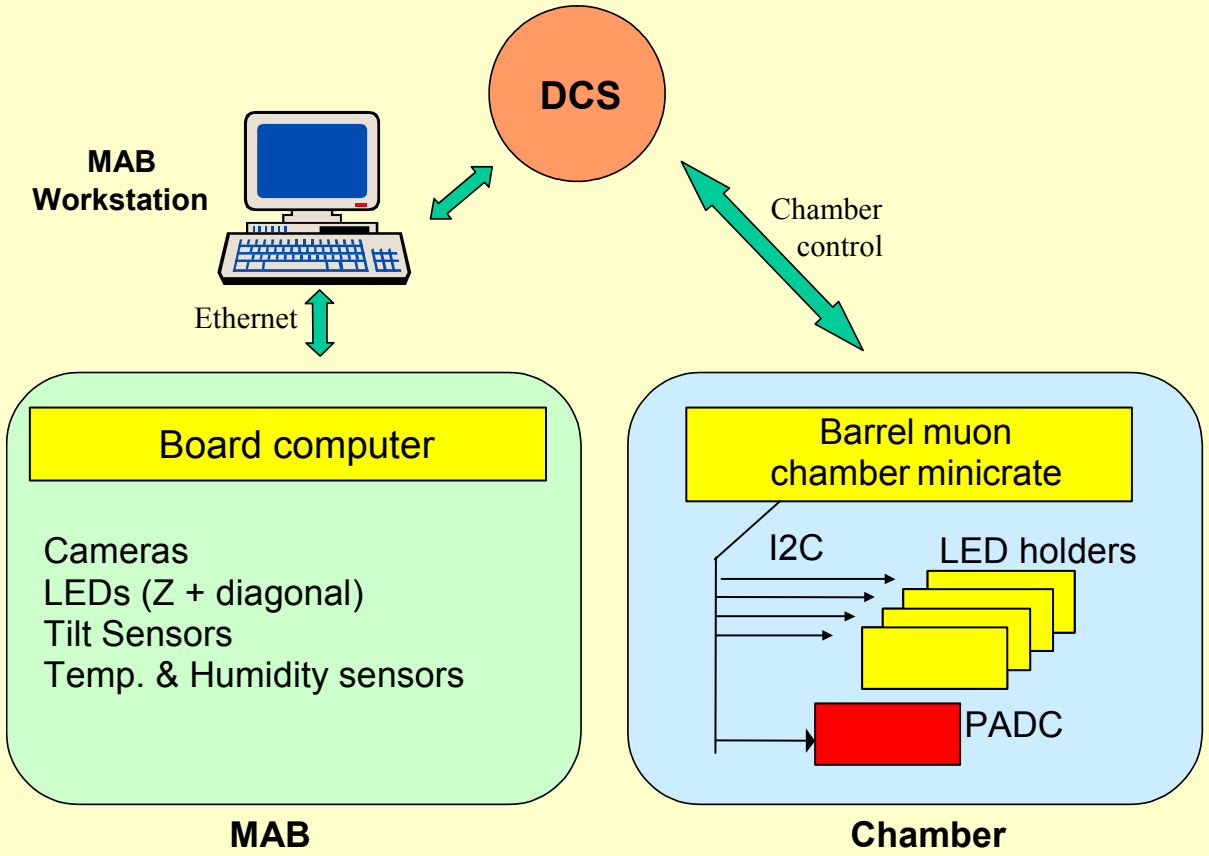
Components of the MBA

For the precise measurement of the positions of the barrel muon chambers in the CMS detector, a Position Monitoring System was developed. It comprise:

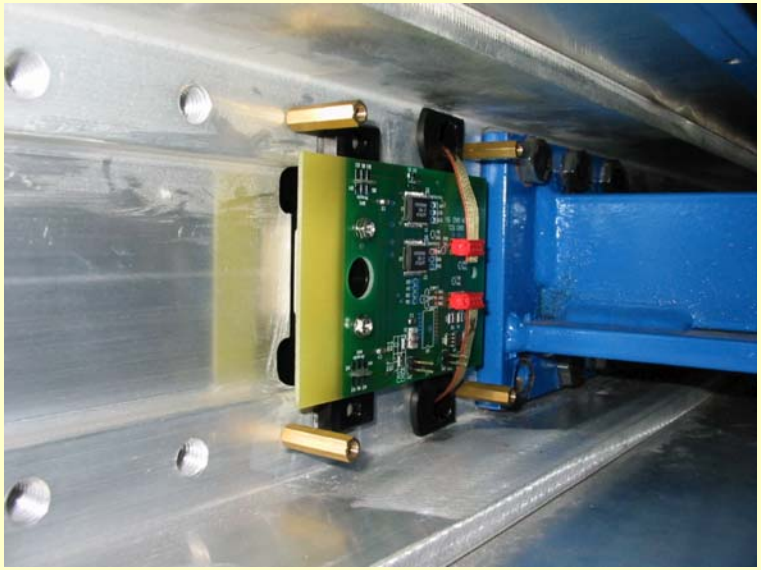
- ~10000 LED light-sources,
- 600 active pixel sensor monochrome video cameras,
- 24 tilt and 72 temperature sensors,
- 36 PC/104 board computers and
- a master control workstation for controlling the system and collecting and analyzing the data received from the sensors and cameras.

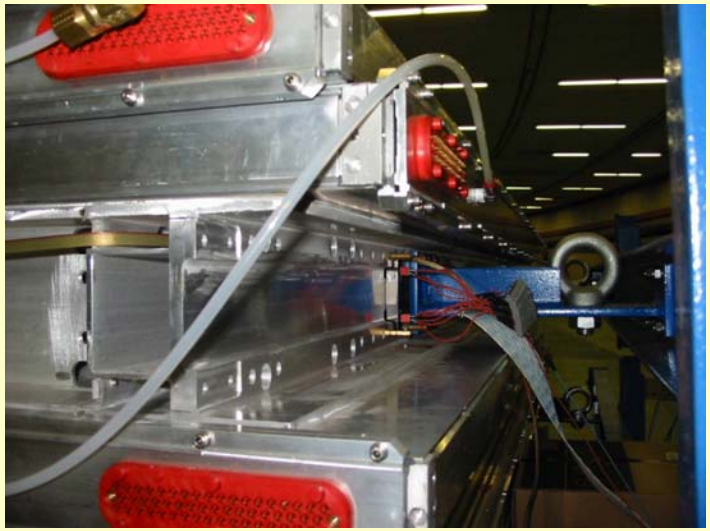


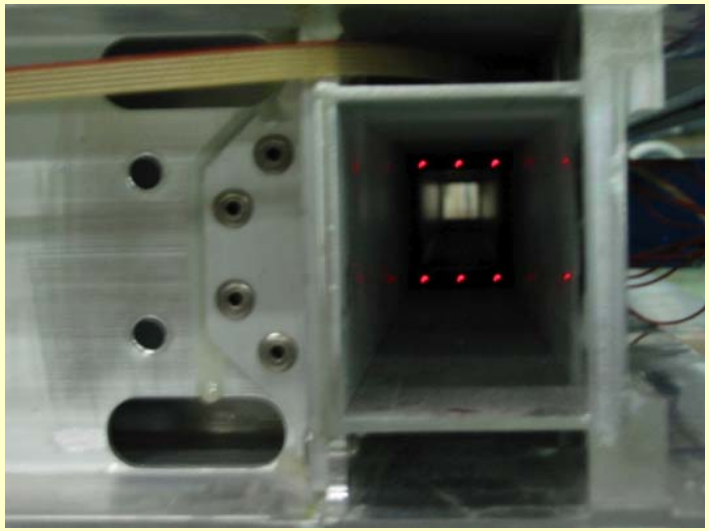
The hierarchy of the DCS and MBA elements



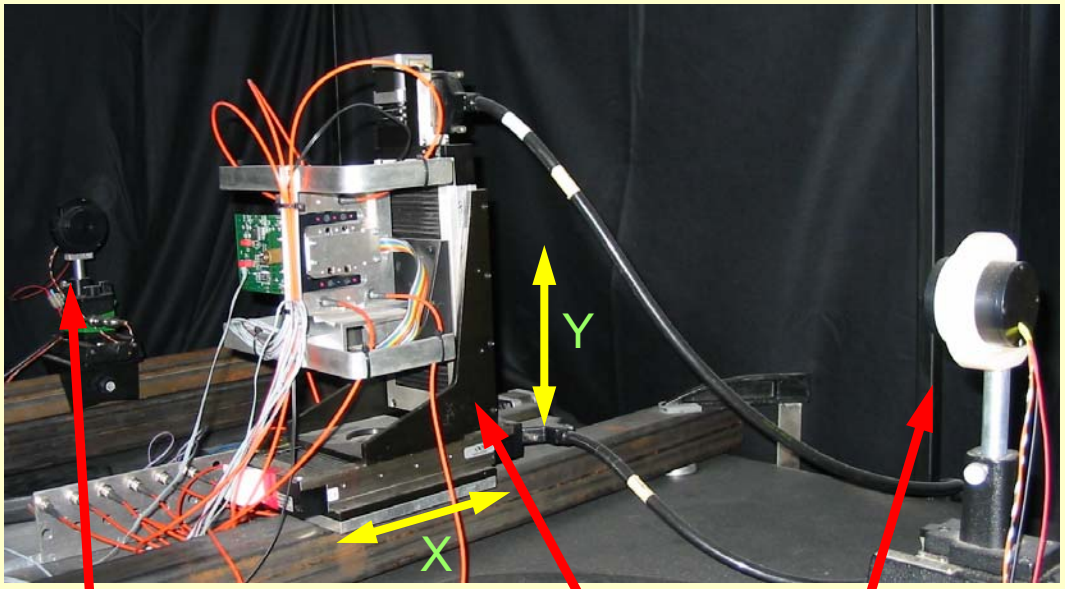
The LED holders

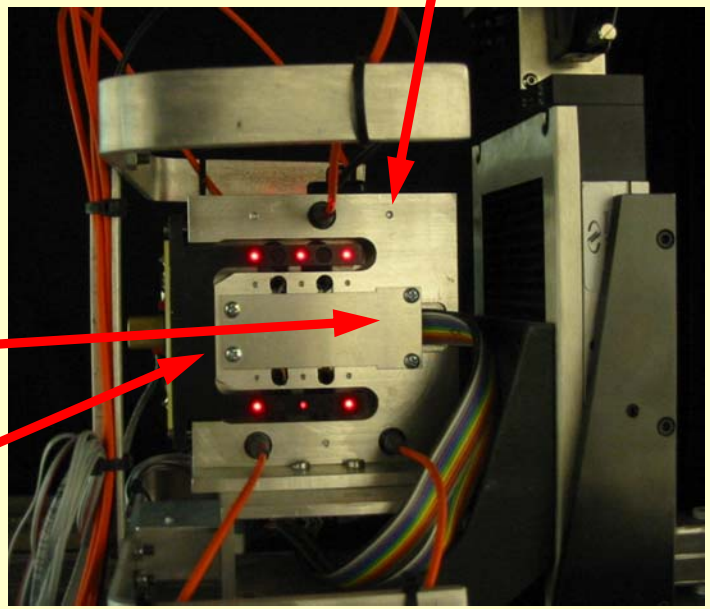


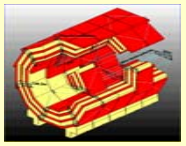




Fork calibration bench





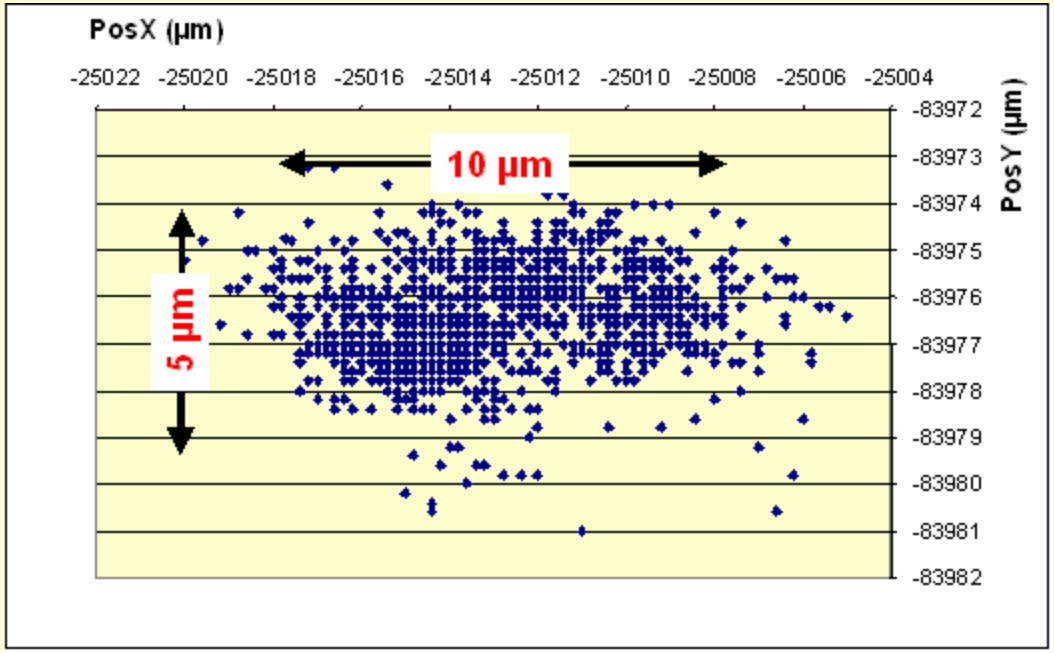


Fork calibration procedure

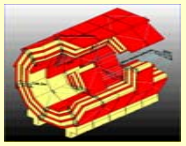
- The table is moved until the centroid of the given source reaches the predetermined position on the camera.
- The LED position is determined by the table movement.
- The procedure is repeated 5-times for each fiber-optical reference source (3 on both sides) and LED (6 and 4 respectively).

Test of the absolute bench precision

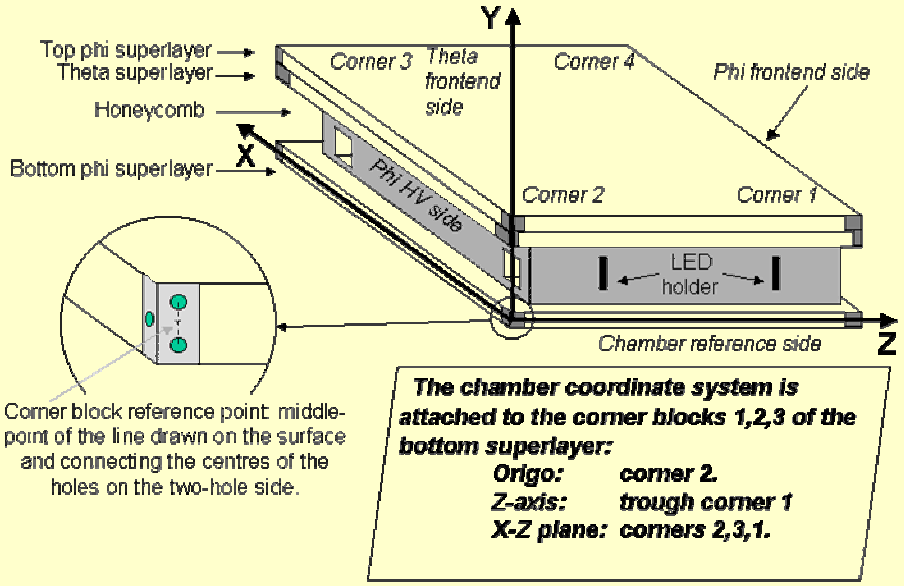
Since the fiber optical reference sources are always measured it is possible to test the precision of the measurement-analysis process

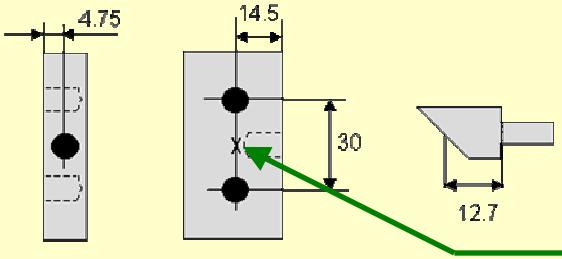


Chamber calibration bench



Chamber coordinate system





Middle point on Corner Blocks' two-target surface is used for this analysis

Calibration procedure

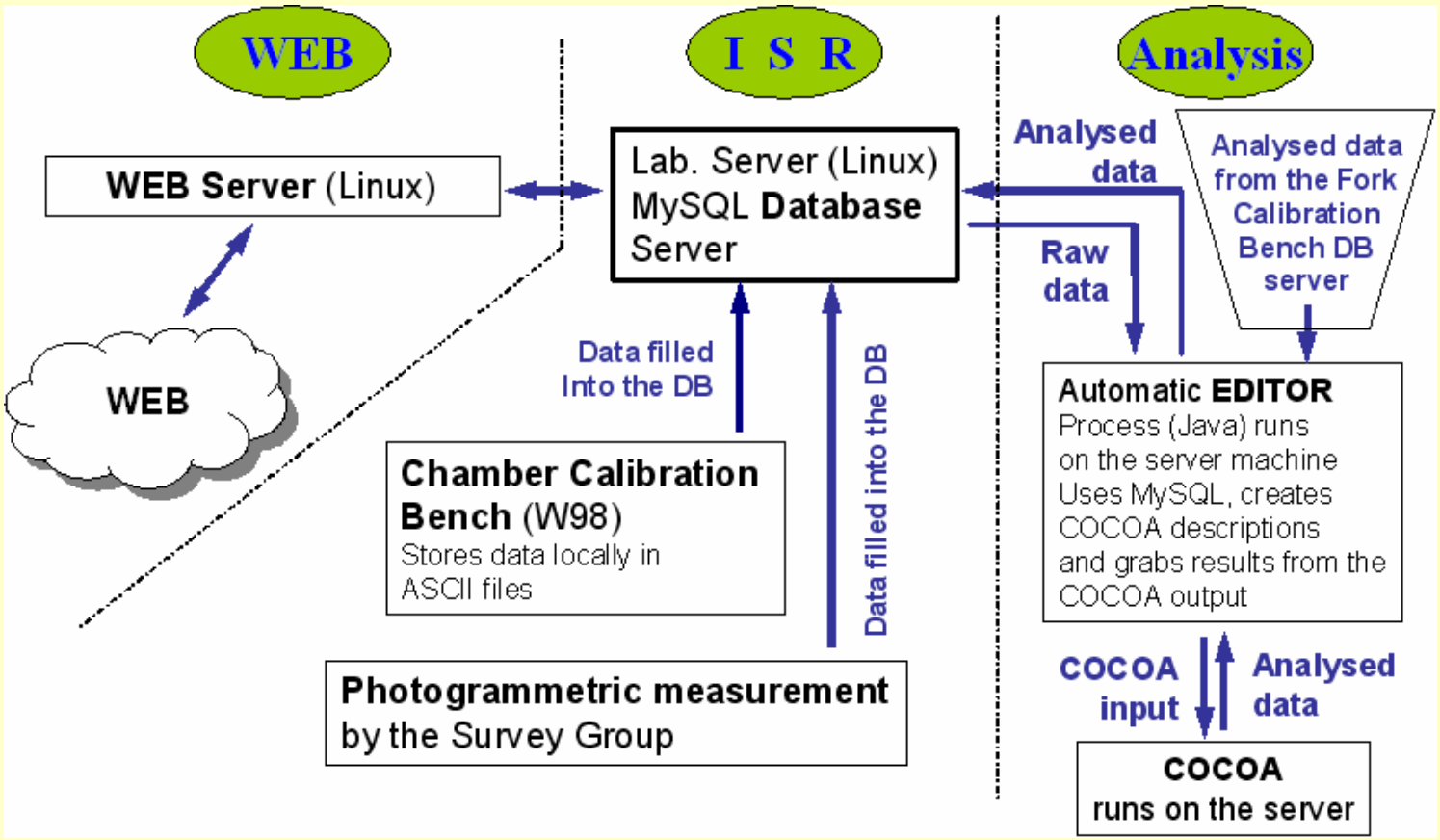
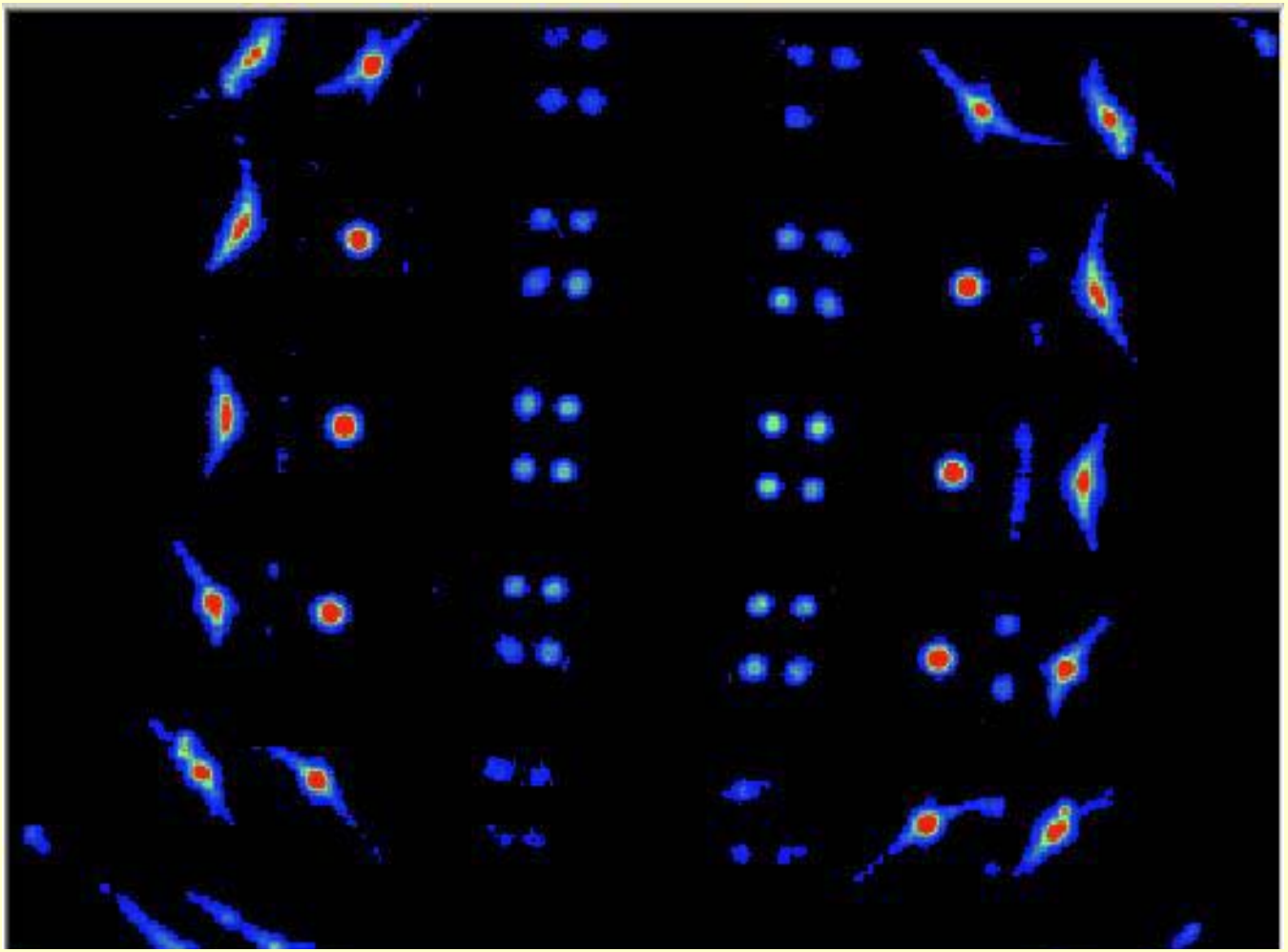
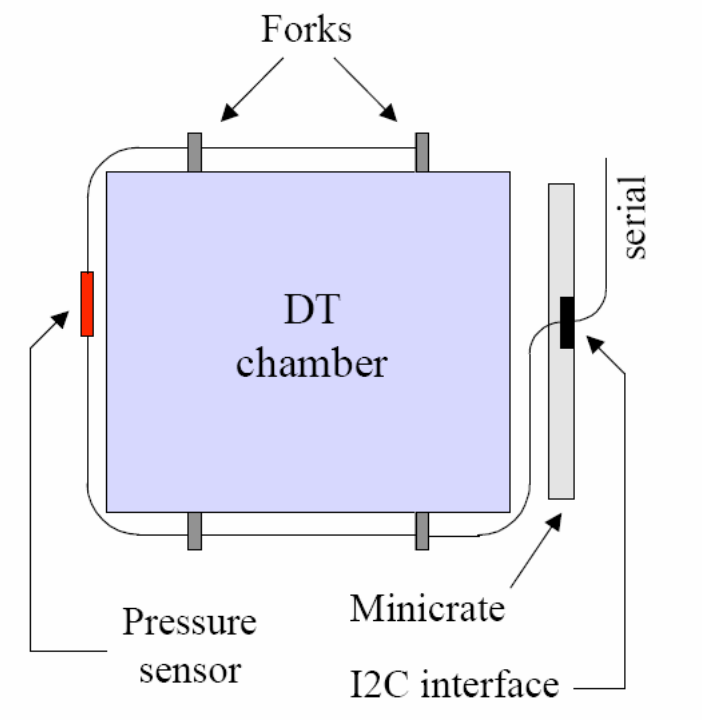
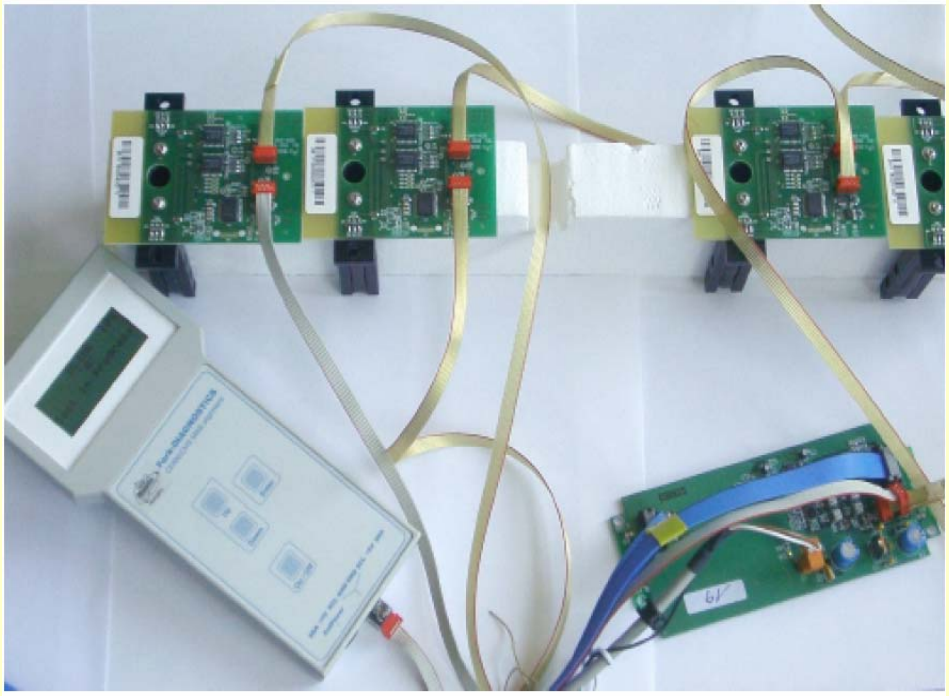


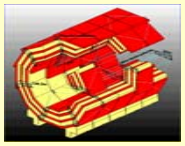
Image of 6 LEDs



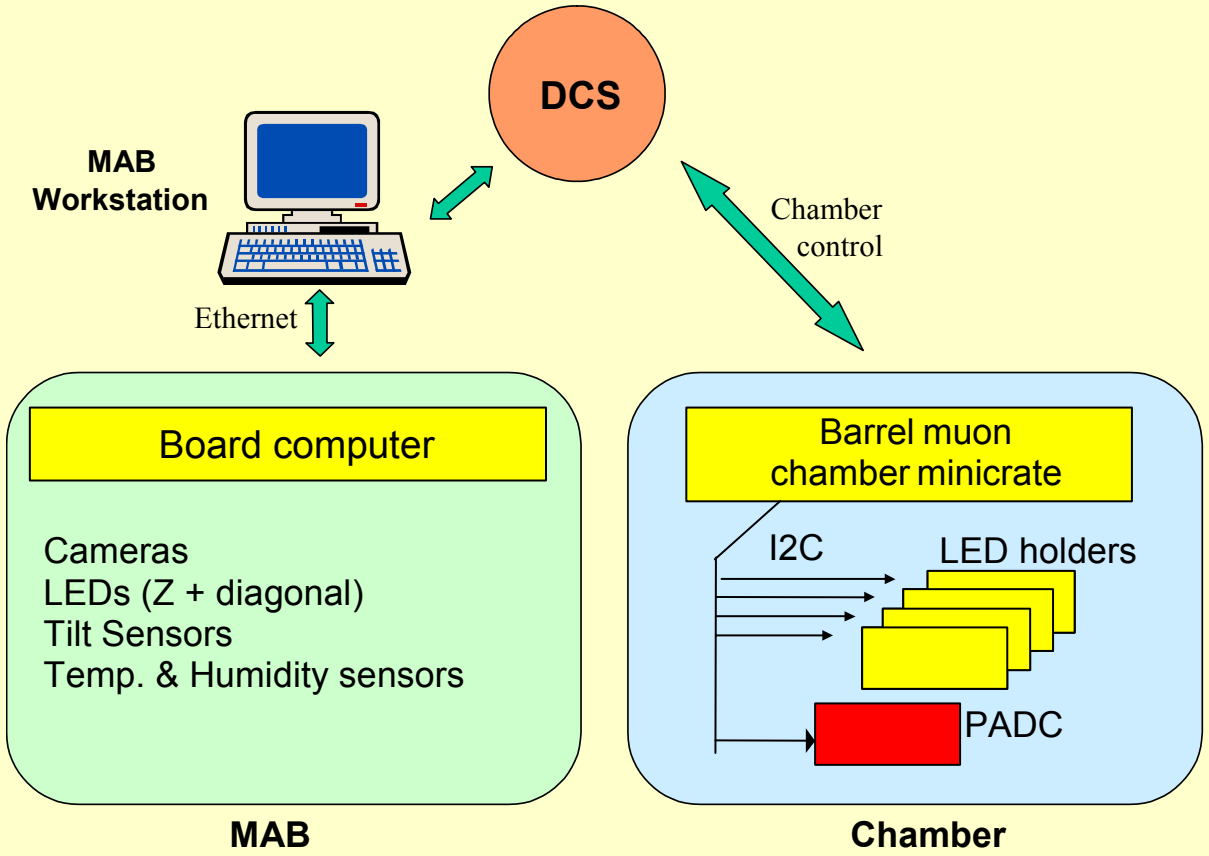
Fork diagnostic tool

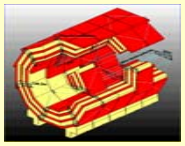




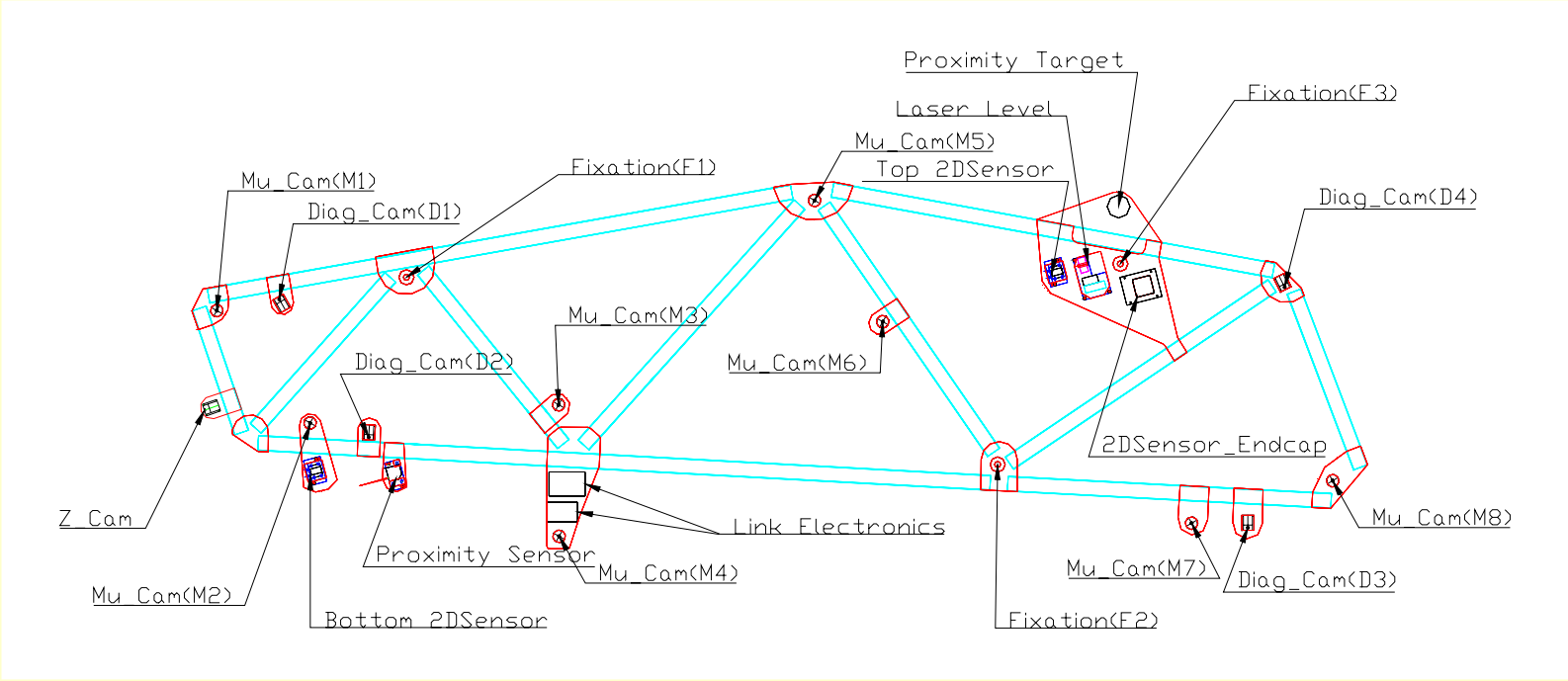


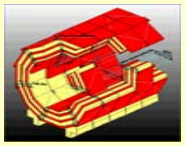
The hierarchy of the DCS and MBA elements



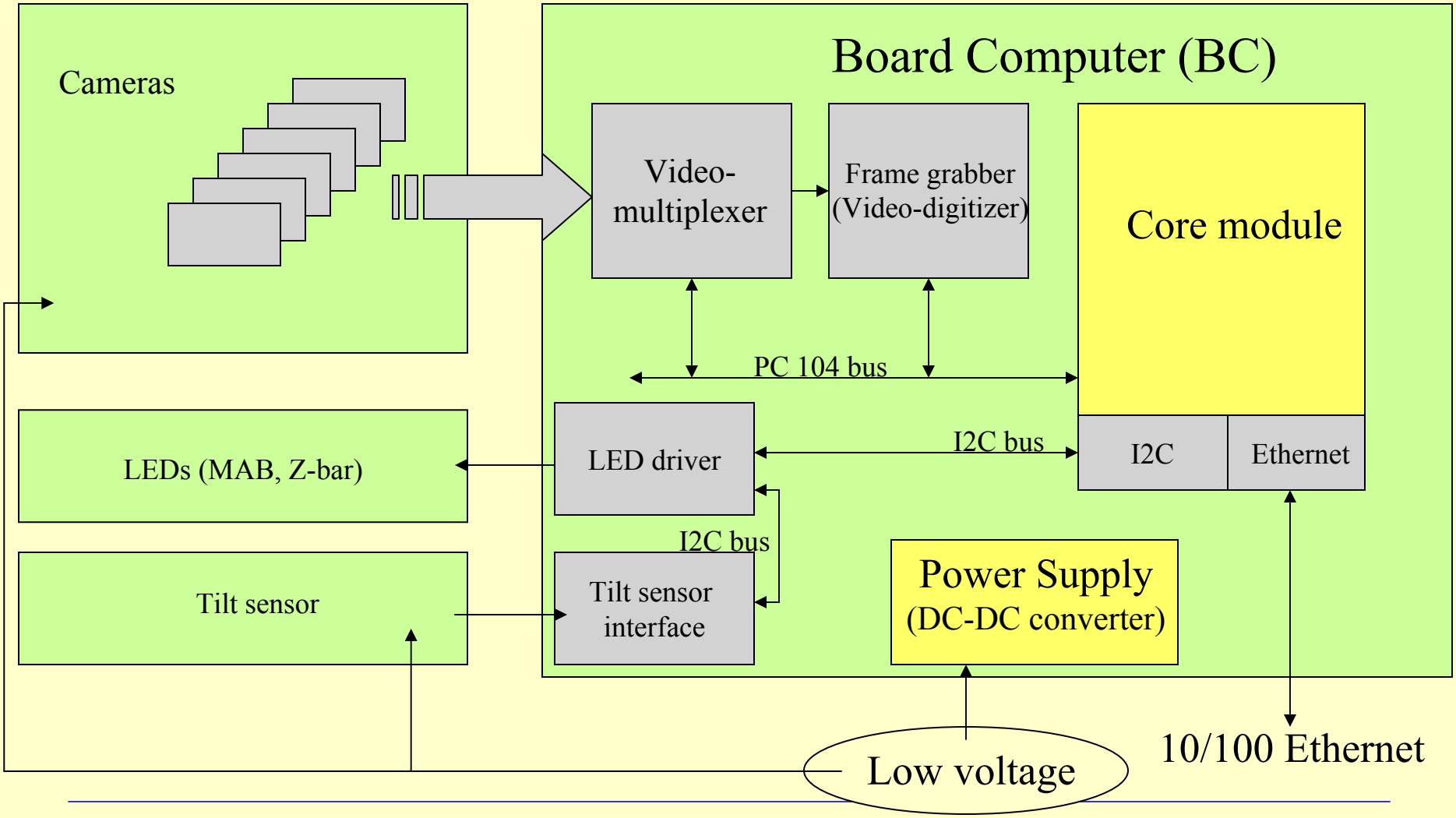


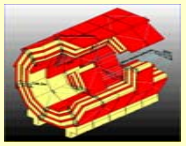
Elements on the MAB-s





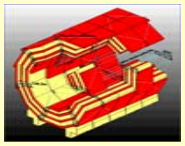
The environment of the BC



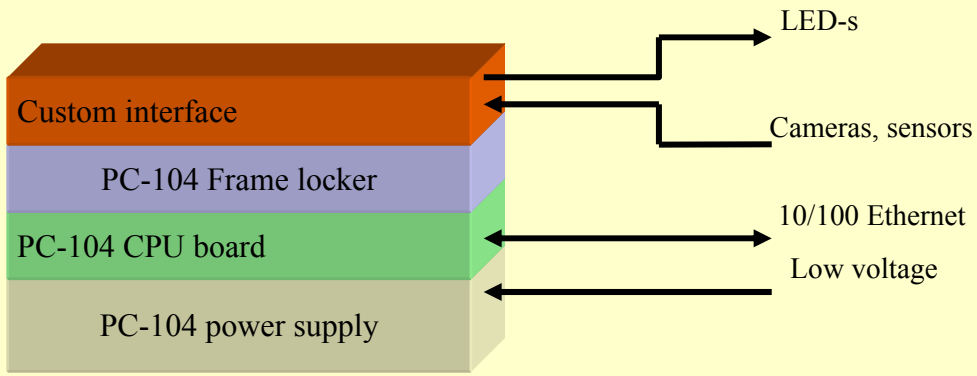


Tasks of the Board Computer

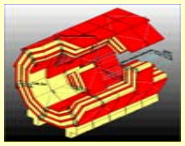
- read and save the pictures of the connected cameras through the FrameLocker,
- calculate the centroids of the LEDs,
- read tilt sensor data as analog input voltage,
- switch on/off z-bar LEDs and LEDs mounted on the MAB through I2C bus,
- publish services and available commands for the DIM name server,
- produce watchdog signals for the DIM name server.



The layers of the PC/104 computer



- As the BC will be placed on the CMS Barrel, it has to function in radiation and magnetic fields. Two sources of problem were identified, the Ethernet isolation transformer and the step-down DC-DC converter on the CPU board. The AMPRO board lacks DC-DC converter for the processor core, the only coil on the board is for the LCD display, which is not needed in the present application.
- The Ajeco frame locker passed both the radiation and the magnetic tests, so all the needed pieces were purchased (36 modules to be built in and 14 as reserve)
- The custom interface has to connect all the sensors around the BC to the CPU board. Temperature and humidity sensors, tilt sensors, up to 32 LEDs (Z bar, diagonal). a custom built 3×8 video multiplexer.



Conclusion

- 1200 pieces of LED holders are calibrated and delivered to CERN. The assembly of the MBA elements on the DT chambers has a good progress.
- All the necessary components on the MAB (BC, camera, proximity sensor, tilt sensor, humidity and temperature sensor) have been defined and the procurement is on the way.
- The SW integration has to be validated and updated after the final version of the BC is completed.