

FIRST LHC DETECTOR ALIGNMENT WORKSHOP – Sept. 06

Alignment Strategy for the LHC Detectors and Survey Data

... in collaboration with the CERN TS-SU survey group

C. Lasseur and the collective TS-SU-EM – EDMS : 769369

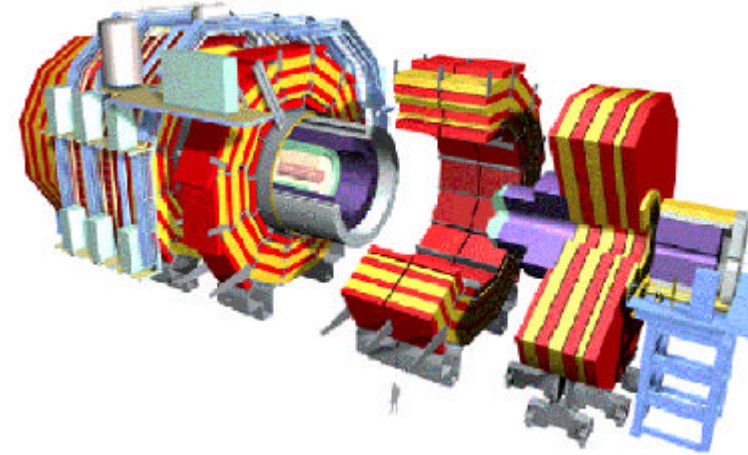
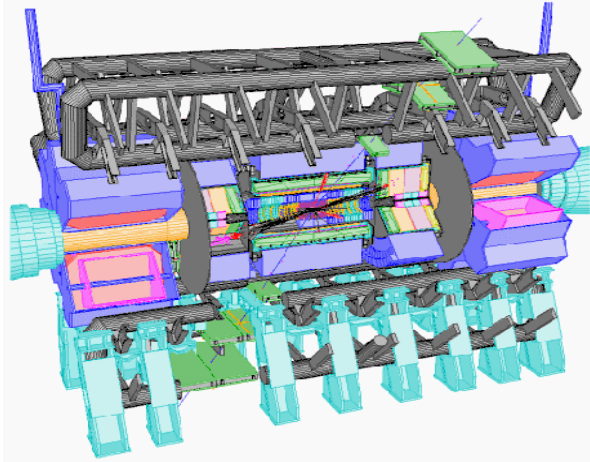
The SU workpackage : our mandate, the ‘deal’ ..., a list of jobs, mutual involvement, some significant examples, tracking and muon : what is (will be) surveyed ?, beam nominal line and monitoring, conclusion and discussion ...

OUR MANDATE ...

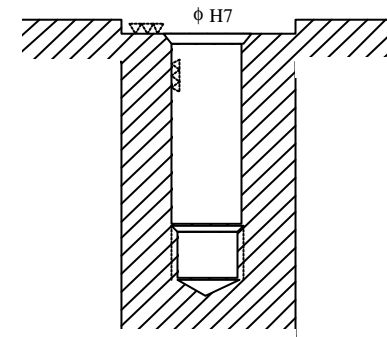
→ the support in metrological and accurate geometrical quality control and positioning procedures of the magnets and detectors, from their manufacturing, assembly and up to their final alignment with respect to the nominal beam line. That implies:

- setting-up and maintenance of precise geodetic grids in the experimental areas (assembly halls, R & D areas, caverns)**
- applying large scale and precise spatial measurement techniques with all relevant contributions in industrial geodesy plus photogrammetry and else metrology techniques**
- specific developments and applications when classical methods cannot be applied**
- providing and reporting 3D coordinates of detectors reference points at all assembly and final alignment stages**

THE DEAL and THE SURVEY METHODOLOGY ...



- VOLUMETRIC, EACH SPECIFIC, NO SIMILAR INDUSTRIAL EXAMPLES
- RUSSIAN DOLLS CONFIGURATION → A METHODOLOGY BOX BY BOX



WHAT WE SEE ...

WHAT YOU WANT !

EACH BOX IS DEFINED BY **AT LEAST 3** OUTSIDE REFERENCE HOLES OR MARKS

A LIST OF JOBS ... every single job – plus regular presentations – is documented and stored in the corresponding experiment EDMS structure



Documents Projects Items
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MUTUAL INVOLVEMENT ... Survey and LHC experiments project leaders and detectors responsible persons is an old story ...

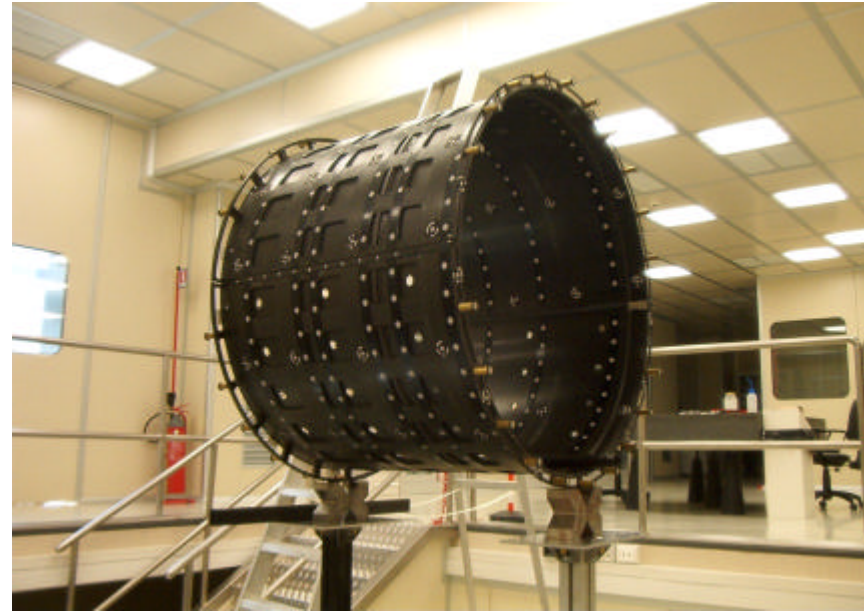
- December 92: 'Alignment of CMS' – A.Hervé, C.Lasseur, E.Radermacher, E.Rosso
- June 97: 'Atlas Survey questionnaire' – F.Butin and C.Lasseur
- Several participations and contributions to general and specific preparatory meetings ...
- Regular reports to technical meetings : TMB Atlas, Cemeste/Wogei CMS, ...
- frequent off-site CERN geometrical quality controls in 1998 ...

from primary fiducialisation ... up to mechanical supporting structure



264 CMS muon barrel chambers (20 000 photos) ... CMS coil swivelling platform (Korea)

SIGNIFICANT EXAMPLES ...



Envelope of the CMS -TC prototype – INFN Pisa
... overall accuracy : 0.03 mm

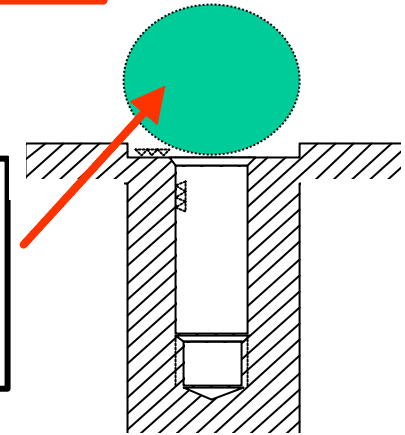
Two photogrammetry challenges ...

Regular control of the construction ... good geometry of the barrel muon system
and the rest ... overall accuracy : 0.1 mm

TRACKING AND MUON : WHAT IS (WILL BE) SURVEYED ?

GENERALITY

- the XYZ reported coordinates are those of the measured point - that is the target (survey or photogrammetric) centered in the reference hole. The mechanical parameters are given - drawings / pictures - in the corresponding EDMS report (distance to the contact surface, etc)

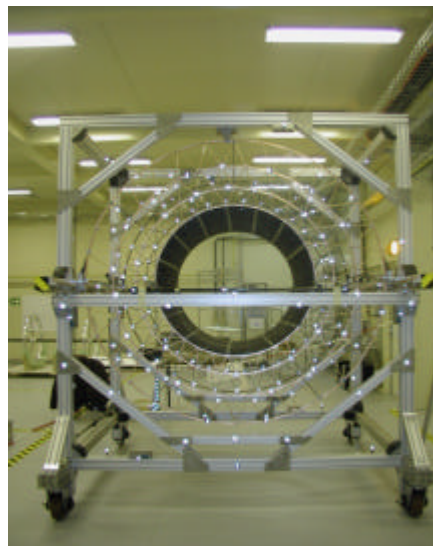


- the internal geometry - that is the link between the reference hole and the detecting part (wire, etc) is not known by SURVEY
- the reference system is either a one defined within the object geometry by SU OR - in the caverns - the one defined by the beam nominal line / tunnel geometry (the Q low-betas) and w.r.to the theoretical interaction point - see further. The system is always described in the corresponding EDMS report
- the naming is 'pure survey'. NO official designation per experiment. Drawings / pictures of the naming are given in the corresponding EDMS report
- a list of receivers has been established per experiment – The CMS reports are submitted to approval. People can be added at request

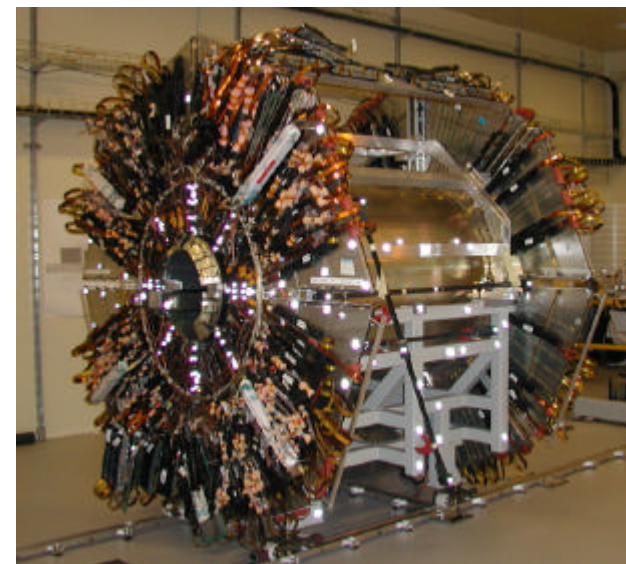
... IN ATLAS - [EDMS Id: ATL- 0000007362](#)

[Tracking](#)

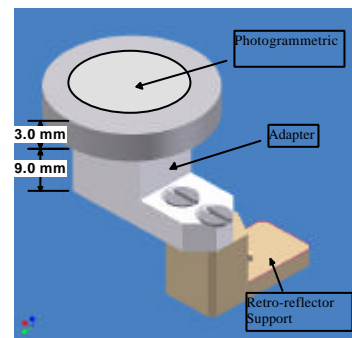
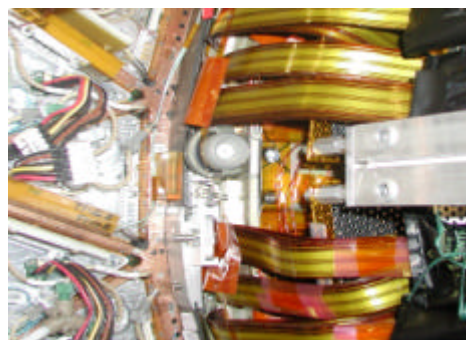
- ATLAS Survey Documents
 - Vacuum Beam Survey Documents
 - Inner Detector Survey Documents
 - Solenoid Survey Documents
 - LArg Calorimeter Survey Documents
 - Tile Calorimeter Survey Documents
 - Toroid Survey Documents
 - Muon Spectrometer Survey Documents
 - Shielding Survey Documents
 - Support Structures Survey Documents
 - Infrastructure Survey Documents
 - Hydrostatic System Survey Documents



Metrology TRT barrel



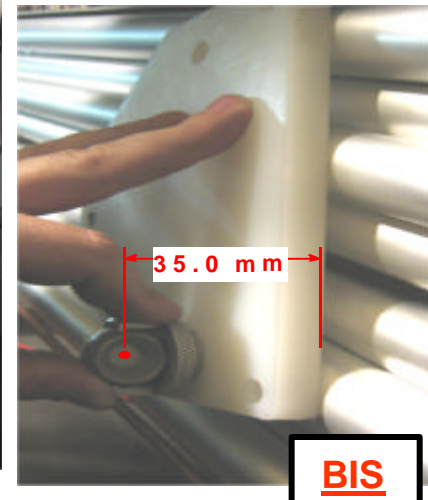
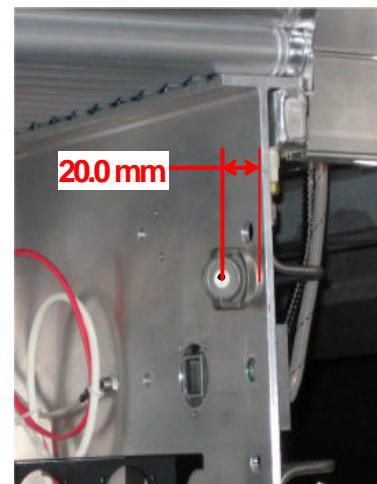
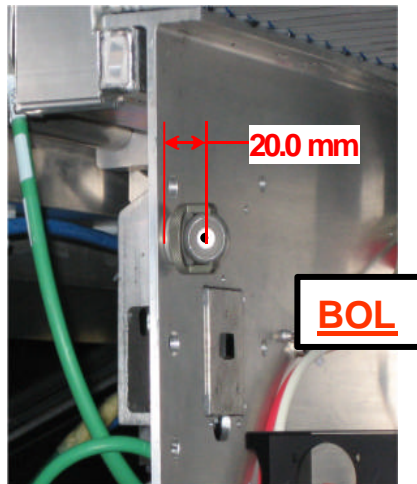
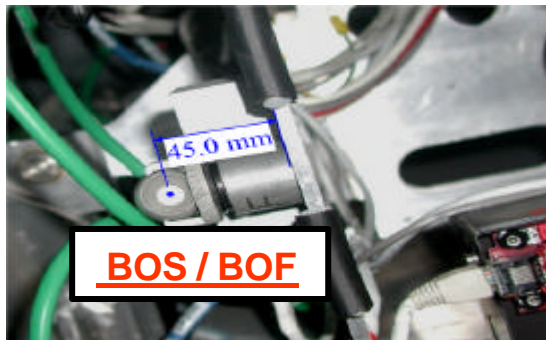
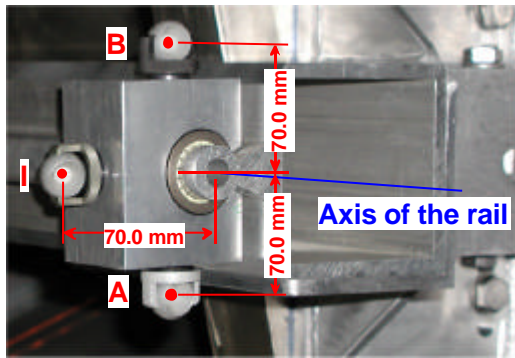
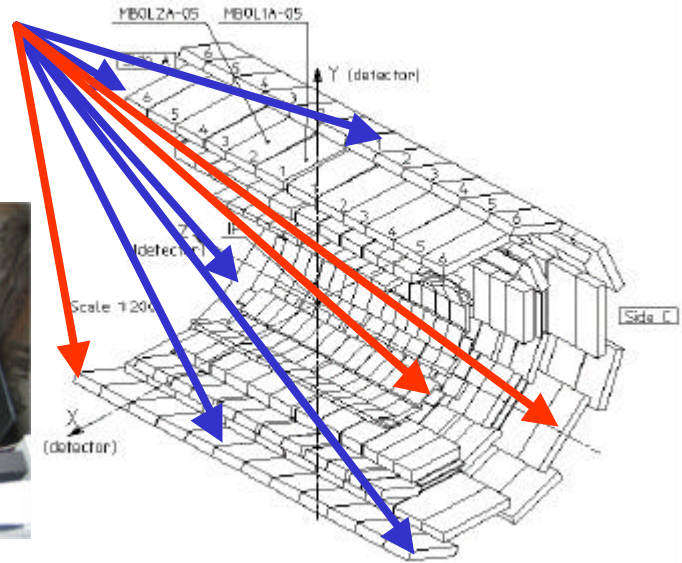
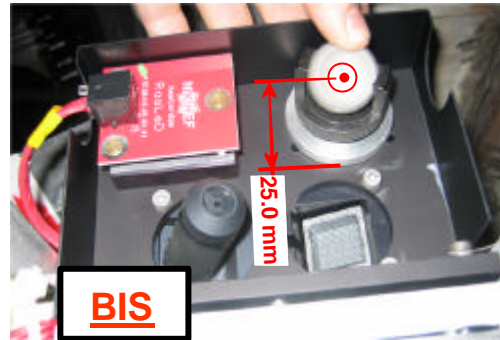
TRT plus SCT



SCT/FSI/Pixel JGI

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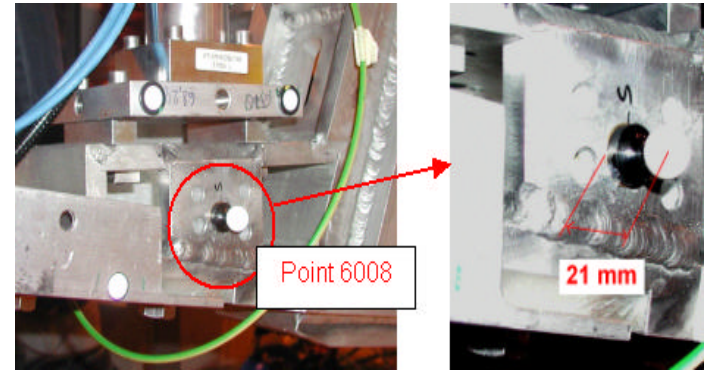
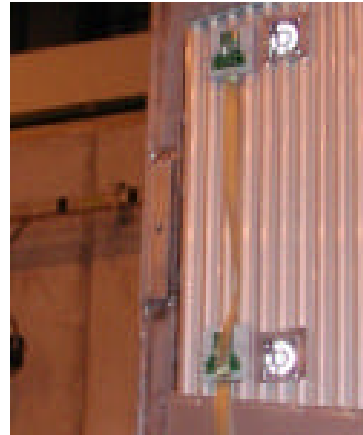
Muon barrel : rails (many times) then pre-control of **SOME chambers on both extremities** (several sorts of marks ...)



When muon barrel completed, **all 'ends' chambers on both extremities** – marks attached to the internal align plates ...

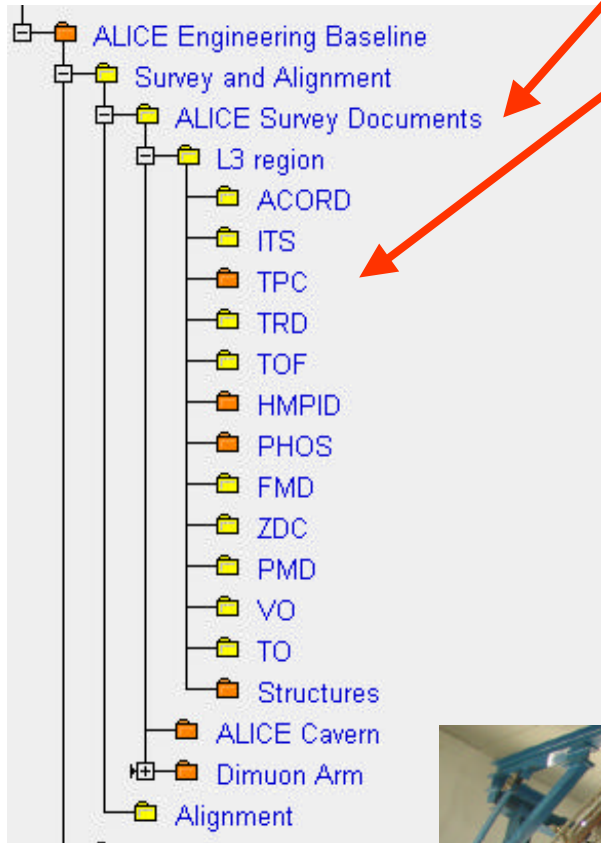
Muon end-cap : marks well defined in advance

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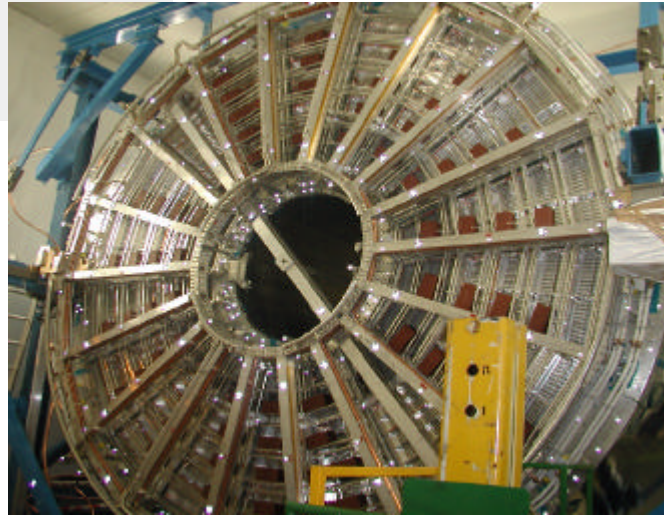
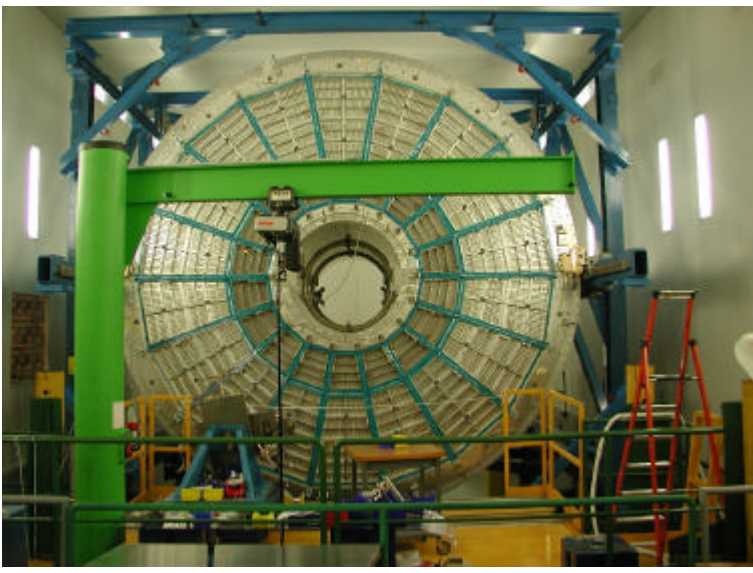


Fiducialisation of all TGC and some MDT sectors partially (C. Amelung) and full measure in the cavern

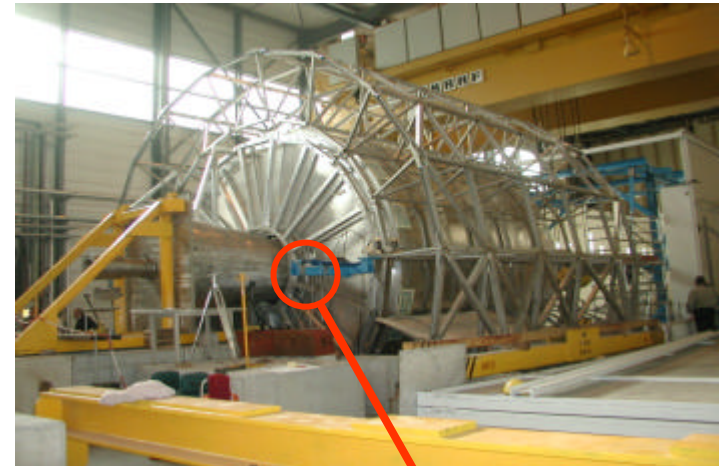
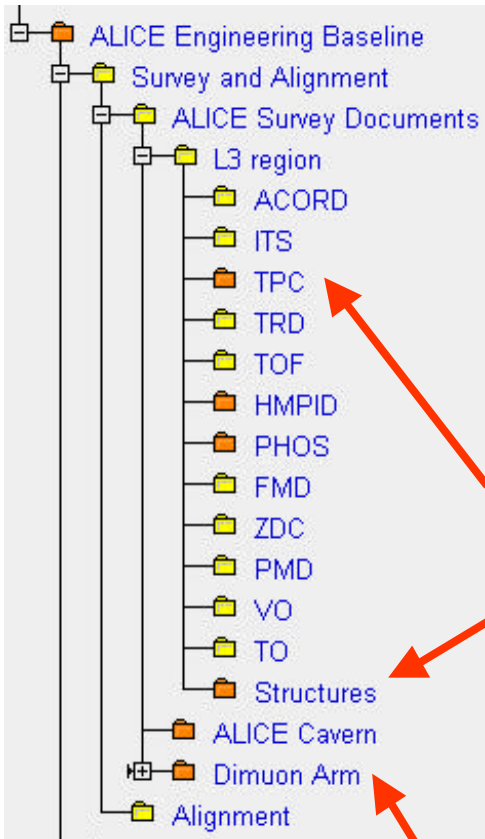
... IN ALICE - [EDMS Id: ATI-0000000407](#)



TPC metrology during assembly : marks well defined in advance



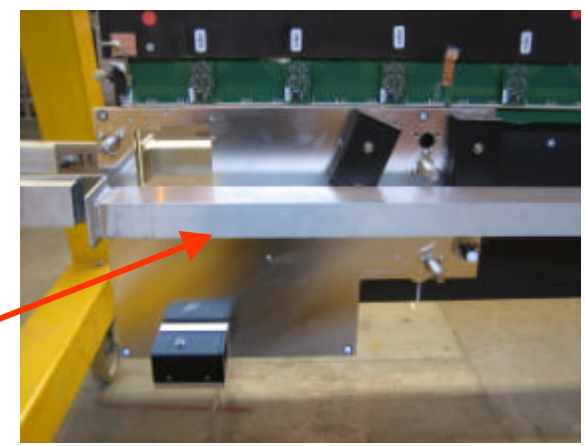
... control after dummy load of the electronics



Deformations spaceframe and TPC insertion test



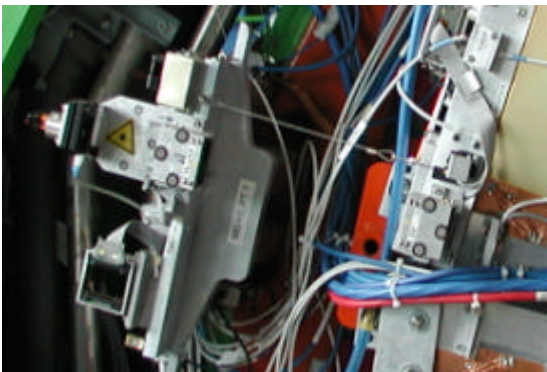
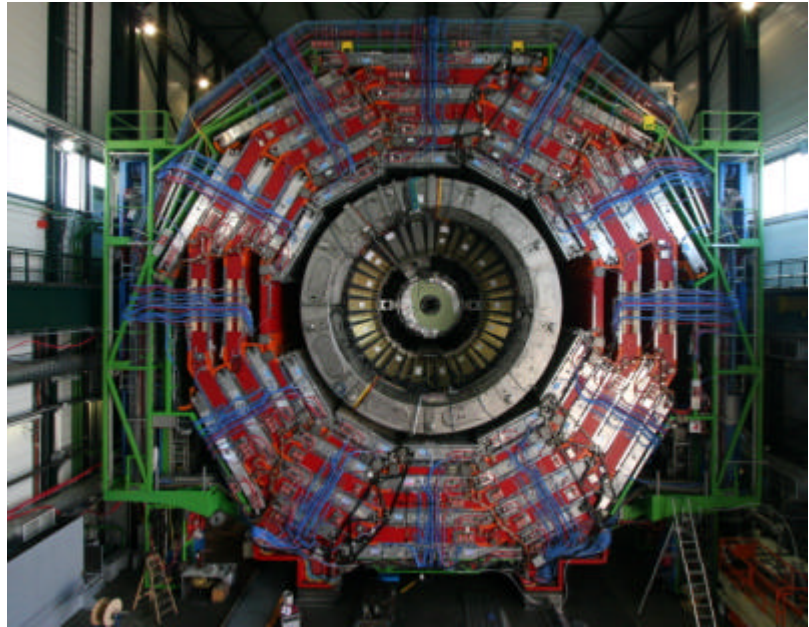
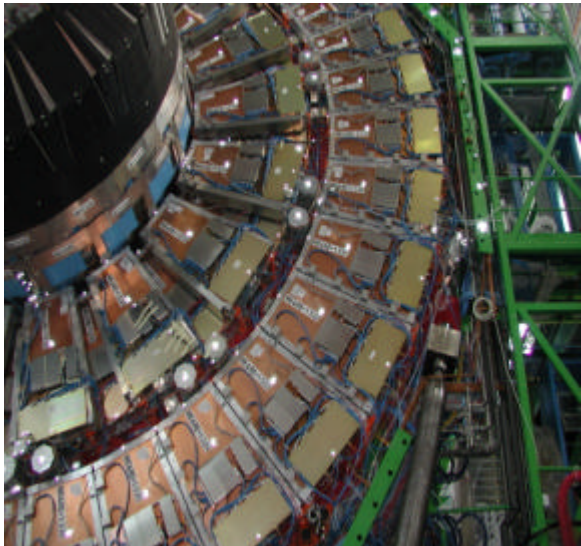
Fiducialisation dimuon with BCAM plates



... IN CMS - [EDMS Id: CMS-0000008380](#)

- CMS Survey Documents**
- Magnet Survey Documents
- HCAL Survey Documents
- ECAL Survey Documents
- Muon Detector Survey Documents
- Infrastructure Survey Documents
- Experimental Area Survey Documents
- Central Tracker Survey Documents

**Muon : all chambers marks well defined
PLUS internal align components ...**

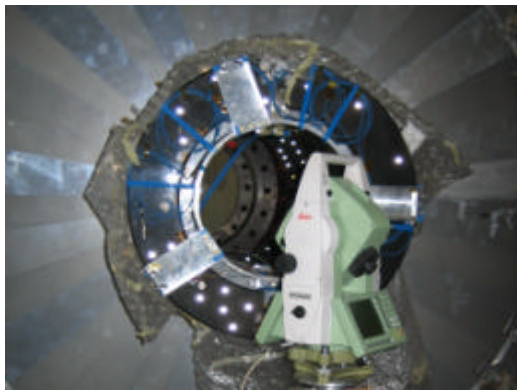
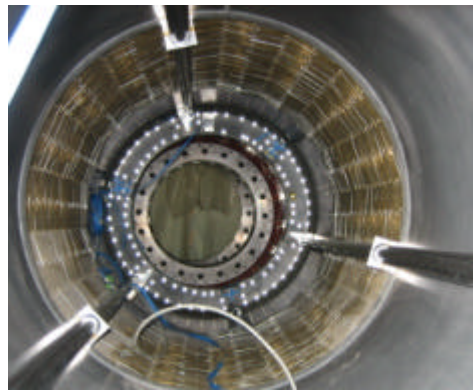


**Endcap transfer plates
and barrel MAB's ...**

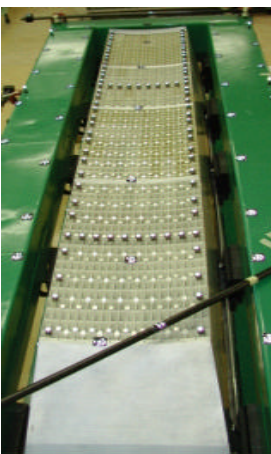


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Muon : and internal alignment transfert lines



Link disk and alignment ring ...

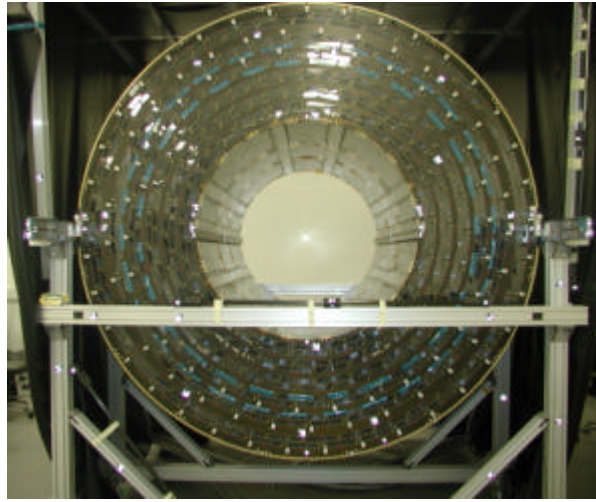


Ecal : each module and supermodule

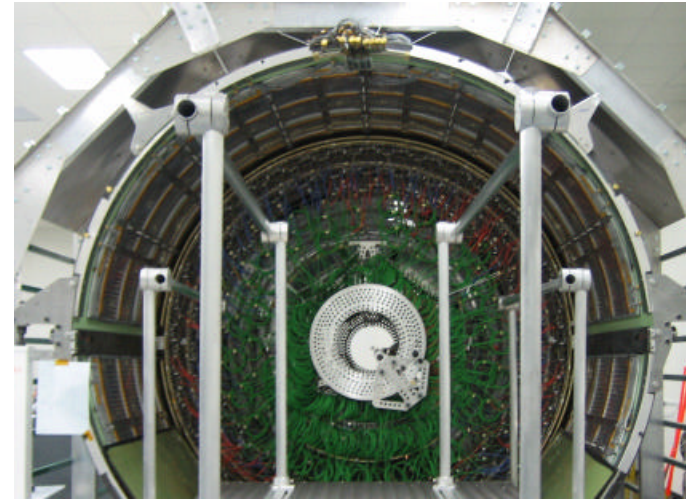
Central Tracker



TEC (Aachen)



TOB plus TIB / TID support



TOB in the support tube

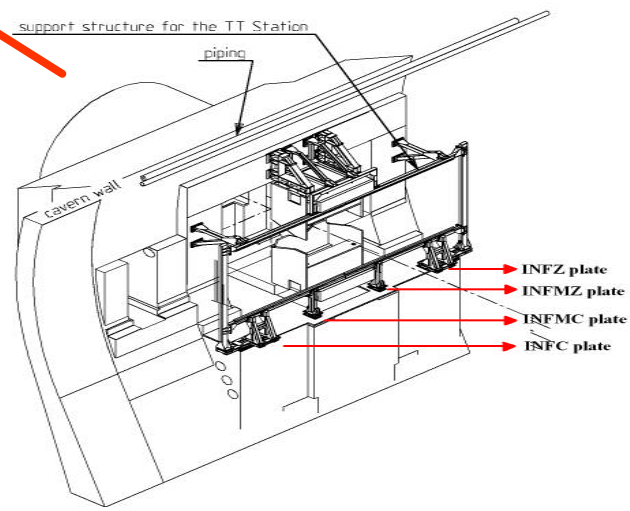
... IN LHC- b - EDMS Id: LHCB-0157

Tracking and Muon

- Technical Coordination
 - Integration
 - Installation
 - LHCb Survey Documents**
 - UXB5 cavern general
 - UXB5 detector general
 - Beam pipe
 - VELO
 - RICH-1
 - Trigger Tracker
 - Magnet
 - Inner Tracker
 - Outer Tracker
 - RICH-2
 - Gantry
 - SPD/PS
 - ECal
 - HCal
 - Muon Detector
 - Muon Filter
 - Hall 156 General



Axonometric view of the support structure for the TT Station



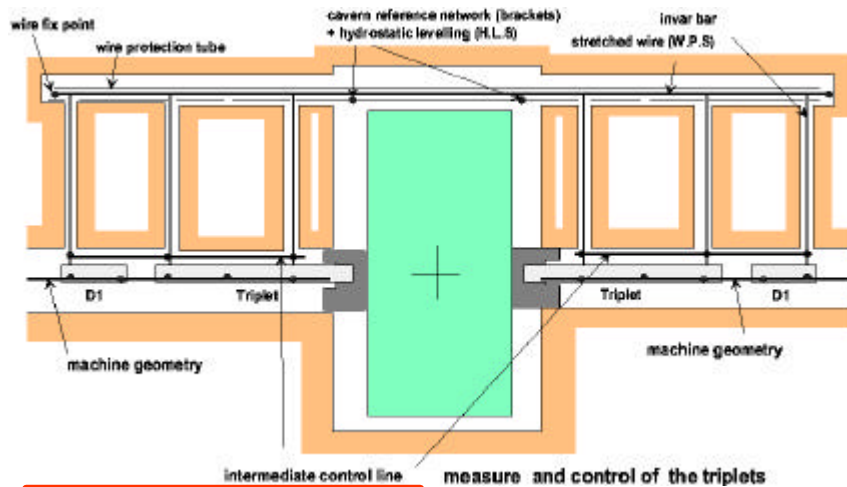
VELO : Fiducialisation and now on the beam line – 0.3 mm

Tracker : structures and modules on the beam line

Muon : pre-alignment then 'indirect' positions ... 2 mm



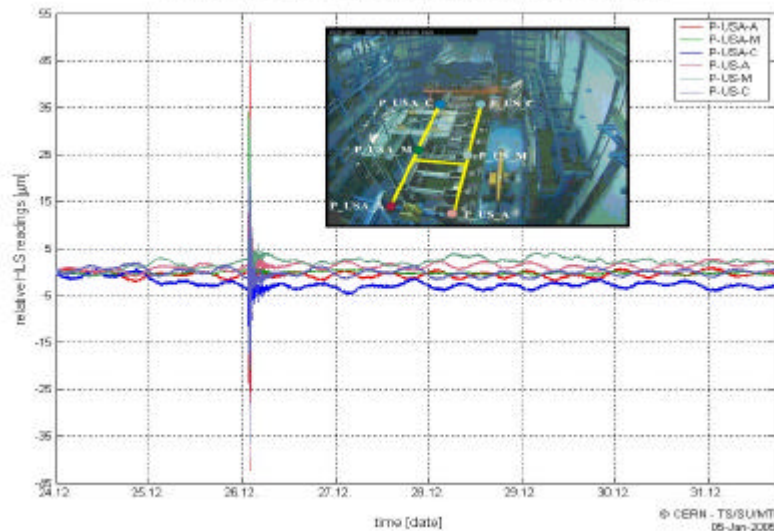
BEAM NOMINAL LINE ...



... is given by the best fit line of the low-betas Quads monitored by a stretched wire (survey galleries in caverns 1 and 5) plus an **hydrostatic line** (all the caverns) and both linked to the experiment reference geometry (brackets on walls, ect). Overall link accuracy : 0.5 mm

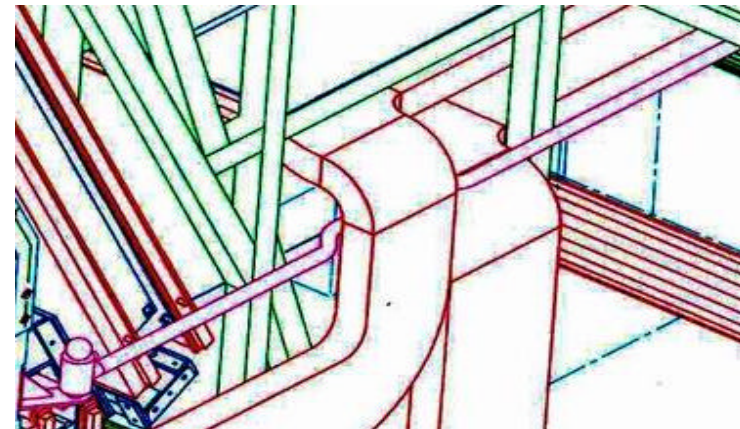
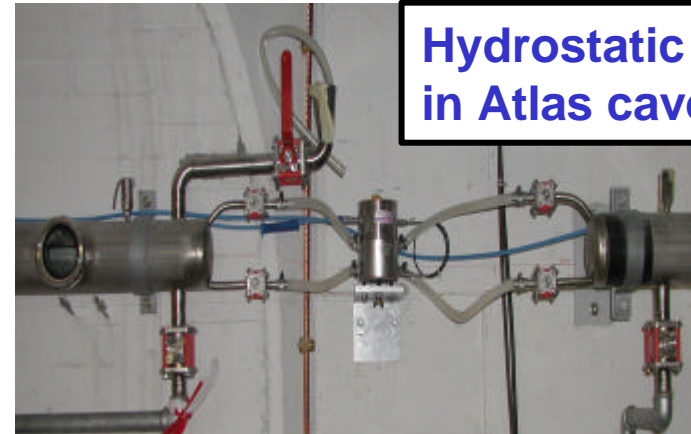
MONITORING

ATLAS BEDPLATES - HLS measurements (24.12.-31.12.2004)



3 hydrostatic lines and 6 hydrostatic stations in the Atlas bed-plate

Hydrostatic line in Atlas cavern



1 hydrostatic station on CMS YB0 directly linked to the Quads and 3 on the YB0 feet PLUS 4 BCAM's lines (relative movements)

WE DO NOT WANT TO GIVE A CONCLUSION ...

**EVERY KNOWN AND IDENTIFIED STEP OF SURVEY IS
FOLLOWED UP, UPDATED WHEN NECESSARY AND
DOCUMENTED ...**

HAVE WE MISSED A DETECTOR ???

- **Question to the project leaders ... to your community also**
- **Still time to correct ... maybe it is too late**

THE DISCUSSION IS OPEN