SECOND LHC DETECTOR ALIGNMENT WORKSHOP – June 07

LHC Detectors : Survey Data and Stability

C. Lasseur and the collective TS-SU-EM – EDMS : 853000

OUR MANDATE … RECALL

→ the support in metrological and accurate geometrical quality control and positioning procedures of the magnets and detectors : manufacturing, assembly and final positioning with respect to the nominal beam line (smoothest line of the low-betas Quads)

→That implies:

- setting–up and maintenance of precise geodetic grids in the assembly halls and experimental areas

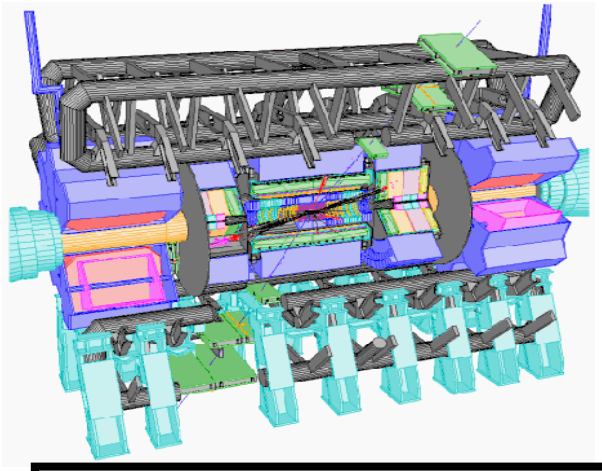
- applying large scale and precise 3D measurement techniques : industrial geodesy, photogrammetry, metrology techniques (Wire Posit. System, HLS, BCAM, …) when classical methods cannot be applied and when on-line monitoring required

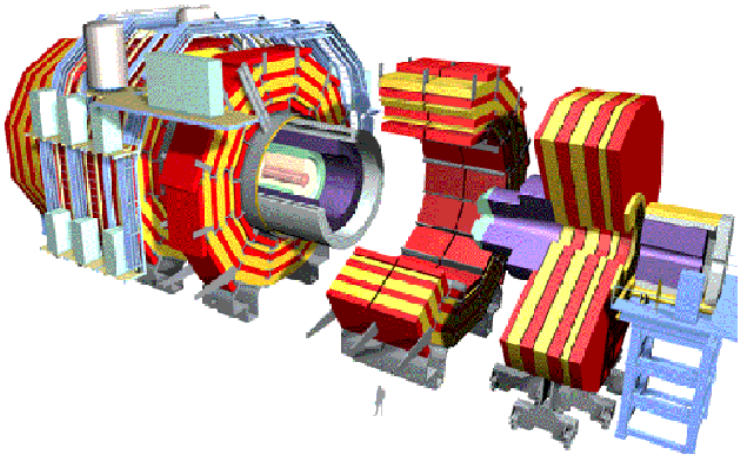
- providing and reporting 3D coordinates of detectors reference points at all assembly and final alignment stages … FOLLOWING REQUESTS !

- WHAT IS 'WELL' SURVEYED TO-DAY … from the requests

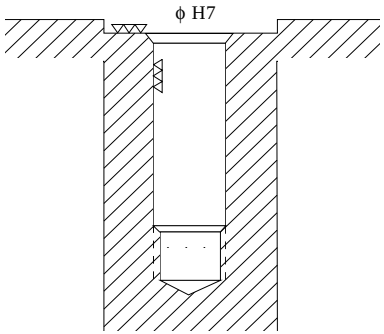
- DATA SURVEY BANK !!!! – STABILITY OF AREAS AND DETECTORS

SURVEY METHODOLOGY …





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

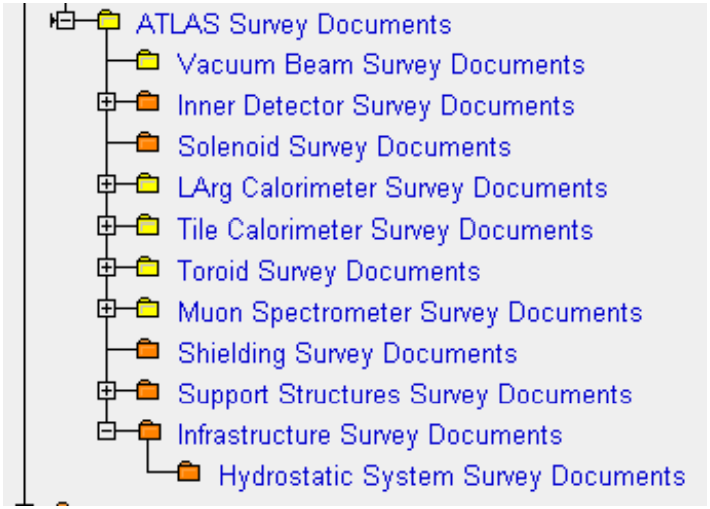


WHAT WE SEE … WHAT YOU WANT !

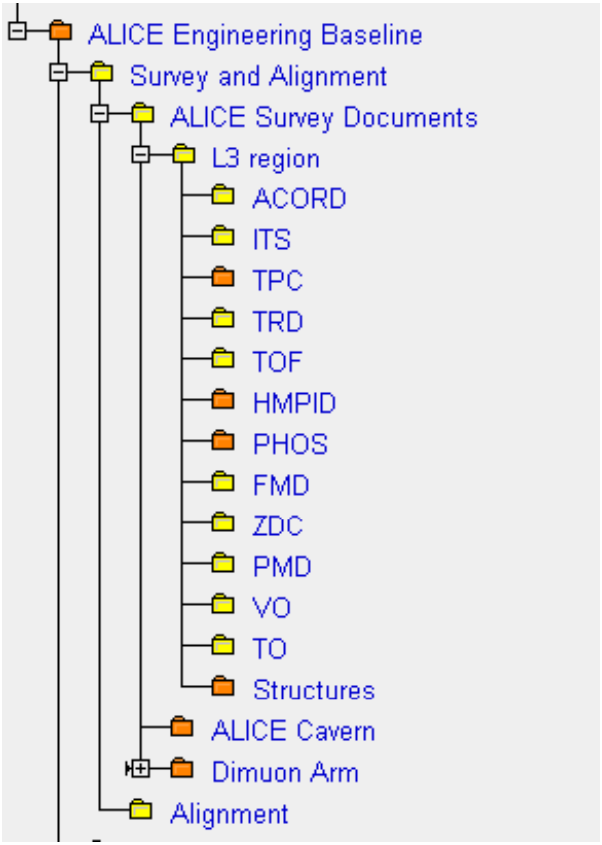
EACH BOX IS DEFINED BY AT LEAST 3 OUTSIDE REFERENCE HOLES OR MARKS

… every single job – plus regular presentations – is documented and stored in the corresponding experiment EDMS structure

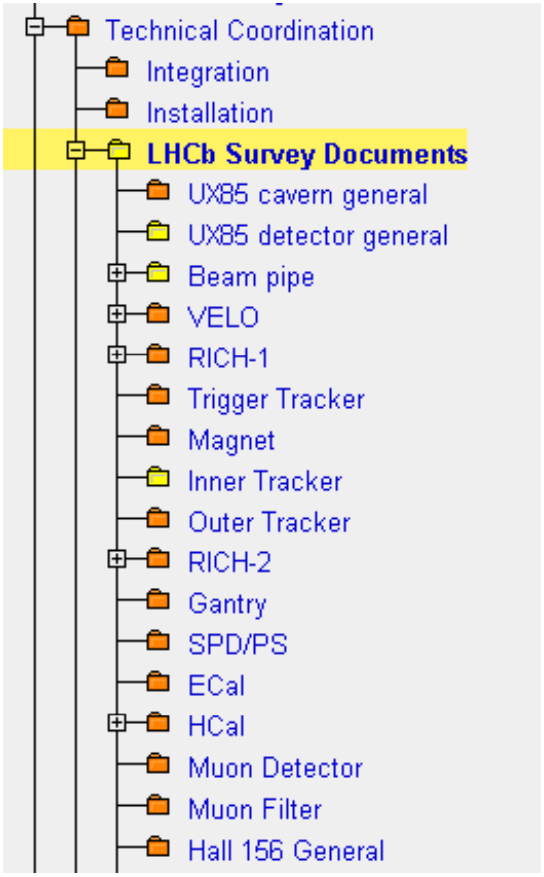
ATL- 000007362



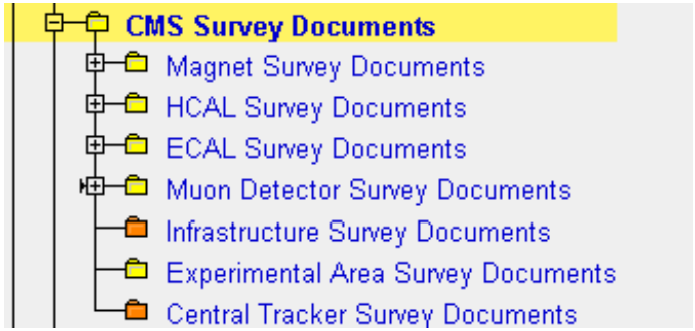
ATI-0000000407



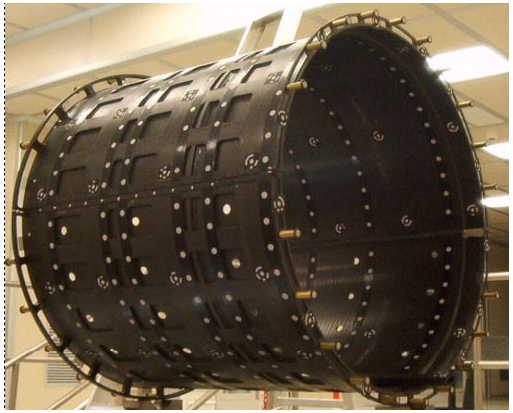
LHCB-0157

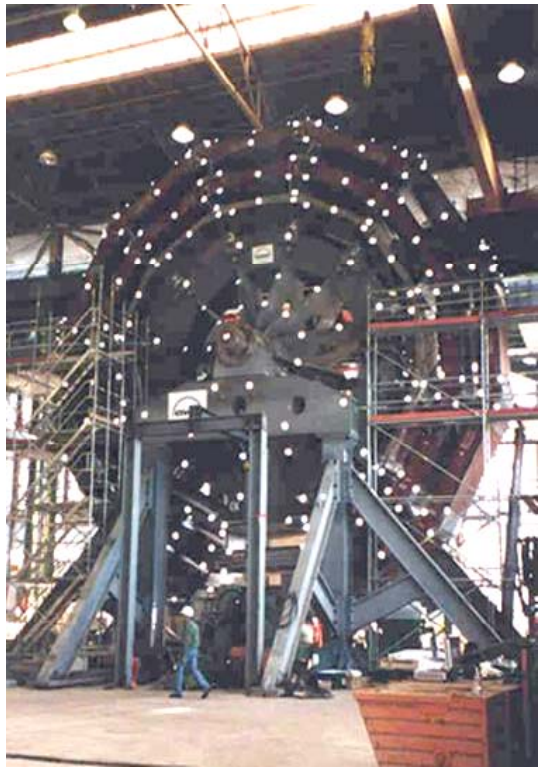


CMS-0000008380



ONLY 4 SIGNIFICANT EXAMPLES … OFF-SITE CERN

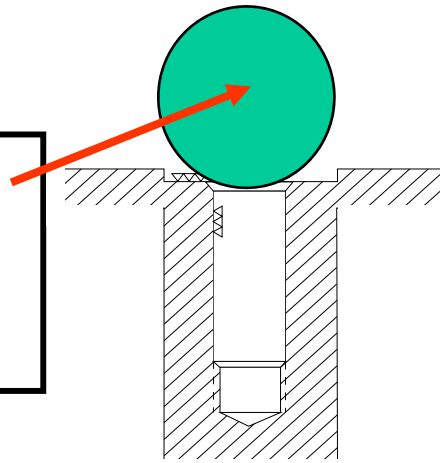




WHAT IS SURVEYED and WHICH INFORMATION ?

- the XYZ reported 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 → NOT GIVEN !!!!

- 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 geometrical theoretical interaction point

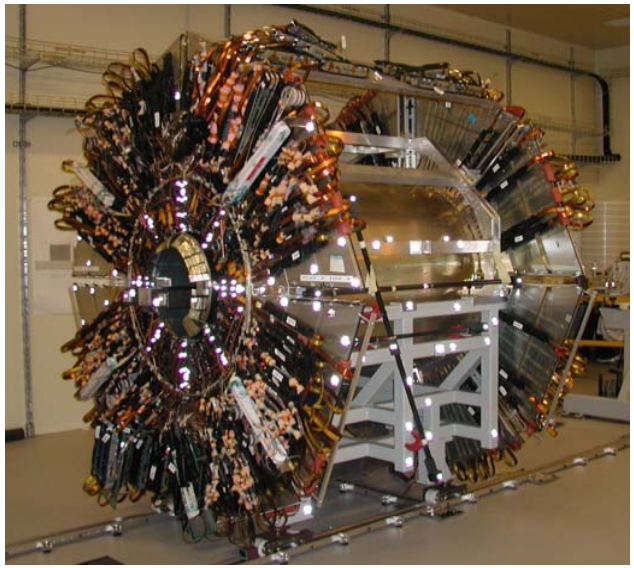
→ it is ALWAYS MATERIALIZED (reference holes, Q low-betas sockets, brackets).

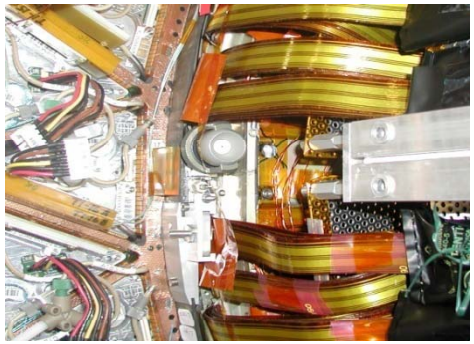
→it is ALWAYS DESCRIBED in the corresponding EDMS report

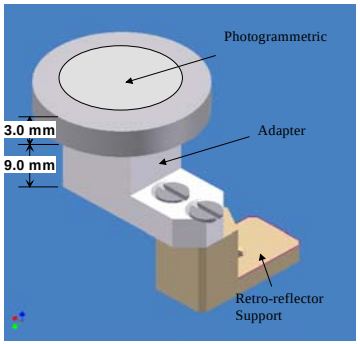
- the naming is 'pure survey'. NO official designation per experiment. Drawings / pictures of the naming are given in the corresponding EDMS report

- a list of receivers has been established per experiment - approval procedure for the CMS survey reports and specific list for the Alice survey reports. Addings/changes possible via the EDMS support and after agreement by the 'experiment' EDMS/Survey structure linkman / supervisor / coordinator

ATLAS Inner detectors : Metrologic validations in laboratory …

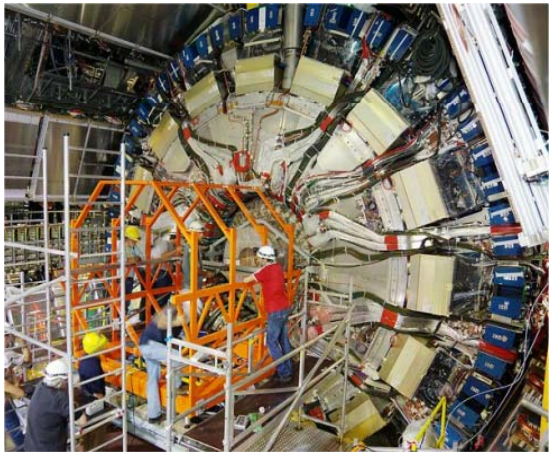


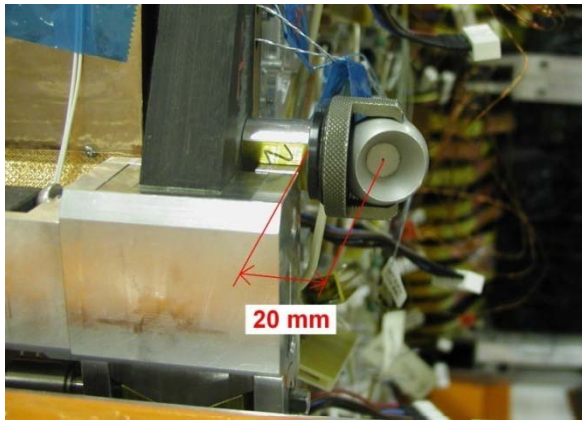




… position measures in the cavern :

- **V-profiles end-caps in IWV, PST and L-profiles,**
- **ID (TRT/SCT) barrel (after the V-profile)**

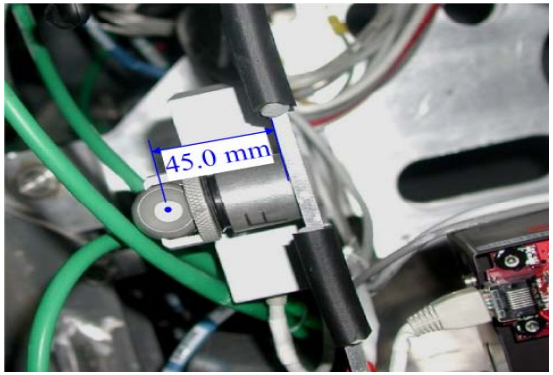


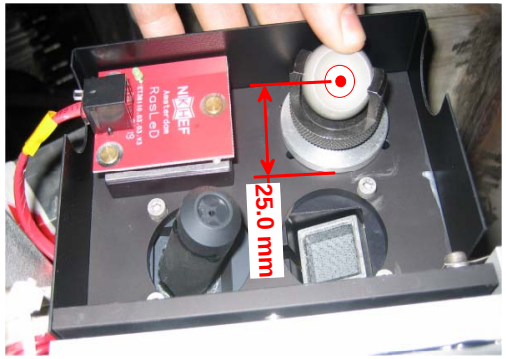


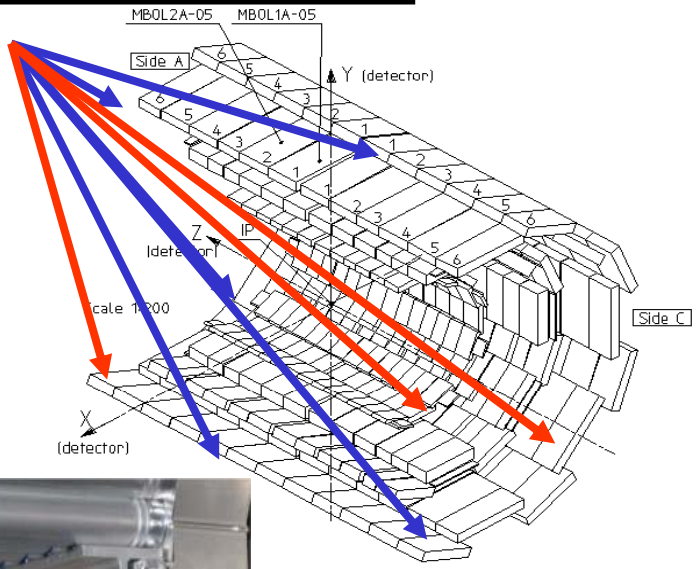
- **corrections after survey ?**
- **survey data definitive ?**

- Survey data-bank : NOTHING ... (?) → A. Catinacio / D.Froidevaux - see 'Tile / LArg'

ATLAS Muon barrel : SOME chambers (several sorts of marks …)



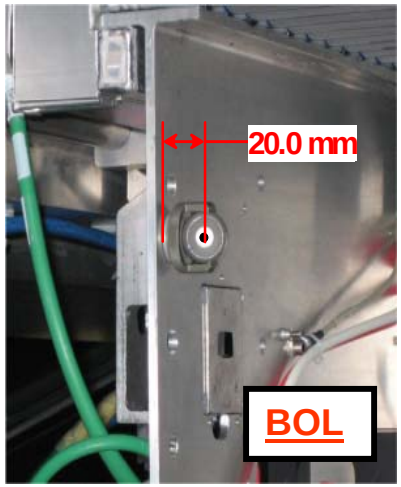


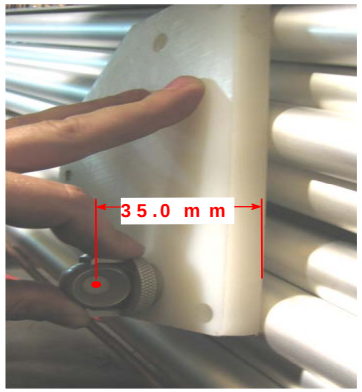


ALL IN THE CAVERN

- last : June 07
- deformations WHEN BT ASSEMBLY ???
- first : February 06

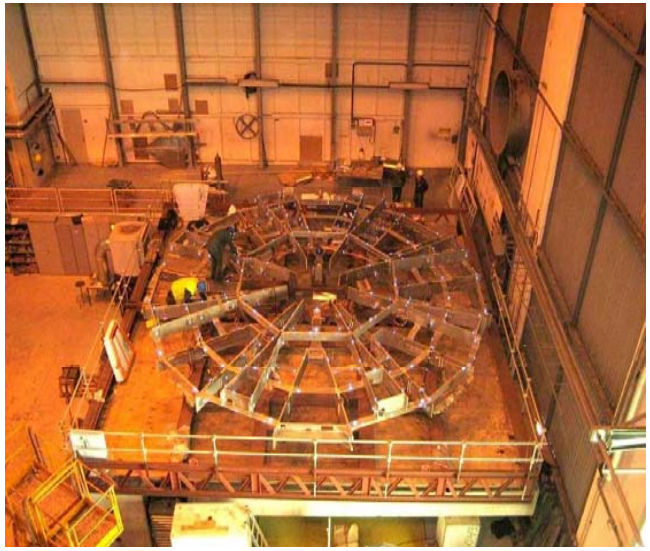
- still some missing to-day





all ‘ends’ chambers on both extremities : done ON A SIDE (March 07) praxial supports … Survey data-bank : NOTHING (?) … BUT 2 summary lists giving the dates of the last rail measures AND the dates of the chambers / BT transp. stops surveys (S. Fenyuk / L. Chevallier)

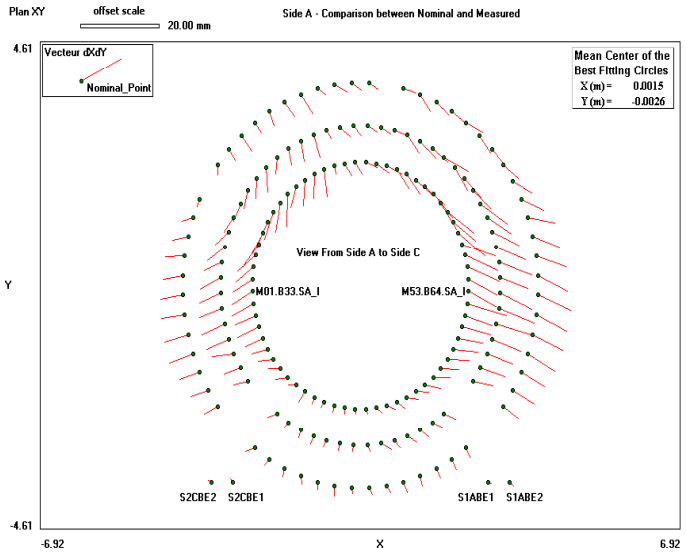
ATLAS Muon endcap : VERY good knowledge of EACH SECTOR and WHEEL

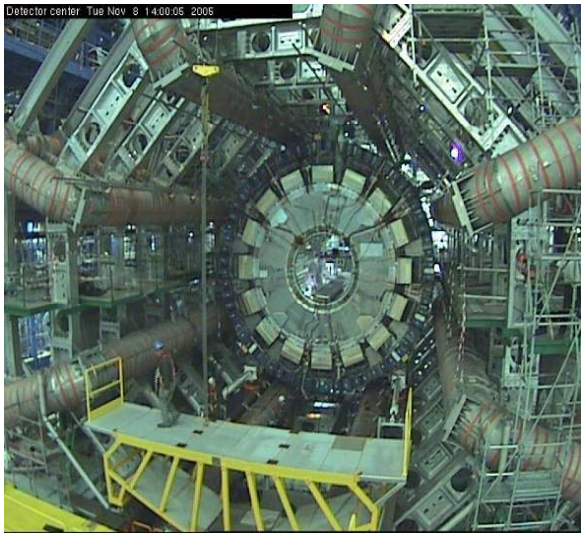


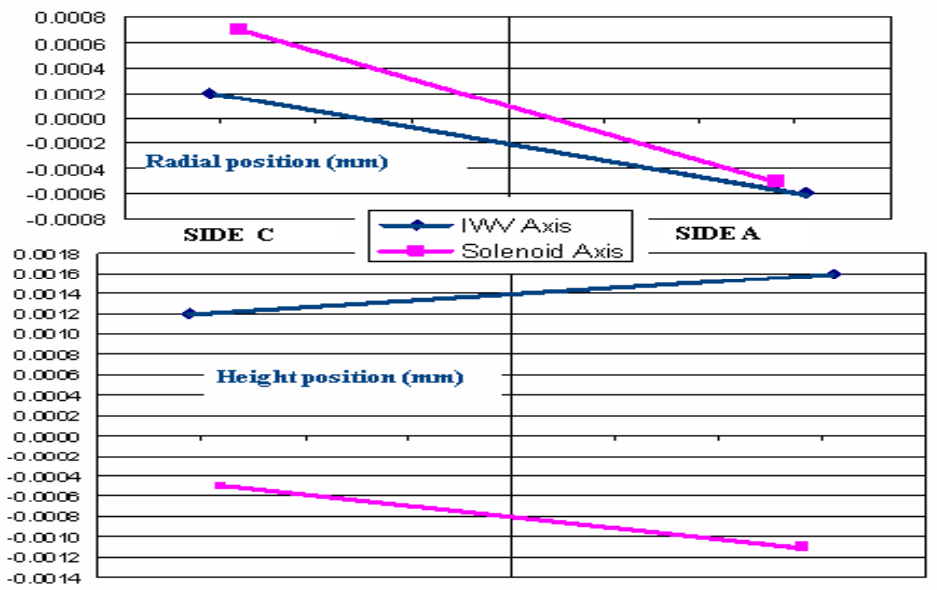
Survey data-bank : NOTHING (?) BUT that cannot be a BIG problem …

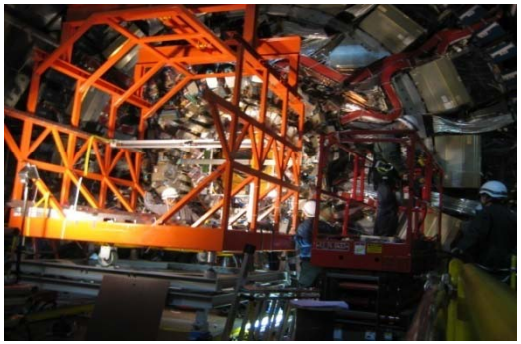
Extension the BCAMs lines from EBB/ECB - EBA/ECA/EBC/ECC to ETC/ETA – JD's – SW … others ?

ATLAS Tile and LArg : Metrologic validations in hall and cavern … plus positioning … STABILITY (December 05 / May 07) … ENGINEERING BOOK









STABILITY … MAY 07 : last chance but quite harsh,

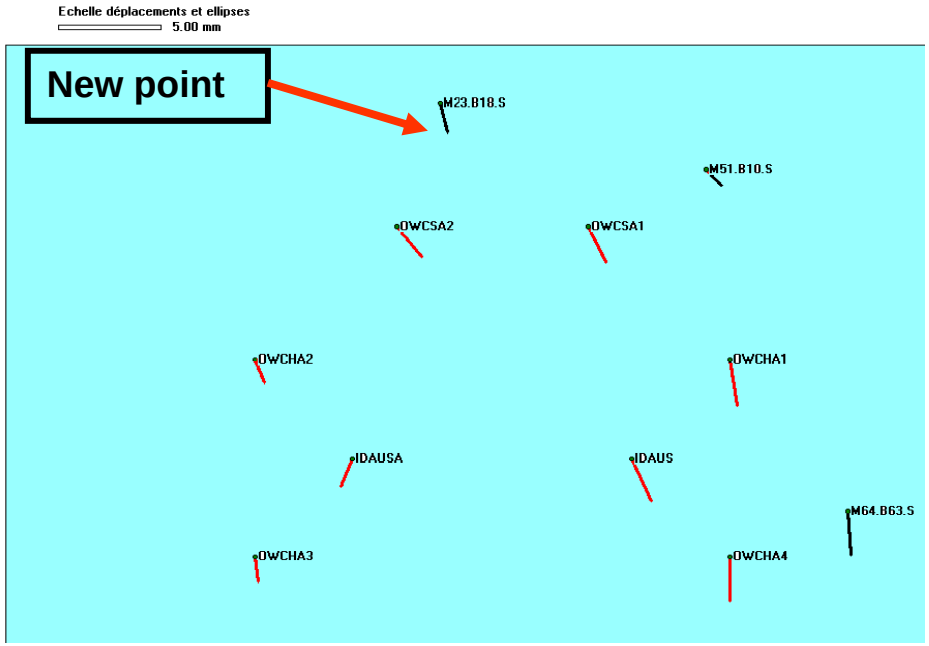
… very few Tile marks AND some broken

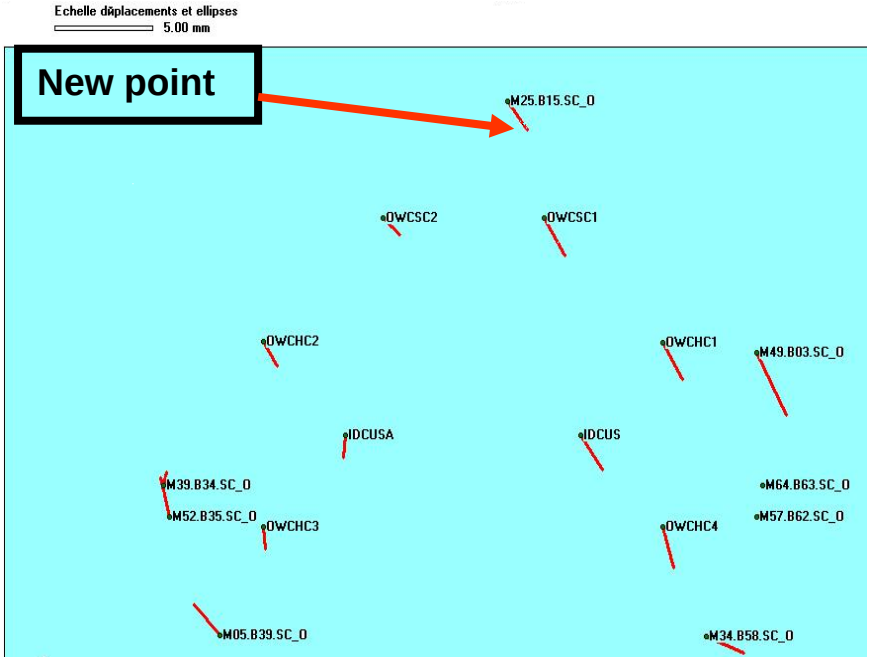
… rather good for LArg → position inner detectors !

side A and side C : December 05 – May 07 (3D adjust on 8 points each side on LArg) – accuracy / 'beam nominal line ' : 0. 7 mm

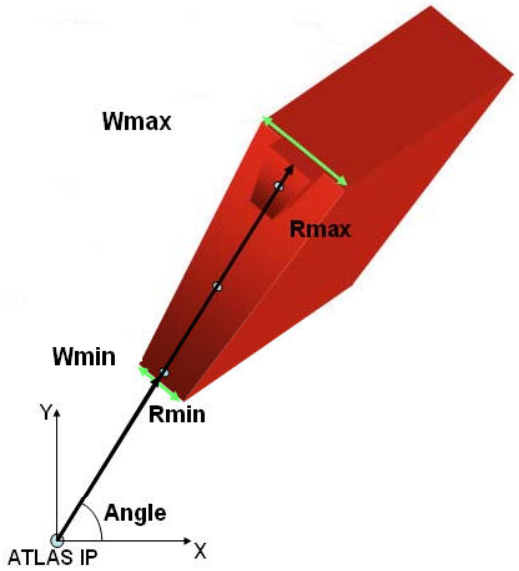
TX = 0.41 mm, TY = -1.48 mm, TZ = 1.09 mm
… X May 07 position : refered to Q low-betas L
… Y : refered to deep reference rods in the tunnel

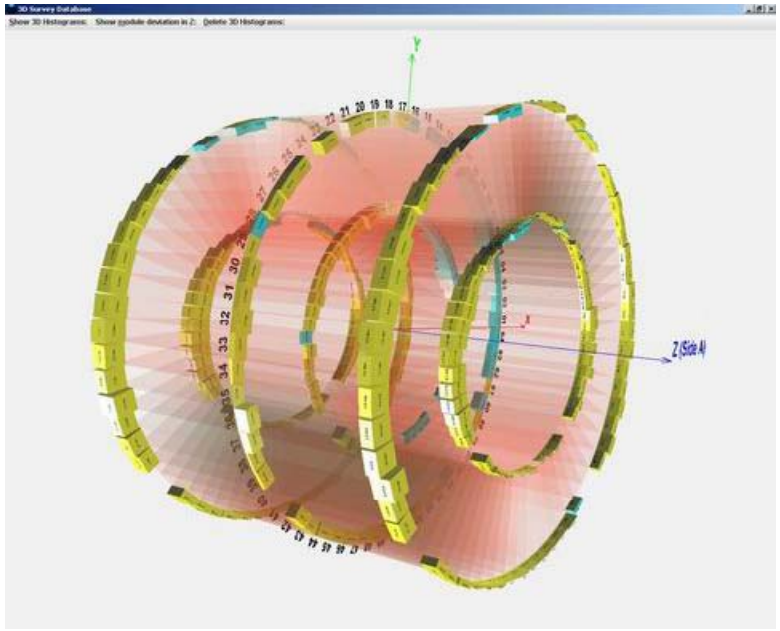
Z beam = 0.2 mrad, X radial = 0.04 mrad, Y height = 0.04 mrad





An ENGINEERING BOOK exists for the Tile barrel





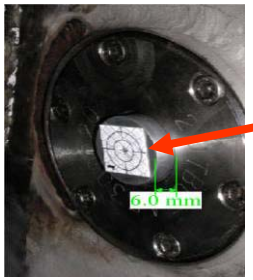
AtlasSurvey3D - Survey Database for The ATLAS Experiment
Survey Targets info (e.g. Toroid, Tile) in Glance
Detailed information for Tile Barrel modules in Glance (Survey Data)

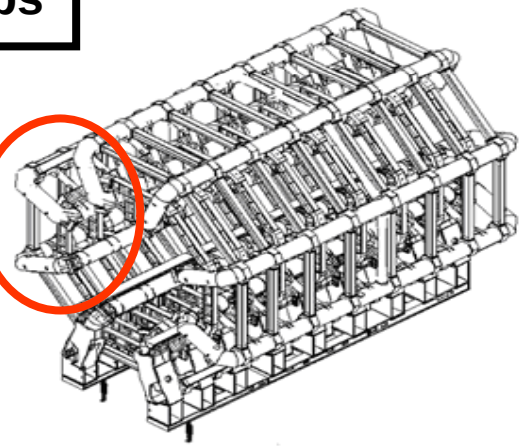
K.Pommes and all: https://edms.cern.ch/document/804033/1
J.Molina-Perez: http://atlassurvey3d.web.cern.ch/AtlasSurvey3D/

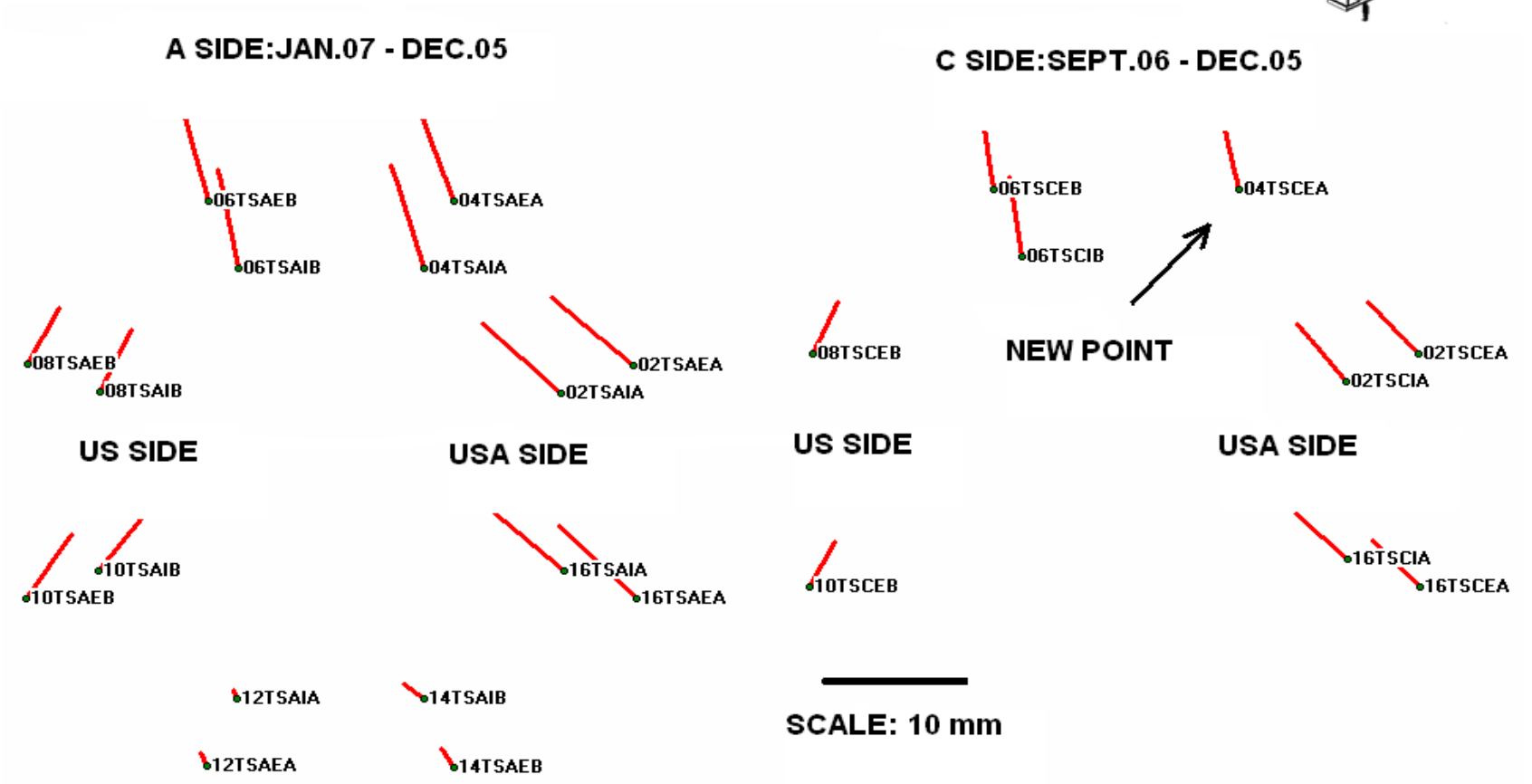
ATLAS BT and deformations : measures of transport stops

- 7 measures from December 07
- last : C side June 07

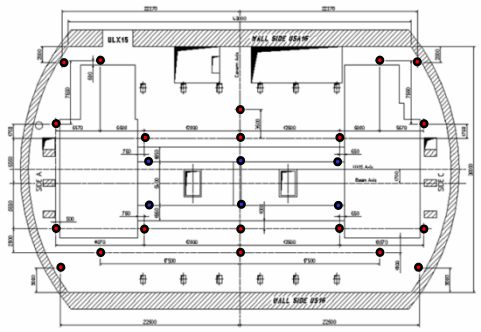
- in accordance to predictions : 1 to 2 mm
- along the coils ?



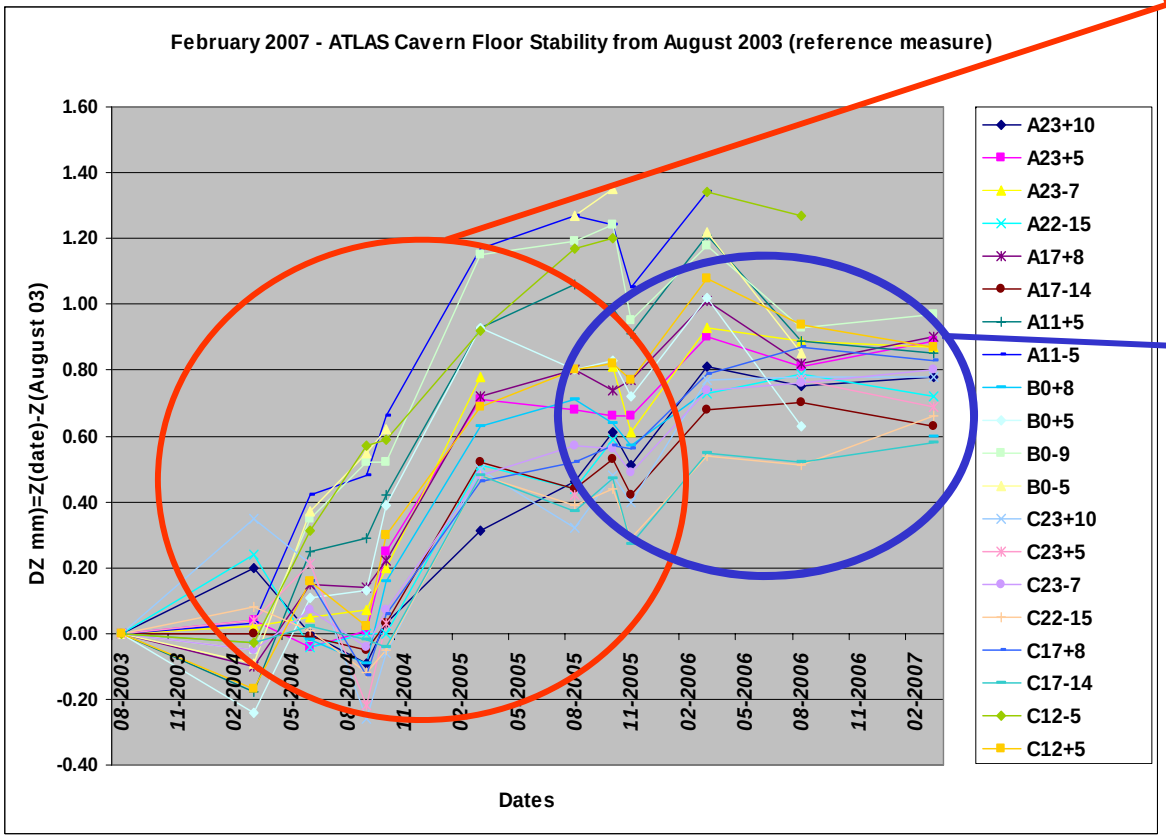


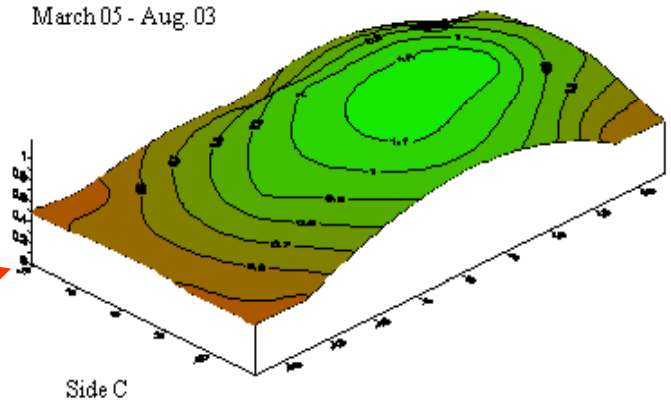


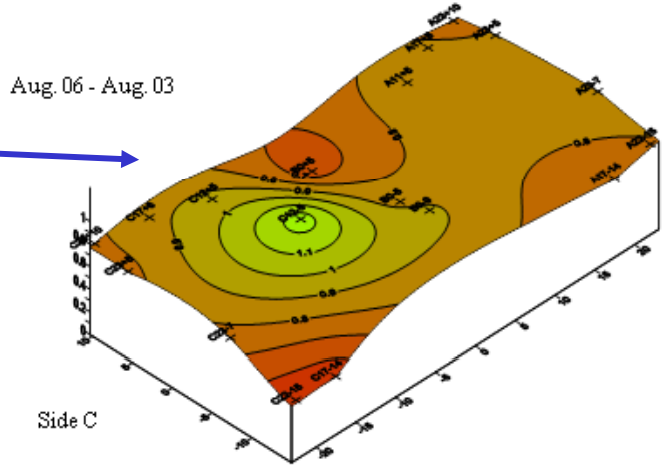
ATLAS cavern floor STABILITY : monitoring from deep reference rods in the tunnel since August 03 – accuracy / beam nominal line : 0.3 mm



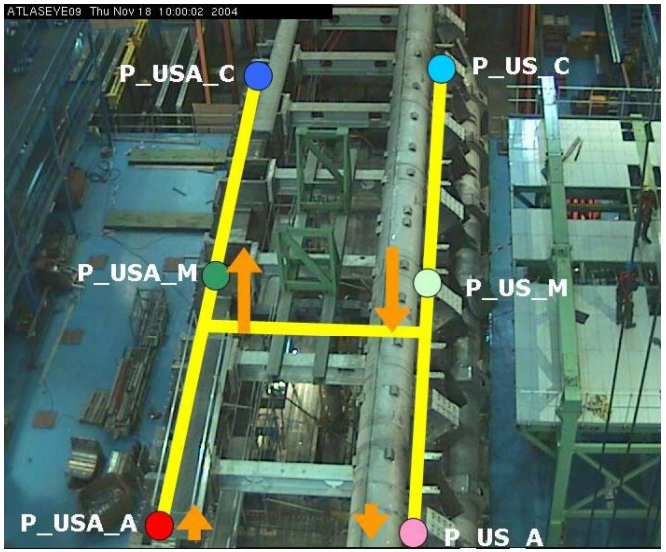
- points on floor …
- not under detectors …

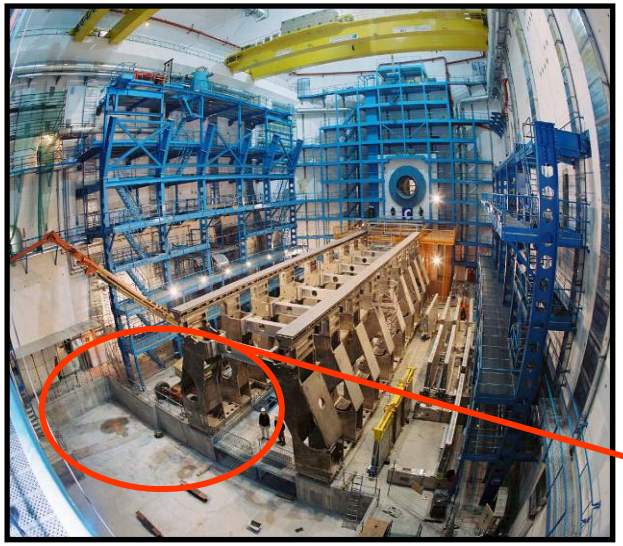






ATLAS cavern floor : predictions … surveyors are not ‘fortune or mis-’ tellers





Floor Movement – Per Year

ATLAS project

Instalation Time*	Floor Movement (no Lift)	Lift 1mm After 1 Year	Net floor Move	Relative To Nominal	Date	Time
Floor installation *	0.0	0.0	0.0	2.5	6/1/02	0
Get Hall.**	-2.0	0.0	-2.0	0.5	4/10/03	10
Toroid/Feet	-2.0	1.4	-0.6	1.9	11/17/03	17
Rail Installation	-2.0	2.2	0.2	2.7	8/1/04	26
Barrel	-3.0	2.3	-0.8	1.8	9/15/04	27
EC Cal **	-4.0	2.5	-1.5	1.0	1/1/05	30
ID Instlation	-6.0	3.2	-2.8	-0.3	8/1/05	38
EC Toroid**	-6.5	3.5	-3.0	-0.5	3/1/06	42
First Beam	-7.5	5.0	-2.5	0.0	6/1/07	60
1 year	-7.5	6.0	-1.5	1.0	6/1/08	72
2 years	-7.5	7.0	-0.5	2.0	6/1/09	84
3 years	-7.5	8.0	0.5	3.0	6/1/10	96
4 years	-7.5	9.0	1.5	4.0	6/1/11	108
5 years	-7.5	10.0	2.5	5.0	6/1/12	120
6 years	-7.5	11.0	3.5	6.0	6/1/13	132
7 years	-7.5	12.0	4.5	7.0	6/1/14	144
8 years	-7.5	13.0	5.5	8.0	6/1/15	156
9 years***	-7.5	14.0	6.5	9.0	6/1/16	168
10 years	-7.5	15.0	7.5	10.0	6/1/17	180
11 years	-7.5	16.0	8.5	11.0	6/1/18	192
12 yeasr	-7.5	17.0	9.5	12.0	6/1/19	204

2 MM Settlement Due to Cement contraction

5.5 MM Settlement Due to ATLAS Weight.

1 MM/year lift Due to hydrostatic pressure

Summary of the “pessimistic” prediction for the floor movements.

- **HLS system : very soon FULLY operational after some improvements (fixations, DAQ and soft)**
- **extension to stable parts (A and C trenches)**
- **values D. Lissauer’ table : STILL VALID ???**

CMS inner detectors : a lot of metrologic validations in laboratory

'We' are organizing a CMS workshop to review the status of our survey data. This will take place Wednesday next week, right after the LHC alignment workshop: http://indico.cern.ch/conferenceDisplay.py?confId=17330 . A contribution from the CERN survey group would be very beneficial to learn more about survey measurements conducted by your group on our detectors (primarily muon and tracker devices).

- a reference list of survey measures (about 50) is available (A. Behrens SU-EM)

833563	29.03.2007	TST 23.02.2007	Pixel rails	MEASUREMENT OF THE PIXEL SUPPORT RAILS
832597	22.03.2007	TST 23.02.2007	TEC+/TEC-	MEASUREMENT OF THE TEC- AFTER INSERTION - FINAL MEASUREMENT OF THE TST, TEC- AND TEC+
830588	19.03.2007	TST 23.02.2007	TOB-/PST-	MEASUREMENT OF TST ENVELOPE Z- SIDE, TST COPPER PIPES, TEC- SUPPORTING RAILS AND PIXEL SUPPORT TUBE
477123	09.06.2004	Local TOB Mockup		Measurement of the TOB Mockup Inner Rails in hall 187
382139	26.03.2003	Local TIB		CMS - Measurement of the Prototype of the Silicon Tracker Inner Barrel in Pisa
365123	28.11.2002	Local craddle		CMS - CENTRAL TRACKER - AJUSTEMENT DU SUPPORT - 28 Novembre 2002

"Alignment is the adjustment of an object in relation with other objects, or a static orientation of some object or set of objects in relation to others" (Picture and text from Wikipedia)

Tracker Survey

Martin Weber
RWTH Aachen

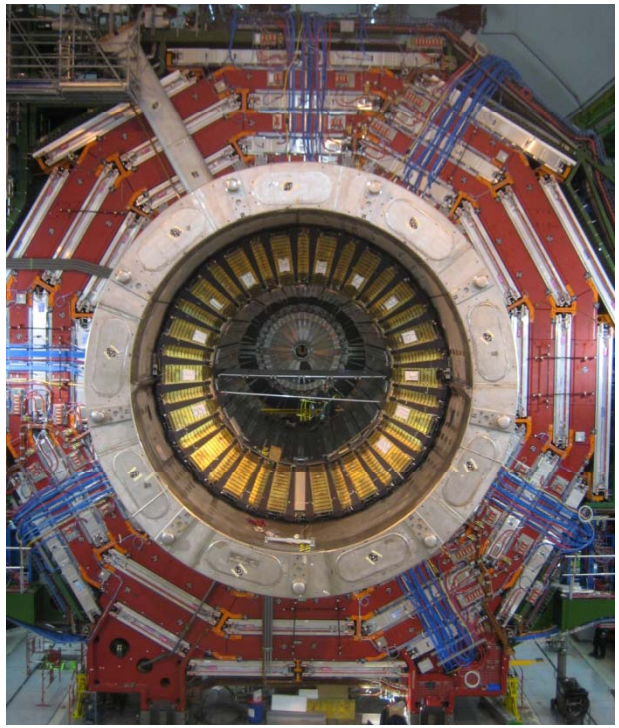
Survey meeting
CERN
May 4, 2007

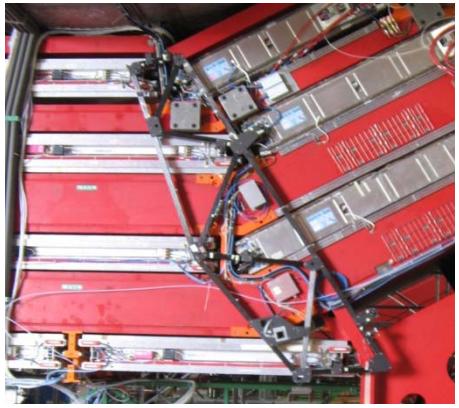
Weekly Tracker Meeting : Survey Meeting - M. Weber and F. Palmonari … good understanding of survey

http://indico.cern.ch/conferenceDisplay.py?confId=14120#1

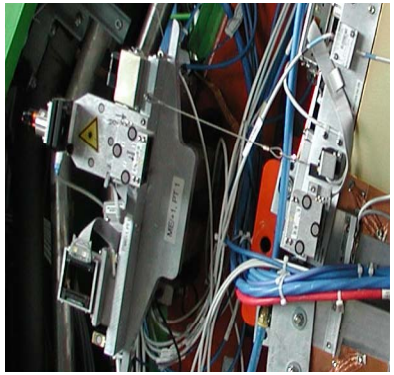
CMS muon system : a lot of metrologic validations in laboratory AND cavern

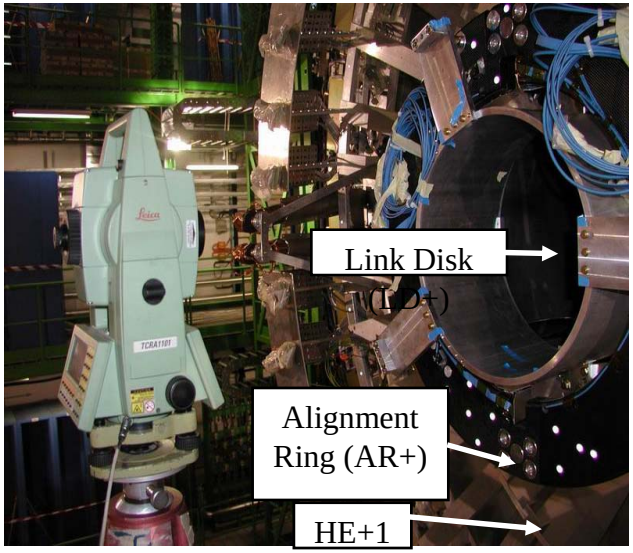
… a CMS workshop to review the status of our survey data … a contribution from the CERN survey group … primarily muon and tracker devices. *The discussion should include also the internal alignt system devices : ARs, LDs, MABs and TPs (calibrations, positions).*
YB0 IS ON THE BEAM NOMINAL LINE with its to-day contents (HB, ECAL …) !!!





Barrel MAB and Forward TP

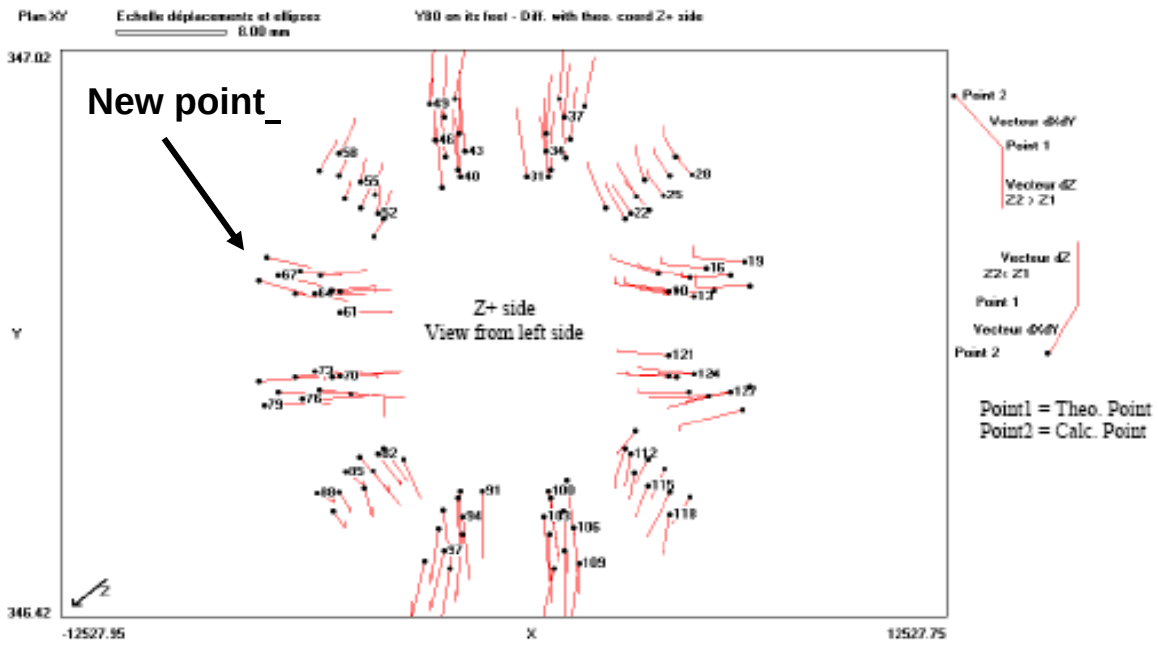




… relative and some beam nominal positions can be given

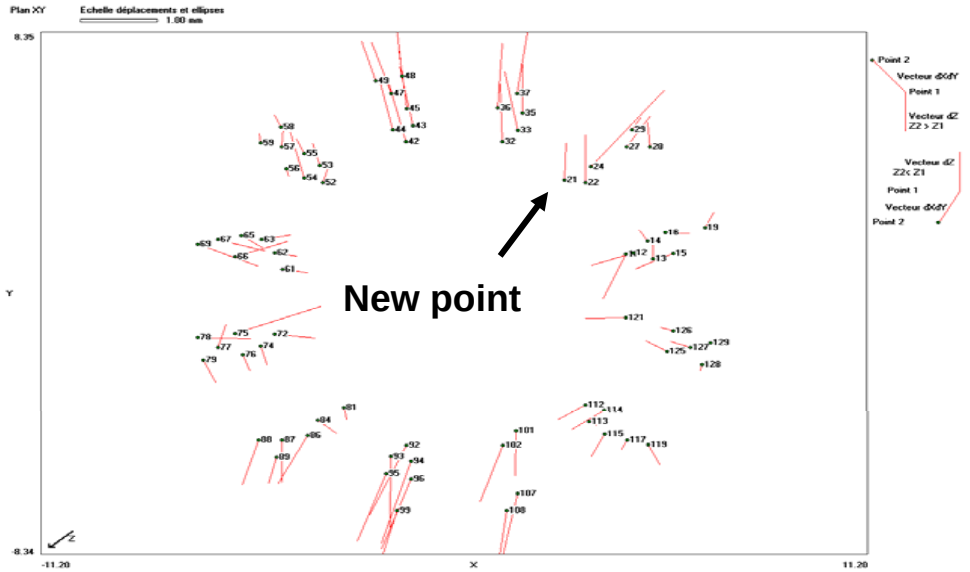
CMS STABILITY : ‘deformations’ of heavy pieces (YB0, YB+2) – R. Goudard

- YB0: chambers, coil, HBs
- differences : assembly/theo. plus deformations



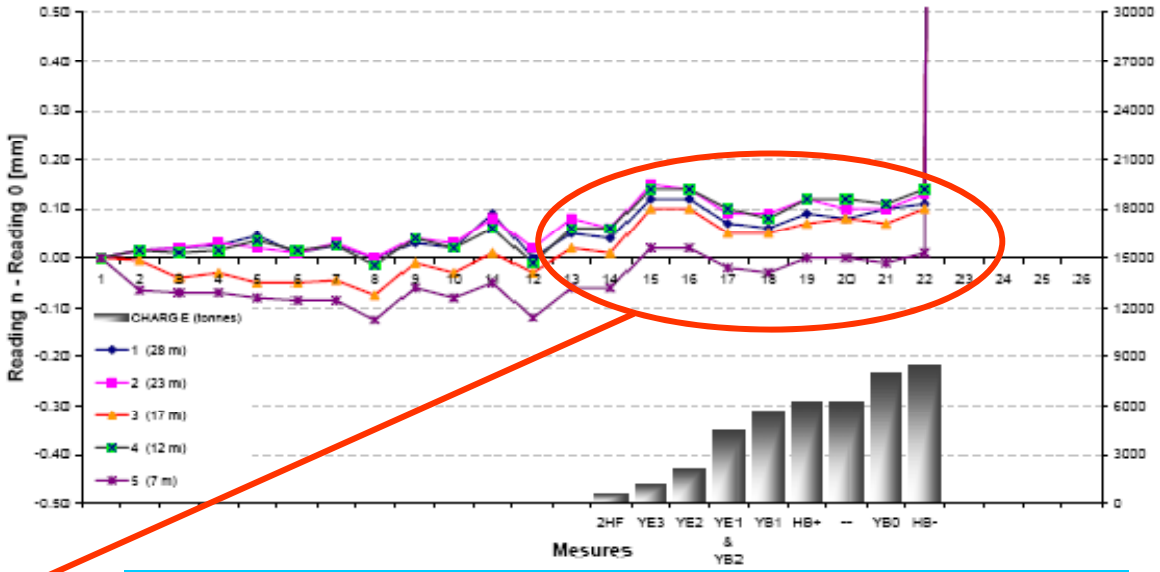
	dX [mm]	**dY [mm]**	dZ [mm]
Min	-10.2	**-9.6**	-1.4
Max	10.5	**11.0**	1.4

YB+2 : control …

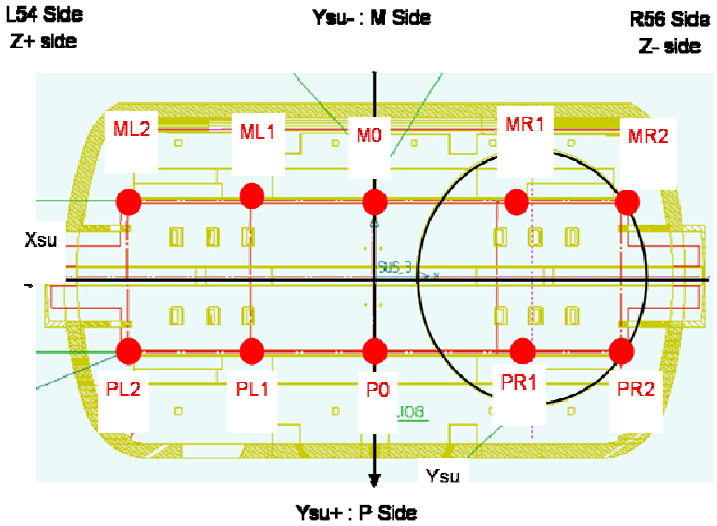


CMS floor stability

- 5 deep rods in the cavern at different depths since Febr.06.
- curve up → floor down



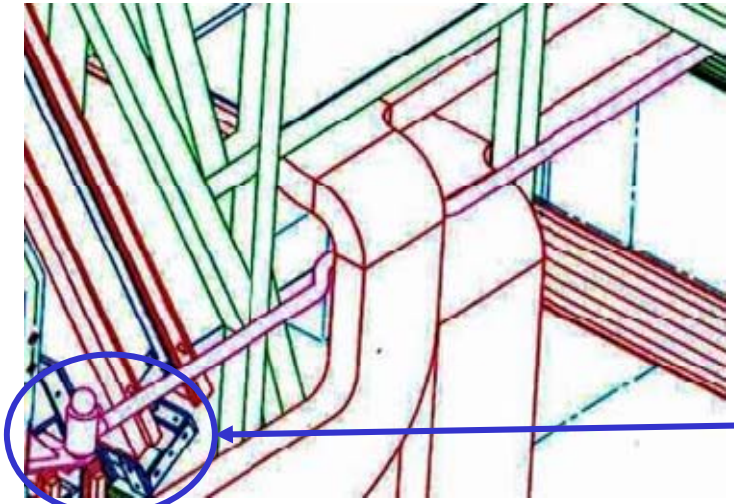
- Some points on floor …



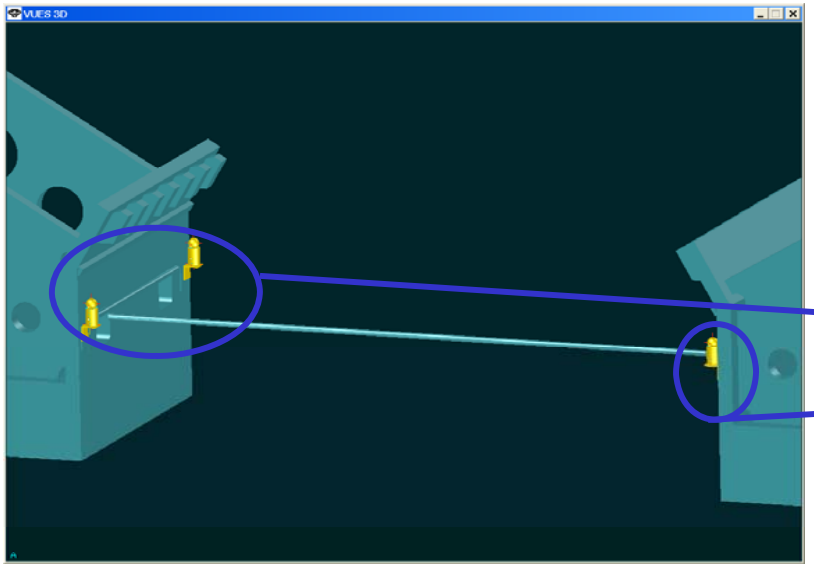
October (meas2) - January (meas1)			
Name	DX [mm]	DY [mm]	DZ [mm]
MR2	-0.2	-0.1	0.0
MR1	0.4	-0.6	-0.2
M0	0.3	-0.2	0.0
ML1	0.2	-0.7	-1.0
ML2	0.8	-0.6	-1.6
PR2	-0.1	-0.1	0.1
PR1	-0.1	0.3	-0.1
P0	0.2	0.1	0.0
PL1	0.3	0.1	-1.1
PL2	1.3	-0.9	-2.7
MAX	**1.3**	**0.3**	**0.1**
MIN	**-0.2**	**-0.9**	**-2.7**
AVERAGE	**0.3**	**-0.3**	**-0.7**

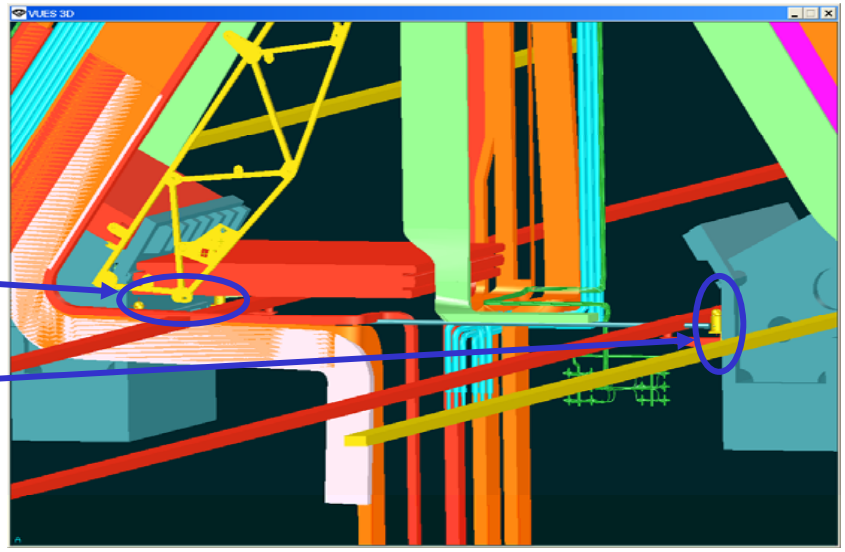
January 07 (meas2) - January 05 (meas1)			
Name	DX [mm]	DY [mm]	DZ [mm]
MR2	-0.3	-1.2	0.2
MR1	0.2	-1.3	0.2
M0	0.4	-0.3	0.3
ML1	0.2	-0.2	-0.5
ML2			
PR2	-0.2	-0.4	-0.2
PR1	0.0	0.6	-0.2
P0	0.4	0.7	-0.3
PL1	0.4	1.2	-1.0
PL2			
MAX	**0.4**	**1.2**	**0.3**
MIN	**-0.3**	**-1.3**	**-1.0**
AVERAGE	**0.1**	**-0.1**	**-0.2**

CMS stability of detectors : 2 HLS systems on YB0 … soon in place



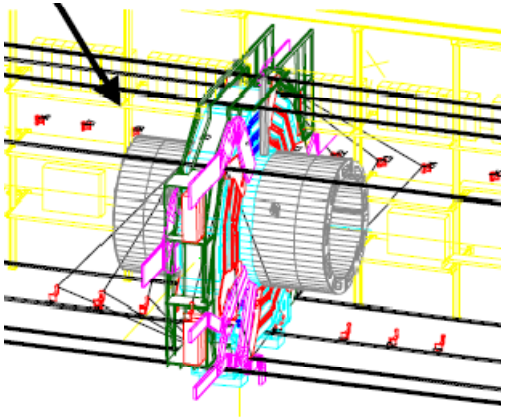
1 HLS in place and link with main low-betas system : 'absolute' … (tube soon in place)

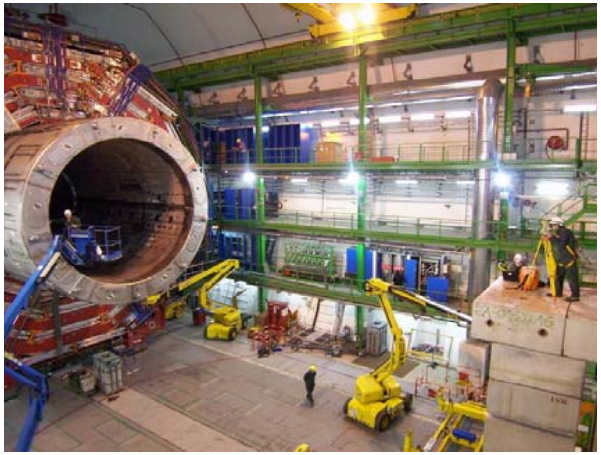




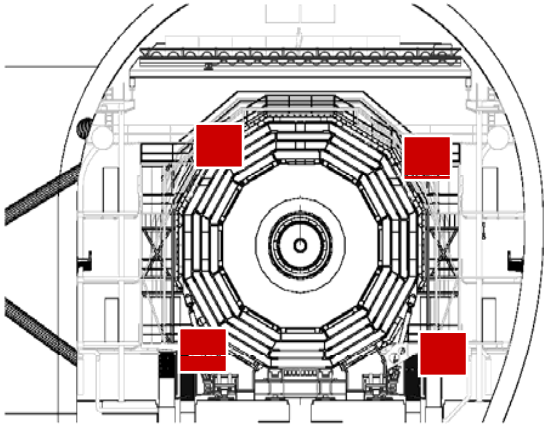
3 HLSs → independent system : rotations monitoring - integration and protection

CMS positions of the YBs and YEs : cavern network by standard survey …





… closure and permanent radial monitoring YBs/YEs from 4 (2?) BCAMs lines – good experience in SX (first magnet closure Sept. 06)

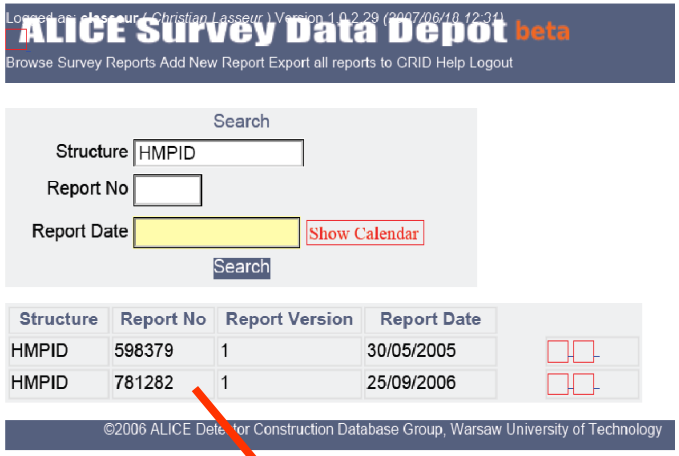


CENTERS	DX (mm) [BCAM - Survey]	DY (mm) [BCAM - Survey]
YB-2	-0.8	1.2
YB-1	-0.6	0.4
YB0	0.0	0.0
YB+1	-0.3	-0.6
YB+2	-0.2	-1.3

MIN (mm)	-0.8	-1.3
MAX (mm)	0.0	1.2
Stdev (mm)	0.3	1.0

ALICE : good understanding of the survey data

'The DCDB interface to upload the survey text files is working well' – R. Salgueiro



http://dcdb.cern.ch/surveydepot-production

- HMPID (installed) and PHOS (not installed) : upload done
- ITS/TOF/FMD/ZDC/PMD/TO/EMCAL : no measures so far (except supports/rails …)
- TRD : module 1 installed not fully measured
- TPC : can be loaded now … see which one after several measures when and after shimming …
- Muon, absorber, dipole, tracking 1 and 2 : will be loaded

> Title: ALICE–HMPID measurement of the reference points on the HMPID structure installed on the SpaceFrame > Date: 25/09/2006 > Subdetector: HMPID > Report URL: https://edms.cern.ch/document/781282 > Version: 1 > General Observations: Point Types: M(easured), T(ransformed), R(eference) > Coordinate System: ALICEPH > Units: m > Nr Columns: 7 > Column Names: Point Name,XPH,YPH,ZPH,Point Type,Target Used,Precision(mm) > Data:
5101,4.5025,1.7796,0.9431,T,Y,1
5102,4.0855,1.5442,2.3043,T,Y,1

… SURVEY : stable and well known area

- cavern network well in accordance with tunnel geometry within 0.5 mm BUT …
- low-betas installed and 'smoothed' quite late (see 'beam nominal line') THEN the VERY definitive positions will be provided only afterwards

LHC-b : understanding of the survey data in progress ? A Survey task Force (S. Blusk) …

Software Week 7-11 of May : "... status of (your) work on implementing the survey measurements into the Conditions DB" with a proposed agenda:
1) What survey measurements do exist ? Maybe some tables of nominal locations & actual locations
2) Timescale for completing the remainder of the survey measurements
3) Scheme for translating survey measurements to relevant offsets in the CondDB
4) What is in the CondDB now, progress toward a first real CondDB based on survey data
5) Timeline for producing a first CondDB using survey data"

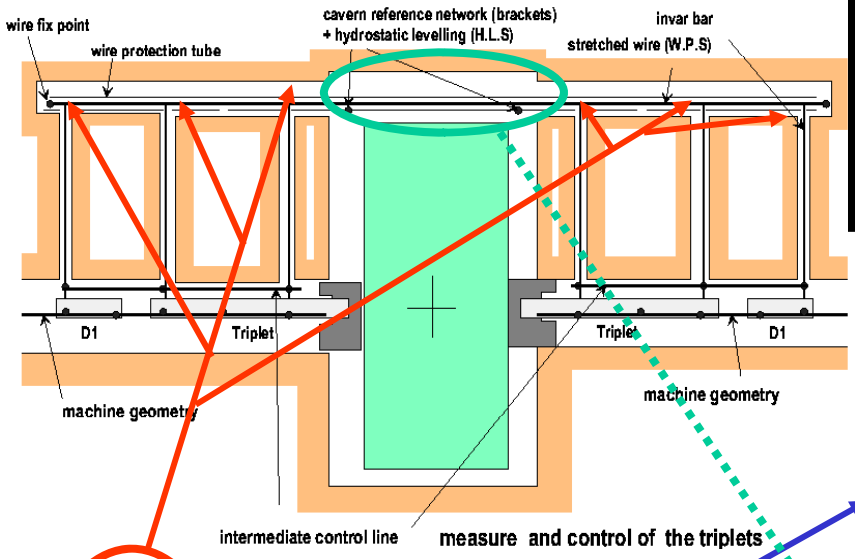
LHCb Week - March 15th, 2007 - REFERENCE LINE FOR POSITIONING OF DETECTORS - SURVEY WORK STATUS Jean-Christophe Gayde / TS-SU-EM
https://edms.cern.ch/document/828727

What about the database LHCbEditor3D ?

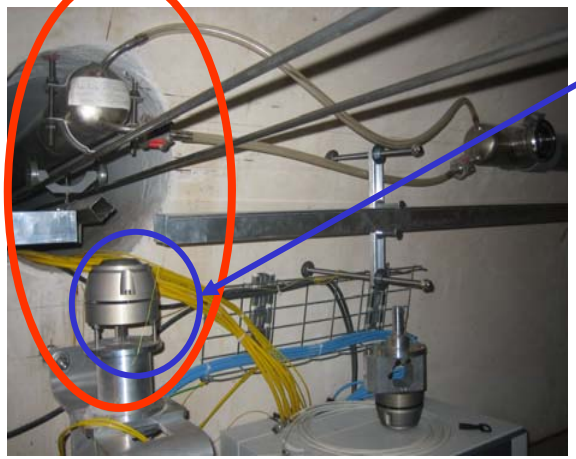
… SURVEY : stable and well known area
- cavern network well in accordance with tunnel geometry within 0.5 mm …
- low-betas installed and 'smoothed' quite early (see 'beam nominal line') THEN the provided positions are 'a priori' definitive – see following

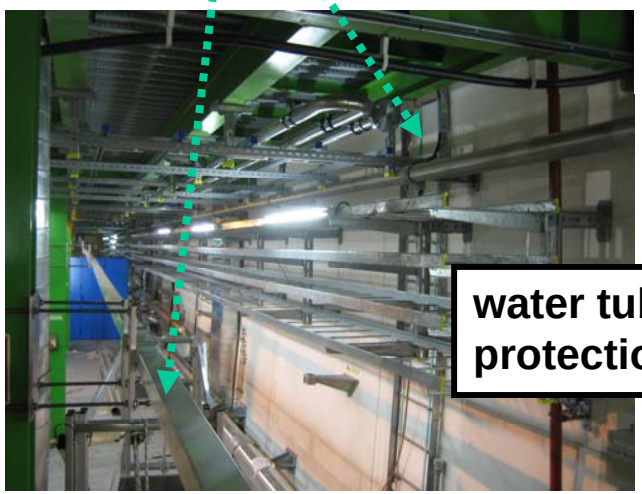
BEAM NOMINAL LINE …

… the ‘smoothest’ line of the low-betas Quads monitored by a strechted wire (link L/R via the survey galeries in 1 and 5) plus an hydrostatic line (all the caverns) and both linked to the experiment reference geometry (brackets on walls, ect). Overall link BEST accuracy : 0.3 mm

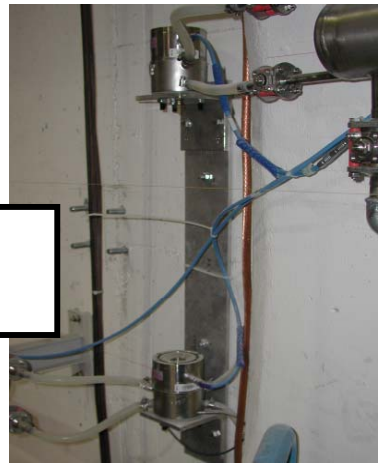


Machine HLS station system in the cavern (Atlas)





water tube and wire protection (CMS)



Each triplet monitored independently with WPS and HLS (20 microns)

‘BEAM NOMINAL LINE’ … and present positions w.r.to low-betas

ATLAS : only L ‘smoothed’ - R ‘smoothing’ : October (both L and R)

ALICE : last installation both sides … L and R ‘smoothing’: November

CMS and LHC-b : both sides ‘smoothed’ BUT ‘re-smoothing’ … November

‘DEFINITIVE SURVEY-DATA’ are available WHEN :

- all the low-betas ‘smoothing’ operations are done and controlled …

- PLUS the commissioning of all the WPS and HLS systems is done

- and the geometrical links WPS / HLS low-betas and machine / experiment FULLY OPERATIONAL and CONTROLLED …

NO BIG GEOMETRICAL ‘MISMATCHS’ EXPECTED AFTER QPOLES REPAIRS BUT re-smoothing has been planed EVERYWHERE AND ANYWAY …

NOT TO US TO GIVE A CONCLUSION …

EVERY KNOWN AND IDENTIFIED STEP OF SURVEY IS FOLLOWED UP, *UPDATED WHEN NECESSARY* AND DOCUMENTED … VERY GOOD REVIEWS HAVE STARTED ALREADY

… IS THERE A MISSING DETECTOR ???

→ **Same as in Sept. 06 : that question IS to your community …**

→ **Still time to correct … maybe it is too late**

→ **Time for a good and efficient preparation of the survey-data**

→ **Integration of 'exotic' survey data IF needed such as WPSs (survey galeries), HLSs (caverns), BCAMs (CMS, extension Atlas)**

→ **OFFICIAL GOOD 'Beam nominal line' positions … maybe late ?**

→ **… BUT we could deliver 'good' approximations NOW !**

→ **… to be discussed !!!**