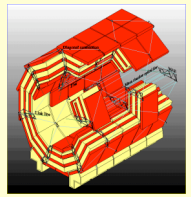

Status Report on

Fork and Chamber Calibrations

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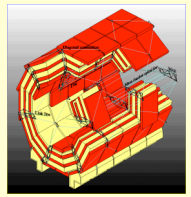
Special thanks to CERN TS-SU Survey group!

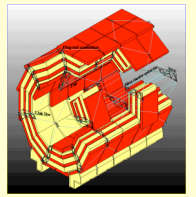
This project is supported by the Hungarian Scientific Research Fund (OTKA): T043145 and T034910



Part I.

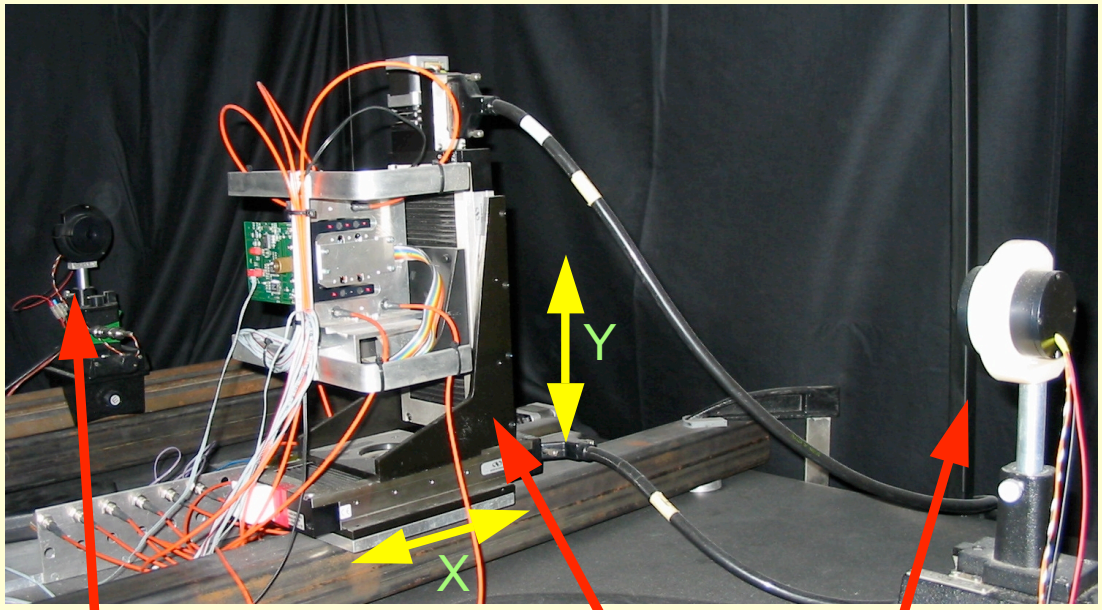
Fork Calibration

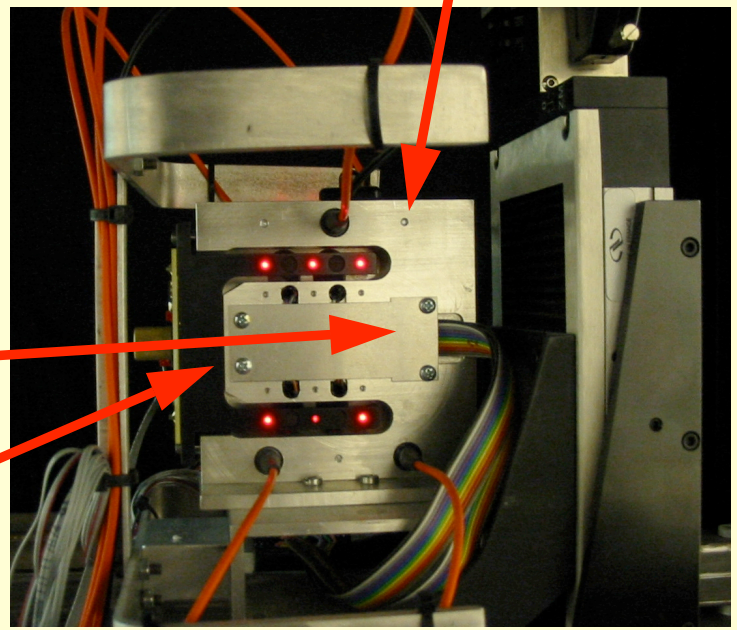
Fork calibration status



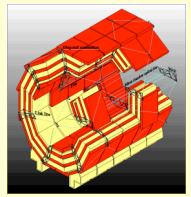
- 1000 forks are already calibrated and delivered to CERN (this is the total need for DT chambers to be installed)
- Up-to-date status can be found at:
  http://kismalac.phys.klte.hu/cgi-bin/indexpage.pl
- Calibration of 200 spare forks is on the way …

Fork calibration bench



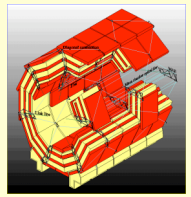


Fork calibration procedure



- The table is moved until the given source centroid 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).

Analysis process



Aim:

Describe LED positions in the coordinate system of the Fork.

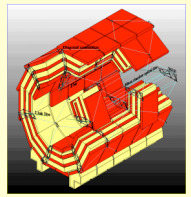
Analysis process:

- transform measured data into the system of the calibration tool
- statistical analysis on multiple measurements
  (estimation of the confidence level of the measurement)
- if the calibration is accepted in general then calculate
  the average position of each object
- calculate the positions in the fork's own system

Remark:

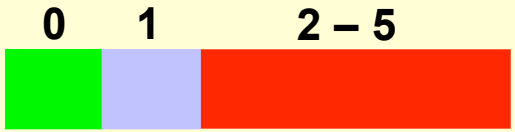
The two sides of the forks are measured independently.
The connection is made through the fiber-optical sources of the calibration tool.

Calibration quality

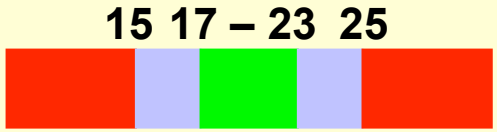


The calibration is classified as GOOD / WARNING / BAD upon the following parameters:

- **Number of rejected measurements (out of 5):**



- **Bench temperature:**



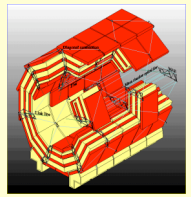
C°

- **Max-Min of the reconstructed position / measurement:**

µm

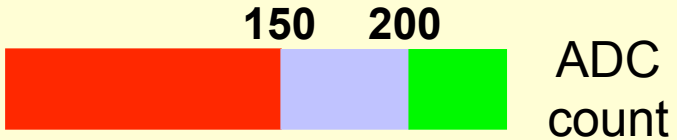
Action in the case of „BAD” qualification: repeat the calibration

Fork quality



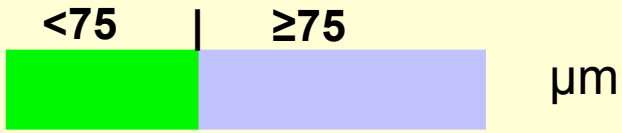
Forks are classified as **GOOD** / **WARNING** / **BAD** upon the following parameters:

- **Light source intensity (0 to 255):**

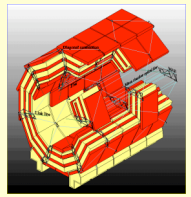


Action in the case of „BAD” qualification: repeat the LED, new calibration

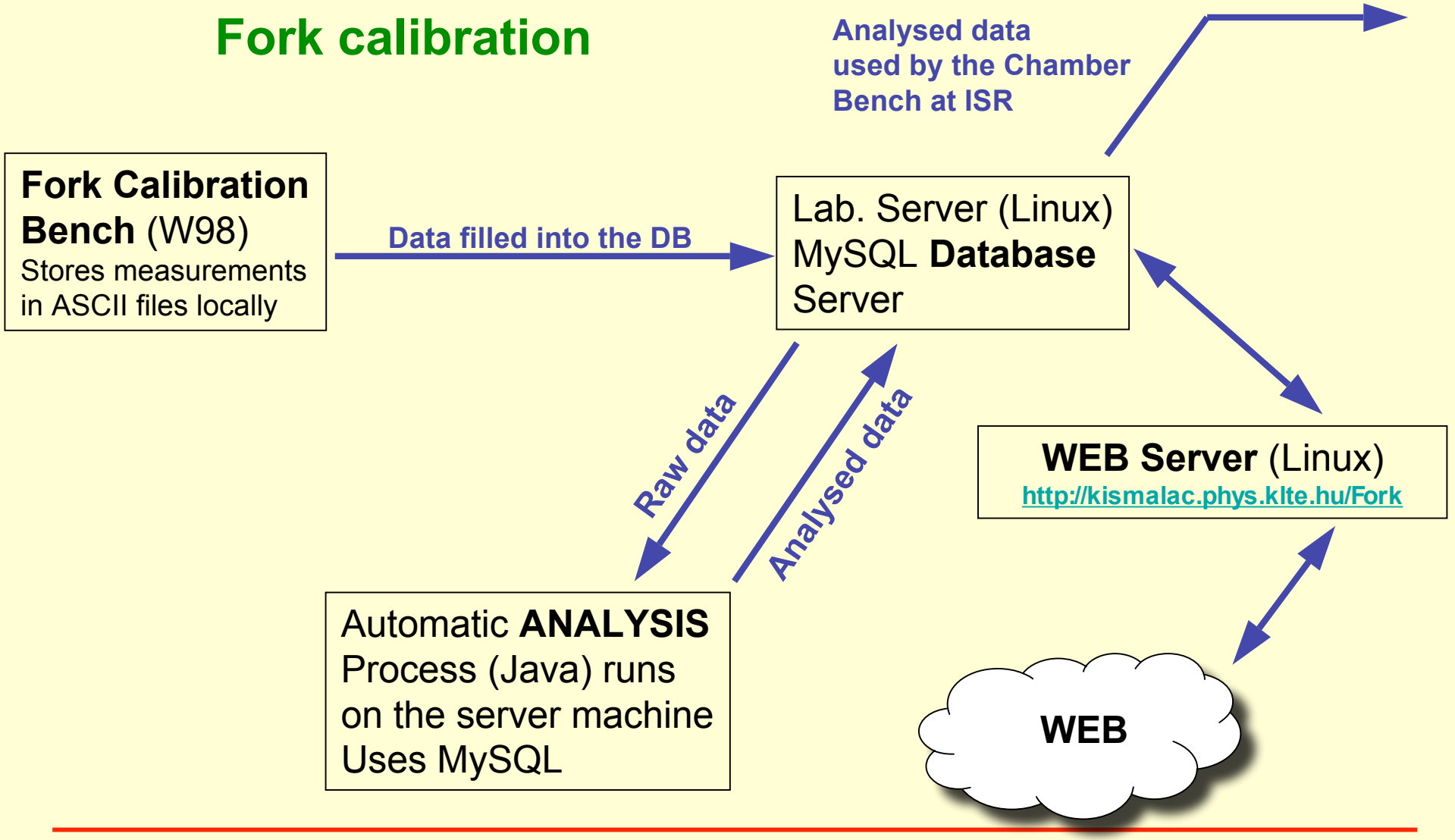
- **LED position deviation from the design value**



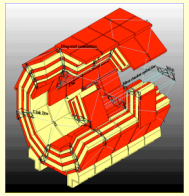
Data flow & storage strategy



Fork calibration

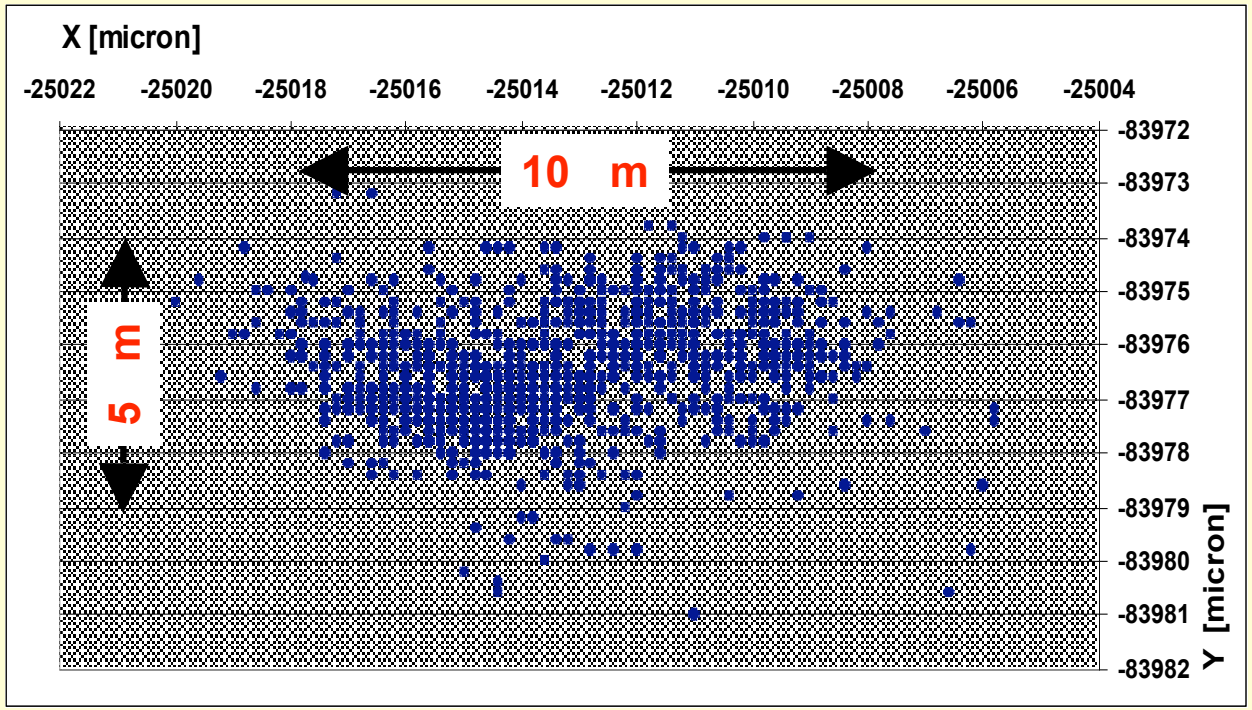


Test of the absolute bench precision



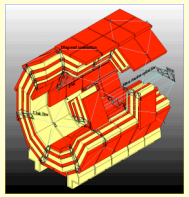
Since the fiber optical reference sources are always measured
it is possible to test the precision of the measurement-analysis process

Example:
fiber-optical source
CLF1



Measurement error < 15 m

Fork repositioning test

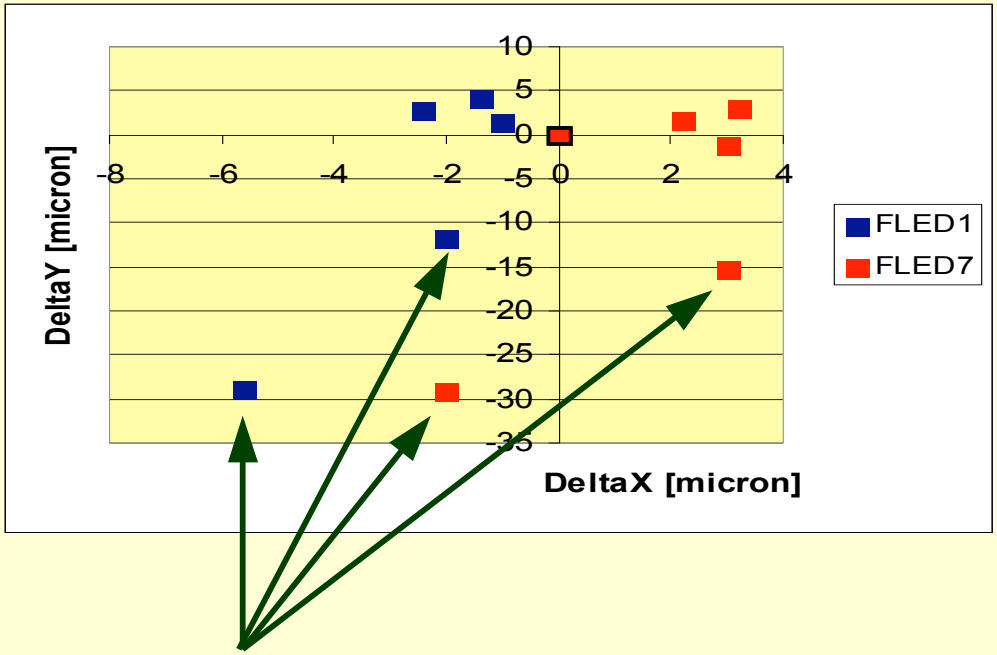


The same fork was measured, de-mounted, mounted, measured again…

Repositioning error:

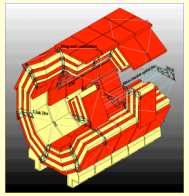
< 6 m in X direction (CMS Phi)
< 30 m in Y direction (CMS R)

Differences between the measurements.
Reference: 1-st measurement



Fork is stressed in
its seat in Y direction

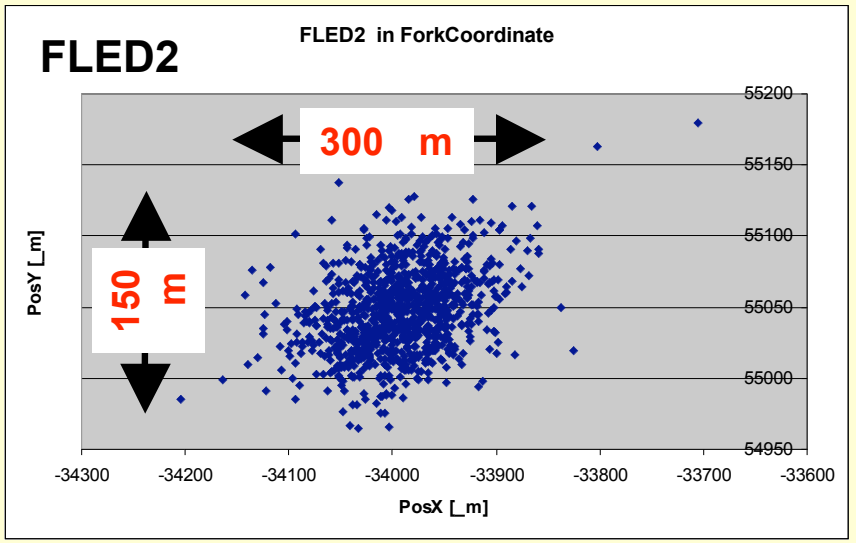
Statistical analysis of the manufacturing – assembly precision

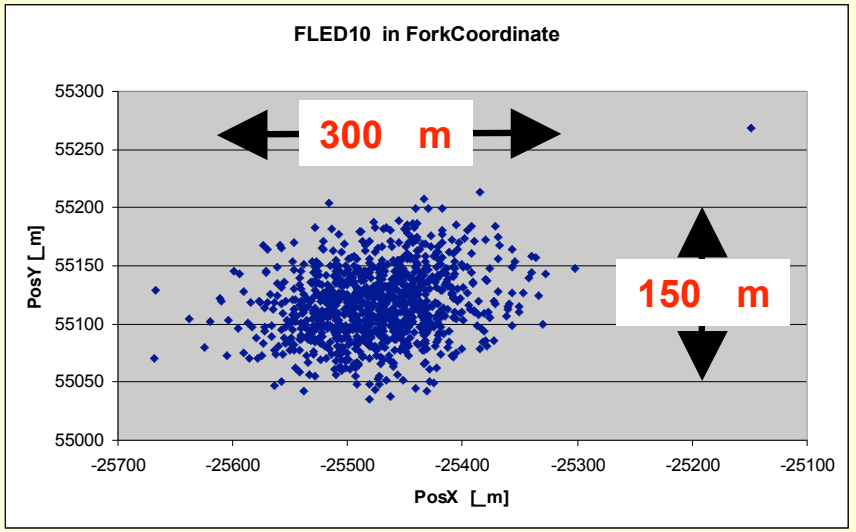


Individual LED positions of in the Fork Coordinate:

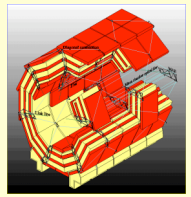
examples: FLED2 and FLED10

Deviation in the range of ~ ±150 m





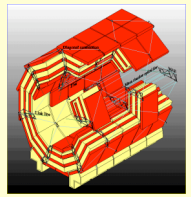
Very good
BUT
Fork calibration is inevitable!



Part II.

Chamber Calibration

Chamber calibration status



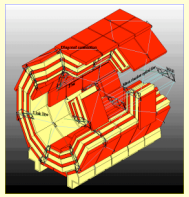
- **Chambers already calibrated:**

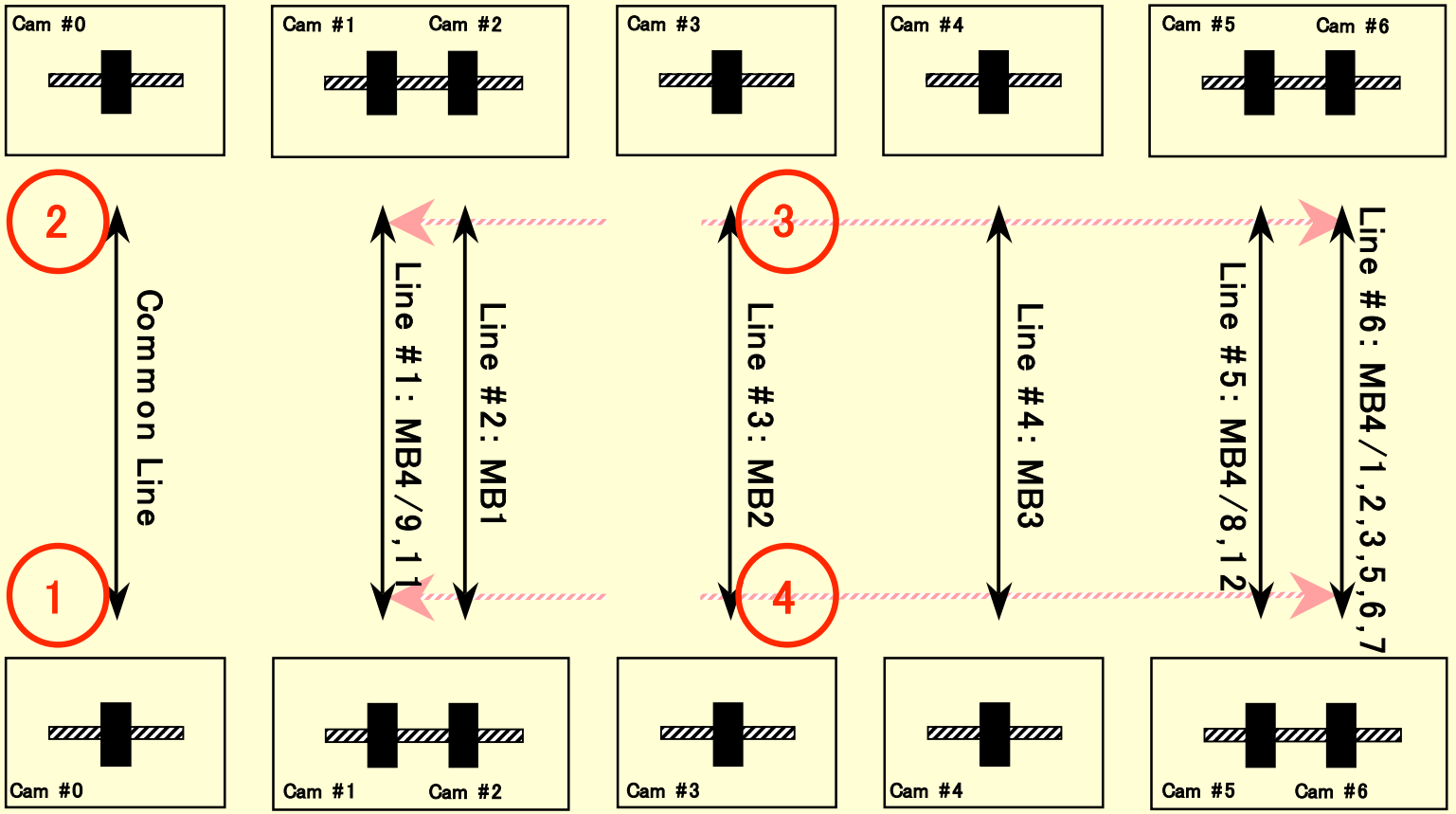
MB1	**32**
MB2	**32**
MB3	**28**
MB4 (all types)	**12**
Total calibrated:	**104**

- **Up to date status can be found at:**

http://kismalac.phys.klte.hu/cgi-bin/Chamber/ChamberSummary.pl

ISR Chamber calibration bench layout



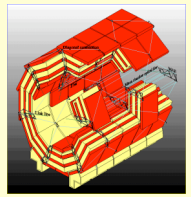


Chamber FrontEnd side

○: Chamber corner

Top view

Chamber calibration procedure

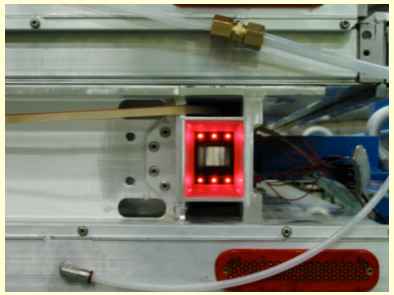


1) Photogrammetric measurement

Provides the Corner Block target positions in the Lab reference frame

2) Fork LED measurement with cameras

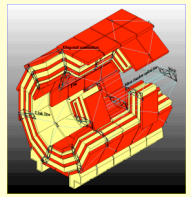
Provides the fork LED centroid positions in the Lab reference frame



3) Analysis – Calculation of

a. Corner Blocks in the SuperLayer Reference frame
b. SuperLayers in the Chamber Reference frame
c. Fork positions in the Chamber Reference frame

Data flow & storage strategy



Chamber calibration

WEB Server (Linux)

Lab. Server (Linux)
MySQL **Database** Server

Analysed data from the Fork Calibration Bench DB server

Raw data

Analysed data

WEB

Data filled into the DB

Data filled into the DB

Chamber Calibration Bench (W98)
Stores data locally in ASCII files

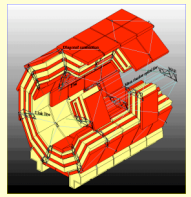
Automatic **EDITOR** Process (Java) runs on the server machine
Uses MySQL, creates COCOA descriptions and grabs results from the COCOA output

Photogrammetric measurement by the Survey Group

COCOA input

Analysed data

COCOA runs on the server

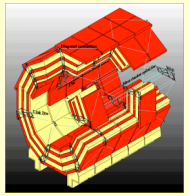


Statistical analysis on the planarity and trapezoidity of the SuperLayers

Analysed: 32 chambers of MB1 type
Specific code: 001-004

☹ **MB2 & MB3 results are coming soon!** ☹

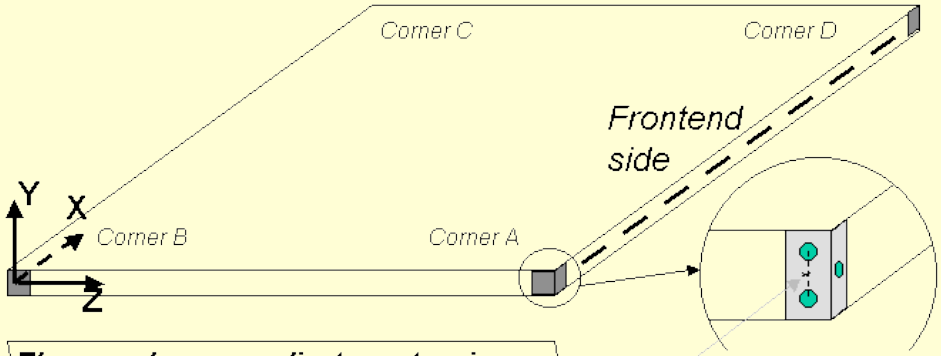
Introduction

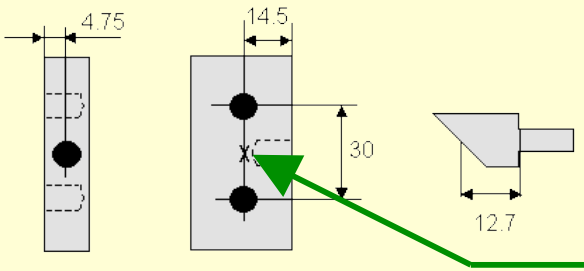


Gives

- **Z position of Corner A**
- **XZ position of Corner C**
- **XYZ position of Corner D**

in the frame of the SuperLayer

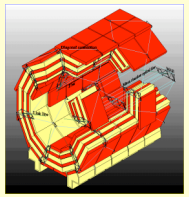




Corner block reference point: middle-point on the line drawn on the surface and connecting the centres of the holes on the two-hole side.

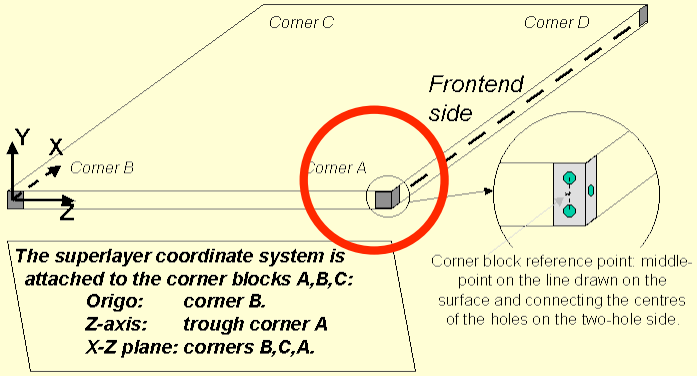
Middle point on Corner Blocks' two-target surface is used for this analysis

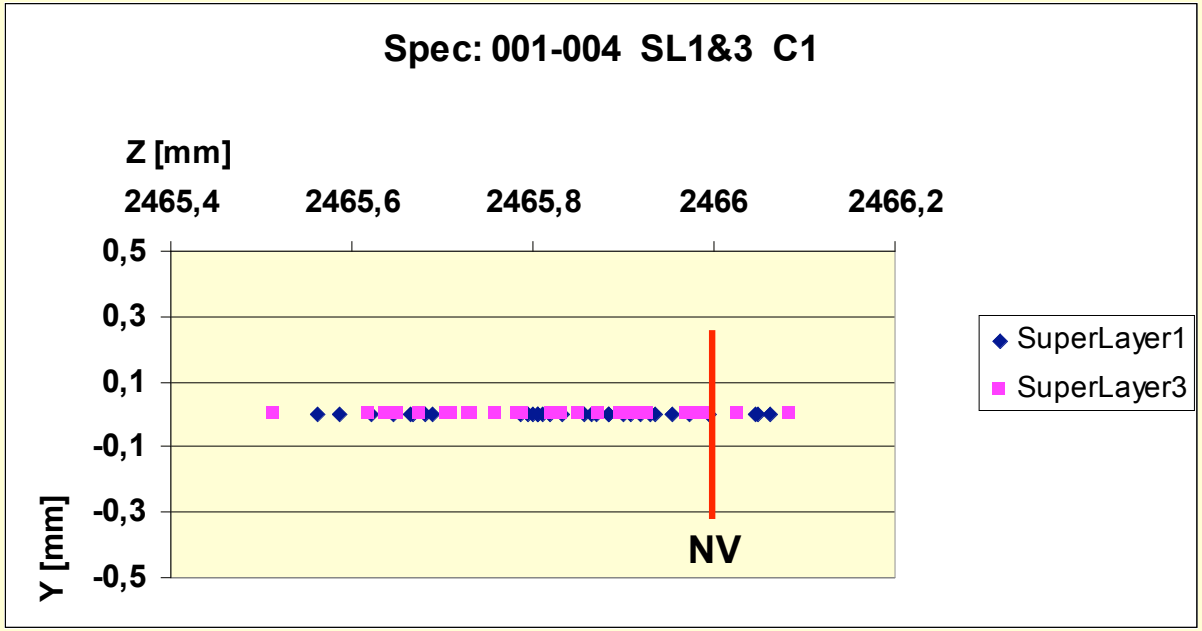
SuperLayers 1 & 3, Corner “A”:



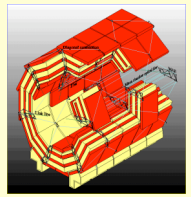
Z [mm]. Nominal value (NV): 2466 mm

	Average	Max	Min	Sigma	Av. - NV
SL1:	2465.831	2466.062	2465.563	0.136	-0.169
SL3:	2465.828	2466.083	2465.513	0.133	-0.172





SuperLayers 1 & 3, Corner “C”:

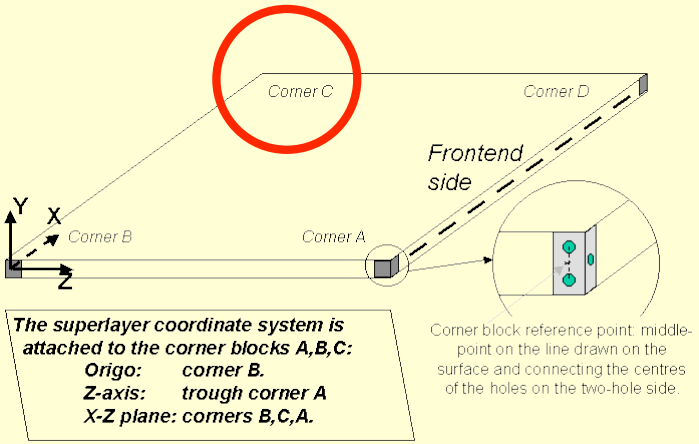


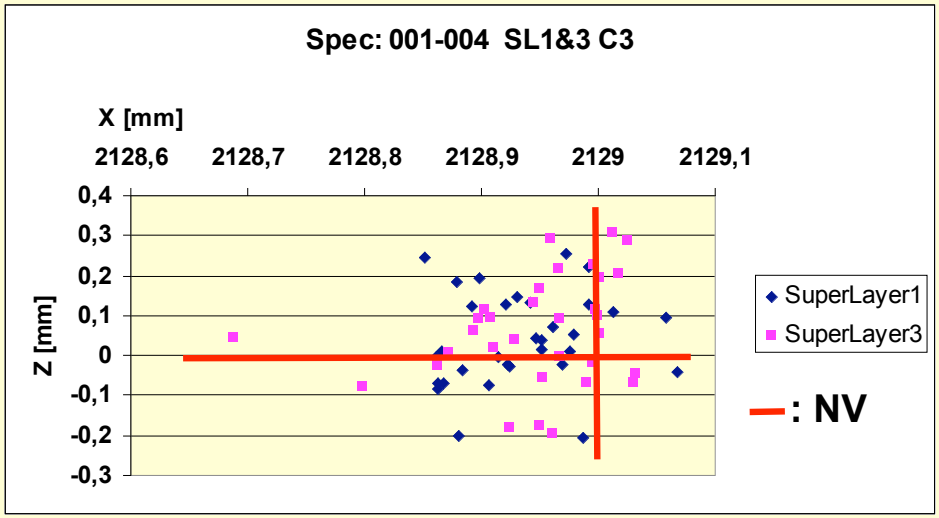
X [mm]. Nominal value (NV): 2129 mm

	Average	Max	Min	Sigma	Av. - NV
SL1:	2128.934	2129.068	2128.852	0.057	-0.066
SL3:	2128.947	2129.033	2128.688	0.072	-0.053

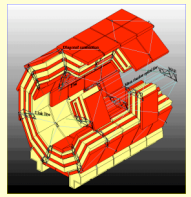
Z [mm]. Nominal value (NV): 0 mm

	Average	Max	Min	Sigma	Av. - NV
SL1:	0.076	0.253	-0.202	0.116	0.076
SL3:	0.058	0.308	-0.194	0.135	0.058





SuperLayers 1 & 3, Corner “D”:



X [mm]. Nominal value (NV): 2129 mm

	Average	Max	Min	Sigma	Av. - NV
SL1	2128.980	2129.097	2128.861	0.063	-0.020
SL3	2128.998 *	2129.127	2128.688	0.097	-0.002

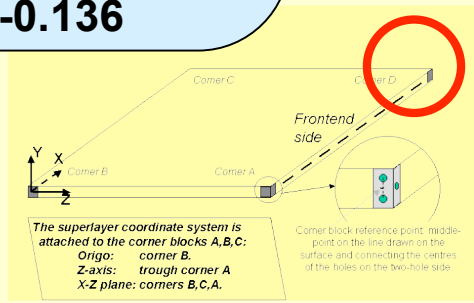
Y [mm]. Nominal value (NV): 0 mm

	Average	Max	Min	Sigma	Av. - NV
SL1	0.154	0.489	0.016	0.149	0.154
SL3	0.129	0.346	0.010	0.126	0.129

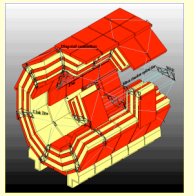
Z [mm]. Nominal value (NV): 2466 mm

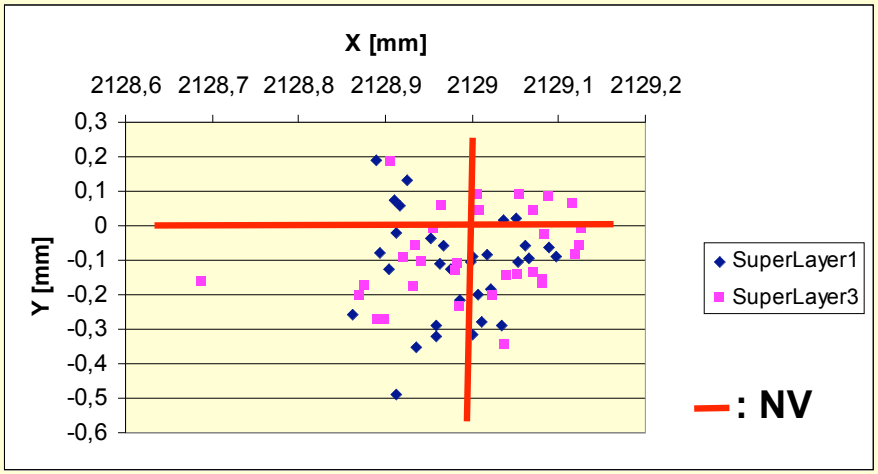
	Average	Max	Min	Sigma	Av. - NV
SL1	2465.885	2466.162	2465.628	0.159	-0.115
SL3	2465.864	2466.152	2465.516	0.167	-0.136

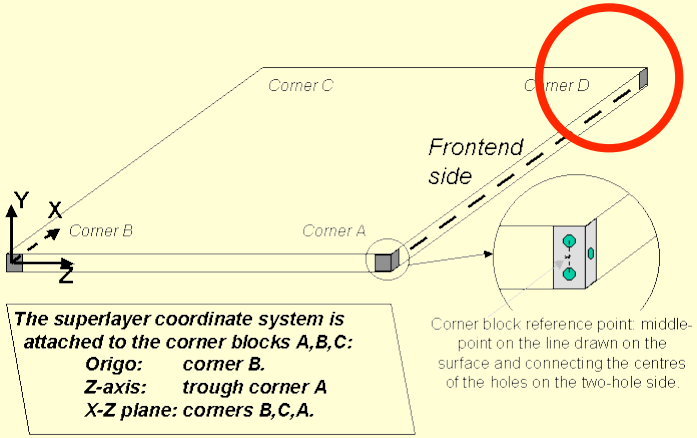
* Avg. without far point: 2129.008

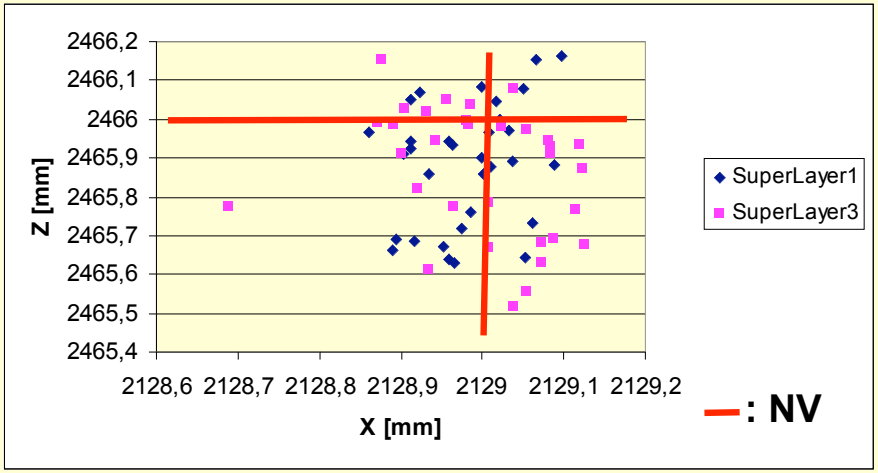


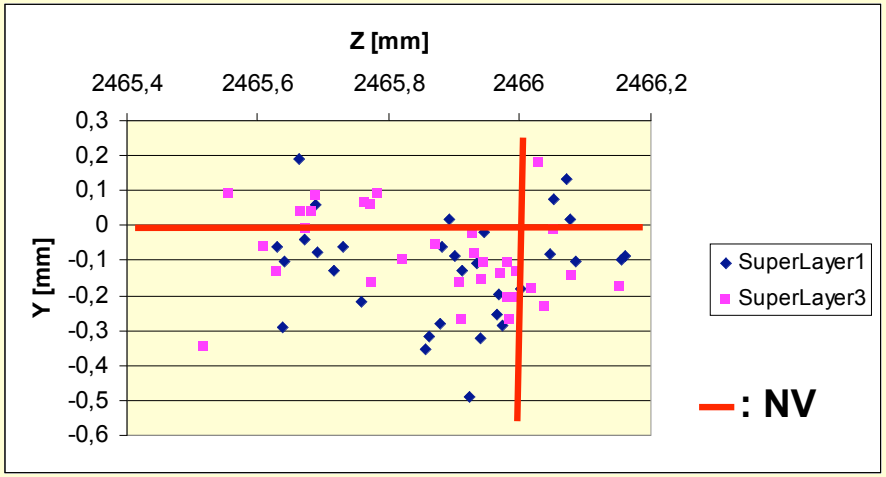
SuperLayers 1 & 3, Corner “D” (cont.):



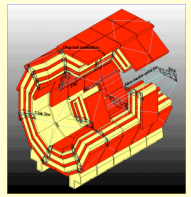






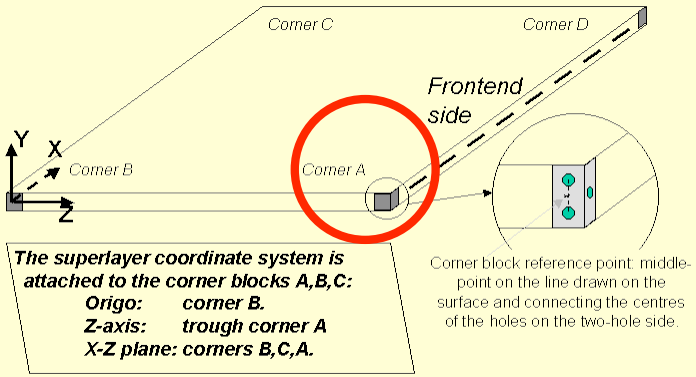


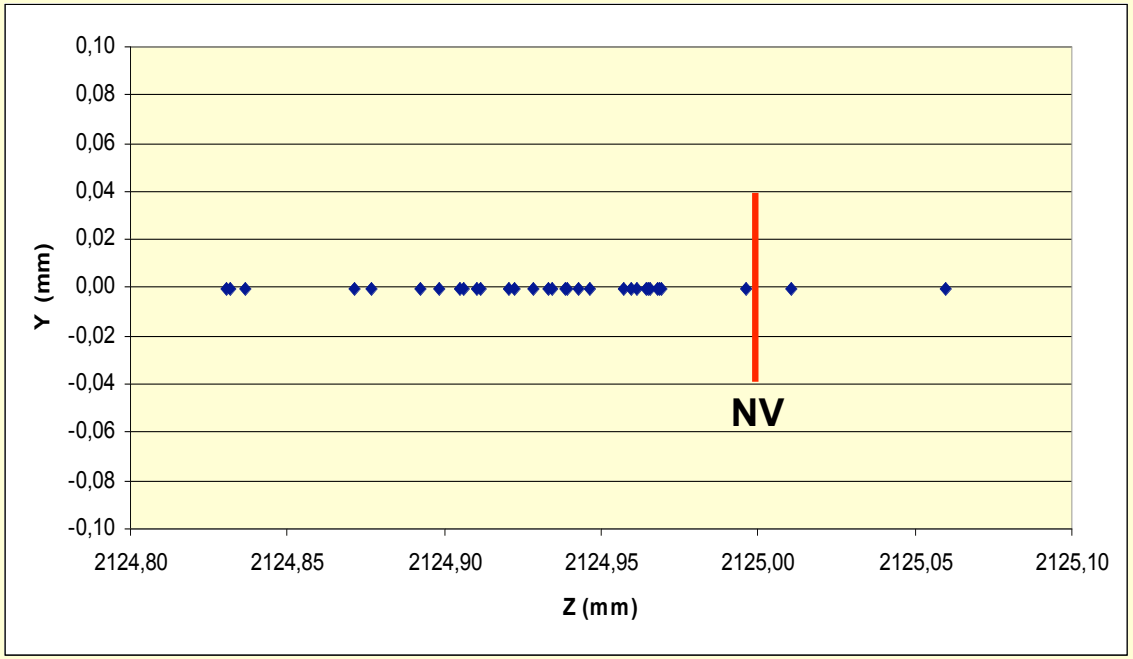
SuperLayer 2, Corner “A”:



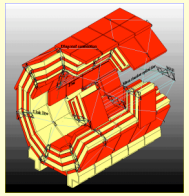
Z [mm]. Nominal value (NV): 2125 mm

	Average	Max	Min	Sigma	Av. - NV
SL2:	2124.932	2125.060	2124.831	0.050	-0.068





SuperLayer 2, Corner “C”:

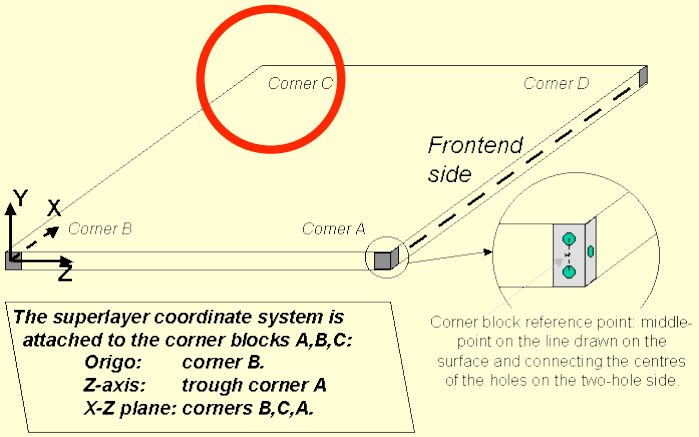


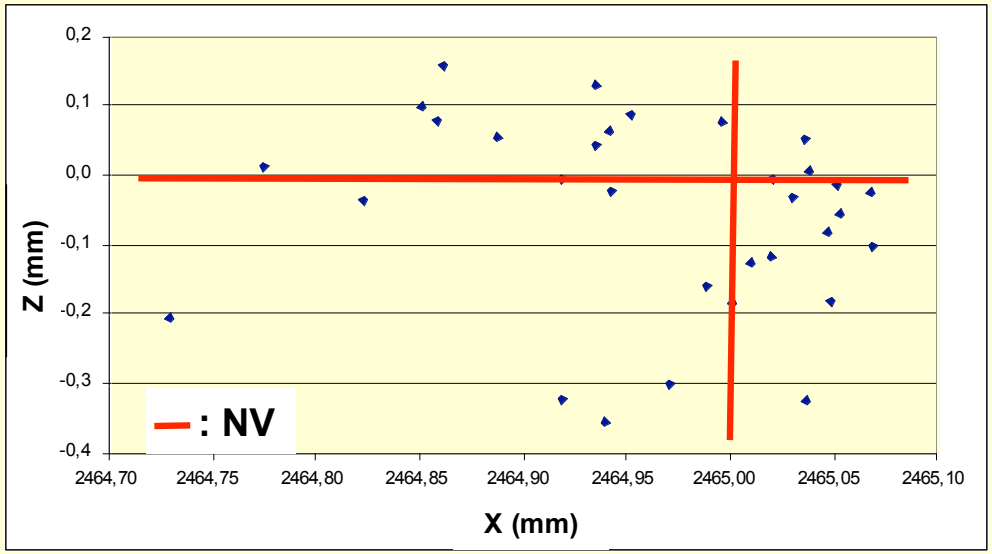
X [mm]. Nominal value (NV): 2465 mm

	Average	Max	Min	Sigma	Av. - NV
SL2:	2464.960	2465.068	2464.728	0.088	-0.040

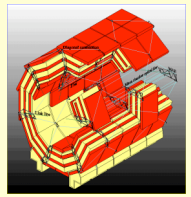
Z [mm]. Nominal value (NV): 0 mm

	Average	Max	Min	Sigma	Av. - NV
SL2:	-0.067	0.169	-0.363	0.139	-0.067





SuperLayer 2, Corner “D”:



X [mm]. Nominal value (NV): 2465 mm

	Average	Max	Min	Sigma	Av. - NV
SL2	2464.950 *	2465.093	2464.267	0.145	-0.050

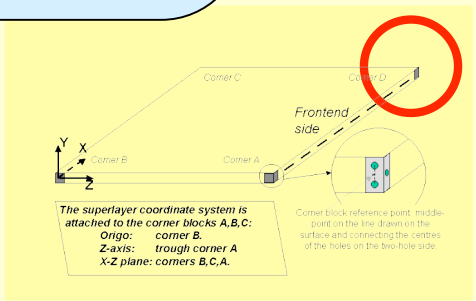
Y [mm]. Nominal value (NV): 0 mm

	Average	Max	Min	Sigma	Av. - NV
SL2	0.114	0.551	-0.138	0.140	0.114

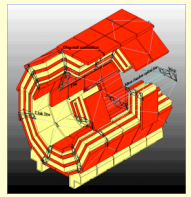
Z [mm]. Nominal value (NV): 2125 mm

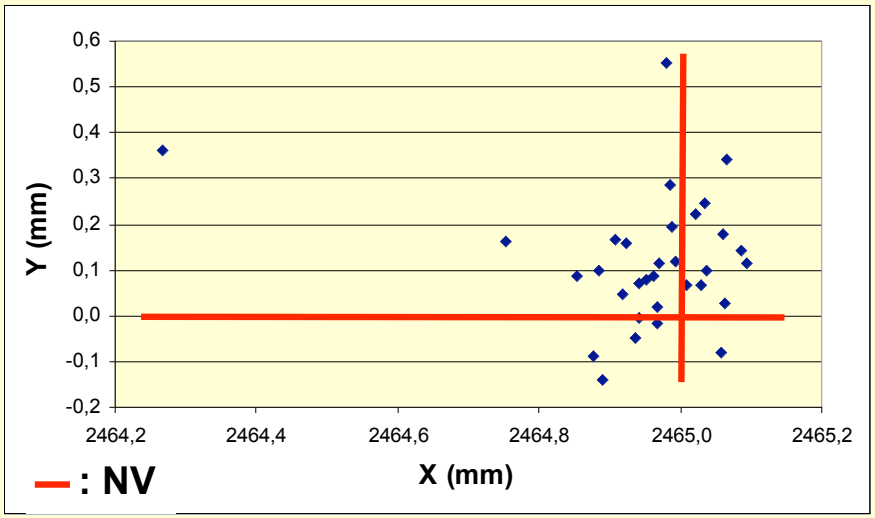
	Average	Max	Min	Sigma	Av. - NV
SL2	2124.891	2125.095	2124.525	0.151	-0.109

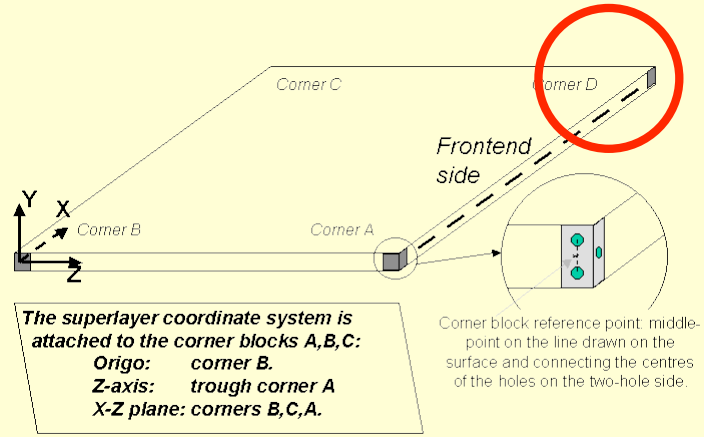
* Avg. without far point: 2464.972

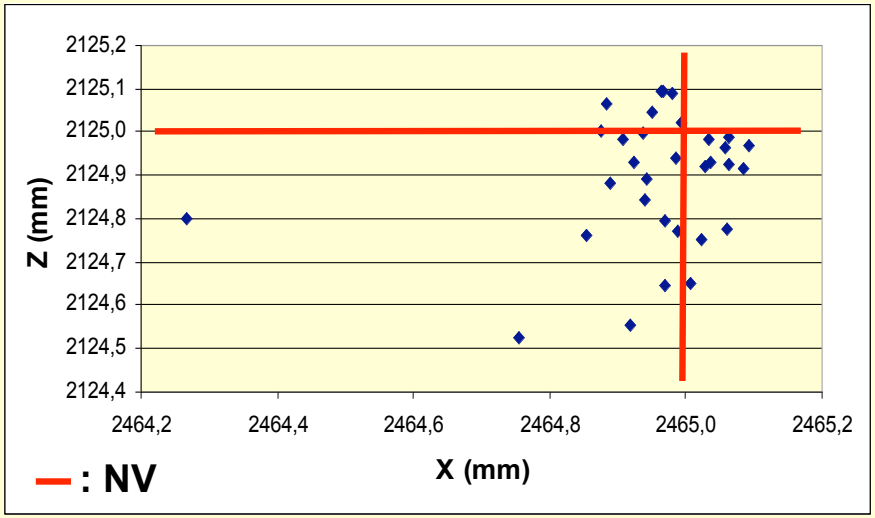


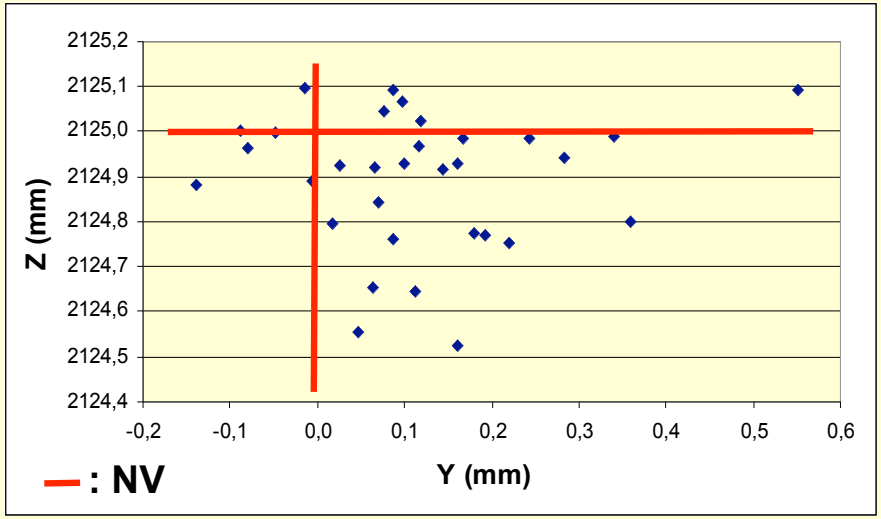
SuperLayer 2, Corner “D” (cont.):

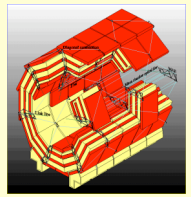








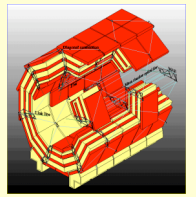




Statistical analysis on SuperLayer positions in the Chamber Frame

Analysed: 32 chambers of MB1 type
Specific codes: 001-004

Introduction

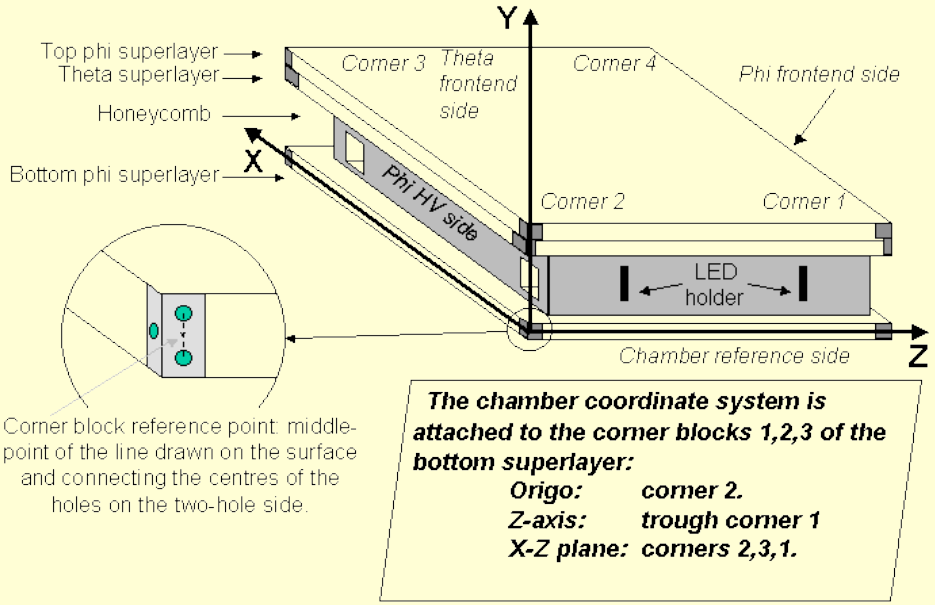


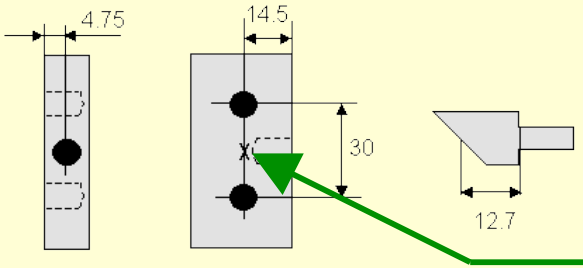
Gives:

- **XYZ position of SL2 Corner 1**
- **XYZ position of SL3 Corner 2**

in the Chamber Reference Frame

Still to be completed with the SuperLayer 2,3 angles w.r.t the SuperLayer 1

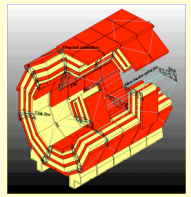




Corner block reference point: middle-point on the line drawn on the surface and connecting the centres of the holes on the two-hole side.

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

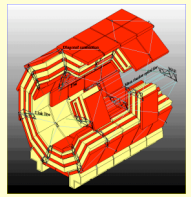
SuperLayer 2, Corner “C1”:



		X	Y	Z
MB1 + :	**Average**	-19.10	182.96	2465.44
(001,002)	**Sigma**	0.15	0.29	0.26
	Max	-18.80	183.54	2465.82
	Min	-19.34	182.56	2464.97
	Nominal	-19.00	---------	2465.50

		X	Y	Z
MB1 —	**Average**	22.95	183.30	2465.32
(003,004)	**Sigma**	0.08	0.68	0.13
	Max	23.08	184.35	2465.51
	Min	22.82	182.61	2465.14
	Nominal	23.00	---------	2465.50

SuperLayer 3, Corner “C2”:



		X	Y	Z
MB1 + :	**Average**	-20.90	236.84	0.03
(001,002)	**Sigma**	0.08	0.37	0.26
	Max	-20.74	237.56	0.51
	Min	-21.06	236.31	0.42
	Nominal	-21.00	---------	0.00

		X	Y	Z
MB1 —	**Ave**	21.10	237.39	-0.06
(003,004)	**Sigm**	0.07	0.67	0.12
	Max	21.18	238.39	0.07
	Min	20.97	236.41	-0.22
	Nominal	21.00	----------	0.00