Gantry Centre Qualification Procedures

CMS Gantry Working Group

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1 Introduction

The Gantry qualification procedures will allow a starting qualification of the gantry setup in each assembly centres. For that reason some assembly rules has to be fixed in order to produce modules as much as possible with the same quality.

Whenever the gantry setup is completed, such starting qualification procedures should be applied on each centre before starting the production phase, in order to assure a good standard quality of the assembly job in all the gantry centres. Before reading this document it's highly raccomended to read the documents about the Pattern recognition software by Alex Ho and the general document written by Michela Lenzi, about the general CERN gantry software.

2 Positioning Precision

On that section are included all the basic tests to certify the gantry precision in the measurement of the fiducial marks coordinates.

2.1 Manual positioning repeatibility

This is a very simple first gantry test, that will certify the error on the repetibility of a manual measurement of the coordinates of the same sensor fiducial marks with the joystick made several times.

- Hold with vacuum a silicon sensor
- Move the camera away randomly from the Silicon Marker (e.g. 50-100 μ m away)

- Measure the position of silicon marker with joystick
- Collect the distribution of X and Y of the silicon marker
- Register the Width of Distribution

3 Pattern Recognition (PR) Precision

In the production phase, in oder to increase the precision and speed-up the assembly job, it will be strictly needed the use of a pattern recognition system to measure the fiducial marks coordinates. When all the PR setup and calibration steps are compeleted, then some very simple tests will be devoted in order to certify the PR realibility

3.1 PR Intrinsic Repeatibility

This test, will certify the error on the repetibility of the measurement of the coordinates of the same sensor fiducial marks with the PR.

- Let place the Camera in fixed position with respect the Silicon Marker (e.g. 50-100μm away)
- Do a 'Find Image'
- Repeat previous step 100 times
- Measure the distribution of X and Y of found image (MMI coordinates)
- evaluate the width of Distribution

3.2 PR Global Repeatibility

This test will certify the reapetibility of the PR measurement, changing the starting point around the position of the target.

- let place the Camera at corners of a grid centered on a Silicon fiducial mark (e.g. 100μm x 100μm with steps of 10μm)
- Do a 'Find Image'
- Repeat previous 2 steps 100 times
- Measure the Distribution of X and Y of found image (MMI coordinates)
- evaluate the width of Distribution

4 Alignment Precision

The tests included in the present section are devoted to certify the gantry accuracy during the sensor pickup and place and rotation, wich are the basic operations of the assembly procedure.

4.1 Pick and Place

During this test, a sensor will be picked up and placed down several times and the differences in the fiducial marks coordinates will be measured.

- Pickup Silicon Wafer
- Put down and vacuum hold
- Measure Marker position
- Repeat previous 3 steps 100 times
- measure the distribution of the position difference between step i and i-1, for X and Y
- Evaluate the mean and the width of the distribution

4.2 Corrections on the rotations

During the test, a sensor will be picked up, rotated and placed down several times in order to certify the whole gantry rotation operation errors.

1. put the sensor on the assembly plate.
2. measure the coordinates of marks A and B to get the initial angle θ_{init} with respect to the Y axis.
3. move the pick-up tool to (or near) the center of the sensor, lift it, ask for a (little) θ_{rot} rotation and then land it.
4. measure the final coordinates of A and B to get the final angle θ_{final}
5. the corresponding error on the rotation will be :

   $\delta\theta_{rot} = \theta_{final}$ - $(\theta_{init} + \theta_{rot})$
6. from the actual position of the sensor, repeat steps 2 to 5 several times with different θ_{rot} ranging from -5° to 5°

7. plot the correlation $\delta\theta_{rot}$ vs θ_{rot}

8. After the measurements the following correlation should be found :

   $f(\theta_{rot})$ = a + b θ_{rot} + c cos (θ_{rot}) in particular (lyon):

   $f(\theta_{rot})$ = - 0.92 + 0.92 cos(17.2 θ_{rot})

9. Thus the effective θ_{rot}^{eff} rotation to be applied instead of the wanted θ_{rot} rotation, will be :

   θ_{rot}^{eff} = θ_{rot} - $f(\theta_{rot})$

5 Assembly Procedure Precision

5.1 Silicon-Silicon-Frame Assembly(I)

- Produce dummy module without glue
- Measure the fiducial markers of the silicon sensors 1-2-3-4 in the precision pins reference frame as shown in Fig 1
- collect the distribution of $Y_2 - Y_3$ and $Y_1 - Y_4$, thus testing the silicon relative position
- collect the distribution of α_{12} - α_{43} , thus testing the silicon to silicon rotation

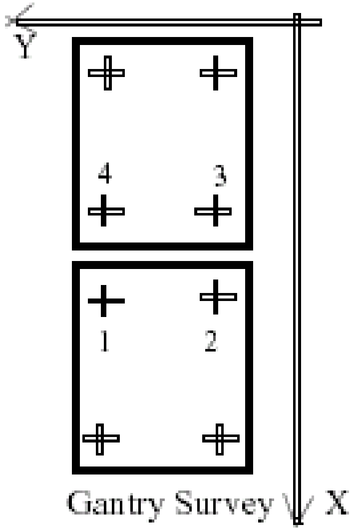

Figure 1: Shematic view of an assembly module

5.2 Silicon-Silicon-Frame Assembly (II)

- Measure on CMM (or on Gantry itself after an absolute calibration), the silicon fiducila marks 1-2-3-4 in precision pins reference frame (Fig 2)
- Distribution of Y_i , thsu testing the absolute precision
- Distribution of $Y_i - < Y >$, thus measuring the dispersion around the mean
- Distribution of $Y_2 - Y_3$, that measuring the silicon relative position
- Distribution of $Y_1 - Y_2$ and $Y_3 - Y_4$, thus testing the silicon to frame rotation

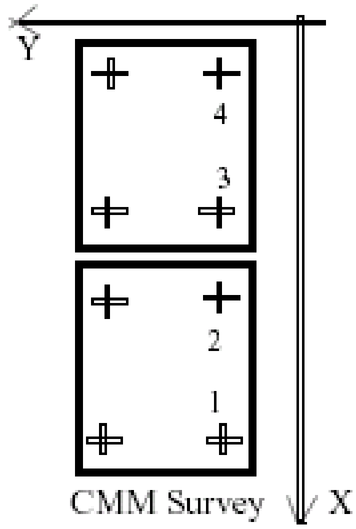

Figure 2: Shematic view of an assembly module under CMM survey

6 Gantry absolute calibration vs CMM

This kind of test will be performed when finally will be chosen a right glass calibration plate. For the assembly job, the gantry does not need in principle an absolute calibration. Whereas for the module quality certification, the final assembled module should be measured under an CMM or with the gantry itself if once corrected with a previuos calibration with a CMM.

- Place a glass low thermal expansion coeff calibration plate over the gantry assembly area
- Measure with high precision measuring machine the coordinates of 21 X 25 crosses 20 mm spaced covering 50 x 50 cm^2 after a mechanical alignment of the plate
- Measure with the gantry, the coordinates of 21 X 25 crossess 20 mm spaced covering 50 x 50 cm^2 after a mechanical alignment of the plate with no calibration file
- Make calibration file to download on the gantry machine
- measure once more the plate with the gantry with the calibration file
- Evaluate Δx,Δy between the CMM measurement vs the gantry one and verify a value around 2 or three microns.