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Amorphous Silicon Position Detectors for the Link Alignment System of the CMS Detector: Users Handbook

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77 pp. 13 figs. 10 refs.

Abstract:
We present the general characteristics, calibration procedures and measured performance of the Amorphous Silicon Position Detectors installed in the Link Alignment System of the CMS Detector for laser beam detection and reconstruction and give the Data Base to be used as a Handbook during CMS operation.

Detectores de Posición de Silicio Amorfo para el Sistema de Alineamiento del Detector CMS:

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Resumen:

Presentamos las caracteristicas generales, procedimientos de calibración y propiedades medidas de los Detectores de Posición de Silicio Amorfo instalados en el Sistema Link de Alineamiento del Detector CMS para la detección y reconstrucción de rayos láser y damos la Base de Datos que ha de ser usada como Manual a lo largo de la operación de CMS.

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1. Introduction

In the multipoint alignment monitoring required for the CMS [1] Link Alignment System (LAS) [2], one needs to measure and monitor accurately (better than 30 μm precision) the space position of a laser beam at several points along its path. For that purpose we use transparent position sensors attached to the pieces whose spatial coordinates have to be monitored. Given the expected independent motions of the pieces (from mm to a couple of cm) the active area of the sensors must be large.

In a recent paper [3] we presented first results on the characterization of a new generation of semitransparent amorphous silicon 2D position detecting (ASPD) sensors for multi-point alignment monitoring that, in addition to a very high performance, have the largest active area ever constructed: 30×30 mm^2. These are the sensors installed in LAS.

The active material of the sensors is hydrogenated amorphous silicon carbide, with a 10% carbon content (a-$Si_{0.9}C_{0.1}$:H). The alloy with carbon shifts the fundamental absorption edge of the a-SiC:H towards slightly higher values, thereby enhancing the optical transmission of the complete ASPD layer stack.

ASPD sensors are semitransparent two-dimensional position strip sensors. They are deposited on top of an antireflection coated glass substrate. The a-SiC:H absorber is deposited between two layers of perpendicular strip electrodes, made of Al-doped ZnO. Careful optimisation, homogeneity and control of all layer thicknesses ensure very high transparency for the desired wavelength (681 nm in LAS) of the positioning laser, by adjusting a transmission maximum of the interference fringes, to match with the wavelength of the laser.

Each intersection of a top and a bottom ZnO strip defines a double-Schottky photodiode pixel, formed by the photoconducting a-SiC:H sandwiched between the ZnO contacts. The position of a light spot onto the sensor surface is then represented by the centre of gravity of the local photoresponses generated by the 2D matrix of photodiode pixels.

The way of accessing the photodiodes in the ASPD is a characteristic of the sensor: let $N_{x(y)}$ be the number of photodiodes along the two orthogonal coordinates X (Y), the ASPD sensor contains $N_x \times N_y$ photodiodes but they are accessed as a set of $N_x + N_y$ rows and columns of photodiodes.

An *ad hoc* readout electronics, called Local Electronic Board (LEB), able to read up to four ASPD sensors simultaneously, was designed and constructed at CIEMAT (Madrid). The photocurrents induced in the ASPD electrodes, are multiplexed in a very simple front-end electronics, and go, through very long (20 to 30 m) twisted pair cables to the LEB, where the signal is converted and the centre of gravity of the various light spots are calculated by programmed microcontrollers.

Transparent amorphous silicon sensors were first developed by H. Kroha et al. [4] at the Max Planck Institute and later commercialized by EG&G [5].

The sensors we are using [3] are developed by the Steinbeis-Transferzentrum für Angewandte Photovoltaik und Dünnschichttechnik with technological support from the Universität Stuttgart (Institut für Physikalische Elektronik, IPE) [6].

In the present document we give, in Section 1, the general sensors specifications as well as the electronics used for readout and control. Sections 3 to 8 are devoted to the sensor characterization procedures, signal reconstruction and intrinsic position resolution, sensor response, linearity and spatial reconstruction resolution, beam deflection angles, and transmittance. In all these sections we quote results as the mean values of the characteristics measured in the sample of 122 constructed units. The study of the multipoint laser beam alignment monitoring is developed in Section 9, while, in Section 10 we describe the three LAS light paths in each Link Alignment quarter of plane, and give, in Section 11, the typical uncertainties in the laser beam reconstruction for the case of the ASPD used in the various LAS light lines. The meaning of the eventual displacements detection during the ASPD sensors monitoring are illustrated with examples in Section 12, while some information, previous to the Data Base, use is given in Section 13.

Finally, the full ASPD sensors Data Base to be used all along the CMS operation, is given as an Appendix.

2. General ASPD sensors specifications, readout and control

The amorphous silicon position detector sensors installed in the LAS are constructed following the sketch in Fig. 1. They consist of a layer of hydrogenated amorphous silicon carbon doped (a-SiC:H) of ~ 300 nm thickness sandwiched between two layers of ~ 110 nm zinc oxide (ZnO:Al) electrodes, perpendicularly segmented to draw a 2D semitransparent matrix of 64×64 Schotky photodiodes.

The zinc oxide is segmented using photolithographic methods. The three layers are deposited onto a ~ 1 mm thick glass substrate. The glass is coated with an antireflection treatment which should minimize interferences and reduce deflection angles.

Laser light is partially absorbed by the a-Si material producing photocurrents on the strips. Saturation occurs at about 4 μA (1000 ADC counts). The signal, extracted via aluminium bonded pads at the ends of the ZnO strips, is multiplexed, converted to voltage and transferred to the ADC of the microcontroller. The most important parameters of these sensors are summarized in Table 1. In Fig. 2 we show the compact final configuration of an ASPD, as seen from the back, where the front end electronics, connectors, resistors and multiplexers can be seen. The axes of the local coordinate system are shown superimposed on the picture. The laser beam may come in either by the active (front) or the glass (back) face. Total volume is $4.7 \times 4.7 \times 4.7$ cm^3.

The strips layout allows to have two orthogonal projections of the incoming beam. Vertical strips reproduce the projection of the beam spot along the X-coordinate while horizontal strips reconstruct the Y-coordinate. The LEB's programmed microcontrollers perform the reconstruction of the light spot centre.

3. Sensor characterization procedures

An ASPD sensor is characterized [3] by the following quantities:

- intrinsic position resolution: light spot reconstruction error in full stability conditions,

- sensitivity: the photocurrent response to a probe laser of given wave-length and output power,
- spatial reconstruction resolution: the error associated to the light spot coordinates reconstruction. It defines the minimum light spot displacement the sensor can resolve,
- beam deflection angle: size of the change of the beam direction when crossing the sensor, and,
- transmittance or transmission power: percentage of the incoming light intensity that is transmitted.

In what follows we will describe the experimental procedures used in the characterization of the 122 constructed sensors (72 of them are installed in LAS), giving the measured average performance. Errors given to these quantities are the dispersions (rms) of the corresponding distributions.

4. Signal reconstruction, stability and intrinsic position resolution

4.1 Experimental set-up

The general experimental set-up, for sensor characterization purposes, consisted of a diode laser working in the visible range (681 nm), with an output power of about 1 mW and the sensor under test located about 5 m downstream the laser collimator and placed on a adjustable (in the plane perpendicular to the laser beam direction) platform. Additional elements will be incorporated for the various measured characteristics presented in this document. All elements were placed on a highly stable granite optical bench.

4.2 Signal reconstruction

Given the geometry of the ASPD electrodes, information about the incoming beam is obtained in the form of two orthogonal intensity profiles. The X- and Y-projections of the light distribution are fitted to Gaussian functions and their mean values determine the position of the centre of the light spot on the sensor active area.

As an example, we show in Figs. 3 a) and b) the signal distributions from vertical and horizontal strips, respectively, of the light spot on an arbitrary location of the active area of one of the sensors. The Gaussian curves are the corresponding fitted functions to the data.

The mean values of the Gaussian fits are interpreted as the reconstructed X- and Y-coordinate of the laser spot in terms of strip units (see Table 1 for dimensions). As it has been already mentioned, the corresponding LEB deals with the reconstruction.

4.3 Stability tests and intrinsic position resolution

The short term stability of the response was evaluated taking data during ten minutes with the laser beam always pointing to the same place of the active area. In principle, and for a perfectly stable set-up, the intrinsic resolution of this kind of sensors is of the order of 1% of the strip pitch (~ 0.5 μm in our devices).

However, in our set-up, while the granite bench is very stable, the sensor handling mechanics and the laser collimator mechanics are not so stable and therefore the measured intrinsic resolutions are somehow larger than expected. The average values measured in the whole sample are 1.5 ± 1.0 μm in both directions.

5. Sensitivity or sensor response

As it was already said, the laser light hitting the sensor surface is partially absorbed by the a-Si material producing photocurrents on the strips. We computed the sensor sensitivity as the ratio between the integrated induced currents by the light spot and the laser output power.

5.1 Experimental set-up

The sensor under characterization is placed on two motorized platforms, 2 μm resolution each, 0.5 m downstream the laser source. The platforms allow performing horizontal (along the X-coordinate) and vertical (along the Y-coordinate) scans over a 20×20 mm^2 area of the sensor.

The operation is done as follows: starting from an arbitrary initial position, the sensor is scanned, by moving the platforms, in steps of about 1 mm in both directions, to cover the accessible surface. At every point of the scan, the photocurrents induced by the laser spot (in both vertical and horizontal strips) are recorded. A matrix of 21×21 integrated signals is obtained in this way. We then divide each integral by the pre-measured laser output power.

At each point, the integral is calculated as the sum of the photocurrents measured at the strip giving the maximum and those from the neighbouring ± 6 strips, averaged over X and Y directions. The mean value of the distribution of the 441 measurements done over the sensitive area scanned is taken as the sensor response to the used laser wave-length.

Fig. 4 gives the distribution of the photo-responses for the whole sensor sample. Mean value is 16.3 ± 7.6 mA/W. Notice that there were detector production bunches presenting sizable deviations from the mean value, corresponding to samples with larger or smaller silicon deposition thicknesses than the average. Nevertheless, all produced sensors present a very acceptable sensitivity as to allow the LEB's microcontrollers a successful reconstruction of the laser spot.

5.3 Dark current measurement

We have measured the diodes currents in obscurity. Resulting values are in all cases below 0.2 nA, and therefore negligible.

6. Linearity and spatial reconstruction resolution

Linearity measurements indicate how well the sensor reconstructs displacements of the light spot. It allows determining the minimum displacement the sensor can resolve. This quantity defines the spatial resolution in the reconstruction of the light spot coordinates.

6.1 Experimental set-up

As for the measurement of the response, the sensor under characterization is placed on two motorized platforms, 2 μm resolution each, 0.5 m downstream the laser source and a scan over a 20 × 20 mm^2 area of the sensor is done.

During horizontal scans light collected in the vertical strips allows to reconstruct the horizontal displacement of the light spot. The same argument stands for a vertical scan and horizontal strips.

The operation is done as follows: starting from an arbitrary initial position, the sensor is scanned, by moving the platforms, in steps of about 1 mm in both directions, to cover the accessible surface. At every point of the scan, data are taken and the centre of the light spot is reconstructed and recorded. A matrix of 21 × 21 points is obtained in this way.

The beam position reconstructed on the sensor is expected to have a linear dependence on the real displacement of the moving platform.

The departure from the linear behaviour, evaluated as the width (rms) of the distributions of the residuals with respect to a linear fit, defines the spatial point reconstruction precision, the σ_x and σ_y values corresponding to the X and Y coordinates, respectively, of the sensor.

6.2 Results

Every 2D scan over the sensor surface is analysed either as 21 independent one-dimensional scans along X or as 21 independent one-dimensional scans along Y, for a fixed position of the orthogonal coordinate.

The distributions of the measured σ_x and σ_y values, in our full sensors sample, are shown in Figs. 5 a) and b), respectively. Mean values are: $\sigma_x = 5.2 \pm 2.6$ μm and $\sigma_y = 5.1 \pm 2.4$ μm. These quantities are, in average, the errors to be assigned to the reconstruction of the light spot position on the sensor surface. In other words, they represent, as already said, the minimum sensor displacement the sensor can resolve.

7. Beam deflection angles

Light propagating through a medium suffers interactions with matter and thus changes its speed and propagation direction. Moreover, when light traverses several layers of material, part of the incoming energy is reflected in the interfaces of the media and interferences may appear due to the phase difference between incoming and reflected light.

In addition, if the glass substrate is not perfectly flat, its curvature induces in turn a change in the light direction (lens effect). It happens similarly when the glass faces are not plan parallel.

The combination of these effects is at the origin of beam deflections: the outgoing ray emerges in a different direction with respect to the incoming ray.

To minimize interference effects, the glass substrate of the constructed sensors (1 mm thickness, plan parallelism better than 5 μm and selection of units with a flatness beter than 4 μm) is treated with an antireflection coating.

7.1 Experimental set-up

The experimental set-up for the measurement of the beam deflection angles (see sketch in Fig. 6) consisted in the laser source, a first sensor located at ~0.5 m from the light source and installed on the two motorized platforms and a second sensor, installed several meters downstream (~ 5 m) from the first one, in a fixed position.

The measurement of the deflection angles (Θ_x and Θ_y) is done studying the reconstructed signal on the second sensor while scanning the sensor under test. First, the second sensor records the undeflected beam when the first one is removed from the light path. This position is used as reference. The reconstructed beam position when the first sensor is back in the light path is then compared with the reference. The angle definition is sketched in Fig. 7.

7.2 Results

The distributions of the measured deflection angles, Θ_x and Θ_y, on the whole sample, are shown in Figs. 8 a) and b), respectively. Mean values are: $\Theta_x = -1.1 \pm 5.1$ μrad and $\Theta_y = 0.8 \pm 3.8$ μrad.

8. Transmittance

The transmittance is the fraction of the light transmitted through a sensor. The measurement is done using the data recorded during the beam deflection measurements.

The integral of the signal collected in the second sensor, together with the reconstructed position of the laser spot onto the first sensor are computed. The ratio of the integral of the signals, with the sensor in the light path and without it, gives the transmittance at a given place of the analysed sensor, for the used laser wave-length.

We show in Fig. 9 the distribution of the measured transmittance values for the full 122 sample of sensors. Average value is T = 84.8 ± 2.9 %. Deviations from the mean value can be observed. Nevertheless, in our sample, more than 90% of the units show a transmission power larger than 80%, this is well above the LAS needs.

Table 2 summarizes the average ASPD characteristics of our sensor sample.

9. Multipoint laser beam alignment monitoring

Once the complete sample of sensors was fully characterized we have evaluated their performance in multipoint alignment monitoring tasks. The results [7] showed that we can monitor the eventual sensors displacements in a plane perpendicular to the laser beam path with an accuracy better than 30 μm in both X and Y directions.

The distributions of the deflection angles in our sensors are so narrow (few μrad [3]) and the spatial reconstruction resolutions so small (few μm [3]), that we can monitor the sensors positions just by direct comparison of the reconstructed laser beam among two, separated in time, recorded data [7].

9.1 Calculation of the resolution in the detection of displacements in a multi-sensors configuration

In a multipoint arrangement, the resolution in the detection of displacements of a given sensor is determined by two effects: first, the spatial reconstruction precision of the sensor and second, the magnitude and uncertainty, of the deflection angles of the laser beam when crossing the preceding sensors in the beam line.

The laser beam crosses the first sensor and then reaches the second one with an incident angle (in the X and the Y directions) that follows a Gaussian distribution with central value and width (rms) as measured in the characterization process of this first sensor. The reconstruction uncertainty in the second one, σ_2(rec), is therefore affected by an additional term, related to the uncertainty in the deflection angles, that can be written as: $\sigma_2^{def} = \sigma_1(def) \times d_{12}$ (where σ_1(def) is the width of the deflection angle distribution of sensor 1 and d_{12} the distance between sensors 1 and 2), to be added quadratically to the spatial reconstruction resolution of the second sensor.

The light ray is subsequently deflected in each of the downstream sensors in the line, always according with their measured values of deflection angles. In a general way, the resulting incident angular distribution on the sensors surfaces is the convolution of the deflections happening successively in the upstream sensors, each of them having its own Gaussian-like distribution. The average deflection in sensor "j", due to the presence of several upstream sensors "i" (i=1÷j–1), can therefore be written as:

$$\Delta_j = \Sigma_{i=1,j-1} (\Theta_i \times d_{ij}), \qquad (1)$$

and the error induced in the reconstruction process in sensor "j" can be expressed as:

$$\sigma_j = \{\sigma_j^2 \text{ (rec)} + \Sigma_{i=1,j-1} [\sigma_i(\text{def}) \times d_{ij}]^2\}^{1/2} \qquad (2)$$

Above expressions apply to both coordinates, X and Y. The value of σ_j is precisely the resolution in the detection of displacements of the j^{th} sensor in the line: the quantity that will allow to determine whether a given sensor has moved or not from its initial position in the beam light.

For instance, if we take five sensors installed along a single light path, with a distance between sensors equal to 1 m, and we assume that all of them can be described by the average characterization constants given in Table 2, we will find typical expected resolutions in the detection of displacements as detailed in Table 3: better than 30 μm, in both perpendicular to the beam light directions, for the fifth sensor in the light path.

10. The Link Alignment System lasers light lines

The LAS is divided into three Φ planes 60 degrees apart (see Fig. 10), starting at $\Phi = 15^o$. Each plane consists of four independent quadrants (see Fig. 11), resulting in 12 laser paths, 6 on each side (positive or negative Z) of the CMS detector, matching the 12-fold segmentation of the barrel muon spectrometer [2].

In Fig. 12 we sketch the Light Lines corresponding to one of the 12 laser alignment quadrants in one of the CMS sides. The figure is artificially split to allow the visualisation of the various light paths in the same quadrant.

ASPD sensors in the quadrant are labelled from P1 to P6. Sensors P3 and P2 are attached to the MAB, sensors P1 and P4 are placed on the Transfer Plate, while units P5 and P6 are attached to the ME1/2 chamber. Position of ME1/1 chamber is determined by distance-meters and biaxial tiltmeters.

There are 4 lasers paths in a quadrant (see Fig. 12). The named *Primary beam* has its collimator in one of the mini-optical benches (Laser Box, LB) located in the Link Disc (LD) at a radius of 619.3 mm. The light beam crosses P1, P2 and P3. Distances are: d (LB – P1) = 2.151 m, d (P1 – P2) = 1.654 m and d (P2 – P3) = 2.538 m.

The line *AR beam* starts in a collimator located at the Alignment Ring (AR, at the Tracker end caps), goes to a mirror at the LB that deflects the beam to cross P1, P2 and P3 as the Primary Beam does. Distance AR – LB is 3.682 m.

The line *Laser-level beam* starts in a collimator located very close to the MAB up-tiltmeter. The light crosses P3, P2 and P1, is deflected at the LB mirror and goes in the direction of the AR.

The line named *Secondary beam* starts in the LB collimator, and, through the modified rhomboidal prism, goes out from LB parallel to the Primary Beam, 4.5 cm apart. The beam crosses sensors P4, P5 and P6. Distances are: d (LB – P4) = 2.151 m, d (P4 – P5) = 0.067 m and d (P5 – P6) = 1.736 m.

11. Expected mean resolutions in the monitoring of the positions of the ASPD sensors installed in the various light lines of the CMS Link Alignment System

Every two minutes lasers are switched on and off and data is taken of the photocurrents induced in the sensors belonging to the light line corresponding to the laser in work. The associated LEBs reconstruct the position of the light spot on the various sensors in the active line.

In this section we will give the expected mean resolutions (errors) to be assigned to each of the reconstructed light spot positions on the active surface of each of the sensors in a given light line.

When comparing the reconstructed coordinates, on a given sensor, of the data recorded at two different times during the alignment monitoring, the values σ_x and σ_y of the resolutions calculated for such a sensor in a given light line will allow to answer whether the sensor (and therefore the mechanical piece to which the sensor is attached) has displaced or not in the plane perpendicular to the laser beam.

Using the average sensor characteristics in Table 2 and the sensor to sensor distances given in Section 10, we have calculated the mean resolutions in the reconstruction of the coordinates of the light spot in each of the sensors in a given light path.

Given that the sensors can receive the laser beam by any of the faces (active or glass, see Fig. 12), and given that the local X- and Y-coordinates may be a rotation of the ones used for sensor characterization, we have assigned a unique resolution value for both coordinates. The chosen values correspond to the maximum of the σ_x and σ_y pairs calculated assuming the coordinate system used during the sensor characterization. Those resolutions are given in Table 4.

Note, as already said, that quantities in Table 4 are mean vales, a fairly good aproximation to the expected resolutions of the sensors according to their position in a given light line. However, for the calculation of the actual resolution (Eq. 2) to be assigned to each sensor in a given light line, the reconstruction programs have to use the own characteristics given in the Appendix Those will be the errors to be assigned to the measured displacements of the sensors along the CMS operation. They will allow to determine, by direct comparison of data, taken at different moments along the ASPD sensors monitoring, whether a difference in the reconstructed light spot coordinates can be considered as a real motion, in the plane perpendicular to the corresponding laser beam.

12. Meaning of the eventual displacements detection during the ASPD sensors monitoring

The six quarters, per CMS side, of the three Link Alignment System planes are independent. In addition, the three Laser Beam lines in each of these quarters, defined in the prvious Section, are also independent (or almost independent), as indicated in Figs. 10 to 12.

Moreover: the sensors in a given Laser Beam line are installed in mechanical pieces attached to various detector elements that are not ridigly connected between them. For instance, sensors in positions P2 and P3 (see Fig. 12) are both attached to the same MAB which is, in principle, a rigid element. Sensors P1 and P2 belong to two rigid, but not connected, structures, a MAB and a Transfer Plate (TP).

These above facts have to be taken into consideration in the interpretation of eventual changes in the reconstruction coordinates of the light spot when monitoring the position of a given ASPD inside a particular Laser Beam line.

The meaning of an eventual detection sensor displacement is not, in general, straightforward and most often one has to check what other sensors (tiltmeters [8] and distancemeters [9]) are indicating. COCOA [10] is the software taking care of the simultaneous interpretation of what could have been happened in between the data recorded in two different times during the Link Alignment System monitoring.

In the subsections below we suggest some few simple interpretations of detected motions. Notice that the light spot reconstruction is done in a plane perpendicular to the laser beam direction and that, in what follows, we will adopt the convention of using a unique orthogonal coordinate axis for all sensors in Fig. 12: a line parallel to the sensor horizontal strips will be defined as the X-axis and a line parallel to the vertical sensor strips will be defined as the Y-axis. This local sensors coordinate axis definition is sketched in Fig. 13.

12.1 The AR Beam Line

Let us assume that at a certain moment T_0, the reconstructed coordinates in each of the sensors are P_{i0} (x_{0i}, y_{0i}), where i runs from 1 to 3, and that at $T_1 = T_0 + \Delta T$ the light spot reconstruction coordinates are P_{i1} (x_{1i}, y_{1i}). Let us denote $\Delta x_i = x_{1i} - x_{0i}$ and $\Delta y_i = y_{1i} - y_{0i}$ and let us denote by $\sigma_i = \sigma_{xi} = \sigma_{yi}$ the resolutions given in Table 4 for sensor P_i in the AR Beam Line.

If $\Delta x_i \pm \sigma i$ and $\Delta y_i \pm \sigma_i$ are compatible with zero, none of the elements in this light path has moved in the time interval (T_0, T_1). Therefore, one expects that this will be corroborated by no motion along the Primary Laser Beam line and no changes in other associated sensors (tilts and proximities).

In case that any $\Delta x_i \pm \sigma_i$ and/or $\Delta y_i \pm \sigma_i$ is different from zero, a motion (of one or more than one of the mechanical elements) happened in that time interval.

If a displacement is detected in the three sensors, it most probably happened that the AR (and with it, its collimator) moved in any (or all) of its most sensitive coordinates (the CMS Φ, Θ, and Z). If this is the case, associated tiltmeters and proximities should also give notice of rotations and/or displacements. Furthemore, since the AR is a rigid body, the six collimators installed on it will have probably moved jointly and what is observed in this quarter of plane will have been also seen in the other five.

If the AR has not moved, a displacement of the three sensors may be due to a motion of the LD (in any or all of its three mentioned sensitive coordinates), resulting in a motion of the LB and its optics. Again, as LD is a quasi rigid body, one should expect to find similar behaviour in all the six quadrants, as well as indications coming from the LD tiltmeters and distancemeters.

Finally, one may also interpret displacements in the three ASPD sensors of this line path as MAB and TP independent motions. Tiltmeters and proximity sensors should, in that case, also change values between T_0 and T_1.

In the case that displacements are only seen in the P1 ASPD sensor, it will mean that only the TP has moved. A similar in size displacement should also be seen on P1 in the Laser Level Beam line and in sensor P4 in the Secondary Beam line (see Fig. 12). In addition to it, variations in the TP biaxial tiltmeters output voltage and/or in the corresponding potentiometers touching the ME1/1 chamber are also expected.

If the displacements are detected only in sensors P2 and P3, and of the same size, this means that the MAB has most probably rotated in Φ. The MAB one dimensional tiltmeter should in this case take notice of it, indicating the sign and size of the rotation. At the same time, the Laser Level Beam line should find no sizeable displacements of those sensors due to the fact that the Laser Level collimator and the sensors P3 and P2 are all of them attached to the same MAB structure.

12.2 The Primary Beam Line

This line starts at the collimater in the LB attached to the LD, so, what it was said about the AR Beam is valid also for the primary beam line, except for what concerns specifically to the AR motions.

12.3 The Laser Level Beam Line

The Laser Level Beam crosses ASPD sensors in locations P3, P2 and P1. In principle, and in absence of sudden mechanical deformations of the MAB, the values Δx_i and Δy_i (i = 2, 3) should be always compatible with zero under all circumstances, since, all three elements, collimator and sensors P3 and P2, are attached onto the same rigid structure. Therefore, in case of any eventual MAB rotation in Φ, the light spot should stay pointing to the same place of the glass surface of the two ASPD sensors.

However, in the case of a MAB rotation, in addition to an observation of such a rotation from the tiltmeter, deviations of the impact point of the laser beam on sensor P1 should be observed. These deviations have to agree, if TP stayed steady, with the size of the measured MAB tiltmeter value.

If MAB rotates and TP moves in the T_0, T_1, time interval, the picture becomes more complicated. The change of position of P1 as seen by the AR and Primary Beam lines, as well as information from the biaxial tiltmeters and potentiometers located at the TP should help to interpret it.

12.4 The Secondary Beam Line

The secondary Beam Line starts at the LB located in the LD. It emerges from the LB parallel to the Primary Beam Line, 4.5 cm apart from it through the fused silica modified rhomboidal optics.

The light path crosses in sequence (see Fig. 12) an ASPD sensor installed in the TP (P4) and two other sensors, P5 and P6 (attached to the ME1/2 chamber).

The meaning of eventual motions is similar to the ones described on the other Beam Lines. In case that values Δx_i and Δy_i (i = 5, 6) are different from zero while Δx_4 and Δy_4 are compatible with zero, the most probable interpretation is that the ME1/2 chamber has suffered a rotation in Φ or a bent in Θ. In that case, the size of the rotations can be directly calculated from the (Δx_i, Δy_i) values and the distances LB-P5 and LB-P6.

If Δx_i and Δy_i (i = 5, 6) are compatible with zero and Δx_4 and Δy_4 are not, it is the TP that most probably moved. The size and direction of the motions can be extracted from the detected displacements on the P4 sensor and the distance LB-P4, that should agree with the informations from the biaxial tiltmeter and the proximity sensors located on the TP.

An eventual rotation of the LD will result, as already seen for other Beam Lines, in values Δx_i and Δy_i (i = 4, 6) different from zero that have to agree with the observations from the LD tiltmeters.

13. Data Base preliminary notes

Before entering into the ASPD sensors Data Base it is important to review a certain number of definitions and conventions taken during the calibration of the sensors.

13.1 ASPD coordinates axis definition

The sensor local coordinates system used in the calibration is shown in Fig. 13, where an ASPD is seen from its front (active) face. The origin of coordinates (0, 0) corresponds to the centre of the pixel formed by the strips $I_x = 0$ and $I_y = 0$. Strips are numbered from 0 to 63. We use the convention of calling I_x to the strips parallel to the X-axis (therefore, the ones that allow to reconstruct the Y-coordinate of the laser spot) and I_y to the strips parallel to the Y-axis (the ones that allow to reconstruct the X-coordinate of the light spot).

13.2 The scanned areas during the characterization processes

The location of the strips, with respect to the incoming laser beam, during the sensor characterization by the "active face" is the one sketched here below:

```
Y-axis  63  I 5 mm xxxxxxxxxxx 5 mm
            I      xxxxxxxxxxx
            I      xxxxxxxxxxx       area of scan (2 × 2 cm²)
            I      xxxxxxxxxxx
            I      xxxxxxxxxxx
            I
            I          |  9 mm
         0  I__________|______________     X-axis

   Strip #  0                     63
```

The front end electronics (see Fig. 13) is on the back of the sensor.

The strip location, with respect to the incoming laser beam, in the sensor characterization by the “glass face” is:

```
        Strip #  0                        63
                 ________________________     X axis
             0   I 5 mm xxxxxxxxxxx 5mm
                 I      xxxxxxxxxxx
                 I      xxxxxxxxxxx           area of scan (2 × 2 cm²)
                 I      xxxxxxxxxxx
                 I      xxxxxxxxxxx
                 I
Y axis           I          |   9 mm
            63   I          |
```

In this case, the front end electronics is on the front of the sensor (see Fig. 2).

A consequence of this layout is that the Θ_x deflection angles have the same sign when calculated for the active and the glass faces and, on the contrary, the Θ_y ones appear to have opposite signs when the characterization is done by the glass face.

Therefore, when using the deflection angles in any calculations, the users have to take the above into account and make the necessary rotations according to the actual local coordinate axis and to the position of the active/glass faces with respect to the incoming laser beam direction.

13.3 Other notes of interest

In the Data Base, sensors are assigned to their particular place in the alignment lines. If not assigned, status and/or “garage” location are noticed. Sensor labels were given along their production in Stuttgart.

Attention should be paid to the “bad strips lists”. This information must be provided to the microcontrollers in order to fit correctly the Gaussian-like signals.

Sensors without any bad strips (I_x and I_y) in the interval 25 to 38 were selected to be installed in position P3 (see Fig. 12), as the laser level collimator is very close to the sensor in this position, the corresponding beam spot is very narrow and only few central strips are driving current and therefore we need all of them to succesfully reconstruct the signal.

Laser output power, for normal response sensors (~ 15–20 mA/W), should be modulated to about 1.0–1.2 mW. Laser output power for high response sensors (beyond 25 mA/W) should be modulated to about 0.5–0.6 mW).

The recommended parameter for the beam light half-width for Gaussian fits is 1.5 strips.

References

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[3] A. Calderon, et al., Nucl. Instr. and Meth. A565 (2006) 603.
[4] W. Blum, H. Kroha and P. Widmann, Nucl. Instr. Meth. A367 (1995) 413.
[5] EG&G Optoelectronics, 45 William Street, Wellesley, MA02181, USA.
[6] http://www.ipe.uni-stuttgart.de
[7] C. Koehler et al., “Production and read-out performance of ASPD sensors for multipoint alignment monitoring”. (To be submitted to Nucl. Instr. and Meth. A).
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[9] A. Calderón et al., “Short distances measurement sensors for the Link Alignment System of the CMS Experiment: Users Handbook”. (To be submitted to CIEMAT Technical Notes).
[10] P. Arce and A.L. Virto, “CMS Object Oriented Code for Optical Alignment (COCOA)”, CMS Note 2002/060.

Table Captions

Table 1: Parameters of the ASPD sensors.
Table 2: Average ASPD characteristics in the sample.
Table 3: Typical expected resolutions in the detection of displacements, for a set of five sensors in the light path, having the characteristics given in Table T1, separated 1 m from each other.
Table 4: Average resolutions (in μm, $\sigma_x = \sigma_y$) in the reconstruction of the coordinates of the light spot in each of the sensors of one Link Alignment System quarter.

a-SiC:H thickness	300 nm
Strip thicknes	110 nm
Glass thicknes	1 mm
Active area	30 mm $\times$ 30 mm
Number of strips	64 horizontal + 64 vertical
Strip pitch	430 μm
Strip gap	22 μm

Table 1: Parameters of the ASPD sensors

Sensitivity (mA/W)	16.3 ± 7.6
σ_x (μm)	5.2 ± 2.6
σ_y (μm)	5.1 ± 2.4
Θ_x (μrad)	-1.1 ± 5.1
Θ_y (μrad)	0.8 ± 3.8
Transmittance (%)	84.8 ± 2.9

Table 2: Average ASPD characteristics in the sample.

Order of sensor in the light path	σ_x (μm)	σ_y (μm)
First	±5.2	±5.1
Second	±7.3	±6.4
Third	±12.5	±9.9
Fourth	±19.8	±15.1
Fifth	±28.4	±21.4

Table 3: Typical expected resolutions in the detection of displacements, for a set of five sensors in the light path, having the characteristics given in Table 2, separated 1 m from each other.

Sensor	P1	P2	P3	P4	P5	P6
Primary and AR beams	± 5	± 10	± 26			
Laser – Level beam	± 24	± 14	± 5			
Secondary beam				± 5	± 7	± 11

Table 4: Average resolutions (in μm, $\sigma_x = \sigma_y$) in the reconstruction of the coordinates of the light spot in each of the sensors of one Link Alignment System quarter.

Figure Captions

Fig. 1: Sketch of the sensor showing the layer arrangement. The drawing is not scaled.
Fig. 2: Back view of an ASPD sensor, showing the front-end electronics, the sensor glass face and the local coordinates system.
Fig. 3: Example of the spot signal reconstruction:

a) X-coordinate
b) Y-coordinate

Fig. 4: Distribution of the measured photorresponses in the whole ASPD set of sensors.
Fig. 5: Spatial reconstruction resolution distributions in our sample:

a) σ_x
b) σ_y

Fig. 6: Sketch of the deflection angles measurement experimental set-up.
Fig. 7: Sketch of the deflection angles definition. For simplicity only the total deflection angle is represented.
Fig. 8: Deflection angles distributions in our sample:

a) Θ_x
b) Θ_y

Fig. 9: Distribution of the measured transmittances in the whole ASPD set of sensors.
Fig. 10: Transverse view of CMS with the situation of the three Φ planes of the Link Alignment System.
Fig. 11: Sketch of one of the three Φ Link Alignment System planes.
Fig. 12: Detail of the lasers paths in one of the Z+ Link Alignment System quarters.
Fig. 13: Front view of an ASPD sensor showing the active face and the local coordinates system.

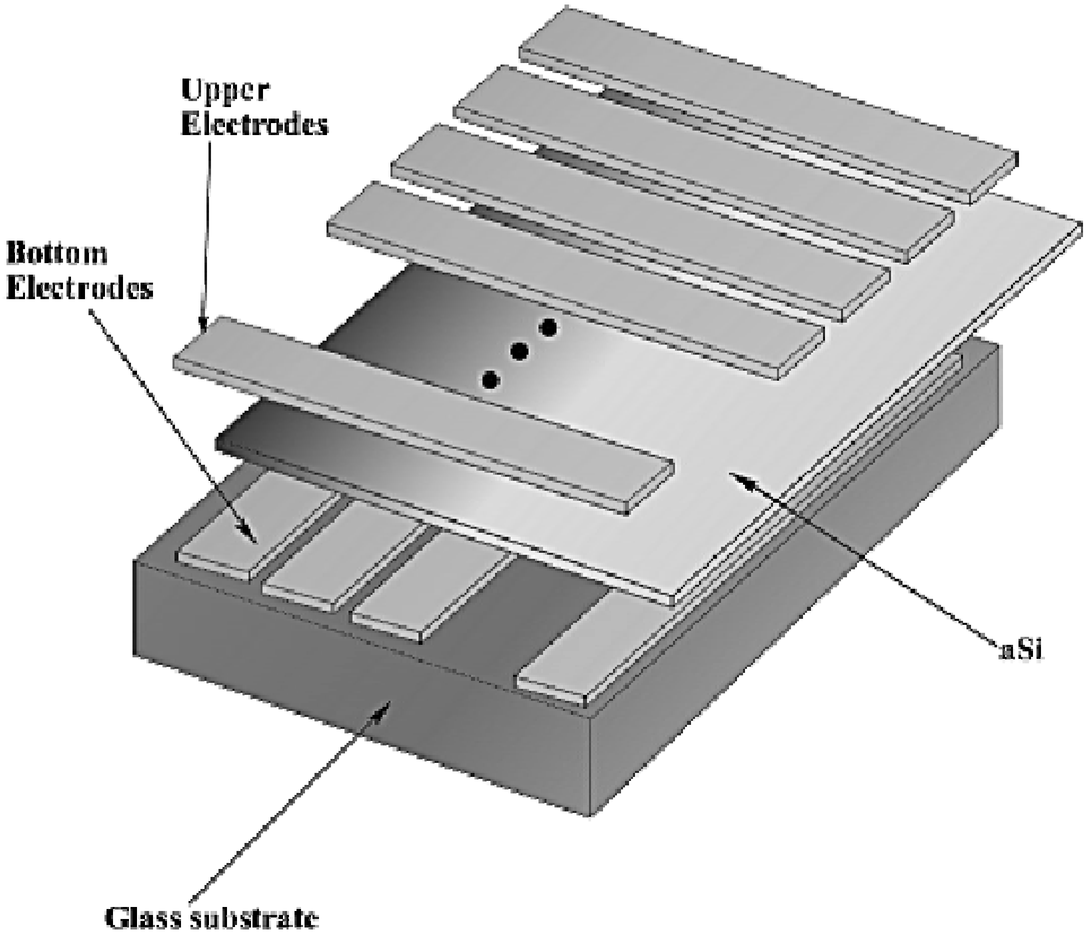


Fig. 1

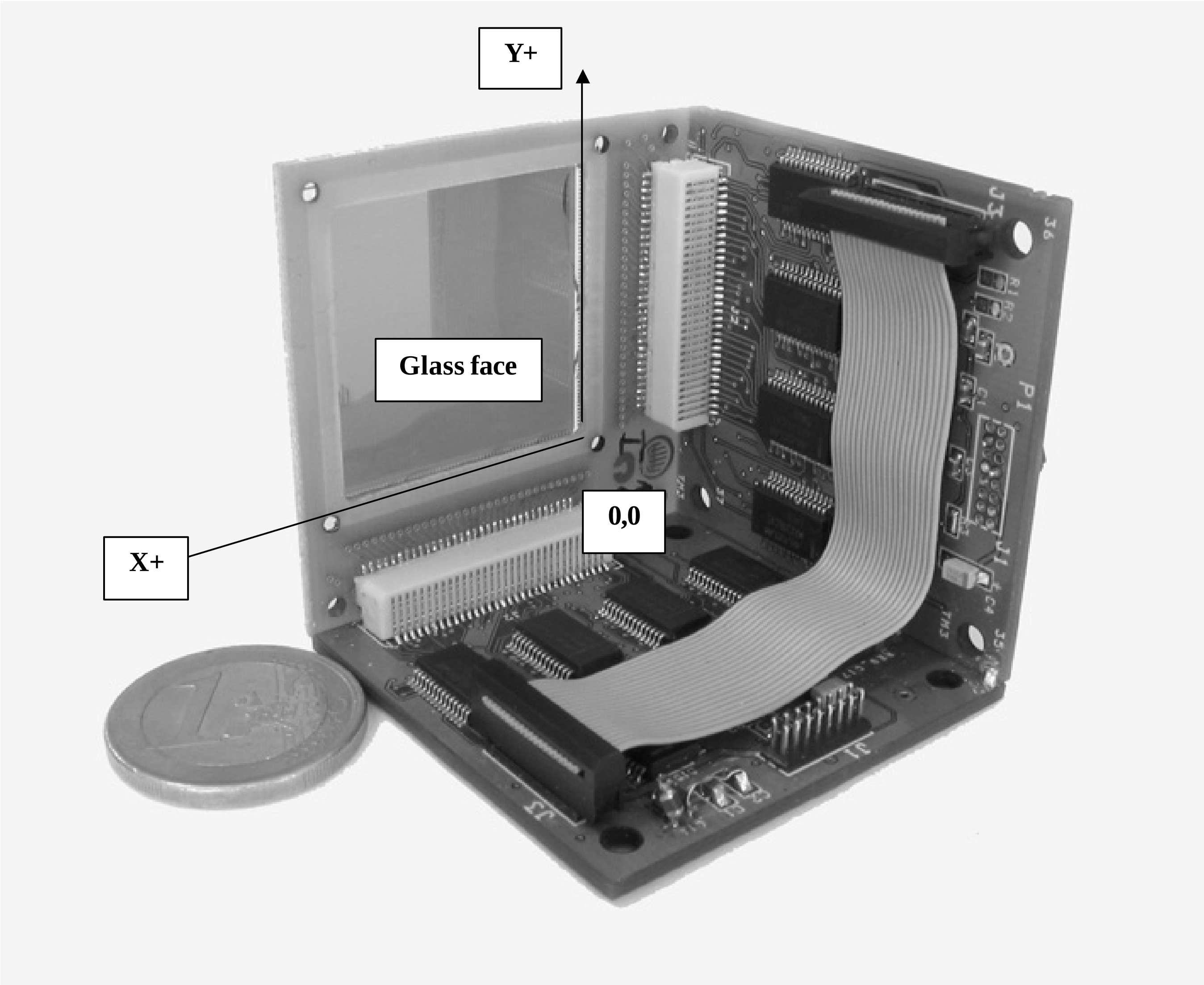


Fig. 2

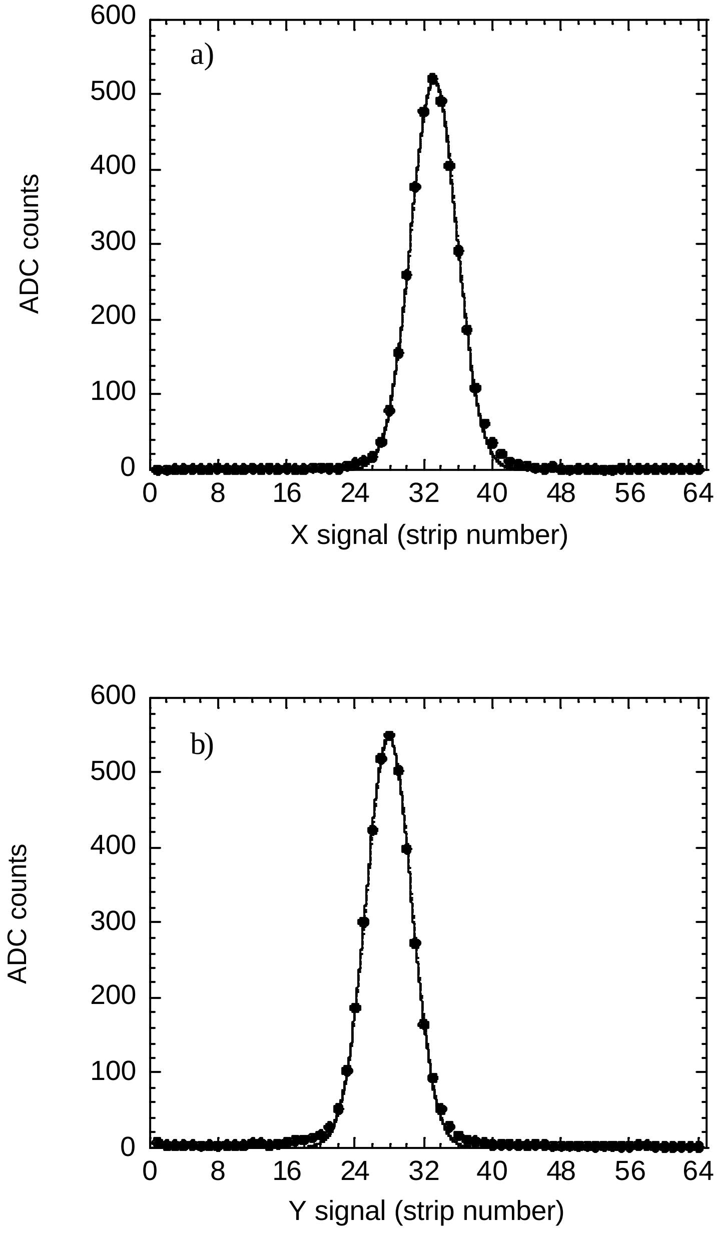
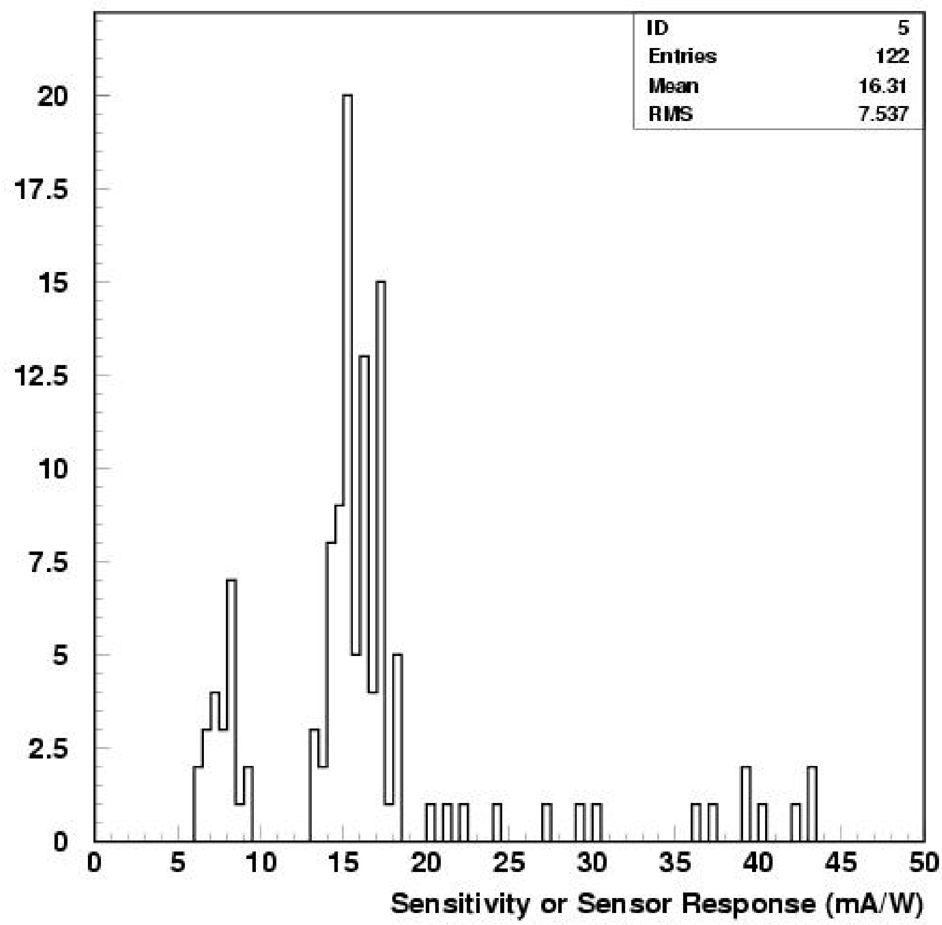

a)
ADC counts
600
500
400
300
200
100
0
0
8
16
24
32
40
48
56
64
X signal (strip number)
b)
ADC counts
600
500
400
300
200
100
0
0
8
16
24
32
40
48
56
64
Y signal (strip number)

Fig. 3



ID 5
Entries 122
Mean 16.31
RMS 7.537
20
17.5
15
12.5
10
7.5
5
2.5
0
0 5 10 15 20 25 30 35 40 45 50
Sensitivity or Sensor Response (mA/W)

Fig. 4

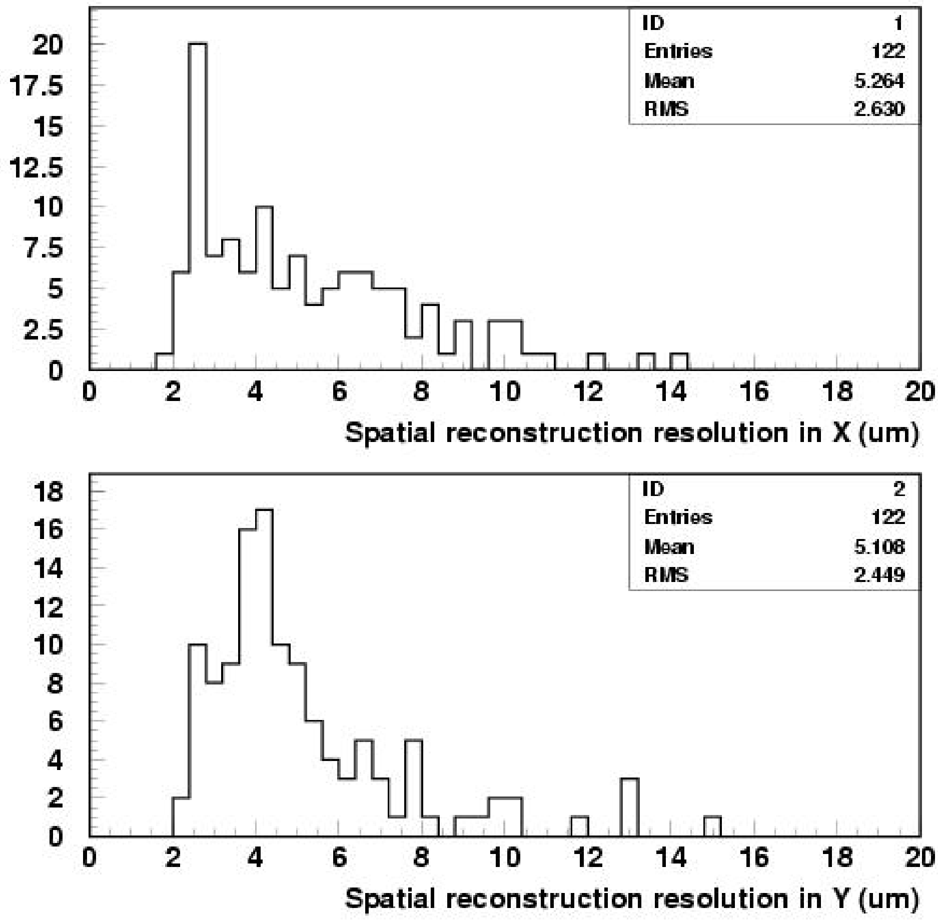

ID 1
Entries 122
Mean 5.264
RMS 2.630
20
17.5
15
12.5
10
7.5
5
2.5
0
0 2 4 6 8 10 12 14 16 18 20
Spatial reconstruction resolution in X (um)
ID 2
Entries 122
Mean 5.108
RMS 2.449
18
16
14
12
10
8
6
4
2
0
0 2 4 6 8 10 12 14 16 18 20
Spatial reconstruction resolution in Y (um)

Fig. 5

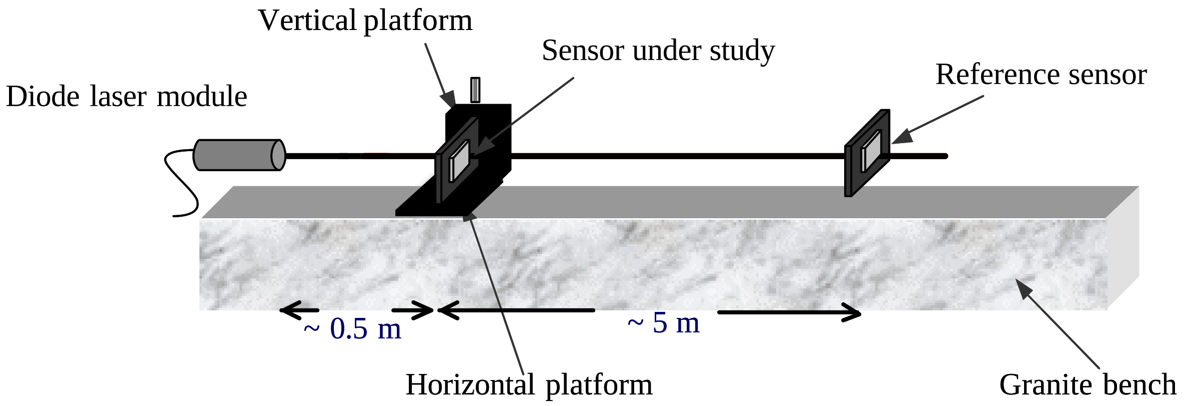

Vertical platform
Sensor under study
Reference sensor
Diode laser module
~ 0.5 m
~ 5 m
Horizontal platform
Granite bench

Fig. 6

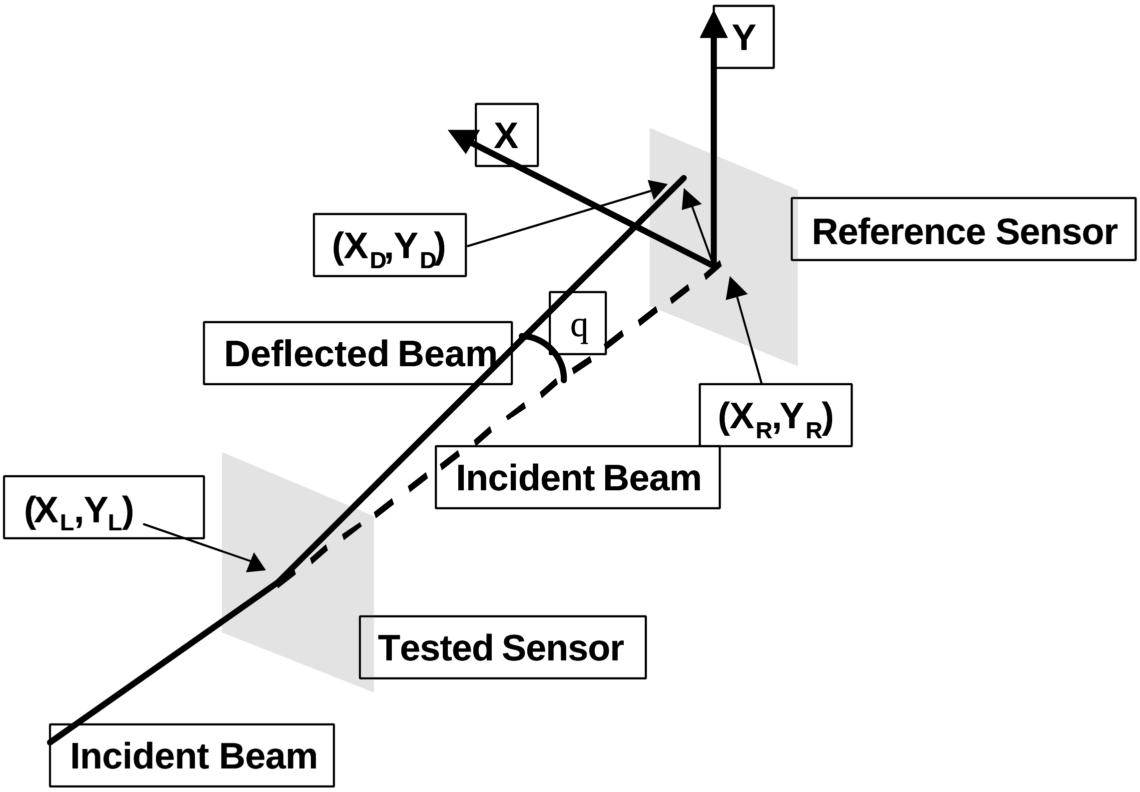

Y
X
(X_D,Y_D)
Reference Sensor
q
Deflected Beam
(X_R,Y_R)
Incident Beam
(X_L,Y_L)
Tested Sensor
Incident Beam

Fig. 7

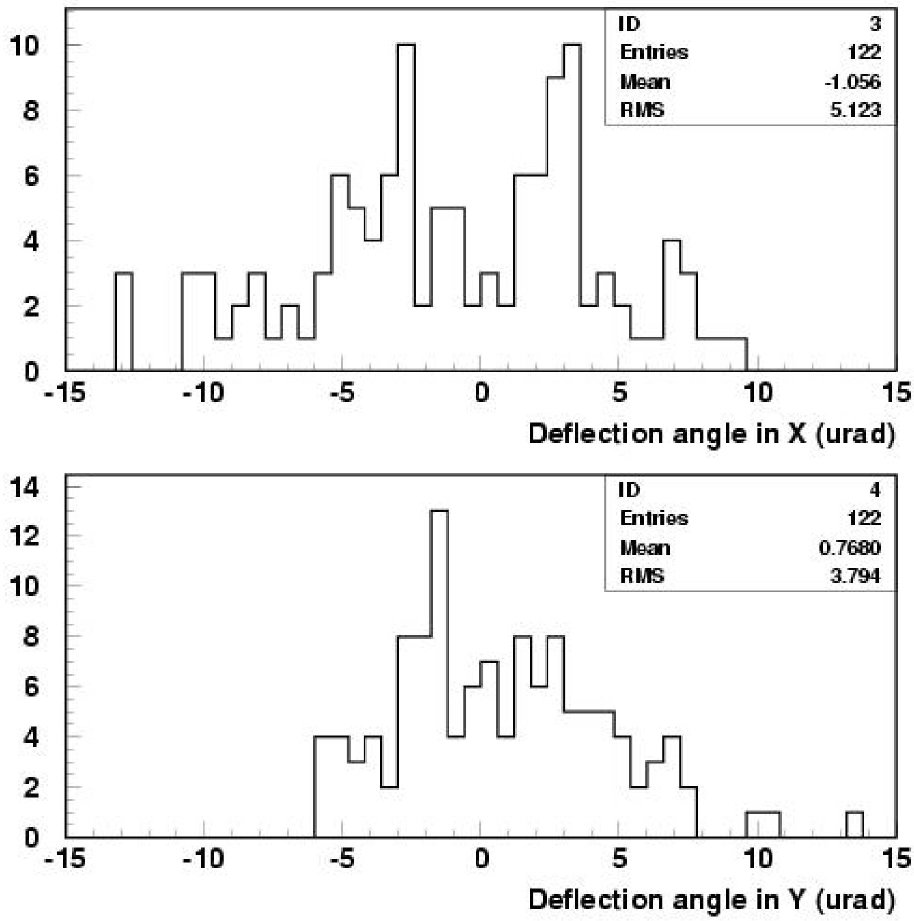

ID 3
Entries 122
Mean -1.056
RMS 5.123
Deflection angle in X (urad)
ID 4
Entries 122
Mean 0.7680
RMS 3.794
Deflection angle in Y (urad)

Fig. 8

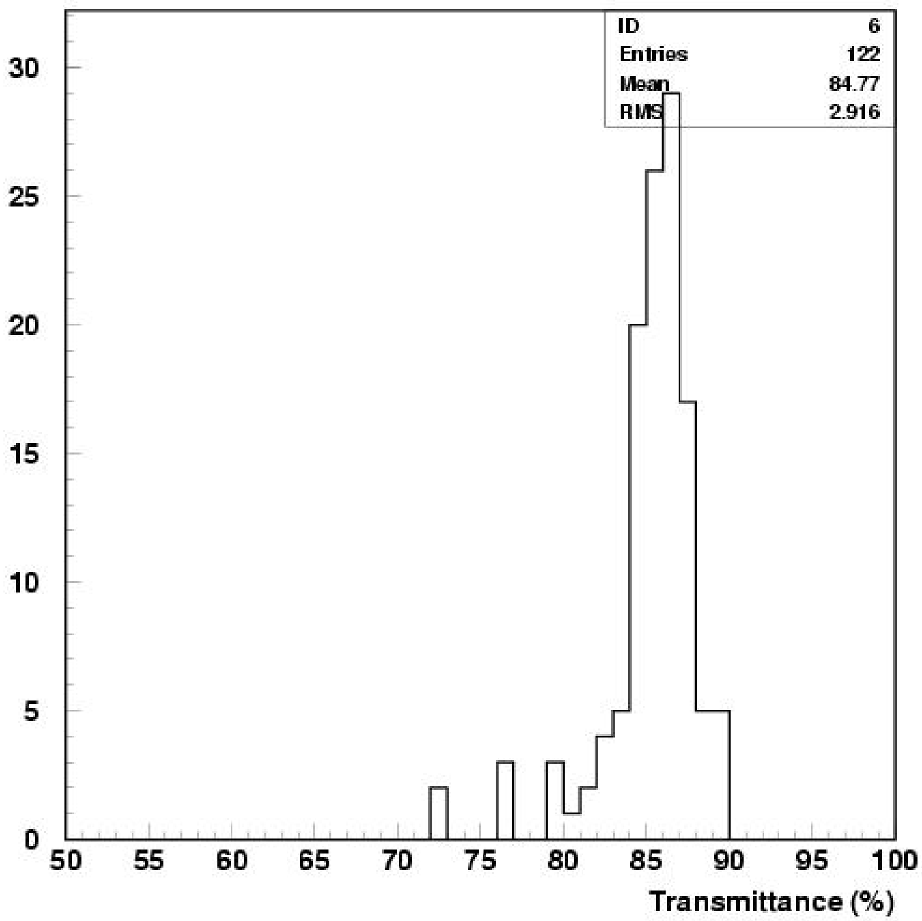

ID 6
Entries 122
Mean 84.77
RMS 2.916
0
5
10
15
20
25
30
50
55
60
65
70
75
80
85
90
95
100
Transmittance (%)

Fig. 9

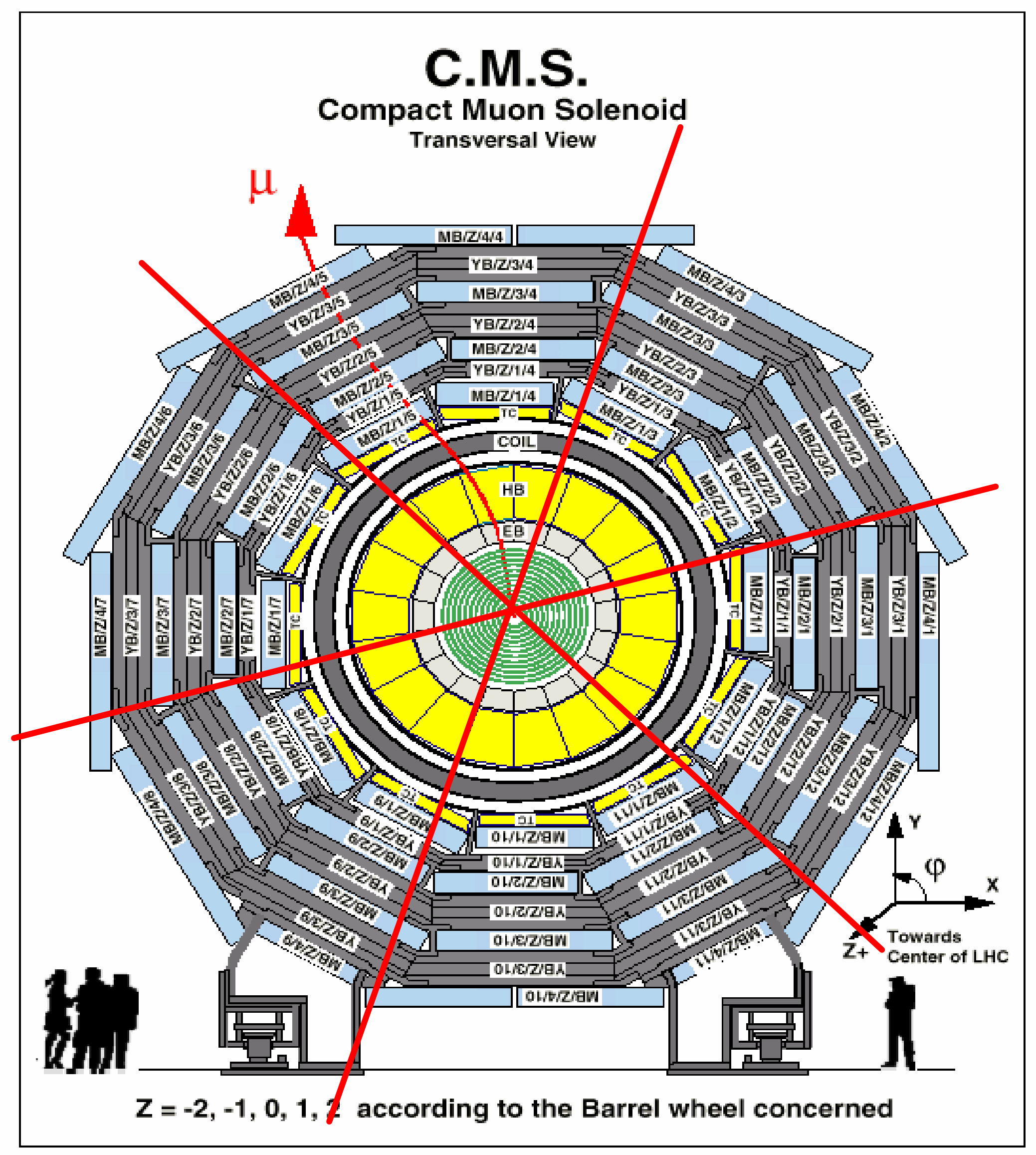

C.M.S.
Compact Muon Solenoid
Transversal View
μ
COIL
HB
EB
Y
φ
X
Z+
Towards
Center of LHC
Z = -2, -1, 0, 1, 2 according to the Barrel wheel concerned

Fig. 10

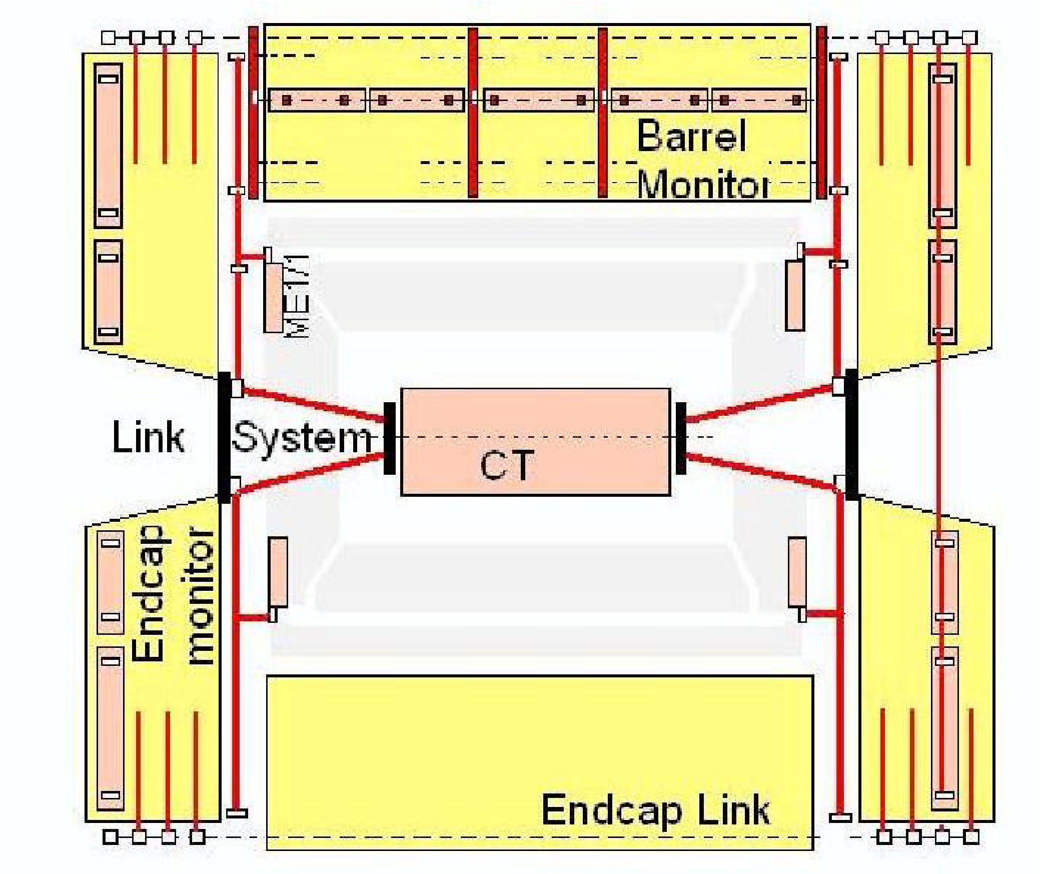

Barrel
Monitor
ME1/1
Link
System
CT
Endcap
monitor
Endcap Link

Fig. 11

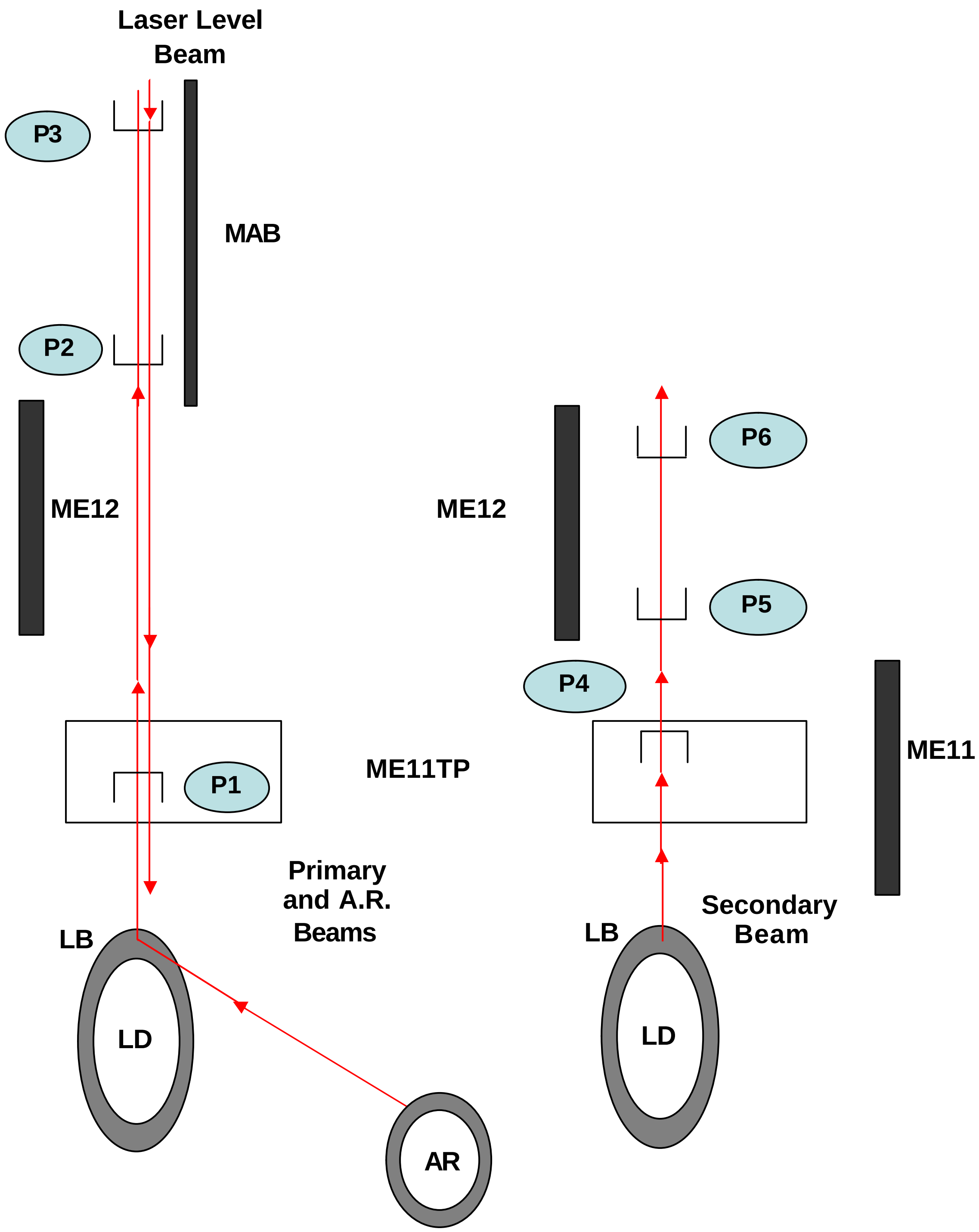

Laser Level
Beam
P3
MAB
P2
ME12
ME12
P6
P5
P4
ME11
ME11TP
P1
Primary
and A.R.
Beams
Secondary
Beam
LB
LB
LD
LD
AR

Fig. 12

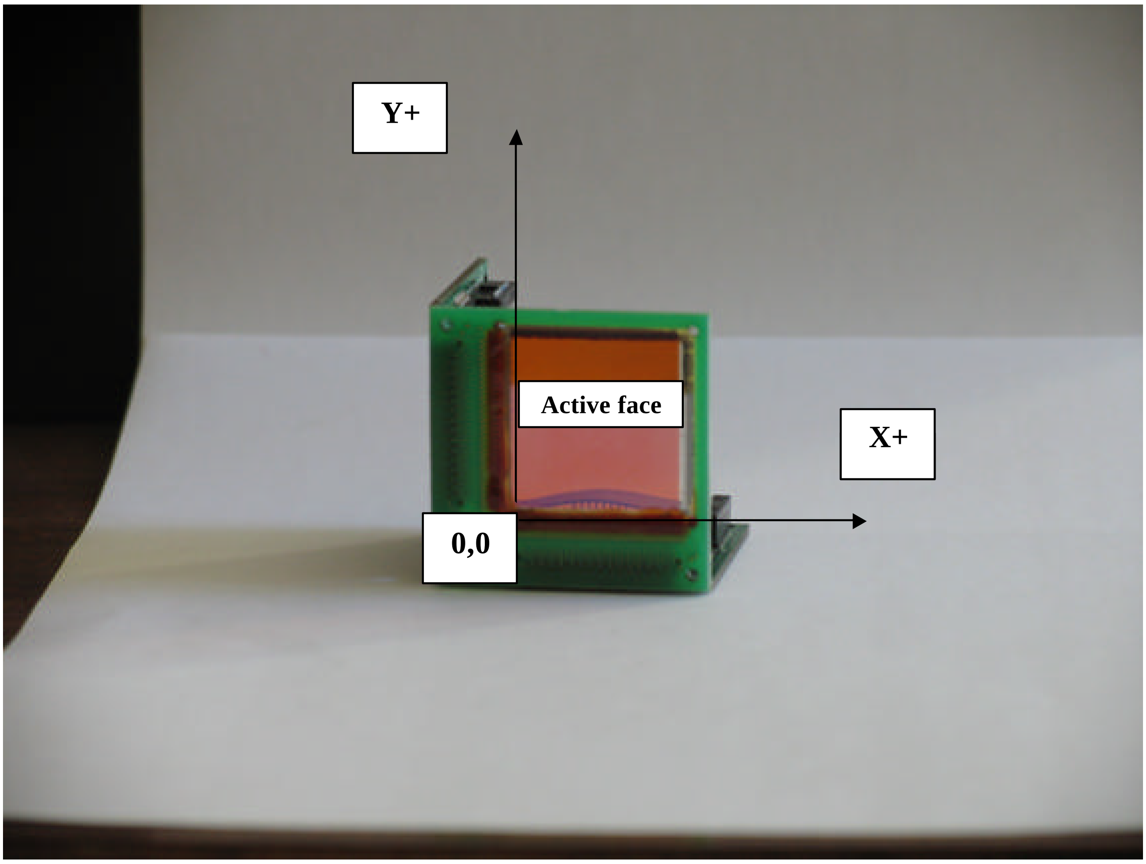


Fig. 13

APPENDIX

ASPD-3030 CHARACTERISTICS DATA BASE

I) Sensors installed at +Z

1) AY08_04_02 ====➔ +Z, 15, P1

Bad horizontal strips (I_x): 11, 36
Bad vertical strips (I_y): 7, 8, 31, 46

Active face	*Glass face*
$\Theta_x = -5.3 \pm 2.8$ μrad	$\Theta_x = -2.8 \pm 3.5$ μrad
$\Theta_y = 4.0 \pm 3.6$ μrad	$\Theta_y = -0.9 \pm 2.6$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 3.7$ μm	$\sigma_x = 6.7$ μm
$\sigma_y = 3.7$ μm	$\sigma_y = 3.7$ μm
response: 7.1 mA/W	response: 7.1 mA/W

2) AY11_05_04 ====➔ +Z, 15, P2

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = -2.3 \pm 1.3$ μrad	$\Theta_x = -3.4 \pm 1.4$ μrad
$\Theta_y = -1.8 \pm 1.5$ μrad	$\Theta_y = 3.1 \pm 1.4$ μrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 3.0$ μm	$\sigma_x = 2.9$ μm
$\sigma_y = 2.7$ μm	$\sigma_y = 2.7$ μm
response: 17 mA/W	response: 15 mA/W

3) AY11_03_01 ====➔ +Z, 15, P3

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = -1.7 \pm 1.8$ μrad	$\Theta_x = -3.3 \pm 1.8$ μrad
$\Theta_y = 2.0 \pm 1.8$ μrad	$\Theta_y = 0.3 \pm 1.5$ μrad
T = 88 ± 1 %	T = 87 ± 1 %
$\sigma_x = 2.2$ μm	$\sigma_x = 2.6$ μm
$\sigma_y = 2.8$ μm	$\sigma_y = 2.4$ μm
response: 17 mA/W	response: 15 mA/W

4) AY08_08_03 ====➔ +Z, 15, P4

Bad horizontal strips (I_x): 24, 25, 35, 36
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = 4.0 \pm 4.0$ μrad	$\Theta_x = 2.6 \pm 4.0$ μrad
$\Theta_y = -3.3 \pm 2.5$ μrad	$\Theta_y = 4.7 \pm 3.1$ μrad
T = 86 ± 2 %	T = 86 ± 2 %
$\sigma_x = 3.4$ μm	$\sigma_x = 5.7$ μm
$\sigma_y = 5.3$ μm	$\sigma_y = 6.7$ μm
response: 13.3 mA/W	response: 12.8 mA/W

5) AY11_03_04 ====➔ +Z, 15, P5

Bad horizontal strips (I_x): 13, 19
Bad vertical strips (I_y): 29, 40

Active face	***Glass face***
$\Theta_x = -2.8 \pm 2.1$ μrad	$\Theta_x = -4.0 \pm 2.0$ μrad
$\Theta_y = -0.4 \pm 1.9$ μrad	$\Theta_y = 2.4 \pm 1.7$ μrad
T = 89 ± 1 %	T = 89 ± 1 %
$\sigma_x = 3.5$ μm	$\sigma_x = 7.0$ μm
$\sigma_y = 4.8$ μm	$\sigma_y = 2.9$ μm
response: 18 mA/W	response: 17 mA/W

6) AY08_02_03 ====➔ +Z, 15, P6

Bad horizontal strips (I_x): 3, 7, 22, 29, 58
Bad vertical strips (I_y): 8, 24, 59, 62

Active face	***Glass face***
$\Theta_x = 2.7 \pm 3.8$ μrad	$\Theta_x = 0.1 \pm 3.8$ μrad
$\Theta_y = -1.8 \pm 3.1$ μrad	$\Theta_y = 4.4 \pm 5.5$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 7.6$ μm	$\sigma_x = 7.8$ μm
$\sigma_y = 4.0$ μm	$\sigma_y = 5.6$ μm
response: 7.0 mA/W	response: 6.8 mA/W

7) AY02_01_II ====➔ +Z, 75, P1

Bad horizontal strips (I_x): 0, 1, 9, 10, 25, 29, 55
Bad vertical strips (I_y): 13, 15, 19, 46, 50, 51, 57, 58

Active face	***Glass face***
$\Theta_x = 3.2 \pm 1.9$ μrad	$\Theta_x = 3.7 \pm 2.9$ μrad
$\Theta_y = 2.2 \pm 2.1$ μrad	$\Theta_y = 0.2 \pm 4.9$ μrad
T = 86 ± 1 %	T = 84 ± 2 %
$\sigma_x = 7.4$ μm	$\sigma_x = 8.7$ μm
$\sigma_y = 5.4$ μm	$\sigma_y = 11.3$ μm
response: 20 mA/W	response: 11.5 mA/W

8) AY08_03_4 ====➔ +Z, 75, P2

Bad horizontal strips (I_x): 35, 43, 44
Bad vertical strips (I_y): 5, 6, 48, 61, 62

Active face	***Glass face***
$\Theta_x = 2.9 \pm 4.3$ μrad	$\Theta_x = 1.4 \pm 4.1$ μrad
$\Theta_y = 4.0 \pm 3.7$ μrad	$\Theta_y = -2.5 \pm 3.1$ μrad
T = 86 ± 1 %	T = 85 ± 1 %
$\sigma_x = 4.8$ μm	$\sigma_x = 6.7$ μm
$\sigma_y = 4.2$ μm	$\sigma_y = 7.5$ μm
response: 6.1 mA/W	response: 6.0 mA/W

9) AY05_04_III ====➔ +Z, 75, P3

Bad horizontal strips (I_x): 43, 44, 57, 58
Bad vertical strips (I_y): 26, 27, 49, 50

Active face	***Glass face***
$\Theta_x = -3.0 \pm 5.7$ μrad	$\Theta_x = -2.9 \pm 3.2$ μrad
$\Theta_y = 6.8 \pm 5.2$ μrad	$\Theta_y = -4.3 \pm 7.1$ μrad
T = 85 ± 2 %	T = 85 ± 1 %
$\sigma_x = 5.9$ μm	$\sigma_x = 7.0$ μm
$\sigma_y = 4.4$ μm	$\sigma_y = 4.4$ μm
response: 21 mA/W	response: 12.1 mA/W

10) AY08_01_02 ====➔ +Z, 75, P4

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): 7, 8, 25, 26

Active face	***Glass face***
$\Theta_x = -3.7 \pm 3.5$ µrad	$\Theta_x = -5.0 \pm 3.7$ µrad
$\Theta_y = 2.8 \pm 4.4$ µrad	$\Theta_y = 0.1 \pm 2.7$ µrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 6.4$ µm	$\sigma_x = 6.3$ µm
$\sigma_y = 2.9$ µm	$\sigma_y = 4.4$ µm
response: 8.4 mA/W	response: 7.8 mA/W

11) AY11_02_03 ====➔ +Z, 75, P5

Bad horizontal strips (I_x): 8
Bad vertical strips (I_y): 4, 5, 15, 16, 37

Active face	***Glass face***
$\Theta_x = -5.2 \pm 1.7$ µrad	$\Theta_x = -6.4 \pm 2.0$ µrad
$\Theta_y = 0.1 \pm 2.0$ µrad	$\Theta_y = 1.4 \pm 2.0$ µrad
T = 76 ± 3 %	T = 76 ± 3 %
$\sigma_x = 6.9$ µm	$\sigma_x = 6.2$ µm
$\sigma_y = 3.2$ µm	$\sigma_y = 3.0$ µm
response: 14 mA/W	response: 12 mA/W

12) AY08_09_02 ====➔ +Z, 75, P6

Bad horizontal strips (I_x): 62
Bad vertical strips (I_y): 16, 17, 62

Active face	***Glass face***
$\Theta_x = -5.1 \pm 3.4$ µrad	$\Theta_x = -5.8 \pm 3.1$ µrad
$\Theta_y = 4.6 \pm 3.3$ µrad	$\Theta_y = -3.6 \pm 9.4$ µrad
T = 86 ± 1 %	T = 85 ± 1 %
$\sigma_x = 6.7$ µm	$\sigma_x = 7.4$ µm
$\sigma_y = 2.8$ µm	$\sigma_y = 4.4$ µm
response: 8.3 mA/W	response: 7.9 mA/W

13) AY08_08_04 ====➔ +Z, 135, P1

Bad horizontal strips (I_x): 13, 31, 32, 38, 49
Bad vertical strips (I_y): 16, 18, 36, 37, 61, 62

Active face	***Glass face***
$\Theta_x = 4.2 \pm 4.1$ μrad	$\Theta_x = 1.8 \pm 3.8$ μrad
$\Theta_y = 6.3 \pm 3.0$ μrad	$\Theta_y = -3.7 \pm 2.9$ μrad
T = 88 ± 1 %	T = 88 ± 1 %
$\sigma_x = 6.3$ μm	$\sigma_x = 9.2$ μm
$\sigma_y = 4.7$ μm	$\sigma_y = 7.0$ μm
response: 14.7 mA/W	response: 14.0 mA/W

14) AY10_01_02 ====➔ +Z, 135, P2

Bad horizontal strips (I_x): 6, 7
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = -0.1 \pm 2.7$ μrad	$\Theta_x = -1.0 \pm 1.9$ μrad
$\Theta_y = -2.9 \pm 5.0$ μrad	$\Theta_y = 4.9 \pm 2.5$ μrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 2.6$ μm	$\sigma_x = 2.2$ μm
$\sigma_y = 2.7$ μm	$\sigma_y = 3.3$ μm
response: 17 mA/W	response: 16 mA/W

15) AY10_01_01 ====➔ +Z, 135, P3

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): 21, 22

Active face	***Glass face***
$\Theta_x = 0.0 \pm 1.9$ μrad	$\Theta_x = -0.9 \pm 1.8$ μrad
$\Theta_y = 4.7 \pm 2.4$ μrad	$\Theta_y = -2.6 \pm 2.3$ μrad
T = 89 ± 1 %	T = 88 ± 1 %
$\sigma_x = 6.2$ μm	$\sigma_x = 6.6$ μm
$\sigma_y = 3.0$ μm	$\sigma_y = 2.3$ μm
response: 18 mA/W	response: 17 mA/W

16) AY12_05_02 ====➔ +Z, 135, P4

Bad horizontal strips (I_x): 28, 29
Bad vertical strips (I_y): 38, 39

Active face	***Glass face***
$\Theta_x = 2.7 \pm 1.8$ μrad	$\Theta_x = 0.7 \pm 1.7$ μrad
$\Theta_y = -1.5 \pm 1.8$ μrad	$\Theta_y = 2.3 \pm 2.0$ μrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 8.1$ μm	$\sigma_x = 6.1$ μm
$\sigma_y = 3.7$ μm	$\sigma_y = 3.1$ μm
response: 15 mA/W	response: 14 mA/W

17) AY11_05_02 ====➔ +Z, 135, P5

Bad horizontal strips (I_x): 9, 16
Bad vertical strips (I_y): 28, 59

Active face	***Glass face***
$\Theta_x = 2.4 \pm 1.7$ μrad	$\Theta_x = 0.7 \pm 1.5$ μrad
$\Theta_y = -2.0 \pm 1.6$ μrad	$\Theta_y = 3.4 \pm 1.5$ μrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 7.3$ μm	$\sigma_x = 5.1$ μm
$\sigma_y = 3.3$ μm	$\sigma_y = 3.0$ μm
response: 17 mA/W	response: 17 mA/W

18) AY08_03_01 ====➔ +Z, 135, P6

Bad horizontal strips (I_x): 39, 40, 54, 55
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = -2.9 \pm 2.3$ μrad	$\Theta_x = -5.3 \pm 2.6$ μrad
$\Theta_y = -2.1 \pm 3.5$ μrad	$\Theta_y = 3.1 \pm 8.4$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 2.5$ μm	$\sigma_x = 3.3$ μm
$\sigma_y = 3.9$ μm	$\sigma_y = 4.3$ μm
response: 8.0 mA/W	response: 7.2 mA/W

19) AY11_03_02 ====➔ +Z, 195, P1

Bad horizontal strips (I_x): 62
Bad vertical strips (I_y): 1, 36, 37, 46, 47

Active face	*Glass face*
$\Theta_x = -1.3 \pm 2.1$ μrad	$\Theta_x = -2.2 \pm 2.0$ μrad
$\Theta_y = 2.5 \pm 1.4$ μrad	$\Theta_y = -0.7 \pm 1.4$ μrad
T = 88 ± 1 %	T = 88 ± 1 %
$\sigma_x = 8.7$ μm	$\sigma_x = 8.6$ μm
$\sigma_y = 2.8$ μm	$\sigma_y = 2.4$ μm
response: 17 mA/W	response: 16 mA/W

20) AY11_05_03 ====➔ +Z, 195, P2

Bad horizontal strips (I_x): 53, 54
Bad vertical strips (I_y): 2, 3

Active face	*Glass face*
$\Theta_x = -2.9 \pm 1.8$ μrad	$\Theta_x = -3.7 \pm 1.8$ μrad
$\Theta_y = 1.3 \pm 2.0$ μrad	$\Theta_y = 0.2 \pm 1.8$ μrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 2.5$ μm	$\sigma_x = 3.4$ μm
$\sigma_y = 3.4$ μm	$\sigma_y = 3.9$ μm
response: 17 mA/W	response: 16 mA/W

21) AY11_03_3 ====➔ +Z, 195, P3

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = -4.1 \pm 1.9$ μrad	$\Theta_x = -5.0 \pm 1.9$ μrad
$\Theta_y = 0.3 \pm 1.8$ μrad	$\Theta_y = 1.4 \pm 1.8$ μrad
T = 89 ± 1 %	T = 89 ± 1 %
$\sigma_x = 2.3$ μm	$\sigma_x = 2.7$ μm
$\sigma_y = 2.9$ μm	$\sigma_y = 2.5$ μm
response: 17 mA/W	response: 15 mA/W

22) AY12_02_03 ====➔ +Z, 195, P4

Bad horizontal strips (I_x): 16, 17
Bad vertical strips (I_y): 28, 29, 34

Active face	***Glass face***
$\Theta_x = -0.8 \pm 1.8$ µrad	$\Theta_x = -1.9 \pm 1.7$ µrad
$\Theta_y = 0.9 \pm 1.6$ µrad	$\Theta_y = 0.4 \pm 1.5$ µrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 8.2$ µm	$\sigma_x = 9.5$ µm
$\sigma_y = 3.5$ µm	$\sigma_y = 3.4$ µm
response: 14 mA/W	response: 13 mA/W

23) AY11_05_01 ====➔ +Z, 195, P5

Bad horizontal strips (I_x): 10, 38
Bad vertical strips (I_y): 27, 36

Active face	***Glass face***
$\Theta_x = 2.1 \pm 1.4$ µrad	$\Theta_x = 0.9 \pm 1.5$ µrad
$\Theta_y = 1.6 \pm 1.8$ µrad	$\Theta_y = 0.0 \pm 1.7$ µrad
T = 89 ± 1 %	T = 88 ± 1 %
$\sigma_x = 3.8$ µm	$\sigma_x = 5.7$ µm
$\sigma_y = 3.5$ µm	$\sigma_y = 4.2$ µm
response: 18 mA/W	response: 16 mA/W

24) AY10_02_02 ====➔ +Z, 195, P6 ***coat on wrong side***

Bad horizontal strips (I_x): 1
Bad vertical strips (I_y): 61

Active face	***Glass face***
$\Theta_x = -0.8 \pm 2.9$ µrad	$\Theta_x = -1.5 \pm 2.8$ µrad
$\Theta_y = -4.5 \pm 2.5$ µrad	$\Theta_y = 5.5 \pm 2.6$ µrad
T = 72 ± 2 %	T = 72 ± 2 %
$\sigma_x = 12.4$ µm	$\sigma_x = 12.2$ µm
$\sigma_y = 9.7$ µm	$\sigma_y = 11.2$ µm
response: 16.5 mA/W	response: 15.2 mA/W

25) AY12_01_02 ====➔ +Z, 255, P1

Bad horizontal strips (I_x): 17, 18, 31
Bad vertical strips (I_y): 2, 24, 25

Active face	*Glass face*
$\Theta_x = 2.2 \pm 1.5$ μrad	$\Theta_x = 1.3 \pm 1.5$ μrad
$\Theta_y = -2.4 \pm 1.5$ μrad	$\Theta_y = 4.2 \pm 1.5$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 6.1$ μm	$\sigma_x = 7.6$ μm
$\sigma_y = 4.9$ μm	$\sigma_y = 4.2$ μm
response: 15 mA/W	response: 14 mA/W

26) AY04_03_II ====➔ +Z, 255, P2

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): 9, 10, 33, 34

Active face	*Glass face*
$\Theta_x = 0.6 \pm 1.7$ μrad	$\Theta_x = 1.0 \pm 3.6$ μrad
$\Theta_y = -3.1 \pm 2.8$ μrad	$\Theta_y = 3.7 \pm 6.2$ μrad
T = 85 ± 1 %	T = 84 ± 2 %
$\sigma_x = 7.3$ μm	$\sigma_x = 10.9$ μm
$\sigma_y = 3.6$ μm	$\sigma_y = 6.0$ μm
response: 22 mA/W	response: 12.7 mA/W

27) AY00_09_IV ====➔ +Z, 255, P3

Bad horizontal strips (I_x): 11, 12, 44, 45, 56, 57
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = -2.4 \pm 1.9$ μrad	$\Theta_x = -2.5 \pm 2.6$ μrad
$\Theta_y = -2.3 \pm 1.5$ μrad	$\Theta_y = 4.9 \pm 8.9$ μrad
T = 72 ± 4 %	T = 72 ± 4 %
$\sigma_x = 3.0$ μm	$\sigma_x = 2.7$ μm
$\sigma_y = 7.7$ μm	$\sigma_y = 6.0$ μm
response: 29 mA/W	response: 16.7 mA/W

28) AY07_01_02 ====➔ +Z, 255, P4

Bad horizontal strips (I_x): 34
Bad vertical strips (I_y): 32

Active face	*Glass face*
$\Theta_x = 6.8 \pm 2.7$ µrad	$\Theta_x = 6.0 \pm 2.0$ µrad
$\Theta_y = -2.3 \pm 3.3$ µrad	$\Theta_y = 4.7 \pm 2.3$ µrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 4.0$ µm	$\sigma_x = 5.0$ µm
$\sigma_y = 3.0$ µm	$\sigma_y = 3.0$ µm
response: 8.0 mA/W	response: 8.0 mA/W

29) AY07_02_01 ====➔ +Z, 255, P5

Bad horizontal strips (I_x): 3
Bad vertical strips (I_y): 55

Active face	*Glass face*
$\Theta_x = -5.7 \pm 4.3$ µrad	$\Theta_x = -5.0 \pm 4.6$ µrad
$\Theta y = 0.0 \pm 3.6$ µrad	$\Theta_y = 5.9 \pm 4.0$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 3.4$ µm	$\sigma_x = 5.5$ µm
$\sigma_y = 2.7$ µm	$\sigma_y = 3.7$ µm
response: 6.7 mA/W	response: 6.1 mA/W

30) AY07_02_02 ====➔ +Z, 255, P6

Bad horizontal strips (I_x): 59, 63
Bad vertical strips (I_y):13, 14, 37, 44

Active face	*Glass face*
$\Theta_x = -3.6 \pm 3.3$ µrad	$\Theta_x = -4.3 \pm 3.4$ µrad
$\Theta_y = 4.9 \pm 4.1$ µrad	$\Theta_y = -0.4 \pm 5.1$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 5.7$ µm	$\sigma_x = 7.2$ µm
$\sigma_y = 3.0$ µm	$\sigma_y = 4.1$ µm
response: 7.0 mA/W	response: 6.5 mA/W

31) AY08_05_02 ====➔ +Z, 315, P1

Bad horizontal strips (I_x): 53, 54, 60
Bad vertical strips (I_y): 35

Active face	*Glass face*
$\Theta_x = -1.8 \pm 4.6$ µrad	$\Theta_x = -7.0 \pm 4.4$ µrad
$\Theta_y = 3.2 \pm 5.1$ µrad	$\Theta_y = -0.6 \pm 4.8$ µrad
T = 84 ± 1 %	T = 84 ± 2 %
$\sigma_x = 4.3$ µm	$\sigma_x = 6.7$ µm
$\sigma_y = 4.0$ µm	$\sigma_y = 7.0$ µm
response: 7.5 mA/W	response: 7.1 mA/W

32) AY11_06_04 ====➔ +Z, 315, P2 ***coat on wrong side***

Bad horizontal strips (I_x): 3, 4, 33
Bad vertical strips (I_y): 59

Active face	*Glass face*
$\Theta_x = -0.8 \pm 1.7$ µrad	$\Theta_x = -1.7 \pm 1.4$ µrad
$\Theta_y = -0.2 \pm 1.6$ µrad	$\Theta_y = 1.7 \pm 1.4$ µrad
T = 85 ± 2 %	T = 84 ± 2 %
$\sigma_x = 5.8$ µm	$\sigma_x = 4.8$ µm
$\sigma_y = 2.3$ µm	$\sigma_y = 3.7$ µm
response: 17 mA/W	response: 15 mA/W

33) AY08_06_01 ====➔ +Z, 315, P3

Bad horizontal strips (I_x): 38, 54, 55
Bad vertical strips (I_y): 0

Active face	*Glass face*
$\Theta_x = -4.3 \pm 3.1$ µrad	$\Theta_x = -6.4 \pm 3.2$ µrad
$\Theta_y = -1.7 \pm 3.1$ µrad	$\Theta_y = 4.5 \pm 7.3$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 3.6$ µm	$\sigma_x = 4.8$ µm
$\sigma_y = 5.8$ µm	$\sigma_y = 5.4$ µm
response: 6.5 mA/W	response: 6.1 mA/W

34) AY08_06_02 ====➔ +Z, 315, P4

Bad horizontal strips (I_x): 15, 16, 51
Bad vertical strips (I_y): 48

Active face	*Glass face*
$\Theta_x = -4.5 \pm 2.6$ µrad	$\Theta_x = -5.5 \pm 2.6$ µrad
$\Theta_y = 4.8 \pm 3.7$ µrad	$\Theta_y = -2.0 \pm 3.0$ µrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 3.9$ µm	$\sigma_x = 5.9$ µm
$\sigma_y = 4.5$ µm	$\sigma_y = 6.0$ µm
response: 6.9 mA/W	response: 6.8 mA/W

35) AY08_06_03 ====➔ +Z, 315, P5

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = 2.0 \pm 4.4$ µrad	$\Theta_x = 3.7 \pm 4.6$ µrad
$\Theta_y = -2.4 \pm 3.2$ µrad	$\Theta_y = 5.7 \pm 4.8$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 4.0$ µm	$\sigma_x = 4.5$ µm
$\sigma_y = 3.1$ µm	$\sigma_y = 4.7$ µm
response: 6.4 mA/W	response: 6.1 mA/W

36) AY08_05_01 ====➔ +Z, 315, P6

Bad horizontal strips (I_x): 24, 50, 61
Bad vertical strips (I_y): 9, 29, 30, 51, 63

Active face	*Glass face*
$\Theta_x = -5.5 \pm 4.8$ µrad	$\Theta_x = -7.8 \pm 5.3$ µrad
$\Theta_y = -1.7 \pm 4.0$ µrad	$\Theta_y = 7.4 \pm 4.8$ µrad
T = 84 ± 1 %	T = 85 ± 1 %
$\sigma_x = 8.9$ µm	$\sigma_x = 7.9$ µm
$\sigma_y = 5.5$ µm	$\sigma_y = 5.2$ µm
response: 8.0 mA/W	response: 7.4 mA/W

II) Sensors installed at - Z

37) AY18_06_01 ====➔ - Z, 15, P1

Bad horizontal strips (I_x): 42
Bad vertical strips (I_y): 62, 63

Active face	*Glass face*
$\Theta_x = 2.6 \pm 3.3$ µrad	$\Theta_x = 1.3 \pm 3.2$ µrad
$\Theta_y = 2.8 \pm 2.4$ µrad	$\Theta_y = -0.1 \pm 2.4$ µrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 2.6$ µm	$\sigma_x = 2.8$ µm
$\sigma_y = 6.7$ µm	$\sigma_y = 5.6$ µm
response: 13.8 ± 0.3 mA/W	response: 12.2 ± 0.2 mA/W

38) AY12_04_04 ====➔ - Z, 15, P2

Bad horizontal strips (I_x): 4
Bad vertical strips (I_y): 36

Active face	*Glass face*
$\Theta_x = -2.8 \pm 1.7$ µrad	$\Theta_x = -3.8 \pm 1.7$ µrad
$\Theta_y = -1.6 \pm 1.7$ µrad	$\Theta_y = 2.8 \pm 1.7$ µrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 2.9$ µm	$\sigma_x = 3.5$ µm
$\sigma_y = 2.7$ µm	$\sigma_y = 2.8$ µm
response: 15 mA/W	response: 13 mA/W

39) AY12_02_01 ====➔ - Z, 15, P3

Bad horizontal strips (I_x): 3, 4
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = 3.1 \pm 1.5$ µrad	$\Theta_x = 1.9 \pm 1.5$ µrad
$\Theta_y = 2.0 \pm 1.6$ µrad	$\Theta_y = -0.9 \pm 1.5$ µrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 2.6$ µm	$\sigma_x = 2.8$ µm
$\sigma_y = 2.9$ µm	$\sigma_y = 2.2$ µm
response: 14 mA/W	response: 13 mA/W

40) AY18_06_03 ====➔ -Z, 15, P4

Bad horizontal strips (I_x): 42
Bad vertical strips (I_y): 0

Active face	*Glass face*
$\Theta_x = -9.1 \pm 1.8$ μrad	$\Theta_x = -10.4 \pm 1.9$ μrad
$\Theta_y = 0.3 \pm 2.7$ μrad	$\Theta_y = 2.3 \pm 2.4$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 2.5$ μm	$\sigma_x = 2.6$ μm
$\sigma_y = 4.2$ μm	$\sigma_y = 4.3$ μm
response: 14.3 ± 0.3 mA/W	response: 12.8 ± 0.2 mA/W

41) AY15_06_02 ====➔ -Z, 15, P5

Bad horizontal strips (I_x): 8, 28, 39
Bad vertical strips (I_y): 35, 40, 63

Active face	*Glass face*
$\Theta_x = 6.7 \pm 3.3$ μrad	$\Theta_x = 5.2 \pm 3.0$ μrad
$\Theta_y = -5.8 \pm 6.9$ μrad	$\Theta_y = 7.6 \pm 6.3$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 2.8$ μm	$\sigma_x = 3.0$ μm
$\sigma_y = 6.4$ μm	$\sigma_y = 5.8$ μm
response: 14.1 ± 0.7 mA/W	response: 13.3 ± 0.7 mA/W

42) AY15_06_03 ====➔ -Z, 15, P6

Bad horizontal strips (I_x): 4, 5
Bad vertical strips (I_y): 19, 20, 56

Active face	*Glass face*
$\Theta_x = -2.7 \pm 1.8$ μrad	$\Theta_x = -4.8 \pm 2.0$ μrad
$\Theta_y = 13.4 \pm 2.3$ μrad	$\Theta_y = -11.6 \pm 2.4$ μrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 3.9$ μm	$\sigma_x = 10.5$ μm
$\sigma_y = 3.8$ μm	$\sigma_y = 3.9$ μm
response: 14.5 ± 1.6 mA/W	response: 14.1 ± 1.7 mA/W

43) AY18_01_01 ====➔ -Z, 75, P1

Bad horizontal strips (I_x): 44
Bad vertical strips (I_y): 4, 21

Active face	*Glass face*
$\Theta_x = 7.0 \pm 1.9$ µrad	$\Theta_x = 5.8 \pm 1.9$ µrad
$\Theta_y = 6.8 \pm 1.9$ µrad	$\Theta_y = -4.0 \pm 2.0$ µrad
T = 82 ± 1 %	T = 82 ± 1 %
$\sigma_x = 2.8$ µm	$\sigma_x = 2.7$ µm
$\sigma_y = 6.6$ µm	$\sigma_y = 6.3$ µm
response: 14.7 ± 1.8 mA/W	response: 13.2 ± 1.7 mA/W

44) AY12_03_02 ====➔ -Z, 75, P2

Bad horizontal strips (I_x): 35
Bad vertical strips (I_y): 17

Active face	*Glass face*
$\Theta_x = 0.4 \pm 3.6$ µrad	$\Theta_x = -0.3 \pm 3.2$ µrad
$\Theta_y = -0.9 \pm 4.0$ µrad	$\Theta_y = 1.3 \pm 5.6$ µrad
T = 86 ± 2 %	T = 86 ± 2 %
$\sigma_x = 3.4$ µm	$\sigma_x = 3.1$ µm
$\sigma_y = 4.1$ µm	$\sigma_y = 3.5$ µm
response: 15 mA/W	response: 13 mA/W

45) AY12_04_02 ====➔ -Z, 75, P3

Bad horizontal strips (I_x): 17, 50
Bad vertical strips (I_y): 4, 59, 60

Active face	*Glass face*
$\Theta_x = 2.2 \pm 2.2$ µrad	$\Theta_x = 1.1 \pm 1.8$ µrad
$\Theta_y = -1.8 \pm 1.6$ µrad	$\Theta_y = 3.2 \pm 1.7$ µrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 4.1$ µm	$\sigma_x = 4.5$ µm
$\sigma_y = 3.7$ µm	$\sigma_y = 3.8$ µm
response: 14 mA/W	response: 13 mA/W

46) AY18_05_01 ====➔ -Z, 75, P4

Bad horizontal strips (I_x): 39, 61
Bad vertical strips (I_y): 7, 30

Active face	*Glass face*
$\Theta_x = 1.5 \pm 4.1$ μrad	$\Theta_x = -0.3 \pm 4.0$ μrad
$\Theta_y = 1.2 \pm 2.3$ μrad	$\Theta_y = 0.9 \pm 2.3$ μrad
T = 86 ± 1 %	T = 85 ± 1 %
$\sigma_x = 2.8$ μm	$\sigma_x = 2.7$ μm
$\sigma_y = 4.0$ μm	$\sigma_y = 3.7$ μm
response: 15.7 ± 1.0 mA/W	response: 13.7 ± 0.5 mA/W

47) AY15_05_02 ====➔ -Z, 75, P5

Bad horizontal strips (I_x): 10, 16, 17
Bad vertical strips (I_y): 11, 12

Active face	*Glass face*
$\Theta_x = 3.2 \pm 4.5$ μrad	$\Theta_x = 2.3 \pm 4.6$ μrad
$\Theta_y = 0.0 \pm 2.1$ μrad	$\Theta_y = 2.9 \pm 2.0$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 6.4$ μm	$\sigma_x = 8.3$ μm
$\sigma_y = 7.1$ μm	$\sigma_y = 6.7$ μm
response: 14.6 ± 1.3 mA/W	response: 13.7 ± 1.2 mA/W

48) AY15_06_01 ====➔ -Z, 75, P6

Bad horizontal strips (I_x): 40
Bad vertical strips (I_y): 41, 42, 51

Active face	*Glass face*
$\Theta_x = -0.7 \pm 2.4$ μrad	$\Theta_x = -2.7 \pm 2.0$ μrad
$\Theta_y = 10.7 \pm 3.3$ μrad	$\Theta_y = -8.6 \pm 2.9$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 10.9$ μm	$\sigma_x = 3.4$ μm
$\sigma_y = 5.0$ μm	$\sigma_y = 6.3$ μm
response: 14.5 ± 0.8 mA/W	response: 13.1 ± 0.9 mA/W

49) AY17_01_03 ====➔ - Z, 135, P1

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = -8.5 \pm 2.8$ µrad	$\Theta_x = -9.5 \pm 2.7$ µrad
$\Theta_y = 5.2 \pm 2.2$ µrad	$\Theta_y = -3.1 \pm 2.3$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 2.6$ µm	$\sigma_x = 2.6$ µm
$\sigma_y = 3.6$ µm	$\sigma_y = 3.2$ µm
response: 15.1 ± 0.6 mA/W	response: 13.3 ± 0.5 mA/W

50) AY12_05_04 ====➔ ? Z, 135, P2

Bad horizontal strips (I_x): 5, 62
Bad vertical strips (I_y): 18, 35

Active face	***Glass face***
$\Theta_x = -4.9 \pm 1.6$ µrad	$\Theta_x = -5.6 \pm 1.6$ µrad
$\Theta_y = -2.6 \pm 1.8$ µrad	$\Theta_y = 3.5 \pm 1.8$ µrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 4.7$ µm	$\sigma_x = 5.2$ µm
$\sigma_y = 2.5$ µm	$\sigma_y = 2.4$ µm
response: 16 mA/W	response: 14 mA/W

51) AY12_04_01 ====➔ - Z, 135, P3

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = 3.4 \pm 1.9$ µrad	$\Theta_x = 1.3 \pm 1.8$ µrad
$\Theta_y = 3.0 \pm 1.8$ µrad	$\Theta_y = -2.4 \pm 1.7$ µrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 2.0$ µm	$\sigma_x = 2.9$ µm
$\sigma_y = 2.3$ µm	$\sigma_y = 2.2$ µm
response: 15 mA/W	response: 13 mA/W

52) AY17_01_04 ====➔ - Z, 135, P4

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = -9.8 \pm 3.2$ μrad	$\Theta_x = -11.4 \pm 3.2$ μrad
$\Theta_y = -3.7 \pm 2.8$ μrad	$\Theta_y = 5.8 \pm 2.9$ μrad
T = 86 ± 1 %	T = 85 ± 1 %
$\sigma_x = 2.5$ μm	$\sigma_x = 2.6$ μm
$\sigma_y = 4.2$ μm	$\sigma_y = 4.1$ μm
response: 16.1 ± 0.3 mA/W	response: 14.2 ± 0.3 mA/W

53) AY14_05_02 ====➔ - Z, 135, P5

Bad horizontal strips (I_x): 30, 31
Bad vertical strips (I_y): 31, 32

Active face	***Glass face***
$\Theta_x = 7.3 \pm 2.5$ μrad	$\Theta_x = 6.5 \pm 2.1$ μrad
$\Theta_y = -4.9 \pm 2.0$ μrad	$\Theta_y = 5.8 \pm 1.7$ μrad
T = 85 ± 2 %	T = 85 ± 1 %
$\sigma_x = 9.1$ μm	$\sigma_x = 5.9$ μm
$\sigma_y = 7.8$ μm	$\sigma_y = 11.0$ μm
response: 17.8 ± 2.7 mA/W	response: 16.3 ± 1.9 mA/W

54) AY15_02_02 ====➔ - Z, 135, P6

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): 11, 12

Active face	***Glass face***
$\Theta_x = 2.9 \pm 2.8$ μrad	$\Theta_x = 1.2 \pm 3.1$ μrad
$\Theta_y = 5.5 \pm 2.5$ μrad	$\Theta_y = -3.3 \pm 2.6$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 8.3$ μm	$\sigma_x = 2.1$ μm
$\sigma_y = 3.9$ μm	$\sigma_y = 3.6$ μm
response: 14.1 ± 0.5 mA/W	response: 13.1 ± 0.5 mA/W

55) AY17_01_02 ====➔ - Z, 195, P1

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = 4.4 \pm 3.2$ µrad	$\Theta_x = 3.5 \pm 2.8$ µrad
$\Theta_y = -4.4 \pm 3.4$ µrad	$\Theta_y = 5.9 \pm 3.0$ µrad
T = 85 ± 1 %	T = 86 ± 1 %
$\sigma_x = 2.7$ µm	$\sigma_x = 2.5$ µm
$\sigma_y = 3.7$ µm	$\sigma_y = 3.6$ µm
response: 15.4 ± 0.5 mA/W	response: 13.7 ± 0.6 mA/W

56) AY12_05_03 ====➔ - Z, 195, P2

Bad horizontal strips (I_x): 57, 58
Bad vertical strips (I_y): 22, 23, 51, 57

Active face	*Glass face*
$\Theta_x = -3.4 \pm 1.3$ µrad	$\Theta_x = -4.7 \pm 1.3$ µrad
$\Theta_y = 3.6 \pm 1.6$ µrad	$\Theta_y = -2.0 \pm 1.6$ µrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 5.6$ µm	$\sigma_x = 8.4$ µm
$\sigma_y = 2.9$ µm	$\sigma_y = 2.1$ µm
response: 16 mA/W	response: 15 mA/W

57) AY07_02_04 ====➔ - Z, 195, P3

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = -3.2 \pm 3.0$ µrad	$\Theta_x = -3.5 \pm 2.8$ µrad
$\Theta_y = -4.0 \pm 2.7$ µrad	$\Theta_y = 5.9 \pm 4.9$ µrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 2.1$ µm	$\sigma_x = 3.2$ µm
$\sigma_y = 2.6$ µm	$\sigma_y = 3.1$ µm
response: 7.7 mA/W	response: 8.2 mA/W

58) AY18_01_03 ====➔ - Z, 195, P4

Bad horizontal strips (I_x): 41
Bad vertical strips (I_y): 3, 4, 55

Active face	*Glass face*
$\Theta_x = -6.1 \pm 4.2$ μrad	$\Theta_x = -7.4 \pm 3.7$ μrad
$\Theta_y = 5.0 \pm 2.1$ μrad	$\Theta_y = -2.2 \pm 2.2$ μrad
T = 83 ± 1 %	T = 83 ± 1 %
$\sigma_x = 4.5$ μm	$\sigma_x = 2.6$ μm
$\sigma_y = 7.3$ μm	$\sigma_y = 5.2$ μm
response: 15.2 ± 1.6 mA/W	response: 13.5 ± 1.5 mA/W

59) AY15_04_02 ====➔ - Z, 195, P5

Bad horizontal strips (I_x): 32, 48, 49
Bad vertical strips (I_y): 11, 12, 49

Active face	*Glass face*
$\Theta_x = 3.5 \pm 3.8$ μrad	$\Theta_x = 2.1 \pm 3.4$ μrad
$\Theta_y = -4.3 \pm 2.4$ μrad	$\Theta_y = 6.7 \pm 2.2$ μrad
T = 84 ± 1 %	T = 85 ± 1 %
$\sigma_x = 9.6$ μm	$\sigma_x = 7.1$ μm
$\sigma_y = 7.8$ μm	$\sigma_y = 7.6$ μm
response: 16 mA/W	response: 15 mA/W

60) AY14_05_01 ====➔ - Z, 195, P6

Bad horizontal strips (I_x): 42, 43
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = 4.4 \pm 2.7$ μrad	$\Theta_x = 3.0 \pm 2.6$ μrad
$\Theta_y = 2.9 \pm 3.0$ μrad	$\Theta_y = -0.1 \pm 2.8$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 4.8$ μm	$\sigma_x = 5.5$ μm
$\sigma_y = 6.3$ μm	$\sigma_y = 5.8$ μm
response: 16.7 ± 1.7 mA/W	response: 15.7 ± 1.5 mA/W

61) AY16_02_04 ====➔ -Z, 255, P1

Bad horizontal strips (I_x): 63
Bad vertical strips (I_y): 35

Active face	***Glass face***
$\Theta_x = -10.3 \pm 1.8$ µrad	$\Theta_x = -10.1 \pm 1.5$ µrad
$\Theta_y = -4.9 \pm 1.9$ µrad	$\Theta_y = 6.9 \pm 2.0$ µrad
T = 85 ± 1 %	T = 86 ± 1 %
$\sigma_x = 2.8$ µm	$\sigma_x = 3.1$ µm
$\sigma_y = 3.8$ µm	$\sigma_y = 3.7$ µm
response: 15.4 ± 1.0 mA/W	response: 14.4 ± 0.9 mA/W

62) AY12_01_01 ====➔ -Z, 255, P2

Bad horizontal strips (I_x): 9, 49
Bad vertical strips (I_y): 6, 7, 25, 43

Active face	***Glass face***
$\Theta_x = 1.6 \pm 1.5$ µrad	$\Theta_x = 0.1 \pm 1.5$ µrad
$\Theta_y = 2.4 \pm 1.5$ µrad	$\Theta_y = -0.4 \pm 1.4$ µrad
T = 83 ± 1 %	T = 83 ± 1 %
$\sigma_x = 5.5$ µm	$\sigma_x = 5.3$ µm
$\sigma_y = 4.2$ µm	$\sigma_y = 4.7$ µm
response: 15 mA/W	response: 14 mA/W

63) AY15_02_03 ====➔ -Z, 255, P3

Bad horizontal strips (I_x): 61
Bad vertical strips (I_y): 10, 12

Active face	***Glass face***
$\Theta_x = -2.6 \pm 3.6$ µrad	$\Theta_x = -4.0 \pm 3.7$ µrad
$\Theta_y = 4.5 \pm 2.5$ µrad	$\Theta_y = -1.5 \pm 3.1$ µrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 2.2$ µm	$\sigma_x = 4.8$ µm
$\sigma_y = 3.7$ µm	$\sigma_y = 4.2$ µm
response: 15 mA/W	response: 15 mA/W

64) AY17_06_04 ====➔ - Z, 255, P4

Bad horizontal strips (I_x): 13, 62, 63
Bad vertical strips (I_y): 24, 29

Active face
$\Theta_x = -4.2 \pm 2.6$ µrad
$\Theta_y = -2.1 \pm 2.1$ µrad
T = 86 ± 1 %
$\sigma_x = 3.0$ µm
$\sigma_y = 4.9$ µm
response: 13.3 ± 0.8 mA/W

Glass face
$\Theta_x = -5.7 \pm 2.5$ µrad
$\Theta_y = 4.9 \pm 2.1$ µrad
T = 86 ± 1 %
$\sigma_x = 3.8$ µm
$\sigma_y = 4.5$ µm
response: 11.9 ± 0.7 mA/W

65) AY16_03_04 ====➔ - Z, 255, P5

Bad horizontal strips (I_x):39
Bad vertical strips (I_y): 25, 26, 54

Active face
$\Theta_x = -8.5 \pm 2.0$ µrad
$\Theta_y = -2.5 \pm 1.9$ µrad
T = 84 ± 1 %
$\sigma_x = 10.2$ µm
$\sigma_y = 13.0$ µm
response: 16.1 ± 1.7 mA/W

Glass face
$\Theta_x = -9.6 \pm 1.6$ µrad
$\Theta_y = 6.3 \pm 2.1$ µrad
T = 84 ± 1 %
$\sigma_x = 10.2$ µm
$\sigma_y = 13.0$ µm
response: 15.1 ± 1.7 mA/W

66) AY15_04_03 ====➔ - Z, 255, P6

Bad horizontal strips (I_x): 1, 33
Bad vertical strips (I_y): 23, 24, 30, 54

Active face
$\Theta_x = -10.2 \pm 2.0$ µrad
$\Theta_y = 0.2 \pm 1.6$ µrad
T = 83 ± 1 %
$\sigma_x = 3.9$ µm
$\sigma_y = 4.5$ µm
response: 16 mA/W

Glass face
$\Theta_x = -11.7 \pm 1.8$ µrad
$\Theta_y = 2.3 \pm 1.6$ µrad
T = 83 ± 1 %
$\sigma_x = 9.7$ µm
$\sigma_y = 4.0$ µm
response: 15 mA/W

67) AY16_01_04 ====➔ - Z, 315, P1

Bad horizontal strips (I_x): 35
Bad vertical strips (I_y): 62, 63

Active face	*Glass face*
$\Theta_x = -5.3 \pm 2.8$ µrad	$\Theta_x = -7.2 \pm 2.7$ µrad
$\Theta_y = 2.1 \pm 2.2$ µrad	$\Theta_y = 0.5 \pm 2.0$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 2.6$ µm	$\sigma_x = 2.4$ µm
$\sigma_y = 4.3$ µm	$\sigma_y = 4.5$ µm
response: 16.6 ± 0.9 mA/W	response: 14.5 ± 0.9 mA/W

68) AY12_03_01 ====➔ - Z, 315, P2

Bad horizontal strips (I_x): 5
Bad vertical strips (I_y): 27

Active face	*Glass face*
$\Theta_x = 0.2 \pm 4.4$ µrad	$\Theta_x = -0.4 \pm 4.2$ µrad
$\Theta_y = 2.4 \pm 3.7$ µrad	$\Theta_y = -1.1 \pm 4.8$ µrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 3.3$ µm	$\sigma_x = 4.3$ µm
$\sigma_y = 2.9$ µm	$\sigma_y = 3.9$ µm
response: 15 mA/W	response: 14 mA/W

69) AY16_04_04 ====➔ - Z, 315, P3

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = -7.4 \pm 3.1$ µrad	$\Theta_x = -8.0 \pm 2.9$ µrad
$\Theta_y = -5.8 \pm 3.9$ µrad	$\Theta_y = 7.4 \pm 3.8$ µrad
T = 86 ± 1 %	T = 85 ± 1 %
$\sigma_x = 2.7$ µm	$\sigma_x = 2.7$ µm
$\sigma_y = 3.8$ µm	$\sigma_y = 3.4$ µm
response: 15.1 ± 0.2 mA/W	response: 13.3 ± 0.2 mA/W

70) AY16_02_03 ====➔ -Z, 315, P4

Bad horizontal strips (I_x): 12, 40
Bad vertical strips (I_y): 3, 4

Active face	*Glass face*
$\Theta_x = -8.0 \pm 2.0$ μrad	$\Theta_x = -9.0 \pm 1.7$ μrad
$\Theta_y = -0.8 \pm 2.5$ μrad	$\Theta_y = 3.1 \pm 2.3$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 2.7$ μm	$\sigma_x = 2.7$ μm
$\sigma_y = 5.1$ μm	$\sigma_y = 6.6$ μm
response: 16.0 ± 1.0 mA/W	response: 15.0 ± 1.1 mA/W

71) AY16_03_02 ====➔ -Z, 315, P5

Bad horizontal strips (I_x): 19, 20
Bad vertical strips (I_y): none

Active face	*Glass face*
$\Theta_x = 7.5 \pm 4.9$ μrad	$\Theta_x = 6.9 \pm 4.5$ μrad
$\Theta_y = -6.0 \pm 2.4$ μrad	$\Theta_y = 8.9 \pm 2.3$ μrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 2.5$ μm	$\sigma_x = 2.5$ μm
$\sigma_y = 6.9$ μm	$\sigma_y = 6.2$ μm
response: 15.6 ± 0.6 mA/W	response: 14.0 ± 0.5 mA/W

72) AY16_03_03 ====➔ -Z, 315, P6

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): 40, 41

Active face	*Glass face*
$\Theta_x = -10.3 \pm 1.6$ μrad	$\Theta_x = -10.8 \pm 1.7$ μrad
$\Theta_y = -2.1 \pm 1.7$ μrad	$\Theta_y = 4.9 \pm 1.7$ μrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 3.1$ μm	$\sigma_x = 10.0$ μm
$\sigma_y = 4.3$ μm	$\sigma_y = 3.4$ μm
response: 14.9 ± 0.9 mA/W	response: 13.6 ± 0.6 mA/W

III) Spare sensors for the –Z side

73) AY16_05_03 ====➔ -Z, any angle, P1

Bad horizontal strips (I_x): 35
Bad vertical strips (I_y): 11, 12, 53, 61

Active face	***Glass face***
$\Theta_x = -5.9 \pm 3.6$ µrad	$\Theta_x = -7.0 \pm 3.4$ µrad
$\Theta_y = 3.5 \pm 2.4$ µrad	$\Theta_y = -1.7 \pm 2.5$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 10.2$ µm	$\sigma_x = 4.2$ µm
$\sigma_y = 4.0$ µm	$\sigma_y = 4.0$ µm
response: 15.5 ± 1.6 mA/W	response: 14.1 ± 1.6 mA/W

74) AY16_03_01 ====➔ -Z, any angle, P1

Bad horizontal strips (I_x): 14, 35
Bad vertical strips (I_y): 38, 39, 51, 63

Active face	***Glass face***
$\Theta_x = 5.8 \pm 4.5$ µrad	$\Theta_x = 5.0 \pm 4.4$ µrad
$\Theta_y = -1.1 \pm 2.3$ µrad	$\Theta_y = 3.4 \pm 2.2$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 9.7$ µm	$\sigma_x = 9.7$ µm
$\sigma_y = 3.9$ µm	$\sigma_y = 3.9$ µm
response: 15.7 ± 1.3 mA/W	response: 14.7 ± 1.3 mA/W

75) AY12_03_04 ====➔ -Z, any angle, P2

Bad horizontal strips (I_x): 26, 63
Bad vertical strips (I_y): 12

Active face	***Glass face***
$\Theta_x = -4.0 \pm 5.0$ µrad	$\Theta_x = -4.5 \pm 6.1$ µrad
$\Theta_y = -0.2 \pm 5.1$ µrad	$\Theta_y = 2.9 \pm 4.3$ µrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 4.6$ µm	$\sigma_x = 3.8$ µm
$\sigma_y = 2.8$ µm	$\sigma_y = 2.1$ µm
response: 14 mA/W	response: 13 mA/W

76) AY16_05_04 ====➔ - Z, any angle, P4

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): 26, 27

Active face	*Glass face*
$\Theta_x = -2.8 \pm 2.9$ µrad	$\Theta_x = -4.0 \pm 2.6$ µrad
$\Theta_y = -5.2 \pm 2.1$ µrad	$\Theta_y = 8.0 \pm 1.8$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 2.7$ µm	$\sigma_x = 7.0$ µm
$\sigma_y = 4.3$ µm	$\sigma_y = 3.4$ µm
response: 15.1 ± 1.0 mA/W	response: 13.8 ± 0.7 mA/W

77) AY16_04_02 ====➔ - Z, any angle, P4

Bad horizontal strips (I_x): 33
Bad vertical strips (I_y): 51, 52

Active face	*Glass face*
$\Theta_x = 3.3 \pm 2.2$ µrad	$\Theta_x = 2.4 \pm 2.5$ µrad
$\Theta_y = -0.3 \pm 2.5$ µrad	$\Theta_y = 2.5 \pm 2.7$ µrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 4.0$ µm	$\sigma_x = 4.3$ µm
$\sigma_y = 4.0$ µm	$\sigma_y = 6.6$ µm
response: 15.0 ± 1.5 mA/W	response: 13.6 ± 1.6 mA/W

78) AY17_06_02 ====➔ - Z, any angle, P5

Bad horizontal strips (I_x): 33, 35, 51
Bad vertical strips (I_y): 46, 60

Active face	*Glass face*
$\Theta_x = 9.0 \pm 1.8$ µrad	$\Theta_x = 7.4 \pm 1.8$ µrad
$\Theta_y = -3.8 \pm 1.8$ µrad	$\Theta_y = 6.4 \pm 1.7$ µrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 2.6$ µm	$\sigma_x = 2.8$ µm
$\sigma_y = 6.7$ µm	$\sigma_y = 7.3$ µm
response: 13.6 ± 1.6 mA/W	response: 12.4 ± 1.7 mA/W

79) AY16_02_01 ====➔ -Z, any angle, P6

Bad horizontal strips (I_x): 12, 56
Bad vertical strips (I_y): 8, 38, 39

Active face	***Glass face***
$\Theta_x = 8.0 \pm 4.8$ μrad	$\Theta_x = 7.4 \pm 4.9$ μrad
$\Theta_y = 3.7 \pm 2.5$ μrad	$\Theta_y = -1.7 \pm 2.8$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 6.3$ μm	$\sigma_x = 7.6$ μm
$\sigma_y = 4.0$ μm	$\sigma_y = 5.3$ μm
response: 14.5 ± 1.3 mA/W	response: 13.0 ± 1.0 mA/W

IV) Free “good” sensors (they are kept at IFCA clean room)

80) AY06_04_03

Bad horizontal strips (I_x): 15, 27, 58, 59
Bad vertical strips (I_y): 6, 20

Active face	***Glass face***
$\Theta_x = 3.0 \pm 5.0$ μrad	$\Theta_x = 1.9 \pm 4.8$ μrad
$\Theta_y = -1.7 \pm 4.4$ μrad	$\Theta_y = 6.4 \pm 5.9$ μrad
T = 82 ± 1 %	T = 82 ± 1 %
$\sigma_x = 4.3$ μm	$\sigma_x = 4.8$ μm
$\sigma_y = 4.6$ μm	$\sigma_y = 5.5$ μm
response: 7.0 mA/W	response: 6.0 mA/W

81) AY12_03_03

Bad horizontal strips (I_x): 9, 14, 25, 26, 45, 46
Bad vertical strips (I_y): 11, 22, 23, 31, 38, 39

Active face	***Glass face***
$\Theta_x = -3.5 \pm 2.4$ μrad	$\Theta_x = -4.4 \pm 3.2$ μrad
$\Theta_y = 4.0 \pm 3.0$ μrad	$\Theta_y = -2.9 \pm 2.4$ μrad
T = 87 ± 1 %	T = 87 ± 1 %
$\sigma_x = 7.8$ μm	$\sigma_x = 10.5$ μm *too many pairs of interconnected*
$\sigma_y = 15.1$ μm	$\sigma_y = 14.9$ μm *strips : keep aside if possible*
response: 17 mA/W	response: 15 mA/W

82) AY14_04_03

Bad horizontal strips (I_x): 25, 26
Bad vertical strips (I_y): 59, 60

Active face	***Glass face***
$\Theta_x = 0.7 \pm 1.5$ μrad	$\Theta_x = 0.2 \pm 1.8$ μrad
$\Theta_y = -2.7 \pm 1.4$ μrad	$\Theta_y = 4.3 \pm 1.6$ μrad
T = 86 ± 1 %	T = 85 ± 1 %
$\sigma_x = 1.9$ μm	$\sigma_x = 1.8$ μm
$\sigma_y = 9.9$ μm	$\sigma_y = 10.3$ μm
response: 18 mA/W	response: 17 mA/W

83) AY14_04_04

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): 16, 17, 61, 62

Active face	*Glass face*
$\Theta_x = 1.3 \pm 1.5$ μrad	$\Theta_x = 0.2 \pm 1.5$ μrad
$\Theta_y = 1.9 \pm 1.7$ μrad	$\Theta_y = -0.2 \pm 1.7$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 4.4$ μm	$\sigma_x = 13.4$ μm
$\sigma_y = 4.0$ μm	$\sigma_y = 3.7$ μm
response: 17 mA/W	response: 18 mA/W

84) AY15_01_04

Bad horizontal strips (I_x): 8, 19
Bad vertical strips (I_y): 18, 26, 33, 34

Active face	*Glass face*
$\Theta_x = -8.4 \pm 2.5$ μrad	$\Theta_x = -10.6 \pm 2.0$ μrad
$\Theta_y = 4.2 \pm 2.4$ μrad	$\Theta_y = -2.4 \pm 2.2$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 7.9$ μm	$\sigma_x = 11.8$ μm
$\sigma_y = 3.2$ μm	$\sigma_y = 5.2$ μm
response: 16 mA/W	response: 15 mA/W

85) AY15_02_04

Bad horizontal strips (I_x): 30
Bad vertical strips (I_y): 42, 43, 49

Active face	*Glass face*
$\Theta_x = -13.1 \pm 5.8$ μrad	$\Theta_x = -13.8 \pm 5.8$ μrad
$\Theta_y = -5.3 \pm 3.7$ μrad	$\Theta_y = 6.4 \pm 3.9$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 6.8$ μm	$\sigma_x = 9.7$ μm
$\sigma_y = 4.7$ μm	$\sigma_y = 5.3$ μm
response: 16 mA/W	response: 15 mA/W

86) AY15_04_01

Bad horizontal strips (I_x): 7, 19, 20
Bad vertical strips (I_y): 0, 1, 38, 39, 55

Active face	***Glass face***
$\Theta_x = 2.3 \pm 3.8$ µrad	$\Theta_x = 0.9 \pm 3.6$ µrad
$\Theta_y = -0.1 \pm 2.0$ µrad	$\Theta_y = 2.2 \pm 1.8$ µrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 14.4$ µm	$\sigma_x = 4.7$ µm
$\sigma_y = 4.8$ µm	$\sigma_y = 3.6$ µm
response: 16 mA/W	response: 15 mA/W

87) AY15_05_04

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): 39, 40, 54, 55

Active face	***Glass face***
$\Theta_x = -12.6 \pm 2.0$ µrad	$\Theta_x = -13.9 \pm 2.0$ µrad
$\Theta_y = -0.8 \pm 2.1$ µrad	$\Theta_y = 2.6 \pm 2.0$ µrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 7.1$ µm	$\sigma_x = 12.3$ µm
$\sigma_y = 3.7$ µm	$\sigma_y = 3.3$ µm
response: 16 mA/W	response: 15 mA/W

88) AY15_05_03

Bad horizontal strips (I_x): 5, 34, 35, 52
Bad vertical strips (I_y): 5, 11, 12, 34, 42, 51

Active face	***Glass face***
$\Theta_x = -10.5 \pm 2.3$ µrad	$\Theta_x = -12.2 \pm 2.6$ µrad
$\Theta_y = 1.8 \pm 2.3$ µrad	$\Theta_y = 0.2 \pm 2.8$ µrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 6.7$ µm	$\sigma_x = 9.5$ µm
$\sigma_y = 5.1$ µm	$\sigma_y = 4.9$ µm
response: 18 mA/W	response: 16 mA/W

89) AY14_05_04

Bad horizontal strips (I_x): 6, 13
Bad vertical strips (I_y): 29, 36, 37, 51

Active face	***Glass face***
$\Theta_x = -2.1 \pm 3.3$ μrad	$\Theta_x = -2.6 \pm 3.2$ μrad
$\Theta_y = -1.6 \pm 2.0$ μrad	$\Theta_y = 4.2 \pm 2.1$ μrad
T = 85 ± 2 %	T = 84 ± 2 %
$\sigma_x = 10.7$ μm	$\sigma_x = 5.5$ μm
$\sigma_y = 20.0$ μm	$\sigma_y = 19.9$ μm
response: 14.7 ± 2.2 mA/W	response: 13.9 ± 2.0 mA/W

90) AY15_06_04

Bad horizontal strips (I_x): 46, 49
Bad vertical strips (I_y): 14, 61, 62

Active face	***Glass face***
$\Theta_x = -0.7 \pm 2.2$ μrad	$\Theta_x = -1.2 \pm 2.0$ μrad
$\Theta_y = 1.0 \pm 3.7$ μrad	$\Theta_y = 0.3 \pm 4.0$ μrad
T = 85 ± 1 %	T = 86 ± 1 %
$\sigma_x = 2.8$ μm	$\sigma_x = 2.7$ μm
$\sigma_y = 5.3$ μm	$\sigma_y = 5.3$ μm
response: 16.0 ± 1.4 mA/W	response: 15.0 ± 1.3 mA/W

91) AY16_02_02

Bad horizontal strips (I_x): 28
Bad vertical strips (I_y): 49

Active face	***Glass face***
$\Theta_x = 2.5 \pm 3.0$ μrad	$\Theta_x = 1.6 \pm 2.6$ μrad
$\Theta_y = -3.0 \pm 2.0$ μrad	$\Theta_y = 4.4 \pm 2.0$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 3.1$ μm	$\sigma_x = 4.0$ μm
$\sigma_y = 3.8$ μm	$\sigma_y = 3.8$ μm
response: 14.5 ± 0.9 mA/W	response: 13.3 ± 0.7 mA/W

92) AY15_01_02

Bad horizontal strips (I_x): 2, 24
Bad vertical strips (I_y): 11, 12, 15, 58

Active face	***Glass face***
$\Theta_x = 7.0 \pm 5.4$ μrad	$\Theta_x = 6.4 \pm 5.1$ μrad
$\Theta_y = 1.8 \pm 2.2$ μrad	$\Theta_y = 1.0 \pm 2.0$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 5.0$ μm	$\sigma_x = 5.9$ μm
$\sigma_y = 4.7$ μm	$\sigma_y = 4.8$ μm
response: 15.3 ± 1.8 mA/W	response: 15.1 ± 1.6 mA/W

93) AY15_03_01

Bad horizontal strips (I_x): 43
Bad vertical strips (I_y): 2, 3, 38, 39, 50

Active face	***Glass face***
$\Theta_x = 3.3 \pm 4.1$ μrad	$\Theta_x = 2.5 \pm 3.8$ μrad
$\Theta_y = 1.7 \pm 2.6$ μrad	$\Theta_y = 0.5 \pm 2.3$ μrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 5.2$ μm	$\sigma_x = 7.7$ μm
$\sigma_y = 5.0$ μm	$\sigma_y = 4.7$ μm
response: 16.4 ± 1.7 mA/W	response: 15.0 ± 1.7 mA/W

94) AY15_03_02

Bad horizontal strips (I_x): 3, 40, 41, 56
Bad vertical strips (I_y): 5, 54, 55, 63

Active face	***Glass face***
$\Theta_x = 4.3 \pm 5.1$ μrad	$\Theta_x = 3.4 \pm 4.8$ μrad
$\Theta_y = -2.2 \pm 2.5$ μrad	$\Theta_y = 3.4 \pm 2.3$ μrad
T = 85 ± 1 %	T = 86 ± 1 %
$\sigma_x = 5.6$ μm	$\sigma_x = 8.9$ μm
$\sigma_y = 12.8$ μm	$\sigma_y = 9.9$ μm
response: 17.3 ± 2.3 mA/W	response: 16.0 ± 2.4 mA/W

95) AY16_04_01

Bad horizontal strips (I_x): 42
Bad vertical strips (I_y): 38, 39, 53

Active face	*Glass face*
$\Theta_x = 5.1 \pm 1.9$ μrad	$\Theta_x = 4.4 \pm 2.1$ μrad
$\Theta_y = 6.2 \pm 1.7$ μrad	$\Theta_y = -4.9 \pm 1.7$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 6.9$ μm	$\sigma_x = 3.2$ μm
$\sigma_y = 4.2$ μm	$\sigma_y = 4.3$ μm
response: 15.3 ± 1.2 mA/W	response: 13.2 ± 1.1 mA/W

96) AY16_06_04

Bad horizontal strips (I_x): 18, 21, 25
Bad vertical strips (I_y): 23, 33, 41, 42, 60

Active face	*Glass face*
$\Theta_x = -7.8 \pm 4.3$ μrad	$\Theta_x = -8.0 \pm 4.3$ μrad
$\Theta_y = -3.8 \pm 2.2$ μrad	$\Theta_y = 5.2 \pm 2.1$ μrad
T = 84 ± 1 %	T = 84 ± 1 %
$\sigma_x = 3.0$ μm	$\sigma_x = 4.5$ μm
$\sigma_y = 10.3$ μm	$\sigma_y = 9.6$ μm
response: 15.7 ± 1.8 mA/W	response: 13.9 ± 1.6 mA/W

97) AY15_02_01

Bad horizontal strips (I_x): 5, 15, 19, 33, 34, 39, 42, 57, 60, 61
Bad vertical strips (I_y): 0, 1, 11, 20, 23, 30, 38, 39, 44, 47, 54, 55

Active face	*Glass face*
$\Theta_x = 7.3 \pm 1.6$ μrad	$\Theta_x = 7.3 \pm 1.6$ μrad
$\Theta_y = 9.6 \pm 2.1$ μrad	$\Theta_y = -9.6 \pm 2.1$ μrad
T = 86 ± 1 %	T = 86 ± 1%
$\sigma_x = 9.8$ μm	$\sigma_x = 9.8$ μm
$\sigma_y = 20.3$ μm	$\sigma_y = 20.3$ μm
response: 16.5 ± 3.2 mA/W	response: 16.5 ± 3.2 mA/W

98) AY18_04_01

Bad horizontal strips (I_x): 26, 55, 63
Bad vertical strips (I_y): 5, 6, 36, 63

Active face	***Glass face***
$\Theta_x = 5.2 \pm 3.8$ µrad	$\Theta_x = 5.4 \pm 4.0$ µrad
$\Theta_y = 7.6 \pm 3.9$ µrad	$\Theta_y = -7.0 \pm 4.1$ µrad
T = 87 ± 1 %	T = 88 ± 1 %
$\sigma_x = 5.0$ µm	$\sigma_x = 2.3$ µm
$\sigma_y = 5.4$ µm	$\sigma_y = 3.5$ µm
response: 15.4 ± 0.6 mA/W	response: 13.9 ± 0.3 mA/W

99) AY18_05_03

Bad horizontal strips (I_x): 38, 39
Bad vertical strips (I_y): 24, 25, 51, 53

Active face	***Glass face***
$\Theta_x = -13.2 \pm 1.4$ µrad	$\Theta_x = -13.4 \pm 1.6$ µrad
$\Theta_y = 1.7 \pm 1.8$ µrad	$\Theta_y = 0.3 \pm 1.9$ µrad
T = 88 ± 1 %	T = 88 ± 1 %
$\sigma_x = 5.7$ µm	$\sigma_x = 5.6$ µm
$\sigma_y = 9.2$ µm	$\sigma_y = 8.1$ µm
response: 15.3 ± 1.1 mA/W	response: 15.0 ± 1.2 mA/W

100) AY17_02_04

Bad horizontal strips (I_x): 26, 27
Bad vertical strips (I_y): 46, 47

Active face	***Glass face***
$\Theta_x = -7.2 \pm 2.2$ µrad	$\Theta_x = -7.3 \pm 2.2$ µrad
$\Theta_y = -0.4 \pm 2.4$ µrad	$\Theta_y = 1.9 \pm 2.3$ µrad
T = 89 ± 1 %	T = 89 ± 1 %
$\sigma_x = 2.2$ µm	$\sigma_x = 6.2$ µm
$\sigma_y = 13.0$ µm	$\sigma_y = 5.3$ µm
response: 15.4 ± 2.7 mA/W	response: 14.2 ± 2.7 mA/W

101) AY17_03_01

Bad horizontal strips (I_x): 0, 1, 35, 53, 54
Bad vertical strips (I_y): 43, 44, 61, 62

Active face	*Glass face*
$\Theta_x = 8.9 \pm 3.7$ µrad	$\Theta_x = 8.2 \pm 3.1$ µrad
$\Theta_y = 1.8 \pm 2.6$ µrad	$\Theta_y = -1.0 \pm 2.6$ µrad
T = 88 ± 1 %	T = 88 ± 1 %
$\sigma_x = 7.6$ µm	$\sigma_x = 2.3$ µm
$\sigma_y = 4.5$ µm	$\sigma_y = 9.5$ µm
response: 17.3 ± 2.0 mA/W	response: 15.2 ± 2.0 mA/W

V) High response sensors (need laser output power ~0.5 mW, also kept at IFCA clean room)

102) AY13_02_04

Bad horizontal strips (I_x): 0, 50, 51, 63
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = -3.3 \pm 2.7$ μrad	$\Theta_x = -4.1 \pm 2.8$ μrad
$\Theta_y = 0.3 \pm 2.2$ μrad	$\Theta_y = 1.8 \pm 2.5$ μrad
T = 79 ± 2 %	T = 79 ± 2 %
$\sigma_x = 4.9$ μm	$\sigma_x = 4.5$ μm
$\sigma_y = 7.7$ μm	$\sigma_y = 6.3$ μm
response: 39 ± 3 mA/W	response: 36 ± 3 mA/W

103) AY13_04_02

Bad horizontal strips (I_x): 0, 23, 24, 63
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = 2.4 \pm 2.4$ μrad	$\Theta_x = 1.5 \pm 2.9$ μrad
$\Theta_y = 1.5 \pm 2.3$ μrad	$\Theta_y = 1.0 \pm 2.2$ μrad
T = 79 ± 2 %	T = 79 ± 2 %
$\sigma_x = 4.1$ μm	$\sigma_x = 3.3$ μm
$\sigma_y = 9.3$ μm	$\sigma_y = 9.7$ μm
response: 40 ± 3 mA/W	response: 34 ± 2 mA/W

104) AY13_04_03

Bad horizontal strips (I_x): 0, 21, 63
Bad vertical strips (I_y): 43

Active face	***Glass face***
$\Theta_x = -1.3 \pm 2.4$ μrad	$\Theta_x = -2.5 \pm 2.4$ μrad
$\Theta_y = 2.6 \pm 1.9$ μrad	$\Theta_y = -1.1 \pm 1.9$ μrad
T = 79 ± 2 %	T = 79 ± 2 %
$\sigma_x = 5.4$ μm	$\sigma_x = 5.8$ μm
$\sigma_y = 5.2$ μm	$\sigma_y = 5.6$ μm
response: 43 ± 4 mA/W	response: 38 ± 4 mA/W

105) AY13_05_01

Bad horizontal strips (I_x): 36, 58
Bad vertical strips (I_y): 6, 24, 25, 52

Active face	***Glass face***
$\Theta_x = -4.8 \pm 2.9$ µrad	$\Theta_x = -5.9 \pm 3.0$ µrad
$\Theta_y = -2.0 \pm 2.4$ µrad	$\Theta_y = 4.1 \pm 2.5$ µrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 8.2$ µm	$\sigma_x = 7.2$ µm
$\sigma_y = 5.4$ µm	$\sigma_y = 5.3$ µm
response: 36 ± 3 mA/W	response: 32 ± 3 mA/W

106) AY13_05_04

Bad horizontal strips (I_x): 18, 19, 50, 51
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = -4.3 \pm 2.9$ µrad	$\Theta_x = -4.8 \pm 2.8$ µrad
$\Theta_y = -5.6 \pm 2.0$ µrad	$\Theta_y = 7.7 \pm 2.0$ µrad
T = 76 ± 1 %	T = 83 ± 1 %
$\sigma_x = 3.9$ µm	$\sigma_x = 4.6$ µm
$\sigma_y = 6.3$ µm	$\sigma_y = 6.3$ µm
response: 43 ± 2 mA/W	response: 40 ± 3 mA/W

107) AY13_02_01

Bad horizontal strips (I_x): 0, 32, 33, 53, 54, 63
Bad vertical strips (I_y): 0, 2, 15, 16, 34, 36

Active face	***Glass face***
$\Theta_x = 1.2 \pm 2.4$ µrad	$\Theta_x = 0.4 \pm 2.5$ µrad
$\Theta_y = 1.7 \pm 2.2$ µrad	$\Theta_y = 0.0 \pm 2.3$ µrad
T = 82 ± 1 %	T = 82 ± 1 %
$\sigma_x = 6.8$ µm	$\sigma_x = 7.0$ µm
$\sigma_y = 5.7$ µm	$\sigma_y = 7.0$ µm
response: 37 ± 4 mA/W	response: 34 ± 3 mA/W

108) AY14_03_03

Bad horizontal strips (I_x): 0, 37, 38, 52, 53
Bad vertical strips (I_y): 17

Active face	***Glass face***
$\Theta_x = -1.2 \pm 2.9$ μrad	$\Theta_x = -2.0 \pm 2.9$ μrad
$\Theta_y = 0.6 \pm 2.6$ μrad	$\Theta_y = 1.2 \pm 2.9$ μrad
T = 85 ± 1 %	T = 85 ± 1 %
$\sigma_x = 4.2$ μm	$\sigma_x = 4.7$ μm
$\sigma_y = 4.4$ μm	$\sigma_y = 5.8$ μm
response: 30 ± 2 mA/W	response: 27 ± 2 mA/W

109) AY13_04_01

Bad horizontal strips (I_x): 0, 54, 55, 63
Bad vertical strips (I_y): none

Active face	***Glass face***
$\Theta_x = 1.2 \pm 2.8$ μrad	$\Theta_x = -0.5 \pm 2.7$ μrad
$\Theta_y = 2.3 \pm 2.6$ μrad	$\Theta_y = -1.0 \pm 2.2$ μrad
T = 80 ± 1 %	T = 80 ± 1 %
$\sigma_x = 3.6$ μm	$\sigma_x = 3.1$ μm
$\sigma_y = 4.6$ μm	$\sigma_y = 7.2$ μm
response: 39.0 mA/W	response: 34 mA/W

110) AY13_05_03

Bad horizontal strips (I_x): none
Bad vertical strips (I_y): 26, 27

Active face	***Glass face***
$\Theta_x = -4.6 \pm 2.8$ μrad	$\Theta_x = -6.7 \pm 2.8$ μrad
$\Theta_y = 0.6 \pm 2.4$ μrad	$\Theta_y = 1.1 \pm 2.2$ μrad
T = 83 ± 1 %	T = 83 ± 1 %
$\sigma_x = 4.9$ μm	$\sigma_x = 6.8$ μm
$\sigma_y = 3.8$ μm	$\sigma_y = 5.1$ μm
response: 42 mA/W	response: 38 mA/W

VI) These sensors are for use in case of extreme need or for "destructive" research (they are at the IFCA clean room)

111) AY15_00_01 ====➔ Be careful, excess of response from I_x = 0 to 5 and from I_y = 0 to 5

Bad horizontal strips (I_x): 1, 3, 19, 20, 36
Bad vertical strips (I_y): 0, 1, 9

Active face	*Glass face*
$\Theta_x = 3.0 \pm 1.9$ µrad	$\Theta_x = 1.5 \pm 1.5$ µrad
$\Theta_y = 2.6 \pm 1.7$ µrad	$\Theta_y = -1.6 \pm 1.8$ µrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 3.3$ µm	$\sigma_x = 4.7$ µm
$\sigma_y = 6.1$ µm	$\sigma_y = 10.3$ µm
response: 17 mA/W	response: 17 mA/W

112) AY15_00_02 ====➔ Be careful, excess of response from I_x = 55 to 63 and from I_y = 0 to 5

Bad horizontal strips (I_x): 0, 30, 31
Bad vertical strips (I_y): 11, 12, 37

Active face	*Glass face*
$\Theta_x = 2.9 \pm 1.6$ µrad	$\Theta_x = 1.9 \pm 1.6$ µrad
$\Theta_y = -1.8 \pm 1.8$ µrad	$\Theta_y = 2.8 \pm 2.0$ µrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 10.0$ µm	$\sigma_x = 2.4$ µm
$\sigma_y = 11.8$ µm	$\sigma_y = 4.1$ µm
response: 17 mA/W	response: 15 mA/W

113) AY15_00_04 ====➔ Be careful, excess of response from I_x = 50 to 63 and from I_y = 50 to 63

Bad horizontal strips (I_x): 2
Bad vertical strips (I_y): 24

Active face	*Glass face*
$\Theta_x = -2.8 \pm 1.6$ µrad	$\Theta_x = -4.9 \pm 1.4$ µrad
$\Theta_y = -1.8 \pm 1.7$ µrad	$\Theta_y = 3.2 \pm 1.8$ µrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 6.0$ µm	$\sigma_x = 5.0$ µm
$\sigma_y = 8.0$ µm	$\sigma_y = 4.1$ µm
response: 17 mA/W	response: 17 mA/W

VII) Sensors out of order

114) AY02_01_I ====➔ Dammaged during MT

Bad horizontal strips (I_x):17, 18, 22, 46, 47, 56, 57
Bad vertical strips (I_y):14, 22, 23, 27, 28, 32, 33, 60, 61

Active face	***Glass face***
$\Theta_x = 2.3 \pm 2.0$ µrad	$\Theta_x = 3.8 \pm 2.7$ µrad
$\Theta_y = 6.4 \pm 2.3$ µrad	$\Theta_y = -3.6 \pm 3.2$ µrad
T = 87 ± 2 %	T = 85 ± 2 %
$\sigma_x = 13.4$ µm	$\sigma_x = 17.3$ µm
$\sigma_y = 10.1$ µm	$\sigma_y = 5.1$ µm
response: 9 mA/W	response: 5.2 mA/W

115) AY01_04_IV ====➔ Missing

Bad horizontal strips (I_x):1, 2, 22, 23, 38, 51, 52, 61
Bad vertical strips (I_y):1, 34, 53, 54

Active face	***Glass face***
$\Theta_x = -9.8 \pm 2.5$ µrad	$\Theta_x = -9.7 \pm 4.9$ µrad
$\Theta_y = 1.1 \pm 3.4$ µrad	$\Theta_y = 1.6 \pm 3.7$ µrad
T = 81 ± 3 %	T = 80 ± 4 %
$\sigma_x = 5.7$ µm	$\sigma_x = 7.2$ µm
$\sigma_y = 6.9$ µm	$\sigma_y = 13.1$ µm
response: 27 mA/W	response: 15.5 mA/W

116) AY01_04_I ====➔ Dammaged during MT

Bad horizontal strips (I_x):10, 14, 15, 33, 38, 52, 58, 60
Bad vertical strips (I_y):10, 17, 24, 57

Active face	***Glass face***
$\Theta_x = -0.2 \pm 2.2$ µrad	$\Theta_x = 1.0 \pm 5.5$ µrad
$\Theta_y = 7.2 \pm 1.7$ µrad	$\Theta_y = -5.4 \pm 4.8$ µrad
T = 81 ± 3 %	T = 77 ± 5 %
$\sigma_x = 4.5$ µm	$\sigma_x = 7.1$ µm
$\sigma_y = 7.7$ µm	$\sigma_y = 9.9$ µm
response: 24 mA/W	response: 13.8 mA/W

117) AY04_03_I ====➔ Dammaged during MT

Bad horizontal strips (I_x): 7, 8, 20
Bad vertical strips (I_y): 45, 46, 58, 59, 63

Active face	***Glass face***
$\Theta_x = 1.6 \pm 1.7$ µrad	$\Theta_x = 2.1 \pm 2.6$ µrad
$\Theta_y = 4.5 \pm 2.6$ µrad	$\Theta_y = -1.3 \pm 3.2$ µrad
T = 83 ± 1 %	T = 83 ± 1 %
$\sigma_x = 4.1$ µm	$\sigma_x = 6.5$ µm
$\sigma_y = 6.4$ µm	$\sigma_y = 4.7$ µm
response: 9 mA/W	response: 5.2 mA/W

118) AY06_04_1 ====➔ Dammaged during MT

Bad horizontal strips (I_x): 36, 53, 54, 63
Bad vertical strips (I_y): 11, 21, 34, 35, 55, 56

Active face	***Glass face***
$\Theta_x = -7.2 \pm 3.7$ µrad	$\Theta_x = -8.0 \pm 3.7$ µrad
$\Theta_y = 7.1 \pm 5.0$ µrad	$\Theta_y = -2.0 \pm 3.2$ µrad
T = 82 ± 1 %	T = 82 ± 1 %
$\sigma_x = 8.9$ µm	$\sigma_x = 8.0$ µm
$\sigma_y = 5.9$ µm	$\sigma_y = 4.9$ µm
response: 7.5 mA/W	response: 6.5 mA/W

119) AY07_01_1 ====➔ Dammaged during MT

Bad horizontal strips (I_x): 55, 56
Bad vertical strips (I_y): 4, 5

Active face	***Glass face***
$\Theta_x = 6.6 \pm 4.3$ µrad	$\Theta_x = 5.1 \pm 2.2$ µrad
$\Theta_y = 3.2 \pm 5.2$ µrad	$\Theta_y = -0.1 \pm 2.5$ µrad
T = 87 ± 2 %	T = 87 ± 1 %
$\sigma_x = 2.3$ µm	$\sigma_x = 4.4$ µm
$\sigma_y = 4.1$ µm	$\sigma_y = 2.7$ µm
response: 8.0 mA/W	response: 7.5 mA/W

120) AY08_05_03 ====➔ Dammaged during MT

Bad horizontal strips (I_x): 2, 6, 10, 54, 56
Bad vertical strips (I_y): 0, 30, 39, 62, 63

Active face	***Glass face***
$\Theta_x = 3.3 \pm 4.0$ µrad	$\Theta_x = 2.3 \pm 4.2$ µrad
$\Theta_y = -2.4 \pm 4.5$ µrad	$\Theta_y = 8.5 \pm 4.9$ µrad
T = 84 ± 1 %	T = 85 ± 1 %
$\sigma_x = 4.1$ µm	$\sigma_x = 6.8$ µm
$\sigma_y = 5.9$ µm	$\sigma_y = 5.5$ µm
response: 8.4 mA/W	response: 8.0 mA/W

121) AY08_09_01 ====➔ Dammaged during MT

Bad horizontal strips (I_x): 34, 54, 55
Bad vertical strips (I_y): 25, 26, 35

Active face	***Glass face***
$\Theta_x = -3.6 \pm 3.2$ µrad	$\Theta_x = -5.9 \pm 4.0$ µrad
$\Theta_y = -1.2 \pm 3.4$ µrad	$\Theta_y = 2.0 \pm 9.8$ µrad
T = 86 ± 1 %	T = 86 ± 1 %
$\sigma_x = 6.4$ µm	$\sigma_x = 7.7$ µm
$\sigma_y = 4.0$ µm	$\sigma_y = 4.5$ µm
response: 8.7 mA/W	response: 7.8 mA/W

122) AY10_02_04 ====➔ Heavily used ***coat on wrong side***

Bad horizontal strips (I_x): 8, 9, 12, 16, 25, 34, 49, 58, 59
Bad vertical strips (I_y): 5, 10, 14, 15, 39, 41, 42, 57

Active face	***Glass face***
$\Theta_x = -4.5 \pm 1.7$ µrad	$\Theta_x = -5.4 \pm 1.4$ µrad
$\Theta_y = -1.8 \pm 1.6$ µrad	$\Theta_y = 2.7 \pm 1.4$ µrad
T = 76 ± 3 %	T = 75 ± 3 %
$\sigma_x = 6.1$ µm	$\sigma_x = 8.0$ µm
$\sigma_y = 3.7$ µm	$\sigma_y = 3.1$ µm
response: 13 mA/W	response: 11 mA/W