Expansion of the InfraTec product family

New angular resolving pyroelectric flame detector PIA-903-X002

As a leading supplier of tailor-made pyroelectric detectors InfraTec has shown extensive expertise in producing a wide range of single and multi-color pyroelectric detectors for gas analysis and flame detection.

With our standard pyroelectric detectors (e.g. single detector LME-551 or quad detector LMM-244) it is possible to detect a flame and its composition in a distance of more than 50 meters, but until now the position of the flame inside the field of view (FOV) was not resolvable. As an upgrade to standard tri-band flame detectors**,** the new PIA-903 detector with 3 x 3 element array and integrated optics is able to provide additional spatial information about the observed scene for a rough angular location of the flame. Calculating the signal ratios of all channels offers an interpolation of the angular position inside of a 100° conic FOV and in combination of two or more flame sensor units a 3D coordinate of a fire pocket.
Instead of the Lithium Tantalate (LiTaO3) pyroelectric material that InfraTec is generally using for the high performance measuring application, here a PZT thin film technology is employed to build the active elements. It allows very small chip sizes which enable us to fully illuminate 9 (3 x 3) individually addressable elements by a 1 mm diameter beam. A built-in lens produces an intra-focal image of the flame, which allows the interpolation between the individual pixel signals and results in a remarkable angular resolution of 5° or even better.
Together with a 9 channel transimpedance amplifier (current mode operation) inside of the housing a high Responsivity of 8000 V/W at 10 Hz is realized. Even for a pixel size of only (500 x 500) µm a high D* of >1.5E10^{8} cm√Hz/W (500 K, 10 Hz, without window and optics) can be guaranteed. Although D* is three times lower as for our LiTaO3 detectors, it is still clearly higher compared to low cost detectors for motion detection or Thermopile arrays.

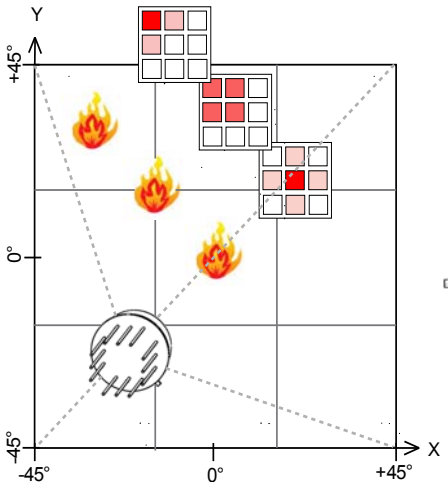

Fig. 1: Monitoring a production area

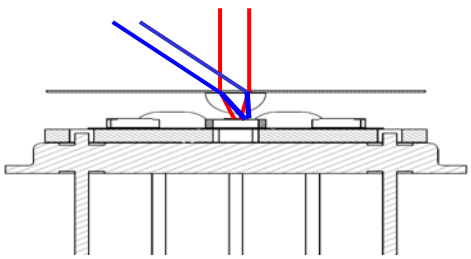

Fig. 2 : Optical scheme

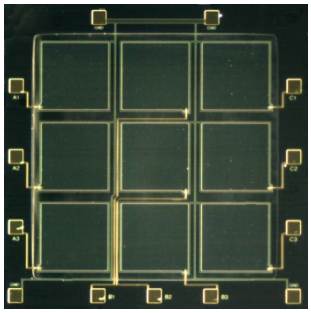

Fig. 3: 3x3 Sensor array

In Fig. 1 the principle arrangement of the detector is illustrated. The position of the light spot on the sensor, a blurred image of the flame (Fig. 6), can be interpolated with a very simple formula, which is normally applied with analog quadrant detectors but can be easily adopted to a 3x3 sensor array. In conjunction with the integrated lens the spot position is directly related to the incidence angle of the detected flame. Fig. 4, 5 & 6 illustrate the principle of angular determination by interpolation simplified to the one-dimensional case (3 sensing elements). The calculated virtual X coordinate is strictly monotonic within the range of ± 50°, in which the resolution is mainly limited by the signal to noise ratio of the measurement.

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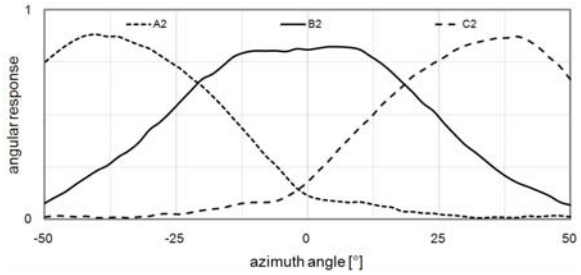

Fig. 4: Measured angular response

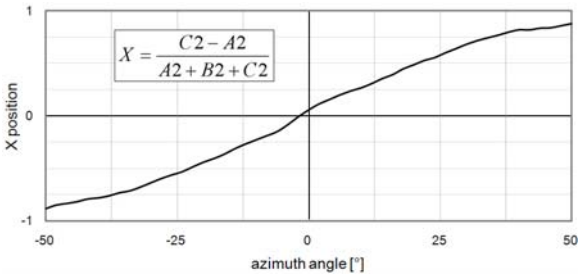

Fig. 5: Interpolated x position

$$X = \frac{(C1 + C2 + C3) - (A1 + A2 + A3)}{\sum A + \sum B + \sum C}$$

$$Y = \frac{(A1 + B1 + C1) - (A3 + B3 + C3)}{\sum A + \sum B + \sum C}.$$

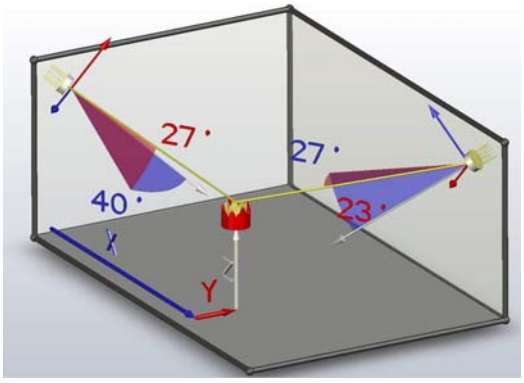

Fig. 8 : Determination of the flame position by means of two PIA-903 detectors

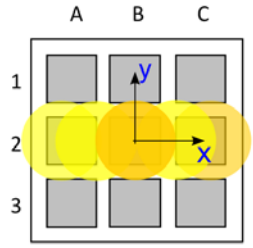

Fig. 6: Images of the flame with varying incidence angle in one direction (azimuth angle)

If this principle is applied to the two-dimensional case the x and y coordinates of the spot position over both angle directions become nearly flat planes (Fig. 7) within a range of about 100°, which indicates a good linearity. An angle resolution of about 5° or better might be achieved, which corresponds to a virtual resolution of about 20x20 pixels.

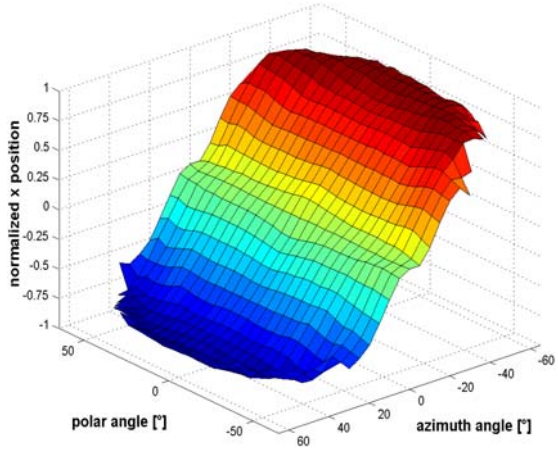

Fig. 7: Interpolated x position plotted over both angle directions

If two PIA-903 detectors are positioned at different locations in one area it is possible to define the 3D coordinate of the flame. This might be helpful for a fast reaction in large production facilities or other places. The principle is illustrated in Fig. 8.

InfraTec continues developing new pyroelectric detectors to better support customer needs.
The PIA-903 detector is the first model of a new InfraTec product line. It was designed to fill a very useful spatial “guard” function in any kind of flame detector. From this many other applications are possible. Any further ideas, remarks or questions are sincerely appreciated by InfraTec.

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