



Introduction

- The numbers of gross counts in each ROI are assumed to follow Poisson distribution. Therefore, expectation values and variances of gross counts are estimated as the numbers of gross counts in a single measurement.
- It could be a problem when the number of counts in the sample is around the number of counts in the detector background. Decision thresholds could be under-estimated in the case when the interference corrections from higher energy ROIs in the sample spectrum or from the net counts in the same ROI in the associated gas background spectrum result in negative values. This underestimation leads to a false positive detection probably. In this poster we investigate a solution.

Method

- Non-negative Interference corrections
 $x_1 = \text{Max}(0, (C_1 - f_s B_1)); \quad x_3 = \text{Max}(0, (C_3 - (f_s B_3 + R_{31} x_1)))$
 - Decision threshold estimation
 - Sample only

$$v_{x_i}(0) = 2B_{C_i} + \sum_{j=1}^{i-1} (R^{-1})_{ij} (C_j - B_{C_j}) + \sum_{j=1}^{i-1} (R^{-1})_{ij}^2 (C_j + B_{C_j})$$
 - Subtraction of the memory effect

$$v_{x_i}(0)(G) = v_{x_i}(0) + F_i x_{G_i}(G) + F_i^2 v_{x_{G_i}}(G)$$
- (See the details in T3.5-P43)

Results of decision thresholds

- Xe-133:** There are no decision thresholds underestimated when the numbers of net counts in ROI-1 are estimated as non-negative (Fig. 1).
- Xe-131m:** The original numbers of net counts in ROI-1 and -3 could be negative, which result in the decision thresholds of ROI-3 below the baselines. Once the numbers of net counts in ROI-1 and -3 are estimated as non-negative, there is no decision threshold underestimated (Fig. 2).

Results of metastable xenon detection

- The detection rates for always subtraction and for the original net counts are even higher than for the samples themselves in Fig. 3 (a) (Xe-131m and Xe-133m). There are false positives caused by the gas background subtraction, especially the negative numbers of net counts.
- The detection rates were reduced significantly when the non-negative net counts are used in Fig. 3 (b). The high detection rates are caused by subtracting negative values of net counts.

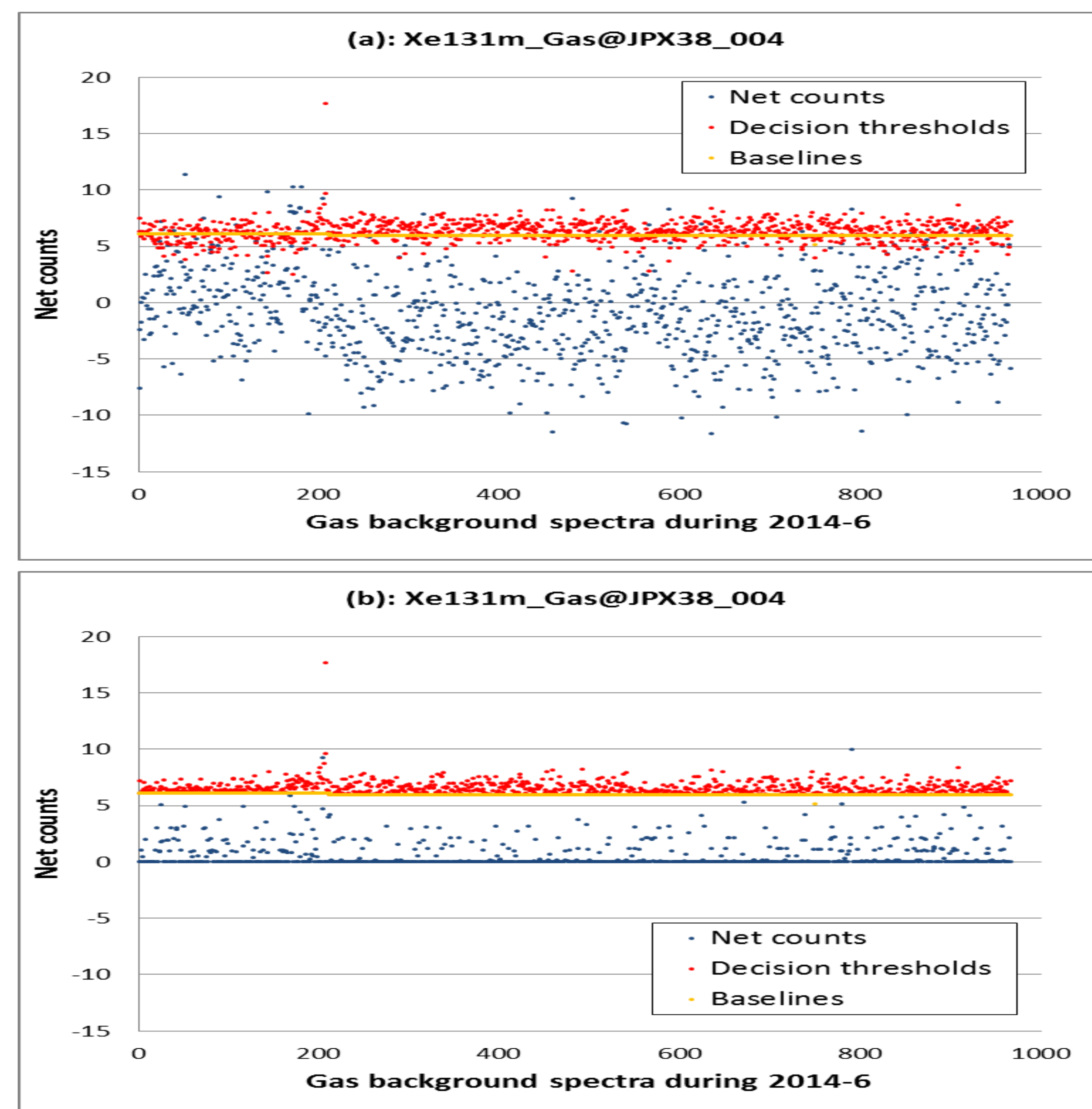


Fig. 2. The numbers of net counts, decision thresholds and their baselines of Xe-131m in 967 gas background spectra from the detector JPX38_004 during 2014 to 2016. The spectra are processed using (a) original net counts and (b) non-negative net counts for radon, Xe-133 and Xe-131m.

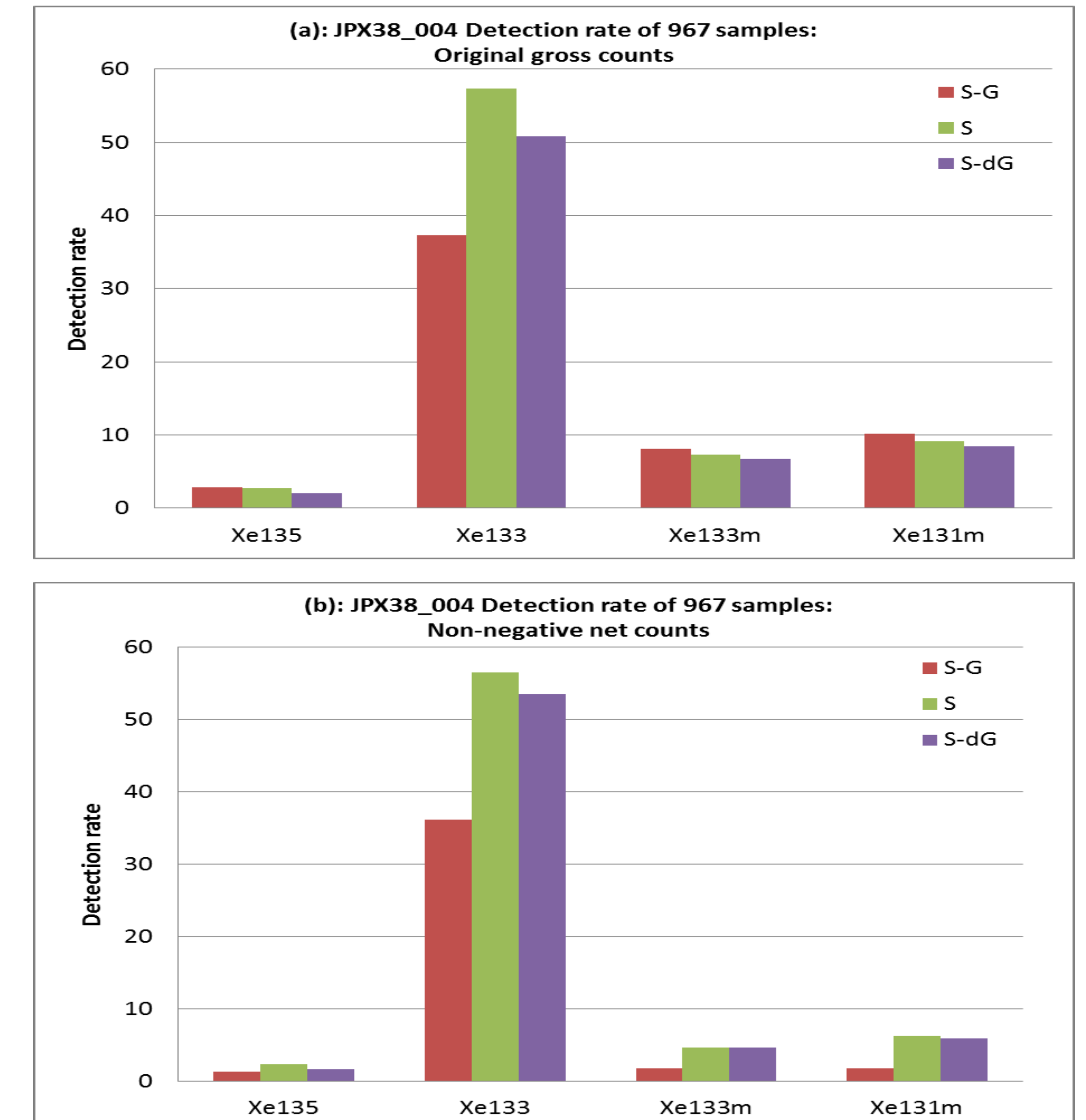


Fig. 3. Detection rates of four xenon isotopes in 967 sample and gas background spectra from the detector JPX38_004 during 2014 to 2016. The spectra are processed using (a) original net counts and (b) non-negative net counts. There are three modes for gas background subtraction: S stands for sample spectra analysis only; S-G stand for subtracted always; and S-dG for subtracted only once the isotope is detected in the associated gas background spectrum.

Summary

A new approach based on a priori knowledge that radioactivity is non-negative was used to estimate the interference corrections when the numbers of gross counts in the sample measurements are below the background counts. That is equivalent to the fact that decision thresholds of net counts are estimated based on the detector background measurement instead of the single measurement itself. There are no decision thresholds under-estimated.

References

- De Geer, L.E., 2007. FOI-R-2350-SE.
 Feldman, G.J., Cousins, R.D., 1998. Phys. Rev. D 57 (7), 3873-3889.
 ISO-11929, 2010.
 IAEA/AQ/48, 2017.

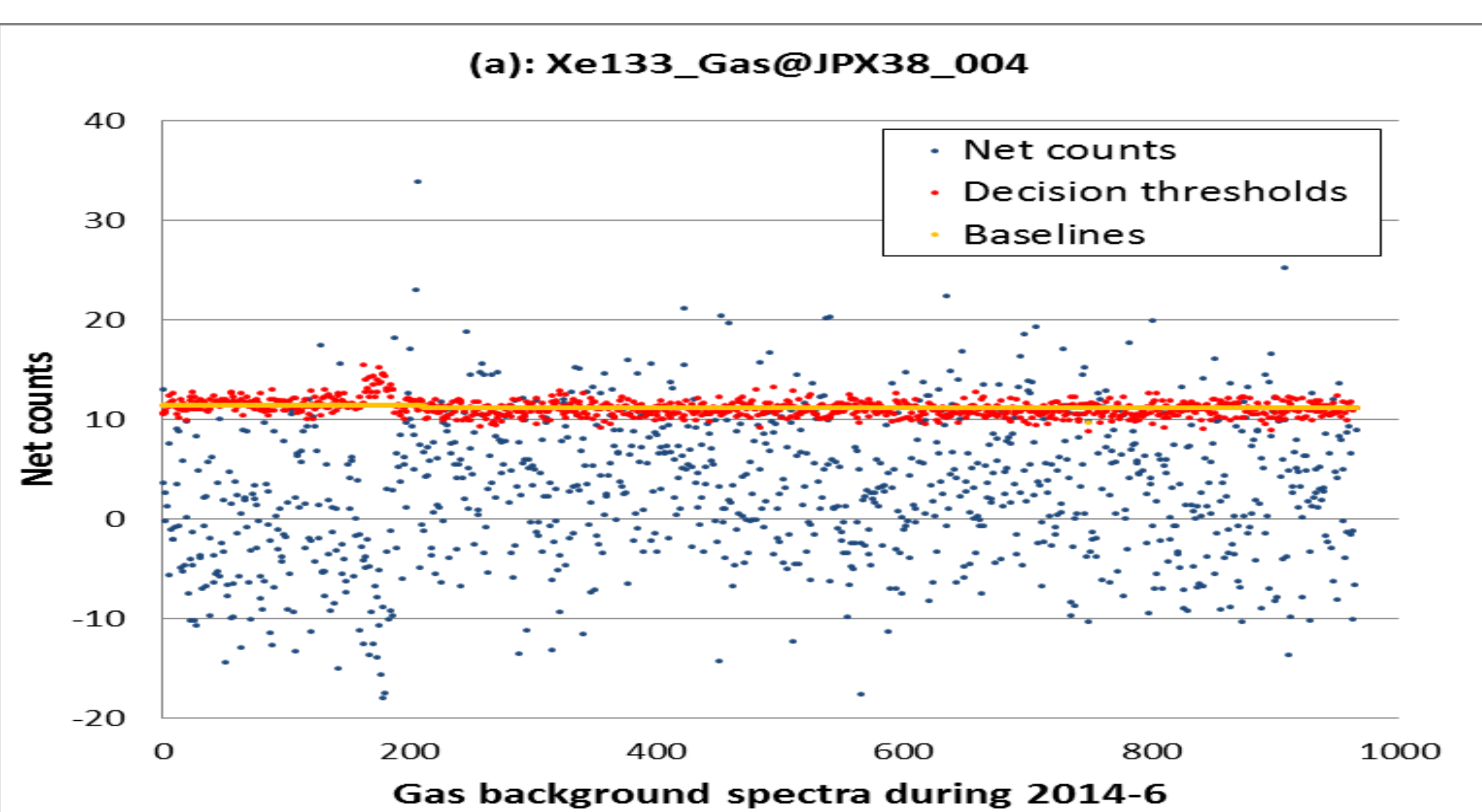


Fig. 1. The numbers of net counts, decision thresholds and their baselines for Xe-133 in 967 gas background spectra from the detector JPX38_004 during 2014 to 2016. The spectra are processed using (a) original net counts, (b) non-negative net counts of radon and original net counts of Xe-133.

