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CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

Statistical Analysis to advance common understanding on SAUNA false positives hypothesis

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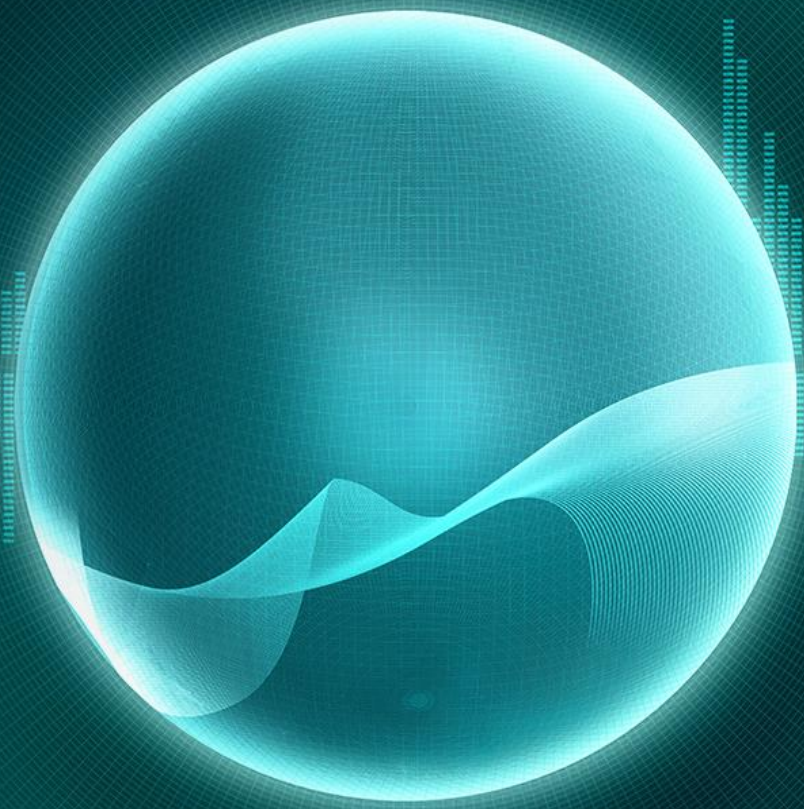
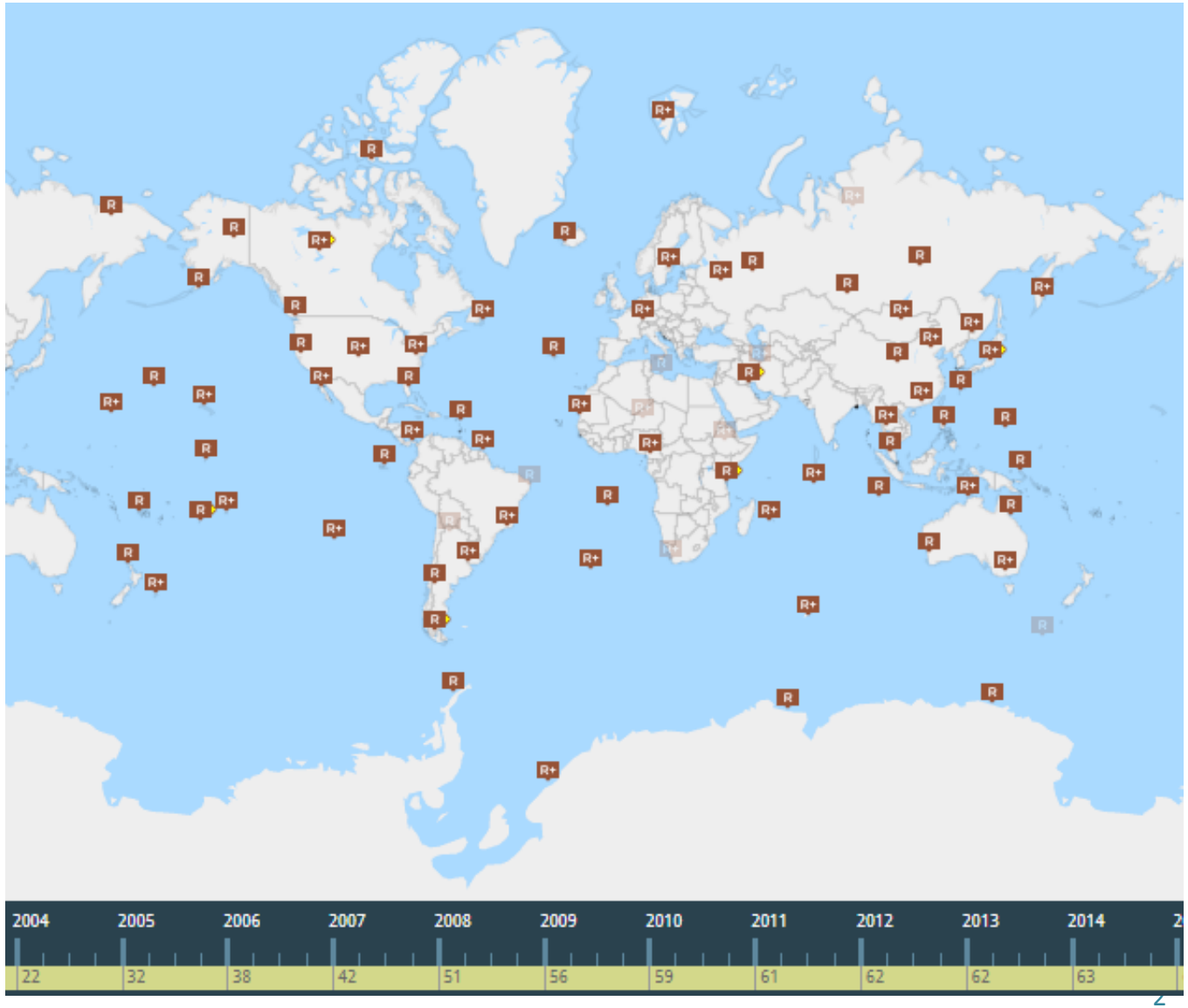


CTBO is establishing an International Monitoring System (IMS) including 80 radionuclide stations.

40 will be equipped with capabilities for measuring CTBT relevant xenon isotopes (Xe-131m, Xe-133, Xe-133m and Xe-135).



Source :https://www.ctbto.org/map/

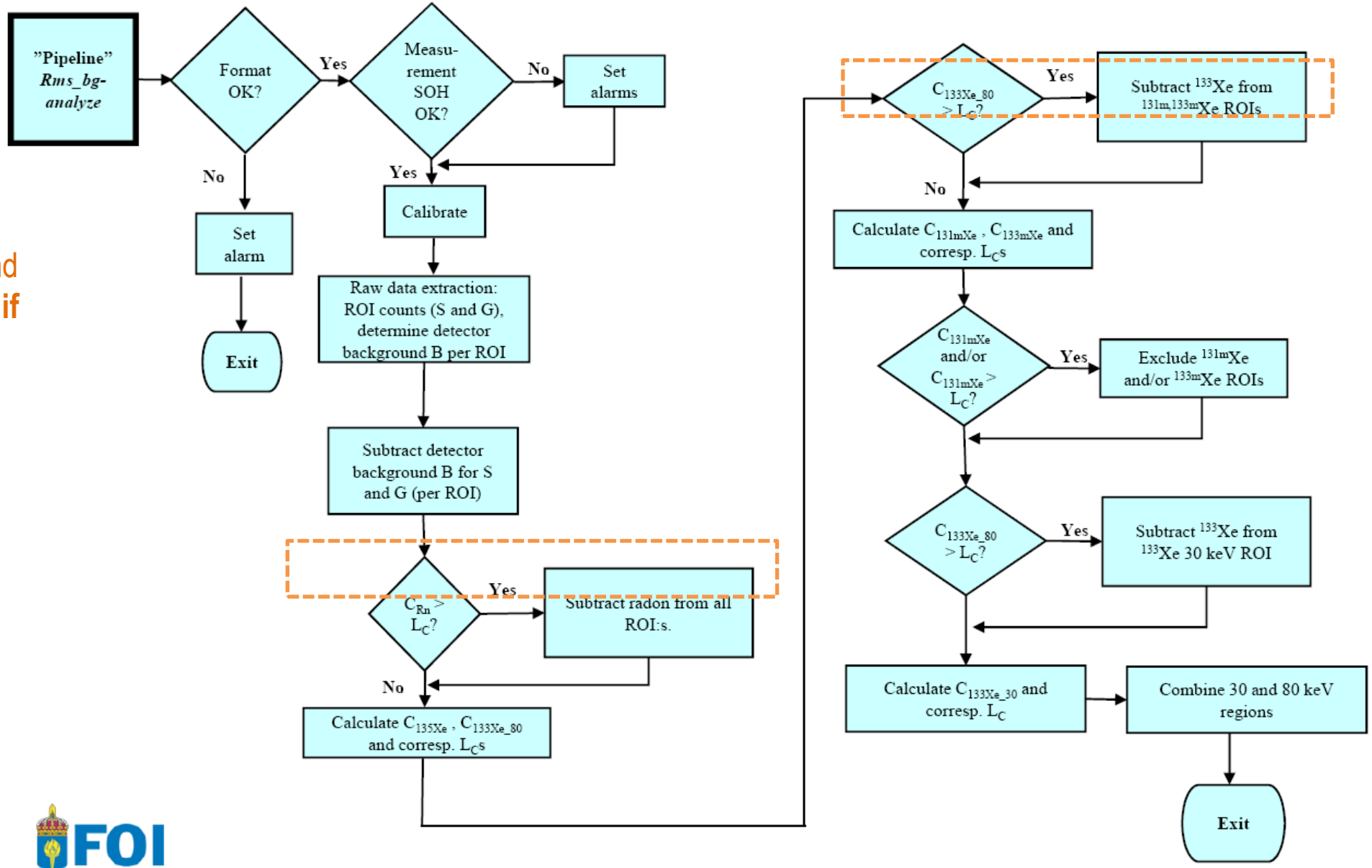
Background

- The CTBTO International Data Centre (IDC) operates dedicated analysis software for processing spectral data from the IMS noble gas systems.

- The analysis of beta-gamma coincidence Noble Gas data is based on **Net Count Calculation** (NCC) method which, in its standard implementation, only **performs interference corrections** if a positive net signal is present.

standard NCC method

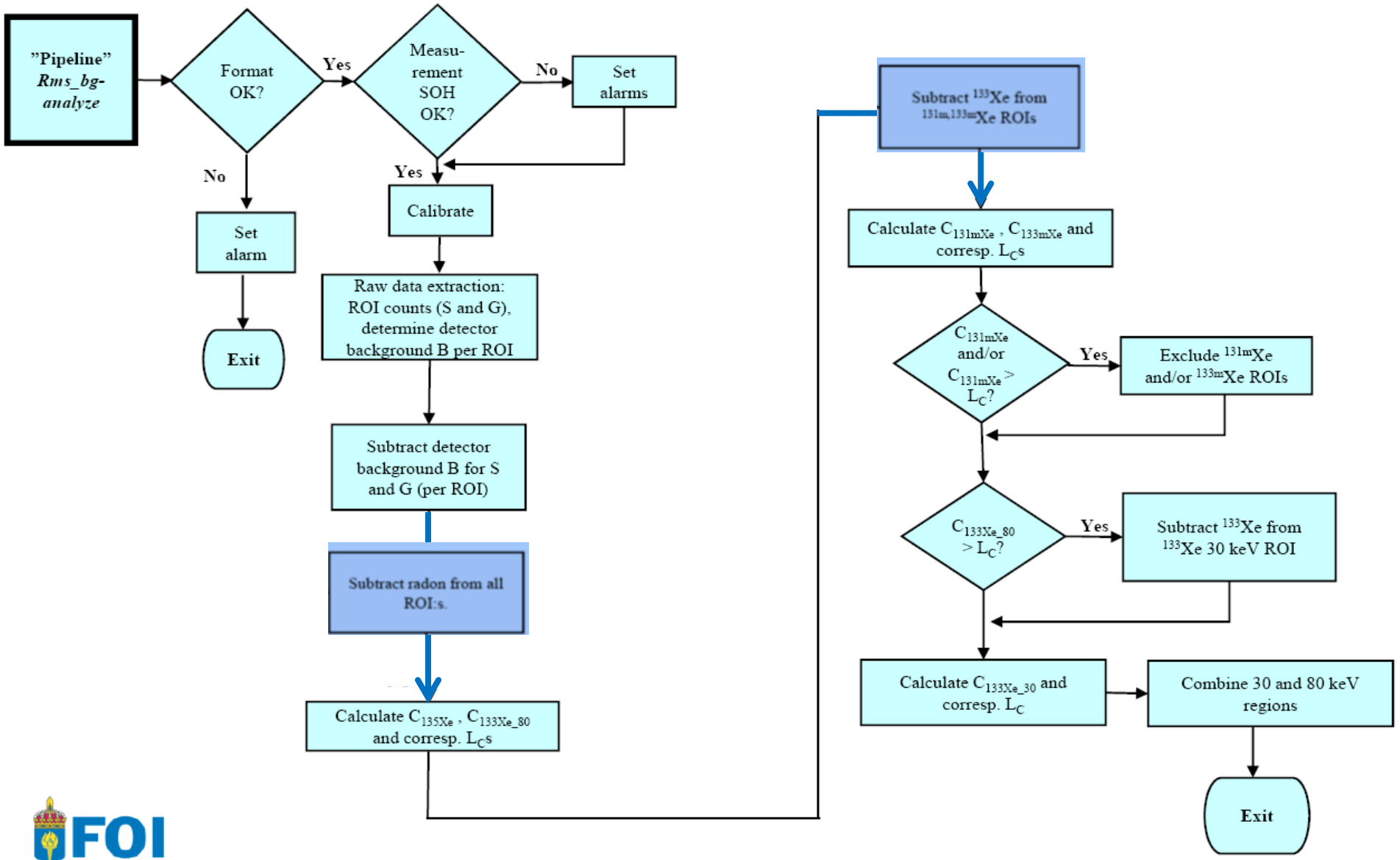
Interferences due to radon and Xe-133 are subtracted ONLY **if counts are above LC**



FOI

New NCC configuration

"interferences" due to radon and Xe-133 to be **systematically** subtracted



FOI

Problem Statement

- A retrospective analysis of reported detections seems to show overestimated rate of false positives for some isotopes.

- With the aim of improving the analysis results, a new configuration of the NCC method that systematically performs interference corrections was tested in offline mode and the results statistically compared with the standard NCC method.

Testing (in offline mode)

Used data (~12 500 samples):
- 3 years (2014-2016)
- 7 SAUNA systems

These correspond to **valid** sample spectral data.
Selection criterion: good sample metrics
- Released with category in IDC Operations.

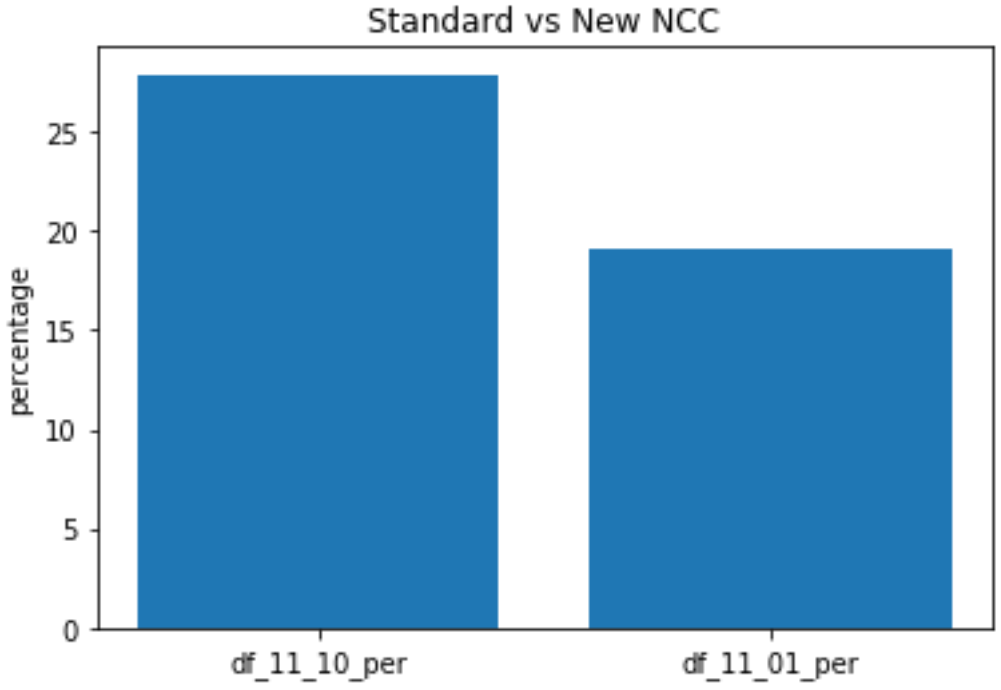
station	location	from	to	#samples
BRX11	Rio de Janeiro, Brazil	01-JAN-14	31-DEC-16	1902
CLX19	Las Condes, Santiago - Chile	01-JUL-15	29-NOV-16	965
GBX66	BIOT/Chagos Archipelago, UK	01-JAN-14	31-DEC-16	1887
JPX38	Takasaki, Gunma, Japan.	16-MAY-14	31-DEC-16	1882
NZX46	Chatham Island, New Zealand	01-JAN-14	31-DEC-16	2113
SEX63	Stockholm, Sweden	01-JAN-14	31-DEC-16	2104
USX75	Charlottesville, VA, USA	01-JAN-14	31-DEC-16	1793

- Statistical tests were performed on non-detections of each isotope and each SAUNA detector of considered SAUNA systems:
    1. BRX11_001, BRX11_002, BRX11_003, BRX11_004
    2. CLX19_003, CLX19_004
    3. GBX66_001, GBX66_002, GBX66_003, GBX66_004,
    4. JPX38_001, JPX38_003, JPX38_004
    5. NZX46_003, NZX46_004
    6. SEX63_003, SEX63_004
    7. USX75_001, USX75_002, USX75_005, and USX75_006

- Figures of merit were used to compare the results of the standard NCC and New configuration.
- Achieved results based on the normality test, skewness and kurtosis were visualized through QQ plots and probability density graphs.

- For Xe-133 the detection rates are the same with both methods.
- Therefore, our work focuses on the other isotopes (Xe-131m, Xe-133m and Xe-135).
- In the next slides, we will illustrate typical examples on achieved results.

Overview of Analysis

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percentage of detection rates
    27.84%              19.03%
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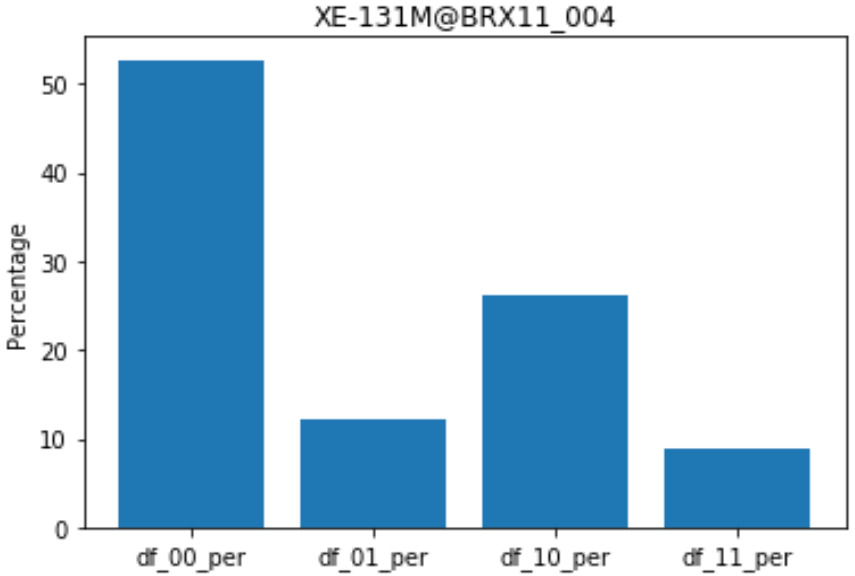
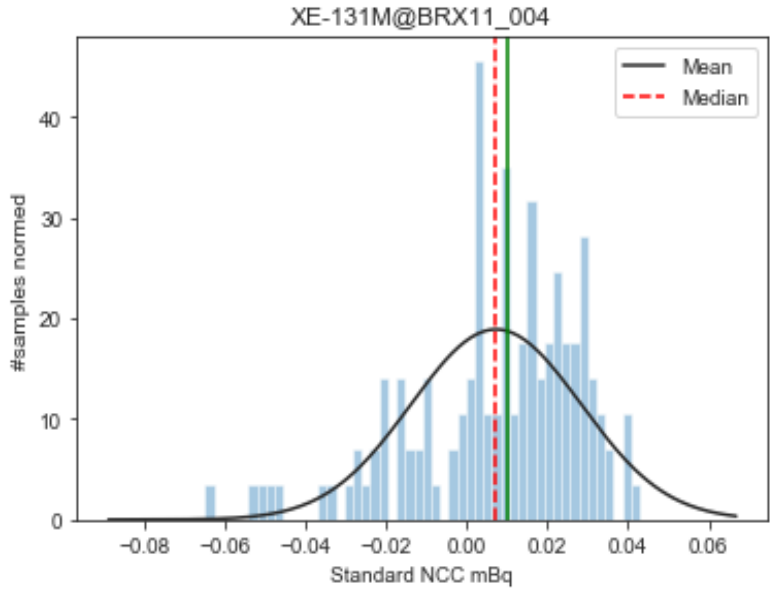
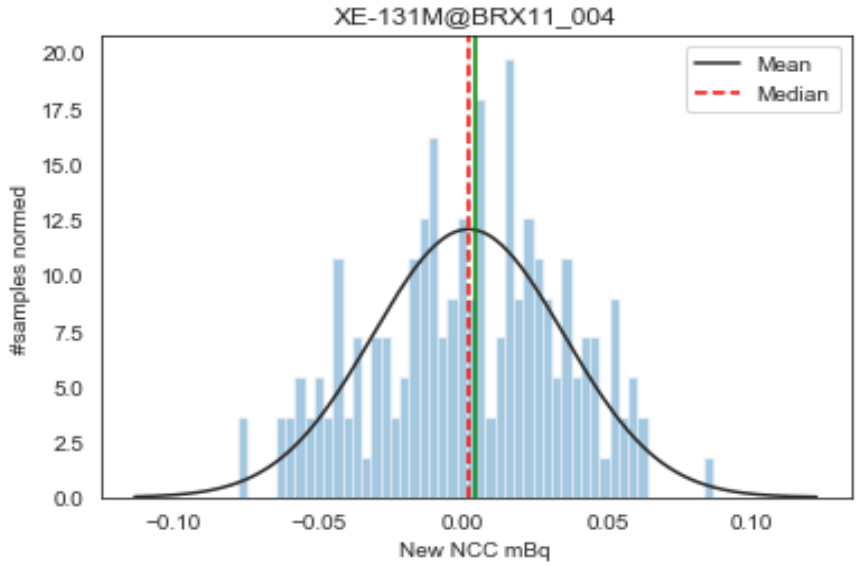
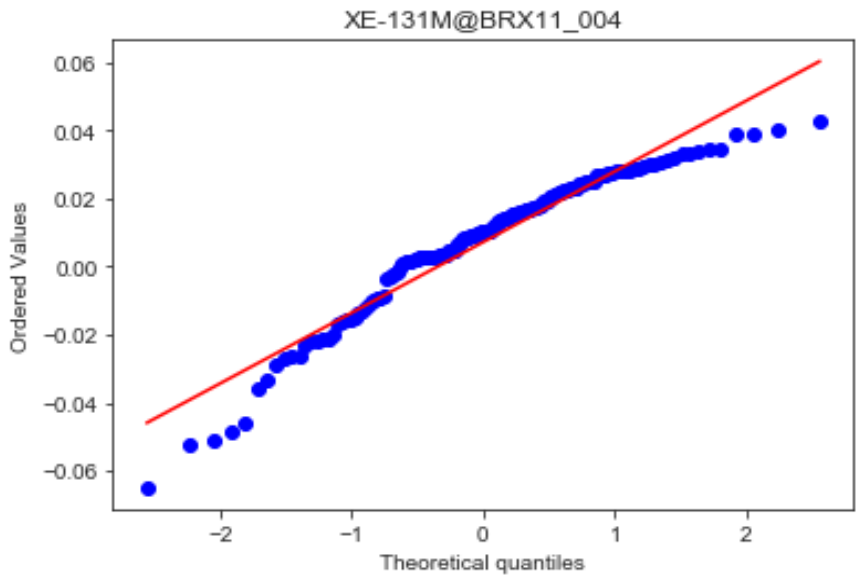
The bar chart combines the false positive with the true positive and the false negative with the true positive In order to graphically visualise the percentage of performance of the two methods.

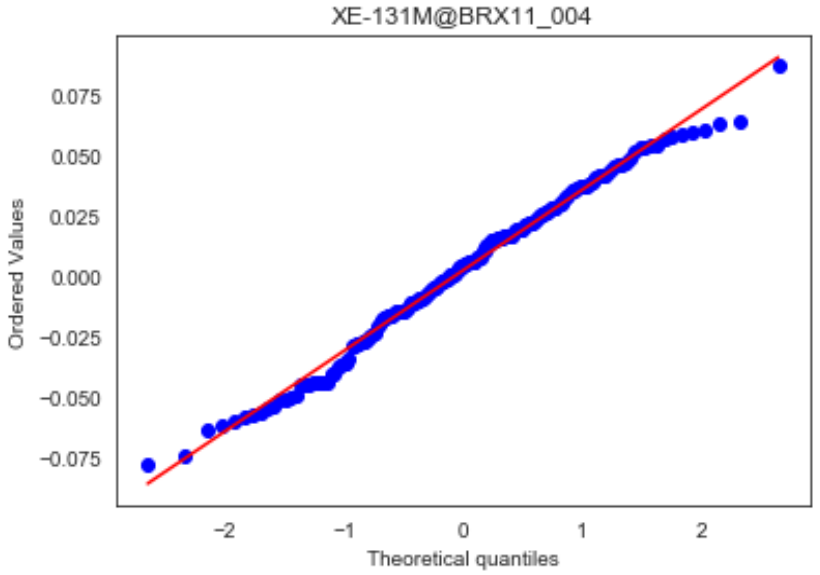
- (11 and 10) representing the standard configuration method
- (11 and 01) representing the New configuration method
- In the case where (10) is higher than (01), it means that the standard configuration method results contain higher false positives than the new configuration method

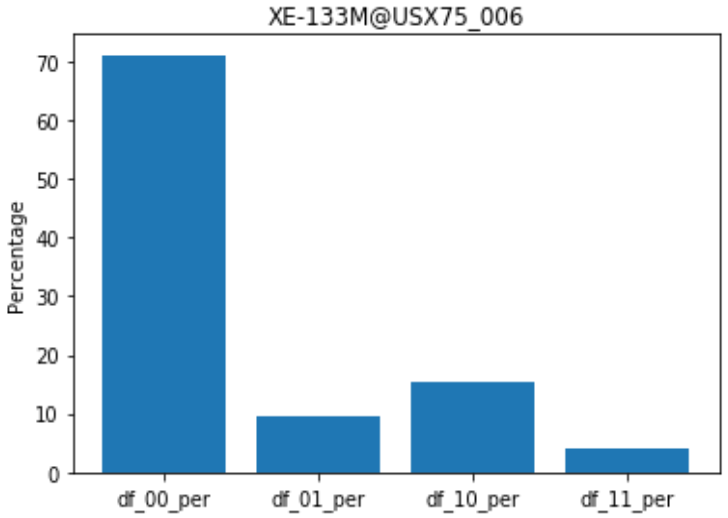

XE-131M@BRX11_004
Percentage
df_00_per
df_01_per
df_10_per
df_11_per

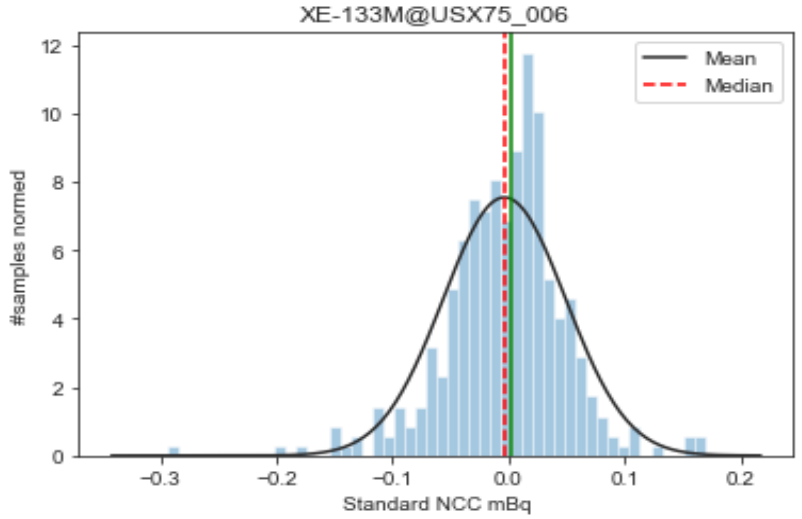

XE-131M@BRX11_004
Mean
Median
#samples normed
Standard NCC mBq

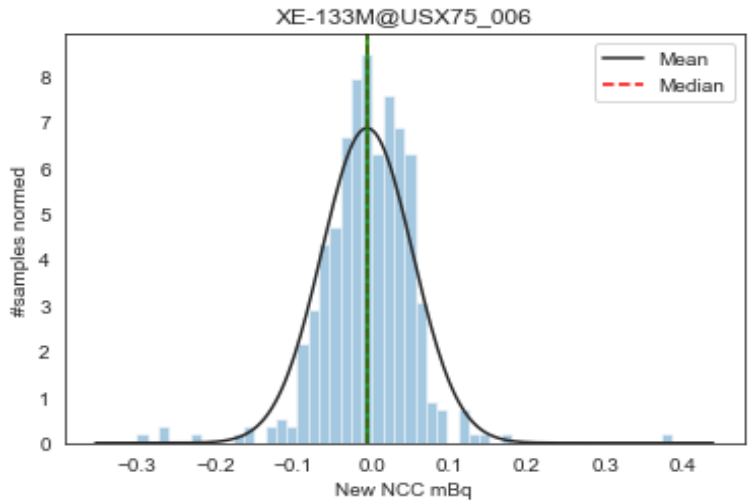

XE-131M@BRX11_004
Mean
Median
#samples normed
New NCC mBq

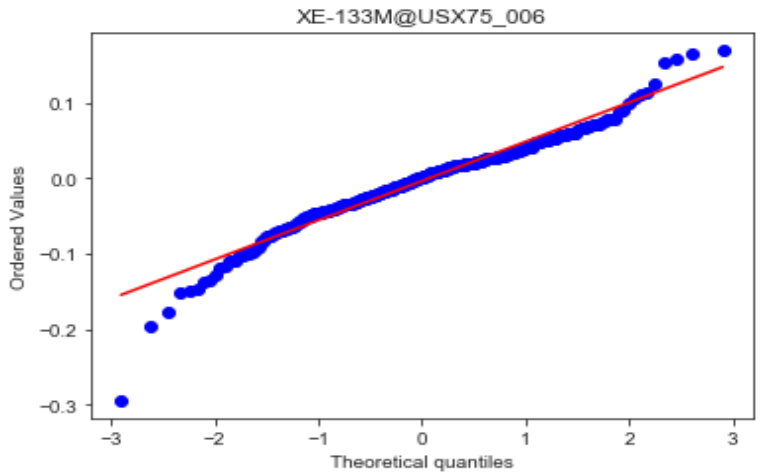

XE-131M@BRX11_004
Ordered Values
Theoretical quantiles

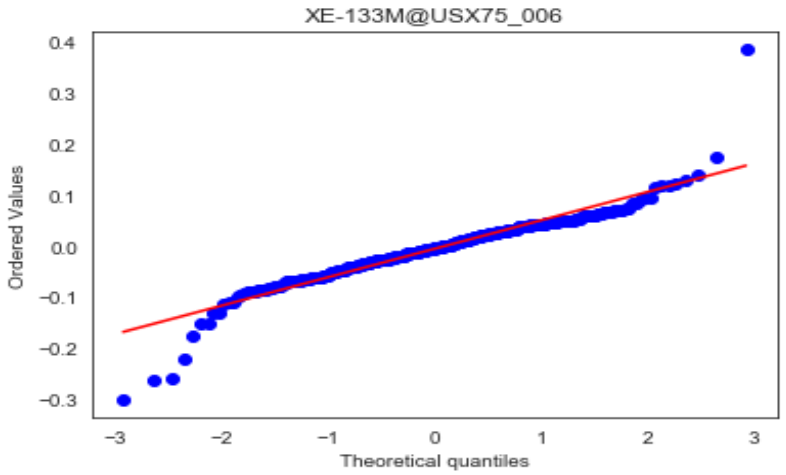

XE-131M@BRX11_004
Ordered Values
Theoretical quantiles


XE-133M@USX75_006
Percentage
df_00_per
df_01_per
df_10_per
df_11_per


XE-133M@USX75_006
Mean
Median
#samples normed
Standard NCC mBq


XE-133M@USX75_006
Mean
Median
#samples normed
New NCC mBq


XE-133M@USX75_006
Ordered Values
Theoretical quantiles


XE-133M@USX75_006
Ordered Values
Theoretical quantiles

Summary

- The frequency distribution and the Q-Q plots were used to test and illustrate the normality hypothesis of the standard NCC method and the new configuration.

- For Xe-131m, Xe-133m and Xe-135 the new configuration method shows a fairly more normal distribution compared to the results of the standard method. This is reflected by the following statistical analysis:
  - The data shows more symmetry on the new configuration method.
  - The QQ plot results show the points having a better fit than the standard method.

THANK YOU