SAUNA-CUBE – a new concept for radioxenon detection

A detection network consisting of *arrays* of less complex noble gas measurement systems at selected sites, would, at comparable cost, have a verification capability superior to the current IMS noble gas network configuration. Such a network would also be more reliable, redundant, and easier to maintain. A prototype system – SAUNA-CUBE - is right now being developed at FOI. SAUNA-CUBE will be the first noble gas system adapted for an array-network solution.

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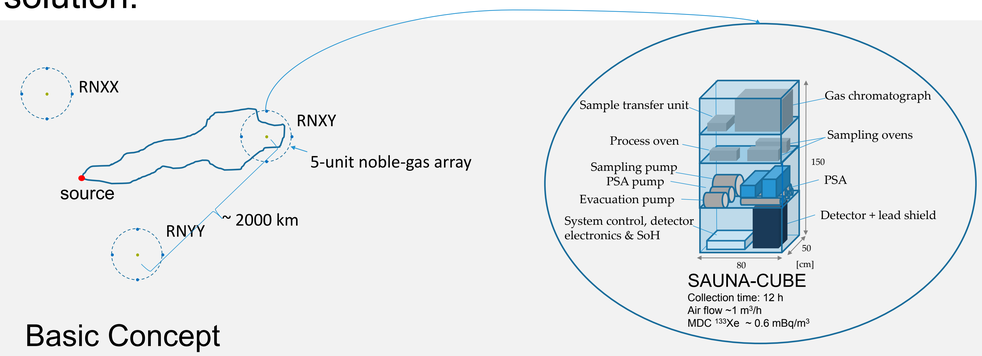
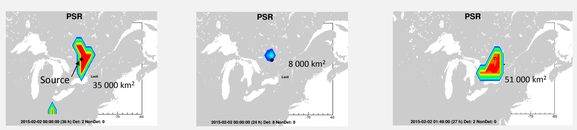


Basic Concept

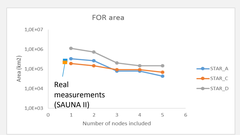
By downscaling and reducing the complexity of the current state-of-the art SAUNA-technology, very robust, compact, inexpensive, reliable systems can be obtained. This allows for array configurations with 4-5 units at a cost comparable to one traditional system. The decreased per-unit sensitivity (^{133}Xe MDC increases a factor 2-3) can be more than compensated for by increased coverage and decreased average source-sensor distance. A goal for the array concept is to detect a release with several sensors, something that is more difficult using the current IMS noble gas network configuration.

Improved location capability

Simulations show that it is possible to reduce the possible source region an order of magnitude if the current IMS station configuration is replaced with arrays. Below is an example of location of a release from the Chalk River IPF detected using an array at USX75, compared with real data.



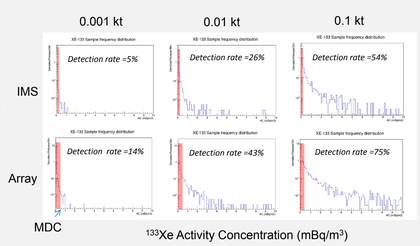
One array-node | Four array-nodes | Current IMS (real data)

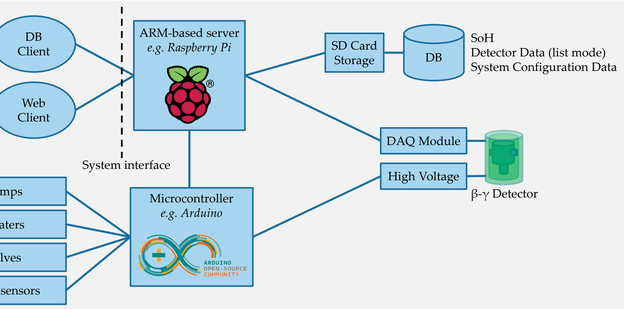


Location precision vs. number of detecting nodes

Improved detection capability

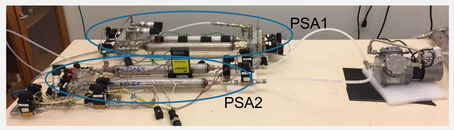
Simulations of 365 daily nuclear explosions (Pu-239, 1 hour containment time, 100% release) in the North Atlantic were performed for three different yields. The resulting detections in Sweden were calculated assuming a 5-node array or the current IMS system in Stockholm.

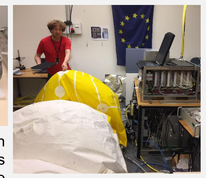




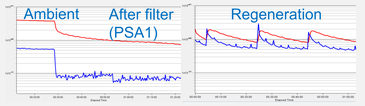
Control system and data flow

SAUNA-CUBE will have a modular and simplified design, with emphasis on standard components, which simplifies production and design changes. The control system is based on an ARM platform running Linux, with module communication through TCP/IP. List mode detector data is stored locally on the internal database, and can be downloaded or e-mailed and further processed by external clients.





The experimental setup for the first part of the gas process in SAUNA-CUBE (top picture). Two traps in each PSA step is currently evaluated. The picture to the right shows sample balloons, collected in different parts of the process, being analyzed in the SAUNA-F prototype, normally used for field samples (e.g. OSI).



Rest gas analyzer data showing the CO_2 (blue) and H_2O (red) PSA1 filter operation.
Left panel: levels in ambient air followed by levels measured after the filter.
Right panel: regeneration of PSA1.

Current project status

- The first two pressure-swing adsorption (PSA) steps (PSA1 and PSA2) have been manufactured and tested, based on knowledge from the development of SAUNA III.
- PSA1, which removes CO_2 and H_2O is fully operational.
- PSA2 currently under optimization, testing column sizes and PSA timings. This step will purify stable xenon in air a factor of 10.
- Current xenon sample size is 0.9 ml (collection time 12 h) with almost 100 % retrieval yield of xenon.
- Next step is to optimize the xenon purification process.
- The new control system concept is being evaluated.

Summary

A new concept for noble gas detection is being developed at FOI. The concept is based on arrays of noble gas measurement systems. Simulations show that this could result in improved verification capability (detection, location, characterization) compared to todays concept used in for instance the IMS. A prototype system is right now being developed at FOI, and is planned to be ready for field-testing in 2018.

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