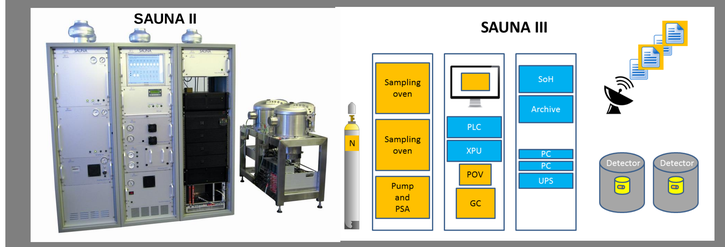
Studies of increased air collection capability for SAUNA III

The current SAUNA II system, installed worldwide in the IMS network, detects radioactive xenon isotopes in an atmospheric air sample. Ambient air is continuously collected, xenon is extracted and measured in sensitive β-γ detectors in an automated process. The development on the new system, SAUNA III, is aimed at improving the time-resolution a factor of two, from 12 to 6 hours, at the same time more than doubling the sample size for each individual sample giving a more sensitive system. A pressure swing adsorption (PSA) step, to be used before the sampling oven, is evaluated to accomplish this performance upgrade. The full gas process will be optimized to allow for a six hour time resolution and using nitrogen as the carrier gas.

Authors

Mattias Aldener, Tomas Fritioff, Johan Kastlander, Anders Ringbom
FOI, Swedish Defence Research Agency

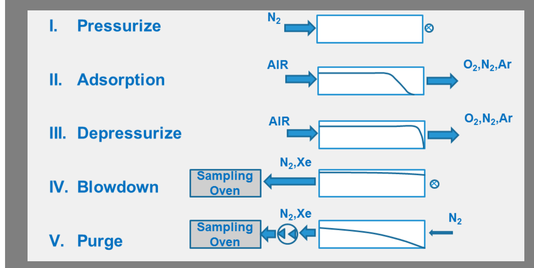


System specifications

Specification	SAUNA II	SAUNA III
Time resolution	12 h	6 h
Collected amount of air per sample	16 m^3	36 m^3
Air flow	22 SLM	100 SLM
Xenon in detector cell, per sample	1.2 cm^3	3 cm^3
Carrier gas	He	N_2

SAUNA II/III

SAUNA II is an automated system were atmospheric air is sampled on activated charcoal (AC) traps at ambient temperature. The system collects 16 m^3 of air every 12 hours, the sample is processed and the xenon extracted, separated from other gases. The modular concept of SAUNA II makes it possible to only replace certain parts when upgrading. The aim for SAUNA III is to collect a xenon sample, every 6 hours, corresponding to 36 m^3 of air.



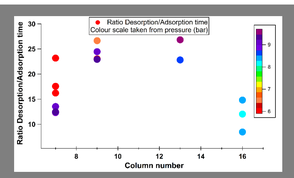
Pressure Swing Adsorption (PSA)

Pressure swing adsorption uses the fact that the adsorption efficiency is pressure dependent. The gas of interest, in this case xenon, is adsorbed at a high pressure (step II) and then desorb at a lower pressure (step IV and V). The material is chosen to have a high selectivity of xenon adsorption versus other gases, *e.g.* N_2 and O_2, to retrieve a sample with high purification. Each PSA cycle is in the order of minutes. This can be compared to temperature swing adsorption, used in the current SAUNA II process, which has a much longer cycle time.

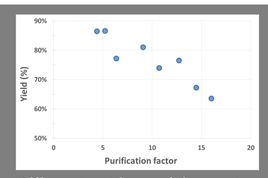
Pre-purification

A purification module, to be placed upstream of the sampling ovens, is currently under development at FOI. The PSA cycle will be utilized to concentrate the xenon levels in the air about ten times before the sample is collected on the charcoal traps. Higher purification will reduce the amount of AC needed allowing a faster and more energy conserving process. The SAUNA II process will be modified to reduce the process time, to account for the larger xenon samples and to use nitrogen as a carrier gas.

The output from the PSA-unit have during the initially development been collected in large sample balloons and the result evaluated with a SAUNA-OSI system.



Maximal time for adsorption and desorption was measured, and the result is shown above. A lower ratio will give a system with fewer traps.



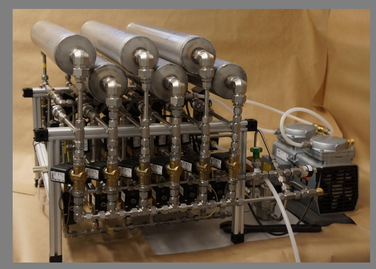
Different settings of the system results in a varying purification factor, defined as the ratio of air sampled to air out from the PSA step. The resulting xenon yield has to be optimized taken the purification into account.

Measurements

Experiments have been carried out in the laboratory to evaluate different materials and column dimensions, initial tests have been made on a single column but a full six column system has been assembled and is currently used to test the full process. The single column output was collected, see figure above, and the result analysed in the SAUNA-OSI system to get the stable xenon volume. Gas composition has also been analysed with a mass-spectrometer.

SAUNA III PSA Module

The pre-purification step, is designed so that it will fit into the sampling rack of a SAUNA II system. The number and dimension of the columns (and the module) will be optimized further.



SAUNA III design

SAUNA III is planned to be implemented as an upgrade to current SAUNA II systems and to fit in the already existing electrical and physical installations. The modular structure of SAUNA II gives that only modules affected by the upgrade needs to be replaced.