SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

T3.2-889

Research on Intelligent Sampling Process for Atmospheric Radioactive Xenon Based on Online Mass Spectrometry

Sheng Yuqiang, Liu Shujiang, Chen Zhanying, An Shaohang, Ma Mengyao, Chang Yinzhong, Li Qi, Wang Shilian

Beijing Radionuclide Laboratory

INTRODUCTION AND MAIN RESULTS

INTRODUCTION

There is an urgent need to develop an intelligent dynamic xenon sampling method based on online mass spectrometry technology to replace the traditional process.

METHODS/RESULTS

Controllable multi-way valves enable precise fluid control, micro-sampling ensures highly sensitive introduction, millisecond-level response guarantees real-time monitoring, ppb-level detection limits enhance trace analysis capabilities, and semi-quantitative methods optimize data processing.

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INTRODUCTION

Traditional atmospheric xenon sampling processes rely on time-fixed control modes and stable xenon measurement techniques using thermal conductivity detectors, which suffer from issues such as process response lag and fluctuations in sample purity. In response to the demand for high-sensitivity monitoring atmospheric radioactive xenon isotopes, this study investigates an intelligent dynamic sampling method based on online mass spectrometry technology.

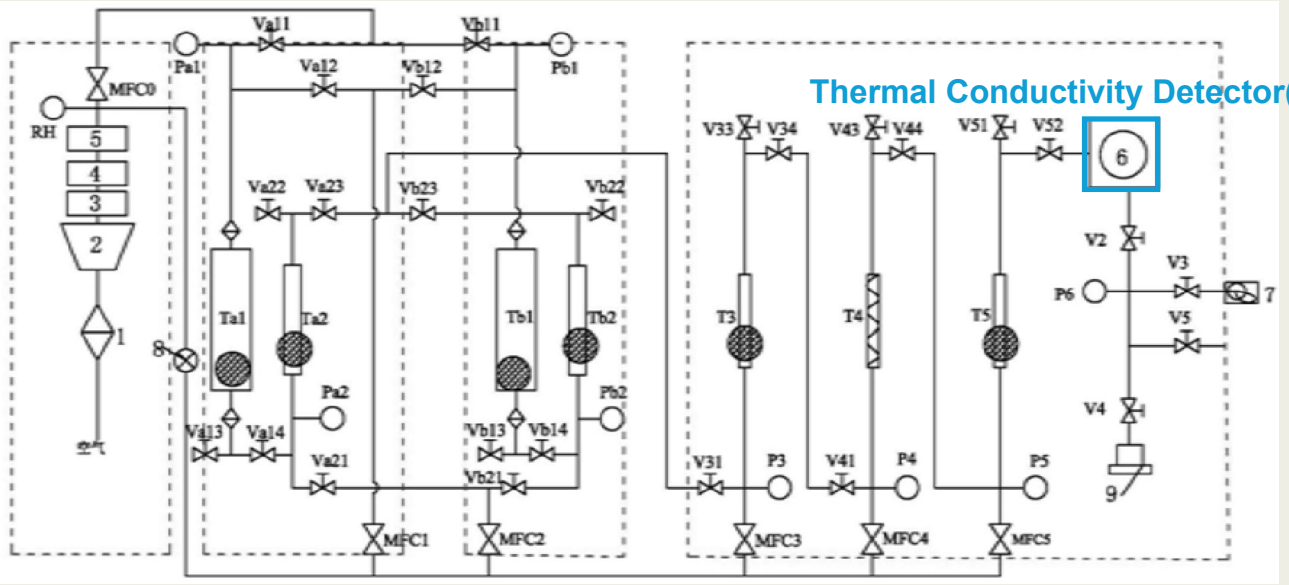

Fig.1 Schematic diagram of the structure of a traditional atmospheric xenon sampling device

- Fixed sequence PLC control logic ***vs.*** dynamic environmental response requirements
- The limitations of binary measurement in TCD ***vs.*** the interference of multiple components in actual gas samples

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METHODS/RESULTS

- The controllable multi-way valve can achieve staged switching control of multi-channel pipelines in the sampling process.
- The micro gas sampling device significantly reduces the influence of monitoring sampling on the final sampling amount of xenon.
- Millisecond-level response time enables comprehensive online monitoring of xenon concentration during the sampling process.

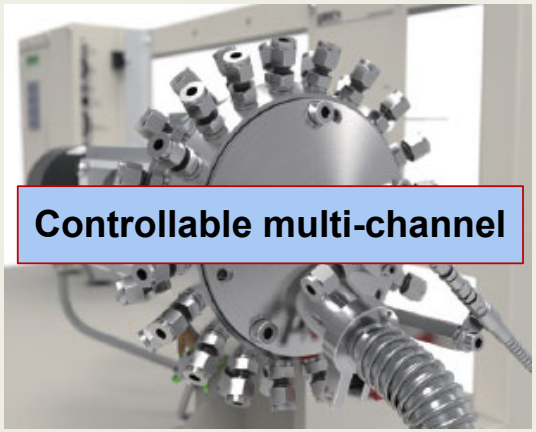

Fig.2 Multi-port valve

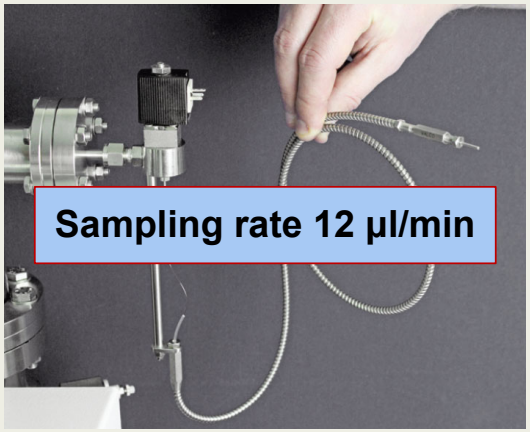

Fig.3 Micro-flow inlet device

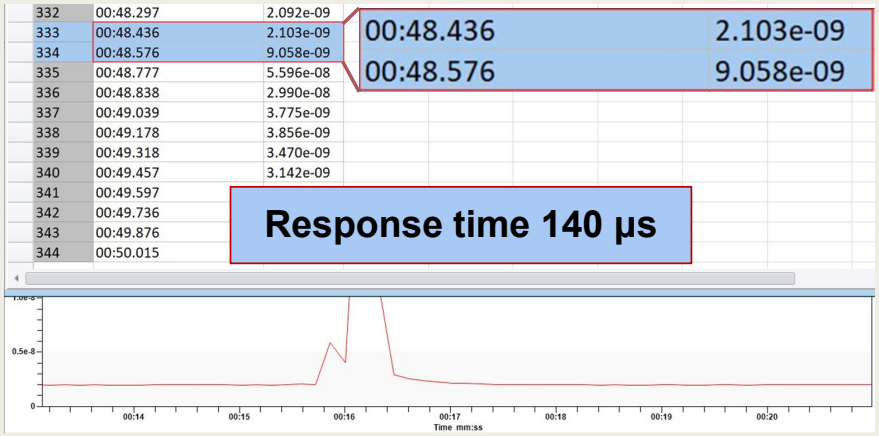

Fig.4 Respond to gas concentration changes in milliseconds

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METHODS/RESULTS

- The detection limit of online mass spectrometry technology reaches 5 ppb, enabling reliable detection of extremely low-concentration xenon in the atmosphere.
- The monotonic exponential decay relationship between the online mass spectrometry signal intensity and the concentration enables semi - quantitative detection of gas concentration.

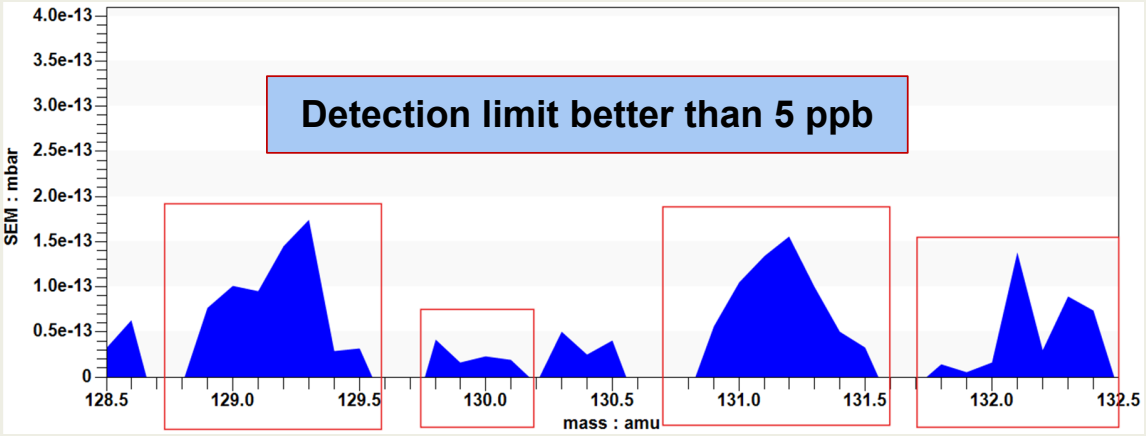

Fig.5 MID spectrum of xenon isotopes in the air

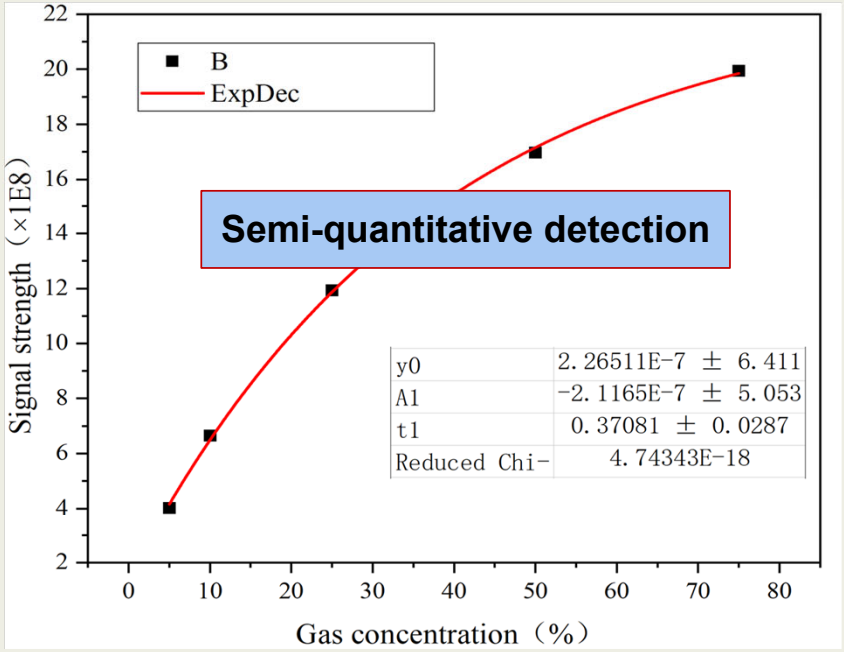

Fig.6 Relationship between signal and concentration

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CONCLUSION

- This research integrates an online mass spectrometer with a micro gas sampling device, achieving a comprehensive online monitoring system capable of semi-quantitative real-time detection from ppb-level atmospheric concentrations to high-purity xenon.
- The core of the intelligent sampling technology lies in establishing a collaborative control system between the online mass spectrometer and a programmable logic controller (PLC).
- By using the xenon concentration signals fed back from the online mass spectrometer, the PLC can dynamically adjust the adsorption and desorption parameters, replacing the traditional fixed-timing control logic and enabling real-time optimization of process parameters.
- The application of this intelligent dynamic sampling technology is expected to significantly enhance the accuracy and timeliness of atmospheric radioactive xenon monitoring, providing a solid technical foundation for the intelligent and adaptive development of atmospheric radioactive xenon sampling.

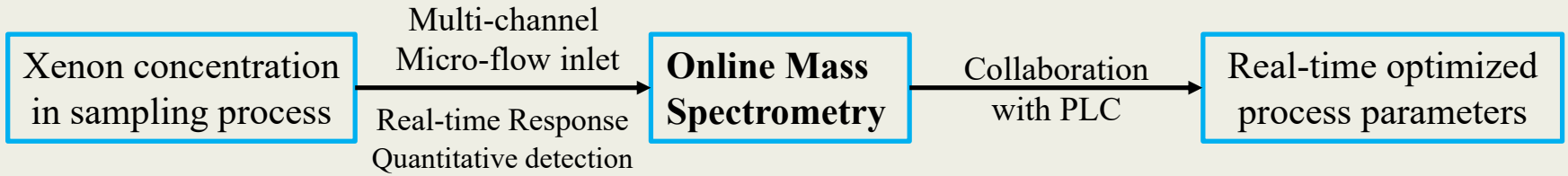

Fig.7 Schematic diagram of the intelligent sampling process for atmospheric radioactive xenon based on online mass spectrometry