

# Possible source location analysis of high $^{135}\text{Xe}$ observations at IMS noble gas systems to test the hypothesis of Light water reactors being the source

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## INTRODUCTION AND MAIN RESULTS

$^{135}\text{Xe}$  is short-lived ( $t_{1/2} \approx 9.2$  h);  $^{135}\text{Xe}/^{133}\text{Xe} > 5$  can flag a possible test. Yet some IMS stations (SEX63, NOX49, USX75) occasionally observed very high ratios or  $^{135}\text{Xe}$  without  $^{133}\text{Xe}$  whose nuclear processes are not fully explained. Using FoR (24–72 h) across multiple IMS sites (SEX63, NOX49, USX75), the spatial coherency between SEX63–NOX49 supports common upwind sectors consistent with NW Europe: **Forsmark NPP which is LWR is likely being the source.** We also identify Hunterston/Torness be the likely source region for the SEX63 2020 cases give compatible source strengths, supporting a reactor origin.



## Motivation & Objectives

- ❑  $^{135}\text{Xe}$  is a fission product with a short half-life ( $\approx 9.1$  h)  
→ timing & transport are crucial.
- ❑ IMS noble gas stations (e.g., SEX63, NOX49, USX75) recorded elevated  $^{135}\text{Xe}$ .
- ❑ Goal: Test the hypothesis that Light Water Reactors (LWRs) are the likely sources.
- ❑ Approach: FoR (24→72 h) for Dec 2019 (multi-station) and SEX63 runs (2 Apr 2020 & 8 Nov 2020).
- ❑ Locate overlap zones & compare with nuclear installations
- ❑ Compute source strength

## Data and Methods

### Data

- ❑ SRM files for stations: SEX63, NOX49, USX75 (Dec 2019).
- ❑ Two SEX63 runs: Run A (2 Apr 2020), Run B (8 Nov 2020).
- ❑ Nuclear installations list (IMS vs other civil facilities).

### Method

- ❑ Slice SRM at target hours (24...72 h; focus: 60–72 h).
- ❑ Compute hourly & cumulative SRS near stations.
- ❑ Map plume overlaps; annotate installations (IMS: dots; others: squares). “Potential sources”:
- ❑ Hunterston & Torness (UK) highlighted where Run A & Run B plumes coincide.

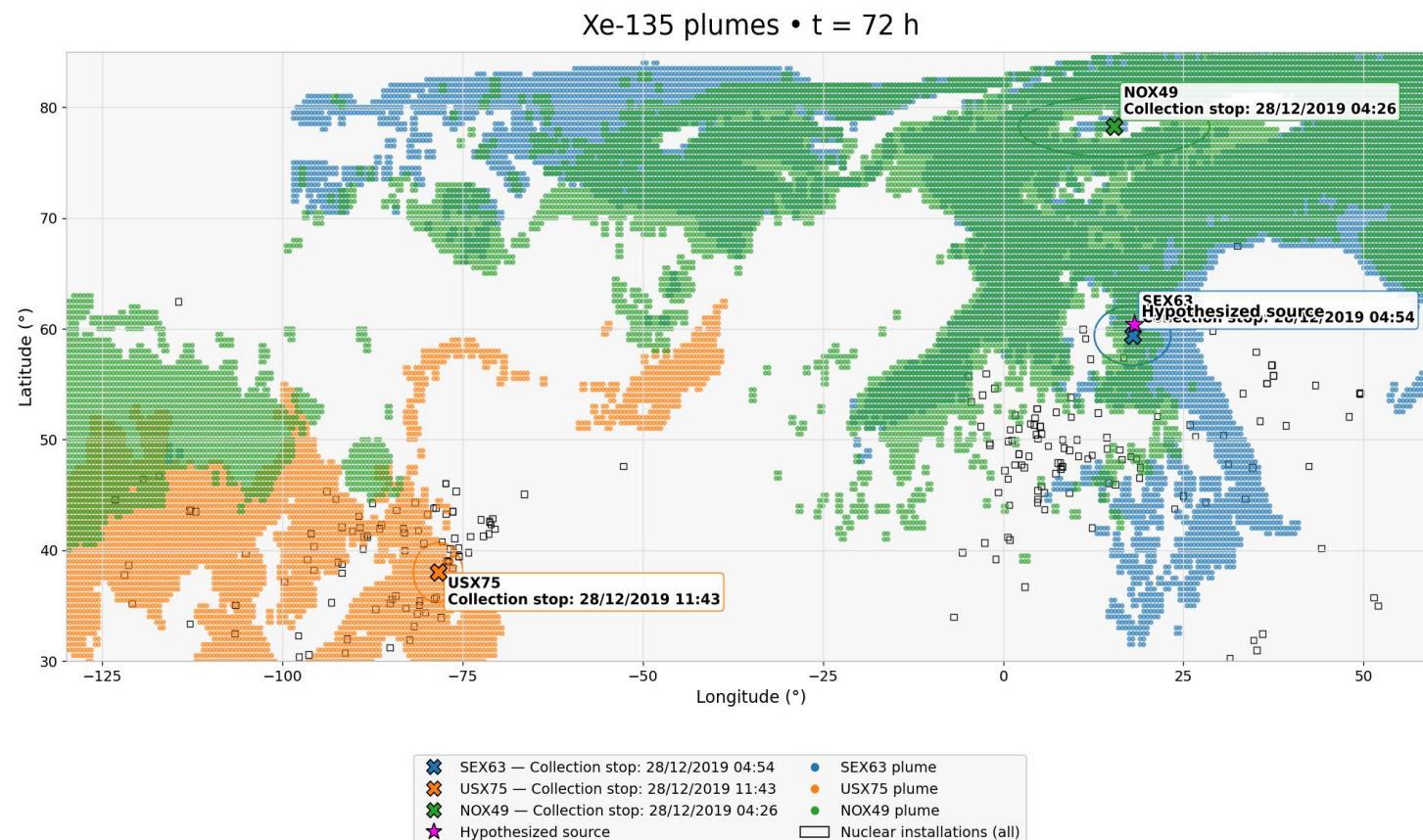


## Results and Discussion

### SEX63, NOX49, and USX75 (December 2019): Overlap & Potential Sources

- Multi-station Cumulative Plumes SEX63 & NOX49 show the strongest plume overlap; USX75 overlaps are sparser.
- Northern-Hemisphere installations filtered to map window; labels trimmed to reduce clutter.
- Facilities near station rings ( $\leq 300$  km) emphasized.

Spatial coherency between SEX63–NOX49 supports common upwind sectors consistent with NW Europe: **Forsmark reactor being the source**



Blue/Green overlap at **Forsmark reactor**



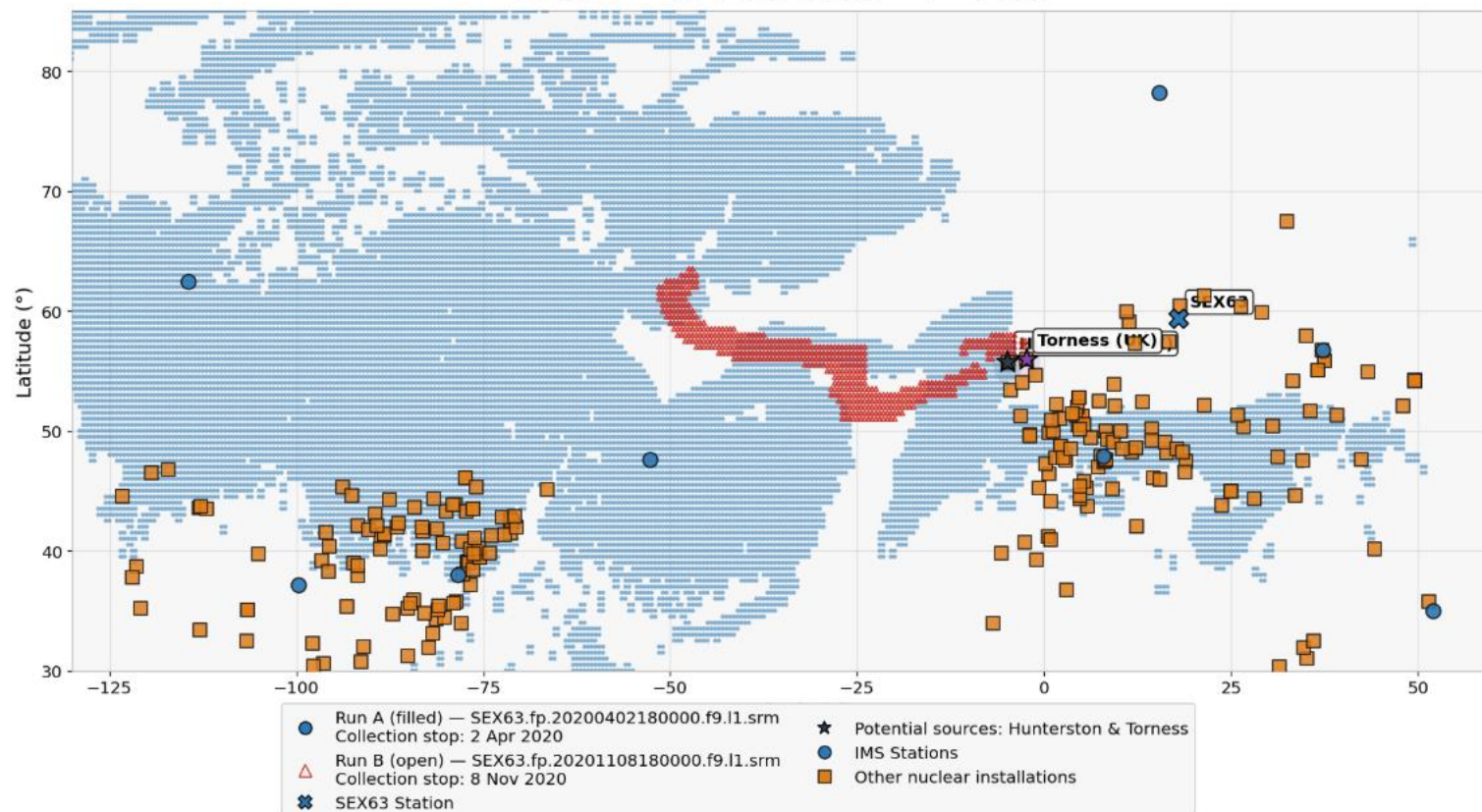




## SEX63 (Run A vs Run B): Overlap & Potential Sources

- ❑ Run A (2 Apr 2020): filled blue circles;
- ❑ Run B (8 Nov 2020): open red triangles.
- ❑ Overlap halos illuminate periods when both runs carry plumes near Hunterston/Torness.

SEX63 — Two SRM runs •  $t = 72$  h



Blue/Red overlap near the eastern Scottish coast (Hunterston and Torness)

Spatiotemporal coincidence over UK east coast motivates Hunterston B and Torness reactors are the potential sources: Hunterston.



- ❑ Backward trajectory and SRM modelling of elevated Xe-135 at IMS station SEX63 revealed consistent plume overlap near **Hunterston B and Torness reactors**.
- ❑ **EDF's 2020** report confirms Hunterston's restart in Sept 2020, supporting the hypothesis that reactor transitions-not nuclear tests-can produce high  $^{135}\text{Xe}/^{133}\text{Xe}$  ratios.



## Conclusions

The decay correction has not been accounted for and the true release is higher.

Run	SRS Sum	Source Strength
A	1714.51	$\frac{32}{1714.51} \times 94.7 \approx \mathbf{1.77 \text{ Bq}}$
B	2296.27	$\frac{26.6}{2296.27} \times 94.7 \approx \mathbf{1.10 \text{ Bq}}$

For 2 April 2020 (32 mBq/m<sup>3</sup>)

For 8 November 2020 (26.6 mBq/m<sup>3</sup>)

“Trajectory overlap and synchronized plume arrival suggest a shared regional origin, likely involving the same reactor complex. The source strength estimates points to confirm the same sources influences both samples.”



[https://www.edfenergy.com/sites/default/files/2020 - holdings\\_accounts\\_signed\\_deloitte.pdf](https://www.edfenergy.com/sites/default/files/2020 - holdings_accounts_signed_deloitte.pdf)

- ❑ **December 2019:** SEX63–NOX49 overlap is strongest; consistent upwind sectors with NW Europe: Forsmark reactor being the source.
- ❑ **2020 SEX63 runs:** overlap near Hunterston/Torness supports LWR potential source hypothesis.
- ❑ **Source strengths are in** good agreement and confirm that the same source influences both samples.
- ❑ This work serves as a demonstration of a method that will be applied to all relevant cases of Xe-135 observations.

