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Problem Statement

The IMS aerosol systems of today are optimized for a low-level leak from a UNE. Several observations have been made from close to two decades of aerosol operations:

- ▶ Fukushima aerosol system experiences showed
 - system weaknesses (e.g. power grid vulnerability)
 - opportunities to obtain high-release information sooner.
- ▶ Xenon system operations during Fukushima showed several benefits of shorter integration times.
- ▶ Also, IMS aerosol systems are located in remote locations such that shipment of samples to IMS labs is problematic.

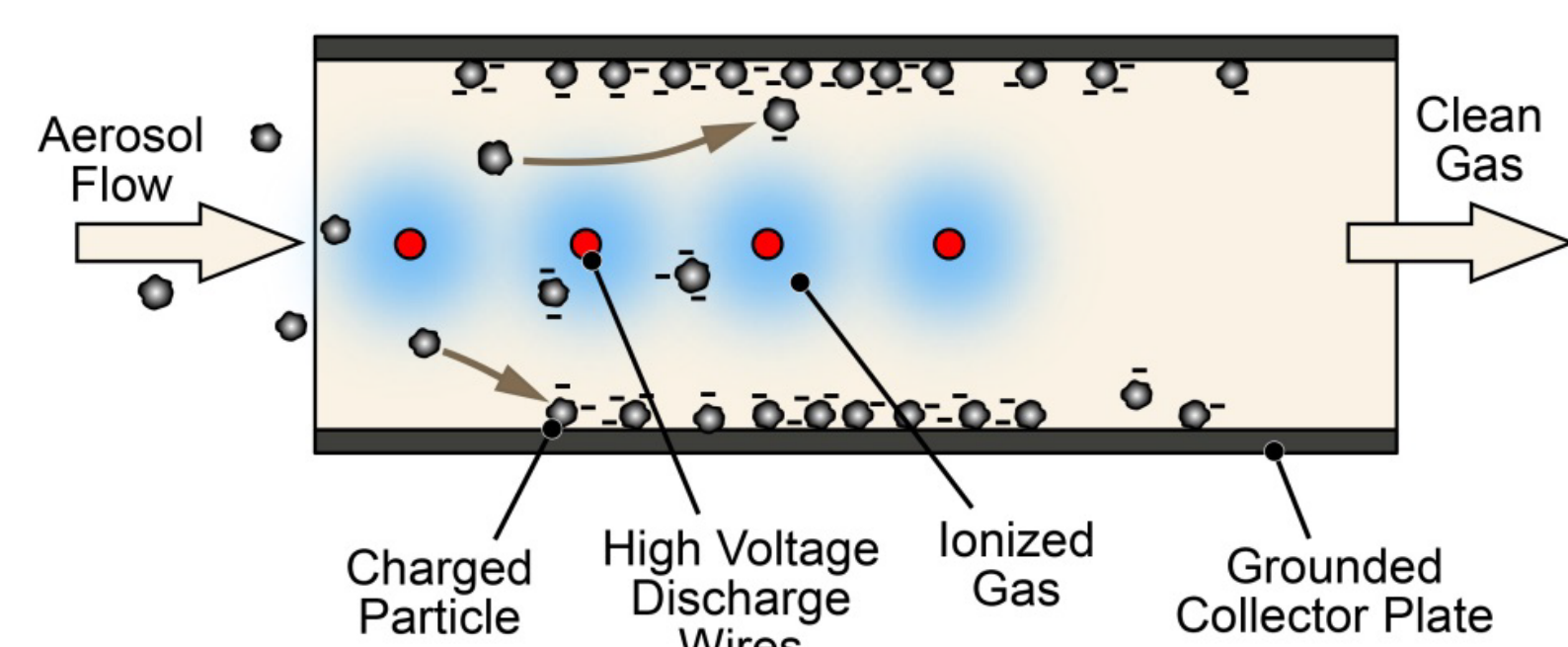
We reviewed the concept of the IMS aerosol system design to find ways to address these issues. Key to this was the use of a simple MDC equation.

$$MDC = \frac{1}{\lambda * Br} * \sqrt{\frac{[bkg] * 2 * FWHM}{\epsilon * d\Omega * V * t}}$$

This equation allowed us to explore operational variations that could add value to early measurements, shorten the integration time without loss of MDC, or improve the MDC with additional air flow.

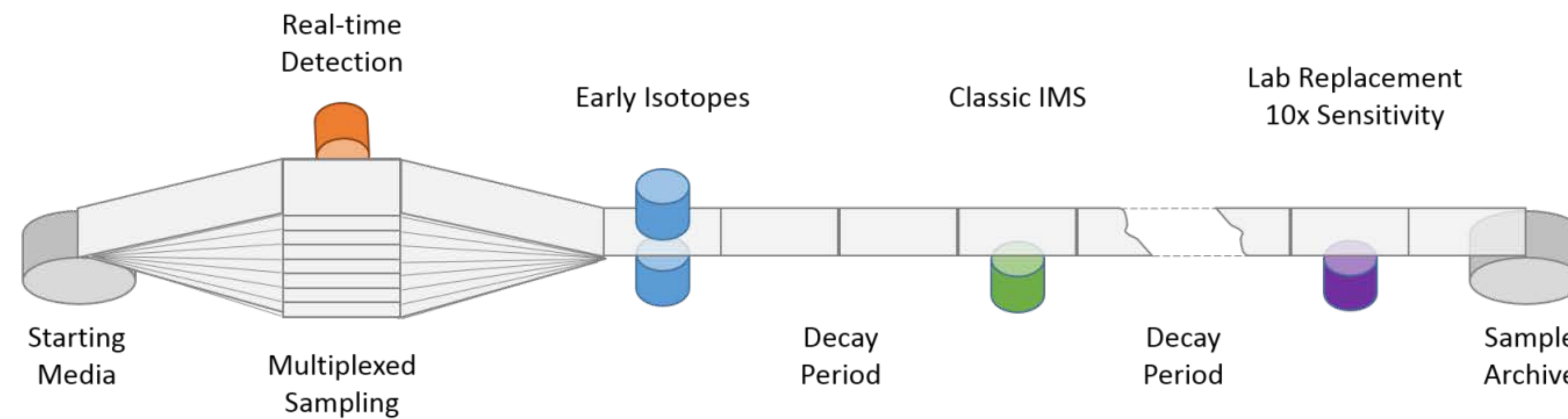
Electrostatic Collection

Electrostatic Precipitation (ESP) does not dissipate as much energy in airflow while sweeping aerosol material from the air. Consequently, far lower power is needed for moving air, and thus allowing the aerosol system to experience a **much higher air flow** per Watt, and potentially be completely battery-backed.



The surfaces on which particles are precipitated can be coated with flexible substrate, far thinner than a classic filter. These can allow a **much more compact sample** to be presented to the detector, including through ingenious folding methods. In the MDC equation, this is $\epsilon * d\Omega$, and we refer to this as 'geometry'.

Impacts of new collection media: We studied one typical material and found some challenges in meeting dissolution requirements. We also showed that it would not raise the background level of a normal IMS measurement, but might contribute signal to an ultra-low level background detector. These areas need further work and consideration, possibly by sourcing different collection media.



Measurement Position vs Capability It Gives	Nominal Detector Main characteristic	Improved Detector 1 Main characteristic	Improved Detector 2 Main characteristic
Real-time Detection	Plastic scintillator	Lanthanum halide	Dual small NaI crystals
Time of arrival, Improved Loc	Basic high count rate	Some spectroscopy	High selectivity
Early Isotopes	Dual NaI 5x10x30 cm	Dual silicon or lanthanum halide	Dual HPGe
Short-lived species, timeliness	High selectivity, efficiency	Higher selectivity, less efficiency	Ultra-selectivity for complex samples
Classic IMS	Single HPGe	Single HPGe w/cosmic veto	Dual HPGe
Existing low level scenario	IMS specifications	Better low-level sensitivity	Ultra selectivity in complex spectra
Lab Replacement For remote stations	ULB HPGe w/cosmic veto. Lab replacement	Dual ULB HPGe w/cosmic veto. Better than IMS labs	

Alternate Operational Modes vs IMS MDC

Row	Geometry	Flow Rate	Sample & Count	Decay Time	MDC Factor
A	0.2	1	24	24	1.00
B	0.2	2	24	24	0.71
C	0.2	3	24	24	0.58
D	0.2	1	12	48	0.92
E	0.2	2	12	48	0.65
F	0.2	3	12	48	0.53
G	0.2	1	8	56	1.06
H	0.2	2	8	56	0.75
I	0.2	3	8	56	0.61
J	0.2	1	6	60	1.24
K	0.2	2	6	60	0.88
L	0.2	3	6	60	0.71
M	0.5	1	24	24	0.63
N	0.5	2	24	24	0.45
O	0.5	3	24	24	0.37
P	0.5	1	12	48	0.58
Q	0.5	2	12	48	0.41
R	0.5	3	12	48	0.33
S	0.5	1	8	56	0.67
T	0.5	2	8	56	0.47
U	0.5	3	8	56	0.39
V	0.5	1	6	60	0.78
W	0.5	2	6	60	0.55
X	0.5	3	6	60	0.45

▶ Today's RASA operations (24/24/24)

▶ Today's RASA (12/48/12)

▶ Today's RASA (8/56/8)

Conclusions

Substantial capability improvements are possible for aerosol systems that would address issues observed in decades of operational experience, especially the Fukushima accident.

▶ Doubled air flow, Better sample geometry
 Fast Early Isotopes, (6/60/6), Better MDC

Abstract

In the 1990s, Pacific Northwest National Laboratory staff developed the Radionuclide Aerosol Sampler Analyzer (RASA) for worldwide aerosol monitoring¹. RASA won an R&D 100 award in 1998 and a Federal Laboratory Consortium tech transfer award in 2000. For the last several years, staff of PNNL and Creare have made investigations into aspects of upgrading the RASA. Key themes have been a modular approach to additional radionuclide measurements, optimizing the sampling/analyzing times to improve detection and location capability, and improving the power consumption via the use of electrostatic collection versus classic filtration. These individual efforts have been made in the context of retrofits to the existing RASA. In this work, we consider a complete RASA redesign at a notional level. Individual studies reported here contain theory and experimental investigations, but none of these has been tested with the others, and further work is needed to verify these gains. With these caveats, this work shows that substantial optimization of detection and location capability of a network of RASA systems is possible, multiple mission spaces can be addressed with additional measurements, and electrostatic collection is a practical advantage, although more work is needed. The quite unexpected result of this study is that some optimization of the existing RASA is possible without any hardware changes at all.

References

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ABOUT

Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory, located in southeastern Washington State, is a U.S. Department of Energy Office of Science laboratory that solves complex problems in energy, national security, and the environment, and advances scientific frontiers in the chemical, biological, materials, environmental, and computational sciences. The Laboratory employs nearly 5,000 staff members, has an annual budget in excess of \$1 billion, and has been managed by Ohio-based Battelle since 1965.

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