

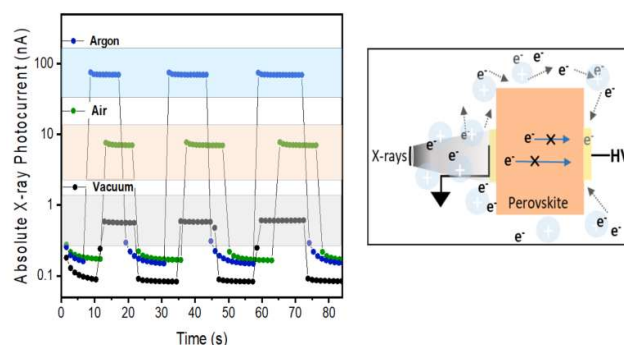
# Re-assessment of the air-mediated response in Bi-based perovskite X-ray detectors.

Aditya Bhardwaj<sup>a,b</sup>, Kostiantyn Sakhatskiy<sup>a,b</sup>, Gebhard J Matt<sup>a,b</sup>, Martin Kotyrba<sup>a,b</sup>, Sergii Yakunin<sup>a,b</sup>, Maksym Kovalenko<sup>§ a,b</sup>

<sup>a</sup> Laboratory of Inorganic Chemistry, Department of Chemistry and Applied Biosciences, ETH Zürich, Zürich, Switzerland. <sup>b</sup> Laboratory of Thin Films and Photovoltaics, Empa-Swiss Federal Laboratory for Material Science and Technology, Dübendorf, Switzerland.

Email: [abhardwa@student.ethz.ch](mailto:abhardwa@student.ethz.ch)

A novel class of perovskite-like materials  $A_3B_2X_9$  (where  $A = \text{Cs/Rb/MA}$ ,  $B = \text{Sb/Bi}$ ,  $X = \text{Cl/Br/I}$ ) has been highly regarded in research community as a sustainable and eco-friendly potential replacement for CdTe and  $\text{CsPbBr}_3$ . Our systematic investigation demonstrates that the X-ray detection performance of these Pb-free materials has been ill-characterized in the past and that the characterization measurements are vitally susceptible to environmental conditions, leading to specious high figures of merit. To decouple the photocurrent contribution by air ionization in these materials and measure their inherent detection performance, a comparative study of X-ray response was conducted in a specifically built chamber while switching its environment between air, argon-filled, and vacuum. After carefully eliminating the plausible deleterious effects of crystallographic orientation, crystal quality, and metallization interface, our findings suggest that nearly a 1000-fold higher X-ray sensitivity may be maneuvered using an argon-filled chamber with smallest metal-semiconductor contact area. The work aims to highlight the importance of air-ionization artefact to be accounted while evaluating X-ray detection response. We encourage a comprehensive X-ray detection characterization for reporting novel materials as X-ray radiation sensors.



**Figure 1:** Depicts a 1000-fold increase in absolute X-ray photocurrent obtained with the  $\text{Cs}_3\text{Bi}_2\text{I}_9$  single crystal when measured under vacuum, air, and argon filled chamber environment. The samples was biased at 150V and 22keV X-ray was turned on after 20-30 seconds leading to increased photocurrent. The schematic depicts the collection of charged ions on the contacts externally instead of photo-generated carrier from the perovskite sensor.

## References:

- [1] Y. He, I. Hadar and M G kanatzidis, *Nature Photonics* **2022**, 16, 14-26.
- [2] X. Geng, Y.A.Chen, Y.Y. Li, J. Ren, G. H. Dun, K. Qin, Z. Lin, J. Peng, H. Tian, Y. Yang, D. Xie and T. L. Ren, *Advance Science* **2023**, 10, 23, 2300256