

Nancy N. Wanna<sup>1,2\*</sup>, Andrew Dobney<sup>1</sup>, Karen Van Hoecke<sup>1</sup>, Mirela Vasile<sup>1</sup> & Frank Vanhaecke<sup>2</sup>

<sup>1</sup>Belgian Nuclear Research Centre, SCK•CEN, Mol, Belgium

<sup>2</sup>Ghent University, Department of Chemistry, Atomic & Mass Spectrometry – A&MS Research Unit, Campus Sterre, Krijgslaan 281 – S12, 9000, Ghent, Belgium

\*E-mail: [nwanna@sckcen.be](mailto:nwanna@sckcen.be)

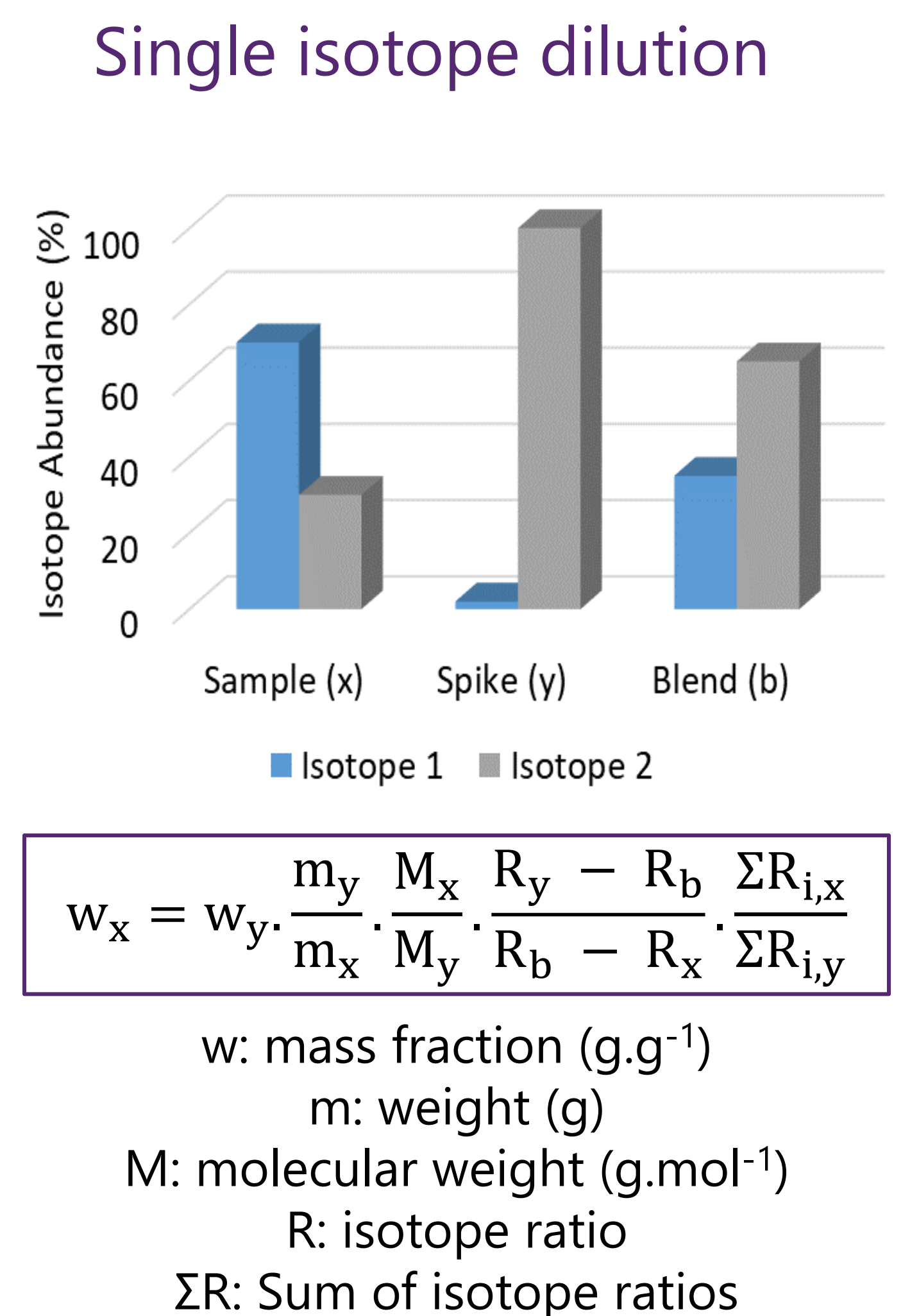
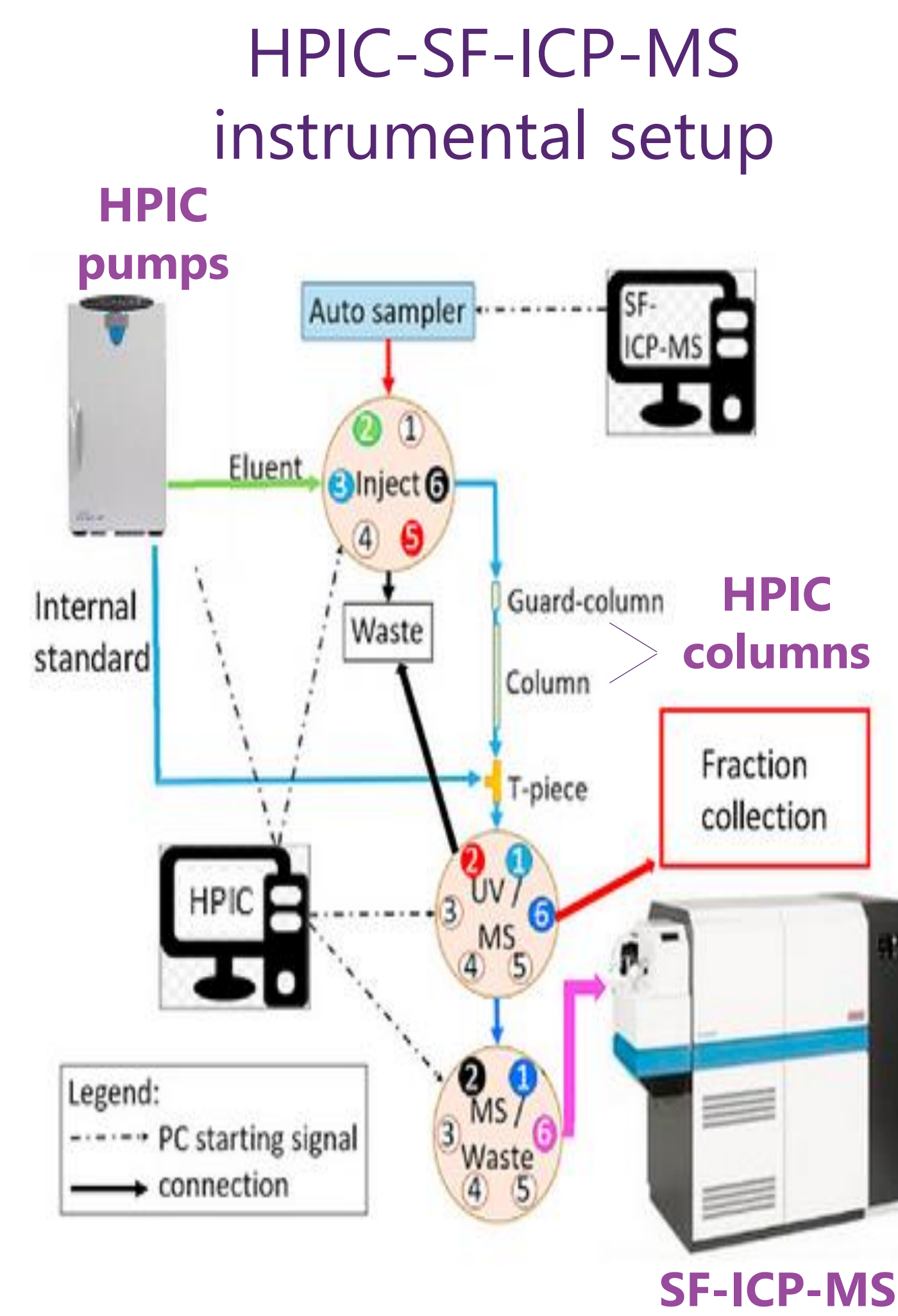
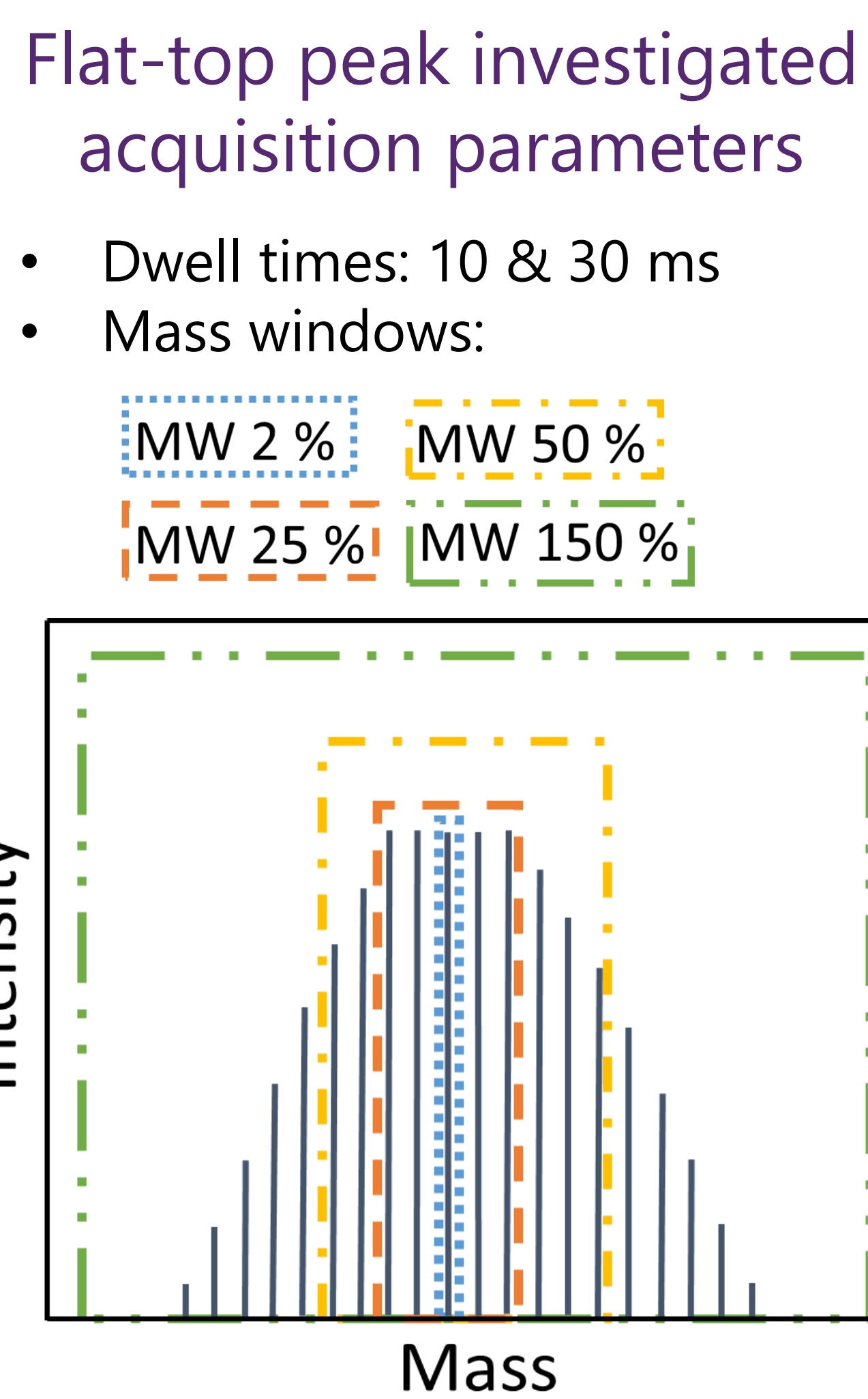
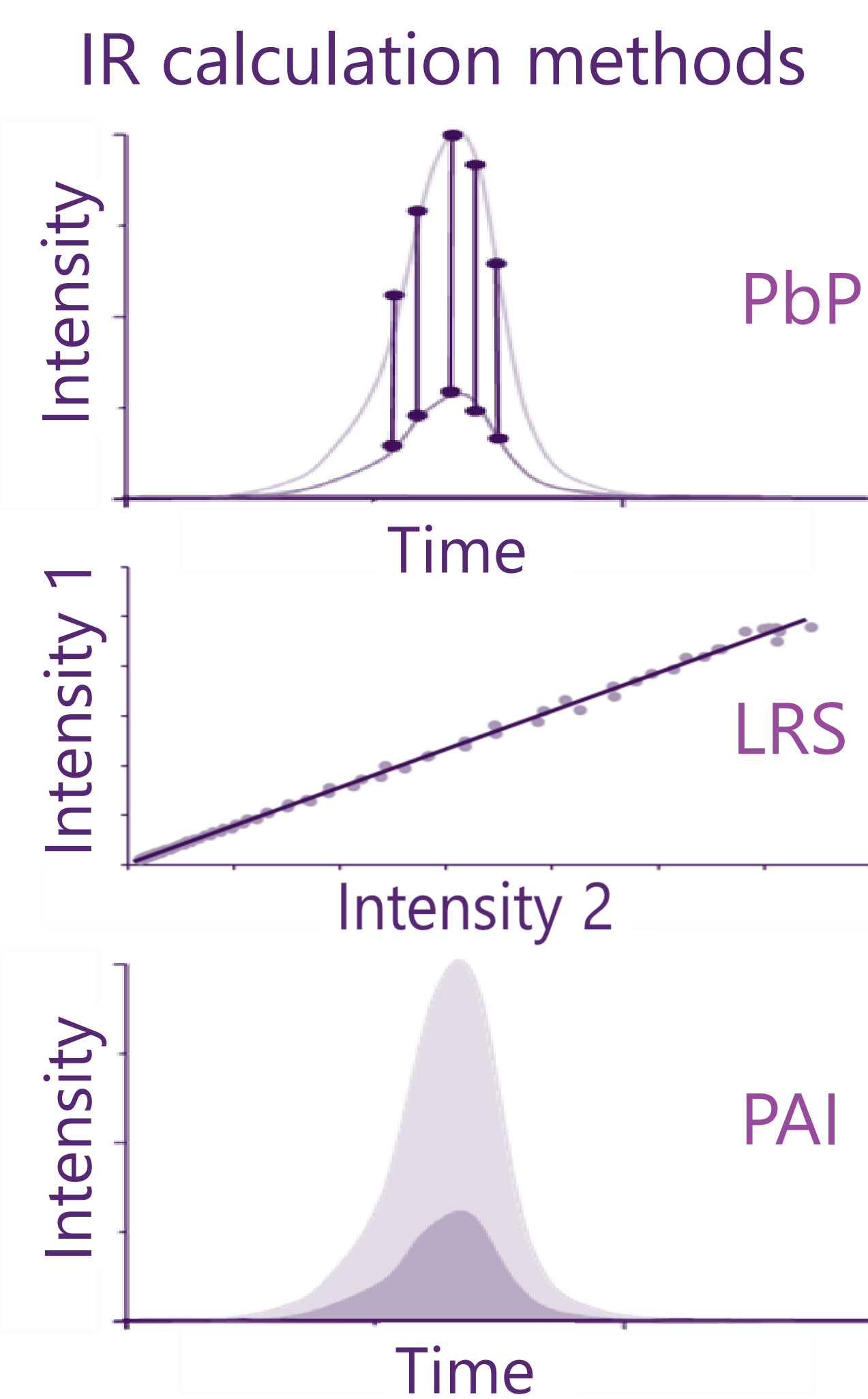
## Introduction

Post-irradiation examination of **spent nuclear fuel (SNF)** includes destructive analysis for the determination of long-lived actinides and lanthanides (fission products) concentrations such as U, Pu, Nd & Gd (in Gd fuels). This is done using **isotope ratio (IR)** measurements with **inductively coupled-plasma mass spectrometry (ICP-MS)** or, alternatively, by **thermal ionization mass spectrometry (TIMS)** &  $\alpha$ -spectrometry. **Sector field (SF)** ICP-MS is a single detector ICP-MS instrument well known for flat top peaks, which increase the precision of IR measurements. Coupling **high pressure ion chromatography (HPIC)** on-line with ICP-MS rapidly eliminates notorious isobaric interferences whilst reducing the analyst's exposure to radiation.

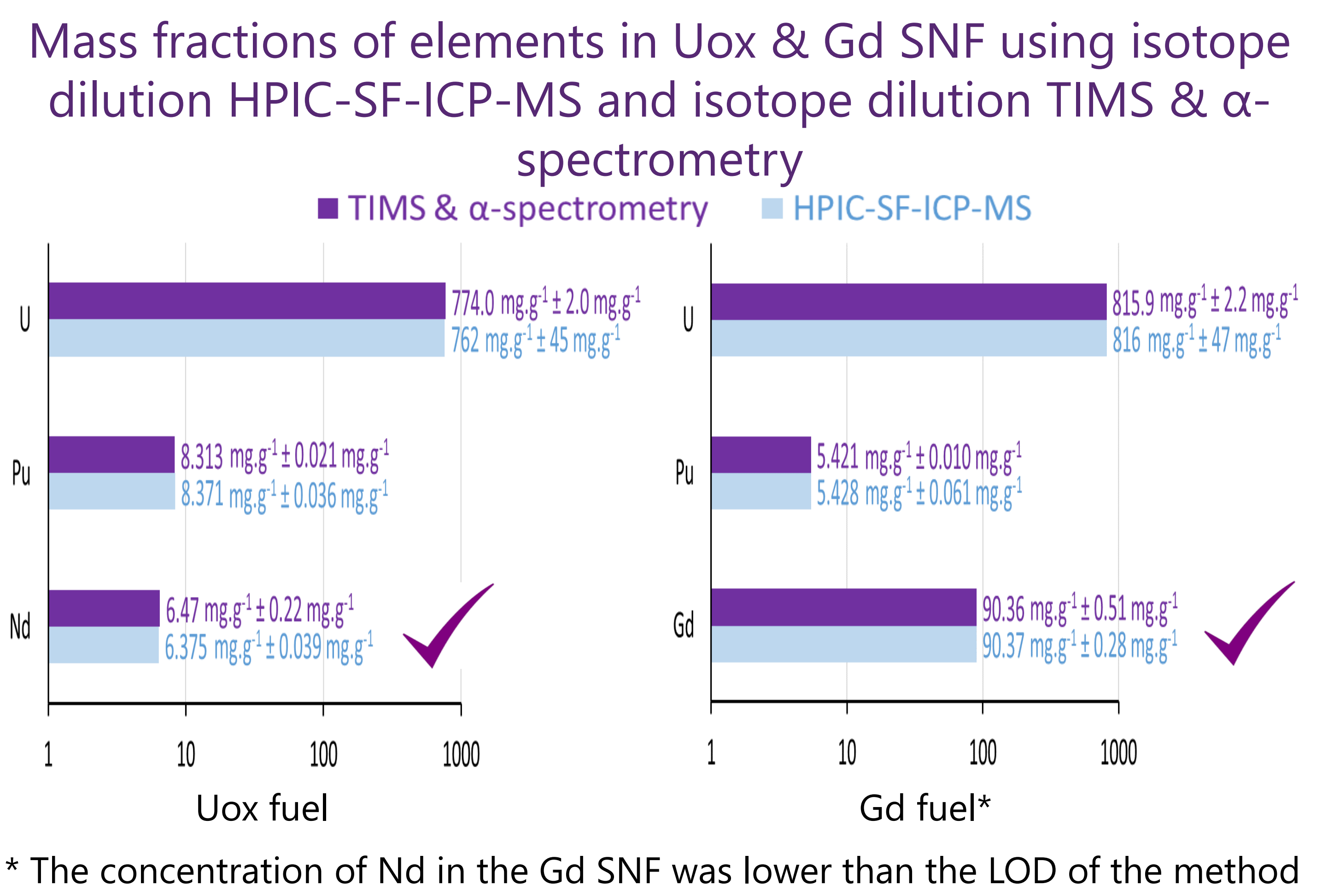
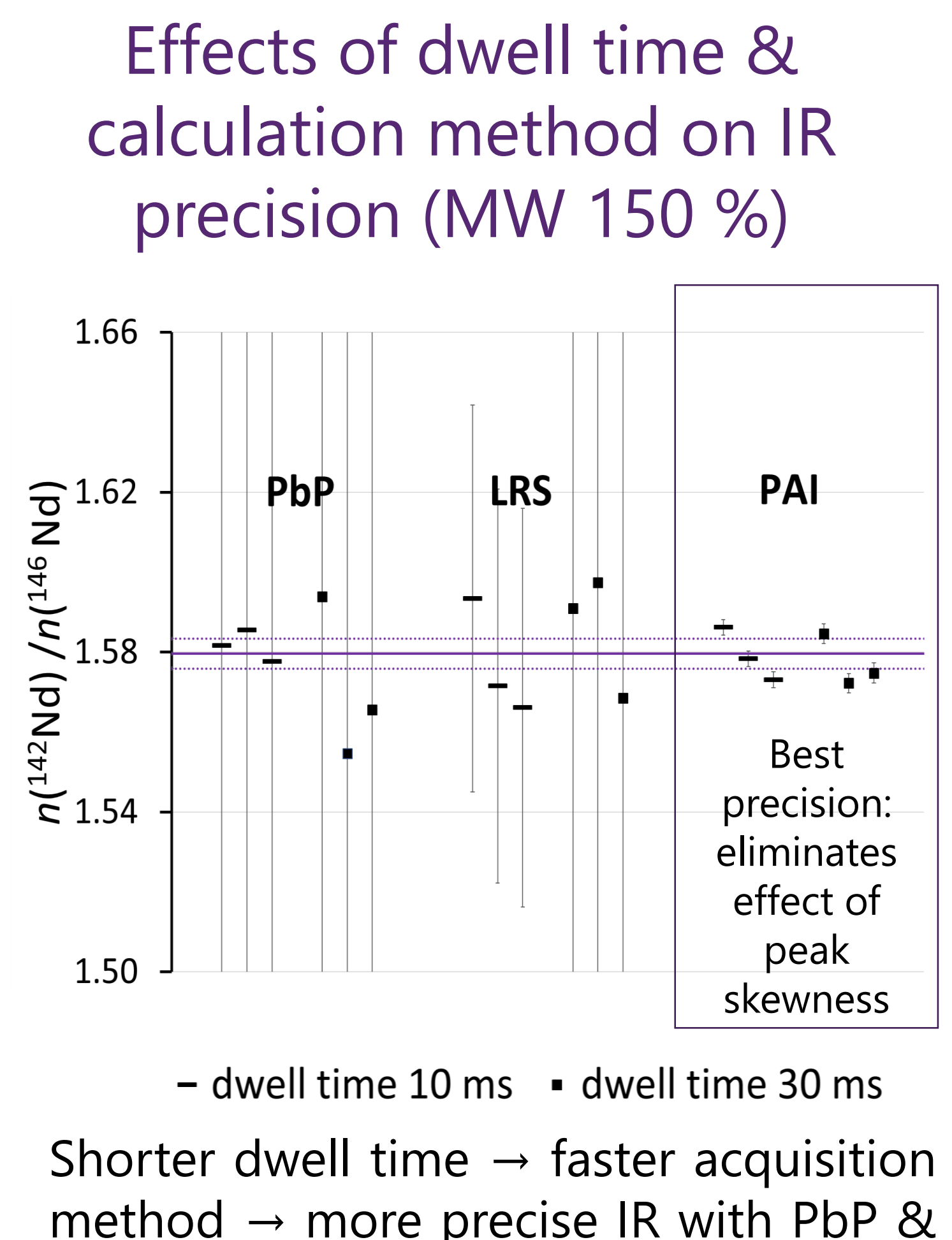
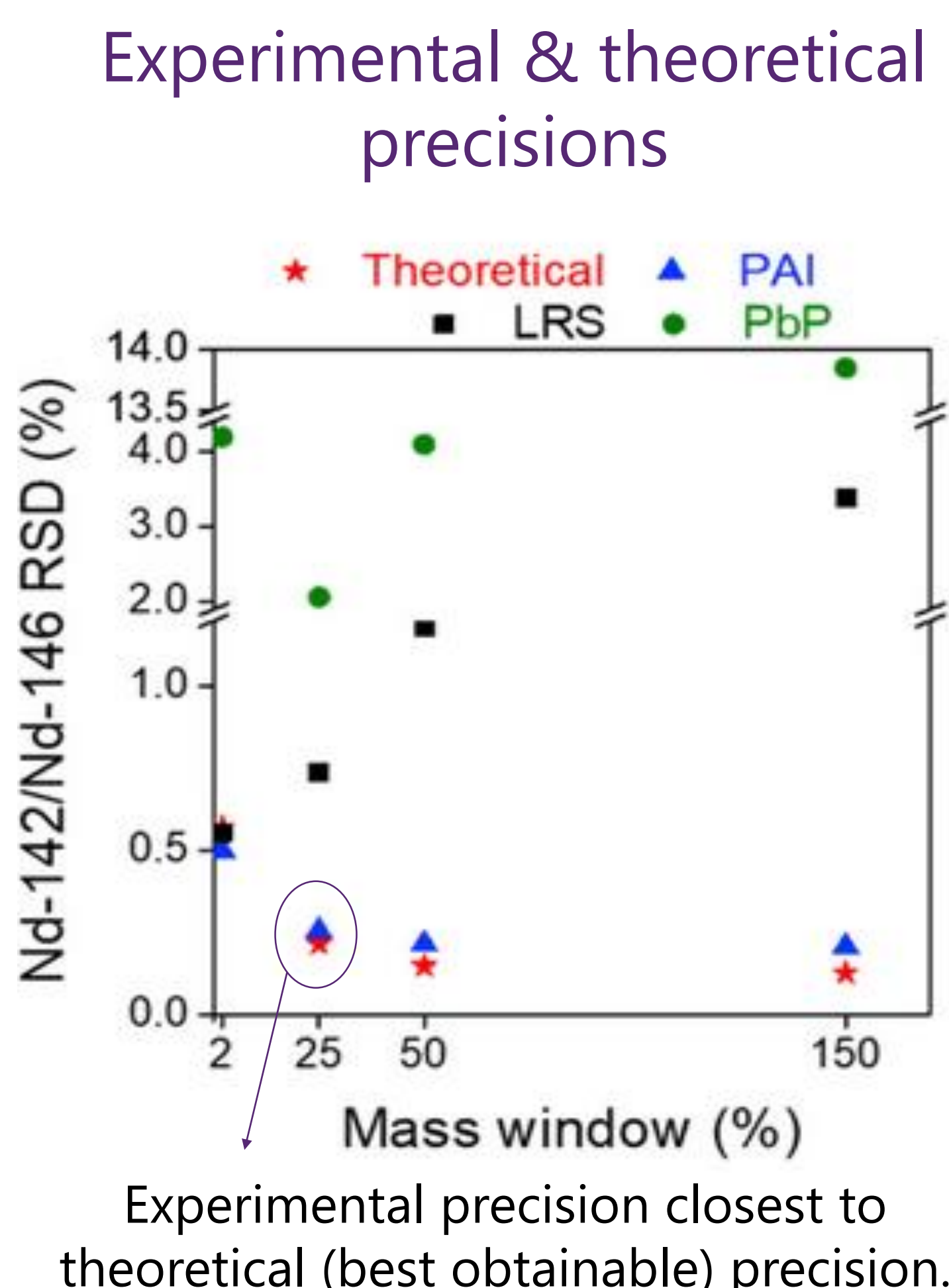
## Objectives

1. Optimize acquisition parameters of the SF-ICP-MS and select a calculation method [**point-by-point (PbP)**, **linear slope regression (LSR)** or **peak area integration (PAI)**] to obtain the most precise IR.
2. Characterize two types of SNF (Uox and Gd fuel) using isotope dilution HPIC-SF-ICP-MS.
3. Determine the overall uncertainty budget of isotope dilution HPIC-SF-ICP-MS to compare it to that of ISO 17025 accredited isotope dilution TIMS &  $\alpha$ -spectrometry.

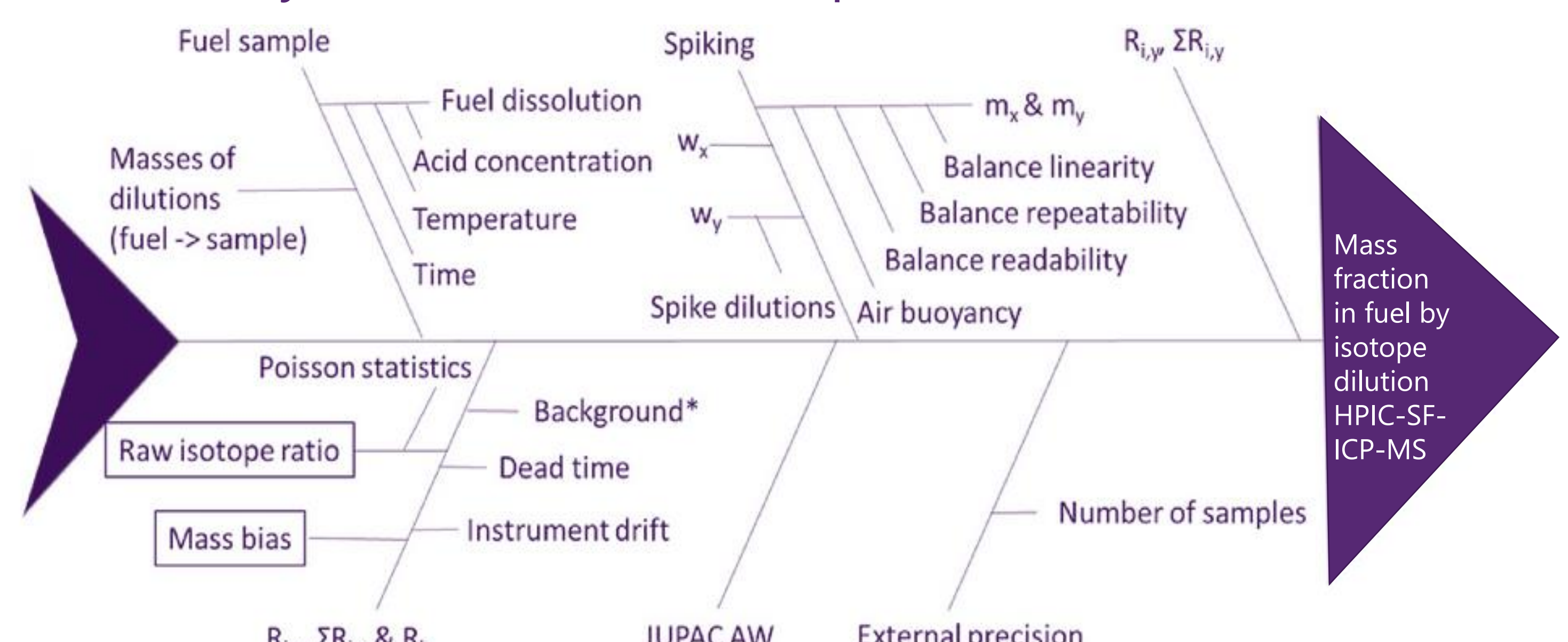
## Materials & methods



## Results



## Uncertainty contributors in isotope dilution HPIC-SF-ICP-MS



\* Background refers to instrumental background as well as signal measured in the blank and has a major effect at concentrations close to LOD.

## Conclusions

- The acquisition parameters of SF-ICP-MS have been optimized to yield IR measurements with the best precision.
- Isotope dilution HPIC-SF-ICP-MS offers accurate Pu, U, Nd and Gd determination in 2 types of SNF compared to isotope dilution TIMS &  $\alpha$ -spectrometry.

## Reference

N. N. Wanna, A. Dobney, K. Van Hoecke, M. Vasile, F. Vanhaecke, Quantification of U, Pu, Nd & Gd for the characterization of spent nuclear fuel using isotope dilution HPIC-SF-ICP-MS, Talanta, DOI: 10.1016/j.talanta.2020.121592

