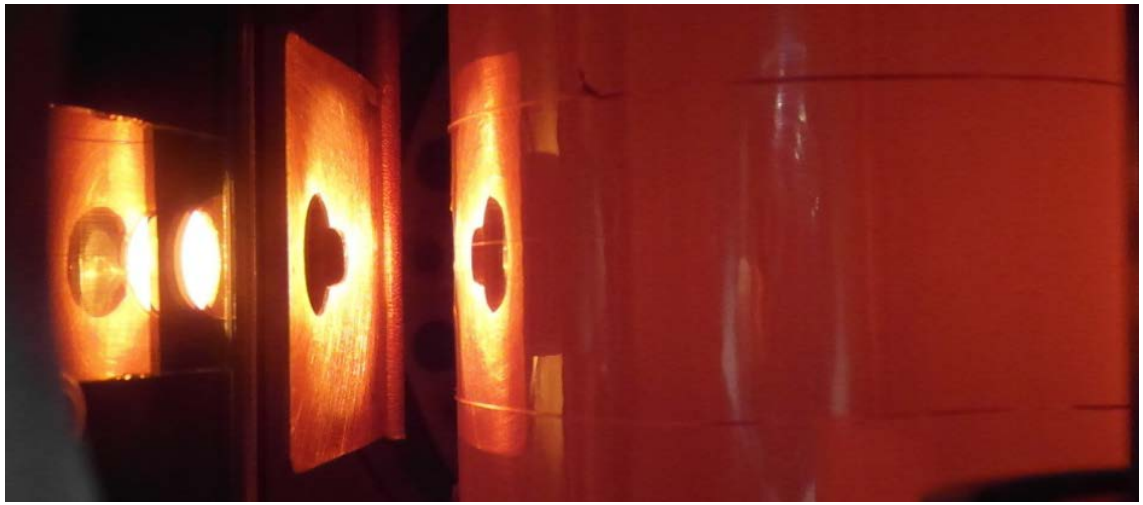
P. Steinegger, Joint Institute for Nuclear Research, Flerov Laboratory of Nuclear Reactions, Dubna, Russian Federation

High-Temperature α-Spectroscopy with Diamond Sensors

5th ADAMAS Workshop | GSI | December 15 & 16, 2016

Outline

- Introduction to SHE chemistry
- Isothermal Vacuum Chromatography
- Heating Diamond Sensors
- Plans
- Conclusion & Acknowledgements

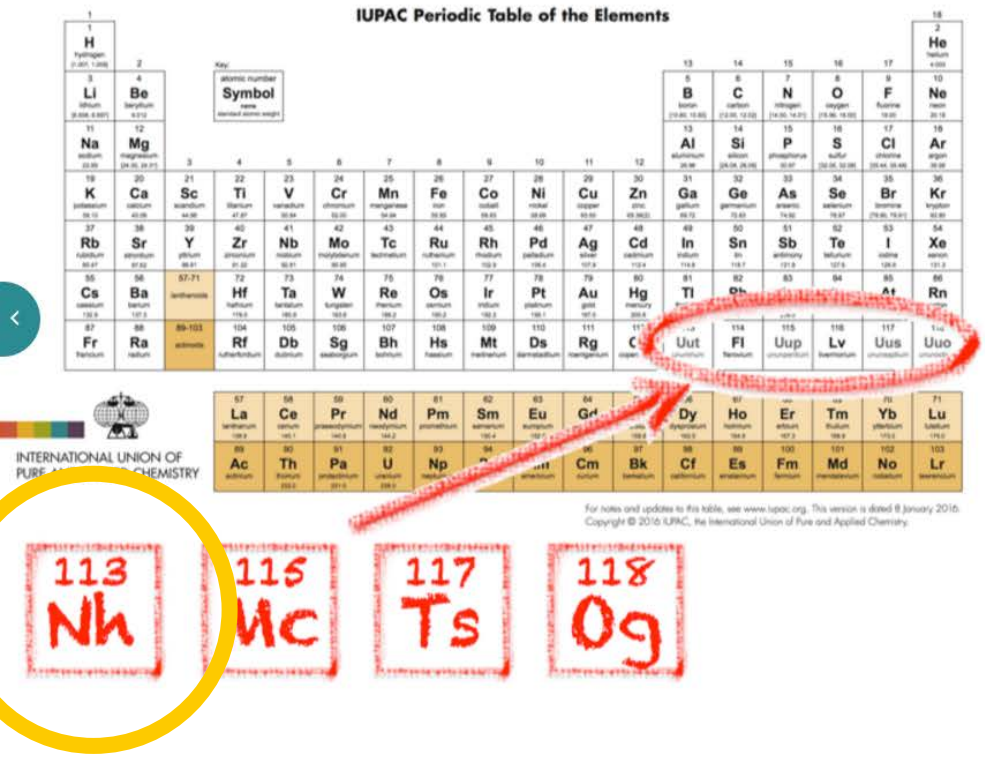


Some News: 7th Period complete

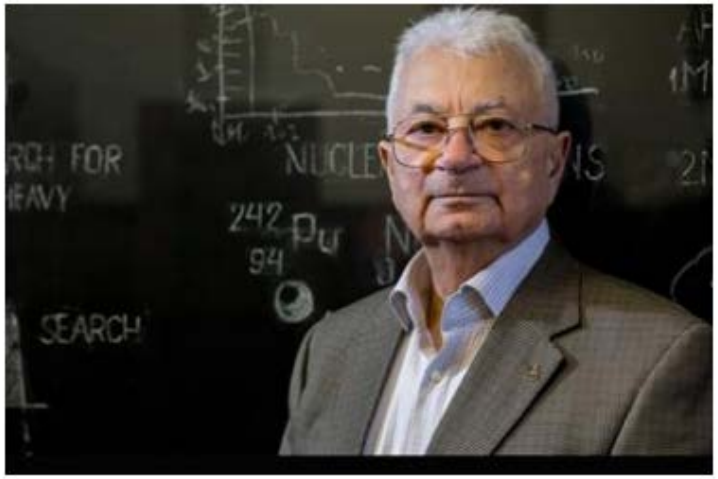
IUPAC INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

CONTACT JOIN LOGIN

WHO WE ARE | WHAT WE DO | EVENTS | PROJECTS | NEWS



CHEMISTRY WORLD



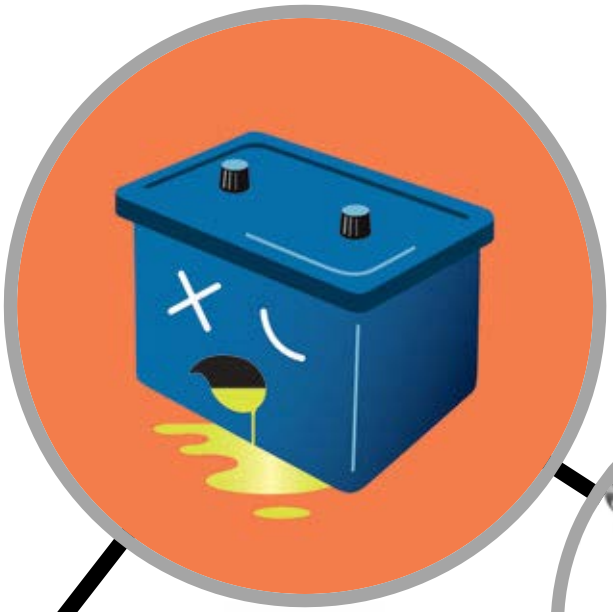
What it takes to make a new element

BY KIT CHAPMAN

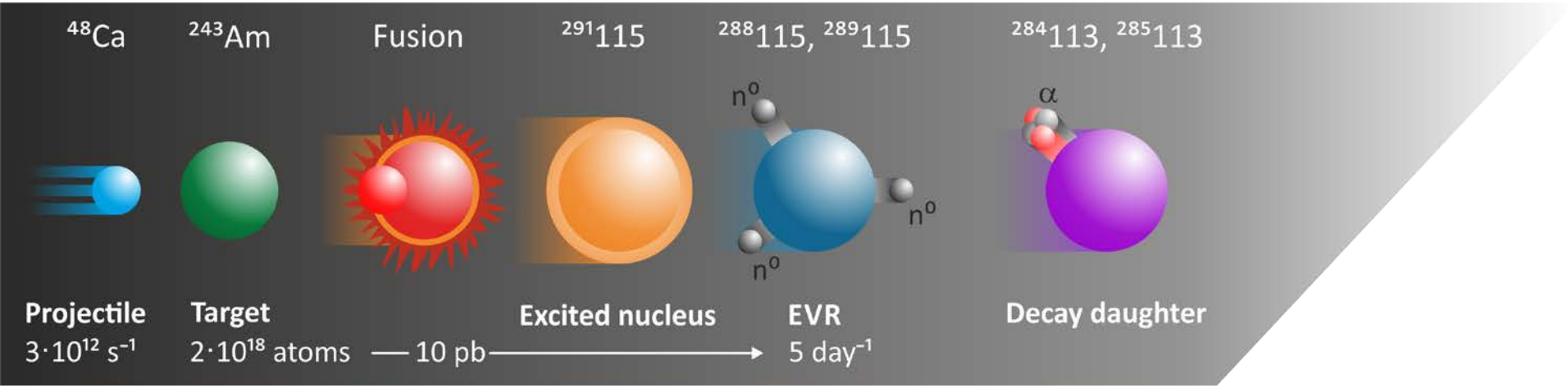
Yuri Oganessian tells us how nihonium, moscovium, tennessine and oganesson were made

https://iupac.org/ (PSE: https://iupac.org/what-we-do/periodic-table-of-elements/)

Introduction: Relativistic Effects

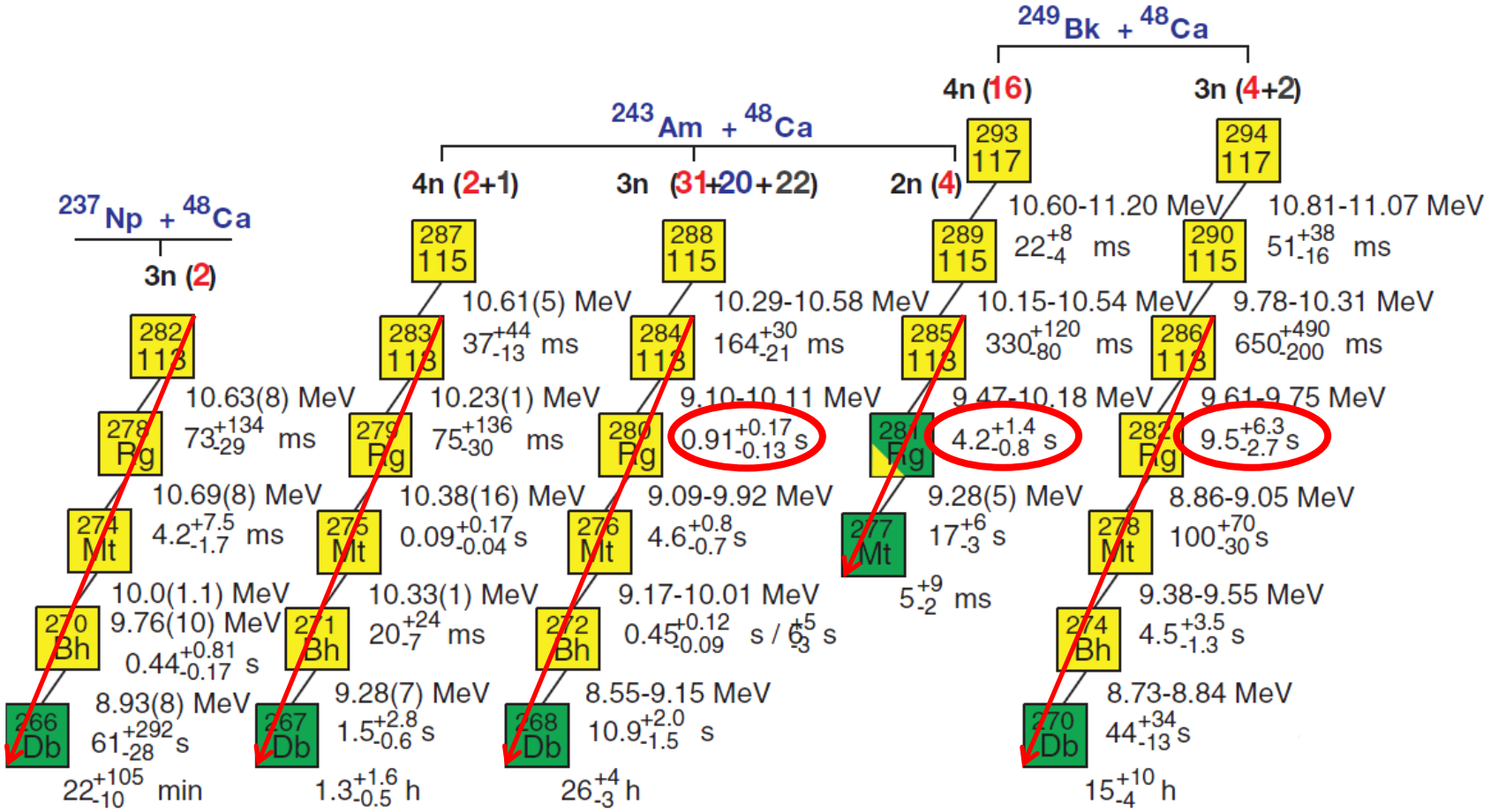


Introduction: Production

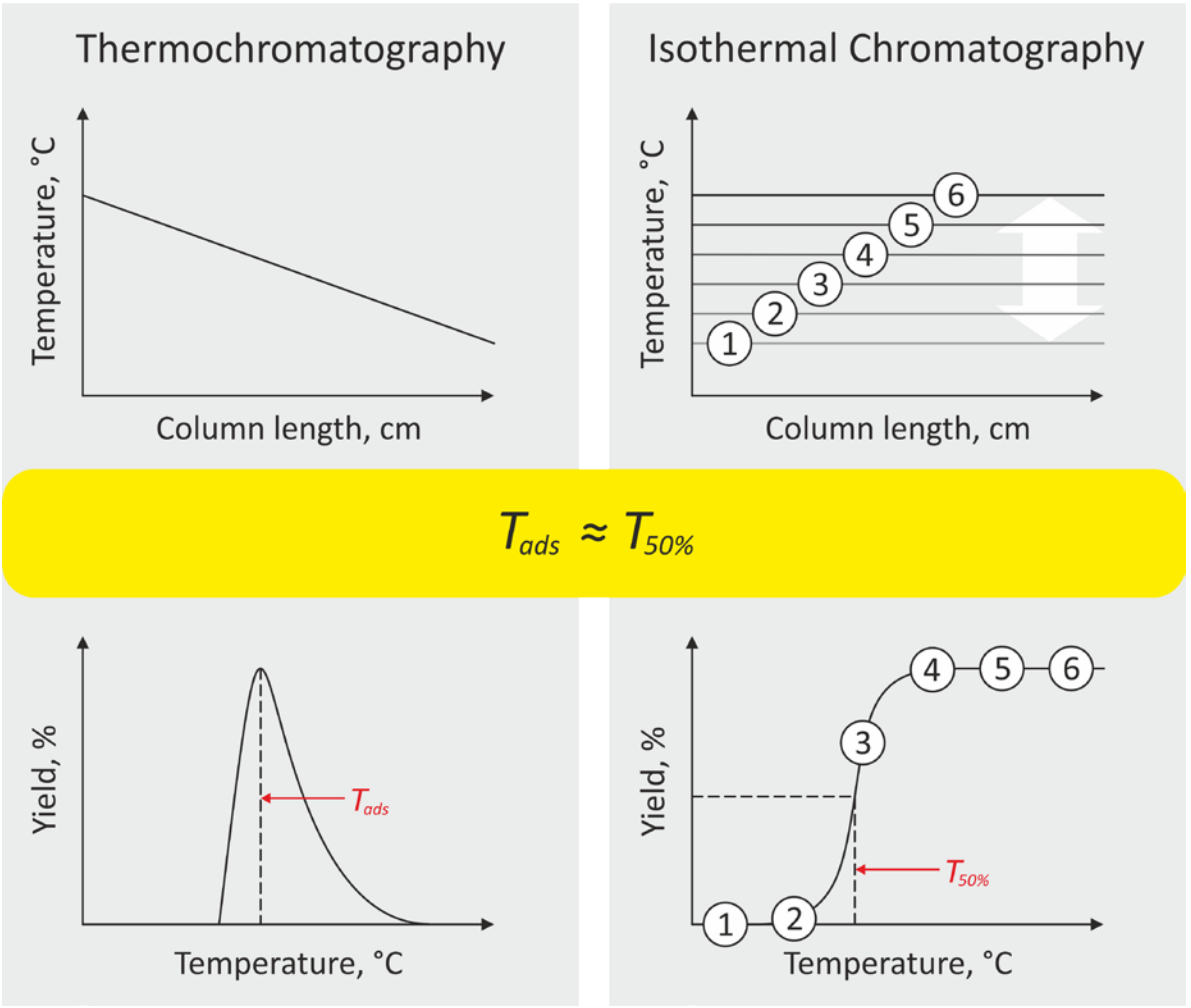


- Chemistry experiments with single atoms at a time (!)
- Fast and efficient approach is needed

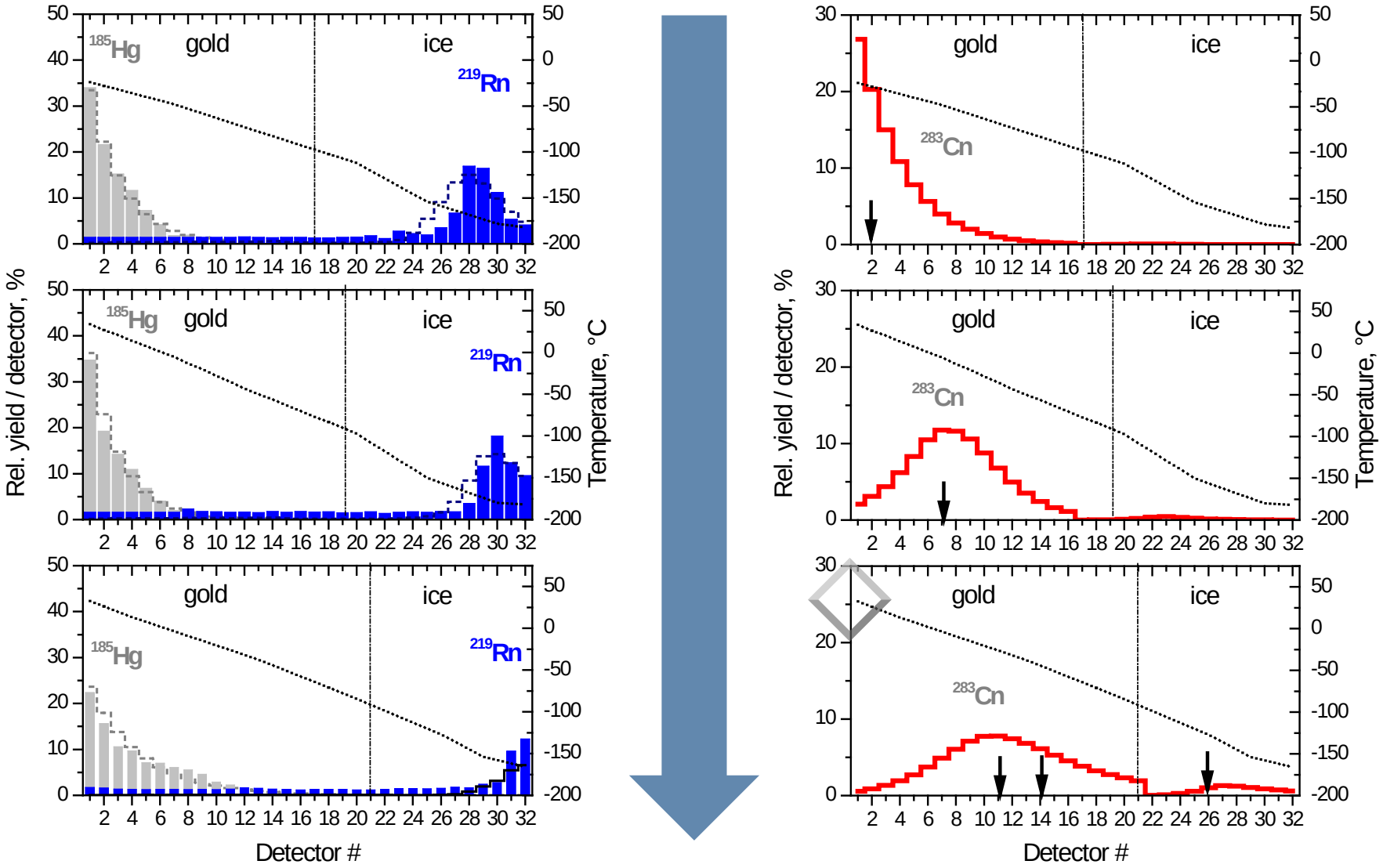
Introduction: Identification



Introduction: Techniques

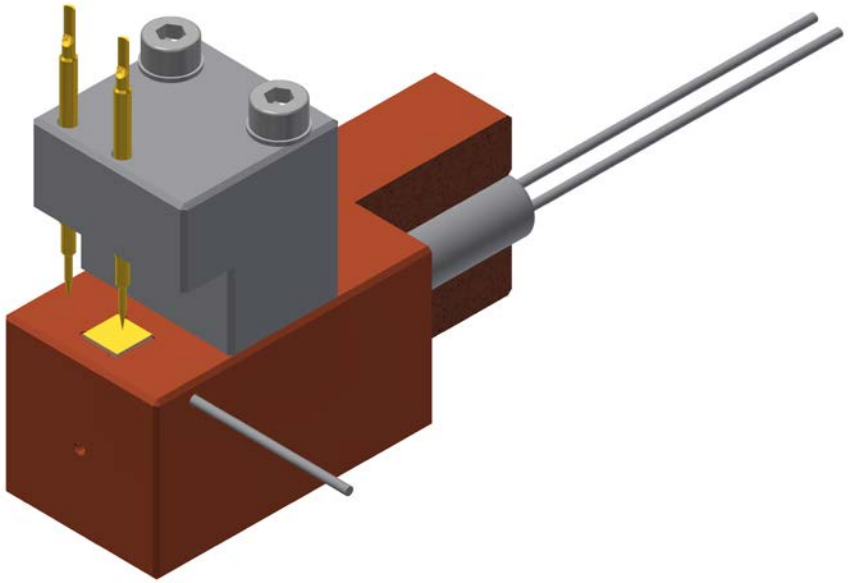


Introduction: Diamonds for COLD (PSI)

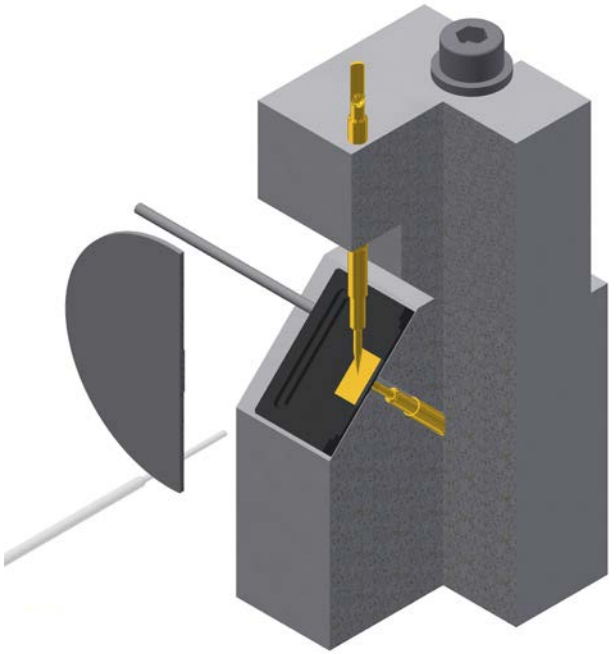


R. Eichler et al., *Nature* 447 (2007), pp. 72-75

Heating: Techniques



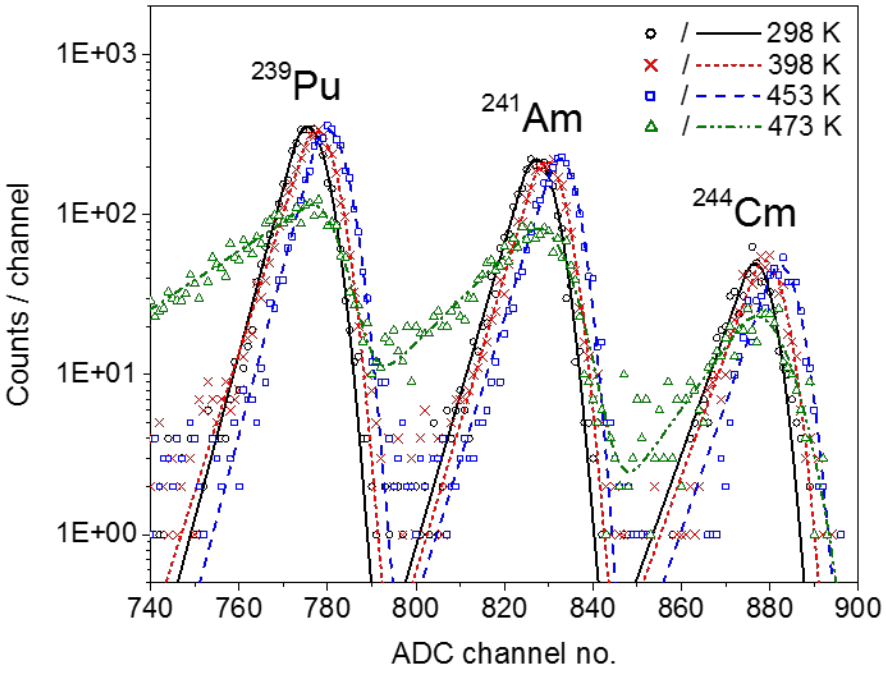
Joule heating (present)



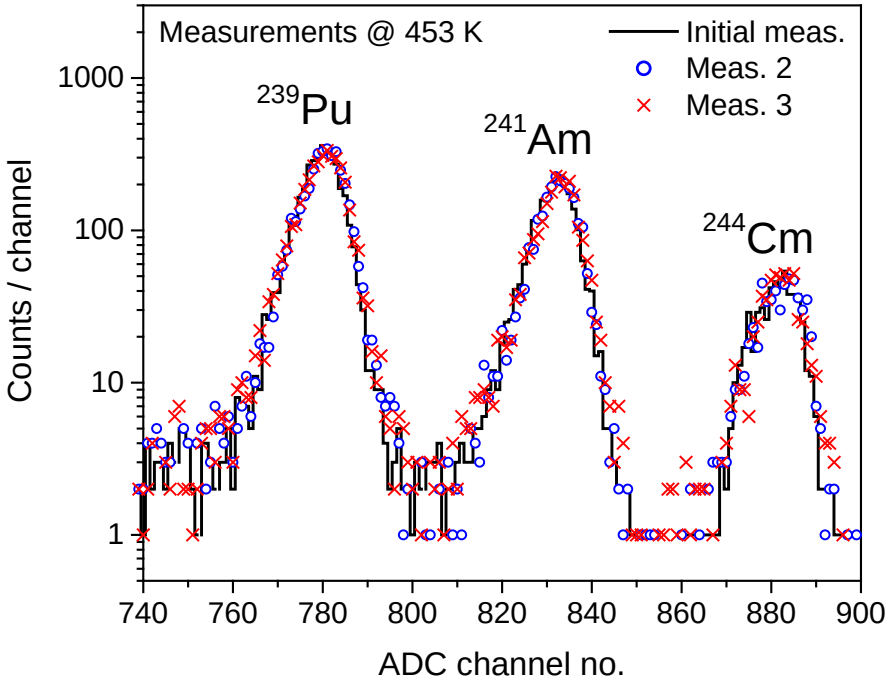
IR-laser heating (future)

P. Steinegger et al., *Nuclear Insturments and Methods A* (2016), http://dx.doi.org/10.2016/j.nima.2016.12.014

Heating: Results up to ≈473 K (≈ 200°C)

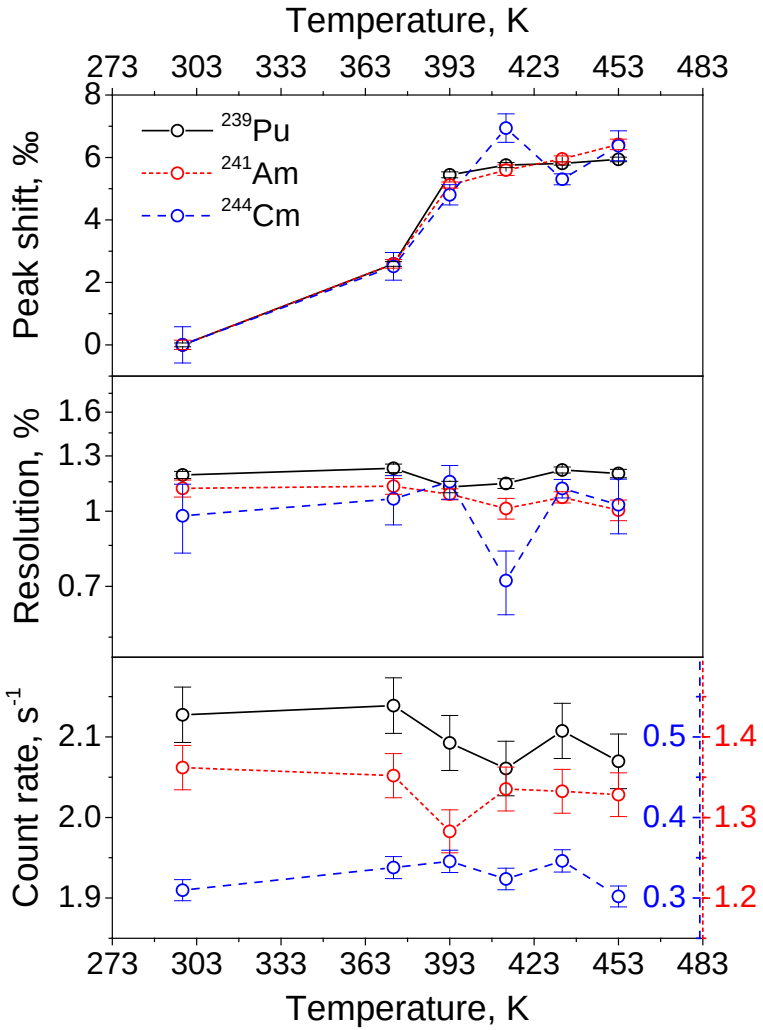


Temperature dependence:
RT (298 K) --> 473 K.



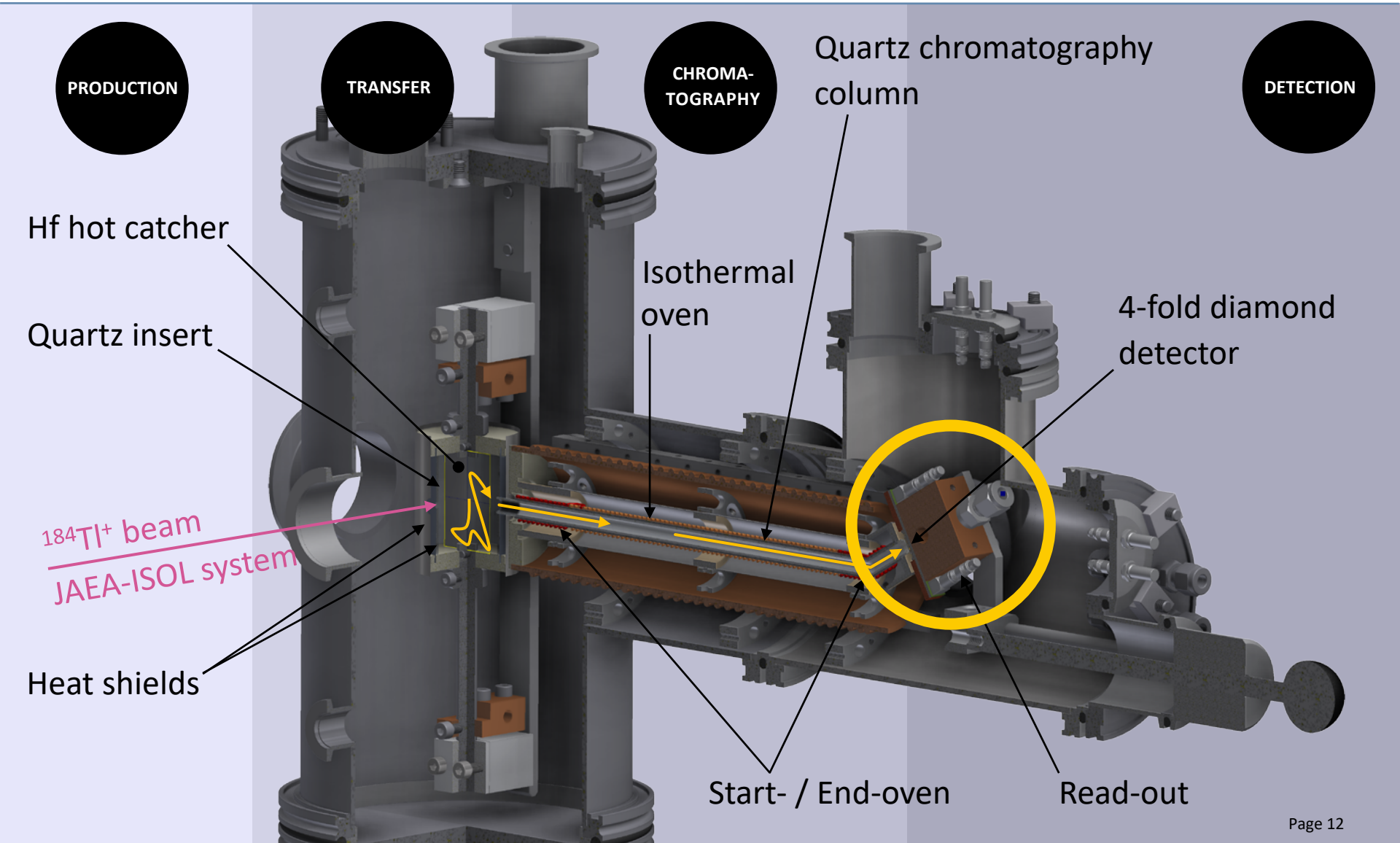
Long term stability @ 453 K

Heating: Results up to ≈473 K (≈ 200°C)

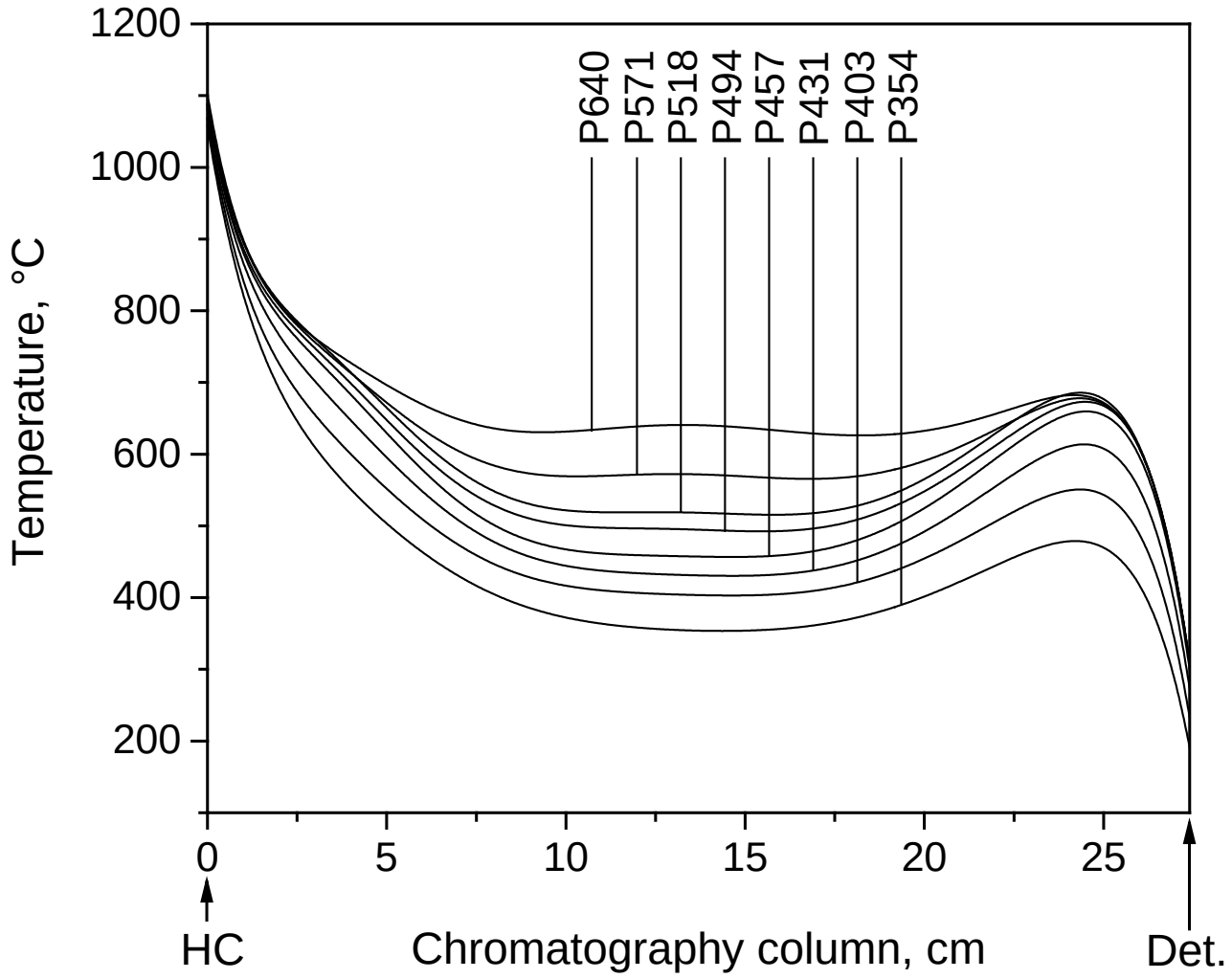


Summary of all spectroscopic parameters.

Vacuum Chromatography: Setup (PSI)

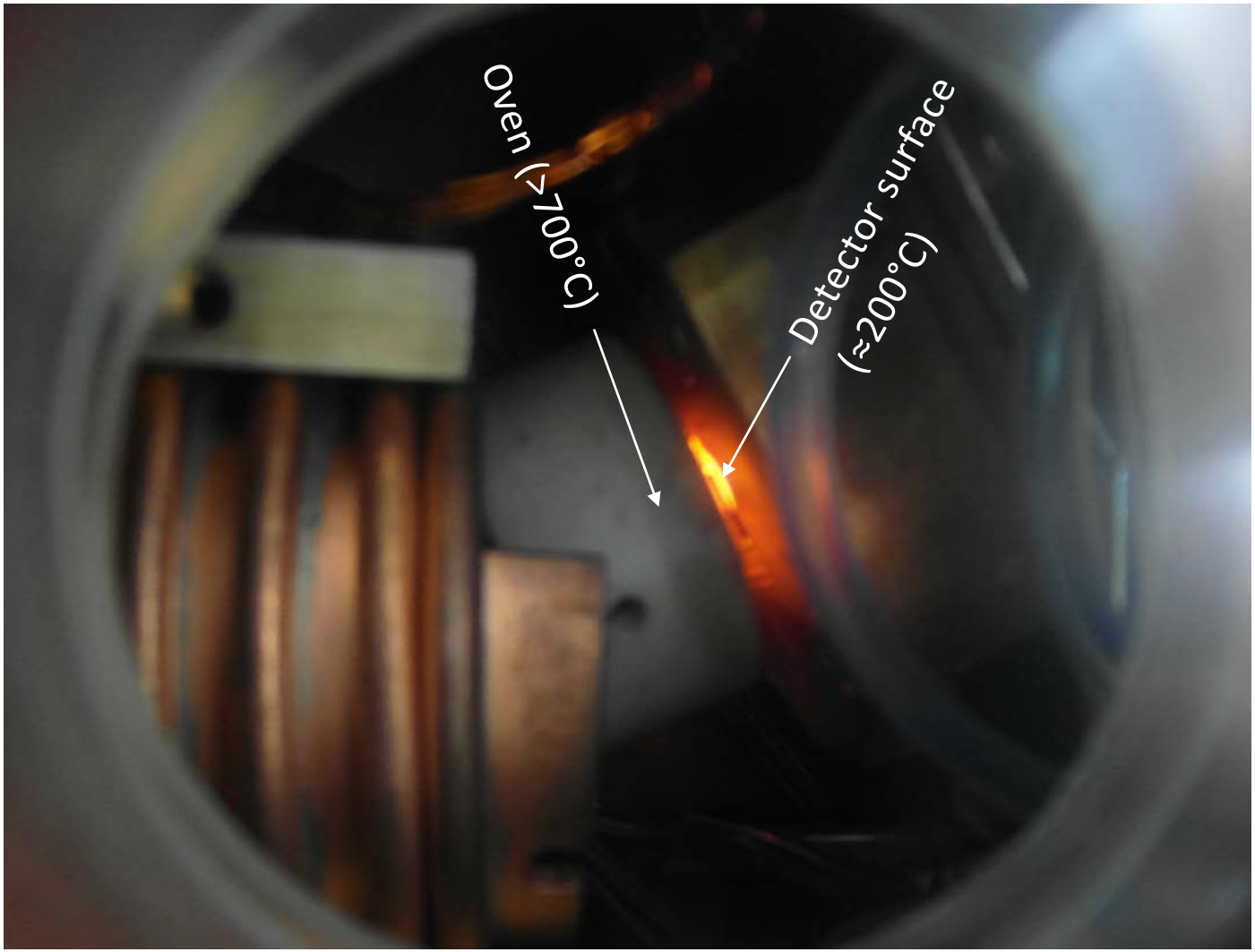


Vacuum Chromatography: T-Profiles

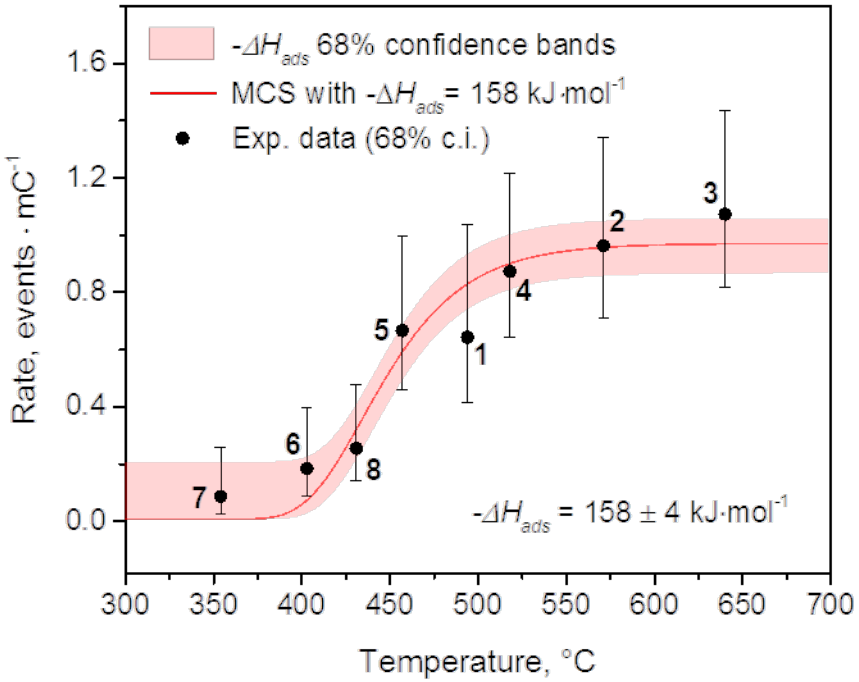


P. Steinegger et al., *Physical Chemistry C* 120 (2015), pp. 7122-7132

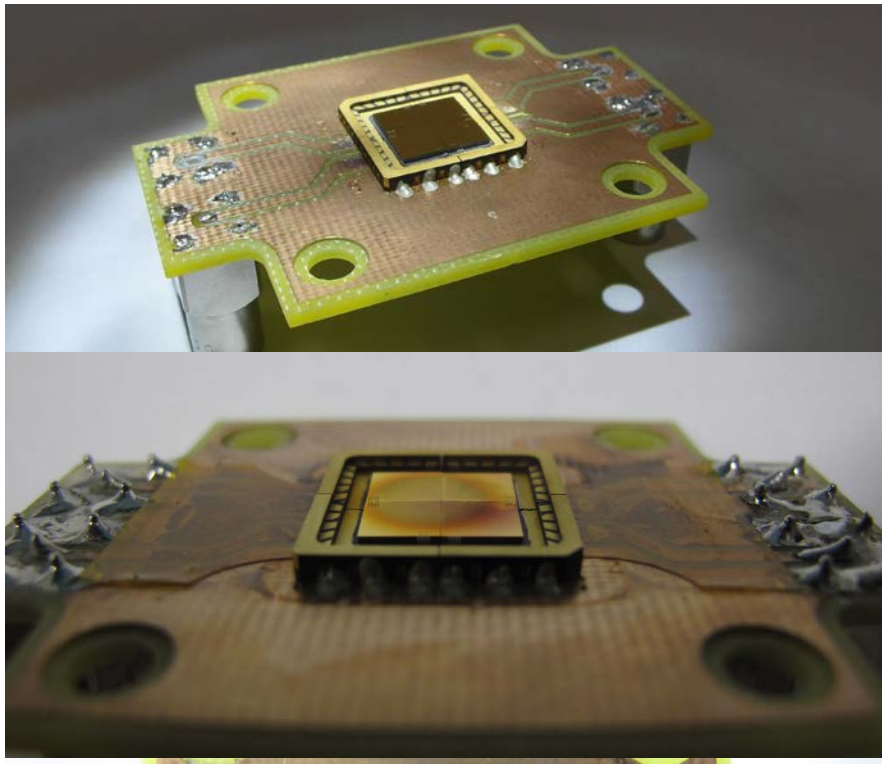
Vacuum Chromatography: Detector (PSI)

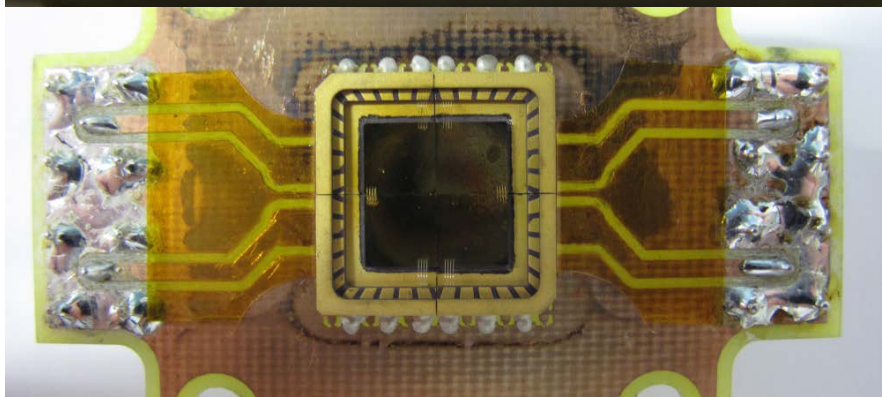


Vacuum Chromatography: Results (PSI)



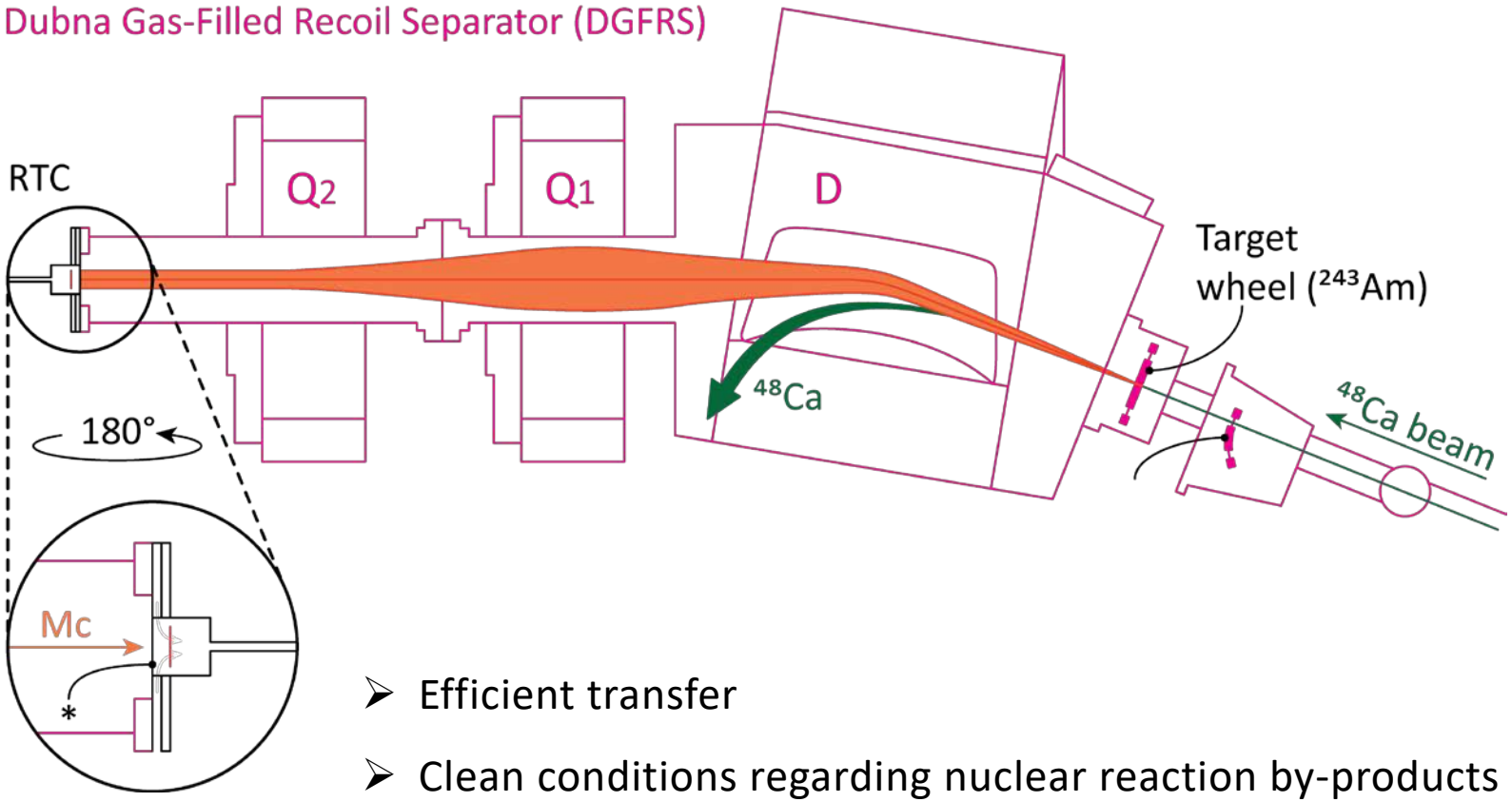
Monte Carlo simulations in combination with the exp. results allow to derive an adsorption enthalpy.





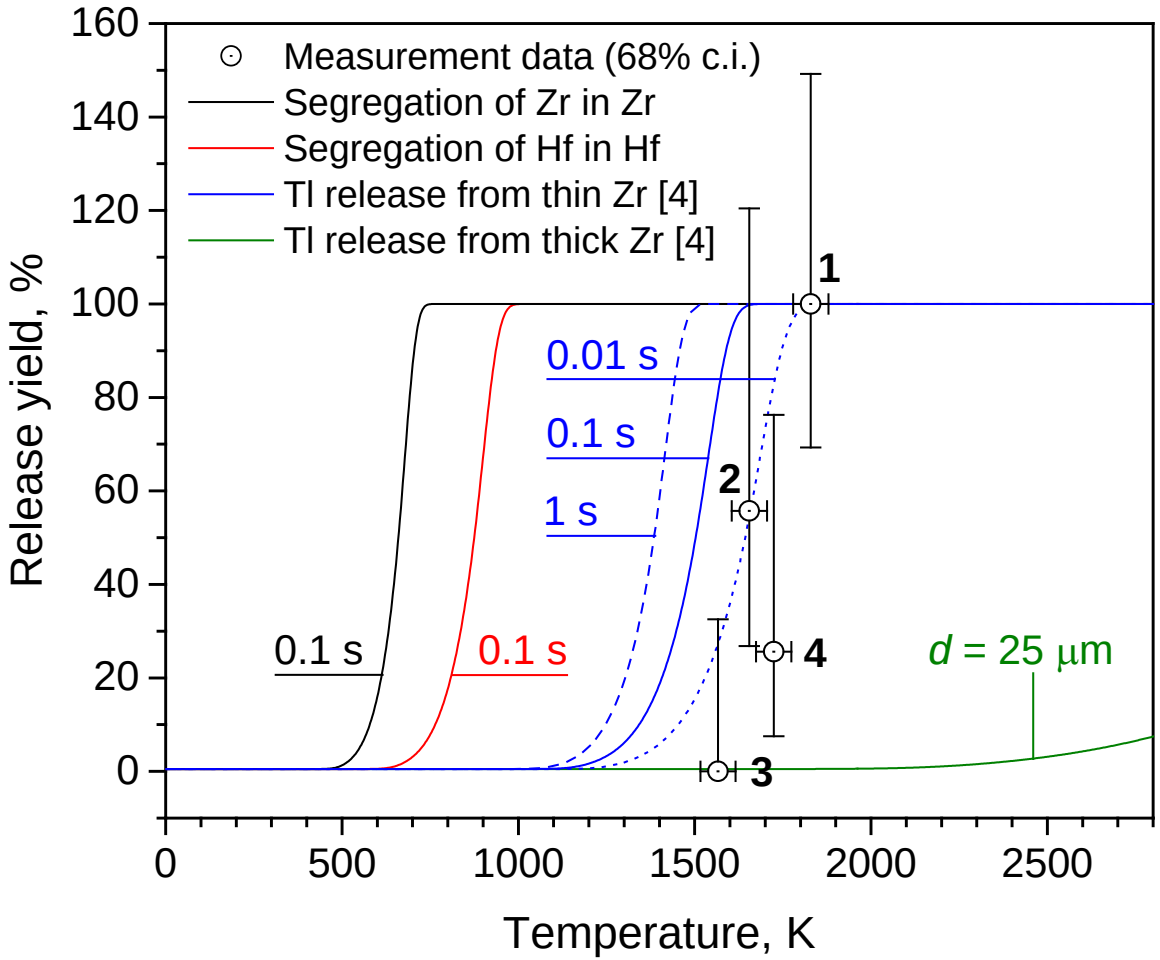
P. Steinegger et al., *Physical Chemistry C* 120 (2015), pp. 7122-7132

Vacuum Chromatography: Plans



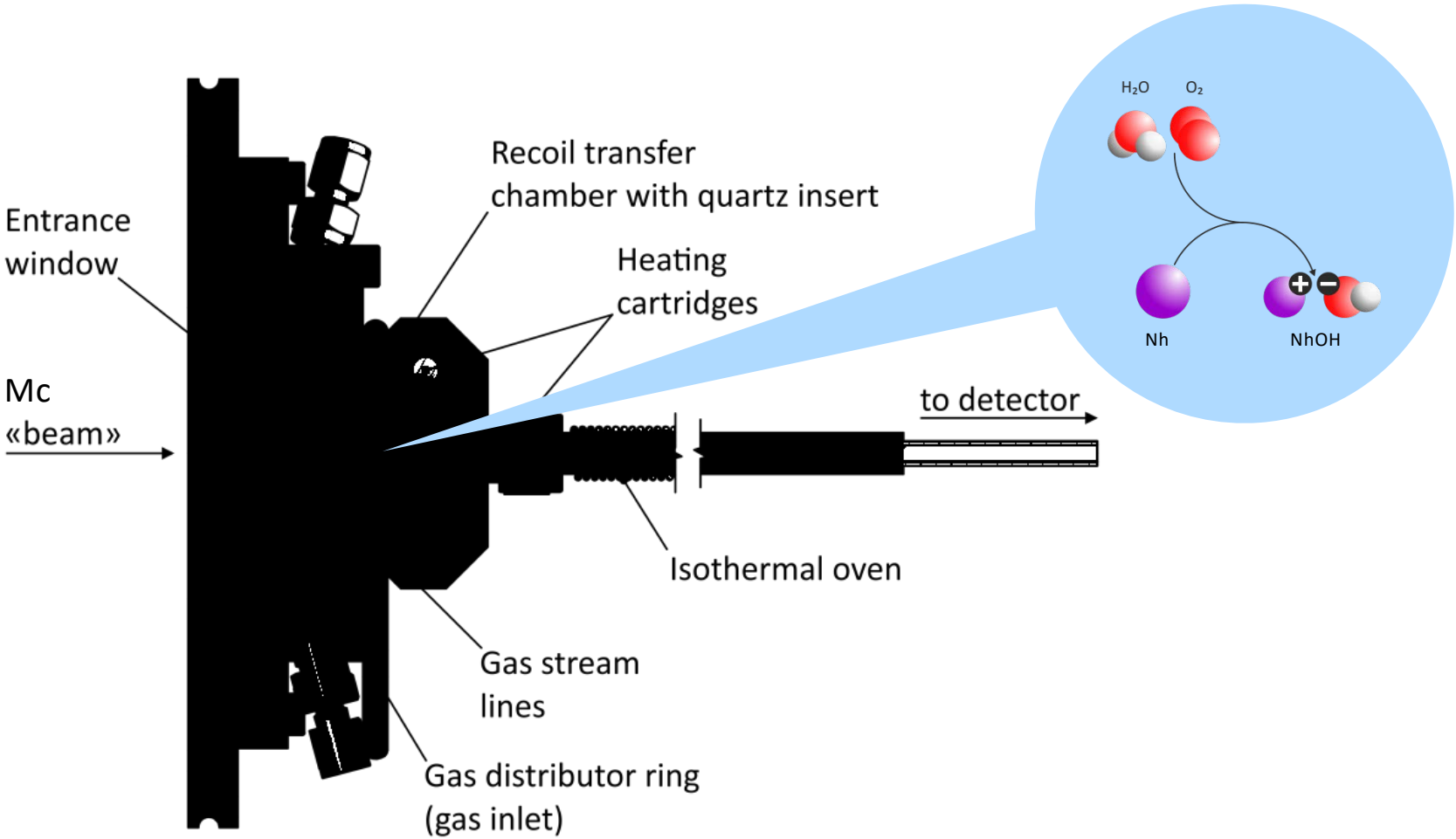
- Efficient transfer
- Clean conditions regarding nuclear reaction by-products

Plans: On-line Measurements of Release

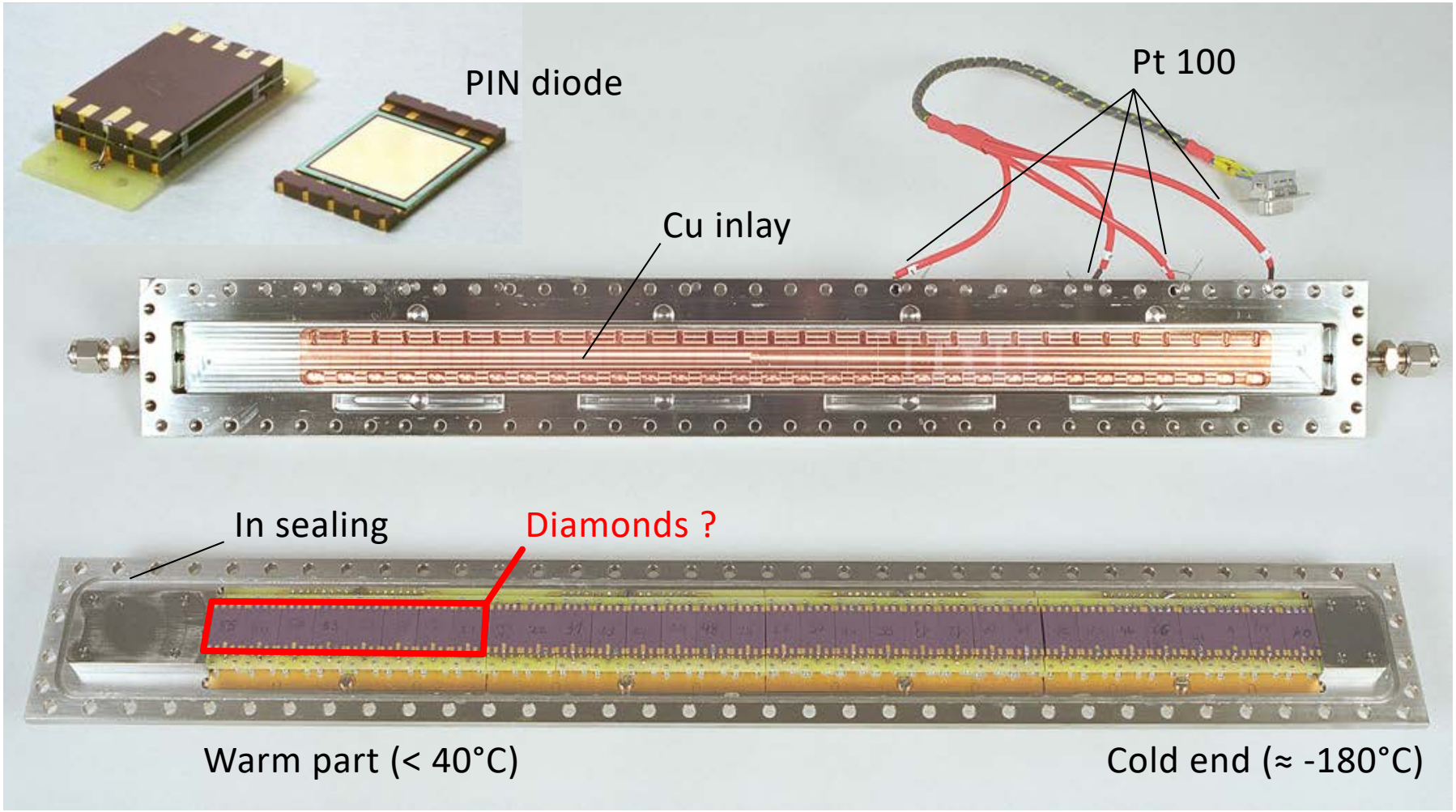


P. Steinegger et al., *LCH Annual Report 2015* (2016), pp. 5 (https://www.psi.ch/luc/annual-reports)

Plans: Chemistry with Nihonium



Plans: Diamonds for COLD (PSI)



Conclusion

- First chemistry experiments (adsoprtion of Tl on SiO_2) were successful.
- Satisfying and stable α-spectroscopic operation up to 453 K.
- Further heating studies are in preparation (IR-laser heating).
- Applications possiblities of sensors for the chemical charcterization of Superheavy Elements are manifold (e.g., NhOH).

Involved people, institutions and company

/// Akina Mitsukai, Alessio Vascon, Alex ///
/// Vögele, Andreas Türler, Atsushi Toyoshima, ///
/// Christina Weiss, Dave Piguet, Erich Gries- ///
/// mayer, Ilya Usoltsev, Kazuaki Tsukada, ///
/// Masato Asai, Matthias Schädel, Nadine M. ///
/// Chiera, Robert Eichler, Rugard Dressler, ///
/// Shinsaku Takeda, Silvan Streuli, Tetsuya ///
/// K. Sato, Yuichiro Nagame, Yusuke Kaneya ///

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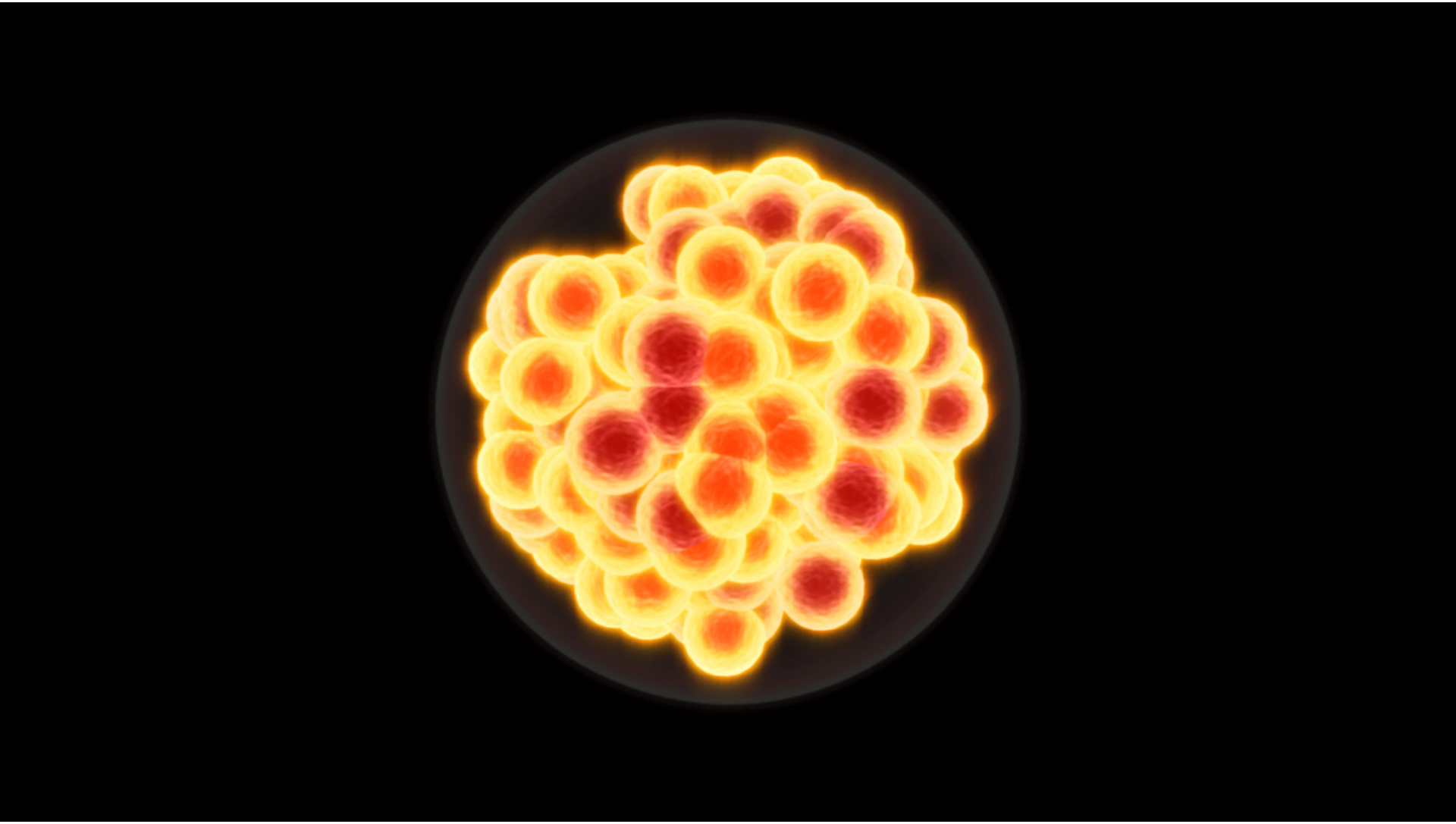
SCHWEIZERISCHER NATIONALFONDS
FONDO NAZIONALE SVIZZERO
SWISS NATIONAL SCIENCE FOUNDATION

cividec
Instrumentation

Thank you for your kind attention!



https://www.llnl.gov/news/lawrence-livermore-credited-discovery-elements-115-117-and-118