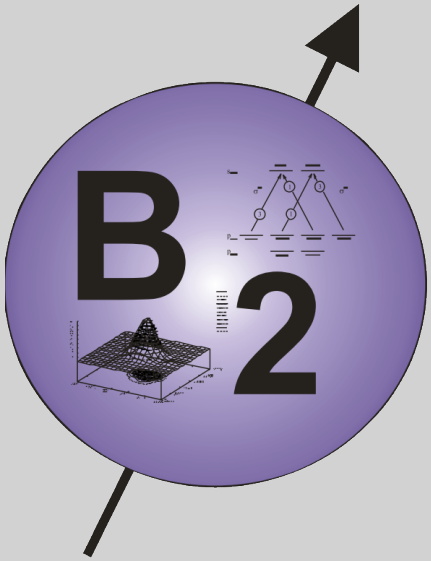


Status of precise measurements of electron-beam polarization changes during long term operation

Preparation of photocathodes with nitrogen trifluoride

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Jennifer Groth

Institut für Kernphysik

28th September 2022

PRISMA+

ACCELENCE

JG|U

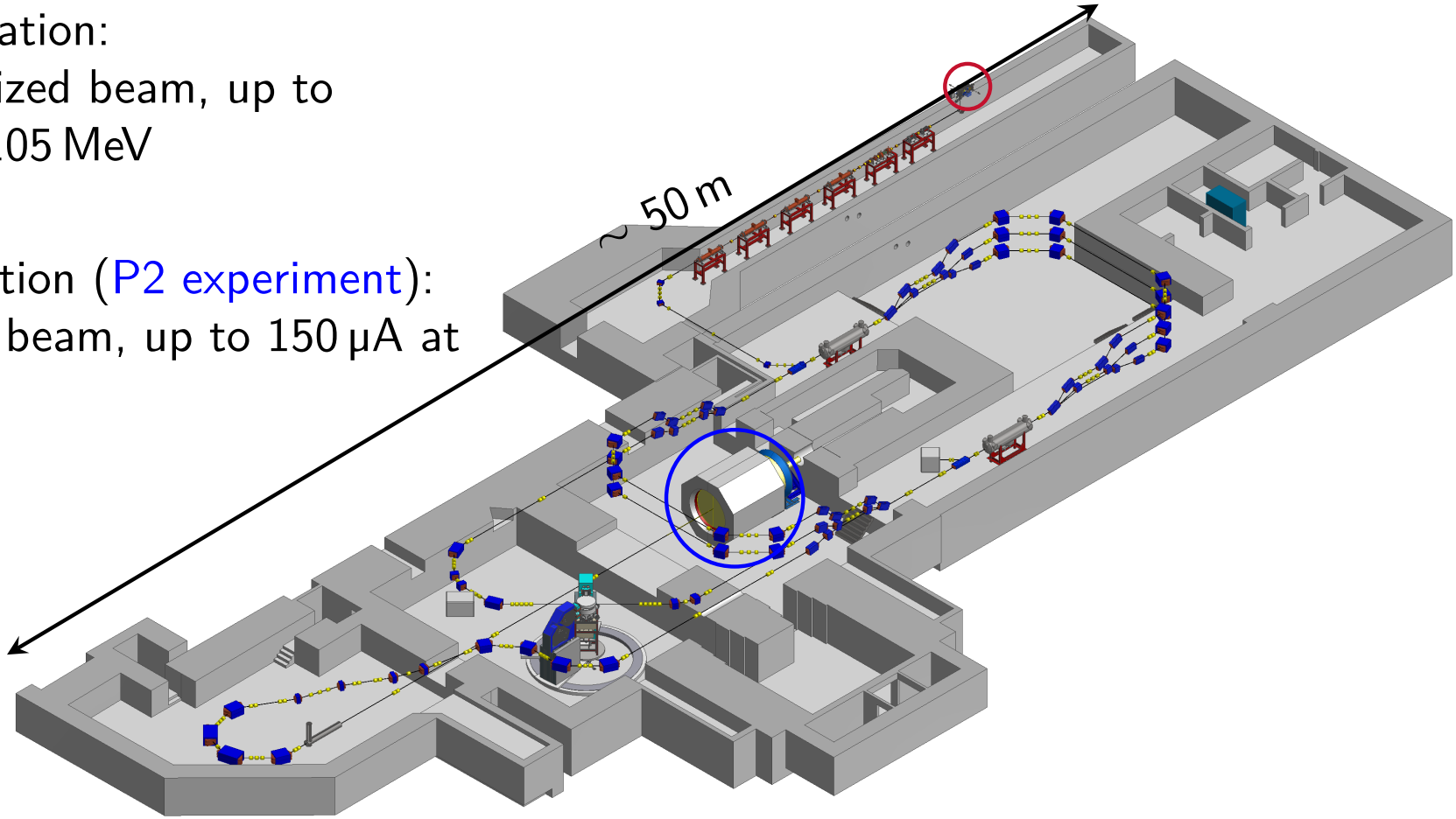
Outline

Based on a LaTeX template by S. Friederich

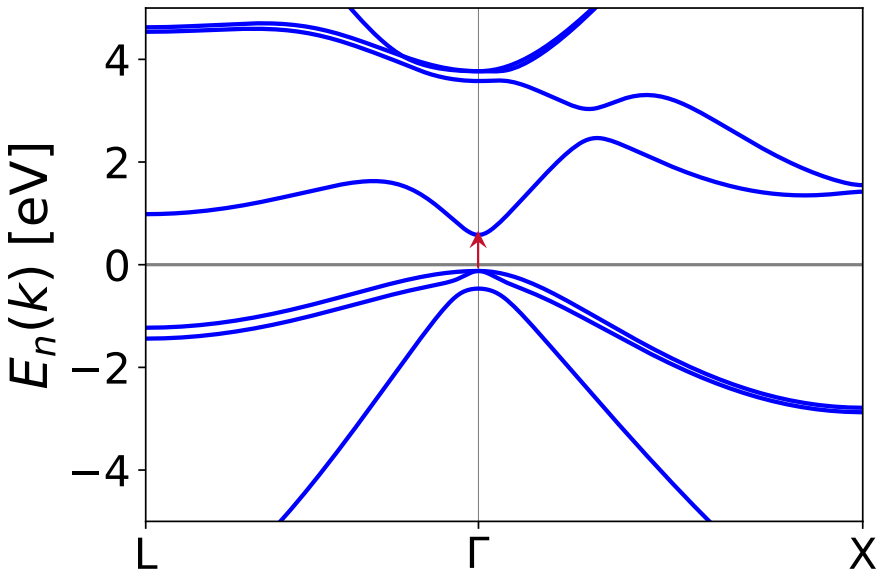
Mainz Energy-recovering Superconducting Accelerator (MESA)

ERL-operation:
(un)polarized beam, up to
1 mA at 105 MeV

EB-operation (P2 experiment):
polarized beam, up to 150 µA at
155 MeV



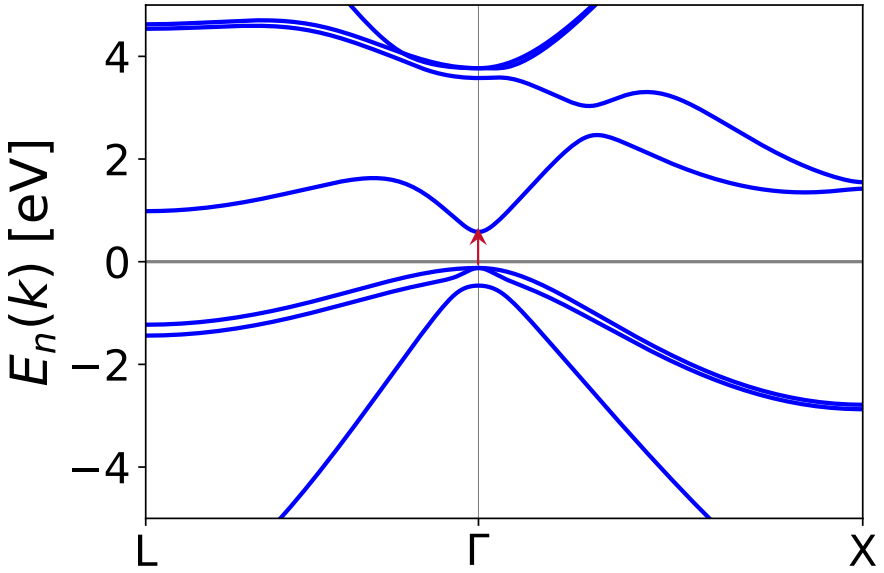
How to generate polarized electrons



Band structure

Band splitting in heavy and light hole band due to spin orbit coupling.

How to generate polarized electrons

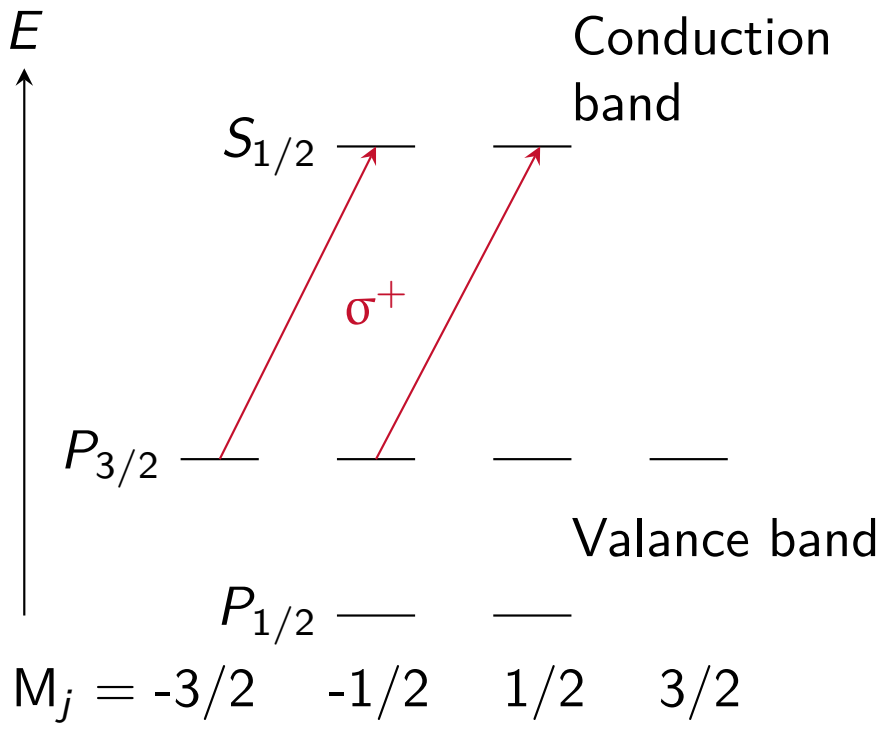


Band structure

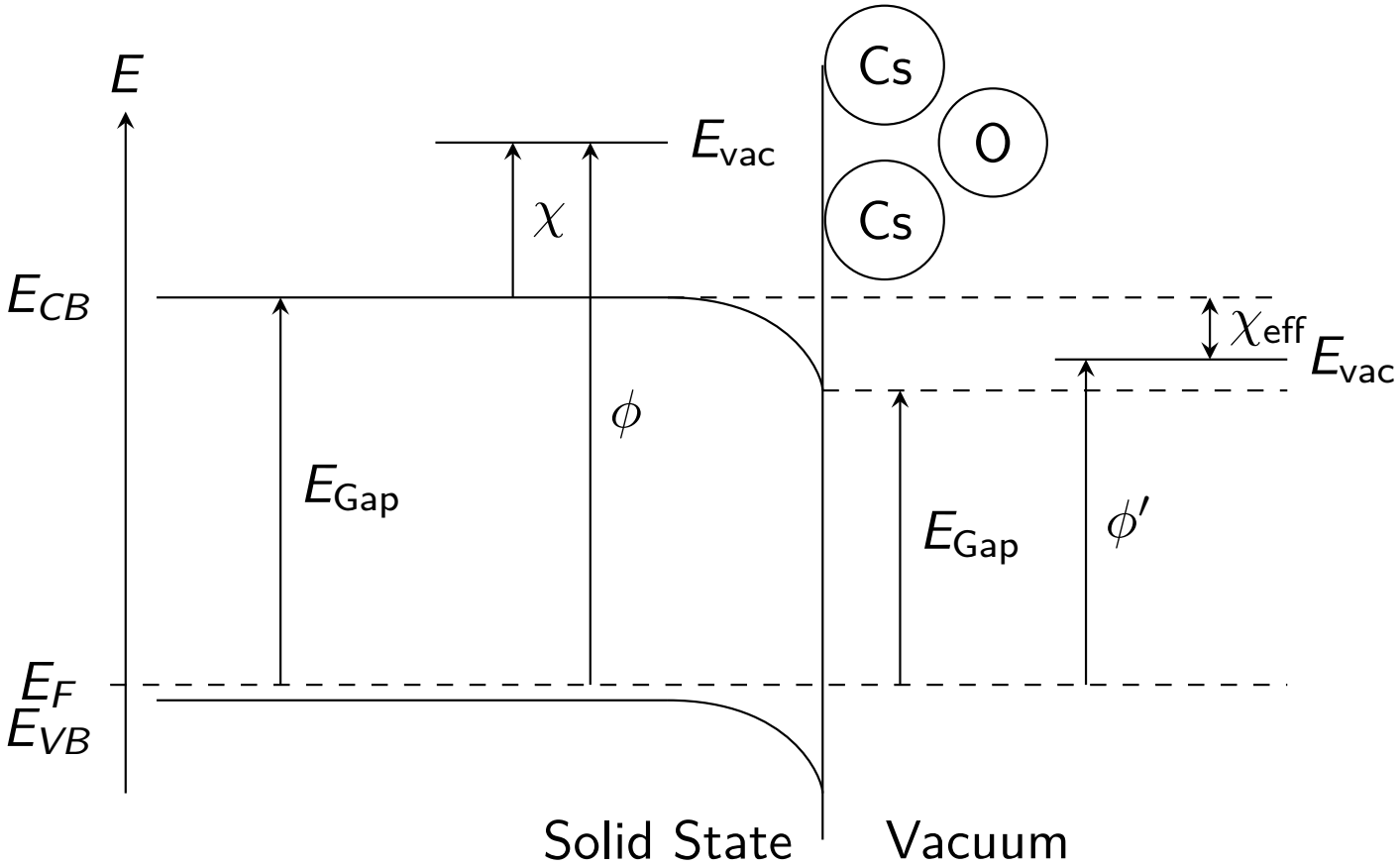
Band splitting in heavy and light hole band due to spin orbit coupling.

Molecular structure

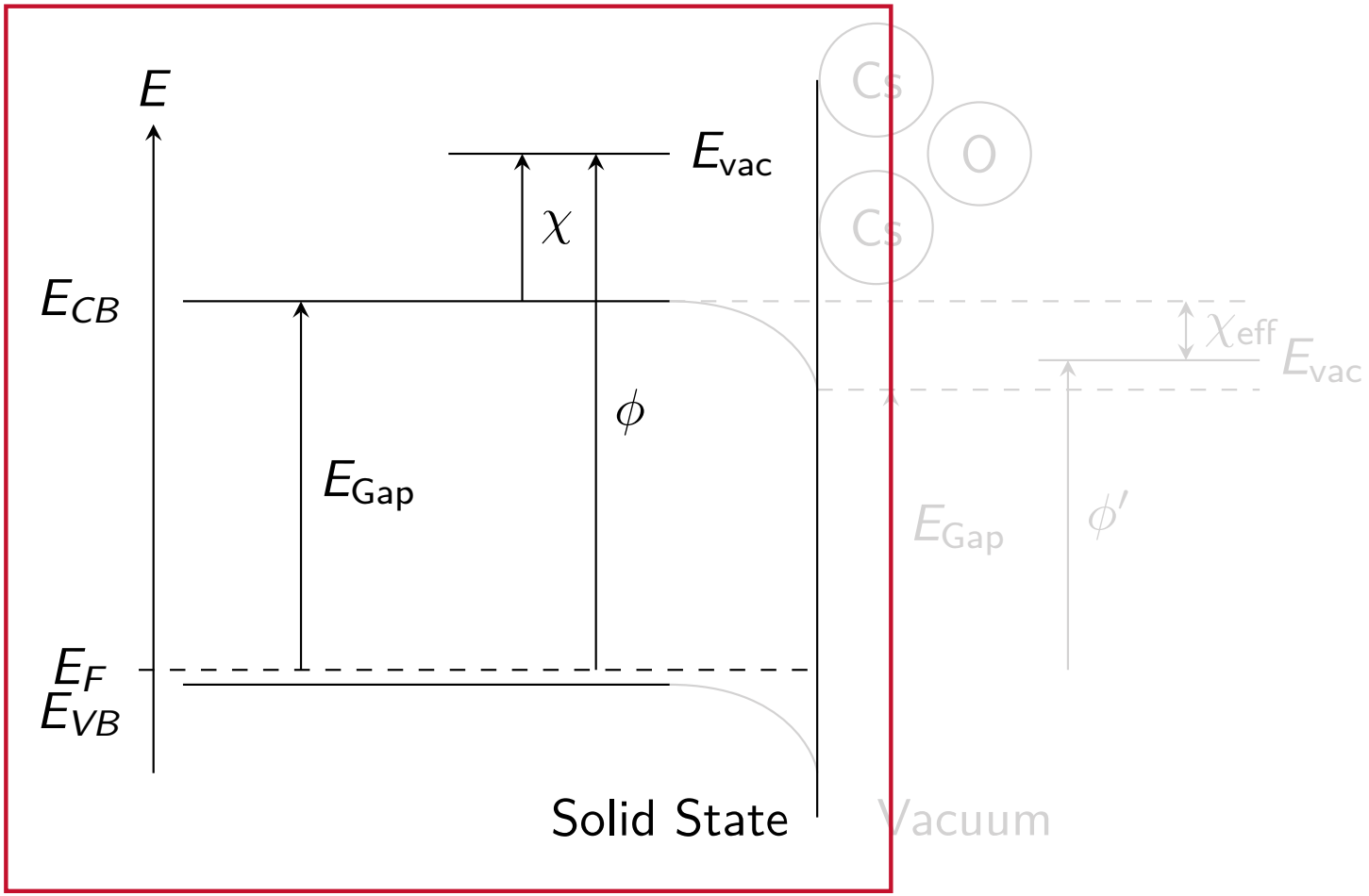
Momentum transfer from photon to electron enables polarized electron emission.



Negative electron affinity

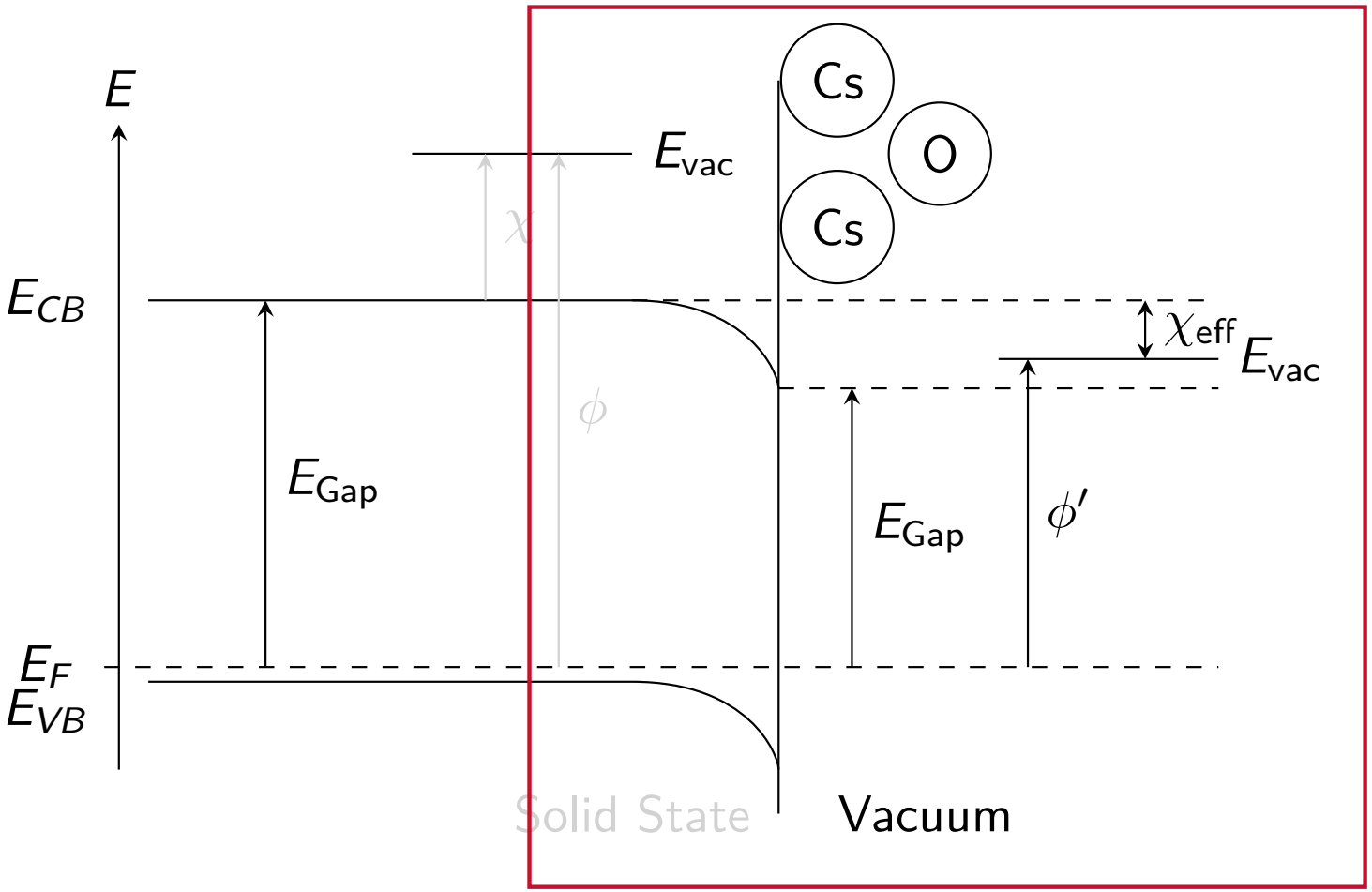


Negative electron affinity



Positive Electron Affinity

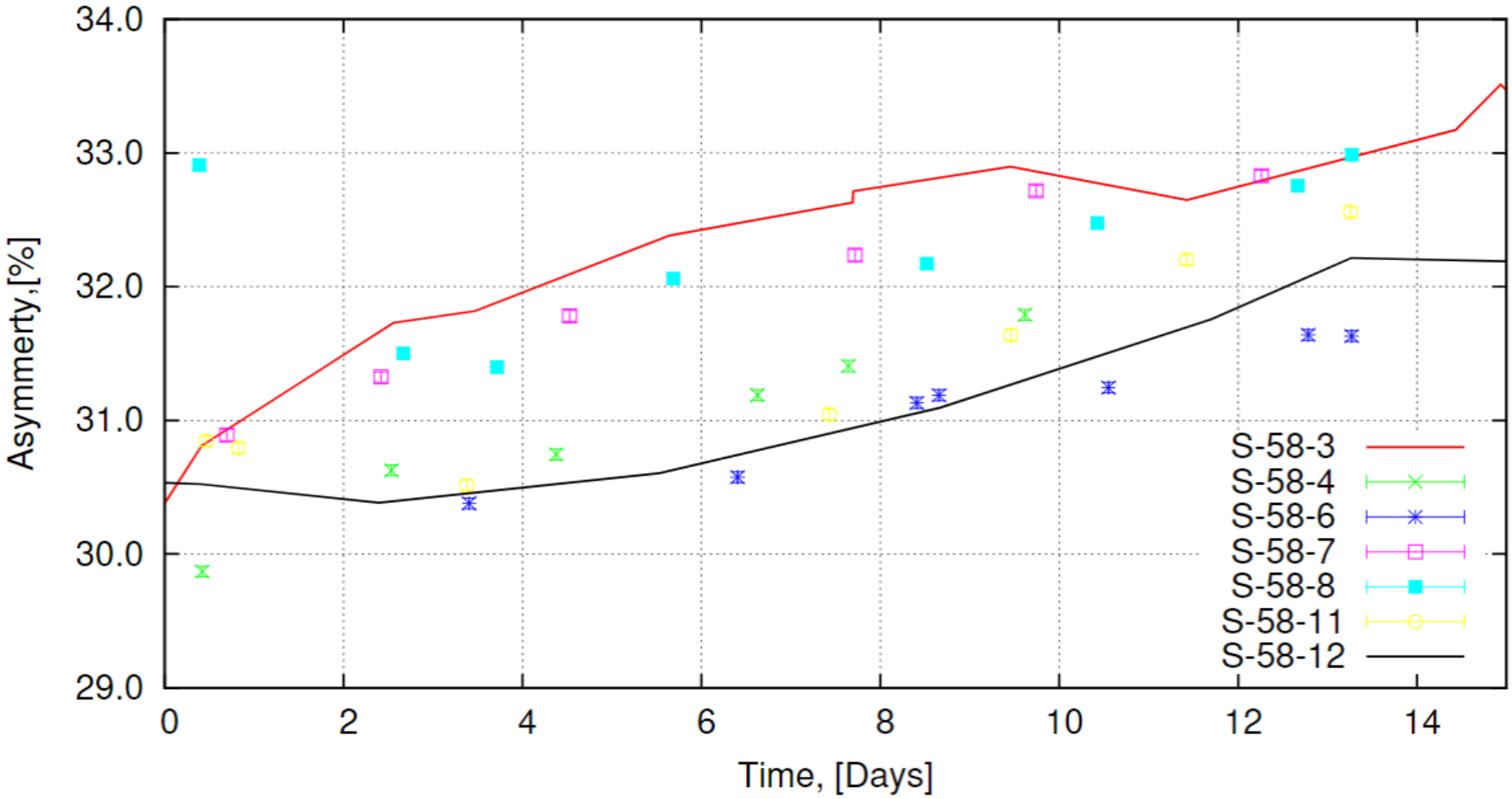
Negative electron affinity



Surface

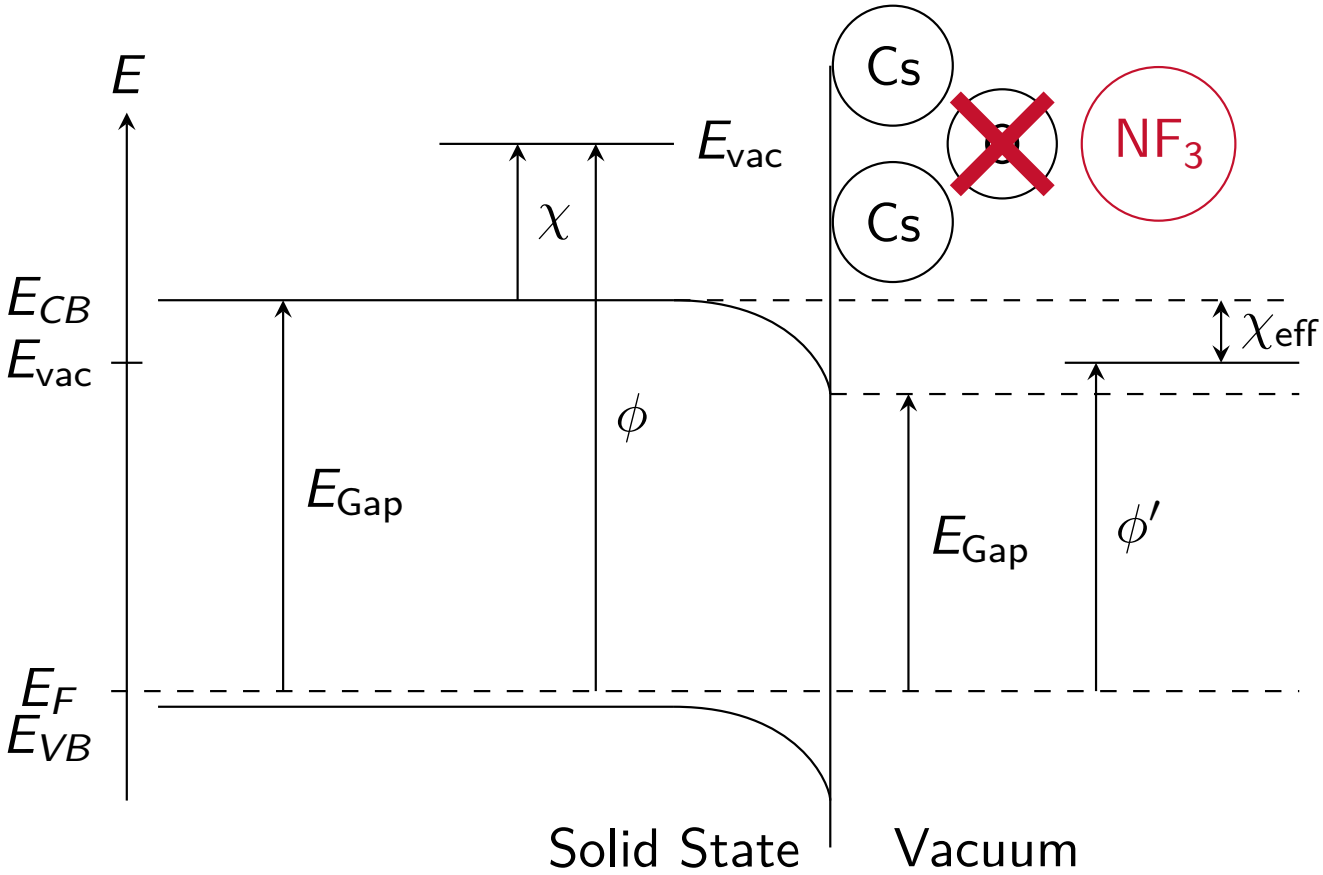
Motivation

With cesium and oxygen preparation the polarization of the electrons change over time.

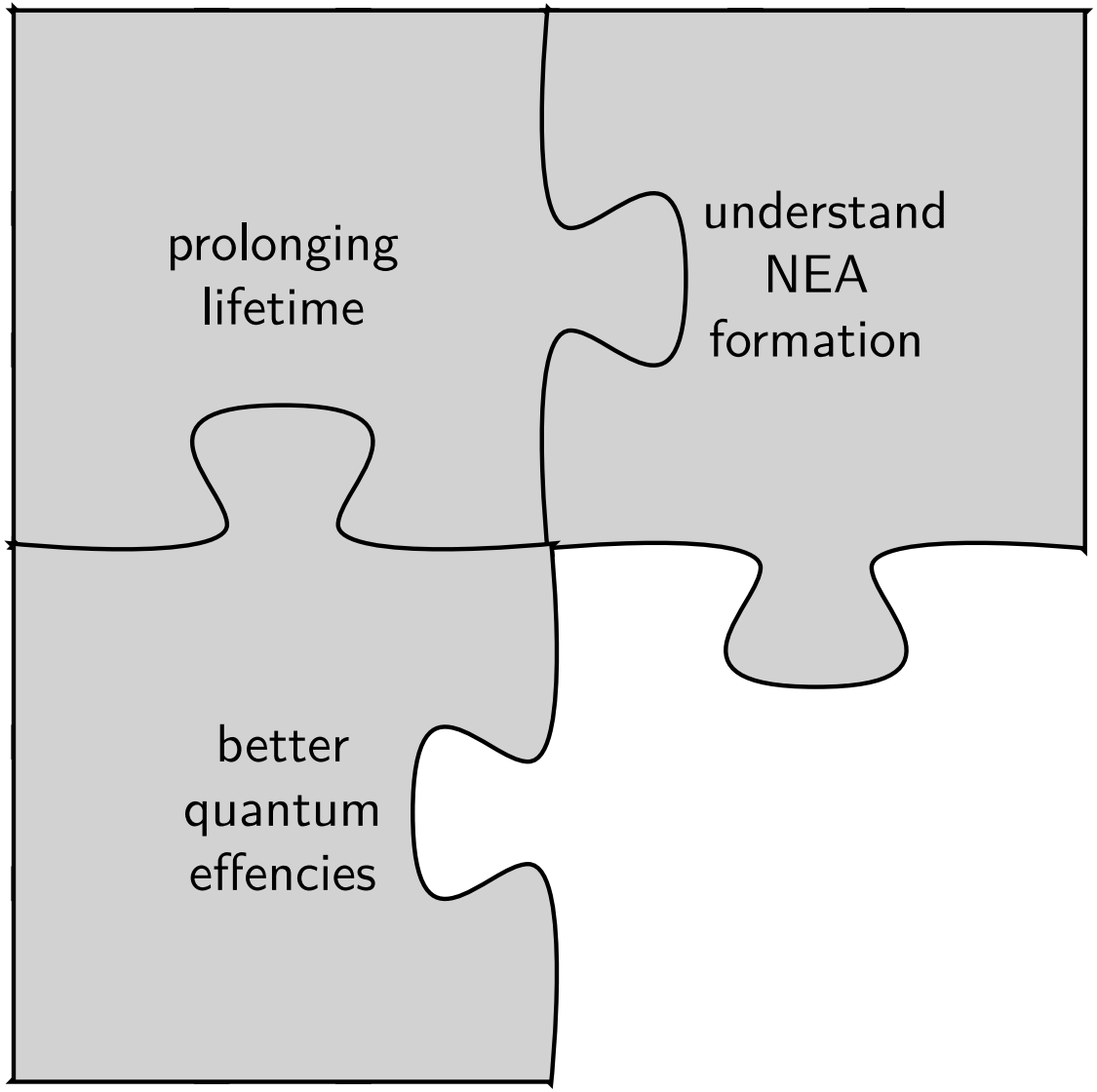


Source: V. Tyukin, K. Aulenbacher, *PoS* **2020**, *PSTP2019*, 1–10

Negative electron affinity

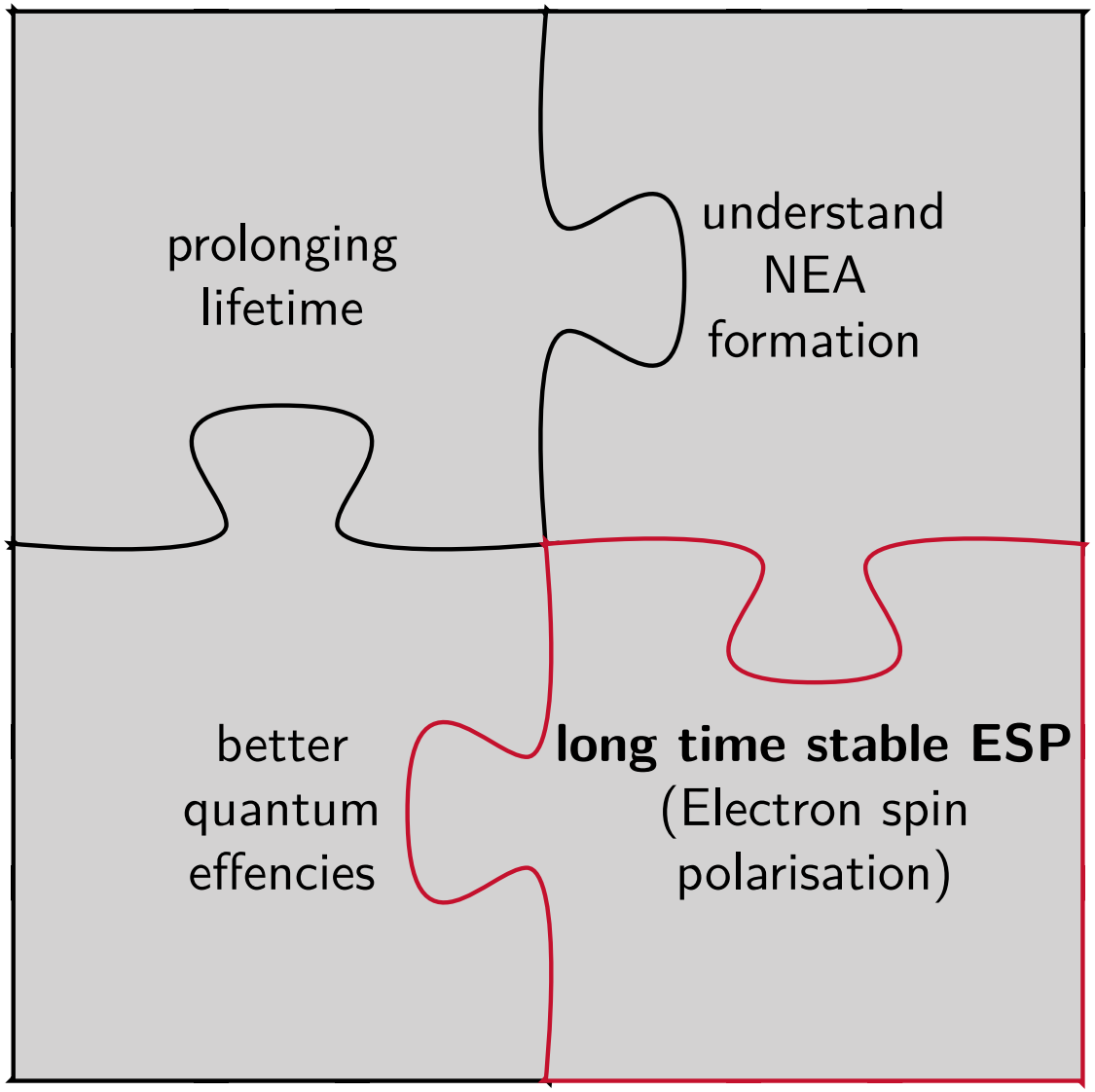


Why using different oxidants?



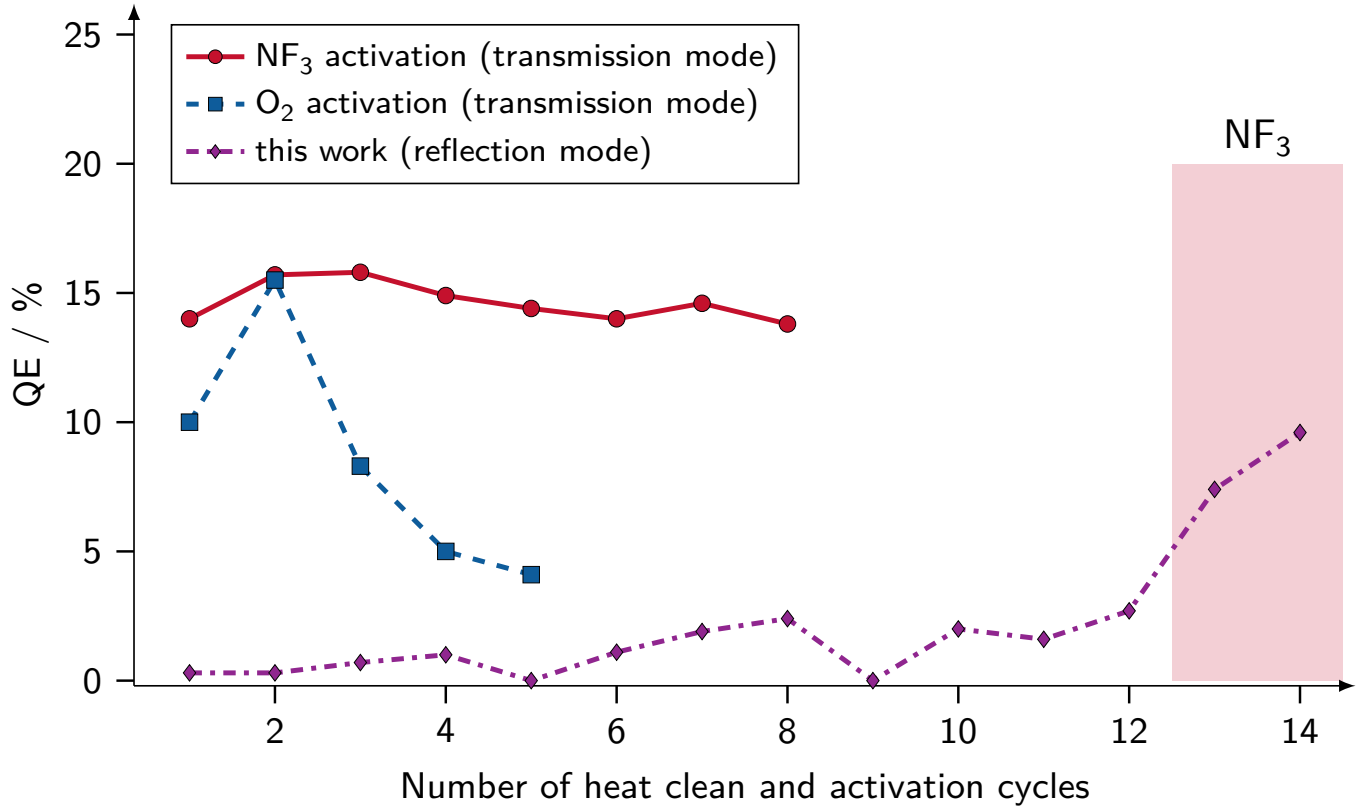
NEA: negative electron affinity, ESP: electron spin polarization

Why using different oxidants?



NEA: negative electron affinity, ESP: electron spin polarization

Stability of QE



adapted N. Chanlek, PhD thesis, University of Manchester, **2011**

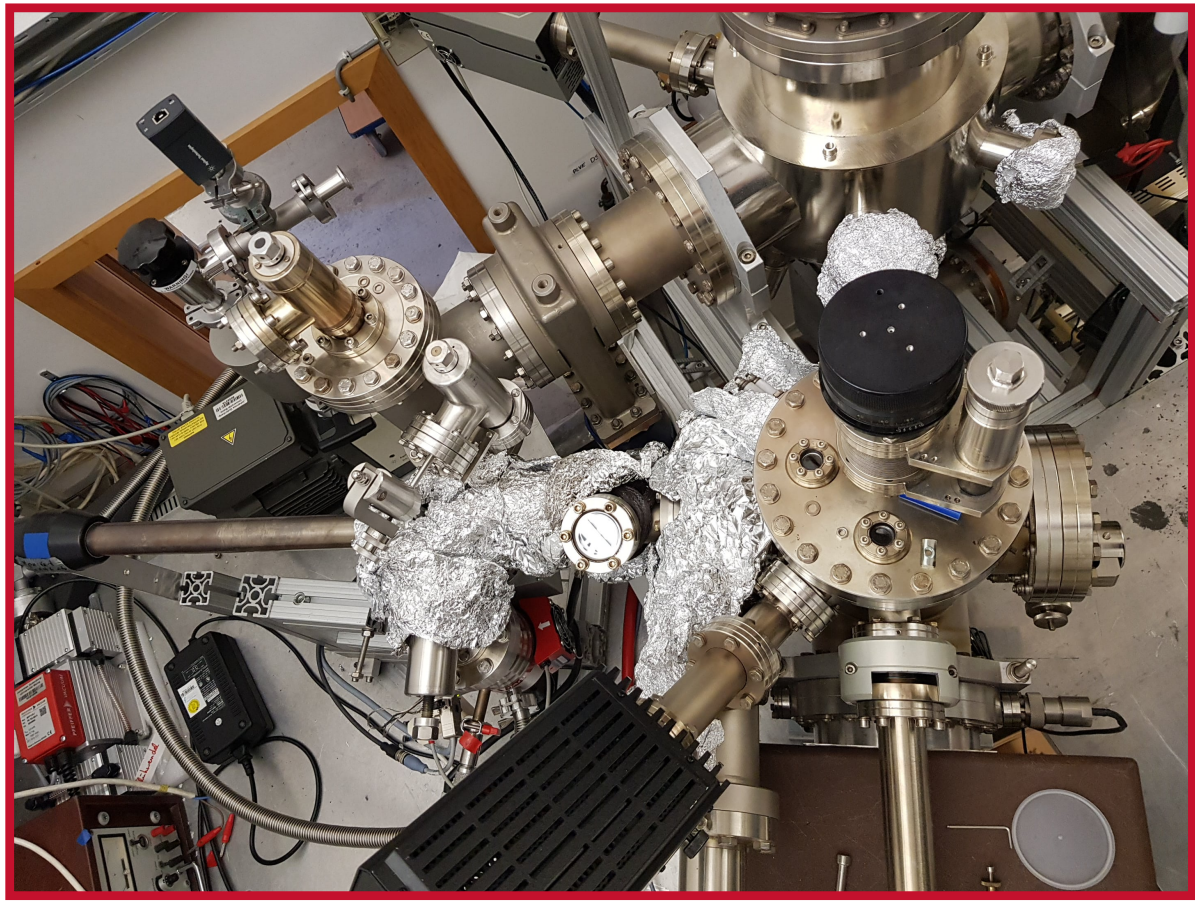
Conclusion

Preparation with NF_3 allows more activation cycles with stable QE

Question

Is longevity also visible with the ESP?

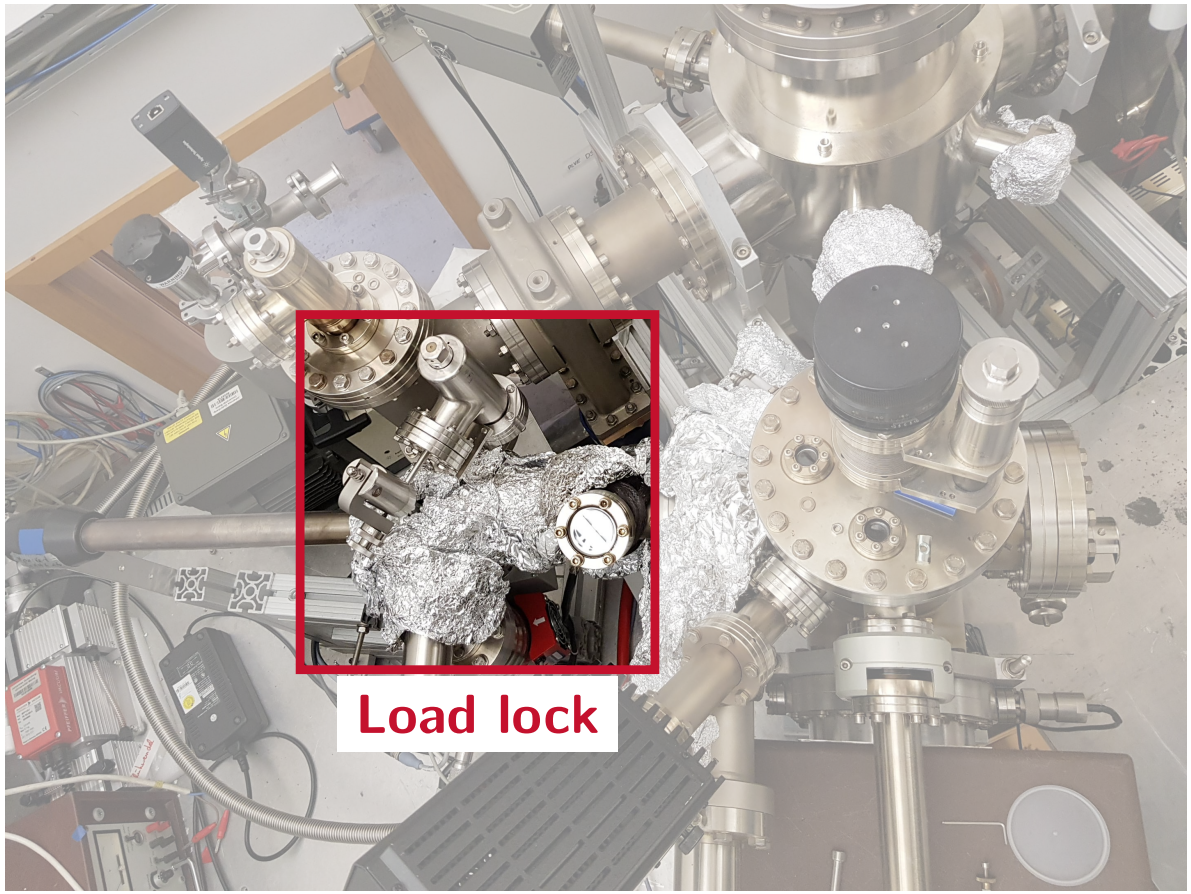
Setup



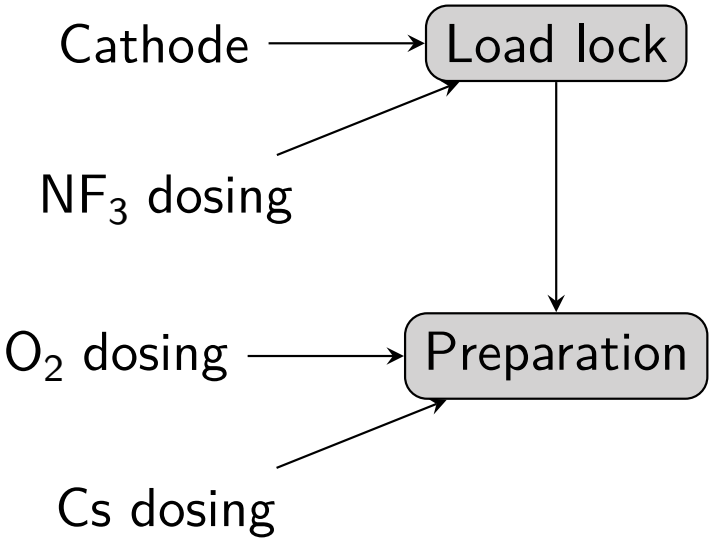
Setup

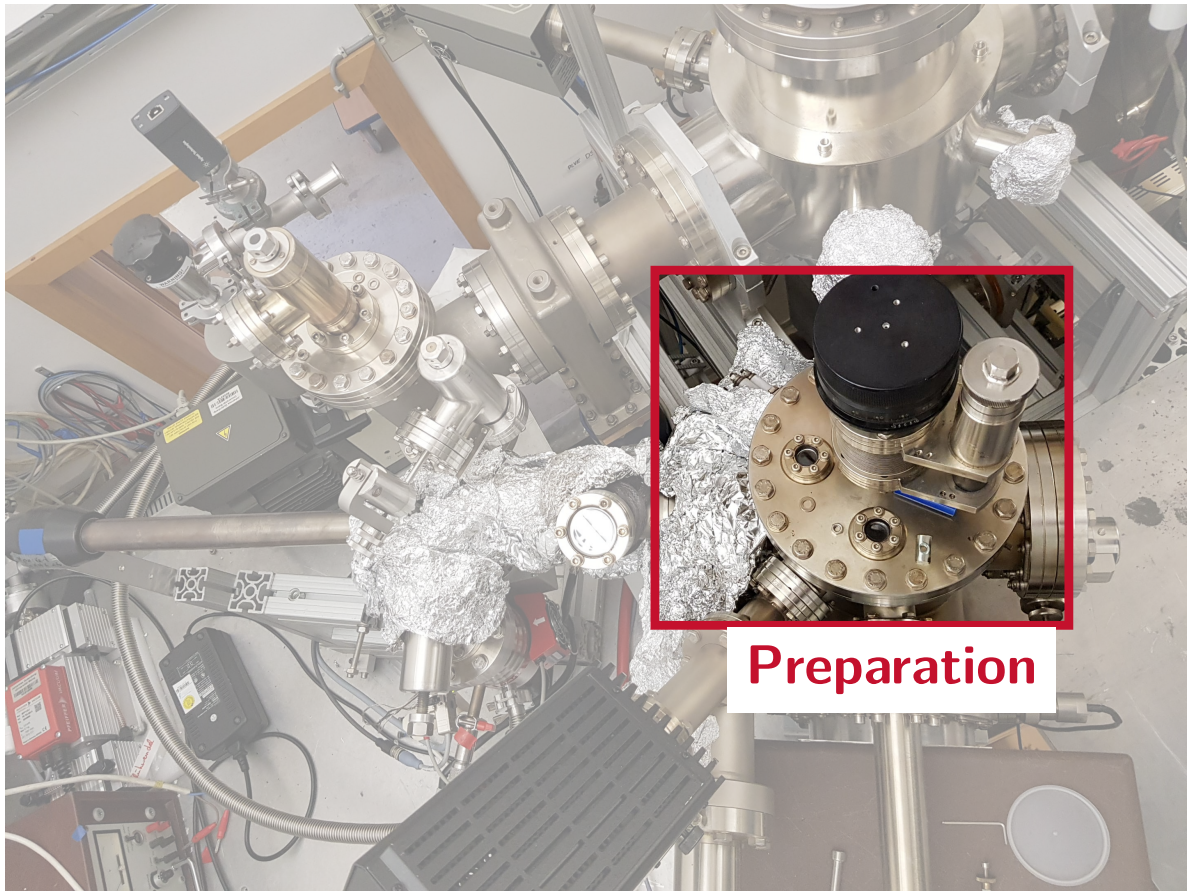
Cathode → Load lock

NF_3 dosing

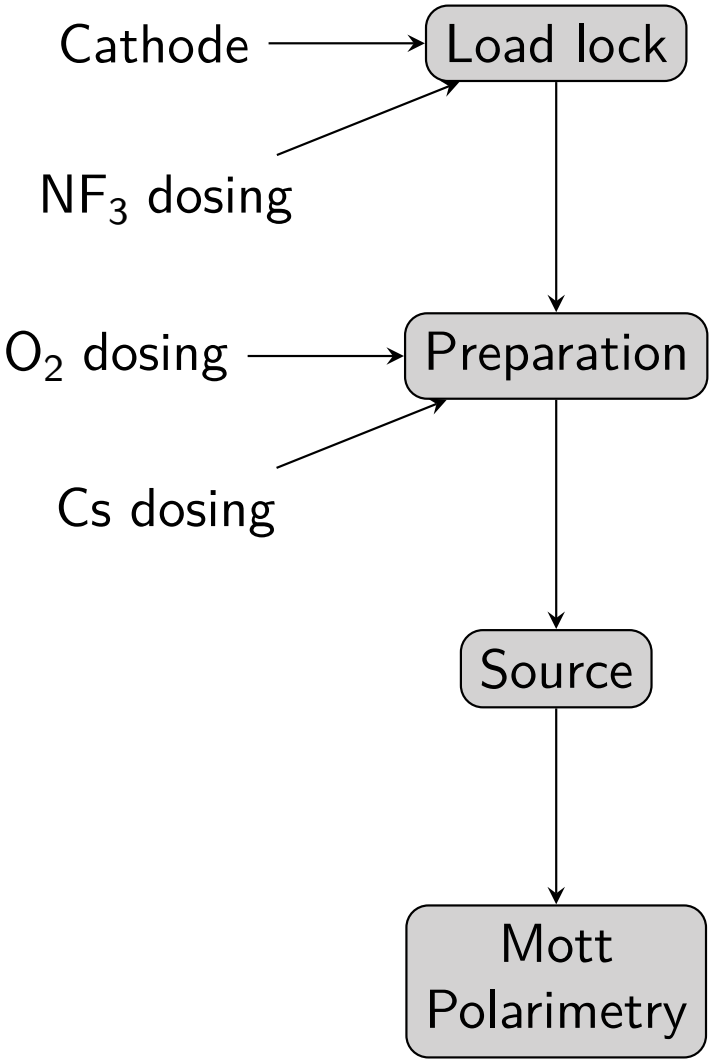


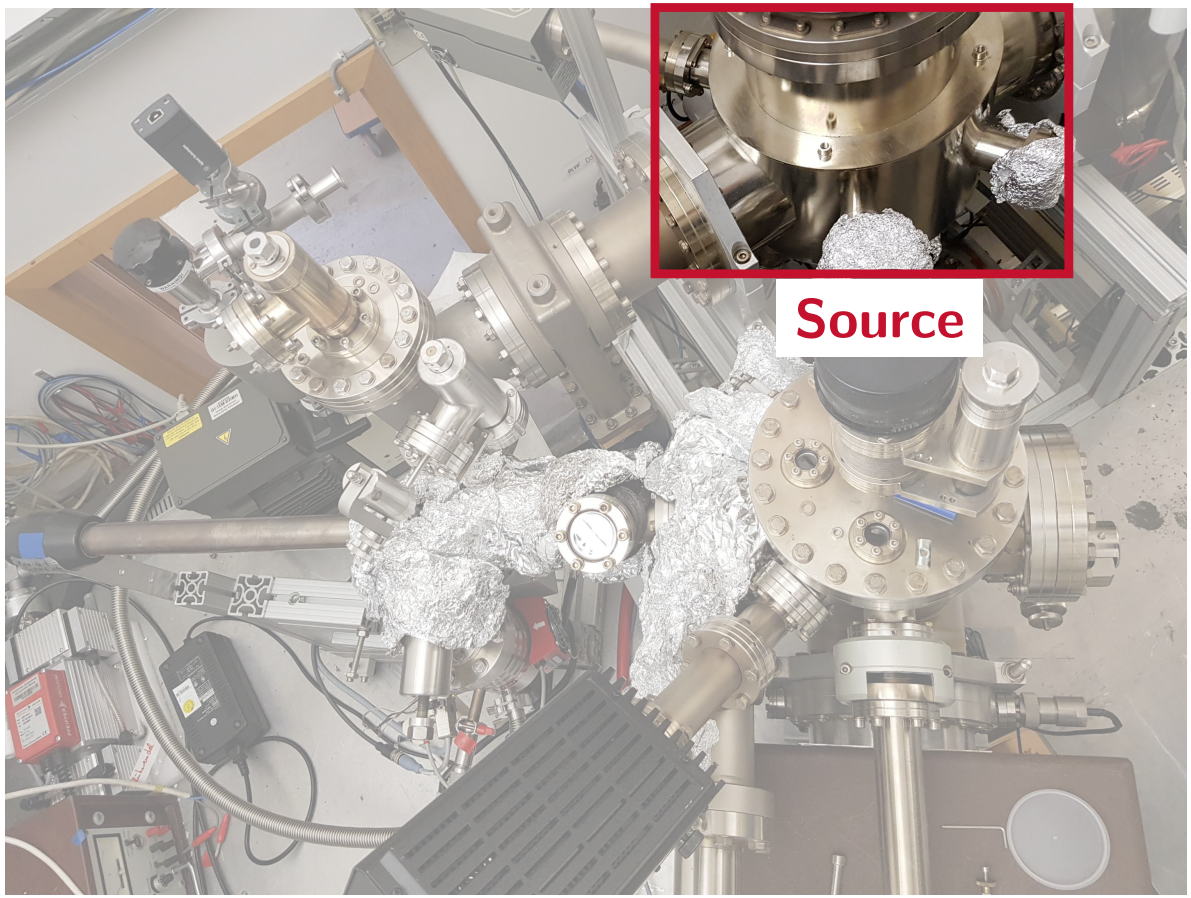
Setup


Cathode
Load lock
NF_3 dosing
O_2 dosing
Preparation
Cs dosing

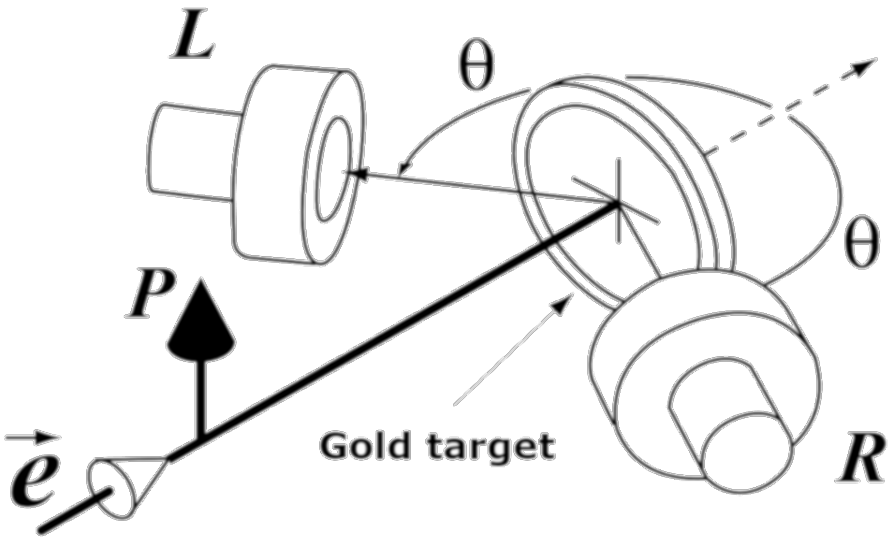

Preparation

Setup


Cathode
Load lock
NF_3 dosing
O_2 dosing
Preparation
Cs dosing
Source
Mott
Polarimetry


Source

Mottpolarimetry



Operational stats

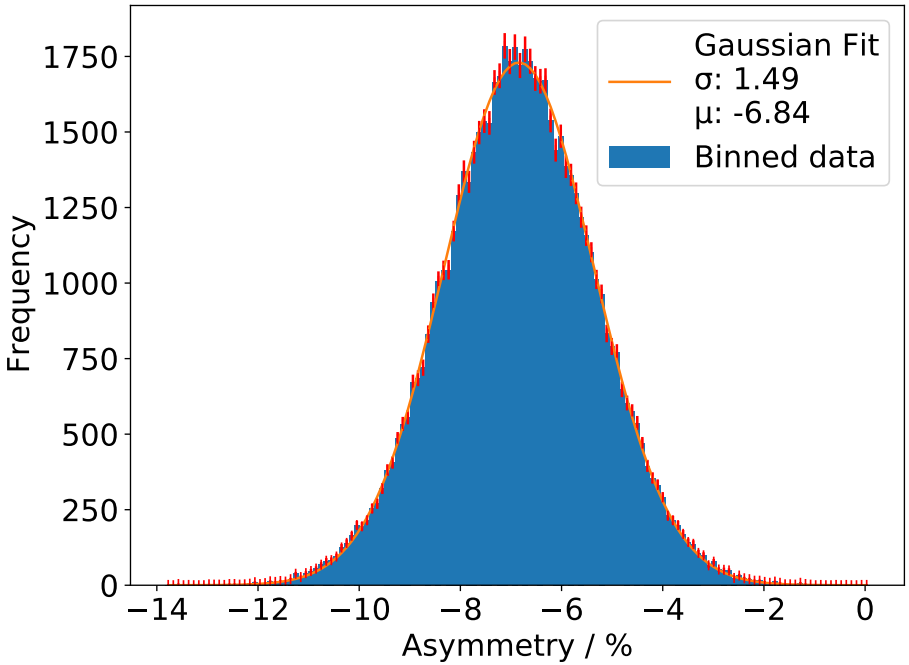
100 keV polarimeter with 120° backscattering angle

Aim

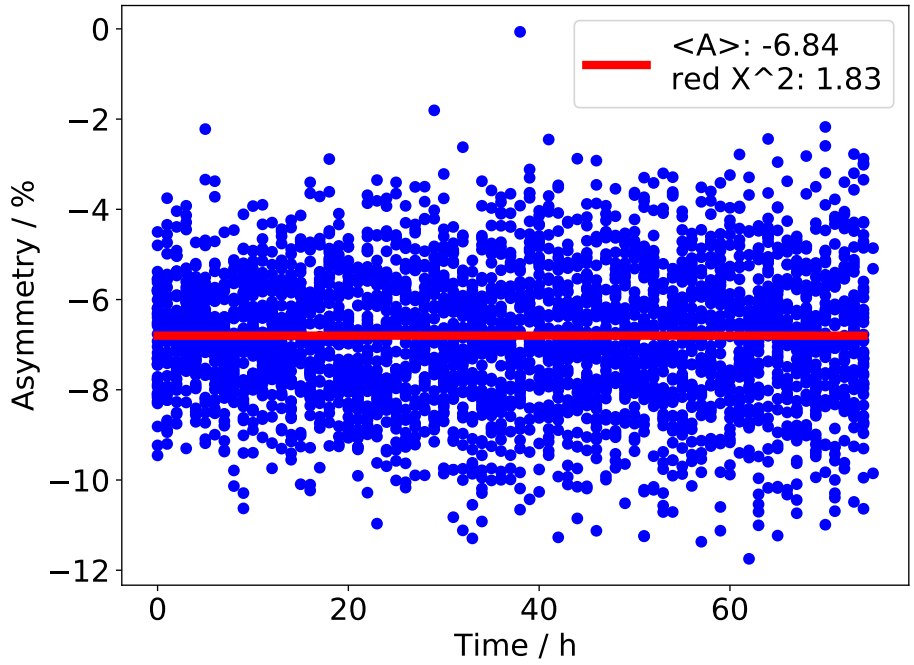
Measure the relative change in asymmetry signal over time.

First measurements

Max. $QE \approx 7\,\%$ with Asymmetry: $6.8\,\%$ with $98\,\mathrm{nm}$ Au @ $100\,\mathrm{keV}$ measured over a $3\,\mathrm{d}$ period.



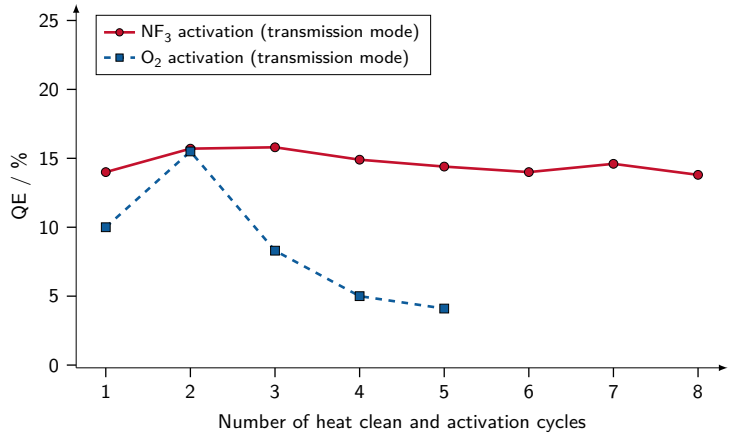
Histogramm of measured asymmetry.



Time developement of asymmetry needs to be investigated further.

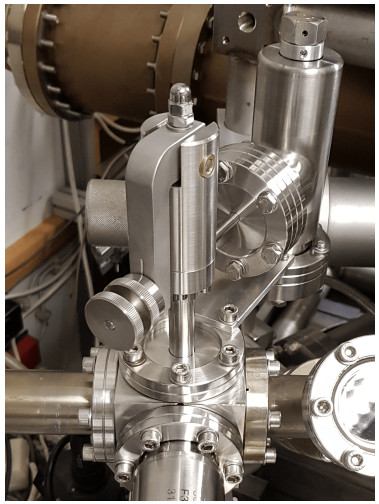
Lessons learned

Beam optics
need to improve

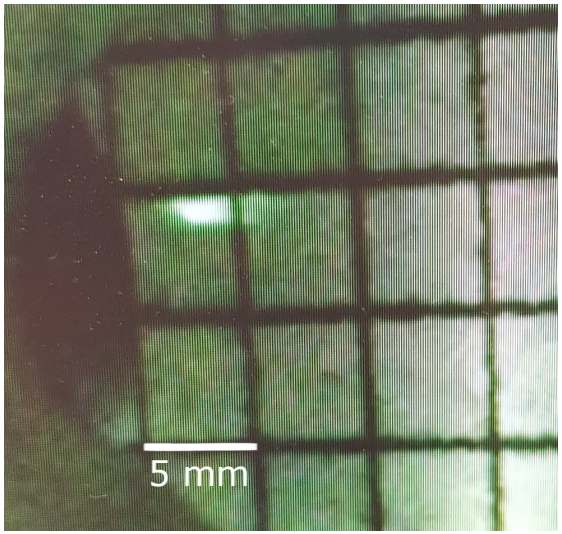


adapted N. Chanlek, PhD thesis, University of Manchester, 2011

QE is better with NF_3 as already shown



NF_3 infrastructure
installed



Beam spot with halo,
limit excess activated area on cathode

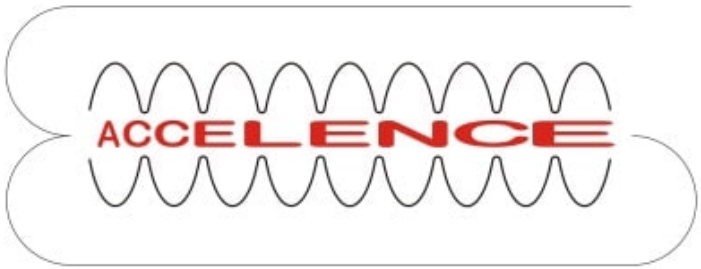
Summary

Same QE archievable and
no difference in starting ESP

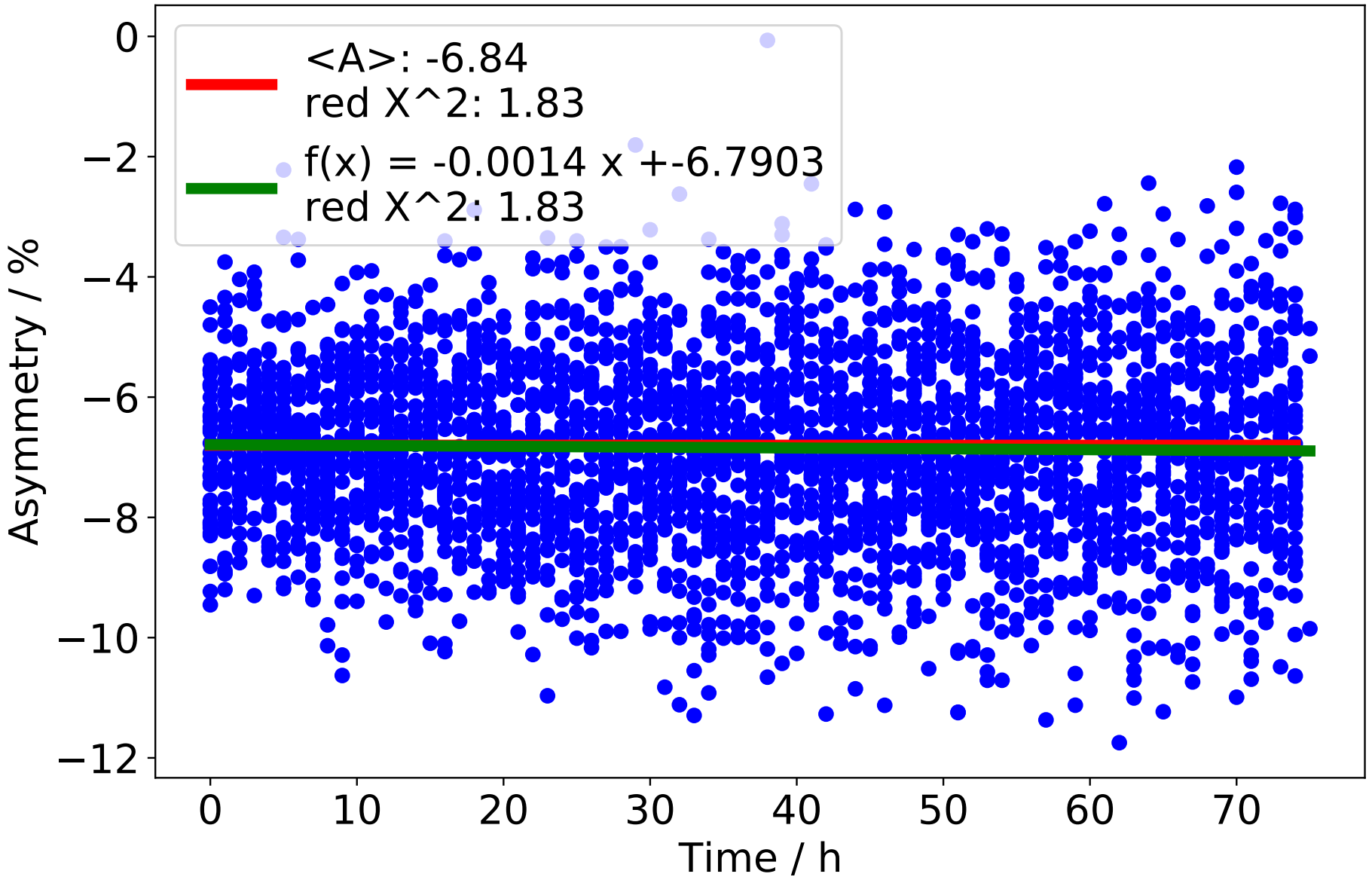
gain more preparation experience

start 14 days measurements

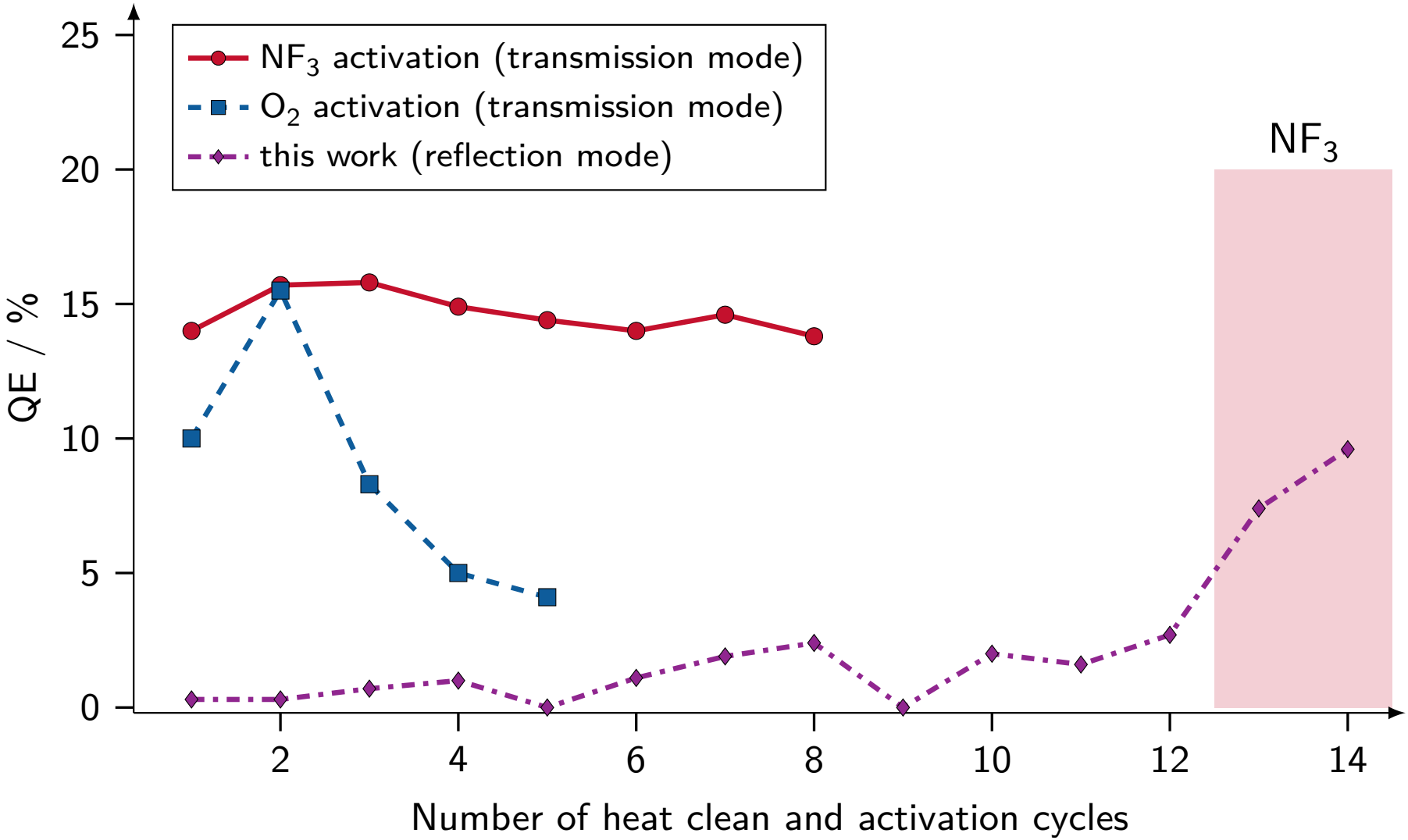
Thank you very much for your attention!



Further into the time development



NF_3 stability



adapted N. Chanlek, PhD thesis, University of Manchester, **2011**