SAND2022-7526C

Sandia National Laboratories

How nitrogen affects hydrogen adsorption on tungsten surfaces

Chun-Shang Wong[1], R.D. Kolasinski[1], J.A. Whaley[1], M.A. Cusentino[2], M.A. Wood[2], B.D. Wirth[3,4], A.P. Thompson[2]

[1]Sandia National Laboratories, Livermore, CA, USA

[2]Sandia National Laboratories, Albuquerque, NM, USA

[3]University of Tennessee, Knoxville, TN, USA

[4]Oak Ridge National Laboratory, Oak Ridge, TN, USA

PRESENTED BY

Chun-Shang Wong

This work was supported by the U.S. Department of Energy, Office of Fusion Energy Sciences (OFES) under Field Work Proposal Number 20-023149.

U.S. DEPARTMENT OF ENERGY NNSA

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

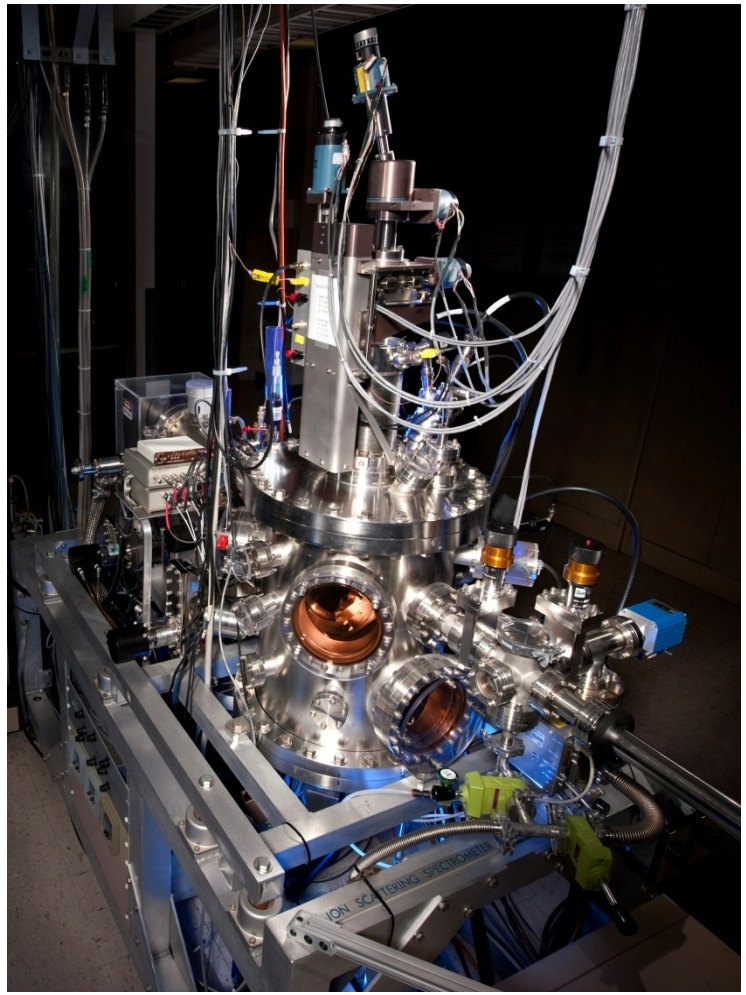
Scientific questions

- How does molecular nitrogen interact with tungsten surfaces?
- How does the presence of nitrogen on tungsten surfaces affect H-W interactions?

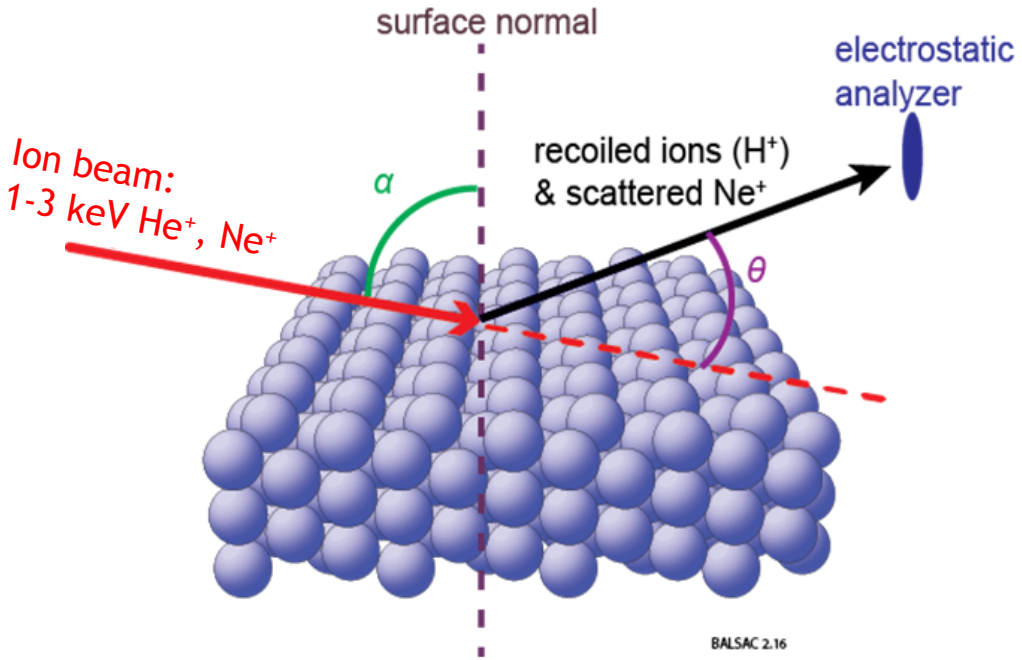
Results aimed to:

1. characterize the mechanisms by which nitrogen impacts key plasma -material interactions, such as tritium retention
2. provide experimental data to aid in the development and benchmarking of interatomic potential models

ARIES: Angle-Resolved Ion Energy Spectrometer

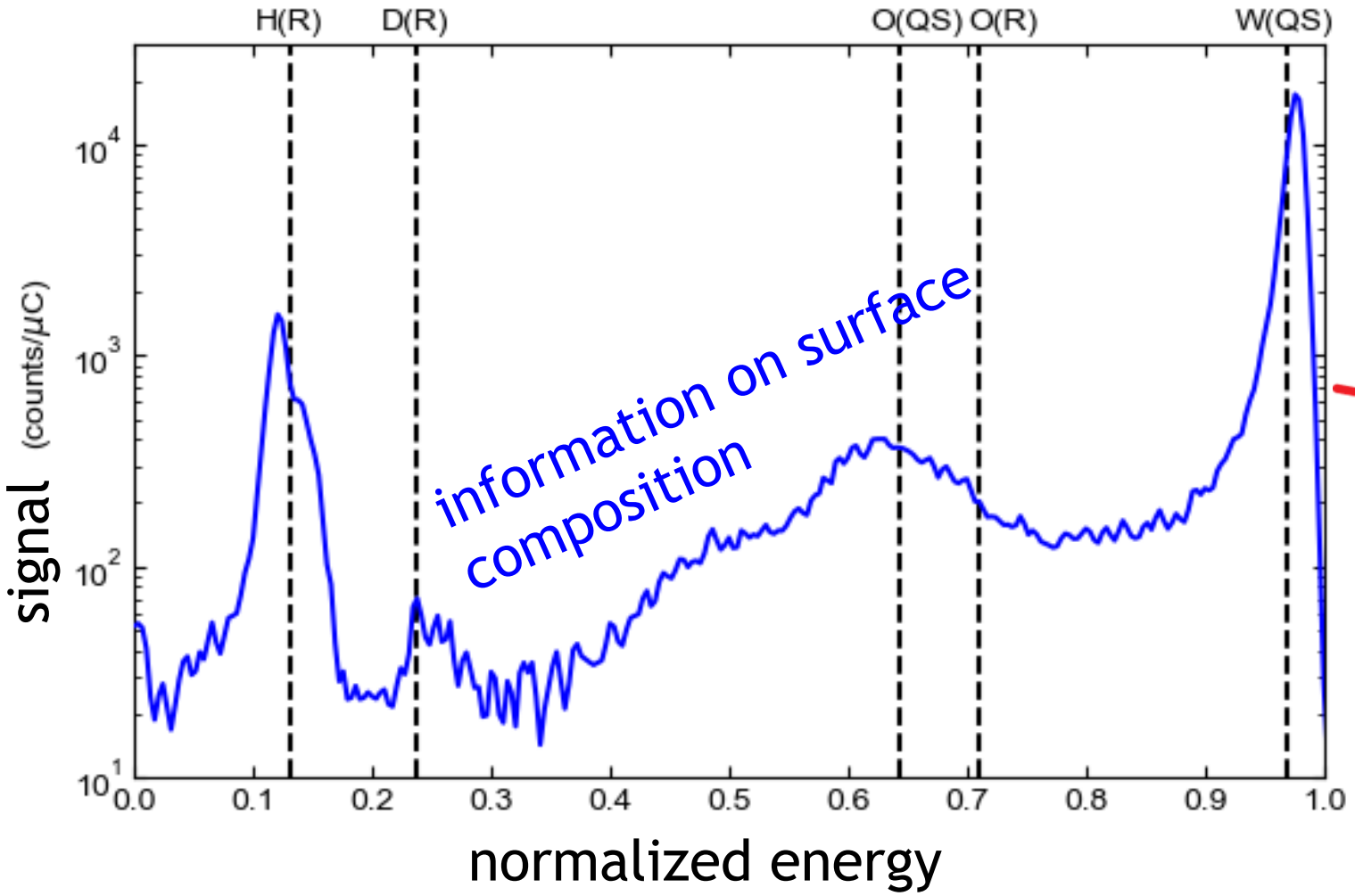


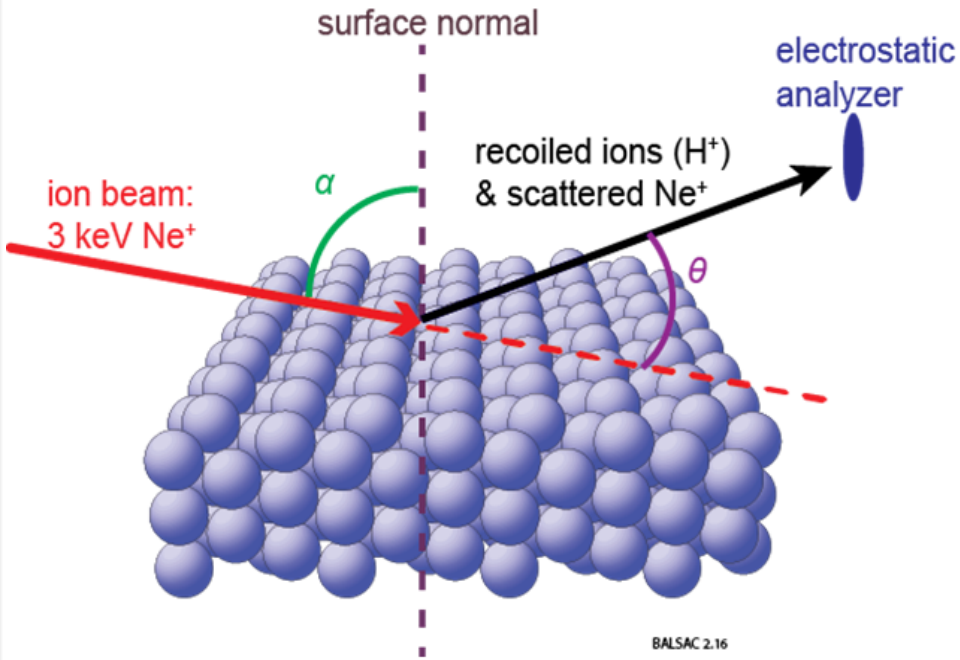
Sandia/CA



- Detects scattered (LEIS) and recoiled (DRS) ions
- Ion energy ➔ chemical composition
- Direct sensitivity to surface hydrogen
- Monolayer sensitivity can be achieved
- Surface can be dosed with N_2, H, H_2, D, D_2 …

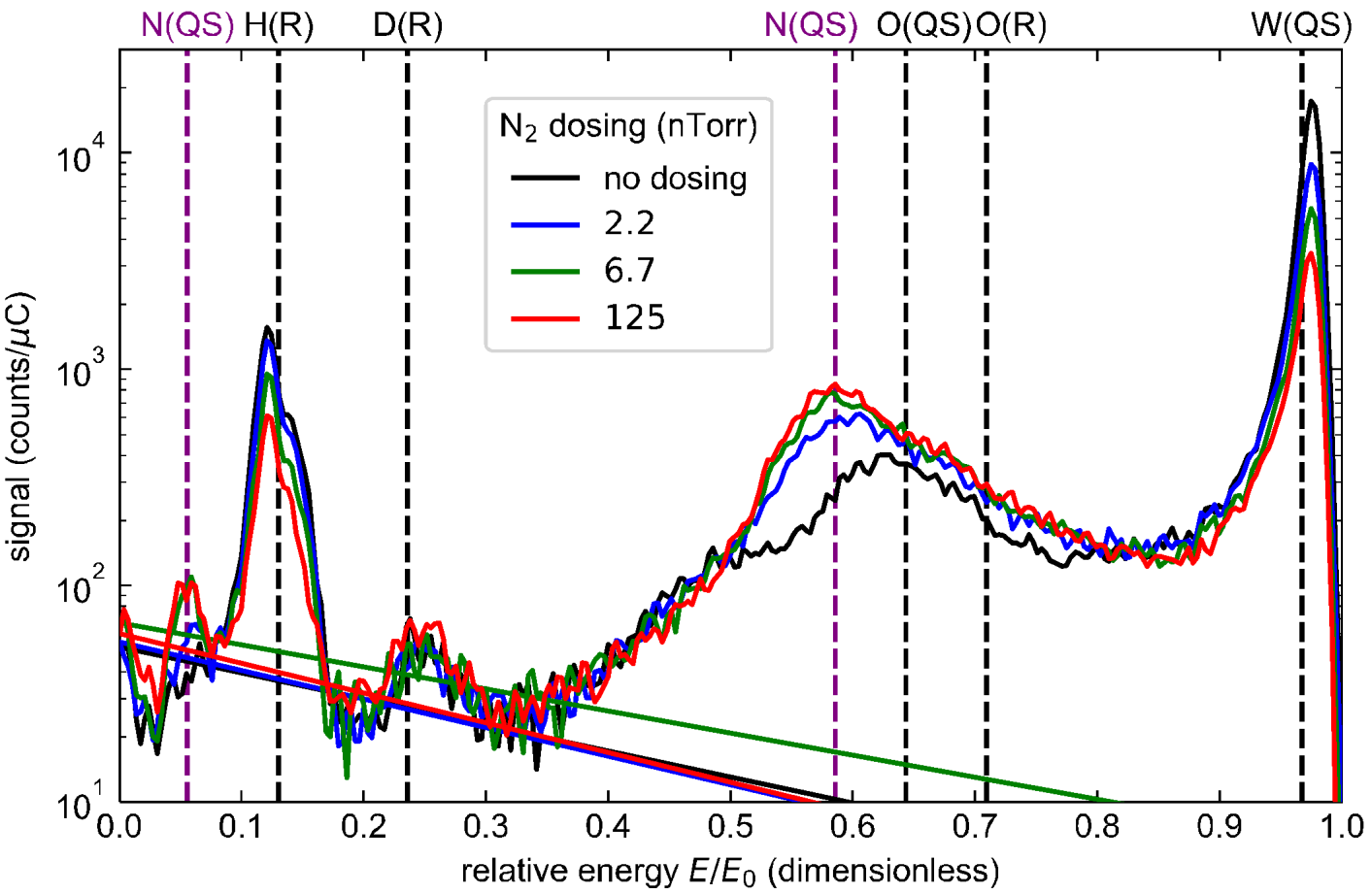
Representative ion energy spectrum for polycrystalline W





Nitrogen effects for H adsorption on ITER-grade W

N_2 dosing on W sample with residual H_2 in chamber

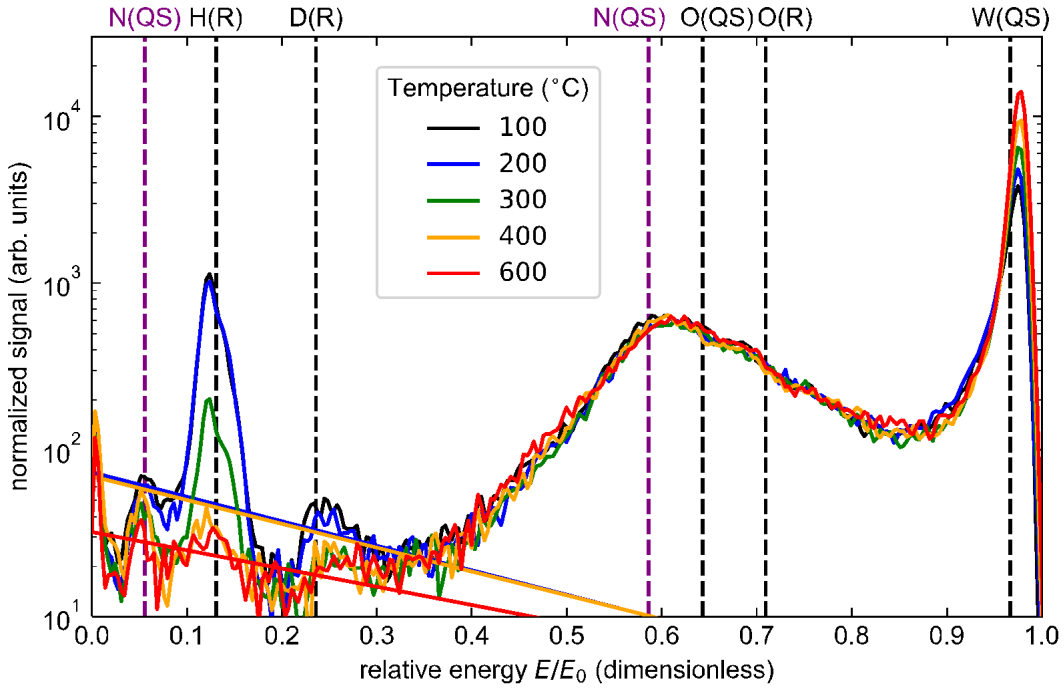


- N_2 is adsorbed onto the surface
- As the N signals increase, W and H decrease—and not at the same rate
- For N_2 @ 2.2 nTorr :
  - N is blocking or matrixing W
  - N is not yet displacing H or preventing H uptake
- For $N_2 \geq 6.7$ nTorr:
  - H signal begins to diminish as well, suggesting N is preventing adsorption of H

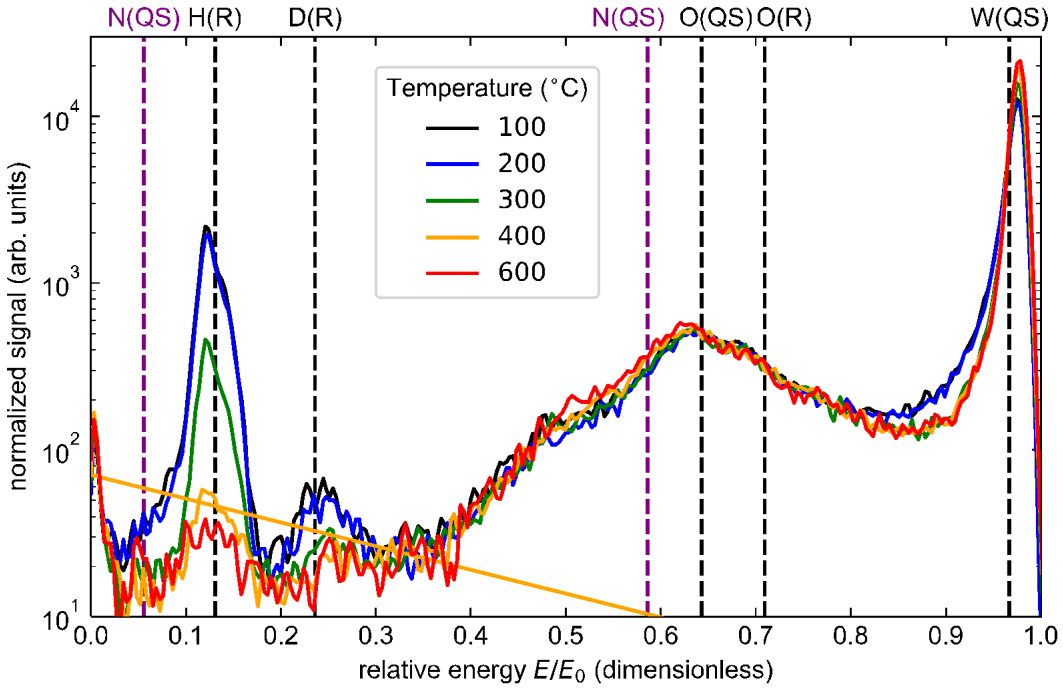
Temperature effects with and without N_2

Does N at the surface affect the H binding energy?

N_2 at 50 nTorr



No N_2 dosing



- H is desorbs similarly with and without N_2 present at the surface.
- N does not get desorbed below 600 °C.

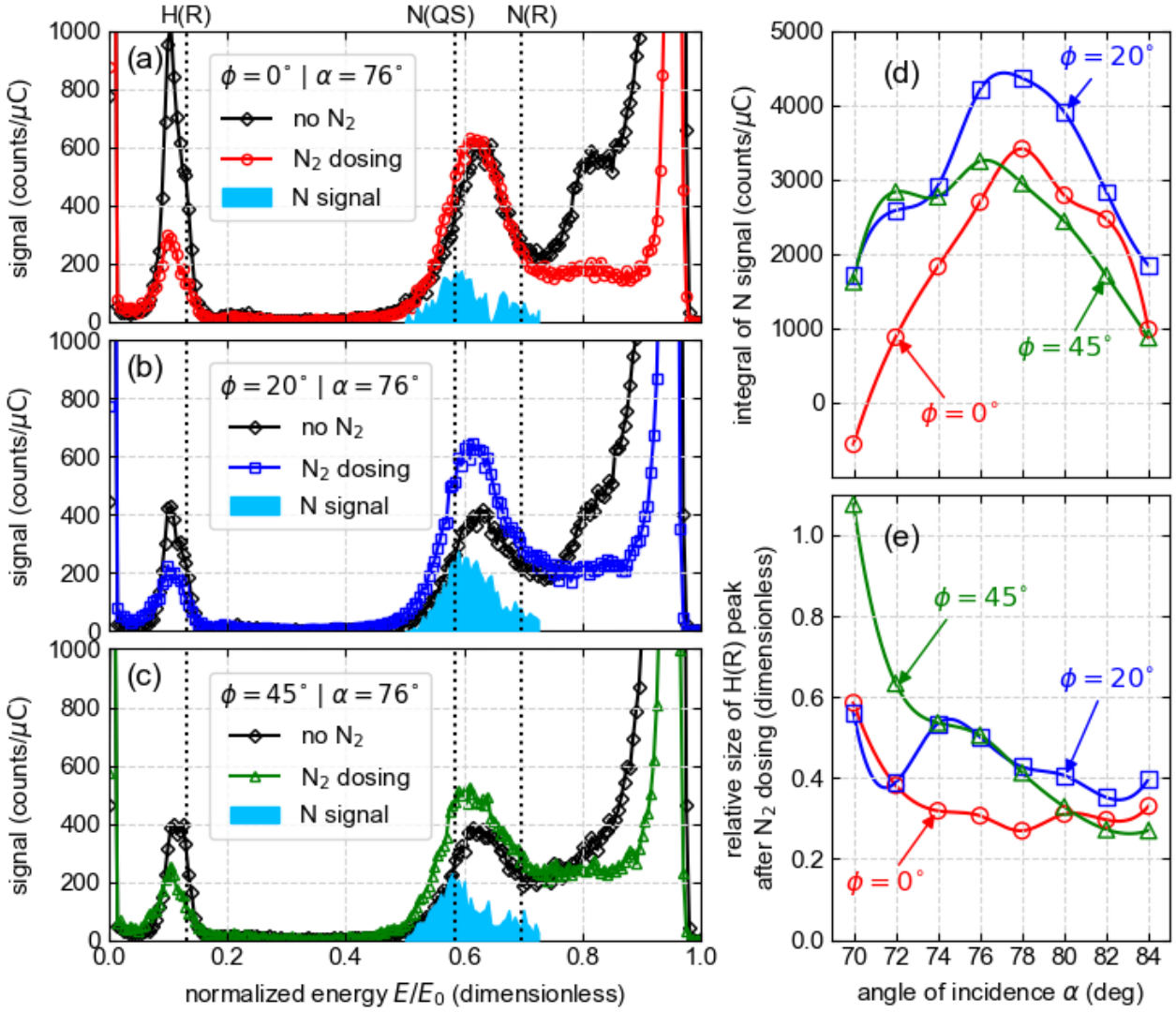
Tungsten single crystal: W(100)

Why study a tungsten single crystal?

- more detailed picture of the interplay between H, N, and W
- well suited to support interatomic potential model development

MD simulations are underway to model and interpret these experimental results:

- Location & quantity of N + H
- Mechanism of H passivation by N



Thank you for your attention!

Chun-Shang Wong (chuwong@sandia.gov)
Robert Kolasinski (rkolasi@sandia.gov)