Nickel Alloys as Fusion Reactor Plasma-Facing Materials

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Goal

Determine the operating temperature range and maximum fluence of hydrogen and helium allowed for nickel alloys as plasma-facing components in fusion reactors (such as DT, DD, D^3He, $p^{11}B$).

Previous Experiments

- Severe damage occurred
- Focused-Ion Beam results of W after ion irradiation

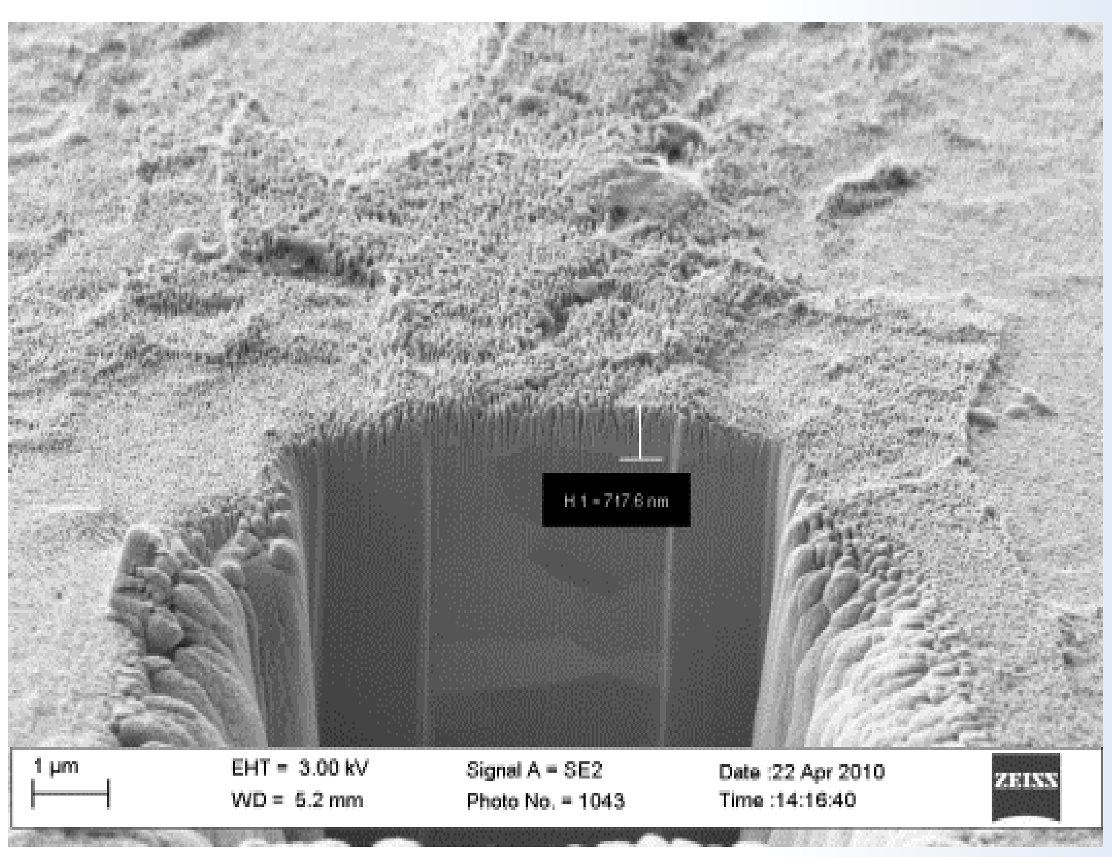

Figure 1: FIB results for a fluence of $1.0x10^{17}$ ions/cm ^{2} at 900°C.

- Scanning Electron Microscope results of W after ion irradiation at varying fluences

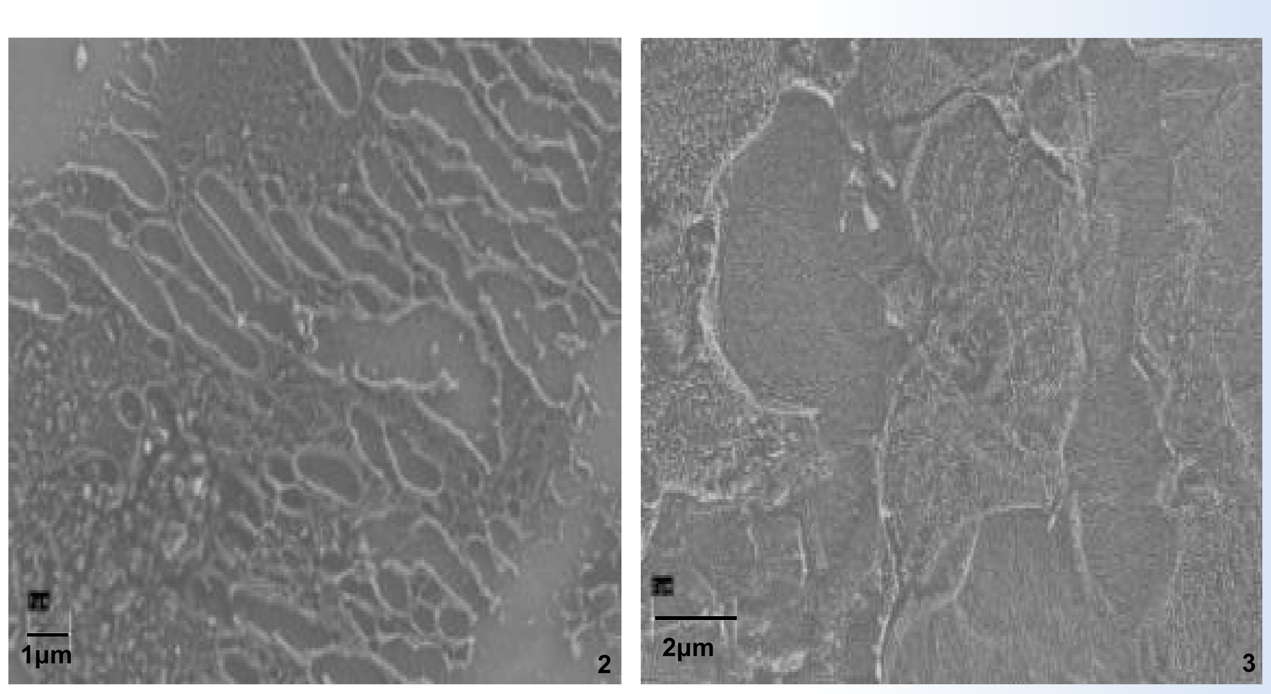

Figure 2, 3: SEM results for fluences of $1.0x10^{17}$ and $1.0x10^{19}$ ions/cm ^{2} at 900°C.

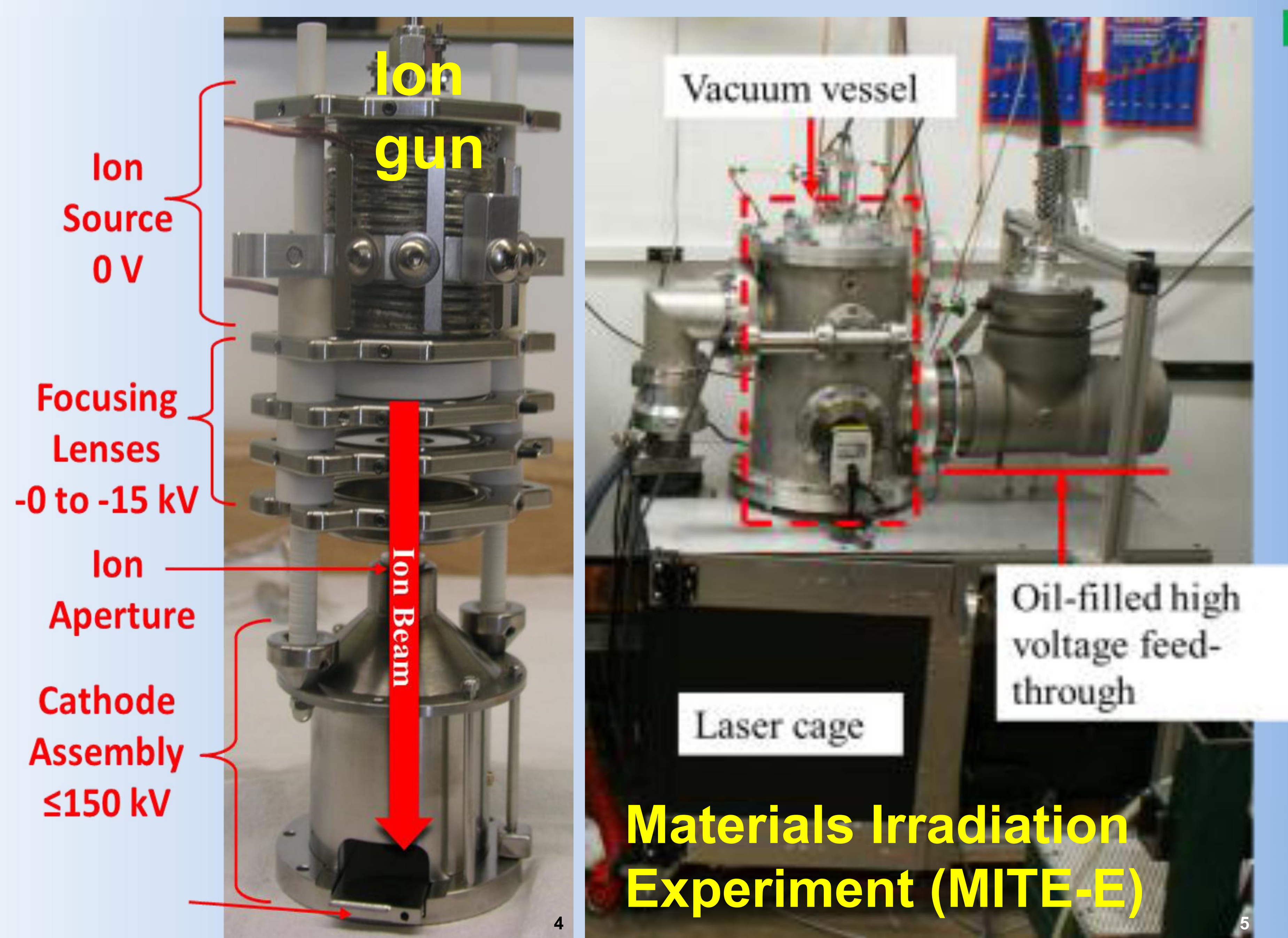

Figure 4, 5: MITE-E ion gun and chamber.

Experimental Approach

- The MITE-E is used to simulate fusion reactor conditions. Samples can be irradiated with He or D under specific conditions:
  - Temperatures between 500 and 1200 C.
  - Ions with energies from 10 to 150 keV with ion currents of 75±3.8 μA, a flux of $4.7x10^{14}$ ions/cm ^{2}s.
  - Fluences of $1.0x10^{17}$ to $1.0x10^{19}$ ions/cm^2.
- A variable power Nd:YAG laser provides additional sample heating.
- The MITE-E typically uses a sample size of ~1cm x 1cm x 1mm.
- To determine physical changes in a sample analysis can be done with Focused-Ion Beam, Scanning Electron Microscope, mass loss measurements, and other techniques.

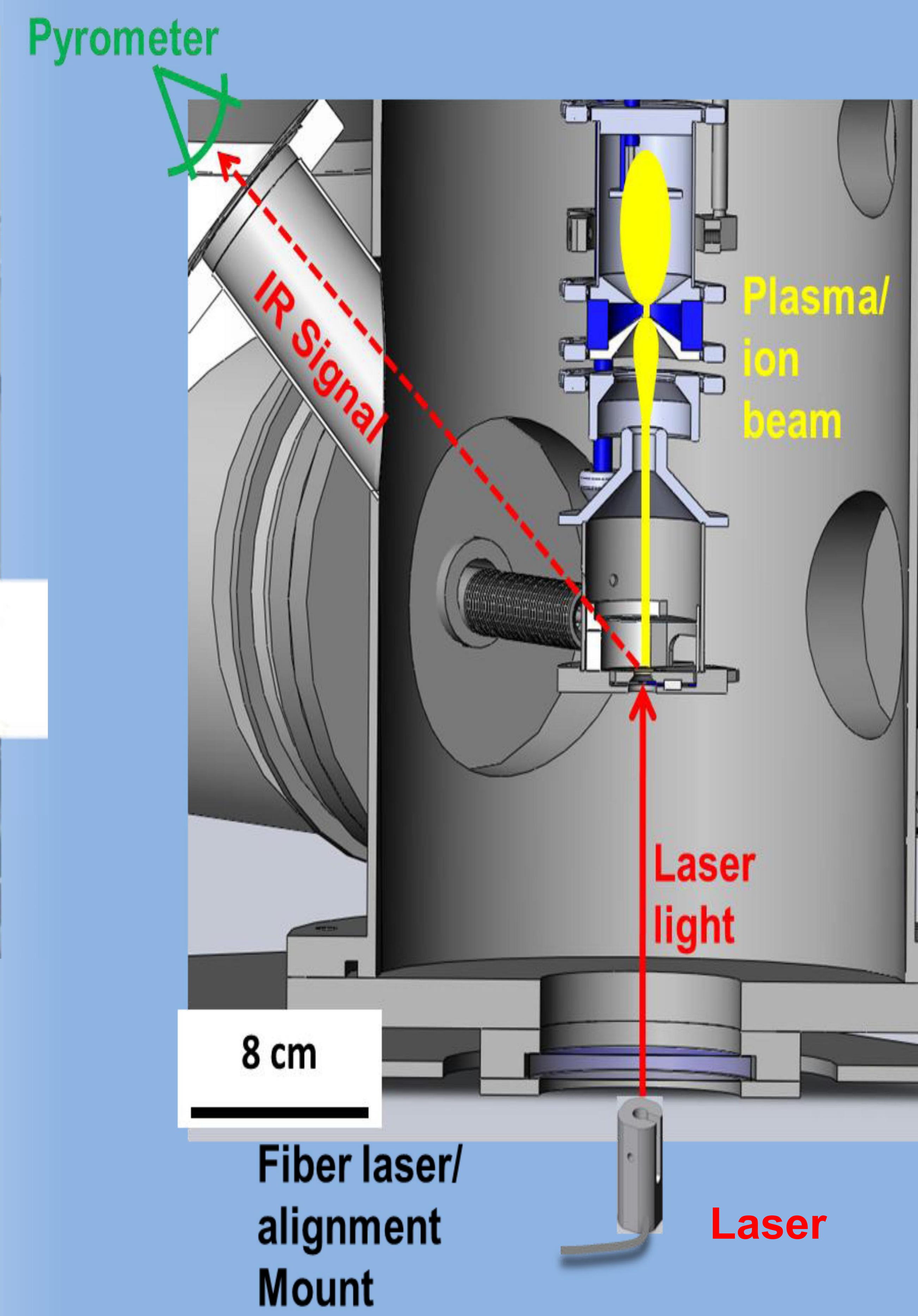

Figure 6: Solidworks^{TM} model of the inside of the MITE-E vacuum vessel.

Nickel Alloys to be tested

- Inconel 600, 625, 718, 740
- Incoloy 800, 825

Future Work

Analyze several nickel alloys at 900 C with a fluence up to $1.0x10^{18}$ ions/cm ^{2} to determine the effects of He and H. This simulation of a reactor setting will help evaluate first-wall use of a nickel alloy.

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