CEMHTI and its contribution to HeRHEA

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EUROFUSION ENR-MAT.02.VTT-T001
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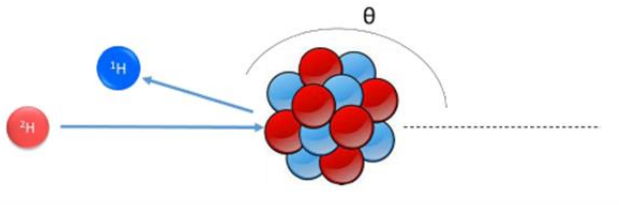
Outline

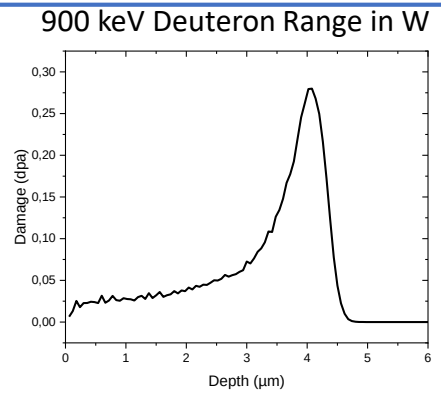
- Experiments from 12/2024-03/2025
  - ^{3}He-exposed single-crystal tungsten (W), and thin-layer HEAs
    1) Pre-exposure test
    2) ^{3}He exposure in single-crystal W and HEAs
    3) Calibration of ^{3}He fluence in progress
- Conclusion
- Perspectives

NRA and RBS in IBIC chamber

Using a deuteron beam at 900keV



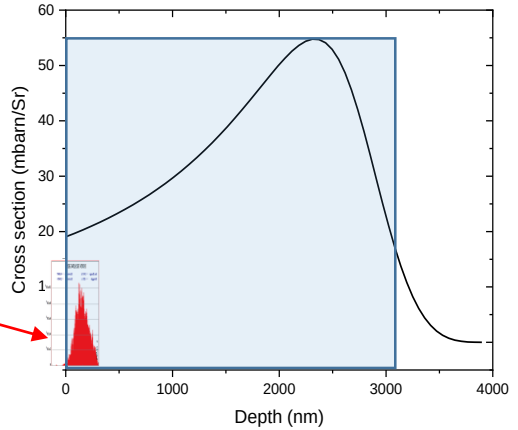
$^{3}He\ (^{2}H, ^{1}H)^{4}He$



Range of 900 keV deuterons : 4 µm

- Detection of ***^{3}He*** by the **$^{2}H\ (^{3}He, ^{4}He)^{1}H$** reaction : emitted ***protons*** with ***high*** energy of 13.3 MeV

^{3}He depth profile in 10 keV 3He implanted Si standart ($1x10^{16}\ cm^{-2}$)



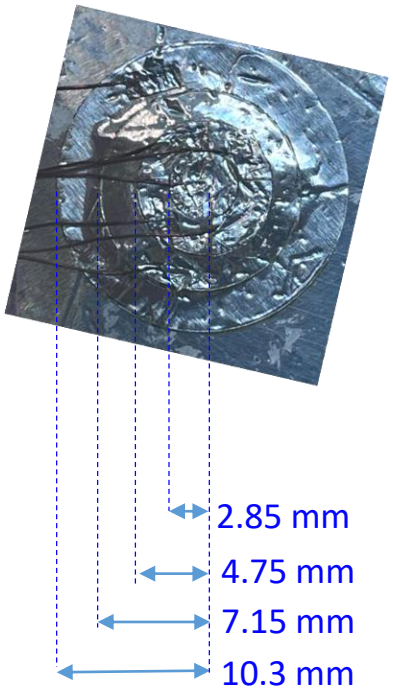
$^{2}H\ (^{3}He, ^{4}He)^{1}H$ cross section in W

probe on ~ 3µm depth in W

- Detection of ***Carbon*** by **$^{2}H\ (^{12}C, ^{13}C)^{1}H$** reaction: emitted ***protons*** with ***low*** energy of 2.9 MeV
- Detection of W : ***backscattered*** deuterons

Test before real exposure

Ion density tester



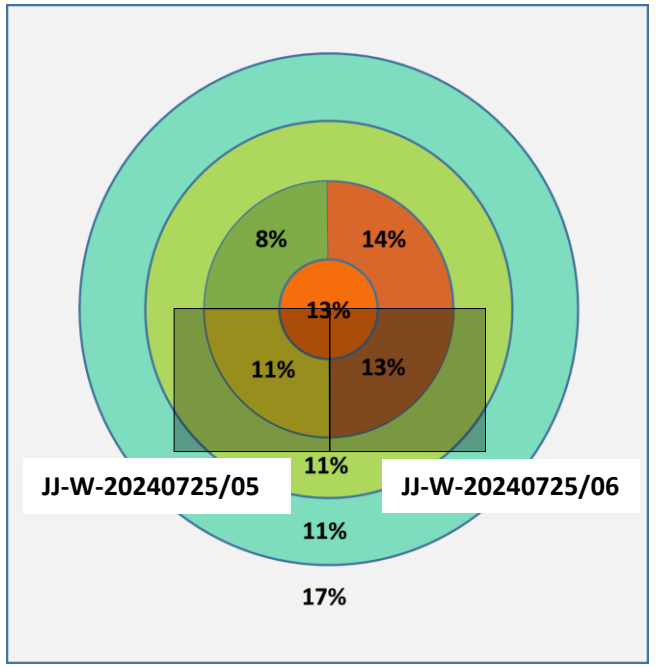
2 polycrystalline W samples of 7×7 mm^2

Energy: 300 eV

Fluence :

6.8×10^{16} ^{3}He.cm^{-2}
(***roughly estimated***)

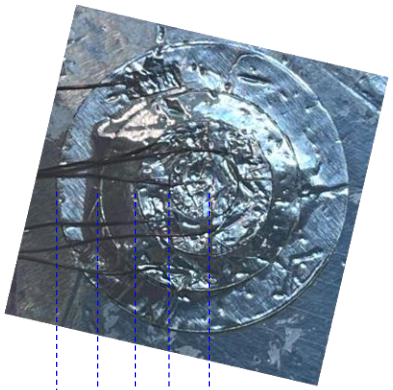
Current density of 8 sections



- The lower half of the circle has an almost homogeneous current density

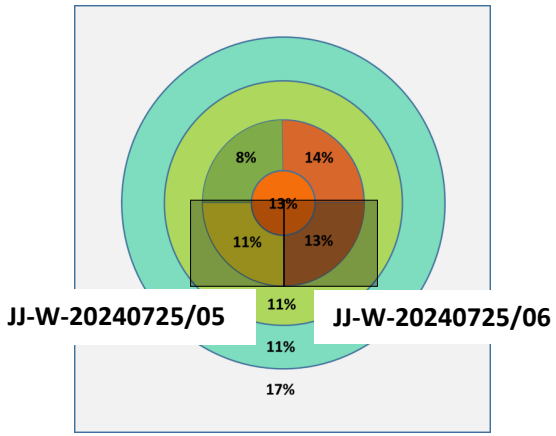
Test before real exposure

Ion density tester



2.85 mm
4.75 mm
7.15 mm
10.3 mm

Current density of 8 sections



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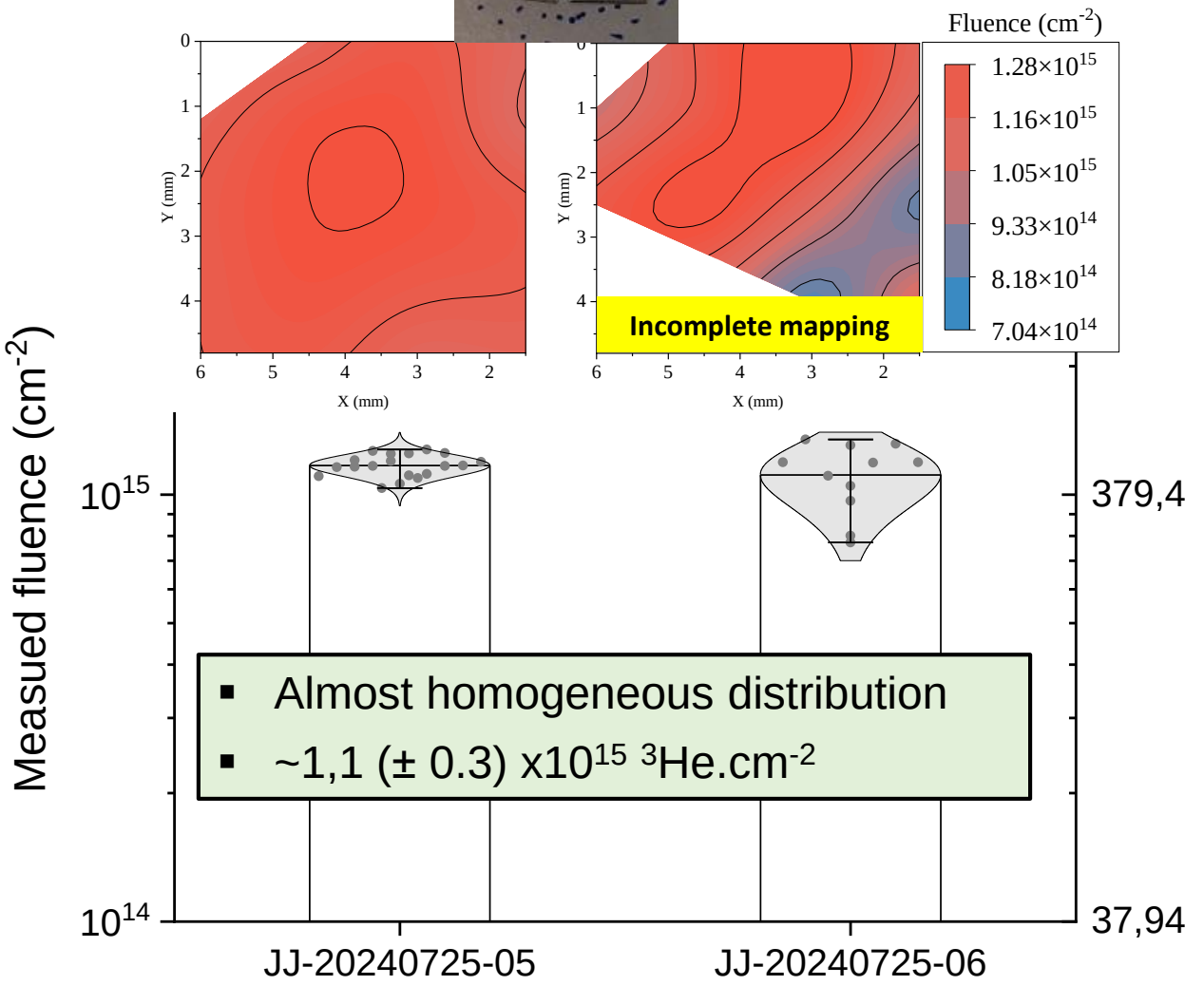
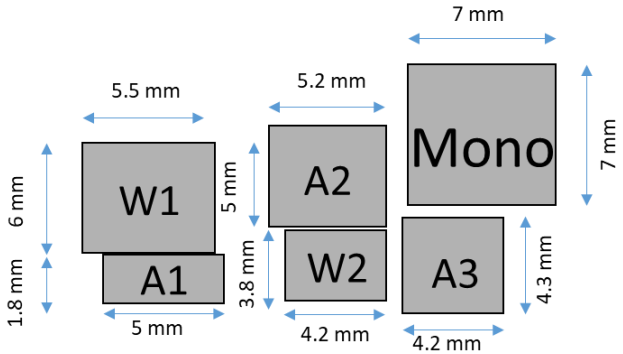


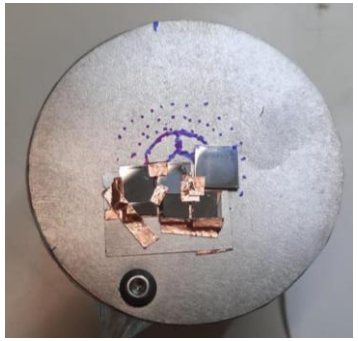
^{3}He exposure to thin-layer HEA, W and thick mono W

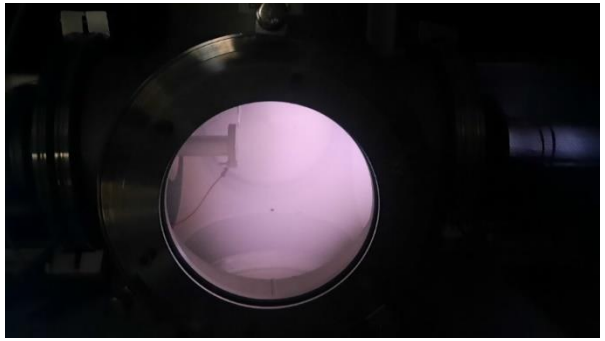


A1: $W_{34.6}Nb_{32.5}V_{33}$

A2: $W_{68.8}V_{31.2}$

A3: $W_{57.2}V_{42.8}$





Thin-layer samples prepared by Z. Chen

Exposition time :16/12/ 2024

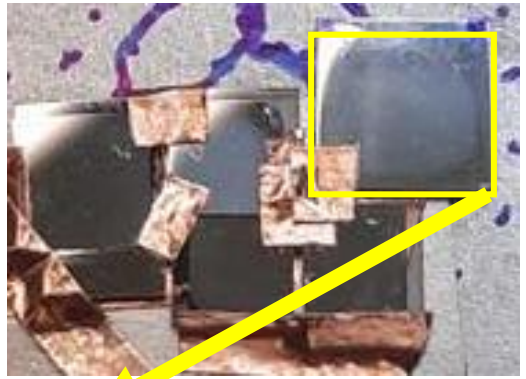
Energy: 300 eV

Fluence :

~7 × 10^{16} ^{3}He.cm^{-2} (***roughly estimated***)

NRA of ^{3}He-exposed single-crystal tungsten

(100) W Single-crystal (W-M-P-01, 7*7 mm^2), Polished and annealed at 1700°C/3 h/vacuum (with a mask (7*7 mm^2)



Energy: 300 eV

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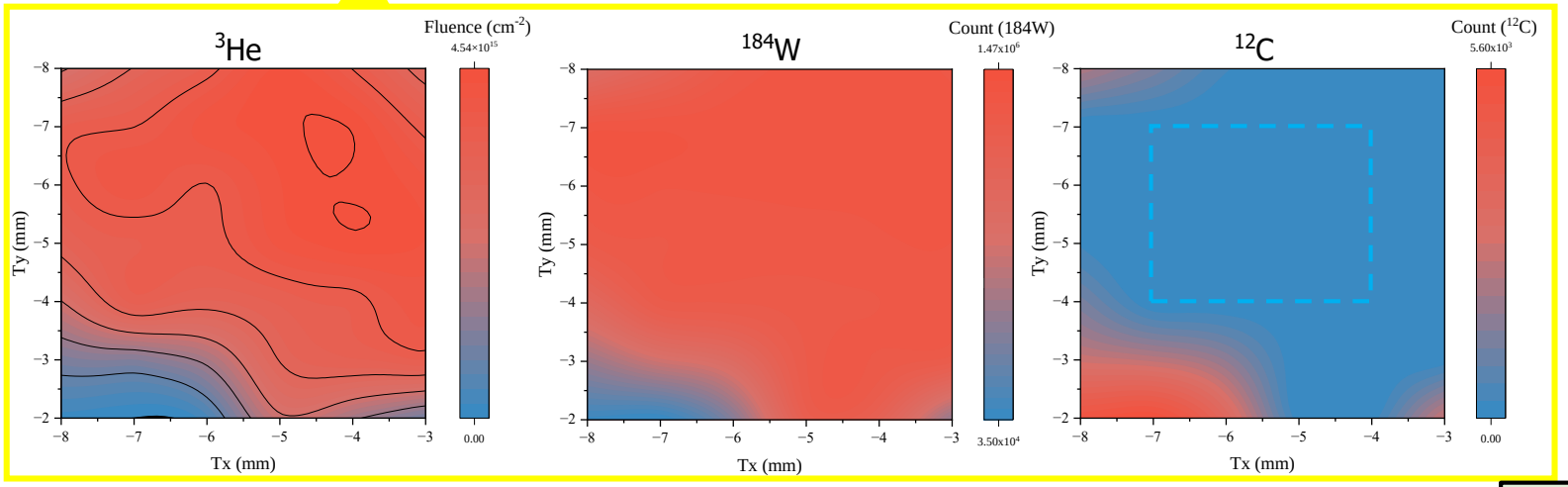
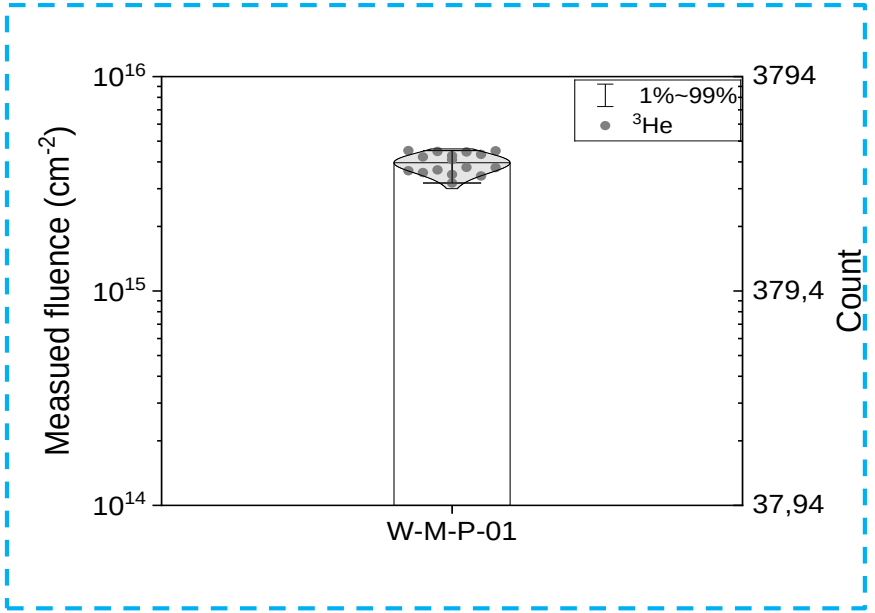
~7 × 10^{16} ^{3}He.cm^{-2}

(***roughly estimated***)

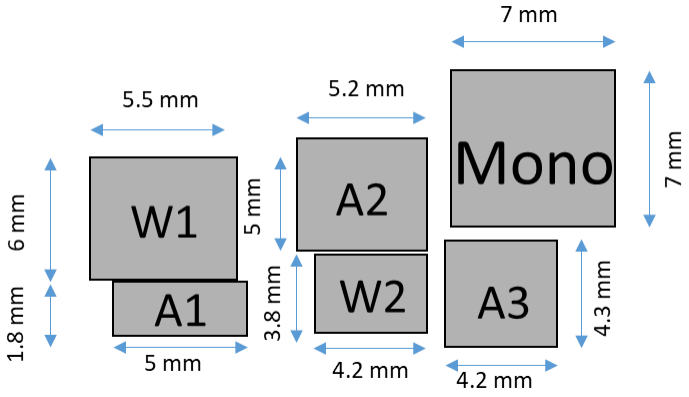


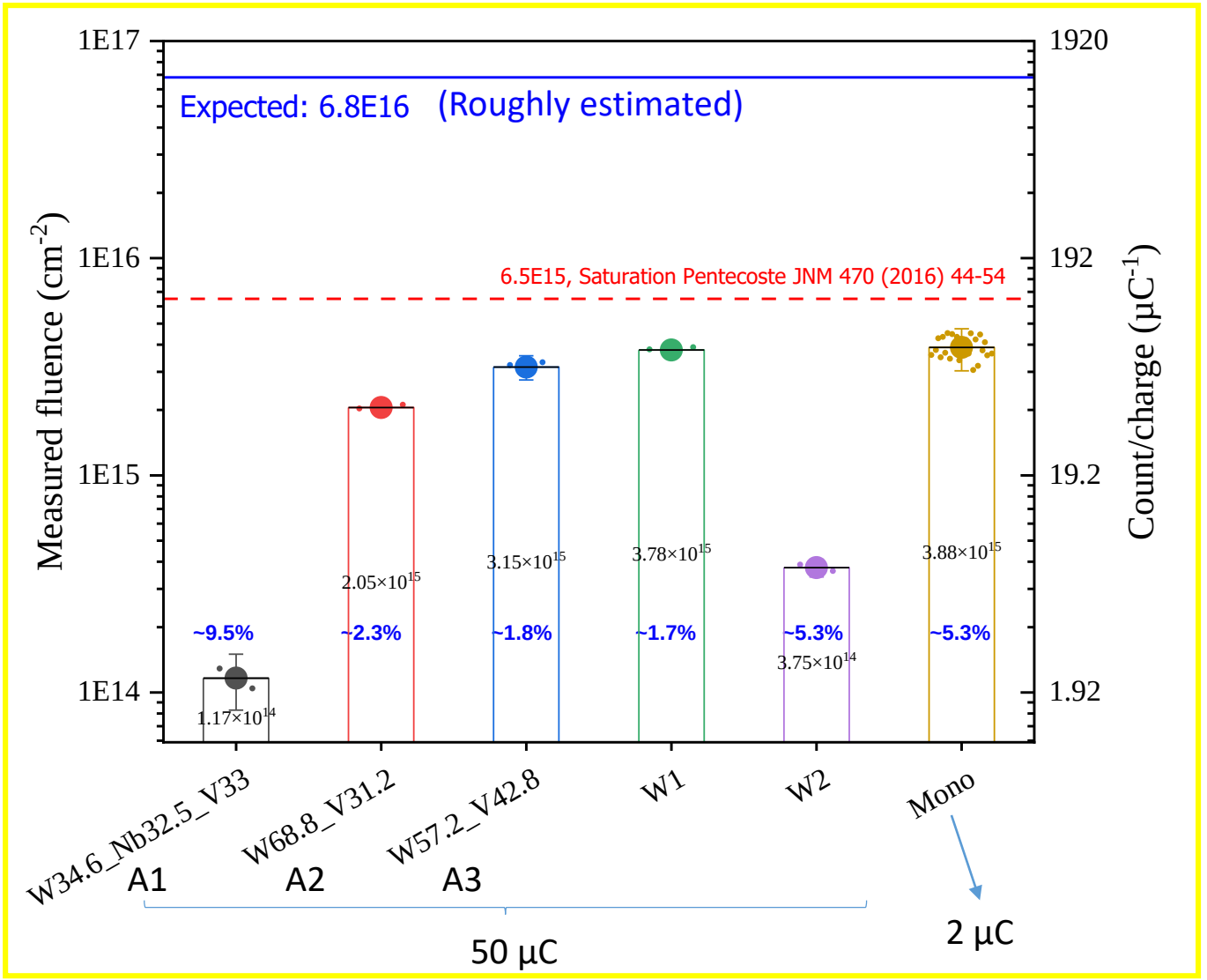


- Homogeneous distribution in clean surface
- $\bar{\Phi} \approx 4\ (\pm 0.4) \times 10^{15}$cm^{-2}

NRA of ^{3}He-exposed single-crystal HEA

HEAs thin layers/ MgO substrate: A1(W34.6-Nb32.5-V33), A2(W68.8-V31.2), A3(W57.2-V42.8), pure W_1, W_2





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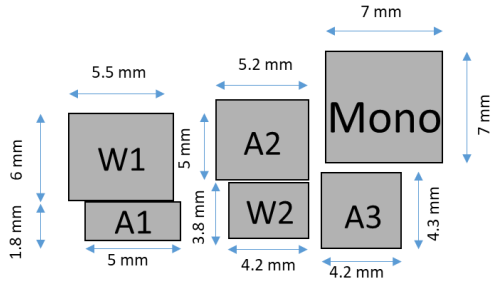
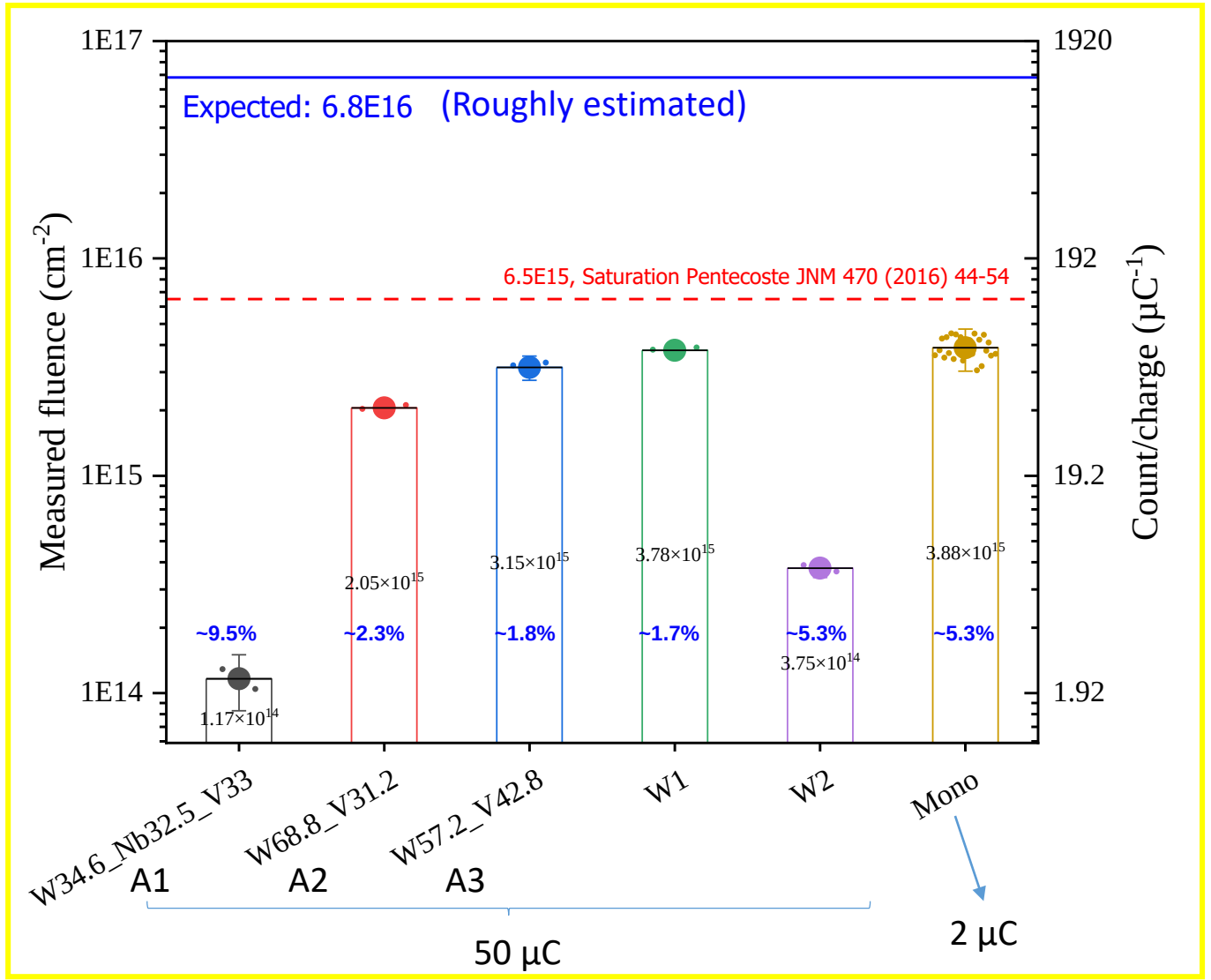


Conclusions

- $[^3He]_{W1} \approx [^3He]_{Wmono}$
- $[^3He]_{W2} < [^3He]_{W1}$ ➔ Why ?
- A1 is too small for a good measurement -> need to be repeated in a new larger sample
- [He] ↘ with [V] ↘, not as expected from calculation, to be confirmed ??
- 2-3 nm C and O Contamination at the surface ≠ ERDA (Z. Chen)
- ^{3}He flux calibration in progress



NRA of ^{3}He-exposed single-crystal HEA

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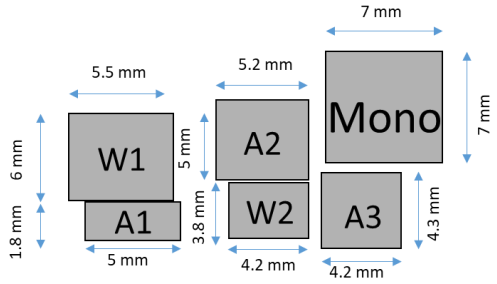
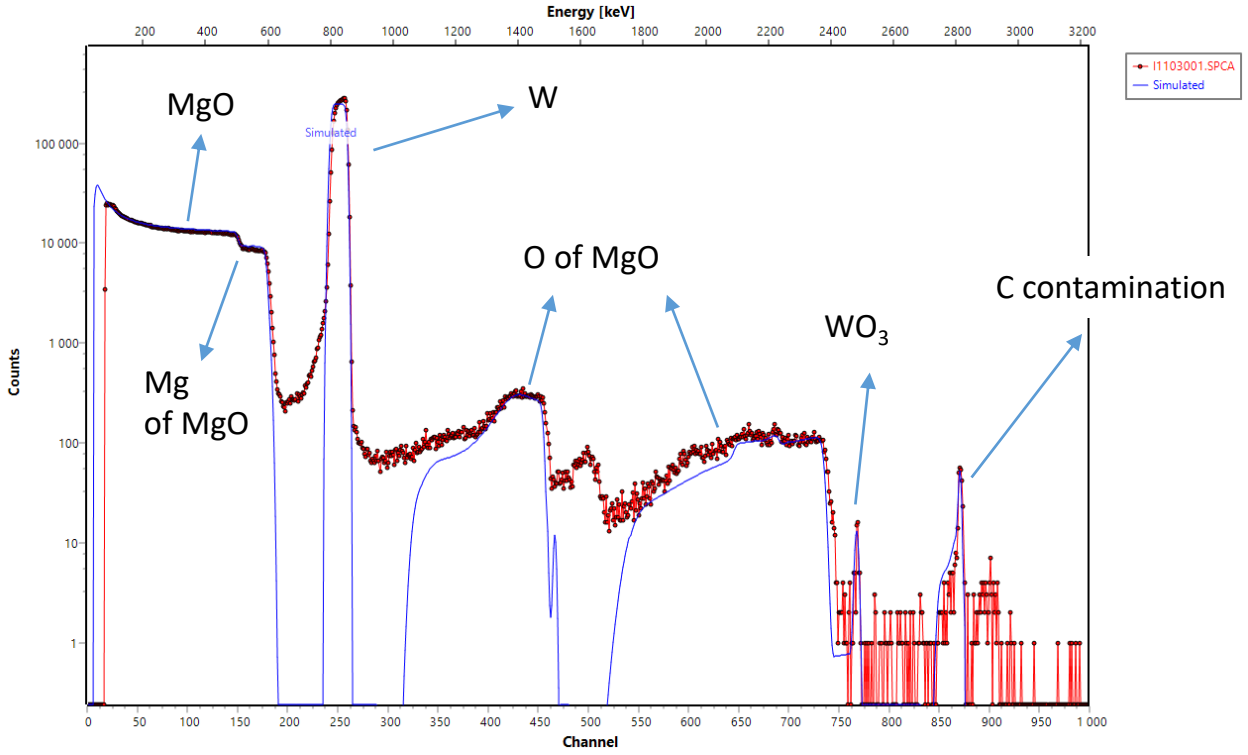


Conclusions

- 2-3 nm C and O Contamination at the surface ≠ ERDA (several tens nm, Z. Chen)
- C contamination in the layers?

Data processing in progress



Summary

Main results :

➢ NRA on ^{3}He-exposed single-crystal HEA and W

- No evident V effect was revealed, whereas the HEA (A1) containing more Nb has lower He retention
- The thin HEA layer has about 150-200 nm, 2-3 nm C, and O contamination at the surface of thin-layer samples.
- Channeling direction does not affect the ^{3}He detection

Perspectives :

➢ for new 3He exposure :

- Pure W (limit the number of holes)
- WV alloys: with increasing V contents (1, 10, 30, 50 at %?: The Calculations used W(50%)V(50%).
- WNbV: repeat the exposure in a layer containing W, Nb, and V similar to A1.

➢ 2 new NRA campaigns are scheduled 29-30/04 and 22-23/05, the new 3He exposure should be carried out the week before