

Investigation on Cs dispersion and Mo coating on SPIDER components

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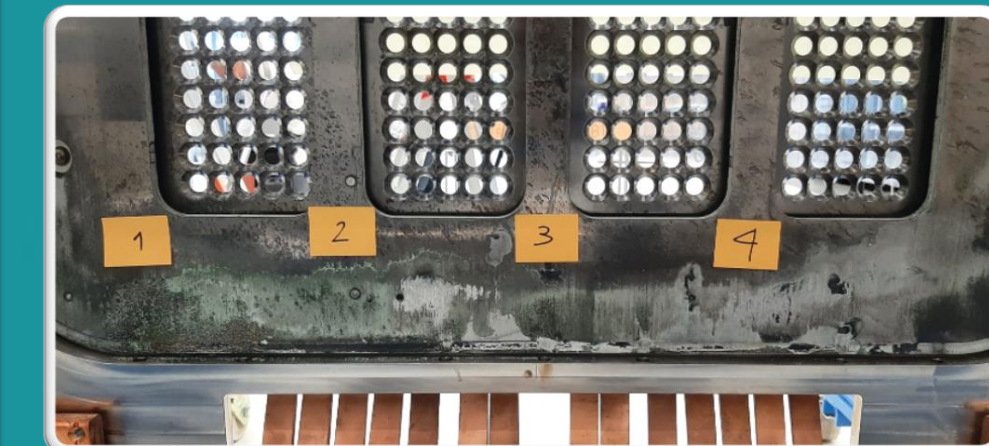
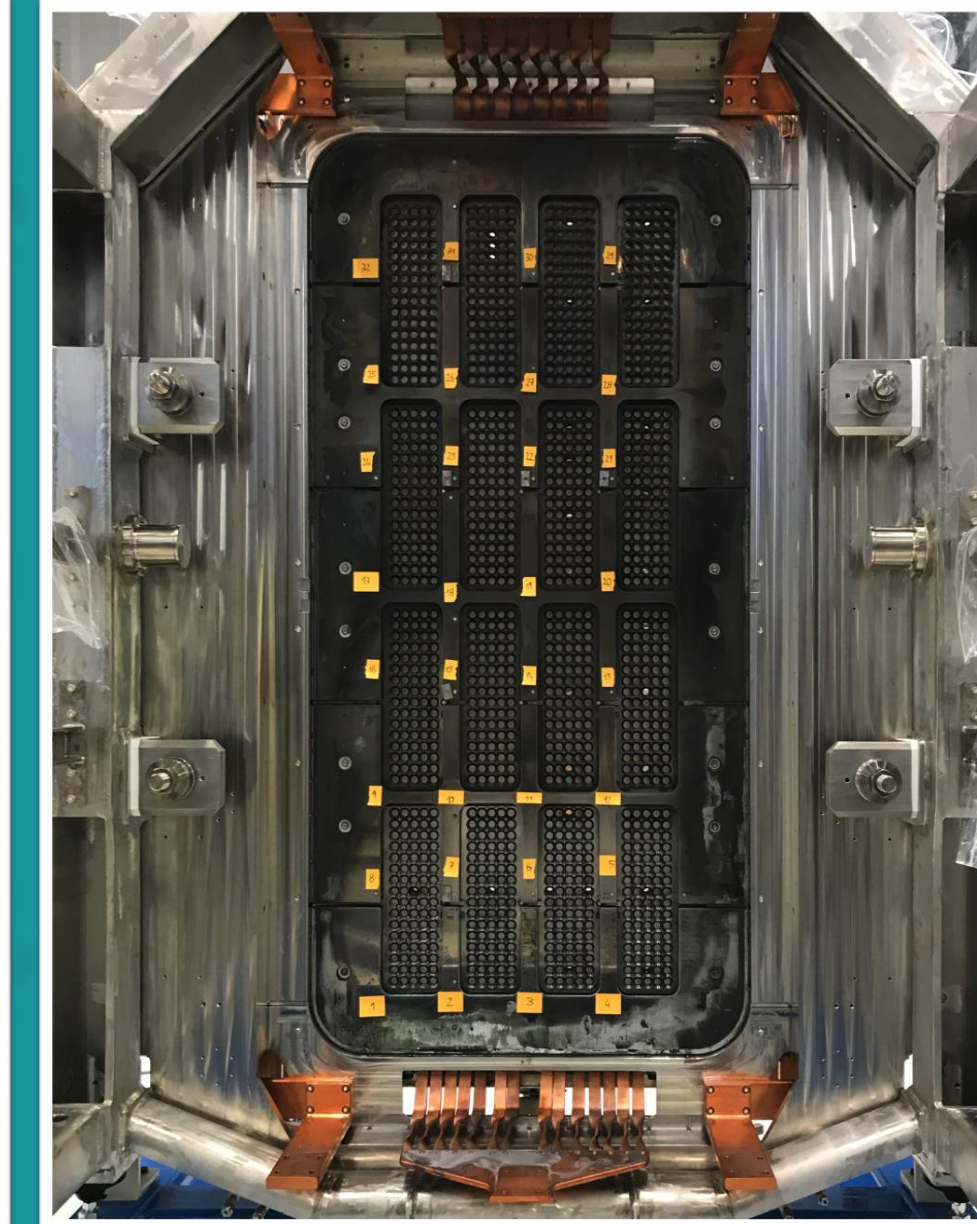
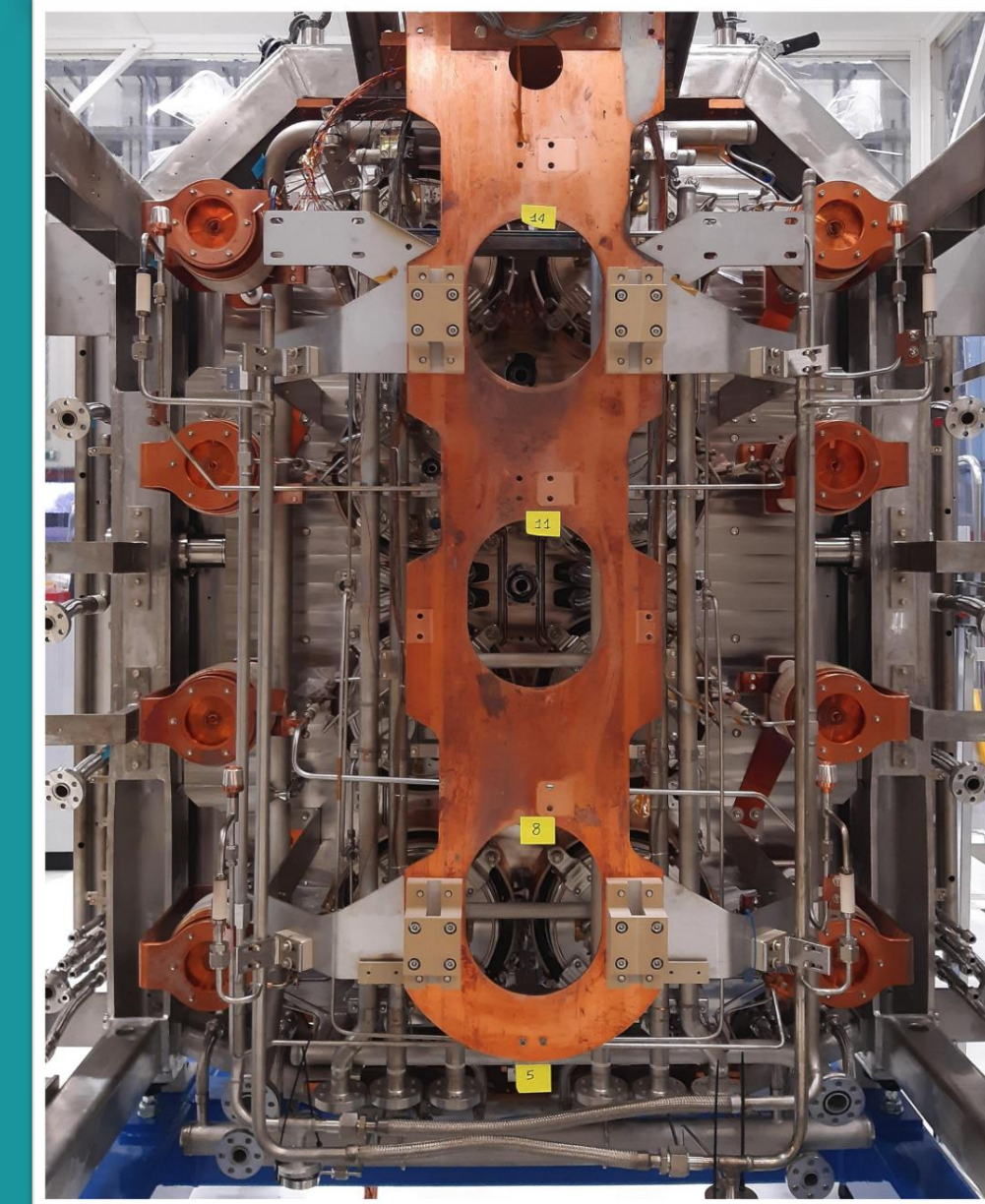
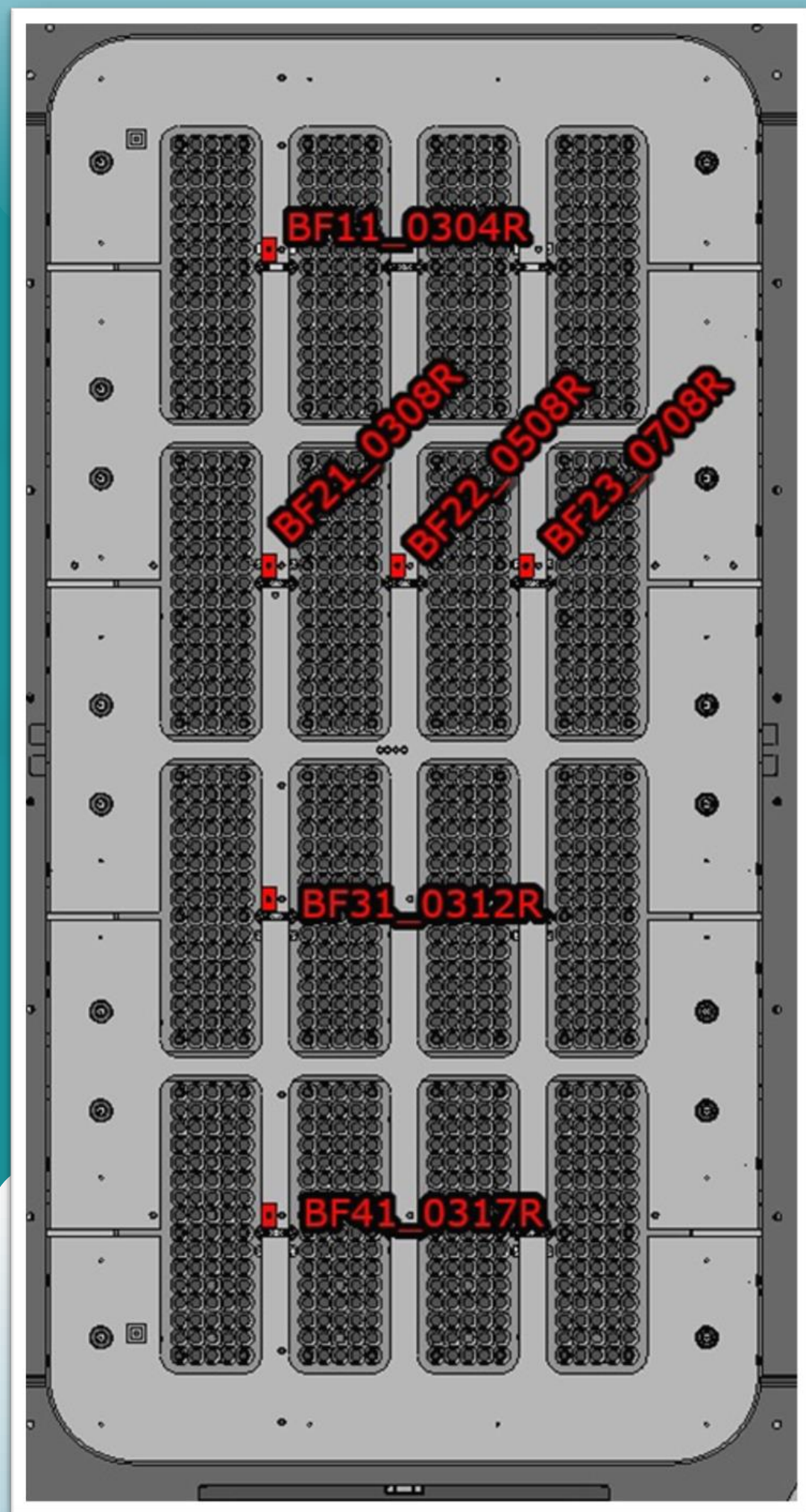


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INTRODUCTION

- SPIDER is the low energy 100 keV ITER full-size Ion Source [1].
- Plasma is produced in the plasma box.
- A thin **molybdenum** layer covers the plasma box components, the Plasma Grid (PG) and the Bias Plate (BP).
- Caesium** spread onto BP and PG to enhance H- production via Cs ovens [2].
- SHUTDOWN 2021**: dismantling of the source → non uniform coatings revealed onto some components! Specifically on PG, BP, EG.

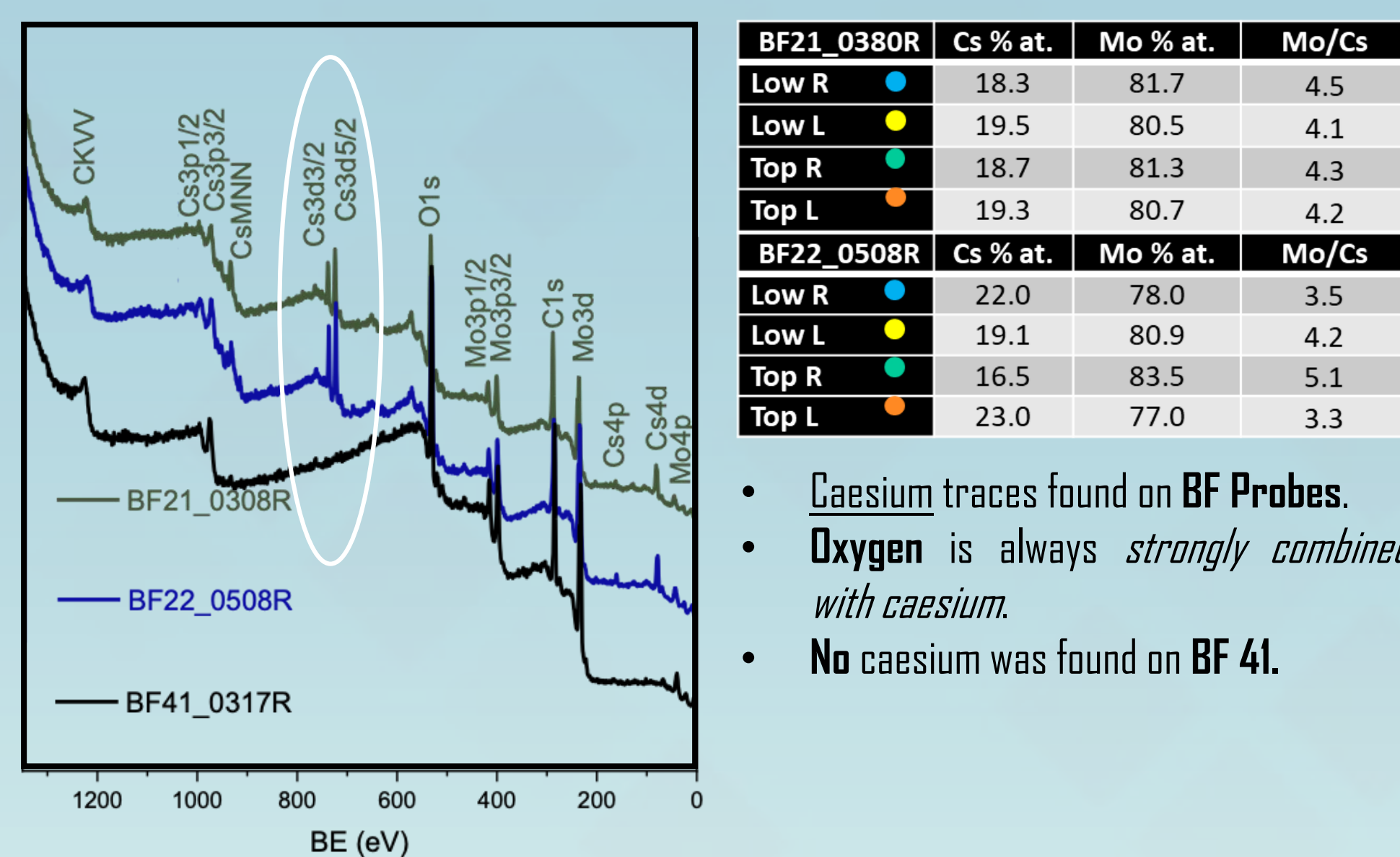
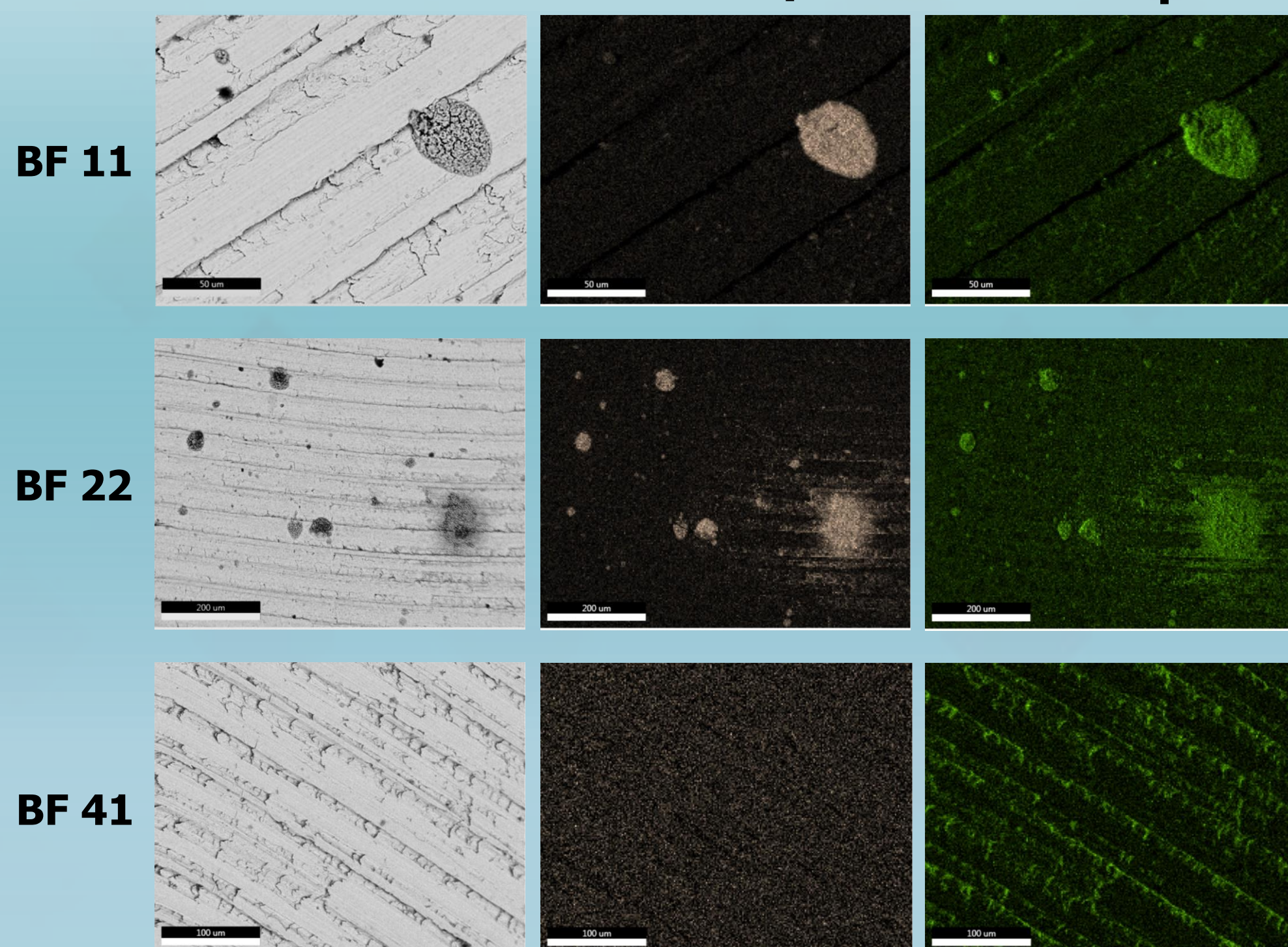


MATERIALS and METHOD

- Samples of the Mo coating that covers the BP and the PG taken scratching the surface with a flat end metallic spatula.
 - BF Probes removed and analyzed. They are bulk Mo platelets fastened to the Bias plate with a screw.
- SEM-EDS, XRD and XPS: on both BP probes and powder residues taken from SPIDER components.

BF PROBES ANALYSES

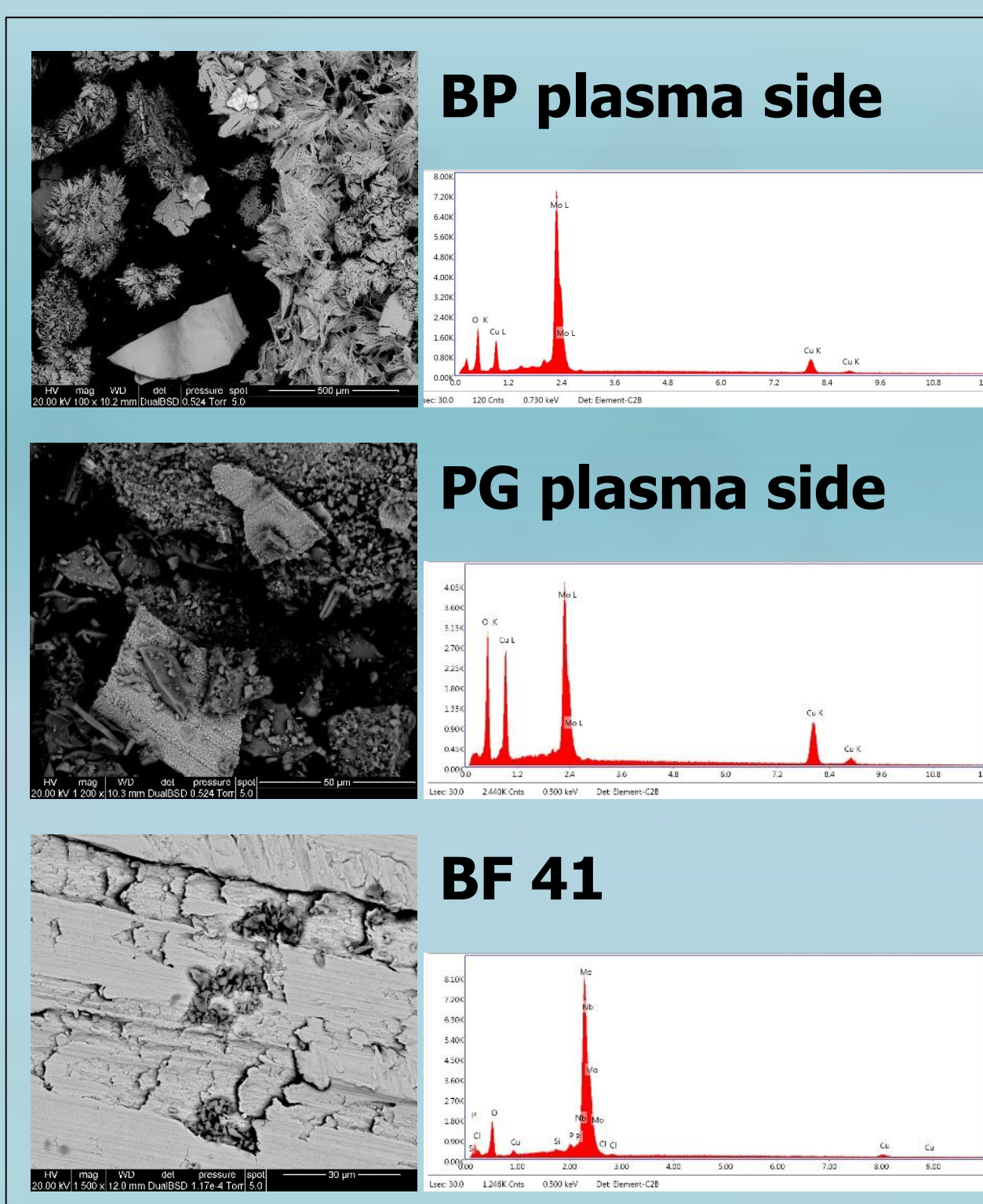
Cs map O map



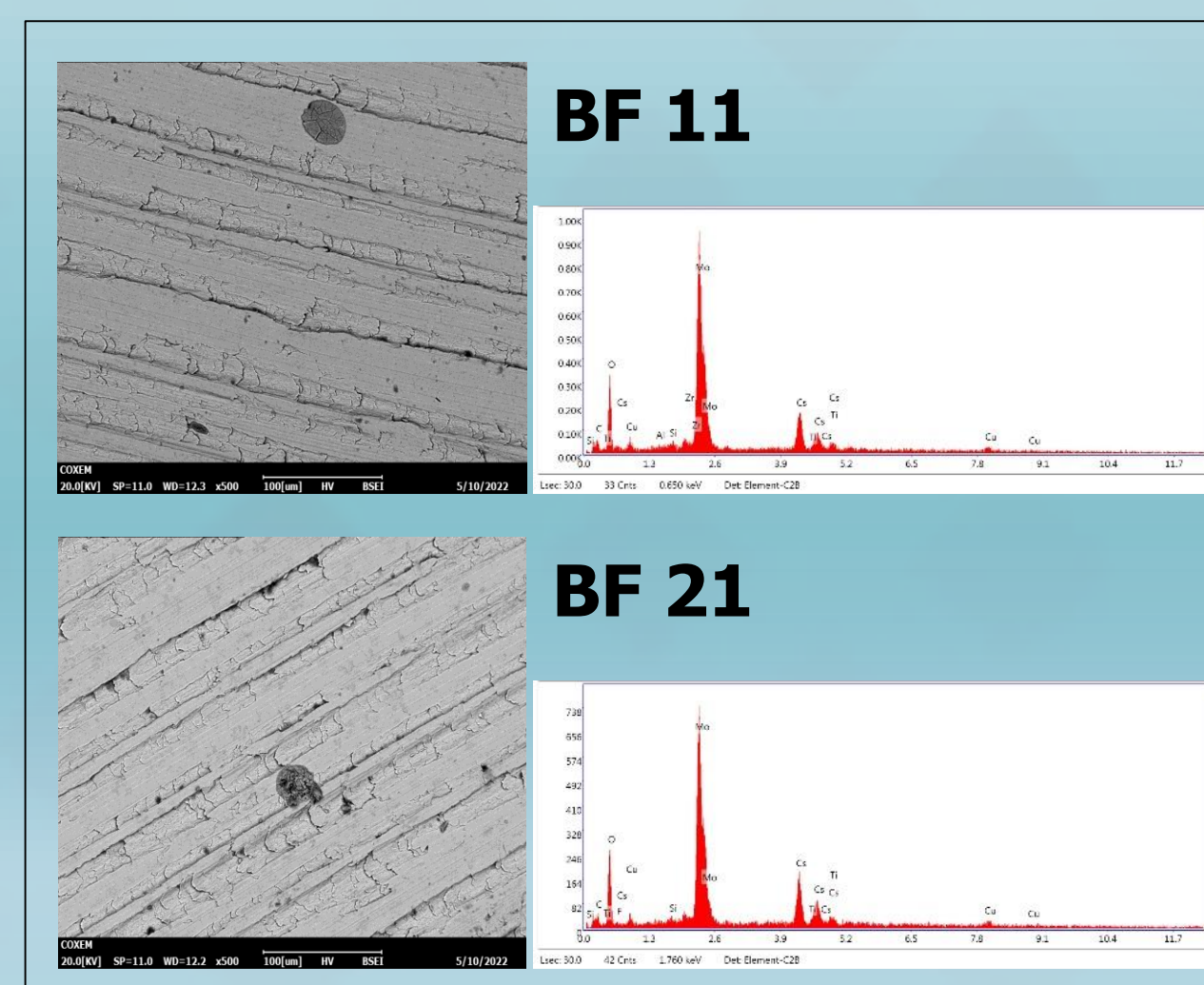
- Caesium traces found on BF Probes.
- Oxygen is always strongly combined with caesium.
- No caesium was found on BF 41.

CAESIUM AND WATER

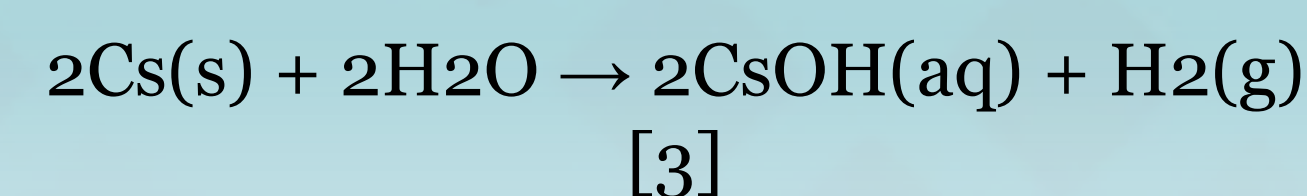
Bottom region: no Cs



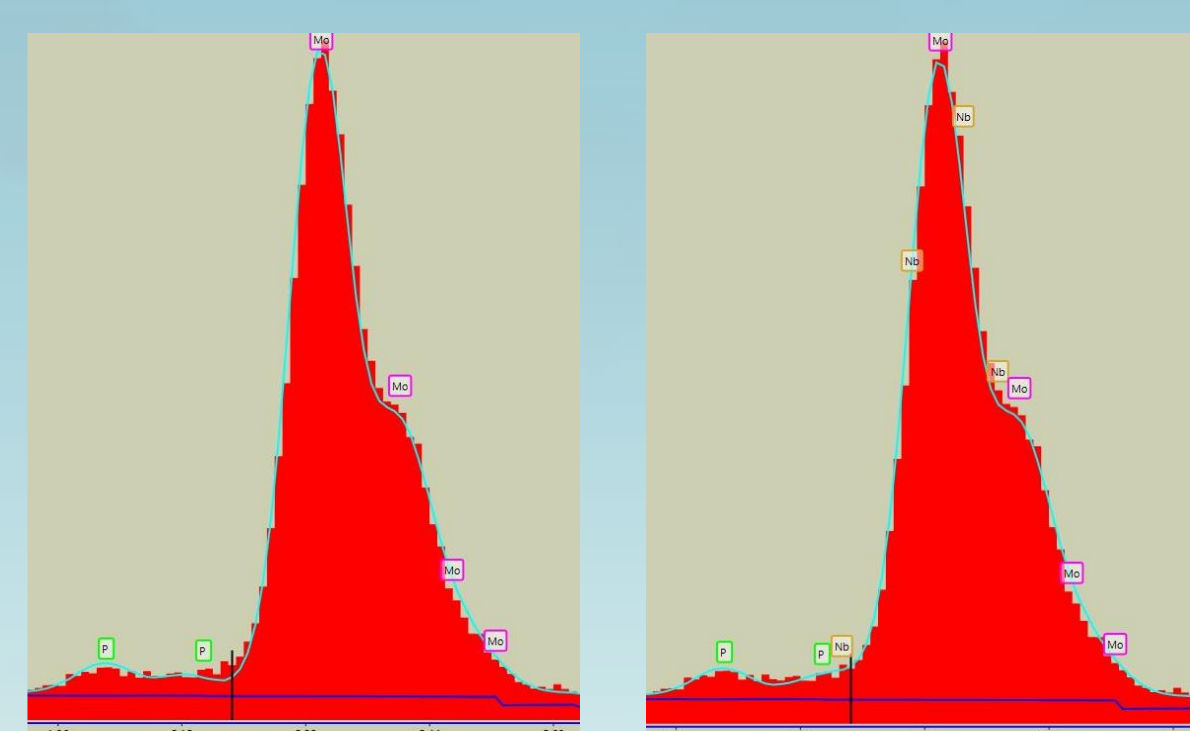
Top region: presence of Cs



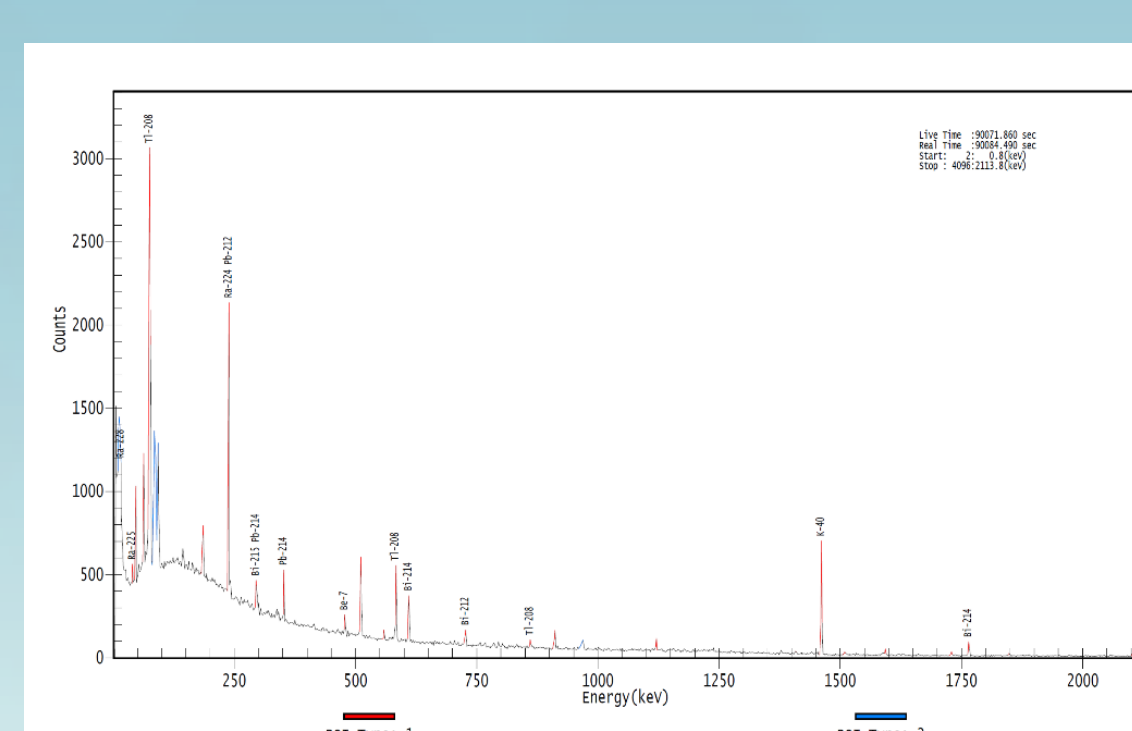
- No caesium found on the bottom part of each component.
- A **water leak** occurred in SPIDER vessel at the end of 2021.
- Caesium reacts with water** by an exothermal and explosive reaction:



Excluding Nb Including Nb



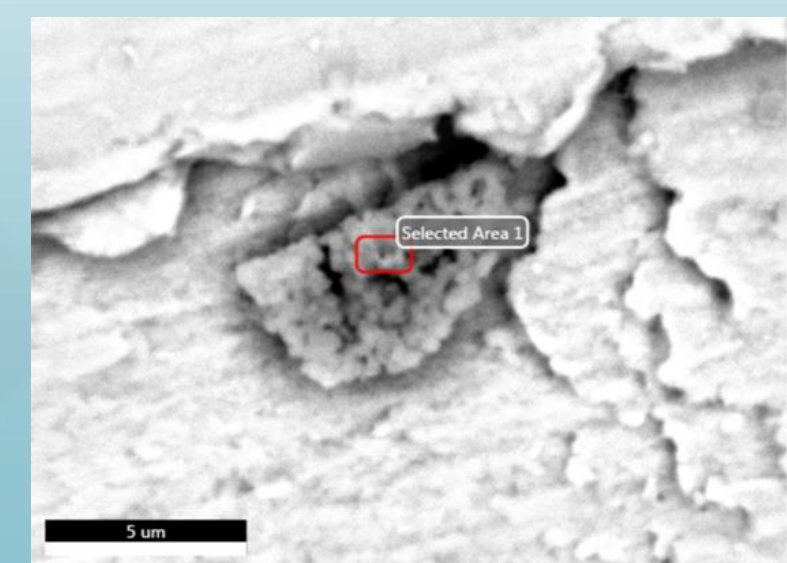
GAMMA SPECTROSCOPY for Nb



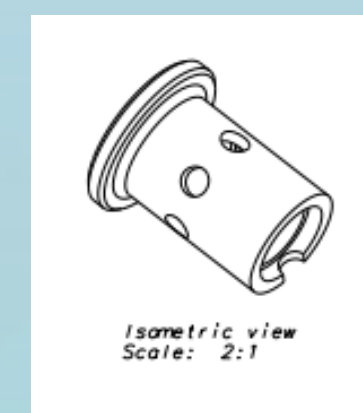
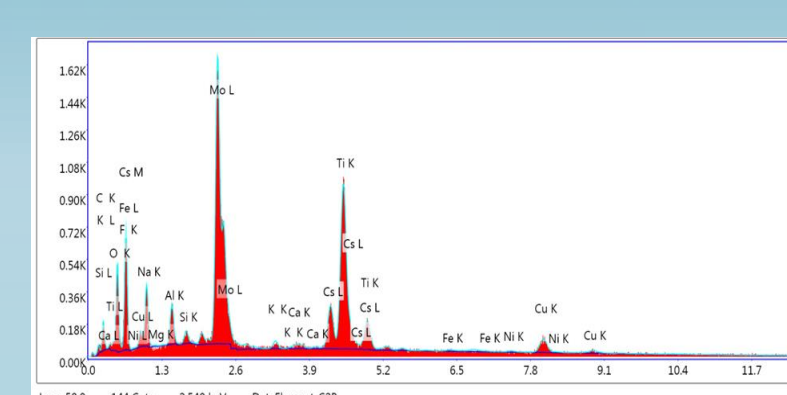
No evidence of Nb. The ⁹⁴Mo (usually present for ~9.18% [4]) do not decay into ⁹¹Nb m/g species by a (p, alpha) no threshold reaction. Moreover, ⁹¹Nb (half-life of 61 days) produces peaks at 105 and 1205 keV [5], not detected.

RESULTS and DISCUSSION

Ti-Cs CHIPS



Porous Ti-Cs chips were found especially on BF21.



Cs nozzle is made of TiZr alloy! Cs strips Ti from the alloy.

CONCLUSIONS

So far, the only evidence of caesium evaporation is its heterogeneous distribution across SPIDER surface. Cs is present on the top half, but no evidence of Cs on the lower part: water leakage occurred and water strongly reacted with Cs. Due to atmospheric exposure, oxygen is most probably bonded to Cs. Further investigations need to be carried out to establish if Cs droplets are hydroxides and/or oxides. Moreover, it was assessed that there is no evidence of Nb due to nuclear reactions on the BF probes. Ti-Cs porous chips, found on the BF probes surfaces are fragments of Cs-ovens nozzles that have been distributed around the source. The nozzles should be observed to confirm the statement. Further investigations need to be carried out on other SPIDER components to analyze both the chemical composition and the Cs dispersion: a test bed is under design and construction at Consorzio RFX to study the effective monolayer caesium distribution on SPIDER grids. TEM analyses will be performed to assess Cs monolayer and its morphology.

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