University of Latvia activities in 2023: Tritium and composition analysis of JET samples – plans and capabilities

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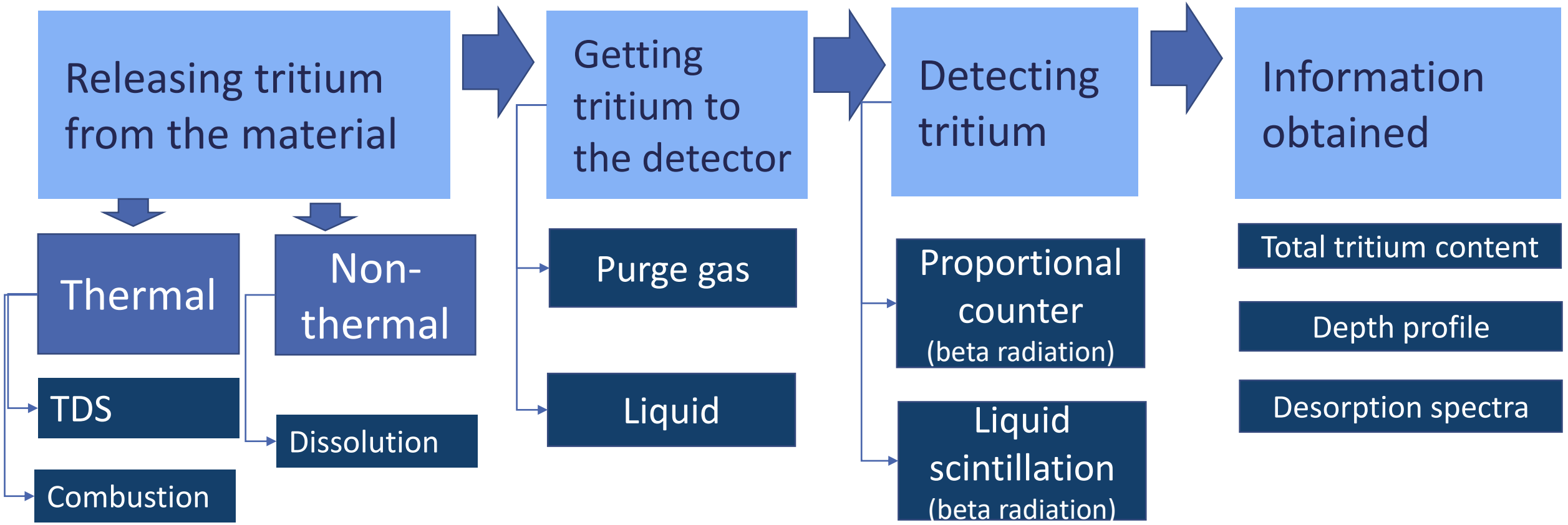
WP PWIE SP E: Kick-off meeting
March 14, 2023

OUTLINE

- Tritium analysis methods
  - Dissolution/etching
  - Thermal desorption
  - Full combustion
  - Long term baking
- Structure and composition analysis

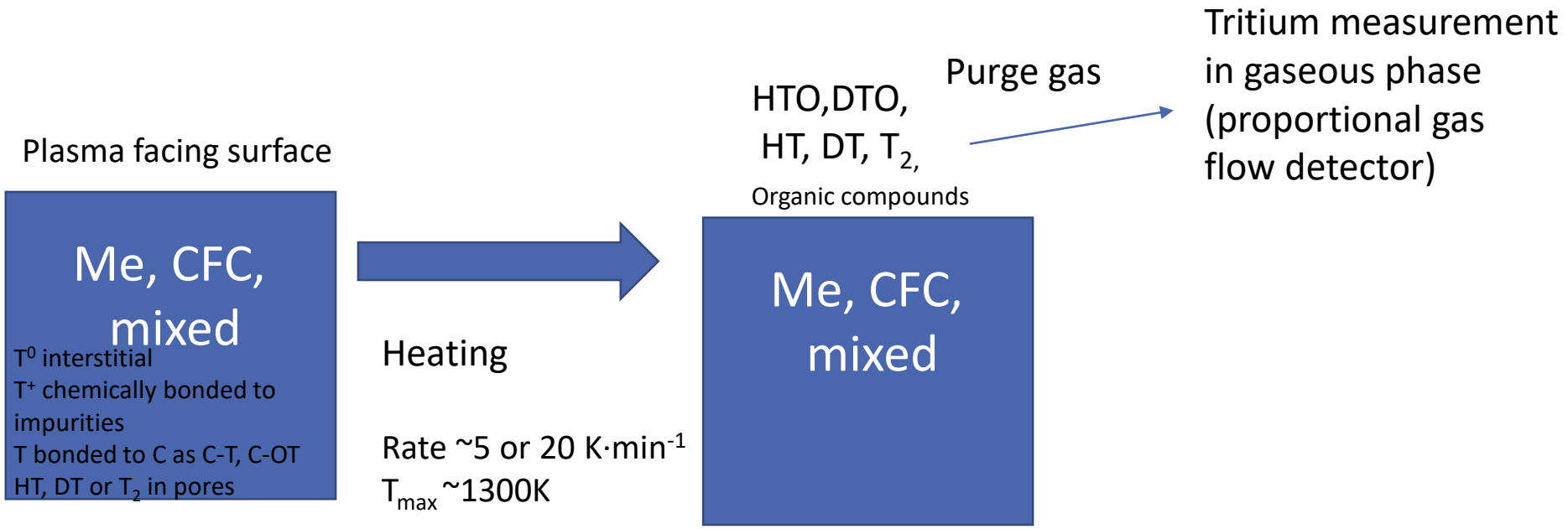
Different concepts of tritium measurements in plasma facing materials (available at UL)

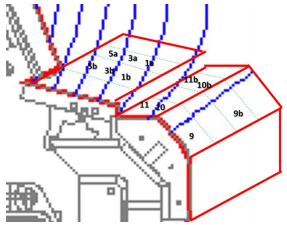


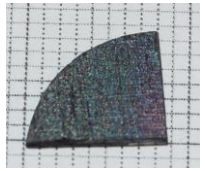
Thermal desorption - **divertor tiles W/C and W lamellas(2023)**

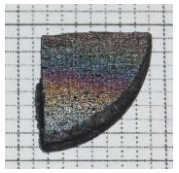
Materials to be applied for: **all**

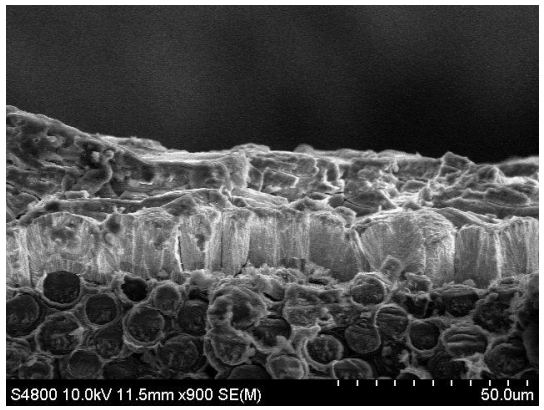
Based on controlled thermal treatment and measurement of tritium being released as a result of thermal desorption

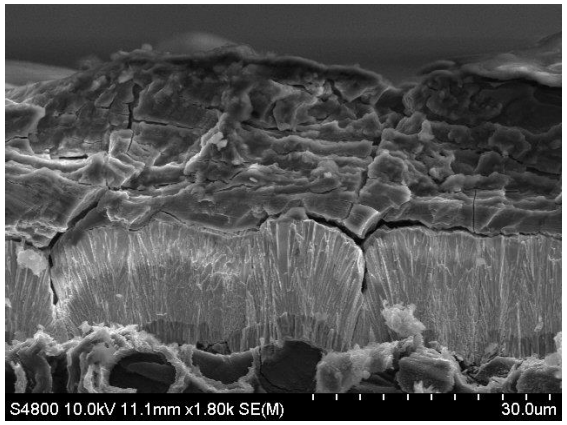


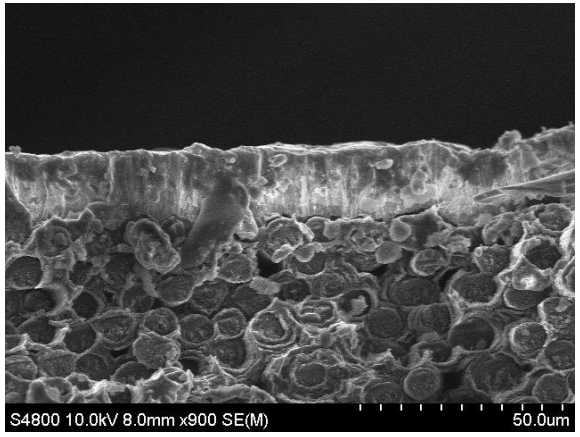


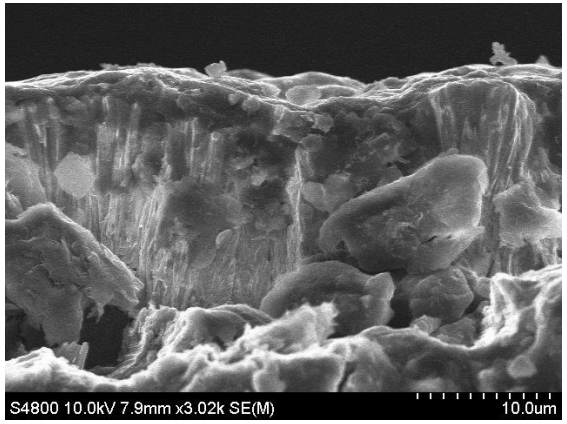


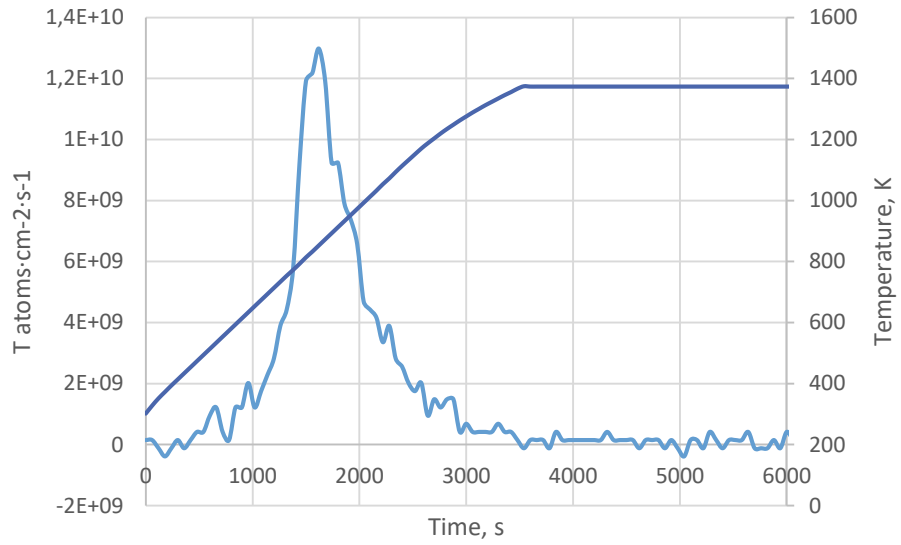



S4800 10.0kV 11.5mm x900 SE(M)
50.0um

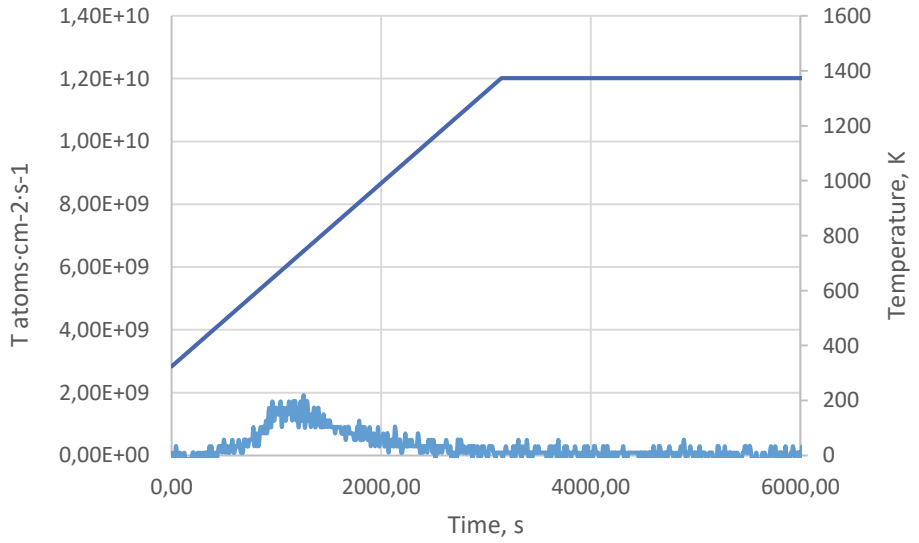

S4800 10.0kV 11.1mm x1.80k SE(M)
30.0um


S4800 10.0kV 8.0mm x900 SE(M)
50.0um


S4800 10.0kV 7.9mm x3.02k SE(M)
10.0um


1,4E+10
1,2E+10
1E+10
8E+09
6E+09
4E+09
2E+09
0
-2E+09
T atoms·cm-2·s-1
0
1000
2000
3000
4000
5000
6000
Time, s
1600
1400
1200
1000
800
600
400
200
0
Temperature, K

1 a

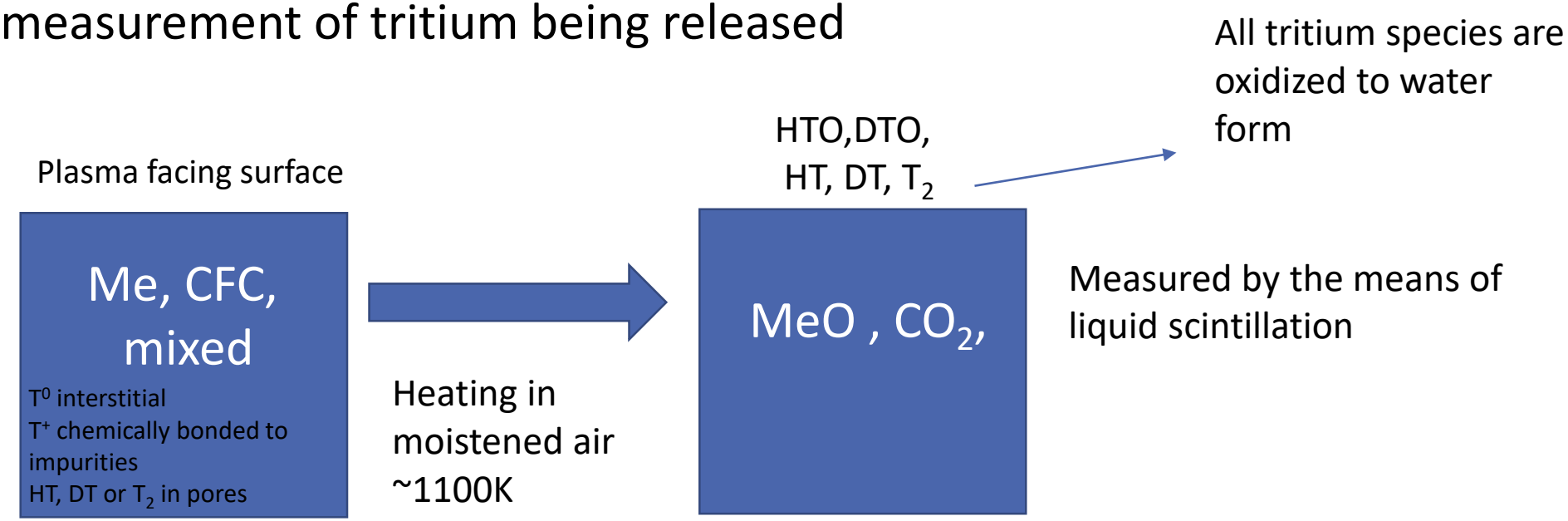

1,40E+10
1,20E+10
1,00E+10
8,00E+09
6,00E+09
4,00E+09
2,00E+09
0,00E+00
T atoms·cm-2·s-1
0,00
2000,00
4000,00
6000,00
Time, s
1600
1400
1200
1000
800
600
400
200
0
Temperature, K

5 a

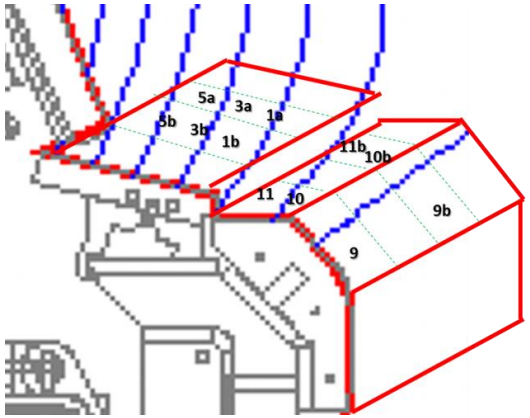
Full combustion - **divertor tiles W/C and W lamellas(2023)**

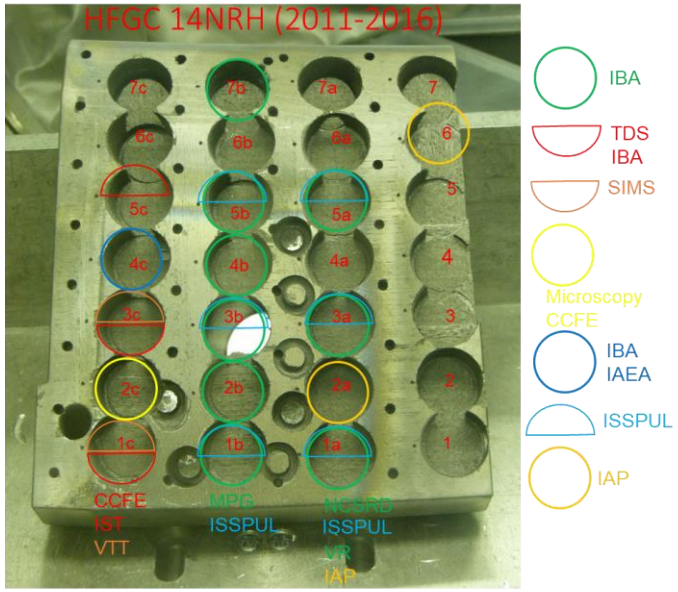
Materials to be applied for: **all combustible**

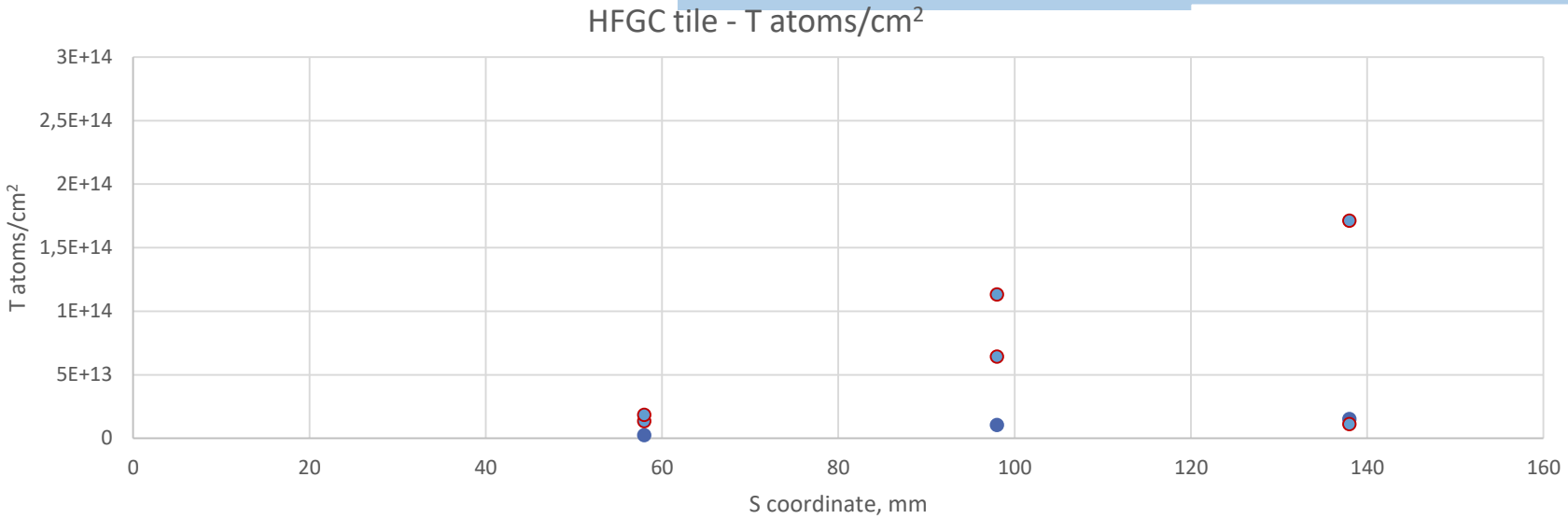
Based on full oxidation of material (destruction of the matrix) itself and measurement of tritium being released

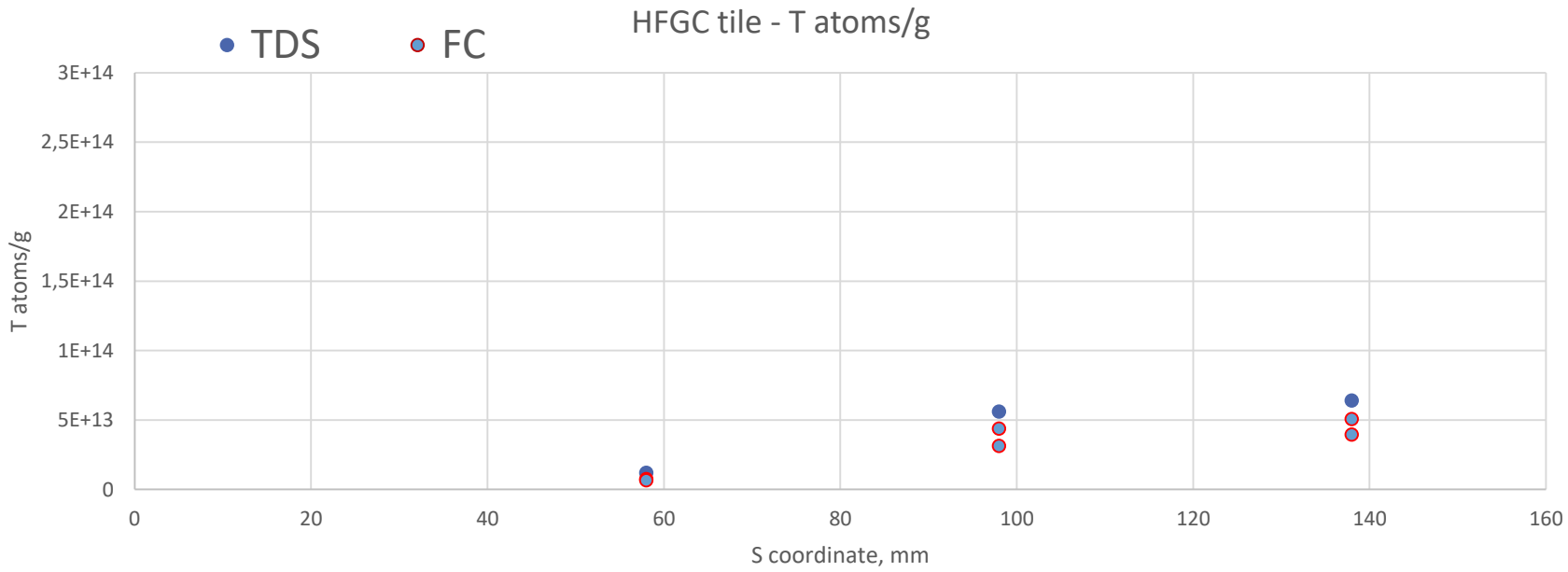


Applied also to all the samples after TDS, dissulution to estimate if any tritium is left


5a
3a
1a
3b
3b
1b
11b
10b
11
10
9b
9

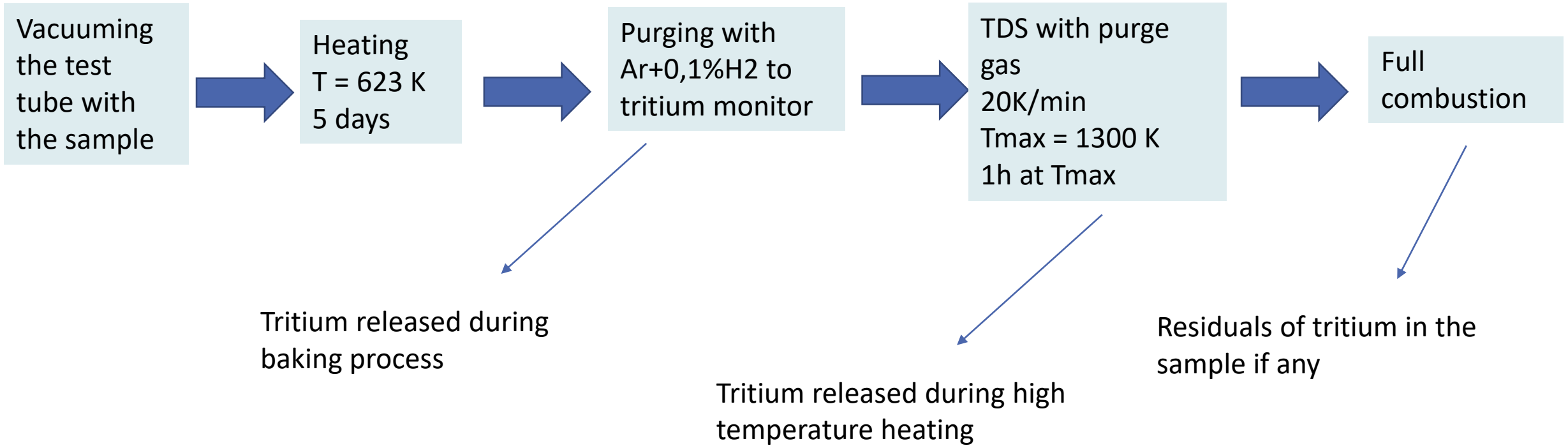

HFGC 14NRH (2011-2016)
7c
7b
7a
7
6c
6b
6a
6
5c
5b
5a
5
4c
4b
4a
4
3c
3b
3a
3
2c
2b
2a
2
1c
1b
1a
1
CCFE
IST
VTT
MPG
ISSPUL
NCSRD
ISSPUL
VR
IAP
IBA
TDS
IBA
SIMS
Microscopy
CCFE
IBA
IAEA
ISSPUL
IAP


HFGC tile - T atoms/cm²
T atoms/cm²
3E+14
2,5E+14
2E+14
1,5E+14
1E+14
5E+13
0
0
20
40
60
80
100
120
140
160
S coordinate, mm


HFGC tile - T atoms/g
TDS
FC
T atoms/g
3E+14
2,5E+14
2E+14
1,5E+14
1E+14
5E+13
0
0
20
40
60
80
100
120
140
160
S coordinate, mm

Long term baking - **divertor tiles W/C (2023)**

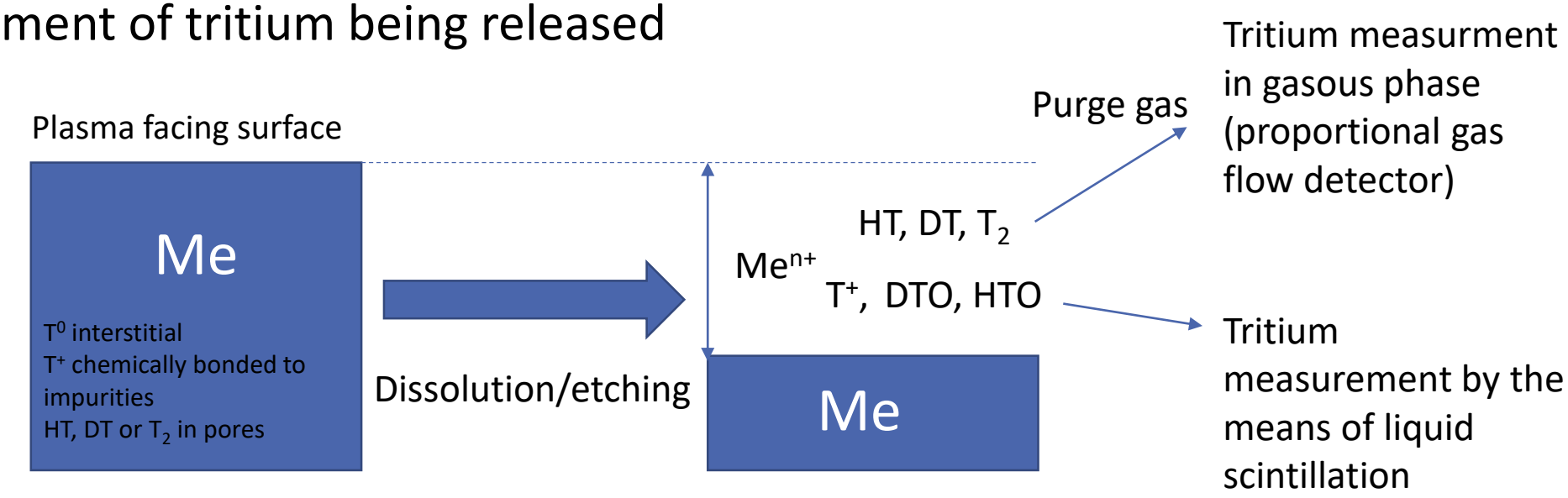
Materials to be applied for : **selected**



Dissolution/etching method - **tungsten lamellas (2023)**

Materials to be applied for: **bulk metals, metallic coatings**

Based on controlled dissolution/etching of metallic matrix and measurement of tritium being released



Tritium measurements based on its radioactivity

$$A_{T_{total}} = A_{T_{gas}} + A_{T_{liquid}}$$

If dissolution/ etching rate is controlled - depth profile can be assessed of tritium released in the gas phase

Summary

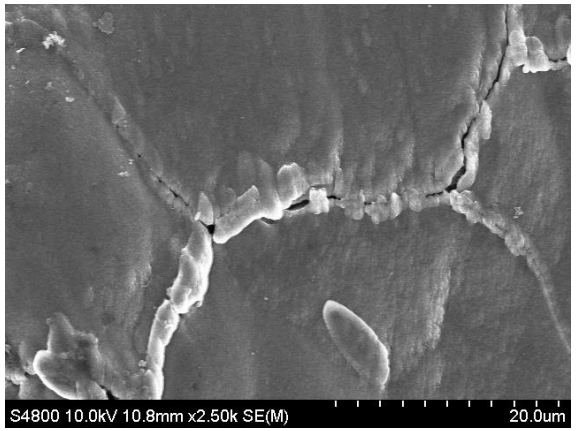
Characteristics	Chemical or electrochemcal etching	TDS	Full combustion
Information obtained	• tritium total amount • depth profile • chemical state (T^o, TH, TD, T_2 in gas phase, T^+ - in liquid phase	• Tritium total amount • Desorption spectra	• Tritium total amount
Tritium release method	Dissolution in 1M H_2SO_4 solution or electrochemical etching with simultaneous hydrogen measurement (by different approaches)	Heating in a furnace, 5 K/min or 20 K/min up to 1300K and held 1h at this temperature	Heating in a furnace in a moistened air, up to 1223K and held for 4-6 h at this temperature, HT and T_2 oxidized in CuO furnace
Carrier gas	Argon, can be varied	Helium + 0,1% H_2 or Argon + 0,1% H_2	Moistened air
Tritium measurement	Proportional counter – gas phase Liquid scintillation – liquid phase	Proportional counter	Liquid scintillation

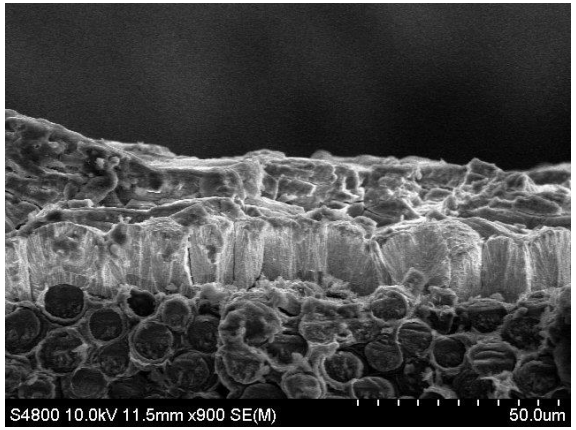
Structure and composition analysis

Scanning electron microscopy: surface structure, estimation of deposition layer thickness

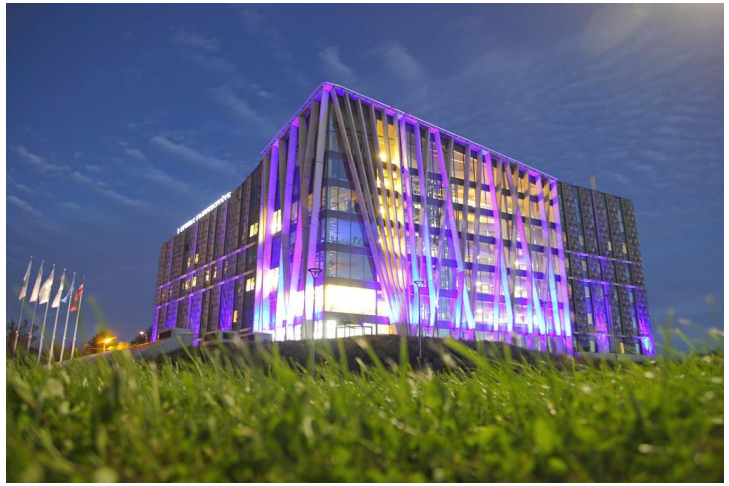
Energy Dispersive X-ray Spectroscopy: composition of the plasma facing surface

FT-IR: composition of the plasma facing surface





Thank you for your attention!



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