



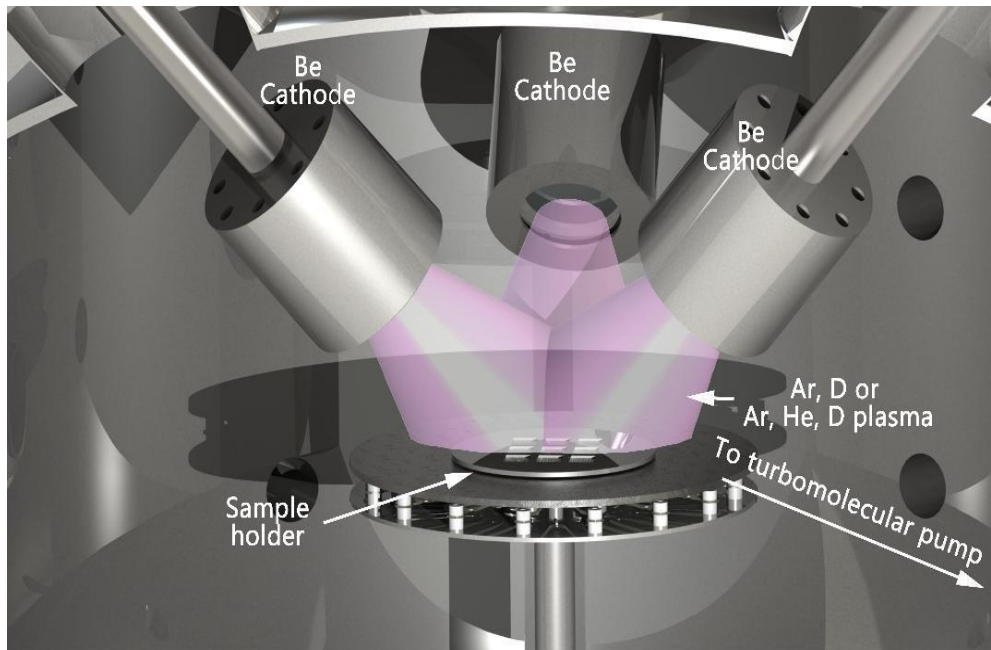
IAP activities in 2021: Be-based coatings with pre-defined properties (incl. SEM, XRD, **GDOES**, TDS characterization) produced for analyses and plasma experiments – plans and capabilities

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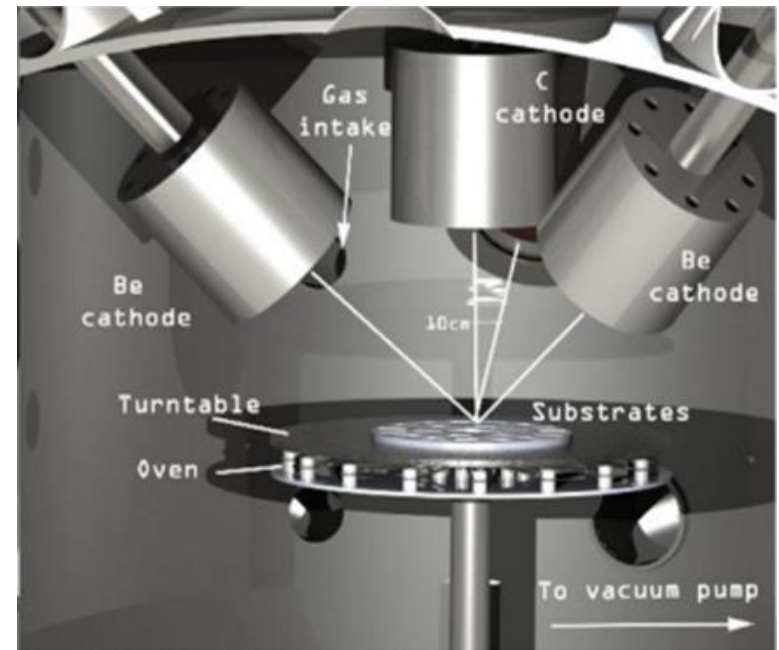


This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Deposition process

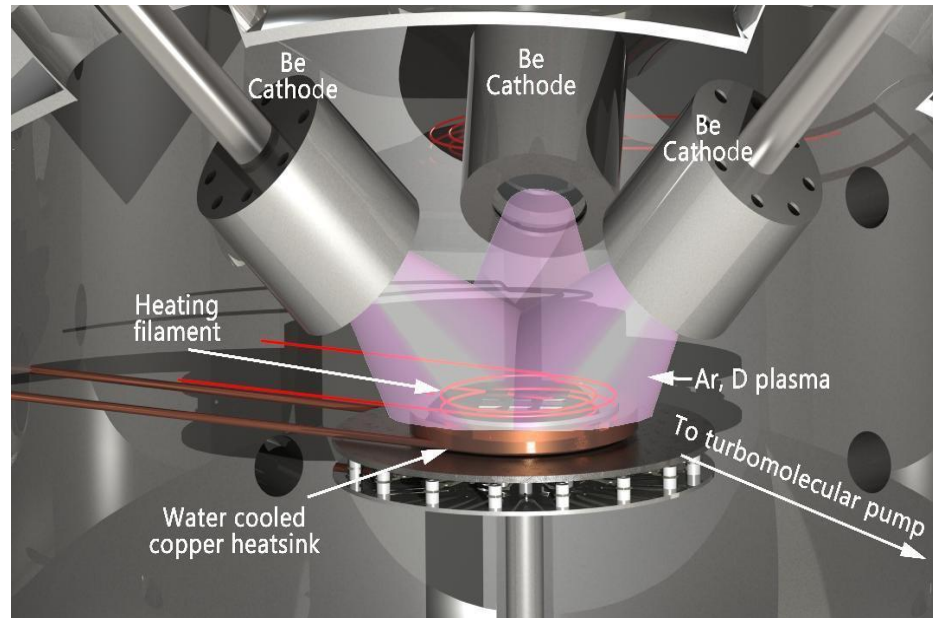


Schematic description of the coating system used for Be-D (Ne, N, He) layer deposition

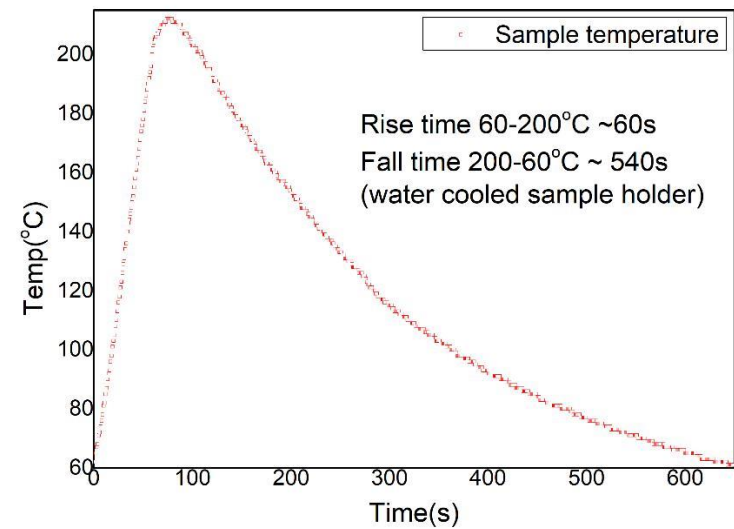


Deposition system used for obtaining Be(-C)-D layers (with He inclusions.)

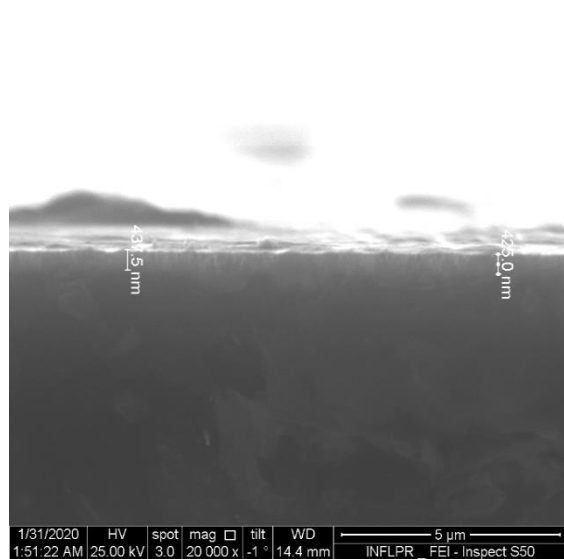
Deposition process - JET ITER-Like Pulses and ITER baking



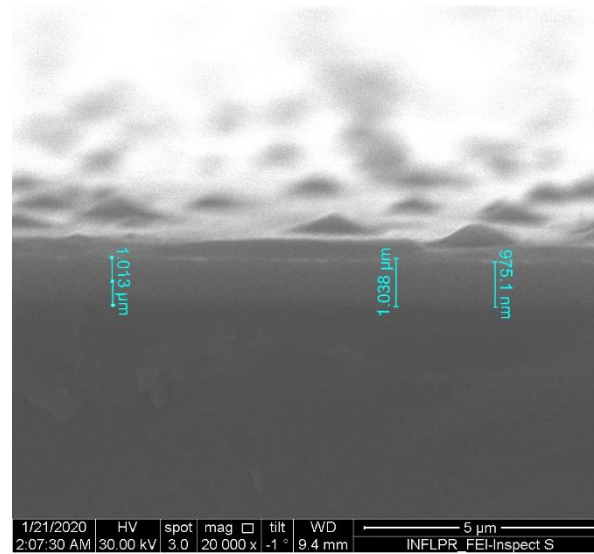
Schematic description of the coating system used for Be-D JET-like pulses layer deposition



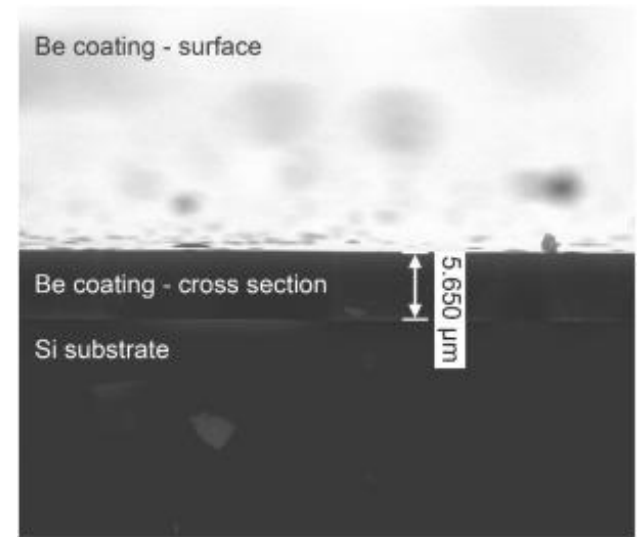
Production of Be-based coatings - SEM



500 nm deposition



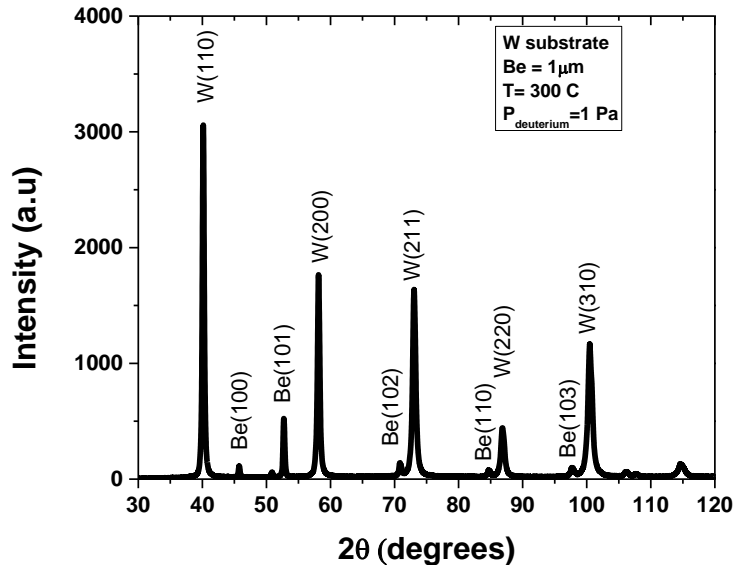
1 micron deposition



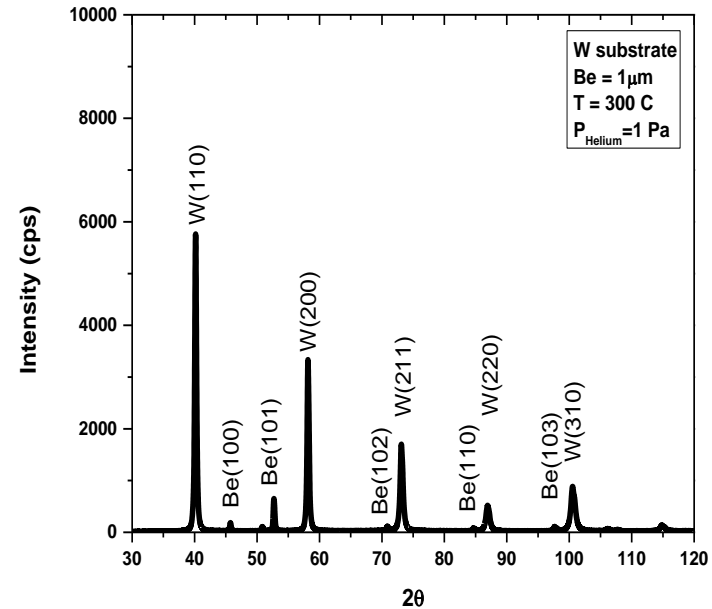
5 microns deposition

SEM images for Be co-depositions on Si substrate

XRD spectra in *Be* co-deposited with *D* or other gasses at different temperatures



Be+D 300°C



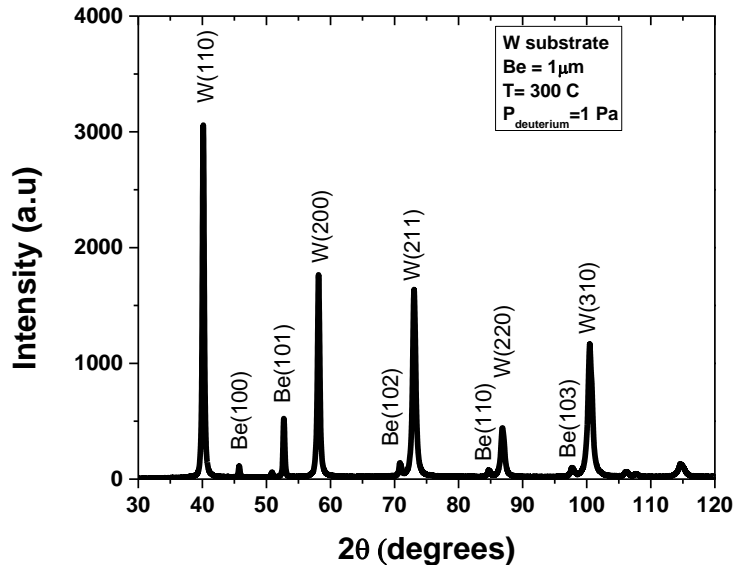
Be+He 300°C

Diffractograms for 1 micron Be co-deposited with D or He on W substrate, at 300°

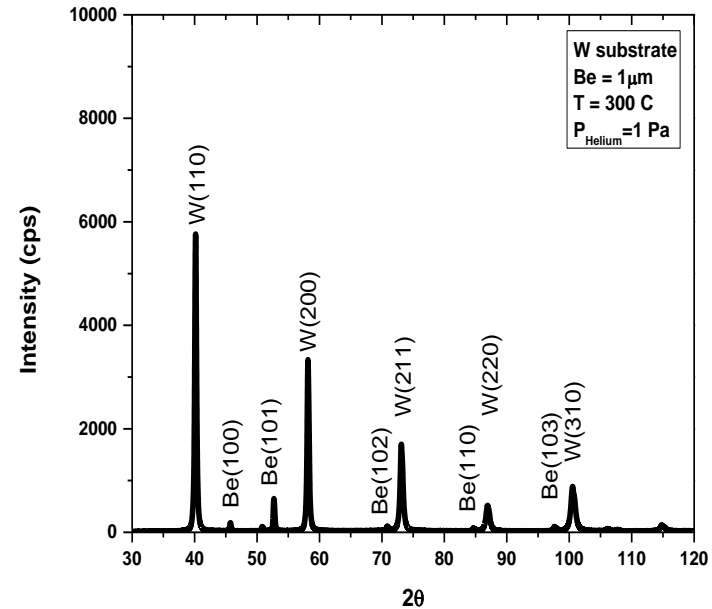
Hexagonal beryllium polycrystalline -sharp peaks for all preferential orientations especially for Be (100), Be (002) and Be (101).

NO significant variation on different gas or with temperature.

XRD spectra in *Be* co-deposited with *D* or other gasses at different temperatures



Be+D 300°C



Be+He 300°C

Diffractograms for 1 micron Be co-deposited with D or He on W substrate, at 300°

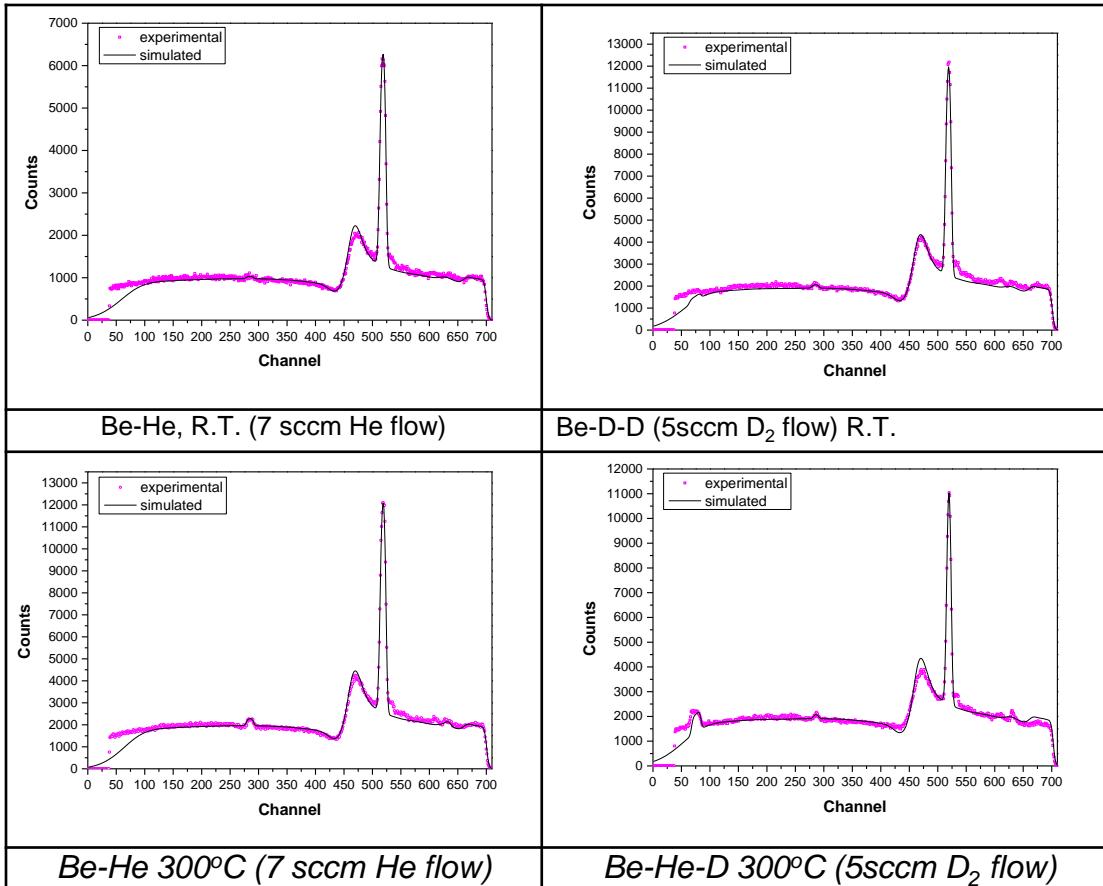
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RBS spectra in *Be* co-deposited with *D* or other gasses at different temperatures



Monoenergetic protons with an energy of 2.6 MeV

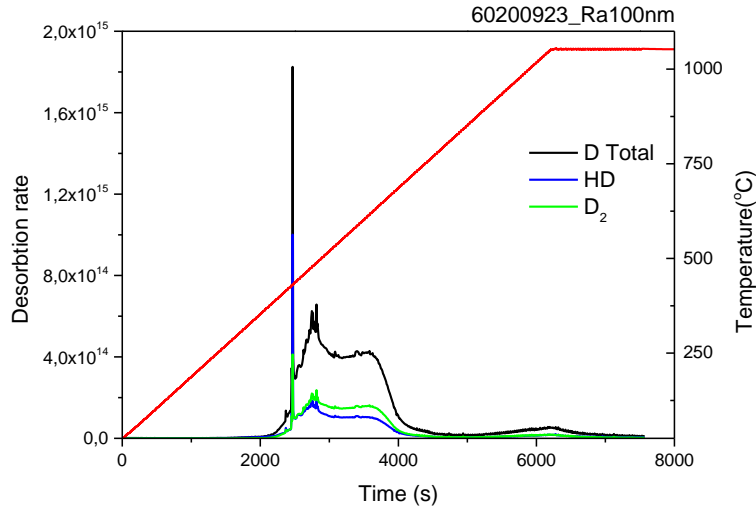


Sample	Be (at%)	He (at%)	D (at%)
Be-He, R.T.	96.5	3.5	-
Be-D, R.T.	95.2	-	4.8
Be-He, 300°C	98.2	1.8	-
Be-D, 300°C	96.4	-	3.6

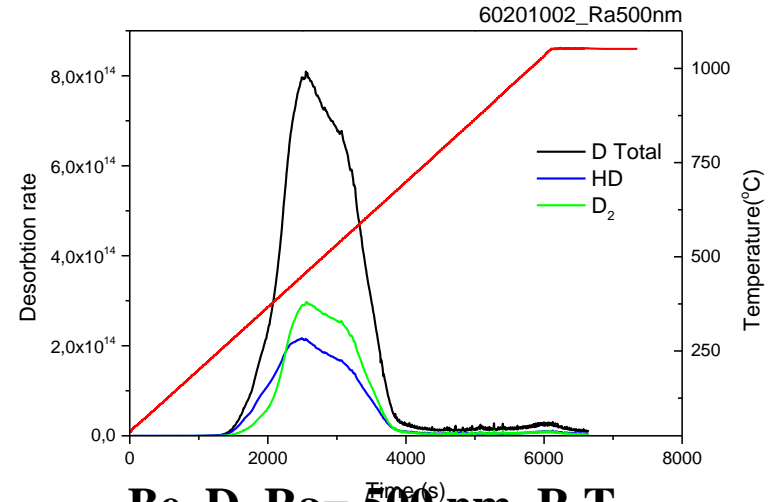
Be-D and He atomic ratio extracted from simulated RBS spectra

RBS measurements on *Be-He* and *Be-D* calibration samples

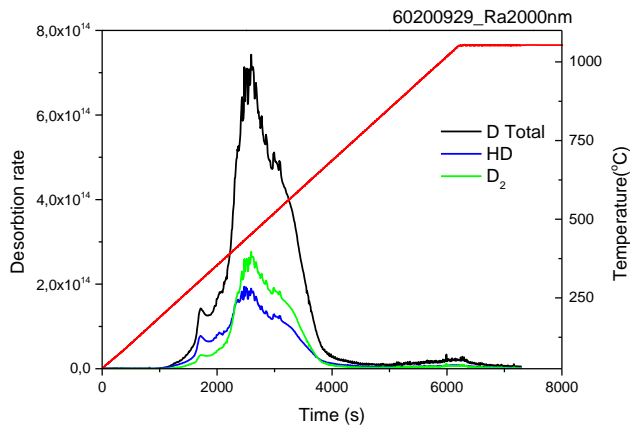
TDS spectra in *Be* co-deposited with *D* or other gasses at different temperatures



Be_D_Ra100nm_R.T.



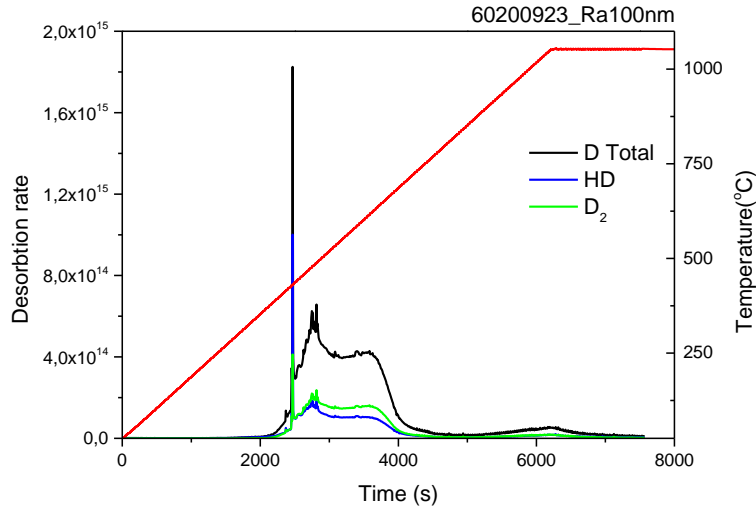
Be_D_Ra= 500 nm_R.T.



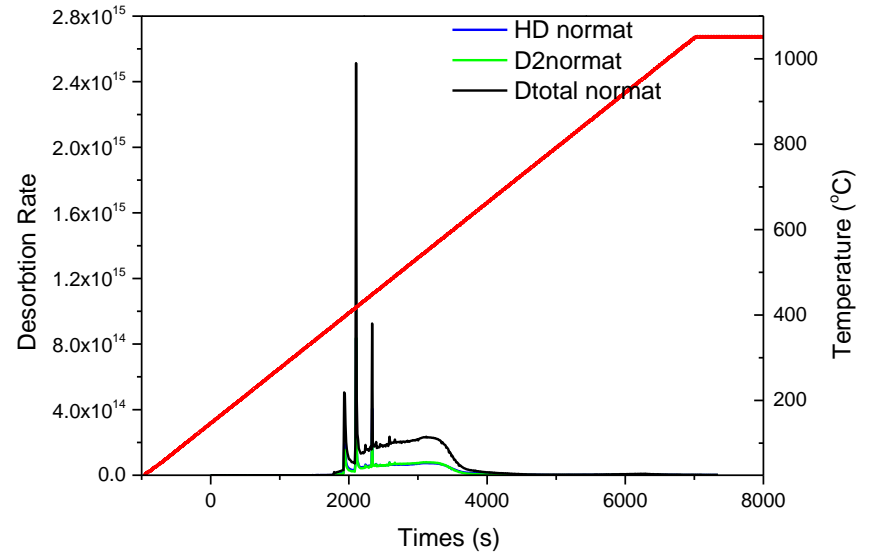
Be_D_Ra 2000nm R.T.

Be+D(5%), Ra = 100nm	7,455E17 D/cm ²
Be+D(5%), Ra = 500nm	8,268E17 D/cm ²
Be+D(5%), Ra= 2000 nm	1,065E18 D/cm ²

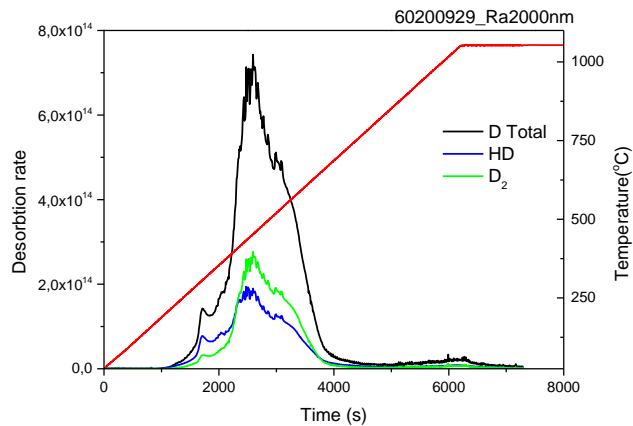
TDS spectra in *Be* co-deposited with *D* or other gasses at different temperatures



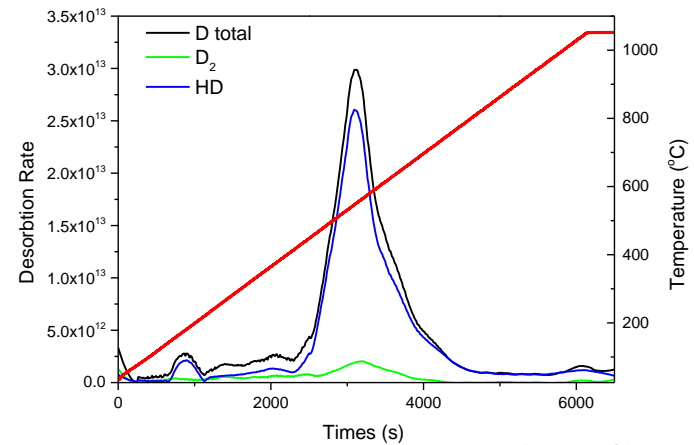
Be_D_Ra100nm_R.T.



Be_D_Ra 100nm_T 100°C

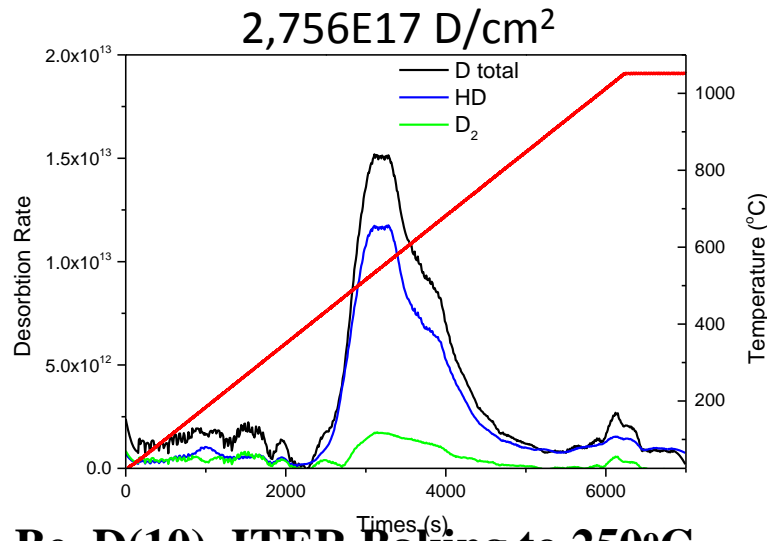


Be_D_Ra 2000nm R.T.

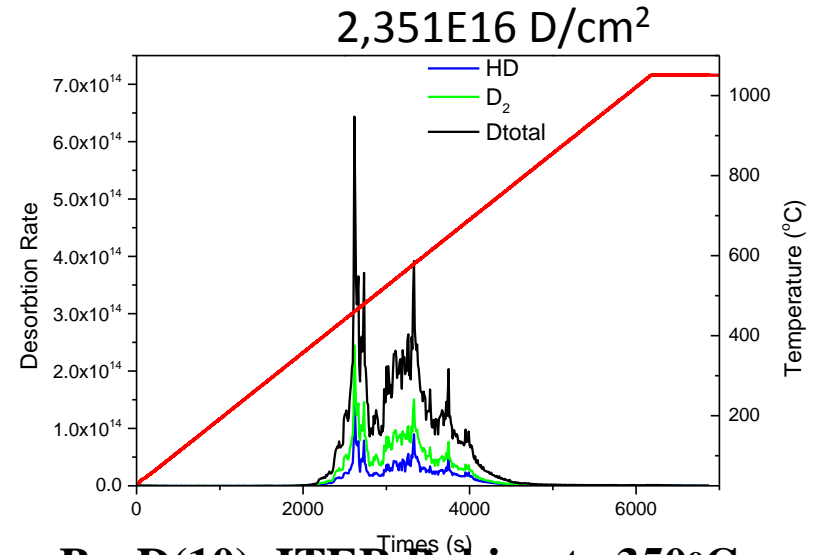


Be_D_Ra 2000nm_T 400°C

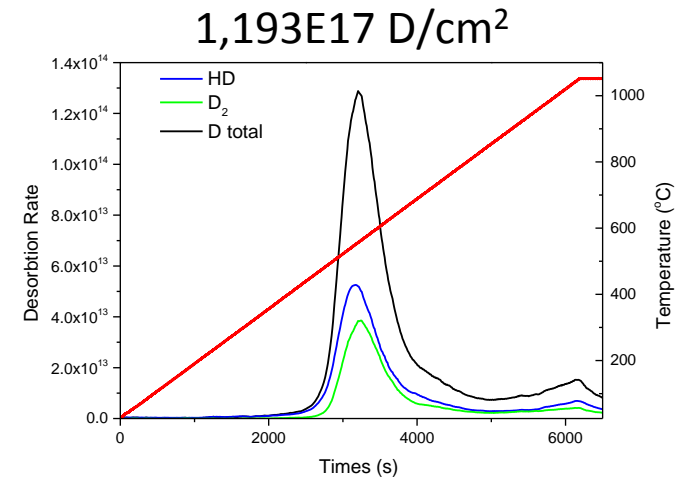
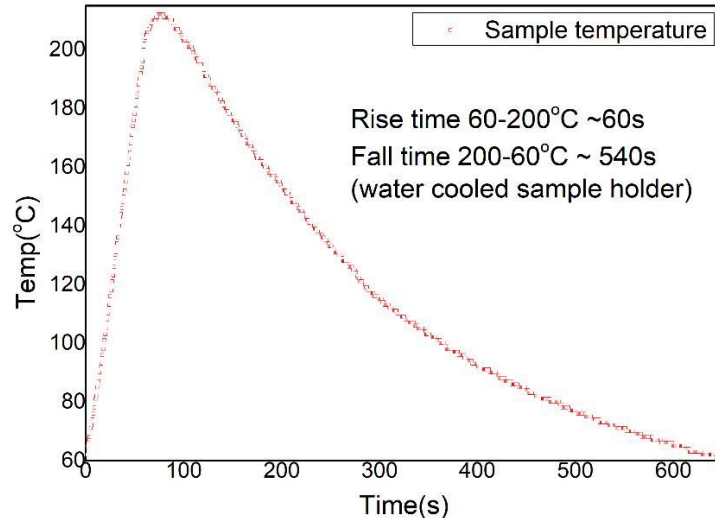
TDS spectra in *Be* co-deposited with *D* or other gasses at different temperatures



Be_D(10)_ITER Baking to 250°C

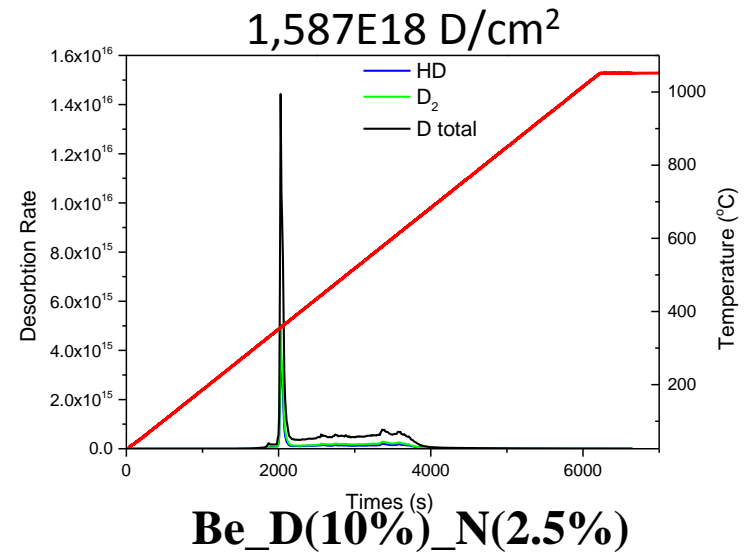
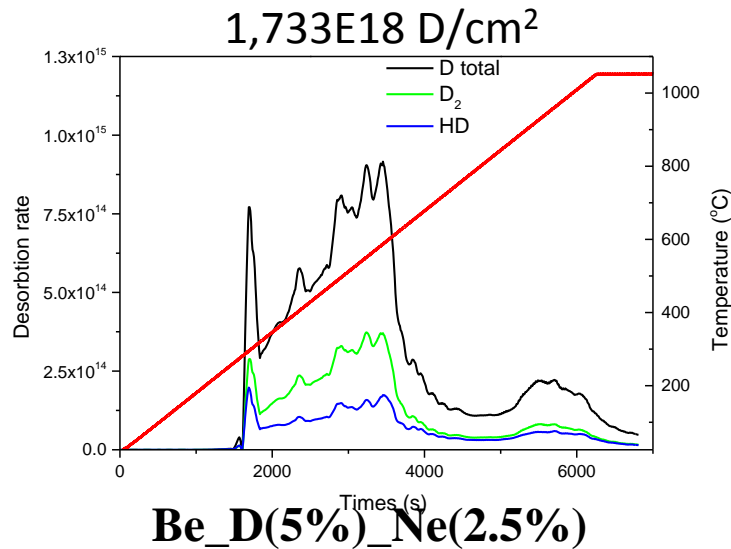
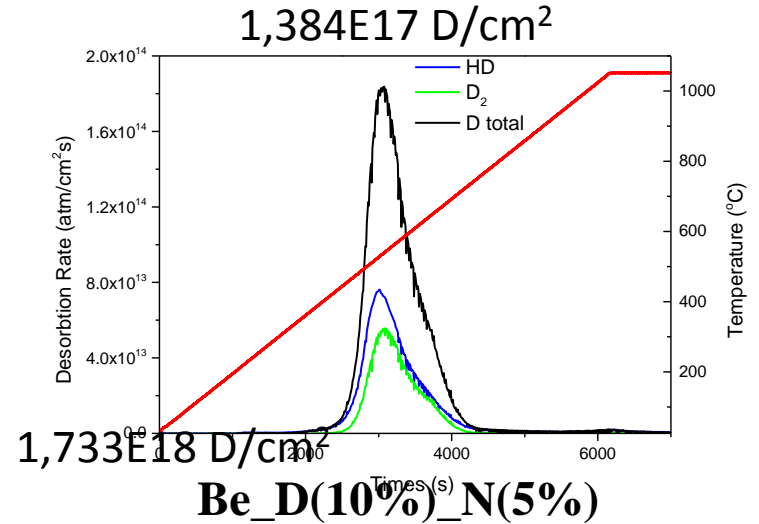
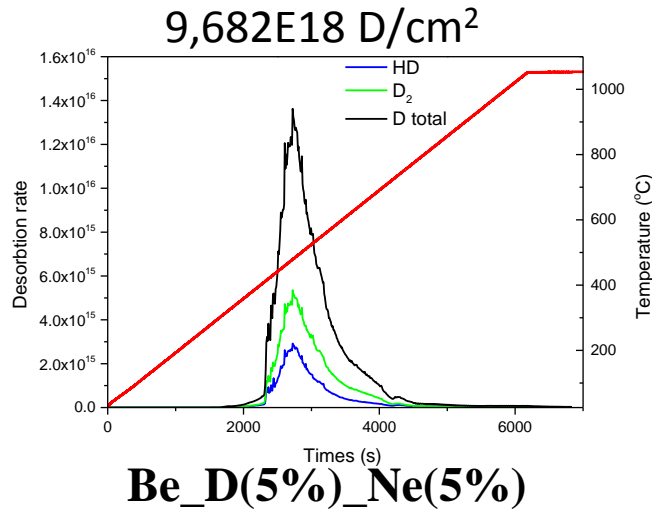


Be_D(10)_ITER Baking to 350°C



Be_D(10)_ITER like pulses

TDS spectra in *Be* co-deposited with *D* or other gasses at different temperatures



Summary of Be samples production capabilities



Production of Be containing reference samples:

Pure Be, binary and ternary mixed layers (Be-W, Be-C, Be-C-W, etc.) without gaseous inclusions using TVA method having controlled roughness.

Pure and binary mixed layers (Be-W, Be-C, etc.) having up to two gaseous inclusions (D, O, N, He, Ne, etc)

In 2019-2020 we produced thick (5 μm) reference samples. With various imposed compositions - Be(-C) samples with gas inclusions (H, D, He, N, O) Different temperatures or **heat/cooling scenarios** available

Pre-characterization before sample delivery:

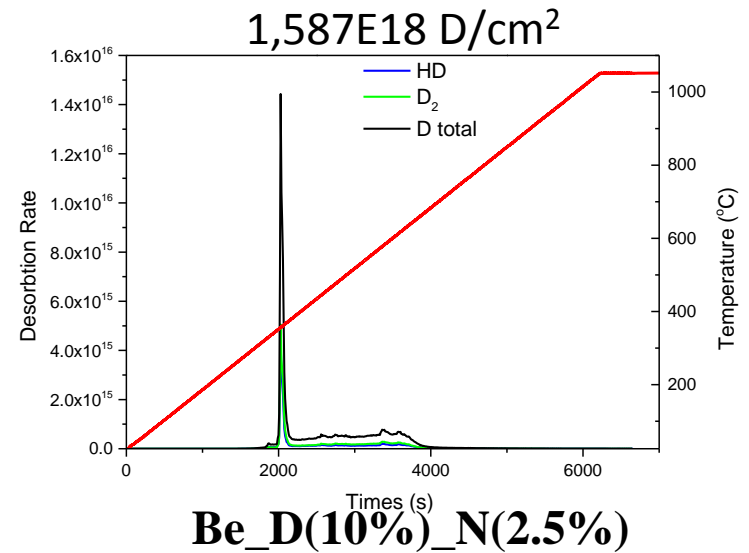
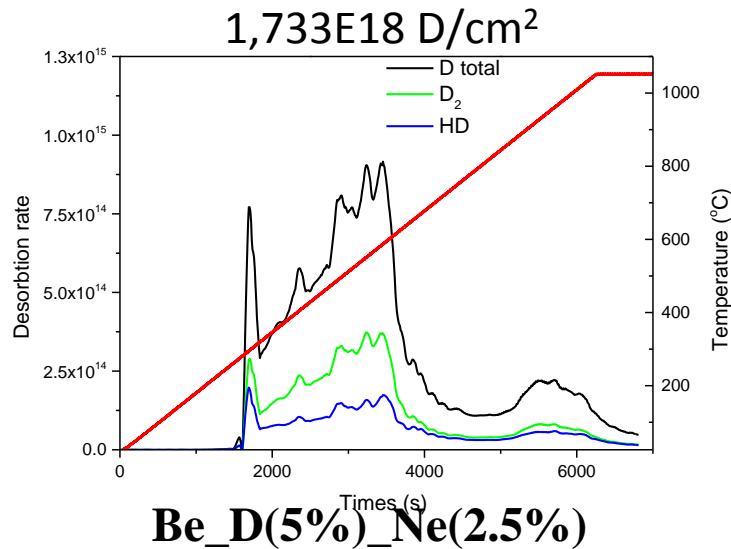
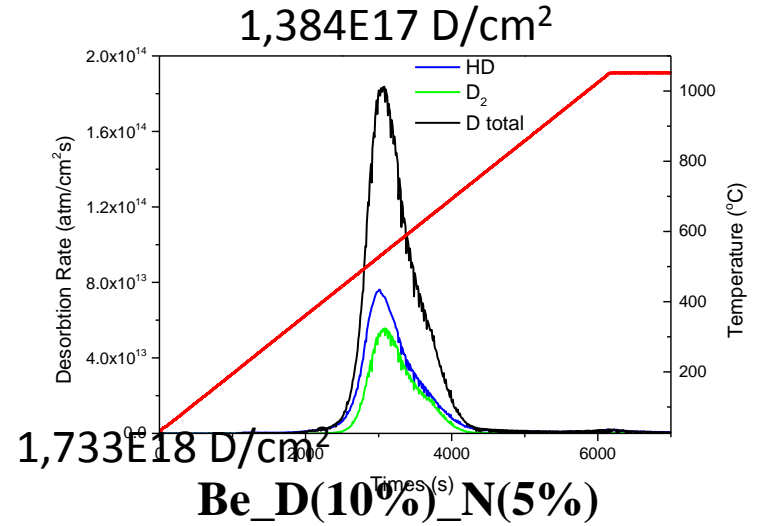
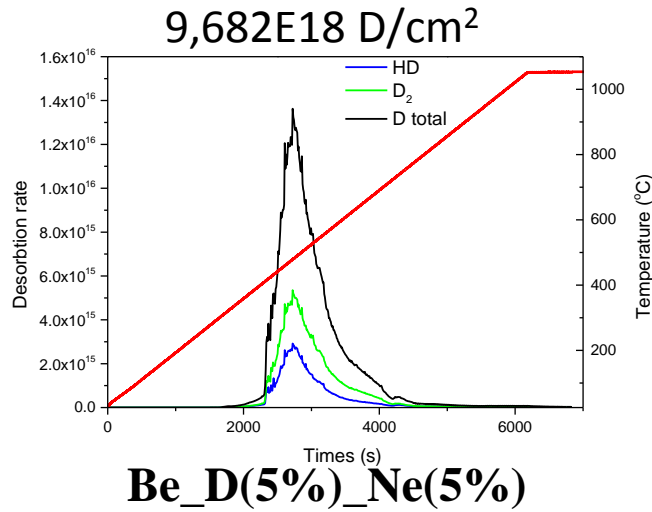
RBS, XRD, TDS, SEM measurements in order to have preliminary information on samples structure and morphology.

Be facility setups and capabilities

Up to **6 magnetrons** deposition chamber for Be reference samples with gaseous inclusions using DC and short pulse HiPIMS

Metallic impurities addition possible

TDS spectra in *Be* co-deposited with *D* or other gasses at different temperatures





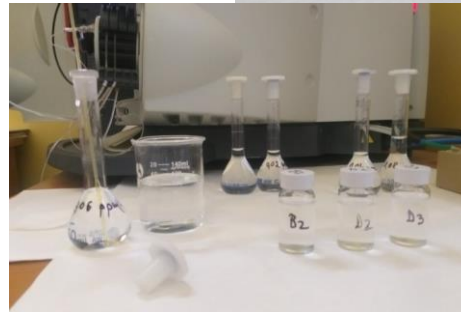
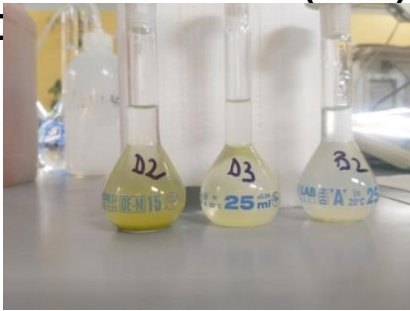
Help Slide 1

Analysis of dust by ICP-OES

D1 - Divertor dust (2015-16) Sample ID – ILW 3-5

D2 - Divertor dust (2014)-6

D3 - Divertor dust (2014)-2

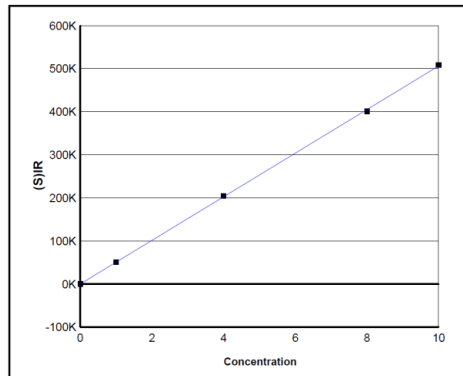


ICP-OES results

Sample name	Divertor dust (2015-2016) Sample ID – ILW 3-5	Divertor dust (2014)-2	Divertor dust (2014)-6
Element	Relative weight ratio, % / sample		
Be	38,47	53,61	91,08
Cr	2,48	1,65	0,06
Cu	29,72	0,88	0,36
Fe	15,20	6,67	2,08
Mo	5,85	32,46	4,18
W	8,28	4,74	2,25

Samples after treatment in HNO₃ samples ready for ICP_OES analysis

Element calibration



Element Name:	Be	
Element Wavelength:	Be 234.861 nm	
Concentration Units:	ppm	
Date of Calibration:	31/10/2019 10:10:56	
Date of Fit:	31/10/2019 10:10:56	
Type of Fit:	Linear	
Correlation:	1.0000	
A0 (Offset):	-8.167	
A1 (Gain):	50.610	
A2 (Curvature):	0.0000	
n (Exponent):	1.000	
	Reslope	QC Normalize
Slope:	1.000	Slope factor: 1.000
Y Int:	0.0000	Offset: 0.0000

