Development of LIBS and LA-TOF-MS for On-line Diagnosis on PWI

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三束材料改性教育部重点实验室4#楼
1F
101 激光快速成型实验室
102 总配电室
103 强流脉冲电子束实验室
104 新能源材料研究所（实验室I）
105 新能源材料研究所（实验室II）
106 新能源材料研究所（实验室III）
106B 化学处理室
107 薄膜技术实验室
108 磁性材料改性实验室
109 开水间
110 等离子体诊断实验室
111 日新－大工联合实验室
209 新能源材料研究所联合实验室
210 新能源材料研究所联合研究室
211 电子封装材料实验室
212 电子封装材料研究室
213 储氢材料研究室
214 凝固与连铸实验室
216 计算材料实验室
217 计算材料研究室
218 王旭东办公室
材料加工检测与控制研究室
材料加工检测与控制实验室
凝固与连铸研究室
312 X射线衍射分析室
314 低压射频等离子体研究室I
315 马腾才办公室
316 低压射频等离子体研究室II
317 朱爱民办公室
318 低压射频等离子体实验室
319 等离子体化学与应用研究室
4F
401 丁洪斌办公室
402 等离子体谱学实验室
大连理工大学

Overview of Motivation

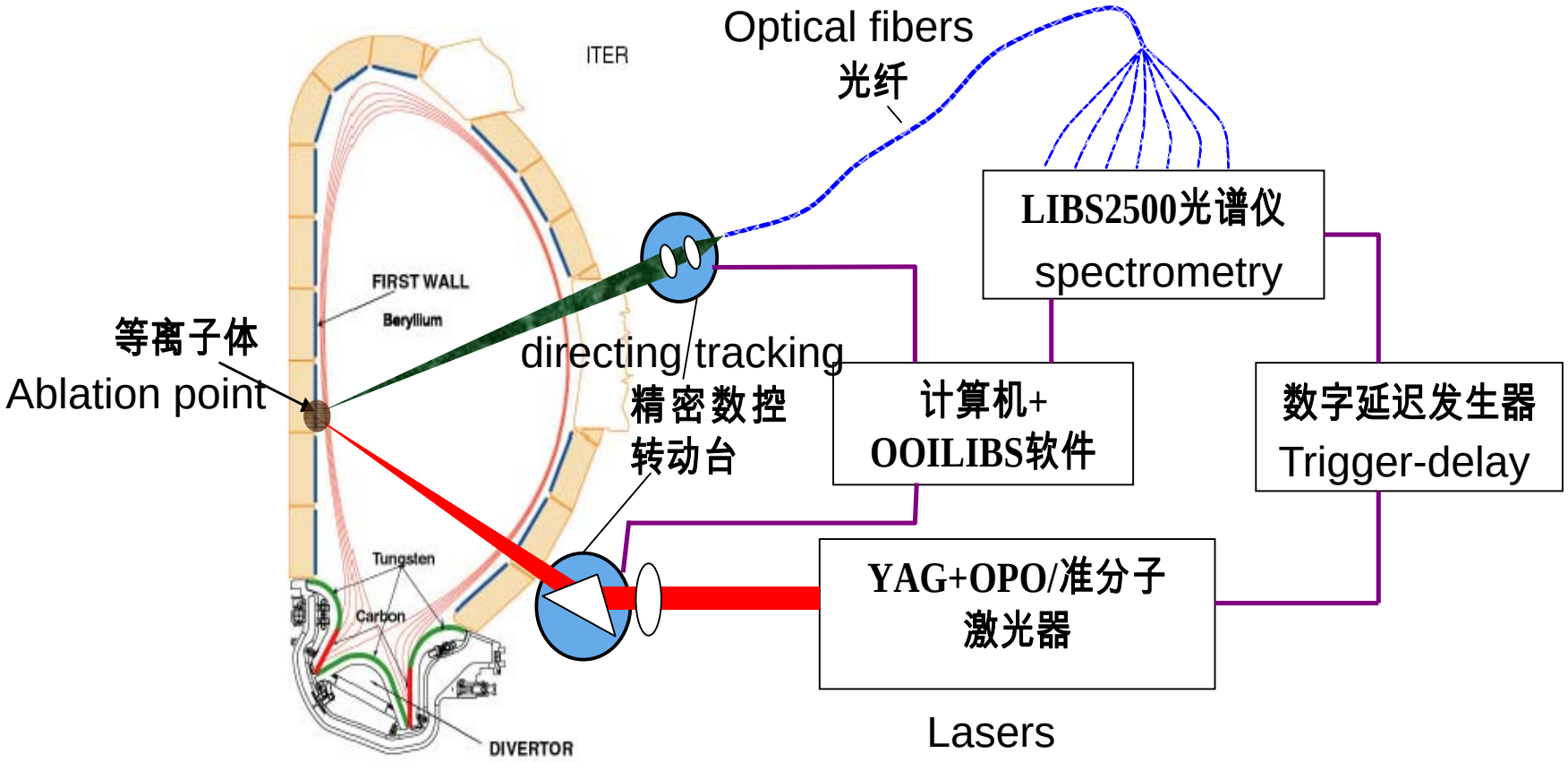
- Development of laser-based technologies for :
- On-line diagnosis using Laser Induced Breakdown Spectroscopy (LIBS) ;
- 3D characterization on D/T retention by Laser Ablation-Time-Of Flight Mass Spectrometry (LA-TOFMS);
- Removable of the co-deposited films on the fist mirror using laser cleaning;
- D/T recovery technique using laser heating .

Experiments

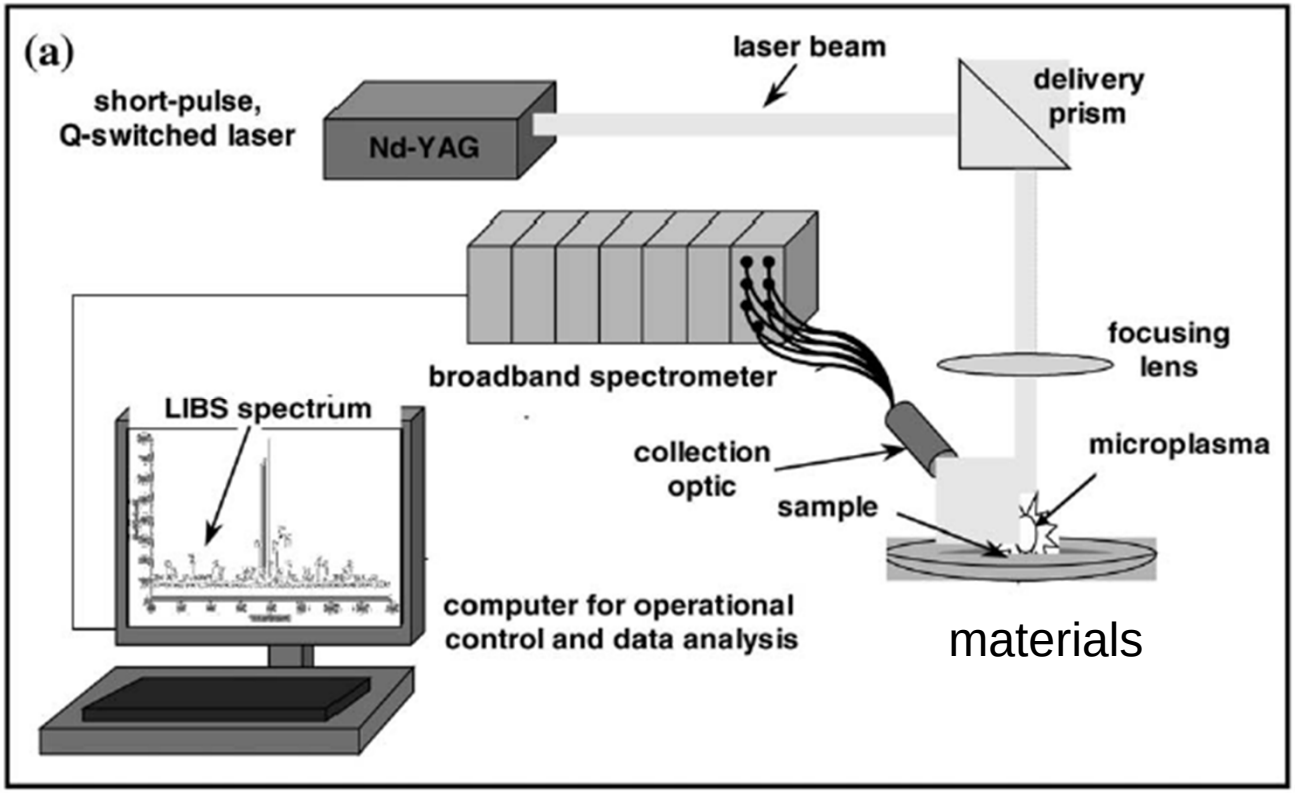
- Laser cleaning co-deposition film on the first mirror combined with LIBS diagnosis;
- Laser ablation TOF mass spectroscopic characterization of H/D-retention on the first mirror.

I. Laser ablation and LIBS system

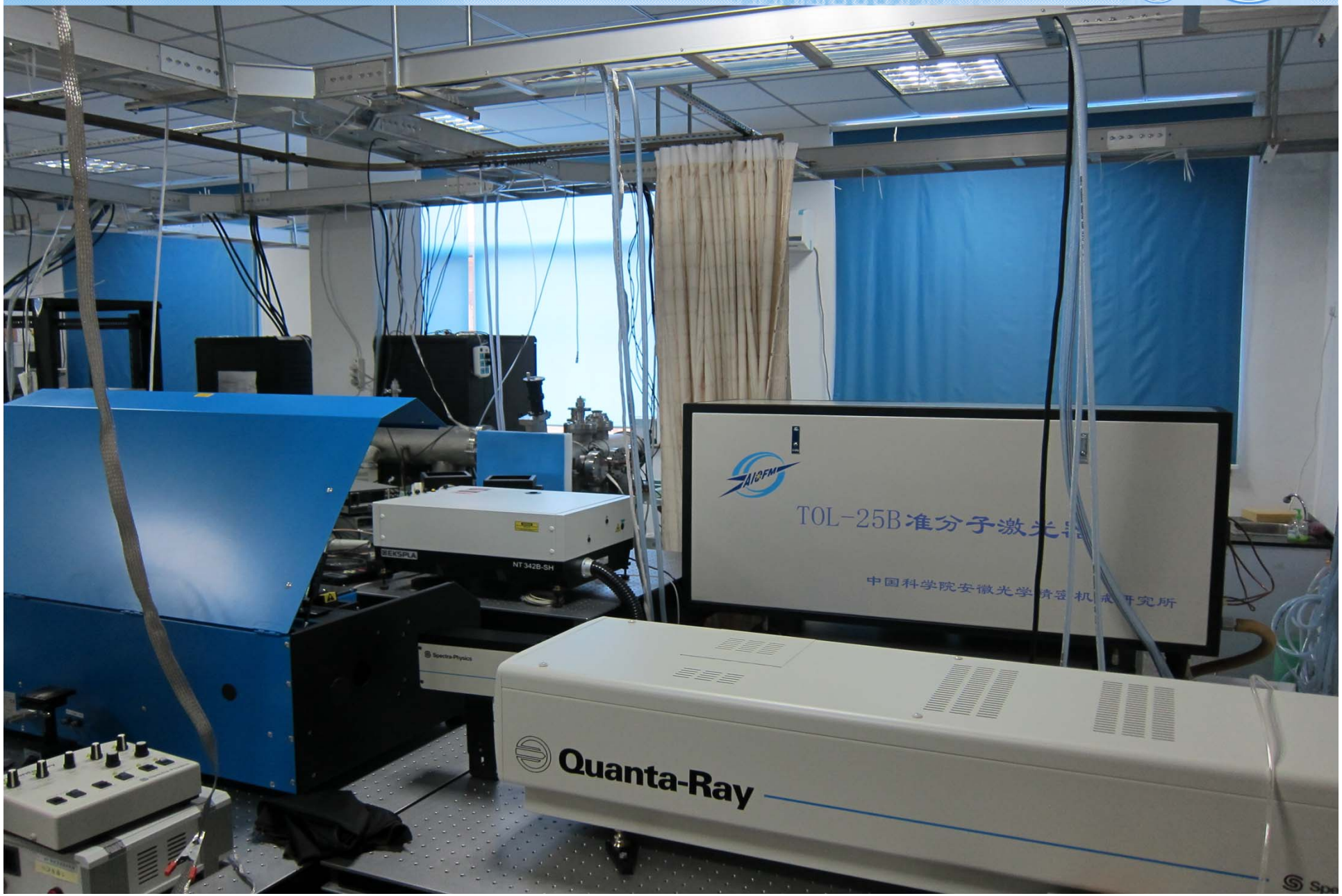
Schematic diagram of LIBS diagnosis or cleaning



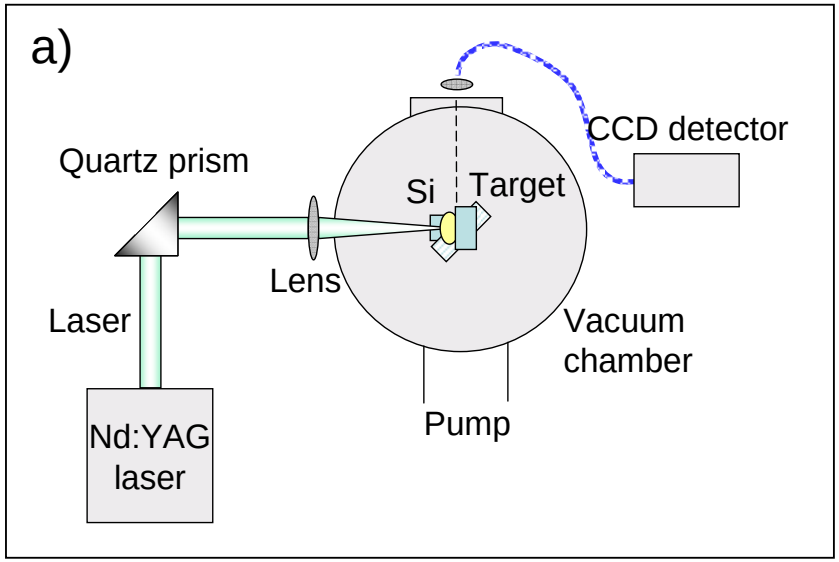
Principle of LIBS

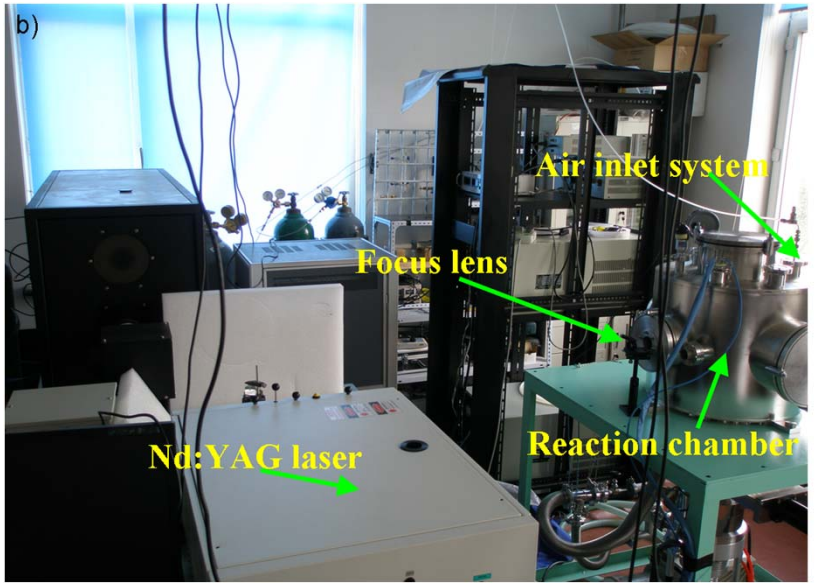


Laser system



Experimental set-up

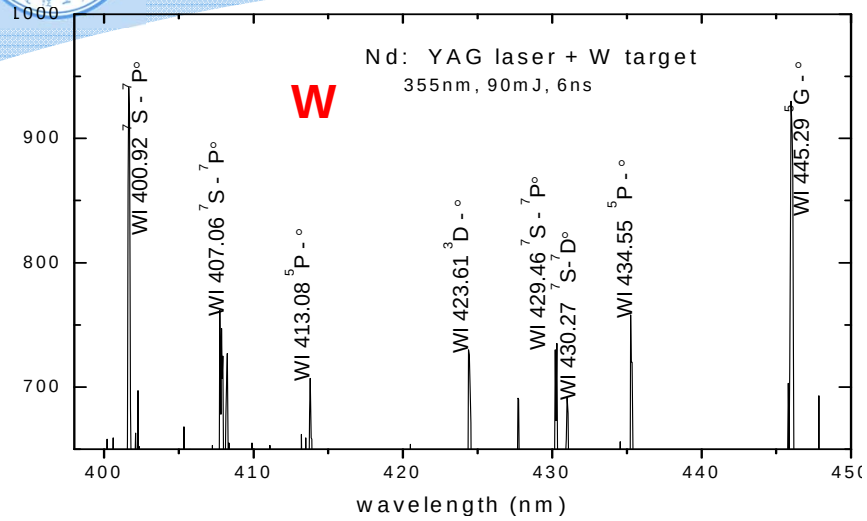


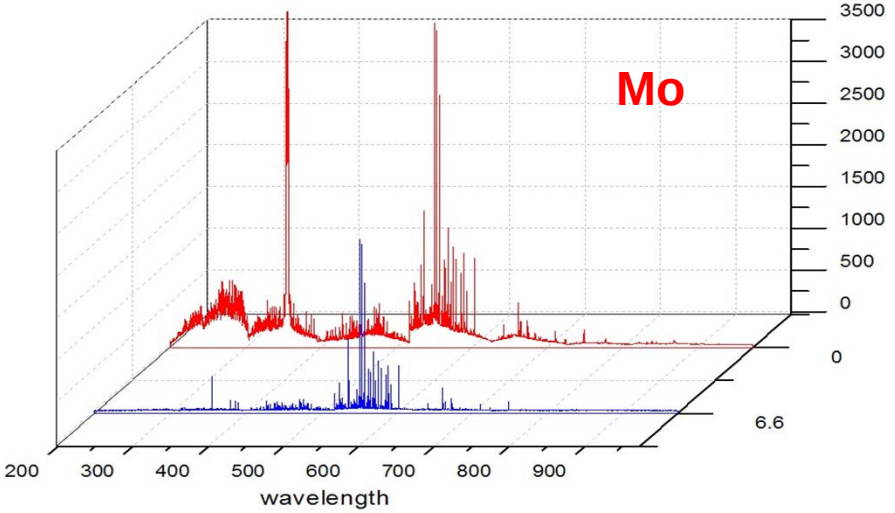


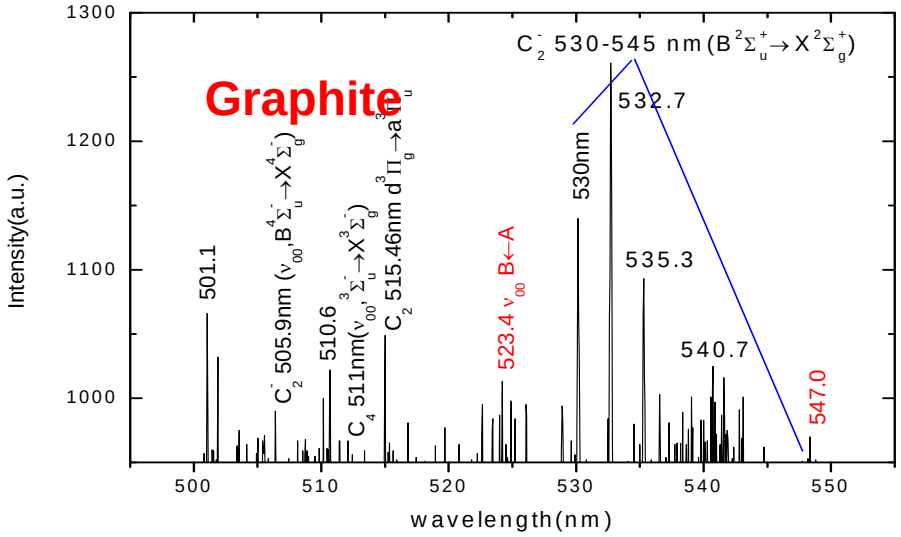
a) Scheme of set-up of laser ablation of the first wall targets

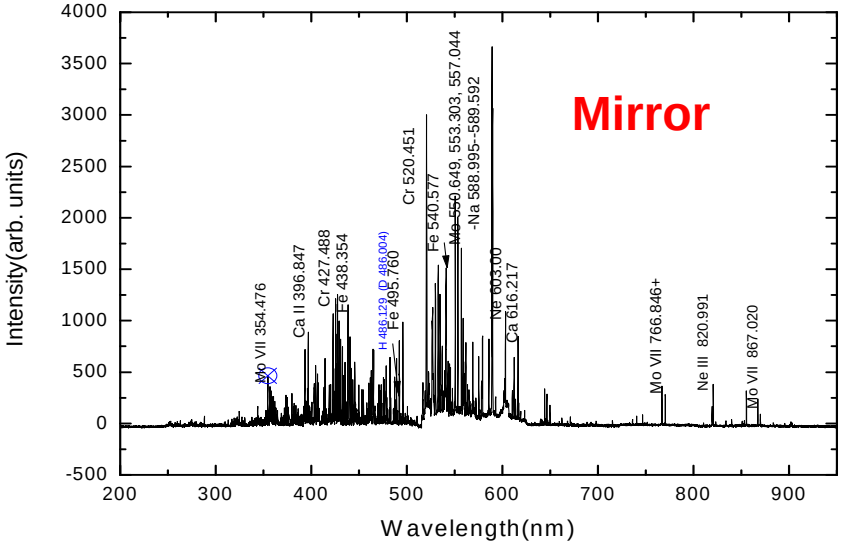
b) Photo of the experimental set-up.

LIBS benchmarked testing @ 355nm laser









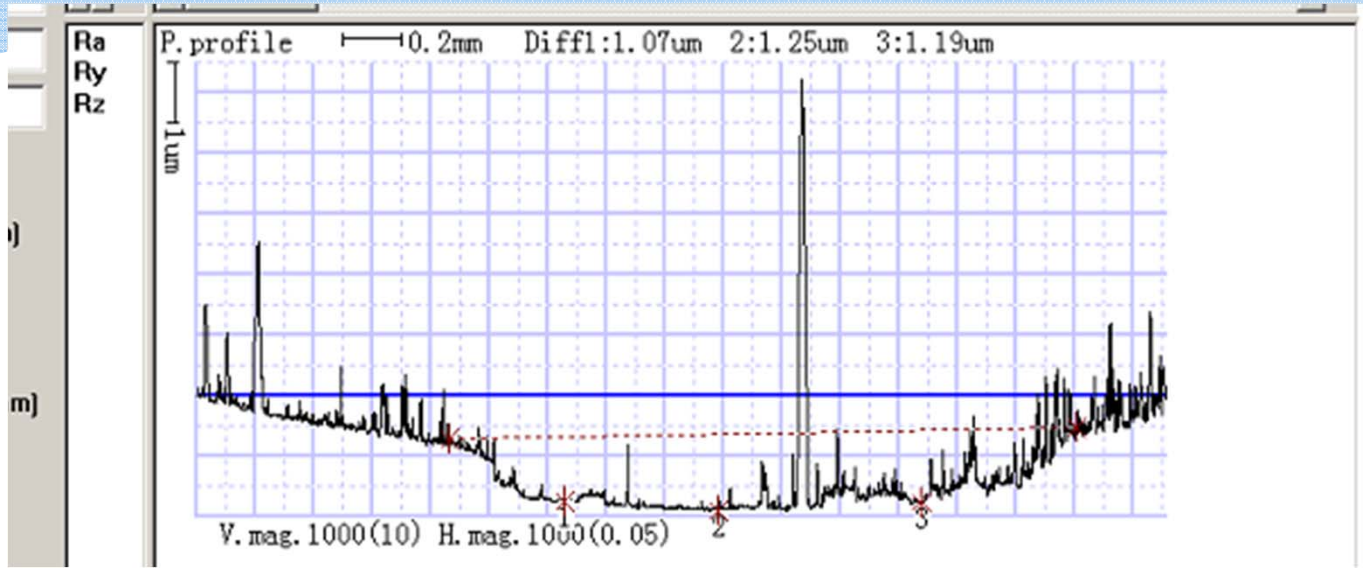
Laser cleaning first mirror

Mirror with 2 years exposure to HL-2A tokamak

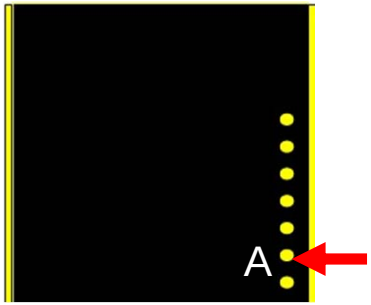
laser energy

(a)-(e)
0.36,
0.3,
0.21,
0.16,
0.12J/cm^2

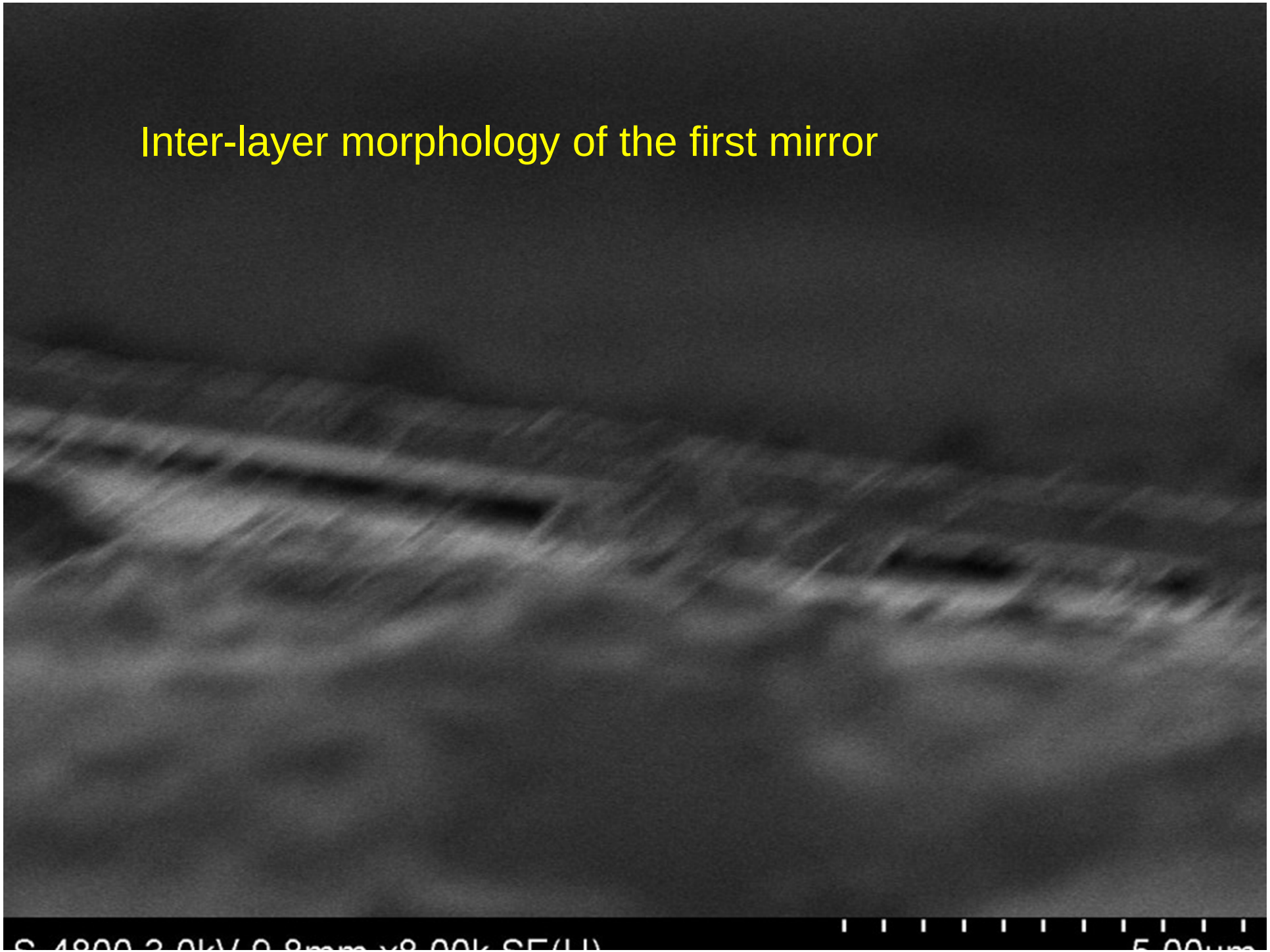
The micro-geometric parameters were measured with profilometer

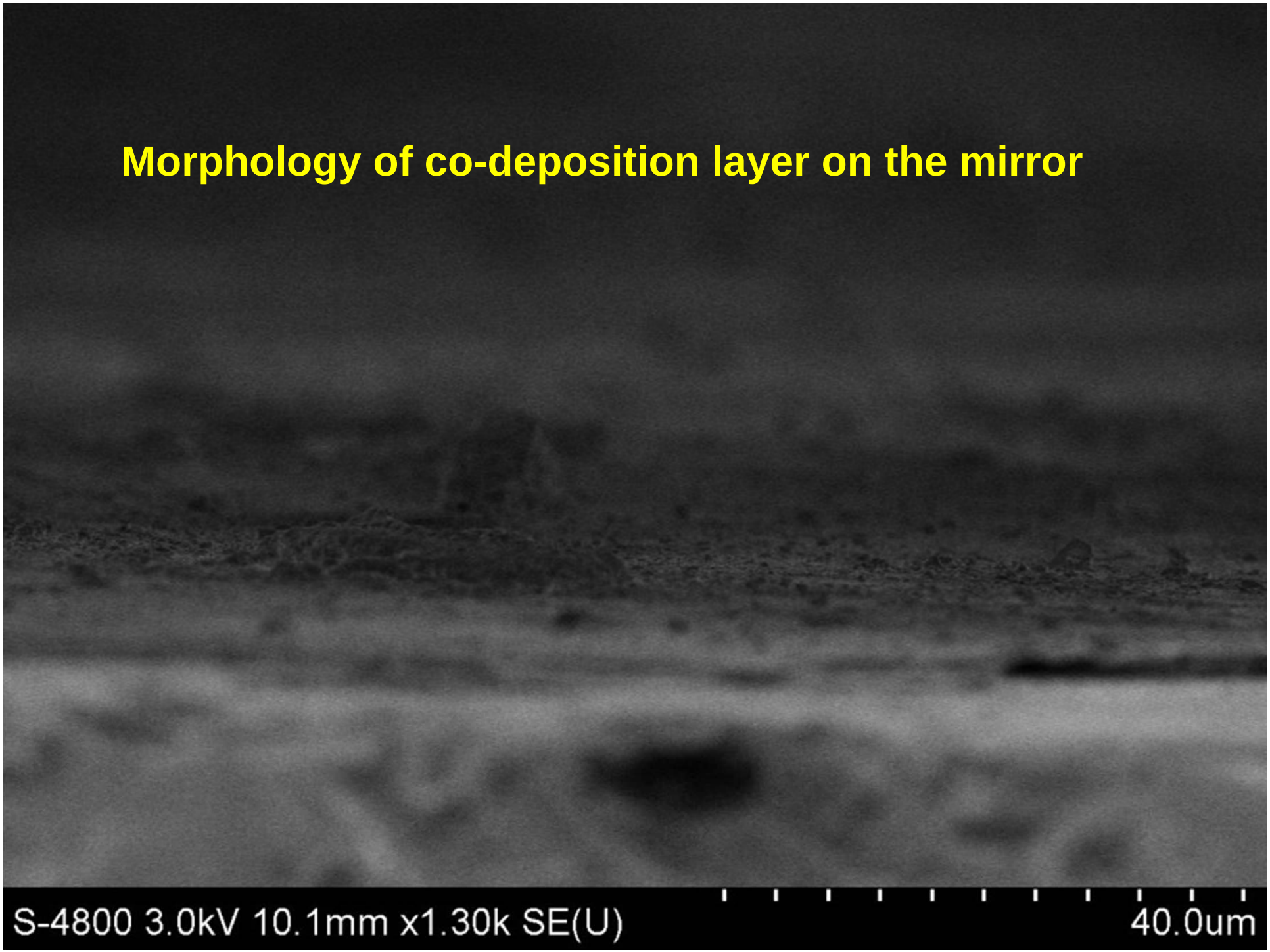


Profile of point A with average depths is 1.17 micrometer

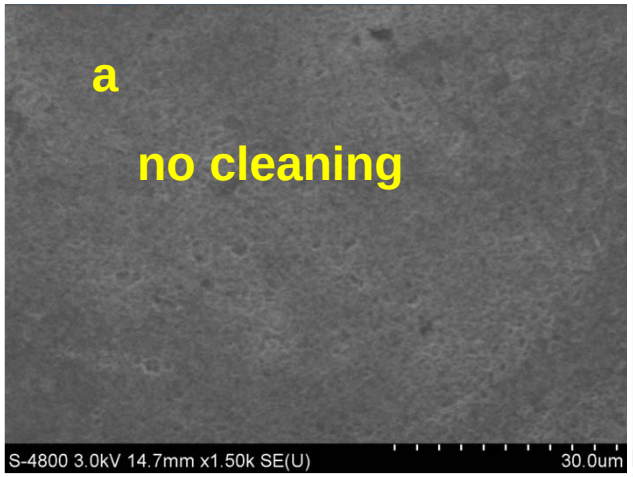


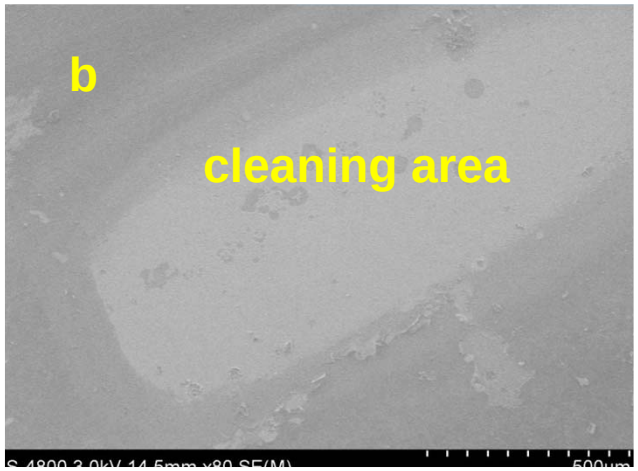
SEM measurements indicate that the depth of the gold film is about 1 micrometer and the dust film is less than 1 micrometer

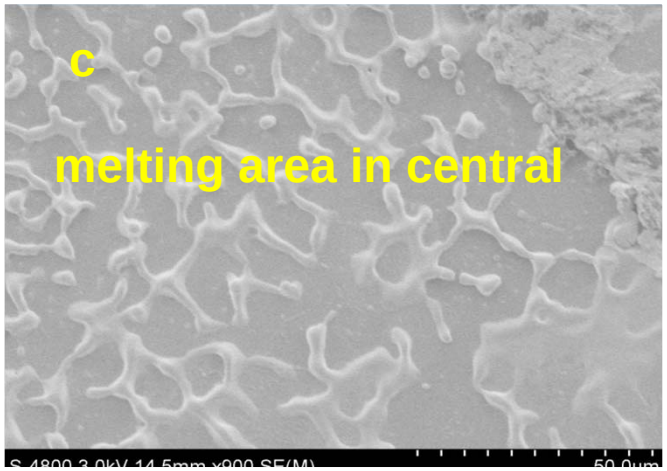

Inter-layer morphology of the first mirror

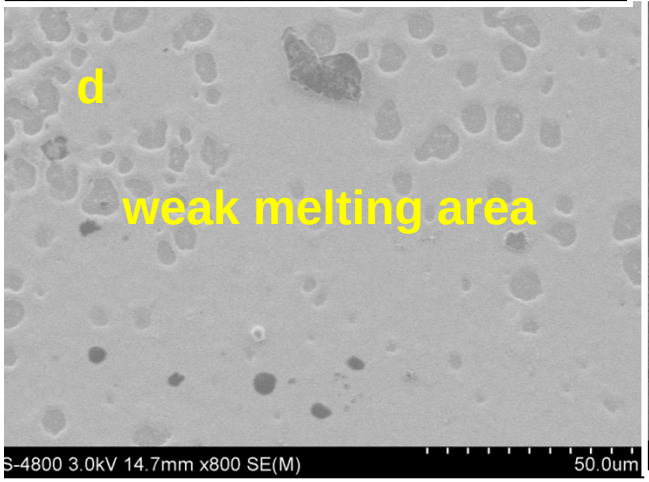

Morphology of co-deposition layer on the mirror
S-4800 3.0kV 10.1mm x1.30k SE(U)
40.0um

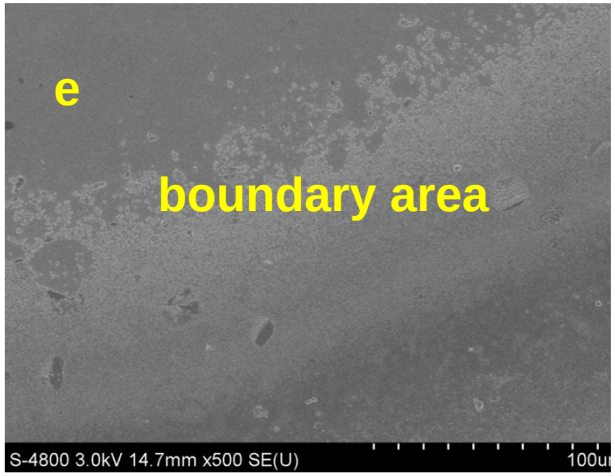
Surface topology after Excimer laser cleaning @193 nm

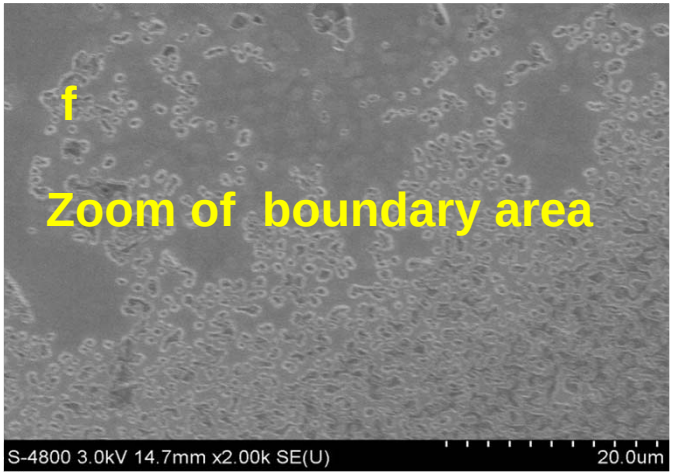




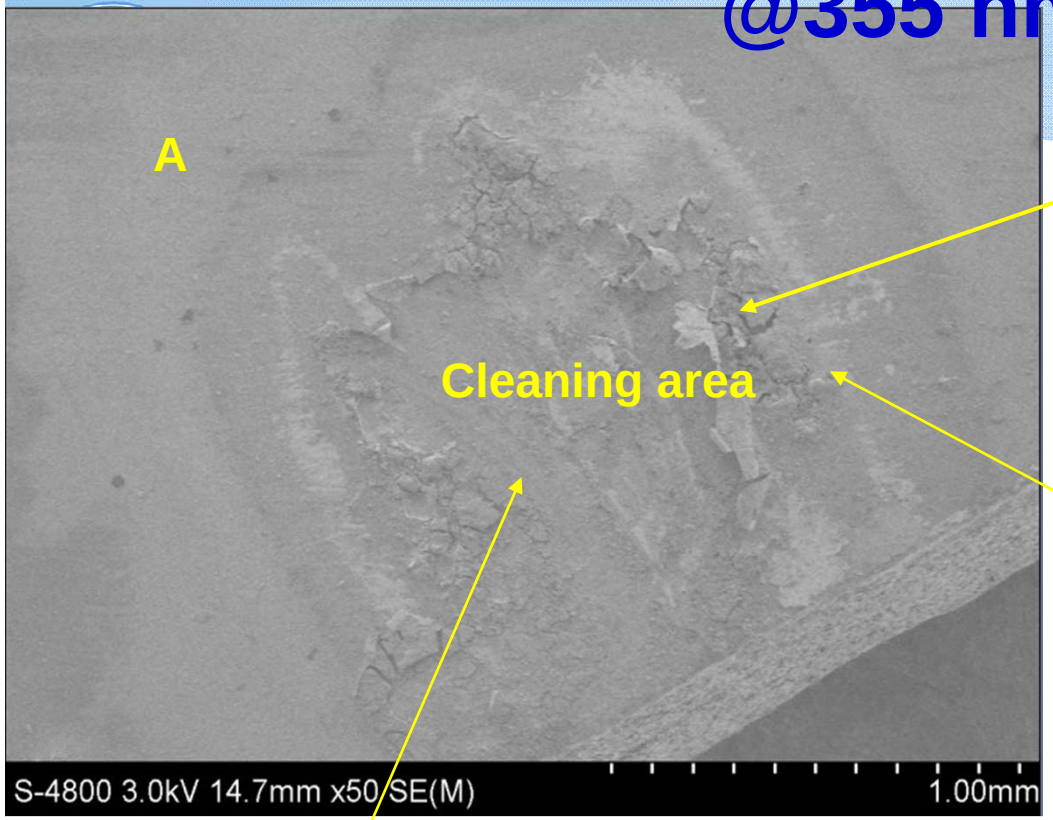


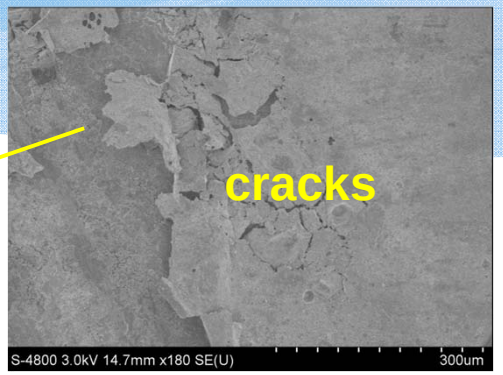


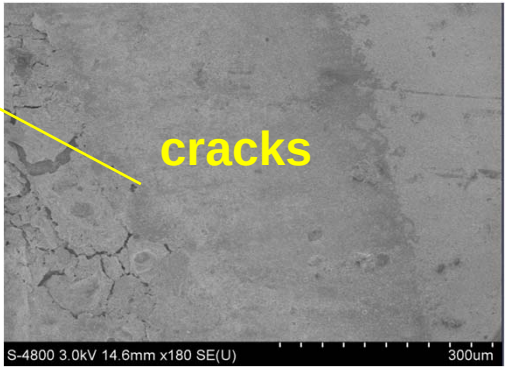


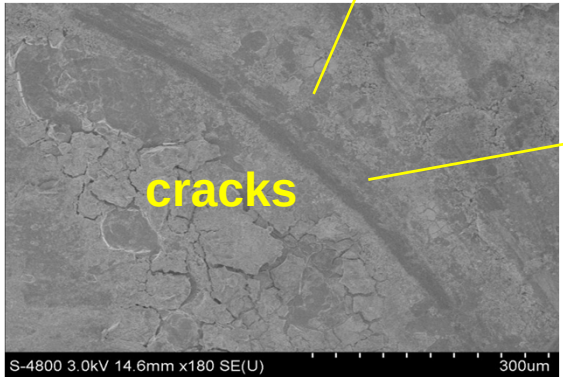


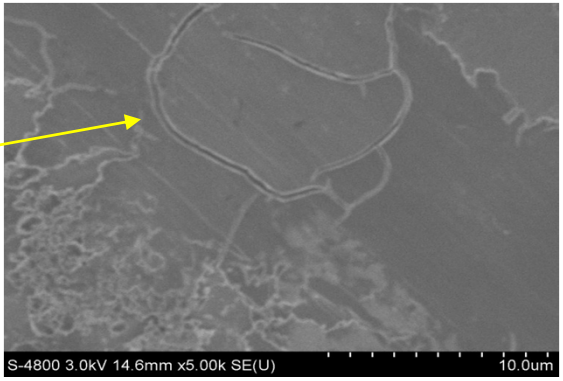
Surface topology after YAG-laser ablation @355 nm









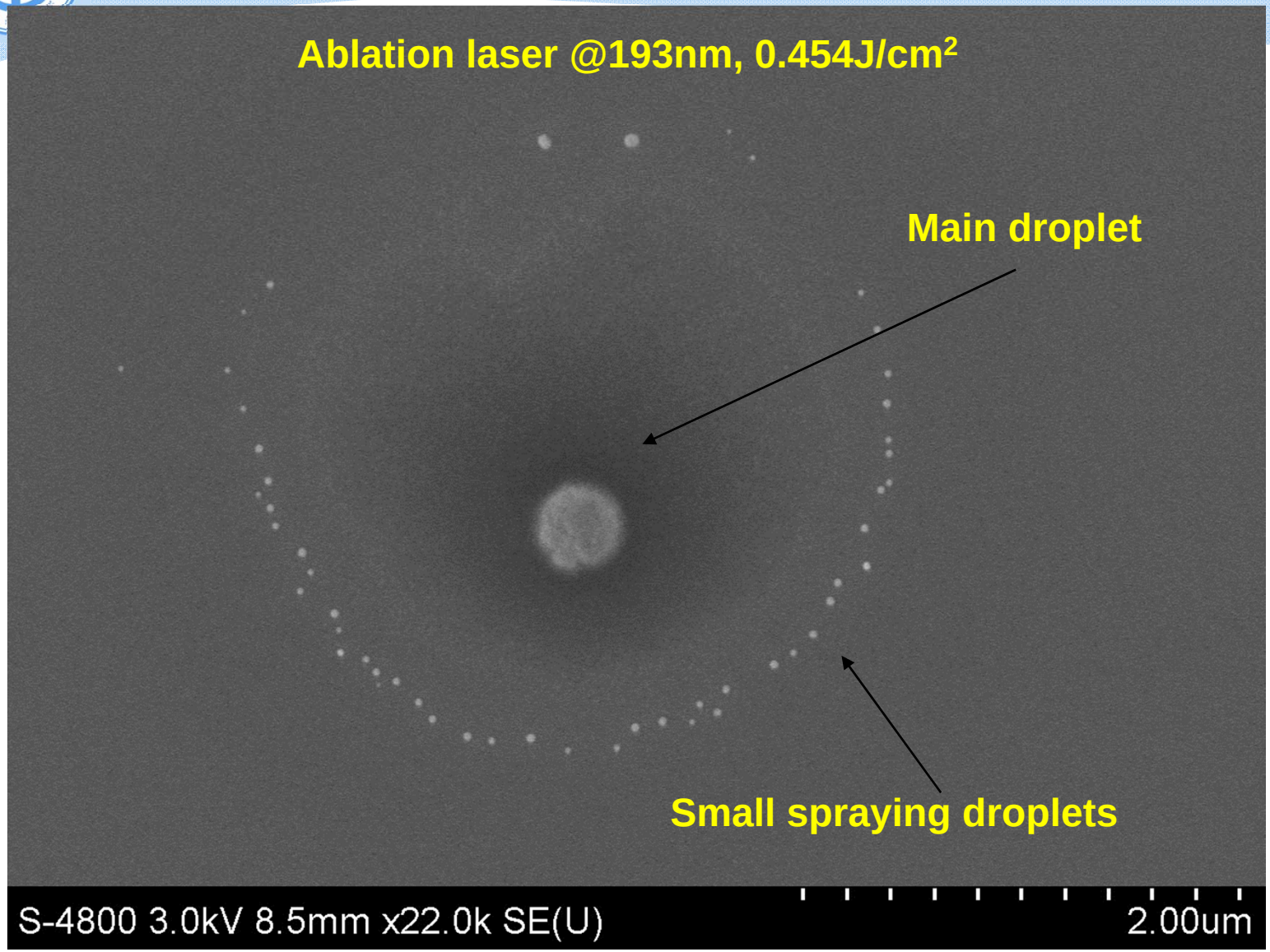


YAG- laser:

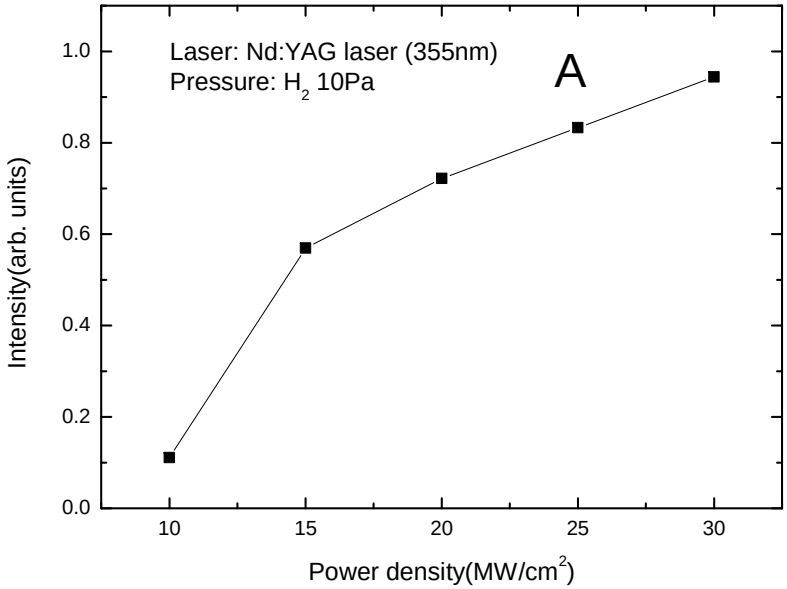
355nm

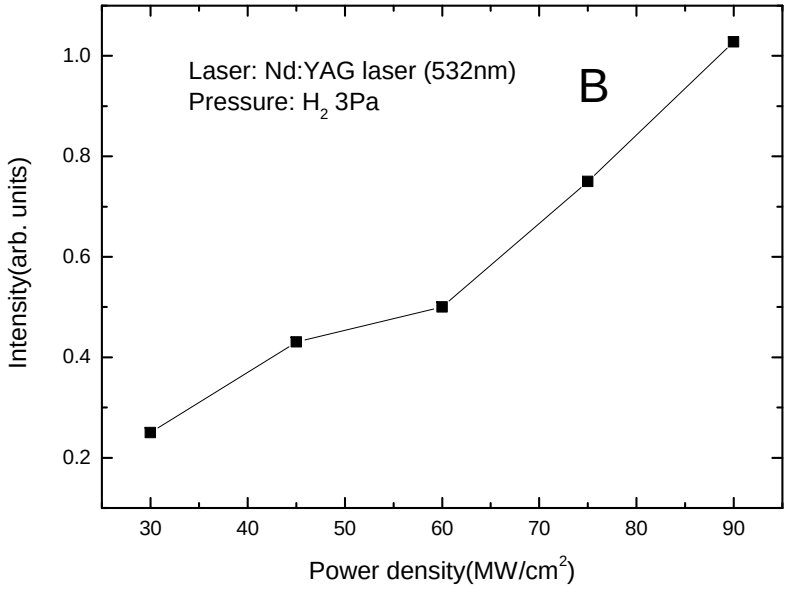
0.692J/cm^2

Observed droplets



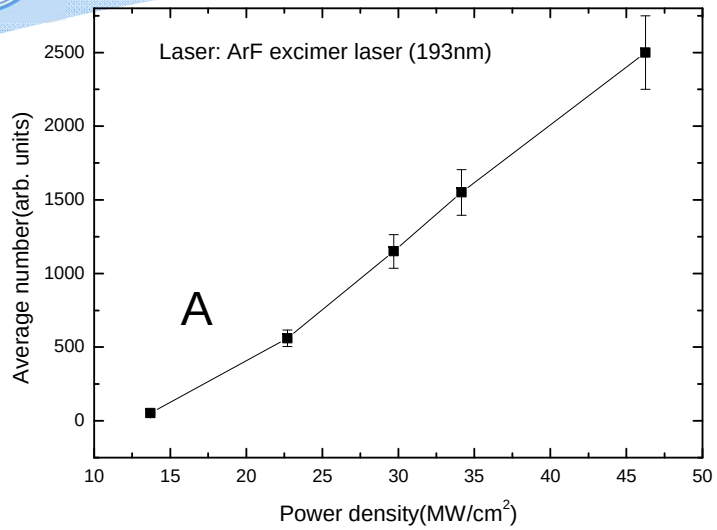
Recovery of reflectivity after laser cleaning

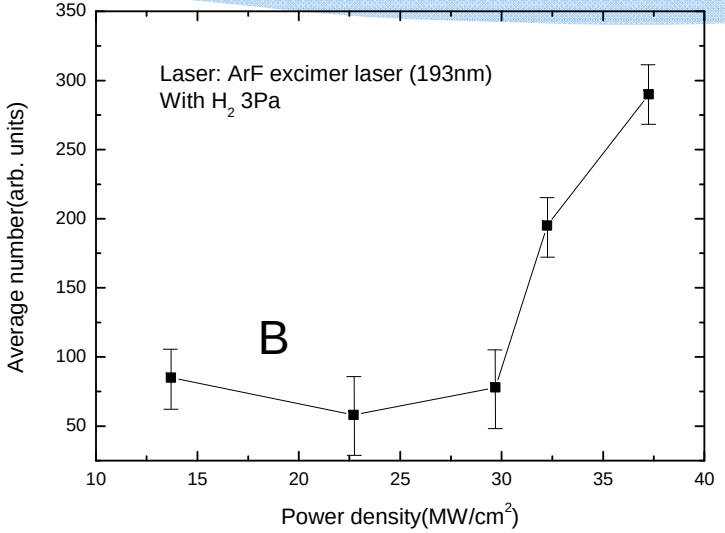


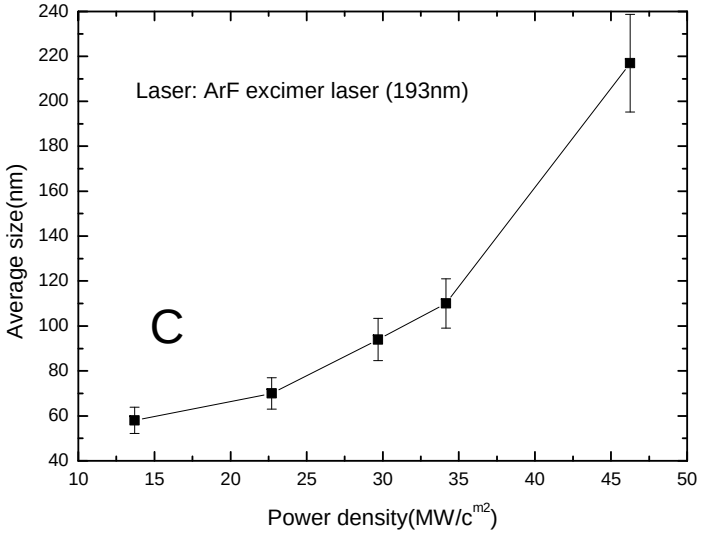


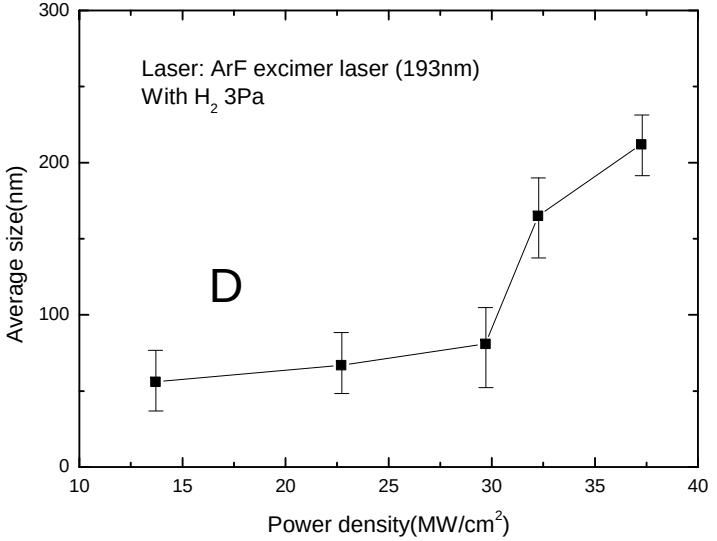
A

The released average dust particles as a function of laser power density







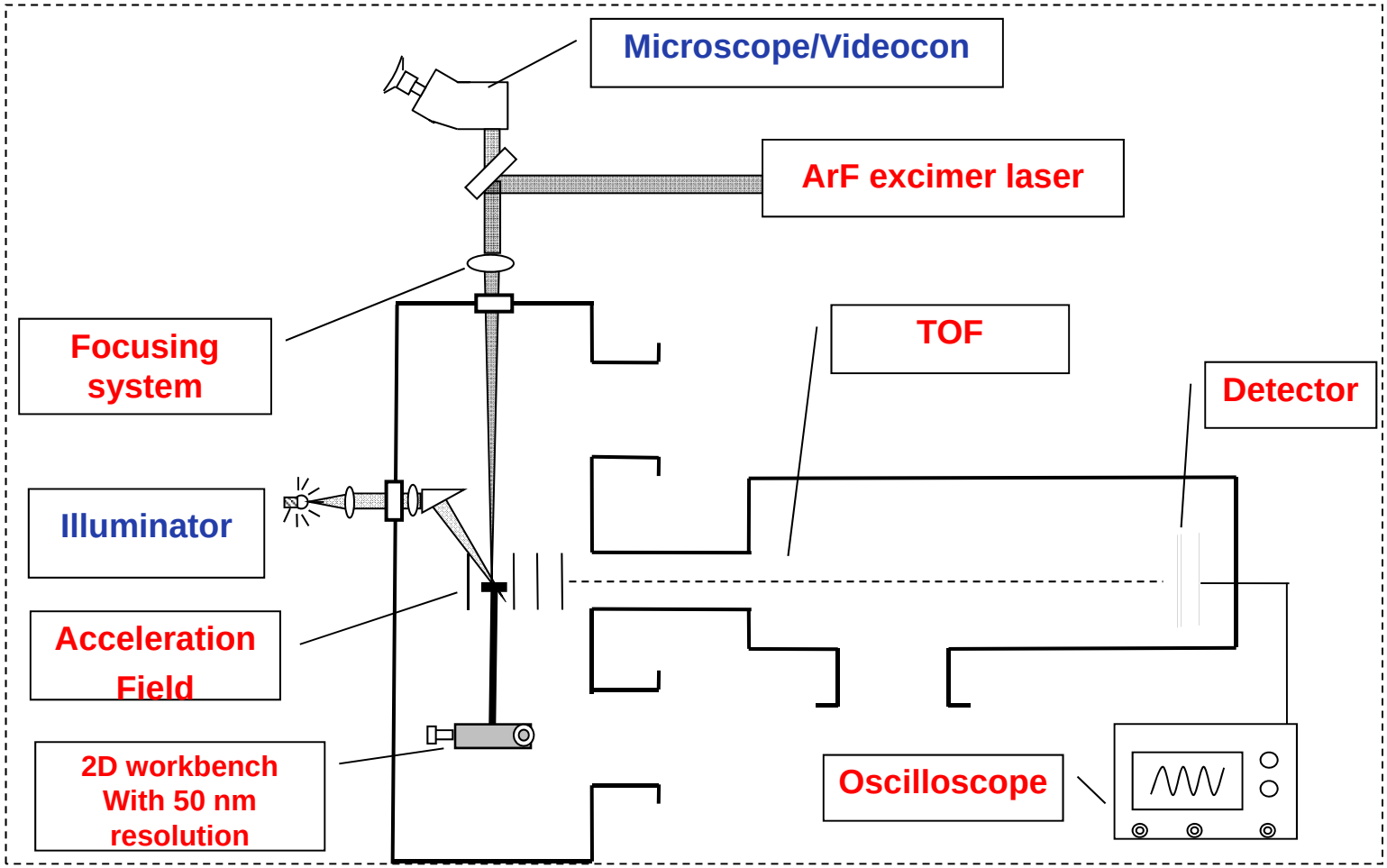


II. Laser ablation TOF mass spectrometry for diagnosis of H/D retention

2D or 3D analysis

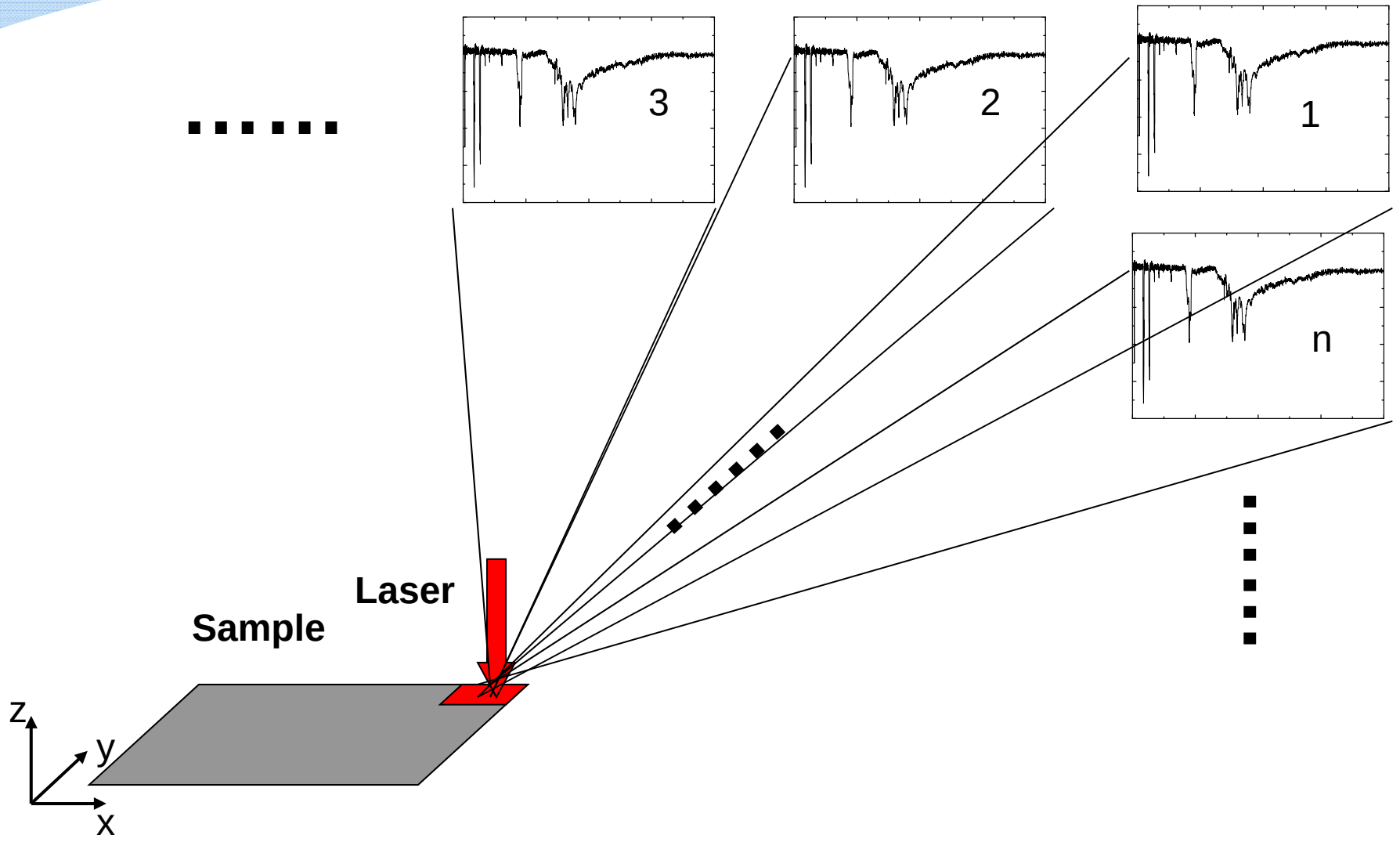
(A method beyond TDS)

The schematic diagram of laser ablation TOF mass spectrometry

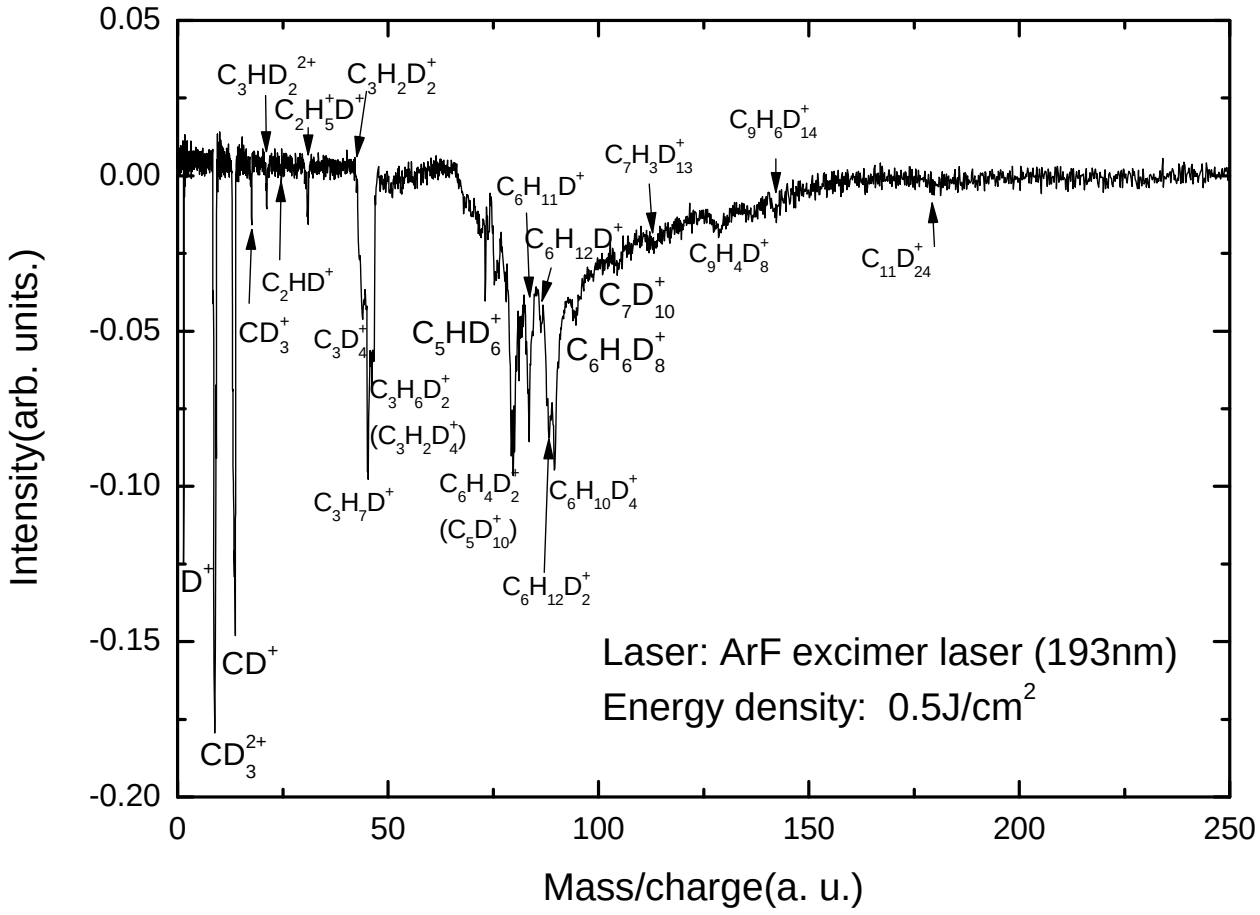


TOF mass spectrometry

LA-TOFMS: how working

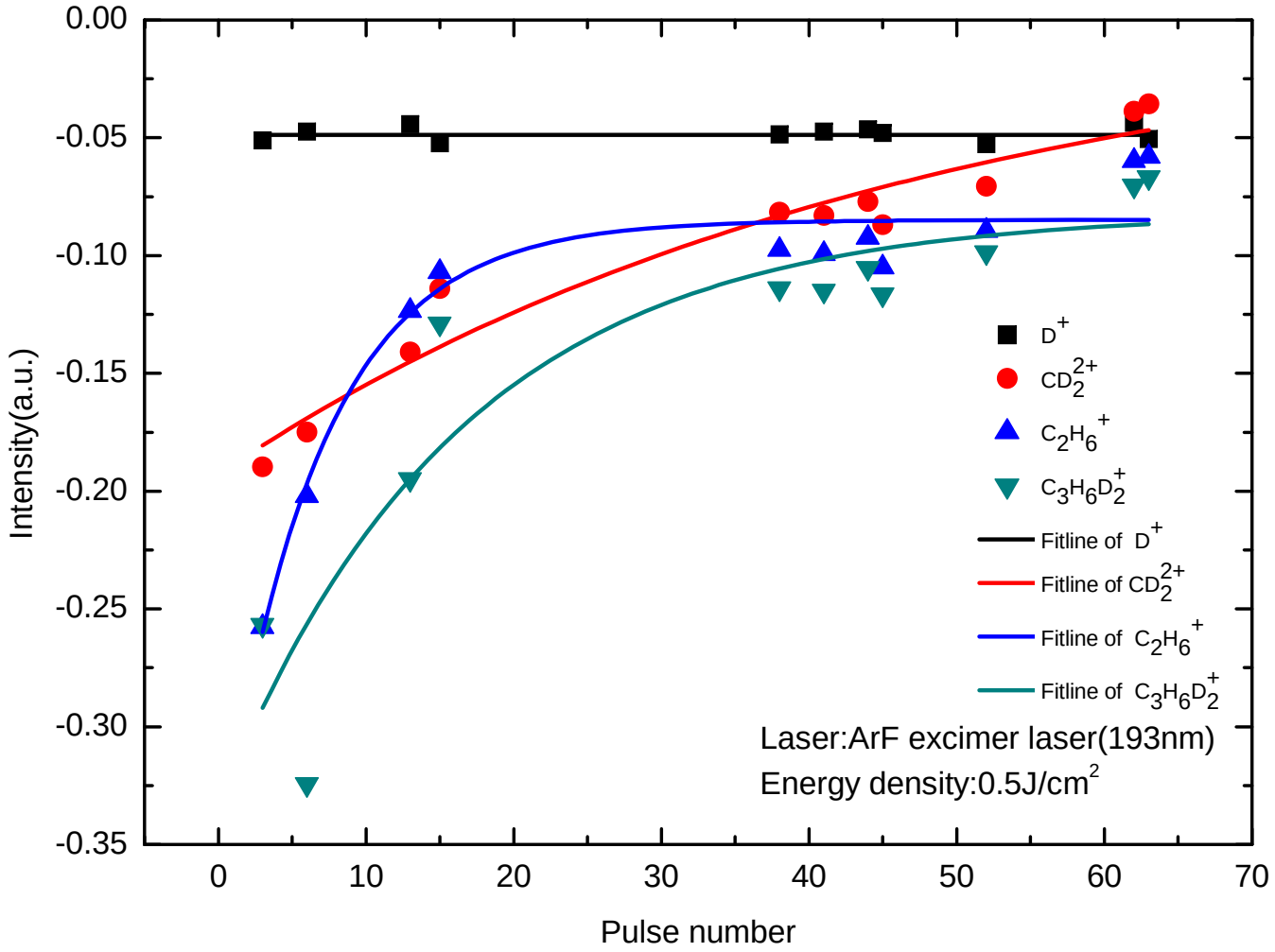


LA-TOF spectrum of co-deposition on the first mirror



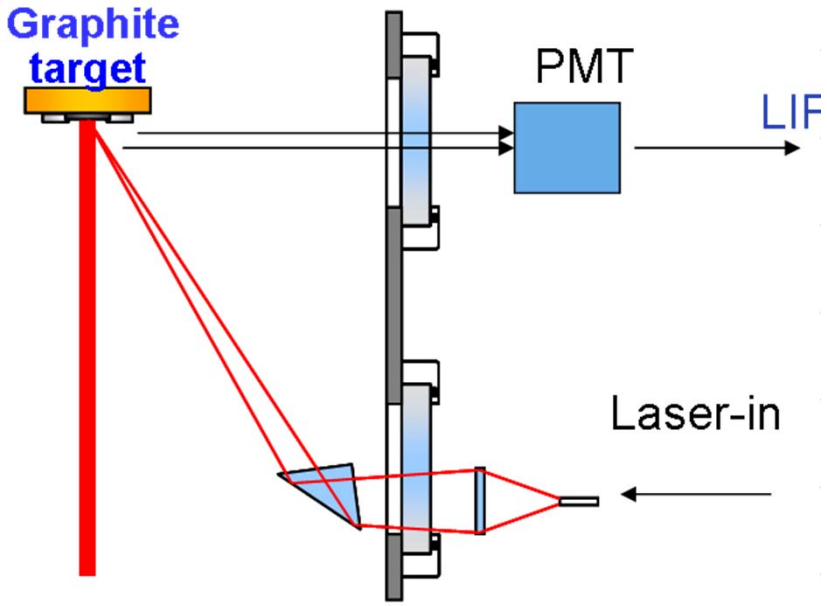
The dominated species are $\mathbf{C_xH_yD_z}$

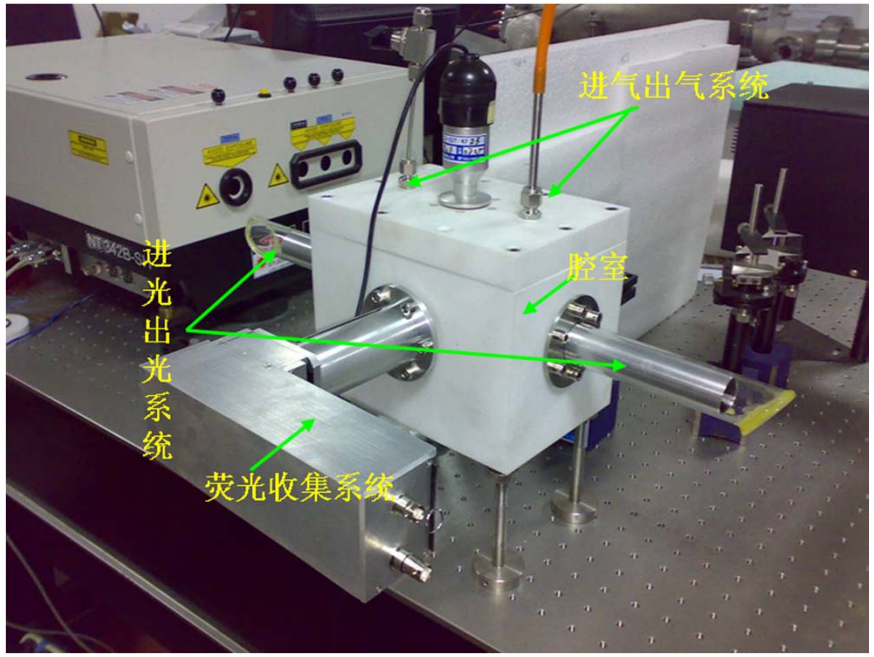
Removing efficiency for different species



Outlook of the future projects

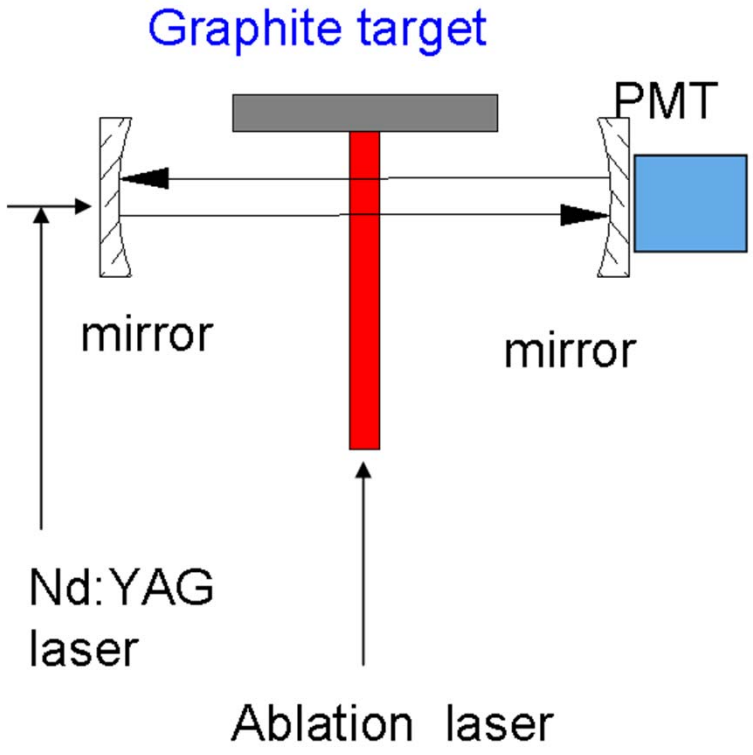
1.Developmment LIF spectroscopy for diagnosis PWI

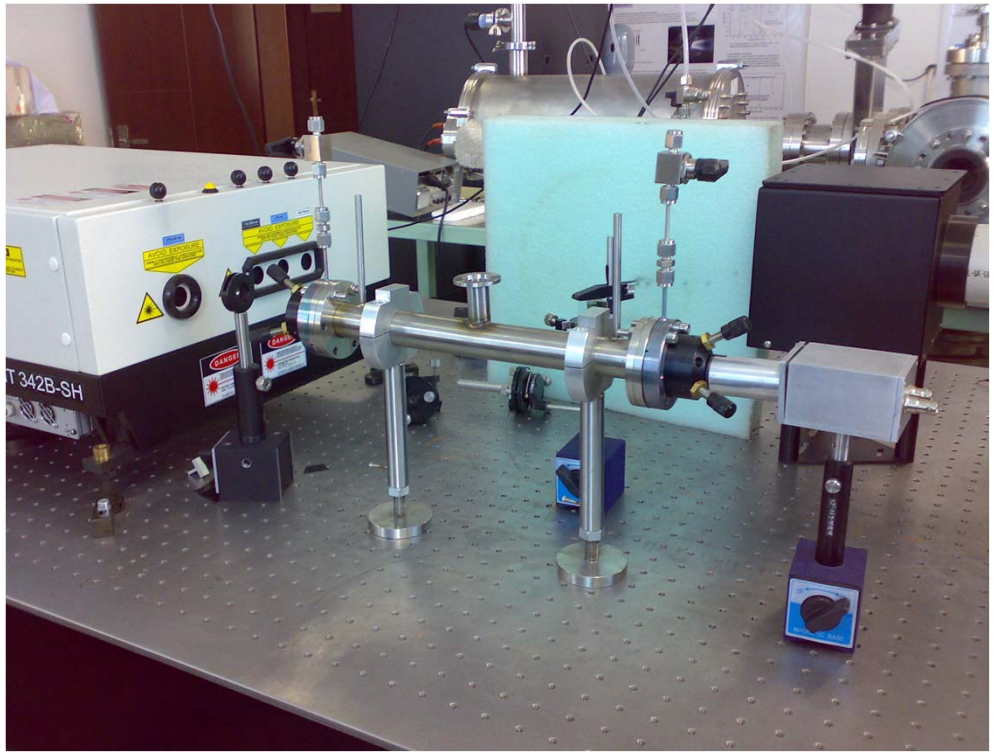




Outlook of the future projects

2.Developmment of CRDS spectroscopy for diagnosis PWI





Acknowledgements

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Thank you!