

# VUV Spectroscopy and Discussion on Line Identification in KSTAR Plasmas

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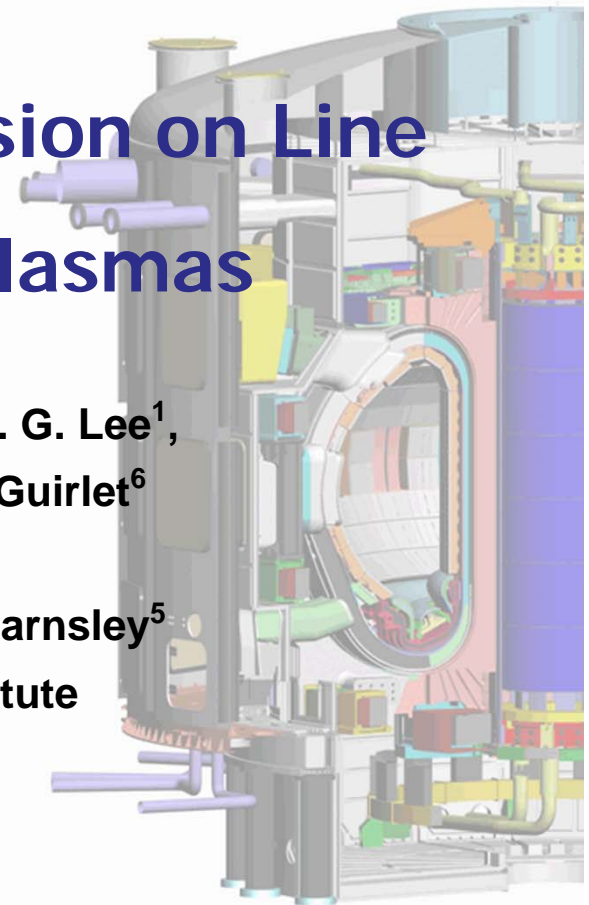
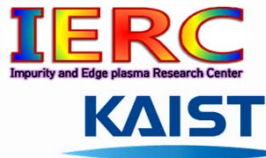
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# Prototyping of ITER VUV Spectrometer

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# Overview of ITER VUV Spectrometer Design

- **VUV Edge Imaging spectrometer (17 nm - 32 nm)**

- ✓ 1-dimensional spatial monitoring, 2 cm spatial resolution at  $\rho/R = 0.85 - 1.03$ ,
- ✓ One field mirror, and one collimation mirror for relay optics

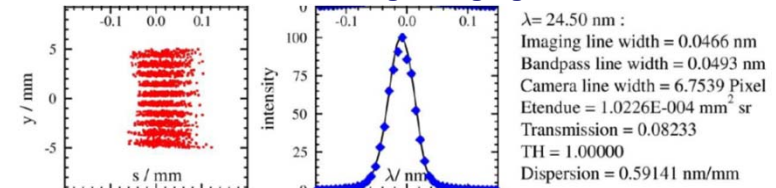
- **VUV Core Survey spectrometer (2.4 nm - 160 nm)**

- ✓ 5-channel spectrometers divided in wavelength for high efficiency
- ✓ 5-mirror optimization for DSM slot minimization

- **Divertor VUV spectrometer (15 nm - 32 nm)**

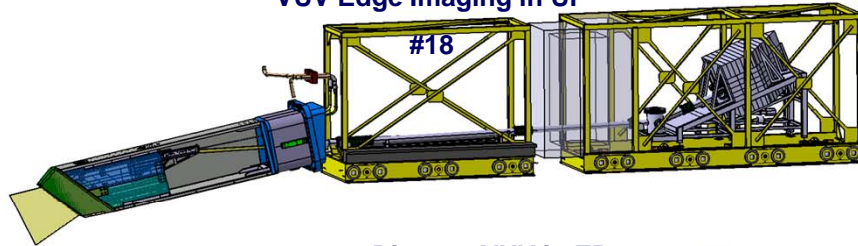
- ✓ Tungsten line emission from divertor plasmas

VUV Edge Imaging

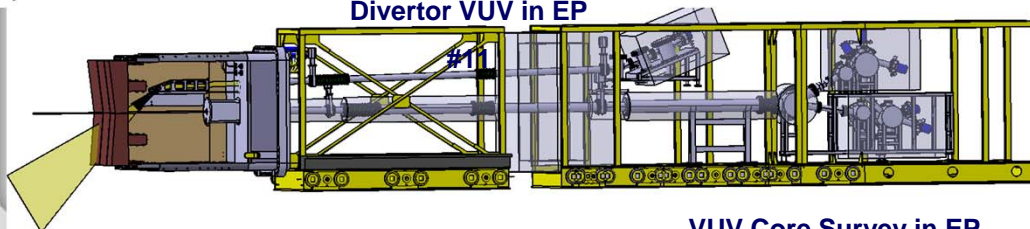


Average line width: Imaging = 0.0464 nm, Camera = 0.0499 nm  
 Mean resolution  $\lambda / \delta\lambda = 491$ , mean line width = 6.807 Pixel, mean Etendue = 1.0175E-004 mm<sup>2</sup> sr

VUV Edge Imaging in UP



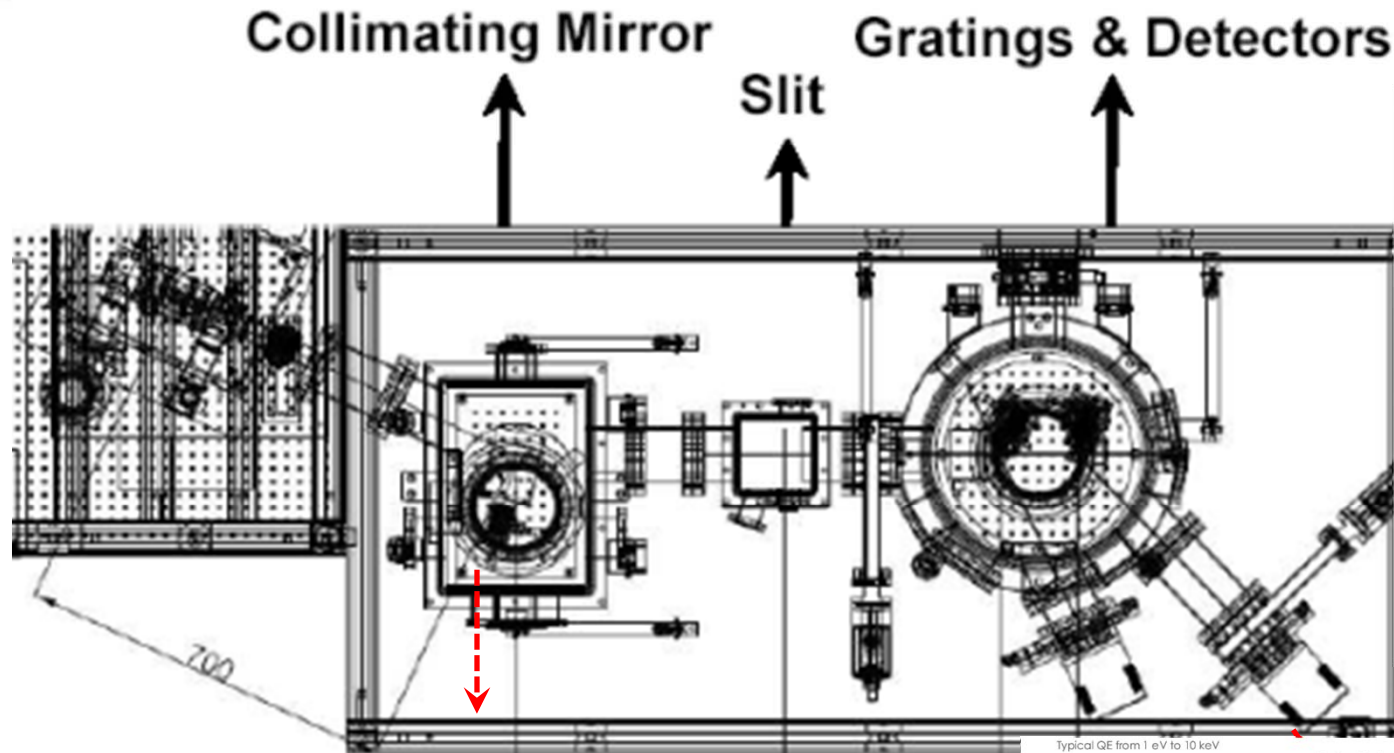
Divertor VUV in EP



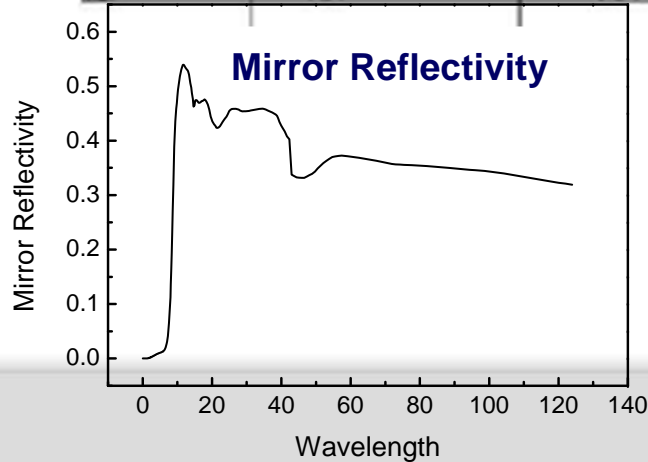
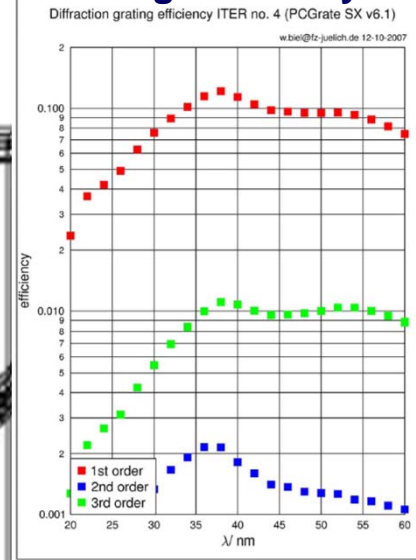
VUV Core Survey in EP

VUV Core Survey	1	2	3	4	5
Wavelength Range (nm)	2.4-7.8	7.0-16.2	14.4-32	29-60	55-159
Line Width (nm)	0.021	0.035	0.044	0.054	0.106
Spectral Resolution (BICCD ~ 20 um)	206	315	462	669	646
Incidence Angle (degree)	3.5	7.0	20	28	45
Distance: Slit to Grating (mm)	650	470	550	400	300
Distance: Grating to Det. (mm)	~550	~470	~550	~400	~300

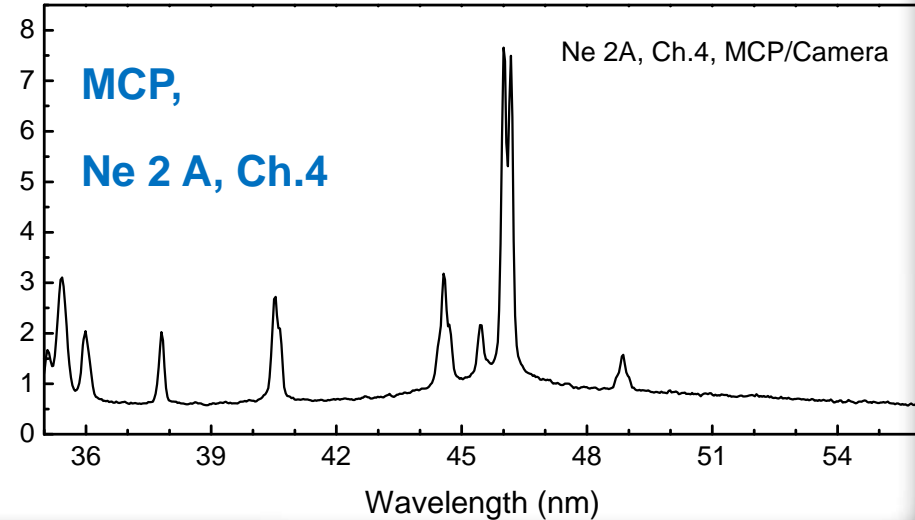
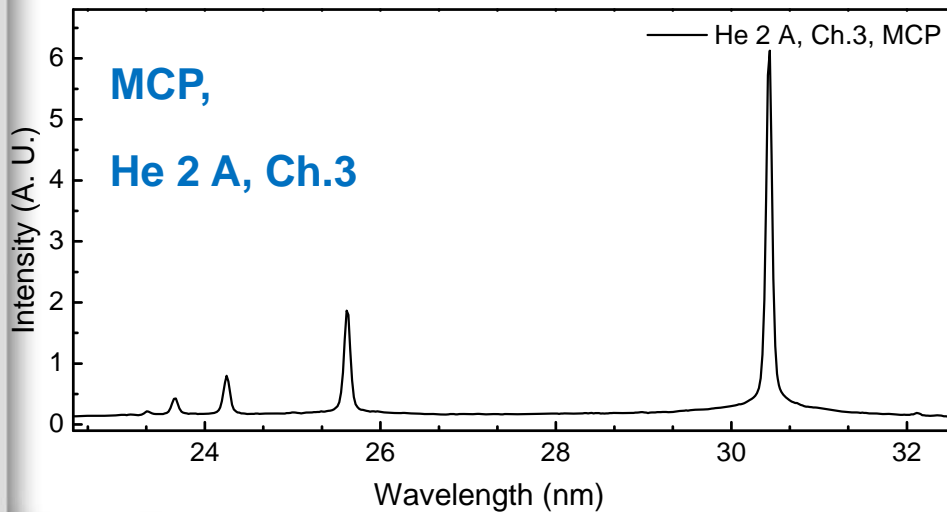
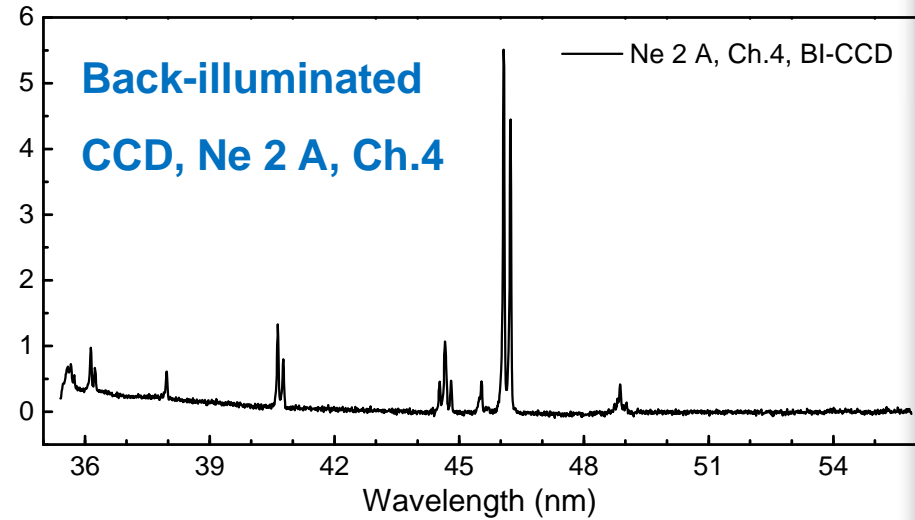
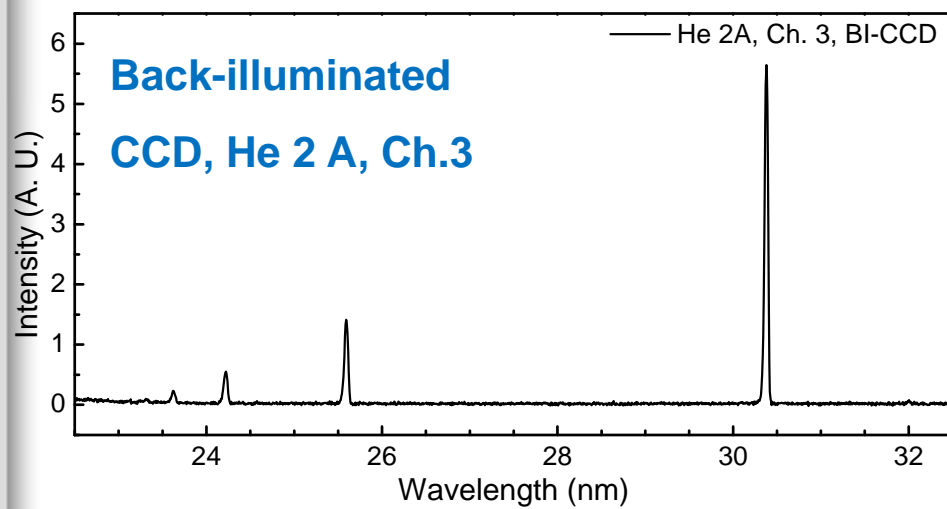
# Prototyping of Two channels (15-30 nm, 30-60 nm)



## Grating Efficiency

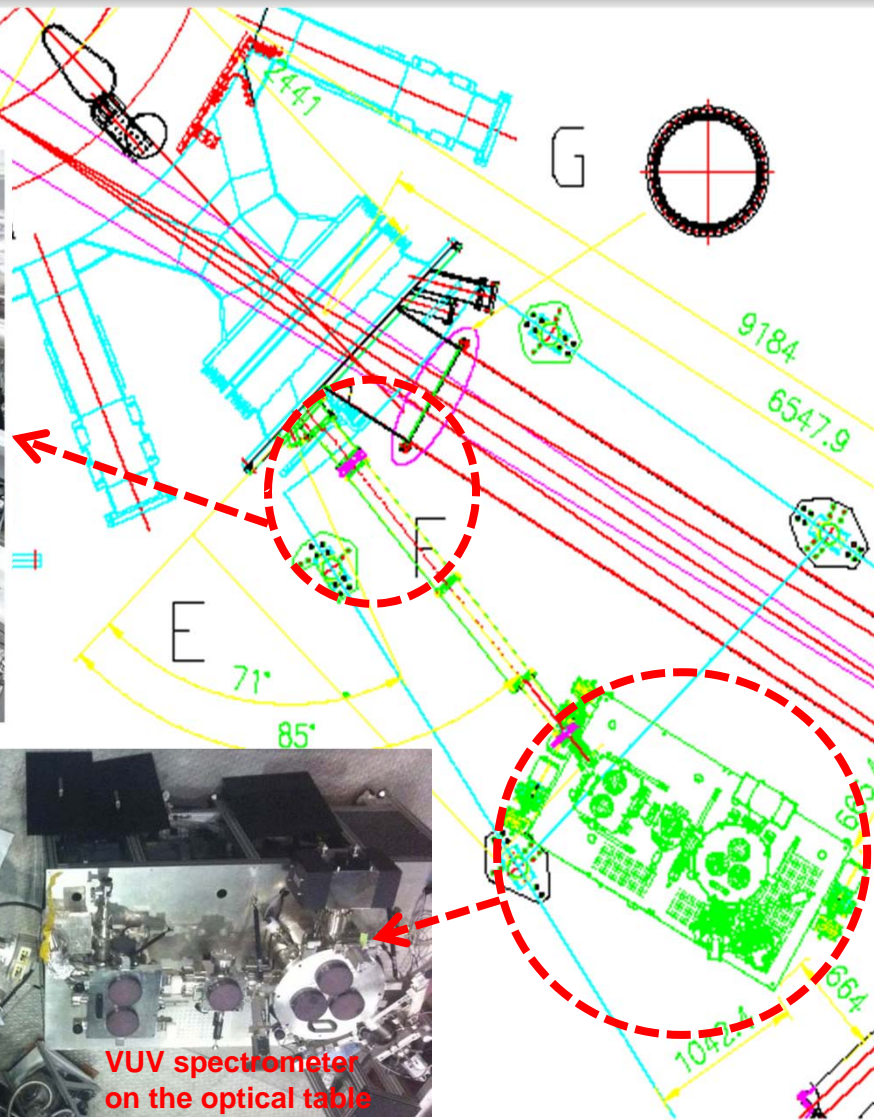
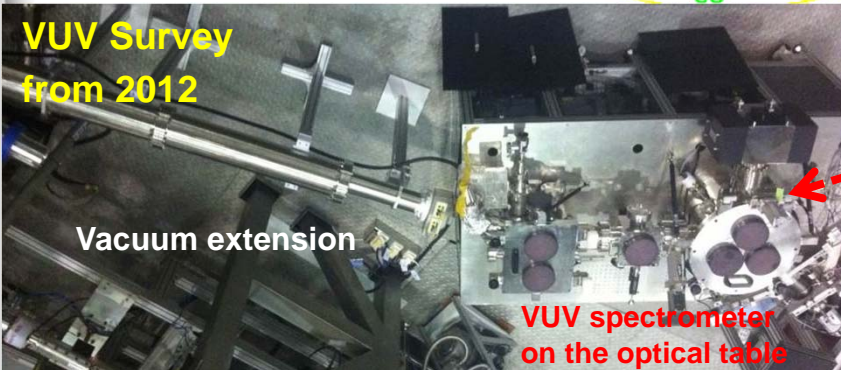


# 2-channel prototype detector test





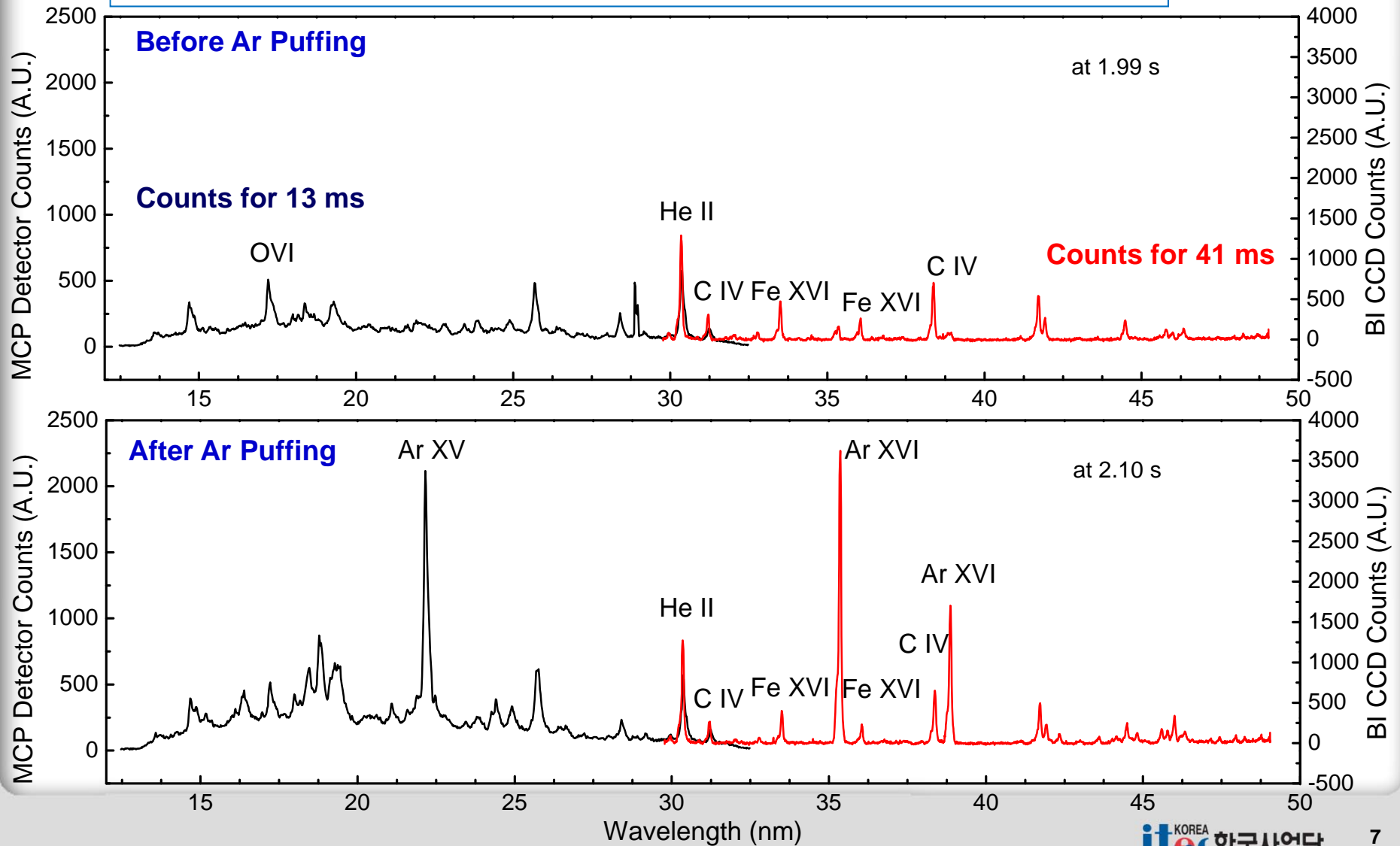
# ITER Prototype VUV Spectrometers at KSTAR



- Spectrometer table on **the F-port deck**
- 3 m - long Vacuum Extension Tube
- Two Gate Valves
- One Bellows
- **VUV survey mirrors**
  - (1) Cylindrical  
10 cm x 5 cm, R.O.C. = 13.5 cm
  - (2) Convex  
10 cm x 5 cm, R.O.C. = 700 cm
- **VUV Imaging**
  - (1) Concave R.O.C. = 50 cm
  - (2) Ellipsoidal

# Ar Puffing Experiment (L mode)

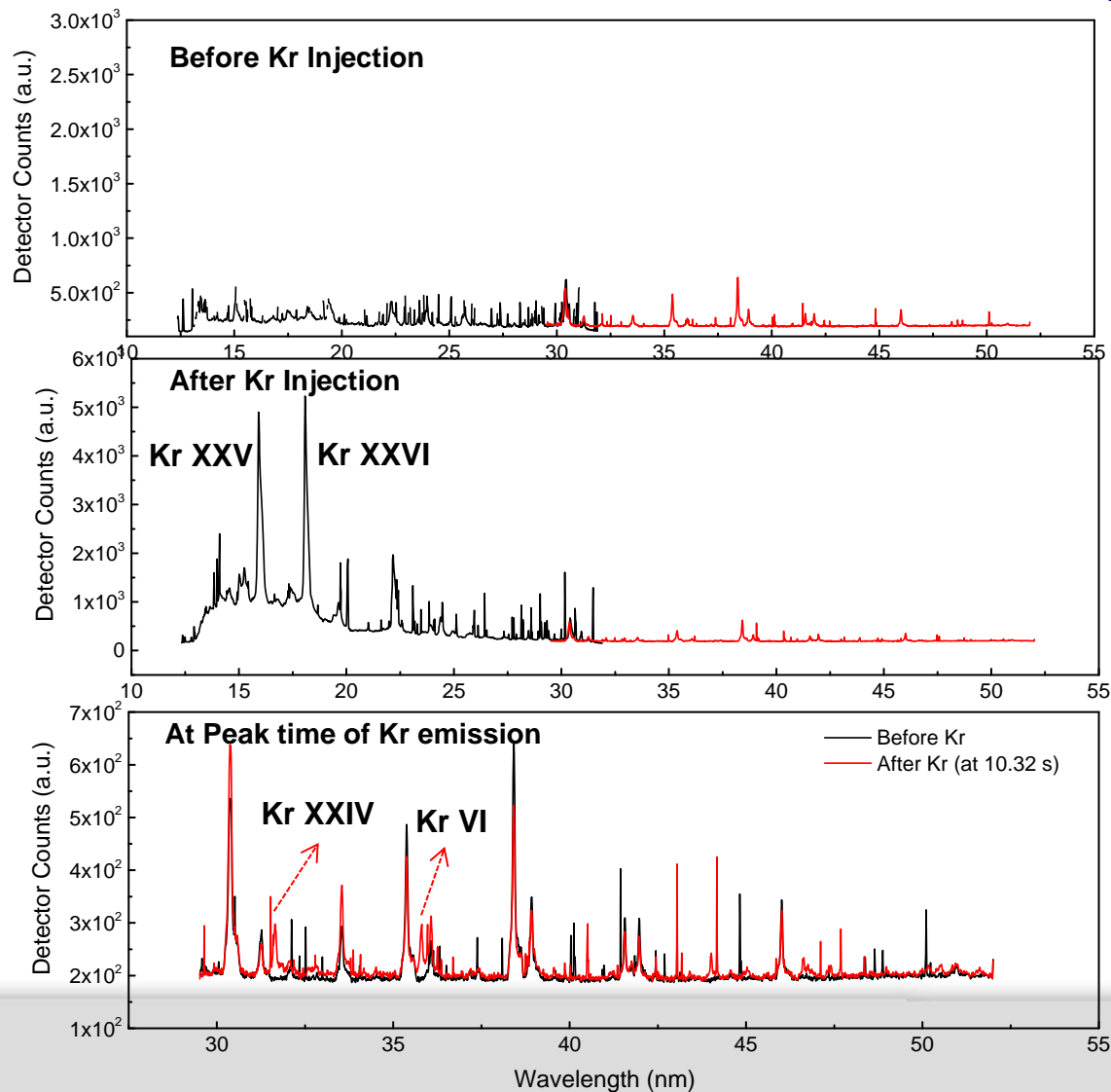
- #7566, L-mode, Flat-top Ar 20ms Puffing at 2.0s,  $I_p=400\text{kA}$



# VUV spectra before/after Kr injection (#13104 by KAIST)

- Kr was injected at ~ 9s during 4 s period.
- Large peaks of Krypton were observed

Need Kr data for transport study





# Summary

- **Prototypes of ITER VUV spectrometer system** have been tested for & **calibrated** in the laboratory with calibrated hollow cathode lamp.
- After laboratory test, **spectrometer system** has been **installed on KSTAR F-port**. Showed nice data from KSTAR campaigns
- Tungsten, Argon, Neon and Krypton lines were identified
- Measured data from VUV spectrometer has been used for **impurity transport study** on KSTAR since 2012 KSTAR campaign & **Cross check with SXR diagnostic** results has been done.
- Using CAES spectrometer, W lines were observed