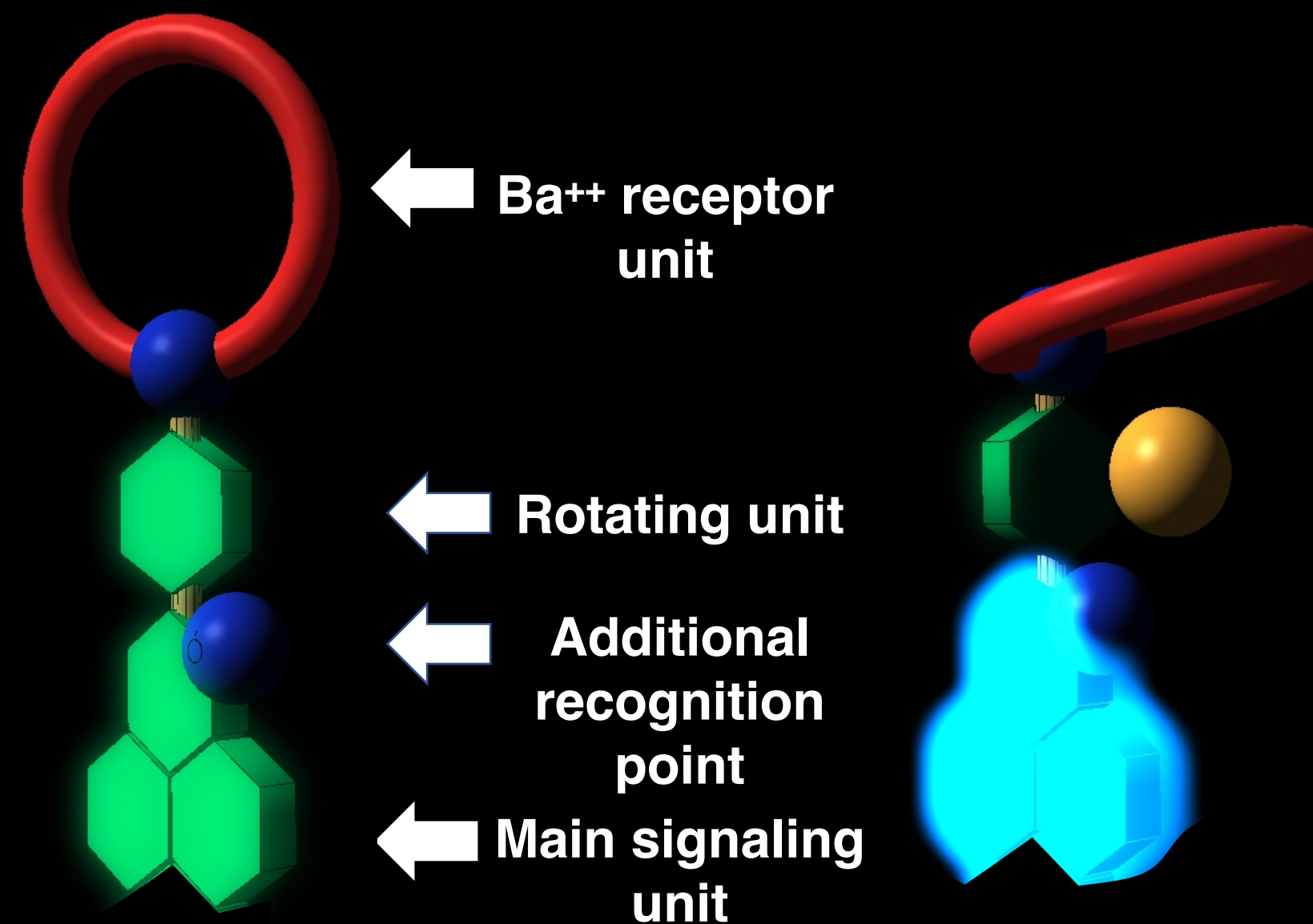
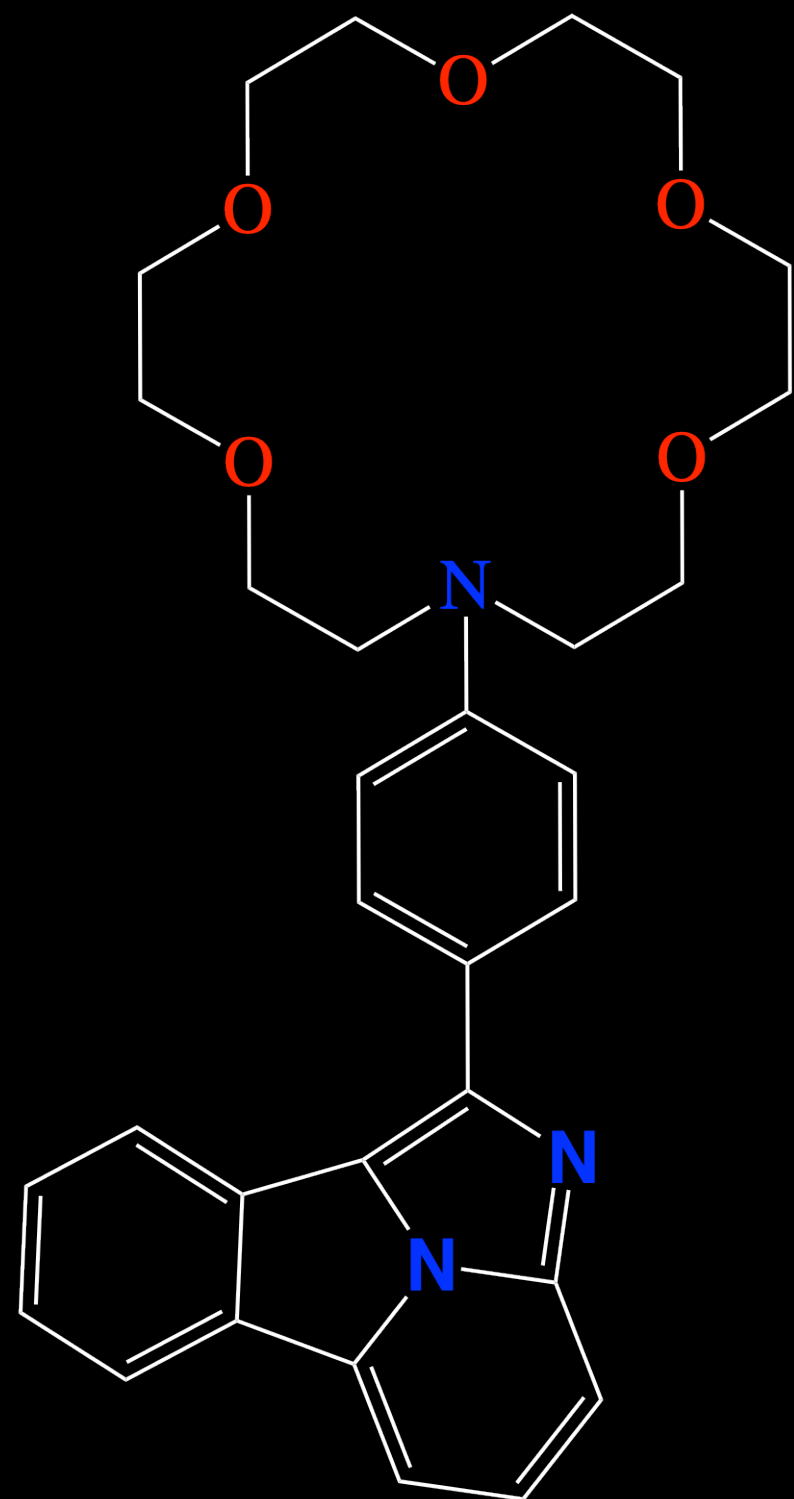


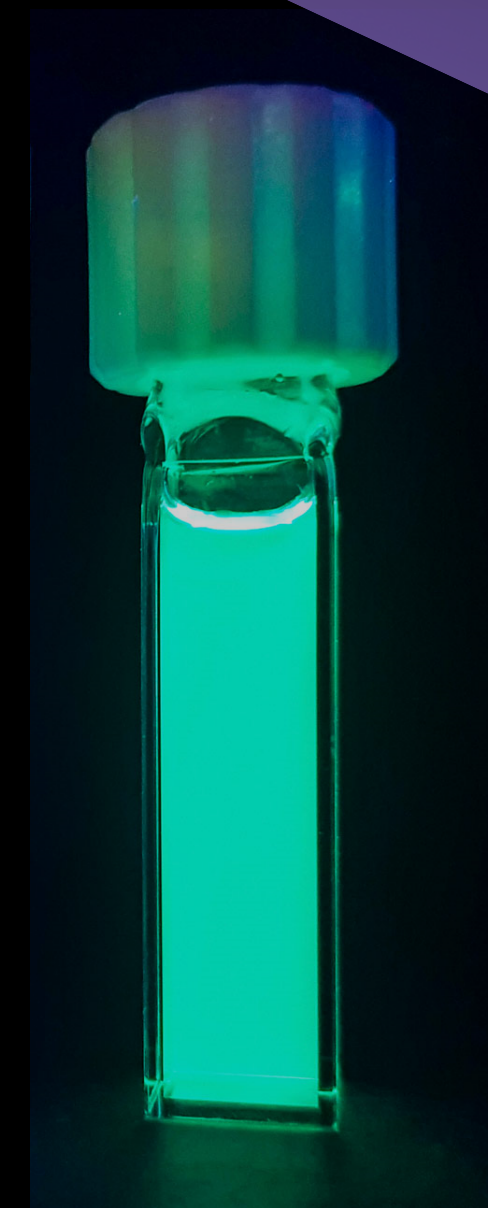
# SABAT approach to $Ba^{++}$ - Tagging

Single Atom BArium Tagging (SABAT) → Fluorescent Bi-color Indicator (FBI )

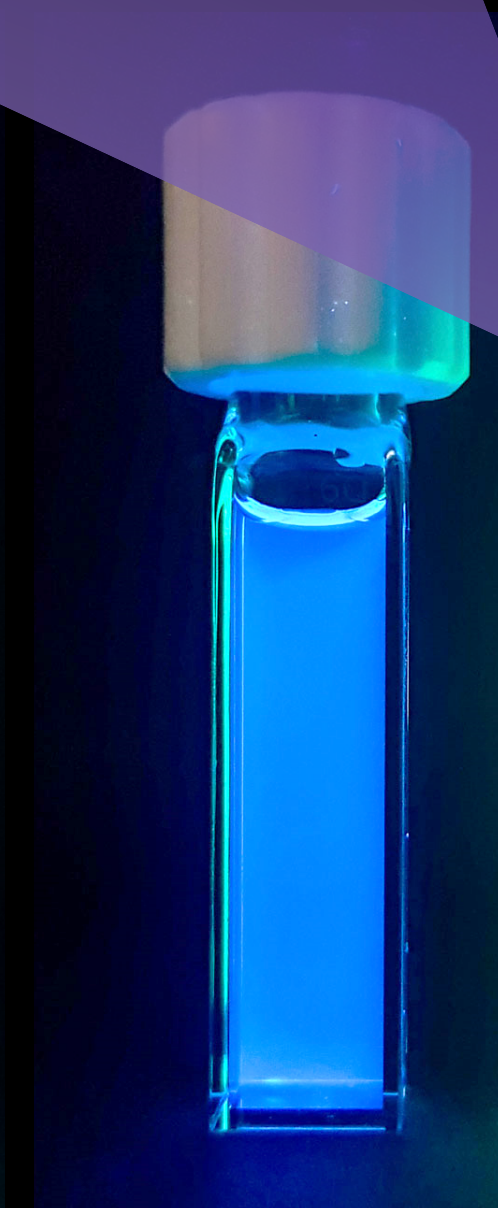
Step 1: Design and synthesis of molecular sensor



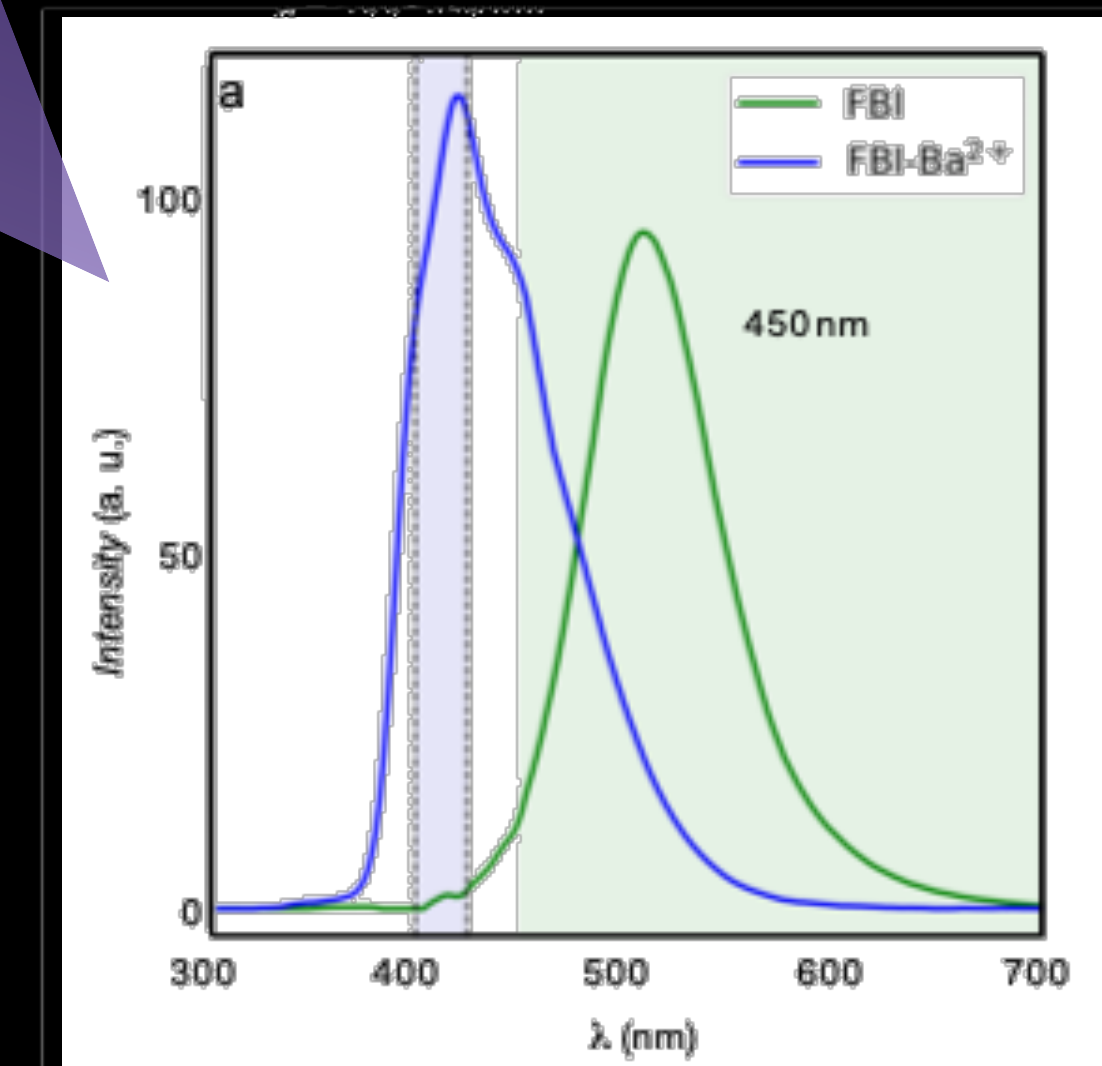
Color shift demonstrated in solution!!



FBI



FBI- $Ba^{++}$

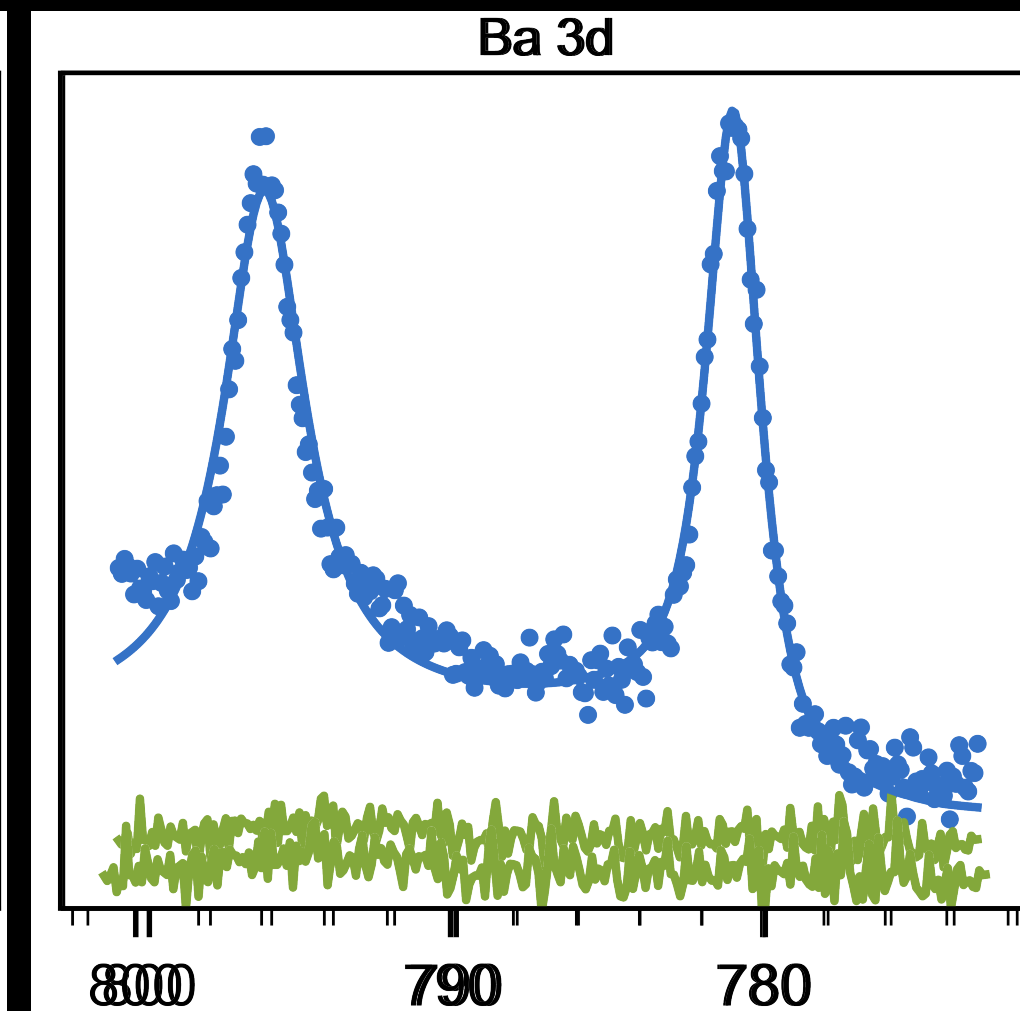
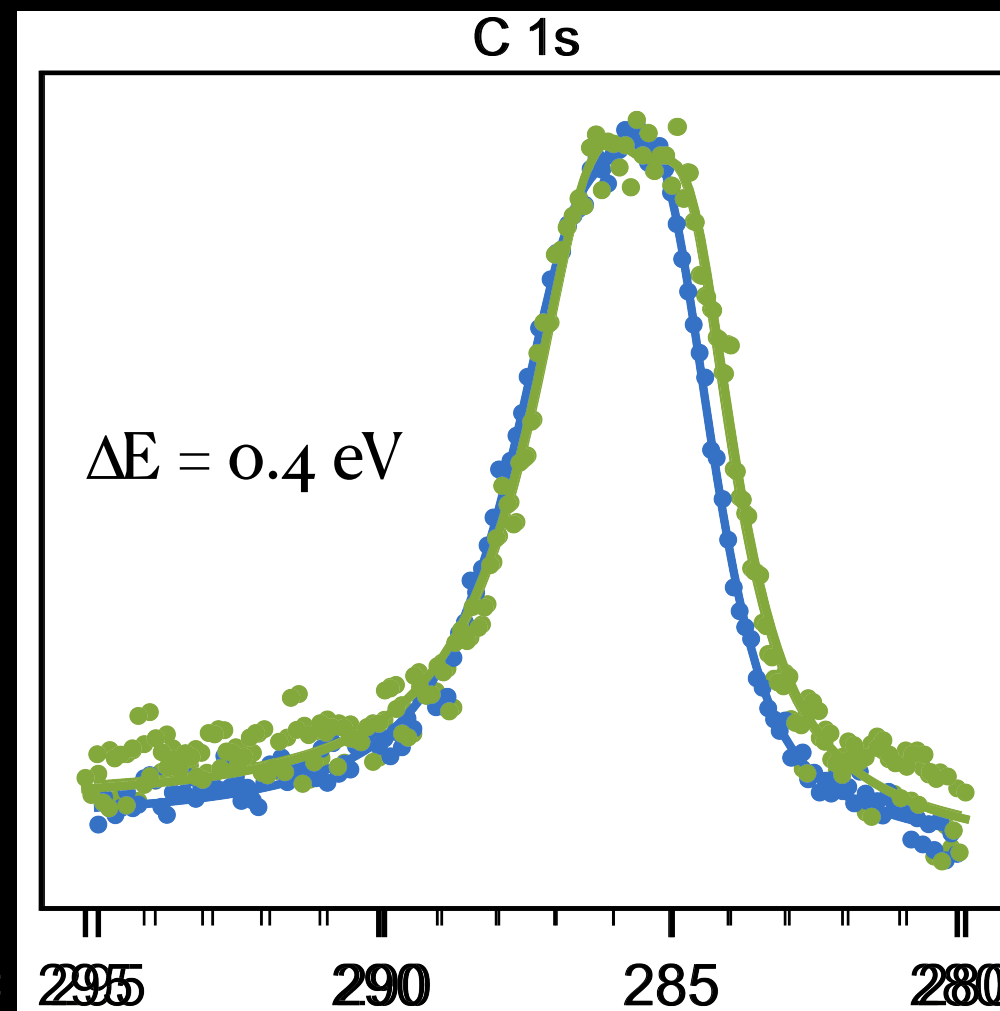
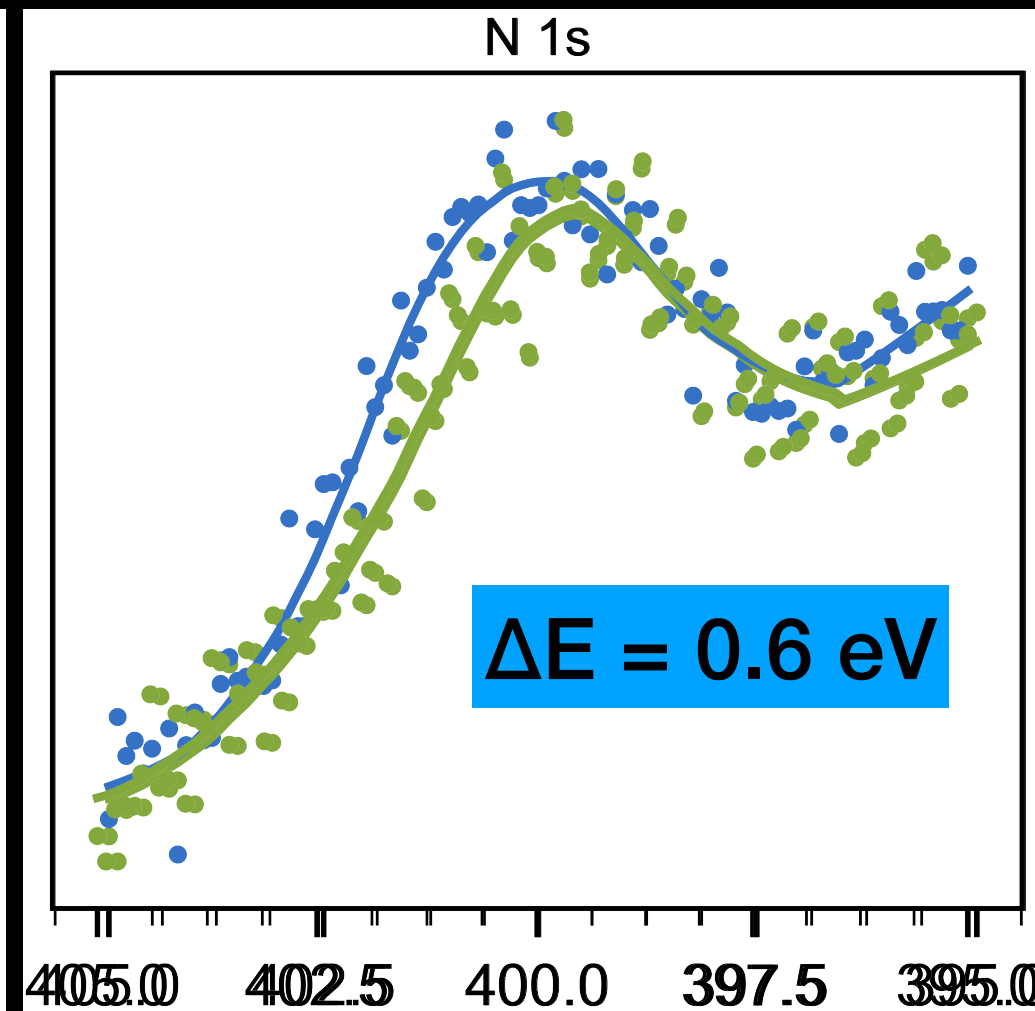
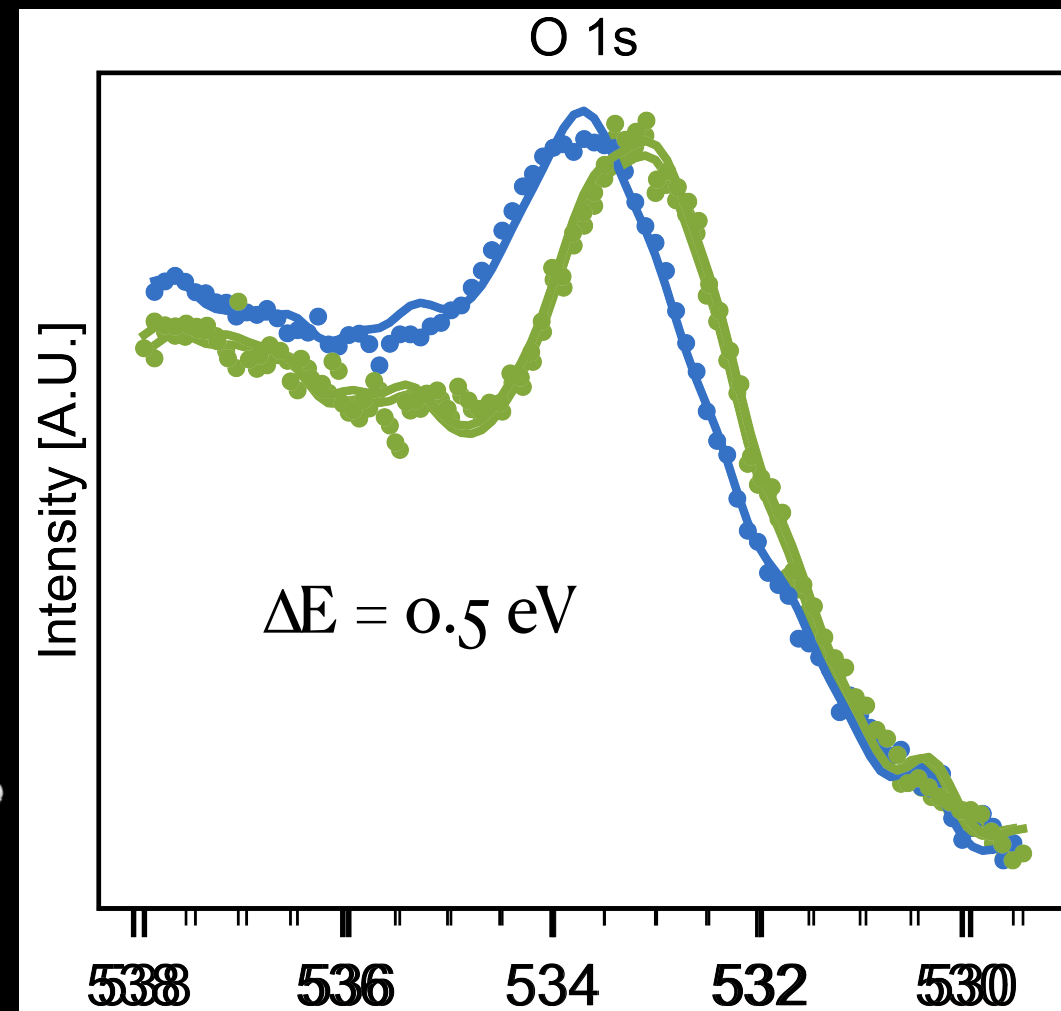
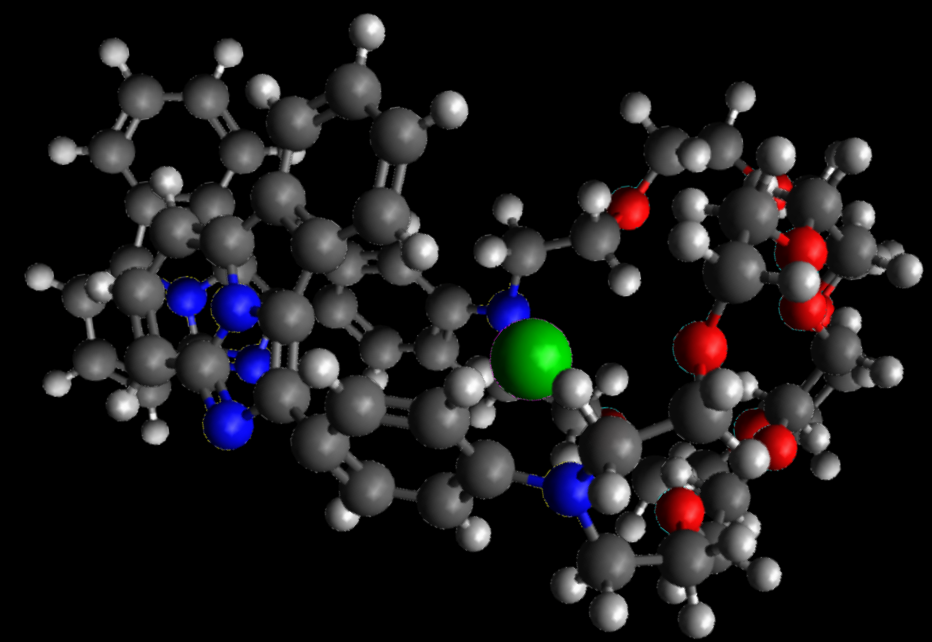




# Chelation with $\text{Ba}^{++}/\text{Na}^{+}$

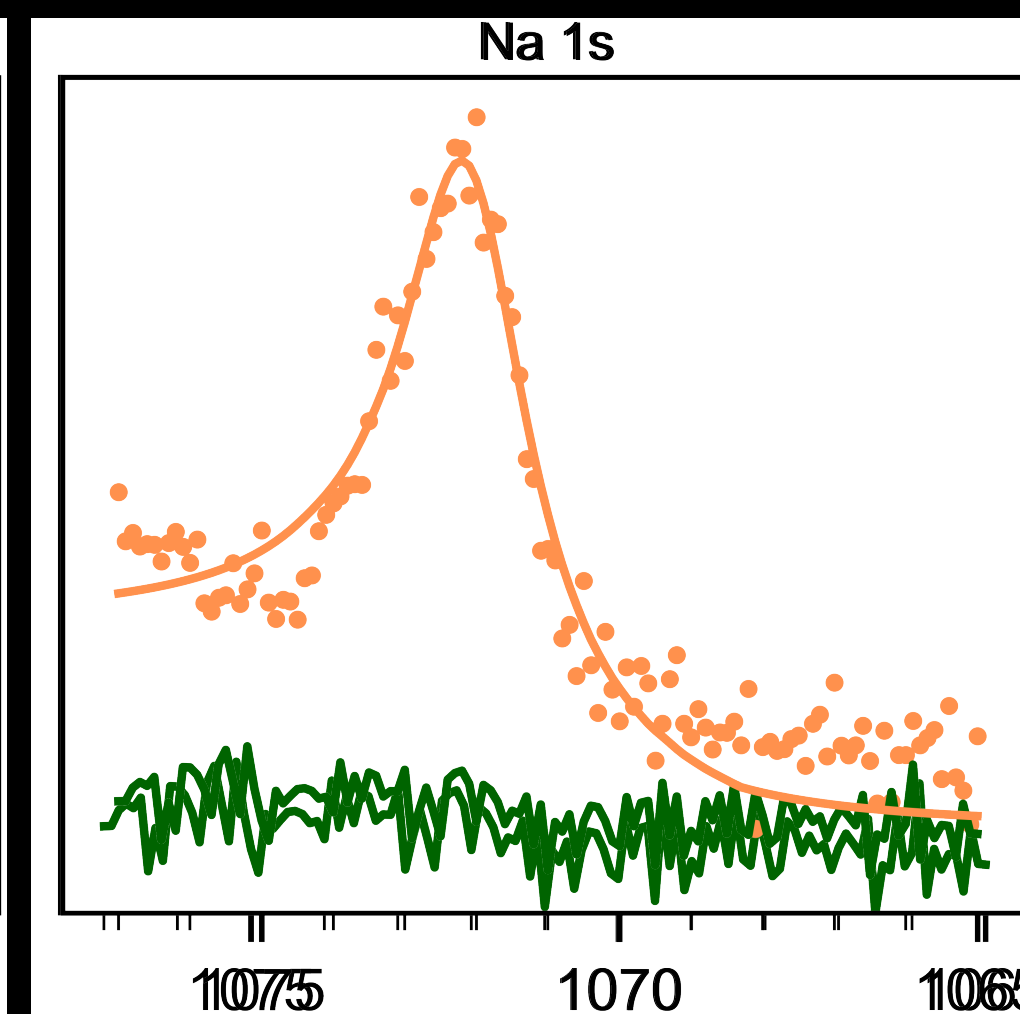
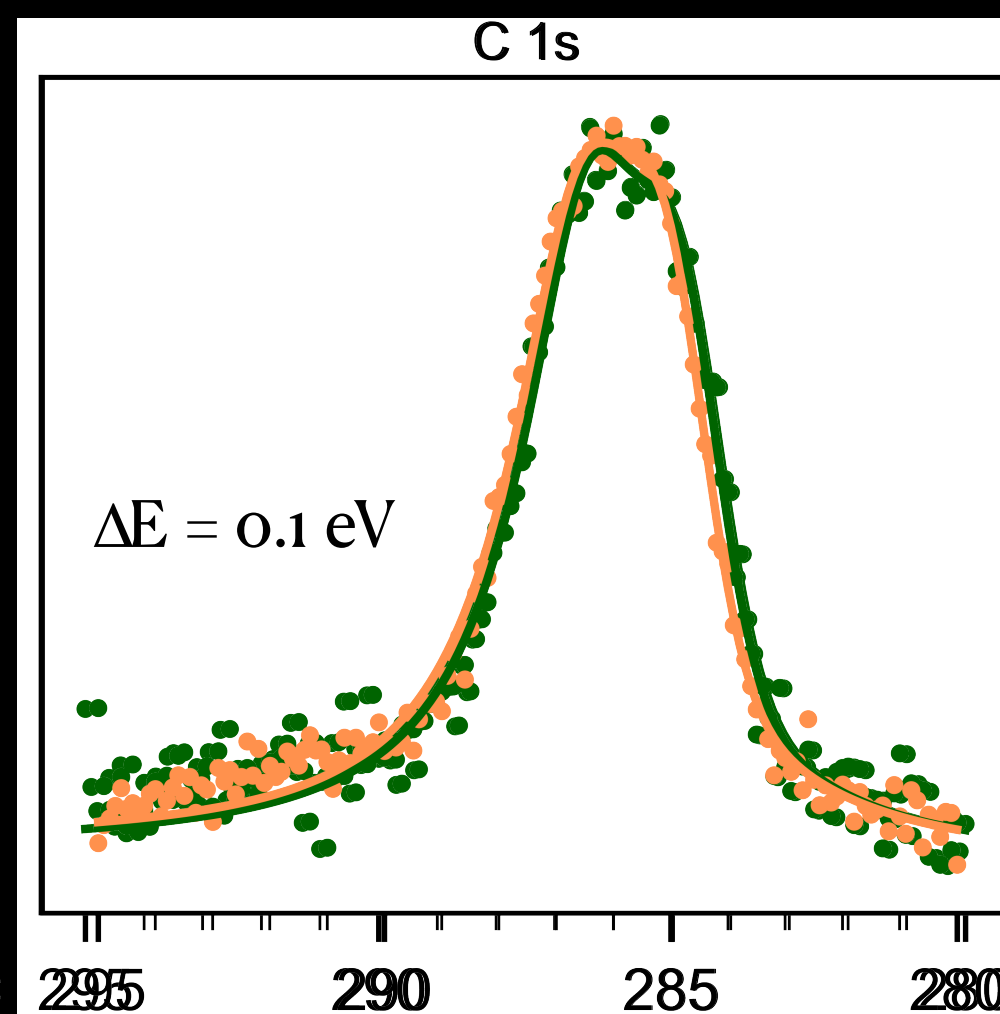
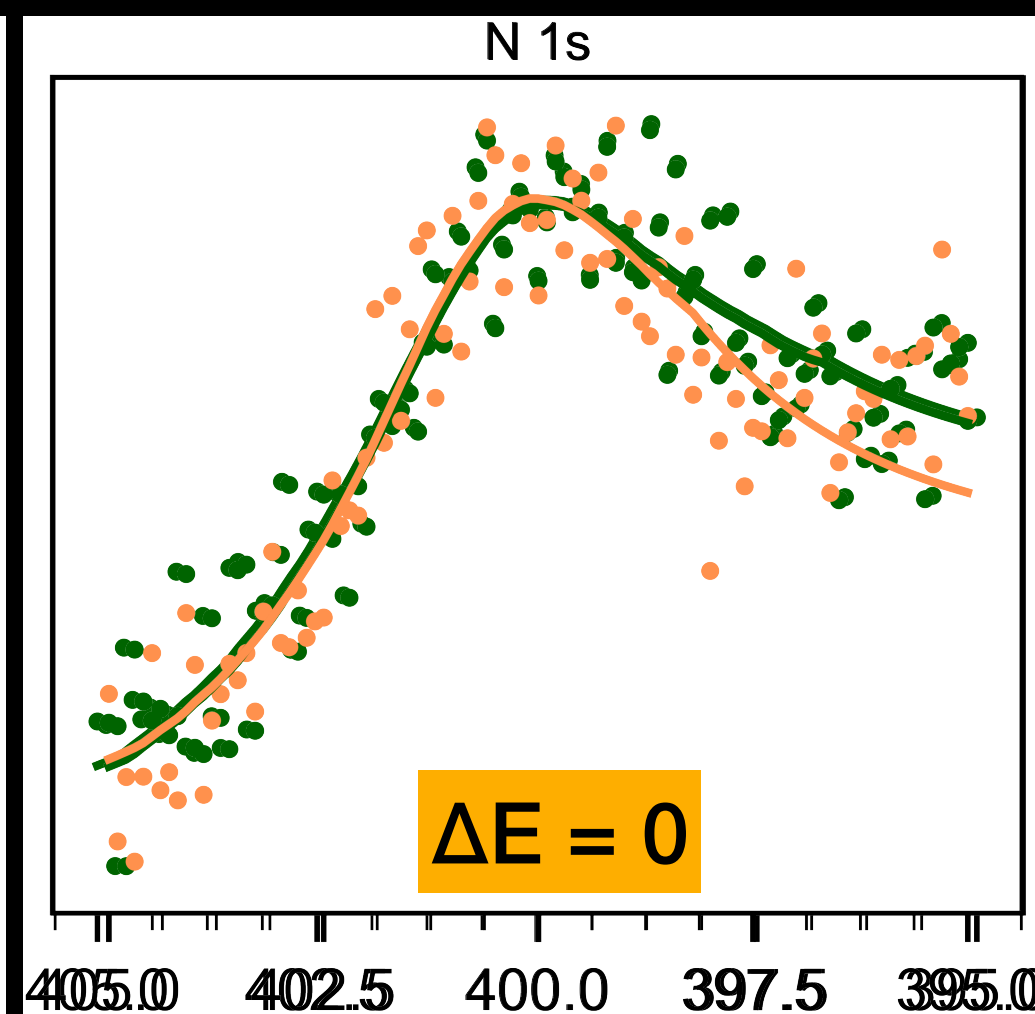
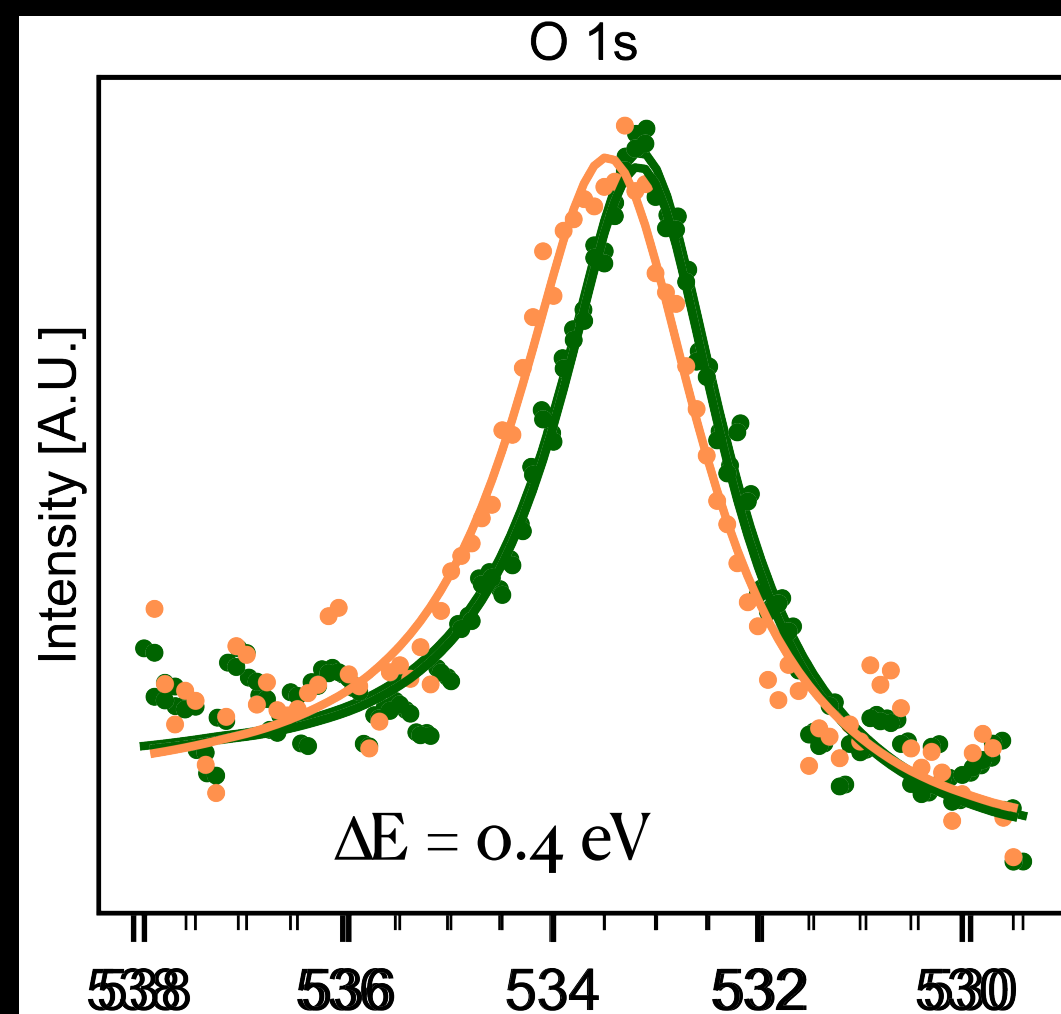
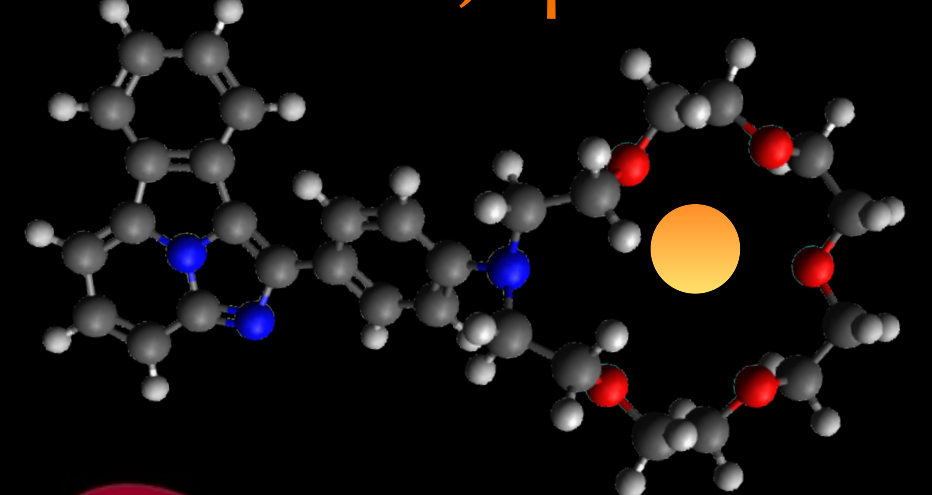
Sample 1:

- FBI 0.65 ML
- $\text{BaCl}_2$ ,  $\phi = 0.8$



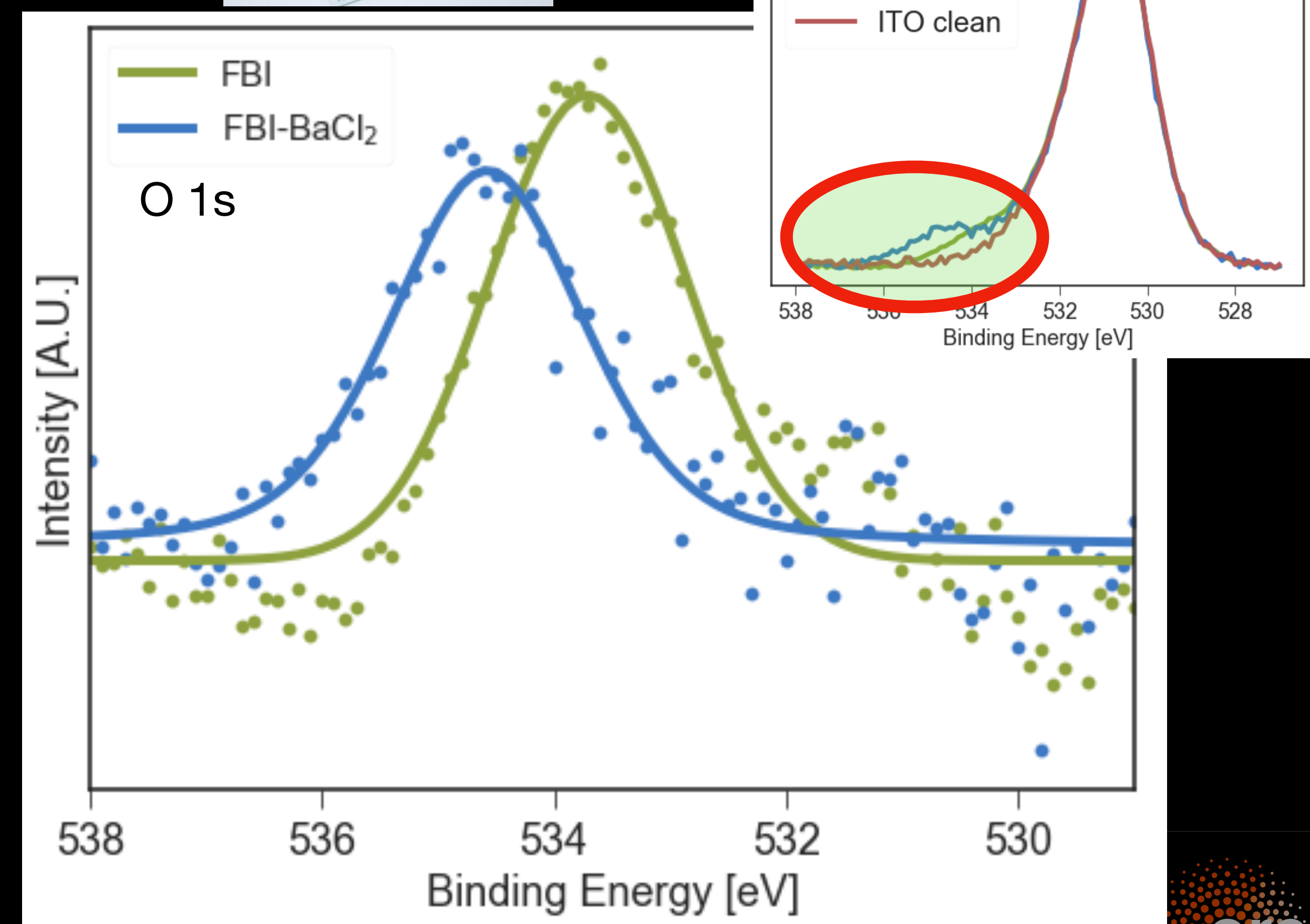
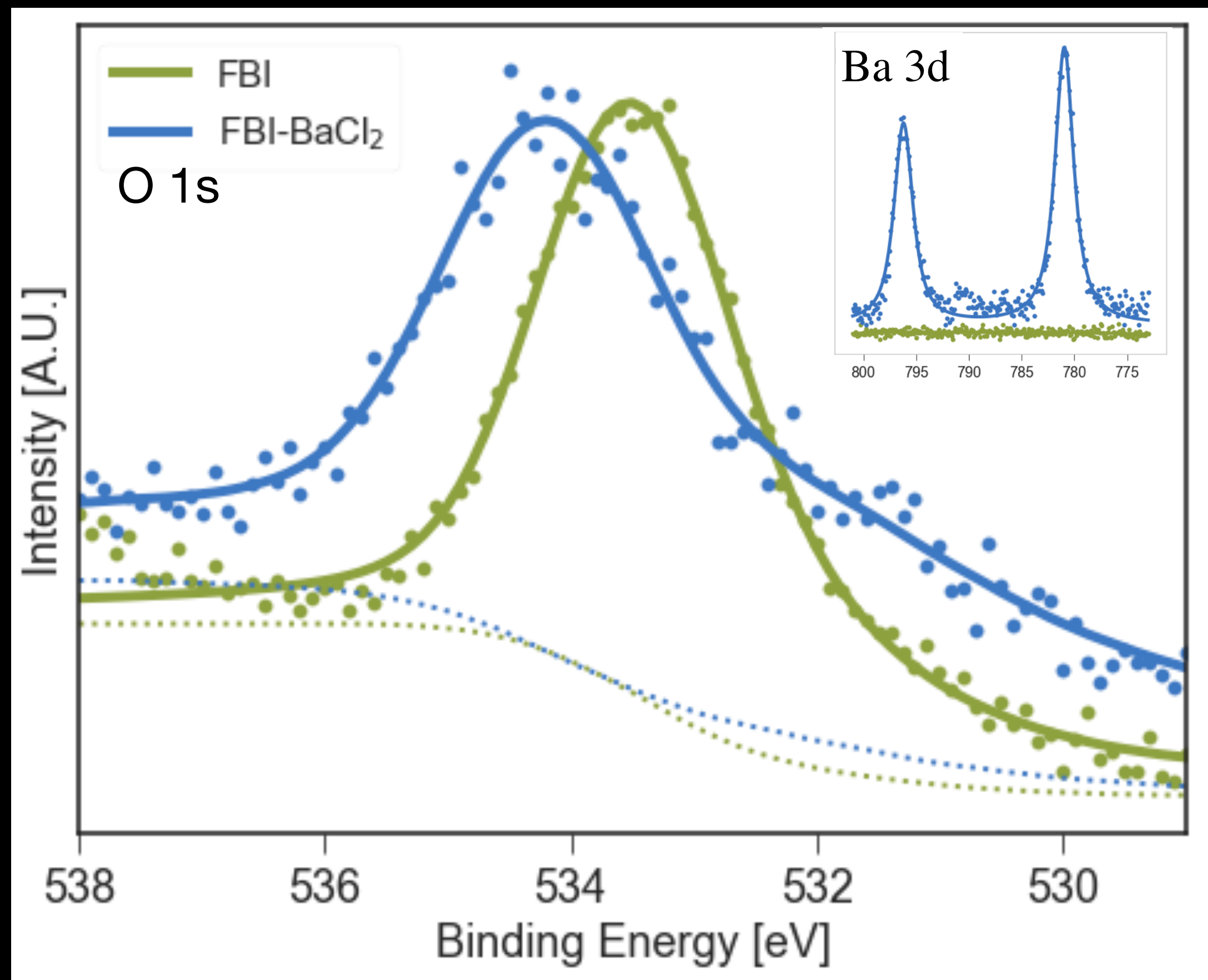
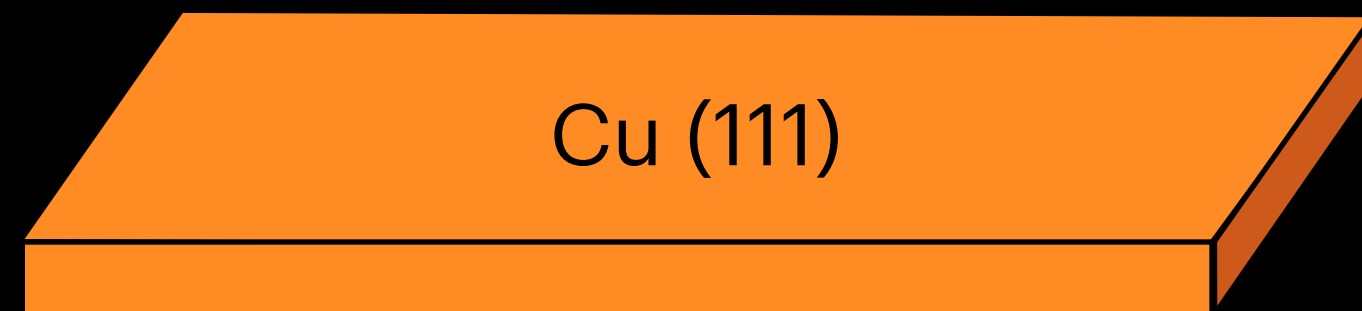
Sample 2:

- FBI 0.6 ML
- $\text{NaCl}$ ,  $\phi = 2.6$





# Effect independent of Substrate



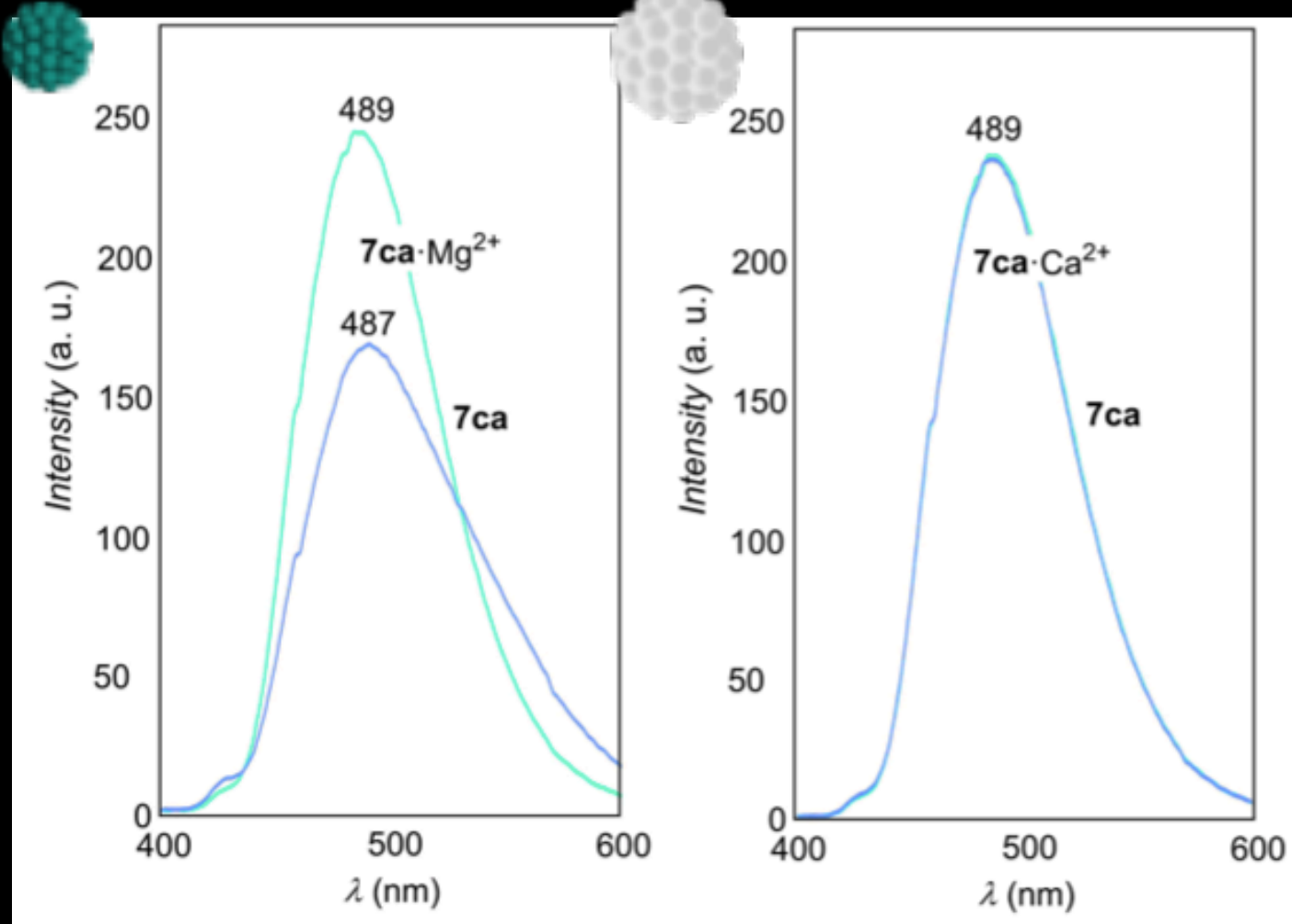


# Selectivity for Ba<sup>++</sup>

Stokes Shift > 35 nm

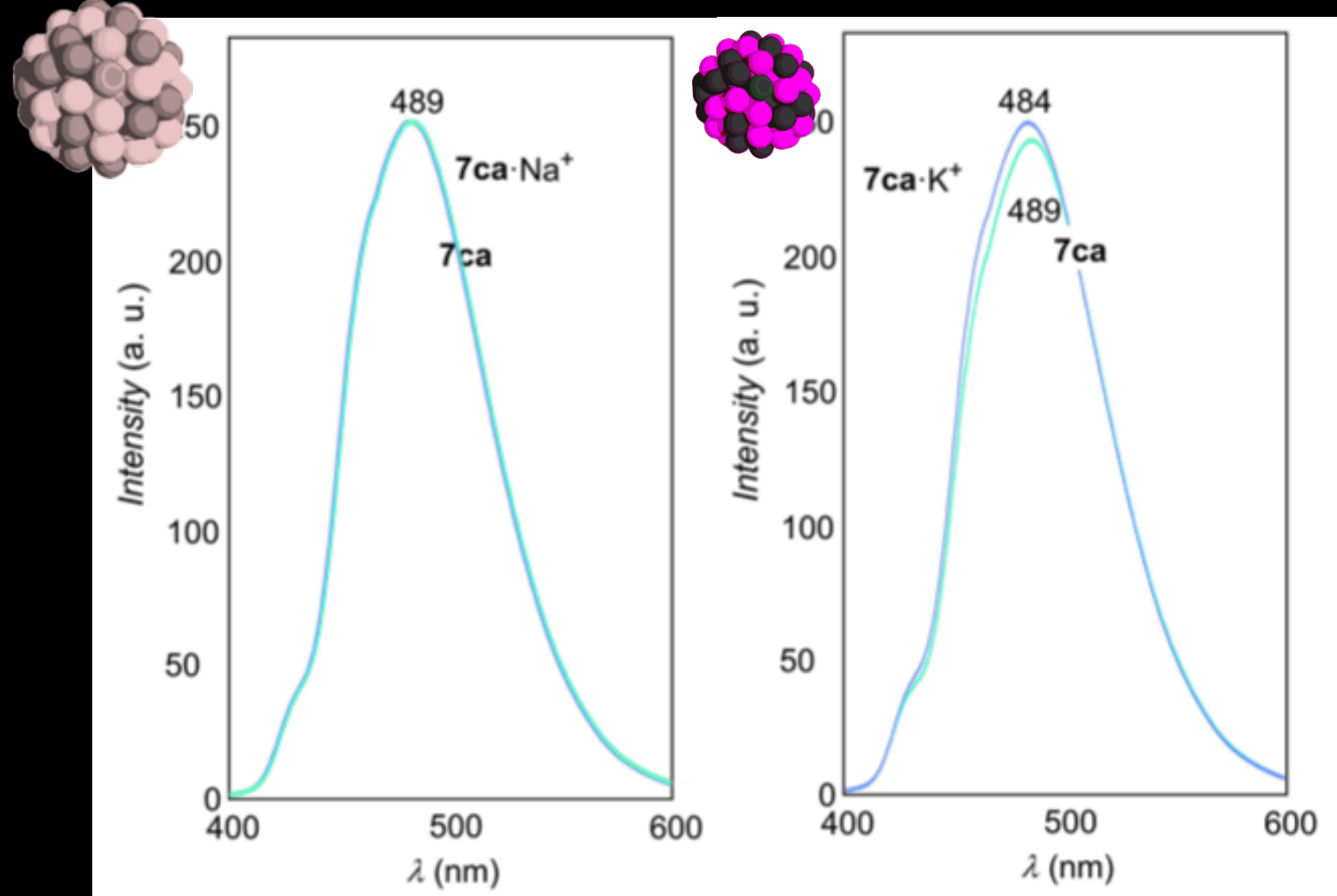
Mg<sup>++</sup>

Ca<sup>++</sup>

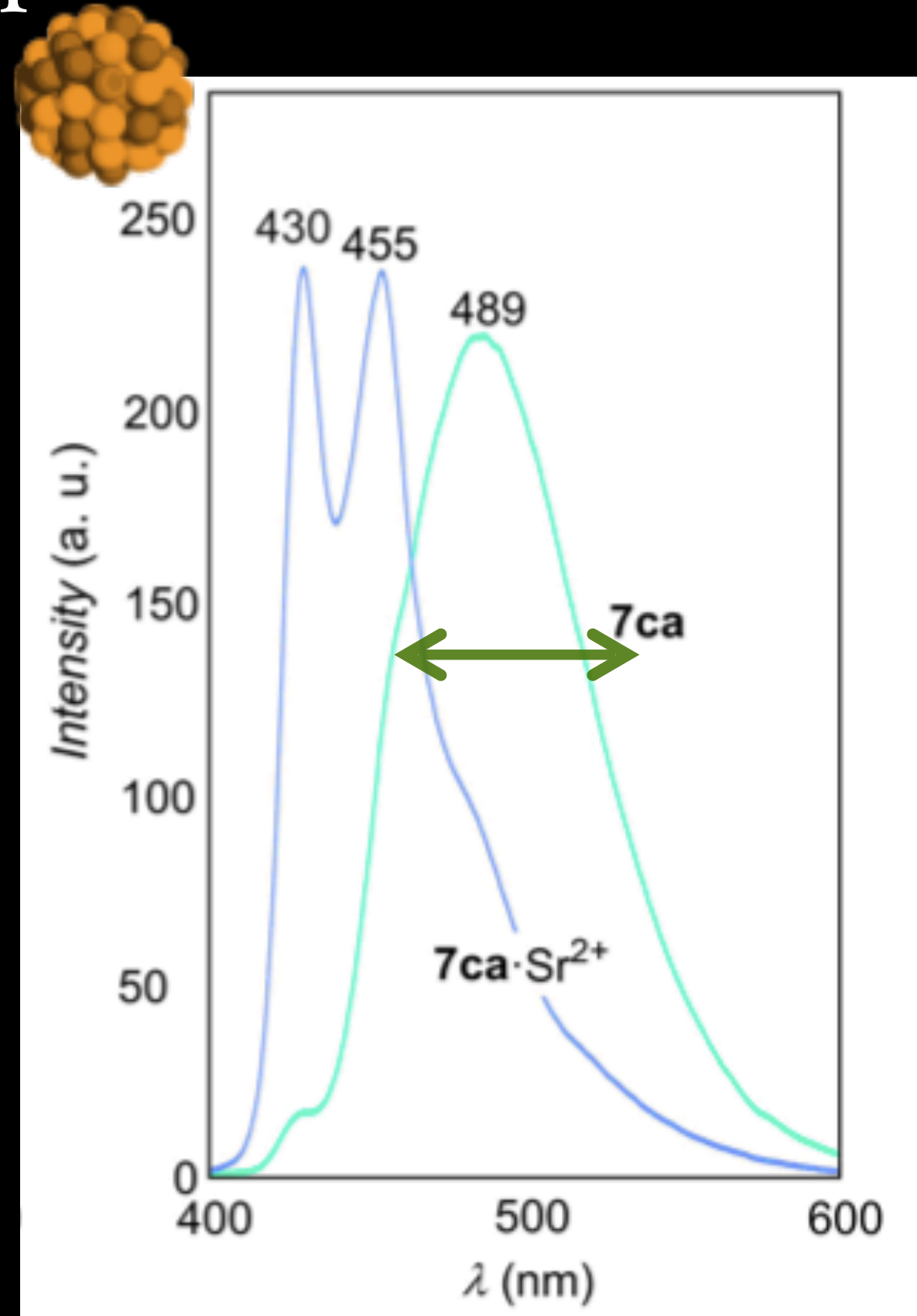


Na<sup>+</sup>

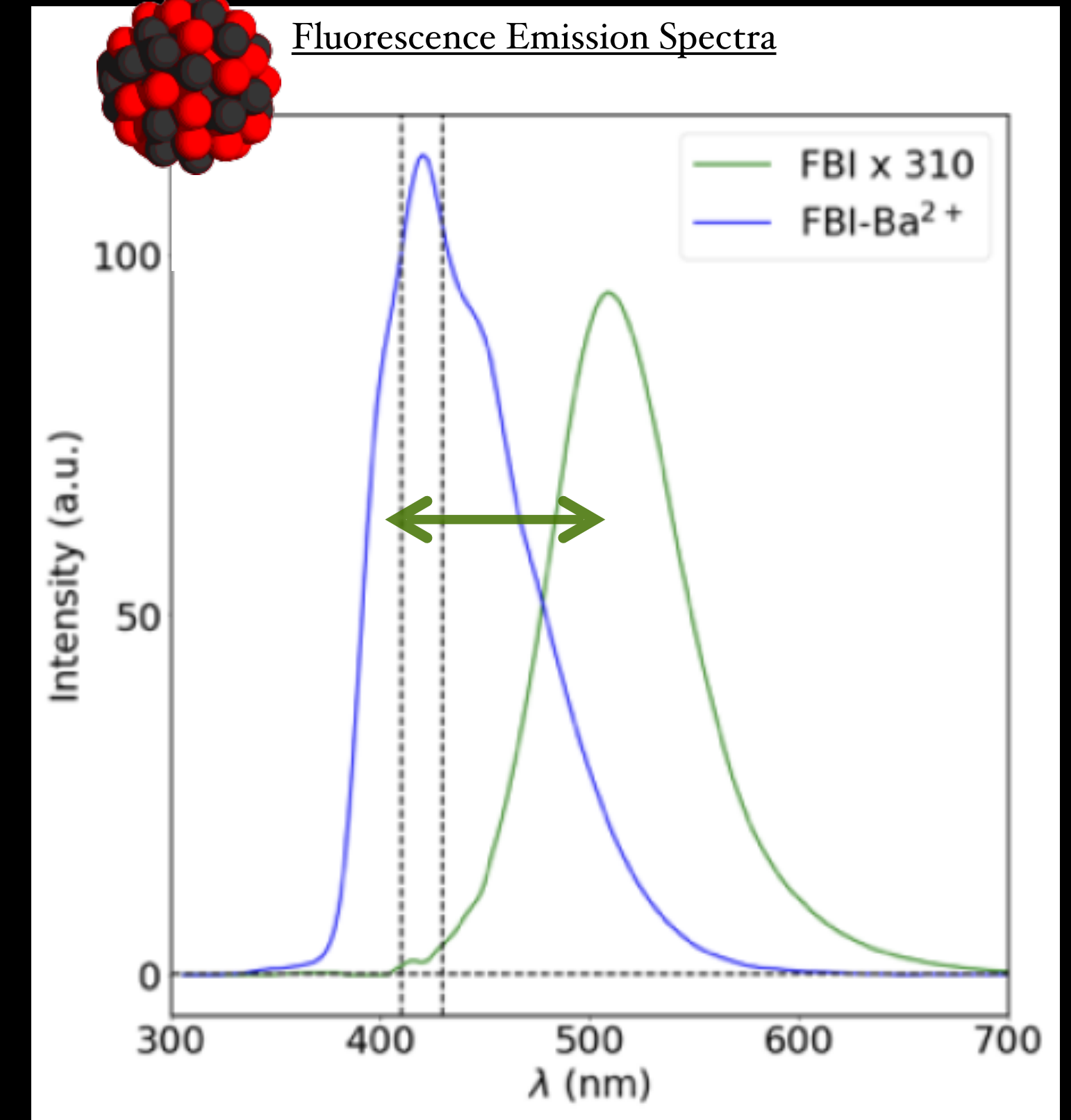
K<sup>+</sup>



Sr<sup>++</sup>



Ba<sup>++</sup>



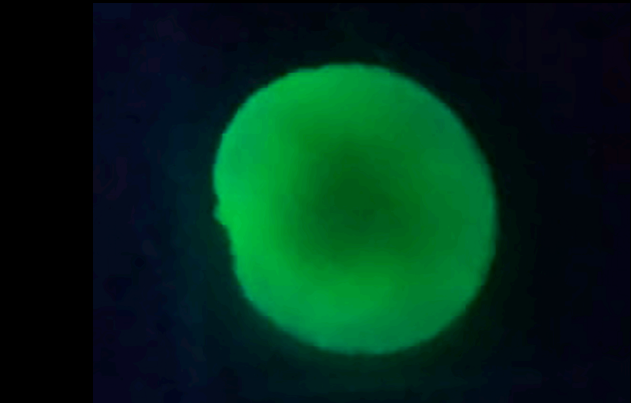
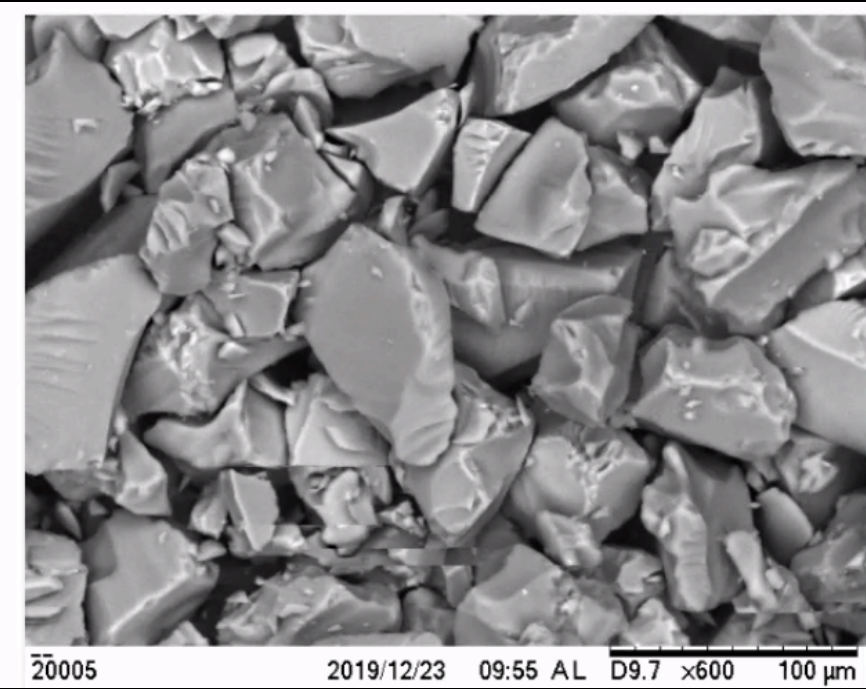
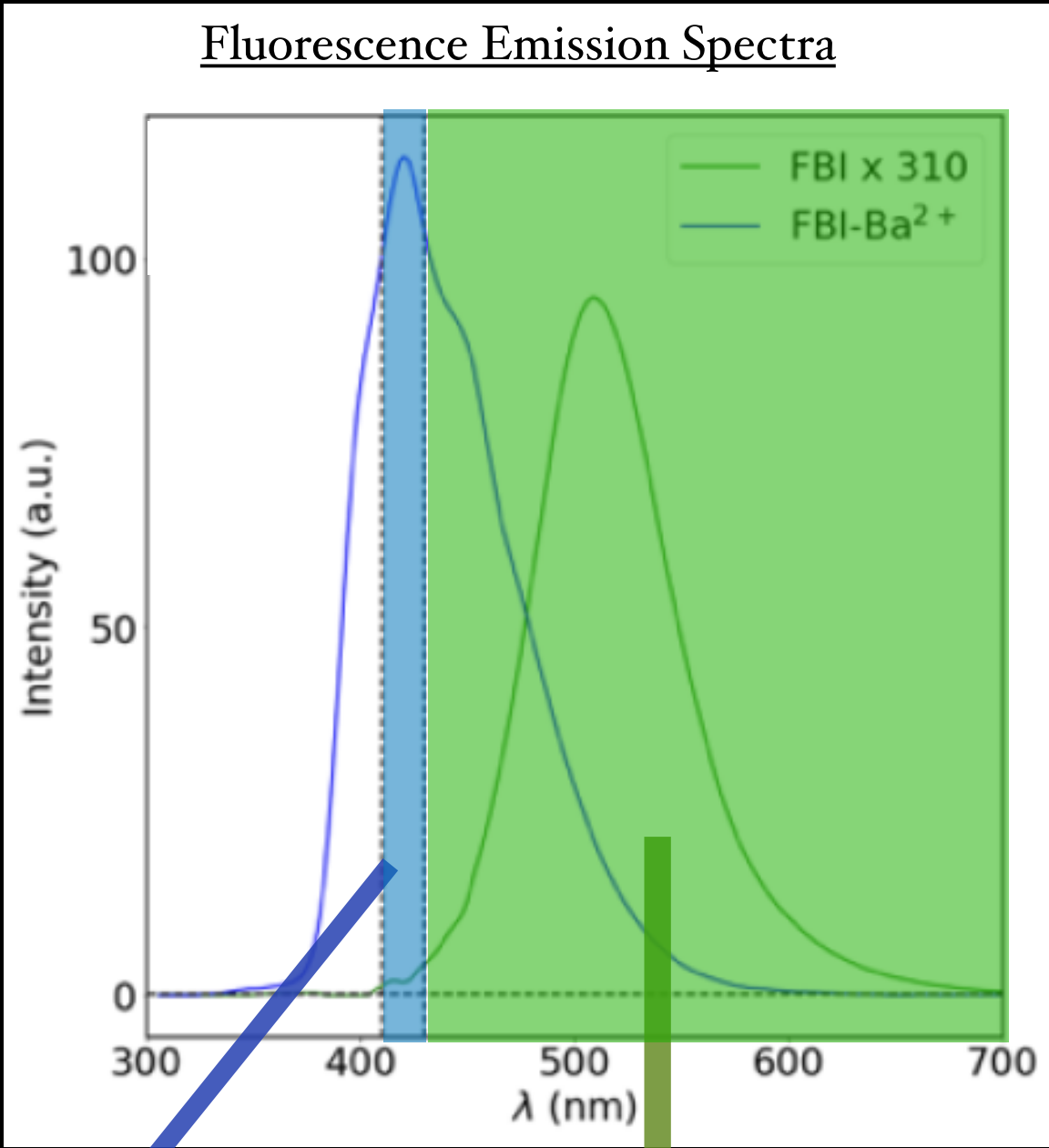
No Shift in  
emission spectra

Nature 2020, 583, 48-54.



# Shift in emission for chelated molecule

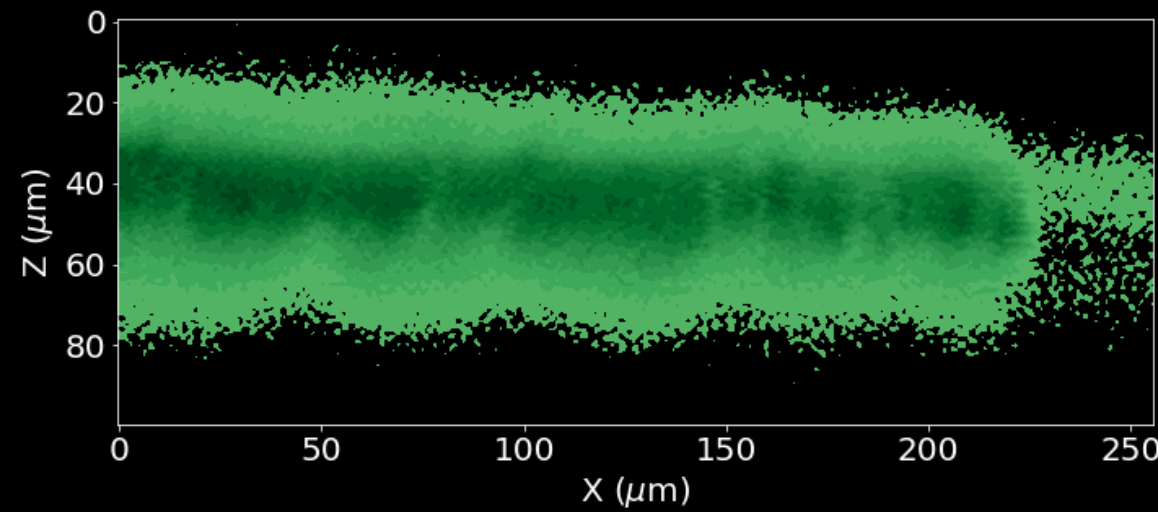
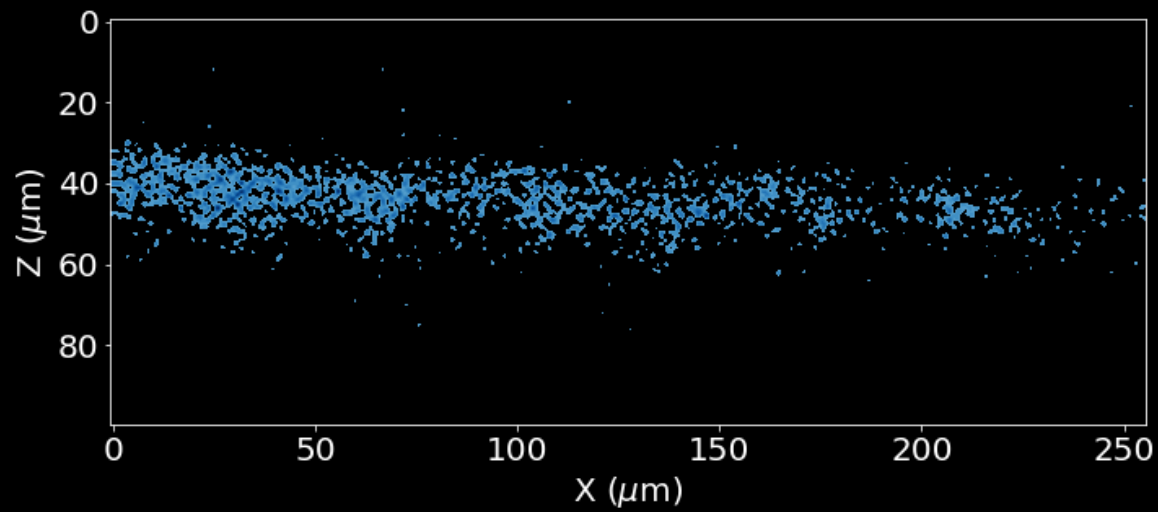
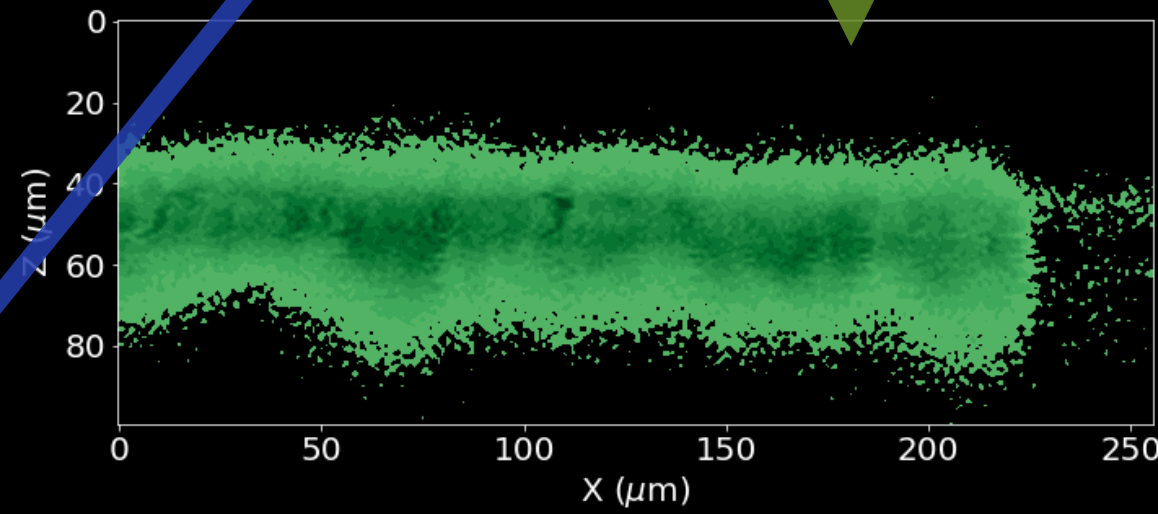
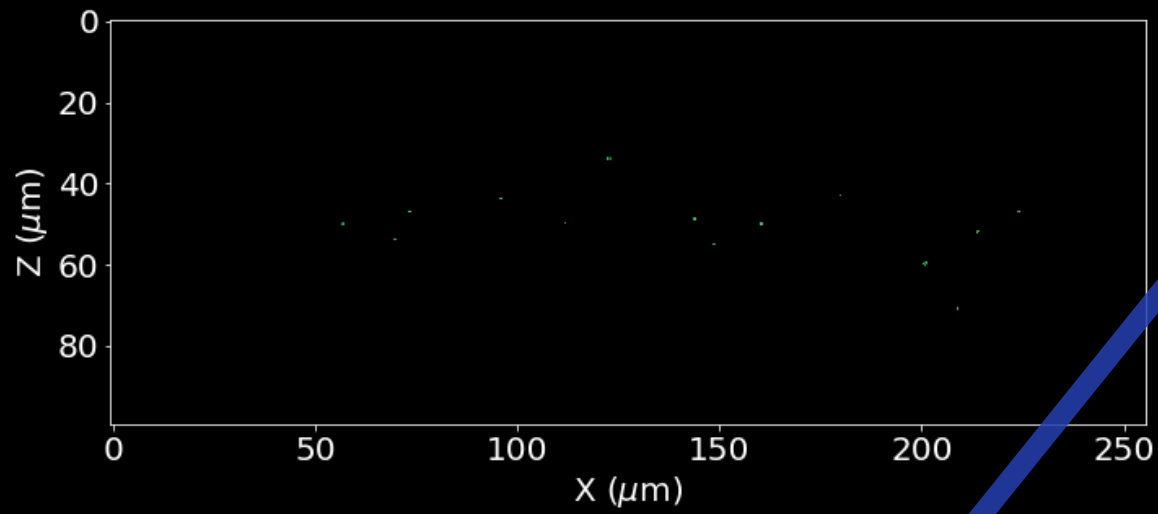
- ▶ Preliminary microscopy studies were carried out with FBI molecules on silica pellets [2].
- ▶ We exposed a sample to  $\text{BaClO}_4$  vapor in vacuum, the molecules became chelated with  $\text{Ba}^{2+}$ .
- ✓ The control sample (no barium) showed only **unchelated emission** ( $\lambda \geq 450$  nm)
- ✓ The sample with  $\text{Ba}^{2+}$  emitted intensely in blue ( $\lambda = 420 \pm 10$  nm) **chelated emission**.
- ▶ However, ambient air humidity might affect the fluorescence.



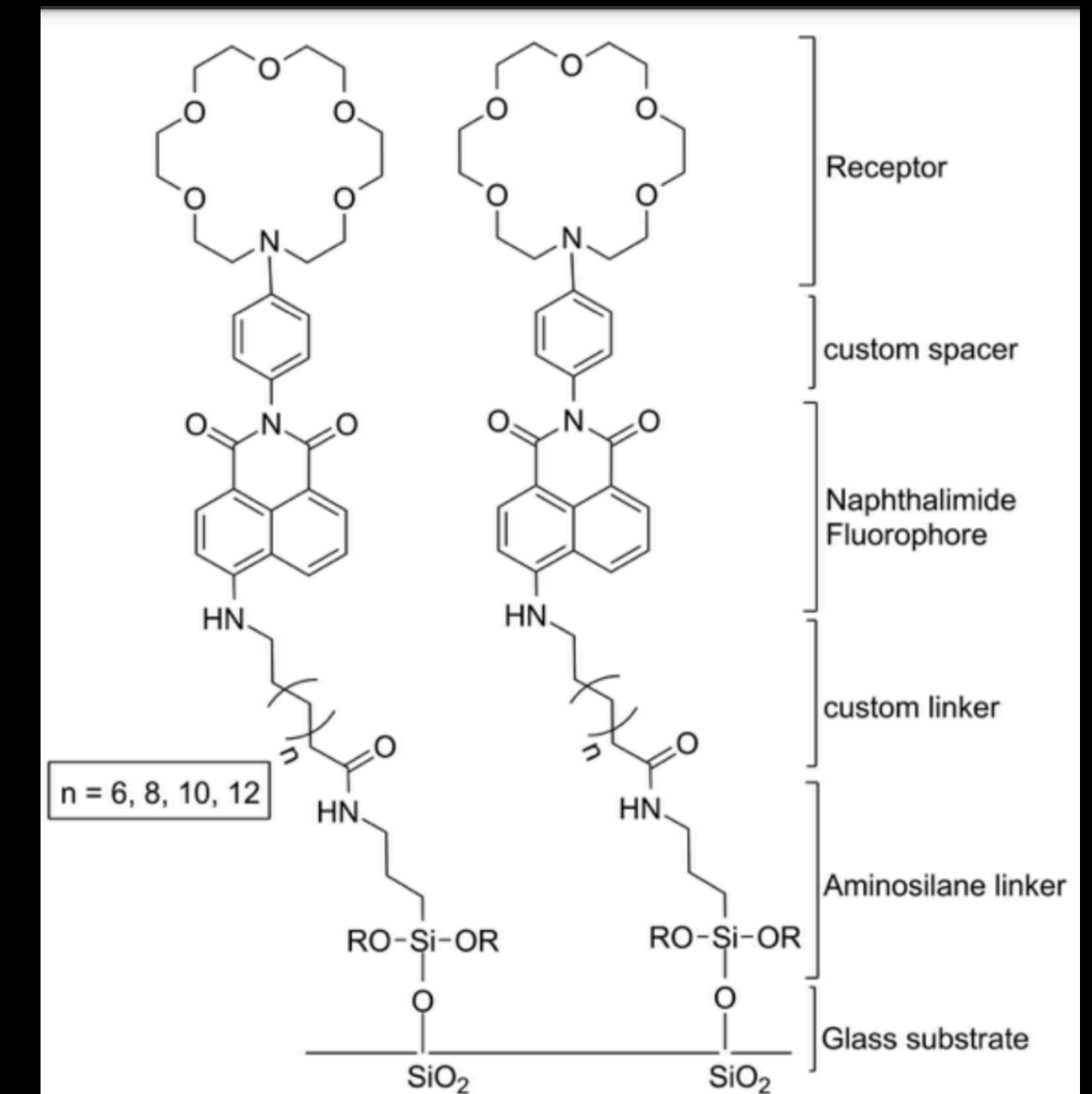
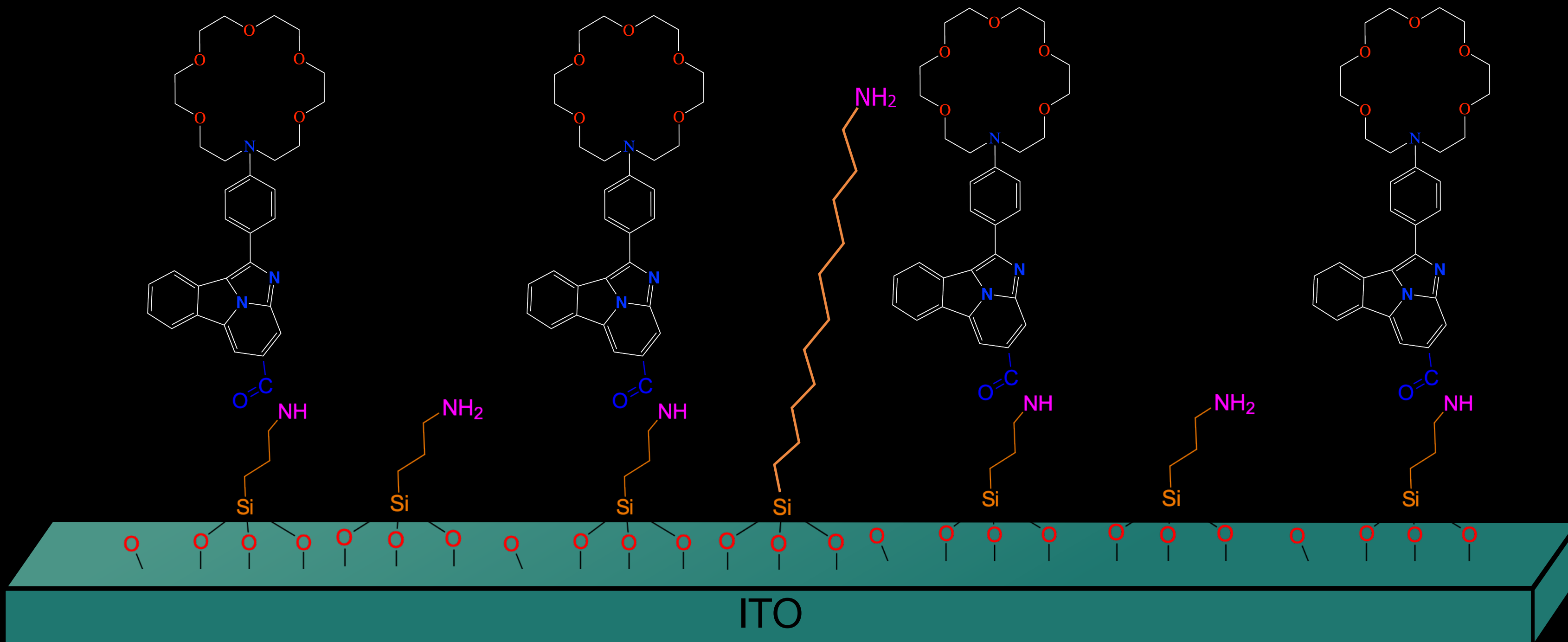
Before sublimation



After  $\text{Ba}^{2+}$  sublimation









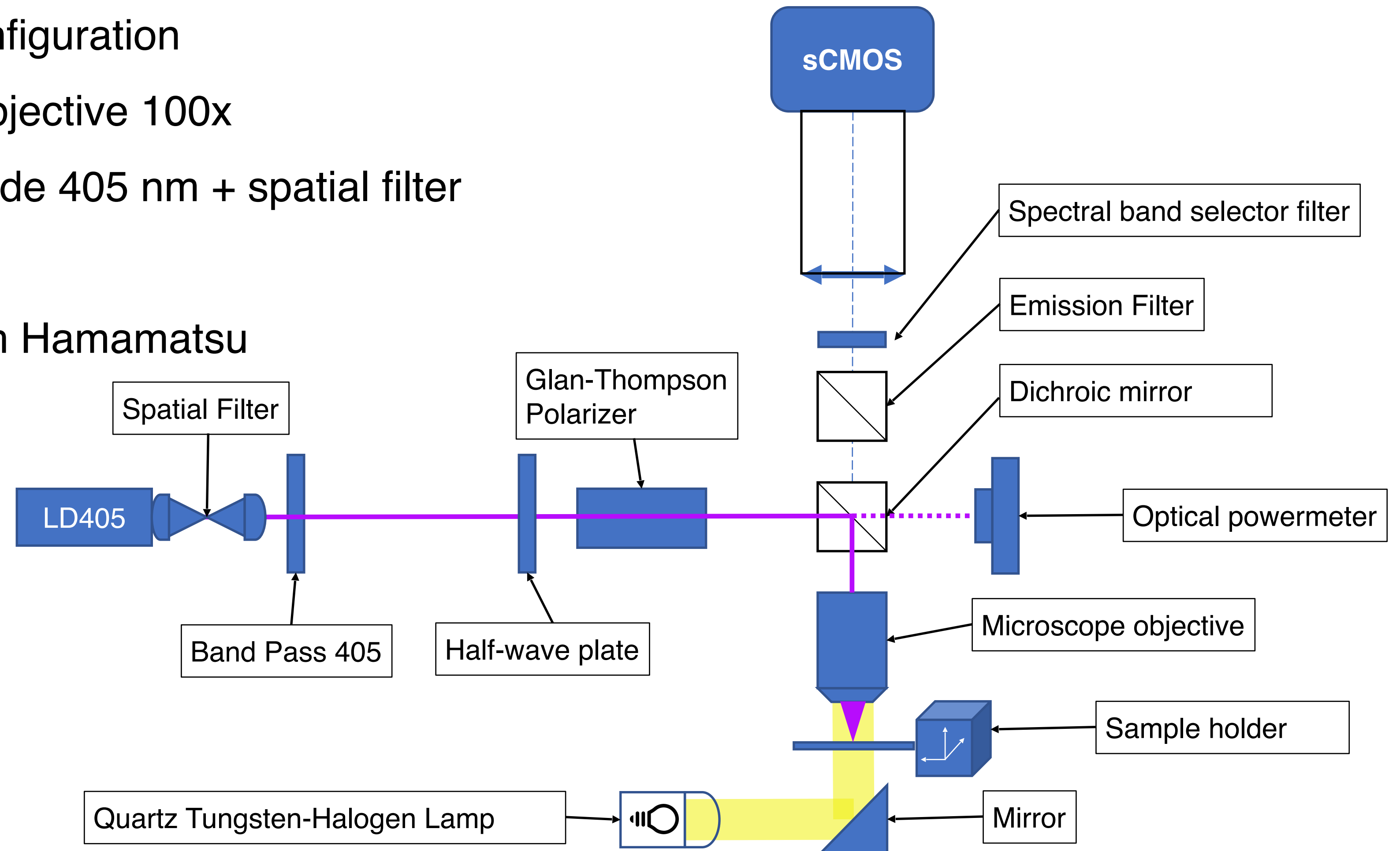
# Stoichiometry FBI in Au

Experiment	N / O	C / N	C / O	N / Ba	Cl / Ba
<b>FBI 0.6 ML</b>	0.51	9.68	4.94	-	-
<b>FBI 0.6 ML BaCl<sub>2</sub> 0.13 nm</b>	0.61	8.73	5.32	2.05	<b>0.62</b>
<b>FBI 0.6 ML BaCl<sub>2</sub> 0.58 nm</b>	0.81	8.50	6.88	0.58	<b>0.55</b>
<b>FBI nominal / <u>FBI-BaCl<sub>2</sub> (1:1)</u></b>	<b>0.6</b>	<b>10.33</b>	<b>6.2</b>	<u>3</u>	<u>2</u>

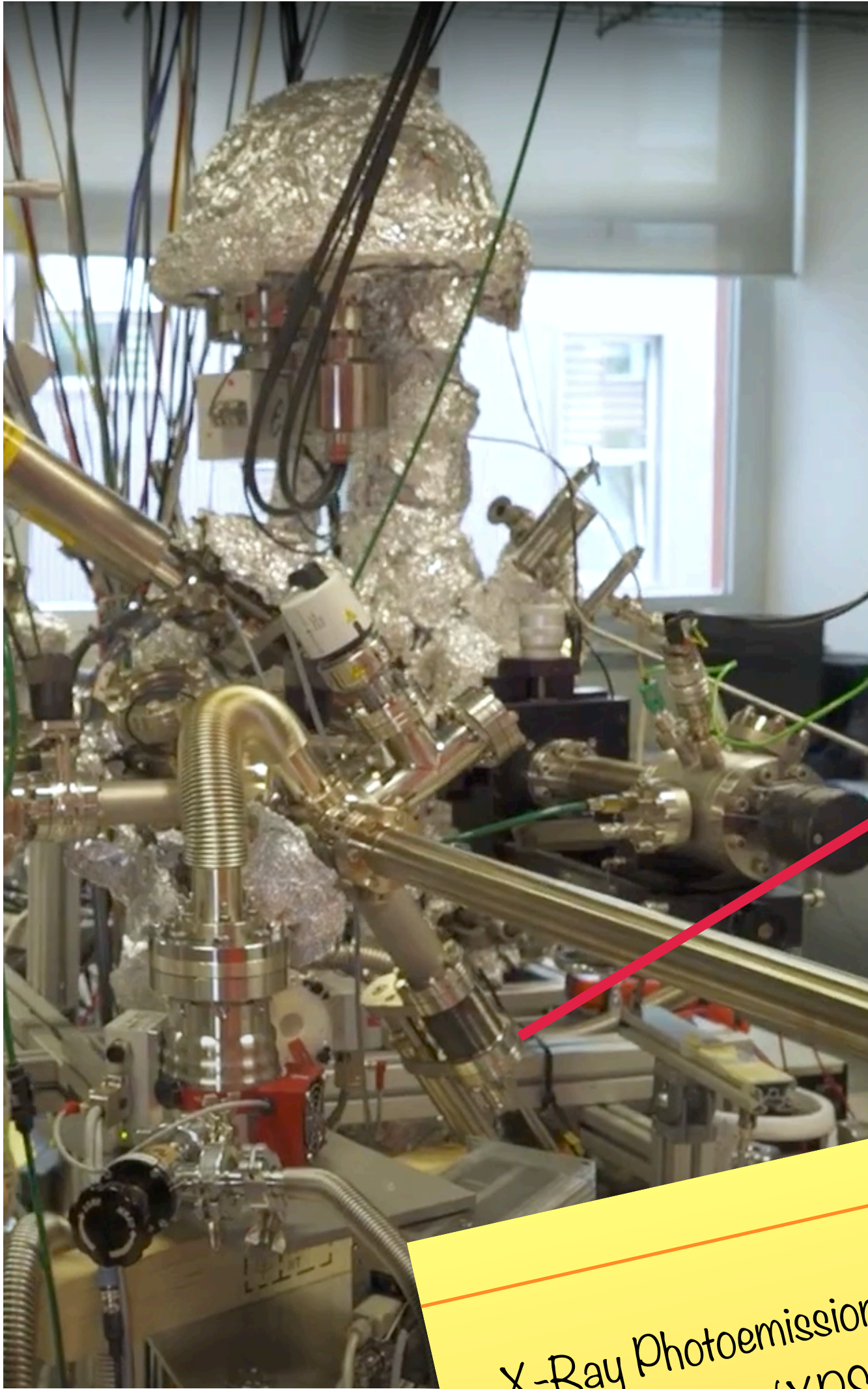
# Detection: optical microscope

## Main features

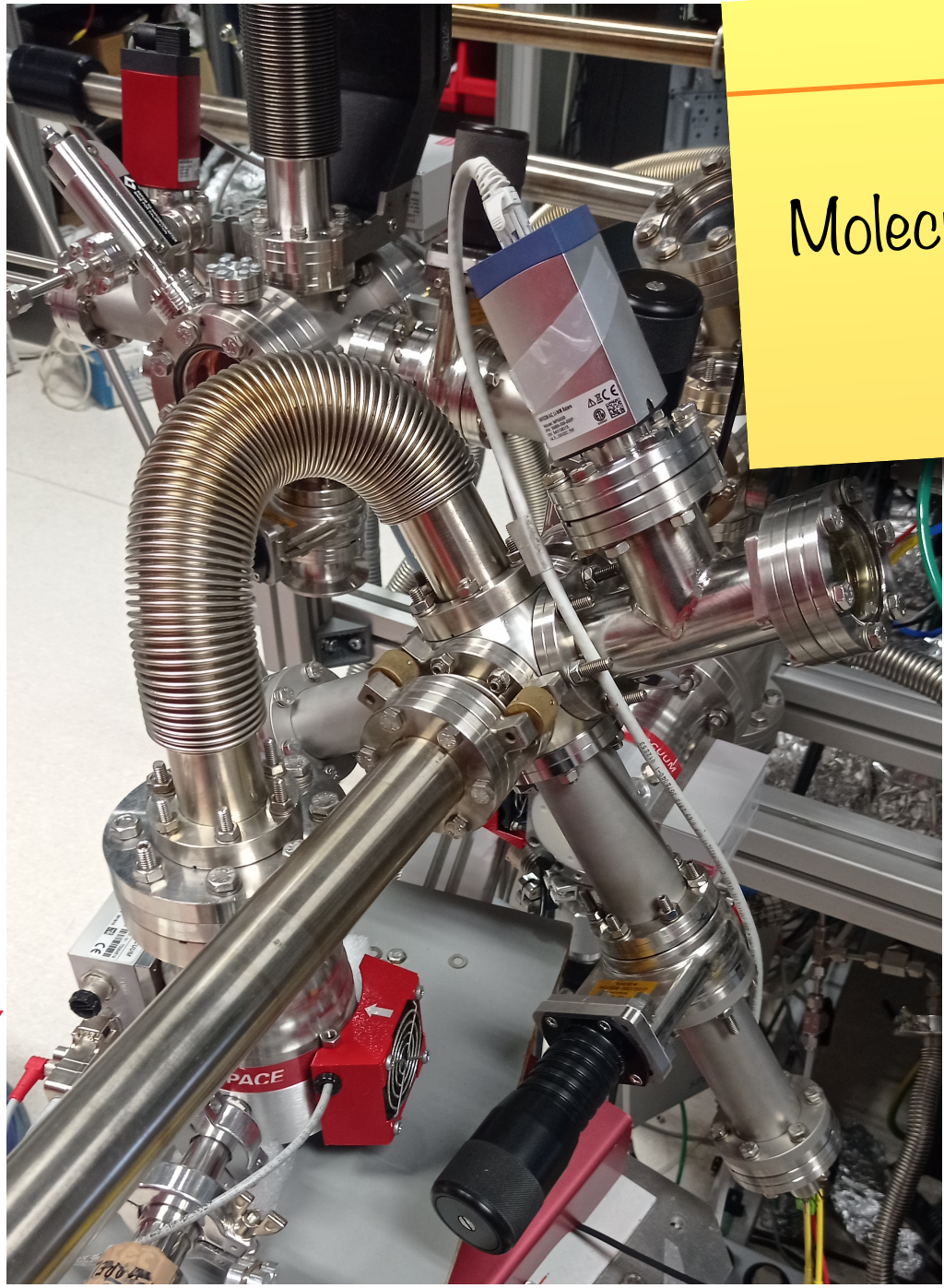
- Epi-illumination microscope configuration
- Infinity corrected Microscope objective 100x
- Light source: NICHIA Laser Diode 405 nm + spatial filter
- Power tuning system
- sCMOS: ORCA –Flash 4.0 from Hamamatsu



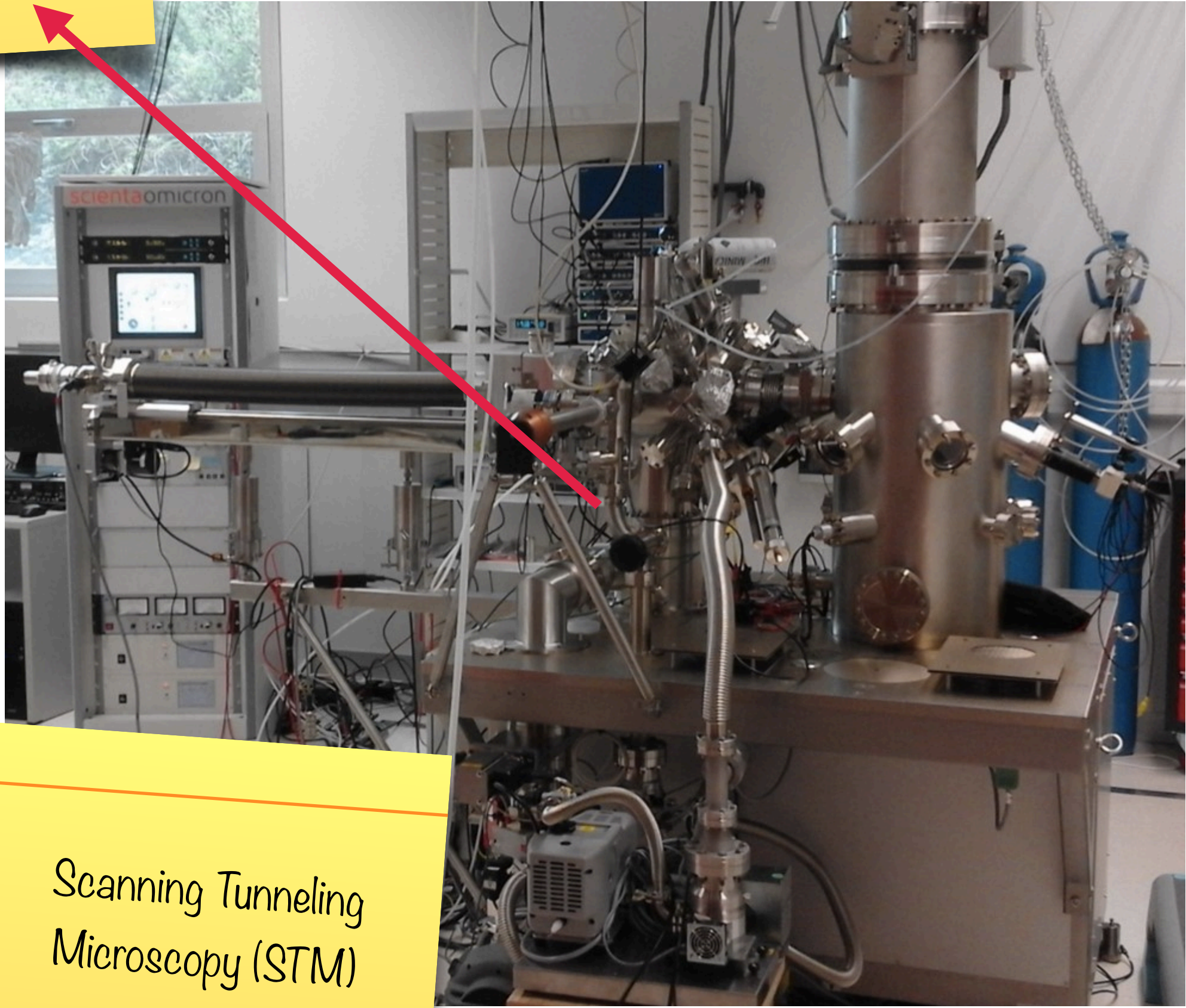




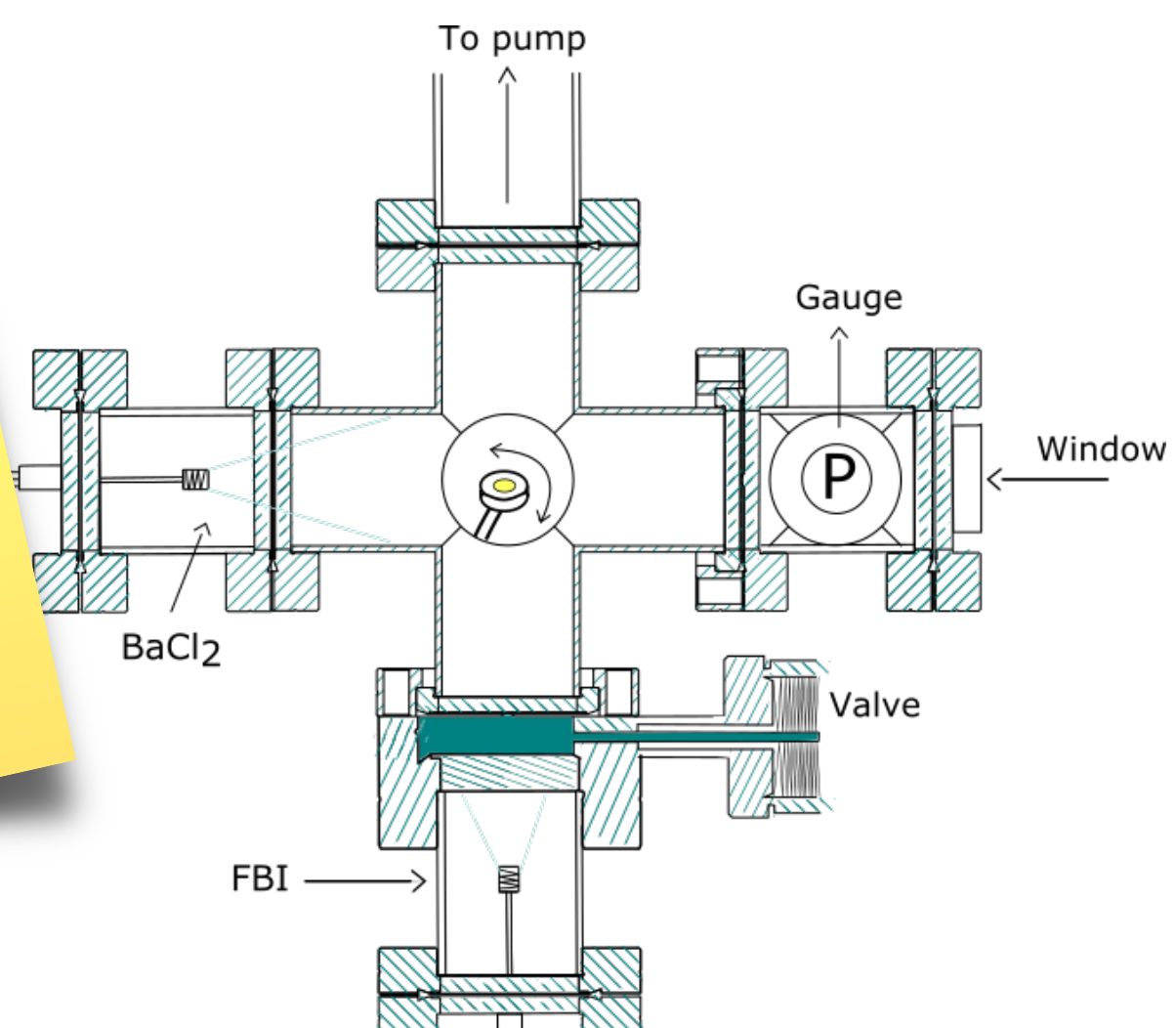
X-Ray Photoemission Spectroscopy (XPS)



Molecular Beam Epitaxy (MBE)

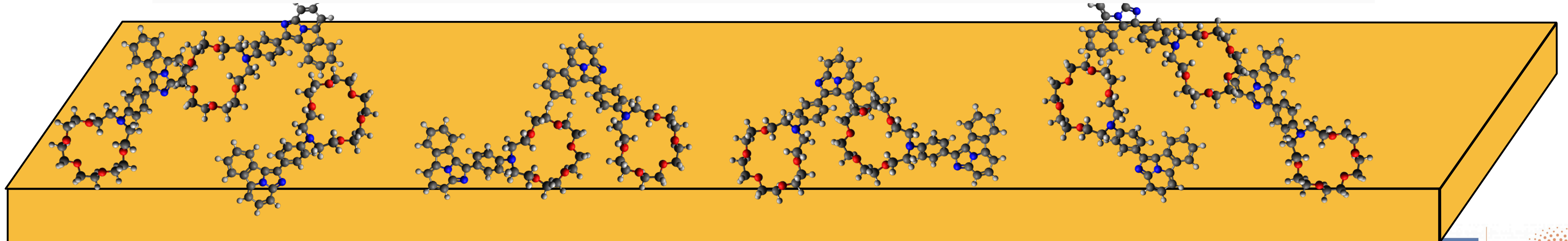
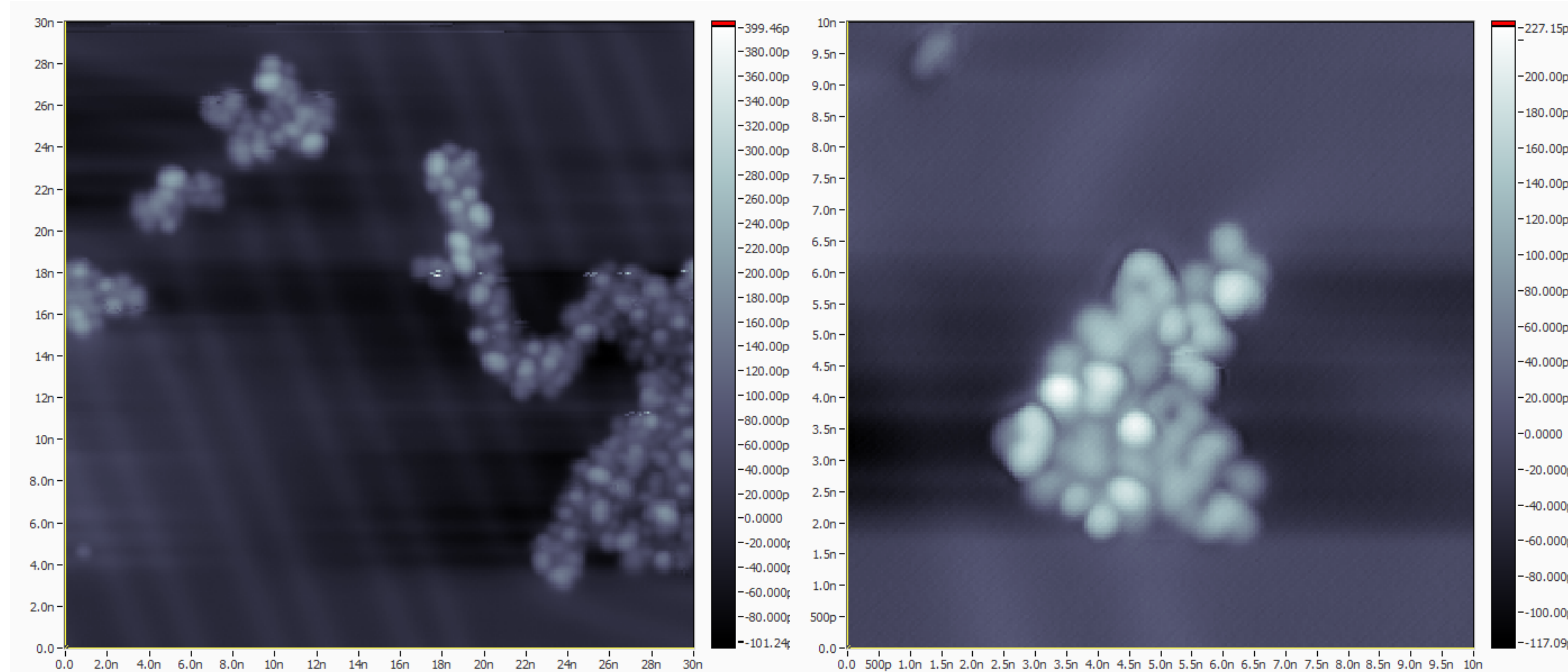


Scanning Tunneling Microscopy (STM)





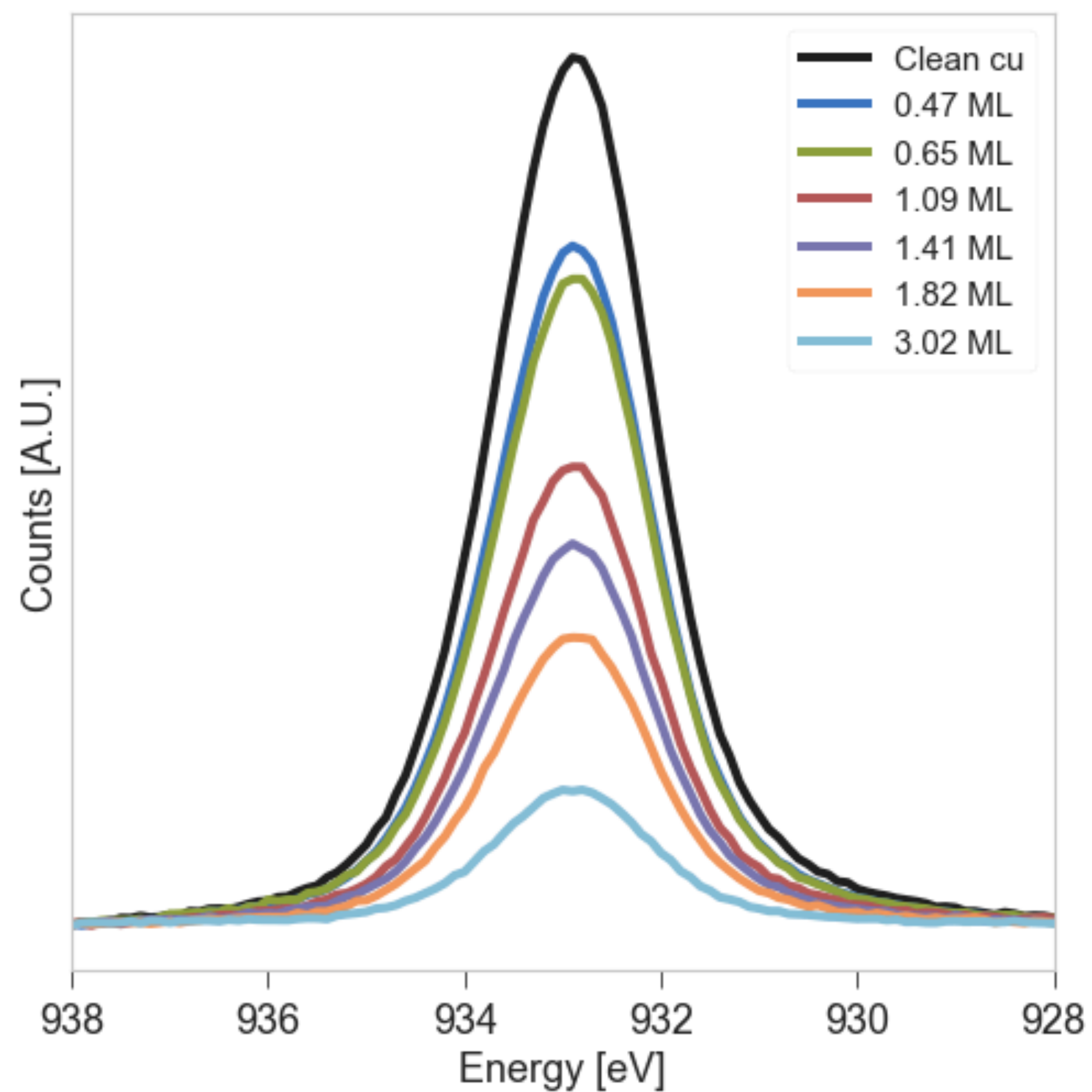
# Towards Ordered MLs





# Sample thickness measurement

Cu 2p 3/2



$$I_f = I_0 \exp(-d/\lambda_{IMFP})$$

