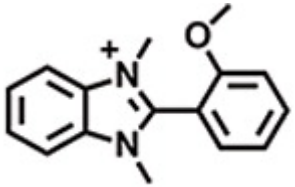
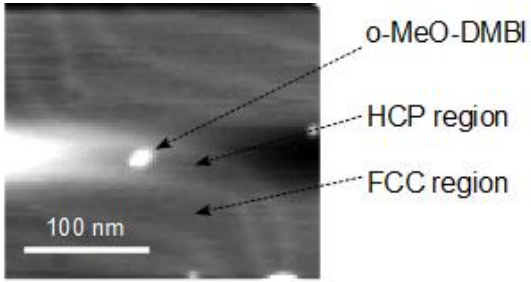
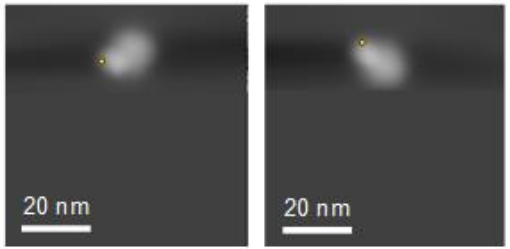
MANIPULATION OF A MOLECULAR ROTOR BASED ON O-MEO-DMBI

O-MEO-DMBI ROTOR







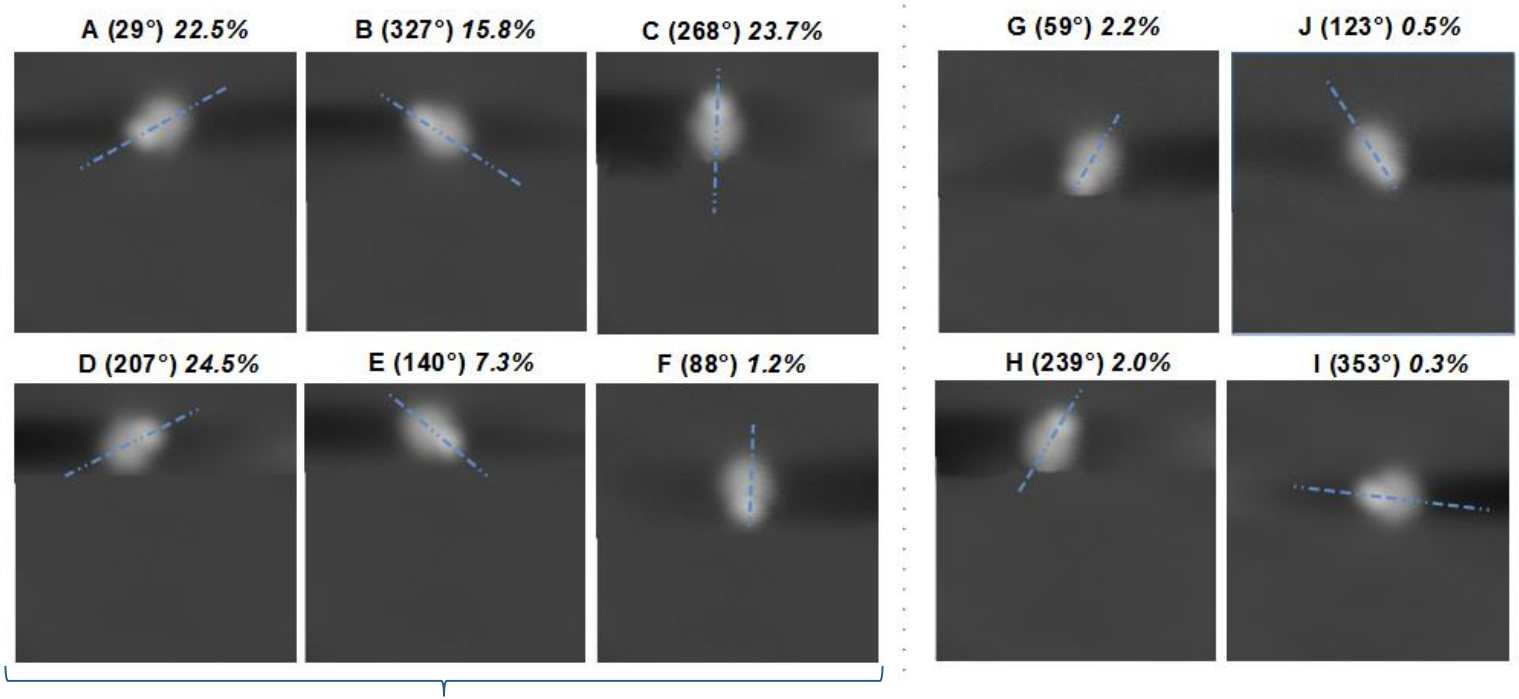
600 Rotation events by applying a voltage pulse at constant current.

Parameters:

Vb = [0.4; 0.5; 0.7; 1.0; 1.2]V

It = [100; 200; 300; 400; 500]pA

OBSERVED STATES



Complete set with hexagonal symmetry

OBSERVED STATES

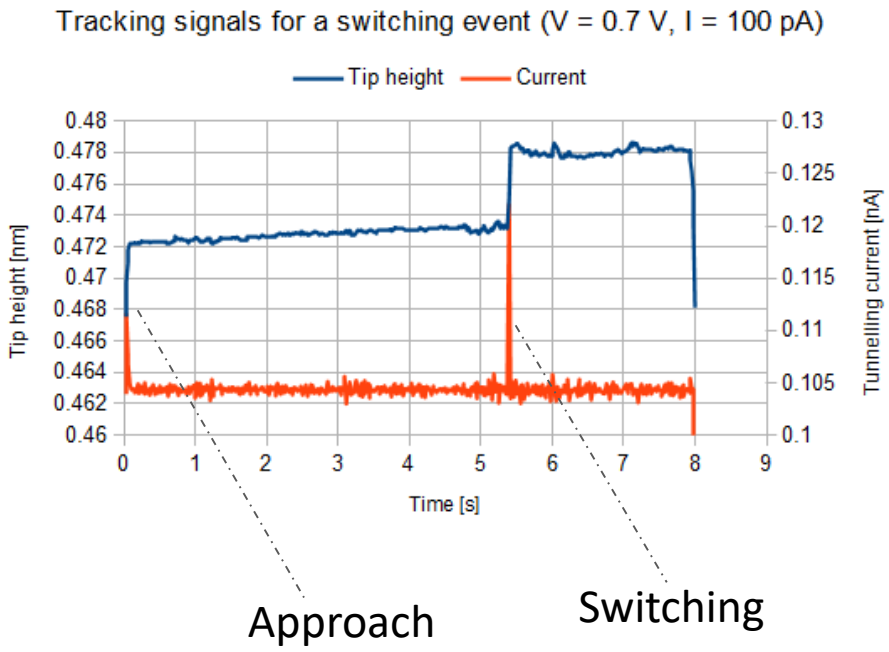
Initial state:	A	
# observations:	135	
Final state	Freq.	Δθ [°]
B	54.8%	62
C	44.4%	121
I	0.7%	36

Initial state:	B	
# observations:	95	
Final state	Freq.	Δθ [°]
C	67.4%	59
D	18.9%	120
H	10.5%	88
G	1.1%	268
Indefinite	2.1%	

Initial state:	C	
# observations:	142	
Final state	Freq.	Δθ [°]
D	87.3%	61
E	9.9%	128
H	0.7%	29
F	0.7%	180
G	0.7%	209
Indefinite	0.7%	

In 4 ocassions (0.7%) the molecule was observed to made a CCW turn in a single step

TRACKING OF A SWITCHING EVENT



Events that happened instantaneously (t<0.02) were not considered for the statistical analysis. This accounts for 129 observations (21.5%)

STATISTICAL ANALYSIS

Assumption:

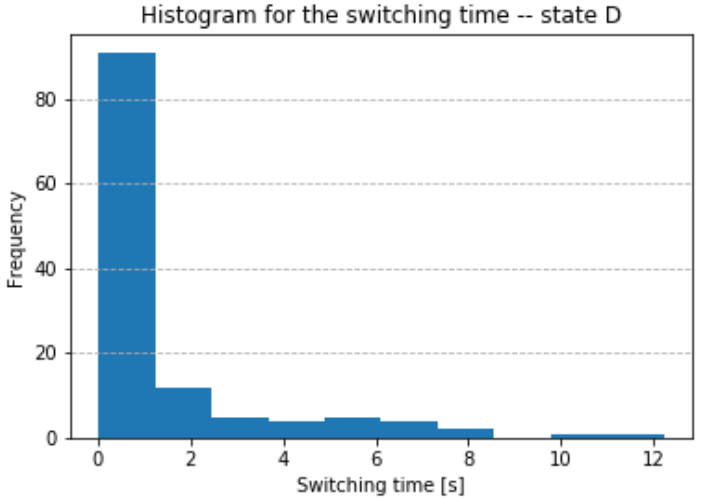
$$f(t) = \lambda e^{-\lambda t} u(t)$$

$$E[T] = \lambda$$

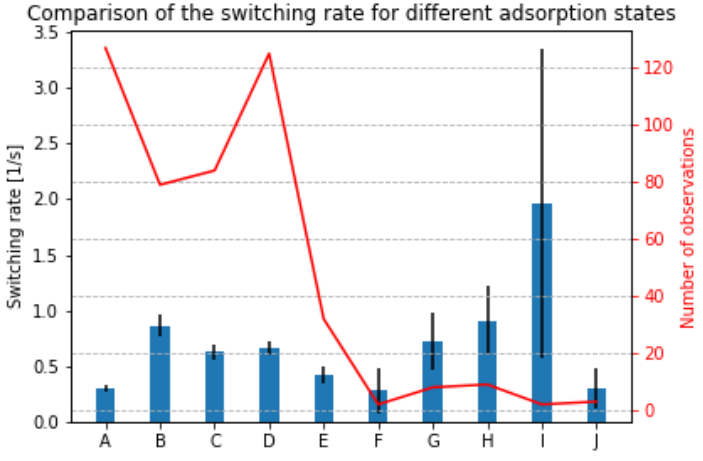
Goal: Obtain Maximum Likelihood Estimator of λ

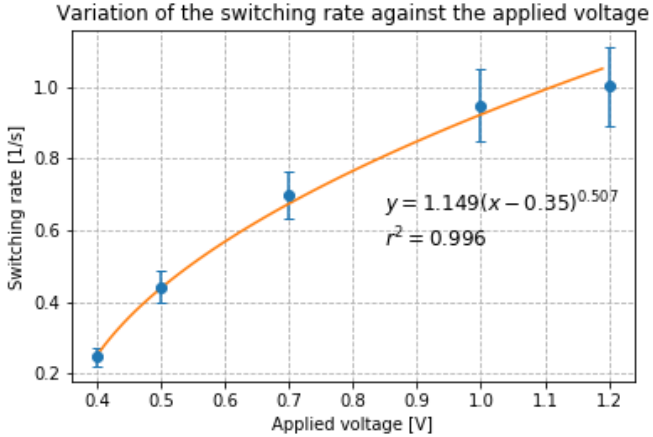
$$\lambda_0 = \frac{N}{\sum t_i}$$

$$Var[\hat{\lambda}] = \frac{\lambda_0^2}{N}$$



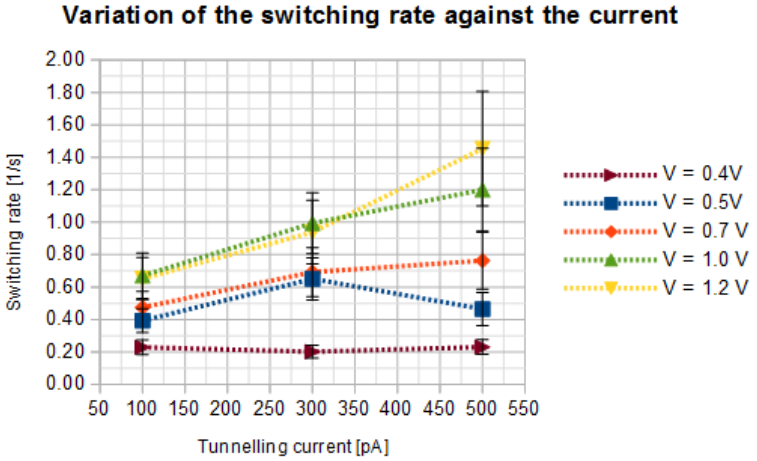
RESULTS: EFFECT OF INITIAL STATE AND VOLTAGE

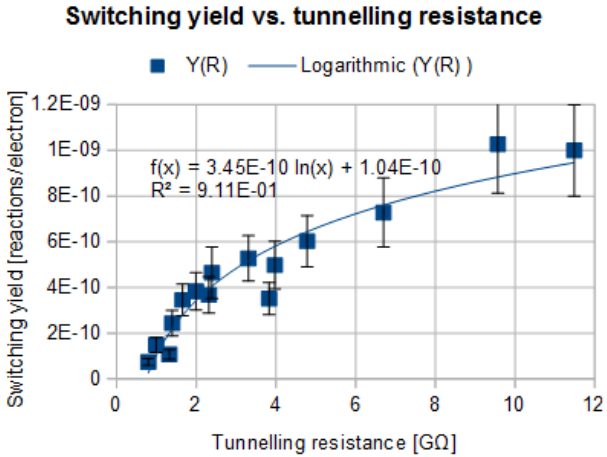




Projected threshold at 0.35V

RESULTS: EFFECT OF CURRENT

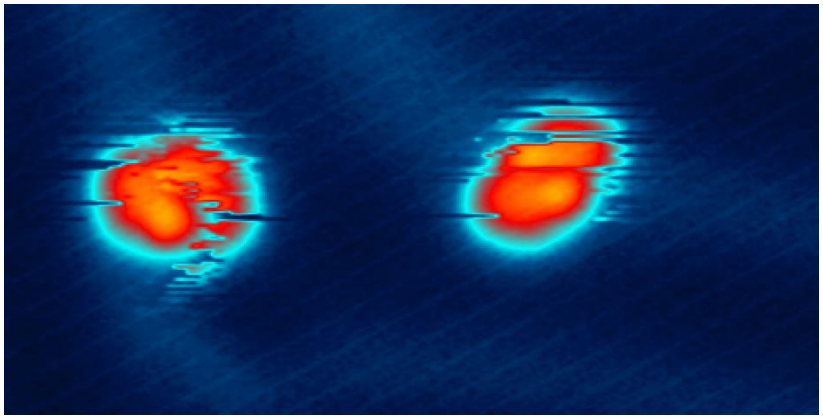




CONCLUSIONS

- O-MeO-DMBI makes CW turns, hopping between 6 observed adsorption states—although some exceptional CCW turns occurred. The adsorption states follow the hexagonal symmetry of the Au(111) surface.
- Upon application of a voltage pulse, the molecule stays in its initial state for a short time before hopping to the next state. This residence time varies with the initial state and the applied voltage, but its dependence on the current is rather weak.

- **DMBI on Au(111) – Heating to induce rotation**



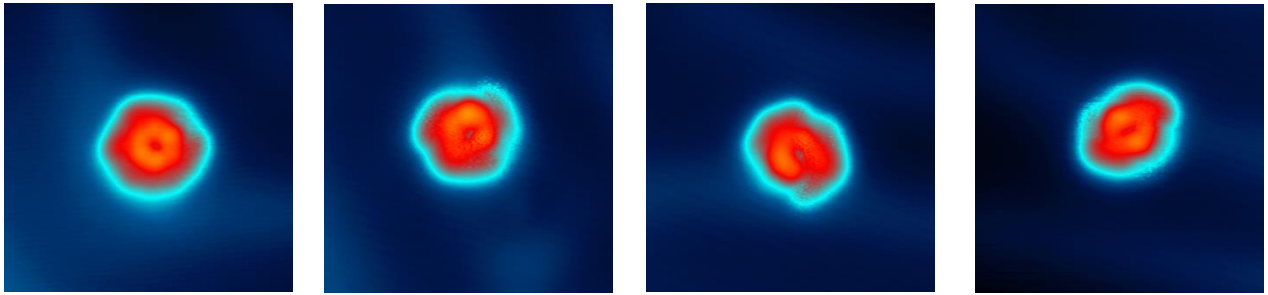
Images: (0.2 V; 20 pA; 10 nm x 5 nm); 15 K

- starts rotation above 9.5 K

- want to adjust temperature that we see single rotation steps or complete rotation

- not all six orientations seems to be present

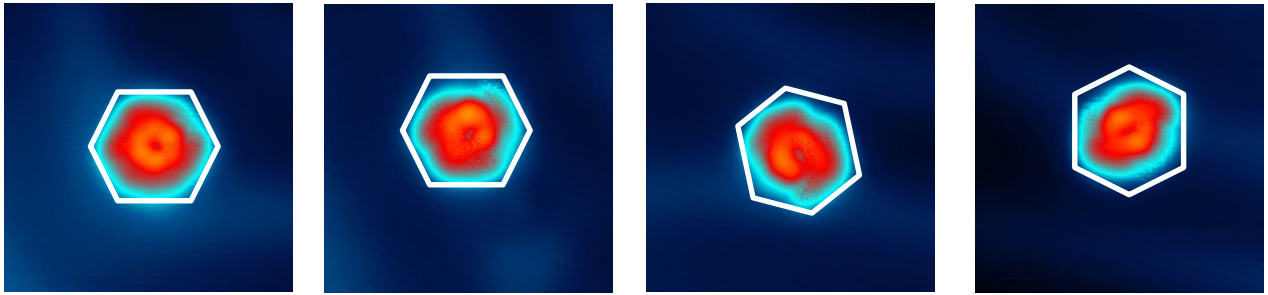
- **DMBI on Au(111) – Heating to induce rotation (20 K)**



Images: (0.2 V; 100 pA; 5 nm x 5 nm); 20 K

- full rotation of the left molecule
- other molecules do not fulfill the full rotation depending on adsorption position
- not all six orientations seems to be present

- **DMBI on Au(111) – Heating to induce rotation (20 K)**

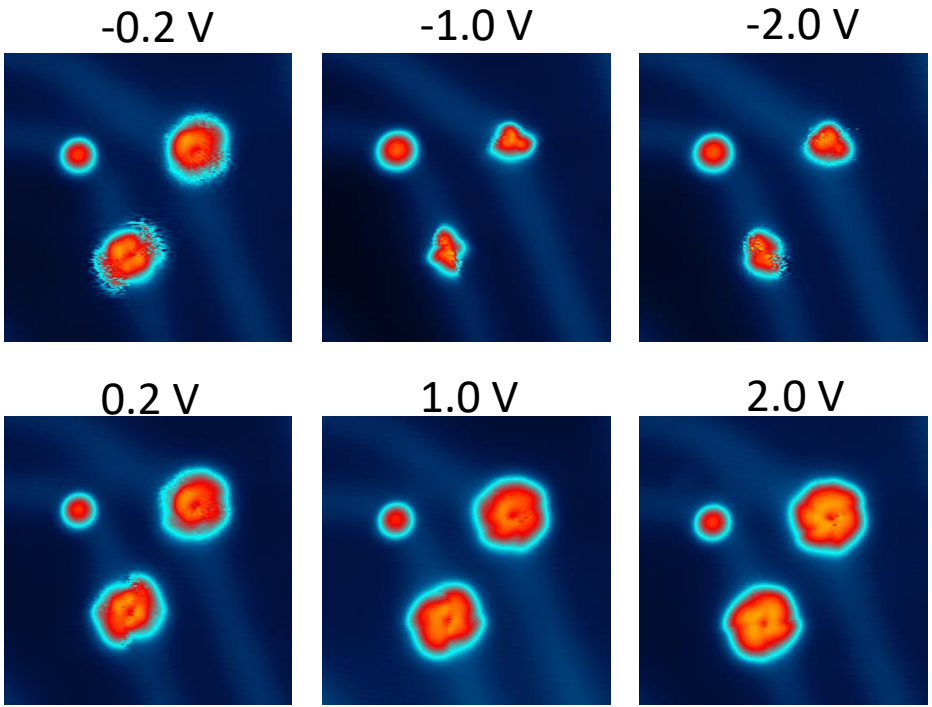


Images: (0.2 V; 100 pA; 5 nm x 5 nm); 20 K

- full rotation of the left molecule
- other molecules do not fulfill the full rotation depending on adsorption position
- not all six orientations seems to be present

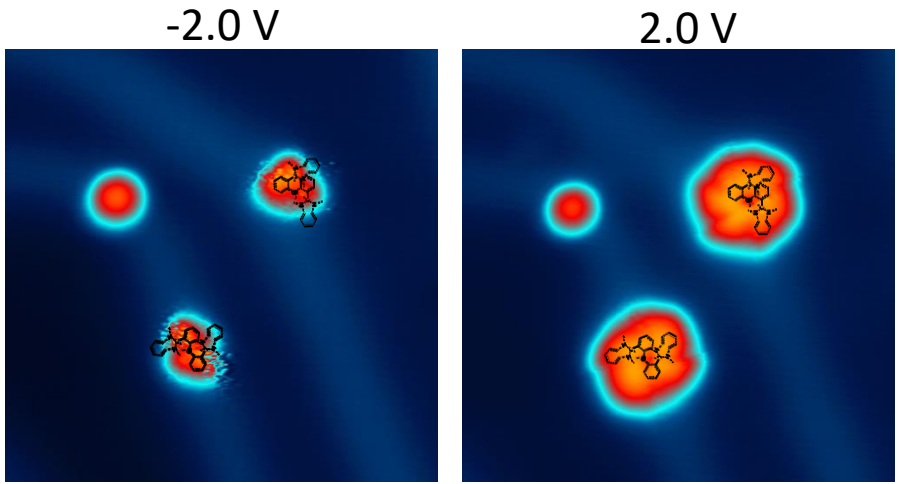
- **DMBI on Au(111) – Heating to induce rotation (20 K)**

- molecules with different chiralities imaged at different biases at 20 K (up-right molecule: R-enantiomer; low-left molecule: S-enantiomer)



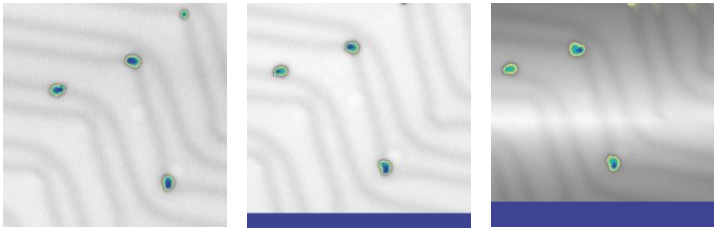
Images: (100 pA; 7.5 nm x 7.5 nm); 20 K

- **DMBI on Au(111) – Heating to induce rotation (20 K)**



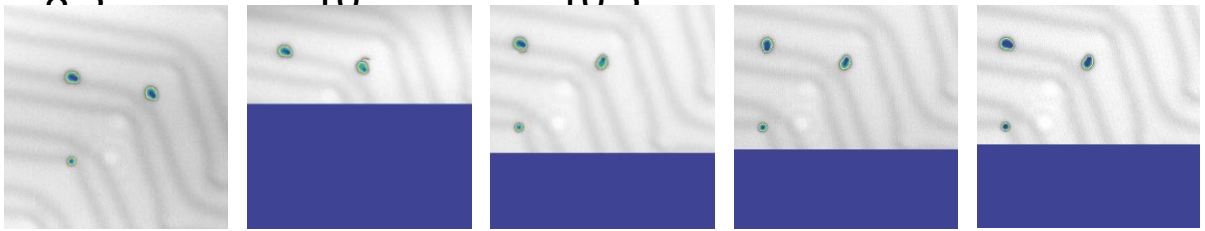
Images: (100 pA; 7.5 nm x 7.5 nm); 20 K

- **DMBI on Au(111) – Heating to induce rotation**



Images: (20 pA; 25 nm x 25 nm); 200mV

8.5 10 10.5



7.5 K 9.5 K 10 K 10 K 10 K

- Molecules start to rotate at ~ 9.5K
- Several preferred orientations, no full rotation: preferred adsorption angles?
- Adsorption individually different
- Fast small (4 nm, 3 s) images show positions, but very fast movement