

## New Challenges – E2S-UPPA 2018

### GO-BEAM

# GO inside a Bacterial cEll methylating Mercury

2018-2021

Marie-Pierre Isaure, *IPREM-LCABIE*

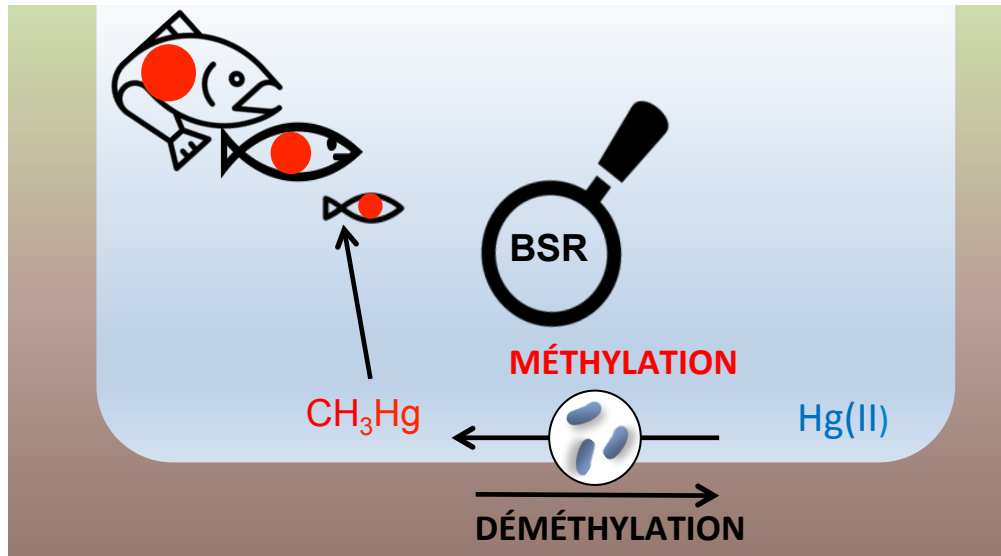
Marisol Goñi-Urriza, *IPREM-EEM*

Mathilde Monperrus, *IPREM-LCABIE*

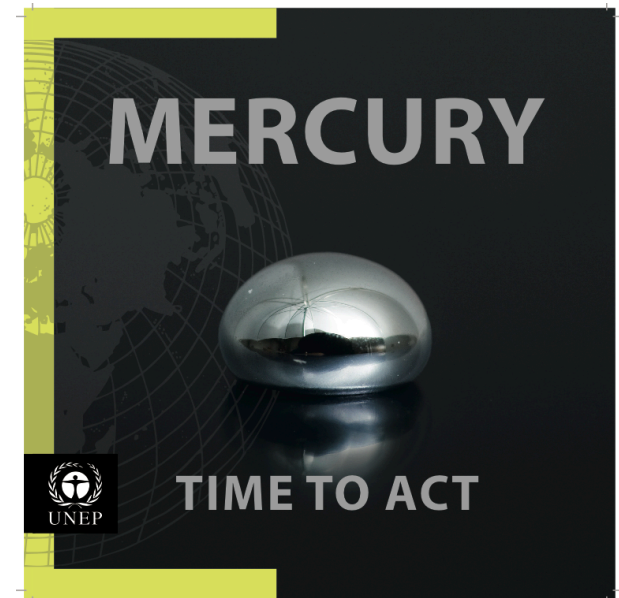
- PhD student: Sophie Barrouilhet  
*Genetic determinisms involved in mercury methylation by sulfate reducing bacteria*
- Post-doc: Maureen Le Bars  
*Understanding Hg uptake and transformations by bacteria: development and input from X-ray imaging and X-ray absorption techniques*
- PhD student still to be recruited:  
*Influence of the environmental conditions on the methylation rates and source of Hg species in microorganisms*

# Context and objective

Hg, a global pollutant, highly toxic



Minamata Convention  
(August 2017)



- 'Hot topic' at the international level
- Global objective : To understand Hg methylation by bacteria

# The historic approach

- IPREM is a leader on the topic by :
  - \* Isotopic labelling and GC-ICP MS => Detection of MeHg et Hg
  - \* 2 original strains :

*Desulfovibrio hydrargyri*  
*BerOc1*



Methylating and  
Demethylating

*Desulfovibrio alaskensis*  
*G200*



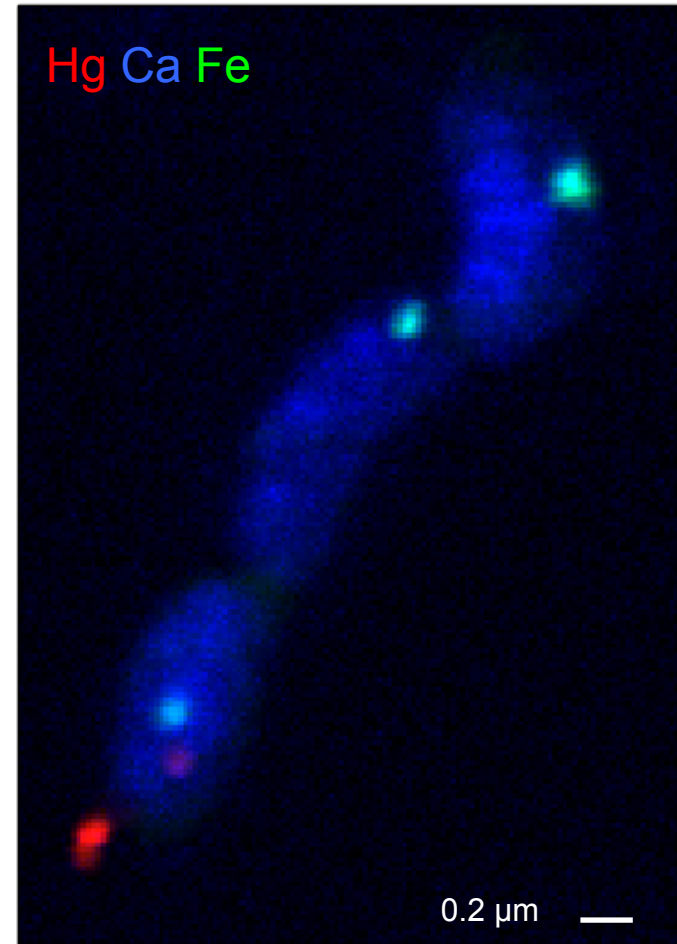
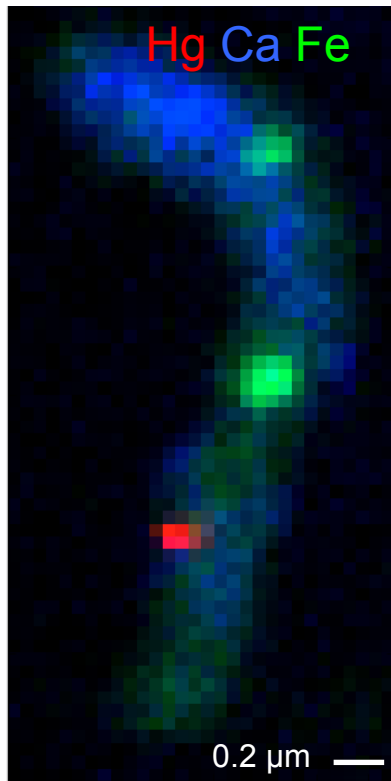
Demethylating

- At the cell level?

# A new challenge : Go inside the cell

➔ Hg Localisation at the cell level

Synchrotron Nano-XRF

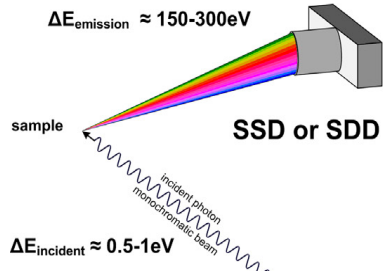


# Hg speciation

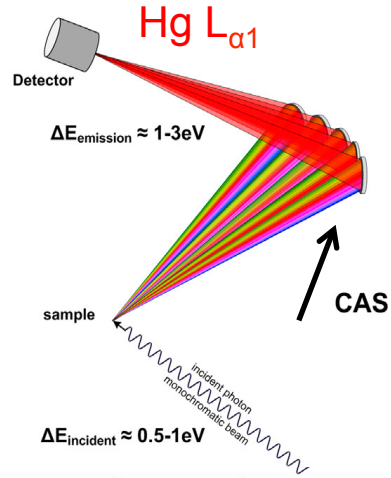
## High Energy Resolution Fluorescence Detection –XANES (HERFD-XANES)

### Conventional XANES

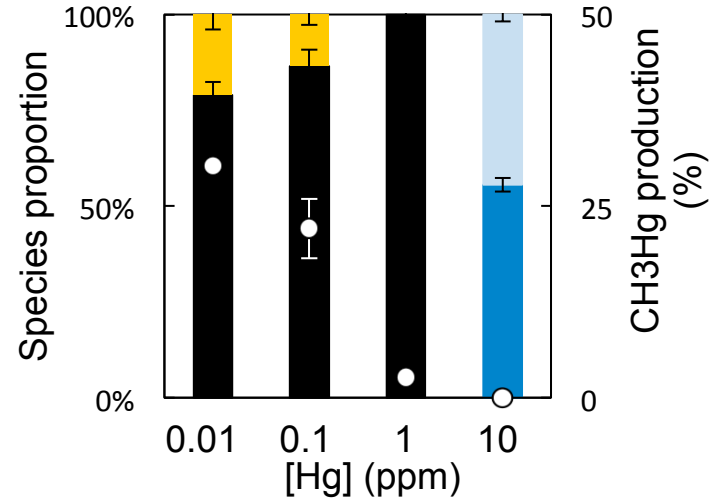
Hg L<sub>α1</sub> and Hg L<sub>α2</sub>  
+ diffused



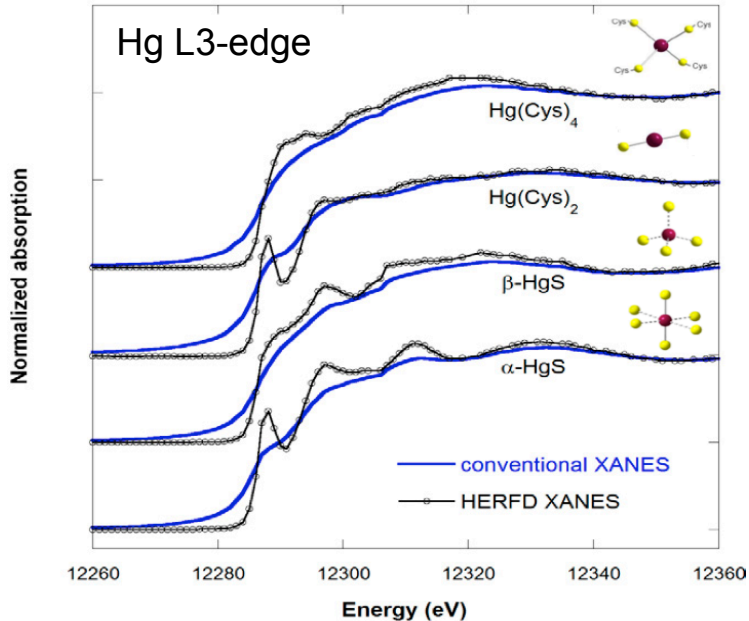
### HERFD-XANES FAME-UHD, ESRF



### BerOc1 exposure HgCl<sub>2</sub>



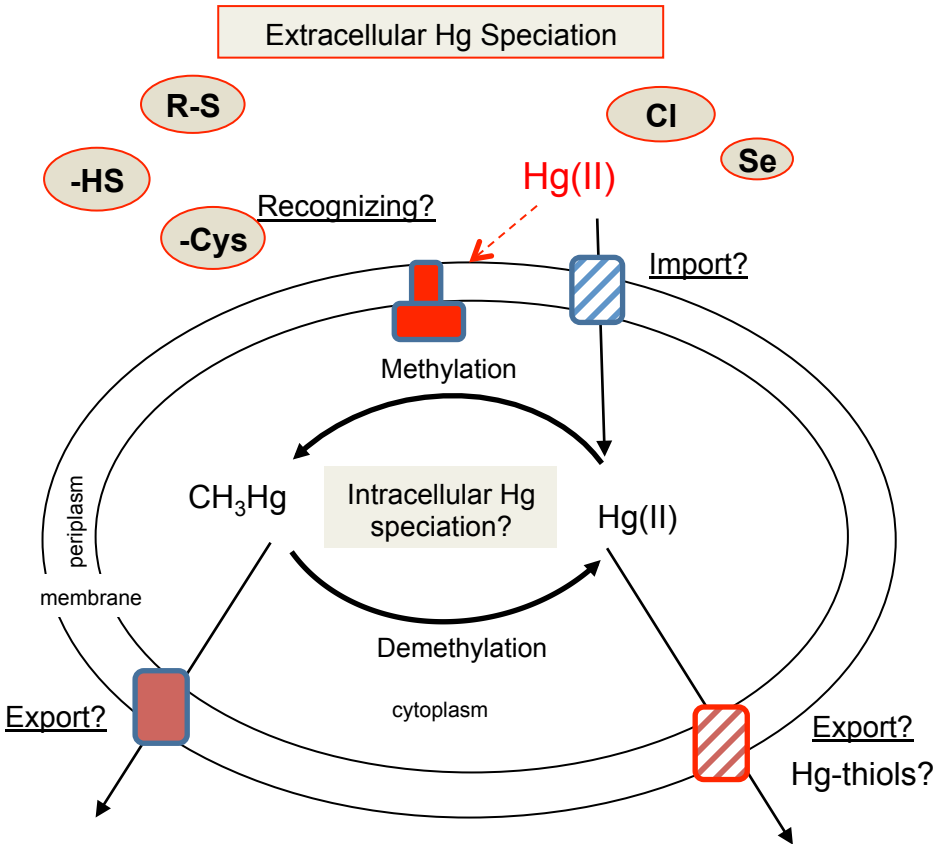
- β-HgS
- CH<sub>3</sub>HgCys
- Hg-thiol
- Hg(0)
- % methylation



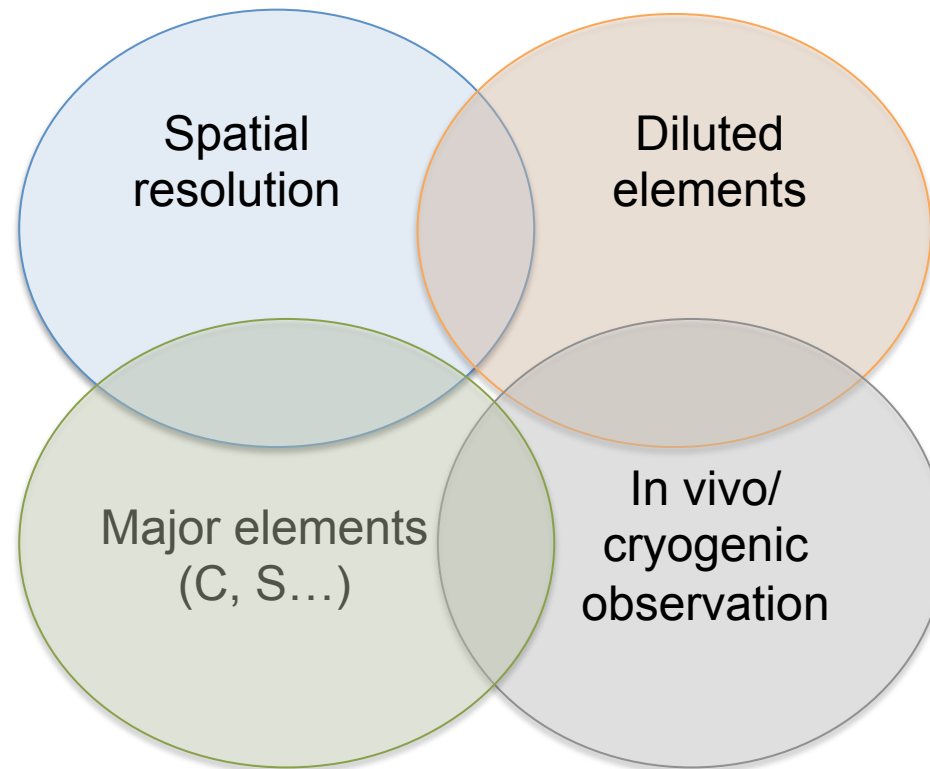
# Specific objectives and hypotheses



- The cascade of events leading to Hg methylation at the cell level?
- Impact of environmental parameters?



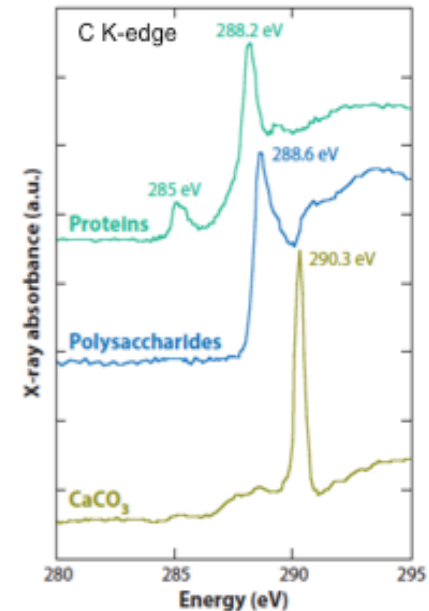
- ⇒ BerOc1 & G200
- ⇒ Mutants BerOc1 *hgcA hgcB* (Parks et al. Science 2013), export and recognizing system
- ⇒ Mutants G200 complemented
- ⇒ BerOc1 hyper-resistant Hg (adaptive evolution)





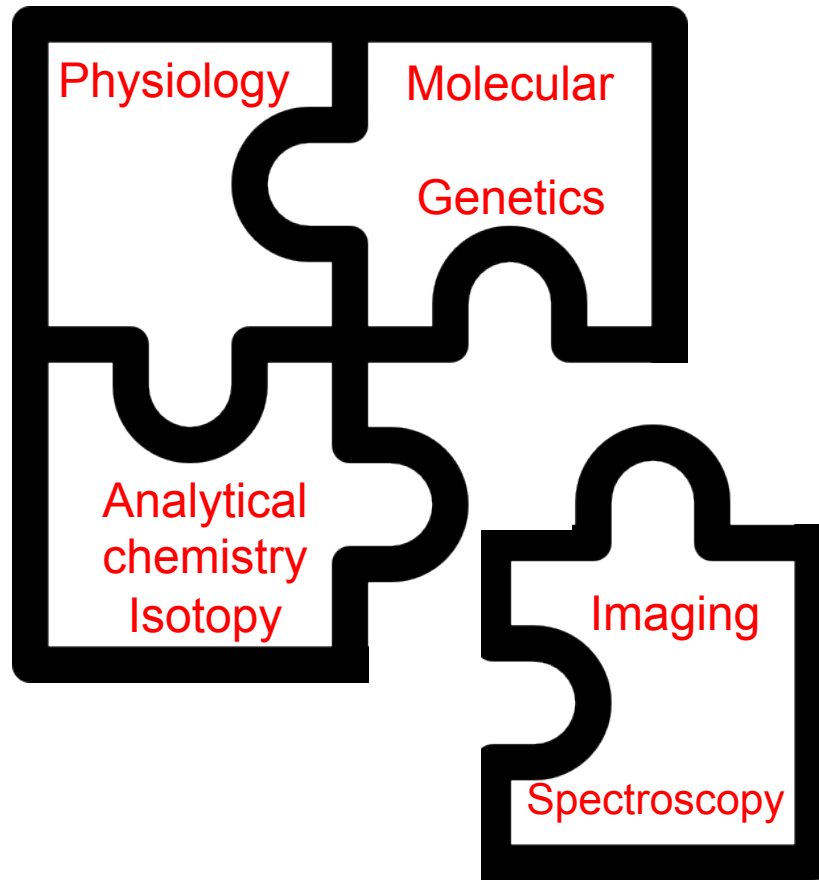
- Speciation of diluted Hg  $\begin{cases} \rightarrow \text{HERFD-XAS} \\ \rightarrow \text{Mass spectrometry (HPLC- ESI MS/MS)} \end{cases}$
- Distribution of Hg in the cell by nano-XRF
- Tracking the origin of S by NanoSIMS
- Scanning Transmission X-ray Microscopy

$\rightarrow$  Imaging the organic constituents by C K-edge



Miot et al. *Annu. Rev. Earth Planet. Sci.* 2014





... a unique approach