

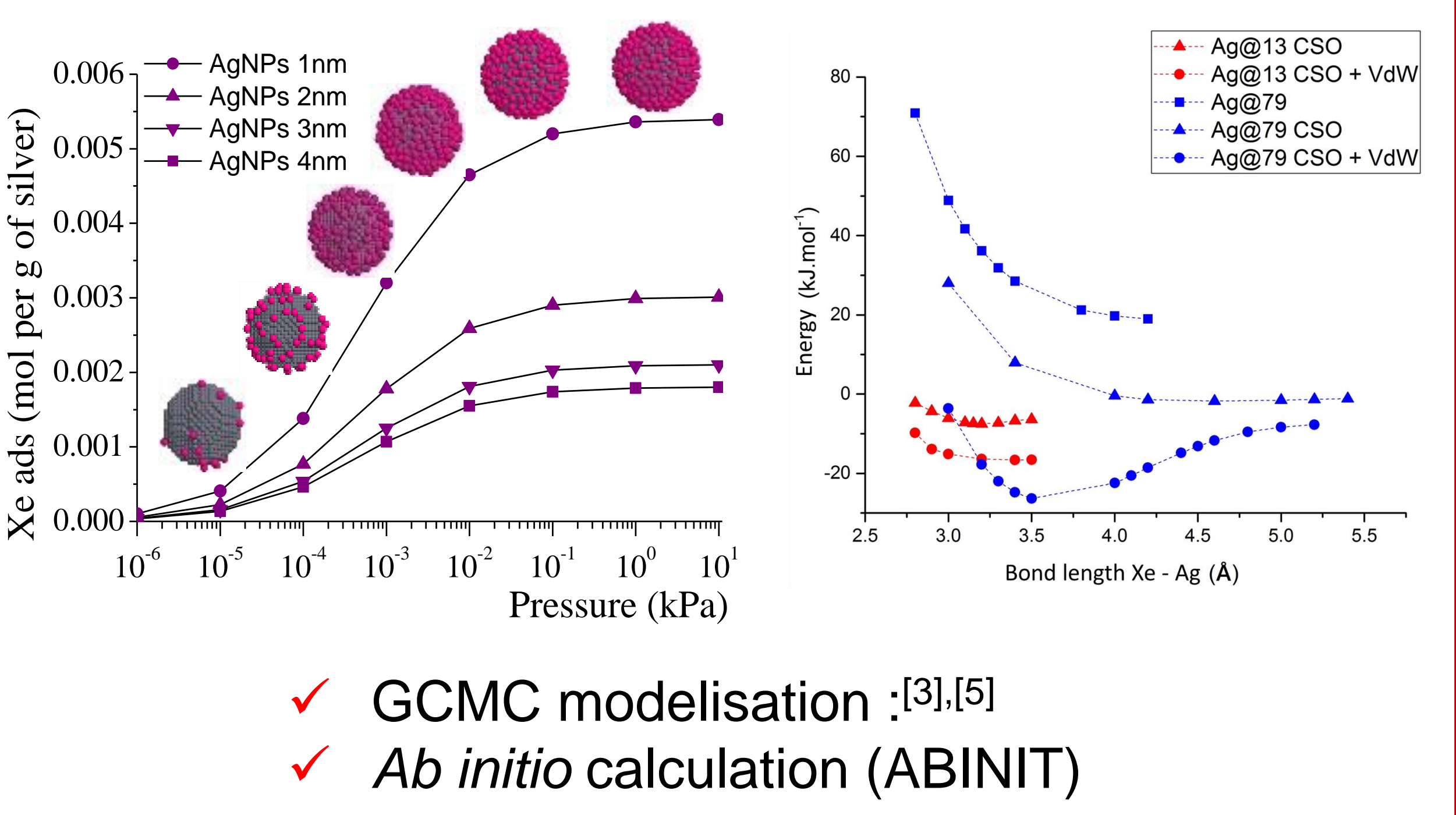
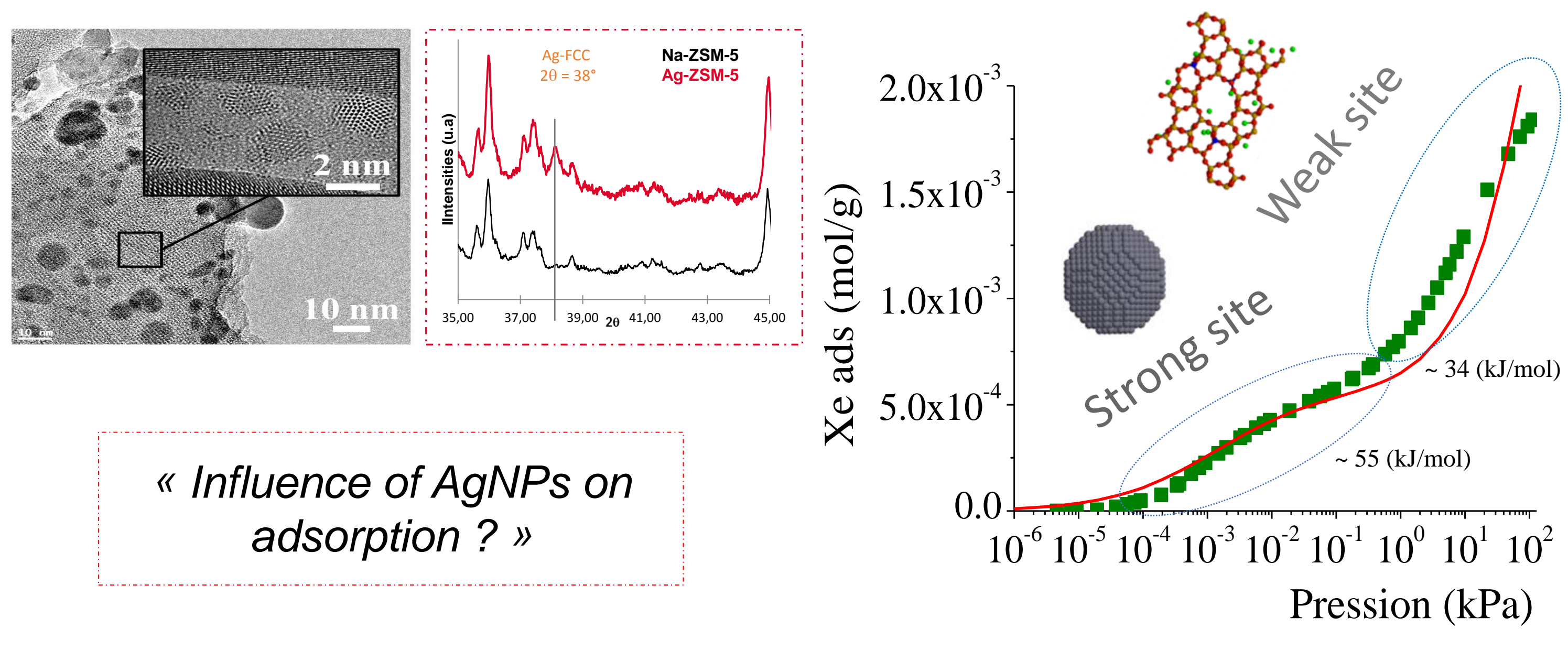


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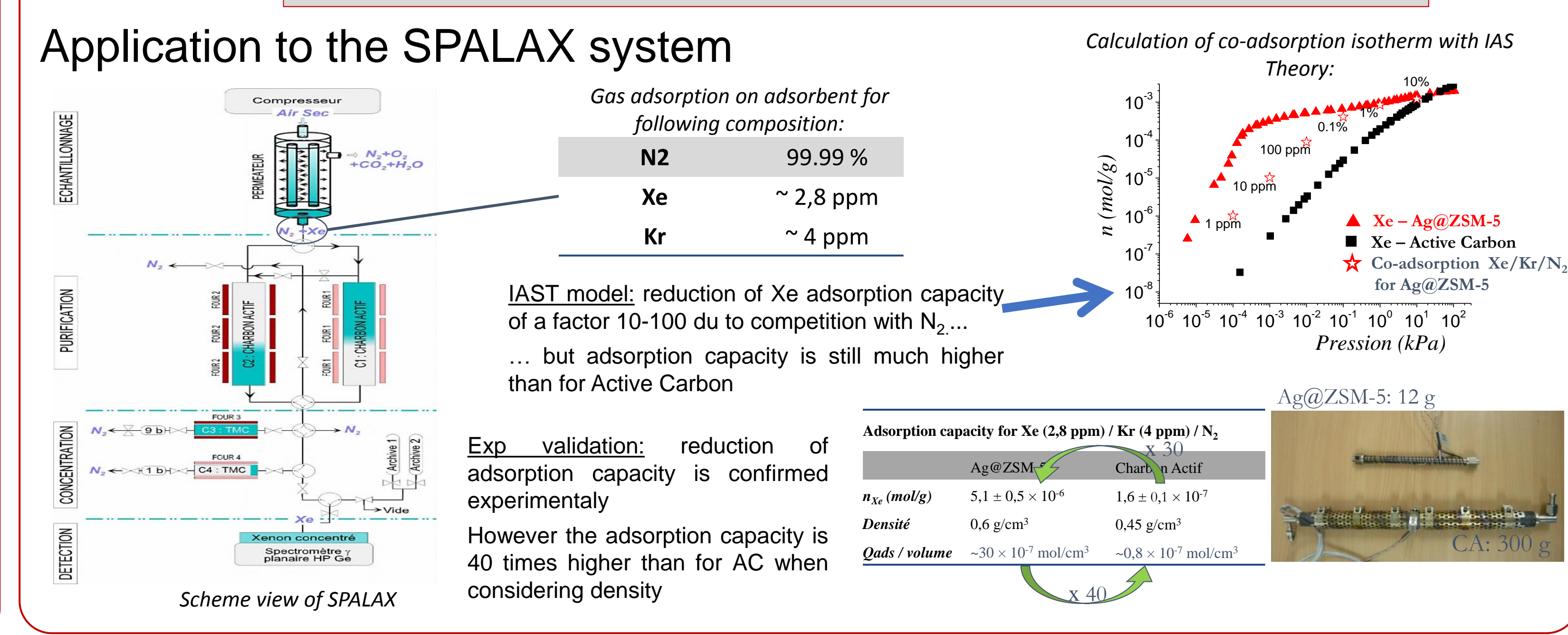
Context / Aim

Rare gas capture and purification is a major challenge for energy, environment, and health applications. In light of the debates on the environmental impact of the nuclear industry, the development of improved Xe/Kr separation techniques has become a key-objective. In addition, separation and concentration of radioactive Xe from air is also of utmost importance for monitoring fission products released upon underground nuclear tests, in the context of the Comprehensive Nuclear Test Ban Treaty (CTBT). In this aim, CEA developed the SPALAX system about 15 years ago which is still under continuous improvement process.^[1] Given the very low abundance (0.087ppm) of Xe in the air and its inert, weakly interacting properties, the adsorbent material used in such a process must exhibit optimal selectivity and adsorption capacity to render the process viable. We have shown that Ag nanoparticles (NPs) supported on a microporous zeolite adsorbents such as ZSM-5 exhibits a Xe/Kr selectivity never achieved and capture Xe with a capacity more than one order of magnitude greater than typical active carbons.^{[2],[3],[4]} Nevertheless, it was observed a deactivation phenomena attributed to sintering and poisoning of AgNPs.^[5] Innovative techniques such as fast electronic tomography or environmental STEM were used to determine the degradation steps.

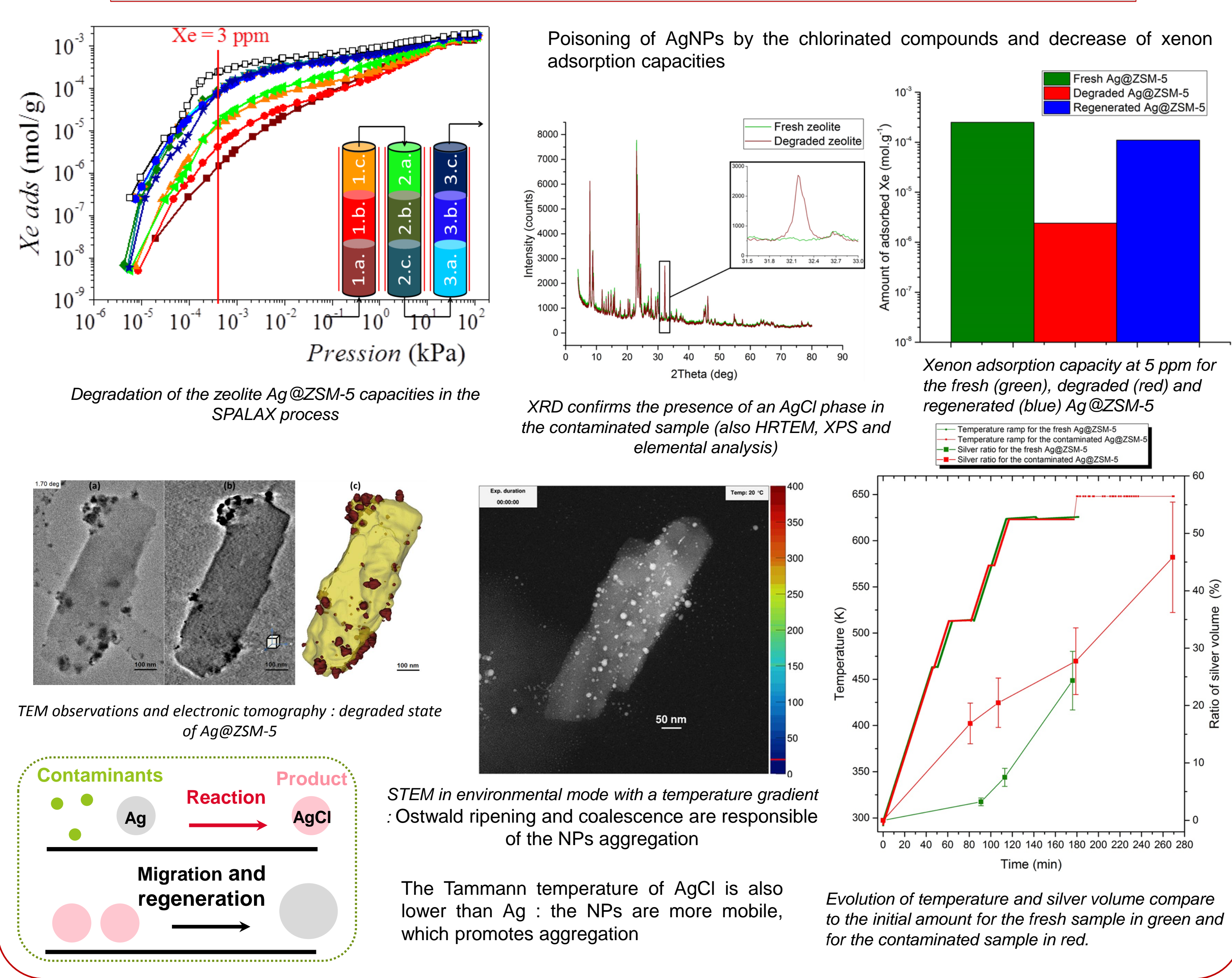
1. Adsorption characterisation



2. NG separation application



3. Long term stability in process conditions



4. Laboratory pilot for material test

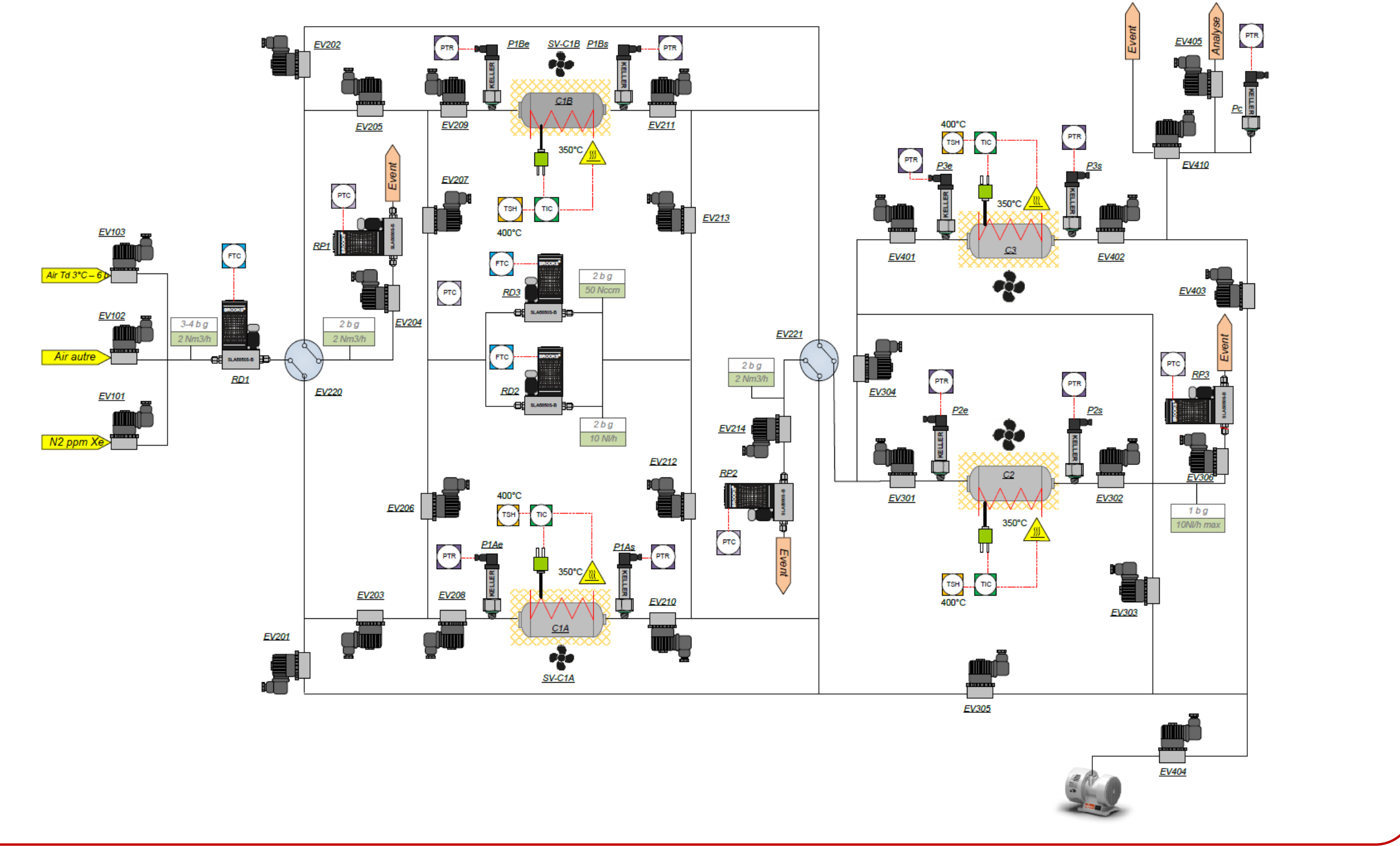
Development of an automated benchtop for material test

- Direct operation with dry air
- Single adsorbent : Ag@ZSM-5
- 2 columns C1A and C1B (60 g) in parallel to trap xenon
- 2 columns C2 (3 g) and C3 (1g) in series

First tests:

- Xenon adsorption capacity of AC with air : $\sim 2 \times 10^{-9}$ mol/g
- Xenon adsorption capacity of Ag@ZSM-5 with air : $\sim 1 \times 10^{-7}$ mol/g

x 50



Conclusions and outlook

- ✓ Ag@ZSM5 presents high performance for Xe adsorption due to the formation of nanoparticles – A model has been set up allowing to determine the NPs distribution – This new adsorbent has been successfully applied in the process condition for treatment of Radioxenon
- ✓ Long term stability is a major concern – deactivation of the NPs is observed after few weeks of operation – Chlorinated compounds are responsible of silver nanoparticles poisoning and promote coalescence – Further works will focus on the development of a specific trap to capture chlorinated compounds at ultra-trace concentrations
- ✓ A new prototype has been developed to test the Ag@ZSM-5 adsorbent directly with dry air – the first results show a good separation of xenon

[1] Topin et al., J. Environ. Radioact. 2015, 149, 43– 50.
 [2] Daniel et al., and S. Topin et al., J. Phys. Chem. C, 2013, 117, 15122– 15129.
 [3] Deliere et al., J. Phys. Chem. C, 2014, 118, 25032-25040.

[4] Deliere et al., Chem. Eur. J., 2016, 22, 1-8
 [5] Deliere et al., Microp. Mesop. Mat. 2016, 229, 145– 154.
 [6] Chen et al., Nature Materials, 2014, 13