MATESA: Proof of concept

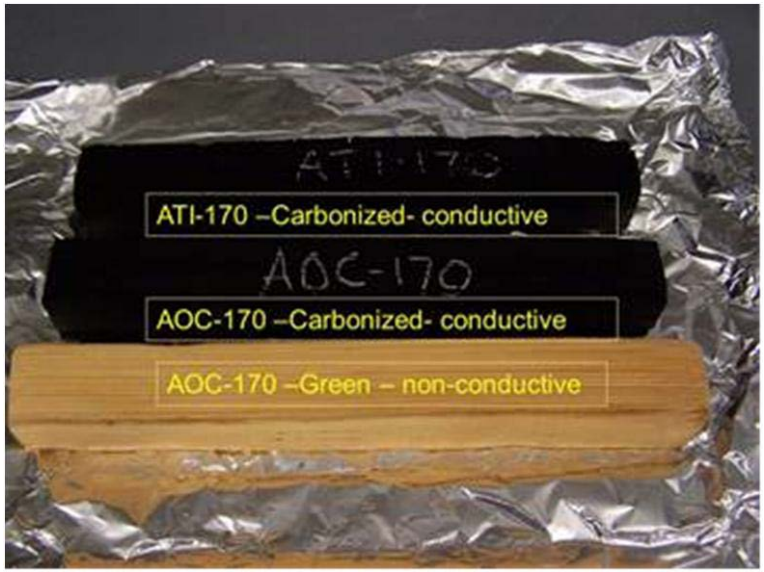
Dissemination Day. Oslo, 16/06/16.

Proof of concept

- Perform breakthrough curve measurements to verify multicomponent adsorption equilibrium and diffusion (for model calibration)
- Demonstrate cyclic performance of honeycomb monoliths
- Calculate power consumption of the real sample. This calculation will be only presented for the case of use of electric power.
- Results by now made with two different honeycomb materials:
  - ZSM-5 honeycomb monolith
  - 13X honeycomb monolith

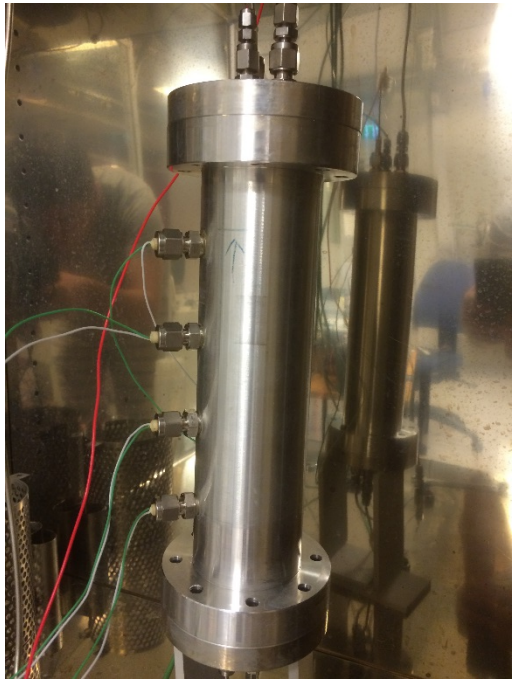
The materials

- Length 20 cm monoliths. ZSM-5 samples are square honeycombs and 13X zeolite are cylindrical → two different reactors needed.



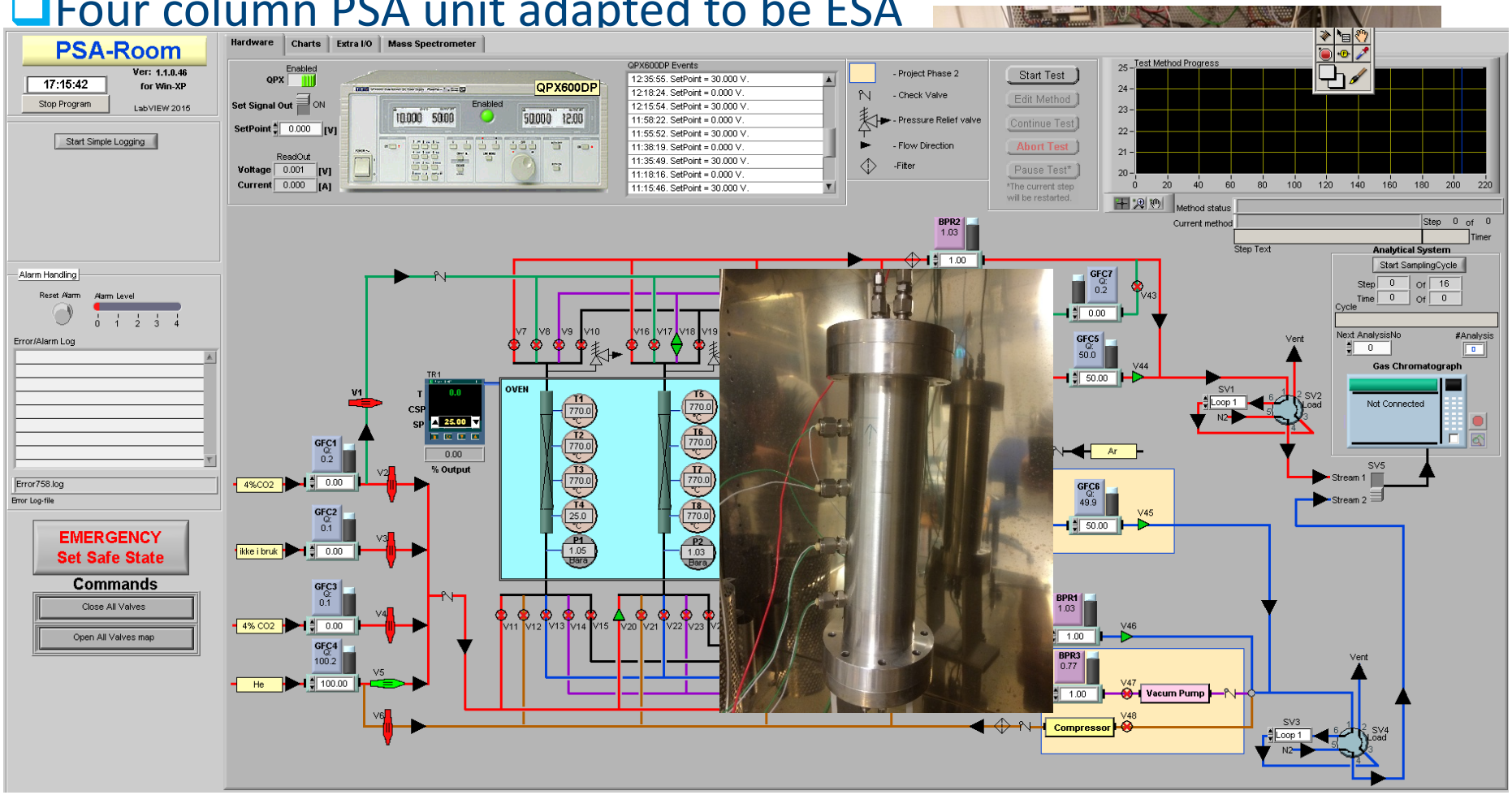
The reactors

- Length 20 cm monoliths. ZSM-5 samples are square honeycombs and 13X zeolite are cylindrical → two different reactors needed.
- Temperature measurement is challenging. Uneven flow distribution must be avoided.

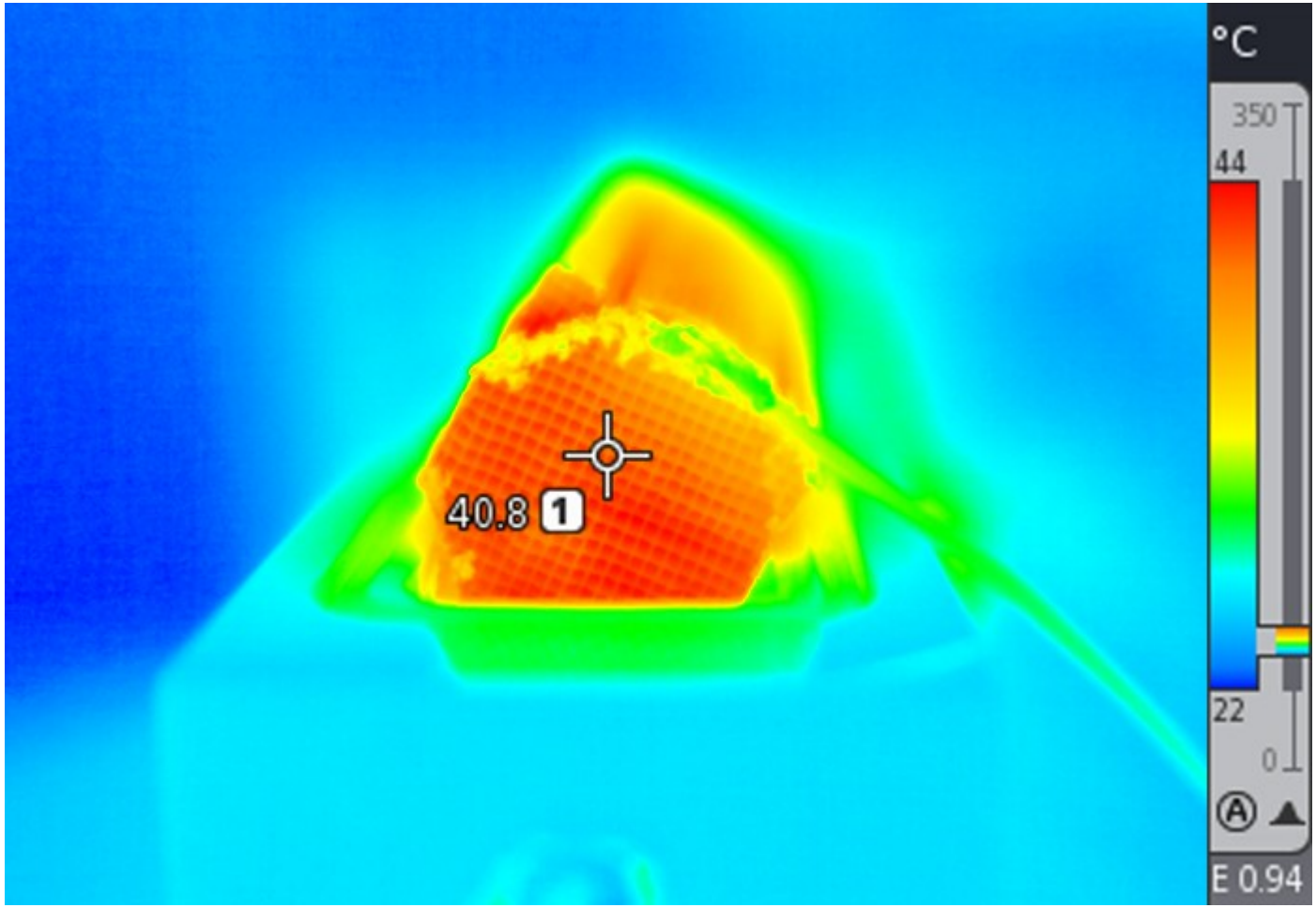


The ESA unit

- Four column PSA unit adapted to be ESA

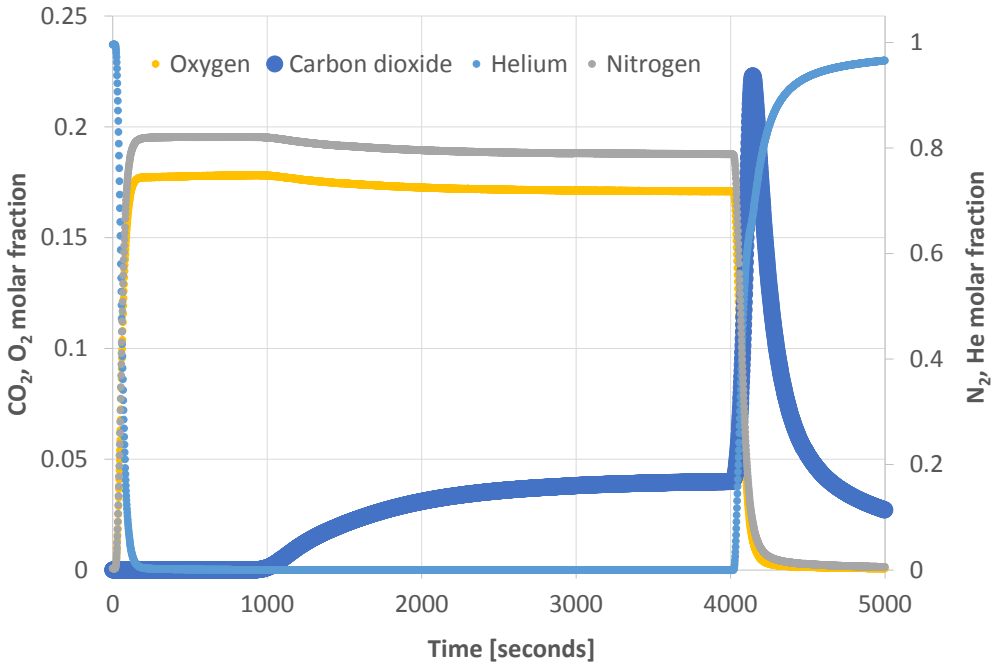


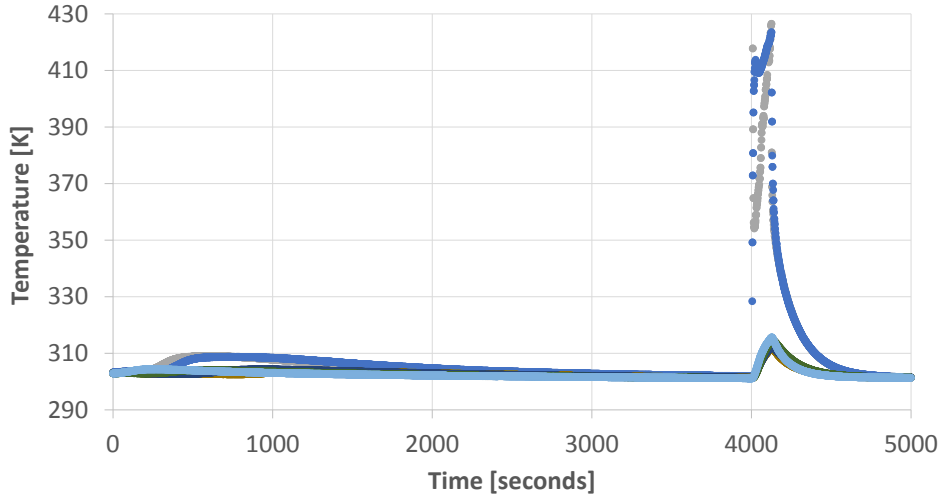
Electric heat in action



Breakthrough curve exar

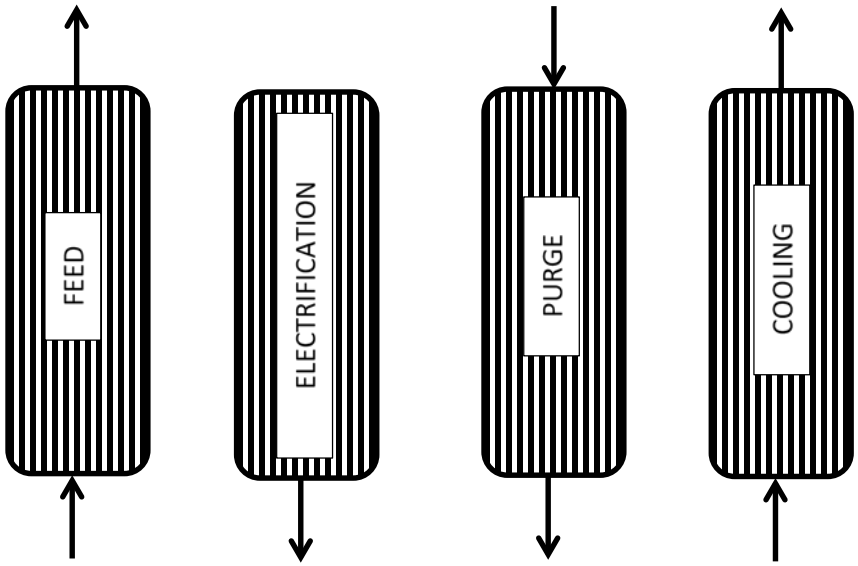
- Adsorption and desorption





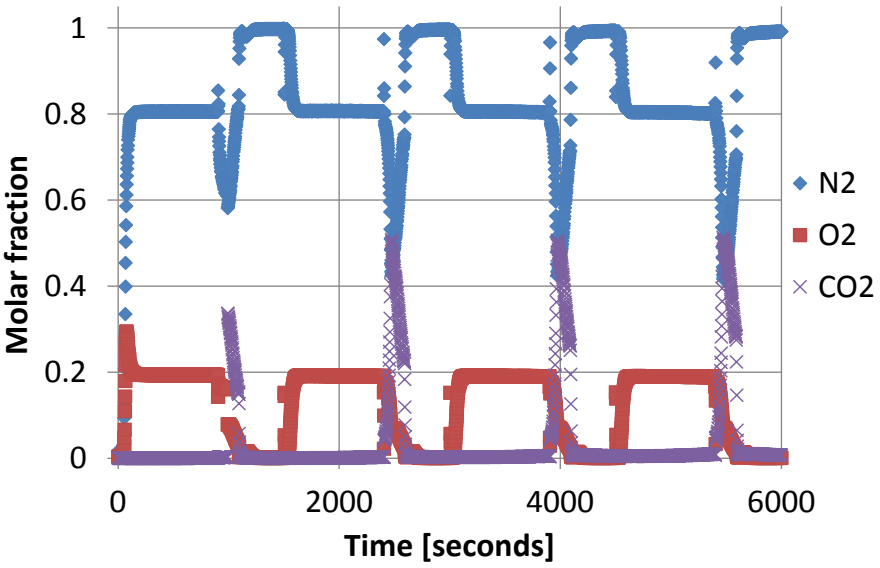
4-step cycle for ESA

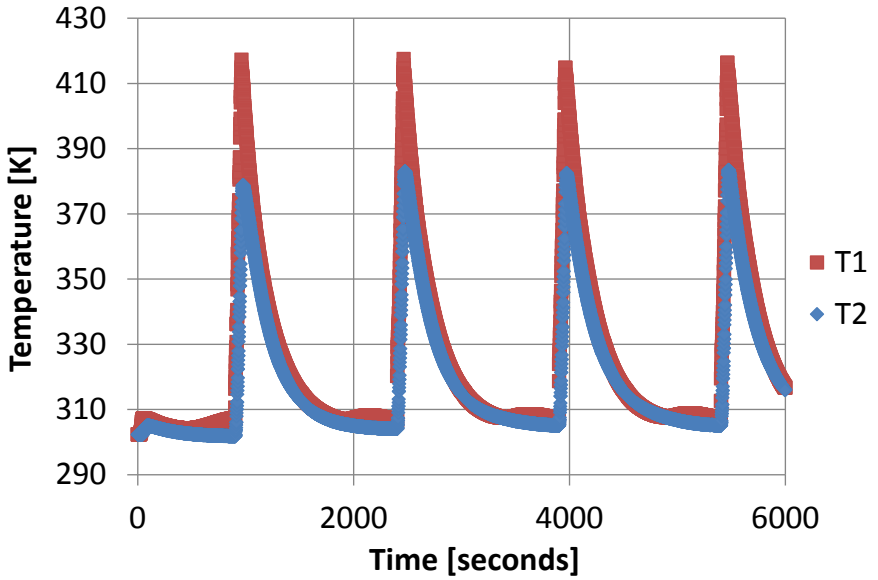
- **Steps:**
  1. **Co-current feed step (4.6 vol% CO_2, 900')**
  2. **Counter-current electrification (60V), no purge (60')**
  3. **Counter-current purge (120', 120 ml/min nitrogen)**
  4. **Co-current cooling (420', 230 ml/min nitrogen)**

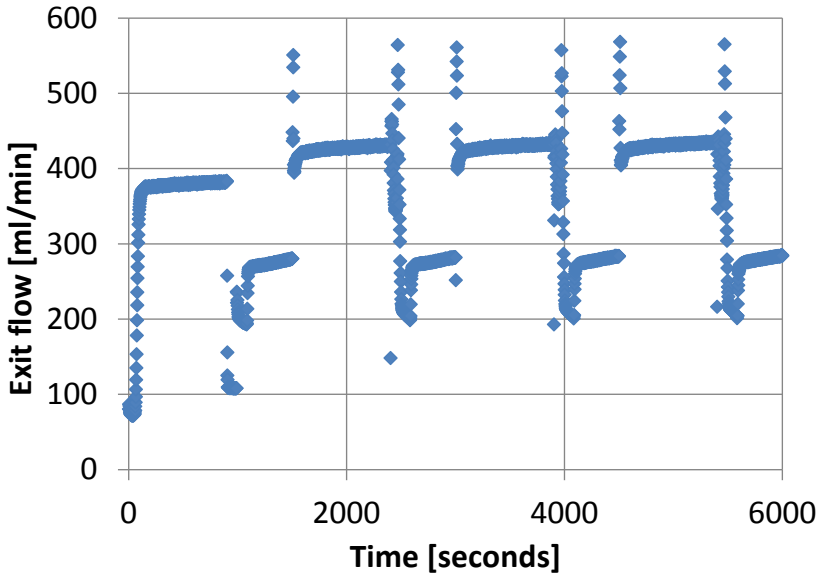


4-step cycle for ESA

- **Results:**
  - **Low CO_2 purity (<51.3%).**

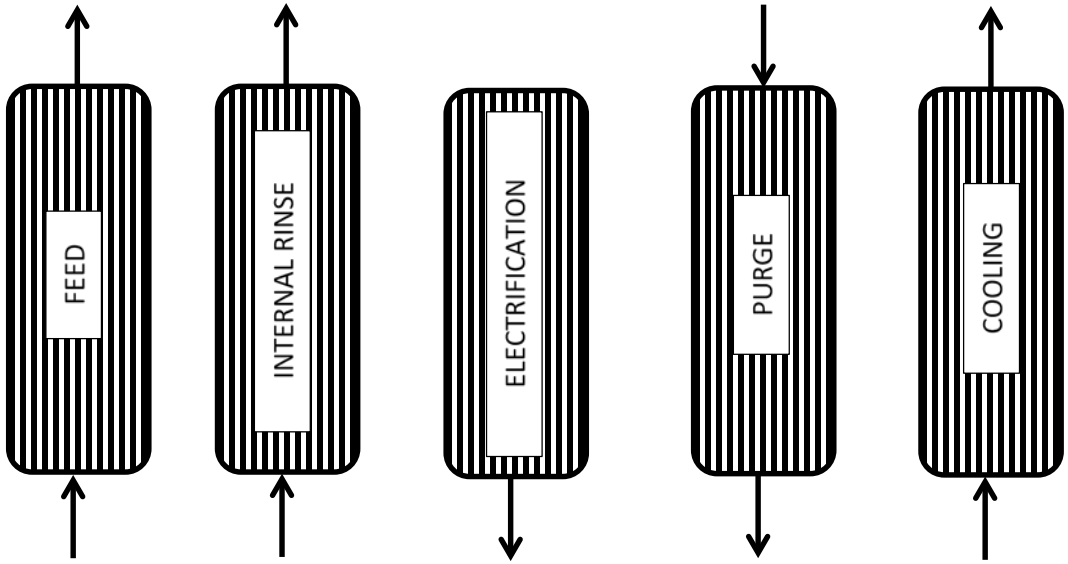






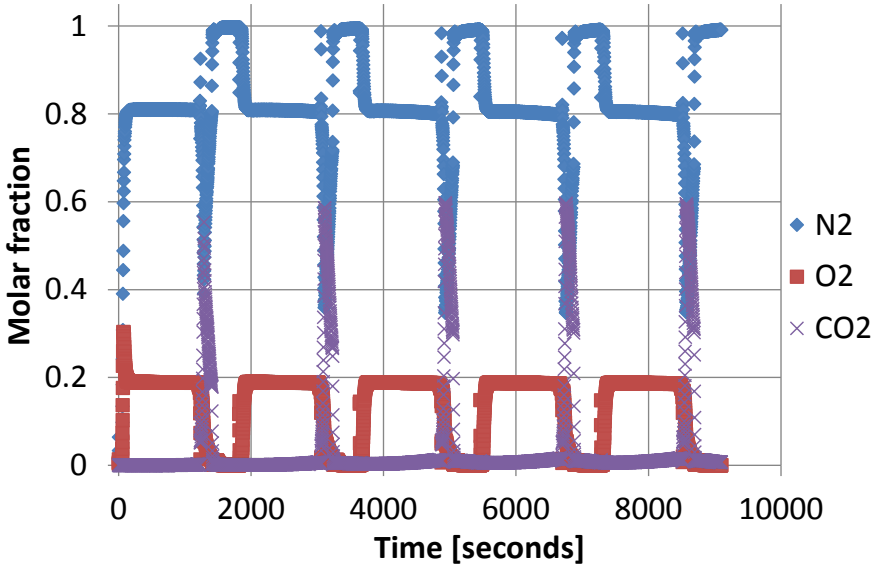
5-step cycle for ESA:

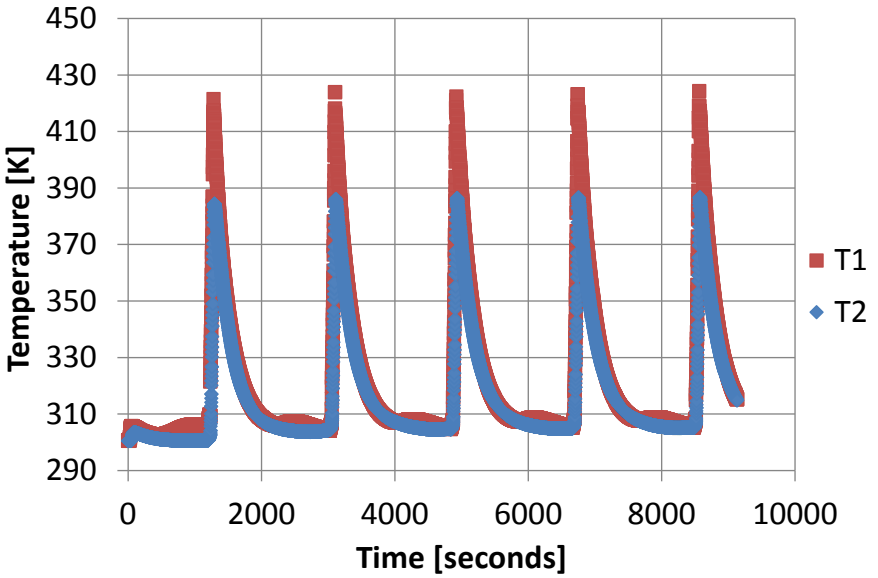
- **Steps:**
  1. **Co-current feed step (4.6 vol% CO_2, 1200')**
  2. **Co-current Internal rinse (15V, 30')**
  3. **Counter-current electrification (51V), no purge (55')**
  4. **Counter-current purge (120', 115 ml/min nitrogen)**
  5. **Co-current cooling (420', 230 ml/min nitrogen)**

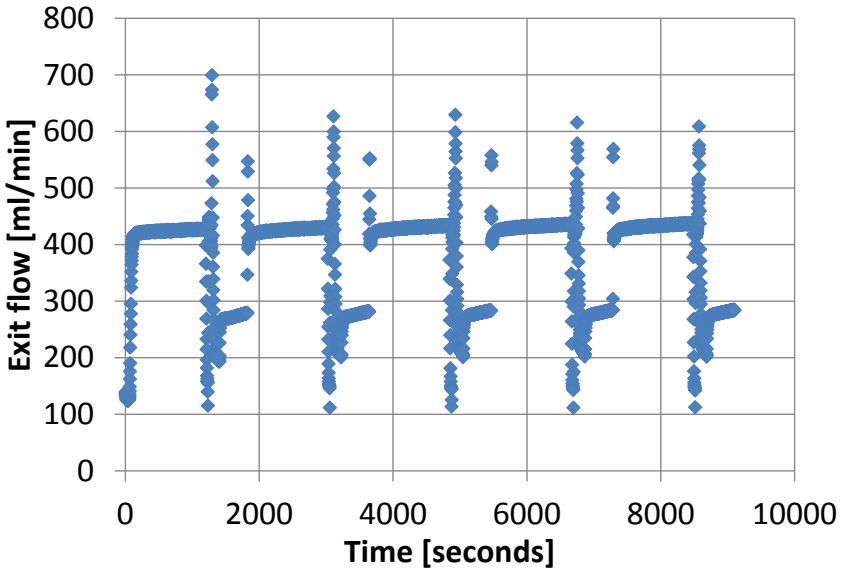


5-step cycle for ESA:

- **Results:**
  - **Higher peak CO_2 purity (59.5%)**







Results so far

- Adsorption equilibrium of the multicomponent mixture has been verified in both monoliths.
- The cyclic steady state is achieved in very few cycles (less than 5).
- Comparison of results with existing materials (activated carbon) show an improvement of at least 300% in CO_2 purity.
- Uneven temperature distribution has been observed with IR camera, perhaps due to agglomeration of zeolite in certain parts of the monolith.

Uneven temperature

- Accurate measurement of temperature is very important.