

WP6: EM2a & DO Monitoring

“EOLI - Efficient Operation of Urban Wastewater Treatment Plants”

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EM2a: Model Applicability FDI Task

- **Resources**

- ⇒ WP2 - Model Selection and Parameter Identification

- 1. EM2 Associated to C/N Removal Processes

- 2. Deliverable D2.3 Validated Model

- ⇒ WP1 POLIMI: Experimental data

- **Steps & Results**

- ⇒ General Evaluation of the Model

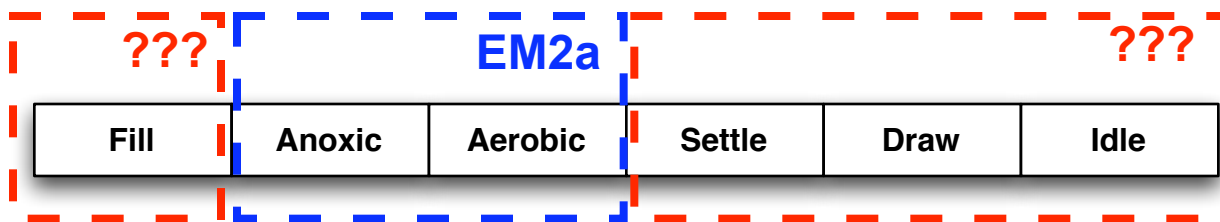
- ⇒ MATLAB Simulator Package

- ⇒ Simulations



EM2a: General Evaluation Results

- **Limited Applicability (Reaction Phases only)**
- **Specific Problems:**
 - ⇒ Fill Phase: Absorption & Aerobic Reaction (aerobic fill)
 - ⇒ No means to work on problems that occur over sequences of process cycles





EM2a: Simulator Package

- **MATLAB/SIMULINK Simulator Package**
 - ⇒ Simulations in Graphical and Script Environment
 - ⇒ Implementation based on the reported model and configured with reported identified model parameters
 - ⇒ If anybody is interested we will provide the package



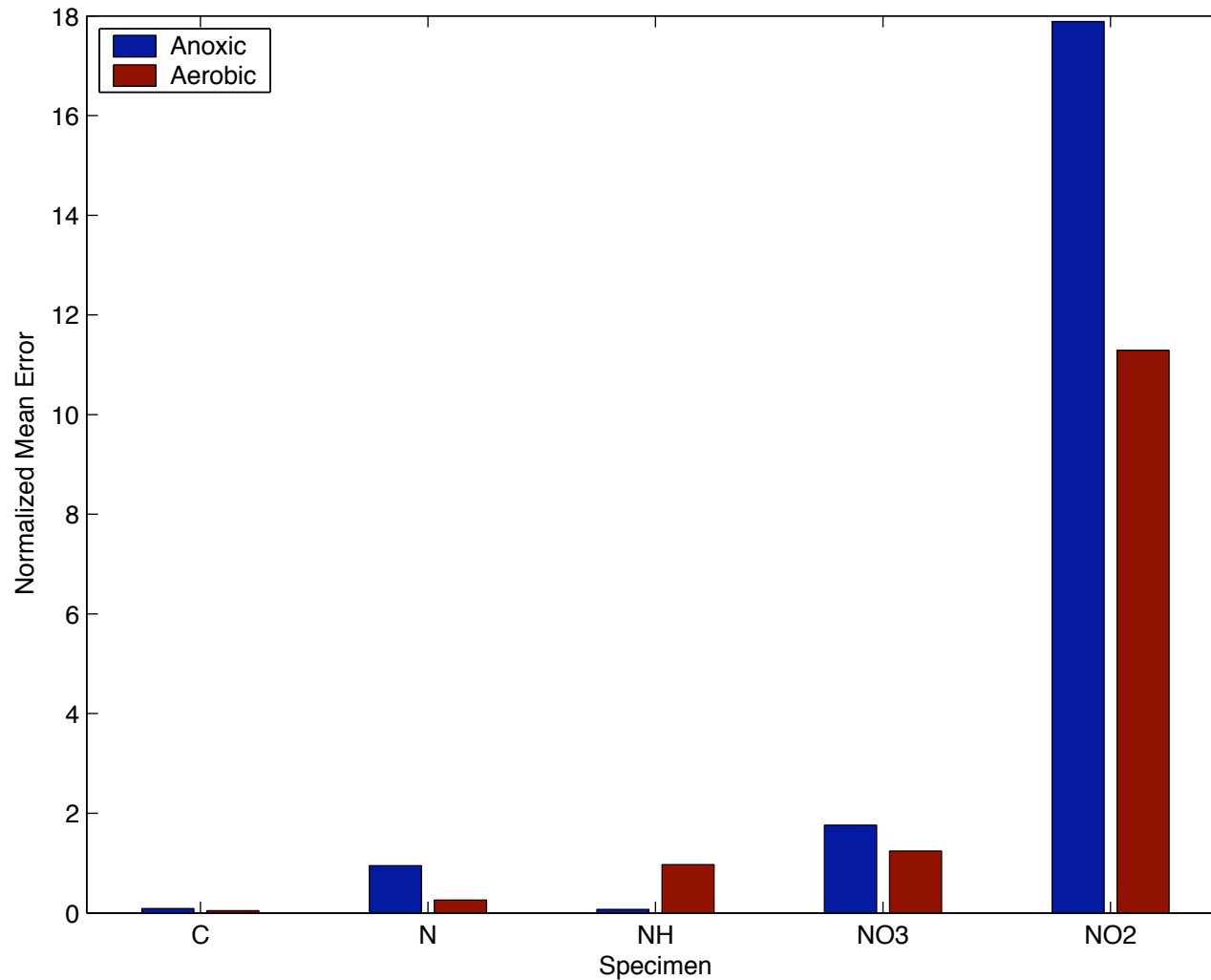
EM2a: Simulation Runs (1)

- **Set 1: Reproduction of Nitrite Outflow >0.6 mg/l**
 - ⇒ Within an isolated cycle
 - ⇒ By variation of the initial conditions (i.e. nitrogen specimen concentrations) of the reaction phase
 - ⇒ Occurrence in Experiments **cannot** be reproduced
- **Set 2: Reproduction of POLIMI Experiments**
 - ⇒ Compare the model output with experimental measurement data
 - ⇒ Calculate a mean cumulative normalized error per phase:

$$\frac{1}{n} \sum_{i=1}^n \left(\frac{C_{x,sim} - C_{x,exp}}{C_{x,exp}} \right)^2$$



EM2a: Simulation Runs (2)





EM2a: Conclusion

- **Mathematical model is not suitable for the detection of this specific problem**
- **Perhaps we can try to work with data based models (pattern recognition/classification problem)**



Online Monitoring

- **Based on DO**
 - ⇒ The only *online* measurement in the model
 - ⇒ Equation is well studied
- **Steps & Results**
 - ⇒ Problems related to the DO dynamics
 - ⇒ Simple Process Model
 - ⇒ Monitoring Possibilities



Monitoring: Problems & Solutions

- **Parameters**

- ⇒ Oxygen Saturation Concentration

- 1. Model (Tromans 1999)

- 2. Approximation (Henry's Law)

- ⇒ KLa

- 1. Online Identification

- **DO Measurement**

- ⇒ Sensor dynamics (response delay)

- 1. Filter Design (Lindberg and Carlson 1996)

- 2. Stable Inverse (if possible)

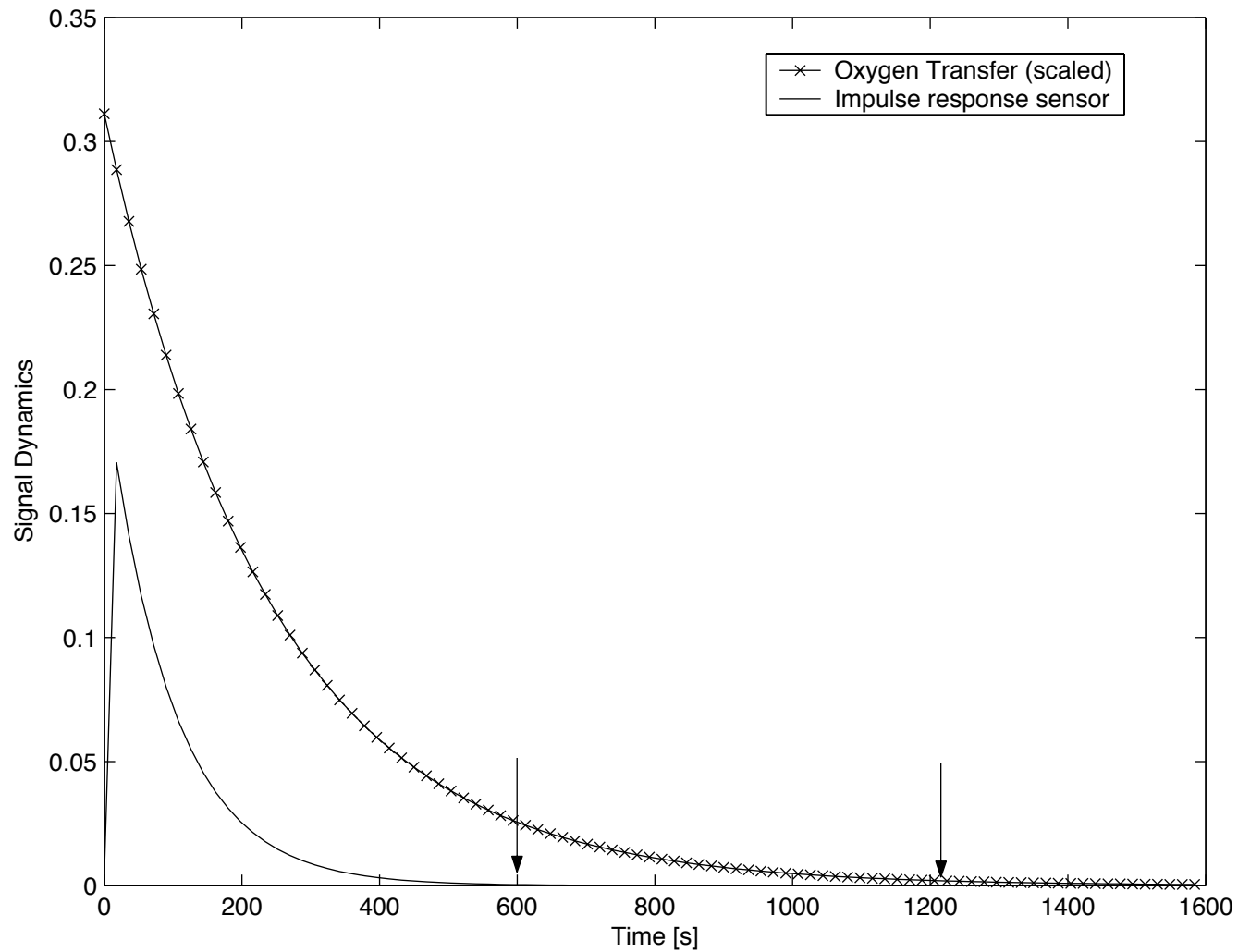


Monitoring: Model & Possibilities

- **Formal DES Model (State Automaton)**
 - ⇒ Natural representation of the sequential process
- **Model Extensions for Monitoring Purposes**
 - ⇒ KLa Identification (once per cycle); detection of deviations from acceptable/usual/standard conditions
 - ⇒ Respiration Test; substrate presence, specially interesting when treating toxic substances
- **Respiration Rate Monitoring**
 - ⇒ Online estimate $r(t)$ in the reaction phase
 - ⇒ Patterns?

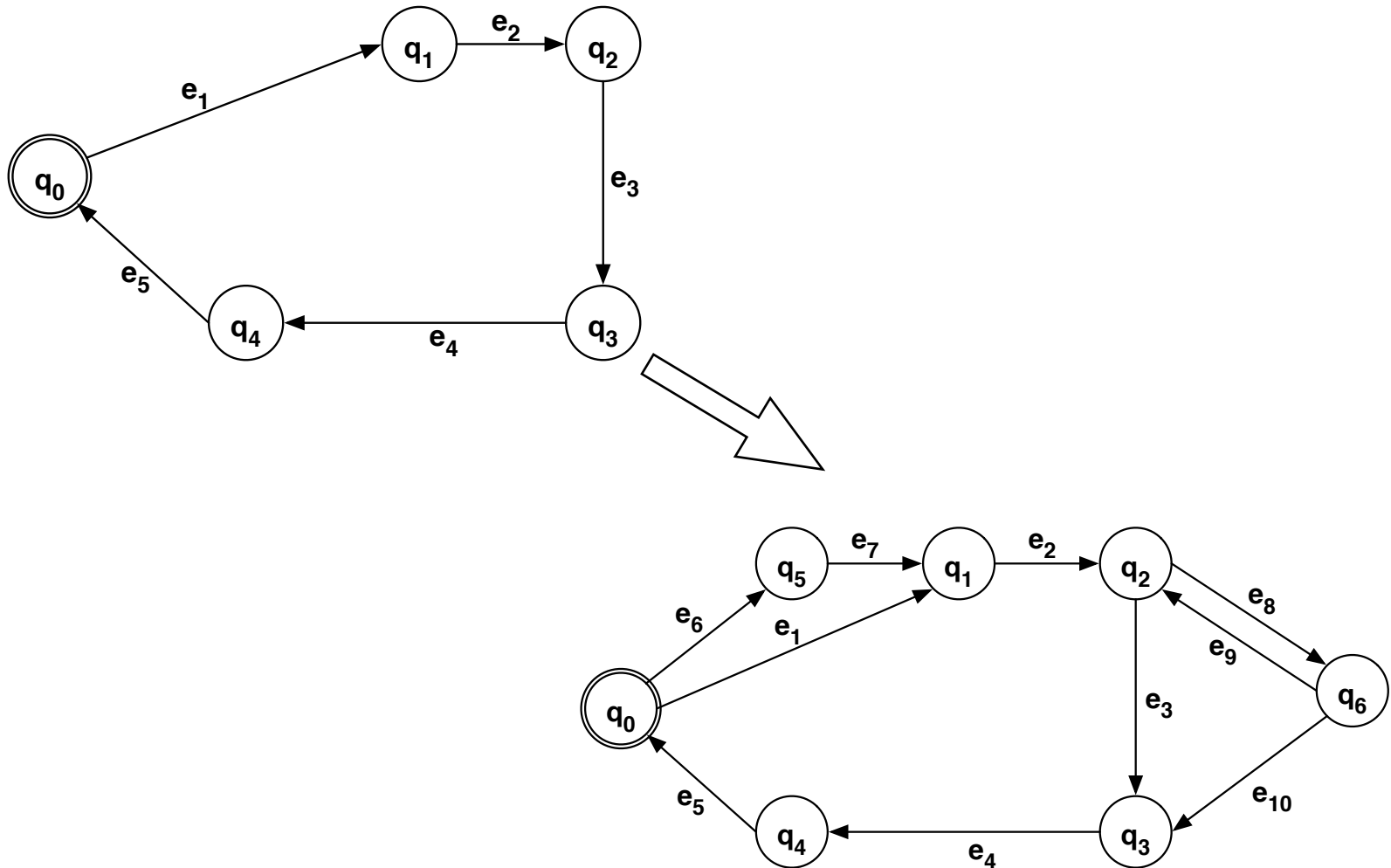


Sensor Dynamics



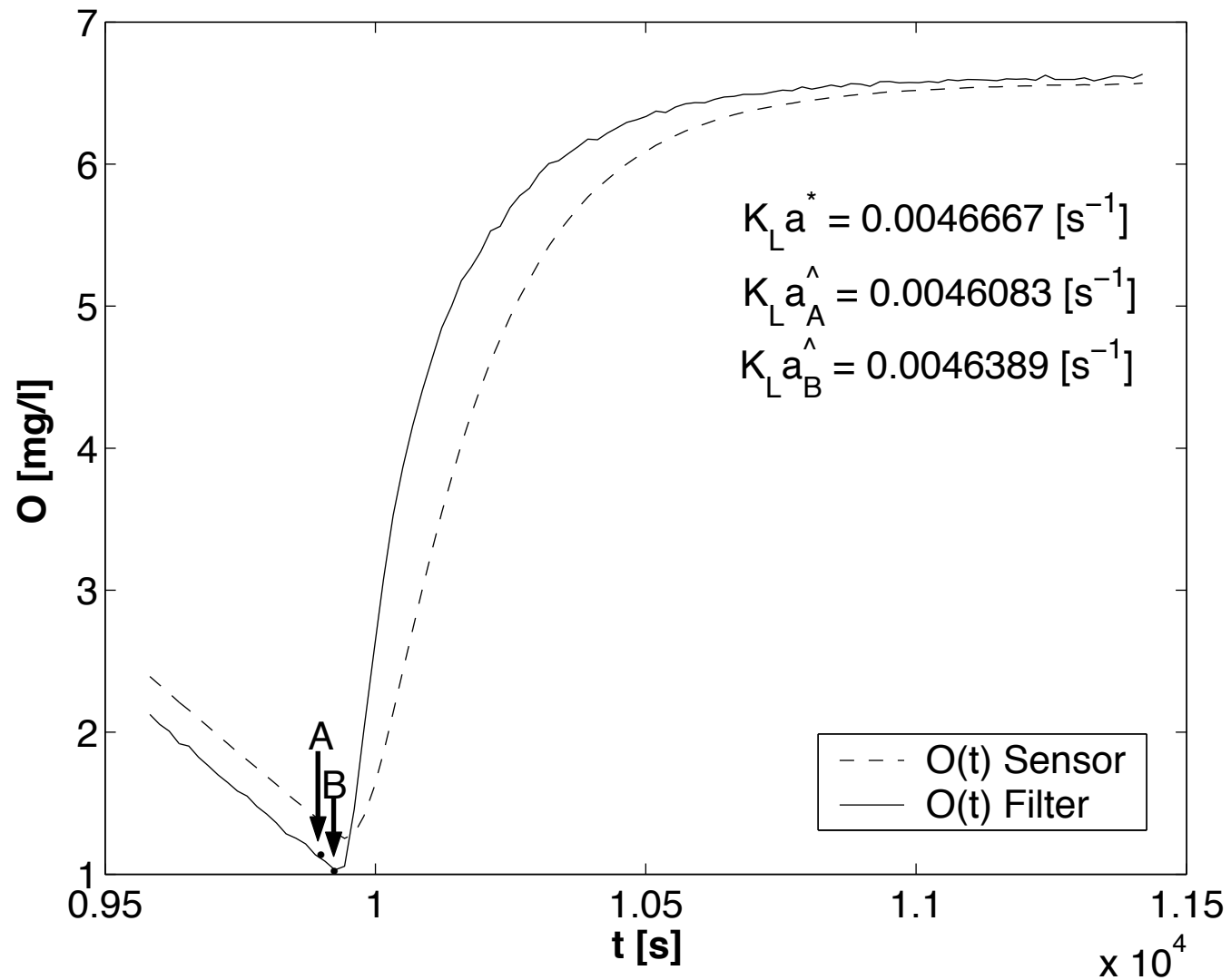


DES Model & Extension





KLa Estimation





Respiration Rate

