



## Modelling of Am stripping step with TODGA - TPAEN

V. Vanel, M. Montuir, V. Pacary, C. Marie, N. Boubals

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SACSESS meeting  
Warsaw, April 2015

# Modelling of Am stripping step with TODGA - TPAEN

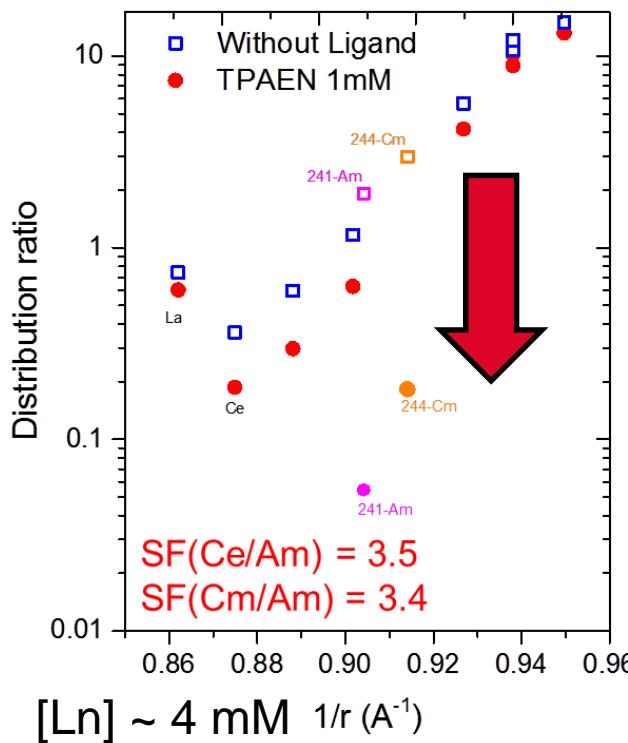
V. Vanel, M. Montuir,  
V. Pacary, C. Marie,  
N. Boubals

CEA Marcoule, Direction de l'énergie nucléaire  
Département radiochimie et procédés  
Service modélisation et chimie des procédés de séparation



# Objectives

- Discuss the feasibility of a flowsheet compared to performances, based on two approaches : theoretical stages and a first model implemented in the PAREX code
- Make a progress report on modelling and identify a list of experiments to strengthen the model
- Suggest a first flowsheet



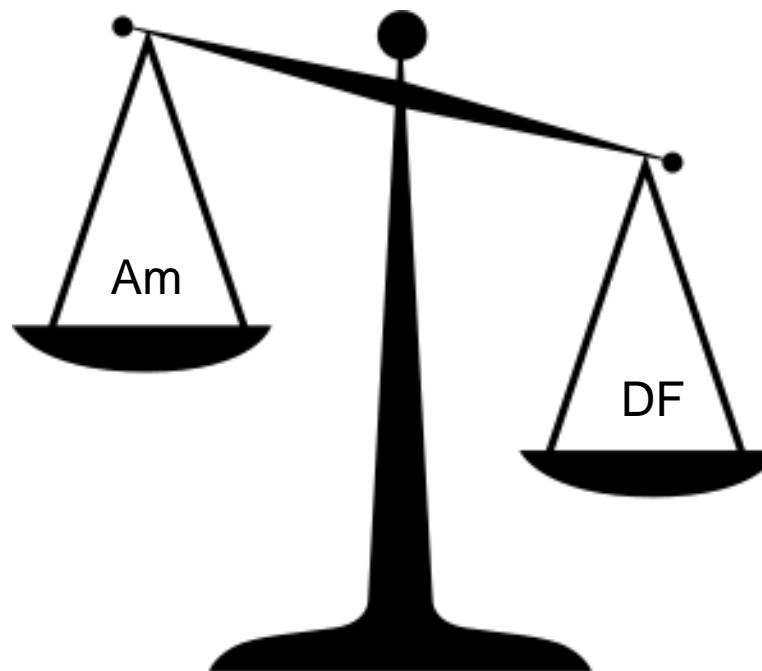
Feed (mg/L)	
[La]	350
[Ce]	750
[Pr]	400
[Nd]	1400
[Am]	420

$[\text{Ln}] \sim 25 \text{ mM}$

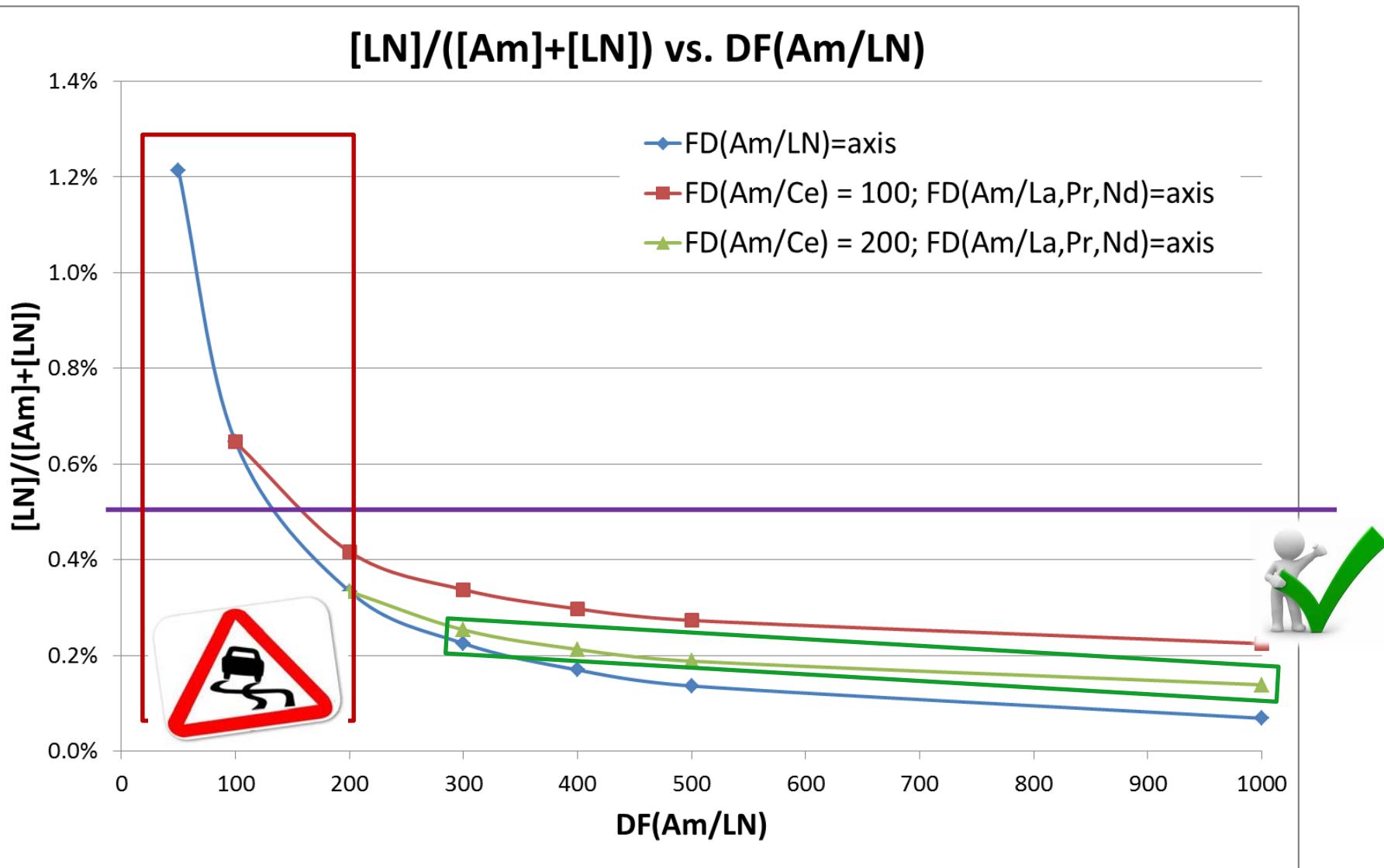
# Target performances

- Am recovery rate : > 90%?, > 95%?, > 99%?
- DF(Am/Cm) > 500 ?
- Ln / (Am + Ln) < 5% ?
- Number of stages

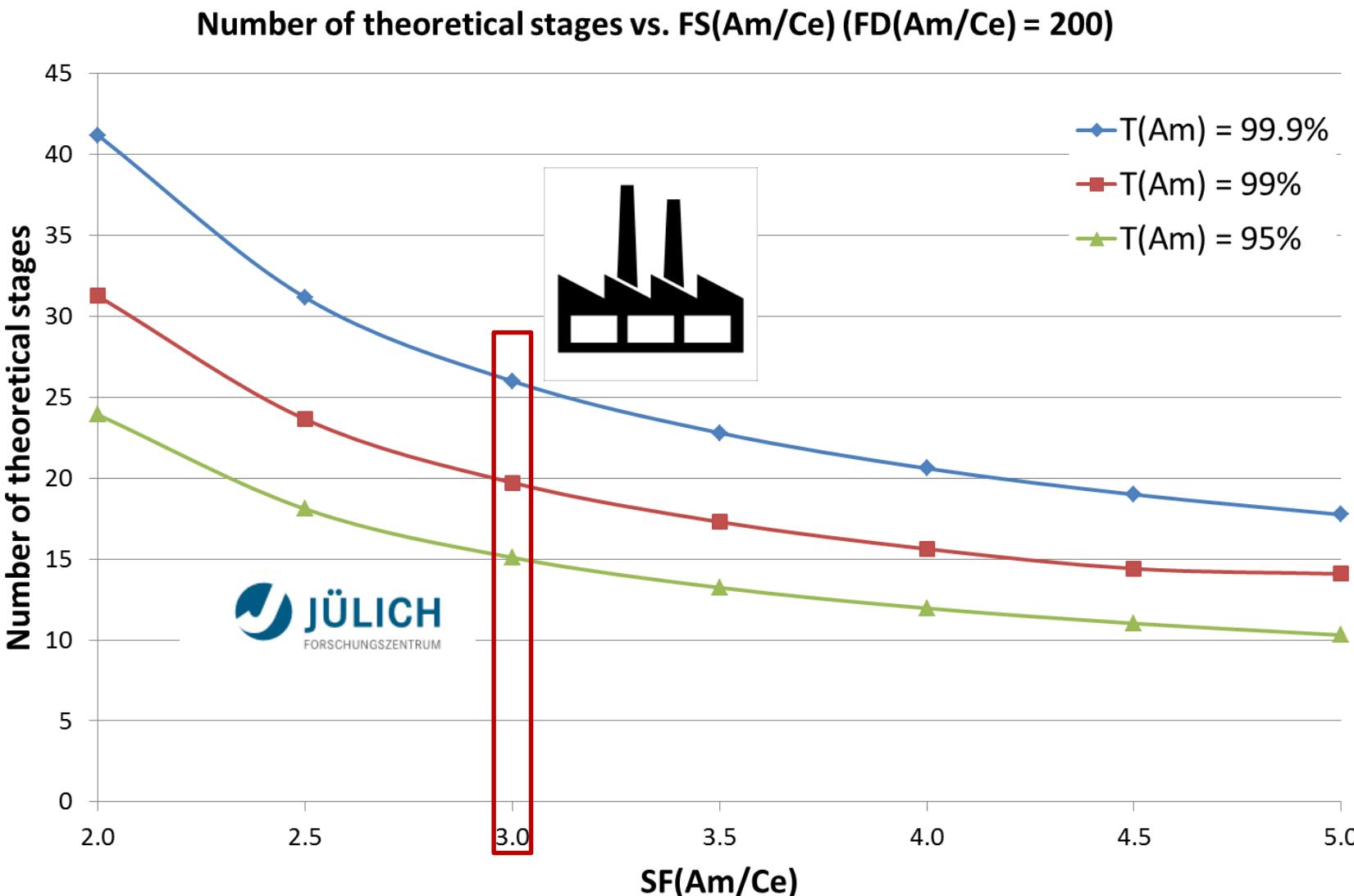
Number of stages  
hot test ≠ industrial process



## Which DF(Am/Ln) ?

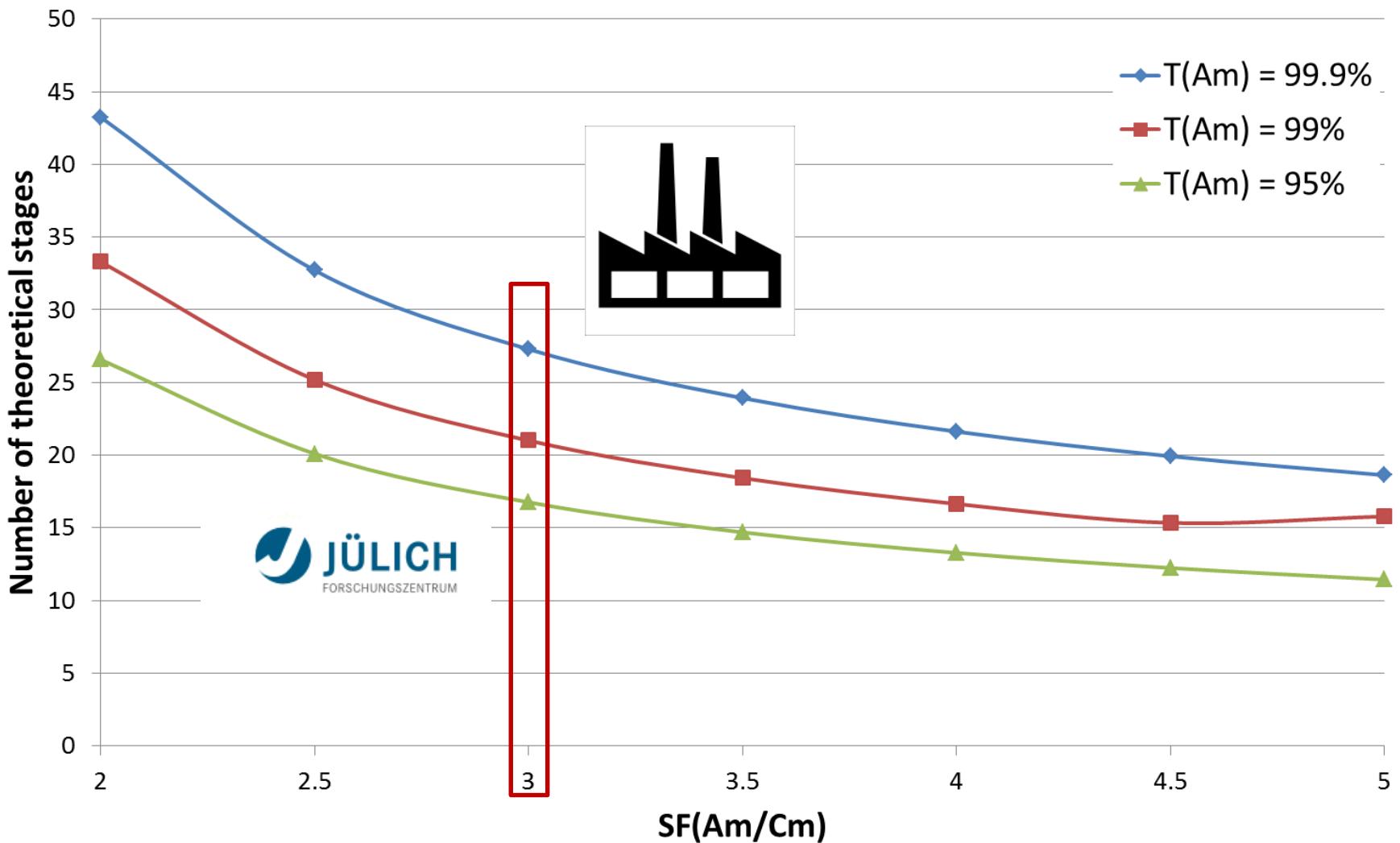


# Am recovery vs. number of theoretical stages and SF(Am/Ce)



# Am recovery vs. number of theoretical stages and SF(Am/Cm)

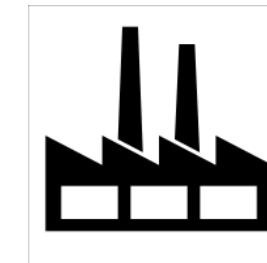
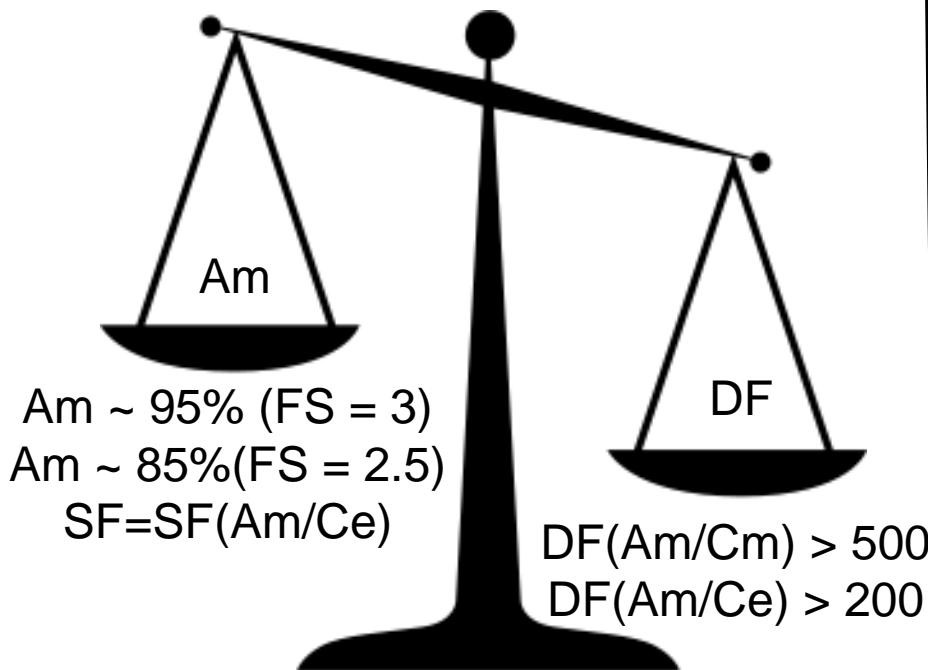
Number of theoretical stages vs. FS(Am/Cm) (FD(Am/Cm) = 500)



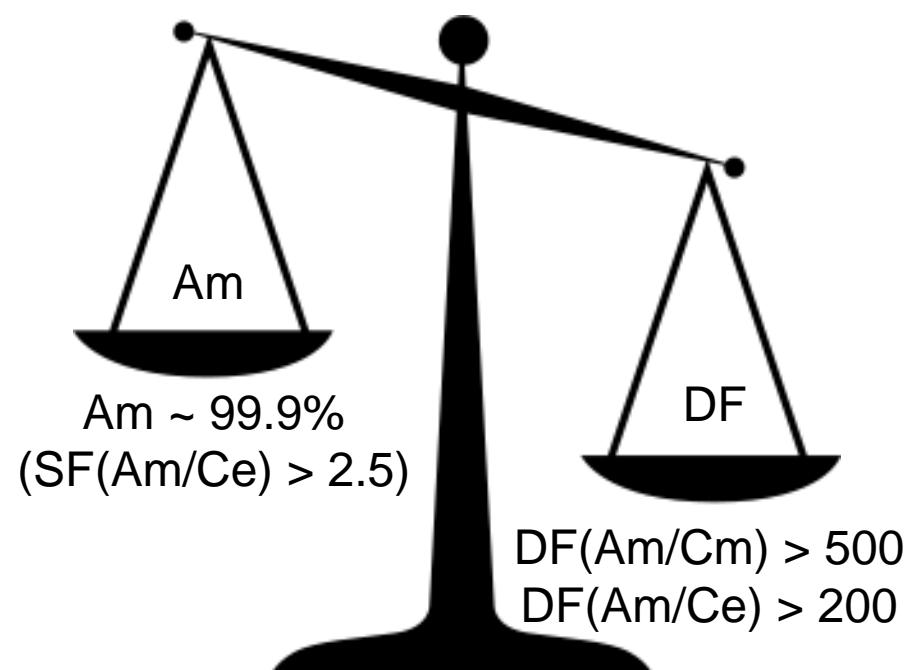
# Target performances



Number of stages = 16



Number of stages = 32



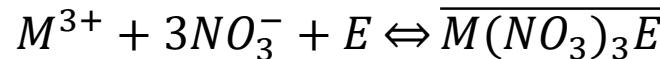
# Modelling implemented in the PAREX code

- Experiments used (2+2)



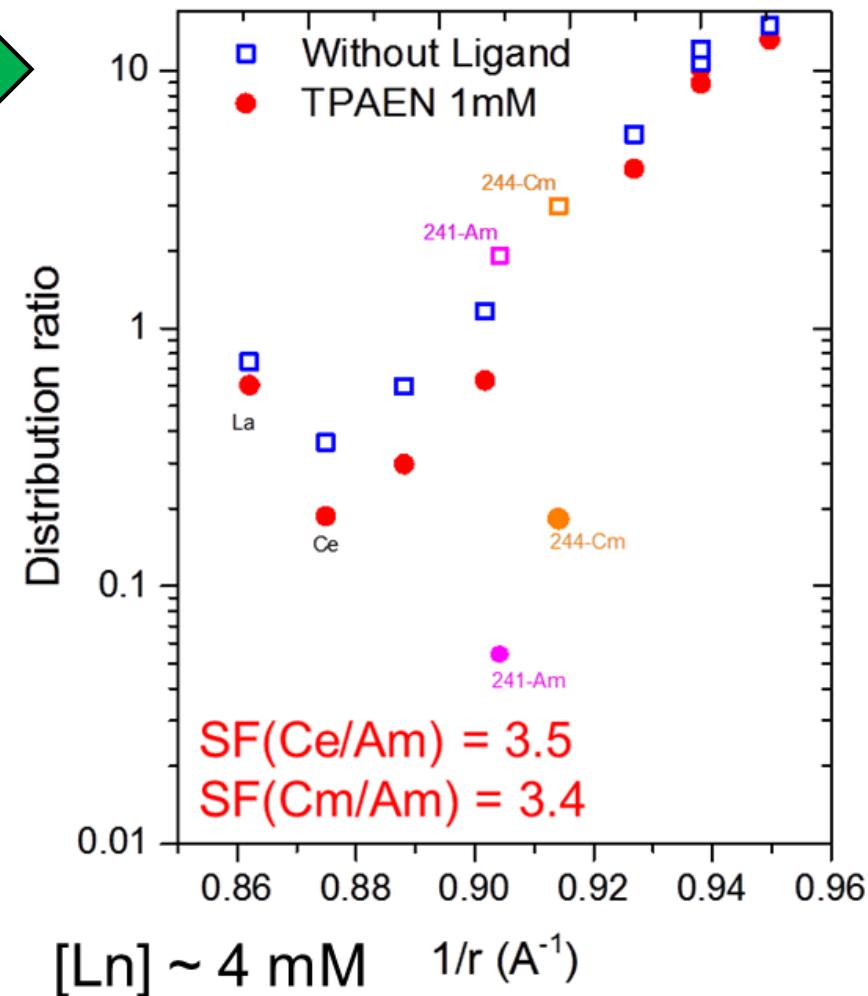
- Assumption : diluted solutions (no salt, no high nitric acid concentration) => not necessary to take into account the deviation from ideality (chemical activities)

- Phenomenological model

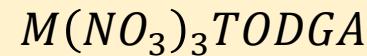
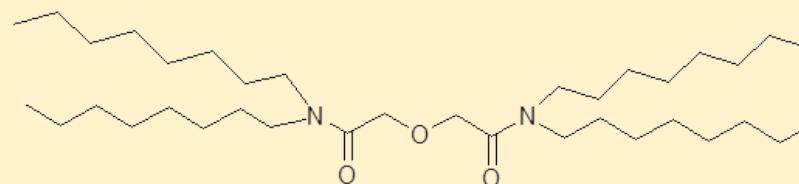


$$[\overline{M(NO_3)_3E}] = K[M^{3+}][NO_3^-]^3[\bar{E}]$$

- First model = a lot of improvements to be made but a good way to determine a list of further experiments

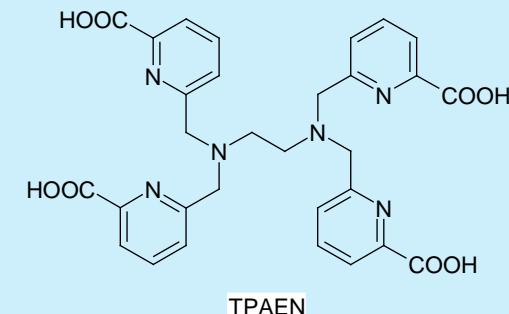


# Modelling implemented in the PAREX code



MH<sub>4</sub>TPAEN (1:1)

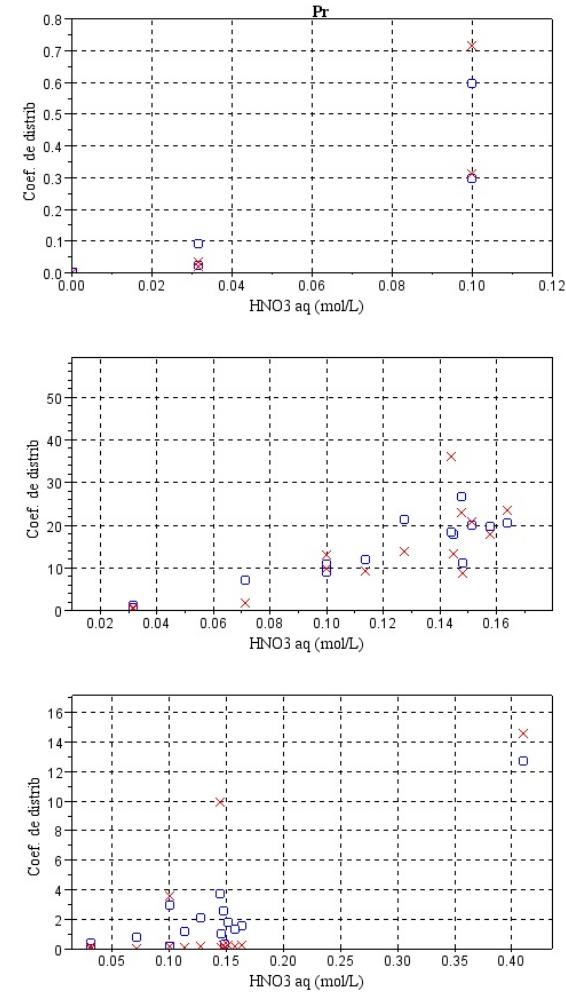
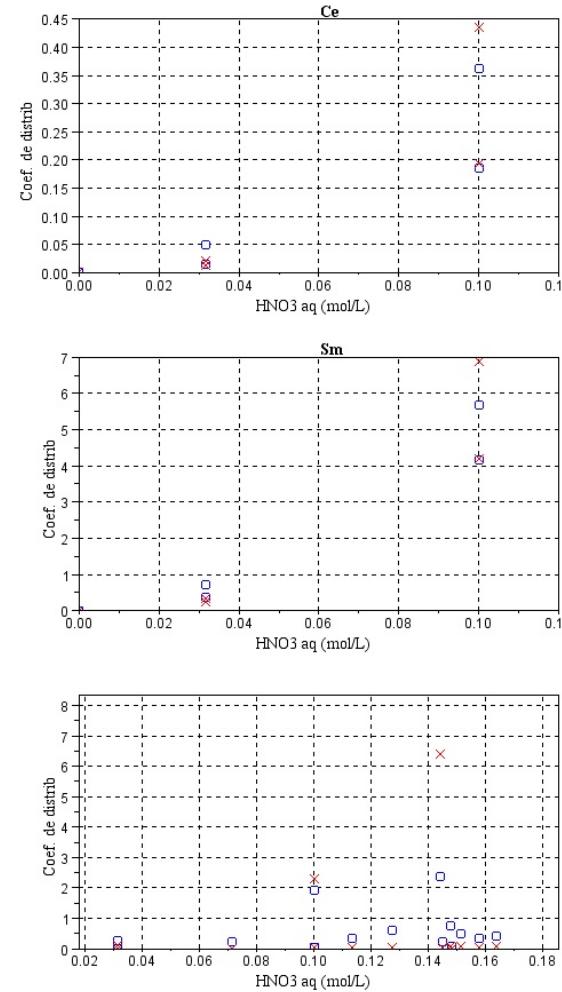
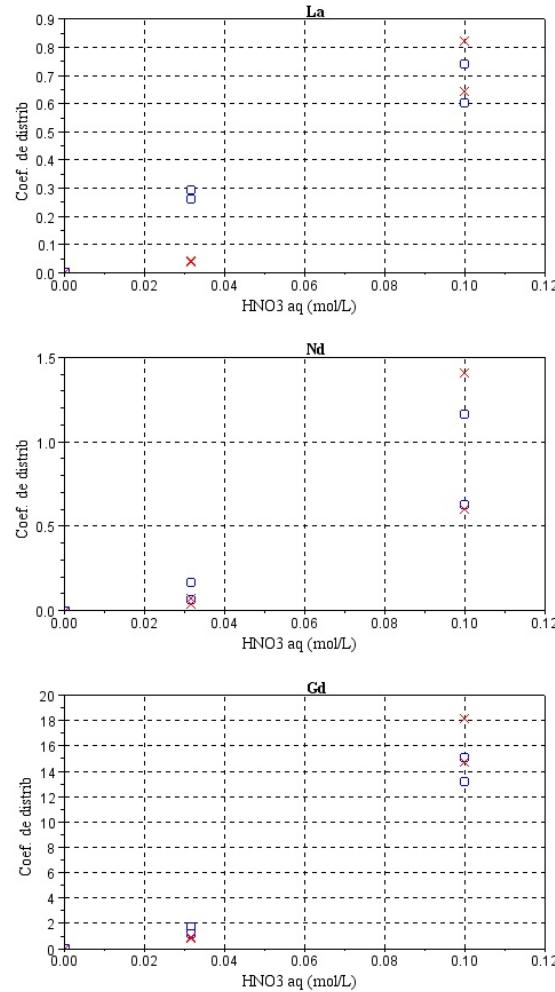
H<sub>6</sub>TPAEN  
H<sub>4</sub>TPAEN  
H<sub>3</sub>TPAEN<sup>-</sup>  
H<sub>2</sub>TPAEN<sup>-2</sup>  
HTPAEN<sup>-3</sup>  
TPAEN<sup>-4</sup>



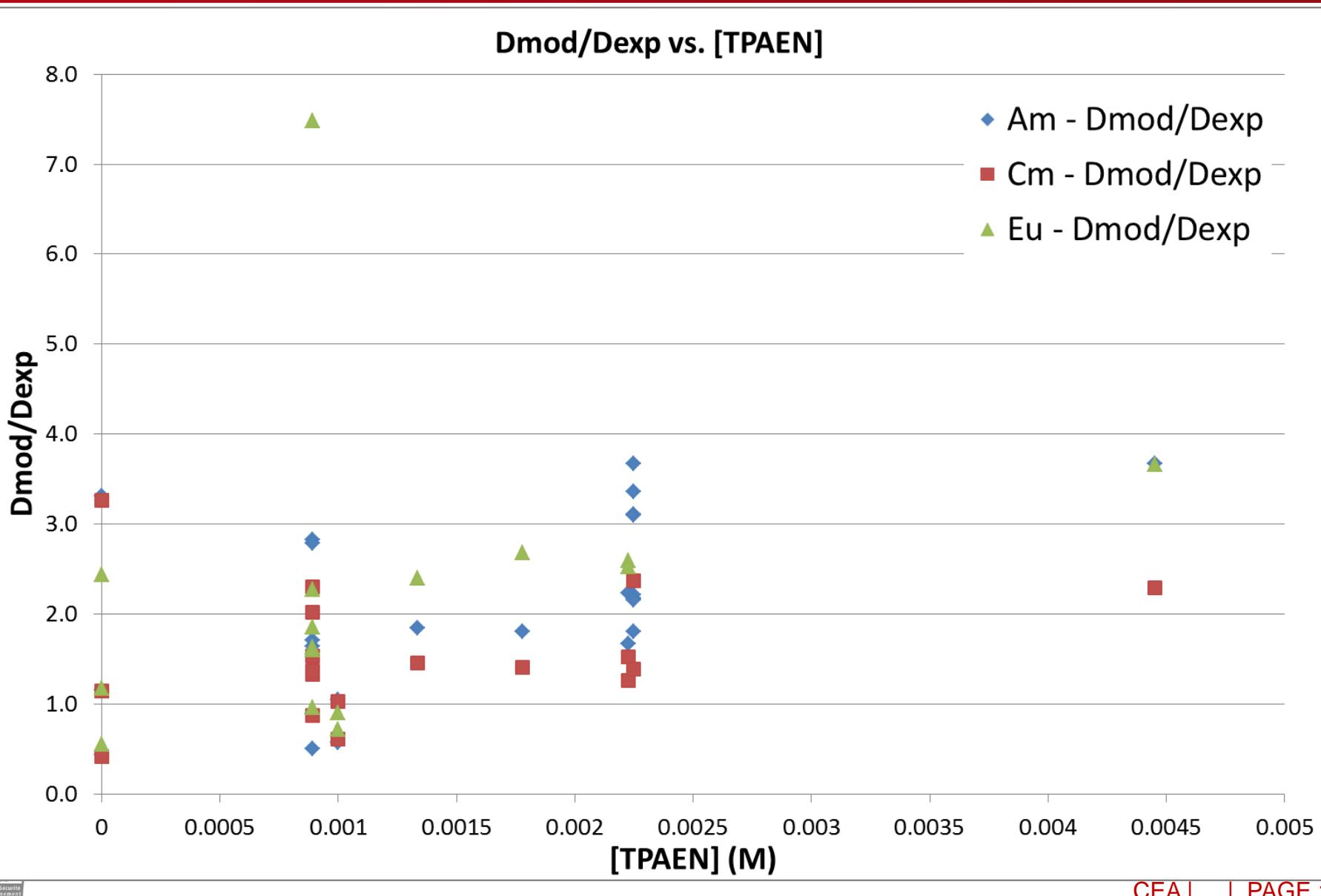
# Modelling implemented in the PAREX code

<b>Log(K)</b>	<b>H<sub>n</sub></b>	<b>Am</b>	<b>Cm</b>	<b>La</b>	<b>Ce</b>	<b>Pr</b>	<b>Nd</b>	<b>Sm</b>	<b>Eu</b>	<b>Gd</b>
M(NO <sub>3</sub> ) <sub>3</sub> TODGA (modelling) (2 experiments)	n=1: -0.27 n=2: -1.8 n=3: -3.82	4.0	4.2	3.6	3.3	3.5	3.8	4.5	4.8	4.9
M(H <sub>4</sub> TPAEN) (modelling) (2 experiments)	n=6: 2.8 n=4: 3.2 n=3: 3.9 n=2: 5.1 n=1: 7.8	6.9	6.6	4.8	5.4	5.4	5.4	5.1	4.9	4.7
M(H <sub>4</sub> TPAEN) (experimental)	n=6: 2.8 n=4: 3.2 n=3: 3.9 n=2: 5.1 n=1: 7.8	6.1	4.3	2.79	2.57	3.19	3.26	2.97	2.75	-

# Modelling implemented in the PAREX code

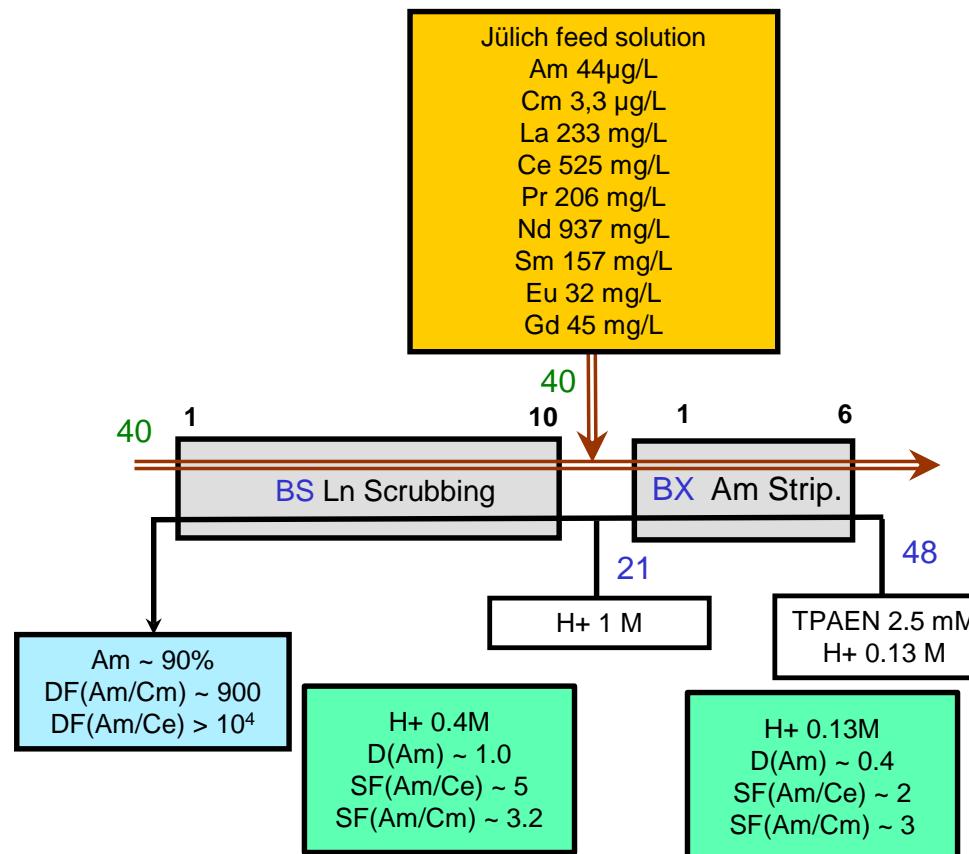


# Modelling implemented in the PAREX code

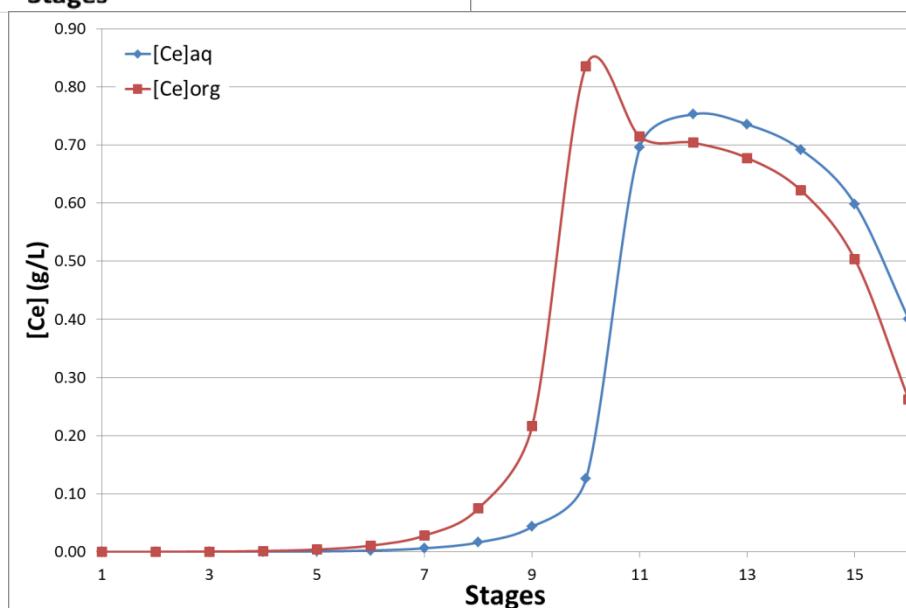
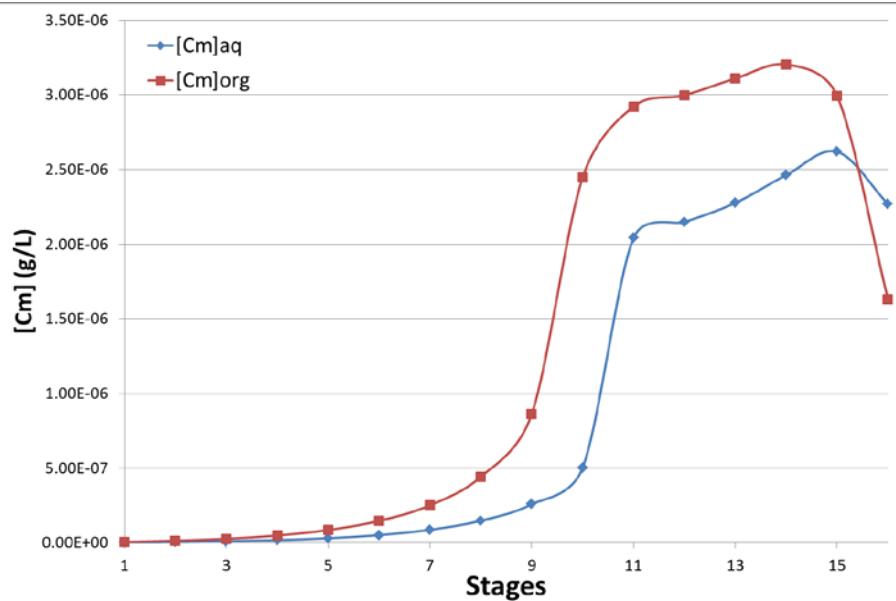
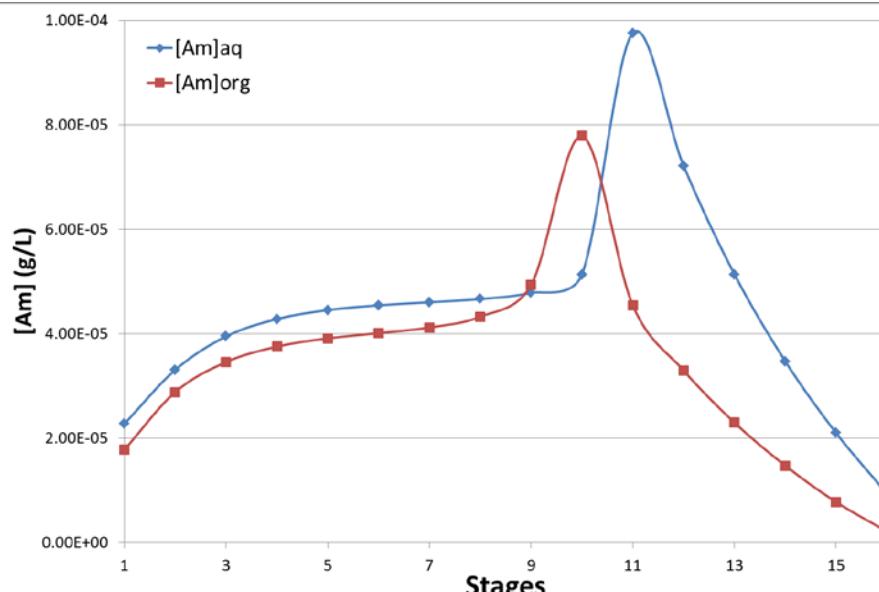


# Suggestion of a flowsheet

- Use  $D(M) = f([H^+])$ : BX lower D / BS higher D



# Suggestion of a flowsheet



# Conclusions

- Difficulties to simulate the last experimental data with macroconcentrations of Ln.
- A first flowsheet made, but necessary to improve this model with new experimental data :
  - Data at equilibrium : D(M), [M]total, ([M]aq, [M]org)
  - 2 families of Ln : La -> Nd and Sm -> Gd. Experiments with one representative from each family (Ce and Eu?) and then with all elements (Am, Cm, Ln)
  - [Ln] : 1-5 mM (BS) to 25 mM (BX)
  - [H+] : 0,1M (BX) to 0.5 M (BS)
  - TPAEN : determine the solubility limit (2.5 mM?)
  - [TPAEN] : 0mM (extraction by TODGA alone) to solubility limit of TPAEN

<b>TPAEN = 0 mM</b>	<b>[Ln] = 1 mM</b>	<b>[Ln] = 5 mM</b>	<b>[Ln] = 15 mM</b>	<b>[Ln] = 20mM</b>	<b>[Ln] = 25 mM</b>
[H+] = 0.1 M					
[H+] = 0.15 M					
...					
0.5 M					

# Conclusions

- Implementation of kinetics aspects and temperature
- Suggestion of a consolidated flowsheet for Jülich hot test
- Sensitivity studies
  
- Study to reduce concentrations of La and Ce in loaded solvent (optimization with Am recovery rate) ?

Commissariat à l'énergie atomique et aux énergies alternatives  
Centre de Marcoule | BP17171 | 30207 Bagnols-sur-Cèze Cedex  
France | T. +33 (0)4 66 79 62 75 | F. +33 (0)4 66 79 63 39

Etablissement public à caractère industriel et commercial | RCS Paris B 775 685 019

Direction de l'énergie nucléaire  
Département de radiochimie des procédés  
Service de modélisation et chimie des procédés de séparation