Technical Workshop on Fuel Cycle Simulation

Fuel Cycle Confidence Improvement

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Motivations

A fuel cycle model requirement is that output should represent « real case »

- Comparison with existing fleet
  - Complex history with lack on input data
  - Lack of output data
- Perform studies for prospective fleet
  - No data

Inter-code benchmarks are usually used to check models reliability but:

- Specifications interpretation depends on users
- Specifications evolves according to outputs
- Simulations simplifications induces deviations from specifications

See Bo Feng (ANL) talk.

- Simple exercices with clear specification
- Exercices design made upstream
- User runs exercices that fits with model

- Increasing complexity
- Sensitivity analysis

FCCI WORKFLOW

1. Experiments
   - Define facilities, links between facilities, simulation time
2. Problems
   - Number of facilities
3. Design of experiment
   - Fixed parameters
   - Input variables and range
4. Runs
   - A set of input variables
5. Sensitivity study
   - Sampling on input variable

Output File Structure

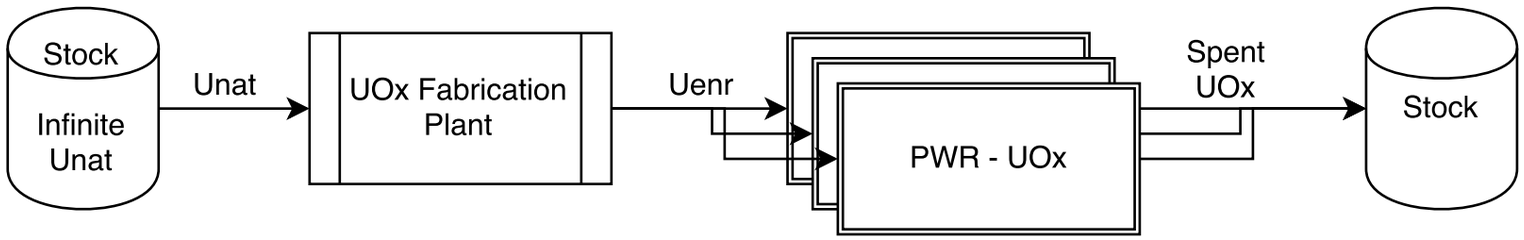
Thermal Power = f(t)

	U Np Pu Am Cm MA Pu8 Pu9 Pu0 Pu1 Pu2 U5 U8 Np7 Am1 Am3 Cm4 Cm5
Total Stock Tot. Facilities	Masse = f(t)
Facility 1 Facility 2	

Experiment #1

1. Experiment

Simulation Time = 100 y



2.

Problem 1	Problem 2	Problem 3	Problem 4	Sensitivity
1 PWR - UOx	2 PWR - UOx	2 PWR - UOx	2 PWR - UOx	10 PWR - UOx

3.

TStart = 0	TS1=0=TS2	TS1=0, TS2=50y	TS1=0, TS2=50y	$TS_i = TS_{i-1} + 10$
TLife = 100y	TL1=100y=TL	TL1=100y=TL2	TL1=60y=TL2	$TL_i = 50y$

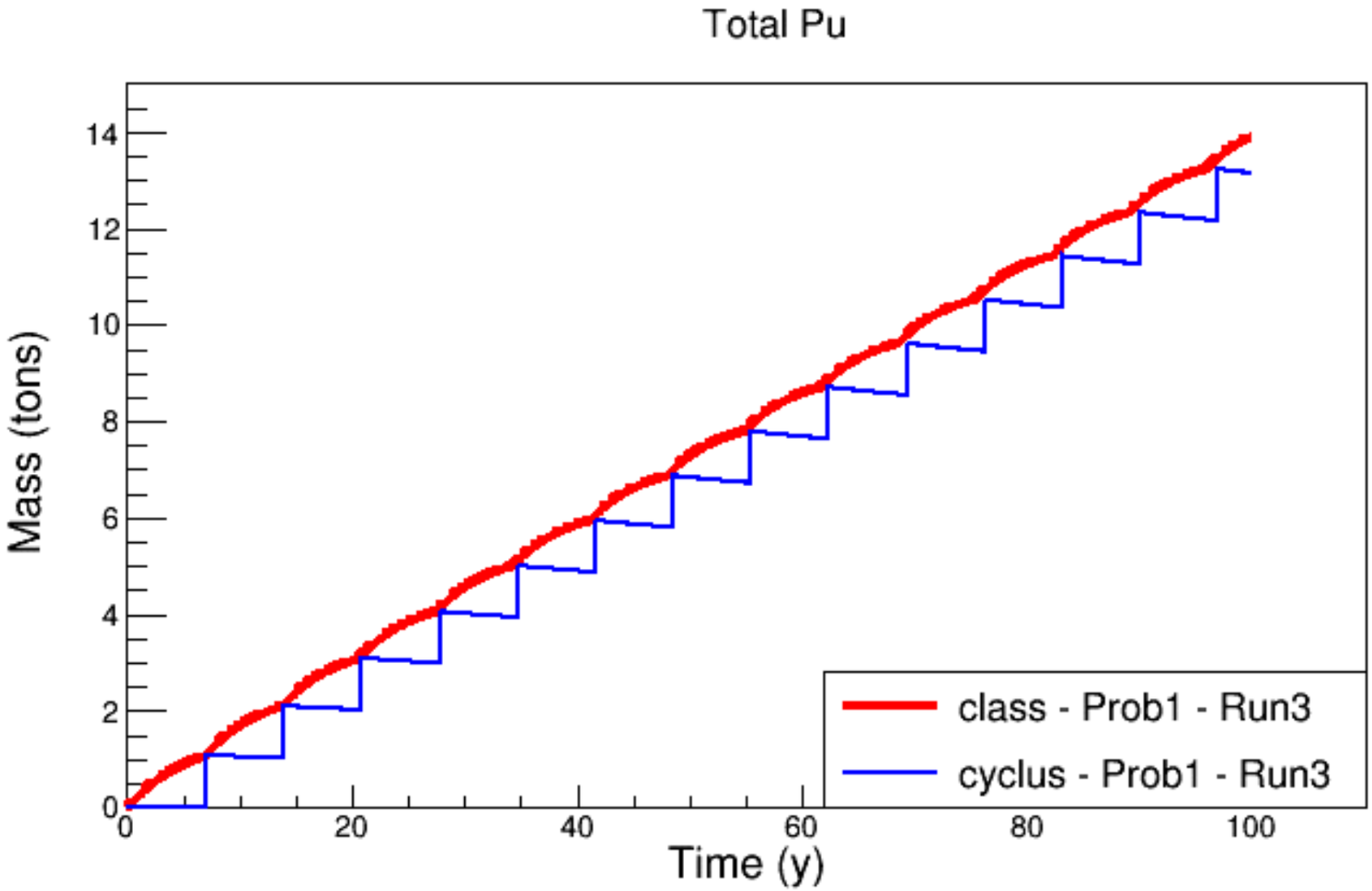
4.

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
	U5 Enr. != f(BU)			U5 Enr. = f(BU)		
Reactor 1 (and 2)				same		
UOX enrich [%w]	3	4	5			
BU (GWd/t]	30	40	50			
spec power [GW/t]	40	30	20			
size [t]	90	90	90			
batching	3	4	3			
If more than 1 reactor	mixing columns					

5.

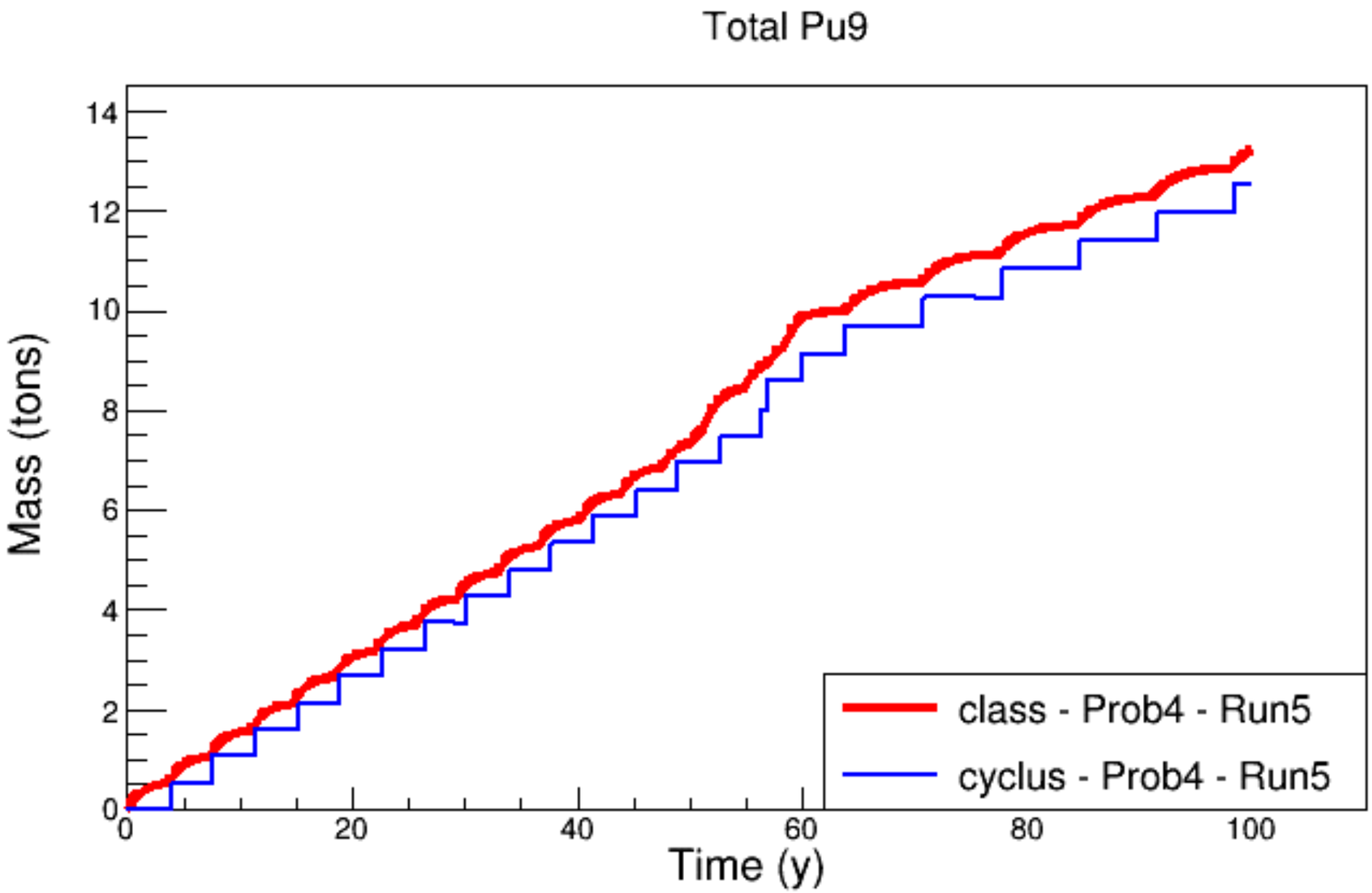
- CLASS Sample
  - LHS - 2000 evts
- CYCLUS Sample
  - LHS - 1000 evts

Exp 1 - Pr 1 - Run 3



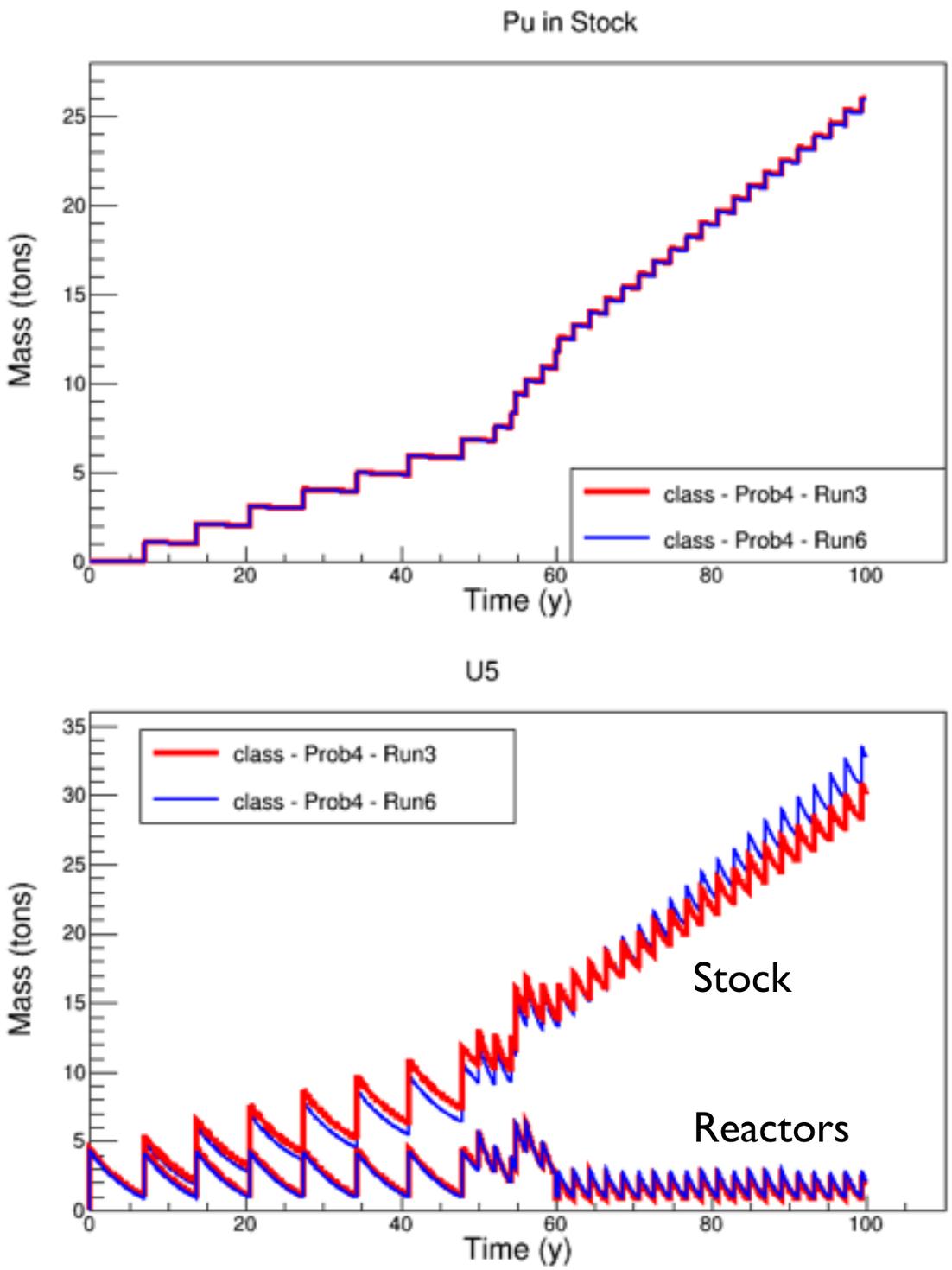
- Cycles steps is because we don't have access to reactor composition
- Very good agreement between CLASS and CYCLUS.

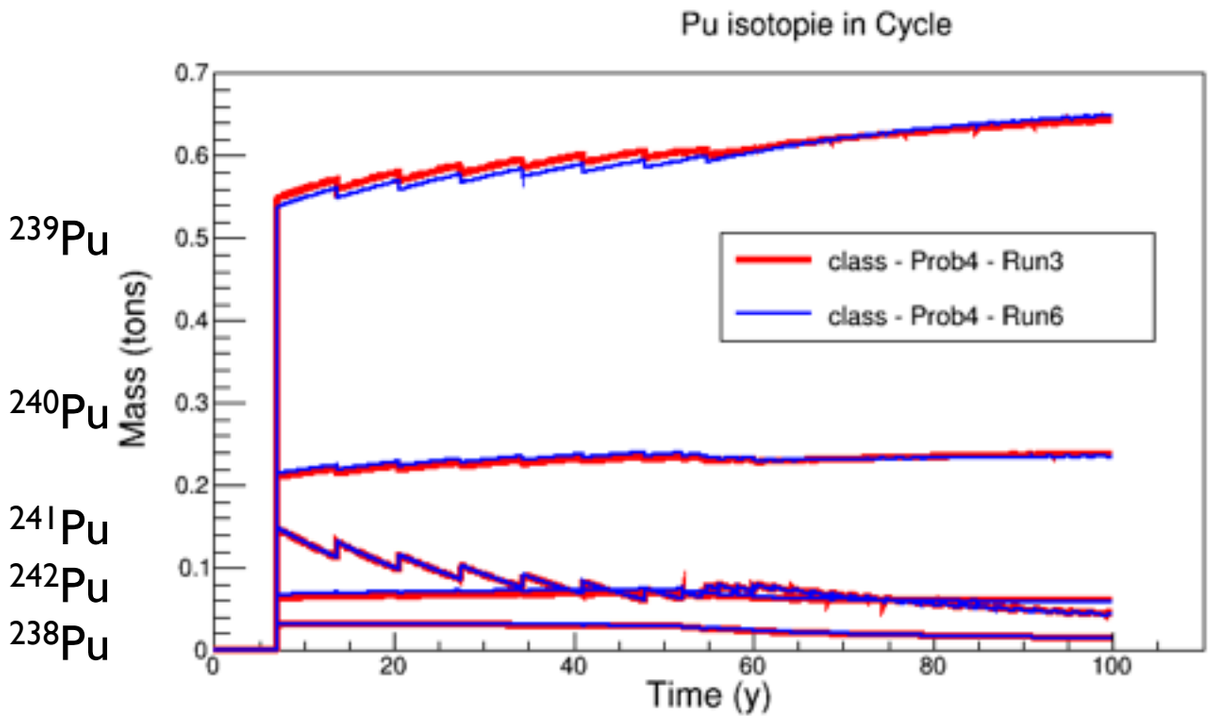
Exp 1 - Pr 4 - Run 5

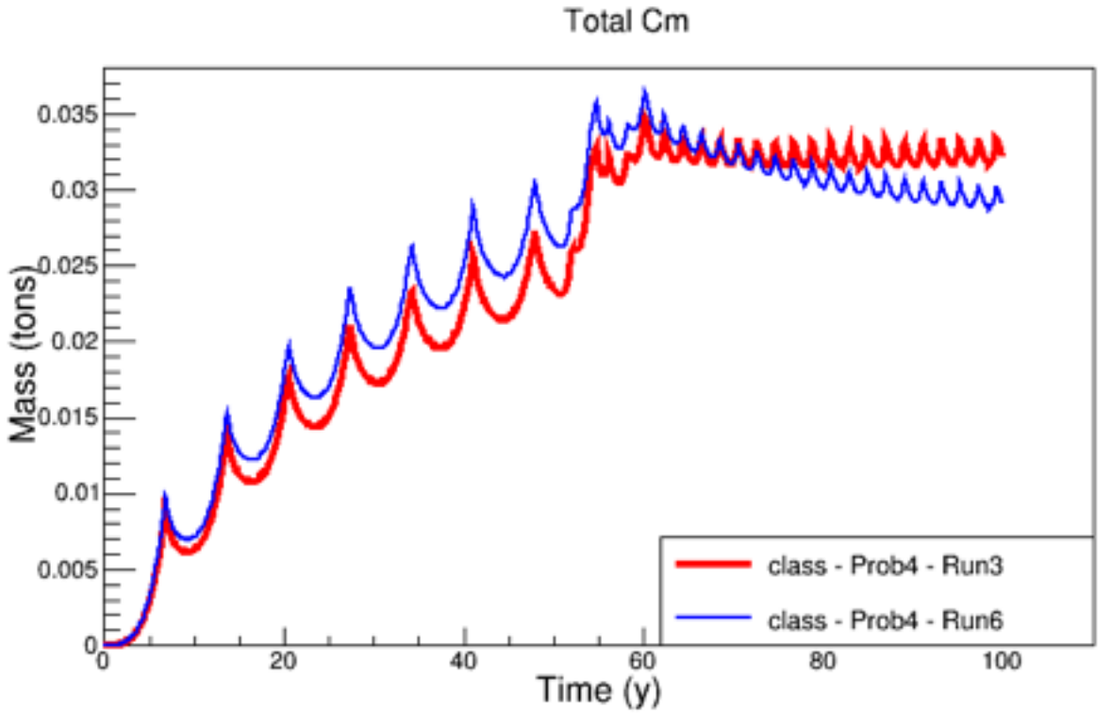


- Small deviation at B.O.S. due to month time step VS seconde time step
- High deviation at the shutdown of the first rector due to different management for reactor shutdown during a cycle.

Exp 1 - Pr 4 - Run 3 vs 6







PERSPECTIVES

- FCCI tries to aggregate a fuel cycle community for fuel cycle analysis improvement

- FCCI provides a framework for fuel cycle tools comparison
  - Very simple simulations with increasing complexity
  - Possibility to cross-check the model and to highlight bugs
  - Each steps add one new feature
    - Easier for understanding deviations

- FCCI provides open access to input and output data
  - New tool runs strengthen the knowledge
  - Each participant could make its own analysis

- FCCI is well suited for benchmarking and physical analysis
  - Increase the number of experiments
  - Improve the web site, and framework for data storage and analysis on line
  - Increase the number of associated fuel cycle tools