

Technical Workshop on Fuel Cycle Simulation

Study of plutonium reprocessing in PWR with the CLASS tool

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Fanny Courtin (PhD)¹

Nicolas Thiolliere (Associate Professor)¹

1 - Subatech, IMTA-IN2P3/CNRS-Université, Nantes, F-44307, France

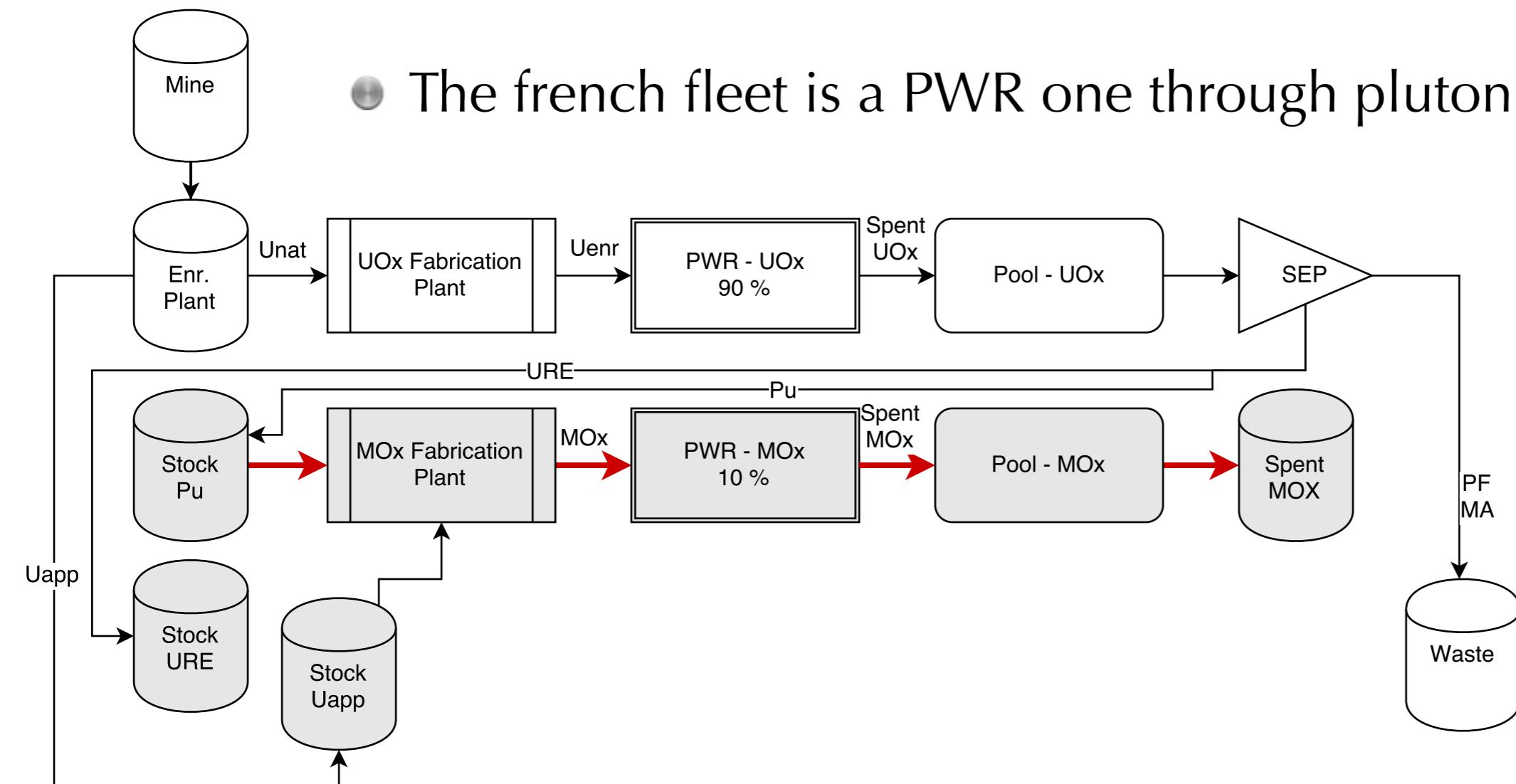


Problematic

- The french fleet is a PWR one through plutonium recycling
- Reference scenarios are based on SFR deployment/Pu closed cycle but...
 - France is involved in a energetic transition in which nuclear position is unclear
 - Safety criteria improvement following Fukushima accident
 - Nuclear waste sustainable management
 - New facilities construction is complex (EPR, CIGEO)
 - Lot of uncertainty around ASTRID building and operation
 - ...
- SFR deployment is called into questions and place the plutonium management at the center of debate
- Hypothesis 1 : SFR deployment will be delayed
 - ▶ Plutonium inventory stabilization
- Hypothesis 2 : SFR deployment will not be
 - ▶ Plutonium incineration

French Fleet

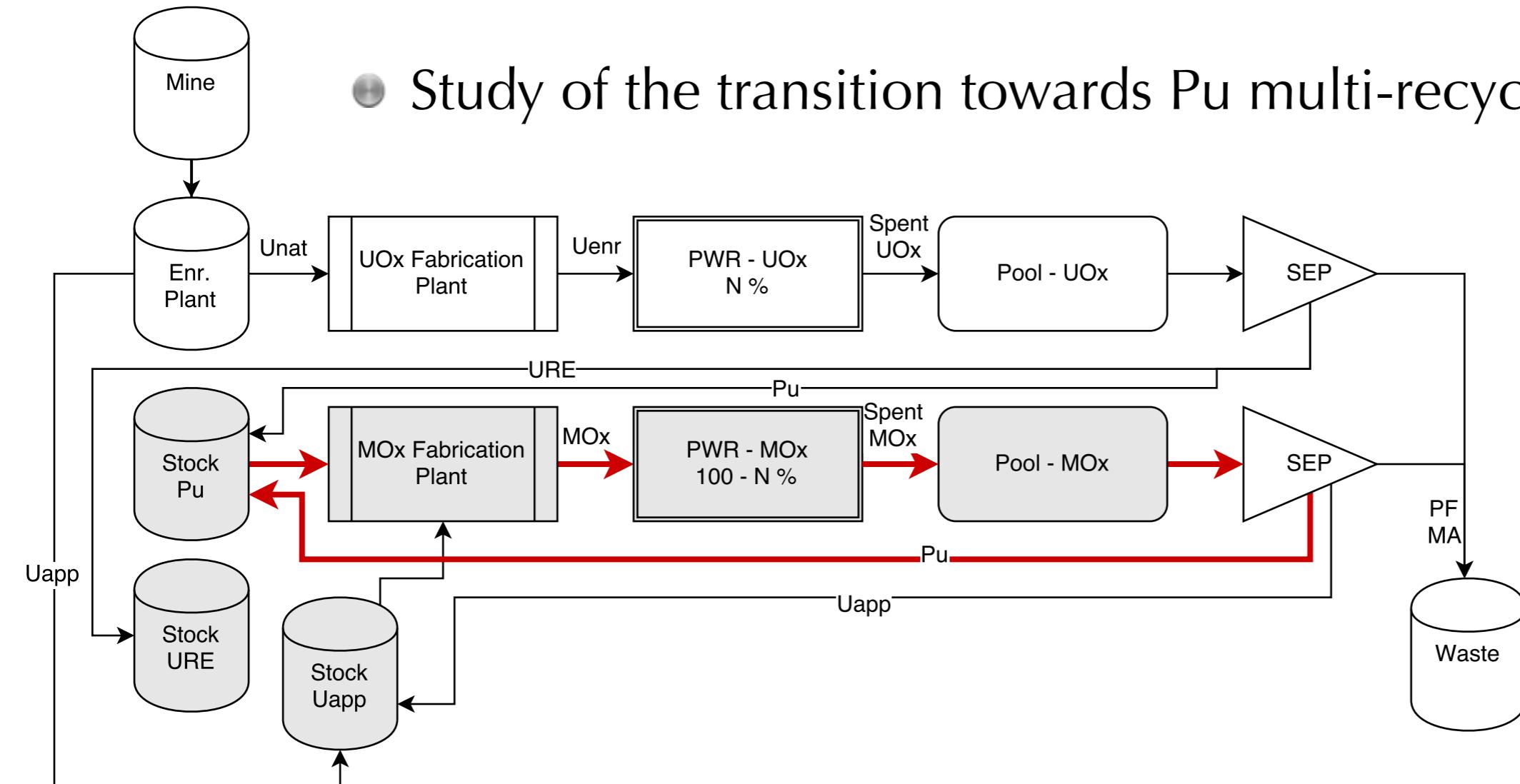
- The french fleet is a PWR one through plutonium recycling



- Plutonium availability for PWR-MOX induces a power maximal fraction
- Plutonium accumulation in the spent MOx stocks
- See Abdoul-Aziz Zakari-Issoufou presentation for details

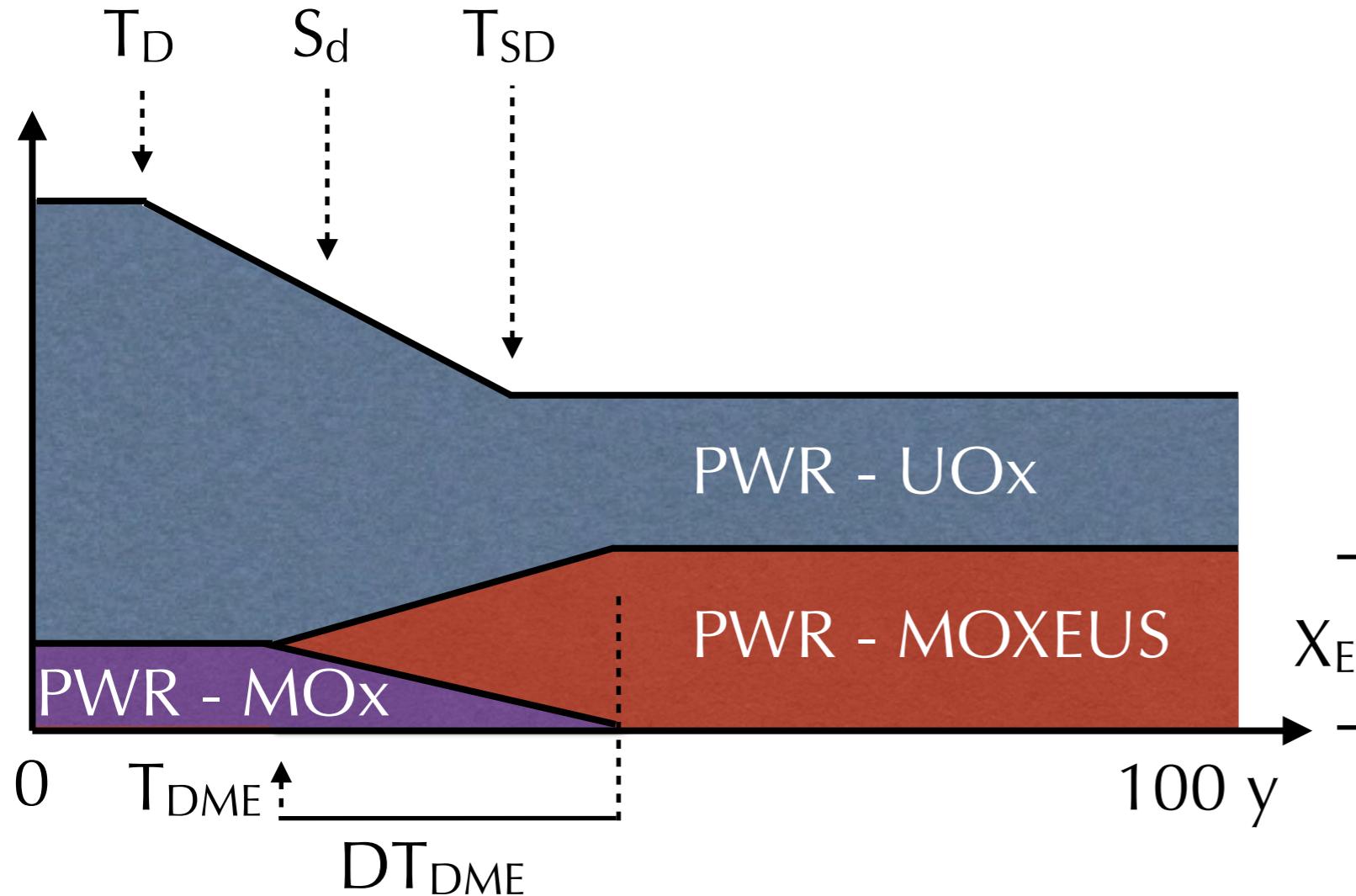
Closing the french fleet

- Study of the transition towards Pu multi-recycling in PWR



1. Literature review on Pu multi-recycling in PWR
2. Choice of concept (MOXEUS) and integration in CLASS
3. Parametric study of simplified scenarios
4. Reference scenario identification and detailed simulations

Design Of Experiment

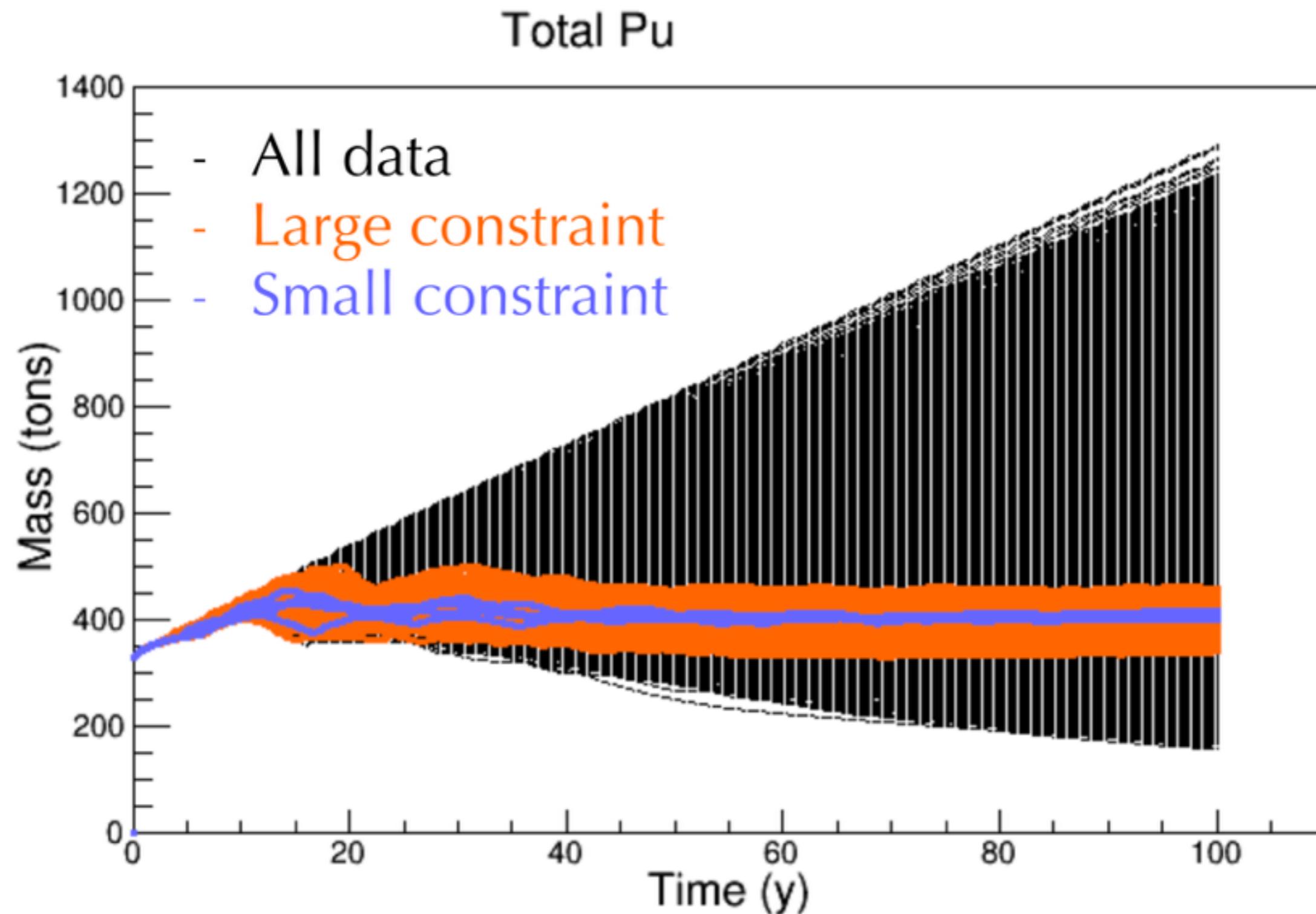


BU UOX	[30 - 65] GWd/t
BU MOX	[30 - 65] GWd/t
BU MOXEUS	[30 - 65] GWd/t
T_{DME}	[10 - 30] y
DT_{DME}	[1 - 4] cycles
X_E	[0 - 1]
Frac Max Pu	[8 - 13] %
TC_{UOx}	[3 - 10] y
TC_{MOX}	[3 - 10] y
TC_{MOXEUS}	[3 - 10] y
T_D	[5 - 15] y
S_d	[0 - -inf] y
T_{SD}	[20 - 100] y
Strat. Fuel	LiFo, FiFo, Mix, Rand

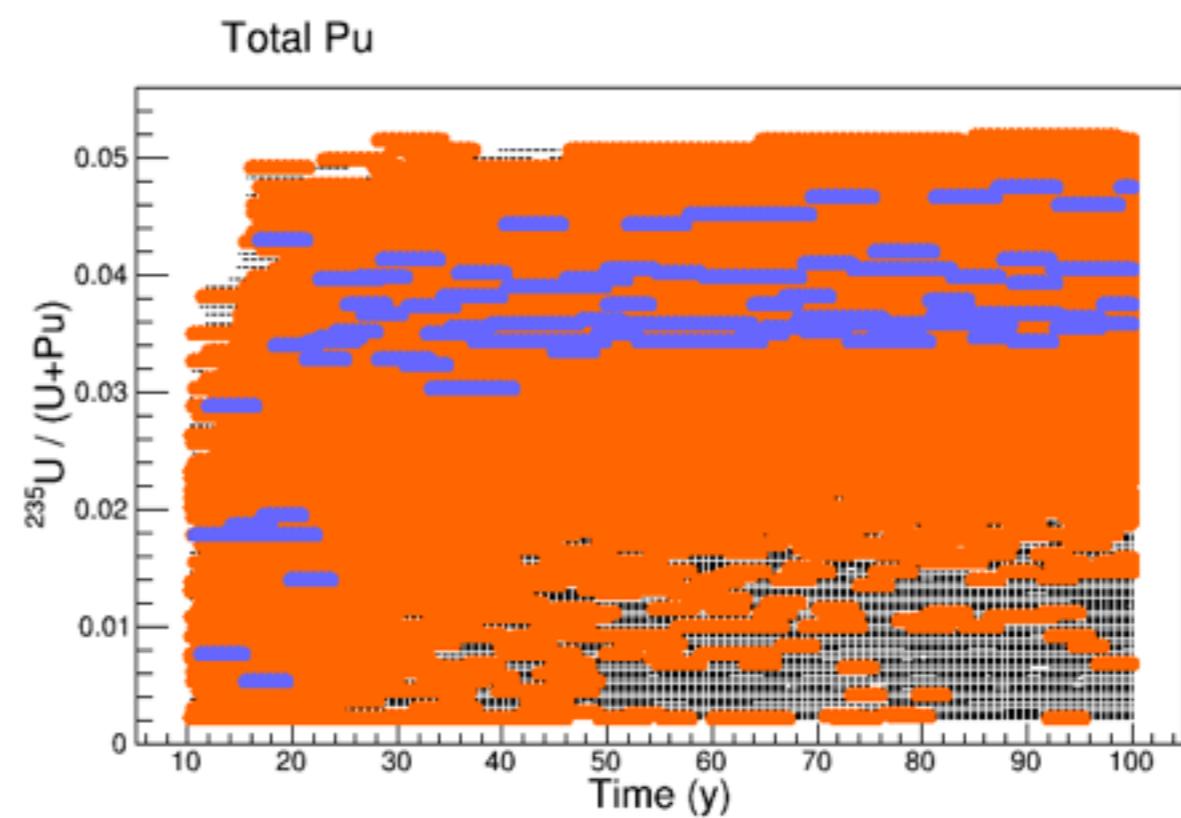
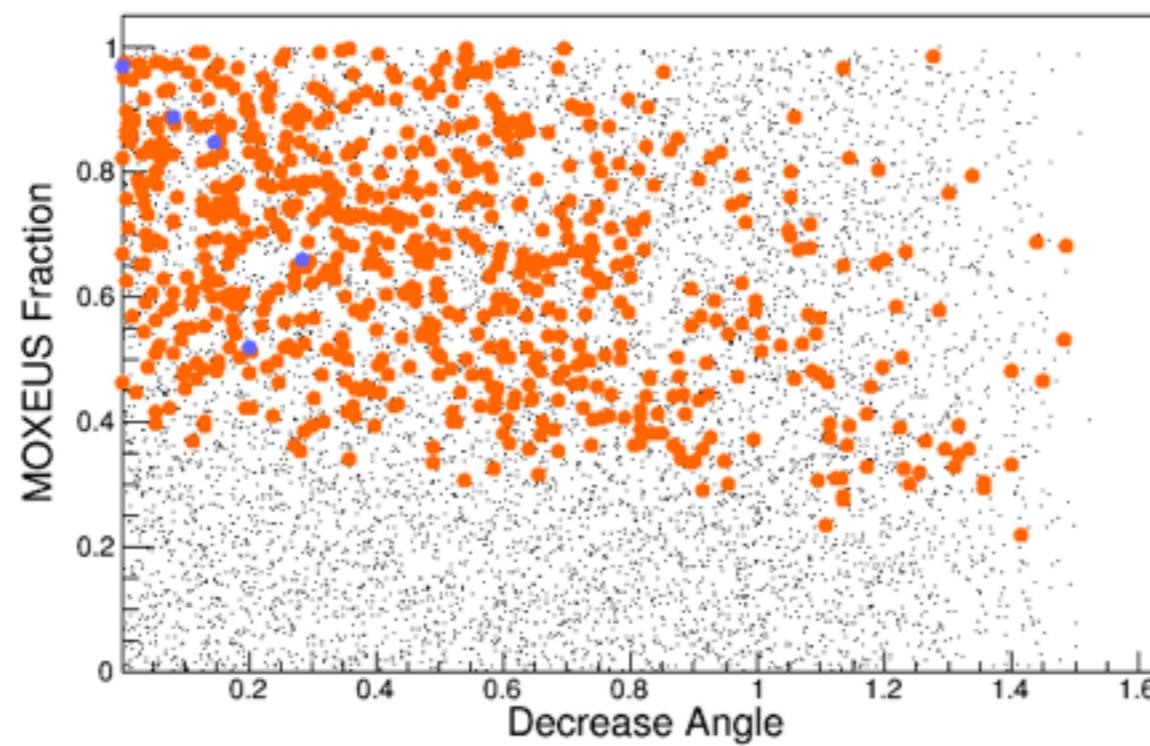
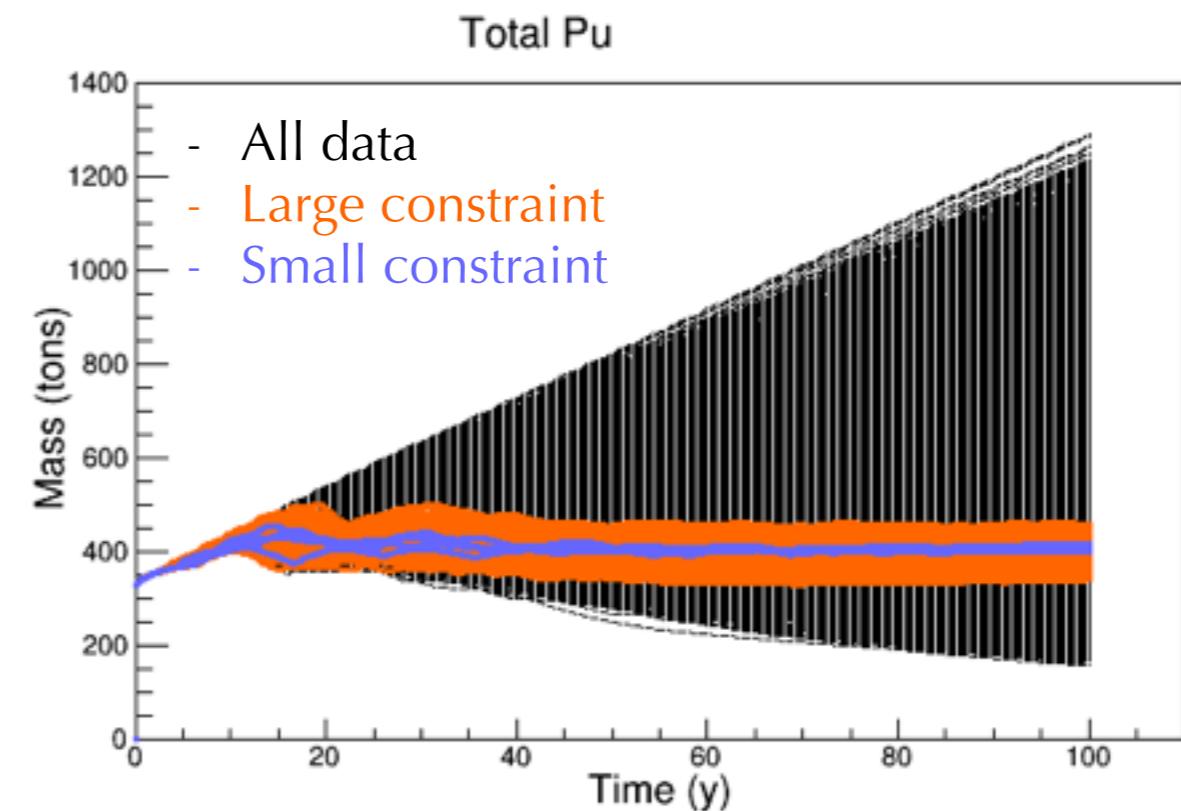
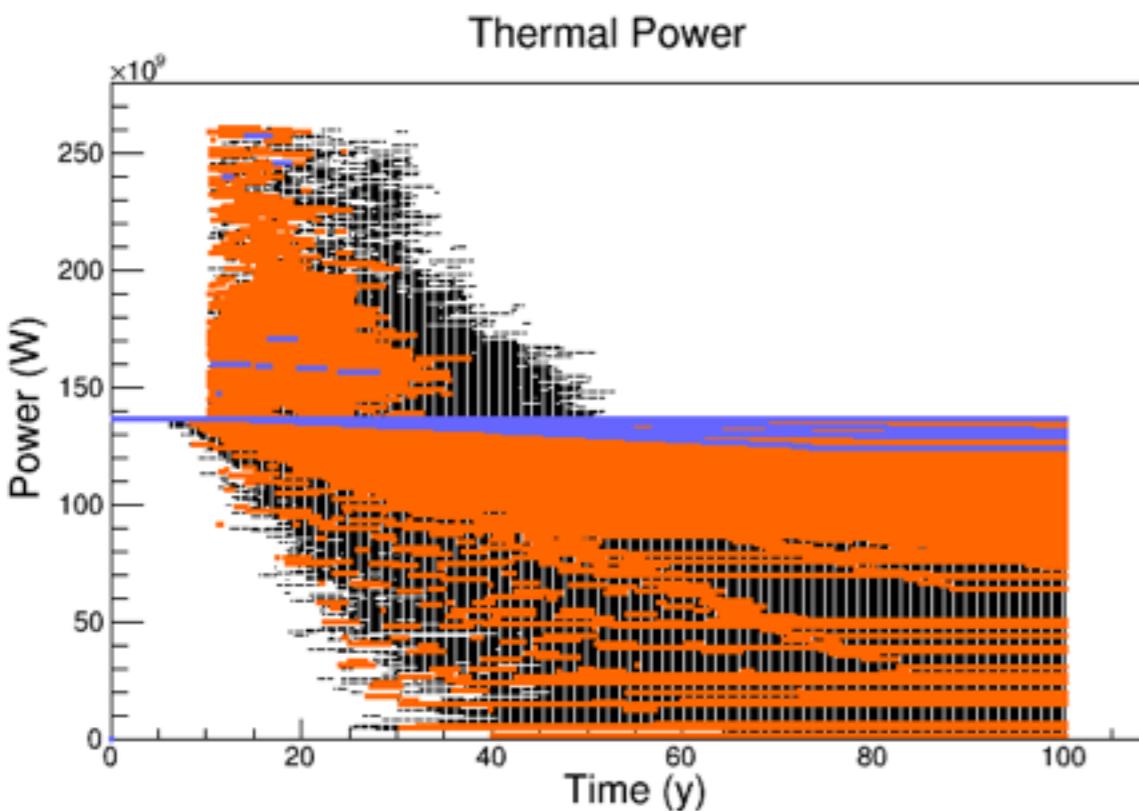
- 10 000 runs with CLASS
- Around 5 hours of calculation time (100 CPU)
- 500 Gb of data

- ROOT TTree
- 14 input data
 - 18 elements / isotopes stored
 - Total inventories = $f(t)$
 - Facilities inventories = $f(t)$

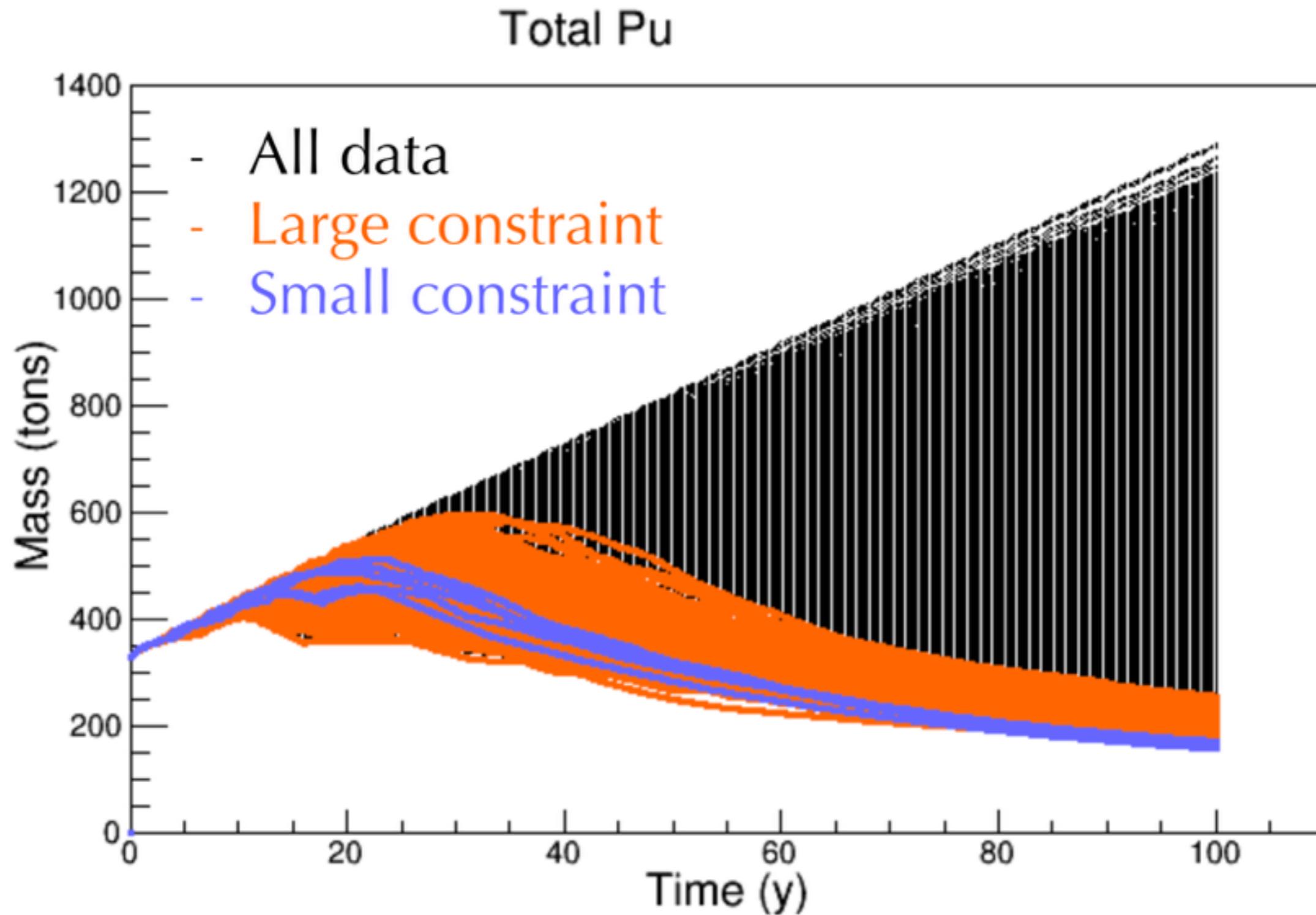
Plutonium stabilization



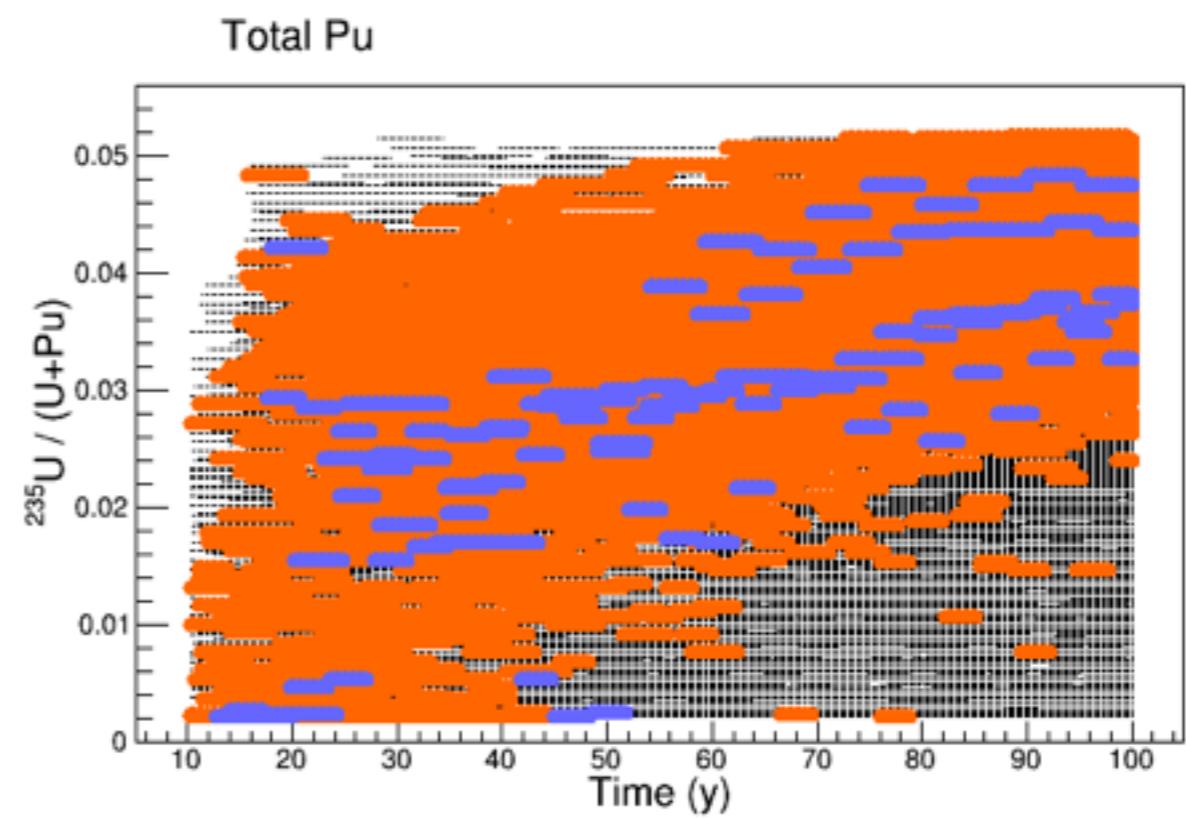
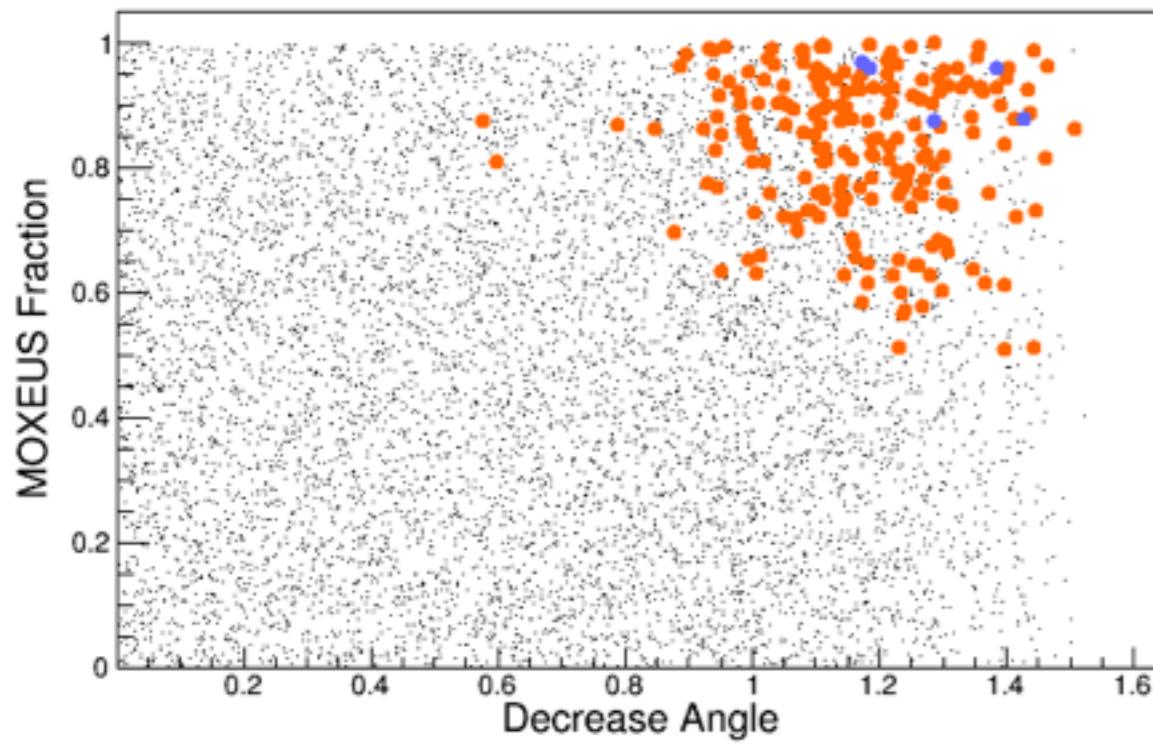
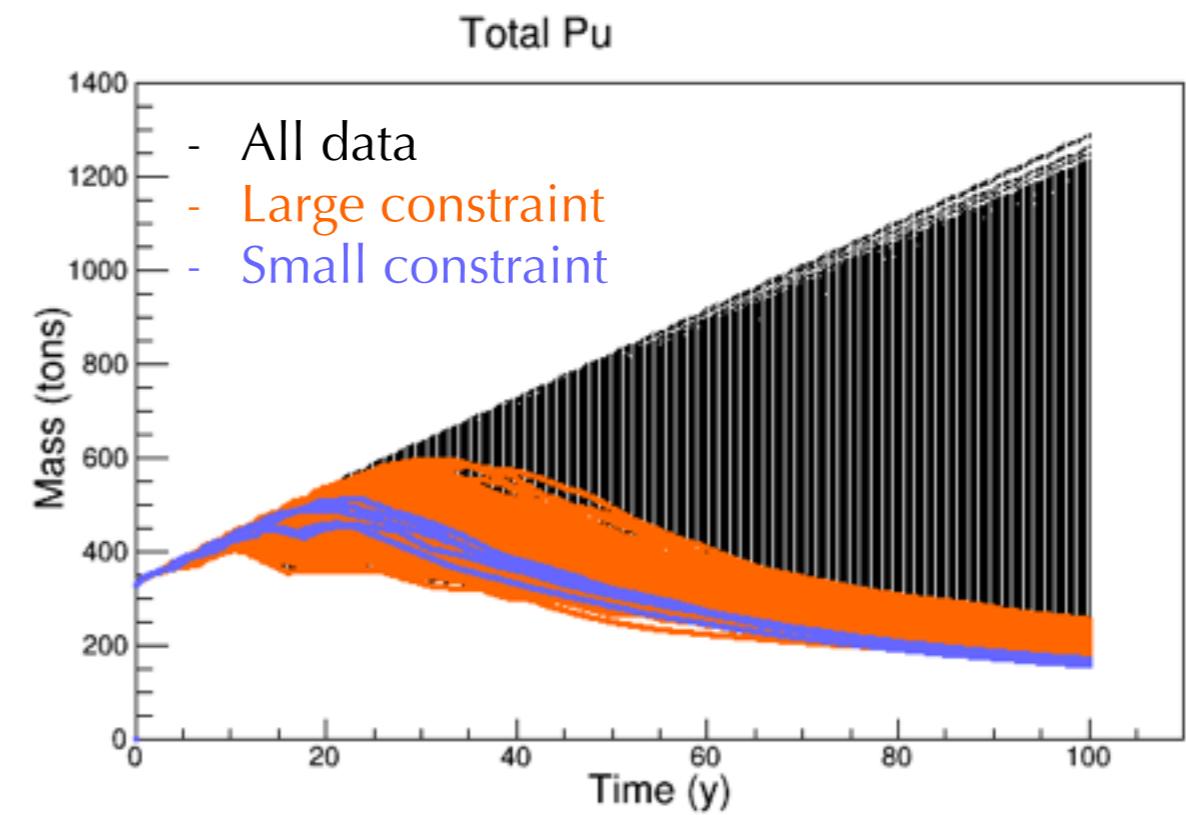
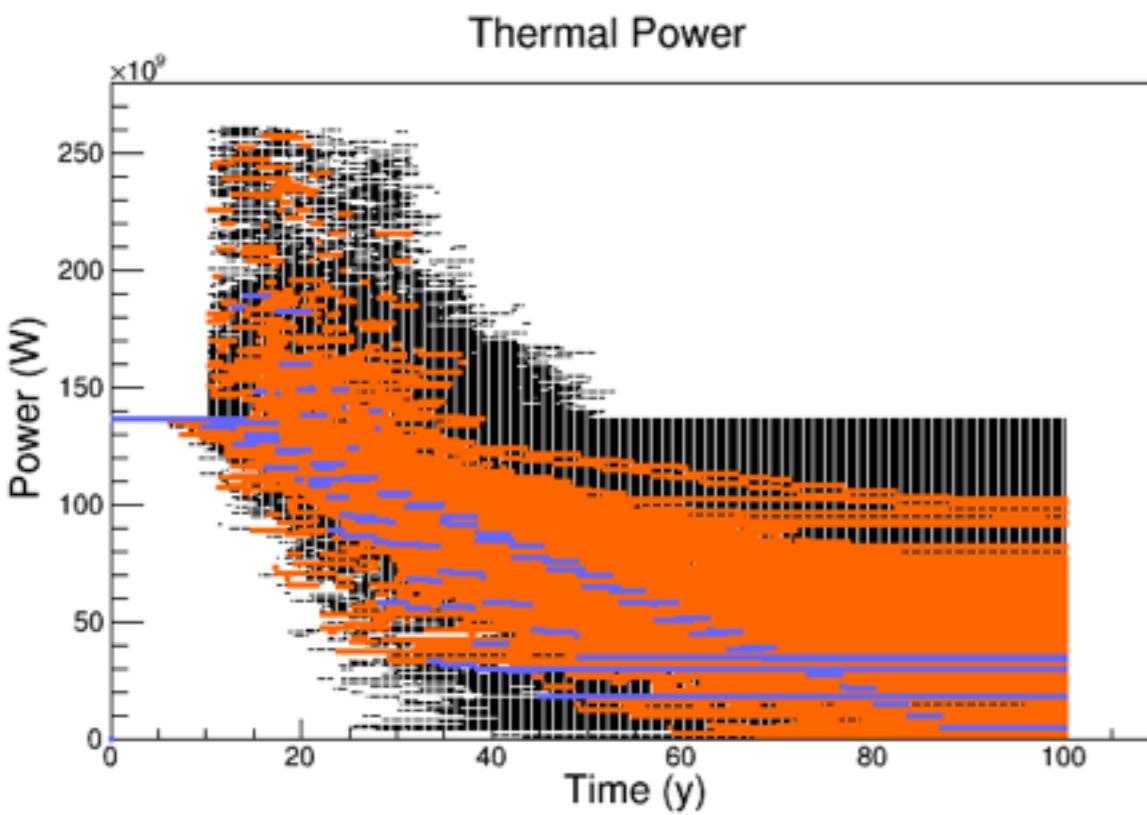
Plutonium stabilization



Plutonium incineration



Plutonium incineration



Conclusion/Perspectives

- Sensitivity analysis provides non intuitive solutions
- The plutonium incineration in PWR implies a decreasing power
 - Uranium enrichment remains low
 - Fission on plutonium are dominant
- Plutonium stabilization is efficient with a constant power
 - Uranium enrichment is high
 - PWR-UO₂-like behavior with bad quality plutonium
- This strategy induces high plutonium conversion to MA rate
- Stay tuned for the bottom line...
- References scenario with detailed fleets will be simulated soon