

# Technical Workshop on Fuel Cycle Simulation

## Study of plutonium reprocessing in PWR with the CLASS tool

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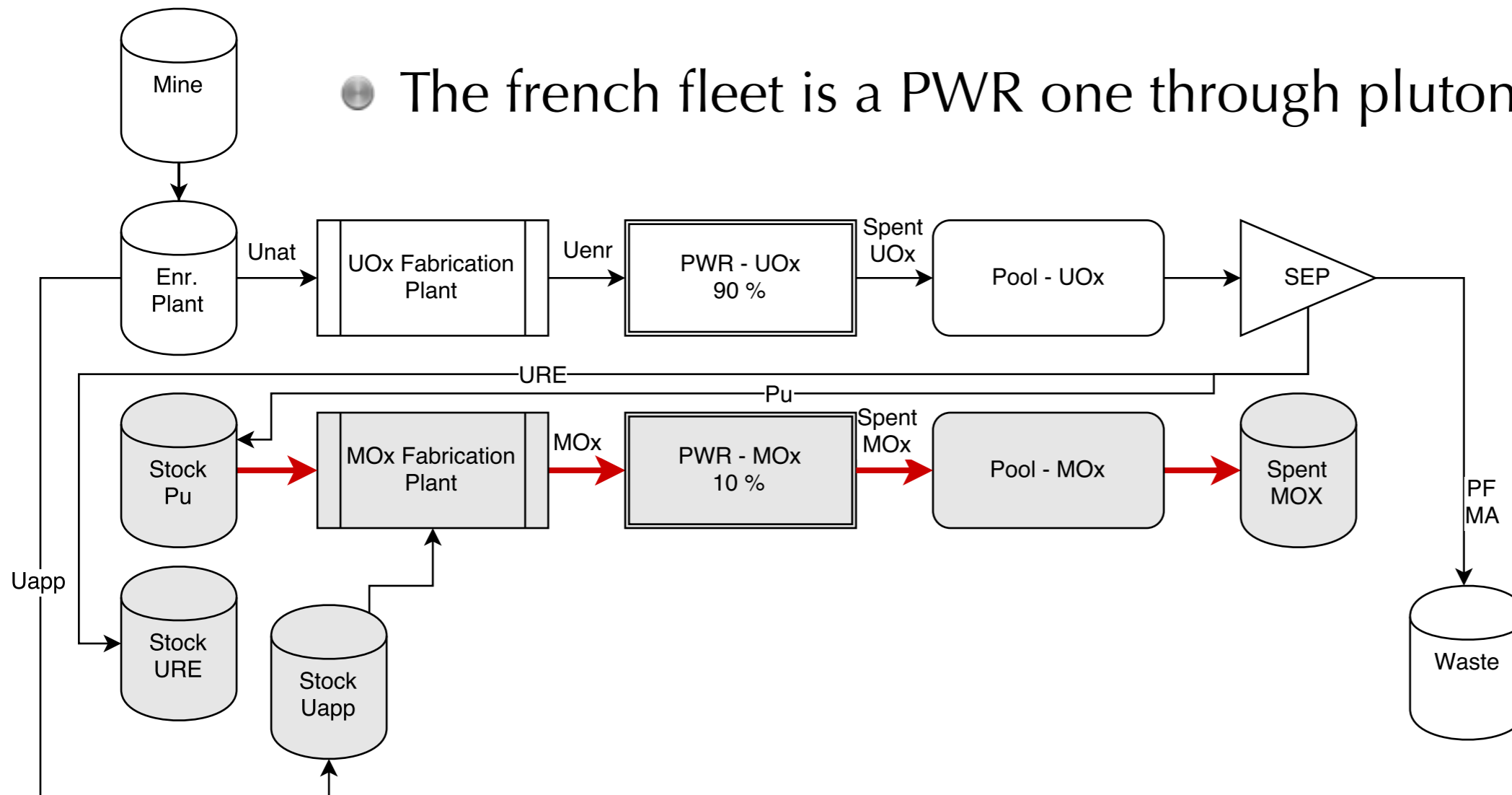
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- The french fleet is a PWR one through plutonium recycling
- Reference scenarios are based on SFR deployment/Pu closed cycle but...
  - France is involved in a energetic transition in which nuclear position is unclear
  - Safety criteria improvement 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

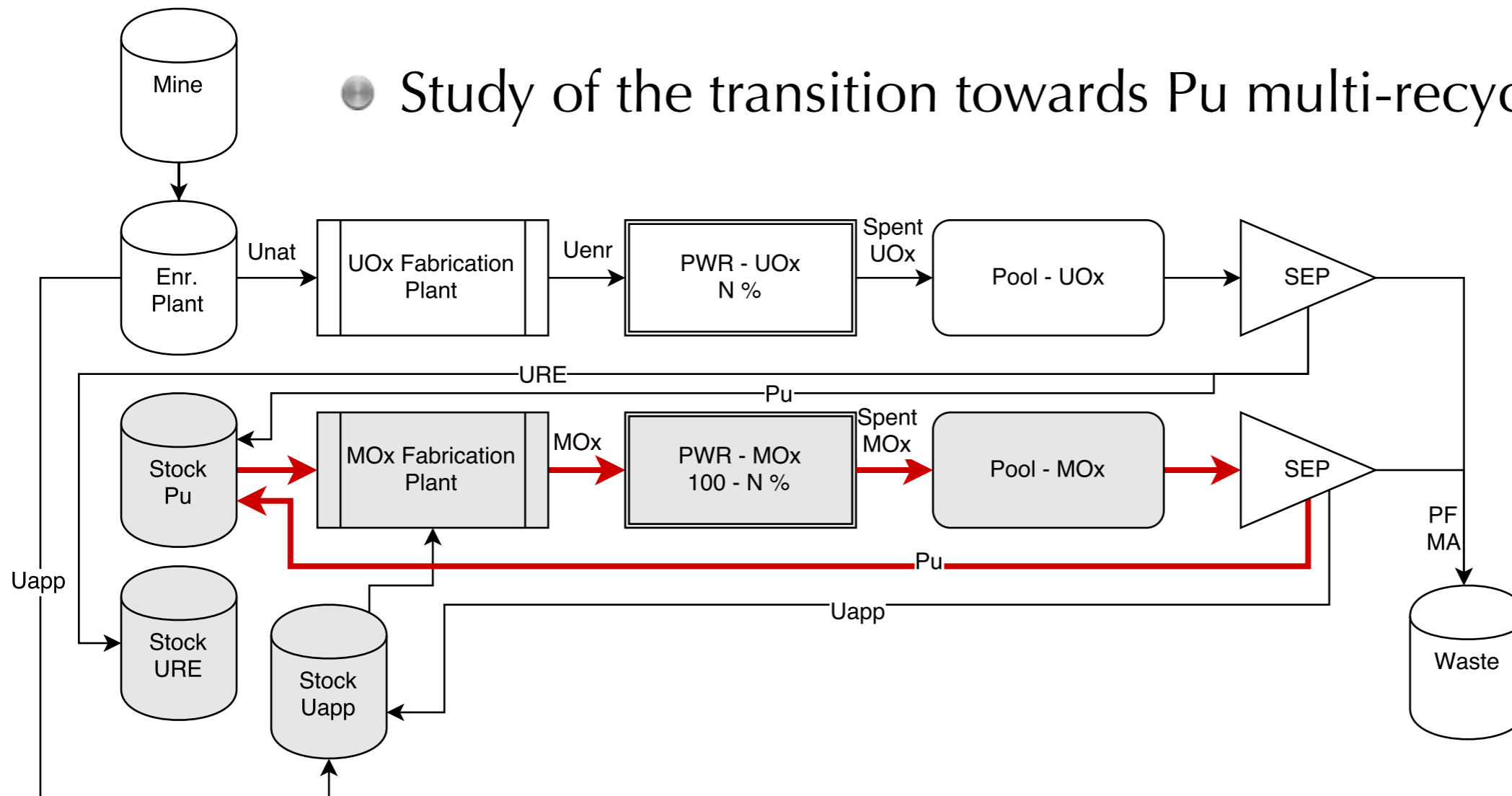
- The french fleet is a PWR one through plutonium recycling



- 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

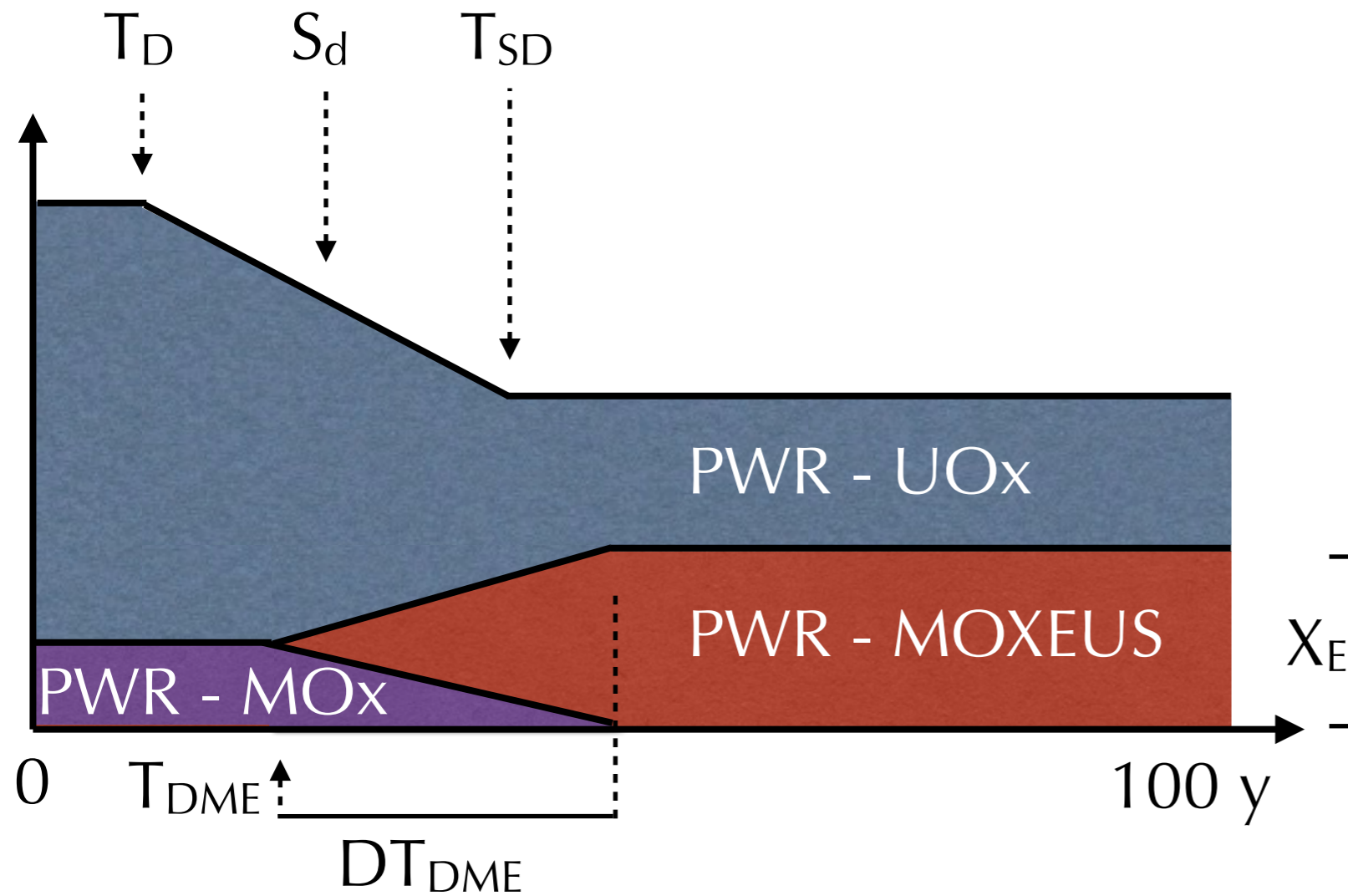
- Study of the transition towards Pu multi-recycling in PWR



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



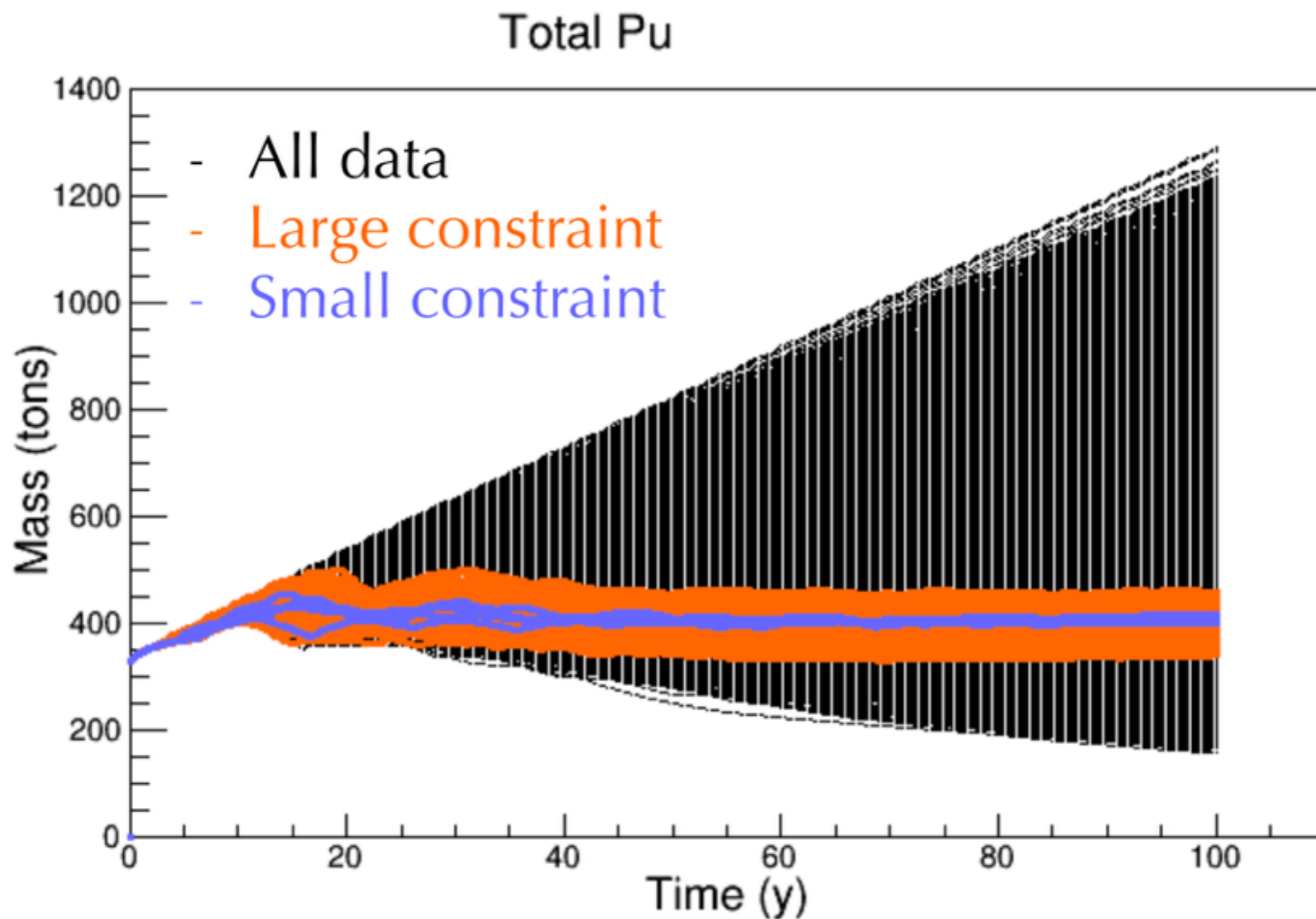
BU UOX	[30 - 65] GWd/t
BU MOX	[30 - 65] GWd/t
BU MOXEUS	[30 - 65] GWd/t
$T_{DME}$	[10 - 30] y
$DT_{DME}$	[1 - 4] cycles
$X_E$	[0 - 1]
Frac Max Pu	[8 - 13] %
$TC_{UOX}$	[3 - 10] y
$TC_{MOX}$	[3 - 10] y
$TC_{MOXEUS}$	[3 - 10] y
$T_D$	[5 - 15] y
$S_D$	[0 - -inf] y
$T_{SD}$	[20 - 100] y
Strat. Fuel	LiFo,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

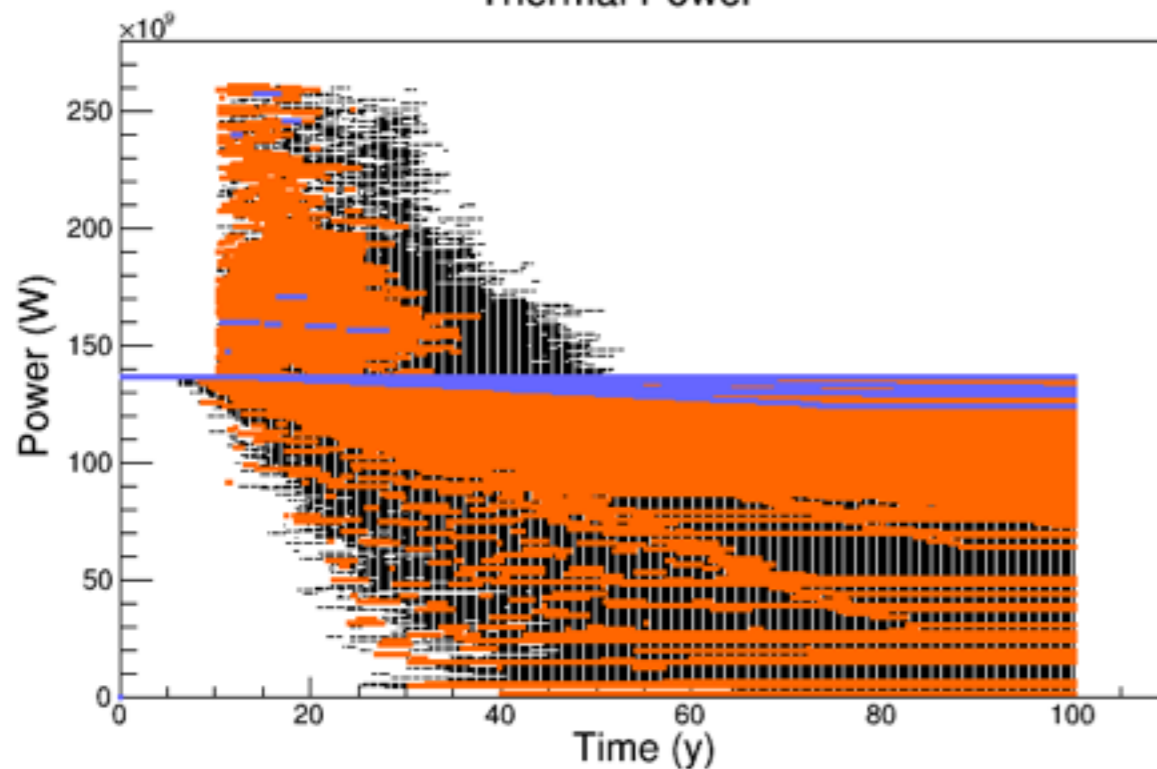
# Plutonium stabilization



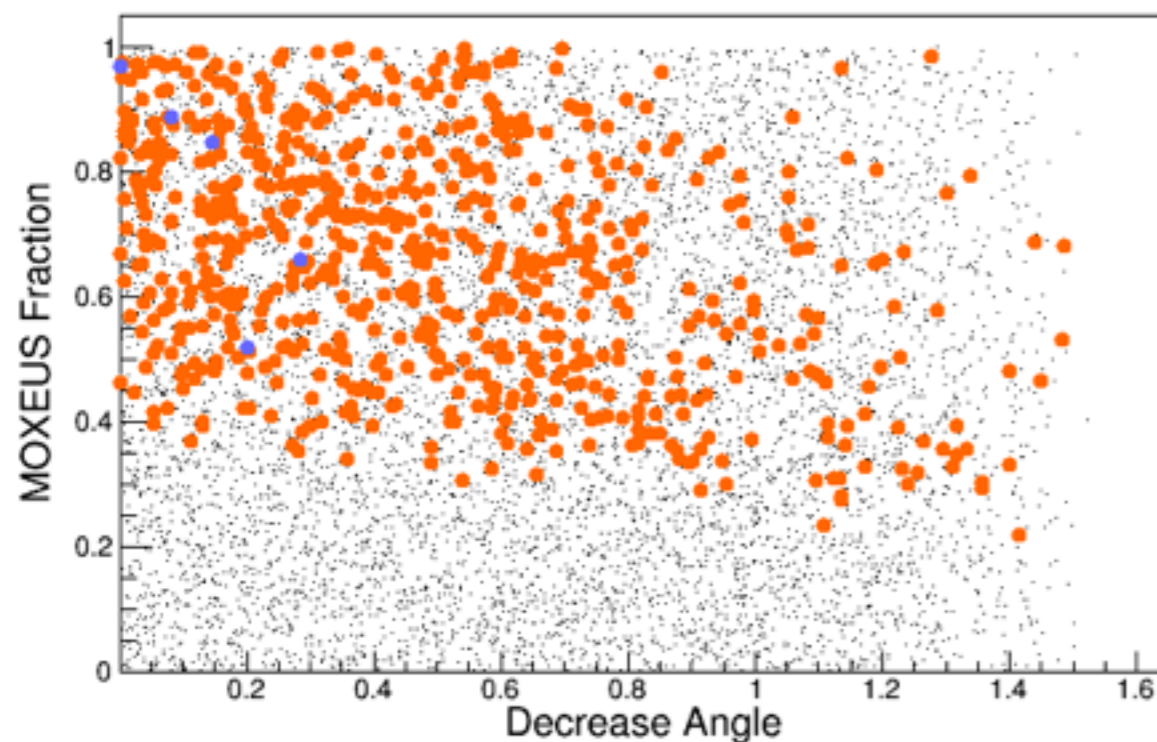
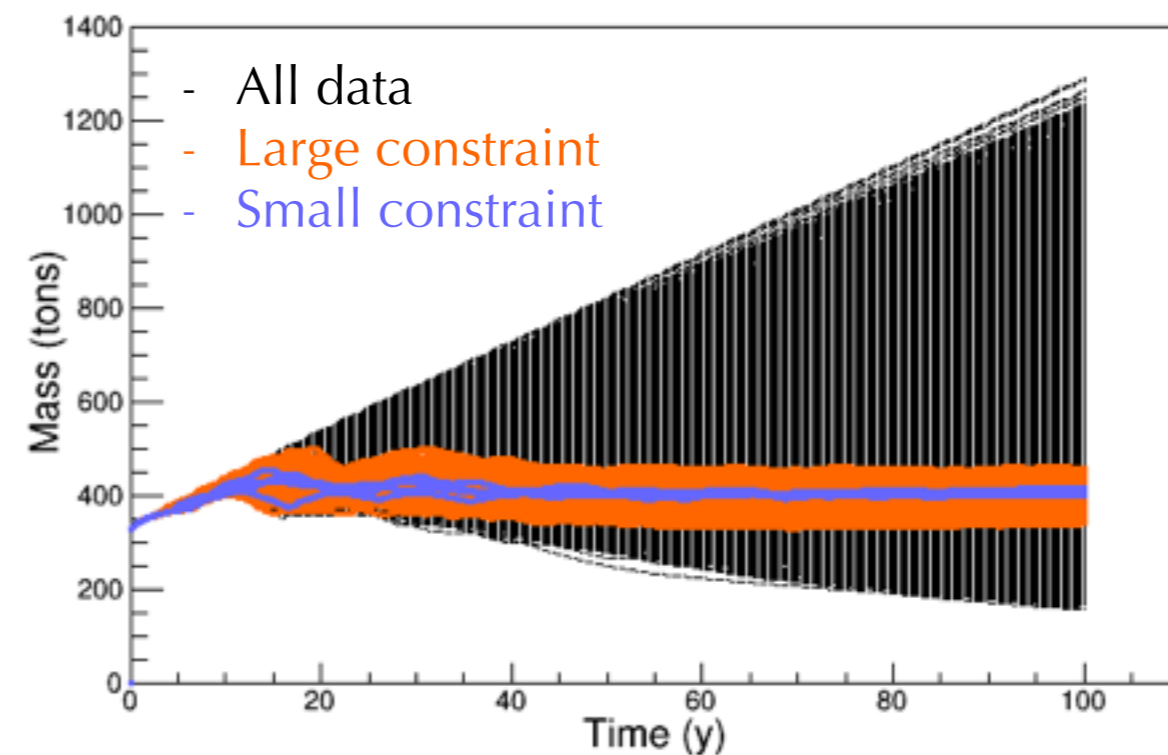


# Plutonium stabilization

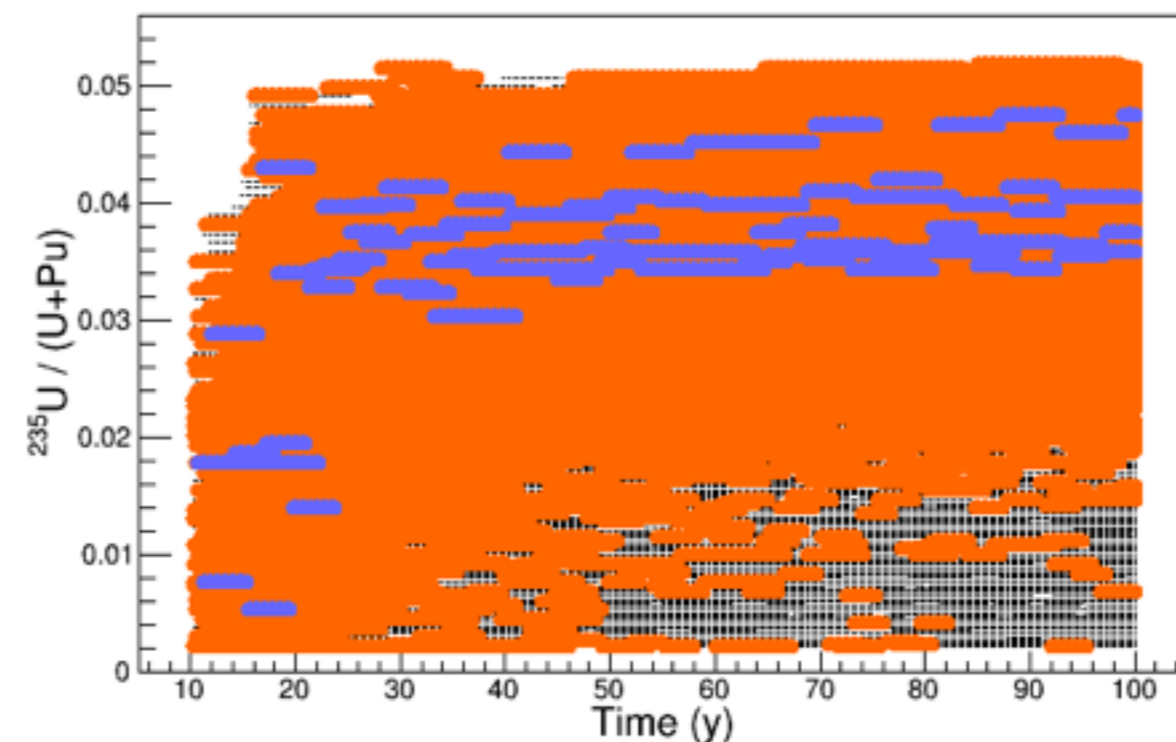
Thermal Power



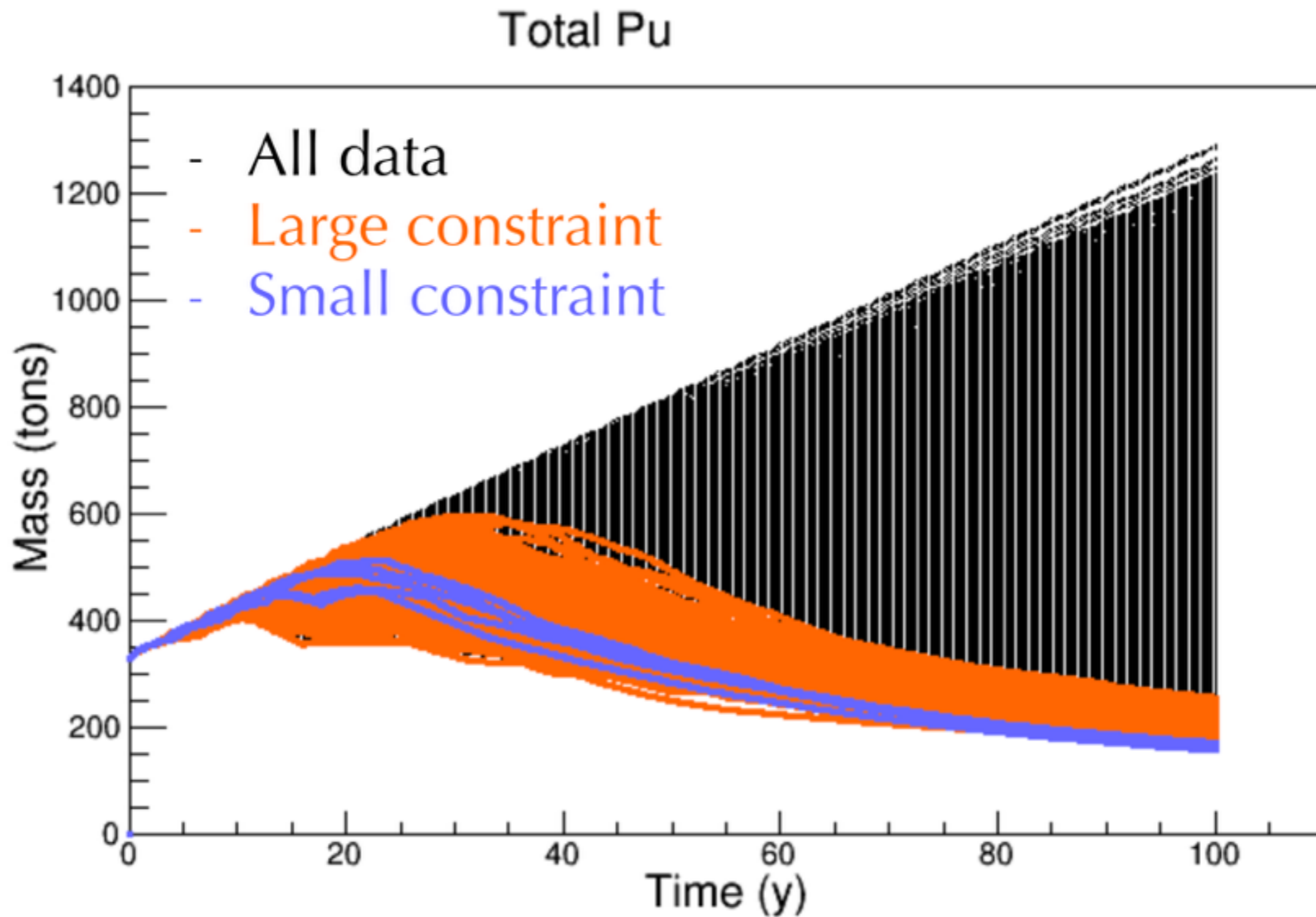
Total Pu



Total Pu

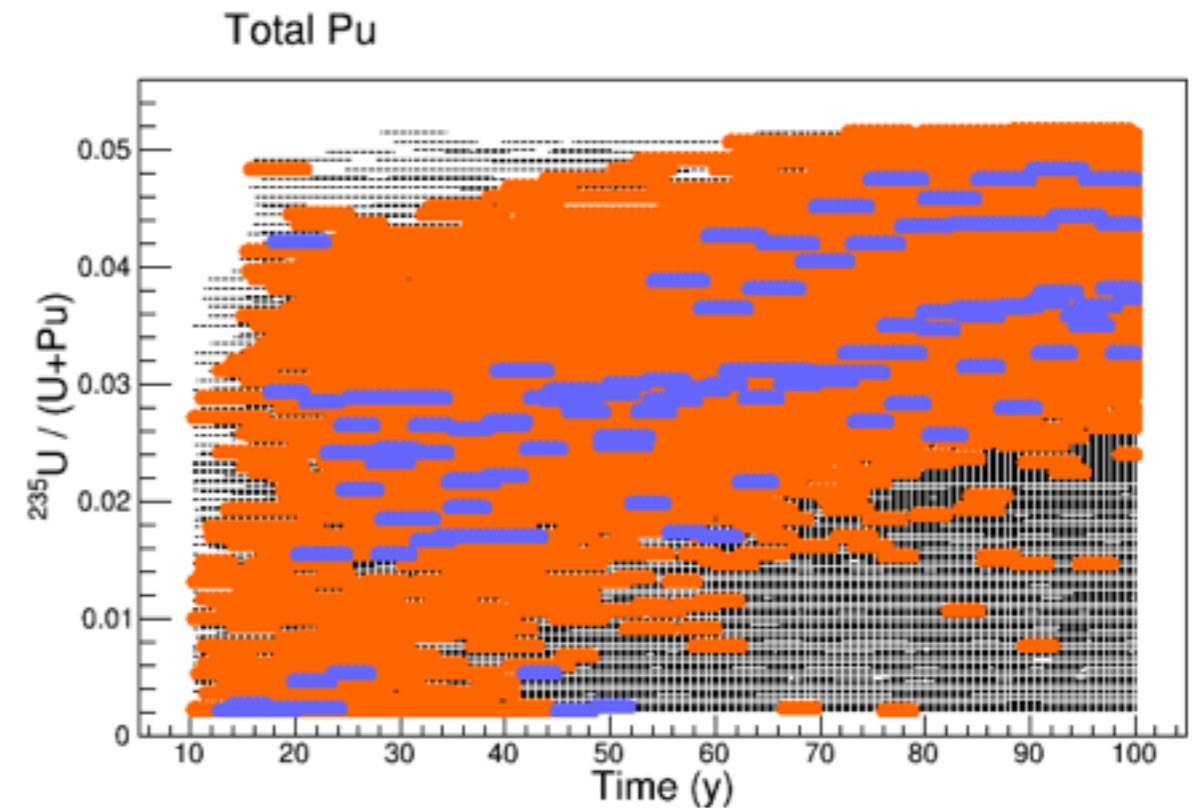
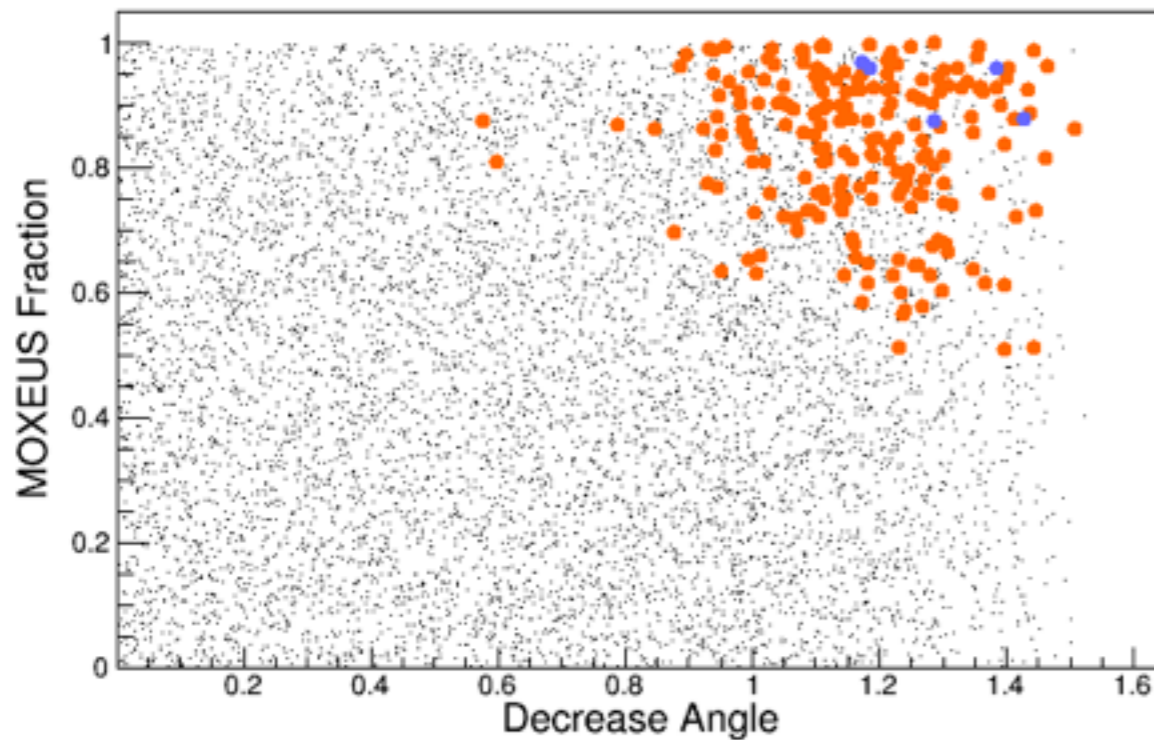
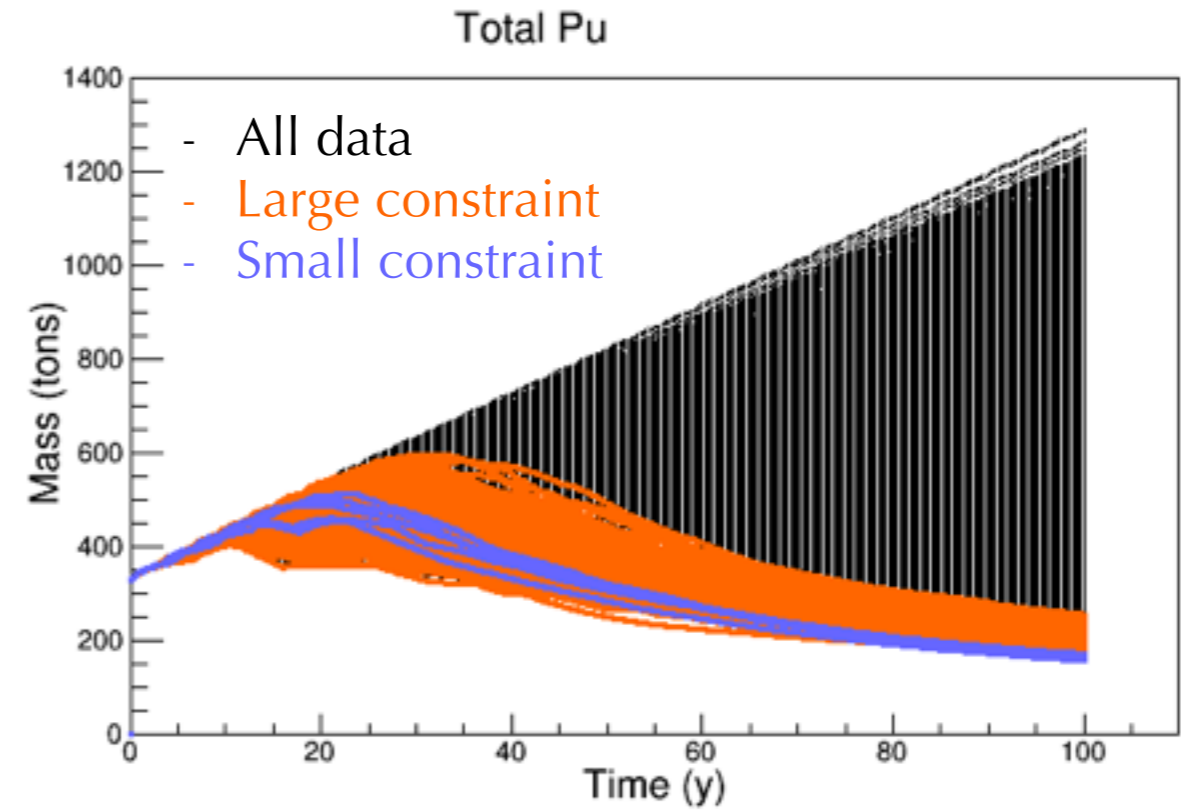
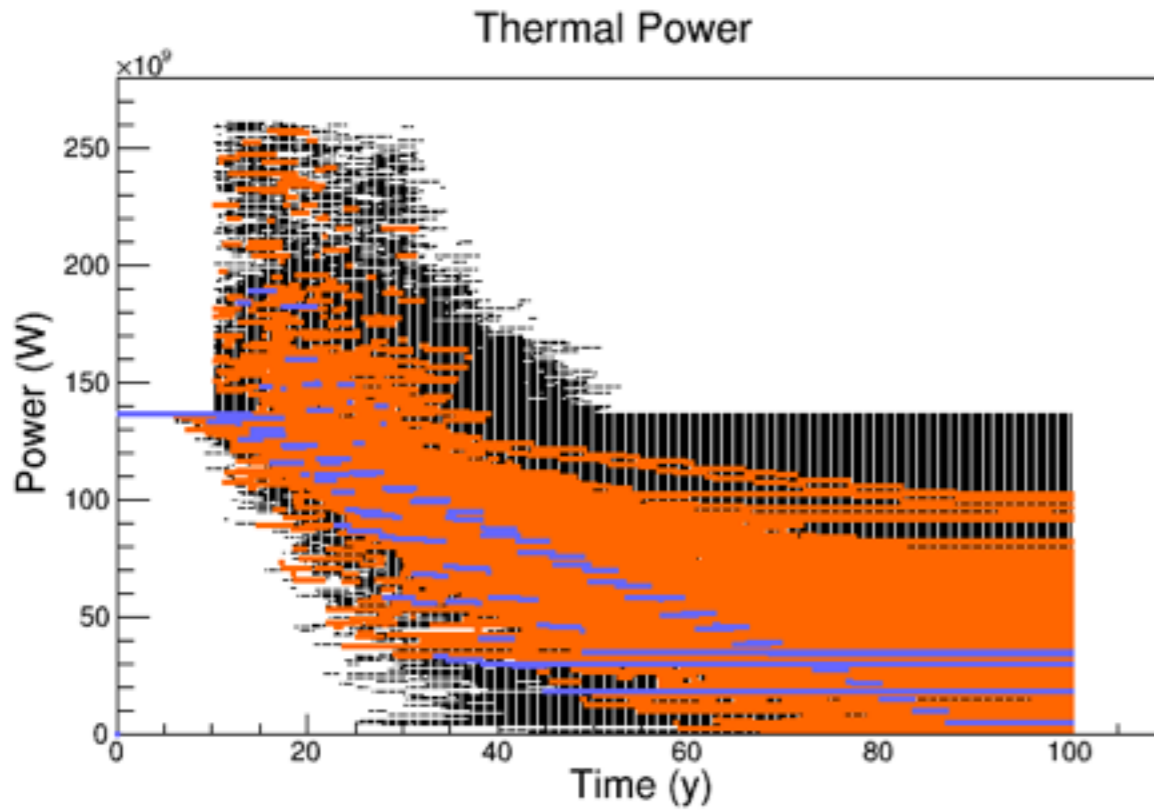


# Plutonium incineration





# Plutonium incineration



- 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-UOx-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