Nuclear diversion within operations uncertainty

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Introduction

Simulations uncertainties:

- Previously evaluated/measured datas
- Modeling simplifications
  - Physics treatment (depletion, fuel fabrication…)
  - Design simplification (timesteps, flows…)
  - Operation

To which extend, uncertainty on fuel cycle operations can impact the fuel cycle output metrics ?

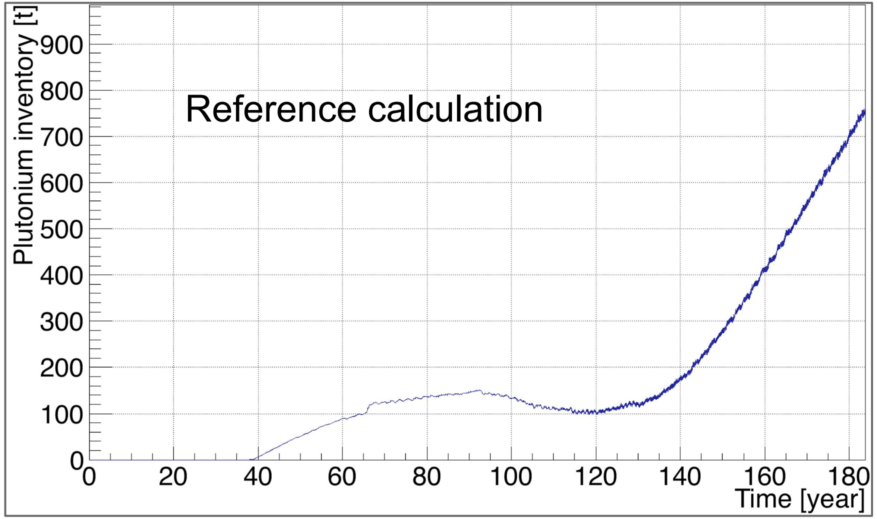
- Nuclear non-proliferation:
  - Nuclear archeology: retrieve the past fissile stock-pile
  - New large scale safeguard

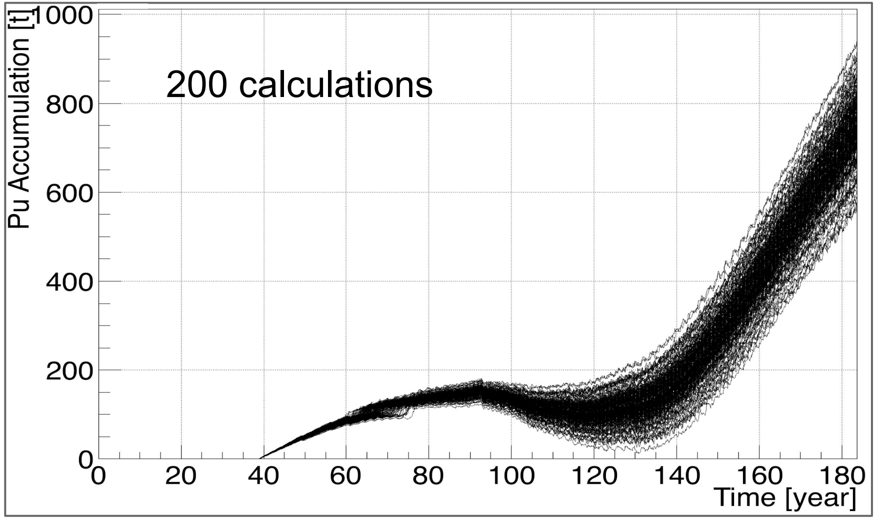
Uncertainty propagation

Stochastic uncertainty propagation:

- 200 simulations,
- random parameter values normally distributed (10%)
- new set of parameters for each facility deployed
- 1 with all parameters sampled
- 1 for each parameter with only 1 sampled

- Output metrics uncertainty: std deviation
- Relative uncertainty: (std_dev)/mean
- Representation: mean +/- std_dev



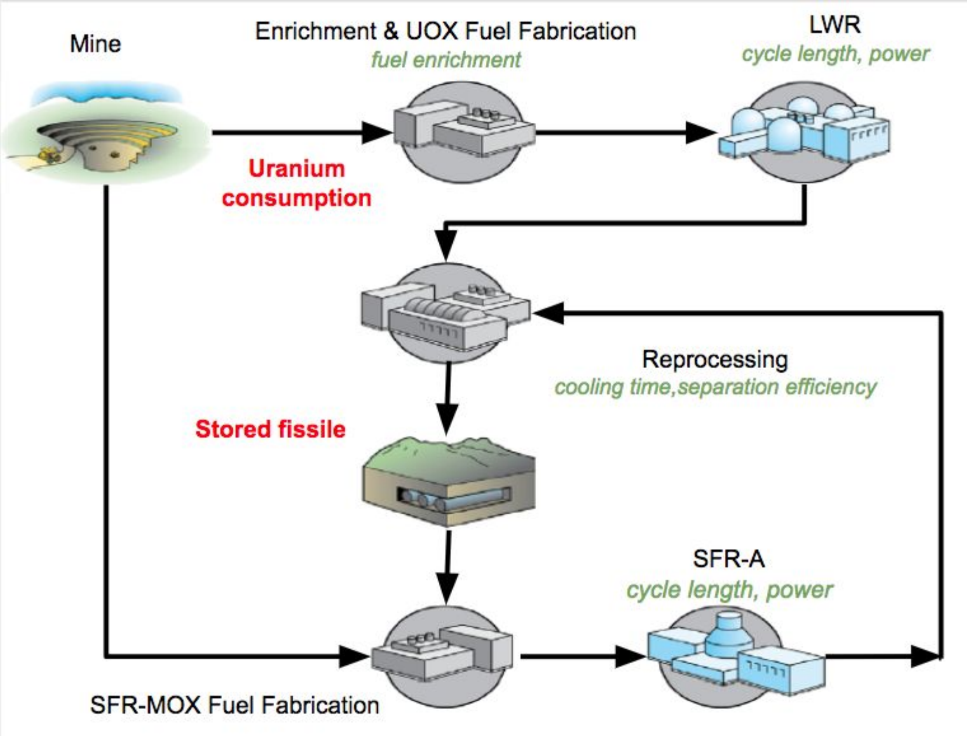


The fuel cycle

EG01 to EG23 transition:

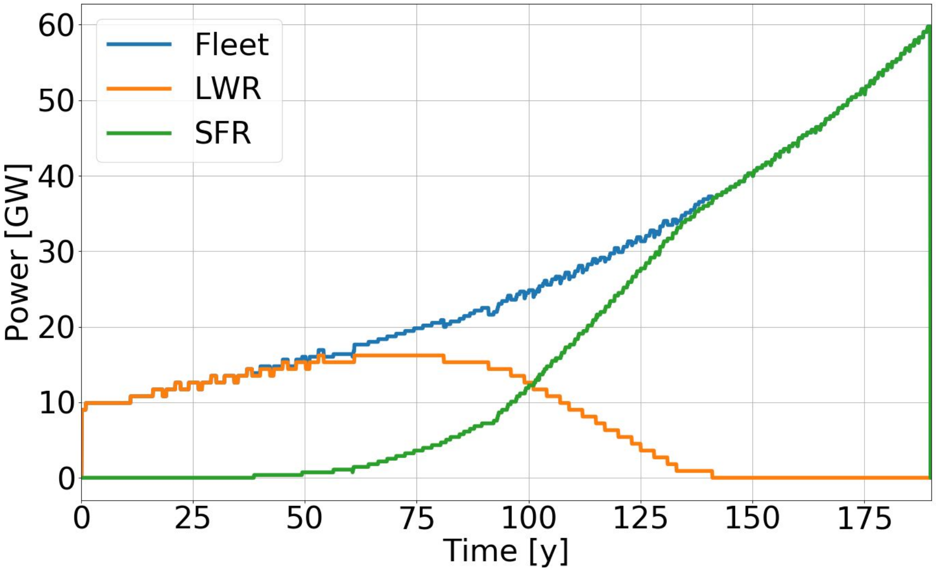
- Full PWR-UOX to full SFR-MOX
- Scaled down (1/10)
- Uncertainty 10%
- CLASS model for fuel fabrication and on the flight depletion

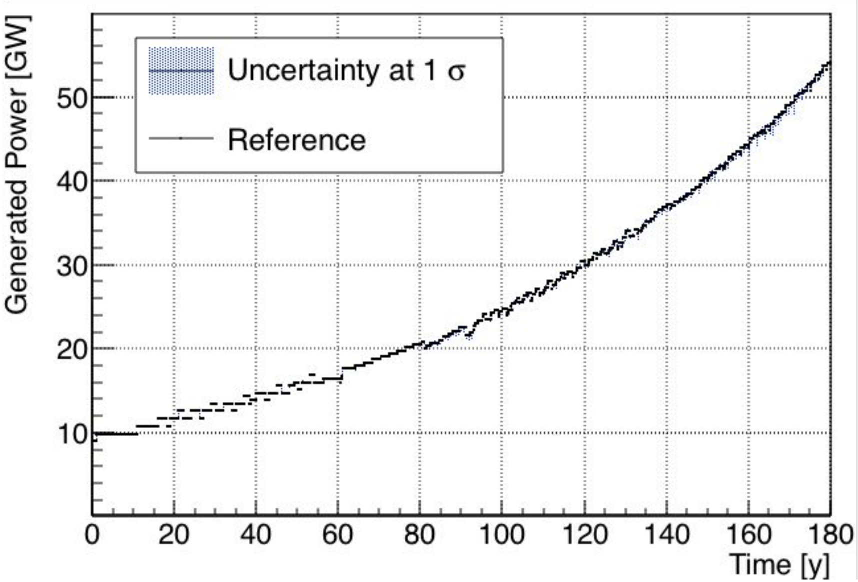
Package	Facility	Parameters
Cycamore	Separation	Separation efficiency
	Storage	Residence Time
CyCLASS	Reactor	Cycle Length Power Fuel Enrichment (PWR-UOX)



Power production

Transition from PWR to SFR



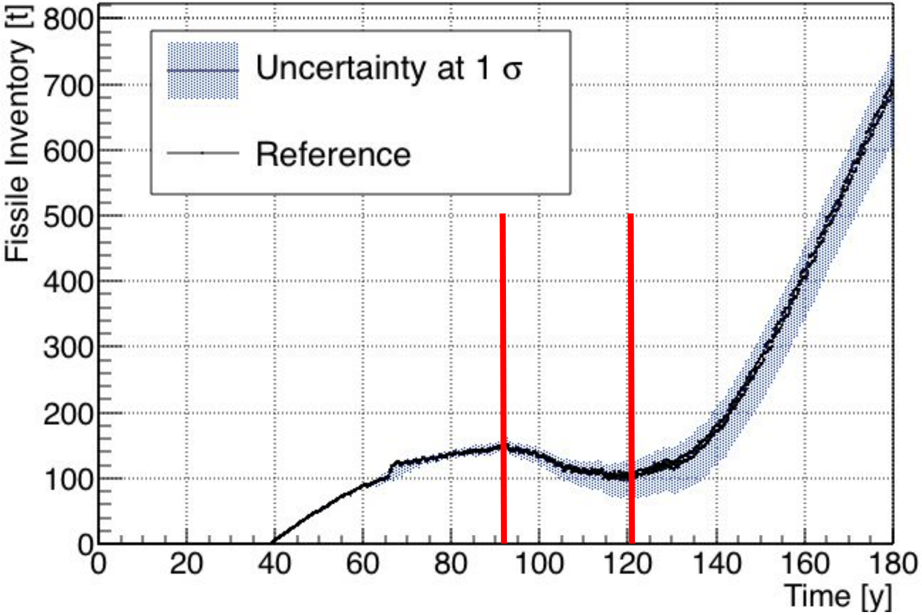


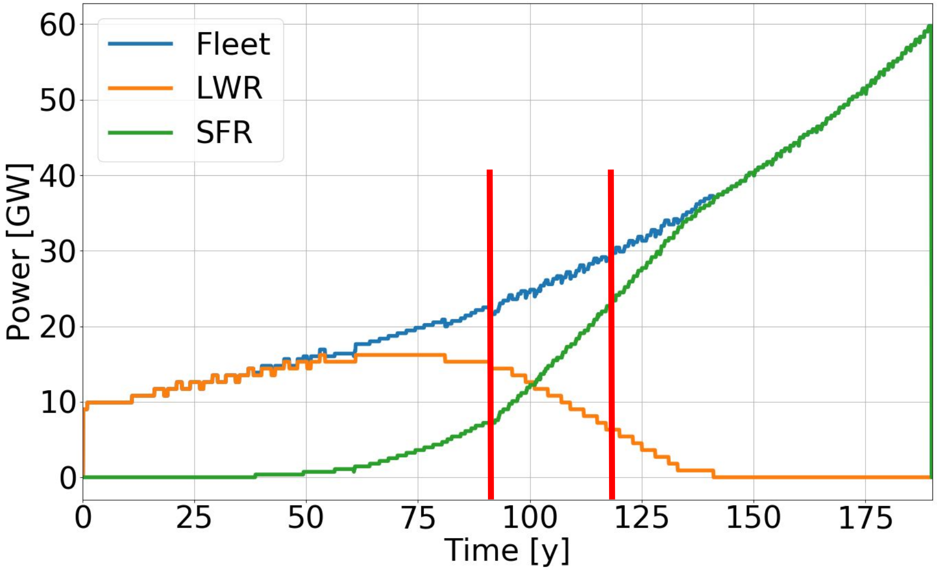
Almost no uncertainty on power production:

- No fuel miss-loading

Plutonium inventory

- 40-90 year: slow increase
- 90-130: the quick replacement of the LWR by SFR
- After 130: SFR reprocessing its own fuel





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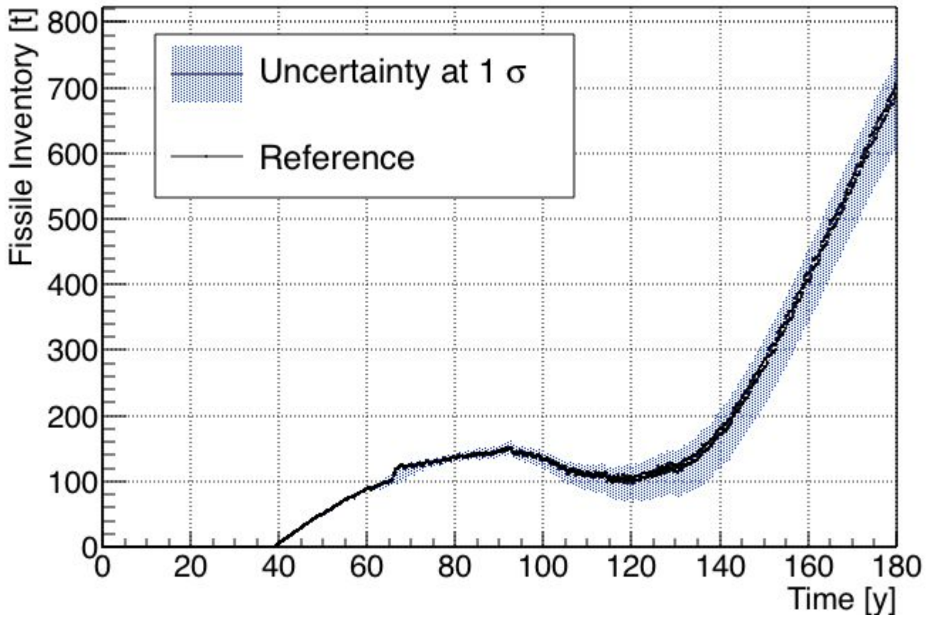
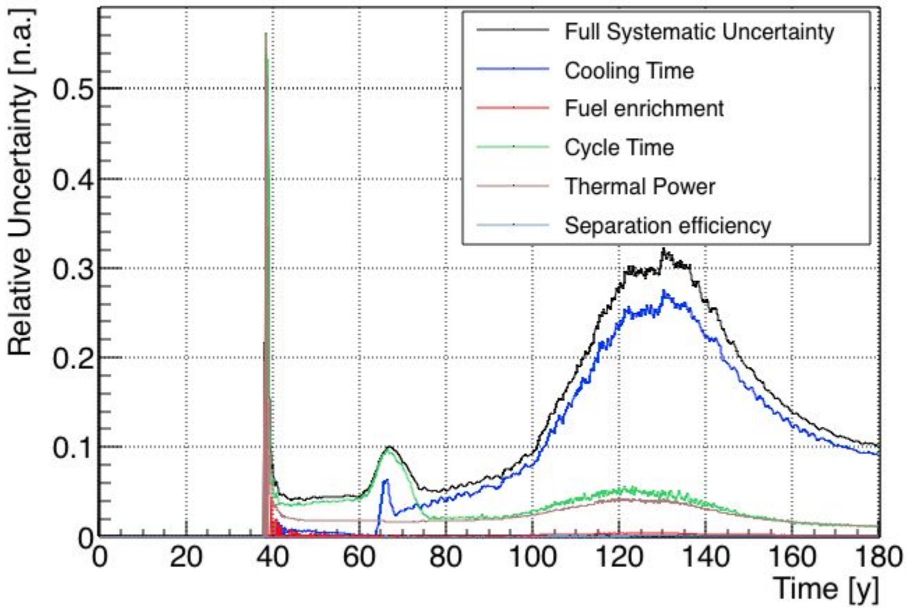


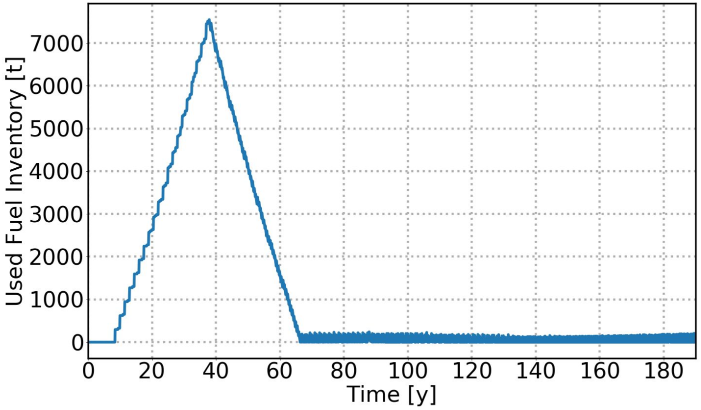
- Dominated by flows schedule
- Change in the main contributor

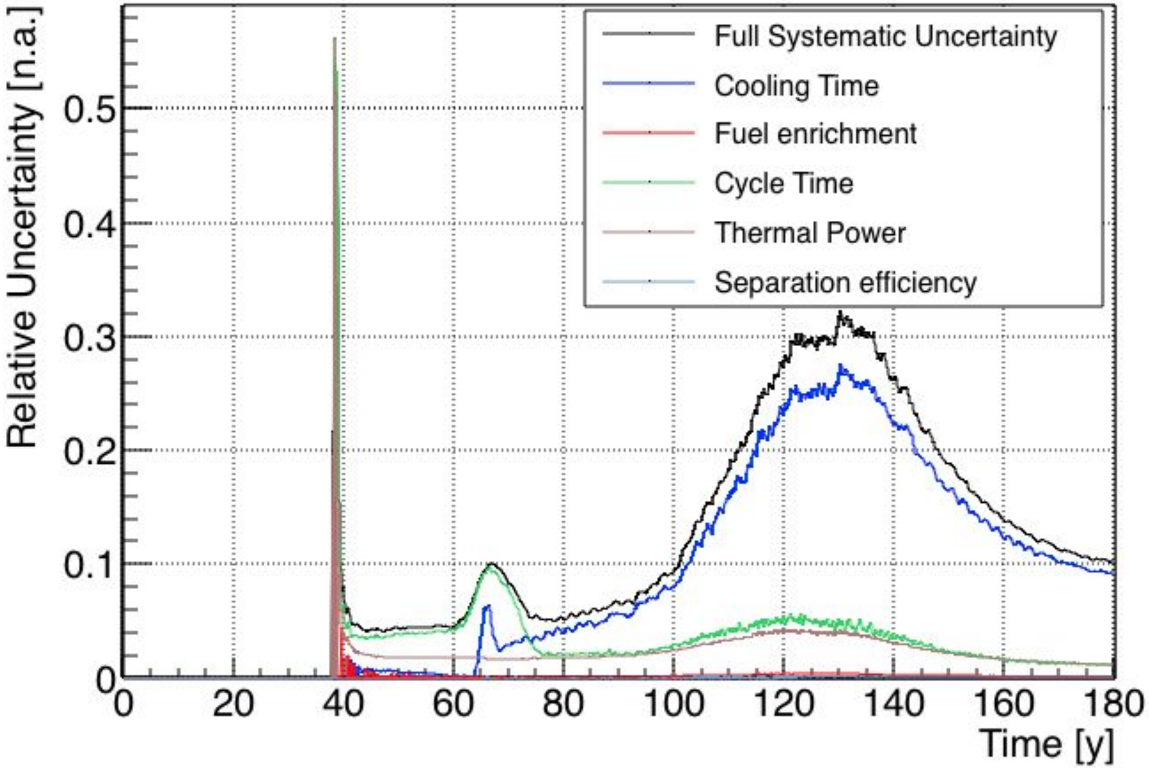


Uncertainty evolution

- Year 40 - 70: fuel load frequency
- Year 70 - 180: reprocessing as available

Cycle time switches from material flow to physics impact contribution





Conclusion

- Different way to look at fuel cycle results.
- Main uncertainty contributors: parameters impacting material flows schedule
- Specific treatment might be needed for such parameters

- Future works:
  - more parameters
  - random/systematic uncertainty propagation

Thank you