Assessment of the alpha risk after a fissile material dissemination in a PWR using the OSCAR v1.4 code

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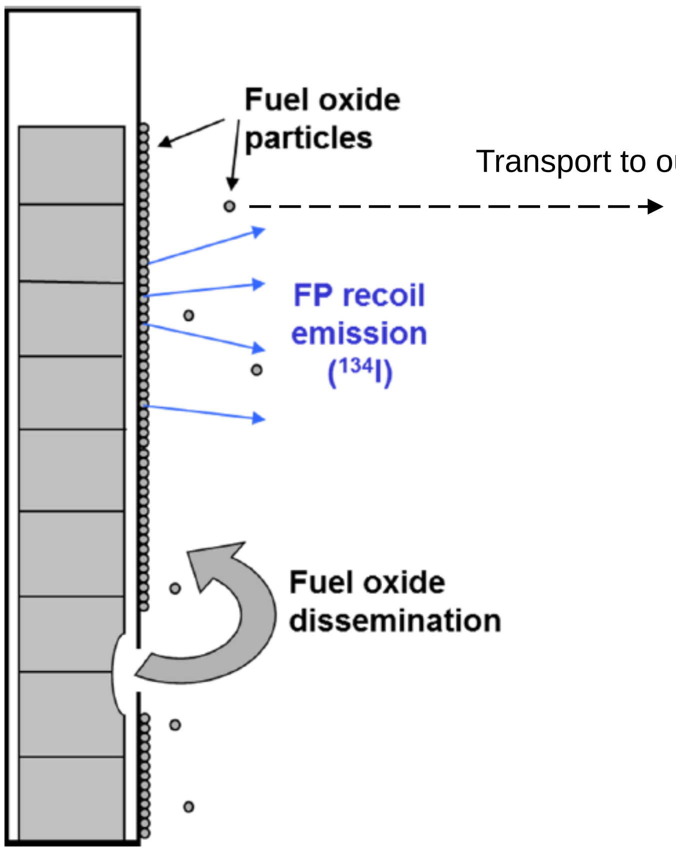
EDF/DIPNN/DT

Introduction

- **Alpha risk comes from the fissile material dissemination into the primary coolant and the contamination of circuit surfaces where maintenance operations are conducted during outage.**



Fissile material disseminates in particulate form and is mainly insoluble in the primary circuit.

Fuel oxide particles are mainly deposited on the primary surfaces.

Then, they undergo erosion and deposition, which induce transfer between in-core surfaces and out-of-core surfaces.

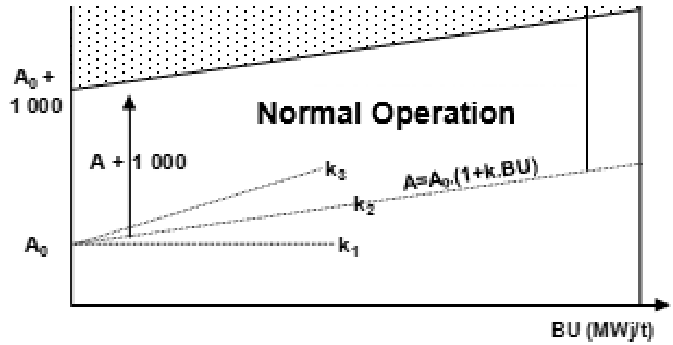
Introduction

- **At EDF, the alpha risk management is based on three main steps (graded approach) :**
  - **1st step : Primary coolant activity monitoring**

ALPHA POTENTIAL RISK if :

- Act (^{134}I) > A+1000 MBq/t (1300 MWe series), A+2000 MBq/t (N4 and 900 MWe series) (= fissile material dissemination risk), <u>or</u>
- α.G > 1 Bq/l, or
- The previous outage was at alpha risk

A=A0.(1+kBU)
Remaining alpha contamination



Objectives of the study

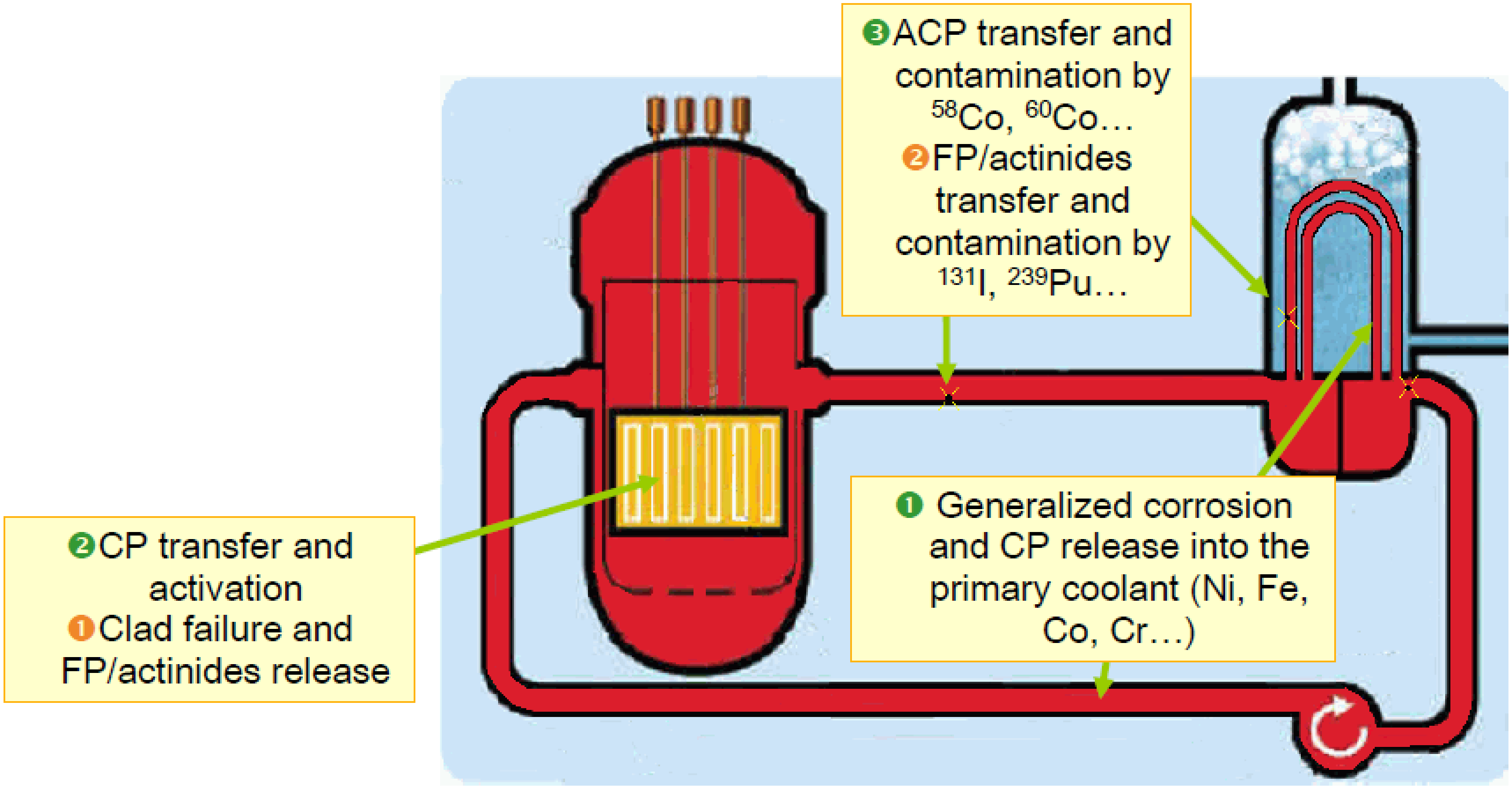
1. *Relation between iodine-134 activity and amount of fissile material dissemination → Elaboration of abacus*

2. *Application : the unit A case*

3. *Unit A scenario modelling (more accurate approach)*

OSCAR v1.4 : a code for simulating the contamination

- **Simulation of corrosion, fission product and actinide transfer in nuclear circuits**
  - Calculation of masses and activities of **CP**/**FP/actinides** in every point of nuclear circuits as function of time



OSCAR v1.4 : a code for simulating the contamination

- **3 computation schemes :**

Computation scheme used for the study

LARGE CLAD FAILURE

Release of **ACTINIDES**

- Alpha emitters (Ex: ^{242}Cm)
- Fissile nuclides (Ex: ^{239}Pu)

OSCAR-CPFP

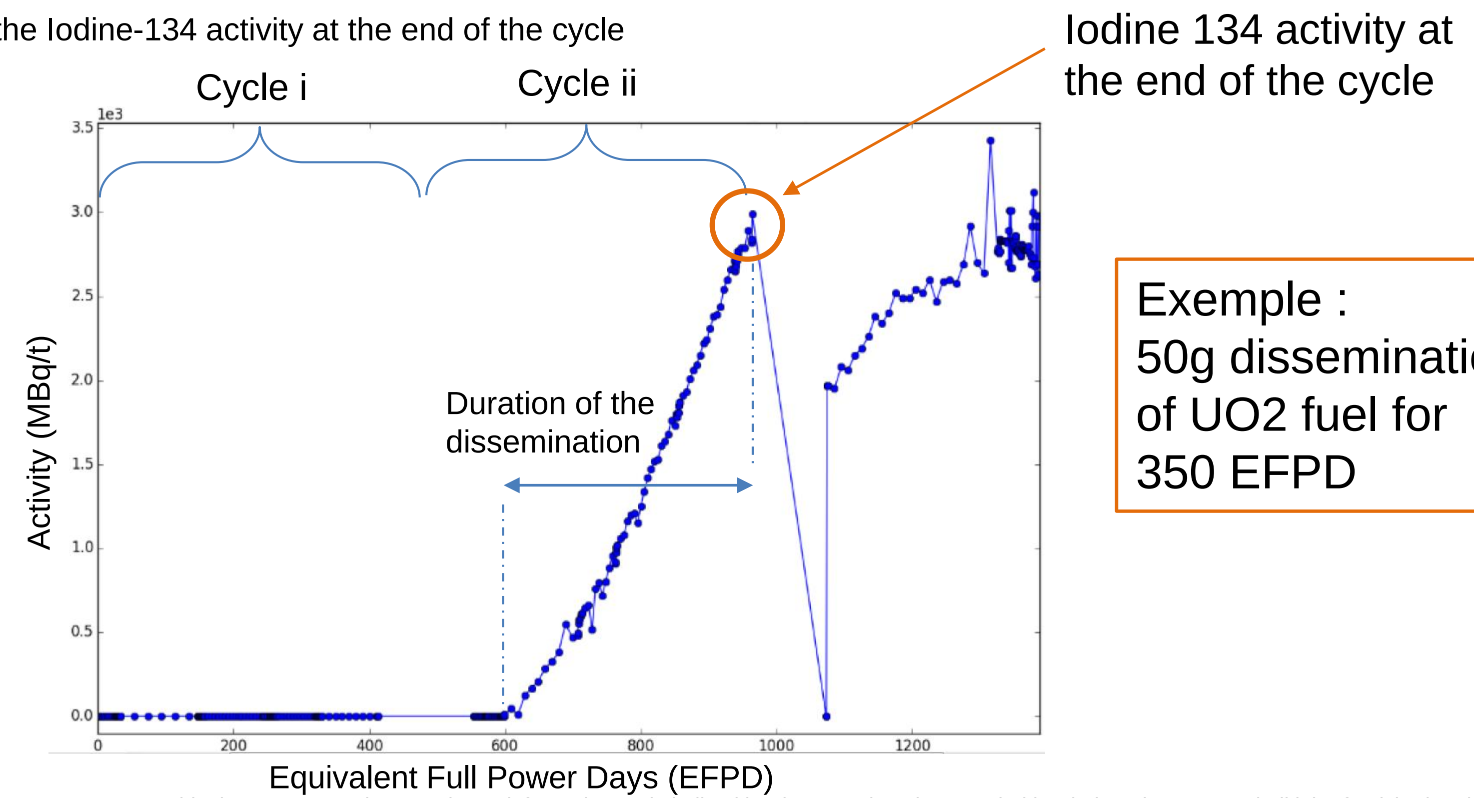
Corrosion Products
Actinides
Fission Products

First objective : Elaboration of abacus

- **Simulation of fissile material disseminations for each French reactor series, for:**
  - Different amounts of fuel released in the primary coolant,
  - Different durations of fuel release,
  - Different burn-up of the fuel,
  - Different kind of fuel (UO2 and MOX)

NB : when a fissile material dissemination occurs, it lasts until the end of the cycle

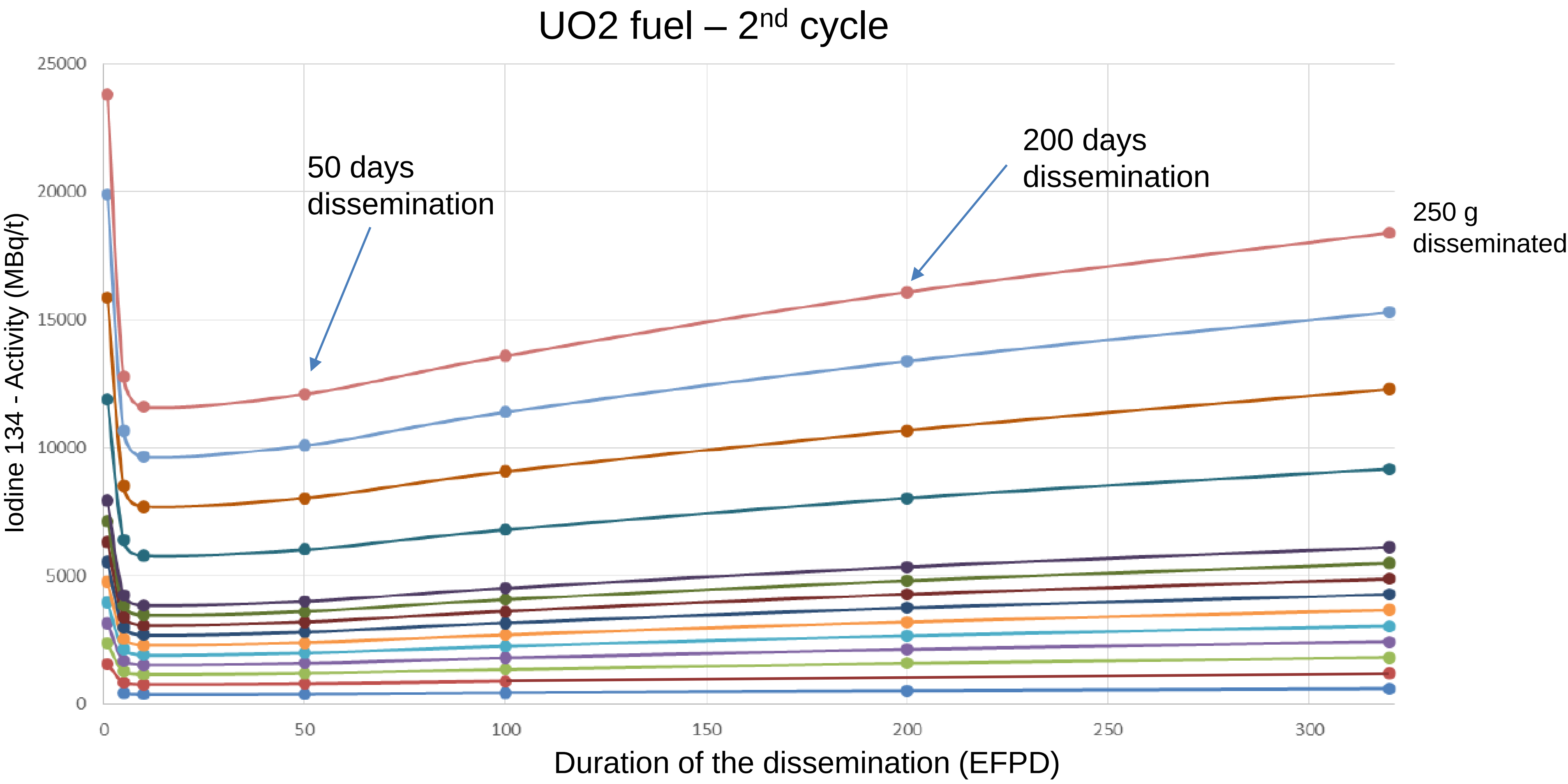
- → take the Iodine-134 activity at the end of the cycle



Exemple :
50g dissemination of UO2 fuel for 350 EFPD

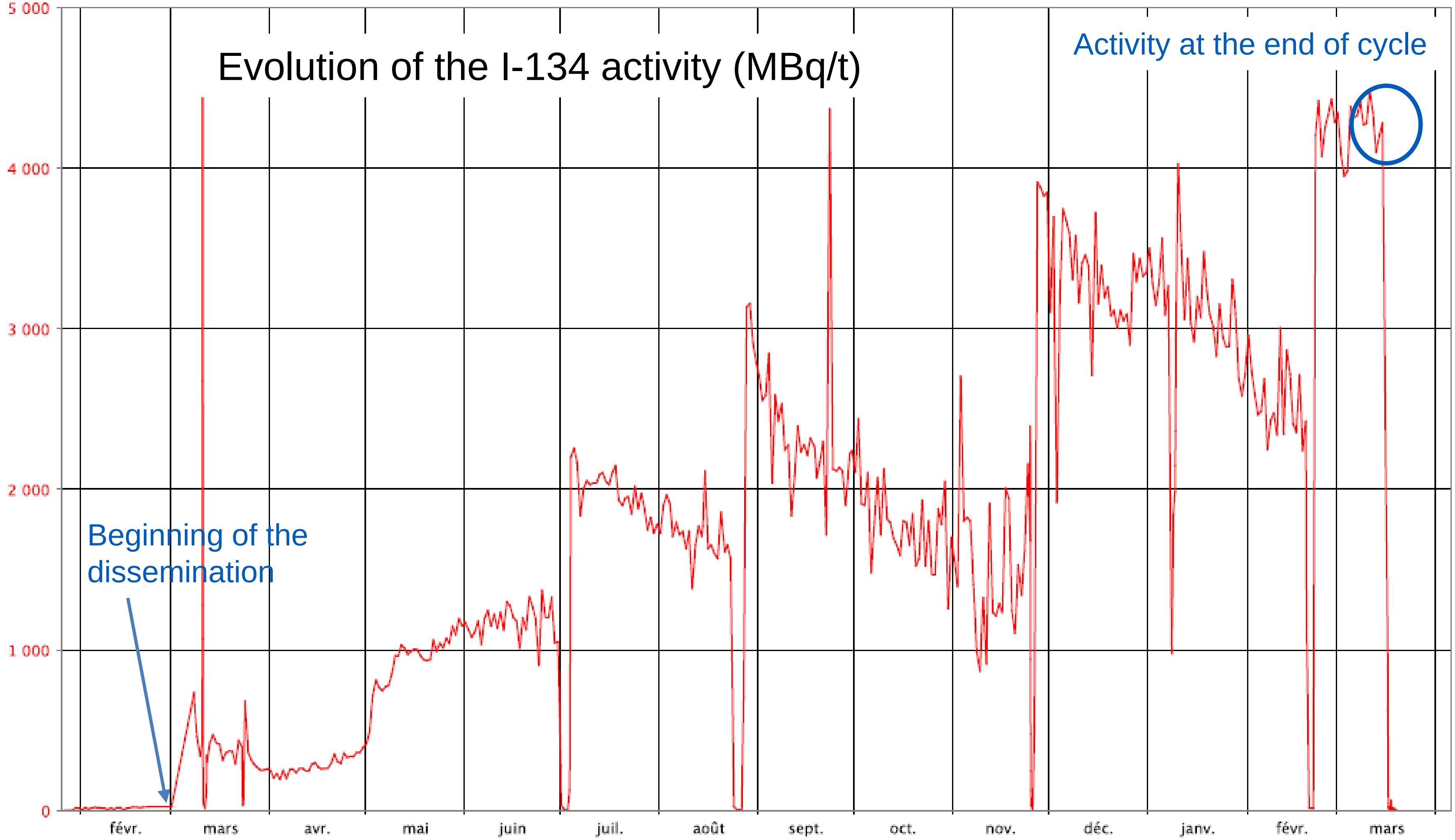
First objective : Elaboration of abacus

- **Example of abacus**

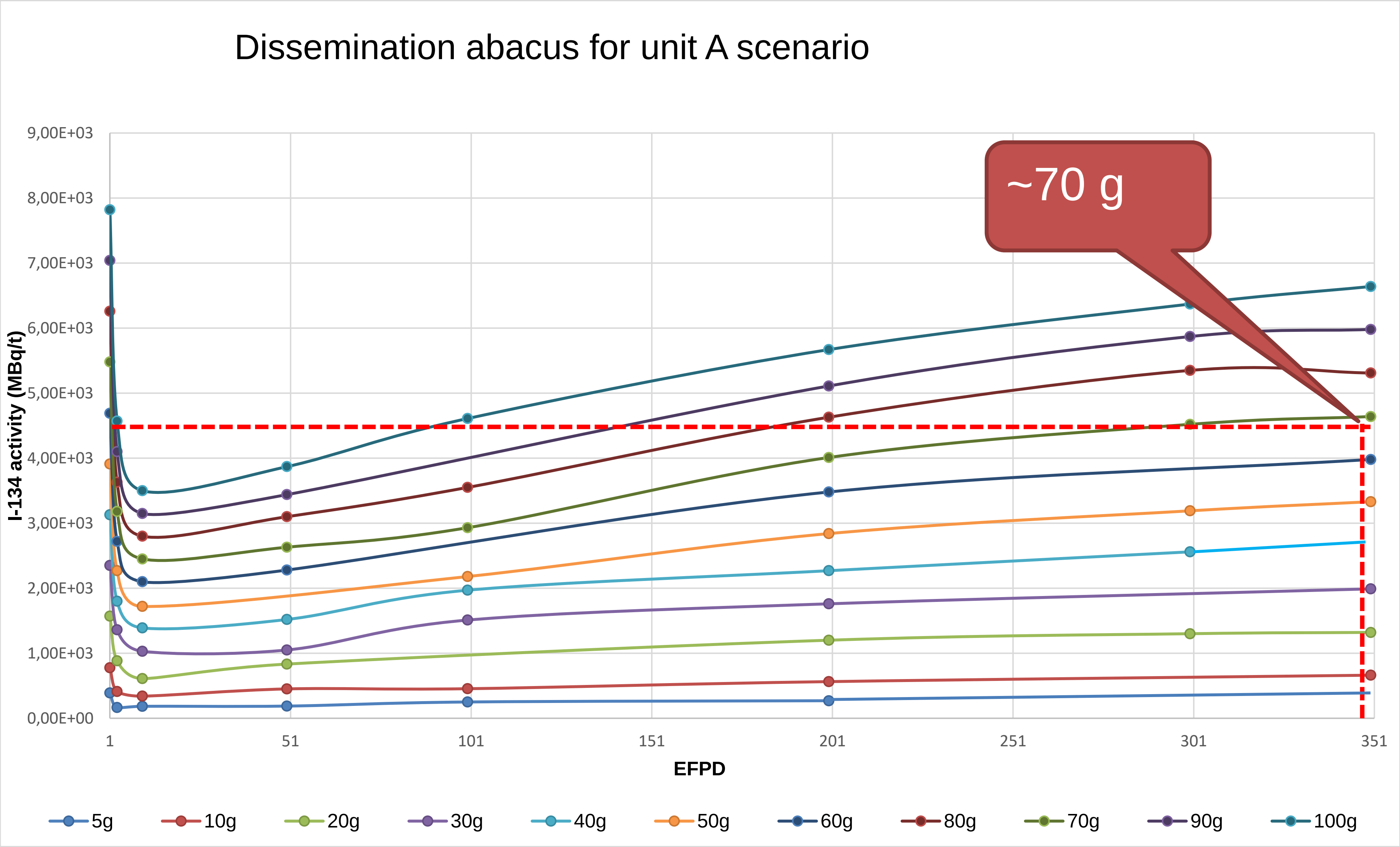


2^{nd} objective : application

- **Unit A experienced a fissile material dissemination**

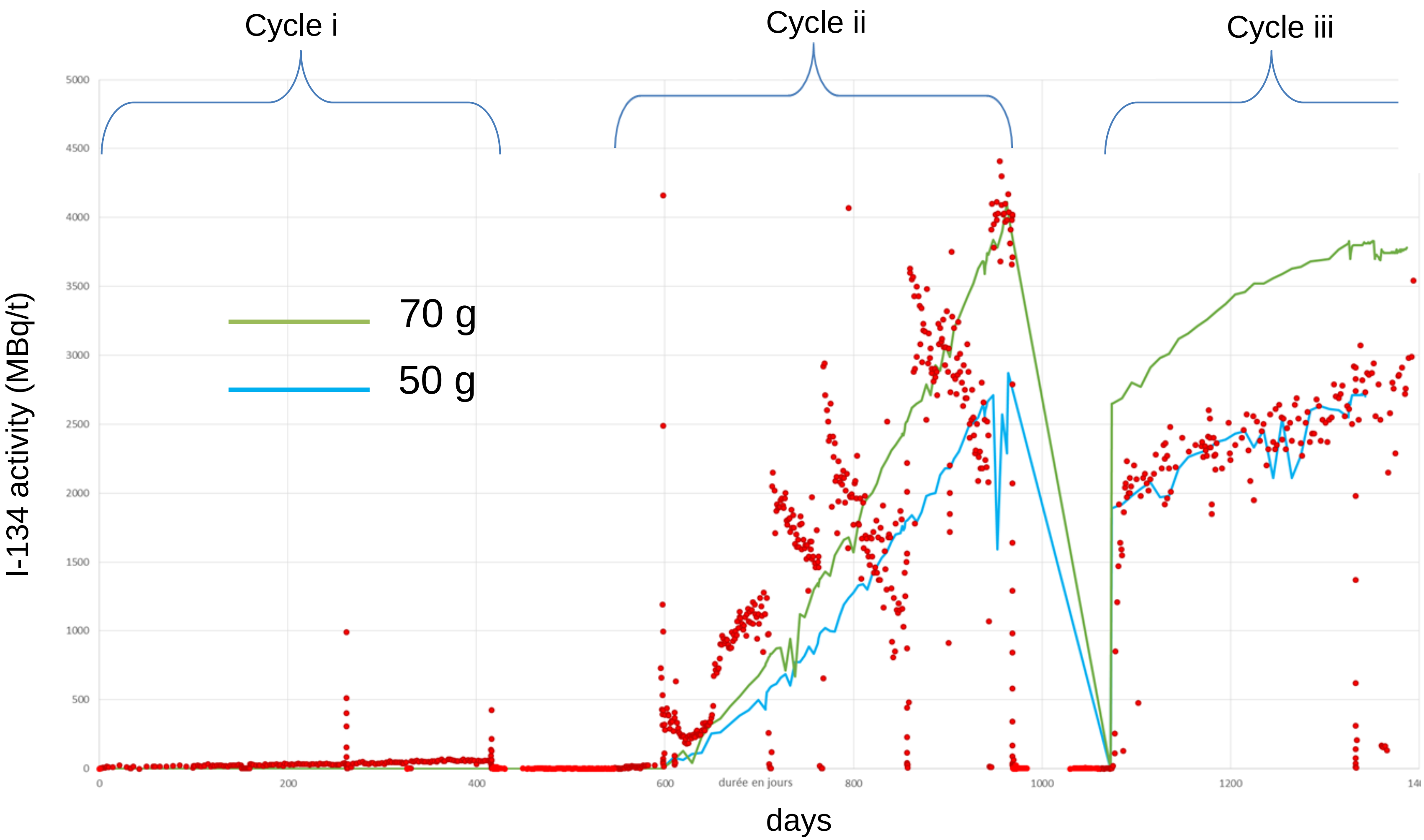


2nd objective : application



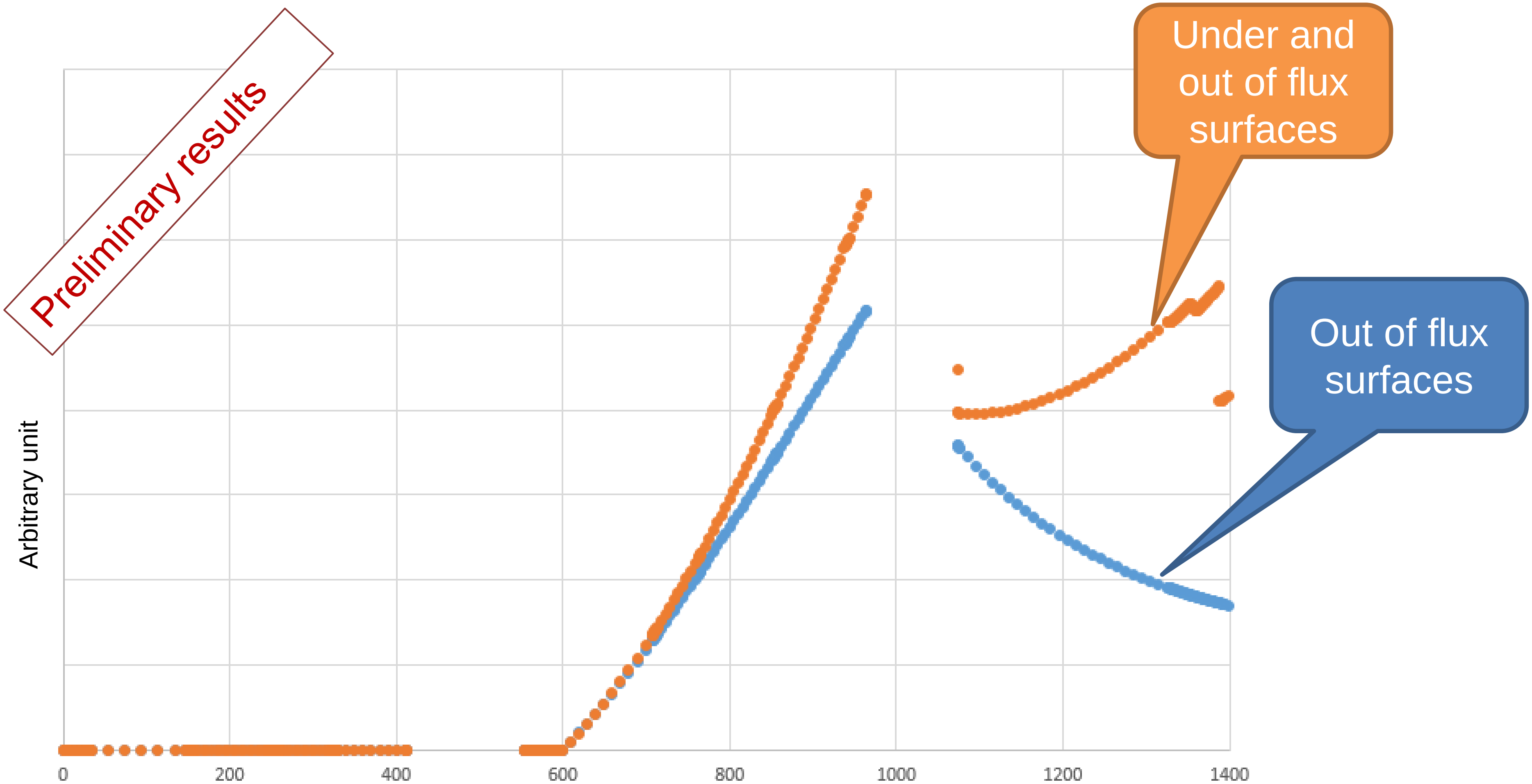
3rd objective : Unit A scenario modelling

- **Unit A scenario modelling, using the OSCAR v1.4 code, taking into account :**
  - **Evolution of the power during the cycle**
  - **Evolution of the B/Li concentrations**



3rd objective : Unit A scenario modelling

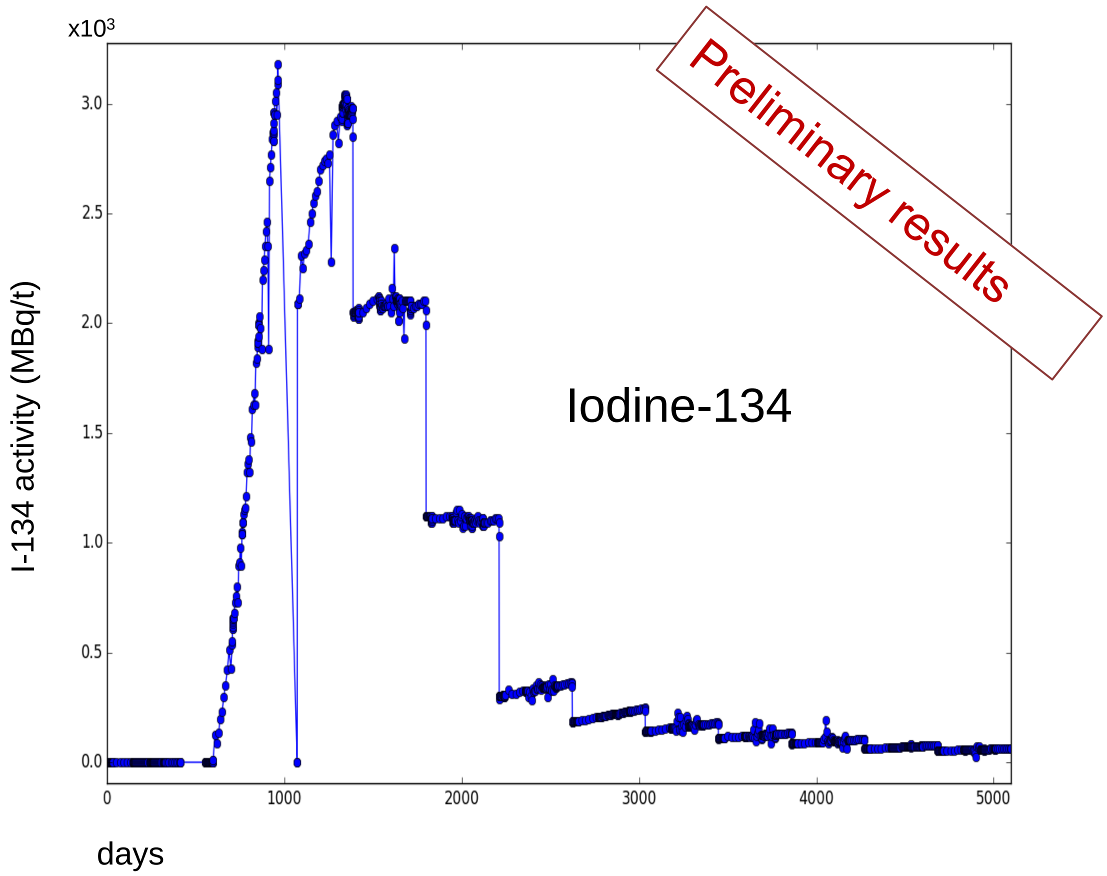
- **Calculation of the alpha emitter contamination on the RCS surfaces**



3rd objective : Unit A scenario modelling

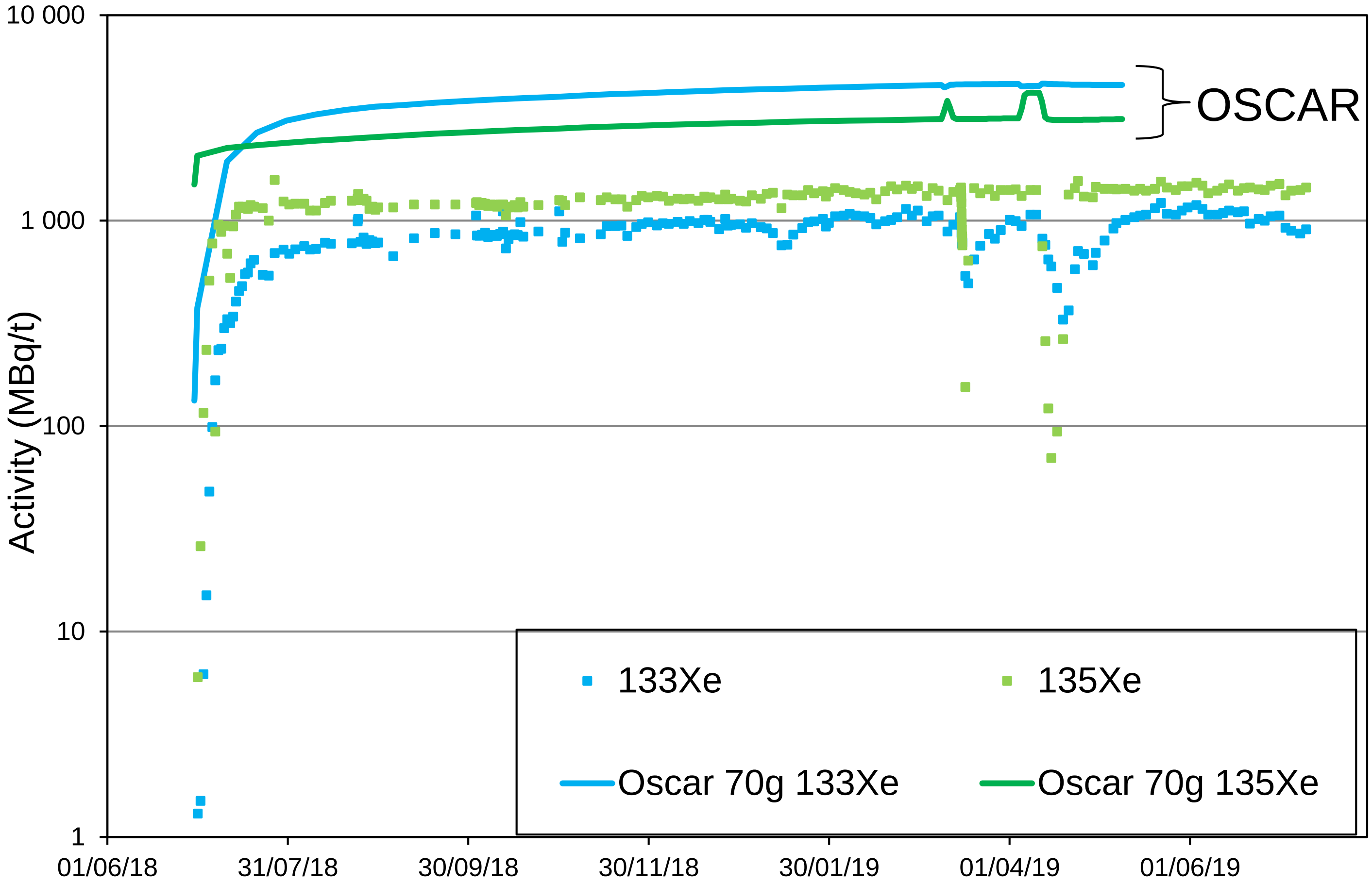
- **Prediction of the alpha emitter contamination**

- 7 cycles after the dissemination cycle are needed to decrease the contamination close to the level observed before the dissemination event



3rd objective : Unit A scenario modelling

- Focus on cycle iii (after the dissemination cycle)
- The defective assembly has been removed…but, according to the radiochemical specifications, the measurements show a "fuel claddind defect presumption"



The OSCAR calculation shows that without any defective fuel rod, the activity in Xe-133 and Xe-135 remains high due to the residual contamination (previous cycle « ii »)

Conclusion

- **This study is an exploratory one which results need to be consolidated**
- **The comparison between alpha surface contamination calculations and alpha measurements (swipes) will be undertaken shortly**
- **In order to reduce uncertainties, the knowledges regarding actinide behavior (during power and shutdown transients) need to be improved**
- **The study shows a good potential in terms of alpha risk management**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