



# ASTRE

## Accessibility Simulation Tool for Radiological Emergency

### Project team:

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EDF R&D

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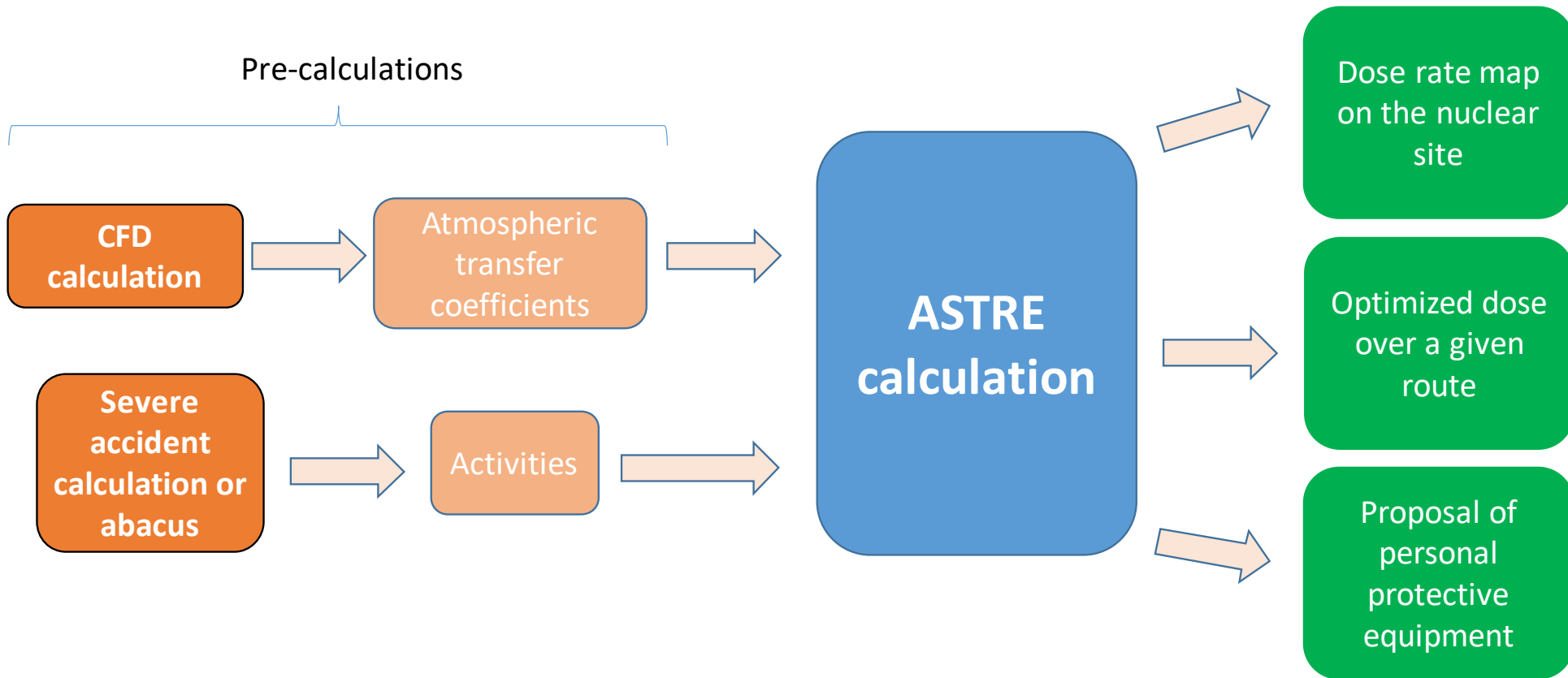
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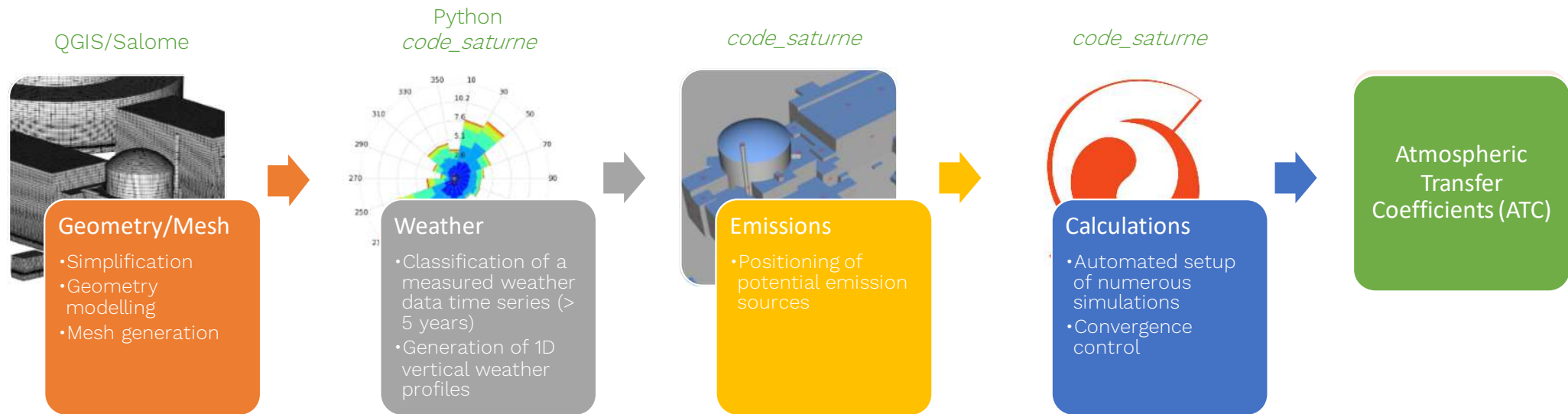
# 1. CONTEXT AND OBJECTIVE OF THE PROJECT

- Development of a tool at EDF R&D dedicated to the radiological emergency situations on the nuclear site  
→ development of the ASTRE tool
- The main goals of ASTRE are to:
  - evaluate the radiological release on the nuclear site and inside some buildings
  - evaluate a realistic dosimetric prevision for the interventions of agents on the power plant in case of radiological emergency situations,
  - propose the personal protective equipment which would be useful during the intervention,
  - evaluate the best path to minimize the dose rate/integrated dose as well as the contamination undergone during an intervention.

## 2. GENERAL ARCHITECTURE

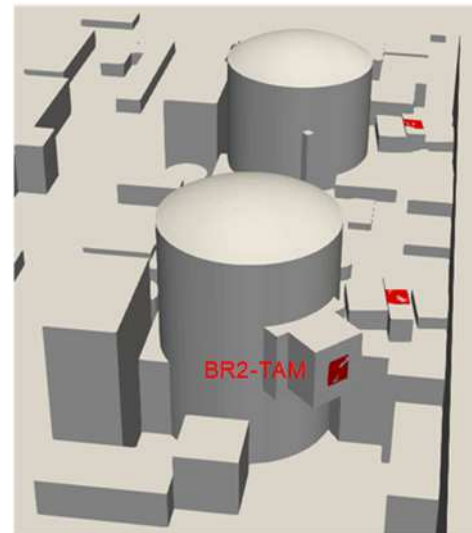
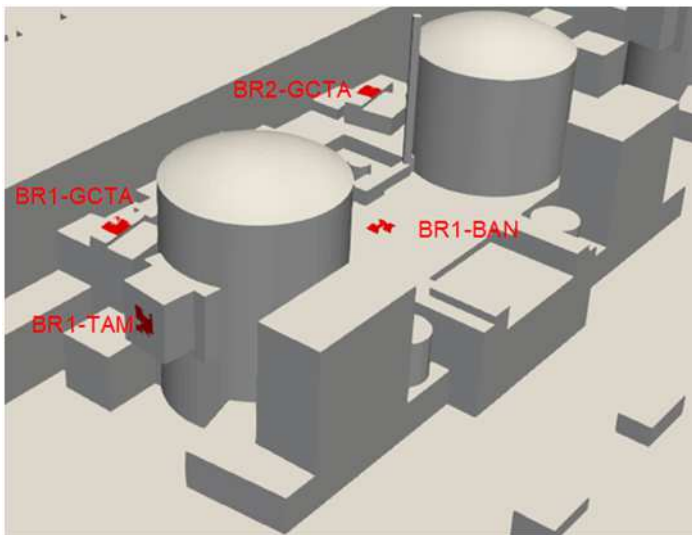


# 3.A. CFD SIMULATION USING CODE\_SATURNE (1/2)



## 3.A. CFD SIMULATION USING CODE\_SATURNE (2/2)

- Potential emission sources



*Boundary faces representing emission sources in the vicinity of the reactor buildings « BR1 » and « BR2 ».*

## 3.B. ESTIMATION OF DOSIMETRIC QUANTITIES

- **Goal:** Estimate realistic dosimetric quantities (dose rate  $D_{ed}$ , integrated dose) during the accident

$$D_{ed}(t) = f(\text{ATC, RN activities})(t)$$

with

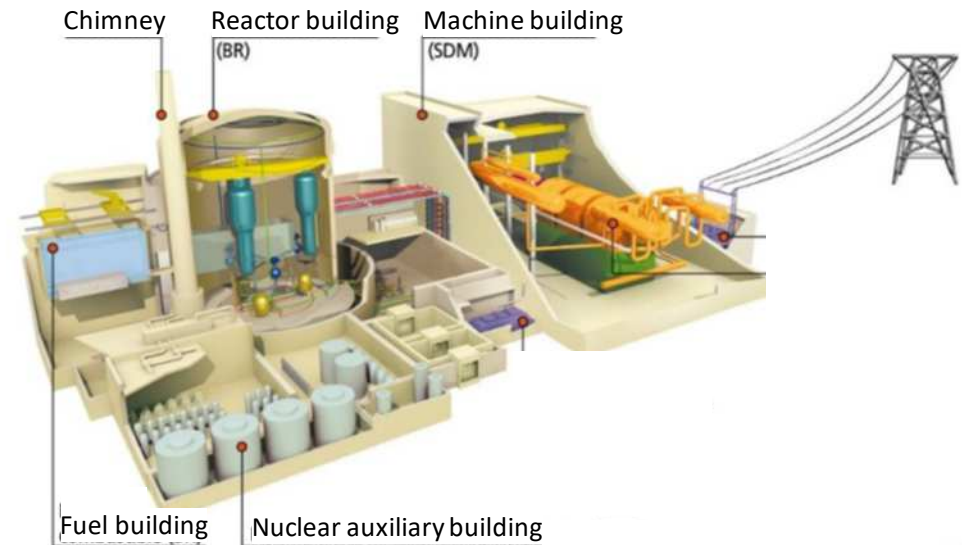
**ATC:** integration of the weather situation (i.e. thermal stratification of the atmosphere, direction and wind strength) – precalculations performed using code\_saturne

**RN activities:** precalculations performed with a severe accident code or abacus

⇒ **Specific on-going studies to improve the estimation of RN activities to realistic values.**

## 3.C. DOSE RATE INSIDE BUILDINGS

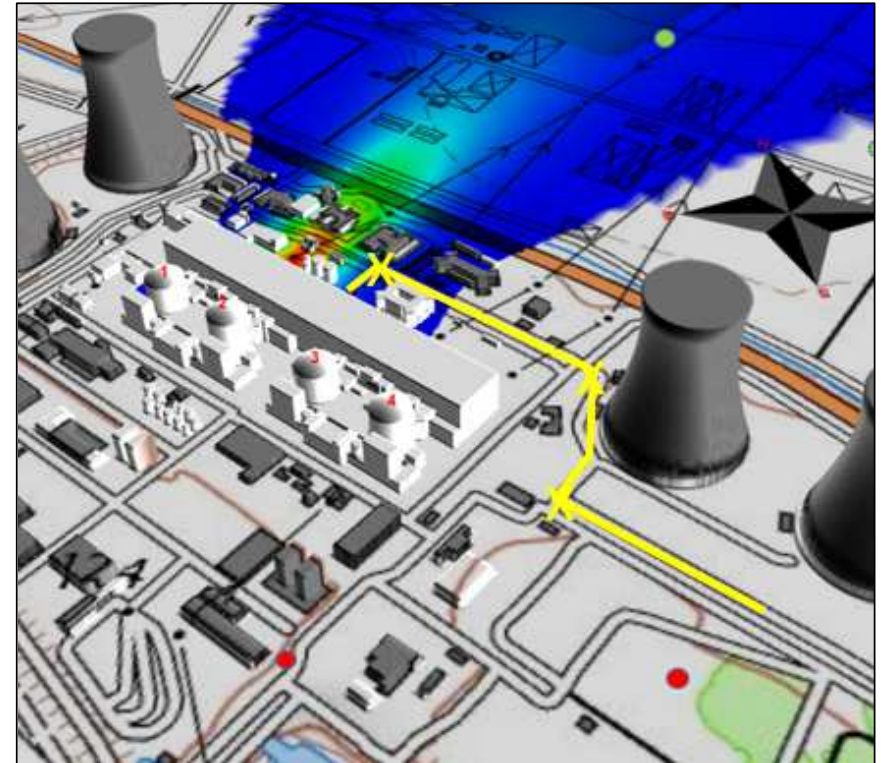
- Goal =
  - to estimate the dose rate in given locals of interest
- Proposed solutions:
  - Simplified model based on a zonal approach
  - More precise one, based on CFD calculations (code\_saturne)
- **New and innovative solutions to be studied as from 2023.**



*Overview of the main buildings of a nuclear reactor*

## 3.D. DATA ASSIMILATION

- *Data assimilation is the technique whereby observation data (here on-site dose rate measurements) are combined with output from a numerical model to produce an optimal estimate of the evolution.*
- Data assimilation may be used to correct the dose rates calculated with ASTRE, using on-site dose rate measurements.
- It could be performed on a given path (too few data to correct the calculation on).
- Application to ASTRE will be studied as from 2023.



Path example

# 3.E. ASTRE INTERFACE

- Study of the ergonomics of the interface
- Very simple use
- Possibility to manually enter all the data
- Visualization on the site map

**Bonjour Jean Dupont**

**ASTRE**

**Paramètres de simulation**

Localisation du rejet:  
Tranche: 1 Bâtiment: BAN [BR]

Initiateur: APRP

Ouverture Filtre US: Oui

AES: En service

Ventilation: En service

**Conditions météo**

Phase (s): 6 Durée totale: 15h

Nom de la phase	Durée (h)	Direction vent	Dispersion
1 Phase initiale	2 h	58 °N	Classe A
2 Nom phase 2	120	°N	Classe B
3 Nom phase 3	46	°N	Classe B
4 Nom phase 4	10	°N	Classe A

**Balises**

Nom balise 1	Nom balise 2	Nom balise 3
valeur	valeur	valeur
Nom balise 4	Nom balise 5	Nom balise 6
valeur	valeur	valeur
Nom balise 7	Nom balise 8	Nom balise 9
valeur	valeur	valeur
Nom balise 10	Nom balise 11	Nom balise 12
valeur	valeur	valeur

**Cheminements**

Parcours: 3

Visu	Nom du parcours	Distance (m)	DDD Intégré
<input checked="" type="checkbox"/>	A Nom chemin A	100	100
<input type="checkbox"/>	B Nom chemin B	100	100
<input checked="" type="checkbox"/>	C Nom chemin C	100	100

**Journal de Bord**

- 04/06/20 15:06 ASTRE  
Evènement automatique issu de ASTRE
- 04/06/20 15:18 Jean Dupont  
Message saisi par Jean Dupont

**Accessability Simulation Tool for Radiological Emergency**

Choix du CNPE: DAMPIERRE Tr1: TEM Tr3: TEM Tr2: AT Tr4: TEM

Choix de la visu: DDD IRRADIATION

Site: Dampierre Initiateur: APRP Filtre US: ON EAS: OFF Ventilation: ON Provenance: undefined Stabilité: classe undefined Validité Temporelle: 4.5 h

3D map showing Dampierre nuclear power plant with cooling towers and surrounding area. A color-coded radiation map is overlaid on the site, showing the distribution of radiation levels. A compass rose is visible on the map.

## 3.F. USE CASE: FUKUSHIMA DAIICHI

- Simulation of the Fukushima Daiichi accident using ASTRE
- CFD simulation using code\_saturne
- Weather and estimated source term taken into account
- Comparison of ASTRE results to on-site measured data



Geometry for the CFD calculation

## 4. CONCLUSIONS AND PERSPECTIVES

- ASTRE: new tool being developed at EDF R&D to evaluate the consequences on the nuclear site of a radiological emergency release.
- Following steps: Improvement of models  $\Rightarrow$  real R&D challenge !
  - dose rate evaluation inside the buildings
  - more realistic source term
  - use of on-site measurements during the accident
- At mid-term: first version of the tool to be tested by the end-users



# Questions