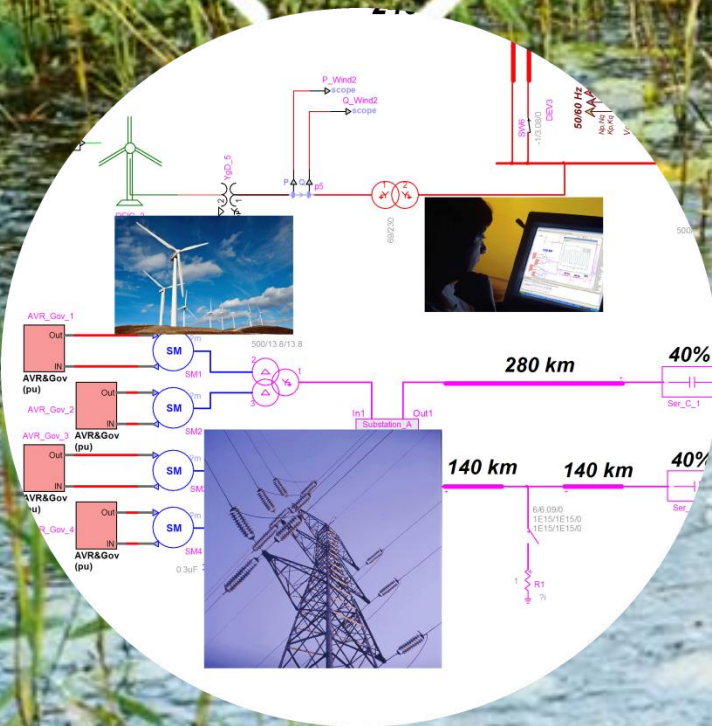


# Usage of EMTP-RV for Nuclear Power Plant Studies

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CHANGER L'ÉNERGIE ENSEMBLE

# Schedule of the presentation

**1. Introduction**

**2. Qualification of the software**

**3. The preparation of models for nuclear plants system modelling**

**4. Perspectives**

# Introduction

Nuclear plants include a huge number of very different and complex electrical components.

Most of these components interact together.

Stakes are very high in terms of availability, reliability, life span and safety.

It is necessary to prove that software programs used for numerical simulation work adequately. This is the role of the qualification.

# The Qualification of EMTP-RV

The **qualification** is to be conducted field of application by field of application.

Or

for each study which is not part of a field of applications already covered by the **qualification**.

Performance of the qualification : the results of the software are compared on test cases with :

- field measurements,
- results from other software programs,
- analytical calculations, etc.

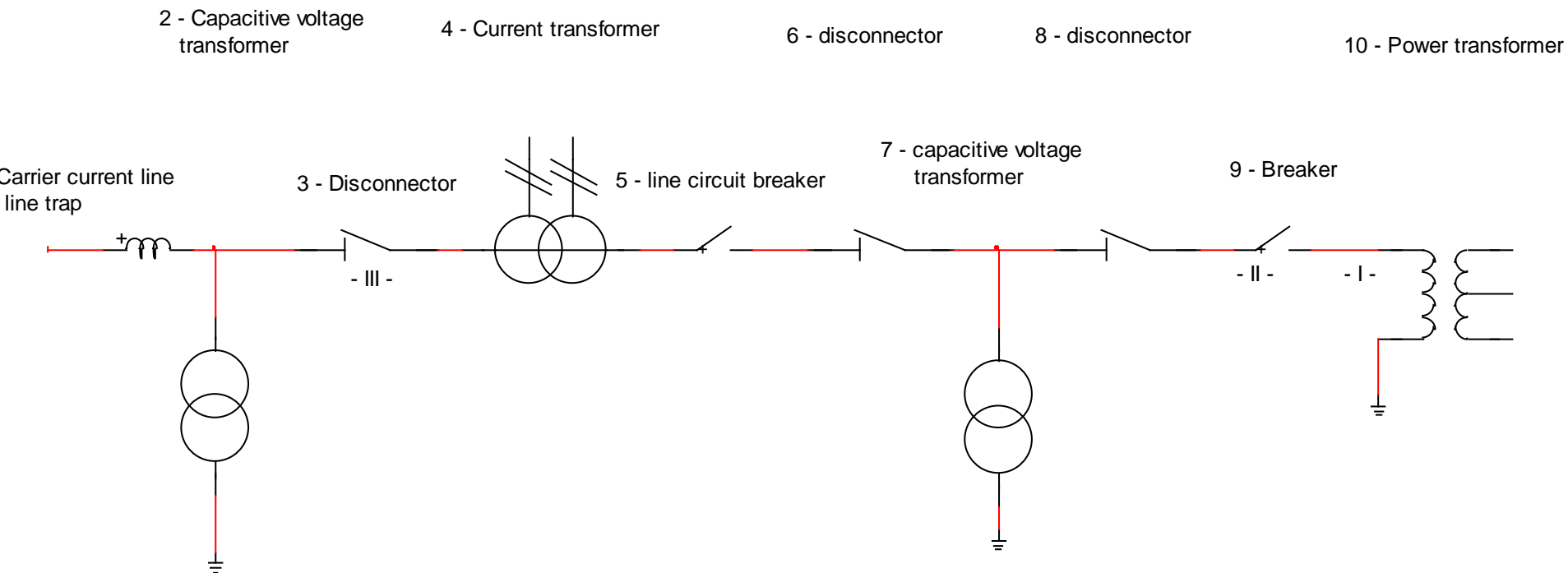
# The qualification of EMTP-RV

In 2011, EMTP-RV version 2.1 was qualified for **fast-front-overvoltage** studies (lightning) ;

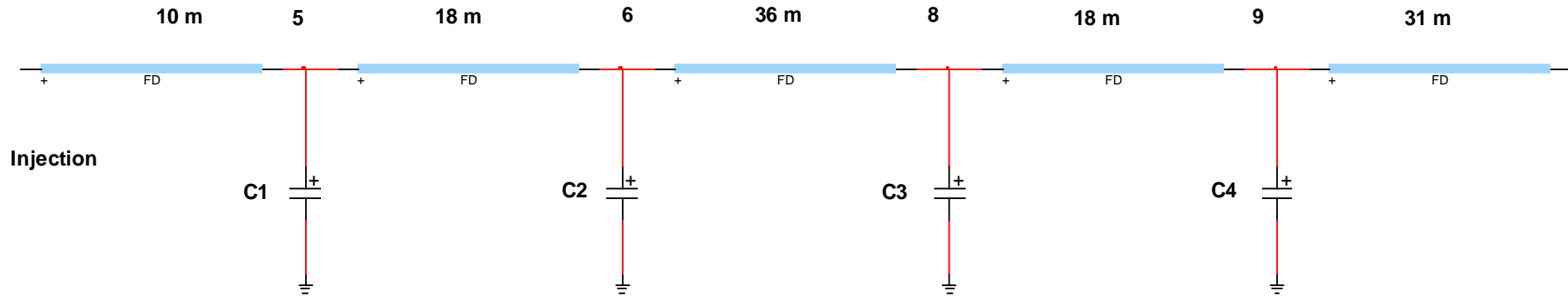
In 2012, the qualification of the **low frequency transformer models** of EMTP-RV is in preparation.

# Example of Test Case – FFO measurements in the substation of Avalon

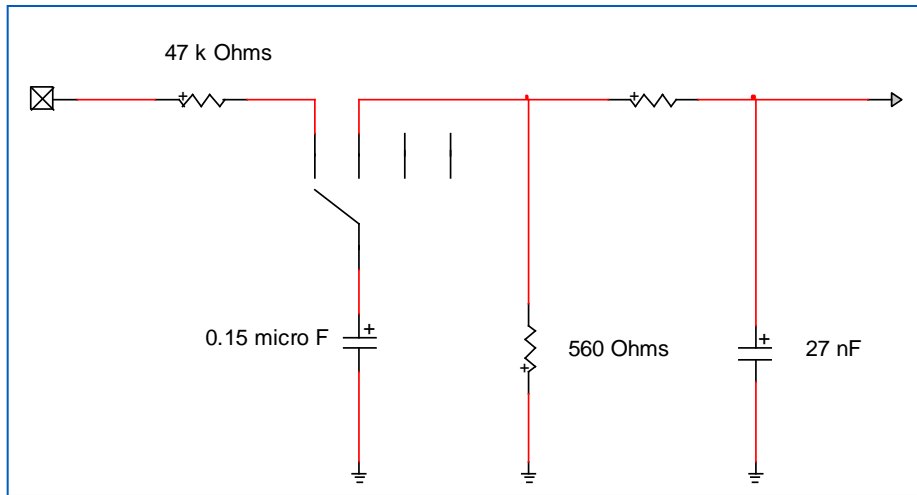
This is an outdoor substation 245 / 63 / 20 kV. This is a 2-busbar substation. When the tests are performed only one line and one transformer are available.



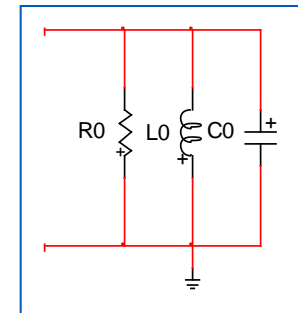
# Modeling of the substation



Capacitance	value (pF)
C1 – circuit breaker at 5	100
C2 – capacitance of the disconnector at 6	50
C3 – capacitance of the disconnector at 8	100
C4 – capacitance of the circuit breaker at 9	50



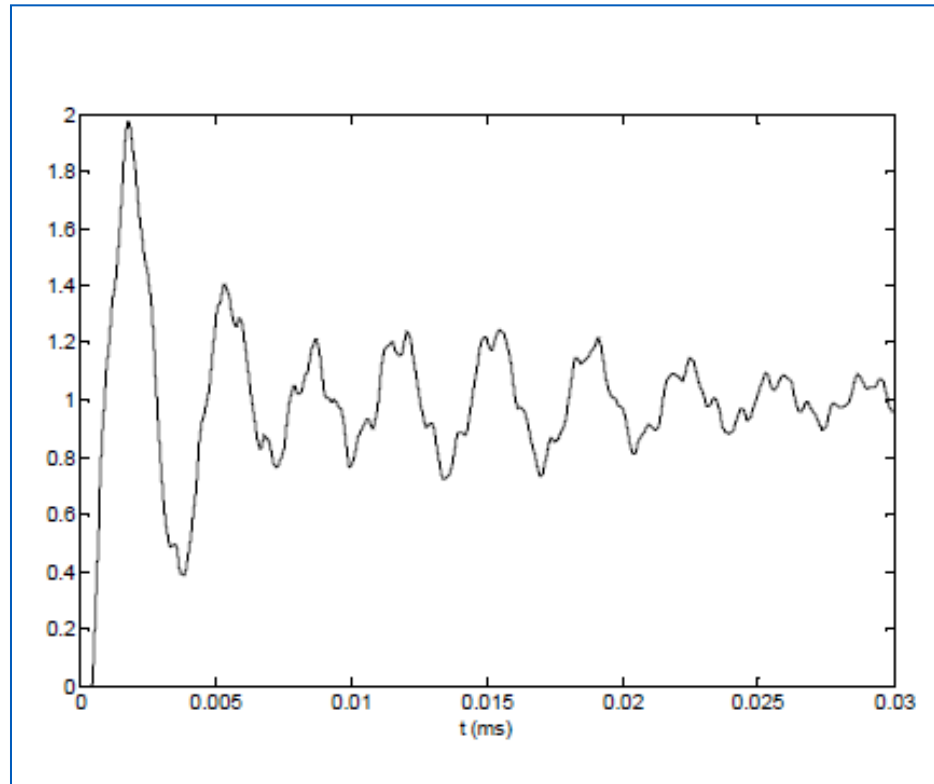
**Representation of the pulse generator**



**Representation of the transformer**



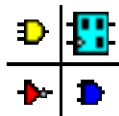
# Injection of an homopolar pulse at point 3



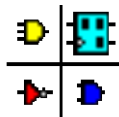
	EMTP-RV	Measurements
Pseudo-frequency	289 kHz	296 kHz
Crest value	2 pu.	1.9 p.u.

# 3 – Models for nuclear plants system

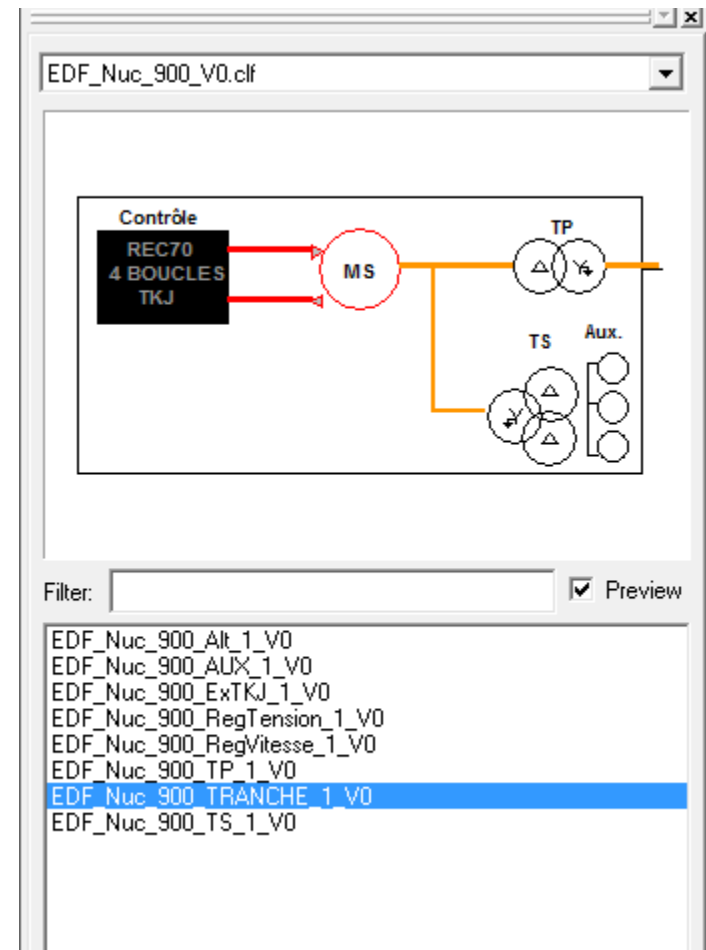
## ▶ Libraries



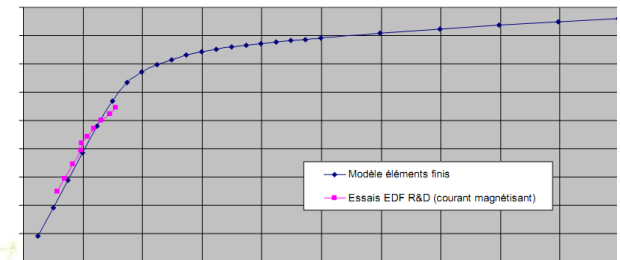
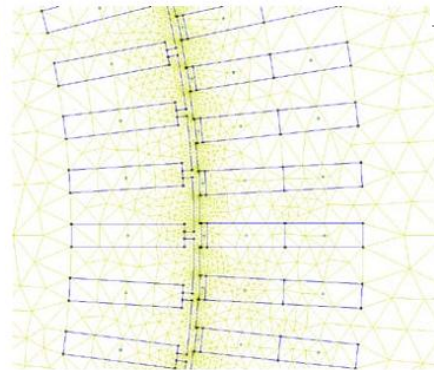
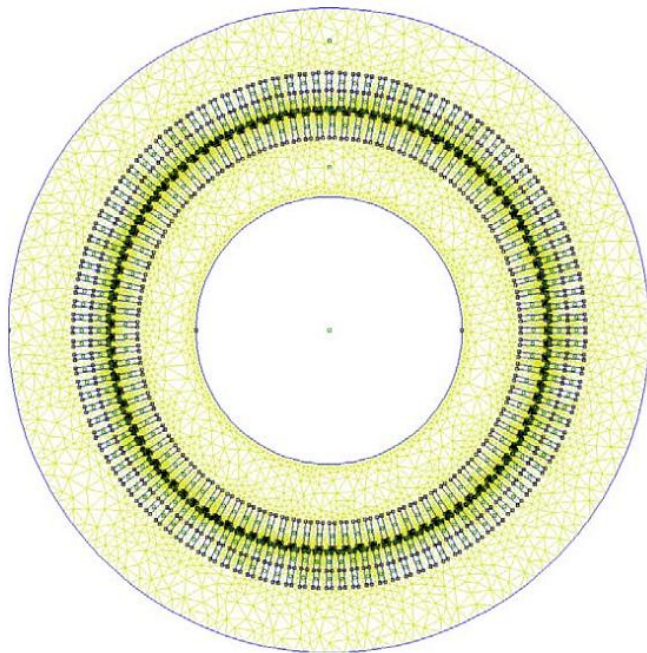
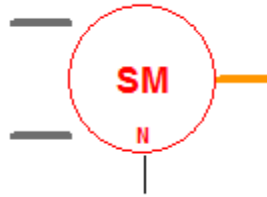
EDF\_Nuc\_900MW.clf



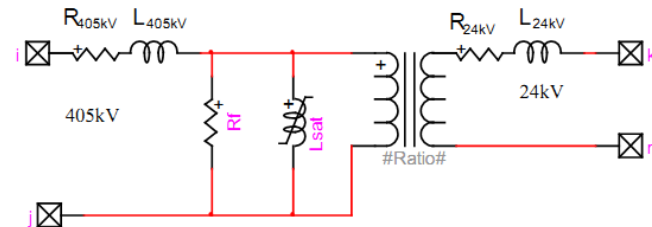
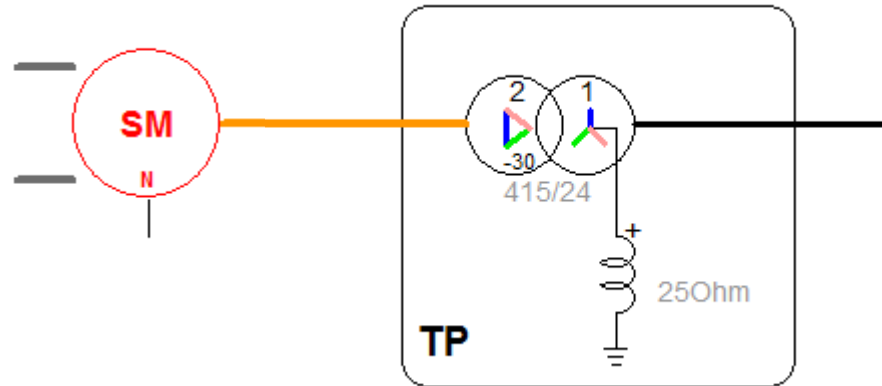
EDF\_Nuc\_1300MW.clf



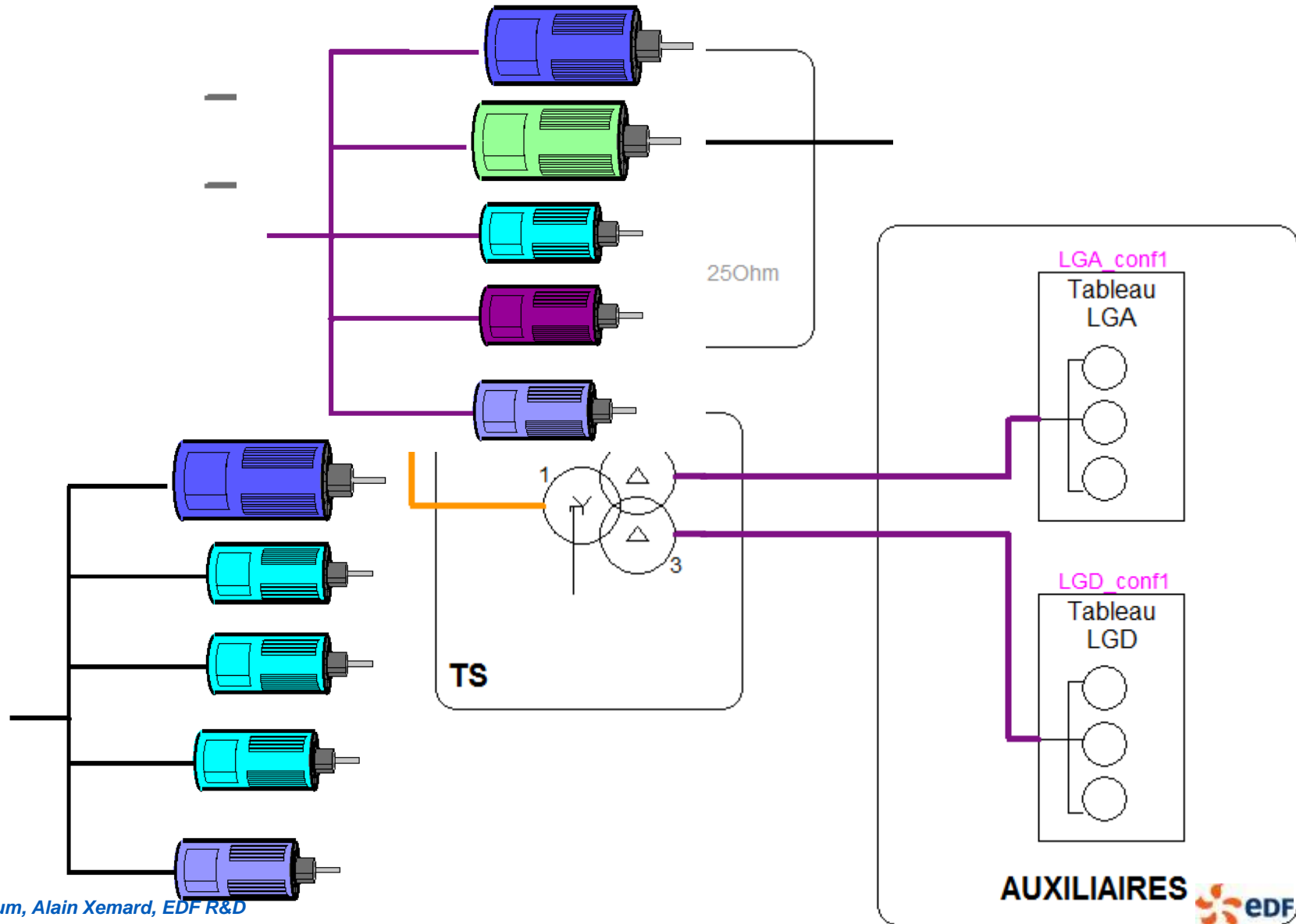
# 3.1 – Turbo-generator



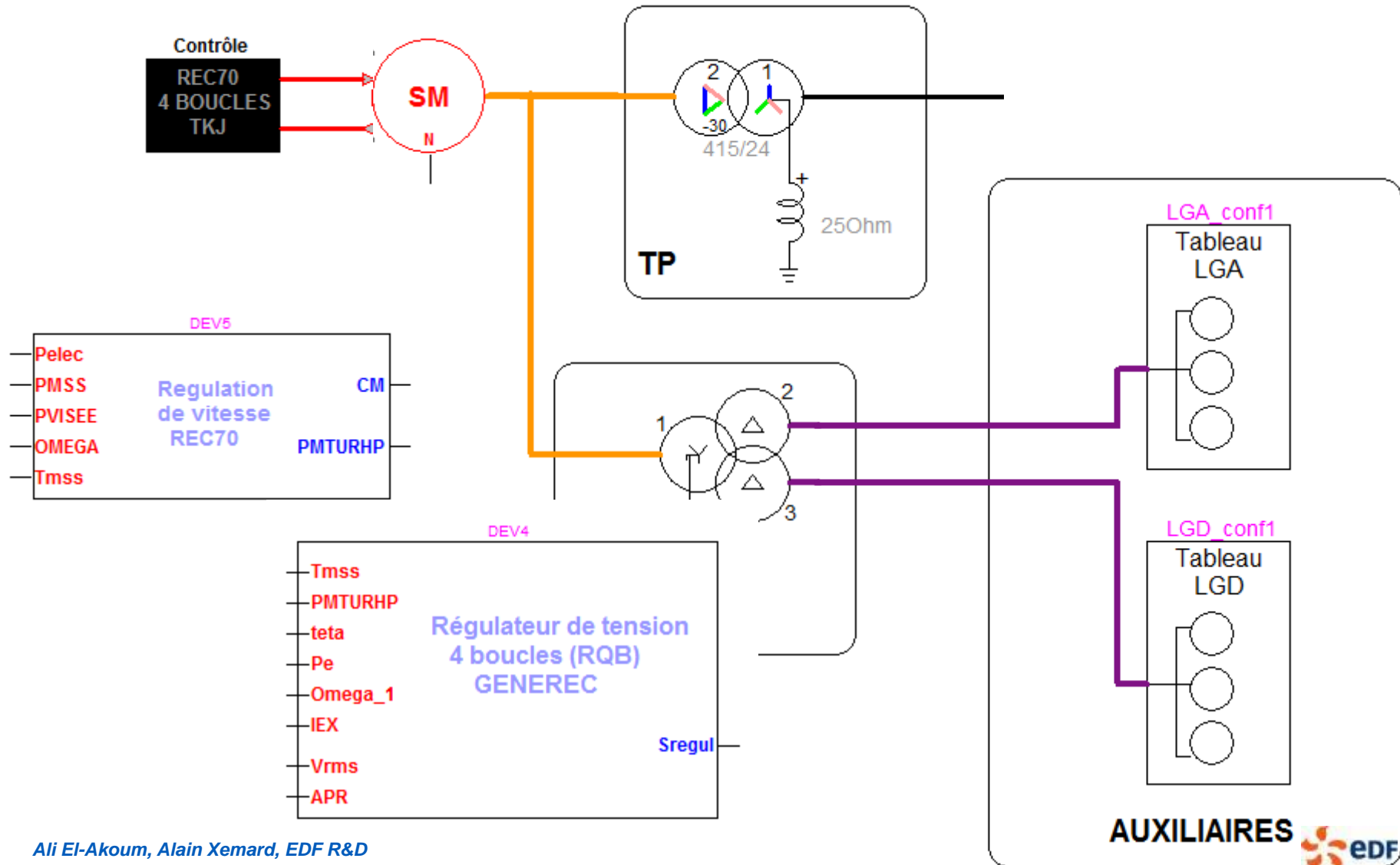
## 3.2 – Main transformer



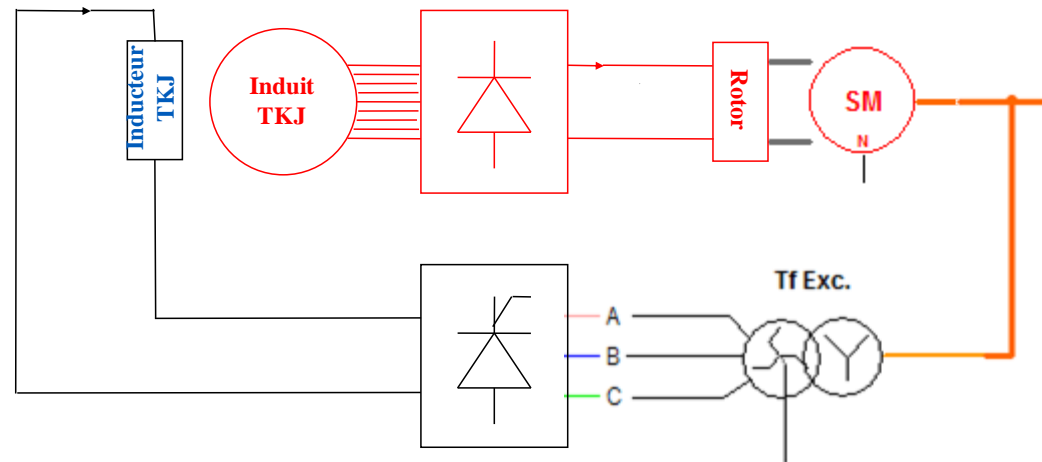
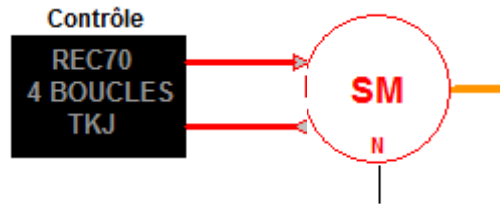
# 3.3 – Auxiliary systems



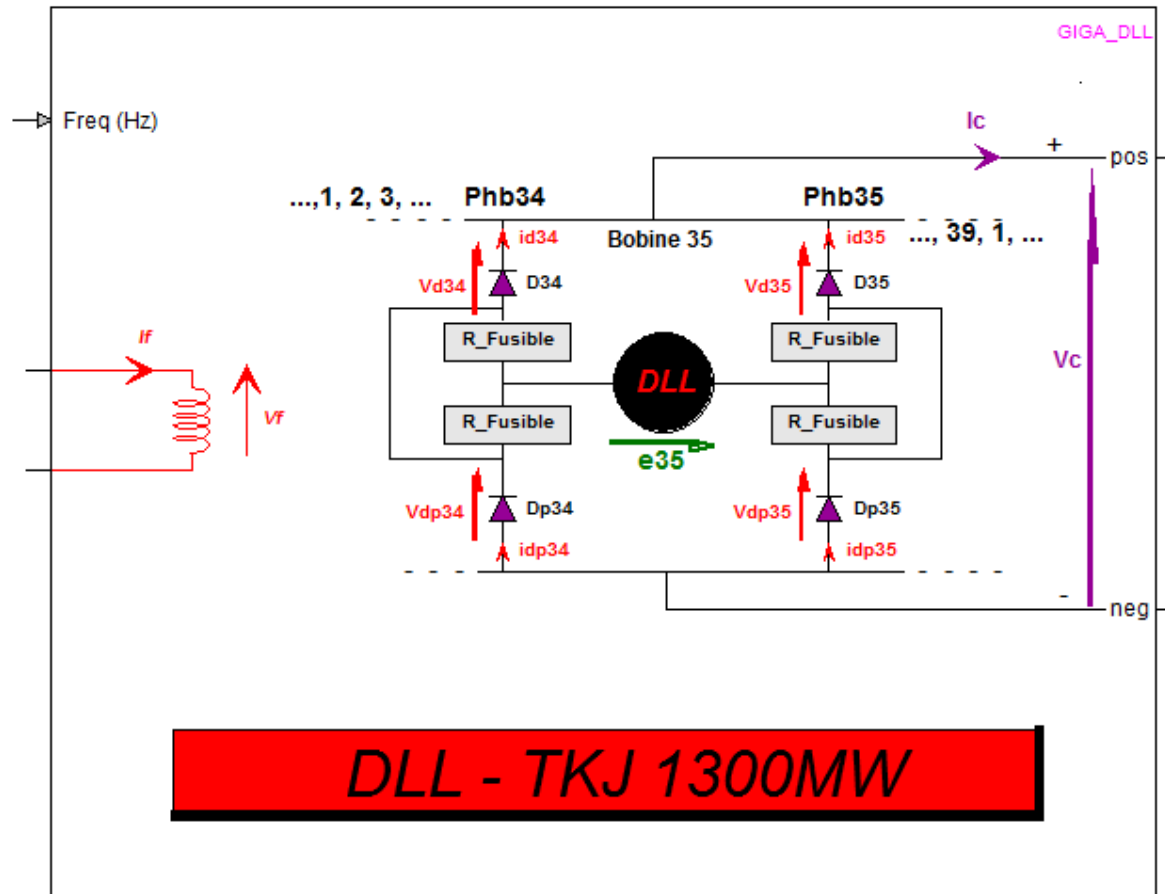
# 3.4 – Regulators and protections



# 3.5 – Excitation system

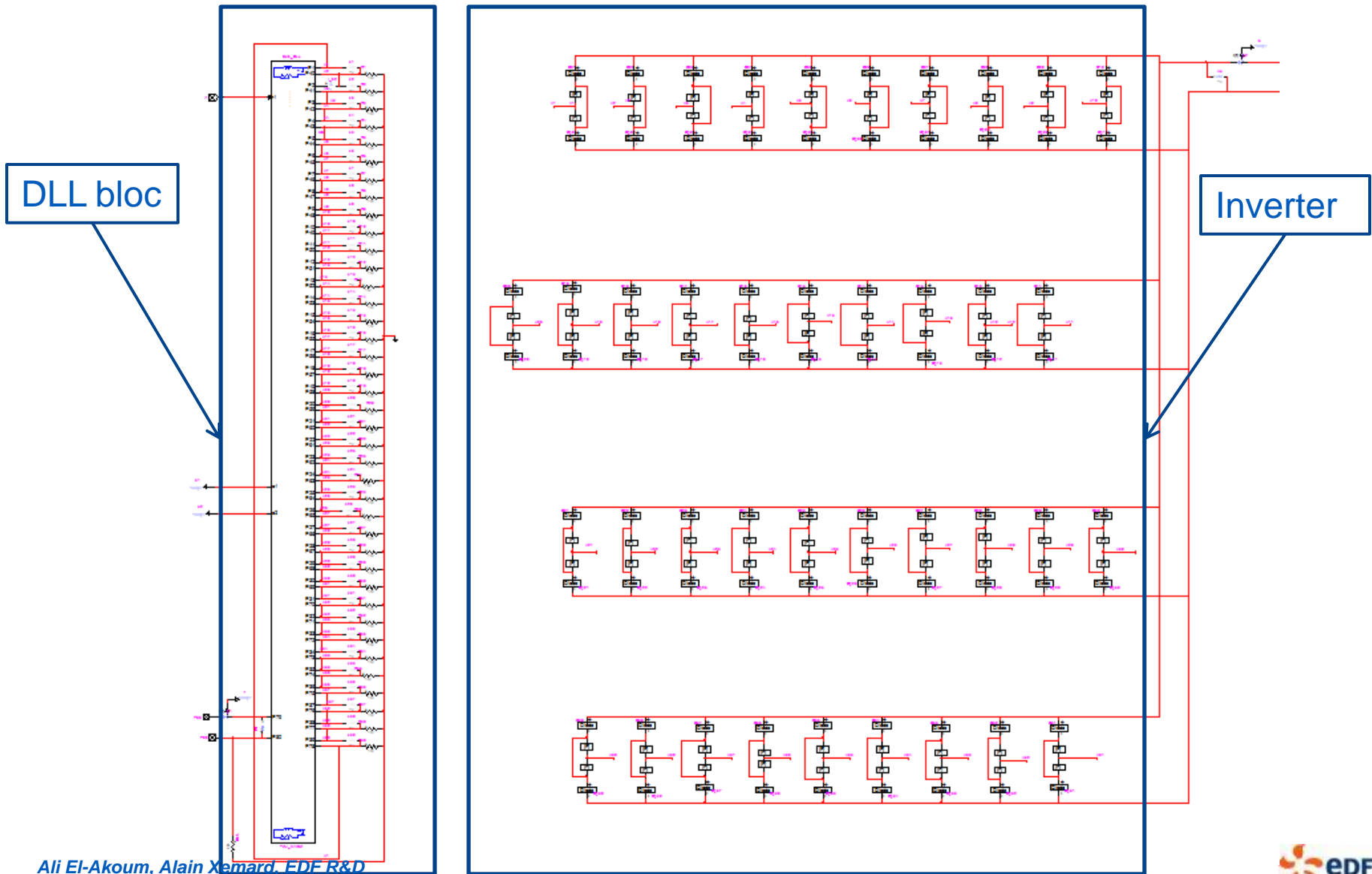


# 3.5 – Excitation system





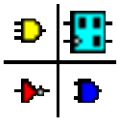
# 3.5 – Excitation system



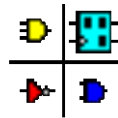
# 4 – Perspectives

## ▶ Work in progress / futur work:

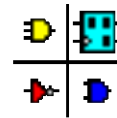
- New synchronous machine models (phasors domain approach);
- Co-simulation ;
- Finite elements methods (Saturation, self inductance ...);
- Libraries :



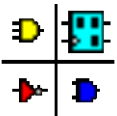
EDF\_Nuc\_900MW.clf



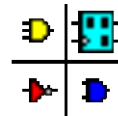
EDF\_Thermal.clf



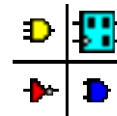
EDF\_Wind\_Power.clf



EDF\_Nuc\_1300MW.clf



EDF\_hydroelectric.clf



EDF\_solar.clf



**Questions ?**

# Thank you for your attention!

