SIMOUEST 2002 Marine Application for ACOTRIS Project (1)

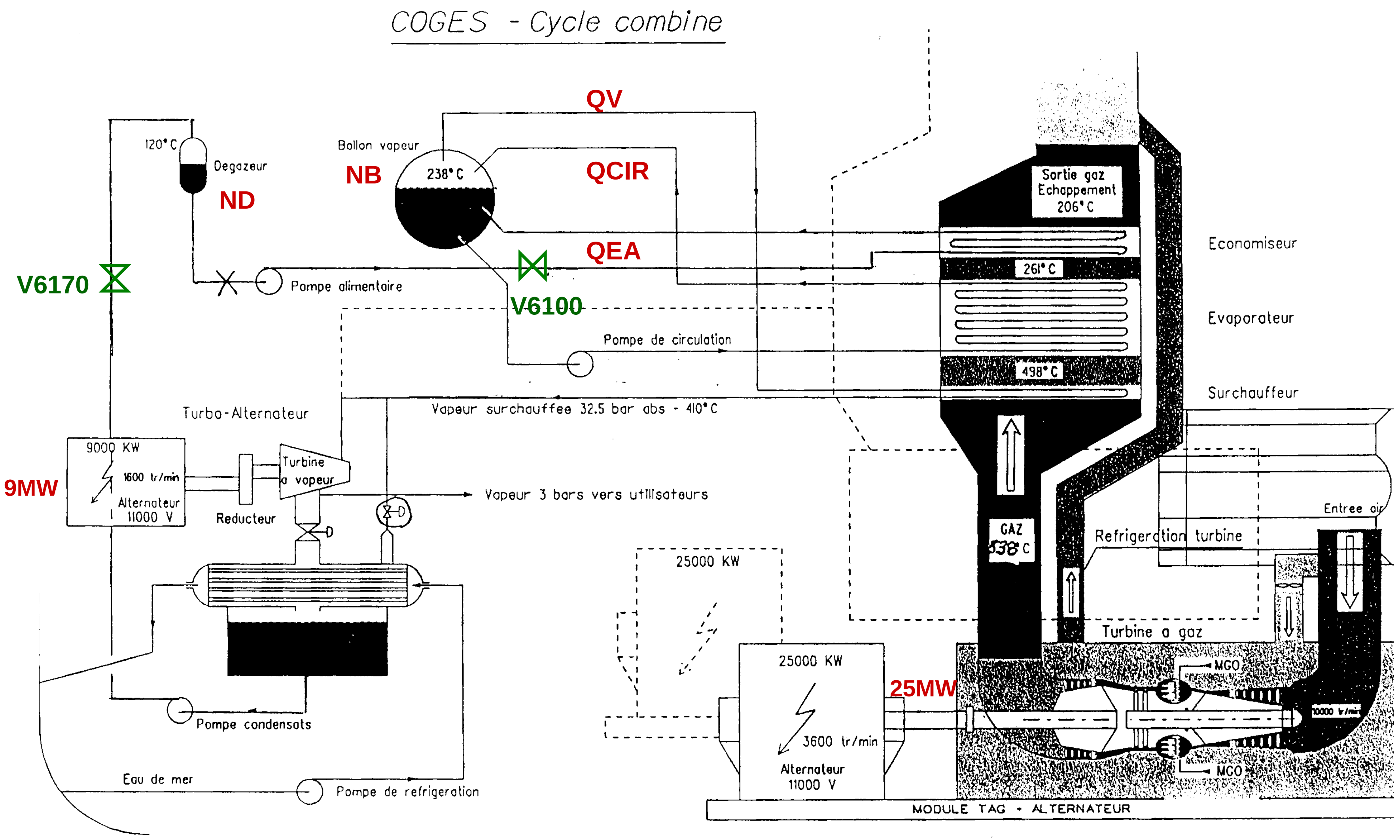
CS & SITIA & CAT

(1) http://www.acotris.c-s.fr

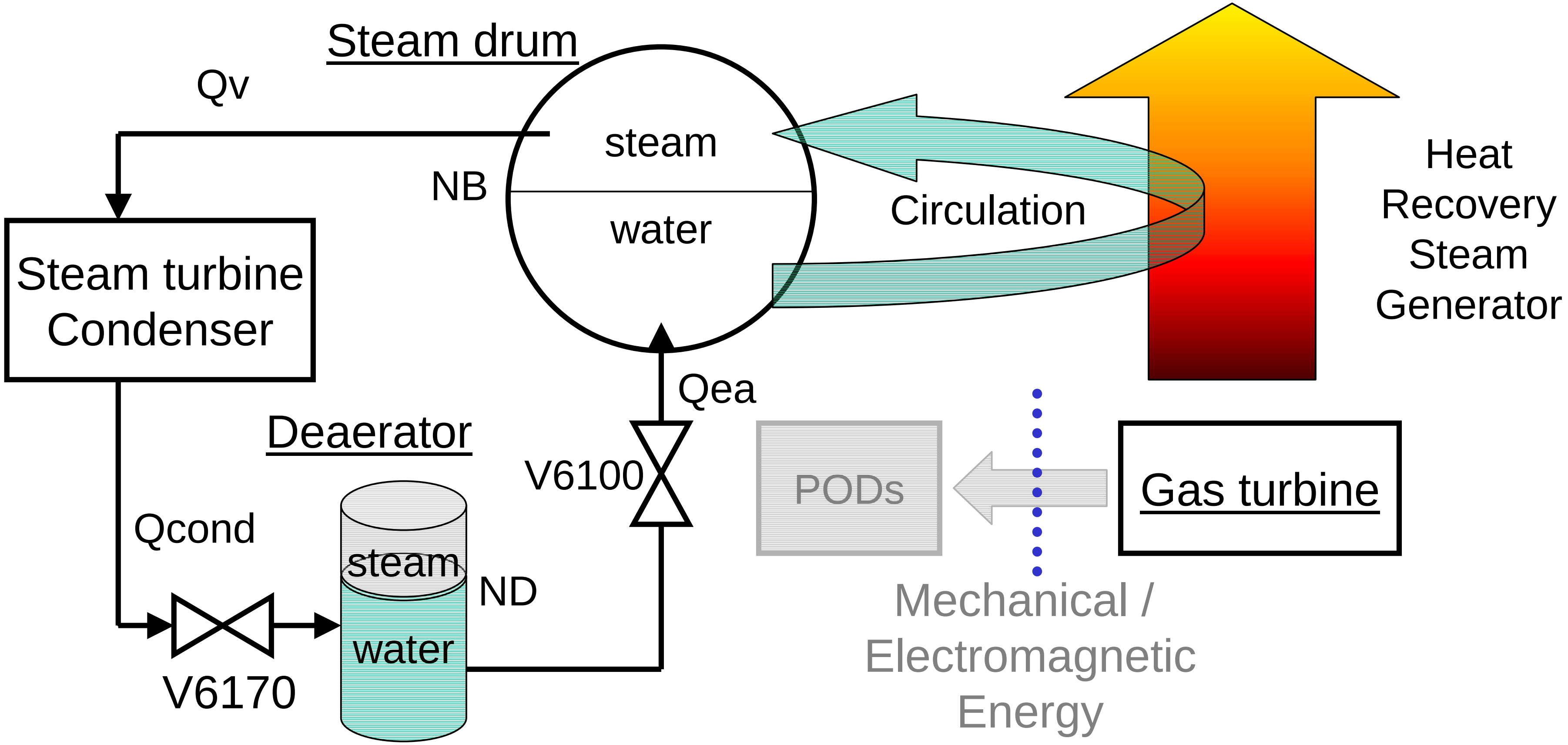
SUMMARY

The marine application general presentation
UML and Signal development
Introducing the demonstration

The marine application general presentation


COGES - Cycle combine
QV
QCIR
QEA
NB
ND
V6170
V6100
9MW
25MW
120°C
Degazeur
Bollon vapeur
238°C
Pompe alimentaire
Pompe de circulation
Sortie gaz
Echappement
206°C
261°C
498°C
Economiseur
Evaporateur
Surchauffeur
Turbo-Alternateur
Vapeur surchauffee 32.5 bar abs - 410°C
9000 KW
1600 tr/min
Alternateur
11000 V
Turbine a vapeur
Reducteur
Vapeur 3 bars vers utilisateurs
Entree air
Refrigeration turbine
GAZ
25000 KW
Turbine a gaz
MGO
3600 tr/min
Alternateur
11000 V
Pompe condensats
Eau de mer
Pompe de refrigeration
MODULE TAG - ALTERNATEUR

Combined Process : general scheme



Some power propulsion units elements modelling

For the ACOTRIS Project, we are focusing on the following

- Steam drum and its control system : level regulation (BAL, CCBAL)
- Deaerator and its control system : level regulation (DEG, CCDEG)
- Gas turbine and its control system : speed and power regulation (TAG, CCTAG)

The Process

Steam drum modelling

- Process : based on real measurements and identification methods

Deaerator modelling

- Process : knowledge modelling + compared with the sea trials

Gas turbine modelling

- Process : internal modelling (SITIA library + CAT advices)

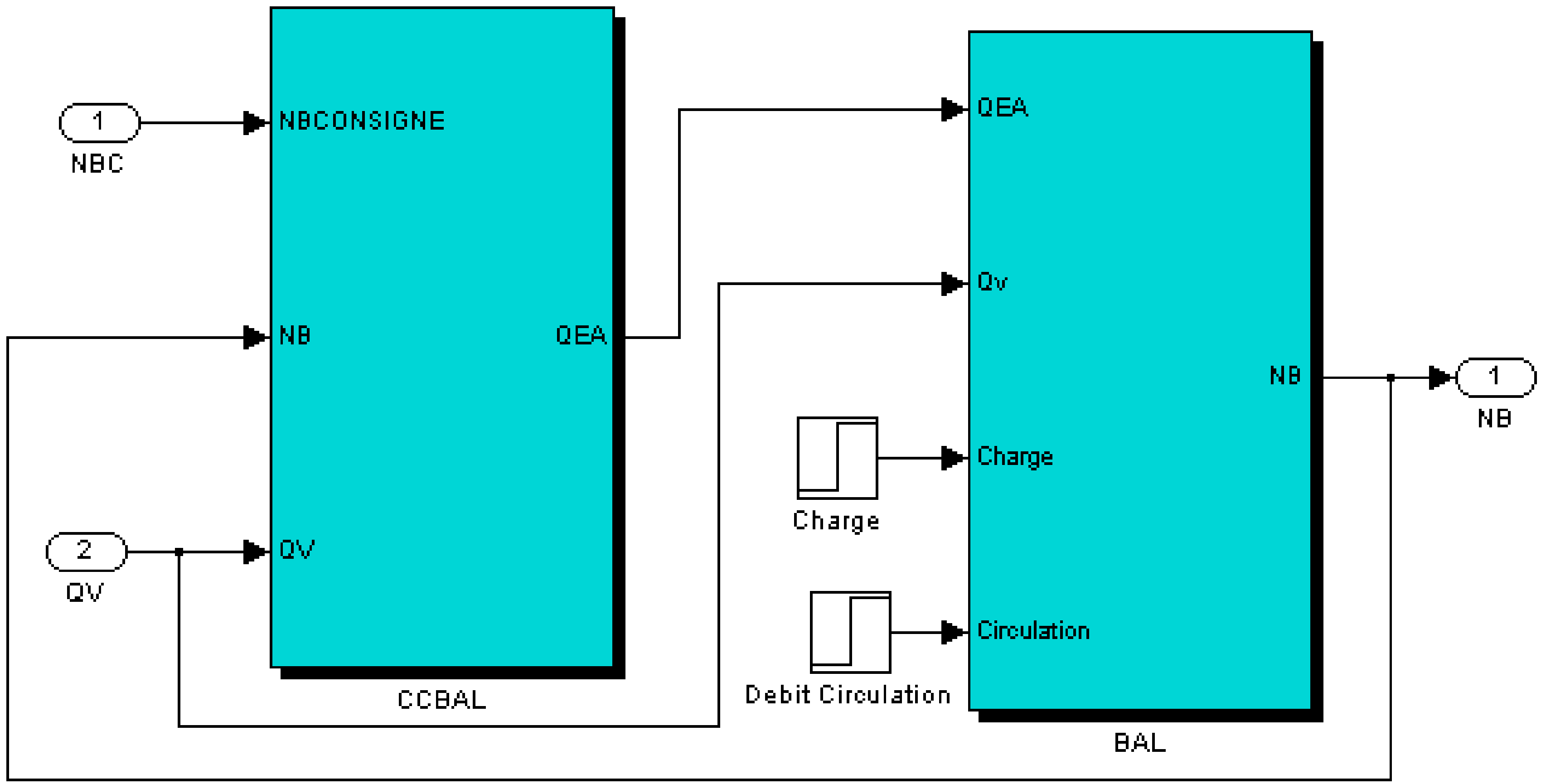
The Control Systems

Given by CAT

Process and continuous control systems knowledge and validation

- Development and simulation under Matlab/Simulink and Scilab/Scicos

Steam drum process and its control system block schemes



System equations

Transfer Function NB/QEA identification
Based on real measurements and identification methods

$$\frac{NB}{QEA}(p) = G(p) = \frac{Kg \cdot KcorG}{Gb_3 \cdot p^3 + Gb_2 \cdot p^2 + Gb_1 \cdot p}$$

where p denotes the Laplace variable

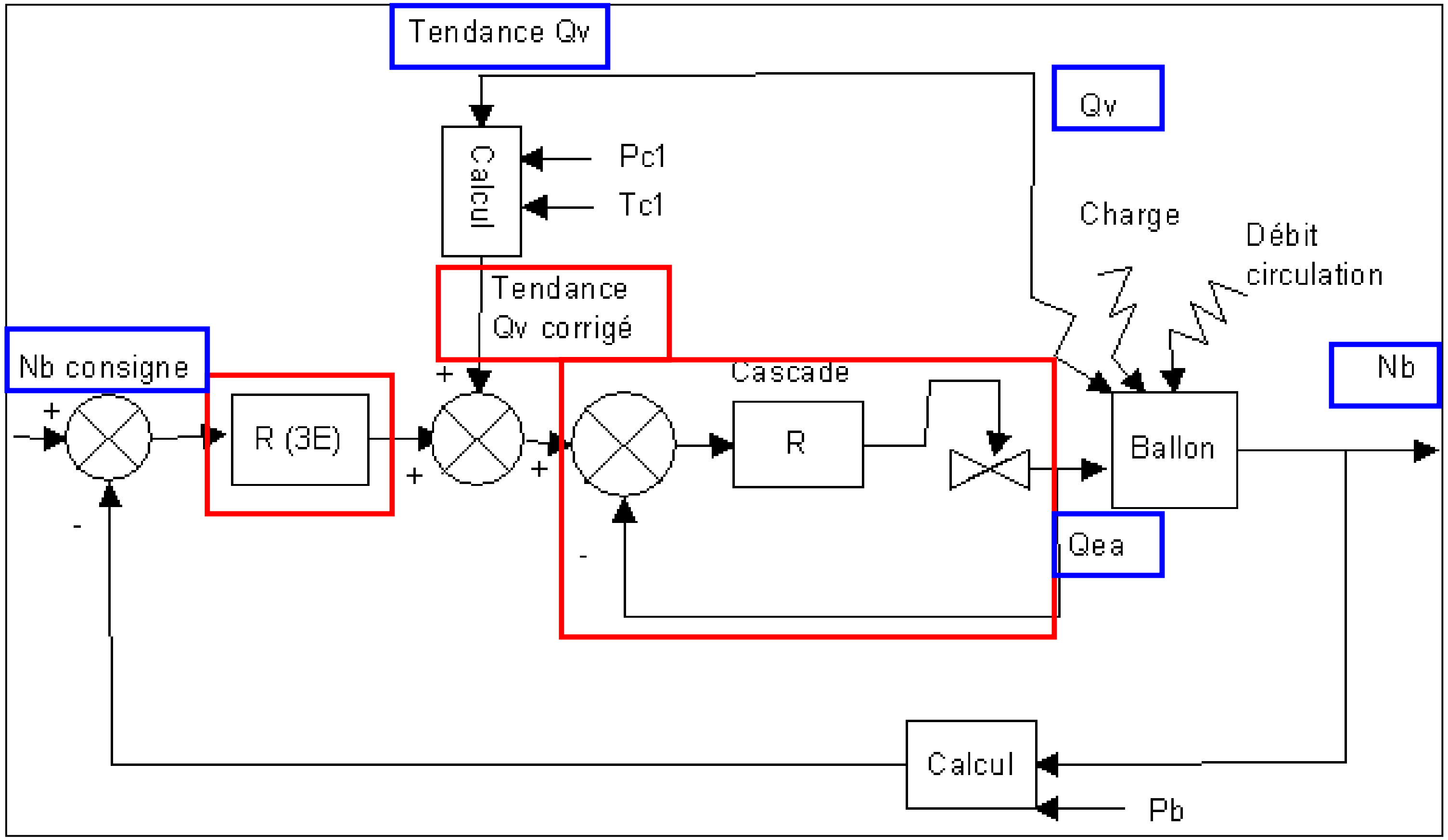
Transfer Function NB/QV identification
Based on knowledge modelling and real measurements

$$\frac{NB}{Qv}(p) = F(p) = \frac{Kf \cdot [1 - To \cdot p]}{Fb_3 \cdot p^3 + Fb_2 \cdot p^2 + Fb_1 \cdot p}$$

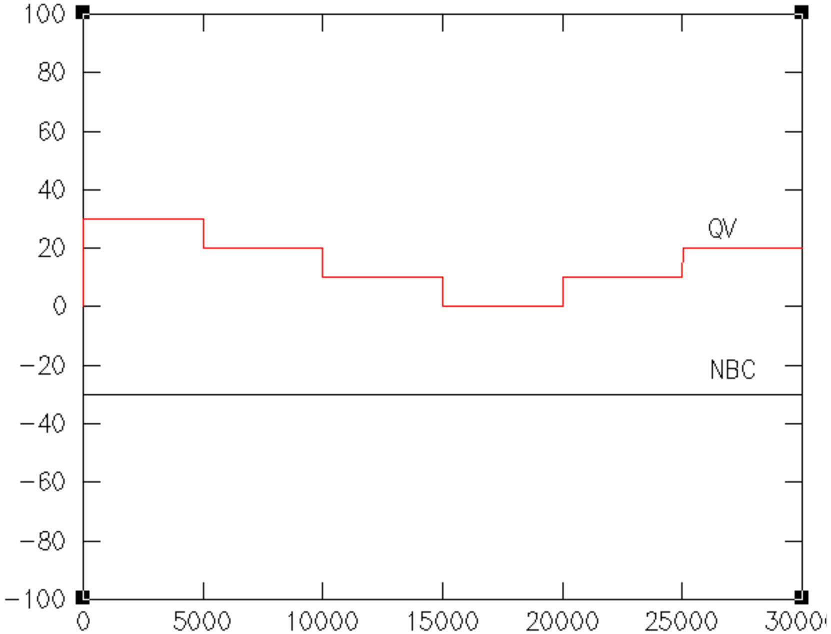
where p denotes the Laplace variable

Identification method used
State-space models estimation by maximum likelihood method (ECN)

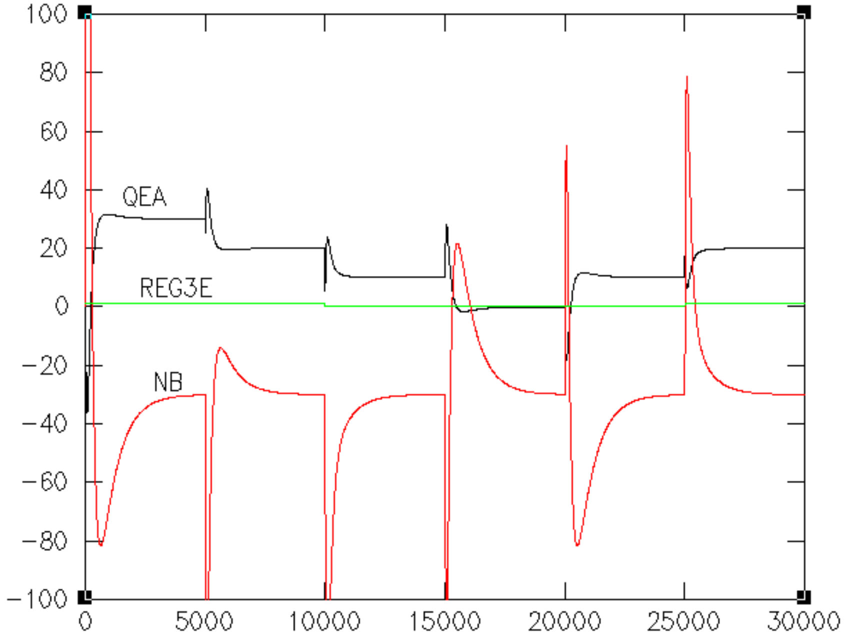
Steam drum level control system : PI regulators, under the steam flows given by : Chantiers de l'ATlantique (CAT)



Simulation under Scicos



Input signals



Outputs and control variables

Development under UML and Signal

Modelling the steam drum control law under UML

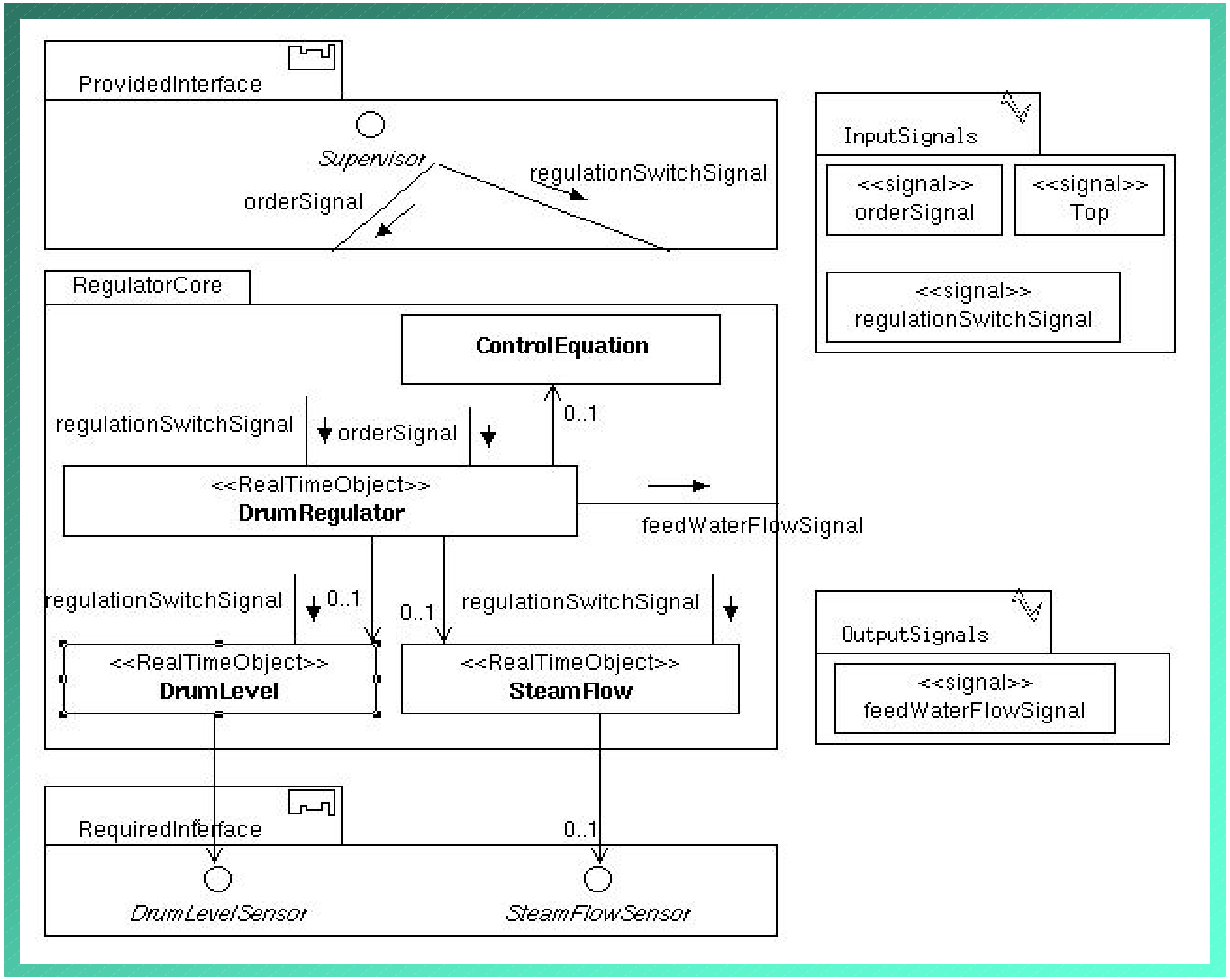
Modelling following Methodology ACCORD-UML

- Using the Objecteering Workshop + ACCORD profiles (CEA)

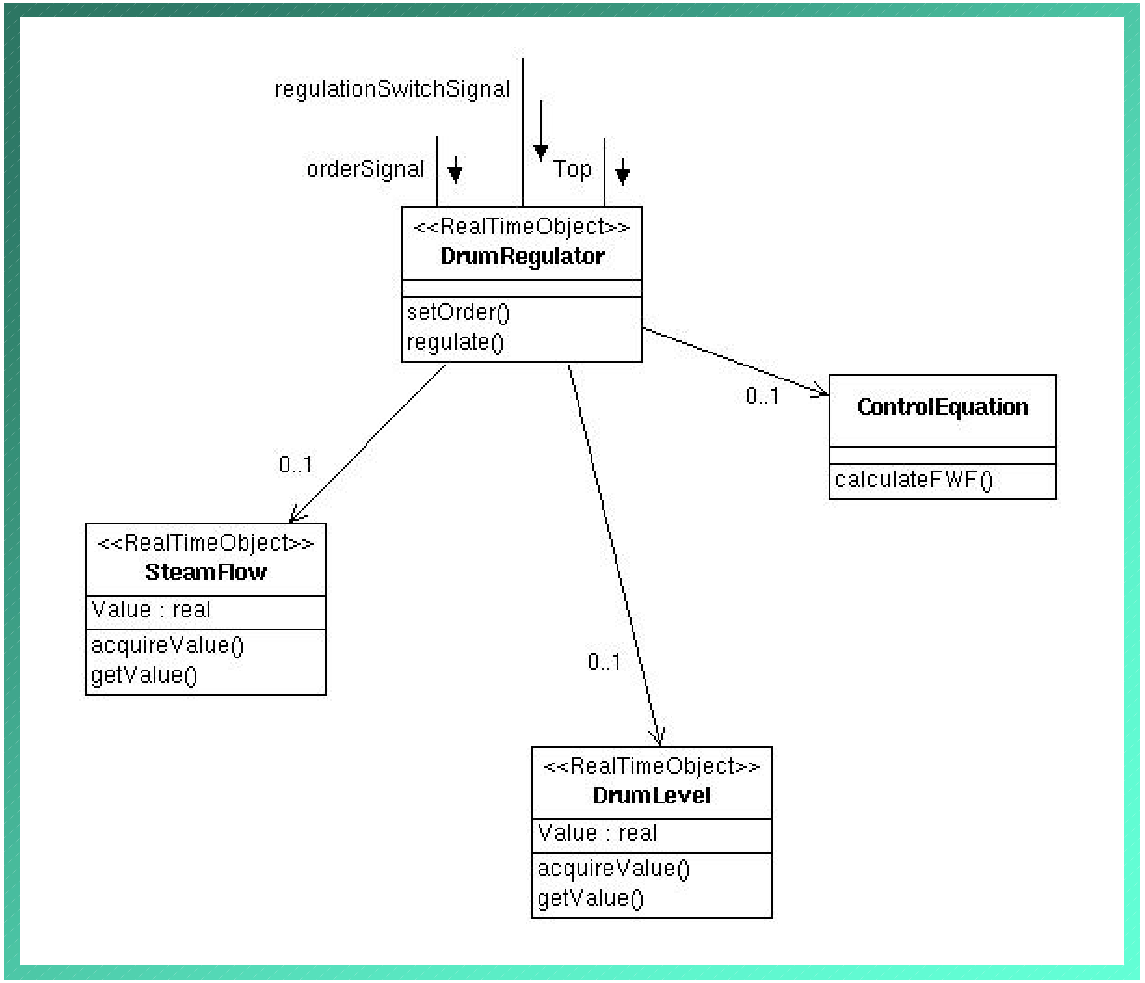
Main points of the control system needs

- To note the steam drum level measure (given from the level sensor)
- To note the steam flow disturbance measure (given from the flow sensor)
- To note the level setpoint (given from the supervisor)
- To periodicaly compute the control law (send to the valve)

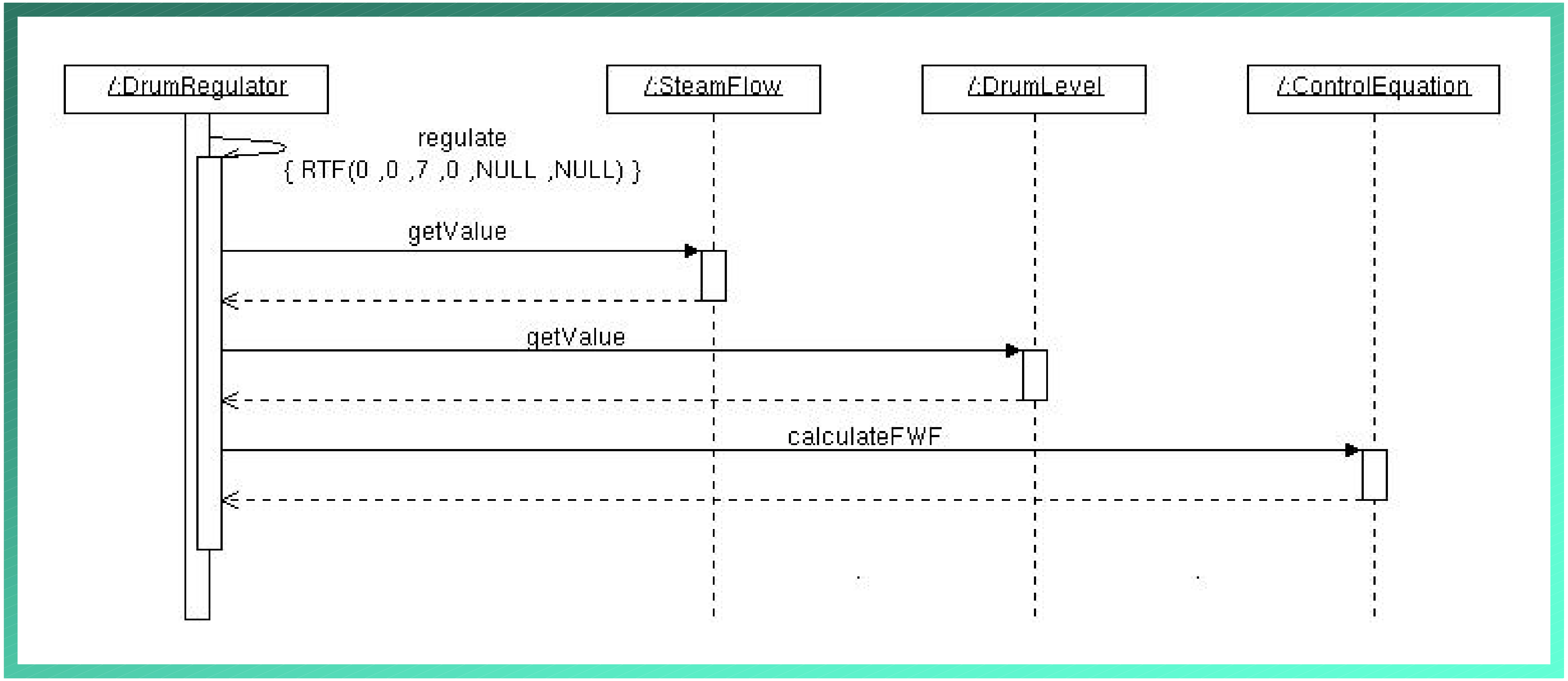
Steam drum Control System Class diagram



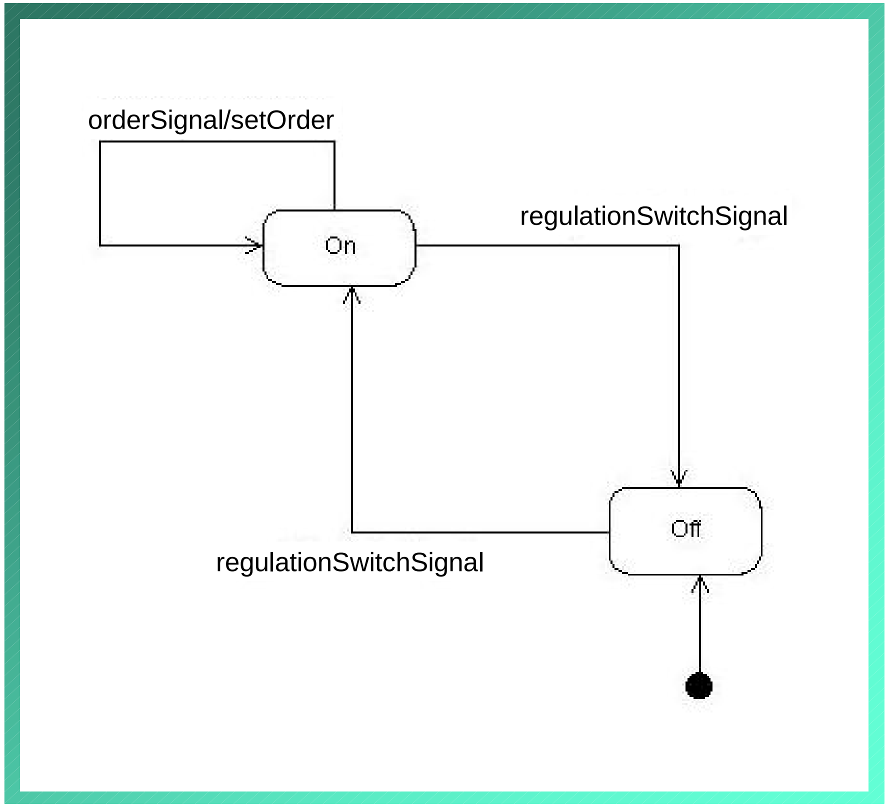
Steam drum Control System detailed Class diagram



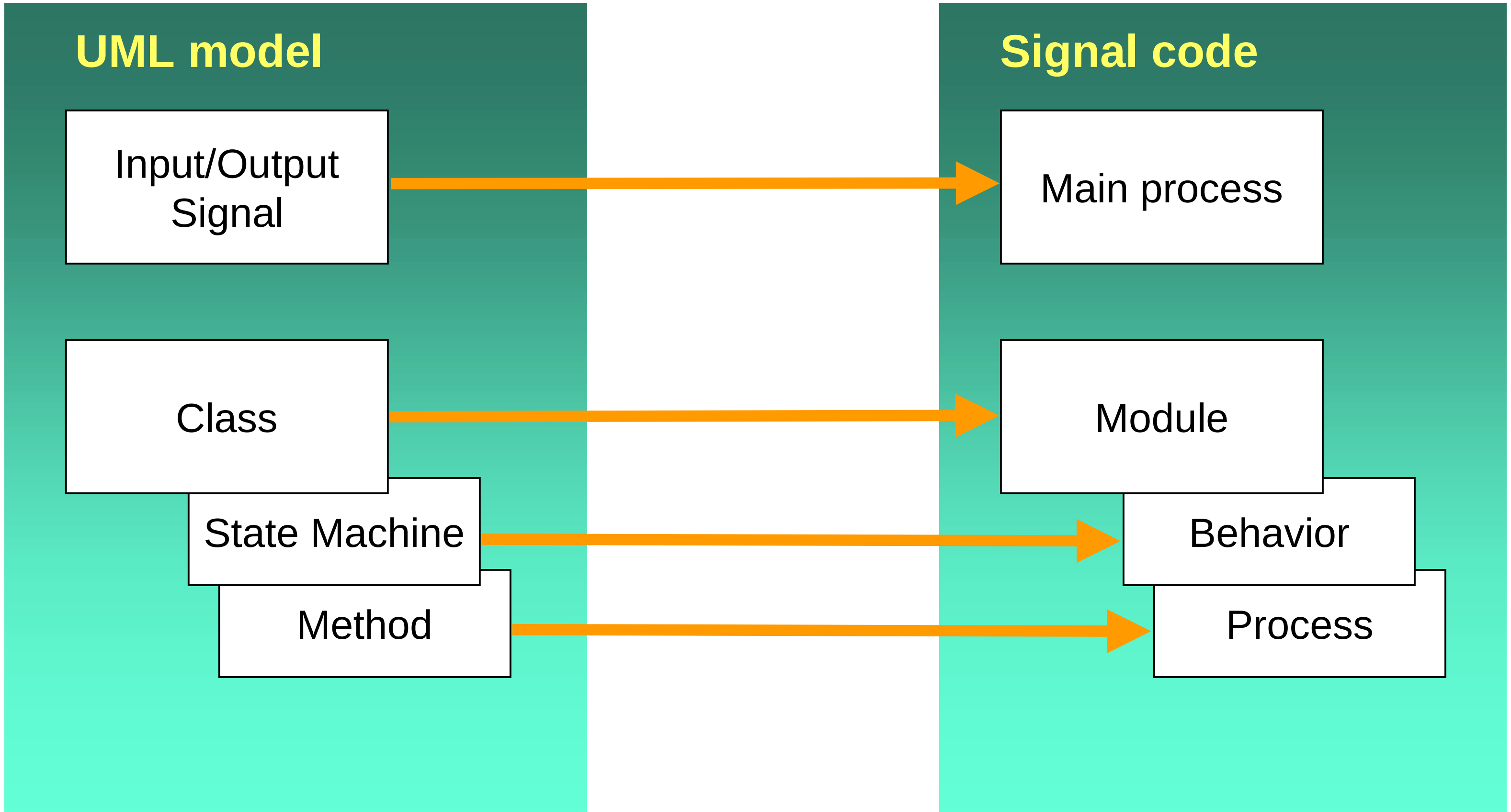
“Regulate” Sequence diagram



“RegulatorCore” class State Diagram



UML toward Signal translation



Demonstration

ANNEXE

Control laws

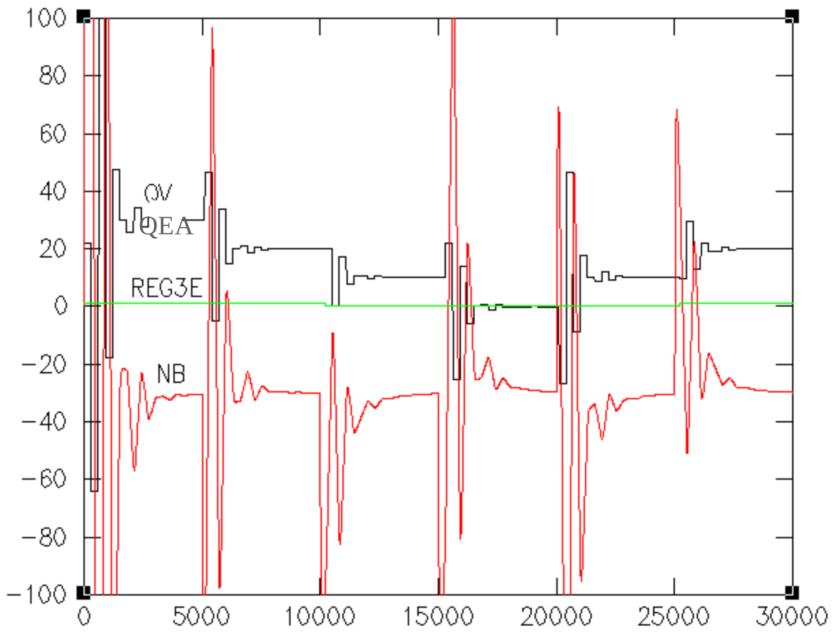
The regulation is realised by a three element control loop (regulation 3E) for important steam flows (when : Qv>QvSeuil)

$$QEA = \frac{1}{KcorG}\left(Kp + \frac{1}{Ti \cdot p}\right)(NBC - NB) + Qv$$

where KcorG, Kp and Ti are some parameters

The level is controlled only by the drum level (regulation 1E) when the steam flow is below than 30% (say : Qv<QvSeuil)

$$QEA = \frac{1}{KcorG}\left(Kp + \frac{1}{Ti \cdot p}\right)(NBC - NB)$$



Process and control simulation with : Te = 300s

Effects of Te increase

(Te is the sample period of the discrete state-space control law)

- First overshoot worst
- Some oscillations appear
- Stability problems

Rules to choose the sample period

- It is not (directly) Shannon theoreme
- Consider a discrete state-space and closed loop control law

- the sample period Te must be « a lot more smaller than » the response time Tr of the closed-loop process :

*0.01*Tr < Te < 0.1*Tr*

- the response time of the closed-loop steam drum process :

Tr # 1500 sec. = 25 min →Te = 150s, 40s, 15s

- when Te > 100 sec. → numerical disturbations

“Acquire Drum Level” Sequence Diagram