

belsim

Electrabel
GDF SUEZ

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TIHANGE 3

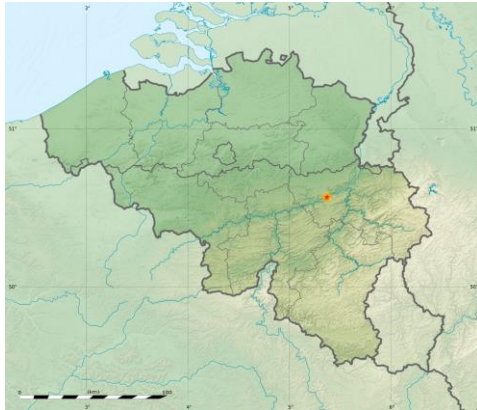
Nuclear Power Plant: Performance Monitoring

Content

- Company Profil
- Project Objectives
- Support Project
- DVR Benefits
 - Reliable Data
 - Performance Monitoring
- Conclusion
- Questions

Company Profile

- Electrabel – GDF Suez
- 30% Belgian Electricity Production
 - Tihange 1: PWR 965MW (1975)
 - Tihange 2: PWR 1008 MW (1983)
 - **Tihange 3: PWR 1054 MW (1985)**



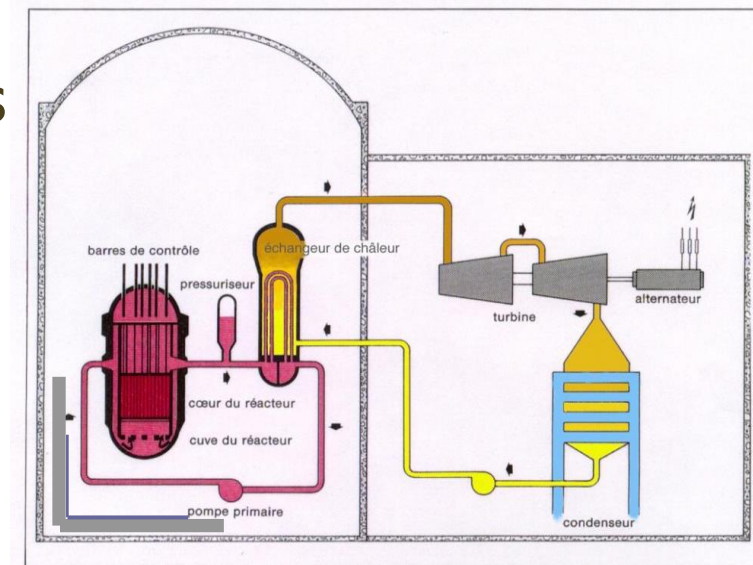
Project Objectives

- Objective n°1:

- Validation of raw measurements
 - Primary system
 - Secondary system
 - Tertiary system

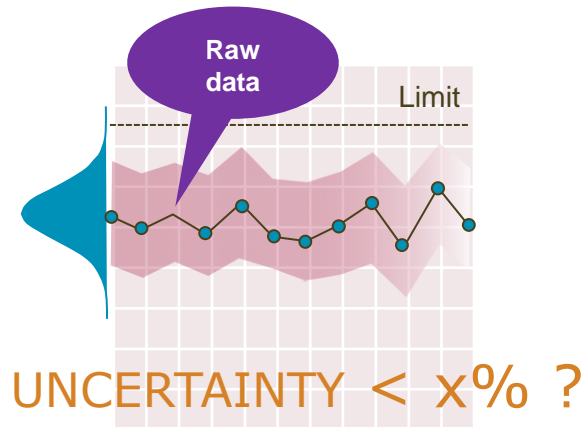
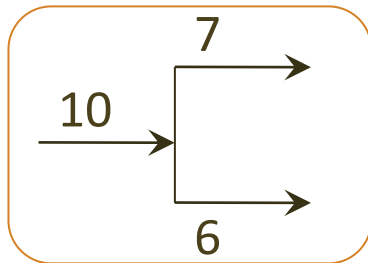
- Objective n°2:

- Improving the knowledge regarding the thermal balance based on reconciled values
- KPIs following and underlining the malfunction of the installation

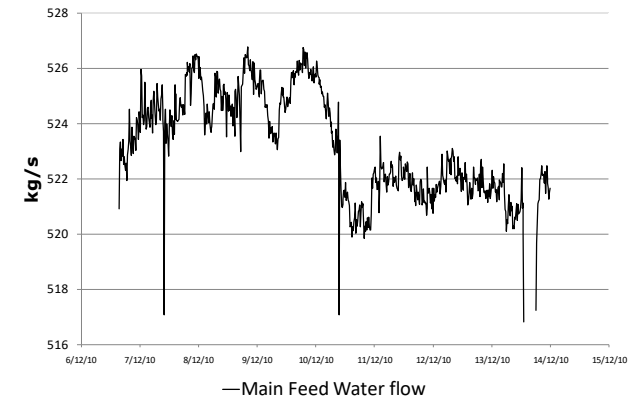


Objective n°1

COHERENCY?



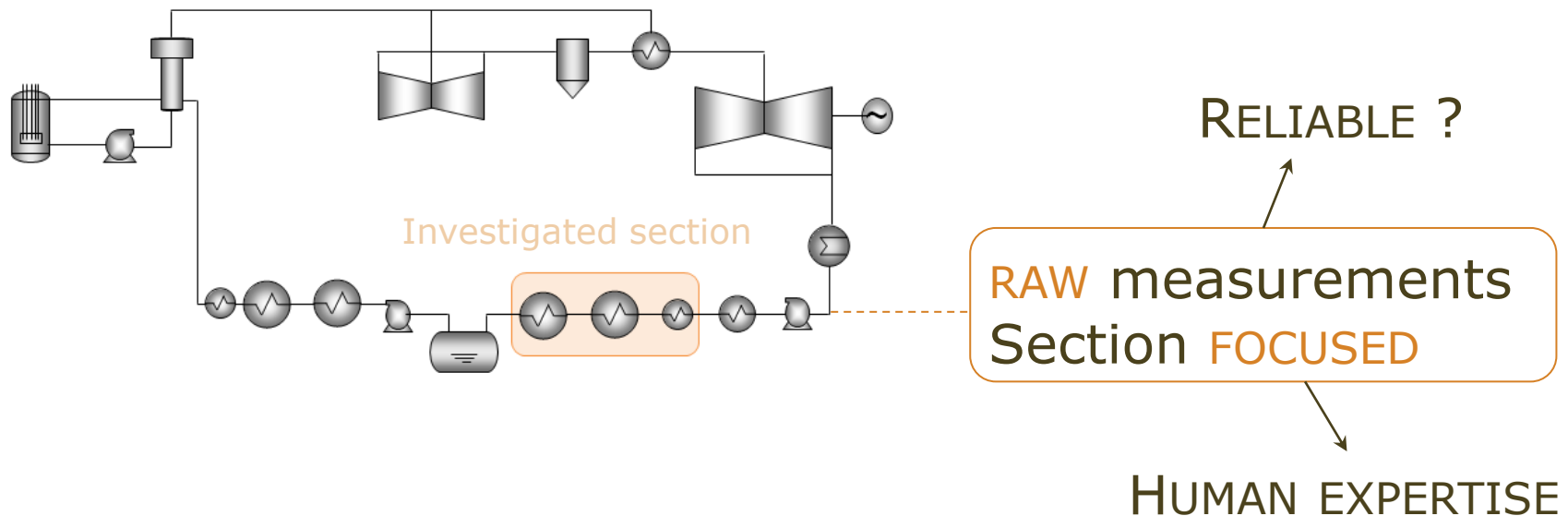
RELIABILITY?



- Heat and mass balances
- Measurement errors propagation
- Data reliability

Objective n°2

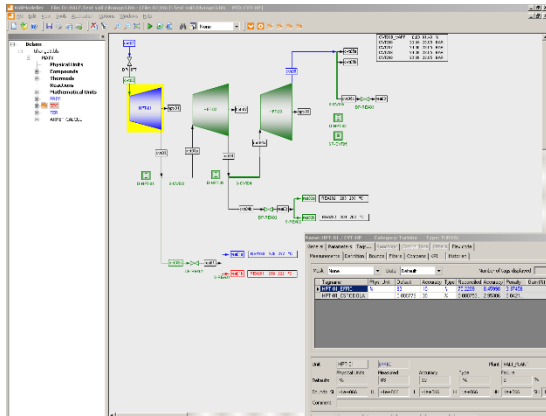
- Performance Monitoring being able to track at early stages
 - Inefficiencies and losses (equipment degradation, leakages, etc.)
 - Drifting Instrumentation



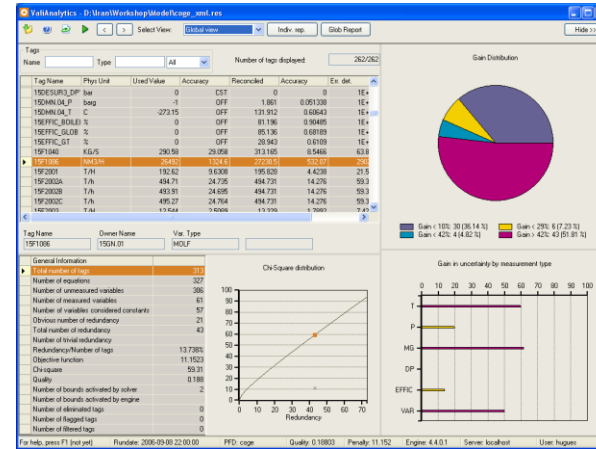
DVR Results: Heat & Mass Balance

- Online run each 15 min
- Close Mass & Heat balance
- No human manual input
- Clear and reliable view of the complete heat cycle
- Customized reports
- Quality of the model: 0,75
- Tags penalty below 4
- Main KPI uncertainty < 0.8%

VALI Solution

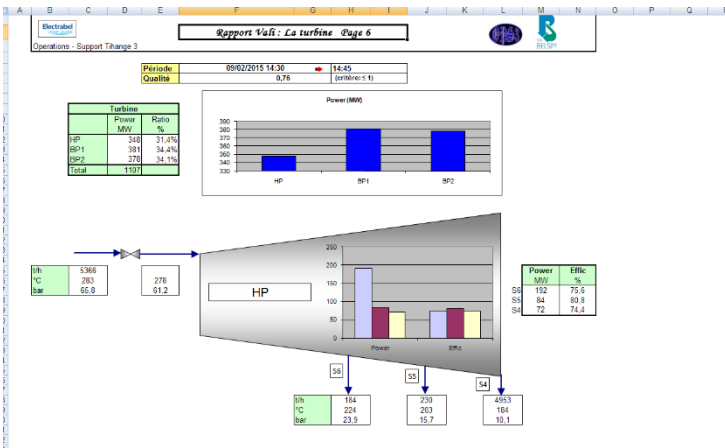


MODELING

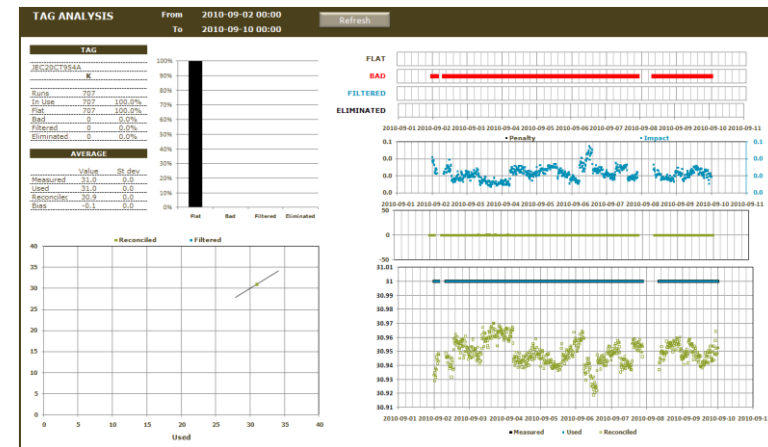


RESULTS ANALYSIS

REPORTING



PERFORMANCE ANALYSIS



Project Benefits

- Less human resources due of automatic computation
- Higher computation frequency => Better results (more accurate)
 - High frequency phenomenon catch
- Use of redundancy
 - More accurate and reliable results
 - Detection of faulty measurement
- KPI & Reporting with better view of results

Support Project

- Systematic support services to:
 - Help in analyzing and exploiting the results
 - Help VALI users to verify stability of the model
 - Provide special training in specific area of functionality (e.g. Benefits & usage of ValiAnalytics)

Support Project

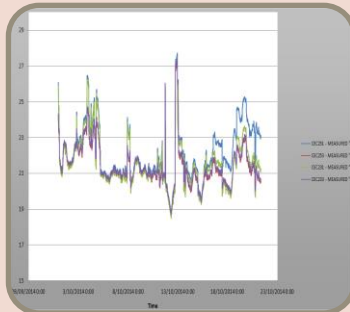
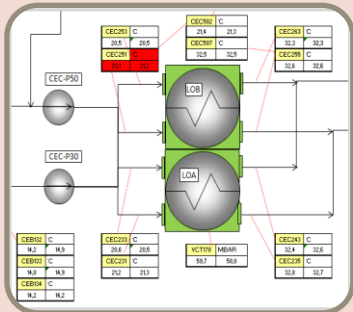
- Included, but not limited to:
 - Exploitation of the results
 - Identify faulty sensors
 - Sensitivity analysis to identify what impacts the value and precision of the KPIs
 - Identify degraded equipments and process performance
 - Identify leaks and losses
 - Find optimal operation conditions

Support Project

- Help with model convergence
 - Further tuning
 - Filtering
 - Verify stability of model(s), application(s)
- When the process changes:
 - Help making changes to the model(s)
 - Help making changes to ValiReport
 - Help making changes to the application(s)
- Training
 - Specialized training to answer customer specific needs

DVR Benefits – Reliable Data

- How to take benefit of penalty information?



Redundancy Information

- Penalty bigger than 4 (red value)

Related Area and/or Historian Information

Cross-Check Information On-Site

- Most Probable state of your plant

Actions:

- On the field
- In the model

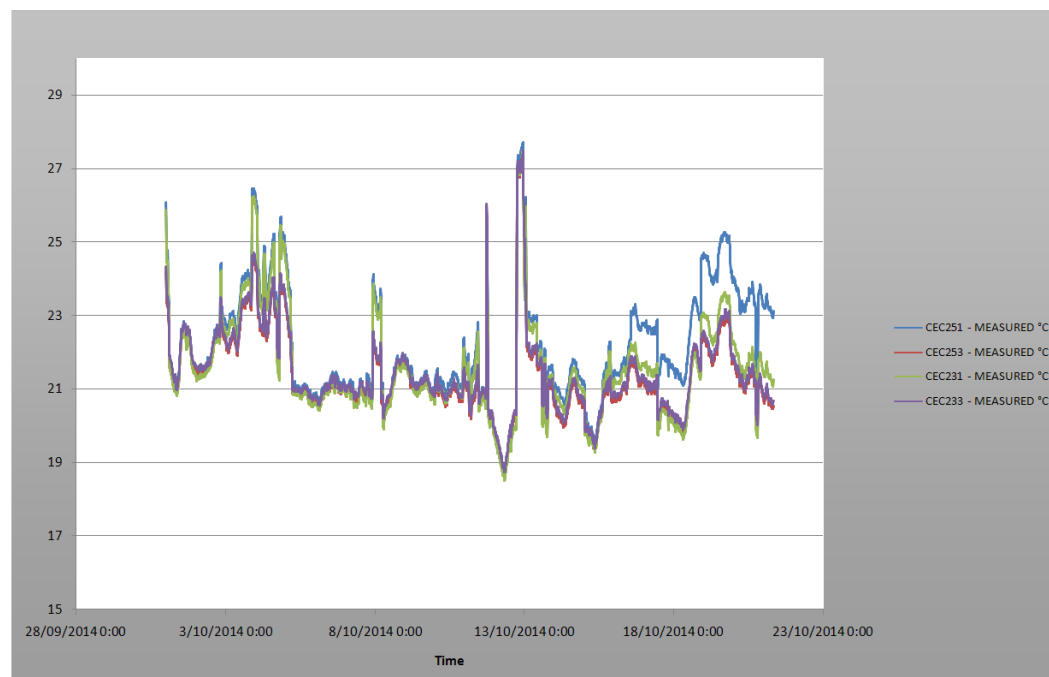
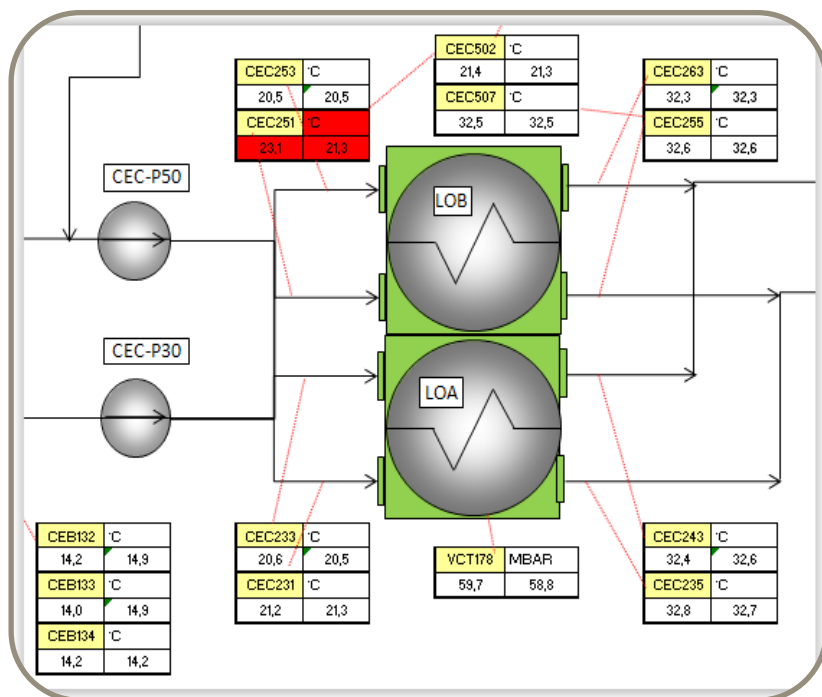
DVR Benefits – Reliable Data

1) Alarm in the report

CEC251 penalty >4

2) Historian & comparison

2°C of difference with the 3 other sensors

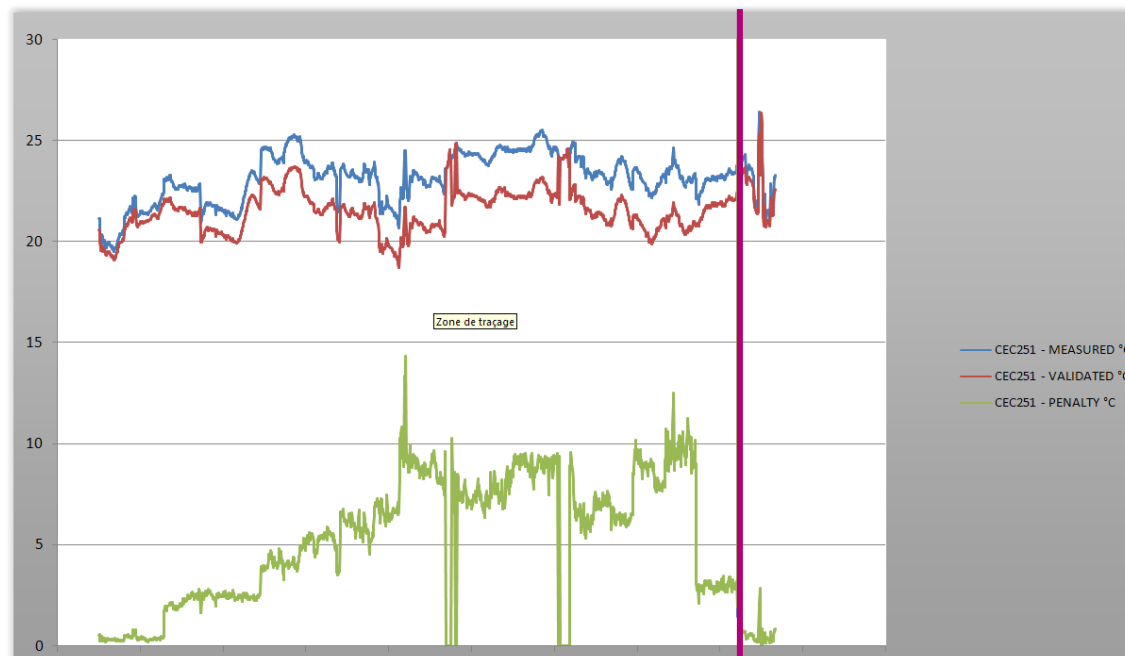


DVR Benefits – Reliable Data

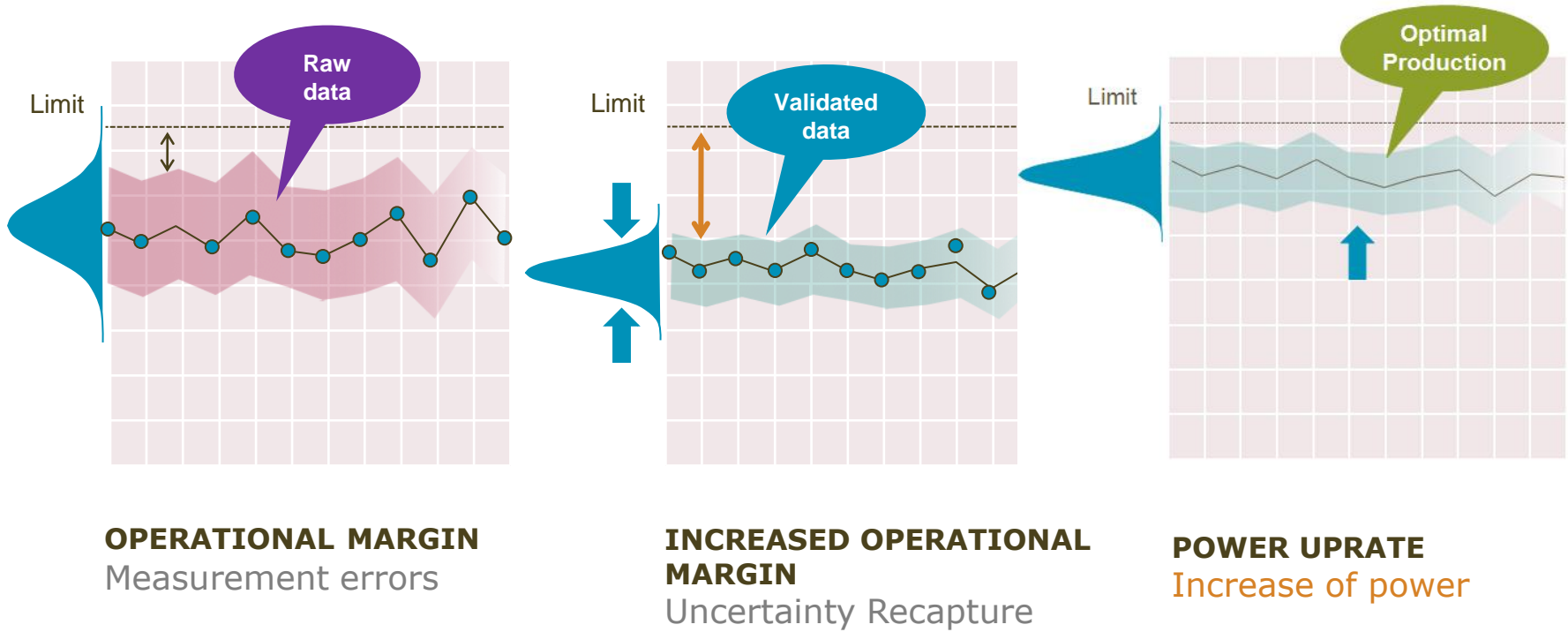
3) 2nd sensor used to cross check the reality

- 22,5°C for the « bad » sensor **vs** 21°C for the 3 sensors


4) Intervention of the maintenance team





DVR Benefits: Reactor Thermal Power



DVR Benefits Performance Monitoring



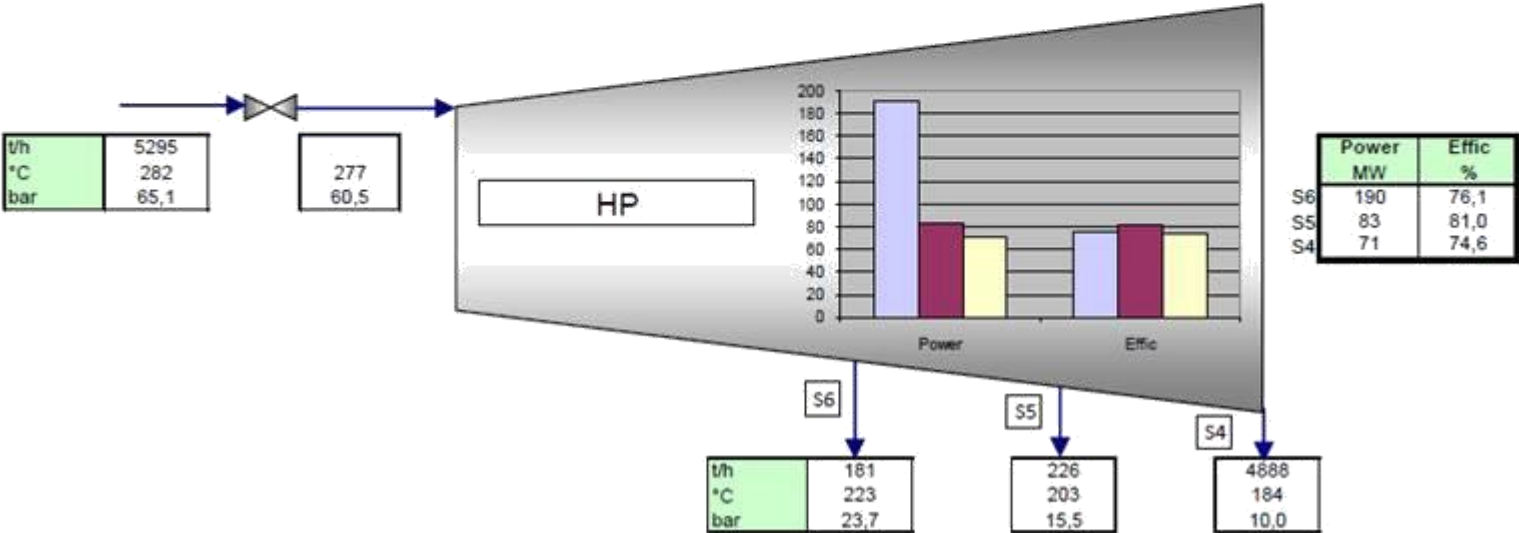
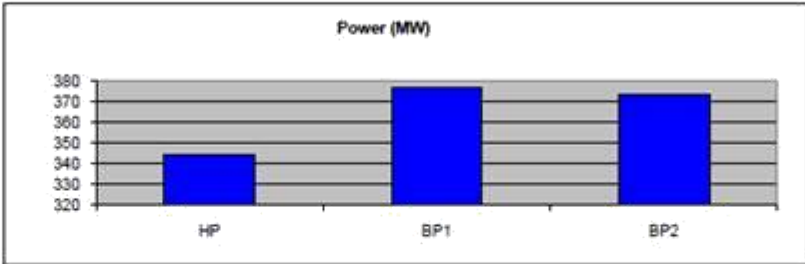



Rapport Vali : La turbine Page 6

Operations - Support Tihange 3

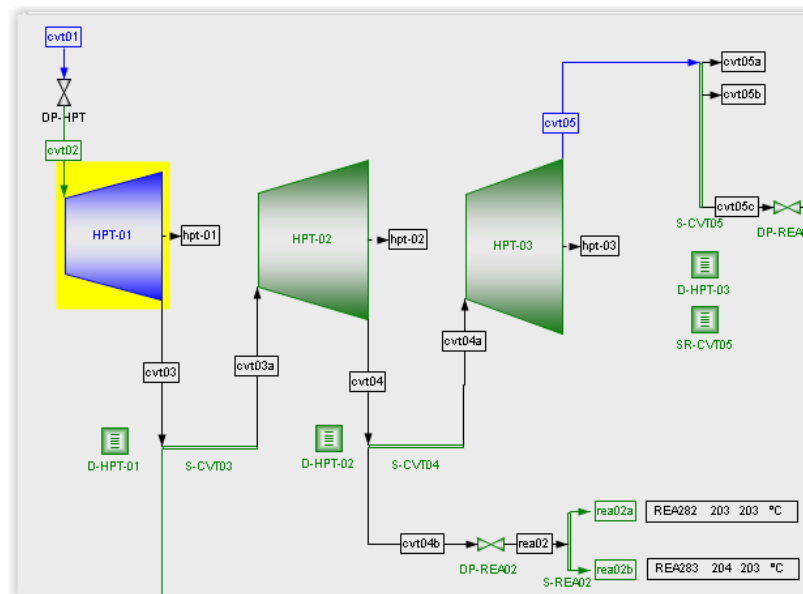
Période	13/02/2015 8:30:00	08:45
Qualité	0,77	(critère: s 1)

Turbine		
	Power MW	Ratio %
HP	345	31,5%
BP1	376	34,4%
BP2	373	34,1%
Total	1094	

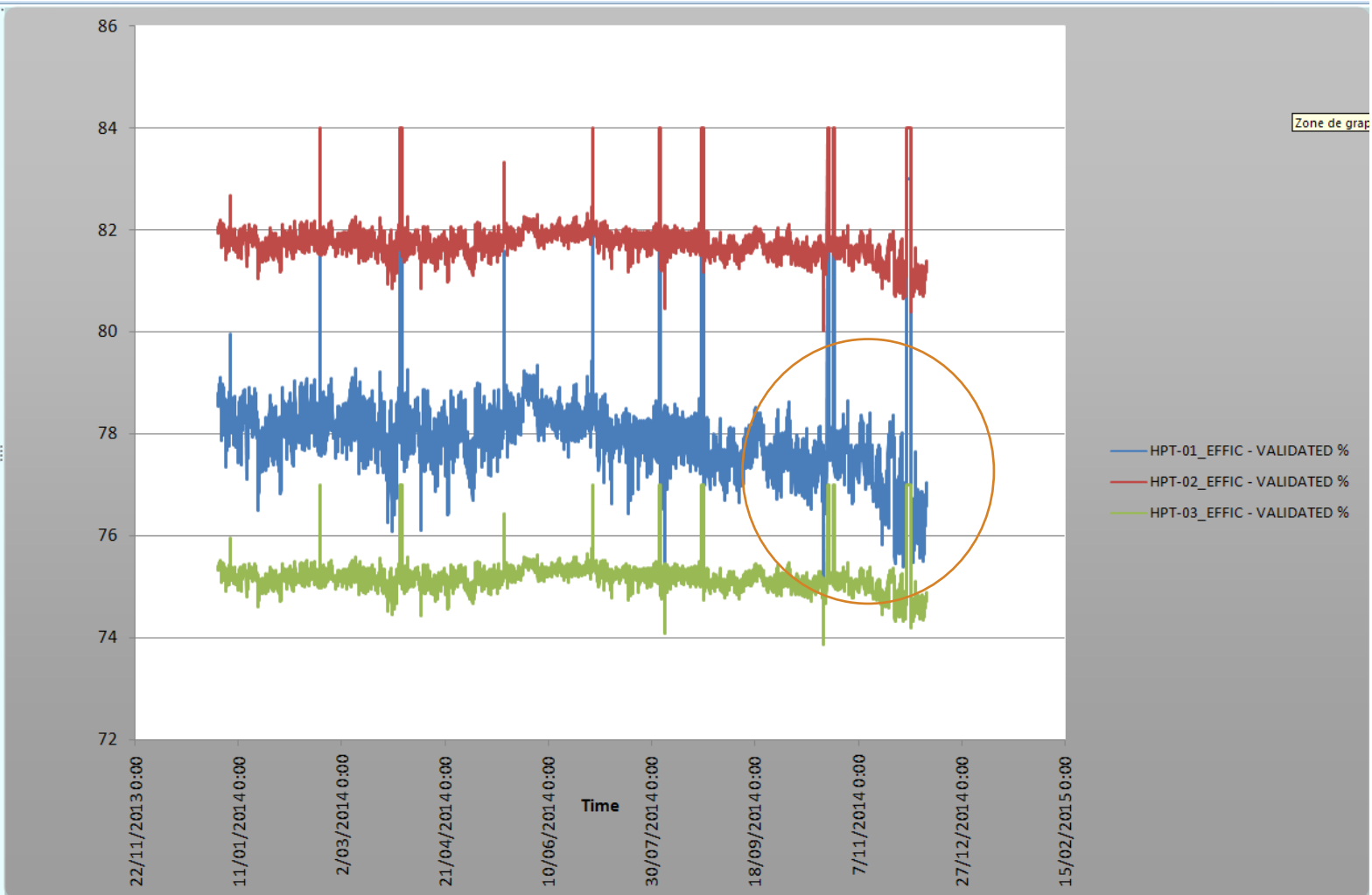


DVR Benefits Performance Monitoring

- Turbines Efficiency Information:
 - Effic. 1st Stage (76%) is below the expected Effic. (83%) => Penalty 3,37
 - Historian data analysis: Efficiency decreasing



DVR Benefits Performance Monitoring

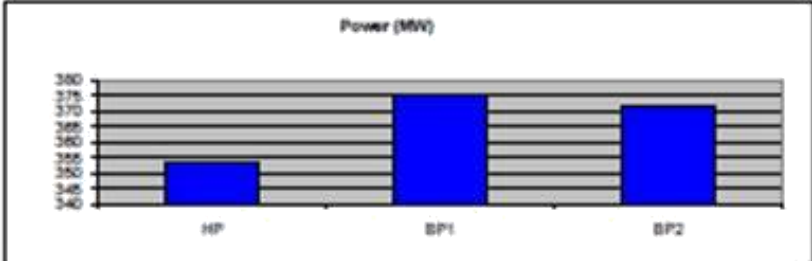


DVR Benefits Performance Monitoring

Electrabel
 Operations - Support Tihange 3
 Rappors Val: La turbines Page 6

Periode	28/06/2016 13:45:00	14:00
Qualite	0,75	(critere: 5 %)

Turbine		
	Power MW	Ratio %
HP	353	32,1%
BP1	375	34,1%
BP2	372	33,8%
Total	1100	



+ 6MW (1,8%)

HP Inlet/Outlet Parameters:

sh	5378	278
°C	286	61,1
bar	69,1	

HP Turbine Performance:

	Power MW	Effic %
06	196	77,9
05	85	81,8
04	72	75,2

HP Outlet Parameters:

sh	179	230	4969
°C	224	204	185
bar	24,0	15,7	10,2

Conclusion

- Reliable and most accurate picture of the plant - **measurement uncertainties minimization**
- Primary, secondary and tertiary heat and mass balances closed - **coherency**
- Reactor thermal power uncertainty $< 0.8 \%$
- **measurement uncertainty recapture**
- Equipment KPIs with lowest level of uncertainty

Questions

- Questions