Yields reconciliation using Sigmafine in an agile refinery

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21/08/2020

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Agenda

1. Presentation of *IPLOM* refinery
2. Yield reconciliation objectives
3. The project
4. The model
5. Analysis of reconciled data
6. Achieved results
7. Future developments

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Refineries in Italy

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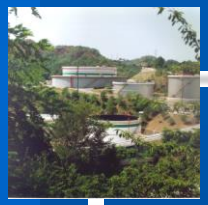
IPLOM Refinery

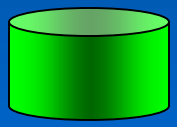


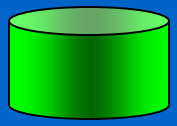
Tanks storage in Genoa

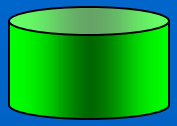
Passo dei Giovi

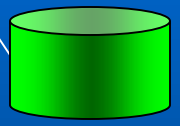
Crude storage

PROCESS PLANT









Finished Product Storage

Railway Loading

Truck Loading

PIPELINES

Genoa Harbor

Pipeline 8”

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Refinery Data

- Has refined and delivered oil products in Busalla since 1943
- Productive capacity: 45.000 bbl/day
- Refines Diesel oil, low sulfur fuel oils, bitumen
- Total area: 126.000 m2
- Tanks : 56
- Storage facilities: 300.000 m3
- 8” and 16” Pipelines: 25 Kilometers

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Refinery Data

- Favorable logistic location:
  - close to the Padana Valley
  - connected to the harbor (8” and 16” pipelines)
  - railway loading (equivalent to more than 80 trucks/day)
- employees : approx. 200 people
- approximately 200 people daily employed in the allied activities
- more than 600 allied

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Plant capacity

- **Atmospheric - vacuum distillation: 45.000 bbl/day**
- **Diesel oil and fuel oil purification 23.000 bbl/day**
- **Gas and water purification, sulfur recovery 345 bbl/day**
- **Electric energy and steam production (cogeneration) 5 MWe + 8 MWt**

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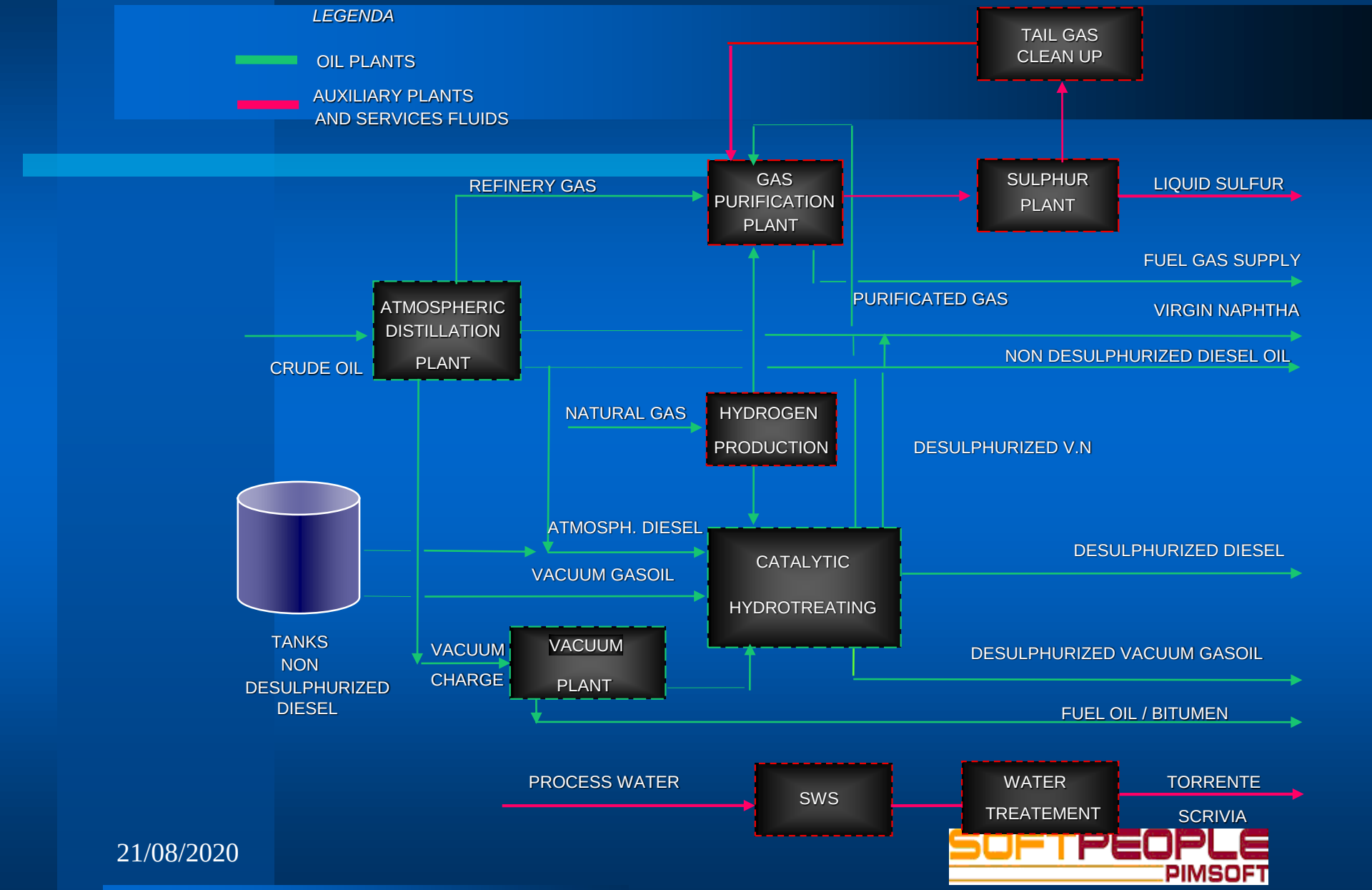
IPLOM Refinery



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IPLOM: an agile refinery

- Efficiency, agility in taking the opportunity of business
- Wide range of customers to be satisfied
- Many operating modes
- Wide range of products
- 110 crude switching (running plans) per year
- Average length of a campaign: 2,5 days
- Performance during a crude switching: 4 hours

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Yields reconciliation objectives

- Operations:
  - Calculation and Presentation of KPI
  - Real-time evaluation of plant performances
- Accounting:
  - Aggregation of campaign results
  - Accuracy of data from the plant floor
- Engineering:
  - Verification of theoretical yields
  - Evaluation of upsets and performances during a crude switching

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Previous situation

- Material balance calculation was done daily using an ad-hoc application built in Excel
- Lack of a data infrastructure able to collect and distribute plant data
- Lack of flexibility in modelling different plant configurations
- Strong involvement of personnel
- A good redundancy of measures, about 120%

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Project guidelines

- Replace ad-hoc tools with a product-based solution
- Flexible plant configuration -> dynamic reconciliation model
- Completely automatic hourly reconciliation mode
- Archiving/presentation of results
- Integration with accounting system

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The choices

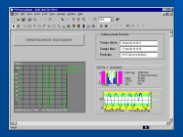
PI

- Real-time data infrastructure

Sigmafine

- Data reconciliation
- Dynamic model management

OSIsoft™



PI-ProcessBook/PI-DataLink

- Integrated data presentation
- Distribution/analysis of results

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Project management

- Collaborative approach
- Strong involvement of refinery personnel
  - process engineer for model development
  - automation engineer for DCS integration support
- Local distributor (Pimsoft) for product and integration services
- Duration: 3 months

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Model design

- Suitable for frequent and automatic reconciliation (hourly)
- Able to represent all possible plant configurations
- Tanks and movements not included
- Mass balance
- All compensations/validations solved at DCS/PI levels

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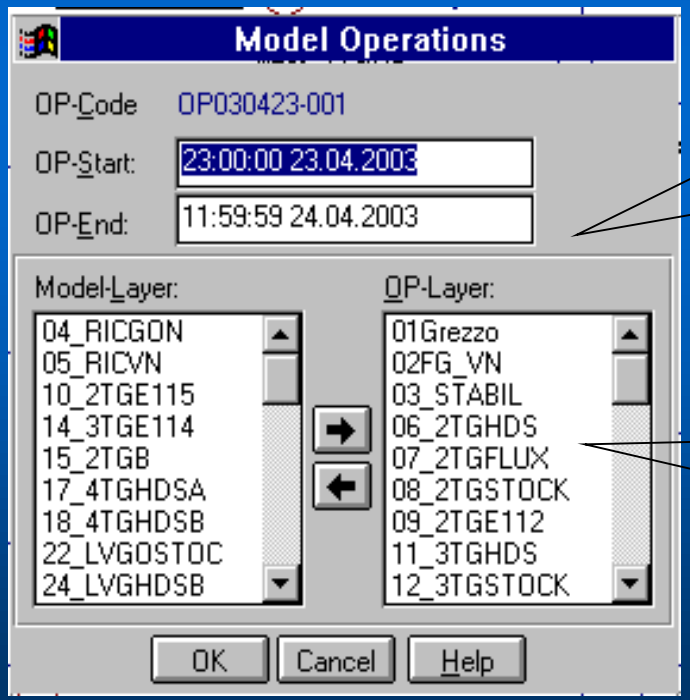
Dynamic modelling

- Model structured on many "layers" (around 50)
- A running plan is represented by a subset of layers



Running Plan start/end times

Layers enabled in the current running plan

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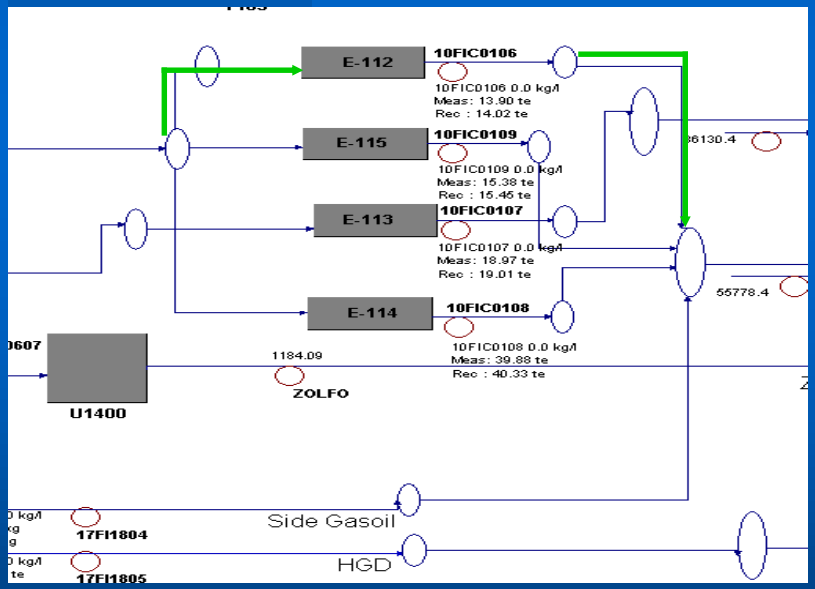
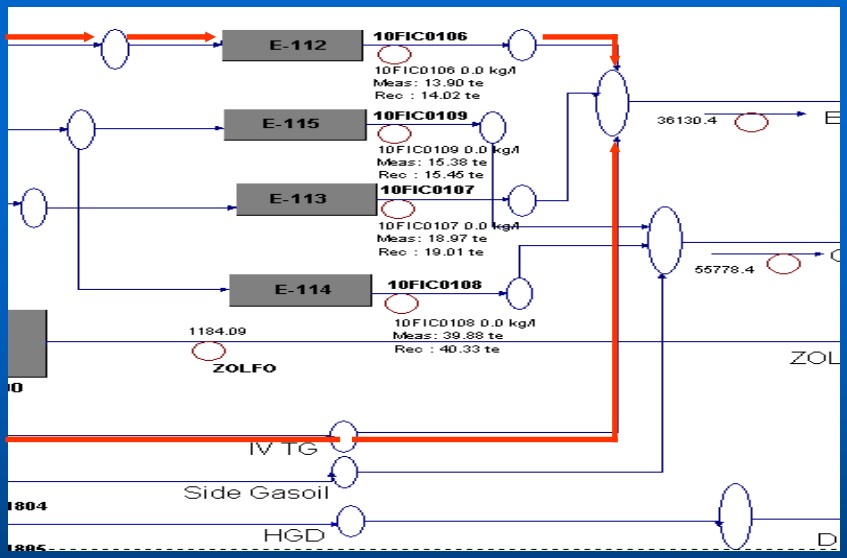
Layers management

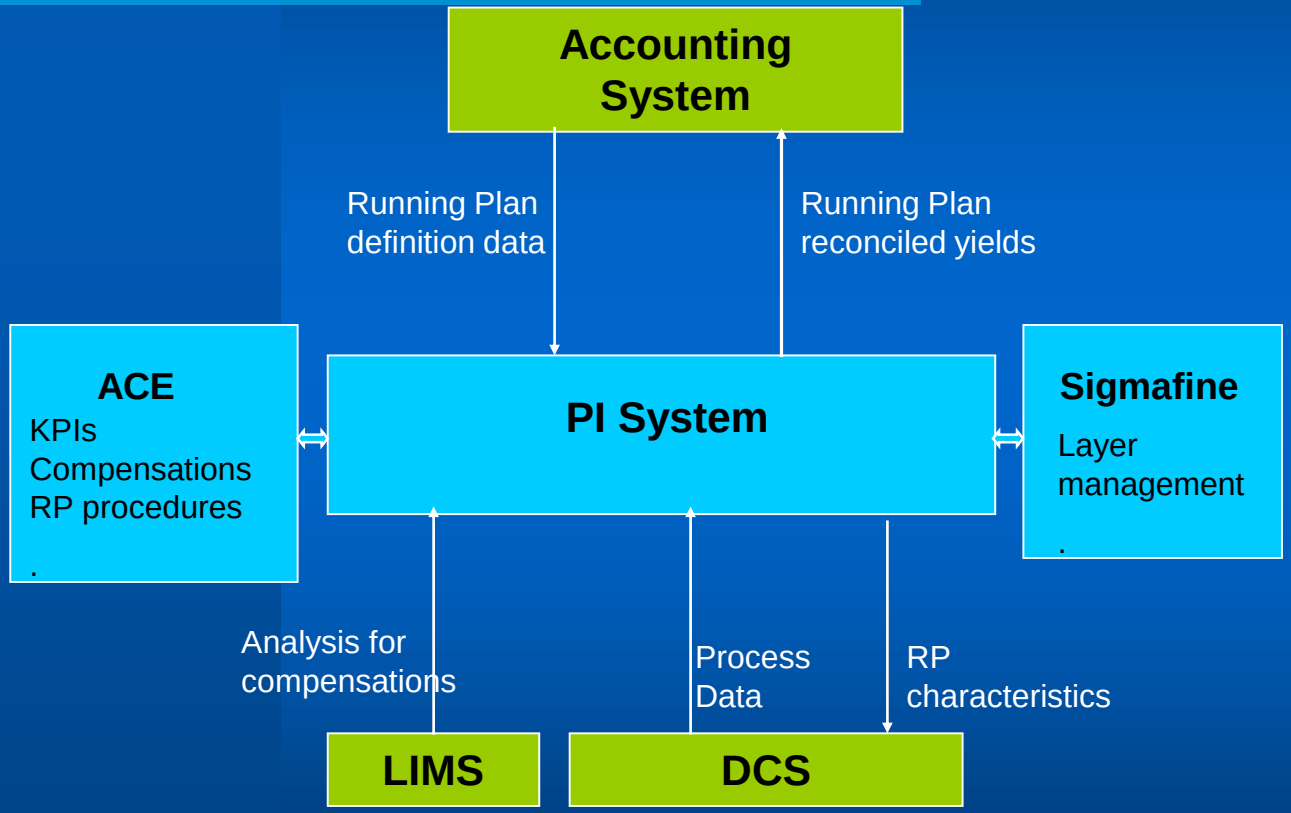
- **Example of two different layers combinations in the model**



OR



Functional architecture

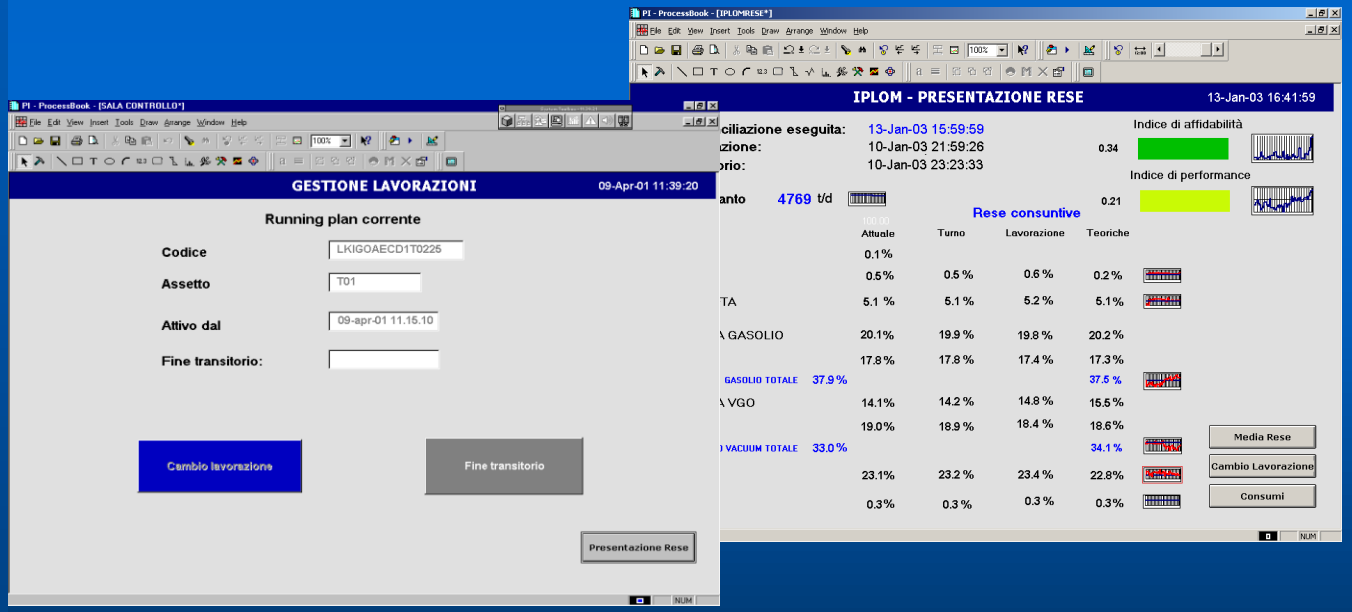


Yields and KPIs presentation

Control Room PB Running Plan Manager

Running Plan manager/1

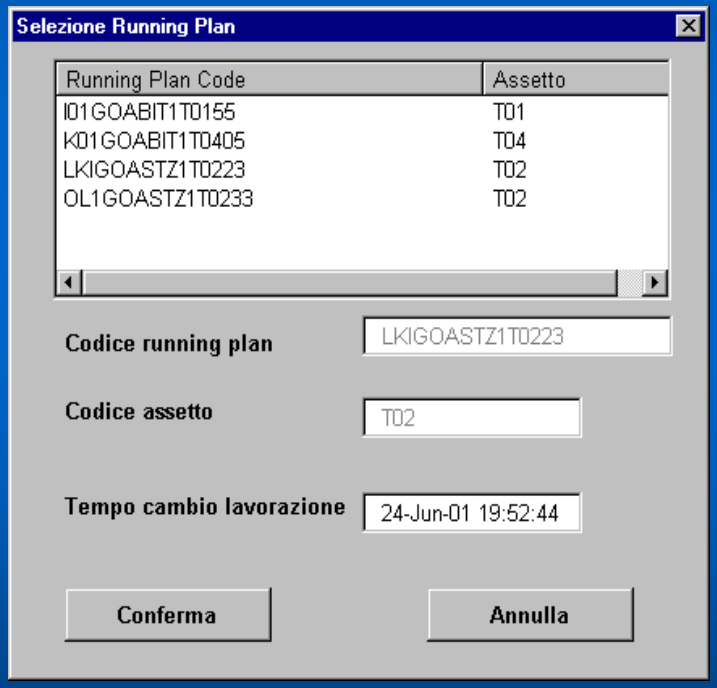
- Located in control room
- Selection of new running plan from accounting DB
- Declaration of running plan (campaign) change



Running Plan manager/2

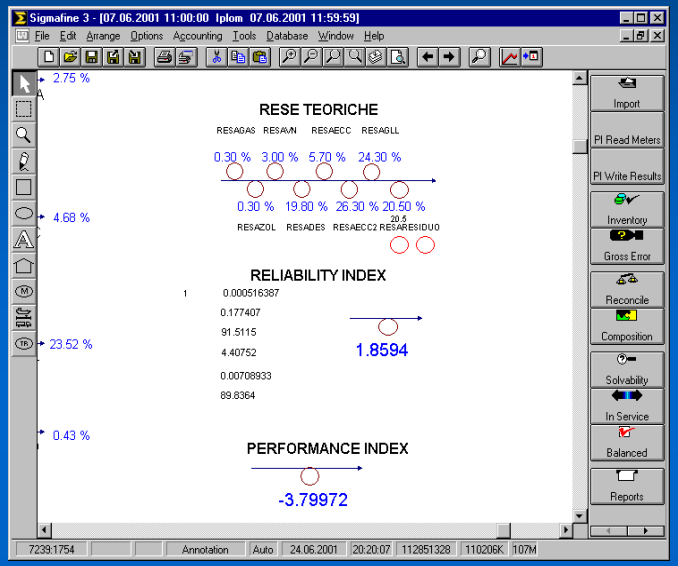
Automatic actions triggered by running plan manager

- **Start Running Plan**
  - Set Sigmafine model layers according running plan configuration
  - Download theoretical data from Accounting System
  - Update theoretical density/viscosity of products for compensation of DCS flow rate measures
- **End Running Plan**
  - Aggregate running plan reconciled data
  - Update Accounting system



Quality indexes

- Automatic reconciliation requires **KPIs** to provide an immediate and simple indication about the "goodness" of the reconciled data



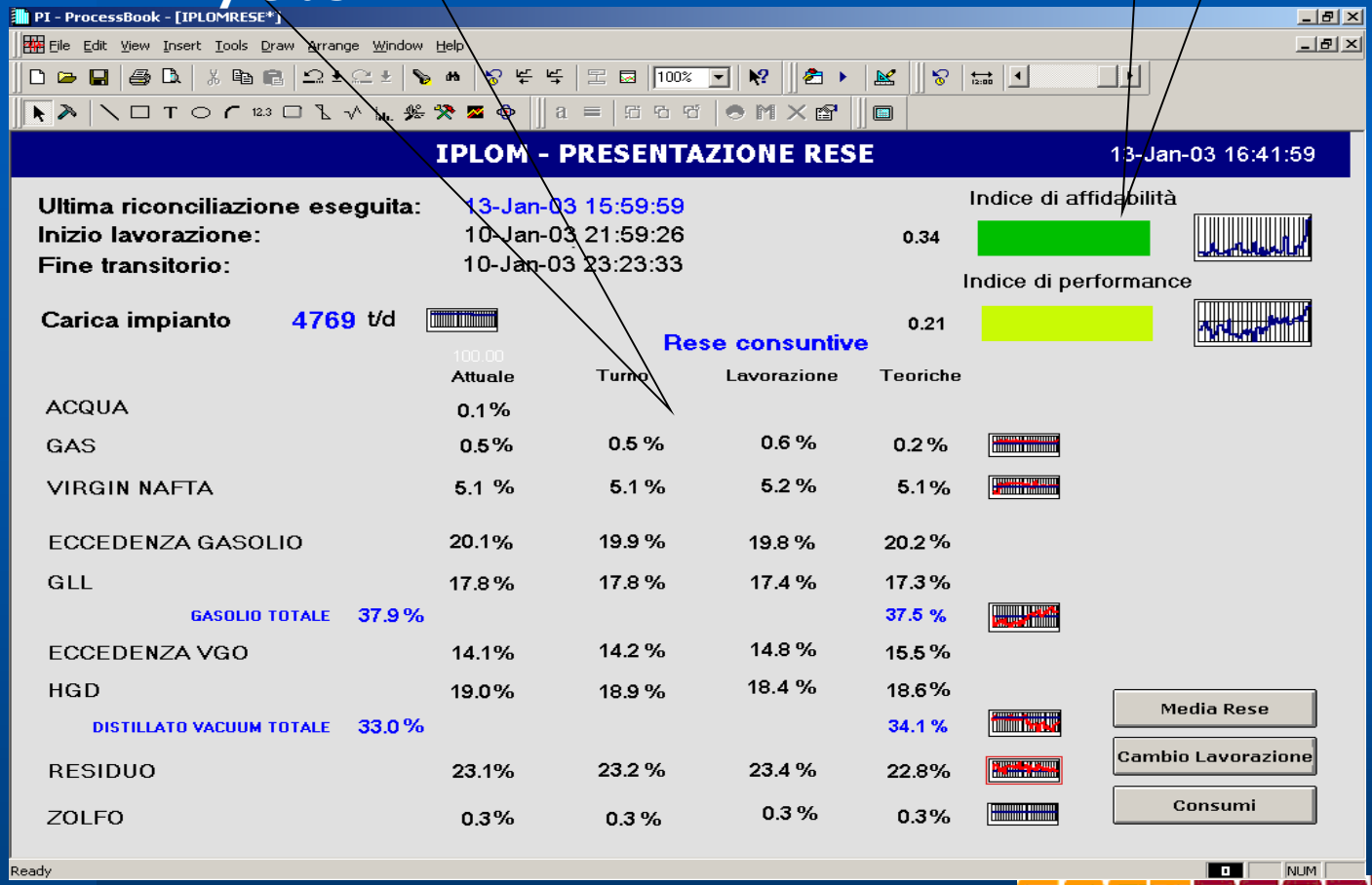
- **Reliability Index** -> reliability of reconciled yields related to theoretical ones

- **Performance Index** -> indicates if the plant is producing more valuable stuff compared to the theoretical performance

Yields and KPIs presentation

current/shift/running plan reconciled vs. theoretical yields

Running Plan KPIs



Plant monitoring/1

Early morning meeting plant situation report

Theoretical yields from running plan

RESA TOPPING

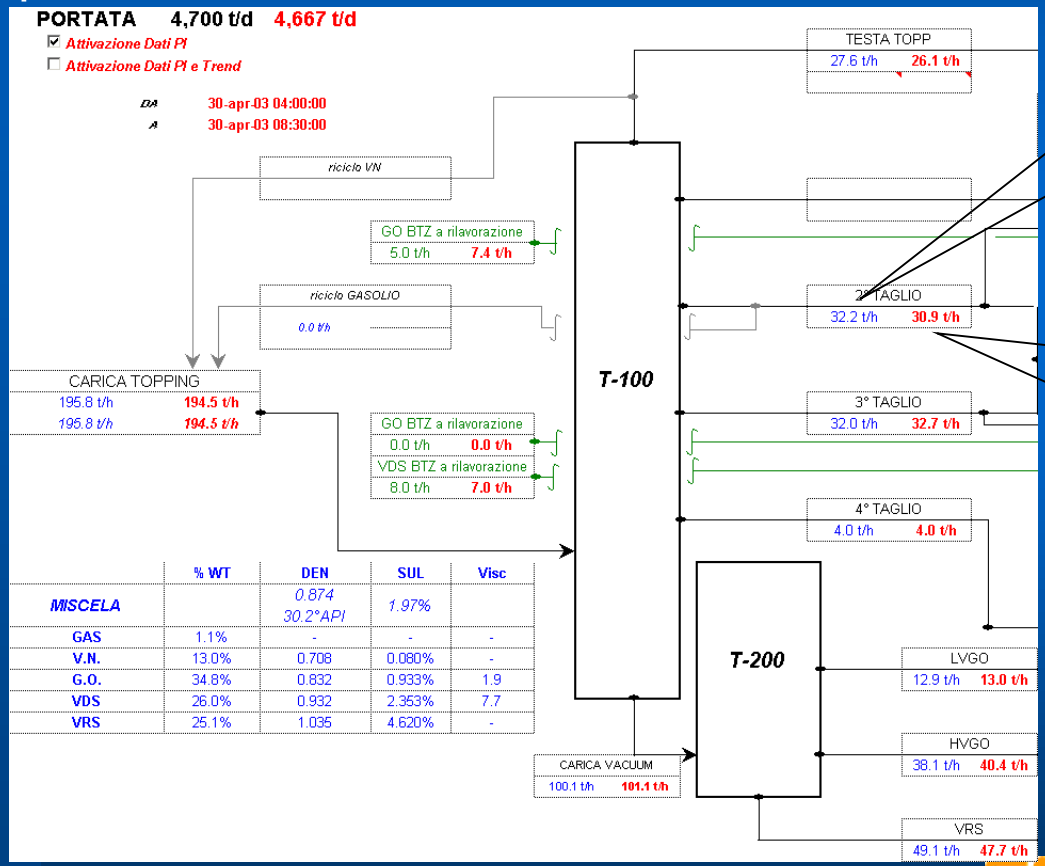
Prodotto	Portata (t/h)		Rese (%)	
Acqua	0.9		0.5%	
Gas	0.4		0.2%	
Virgin Naphtha	7.2		4.0%	
I taglio				
II taglio ad U.1700	19.1	38.4	21.2%	43.2%
II taglio a eccedenza	16.2			
II taglio flux	3.1			
III taglio ad U.1700	10.9	36.6	20.3%	
III taglio a eccedenza	25.7			
IV taglio (GOP)	3.0		1.7%	
LVGO	7.8		4.3%	
HVGO	47.9		26.5%	
VRS	38.3		21.2%	
Totale (t/h)	180.5		100.0%	

RESA RAFFINERIA

Prodotto		Portata (t/h)	Rese (%)		Rese (%) spec marcia	
Acqua		0.9	0.5%			
Gas		1.0	0.6%		V.N	5.6
Virgin Naphtha		10.8	6.0%		GOLL	17.8
Gasolio Totale	LGO+ECC	78.8	43.7%	43.7%	GO ECC	22.9
	SIDE GASOIL	0.0	0.0%		VGO ecc	12.0
LVGO ad ecc.		0.0	0.0%	6.1%	HGD	17.8
HVGO ad ecc.		11.0	6.1%		VRS	22.9
HGD		35.4	19.6%			
VRS		41.4	22.9%			
zolfo		1.2	0.7%			
Totale (t/h)		180.5	100.0%			
GO a R-1701/R-1702		22.1	12.3%			
VDS a R-1702		18.2	10.1%			

Plant monitoring/2

Running plan



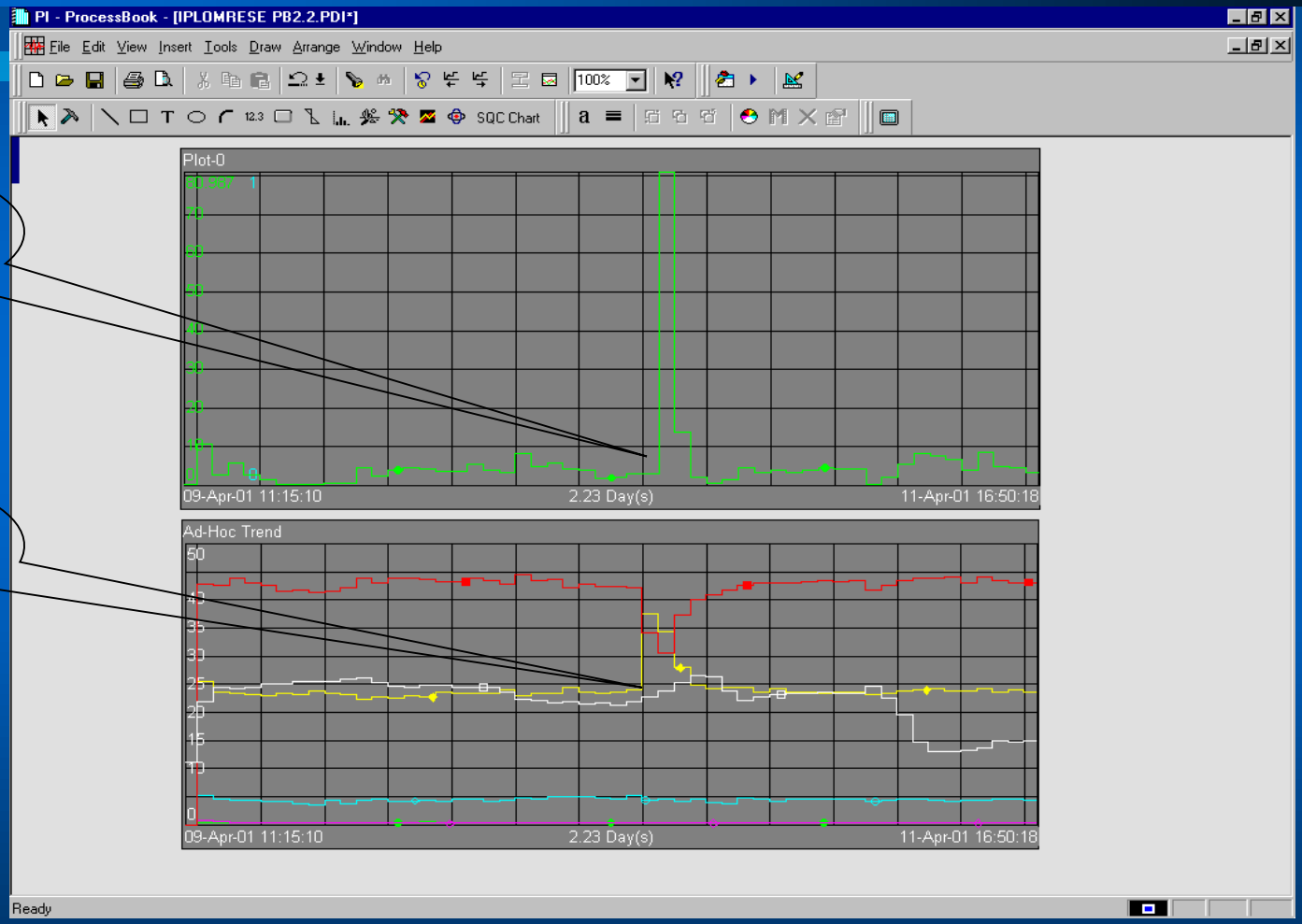
Theoretical yields from running plan

Reconciled yields from running plan

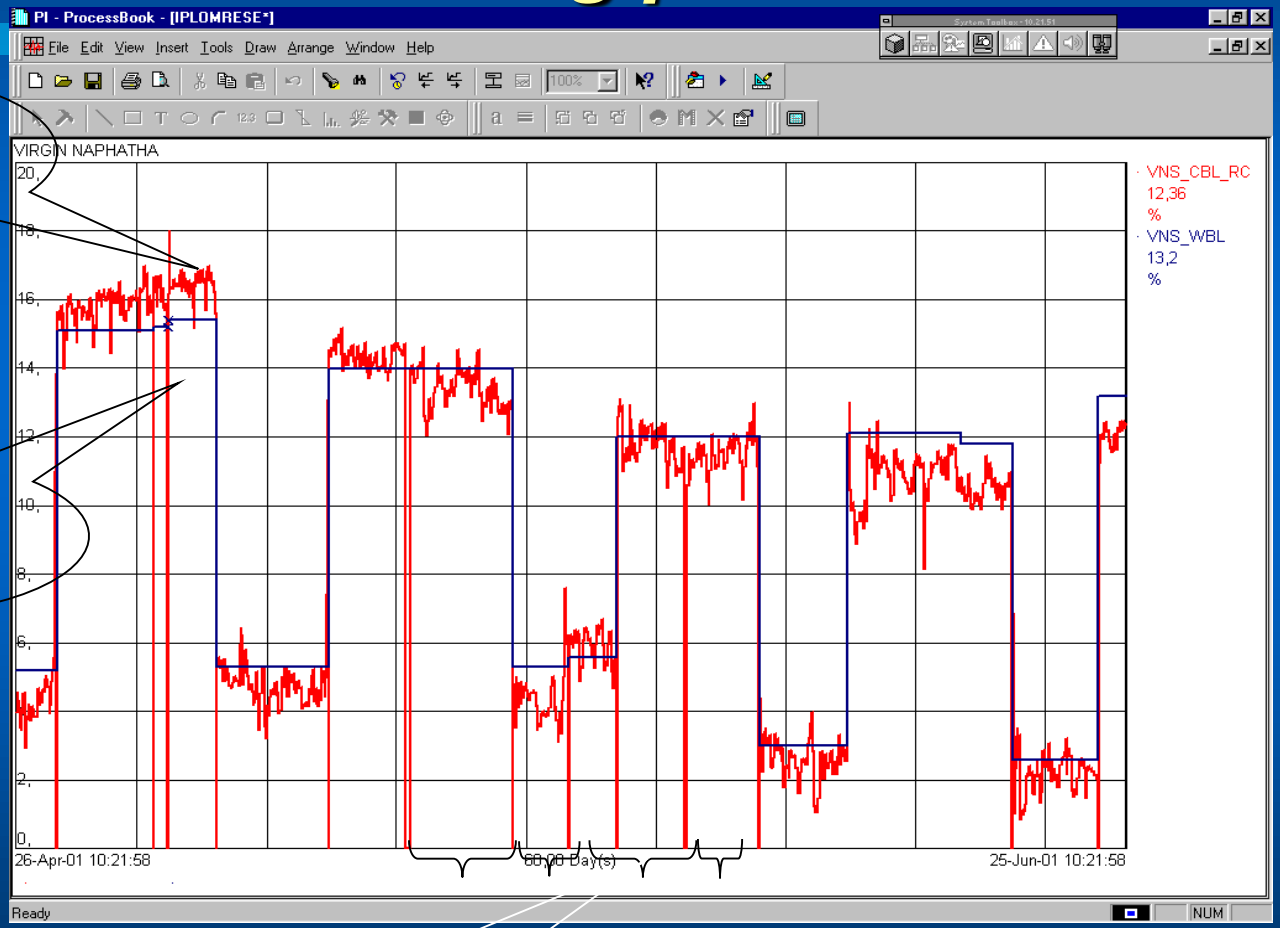
Upset identification/evaluation

Reliability Index

- gasoil + residual



Reconciled vs. theoretical yields across more running plans



Reconciled yields

Theoretical yields

Running plans

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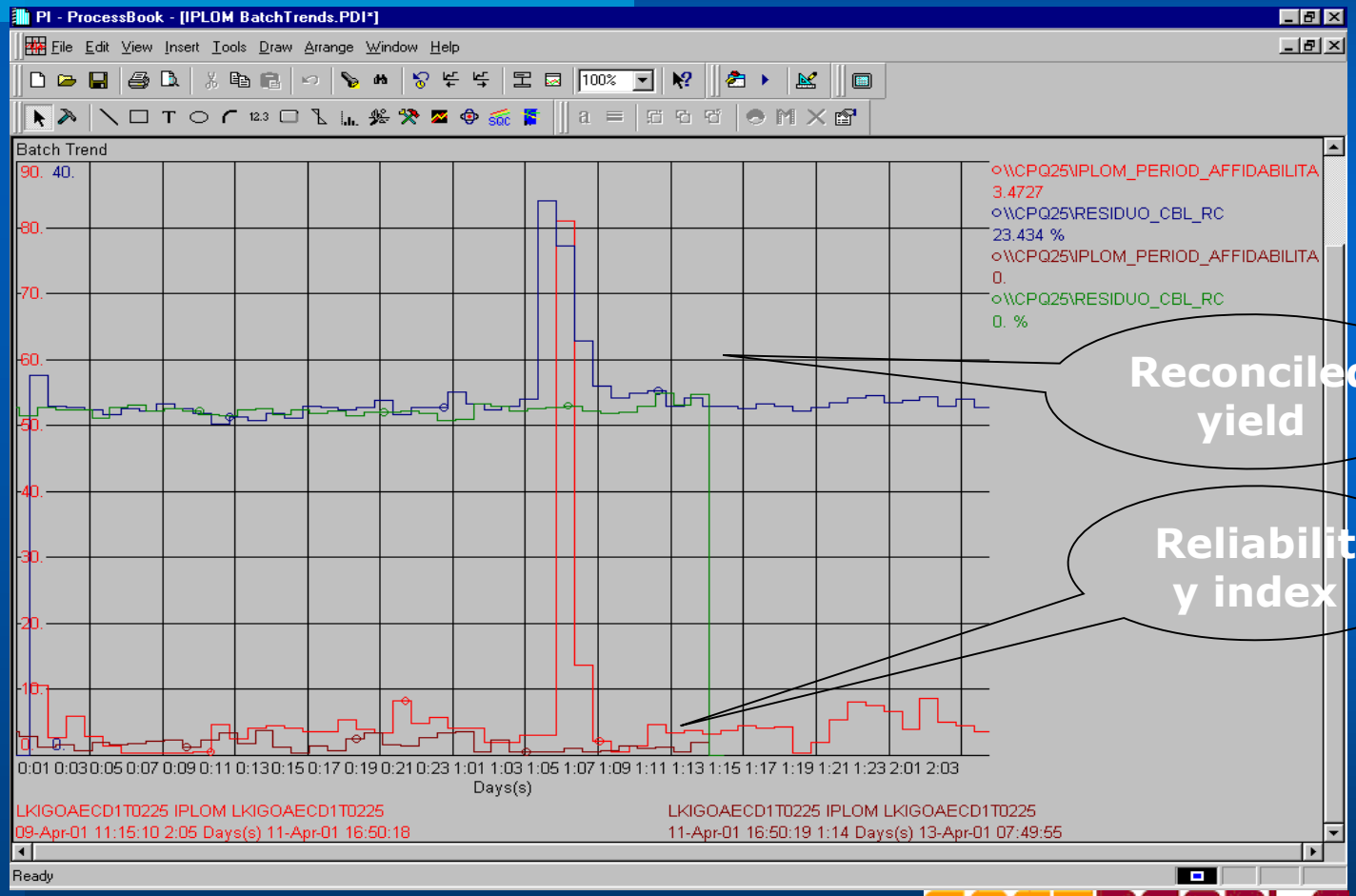
Comparing two running plans of the same campaign



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Achieved results

- *The use of PI and Sigmafine enabled the refinery to achieve better control and knowledge of its performances*

- *KPIs and yields are calculated and available in real-time giving an homogeneous trend of the production to all refinery people (from operating people to the production manager)*

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Achieved results

A posteriori analysis and comparison of reconciled and theoretical data lead to:

- ***Clear reduction of transition time especially during the change of production***
- ***Gasoil-diesel yields improvement of about 1%***

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Future developments

- Daily Complete refinery model in progress
  - inclusion of tanks and fiscal movements
  - integration with hourly yields model
- Use of Composition tracking to evaluate the crude tanks composition
- Sigmafine4 and PI-Application Framework
  - Migration of dynamic reconciliation to PI-AF
- PI-ICE
  - distribution of yields and KPIs cockpits

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