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INNOVATIVE SOLUTIONS



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Improve decision making through model based material qualities estimation

Application of Sigmafine Quality Tracking algorithm in ENI Versalis aromatic plant in Priolo, Sicily

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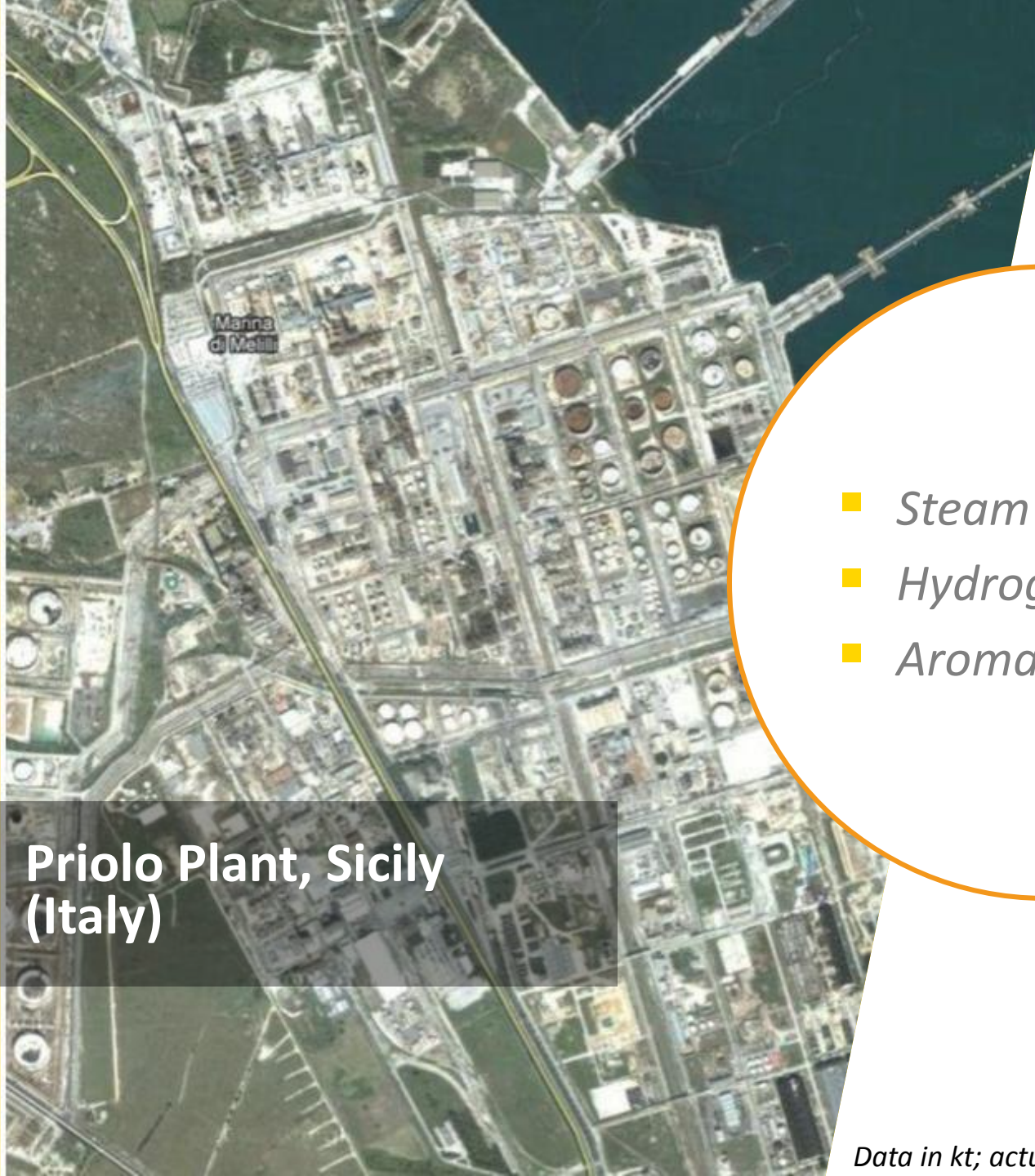
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Versalis (Eni) is Italy's largest chemical company interfacing with markets on the international scene of the basic chemicals, plastics, rubber and, recently, bio-based industry, holding market stewardship in manufacturing intermediates, polyethylene, styrenics and elastomers

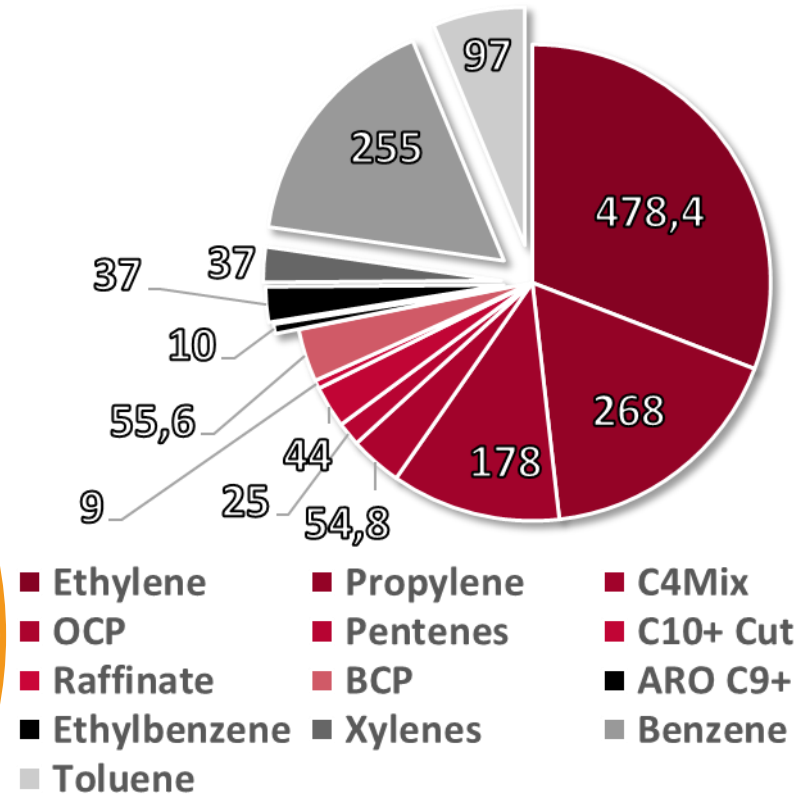




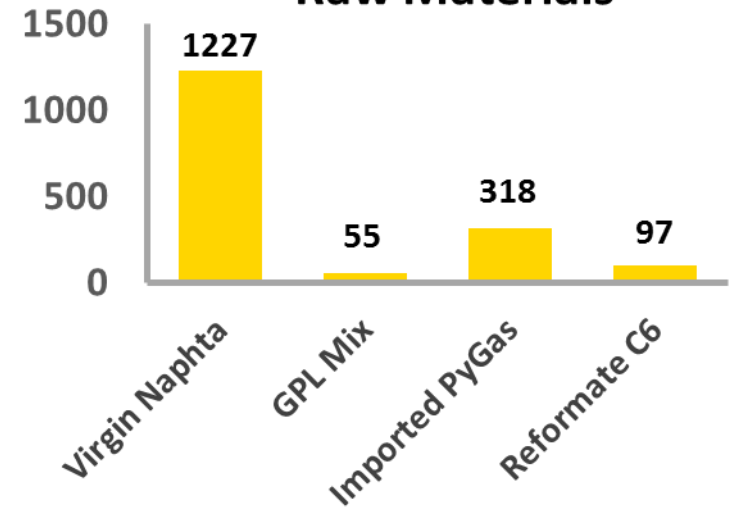
**Priolo Plant, Sicily
(Italy)**

- *Steam cracking*
- *Hydrogenation*
- *Aromatic plant*

Productions



Raw Materials



Data in kt; actuals 2016; source: eni versalis

Main target

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Plan and optimize consumptions, shipping and selling

- Compare the actual yields in terms of material productions and the theoretical yields while charge is processed to timely update planning and take better decisions

Daily Plant efficiency monitoring

- Daily monitoring of plant efficiency and yields to spot inconsistencies between expected and actual yields, resulting a faster and timely response and action

Accurate daily inventories and consumption

- Get accurate daily inventories and consumption by material to update ERP material movements

Strong correlation between material qualities and plant efficiency & production data

Data quality related issues for Aromatic plant

automated monitoring of unit feed quality

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Data unavailability

- Data regarding material qualities was available in different systems (even on paper record) and not integrated into one system
- Original balance system did not include daily quantity and composition of feeds → no relation between plant flow data and material properties
- Monitoring was done off-line and limited by manual effort in retrieving data day by day, feeding a spreadsheet



Need of an automated solution that tracks most important qualities of the feed at least on a daily basis and related to actual plant data

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Solution based on Sigmafine Quality Tracking

SIGMAFINE®

Data Validation and Reconciliation

Composition Tracking

Quality Tracking

Set of reconciled values for all flows, movements and inventories, satisfying the mass balance

Tracks the movement of materials from the boundaries and inventories according to the declared flows and movements

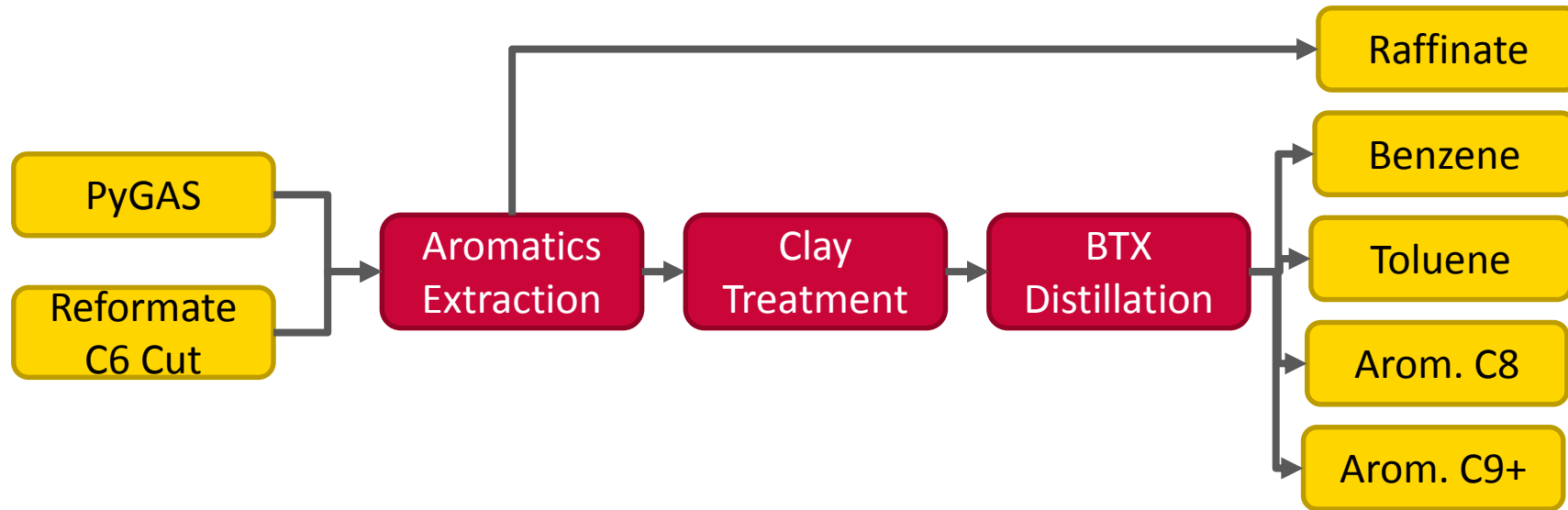
Input:

- Reconciled data (from data reconciliation)
- Available analyses
- Qualities calculated for the previous day
- Mixing rules (linear / non linear) and mixing models (well-mixed, FIFO, LIFO, ...)

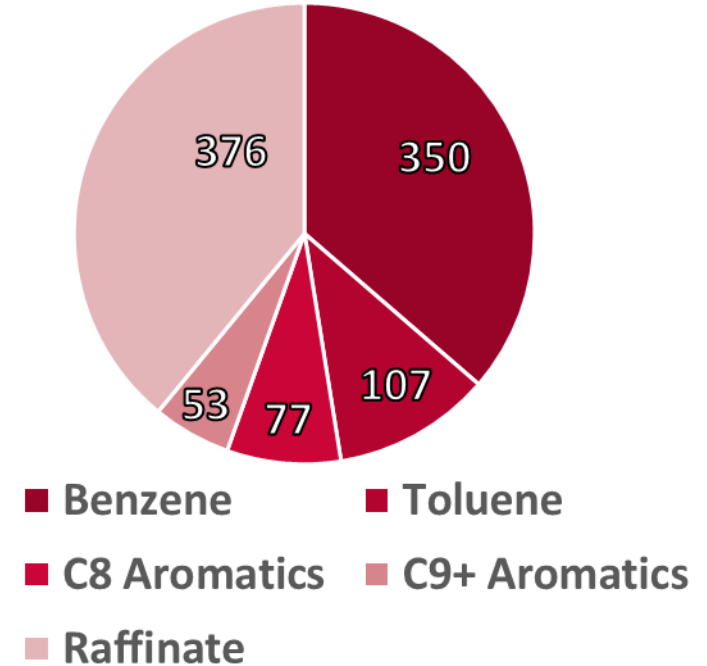
Output:

- Estimation of qualities for each flow and inventory (including aromatic unit feed) and for each material

Main productions and valuable material properties for aromatic plant



Nameplate production capacity

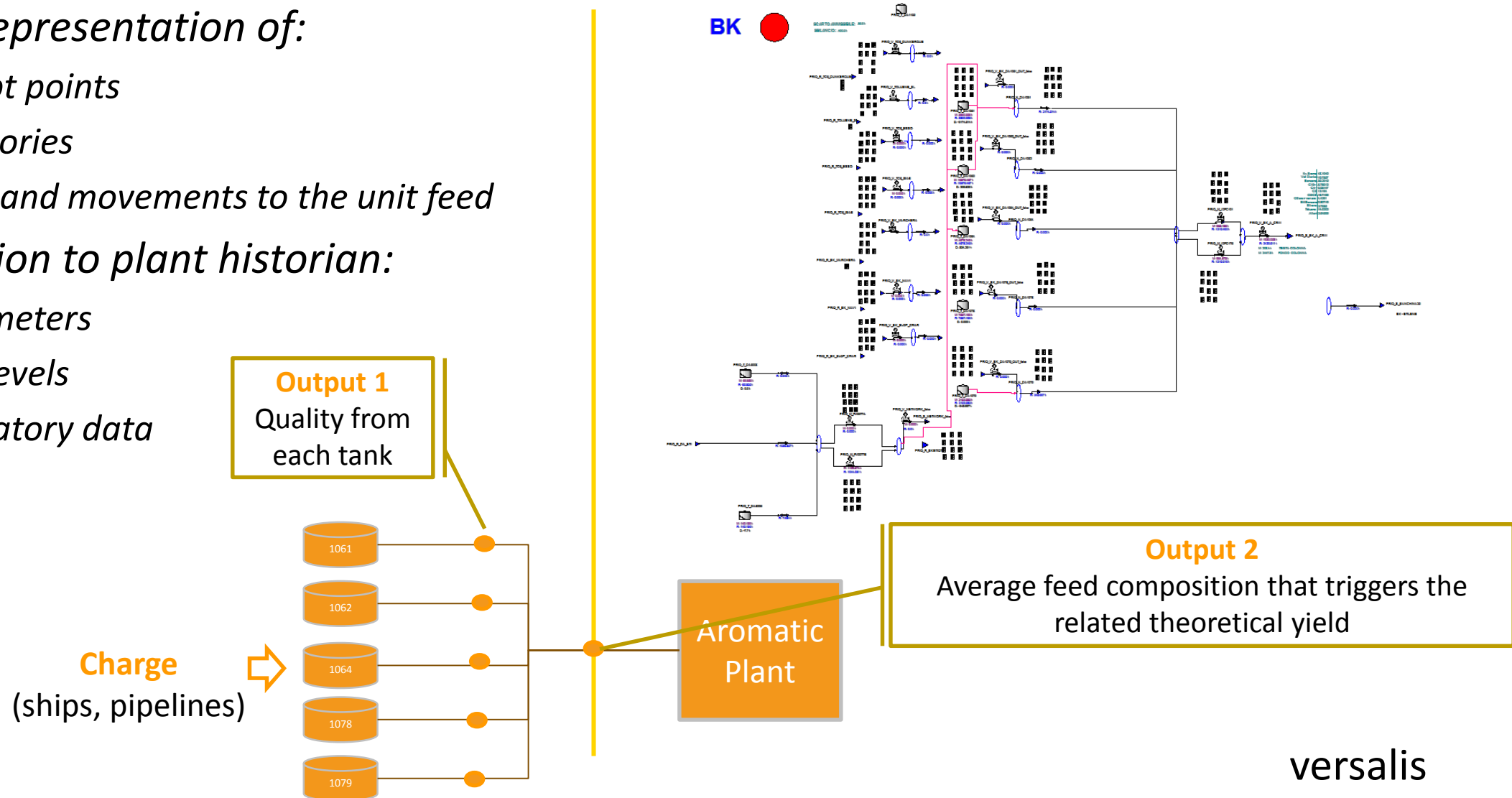


Key material properties to monitor unit yield:

- *Content of:* Benzene, Toluene, Xylenes, Ethylbenzene, Styrene, C4, C5, C6-C8, C9, C10
- *Diene Number:* measurement of conjugated olefines in a charge which has a strong correlation with distillation behaviour
- *Bromine Number:* measurement of aliphatic unsaturation which is related to the olefine content

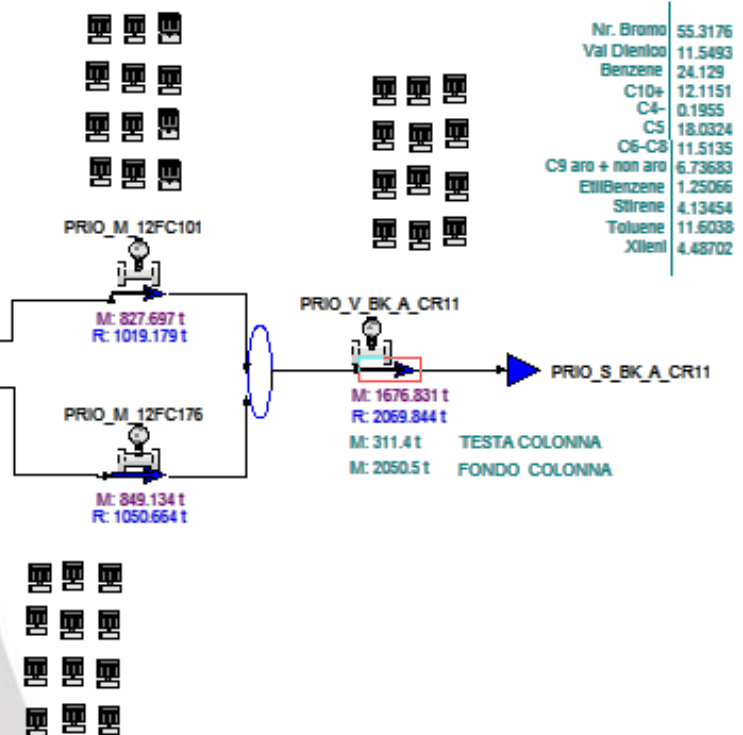
Solution based on Sigmafine Quality Tracking for Aromatic Plant

- *Model representation of:*
 - Receipt points
 - Inventories
 - Flows and movements to the unit feed
- *Connection to plant historian:*
 - Flow meters
 - Tank levels
 - Laboratory data



Calculated qualities at plant feed point

Overall Qualities at feed point

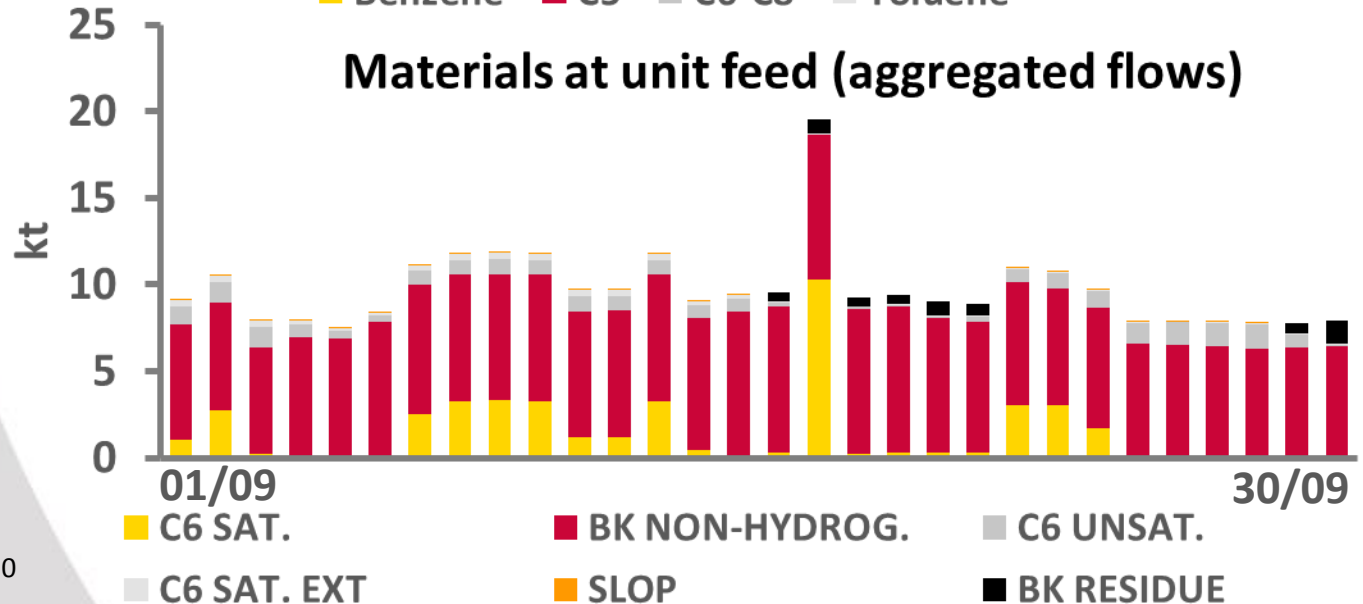
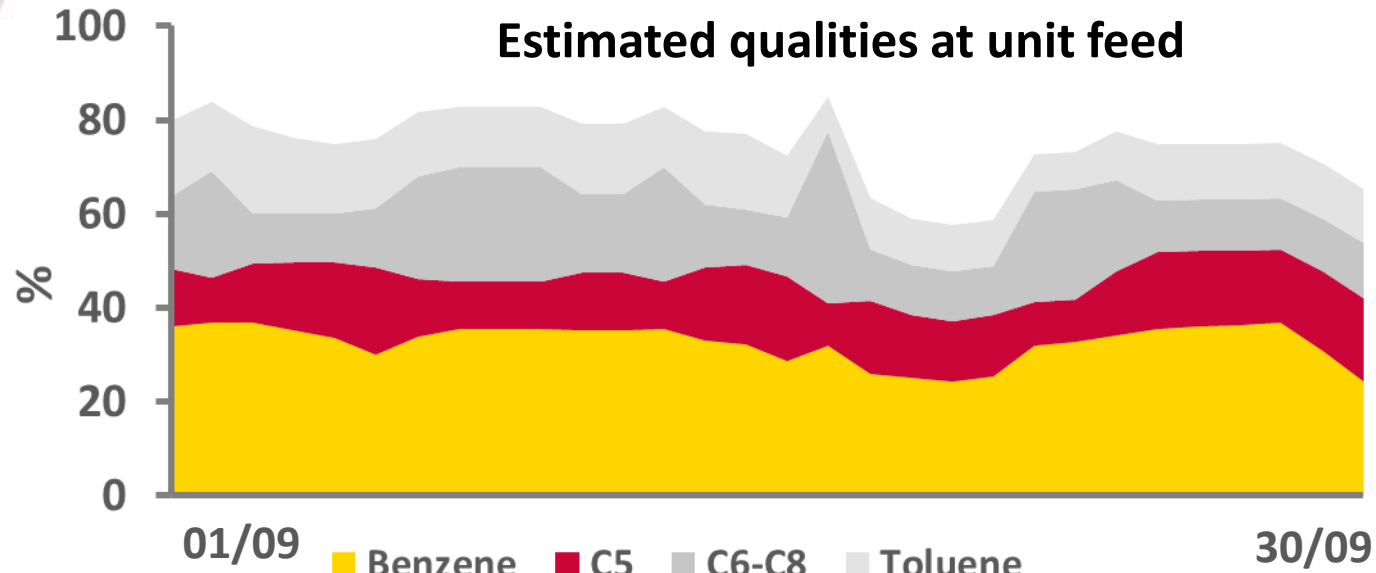


Detailed Qualities by material

Sequence	Quality	Value
1	NrBromo	55.3
1	pBenzene	24.1
1	pC10	12.1
1	pC4	0.19
1	pC5	18.0
1	pC6C8	11.5
1	pC9	6.73
1	pEtilBenz	1.25
1	pStirene	4.13
1	pTolu	11.6
1	pXileni	4.48
1	ValDienico	11.5
*		

Material	Quantity	Quality	Value
C6 SAT.	41893	NrBromo	0
C6 UNSAT.	35265	NrBromo	30,7
C6 SAT. EXT	9901	NrBromo	0
BK NON HYDR	1626002	NrBromo	60,9
BK RESIDUE	356782	NrBromo	39,9
C6 SAT.	41893	pBenzene	36,5
C6 UNSAT.	35265	pBenzene	71,4
C6 SAT. EXT	9901	pBenzene	0
BK NON HYDR	1626002	pBenzene	28,1
BK RESIDUE	356782	pBenzene	0,49
C6 SAT.	41893	pC10	0
C6 UNSAT.	35265	pC10	0
C6 SAT. EXT	9901	pC10	0
BK NON HYDR	1626002	pC10	13,1
BK RESIDUE	356782	pC10	10,3

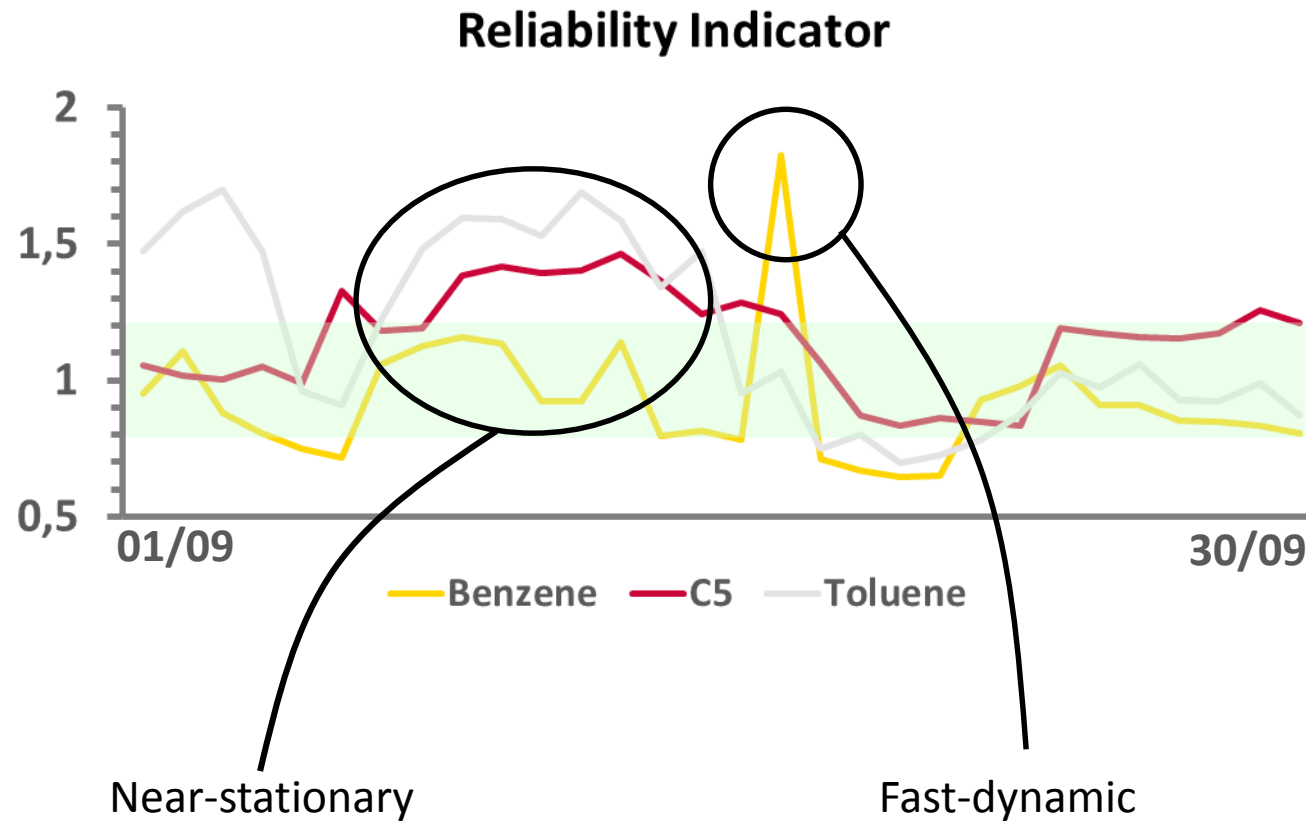
Relation between materials and qualities



- Histogram of material quantities: aggregation of reconciled flows and composition tracking results
- Impact of change in materials at unit feed directly impact compositions calculated by quality tracking
- Presence of more saturated C6 in the feed causes an increase of Benzene and C6-C8 fraction (relation is really marked for the 17/09)

Trends of daily data, September 2017; source: eni versalis

Reliability indicator



- Ratio between feed flow and output flow by composition
- Green band marks reliable qualities
- During fast transitory, indicator may depart due to plant hold-up
- During near-stationary conditions, indicator outside the bounds suggests verifying the composition of material at inlet (laboratory sample or certificate)

Trends of daily data, September 2017; source: eni versalis

$$R_i = \frac{\sum_{j=1}^N q_{i,j} \cdot m_j}{m_i}$$

i: quality index
j: input flow
q: quality value
m: flow value

