Coker advanced control and inferential modeling at BP Gelsenkirchen refinery

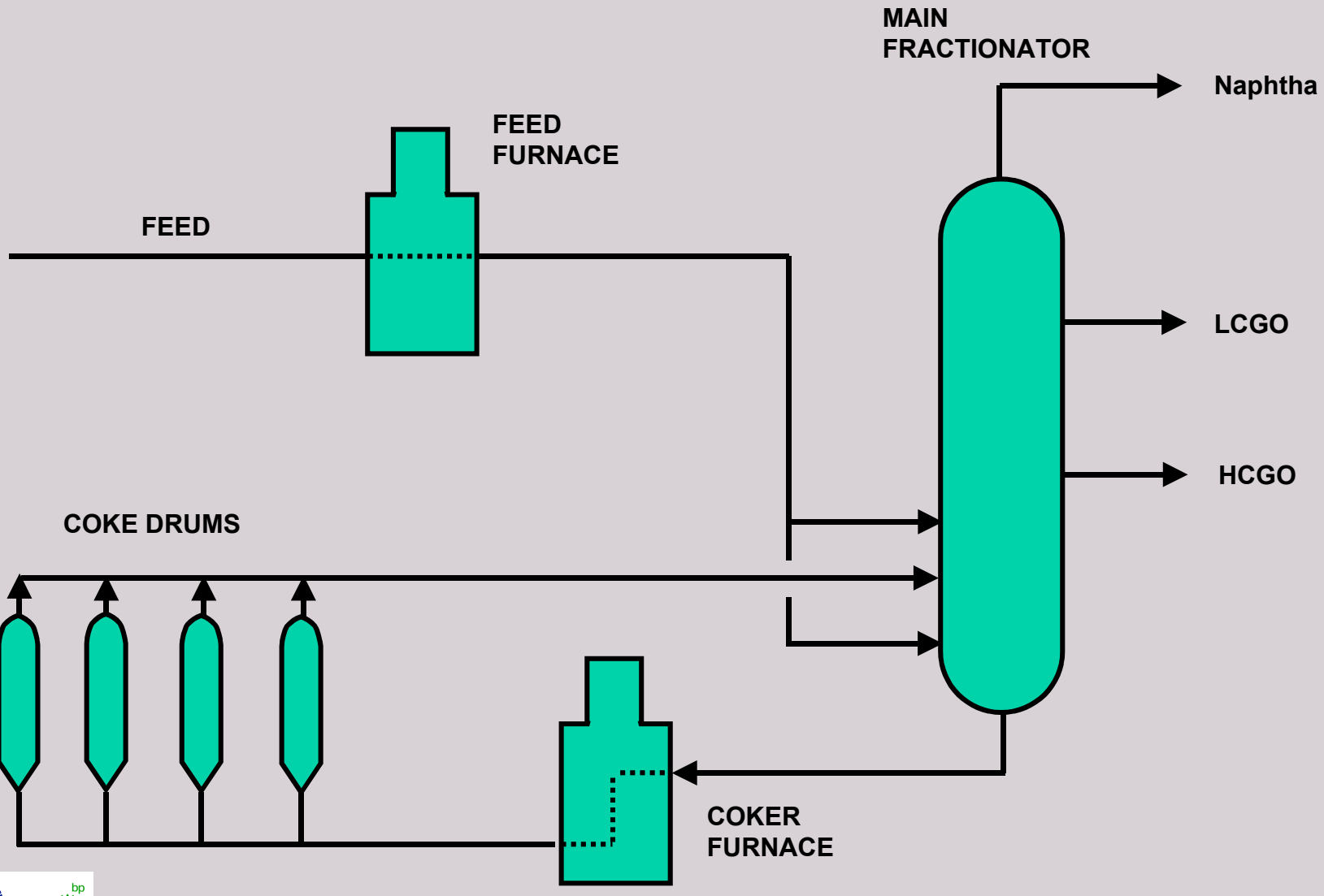
Volker Haseloff, BP Gelsenkirchen
Sean Goodhart, AMT
Y. Zak Friedman, Petrocontrol

PDVSA bp RUHR OEL GMBH

Petrocontrol

AMT

Coker unit overview



PDVSA bp RUHR OEL GMBH

Petrocontrol

AMT

Coker APC challenge

- **Batch reactors (coke drums), integrated with a continuous distillation process.**
- **Two completely different modes of operation: low sulfur and high sulfur**
- **Drum switching every twelve hours or so**
- **After switching the unit is short of heat and light products. The challenge is to keep the unit under control during that time.**
- **Product separation optimization is a secondary challenge. Large product price differences provide incentive for precise product quality control.**

Project objectives

- Control drum switch procedure
  - Warm up
  - Cool down
  - Throughput and inventories
- Control product qualities
  - Keep within range during drum switches
  - Optimize during steady operation
- Maximize feed

Design features

- Foxboro IA instruments, Foxboro DMCplus Bridge interface
- DMC+ multi-variable predictive controller (MVPC)
- First principles inferential models (FPM)
- FPM's are coded on Aspen IQ platform
- Performance monitoring by Aspenwatch

Project highlights

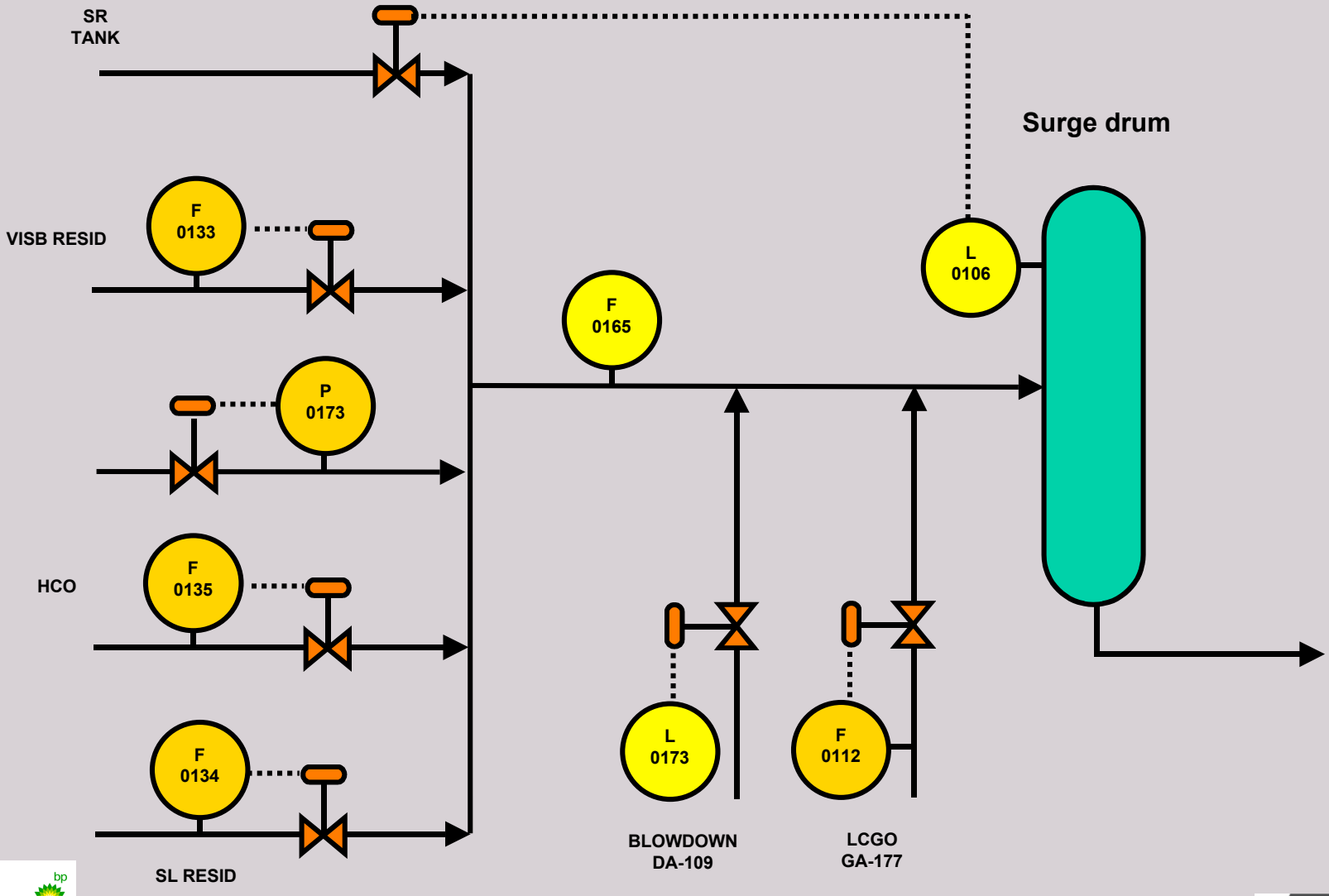
- **Implementation by AMT**
  - Functional design
  - Step testing
  - Coding FPMs
  - Commissioning
- **FPM by Petrocontrol**
  - GCC model for the fractionator
  - Coke drum outage model (in open loop)
  - Petrocontrol also acted as a client representative for the project
- **Heavy participation by ROG**
  - Step testing
  - Operator training
  - Commissioning support
  - Performance testing

DMC sub-controllers

- **Feed surge drum “FEED”**
- **Feed furnace “BA160”**
- **Coker furnace “BA101”**
- **Main fractionator “FRAC”**

- **Total size: about 90CVs, 30MVs, 14FFWs**
- **One set of DMC dynamic models satisfy both modes of operation**

Feed management



PDVSA bp
RUHR OEL GMBH

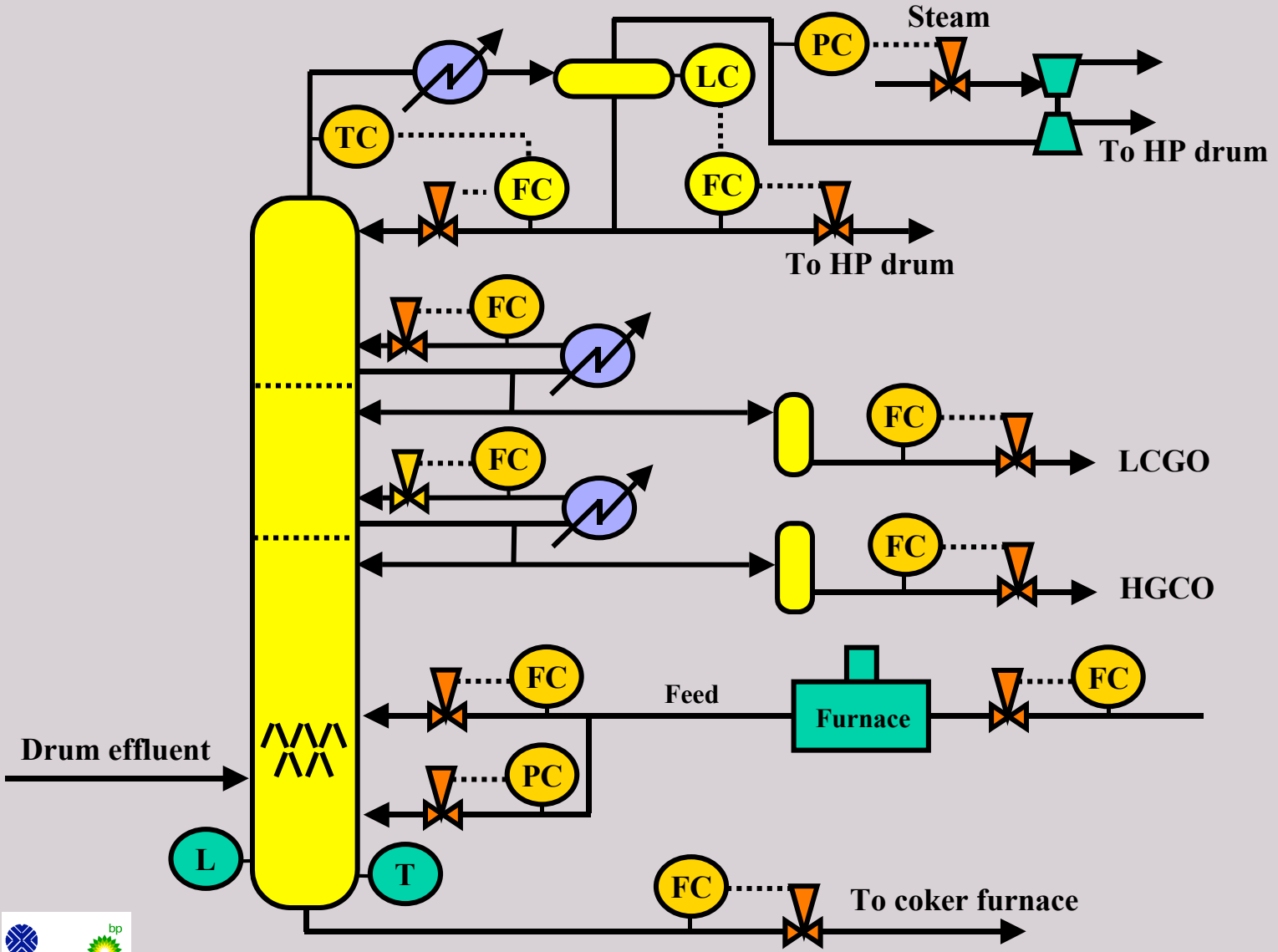
Petrocontrol

AMT

Feed management

- Feed surge drum
- Many feeds
  - Feed surge drum LC slave can be selected to be any one of the feeds
- Recipe to be controlled
- Hydraulic constraints
- Feed management through drum switches and warm-ups

Coker Fractionator



Petrocontrol

PDVSA
bp
RUHR OEL GMBH

AMT

Fractionator control

- Product quality control
- Responding to drum switches
- Column level – a key CV
- Column bottom temperature
- Hydraulic constraints

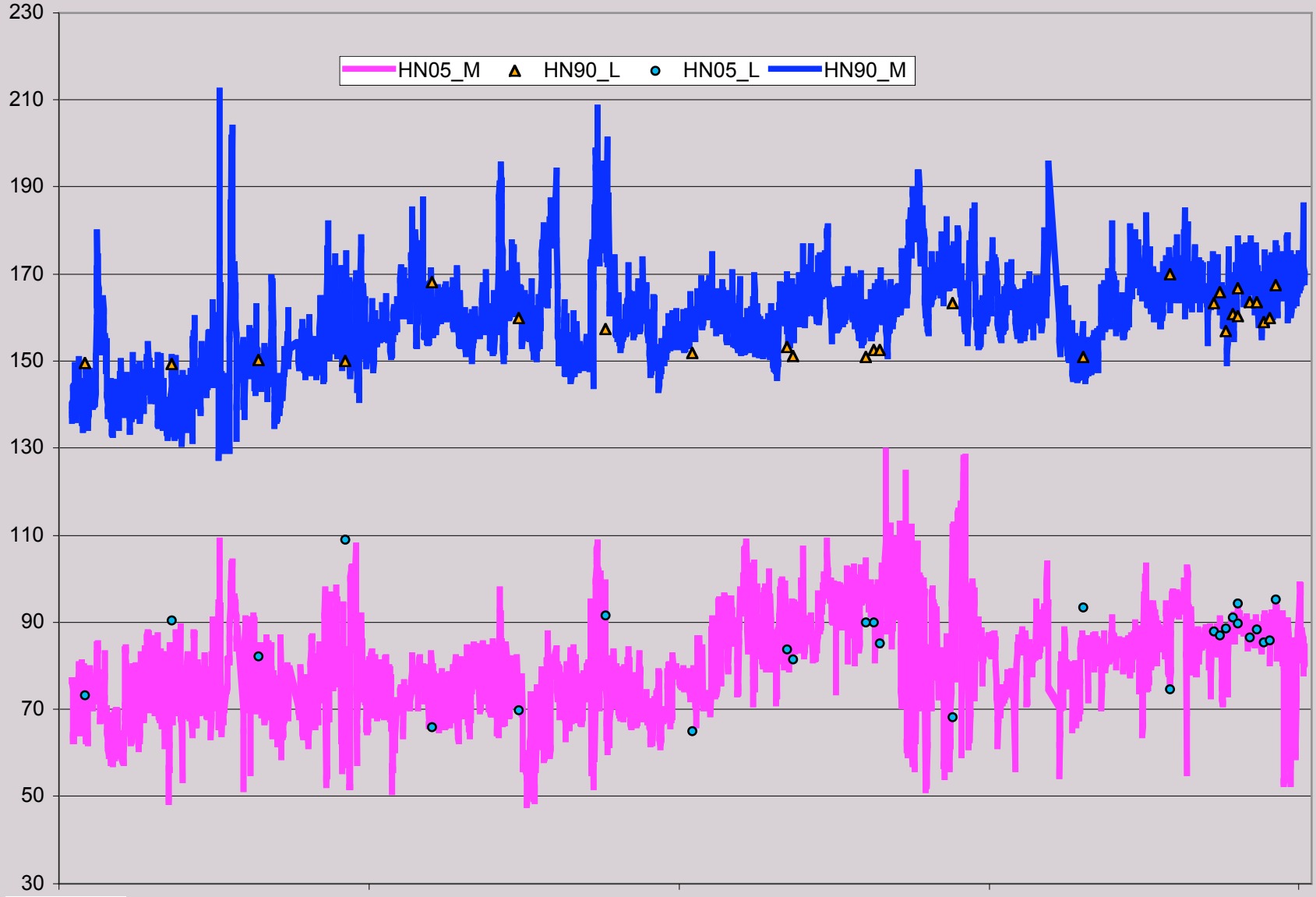
Key inferences

- **Naphtha 90% point**
- **Heavy naphtha 5% point**
- **LCGO flash and 90% point**
- **HCGO 90% point**
- **Coke drum outage (in open loop)**

Coker furnace

- Many constraints
- Pass balancing by skin temperatures
- Throughput maximized to
  - Furnace constraints in both furnaces
  - Inventory constraints
  - Fractionator constraints, when the fractionator sub-controller cannot handle them

Heavy naphtha 5 and 90% inference

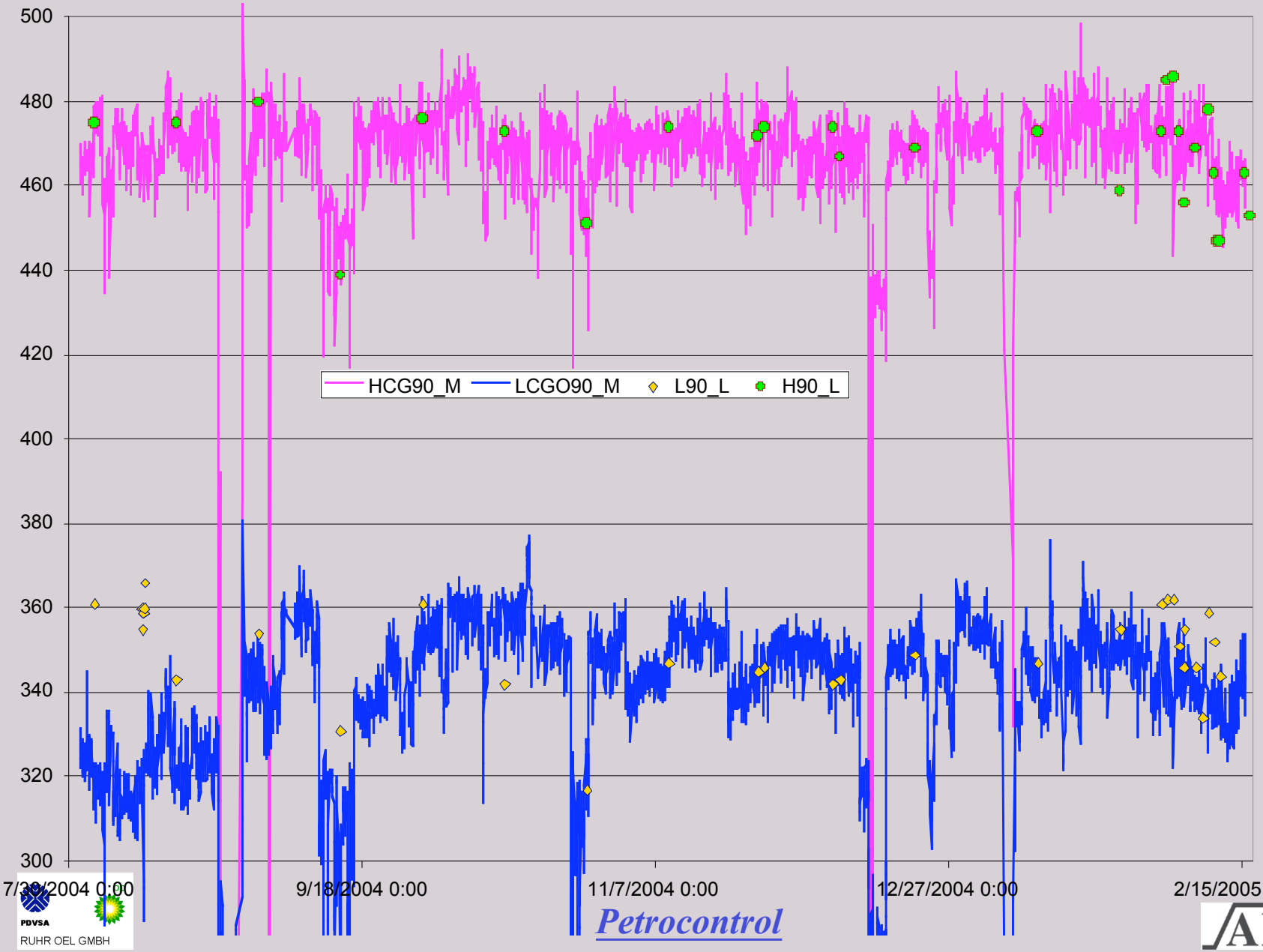


PDVSA
RUHR OEL GMBH

Petrocontrol

AMT

LCGO and HCGO 90% inference

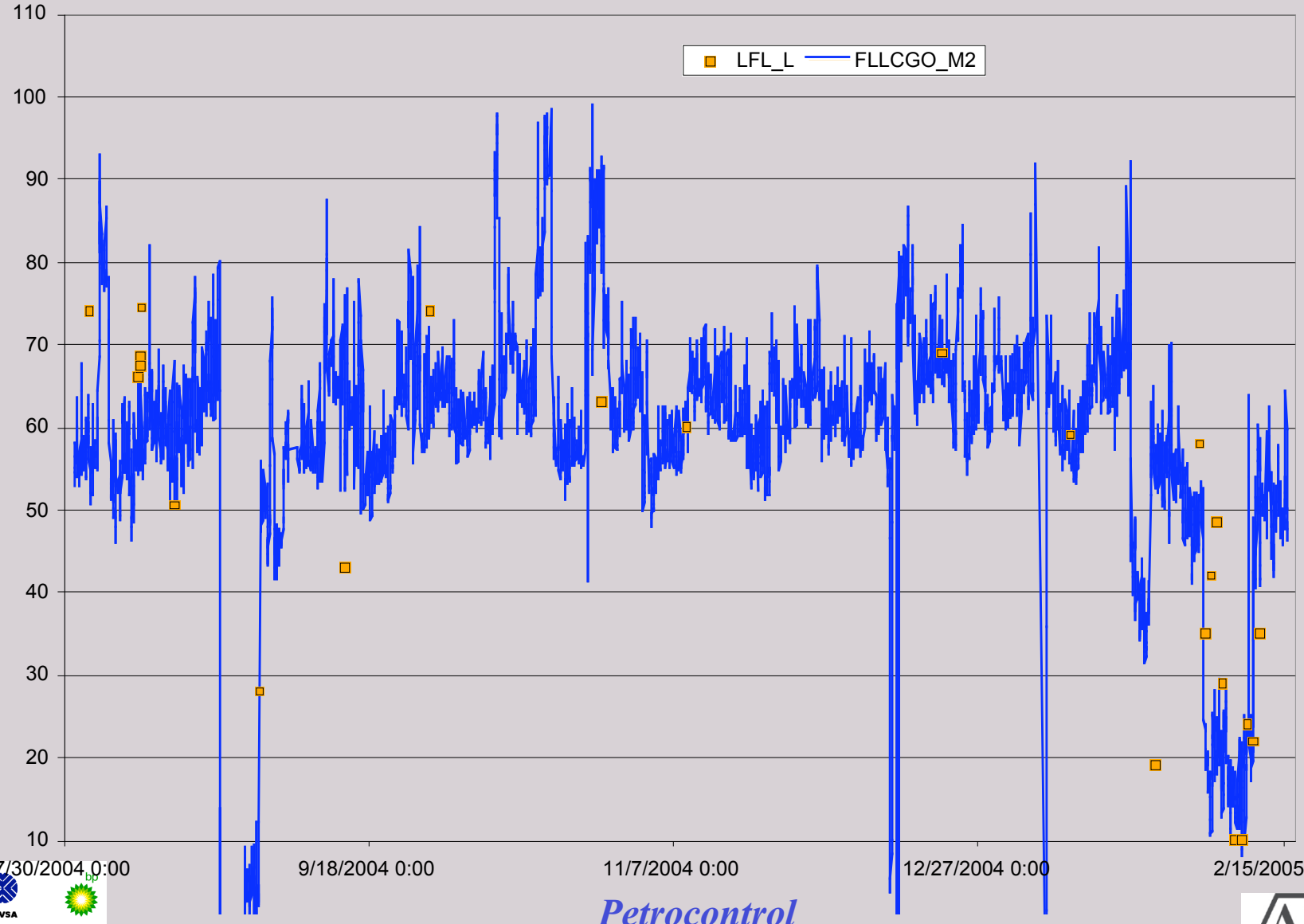


PDVSA
RUHR OEL GMBH

Petrocontrol

AMT

LCGO flash inference



PDVSA
bp
RUHR OEL GMBH

Petrocontrol

AMT

Commissioning issues

- **Difficult to identify coker real constraints pertaining to downstream units.**
- **The noise pattern of certain flow readings impeded inferential model commissioning.**

  Implemented validation routines and/or alternative measurements.

  Also applied custom validation for all CVs.
- **Secondary constraints caused DMC to move furnace feed flow unnecessarily during drum switches**

  DMC parameters were set to avoid throughput reduction unless no other route is possible.
- **The application is now almost fully commissioned, and we will report performance data in another paper.**