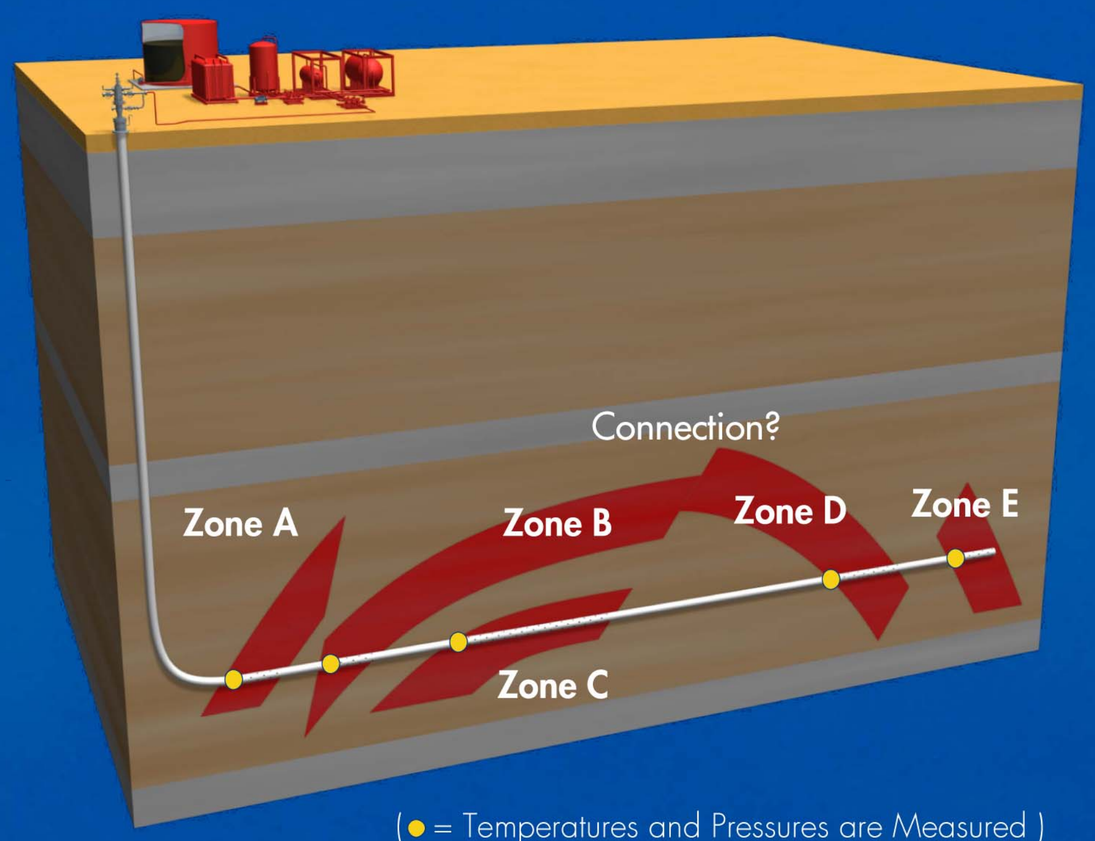
Shell Exploration & Production

Oil to Algebra

Multi-Zone-Well to Measurements

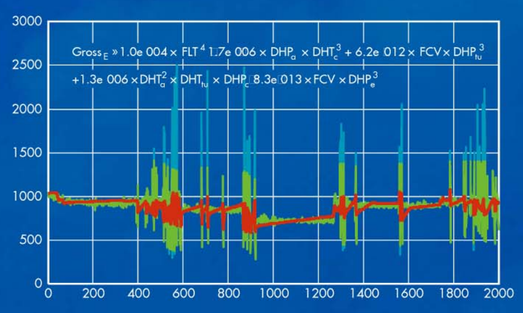


(● = Temperatures and Pressures are Measured)

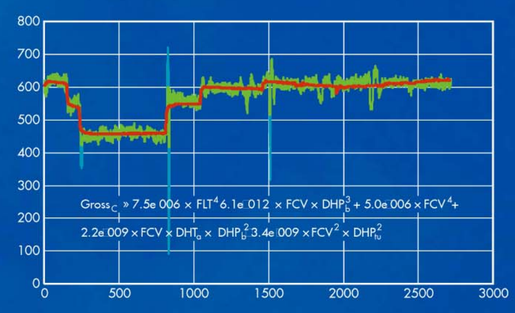
- Which Zone contributes which amount to the total production?
- How do the Zones interact and relate to each other?

Measurements to Polynomials

Approximation of …

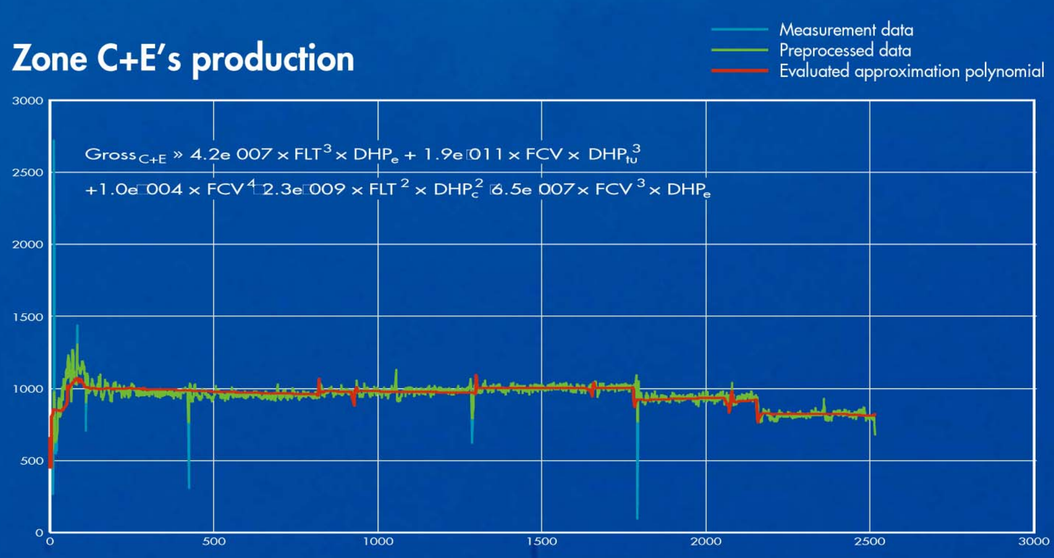


Zone C's production



Zone E's production

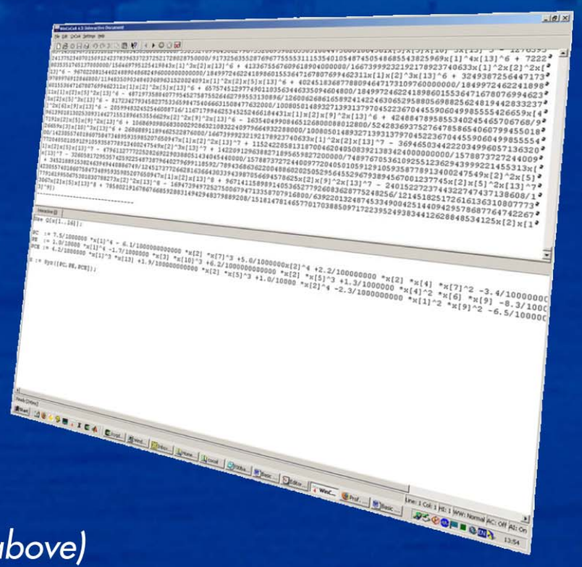
Zone C+E's production



Polynomials to Decomposition

$$(q_1, q_2, q_3) \in Syz\,(P_C, P_E, P_{C+E}) \rightsquigarrow$$

$$P_{C+E} = \frac{q_1}{q_3} P_C + \frac{q_2}{q_3} P_E$$



More Algebra, more Oil…

Algebraic Subject	E & P Application
Syzygies	**Interrelationships** *(see description above)*
Differential Gröbner Basis	**Dynamical Systems** Including long-term changes → Forecasting, Reservoir management. Special activity: Good Slugs, using the energy generated by slugs for production – and exploration *(see last pair)* applications
Elimination Theory	**www2.m** Acronym for 'Where, when, what to measure'. Minimal requirements technical infra structure.
Invariant Theory	**Generic elements** Global exchange of information.
Homotopy	**Test versus Production** The change from the test – to the production situation for a well is viewed as a continuous deformation of the well test model
Automated Theorem Proving	**Diagnostics and Decisions** Including relationships between processes that run on different time scales, e.g. early recognition of building-up water break through. Subject may be considered as next generation Artificial Intelligence.
Computational Homology	**Surface characterization** Surface characterization of sub- surface through computation of homology groups. Of particular importance for last pair.
D – Modules	**Non-seismic Exploration** This application is possible since this algebraic subject allows the consideration of spatial variation. This pair is coupled with the first – and second pair.

Other Approaches:

- Using Normal Remainder
- Using Approximation Theory

CoCOil is a cooperation between the University of Dortmund, the University of Genova and Shell International Exploration & Production

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