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Methods and Workflows to Process Dynamic Data in Intelligent Fields

Olivier Houzé

KAPPA

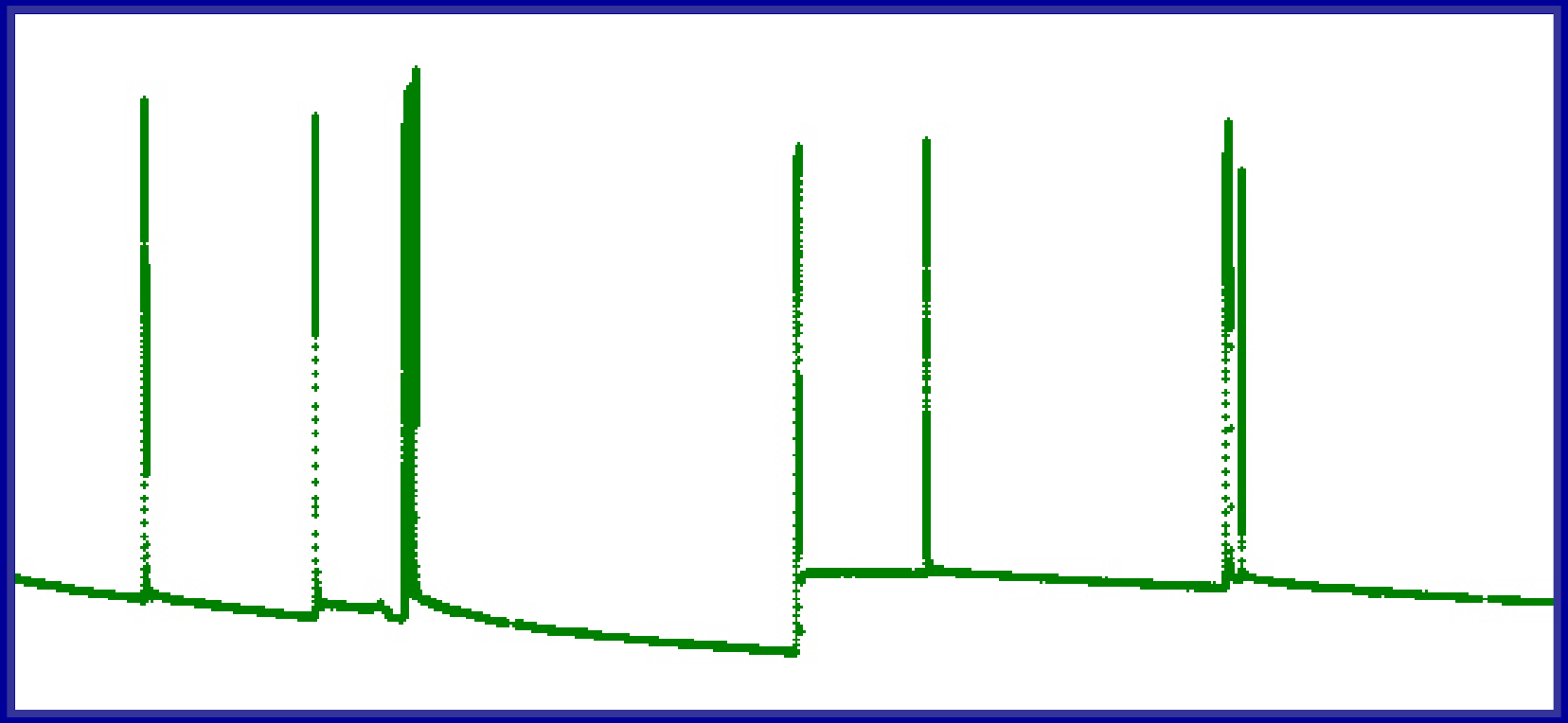
Analysis of Dynamic Data

- … create a flow sequence
- … measure rates, pressures, temperature
- … at any scale in time or space
- … *analyse* and match data with a *model*
- … use the *analysis* for operational decisions
- … use the *model* to forecast scenarios
- **Intelligent Fields**: all this in ‘real time’

Dynamic Data Sources

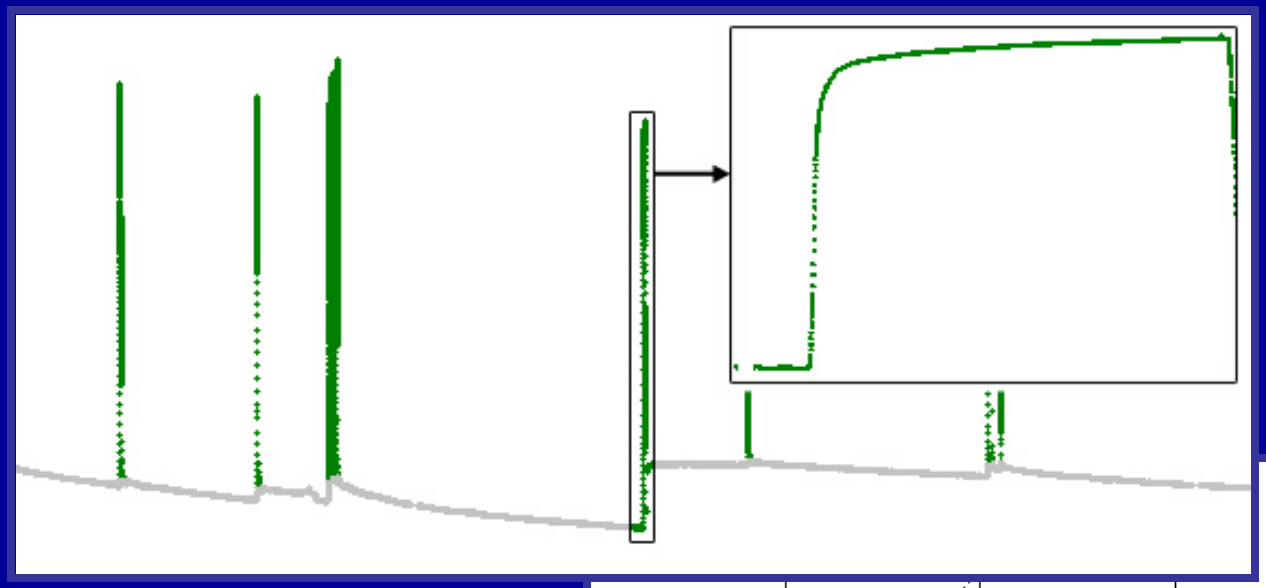
- Well tests: q(t), P(t), T
- Formation tests: q(t), P(t), T … vs. z
- Production logs: q(z), P(z), T(z) … vs. t
- Production data: q(t), Q(t)
- **PDG data**: P(t), T
- Fiberoptics: T(z,t), P(z,t)

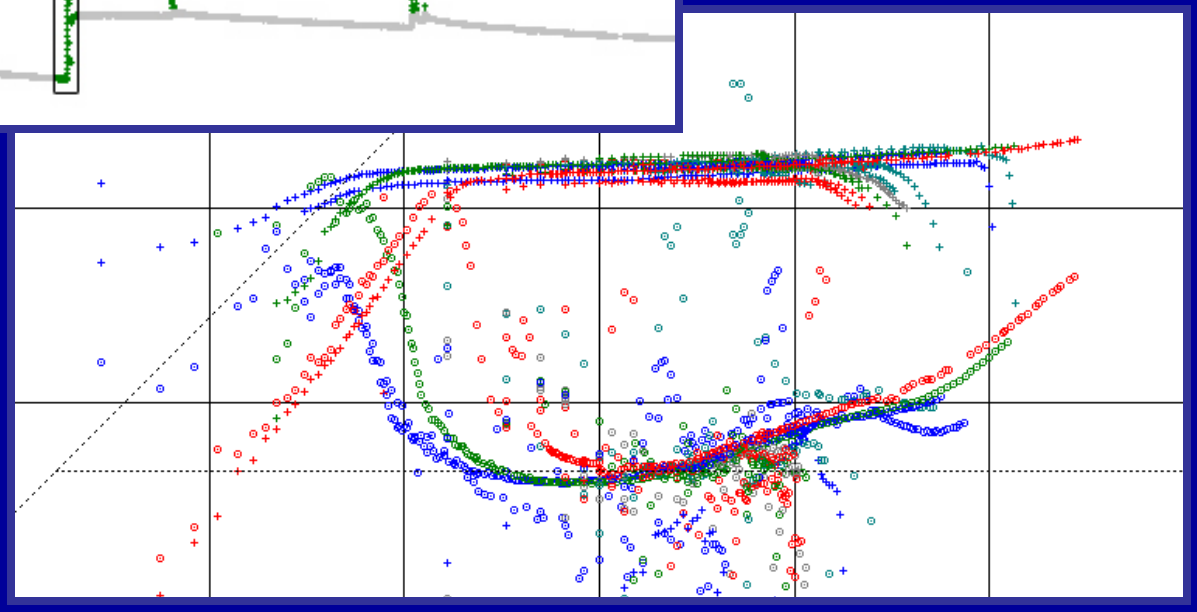
PDG Data
(Permanent Downhole Gauges)



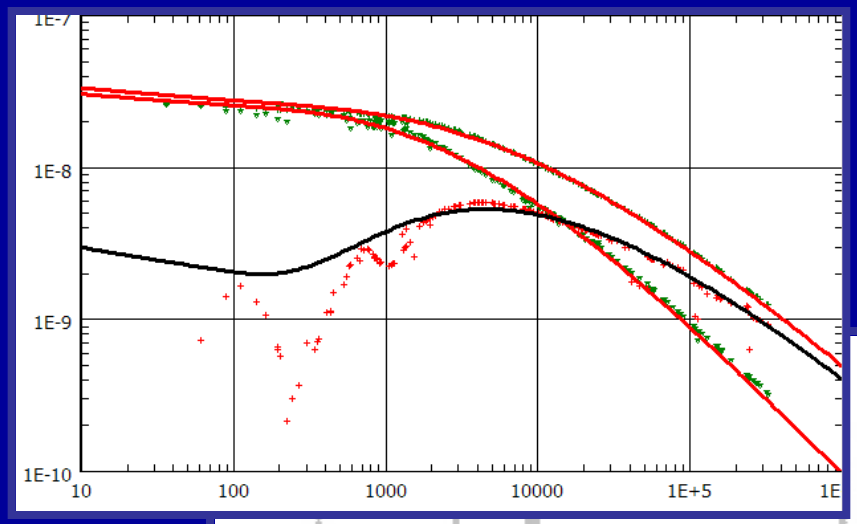
Est: 75,000 to 100,000 PDG + 15,000 /year – 5,000 IFM +800 /year – 150 DFM

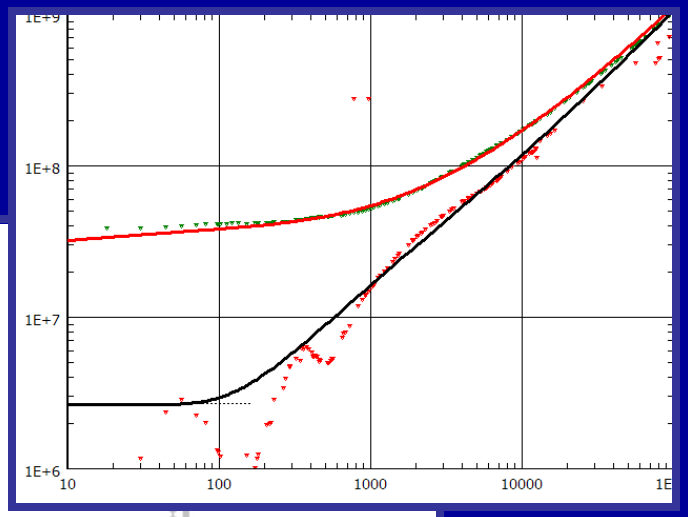
PDG Usage: PTA
(Pressure Transient Analysis)

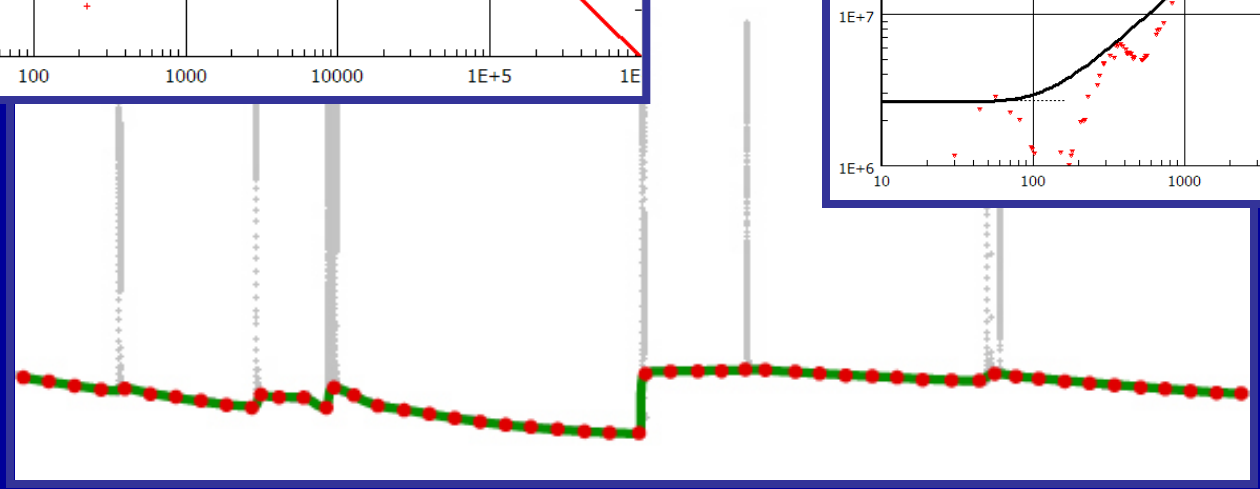




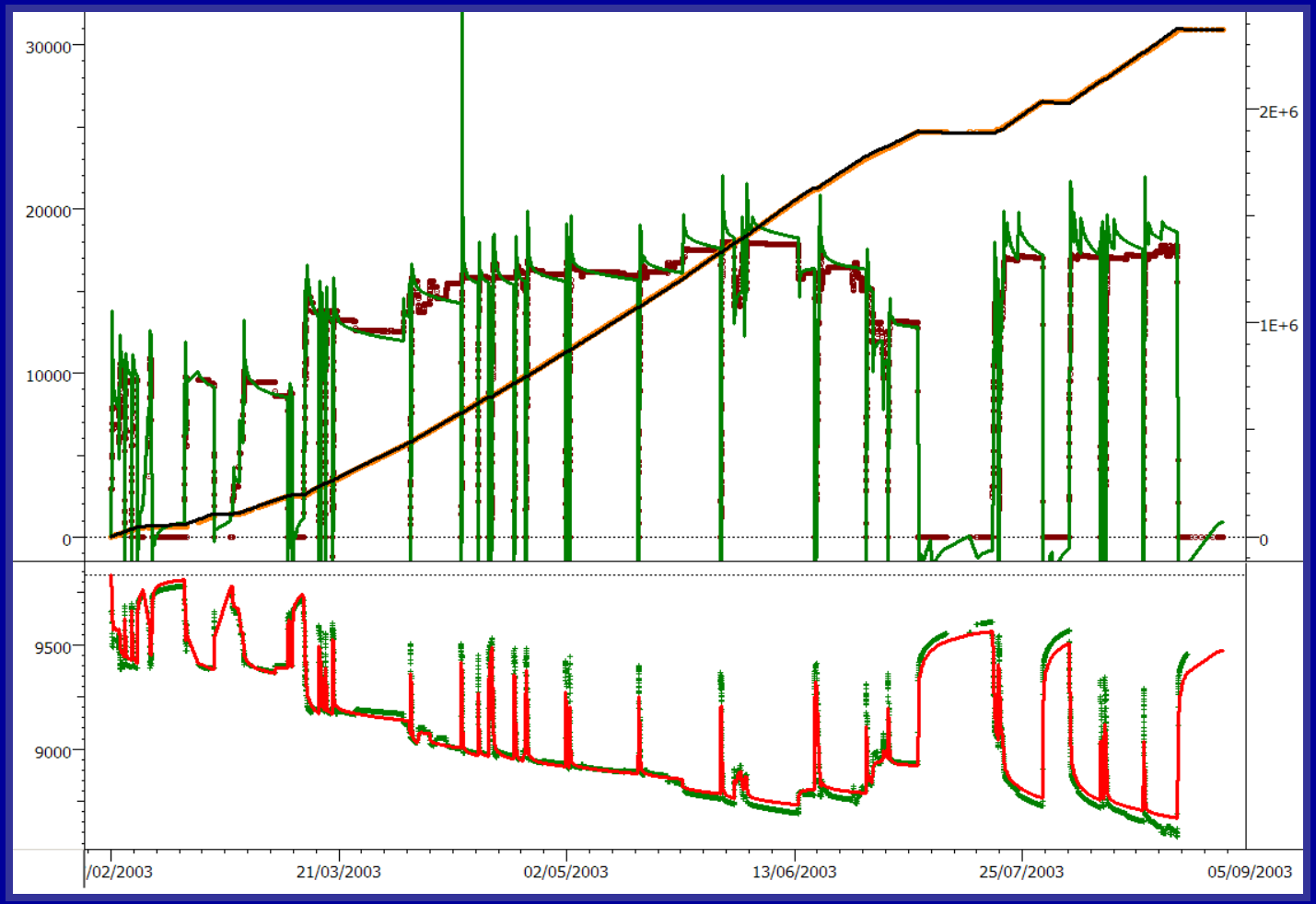
PDG Usage: PA
(Production Analysis)







PDG Usage: History Matching

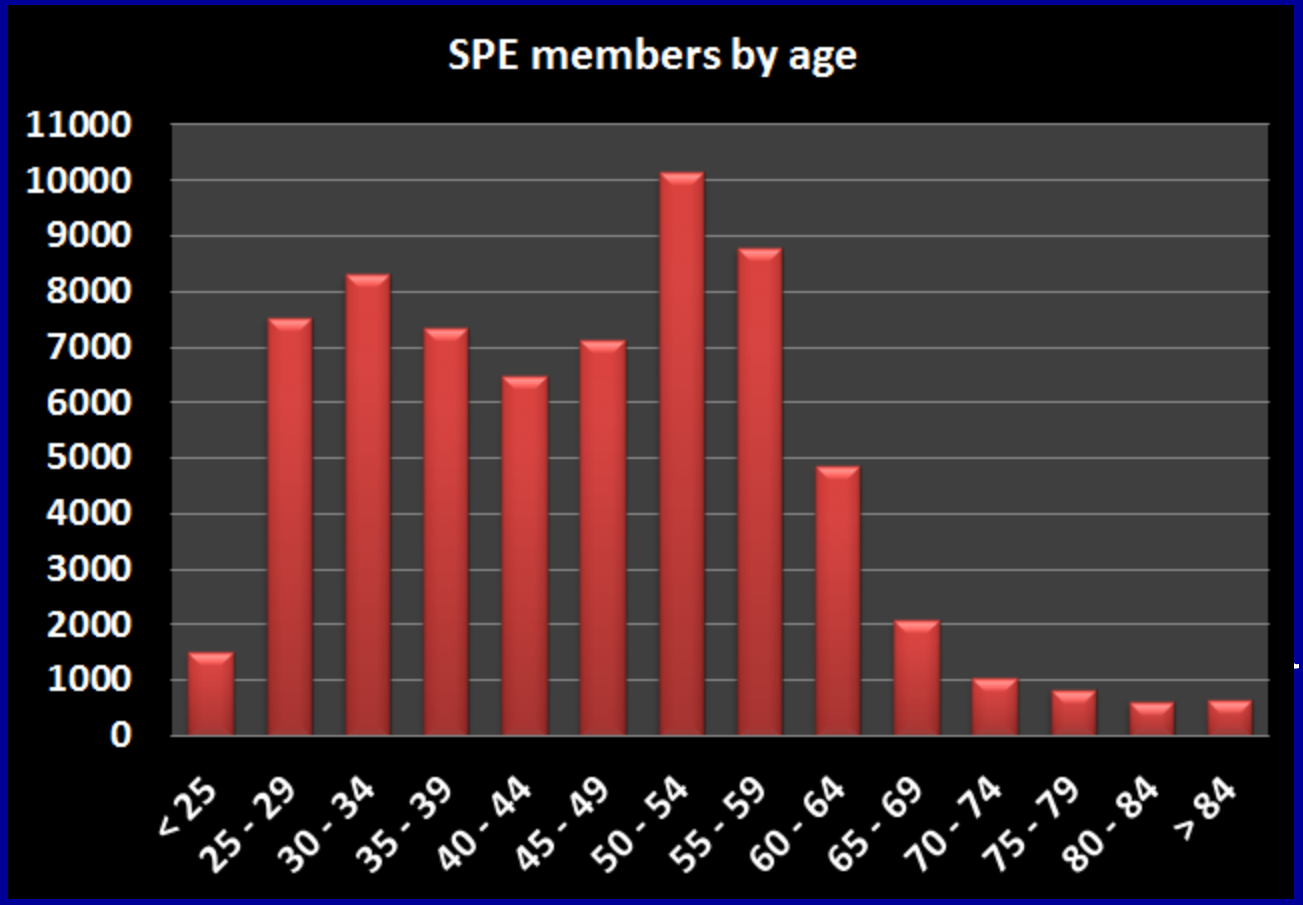


Issues

- Data overflow
- Information overflow

- Scarce human resources
- > 50% of time wasted fighting data
- Process rather than engineering
- Large crew change to come

Issues

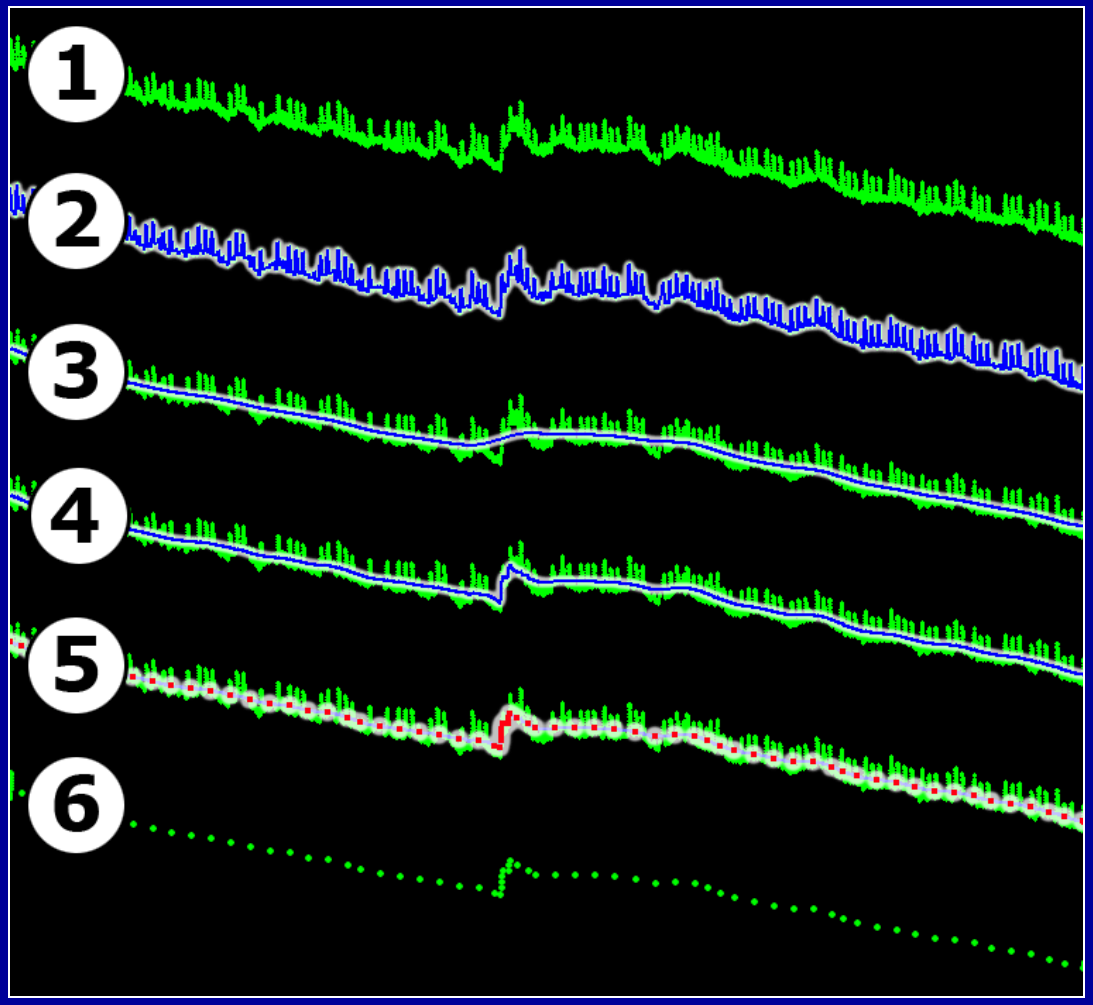


- Large crew change to come

Tools / Methods

1. Wavelet filtering
2. Events identification
3. Deconvolution
4. Flexible numerical models
5. Proxys and virtual metering

1. Wavelet Filtering



11656 points

too low

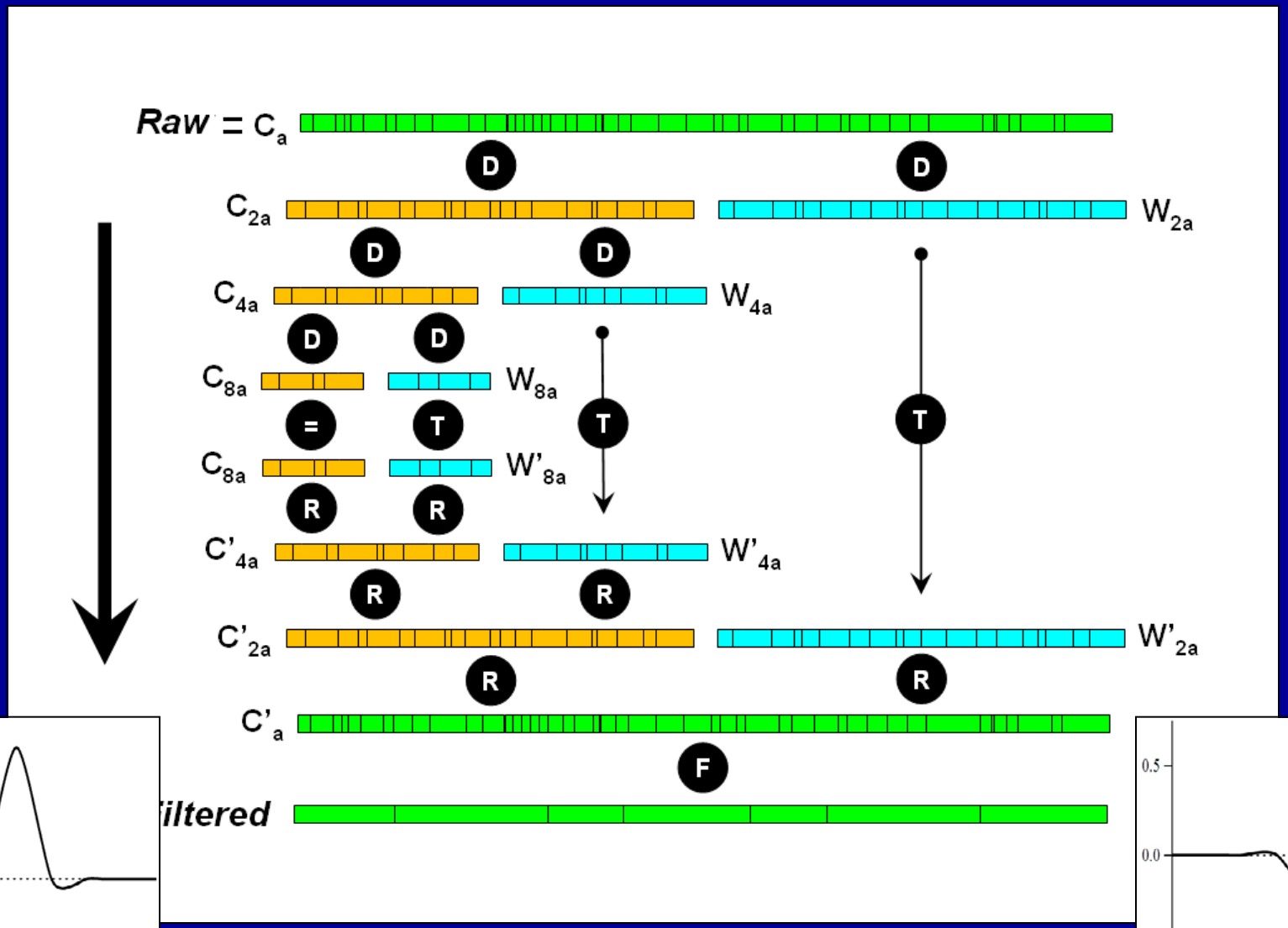
too high

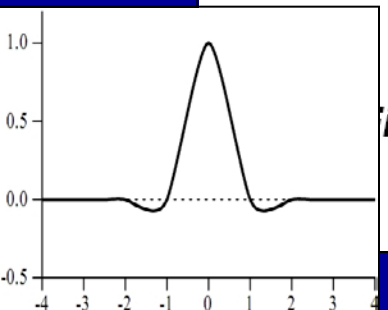
OK

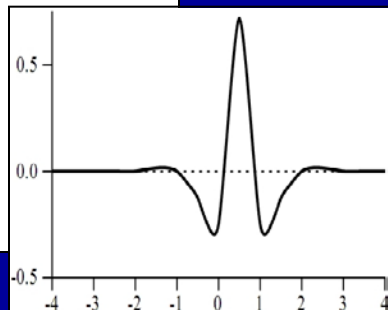
Post-filtering

70 points

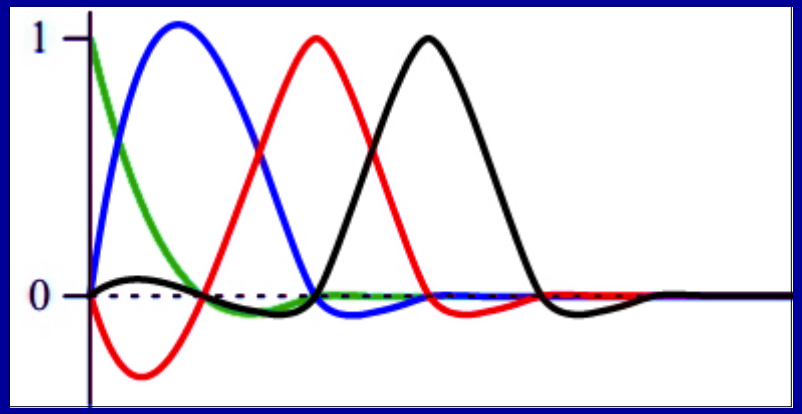
Wavelets filtering

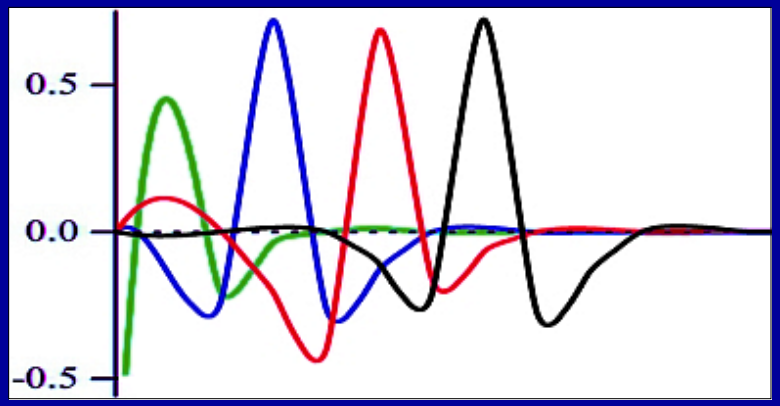


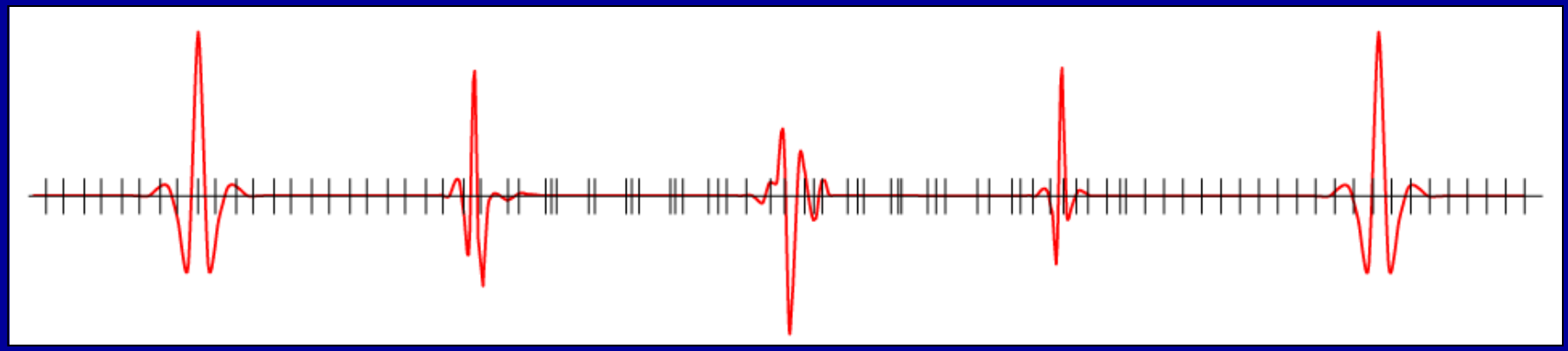




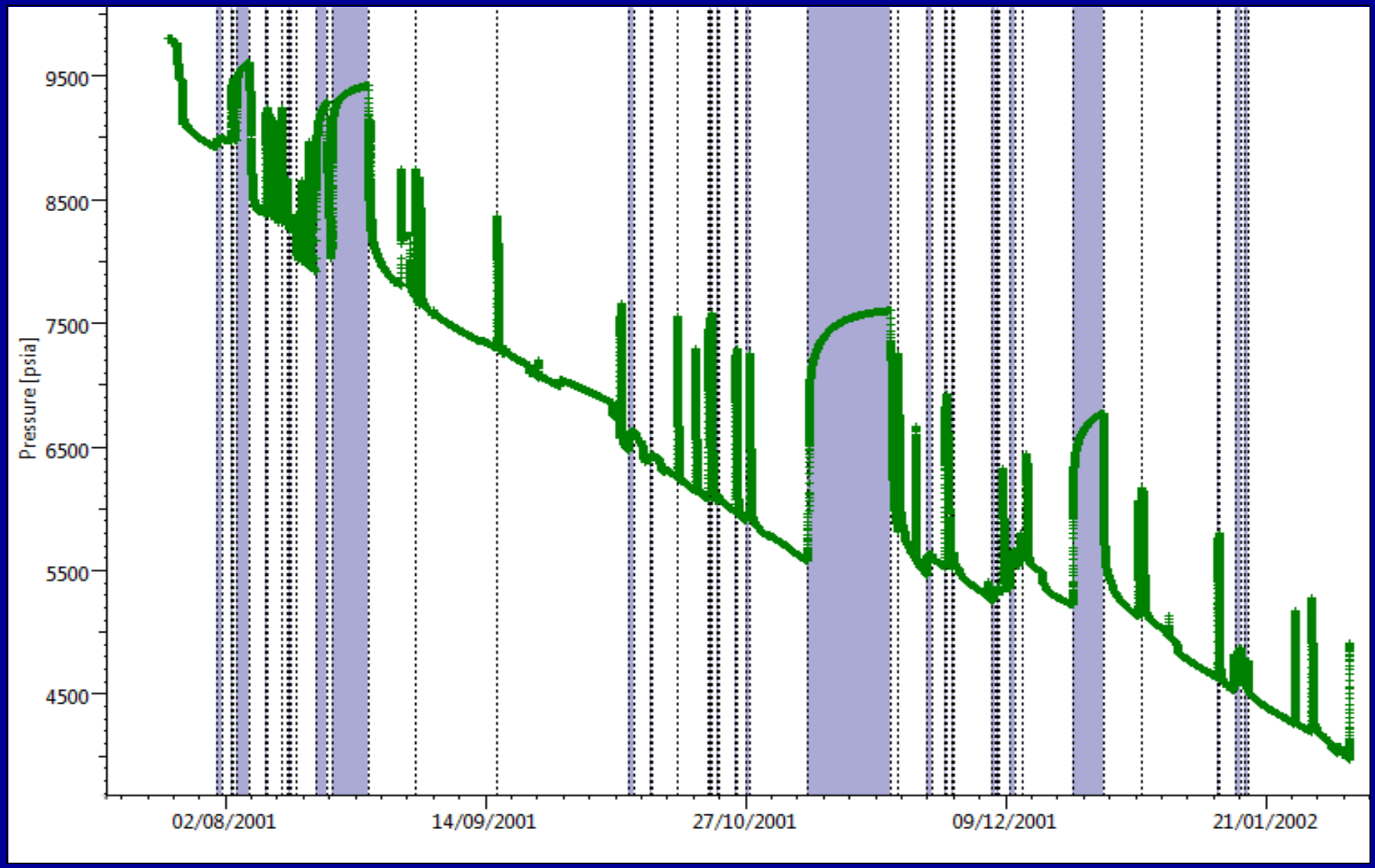
Adaptative wavelets (2010)



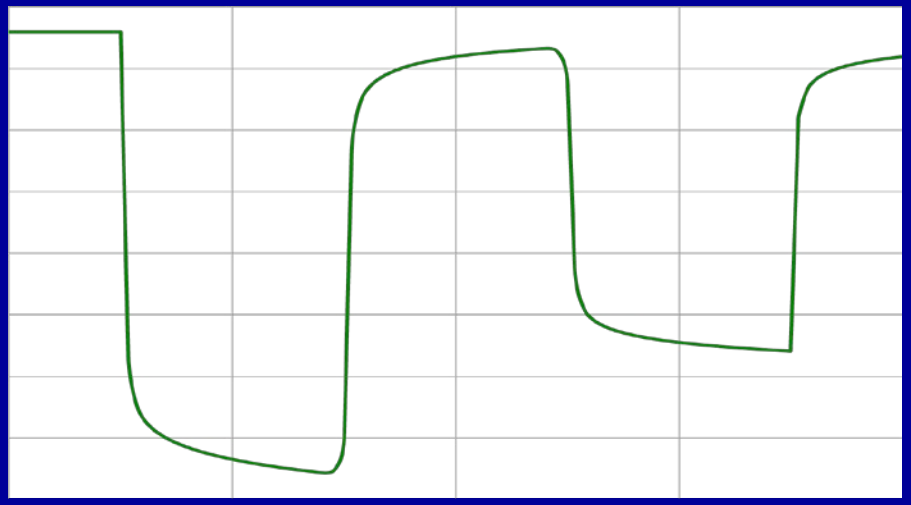


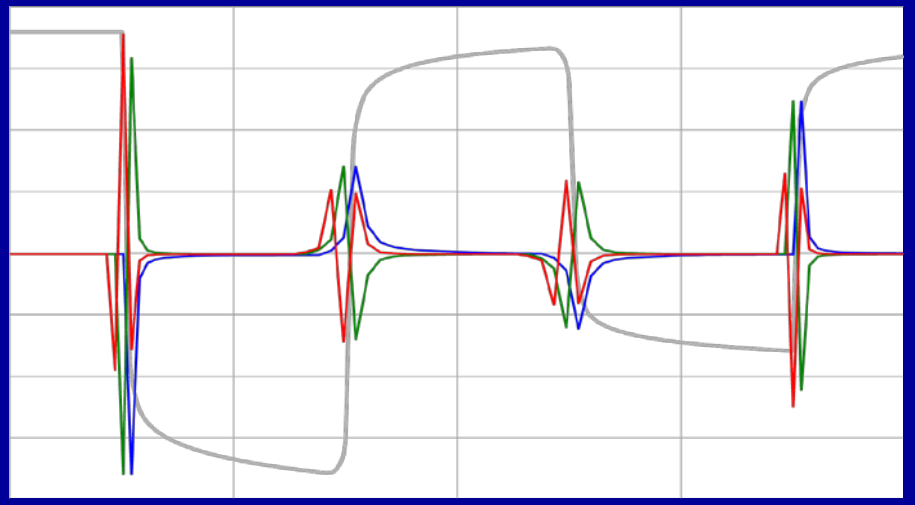


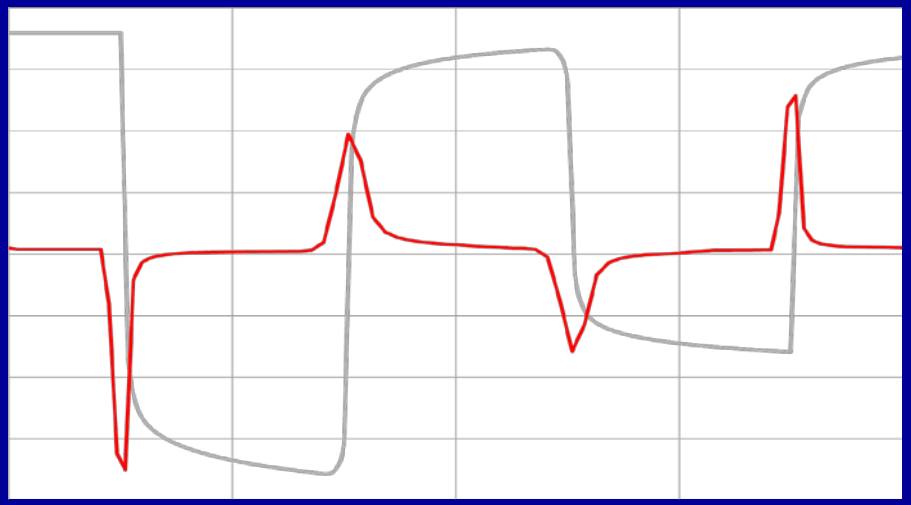
2. Events identification

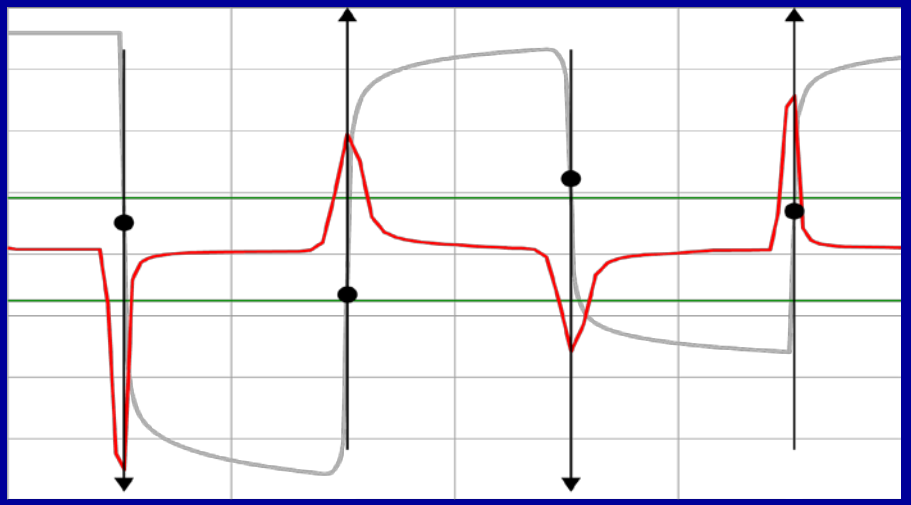


Identifying events



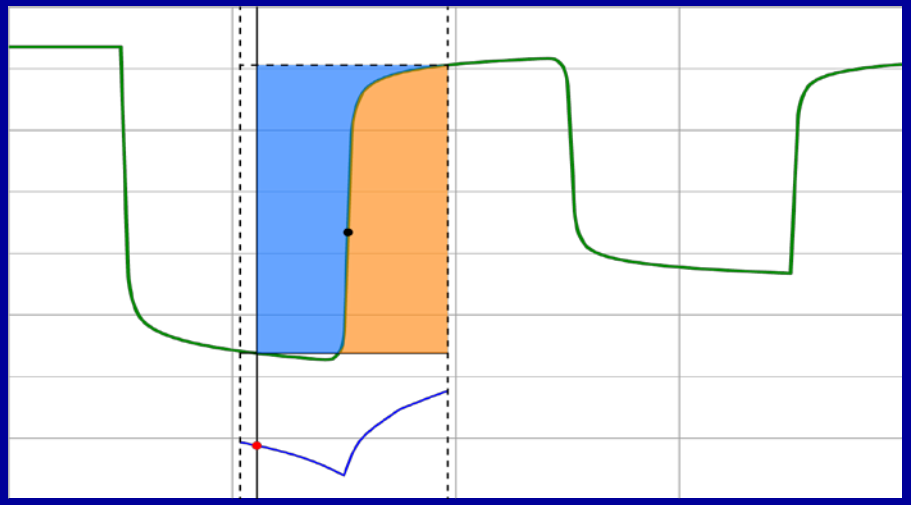


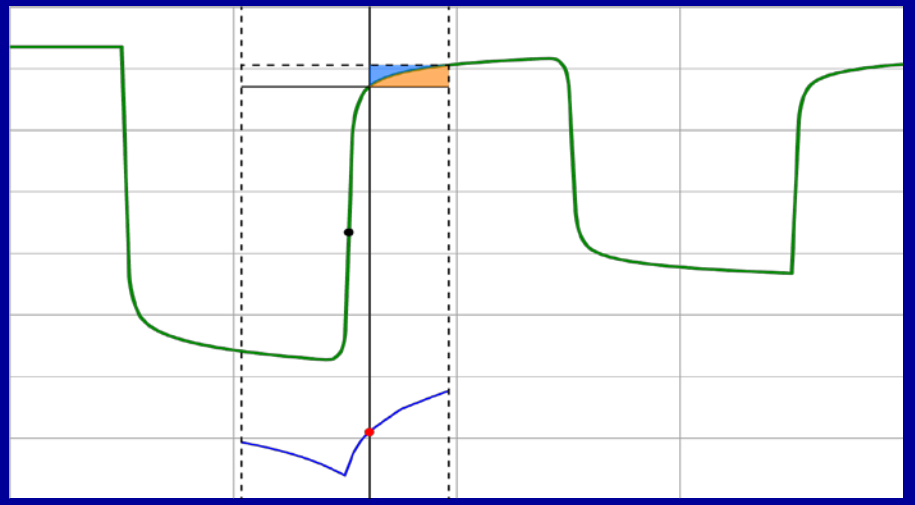


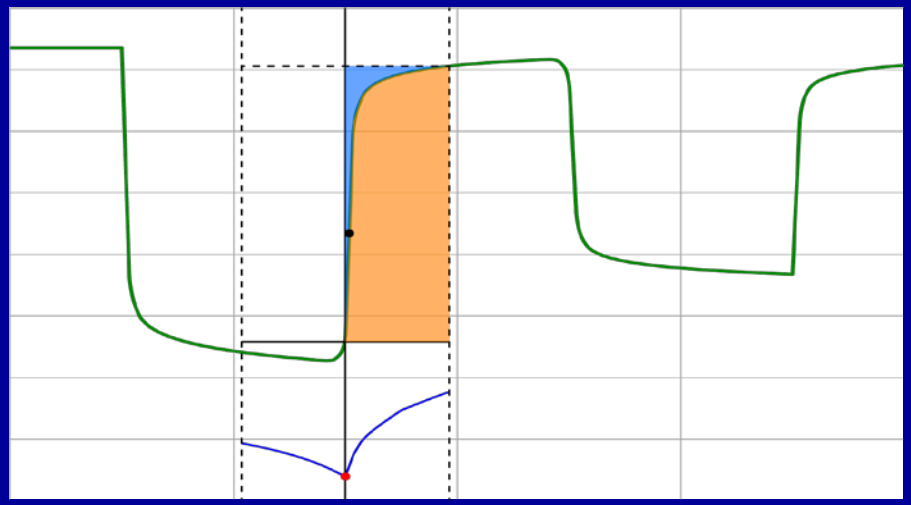


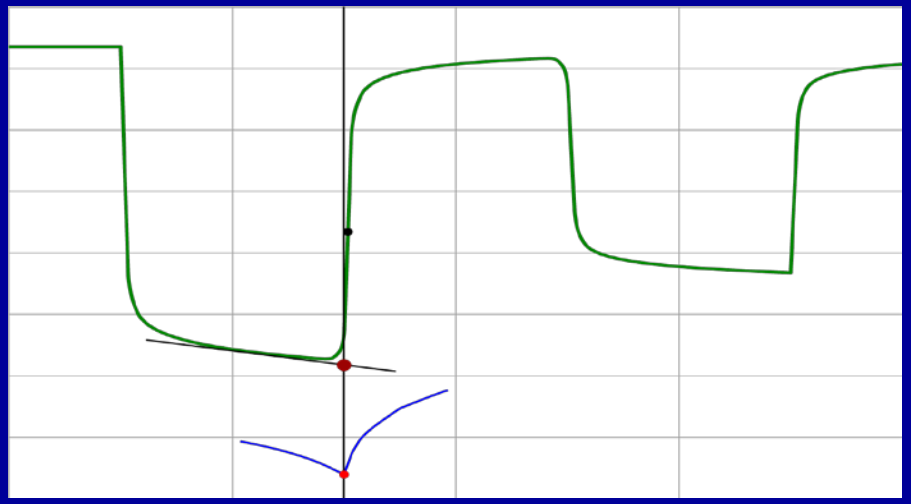
Pressure or temperature vs. time (scale irrelevant)

Locating events



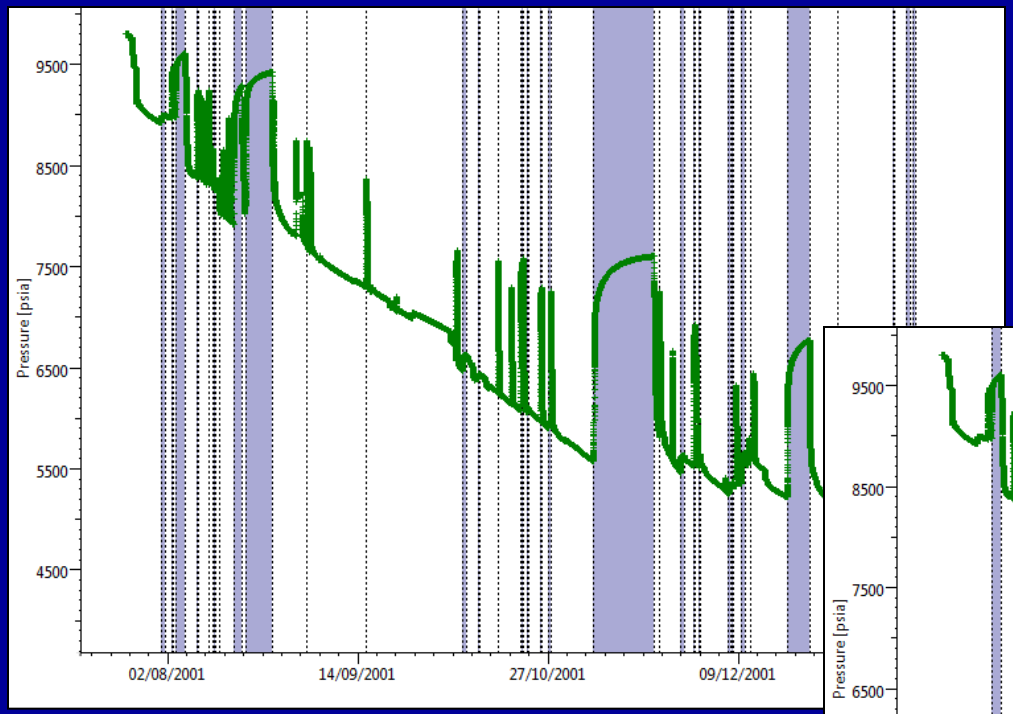






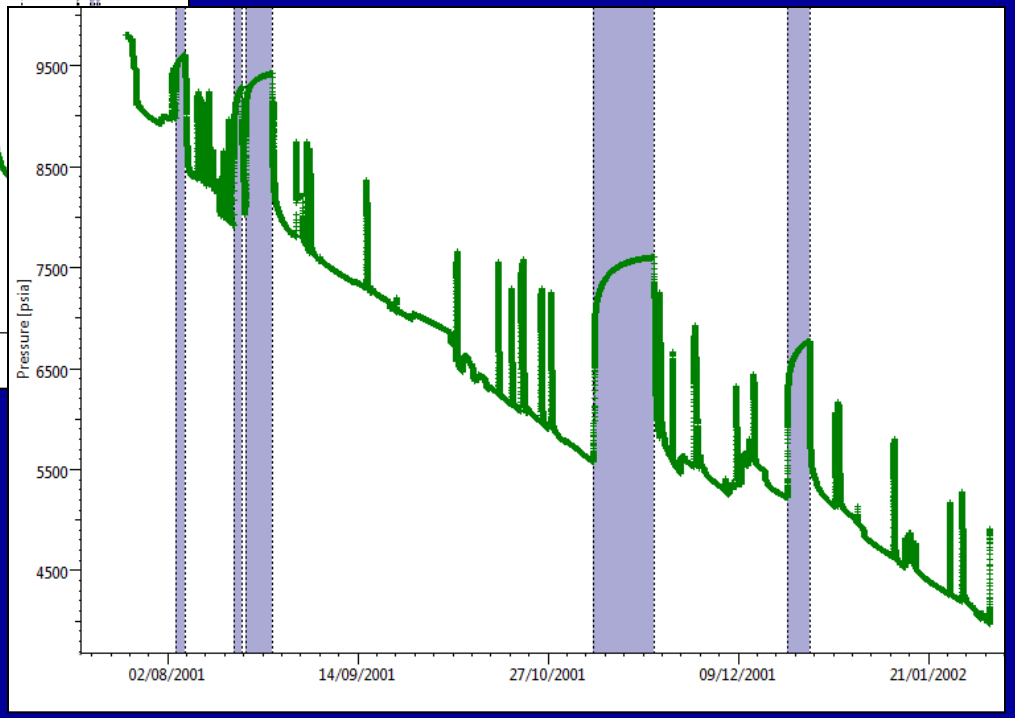
Pressure or temperature vs. time (scale irrelevant)

Setting thresholds



30 mn & 50 psi

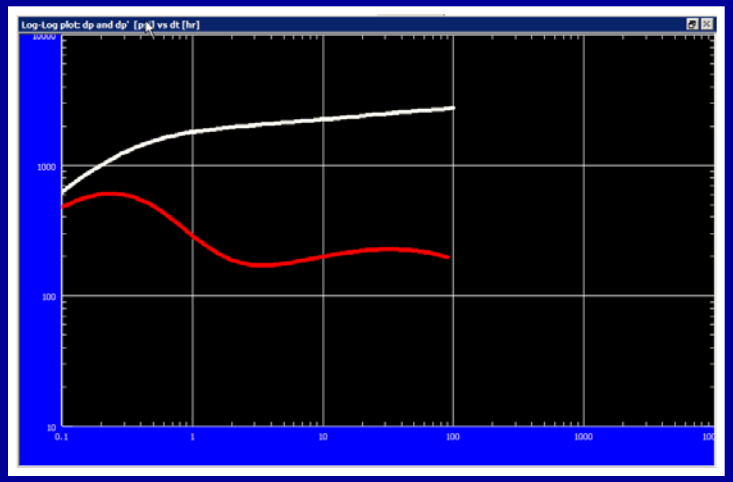
10 hr & 100 psi



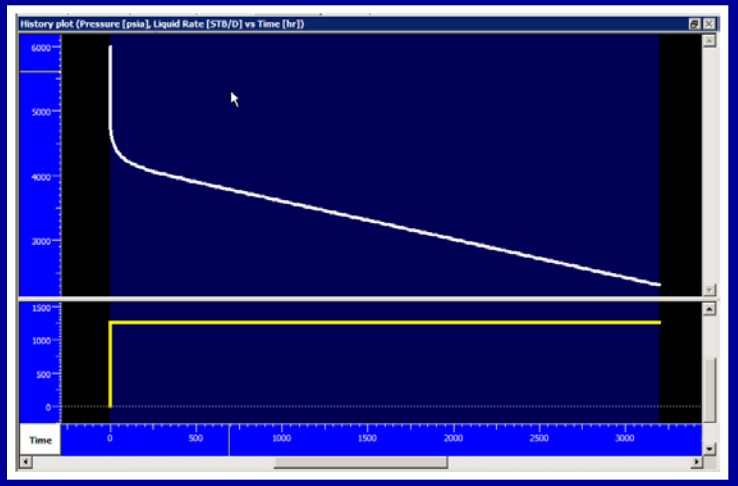
Pressure vs. time

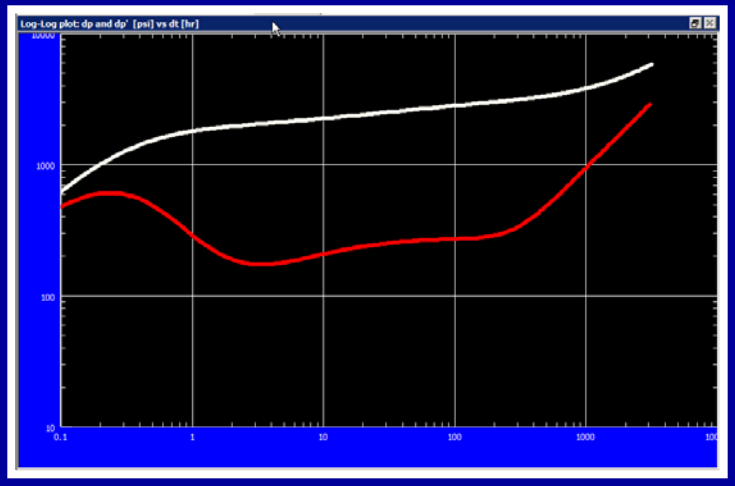
3. Deconvolution

we have



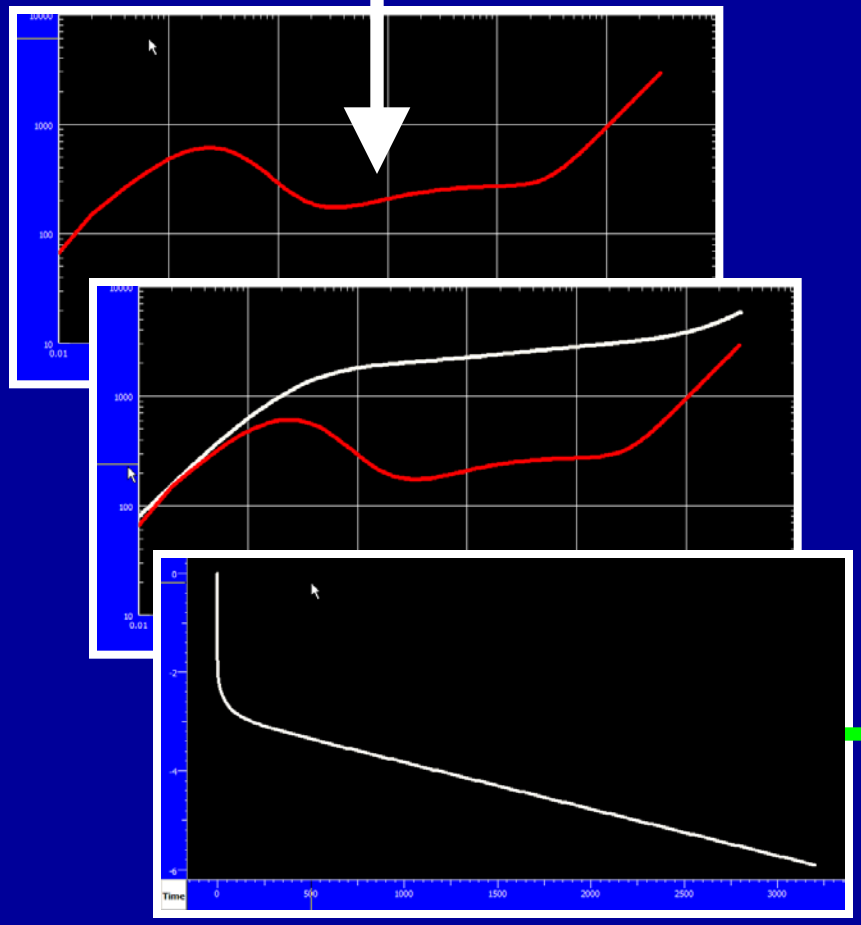
we want



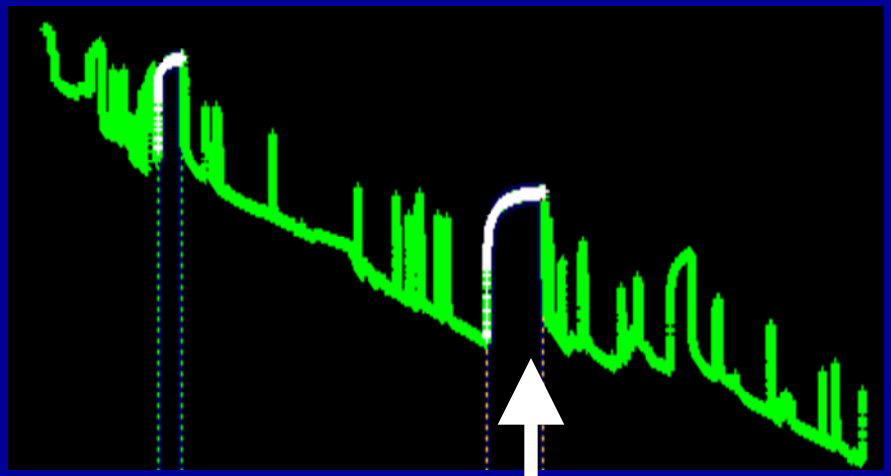


Deconvolution: How?

We change this…

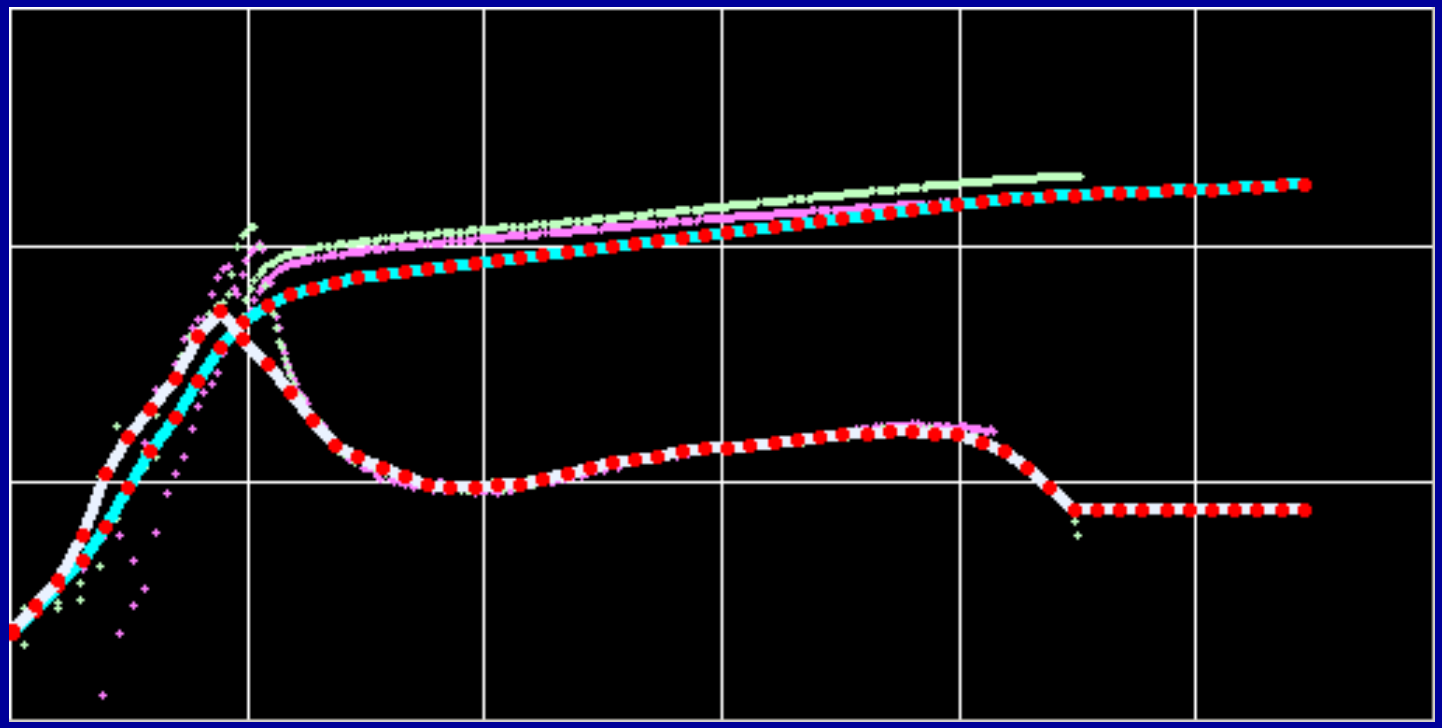


Convolution



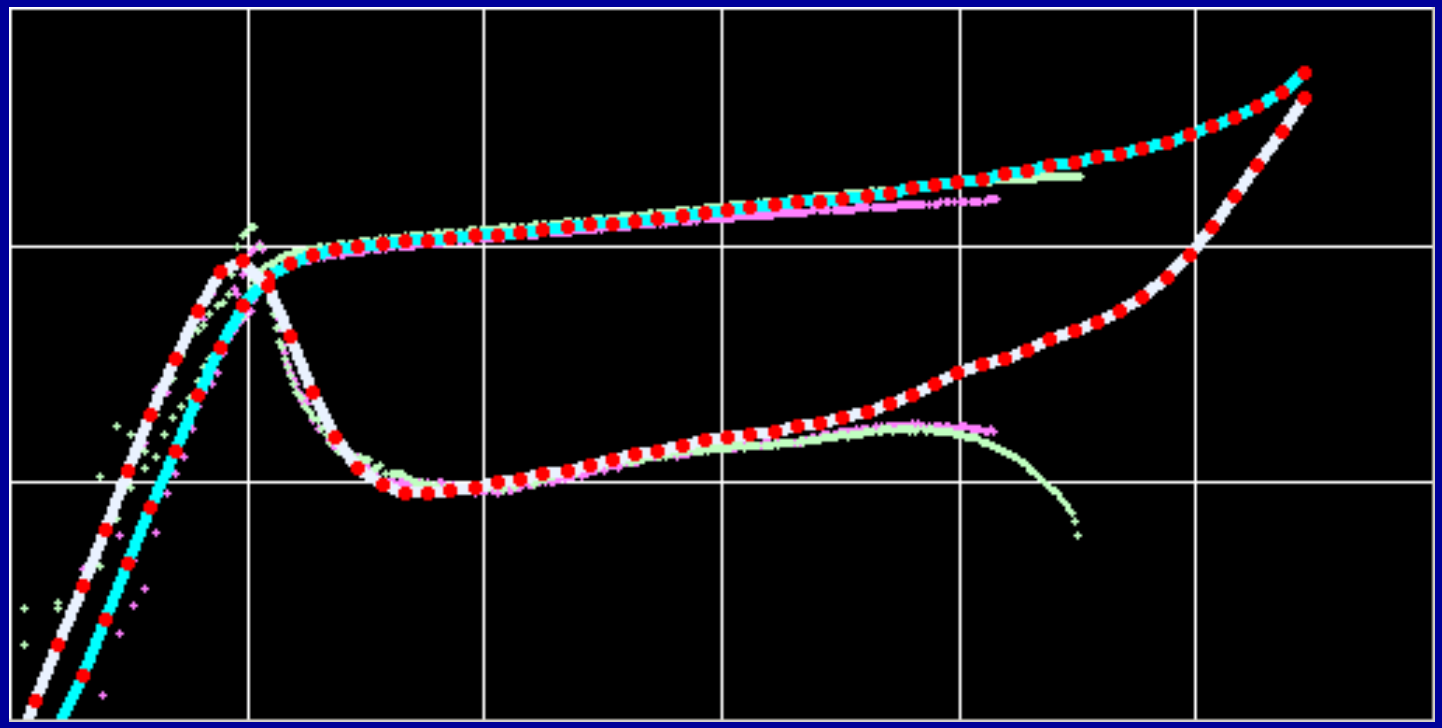
…to match that

Deconvolution in action



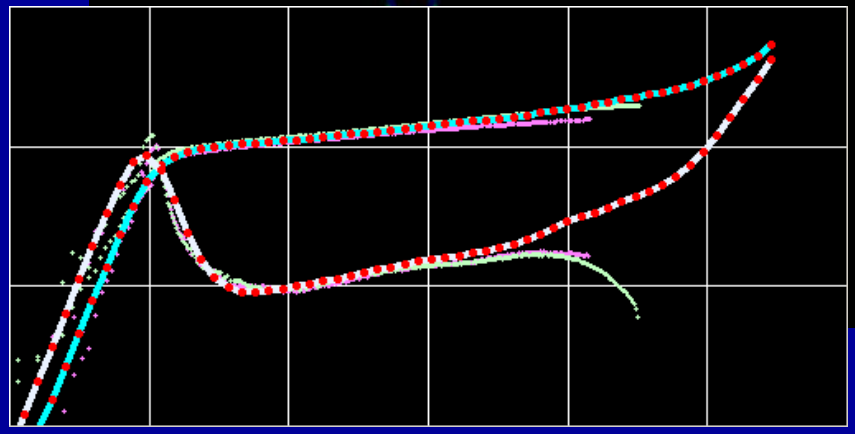
2 – Initial guess of the deconvolution response

Deconvolution in action



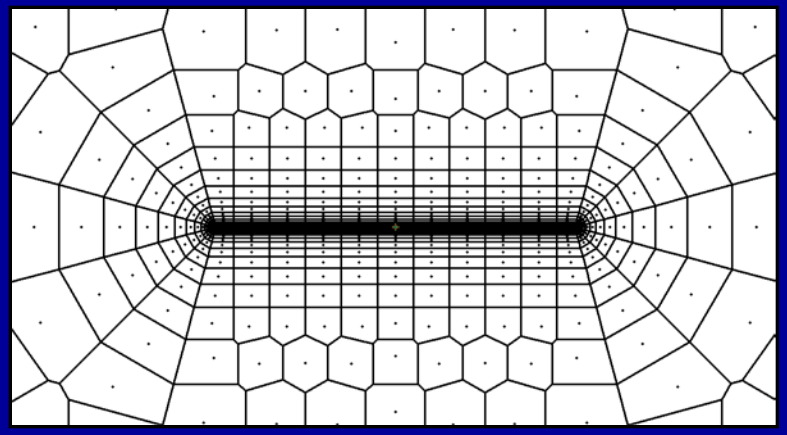
6 – Final deconvolved response ☺

Deconvolution explained

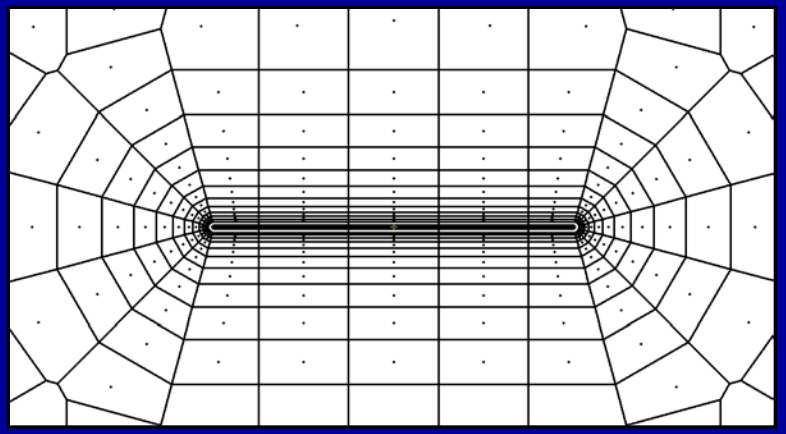


4. Flexible Numerical Models

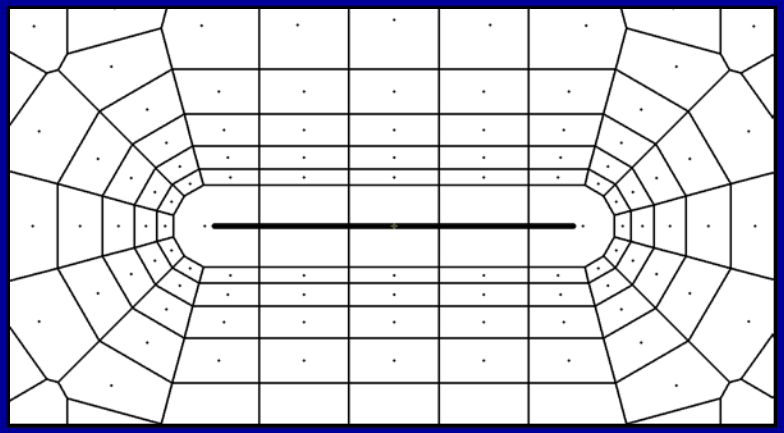
PTA - 2000 Cells



PA - 200 Cells

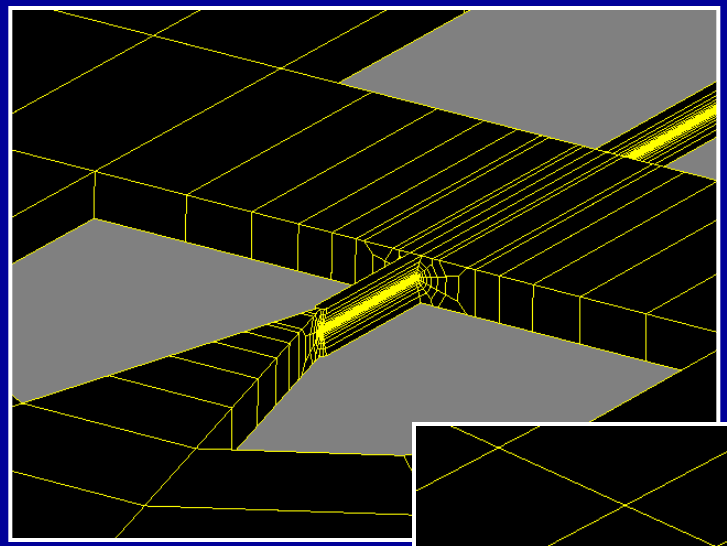


Simulation - 5 Cells

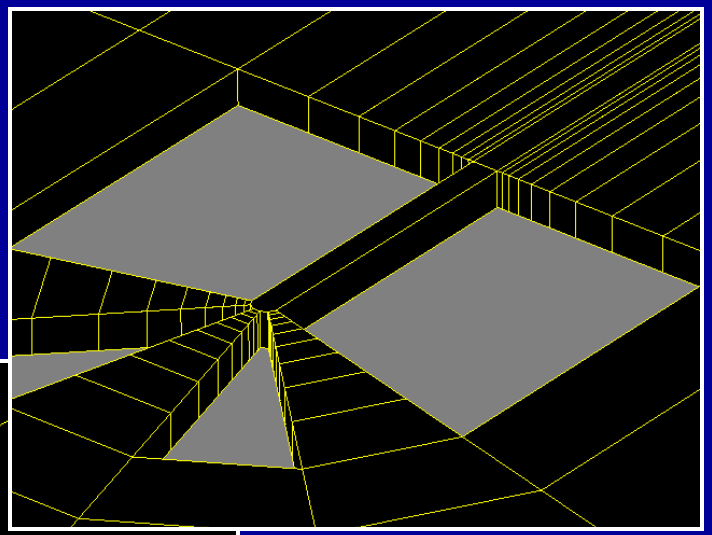


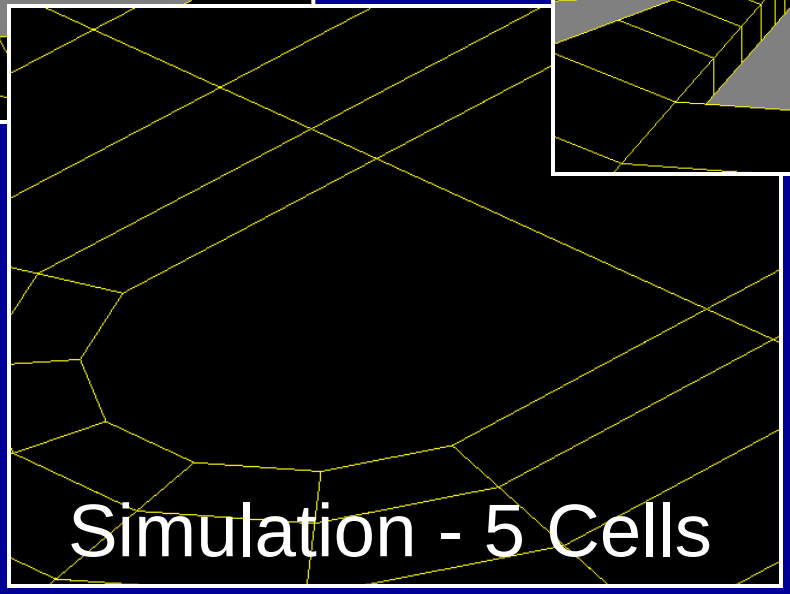
Adaptative gridding

PTA - 2000 Cells

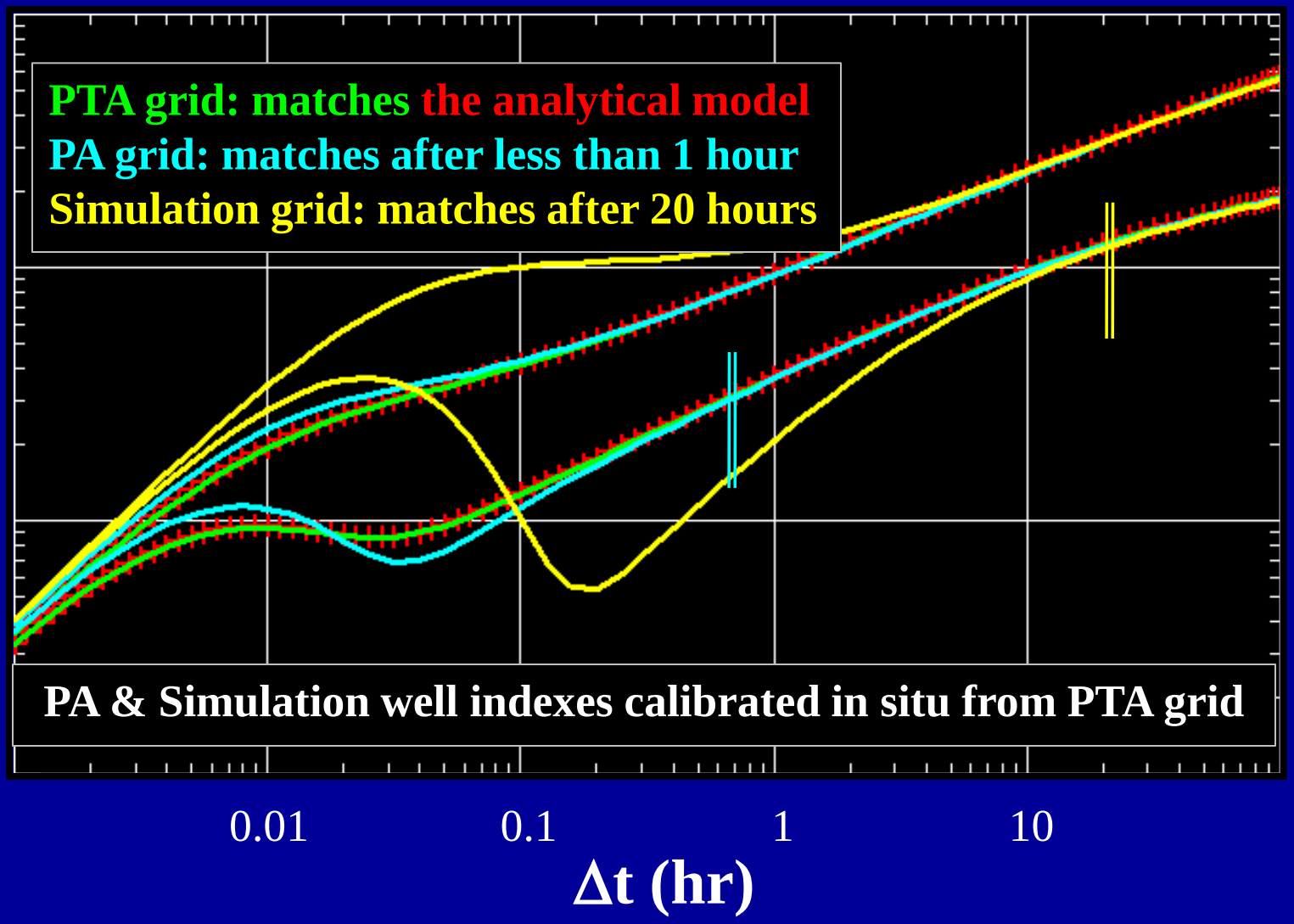


PA - 200 Cells

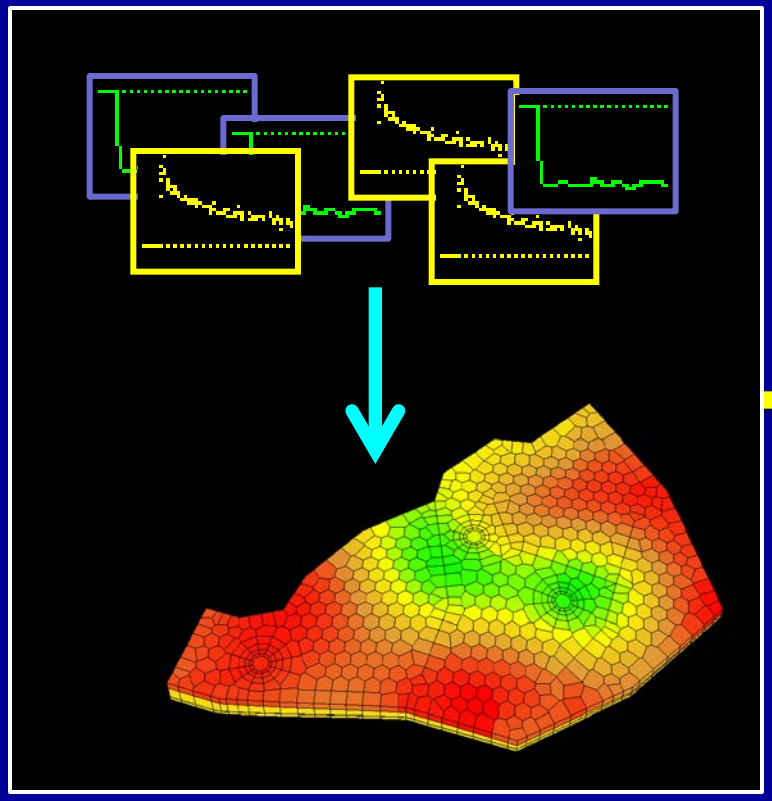




Comparison of grid refinements

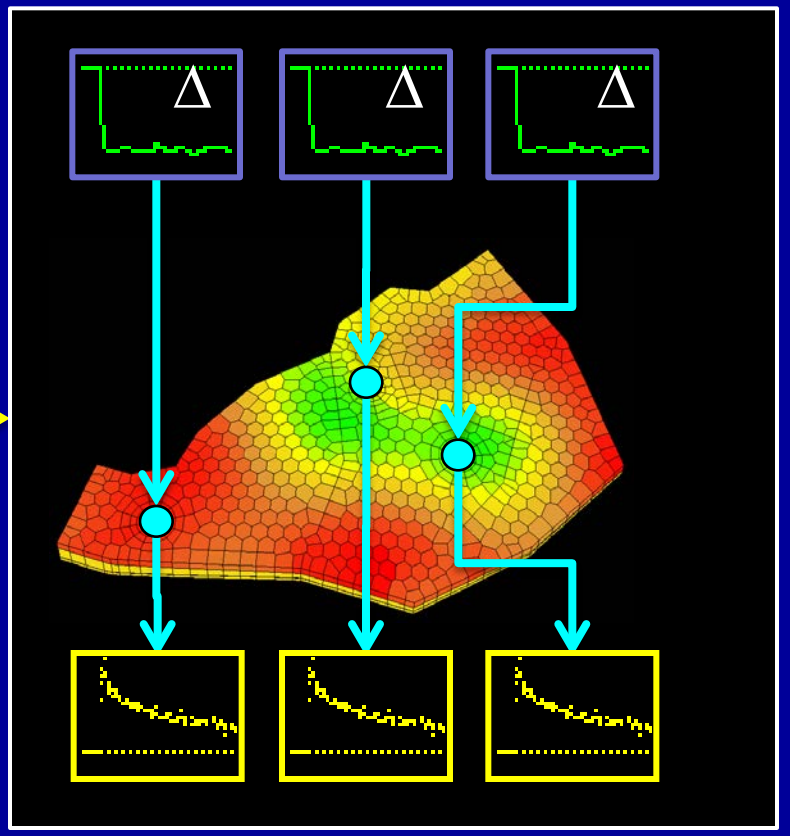


5. Proxys & Virtual Metering

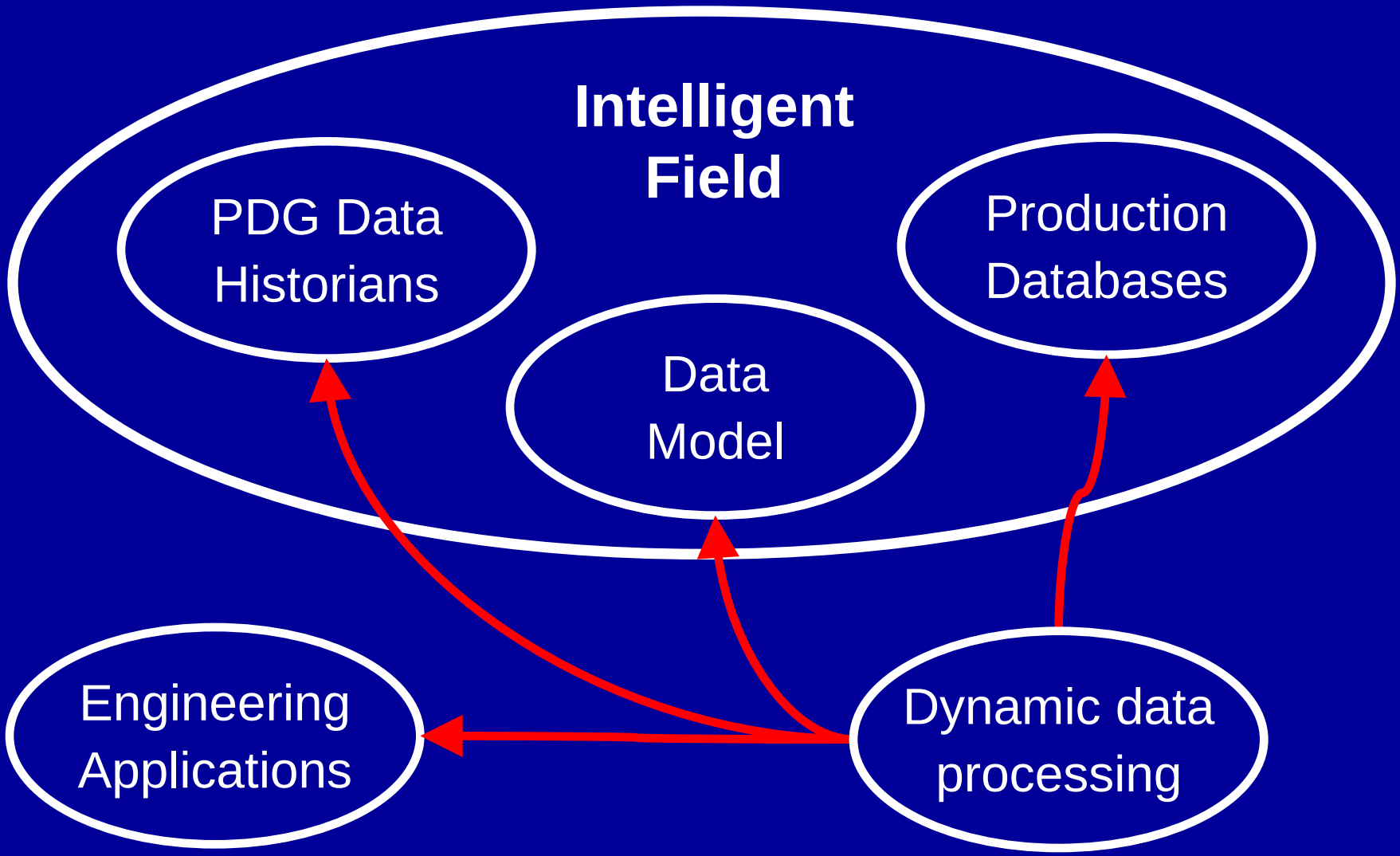


Dynamic Data Analysis

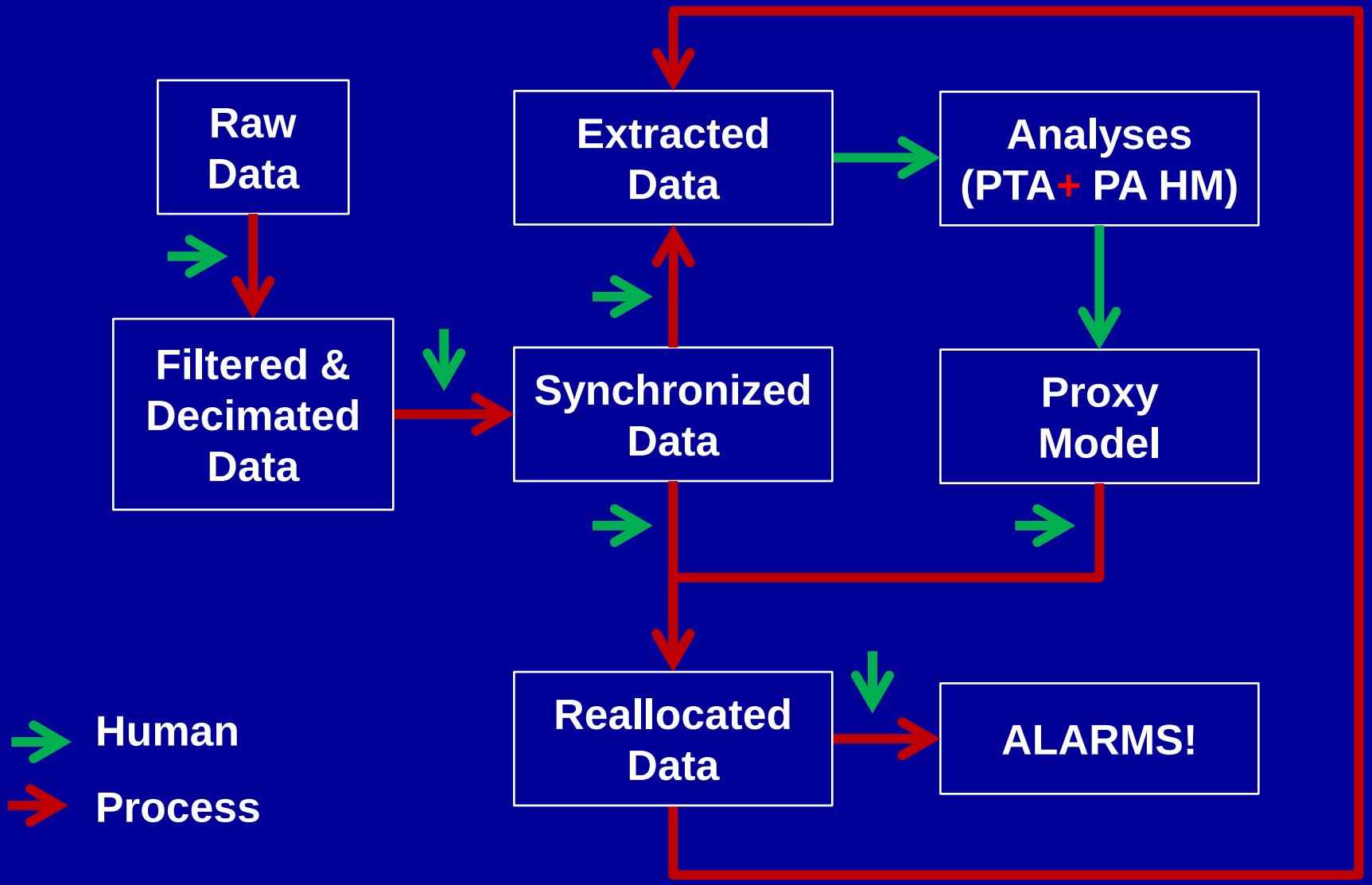
Virtual Metering



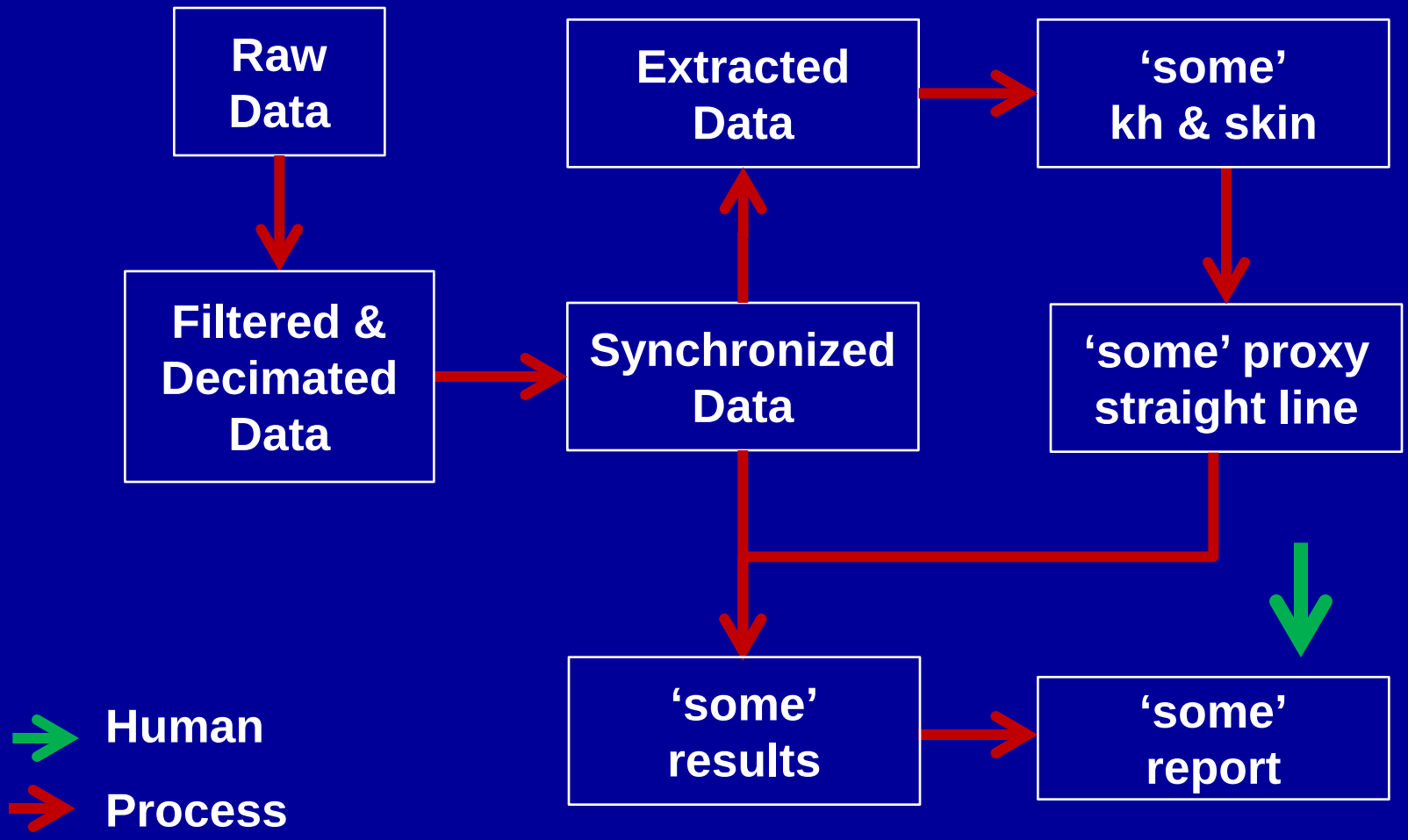
Dynamic data in intelligent fields



The goal: Dynamic Data Workflow



The risk: from Engineering to Process



What's next ?

Mr Spock, please filter these PDG data and get a match
DDA
RTFM
Analytically or numerically?
Err… Well, thinking about it, just beam all the oil & gas off this damned planet into Bay 4. Leave them the H2S

Conclusion

- Masses of potentially useful data
- Data overflow ✓
- Information overflow ✗
- More Research & Development needed
- Leave processes to computers
- Leave engineering thinking to Engineers
- More education & training (crew change)
- More awareness from stakeholders (SPE)

A final remark on research

Most technologies described here were initiated by research projects in the Petroleum Eng. Department of various universities: Stanford, Tulsa, Imperial College, Texas A&M, etc.

Yesterday's investment in these projects turned out to be marginal compared to today's benefits…

Thank you !

Спасибо !

¡ Gracias !

Merci !

ありがとう!

Grazie!

Danke !

Obrigado!

谢谢!

Зур рахмәт!

Дякую!

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