IQA - Injector Quantity Adjustment

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IMA

- Why IQA?
- What does IQA do?
- Operating principles
- IQA Adjustment Map
- EOL programming
- IQA accuracy
- Perspective

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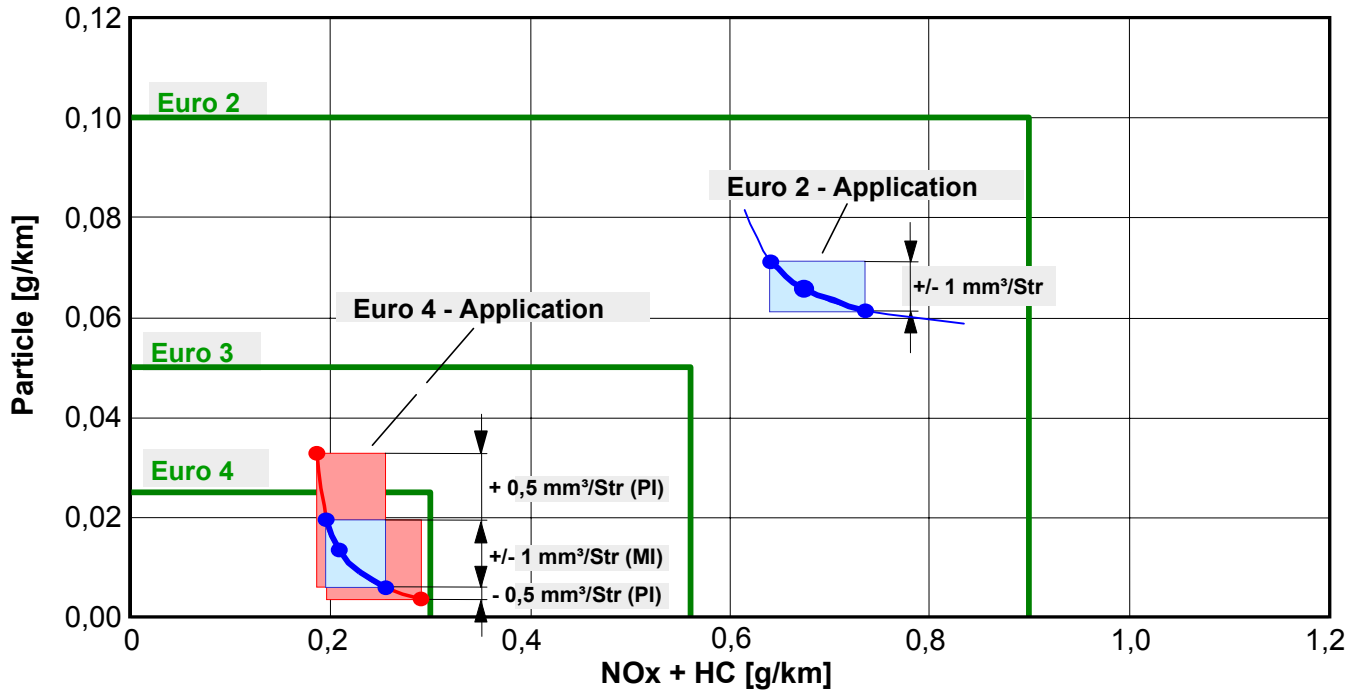
Why IQA?



- The actual fuel quantity must be as exact as possible to reach the emission limit values
- High technical effort to reduce the production line tolerances

Advantage of IQA is

- To reach the emission limit values of the future
- Equal injection fuel quantity for each cylinder
- To increase the injector first pass yield (FPY) by widening the production tolerances

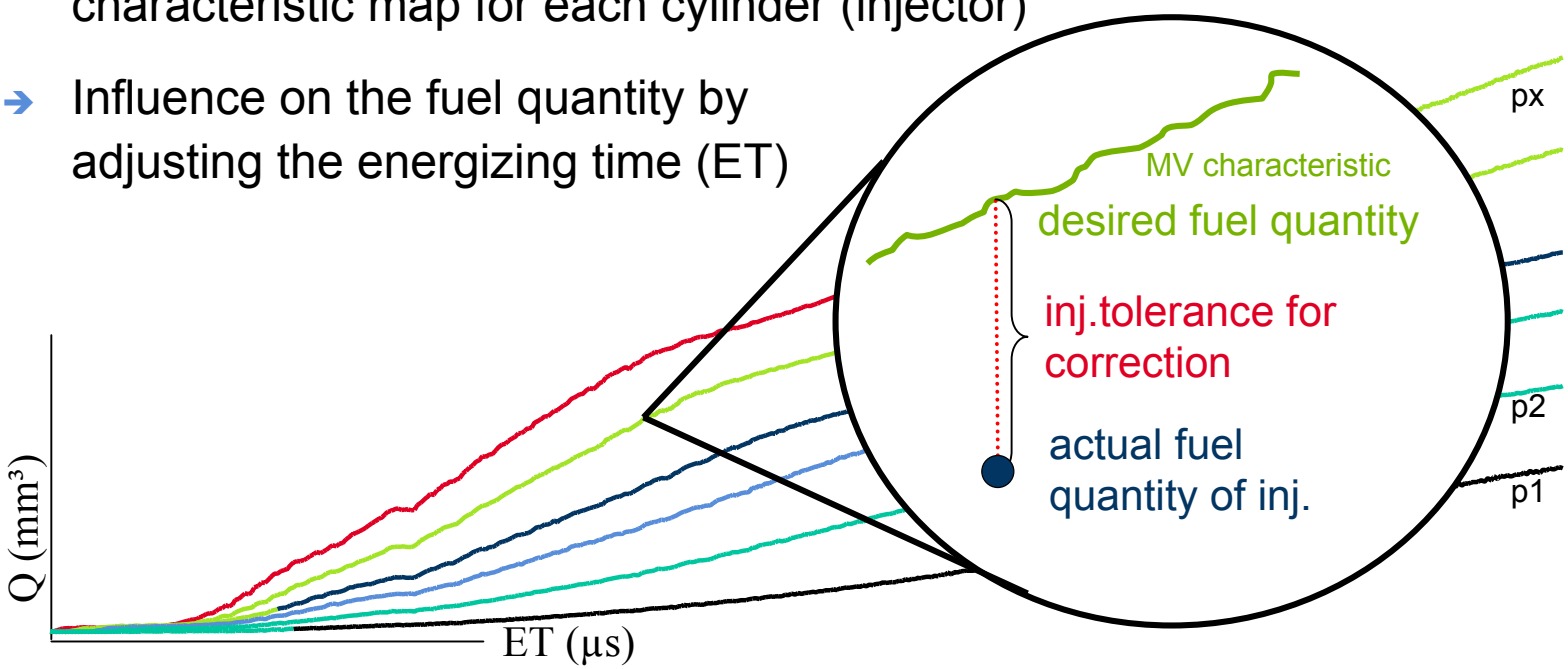
What is IQA not able to do?

- Correction of the PI within the „plateau“ (i.e. CRI2)
- Correction of the start of the injection
- Correction of the drift of the injector (no closed-loop control)

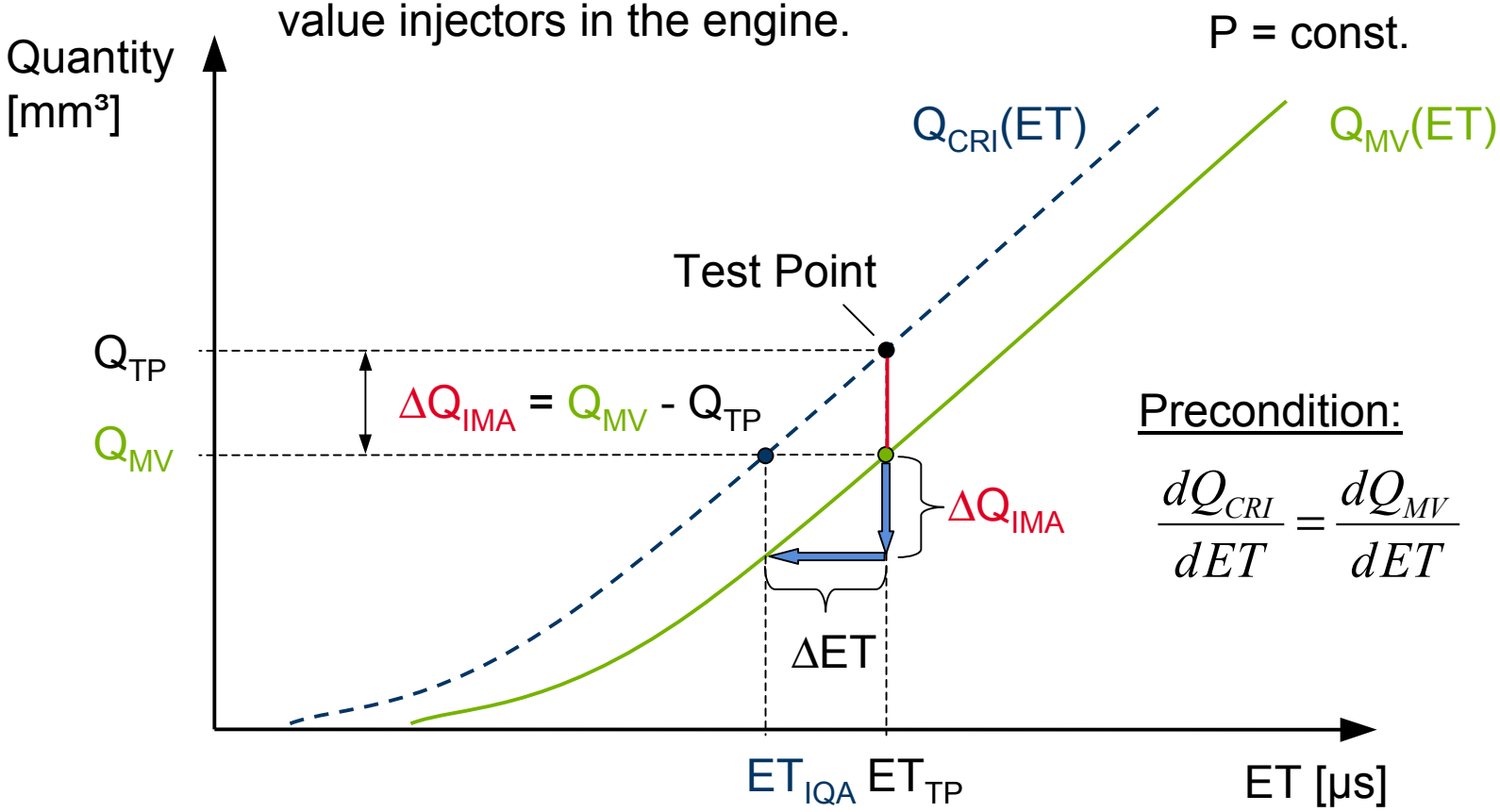
Operating principle IQA

Characteristics

- Correction of the fuel quantity of new injectors
- Individual correction of tolerances at each point in the characteristic map for each cylinder (injector)
- Influence on the fuel quantity by adjusting the energizing time (ET)



The energizing time map in the ECU characterises the behaviour of mean value injectors in the engine.



Precondition:

$$\frac{dQ_{CRI}}{dET} = \frac{dQ_{MV}}{dET}$$

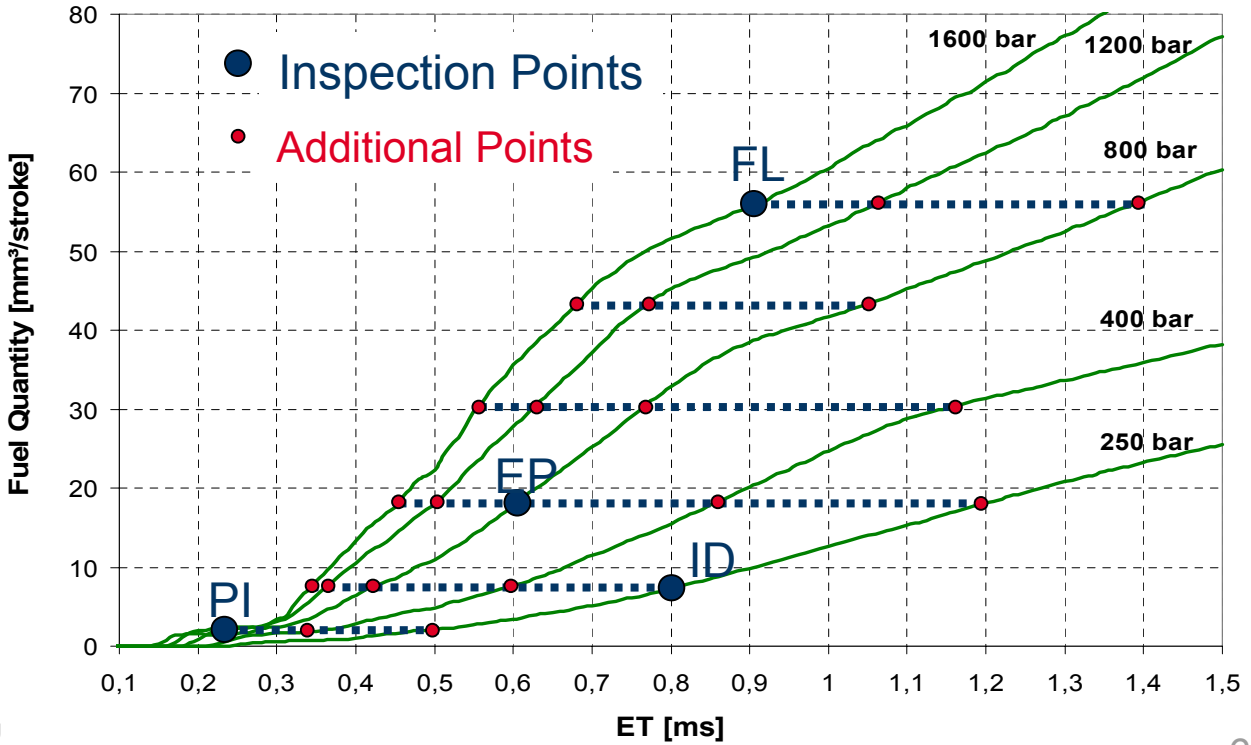
➔ **Definition of the 4 inspection points ID, PI, EP, FL in agreement with the customer and the injector development**

➔ **Definition of a control duration map from the average of a batch of 25 injectors**

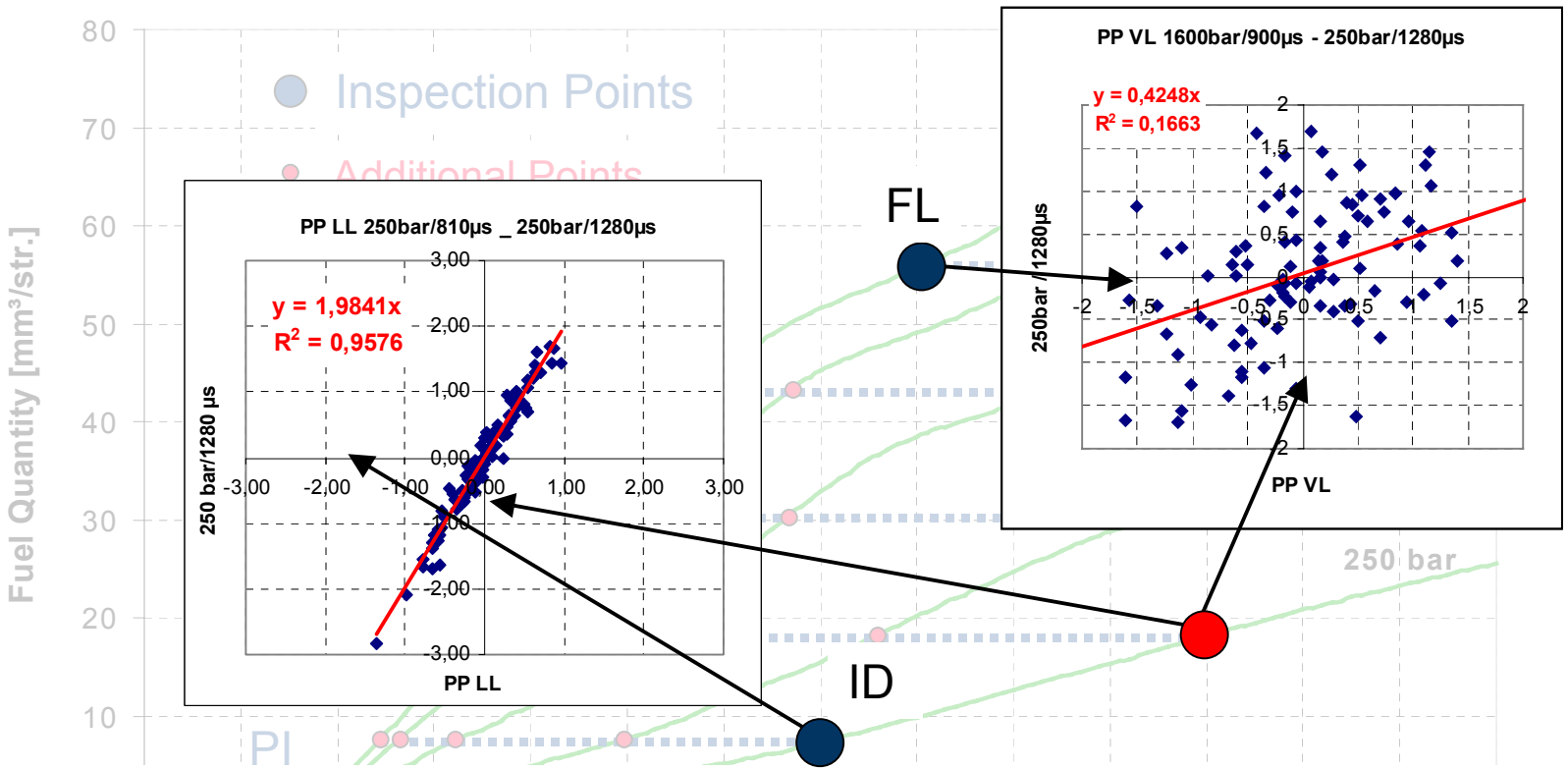
- Additional pressure lines may be required

➔ **Definition of the additional measuring points for the available quantity values**

Example



➔ **Selection of the most suitable matching points between inspection points and additional points**



Chosen inspection point ID

•Fuel quantity tolerance at additional measuring point 1.98 * correction value ID

Operating principle IQA Adjustment Map

IQA Adjustment Map

Fuel Quantity [mm3]

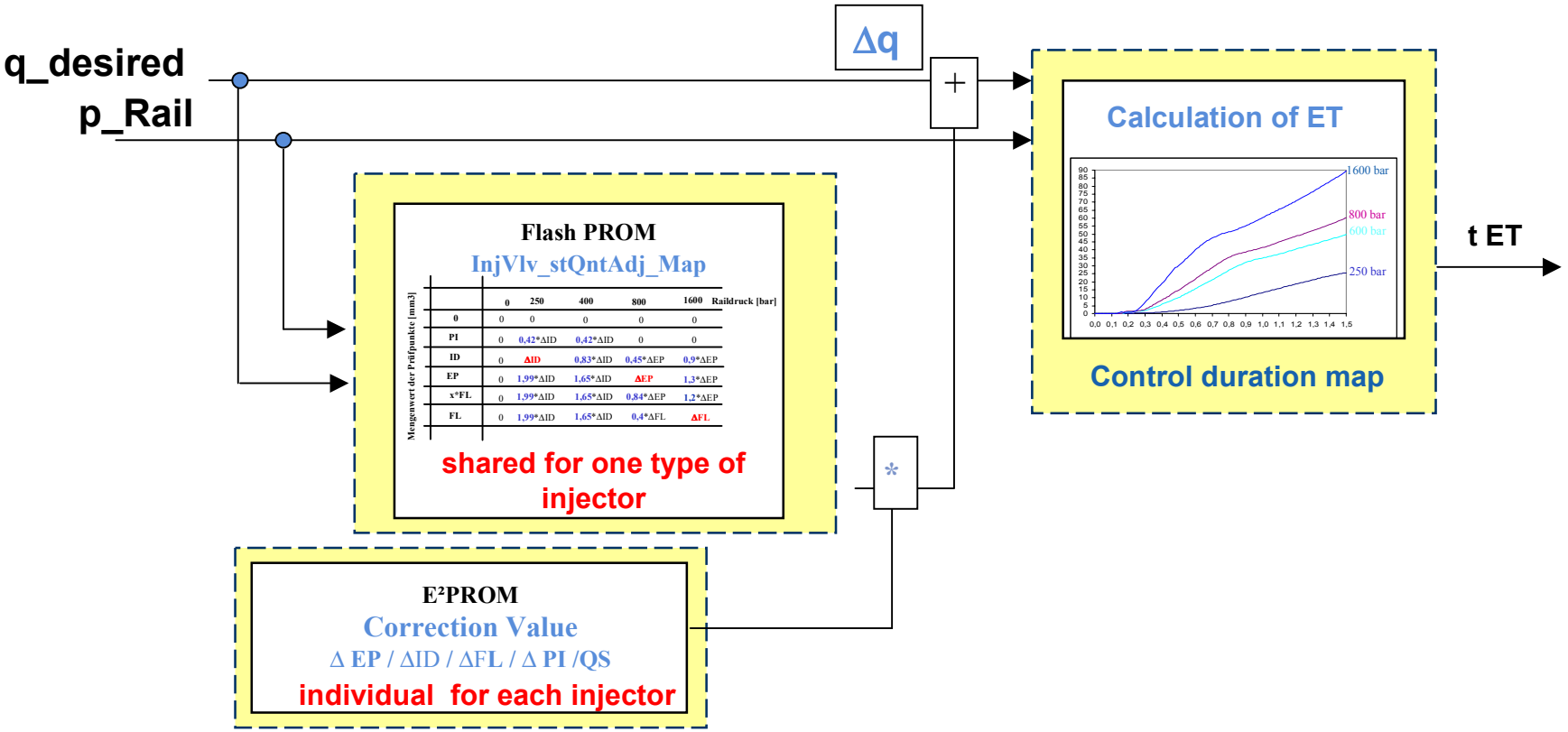
	0	250	400	800	1600 Rail Pressure [bar]
0	0	0	0	0	0
PI	0	0,42*ΔID	0,42*ΔID	0	0
ID	0	ΔID	0,83*ΔID	0,45*ΔEP	0,9*ΔEP
EP	0	1,98*ΔID	1,65*ΔID	ΔEP	1,3*ΔEP
PL	0	1,98*ΔID	1,65*ΔID	0,84*ΔEP	1,2*ΔEP
FL	0	1,98*ΔID	1,65*ΔID	0,4*ΔFL	ΔFL

Weighting Factors

Inspection Points

Operating principle in ECU

Dynamic Interrupt



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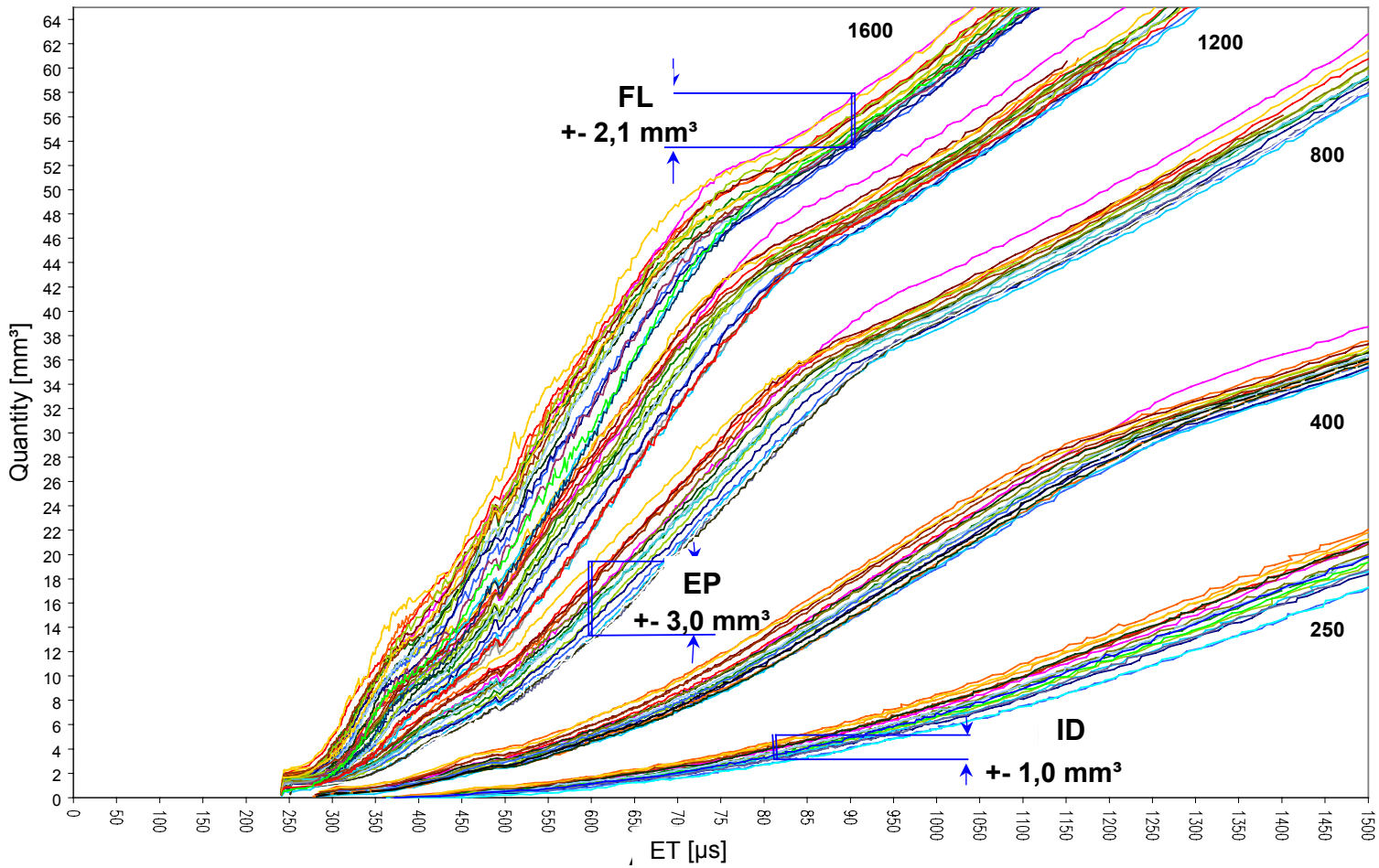
Quantity energizing time map - without IQA



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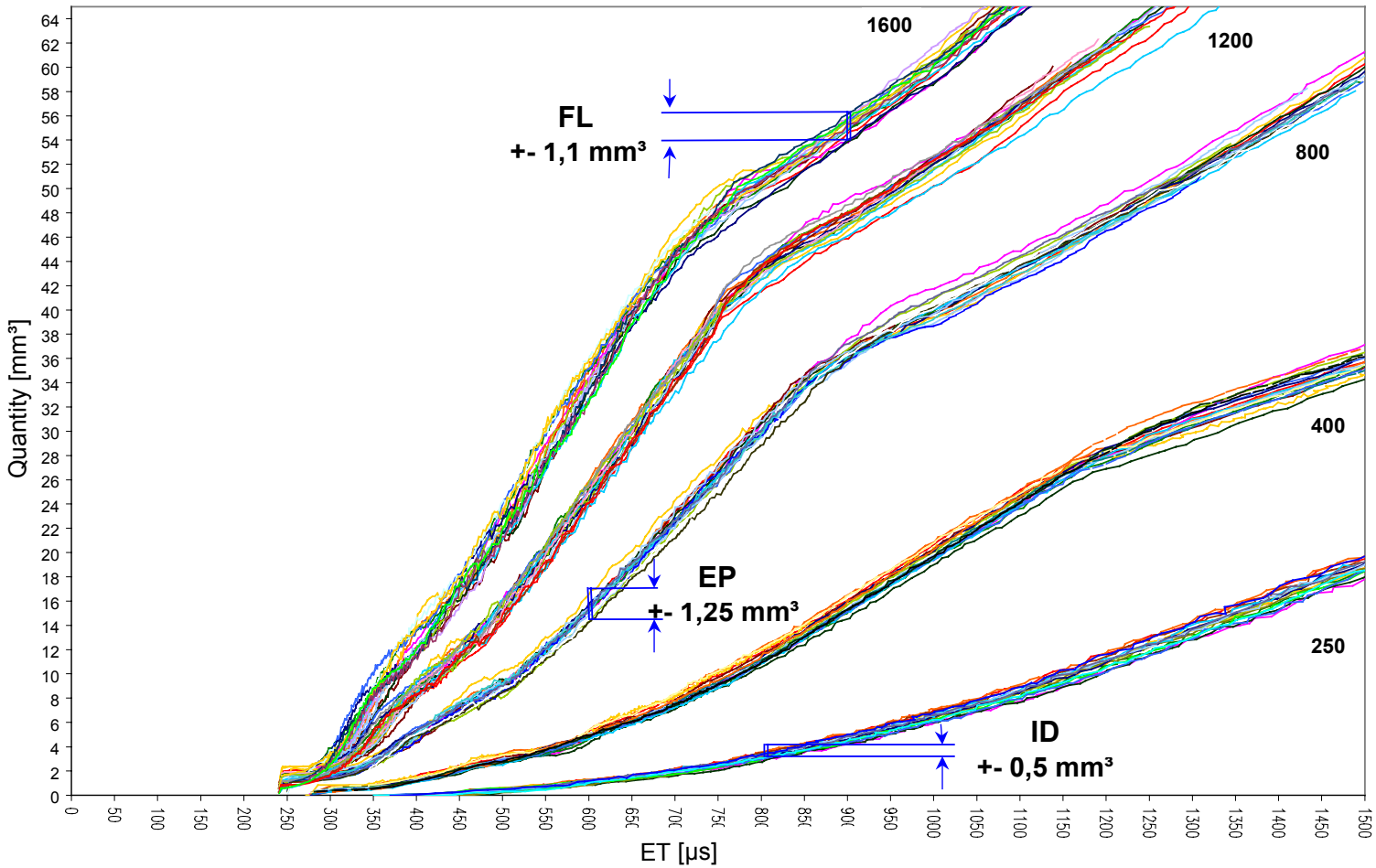
Quantity energizing time map - with IQA



Influences on IQA accuracy

- ➔ accuracy of measuring process
  - reproducibility of measurement (RM)
    - accuracy of measuring device
    - stability of injector:
      i.e. sensitivity to backflow config., temperature, test sequence, clamping ...
  - differences between test stations within one production line and between different production lines (DTS)
- ➔ accuracy of injector
  - quantity stability over lifetime
  - slope variation in the Quantity-ET map ($DQ_{CRI} \neq DQ_{MV}$) (SV)
  - maximum required correction value (RCV_{max})
- ➔ compatibility of the production quantity deviation to the engine quantity deviation

Implemented process for EOL-Programming

Labeling of injectors with alpha-numeric and Data-Matrix-Code

Mounting of injectors and reading of the IQA Code

Transmission of IQA Code into ECU

Reduction of emission dispersion in the engine

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Customer

Perspective

- IQA will be introduced in passenger cars in all future projects
- The inspection points will be determinated by IQA (requirement for high correlation to additional points)
- Further optimisation of the IQA algorithm
  - correction of the slope variation
  - multi linear IQA coding

Summary

- The IQA functionality is assigned to correct the injector quantity of each injector of a Common-Rail-System individually and across the complete range of the Q(ET) - map.
- The input of the function are the ECU correction values. They represent the difference to the nominal values of the respective test point and will be encoded and labeled on top of each injector.
- At the end of the automobile manufactur line, the ECU adjustment values of the mounted injectors and the allocated cylinders are programmed into the ECU.

IQA - Flow Chart for an application

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(Responsibility in Europe, to be defined at RBAJ)