

## Engine performance (1/3)

■ Performance increases (torque, power) always rely on the same principles:

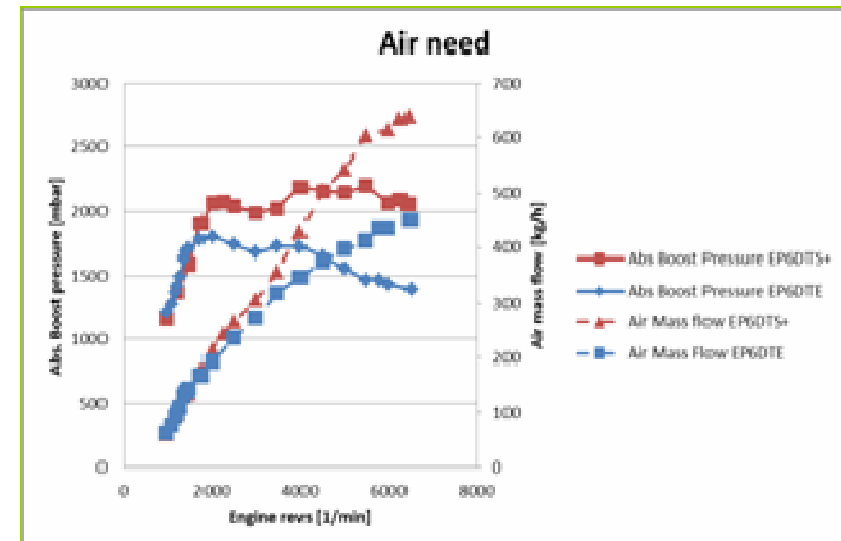
- Increased air and fuel flow
- Optimization of combustion under full load: reduction of sensitivity to knocking

■ Increased airflow

- To increase the air flow from 450 to 640 kg/h (in nominal conditions), the definition of the turbo has been optimized

	DS3 156	DS3 Racing
compressor	2068	2074
Turbine	304.92	304.98

Technical definition from Borgwarner



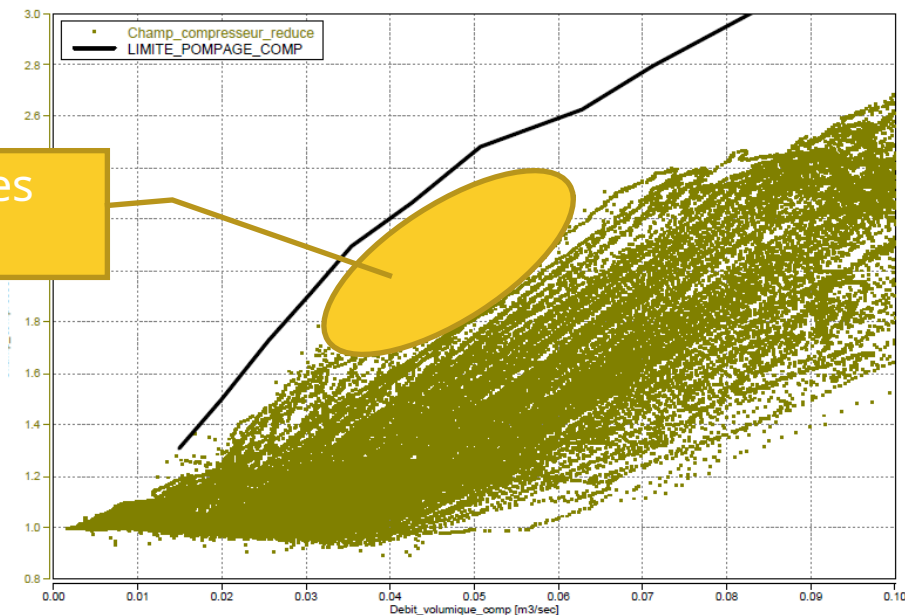
## Engine performance (2/3)

### Increasing airflow (continued)

- The validations carried out during emissions at altitude and in hot climates showed that the use of the new turbo had no impact on the risk of compressor surge:

- Acoustic
- Sustainability

Foot releases full load



- It was obviously possible to use a "bigger" turbo, favoring power, but we felt that this would have affected the balance between Power (Vmax) and Transients (increased torque felt) too much.

## Engine performance (3/3)

### ■ Knock optimisation:

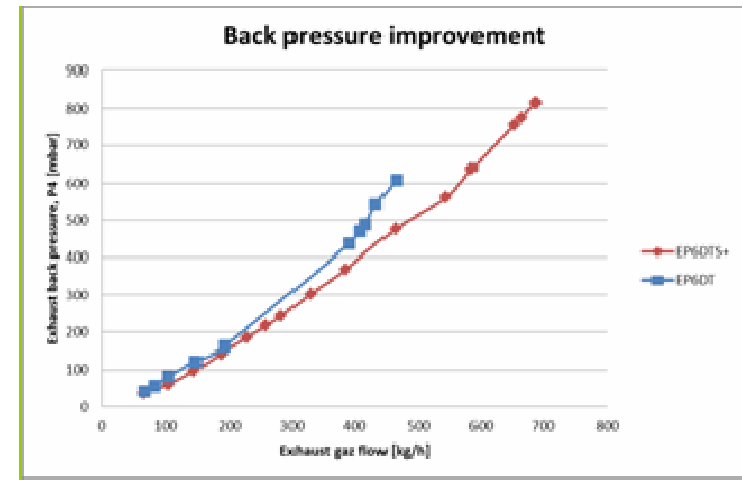
In order to desensitize the engine vis-à-vis knocking, 2 ways were retained:

- Use of high RON fuel (~Super Plus with 99-100 RON). NB: all other PSA engines have a basic calibration in RON 95 or lower.

- Reduction of IGR levels in the combustion chamber: reduction of exhaust back pressure. To achieve this, it was decided to remove the silencer intermediate on the DS3 Racing:

- CPE gain of 60mbar @ 550kg/h of gas
- Low frequency sound typing

- Important Note : The volumetric compression ratio remains unchanged (10.5) so as not to degrade performance **CO<sub>2</sub>**.



# Engine calibration work (1/2)

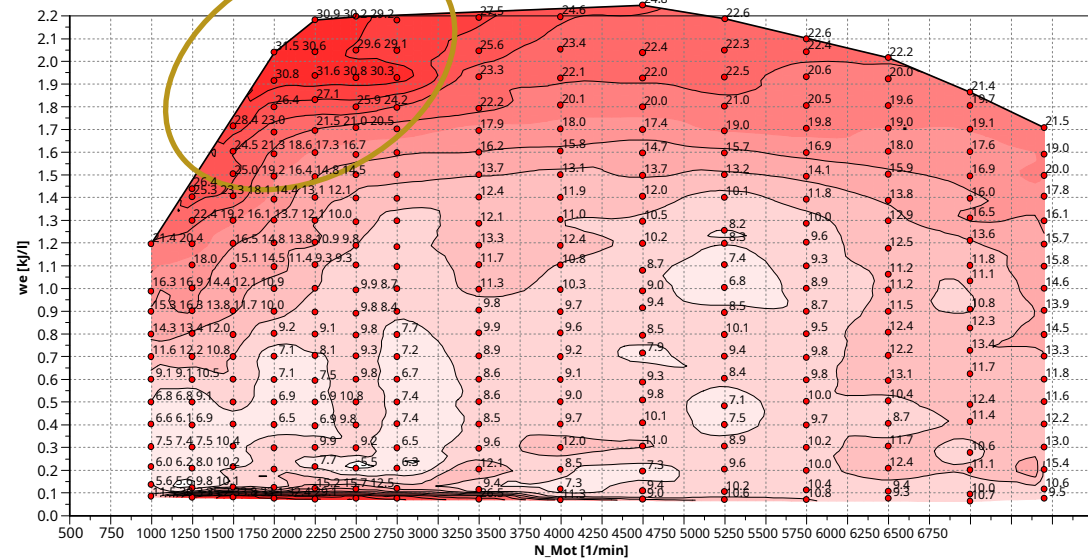
- The calibration activities were carried out along two axes:
  - Basic calibration on the engine bench** to increase performance: knocking (including Rumble), component protection, high fuel pressure loop, adaptation of the supercharging control

Combustion timings at heavy loads at low engine speeds are under control to minimize the risk of "rumble"

## DS3 Racing - grid measurement AIQ50 [°KW]

customer: PSA Racing engine management: MED17.4 person in charge: Hoedicke

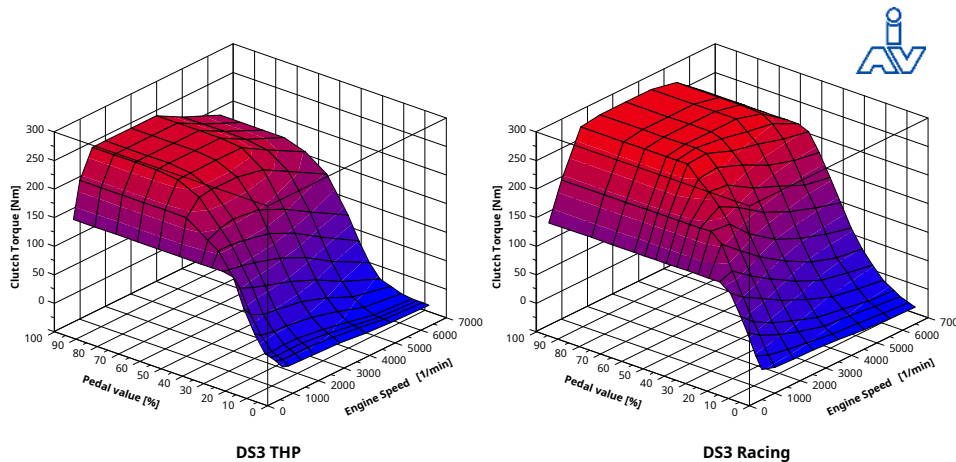
bench test	date	motor	fuel	T <sub>box</sub>	ambient press	program version	data set	How? Or What
05	06.10.2010	793182	RO2 98	25°C	1014 mbar	7G140F	5c	w/o orig. exhausted; backpressure 595mbar/550kg/h



# Engine calibration work (2/2)

## ■ Vehicle calibration for emissions and approval:

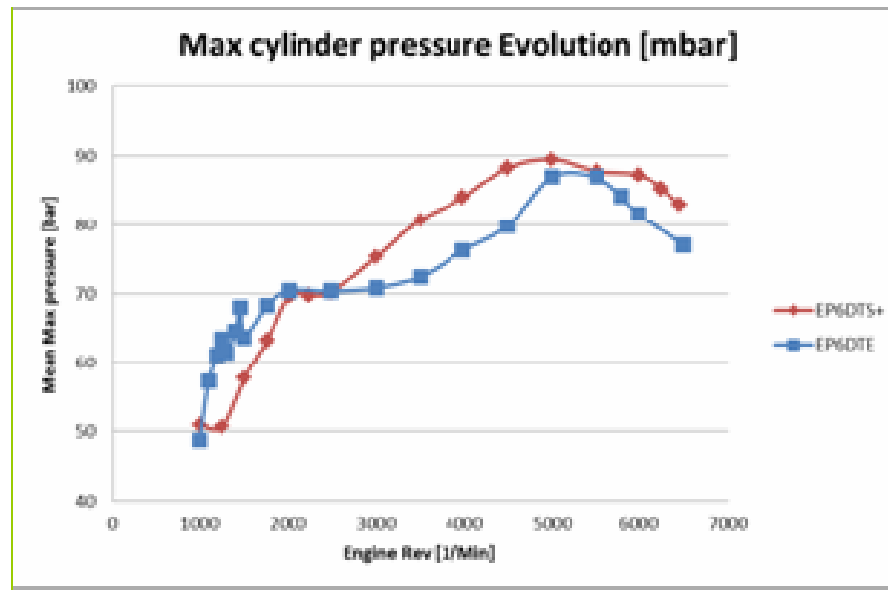
- Limited efforts on emissions due to the €uro 5 compatibility of the basic DS3 THP (resumption of the catalysis system)
- In order to achieve a sporty typing of the vehicle, the characteristics of the pedal mapping were optimized, more particularly the dosability at high load and the tip in / tip out to increase the load transfers on the front axle.



The pedal mapping of the DS3 Racing is the direct result of the involvement of Ph. Bugalski (French Rally champion 1998, 1999 & 2000, DS3 WRC development driver)

## Engine architecture (1/3)

- Prolonged heavy-load driving puts considerable strain on the engine's mechanical base. That's why the engine of the DS3 Racing receives a set of adapted parts:



*NB: we note that thanks to the conservation of the RVC, the maximum  $P_{cyl}$  levels do not increase but the range of heavy loads is wider.*

### ■ New candle definition:

- Same electrode spacing, same chamber penetration,
- But colder thermal index and a larger platinum pin to offer better durability against high voltages.
- The DS3R spark plug is also characterized by a hexagonal to differentiate it from the spark plug of the 156hp version (bi-hex): after-sales foolproofing function.

## Engine architecture (2/3)

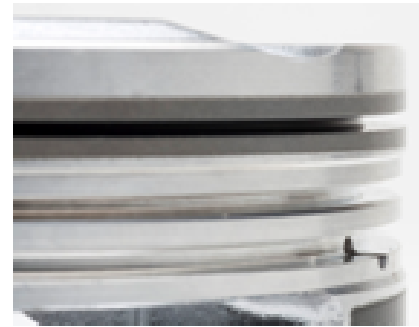
### ■ New piston definition:

- As a result of the greater range of maximum cylinder pressures, the pistons of the Racing engine are characterized by an anodized first piston groove. This allows to be compatible with the standard PSA durability (240,000km)

DS3 THP



DS3 Racing



Pictures from Mahle

- The rest of the piston design is carried over (first ring height, piston bottom, flame face, etc.)

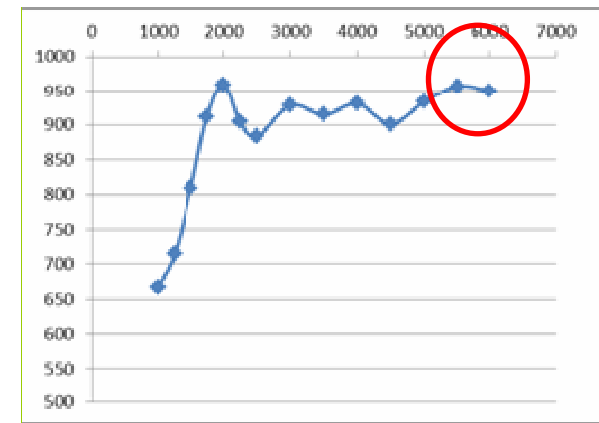


## Engine architecture (3/3)

- On the one hand, operation at high loads induces high thermal stress on the exhaust face which is limited by the enrichment of combustion.
- On the other hand, we know that too high a richness induces combustion initiation disorders (- combustion instability).

- This is why the exhaust temperature (T3) is limited to 920°C over the entire engine operating range, **except at the power point where it is increased to 950°C**. This allows to:

- Locally increase combustion stability at Pmax,
- Without any impact on the durability of the exhaust face (cast iron manifold)



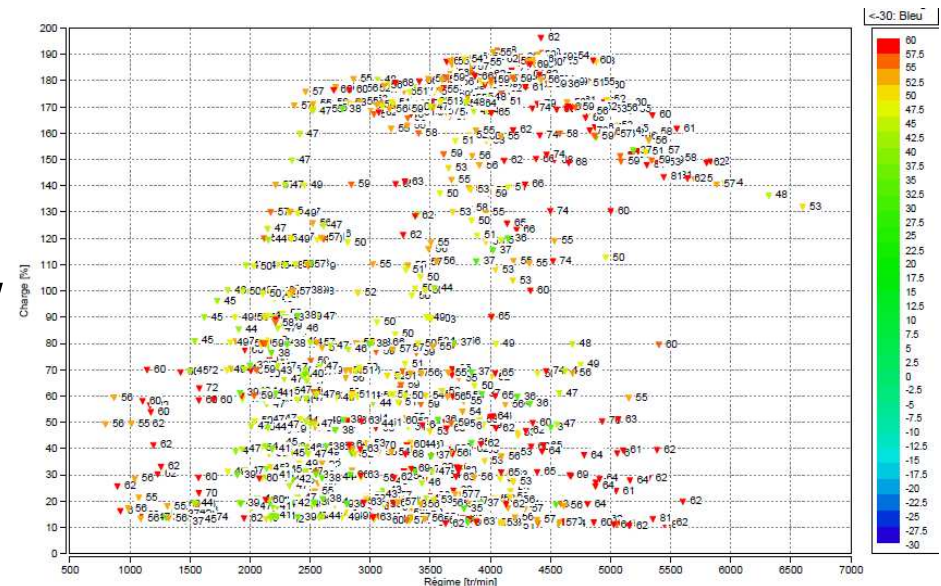


## Motor adaptation

■ The standard engine air cooling needs are not sized by the Vmax constraints, but by certain cases of towing on long climbs.

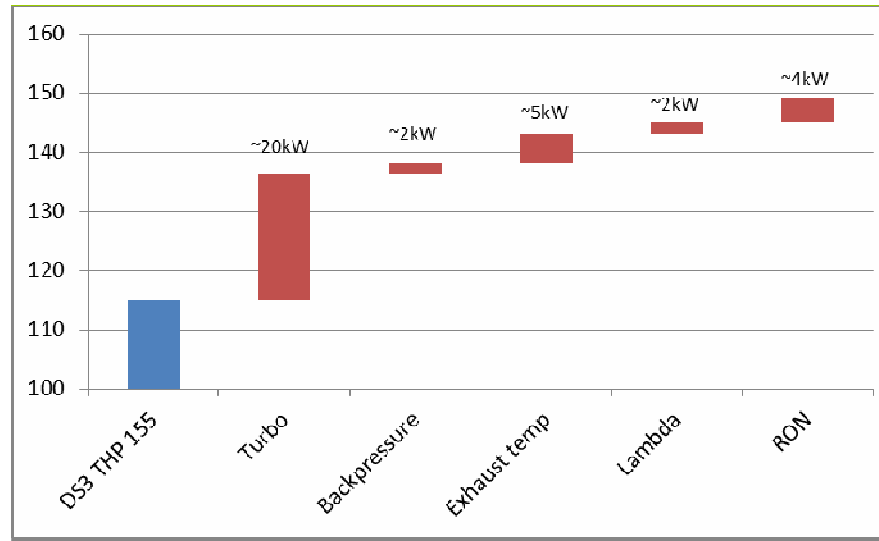
■ Thus, by condemning any possibility of towing on the Citroën DS3 Racing, it was possible to exploit the full potential of the RAS series for pure performance.

■ However, measurements taken in extreme conditions show a deterioration in performance at low speeds (attachment speed + 500 rpm max).



# Full load performance - engine

- We have seen that the development of the DS3 Racing engine focused on several points. We can summarize the gains brought to this version as follows:



- The Racing engine thus offers:

- Maximum torque of 275Nm from 2000 rpm
- Maximum power of 149kW @ 6000 rpm

