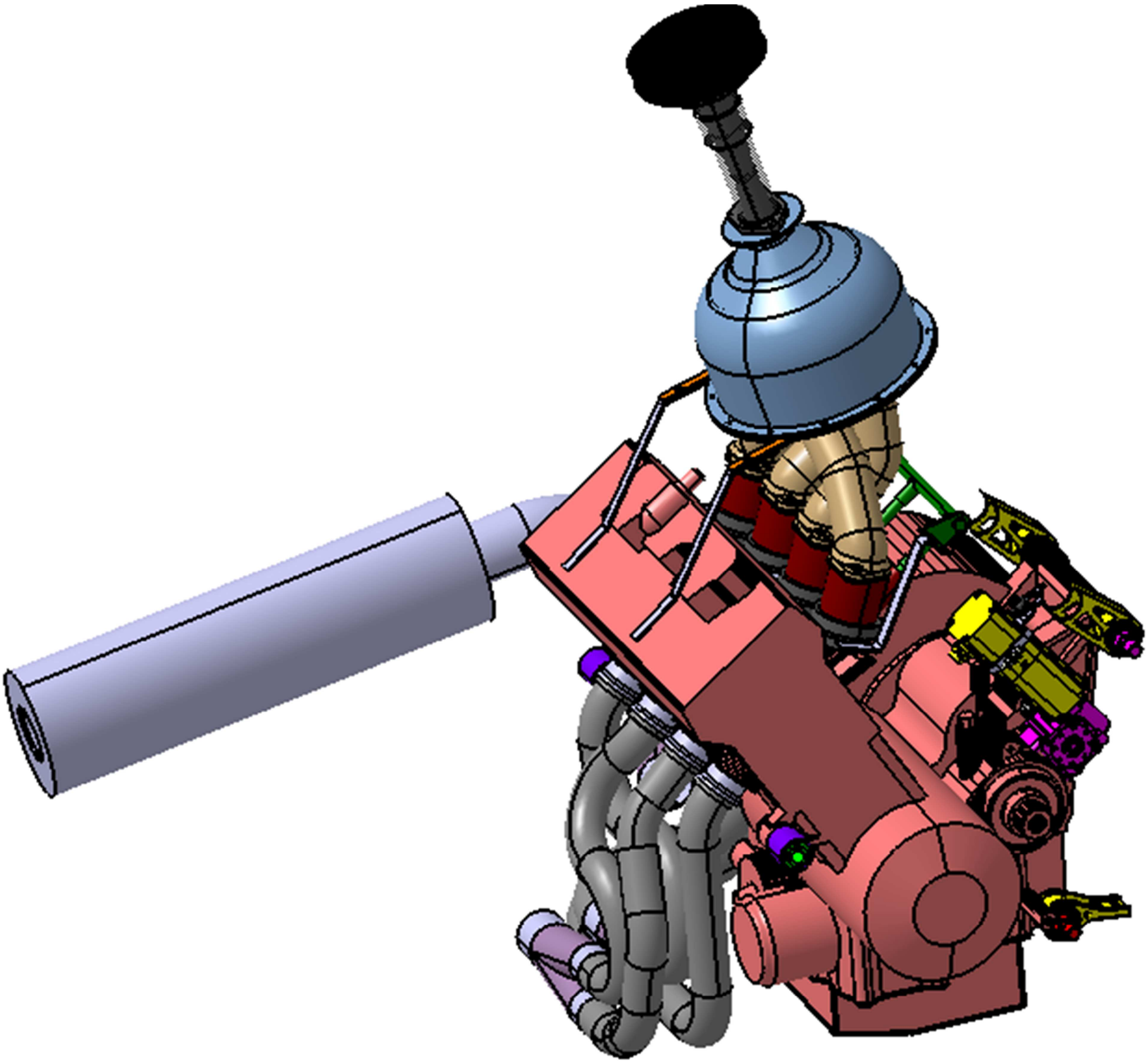
EPSA TEAM – CAR N. 81
Design Presentation



Engine Optimisation

Introduction:

This document aims to present the optimisation work done on the engine. First the motor choice, than the intake and exhaust line design and finally the electronic optimisation on dyno and track.

Motor choice:

Choice between three different architectures: One, two and four cylinder

- Basic 0 D Model for power assumption with restrictor
- Maximize the power / mass ratio
- 300 kg global weight of car + driver assumption

Four cylinders better

Motor :
HONDA CBR600RR from 2008 (PC40)
Displacement: 599 cm^3
Bore x Stroke: 67 x 42.5 mm
Compression: 12.2 : 1

Figure 1: Original Motorbike + engine

Intake and exhaust line design:

Air restrictor:

Buy AT Power Air restrictor (20mm)
Save time
No way to test and validate a model before producing

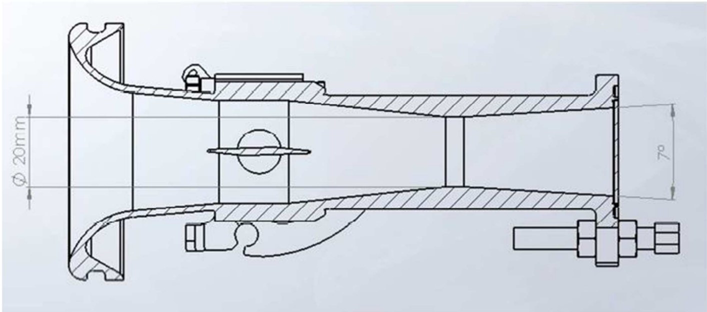


Figure 2: Air restrictor

Manifold design :

Conical Manifold for equal air distribution

Volume: 2.3 L
Realization: Rapid prototyping (Poliamid 12)
Base plate for runners + engine mounts: steel

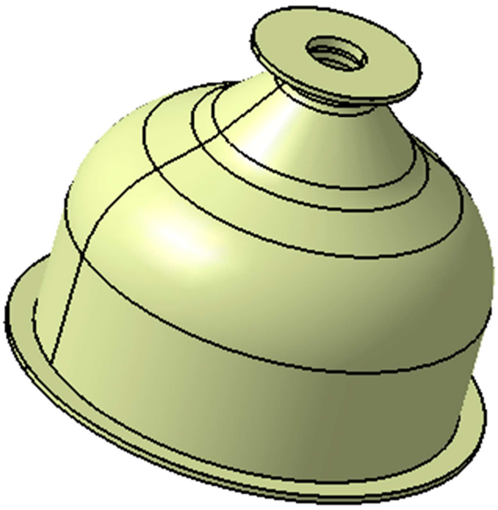


Figure 3: Manifold

Intake and Exhaust line design:

Use of kadenacy effect to have constant torque on a lowest wide range
4-2-1 Exhaust architecture

1D qualitative model build with GT Suite

Iteration of the intake and exhaust pipes length

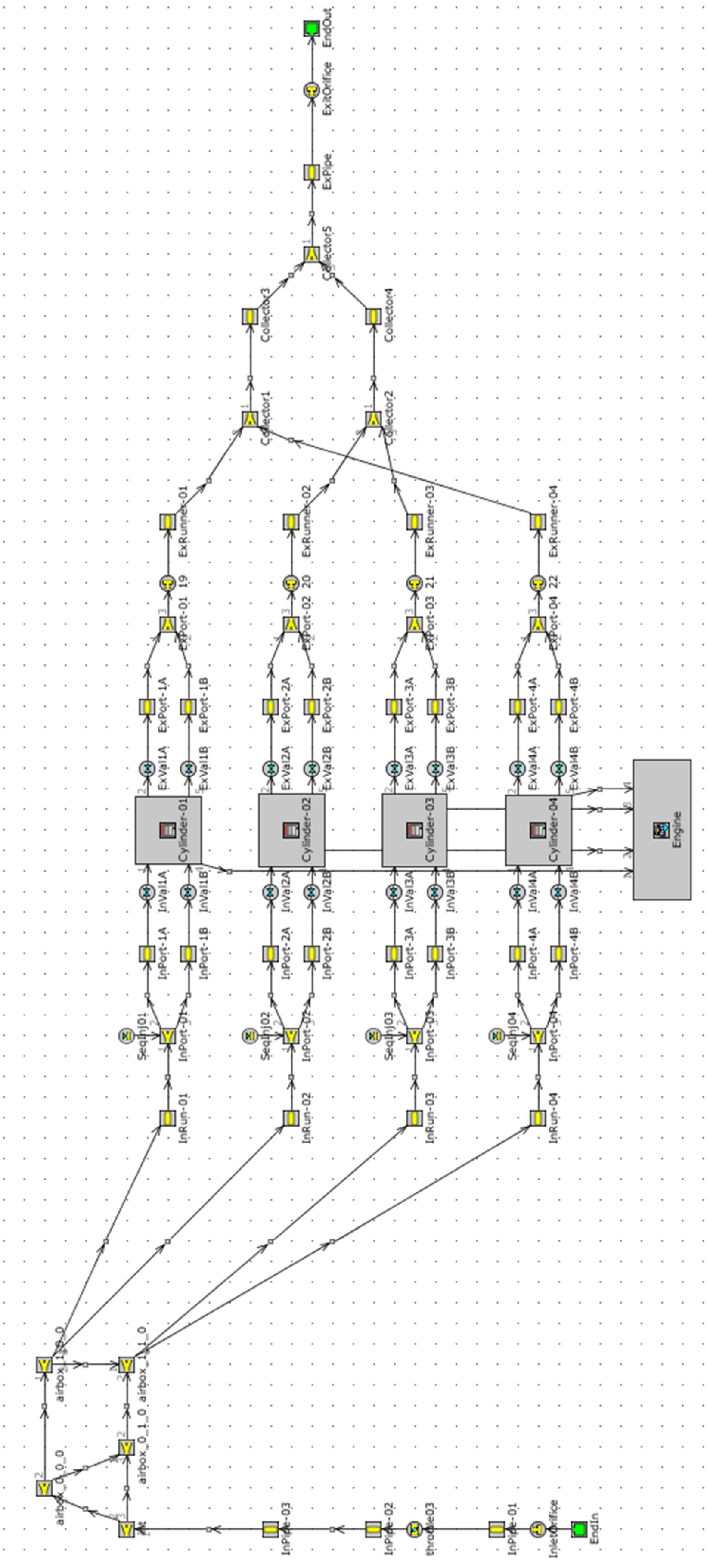


Figure 4: 1D GT Model

	Length	Diameter
Intake runner	225mm (+/-15mm)	36mm
Exhaust runner	300mm (+/- 30mm)	31mm
Exhaust collector	150mm (+/- 15mm)	39.2mm
End pipe + muffler	1000mm	50mm

Intake runner:

Rapid prototyping parts (Poliamid 12)

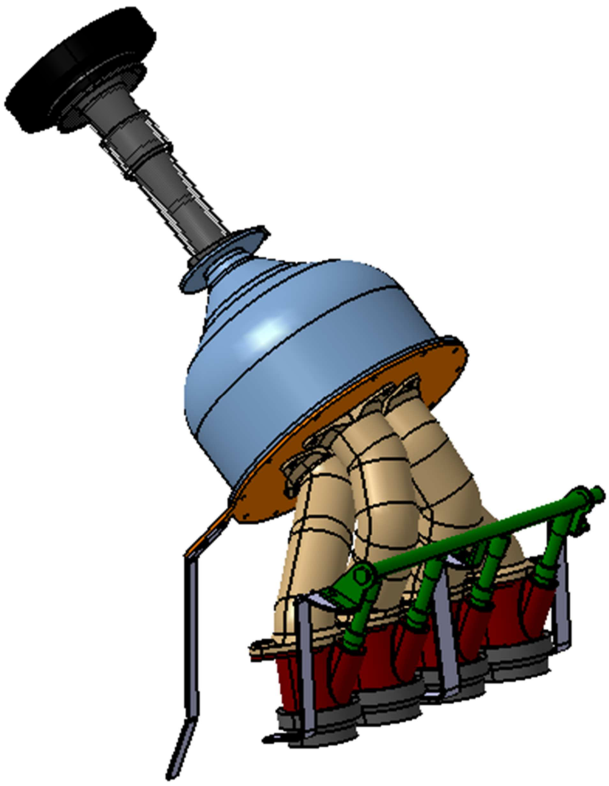


Figure 5: Intake system

Exhaust line:

Welded cast iron
Integration of a wide band lambda sensor

Muffler: Ixil CoV 393mm

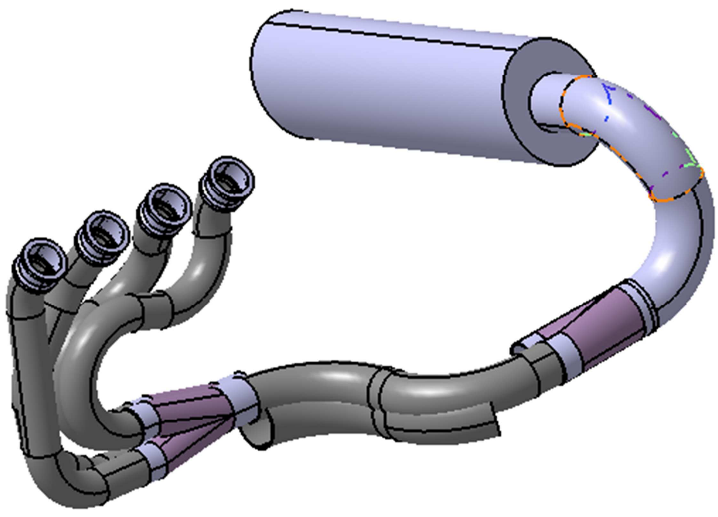


Figure 6: Exhaust line

Torque / Power Curve

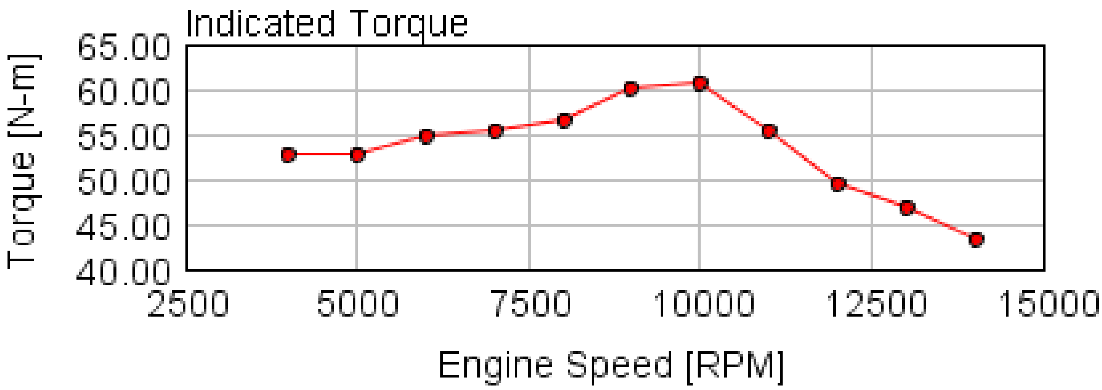


Figure 7: Simulation result for indicated torque

Dyno optimisation

Programmable ECU: DTA Fast S60

Injection time map

Lambda value close-loop optimisation
Concentrate on middle range rpm

Smooth the result to avoid step

	0	4	8	13	18	25	33	41	50	59	68	77	86	95
1500	1	1	1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
2000	1	1	1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
2500	1	1	1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
3000	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
4000	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
5000	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
6000	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
7000	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
7500	1.2	1.2	1.2	1.2	1	1	1	1	1	0.88	0.88	0.88	0.88	0.88
8000	1.2	1.2	1.2	1.2	1	1	1	1	1	0.88	0.88	0.88	0.88	0.88
8500	1.2	1.2	1.2	1.2	1	1	1	1	1	0.88	0.88	0.88	0.88	0.88
9000	1.2	1.2	1.2	1.2	1	1	1	1	1	0.88	0.88	0.88	0.88	0.88
9500	1.2	1.2	1.2	1.2	1	1	1	1	1	0.88	0.88	0.88	0.88	0.88
10000	1.2	1.2	1.2	1.2	1	1	1	1	1	0.88	0.88	0.88	0.88	0.88
10500	1.2	1.2	1.2	1.2	1	1	1	1	1	0.88	0.88	0.88	0.88	0.88
11000	1.2	1.2	1.2	1.2	1	1	1	1	1	0.88	0.88	0.88	0.88	0.88
11500	1.2	1.2	1.2	1.2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
12000	1.2	1.2	1.2	1.2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
13000	1.2	1.2	1.2	1.2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
14000	1.2	1.2	1.2	1.2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88

Figure 8: Target lambda map

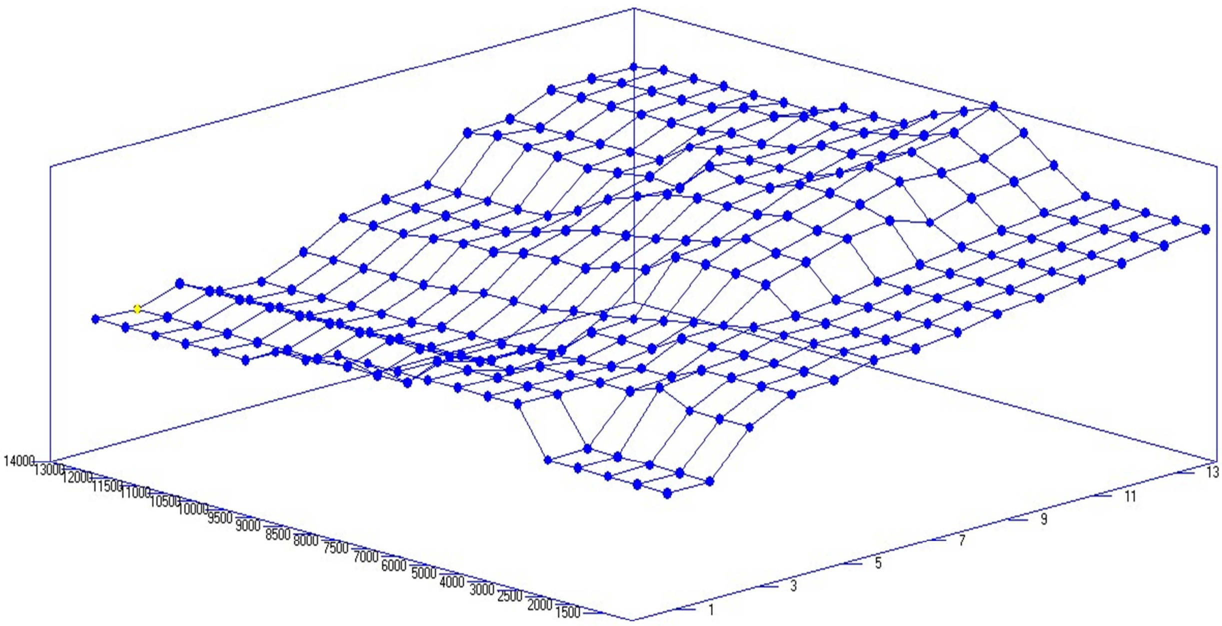


Figure 9:Injection time map

Acoustic resonance at 7000 and 9500 rpm

Add some fuel at start
Cooling the engine at 110°C by progressive fuel increase

Tip in fuel increase (100%) for 100 engine turns (ECU limit)
Tip out fuel decrease (100%) for 100 engine turns (ECU limit)

Ignition map

Optimisation for maximum torque
Knock sensor for knock detection

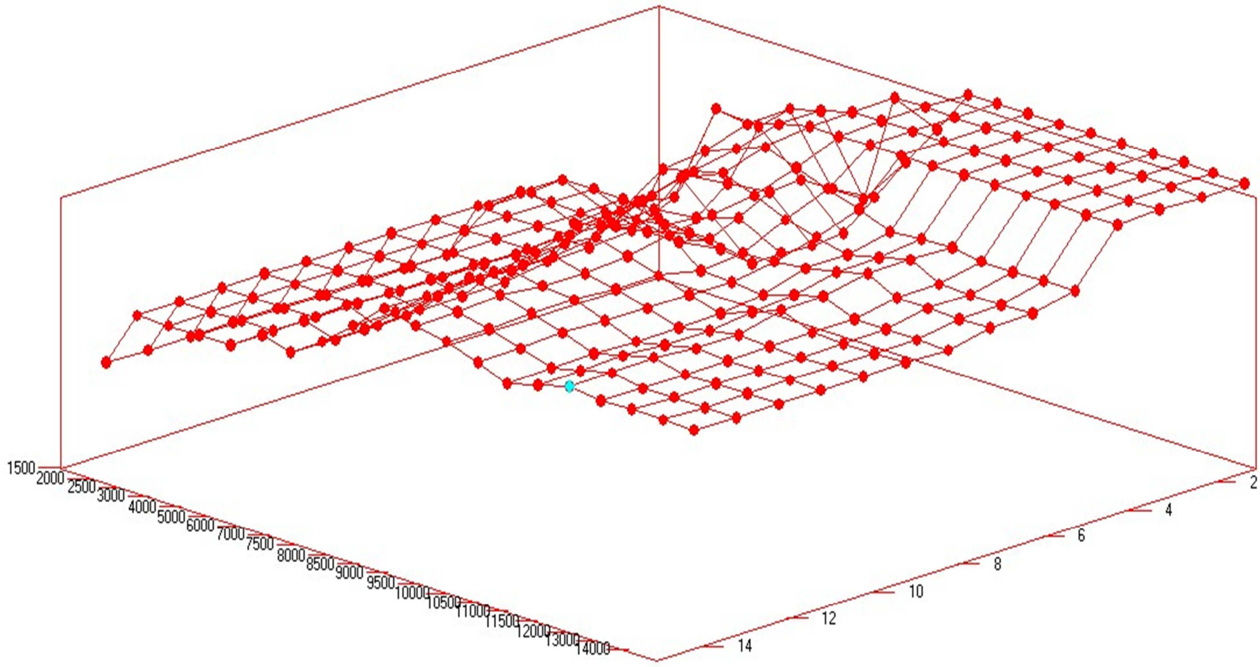


Figure 10: Ignition map

Final torque curve:

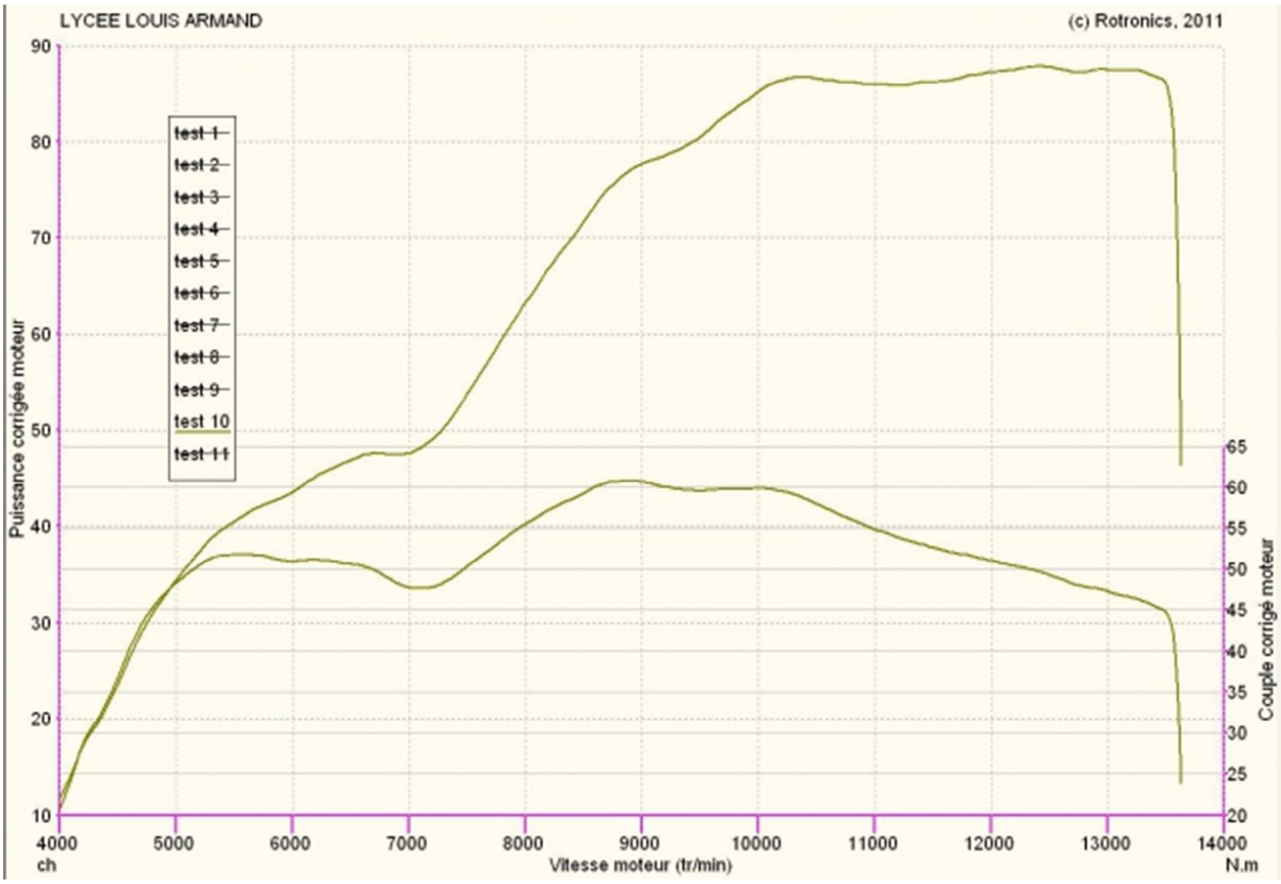


Figure 11: Power / Torque Dyno curve

Conclusion :

Optimisation by design and dyno test
Wide band torque for driving agility