

PORSCHE



BOXER meets BATTERY

The Next Stage of the 9A3 Engine Family

IN THE NEW **PORSCHE 911 TURBO S**

Dipl.-Ing. Matthias Wunder



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Introducing TURBO technology



Porsche 917/10 '1972

- 180-degree V12 engine
- Displacement: 4.999 cm³
- Twin Turbochargers
- First Turbocharged Race-Car at Porsche
- Won 6 of 9 Races and Championship



Porsche Carrera Turbo RSR 2.1 '1974

- 6-Cylinder Boxer engine
- Displacement: 2.142 cm³
- Mono-Turbo Charger with intercooler
- Finished second overall at 24 Hours of Le Mans
- Competed against 3.0-litre V12 engine

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Porsche 911 Turbo (Type 930) '1974

- First production 911 Turbo
- Rated power 260 PS
- 0 - 100 km/h in 5.5 s
- Top speed 250 km/h



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Engine of first 911 Turbo



- Six-cylinder Boxer Engine with 2994 cm³
- 260 PS (191 kW) and 343 Nm
- Reinforced crank drive and reduced compression ratio
- Single turbocharger
- Boost pressure controlled by a wastegate

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Conflict of Objectives



INNOVATION

TRADITION

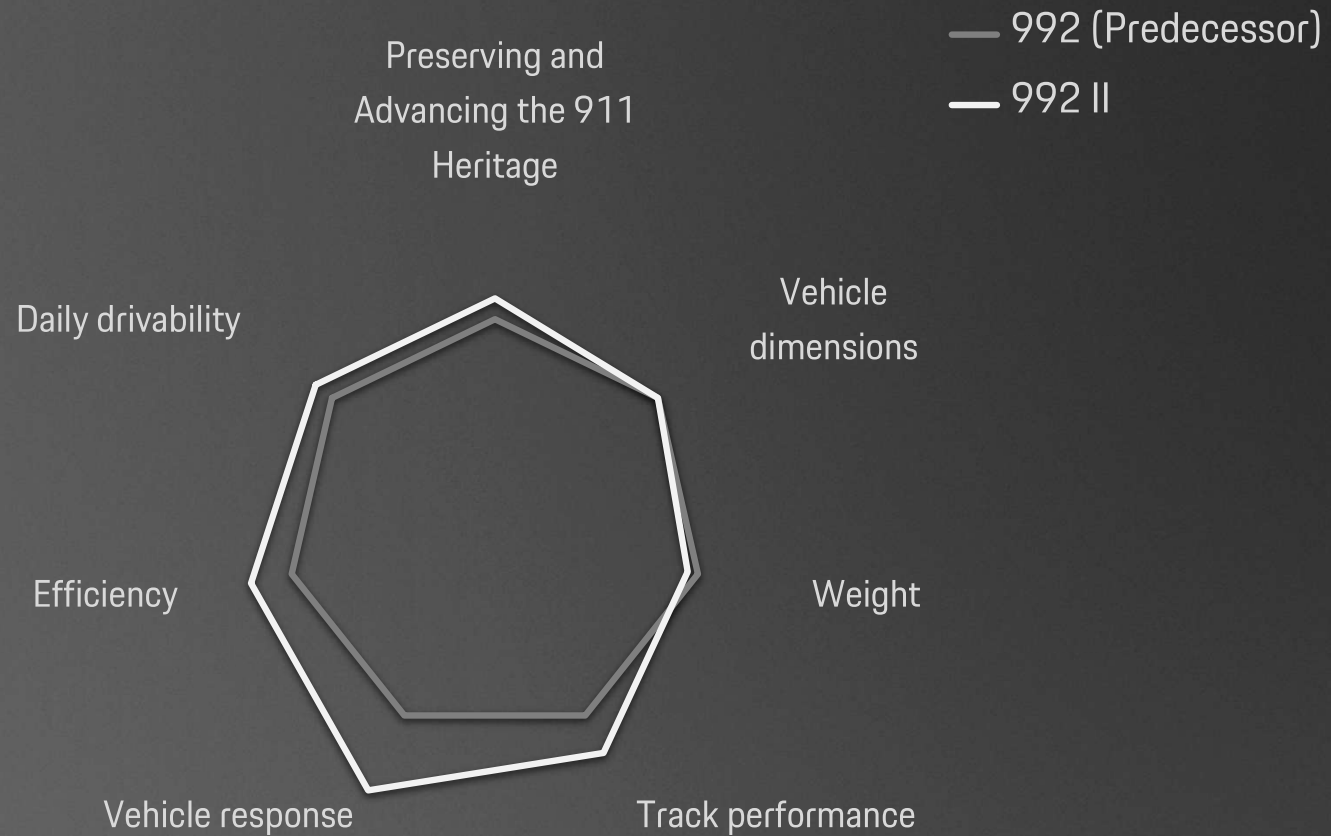
PERFORMANCE

EVERYDAY DRIVING



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POWERTRAIN development objectives



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POWERTRAIN development objectives

Predecessor



911 Turbo S

- Six-cylinder Boxer engine with 3.745 cm³
650 PS (478 kW) and 800 Nm
- Specific power: 127 kW/l
- Twin-Turbocharging with VTG
- Eight-Speed-Dual clutch transmission
- Electronically controlled all-wheel drive
- Acceleration: 0 -100 km/h in 2.7 s

Preserving and
Advancing the
911 Heritage

— 992 (Predecessor)
— 992 II

Daily drivability

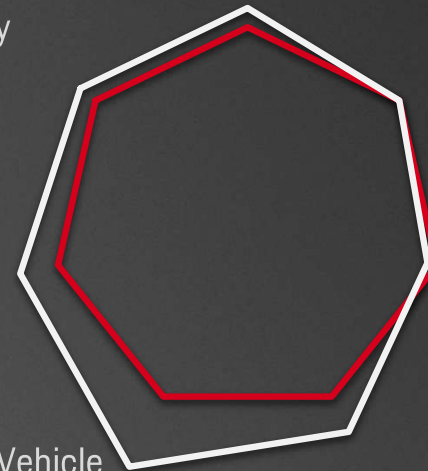
Vehicle
dimensions

Efficiency

Weight

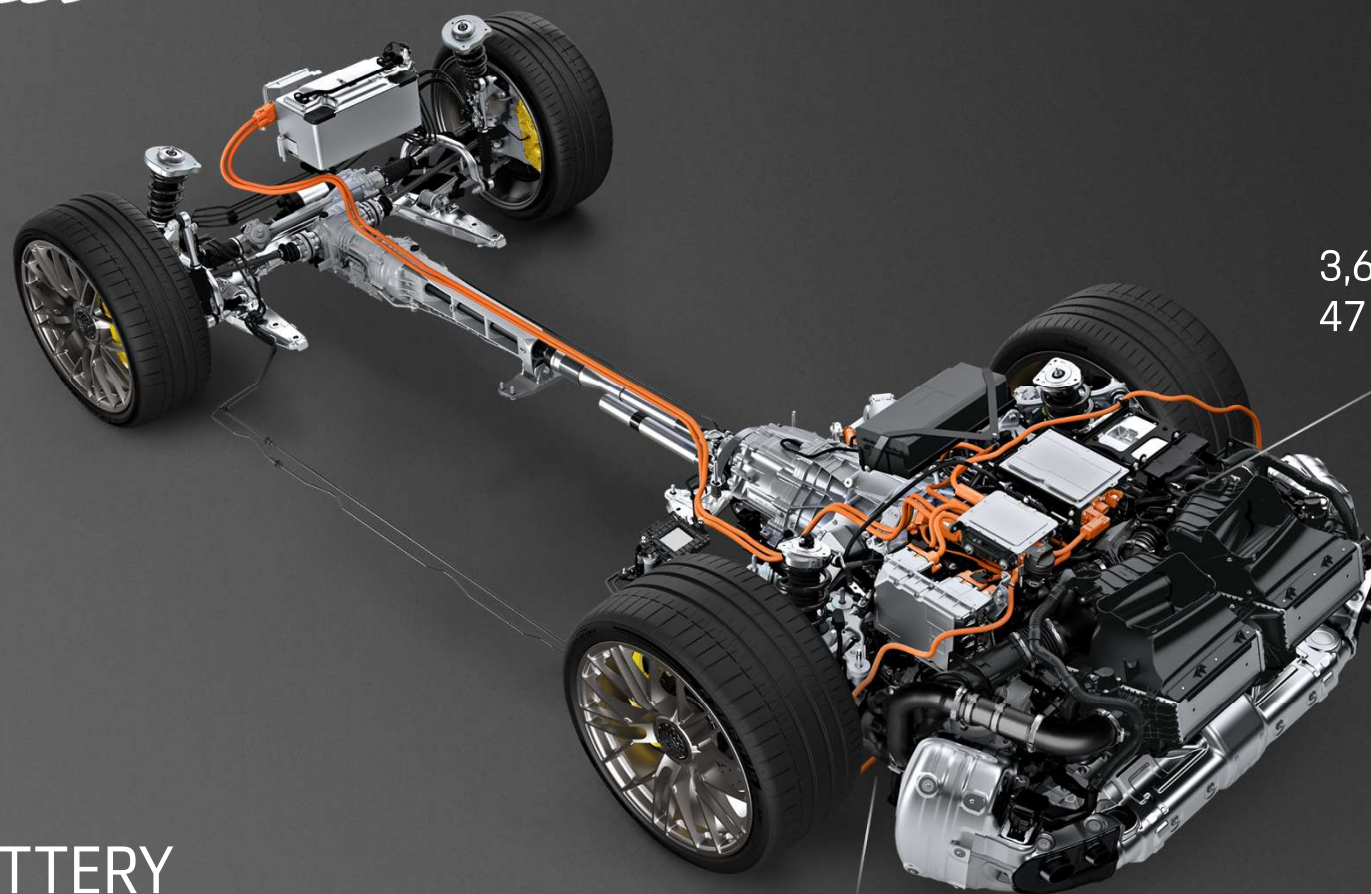
Vehicle
response

Track
performance



911 *Turbo S*
t-hybrid

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3,6 l Boxer engine
471 kW | 760 Nm

BOXER_{meets} BATTERY

Electric turbochargers (Twin-Turbo)
each 25 kW | 3,4 Nm

911 Turbo S t-hybrid

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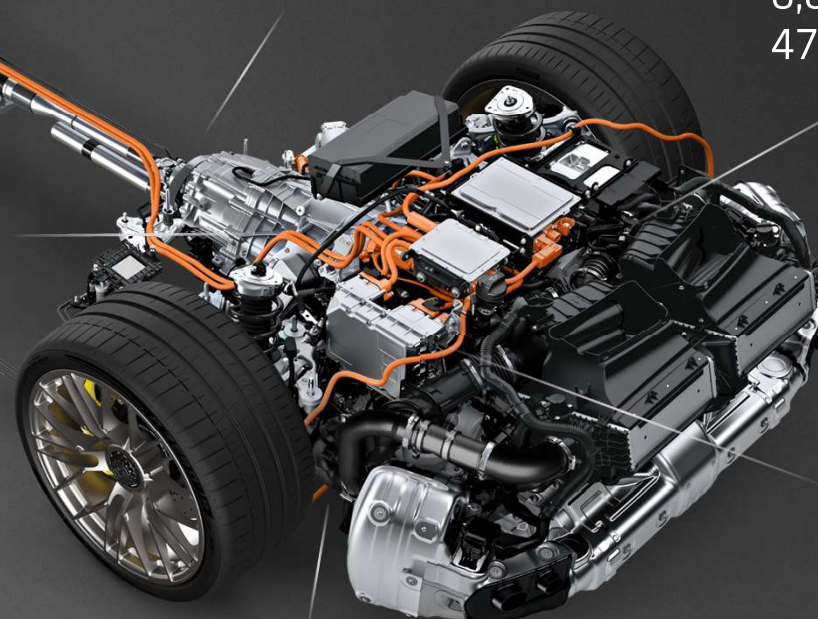


Li-Ion battery 400 Volt
1,9 kWh | 43 kW

PDK II evo - 8 speed
No disengagement clutch

3,6 l Boxer engine
471 kW | 760 Nm

P1 Electric motor
60 kW | 188 Nm



HV-components
low temperature
cooling system

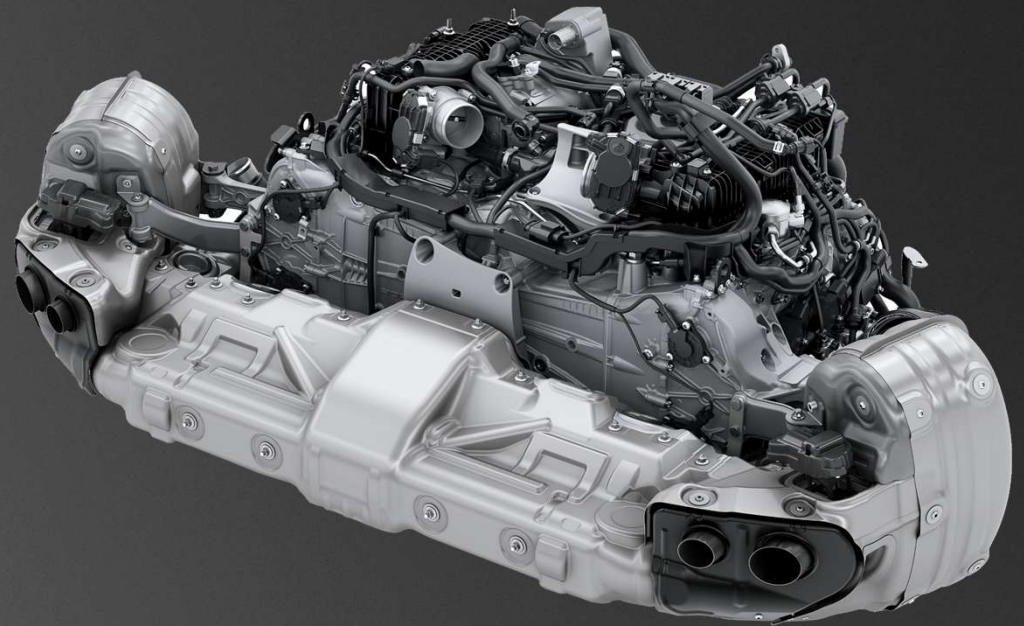
BOXER_{meets} BATTERY

Electric turbochargers (Twin-Turbo)
each 25 kW | 3,4 Nm

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ENGINE of new 911 Turbo S (9A3)

- Six-cylinder Boxer engine with 3591 cm³
640 PS (471 kW) and 760 Nm
- Specific power: 131 kW / l
- Stroke: 81 mm; bore: 97 mm
- Twin-Turbo with electric turbochargers
- All new engine peripherals



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ENGINE development objectives



- Six-Cylinder Boxer engine with 3591 cm³
- 640 PS (471 kW) and 760 Nm
- Specific power: 131 kW / l
- Stroke: 81 mm; bore: 97 mm
- Twin-Turbo with electric turbochargers
- All new engine peripherals



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Compactness

Height
reduction

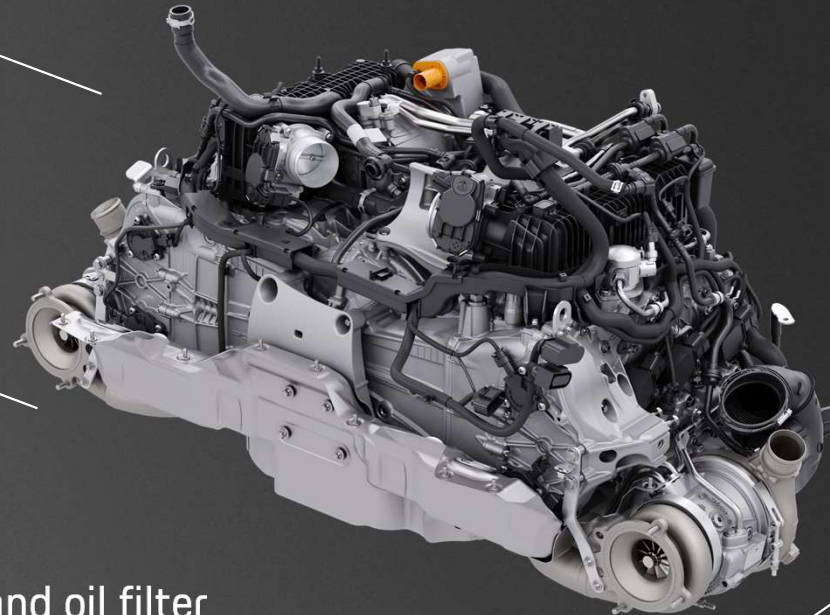
-110 mm

Reduced length and height

- optimized auxiliaries design without a belt drive
- new arrangement of the water pump, oil cooler and oil filter
- new intake-manifold system

Similar width

- increased stroke is compensated by cylinder head height



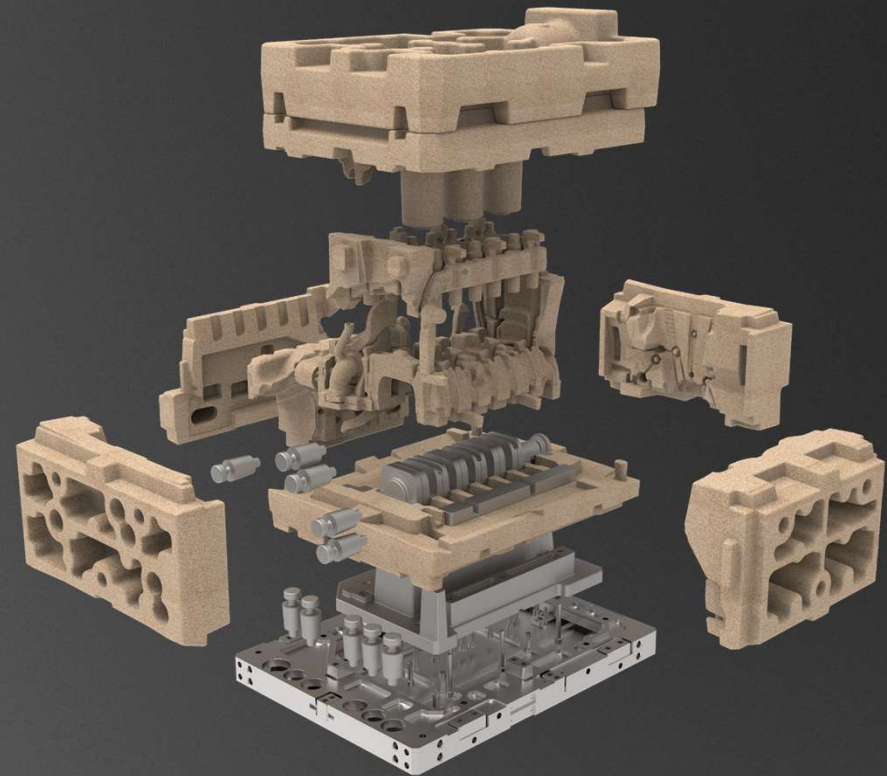
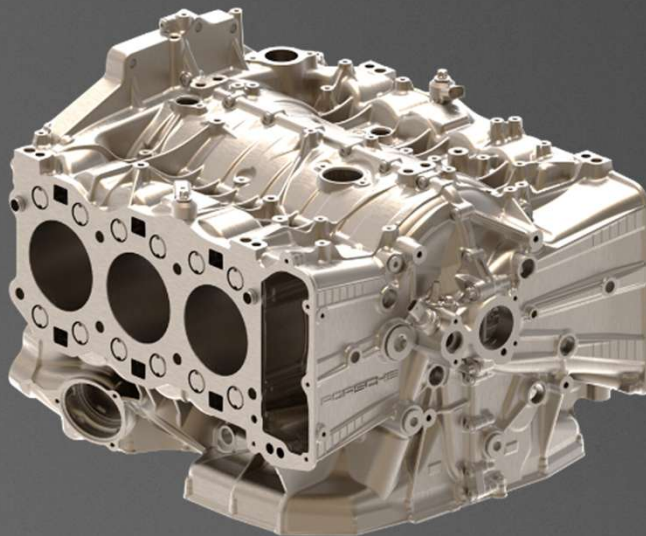
Length
reduction

- 30 mm

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Weight

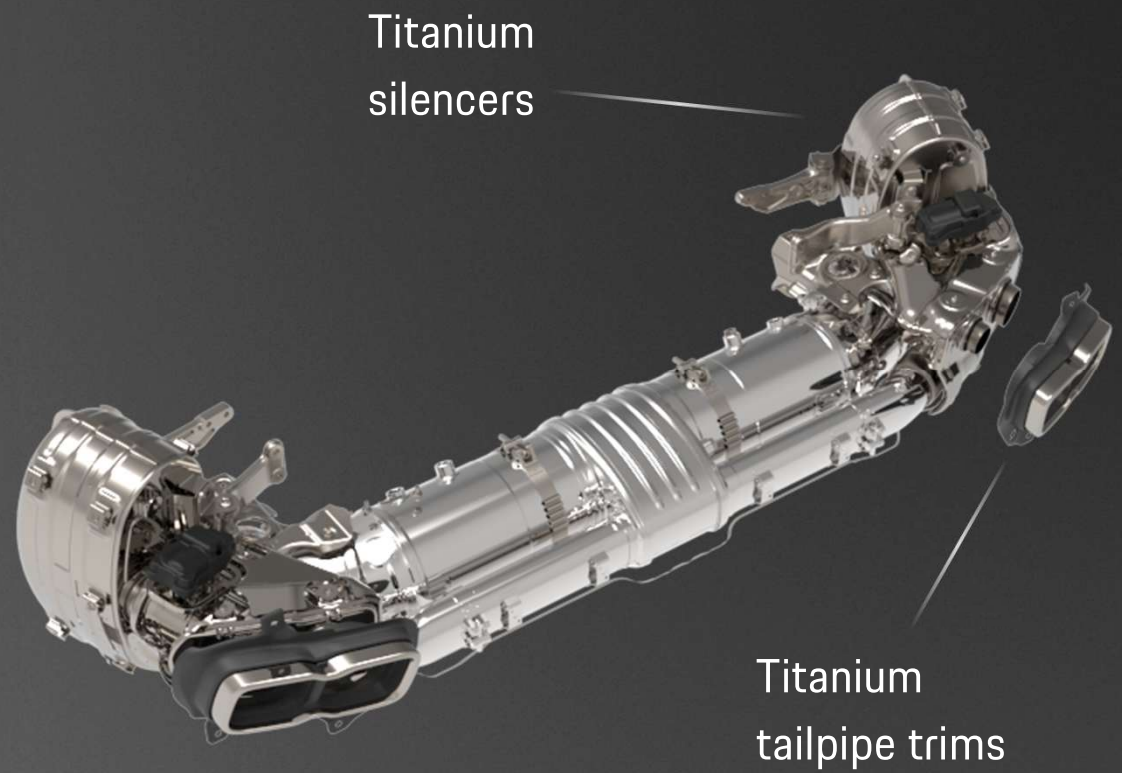
- Highly integrated sand-cast crankcase



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Weight

- Highly integrated sand-cast crankcase
- Titanium exhaust system

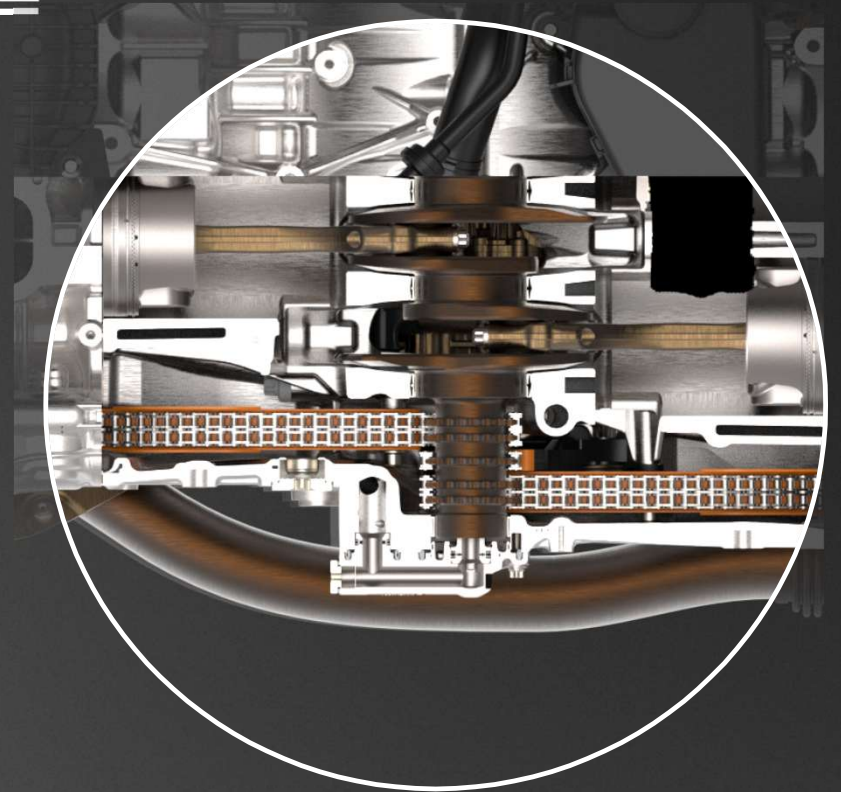
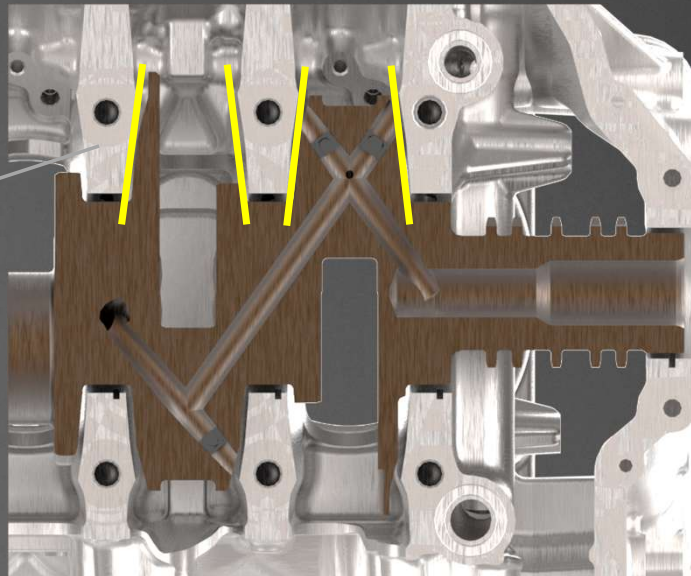


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Mechanical Robustness

- V-shaped crank webs for increased bending stiffness
- Crankcase with machined v-shaped running clearance
- Reinforced crankcase saddle

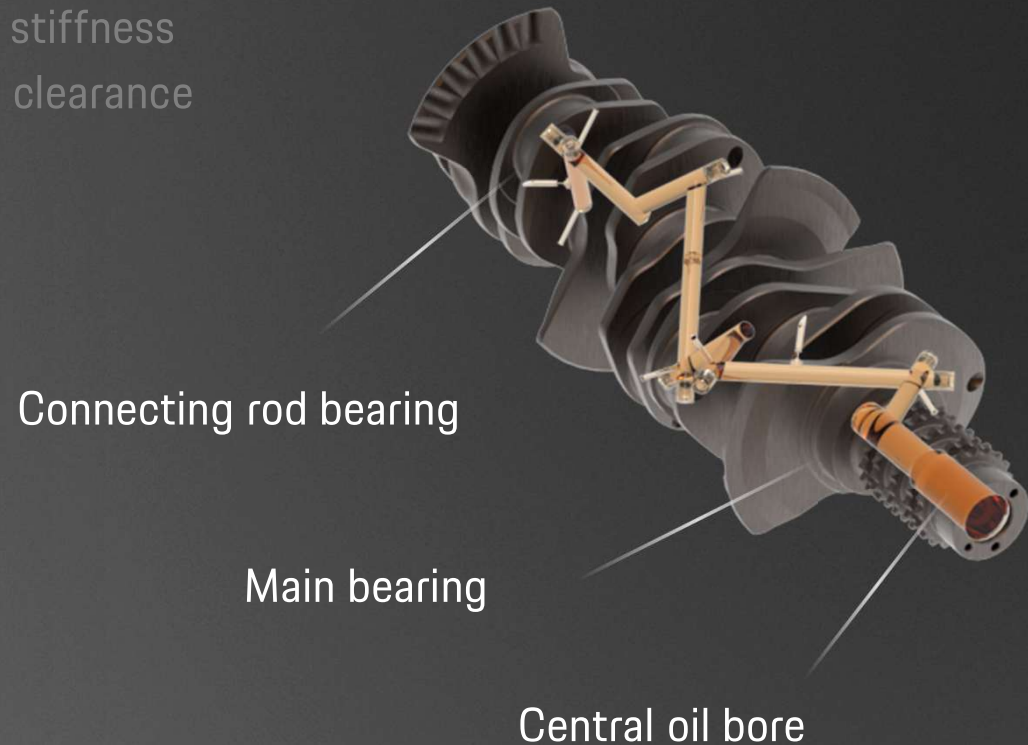
Crankcase
saddle



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Mechanical Robustness

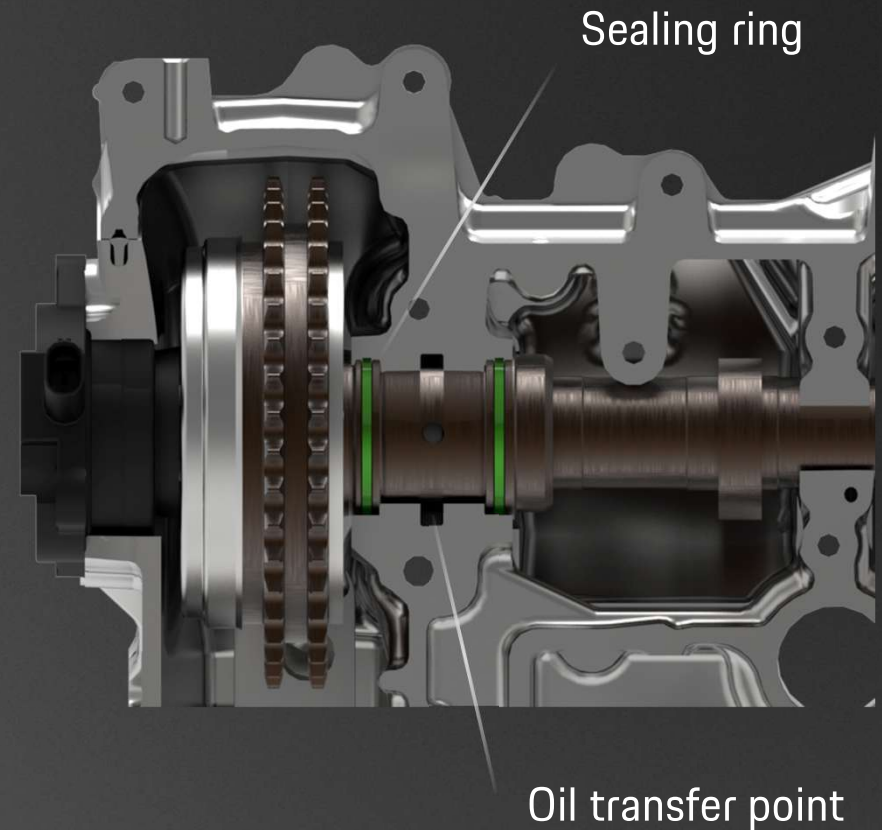
- V-shaped crank webs for increased bending stiffness
- Crankcase with machined v-shaped running clearance
- Reinforced crankcase saddle
- Crankshaft with central oil supply



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Reduced mechanical losses

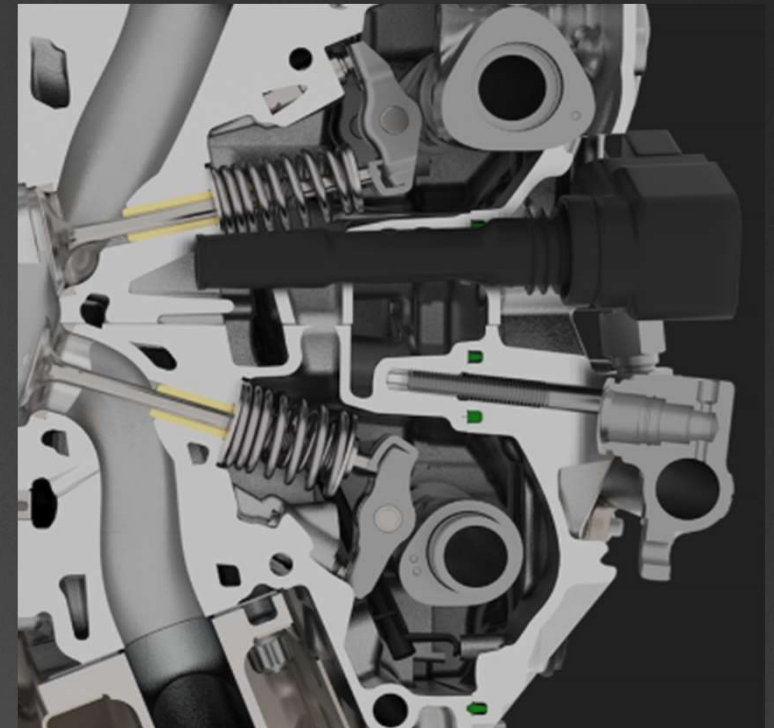
- Reduced overall oil flow rate
 - Reduced crankshaft-bearings losses due to central oil supply
 - Camshaft with sealed oil-transfer points
 - Camshaft adjuster with internal oil return



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Reduced mechanical losses

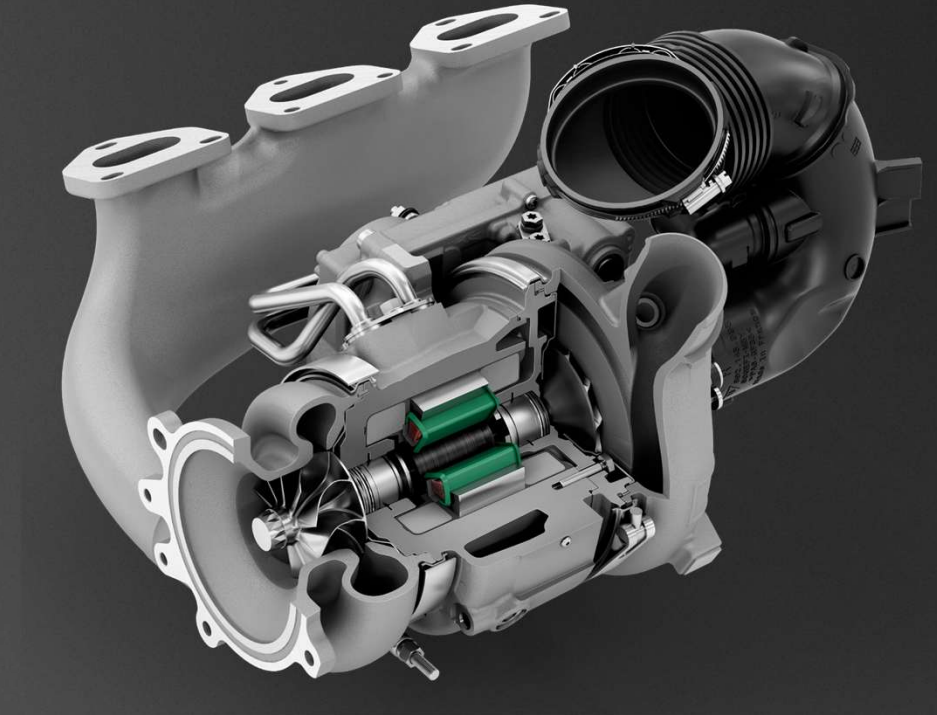
- Reduced overall oil flow rate
 - Reduced crankshaft bearings losses due to central oil supply
 - Camshaft with sealed oil transfer points
 - Camshaft adjuster with internal oil return
- Mechanical losses
 - Friction optimised roller finger follower system



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Hybridisation

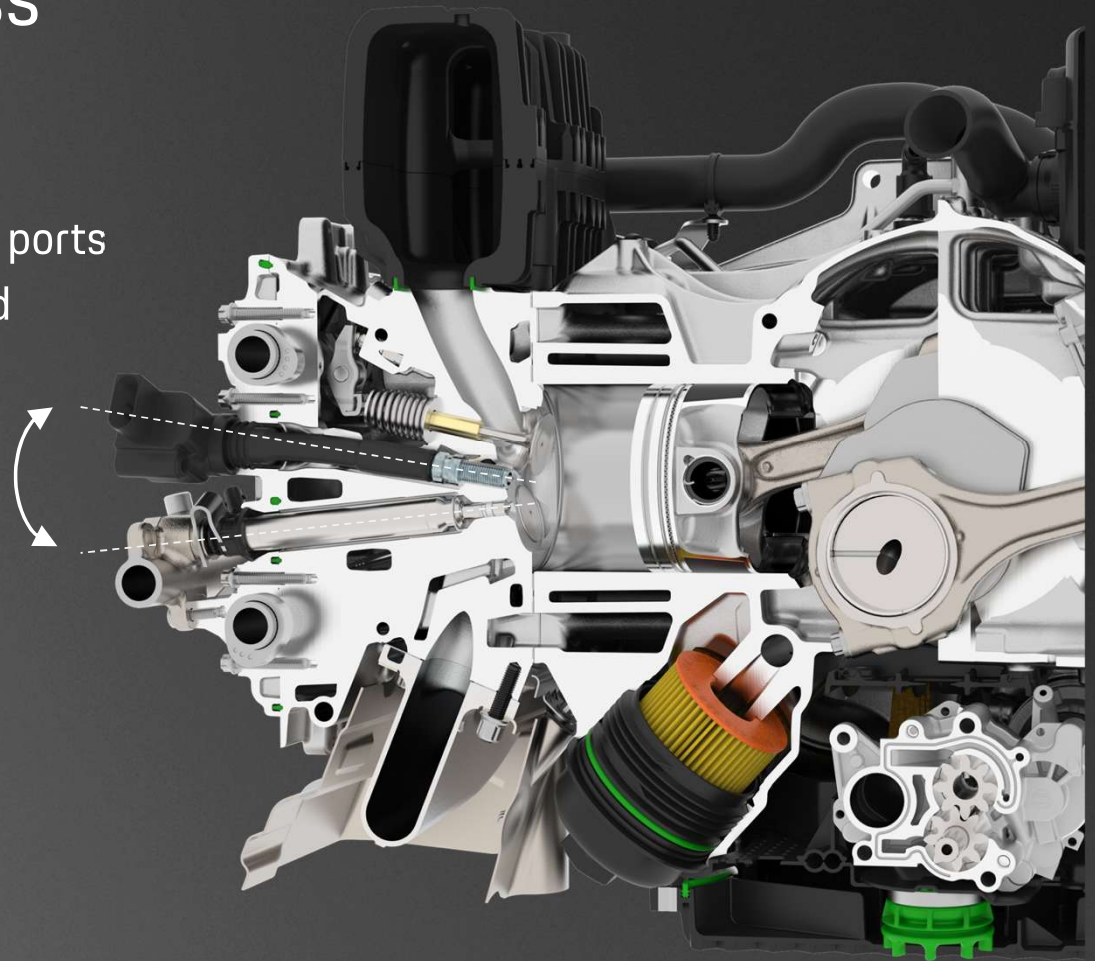
- Newly developed electric turbocharger
 - Output: 25 kW peak, 20 kW continuous
 - Modular core design
 - Permanent-magnet synchronous motor
 - Integrated SiC inverter
 - New turbine and compressor wheel
- Electrified auxiliaries
 - A/C compressor
 - Chassis control system
 - Starter and generator functions integrated into the P1-Motor



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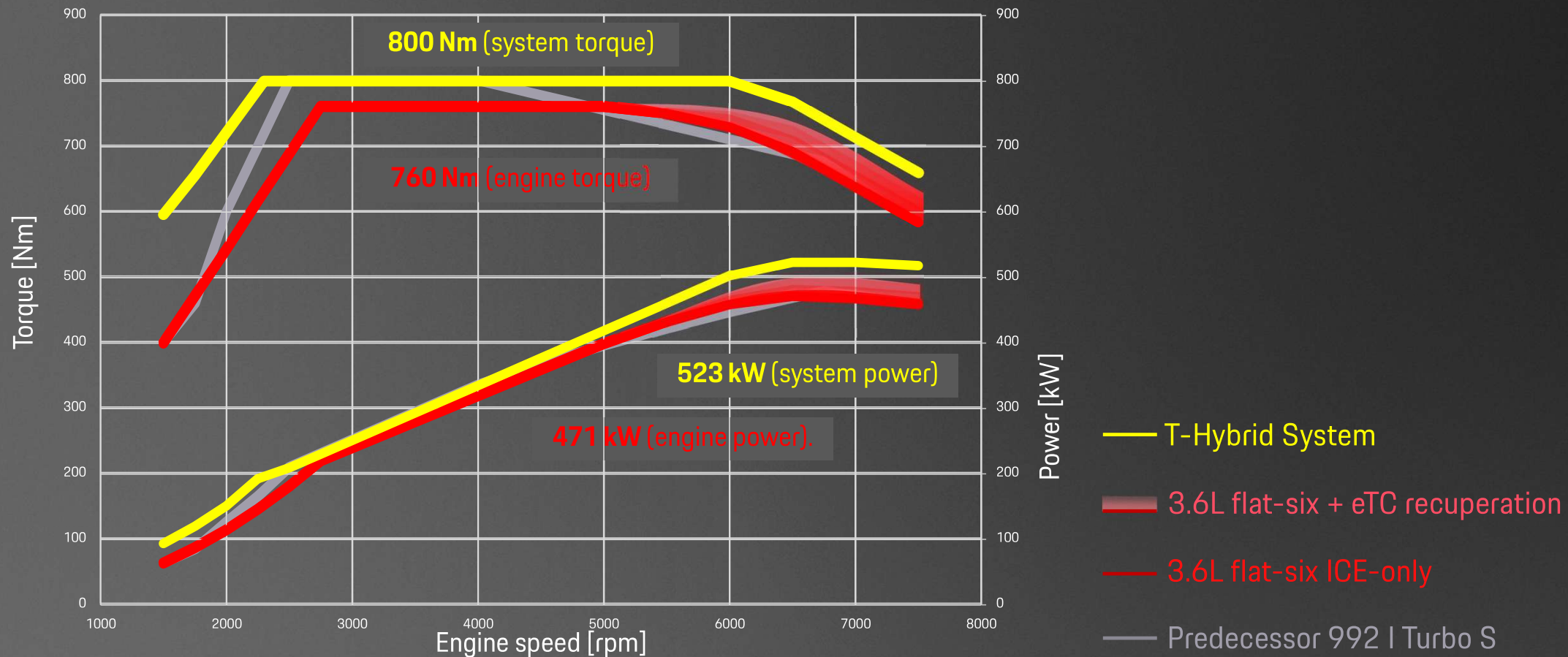
Improved combustion process

- Increased stroke-to-bore ratio of 0.84
- Cylinder head with redesigned intake and exhaust ports
- Positions of Piezo injector and spark plug swapped
- Valvetrain with roller finger followers



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Power and Torque



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Torque [Nm]

900

800

700

600

500

400

300

200

100

0

1000

2000

3000

4000

5000

6000

7000

8000

Engine speed [rpm]

Brake specific fuel consumption

992 Turbo S

992 II Turbo S ICE+eTC (recup.)

-3%  -23%

992 II Turbo S ICE-only

-23%

50%

100%

T-Hybrid System

3.6L flat-six ICE-only

3.6L flat-six + eTC recuperation

Driving resistance 6th gear

V_{max}

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Launch Acceleration

DISTANCE COVERED AFTER 2.5 SECONDS

WITH LAUNCH CONTROL



911 *Turbo S*

17 m



911 *Turbo S*
E-hybrid

25.5 m

+ 8.5 m

0-100 km/h

2.7 s

2.5 s

0-200 km/h

8.7 s

8.4 s

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Turbo S

Laptime

6:40.42

Speed km/h

310

BRAKE

THROTTLE



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Summary



911 Turbo S
T-hybrid

- Similar vehicle dimensions
- Improved overall powertrain performance
 - Nürburgring Nordschleife lap time -14 s
 - Acceleration 0-100 km/h -0.2 s
 - Distance after 2.5s +8.5 m
- ➔ More than compensates for the additional weight
- Improved efficiency in WLTP and at high loads

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Advancing the
911 Heritage

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— 992 II



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