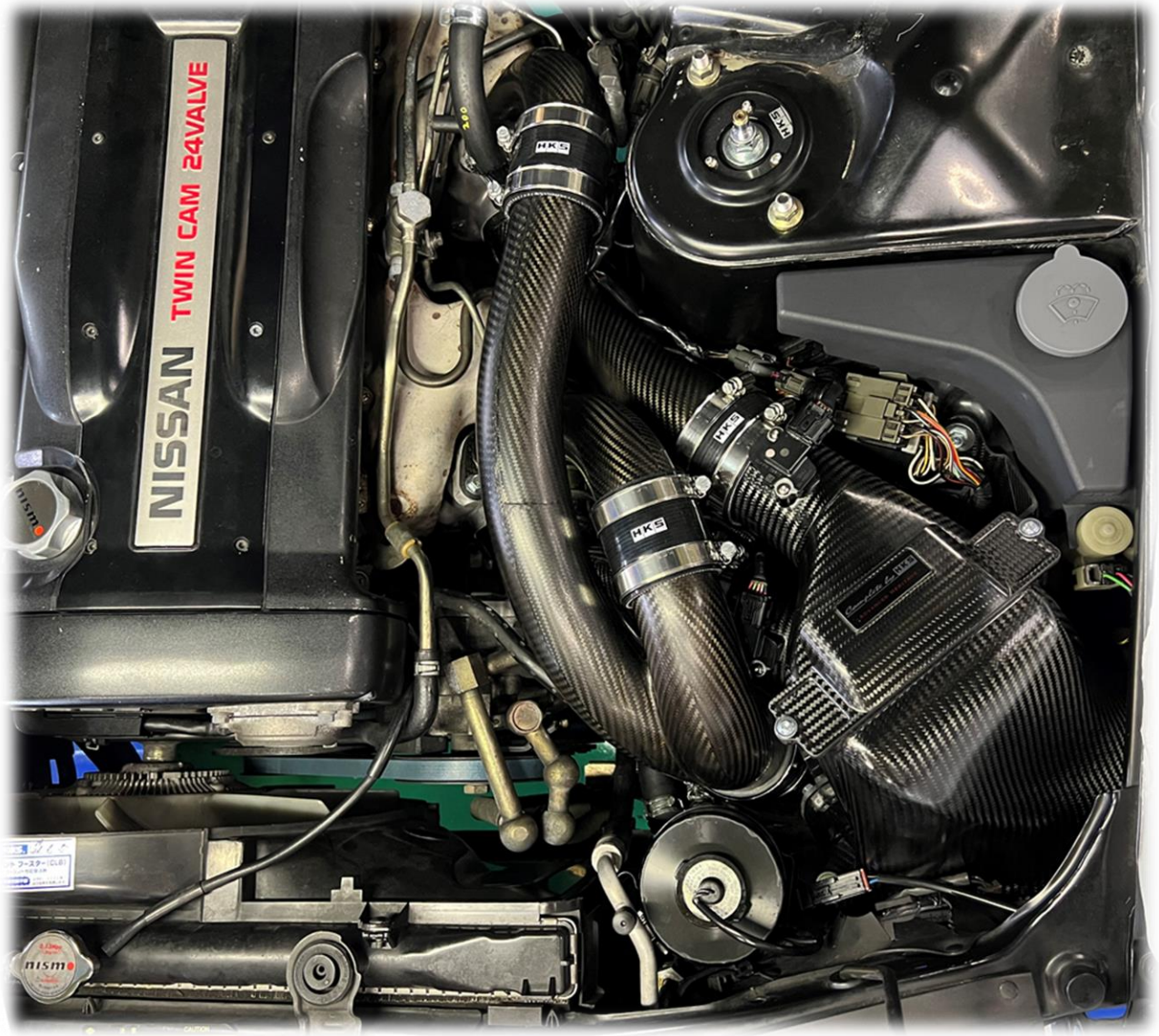
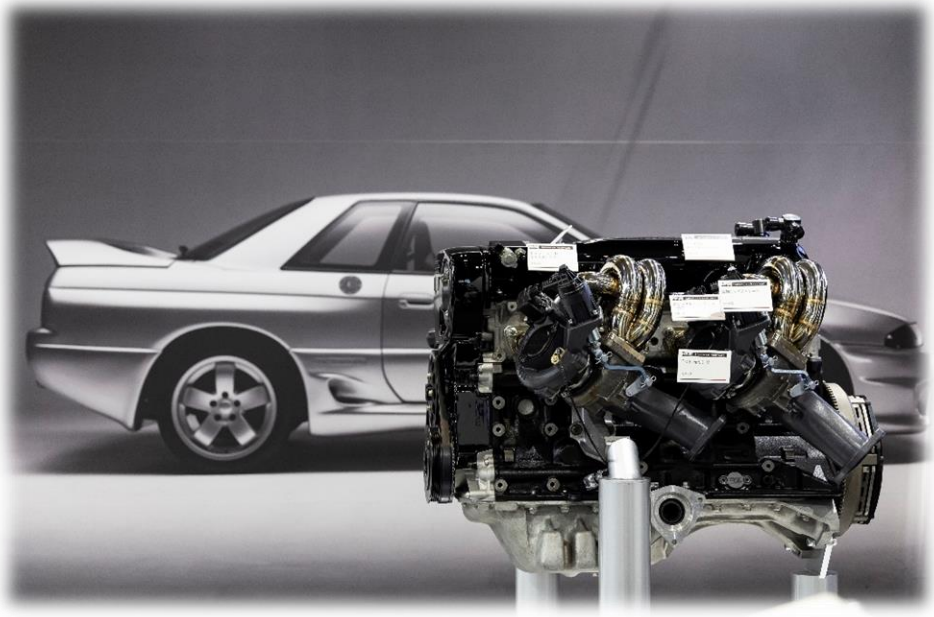
Complete by HKS
- ADVANCED HERITAGE -

# CFRP INTAKE SYSTEM
# For BNR32



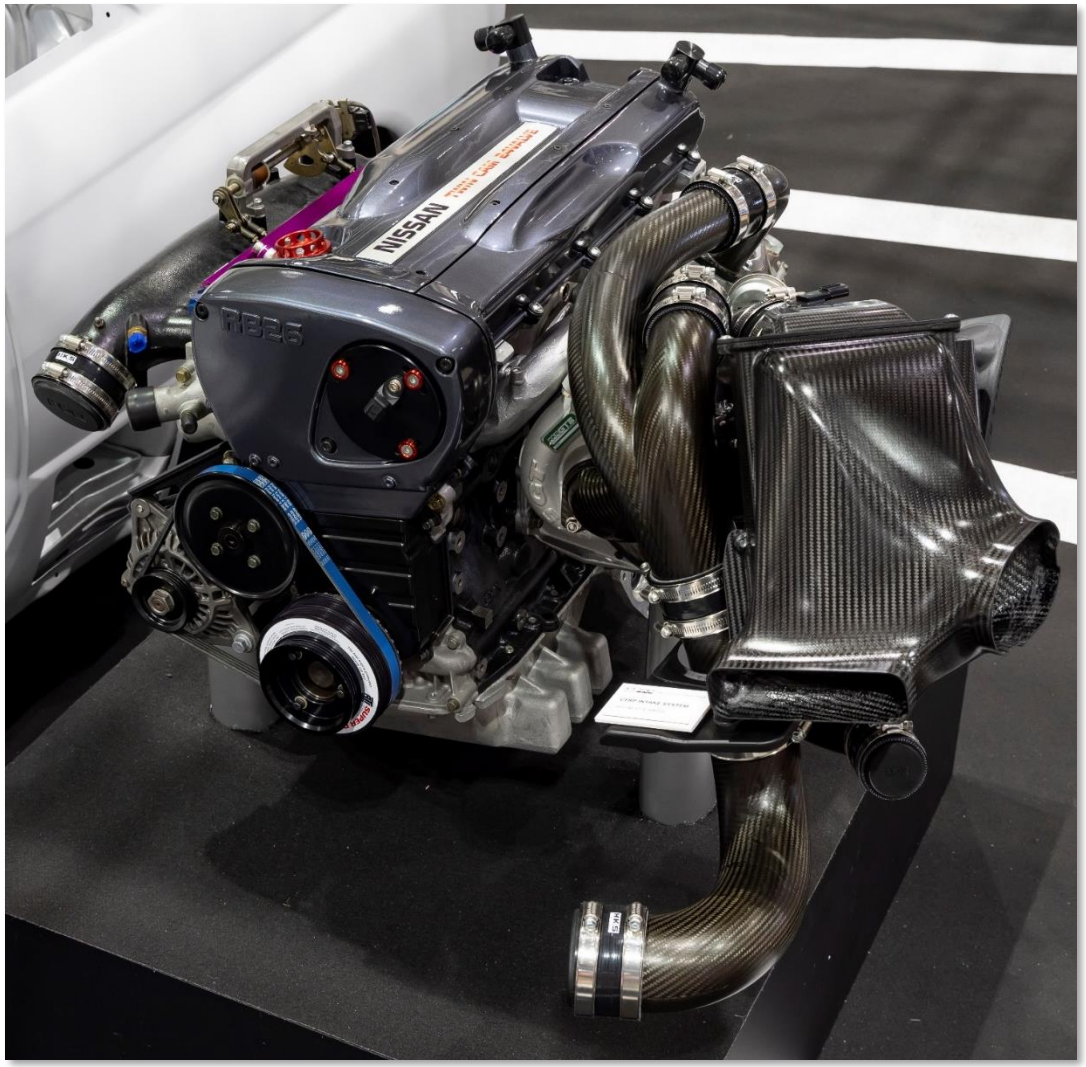
# What is HKS ADVANCED HERITAGE ?

**This project brings innovative value to heritage parts. We take ancient heritage cars with their past glory and bring their charm back to life with modern technology and design. This results in parts with a whole new dimension, a perfect fusion of tradition and innovation.**



Complete by HKS
- ADVANCED HERITAGE -

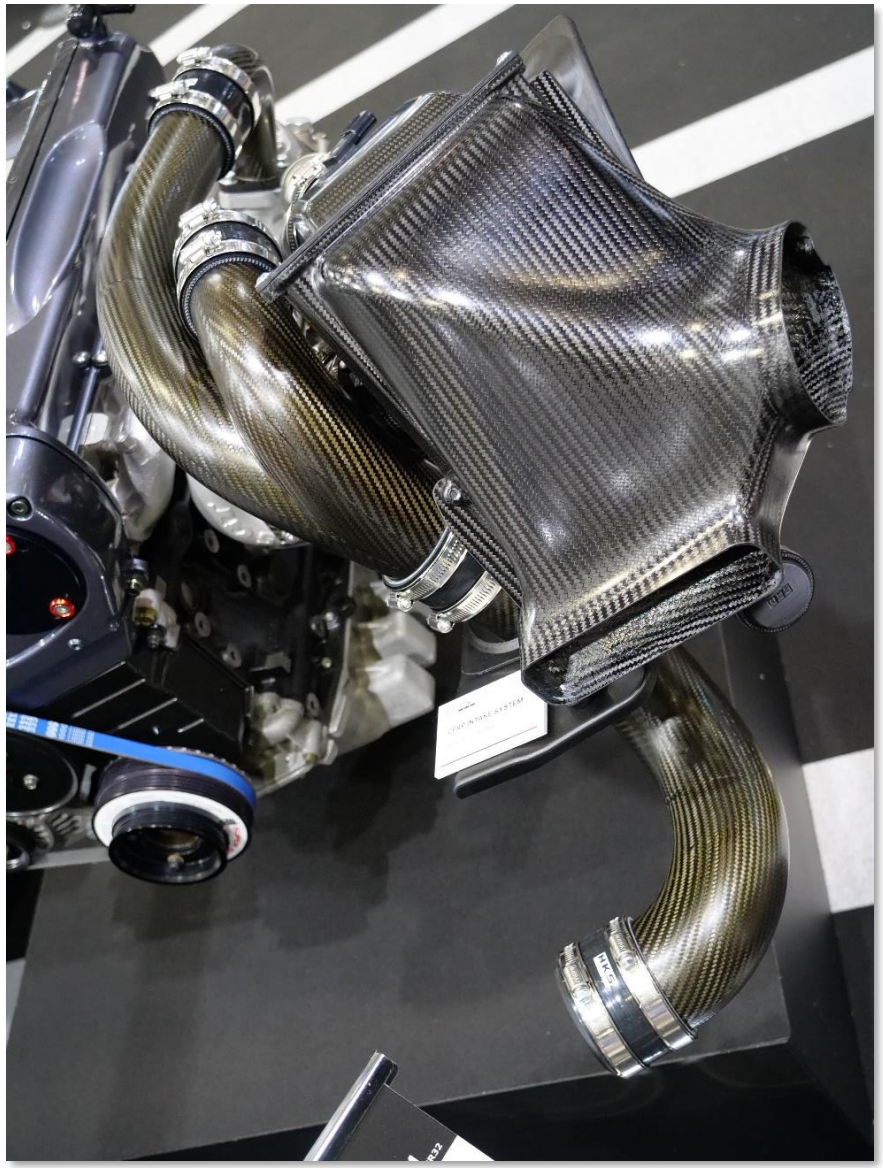
**HKS has commenced the development of enhanced heritage parts, incorporating the latest parts development technology and future-oriented techniques, with the aim of making discontinued vintage cars more appealing and ensuring their long-lasting use with greater confidence.**




## Development of the RB26 with the latest technology.

**The first product in their lineup, HKS has completed the development of a carbon intake system that incorporates the Advanced Heritage Concept and fine-tunes the efficiency of each component, specifically designed to fit the BNR32's factory layout.**

| Vehicle | Model | E/G | Model Year | JAN Code | Part No. | MSRP | Remarks |
|---|---|---|---|---|---|---|---|
| SKYLINE GTR | BNR32 | RB26DETT | 1989/8～1994/12 | 4957266260739 | 70029-AN001 | ¥1,580,000 | Exclusive for HKS dealers and distributors |



*Product image for illustration purposes only. Actual product may vary.

# HKS ADVANCED HERITAGE CFRP INTAKE SYSTEM for BNR32

## ■ Main Features

### Reducing intake resistance (P6-7)

The pressure loss has been significantly decreased by 46% compared to the previous installation of the HKS special piping kit. This improvement is achieved through an enlarged suction capacity and an increased cross-sectional area for introducing outside air. The dual intake ducts allow for approximately 2.4 times more air to enter than the stock system.

### Reducing Intake air temp (P8)

The enclosed design minimizes the intake of hot air into the engine compartment, resulting in a reduction of up to 60% in intake air temperature during WLTC mode when compared to the exposed HKS Super Power Flow system.

### Expanding intake interference/surge margin (P9-12)

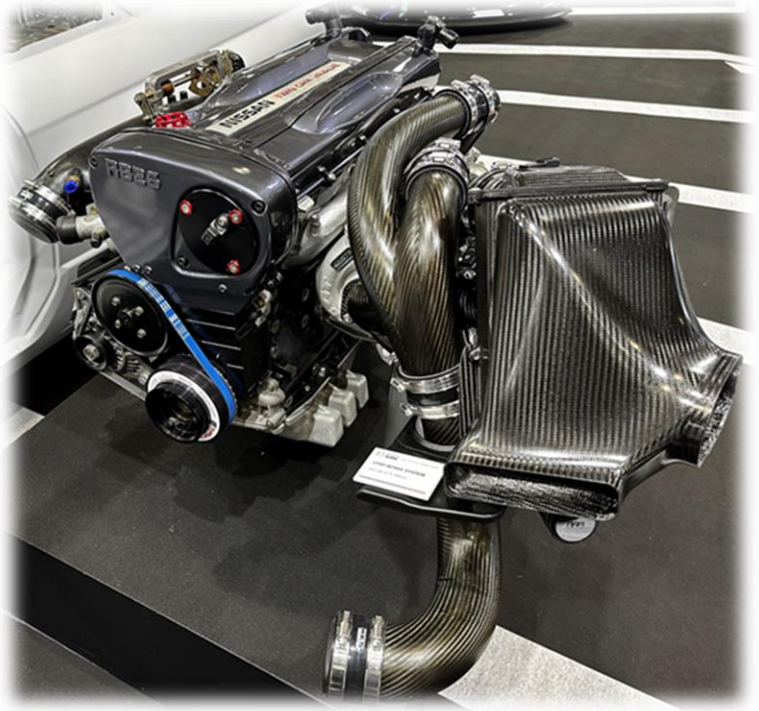
An anti-surge plate, also known as a surge suppression rectifier plate, has been installed in the suction pipe to address the issue of intake air interference, which has been a persistent problem in the RB26 twin-turbo layout.

### Verification of the front/rear balance of the pipe (P13)

The geometry of the 2-in-1 chamber pipe has been optimized to ensure consistent operating conditions for both the front and rear turbines. This improvement results in a more balanced flow and performance. In comparison to conventional HKS special piping kits, the flow discrepancy between the front and rear turbines has been reduced by an impressive 90%.

### Weight reduction through CFRP

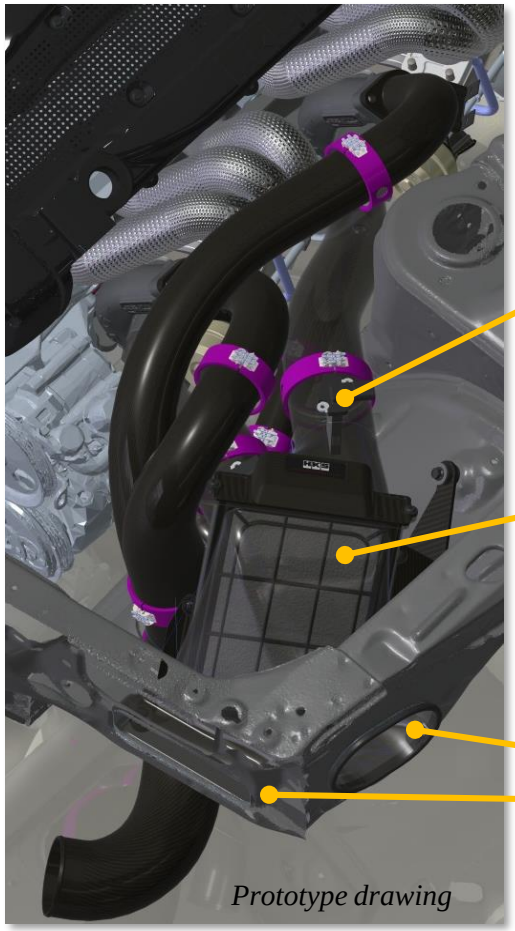
CFRP (Carbon Fiber Reinforced Polymer) is utilized for the primary components, including the piping and air cleaner box, to achieve a weight reduction of approximately 65% compared to the factory intake system. For enhanced heat resistance, a high heat-resistant prepreg with a temperature resistance of 350°C or higher is employed for the chamber pipe after supercharging and the suction pipe near the turbine, as these components are exposed to high temperatures.



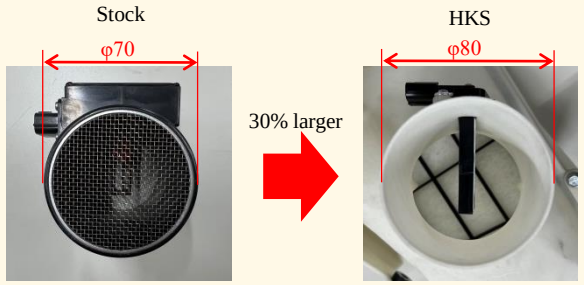
# Reducing intake resistance

## ◎Induction box (dual intake duct) & suction pipe

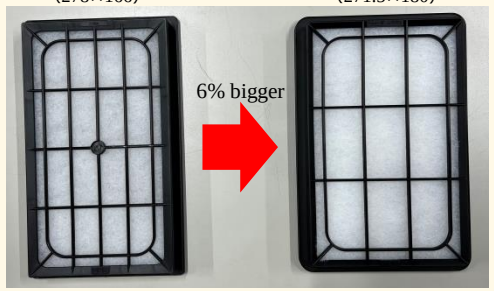
In a closed-layout similar to the stock configuration, the intake resistance of the external air introduction section, which can be a bottleneck, is reduced by adopting a dual intake duct system (approximately 140% larger) with two separate external air intake paths. Additionally, the suction capacity is increased (approximately 30% larger) by incorporating a high-flow air flow sensor, and the filter capacity is expanded (approximately 6% larger), resulting in reduced pressure loss even compared to the traditional open-layout (mushroom type) air cleaner.



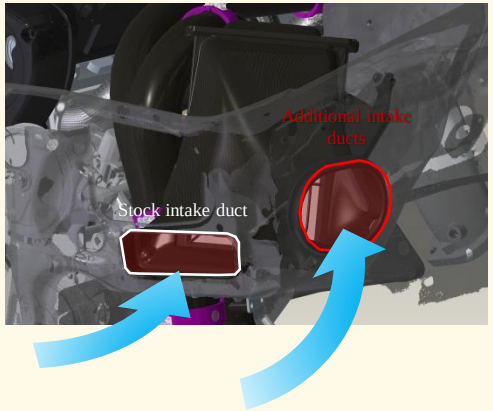

■ Expansion of suction piping capacity



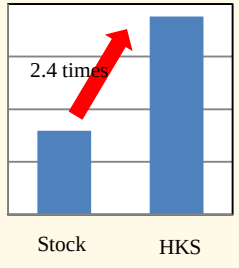

■ Air filter capacity expansion




■ Dual intake ducts to increase the cross-sectional area of outside air intake.




Outside air inlet Cross-sectional area comparison



# Reducing intake resistance

## ◎Induction Box (Dual Intake Duct) + Suction Pipe

- Verification of the effect of reducing air intake resistance (confirming its superiority over conventional products).

To verify the reduction in intake resistance, the intake resistance values [kPa] were measured for individual components under each specification. The HKS Advanced Heritage (①) exhibited approximately a 45% reduction in intake resistance compared to the HKS Traditional Spec (②) at a flow rate equivalent to 600 PS.

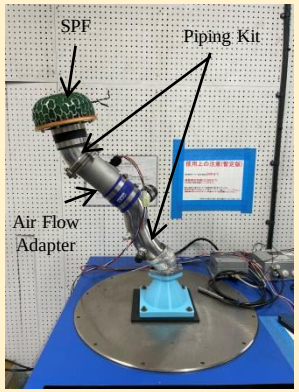
■ Test details

Test Equipment: Super Flow SF-1020 (At HKS HQ Facility)
Environmental Values during Testing:
- ✓ Test Temperature: 20.0 [℃]
- ✓ Test Relative Humidity: 40 [%]
- ✓ Test Atmospheric Pressure: 96.015 [kPa]

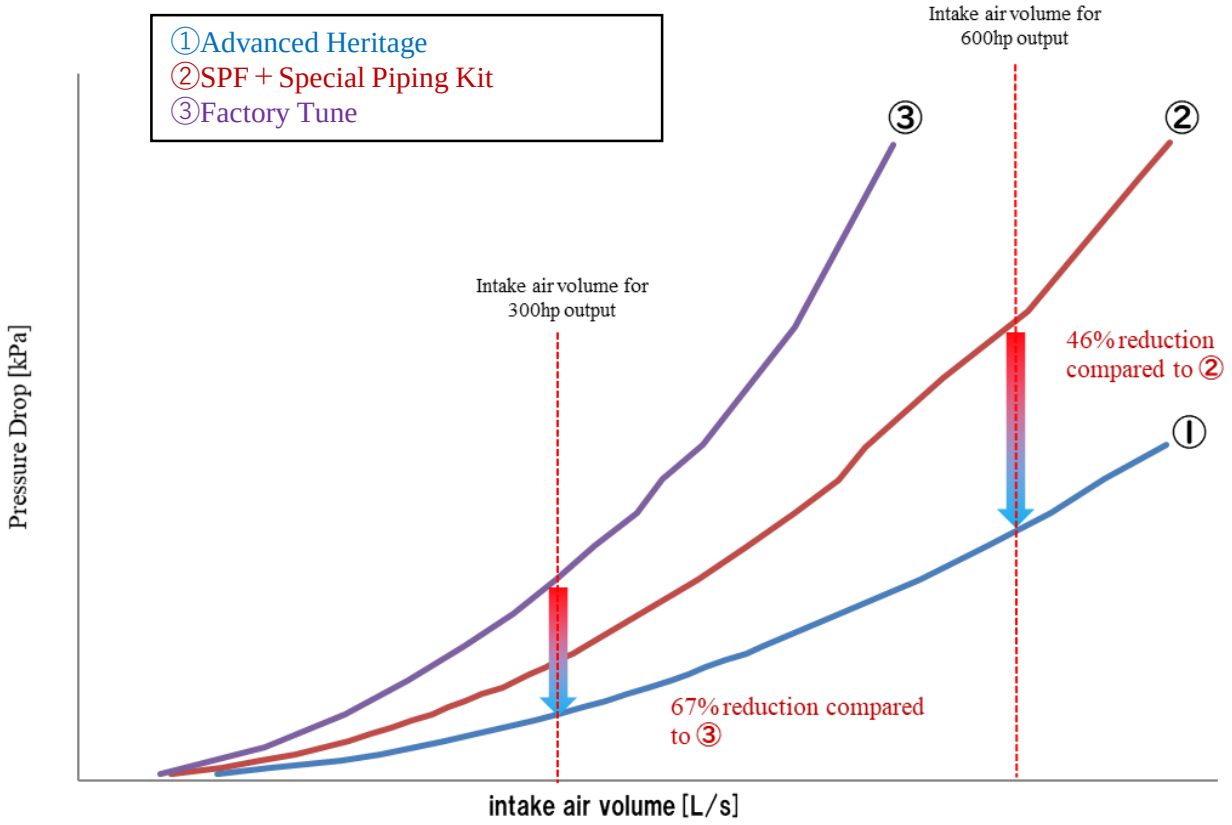
■ List of EUT

① HKS ADVANCED HERITAGE
(Induction Box + Suction Pipe)


② HKS Traditional spec
(HKS SPF + Special Piping Kit)




③ Stock layout
（Stock intake box＋HKS SAF）

# Reducing intake resistance

## ◎ Induction box (Open Vs Closed Box Air Intake)

Verification of effectiveness in reducing intake air inlet temperature (confirming superiority over mushroom type)

The enclosed design minimizes the intake of hot air into the engine compartment, resulting in a reduction of up to 60% in intake air temperature during WLTC mode when compared to the exposed HKS Super Power Flow system.

Test Equipment: AVL Chassis Dynamometer (At HKS HQ Facility)

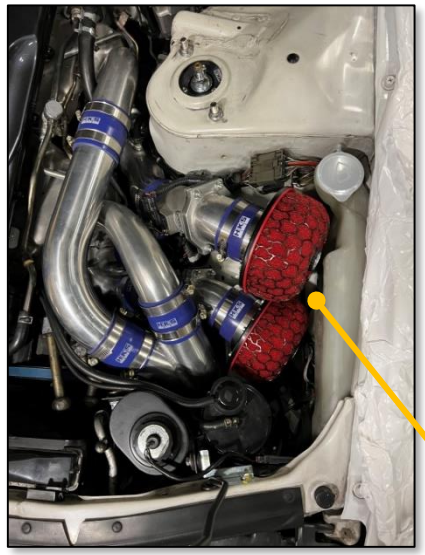
Environmental Values during Testing:
Test Temperature: 23.0 [℃]
Test Relative Humidity: 17.3 [%]
Test Atmospheric Pressure: 95.0 [kPa]
Test Samples:
① ADVANCED HERITAGE (CFRP INTAKE SYSTEM)
② HKS SPL Piping Kit (Mushroom type)
Test Conditions:
WLTC (Worldwide harmonized Light-duty Test Cycle)

≪Test Vehicle Specifications≫
Vehicle Model: BNR32
Engine: RB26 2.8L HIGH RESPONSE
Displacement: 2711cc
Compression Ratio: 8.6
Output: 600ps (441kW)

①HKS Advanced Heritage (Proto)

Intake air inlet temperature measurement position

②HKS SPL Piping Kit (Mushroom)



Intake air inlet temperature measurement position

- Advanced Heritage : Intake air inlet temperature [℃]
- HKS Mushroom-type intake : Intake air inlet temperature [℃]
- **Vehicle speed (WLTC)**

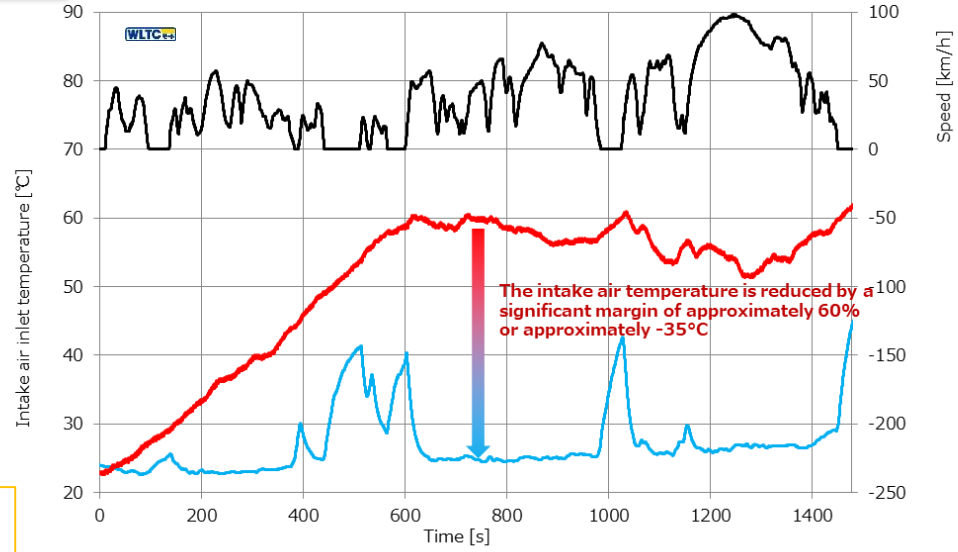



Fig. Transient Change in Intake Air Temperature during WLTC Mode Driving for Each Intake System Specification.

# Intake air interference and surge margin increase (intake air interference mechanism)

## ◎Inspection, evaluation and discussion of the RB26 twin-turbo air intake interference mechanism on a dyno.

■ Test Equipment:
AVL Chassis Dynamometer (At HKS HQ Facility)
■ Test Conditions
-3000-4000rpm
-Partial load (TP: 35% constant) Closed throttle after intake interference occurs

※1 What is surging

The phenomenon you are describing commonly occurs in turbo systems such as twin-turbocharged cars. This phenomenon is known as surging, which occurs when there is a sudden throttle input at low engine loads, causing an imbalance in the pressure within the turbo system and disrupting the airflow. When surging occurs, it can lead to a decrease in engine performance and impose additional stress on the engine and turbo. To prevent this, it is important to properly manage the load on the turbo and optimize the intake system, among other measures.

## 《 Intake air interference process 》

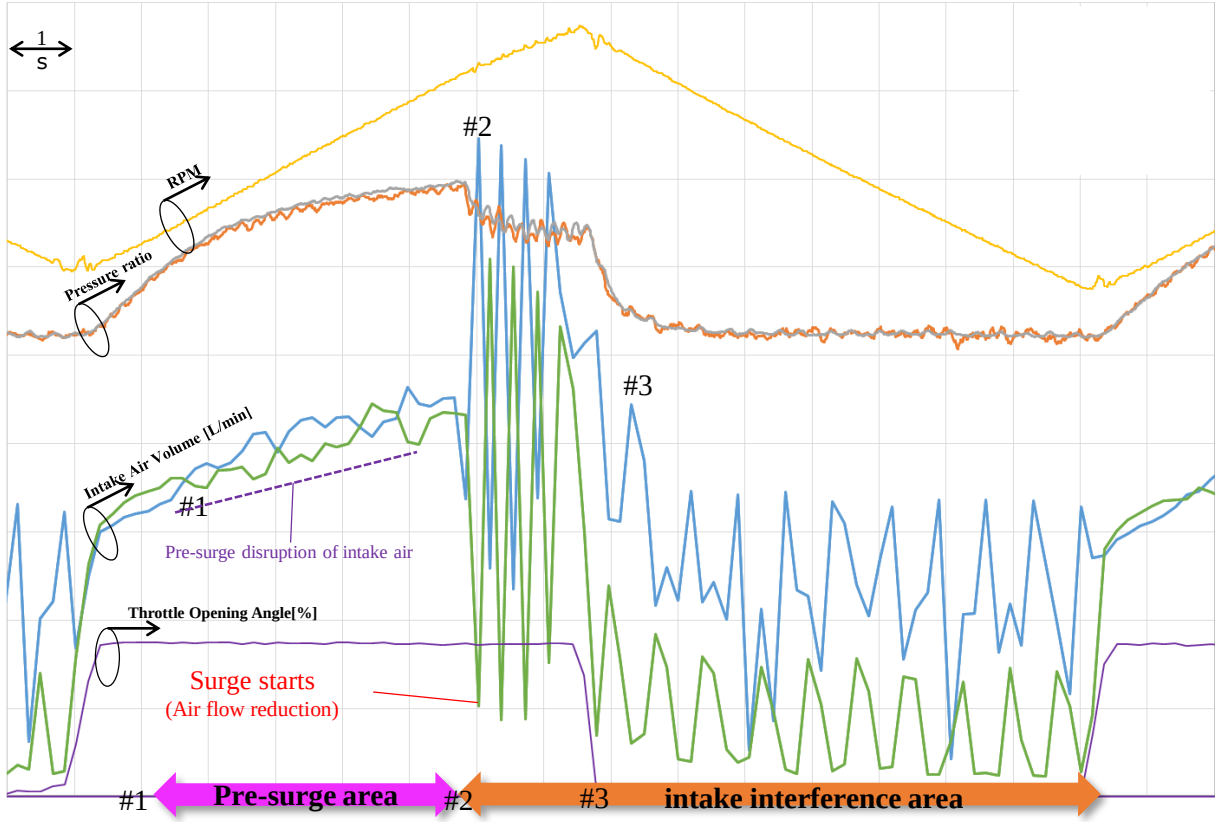
① Pre-surge Range:
In the range just before the occurrence of intake interference, a slight decrease in flow rate (pre-surge) can be observed. Although torque fluctuations are minimal, making it difficult for drivers to feel it, it is possible to find the precursors by measuring various parameters of the system.

② Intake Interference Range:
As the pressure ratio further increases, surge*1 occurs in one of the turbochargers (generally the rear one), causing a significant decrease in flow rate (green line). As a result, the flow rate in the other turbocharger (blue line) increases significantly, leading to surge. The two turbochargers enhance each other's surge, causing it to repeatedly occur.

③ Intake Interference (T/C Outlet-induced) Range:
Intake interference (surge) continues even after the throttle is fully closed. This is because the throttle closure causes an increase in T/C outlet pressure (pressure ratio increase), leading to the conditions for surge occurrence (the blow-off valve is out of its operational range in this low boost region).

In the case of RB26 twin-turbo engines, surge, which is the main cause of intake interference, mostly occurs in the rear turbocharger. This is because the layout results in longer paths for the suction and chamber pipes, leading to a relative increase in pipe resistance. Additionally, the rear turbocharger is located close to the exhaust, which is believed to cause an increase in intake temperature due to radiation.

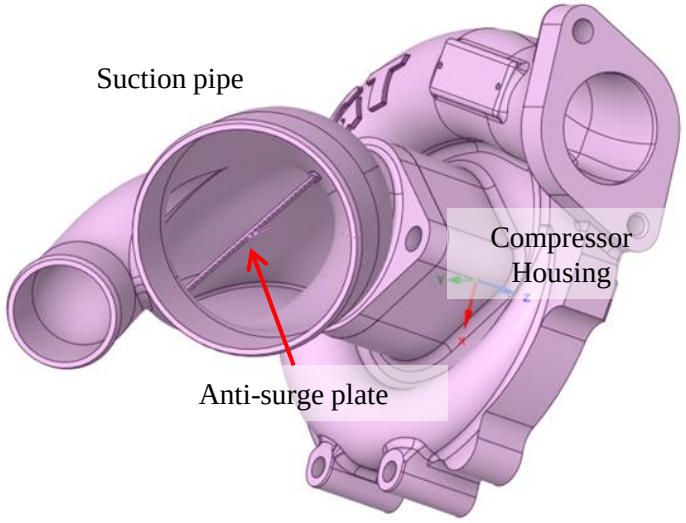
■ DYNO transient tests - Timeline data




**Study** To control intake interference, it is necessary to mitigate the primary factor, which is surge*1.

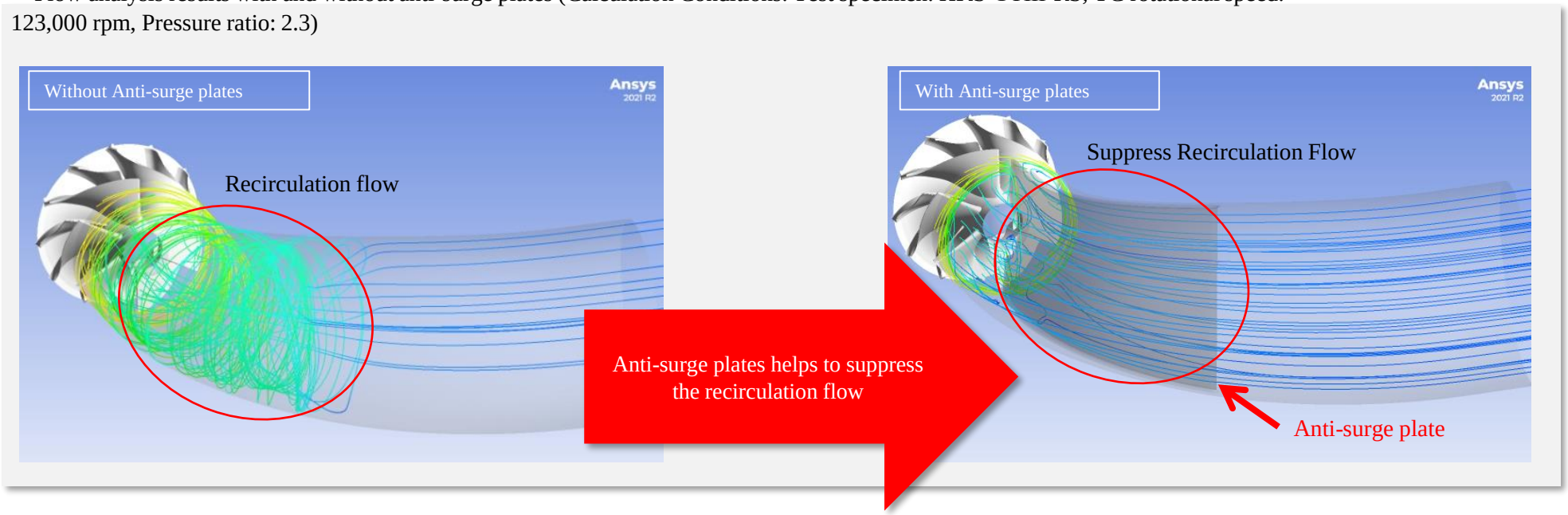
## ◎ surge suppression rectification plates (anti-surge plates)

Installed surge suppression rectification plates (anti-surge plates) in the suction piping just before the turbocharger. By suppressing the recirculation flow that accompanies strong rotation and is a cause of surge generation, the anti-surge plates reduce the surge limit flow rate in a wide pressure ratio range. This expands the margin for occurrence of intake interference, which has been a challenge in the RB26 Twin. Furthermore, unlike the conventional measure of ported shrouds, this specification does not lead to a decrease in compressor efficiency in high-flow regions.




## ◎ CFD analysis comparison

■ Flow analysis results with and without anti-surge plates (Calculation Conditions: Test specimen: HKS GTIII-RS, TC rotational speed: 123,000 rpm, Pressure ratio: 2.3)



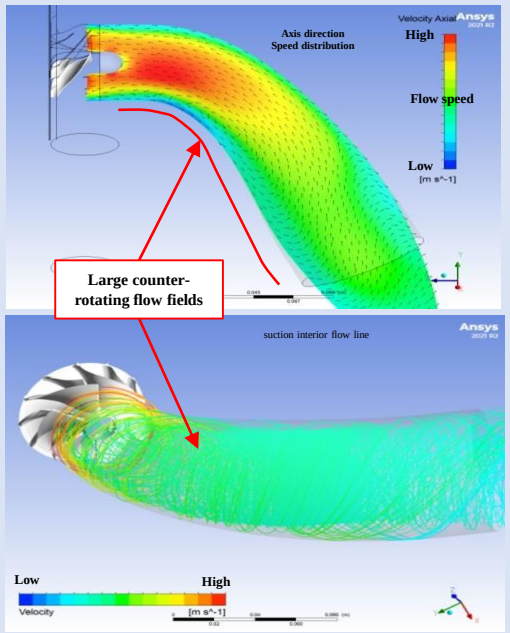
# ■ CFD anti-surge plate verification~ Prediction of the effect of surge margin expansion ~

In order to confirm the surge margin enlargement effect of the anti-surge plate, a numerical simulation analysis was performed using the general-purpose computational fluid dynamics software ANSYS CFX to analyze the internal flow within the T/C inlet suction pipe in the surge generation area.

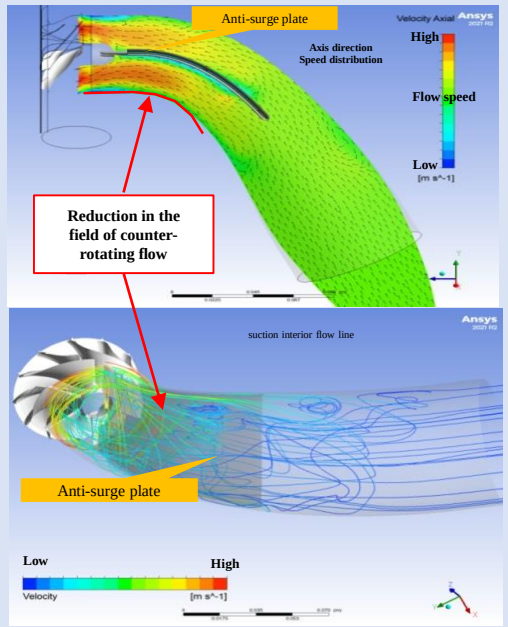
The CFD analysis confirmed that the anti-surge plate effectively suppresses the strong recirculation flow (backflow) accompanied by intense swirling during surge events. Additionally, it was observed that the anti-surge plate helps to equalize the internal flow distribution, thereby mitigating the flow imbalance caused by bends in the suction pipe near the compressor inlet.

## ■ Anti-surge plate to increase surge margins (CFD verification)

Without anti-surge plate




With anti-surge plate




■ Compressor map

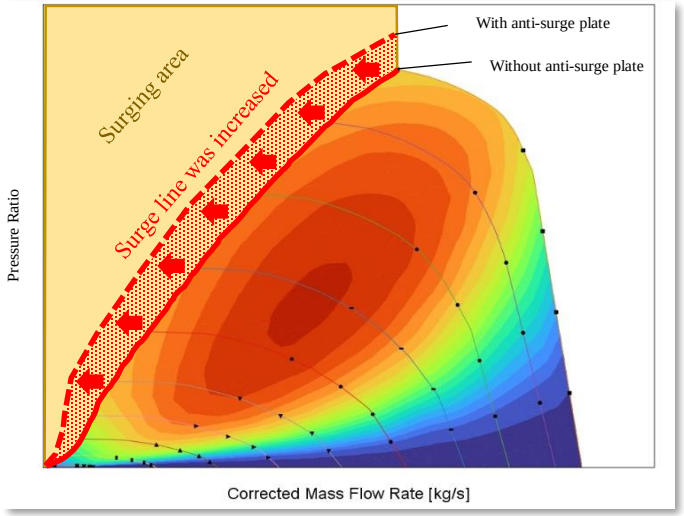



Fig. concept of enlarged surge line*2.

※2 What is Surge line

The surge line represents the boundary at which surge occurs. When the operating of the compressor fall below the surge line, specifically lower flow rate and higher pressure ratio (left hand boundary of the compressor map), surge will occur.

CFD Analysis Results

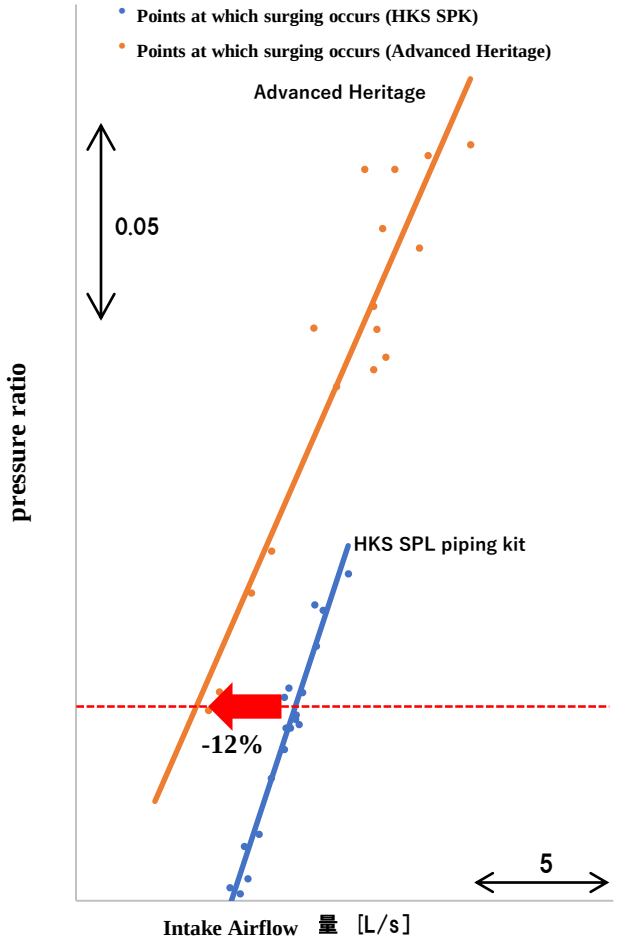
Confirmation of the surge suppression effect by suppressing the recirculating current generated during surges using an anti-surge plate.

# ■ Surge line evaluation test results on real equipment (transient conditions)

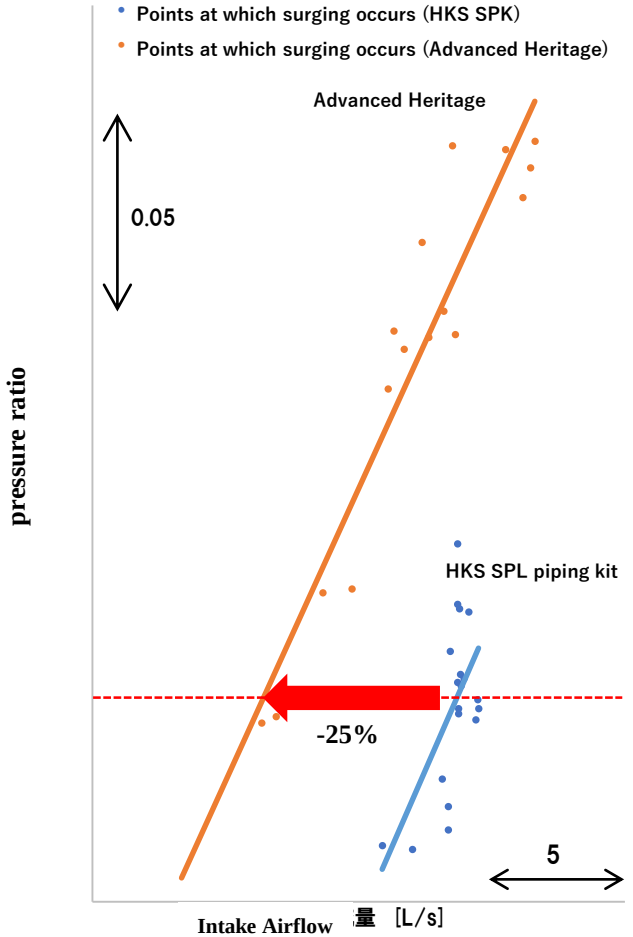
■ Test Equipment: AVL Chassis Dynamometer (At HKS HQ Facility)
■ Test conditions:
・3000-4000 rpm (transient)
・Partial load (TP: 35% constant)

■ Surge line real equipment verification (chassis dynamometer)

■ Front T/C surge line comparison
(HKS SPK vs Advanced Heritage)




■ Rear T/C surge line comparison
(HKS SPK vs Advanced Heritage)




Chassis dynamometer Real equipment evaluation results

The test confirmed a 12% to 25% reduction in intake air flow at the point of surge generation (increased surge margin).

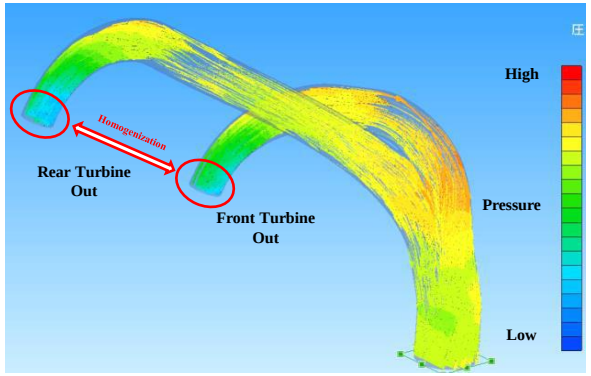
# ◎ Chamber Pipes

・Verification of the front/rear balance of the pipe

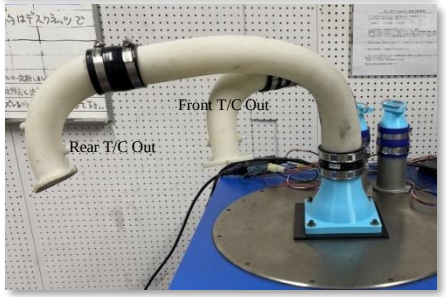
In order to ensure the accuracy of the front and rear flow balance for each specification, we have conducted measurements on individual components. Based on our findings, we are pleased to confirm that the HKS Advanced Heritage specification (①) demonstrates a significant reduction of approximately 90% in the flow difference of the Chamber Pipe assembly compared to the existing product (HKS SPL Piping Kit) (②) at a flow rate equivalent to 600ps.

Test Equipment: Super Flow SF-1020 (At HKS HQ Facility)
Environmental Values during Testing:
- ✓ Test Temperature: 24.4 [℃]
- ✓ Test Relative Humidity: 73.6 [%]
- ✓ Test Atmospheric Pressure: 95.306 [kPa]

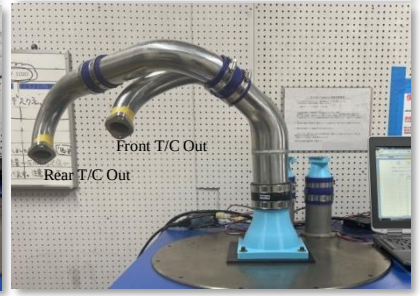
■**Verification of the front/rear balance of the pipe**




①Advance Heritage (Prototype)




②HKS SPK Kit



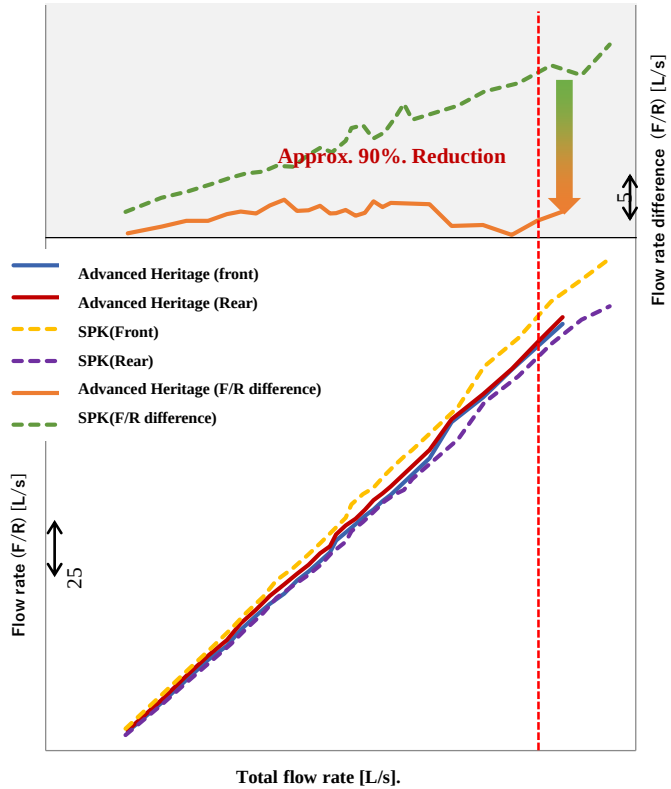

■**Flow measurement using a flow bench (2 in 1 manifold)**

Optimization of the chamber pipe manifold balance was performed by varying the cross-sectional areas of each section. (In a typical layout, there is a tendency for the intake resistance on the rear side with longer pipe length to be relatively higher, resulting in increased airflow on the front side.)

■Improvements

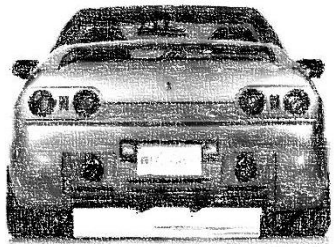
By optimizing the front-to-rear balance of the chamber pipe manifold, the operating conditions of the front and rear turbochargers are equalized, leading to an expansion of surge margin and improved turbocharger efficiency.

Fig. Comparison of front and rear flow rate differences in the chamber pipes.




Flow Bench Evaluation Results

The front-to-rear flow rate difference in the chamber pipe manifold was reduced by approximately 90% (at a flow rate equivalent to 600ps).



Complete by HKS

- ADVANCED HERITAGE -