“We Will See a Drastically Reduced Dependency on Physical Test Vehicles”

Meena Kumari, Polestar Performance AB
Anton Albinsson, Polestar Performance AB

Polestar is using a new type of integrated test environment for brakes, steering and suspension developed in close collaboration with IPG Automotive. Henning Kemper, Specialist Editor at IPG Automotive, spoke to Meena Kumari and Anton Albinsson, engineers in the Vehicle Motion Control Team at Polestar, about the role of simulation in the company, the benefits they expect to generate for development and the purposes for which the test system will be used.

Could you briefly describe what goals the Vehicle Motion Control Team at Polestar is pursuing?

Meena: Yes, of course! One of the main focuses of this team is on the system development of brakes, steering and suspension. Tasks such as definition, evaluation, implementation and management of functional requirements, safety requirements and cyber security requirements are carried out here.

We also take care of function, system and performance verification and validation and have expert status in tuning and calibration.

Which role does simulation play in your development process?

Anton: We use an end-to-end testing strategy to verify that all systems are working correctly throughout the whole development process. This also ensures that all components of a system are able to operate and perform optimally under real-world conditions.

This process starts with pure software tests, followed by combined software and hardware testing and then finally system integration, verification and validation under real-world conditions, where hardware-in-the-loop (HIL) systems are an important element in enabling process efficiency. Throughout this process, virtualization and scalability continue to decrease, while cost and effort increase.

Meena: The first step is to develop a virtual prototype in MATLAB Simulink and CarMaker. This prototype can be used to quickly evaluate representative vehicle performance or to develop a control logic.

We then use a combination of CarMaker and model-in-the-loop (MIL) components from suppliers. At this stage, tests are mainly performed to evaluate braking, steering and suspension control logic. As no real hardware is used, there is a limit for performance simulations in a specific project.

To combine virtual and physical testing, we use a combination of a driving simulator, a HIL system from IPG Automotive and a component HIL. The driving simulator provides driver-in-the-loop (DIL) testing of functionality and calibration for realistic driver input. The HIL system from IPG Automotive is used for performance-based testing – it allows us to test objective ride, handling and steering metrics as well as to perform reproducible testing of software, hardware and calibration for ‘failure modes’ that may occur. As this involves real ECUs, there are some limitations in sensors. It also requires a higher degree of correlation between the physical vehicle and the simulation.

What are your plans for the use of the combined Brake- and Steering-in-the-Loop system at Polestar?

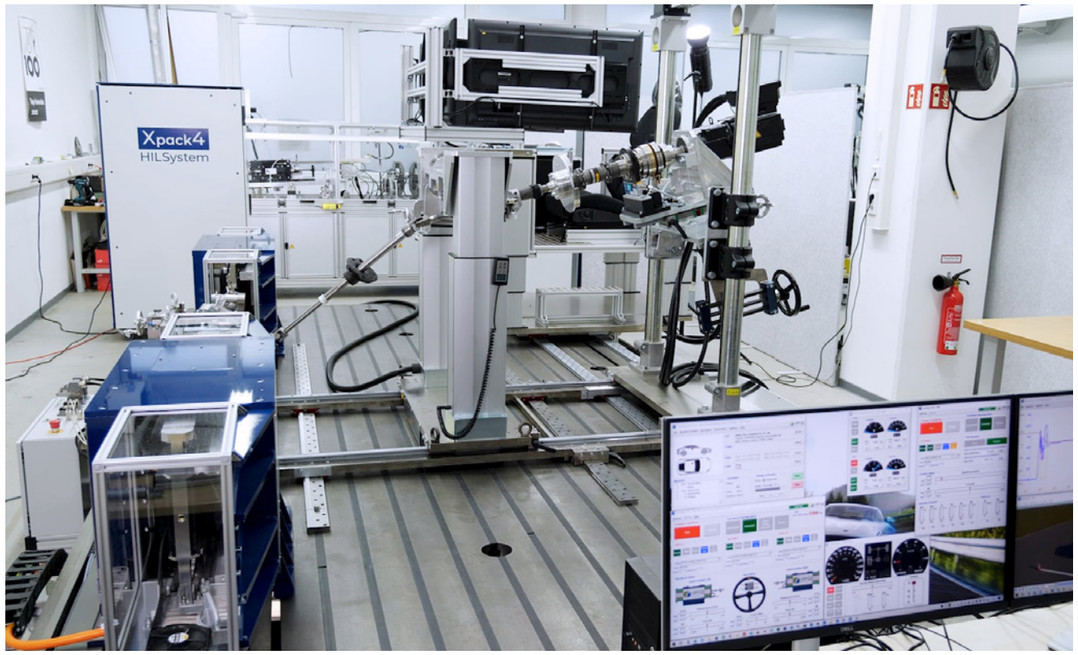
Meena: The system will primarily be used in the early to middle stages of development mentioned at the beginning, i.e. in software development and testing as well as system integration verification and validation.

We plan to use it to test a combination of real steering, braking and suspension systems for functions that have high interdependency, for example traction control functions. We expect this to massively increase process efficiency and enable reproducible conditions for component and system validation at any time. The primary goal is to reduce the time and cost of vehicle testing – early fault detection contributes to this.

The test bench allows us to perform regression testing of performance to detect calibration issues such as steering oscillation, cogging torque, internal brake system model issues such as pressure-volume (P-V) and brake force distribution. We can also quantify performance and run reproducible tests on real-world issues such as steering friction and steering effort.

What time and development effort savings do you expect?

Anton: It is not easy to put an exact figure on it. The test system should lead to reduced dependencies on physical test vehicles. The short-term benefits are likely to be limited as it will take some time to set up the processes and activities. But, and this is the crucial point, we see profound long-term benefits.



The Steering-in-the-Loop test system

The bottom line is: We will see a drastically reduced dependency on physical test vehicles.

The modular architecture of CarMaker HIL and the Xpack4 real-time platform allows configuring individual systems. What use cases did you have in your particular situation?

Anton: To go into this in detail would probably go beyond the scope of this interview – we have numerous use cases. As an example, we can use it to perform brake, steering and suspension ECU optimization, objective and subjective optimization and brake performance testing. But equally relevant are chassis optimization, global system optimization, brake function testing and, last but not least, software safety testing like ISO 26262.

What are the special challenges with electric vehicles in terms of steering and braking adjustments?

Anton: Indeed, when it comes to braking and steering, the requirements for developing an electric vehicle are quite different from those for conventional powertrains. First and foremost, of course, is energy efficiency, especially in terms of recuperation.

The transition from regenerative braking to mechanical braking is far from trivial in order to create a natural braking feel – this is known as brake blending. Traction control and electronic dynamic torque control are also important, especially with the possible motor configurations of up to one motor per wheel.

What did the process of planning the test system look like and how did you experience the cooperation with the engineers from IPG Automotive?

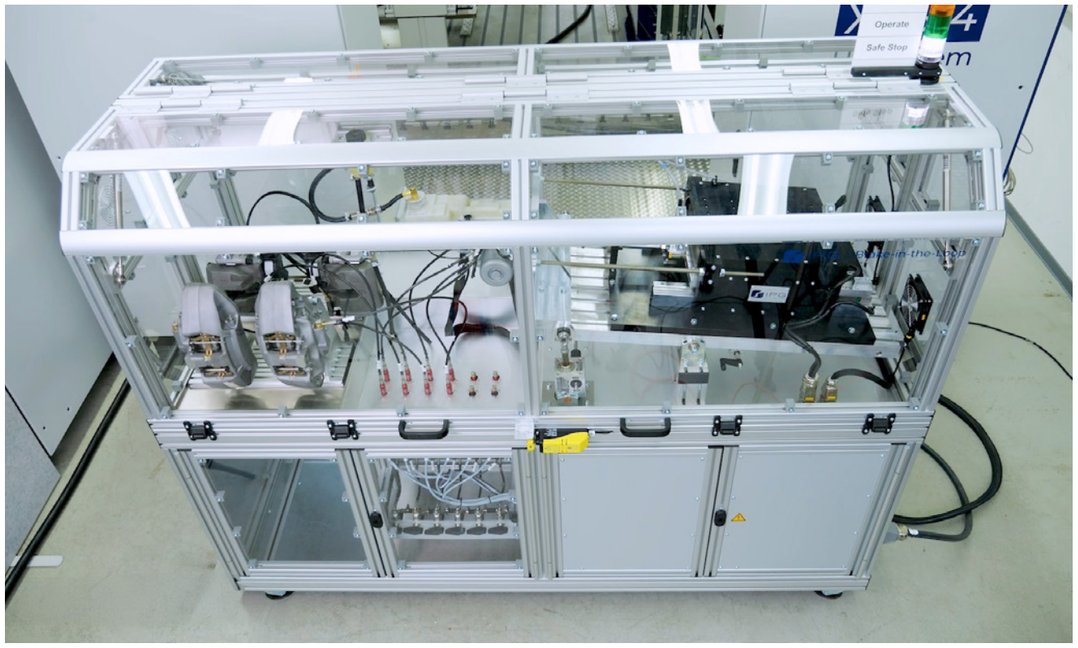
Meena: In the beginning, we needed a test system that would cover most of the verification and validation of the complete vehicle motion system. This system should be as close as possible to the real vehicle to test functional safety, performance, efficiency and calibration aspects.

IPG Automotive's own test system gave us the confidence that they could fully customize it to meet our needs.

Once we decided to go for this solution, the process was smooth. It started with a kick-off meeting where all the complete system overview and timeline and inputs needed to build the system were presented and then we had regular syncs involving all stakeholders until the end of the project. Of course, there have been some challenges on both sides, but with continuous support we have been able to find solutions quickly.

Being part of the whole project development was a rewarding experience; the teamwork was excellent. The smooth communication and technical input provided for the solution is really appreciated.

Thank you for your time and this interview.



The Brake-in-the-Loop test system