AB Dynamics

Advanced Vehicle Driving Simulator

Applications include: ADAS, chassis control, drivetrain, human machine interface and ergonomics.

Advanced Vehicle Driving Simulator (aVDS)

Dynamic, immersive driving simulation that streamlines vehicle development.

The AB Dynamics aVDS

With dynamics-grade performance, class-leading excursion and ultra low latency, the aVDS makes a significant step forward in all aspects of simulator performance. New areas can now benefit from driver-in-the-loop simulation – taking time and cost out of vehicle development.

Automatic driver assist systems (ADAS), chassis control systems and drivetrain systems.

Traditional vehicle development has required extensive use of prototypes during laboratory and track testing, at great expense. By using the aVDS to front-load the design process and strip out costly prototype iterations, vehicle development time and cost is dramatically reduced.

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aVDS – an essential tool for vehicle development

AB Dynamics' new aVDS front-loads the design process, reducing the associated time and cost of vehicle development.

An essential tool

Simulations are the virtual recreation of a real-world scenario. Sufficiently accurate simulations can become powerful tools in predicting the behaviour and outcomes of real driving scenarios, but without either the risk or cost associated with actual driving.

Market-leading dynamic performance enables simulator applications that were previously not possible.

The aVDS has the dynamic response needed to achieve a level of realism that allows complex vehicle design and calibration activities without a prototype vehicle.

'The aVDS significantly reduces vehicle development time and cost.'

Greater efficiency

Driving simulators enable testing to take place much earlier in the development process, meaning the vehicle is closer to production when the physical prototypes are produced. The simulator then becomes an integral part of the vehicle development cycle.

Simulator test data provides a natural link between the phases of car design, from computer modelling to laboratory testing and finally to the track.

True to real-life

Immersion is the single most important aspect of a simulation. The driver must feel as if they are in a real vehicle, driving in a realistic environment. Their response to the virtual world around them and the virtual vehicle they are operating must be true to life.

Every aspect must replicate the feel and response of the driving experience. Once the difference between the simulation and the real-world is almost negligible, the resulting data and feedback becomes incredibly valuable.

- **Driver environment**
  The driver's immediate surroundings must replicate that of a real car. The things that they see, hear, and feel should all deepen the immersion, reinforcing the experience.
- **Cueing and low latency**
  The latency in response to input and feedback must be as low as possible. Cues to the driver's senses are provided in vestibular, sound, haptic and visual forms – these must be delivered with minimal delay.
- **Accurate road data**
  The simulation recreates a real-world environment. With a human driver 'in the loop' (DiL) it is vital that they are convinced of the simulated world's realism.

A partnership built on excellence and expertise

From cutting edge Formula One™ technology, state-of-the-art virtual environments and world-leading vehicle dynamics comes a revolutionary simulator.

AB Dynamics

AB Dynamics' new advanced vehicle driving simulator – the aVDS – brings synergy to the suite of vehicle development tools that are already valued by many of the world's leading manufacturers.

AB Dynamics' range of test equipment is valued by OEMs, tyre manufacturers and test houses across the world.

The aVDS provides the link between lab and track testing solutions. Incorporating consistent software, data and test scenarios, engineers benefit from complimentary tools and systems that work to reduce development time and cost.

The broad range of driving robots and ADAS targets give precise control over the test manoeuvres performed on the proving ground. In the lab, industry-standard testing and measurement equipment enables advanced vehicle dynamics research.

AB Dynamics' driving robots are also key tools for testing collision avoidance systems and combine seamlessly with our range of soft vehicle and pedestrian targets.

By collaborating with industry's leading experts and bringing to bear over thirty-five years of vehicle testing experience, AB Dynamics present a class-leading, next generation driving simulator.

Williams Advanced Engineering

Williams Advanced Engineering, part of Williams Group, is the developer and supplier of the aVDS Motion Platform.

Since 2001, Williams has pioneered state-of-the-art immersive software, hardware and driver-in-the-loop vehicle simulation technologies to train racing drivers and to use as a powerful engineering tool for improving the performance of its Formula One™ cars.

By partnering with AB Dynamics this proficiency, in simulator development and technology can now be applied by automotive manufacturers and suppliers.

rFpro

rFpro software handles the graphics, the audio and the road surface data. Additionally it provides the connection to the real-time vehicle models, sensor models and traffic scenarios.

rFpro software is being used by most of the top ten largest OEMs in the world, as well as many smaller OEMs and T1s, for virtual test programmes of road vehicles, subsystems, ADAS and Autonomous systems.

By focusing on speed of response and video bandwidth with minimal latency, rFpro allows the aVDS simulator to be used in highly dynamic situations; enabling tests of anything that affects the dynamic behaviour of the vehicle.

'The frequency response of the motion must be high enough to transmit the inputs that are expected during a journey on a real road.'

Significant benefits through advanced Driver-in-the-Loop simulation

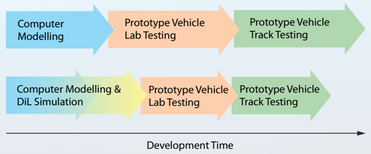
Pushing the envelope of modern simulation enables the 'front-loading' of key development areas.

Front-loading the design process

Development that can be done earlier in the design process lowers the overall cost, as fewer iterations are prototyped. This is known as front-loading: the start of the vehicle project is loaded with increased input and iterative improvements to the design. The advantage of this approach is that costly prototype manufacture and track-test time is significantly reduced.

Simulation leads to a more dynamic development process: testing design changes on the fly.

Increased front-loading achieved by simulation systems that faithfully replicate the driver's environment, both inside and outside of the vehicle. This is further enhanced by accurate re-creation of the motions and feeling of a vehicle based on its chassis and drivetrain design.



ADAS testing and validation

Simulation provides an exciting new realm of possibility for ADAS and autonomous systems development, across a variety of real-world scenarios, weather and lighting conditions.

AB Dynamics' track testing systems are widely used in the development of ADAS. Control software and Soft Crash Targets are used to create accident scenarios on the track that test or verify the operation of ADAS algorithms.

The aVDS now enables these test scenarios to be recreated in a simulated environment, providing significant cost savings to the design process.

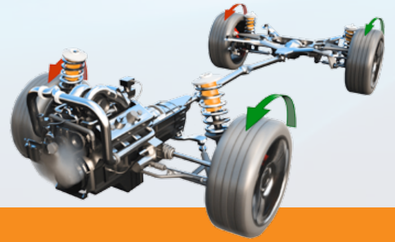
The simulator uses the same test scenario software that is used on the track, allowing tests to be replicated and information to be shared seamlessly between the real and virtual worlds

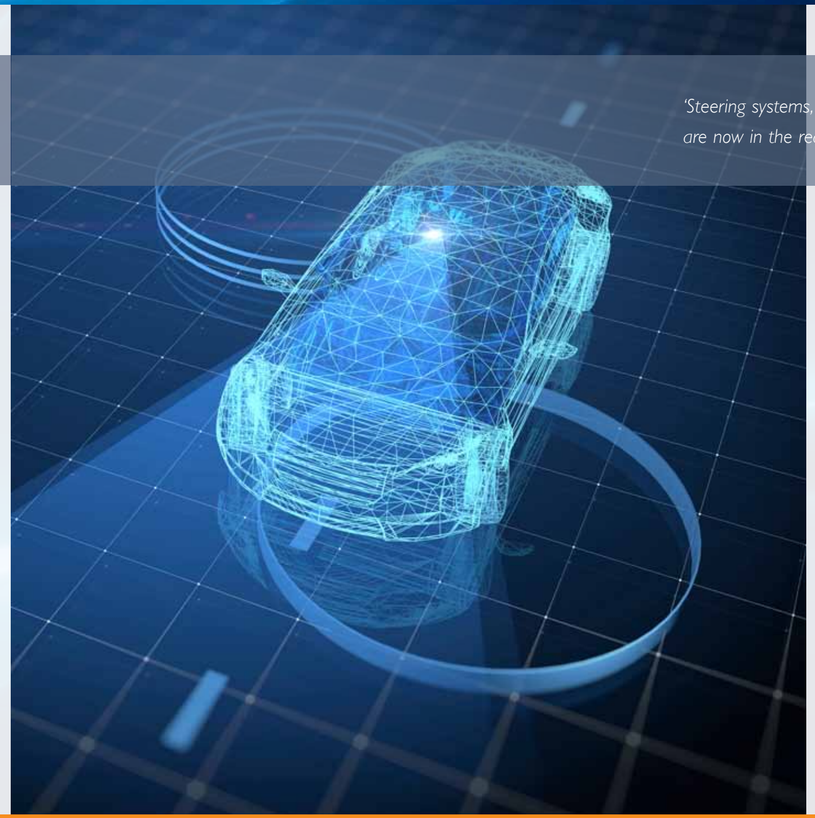
Chassis and drivetrain development

The aVDS's highly dynamic capability allows simulation to be used for vehicle dynamics applications that have not been possible with traditional simulator systems.

Steering, chassis and suspension systems can be accurately modelled and implemented in simulation. They can be tested and improved with a much shorter design iteration cycle, leading to vehicles that are much nearer to completion when the first prototypes are made.

Simulation can also be used to test electronic stability control, traction control and torque vectoring systems without the need for real vehicles and expensive track time, while ECU and emissions testing can now benefit by coupling a simulator to a drivetrain dyno.



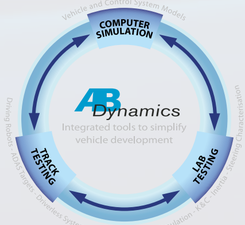


'Steering systems, ride and handling development are now in the realm of simulation.'

Development synergy

AB Dynamics ensure that simulated tests work in perfect harmony with existing test equipment. The aVDS driving scenarios replicate tests that are run using in a model, conducted in the lab or performed on the track.

This gives a validation path that joins together crucial development environments. Vehicle developers can ensure correlation between the real and virtual test data, enabling them to exploit the simulated environment and make huge savings in cost and time.



With unequalled experience and hundreds of test systems in use, only AB Dynamics offers the coordinated systems that complement the vehicle development process.

aVDS – Inspirational design using the world's most advanced video and motion

From the motion platform to the virtual environment, the aVDS offers market-leading vehicle dynamics-grade simulation.

'The aVDS significantly improves the link between the key phases of car design: computer modelling, laboratory testing and finally proving on the track.'

1 Motion platform

At the core of the simulator is the motion platform. The aVDS uses a unique platform developed by Williams Advanced Engineering with class-leading Formula One™ technology.

The dynamic performance and working envelope of the platform are optimised for vehicle driving simulation, leading to a powerful yet compact solution. Its unique kinematic mechanism ensures a consistent and linear response, throughout the range of travel, providing accuracy no matter where the platform is.

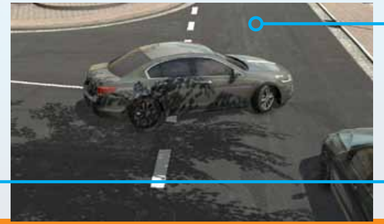
The high payload platform can be quickly configured according to the test requirements, giving maximum flexibility to the system.

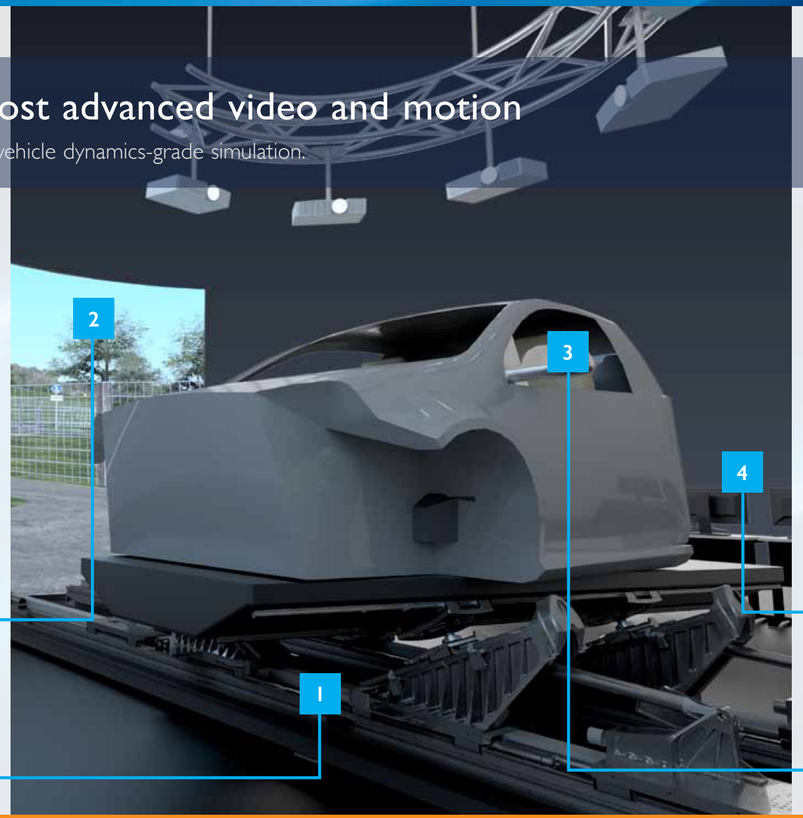
2 Immersive driving environment

The aVDS immerses the driver in a virtual world, delivered by state of the art audio and visual systems. By providing a convincing driver experience, the data obtained from their response to test circumstances is accurate enough for use in vehicle development.

rFpro's software provides a rich and detailed world, with data taken from exhaustive analysis and measurement of terrain. The road surface information has been collected from standard test tracks, proving grounds and even real road networks and can be presented to the driver with extreme accuracy.

A large wrap-around screen uses either a stereo or mono projection system to provide low-latency graphics, ensuring that the view of the virtual environment responds intuitively to the driver.





3 In-car realism

Years of experience in vehicle-driving robots give the AB Dynamics aVDS a cutting edge in haptic feedback – the sensory information felt through touch. For example the modified SR35 steering actuator ensures that every characteristic of the steering system is felt by the driver.

The field of view from within the cockpit is as realistic as possible. Critical visual obstructions such as the body A and B pillars are included so that the driver's response to traffic scenarios is equivalent to real performance.

Additional systems, such as belt tensioning, brake feedback, dials and mirrors, provide further cues to the driver – aligning their senses with the perceived environment.

4 Control software and cueing

The aVDS system architecture employs the very best in control and simulation technology, giving the greatest correlation to real-world behaviour, together with the flexibility that vehicle developers require.

rFpro software works seamlessly with industry standard vehicle modelling packages whilst integrating high resolution road profile data for many real-world tracks. User vehicle models designed in packages such as CarMaker, CarSim, Dymola, SIMPACK, VSM and ASM and others can be handled.

The response of a model vehicle to road and driver inputs is relayed with exceptional clarity though class-leading, low-latency cueing algorithms that ensure the driver feels immersed in the experience.

The motion platform – an unrivalled platform designed specifically for driving simulation

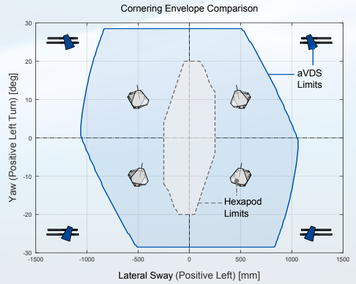
High performance, low profile, increased load bearing and compact footprint make for a truly remarkable platform.

Optimum, compact working envelope

A driving simulator needs to have enough travel and in the right directions. The dominant accelerations that need to be mimicked are cornering and braking.

Traditional methods of providing motion use a hexapod or 'Stewart Platform'. These have impressive-sounding axis travel, but it is limited when directions are combined. This is a consequence of adopting technology from flight simulation, where requirements are very different.

The aVDS has been specifically designed for vehicle applications, delivering a working envelope ideal for driving simulation.

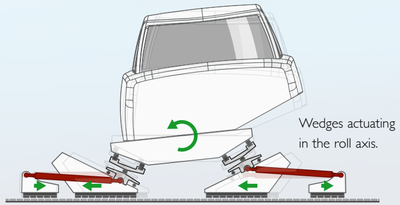


Ultra low latency for onset cueing

The motion platform uses four 'wedge' actuator modules, mounted on two parallel rails. Quiet and lightweight linear motors control the height of the platform on the wedge and the position of the wedge on the rail.

With lower latency, a test driver detects smaller parameter changes, making the simulator more valuable for development.

Exceptional kinematics and control design provides very low latency actuation – crucial for onset acceleration cueing – in six degrees of freedom.



Wedges actuating in the roll axis.

Consistent high performance

Dynamic performance of the simulator is critical to ensuring that the cues to the driver are delivered in a realistic way and with minimal latency.

The frequency response of the motion must be high enough to transmit the inputs that are expected during a journey on a real road.

The frequency content of the vestibular cues can mean that large excursions are necessary around the motion envelope, it is important that the simulator can meet the high frequency objective, wherever the platform goes.

The unique wedge-link mechanism of the aVDS provides kinematics that are ideal for consistency, providing a linear response that is much easier to control.

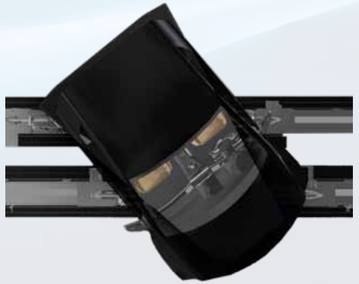
Direction	Bandwidth	90° Lag	Latency
Yaw	35 Hz	26 Hz	10 ms
Pitch	50 Hz	26 Hz	10 ms
Roll	50 Hz	>50 Hz	4 ms
Surge (x)	15 Hz	>15 Hz	8 ms
Sway (y)	35 Hz	35 Hz	7 ms
Heave (z)	50 Hz	35 Hz	7 ms

Performance data from constant acceleration (linear) and constant velocity (rotation) frequency sweep.
Data is indicative only and will vary depending on the payload.

Large payload capacity

AB Dynamics has developed the aVDS to ensure that configuration changes can be made easily, meaning that a variety of test applications can benefit from one simulator system. The aVDS is supplied with a lightweight driver seat and canopy that optimises high frequency performance.

Human-machine interface and ergonomic studies often require a more realistic model of a car body and interior to be tested. The aVDS provides a convenient hardpoint mounting system and a 500kg payload capacity that makes a configuration change straightforward.



'Low latency is crucial to effective, worthwhile simulation. With AB Dynamics aVDS, the lowest latency achievable is designed in from the outset.'

High performance, low profile motion platform developed by Williams Advanced Engineering.

Real driving environments – made seamlessly virtual

From the delivery of real-world content to the cueing of simulated road data, an immersive simulation is created.

Screen

A typical aVDS installation has a four metre radius, 240 degree wrap angle and three metre high screen. Screens can be provided in both hard-shell and stretched fabric, depending on specific requirements. The screen size ensures that realism through a sufficient field of view is achieved. This allows the driver to observe the virtual world in all of the directions they are used to.

Using a screen that is structurally separate from the motion platform allows the platform and its payload to have a lower inertia, as the screens and projector do not have to be moved. This is an essential aspect of providing the performance needed for a vehicle dynamics-grade simulator.

Projector system

There are multiple options available for the projection system, depending on the user's requirements. The most immersive is provided by stereo projection, in which right and left eye perspectives are generated by separate projectors.

The projected image must be visually realistic.

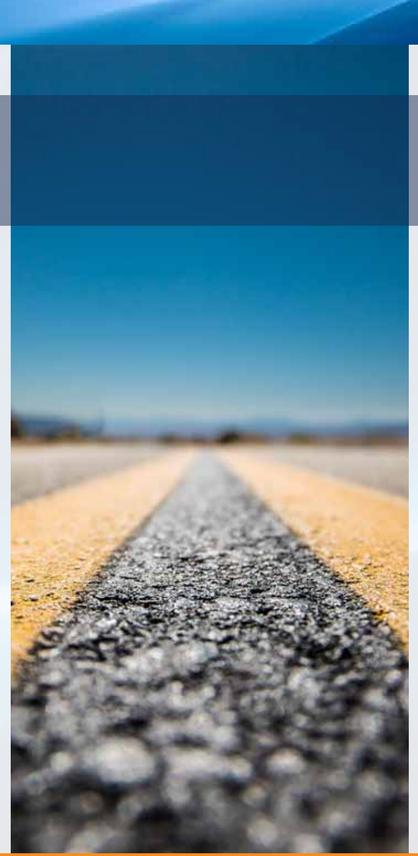
Using special warp and blend software from VIOSO that alters the brightness and shape of the projected images, the curves of the screen are accounted for and the driver sees no overlap.

Graphics handling

rFpro provides the connection between the vehicle dynamics model used to represent the vehicle and the virtual environment.

Databases of test tracks, proving grounds and real-world road data provide the user with a wide range of accurate test environments. Traffic flow management modules and simulated sensor image systems enable the simulator to be used to validate ADAS and autonomous systems.

The rFpro software also creates an ideal link between the motion platform and video feed, ensuring that the motion of the platform is compensated for in the projected image. This crucial task allows the full working envelope of the platform to be exploited, without detrimental effect to the visual system.



'AB Dynamics works with the world's leading suppliers in audio and visual equipment ensuring realism and accurate data.'

Road Scanning and LIDAR data

LIDAR (laser) scans of road profiles and road-side environments provide accurate simulation data that can be used to create reliable test scenarios with enough fidelity for ADAS validation.

From LIDAR scanned surveys, a road profile resolution of less than one millimetre, every five millimetres across the road surface, is possible. This ensures that the model vehicle's response to the scanned road is truly indicative of real-world use.

This in turn provides the driver with feedback accurate enough to ensure that their actions and reactions are natural.

Minimal miscues

Quiet direct-drive motors and the use of electric actuation are key to ensuring that audio miscues to the driver are minimised.

Preventing the driver from receiving external sensory information is just as important as ensuring the driver receives the correct cueing from the simulator. Sensory data that the driver receives, that he is not expecting, will remove him from the immersive experience and remind him that he is in a laboratory and not, in fact, driving a car.

By eliminating unwanted noise and vibration, the aVDS isolates the driver in the virtual world, free from distractions or miscues.

In-car realism – creating a world of sensory perception through simulated inputs

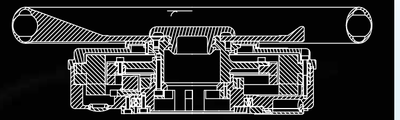
Combined control fidelity with engineering expertise ensures force feedback cues through the steering.

'Our experience in developing test equipment, such as the AB Dynamics steering robot, has led to unrivalled knowledge of haptic feedback, essential for immersion in simulation.'

Haptic feedback

Feedback from the steering wheel is one of the most important aspects in the simulation of a vehicle. AB Dynamics have drawn on 20 years of experience in developing track test steering robots to deliver the steer torque feedback system for the aVDS.

The SR35 is one of the most recent additions to the steering robot range, and is used with the NISSHO torque cell measurement system to control the steering response of the virtual vehicle to very high fidelity. With its ultra-low inertia and high frequency response, the SR35 is the natural choice for the aVDS.



Realism in-vehicle

The video system of the aVDS is detached from the motion platform, which allows for a realistic interior environment to be placed around the test driver.

Depending on the application, either a lightweight cockpit or a cut-down prototype of a real vehicle can be mounted.

In either case, it is important that the immediately obvious elements of the driver's surrounds are faithfully recreated. In particular, the two main pillars of a vehicle – the A and B pillars – are appropriately located. This allows the correct assessment of ADAS scenarios where blind spots may play an important role.

Dials and dashboard displays – including a speedometer and tachometer are provided as standard. Configuring the dashboard of a prototype vehicle is also possible.

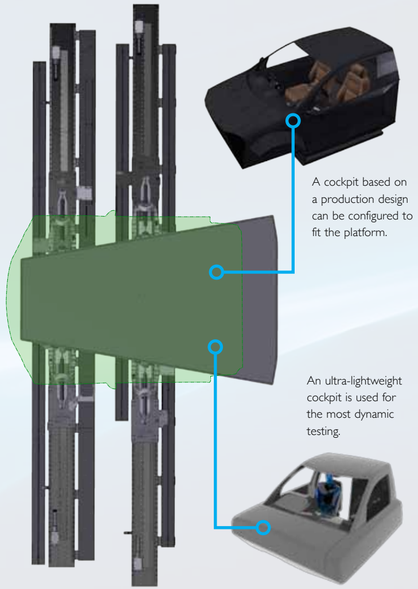
Active brake pedal actuation and a seat belt tensioning system are used to enhance the haptic cues to the driver, adding to the realism of the experience.

In-vehicle audio

A multi channel audio system provides communication between the test driver and the control room in addition to high fidelity audio feedback from the driving simulation..

Reconfigurability

The payload capacity of up to 500kg is combined with a reconfigurable platform that allows a cut-down prototype vehicle to be mounted to the simulator. This extends the application areas of the machine to include classical use-cases, such as human machine interface and ergonomic studies.



Control software and cueing – essential for driver immersion

To convince a person a simulation is real, the right action must occur at the right time – specialised control systems are key.

System architecture

Putting the driver in the loop is the central aim of the aVDS, as it allows engineers to develop their designs with a reliable, subjective input from expert test drivers.

To ensure the simulation is effective, the architecture of the software, controllers and systems has to be exceptional.

The aVDS uses:

- Concurrent Realtime – the leading standard in real-time control.
- Beckhoff EtherCAT motion control – the performance, compatibility and connectivity crucial for safety-critical systems.
- Dedicated graphics computers to handle rFpro.

'The unique arrangement of the aVDS motion platform means that consistently high frequency response is achieved throughout the full range of travel.'

Low-latency and cueing

The cueing algorithms used in the aVDS ensure that the maximum excursion throughout the envelope is exploited. This delivers the vestibular, visual and haptic feedback required.

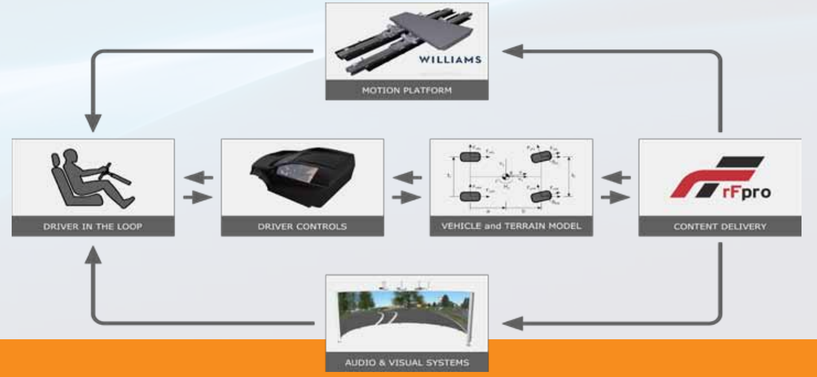
Exceptionally fast communication and real-time handling ensures that latency is kept to a minimum – vital in helping eliminate motion sickness. This enables the test driver to detect smaller changes to model parameters, thereby enhancing simulator capability.

Vehicle model handling

The aVDS supports all the major vehicle model systems available, thanks to rFpro's suite of car model interfaces.

Vehicle design and modelling tools including Dymola, SIMPACK, Simulink, AVL-VSM 4™, ASM, dSPACE, veDYNA, CarSim, CarMaker, LMS Virtual.Lab Motion. and C++ can all be handled.

Several system architecture solutions exist to incorporate the preferred systems and models that are required.



Typical installation layout

A compact platform provides the most advanced simulation within a very modest space.

Flexible installation

There are a number of installation options that make the aVDS a flexible system for specifying building requirements.

The projector set can be mounted to the existing building structure or using an overhead gantry.

Screen size and design is flexible according to motion range, a typical screen being eight metres in diameter and three metres in height. Screens are available in either stretched fabric or hard composite form.

A simple and easy to prepare reinforced base provides the necessary ground fixture for the motion platform.

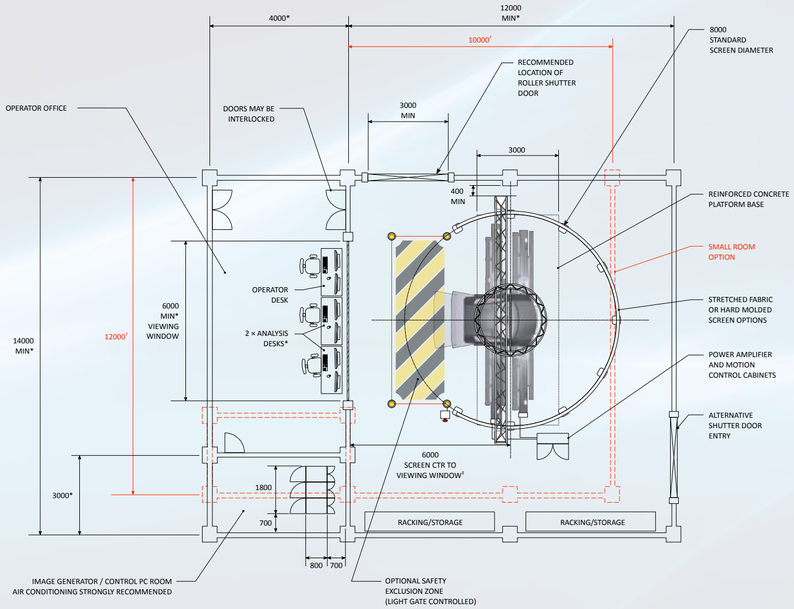
A typical installation is shown here, where the following notes apply:

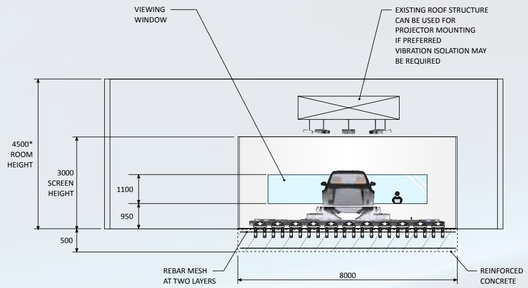
* Indicates recommended minimum dimension for installation

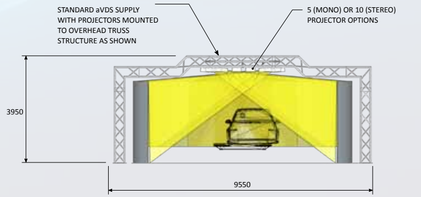
† Indicates minimum dimension possible in a very compact installation

‡ Distance between screen centre and viewing window can be reduced for small room installation

Air conditioning is recommended but units should not direct air flow to the screen if a fabric screen option is selected.

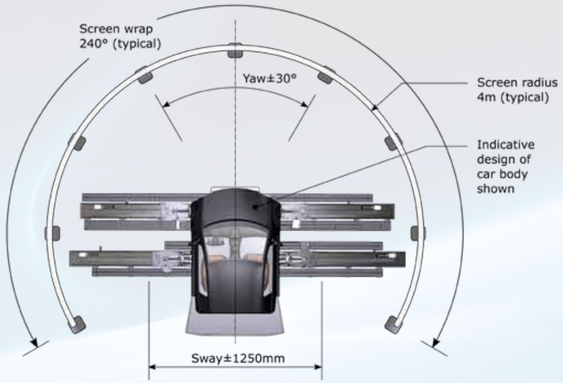






'aVDS – Fully working installation commissioned in Europe in 2017, with eight metre fabric screen diameter and ten stereo projector option.'

Dimensions



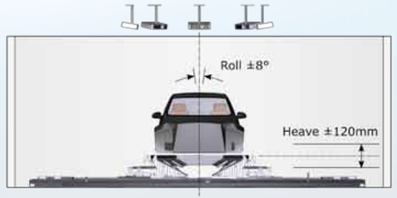
Advanced Vehicle Driving Simulator (aVDS)

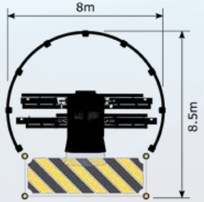
Excursion capability	
Roll†	±8.0°
Pitch†	±9.0° (greater than)
Yaw†	±30°
Surge	±540mm (actual total travel >1130mm)
Sway	±1250mm (greater than)
Heave	±120mm
Services	
Power supply	3 Phase
25kVA continuous	40kVA Peak

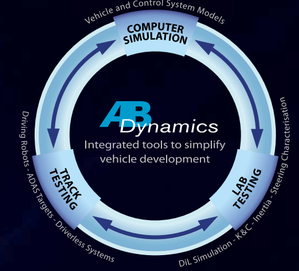
†Rotation axis is on the motion platform top surface, directly below the drivers eyepoint in ABD's standard vehicle cockpit.

Overall dimensions* (Includes safety zone.)	
Length	8500 mm
Width	8000 mm
Height	4500 mm
Platform Payload capacity	500kg
Screen and Projectors	
Wrap angle	240°
Height	3m
Radius	4m
Projectors Up to 10 ×	Barco F50 in Stereo/Mono

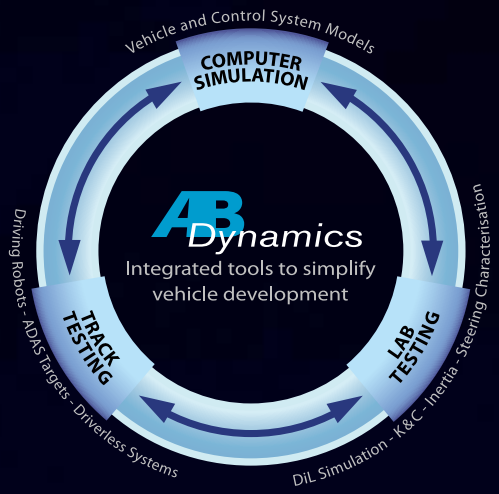
* Excludes gantry, server and control rooms.







AB Dynamics supply advanced testing technology to vehicle manufacturers and their suppliers throughout the world.



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