Ansys SPEOS HUD Design & Analysis – Add-On

Design automotive HUD imaging systems and test HUD image quality against standards and specifications.

The **Ansys SPEOS HUD Design & Analysis** add-on delivers cutting-edge features dedicated to the development of automotive head-up displays (HUDs). With user-friendly automated processes, you can drastically improve optical systems during development by identifying potential issues early in the design.

With this intuitive set of features, design from scratch or on-the-fly, optimizing layout and shapes directly in a CAD environment is easy. Generate design variations for different driver heights, and display the optical volume required for your HUD system.

With **SPEOS HUD Design & Analysis**, study the technical feasibility of HUDs according to the windshield shape and packaging constraints that necessitate highly compact designs. Automated tools help with optical system design and improve the perceived quality of the image. Specifically, the add-on tools can:

- Optimize layout and shapes.

- Generate a rotation axis.

- Calculate angles for variations in driver height.

- Automatically display the required optical volume.

The add-on also enables an objective qualification of the image quality and compares the optical and visual performance of several options. You can measure compliance against your own acceptance criteria.
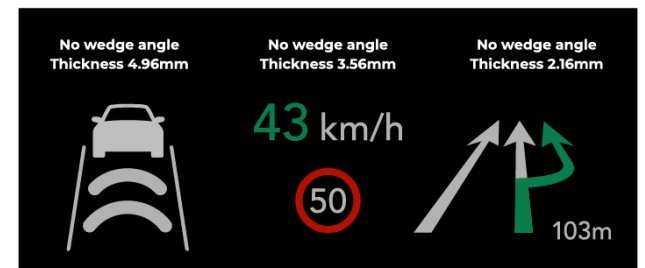
/ HUD Optical Design

Ansys SPEOS HUD Optical Design helps you create complete optical systems for automotive head-up displays by automatically optimizing optical mirror layouts and shapes. This optimization guarantees the highest virtual image quality from the specified 3D eyebox/head motion box, target image and windshield shape.

The mirror shapes, generated as native surfaces, are naturally compatible with geometric operations. This helps avoid the loss of accuracy caused by geometry conversions, manual transfer operations, multiple product definitions and specific processes for mold design.
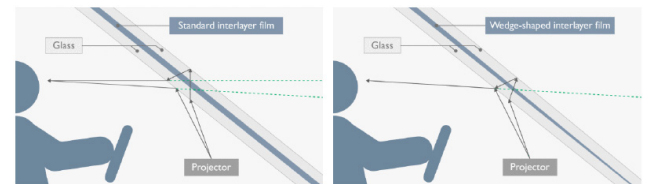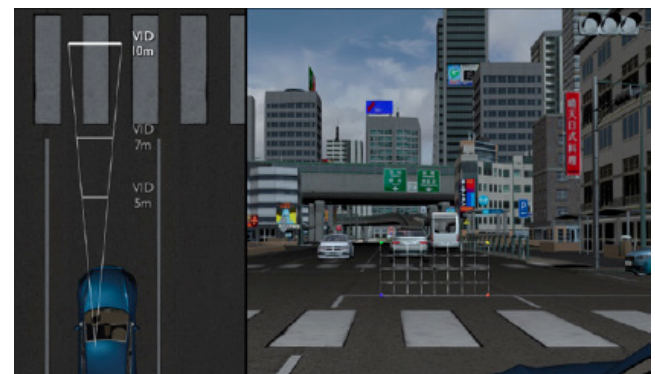
Comparison of the optimal configuration according to specific definitions.

Evaluation of the impact of glass thickens in ghost images visualization.

Target	Upper Eyebox	Central Eyebox	Lower Eyebox
< 1.50'	1.45	1.35	2.52

SPEOS HUD Optical Design automatically designs multi-freeform mirrors: The number of elements, distance and orientation are defined interactively with respect to mechanical constraints. Each mirror has its own freeform parameters, which are optimized to reduce aberration of the complete assembly.

HUD Optical Design

Ansys SPEOS HUD Optical Analysis is an automated feature used to qualify the quality of the virtual image in automotive HUDs from PGU outputs, mirrors, windshields or combiners. You can rapidly deliver best-in-class HUD mirror shape designs, perform designs and performance analysis in minutes, instead of days. The feature facilitates communication between relevant internal departments (responsible for HMI electrical, packaging, glazing and GD&T), and between customers and suppliers. It provides a unified digital mock-up experience for mechanics and optics, improving collaboration on a global level.

The automated analysis is easy to perform: The intelligent embedded software eliminates the need for user optical expertise. It provides optical metrics describing the system performance, including image distortion, image sharpness, ghosting and visual disparity. The analysis also delivers intuitive visualizations for better understanding of advanced optical and visual concepts. Analysis reports can be based on automotive standards or customized with a specific car manufacturer's optical metrics definition and acceptance criteria.

Additionally, **SPEOS HUD Optical Analysis** is able to analyze the performance of a HUD that has a geometrical definition based on 3D NURBS or measured meshed surfaces. You can perform reverse engineering of HUDs, assessing the performances of a manufactured windshield to propose deformation-correcting design changes.

Finally, the analysis feature can create warping data to feed predistortion image correction. Warping information can also be imported. In both cases, optical metrics are calculated by simulating the warping process of the vehicle's embedded software to reflect the optical performance of the full HUD system.

CNC Compatibility

SPEOS HUD Design & Analysis is compatible with computer numerical control (CNC) machining. Users can directly export the information about SPEOS-generated optical surfaces as polynomial coefficients. The information can then be transmitted to the CNC machine and optical surfaces can be directly produced. This compatibility greatly eases data transfers between part suppliers.
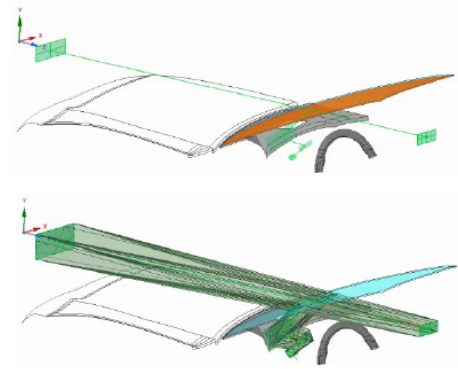
Design steps of an imaging system.
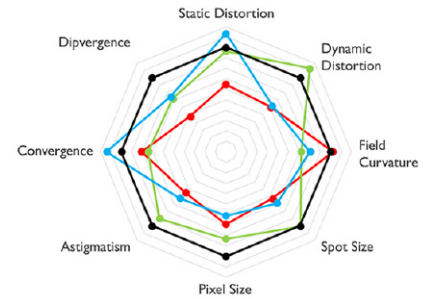
The analysis features enables to check the compliance with requirements and compare design options.
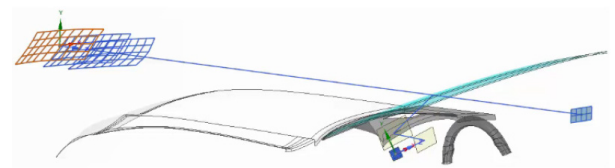
HUD image quality analysis.
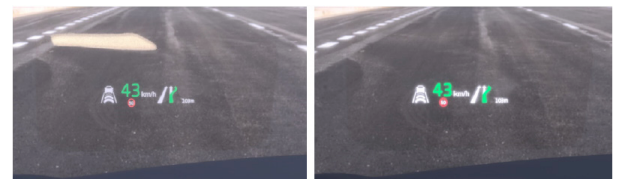
Visualization of the impact of the HUD's housing materials on the projected image. The important straylight visible on the left picture is eliminated on the right picture by changing the material of the housing. The comparison shows that ultra-low reflectance is ensured, even at glancing angles.

Ansys SPEOS	PrepPost / Solver Bundle Packages			Add-Ons				
	Pro	Premium	Enterprise	Optical Part Design	Optical Sensor Test	Far Infrared Extension	HUD Design & Analysis	Optical Design Optimizer
General Solver Capabilities								
Monte-Carlo Forward Ray Tracing	○	○	○					
Monte-Carlo Backward Ray Tracing		○	○					
Deterministic Simulation	▪	○	○					
Spectral Propagation	○	○	○					
Polarization Propagation	○	○	○					
Dispersion	○	○	○					
Surface Diffusion	○	○	○					
Volumic Diffusion	○	○	○					
Ambiant Material	○	○	○					
SPEOS Live Preview (GPU acceleration)		○2	○2					
Virtual BSDF			○1					
Photometry								
Intensity	○	○	○					
Illuminance	○	○	○					
3D Illuminance	○	○	○					
Luminance	▪	○	○					
3D Energy Density		○	○					
360° View - Observer		○	○					
360° View - Immersive		○	○					
Human Vision								
Dynamic Adaption			○					
Glare Simulation			○					
High Dynamic Range Screen Support			○					
Wavelength Range								
Visible (360nm - 830nm)	○	○	○					
UV (50nm - 360nm)		○	○					
Near IR (830nm - 2.5µm)		○	○					
Far Infa-Red (2.5µm - 100µm)								
Optical Design								
Parabolic Surface	○	○	○					
TIR Lens	○	○	○					
Projection Lens	○	○	○					
Optical Lens				○				
Optical Surface				○				
Light Guide				○				
Sharp Cut-Off Reflector				○				
Poly-Ellipsoidal Surface				○1				
Micro Optical Stripes				○1				
Honeycomb Lens				○1				

○ Fully Supported   ▪ Limited Capability   ◆ Requires more than 1 product   ○1 Not available for Ansys SPEOS   ○2 Only for Ansys SPEOS

Ansys SPEOS	PrepPost / Solver Bundle Packages			Add-Ons				
	Pro	Premium	Enterprise	Optical Part Design	Optical Sensor Test	Far Infrared Extension	HUD Design & Analysis	Optical Design Optimizer
Optical Sensors								
Field of View					○			
Export Sensor Grid as Geometry					○1			
Camera Sensor	■				○			
LiDAR Sensor					○			
Camera Sensor Port Processing					○			
Head-up Display								
HUD Optical Analysis						○		
HUD Optical Design						○		
HUD Visualization						○		
HPC-SPEOS								
Default Number of Cores	4	4	4					
Parallel Solving on Local PC	○	○	○					
Parallel Solving on Cluster	○	○	○					
Ansys RSM compatibility	○	○	○					
Simulation Preparation								
Source Group	○1	○1	○1					
Geometry Group	○1	○1	○1					
Local Meshing	○1	○1	○1					
3D Textures	○	○	○					
Polarization Plate		○1	○1					
Fluorescent Converter		○	○					
Texture Mapping (bump, multi-layer)		○1	○1					
Sky		○	○					
Thermic Source							○	
Earth Atmosphere model							◆	
Post Processing								
Virtual Lighting Controller		○	○					
Photomeric Numerical Certification	○	○	○					
Colorimetric Analysis	○	○	○					
Spectral Analysis		○	○					
Light Expert	○	○	○					
Layer by Source		○	○					
Layer by Face		○	○					
Layer by Sequence		○	○					
Stray Light Analysis		○	○					
Layer by Polarization		○	○					
Visibility & Legibility			○					
Night Vision Goggle							○	
Script Automation	○	○	○					
Optimization								
Parameters	○	○	○					
Design of Experiment	○	○	○					
Design Optimization (1)								
Ansys DesignXplorer (2)	○	○	○					
Ansys optiSLang interface (2)	◆	◆	◆					

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