

IPS Virtual Paint – Spray

Capability

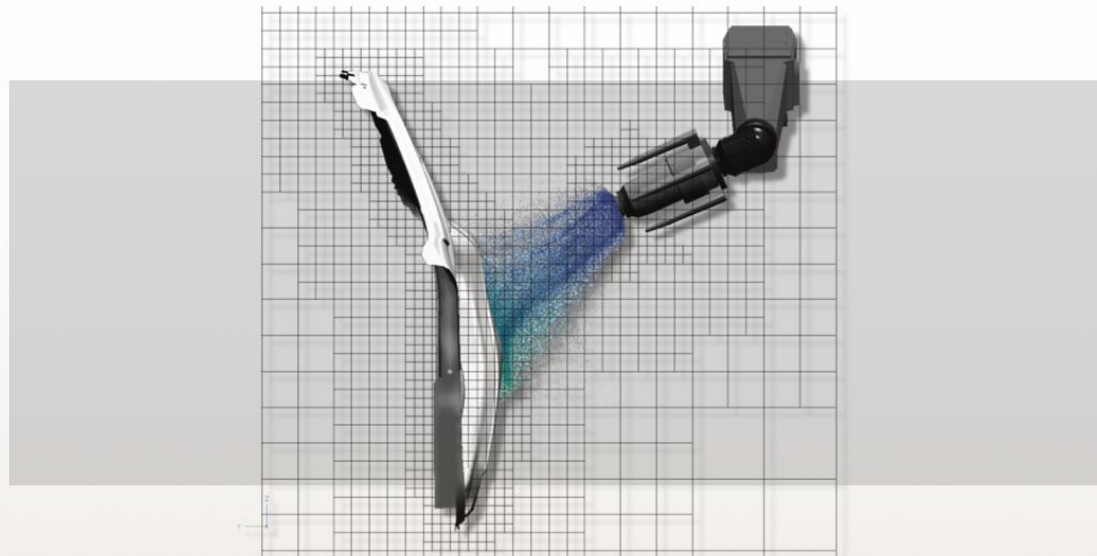
- ➔ *Accurate simulation of spray painting*
- ➔ *Seamless integration of multi-physics solver*
- ➔ *Extremely robust, accurate and fast algorithms with immediate visualization*
- ➔ *Requires no expertise on computational tools*

Benefits

- ➔ *Power (Detailed physical models)*
- ➔ *Speed (Full car simulation overnight)*
- ➔ *Easy to use (one day crash course)*

Results

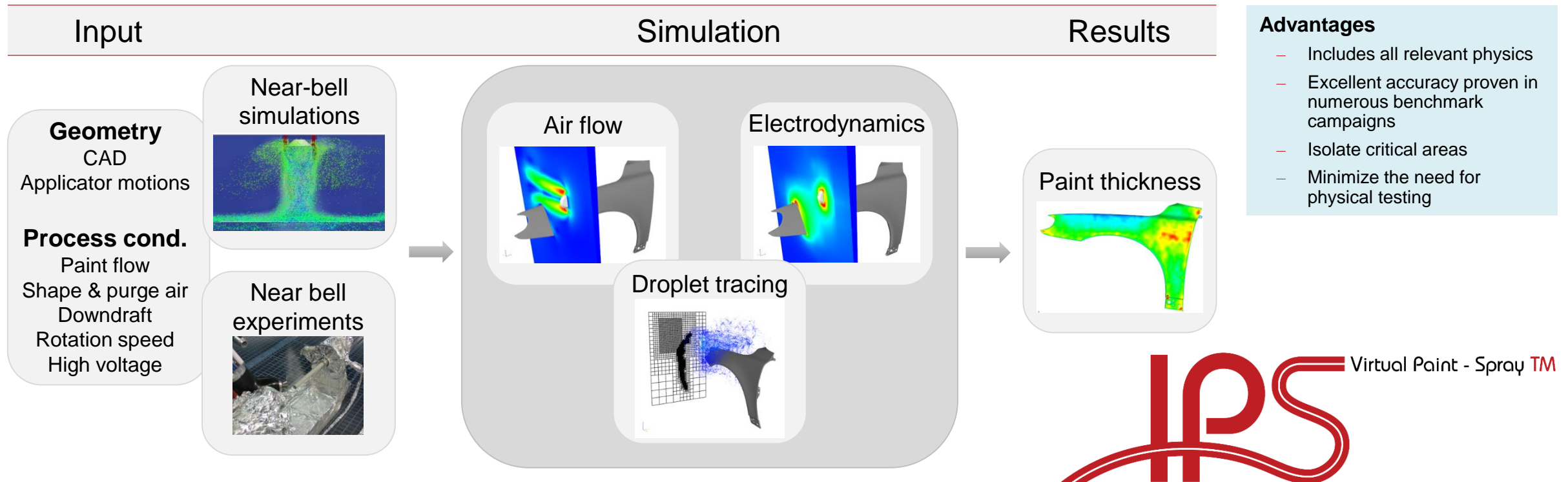
- ➔ *First software on the market*
- ➔ *Successful validation campaigns*



IPS Virtual Paint – Spray

Physics-based simulation

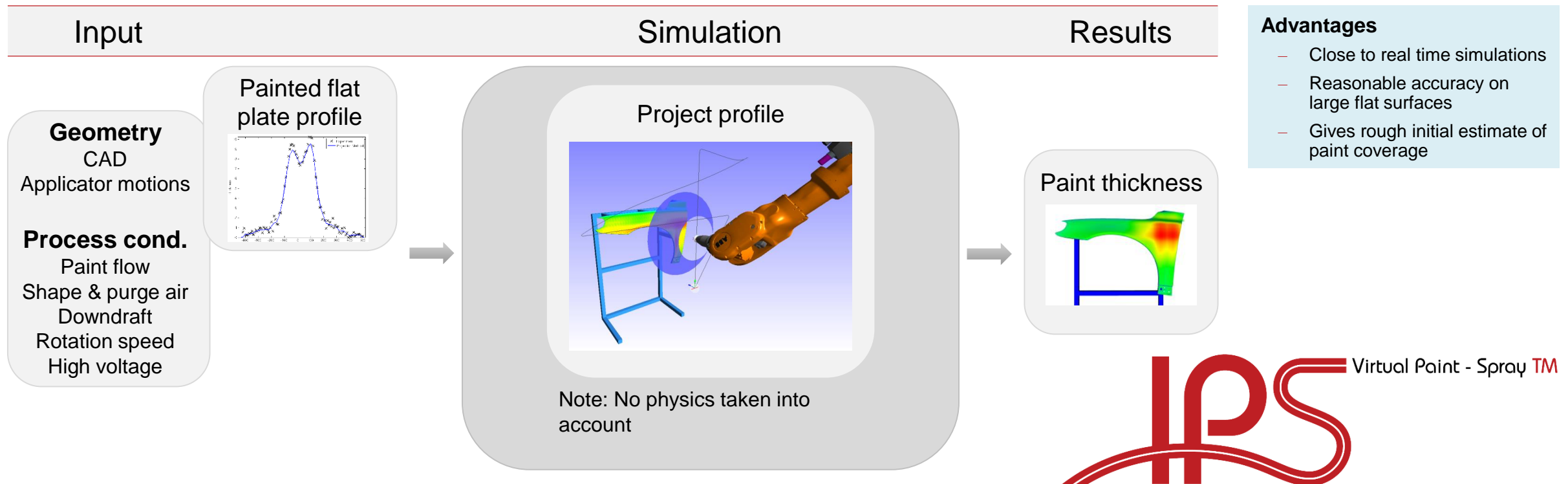
- Automatically generated adaptive octree grids and immersed boundary techniques
- Fast solvers using GPU acceleration running on desktop computers (full car simulation overnight)
- Internally and externally charged rotary bells supported



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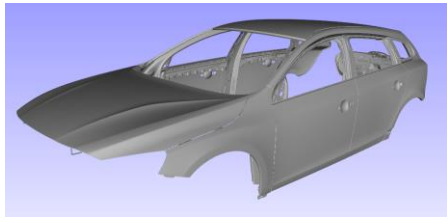
Projection Method

- Paint a plate with one stroke and measure the thickness
- Reconstruct a static brush that corresponds well with the measurements when projected on the plate
- Takes object curvature, robot speed and TCP distance into account

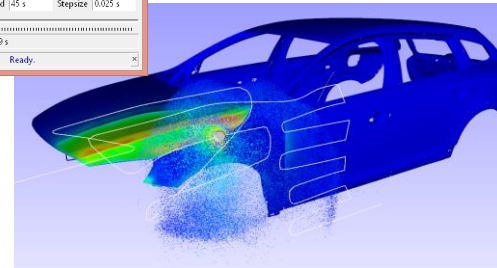
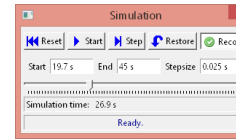


IPS Virtual Paint – Spray

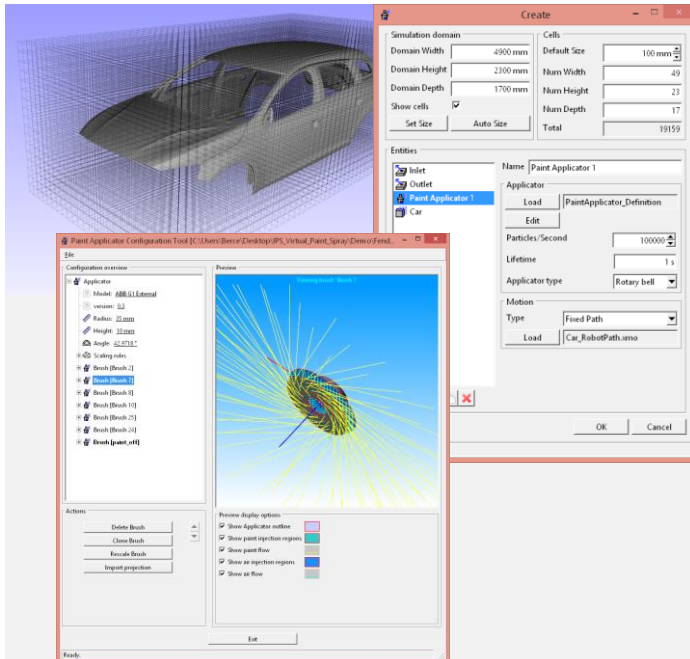
Simulation Procedure



1. Import geometry
 - CAD description

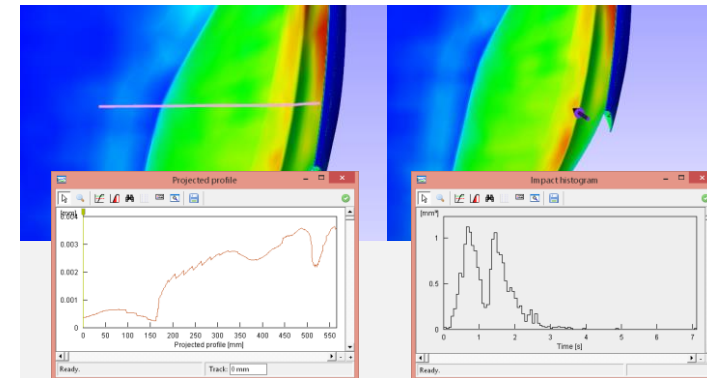


3. Perform Simulation
 - Physics-based
 - Projection



2. Process conditions:

- Brush definition
- Applicator motion
- Spray-box:
Downdraft



4. Evaluate results

- Paint distribution
- Thickness profile
- Impact histogram
- Transfer efficiency

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Selected validation campaigns

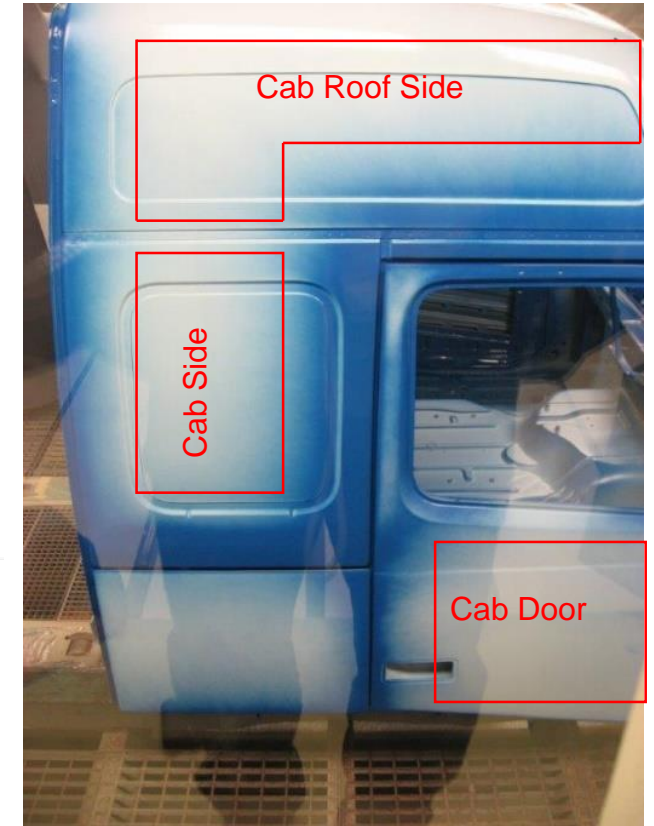
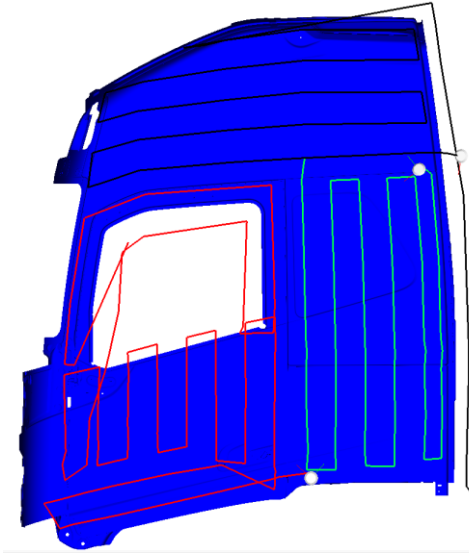
- Volvo Cars 2011
 - V60 car fender, plates
 - Dürr Ecobell 2 atomizer, internally charged
 - Clear coat
 - Measurements performed at Fraunhofer IPA, Stuttgart
- General Motors NA 2012
 - Car hood, car door
 - Dürr Ecobell 2, internally charged
 - Clear coat
- Volvo Cars 2013
 - Full car
 - Atomizers ABB G1, ABB RB1000, internally charged
 - Clear coat, base coat, filler
- General Motors NA 2013
 - Full car
 - Atomizer Fanuc, internally charged
 - Base coat
- Volvo Trucks 2014
 - Cab side
 - Dürr Ecobell 2, internally charged
 - Top coat



IPS Virtual Paint – Spray

Painting a Volvo Truck Cab

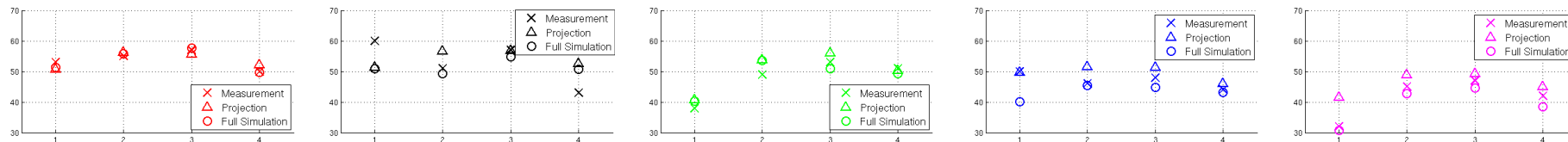
- Number of robot programs: 3
 - TFH_S.TID (21.3 s)
 - TFH_SD.TID (30.8 s)
 - TFH_35SU.TID (22.3 s)
- Number of brushes: 16
 - Measurements on plates for 4 brushes
- Paint applicator: Dürr Ecobell 2
- Select validation areas that are not affected by overspray from interior painting
- Physics-based simulation overnight
- Projection method simulation in a few minutes



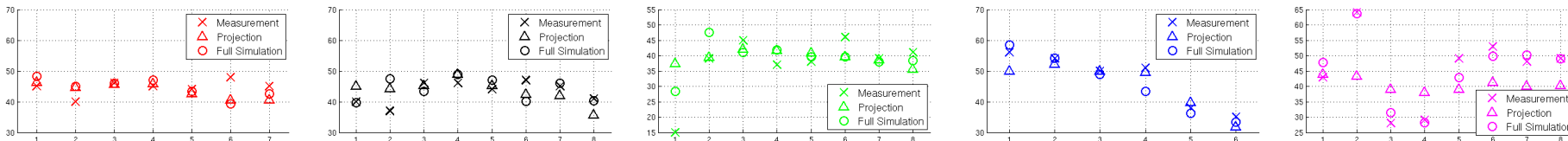
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Validation

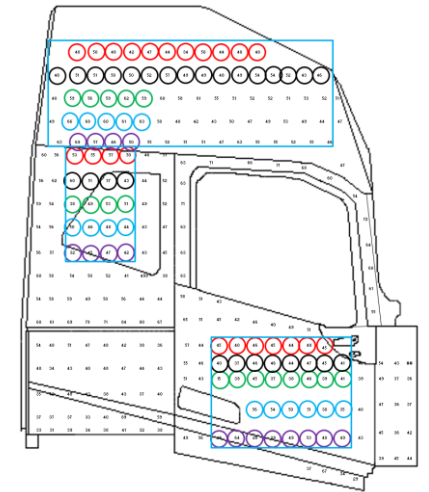
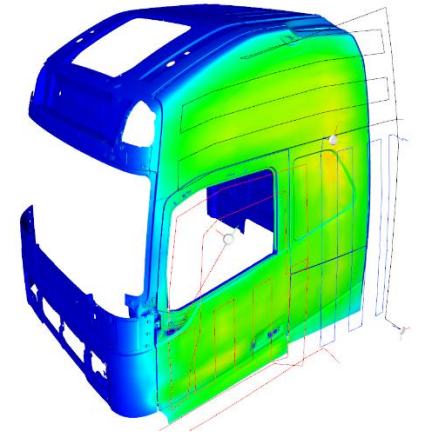
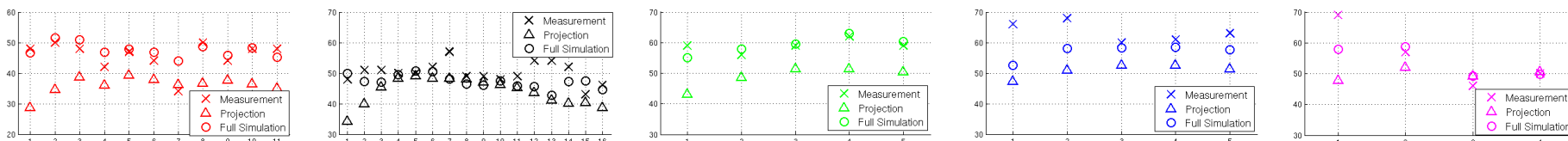
Cab side



Cab door



Cab roof side



- Physics-based simulation shows excellent agreement
- Projection method shows good agreement

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Technical advantages

- Extremely robust, accurate and fast method with immediate visualization
- Running on desktop computer
- E-field, airflow and particles in one environment
- Many brushes at the same time, tested up to 20 brushes
- Opening doors during simulation does not cost additional time
- Contamination of applicators can be investigated and minimized
- No mesh generation
- No special know-how of FEM, solvers, meshing necessary.
Training in one-day

Benefits

- ⇒ Saves days of simulation time and time for correcting wrong setup
- ⇒ Saves money for HW-resources
- ⇒ No co-simulation of different complex SW-tools
- ⇒ Realistic setup of the paint shop over night.
- ⇒ One continuous simulation instead of splitting into sections
- ⇒ Tremendously reduced time and cost for cleaning
- ⇒ Saves man days of preparation
- ⇒ Ready for productive use in short time frame

