Crosswind stability is a safety consideration for the operation of a high-speed train (HST): how stable it is (how likely is it to de-rail) when exposed to crosswind. This is a greater consideration for light-weight HSTs.

Train + crosswind → 3D flow field → asymmetric pressure distribution → overturning forces / moments
can take time to develop, varies over space & time

Potentially, a difference in predicted forces & moments exists between a steady or transient interaction between the train and the crosswind.

- **Steady**: wind-tunnel experiment with stationary yawed models / steady computer simulations
- **Transient**: moving-model experiments with crosswind / complex transient computer simulations

Clear motivation to:
- improve understanding of transient crosswind stability
- potentially develop more accurate predictions of a HSTs crosswind stability characteristics.
Moving-Model Facility

The moving-model facility at DLR Göttingen is used to accelerate reduced-scaled models using a hydro-pneumatic catapult mechanism. The models freely move on rails through the test-section and are then decelerated in a tank of polystyrene balls.

- Model speeds of $u_t=70\text{m/s}$
- Scales ~1:25

This facility can be used to assess a HSTs:
- Slipstream
- Head & micro pressure-pulse
- Drag
- Crosswind stability

The crosswind module generates side winds with a wind-tunnel which the moving-model passes through

- $v_{cw}=10\text{-}25\text{m/s} \ (\beta=0\text{-}45^\circ)$
- 4 x 30 kW fans.

Experimental model: ICE3 (Siemens Velaro)
- 1:25th scale
- Wheels rotating on rails
- Correct ground-vehicle relative motion
- Existing crosswind-stability reference data
- CAD geometry available
On-Board Data Acquisition Functionality

A new system on-board data acquisition (DAQ) was developed to investigate the effect of crosswind on the HST System. Successful functionality of the system operate under challenging test conditions due to high accelerations (±60g) and vibrations.

DAQ system:
- Teensy 3.6 Micro-controller
- microSD card
- 6x AA batteries
- Signal-noise ratio ~10
- Samples: 3s, @3.5khZ.

a. Surface Pressure Measurement:
- 24 Freescale ±7kPa differential-pressure transducers

b. Position/Velocity Measurement:
- Photodiode
- 2 x pairs of LED strips

c. Trigger & Vibration Measurement:
- ±16g ADXL326 accelerometer

Figure 4: DAQ system functionality a. pressure, b. phototransistor, c. accelerometer
Transient-Pressure Results

Initial measurements during the passage through the crosswind section at the windward (WW) and leeward (LW) side of the train’s nose: Model speed of $u_t=32\text{m/s}$, Crosswind: $v_{cw}=18.5\text{m/s}$, Effective yaw angle of $\beta\approx30^\circ$

During exposure to the crosswind:
- **WW** side increase in pressure of $C_p\approx0.9$ quickly ($\Delta t=0.02\text{s}$)
- **LW** side decreases to $C_p\approx-1.4$ at a slower rate ($\Delta t=0.07\text{s}$).

- Sensitivity to unsteady crosswind modelling indicated
- further investigations planned

Figure 5: Pressure tap locations

![Figure 5: Pressure tap locations](image)

Figure 6: Transient pressure during exposure to crosswind