ISWIM

Southern African Transport Conference

Jan Fučík, CAMEA

Using Long-Term Experience to Develop a Novel Weighing Digital Sensor for Further Evolution of WIM Technology

Long-Term WIM Experience

850+
LANES

WEIGH-IN-MOTION

200+
LANES

WIM DIRECT ENFORCEMENT

1,350+
LANES

ITS WORLDWIDE

80+
LANES

WIM IN AFRICA

East Africa - WIM References

- More than 30 stations used for various purposes
  - Pre-selection for static scales
  - Data collection for WIM statistics
  - Monitoring in a single data center

"We are pleased to report the observed reality on Kenyan National roads. Queues at the static weigh stations are significantly shorter, compared to before implementing the Weigh-In-Motion. The Weigh-In-Motion solution, both at the static and virtual weigh stations, helps reduce overloading, facilitate trade and protects both infrastructure and people in the long run."

ENG. MUITA NGATIA, DEPUTY DIRECTOR, ROAD ASSET MANAGEMENT (KENHA)

South Africa - WIM Station

- Near the Mantsole Weighbridge
- WIM in the slow lane
- Detection of avoiding drivers in the fast lane and road shoulders
- Camera system for documentation

South Africa - WIM Station

Experience with WIM in Africa

- Drivers avoid weighing (not paying fines)
  - Speed changes 2 - 5 %
  - Maneuvers 10 - 25 %
- Experience with bad roads
  - Vehicle vibrations can have a significant impact on measurements
- Some of the maneuvers are unintentional
  - Unmarked WIM station
  - Drivers' habits (driving on road shoulder)
  - Placement of sensors in the traffic lane (limited by joints between concrete blocks)

Issues Associated with High-Speed Weighing

- Road quality
- Drivers avoiding measurement
- Drivers avoiding documentation
- WIM sensor lifespan
- WIM site complexity
- Sensitivity shift due to temperature changes

Ways to Address WIM Issues

Following Standards and Recommendations

- When selecting a WIM site, the criteria for road quality must be followed:
  - Road surface conditions
  - Used materials
  - Pavement thickness
  - Transverse and longitudinal slope
  - Curvature
  - No rutting or cracking is acceptable
- E.g., COST323 Class "I Excellent" required for 5% gross weight accuracy (WIM direct enforcement)

Ways to Address WIM Issues

Government Measures - Barriers

Ways to Address WIM Issues

Government Measures - Keeping Distance

Ways to Address WIM Issues

Government Measures - No Maneuvers Allowed

Ways to Address WIM Issues

Other Government Measures

- Marking the WIM station - the law forbids any maneuvers
- The license plates must be visible to ensure the identification
- Fining of maneuvers to avoid the weight measurement
  - Thanks to detection and documentation by the WIM system
  - The fine can even be higher than for overloading

Ways to Address WIM Issues

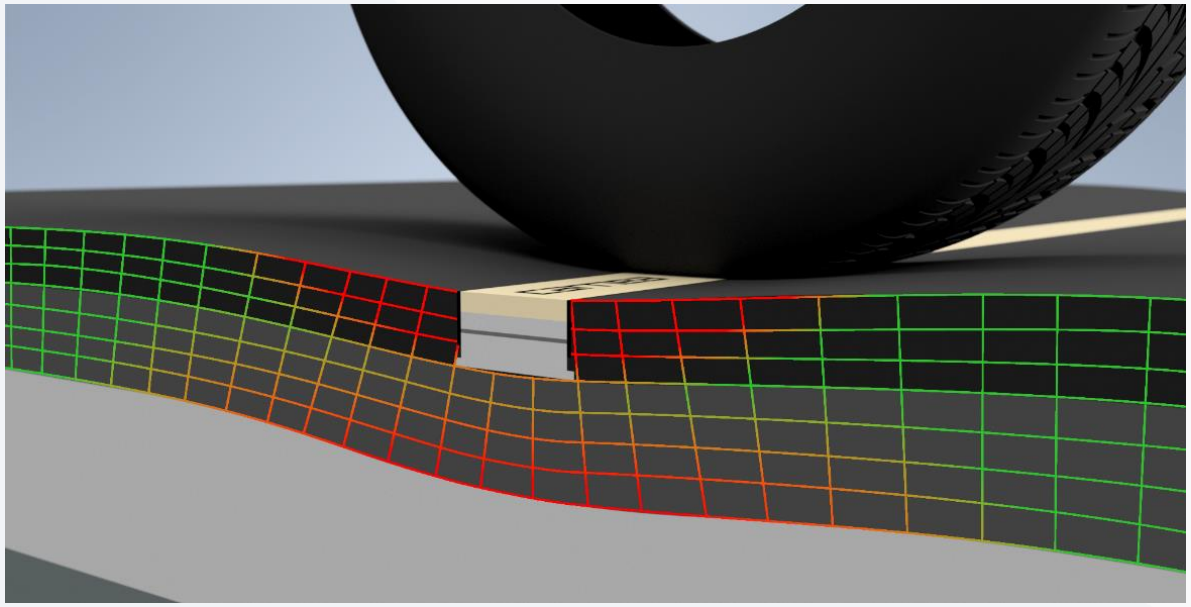
Technology Evolution: Novel Digital WIM Sensors

- Embedded digital processing and transfer of measured data
- Wide and rugged build while keeping a low profile for minimum road intrusion
- High accuracy
- Easy installation
- High and uniform sensitivity
- Detection of maneuvers for measurement validation
- Tire footprint, pressure and Pressure-In-Motion (PIM) measurement
- Measurements of the road parameters (deflection, rutting, etc.)

Low Sensor Height - Less Road Damage

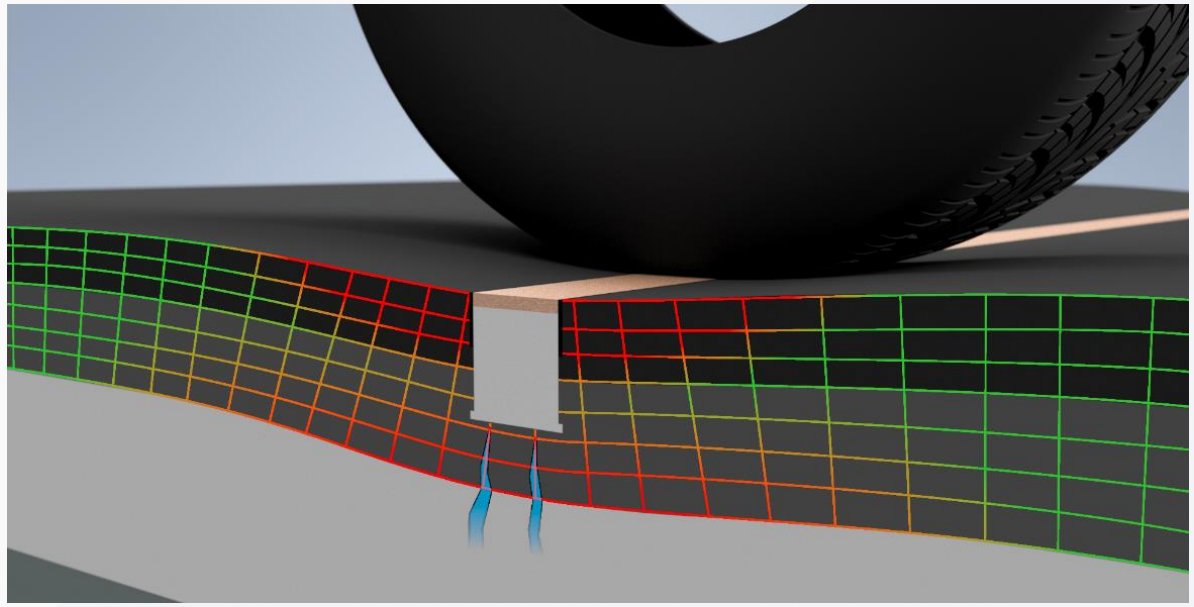
NOVEL DIGITAL WIM SENSOR

- Lower profile design
  - Less intrusive



SOME OF THE CURRENT WIM SENSORS

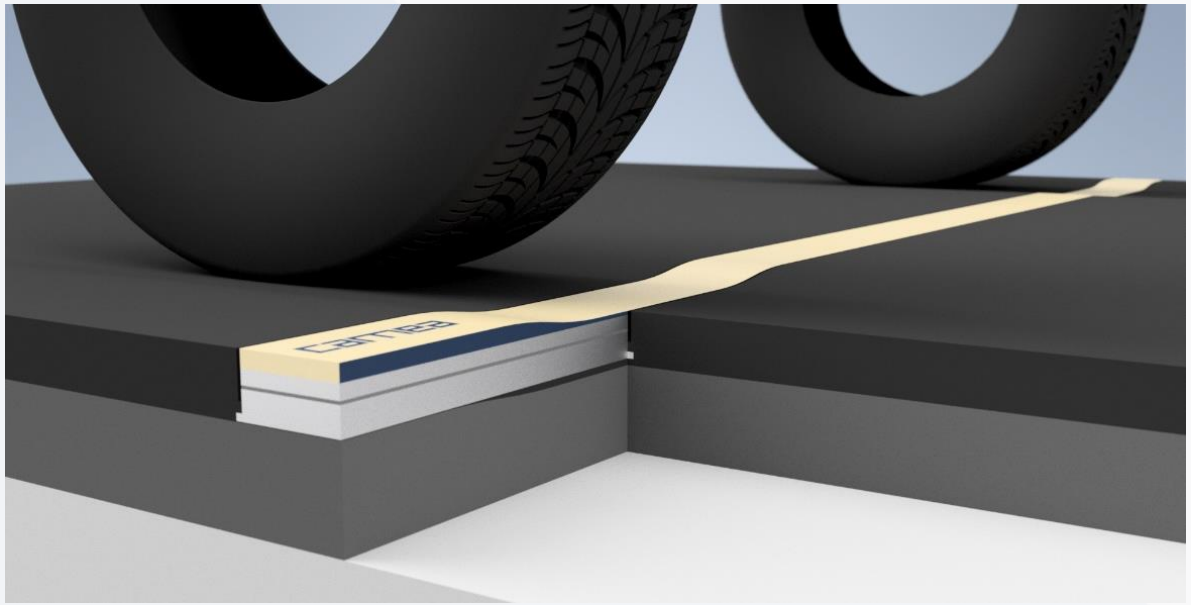
- Higher profile design
  - More intrusive



High Abrasive Layer - Long Lifetime

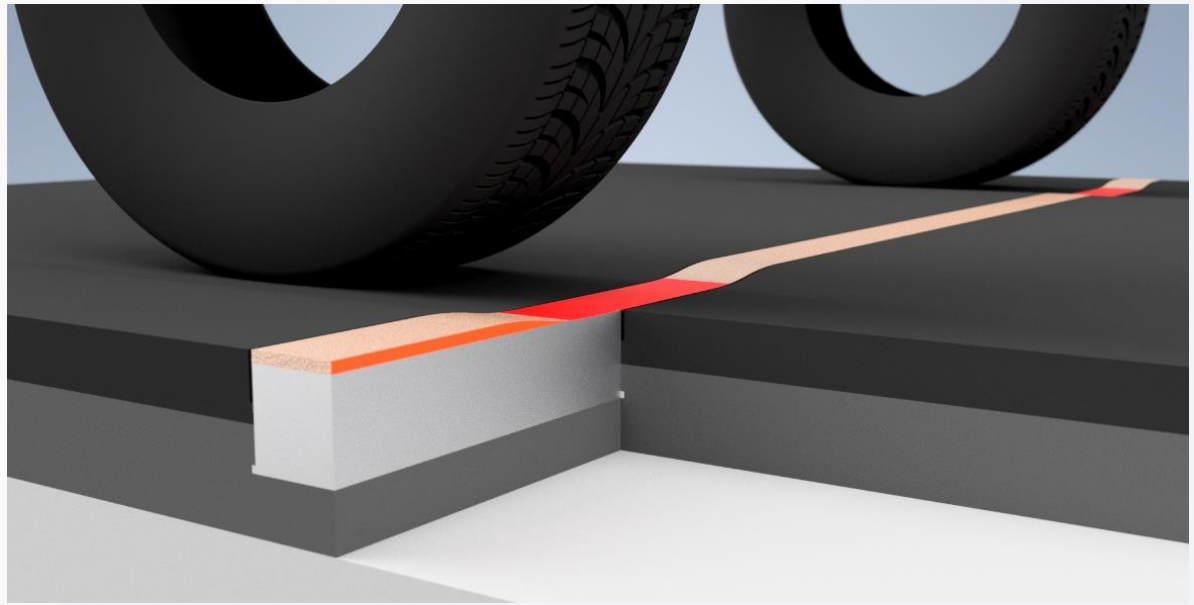
NOVEL DIGITAL WIM SENSOR

- Higher sensor abrasive layer
  - Longer service life



CURRENT WIM SENSORS

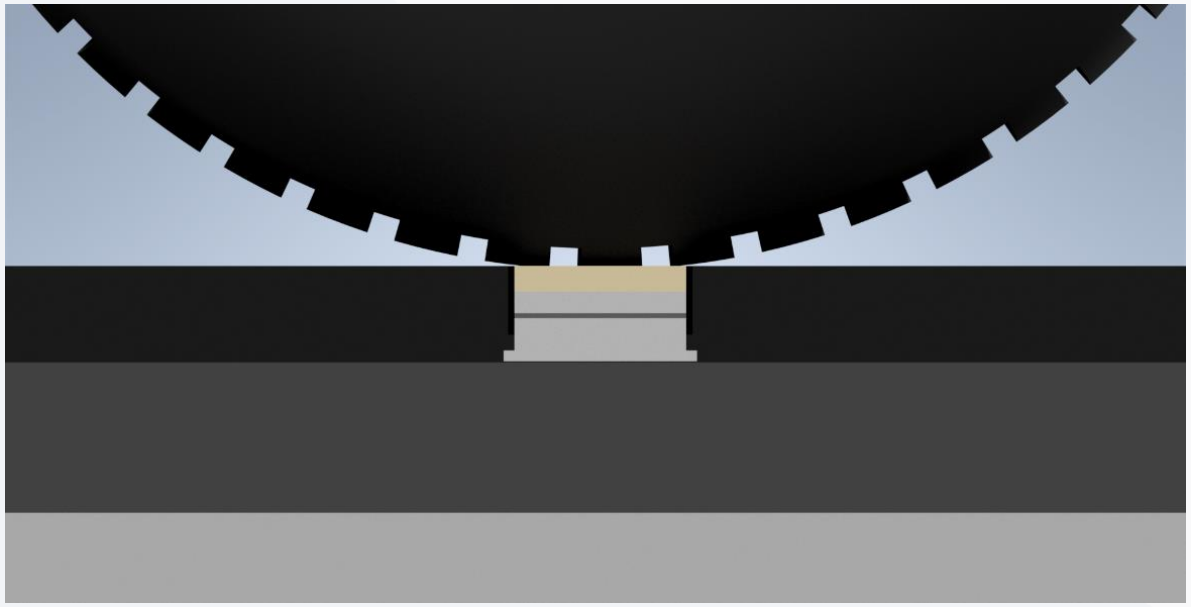
- Lower sensor abrasive layer
  - Shorter service life



Wide Sensor - High Accuracy

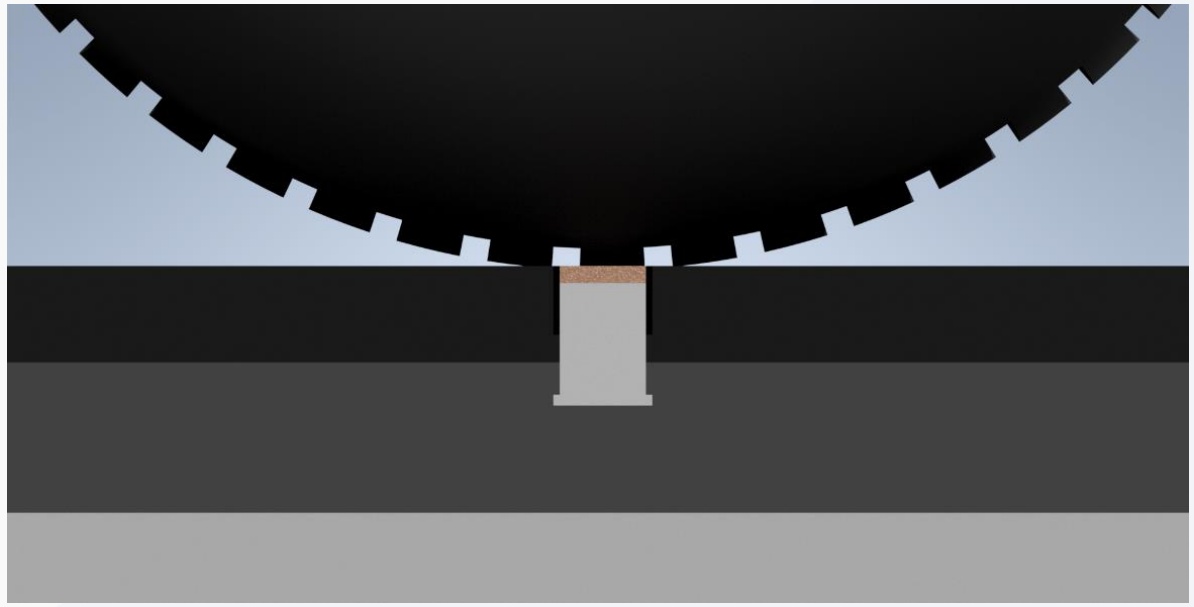
NOVEL DIGITAL WIM SENSOR

- Longer tire contact - 80 mm
  - Accuracy less affected by tire pattern



CURRENT STRIP WIM SENSORS

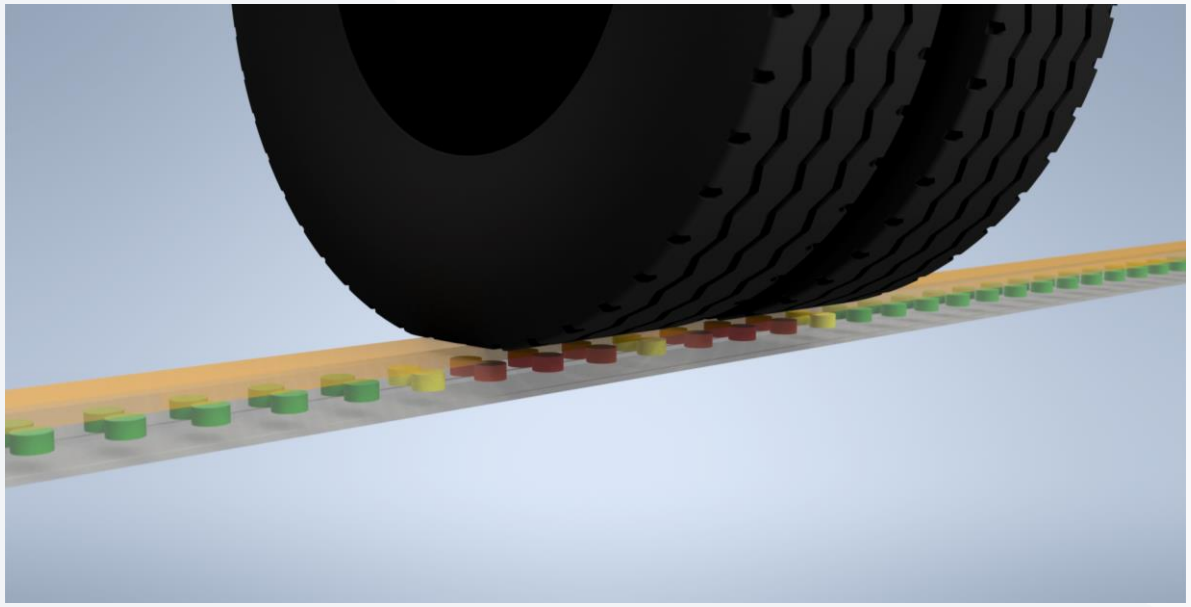
- Shorter tire contact - 40-70 mm
  - Tire pattern can affect accuracy



Tire Position - Dual Tires and Wheelbase

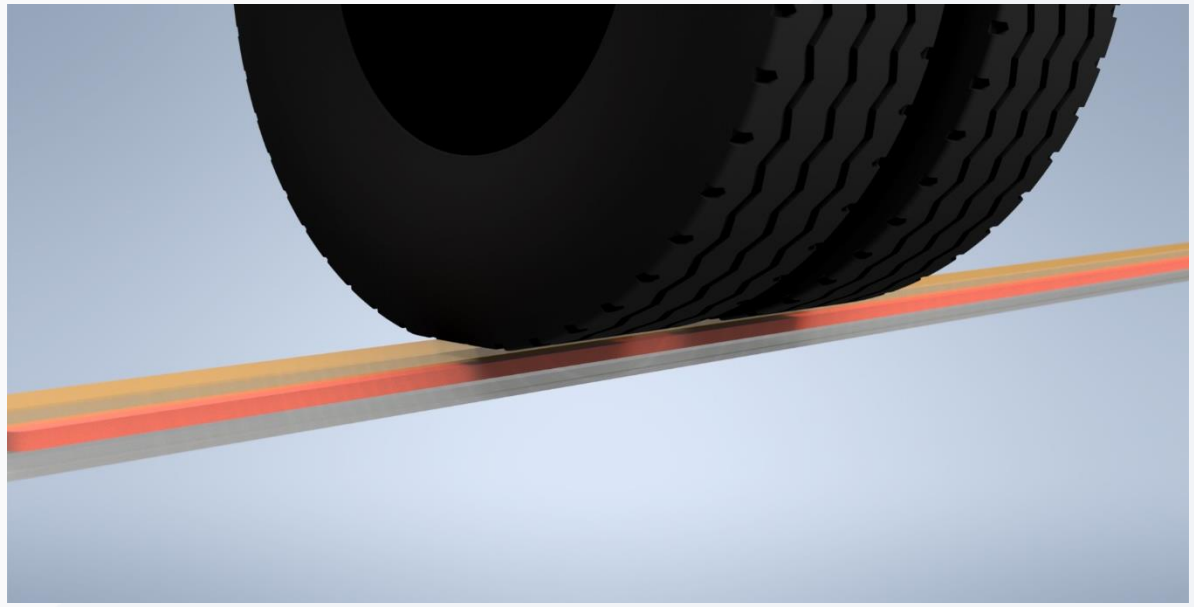
NOVEL DIGITAL WIM SENSOR

- Tire position measurement
  - Dual tires and wheelbase



ANALOG WIM SENSORS

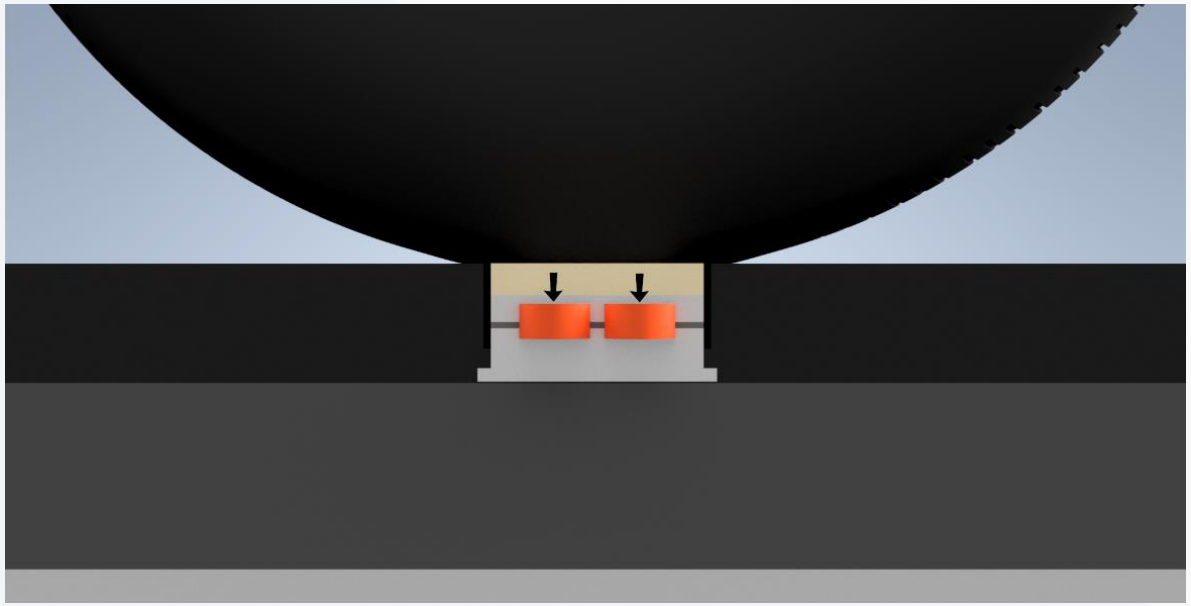
- One response of the entire sensor
  - Tire mount and position is unknown



Double Measurement - Higher Accuracy

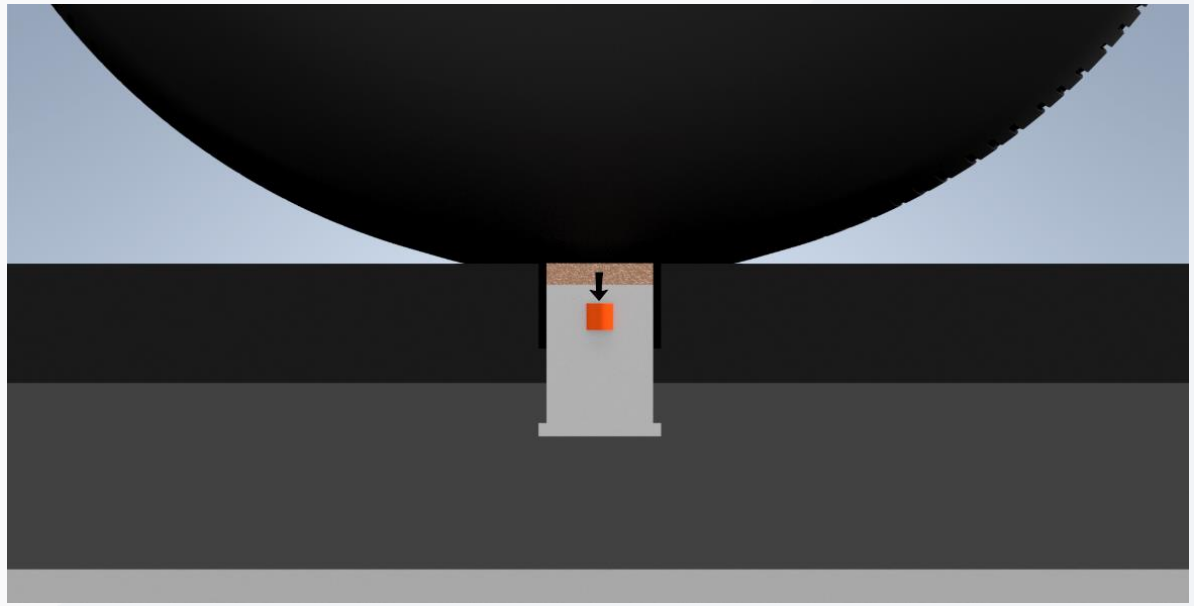
NOVEL DIGITAL WIM SENSOR

- Double measurement
  - Higher accuracy, additional data



CURRENT WIM SENSORS

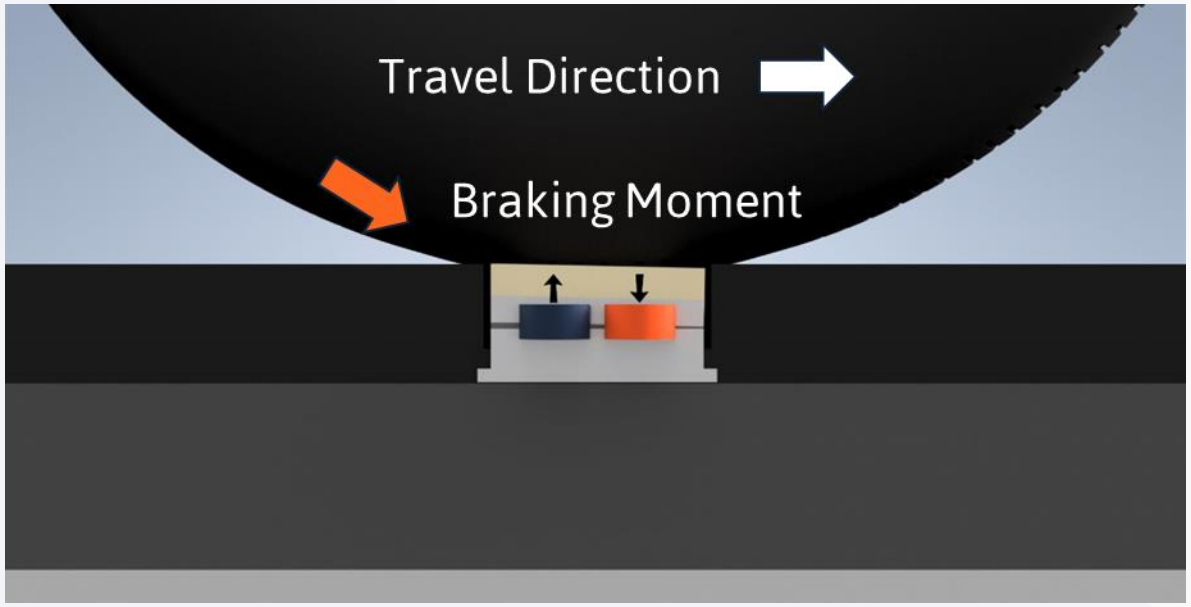
- Single measurement
  - Lower accuracy, no additional data



Braking Detection - Measurement Validation

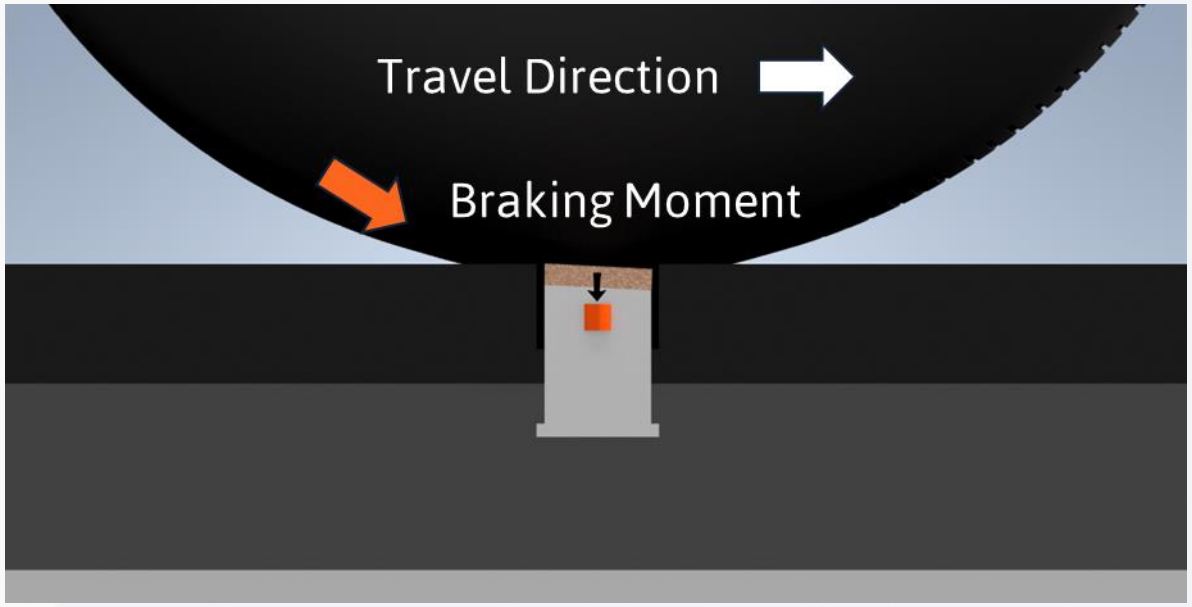
NOVEL DIGITAL WIM SENSOR

- Braking can be detected
  - Inaccurate data can be invalidated



CURRENT WIM SENSORS

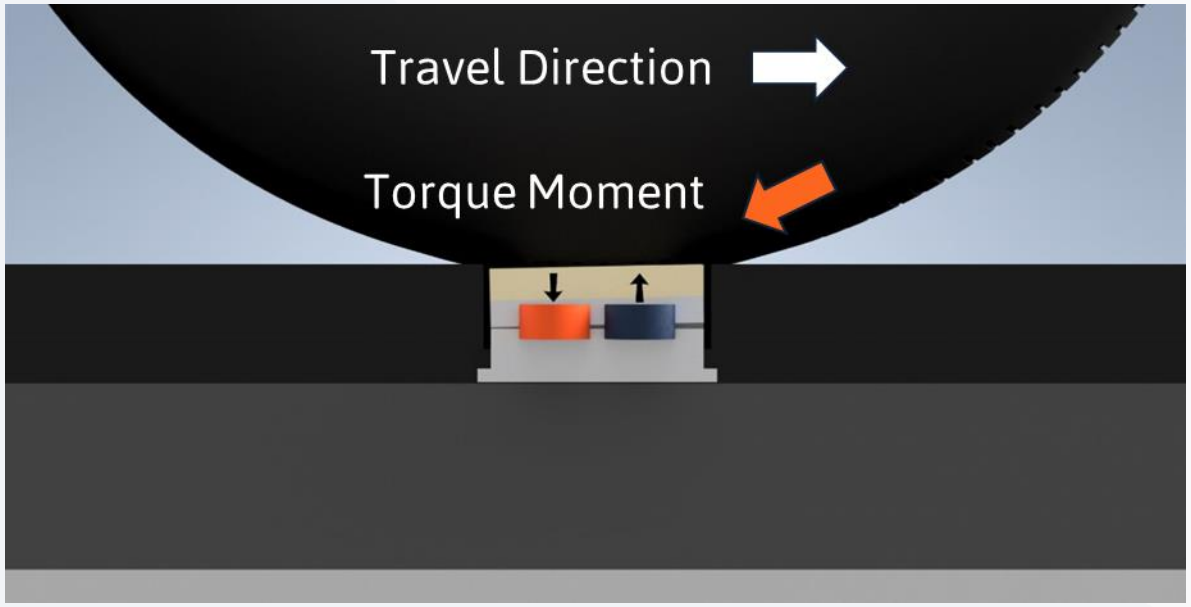
- Braking cannot be detected
  - Incorrect data affects accuracy



Torque Detection - Measurement Validation

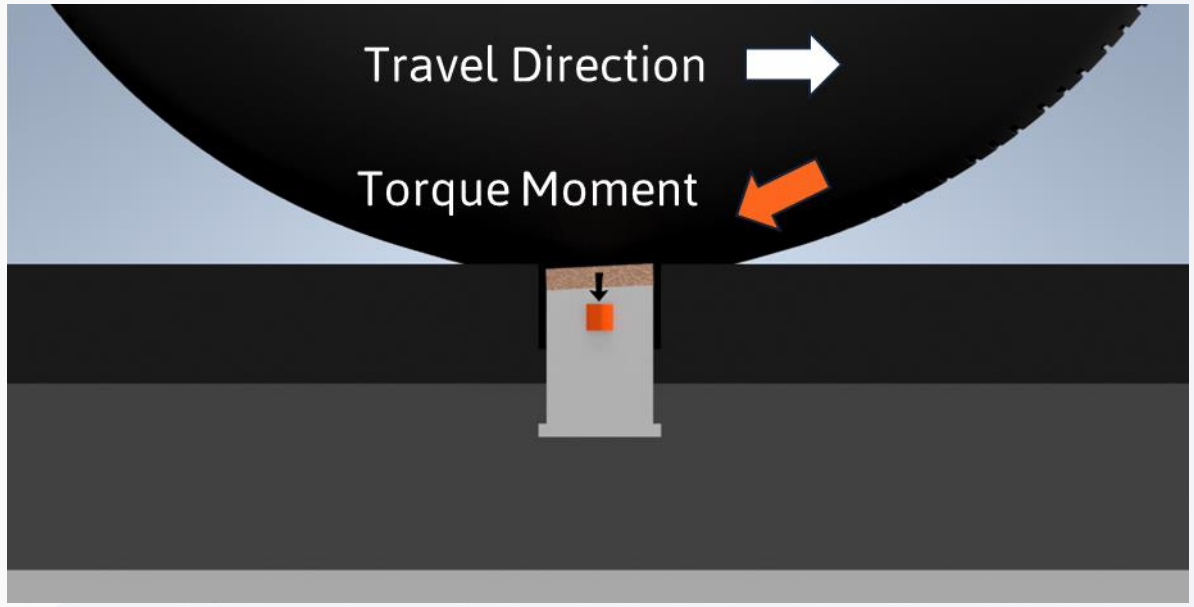
NOVEL DIGITAL WIM SENSOR

- Torque can be detected
  - Inaccurate data can be invalidated



CURRENT WIM SENSORS

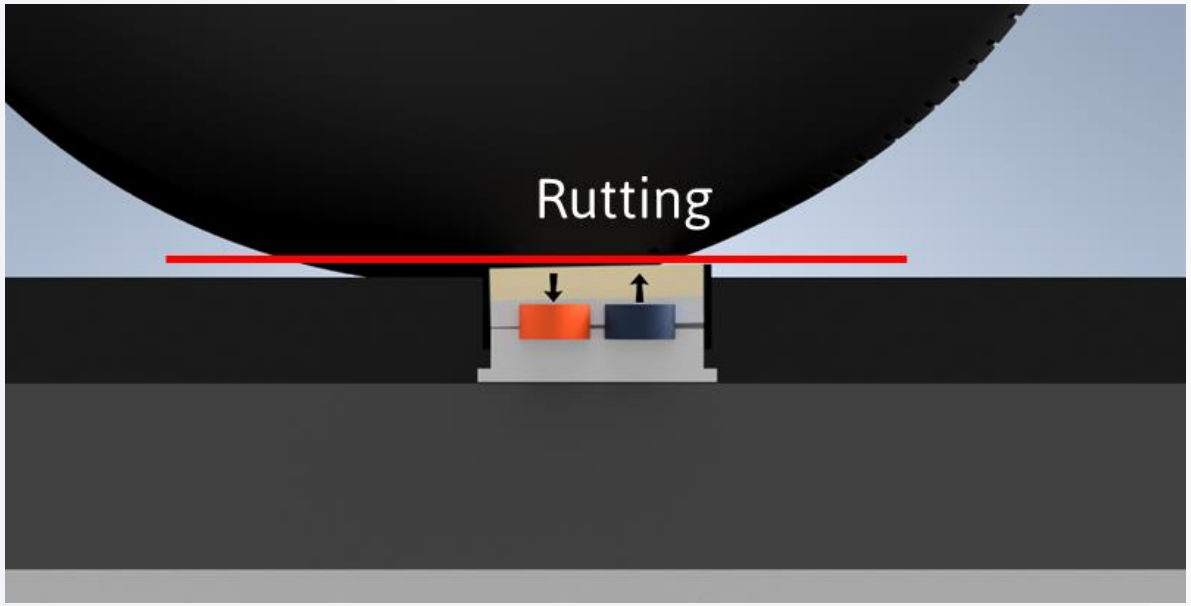
- Torque cannot be detected
  - Incorrect data affects accuracy



Rutting Detection - Measurement Validation

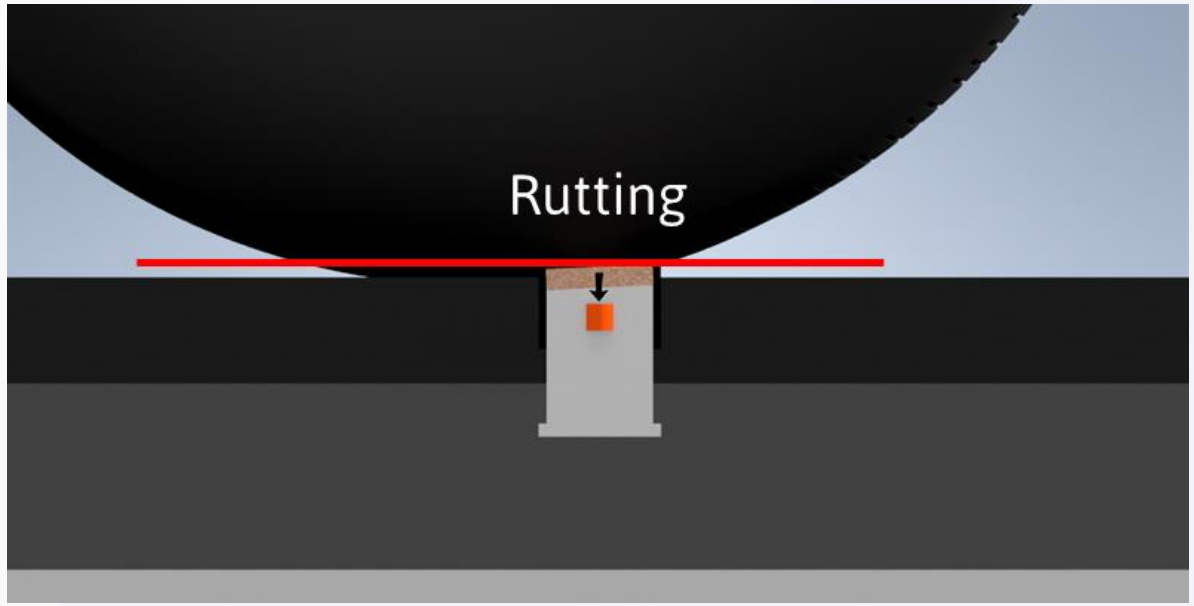
NOVEL DIGITAL WIM SENSOR

- Rutting can be detected
  - Inaccurate data can be invalidated



CURRENT WIM SENSORS

- Rutting cannot be detected
  - Incorrect data affects accuracy



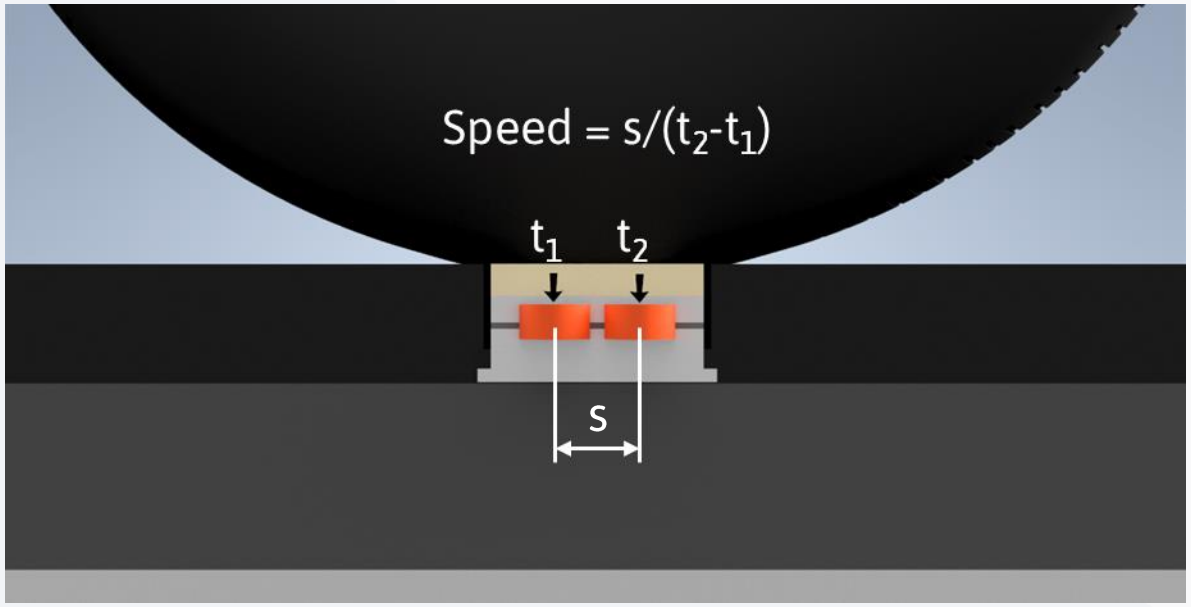
Wheel Speed - Measurement Validation

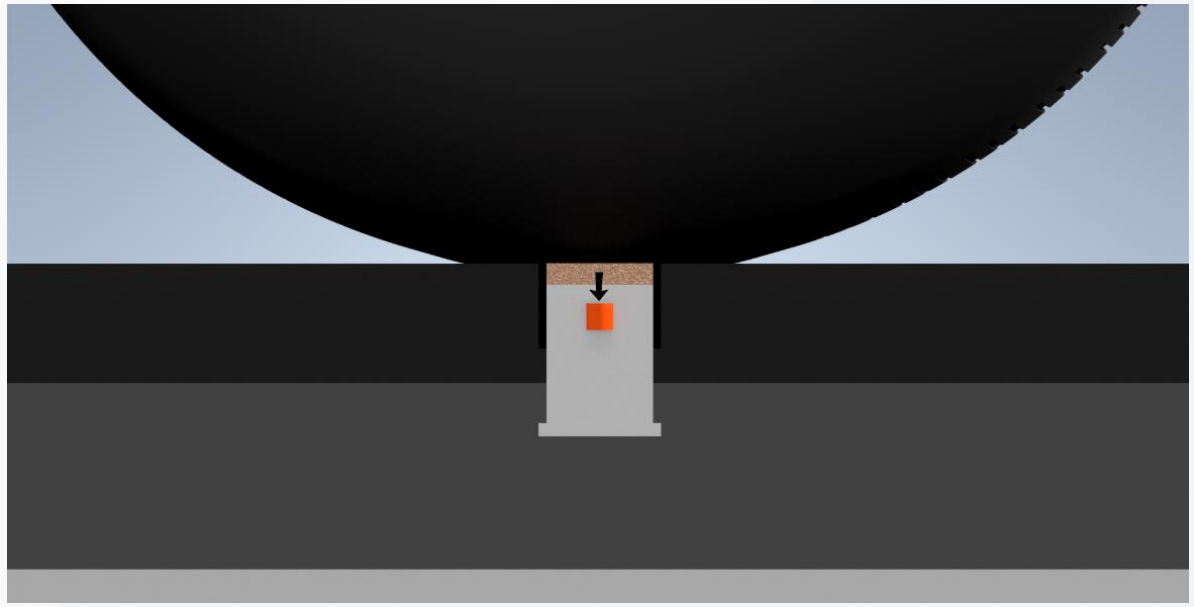
NOVEL DIGITAL WIM SENSOR

- Two successive measurements
  - Speed can be determined

CURRENT WIM SENSORS

- Single measurement
  - Speed cannot be determined

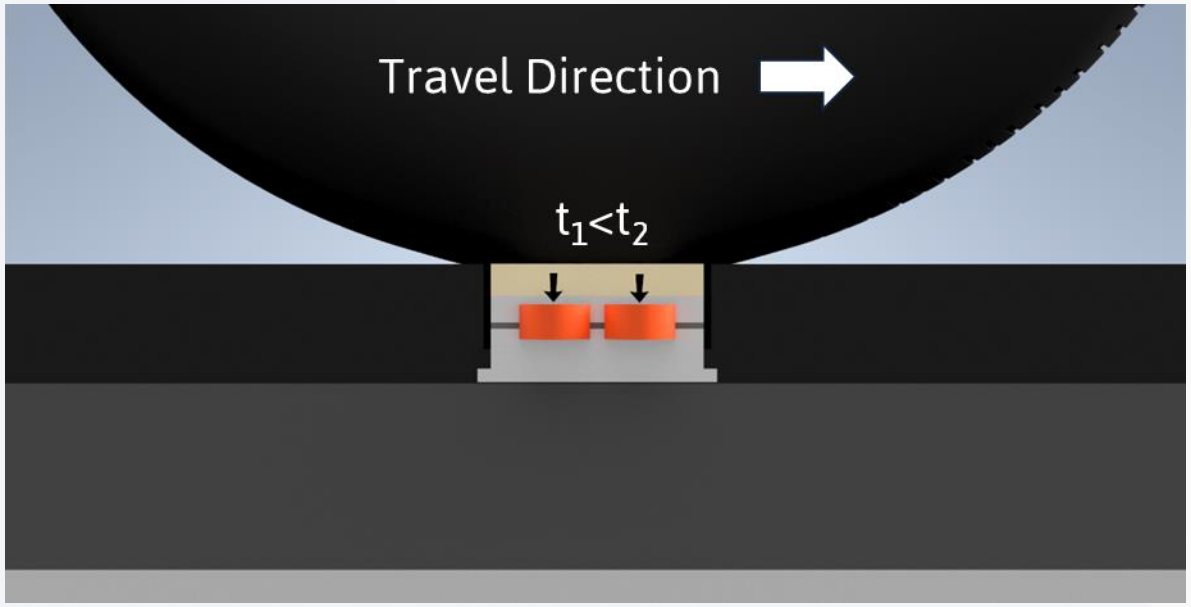




Travel Direction Detection

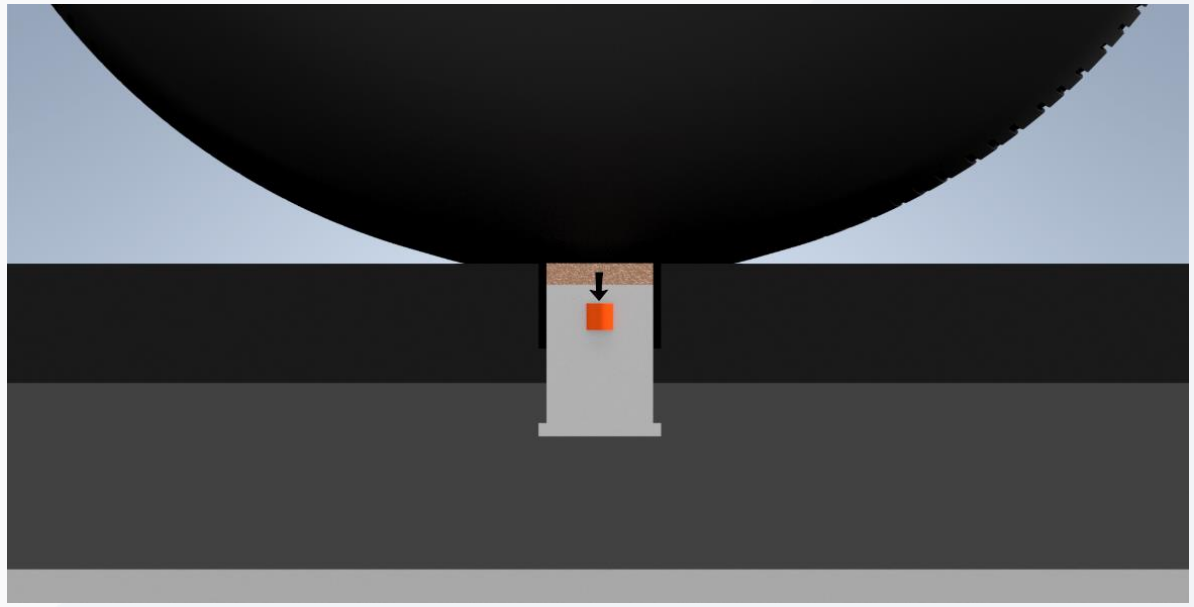
NOVEL DIGITAL WIM SENSOR

- Two successive measurements
  - Travel direction can be determined



CURRENT WIM SENSORS

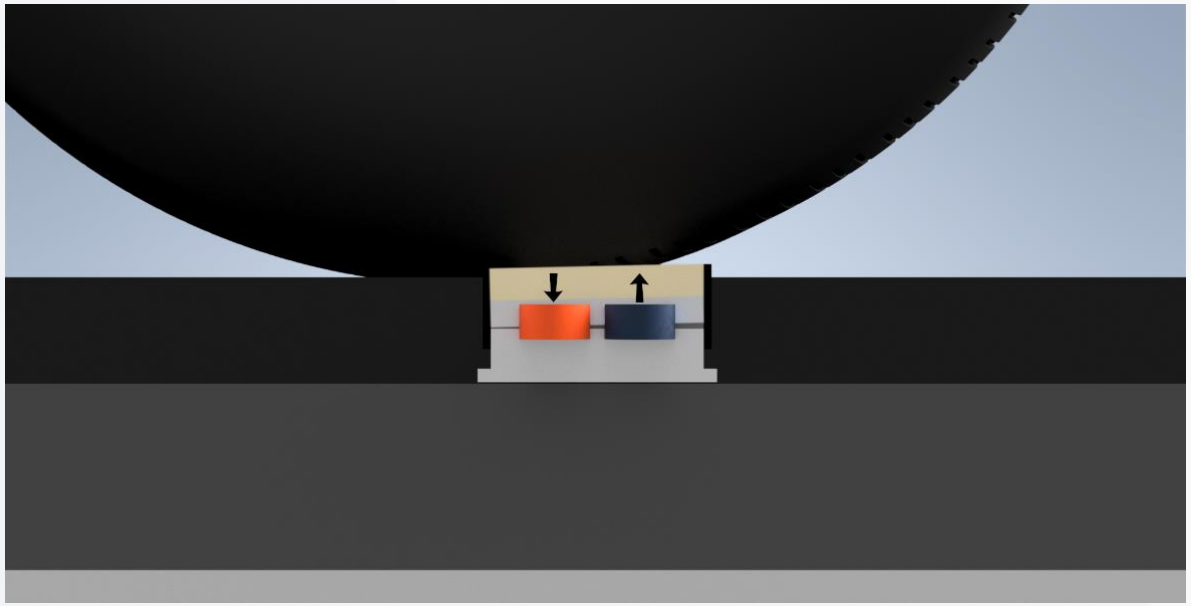
- Single measurement
  - Travel direction is undetectable



Low Side Bending Effect

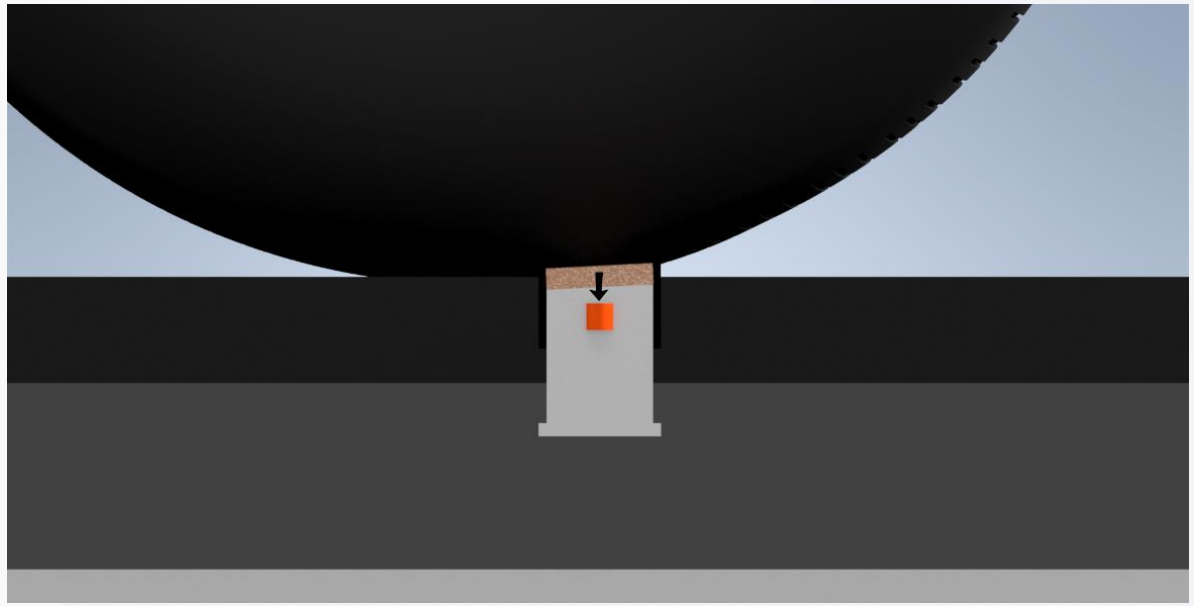
NOVEL DIGITAL WIM SENSOR

- Sensor side bending is low
  - Greater overload resistance



CURRENT WIM SENSORS

- Sensor side bending is high
  - Overloaded wheels can cause damage



Tire Footprint Measurement

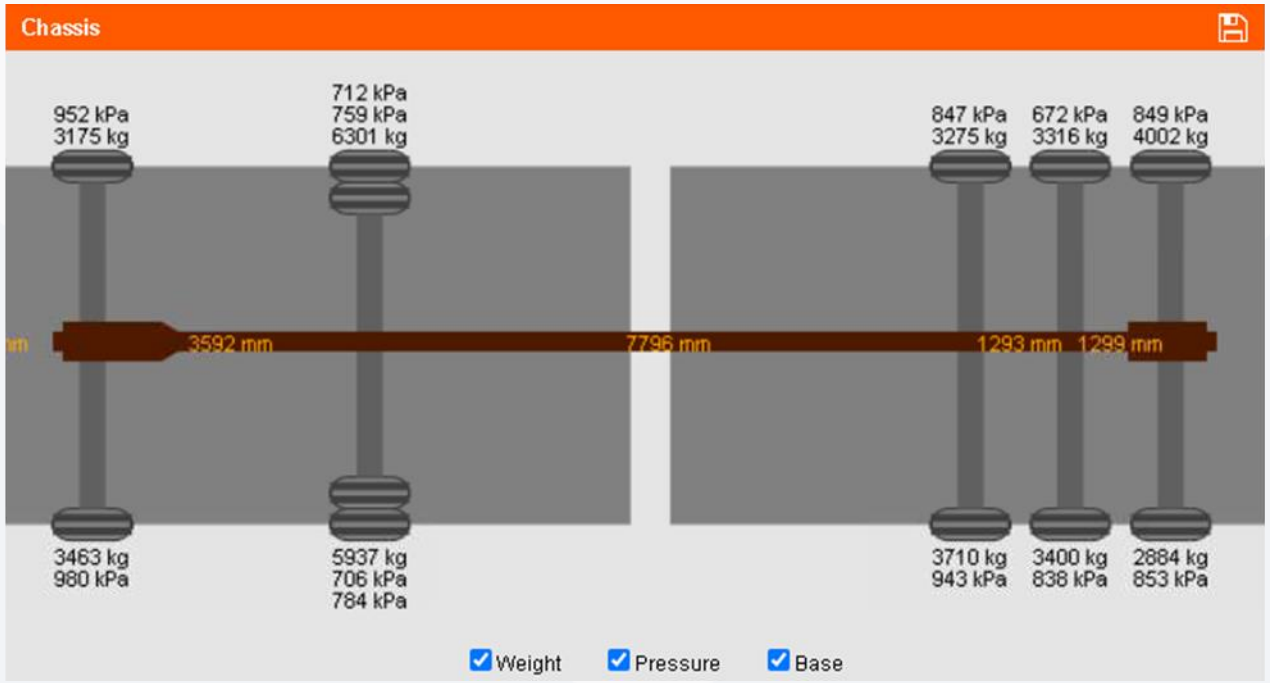
Underinflated

Correctly Inflated

Overinflated

Tire Pressure - Pressure-In-Motion (PIM)

Allows both weight and pressure measurement



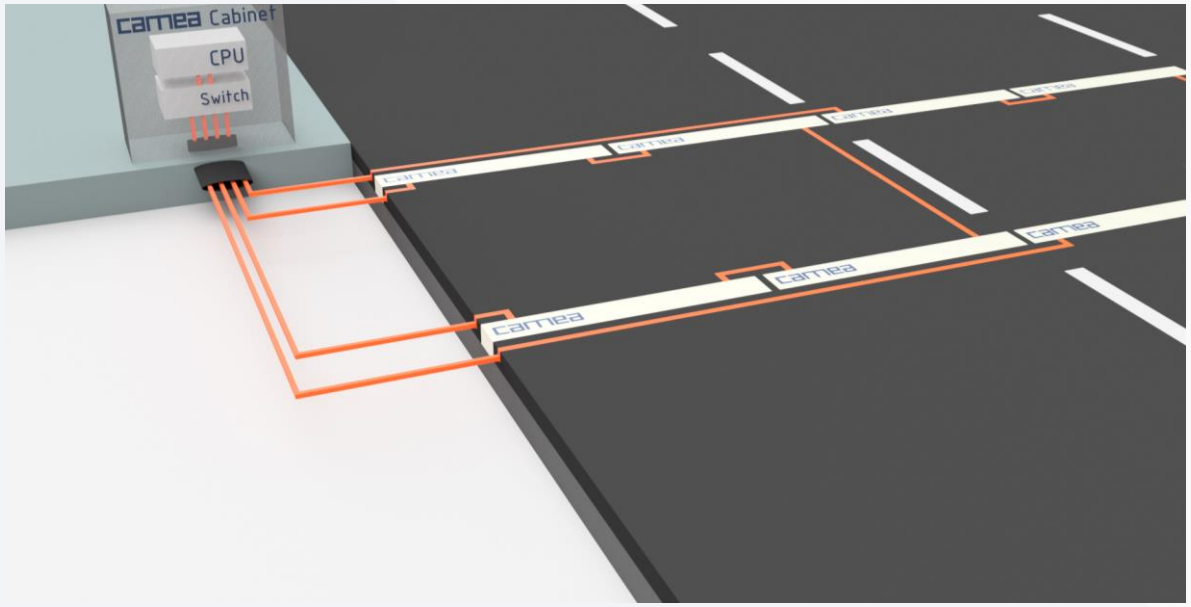
Road Deflection - Measurement Validation

Allows both wheel load and road deflection measurement

Cheap and Easy Cabling

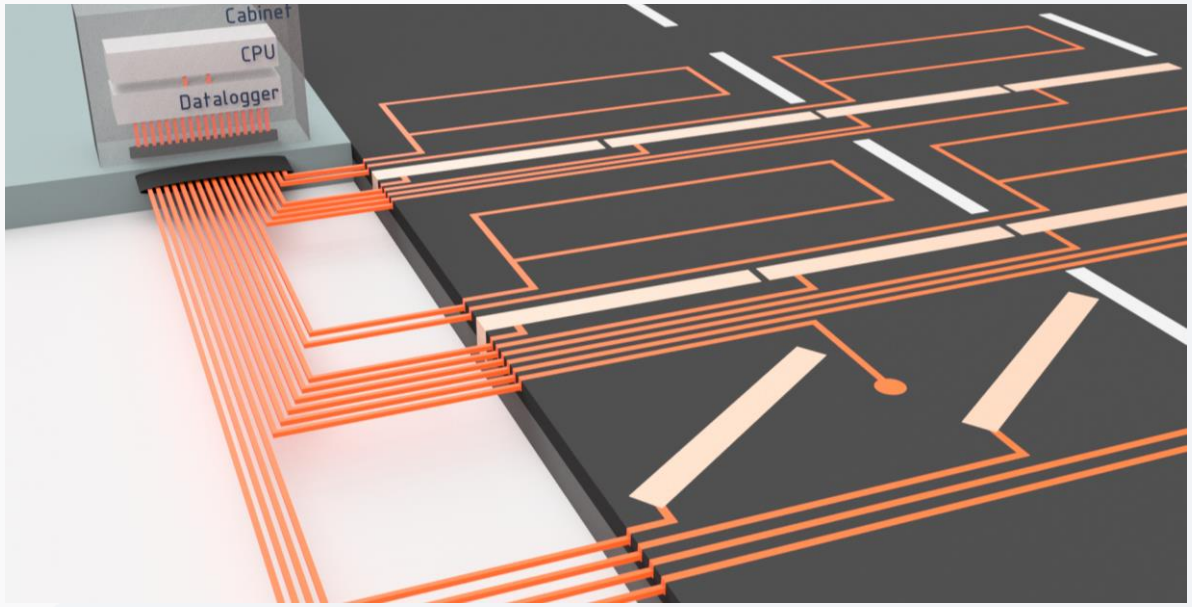
NOVEL DIGITAL WIM SENSOR

- Interconnection
  - 4 cables per 8 sensors (ring daisy-chain)



OTHER WIM SOLUTIONS

- Complex and expensive cabling
  - Significantly more cables



Recommendations for WIM Enforcement

- Road quality is key for high accuracy
- Drivers avoiding weighing must be detected and documented
  - Technology to enable detection and validation of weighing results
  - High quality camera system for documentation
- Law measures should prevent avoiding of weighing
- Accurate, reliable sensors with a long lifespan
- Proper maintenance and calibration of WIM stations

Thank you!