



TRACTOR ROLLOVER INVESTIGATION AND STABILITY TESTS

THE CONTEXT

Between 2002 and 2012 in Italy, 24% of fatal accidents were due to tractor rollovers.

TABLE 1: STATISTICS OF FATAL ROLLOVER ACCIDENTS OCCURRED BETWEEN 2008 AND 2019

Italy	Northern Regions	Trentino Alto Adige
1414	525	74

CHALLENGES	Simulator for tractor stability estimation.	Sloped and rugged farming terrains.	Enhanced safety and efficiency in farming.
Challenging regional conditions.			

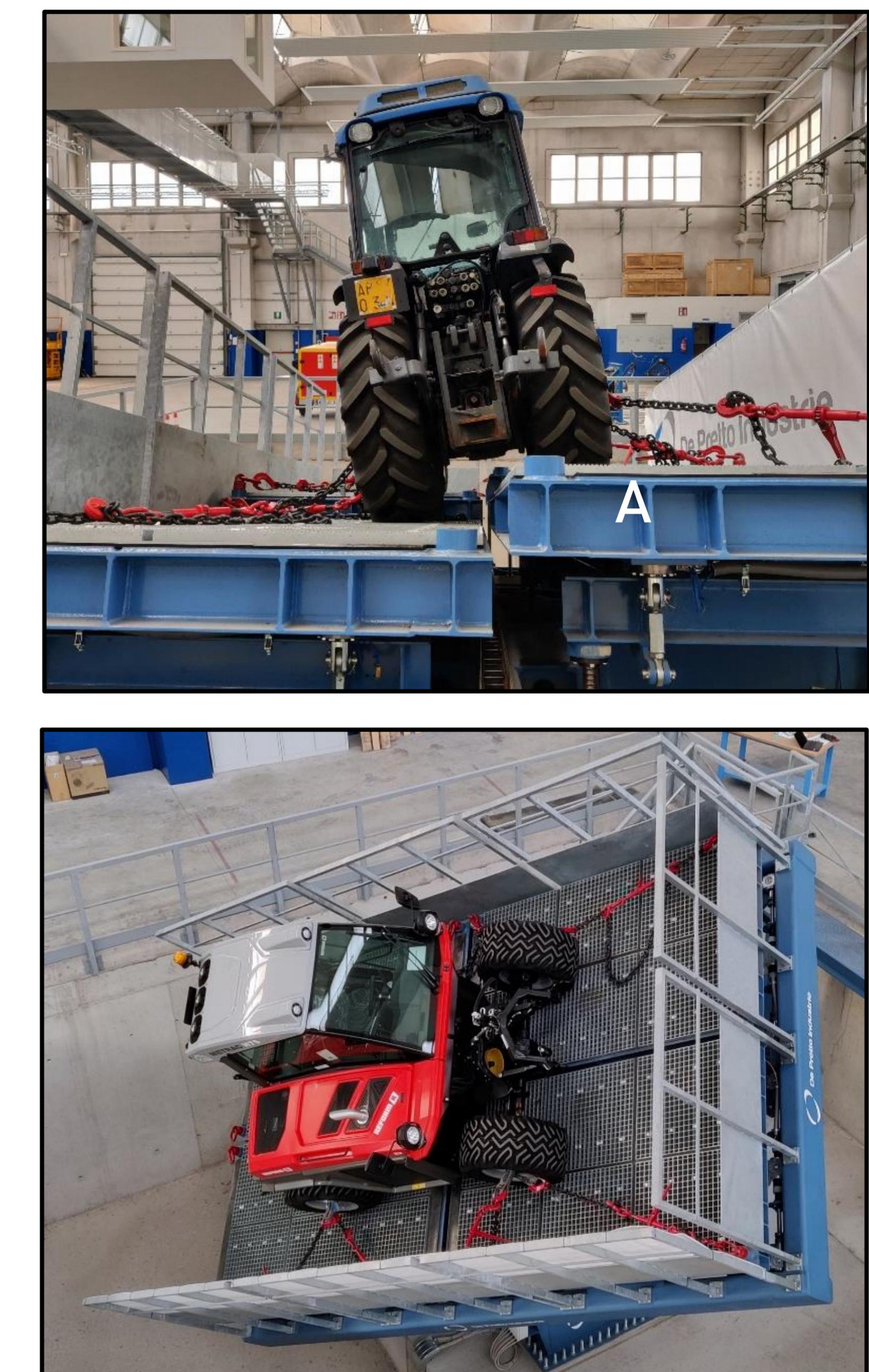
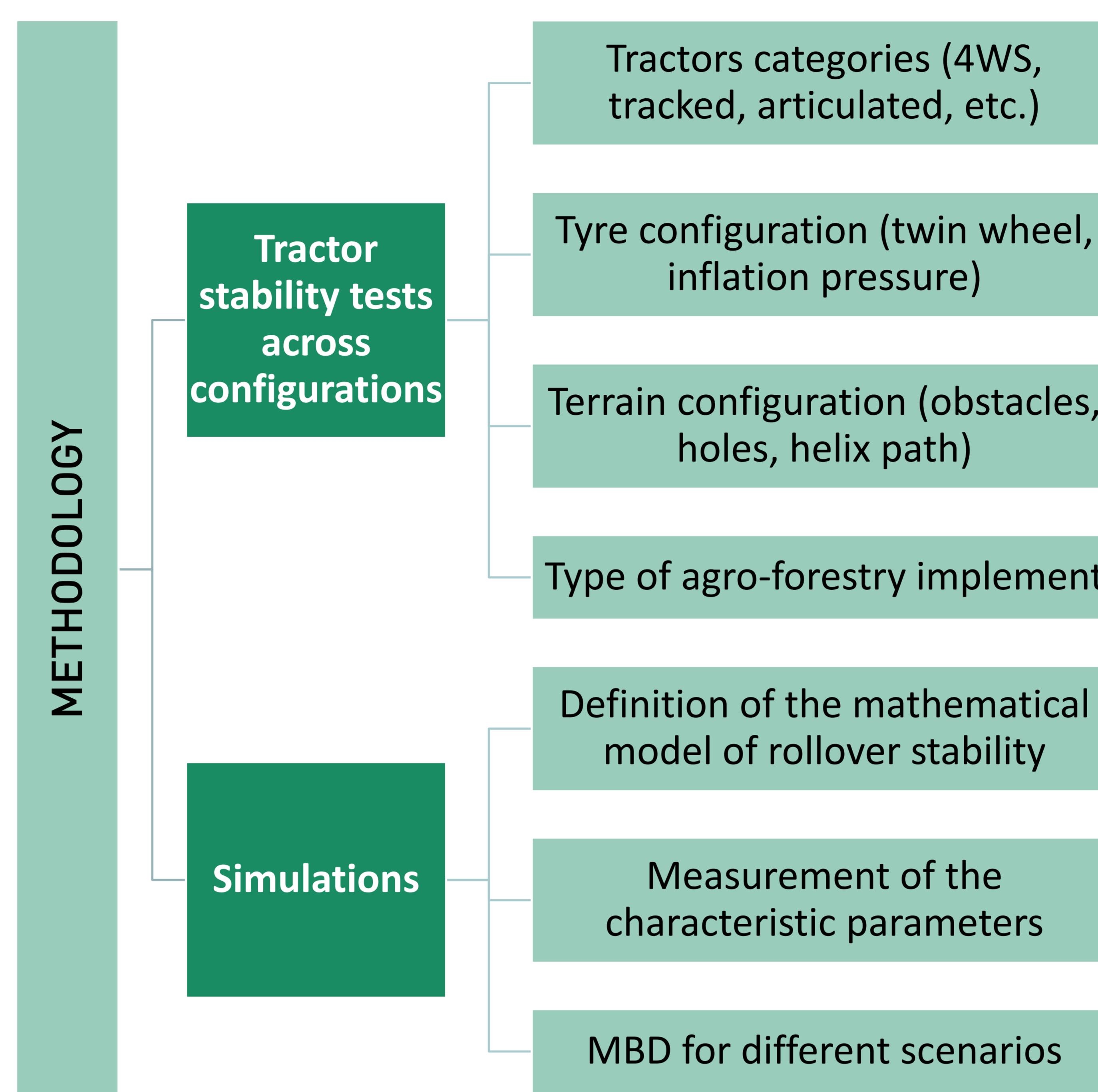


Figure 1: Stability tests of various tractors

EXPERIMENTS

Test-rig properties:

- Tilttable and rotatable platform,
- 10-ton weight capacity,
- 6.42 x 4.46 m overall dimensions,
- Capacity to simulate bump or potholes,
- Special metal grids to increase friction.

Test procedure:

- Measurement of the main dimension,
- CoG measurement: angles are scanned with 15° step for 15° and 20° of tilt angle and wheel loads are measured.
- Tilt angle measurement: angles are scanned with 15° step until one of the wheels detach from the platform surface.

RESULTS:

- A stability map is a graphical tool that represents the tractor stability condition.
- Radial axis -> tilt angle (α),
- Circumferential axis -> orient. angle (β)
- $\beta=+90^\circ$ right lateral,
- $\beta=-90^\circ$ left lateral,
- $\beta=0^\circ$ front,
- $\beta=180^\circ$ rear tilting conditions.
- Lines are the results of the stability simulator and MBD analyses,
- Coloured dots are the values obtained from experimental procedure.

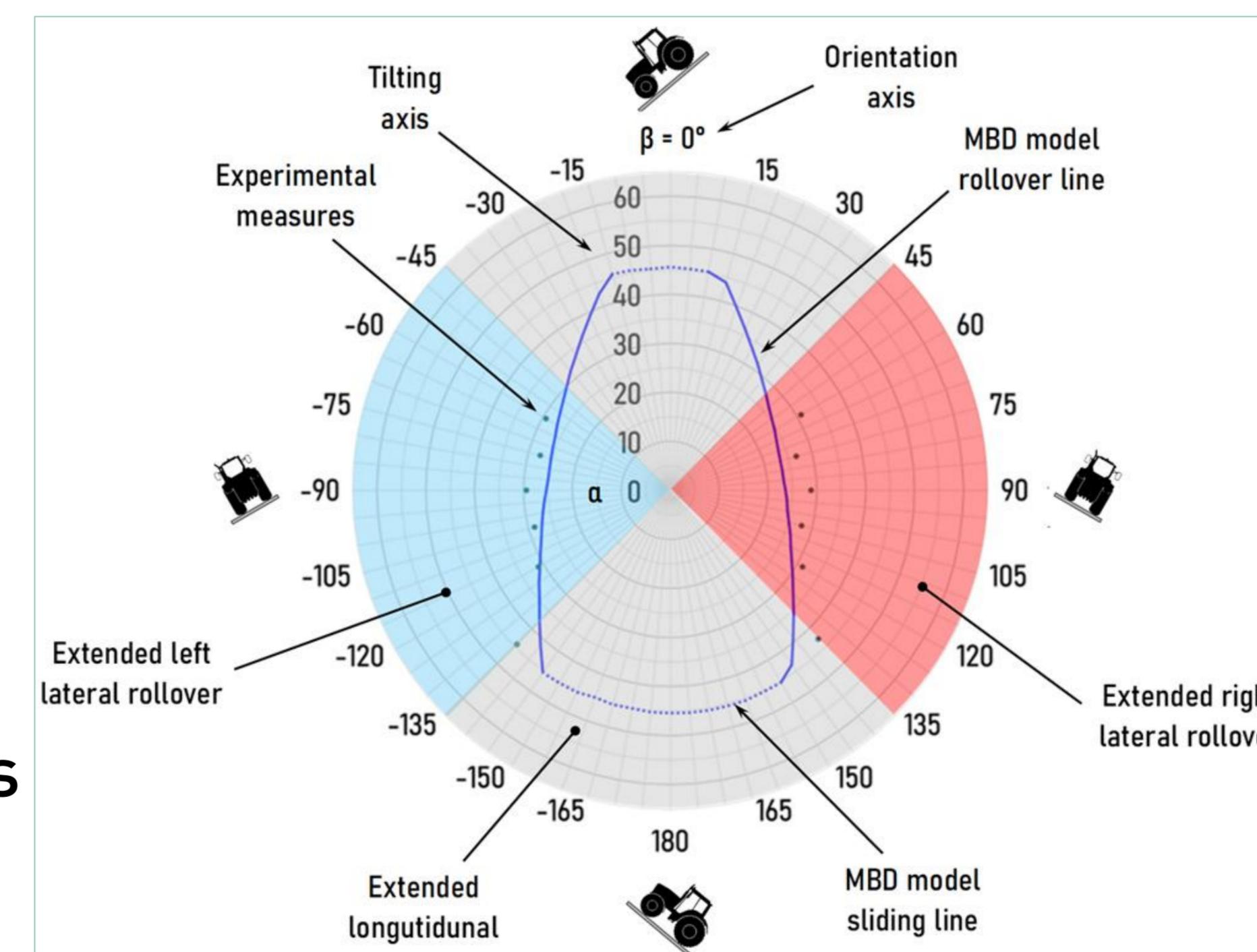


Figure 2: MBD model of the stability test

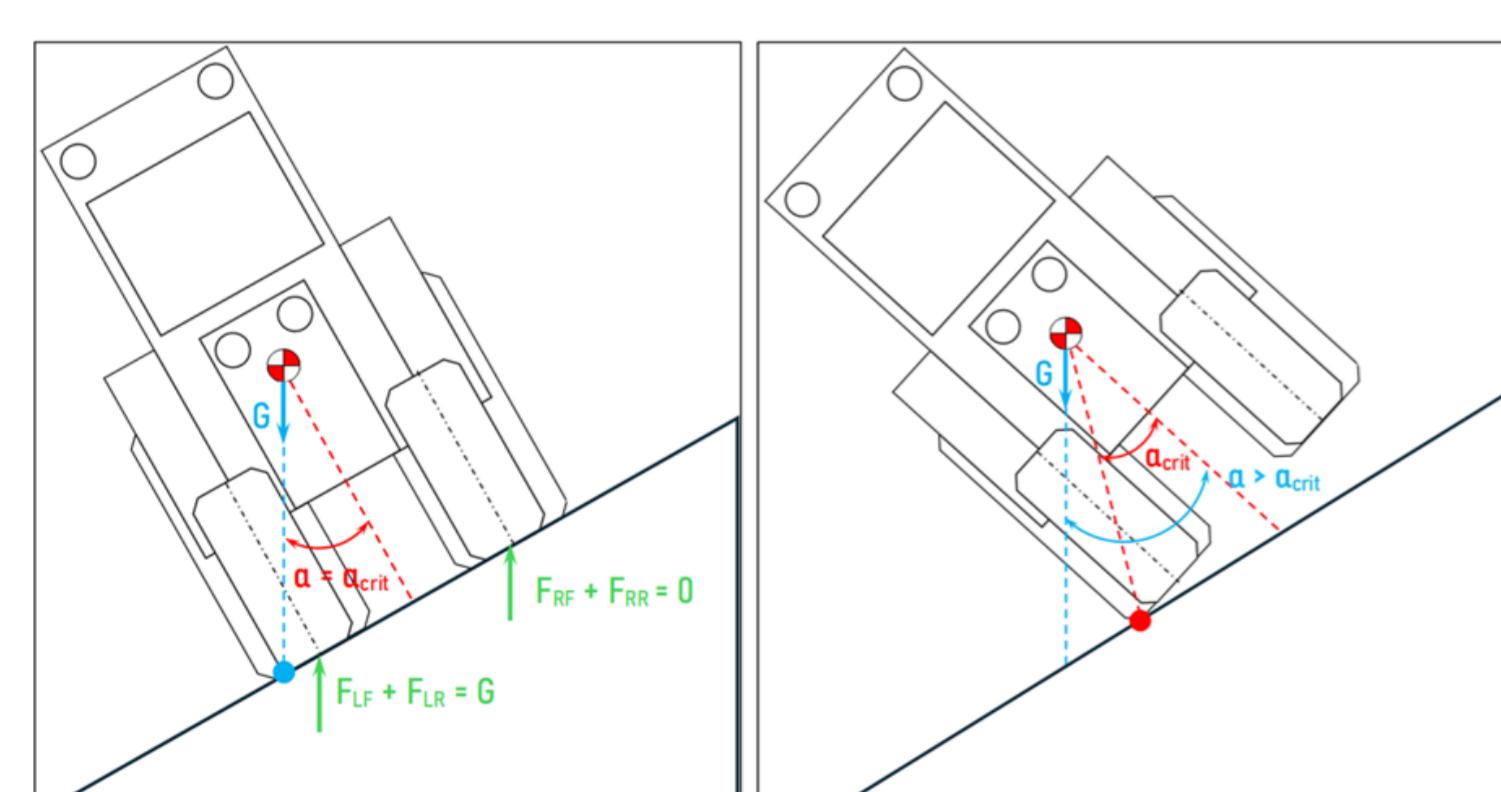


Figure 3: Stability condition of a tractor

ONGOING ACTIVITIES:

- Stability estimator prototype
- MBD simulations → dynamic scenario and various road/obstacle profile analyses
- Realistic tyre model adaptations

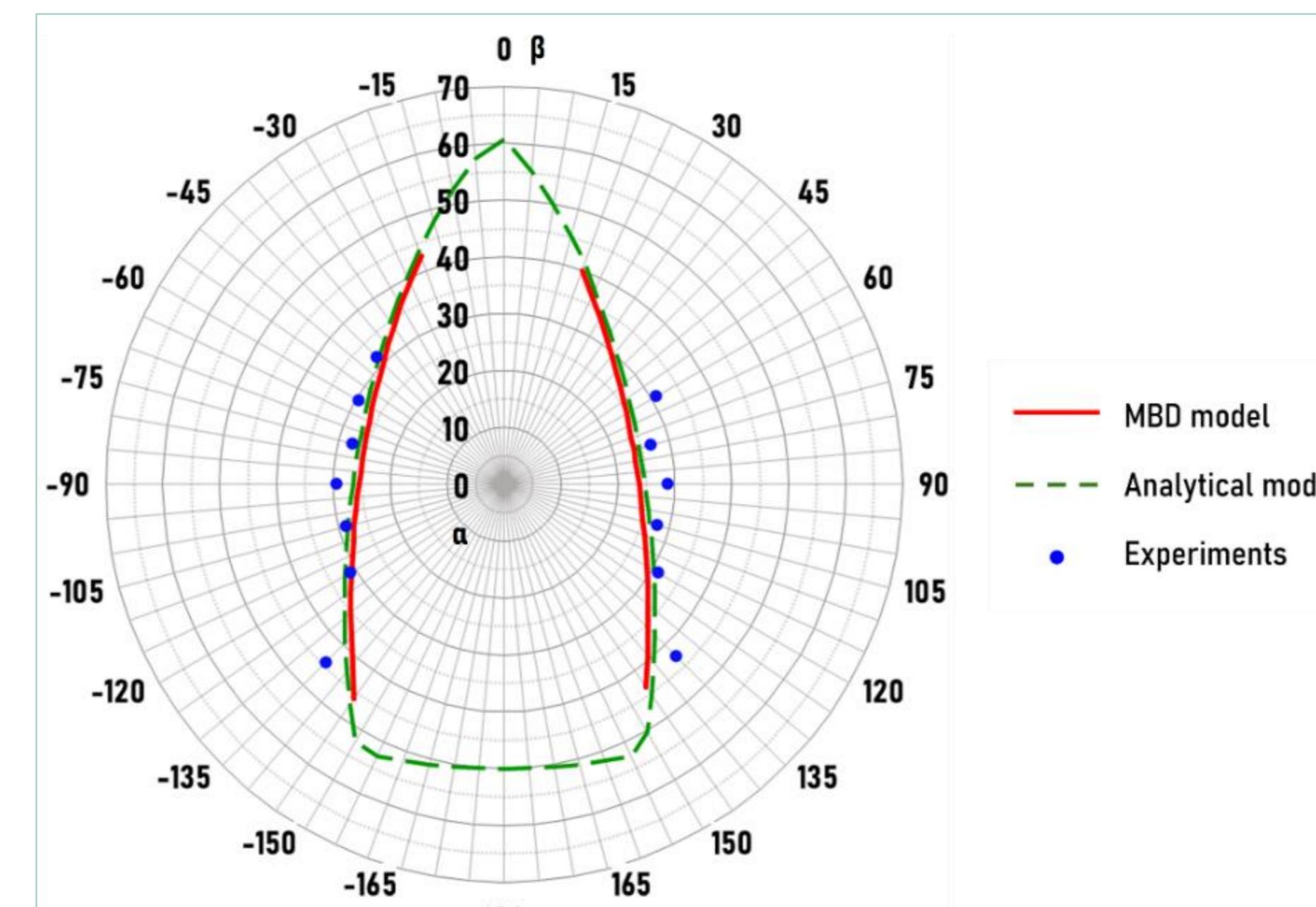


Figure 4: Stability maps of different scenarios and simulators

ACHIEVEMENTS:

- CoG determination
- Rollover risk characterization
- Stability simulator and stability maps
- Implement induced stability assessments
- Multi-dimensional risk assessment
- MBD analyses and tire behaviour investigation
- MBD models for dynamic scenario investigation
- Instantaneous position and orientation determination with gravitational sensors
- Operational monitoring