

## TRACTOR ROLLOVER INVESTIGATION AND STABILITY TESTS

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### 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

Simulator for tractor stability estimation. Sloped and rugged farming terrains.

### CHALLENGES

Challenging regional conditions. Enhanced safety and efficiency in farming.

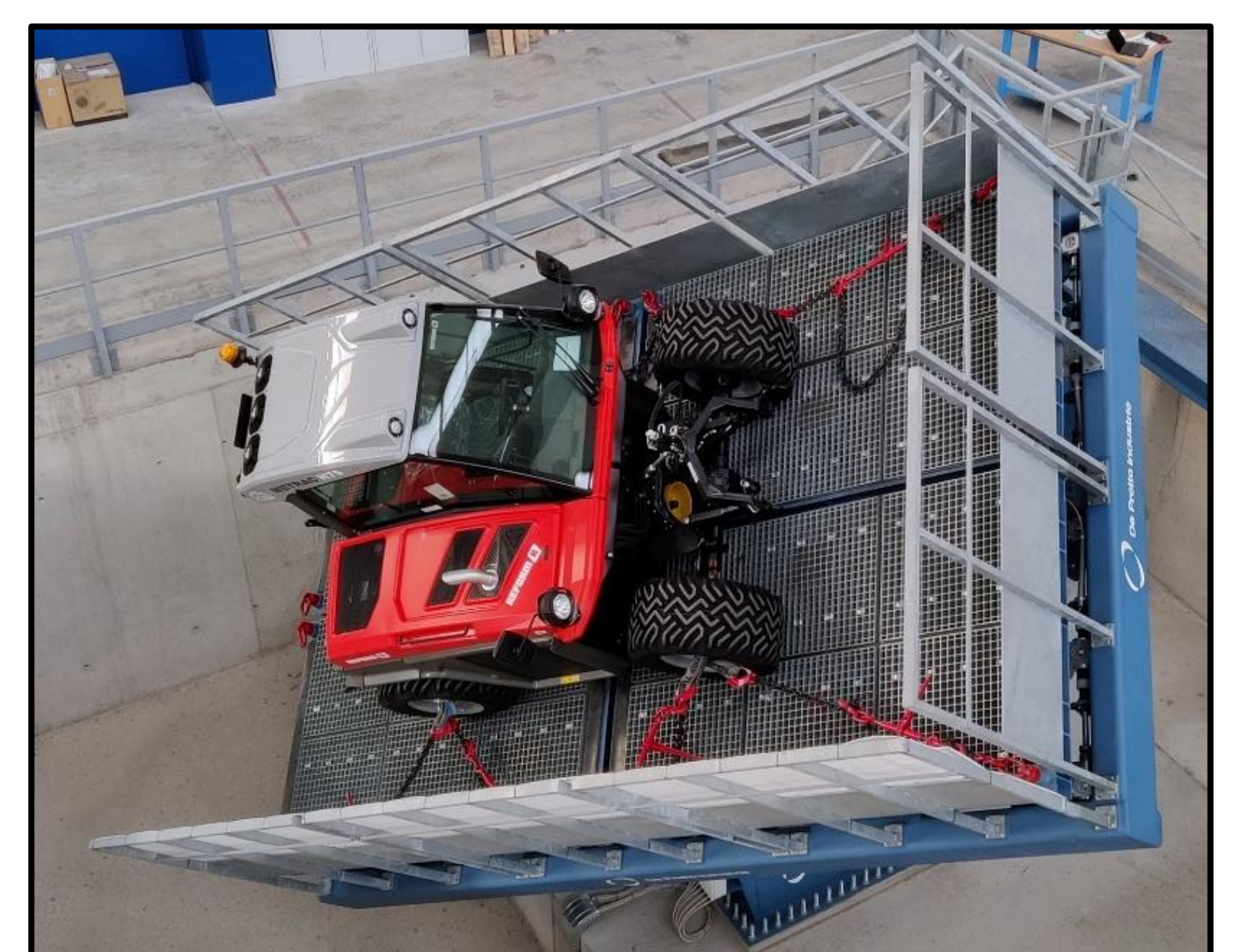
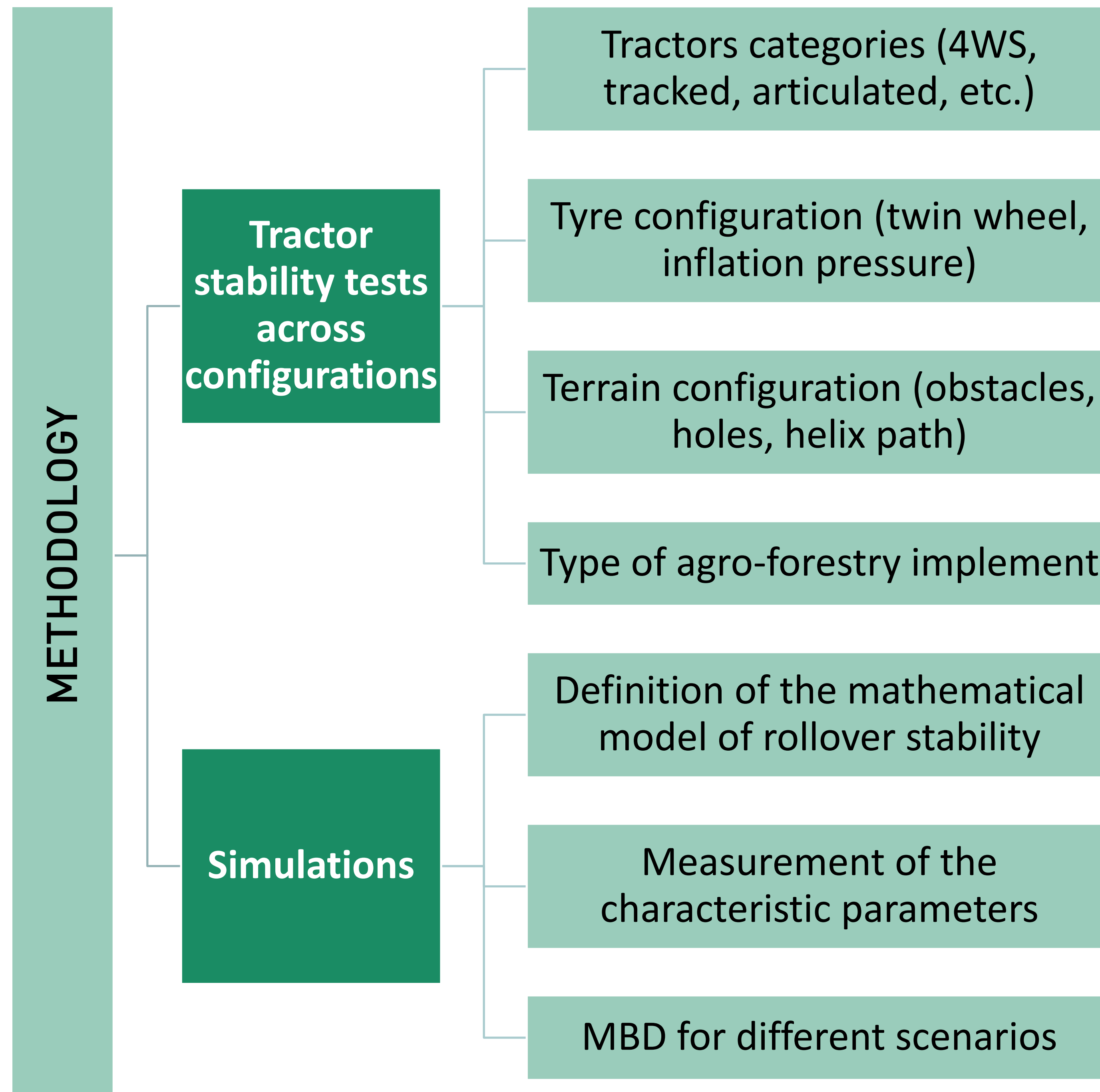


Figure 1: Stability tests of various tractors

### EXPERIMENTS

#### Test-rig properties:

- Tiltable 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 ( $\alpha$ ),
- Circumferential axis -> orient. angle ( $\beta$ )
- $\beta = +90^\circ$  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.

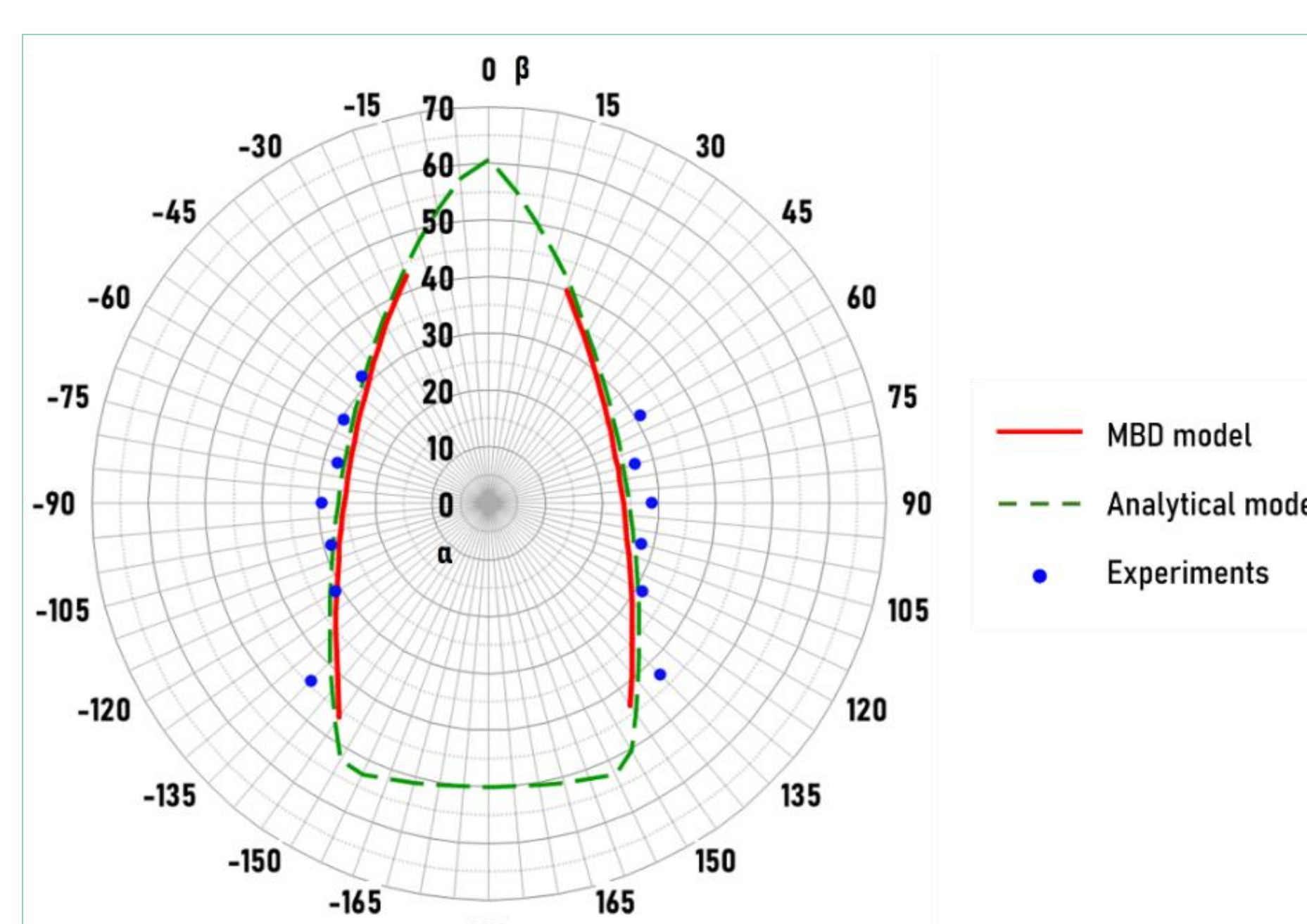
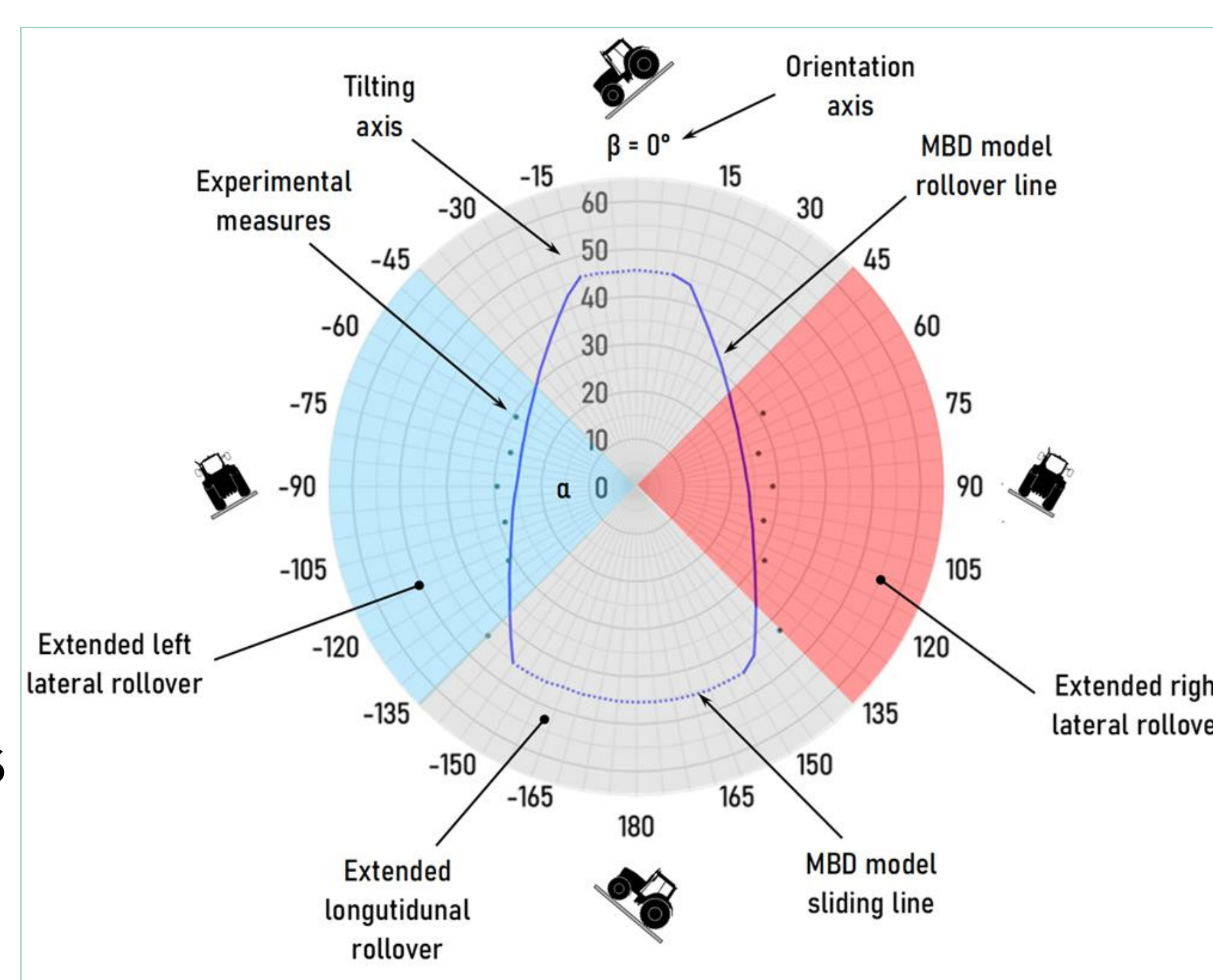


Figure 4: Stability maps of different scenarios and simulators

### 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

### ONGOING ACTIVITIES:

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

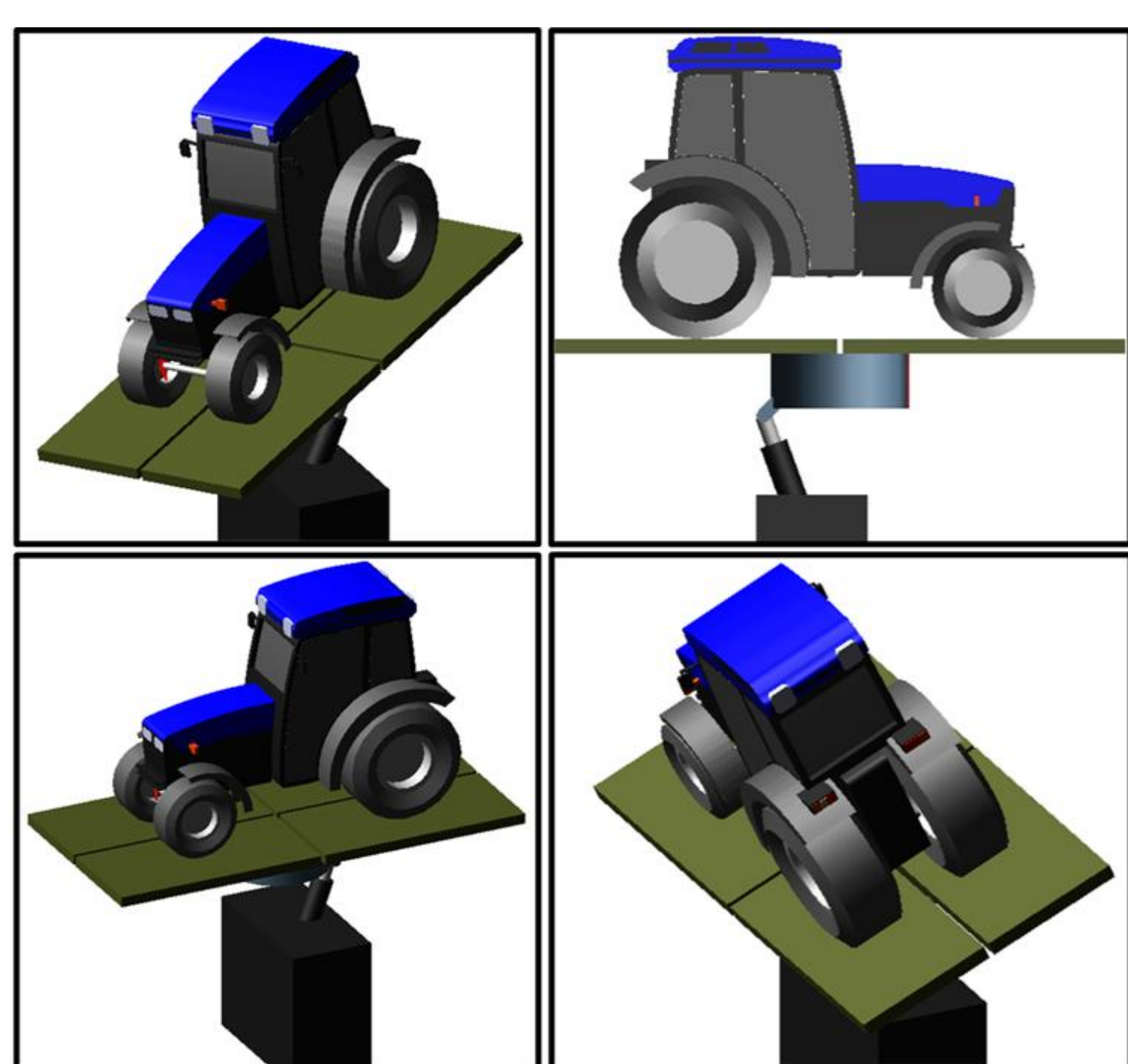


Figure 2: MBD model of the stability test

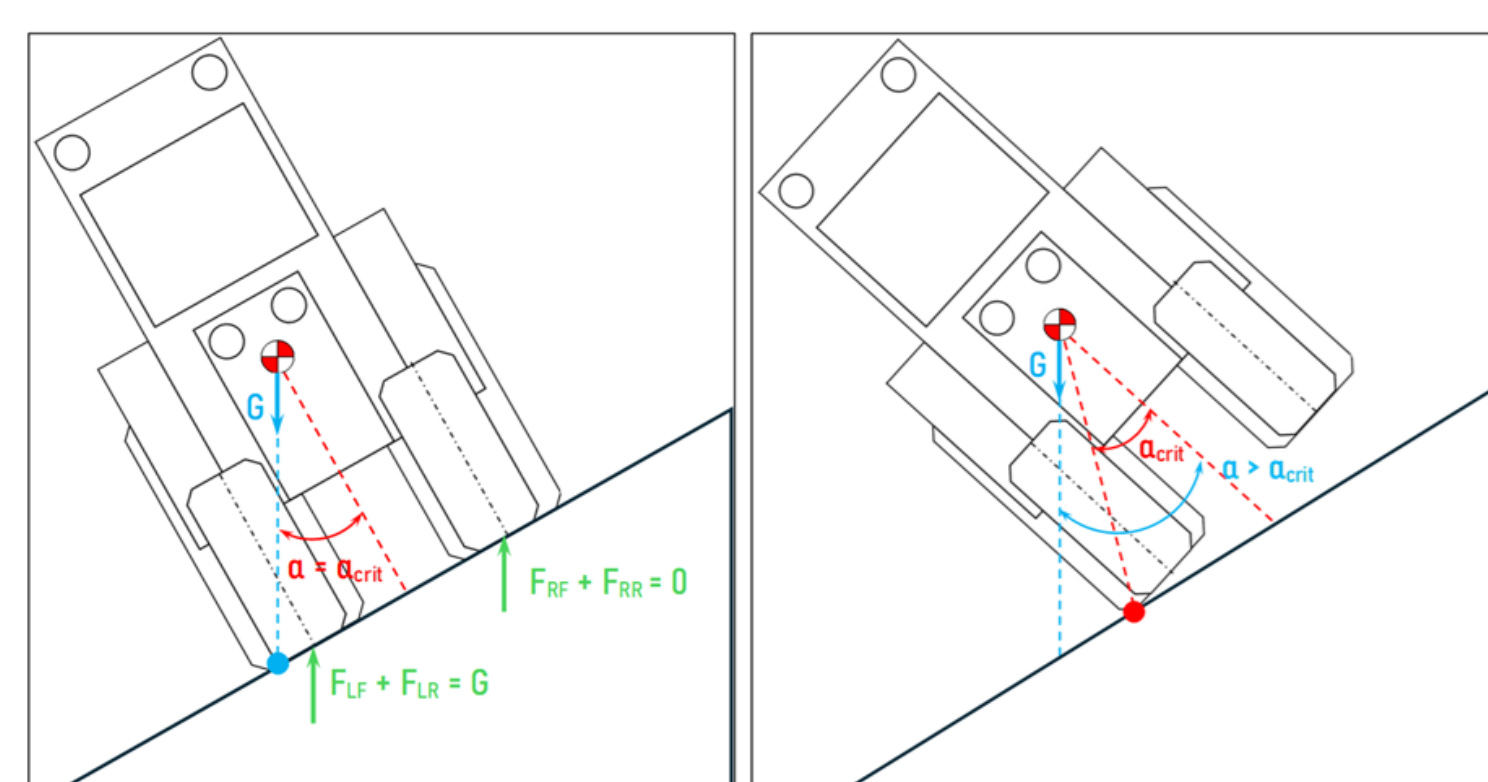


Figure 3: Stability condition of a tractor