Electrorheologic semi-active damper for racing motorcycles

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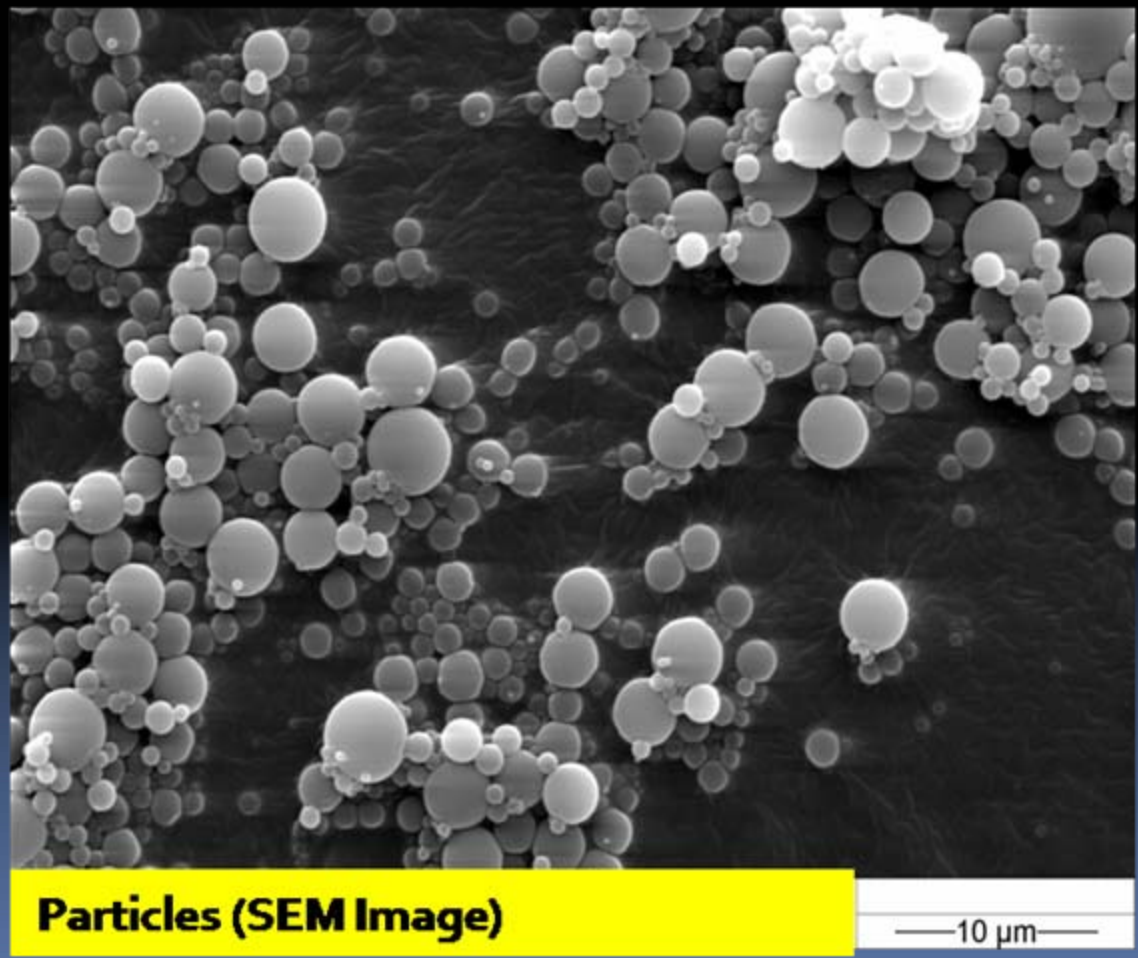
Agenda

- Some words about electrorheology
- Motorcycle riding dynamics characteristics
- Positive effects of ER technology on motorcycle riding dynamics
- ER rear damper design
- Damper performance comparison

ER Fluid

- Fludicon's ER Fluid is a dispersion of electrically polarizable particles (PUR) in a nonpolar base liquid (silicone oil)
- Non-abrasive
- Non-toxic
- Lightweight



ER Fluid

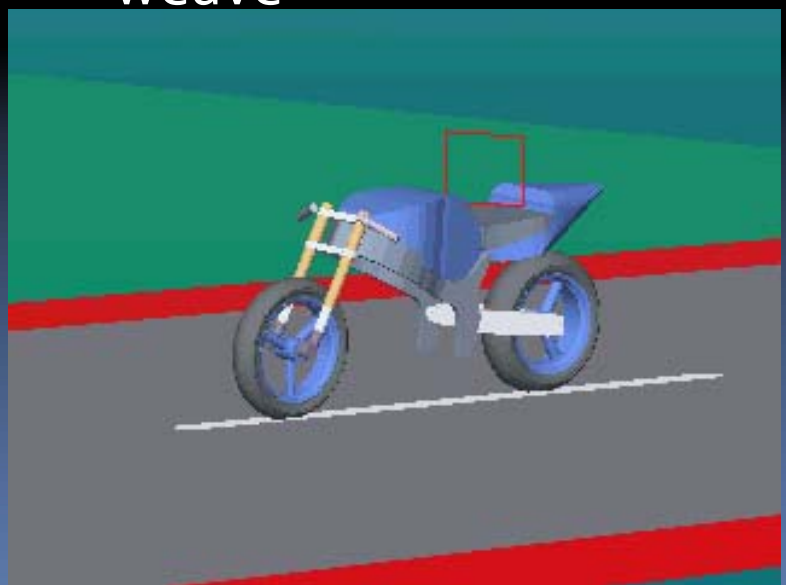
- An electric field induces dipoles in the particles (PUR) which form chain-like structures along the electric field lines. Therefore the visco-elastic behaviour of the ERF changes dramatically from a Newtonian fluid to a Bingham Plastic
- This change is continuous, reversible and extremely fast (< 1ms)

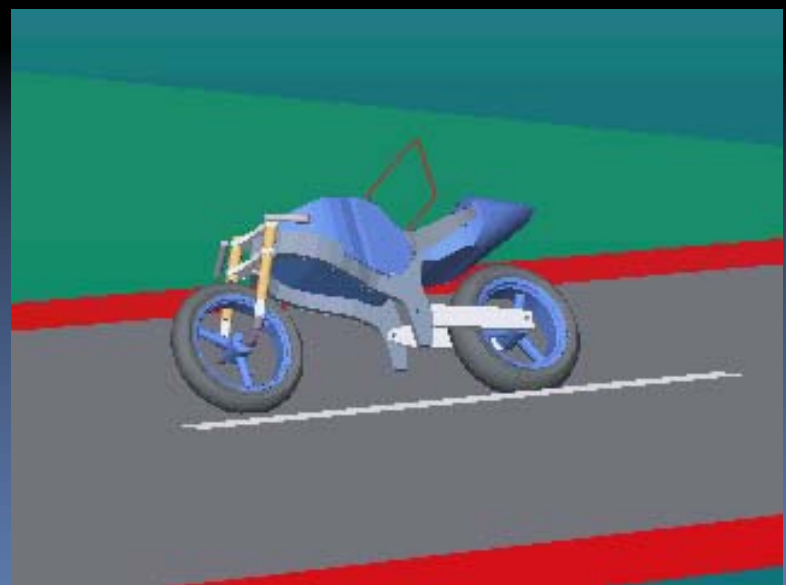
Motorcycle Riding Dynamics

- Longitudinal Dynamics – Pitch
  - High center of gravity in combination with short wheelbase and suspension kinematics leads to large pitch motions when braking
  - Especially at the beginning of a braking manoeuvre, wheel loads strongly depend on pitch angle and its derivations
  - When racing, the pitch angle should be built up as quickly as possible
  - In real-world traffic situations, front wheel load must be built up as quickly as possible to prevent dynamic front locking and to help ABS to achieve short braking distances

Motorcycle Riding Dynamics

- Lateral Dynamics – Weave
  - Every lateral motion leads to suspension response, wheel load depends on roll angle and its deviations
  - Especially in-curve weave leads to strong suspension response
  - Semi-active suspensions can dramatically mitigate in-curve weave





Courtesy of R.S. Sharp, ICO London

Motorcycle Riding Dynamics

- Lateral Dynamics – Wobble / Kickback
  - One essential cause for wobble is front wheel load variation
  - Semi-active suspensions can mitigate wobble events

Courtesy of Eurosport

Motorcycle Riding Dynamics

- Lateral Dynamics – Highsider
  - When a sliding rear wheel grips again, the rear spring is compressed dramatically
  - The rapid expansion of this preloaded spring leads to a catapult-like acceleration of rider and motorcycle, mostly upwards
  - ***eRRide*** technology restrains spring uptake and expansion and so mitigates highsider events

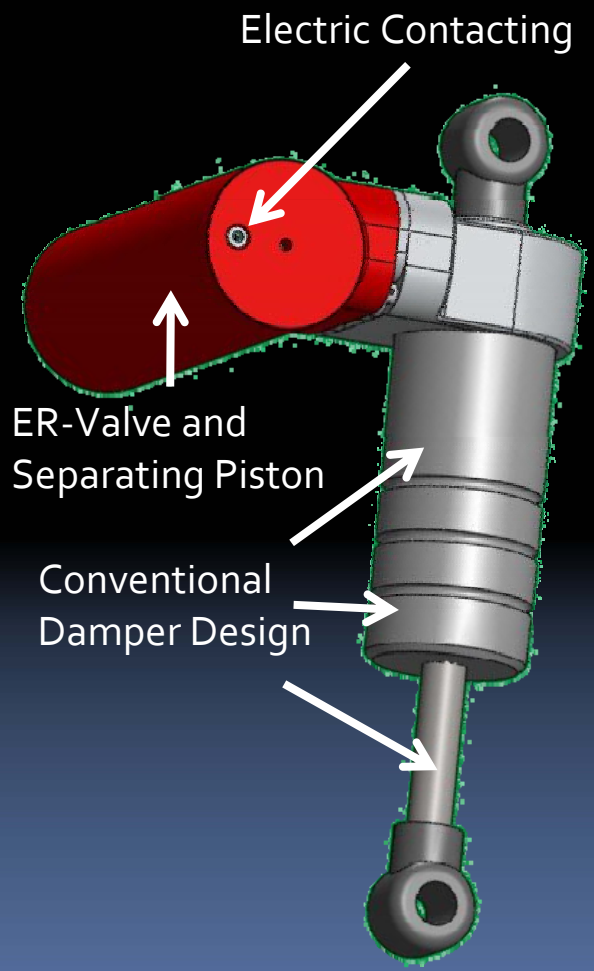
Courtesy of RTL

Motorcycle Riding Dynamics

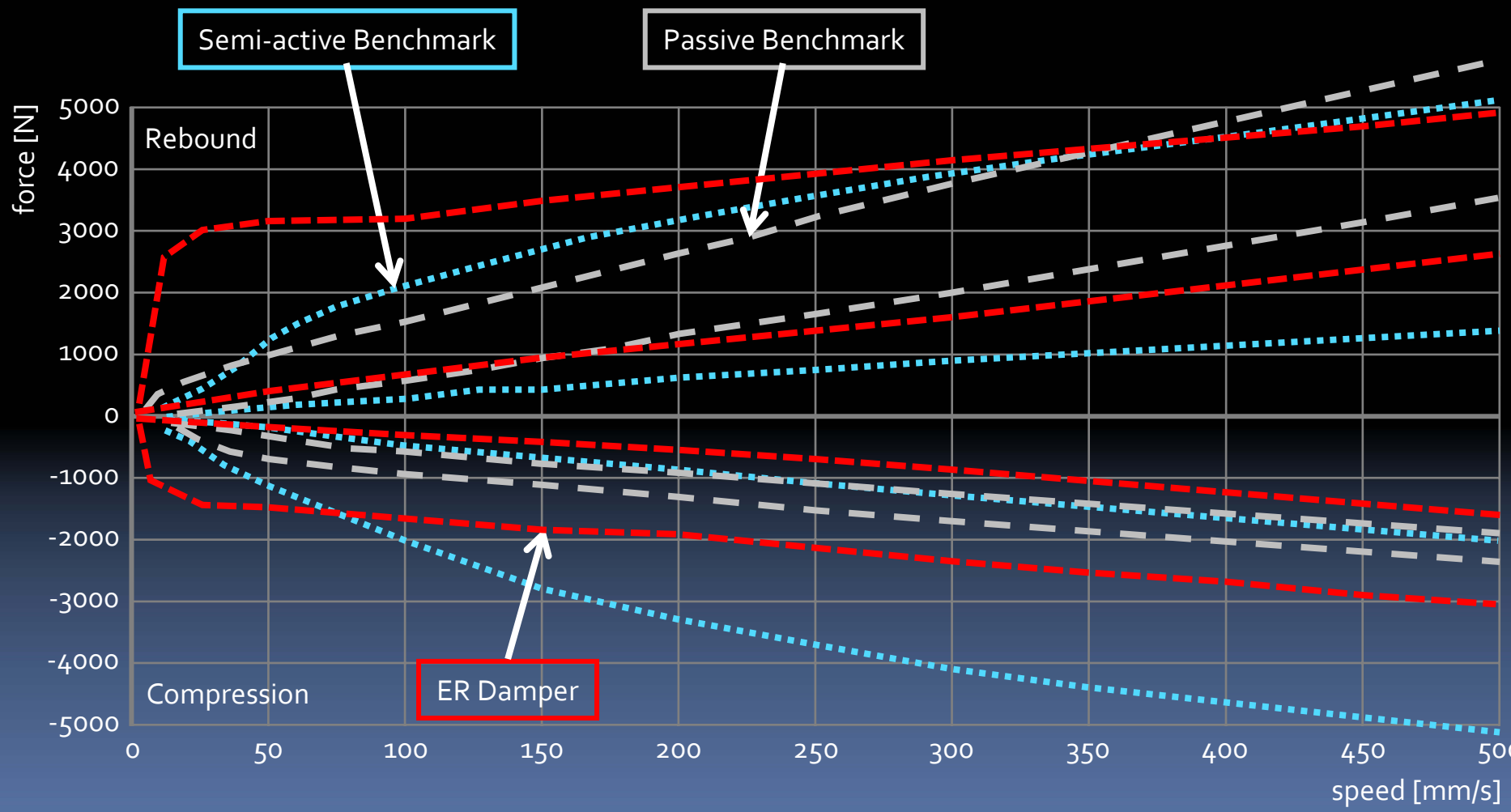
- Vertical Dynamics – Load, Comfort and Wheel Load Variations
  - Wheel load variation of motorcycles in some driving situations is extreme (can exceed 400% of static wheel load)
  - Semi-active suspensions with high authority on the vehicle like ***eRRide*** considerably reduce heave and pitch motions and so improve rider comfort
  - Dynamic wheel load variations are clearly reduced by ***eRRide*** , the fastest responding semi-active suspension system offered today. This is extremely helpful in ABS braking situations on uneven road

ER Motorcycle Damper Design

- Damper packaging designed for actual motorcycle
- Damping force is only generated on the pressure side
- Static friction < 40N; comparable to the friction of top-quality off-the-shelf shock absorbers for hyper-sport motorcycles
- High hydraulic stiffness; extremely fast response to highly dynamic events such like tyre chatter (<< 10µs)
- High authority especially at low damper velocities
- Extremely quick response to force change requests (< 10ms)



ER Motorcycle Damper Benchmark



ER Motorcycle Damper System and Project Issues

- System to be completed by client (ECU, tuning software, sensors, control)
- Ongoing tests at damper manufacturer
- Future tests at OEM on race track
- Pre-production 1Q10

THANK YOU