Technische Universität Braunschweig

IGEP TU Braunschweig Institut für Geophysik und extraterrestrische Physik

# Bouncing Probe Proposal for characterisation of surface stiffness properties

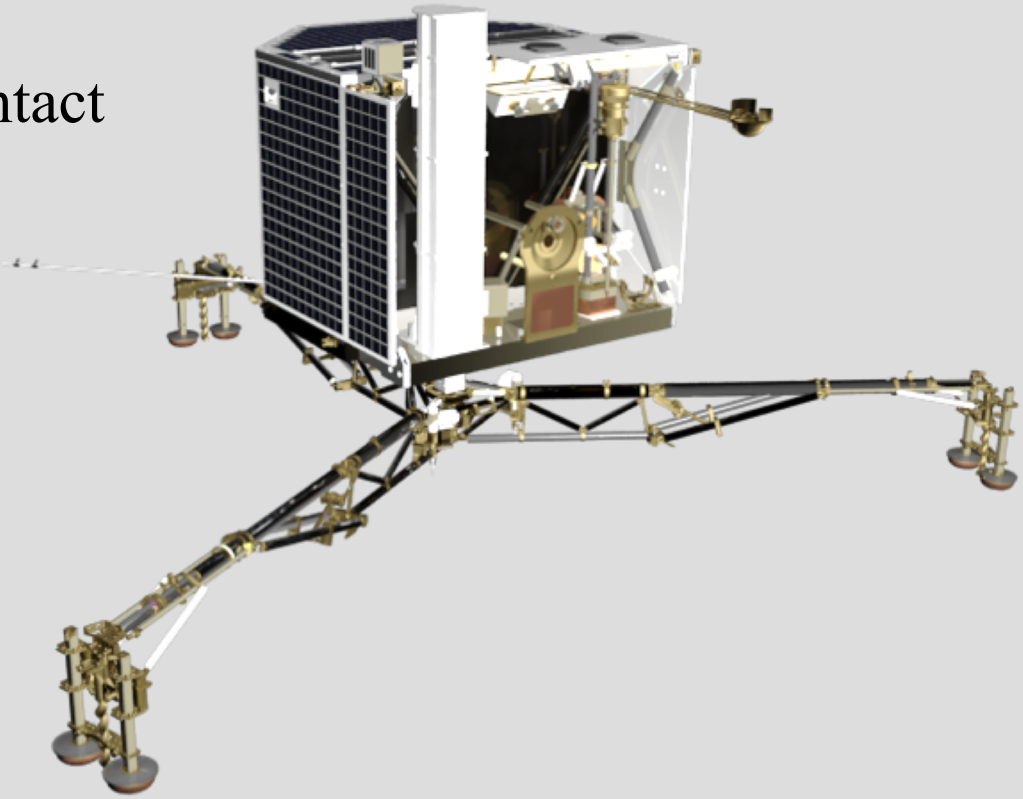
Uli Auster, David Hercik, Karl-Heinz Glaßmeier

TU-Braunschweig

# Experiences from PHILAE mission

ROMAP Magnetometer:

- Attitude
- Acceleration during contact
- Timing



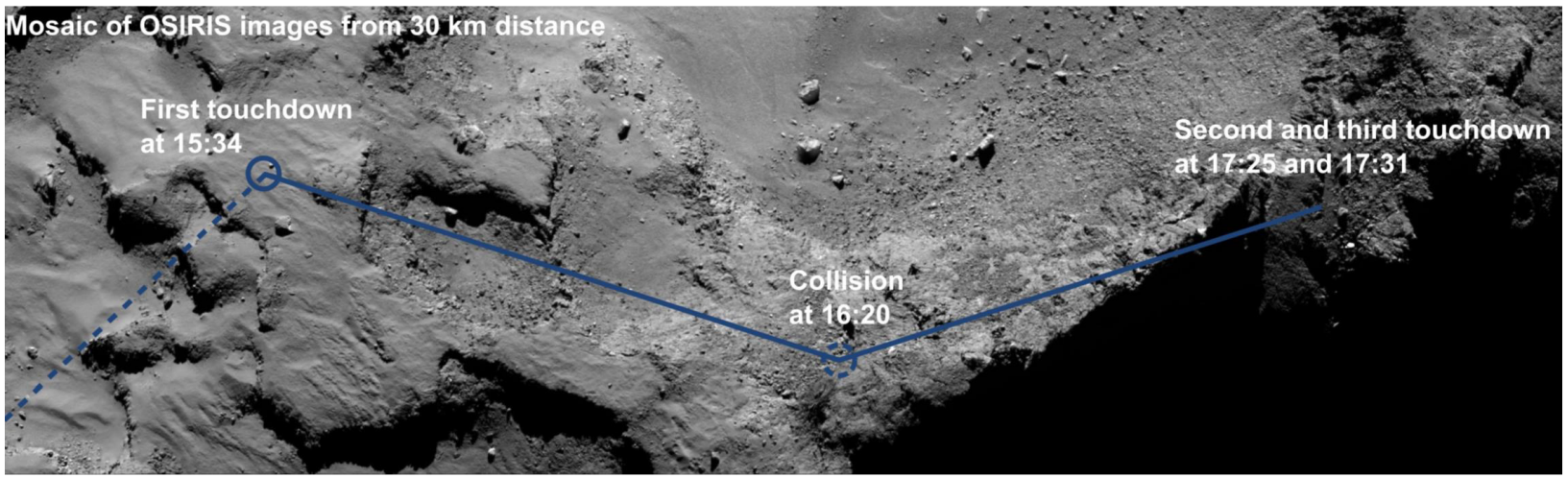
Technische Universität Braunschweig



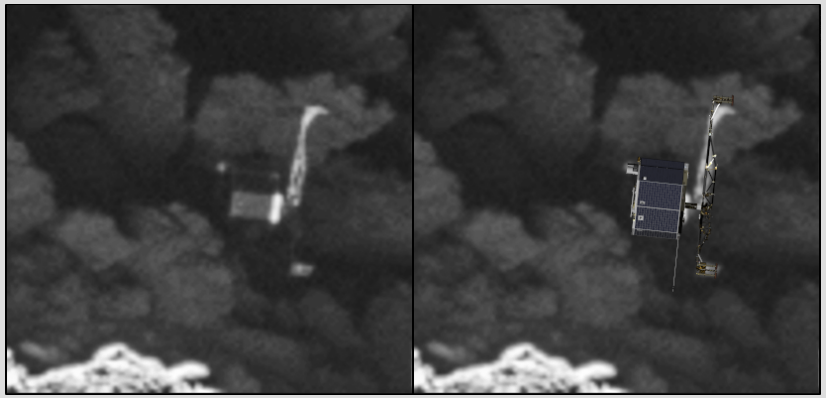
IGEP TU Braunschweig Institut für Geophysik und extraterrestrische Physik

# Experiences from PHILAE mission

Investigation of Lander motion (touchdowns, rotation) and Lander orientation




- Input for Lander operation
- Recovering of data during bouncing
- Surface properties particularly at collision and second touchdown



Technische Universität Braunschweig

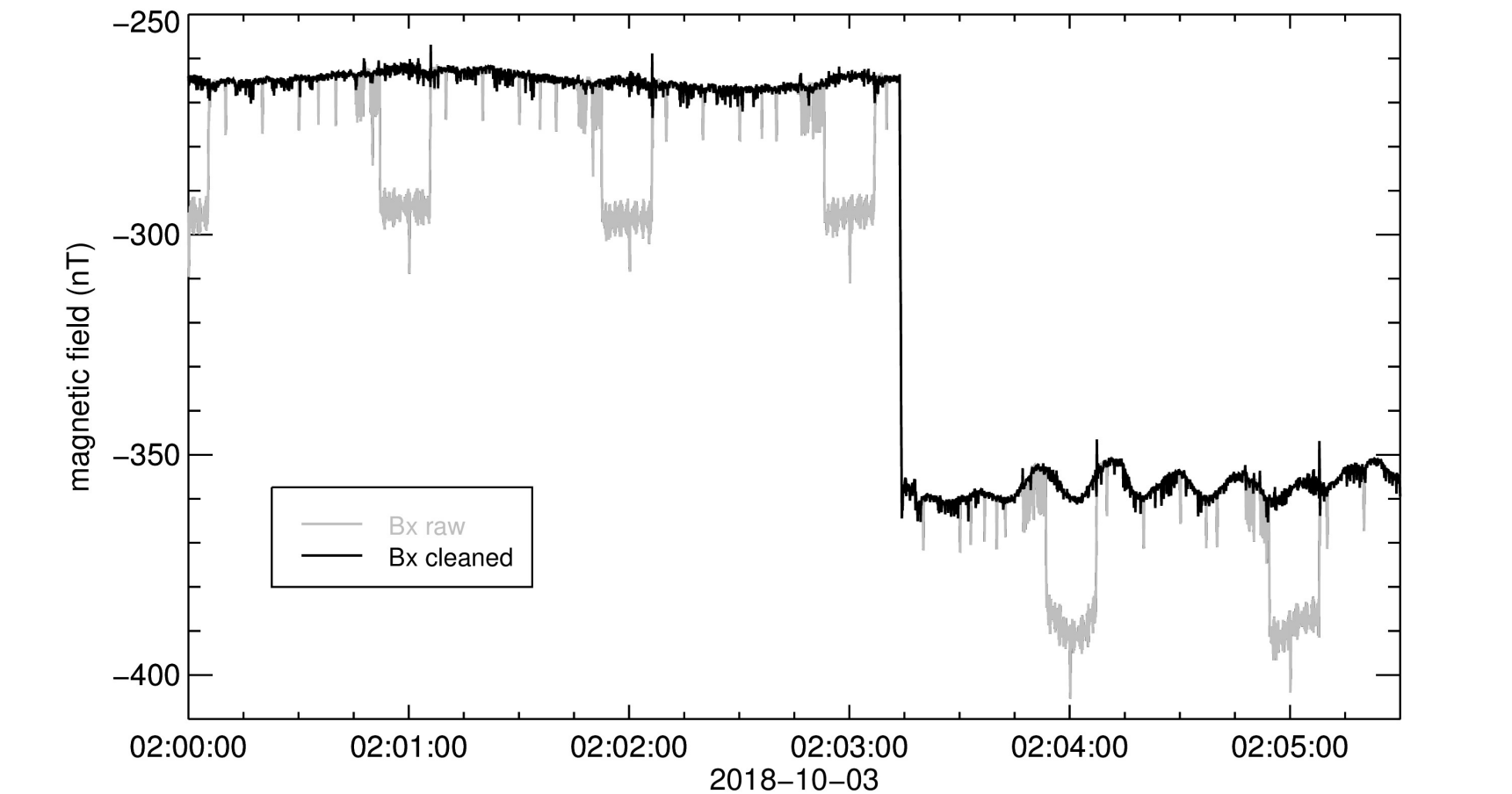
IGEP TU Braunschweig Institut für Geophysik und extraterrestrische Physik

# Experiences from PHILAE mission

- MAG data and OSIRIS images allowed flight reconstruction
- TD dynamics based on MAG data
  -> Determination of energy balance & contact forces

- Collision: $\leq$ 399 Pa
- Touchdown 2: $\leq$ 147 Pa
- Scratches: $\leq$ 10 Pa

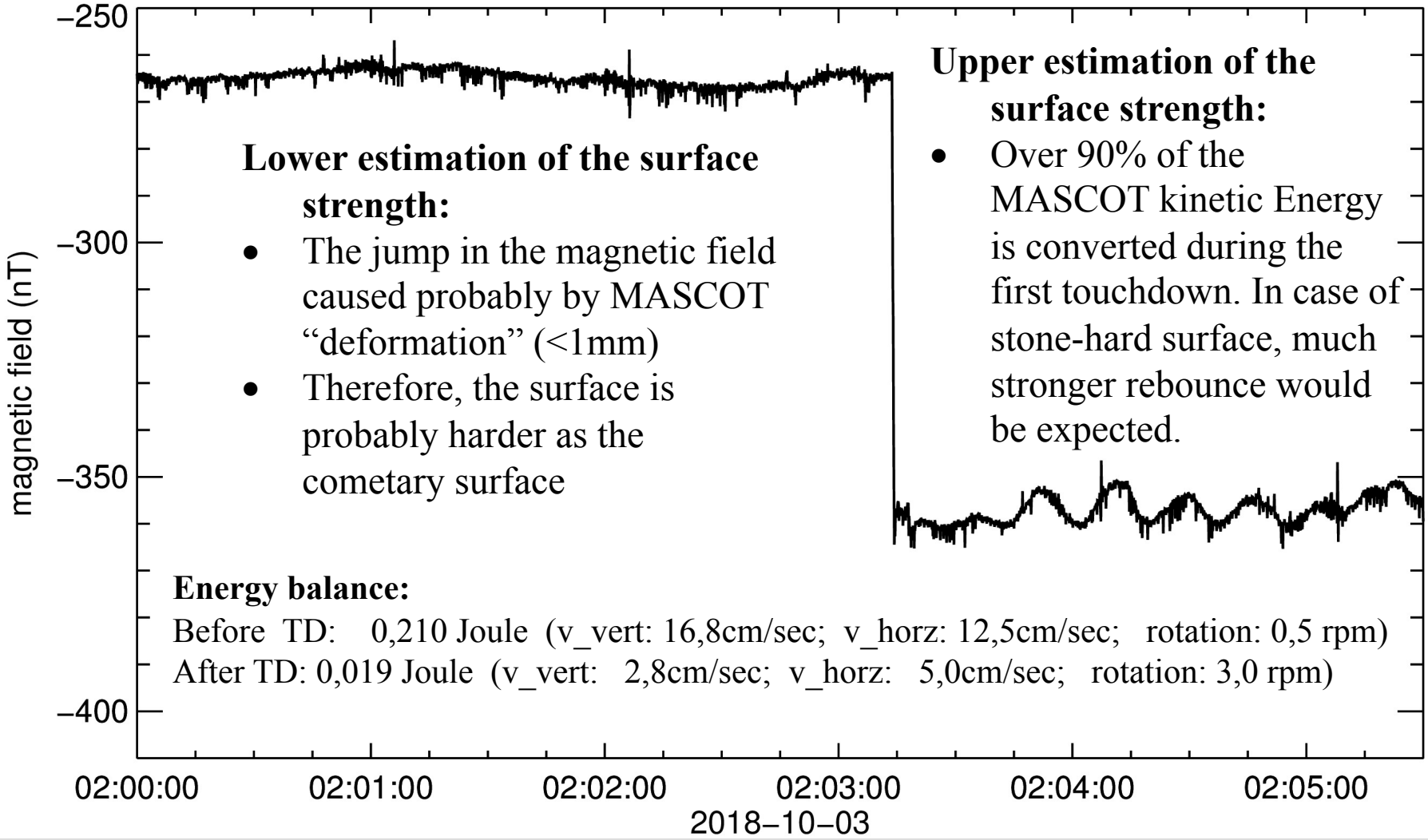
# Experiences from MASCOT mission




Technische Universität Braunschweig

IGEP TU Braunschweig Institut für Geophysik und extraterrestrische Physik

# Experiences from MASCOT mission




**Lower estimation of the surface strength:**

- The jump in the magnetic field caused probably by MASCOT "deformation" (<1mm)
- Therefore, the surface is probably harder as the cometary surface

**Upper estimation of the surface strength:**

- Over 90% of the MASCOT kinetic Energy is converted during the first touchdown. In case of stone-hard surface, much stronger rebounce would be expected.

**Energy balance:**

Before TD: 0,210 Joule (v_vert: 16,8cm/sec; v_horz: 12,5cm/sec; rotation: 0,5 rpm)
After TD: 0,019 Joule (v_vert: 2,8cm/sec; v_horz: 5,0cm/sec; rotation: 3,0 rpm)

# Do it for HERA professionally

**How to optimize :**

- Bouncing shall be the primary goal of a cubesat
- Equipping the cubesat with a magnetic skin which allows the monitoring of any kind of deformation (temporary or permanent). Designed for being sensitive for surface strange between 0,1kPa … 1MPa
- Adding accelerometer for investigating bouncing behavior and cameras for observing impact depression to the instrument set

It’s collision physics on a smaller scale (dart failing to stick)

# Feasibility, TRL ?

**Cubesat :**

- No navigation needed, battery powered, telemetry has to be provided, livetime hours …

**Instruments :**

- Magnetometer TRL 9
- Accelerometer, is under development for MMX
- Cameras, hardware at different quality levels available, but more important: community has great skills in operating cameras

**Magnetic Skin :**

- TRL: -1, but a doable challenge …

# How to design a magnetic skin

**Mash of thin wires**

- Stimulated by the magnetometer electronics
- AC signals at different frequencies for each string or each string stimulated sequentially for separating areas of deformation
- Field changes trigger camera

**Compressible layer below mash**

- Permanent deformation (e.g of foam) with well tested energy absorption
- Spring like behavior (football) – fast detection needed