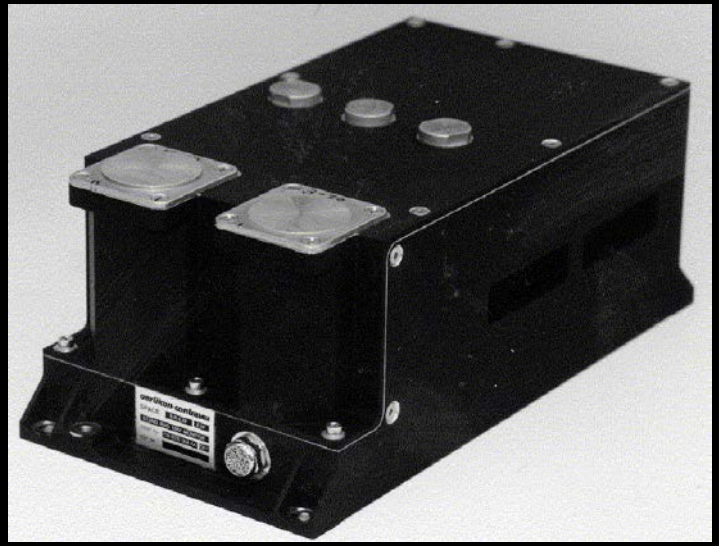
A mysterious attenuation of galactic cosmic rays in the environment of comet 67P/Churyumov-Gerasimenko, recorded by the radiation monitor onboard Rosetta

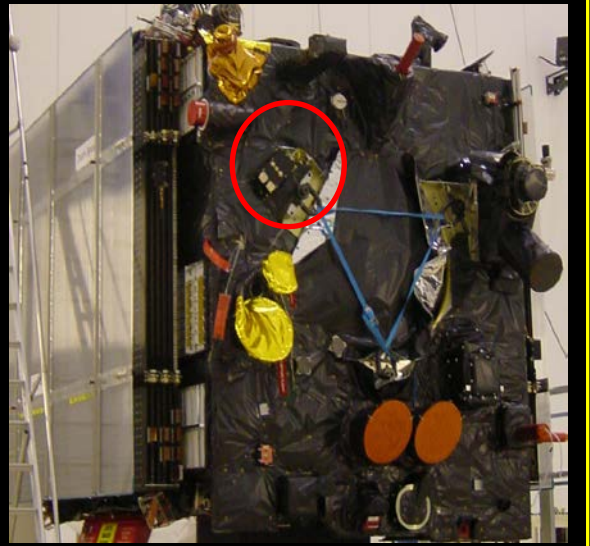
Olivier, Thomas, Erik, Matt, Owen, Denise, Yannis, ESA/TEC-EES,
Kiel and Leicester Universities colleagues

Radiation Environment Monitors



Instrument

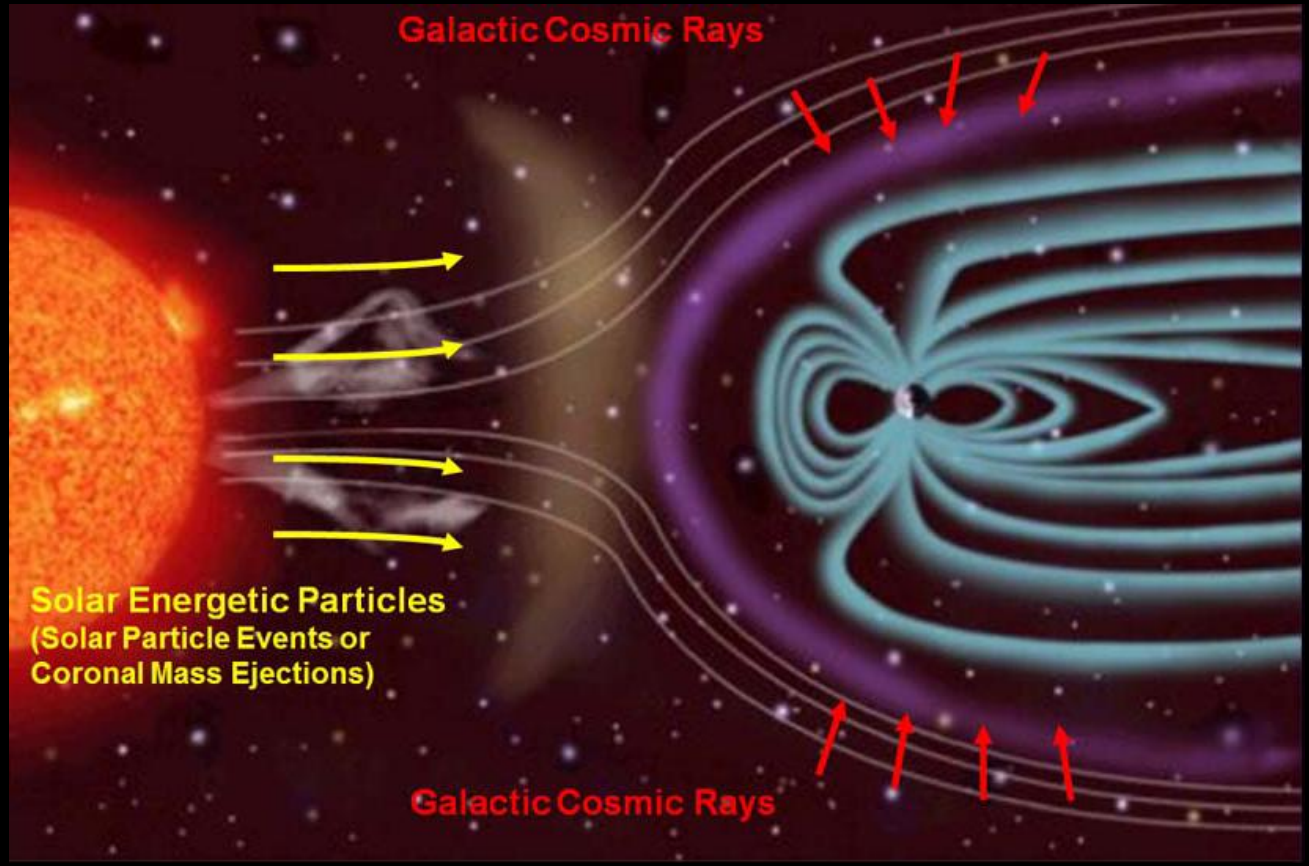
INTEGRAL



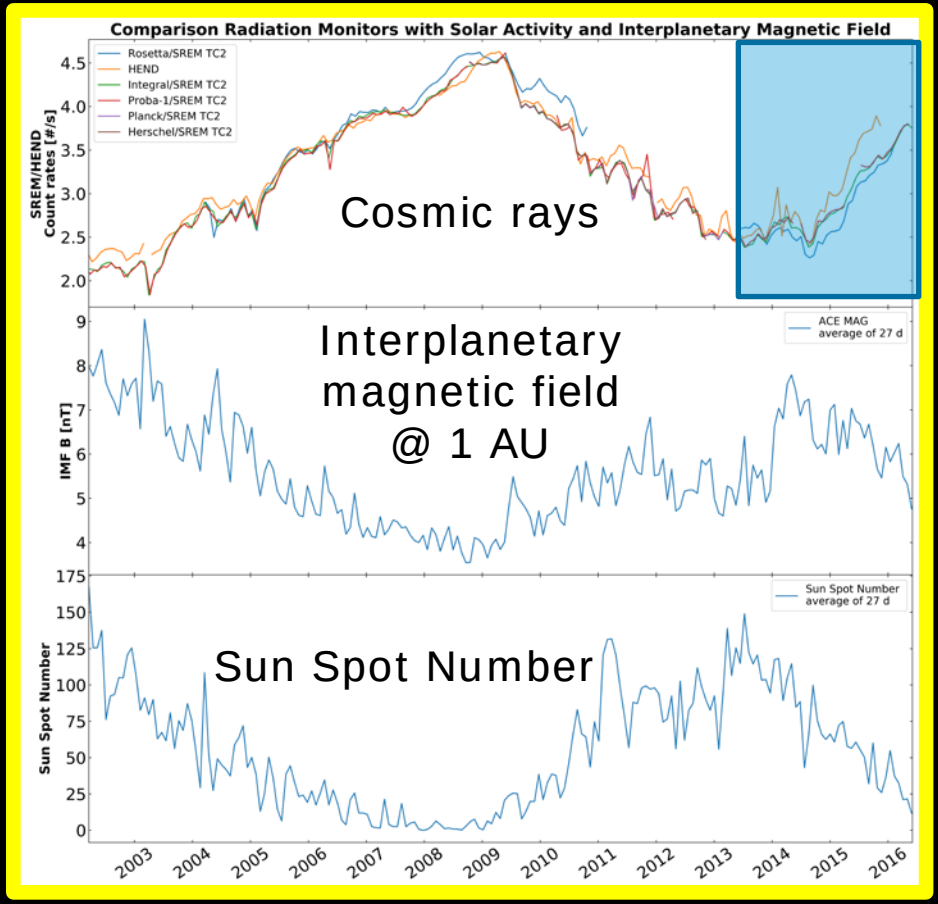
ROSETTA

Measurements
of protons (E>12 MeV)
and electrons (E> 1 MeV)

Radiation in the solar system



Temporal variations of the data over 15 years

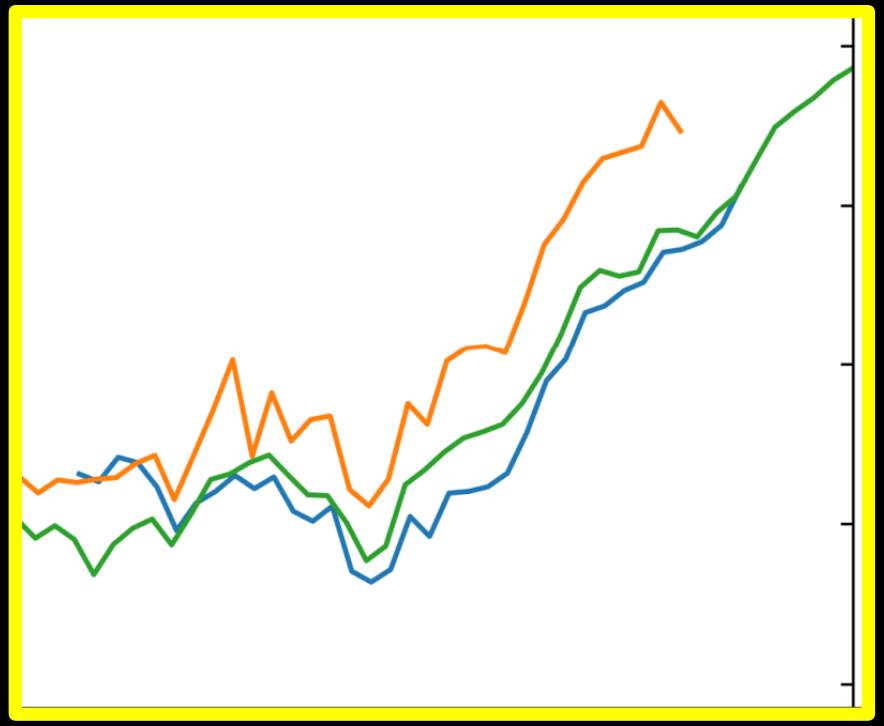


- Variation of cosmic ray intensity anti-correlated with interplanetary magnetic field and solar activity.
- Gradient with heliocentric distance of cosmic ray intensity can de computed:

Gradient : 2-3 % /AU

- Useful data set to understand the dynamics of the heliosphere, the propagation of solar wind features, propagation of galactic cosmic rays etc...

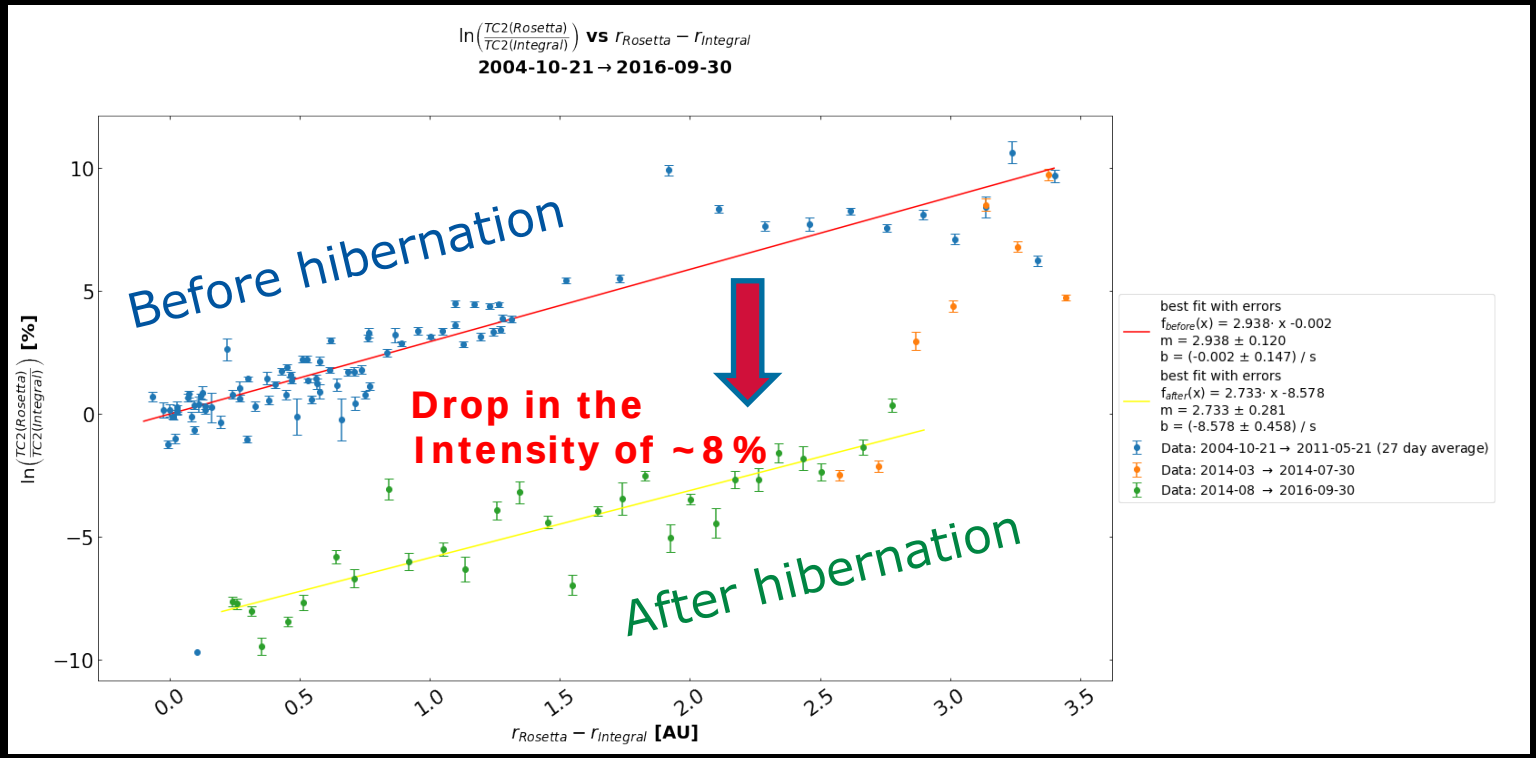
Zoom on the Rosetta science mission timeline



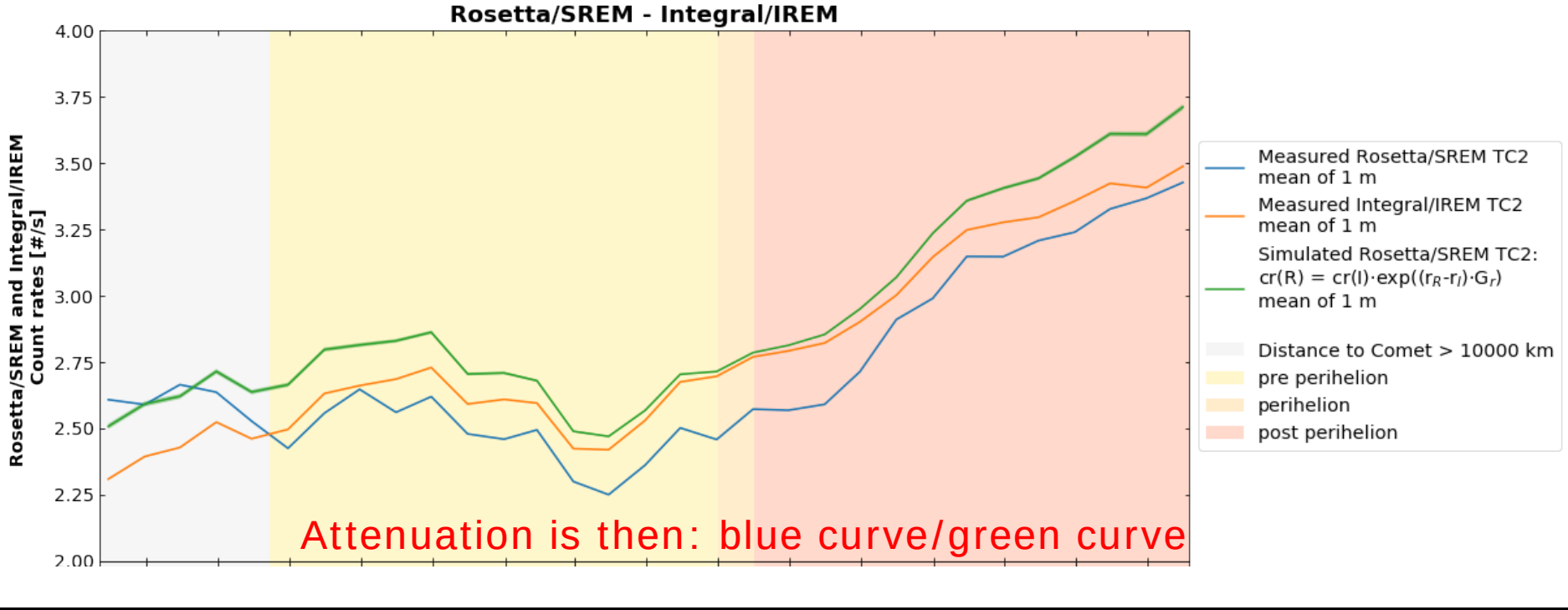
-- Mars data (ignore for the moment)
-- INTEGRAL
-- ROSETTA

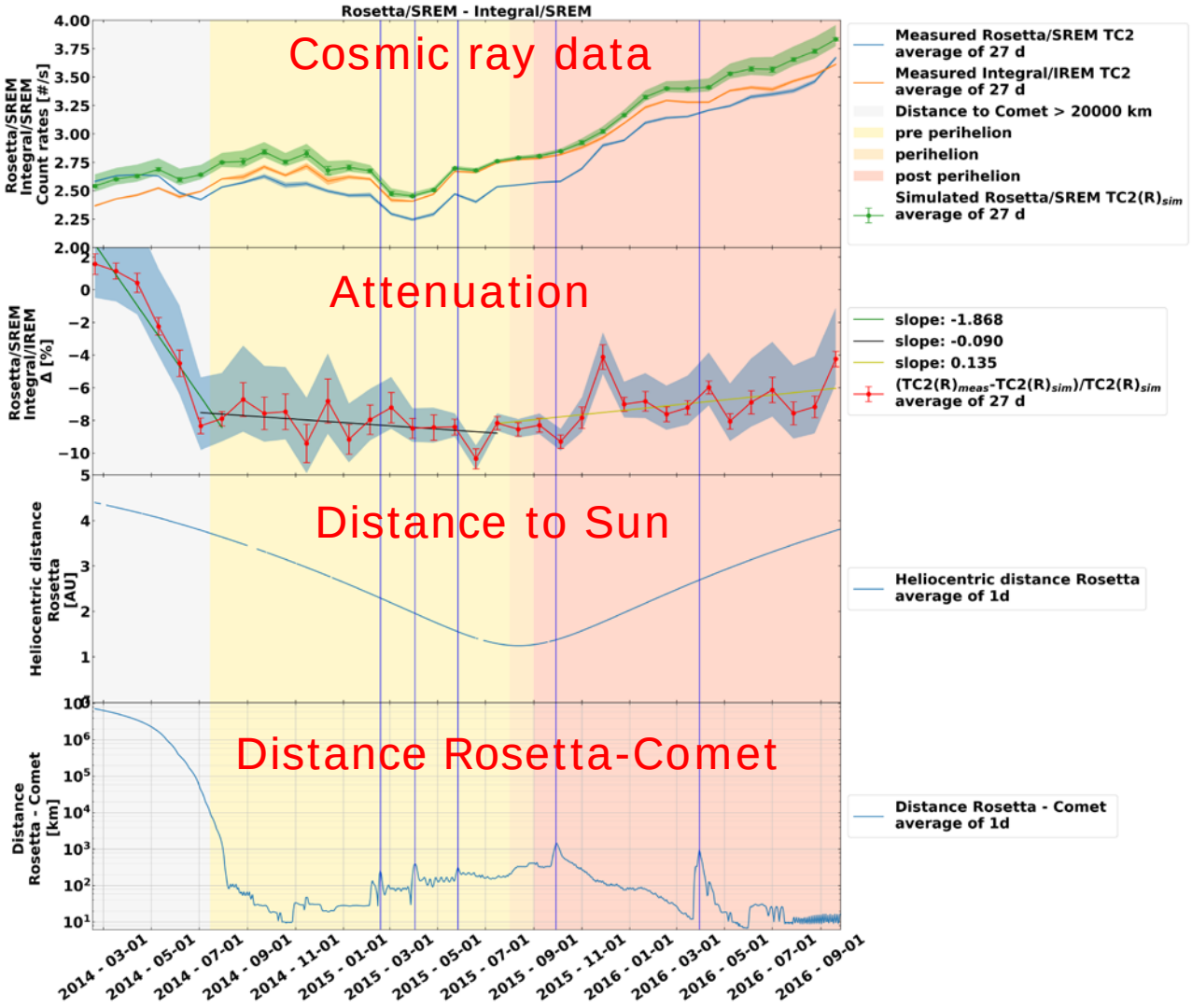
Rosetta is at 1.5-4 AU
→ Intensity of GCR at comet 67P should be > at Earth!

Drop in the cosmic ray intensity measured after exit of Rosetta hibernation



Use of the INTEGRAL data + gradient → estimation of the Rosetta measurements





Absorption

Main facts:

- Attenuation of cosmic ray intensity of ~ 8%
- Most striking: correlation between attenuation and decreasing distance to the comet during the approach phase
- -8% reached when Rosetta was < 20,000 km from the comet
- Very little effect of heliocentric distance
- During the nominal mission, no effect of the Rosetta-Nucleus distance

How to explain this Galactic Cosmic Ray attenuation?

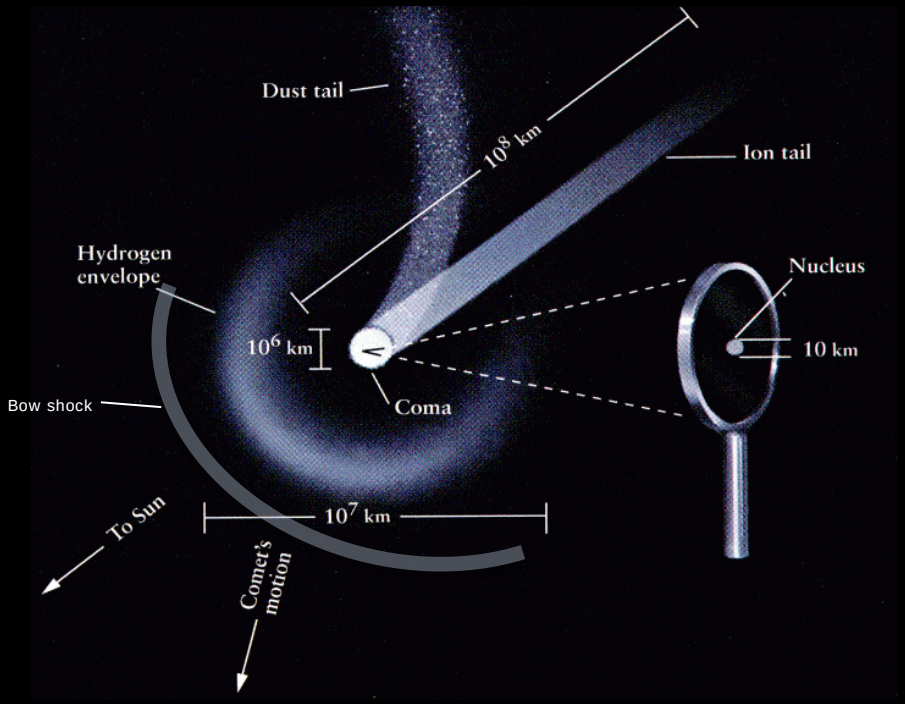
✓ Instrumental issue? → we do not think so, although not ruled out

✓ Incorrect scaling of the Rosetta data due to a problem with the INTEGRAL data? → Sanity checks were done, no issue

✓ Heliophysic origin? → We do not think so

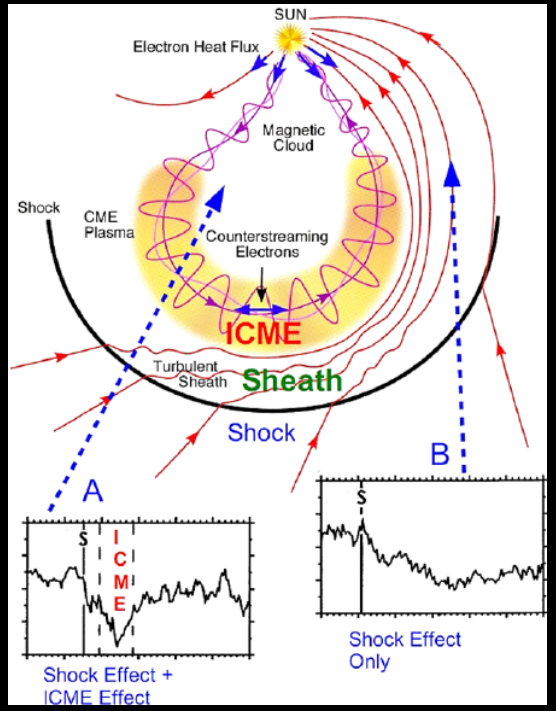
✓ Due to the environment of the comet? → Next slide

Environment of the comet



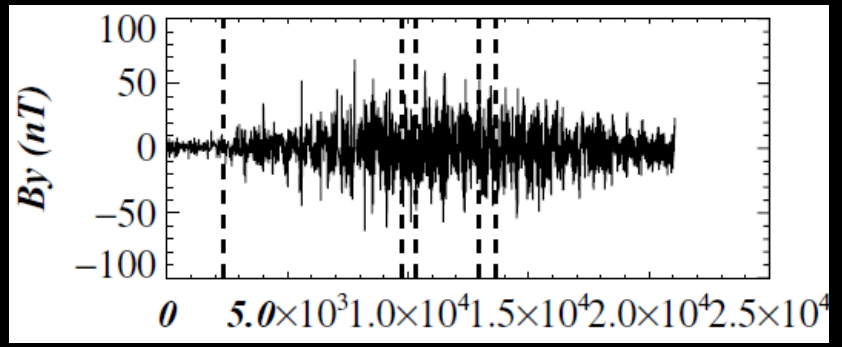
- Shielding by the nucleus ? → No
- Absorption by the gas in the coma (water vapor, etc..) ? → No
- Absorption by hydrogen ? → No
- Absorption by dust ? → To be tested
- Absorption by ion tail ? → To be tested
- Absorption/scattering due to magnetic field turbulence ?
  → test ongoing, next slide

Attenuation / scattering of GCR due turbulence?



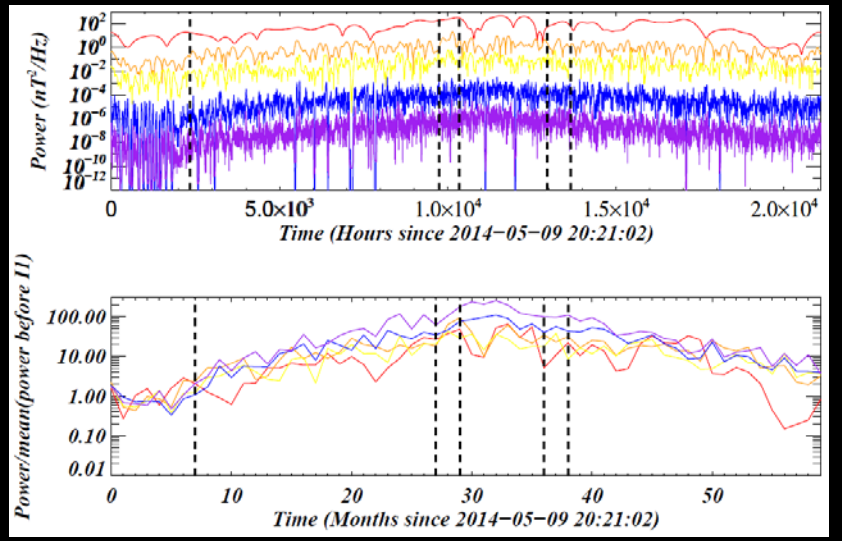
Basic principle

Magnetic field →



Turbulence →

The fluctuation amplitudes increases when we see the attenuation.



Concluding remarks

- Radiation monitor data → public data (but not in the PSA!), useful for science!
- Original study that includes data from INTEGRAL and Rosetta
- Mysterious absorption of galactic cosmic rays in the 67P comet environment
  - → UNEXPLAINED so far!
  - → your ideas are more than welcome
- Are other data sets at comets useful?
  - → Giotto high energetic particle instrument → NOT ARCHIVED ☹

Thank you for your attention!