

Spectroscopy of gamma-rays of Earth, Venus and Mercury: MGNS instrument onboard BepiColombo mission

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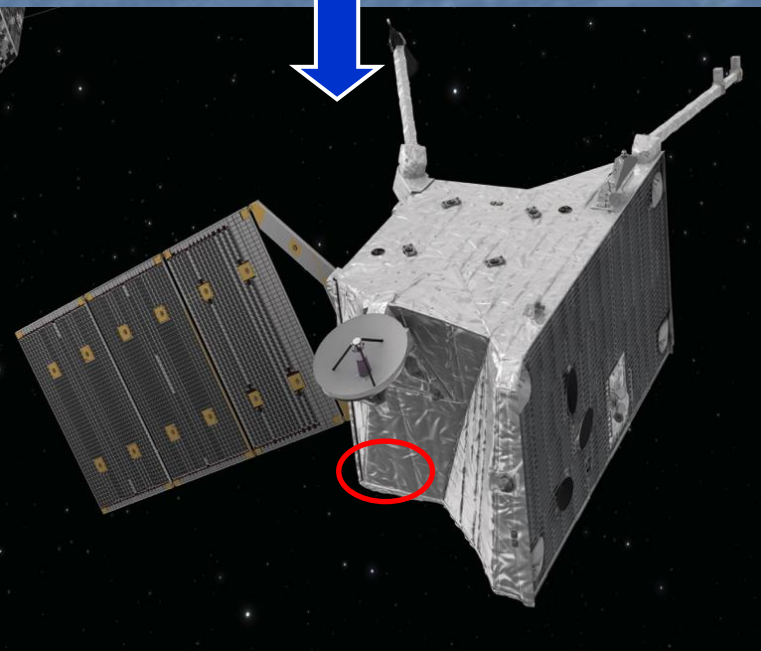
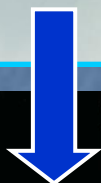
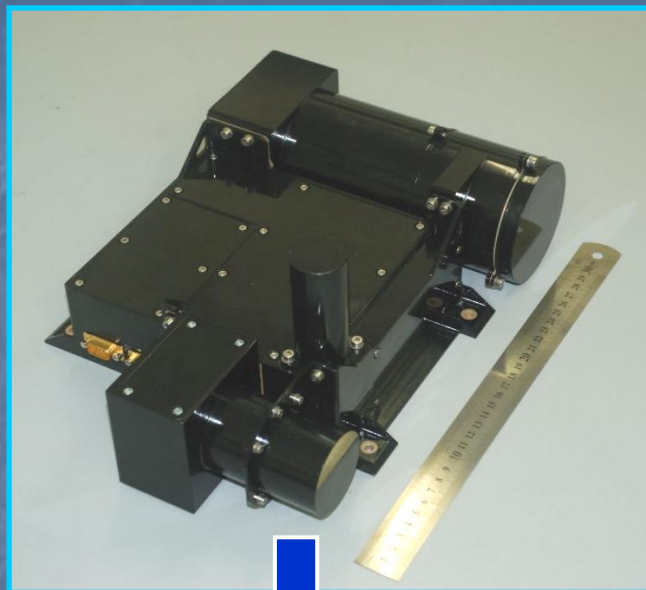
MGNS: main characteristics

Goal: The gamma and neutron mapping of Mercury surface

Science objectives:

- 📁 The mapping of water content in Mercury subsurface
- 📁 The mapping of Mercury soil composition

Parameters:



PARAMETER	VALUE
Mass	5.5 kg
Power	6.5 W
Surface Resolution	400 km
Minimal time resolution	(1/8)s, nominal 20s
Energy range, neutrons	Multi energy bands covering 10^{-3} eV – 10 MeV
Energy range, gamma	300 keV – 10 MeV
Energy resolution, gamma	4,6% at 660 keV
Detectors	^3He proportional counters, stilben crystal, CeBr_3 crystal
Operational temperature range, deg / stabilization	(-20C, +45C) , 10 deg/h
Position	ESA: MPO BepiColombo
Altitude	400 km – 1500 km
Telemetry rate, Mbytes/day	HK: 0.57; SCI: 34.85; SCI SEL: up to 696.92

MGNS instrument: high energy neutron detector and gamma-ray spectrometer

High energy
neutron
detector

Gamma-ray
spectrometer

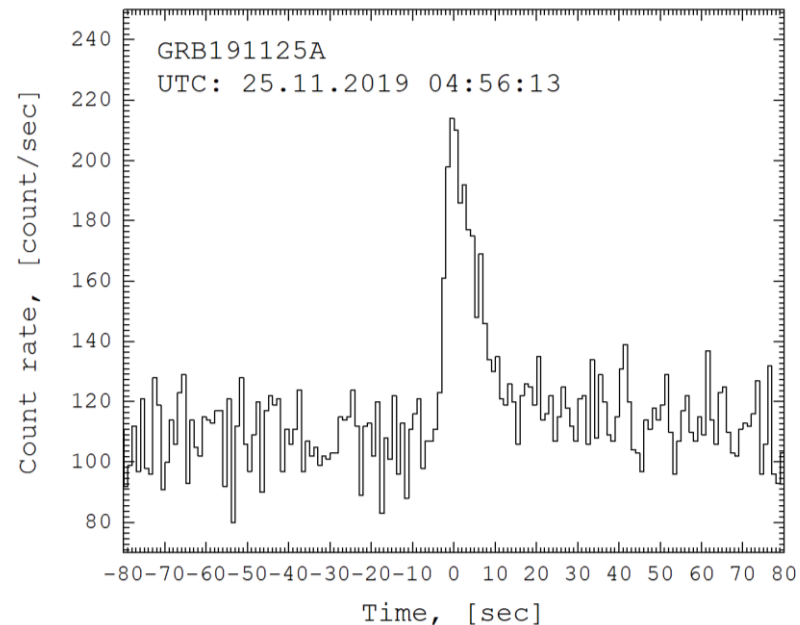
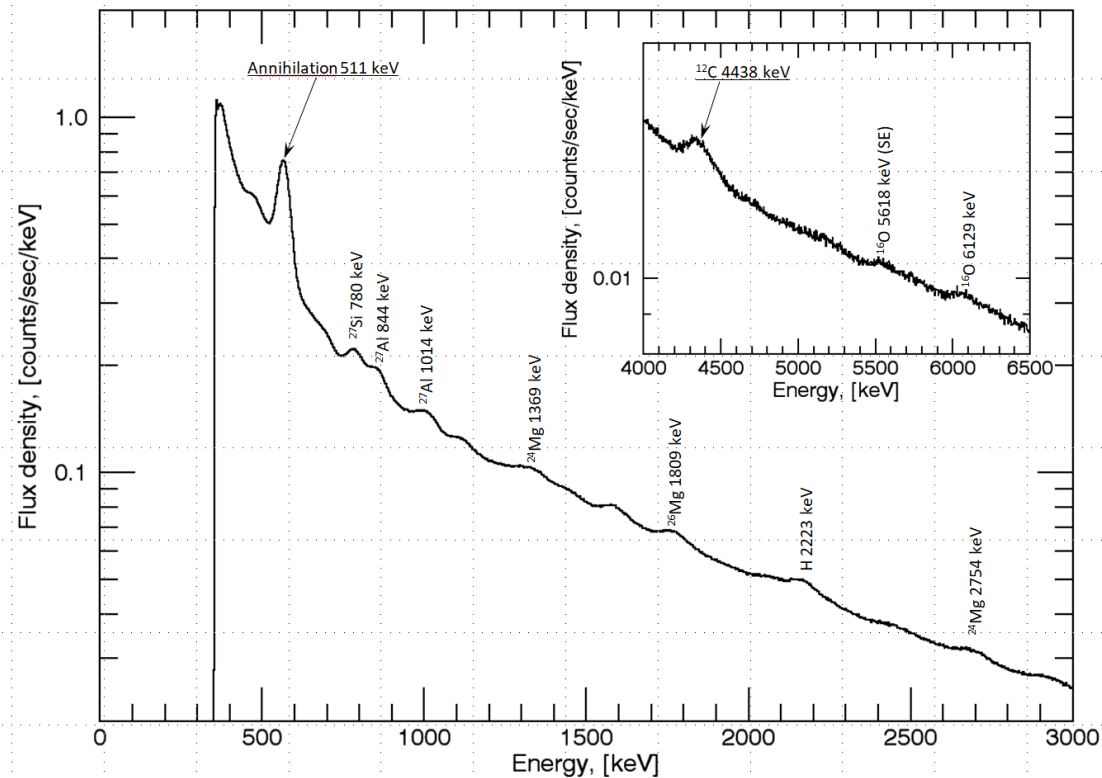


PMT
R6233-01

CeBr₃
crystal

Fast neutron
detector

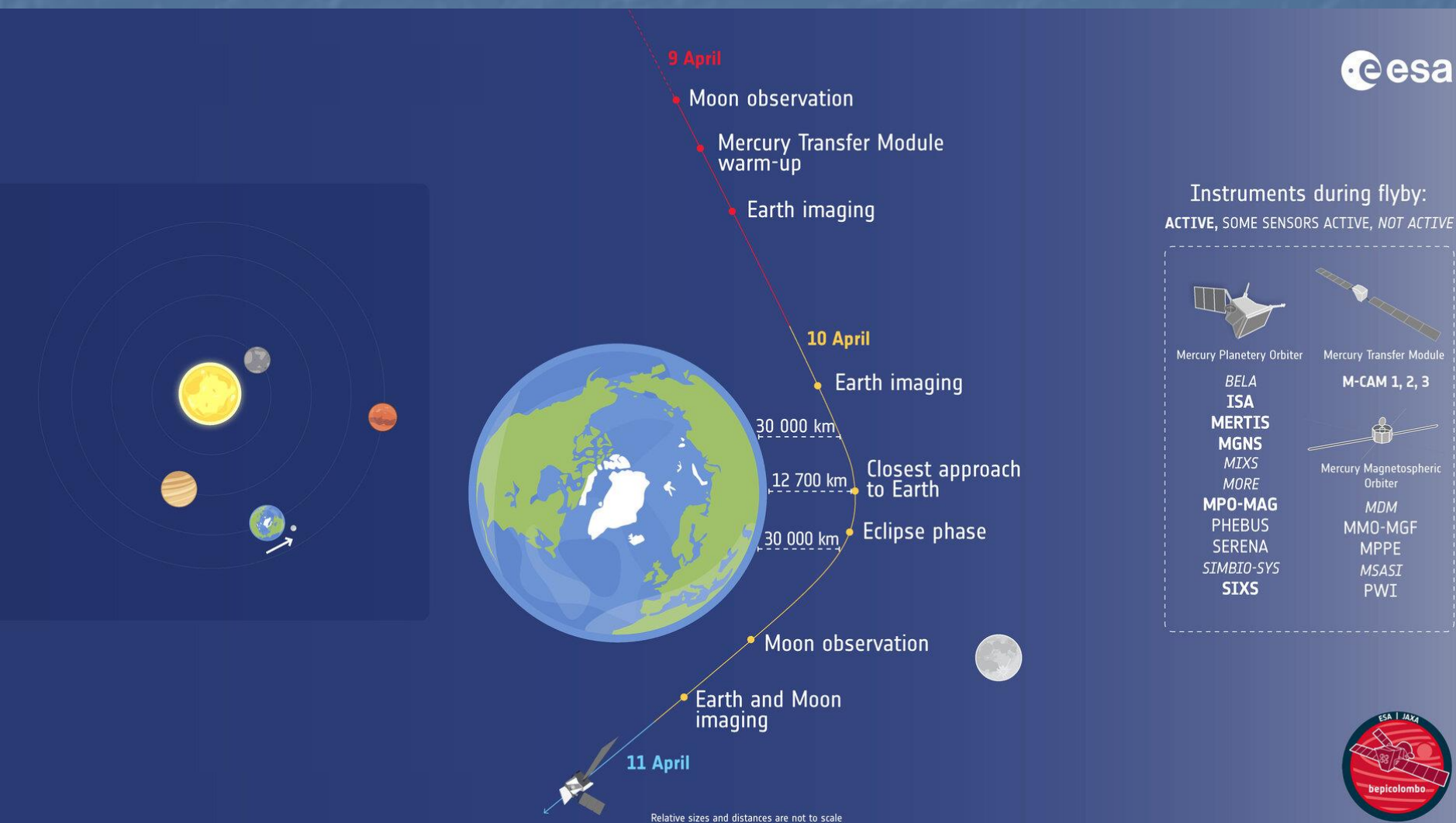
During the BepiColombo long cruise to Mercury, it is planned that the MGNS instrument will operate continuously to perform measurements of neutrons and gamma-rays fluxes for achieving two main goals of investigations: monitoring of the local radiation background of the prompt spacecraft emission due to bombardment by energetic particles of Galactic Cosmic Rays and the participation in the Inter Planetary Network (IPN) program for the localization of sources of Gamma-Ray Bursts in the sky.



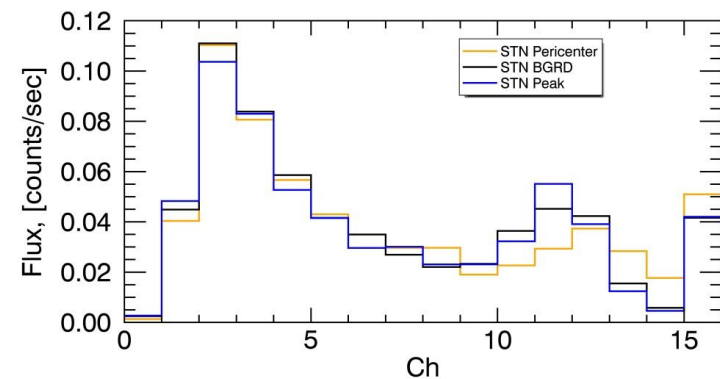
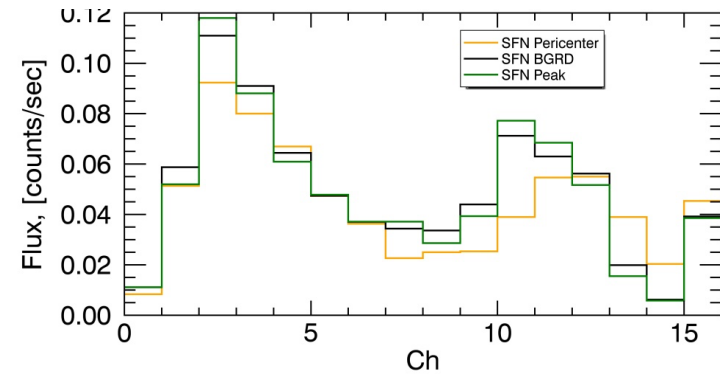
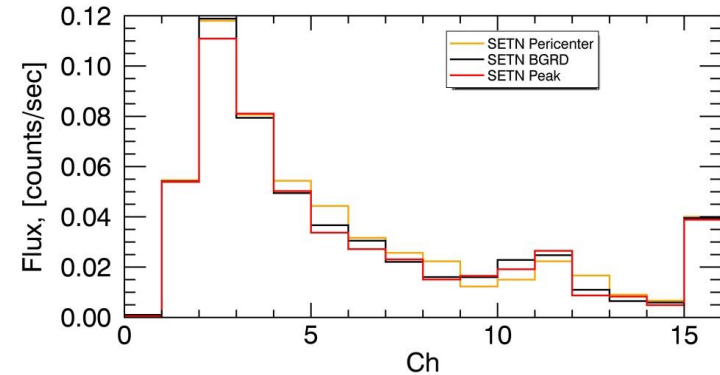
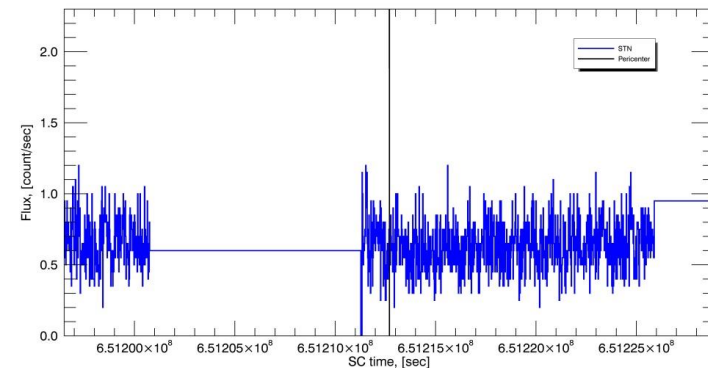
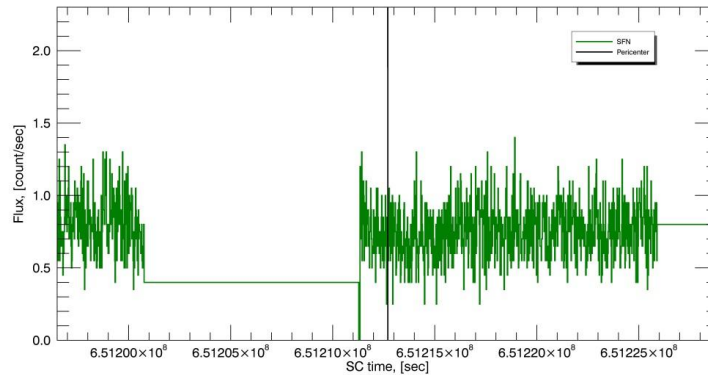
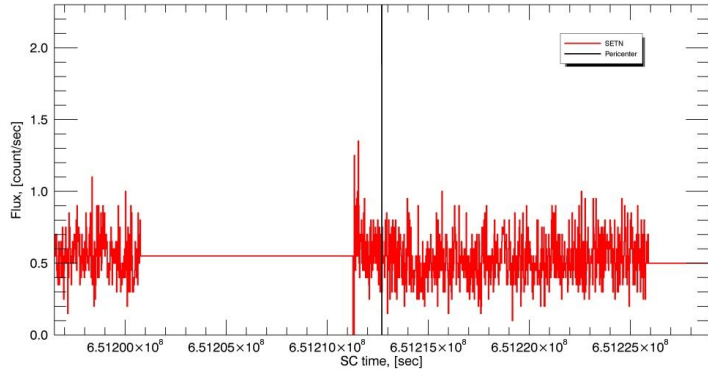
Earth, Venus and Mercury fly-by's science

The MGNS instrument will perform special sessions of measurements during flybys of Earth, Venus and Mercury with the objective to measure neutron and gamma-rays albedo of the upper atmosphere of Earth and Venus and of the surface of Mercury. Another objective is to test the computational model of the local background of the spacecraft using the data measured at different orbital phases of flyby trajectories. The low altitude flybys (such as the 700 km flyby for Venus and three 200 km flybys for Mercury) would be the most useful for such tests being BC maximally shadowed for cosmic radiation by the actual planet. Neutron and gamma-rays measurements during Earth flybys enable investigation of interaction between solar wind and Earth environments as well as studies of spacecraft neutron and gamma-rays background upon its passage through the Earth's radiation belts.

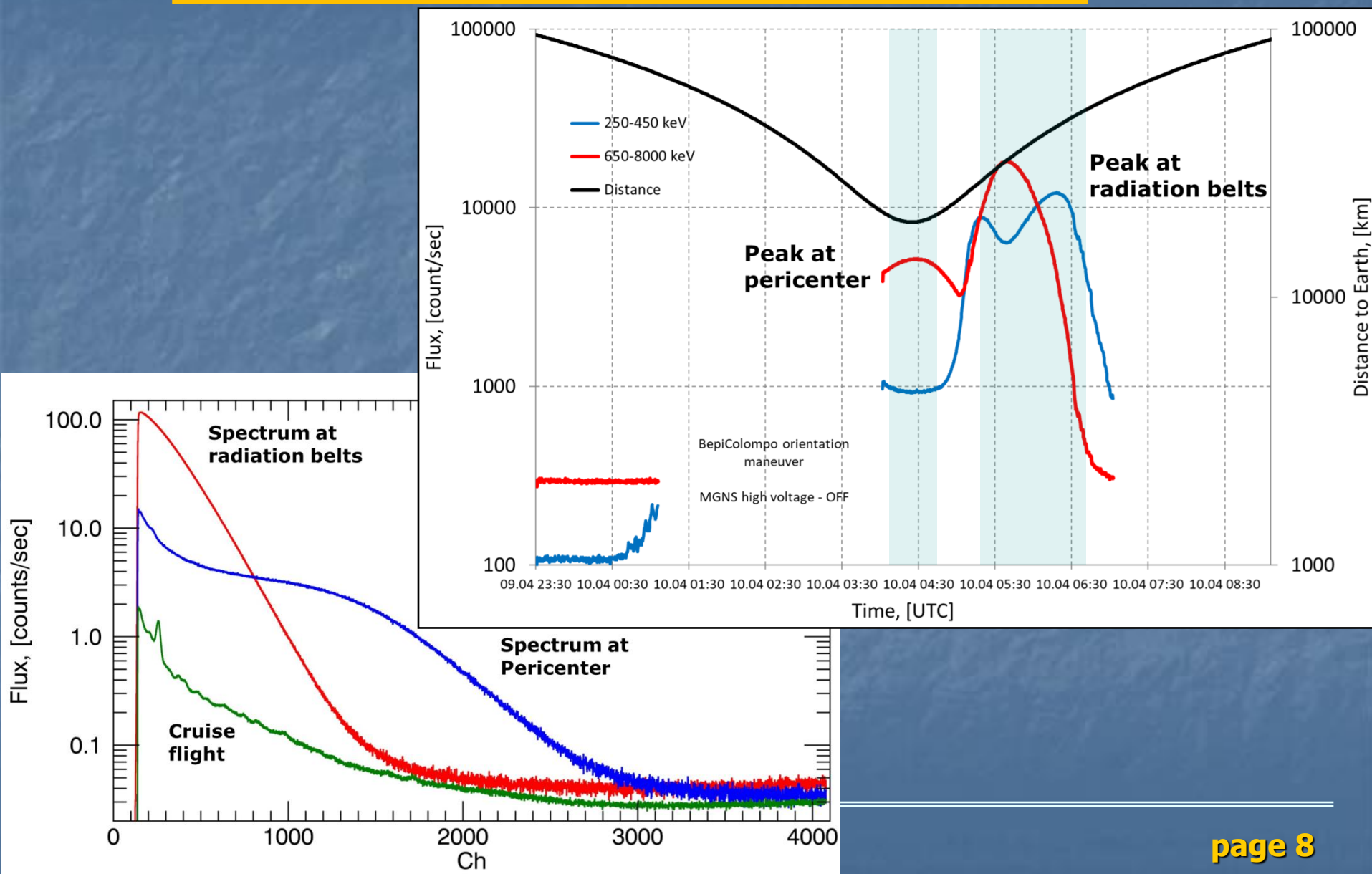
Earth fly-by



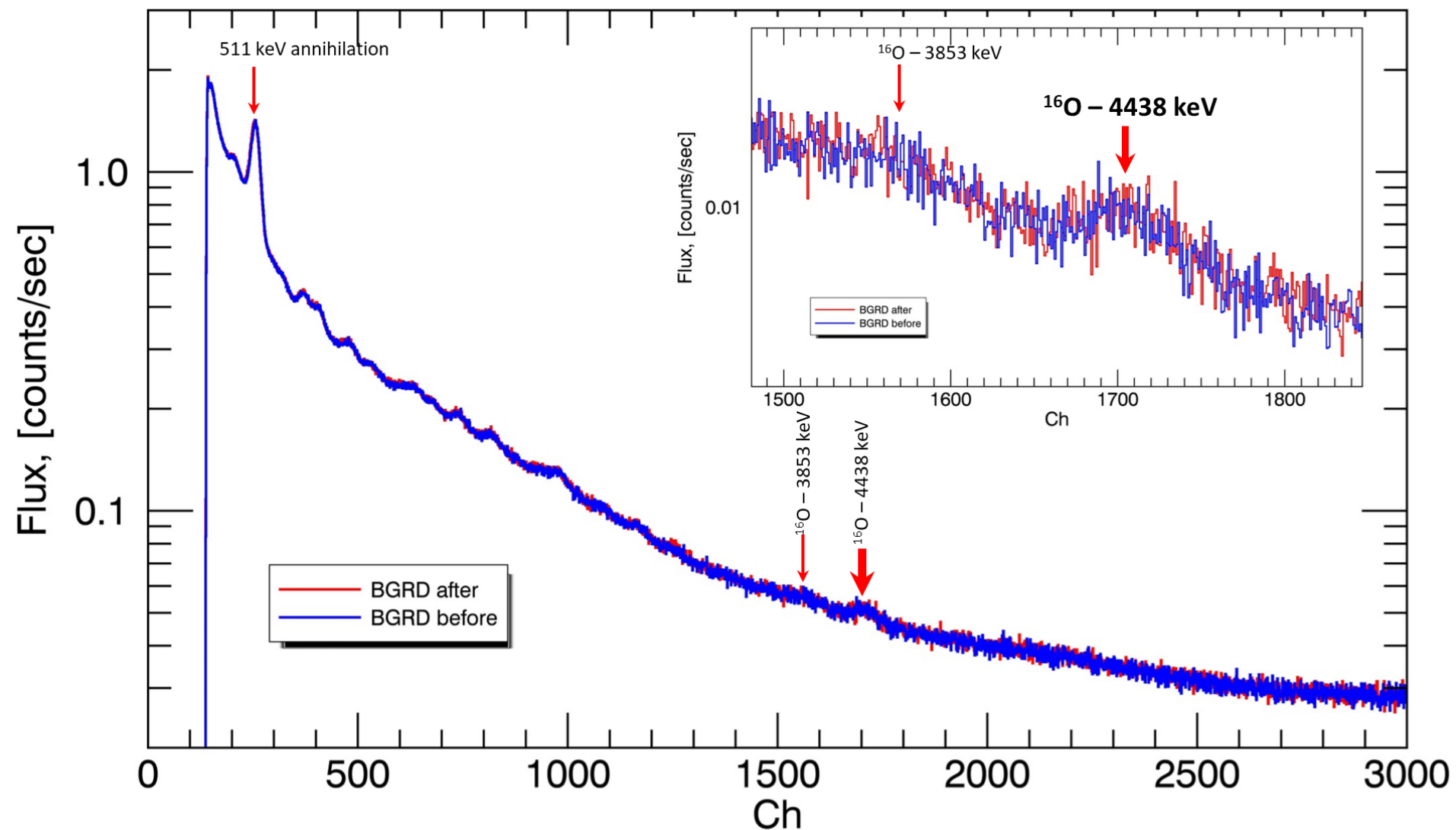
MGNS neutron data show no effect at Earth's fly-by flight of BepiColombo



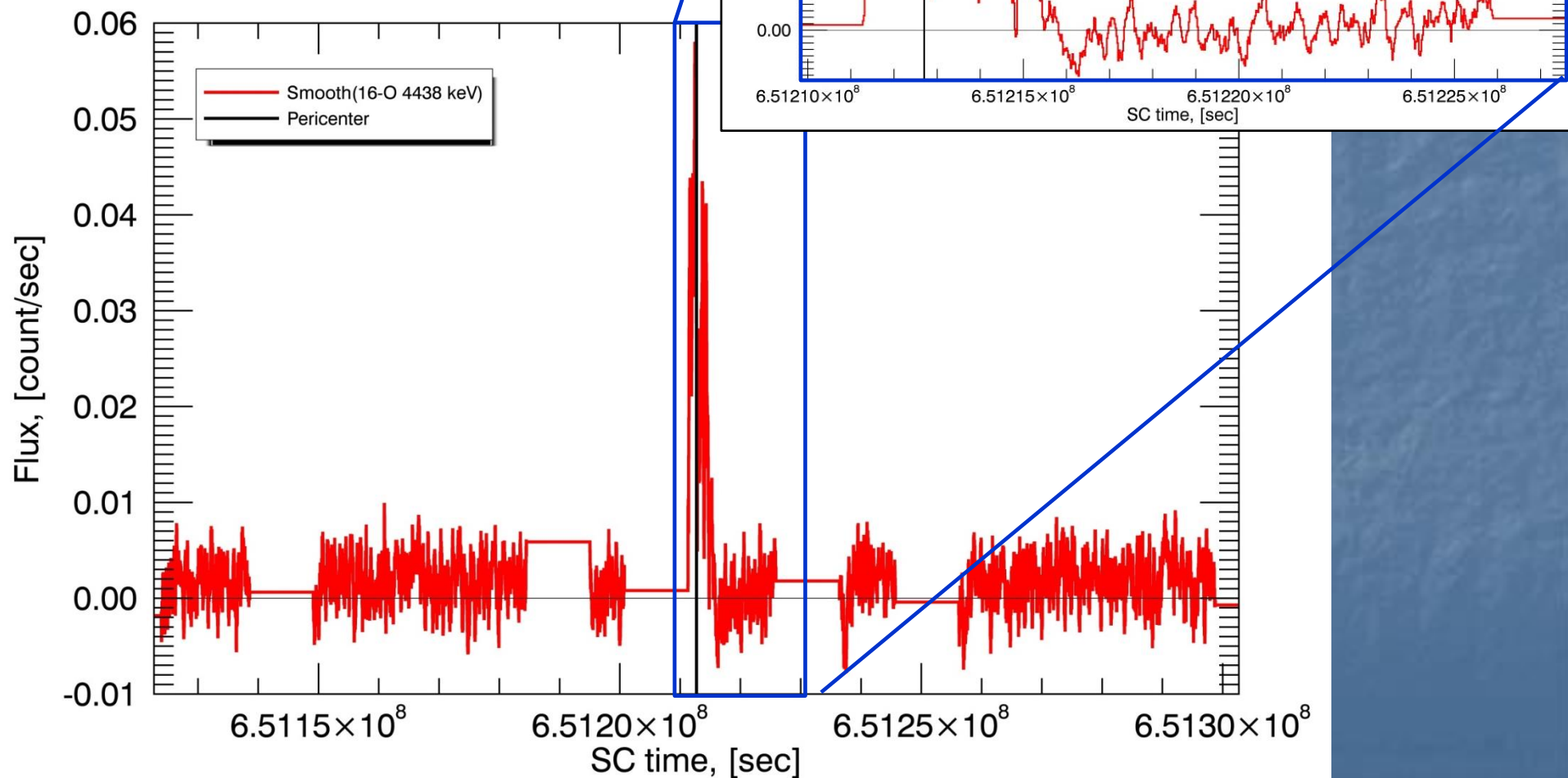
MGNS time profiles and count spectra of gamma-ray spectrometer at Earth fly-by flight of BepiColombo



MGNS gamma-rays spectra for ^{16}O nuclear line at cruise flight of BepiColombo



MGNS gamma-rays time profile
for possible terrestrial ^{16}O nuclear
line detected at Earth fly-by flight
of BepiColombo



CONCLUSION:

- ☐ **MGNS data of neutron sensors did not show any effect during the Earth fly-by: there are no neutron emission at 12700 km altitude;**
- ☐ **MGNS data of gamma-ray spectrometer show the effect of passage through the Earth's radiation belts;**
- ☐ **MGNS data of gamma-ray spectrometer likely show the effect of the Earth's emission at ^{16}O nuclear line at 4438 keV; spacecraft shielding should be taken into account for time-profile interpretation;**
- ☐ **Using the data for the Earth fly-by the Mercury's magnetosphere effects should be considered for orbital measurements by MGNS.**