

# The soft and hard X-ray emission of 3C 273 from 1996 to 2004 with *BeppoSAX* and *XMM-Newton*

S.J. Deluit <sup>a,\*</sup>, M. Stuhlinger <sup>b</sup>, R. Staubert <sup>b</sup>

<sup>a</sup> Centre d'Étude Spatiale des Rayonnements, 9 Avenue du Colonel Roche, 31028 Toulouse, France

<sup>b</sup> Institute of Astronomy and Astrophysics, University of Tübingen, Sand 1, D-72076 Tübingen, Germany

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## Abstract

We present the results of a long monitoring of the quasar 3C 273 with *BeppoSAX* (1996–2001) and *XMM-Newton* (2000–2004). Our dataset is composed of nine *BeppoSAX* and 15 *XMM* observations for a total exposure time of 855 ks (~492 ks for *BeppoSAX* and ~363 ks for *XMM*).

In the soft X-ray domain, we investigate the 2–10 keV continuum with MECS and PN and the presence of an Fe line with MECS. The hard X-ray emission of 3C 273 is analyzed using PDS (15–220 keV) on board *BeppoSAX*.

Two particular flux states are observed in our dataset with a flare of non-thermal emission from the jet in January 1997, whereas the X-ray flux reaches its lowest value in June 2000 and in particular in June 2004.

We confirm the detection of an Fe line in one observation performed with *BeppoSAX* in July 1996. In addition, we report two new detection with MECS of a relatively broad Fe line in June 1998 (also detected by *ASCA*) and in June 2001.

Presence or lack of correlation between different spectral parameters allow us to distinguish the influence of the two emission processes (non-thermal + thermal) on the observed X-ray emission of 3C 273.

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## 1. Introduction

3C 273 is a bright and nearby ( $z = 0.158$ ) radio loud quasar. It is a source very well studied in all wavelengths, from radio up to GeV allowing us to study it at all distance scales, from the central engine to the jet showing superluminal motion.

The 3C 273 emission presents characteristics common to a blazar but also to a Seyfert 1-like galaxy emission with the presence of a soft excess and a broad Fe line. These properties constitute a great interest to study 3C 273 since the information on

the physics of this object is useful for all classes of AGN. 3C 273 has a “big blue bump” occurring in the optical and UV domains continuing with an excess into the soft X-rays (below 1 keV). Another characteristic of 3C 273 is related to the complex behavior of the Fe line since it seems that the Fe line arises and disappears following the observations. The complexity of the nature of 3C 273 could explain this behavior. Indeed, non-thermal and thermal emission processes could occur at the same time but in different proportion in the 3C 273 emission.

The combination of *XMM-Newton* and *BeppoSAX* data allows a detailed investigation of the spectral characteristics of 3C 273 in soft (with MFCS and PN) and hard X-rays (with PDS).

\* Corresponding author. Tel.: +33 5 61 55 75 32.

E-mail address: [Sandrine.Deluit@cesr.fr](mailto:Sandrine.Deluit@cesr.fr) (S.J. Deluit).

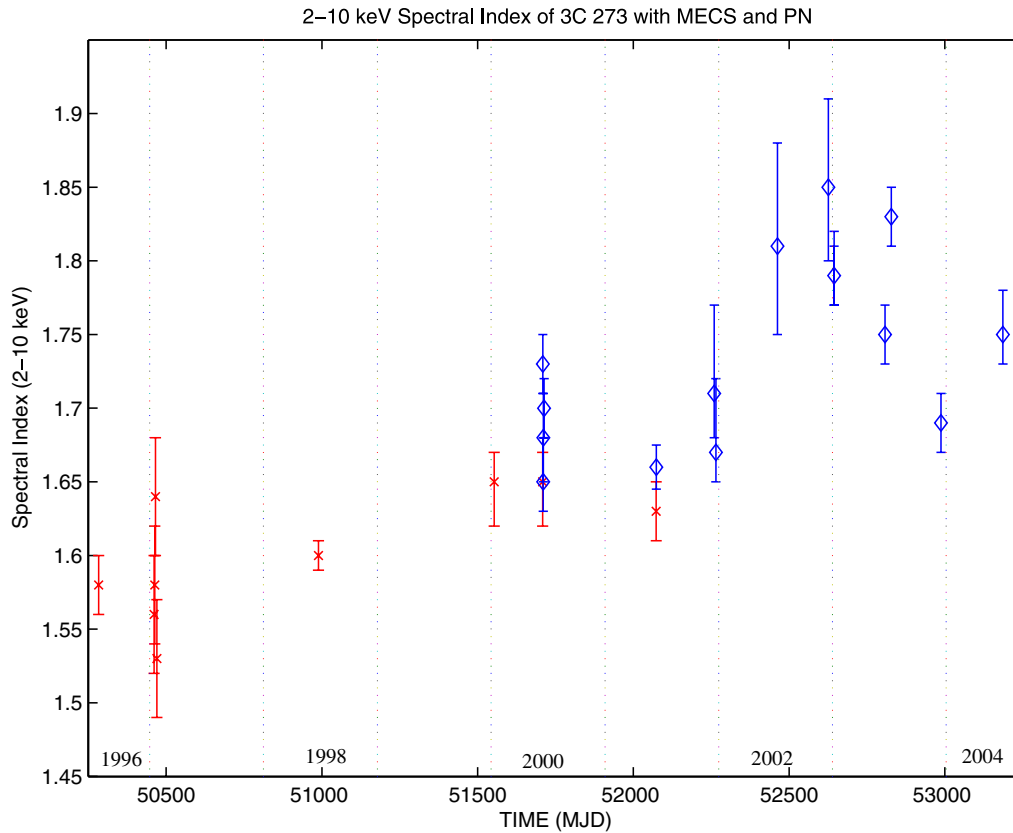


Fig. 1. Development of the spectral index of 3C 273 in the 2–10 keV energy band with MECS (red crosses) and PN (blue diamonds). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

## 2. Dataset

The Narrow Field Instruments (NFI) of the *BeppoSAX* satellite are composed of a Low Energy Concentrator Spectrometer (LECS: 0.1–5 keV), three Medium Energy Concentrator Spectrometers (MECS: 2–10 keV) and a Phoswich Detector System (PDS: 15–300 keV). The SAX dataset is composed of nine observations from July 1996 to June 2001. We have analyzed all the observations of 3C 273 performed with the *BeppoSAX* satellite. Indeed, the SAX observations of 1996 and 1997 have been the subject of articles but the data analyzes were performed with old response matrices. Moreover, since 1997 a recalibration of MECS and a LECS and MECS coordinate estimate improvement have been performed. We thus re-analyzed all the data with the last response matrices and used the updated data files from the SDC<sup>1</sup> archive.

Our study is also based on all the 3C 273 observations performed on axis as part of the Guaranteed Time of the *XMM-Newton* satellite composed of the EPIC PN and MOS camera and of the spectrometer RGS. The

*XMM* dataset is composed of 15 observations from June 2000 to June 2004.

## 3. The soft X-ray (2–10 keV) emission of 3C 273

### 3.1. The 2–10 keV continuum of 3C 273 from 1996 until 2004 with *BeppoSAX*/MECS and *XMM*/PN

Combining MECS and PN data, we can study the behavior of the soft X-ray continuum of 3C 273 over long timescales, from 1996 to 2004.

In order to characterize the soft X-ray continuum, we fit the 2–10 keV MECS and PN spectra with a simple absorbed power law with a photoelectric absorbing column fixed at the Galactic value ( $N_{\text{H}} = 1.79 \times 10^{20} \text{ cm}^2$ , Dickey and Lockman, 1990).

From 1996 to 2004, the spectral index increased from  $\Gamma \sim 1.53$ – $1.58$  in 1996 to  $\Gamma = 1.83$ – $1.85$  at the end of 2002, before decreasing again to  $\Gamma \sim 1.75$  in mid 2004 (Fig. 1). The 2–10 keV flux evolution of 3C 273 between 1996 and 2004 (Fig. 2) emphasizes the particular bright state of the quasar in 1997. On the contrary, the last observation performed in June 2004 corresponds to the lowest flux state. Except the 1997s particularity, the flux varies between  $0.66$  and  $1.19 \times 10^{-10} \text{ erg cm}^{-2} \text{ s}^{-1}$ , thus a

<sup>1</sup> <http://bepposax.gsfc.nasa.gov/bepposax/>.

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