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<b>Authors</b>	BRIENZA, MARISA, Morganti, R., Harwood, J., Duchet, T., Rajpurohit, K., Shulevski, A., Hardcastle, M. J., Mahatma, V., Godfrey, L. E. H., PRANDONI, ISABELLA, Shimwell, T. W., Intema, H.
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J/A+A/638/A29 3C388 145, 392, 614, 1400 and 4850MHz images (Brienza+, 2020)

Radio spectral properties and jet duty cycle in the restarted radio galaxy 3C388.

Brienza M., Morganti R., Harwood J., Duchet T., Rajpurohit K., Shulevski A., Hardcastle M.J., Mahatma V., Godfrey L.E.H., Prandoni I., Shimwell T.W., Intema H.

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=[2020A&A...638A..29B](#) (SIMBAD/NED BibCode)

**ADC\_Keywords:** Galaxies, radio ; Radio continuum

**Keywords:** galaxies : active – radio continuum : galaxy – individual: 3C388

**Abstract:**

Restarted radio galaxies represent a unique tool to investigate the duty cycle of the jet activity in Active Galactic Nuclei. Due to a sharp discontinuity of the GHz spectral index distribution within its lobes, the radio galaxy 3C388 has for long being claimed to be a peculiar example of AGN with multi-epoch activity

The goal of this work is to perform for the first time a spatially resolved study of the radio spectrum of this source down to MHz-frequencies, in order to investigate its radiative age and constrain its duty cycle.

We have used new low frequency observations at 144MHz performed with the Low Frequency Array and at 350MHz performed with the Very Large Array combined with archival data at higher frequencies (614, 1400, 4850MHz). Results. We find that the spectral indices in the lower frequency range 144–614MHz have flatter values ( $\alpha_{\text{low}} \sim 0.55\text{--}1.14$ ) than those observed in the higher frequency range 1400–4850MHz ( $\alpha_{\text{high}} \sim 0.75\text{--}1.57$ ) but follow the same distribution across the lobes, with a systematic steepening towards the edges. However, the spectral shape throughout the source is not uniform and often deviates from standard models. This suggests that mixing of different particle populations is occurring, although it remains difficult to understand whether this is caused by observational limitations (insufficient spatial resolution and/or projection effects) or by the intrinsic presence of multiple particle populations, possibly related to the two different outbursts.

By using single-injection radiative models we compute that the total source age is  $\approx 80$ Myr and that the duty cycle is about  $t_{\text{on}}/t_{\text{tot}} \sim 60\%$ , which is enough to prevent the intracluster medium from cooling according to X-ray estimates. While to date the radio spectral distribution of 3C388 remains a rare case among radio galaxies, multi-frequency surveys performed with new generation instruments will soon allow us to investigate whether more sources with the same characteristics do actually exist.

**Description:**

We used a recent dataset obtained on June 26th, 2019, as part of the LOFAR Two-metre Sky Survey (LoTSS, see Shimwell et al., [2019A&A...622A...1S](#), Cat. [J/A+A/622/A1](#)).

We observed the source with the Very Large Array (VLA) in A configuration on July 28th 2015 using the P-band receiver centered at 350MHz.

We reprocessed the data used by Roettiger et al. ([1994ApJ...421L..23R](#)) at 1400MHz and 4850MHz. The data consists of observations in B array at 1400MHz and in C array at 4850MHz. The target was observed for 7 hours at 1400MHz and for 5 hours at 4850MHz.

The target was observed with the legacy Giant Metrewave Radio Telescope (GMRT) at 614MHz and 240MHz in dual frequency mode and data were published in Lal et al. ([2008MNRAS.390.1105L](#)). The observations were performed on July 29th and 30th, 2005.

3C388 was observed by Chandra on February 9th and 29th, 2004 with the ACIS-I detector (obs ID 4756 and 5295, respectively) and the data were published by Kraft et al. ([2006ApJ...639..753K](#)).

**Objects:**

RA	(2000)	DE	Designation(s)
18 44 02.42	+45 33 29.8		3C 388 = LEDA 62332

**File Summary:**

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
<a href="#">list.dat</a>	121	5	List of fits images
fits/*	0	5	Individual fits images

**See also:**

[J/A+A/622/A1](#) : LOFAR Two-metre Sky Survey DR1 source catalog (Shimwell+, 2019)

**Byte-by-byte Description of file:** [list.dat](#)

Bytes	Format	Units	Label	Explanations
1-	9	F9.5	<a href="#">deg</a>	RAdeg Right Ascension of center (J2000)
10-	18	F9.5	<a href="#">deg</a>	DEdeg Declination of center (J2000)
20-	23	I4	---	Nx Number of pixels along X-axis
25-	28	I4	---	Ny Number of pixels along Y-axis
30-	50	A21	<a href="#">"datetime"</a>	Obs.date Observatino date
52-	59	F8.3	<a href="#">MHz</a>	Freq Observed frequency
61-	64	I4	<a href="#">Kibyte</a>	size Size of FITS file
66-	96	A31	---	FileName Name of FITS file, in subdirectory fits
98-	121	A24	---	Title Title of the FITS file

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**(End)**

Patricia Vannier [CDS] 07-Apr-2020

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