Wolf–Rayet stars in M33 – II. Optical spectroscopy of emission-line stars in giant H II regions

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ABSTRACT
We present optical spectra of 14 emission-line stars in M33’s giant H II regions NGC 592, 595 and 604: five of them are known Wolf–Rayet (WR) stars, for which we present a better quality spectrogram, eight are WR candidates based on narrow-band imagery and one is a serendipitous discovery. Spectroscopy confirms the power of interference filter imagery to detect emission-line stars down to an equivalent width of about 5 Å in crowded fields. We have also used archival Hubble Space Telescope (HST)/WFPC2 (Wide Field and Planetary Camera 2) images to correctly identify emission-line stars in NGC 592 and 588.

Key words: stars: Wolf–Rayet – galaxies: individual: M33 – Local Group.

1 INTRODUCTION
The overwhelming majority of stars in the Universe display absorption lines in their visible range spectrum. Emission lines in stellar spectra are therefore notable exceptions which betray fascinating properties such as the presence of unusually strong chromospheric activity, rapid rotation or, in the case of interest to this paper, strong mass loss and high luminosity. Nearby giant H II regions are hosts to an interesting zoo of emission-line objects (Walborn & Fitzpatrick 2000), most of them being post-main-sequence massive stars of notable interest for our understanding of stellar evolution at the top end of the initial mass function. They also offer important test beds to understand the more distant, unresolved starbursts: individual stars can be counted and spectroscopically classified, allowing a direct comparison with the modelization of the spatially integrated properties of their ionizing cluster [see Vacca et al. (1995) for such a comparison in 30 Doradus or Bruhweiler, Miskey & Smith Neubig (2003) in NGC 604]. Among massive stars with emission lines, those of Wolf–Rayet (WR) type are the easiest to detect and classify because of their strong and broad emission lines in the visible part of the spectrum. Thanks to surveys in Local Group galaxies (Massey & Johnson 1998) and improvements in theoretical models (Meynet & Maeder 2005), the evolutionary status of WR stars is now understood well enough to use them as diagnostics to infer the properties of starburst regions. For instance, in unresolved clusters or starburst knots of distant galaxies, the equivalent width of the ‘WR bumps’ is a good indicator of the age and upper mass limit of the stellar population (Pindao et al. 2002).

The small spiral galaxy M33 is host to four giant H II regions bright enough to have their own NGC number: NGC 604, the second most luminous starburst cluster in the Local Group; then, in decreasing order of Hα luminosity, NGC 595, 592 and 588. Despite their different galactocentric distances, these four regions have very similar metallicities, with 12 + log O/H = 8.4–8.5 (Magrini et al. 2007). Two papers published in the fall of 1981 presented the spectroscopic discovery of WR stars in these clusters: D’Odorico & Rosa (1981) derived a surprisingly large (50) number of WR stars in NGC 604, while Conti & Massey (1981) noted that some WR stars in the four regions were exceedingly luminous. Both studies, however, suffered from a lack of spatial resolution. More WR candidates were identified by interference filter imagery (taking advantage of their strong He II emission) and spectroscopically confirmed by Massey & Conti (1983), Armandroff & Massey (1985, 1991) and Massey, Conti & Armandroff (1987). The most detailed catalogue of WR stars (with spectral classification) and WR candidates in M33 is presented in Massey & Johnson (1998). Drissen, Moffat & Shara (1990) and Drissen, Moffat & Shara (1993) (hereafter DMS93) identified more WR candidates based on high-resolution CCD images with interference filters; but until now however, none of these was spectroscopically confirmed.

In the first paper (Abbott et al. 2004) of this series dedicated to WR stars in M33, we presented new spectra of one Of, 14 WN, one transition-type WN/WC and 26 WC stars in the field of M33. In this second paper, we present spectra of known WR stars and most of the WR candidates in the giant H II regions NGC 604, 595 and 592.

2 OBSERVATIONS
The spectroscopic data were obtained with the Multi-Object Spectrograph (MOS) attached to the 3.6-m Canada–France–Hawaii Telescope (CFHT) in 2000 September and 2001 October. Prior to

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spectroscopy, a high-quality image of each region was obtained in order to identify the targets and position the slitlets with sub-
ascent accuracy. The seeing during both observing runs ranged from 0.7 to 1.0 arcsec, except when the observations of NGC 592 were obtained (1.5 arcsec at high airmass; see below). After the spectra were obtained, a superposition of these images with the resulting 2D spectral images ensured a correct a posteriori identification of the stars. We used the B600 grating, which, combined with the slitwidth of 1.5 arcsec, provided a spectral resolution of ∼9 Å. Exposure times were 900 s for NGC 592, 2700 s for NGC 604 and 2700 s for NGC 595. In the case of NGC 592, the observations were obtained at the end of the night with a long and wide (5 arcsec) slit, which reduced the spectral resolution. The data were then reduced using standard procedures in IRAF.

To complement these spectroscopic observations, we have used archival images obtained with the Wide Field and Planetary Camera 2 (WFPC2) and the Advanced Camera for Surveys (ACS) on board the Hubble Space Telescope to correctly identify emission-line stars in all regions. Table 1 lists the names and properties of the imaging data sets that we have used for this research. The data were extracted from the Canadian Astronomy Data Centre’s web interface.

3 RESULTS

Spectrograms of Of and WN stars in the spectral range of the strongest emission lines are shown in Fig. 1, while those of the three WC stars are shown in Fig. 2. Table 2 summarizes the photometric and spectroscopic properties of all the emission-line stars detected in these regions, from this and from previous work. The equivalent widths listed in this table as EW (WR) refer to the entire emission lines in the ‘WR bump’ between 4630 and 4700 Å.

Figure 1. Rectified spectra of Of and WN stars in our sample, in the 4600 Å region. We should note that much of the strong, narrow emission line at 4471 Å in the spectra of N604-WR8 and WR10 is of nebular origin.

Figure 2. Rectified spectra of WC stars in our sample, in the wavelength ranges of the most prominent lines.

3.1 NGC 604

DMS93 presented finding charts for the WR candidates in NGC 604, from aberated WF/PC images. We update this chart in Fig. 3 with a much better quality image obtained from a series of archival HST/ACS images (filters F220W and F250W).

Bruchweiler et al. (2003) were able to derive the spectral type of 40 stars in the central region of NGC 604 based on ultraviolet spectral imagery with HST’s Imaging Spectrograph (STIS).
Finding chart for emission-line stars in NGC 604, from an ultraviolet HST/ACS image (combination of F220W and F250W filters). Star WR13 is outside this field of view, and is shown in Fig. 6. The field of view is 23 × 20 arcsec$^2$ (80 × 70 pc), with north to the top and east to the left.

UV spectroscopic classification is not hampered by the very strong nebular emission lines present in the visible region; this survey is therefore the most complete stellar census so far in this cluster. We now describe the spectra of the newly observed stars.

WR5 was first identified as a WR by Conti & Massey (1981), but their spectrogram also included neighbouring WR4 and WR3; it was thus classified as a WN star. However, Drissen et al. (1990) tentatively classified it as WC based on their narrow-band photometry. Our spectrogram (Fig. 2) is unambiguous: with very strong C IV lines at λ 4650 and 5808 Å, and weaker but still conspicuous lines of C III λ 5696 and O III–V λ5590, WR5 is a WC6 star, according to the classification criteria of Crowther, de Marco & Barlow (1998).

One of the most intriguing stars in the sample is WR6, which shows broad Balmer and He I lines unlike most typical late-type WN stars. An excellent spectrogram of this star, obtained nine years before ours, is shown by Terlevich et al. (1996, see their fig. 7). These authors call attention to the strong spectroscopic variability of WR6’s emission lines between 1980 and 1992. Our spectrogram (Fig. 4) is virtually identical to the one shown by Terlevich et al., including linewidths and He/H line ratios; this suggests a (temporary?) stagnation in the rapid spectroscopic evolution of this star observed recently. We must note that our spectrogram includes the strong continuum from the star 0.6 arcsec to the west of WR6, but our 2D spectrogram clearly shows that all the broad emission lines come from the faintest of the pair.

Emission-line stars in M33’s giant H II regions

Table 2. Properties of emission-line stars in M33’s giant H II regions. Coordinates are in J200.

| Star | RA        | Dec.      | B         | $M_B$ | EW(WR) | Sp. (old) | Sp. (new) | Alt. names$^d$ |
|------|-----------|-----------|-----------|-------|--------|-----------|-----------|----------------|
| N604-WR1 | 01:34:32.37 | +30:47:00.9 | 17.7      | −7.4  | –      | WCE       | –         | CM11, MJ-WR135 |
| N604-WR2 | 01:34:32.50 | +30:47:00.3 | 17.1      | −8.0  | –      | WN        | –         | CM11, MJ-WR135 |
| N604-WR3 | 01:34:32.69 | +30:47:05.4 | 17.8      | −7.3  | –      | WN        | –         | CM12, MJ-WR136 |
| N604-WR4 | 01:34:32.65 | +30:47:07.1 | 17.1      | −8.0  | –      | WN        | –         | CM12, MJ-WR136 |
| N604-WR5 | 01:34:32.83 | +30:47:04.6 | 19.0      | −6.1  | 450    | WC        | WC6       | CM12          |
| N604-WR6 | 01:34:33.68 | +30:47:05.8 | 17.9      | −7.2  | 35     | WN        | WNL       | CM13          |
| N604-WR7 | 01:34:33.87 | +30:46:57.6 | 20.1      | −5.0  | 160    | WR7       | WC4       |               |
| N604-WR8 | 01:34:32.17 | +30:47:07.0 | 18.5      | −6.6  | 18     | WR7       | WN6       |               |
| N604-WR9 | 01:34:32.74 | +30:46:56.5 | 18.5      | −6.6  | 18     | WR7       | WN6       |               |
| N604-WR10| 01:34:34.06 | +30:46:56.2 | 20.7      | −4.4  | 6      | WR7       | WNE       |               |
| N604-WR11| 01:34:32.55 | +30:47:04.4 | 18.1      | −7.0  | 15     | WR7       | WN10      |               |
| N604-WR12| 01:34:35.15 | +30:47:05.8 | –         | –     | 5      | –         | O6.5Iaf    |               |
| N604-V1  | 01:34:32.30 | +30:47:03.9 | 17.8      | −7.3  | 13     | WR7       | Of/WNL    |               |
| N595-WR1 | 01:33:32.22 | +30:41:38.1 | 18.3      | −6.8  | 47     | WNL       | WN7       | CM6, MC32, AM6, MJ-WR49 |
| N595-WR2 | 01:33:33.76 | +30:41:34.0 | 19.7      | −5.4  | –      | WNL?      | –         | CM5, MC31, MJ-WR47 |
| N595-WR3 | 01:33:33.72 | +30:41:34.2 | 18.2      | −6.9  | –      | WNL?      | –         | CM5, MC31, MJ-WR47 |
| N595-WR4 | 01:33:33.81 | +30:41:29.8 | 20.5      | −4.6  | 300    | WC        | WC6       | CM29, AM5     |
| N595-WR5 | 01:33:32.95 | +30:41:36.2 | 18.1      | −7.0  | –      | WN        | –         | AM4, MJ-WR43  |
| N595-WR6 | 01:33:32.80 | +30:41:46.2 | 18.2      | −6.9  | 80     | WNL       | WN7h      | AM3, MJ-WR42  |
| N595-WR7 | 01:33:32.61 | +30:41:27.3 | 19.1      | −6.0  | –      | WN        | –         | MC28, AM2, MJ-WR41 |
| N595-WR8 | 01:33:34.28 | +30:41:30.5 | 20.3      | −4.8  | –      | WN        | –         | AM7, MJ-WR51  |
| N595-WR9 | 01:33:34.02 | +30:41:17.2 | 20.3      | −4.8  | –      | WN        | –         | MCA4, MJ-WR48 |
| N592-WR1 | 01:33:11.81 | +30:38:53.1 | 18.1      | −7.0  | –      | WN        | –         | CM3, MC17, MJ-WR25 |
| N592-WR2 | 01:33:12.42 | +30:38:48.4 | 19.7      | −5.4  | 25     | WR7       | WN4       |               |
| N592-MC19| 01:33:15.00 | +30:37:07.4 | 19.8      | −5.3  | –      | WCE       | –         | MJ-WR30      |
| N592-MC2A| 01:33:10.70 | +30:39:00.6 | 20.8      | −4.3  | –      | WN        | –         | MJ-WR24       |
| N588-UIT008| 01:32:45.33 | +30:38:58.4 | 17.6      | −7.5  | –      | Ofpe/WN9  | –         | MJ-WR5, J1    |
| N588-MC3 | 01:32:45.66 | +30:38:54.4 | 18.1      | −7.0  | –      | WN        | –         | CM1, MC3, MJ-WR6, J2 |

$^a$ Newly confirmed emission-line stars appear in bold characters.

$^b$ Equivalent width, in Å, of the emission lines in the 4600–4700 Å region.

$^c$ New emission-line stars appear in bold characters.

$^d$ CM: Conti & Massey (1981); MC: Massey & Conti (1983); MCA: Massey et al. (1987); MJ: Massey & Johnson (1998) and AM: Armandroff & Massey (1985, 1991).
Two WR stars, WR7 and WR11, are located in an area with high extinction, according to the extinction map of Maíz-Apellániz, Pérez & Mas-Hesse (2004; compare their fig. 6 with our Fig. 3). Their continuum and emission-line flux were therefore found to be low in the previous imaging work. But the spectrum of WR7 is unambiguous with very strong lines of C IV at 4650 and 5812 Å but no evidence of C IV 5696, indicating a WC4 classification. WR11, first noted as an emission-line star by DMS93, is not correctly identified in the original finding chart (their fig. 6). A careful superposition of the 1991 emission-line image from the CFHT, which was originally used to identify WR candidates, with the more recent HST/ACS images, as well as an analysis of the location of the emission line in our more recent 2D spectra, clearly identifies WR11 as the brightest star in a very tight group of a half-a-dozen stars separated by less than 2 arcsec; its correct identification is now shown in Fig. 3. The only emission feature visible in the spectrum of WR11 is a broad (FWHM = 37 Å) He II 4686 line. Because the group of stars in which WR11 stands is unresolved in ground-based spectrum, the true equivalent width of the line is certainly much higher, making WR11 a genuine WN star. However, we find no evidence for He II 5411 or C IV 5800 in its spectrum.

WR8 and WR10 were first detected in the CFHT images of DMS90, and Fig. 1 shows that their spectra are very similar. With well-resolved emission lines of He II 4686 (FWHM = 15 Å), N III 4634, 40 and C IV 5808, as well as absorption features of N v 4604 and 4620 Å, the spectrum of these two stars is very similar to that of the Galactic WN6 star HD 93162 (WR25; see fig. 1 in Walborn & Fitzpatrick 2000).

WR12 was identified as having a weak He II excess by DMS93 in their ground-based CFHT images, but not in their pre-CoStar HST images because of the low signal-to-noise ratio (S/N). WFPC2 ultraviolet (F170W filter) images shown by Bruhweiler et al. (2003) clearly separate WR12 into two stars separated by less than 0.3 arcsec, labelled 690A (the faintest of the pair, classified as O5 III according to STIS UV spectra) and 690B (B0 Ib). Based on this UV classification, one should not expect to see He II 4686 in emission in either star (Walborn & Fitzpatrick 1990). Our slit includes both stars, and the resulting spectrum (Figs 1 and 5) clearly shows a broad emission bump (total $W_r = 15$ Å) which includes the He II line ($W_r = 5$ Å confirming the early diagnostic based on imagery) accompanied by He I 4713, N iii 4634, 40 and possibly C IV 4650. We also detect strong P Cygni profiles of He I at 4388, 4471 and 4921 Å as well as an absorption line of He II 5411; a careful examination of the 2D spectroscopic images along the trace of WR12 clearly shows that these lines are of stellar origin and are not significantly contaminated by nebular emission. The more extended spectrogram of WR12 shown in Fig. 5 bears striking similarities with that of the WN10 star Sk 66–40. Although our optical spectrum is a composite of two stars, it is more likely that most of the emission lines come from the brightest one (690B).

To confirm this, we have analysed WFPC2 images (program 5773) obtained with the nebular filters F656N (H α) and F673N (centred on the [S II] λ6717, 31 doublet). Since stellar spectra do not show the presence of these sulphur lines, and since the two nebular filters are close enough in terms of wavelength (reducing possible extinction effects), we have used the F673N image as a continuum reference (Fig. 6) and subtracted it from the H α image. Selected fields from the resulting continuum-subtracted image are shown in Figs 7 and 8. Fig. 7 demonstrates the power of this technique on a field centred on NGC 604-WR6, which is known to be a strong Hα emitter (see Fig. 4). Fig. 8 shows the field around WR12. In addition to WR12, He II emission-line stars WR3, WR8 and V1 clearly show up as Hα emitters. A comparison of the upper and lower panels of Fig. 8 also confirms that, as expected, star 690B is a strong Hα emitter whereas 690A does not show up.

N604-V1 was found to be photometrically variable (on a timescale of one night, possibly eclipsing?) by Drissen et al. (1990). DMS93 allude to a spectrogram, obtained in 1992 October, showing He II in emission, but did not publish it. The more recent spectrogram (2001 October) shows this line (FWHM = 14 Å), as well as N iii 4640 in emission, absorption lines of He II 4541 and 5411, and P Cygni profiles for the He I lines at 4471 and 5876 Å. We also detect a weak ($W_r = 1.0$ Å) emission line of C IV λ5696. A comparison between spectra obtained in 1992 and 2001 shows a significant weakening (by a factor of 2.5) of the He II 4686 line (Fig. 9). The 1992 spectrum did not show either the He II absorption lines (perhaps filled with emission) or the C IV λ5696 emission.

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**Figure 4.** Spectrum of NGC 604-WR6. The emission lines are diluted by the continuum from the bright star 0.6 arcsec to the west of WR6.

**Figure 5.** Spectrum of NGC 604-WR12.
Finally, WR13 was never identified as a WR candidate but since it is the brightest star inside a prominent ionized arc in the northeastern part of the nebula (see Fig. 6), we took advantage of the MOS capabilities and superposed a slit on it to satisfy our curiosity. Its spectrum shows very weak emission lines of He II 4686 ($W_e = 1.2 \, \text{Å}$) and N III 4640 ($W_e = 3.3 \, \text{Å}$), as well as absorption lines of He II 4541 and 5411 and He I 4471. A comparison with stars in the atlas of Walborn & Fitzpatrick (1990) suggests a spectral type O6.5 Iaf, similar to the galactic star HD 163758.

3.2 NGC 595

An updated finding chart for WR stars in NGC 595 is shown in Fig. 10. Among all WR candidates in NGC 595, only WR2 (components a and b), WR9 and WR11 lacked a clear, individual, spectroscopic identification, although spectrograms including both WR2ab and WR11 (both objects, separated by less than 2 arcsec, are themselves multiple as shown by WFPC2 images) as well as WR9 clearly show the presence of at least one WNL star (Conti & Massey 1981; Massey et al. 1996). But a re-examination of the HST/WFPC images discussed by DMS93 shows that the excess of light at 4686 Å at the location of the candidate WR star WR11 is marginal at best, and no emission excess could be detected for WR10. Indeed, Massey & Johnson (1998) question the presence of emission lines in WR10. Moreover, Royer, Lundström & Vreux (2003) unambiguously not only detect WR2 and WR9 as WR candidates in their images obtained with a set of narrow-band filters, but also fail to detect WR10 and WR11. So, we decided to remove both objects from our list of WR candidates and therefore they do not appear in Fig. 10.

The only new spectroscopic confirmation from this paper is that of NGC 595-WR9. Its spectrum (Fig. 1) is comparable to that of the Galactic star WR22 (HD 92740; see fig. 1 in Walborn & Fitzpatrick 2000), with $W_e = 18 \, \text{Å}$ for He II 4686 and 9 Å for N III 4634, 40. We also detect an emission line of He II 5411 ($W_e = 4.5 \, \text{Å}$).

The first spectrogram of WR3 (MC29), published by Massey & Conti (1983), allowed a crude WC classification. Line ratios (C IV 5808, C III 5696 and O III, v 5590) in our spectrogram (Fig. 2) allow us to refine the classification to WC6. It is interesting to note that WR3 is the only WC star in NGC 595.

NGC 595-WR1 and 595-WR5 have very similar spectra in terms of line ratio, and both can be classified as WN7. The equivalent width of all lines is larger by a factor of 2 for WR5; this could be due, at least in part, to some contamination by the continuum of the bright star 1.3 arcsec south of WR1. NGC 595-WR5 is in a region of relatively weak nebular emission, and we were able to subtract the nebular component from its spectrum, which is shown in its entirety in Fig. 11. The relative strengths of the pure helium lines (4200, 4541 and 5411 Å) to those for which helium and hydrogen both contribute (4340 and 4860 Å) clearly indicate the presence of hydrogen in the atmosphere of NGC 595-WR5.

3.3 NGC 592 and 588

NGC 592 and 588 are much less luminous and rich in WR stars than NGC 595 and 604, by factors of 3 to 10, but they nevertheless include a fair population of young, massive stars. We defer the analysis of their stellar content, based on HST archives, to another paper (Ubeda, Drissen & Crowther, in preparation), but we present...
here a spectrum and some images relevant to their emission-line star content.

NGC 592 is 10 times less luminous than NGC 604, in terms of both H α luminosity (Bosch, Terlevich & Terlevich 2002) and UV continuum (as measured with the large Far Ultraviolet Spectroscopic Explorer (FUSE) aperture at 1150 Å; see Pellerin 2006), and until now very little is known about its stellar content. It includes four WR stars: two in the core (identified as WR1 and WR2 following DMS90) and two more in the outskirts: MC19 and MCA2. Their positions are labelled in a composite visible image in Fig. 12 as WR1, WR2, MC19 and MCA2. Despite the factor 10 smaller in H α luminosity compared to NGC 604, Fig. 12 shows that the ionizing cluster of NGC 592 still contains a fair number of massive stars.

A spectrogram of NGC 592-WR1 (WNL) is shown in Conti & Massey (1981, CM3). NGC 592-WR1 (also known as MC17, or WR25 in Massey & Johnson 1998) was originally misidentified with the brighter but slightly redder companion 1 arcsec to the north-east (star B67 in Humphreys & Sandage 1980), but it was already strongly suggested by the images presented in Drissen et al. (1990) that the WR star was not the brightest component of the tight pair; it is now obvious in the WFPC2 images. NGC 592-WR1 is also the cluster’s brightest UV source in the F170W image.

NGC 592-WR2, first identified as a WR candidate by Drissen et al. (1990), lacked spectral confirmation until now. Our spectrogram of this star is shown in Fig. 13, and is that of a WN4 star as deduced from the weakness of the He I 5876 line and the absence of N III 4640. A comparison of our spectrum with those of a dozen Galactic WNE stars shows that the red spectrum of NGC 592-WR2 most closely resembles that of the Galactic WN4 star WR44, analysed by Hamann & Koesterke (1998). A careful comparison of the
Emission-line stars in M33’s giant H II regions

Figure 11. Spectrum of NGC 595-WR5. The (weak) surrounding nebular component has been subtracted, leaving only stellar lines.

Figure 12. Composite image of NGC 592 from HST/WFPC2.

WFPC2 image and the CFHT 2D spectra clearly shows that WR2 is the brightest of a close pair separated by 0.6 arcsec.

The spectrum of MC19 (WCE) was first published by Massey & Conti (1983), while MCA2 is a WN star whose spectrum has been published by Massey et al. (1987).

NGC 588 was not part of the imaging survey by Drissen et al. (1990). However, two emission-line stars are known in this cluster: MC3, a WNL, detected with narrow-band imagery by Conti & Massey (1981) and spectroscopically confirmed by Massey & Conti (1983) and UIT-008, a transition Of/WN9 star (see Massey & Johnson 1998 for a visible spectrogram and Bianchi, Bohlin & Massey 2004 for an UV spectrogram) selected for follow-up spectroscopy because of its high UV luminosity. NGC 588 is, like the other giant H II regions discussed in this paper, a crowded place, and high-resolution images are required to properly identify the stars. Fortunately, NGC 588 was imaged with WFPC2 in many bands in 1994 (Fig. 14), including F469N, a narrow-band filter centred on the He II 4686 emission line. Only MC3 clearly stands out in the F469N image; it is 0.5 mag brighter than in the F439W image. UIT-008 is marginally brighter in the F469N image than in the continuum F439W, by 0.1 mag; this is consistent with the weakness of its emission lines.

4 CONCLUSIONS

We have spectroscopically confirmed the presence of emission lines in a sample of WR candidates selected by interference filter imagery. Most of them are genuine WR stars, but we have also detected transition-type evolved O stars, with a He II equivalent width as low as 5 Å. As demonstrated here and in previous publications, this technique is very efficient, especially in crowded fields (see also Hadfield & Crowther 2007), with a very high success rate and relatively few false detections. The census of the WR population in NGC 588, 592, 595 and 604 is now essentially complete: only three stars (NGC 604-WR2, 604-WR4 and 595-WR2), which are members of very dense and barely resolved groups, lack a clear identification although their WR nature is not in doubt. We have also obtained good-quality spectrograms of previously known WR
stars in these regions, allowing a better spectral-type identification. The four giant H II region studied here harbours about 20 per cent of the entire known WR population of M33, with a WC/WN ratio significantly lower (0.25) than that of the field (0.4; Massey & Johnson 1998).

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