EWOCS: THE EXTENDED WESTERLUND ONE CHANDRA, AND JWST, SURVEY

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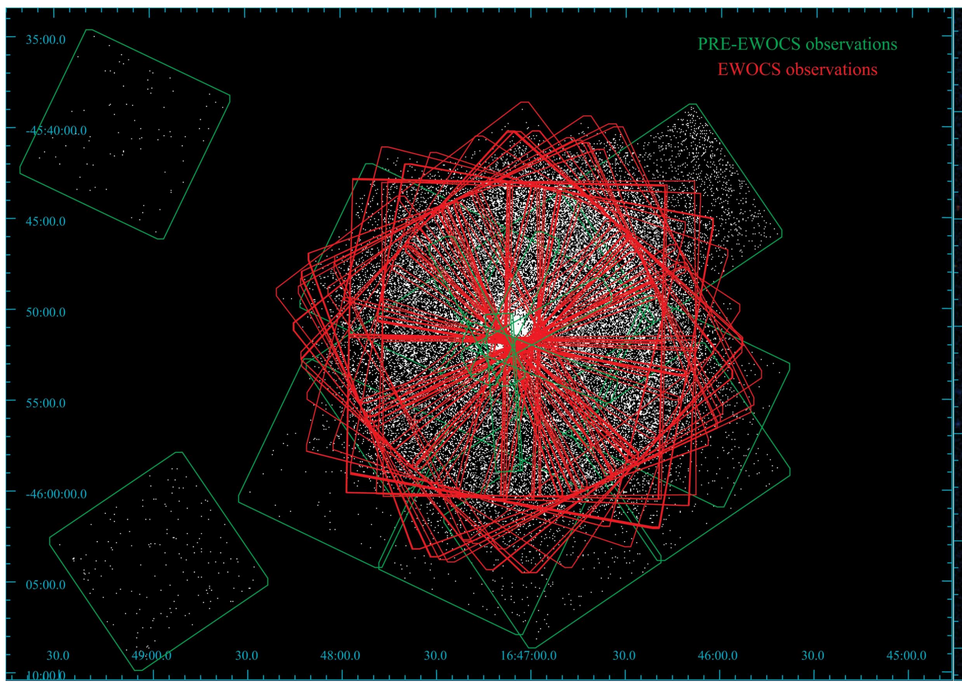
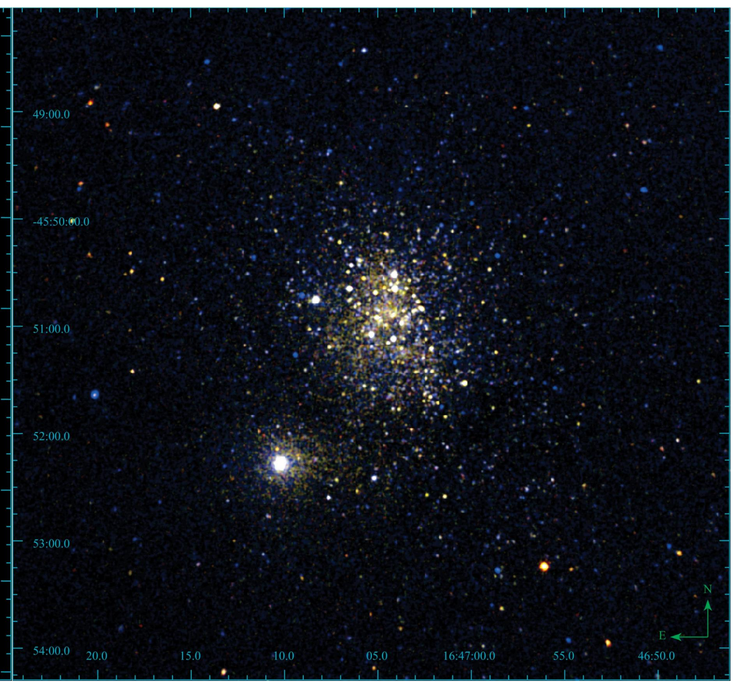




Left: combined ACIS-I (EWOCS) and -S (pre-EWOCS) images of Westerlund 1. Right: RGB image of the central field (0.5-1.2 keV in red, 1.2-2.0 keV in green, 2-8 keV in blue).

ABSTRACT AND MOTIVATION

The EWOCS project aims at studying star formation, early stellar evolution, planet formation, the evolution of massive stars and compact objects in starburst environments.

Westerlund 1 is the closest starburst cluster to the Sun (2.6-5 kpc, *Clark+2005, Aghakhanloo+2020*), the most massive (5-9×10^4 $M_\odot$) known in the Milky Way (*Andersen+2013*), and it is young (<10 Myrs) enough to still host YSOs with protoplanetary disks.

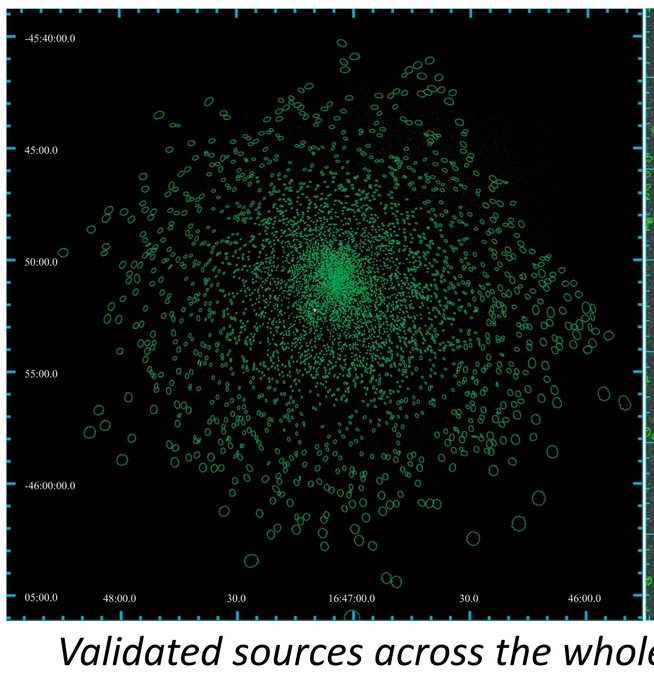
EWOCS is based on a 1Msec Chandra/ACIS-I Large Project, 18.9 hours of JWST (MIRI and NIRCam) observations, and a 48ksec NICER observation.

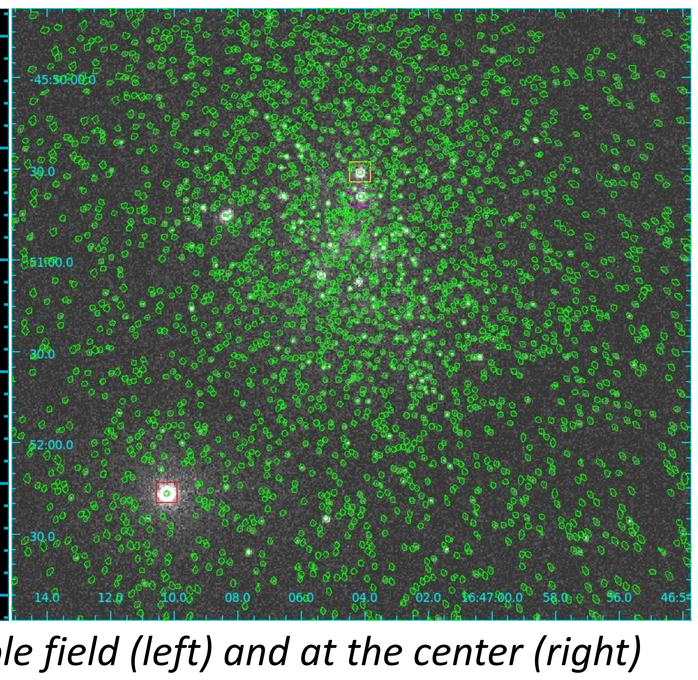
EWOCS X-ray Catalog

Data reduction, source extraction and source validation has been done using ACIS Extract software and related tools (*Broos+2010*).

From a preliminary list of **9421** candidate sources selected with WavDetect, PWDetect, the Image Reconstruction method, and a time-resolved PWDetect, **5423** sources have been validated.
We selected for the first time a rich cluster halo, and detected 140 of the massive stars listed in *Clark+2020*.

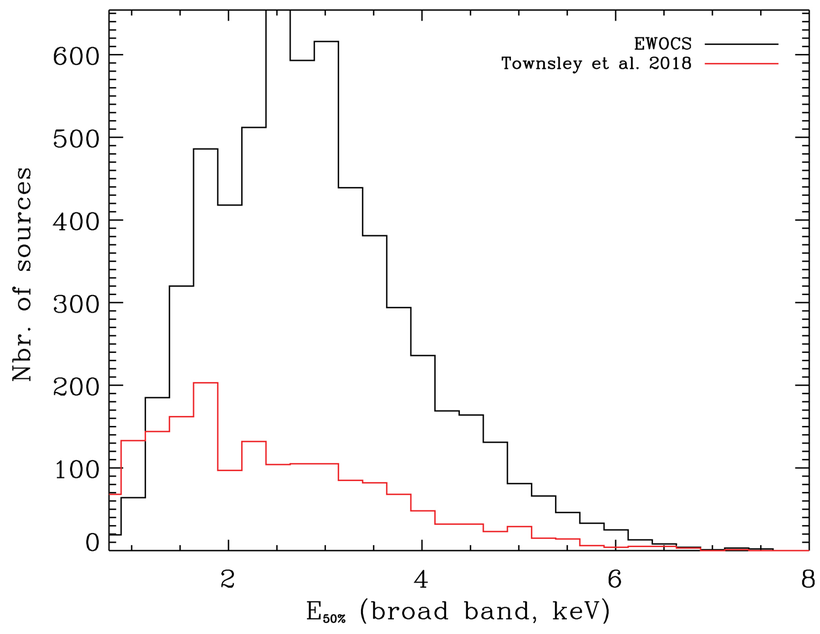
The brightest sources are the magnetar CXO J164710.2-455216 (□*Muno+2005*), the SgB[e] star W9 (□*Clark+2014*), the post-binary blue straggler W30 (□O4-5Ia+ *Clark+2019, 2008*), and some of the Wolf-Rayet stars.





Validated sources across the whole field (left) and at the center (right)

SOME PRELIMINARY RESULTS

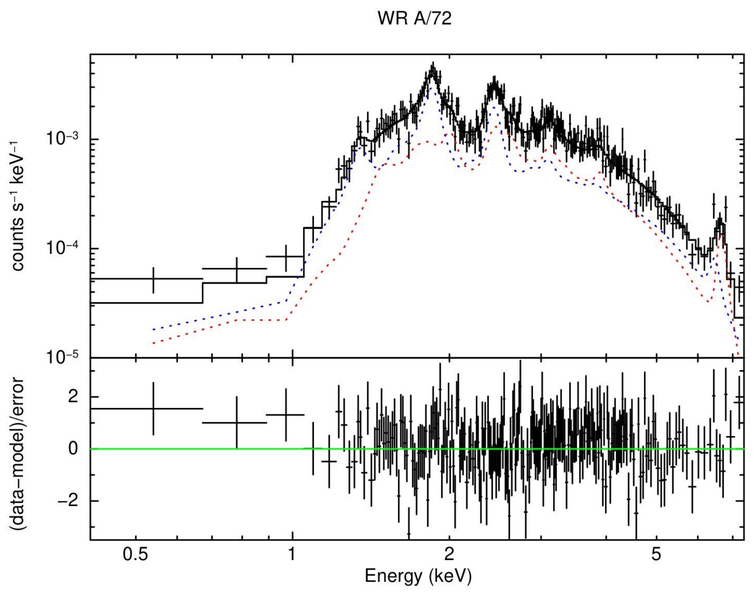


PHOTONS ENERGY DISTRIBUTION

The median value of the photon energy distribution is 2.8 keV.

Since interstellar absorption is high in the direction of Westerlund 1, the background population can hardly be distinguished from the young stars of the cluster from their photon median energy distributions.

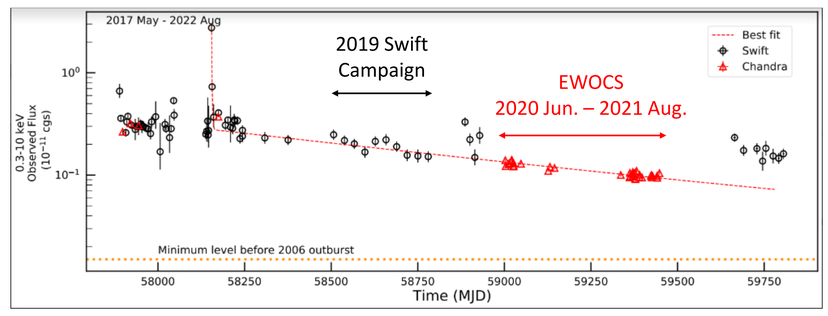
A possible secondary peak at energies below 2 keV (which dominates the distribution from *Townsley+2018* catalog) could in principle be attributed to a foreground population.



SPECTRAL ANALYSIS OF THE WR STARS

20 Wolf-Rayet stars are detected in X-rays. 16 stars show convicing evidence for the presence of the Fe XXV Kα line at 6.7 keV, emitted by >25MK plasma, likely in the wind collision zone.

This suggests a very high binary fraction among the WR stars in the cluster, and that binarity must be invoked to explain the presence of such a rich population of Wolf-Rayet stars in the cluster.



MAGNETAR TIMING ANALYSIS

Westerlund 1 hosts the active magnetar CXO J164710.2-455216. EWOCS observations caught the source far from bursts and glitches,
allowing us to estimate a new timing solution and, thus, the characteristic age and dipolar magnetic field intensity:

$P = 10.61072198(5)$ s

$\dot{P} = 2.49(1)\times10^{-13}$ s/s

$\ddot{P} = -4.9(4)\times10^{-21}$ s/s^2

$B_{dip} \lesssim 5\times10^{13}$ G

$\tau_c \gtrsim 0.7$ Myr

https://westerlund1survey.wordpress.com/