Clusterix 2.0 for Gaia EDR3

http://clusterix.cab.inta-csic.es

L. Balaguer-Núñez[a], E. Solano[bc], D. Galadí-Enríquez[d], C. Jordi[a], F. Jiménez-Esteban[bc]

[a]Dept. Física Quàntica i Astrofísica, Institut de Ciències del Cosmos, Universitat de Barcelona (IEEC-ICCUB), Barcelona, Spain
[b]Dpto. Astrofísica, Centro de Astrobiología (INTA-CSIC), Apartado de Correos 78, E-28691, Villanueva de la Cañada, Madrid, Spain. [c]Spanish Virtual Observatory
[d]Centro Astronómico Hispano-Alemán, Calar Alto (CSIC-MPG) 04004 Almería, Spain

The VO interactive tool to estimate cluster membership probabilities for Open Clusters has been upgraded and updated to make better use of the latest Gaia data release EDR3. The **number of sources in EDR3** that have a parallax and proper motion is **only 10% higher** than in Gaia DR2. However, the average improvement on **the standard uncertainties is roughly a factor** 0.8 for the positions and parallaxes, and **0.5 for the proper motions**. These factors reflect the higher number of observations per source, by more than 50% on average, and the longer time span of the data, which make the astrometric results considerably more robust and help to reduce systematic errors.

Step 1/3 Improvements to *Clusterix 2.0*

➤ Clusterix offers the following improvements:
  - Choice between all of the **Gaia releases to date** (TGAS/DR1, DR2, EDR3)
  - The recommended flag **RUWE filtering** at the beginning of the search for Gaia EDR3 is now included
  - An **improved performance** now allows the handling of **up to a million stars** without problems for the server or the user machine
  - A more **efficient management** of temporary files
  - Monitoring of the application to **minimize the impact of crashes** due to simultaneous heavy queries
  - Implementation of new security patches
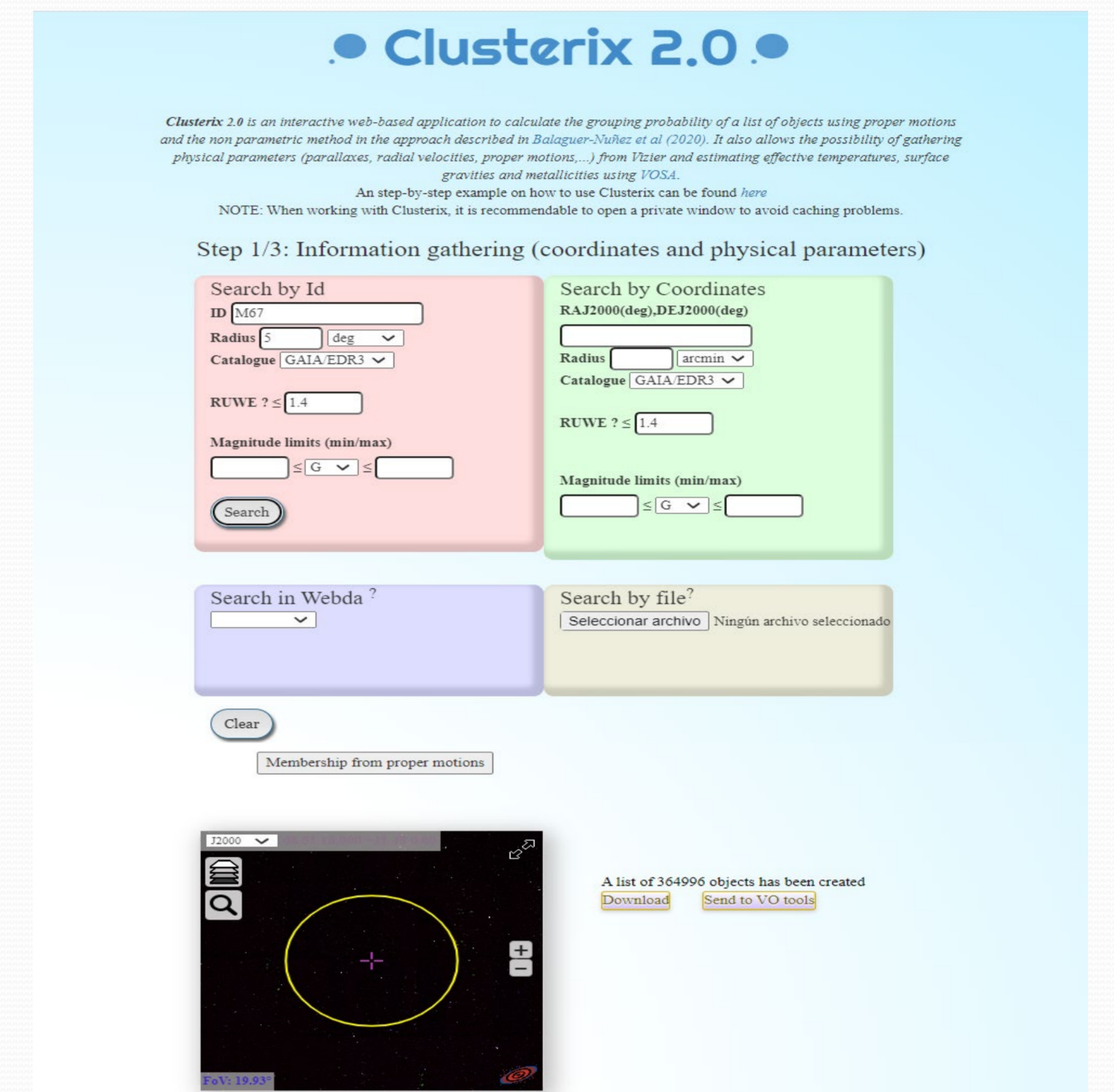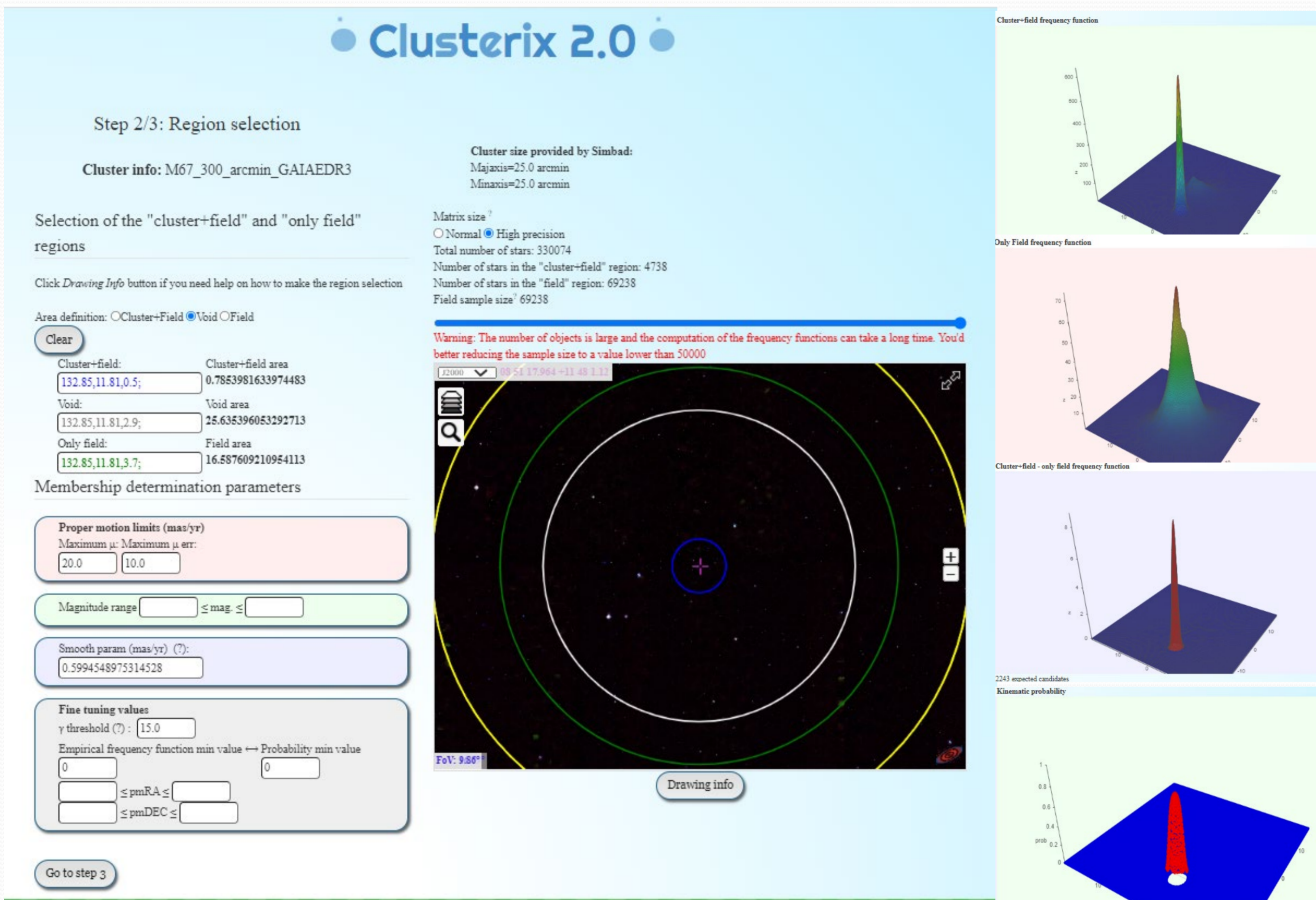
## Step 2/3: Selection of the *"cluster+field"* and *"only field"* regions

➤ As an example of the new capabilities we present results for the **open cluster M67** where we are now using the full data up to the photometric limit of Gaia finding members up to **G=20.8** in an area of **5 degrees**.
➤ In this step the user defines the *"cluster+field"* and *"only field"* regions. As it is a very extended and rich OC, we also define a buffer region "void" that surrounds the cluster area but is not yet clean enough to be representative of the field.
➤ Cluster / field segregation is performed by Clusterix using the non-parametric approach described in Galadí-Enríquez et al. (1998) under two basic assumptions:
  - The region selected as *"only field"* has a negligible cluster contribution.
  - The *"only field"* region gives a reliable representation of the field frequency function in the region of the sky occupied by the cluster.
➤ We get **48% more probable member stars** after the proper motion selection, than with the same selection based on Gaia DR2 data (Balaguer-Núñez et al. 2019).

M67 (NGC 2682)

➤ In an area of 5° around M67 (364 996 stars) Clusterix finds one clear cluster with 2292 candidate members in total. With the results from Clusterix we plot the colour magnitude diagram (see figures below) where all the stars in the area up to G= 20.8 mag are in grey, candidate members in red. By simply introducing a further selection with a 1 sigma in parallax, we found 1570 member stars (in blue).
➤ The average parameters of the cluster are:
  - $\mu_\alpha \cos \delta$ = -10.97±0.26 mas yr^{-1} ; μ_δ = -2.91±0.26 mas yr^{-1}; ϖ = 1.14±0.07 mas
  - vrad = 34.2±4.4 km s^{-1} (from 78 members)
  In agreement with the values found by Balaguer-Núñez et al. 2020.

Step 3/3: Determination of membership probabilities

➤ In this step Clusterix returns a table with the membership probabilities of the list of objects gathered in the first step and fulfilling the requirements defined in the second step. The expected number of members is in this case 2243 stars, what puts the probability limit at 0.7948. That probability cut gives us 2520 members with the Flag label "M". The full table can be downloaded as a text file or send via SAMP to other VO tools (TOPCAT) for its further analysis and to VOSA for the calculation of physical parameters of only those selected members.

$0.95 < \varpi < 1.32$
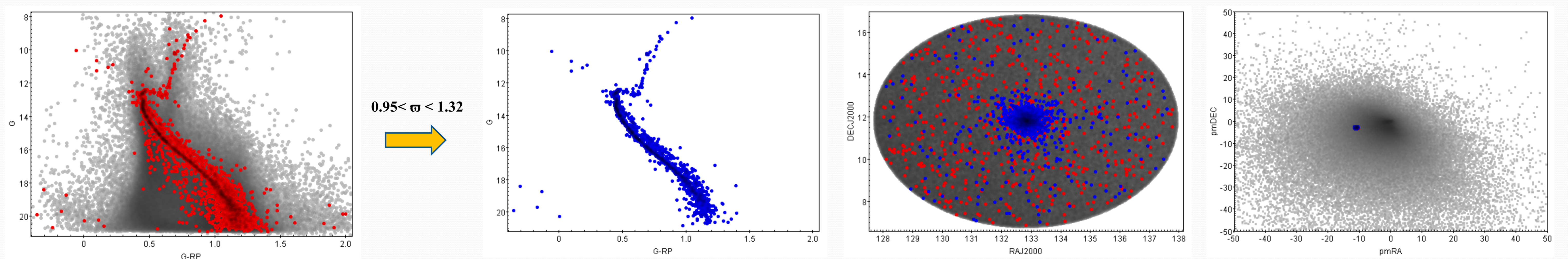
➤ Email contact:
  lbalaguer@fqa.ub.edu

Conclusions

➤ In an area of 5° around M67 up to **G=20.8** Clusterix **finds 9% more stars than using Gaia DR2** where the limit was G=19
➤ Most **member stars** are located inside the central 2 degrees but there are members **up to a distance of 200' (50 pc)**
➤ We found in our cleanest sample even **White Dwarfs and Blue Straggler Stars** up to the same distance of 200' (50 pc)