pyFAT Status Report
Release v0.0.2

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June 3, 2021

The python Fully Automated TiRiFiC(pyFAT) is a python wrapper around the tilted ring fitting code (TiRiFiC, Józsa et al., 2007) that aims to fully automate the process of fitting simple tilted ring models to line emission cubes. This is the continued development of the previous IDL/GDL code. The code can be found here `https://github.com/PeterKamphuis/pyFAT`.

Although the code is well tested errors and bugs can still be present. The initial description of the IDL/GDL code can be found in Kamphuis et al. (2015), however over time many new features have been added. The current release allows for variations of the ring sizes in the input files and it will automatically adapt the ring size when it determines that not enough rings are present for accurate fitting. The current version allows the inclination, PA and dispersion to be fixed or fitted radially in the final fit and these can now be set individually. A more extensive description of the new features can be found in Kamphuis (2021).

This document provides an overview of plots from Kamphuis (2021) which illustrate the performance of the current version of pyFAT. These differ from the plots of Kamphuis et al. (2015) as now the python HI Artificial and Redshifted (pyHIARD) test database[1] is used for verification (Figures 2 and 3). This database is more realistic and versatile than the initial Artificial galaxies used and contains a set of modified real observations. Unlike FAT, pre-release pyFAT does not exclude fits based on their inclination or size which, at first glance, can make it appear that the code is performing worse than the FAT counterpart. This is in order to re determine these ranges. The code used to produce the figures is available here `https://github.com/PeterKamphuis/FAT_Support`. If you are looking for specific functionality or find that pyFAT is not performing well despite the galaxy having regular rotation or just want to chat about tilted ring modelling pipelines please do not hesitate to contact me.

For a direct comparison with the original release we reproduce figures 7 and 12 from Kamphuis et al. (2015) (Figure 4 and 5, respectively) as well.

It is important to remember that pyFAT is meant for batch fitting. Hence, the aim of the code is to provide tilted ring models that are accurate for a large fraction of galaxies. Ideally, pyFAT should identify galaxies that are not fitted well however this feature is not optimal yet. When fitting individual galaxies it is recommended to run FAT and subsequently fine tune the model by hand in TiRiFiC. In most cases such fine tuning will be limited to a few outer rings but in the case of complex galaxies with significant non-cylindrically symmetric motions the models can fail (Or in the case of very bad data but that is not a pyFAT issue). pyFAT is not an automated version of the extended functionality of TiRiFiC. FAT fits simple rotationally symmetric discs with asymmetric warps and surface brightness distributions. However, TiRiFiCitself provides a much more extended functionality and should be used for identifying significant non-cylindrically symmetric motions, thick discs, bars and other such H I features. When modelling such galaxies ideally FAT can provide a base model and setup a .def file with merely a thin disc. These can then be used in TiRiFiCin order to explore large scale motions not captured by FAT's simple model. For examples of such modelling please see Kamphuis et al. (2011); Zschaechner et al. (2011); Kamphuis et al. (2013); Gentile et al. (2013)

References

Gentile, G., Józsa, G. I. G., Serra, P., et al. 2013, A&A, 554, A125

Józsa, G. I. G., Kenn, F., Klein, U., & Oosterloo, T. A. 2007, A&A, 468, 731

Kamphuis, P., Józsa, G. I. G., Oh, S.-. H., et al. 2015, MNRAS, 452, 3139

Kamphuis, P., Peletier, R. F., van der Kruit, P. C., & Heald, G. H. 2011, MNRAS, 414, 3444

[1] `https://github.com/PeterKamphuis/HI_TRM_Test_Database`

Kamphuis, P., Rand, R. J., Józsa, G. I. G., et al. 2013, MNRAS, 434, 2069

Kamphuis, P. e. a. 2021, in prep, 1

Zschaechner, L. K., Rand, R. J., Heald, G. H., Gentile, G., & Kamphuis, P. 2011, ApJ, 740, 35

Figures

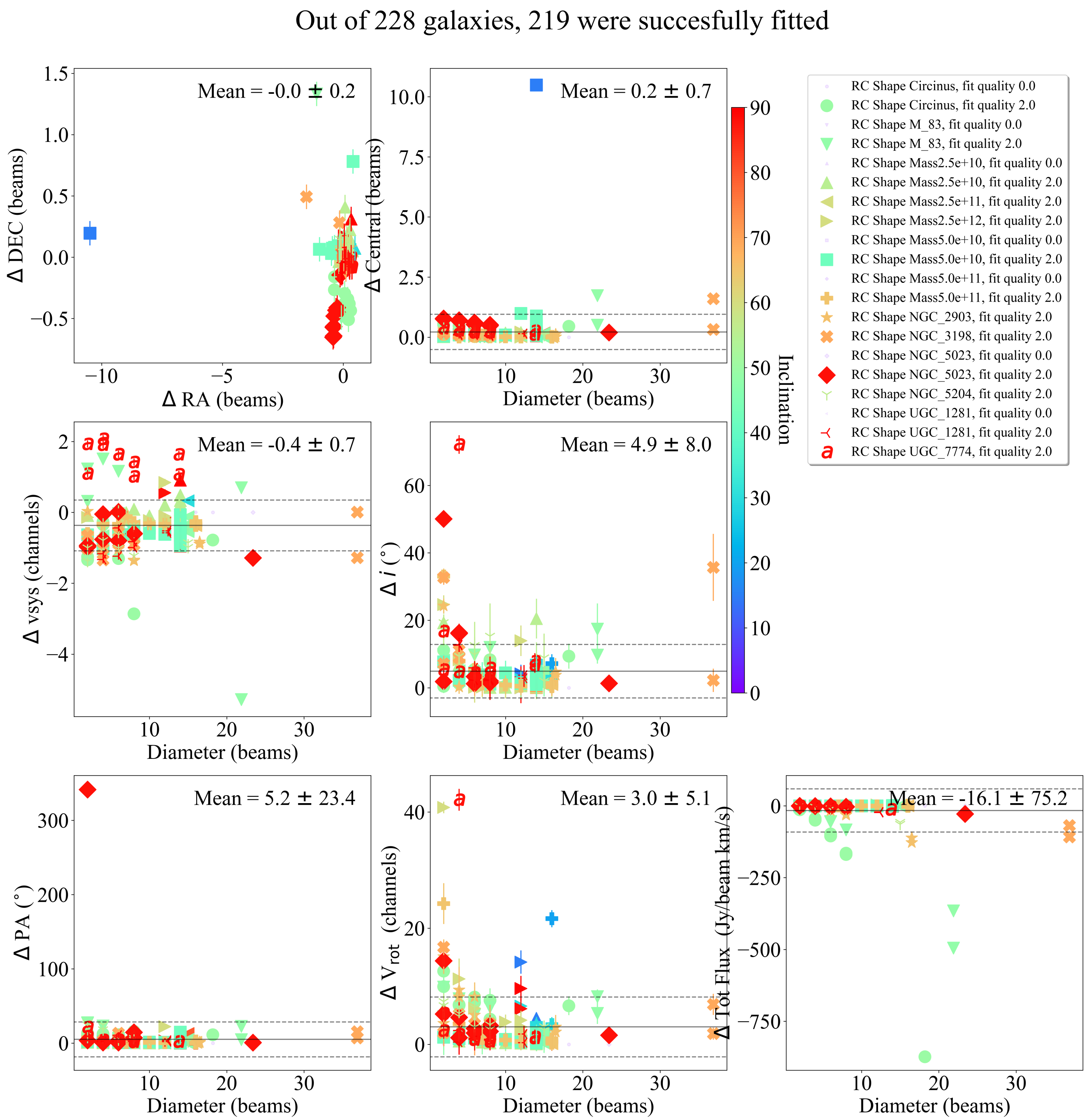

Figure 1: Difference between the database galaxy inputs and FAT output. On the y-axis the difference between the model input and best fitting FAT values is shown for various parameters. The solid line shows the mean deviation over the whole sample and the dashed lines show the 1σ standard deviation from the mean calculated from the differences. The errors on the points are calculated as the average FAT error on all rings in the model. The color coding indicates the inner inclination of the model. Fit Quality 0 = failed fit, 1 is only flat disk, 2 is fully fitted.

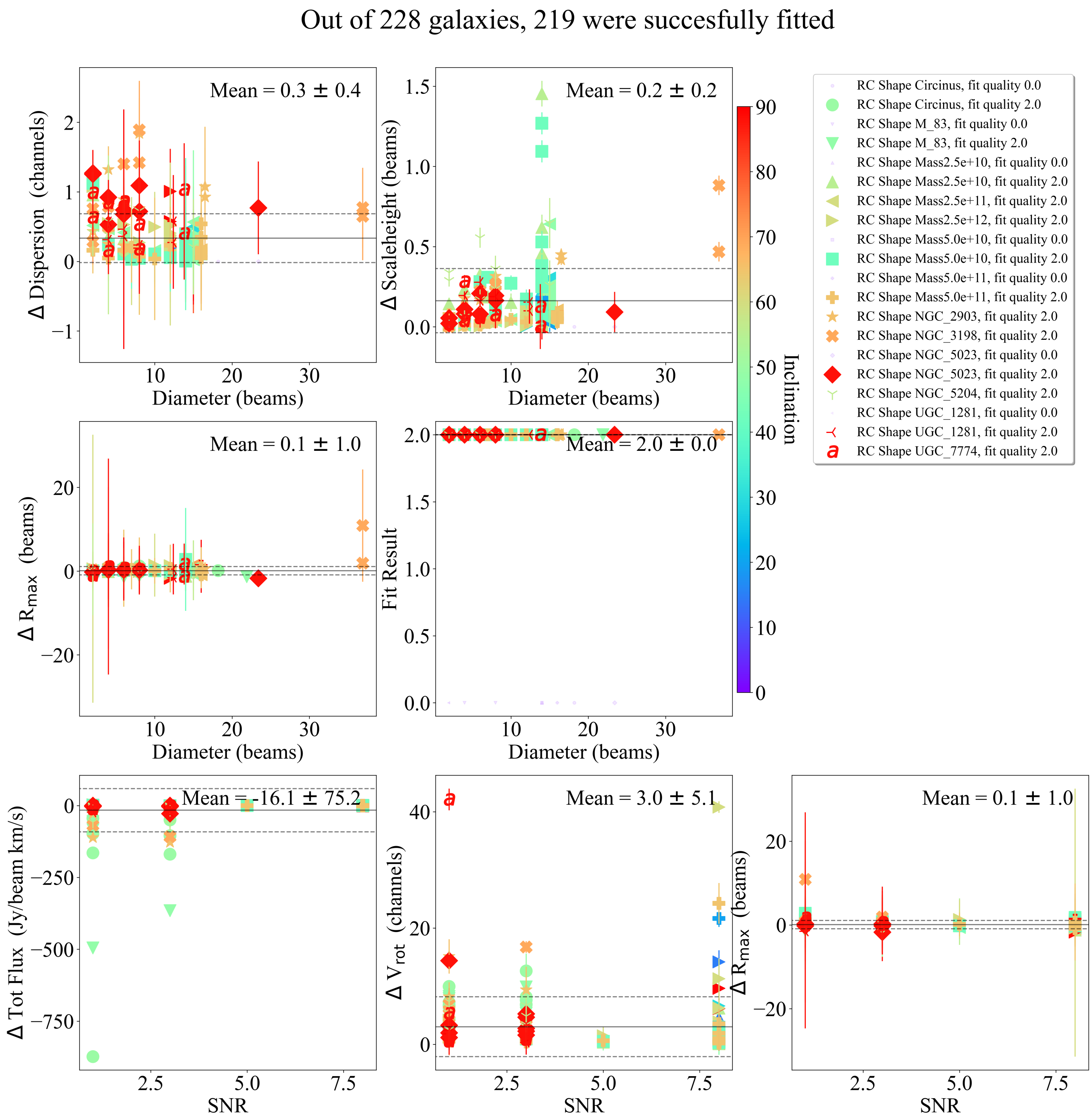

Figure 2: Difference between the database galaxy inputs and FAT output. On the y-axis the difference between the model input and best fitting FAT values is shown for various parameters. The solid line shows the mean deviation over the whole sample and the dashed lines show the 1σ standard deviation from the mean calculated from the differences. The errors on the points are calculated as the average FAT error on all rings in the model. The color coding indicates the inner inclination of the model. Fit Quality $0 =$ failed fit, 1 is only flat disk, 2 is fully fitted.

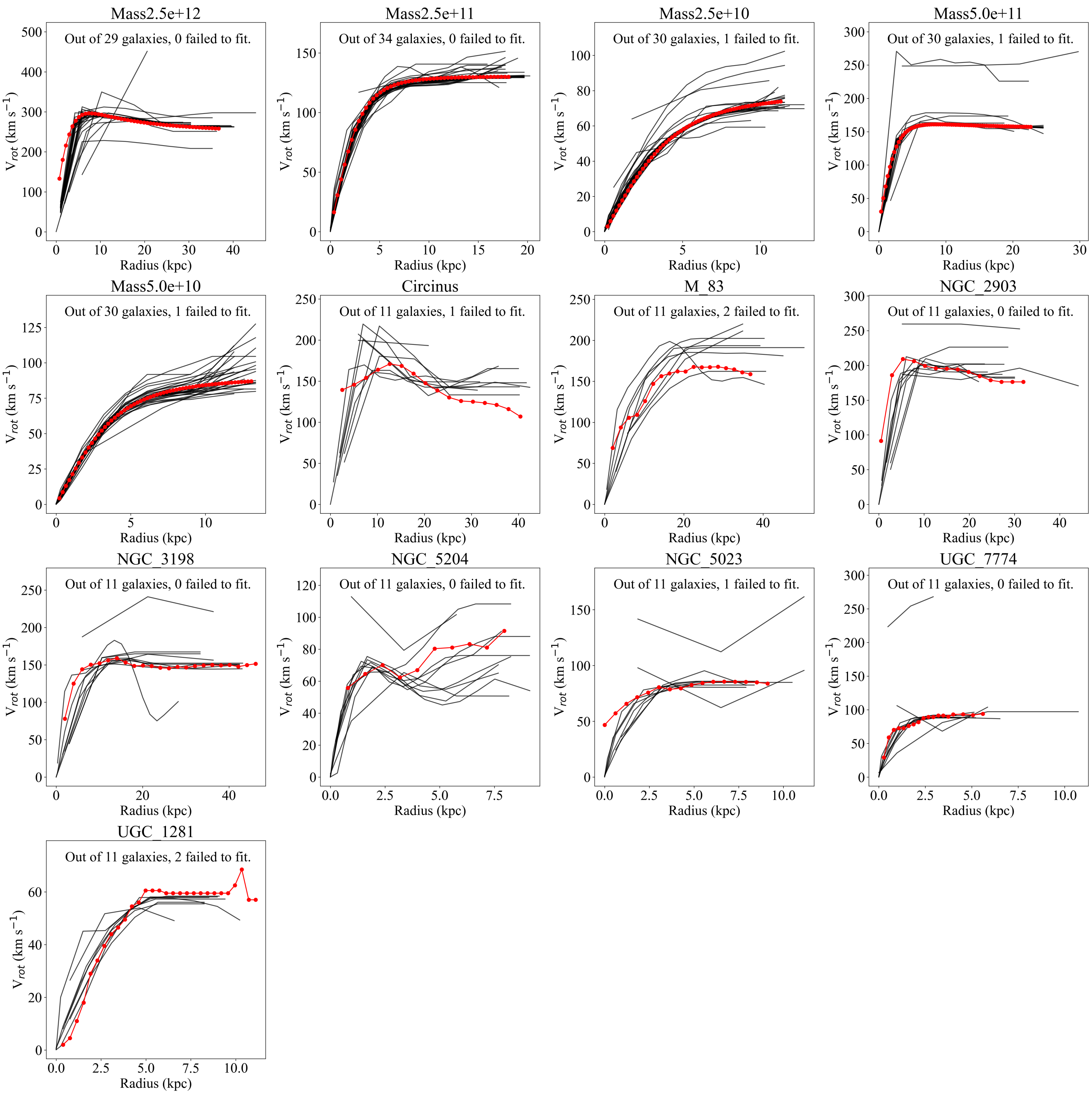

Figure 3: Rotation curves used and fitted in the galaxy database. Red dots and lines are the input model, dashed lines are flat disks (No variations allowed, solid line successful fits.

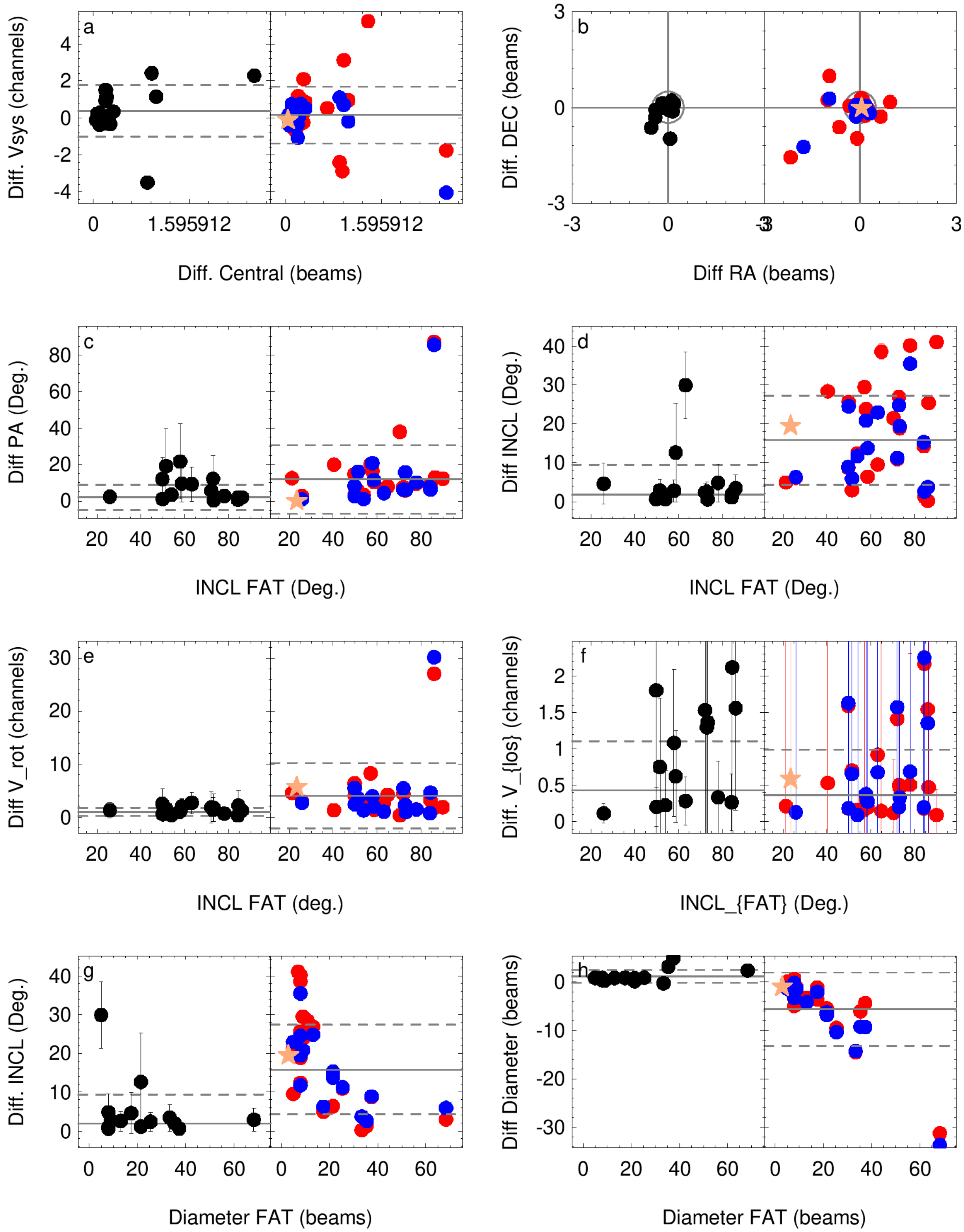

Figure 4: Results of the current release on the LVHIS-26 sample. This is a reproduction of Figure 7 in Kamphuis et al. (2015). Differences between the final fits with FAT, ROTCUR and DISKFIT. Left-hand side of each panel: the difference between ROTCUR and DISKFIT,i.e. ROTCUR–DISKFIT, right-hand side of each panel: blue: the difference between ROTCUR and FAT, red: the difference between DISKFIT and FAT. The solid grey lines show the weighted average and the dashed lines show the 1 σ deviation from this average in each plot. Stars correspond to final fits outside the previously determined reliable range (see Section 4.1) and circles to ones inside these limits. The errors on the points are calculated as the average of the error for all rings divided by $\sqrt{N}$ with N the number of rings in the model. The panels show (a) central coordinate difference versus systemic velocity difference,(b) right ascension difference versus declination difference, (c) PA difference versus inclination, (d) inclination difference versus inclination, (e) rotational velocity difference versus inclination, (f) velocity along the line of sight versus inclination, (g) rotational velocity difference versus model extent, (h) model extent difference versus model extent. Panels (c)–(g) show absolute differences.

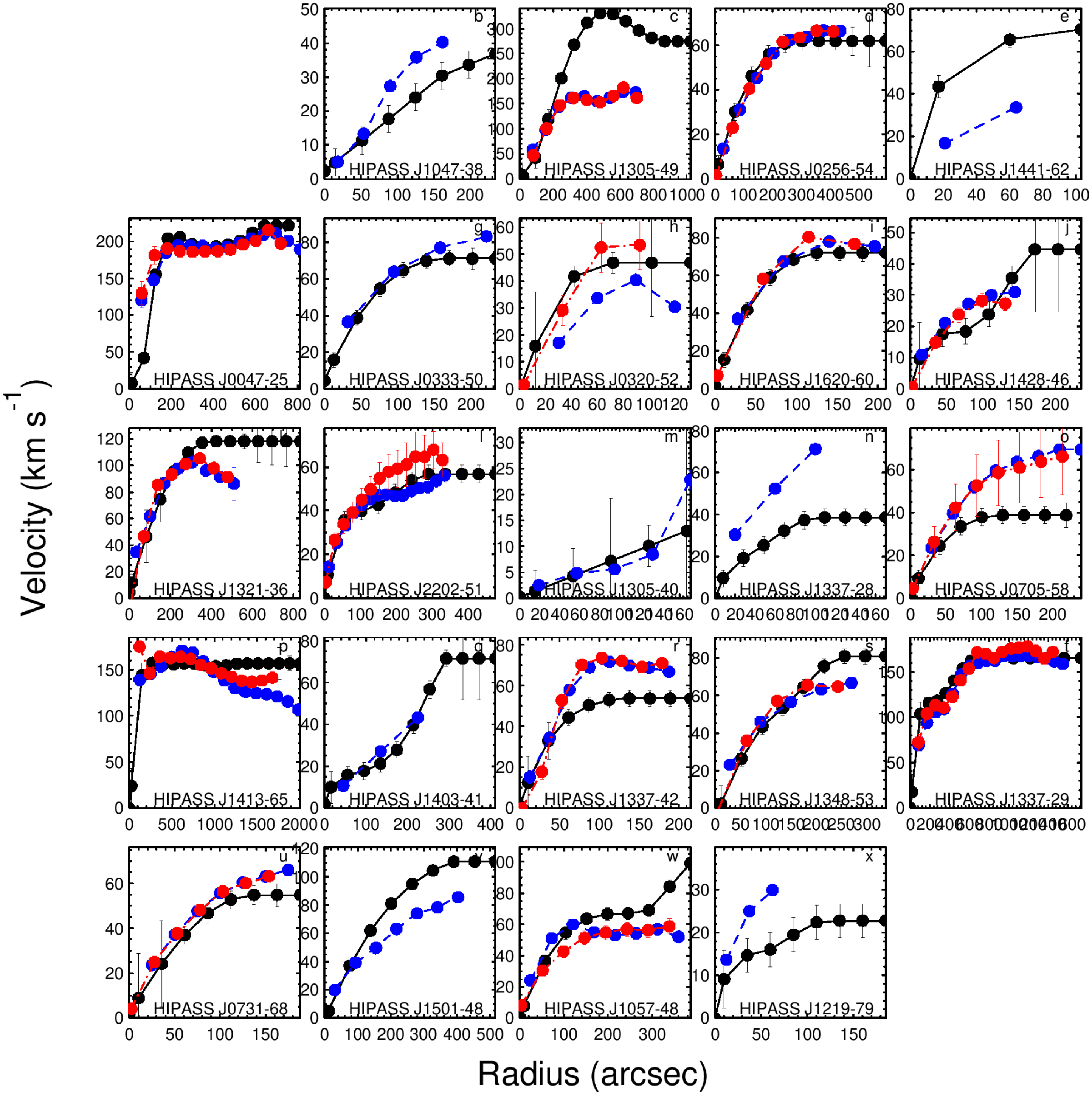

Figure 5: Rotation curves of the current release on the LVHIS-26 sample. This is a reproduction of Figure 7 in Kamphuis et al. (2015). The plots are ordered according to their FAT inclination, with the lowest inclination inthe bottom left. Black lines: FAT , red lines: DISKFIT, blue lines: ROTCUR. The error bars are the formal errors derived by DISKFIT and ROTCUR for the red and blue lines, respectively. For FAT, the error is an empirical estimate derived from the regularization process. Stars indicate curves outside the reliably fitted range.