# Imaging Spectral-Line Deep Fields in the SKA-Era: insights from CHILES

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Neutral hydrogen plays a central role in both driving and regulating star formation over the last 4.6Gyr. Observations show that the star formation rate has dropped by a factor of 3 over that range [1], with the larger galaxies forming most of their stars earlier and the smaller galaxies still forming stars today. The low mass galaxies have either not formed stars efficiently over their lifetime as compared to more massive galaxies, or they have acquired their reservoirs late. It is essential to have a complete unbiased survey of the HI mass of a large range of galaxy masses over a large range of redshifts. Thus there are a number of deep HI surveys planned and on-going that are attempting to answer these questions.

Deep Spectral Line imaging with SKA and the pathfinders, however, is one of the greatest challenges for the next generation instruments as the data volumes are too large to store the raw visibilities to be used for forming the final image. The current plans are for the instruments to have sufficient storage for one day of spectral line data; deep imaging will then be formed from many days of observations.

COSMOS HI Large Extragalactic Survey (CHILES) is a legacy survey on the ngVLA, and has now observed over 1000 hours over 5 epochs in B-array. These observations are made up of several hundred individual observing sessions. The total data volume from CHILES is about that of a single day of SKA observing. We have been using CHILES as a test dataset for Data Intensive Astronomy in designing an actual SKA-Scale data flow [2], using the innovative data manager DALiuGE [3].

One of the most important demonstrations from the CHILES analysis is that is it vital to retain the visibilities, at least in some form. In particular in our case the sensitivity was so high that sources as much as 3° from the phase centre had significant impact of the residual image quality. These out-of-field sources, when observed with JVLA, suffer from the outer edges of the primary beam response. This introduces strong spectral- (the well-known 17MHz ripple) and hour angle-effects (the sidelobes from the feed structure). Thus we were forced to model these for the handful of sources detected out-of-field and subtract these from the time-based visibilities.

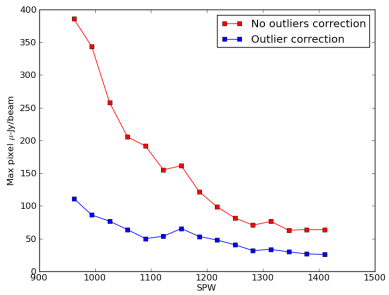


*Fig 1.: Peak residual flux for CHILES spectral windows before and after accounting for the out-of-field sources in the visibilities.*

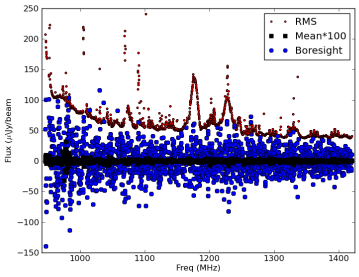


*Fig 2.: Final per channel RMS of the deep CHILES spectral line cube(s) over the full frequency range, from Epoch-1 data only*

This is informing our work on the Deep Investigations of Neutral Gas Origins (DINGO) survey where we cannot store the full datasets, as these would be hundreds of PB. We are actively developing an alternative data processing pipeline, in which we store the daily datasets as gridded data [4].

## References

[1] Hopkins & Beacom, 2006, "On the Normalization of the Cosmic Star Formation History", ApJ, 651, 142
[2] Dodson, R. etal., 2016, "Imaging SKA-scale data in three different computing environments", A&C, 14, 8
[3] Wu, C. etal., 2017, "DALiuGE: A graph execution framework for the astronomical data deluge", A&C, 20, 1
[4] Rozgonyi, K. etal., 2020, "Gridded visibility storage for deep spectral line surveys", MNRAS, Submitted