Optimisation of the 2-km core of ASKAP–30

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Overview

This document describes three different core configurations for ASKAP–30 that were investigated with respect to their performance for WALLABY. All configurations assume that the outer antennas 32, 33, 34, and 36 are included, while antennas 31 and 35 are left out. Hence, the problem reduces to removing four antennas from the 30-antenna core of ASKAP. The three configurations tested include:

- The default ASKAP–30 configuration put forward by **CASS** and submitted to AAL. This configuration has the four outermost available antennas within the 2-km core, that are not part of either BETA or ASKAP–12, removed. Such a configuration essentially results in the most compact possible core and hence provides maximum sensitivity at lower resolution ($\approx 30''$), making it suitable for WALLABY and GASKAP.
- An optimised configuration ("**Optimised**") with the most Gaussian UV coverage in the core. This configuration was created by fitting a Gaussian to the radial UV histogram of the 2-km core of all possible ASKAP–30 configurations and then selecting the one that results in the best fit with the lowest RMS. Again, all ASKAP–12 antennas were required to be included, but BETA antennas were not. This configuration results in a slightly more extended core than the "CASS" configuration by removing some of the inner antennas (including antenna 1), but its UV coverage is more homogeneous, resulting in lower sidelobe levels and better sensitivity at higher resolution ($\approx 20''$–$25''$), making it suitable for DINGO and FLASH.
- A compromise configuration ("**Compromise**") that was created in a similar way as "Optimised", but this time also requiring BETA antennas 1 and 3 to be included to ensure that all of the shortest baselines are present. This configuration is meant to be a compromise between point-source sensitivity and surface brightness sensitivity.

Configurations considered

Name	Config.	Missing antennas	Description
CASS	50145001471	22, 25, 26, 29, 31, 35	Configuration proposed by CASS
Compromise	50196380607	07, 11, 21, 29, 31, 35	Optimisation of core with requirement of antennas 1, 3, 32, 33, 34 and 36, ASKAP–12, and omission of antennas 31 and 35.
Optimised	50464816062	01, 07, 11, 21, 31, 35	Optimisation of core with requirement of antennas 32, 33, 34 and 36, ASKAP–12, and omission of antennas 31 and 35.

Assumptions

- All results presented assume $\delta = -30°$ and a symmetric hour-angle coverage of 8 h.
- All results are derived at a frequency of $\nu = 1420$ MHz.
- All performance measurements are based on simulations with Miriad's task "uvgen".
- Only baselines < 2 km were used when generating images with "invert".

Performance

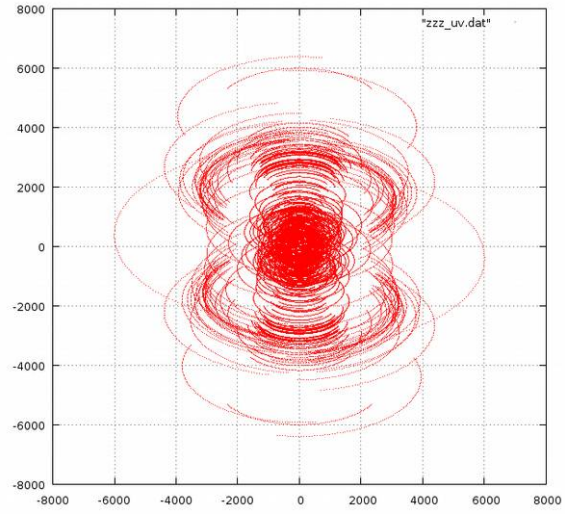
Config.	Beam size (arcsec)	Beam ellipt.	Sidelobes (%)	RMS (mJy)	RMS (K)
Robustness 2					
CASS	33.1 × 26.2	0.608	−3.4…+6.9	2.12	1.48
Compromise	30.7 × 23.5	0.644	−2.8…+6.9	2.11	1.77
Optimised	28.0 × 22.8	0.578	−3.4…+5.6	2.10	1.99
Robustness 0.5					
CASS	26.8 × 21.5	0.596	−5.4…+4.4	2.24	2.35
Compromise	25.0 × 19.9	0.605	−5.7…+4.7	2.22	2.70
Optimised	23.3 × 19.7	0.535	−5.2…+4.1	2.21	2.92
Robustness 0.5 + tapering to 30″					
CASS	32.4 × 27.8	0.514	−5.4…+5.2	2.26	1.52
Compromise	32.8 × 27.4	0.551	−6.2…+6.2	2.32	1.56
Optimised	31.7 × 28.4	0.446	−6.3…+5.7	2.34	1.58

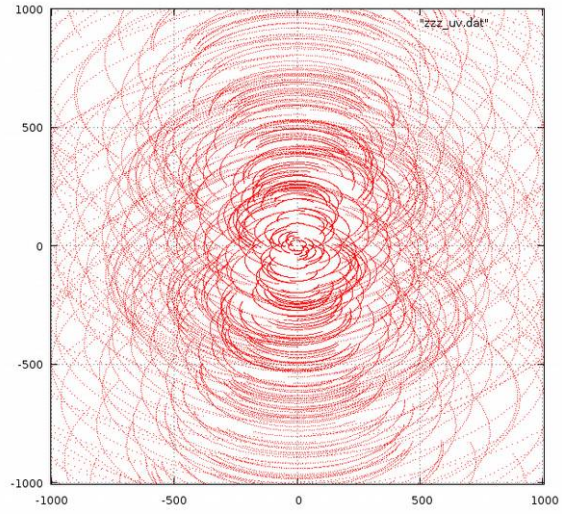
Main conclusions

- The configuration proposed by **CASS** generally works best at 30″ resolution in terms of improved sensitivity and lower sidelobe levels.
- The optimised configuration, **Optimised**, generally works best at higher resolution in terms of improved sensitivity and lower sidelobe levels.
- The compromise configuration, **Compromise**, is somewhere in between in terms of performance, with marginally better sensitivity than “CASS”, but slightly higher sidelobe levels.

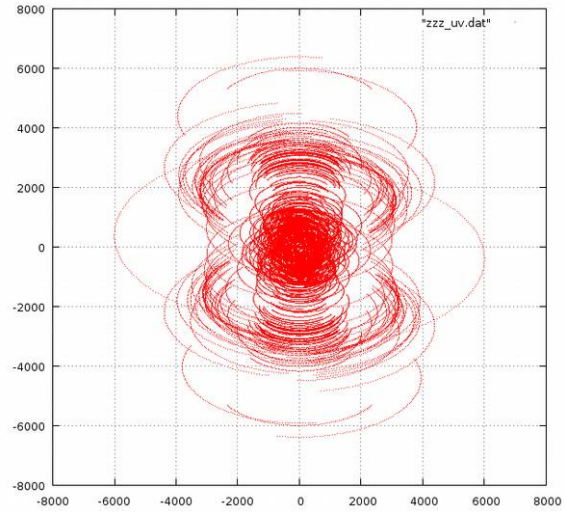
UV coverage

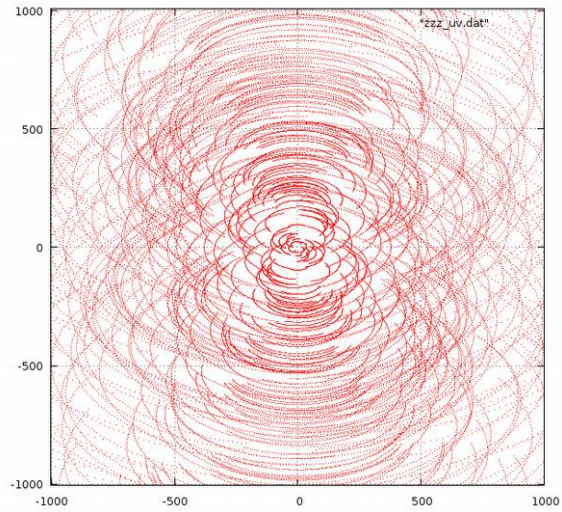
CASS



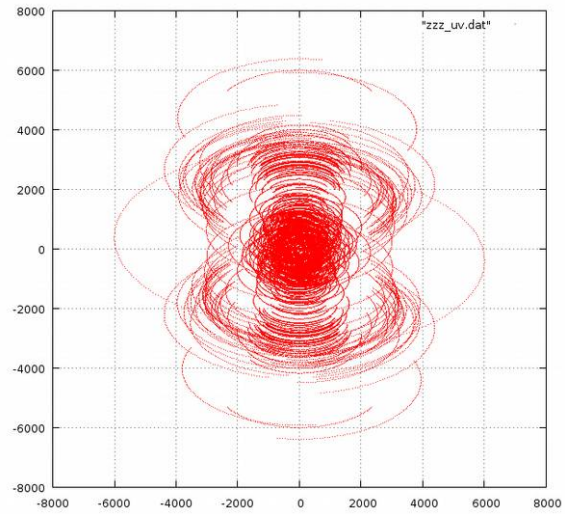


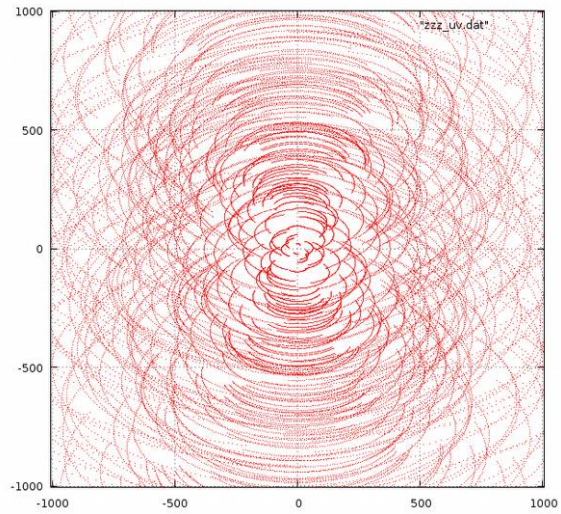
Compromise



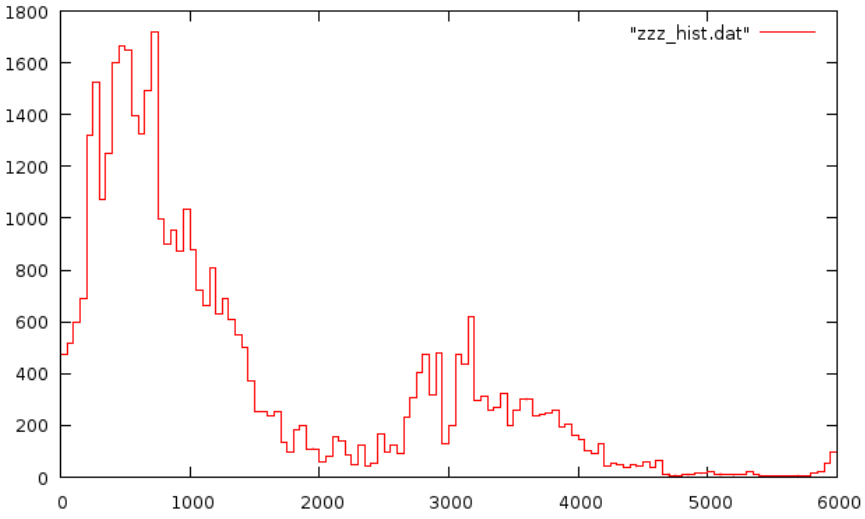
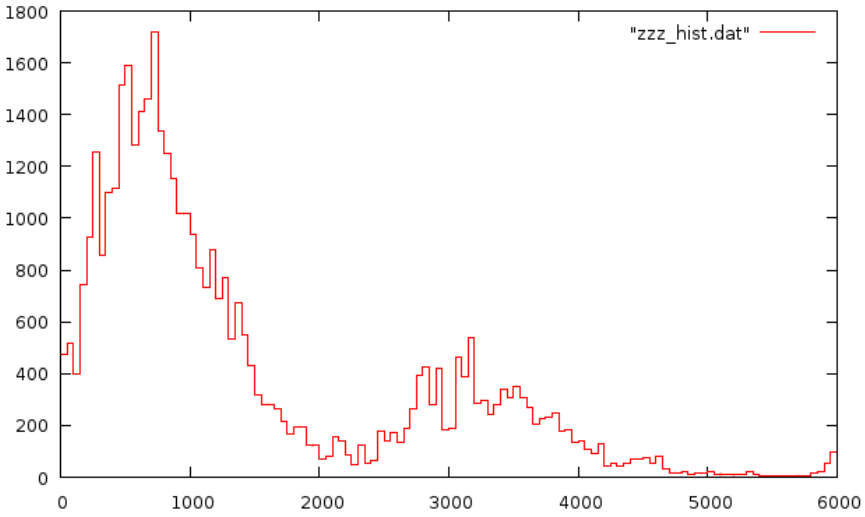
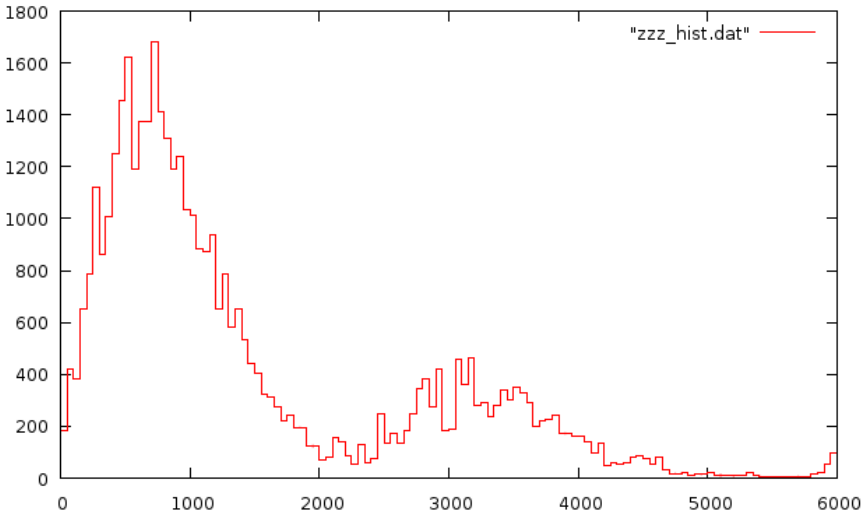


Optimised

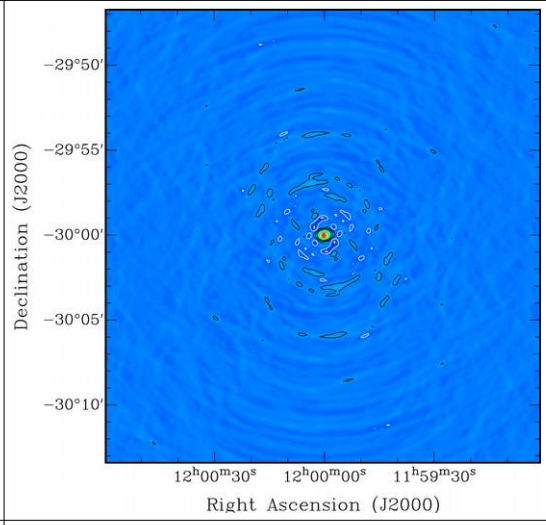
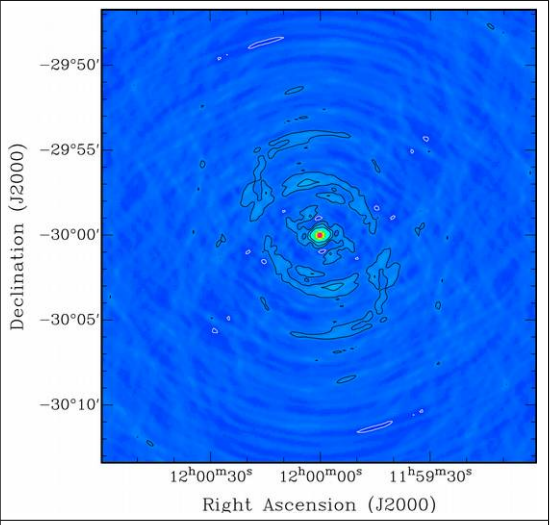
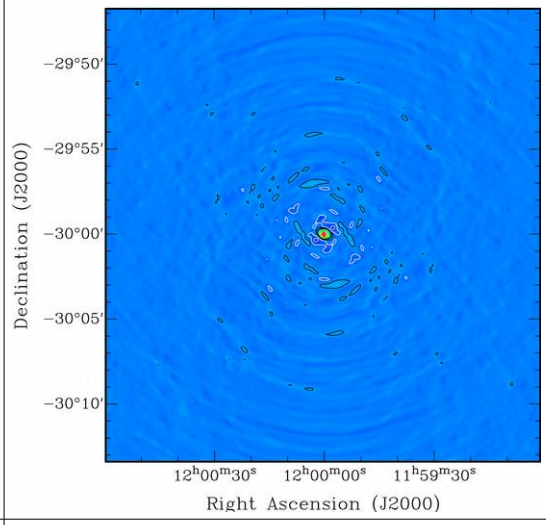
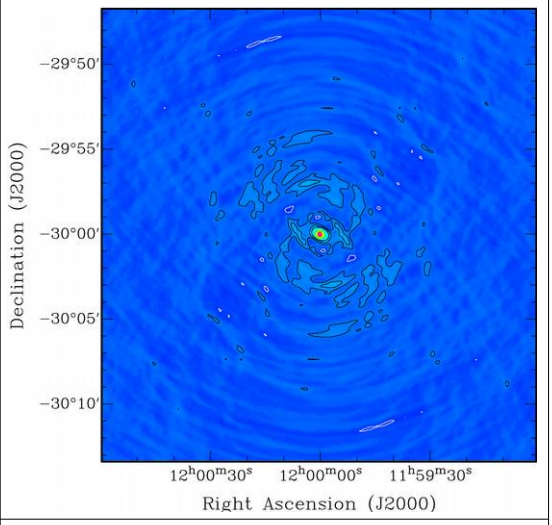
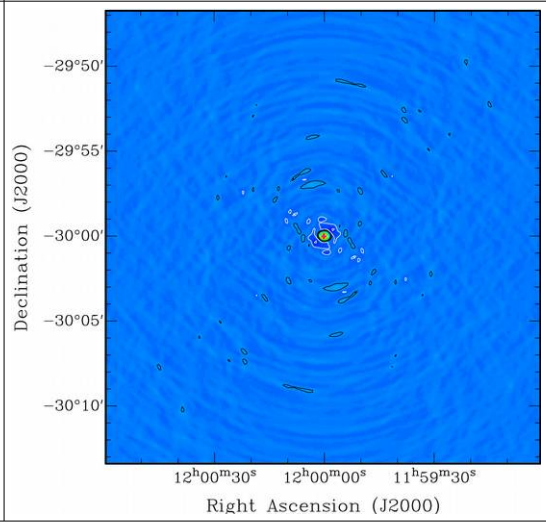
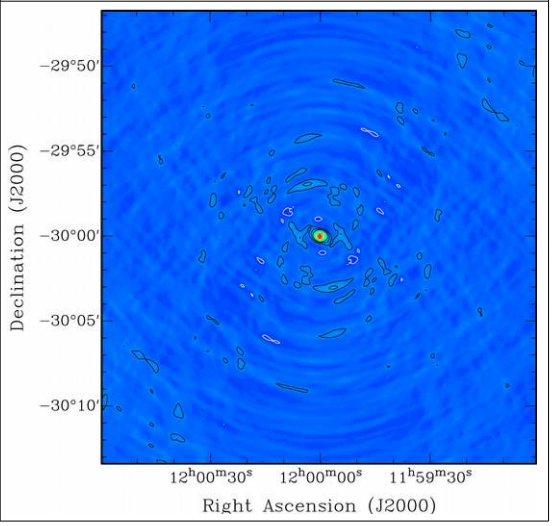




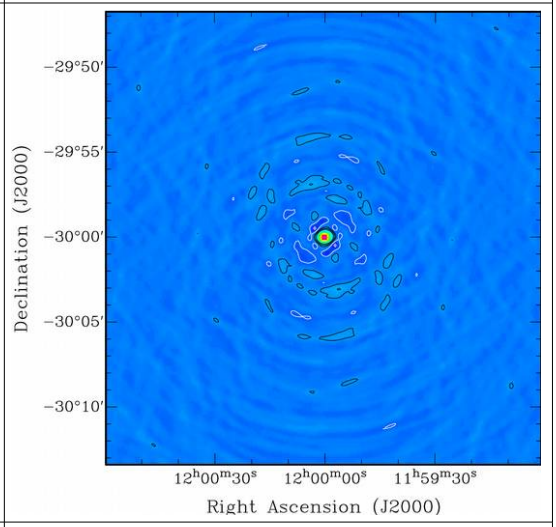
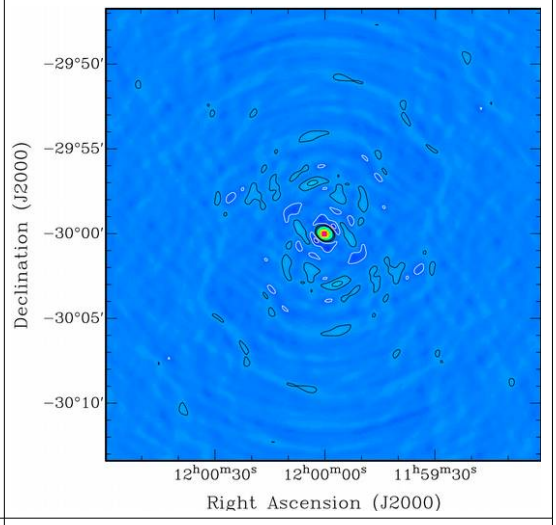
Projected radial UV histograms

CASS	
Compromise	
Optimised	

Beam images

	Robustness 0.5	***Robustness 2***
CASS		
Compromise		
Optimised		

Contour levels are ±2%, ±5% and ±10%, with negative contours in white.

	Robustness 0.5 + tapering to 30″
CASS	
Compromise	
Optimised