
# Progress in the electromagnetic modelling of SKA stations

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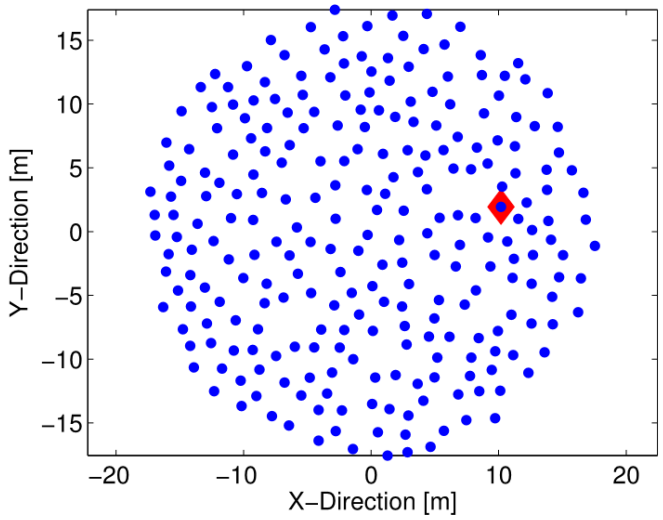
# Contributions


1. More accurate meshing of the antenna.
2. Fast direct solver for multi-station simulations (*).
3. Fast elementary operations with the EEPs for general imaging and calibration (**).

(*) Q. Gueuning, E. de Lera Acedo and A.K. Brown, ‘’An inhomogeneous plane-wave based fast direct solver for the mutual coupling analysis of large arrays’’, to be submitted to TAP.
(**) ongoing

# Reminder on HARP






The computation of EEPs with HARP scales as $\mathbf{O(N_a N_{mbf})^3}$

$N_a = 256$ antennas and
$N_{mbf} \sim 15 - 75$
$N_b \sim 1200$ mesh elements on the single antenna

TABLE I

COMPUTATIONAL TIME OBTAINING EEPS OF AN SKA1-LOW STATION AT 110 MHZ

| | CST | WIPL-D | HARP |
|---|---|---|---|
| Simulation Time | 96 hours | 97 hours | 0.5 min. |

→ x10-20 for SKALA4

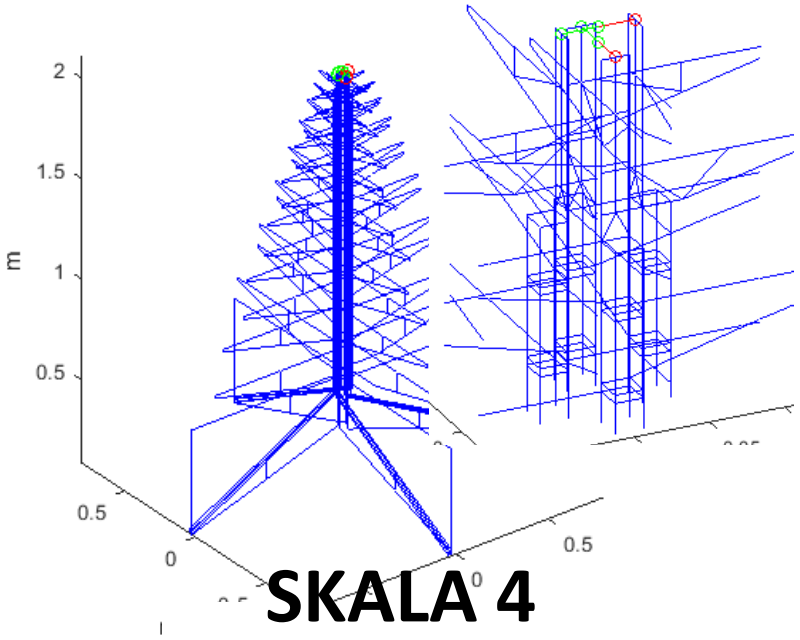
↔ 10^4 speed up !

(*) Ha, et al., " Fast and Accurate Simulation Technique for Large Irregular Arrays ", TAP 2018

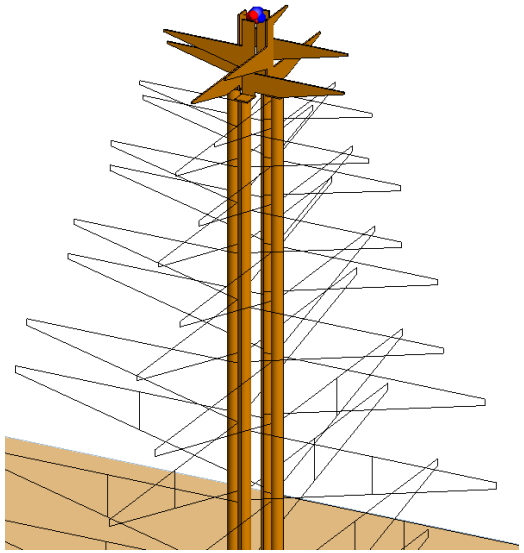
# More accurate element meshing

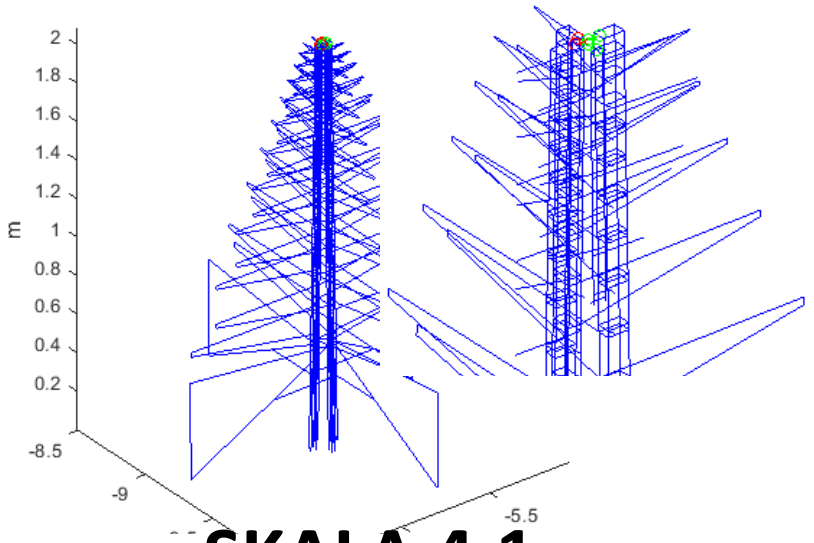
Wire

‘Real’

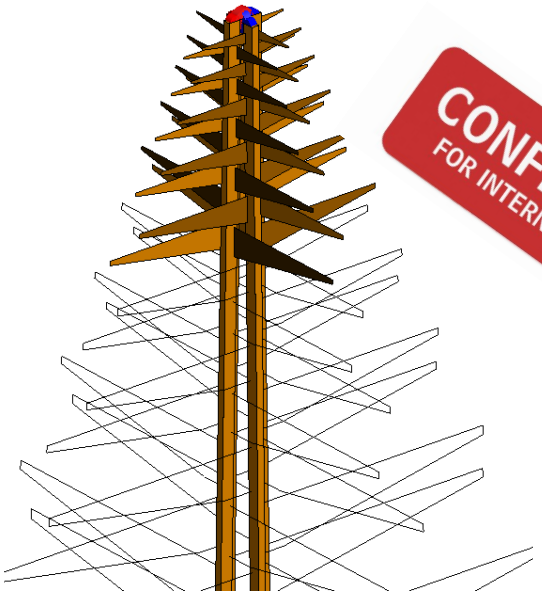



**SKALA 4**



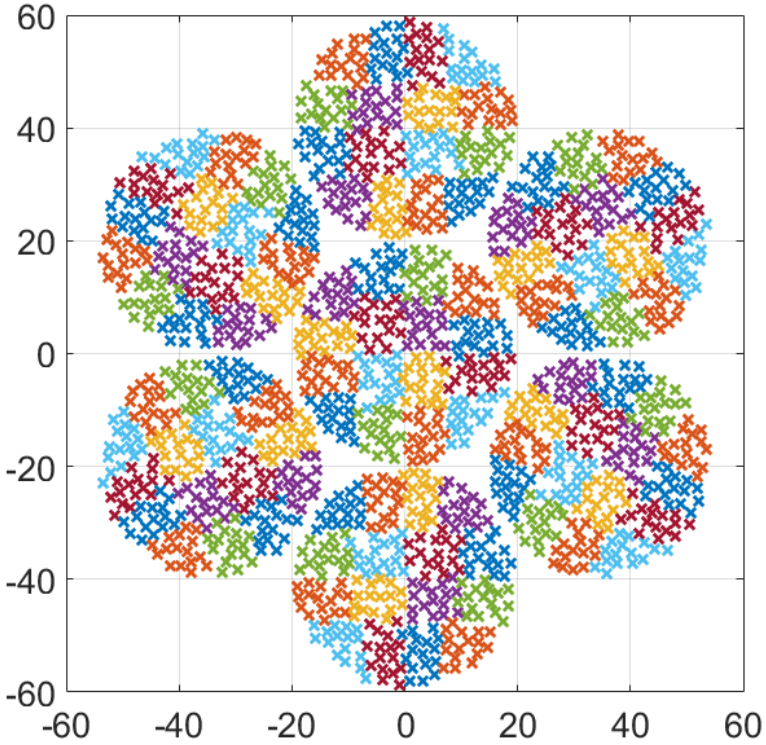



**SKALA 4.1**



# Cambridge's Fast Solver






Application : simulate the mutual coupling between close-by stations.

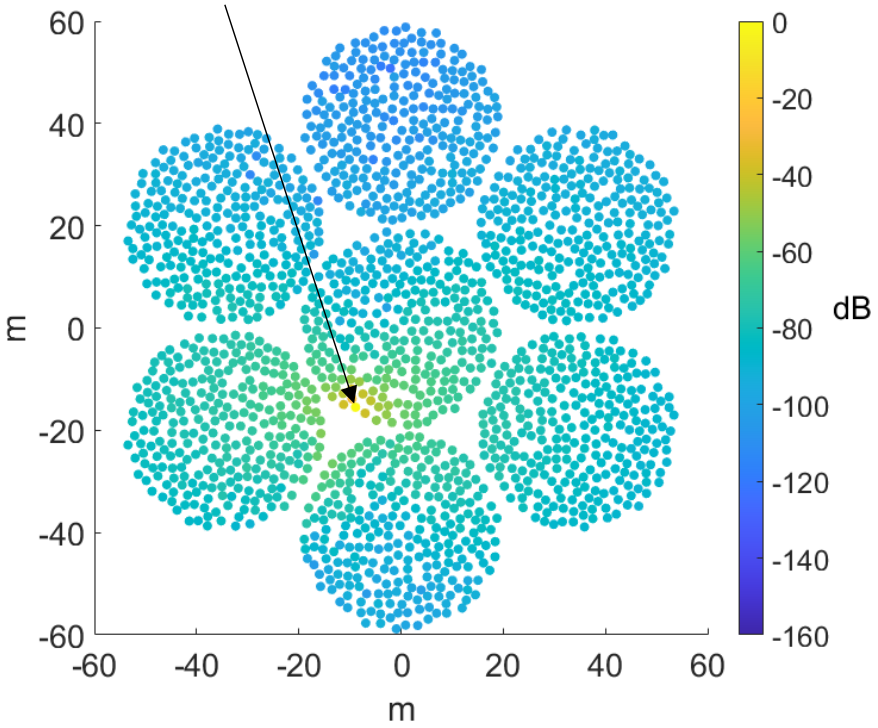
Principle: perform the operations at the group level instead of at the element level.

# Example : inter-station coupling

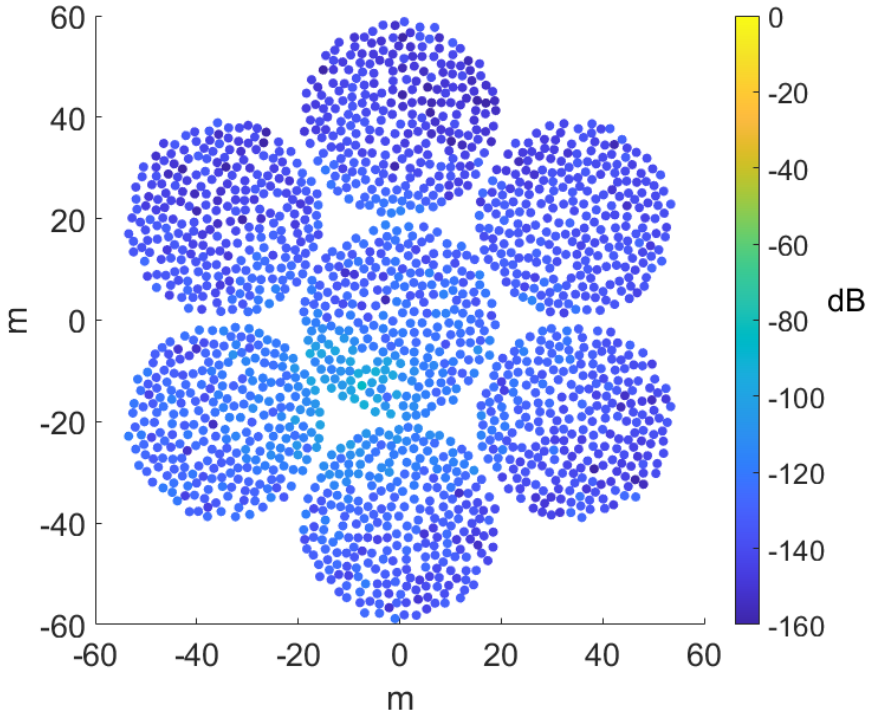


| | HARP | Fast solver |
|---|---|---|
| Computation time | 4 hours | 15 mins |
| Memory | 400 GB | 20 GB |

Port currents when only this antenna is excited at 50 MHz



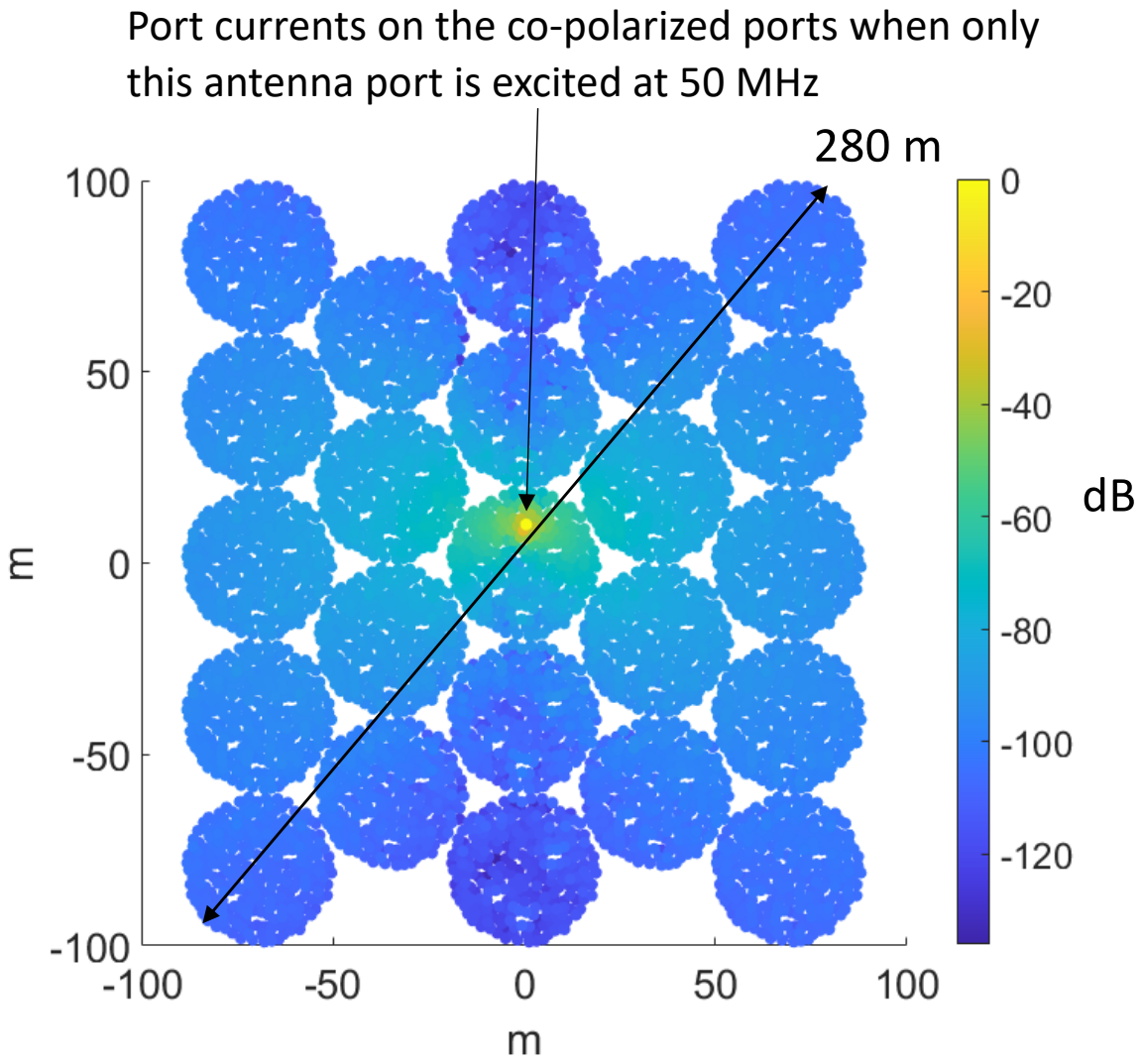

-40 dB absolute error (2 digits accuracy) versus HARP



# 23 stations, 5888 irregular-spaced SKALA4 antenna



The full simulation takes +- 3 hours, 300 GB memory



# Preliminary results for EEP models

Results for a regular array with inter-element distance slightly larger than lambda/2

Number of spherical wave coefficients = O(Na)

Grid over the sky O(Na)

Nyquist limit = O(Na)

2 Na

Our approach O(log Na)