SKA1 DISH HIGH FIDELITY FAR FIELD PATTERNS

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DOCUMENT SOFTWARE

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Other			

ORGANISATION DETAILS

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1 Introduction

This document serves as a cover note to accompany the set of far field patterns that have been generated to support advanced analysis within the SKA1 project.

2 References

The following documents are referenced in the text:

[1] A. Peens-Hough, *SKA1 DISH Model for High Fidelity EM Analysis*, SKA-TEL-DSH-0000137, rev 1
[2] R. Lehmensiek, *SKA1 SPF Band 1 Far Field Patterns*, 2019_08_06_SKA_SPFB1.zip, 6 August 2019
[3] R. Lehmensiek, *SKA1 SPF Band 2 Far Field Patterns*, 2019_08_06_SKA_SPFB2.zip, 6 August 2019
[4] R. Lehmensiek, *SKA1 Ku-band Test Receiver Far Field Patterns*, 2019_08_06_SKA_Ku.zip, 6 August 2019
[5] R. Lehmensiek, *SPF Band 2 Signal Chain Design Document*, SKA-TEL-DSH-0000111, rev 2

3 The DISH Model

The far field patterns represent the EM response of the SKA1_MID DISH element when the as-designed SPF Feeds are fitted to the as-designed Dish Structure. The requirements for the model and analysis methods were stipulated in detail [1], with the following of relevance:

1) The model is based on a structural Finite Element Model of the reflector system incorporating the following detail of the CAD model (illustrated in Figure 1):
    a. actual designed reflector surfaces, including outer rim geometry, and
    b. all conductive objects within 0.5 m from the geometrical optical ray paths.
2) The reflectors are represented as continuous conducting surfaces (no panel gaps) and with infinite conductivity (no Ohmic losses).
3) The model employs structural Finite Element Models of the SPF Band 1 & Band 2 feeds as produced for DDR's. A FEM model is also for the MeerKAT Ku-band feed horn & probes.
4) The far field patterns were generated for transmission, referred to the nominal ***phase reference point***. This point is also the origin of the nominal feed coordinate system. The far field azimuthal angle ϕ is measured positive from the X axis towards Y (with reference to the coordinate axes indicated in Figure 1).

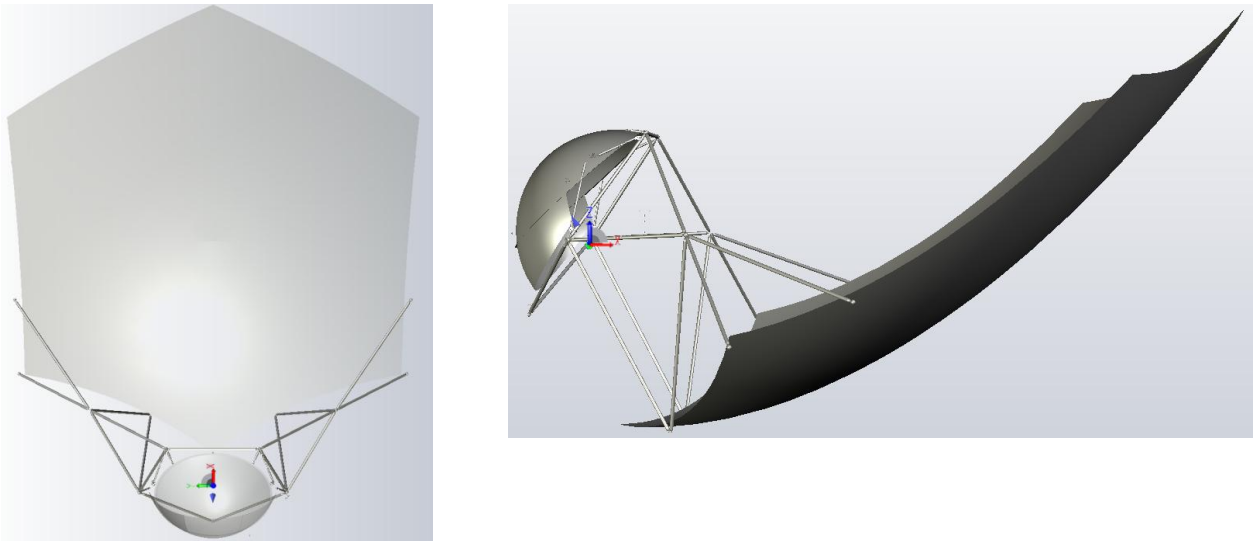

Figure 1: Illustration of the key components included in the DISH model. The *phase reference point* is at the origin of the coordinate axes.

4 Usage Notes

The far field patterns are distributed as collections of compressed MATLAB files [2], [3], [4]. All follow the same conventions including coordinate systems, units and naming conventions.

The file naming convention is as follows:

```
"B%s_%d_%d.mat" % (band, elevation_deg, f_MHz)
```

Variable naming conventions are as follows:

th is the angle [deg] away from bore sight, with *th=0* defining bore sight direction.
ph is the angle [deg] in the aperture plane (x-y axes), *ph=0* defines the plane of symmetry
J*: Jones matrix (voltage) patterns, un-normalized.
Jqh: response of the horizontally polarized feed due to a horizontally polarised wave
Jqv: response of the horizontally polarized feed due to a vertically polarised wave
Jph: response of the vertically polarized feed due to a horizontally polarised wave
Jpv: response of the vertically polarized feed due to a vertically polarised wave

The patterns may be manipulated using standard tools, for example using the standard python, numpy & scipy libraries as illustrated below.

```
import scipy.io
D = scipy.io.loadmat("B2_45_%d.mat"%freq_MHz)
th = D["th"].squeeze() # angle from bore sight with th=0 defining bore sight [deg]
ph = D["ph"].squeeze() # angle in aperture plane with 0="up from vertex" and
defines plane of symmetry [deg]
JHH = D["Jqh"].squeeze() # Jones "voltage" pattern, arranged rows:th x columns:ph
JVV = D["Jpv"].squeeze()
JHV = D["Jqv"].squeeze()
JVH = D["Jph"].squeeze()
```

Note that these patterns are not normalized to bore sight directivity. An example pattern has been generated and included in Figure 2, for reference.

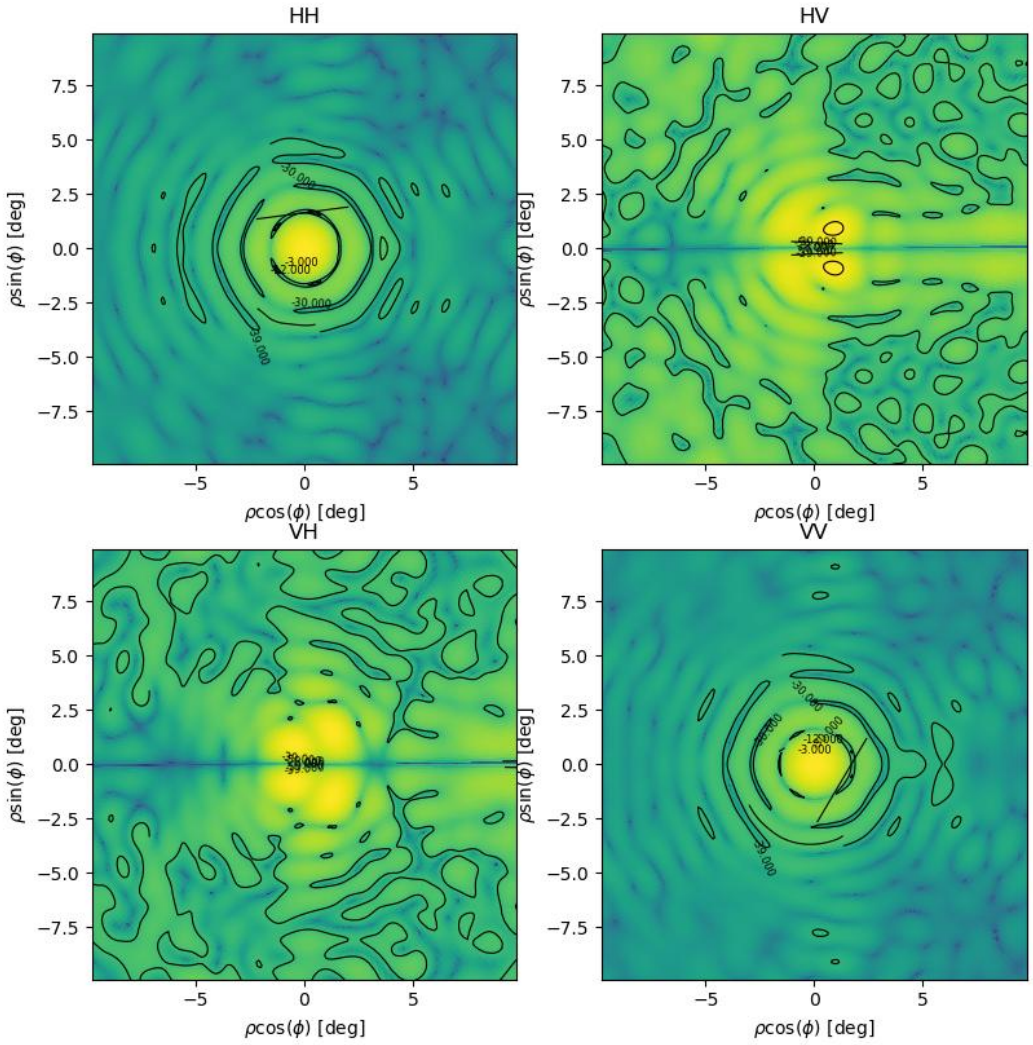

Figure 2: Sample far field patterns for Band 2 (965 MHz) with the reflectors oriented at 45° Elevation angle

Note that the far field figures included in the SPF Band 2 design report [5] have the HV and VH patterns swapped around. This has been confirmed with the author to be an error in that document.

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