Metrology of the HIRAX Dishes

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1 Introduction

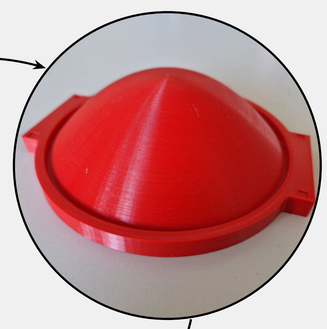
The **H**ydrogen **I**ntensity and **R**eal-time **A**nalysis e**X**periment is a radio interferometer with a compact, redundant array layout which will be co-located with SKA in the Karoo in South Africa. The 256 element array consists of dishes which each have a diameter of six meters. The instrument is going to operate between 400-800 MHz with a field of view of 5-10 degrees. With the primary goal to observe HI via intensity mapping to probe the evolution of dark energy.

HIRAX array how it is envisioned in the Karoo desert [1].

2 Dish Production

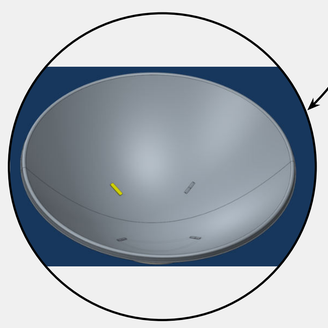
Reflector Plug

- Machined in 2 halves
- Combined to a single piece after machining



Mold

- 4 molds in total
- Single piece



Dish

- First 2 prototypes in July
- Out of fiberglass with an aluminium mesh embedded

3 Systematics and Requirements

- Foreground highly dominates
- The limits of the foreground wedge are determined by the instrument
- Very low systematics and a very good understanding of the instrument is required

2D Power spectrum with and without foreground [2].

Telescope mechanical parameter	Target precision
Receiver position relative to focus	0.5 mm
Dish surface deviations	1 mm

Table 1: Dish requirements [1]

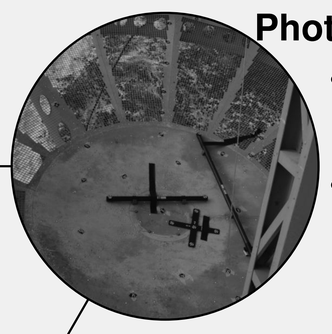
4 Measurement Equipment

Laser Tracker

- Quality control in the factory
- Sweep reflector over surface of DUT

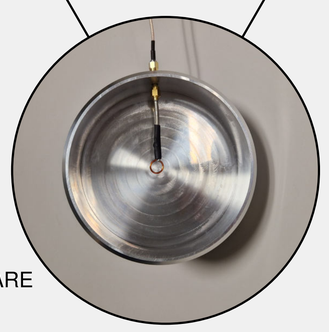
Photogrammetry

- Measuring on site
- Permanent targets on the dish
- Measure surface change



Reflectometer

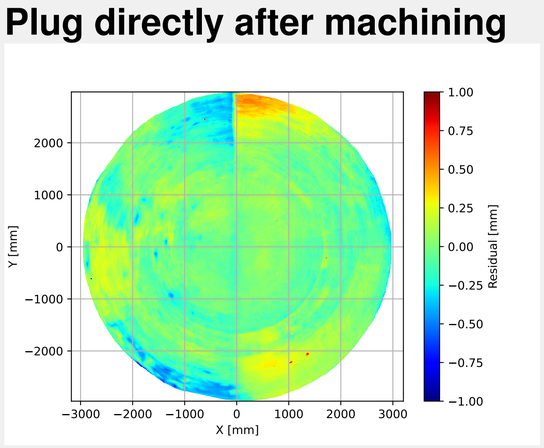
- Measure the actual EM surface relative to the dish surface



Equipment funded through SNSF FLARE Grant 216653

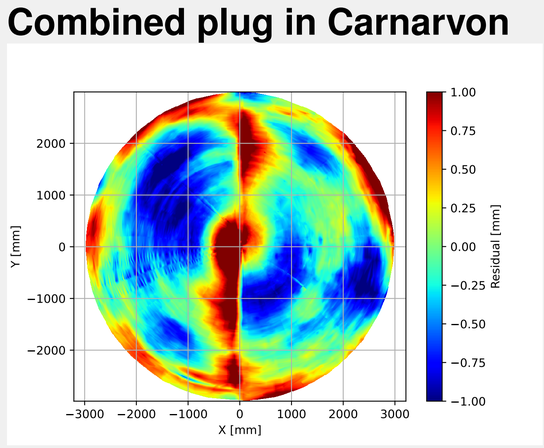
5 Results

Plug directly after machining



The **RMS** value is **0.123 mm** for a best fit paraboloid of a **focal length** of **1260.0 mm**.

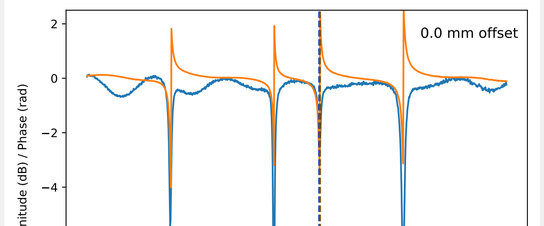
Combined plug in Carnarvon



The **RMS** value is **0.607 mm** for a best fit paraboloid of a **focal length** of **1260.0 mm**.

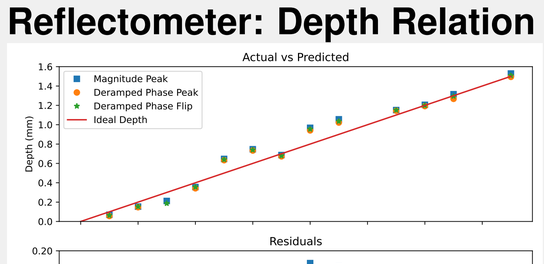
The surface of the plug changed due to the transport and needs to be remachined to be within the required RMS of 0.6 mm.

Reflectometer: Resonance



Measuring the resonance mode of the reflectometer when pressing it onto a reflective surface.

Reflectometer: Depth Relation



Relating the theoretically calculated depth from the frequency mode propagation to the actual physical offset.

6 Next steps

- Improve the plug and remeasure
- Check and measure the first mold and prototype
- Propagate the measured residuals into a beam model

References

[1] Devin Crichton et al. The Hydrogen Intensity and Real-time Analysis eXperiment: 256-Element Array Status and Overview . 2021.

[2] Sourabh Paul et al. HI intensity mapping with the MIGHTEE survey: power spectrum estimates. 2020.