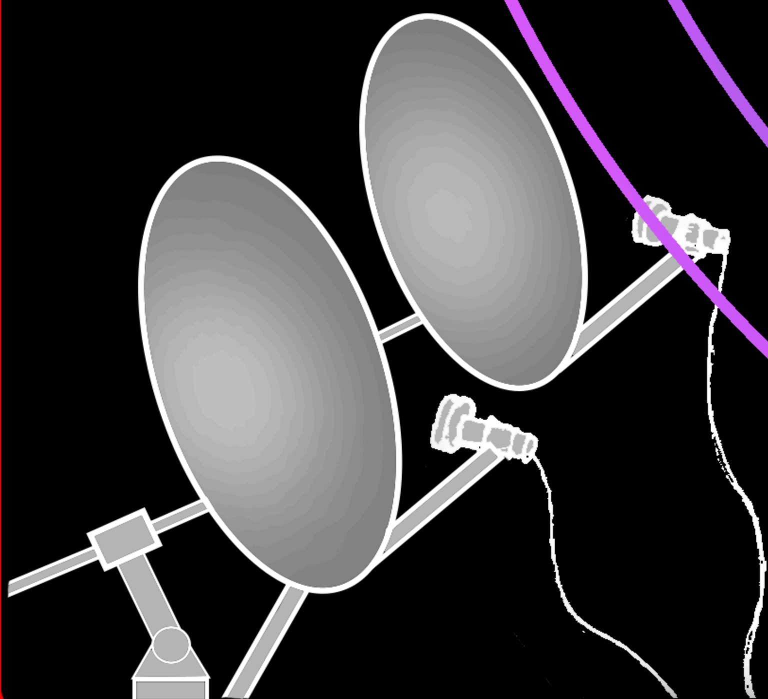
KISS

THE KAPTEYN INTERFEROMETER FOR SHORT-BASELINE SOLAR OBSERVATIONS



KISS is a BSc. Thesis project aimed at the design and construction of a cheap 10 GHz radio interferometer for Solar observations.

WHAT YOU NEED

By Casper Farret Jentink
for the Royal Astronomical Society Poster Exhibition

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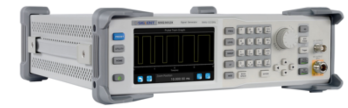

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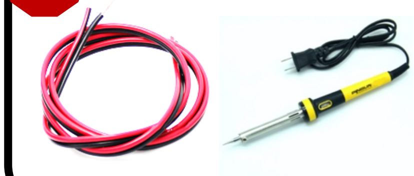

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1. Satellite dish (2x)
2. Equatorial mount (2x)
3. Power meter + sensor
4. Frequency generator
5. Coax cable (50 meters)
6. Raspberry Pi
7. Power supply
8. Soldering iron and wires
9. Low-Noise-Block (LNB) receiver (2x)
10. Antenna splitter (2x)

SETTING IT UP

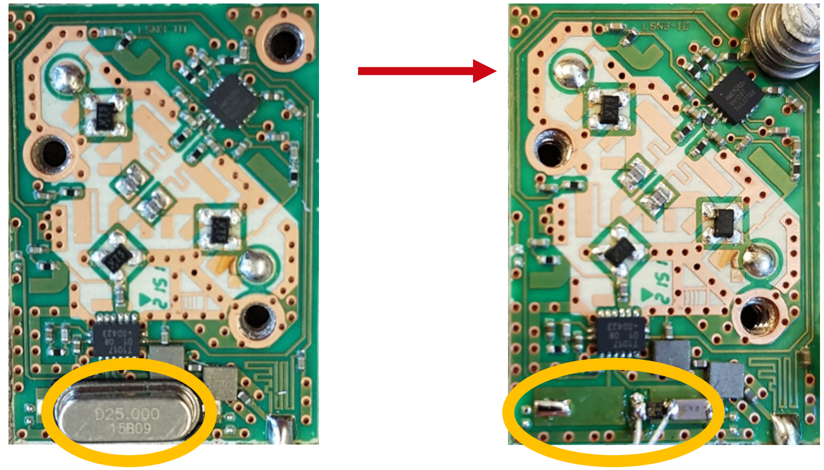
The *cheapest* correlator ever

For an interferometer to work, signals from multiple telescopes need to be 'correlated'. This means that their signals have to interfere. In case of KISS, correlation is not done with a supercomputer but by means of an inverted antenna splitter. It was less than 5 euros. Take that A.L.M.A.!

How to correlate?

1. Plug in both telescope signals.
2. Measure the output.

LNB Receiver modifications



1. Open up the receiver.
2. Measure how much power the 25 MHz quartz crystal supplies to the circuit and solder it out.
3. Replace the poles with wires which run to an external frequency generator at 25 MHz (at the power you measured).
4. Do this for both receivers so you can supply them with the same input. This will cause them to phase lock, essential for interferometry.

Did you know

KISS is currently used by astronomy and mechanical engineering students in Groningen (the Netherlands) to do observations and learn about interferometry.

MEASUREMENTS AND RESULTS

Taking a measurement

Measurements are done with help of drift scans: We point both dishes at the Sun and let Earth's rotation move the Sun out of the beam of the telescopes. The path length that the Sunlight needs to travel changes over this period. Every time it changes by one wavelength (λ) we get a 'fringe', constructive and negative interference. The distance between both telescopes is what we call the baseline *B*, usually also expressed in terms of λ. We measure the output of our antenna splitter correlator with a power meter and sensor, coupled to a Raspberry Pi.

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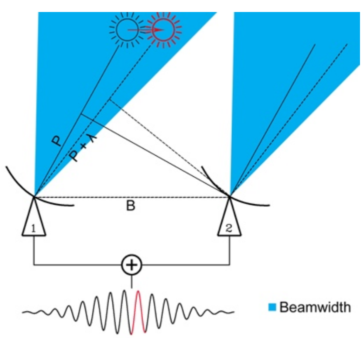
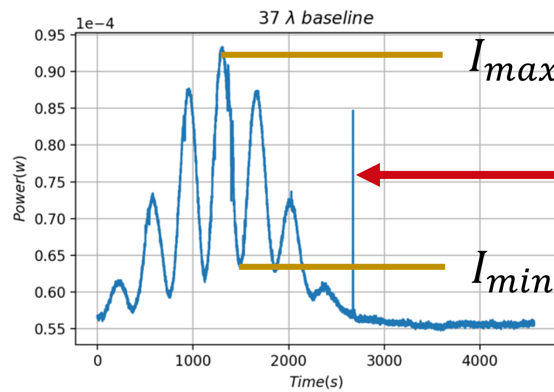
Jasper Steringa



Data Analysis

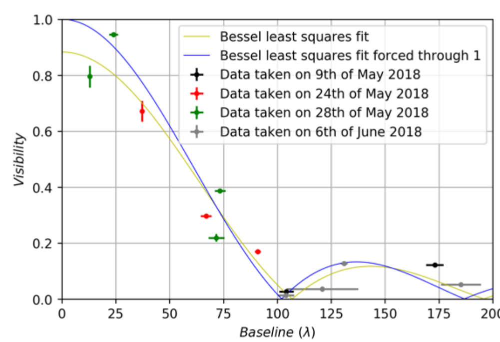
Interferometers measure the Fourier transform of the sky. We call the values in Fourier space 'visibilities'. We can determine one (absolute) visibility value per baseline measurement by means of this equation:



$$V_0(u,v) = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$$

When one of your professors walks through the beam, you measure the heat radiation emitted from their body (or cup of coffee).

A typical dataset looks like this. For this particular measurement, the telescopes were placed 37 wavelengths apart. The Sun passes through the beam and we measure a correlated signal.



Merging our visibilities for all baselines into one plot produces the result on the left. We have fitted the Fourier transform of a disk (what we believe is the shape of the Sun) through the data. This can tell us the angular size of the Sun! :

$$(0.54 \pm 0.02)^\circ$$