Configurations: Proposal for altered dish distribution.

CTF

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In SKA Memo 100 a dish distribution was put forward where 50% of the collecting area was within a central core 5km in diameter, 25% was distributed between 2.5 and 180km distance from the centre and the remaining 25% was distributed between 180 and 3000km from the array centre.

It has been suggested (Joe Lazio, email 16th June 2009) that a "scale free" distribution is the ideal from an imaging perspective. The concentration of collecting area in the central core and the limitations on minimum separation between antennas precludes a fully scale free baseline distribution.

Here we propose a slightly altered dish distribution that gives a baseline distribution closer to a scale-free logarithmic distribution in the range 10-3000km, compared to the Memo 100 distribution.

Fraction of collector / number of dishes	Central area (core) Radius 2.5km	2.5km – 180km	180km – 3000km
Memo 100 distribution	50% 1500 [75]	25% 750 [37]	25% 750 [38]
Proposed distribution	50% 1500 [75]	30% 900 [45]	20% 600 [30]

Table 1: Comparison of the Memo 100 and proposed dish distributions. Numbers in square brackets are the number of 20-dish equivalent stations in each region - used to generate layouts of 150 positions to assess the baseline distribution out to 3000km.

The dish distribution numbers chosen for the new distribution are close to logarithmic in scaling outside the core.

We have generated layouts of 150 positions with a 2.5km radius core randomly (with uniform probability density) populated with 75 positions and then with 5 spiral arms out to 1000km and 3 spiral arms from 1000km to 3000km.

These two layouts are shown in Figure 1 and Figure 2. The cores and spiral arm shapes are identical in each layout, only the manner in which the arms are populated with positions varies. In each distribution we spread the positions logarithmically within the 2.5-180 and 180-3000km bins.

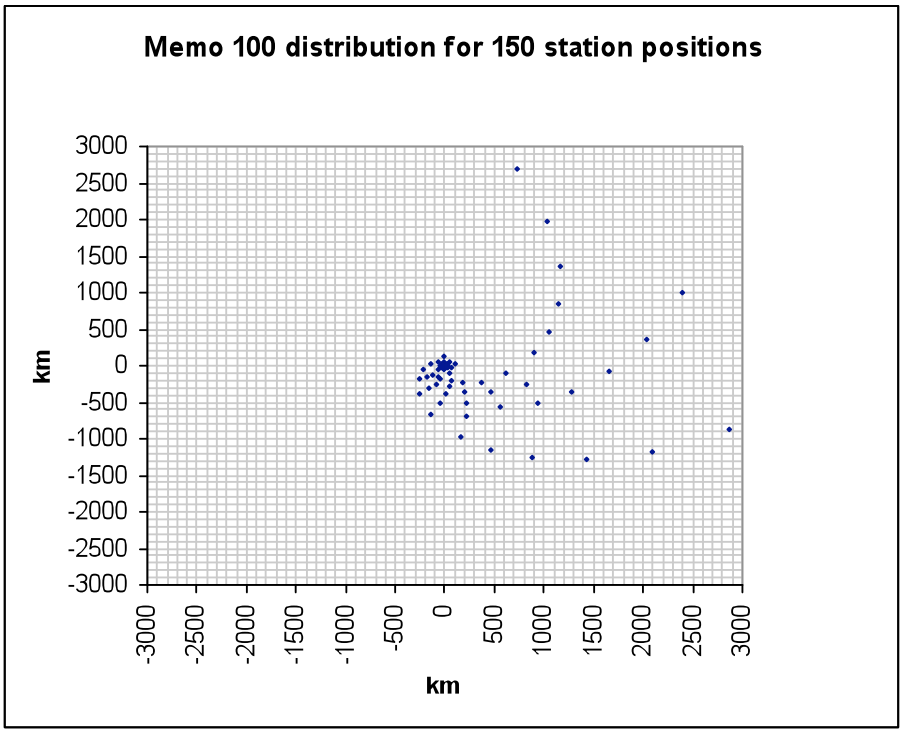

Figure 1: The layout tested using the distribution rules from Memo 100.

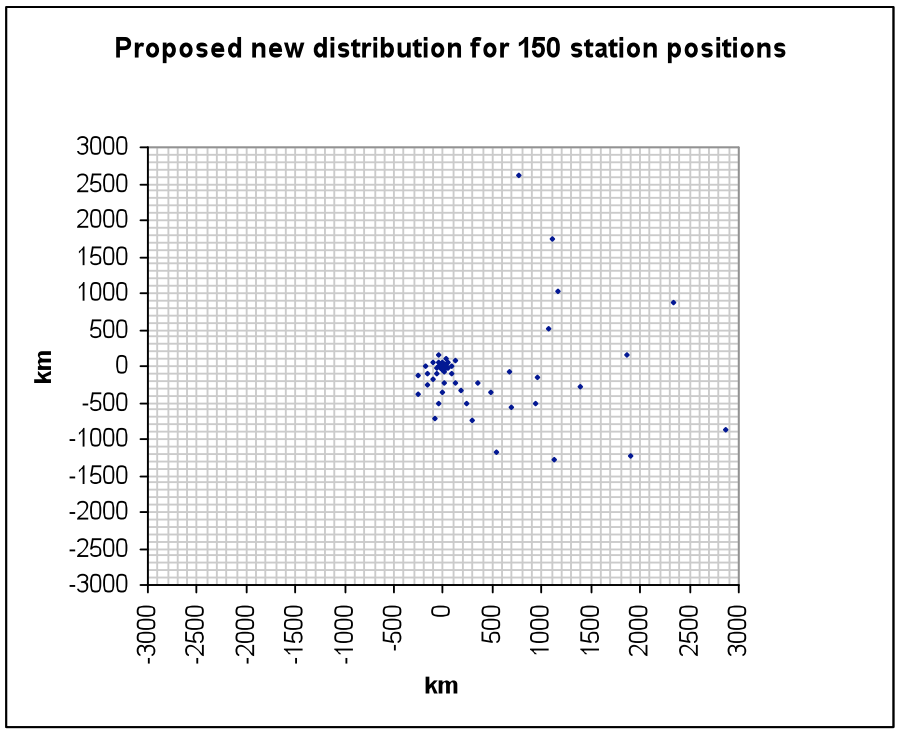

Figure 2: The layout tested using the rules from the proposed new distribution.

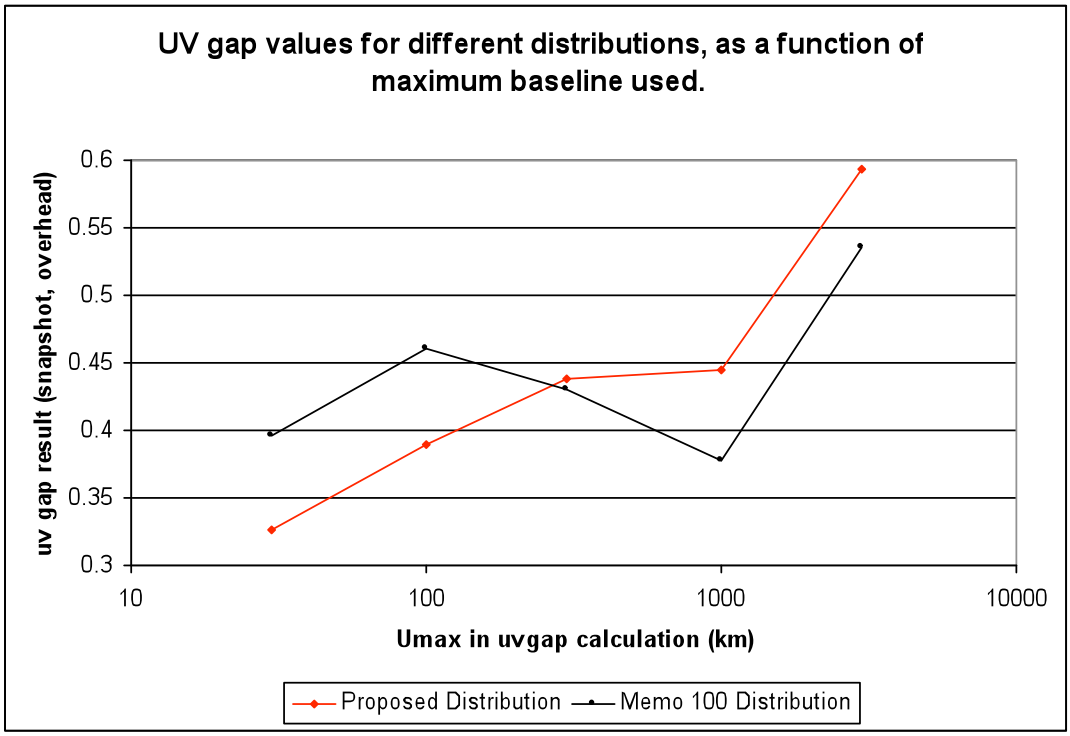

Figure 3: Comparison of uvgap results for the two layouts, for different maximum baselines.

We have analysed these layouts by calculating the uv-gap value for them (for a snapshot observations for a source at Dec -30, where the layouts were generated at Dec -27, and at 0hrs HA – i.e. the source elevation was 87 degrees at the array centre). To assess the uv-gap we select a maximum baseline length to include in the calculation – results for the two arrays of 150 positions at max baseline values of 30, 100, 300, 1000 and 3000km are shown in Figure 3. Clearly, since lower uv-gap values represent better coverage in the uv-plane at the shorter baselines the new distribution is better than the old distribution, but at baselines beyond 200km the distribution in Memo 100 gives better uv-gap values. This is exactly as one would expect because the proposed new distribution sees a shift in dish positions from the outer range (>180km) into the 2.5-180km range.

In Figure 4 we plot the fraction of *baselines* within a given baseline length for the two distributions. This shows clearly that whilst neither distribution gives a perfectly straight line on the log plot, the proposed new distribution gives a curve which is much closer to a logarithmic scaling that the Memo 100 distribution does. There is a dearth of baselines in the 5-200km range for the Memo 100 distribution.

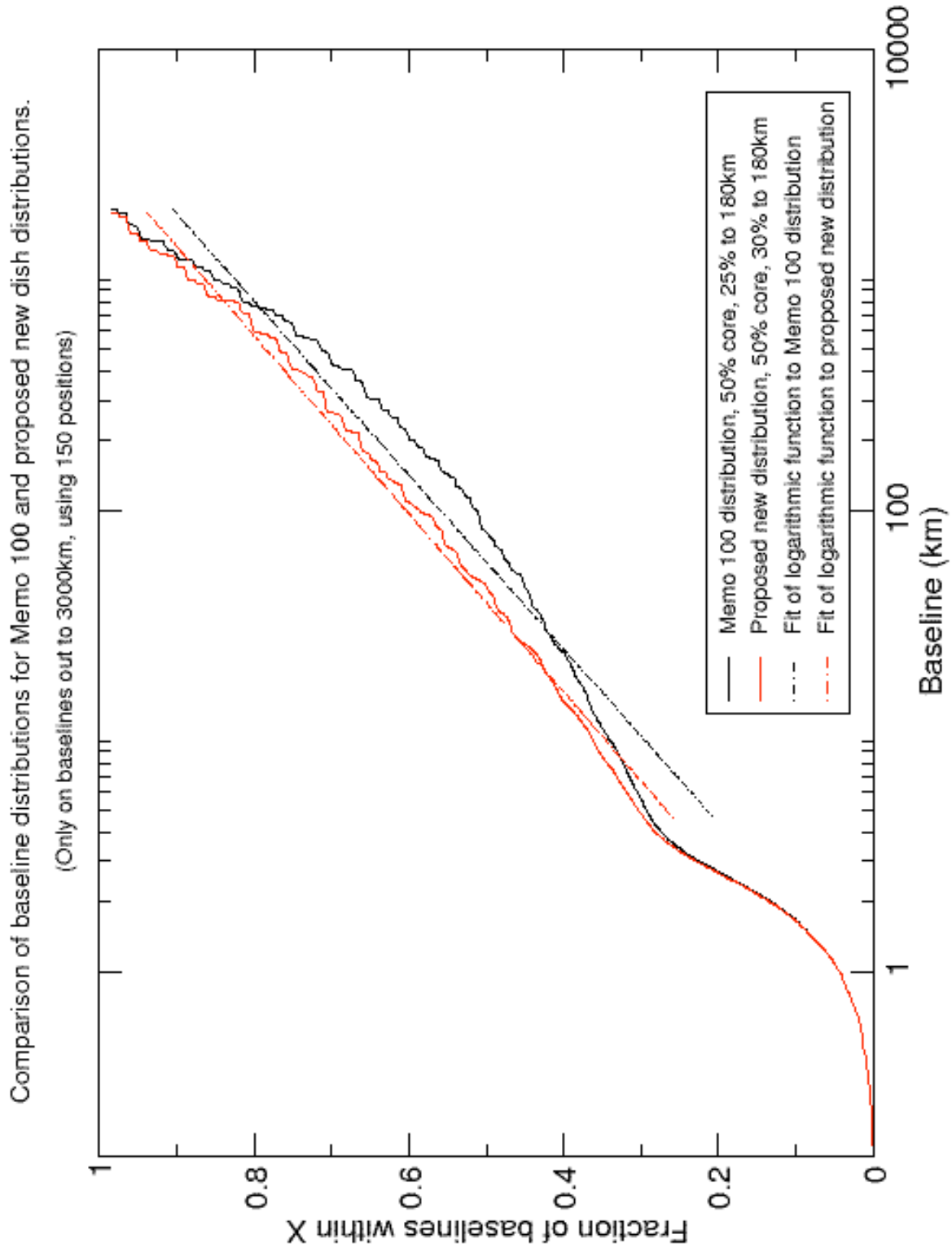

Figure 4: Comparison of the distribution of baselines with baseline length for the two distributions, shown alongside logarithmic fits to the curves where fitting was done for baselines beyond ~5km.

An Example distribution with 2400 dishes and 40 stations

Using the new rules that we propose here, we have generated an example layout with 1500 dishes in a 2.5km radius core (600 of which are within 500m from the core centre and with a distribution following a Gaussian profile[*]), there are then a further 900 dishes between 2.5km and 180km, logarithmically spread along 5 spiral arms. The remaining 600 dishes are assumed to exist in stations of 15 dishes each (so there are 40 stations) and these are placed logarithmically also along the same 5 spiral arms, between 180km and ~3000km.

With the assumption that on the long baselines, each station of dishes will be correlated against every other collector (i.e. every other dish or station of dishes) there are then 2440 effective collectors in this array, with a total of 2975580 baselines for a snapshot.

We present graphs of the distribution of collecting area and baseline length for a snapshot observation of a source very close to the zenith (layout centre lat -28.66 degrees, source dec -30 degrees, HA = 0).

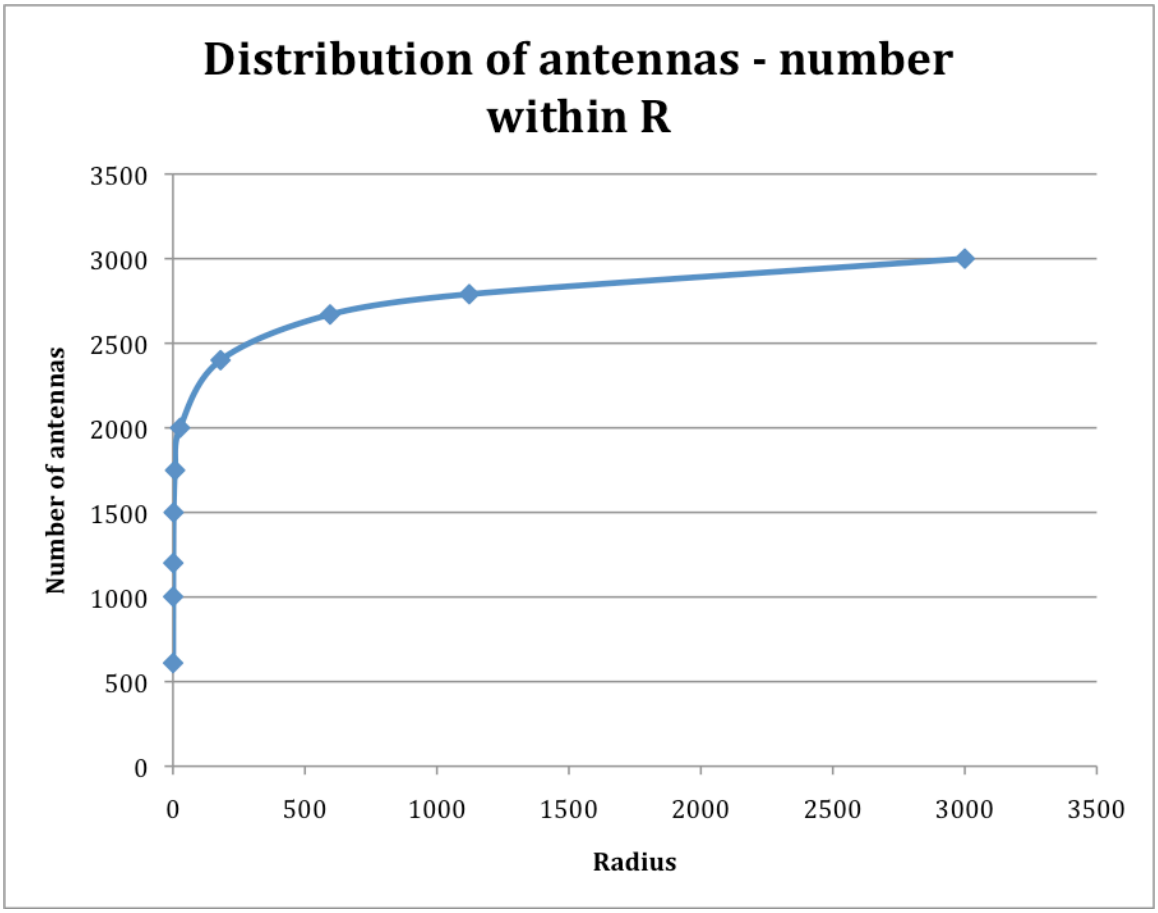

Figure 5: Distribution of collectors: number of dishes within a radius from the array centre.

[*] For the enthusiasts, this is layout "P" from the core distribution document.

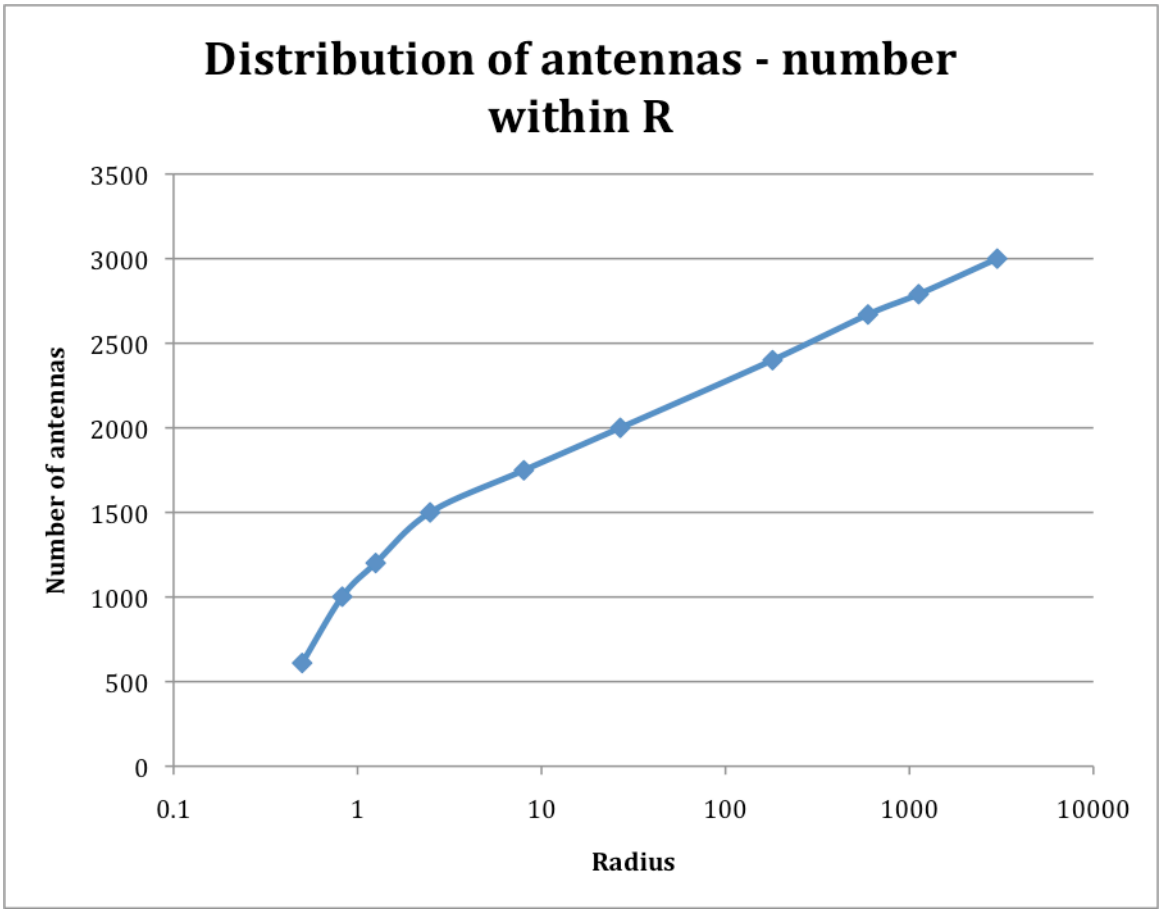

Figure 6: as previous but with a logarithmic scale in radius.

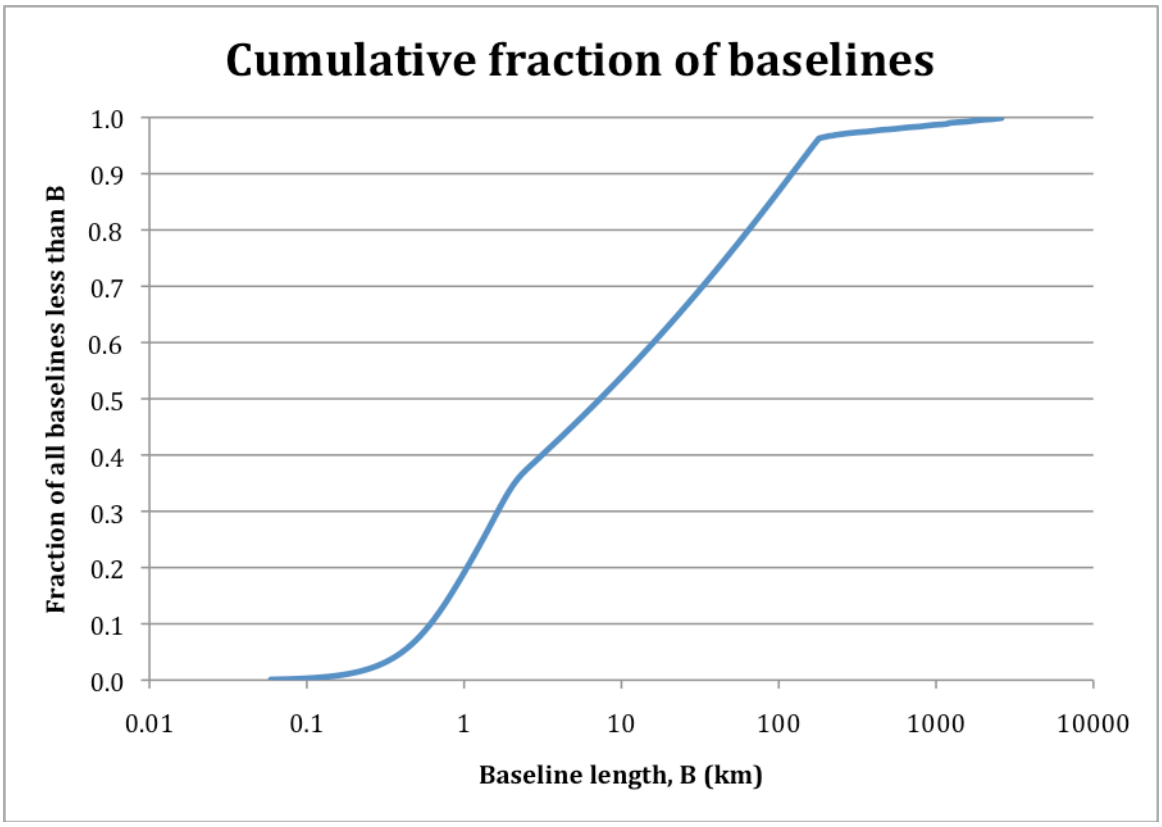

Figure 7: Cumulative fraction of baselines shorter than a certain baseline length. Note that only 3% of the baselines come from the stations - i.e. the curve has a kink at ~200km, 0.97.

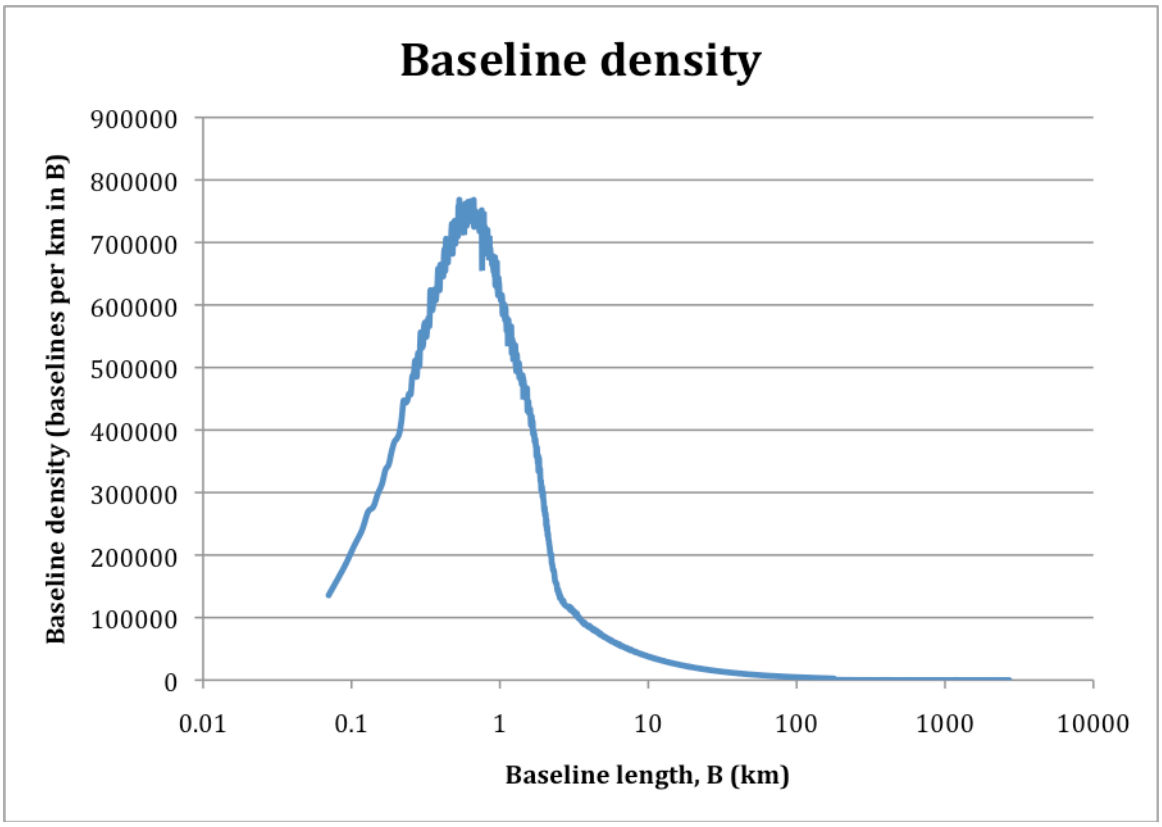

Figure 8: Linear Baseline density for this distribution - I.e. the number of baselines between B1 and B2, divided by (B2-B1).