MMA Memo 212:
Optimization of an Array Configuration with a Donut Constraint

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Abstract

Algorithm of the optimization of an array configuration described by L. Kogan in [1] has been enhanced by the ability following a donut constraint. The result of optimization for number of elements 36, for different width of the donut, and different sky area of optimization has been presented. The achieved minimum worst side lobe practically coincides with the minimum obtained after optimization without the donut constraint, if the width of the donut more than 0.25. In some cases the elements of the optimum configuration are concentrated near the donut's circles. *So the two circle configuration, having advantage in maintenance of the array, can be close to the optimum as well.* The calculation has been carried out for the array size 840 m (B configuration) with minimum spacing 15 m.

1 Discussion

I applied the modified task for the 36 elements array optimization in snapshot observation at zenith with the constraint of the array shape as donut. The optimization has been provided for different area of optimization at the sky and different width of the donut. I define the width of the donuts as ratio of the radiuses difference to the outer diameter of the donut. So the width can be varied from zero - the infinite thin circle to one half - the full covered disk. The calculation has been carried out for the array size 840 m (B configuration) with minimum spacing 15 m. The result is presented in the tables 1, 2, 3 for circle area of optimization at the sky of radius 10, 20, and 40 elements of resolution.

Table 1: The worst side lobe versus width of donut. The radius of circle area of optimization at the sky $\mathbf{10\frac{\lambda}{D}}$

Donut's width	0	0.1	0.2	0.3	0.5
The worst side lobe	0.16	0.14	0.08	0.07	0.07

Zero width configuration has been defined as increasing spacing by linear law with optimum value of the minimum spacing. It is seen from the tables 1, 2, 3 that donut constraint does not aggravate minimum worst side lobe , if the width of the donut more than 0.25.

The optimum configurations together with UV coverage for different donuts' width and three different radiuses of the sky circles of optimization are shown at figures (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), (11), (12), (13)

Table 2: The worst side lobe versus width of donut. The radius of circle area of optimization at the sky $\mathbf{20\frac{\lambda}{D}}$

Donut's width	0	0.05	0.1	0.2	0.3	0.5
The worst side lobe	0.21	0.16	0.14	0.12	0.10	0.10

Table 3: The worst side lobe versus width of donut. The radius of circle area of optimization at the sky $\mathbf{40\frac{\lambda}{D}}$

Donut's width	0	0.1	0.2	0.3	0.5
The worst side lobe	0.23	0.16	0.15	0.14	0.13

2 Conclusion

The achieved minimum worst side lobe practically coincides with the minimum obtained after optimization without the donut constraint, if the width of the donut more than 0.25. In some cases (width=0.1, Rsky = $\mathbf{10\frac{\lambda}{D}}$; width=0.2, Rsky = $\mathbf{10\frac{\lambda}{D}}$)) the elements of the optimum configuration are concentrated near the donut's circles. So the two circle configuration, having advantage in maintenance of the array, can be close to the optimum as well.

References

[1] L.R. Kogan, MMA memo 171, 1997

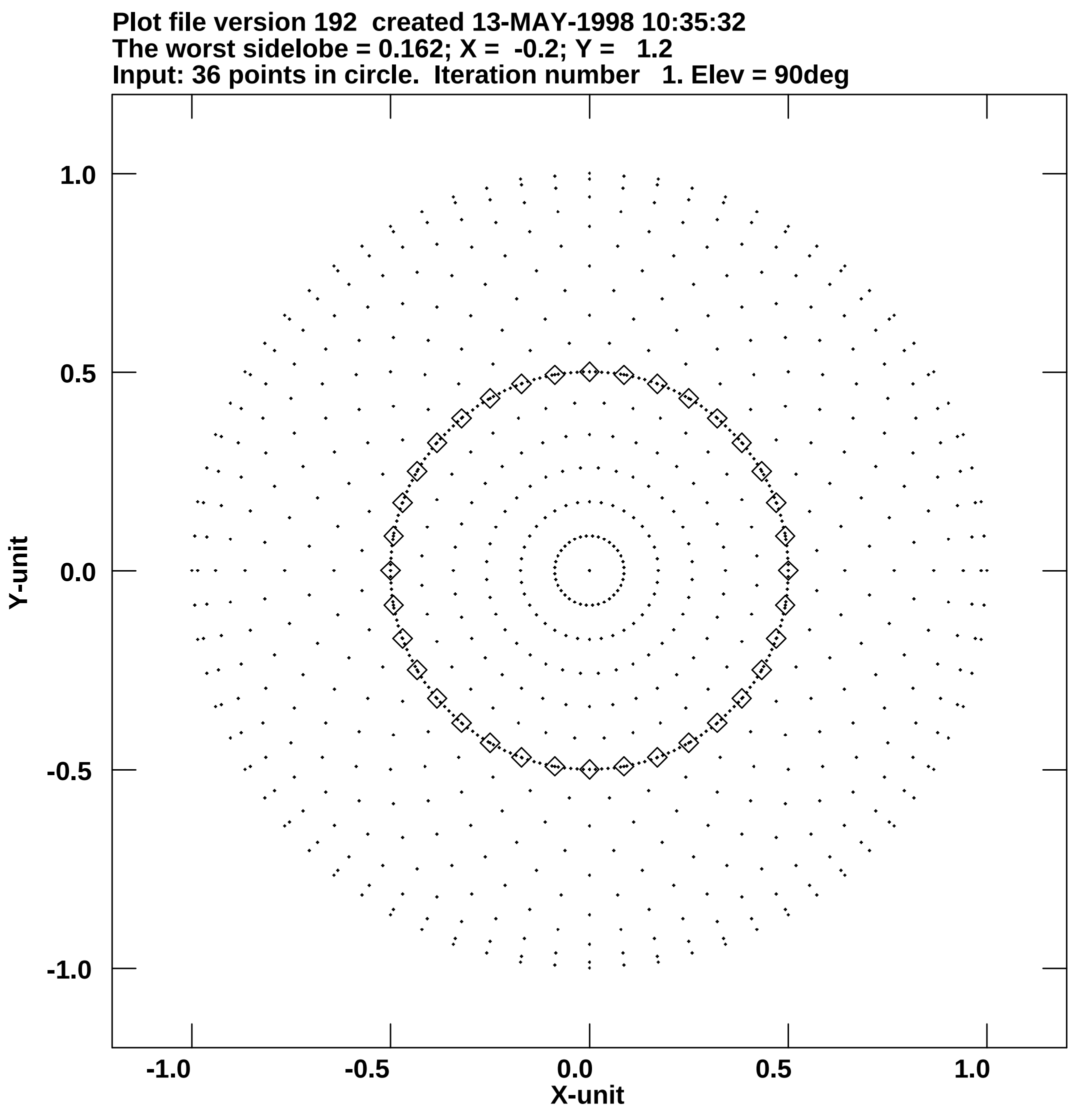

Figure 1: Even distributed elements along the circle. Radius of the sky circle of optimization is $\mathbf{10\frac{\lambda}{D}}$

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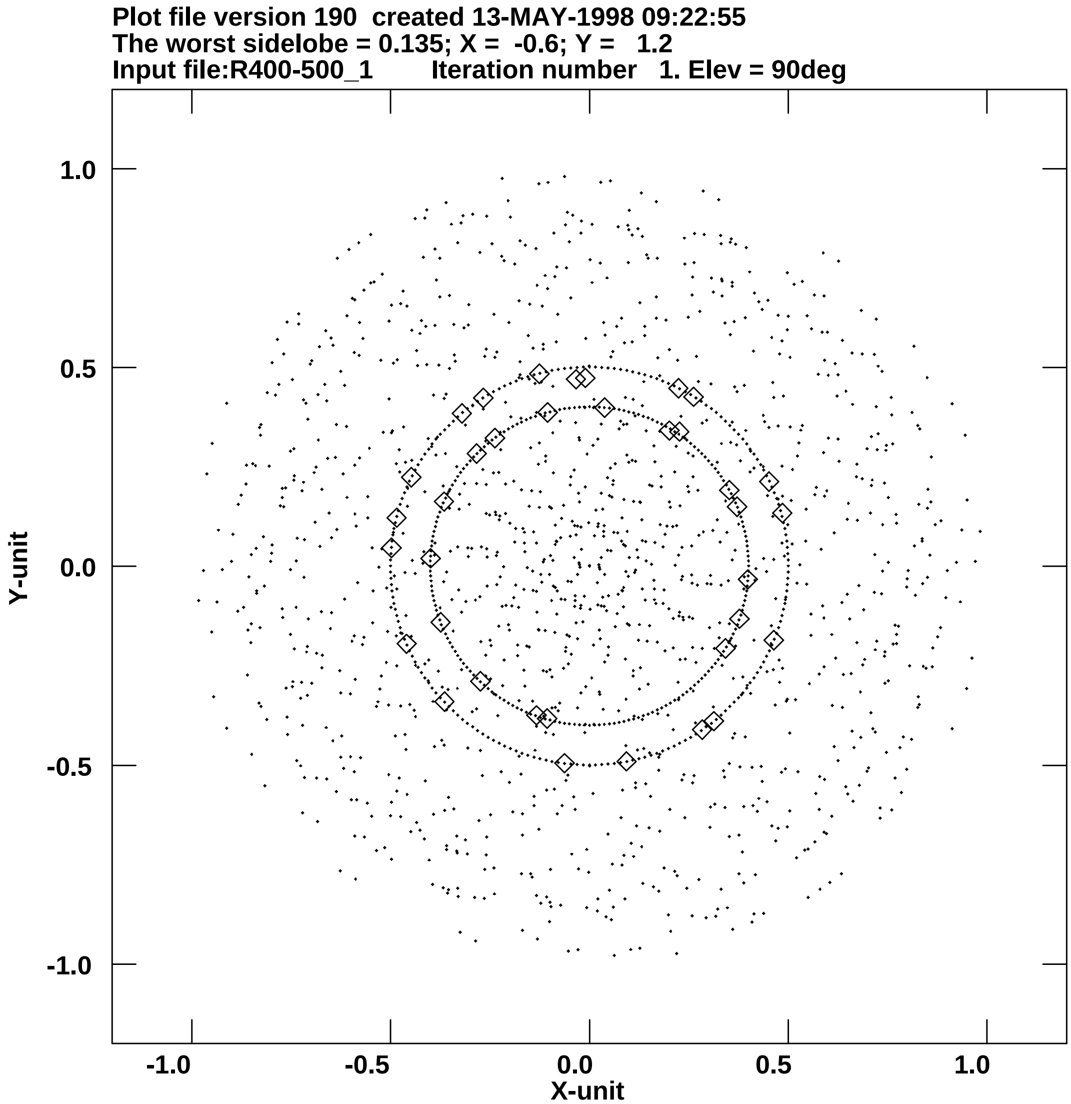

Figure 2: The optimum configuration and UV coverage. Donuts' width is $\mathbf{0.1}$. Radius of the sky circle of optimization is $\mathbf{10}\frac{\lambda}{\mathbf{D}}$

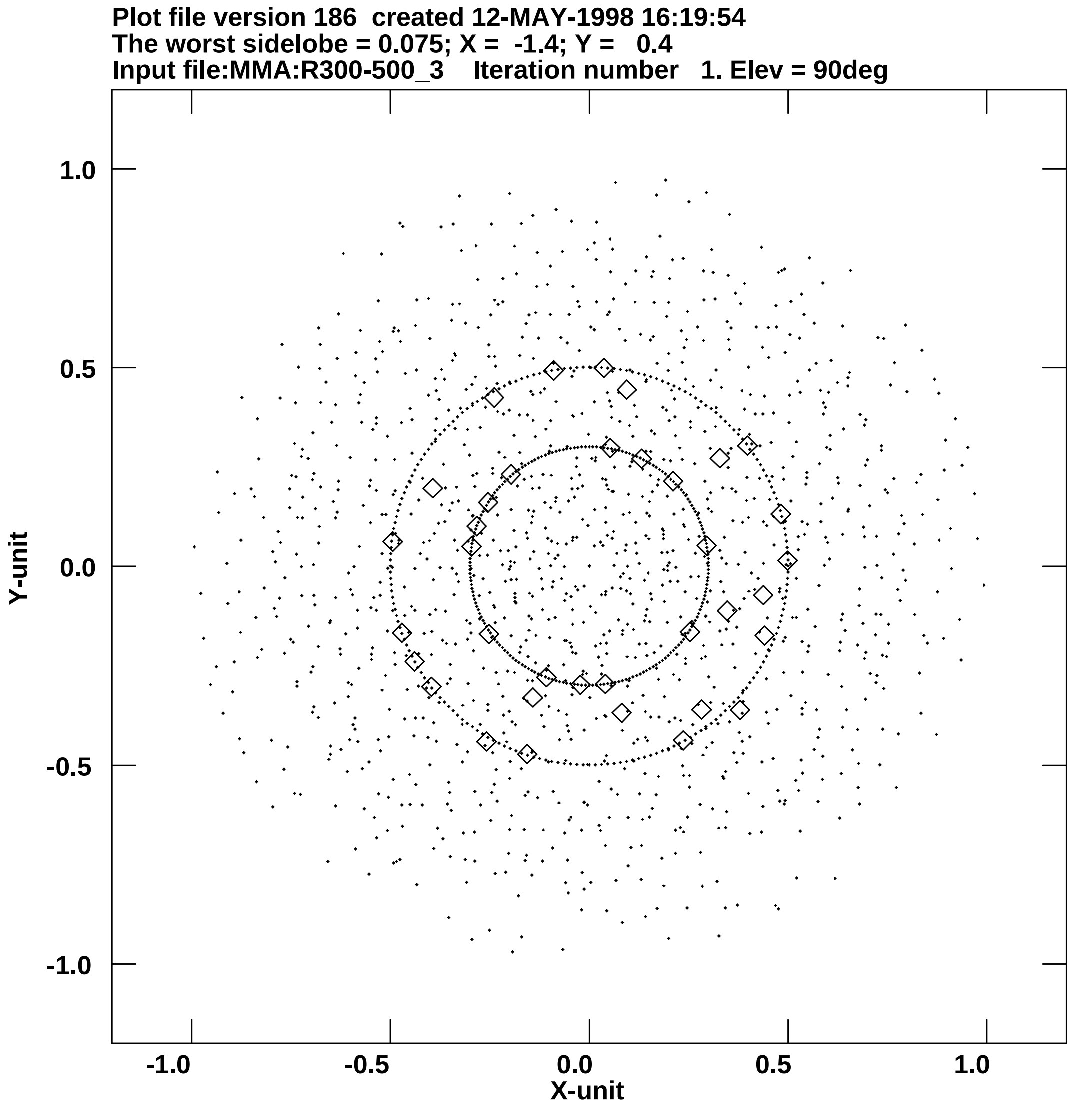

Figure 3: The optimum configuration and UV coverage. Donuts' width is $\mathbf{0.2}$. Radius of the sky circle of optimization is $\mathbf{10}\frac{\lambda}{\mathbf{D}}$

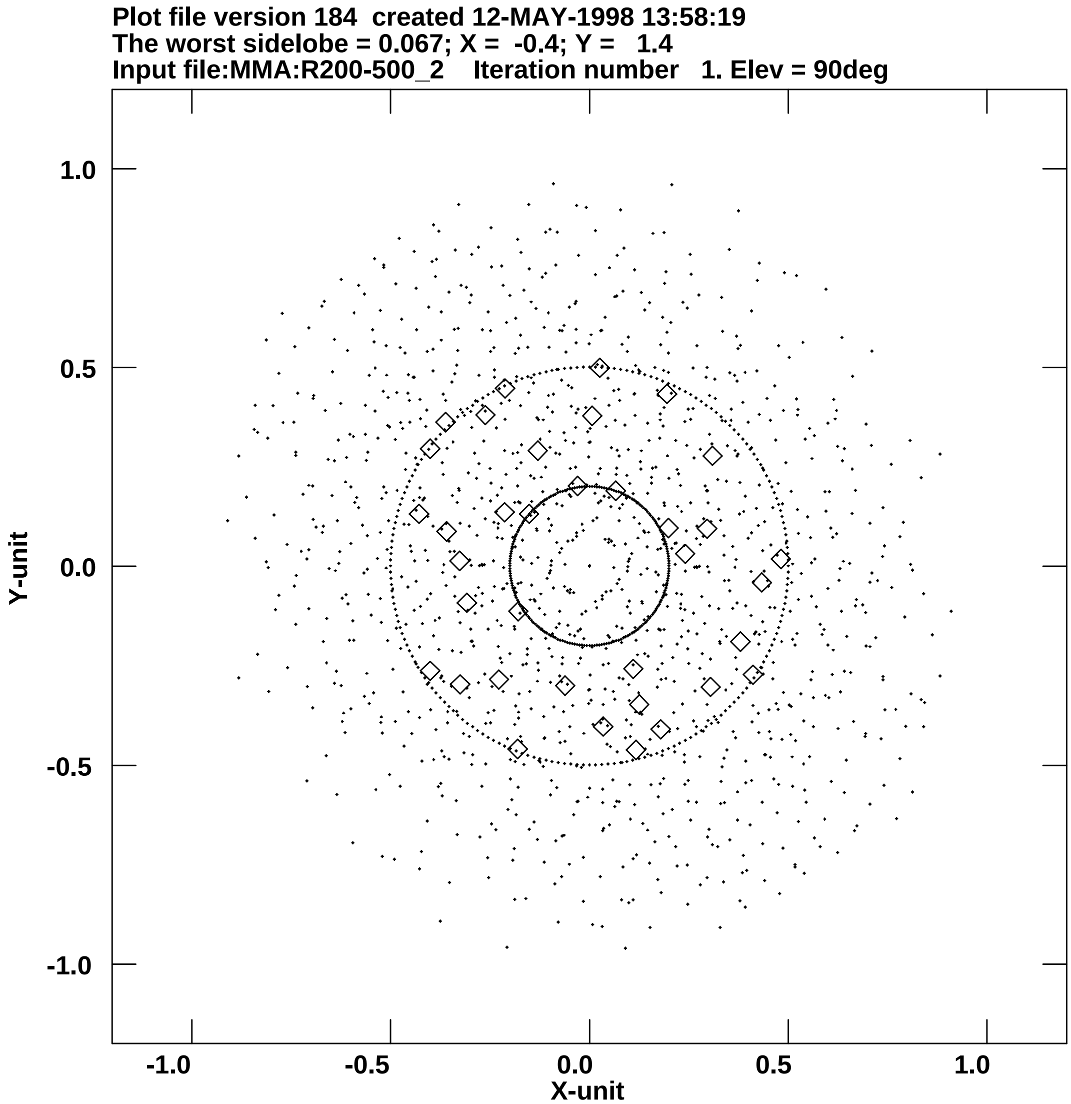

Figure 4: The optimum configuration and UV coverage. Donuts' width is $\mathbf{0.3}$. Radius of the sky circle of optimization is $\mathbf{10\frac{\lambda}{D}}$

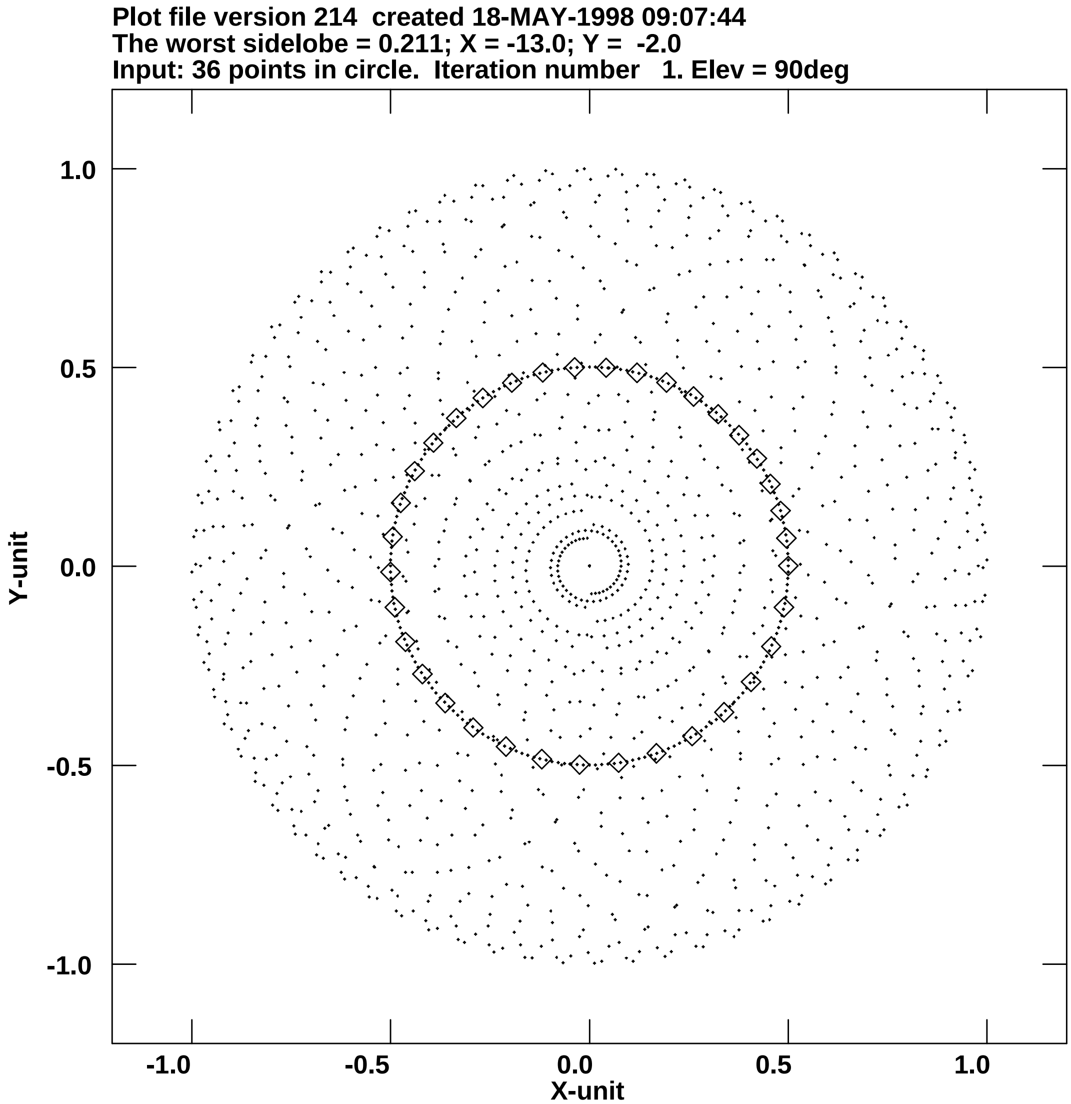

Figure 5: The elements are located at the circle with increasing spacing. The minimum spacing is optimum. Radius of the sky circle of optimization is $\mathbf{20\frac{\lambda}{D}}$

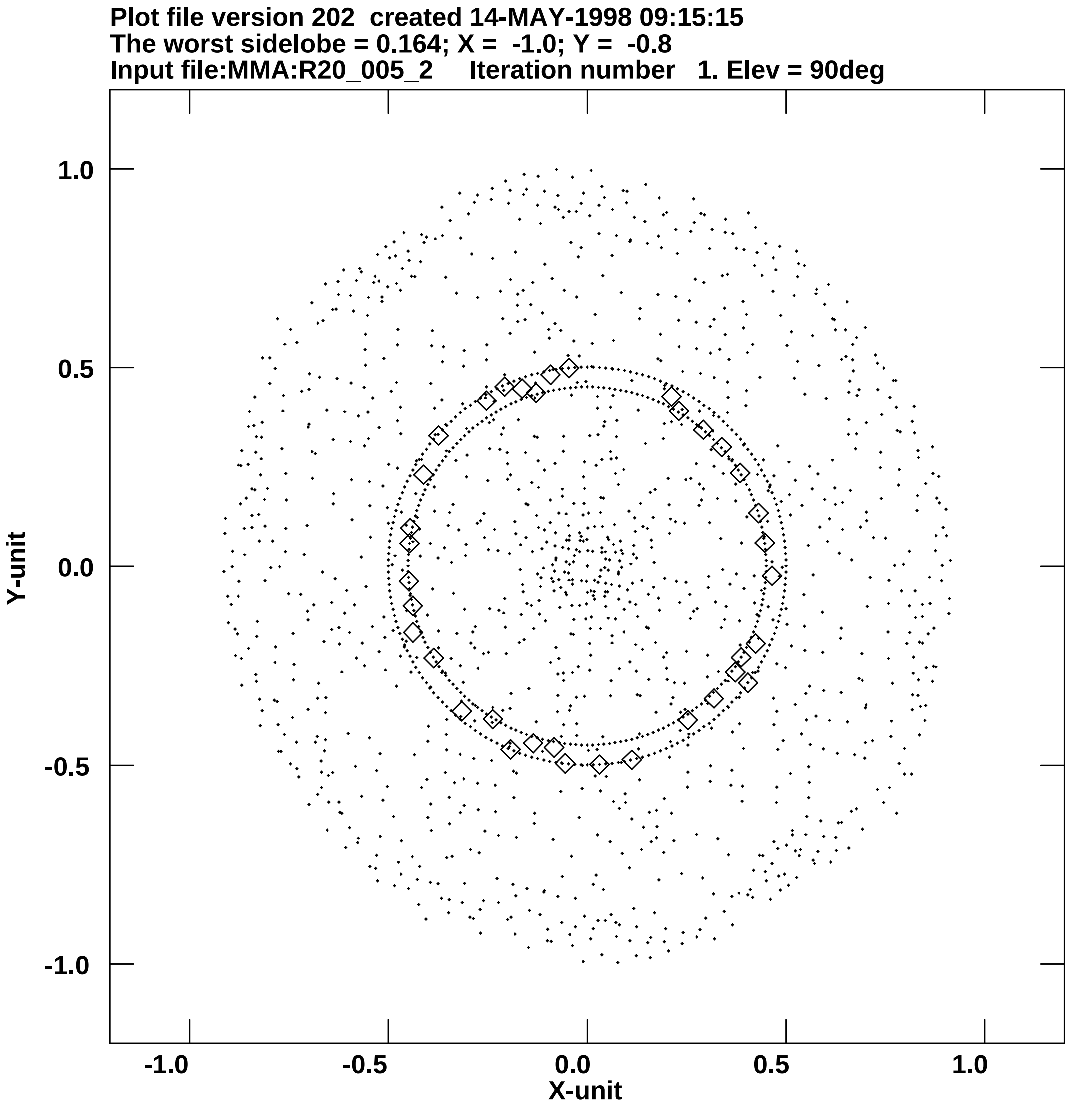

Figure 6: The optimum configuration and UV coverage. Donuts' width is $\mathbf{0.05}$. Radius of the sky circle of optimization is $\mathbf{20}\frac{\lambda}{\mathbf{D}}$

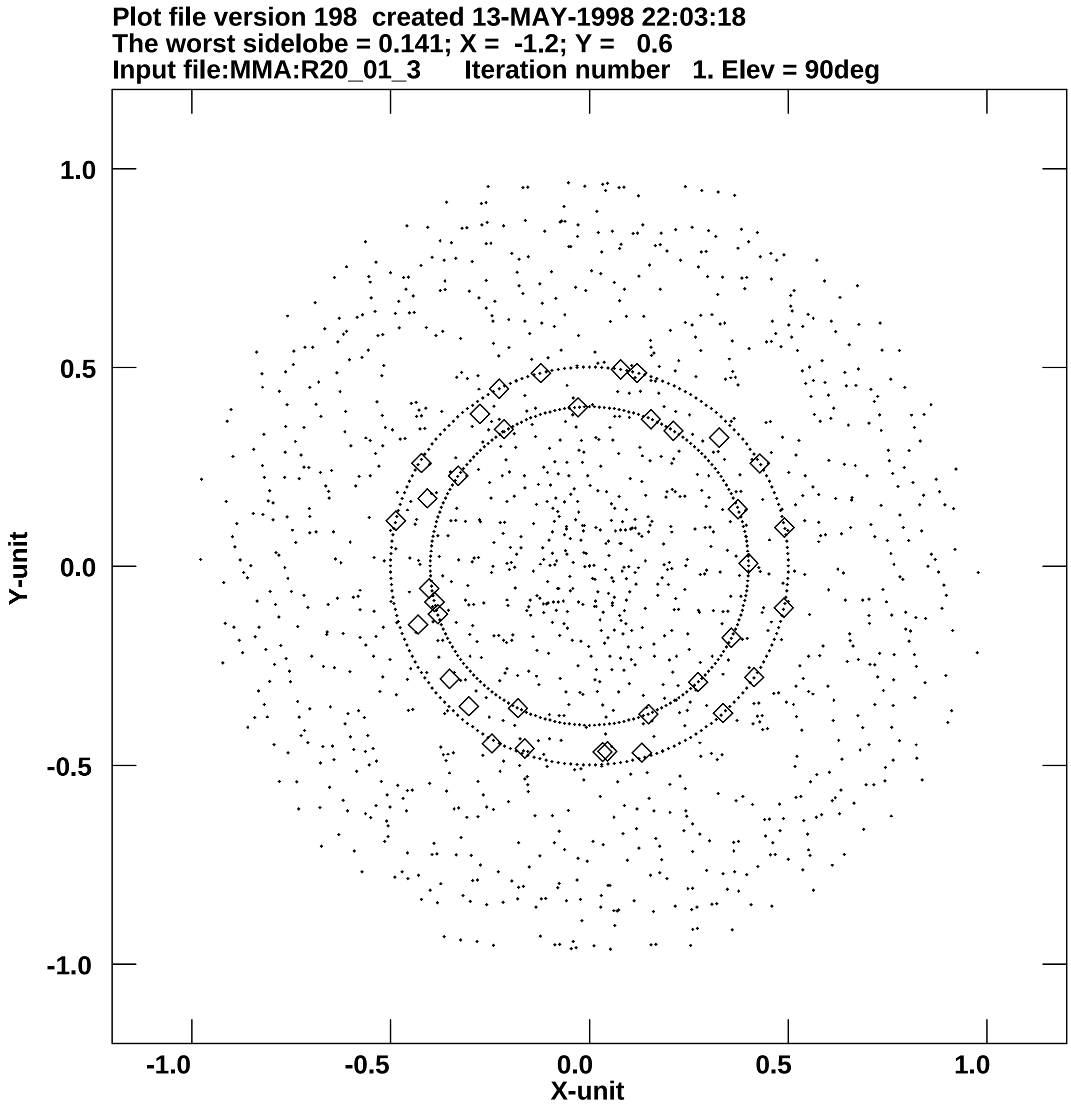

Figure 7: The optimum configuration and UV coverage. Donuts' width is $\mathbf{0.1}$. Radius of the sky circle of optimization is $\mathbf{20\frac{\lambda}{D}}$

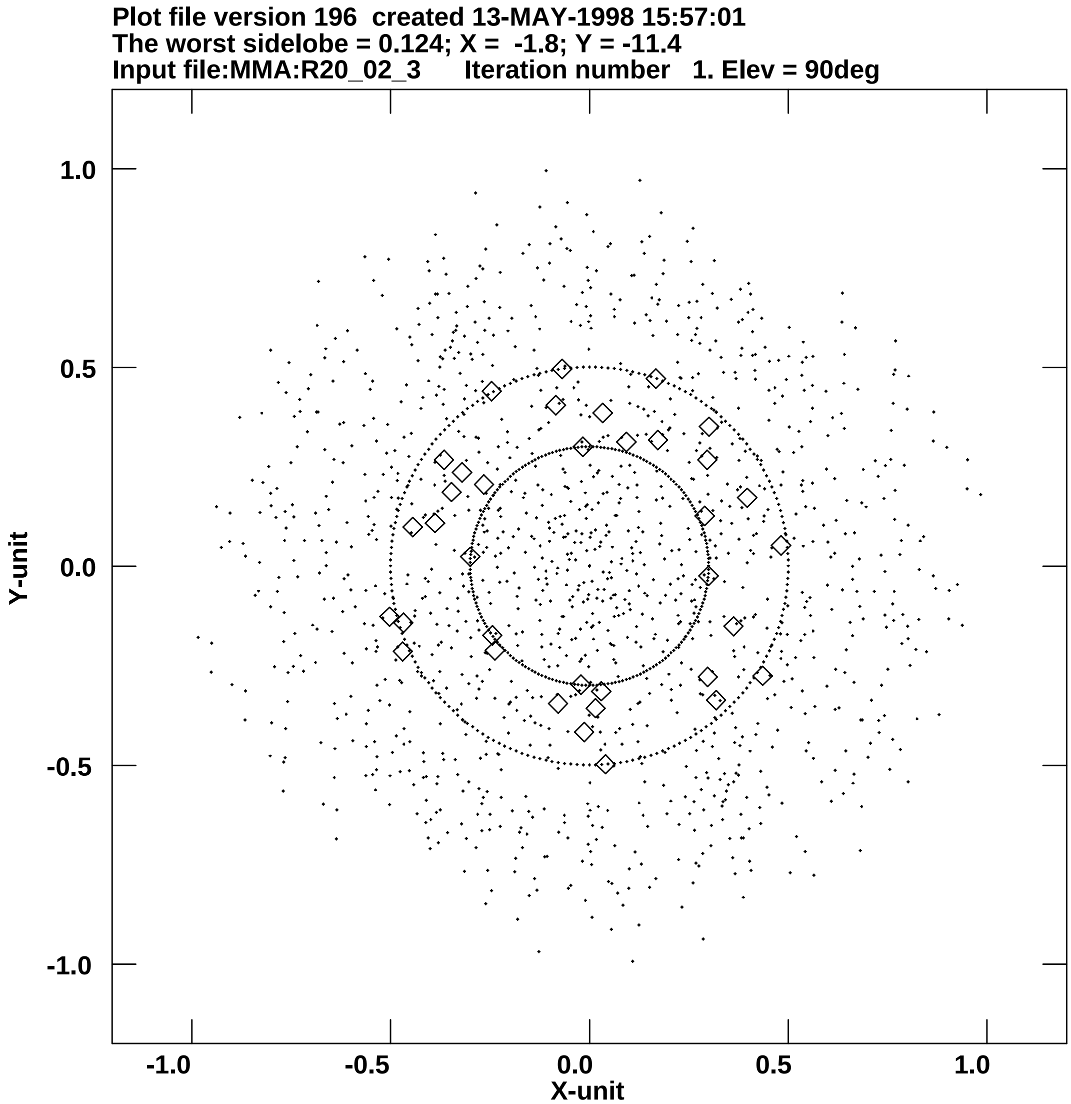

Figure 8: The optimum configuration and UV coverage. Donuts' width is $\mathbf{0.2}$. Radius of the sky circle of optimization is $\mathbf{20\frac{\lambda}{D}}$

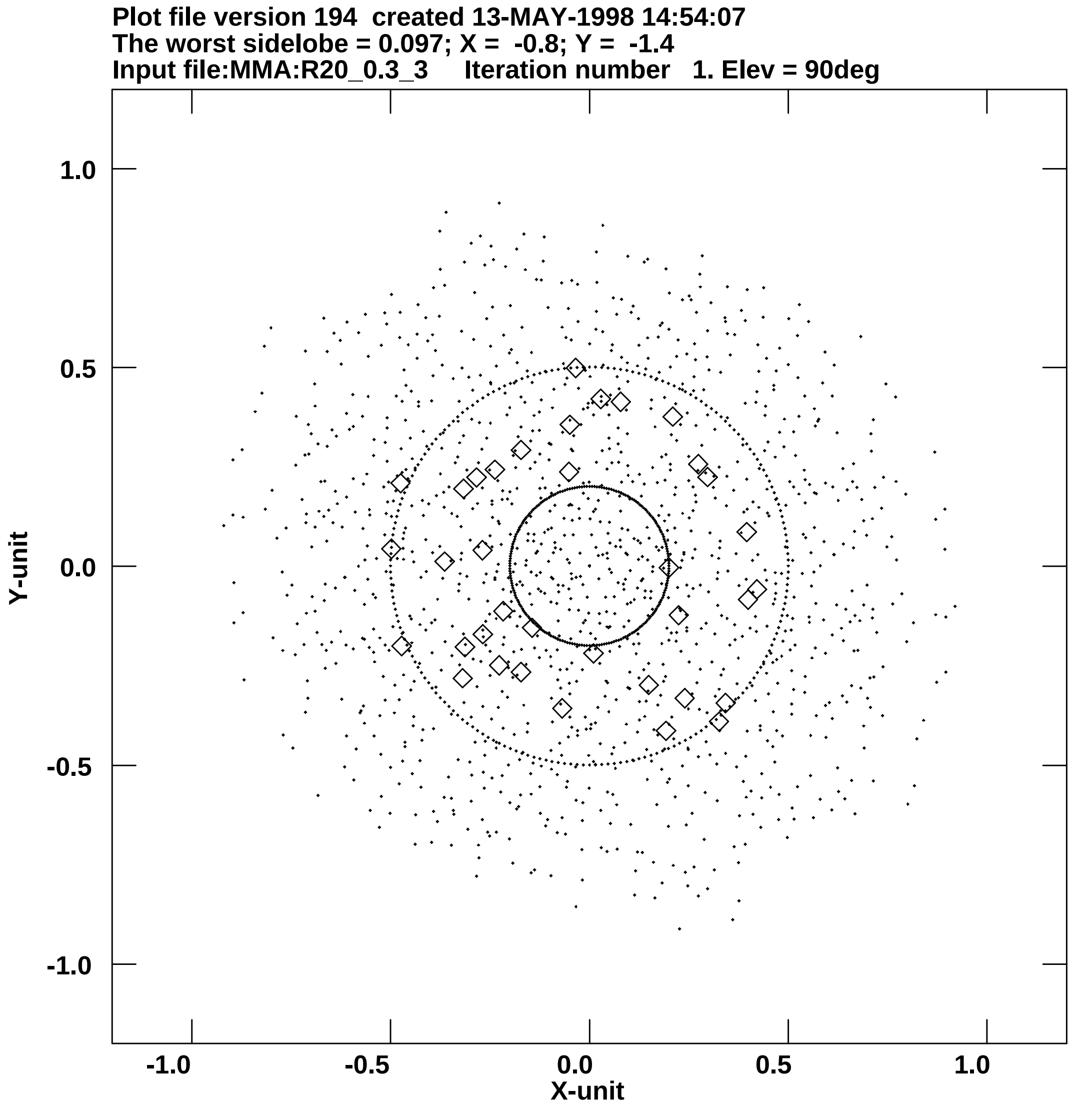

Figure 9: The optimum configuration and UV coverage. Donuts' width is $\mathbf{0.3}$. Radius of the sky circle of optimization is $\mathbf{20\frac{\lambda}{D}}$

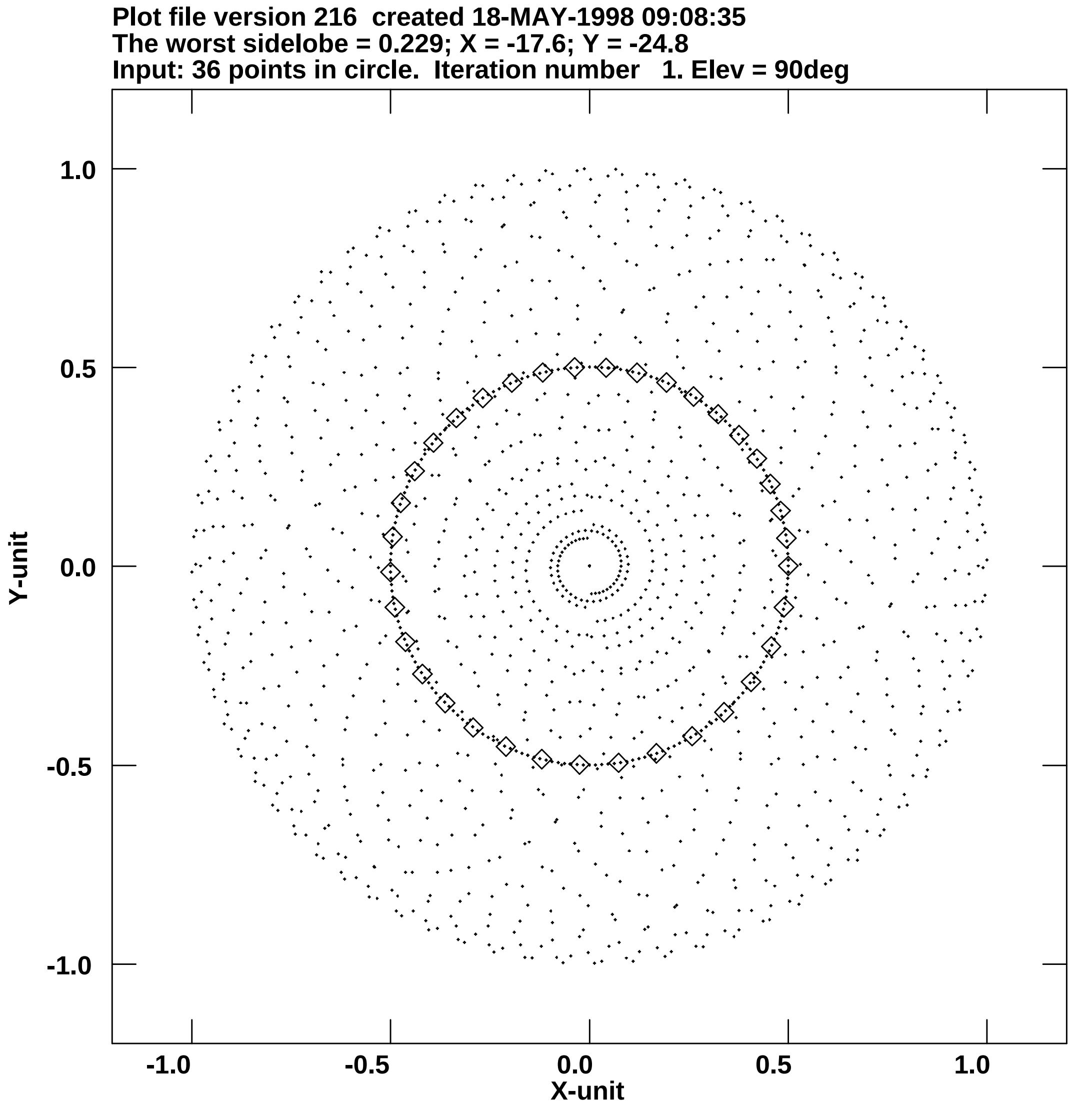

Figure 10: The elements are located at the circle with increasing spacing. The minimum spacing is optimum. Radius of the sky circle of optimization is $\mathbf{40}\frac{\lambda}{\mathbf{D}}$

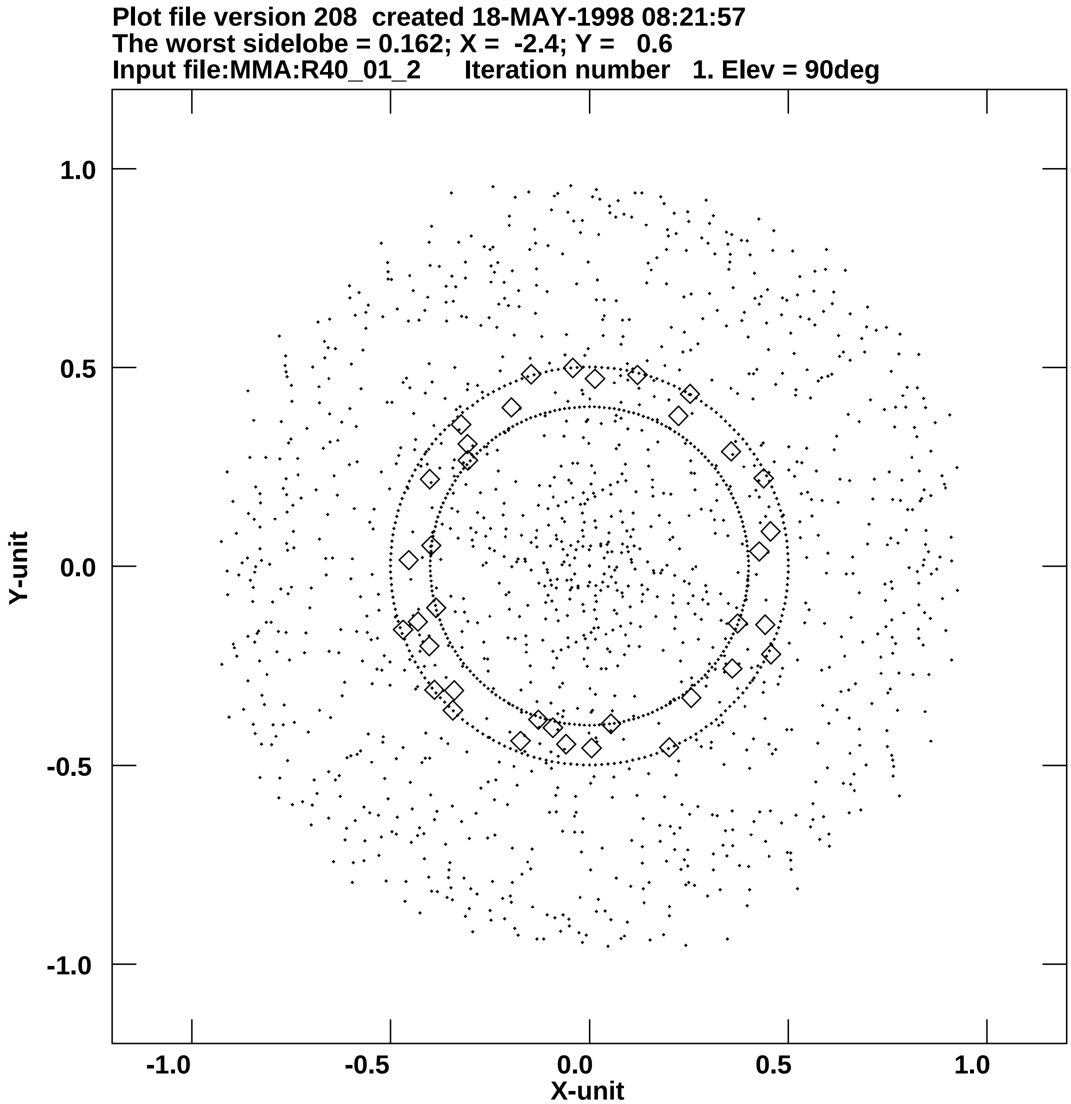

Figure 11: The optimum configuration and UV coverage. Donuts' width is $\mathbf{0.1}$. Radius of the sky circle of optimization is $\mathbf{40}\frac{\lambda}{\mathbf{D}}$

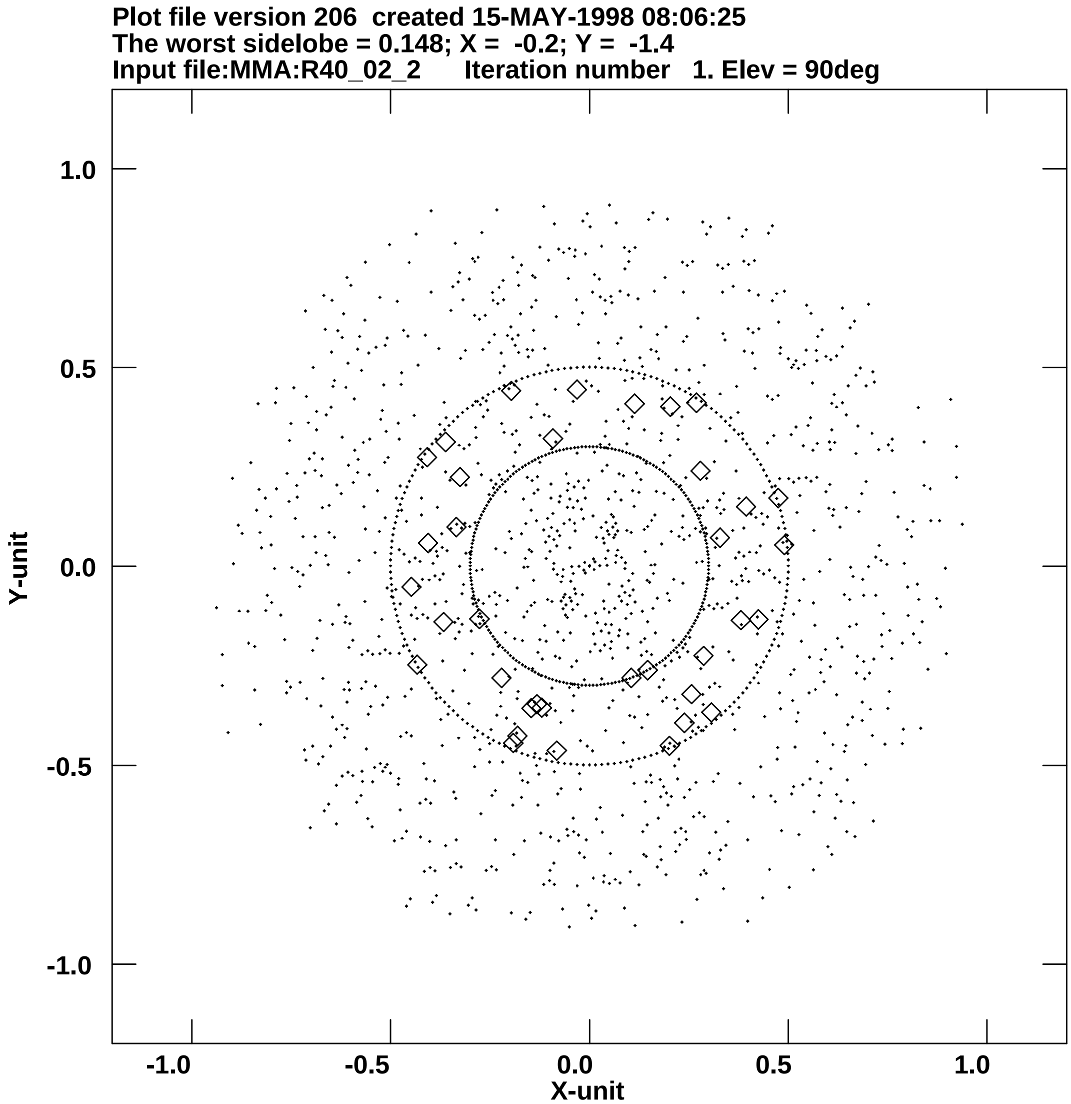

Figure 12: The optimum configuration and UV coverage. Donuts' width is $\mathbf{0.2}$. Radius of the sky circle of optimization is $\mathbf{40}\frac{\lambda}{\mathbf{D}}$

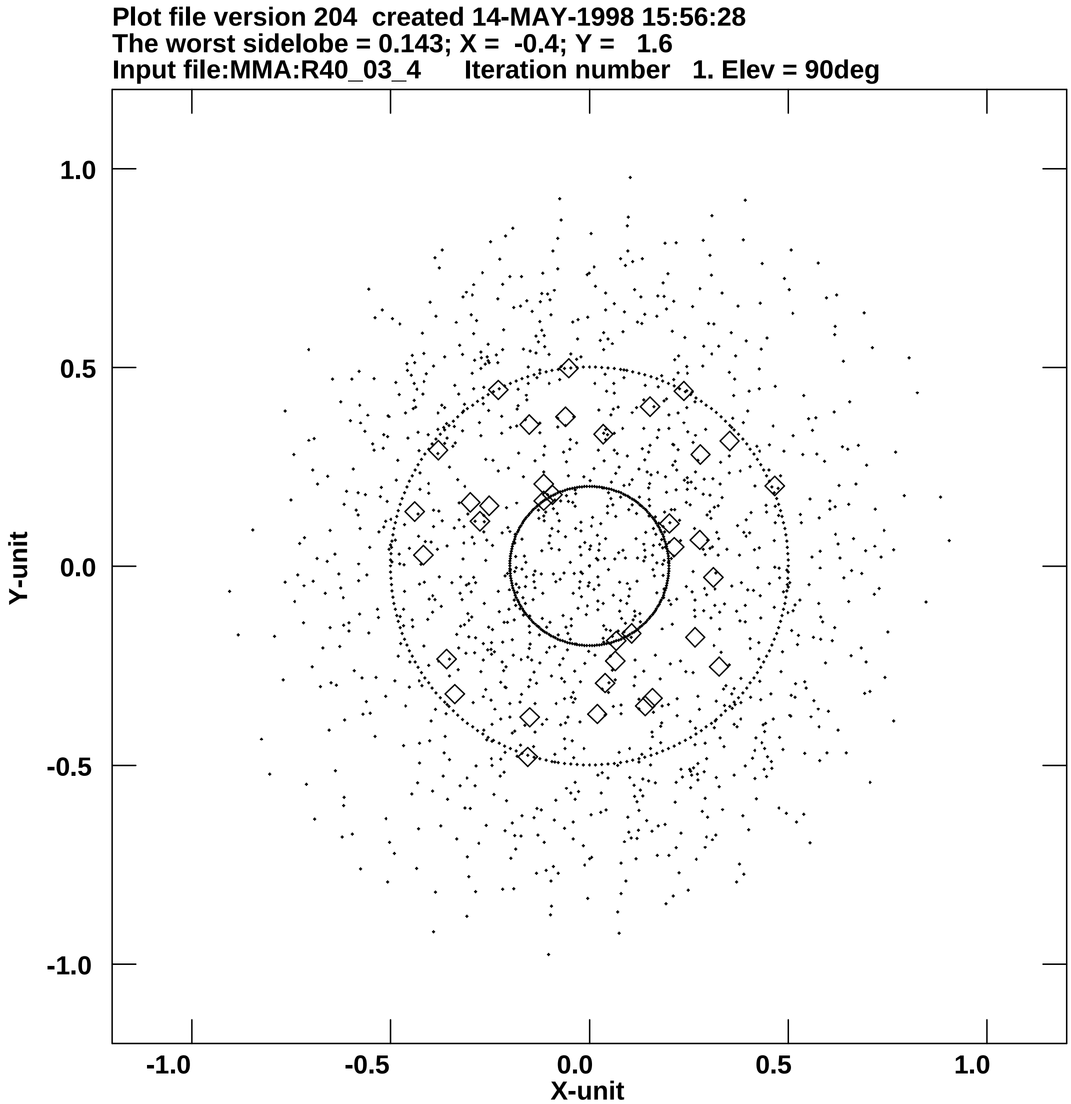

Figure 13: The optimum configuration and UV coverage. Donuts' width is **0.3**. Radius of the sky circle of optimization is $\mathbf{40\frac{\lambda}{D}}$