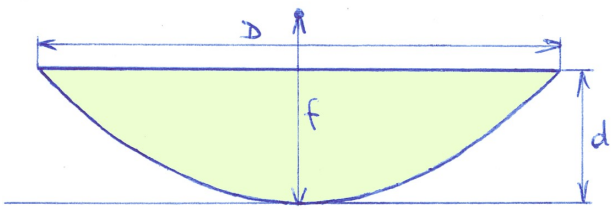
Collapsible parabolic dish microphone: explanation of the calculations

Base dish

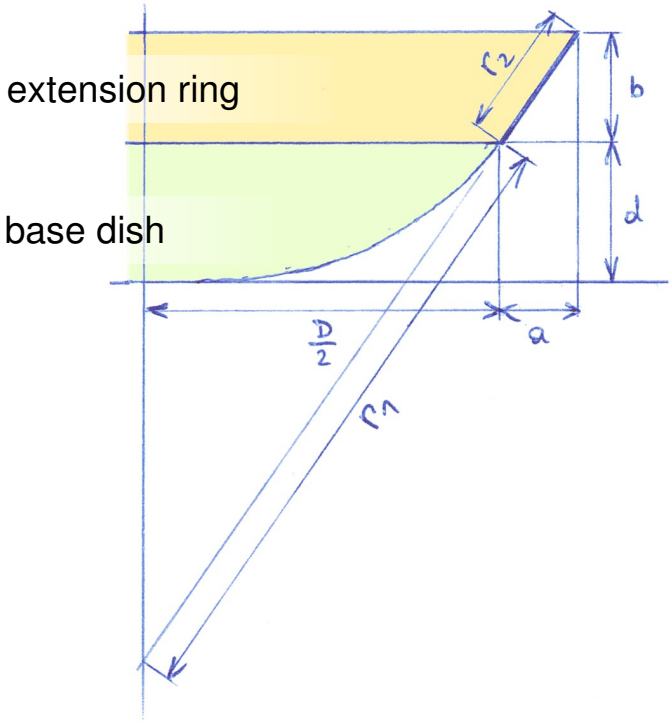


focal distance: $f = \frac{D^2}{16\,d}$

normalizing factor *n*:
We normalize the measurements so that we can calculate using the simple parabolic function ($y = x^2$).

$$d = \left(\frac{D}{2} \cdot n\right)^2 \Leftrightarrow n = \frac{\sqrt{d}}{D/2}$$

extension of the dish, cross-section



The extension ring is the surface of a section of a cone with the outer edge of ($r_1 + r_2$) and the radius ($D/2 + a$).
In the cross-section, this geometry results in a secant of the parabolic shape (the ring r_2 intersects with the parabolic at its inner and outer edges).

We get the height *b* of the ring using the parabolic formula, and from there we calculate r_2 which forms a right-angled triangle together with *a* and *b*.

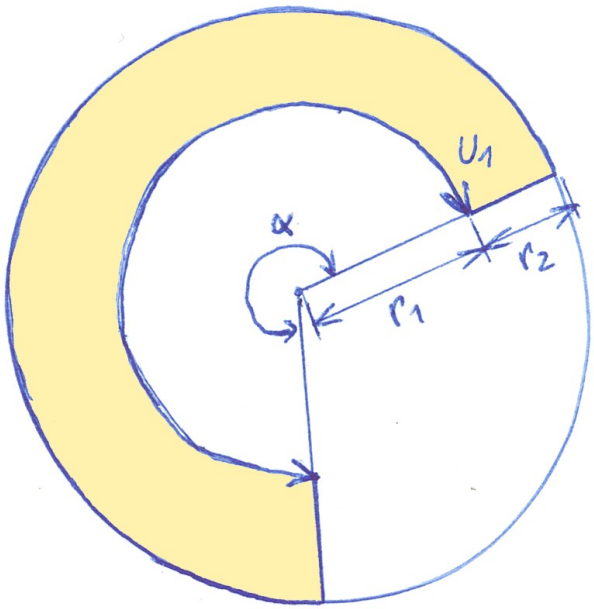
$$b = \left(\frac{D}{2} + a\right)^2 - d$$

$$a^2 + b^2 = r_2^2 \Leftrightarrow r_2 = \sqrt{a^2 + b^2}$$

The right-angled triangles $(r_2 - a - b)$ and $(r_1 - D/2)$ in the cross-section are similar to each other. Thus, given the width *a* of the cone section and the inner diameter *D*, we get the inner radius *r1* and the length U_1 (see next page) of the ring segment to cut from our sheet.

$$\frac{r_2}{a} = \frac{r_1}{D/2}$$

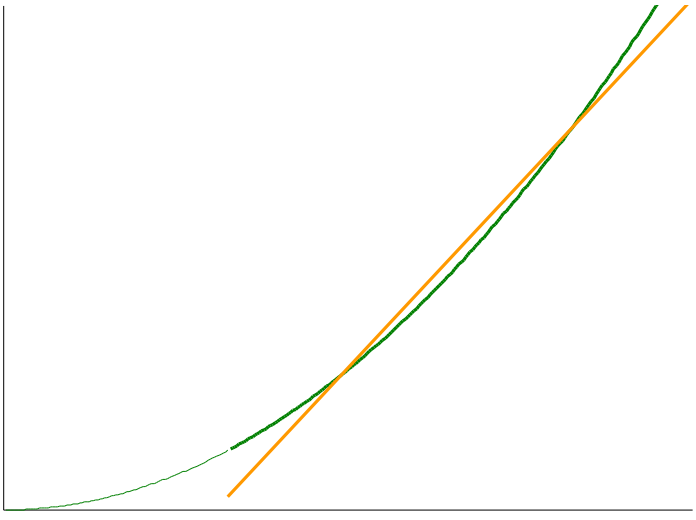
Unrolling the Ring



When flattening the conical surface we get a ring segment with the inner radius of r_1, the width of r_2 and the inner perimeter length U_1 which is also the perimeter of the base of the cone formed by r_1 and D: $(U_1 = D * \pi)$, and the full perimeter of the inner circle is $(U = 2 * r_1 * \pi)$ (see previous page). The relation of the perimeters (U_1 / U) is equal to the relation of the ring opening to the full circle $(\alpha / 360°)$. Given α, we will be able to draw the ring segment on the plastic sheet.

$$\frac{U_1}{U} = \frac{D \cdot \pi}{2 r_1 \cdot \pi} = \frac{\alpha}{360°} \Rightarrow \alpha = 360 \cdot \frac{D}{2 r_1}$$

Because the surface of the rolled-up conical ring is radially straight, it can only give an approximation to the parabolic shape. In order to keep the error small and thus the width r_2, it is advisable to use 2 or more rings on top of each other. At the same time, the relation (r_2 / r_1) should be chosen in a way so that we keep the cutting scrap small. **The ring should be widened by 5 millimeters or so on the inner edge so that the rings overlap when we mount them on top of each other.**



The spreadsheet uses a slightly modified geometry than the one shown here. The extension ring intersects with the ideal parabolic shape not at its edges but at ¼ and ¾ of its width. This gives a better approximation to the parabolic shape. Apart from this, the ring slips over the outer edge of the base dish which makes mounting more easy. Ideally, the divergence at the inner edge of the ring equals the thickness of the material used. Several small rings will make for a better approximation than a single large one.