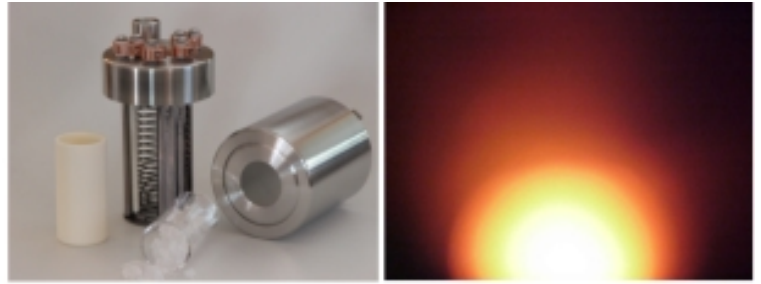




## **Flux distribution and uniformity**



We've measured the flux from our Radak II furnace and used curve fitting to determine a distribution for modeling (see [Figure 1](#)).

Radak Furnace Flux Distribution

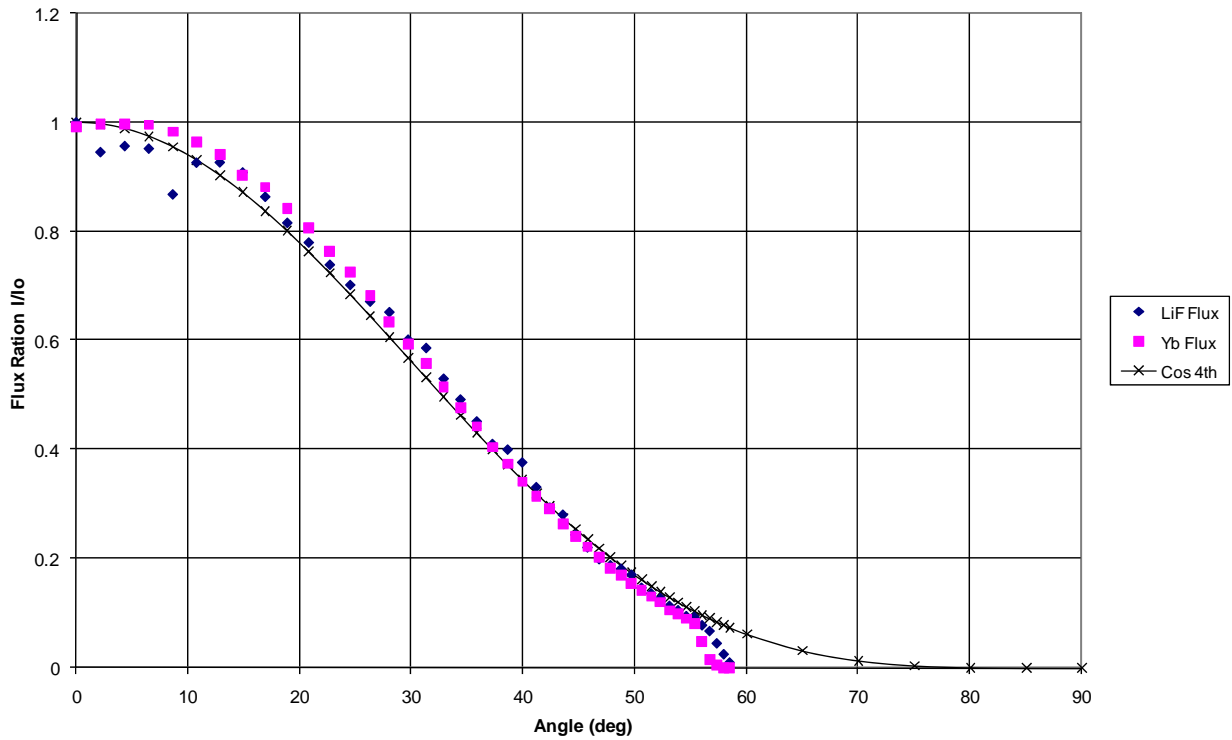


Figure 1 Measured flux distribution.

The flux equation (1)  $J_{\theta} = J_0 \cos^4 \theta$  (Vossen & Kern) is used to approximate the flux distribution at any point on a wafer relative to the flux at the center of the wafer (Figure 2).

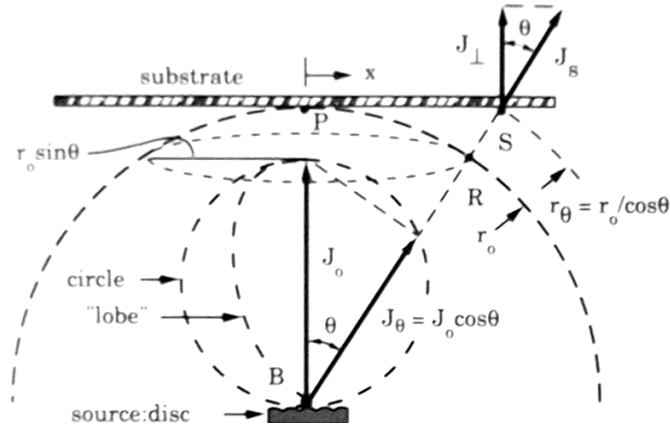
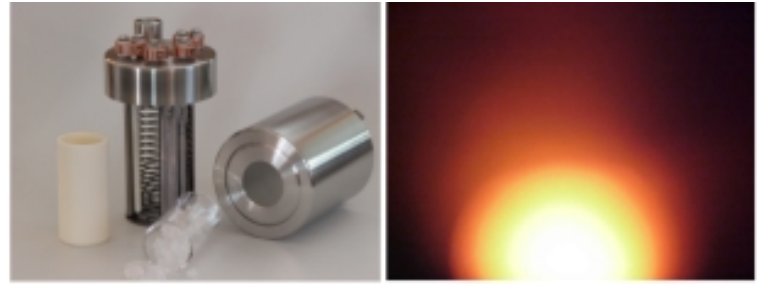


Figure 2 Vacuum deposition flux geometry (Smith)

Using this equation and assuming a  $\text{Cos}^4$  distribution for our furnaces, we can estimate non-uniformity =  $(T_{\text{max}} - T_{\text{min}}) / T_{\text{max}}$ .



Here are some typical values you might expect for a range of configurations:

Source to Substrate in(cm)	Source Offset in(cm)	Platter Offset in(cm)	Rotation	Non-uniformity (%)
3 (7.62)	0	0	none	25
5 (12.7)	0	0	none	10.3
7 (17.78)	0	0	none	5.4
10 (25.4)	0	0	none	2.7
3 (7.62)	1 (2.54)	0	simple	17.7
5 (12.7)	1 (2.54)	0	simple	8.9
7 (17.78)	1 (2.54)	0	simple	5.0
10 (25.4)	1 (2.54)	0	simple	2.6
3 (7.62)	0.5 (1.25)	2(5.1)	planetary	4.2
5 (12.7)	0.5 (1.25)	2(5.1)	planetary	5.6
7 (17.78)	0.5 (1.25)	2(5.1)	planetary	3.9
10 (25.4)	0.5 (1.25)	2(5.1)	planetary	2.3

Table 1 Uniformity calculations based on  $\text{Cos}^4$  distribution and 6 cm diameter wafer.

Table 1 source to substrate distance is taken as the distance between the top of the furnace and the face of the wafer. Source and platter offsets are the distance from the centerline of the chamber to the centerline of the furnace and platter respectively. Simple rotation is rotation about the centerline of the substrate to be coated. Planetary rotation is a compound motion where the substrate rotates on its centerline which in turn rotates about the centerline of the chamber.

These calculations have many assumptions and should be verified upon installation. The basic tradeoff is between uniformity and source utilization. The majority of the source material will end up on the substrate if the furnace is mounted closely below the centerline but results in poor uniformity. By comparison, a long throw distance and planetary motion results in the best uniformity but lower source utilization. The good uniformity at a low throw distance of the 3" planetary example is due to the substrate being significantly out of the flux of the furnace and should be used only for illustrative purposes, not a viable installation option.

Smith, D. L. (1995). *Thin-film deposition: principles and practice*. New York: McGraw-Hill.

Vossen, J. L., & Kern, W. (1991). *Thin film processes II*. Boston: Academic Press.