INVESTIGATING AND SIMULATING THE MECHANICAL DEFORMATIONS IMPACT ON THE FIELD DISTRIBUTION IN THE ANTENNA APERTURE FOR THE ROT-54/2.6 RADIO OPTICAL TELESCOPE

Artavazd Khachatryan

National Polytechnic University of Armenia

HUSC
Herouni United
Space Centre

INTRODUCTION

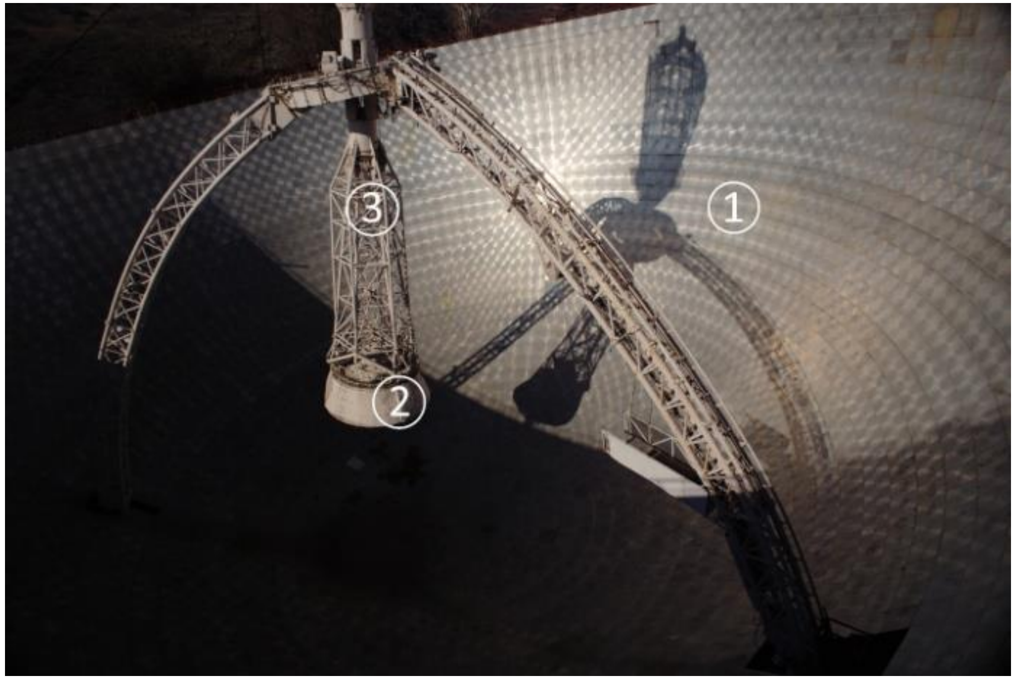
- 305 m in diameter
- Constructed inside the depression
- Reflector -steel cables

- 54 m in diameter
- Constructed inside the depression
- Reflector -3716 solid aluminum panels

- 500 meters in diameter
- Nestled in a natural basin
- Reflector -metal panels

ROT-54/2,6 ANTENNA CONSTRUCTION

- Large fixed spherical reflector -1
- The small reflector -2
- Support structure for movement of small reflector -3



ROT -54/2,6 antenna

ERRORS JOINT INFLUENCE ON PHASE DISTORTION

Regardless of reflectors profile and quantity the following equation can be written:

$$\sum x_i - \sum c_i = 0$$

C -is the length of distance of central beam in the mirror system

X -the same for current beam

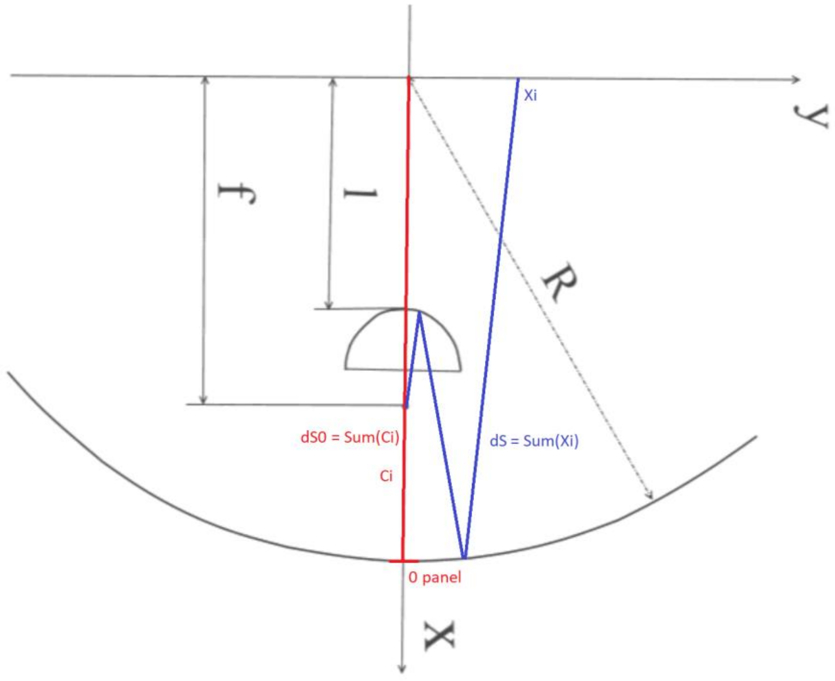
The difference of the beams can be expressed as following:

$$dS = dS_\theta - dS_o \qquad dS = \frac{d\varphi}{d\pi}\lambda$$

$$dS_\theta = \sum dx_i$$

$$dS_o = \sum c_i$$

$$R = 27000mm,\ l = 0,49R,\ f = 0,63R$$



The schematic view of parameters R, l and f.

ERRORS JOINT INFLUENCE ON PHASE DISTORTION

$$dS_{\theta} = dn + db + da$$

$$n = \frac{Cos\theta}{Cos(2\theta - \theta_1)} R$$

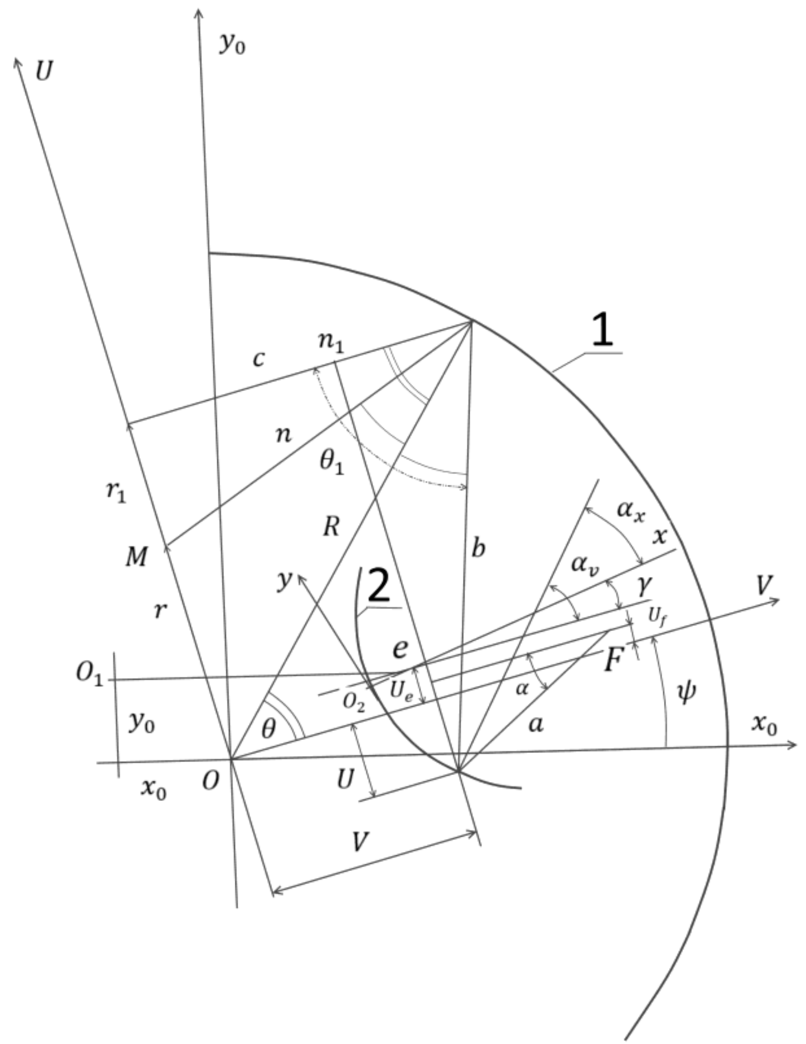
$$a = \sqrt{(V_f - V)^2 + (U_f - U)^2}$$

$$b = \sqrt{(n_1 - V)^2 + (r_1 - U)^2}$$

$$U_0 = y_0 Cos\psi - x_0 Sin\psi$$

$$V_0 = y_0 Sin\psi + x_0 Cos\psi$$

$$V_e = V_0 + \sqrt{e^2 - (U_e - U_o)^2}$$

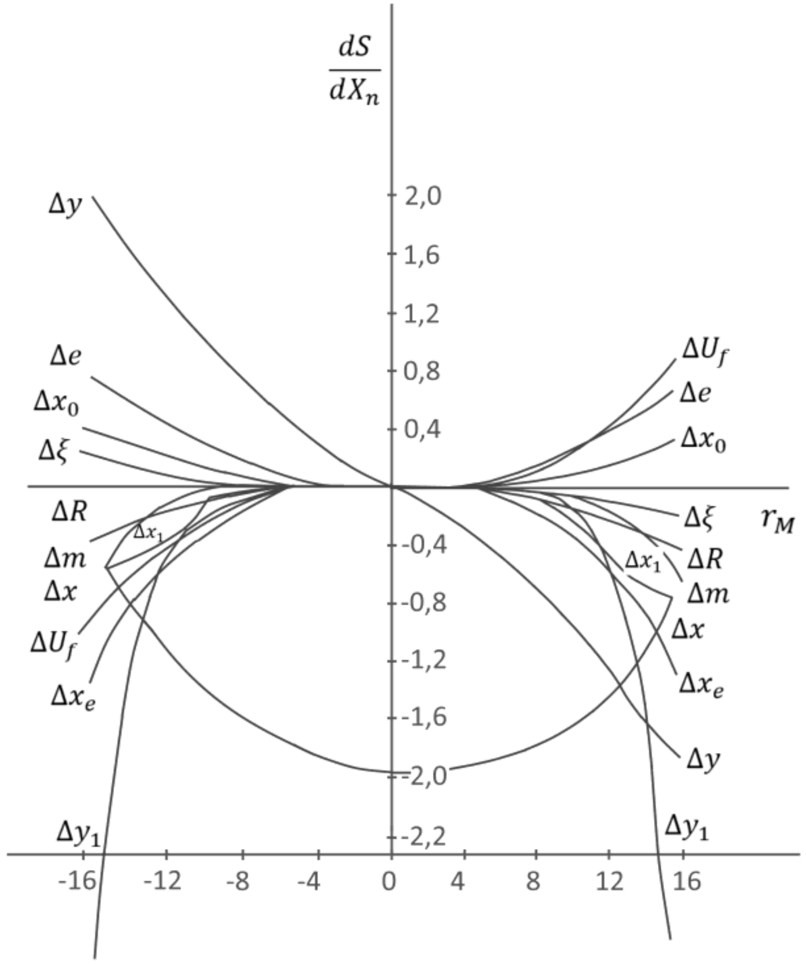


Design scheme of a double reflector spherical antenna

ERRORS JOINT INFLUENCE ON PHASE DISTORTION

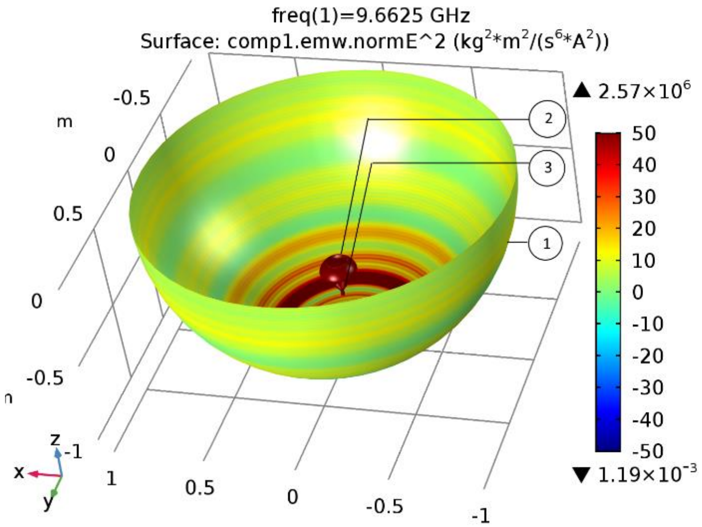
$$dS = 2cos\theta dR - 2dR_{\zeta} + 2sin^2\theta cos\psi dx_0 +$$
$$+2\,sin^2\theta sin\psi dy_0 + 2sin^2\theta de - (sin2\theta - sin\alpha)dU_e +$$
$$+(cos2\theta + cos\alpha - 2)dx_e - (cos2\theta + cos\alpha)dx + 2dx_{\zeta} -$$
$$-(sin2\theta - sin\alpha)dy - sin\alpha dU_f - (1 - cos\alpha)dm +$$
$$+(esin2\theta - sin\theta + msin\alpha)d\eta$$

$$\left.\begin{aligned} m &= f - e \\ d\eta &= Rd\gamma \\ \alpha &= arcsin\left[\frac{y}{\sqrt{(f-x-l)^2 + y^2}}\right] \end{aligned}\right\}$$

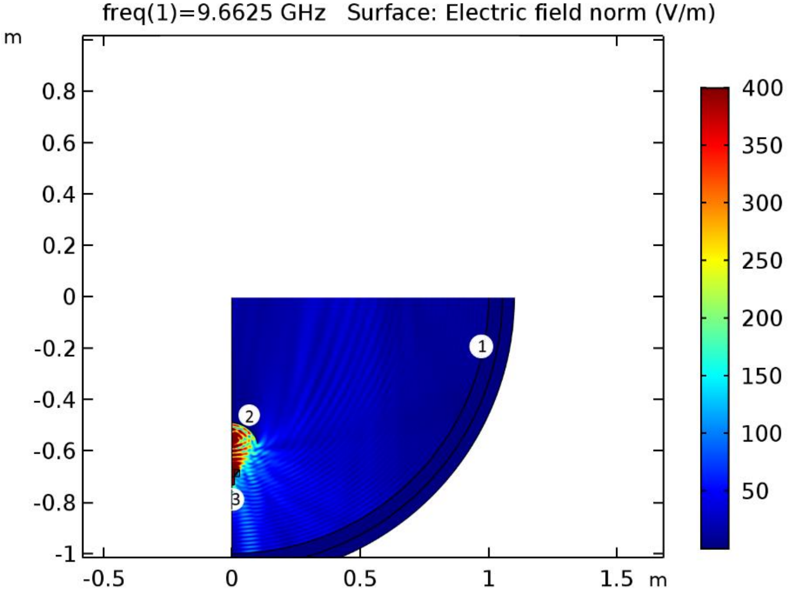


The curves of phase deviation on antenna’s aperture plane

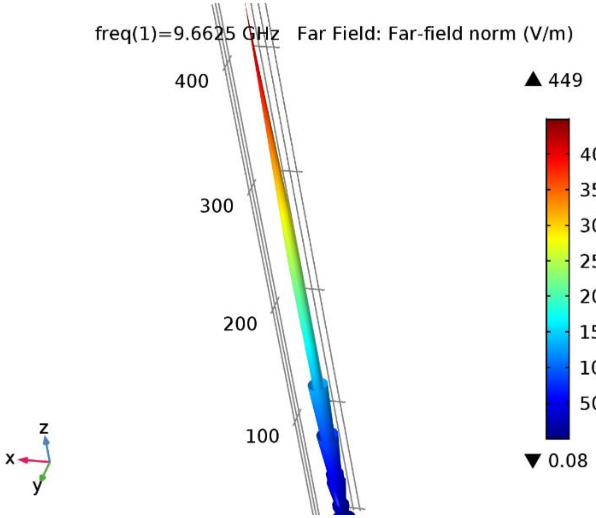
MATHEMATICAL SIMULATION OF ROT 54/2.6 RADIO TELESCOPE



3D model of simulated ROT 54/2.6 antenna

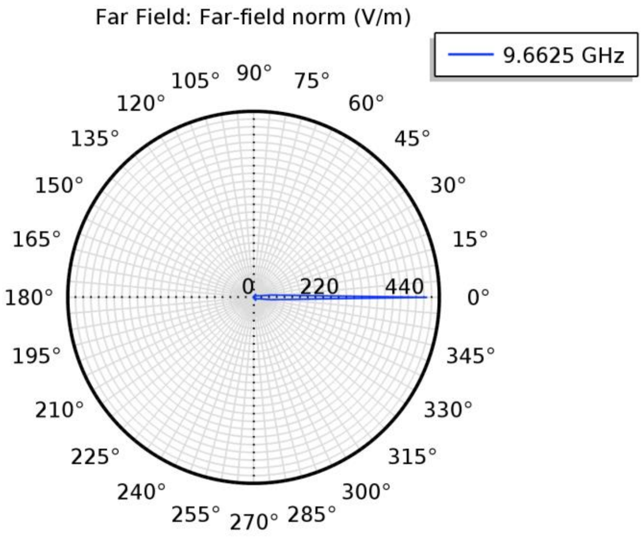


Radiation distribution in antenna

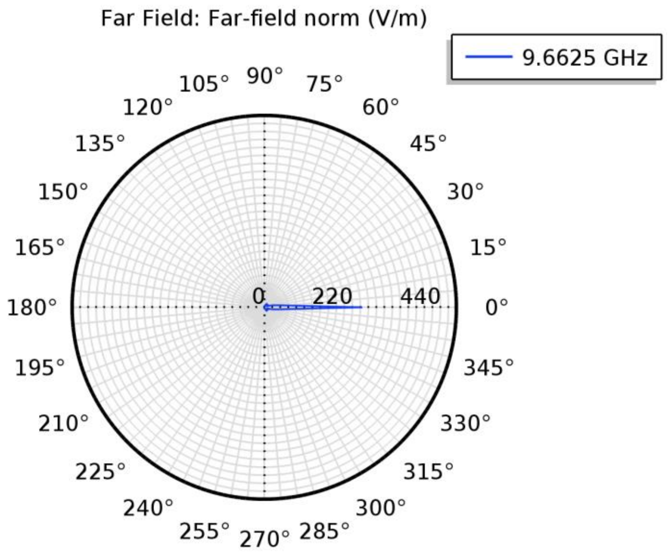


The far field radiation pattern in 3D.
Surface errors are less than λ/16

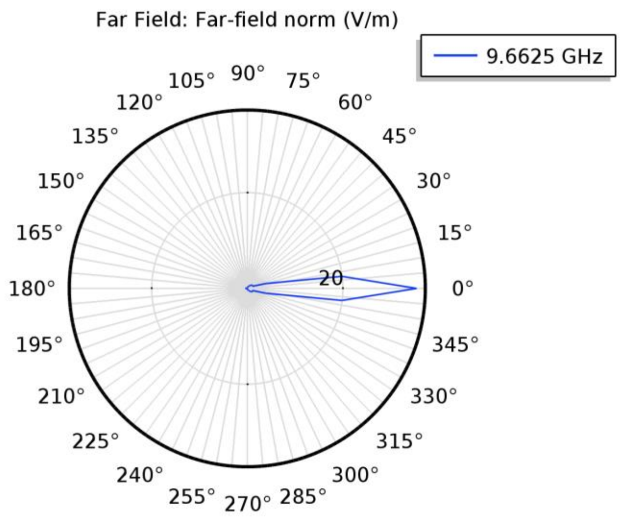
FAR FIELD NORMALIZED GRAPHS FOR DIFFERENT DEFORMATIONS



The far field radiation pattern, when surface roughness is less than λ / 16



The far field radiation pattern when surface roughness is equal to λ / 8



The far field radiation pattern when surface roughness is equal to λ / 3

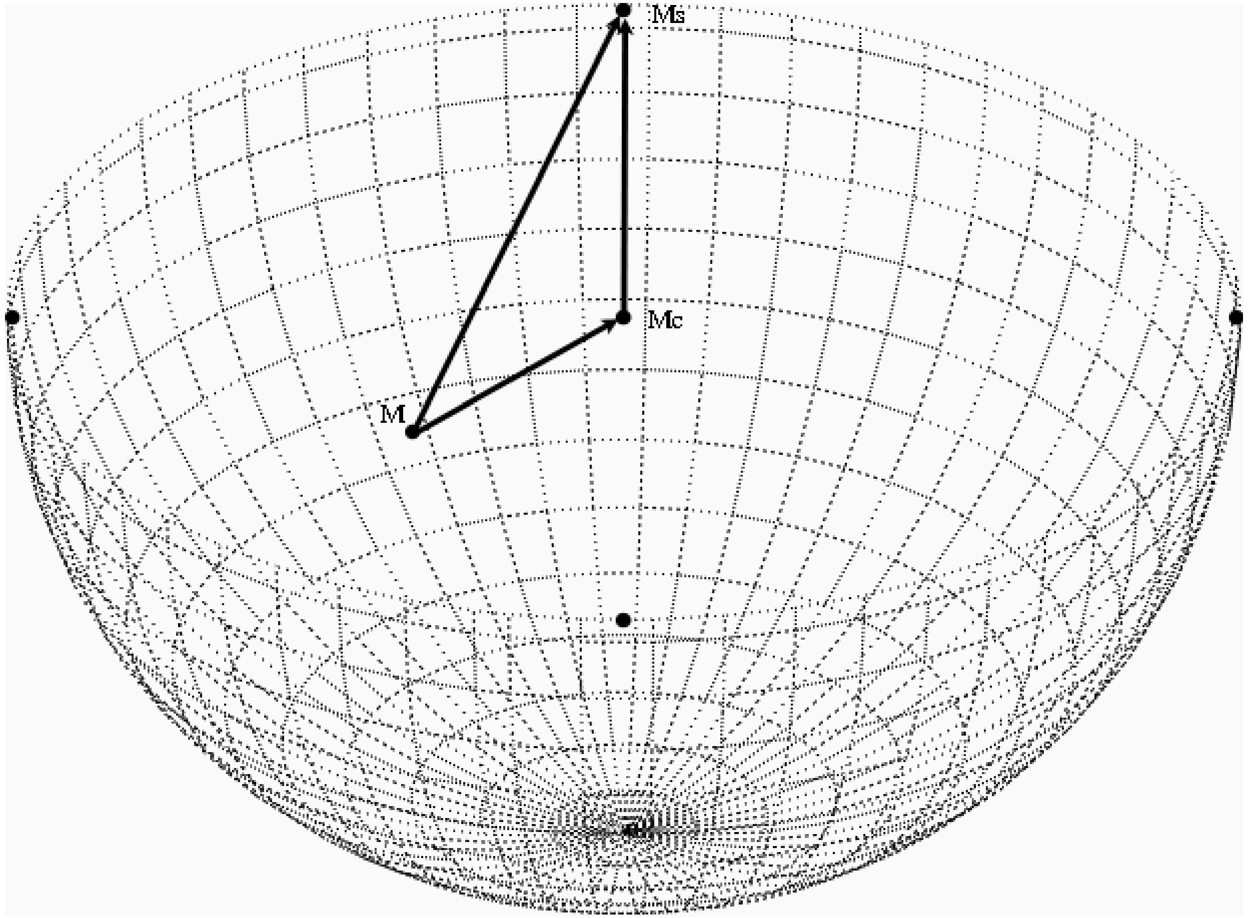
ROT 54/2.6 Radio telescope surface roughness measurements using laser rangefinder

$$\overrightarrow{M_l M_c} = \hat{\imath} r \cos\theta \sin\varphi + \hat{\jmath} r \sin\theta \sin\varphi + \hat{k} r \cos\varphi$$

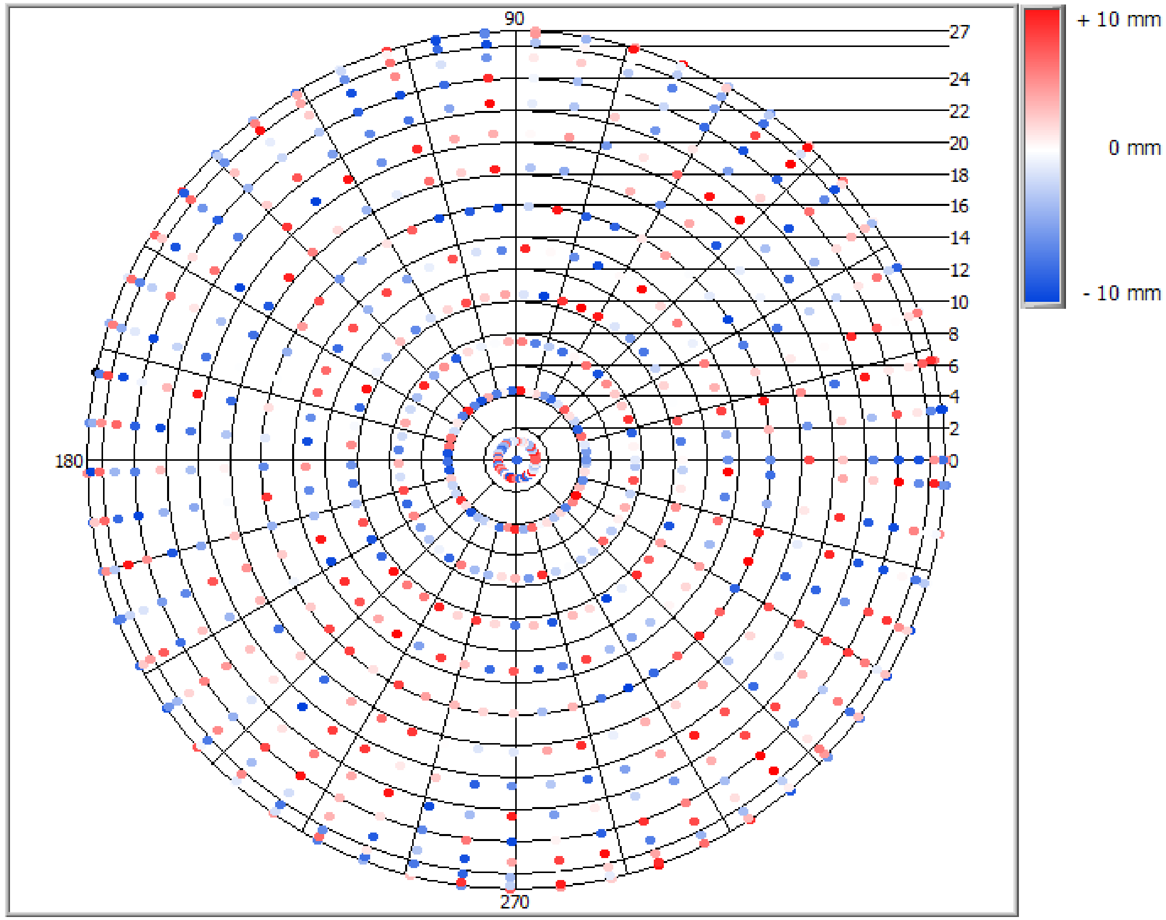
$$\overrightarrow{M_l M_s} = \hat{\imath} l \cos\theta \sin\varphi + \hat{\jmath} l \sin\theta \sin\varphi + \hat{k} l \cos\varphi$$

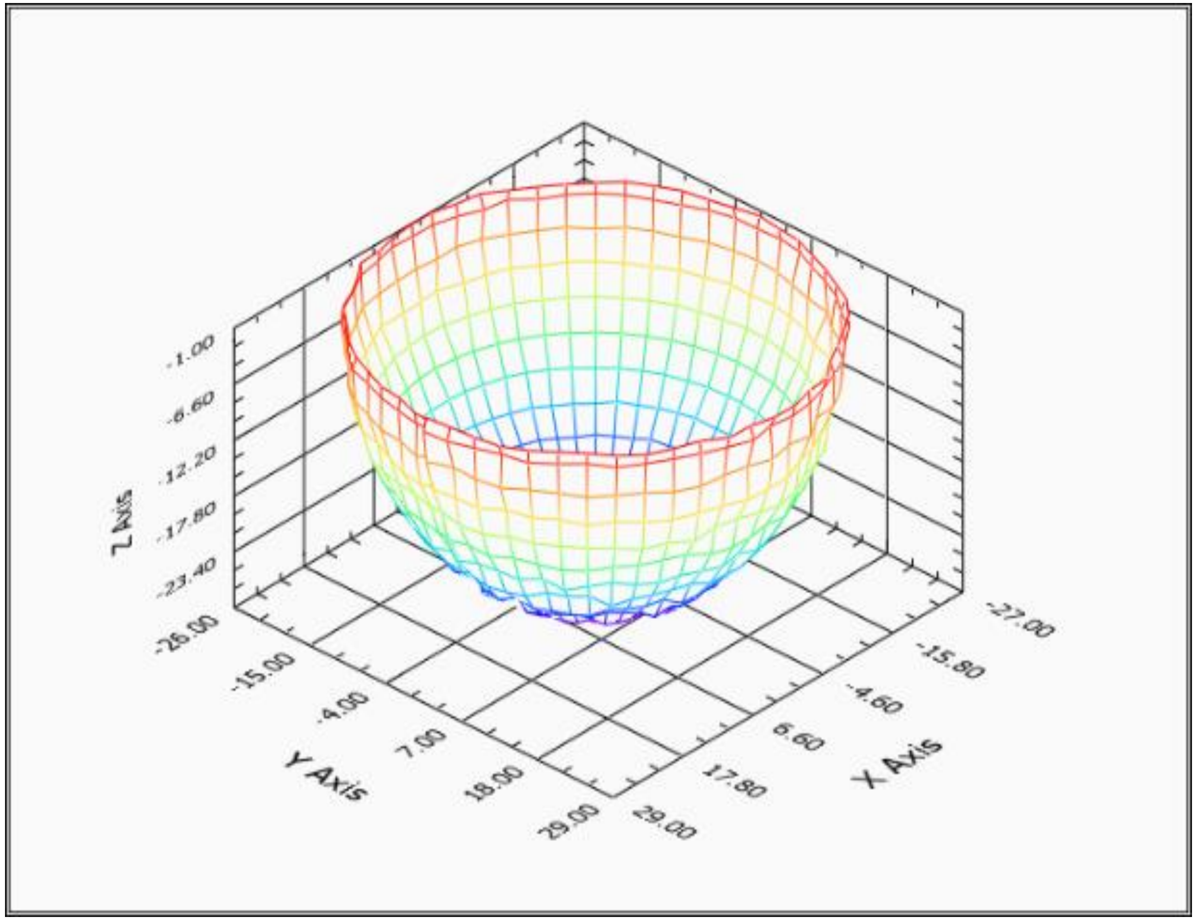
$$\overrightarrow{M_c M_s} = \overrightarrow{M_l M_c} - \overrightarrow{M_l M_s}$$

$$Surface\ error = R - \left|\overrightarrow{M_c M_s}\right|$$



Software based data visualization





Thank you