Yuri Batygin, 06/15/2004

Pole surface profile for spectrometer

Table 1. Parameters of the structure

Bending radius, R	12.5 cm
Bending angle	90°
Gap, g	5 cm
Fringe field coefficients: K_1	0.7
K_2	4.4
Pole face rotation angle, α	0°
Field index, n	0.4
Vertical aperture, a_y	3 cm
Horizontal aperture, $2a_x$	10 cm
Aperture at the exit of transport system	5 x 5 cm^2
Drift between bending magnets, L	20 cm

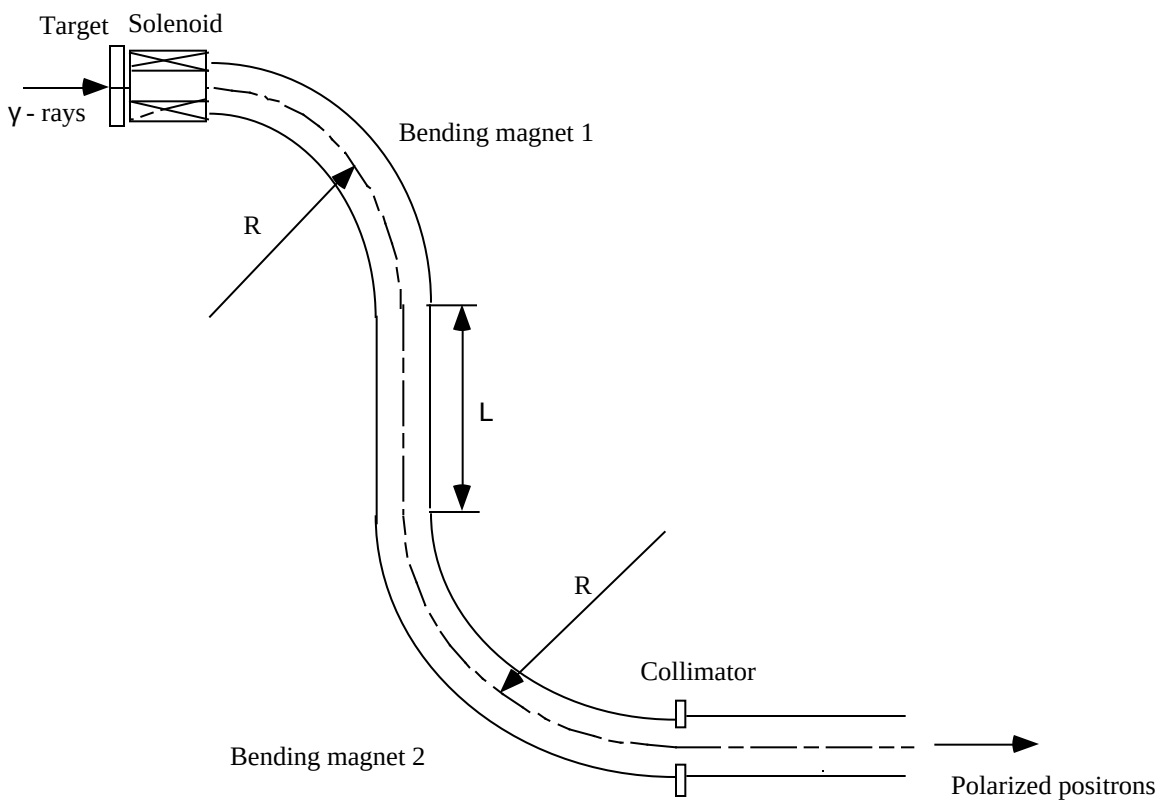

Fig.1. Layout of spectrometer.

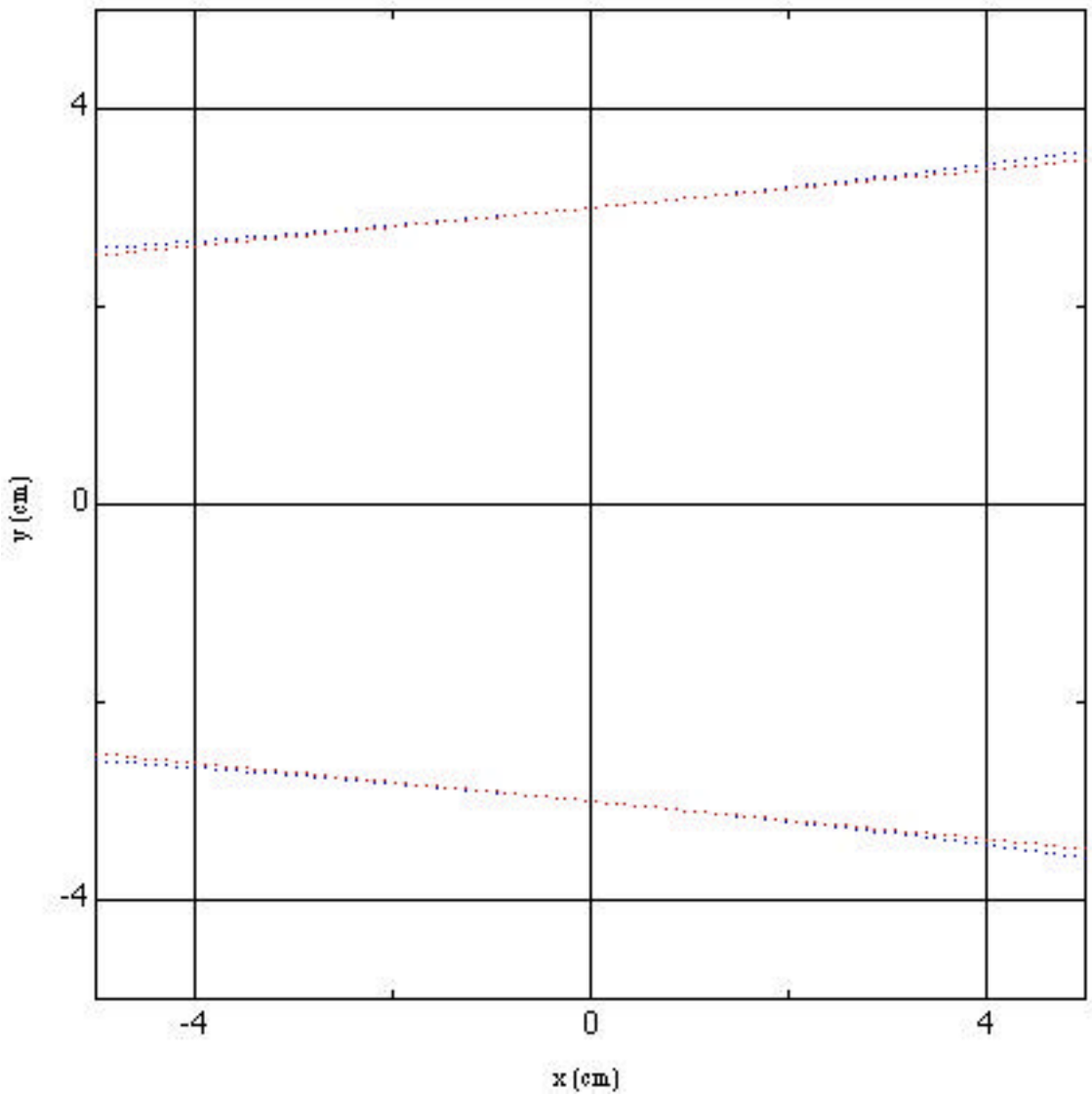

Fig. 2. Pole face profile of bending magnets: (blue) exact hyperbolic profile, (red) linear approximation.

In Ref. [1] it was mentioned that optimal focusing is provided for the bending magnets with the value of field index

$$n = -\left[\frac{R}{B_y}\frac{\partial B_y}{\partial x}\right]_{x=0,y=0} = 0.4 \qquad (1)$$

where magnetic field inside the bending magnet is described by the Taylor expansion:

$$B_x(x,y,z) = -B_y\, n\, \frac{y}{R}, \qquad (2)$$

$$B_y(x,y,z) = B_y\,[1 - n\frac{x}{R} + \frac{n}{2}\frac{y^2}{R^2}]. \qquad (3)$$

Pole surface providing linear magnetic field, Eqs. (2), (3) is described by the equation [2]:

$$y = \frac{R\,a_y}{n}\frac{1}{(\frac{R}{n} - x)} \qquad (4)$$

where a_y is the value of half vertical aperture in the gap center. Eq. (2) describes hyperbolic surface. It can be well approximated by a straight line

$$\frac{dy}{dx} = -\frac{R\,a_y}{n}\frac{1}{(\frac{R}{n} - x)^2}\Big|_{x=0} = n\frac{a_y}{R} = 0.096 \qquad (5)$$

Fig.2 illustrates exact shape of pole surface (blue points) and linear approximation to it (red points). It is clear that the difference between them is negligible and poles can be made flat.

References

[1] Yuri Batygin, Internal memo of 2004/06/08, http://www.slac.stanford.edu/exp/e166.
[2] Handbook of Accelerator Physics and Engineering, Editors: A.Chao and M.Tigner, World scientific, 1999, p.439.