HERA-B RICH Lens Specifications
18 August 1997
(R. Schwitters)

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This file contains a collection of documents that, I believe, represents the currently best available documentation on the light collector lens specifications. The poor quality of some of the pdf pages is due to assembling information of various formats. Even though it looks terrible on a screen, this file should print out OK.

The first 3 pages are Reinhard's translation of the formal order for the lenses.

The next page is my rendition of the index of refraction and transmission data that went along with the formal lens order.

Finally, I've included a page from my spreadsheet program, to indicate the optics design as currently proposed by Dan. (His writeup is not yet available.) The parameters are actually from an exact solution to the linear optics problem with a magnification of m = -0.504, but they agree very well with the fitted parameters Dan finds. For these calculations, I used the mean index of refraction weighted over the expected photo-electron spectrum, n = 1.5075.

Dan now suggests new distances between lenses. The Surfaces table on the last page is revised with figures as of 3-9-97

Specification

Two different lenses should be ordered. 4000 pieces of a square aspherical planoconvex lense with dimensions $35,3 \times 35,3mm^2$ and 3000 pieces of a round aspherical biconvex lense with diameter 32 mm. Both lenses should fullfill the following quality requierments:

- For the error of the lense axis: DIN 3140,4/ 10'. The sum of bubbles DIN 3140 Teil 1, digits DIN 3140 Teil 2 und scratches DIN 3140 Teil 5 should not exeed 1% of the surface area.
- DIN 16901 for the tolerances in length
- error of the thickness in the middle of the lense: $\pm 0.2\,\mathrm{mm}$

This specification should be fullfilled for the planoconvex lense on an area of $34.3 \times 34.3mm$, for the biconvex lense on a circular area with 30 mm diameter around the center of the lense. In this areas the surface of the lense has to deviate from the design surface by less then 10 μm. The shape of the surface is described by:

$$z = \frac{cr^2}{1 + \sqrt{1 - (1+k)c^2r^2}} + a_4r^4 + a_6r^6 + ... \tag{1}$$

with the following parameters:

	planoconvex lense	biconvex lense
c=1/R $[mm^-1]$	0.020640	0.032388
k	-1	-1
$a_4 = \frac{bc^3}{8}$	-1.449574E-6	-6.454017E-6

The two surfaces of the biconvex lense are the same. The thickness on the edge is 1mm for the plano convex lense and 2 mm for the biconvex lense. The outer dimension of the lenses are shown in picture 1. The lense material has to be choosen so, that the refractive index deviate less than 1 % from the one shown in figure 2. The transmission of this material has to be at no wavelength more than 5 % worse, than shown in figure 3.

quality control

Before starting the mass production the company have to show have to show, that the lenses have the required qualtity. It is required to do the following measurements:

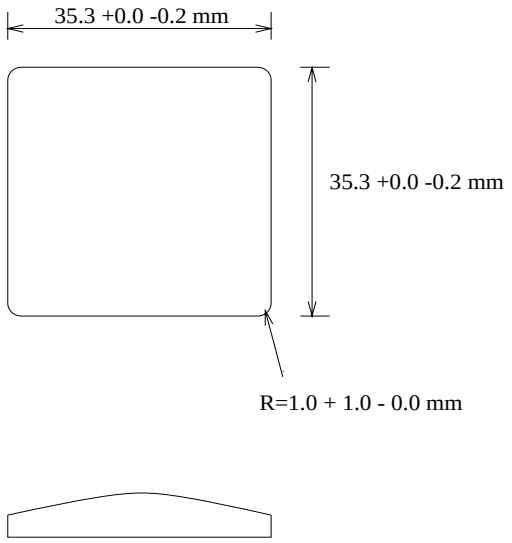
1. measurement of the surface along two orthogonal diagonals.

2. measurement of the focal length (planoconvex: f=95 mm, biconvex: f=30,37 mm)
3. measurement of the amount of bubbles,digits and scratches
4. measurement of the axis error
5. measurement of the refractive index
6. measurement of the transmission,

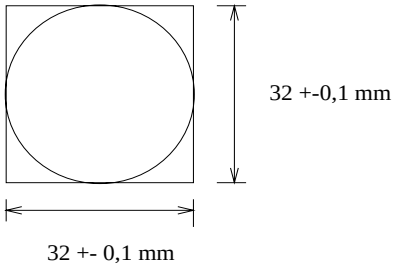
Parallel at DESY at least one lensesystem consisting out of one of each lense shall be studied. If this study shows, that the quality of the lenses is so high, that the lenses can be used as proposed, then it is not necessary to execute the measurements 4 to 6.

figure 1

Plankonvex Linse



Bikonvex Linse



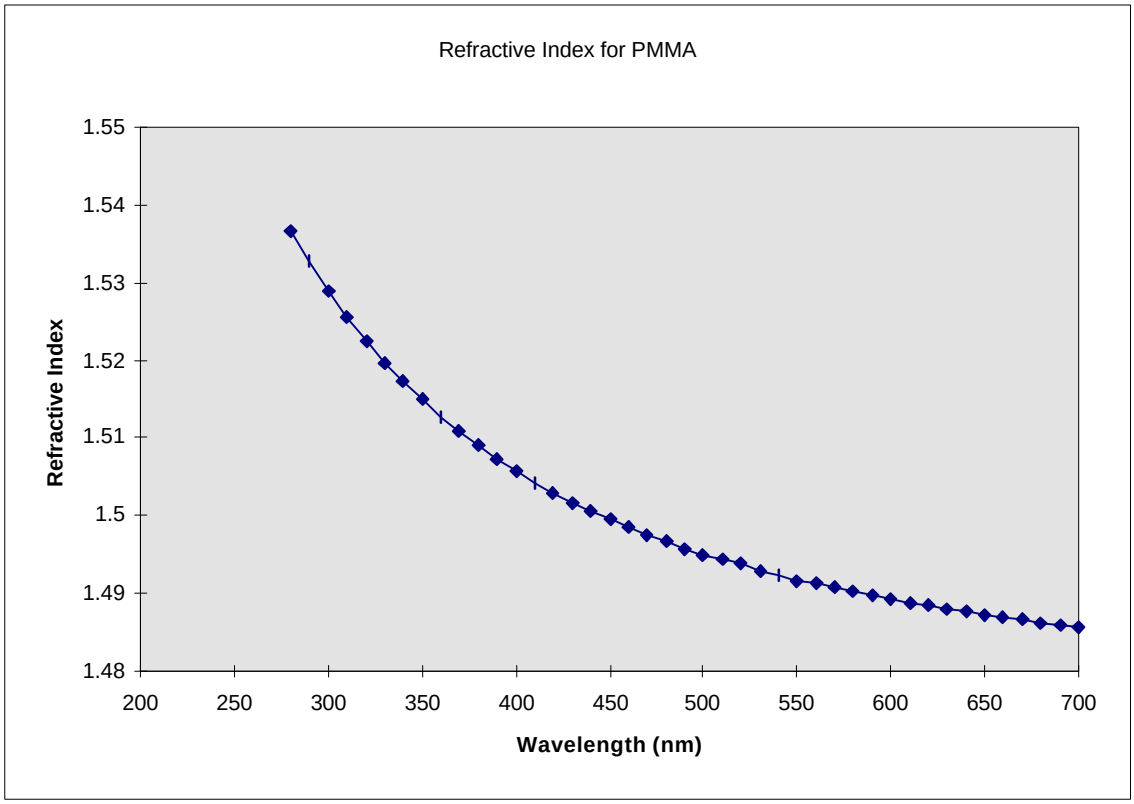


Figure 2: Index of Refraction

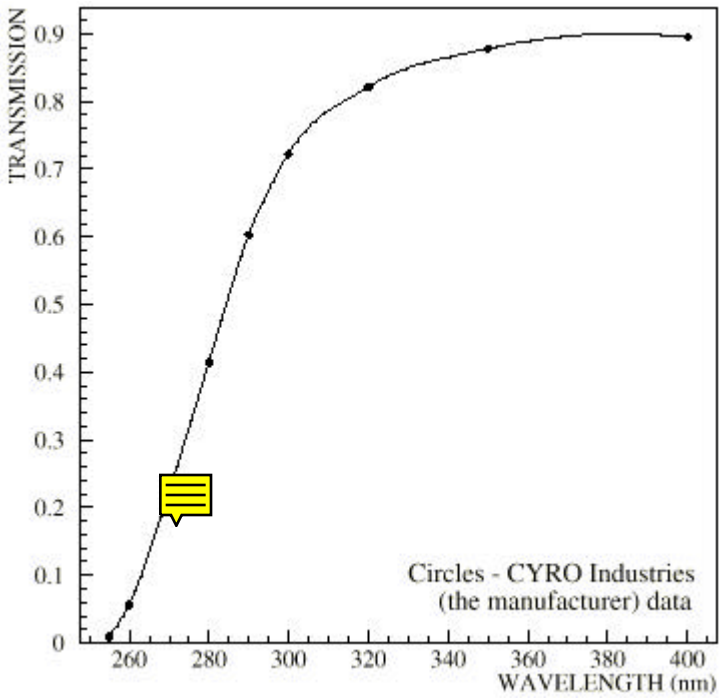


Figure 3. Transmission vs wavelength

Parameters describing surfaces of optical components:

units are mm and radians 10 Total Elements 3 Screens

Description	Index of S	Location vector of a point on S			Unit-vector normal to S at P			Curvature	Eccentricit	4th Order	6th Order	Index of Refraction			Aperture
	i	*P.x*	*P.y*	*P.z*	*N.x*	*N.y*	*N.z*	*1/rho*	*epsilon*	*A4*	*A6*	*n0*	*n1*	*n2*	*XX*
Starting point	1	0	0	0.0	0	0	1	0	0	0	0	1	0	0	
Entry screen	2	0	0	0.0	0	0	1	0	0	0	0	-99	0	0	
Front face of field lens	3	0	0	0.0	0	0	1	0	0	0	0	1.507	0	0	17.65
Curved face of field lens	4	0	0	6.9	0	0	1	-0.02064	-1	-1.31887	0	1	0	0	17.65
Entry surface of condenser	5	0	0	97.9	0	0	1	0.032388	-1	-1.51974	0	1.507	0	0	-16
Center of condenser	6	0	0	102.7	0	0	1	0	0	0	0	-99	0	0	
Rear surface of condenser	7	0	0	107.4	0	0	1	-0.03239	-1	-1.51974	0	1	0	0	-16
Front face of PMT	8	0	0	150.7	0	0	1	0	0	0	0	1.5	0	0	
Rear surface of PMT window	9	0	0	150.7	0	0	1	0	0	0	0	1	0	0	
Screen at image plane	10	0	0	150.7	0	0	1	0	0	0	0	-99	0	0	