Refractive Index uniformity: Studies with gradient method

L. Barion, M. Contalbrigo, P. Lenisa,
A. Movsisyan, L. Pappalardo
INFN Ferrara

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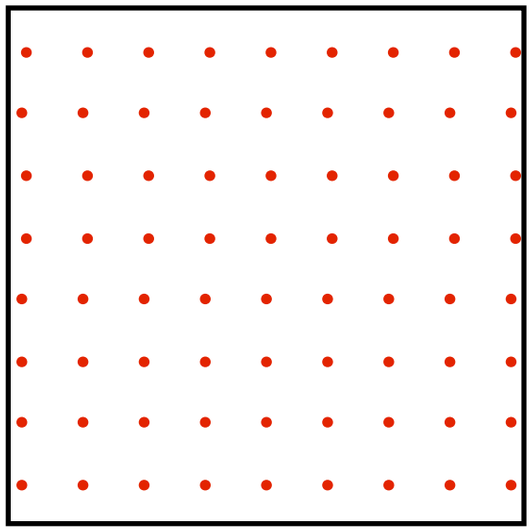
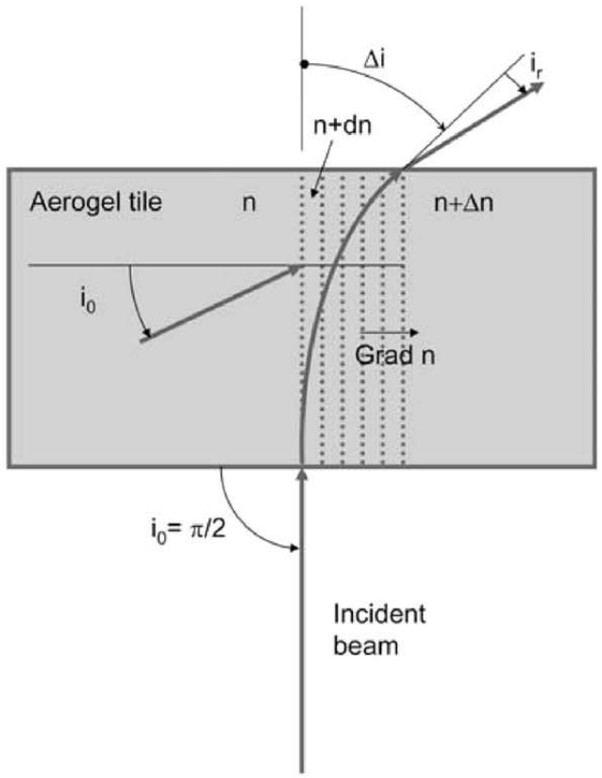
Introduction



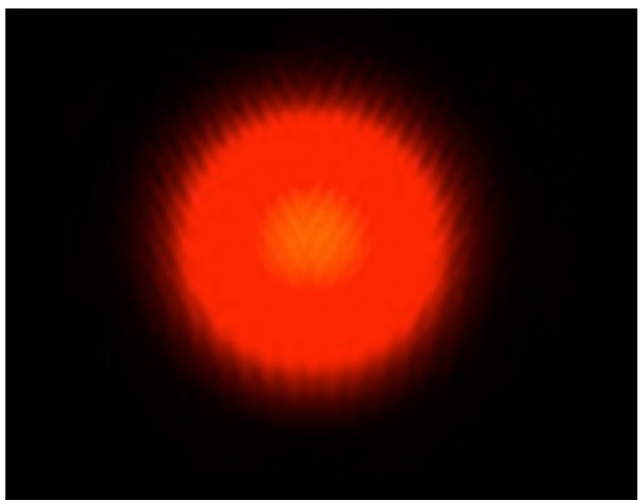
Determine the transverse gradient of n from deflection of beam

Fitting X and Y profiles of the laser spot, over the surface of the aerogel

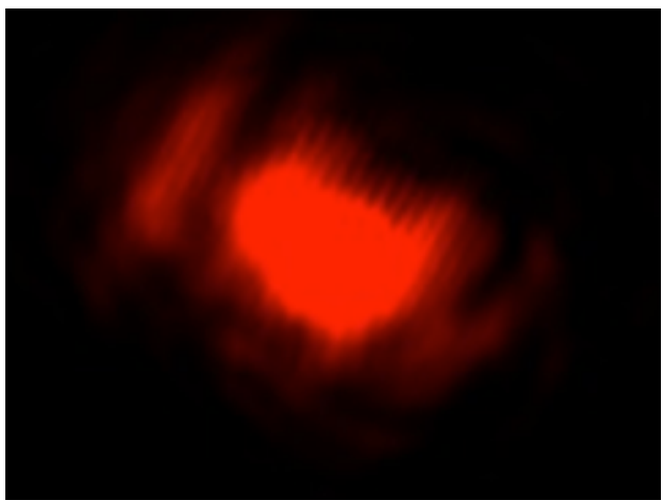


NIM A 614 (2010) 184-195

Spot image w/o aerogel

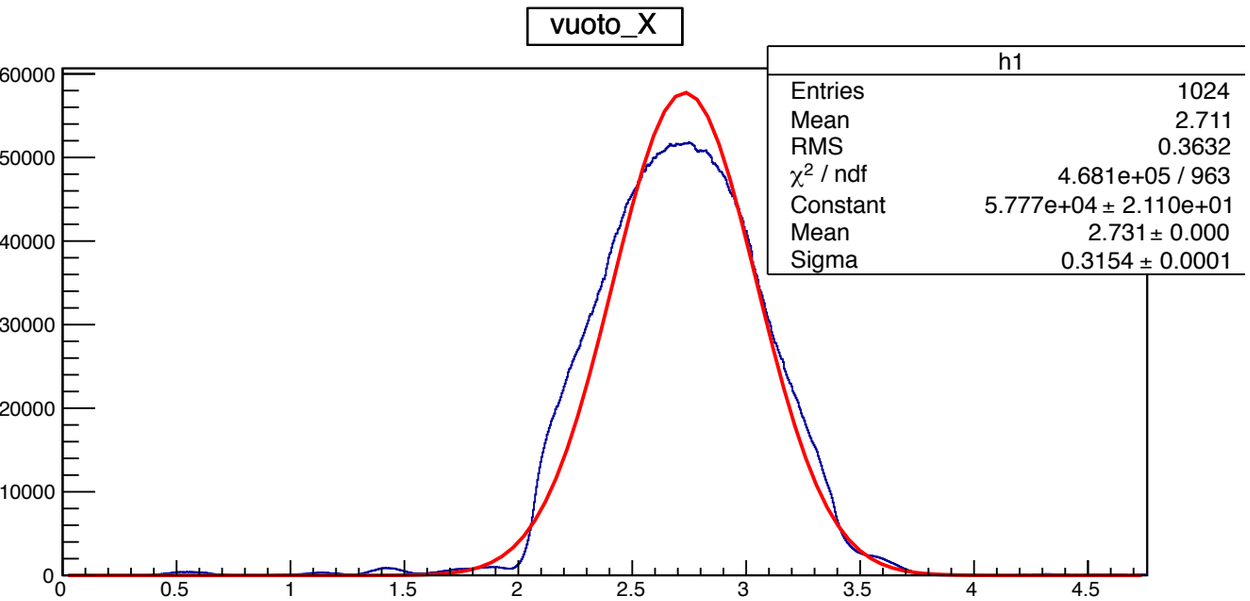


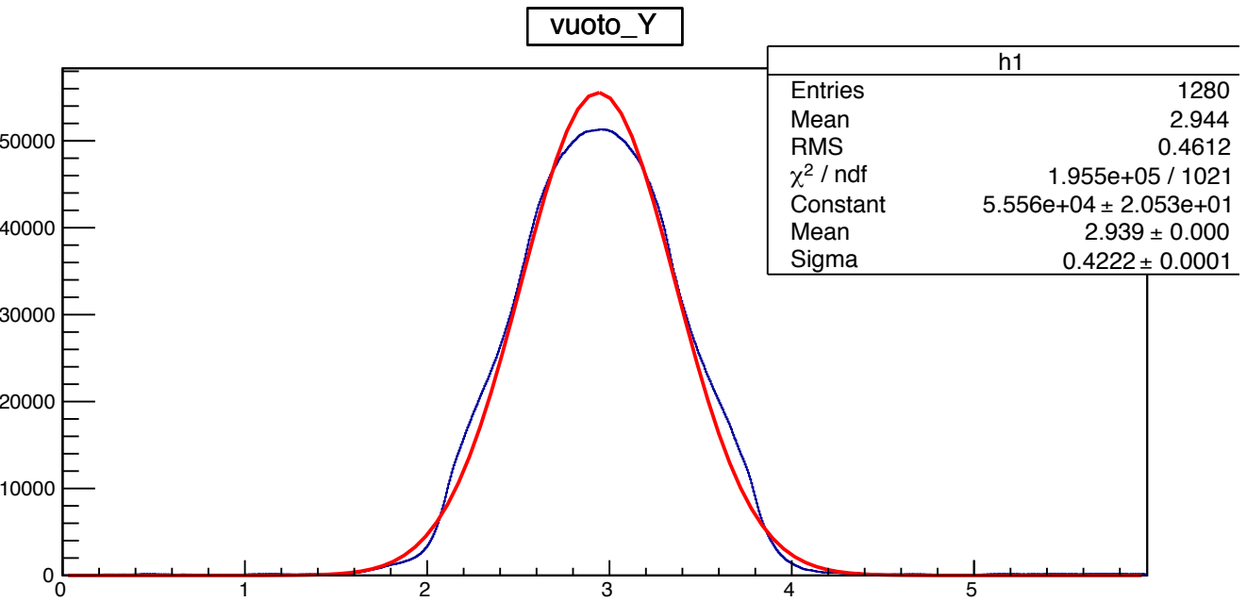
Spot image with aerogel



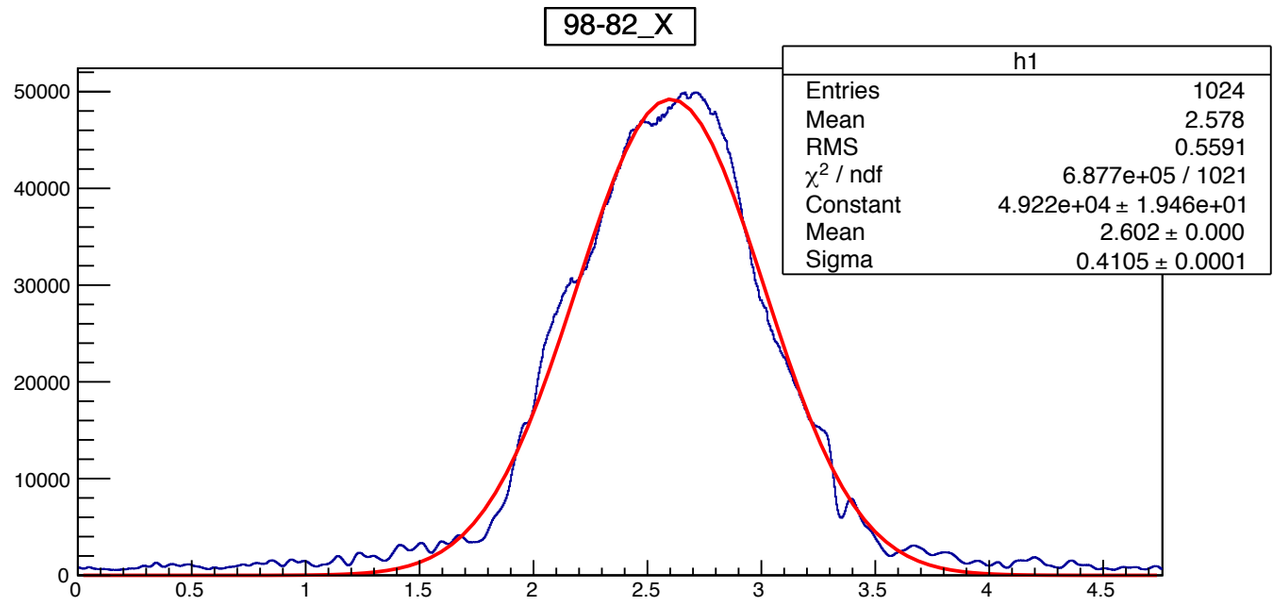
profile distributions

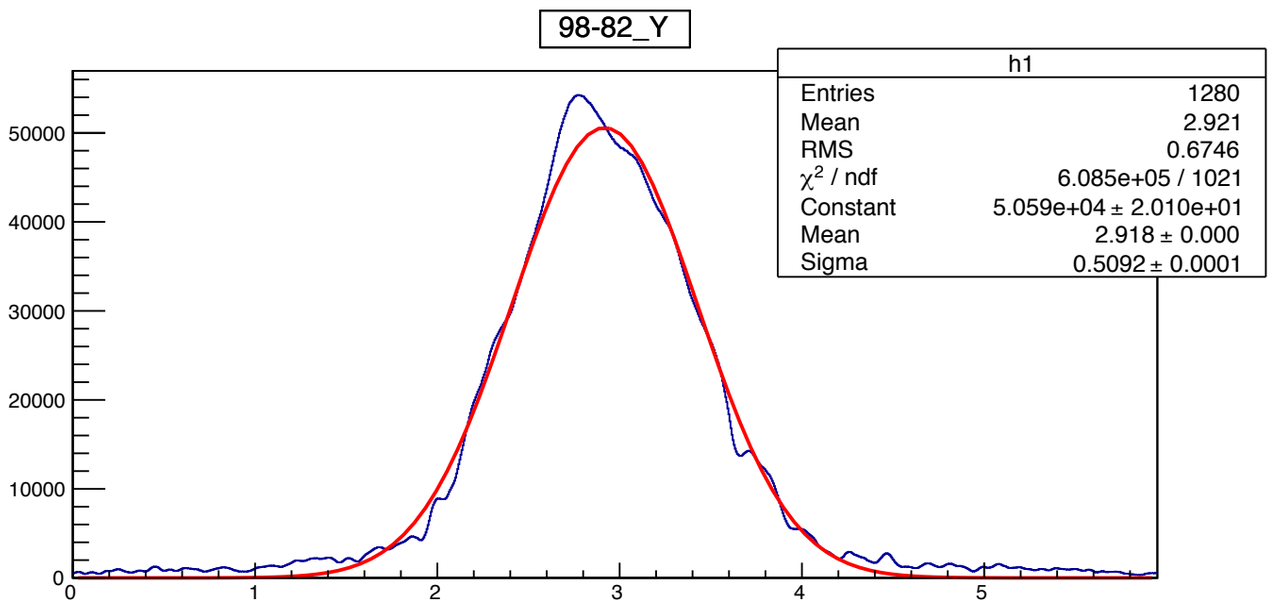
profile distributions w/o aerogel



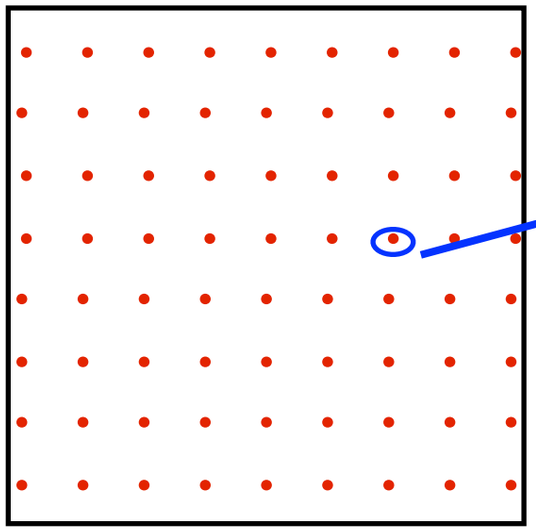


profile distributions with aerogel





Model for linear dependence



$$\begin{cases} n_{ij} = \frac{1}{2}[(n_{i,j-1} + \Delta_{i,j-1}d) + (n_{i,j+1} - \Delta_{i,j+1}d)] \\ n_{ij} = \frac{1}{2}[(n_{i-1,j} + \Delta_{i-1,j}d) + (n_{i+1,j} - \Delta_{i+1,j}d)] \end{cases}$$

$$\begin{cases} n_{ij} - \frac{1}{2}(n_{i,j-1} + n_{i,j+1}) = \frac{1}{2}(\Delta_{i,j-1}d - \Delta_{i,j+1}d) \\ n_{ij} - \frac{1}{2}(n_{i-1,j} + n_{i+1,j}) = \frac{1}{2}(\Delta_{i-1,j}d - \Delta_{i+1,j}d) \end{cases}$$

A n S

$$\begin{bmatrix} \\ \vdots \\ \\ \end{bmatrix} \times \begin{bmatrix} n_{00} \\ \vdots \\ n_{IJ} \end{bmatrix} = \begin{bmatrix} s_{00} \\ \\ \vdots \\ \\ s_{IJ} \end{bmatrix} \qquad An = S$$

Time Performance vs Bias

$$\underset{\mathbf{S}}{\begin{bmatrix} s_{00} \\ \vdots \\ s_{IJ} \end{bmatrix}} = \underset{\mathbf{N}}{\begin{bmatrix} & \vdots & \end{bmatrix}} \times \underset{\mathbf{\Delta}}{\begin{bmatrix} \Delta^x_{00} \\ \vdots \\ \Delta^y_{IJ} \end{bmatrix}}$$

$$W_\Delta = \begin{pmatrix} 1/\sigma^2_{00} & \cdots & \\ & \ddots & \\ \vdots & & 1/\sigma^2_{IJ} \end{pmatrix}$$

$$An = N\Delta$$

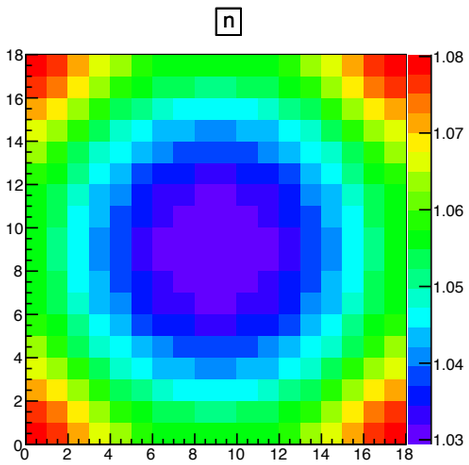
$$N^{-1}An = \Delta \;\; \Rightarrow \;\; Mn = \Delta$$

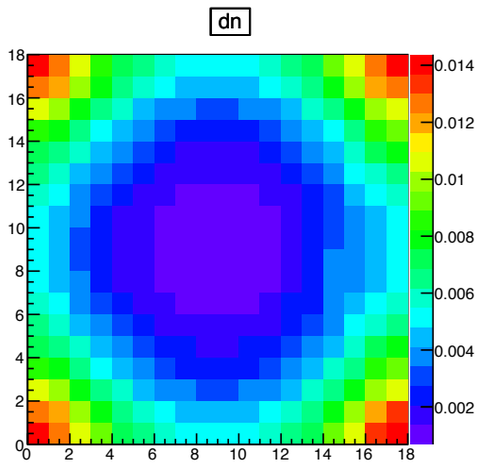
$$n = (M^T W M)^{-1} M^T W \Delta$$

$$C_n = (M^T W M)^{-1}$$

test of the procedure

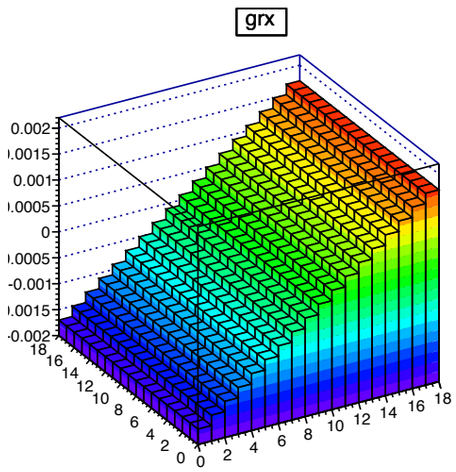
extracted ref. index

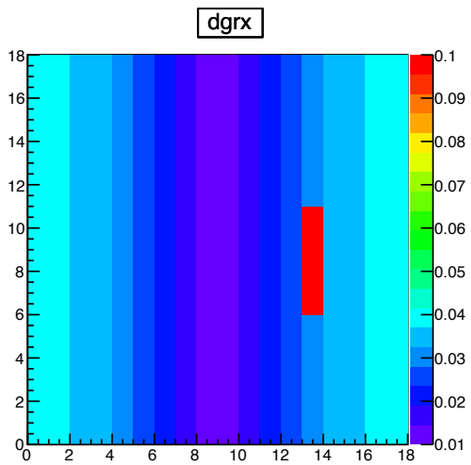




extracted errors

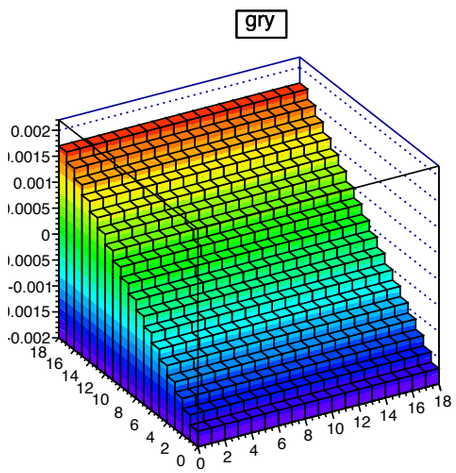
implemented gradient in x

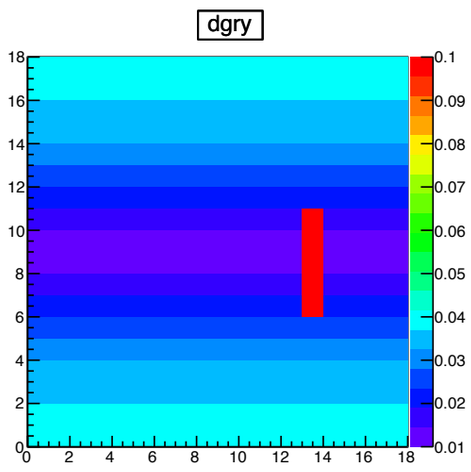




implemented errors on gradient in x

implemented gradient in y





implemented errors on gradient in y

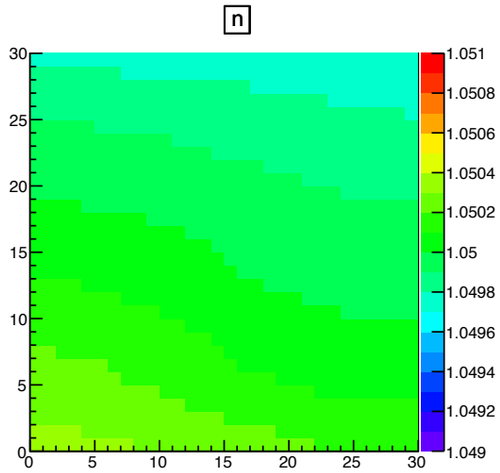
implemented refractive index map

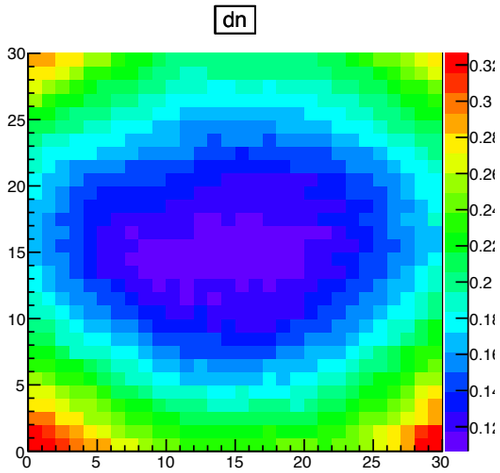
$$n(x,y) \propto x^2 + y^2$$

$$grad\, n(x) \propto x$$
$$grad\, n(y) \propto y$$

measurements with glass

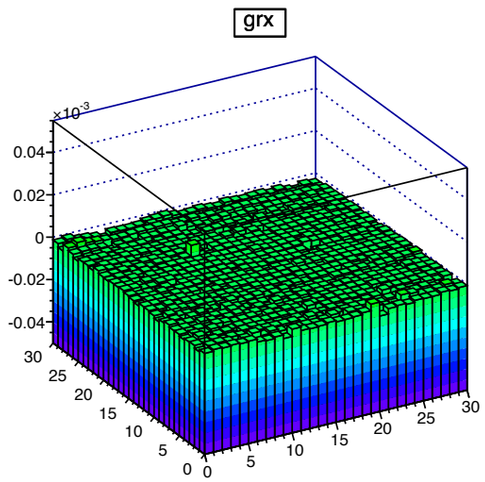
extracted ref. index (relative)

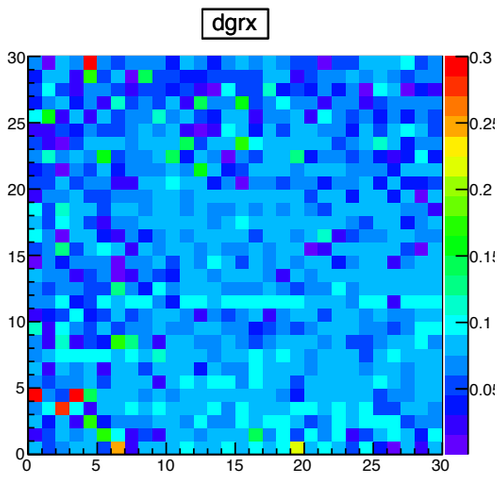




extracted errors (relative)

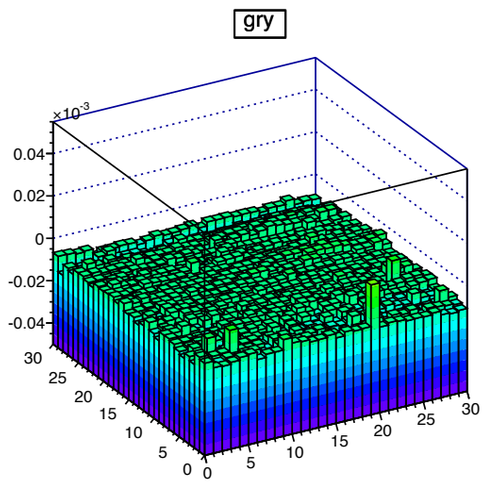
measured gradient in x

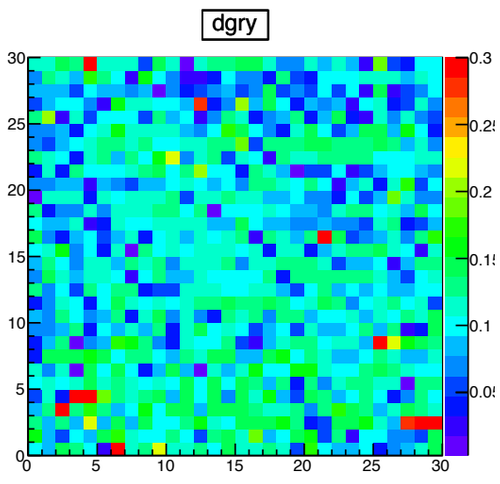




measured errors on gradient in x

measured gradient in y

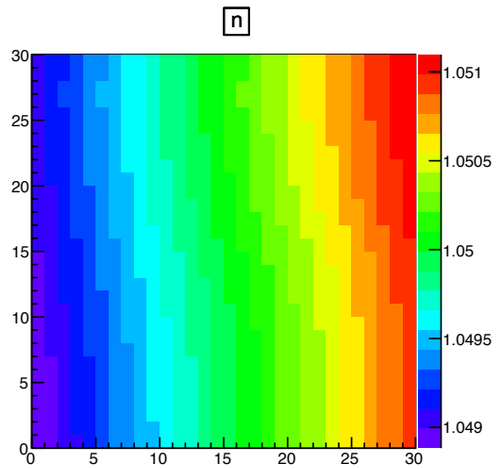


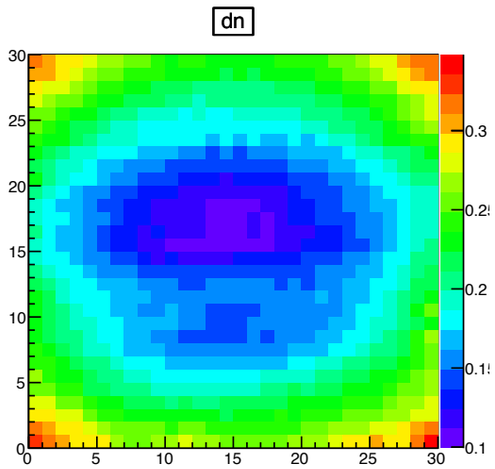


measured errors on gradient in y

measurements with glass (tilted)

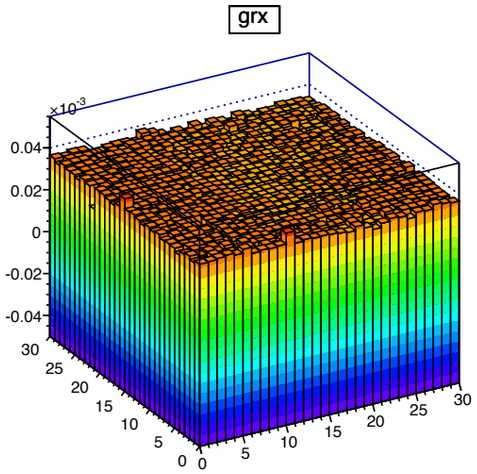
extracted ref. index (relative)

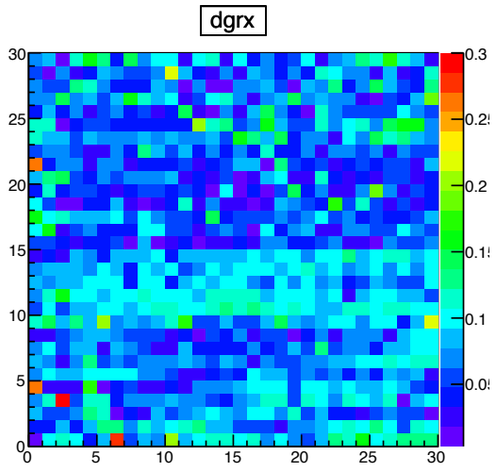




extracted errors (relative)

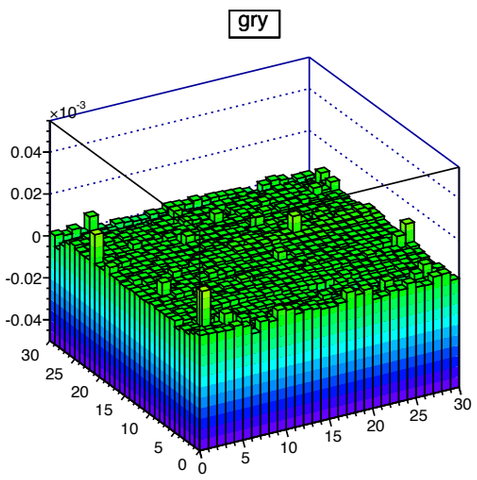
measured gradient in x

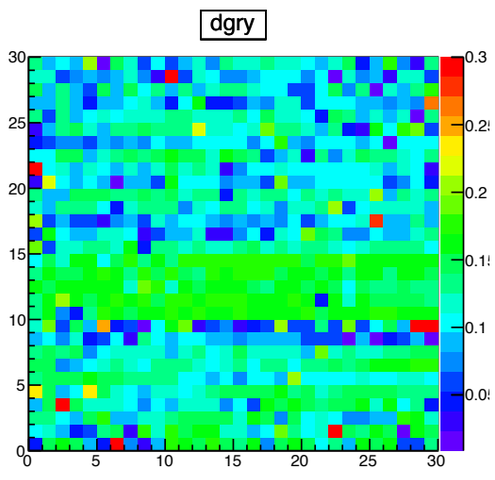




measured errors on gradient in x

measured gradient in y

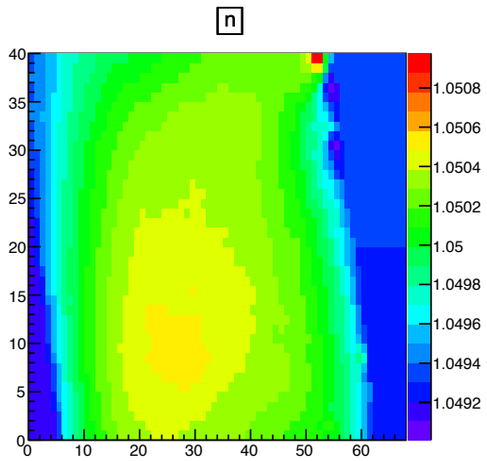


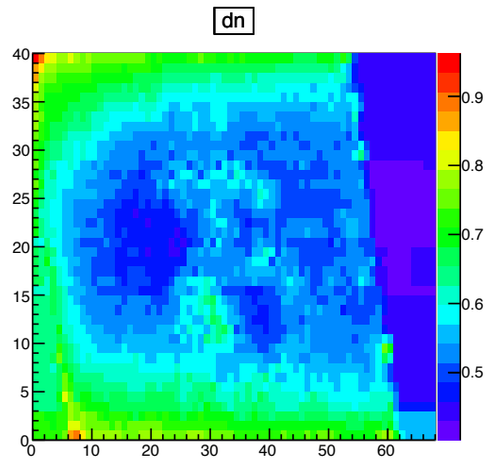


measured errors on gradient in y

measurements with aerogel

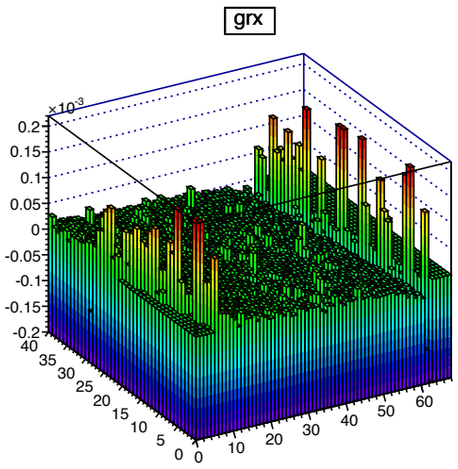
extracted ref. index

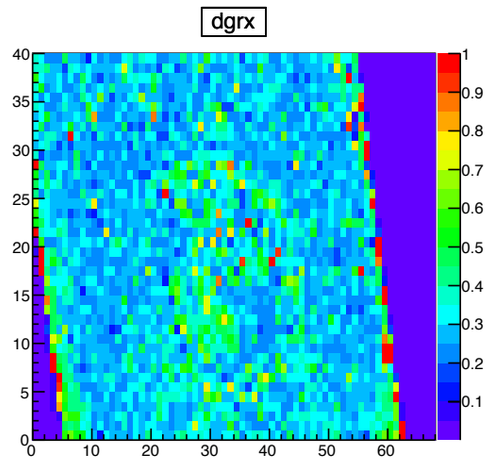




extracted errors (relative)

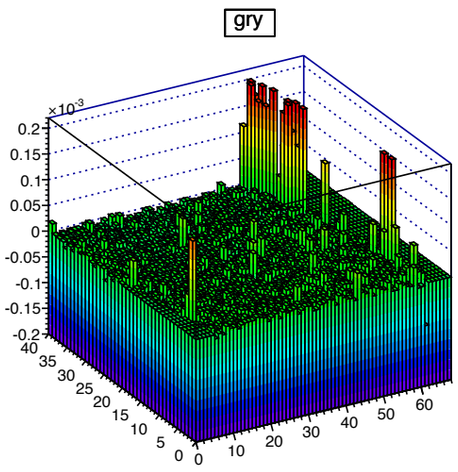
measured gradient in x

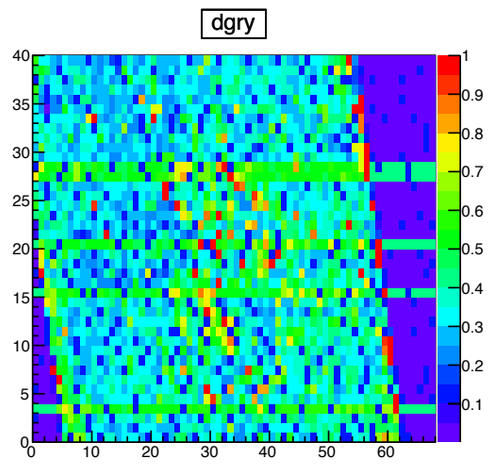




measured errors on gradient in x

measured gradient in y





measured errors on gradient in y