IP waist scans experimental procedure for ATF2

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Goal: adjust waists in each of the x and y planes

Method: orthogonal waist scans, linear combinations of QD0 and QF1 can be computed to enable to independently vary α_x and α_y

Orthogonal waist scans:

$$\begin{pmatrix}\Delta f_x\\ \Delta f_y\end{pmatrix}=\underbrace{\begin{pmatrix}a & b\\ c & d\end{pmatrix}}_{M}\begin{pmatrix}\delta_{QD}\\ \delta_{QF}\end{pmatrix} \quad \rightarrow \quad \begin{pmatrix}\delta_{QD}\\ \delta_{QF}\end{pmatrix}=M^{-1}\begin{pmatrix}\Delta f_x\\ \Delta f_y\end{pmatrix}$$

The fractional quadrupole strength $\delta_{QD,\,QF}$ are in parts per thousand, and the longitudinal waist motions Δfx,fy are in meters.

- For different **β**, M remains almost the same.

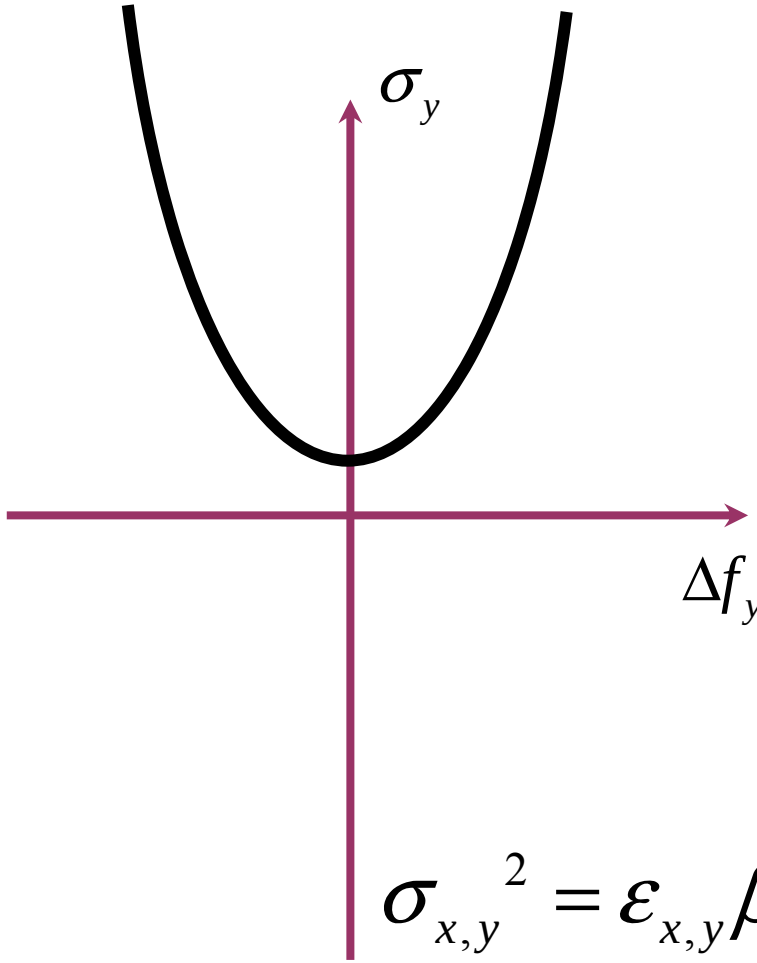
Nominal IP: $M=\begin{pmatrix}2.57 & -16.8\\ -1.68 & 0.24\end{pmatrix} \rightarrow M^{-1}=\begin{pmatrix}-0.0087 & -0.6085\\ -0.0609 & -0.0931\end{pmatrix}$

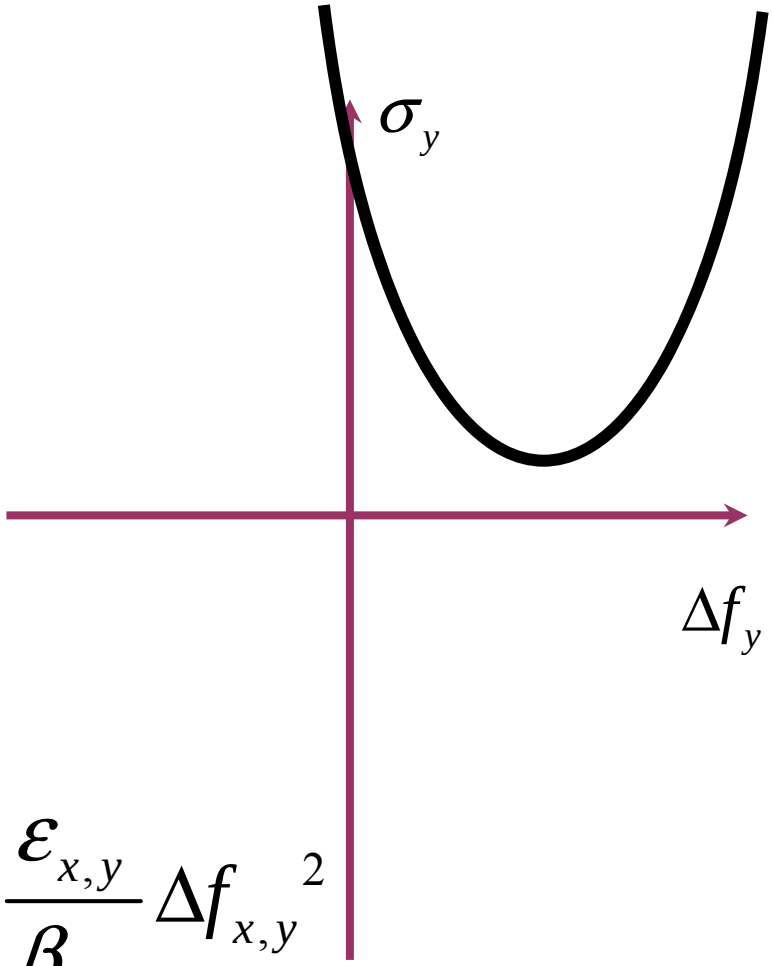
IP+39cm:

$$M^{-1}=\begin{pmatrix}-0.0087 & -0.418\\ -0.0522 & -0.0741\end{pmatrix}$$

IP-54cm:

$$M^{-1}=\begin{pmatrix}-0.0076 & -1.3027\\ -0.0746 & -0.1438\end{pmatrix}$$





$$\sigma_{x,y}^{\ 2} = \varepsilon_{x,y}\beta_{x,y} + \frac{\varepsilon_{x,y}}{\beta_{x,y}}\Delta f_{x,y}^{\ 2}$$

Without errors

With errors

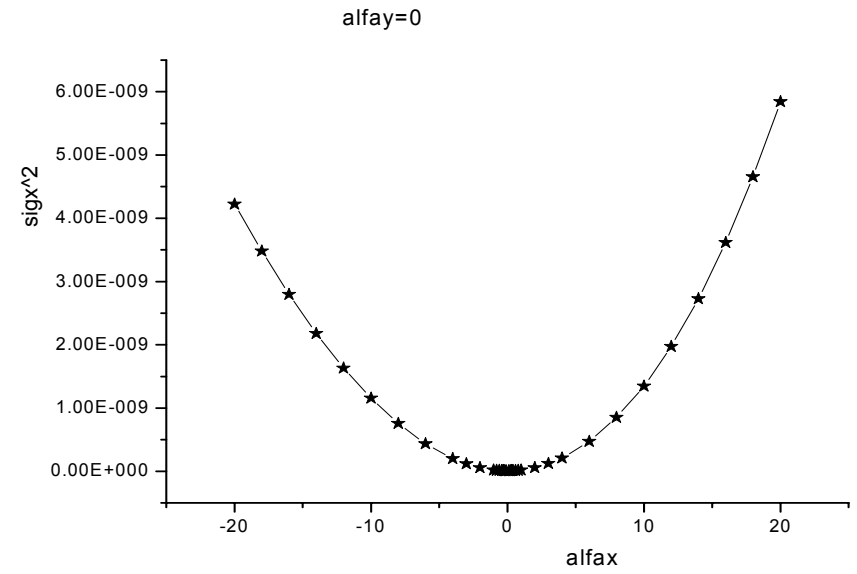
The same for X !

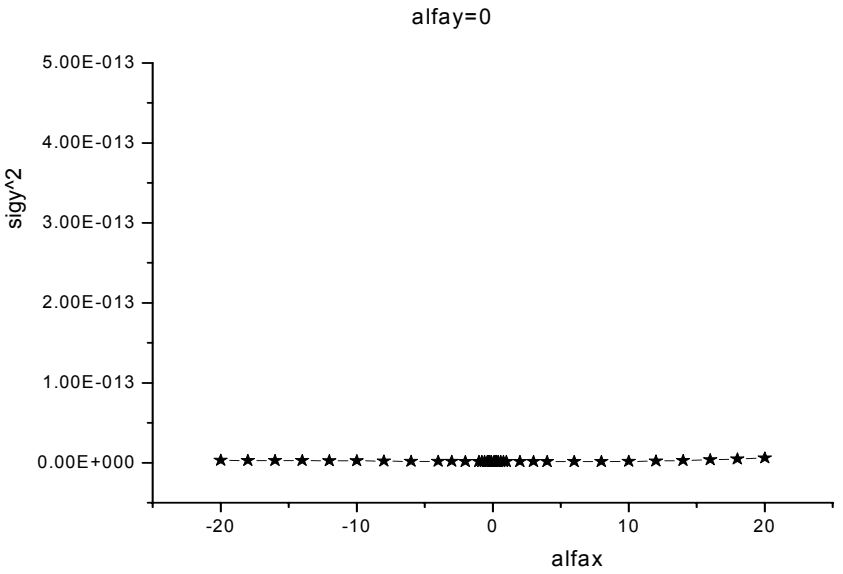
$$\Delta f_x = 0 \quad \rightarrow \quad \begin{pmatrix} \delta_{QD} \\ \delta_{QF} \end{pmatrix}_y = M^{-1} \begin{pmatrix} 0 \\ \Delta f_y \end{pmatrix}$$

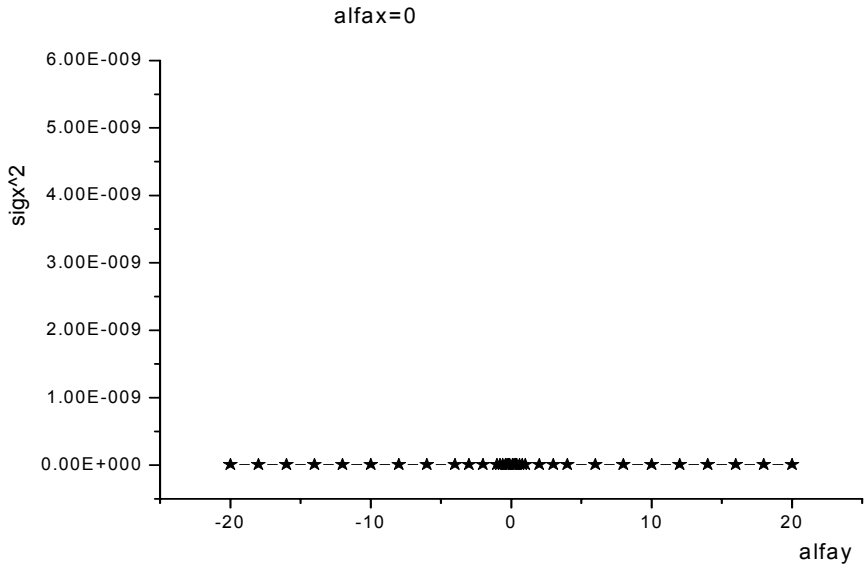
$$\Delta f_y = 0 \quad \rightarrow \quad \begin{pmatrix} \delta_{QD} \\ \delta_{QF} \end{pmatrix}_x = M^{-1} \begin{pmatrix} \Delta f_x \\ 0 \end{pmatrix}$$

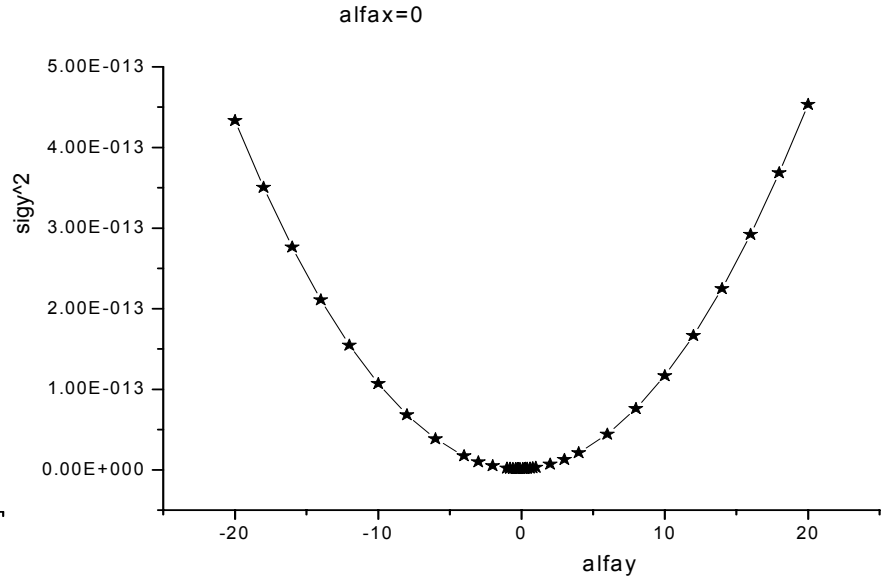
Get waist in each plane !

→ Define in terms of $\alpha = \Delta f / \beta$ → more orthogonal & linear









Next → 1) check orthogonality & linearity with input 4D mismatch

2) integrate and prepare GUI e.g. within flight simulator