Hosing Analysis – UPDATED Parameter Scan for Fits to Simulation Data

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Recap: Fit Parameter

- Beam centroid equation:

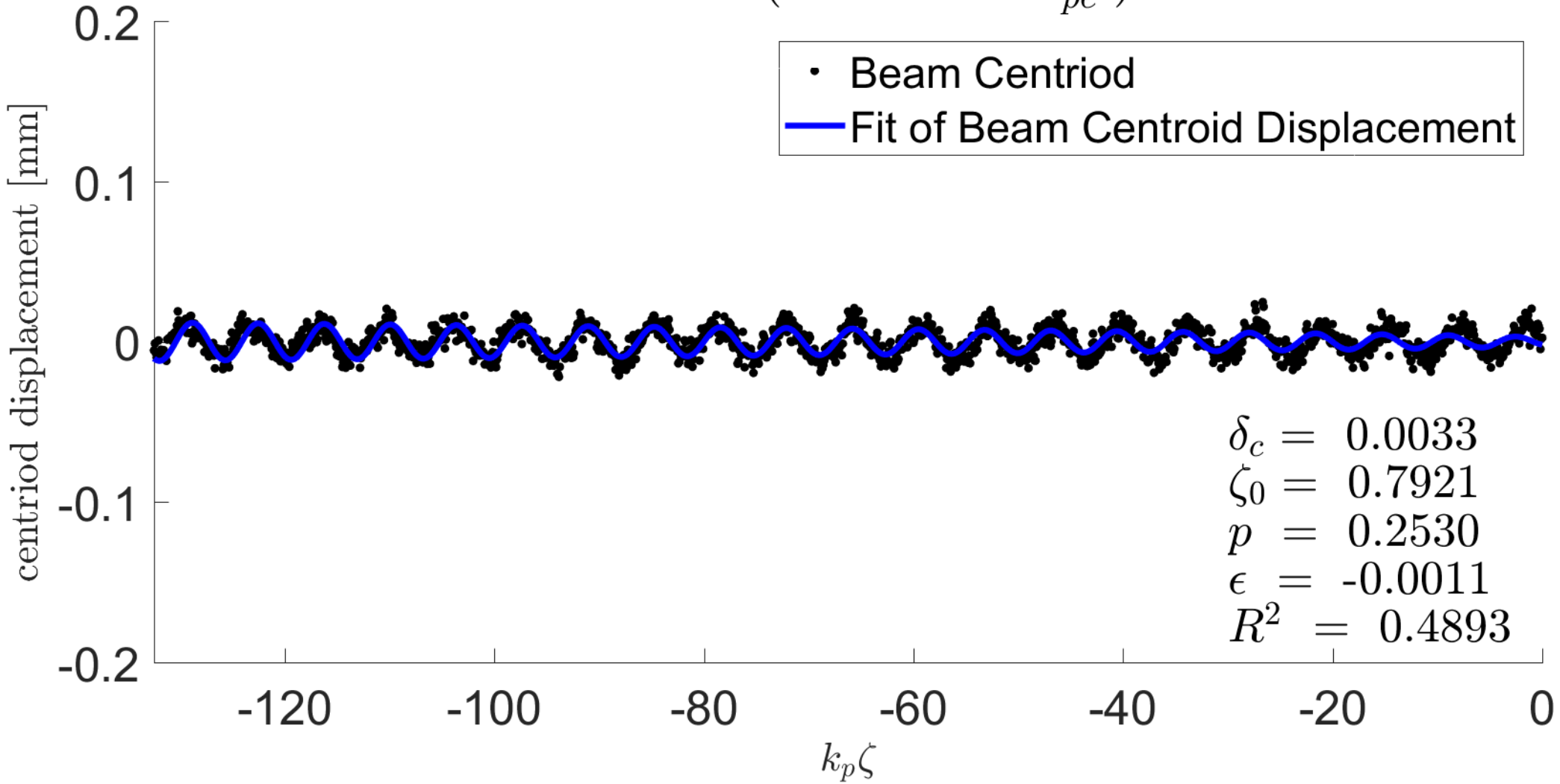
$$x_c = \delta_c \cdot \frac{3^{1/4}}{\sqrt{8\pi}} \cdot \frac{e^{N_h}}{\sqrt{N_h}} \cdot \cos\left(\frac{\pi}{12} - k_p(\zeta - \zeta_0) - \frac{N_h}{\sqrt{3}}\right) \cdot (1 + \epsilon \cdot \sin(k_{pe}(\zeta - \zeta_0)))$$

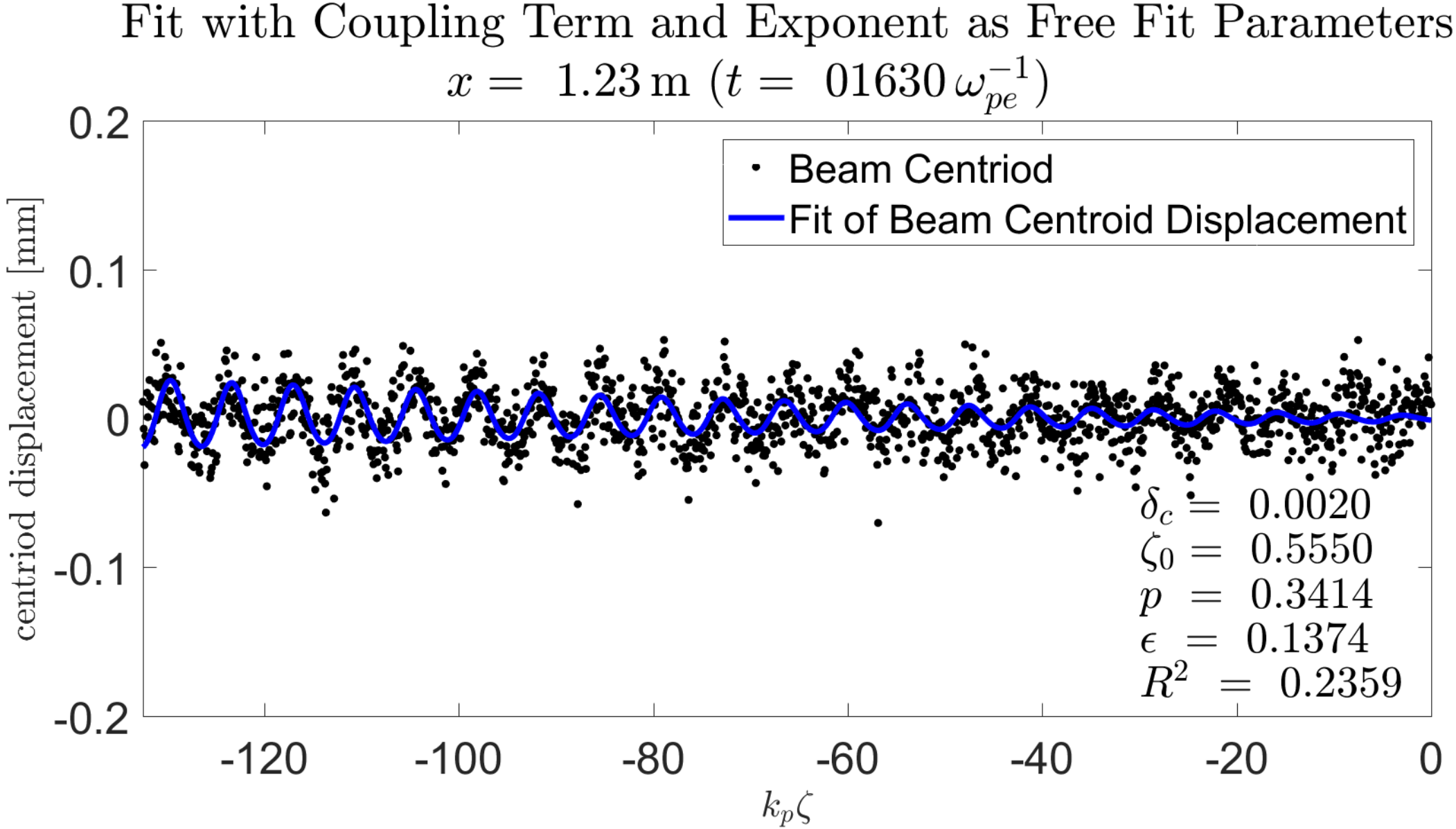
$$\text{and} \quad N_h = \frac{3^{3/2}}{4} \cdot \left[\mu \cdot (\zeta - \zeta_0) \cdot \hat{k}_\beta^2 k_{pe}^3 z^2\right]^p$$

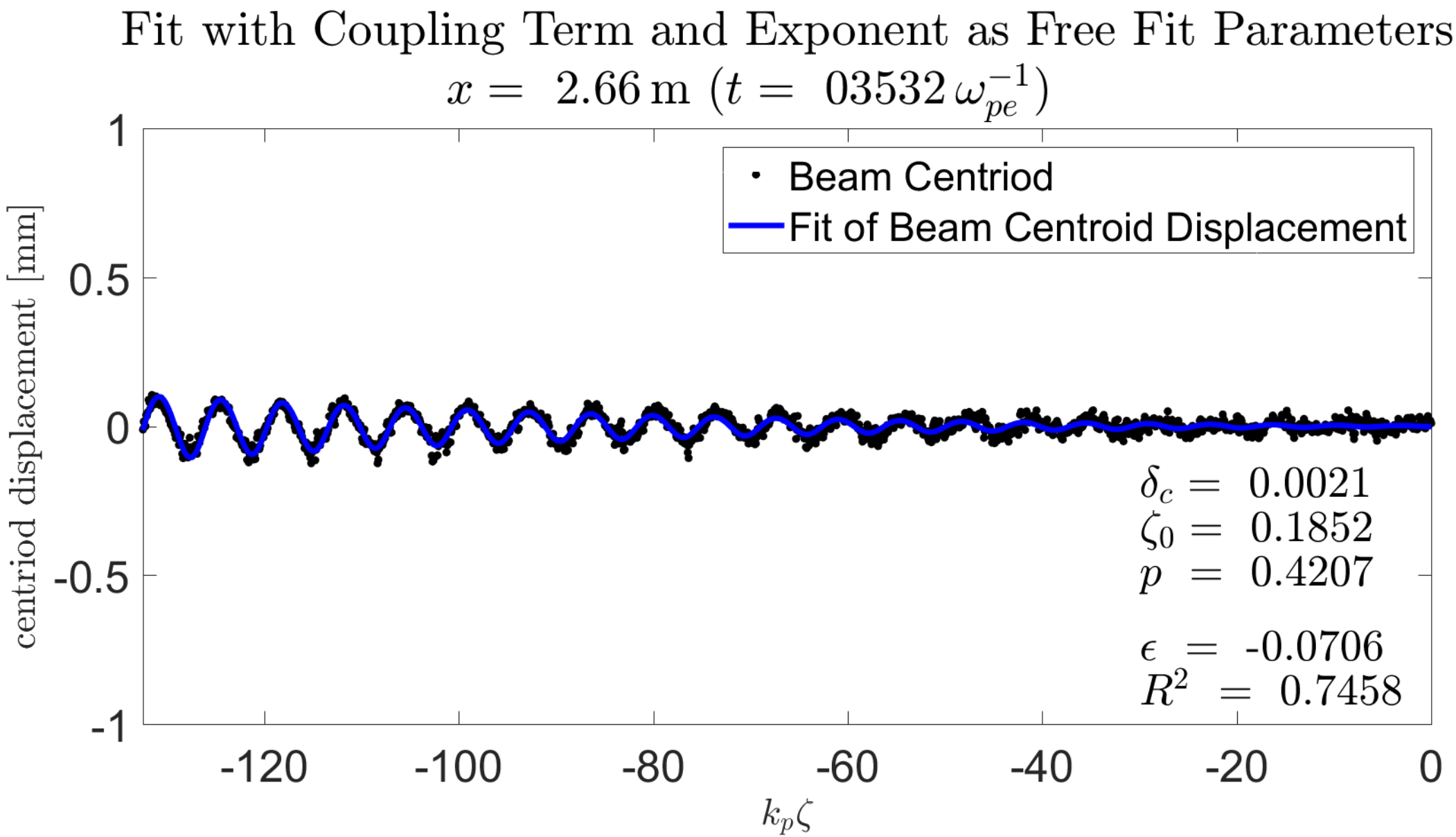
with four fit parameters:

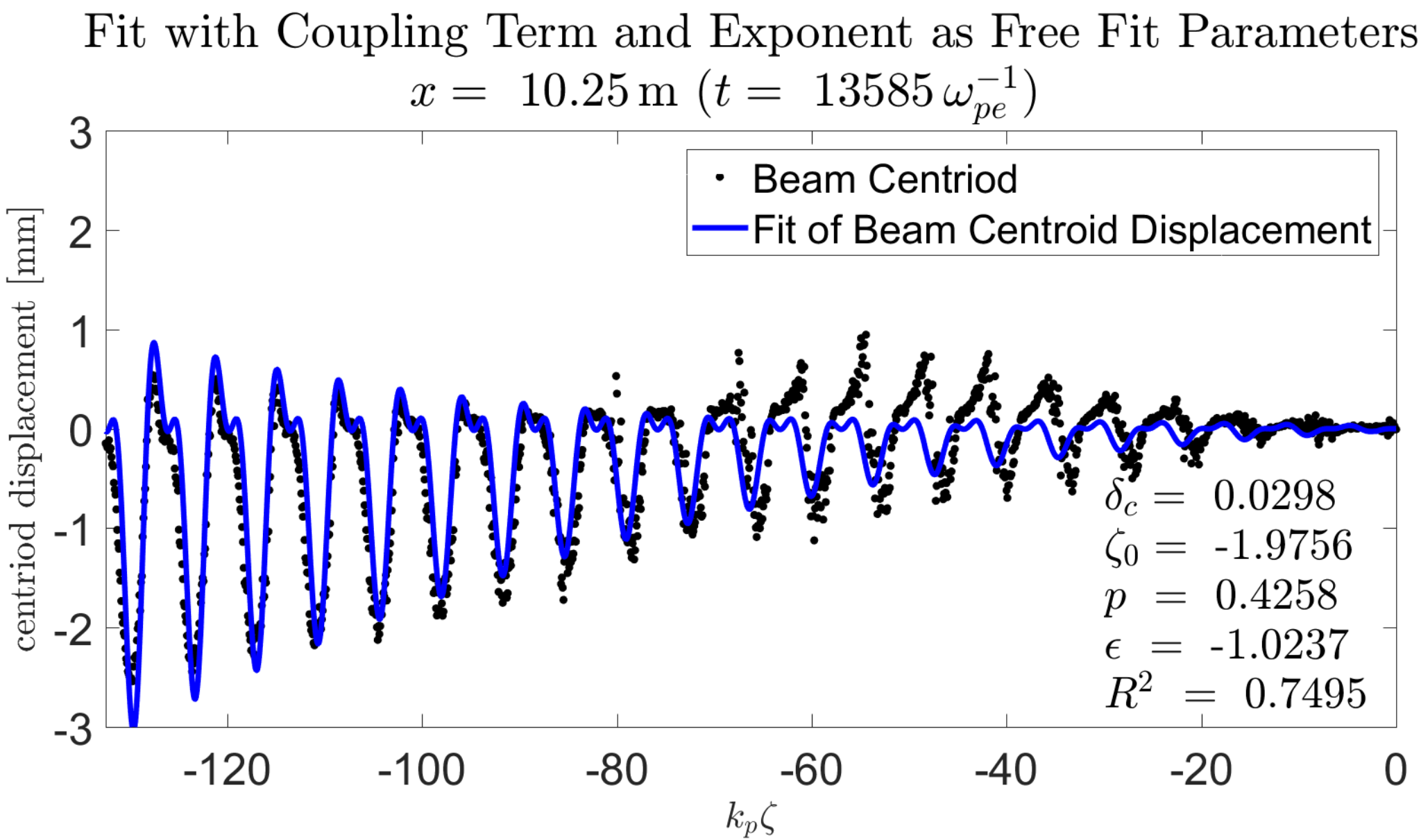
- amplitude of oscillation δ_c
- phase of oscillation ζ_0
- coupling constant ϵ
- exponent of e-foldings p

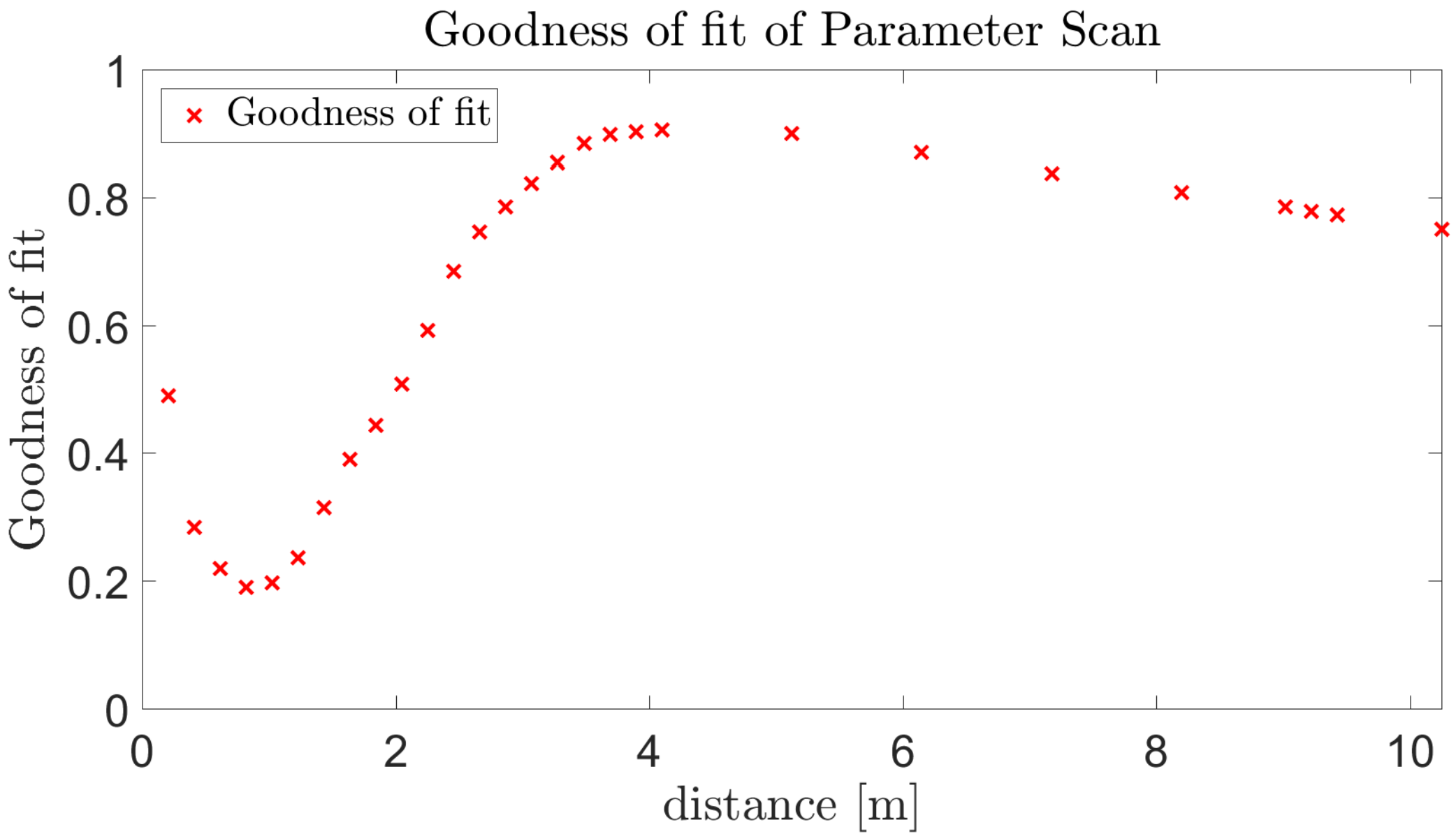
➢ from Mariana: 50 proton charge files for different dumps between 0.21m and 10.25m along the plasma

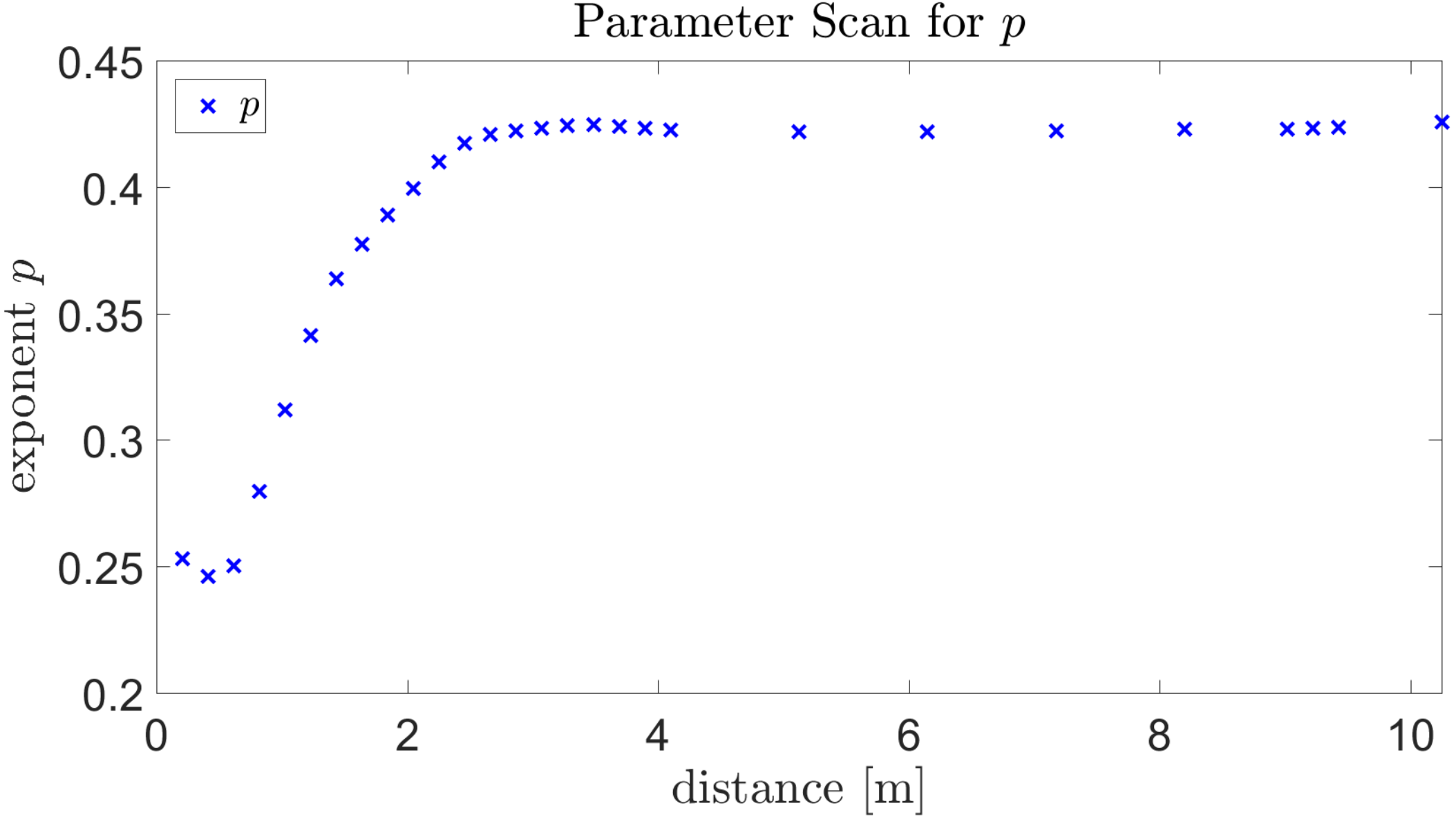

Fit with Coupling Term and Exponent as Free Fit Parameters
$x = 0.21\,\mathrm{m}\ (t = 00272\,\omega_{pe}^{-1})$
Beam Centriod
Fit of Beam Centroid Displacement
$\delta_c = 0.0033$
$\zeta_0 = 0.7921$
$p = 0.2530$
$\epsilon = -0.0011$
$R^2 = 0.4893$
centriod displacement [mm]
0.2
0.1
0
-0.1
-0.2
-120
-100
-80
-60
-40
-20
0
$k_p\zeta$

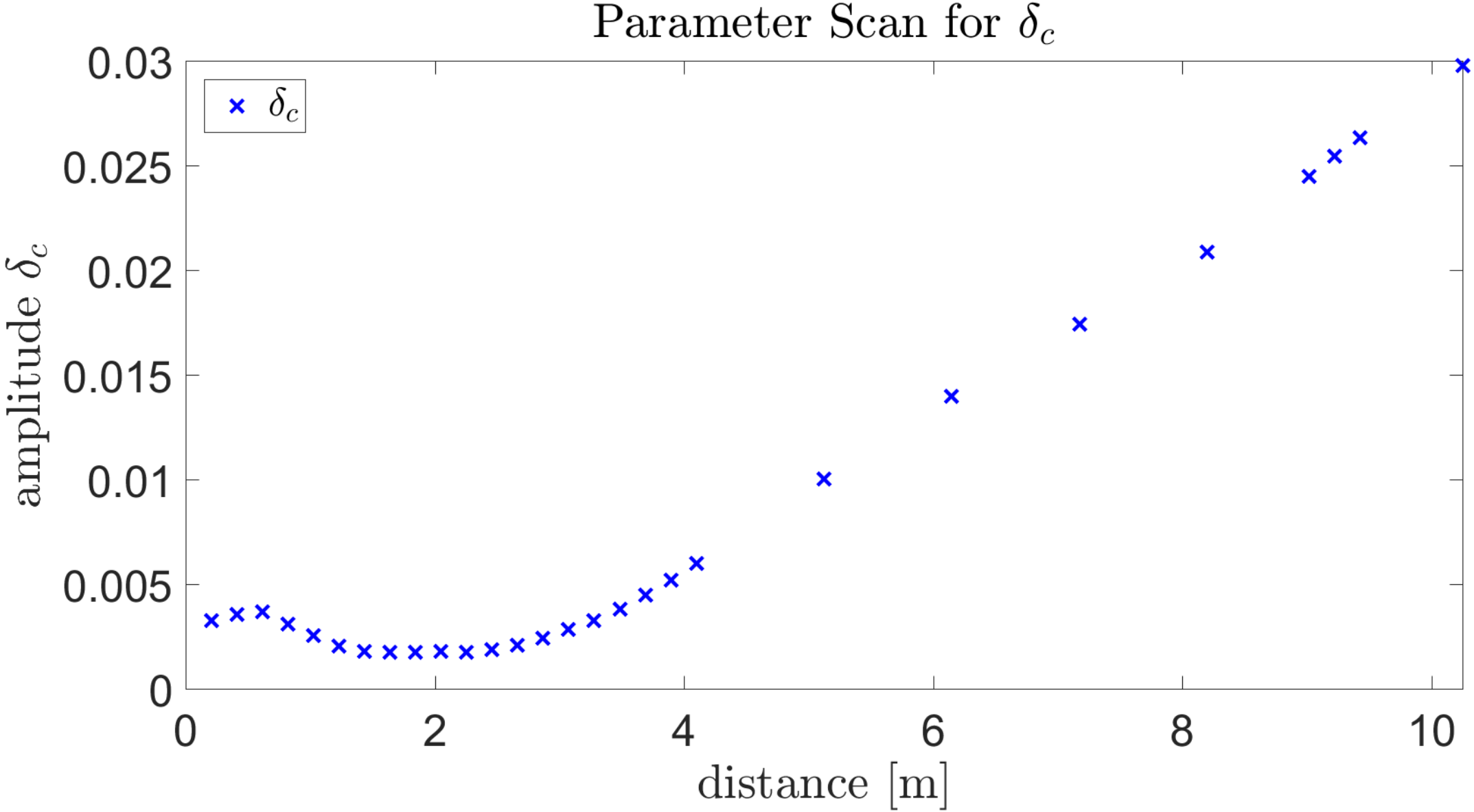

Fit with Coupling Term and Exponent as Free Fit Parameters
$x = 1.23\,\mathrm{m}\ (t = 01630\,\omega_{pe}^{-1})$
Beam Centriod
Fit of Beam Centroid Displacement
$\delta_c = 0.0020$
$\zeta_0 = 0.5550$
$p = 0.3414$
$\epsilon = 0.1374$
$R^2 = 0.2359$
centriod displacement [mm]
0.2
0.1
0
-0.1
-0.2
-120
-100
-80
-60
-40
-20
0
$k_p\zeta$

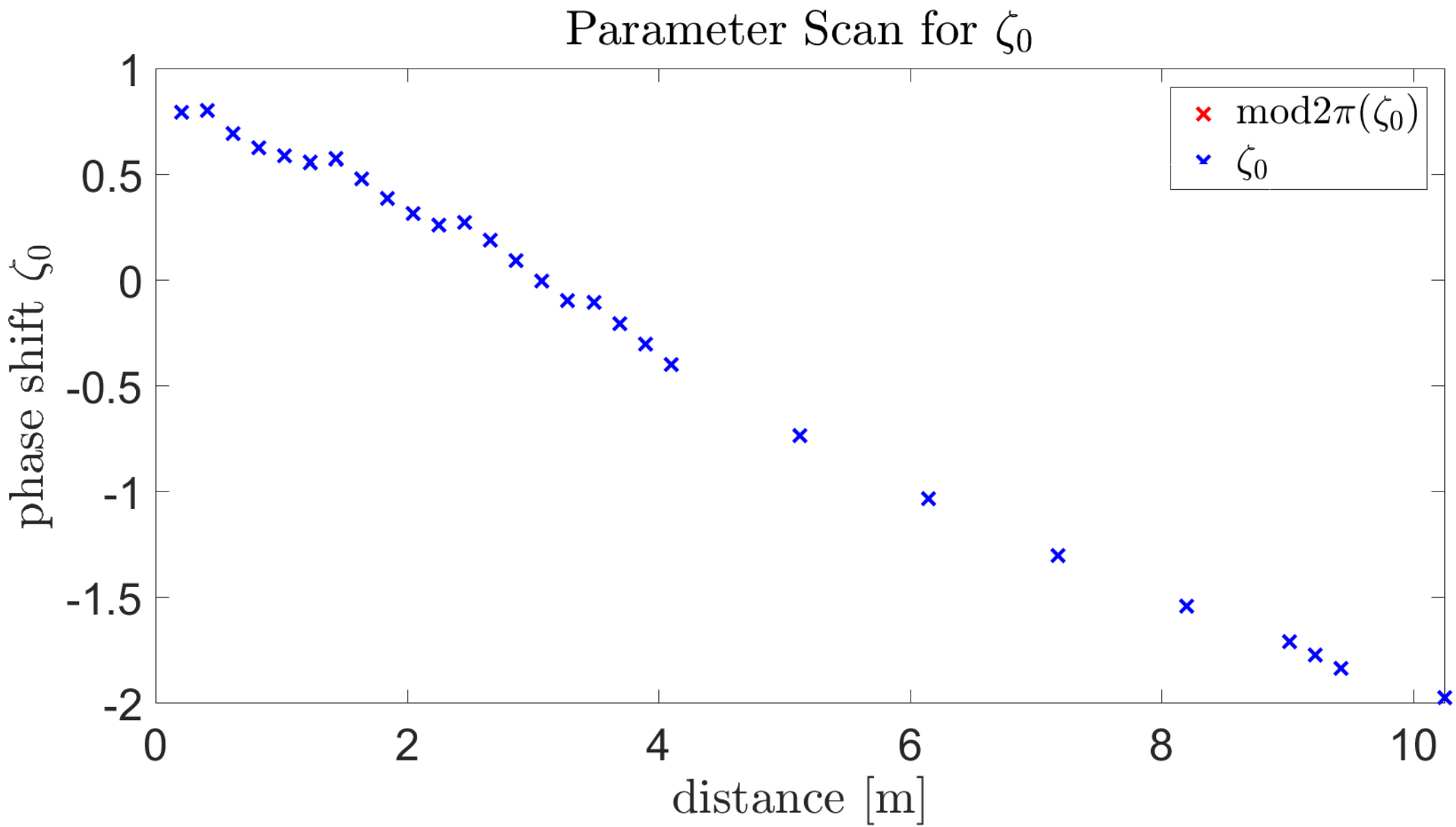

Fit with Coupling Term and Exponent as Free Fit Parameters
$x = 2.66\,\mathrm{m}\ (t = 03532\,\omega_{pe}^{-1})$
Beam Centriod
Fit of Beam Centroid Displacement
$\delta_c = 0.0021$
$\zeta_0 = 0.1852$
$p = 0.4207$
$\epsilon = -0.0706$
$R^2 = 0.7458$
centriod displacement [mm]
1
0.5
0
-0.5
-1
-120
-100
-80
-60
-40
-20
0
$k_p\zeta$

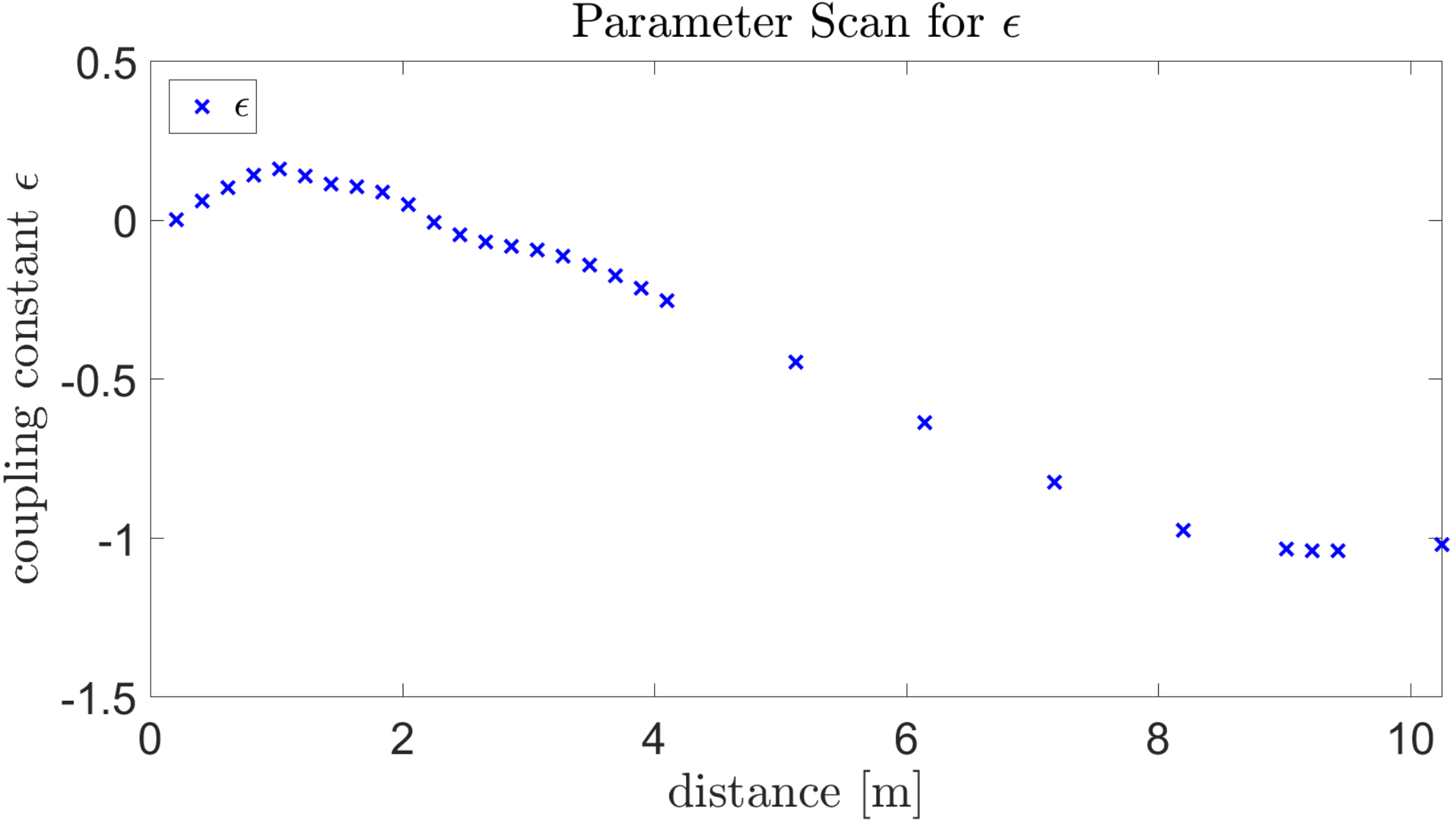

Fit with Coupling Term and Exponent as Free Fit Parameters
$x = \ 10.25\,\mathrm{m}\ (t = \ 13585\,\omega_{pe}^{-1})$
Beam Centriod
Fit of Beam Centroid Displacement
$\delta_c = \ 0.0298$
$\zeta_0 = \ -1.9756$
$p \ = \ 0.4258$
$\epsilon \ = \ -1.0237$
$R^2 \ = \ 0.7495$
centriod displacement [mm]
3
2
1
0
-1
-2
-3
-120
-100
-80
-60
-40
-20
0
$k_p\zeta$


Goodness of fit of Parameter Scan
Goodness of fit
Goodness of fit
distance [m]
0
0.2
0.4
0.6
0.8
1
0
2
4
6
8
10


Parameter Scan for p
p
exponent p
0.45
0.4
0.35
0.3
0.25
0.2
0
2
4
6
8
10
distance [m]

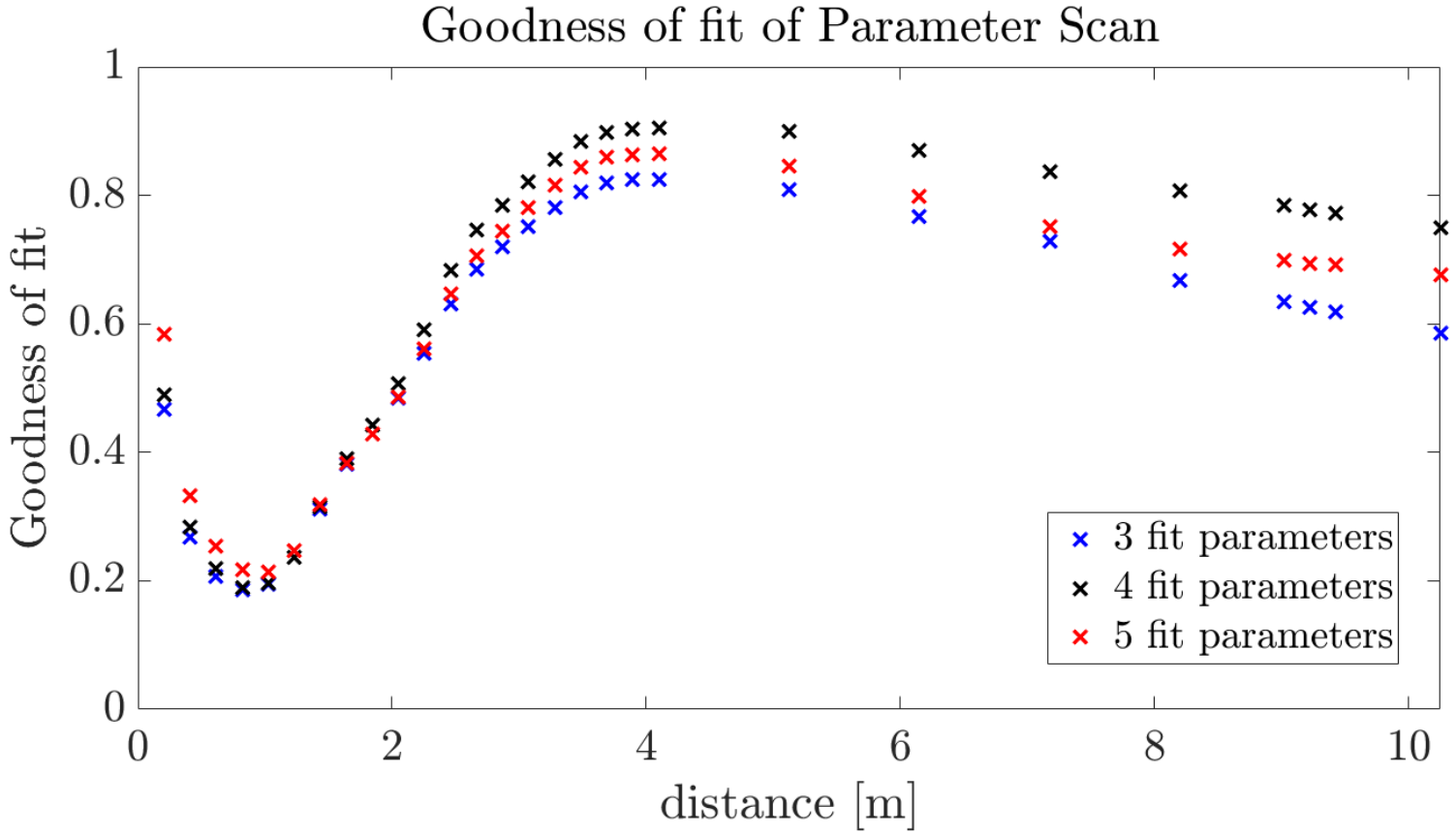

Parameter Scan for δ_c
δ_c
amplitude δ_c
distance [m]
0.03
0.025
0.02
0.015
0.01
0.005
0
0
2
4
6
8
10


Parameter Scan for ζ_0
mod2$\pi(\zeta_0)$
ζ_0
phase shift ζ_0
distance [m]
1
0.5
0
-0.5
-1
-1.5
-2
0
2
4
6
8
10


Parameter Scan for ϵ
ϵ
coupling constant ϵ
0.5
0
-0.5
-1
-1.5
0
2
4
6
8
10
distance [m]

Adding Second Term to Coupling Term

- Replace coupling term $\left[1 + \varepsilon \cdot \sin\left(k_{pe}\xi\right)\right]$ by higher order term $\left[1 + \varepsilon_1 \cdot \sin\left(k_{pe}\xi\right) + \varepsilon_2 \cdot \sin^2\left(k_{pe}\xi\right)\right]$
- No significant change to fits and fit stability even decreases!

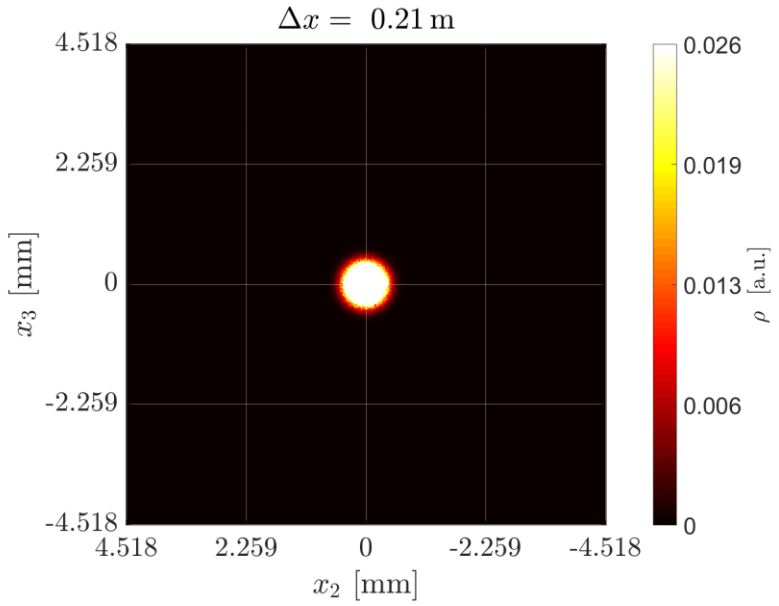


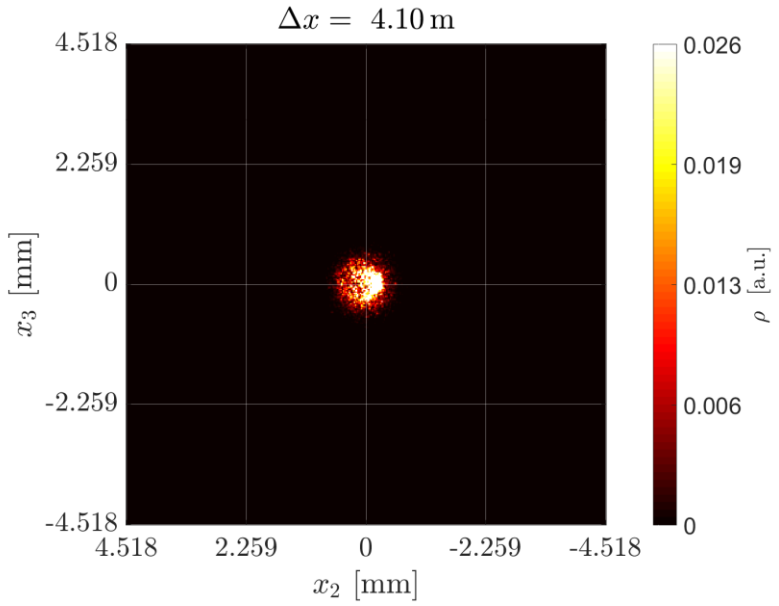
Next Steps

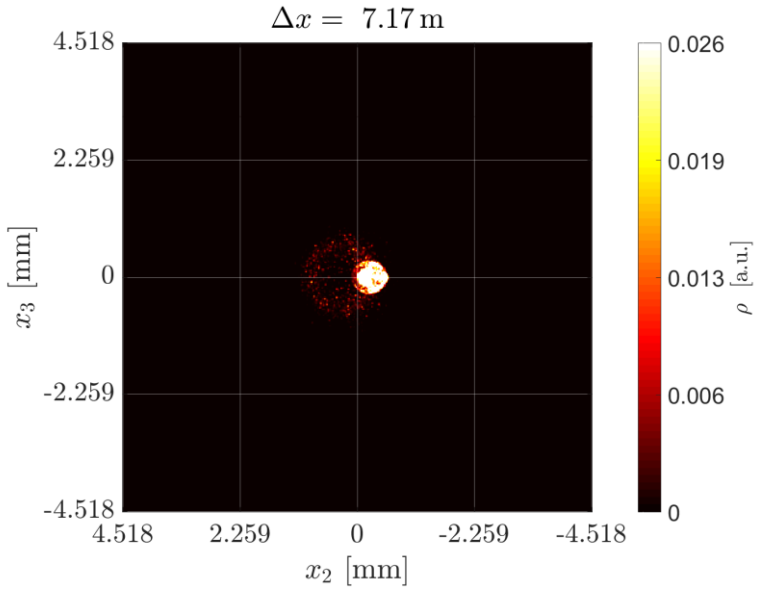
- Mariana will run the simulation again and dump all macro-particles to be able to get the centroid directly from the simulation
- hopefully this will reduce the noise on the centroids!

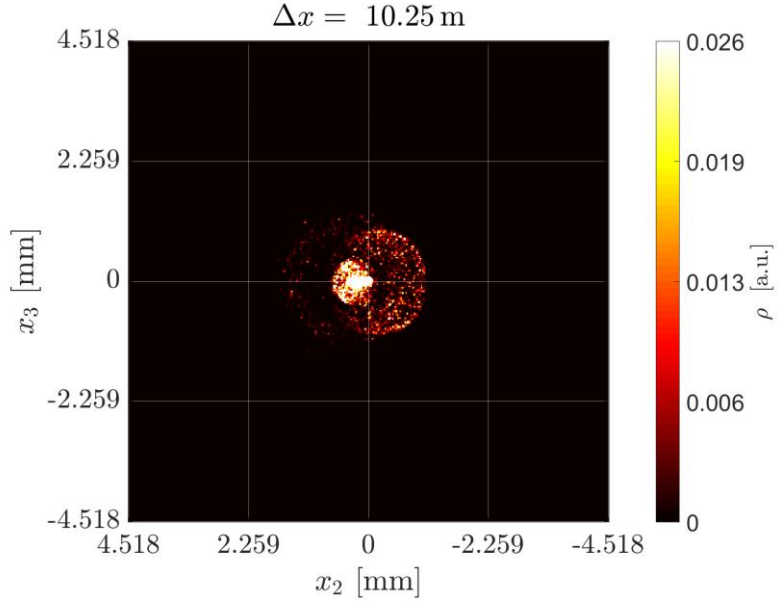
- do the fits again and see whether somethings changes

Cuts through x_2x_3-plane in Simulation









Sum over x_2x_3-plane in Simulation