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A Method for Measuring Plasma Position in TJ-I Tokamak

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Abstract: A method using pairs of Mirnov coils to measure the plasma position in TJ-I is presented. The simple toroidal filament model which neglects the effect of plasma current density profile is proved to be acceptable within experimental accuracy. The effect of plasma current density profile remains to be small, if the plasma current density profile has a quadratic form.

1. Introduction

TJ-I is a tokamak with a rectangular cross-section of vacuum vessel (19x25 cm^2). The method using the sine-cosine coils[1-2] to measure the plasma displacements, which has been commonly used in circular tokamaks, is not applicable here. To measure the plasma displacements in a rectangular tokamak, the technique of using the modified Rogowski-saddle coils has been proposed[3-4]. But those continuous coils are quite big in size, it is very difficult to install them at TJ-I device which has an uneasy access between the vacuum vessel and the main toroidal-field coils, due to its compact structure of the main toroidal-field-coils.

Here we present a method using the so-called Mirnov coils[5] to measure the plasma displacements in TJ-I. This simple method has been used extensively. The advantage to use these small and discrete coils is that they can be installed inside the vacuum vessel behind the limiters, as they have already been done for measuring the magnetic fluctuations in TJ-I. The main difference here is those coils used to measure the plasma horizontal displacement cannot be located in the equatorial plane of device, therefore, the measurement of horizontal displacement in TJ-I becomes more complicated than in other devices.

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2. Principle of measurement

We assume that the plasma current centre in TJ-I has both horizontal and vertical displacements characterized by $\Delta_{\|}$ and $\Delta_{\perp}$, respectively, as shown in Fig.1. The coordinate systems used below include the cylindrical coordinates (r, φ, z) on the torus, the planar coordinates (x, y) on the cross-section of vacuum vessel and the local polar coordinates (ρ, θ) on the poloidal cross-section of plasma column, see Fig.1. Their basic relations are as follows:

$$r = R_0 + x, \qquad z = y,$$
$$x = \Delta_{\|} + \rho\cos\theta, \qquad y = \Delta_{\perp} + \rho\sin\theta. \tag{1}$$

where R_0=30cm is the major radius of TJ-I, and the plasma current centre is supposed to be at ρ=0.

It needs at least four coils (in two pairs) to evaluate both plasma vertical and horizontal displacements by measuring the external magnetic field produced by the plasma current at four different points. The positions of these four coils are indicated in Fig.1 by the numbers 1-4, their x-y coordinates are: $(x_1, y_1)=(-A, D)$, $(x_2, y_2)=(0, D)$, $(x_3, y_3)=(A, D)$ and $(x_4, y_4)=(0, -D)$, A and D are the geometric constants (see Fig.1). The pair of coil-1 and coil-3 is used to estimate the plasma horizontal displacement, while the pair of coil-2 and coil-4 is used to estimate the plasma vertical displacement.

Below, we will first discuss a toroidal filament model in which the plasma current density profile is considered like a δ-function. The effect of plasma current density profile on the measurements will be considered later.

2.1. Cylindrical geometry

First we consider, in cylindrical geometry, an infinitive straight-line current I_0 flowing through the x-y plane at the point: $(x, y)=(\Delta_x, \Delta_y)$. The magnetic field produced by this straight-line current at any given point (x_i, y_i) is as follows:

$$B_i = \frac{\mu_0 I_0}{2\pi\, d_i}$$

$$d_i = \left[(y_i - \Delta_y)^2 + (x_i - \Delta_x)^2\right]^{\frac{1}{2}} \tag{2}$$

where d_i is the distance between the given point (x_i, y_i) and the straight-line current I_0, μ_0 is the magnetic conductivity. The radial component of this magnetic field B_i is:

$$B_{ri} = \frac{\mu_0 I_0}{2\pi\, d_i} \frac{(y_i - \Delta_y)}{d_i} \tag{3}$$

All the coils are supposed to be installed in such a way that they pick up only the radial components of local magnetic fields. Therefore, after integration, the signals of these coils can be expressed by:

$$S_i = k_i B_{ri} = k_i \frac{\mu_0 I_0}{2\pi} \frac{(y_i - \Delta_y)}{d_i^2}, \quad i = 1,2,3,4. \tag{4}$$

where k_i are the constants proportional to the effective areas of magnetic coils, their values are equal for the identical coils. For notational flexibility, we normalize all the integrated signals of coils by the factor $(k_i \mu_0 I_0 / 2\pi)$ in the following.

The vertical displacement Δ_y can be derived from the signals of S_2 and S_4, their absolute values are given by:

$$S_2 = \frac{D - \Delta_y}{(D - \Delta_y)^2 + \Delta_x^2}$$

$$S_4 = \frac{D + \Delta_y}{(D + \Delta_y)^2 + \Delta_x^2} \tag{5}$$

Here the coordinates $(x_2, y_2)=(0, D)$ and $(x_4, y_4)=(0, -D)$ have been used. To the first order of the ratios $\Delta_x/D<<1$ and $\Delta_y/D<<1$, we can get the following two approximate formulas:

$$S_2 \approx \frac{1}{D-\Delta_y} \approx \frac{1}{D}(1+\frac{\Delta_y}{D})$$

$$S_4 \approx \frac{1}{D+\Delta_y} \approx \frac{1}{D}(1-\frac{\Delta_y}{D}) \qquad (6)$$

Their sum and the difference between them are:

$$S_2 + S_4 = 2/D$$

$$S_2 - S_4 = 2\Delta_y / D^2 \qquad (7)$$

Dividing the second formula by the first one in Eq.(7), we obtain the following relation:

$$\frac{S_2 - S_4}{S_2 + S_4} = \frac{\Delta_y}{D} \qquad (8a)$$

or

$$\Delta_y = D\,\frac{S_2 - S_4}{S_2 + S_4} \qquad (8b)$$

Similarly, the horizontal displacement Δ_x can be evaluated from the signals S_1 and S_3 of the other two coils at the points $(x_1, y_1) = (-A, D)$ and $(x_3, y_3) = (A, D)$, their values are given by:

$$S_1 = \frac{D-\Delta_y}{(D-\Delta_y)^2 + (A+\Delta_x)^2}$$

$$S_3 = \frac{D-\Delta_y}{(D-\Delta_y)^2 + (A-\Delta_x)^2} \qquad (9)$$

For $\Delta_x/D<<1$, $\Delta_y/D<<1$ and $A/D<<1$, we have approximately:

$$S_1 \approx \frac{1}{D-\Delta_y}\left(1-\frac{(A+\Delta_x)^2}{(D-\Delta_y)^2}\right)$$

$$S_3 \approx \frac{1}{D-\Delta_y}\left(1-\frac{(A-\Delta_x)^2}{(D-\Delta_y)^2}\right) \tag{10}$$

their sum and difference are:

$$S_3+S_1 \approx \frac{2}{D-\Delta_y}\left(1-\frac{A^2+\Delta_x^2}{(D-\Delta_y)^2}\right) \approx \frac{2}{D-\Delta_y}$$

$$S_3-S_1 \approx \frac{2}{D-\Delta_y}\frac{2A\Delta_x}{(D-\Delta_y)^2} \tag{11}$$

Therefore, we have the relation:

$$\frac{S_3-S_1}{S_3+S_1} = \frac{2A\Delta_x}{D^2} \tag{12a}$$

or

$$\Delta_x = \frac{D^2}{2A}\,\frac{S_3-S_1}{S_3+S_1} \tag{12b}$$

The relationships between the displacements (Δ_x, Δ_y) and the magnetic field signals S_i (i=1,2,3,4) of a straight-line current, given by Eq.(8) and Eq.(12), are basic relations for evaluating the plasma displacements in a tokamak device, in fact they are the zeroth order ($R_0 \to \infty$) approximations to the case of a toroidal filament current with a finite value of R_0.

2.2. The toroidal filament model

A toroidal filament which carries a current equal to the plasma current is a simple approximation to a tokamak plasma, which just neglects the effect of plasma current density profile. We assume that this toroidal filament has the same horizontal displacement $\Delta_{\parallel}$ and vertical displacement $\Delta_{\perp}$ from the centre of vacuum vessel as the plasma current centre has. In this case, the integrated signals of magnetic coils are proportional to the radial components of local magnetic field produced by this toroidal filament current, which we indicate with V_i (i=1,2,3,4) below. We will see that the displacements $\Delta_{\parallel}$ and $\Delta_{\perp}$ can be derived from the magnetic field signals V_i.

According to Eq.(8b) and Eq.(12b), we can define the following two parameters D_y and D_x with the signals V_i (i=1,2,3,4):

$$D_y \equiv D \frac{V_2 - V_4}{V_2 + V_4} \tag{13}$$

$$D_x \equiv \frac{D^2}{2A} \frac{V_3 - V_1}{V_3 + V_1} \tag{14}$$

These two parameters are considered as the zeroth order approximations ($R_0 \to \infty$) to the toroidal filament displacements $\Delta_{\perp}$ and $\Delta_{\parallel}$, respectively. The displacements $\Delta_{\perp}$ and $\Delta_{\parallel}$ can be then derived from the expansions in D_y and D_x as follows:

$$\Delta_{\perp} = \alpha_0 + \alpha_1 D_y + \alpha_2 D_y^2 + \alpha_3 D_y^3 + \cdots, \tag{15}$$

$$\Delta_{\parallel} = \beta_0 + \beta_1 D_x + \beta_2 D_x^2 + \beta_3 D_x^3 + \cdots, \tag{16}$$

where the coefficients α_i and β_i are determined by the numerical simulations, they are generally the functions of $\Delta_{\parallel}$ and $\Delta_{\perp}$: $\alpha_i = \alpha_i(\Delta_{\parallel})$ and $\beta_i = \beta_i(\Delta_{\perp})$.

As shown in Fig.2, if there is a toroidal filament with a radius a_f carrying a current I_p, the magnetic field produced by this current at the point P(r, 0, z) is given by:

$$\begin{aligned} b_r &= \frac{\mu_0 I_p}{2\pi} \frac{(z/r)}{\sqrt{(a_f + r)^2 + z^2}} \left(-K + \frac{a_f^2 + r^2 + z^2}{(a_f - r)^2 + z^2} E \right) \\ b_z &= \frac{\mu_0 I_p}{2\pi} \frac{1}{\sqrt{(a_f + r)^2 + z^2}} \left(K + \frac{a_f^2 - r^2 - z^2}{(a_f - r)^2 + z^2} E \right) \end{aligned} \tag{17}$$

where K and E are the complete elliptic integrals of the first and second kinds, defined by the following expressions:

$$K(k) = \int_0^{\pi/2} \frac{d\theta}{\sqrt{(1 - k^2 \sin^2\theta)}}$$

$$E(k) = \int_0^{\pi/2} \sqrt{(1 - k^2 \sin^2\theta)}\, d\theta \qquad (18)$$

$$k \equiv \sqrt{4 a_f r / [(a_f + r)^2 + z^2]}$$

Thus, through Eq.(17) and Eq.(18), we can calculate numerically the magnetic field signal V_i at any given point, which is proportional to the local value of b_r.

The steps to determine the coefficients $\alpha_i(\Delta_{\parallel})$ and $\beta_i(\Delta_{\perp})$ are as follows:

(a) for the given displacements $\Delta_{\parallel}$ and $\Delta_{\perp}$ of the toroidal filament current, we calculate the magnetic-field signals V_i at the given points through Eq.(17) and Eq.(18);

(b) use the magnetic-field signals V_i obtained in the step (a) to calculate the corresponding values of D_y and D_x defined by Eq.(13) and Eq.(14);

(c) repeating the above two steps for other values of $\Delta_{\parallel}$ and $\Delta_{\perp}$, we can obtain the relationship $\Delta_{\perp}$~D_y depending on the value of $\Delta_{\parallel}$, and the relationship $\Delta_{\parallel}$~D_x depending on the value of $\Delta_{\perp}$, respectively;

(d) taking the power series form to fit the relation curves obtained above, the coefficients $\alpha_i(\Delta_{\parallel})$ and $\beta_i(\Delta_{\perp})$ can be finally determined.

Note that in the process of numerical simulations, there are two cylindrical coordinate systems being used: one is fixed on the torus as shown in Fig.1, in which the position of toroidal filament current is given by: $r = R_0 + \Delta_{\parallel}$, $z = \Delta_{\perp}$, with the relation $a_f = R_0 + \Delta_{\parallel}$; another as shown in Fig.2 is used to calculate the distribution of magnetic field, which moves by the amount $\Delta_{\perp}$ along the z-axis of the fixed one, and the z-coordinates of magnetic coils change as the vertical displacement $\Delta_{\perp}$ varies, i.e., $z_i = \pm D + \Delta_{\perp}$.

The relationships $D_y \sim \Delta_\perp$ obtained by numerical simulations for D=11cm are shown in Fig.3, as the horizontal displacement $\Delta_\parallel$ varies within ±3cm. It is seen that all the relation curves obtained are almost linear and symmetrical about the zero point. This means that among all the coefficients α_i, only α_1 is dominant, others keep to be very small. By applying a three-order (i.e., $i=0,1,2,3$) polynomial curve-fit routine (with an accuracy at least 0.999) to the relation curves $\Delta_\perp \sim D_y$ obtained reversely from those in Fig.3, we obtain the coefficients α_i shown in Fig.4 as the functions of $\Delta_\parallel$, where the coefficients α_0 and α_2 are not plotted out, due to their too small values ($\sim 10^{-6}$). In Fig.4 we see, the coefficient α_1 reaches order unity, while α_3 is on the order of 10^{-3}, which is also ignorable for small displacements.

The values of coefficients α_i are very weakly dependant on the location distance D. For D=10cm and D=12cm, the value of α_1 changes within ±4% from that in Fig.4, others remain to be ignorable small.

In Fig.5 are shown the relationships between D_x and $\Delta_\parallel$ obtained for D=11cm and A=2cm, as the vertical displacement $\Delta_\perp$ changes within ±3cm. Here we see that all the relation curves are nonlinear and asymmetrical about the zero point. Asymmetry is the nature of toroidal geometry with a finite radius R_0, while the nonlinearity is mainly caused by the unfavoured locations of magnetic coils, they are not in the equatorial plane of device. The coefficients β_i ($i=0,1,2,3$) obtained from Fig.5 are shown in Fig.6, as the functions of vertical displacement $\Delta_\perp$. It is seen from the Fig.6 that both coefficients β_0 and β_1 are on the order of unity, and the other two coefficients β_2 and β_3 are smaller by two orders. Note that the coefficient β_0 is in unit of cm, it represents the effect of toroidal geometry on measurements of horizontal displacement.

The coefficients β_i also depend on the separated distance (=2A, see Fig.1) between two coils. Generally, the values of β_i increase with the distance A, as shown in Fig.7(a)-Fig.7(d) for some values of $\Delta_\perp$=0cm, ±3cm.

When we apply the formulas in Eq.(15) and Eq.(16) to calculate the plasma displacements $\Delta_\parallel$ and $\Delta_\perp$ from the experimental data, however, we find there is a difficulty to determine the accurate values of coefficients α_i and β_i, because both α_i and β_i are also the functions of the displacements $\Delta_{\parallel}$ and $\Delta_{\perp}$. One approach to this problem is using the time-delay method: replacing the present values $\alpha_i(t_n)$ and $\beta_i(t_n)$ with their previous ones $\alpha_i(t_{n-1})$ and $\beta_i(t_{n-1})$, provided that the time-step Δt ($=t_n-t_{n-1}$) is chosen to be small enough. The initial values $\alpha_i(t_0)$ and $\beta_i(t_0)$ are given by the assumption that the plasma has no displacements at the beginning of discharges: $\Delta_{\parallel}(t_0)=0$ and $\Delta_{\perp}(t_0)=0$, t_0 is the start time of discharges. In this case, Eq.(15) and Eq.(16) can be rewritten as:

$$\Delta_{\perp}(t_n) \approx \sum_{i=0}^{3} \alpha_i(t_{n-1}) \cdot D_y^i(t_n), \quad n = 1,2,3,\cdots, \tag{19}$$

$$\Delta_{\parallel}(t_n) \approx \sum_{i=0}^{3} \beta_i(t_{n-1}) \cdot D_x^i(t_n), \quad n = 1,2,3,\cdots, \tag{20}$$

with the initial values $\alpha_i(t_0)$ and $\beta_i(t_0)$ given by the initial conditions: $\Delta_{\parallel}(t_0)=0$ and $\Delta_{\perp}(t_0)=0$, respectively.

There is also another approach which seems more convenient for processing experimental data. In Fig.4, it can be seen that the dominate coefficient α_1 depends very weakly on the horizontal displacement $\Delta_{\parallel}$. This implies that if we take the mean value of α_1 instead of its particulars dependant on the horizontal displacement $\Delta_{\parallel}$, the relative errors may be quite small. In fact, all the relation curves in Fig.3 can be replaced by that one curve for $\Delta_{\parallel}$=2cm, with an error bar less than 8% when the horizontal displacement $\Delta_{\parallel}$ varies within ±3cm. That is:

$$\begin{gathered} \Delta_{\perp} = \Delta_{\perp}(D_y, \Delta_{\parallel} = 2\text{cm}) \cdot (1 \pm \delta), \\ \delta < 8\% \text{ for } |\Delta_{\parallel}| \leq 3\text{cm}. \end{gathered} \tag{21}$$

Therefore, with an acceptable accuracy, we can get the vertical displacement $\Delta_{\perp}$ directly from the experimental data through the following expression:

$$\Delta_{\perp} \approx 0.893\, D_y + 1.7\text{x}10^{-3} D_y^3 \tag{22}$$

where α_1=0.893 and α_3=1.7x10^{-3} are the values for $\Delta_{\parallel}$=2cm and D=11cm. In this case, the horizontal displacement $\Delta_{\parallel}$ is still given by Eq.(16) rather than Eq.(20), the coefficients β_i are determined from the approximate values of $\Delta_{\perp}$ obtained through Eq.(22).

2.3. Effect of current density profile

To consider the effect of plasma current density profile, we assume that the plasma current density profile has a quadratic form as follows:

$$j(\rho) = j_0 (1 - \frac{\rho^2}{a_p^2}) \tag{23}$$

where a_p is the plasma minor radius given by: $a_p = a_l - \max\{|\Delta_{\parallel}|, |\Delta_{\perp}|\}$, a_l is the limiter radius. In this case, we can still define two parameters D_y^m and D_x^m through Eq.(13) and Eq.(14), the signals V_i are now proportional to the radial components of local magnetic field produced by the plasma current with a current density profile given by Eq.(23). Replacing D_y and D_x by D_y^m and D_x^m in Eq.(15) and Eq.(16), respectively, the plasma displacements $\Delta_{\perp}$ and $\Delta_{\parallel}$ can be then obtained with the new values of coefficients α_i and β_i given by the numerical simulations involving the current density profile.

When the current density profile Eq.(23) has been taken into account, the numerical simulations show:

(1) Corresponding to the same value of vertical displacement $\Delta_{\perp}$, we have the following relation for the range of $|\Delta_{\parallel}| < 4$cm:

$$D_y^m = D_y \cdot (1 \pm \delta_{\perp}), \quad \delta_{\perp} \leq 3\%. \tag{24}$$

where the plus and minus corresponds to the values of $\Delta_{\parallel} < 0$ and the values of $\Delta_{\parallel} > 0$, respectively, and $\delta_{\perp} \approx 0$ if $\Delta_{\parallel} = 0$. In other words, the values of coefficients α_i keep almost the same for both relationships $\Delta_{\perp} \sim D_y^m$ and $\Delta_{\perp} \sim D_y$. Thus, the effect of plasma current density profile on measurements of plasma vertical displacement is very small, the toroidal filament model is good enough here.

(2) The toroidal filament model is also acceptable to estimate the plasma horizontal displacement within the experimental errors. Although the new values of coefficients β_i obtained within the quadratic current density profile are different from those values (in Fig.6) given by the toroidal filament model, the final results on horizontal displacement $\Delta_{\parallel}$ do not change significantly. In fact, the value of horizontal displacement $\Delta_{\parallel}$ given by D_x^m (quadratic profile model) just shifts down a little from that value given by D_x (toroidal filament model). Figure 8 shows their comparison for $\Delta_{\perp}=0$ and $\Delta_{\perp}=\pm 3$cm, it is seen that the amount of down-shift is ≤ 0.2cm.

3. Discussion

The method presented here is very suitable to measure the plasma displacements in TJ-I tokamak which prevents one from using some continuous magnetic coils in it. In the case of experiments, one can improve measurements of plasma horizontal displacement by employing more pairs of magnetic coils. For example, we can add one more pair of coils at $(x_5, y_5)=(-A, -D)$ and $(x_6, y_6)=(A, -D)$, indicated by the numbers 5 & 6 in Fig.1, to check the results of horizontal displacement measurements given by the pair of coil-1 and coil-3. For this new pair of coils, all the above formulas can be used directly, the only need to change is $\beta_i(\Delta_{\perp}) \rightarrow \beta_i(-\Delta_{\perp})$ in Fig.6.

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5. Figure Captions

Fig.1 Schematic diagram of TJ-I, magnetic coils and coordinate systems.

Fig.2 A circular current loop.

Fig.3 Relationship between D_y and $\Delta_\perp$ for D=11cm, as $\Delta_\parallel$ varies within ±3cm.

Fig.4 Some coefficients $\alpha_i(\Delta_\parallel)$ obtained from Fig.3.

Fig.5 Relationship between D_x and $\Delta_\parallel$ for A=2cm and D=11cm, as $\Delta_\perp$ changes within ±3cm.

Fig.6 Coefficients $\beta_i(\Delta_\perp)$, i=0,1,2,3 obtained from Fig.5.

Fig.7 Coefficients β_i (i=0,1,2,3) versus A, the half separated distance between two coils.

Fig.8 Effect of current density profile on measurements of plasma horizontal displacement.

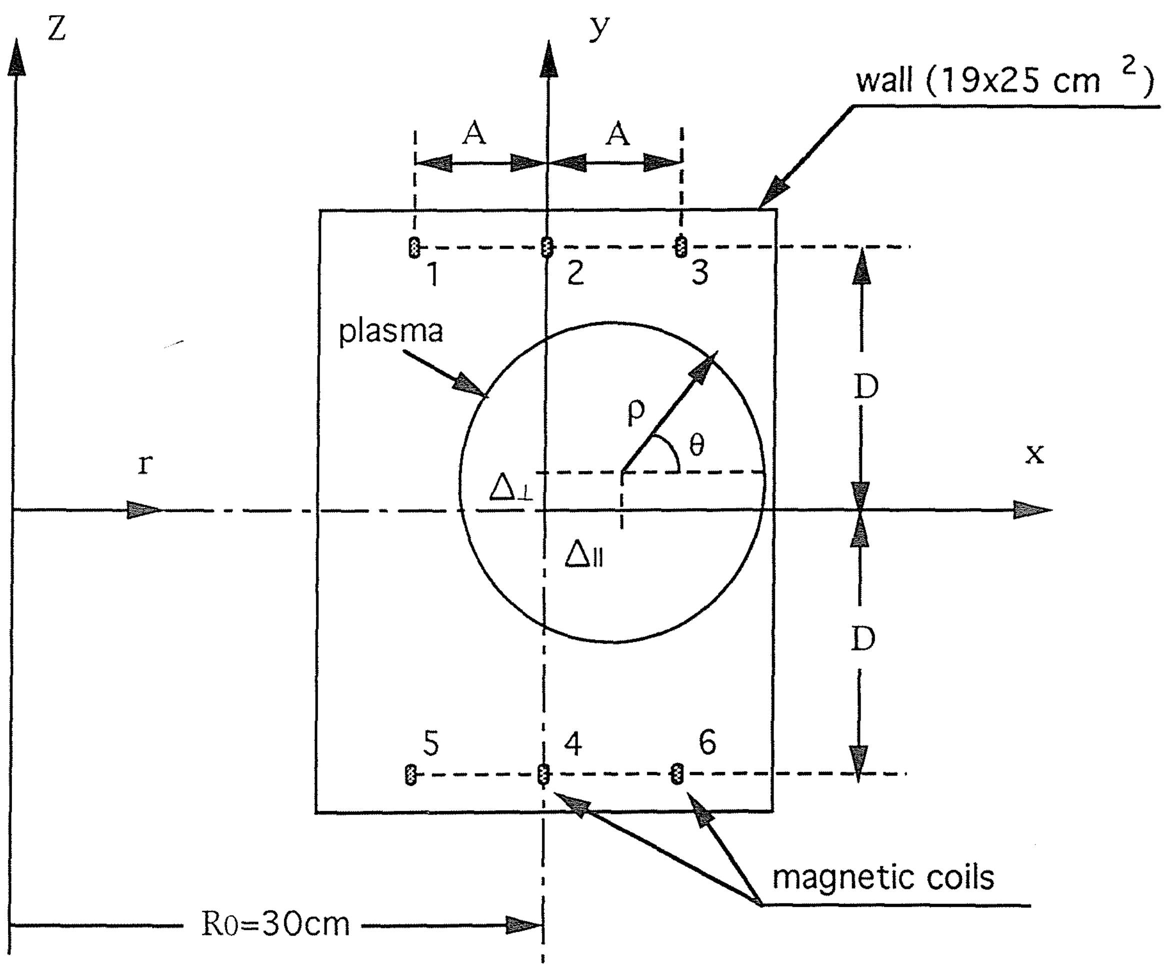

Z
y
wall (19x25 cm ^{2})
A
A
1
2
3
plasma
ρ
θ
D
x
r
Δ⊥
Δ||
D
5
4
6
magnetic coils
R0=30cm

Fig.1

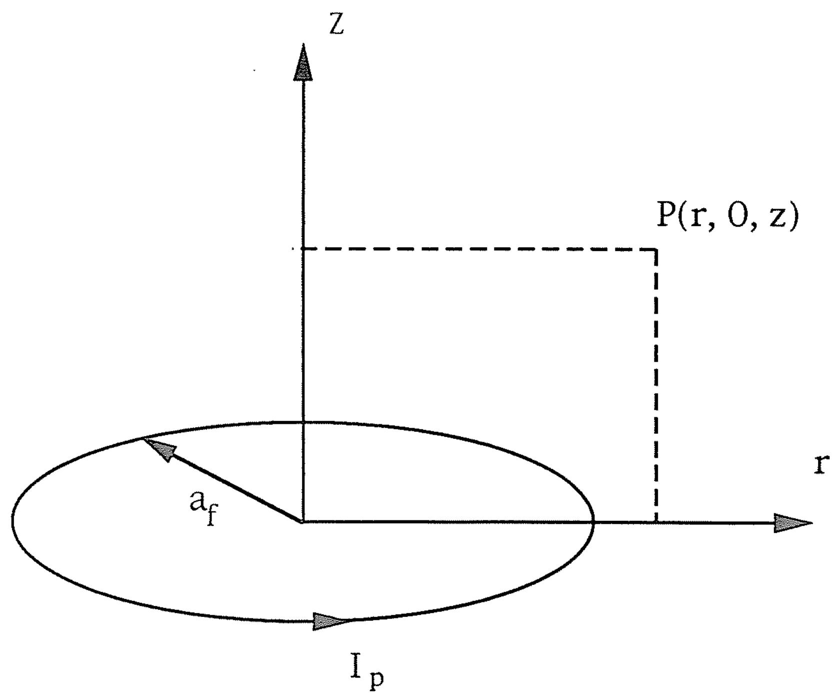
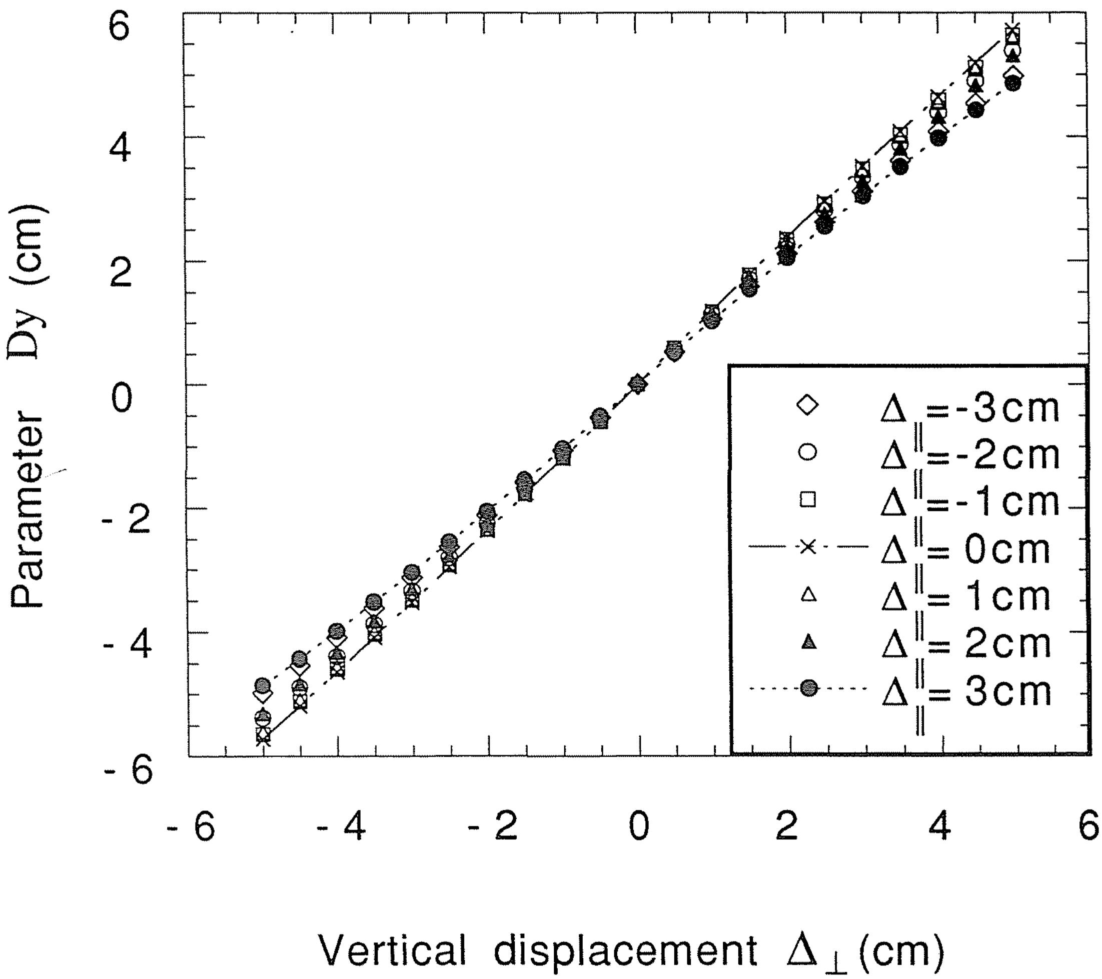
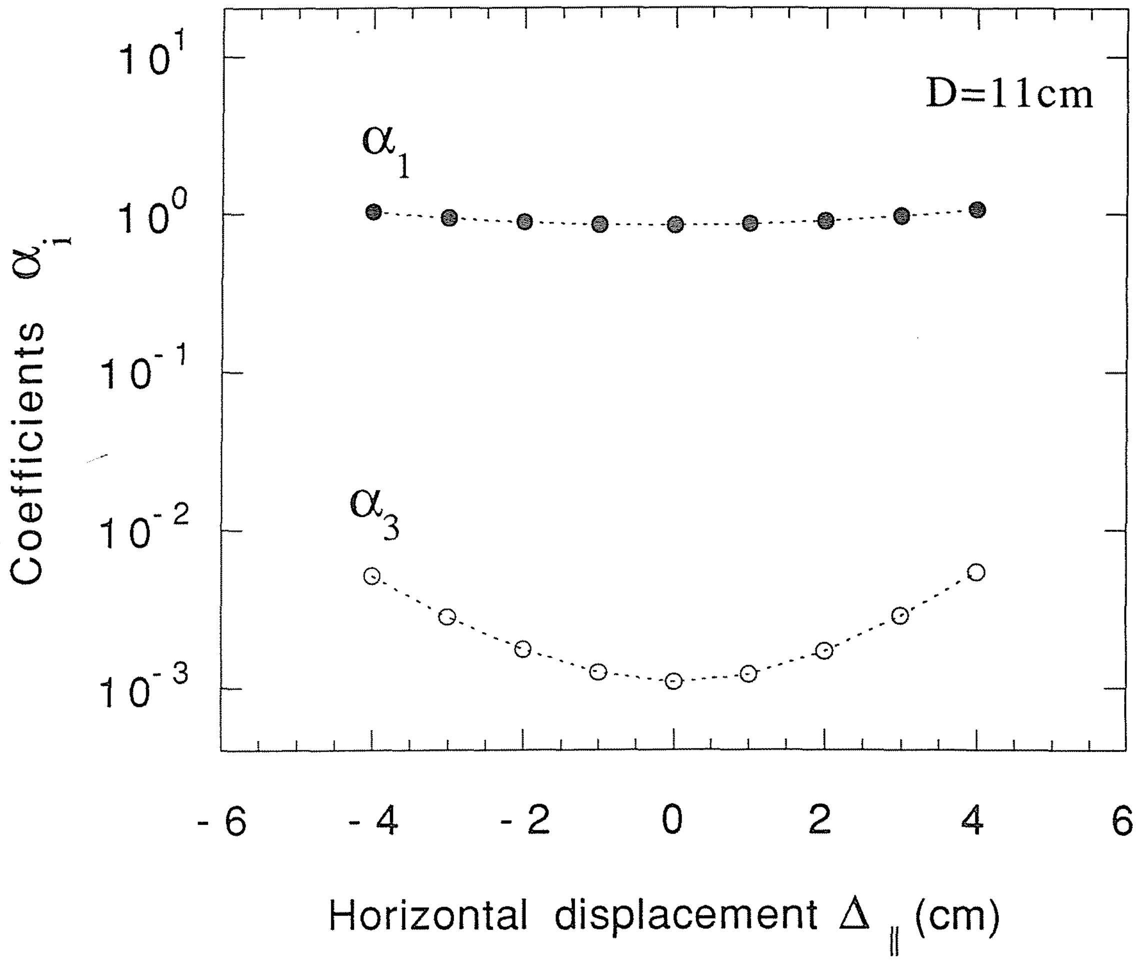


Fig.2



Parameter Dy (cm)
6
4
2
0
- 2
- 4
- 6
- 6
- 4
- 2
0
2
4
6
Vertical displacement $\Delta_\perp$ (cm)
$\Delta_\parallel$=-3cm
$\Delta_\parallel$=-2cm
$\Delta_\parallel$=-1cm
$\Delta_\parallel$= 0cm
$\Delta_\parallel$= 1cm
$\Delta_\parallel$= 2cm
$\Delta_\parallel$= 3cm

Fig.3



D=11cm
α_1
α_3
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
Coefficients α_i
-6
-4
-2
0
2
4
6
Horizontal displacement $\Delta_{\parallel}$ (cm)

Fig.4

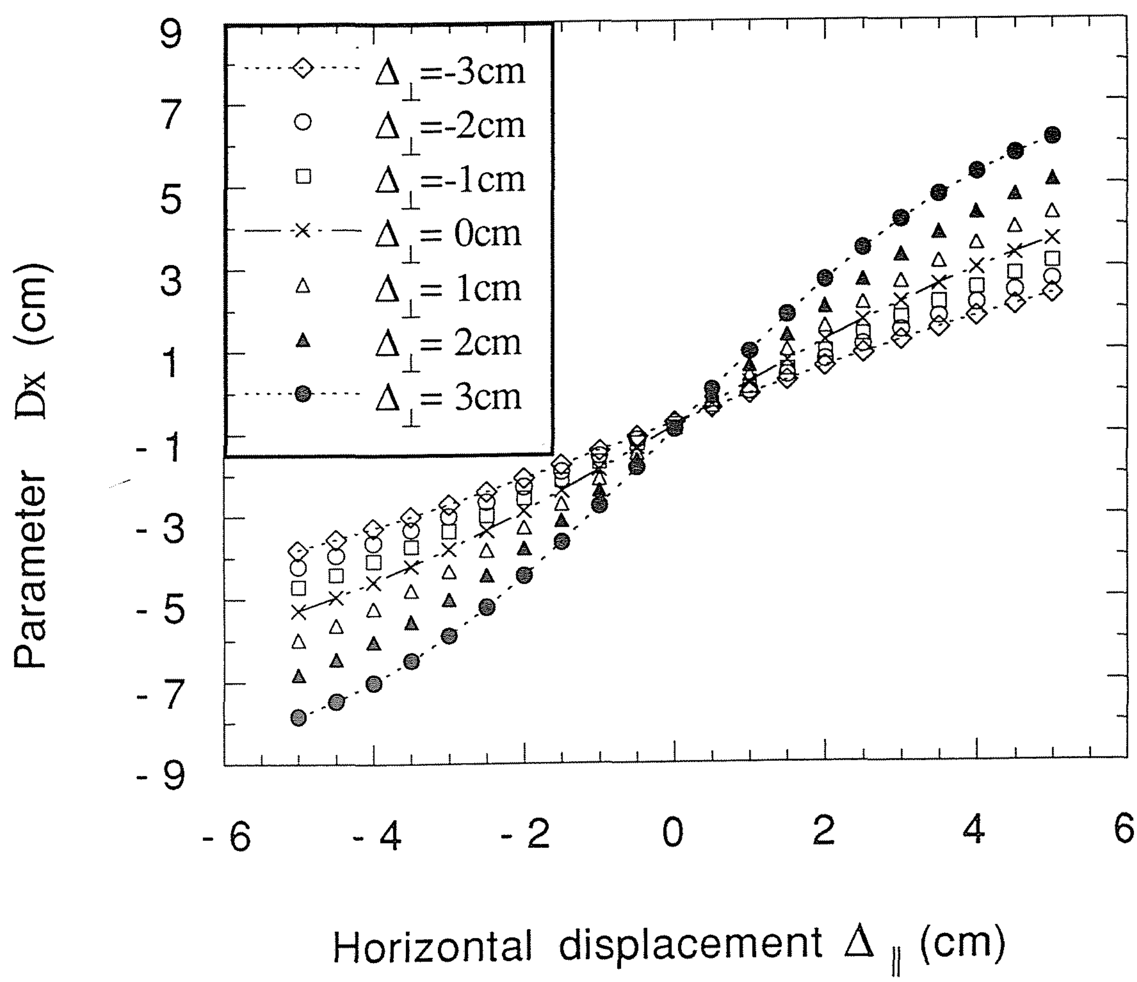
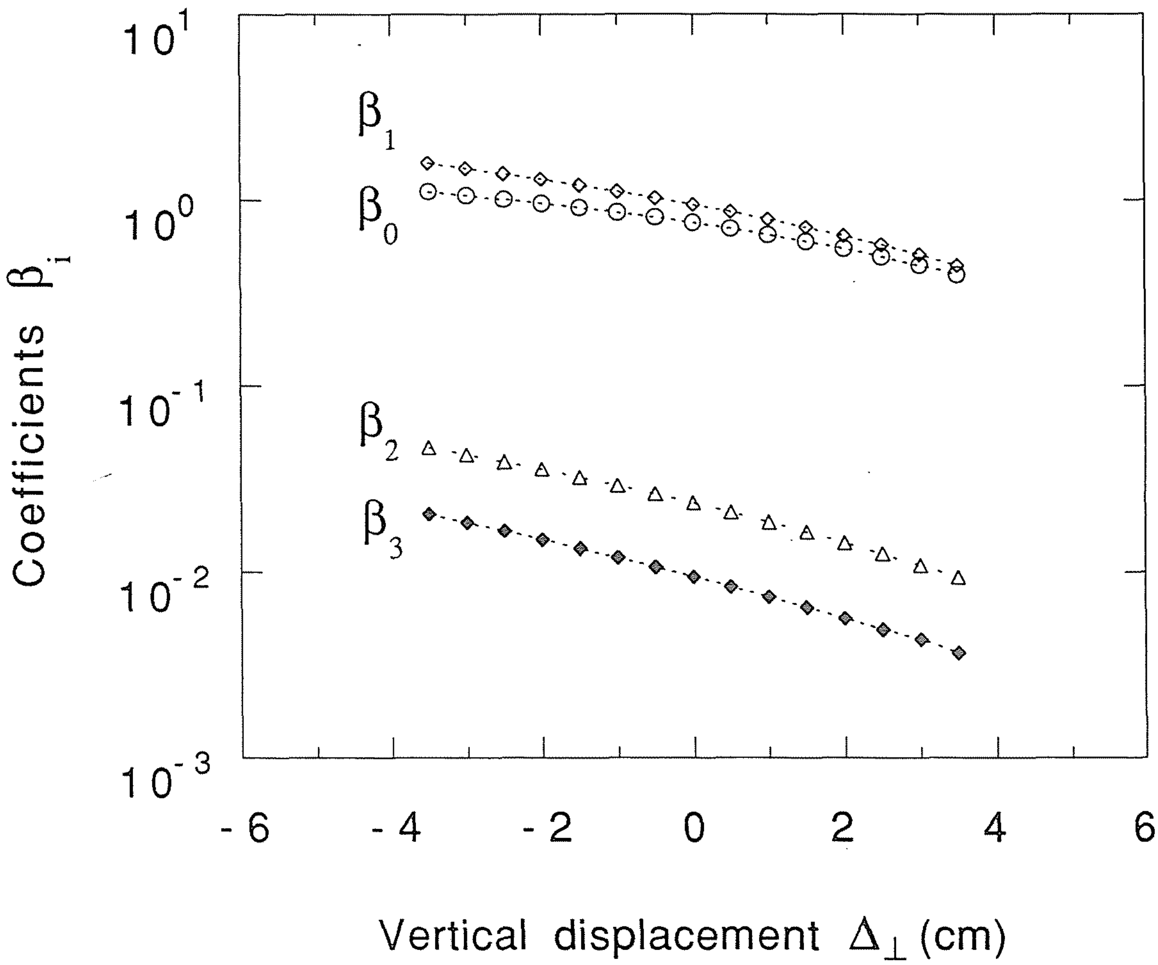
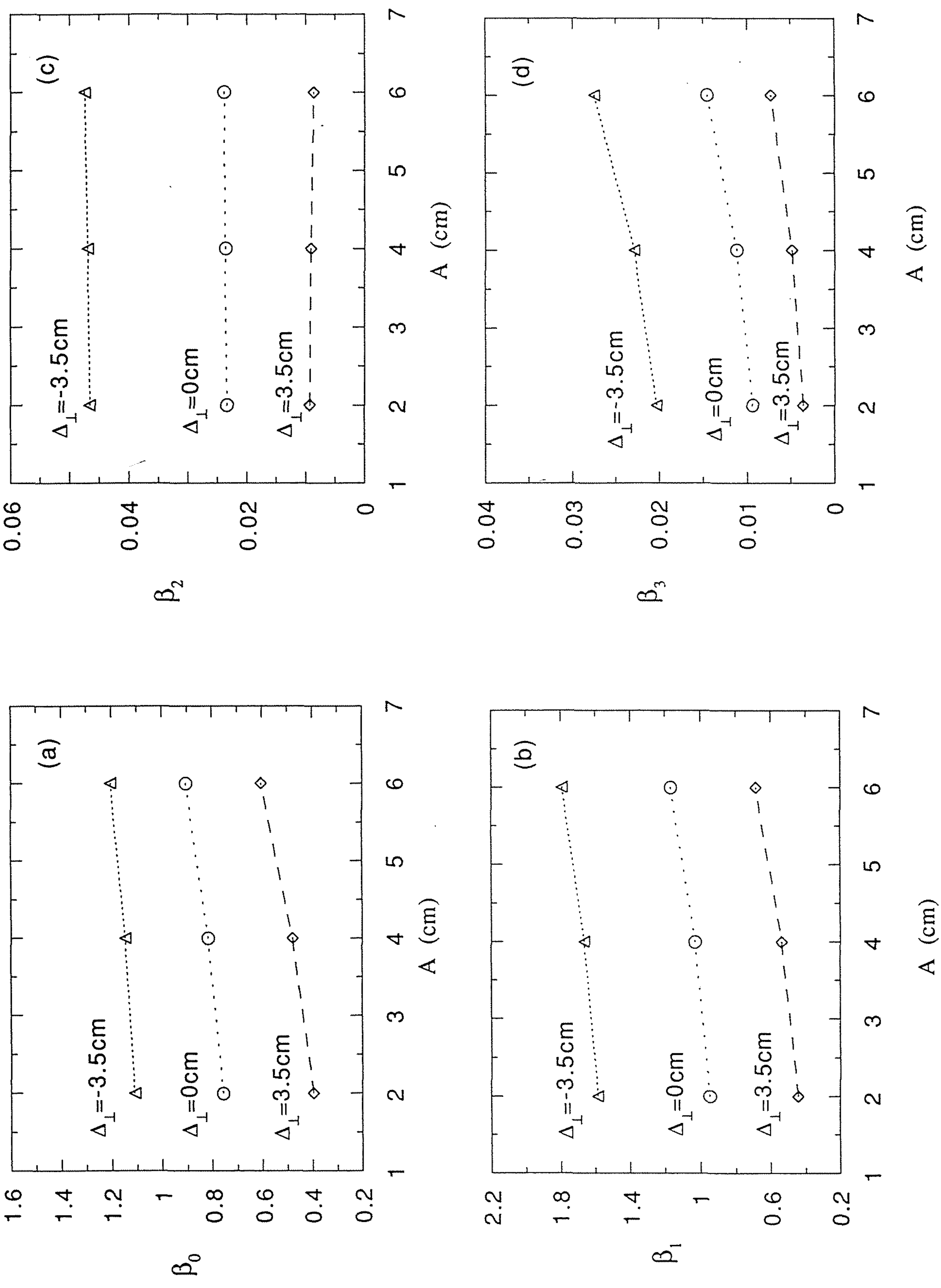

Parameter Dx (cm)
9
7
5
3
1
- 1
- 3
- 5
- 7
- 9
$\Delta_\perp$=-3cm
$\Delta_\perp$=-2cm
$\Delta_\perp$=-1cm
$\Delta_\perp$= 0cm
$\Delta_\perp$= 1cm
$\Delta_\perp$= 2cm
$\Delta_\perp$= 3cm
- 6
- 4
- 2
0
2
4
6
Horizontal displacement $\Delta_\parallel$ (cm)

Fig.5



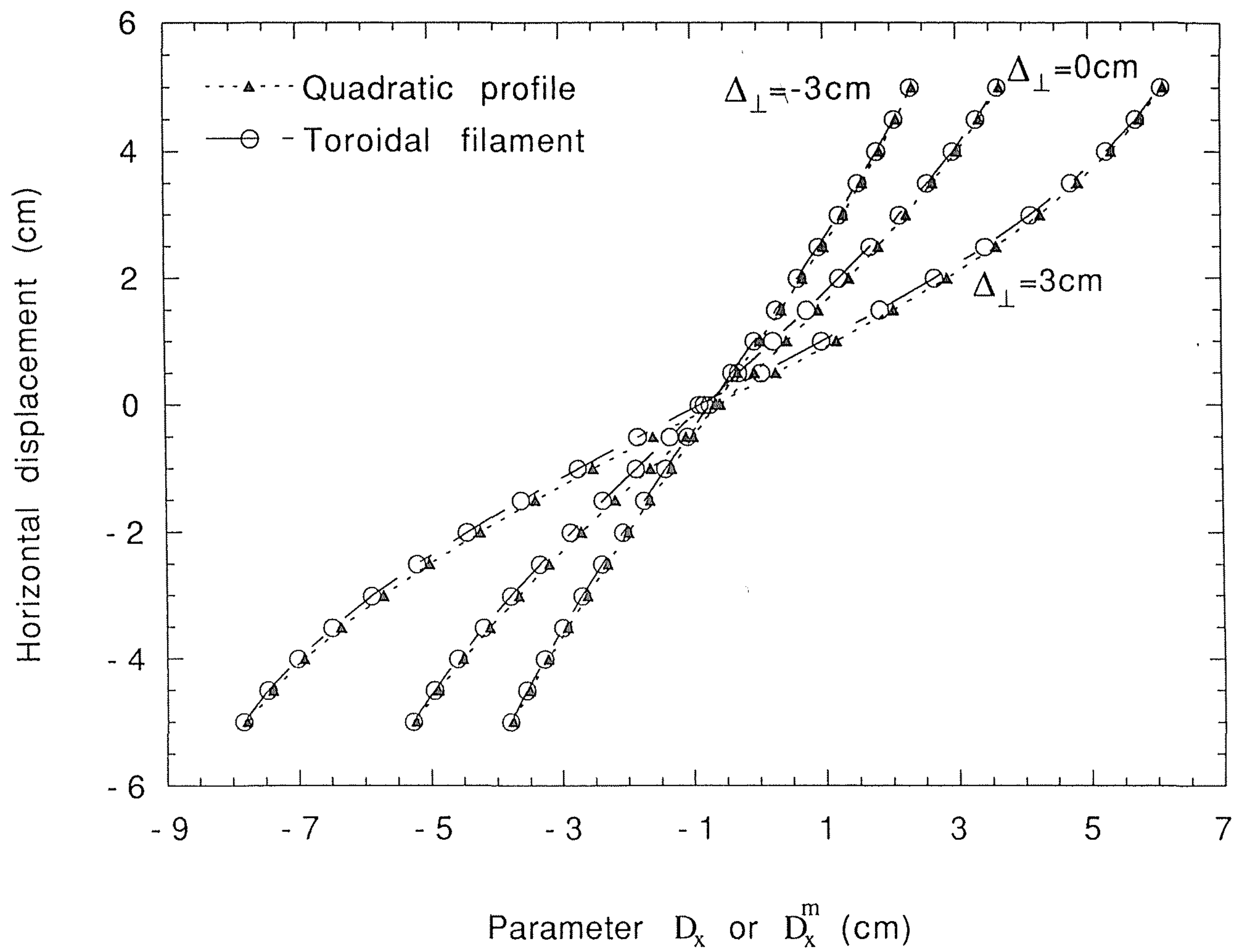
Coefficients βi
10^1
10^0
10^-1
10^-2
10^-3
β1
β0
β2
β3
-6
-4
-2
0
2
4
6
Vertical displacement Δ⊥ (cm)

Fig.6



(a)
(b)
(c)
(d)
$\Delta_\perp$=-3.5cm
$\Delta_\perp$=0cm
$\Delta_\perp$=3.5cm
β_0
β_1
β_2
β_3
A (cm)

Fig.7



Quadratic profile
Toroidal filament
$\Delta_\perp$=-3cm
$\Delta_\perp$=0cm
$\Delta_\perp$=3cm
Horizontal displacement (cm)
Parameter D_x or D_x^m (cm)

Fig.8

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Instituto de Investigación Básica.- Madrid

A METHOD FOR MEASURING PLASMA POSITION IN TJ-I TOKAMAK

J. Quin and TJ-I Team, 24 pp., 8 fig., 5 ref.

A method using pairs of Mirnov coils to measure the plasma position in TJ-I is presented. The simple toroidal filament model which neglects the effect of plasma current density profile has proven to be acceptable within the experimental accurecy. The effect of plasma current density profile remains to be small, if the plasma current density profile has a quadratic form.

DOE CLASIFICATION AND DESCRIPTORS: 700320, Tokamak devices, Plasma diagnostics, Magnet Coils, Plasma radial profiles.

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METODO PARA LA MEDIDA DE LA POSICION DEL PLASMA EN EL TOKAMAK TJ-I

J. Quin y Grupo TJ-I, 24 pp., 8 fig., 5 ref.

En este informe se presenta un método para la medida de la posición del plasma en TJ-I utilizando pares de bobinas de Mirnov. Se utiliza un modelo simplificado de filamento toroidal para la corriente, que es válido dentro del error experimental de la medida. El efecto de la distribución radial de la corriente es pequeño si los perfiles son de tipo cuadrático.

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