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Wire Positions of CJC

This note describes the way the positions for fabricating the CJC endwalls have been calculated. The input are several parameters (listed below under "Software description") which are also the basic parameter set of the software. Furthermore there are a few more parameters needed in addition to describe the hole positions for the sensewires.
This note does not cover:
- the actual positions after manufacturing the endwalls
- the positions of cathode and field wires.

1. Parameters

1.1. Software description (for each CJC)

All coordinates r, φ refer to the **nominal sense wire positions** (i.e. without staggering).

r_0	radius of first sense wire position
r_N	radius of last sense wire position
φ_0	azimuth of first sense wire position of cell 0
φ_N	azimuth of last sense wire position of cell 0
s	staggering of first sense wire
N	number of sensewires - 1 per cell
z	number of cells - 1

1.2. Mechanics parameters use in this note

r_d	radius of sense wires
r_p	radius of position hole for sense wires
Δ_d	Distance centre position hole $\leftrightarrow$ feedthrough

1.3. Parameter Values for the Jet Chambers

(Version **N** *of 27.6.88)*

	CJC1	CJC2	Unit
r_0	21.8272	54.4807	cm
r_N	42.5763	82.3208	cm
φ_0	22.8983	13.9175	° (degree)
φ_N	2.5898	1.2910	° (degree)
s	0.0150	0.0150	cm
N	23	31	
z	29	59	
r_d	0.001		cm
r_p	0.045		cm
Δ_d	0.065		cm

(Parameters given in H1 coordinates)

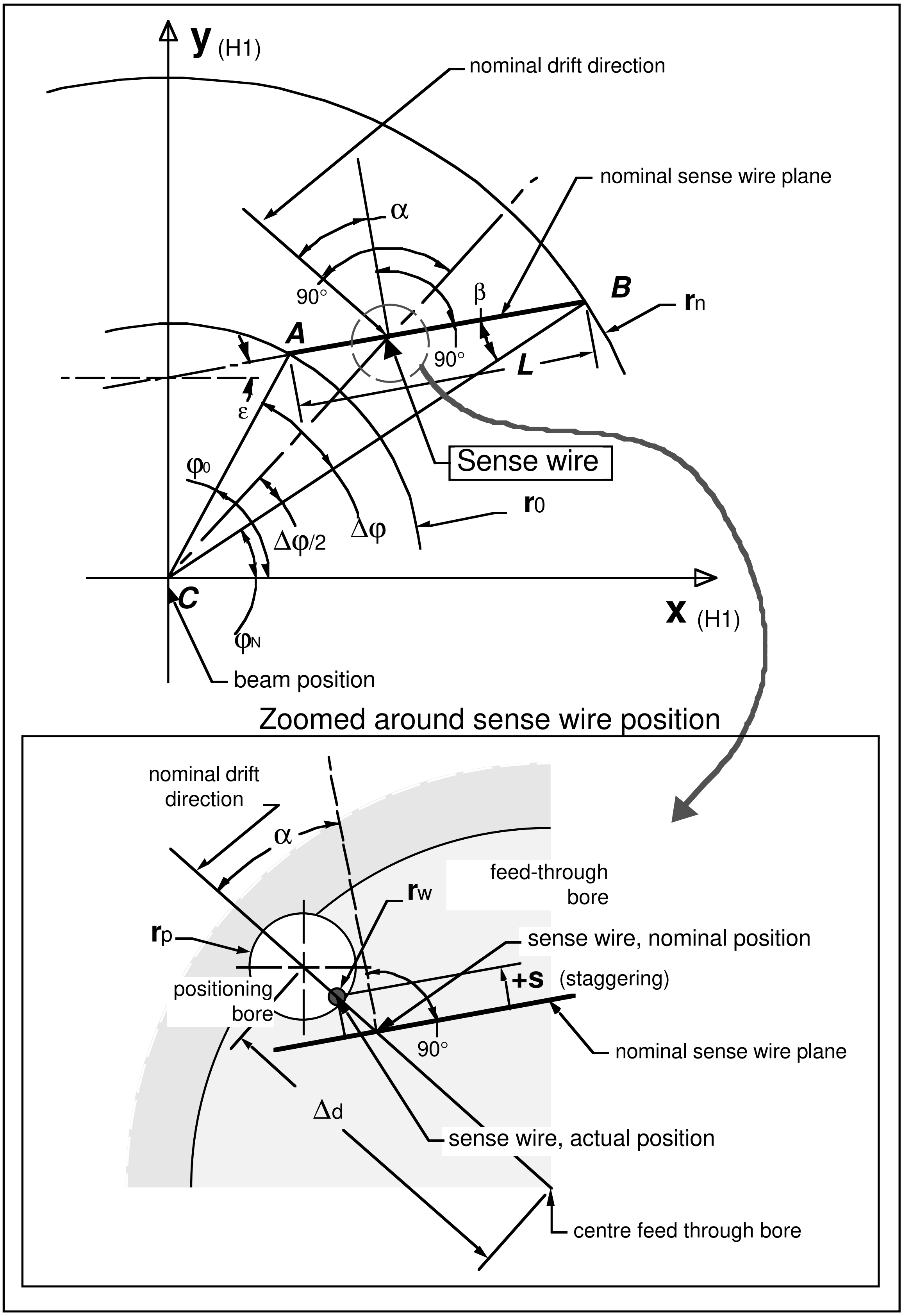

Fig. 1. Definitions of nominal and actual sense wire positions

2. General geometry description

2.1. Nominal sense wire plane

Definition: The line connecting the points *A* and *B*, with polar coordinates (r_0, φ_0) and (r_N, φ_N) resepctively, is a projection of the nominal sense wire plane. In the context of this note this line is called **nominal sense wire plane**.

The angles and lengths in the triangle formed by the nominal wire plane and the centre *C* are used to calculate the wire positions.

Central angle of nominal sense wire plane

(i.e. angle BCA):

$$\Delta\varphi = \varphi_N - \varphi_0$$

Length of sense wire plane:

$$L = \sqrt{(r_0^2 + r_N^2 - 2 r_0 r_N \cos\Delta\varphi)}$$

Note: The disign is fixed such that $L = 2 \cdot \frac{2}{10}'' \cdot N = 1.016\ \mathrm{cm} \cdot N$. This is true, given the values of the above table, within < ±0.1µm.

Angle between radius and upper end of nominal sense plane

(i.e. angle CBA)

$$\beta = \arcsin(\tfrac{r_0}{L} \sin\Delta\varphi).$$

2.2. Nominal Lorentz angle

Definitions:

The **nominal drift direction** is defined as to be normal to the half angle radius ($\Delta\varphi/2$).

The **nominal Lorentz angle** α is the angle between the nominal drift direction and the normal to the nominal sense wire plane.

$$\alpha = \tfrac{\Delta\varphi}{2} + \beta$$

Important: the nominal Lorentz angle is slightly different to the design value (30°) and is not identical for CJC1 and CJC2. Given the values of the above table one obtains numerically for CJC1 and CJC2 29.0708° and 28.5304° respectively. This is forced by the fact that the length of the nominal sense plane *L* is fixed to multiples of 2/10".

2.3. Parameters derived from mechanics of feedtrough

distance centre sensewire ↔ centre position hole

$$d_p = r_p - r_d$$

distance centre sensewire ↔ centre feedthrough hole

$$d_f = \Delta_d - r_p + r_d$$

3. Nominal position of first and last sense wires of cell *m*

$$m \in \{0, z\}$$

Nominal azimut of first ($\nu = 0$) and last ($\nu = N$) wire of cell m

$$\varphi_\nu^m = \varphi_\nu + m \cdot \frac{2\pi}{z+1}$$

Position of first (ν = 0) and last (ν = N) wire

$$\vec{r}_\nu^{\,m} = r_\nu \cdot \begin{pmatrix} \cos\varphi_\nu^m \\ \sin\varphi_\nu^m \end{pmatrix}$$

Angle of nominal sense wire plane w.r.t. x-axis:

$$\varepsilon^m = \varphi_N^m + \beta$$

4. Sensewire Positions of cell *m*

Number of wire: $n \in \{0, N\}$

Nominal sense wire position:

$$\vec{r}_n^{\,m} = \vec{r}_0^{\,m} + n\tfrac{L}{N}\begin{pmatrix} \cos\varepsilon^m \\ \sin\varepsilon^m \end{pmatrix}$$

Staggering vector:

$$\vec{s}_n^{\,m} = a_n \cdot s \cdot \begin{pmatrix} -\sin\varepsilon^m \\ \cos\varepsilon^m \end{pmatrix} \quad \text{with} \quad a_n = \begin{cases} +1 & \text{for} \quad n = 2k \\ -1 & \text{for} \quad n = 2k+1 \end{cases} \qquad \forall k \in \{0, \tfrac{N+1}{2}\}$$

Actual sense wire position (i.e. with staggering):

$$\vec{p}_n^{\,m} = \vec{r}_n^{\,m} + \vec{s}_n^{\,m}$$

Note: The fact that the first and last sense wires are thicker than the others is not taken into account

Position of centre of positioning hole

$$\vec{p}_{P\,n}^{\,m} = \vec{p}_n^{\,m} + a_n d_p \begin{pmatrix} -\sin(\varepsilon^m - \alpha) \\ \cos(\varepsilon^m - \alpha) \end{pmatrix}$$

Position of centre of feedthrough hole for sense wires

$$\vec{p}_{F\,n}^{\,m} = \vec{p}_n^{\,m} - a_n d_f \begin{pmatrix} -\sin(\varepsilon^m - \alpha) \\ \cos(\varepsilon^m - \alpha) \end{pmatrix}.$$

5. Potential wires

There are four potential wires around each sense wire forming a square with the length $2\Lambda = \frac{L}{N}$ (i.e. distance between two nominal sense wire positions) and the centre at the position of the nominal sense wire position. The distance Λ is fixed to be 2/10" = 0.508 cm. The position of the potential wire is identiacal with the centre of the feedtrouh bore.

Number of potential wire: $k \in \{0, 2N+3\}$
Hence the total number of potential wires per cell is $K = 2N + 4$.

Position of potential wire k of cell m:

$$\vec{p}_{pot\ k}^{\ m} = \vec{r}_0^{\ m} + (n-1) \cdot \frac{L}{2N} \begin{pmatrix} \cos \varepsilon^m \\ \sin \varepsilon^m \end{pmatrix} + b_k \cdot \frac{L}{2N} \begin{pmatrix} -\sin \varepsilon^m \\ \cos \varepsilon^m \end{pmatrix}$$

with

$$b_k = \begin{cases} +1 & \text{for} \quad k = 2n \\ -1 & \text{for} \quad k = 2n-1 \end{cases} \qquad \forall n \in \{0, N+2\}$$
