Segment Angles of the GSI-Clover Detector

A.) Transformation of a polar coordinate system from the target position to a flat detector

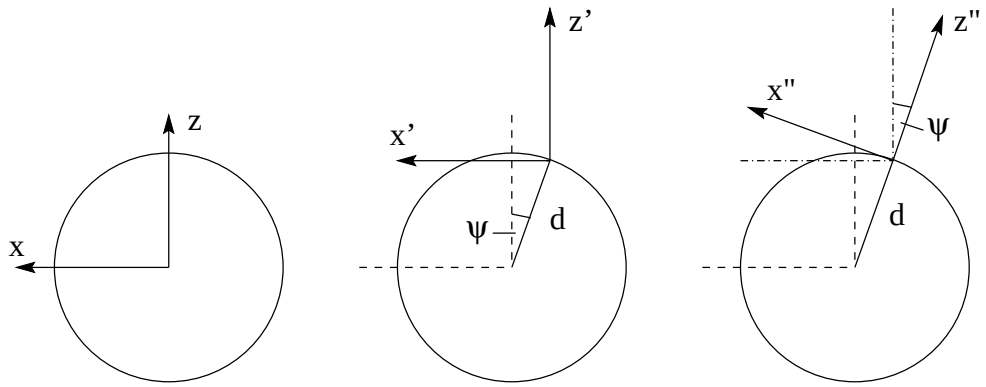

Figure 1: Left: polar coordinate system in target or source position (y-axis points out of plane); center: coordinate system moved in detector position (d=distance between detector and target, $\Psi = -20^0$); right: coordinate system rotated around the y-axis ($\Psi = -20^0$) to measure events from the target.

1.) Polar coordinate system with its origin in target position (y-axis points upwards)

$$x = r * \sin\vartheta * \cos\varphi \quad (1)$$
$$y = r * \sin\vartheta * \sin\varphi \quad (2)$$
$$z = r * \cos\vartheta \quad (3)$$

2.) The origin of the coordinate system is shifted to detector surface (d = distance from detector surface to target position, Ψ-angle is negative for the displayed example in fig.1)

$$x' = x - d * \sin\Psi \quad (4)$$
$$y' = y \quad (5)$$
$$z' = z - d * \cos\Psi \quad (6)$$

3.) The coordinate system is rotated around y-axis (Ψ-angle is negative for the displayed example in fig.1)

$$x'' = x' * \cos\Psi - z' * \sin\Psi \quad (7)$$
$$y'' = y' \quad (8)$$
$$z'' = x' * \sin\Psi + z' * \cos\Psi \quad (9)$$

Boundary condition: $z'' = 0$ for flat detector surface

$$\begin{aligned} z'' = 0 &= (x - d * \sin\Psi) * \sin\Psi + (z - d * \cos\Psi) * \cos\Psi && (10)\\ &= x * \sin\Psi + z * \cos\Psi - d && (11)\\ &= r * \sin\vartheta * \cos\varphi * \sin\Psi + r * \cos\vartheta * \cos\Psi - d && (12) \end{aligned}$$

$$r = \frac{d}{\cos\vartheta * \cos\Psi + \sin\vartheta * \sin\Psi * \cos\varphi} \quad (13)$$

One obtains the following relation for a point (x'', y'') on the detector surface and the polar angle ϑ and azimuthal angle φ:

$$\begin{aligned} \frac{x''}{d} &= \frac{\sin\vartheta * \cos\varphi * \cos\Psi - \cos\vartheta * \sin\Psi}{\cos\vartheta * \cos\Psi + \sin\vartheta * \sin\Psi * \cos\varphi} && (14)\\ \frac{y''}{d} &= \frac{\sin\vartheta * \sin\varphi}{\cos\vartheta * \cos\Psi + \sin\vartheta * \sin\Psi * \cos\varphi} && (15) \end{aligned}$$

$$\begin{aligned} \cos\vartheta &= \frac{\cos\Psi - \frac{x''}{d} * \sin\Psi}{\sqrt{(\frac{x''}{d})^2 + (\frac{y''}{d})^2 + 1}} && (16)\\ \cos\varphi &= \frac{\frac{x''}{d} * \cos\Psi + \sin\Psi}{\tan\vartheta[\cos\Psi - \frac{x''}{d} * \sin\Psi]} && (17) \end{aligned}$$

B.) Calculation of the GSI-clover segment angles

The GSI-clover detector has 16 position segments which are displayed in Fig.2.

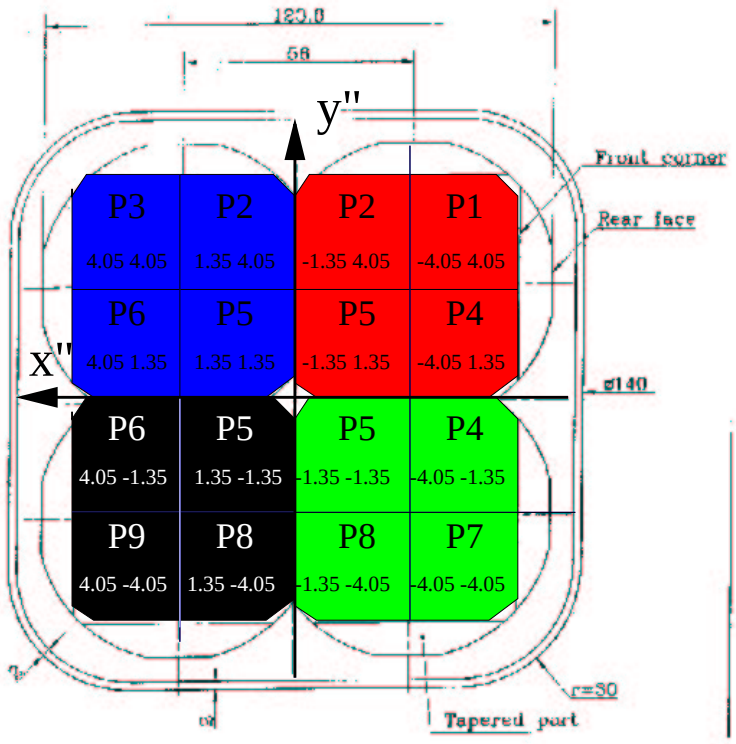

Figure 2: The centriods (x'', y'') of the 16 position segments of the GSI-clover detector N^{o}1 are given in cm. The central contacts are blue and red (upper half from left to right) and black and green (lower half from left to right).

x'' (cm)	y'' (cm)	ϑ (^{0})	φ (^{0})
4.05	4.05	33.06	45.00
1.35	4.05	25.88	71.57
-1.35	4.05	25.88	108.43
-4.05	4.05	33.06	135.00
4.05	1.35	25.88	18.43
1.35	1.35	12.24	45.00
-1.35	1.35	12.24	135.00
-4.05	1.35	25.88	161.57
4.05	-1.35	25.88	341.57
1.35	-1.35	12.24	315.00
-1.35	-1.35	12.24	225.00
-4.05	-1.35	25.88	198.43
4.05	-4.05	33.06	315.00
1.35	-4.05	25.88	288.44
-1.35	-4.05	25.88	251.57
-4.05	-4.05	33.06	225.00

Table 1: Polar- (ϑ) and azimuthal (φ) angles of the GSI-clover segments for $\Psi = 0^0$ and d=8.8 cm

central contact	P1	P2	P3	P4	P5	P6	P7	P8	P9
red(5)	33.06	25.88	-	25.88	12.24	-	-	-	-
green(8)	-	-	-	25.88	12.24	-	33.06	25.88	-
black(7)	-	-	-	-	12.24	25.88	-	25.88	33.06
blue(6)	-	25.88	33.06	-	12.24	25.88	-	-	-

Table 2: Polar (ϑ) angles of the GSI-clover segments for different central contacts ($\Psi = 0^0$, d=8.8 cm)

central contact	P1	P2	P3	P4	P5	P6	P7	P8	P9
red(5)	135.00	108.43	-	161.57	135.00	-	-	-	-
green(8)	-	-	-	198.43	225.00	-	225.00	251.57	-
black(7)	-	-	-	-	315.00	341.57	-	288.44	315.00
blue(6)	-	71.57	45.00	-	45.00	18.43	-	-	-

Table 3: Azimuthal (φ) angles of the GSI-clover segments for different central contacts ($\Psi = 0^0$, d=8.8 cm)

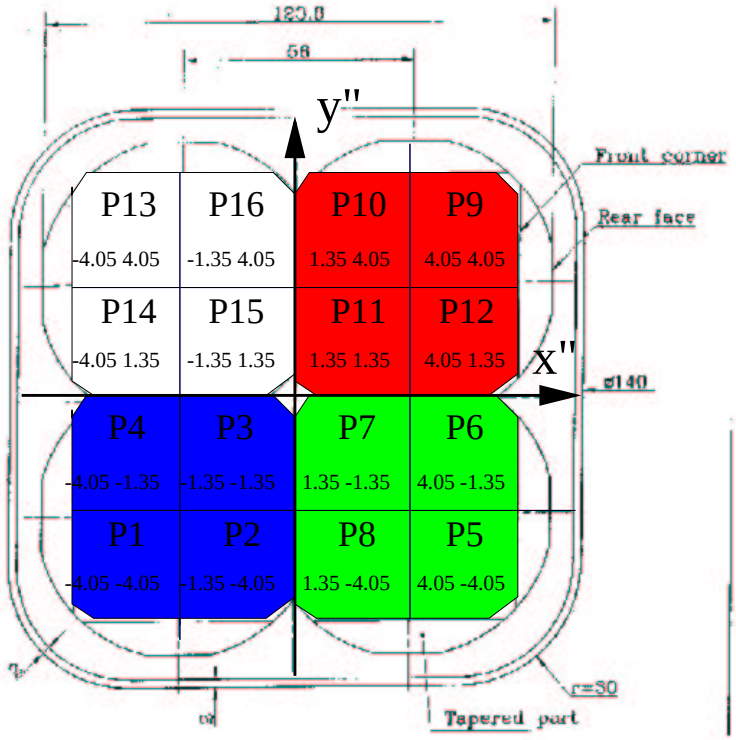

Figure 3: The centriods (x'', y'') of the 16 position segments of the GSI-clover detector N^{o}2 are given in cm. The central contacts are white and red (upper half from left to right) and blue and green (lower half from left to right).

x'' (cm)	y'' (cm)	ϑ (^{0})	φ (^{0})
4.05	4.05	146.94	45.00
1.35	4.05	154.12	71.57
-1.35	4.05	154.12	108.43
-4.05	4.05	146.94	135.00
4.05	1.35	154.12	18.43
1.35	1.35	167.76	45.00
-1.35	1.35	167.76	135.00
-4.05	1.35	154.12	161.57
4.05	-1.35	154.12	341.57
1.35	-1.35	167.76	315.00
-1.35	-1.35	167.76	225.00
-4.05	-1.35	154.12	198.43
4.05	-4.05	146.94	315.00
1.35	-4.05	154.12	288.44
-1.35	-4.05	154.12	251.57
-4.05	-4.05	146.94	225.00

Table 4: Polar- (ϑ) and azimuthal (φ) angles of the GSI-clover segments for $\Psi = 0^0$ and d=8.8 cm

	blue(1)	green(2)	red(3)	white(4)
P1	146.94			
P2	154.12			
P3	167.76			
P4	154.12			
P5		146.94		
P6		154.12		
P7		167.76		
P8		154.12		
P9			146.94	
P10			154.12	
P11			167.76	
P12			154.12	
P13				146.94
P14				154.12
P15				167.76
P16				154.12

Table 5: Polar (ϑ) angles of the GSI-clover segments for different central contacts ($\Psi = 0^0$, d=8.8 cm)

	blue(1)	green(2)	red(3)	white(4)
P1	225.00			
P2	251.57			
P3	225.00			
P4	198.43			
P5		315.00		
P6		341.57		
P7		315.00		
P8		288.44		
P9			45.00	
P10			71.57	
P11			45.00	
P12			18.43	
P13				135.00
P14				161.57
P15				135.00
P16				108.43

Table 6: Azimuthal (φ) angles of the GSI-clover segments for different central contacts ($\Psi = 0^0$, d=8.8 cm)