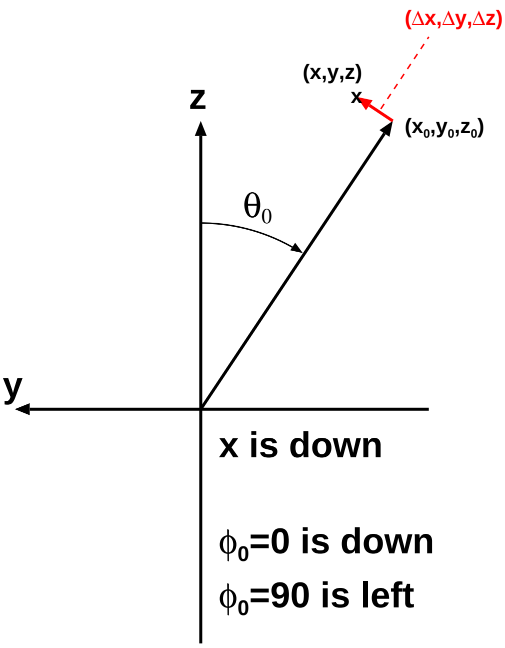
Coordinates of central spectrometer point (unit vector):

$x_0 = \sin(\theta_0) * \cos(\phi_0)$

$y_0 = \sin(\theta_0) * \sin(\phi_0)$

$z_0 = \cos(\theta_0)$



$(\Delta x,\Delta y,\Delta z)$ coming from xptar and yptar:

* xp=dx/dz=xptar, yp=dy/dz=yptar
* Assume spectrometers in plane (ϕ_0=90/270)

$\Delta x = xp$

$\Delta y = yp*\cos(\theta_0)$

$\Delta z = -yp*\sin(\theta_0)*\sin(\phi_0)$

(x,y,z) for the real event, in terms of central spectrometer and xp/yp (xptar/yptar).

$x = x_0 + \Delta x = \sin(\theta_0)*\cos(\phi_0) + xp = xp$ (for in-plane spectrometers).

$y = y_0 + \Delta y = \sin(\theta_0)*\sin(\phi_0) + yp*\cos(\theta_0)$

$z = z_0 + \Delta z = \cos(\theta_0) - yp*\sin(\theta_0)*\sin(\phi_0)$

To get the direction (unit vector) for the real event, need to divide by total length (which is easy to express in terms of the spectrometer unit vector and xptar/yptar).

$d = \mathrm{sqrt}(x^2 + y^2 + z^2) = \mathrm{sqrt}\,(1 + xp^2 + yp^2)$

$\hat{x} = x / d, \quad \hat{y} = y / d, \quad \hat{z} = z / d$

Next, the physics angles for the event (θ,ϕ) are calculated as follows:

$$\cos(\theta) = z / d = \frac{[\,\cos(\theta_0) - yp*\sin(\theta_0)*\sin(\phi_0)\,]}{\mathrm{sqrt}\,(1 + xp^2 + yp^2)}$$

$$\tan(\phi) = y / x = \frac{\sin(\theta_0)*\sin(\phi_0) + yp*\cos(\theta_0)}{\sin(\theta_0)*\cos(\phi_0) + xp}$$

1)Note that denom.=dx if HMS&SOS in-plane
2)Must take care to get correct 'phase' when taking atan(y/x)

And finally, getting xptar/yptar from $\hat{x},\hat{y},\hat{z}$. Start by getting angle between the spectrometer unit vector (p_0) and the event unit vector (p).

$\hat{p}_0 \bullet \hat{p} = \cos(d\theta) = dz/\mathrm{sqrt}(dx^2 + dy^2 + dz^2) = 1/d$

$\hat{x} = x / d = dx / d \implies dx = \hat{x} * d \implies dx/dz = (\hat{x}*d)/dz = \hat{x}/(dz/d) = \hat{x}*\cos(d\theta)$

$d^2 = 1 + xp^2 + yp^2 \implies dy/dz = yp = \mathrm{sqrt}(\,d^2 - 1 - xp^2\,)$