Rod Calibration Routine:

Using rod calibration to perform conversion from strip numbers to ut-coordinates

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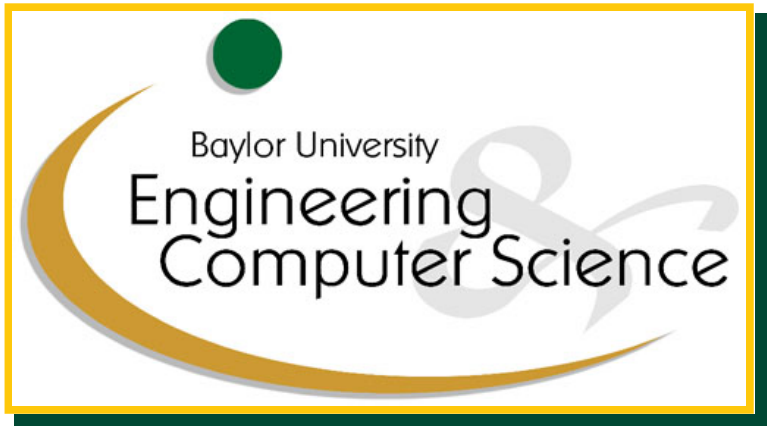

(1) Outline of rod calibration routine

1. For each t strip number in first proximal tracker plane, calculate the mean difference between v strip numbers in first and second proximal planes (i.e. $\Delta v = mean(v_2 - v_1)$
2. For each v strip number in first proximal tracker plane, calculate the mean difference between t strip numbers in first and second proximal planes (i.e. $\Delta t = mean(t_2 - t_1)$
3. For each t strip number in first proximal tracker plane, fit a line to t strip number vs. mean v strip number difference (i.e. $t_{1,i}$ vs. Δv)
4. For each v strip number in first proximal tracker plane, fit a line to v strip number vs. mean t strip number difference (i.e. $v_{1,i}$ vs. Δt)
5. Slope $m_{\Delta v} = \frac{d\Delta v}{dt_1}$ can then be used to determine v_2 strip corresponding to ($t_{1,i}$,$v_{1,i}$) in first proximal plane using $v_{2,i} = \left(\frac{d\Delta v}{dt_1}\right) t_{1,i} + v_{1,i}$
6. Slope $m_{\Delta t} = \frac{d\Delta t}{dv_1}$ can then be used to determine t_2 strip corresponding to ($t_{1,i}$,$v_{1,i}$) in first proximal plane using $t_{2,i} = \left(\frac{d\Delta t}{dv_1}\right) v_{1,i} + t_{1,i}$
7. Thus,

$$\begin{bmatrix} t_{2,i} \\ v_{2,i} \end{bmatrix} = \begin{bmatrix} 1 & \frac{d\Delta t}{dv_1} \\ \frac{d\Delta v}{dt_1} & 1 \end{bmatrix} \begin{bmatrix} t_{1,i} \\ v_{1,i} \end{bmatrix}$$

   (a) For protons passing through the outer parts of proximal tracker planes, project from proximal tracker planes to distal tracker planes to determine expected value of t/v
   (b) Calculate the difference between expected and observed values of t/v in the two distal tracker planes
   (c) Calculate the average difference between expected and observed values of t/v.
   (d) This average shift gives the relative shift between the two distal planes, which combined with the shift between first and second tracker plane now provides relative shifts between all tracker planes

8. Determine strip number corresponding to $t = 0/v = 0$ in each plane
   (a) Determine entry/exit points of reconstruction volume by projecting forward/backward from proximal/distal planes, accounting for relative shift between planes
   (b) Bin WEPL values according to angular/t/v bin and computer mean WEPL in each bin
   (c) Find COM of WEPL distribution for each angle and slice

(d) Determine mean COM across all angles for each slice. If the rod does not coincide exactly with the rotation axis, the COM will shift from angle to angle, so the mean gives the location of $t = 0$

(e) Perform linear least squares between COM in each slice to determine angle between tracker planes and rotation axis