# Major steps in TOF calibration

- ADC and TDC calibration

- PMT gain-balancing and monitoring

- Time-walk corrections

- Single-paddle calibration

- Paddle-to-paddle timing offsets

- Overall TOF timing fit to RF time

# 1. ADC and TDC calibration

- Verify Flash ADC offset calibration (pulser run)

- Verify RC-delays calibration of VX1290A (any random data but special TDC mode)

- TDC counts to time conversion (pulser data)

- Occupancy histograms monitoring to identify dead channels (normal runs)

# 2. PMT gain-balancing and monitoring

- Initial HV values and ADC peak position from $Sr^{90}$ are recorded during constructon

- $Sr^{90}$ mounted on a rail with a step motor to measure Landau peak position to monitor PMT gains and adjust HV (during downtime)

- Alternatively, monitor dE/dx from high-momentum pions hitting particular spot on a paddle (requires track reconstruction of normal data)

# 3. Time-walk corrections

- Use Elton's prescription. In a low-intensity run, identify single related hits in X and Y planes.

- Use time of hit in one plane to remove unknown $t_o$ from time in the other plane.

- Minimize $\sum\limits_{areas} \sum\limits_{events} (t_x - \bar{t}_x)^2 + (t_y - \bar{t}_y)^2$ to find time-walk parameters

- Average $\bar{t}_x$ and $\bar{t}_y$ are determined over all events in each 6x6 cm$^2$ intersection areas

# 4. Single-paddle calibration

- To remove relative timing offsets between left and right channels of the same paddle, offset one of the times so that $t_L - t_R$ is centered at zero

- This can be done either with cosmic ray hits, or with $Sr^{90}$ measurements at both ends. Normal data can be skewed due to acceptance

- Use width of $t_L - t_R$ to determine $v_{eff}$

# 5. Paddle-to-paddle timing offsets

- In each plane, find cosmic rays with hits in at least 3 neighbouring paddles

- Use $(t_L - t_R)/2$ to determine hit position along each paddle

- Select only events with positions along a straight line (within resolution)

- In a minimization fit, adjust relative timing offsets of $(t_L + t_R)/2$ hit times to coincide with the expected propagation time from paddle to paddle

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# 6.  Overall TOF timing fit to RF time

- Timing offsets determined so far are only for initial calibrations or after major hardware changes affecting timing

- For final production calibration, use reconstructed tracks from normal data (perhaps, with some physics filter on pions or Kaons)

- Swim tracks back from TOF to vertex. Determine timing calibraion constants for each channels by minimizing difference between vertex time and RF time (use start counter to determine proper RF bunch)