Lock-in amp drives beam in \( x \) (or \( y \)) with \( A \cos \nu_x \omega_{\text{rev}} t \).

Transverse feedback

\[ \sum \]

Set drive to starting level. Run auto-gain, wait, then run auto-reserve.

Drive Level

Find standard deviation of \( \Delta \theta \) over \( N \) readings.

\[ \text{St dev} > 2^\circ? \text{ Drive} < \text{high limit? Raise} \text{ drive} \ 1 \text{ dB.} \]

\[ \text{St dev} < 1^\circ? \text{ Drive} > \text{low limit? Lower} \text{ drive} \ 1 \text{ dB.} \]

Downconverter forms \( \Delta x \) from sums, difference of pick-ups.

Tune-setting quadrupole magnets

Downconvert from \( 2\omega_{RF} \pm \nu_x \omega_{\text{rev}} \) to \( \omega = \nu_x \omega_{\text{rev}} \)

Kicker

Tune-setting on beampipe

Pick-up buttons

Lock-in finds magnitude \( R \) and phase \( \theta \) of signal at \( f \).

Get difference \( \Delta \theta = \theta - \theta_0 \) from center of tune resonance.

\[ \text{Drive on?} \]

No

No

Beam current < minimum?

Yes

Low or No Beam

Yes

When beam is lost, set:

\[ \text{Tune to zero-current value; Drive}\ 
\text{starting level 3 dB below present; Drive} = \text{minimum;}
\text{Sensitivity} = \text{maximum; Dynamic reserve} = \text{normal.} \]

\[ \Sigma \]

Adjust tune multiknob by \( \Delta \nu_x \).

Desired Tune

\[ \Delta \nu_x \]

Move drive frequency to reduce \( \Delta \theta \), using slope \( \frac{d\theta}{df} \) near \( \theta_0 \).

\[ \text{Compute tune:} \nu_x = f f_{\text{rev}}. \]

Take \( N \) readings. Apply smoothing to tune data.

Sensitivity Range

Compare mean of \( R \) over \( N \) readings to sensitivity range.

\[ R > 75\% \text{ of full scale? Go up one range.} \]

\[ R < 25\% \text{ of full scale? Go down one range.} \]

Tune Tracking