Beam Emittance and Skew Calculations with Wires

**Author:** Sanchez, Hendrickson  
**Subsystem:** Accelerator  
**Panel Changes:** Few  
**Documents:** Yes  
**User Impact:** Some  
**Help File:** None

Emittance and skew calculation software has been recently released to support the new linac wire scanners.

Emittance calculations using four (or three) wires are supported for LI02 and LI28. Sets of four wires in these micros are separated by a 45 degree betatron phase advance. By scanning with any three of these units, the X or Y beam emittance is calculated using the fitted beam width-squared at each point and the associated R matrices. It is not necessary to vary upstream quadrupole settings. After the single scans are performed and fit, the beam emittance and values for the alpha and beta functions are calculated with a least-squares fit using the single scan data. This calculation utilizes data from four wires if available. The alpha and beta values are always calculated at the Z position of the first of the four wires, even if this wire is offline. In addition to the combined fit, if four wires were scanned, for each combination of three wires the software calculates the beam emittance, alpha and beta. In this case there are four combinations of scanners resulting in four additional calculated values for emittance, alpha and beta.

Emittance measurement for both X and Y planes for a given beam and micro may be selected from the button on the LI02 and LI28 wire scan panels. After the scans and calculation are performed a display is generated. This display indicates the micro and beam measured. The composite emittance, alpha and beta values are listed first with associated errors. In addition, for each wire scanner, the fitted width-squared and errors are output. If four wires were scanned, a second page of the display is produced listing emittance values and errors for each three-wire combination. The display for the most recent emittance measurement may be regenerated later from the same SCP in which the measurement was taken by pushing the button. After the emittance measurement is complete, the scan data for the individual wires is put into correlation plot variables to allow further analysis and display. Gaussian fit parameters are written into the WIRE database for each wire scanned and calculated emittance parameters are written into the WIRE database for the first wire of the set. These are available for History Buffer Plots.

Beam skew calculations are supported for wire scanners which include an X wire, a Y wire and a diagonal (U or V) wire. This includes scanners in LI02 and LI28 as well as additional units which will be installed later. The skew angle of the beam is calculated by performing a single scan in each of the three planes.
From the wire scanner panels, the MEAS SKEW button initiates a skew angle calculation for the currently selected unit. After the three planes are scanned, a display is generated indicating the beam and wire, the calculated X, Y and U or V beam widths, the calculated skew angle and its propagated error. The skew angle is the angle of the major axis of the beam ellipse relative to the X axis. In addition a "Skew Parameter" is calculated which quantifies the skewness of the beam, incorporating both the skew angle and the "roundness" of the beam. This skew parameter is defined as:

\[ S = \frac{(\text{major.width}^2 - \text{minor.width}^2)}{(\text{major.width}^2 + \text{minor.width}^2)} \times \sin(2 \times \text{skew.angle}) \]

where major.width and minor.width are the widths of the major and minor axes of the beam ellipse.

The display for the most recent skew angle calculation may be regenerated by selecting the Disp SKEW button from the same SCP which performed the measurements. Scan data for each plane is put into correlation plot variables for further analysis. The skew angle and other parameters are saved into the WIRE database after a successful measurement.

Support for wire scanner emittance and skew calculations has been added to correlation plots. Four-wire emittance calculation results are available under the PHYS correlation plot pseudo-primary. The micro names allowed are LI02 and LI28. Associated pseudo-secondaries are X.EMIT, X.BETA, X.ALPHA, Y.EMIT, Y.BETA, Y.ALPHA. Wildcards supported are X*, Y* and ALL*, which result in calculations for X emittance, Y emittance or both. Four wire scans are performed for each requested plane for each data point.

Skew calculations are supported under the WSCN primary. The user should enter the micro name and WIRE unit number for any wire which supports X, Y and diagonal (either U or V) scan planes. Supported pseudo-secondaries are as follows. SKEWANGL is the calculated angle of the major axis of the beam spot ellipse with the horizontal. SKEWMJSQ and SKEWMNSQ are the squares of the beam size along the calculated major and minor axes of the beam spot ellipse. SKEWPARM is the skew parameter which will equal zero for upright or round beams. Wildcards associated with the Skew calculation are S* and ALL*. S* provides all Skew results and ALL* provides Skew results in addition to fits for X, Y and diagonal scans. Three wire scans are performed for each requested Skew calculation.

### Autosave of Emittance Setup Parameters

<table>
<thead>
<tr>
<th>Author: Michael Glaviano</th>
<th>Subsystem: SCP</th>
<th>User Impact: Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel Changes: Few</td>
<td>Documents: No</td>
<td>Help File: No</td>
</tr>
</tbody>
</table>

Emittance setup parameters are now saved to the database as they are changed. This avoids the loss of changes one has made to the setup. These parameters are associated in the database with measurement devices which include profile monitors (primary PROF) and wire scanners (primary WIRE.) To avoid possible confusion, the explicit (manual) save of a window's parameters (from the Select Window panel) has been disabled. The autosave feature is activated automatically and requires no user action.
New Option for Klystron Golding

Author: Bob Hall
Panel Changes: None
Subsystem: Accelerator
Documents: No
User Impact: Small
Help File: None

A new option has been added to the UPDATE GOLD ONLY button on the Klystron Golding Panel. This option will allow one to update the gold phase for just one klystron instead of updating klystrons over a range of sectors. The old options for updating klystrons or subboosters for a range of sectors remain available.

New Klystron Features

Author: Bob Hall
Panel Changes: Few
Subsystem: Accelerator
Documents: No
User Impact: Small
Help File: Yes

Two new features have been added to klystron panels. The first is the addition of two new choices available from the HISTA Mode button. Along with the previously existing three choices for the state of a klystron or subbooster (ON, OFF, or MAINT), two new options may be selected: TBR (To Be Replaced) and ARU (Awaiting Run Up). Previously, the MAINT state had been used to indicate these two conditions. The TBR and ARU states may now be selected to give a better indication of the status of a klystron or subbooster. These new states will appear on all displays on which the maintenance state can appear, including the Klystron Status Display.

Also, the button has been added to the Klystron Diagnostics panel. This button may be pressed to display a description of each hardware descriptor (HDSC) bit along with an indication of which of these bits are set for the currently selected unit. The display is very similar to that produced when selecting the existing DECODE STATUS BITS and DECODE DSTA BITS buttons, which are also on the same panel.

Delay in reporting Klystron Phase Error

Author: Bob Hall
Panel Changes: None
Subsystem: Accelerator
Documents: No
User Impact: Small
Help File: None

In order to eliminate spurious phase mean errors, the logic for reporting "phase out of tolerance" has been modified. After changing the klystron, the PIOP takes 30-60 pulses to recalculate a new phase. In the past, this would immediately be reported as a phase mean error, causing the klystron to turn red briefly on the Klystron Status Display.

With the new software, a yellow "Desired Phase Change" is shown on displays for up to 20 seconds after a change has been made while the klystron phase value is out of tolerance. This allows time for the PIOP to update or for the klystron to be trimmed back into tolerance. Only if the klystron is still out of tolerance more than 20 seconds after the requested change will a phase mean error be reported.
Modified Klystron Auto Trim Function

July 9, 1990

Author: Bob Hall
Panel Changes: One

Subsystem: Accelerator
Documents: No

User Impact: Small
Help File: Yes

The Klystron Auto Trim function has been modified to use a “touch up” logic similar to that used by the Magnet Auto Trim. For a “touch up”, a device is not trimmed if the phase value is too far out of tolerance or the phase jitter is too large. This logic is used for micro asynchronous trims as well as for periodic Paranoia trims. As before, phase trim requests from the SCP are implemented regardless of how far the device is out of tolerance.

If it is desirable to have auto trim for some device do unconditional trim instead of using “touch up” logic, the AUTO TRIM FUNCTN button on the Special Klystron Function Panel may be toggled from “touch up” to “trim.”

This toggle has no effect if auto trimming is already disabled.

Slow Feedback Updates

July 18, 1990

Author: Ed Miller
Panel Changes: None

Subsystem: SLC
Documents: No

User Impact: Small
Help File: Yes

Several fixes and enhancements have been recently incorporated in the Slow Feedback process.

- In the past, it has been possible to specify a CONFIG change for a feedback group from the SCP panel. However, because of a program error, the affected loops had to be turned OFF then ON to pick up the change. This error has been corrected, so you should be able to dispense with this arcane bit of knowledge.

- The two summary displays selectable from the feedback panels, ‘Active Unit Display’ and ‘Summary Display’ are somewhat compromised in their usefulness because information on so many loops is presented. This has now been ameliorated to an extent by eliminating from these two displays most REQUEST-ONLY loops that are not classified as normally SCHEDULED (for either control or monitoring). Now, the only times such loops will appear on the display is if either they have recently (typically within 5 minutes) been run or they are a member of the currently selected group.

- The classification of feedback loops for the SDS display has been corrected and modified.

1. Previously, the classifications ‘NO BEAM’ and ‘REQ ONLY’ were inadvertently reversed. This has been corrected.

2. Previously, all loops in a miscellaneous failed state were labelled as ’OUT LIMS’. Now only those whose command is outside limits will be labelled as ’OUTCLIM’; others will be labelled simply as ’BAD’.

3. Previously, loops which were in a good state were labelled as ‘IN LIMS’; now they will be labelled simply ‘GOOD’.

4. Those loops labelled as ‘REQ ONLY’ or ‘OFF’ will now be displayed in one of two colors: YELLOW if they are normally SCHEDULED (for either control or monitoring) and WHITE otherwise.
Slow Feedback History Plot Improvements

**Author:** Tom Himel  
**Subsystem:** Feedback  
**Panel Changes:** Few
**Documents:** No

July 11, 1990  
**User Impact:** Small  
**Help File:** YES!!!

A few minor improvements have been made to the slow feedback history plots. There is now a NEXT LOOP button on the history plot panel. This makes it easier to look at the same history plot for all the loops in a group. Also the SIGNAL history plot is now auto-scaled instead of having its scale determined by the signal limits.

Last, but not least, all of the SLOW FEEDBACK panels now have help available for all their buttons.

Machine Operating Mode History

**Author:** Ralph Johnson  
**Subsystem:** All  
**Panel Changes:** Few
**Documents:** No

July 18, 1990  
**User Impact:** Some  
**Help File:** No

The state of the accelerator operating mode (SLC, PEP, etc.) as set on the operations maintenance panel is now saved in the history buffer. One may look at it by selecting the mode history panel from the operations maintenance panel. The vertical axis is labeled with the mode names.

Additionally, the currently selected mode is now indicated on the summary display.