Long-term beam stability can be improved using a simple linear algorithm.

Autotune

How to do it:

- Change a corrector by a known amount.
- Record how much the beam moves at each BPM downstream of the corrector.
- Do this for all correctors.
- Now we have a simple relationship:

$$\Delta x = R \Delta B$$

- Invert R, so you have:

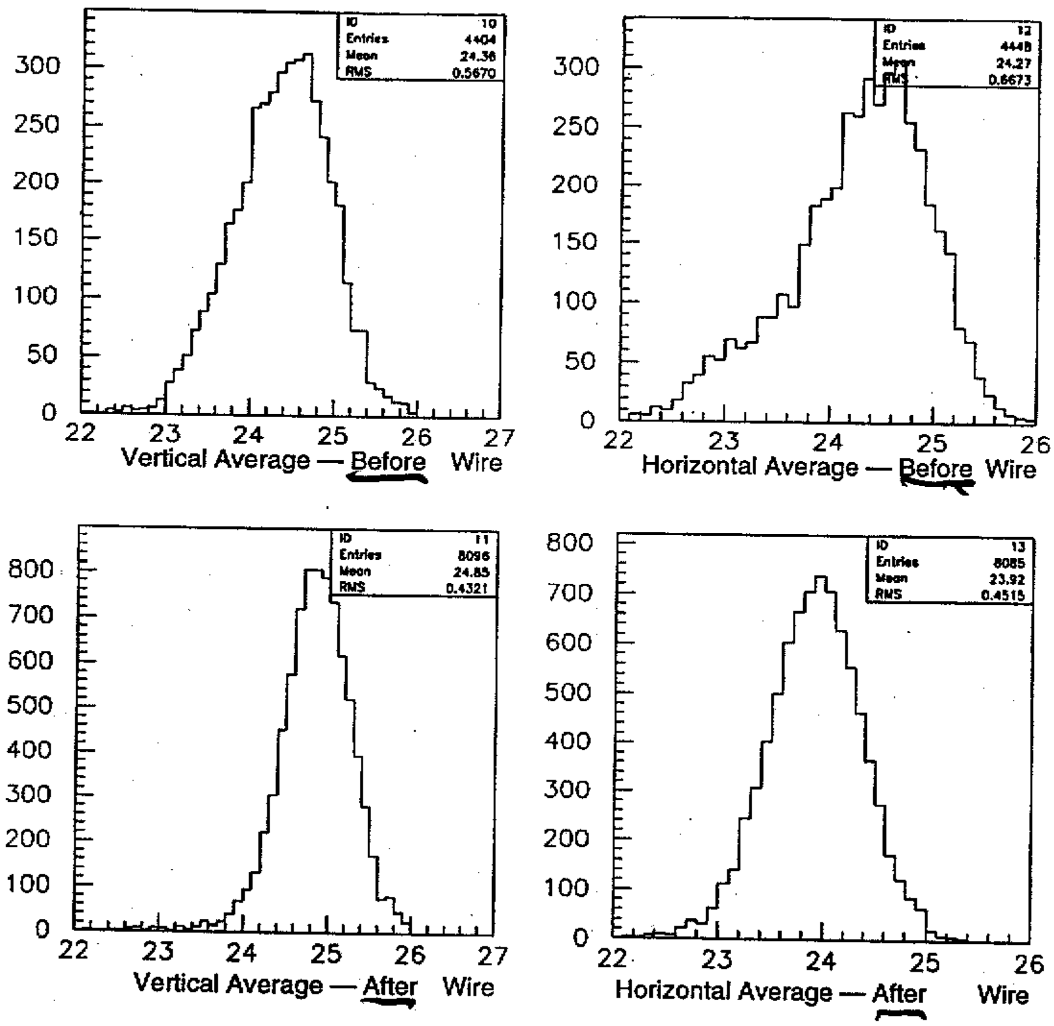
$$\Delta B = R^{-1} \Delta x$$

Important features:

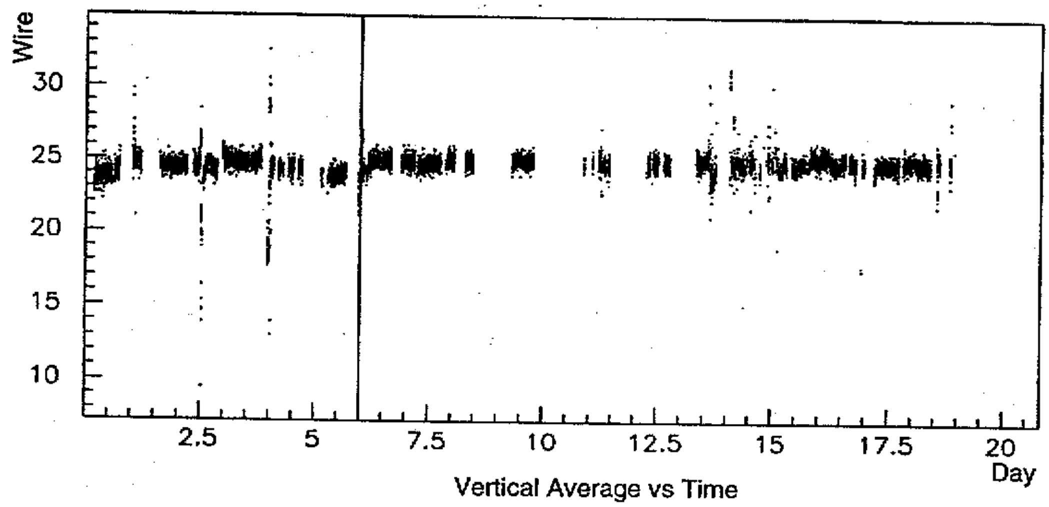
- The correction matrix can be calculated using standard optics programs. Of course, the values should be checked when the beamline is commissioned.
- The correction matrix must be recalculated if any quadrupoles are changed. This can also be done using the standard optics programs.
- The full correction should not be made—pulse-to-pulse variations and noise on the readback introduce errors, guarantying that the correction you calculate is incorrect for the upcomming pulse! However, because the problem is linear, by applying a fraction of the correction it will eventually converge.
- It is important to calculate the corrections in terms of B, and then calculate the appropriate current change, taking into account saturation.
- The majority of work goes into checking the state of the beamline. For example, is the beam intensity sufficient to trigger the BPM?

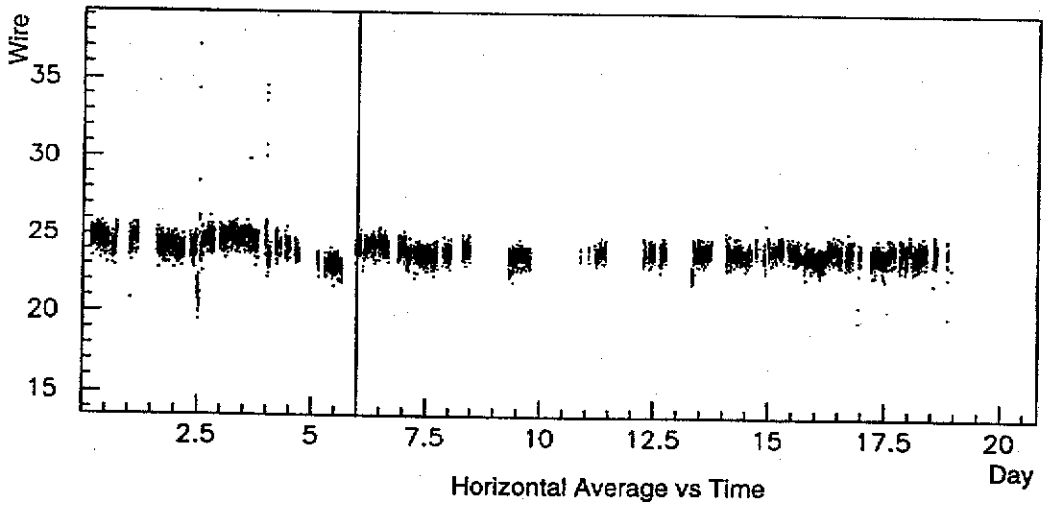
Stale data

From FEMILAB-TM-2037



From FEMILAB-TM-2037





Sample "flow chart" to be used for Fermilab E898:

initialize

↓

wait for $1D ←

read magnet settings

read BPM positions

check permits

calculate beam changes

calculate magnet changes

set magnets → (return to "wait for $1D")

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- Gaston Gutierrez
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