NLC - The Next Linear Collider Project

NLC Feedback Requirements

Linda Hendrickson

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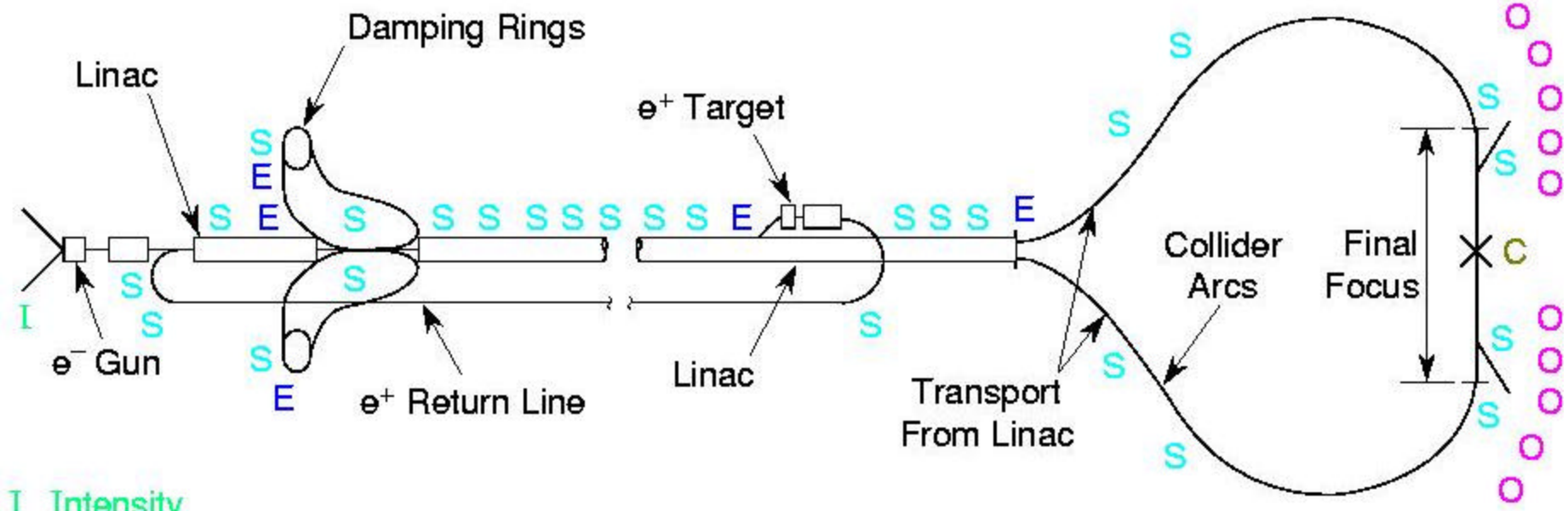
Purpose:

Feedback systems provide automated control and monitoring of beam-based machine parameters. This includes BPM-based feedbacks throughout the machine, except for the ultra-high rate feedbacks in the damping rings and IP.

SLC Feedback Diagram



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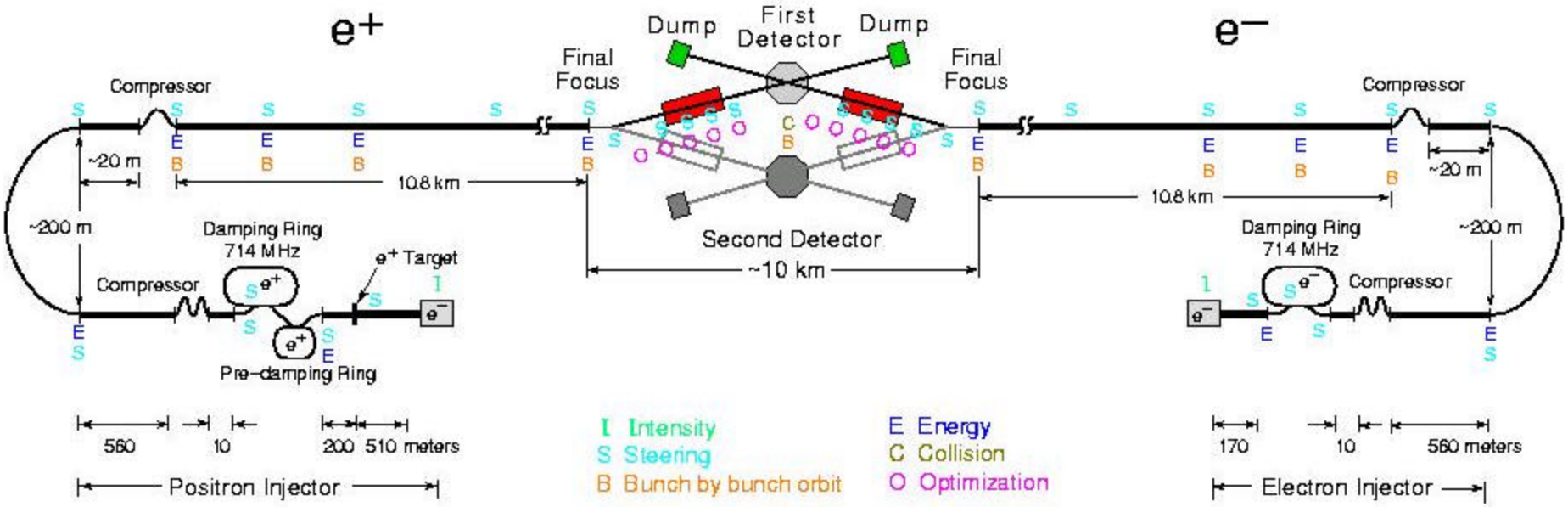
NLC Feedback Diagram

500 GeV c.m., 120 Hz, 95 Bunches, 2.8 ns Spacing



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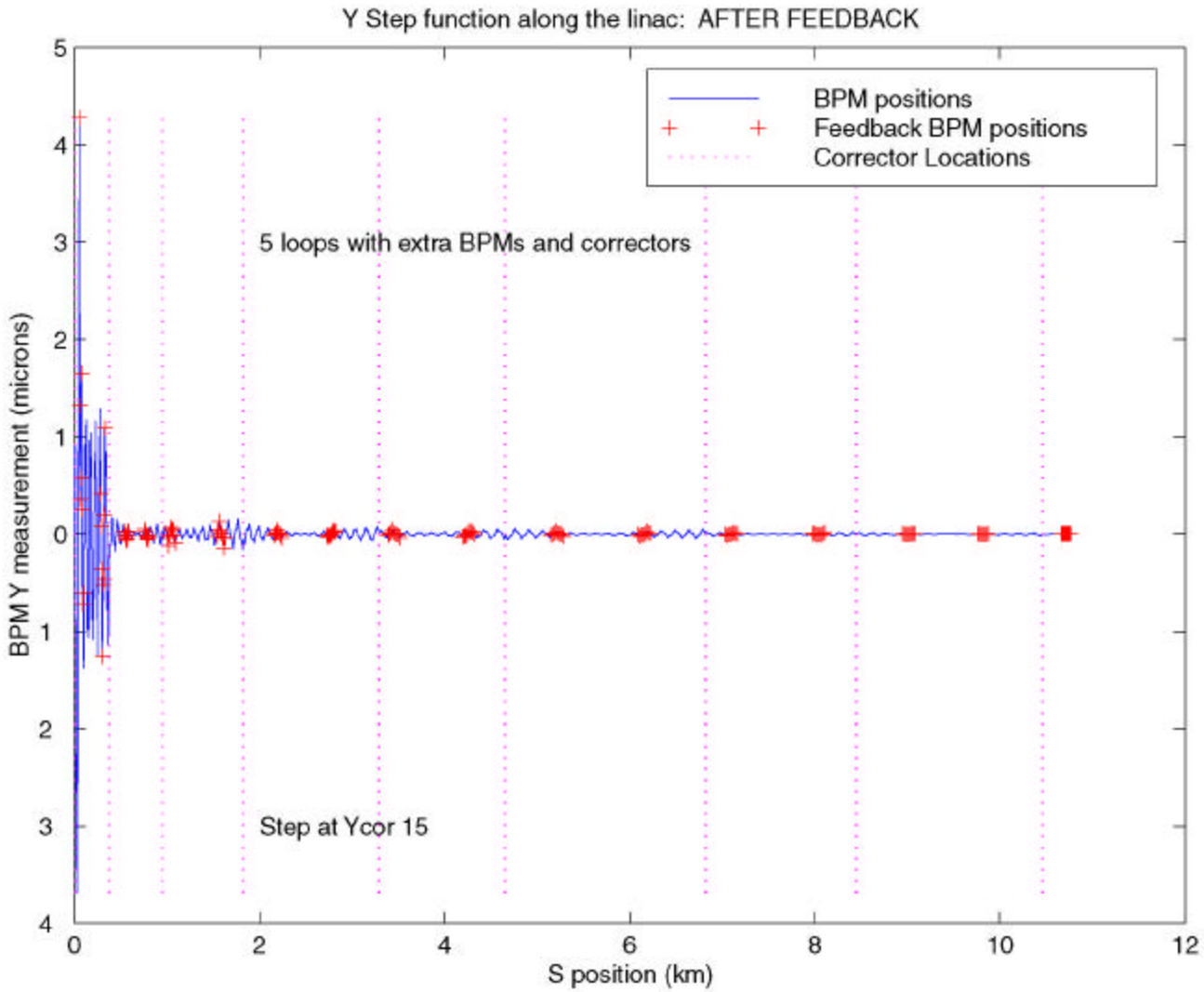
USE:

Feedback is a fully automated system which runs continuously.

PROCEDURE:

A variety of feedback systems will be available, with differing algorithms and specifications. Because a large number of systems must be supported, the software must be generalized and database-driven. Here is a proposed procedure for the linac steering feedback system:Each of the two linacs will contain 5 feedback loops, each with around 30 beam position monitors (BPMs) and 8 correctors. (For a single loop, these devices are distributed along the accelerator and not clumped in a single location.) The feedback algorithm will be designed in advance using the accelerator model, and matrices will be periodically calculated offline using a math package and stored in the online database.After the beam passes, the BPM system calculates position measurements for a single selected bunch, or for the average of a number of bunches. Each feedback calculates intermediate beam states for its region and sends information to all downstream loops. The downstream loops combine the beam information from all upsteam loops and their own measurements to determine the amount of a disturbance which must be corrected by this loop. Actuator settings are calculated and implemented.


Y Step function along the linac: AFTER FEEDBACK
BPM positions
Feedback BPM positions
Corrector Locations
5 loops with extra BPMs and correctors
Step at Ycor 15
BPM Y measurement (microns)
S position (km)
5
4
3
2
1
0
1
2
3
4
0
2
4
6
8
10
12

USER INTERFACE:

The user can enable/disable feedback control, modify gain and setpoints, save and restore machine configurations. Real-time and archived data from feedback systems can be displayed and correlated with other 120 hz data.

PERFORMANCE REQUIREMENTS:

Typical feedback response time should be 2 120-Hz machine pulses. This includes time for measurement digitization, any system latencies, network traffic, calculation time, and time for corrector power supplies to change and affect the beam. Since corrector changes are likely to require a full 120-Hz interval, only a single 120 Hz period can be allocated for the other functions. Timing variability should be limited to 1/360 second.Because of the large number of feedback loops and their importance to operations, the system must remain functional without requiring frequent human intervention. For instance, a power supply driver which frequently freezes up and requires user reset would be unacceptable for feedback use. System designers should plan to accommodate periodic, automated control even for slow devices for which feedback control is not initially anticipated.

SYSTEM IMPACT:

Feedback must coordinate with other applications using devices in the same region. This includes pausing feedback for another activity, sharing of data, and synchronization of control requests. All feedback data must be shareable with other users.

SERVICES USED:

- **120 hz data from BPMs, charge monitors, and other pulse-synchronized devices**
- **120 hz control of magnets, RF, timing devices**
- **120 hz distribution of feedback state data to other systems**
- **Synchronized control of slow devices**
- **Orbit plotting facility for BPM data**
- **Database access for matrices, parameters**
- **Archiving of data from ~few K pulses + long term archiving**
- **Error logging and metering**
- **Contention resolution**
- **Simulation facilities**

TAXONOMY:

Initiated	**manually or automatically.**
Frequency	**continuous.**
Running state	**compatible with normal operation.**
Read/write	**write .**
Latency	**2 pulses.**
120 Hz	**data and control.**
Shareable input	**yes.**
Sync time	**1 pulse.**
Missing data	**can tolerate some broken BPMs.**
Geography	**regional/global.**
# of users	**varies, single feedback instances by region.**
input data	**lots**

Comments:

Measurements:

Supported measurements must include beam position monitors, charge and intensity measurements, and a variety of ADC devices (analog to digital converters), which provide general pulse-synchronized measurements. In addition, the system is capable of reading back other analog signals such as magnet voltages. Data rates must be configurable, and allow selection of a subset of pulses, synchronized over multiple regions of the machine. The system must be capable of sharing measurement data with users, so that it is not interrupted frequently. Feedback should not require dedicated measurement devices, but must be capable of utilitizing the standard control system devices.

Actuators:

The feedback system must control a variety of devices, including standard correctors, fast pulsed correctors, klystron and subbooster phases, and device timing including programmable delay hardware.The feedback system must be capable of utilizing general control system actuators which are available for user tuning. Interfaces must be provided to any other device drivers, so that the feedback does not fight with users for control. Other facilities must be aware of the feedback system and interface appropriately to avoid confusion and contention. Optimization feedbacks may need the ability to control fast pulsed devices remotely in a synchronized fashion. This involves the ability to pre-program synchronization signals with a user-configured pattern.

Database:

The feedback configuration is fully database-driven, and databases store static information about the feedback configuration, user control options, and dynamic measured beam parameter data.

Networks:

A fast intermicro communication system allows feedback calculations for different machine regions to communicate.

Error Logging, Messaging and Metering Facilities:

Because the feedback systems run at a high rate and because diagnostics are important, error and message logging facilities are important for this application. Such a facility must include the ability to generate messages, identified by specific feedback loop name, and allowing options of severity. The application must have control over whether a message is broadcast to all users, to a specific user or just to a log. Messages must be metered to prevent system saturation, separately according to feedback loop and error type. Capability is needed to provide an optional accounting of dropped messages.