Machine History Visualization / Predictive Monitoring

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Abstract

The NIF Machine History Viewing Tools Enable Users to Analyze Control System Behavior.

Background The National Ignition Facility control system includes over 10,000 motors and tens of thousands of other types of devices. Machine history data is collected to keep a record of the behavior of these devices. This data is used proactively to prevent potential future system failures, and to examine past behavior (for situational awareness for operators and to troubleshoot past unexpected behavior).

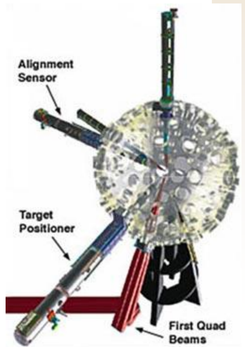
Use Cases The Machine History Viewing Tools are used by system operators, scientists, engineers and technicians. System operators gain situational awareness from recent history (e.g., temperature or position plots). Scientists can improve system alignment accuracy by identifying interferences such as heat from chamber illumination sources. Engineers and technicians can troubleshoot system problems and design efficiency improvements for future upgrades. Engineers can also observe trends in system behavior which will allow repairs or service to be performed before a system failure occurs.

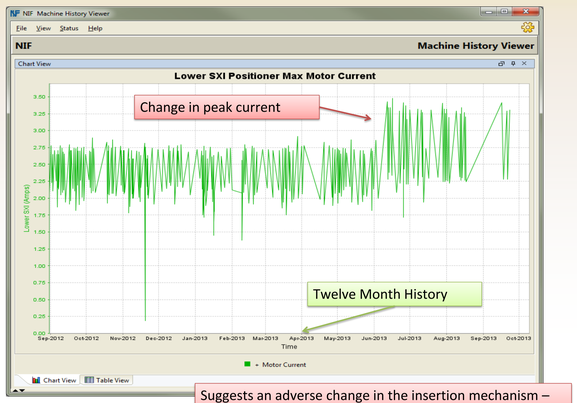
Capabilities The Viewing Tools provide strip chart and table views of the machine history, and display numeric and text data. Upgrades in progress are adding image display with metadata. The strip chart is particularly well-suited to time-correlate events, to help identify cause and effect between devices, and to reconstruct complex sequences of events. Multiple Y-scales allow different devices to be shown on the same chart without one device dominating the scale. The table views are useful to identify specific values and changes in values. Export to Excel allows further customized analysis of the user's data.

Report Specification Because of the large number of devices in the system, multiple mechanisms are provided for the user to specify their report content. For system operators, each of their device control maintenance panels can show the history for that one device. Operators may drag and drop one history report on another to combine and correlate multi-device behavior. For troubleshooting past behavior, users can use the Report Wizard, which prompts the user for all report criteria, with pop-up lists of available device names, attributes, and time-frames. For reports which are run on a regular basis, users can save their report criteria to Report Criteria Text Files. This can be drag and dropped into the report generator to quickly set up simple or complex reports.

Examples This poster shows several examples of disparate types of information available from the NIF Machine History. It also shows how that data can be used to improve system understanding and operations. Annotations are included to describe both the data and the features of the viewing too.

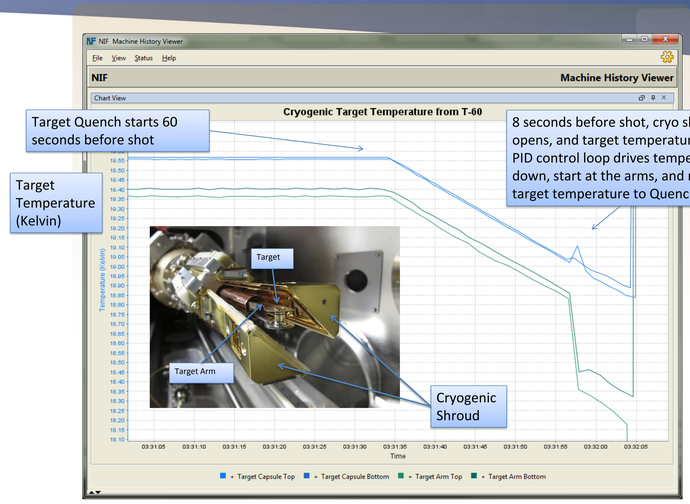
Long-Scale Performance Trending





Suggests an adverse change in the insertion mechanism – investigation linked change to replacement gearbox

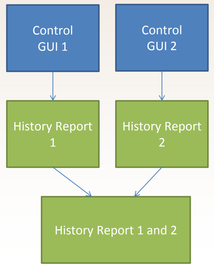
Fast Cryogenic Control Systems



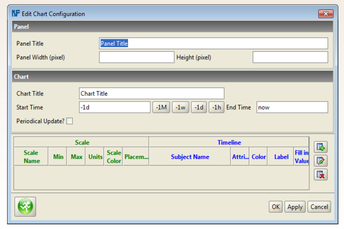
Servo Motor Stall Analysis

Multiple Methods to Specify Report Criteria

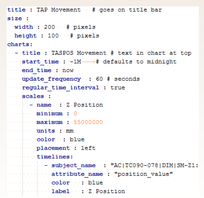
Dynamic Reports: Drag-to-Merge



Report Wizard



Report Criteria Files



Large Archive of Machine History

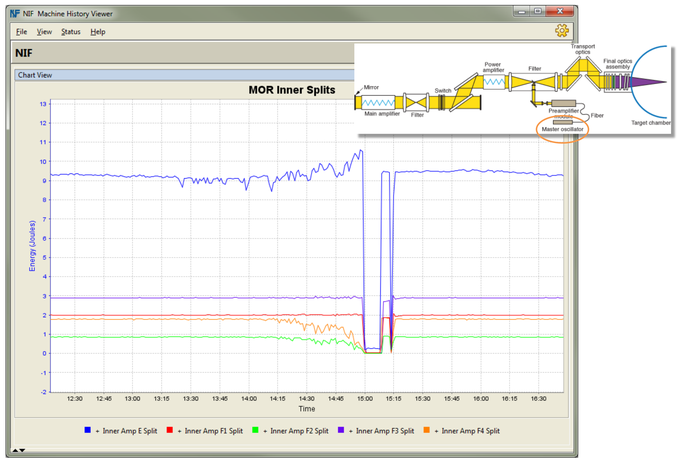
Most machine history is saved in an Oracle database in many different tables. The History Viewer provides a single user interface to access all of this data, and presents the results in an integrated display.

Additional history data is available in Comma Separated Value files. This history is also seamlessly merged into the viewing tool, so users have access to all information available about the controls.

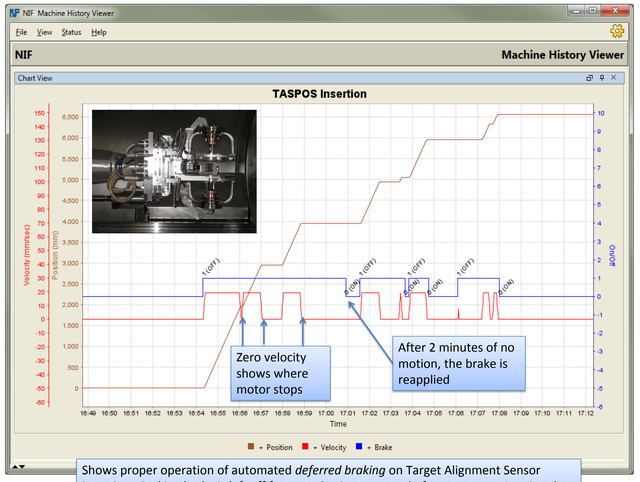
The NIF control system has about 40,000 control points, many of which write to machine history each time they change position. This generates a large body of data that is continually expanding. Additionally, as users seek more insight into the control system, new types of machine history are added into the device controller software.

NIF Motors	> 10,000
NIF Binary Devices	> 2000
NIF Other Devices	> 25,000
Machine history records	319,082,000
New records/month	14,000,000

Laser Energy at the Master Oscillator

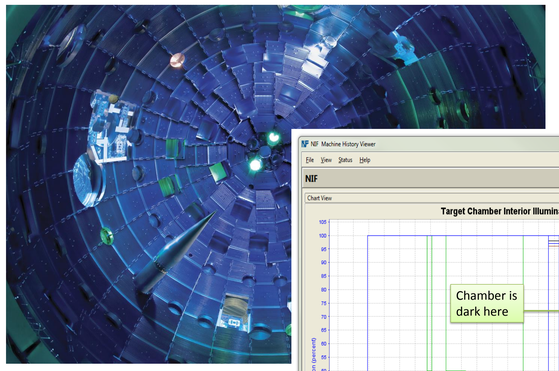


Validation of Complex Motor Behavior



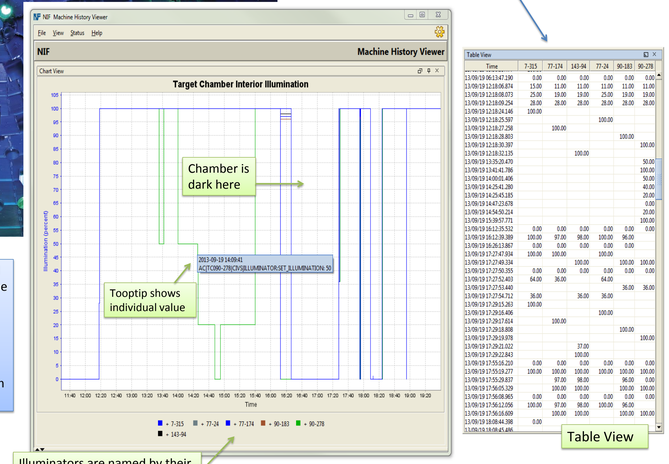
Shows proper operation of automated *deferred braking* on Target Alignment Sensor insertion. Parking brake is left off for up to 2 minutes at end of most moves. Leaving the brake off for short periods reduces insertion time when starting/stopping frequently.

NIF Target Chamber Interior Illumination



Target Chamber Illumination can be tracked against target temperature, to determine the effect of the radiant heat from illumination on the cryogenically cooled target. Illumination can be tracked against positioner movement to see how often the chamber is lit compare to how often positioners are moved (the lights must be on to observe all moves).

Strip charts work well to correlate information, and tooltips work well on the strip charts to see individual values. However it is sometimes useful to have a table view of all the data, so that is provided as a separate "tear out" panel.



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