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Management of Experiments and Data at the National Ignition Facility

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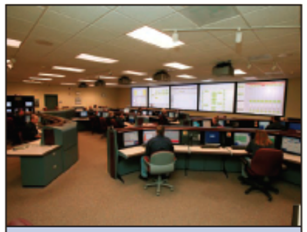
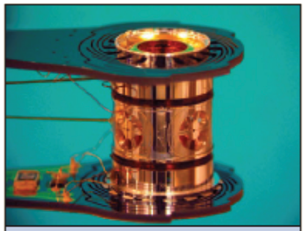
NIF experiments involve the entire facility – each requires careful planning and efficient execution


Operations

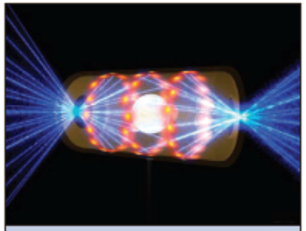

Engineering


Control System


Factories


Optics


Experimenters

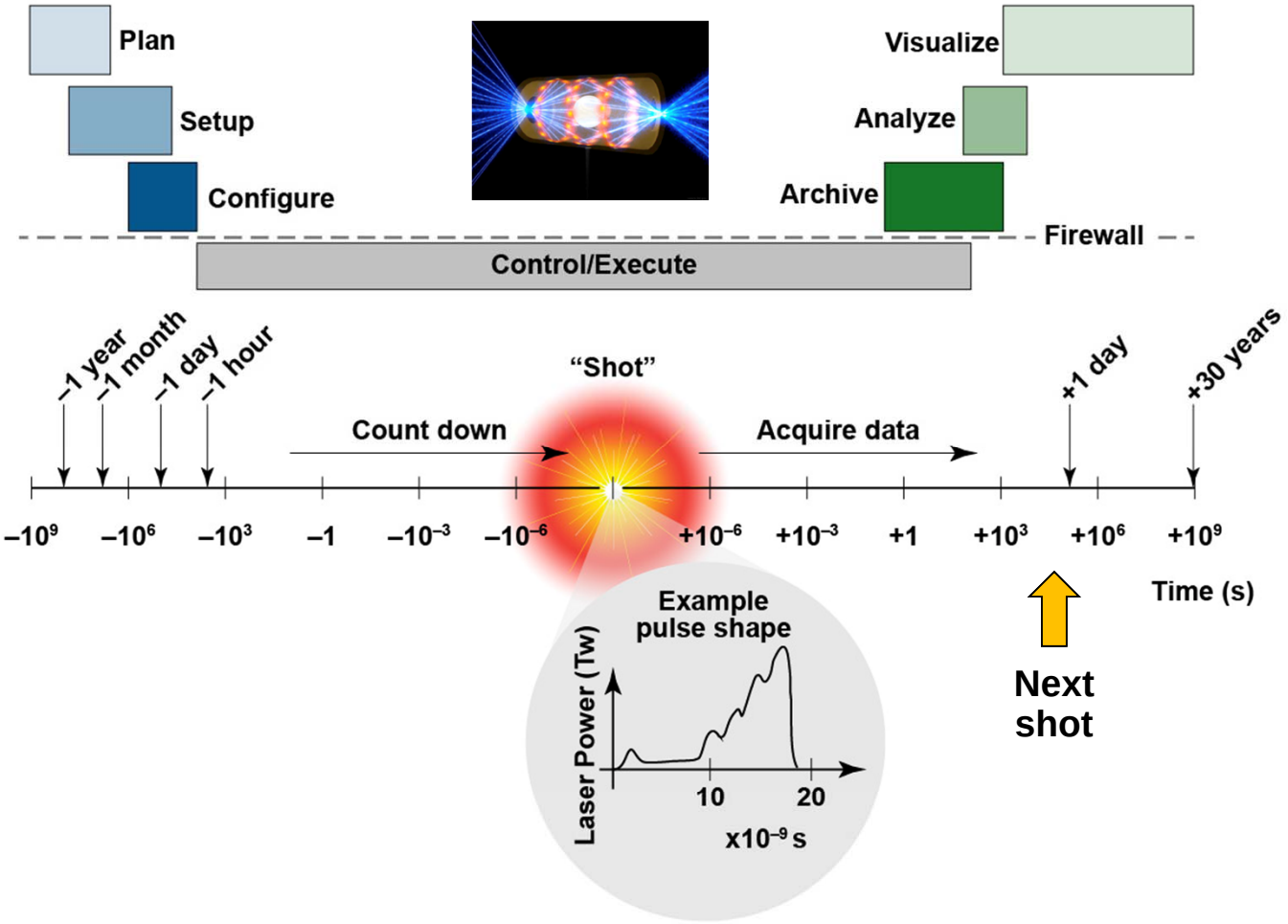

Simulators


Diagnostics

- 192 lasers to one target
  - Laser controls & restrictions
  - Target chamber controls
  - Target positioning & cooling
  - Industrial controls
  - Safety Systems
- >30 high-speed diagnostic systems
  - Alignment to target
  - Timing and triggering
  - Configuration and calibration
  - Acquisition, storage, analysis

Our goal was to design integrated web-based enterprise tools for experiment support – from planning through final analysis

NIF shots are isolated events that take months to plan, seconds to execute… with the results stored for years



The next shot can occur within hours (days for target shots), and is likely to require a very different configuration.

Shot-based operations at NIF need flexible, high-performance tools to plan and analyze experiments

2003 – First Four Beams

Rudimentary tools
- **File system, spreadsheets, macros**
- **Person to person communication**
- **Limited verification**

2010 – Full NIF

Specialized web-based expert tool suites
- **Collaborative planning**
- **Verifiable experimental setup**
- **Repeatable experimental analysis**

Shot Planning Tools serve to coordinate teams and maximize facility availability for experiments

Planning Tools help teams ask:

- When is the experiment needed?
- What is needed from the facility?
  - Laser beams used, pulse shapes
  - Target constraints
  - Diagnostic configurations
  - Facility and personnel safety
- What supplies are needed from the factory?
- What replacements are predicted?
- When is maintenance scheduled?

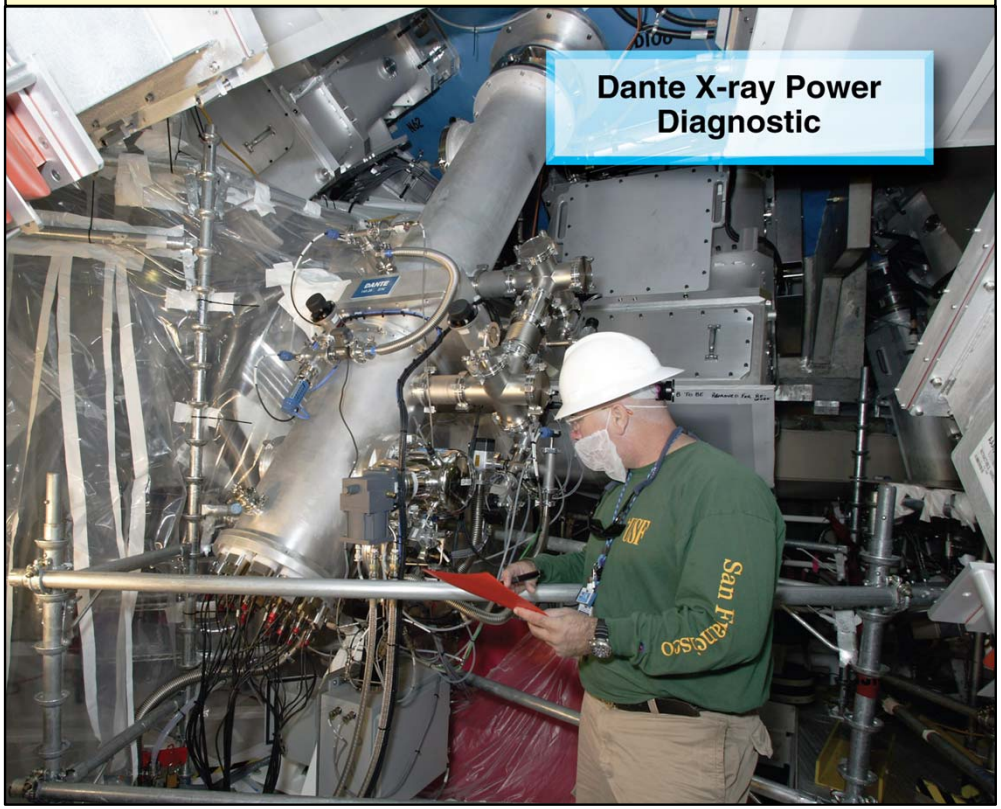
NIF Managers use these tools to plan hundreds of shots per year, and to communicate the schedule to the NIF community

Setup Tools enable the users to configure the facility for an experiment… and to verify that it is correct

Shot Setup Tools provide:

- All shot details (laser, target, diagnostics, facility)
- A “Rules Engine” to enforce operating envelope
- Electronic reports and approvals
- Automatic installation orders
- Comparison of Requested to Actual configuration
- Over 15,000 setup items and over 100,000 serialized parts

Dante alone has over 500 setup parameters



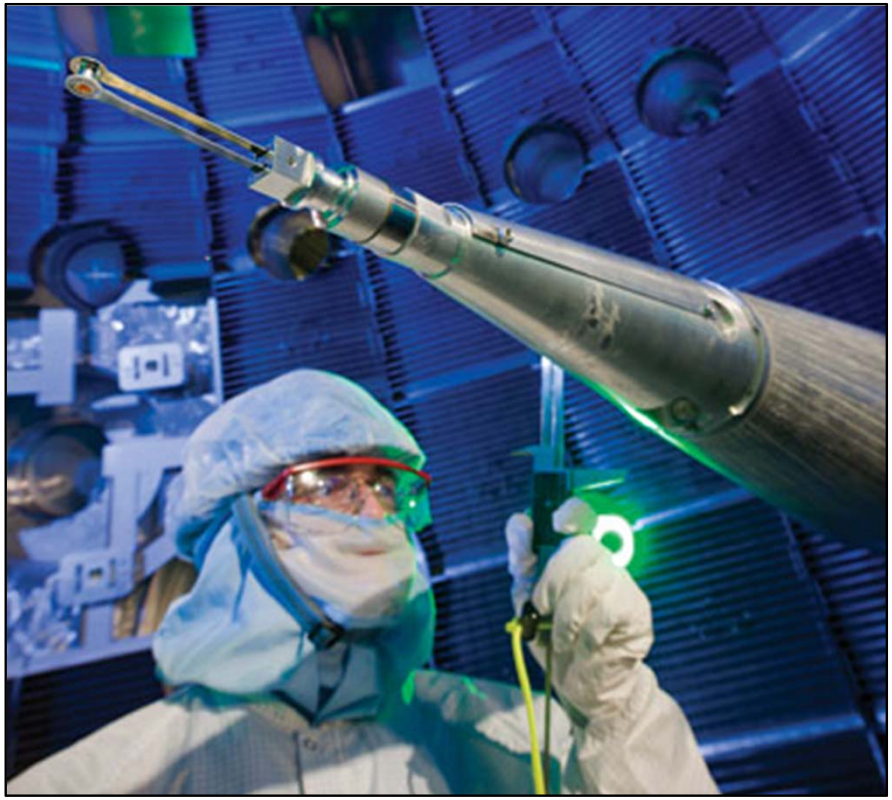
Each shot setup report is over 200 pages long (if printed)

Configuration Tools maintain a historical record of millions of parts installed on NIF

Configuration Tools answer:

- **Where is a part or assembly installed?**
- **When was it installed?**
- **What is its calibration?**
- **What is its maintenance plan?**
- **What is its exposure to laser fluence?**

- **“Seating Chart” shows current state**
- **Integrated Work Orders track parts**
- **Drawings are under strict document control**



Facility configuration is an integral component of data pedigree

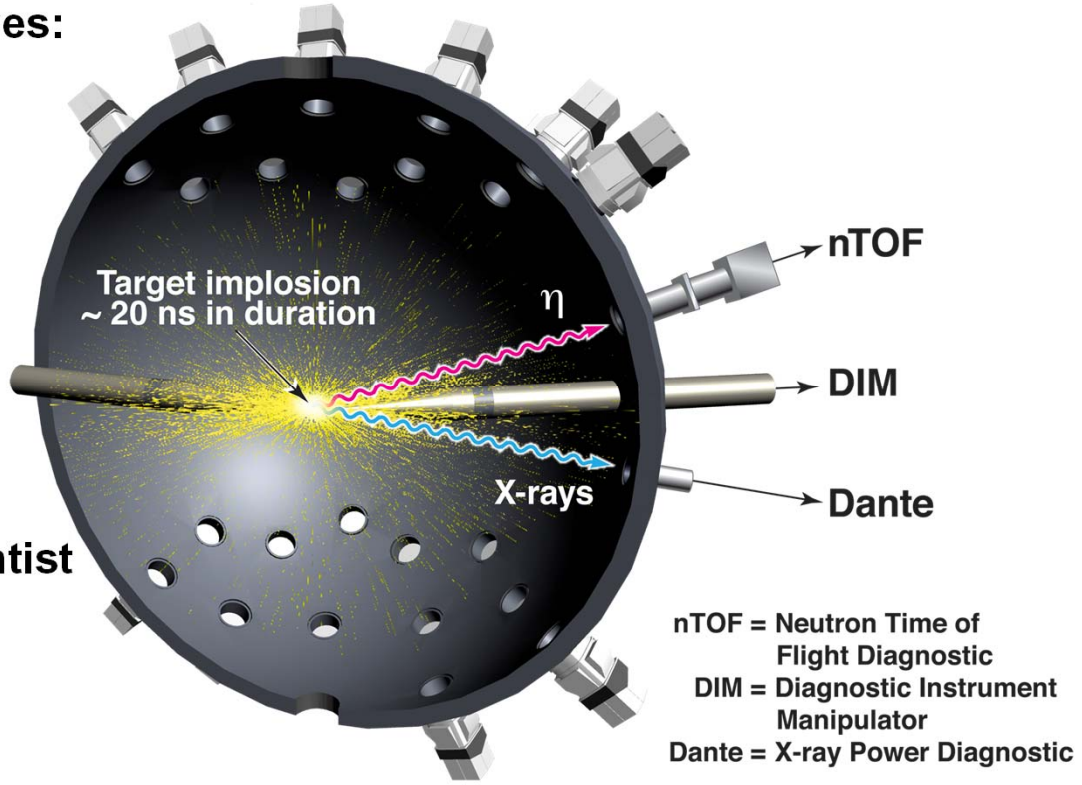
Archival Tools store diagnostic data post-shot, along with configuration and calibration details

Content Management System saves:

- Raw data and metadata
- Shot configuration
- Device calibrations
- Analysis parameters

The data must be

- Web-visible (in a few minutes)
- Reviewable – approved by scientist
- Downloadable
- Secure (for 30 years)



The association of data with its complete context is referred to as "pedigree", without which the results can be questionable

Analysis Tools provide scientists with integrated access to analysis algorithms and parameters

A team of Data Analysis experts work with the scientists to provide:

- Integrated analysis tools (in IDL) that maintain configuration and pedigree
  - Data-driven automated results available within 30 minutes
  - Desktop algorithms (for re-runs and “what-if” analysis)
- Results, error bounds, and quality metrics stored back in the archive
- Upload tools for off-line results (e.g., film, counters, gaseous sampling)
- Flow customized for each diagnostic

Automated Shot Analysis tools now process ~70% of NIF data, and <u>all</u> data are available for download and off-line analysi.

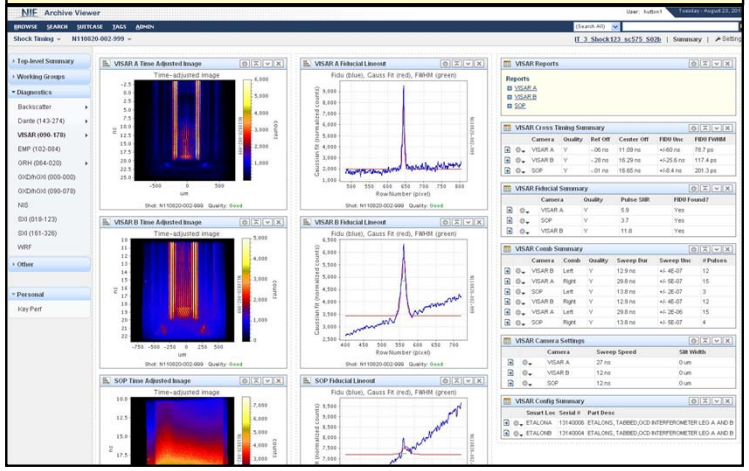
Visualization Tools provide scientists with various windows into their physics results

Archive Viewer provides:

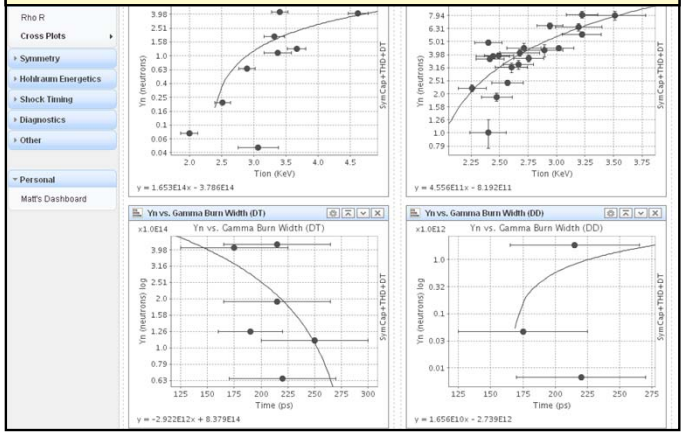
- **Configurable, interactive charts**
- **Rapid data availability**
- **Dashboards for Working Groups to "authorize" physics results**
- **Predicted simulations (pre-/post-shot)**
- **Cross-plots for correlations**

Comparison to simulations

Single-diagnostic view



Multi-shot trending



Web-based forms provide fast and flexible display capabilities

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2013 – User Facility

User-focused tool suites
- Secure and transparent access to tools and data
- Intuitive user experience and mobile applications
- Improved efficiency and availability of the facility

We now have over 40 integrated collaborative tools that routinely support dynamic, data-driven, high-quality shots on NIF


NIF