How does a shot RI get help?

NIF User Forum

Dan Kalantar
Senior Scientist, NIF User Office

November 10, 2015
How does a shot RI get help?

- The answer is coupled to roles and responsibilities
  - Shot RI roles and responsibilities
  - The shot lifecycle
  - Resources
  - Expectations

- This is a work-in-progress
  - As more complex and varied experiments are planned we discover additional information that is needed
The shot lifecycle has a number of steps to navigate

- Proposal
- Award
- Submission into shot planner
- Scheduling
- 6-month pre-review
- Target/diagnostics reviews as applicable
- 6-week submission for EG assessment
- 3-week setup review
- App-man sign-off
- Shot brief
- Execution
- Shot survey/feedback
The shot lifecycle has a number of steps to navigate.
The shot RI is responsible for the success of the experiment

- Defining the target, laser, and target diagnostics
  - Target requirements and experiment configuration
  - Beam selection, pointing, and laser setup
  - Diagnostic use and settings

- Ensuring all aspects of the experiment meet facility requirements
  - Materials use, laser energy and optics damage, debris and shrapnel
  - Alignment sequence, TAS interference, 3w and 1w light interactions

- Ensuring reviews are completed, negotiating rules of engagement

- Reviewing target and diagnostic metrology and alignment data

- Verifying alignment and diagnostic dry runs

- Providing feedback
Some of the resources that are available to the shot RI

- **Organizational resources**
  - Program management
  - Campaign PI
  - Project engineer
  - User Office
  - Expert groups
  - TF engineer
  - TD RS/RI
  - NIF Operations

- **Information repositories**
  - User Office web site
  - Contact list
  - User guide
  - Shot RI training program
The NIF User Office is publishing resource information

- NIF User Forum presentations (sharepoint)
- Shot lifecycle and review process (April Forum charts)
- Point of contact list
- User guide (update planned early 2016)
- Other useful information
  - Beam angles
  - Pointing limits
  - Shot RI tips
# NIF Contact List

<table>
<thead>
<tr>
<th>Area</th>
<th>Primary</th>
<th>Phone (925)</th>
<th>email</th>
<th>Backup</th>
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</tr>
</thead>
<tbody>
<tr>
<td>General User Support</td>
<td>NIF User Office</td>
<td>422-2179</td>
<td><a href="mailto:nifuseroffice@llnl.gov">nifuseroffice@llnl.gov</a></td>
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<td>Archive viewer</td>
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<tr>
<td>Laser setup</td>
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<tr>
<td>Pulse shaping and Timing</td>
<td>Mark Bowers</td>
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<tr>
<td>Power limits</td>
<td>Brian MacGowan</td>
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<td>BLIP and power balance</td>
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<tr>
<td>Beam pointing, TASPOS setup</td>
<td>Pascale Di Nicola</td>
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<tr>
<td>Unconverted light mitigation</td>
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<td>TaLIS, Beam stayout zones</td>
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<td>Target Production</td>
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<td>DIM based diagnostics</td>
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<td>Tim Sarginson, Bob Ehrlich</td>
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<td>Snout, filter and New capability requests, RVP</td>
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As of 2/19/2015

LLNL-M1-668130
Shot RI training

- There are two aspects to the NIF Shot RI training program
  - Facility required training (defined classes)
  - Program training (mentoring)
- Facility required training
  - Introduction to Shot RI Training
  - Introduction to CMT
  - Laser Performance
  - Target Fabrication
  - NIF Operations
  - Target Fielding
  - Diagnostics
  - Alignment
  - NIF User Office
Example – TD RS/RI role in specifying diagnostic configuration

- RS/RI is responsible for defining the standard operating mode for the diagnostic
  - Standard calibration, safe operation, golden templates

- RS/RI is responsible for reviewing the use for safety
  - Evaluating the configuration and use, not validity for data acquisition

- The RS/RI is a resource for guidance but not to engage the design aspects of the experiments
  - If the use falls outside the normal range of operation then it requires negotiation, priority, funding to establish a collaboration with the RS/RI

- Examples
  - Dante
Example – BLIP role in specifying laser setup

- BLIP has defined standard configurations for laser operation and rule-sets that are applied through CMT
- BLIP manages the laser model to meet standard performance
- BLIP reviewers verify the safe operation of the laser, do not review for consistency with physics goals or requirements
  - If the use falls outside the normal range of operation then it requires negotiation, priority, funding to establish a collaboration with BLIP scientists

- Examples
  - Large numbers of rod shots due to poor selection of amp configuration
  - Timing variability with 300 ps gaussian pulses
NIF User Office

- The User Office serves as an interface between all users and the facility
  - Solicitations, performance surveys, tracking
  - Maintains priorities for tools and capabilities
  - Optimizing and managing the schedule

- Senior scientist serves as a point of contact for information
  - Sometimes the source of information is from the program!
NIF data trends tool

NIF User Forum

Andrew MacPhee

10th / 11th November 2015
The NIF data trends tool provides a convenient way to visualize (and extract) scalar NIF data.

Available on the NIF wiki, runs in free Mathematica viewer.
First define the data series

Define data series here
Then select the X-Y axes for the plot

Choose axes here
Add additional labels to appear below the default labels

Choose additional plot labels here
The plot updates as you go along
Export series data, save settings, overlay least-squares fits, choose axes type, copy plot

Export data, save settings, fit data here
Example:
First choose how many data series to plot
Define up to 6 series (overlapping series points are progressively larger and distinguishable)

Series 1 and 2 are enabled in this example
Filter shots to include in each series from all target shots since NIC shock timing (N110603)

Define series 1

Define series 2, 3, 4, 5, 6
Choose one or more parameter to filter shots by
For example, filter by “Sub-campaign” name:
Select which “sub-campaign” names to include e.g., all “High Foot” and “High foot DT” shots
This filter returns 65 shots:
Hover over series name to see the list of shots that match the filter (click for table and copy/paste)
Include additional parameter to further refine the filter
For example, include all “AuDU” hohlraums
This refined filter returns 15 shots

i.e., 15 shots since N110603 were in Sub-campaigns “High foot” and “High foot DT”, and also used a “AuDU” hohlraum
Select X and Y axes for the plot:
Example: X axis: $T_{\text{ion}_{\text{DT}}}$, Y axis: 13-15MeV yield
...gives this plot.
By default the plots are labelled with a few key parameters.
Change labels to shot number only:

Change label to shot number
Weighted least-squares fit, hover for fit parameters. Uses method of D. York

Am. J. Phys. 72 (3), March 2004

weighted least-squares fit
Copy data for all series to the clipboard

Copy XY data to clipboard

Fit: $\log_{10} y = (4.701 \pm 0.989) \times 10^{-1} x + (1.294 \pm 0.0286) \times 10^{1}$, $X_{n-2} = 2.10547$
Copy filter criteria to clipboard
Hover over XY points for more detailed shot info:
Includes “Shot Purpose” and “Main Physics Learned” cells from Nino’s spreadsheet
The tool combines data from several sources: Webdav (archive), Nino’s spreadsheet, Prav’s derived metrics pressure etc, Target RVP, other derived metrics i.e. coast time, $\Delta B T_{x-\gamma}$ etc...

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<thead>
<tr>
<th>Enable data series:</th>
<th>1 2 3 4 5 6</th>
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<tr>
<td>Color code:</td>
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<tr>
<td>Target RVP and laser</td>
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<td>Derived metrics</td>
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<td>Diagnostics</td>
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</table>

1: Switch series' on/off using the 6 buttons above
2: Define shot series' using criteria in the tables below:
   i) Select parameters in the left panel
   ii) Select values in adjacent tabbed panels
      Use **SHIFT** for a range, *** (or **CTRL** on pc) for discrete multiples
3: Set x/y plot axes using the menu on the right

Hover over points, legend etc for details (click for more)
'Interactive plot' button enables zoom:
Click and drag to zoom, shift to pan, double click to reset
Interactive plot interferes with series selection so disable when selecting data
Weighted (in both x and y) orthogonal regression of a straight line uses **York**
You can find the data trends tool in the NIF wiki under HED-ICF.

In NIF wiki select HED-ICF
Select NIF Data Trends Tool in left panel

![Select NIF Data Trends Tool in left panel](https://nifit.llnl.gov/wiki/display/vc/NIF+Data+Trends+Tool)

Select NIF Data trends Tool here
Download the tool here

Download the latest version of the interactive NIF Data Trends Tool here

Generate exportable interactive plots of NIF data using various tools.

You can run the tool using the FREE Mathematica CDF Player v10, you don't need Mathematica installed (although it will also work with any CDF player)

A new version of the tool is built every morning using freshly downloaded data back files (so if a bunch of values get retroactively updated as happens from time to time, this will account for those)

Build starts at 7am and is usually available by ~8:10am. The date in the box below shows when the tool was last updated

The tool works cross-platform on OSX, Window and Linux

Here's a zip file of the raw data embedded in the tool (not needed to run the tool)

Email me if you have any questions or if you would like to use the tool for something else

Andrew MacPhee
The tool runs in the free Mathematica viewer. Also runs in the full Mathematica version.
Beware spurious correlations:

Letters in Winning Word of Scripps National Spelling Bee correlates with Number of people killed by venomous spiders

Correlation: 80.57% (r=0.8057)

From: http://www.tylervigen.com/spurious-correlations

Data sources: National Spelling Bee and Centers for Disease Control & Prevention
Most of the data is pulled from the archive daily on the fly using WebDav, hence always up to date

http://nifitservices.llnl.gov/ArchiveWebDav/export/shotdata/tags
Requires a webdav username and password (Steve Hahn, B671, x4-5542)

“tags” define the list of shots retrieved:
DT_shots, Target_shots_since_shock_timing,…

“reports” define what data is retrieved:
Authorized_values, Shot_inputs,…
The list of available reports has grown over the years. Clicking a link fires up a script that goes and builds the .csv for that tag.

<table>
<thead>
<tr>
<th>Report Name</th>
<th>Date/Time</th>
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Target Gas Density Calculator
Concept, Usage & Limitations

NIF Users’ Forum

Dean Holunga, PhD
Cryo Ops Process Engineer

Originally authored by Jim Fair, PhD
Mac conversion by Curtis Walters, PhD

November 10, 2015
Why Have a Gas Density Calculator?

- In 2012, it was realized that the non-ideality of subcritical THD gas mixtures exceeded the allowable uncertainty of the capsule density.
  - Why? Conversion from density to pressure was not accurate using the Ideal Gas Law alone.
  - Jim Fair authored the first calculator that calculated the density of the isotopic mixtures of hydrogen and helium.
    - Other gases & gas mixtures being shot are similarly non-ideal. E.g., Neopentane.

- Primary purpose
  - To calculate an accurate conversion of density (mg/cm³) to pressure (torr) in target gas fill requests.
    - To quantify the non-ideal behavior of subcritical or high pressure gases and gas mixtures.

- Secondary purposes
  - To predict the equilibrium of THD mixtures (H₂, D₂, T₂, HD, HT, DT) from cryogenic to room temperature.
  - To predict the atomic particle density (atoms/cm³).
Model Approach To Non-Ideality Corrections

- Virial Coefficient Corrections to the Ideal Gas Law
  \[ z = \frac{P}{RT\rho_m} \approx 1 + B\rho_m + C\rho_m^2 + \ldots \]
  - Mixing Rules (generally accepted for B, but not universally accepted for C)
    - 2\textsuperscript{nd} Virial Coefficient – for low pressure, low temp or moderate pressure, high temperature gases
      \[ B_{ij} = \frac{(B_i + B_j)}{2} \]
      \[ B_{mix} = \sum_{i=1}^{N} y_i B_{ii} + \frac{1}{2} \sum_{i=1}^{N} \sum_{j=1}^{N} y_i y_j \delta_{ij} \]
      \[ \delta_{ij} = 2B_{ij} - B_{ii} - B_{jj} \]
    - 3\textsuperscript{rd} Virial Coefficient – for high pressure gases near critical temperature
      \[ C_{ijk} = \frac{(C_i + C_j + C_k)}{3} \]
      \[ C_{mix} = \sum_{i=1}^{N} \sum_{j=1}^{N} \sum_{k=1}^{N} y_i y_j y_k C_{ijk} \]
Caveats

- How good are the predictions? As good as the data.
  - E.g., Vapor pressure. Sources include:
    - Correlations from NIST
    - Compilation of literature data – polynomial fit
    - Antoine equation
  - THD Virial Coefficients
    - 2\textsuperscript{nd} VC - High Confidence:
      - From PIMC models, which match historical data from Souers, Sherwood, Reed, Grilly and others, and is valid from 15K through RT.
    - 3\textsuperscript{rd} VC - Unproven:
      - Is estimated using H\textsubscript{2} 3\textsuperscript{rd} VC data and a corresponding states mapping (about T_c) from the 2\textsuperscript{nd} VCs.

- Programming sanity checks is time consuming
  - Use your own judgment and knowledge of the materials being studied.
  - When in doubt, call me.
Using the Density Calculator (Demo)

- **V2.5 & above:**
  - On a PC: Open the document, accept that Macros need to be run.
  - Navigate to the “Calculator” tab.
  - Enter the desired mass density & shot temperature.
  - Adjust the composition.
  - Check the right hand fields.
  - Find the pressure alongside the desired composition

- **V2.4 (Mac)**
  - Open the document.
  - Navigate to the “Calculator” tab.
  - Enter the desired mass density & shot temperature.
  - Adjust the composition.
  - For THD Mixtures ONLY:
    - N.B. Click the “THD Mixture Calculate” button. Wait for convergence.
    - If there is no convergence, navigate to the “THD EquilibriumCalculator” tab
      - Click “Reset” and “Solve” buttons.
      - Adjust “initial value factor” if necessary.
      - Re-click “Solve” to increase the number of solver iterations.
  - Check the right hand fields.
  - Find the pressure alongside the desired composition

- **V2.6 beta**
  - Working to resolve the issue of porting VB from PC to Mac version.
Using the Density Calculator (Demo)

- Case 1: Recent D₂-Filled HDC Symcap shot (N151025-001)
- Case 2: How do I request a specific density/mixture?
- Case 3: Post shot re-verification
Using the Density Calculator – Case 1

- Recent D₂-Filled HDC Symcap shot (N151025-001)
  - Original desired density:
    - 4 mg/cc at 32K
  - AppMan Request
    - 1486 Torr at 24K
  - Fielded Capsule
    - Liquid Deuterium
  - What red flags existed?
Using the Density Calculator (Case 2)

- Case 2: How do I request a specific density/mixture?
  - 10 mg/cc of D₂ at 32K
    - Answer should be immediately available
  - 10 mg/cc of 0.4 at% D⁻³He at 32K
  - 10 mg/cc of 50:50 DT at 32K
    - Mac: must click solver button
  - 10 mg/cc of 2/24/74 HDT at 32K
    - Mac: must click solver button
Using the Density Calculator (Demo)

- Case 3: Post shot analysis
  - Requested: 10 mg/cc of 0.75/0.25 HT at 32K
    - Calculator indicates: 5022 Torr at 32K.
  - Cryo Reports on !DATA:
    - 5069 Torr
    - Mass Spec Analysis
      - 74% H
      - 25% T
      - 1% D
    - Calculator (trial & error)
      - 10.21 mg/cc at 32K
  - NOTE: 75/25 from calculator is 10.13 mg/cc
Recently added/changed features

- On the PC version, the THD Equilibrium Calculator is now “live,” no need to hit a reset & run-macro button
  - Seems to work for three-component THD mixtures.
  - Uses a pragmatic “forced-mass-balance” scheme to converge the equilibrium expressions.

- Science fiction checks
  - Polynomial correlation of saturated vapor density of THD.
  - Color coding: an indication of when an estimate is violating something
    - **Green** is good
    - **Red** is bad
    - Any other color: **Use with Caution**
      - Data may be extrapolated or near some critical value (e.g., saturation temp, valid range of vapor pressure expression, etc.)

If its broken, or if the calculator doesn’t have a mixture or material that is of interest, contact me.