U.S. DEPARTMENT OF ENERGY | Office of Science

NSTX-U

Navigating the PCS Interface

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NSTX-U Physics Operators Training
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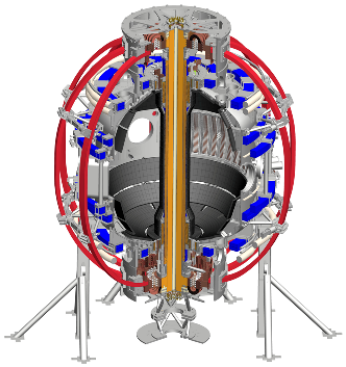
PPPL



Starting the PCS Interface

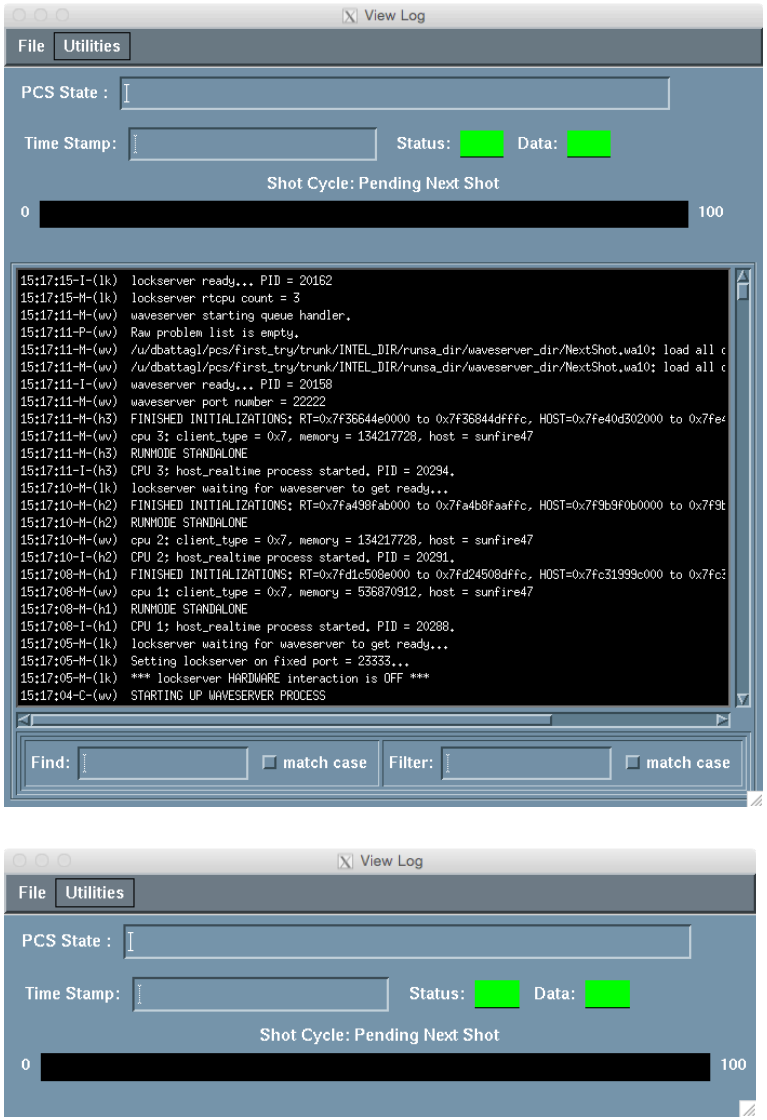
- Become a member of PCS Unix group
  - Submit a ticket to helpdesk
- Log in to the real deal when sitting at the P.O. station
  - ssh -Y user@pcs-rt-3
  - ssh -Y user@pcs-srv-3 (preferred once it is ready)
  - Navigate to folder /opt/pcs/INTEL_DIR/
    - ./run_wave
- Or run stand-alone PCS anywhere
  - Set up PCS for future shots or run simulations
  - Keith or Roman can help you get this code in your area
  - ssh -Y user@pcspool
  - Navigate to folder /trunk/INTEL_DIR/
    - ./runsa

You get the purple box

- File
  - Version
  - Quit
- Control
  - Next shot
  - Future shot
  - Shared shot
- Utilities
  - View PCS log

PCS log provides useful feedback on status and communication with realtime system

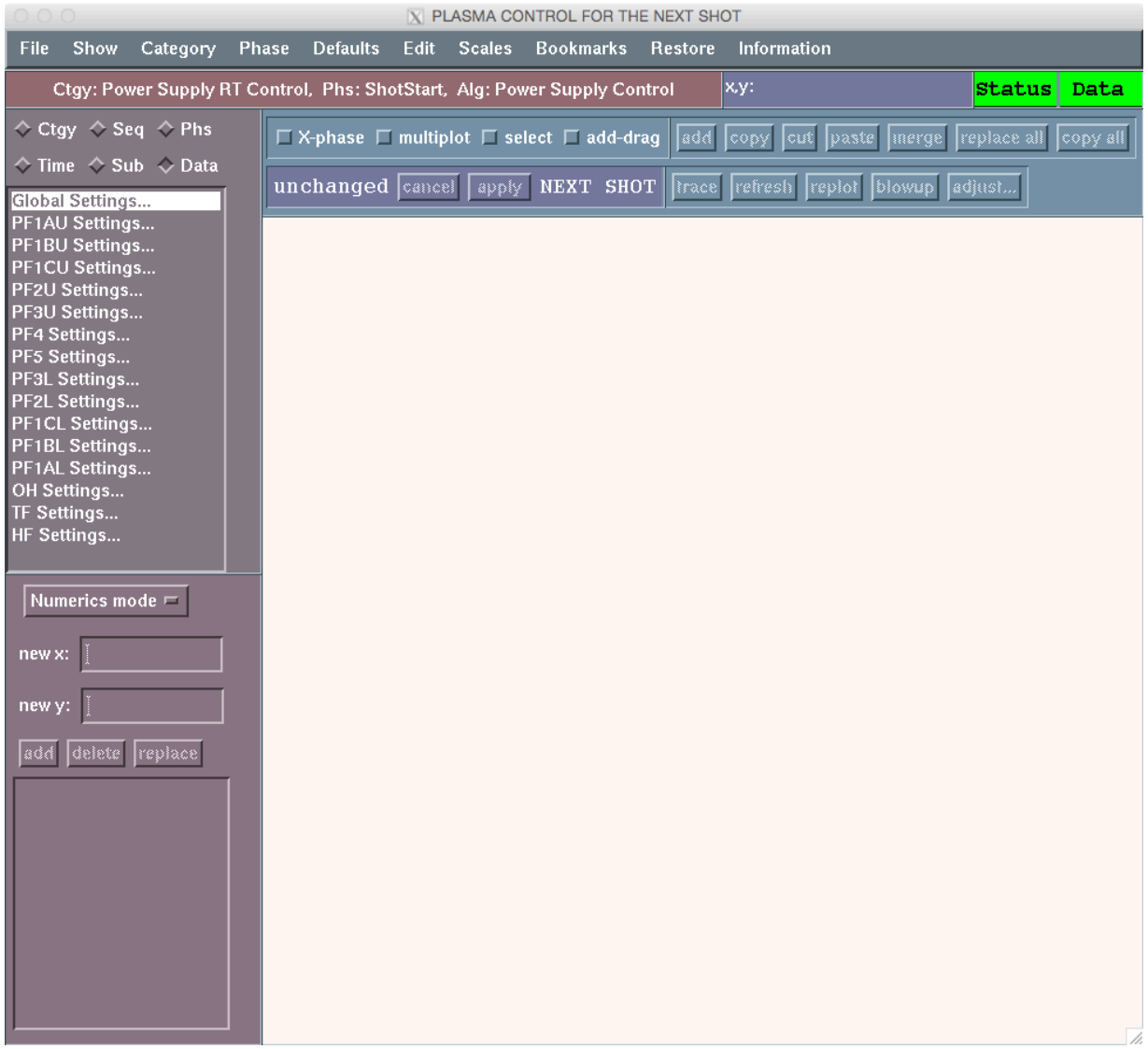
- File
  - Quit
- Utilities
  - Show pcs log messages
  - Hide pcs log messages
    - This is the default
  - PCS process table
    - Shows what computers are up
  - Show realtime errors only
- I like to keep this window open on the desktop



Choose the type of control

- Control
  - Next shot
    - Changes made in GUI are written to the realtime computer
      - On pcspool … change parameters for next simulation
      - On pcs-rt-3 … change parameters for next shot
  - Future shot
    - Set up a shot for restoring later
  - Shared shot
    - Change a future shot made by someone else

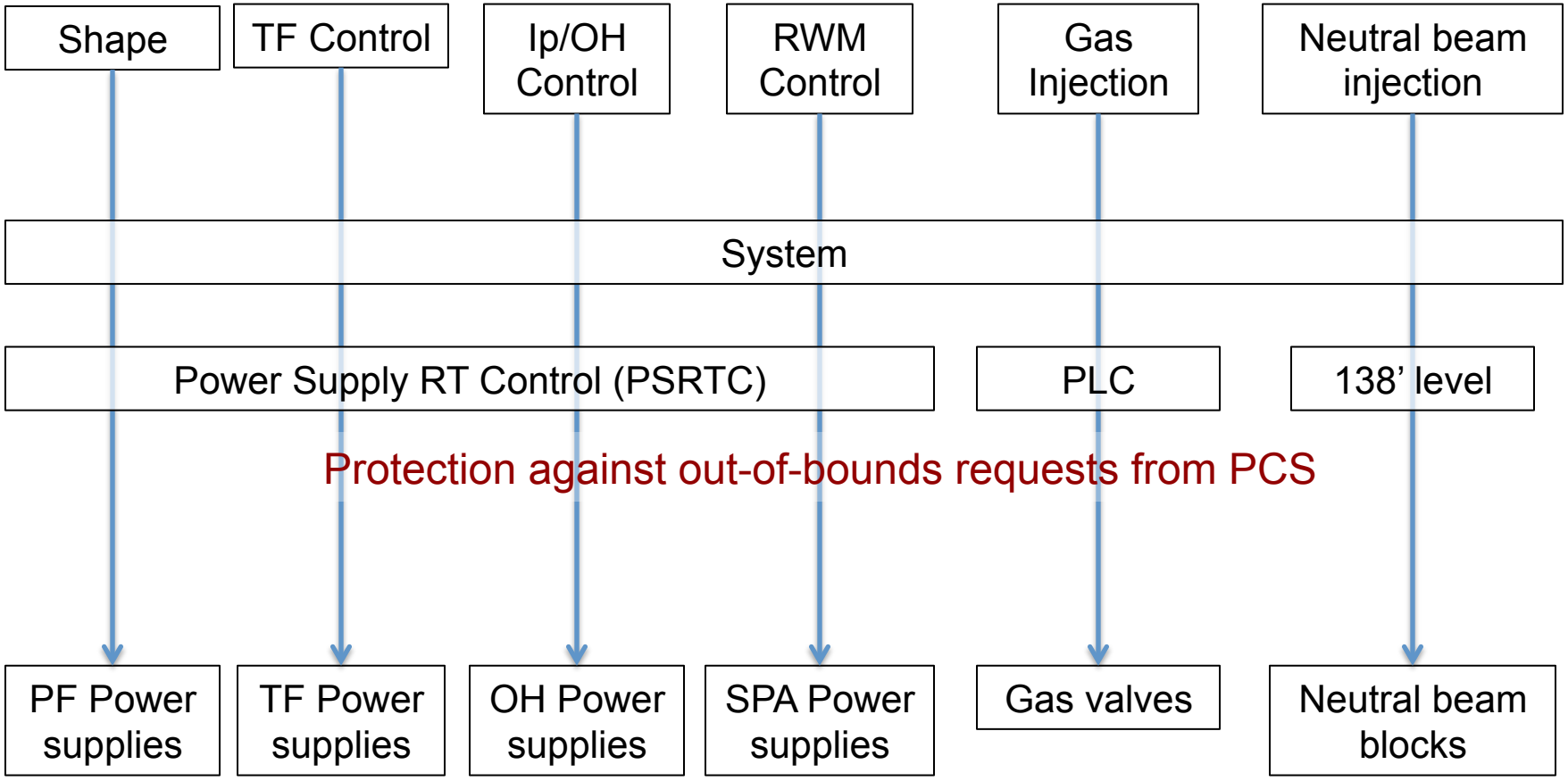
Choosing “Next shot” opens the PCS GUI



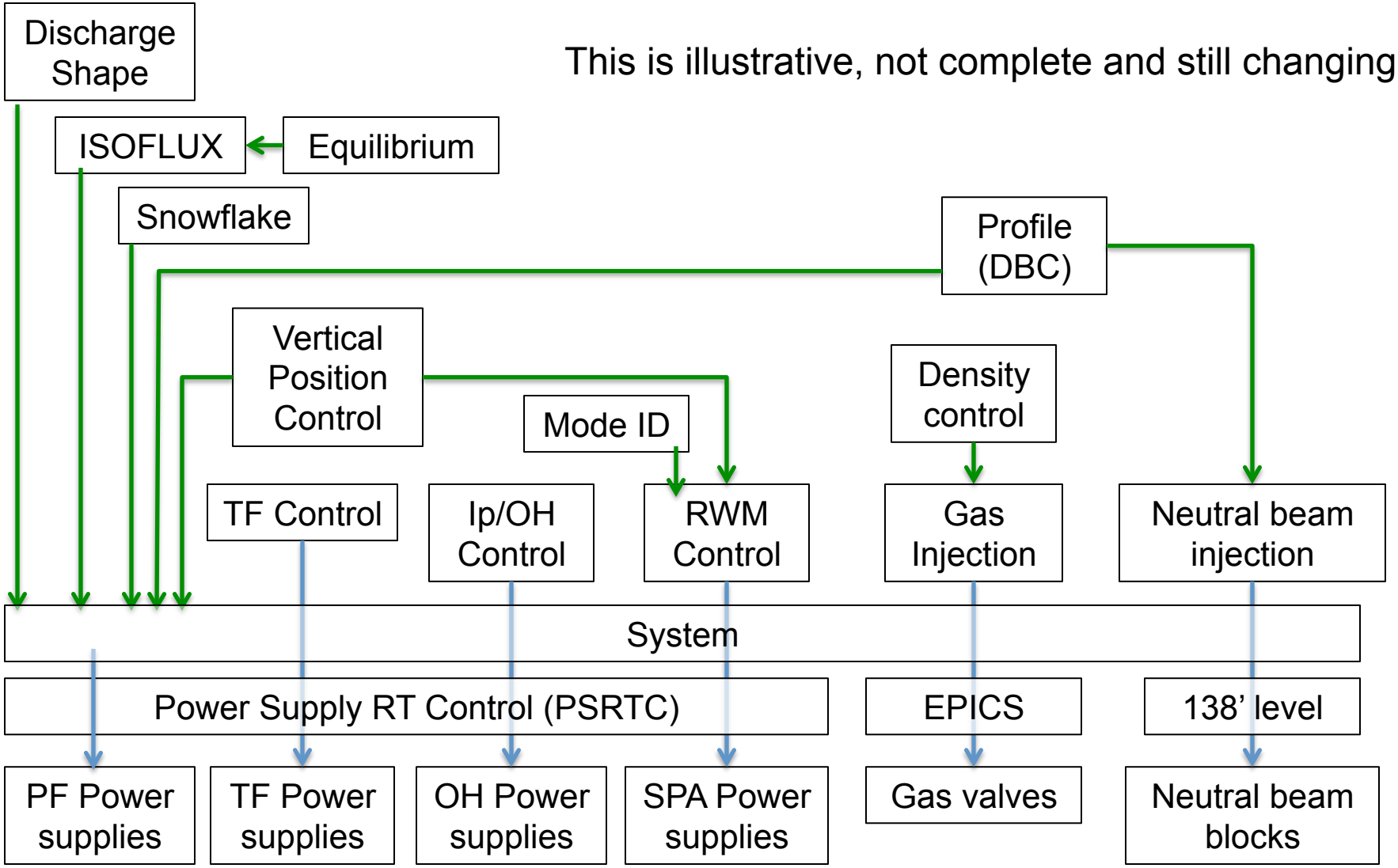
- Talk will now focus on navigating this window
  - But first, let’s take a step back

PCS baseline categories align with control actuators

"Baseline Categories" provide control and/or control switches for a single actuator



Upper level categories send requests to baseline categories



Every category has “Algorithms”

- TF control has two Algorithms
  - **TF current control**: request TF coil current versus time
  - **TF rampdown control**: ramp TF current from initial value to zero over a specified time interval

- Discharge Shape has three Algorithms
  - **Do Nothing**: category is disabled
  - **Day0**: Current control of PF coils
  - **PCC**: Day0 capability plus I_{PF} vs I_{OH}, I_{PF} vs I_P, outer gap
    - Categories accrue algorithms as new versions come along

Every category has “Phases”

- Each phase runs one algorithm with unique parameters
  - P.O. can add/delete phases, cannot add/delete algorithms
- You could have multiple phases calling the same algorithm but with different control parameters
  - Divide pulse into separate experiments where a number of algorithm parameters change
  - Or save different settings for an algorithm
    - For example “rampdown” and “fast rampdown” in the IP/OH category
- Most categories have just one phase for each algorithm
  - For example, TF Control category has two Algorithms and Phases
    - [Phase] ShotStart = TF current control [Algorithm]
    - [Phase] Rampdown = TF rampdown control [Algorithm]

Every category has a "Primary" phase sequence

- "Primary" phase sequence sets timing of the phases
  - For example, TF Control Primary Phase Sequence:
    - T = -5s [Phase] ShotStart = TF current control [Algorithm]
    - T = +3s [Phase] Rampdown = TF rampdown control [Algorithm]

- Category may also have "Alternate" phase sequences
  - P.O. cannot add/delete alternate phase sequences
    - P.O. can change the phases in each alternative sequence
  - Algorithms switch to these alternate phase sequences
    - For example, IP/OH category has two alternate phases that are activated by the IP0 algorithm
      - **Insufficient Ip**: Switch to this sequence if I_p is below a threshold
        » [Phase] Rampdown = IP1 [Algorithm]
      - **Ip LOC**: Switch to this sequence if OH coil current exceeds bounds
        » [Phase] Fast rampdown = IP1 [Algorithm]

Let's review

- PCS control is divided into categories
- Every category has a library of algorithms
- You create a library of phases
  - Each phase uses a single algorithm
- You define the timing of phases in the Primary phase sequence
  - You also define the timing of phases in any Alternative (dynamic) phase sequences

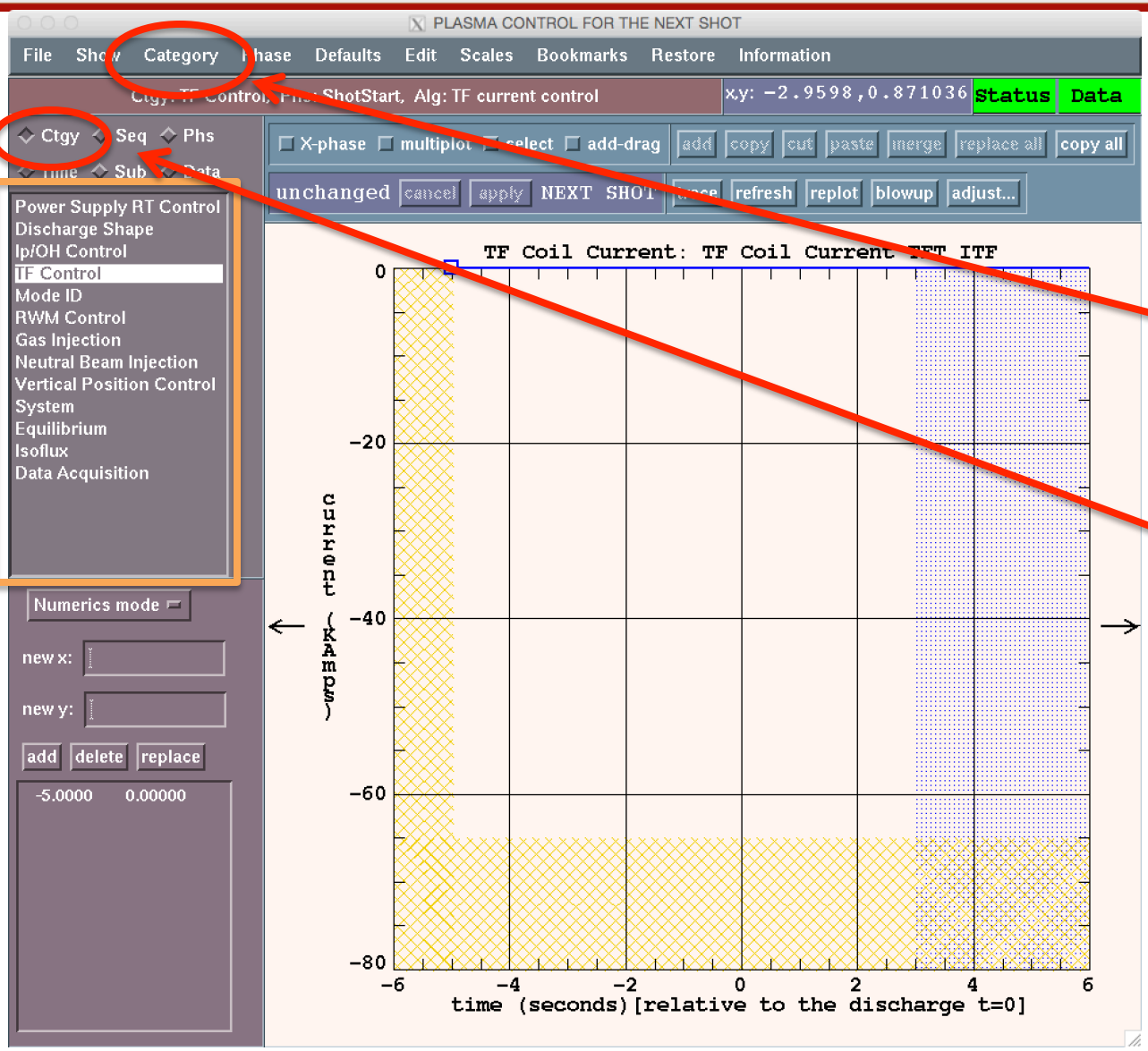
The main task of a P.O. is to change the input parameters for control algorithms

- Inputs to algorithms are organized into subsets
  - [Cat] TF Control, [Phase] ShotStart, [Alg] TF current control
    - Coil Current
      - TF Coil Current
    - TF gains
      - TF Gain, P
      - TF Gain, I
    - Rampdown Info
      - Automatic Rampdown
      - Ip Rampdown Threshold

Subset
Waveform, table or GUI

We aim to have specs for each algorithm

Let's begin the tour



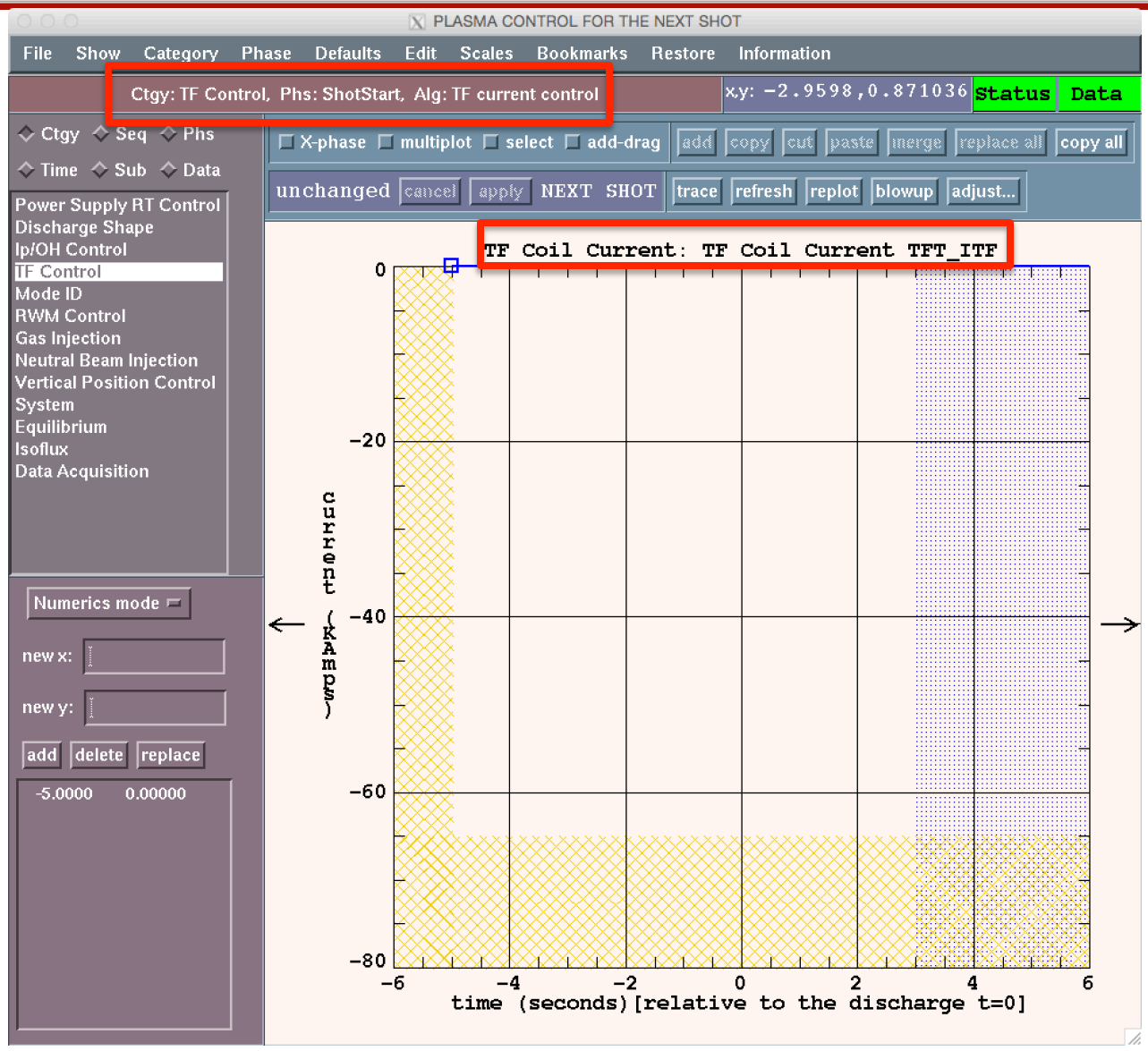
Open a category:

- Select from Category menu

--- or ---

- Click Ctgy radio button and select from menu

Selecting a category

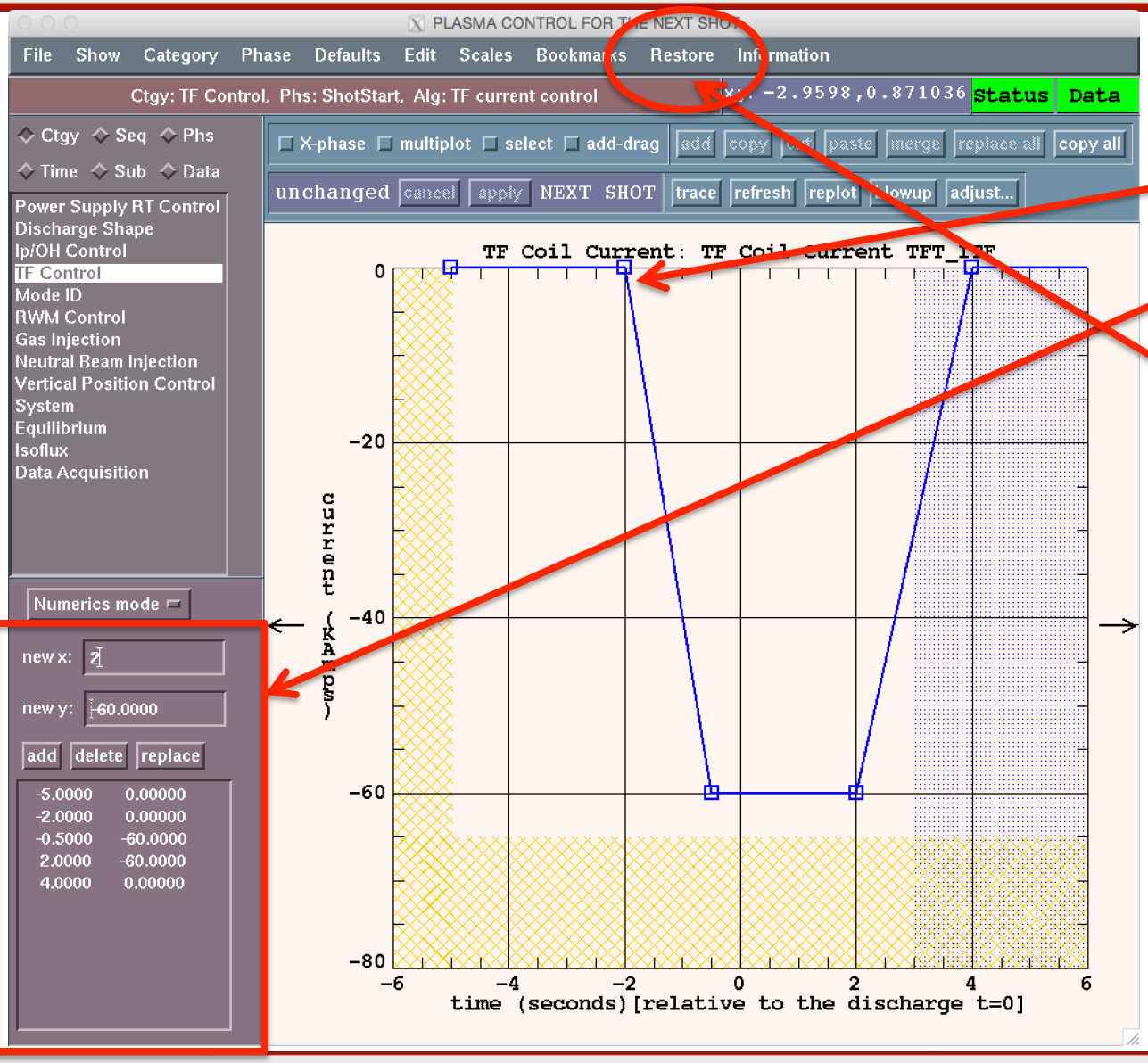


I have selected "TF Control" Category

Now we see the first waveform in the first subset of the algorithm in the first phase of the primary sequence

- Coil Current
  - TF Coil Current
- TF gains
  - TF Gain, P
  - TF Gain, I
- Rampdown Info
  - Automatic Rampdown
  - Ip Rampdown Threshold

Enter a waveform



You can…

Draw in points

Type in points

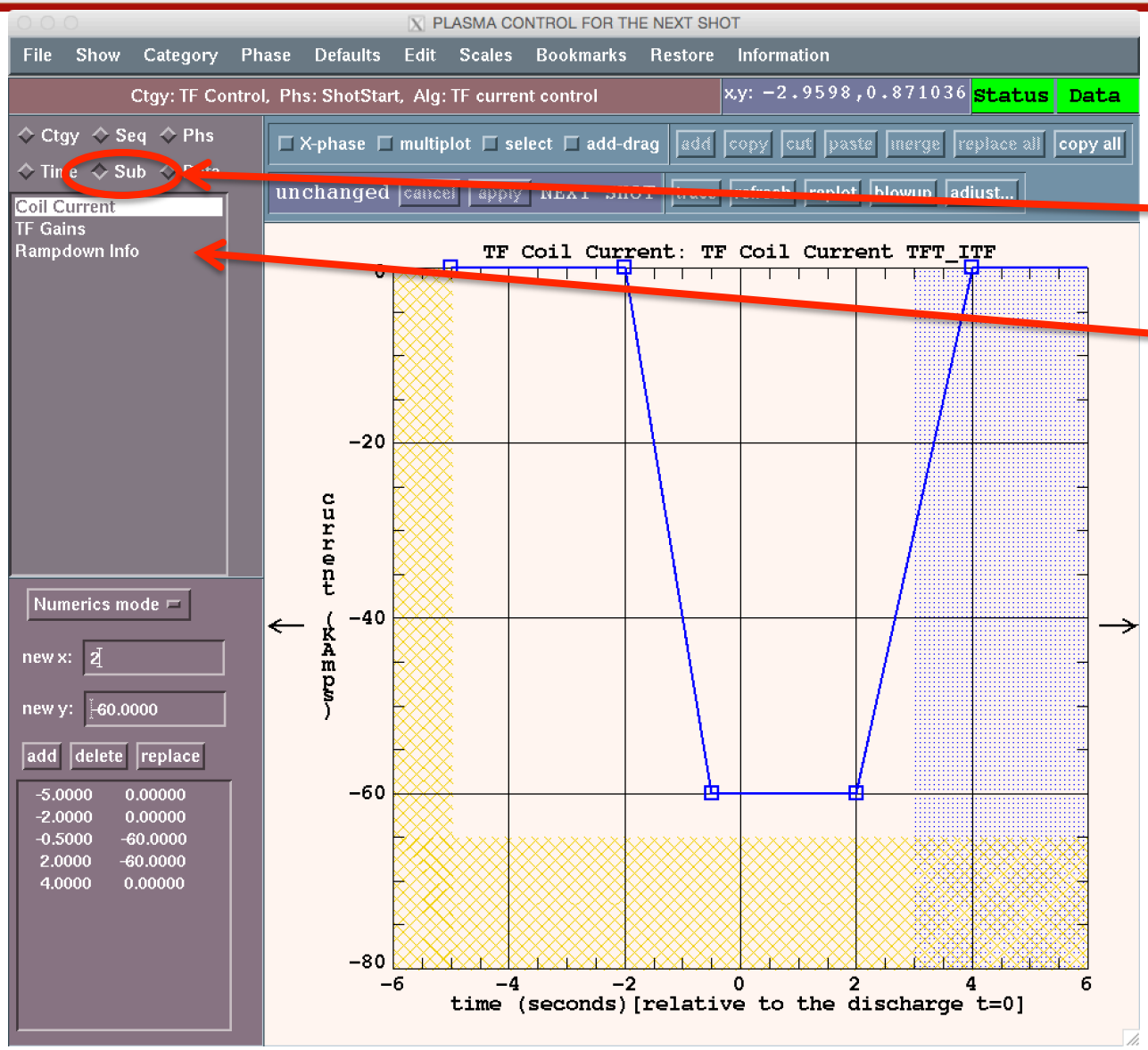
Restore points

… more on this later

Yellow: bounds

Blue: switch to new phase

Navigate to a new waveform

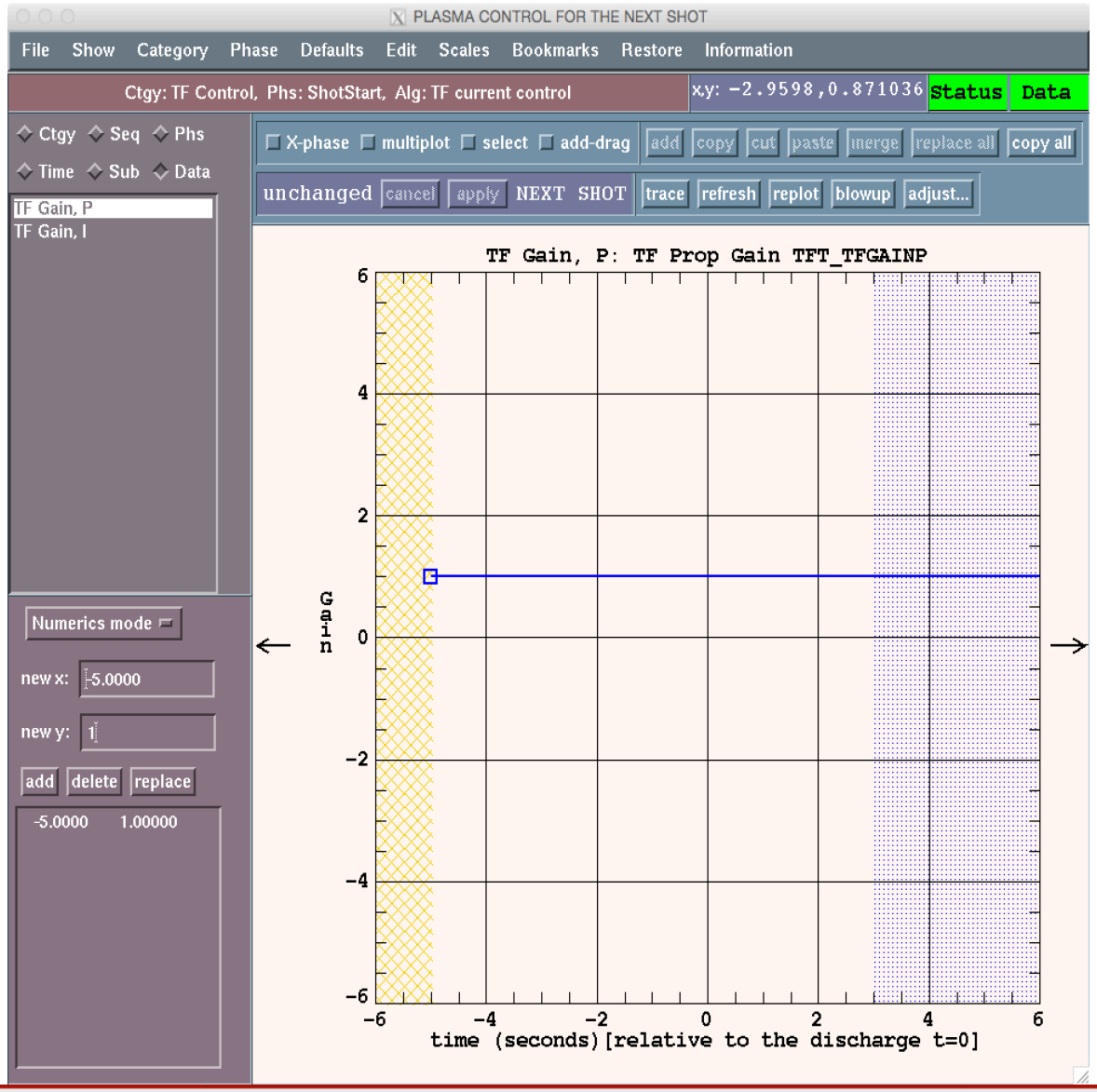


Select Sub radio button

Subsets appear in menu window

- Coil Current
  - TF Coil Current
- TF gains
  - TF Gain, P
  - TF Gain, I
- Rampdown Info
  - Automatic Rampdown
  - Ip Rampdown Threshold

Enter values for a new waveform

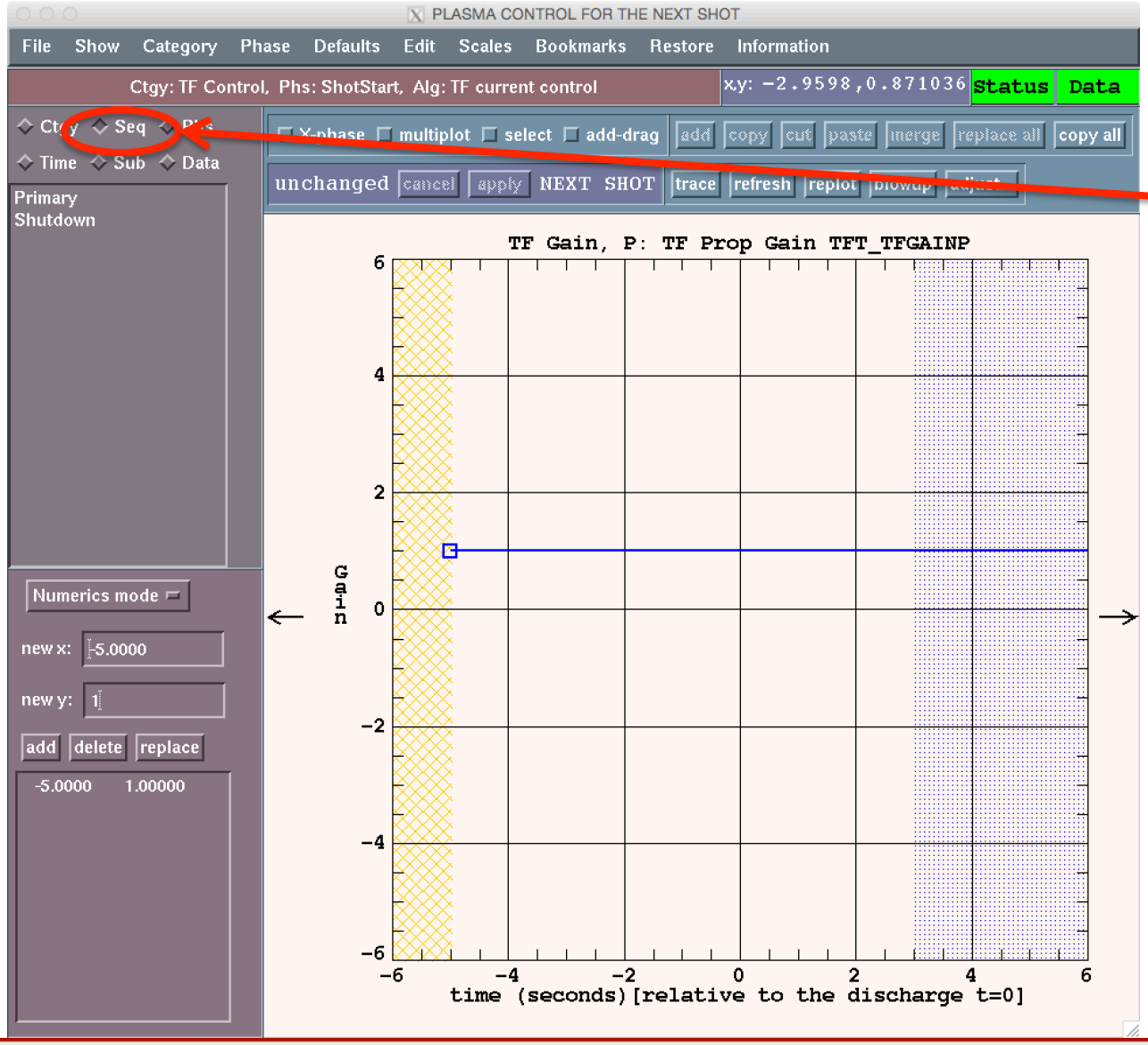


I selected TF Gains subset

Now editing TF proportional gain

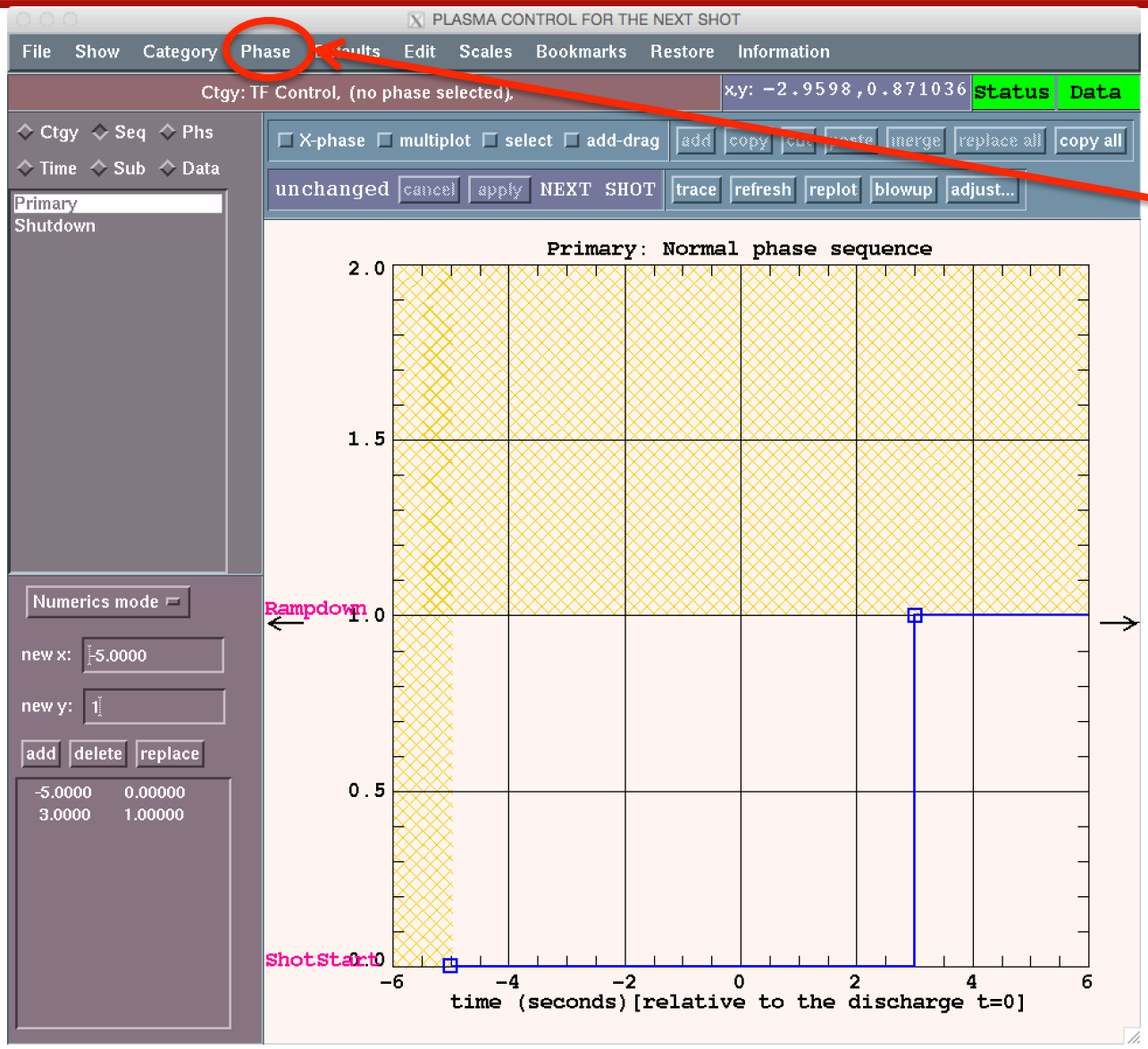
- Coil Current
  - TF Coil Current
- TF gains
  - TF Gain, P
  - TF Gain, I
- Rampdown Info
  - Automatic Rampdown
  - Ip Rampdown Threshold

Navigate to Phase sequence



Select the “Seq” radio button

Primary sequence describes order and timing of phases within category



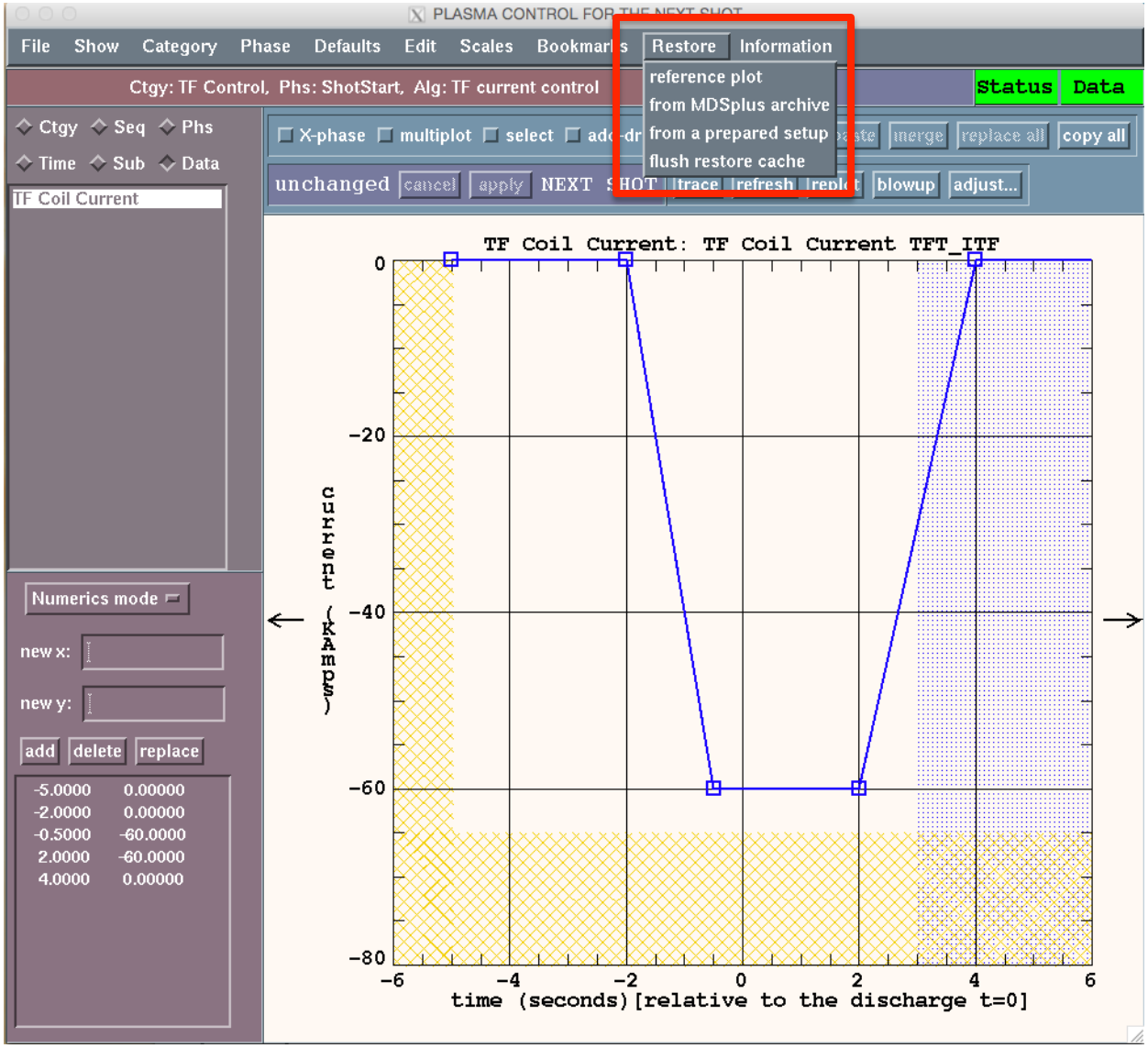
You can add/delete phases in the category using the phase menu

The waveform describes timing of phase switching

TF category has one alternative sequence called Shutdown.

It is called if
Ip < threshold

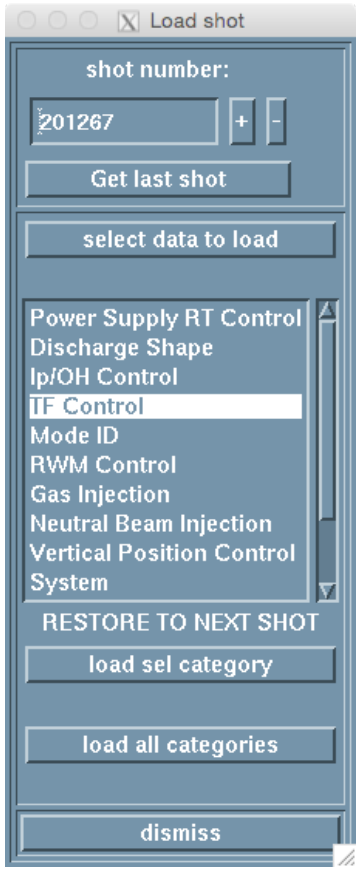
Restoring data from older shots or prepared shots is a common activity



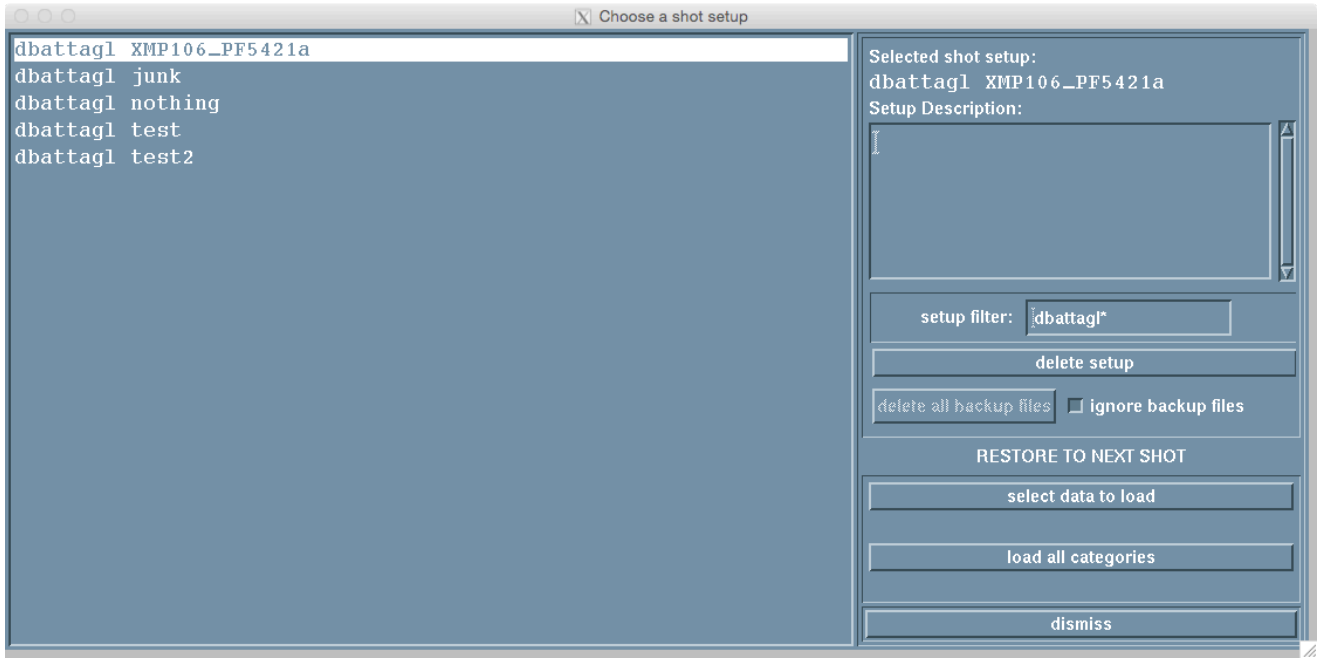
- Restore menu
  - Reference plot
    - Plot data from a shot to compare
  - MDS archive
    - Restore data from an old shot
  - Prepared setup
    - Restore data from a future shot
  - Flush cache

Loading data from an old shot or prepared setup

Load data from shot

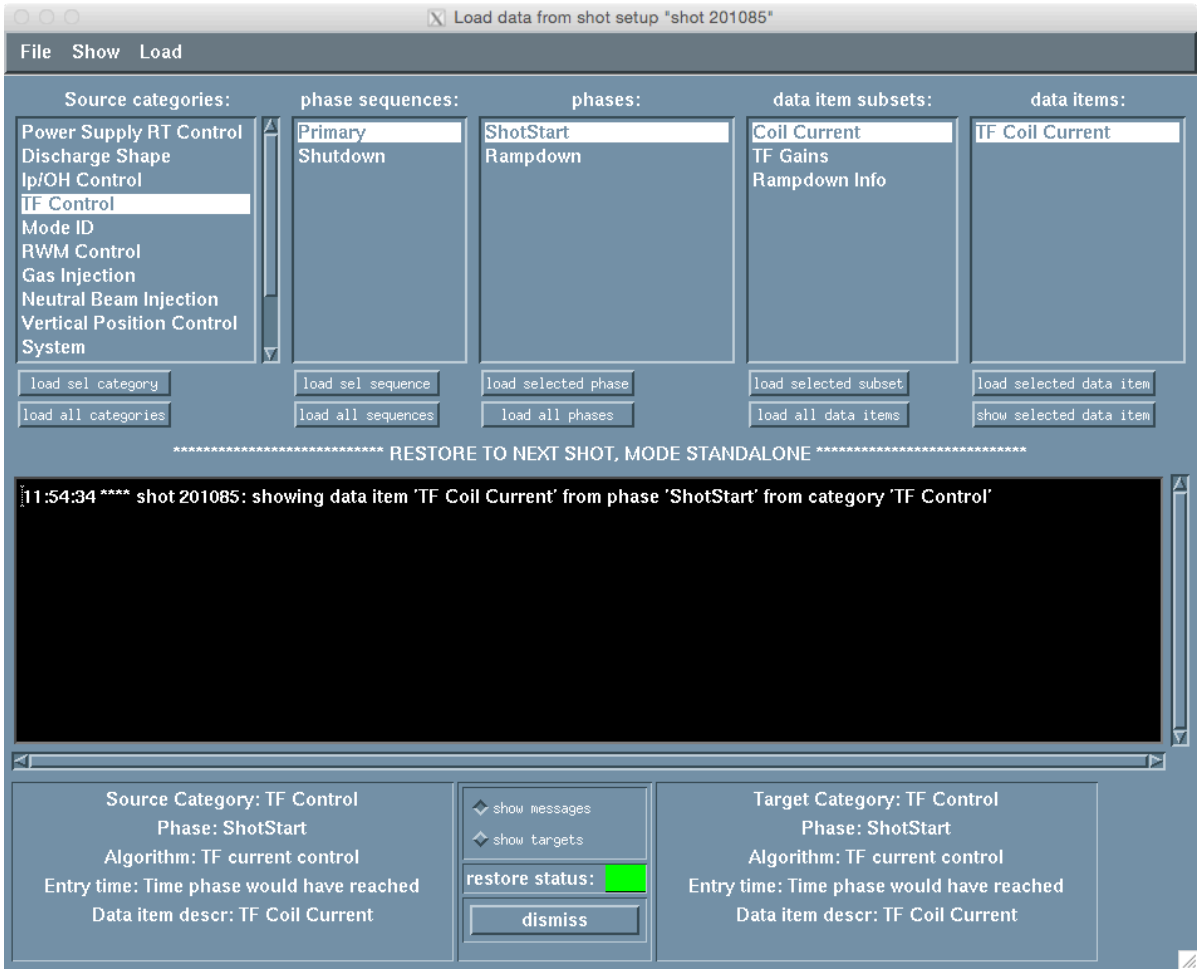


Load data from a prepared setup



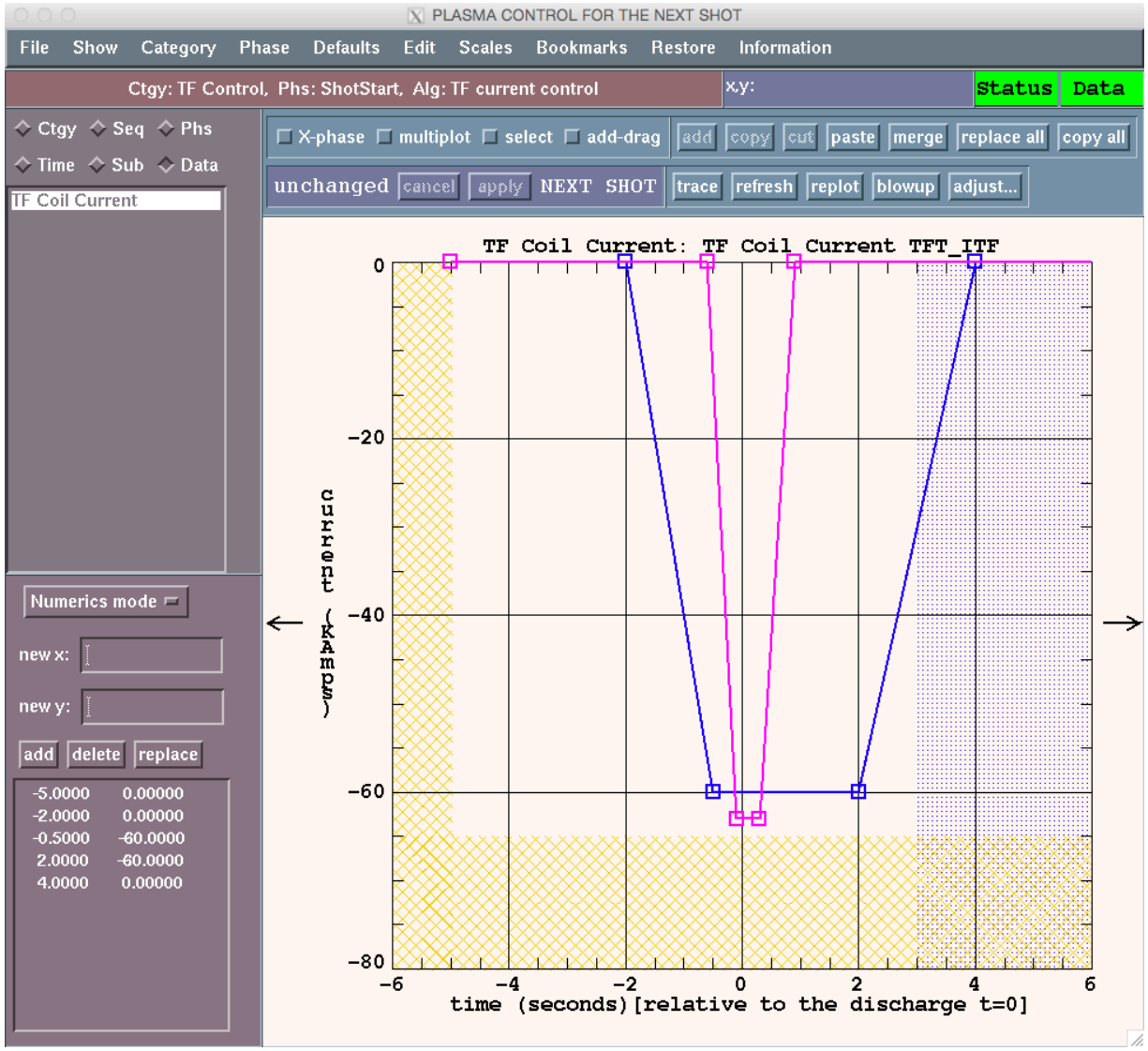
Load all categories: Reload everything it can
Load sel category: Just reload selected category
Select data to load: Opens a new window

“Select data to load” gives full control over what to load and where



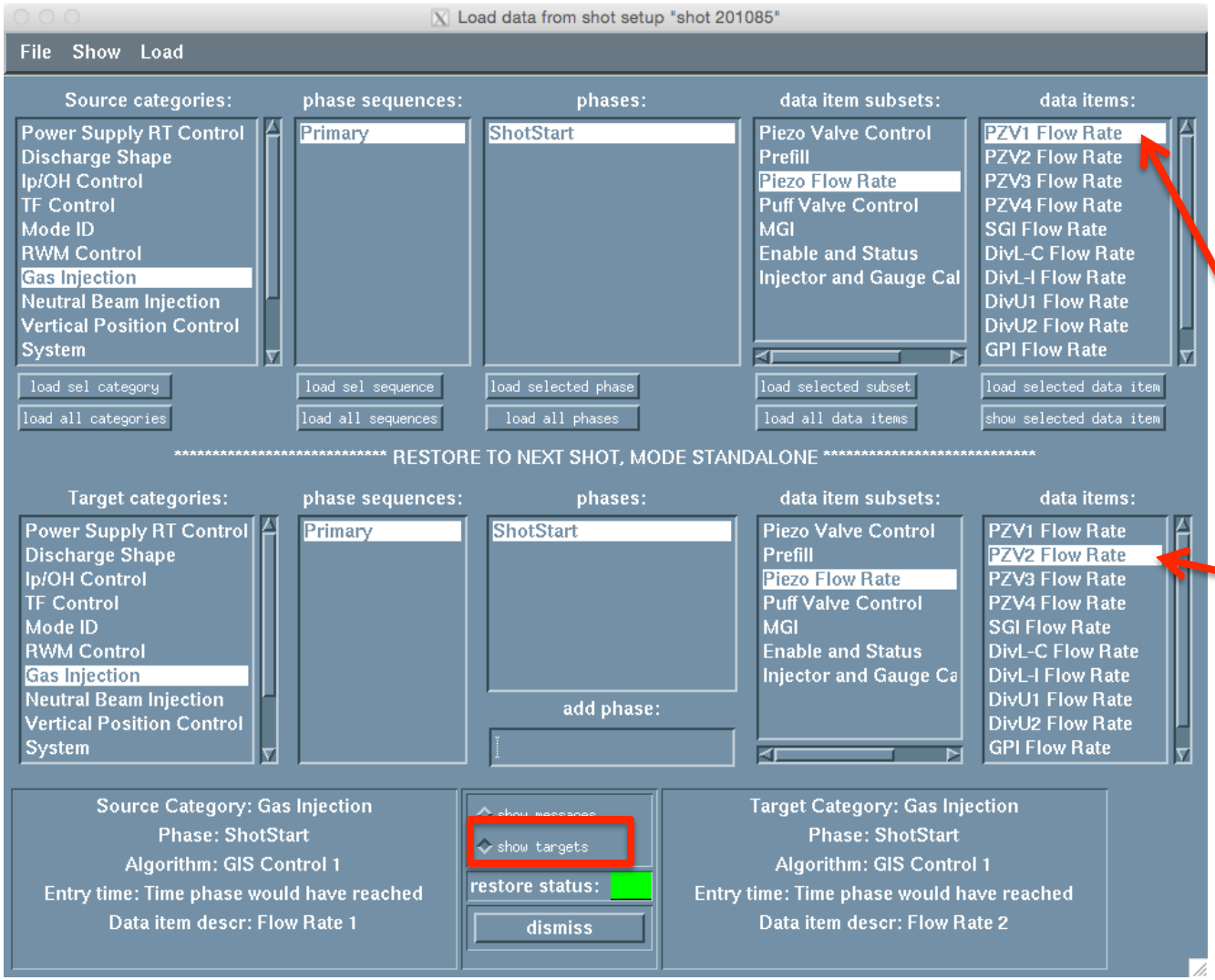
- Load selected data item
  - Loads that data item from the source
- Show selected data item
  - Plots that data item for comparison

Using “Show selected data item” before restore is good practice



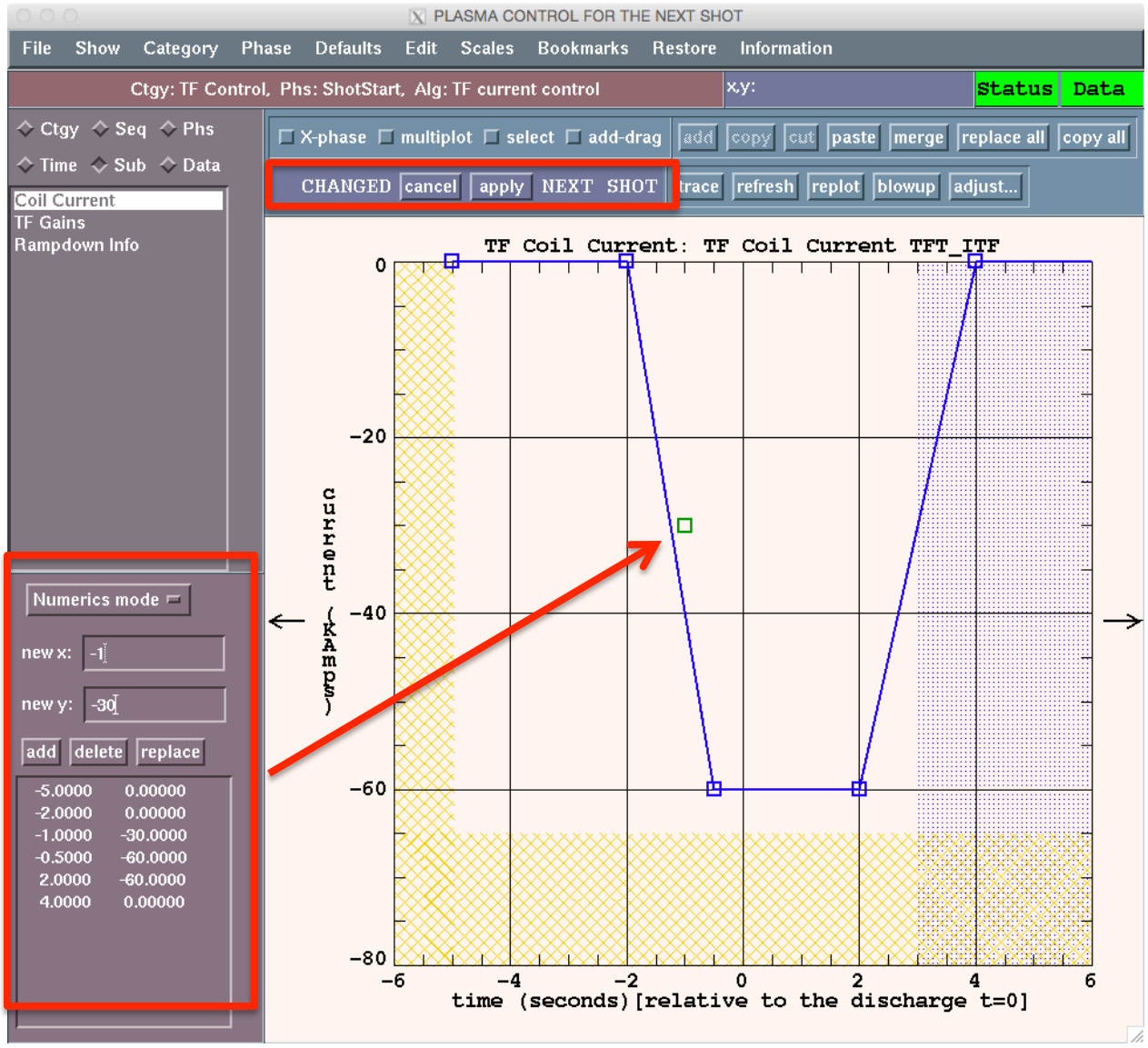
- Comparing the TF current request waveform (blue) to the TF request for shot 201085 (pink)

Load a data item into a target with a different name



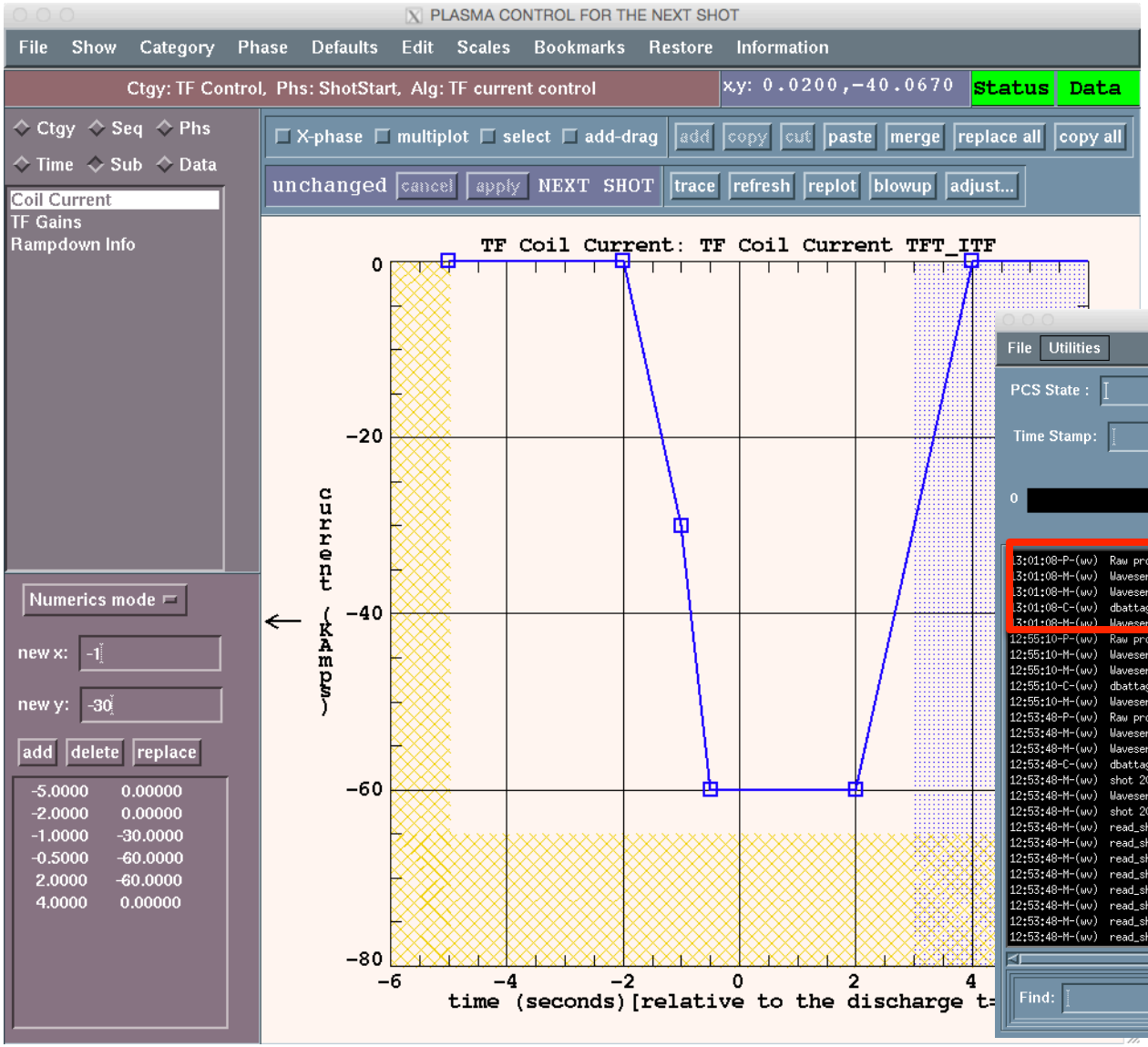
- The radio button "show targets" is selected
- Loading the PZV1 Flow Rate from shot 201085 into PZV2 Flow rate for the next shot

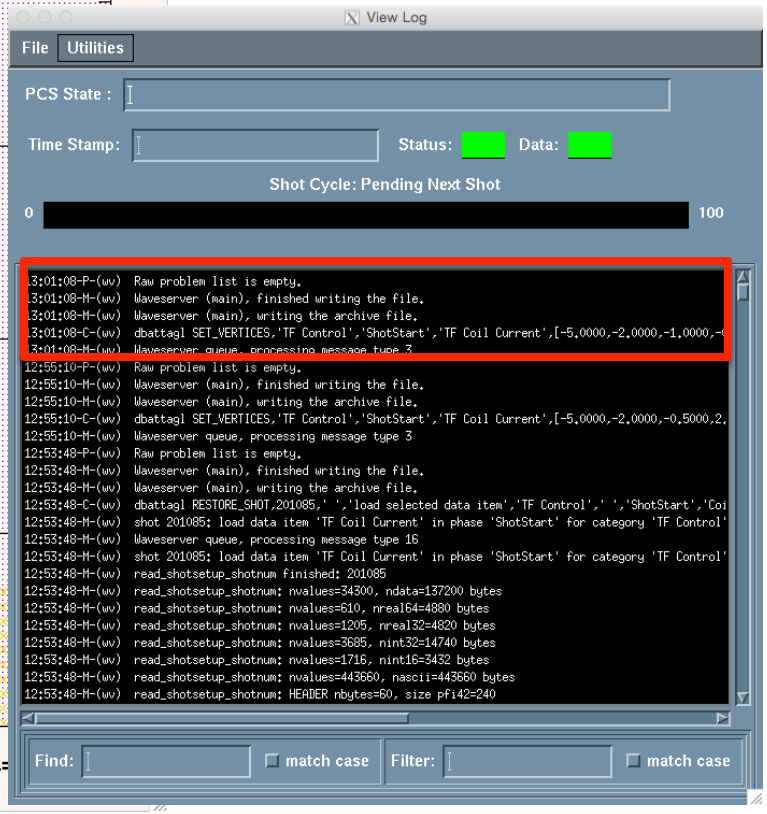
Changing a waveform



- A point is added by entering the new x and new y coordinates and pressing "add"
- THE CHANGE IS NOT MADE UNTIL YOU PRESS APPLY

Press apply and the change is made



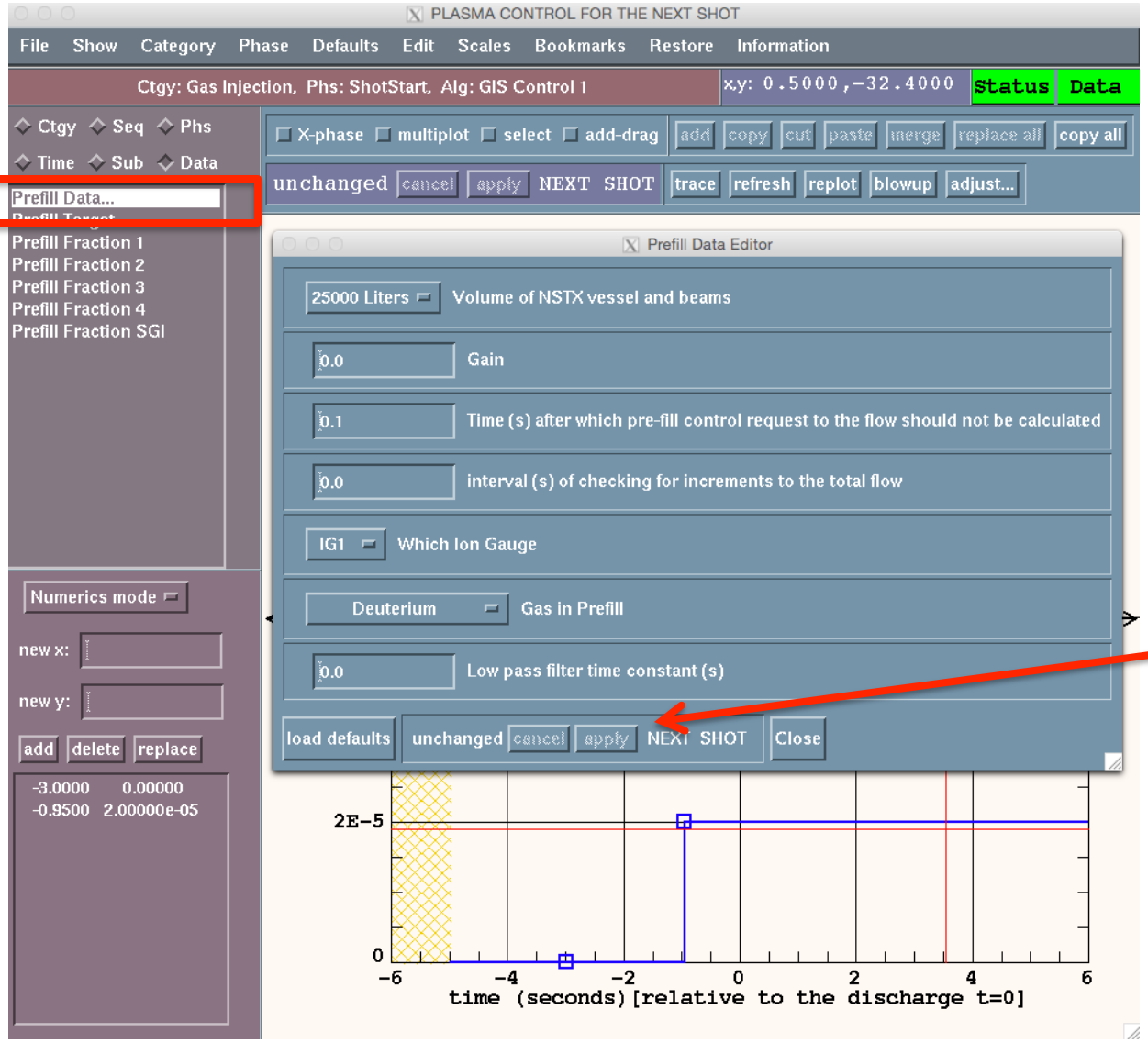


You have until first lockout (t = -60s in countdown)
to APPLY changes

Entering and manipulating waveforms is best learned on the job

- Mouse control lets you select points, add points, delete points, pan and zoom
- There is a clipboard for cutting, copying and pasting
- Scale or shift selected points
- Overplot references, proposed changes
- Load points from a text file or use a function generator

Some data items are GUIs instead of waveforms



GUIs are indicated with "…" in the list of data items within a algorithm subset

GUI could have a mix of menus, radio buttons, sliders and single number parameters

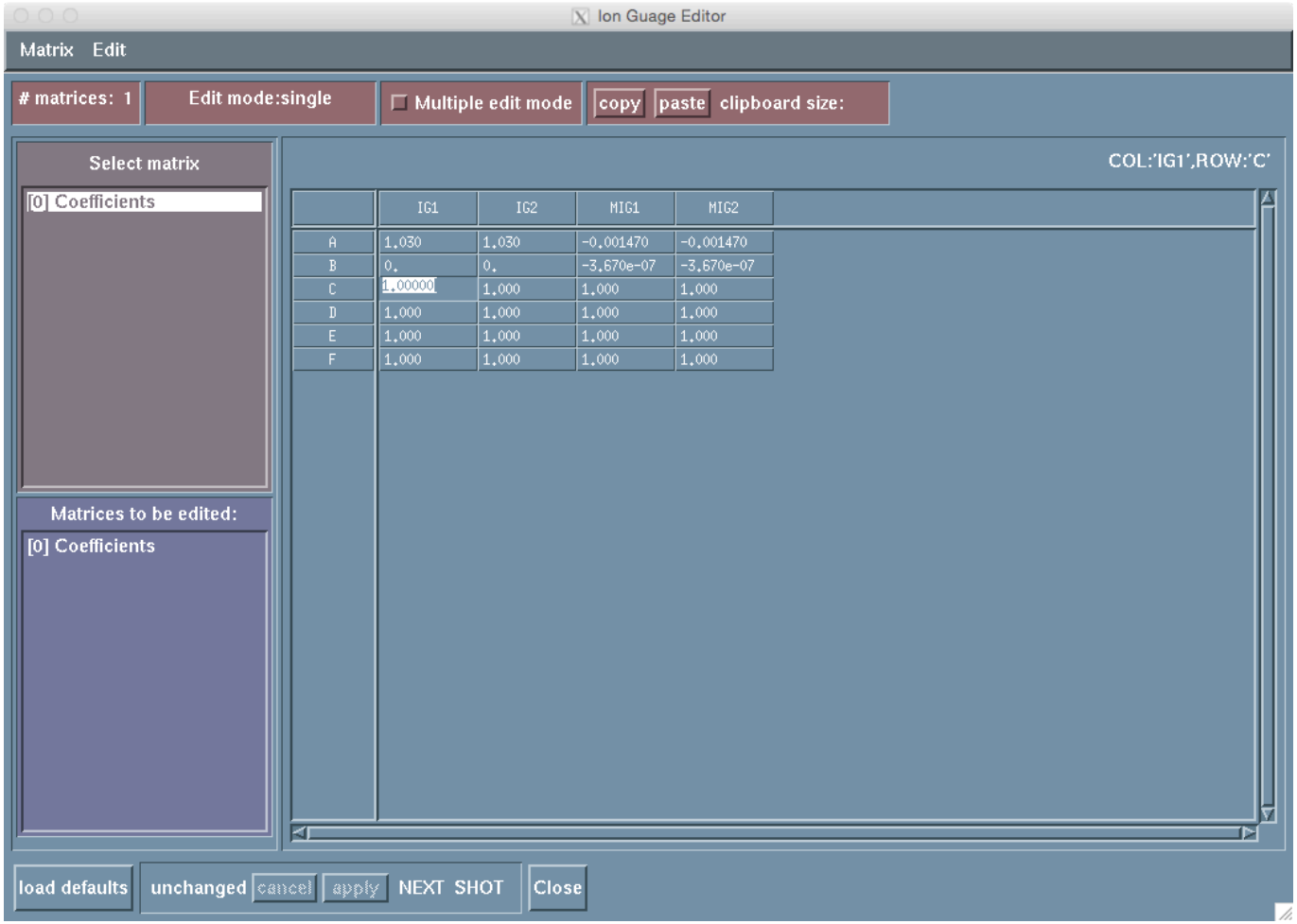
Don't forget to hit APPLY!

GUIs can also be tables

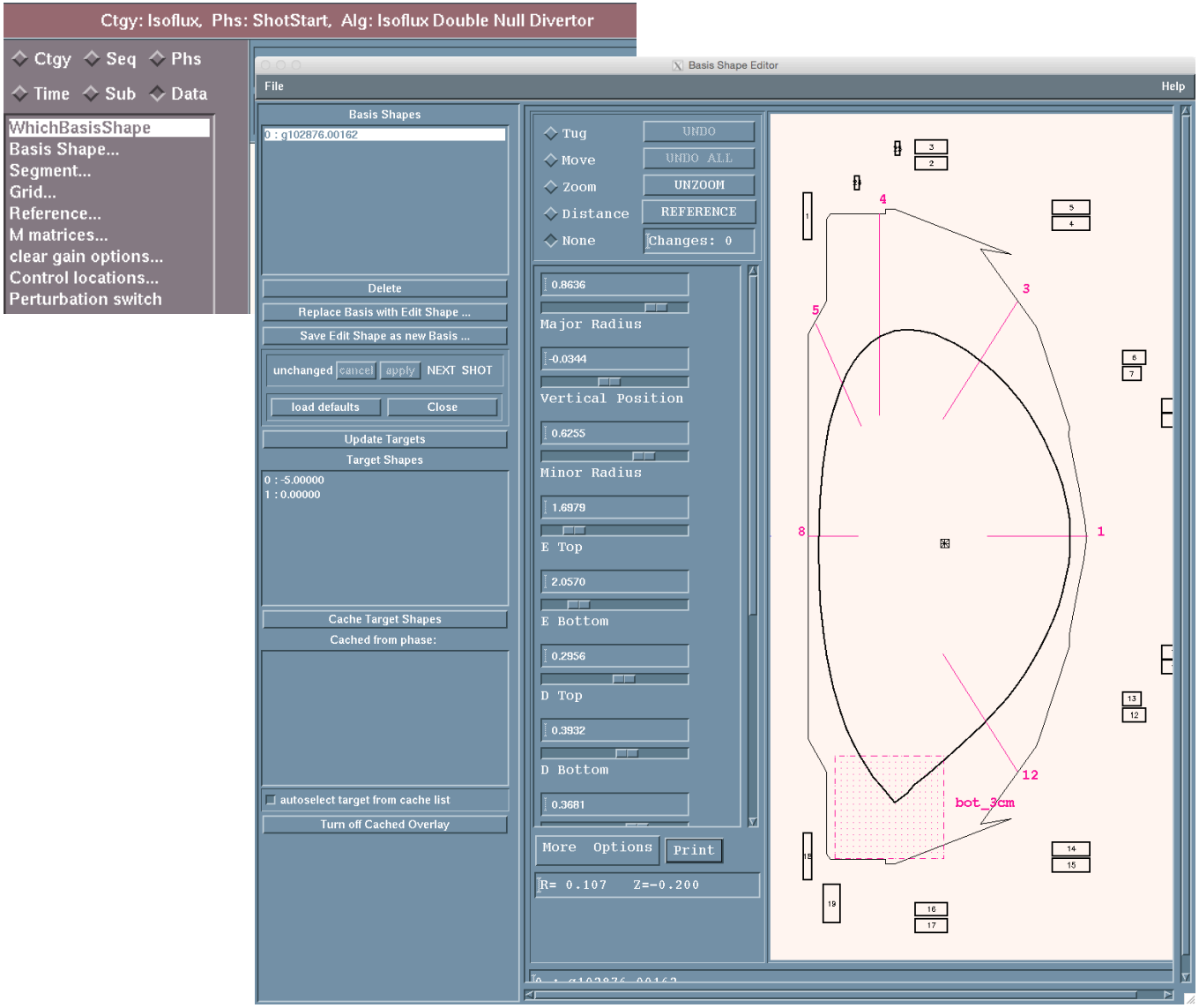
Multiple versions of the table can exist (a waveform is used to select which table to use)

You can edit the same cell in multiple tables

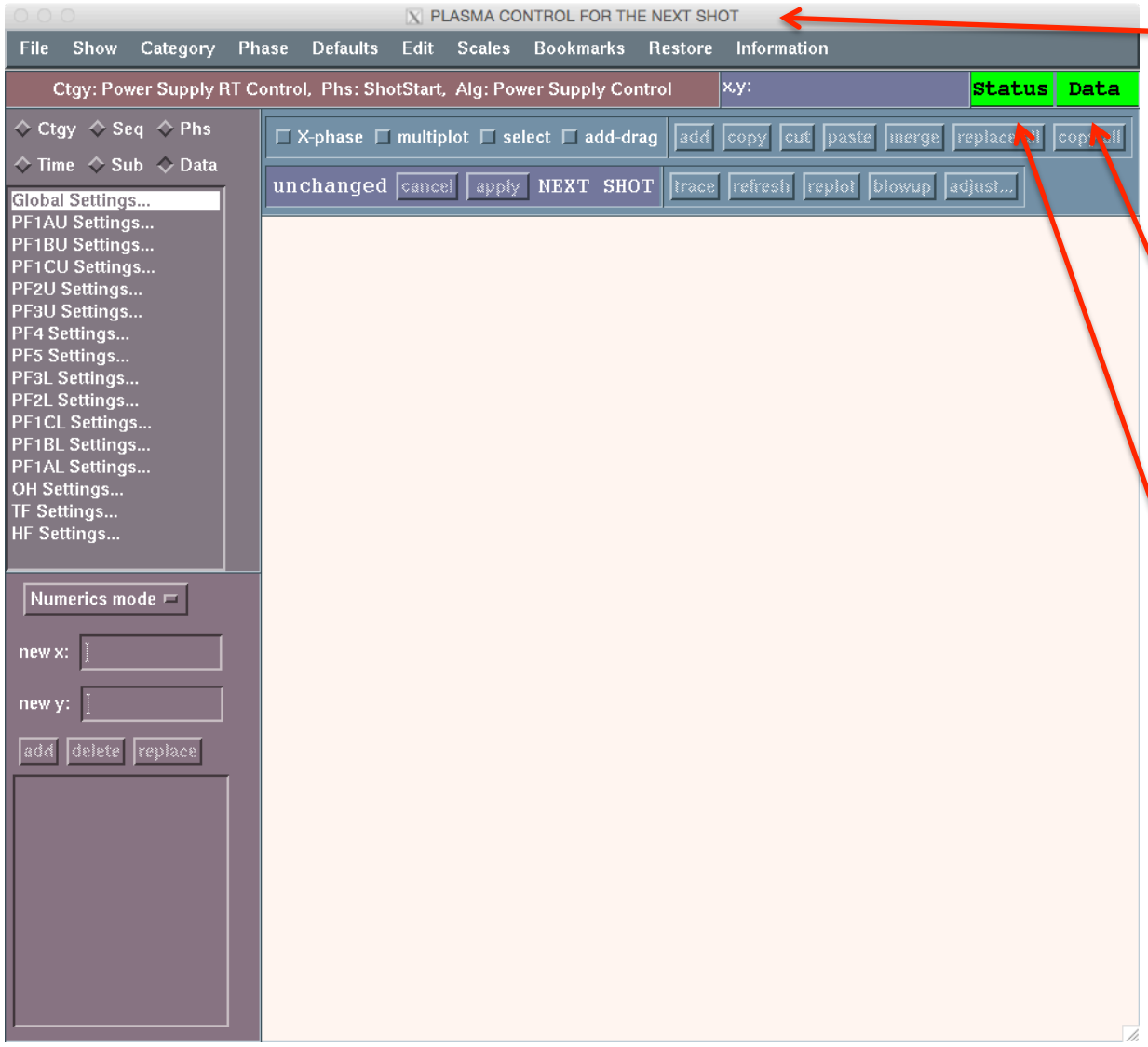
Don't forget to hit APPLY!



The ISOFLUX GUIs deserve a separate talk



Indicators on the PCS GUI



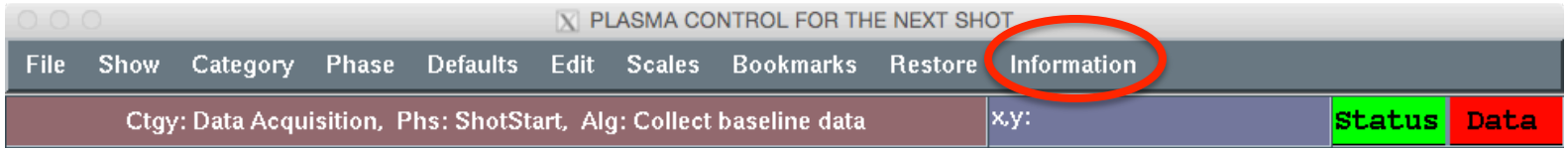
Note the title of the window. You could have multiple “Next shot” and “Future shot” GUIs open

Data light:
Green means all GUI parameters are in a valid configuration

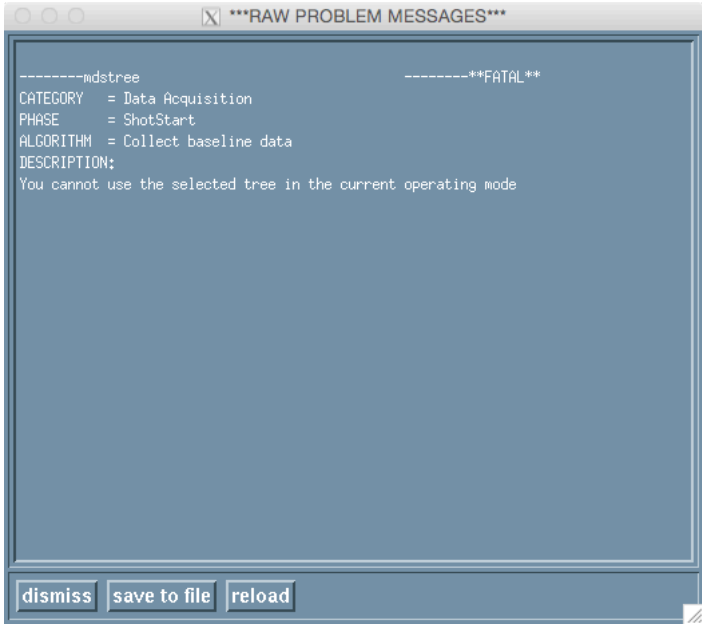
Status light:
Green means computer systems are running

Shot will not run if either light is red

If you get a red or yellow Data light …



- Go to “Information” > “Raw data problems”
  - Window shows the issue(s)
  - Most likely to occur when restoring a shot



Start exploring the PCS GUI

- Get in the PCS Unix group
- Get the stand-alone PCS software
- Refer to:
  - PCS programmers manual:
    http://nstx.pppl.gov/nstx/controls/pcs/PCS_doc/master.pdf
  - NSTX-U PCS specs in the NSTX PCS shared google folder
- Read the specs and navigate through the categories
  - Practice changing things
  - Ask questions

Summary

- PCS software is divided into Categories
  - Each category has a library of control algorithms
- The PCS interface is used to set the sequence of phases where each phase runs a single algorithm
- Each algorithm has waveforms and GUIs that can be edited using the PCS interface
- Dennis: “With power and flexibility comes complexity”
  - With time and practice, it all makes sense