NSTX-U

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Software and Analysis Tools Overview

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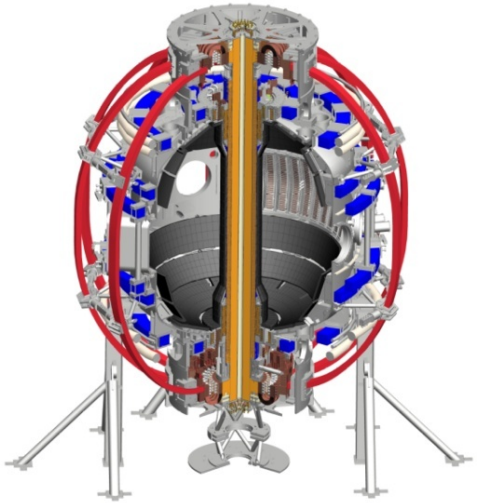
Physics Meeting
B-318
Jan. 28, 2015



Coll of Wm & Mary
Columbia U
CompX
General Atomics
FIU
INL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Lehigh U
Nova Photonics
ORNL
PPPL
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
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UCSD
U Colorado
U Illinois
U Maryland
U Rochester
U Tennessee
U Tulsa
U Washington
U Wisconsin
X Science LLC

Culham Sci Ctr
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Inst for Nucl Res, Kiev
Ioffe Inst
TRINITI
Chonbuk Natl U
NFRI
KAIST
POSTECH
Seoul Natl U
ASIPP
CIEMAT
FOM Inst DIFFER
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep

Overview

- Status of MDSplus
- Various plotting options
- What's new in Web Tools
- EFITviewer
- XPC for Postscript output and scrolling
- SigAlert to watch for bad/missing signals
- Databases at PPPL
- What other training or tools are needed?

Status of MDSplus

- MDSplus has had an extensive workout for DCPS testing
- We plan to minimize changes before CD-4 to reduce risk of delays
- Network trunks have increased from 1 Gb/s to 10 Gb/s
- Disks and CPUs will be beefed up before Physics Ops
  - CMOD is acquiring 15 GB/shot with straightforward architecture
- UDP events will be used (after CD-4) with a relay to TCP/IP when needed

Plotting Options

- Scope family
  - DWScope (solid; many examples available to start from)
  - jScope (uses java; color, overlays, contours, animations)
- Web Tools
  - Now can run from file input
  - Actively maintained, e.g., Open Science options coming
- ReviewPlus from GA
  - Bugs will be fixed
  - Difficult to add features
- Custom written programs
  - IDL (most widely used here)
  - Matlab (a more modern choice)
  - Python (free and being used more and more in fusion community)

Documentation and Web Tools found at http://nstx.pppl.gov/nstx/Software

NSTX software

Overview | Programming | Diagnostics | Applications
FAQ | Web Tools | UNIX & VMS | MDSplus

Search NSTX software pages

What's New as of 23-Jan-2015 New!

NSTX Status **NSTX Run Schedule**

FAQ The answers to a lot of Frequently Asked Questions are available. If you can't find what you need there, ask a programmer (list below).

MDSplus is a set of software tools for data acquisition and storage. NSTX data is organized according to the MDSplus paradigm, so users need to be familiar with it.

General Purpose Computers : Access to the NSTX MDSplus data is available at PPPL from the UNIX cluster, personal computers, or the Web. All access to the NSTX CAMAC highways must be done from skylark. IDL is now available on all PPPL computers.

Web Tools provide the ability to plot data from the web, search for MDSplus signal names and locate shot lists by date and by experimental proposal.

Documentation

Logbook The NSTX Electronic Logbook is available on the web or from IDL on UNIX (as syb_entry).

IDL is a popular programming language for analyzing NSTX data. The PPPL IDL pages include an introduction to IDL and examples for MDSplus data access for NSTX.

This part of the NSTX web site is maintained by the NSTX Software Support Staff (see below) for use by NSTX Scientists and Engineers. You will find links for analyzing NSTX data from the web, as well as documentation on software you may use from other computers. Click on the FAQ tab above for answers to the most frequently asked questions on data access and computer use, or browse through this site from the other links here, or try using the site map.

Need help? Ask the NSTX software support staff

Control Room Support, IDL, database, analysis	Bill Davis
VMS Operating System	Tom Carroll, VMS Admin
Control Room Support, PCs, LabView	Gretchen Zimmer
Unix	Unix Sys Admins
MDSplus	NSTX ITD Support Staff

NSTX software

Overview | Programming | Diagnostics | Applications
FAQ | Web Tools | UNIX & VMS | MDSplus

Search NSTX software pages

LOOKING AT MDSplus DATA

PLOTTING OPTIONS

SEARCHING/COMPARING/LISTING

INFORMATION ABOUT DATA

LOGBOOK searching/viewing with Plot Summaries

FINDING SIGNAL NAMES from Label list

SHOT LISTS
by XP
by XMP
by Date
of Calibration shots

Accessing TRANSP data in MDSplus

List of some MDSplus events used on NSTX

RELATIONAL DATABASE DATA

TF Tools

Find shots based on EFIT parameters

TRANSP Run Listings

EFIT and LRDfit runs by owner NEW!

MISCELLANEOUS

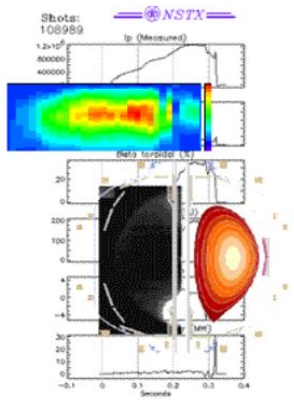
Setting up TRANSP runs

NSTX Controls Software Information

NSTX Status Page New

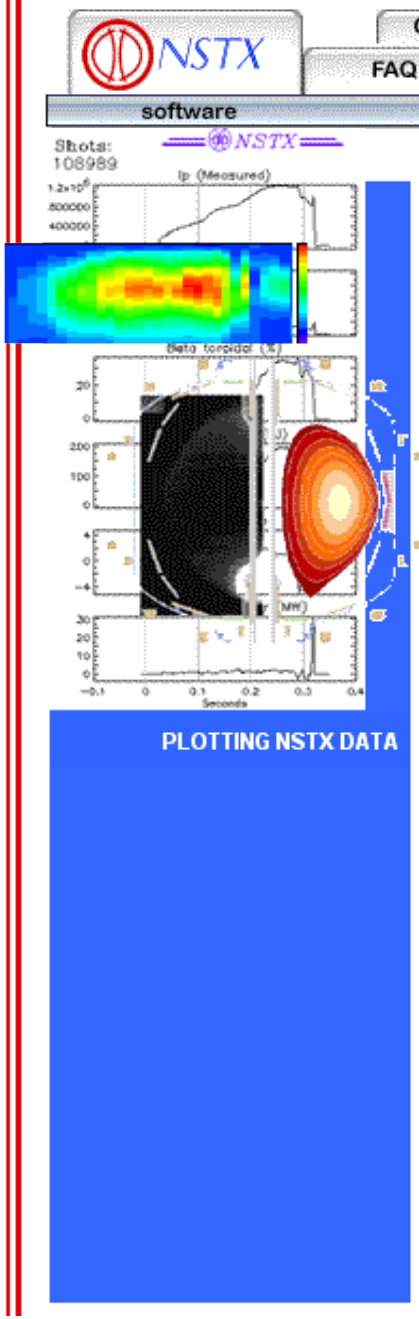
Launch EPICweb New

NSTX Control Room Monitoring New



What's New in WebTools

- Web Plotting Tool can read settings from a file
- IDL code can be called within a web plotting tool (like in ReviewPlus)
- Plot directly from search results output, e.g., http://nstx.pppl.gov/nstx/Software/WebTools/treesearch.html
- Fast Camera and Blob Tracking pages enhanced



mdsPlotList, Web Tool for Plotting Signals OR Listing MDSplus Data for NSTX **(BEST)** (20-signal version). There is now a version that reads your inputs from a file! You can also plot from different servers.
mdsMultiSig, (example) for Plotting Multiple MDSplus Signals **on the same Frame**. Timebases are automatically converted WOW for math on signals (20-signal version).

NEW! You can read most of the input fields for web plotting from a file in mdsplotfileinput.php.

mdsSignals_clean, NSTX MDSplus Signal Plotting (doesn't remember previous settings)

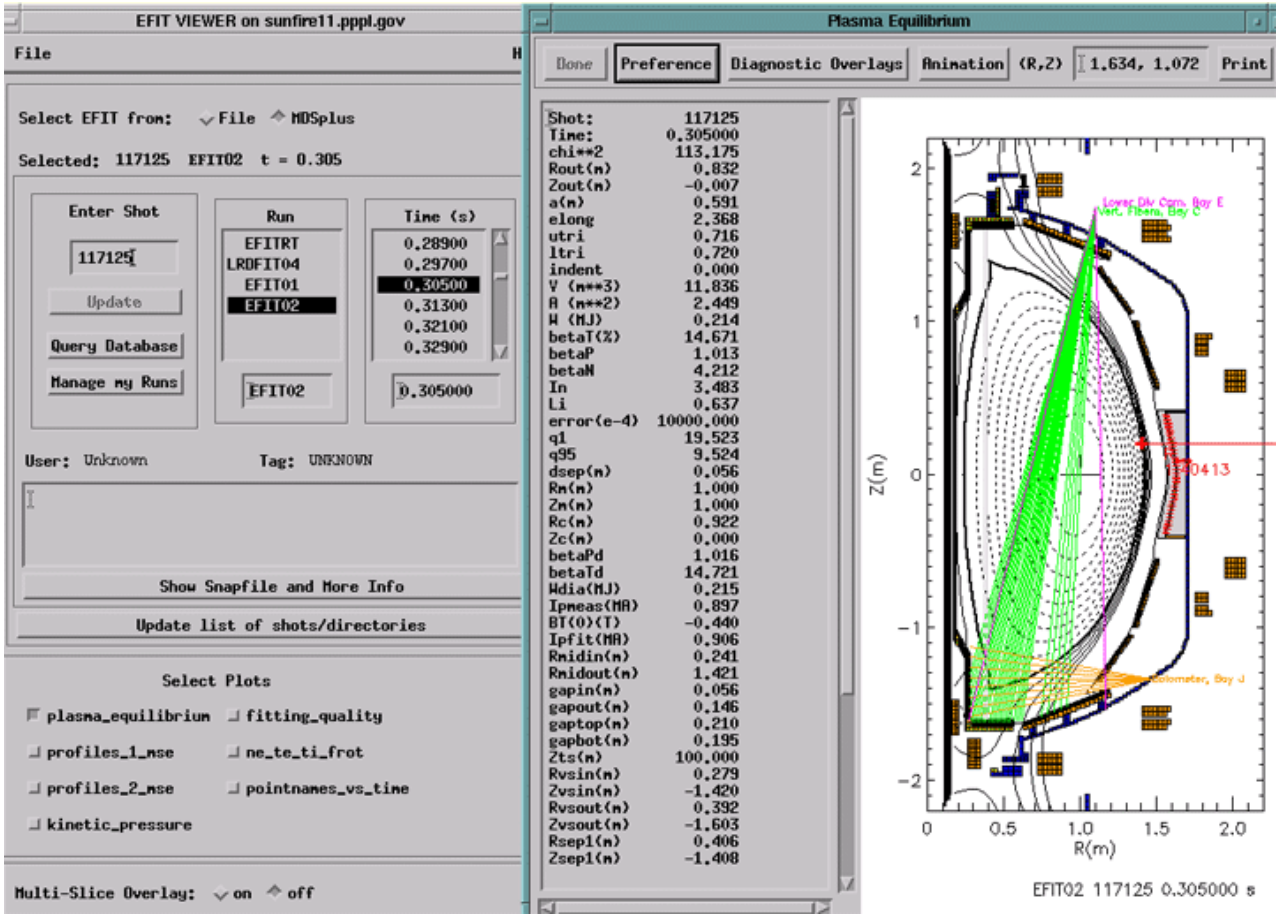
mdsPlot1, NSTX MDSplus Plotting Tool (for various "canned" plots)
mdsScopeAdj, NSTX MDSplus **Adustable** Scope Plotting Tool (plots in a new window) (**BEST for scopes**)
mdsScope_clean, NSTX MDSplus Scope Plotting Tool (doesn't remember previous settings)

mdsCrossPlot, Plot One MDSplus Signal vs. Another. Optionally display X-axis as HH:MM.

Flux Cross-sections NSTX **EFIT/LRDfit** Flux and Thomson Data Plotting
MPTSplots (or mptsColorCont (example)) NSTX Multi-point Thomson Data Plotting
NSTX Fast Camera Movies 1 or 2 cameras with optional overlays of MDSplus signals.
NSTX RGA Trend Data (example)

EFITviewer Enhancements

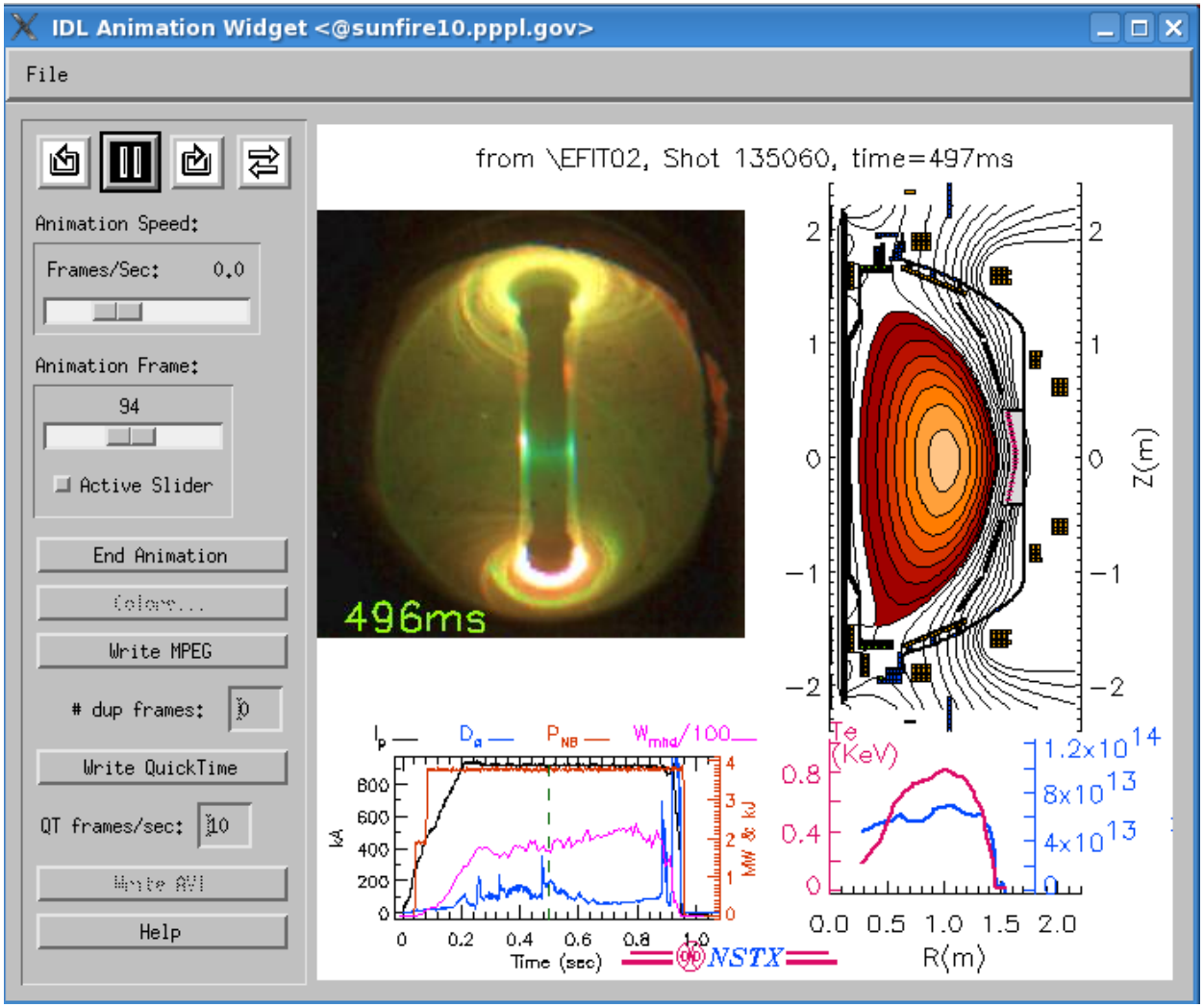
- Vessel geometry drawn based on shot number
- Devon Battaglia helping with diagnostic sight lines
- DCPS and various test versions of EFIT trees supported



Always looking for ways to show diverse data synchronously

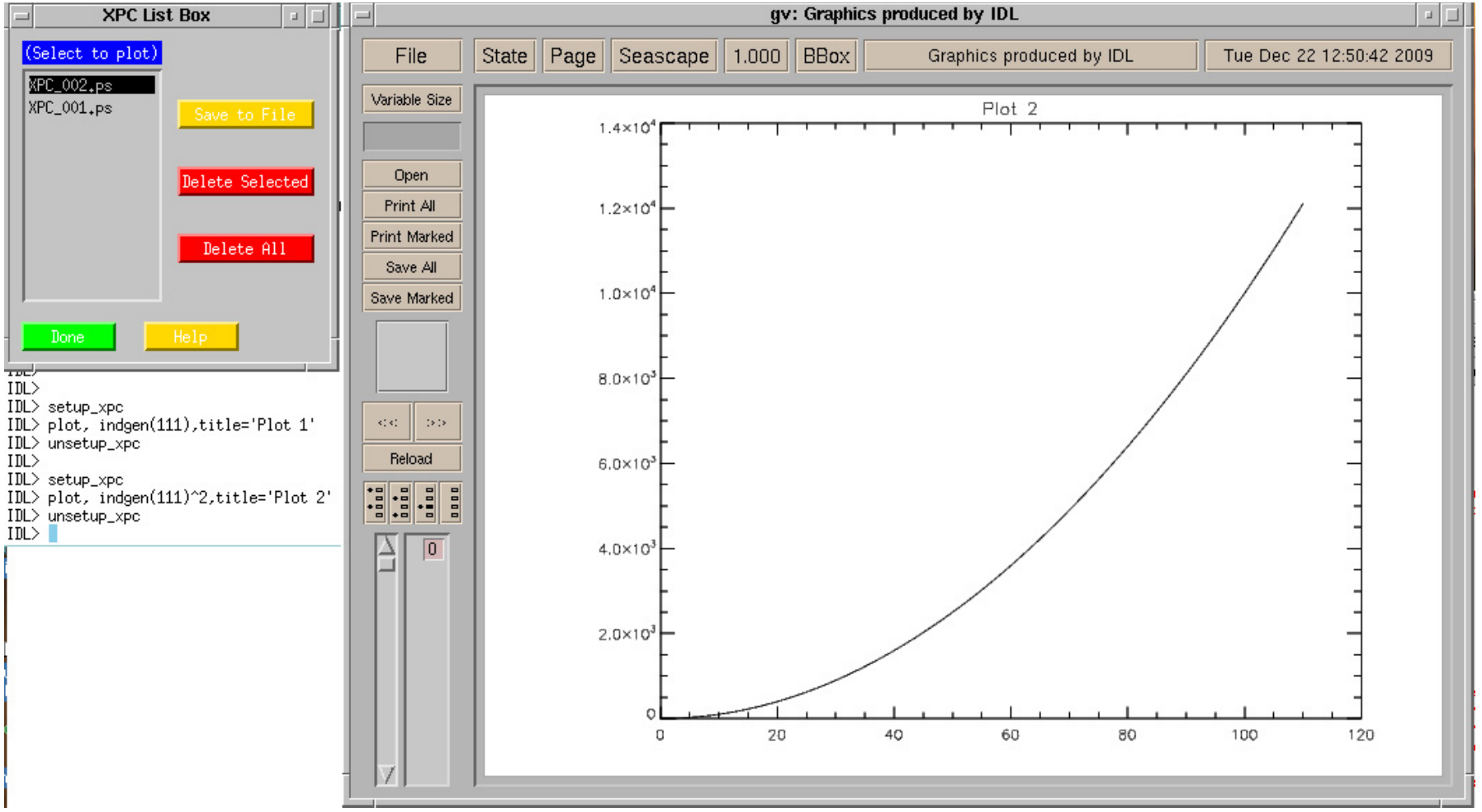
Created in IDL in X-windows on the PPPL Linux cluster by:

IDL> efitmovies,"miro*135060", /thomson, /summary



X-window Postscript Plot Control

XPC allows you to "scroll back" to earlier plots created from IDL,
as well as print or save them, without having to resend all the plot commands.



SigAlert identifies signal problems

An automatic task reads specified signals after a shot , and sends email if:

1. The signal does not exist for the current shot.
2. (Optional) No part of the signal reaches a minimum required value.
3. (Optional) Any part of the signal exceeds a maximum allowed value.

Sample input file:

```
Signal      email   checkEvent   nsmooth max     min  idlCall setEvent   epicsAlarm
\wf::pnb    bdavis  NSTX_SOP     5       800    -10     none    none       none
\wf::prf    bdavis  NSTX_SOP     3       1e38   -1e38   none    none       none
```

- If you want an IDL routine to be executed before checking the min or max, you can specify it in the "idlCall" column with the "data" variable operated on, e.g.,

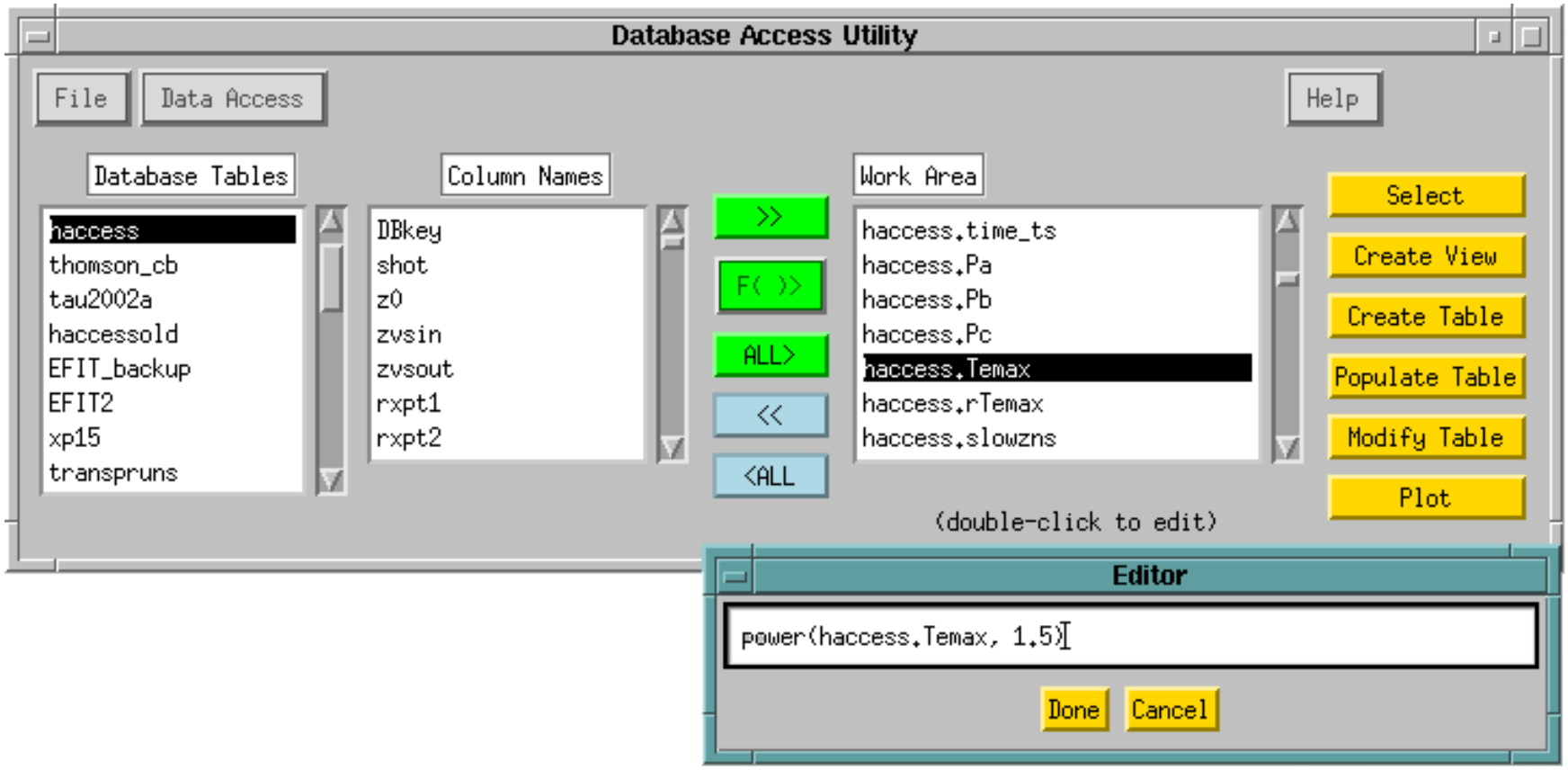
```
data=smooth2d(data,/edge_truncate)
```

- If you want an MDSplus event declared when an alarm is raised by sigalert.pro, specify that in the "setEvent" column.

- See http://nstx.pppl.gov/nstx/Software/Applications/SigAlert.html for details

Database Tools are supported

```
IDL> dbaccess
```



Manual available at:
http://nstx.pppl.gov/nstx/Software/Documents/dbaccess.html

"Public" tables available in the NSTXLOGS Database

- "Survey" table contains a few dozen parameters at 3 times of interest (FlatTop, MaxIp, RampUp) for each shot
- EFITnn tables contain most of the EFIT parameters at 6 times of interest for each shot
- Neutron production
- XP-specific tables
- "Haccess" table contains parameters related to H-mode
- Blob database contains blob characteristics for NSTX and CMOD shots
- (Better organization and documentation of existing public tables are needed)

Summary

- MDSplus and computer support is a bit challenged at the moment, but no significant risk seen
- Web Tools continue to increase in utility
- We should expand our expertise in Matlab and Python in future years
- Public Databases for NSTX-U make results accessible and archivable; tools are available and can be supported
- We need to know about increased data loads, especially for camera data
- Let us know what training and tools will help your research

Backup Slides Follow

Questions to Bill Davis, x-2546, or bdavis@pppl.gov

For time-critical notification or questions, send email to nstxops@pppl.gov

Overlaying Te Profiles from different shots

NSTX MDSplus Multiple Signal Plotting

Plot different MDSplus Signals on the same plot frame. (example 1 example 2)
When math is performed on signals on different timebases, conversion to the coarser timebase is automatic.

Shot Number(s): < 127529-3 > (arrows plot shot before or after)
For tips on convenient shot entry methods, see ShotEntryHelp.html. (search for desired shot numbers)

Paste a Column of signals from the clipboard | Paste All 4 Columns | Help

Enter Signal(s) with tree name, e.g., \wf::ip	Y: (autoscale if blank)				Plot #
\activespec::tes[0.23,*]	from		to		1
	from		to		1
	from		to		1
	from		to		2
	from		to		2

All->1

-> For signal names see the NSTX Signals and Labels page or the MDSplus Tree Search Tool.

Plot Ranges: X: (•) Autoscale ( ) from 0.0 to 0.8 (sec., points, etc.)

Plot Labels: (•) From MDSplus ( ) Tag Names ( ) None

Size of Plot Window: Horizontal: 780 Vertical: 600 (pixels)

GO

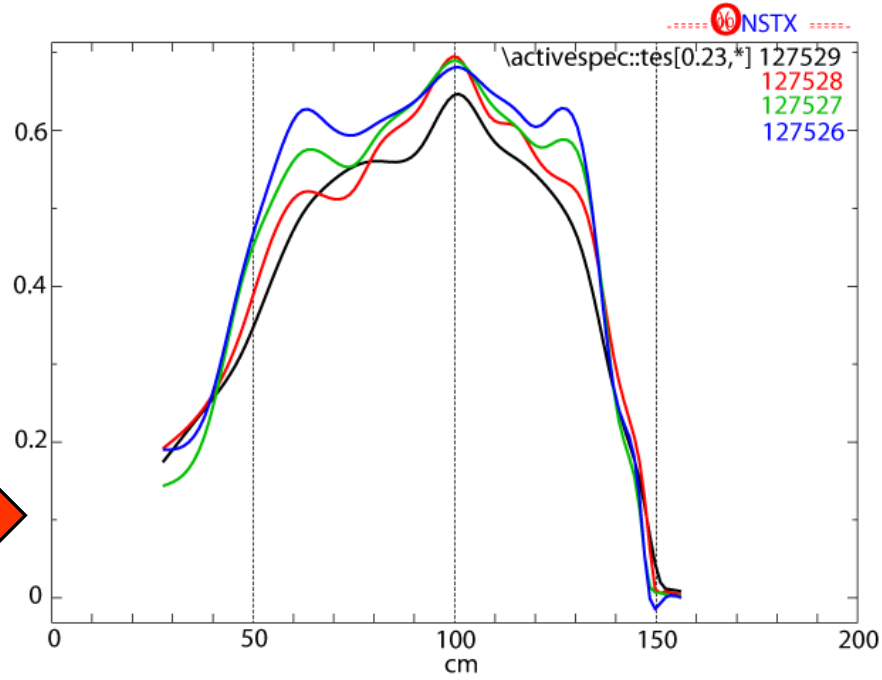
Output Desired: (•) Plots ( ) Numerical Listing

Plot File: ( ) None (•) Postscript ( ) PDF named: plot##### +ext

Output File Font: Default

[x] E-mail file to: bdavis [ ] keep aspect ratio same as plot window.

Reset



http://nstx.pppl.gov/nstx/Software/WebTools/mdsmultisig.html

NSTX MDSplus Multiple Signal Plotting

Shot Number(s): < 127523-5 > (arrows inc. shot)

Paste signals or Paste All 4 Columns Help

Enter Signal(s) with tree name	Y:		Plot #
\usxr::usxr_hup_00	from	to	1
\usxr::usxr_hup_00+100	from	to	1
\usxr::usxr_hup_00+200	from	to	1
\usxr::usxr_hup_00+300	from	to	1
\usxr::usxr_hup_00+400	from	to	1
\usxr::usxr_hup_00+500	from	to	1

(See the MDSplus Tree Search to find signal names)

Plot Ranges: X: ○ Auto ◉ from 0.2 to 0.34 (sec., points, etc.)

Plot Labels: ◉ From MDSplus ○ Tag Names ○ None

Size of Plot Window: Horizontal: 780 Vertical: 600 (pixels)

Output type: ◉ Plots ○ Listing GO

Plot File: ◉ None ○ Postscript ○ PDF named: plot###### +ext

Output Font: Default

☐ E-mail file to: ☐ maintain aspect ratio

Signal Units Displayed: ○ None ◉ on Y-axis ○ append to Title

Median-Smoothing Neighborhood: (Default: no smoothing)

Layout of Plots: # of rows: # of columns: (Blanks OK)

Color Indices for Lines:
(in IDL style, e.g., [20,40,60,80,100] or findgen(20)*10, or use these)

IDL Color Table for Indices: 34

Styles for Lines: (Help)

Symbols for Points: (Help)

☐ No NSTX Logo on plot ☐ Display values of all X-axes

Optionally enter values 0-0.2 to adjust spacing between plots:

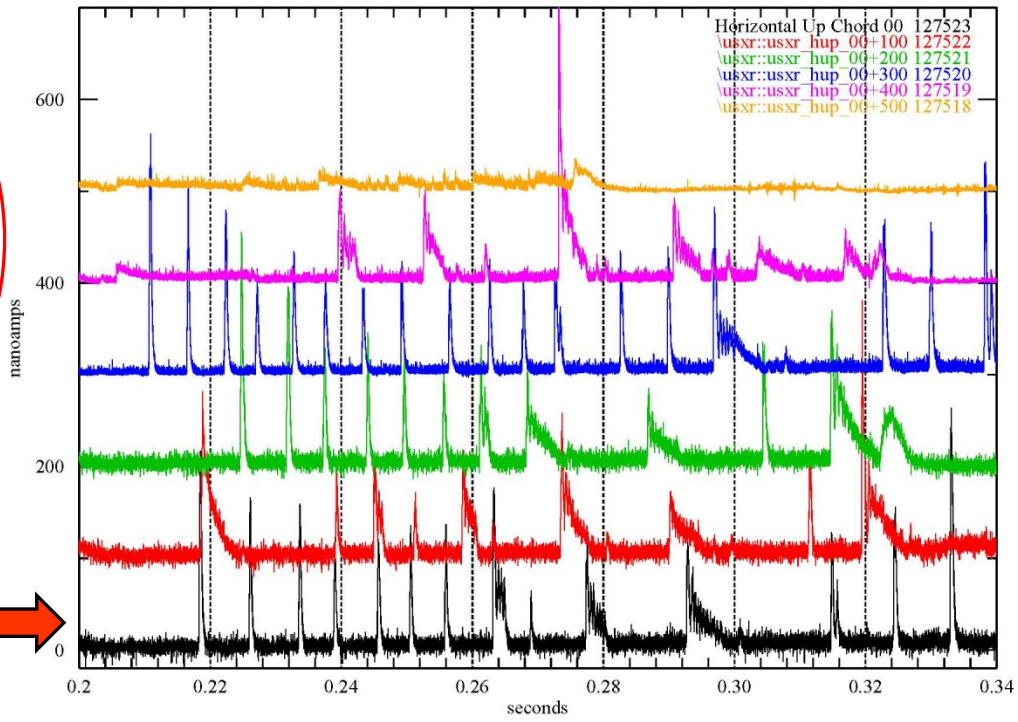
Fraction between columns: 0.08 Fraction between rows: 0.05

Fraction at top of page: 0.06 Fraction at bottom of plot: 0.08

Fraction to right of plots: 0.04 Fraction to left of plots: 0.13

Expert Entry: of plot keywords

e.g., (Click to see examples)



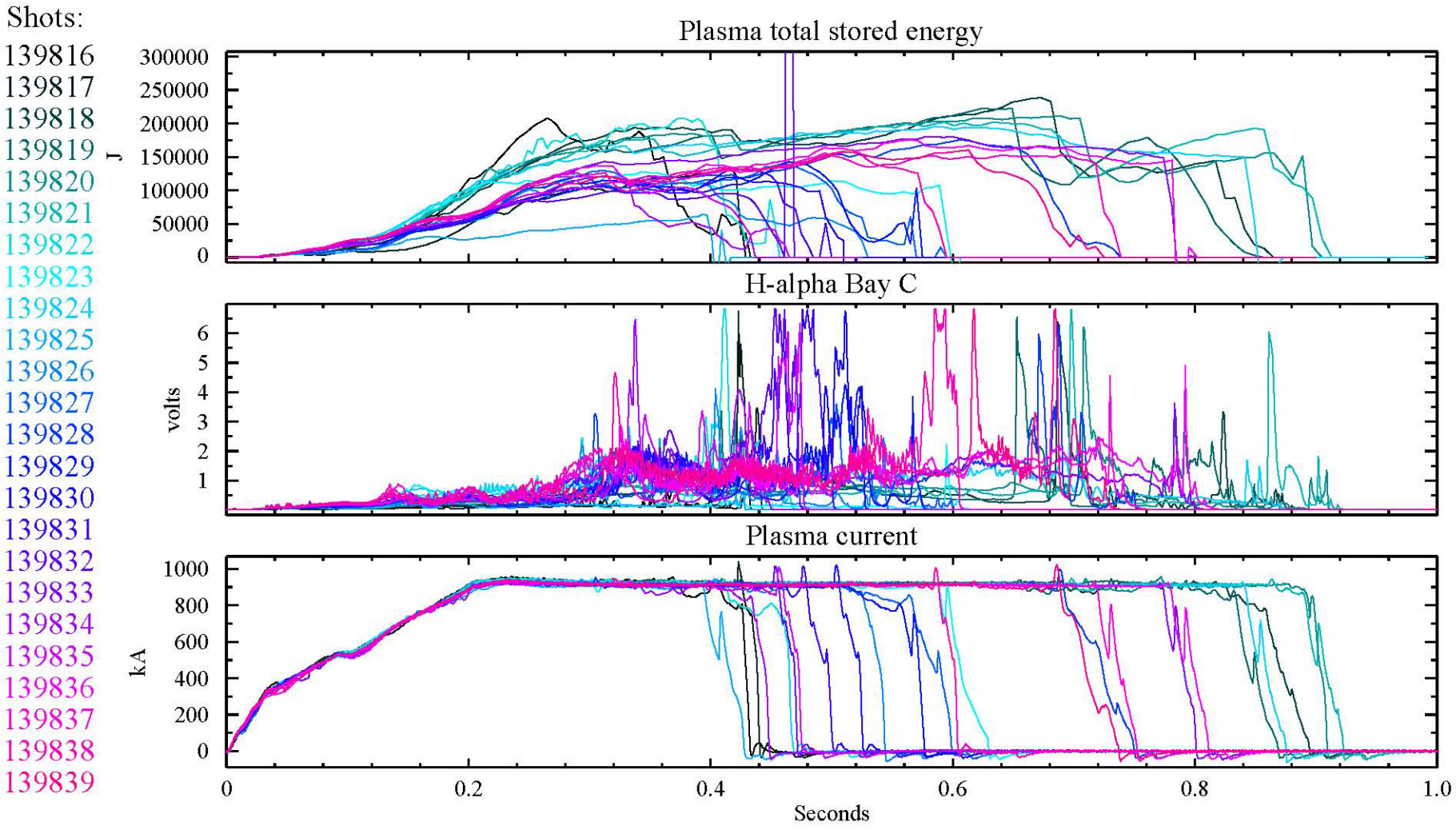
http://nstx.pppl.gov/nstx/Software/WebTools/mdsmultisig.html

- Can overlay different shots of same signal, different signals of same shot, etc.

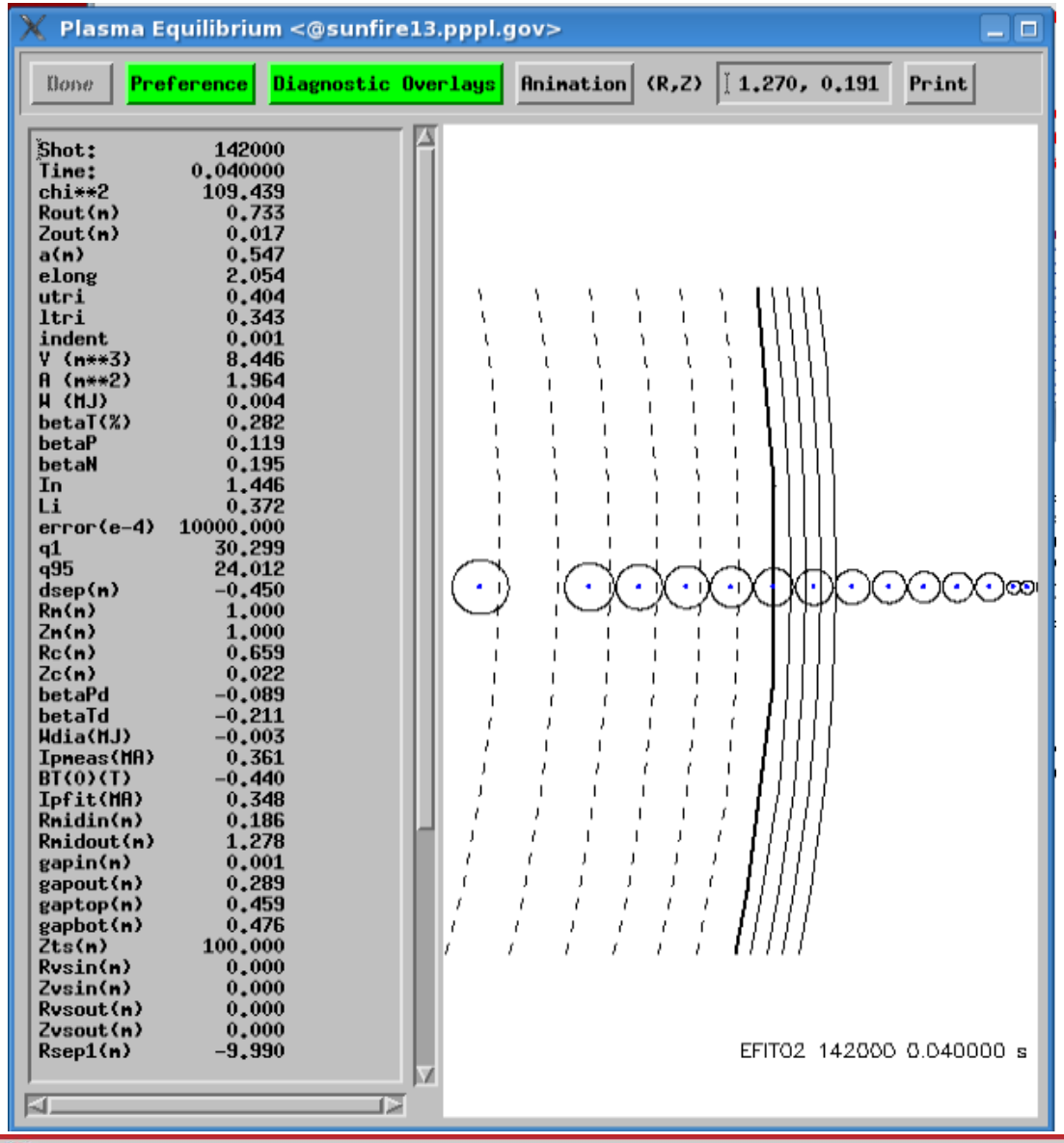
Web Tools plotting has many options

http://nstx.pppl.gov/nstx/Software/WebTools/mdsplotlist.html

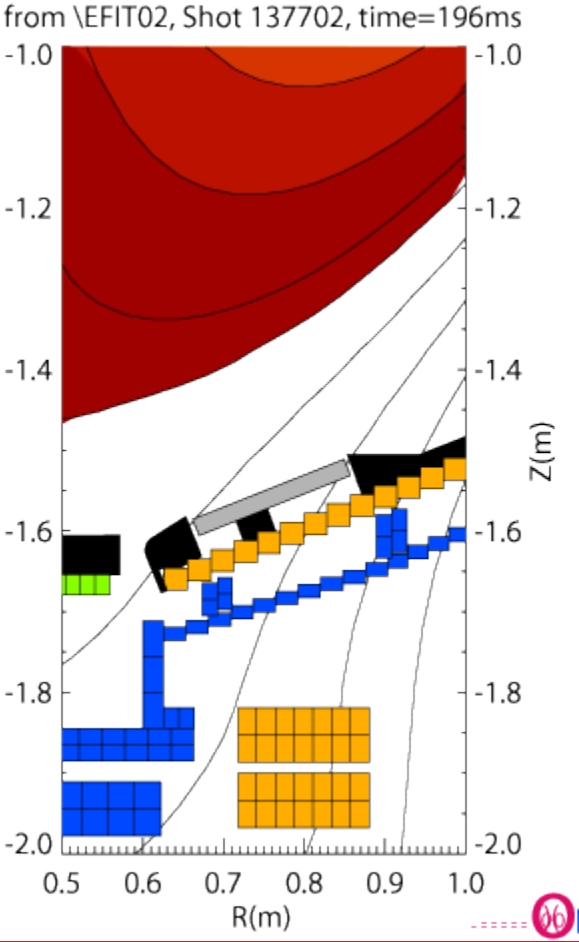
Shot Number: "139816+23" Color Indices for lines: "findgen(24)/24*240" Color Table: "10"



EFITviewer - zoom in to see MPTS locations, strike points, e.g.

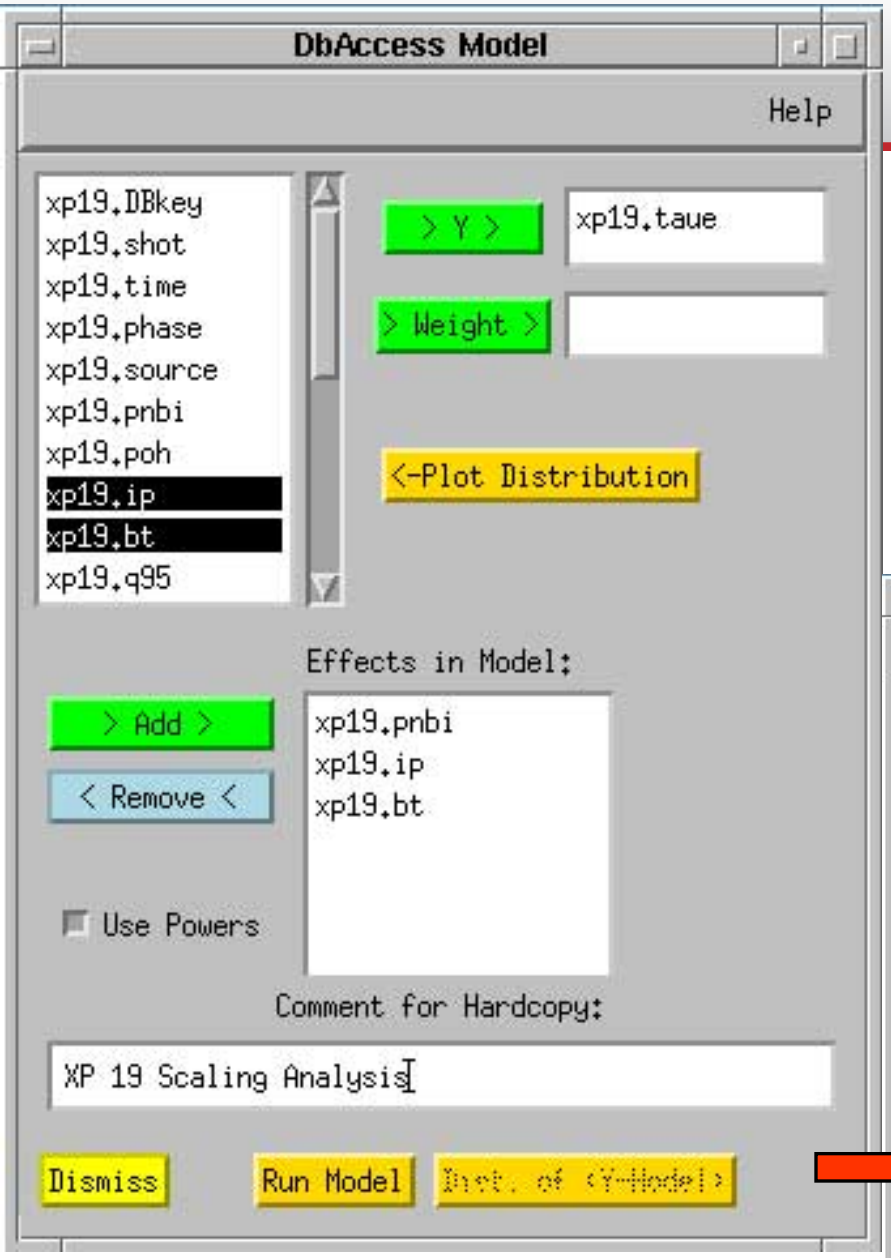


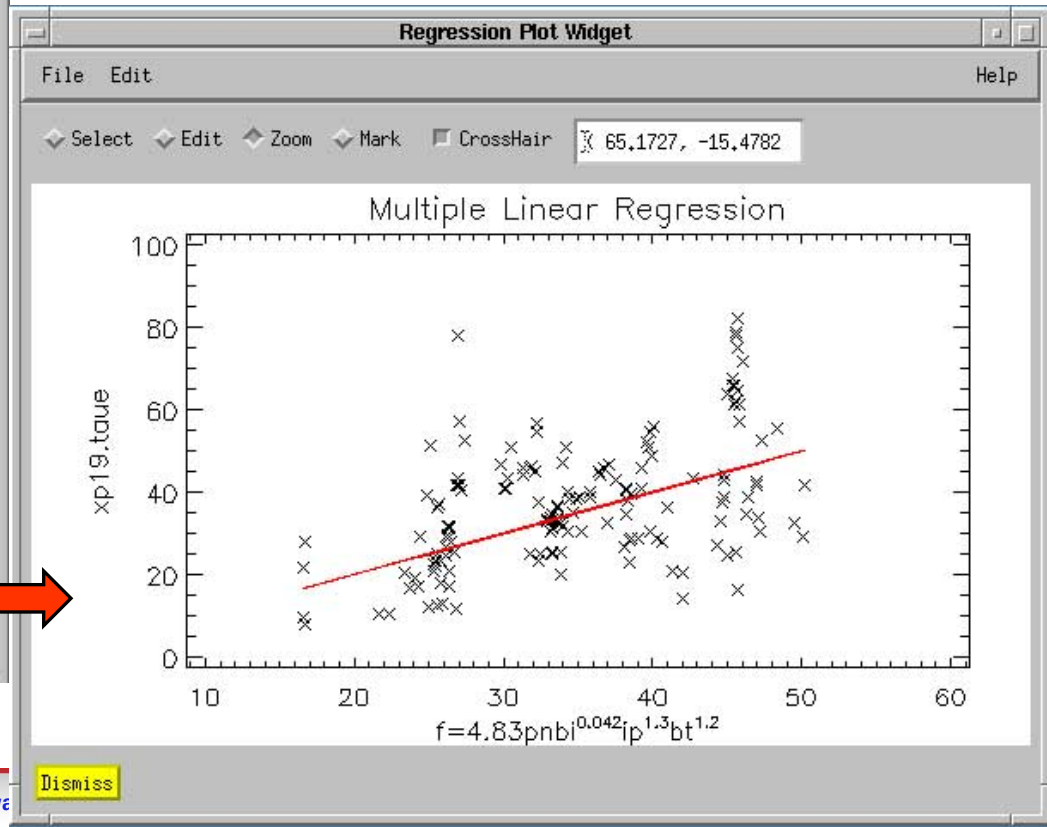
Ctl-clicking on the plot will print out the R and Z coordinates



Statistical Interface in DbAccess

- Multiple Linear Regression
- Powers Optional
- Weighting Optional
- Distribution Plotting





Search EFIT Database Table

http://nstx.pppl.gov/nstx/Software/WebTools/searchefitdb.html

Search the EFIT1 table in the NSTX Logbook database (NSTXLOGS).

Not all EFITs are available for all shots. See fitsAvailable.html

Optionally limit to entries in which:

betan >=	*	AND	betan <		(Normalized Beta)
betat >=		AND	betat <		(Toroidal Beta)
BT0 >=		AND	BT0 <		(Toroidal Field at Mag. Axis, 0-1)
chisq >=		AND	chisq <		(Magnetic Chi^2)
gapbot >=		AND	gapbot <		(bottom gap - m)
gapin >=		AND	gapin <		(inboard gap - m)
gapout >=		AND	gapout <		(outboard gap - m)
gaptop >=		AND	gaptop <		(top gap - m)
Ip >=	500000	AND	Ip <		(Plasma Current, amps)
kappa >=		AND	kappa <		(Elongation, 1-3)
Li >=		AND	Li <		(Internal Inductance)
nebar_ts >=		AND	nebar_ts <		(Electron Density - n/cm^3)
Pa >=		AND	Pa <		(NB Source A, watts)
Pb >=		AND	Pb <		(NB Source B, watts)
Pc >=		AND	Pc <		(NB Source C, watts)
Pnbi >=		AND	Pnbi <		(Injected NB Power, watts)
Prad >=		AND	Prad <		(Radiated Power - w/cm^3)
Prf >=		AND	Prf <		(RF Power - watts)
taumhd >=	*	AND	taumhd <		(Energy confinement time - s)
Temax >=	*	AND	Temax <		(Peak Electron Temp, eV)
tribot >=		AND	tribot <		(bottom triangularity, 0-1)
tritop >=		AND	tritop <		(top triangularity, 0-1)
wmhd >=		AND	wmhd <		(wtot; Total Plasma Energy - J)

(a * will return that field, but not limit the query;
if both fields are blank, that parameter won't be returned)

Time of Interest= Max Ip

Configuration=

Limit the Search to **Shots** from 136000 to 137000 (Optional)

Select shot, BETAN, IP, TAUMHD, TEMAX, TOI, TIME from EFIT

where shot>=136000 AND shot <=137000
AND IP>=500000 AND TOI='maxip' order by shot

shot	BETAN	IP	TAUMHD	TEMAX	TIME
136000	5.14471	751026	-1.71009	177.696	0.553
136001	2.06752	775327	-0.006489	0.923537	0.265
136002	3.32942	768031	0.03963	405.139	0.217
136003	3.50953	761056	0.057189	155.196	0.304
136004	1.64804	751014	-0.021714	0.99357	0.249
136005	2.43354	775475	-0.056866	0.739999	0.175
136006	3.56997	788279	-0.077491	0.741862	0.193
136007	2.76261	781949	-0.088126	1.34959	0.185
136008	1.66388	734348	-0.048584	0.728282	0.583
136009	2.65181	779994	-0.060781	0.681013	0.181
136010	2.23641	768482	-0.067917	0.672851	0.169
136011	2.46628	772562	-0.063587	0.668319	0.175
136012	2.72194	785012	-0.053308	25.7932	0.18
136013	6.4532	744939	-0.051581	345.731	0.535
136014	2.5175	776437	-0.045682	238.921	0.175
136015	1.83123	757323	-0.035338	0.695359	0.49
136016	0.99563	721911	-0.019168	0.658756	0.41
136017	1.77389	760615	-0.03144	0.836369	0.285
136018	1.85509	766116	-0.065414	0.618252	0.169
136019	1.78315	767601	0.029537	1.18659	0.304
136020	2.95963	786564	-0.065389	1.46719	0.185

Search for shots with certain criteria

http://nstx.pppl.gov/nstx/Software/WebTools/mdsshots.html

NSTX software

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Search for Shots in the NSTX MDSplus trees

(To use this page from outside the pppl.gov domain, you must be authenticated at the firewall)

This page will list shots from the NSTX MDSplus Trees which meet certain criteria. You may select common parameters from the menus below, or specify your own signals. (This method is MUCH slower than using a database, such as Searching the EFIT database.)

Search **Shot(s)** 136000-136020

For tips on convenient shot entry methods, see ShotEntryHelp.html.
To find the shots for a certain date, Query the NSTX Logbook

(You may wish to copy and paste shots from the NSTX XP Lists

The min and max of the last signal you specify will be displayed with the shot list.

Where the **Maximum value** for Signal:

Beta Toroidal (%)	is	>	2
Plasma Current (KA)	is	>	700
(Selection Menu)	is	>	
	is	>	
	is	>	
	is	>	

(Typed signal names must include the tree, e.g., \wf::ip
-- See the NSTX Signals and Labels page or the MDSplus Tree Search Tool).

For the Signals specified above, use a **Median-Smoothing** Neighborhood of 5 points

Format to use for data list : (blank is default)

Search Reset

Shots with a Max of \EFIT01::betat GT 2
and Shots with a Max of \wf::ip GT 700

SHOT	MIN	MAX	Units
136000	-7.3507	800.045	kA
136001	-30.38	817.384	kA
136002	-27.772	853.651	kA
136003	-28.058	839.946	kA
136004	-32.09	819.479	kA
136005	-31.119	826.311	kA
136006	-31.303	808.516	kA
136007	-32.047	813.431	kA
136008	-27.533	825.746	kA
136009	-29.964	811.417	kA
136010	-32.703	810.815	kA
136011	-30.77	817.195	kA
136012	-32.254	807.92	kA
136013	-27.453	809.922	kA
136014	-26.624	806.96	kA
136015	-28.935	825.323	kA
136016	-31.572	846.212	kA
136017	-28.491	816.568	kA
136018	-30.761	805.05	kA
136019	-24.551	844.514	kA
136020	-28.067	813.223	kA

Search the NSTX Logbook

http://nstx.pppl.gov/nstx/Software/WebTools/weblogplus.html

Search/view the NSTX Logbook with Plot Summaries

This page will search the ENTRIES table in the NSTX Logbook database (NSTXLOGS).
(for output in table form, see searchlogbookcomments.html; For a simpler version of this page, see logbook.html.)

Optionally limit to entries where the **comments** contain the strings (blanks are OK):
[ ] AND [ ] AND [ ]
(NOT case sensitive)

Optionally limit to:
username= [ ] (e.g., KAYE; blank returns all users)
☐ Include all entries with TOPIC='PHS OPS', 'SESSION LEADER', or 'RF'.

xp= [ ] (e.g., 5; blank returns all)
topics to display: **ALL:** ☑ (if checked, ignores boxes below)
BOLOMETRY: ☐ **BOUNDARY PHYSICS:** ☐ **CHI:** ☐
CONDITIONING: ☐ **EFIT:** ☐ **ENGINEERING:** ☐ **FIDA:** ☐
HYBRID: ☐ **IMPURITIES:** ☐ **MAGNETICS:** ☐ **MHD:** ☐
MPTS: ☐ **MSE:** ☐ **PHYS OPS:** ☑ **RF:** ☑ **SESSION LEADER:** ☑

Limit the Search to **Shots** from 139400 to 139499 (Optional) Also see ShotEntryHelp.html

Limit the Search to **Rundate** (yyyymmdd) [ ] (Optional) e.g., 20080229; **0=today**

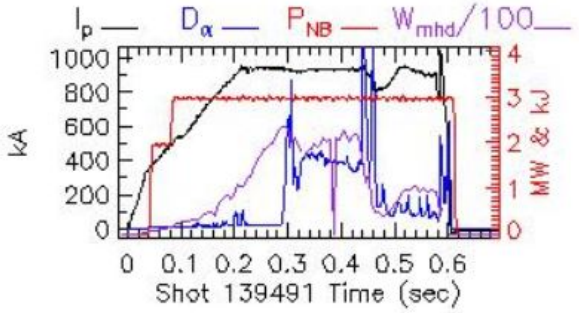
(defaults to all of the most recent day with an entry)

Search ☐ Suppress plot thumbnails Reset

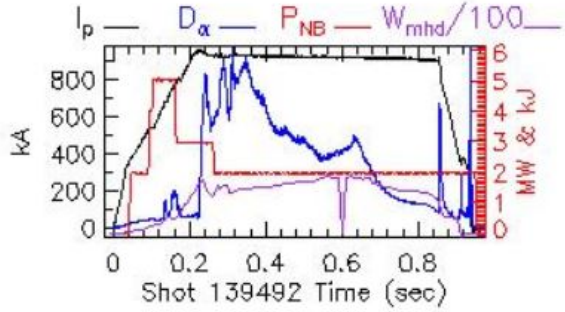
(Output will appear in a separate window entitled "**Search Results from the NSTX Logbook**")

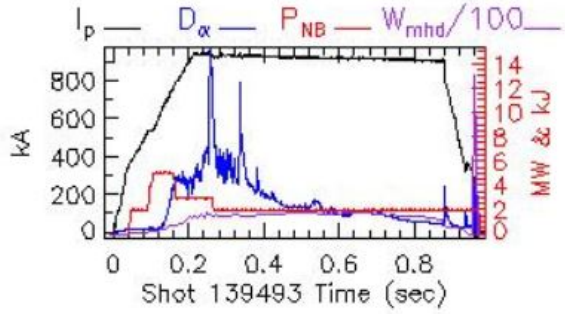
Output from Searching the NSTX Logbook

```
139491  XP# 1045   SESSION LEADER     Aug 03 2010 01:59PM   ekolemen
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
Problem with the reproduction of the x-point shot from friday.

Try to reload 137983.

OK but the beams were not the same. Ends at 450 ms.
--------------------------------------------------------------------------------
```




```
139491  XP# 1045   SESSION LEADER     Aug 03 2010 02:00PM   VLAD
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
Try loadin 137983, another SP-controlled shot.
Result: better, but still short.
--------------------------------------------------------------------------------
139492  XP# 1045   SESSION LEADER     Aug 03 2010 02:00PM   ekolemen
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
Reload the same beams. Good match. We can start the XP.
--------------------------------------------------------------------------------
```




```
139492  XP# 1045   SESSION LEADER     Aug 03 2010 02:01PM   VLAD
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
Repeat previous shot, with NBI from 137983.
Better.
--------------------------------------------------------------------------------
139492  XP# 1058   BOLOMETRY          Aug 03 2010 02:15PM   spaul
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
Very high Prad with peaked profile,collapsing at .65 sec  Prad on wings
   rises
forming a hollow profile with edge power density exceeding .2 MW/m^3.
Total Prad about 1.5 MW and Te decreases after .6 sec.
--------------------------------------------------------------------------------
139493  XP# 1045   SESSION LEADER     Aug 03 2010 02:04PM   ekolemen
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
Move the strik point inwards by 3 cm from 250 to 350 ms to 47 cm.
--------------------------------------------------------------------------------
```