

# **IMASViz - IMAS visualization utility**

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DE LA RECHERCHE À L'INDUSTRIE





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# About the IMASViz project



- Started in 2016 (~ 1 year of effective development)
- Written in Python3.7, uses libraries:
  - PyQt5 for graphical user interface (GUI)
  - Pyqtgraph for plotting functionalities (plugins can also use matplotlib)
  - Sphinx for generating documentation (.pdf, .html etc.)
- Project sources hosted at git.iter.org (Visualisation/VIZ)
- IMASViz deployed on GateWay, ITER HPC and WEST
- Latest documentation is available on:
  - the GIT repository:
    - .pdf: <u>https://git.iter.org/projects/VIS/repos/viz/browse/doc/IMASViz.pdf</u>
    - .zip containing .html documentation (open index.html file in web browser): <u>https://git.iter.org/projects/VIS/repos/viz/browse/doc/IMASViz\_documentation\_html.zip</u>
  - PSNC webpage: <u>https://docs.psnc.pl/display/WFMS/IMASViz+v2</u>

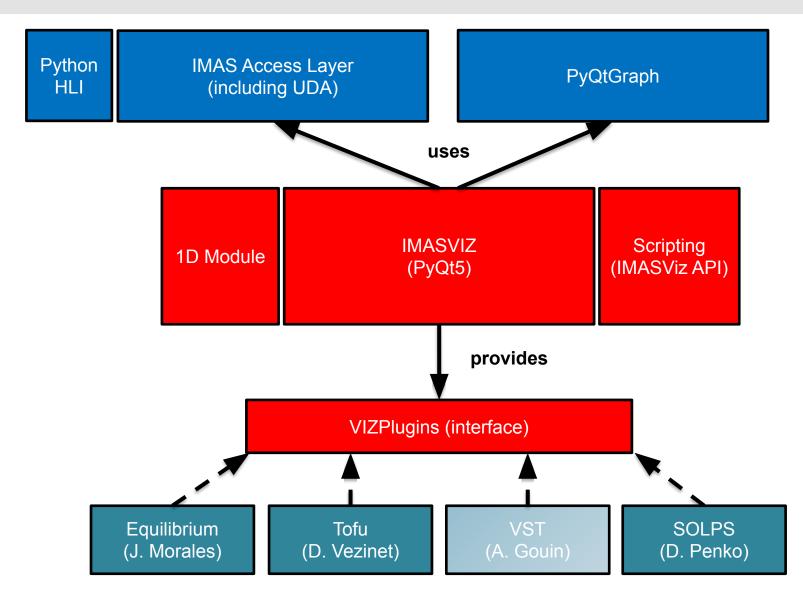
# **IMASViz key strengths**



- GUI reflects the Physics Data Model
- No prior knowledge of signals names required
- Use of IMAS Access Layer and UDA for remote access
- GUI/Scripting: API dedicated to data selection in the PDM and plotting
- Quick data comparison between signals from different /shot/run/machine
- Exportable scripts to other platforms
- Tool available for all laboratories using IMAS/UDA solution
- Design of a plugins mechanism for extending available features

## **IMASViz design**

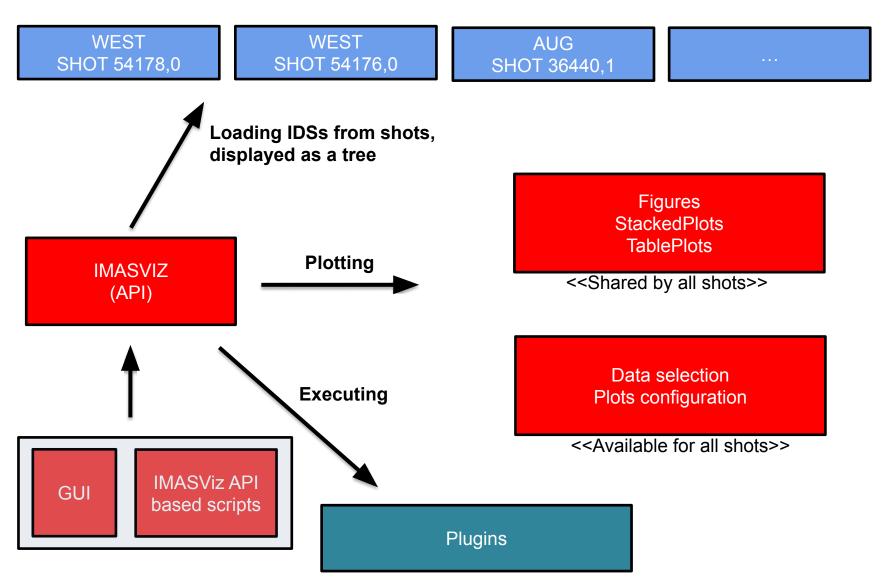




NOTE: Tofu plugin is currently not available on Gateway and HPC-ITER

## **IMASViz** operation





# About the demo

- Running IMASViz on the GateWay
- Loading shot data
  - Opening several shots, loading IDSs
  - Managing shots windows
- Plotting 1D arrays, comparing shots
- Plot configuration
- Selecting data
- Saving a selection
- Applying a selection on a new shot
- Visualizing 0D and 1D data embedded in time slices
- Using UDA: displaying the magnetics IDS from a JET shot
- Exporting data to a new IMAS pulse file
- Example of using the plugins Equilibrium plugin

#### Running IMASViz on the GateWay

1. In a new terminal, execute the following command in order to load the

> module load imasenv # or any other specific <u>imasenv</u> module version
 > module switch imas-viz/2.3.0 # A suitable IMASViz module might be already loaded by the <u>imasenv</u> module

2. With the environment set, run the IMASViz by simply typing the following command:

> viz

An empty dialog window will appear

X IMAS_VIZ	(ver	sion 2,3,0)	_ <b>— ×</b>
Local data so	urce	Experiment data source	
User name	g2us	er	
Tokamak			
Shot number			
Run number	0		
		Open	

Note: IMASViz documentation can be accessed by running the command > viz-doc

- 1. The Local data source tab should be selected (default on IMASViz run).
- 2. In the text boxes set:
  - a. User name: g2dpc
  - b. Tokamak: aug
  - c. Shot number: 36440
  - d. Run number: 1
- 3. Press Open button

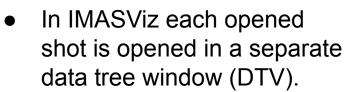
An empty data tree view (DTV) window will appear (see next slide).

IMAS\_VIZ (version 2.3.0)
Local data source Experiment data source
User name g2dpc
Tokamak aug
Shot number 36440
Run number 1
Open



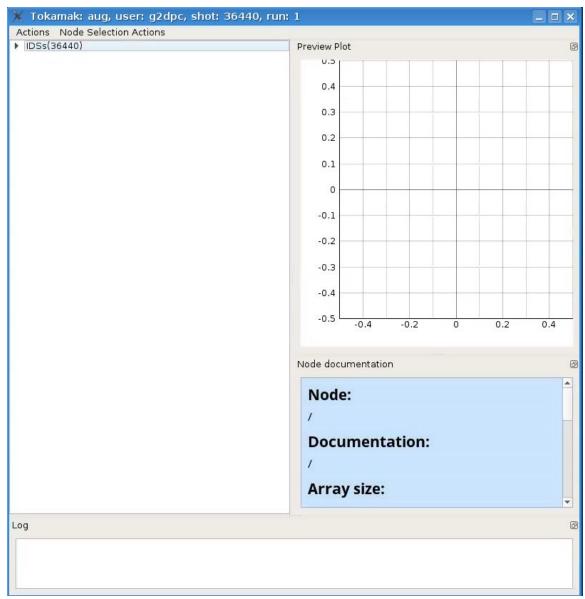
#### GUI overview: Data Tree View (DTV)





- The main components are:
  - Menu bar (on top)
  - Data tree browser (left)
  - Preview Plot widget (top right)
  - Node Documentation widget (bottom right)
  - Log window (bottom)

**NOTE:** closing the window with the cross button only hides the DTV. Deleting DTV can be performed (see next slide)





# **Right clicking on** the main GUI tab allows you to show/hide or delete a shot window

X IMAS_VIZ	(vers	ion 2.3.0)		_ = ×	
Local data so	urce	Experiment data sour	ce		
User name	g2dp	c			
Tokamak	aug				
Shot number	3644	0			
Run number	1				
		🔄 Show/Hide	🕨 🗛 Views	Shot:84600 Run:0	Tokamak:JET (UDA)
		💼 Delete	•	Shot:36440 Run:1	Tokamak:aug User:g2dpc
		Ĩ	Open		

## **Opening IDSs**



# In the DTV, filled IDSs are marked by blue color.

To open an IDS (in this case **nbi IDS**):

- 1. In the DTV, right click on the **nbi**
- In the available selection, select the wanted occurrence (in our case Occurrence 0) (note: same can be achieved by double clicking on the IDS label)

Reading the IDS might take a few seconds, depending on the size of the contents found in the IDS.

 Click on the arrow beside the **nbi** label. The IDS tree structure will be shown

ne 🛛 Get nbi data for occurrence 🔹 🕨	Occurrence 0
ntms pellets	Occurrence 1
pf_active	Occurrence 2
pf_passive polarimeter	Occurrence 3
pulse_schedule	Occurrence 4
le se	Occurrence 5
	Occurrence 6
	Occurrence 7
	Occurrence 8
	Occurrence 9

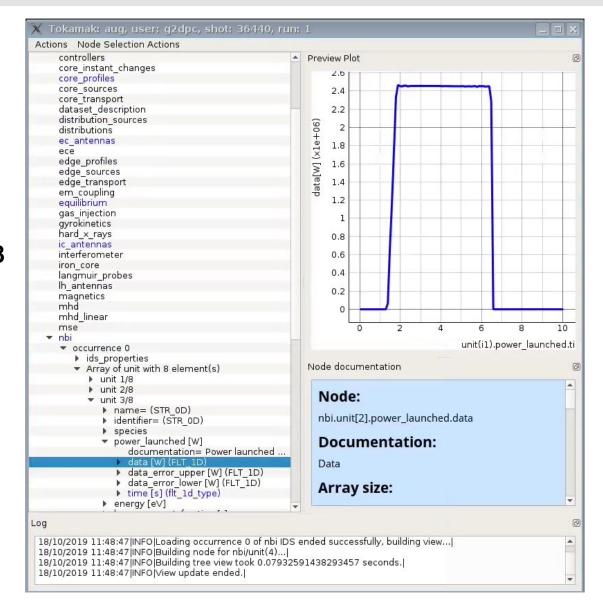
<ul> <li>occurrence 0</li> <li>ids_properties</li> </ul>	
ids_properties	
Array of unit with 8 element(s)	
▶ code	
time [s] (flt_1d_type)	

#### Navigating through database

The tree view allows navigating through the database.

- 1. Navigate to and select:
  - ≻ nbi
  - Array of unit with 8 element(s)
  - ➤ unit 3/8
  - power\_launched [W]
  - ➤ data [W] (FLT\_1D)

A **Preview Plot** will be displayed (top right window) and **Node Documentation** will be populated, displaying some basic info.



## Plotting 1D arrays



To create a basic plot:

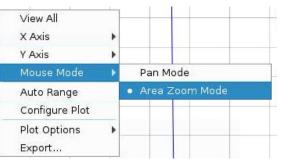
1. Right click on data [W] (FLT\_1D)

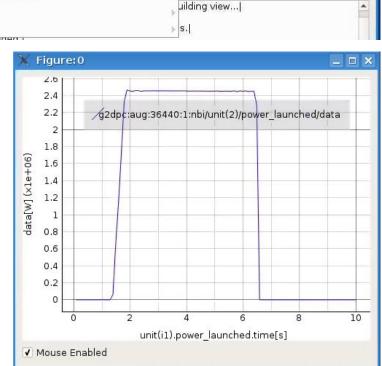
Plottable data is marked by blue color.

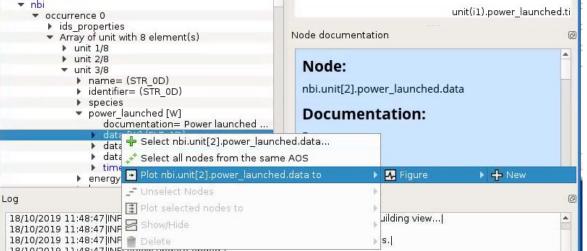
- 2. In the open menu select:
  - Plot nbi.unit[2].power\_launched.data to
  - ➤ Figure
  - ≻ New

# A new window with the plotted data will be shown.

**NOTE:** Right clicking within the plot window displays a menu from which many available features for plot analysis such as setting the mouse button mode to **Zoom to area**, exporting the plot to matplotlib window etc.







## Plotting data to existing figure

unit 8/8

species

energy

beam p

code

data data

name= (STR 0D) identifier= (STR 0D)

power launched [W]

documentation= Power launched ...

🕂 Select nbi.unit[7].power launched.data...

Select all nodes from the same AOS



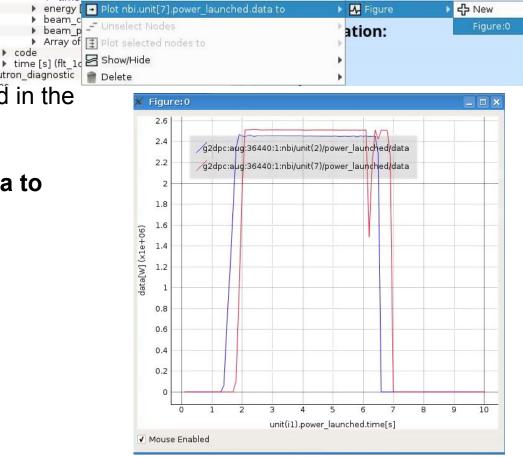
unit(i1).power launched.ti

IMASViz allows adding plots to already existing plots.

Example:

- 1. In DTV, navigate to nbi.unit[7]. power\_launched. data...
- neutron\_diagnostic 2. Right click on the node and in the open menu select:
  - Plot nbi.unit[7].  $\succ$ power\_launched.data to
  - Figure  $\succ$
  - Figure:0  $\triangleright$

The plot will be added to the previous plot window.



Node documentation

0 2 4 6

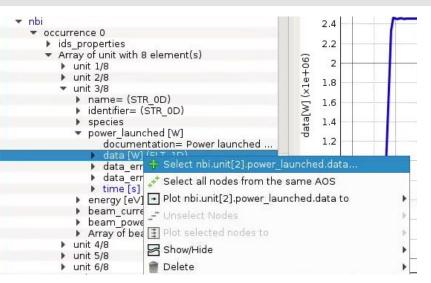
### Manually selecting multiple data

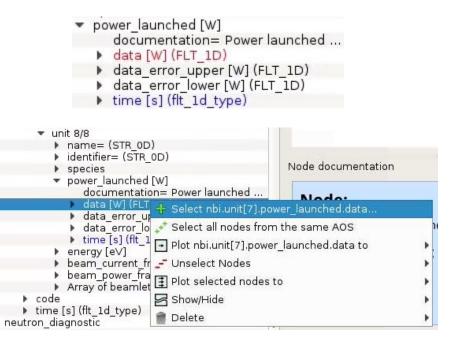


IMASViz allows selecting multiple data at once. Selected data is marked by red color.

- 1. Right click on the **nbi.unit[2].power\_launched.data**
- Select Select nbi.unit[2].power\_launched.data...
- 3. Navigate to
  - ≻ unit 8/8
  - > power\_launched [W]
  - ➤ data [W] (FLT\_1D)
- 4. Select Select

nbi.unit[7].power\_launched.data...





### Plotting a selection



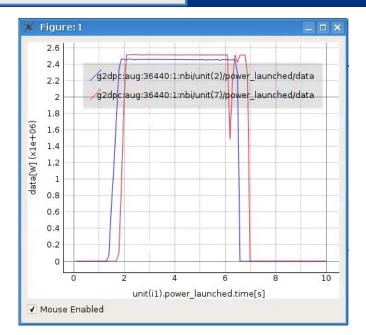
To plot the data from selected signals:

Node: code Document	ation:		
e AOS	of the code-specific code that has produced	I this	
	🕨 🗛 Figure	🕨 🕂 New	🕨 🛅 This IMAS Database
- 24	TablePlotView     EstackedPlotView	•	All IMAS Databases
	code	code Documentation: nched.data e AOS d.data to Figure TablePlotView	code Documentation: nched.data e AOS d.data to Figure Figure TablePlotView

- 1. Right click on one of the selected signals (marked by red color)
- 2. Select:
  - Plot selected nodes to
  - ➤ Figure
  - ≻ New
  - This IMAS Database

A new plot containing both signal data will be shown.

**NOTE:** when plotting on figures, IMASViz check that data share the same coordinates and the same units, otherwise the plot cannot be performed. This note concerns only figures, not stacked or table plots since data are not sharing plot axis for such plots.

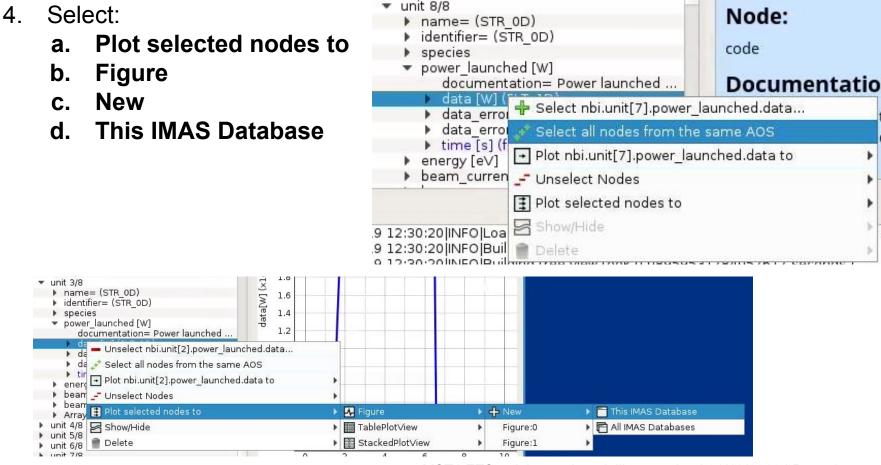


### Selecting all data in the AOS (Array of Structures)



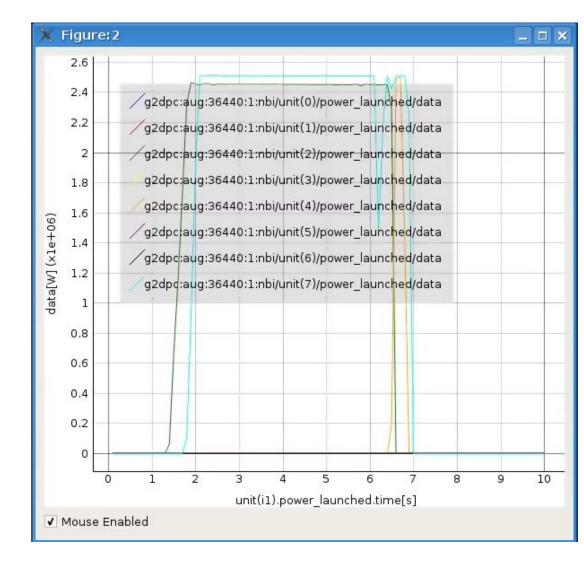
IMASViz allows selecting all data found in the AOS at once:

- 1. Right click on any **nbi.unit[:].power\_launched.data**
- 2. Select Select all nodes from the same AOS
- In order to plot the selection, same as before, right click on any nbi.unit[:].power\_launched.data again





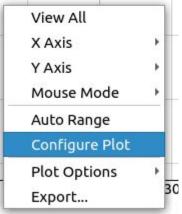
The result of plotting all **nbi.unit[:].power\_launched. data** is shown on the right figure.



IMASViz enables some of the plot configuration features (not provided by PyQtgraph library).

- 1. Right click anywhere inside the plot
- 2. Select Configure plot

A Plot Configuration User Interface will be shown



Line Properties	Text properties	Plot Design Pro	pert	C. 1656(A)				
ine	Color	Style		Thickness	Symbol	Symbol Size	Symbol Color	Symbol Outline Colo
		Solid Line	*	1.00	None 👻	10.00		
		Solid Line	•	1.00	None -	10.00		
		Solid Line	•	1.00	None 👻	10.00		
<u>_</u>		Solid Line	•	1.00	None 👻	10.00		
<u> </u>		Solid Line	•	1.00	None 👻	10.00		
2		Solid Line	•	1.00	None 👻	10.00		
		Solid Line	•	1.00	None 👻	10.00		
2		Solid Line	-	1.00	None 👻	10.00		
								OK Cancel

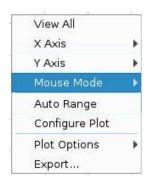
#### Plot configuration: Example



2.6	g2dpc:aug:3644	Line Proper	rties Text prope	erties	Plot De	sign Properties	5				
2.4	gzupc.aug.3044	Line Color	Style		Thickness	s Symbol		Symbol	Size S	ymbol Color Symbol Ou	utline Co
2.2	g2dpc:aug:3644		Solid Line	•	1.00	None	•	10.00	2		
2	g2dpc:aug:3644		Solid Line	•	1.00	None	•	10.00	1		
1.8	g2dpc:aug:3644		Solid Line		the second se	None	•	10.00			
1.6	g2dpc:aug:3644		Solid Line			None	•	-			
1.4	g2dpc:aug:3644							10.00			
1.2	g2dpc:aug:3644		Solid Line	•	1.00		*	10.00			
1	• g2dpc:aug:3644		Solid Line	•	1.00	None	•	10.00	¢		
0.8			Solid Line	•	1.00	None	-	10.00	1		
0.6			Solid Line	•	1.00	0	•	10.00	1		
0.4											
0.2											
0											
0 1 2 3 4	5 6 7 8 9 10									ОК	Cance
unit(i1).po	wer_launched.time[s]										

**Note:** a menu is available when right-clicking on a plot (including subplot) for:

- zooming
- executing filters on the data
- exporting plot to different formats
- ...



#### Saving a selection



IMASViz allows saving the signal selection and then applying it to another shot.

- 1. In the menu bar, navigate to and select:
  - Node Selection Actions
  - Save Node Selection
- 2. A dialog window will be shown. There a configuration label can be specified. Leave it empty for now.
- 3. Press OK.

Actions	Node Selection Actions	
core	Save Node Selection	
dat; dist	Display Node(s) selection	
dist	Unselect All Nodes	•
ec_	Plot selected nodes to	

🗙 Dialo	og	? X
Note, If	left empty the election-18-10	configuration. default name -2019
	ОК	Cancel



#### To apply the saved selection to a new shot:

- Bring up the IMASViz initial window 1.
- 2 In the text boxes set new values:
  - User name: g2dpc а.
  - Tokamak: aug b.
  - Shot number: 36440 C.
  - Run number: 4 d.
- Press **Open** button 3.

	(VCI	51011 213107	
Local data so	urce	Experiment data source	
User name	g2dp	:	
Tokamak	aug		
Shot number	36440	)	
Run number	4		
		Open	

Toka Actions

A new DTV window will appear. There:

- 4. In menu bar navigate to:
  - > Actions
  - > Apply Configuration
- In the open window select tab 5. **Available Node Selection** Configurations
- 6. From the list select the configuration name (if default label was used it she signalSelection-<day>-10-2019.lsp
- Press button Apply Node 7. Selection...

okamak: aug, user:	q2d X Apply Configurations ? □ x
ns Node Selection Acti	ons ot Configurations Available Node Selection Configurations
Apply Configuration	111.lsp innsbruck.lsp magnetics flux 0-5.lsp
xport to IDS	magnetics_flux_10-13.lsp mgn01.lsp mgn_0_1_3.lsp
	signalSelection-15-10-2018.lsp signalSelection-18-10-2019.lsp signalSelection-20-10-2019.lsp signalSelection.lsp test.lsp test2.lsp
on	Apply Node Selection Configuration to current IMAS database
-	Remove configuration
should be <u>Isp</u> )	Note: The configuration will be applied ONLY to the single currently opened IMAS database source: Tokamak: aug, user: g2dpc, shot: 36440, run: 4

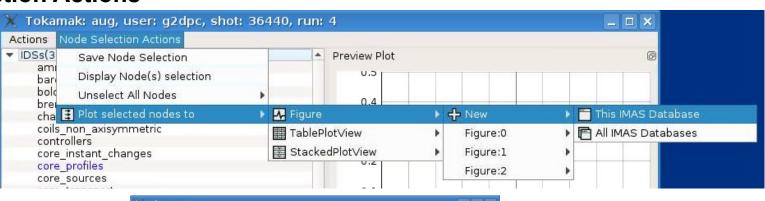


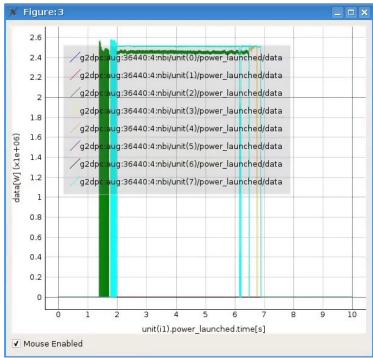
#### To plot the selected data (no navigation required), in the menu bar select:

> Node Selection Actions



- ≻ New
- This IMASDatabase







Selections from 36440/4 can be added to existing plot containing data from 36440/1 shot.

In menu bar, navigate to:

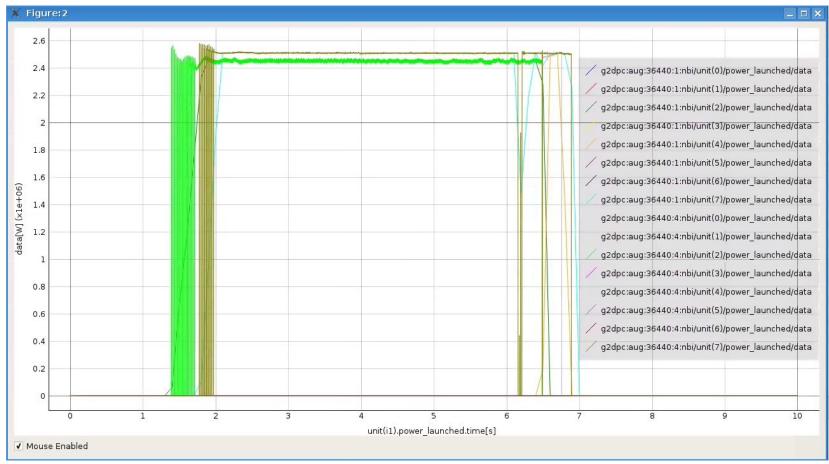
- Node Selection Actions
- Plot selected nodes to
- ➤ Figure
- ➤ Figure:2
- This IMAS Database

🗶 Tokamak: aug, user: g2dpc, shot: 364	440, run:	4				. 🗆 🗙
Actions Node Selection Actions						
<ul> <li>IDSs(3 Save Node Selection ami bar</li> <li>Display Node(s) selection</li> <li>Unselect All Nodes</li> </ul>		Preview Plot				
cha 茸 Plot selected nodes to 🔹 🕨	Figure		► <del>2</del>	🗘 New	•	
controllers	TablePl		*	Figure:0	•	
core_instant_changes	Stacke			Figure:1		
core_profiles		0.2		Figure:2	🕨 🧮 This	s IMAS Database
core_sources core_transport		0.1		Figure:3	IIIA 🛅 ୶	MAS Databases

#### Comparing shots (2)



#### The Figure:2 will get updated with the added plots from the 36440/4 case.



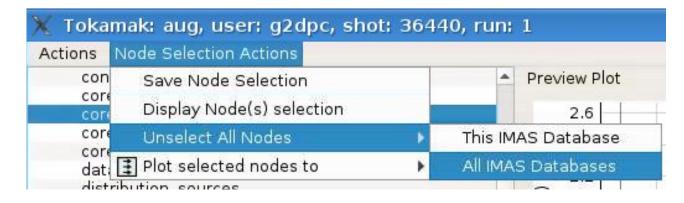
Note: With signals selected in 36440/1 and 36440/4 DTV, the same could be achieved by using (from the menu bar): Node Selection Actions -> Plot selected nodes to -> Figure -> New -> All IMAS Databases

#### Unselecting signals



To unselect signals in the menu bar select:

- Node Selection Actions
- unselect All Signals
- ➤ All IMAS Databases



This will unselect all signals selected in all opened IDS cases (DTV windows).

## Plotting 1D data embedded in time slices (1)



In opened 36440/1 case DTV window:

- 1. Open equilibrium IDS
- 2. In tree view navigate to
  - ➤ equilibrium
  - > Occurrence 0
  - Array of time\_slice with 73 elements
  - ➤ time\_slice 1/73
  - > profiles\_1d
  - ➤ f [T.m] (FLT\_1D)
- 3. Right click on the node and select **Plot as function of time**

K Tokamak: aug, user: g2dpc, shot: 36440, run: 1 Actions Node Selection Actions		
distributions	*	Preview Plot
ec_antennas ece		E
edge profiles		-4.123
edge sources		-4.123
edge transport		
em_coupling		4.304
💌 equilibrium		-4.124
<ul> <li>occurrence 0</li> </ul>		
ids_properties		1.105
vacuum_toroidal_field		-4.125
<ul> <li>Array of time_slice with 73 element(s)</li> <li>time slice 1/73</li> </ul>		
<ul> <li>boundary</li> </ul>		
<ul> <li>boundary_separatrix</li> </ul>		-4.126
constraints		
global_quantities		
🔻 profiles 1d		-4.127
documentation= Equilibrium profiles (1D r		E.
psi [Wb] (FLT_1D)		
psi_error_upper [Wb] (FLT_1D)		-4.128
psi_error_lower [Wb] (FLT_1D)		1
phi [Wb] (FLT_1D)		
<ul> <li>phi_error_upper [Wb] (FLT_1D)</li> <li>phi_error_lower [Wb] (FLT_1D)</li> </ul>		-4.129
<pre>pressure [Pa] (FLT 1D)</pre>		
<ul> <li>pressure_error_upper [Pa] (FLT_1D)</li> </ul>		1
pressure error lower [Pa] (FLT 1D)		
f 🖶 Select equilibrium.time_slice[0].profile:	s_10	d.f
f select all nodes from the same AOS		
▶ d ▶ d ■ Plot as function of time		
d Plot equilibrium.time_slice[0].profiles_1	Ld.f	to
Unselect Nodes		
🕨 🗗 📑 Plot selected nodes to		
▶ i		
Delete		
	-	



\_ 🗆 ×

In the opened plot window the **time slider** on the bottom can be moved and the plot will update accordingly.

Figure: 10

-4.13 g2dpc:aug:36440:1:equilibrium/time\_slice(10)/profiles\_ld/f -4.14 -4.15 [T.m] -4.16 -4.17 -4.18 -4.19 -0.8 -0.6 -0.4 -0.2 0 -1.2 -1 0.2 equilibrium/time\_slice(10)/profiles\_1d/psi ✓ Mouse Enabled Time Slider Index Value: 10 Time: 1.2999999523162842 [s]

**NOTE:** The X-axis corresponds to **coordinate1**, in this case **psi** found under **equilibrium/time\_slice(<time index>)/profiles\_1d/psi**.

*	pressure_error_lower [Pa] (FLT_1D) f [T.m] (FLT_1D)
	coordinate1=time slice[itime].profiles 1d.psi
	documentation= Diamagnetic function (F=R B Phi)
	name=equilibrium.time slice[0].profiles 1d.f (STR 0D)
	f error upper [T.m] (FLT 1D)



In opened 36440/1 case DTV window:

- 1. Open equilibrium IDS
- 2. In tree view navigate to
  - ➤ equilibrium
  - Occurrence 0
  - Array of time\_slice with 73 elements beta\_normal\_error\_lower=-9e+40...

ip erro

volume

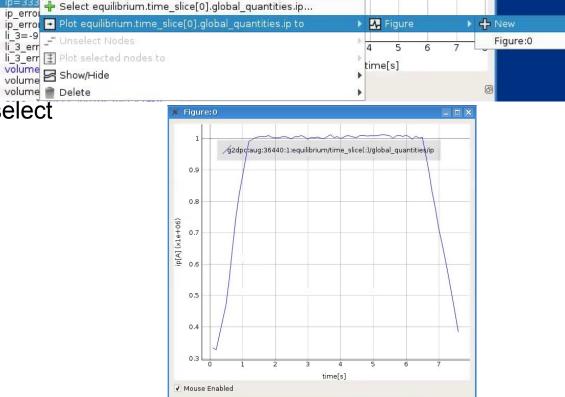
volume

Show/Hide

- $\succ$  time\_slice 1/73
- i 3=-9 ▶ li 3 err global\_quantities;
- ≻ ip

volume Delete Right click on the node and select

Plot as function of time.



# Using UDA: UDA requirements for IMASViz on the Gateway



TCV, AUG and WEST requires a configuration file for enabling the UDA connection. The file should be located in your home directory. However UDA JET access is public, nothing to set.

#### Accessing TCV

You have to provide a file '.exp2imas' with the following content in a single line:

TCV username password

The file should be located in your home directory (filename='.exp2imas', do not forget the dot !).

#### Accessing AUG

You have to provide a file '.exp2imas' with the following content in a single line:

AUG username password

The file should be located in your home directory (filename='.exp2imas', do not forget the dot !).

#### Accessing WEST

You have to provide a file '.west\_tunnel ' with the following content in a single line:

WEST username password

The file should be located in your home directory (e.g. filename='.west\_tunnel', do not forget the dot !).

IMPORTANT: For the UDA to work, ~/logs/uda directory must exist! On the GW this can be done with:

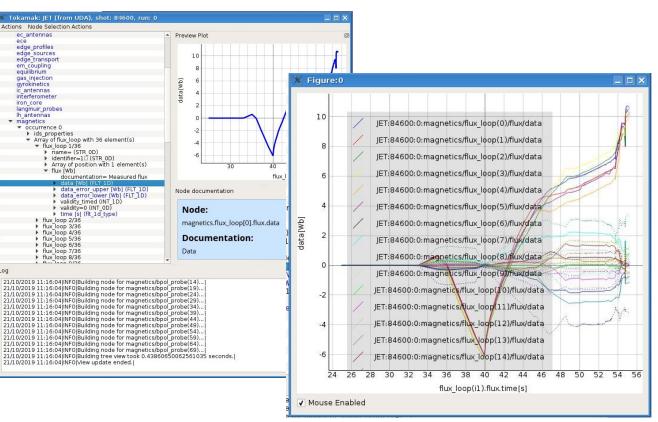
cd \$HOME mkdir logs cd logs mkdir uda

## Using UDA: displaying the magnetics IDS from a JET shot



- Select tab
   'Experiment data source' from the main GUI
- 2. Fill the fields according to the picture (shot 84600 from JET)
- Click open (takes a few seconds to load data)
- 4. Load the magnetics IDS
- Right click on one flux\_loop and execute 'Select all nodes from the same AOS'
- 6. Plot all selected nodes to a new figure.

Local data sourd	Experiment data source	
Shot number	84600	
Run number	0	
Unified Data Access	JET	





To export the opened IDSs from the DTV to a new local IMAS pulse files:

- 1. In the menu bar navigate to
  - > Actions
  - Export to IDS
- In the opened window set the database parameters (Note that the Database must exist!)

🗙 Export	browsed tree view contents to local ID ?	۲
	y IDSs, that are CURRENTLY OPENED in the tree view, will be exported! ke sure the database/machine (created using imasdb command) exists!	
User:	/	
Database:	/	
Shot:		
Run:		
	OK	
	Cancel	

3. Press OK

🗙 Toka	amak: JET (from UDA),		
Actions	Node Selection Actions		
Appl	y Configuration		
Export to IDS			

## Example of using the plugins – Equilibrium plugin

1.

2.

3.

plugin'



Tokamak: west, user: g2lfleur, shot: 54178, run: 0 \_ 🗆 🗙 Actions Node Selection Actions Open the WEST shot IDSs(54178) . Preview Plot amns data (g2lfleur,west,54178,0) U.J barometry bolometer While keeping the **shift** bremsstrahlung visible . E X charge exchange keyboard button pressed, coils non axisymmetric Local data source Experiment data source controllers right-click on the core instant changes User name g2lfleur core profiles 'equilibrium' IDS core sources west Tokamak core transport Select the 'Equilibrium Shot number 54178 dataset description distribution sources Run number 0 distributions ec antennas ece edge profiles The Equilibirum overview plugin edge sources edge transport window will be shown. em coupling gas\_injectio 🕂 Equilibrium overview. gyrokinetics Open The **slider** on the bottom of the ic antennas User g2lfleur window can be used to show data Equilibrium Shot 54178 Run 0 Machine west Psi with B0=-3.835 [T] at R0=2.370 [m] 1.3 400 for different time values. [ky] di 200 0.8 Buo 1.2 0.6 0.4 triang q95 triang up -50 --- q\_axis -- triang low 0.2 EN----[MA/m2] -10 Z [m] (+)0.0 EII3 -0.2 1250 -0.4 1 200 [[x] pyuw 0 [u] 2.55 [kPa] -0.6 Р -0.8 0 2.5 2.0 3.0 0.025 R [m] ÷ ₩ 2.50 ₩ 2.45 Time = 38.056514739990234 08-288 Z [m] 0 0.025 σ ā. ¥ 0.000 -1e+05 40 60 0.0 0.6 1.0 50 0.2 0.4 0.8 0.0 0.2 0.4 0.6 0.8 1.0 Time [s] rho tor norm rho tor norm y=0.000427702 x=44.8578 B O 圭 Run Stop Enable Grid Time value to draw (press enter) 48.0