

2007 International RELAP5 User's Seminar  
Idaho Falls, Idaho  
November 7-9, 2007

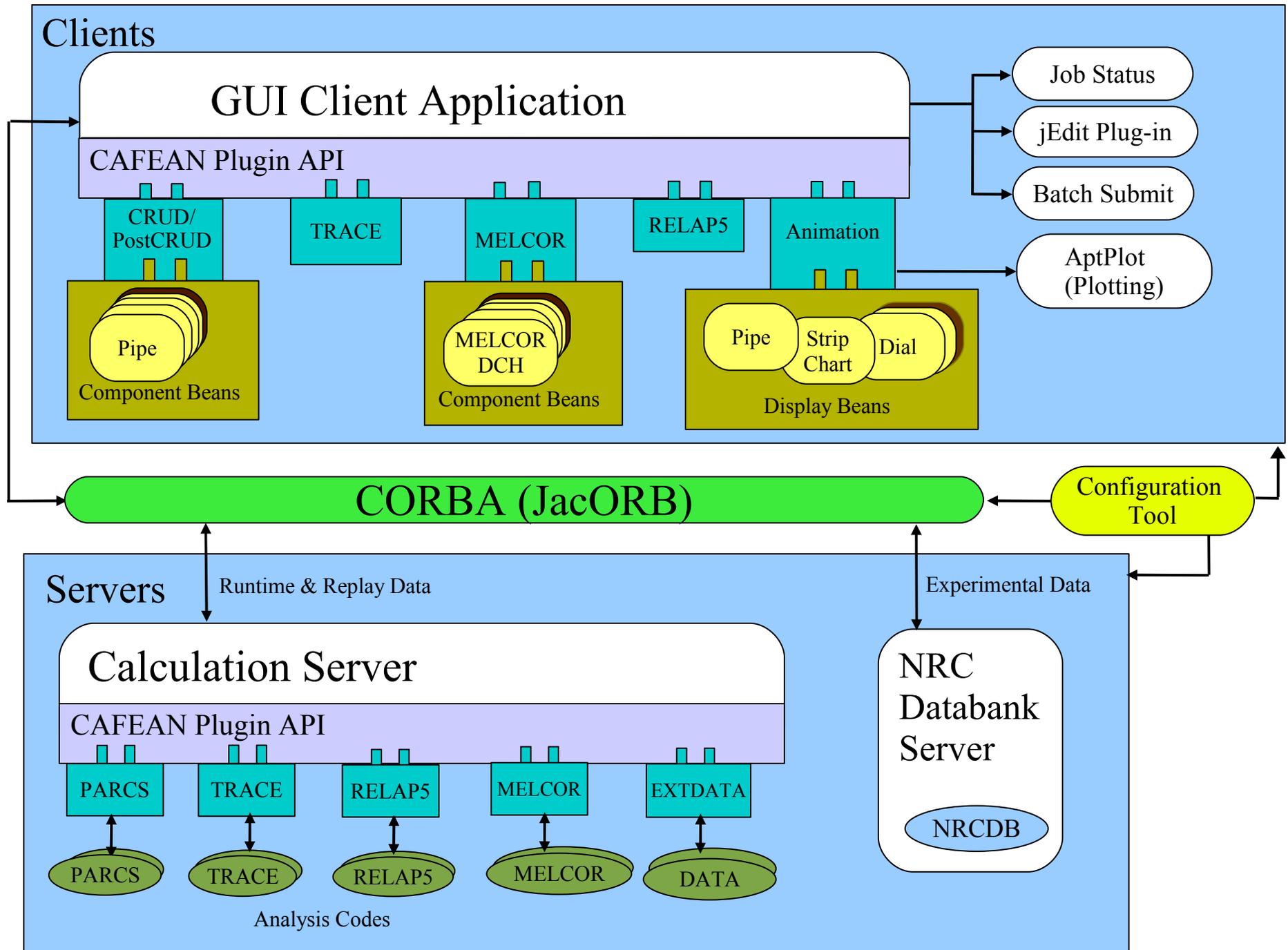
# Symbolic Nuclear Analysis Package (SNAP)

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# Outline

- Brief Overview of System Architecture
- Extensibility
- GUI Features
- SNAP Demo

# SNAP System Architecture



# Design Features

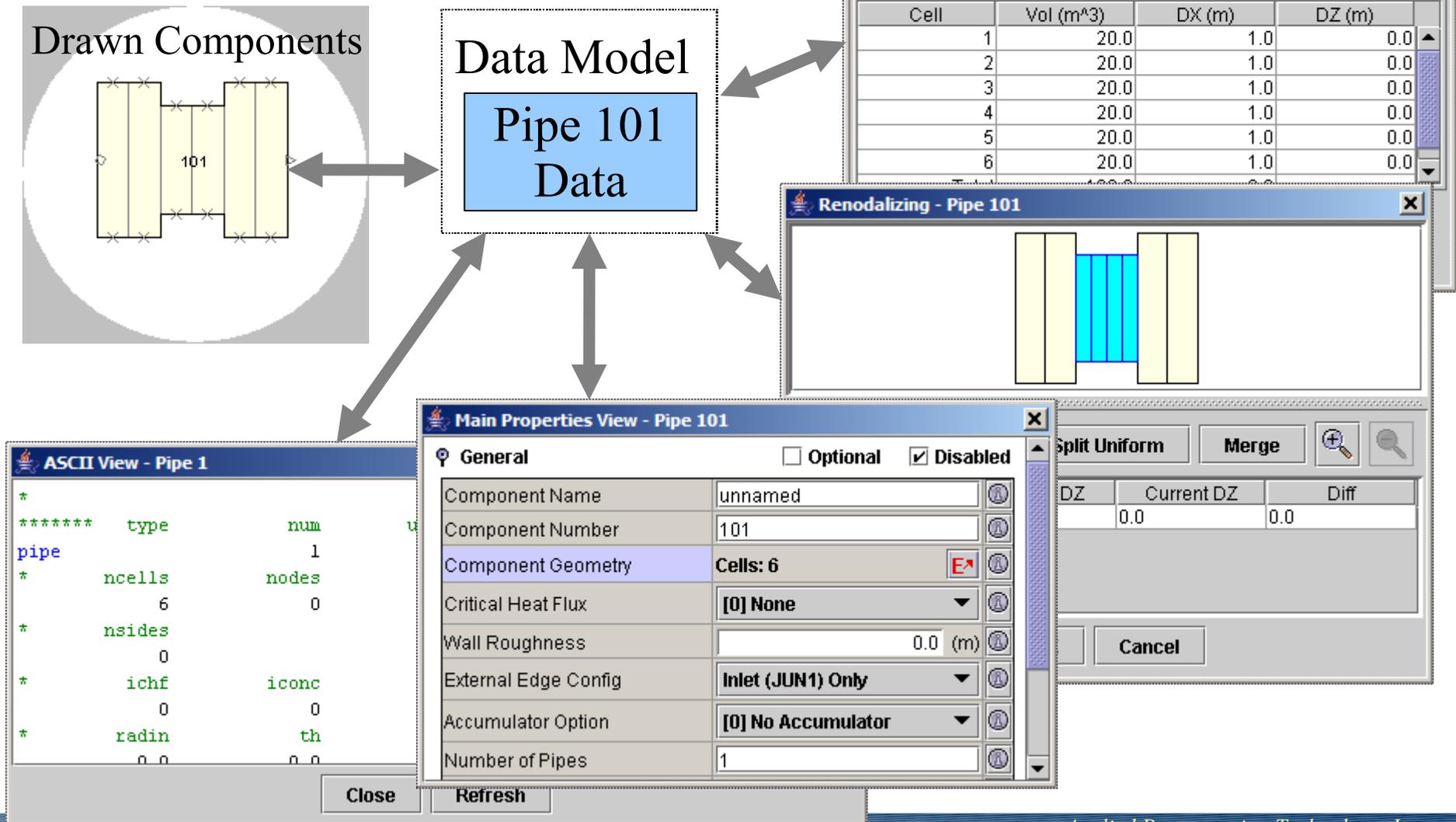
- Platform Independent
  - Java 1.5 or newer
  - Supported on: Windows, MAC OS X, Linux, Solaris, HP-UX, etc...
- Common Environment for Performing Engineering Analysis
  - An Interface for constructing and editing input models
  - A Tool for visualization of code outputs and data
  - Runtime Job Control
  - Job organization features; keeps track of your input and output files
  - Easy access to analytical code documentation
- Highly Extensible and Flexible
  - Framework provides a support for many different types of analytical codes
  - Plug-in based architecture allows for extensibility to new/other analytic codes
  - No Modification of the Base Code Required
  - Python Scripting:
    - User Defined Functions – Calculate Model Input
    - Python Data Channels – Post-Processing Calculations, Animations

# Plug-ins

- A SNAP “code” plug-in is a program unit that encapsulates all user interface, input, output, and run-time features for a particular analytic code.
- SNAP Code Plug-ins (Partial List)
  - TRACE
  - RELAP5 (MOD 3.3 & RELAP5-3D<sup>©</sup>)
  - CONTAIN
  - MELCOR 1.8.6
  - PARCS
  - COBRA
- A SNAP plug-in can also implement a “feature” or extended capability that may or may-not be related to a specific analytic code.
  - Animation Model Plug-in
  - RELAP5 to TRACE Model Conversion Plug-in
  - Model Documentation Plug-in
- Plug-in API for Adding New Analysis Codes & New Features
  - available at: <http://www.nrcsnap.com/snap>

# Component Data Model

- All Component Data is Declared Private
- Views Implement a ComponentListener Interface
- Changes to Component Data are Automatically Reflected in all Views.



# Multiple-Window Mode

The screenshot displays the Model Editor 0.22.9 interface in Multiple-Window Mode. The main window shows a 2D view of a pipe structure with various components and variables. A red box highlights the 'Interactive Calculation' section, which includes a list of 'Interactive Variables' used to control the simulation: Outer Surface Heat Flux, Fill State Conditions, and Inlet Steam and Vapor Velocities. A yellow box labeled 'Output Signal Variables' shows 'Inner Surface Temp.'. A blue box labeled '2D Views' points to the pipe structure. A blue box labeled 'Component Navigator' points to the left-hand tree view. A blue box labeled 'ASCII Views' points to the 'ASCII View - Pipe 21' window, which displays a table of pipe properties. A blue box labeled 'Property View' points to the 'Main Properties View - Pipe 21' window, which shows the general and pipe wall properties. A blue box labeled 'Message Window' points to the 'Message Window' at the bottom, which displays system messages and logs.

**Component Navigator**

**Main Properties View - Pipe 21**

**Interactive Calculation**

**2D Views**

**ASCII Views**

**Property View**

**Message Window**

Variable	Value
Outer Surface Boundary Flux	-1 Variable
Pressure	-15 Variable
Void Fraction	-14 Variable
Liquid Velo	-10 Variable
Vapor Velo	-1 Variable
Liquid Tem	-12 Variable
Vapor Tem	-12 Variable

```

ASCII View - Pipe 21
*****
type          num      userid      component name
pipe          21         1            unnamed
ncells       20         0            eps
nsides       0
ichf         1         0            ipow         npipes
iacc         0         0            houtv        toutl
pwin         0.0       0.0         0.0          0.0
pwoff        0.0       0.0         0.0          0.0
rpxmx        0.0       0.0         0.0          0.0
dx           1.0       1.0         1.0          1.0s
dx           1.0       1.0         1.0          1.0s
    
```

Message Window

```

Messages
Open Complete.
Opening file C:\SNAP_PROJECTS\SNAP\lib\Demo\Interactive\interactive_anim.med
loading C:\SNAP_PROJECTS\SNAP\lib\Demo\Interactive\interactive_anim.med please wait...
Open Complete.
Opening file C:\SNAP_PROJECTS\SNAP\lib\samples\Typypwr\typypwr_anim.med
loading C:\SNAP_PROJECTS\SNAP\lib\samples\Typypwr\typypwr_anim.med please wait...
Open Complete.
connected to: Master: calcserv://localhost/Local/LR5_308110537
initializing Python Interpreter...
    
```

# Single-Window Mode

**Model Editor 0.22.9**

File Edit Tools Window Help

RELAP5 models  
\*\*typwr.med - (typwr)\*\*  
Animation models  
\*\*typwr\_anim.med - (Typical PWR)\*\*  
Model Options  
Python Data Source  
Data Sources [1]  
Ranges [4]  
Numerics [0]  
Views [3]  
Primary Full Plant  
Fluid Condition Range  
Temperature Range (Fuel)  
Primary Vessel  
Python Example

**General**  Optional  Disabled

Data Source	Master: calcserv://local...
Range	Fluid Condition Range
Volume ID	108040000
X-Axis Alignment	0.5
Y-Axis Alignment	0.5
Background Color	204, 204, 204
Border	None
Command Menu	-not set-
Curved Fraction	0.75
Font	Dialog 8
Foreground Color	0, 0, 0
Opaque	<input type="radio"/> True <input checked="" type="radio"/> False
Orientation	South-West
Outline Width	3
Pipe Width Fraction	0.5
ToolTip Text	volume-108040000

**Primary Typical PWR Model**

Time: 706.03 s  
% CTP: 2.31 %  
Pressure: 9.04e+02 psia

Fuel (Temperature) scale: 300 to 1500 K

Fluid Condition scale: 300 (K) to 2000 (K)

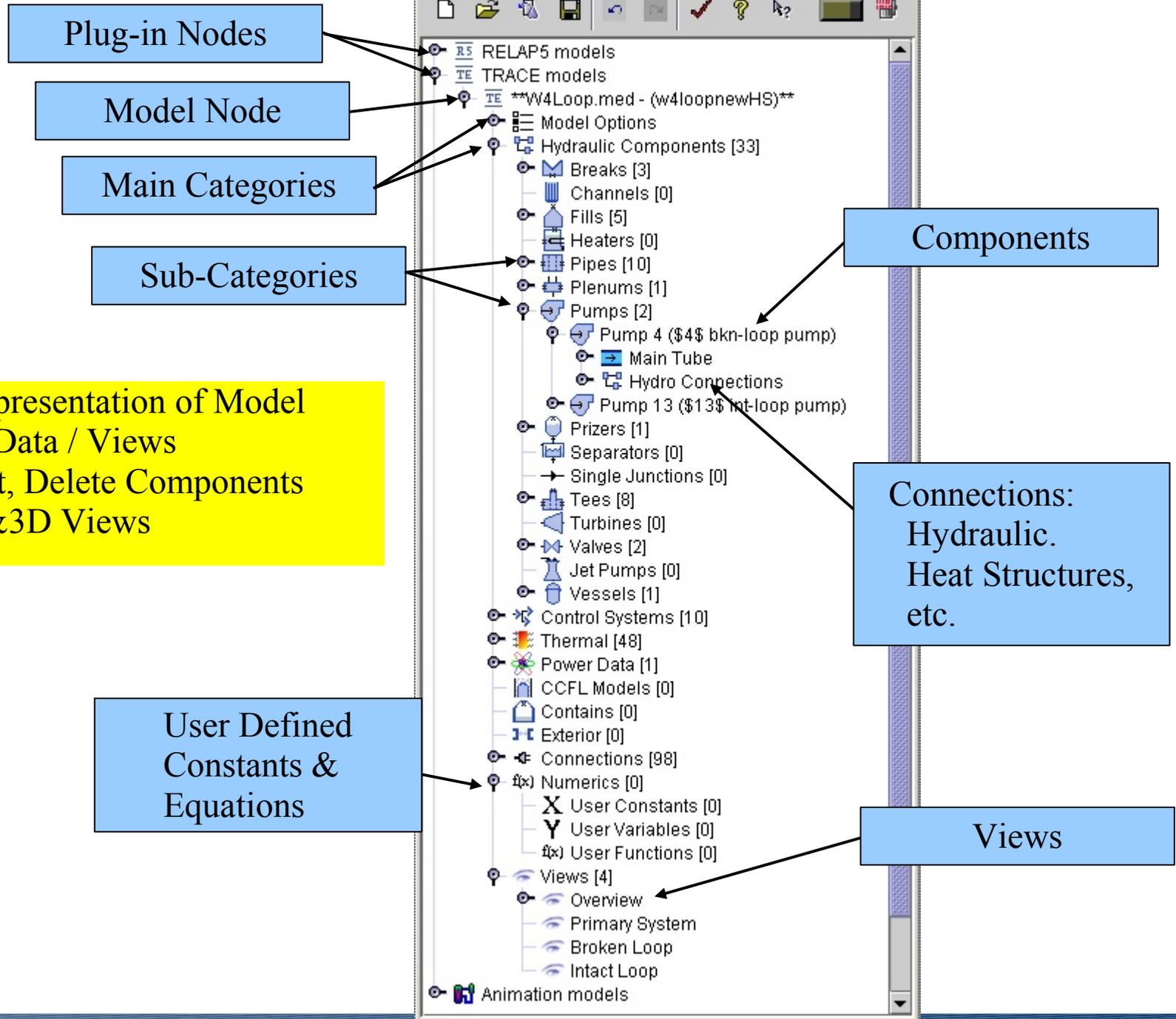
Primary Hydraulic View | Broken Loop Steam Generator | Intact Loop Steam Generator | Primary Full Plant | Primary Vessel

Messages

- Disconnected from: Python Data Source
- Disconnected from: Master: calcserv://localhost/Local/LR5\_308110537
- Connected to: Master: calcserv://localhost/Local/LR5\_308110537
- Connected to: Python Data Source

# Component Navigator

- Logical Representation of Model
- All Model Data / Views
- Create, Edit, Delete Components
- Create 2D&3D Views



# Properties View

**Mini-Navigator** points to the tree view on the left showing the hierarchy: Break 7 (\$7\$ bkn-loop containment) > Hydro Connections > Hydro Connection [8]: Valve 6 (\$6\$ bkn-loop break valve).

**Display Options** points to the  Optional and  Disabled checkboxes at the top of the General tab.

**Help Buttons** points to the question mark icons in the right margin of the attribute rows.

**Attribute Descriptions** points to the Description and Comments fields.

**Attribute Values** points to the input fields for Length (0.1 m), Volume (10.0 m<sup>3</sup>), Initial Gas Volume Fraction (1.0), Initial Mixture Temperature (300.0 K), and Initial Pressure (1.0E5 pa).

**Attribute Groups** points to the expandable sections: Scale Factors, Trace Species, State Controllers, and Contan Coupling.

**Custom Editors** points to the 'E' icons in the Break Table and Rate Factor Table rows.

**Attribute Popup Help** points to the IBTY popup window, which contains the following text:

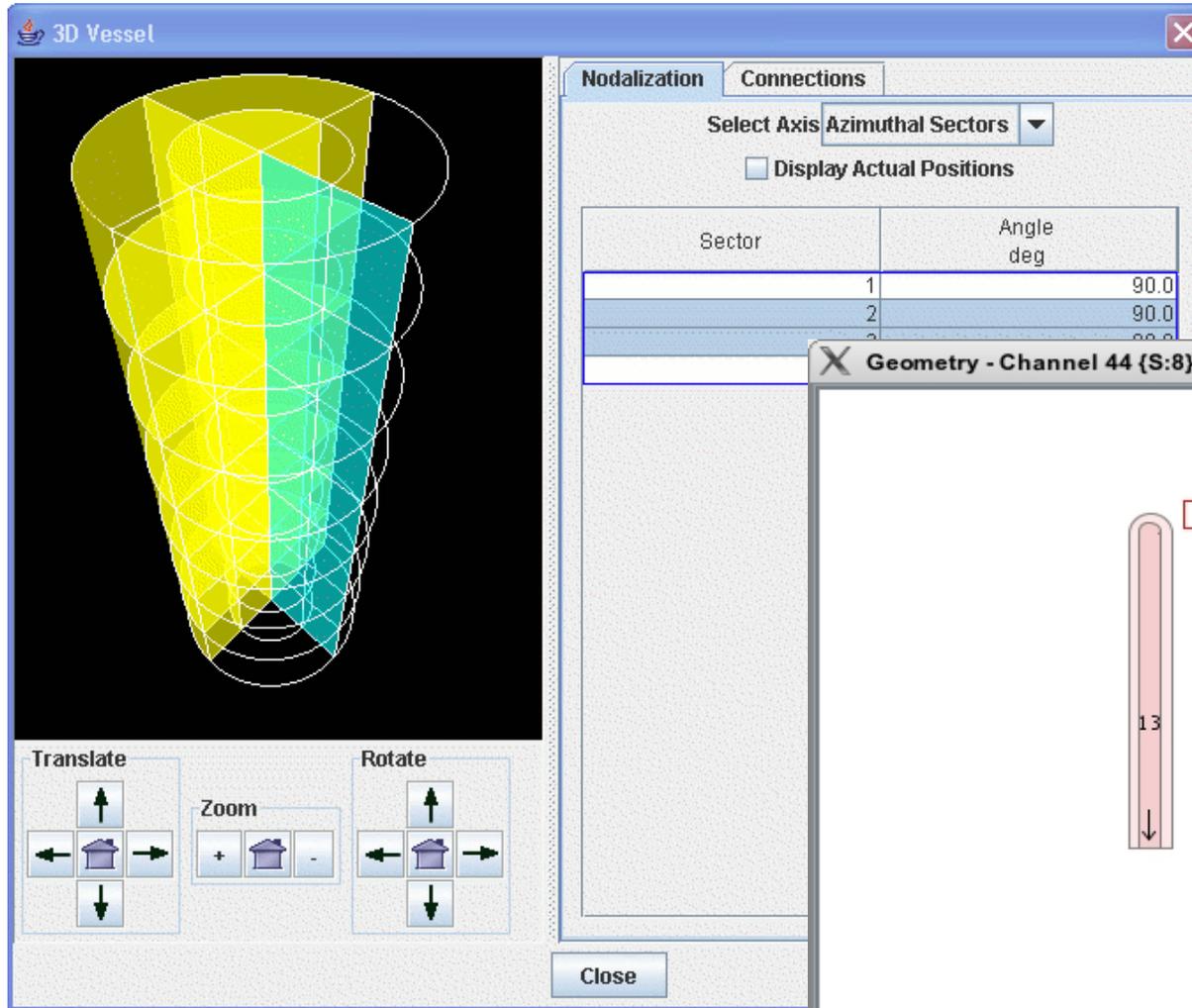
**IBTY**

BREAK-type option.  
 0 = no tables input and not a Generalized BREAK (see IBTY = 6);  
 1 = input pressure table (array PTB, Card Set 14);  
 2 = input pressure and temperature tables (arrays PTB and TLTB, and TVTB if ISAT = 4, Card Set 14, Card Set 15, and Card Set 16);  
 3 = input above tables plus gas volume-fraction table (array ALPTB, Card Set 17);  
 4 = input above tables plus noncondensable-gas partial-pressure table (array PATB, Card Set 18);  
 5 = input above tables plus solute-to-coolant mass-ratio table (array CONCTB, Card Set 19), [requires ISOLUT = 1 (Word 3 on Main-Data Card 9)];  
 6 = Generalized-BREAK fluid parameters defined individually by a signal variable or control block (see Card Number 10). Note: this option is not under direct control by trip ID number IBTR (Word 1 on Card Number 4) and the rate of change of the fluid parameters is not constrained by RBMX (Word 3 on Card Number 6).  
 7 = Connected with CONTAN component. All BREAK fluid parameters are defined by the connecting CONTAN compartment.

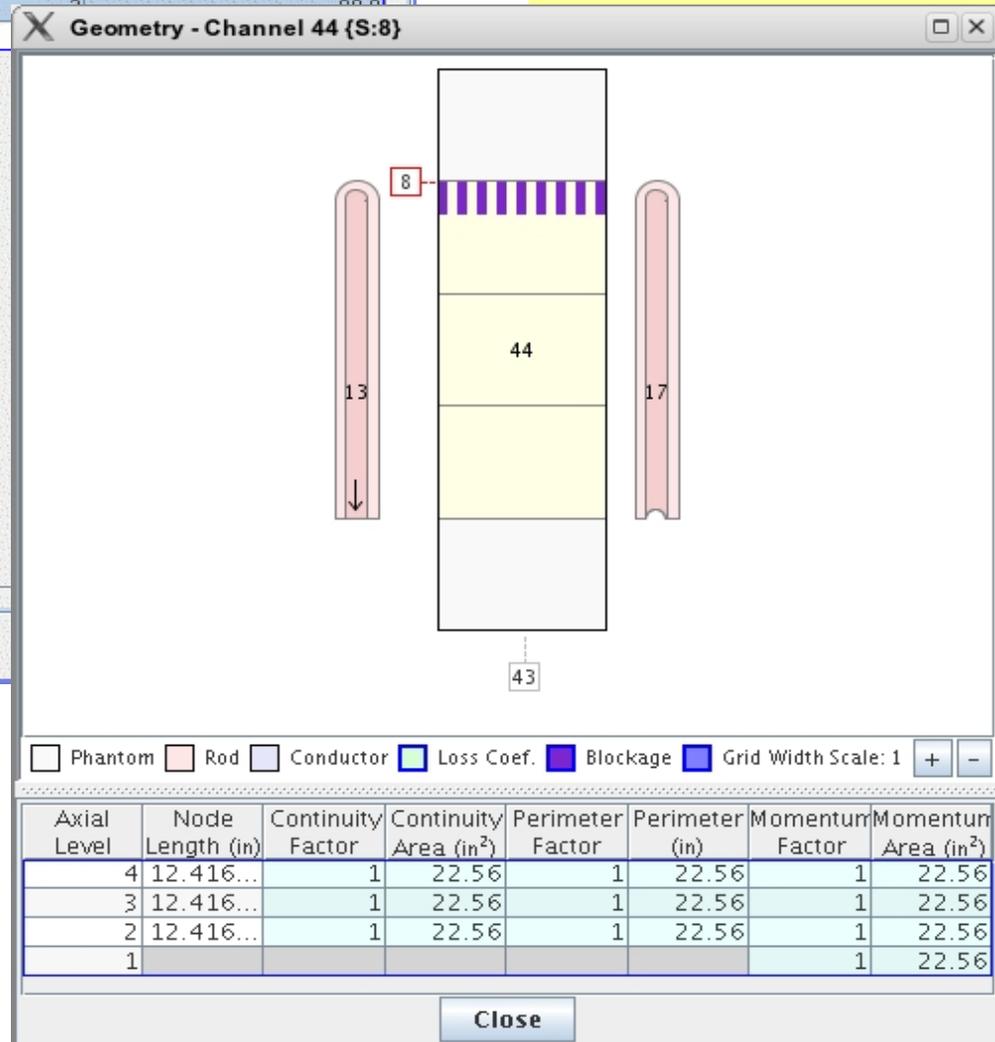
**The Main Property View**

- Reflects the Current Selection
- Supports Multi-Selection-Edit

# Custom Editors

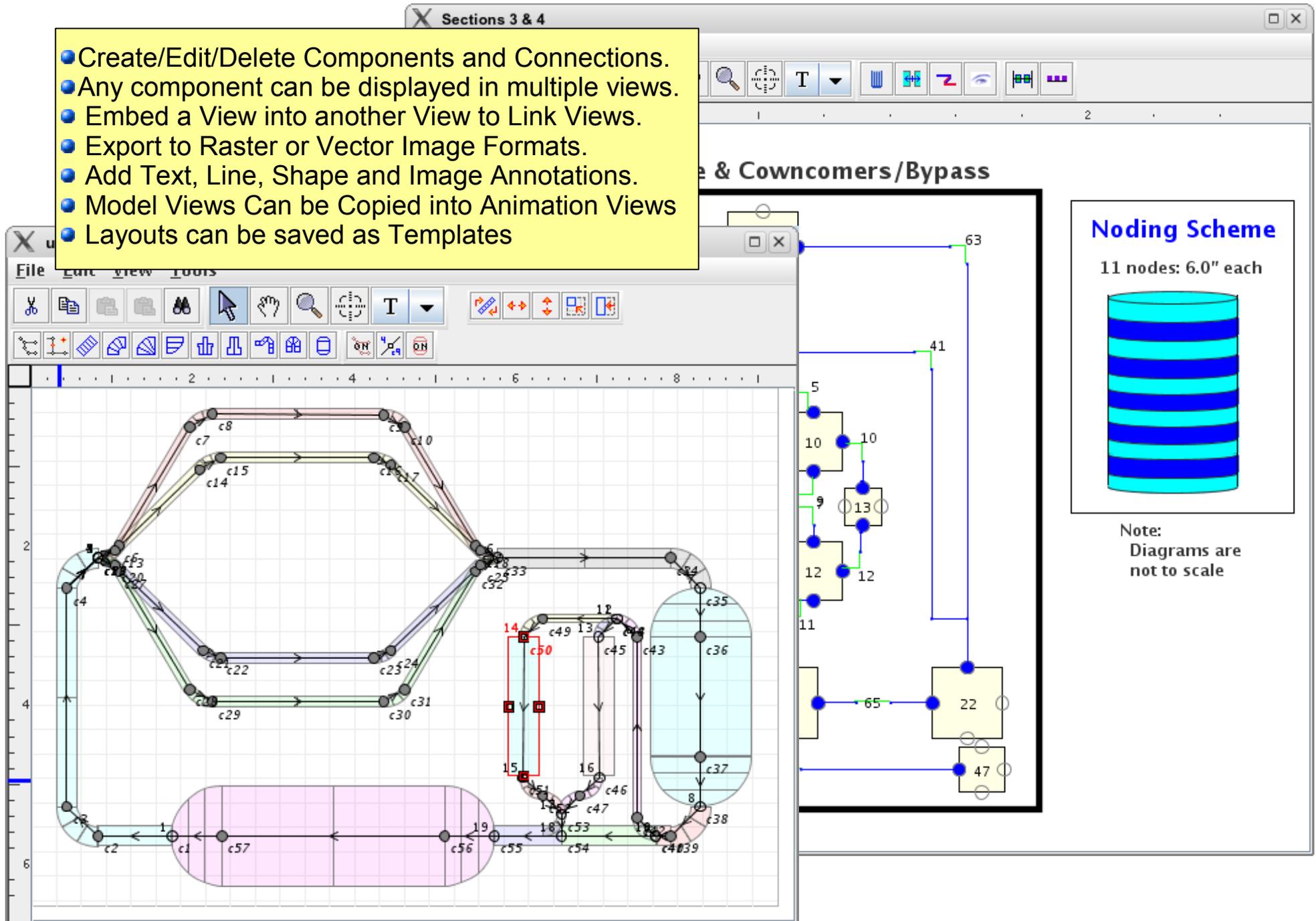


- Used to Provide Intuitive Interface for Editing Complex Data
- Table Data can be Copied to/from Spreadsheet Apps

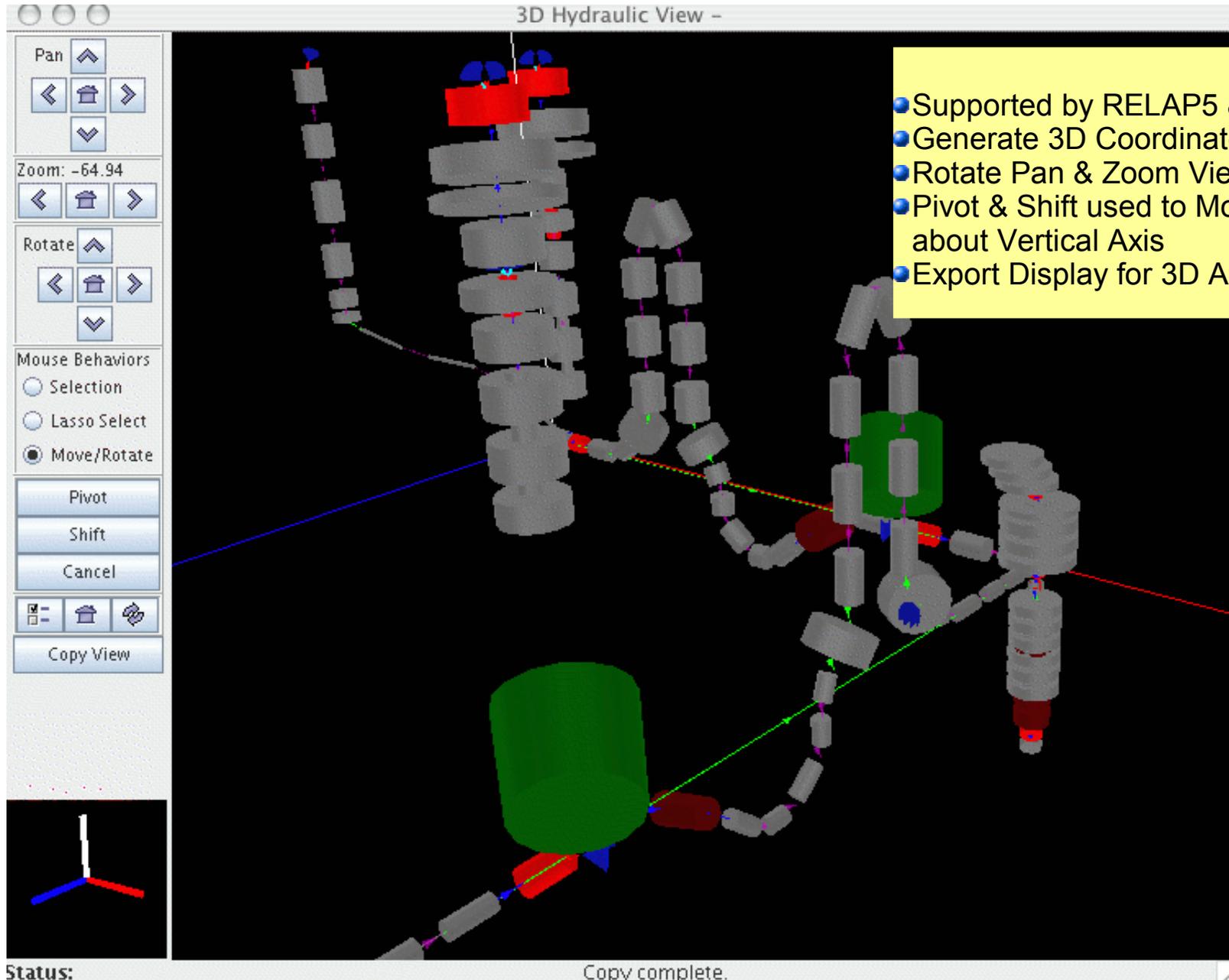


# 2D Model Views

- Create/Edit/Delete Components and Connections.
- Any component can be displayed in multiple views.
- Embed a View into another View to Link Views.
- Export to Raster or Vector Image Formats.
- Add Text, Line, Shape and Image Annotations.
- Model Views Can be Copied into Animation Views
- Layouts can be saved as Templates



# 3D Visualization



- Supported by RELAP5 & TRACE Plugins
- Generate 3D Coordinates
- Rotate Pan & Zoom View
- Pivot & Shift used to Move Components about Vertical Axis
- Export Display for 3D Animation

# ASCII Views

- Component “Show ASCII” Menu Item
- Automatically Updates When Component Data Changes
- Syntax Highlighting

ASCII View - PUMP 113 (IPUMP)

*	name	type				
1130000	"ipump"	pump				
*	area	length	vol			
1130101	15.723	0.0	168.0			
*	az-angle	inc-angle	dz			
1130102	0.0	33.0	5.812			
*	flags					
1130103	0					
*	ebt	press	temp			
1130200	003	2246.0	529.93			
*	to	area	kfor	krev	flags	
1130108	112050002	15.723	0.069	0.069	0	
*	flow	mfl	mfv	unused		
1130201	1	3.046455e4	0.0	0.0		
*	to	area	kfor	krev	flags	
1130109	114010001	12.3741	0.0	0.0	0	
*	flow	mfl	mfv	unused		
1130202	1	3.046455e4	0.0	0.0		
*	phase twophase	tdiff	mtorq	tdvel	ptrip	rev
1130301	-2	0	-2	-1	-1	501 0
*	pvel	pratio	rflow	rhead		
1130302	1189.0	1.0057	2.655e5	277.0		
*	rtorq	imoment	rdens	rmtor		
1130303	9.48e4	2.46e5	62.4	0.0		

Close Refresh

# User Defined Functions

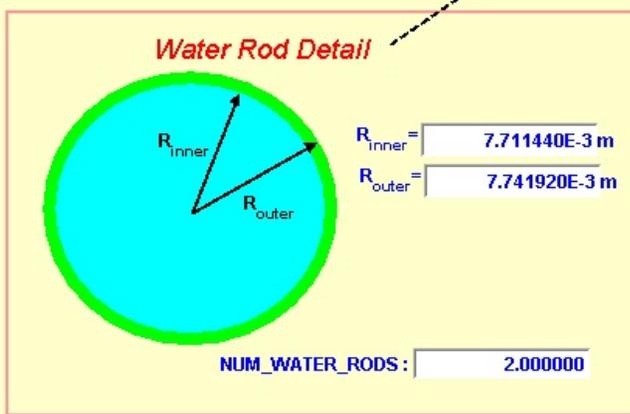
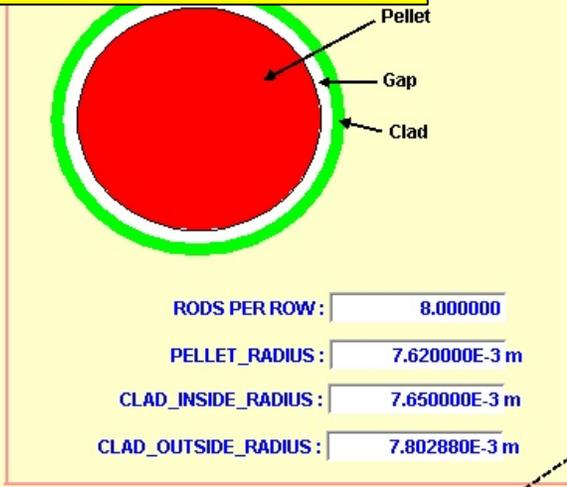
- **Constants/ Variables:**
  - Can be used to define values in editing dialogs
  - Include Engineering Units
  - Can be displayed and edited in 2D Views
  - Parametric Constants generate a set of Calculations
- **Functions:**
  - Python Interpreter
  - Calculate Variables based on Constants and Variables

```

Source Editor - Function: Fuel Element Calcul
# Define some constants
PI = 3.1415926
r = GetConstant("CHAN_CORNER_RADIUS")
w = GetConstant("CHAN_INSIDE_WIDTH")

# Calculate the Channel Inside Perimet
p = 4 * ( w - 2*r ) + ( 2*PI*r )
# Set the Result
SetVariable("CHAN_INSIDE_PERIM", p)

# Now Calculate the flow area
chanarea = w*w - (r*r - ( 2 * PI * (r*
rodsPerRow = GetConstant("RODS_PER_ROW
numFuelRods = rodsPerRow*rodsPerRow-Ge
fuelRodArea = PI*GetConstant("CLAD_OUT
waterRodArea = PI*GetConstant("WR_OUTS
#
chanFlowArea = chanarea-( numFuelRods
# Set the Result
SetVariable("CHAN_FLOW_AREA", chanFlow
    
```



## R 8x8 Fuel Element Calculations

CHAN\_INSIDE\_WIDTH: 0.128016 m  
 CHAN\_CORNER\_RADIUS: 0.012558 m

**Calculated Variables**

CHAN\_INSIDE\_PERIM : 0.490505m  
 CHAN\_FLOW\_AREA : 4.985552E-3m^2

# Runtime & Post-processing

- Support for Interactive and Batch Modes as well as Importing Completed Runs
- Provides Access to Plot Data for Client Applications (Animation & Plotting)

The screenshot shows the SNAP Job Status 0.24.2 application. The main window displays a tree view of local and remote hosts. A table shows the status of a job named 'Typpwr-2' on 'localhost:5006', which is 'Complete' with a 'Calc Time' of 1998.028687 and 'Started' at 15:51:54.

An output window titled 'Output for Typpwr-2 file #0' is open, showing a 'Points Of Interest' section with a 'Goto', 'Find', and 'Close' button. The output text includes:

```

MAJOR EDIT !!!time= 400.261 sec
0 advancement total between edits|
0 attempted: 1728 48 | min.dt= 0.265808 sec last dt= 0.453078 sec emas
0 repeated: 5 0 | max.dt= 0.500000 sec crnt.dt= 0.453078 sec tmas
0 successful: 1723 48 | avg.dt= 0.418873 sec merr.est= 1.022289E-05 em/t
0 requested: 1724 48 | req.dt= 0.500000 sec cpu= 8.28000 sec tir

0 Trip number, trip time (sec)
501 11.28245 502 14.72960 503 12.11710 504 17.15959 505 25.
506 1.0352478E-02 507 0.000000 508 -1.000000 509 -1.000000 510 -1.0
511 -1.000000 512 0.000000
1601 -1.000000 1602 -1.000000 1603 -1.000000 1604 -1.000000 1605 25.
1606 -1.000000 1607 25.34366 1608 25.34366

0 Total power fission power gamma power reactivity rec. period
(Watts) (Watts) (Watts) (dollars) (sec-1)
9.17100E+07 63862. 9.16462E+07 -14.851 -1.63465E-02

0 System 1 PRIMARY mass= 2.25795E+05 kg mass error = 56.003 kg merr.est.= 1.02229E-05
0 Vol.no. pressure voidf voidg voidgo tempf tempg satt-part uf
(Pa) (K) (K) (K) (J/kg)
ih1 pipe
    
```

The status bar at the bottom indicates 'Current Line: 42630'.

- Job Status Tool:**
- View Status of All Runs
  - Interactive Commands
  - View ASCII Output
  - Delete Runs

# Animation Models

**Animation Models**

**Data Sources**

**Animation Controls**

**Output Signal Variables**

**Interactive Calculation Demo.**  
Vertical, 20m, 6" Schedule 80 Pipe.  
Heated from 2m-18m.

Interactive Variables are used to control:

- Outer Surface Heat Flux
- Fill State Conditions
- Inlet Steam and Vapor Velocities

**Inner Surface Temp.**  
SURFT sv6 314.5 k

**Outer Surface Temp.**  
SURFT sv7 315.1 k

**Last Cell Temp**  
TEMPF sv3 309.2 k

**First Cell Temp**  
TEMPF sv2 308.0 k

**Fluid Velocity**  
FLUVELX sv5 0.0 m/s

**Fluid Conditions (Fluid Condition)**

2000 (K)  
Sat. Steam  
Sat. Liquid  
300 (K)

**Temperature**

360.0  
350.0  
340.0  
330.0  
320.0  
310.0

Reset 0.0 100.0

sv2  
sv3  
sv6  
sv7

**General**  Optional  Disabled

Include in Animation  True  False

Master Source  True  False

Name Master

Source Run URL calcserv://localho...

**Heat Structure**

**Outer Surface Boundary Flux**

**Fill State Controller**

**Pressure**  
Variable cb15 6.0E6 pa

**Void Fraction**  
Variable cb14 0.0

**Liquid Velocity**  
Variable cb10 0.0 m/s

**Vapor Velocity**  
Variable cb11 0.0 m/s

**Can be Created Directly from Model Views**

**Multiple Simultaneous Data Sources**

- Analysis Code Calculations
- Experimental Data
- Python Calculations

**2D & 3D Animation**

**Dynamic T/H Property Range Selection**

**Interactive Capability**

**JavaBean Display Elements**

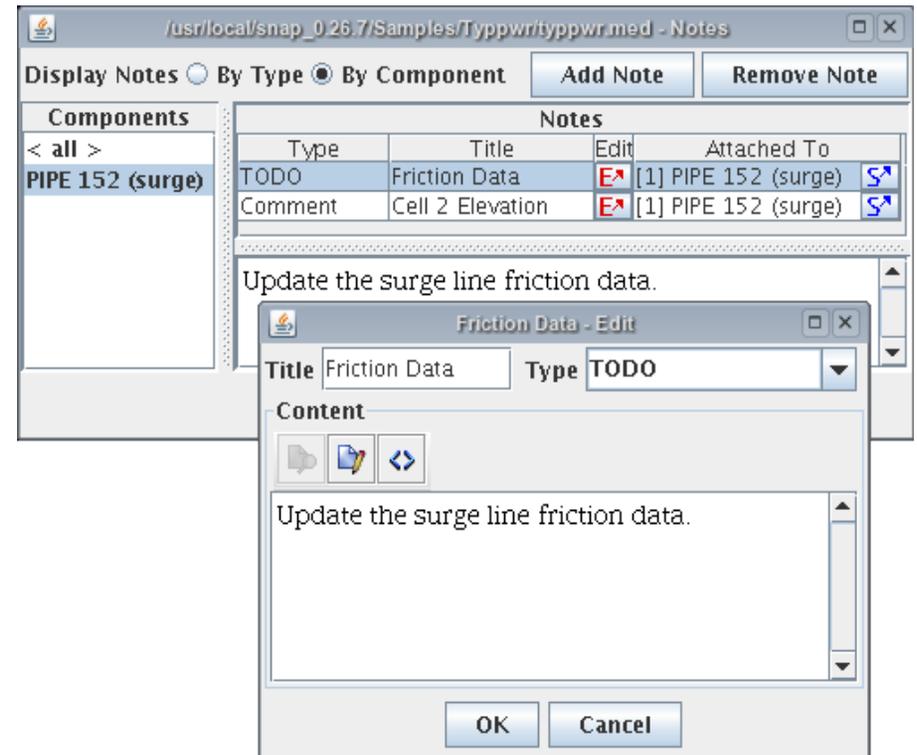
- Easy to Add New User Defined Beans

# Recent UI Improvements

- Improved Table Editors
  - More Intuitive Multi-Cell Editing
  - Copy/Paste between Editors and Spreadsheets
  - Plot Selected Data Directly to AptPlot
- New Modes for Drawn Connections
  - Single Line - A single segmented line to represent a connection between two components.
  - Source Marker - A "marker" connected to the source component that displays a short description of the target side.
  - Target Marker - A "marker" connected to the target component that displays a short description of the source side.
  - Source & Target - Both source and target markers.
- Component Grouping added to 2D Views.
- Horizontally and vertically constrained dragging in 2D Views
- "Open Recent" file menu was updated to include sub-menus for each of the available plug-ins.
- "View Files" button was added to the Run Console to allow the Output Viewer to be launched directly from the console.

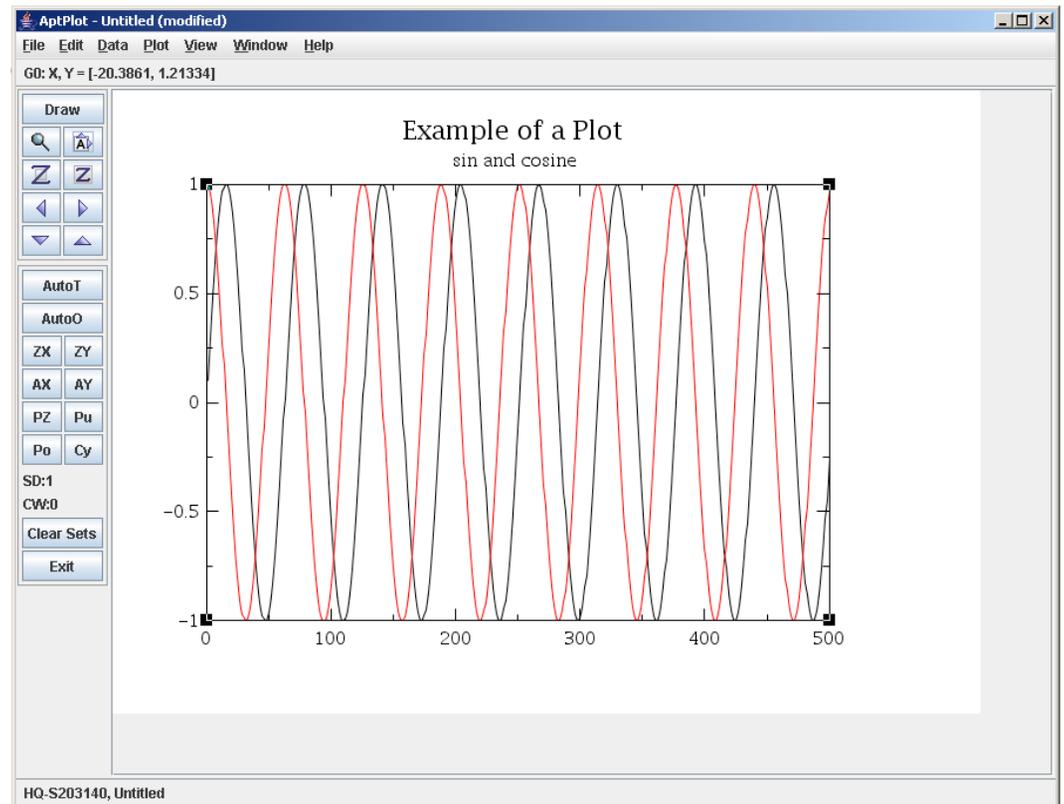
# Model Documents (MDOCS) Feature Plug-in

- Add a note to one or more components.
- HTML formatting can include hyperlinks to external documents.
- Flexible note types: TODO, Comment, User-specified.
- Sort by type or component.
- Works for all new and existing plug-ins automatically Saved with the model.
- Notes can be added programmatically by other plug-ins.



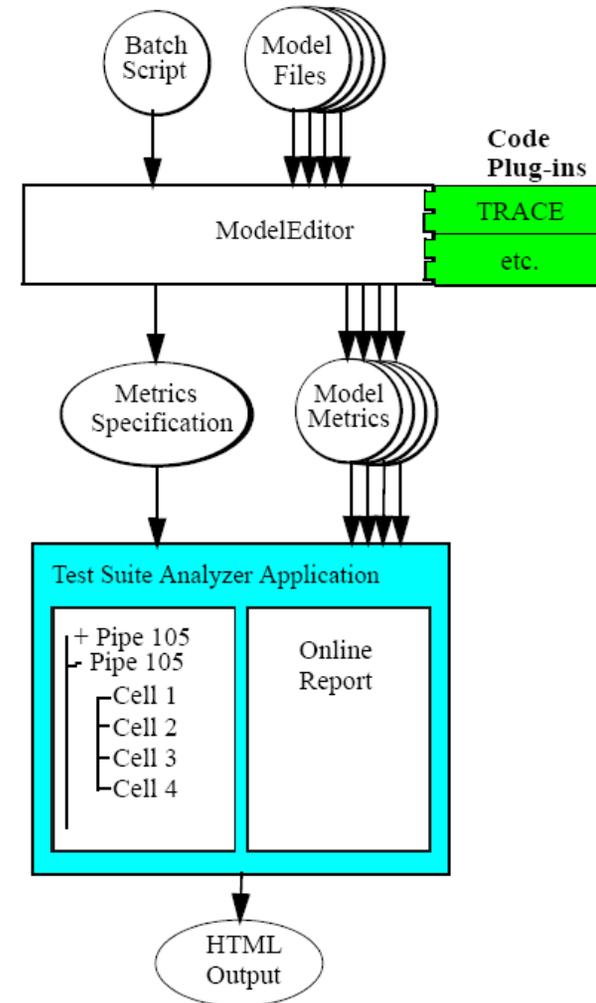
# AptPlot Plotting Package

- Pure-Java replacement for Xmgr5 & AcGrace
- Extensive batch capability.
- Produces publication quality output (postscript, PDF, SVG, etc...)
- Java based plot files demultiplexers for RELAP5, TRACE, MELCOR, etc...
- AptPlot can be integrated with SNAP



# Test Suite Analyzer (TSA)

- Collect and Analyze Model Metrics
- Identify Holes in the Test Suite
- Generate summary and detailed reports.
- Embedded SQL Database (DERBY)
- Custom and free-form queries may be used to explore the data.



# Contacts

## Websites:

<http://www.nrcsnap.com> (SNAP)

<http://www.applot.org> (AptPlot)

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