SAND2019-1660PE

# MELCOR Uncertainty Analysis with SNAP & DAKOTA

PRESENTED BY

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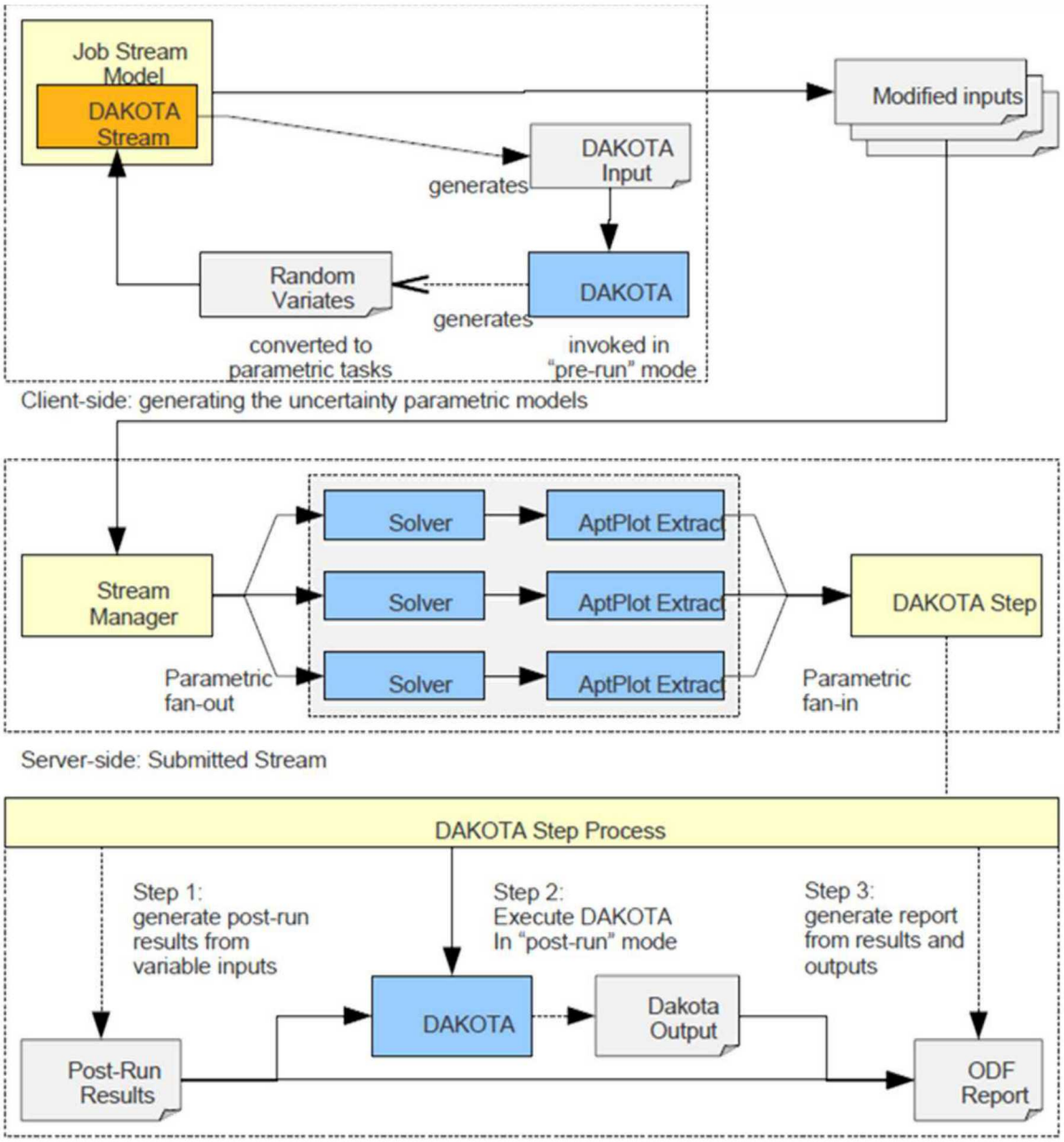
# SNAP/DAKOTA Uncertainty Analysis

## Pros

- SNAP provides access to MELCOR's rich inventory of sensitivity coefficients and input parameters.
- Rich set of parameter distributions to choose from.
- Graphical interface to DAKOTA input
- Familiar SNAP interface
  - Input, post-processing, UA
  - MELCOR, RELAP, TRACE,COBRA, CONTAIN, FRAPCON, PARCS
- All-in-one solution for UA
  - SNAP schedules multi-parameter runs after setup
  - SNAP prepares statistical report generated upon job completion

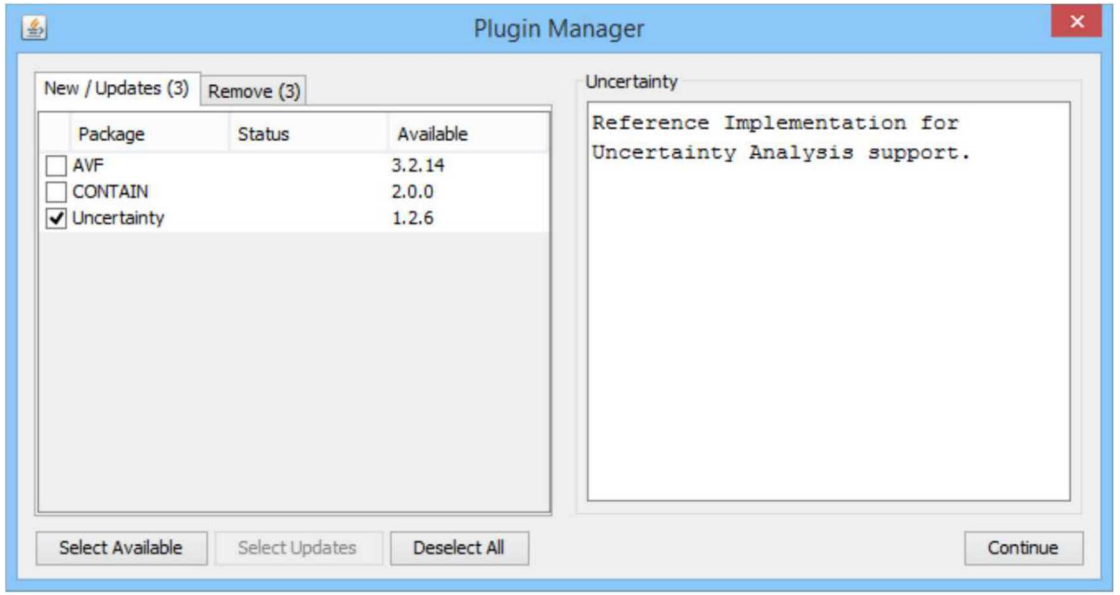
## Cons

- SNAP has relatively step learning curve for beginner
- Failed runs (realizations) are not accounted for and no statistical report is generated. They lead to an incomplete job with no diagnostics to user.
- Input decks with new MELCOR models (relative to SNAP version) cannot be used



# Performing a Sensitivity Study with SNAP
## Step I – Downloading Dakota Plugin

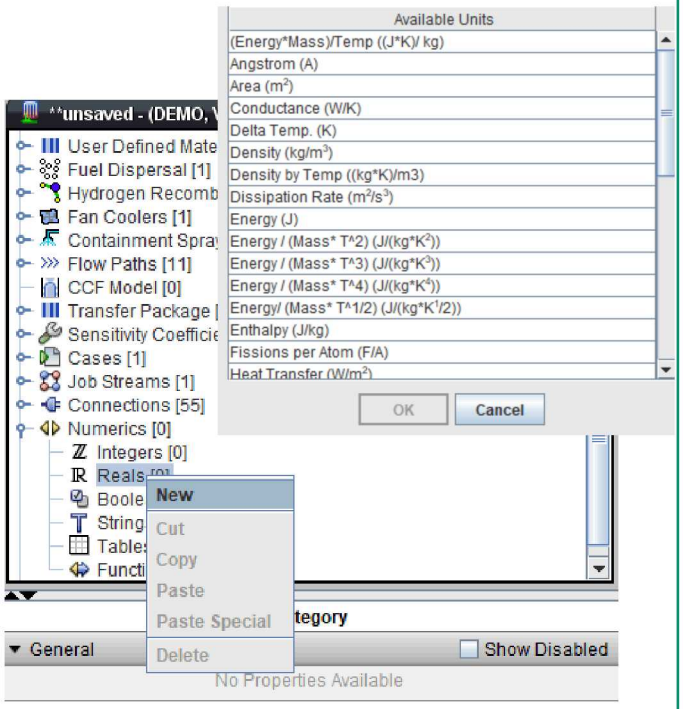
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

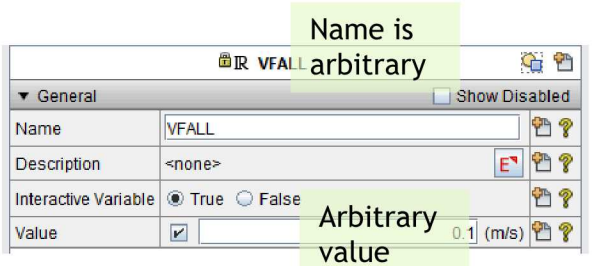


# Performing a Sensitivity Study with SNAP
## Step 2 – Adding a Numeric (I)

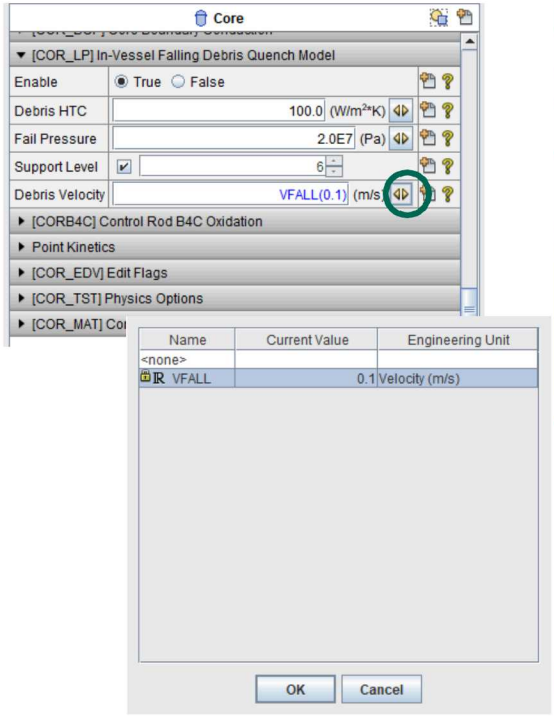
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. **Create a Numeric value in your model**
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

### Create the Numeric



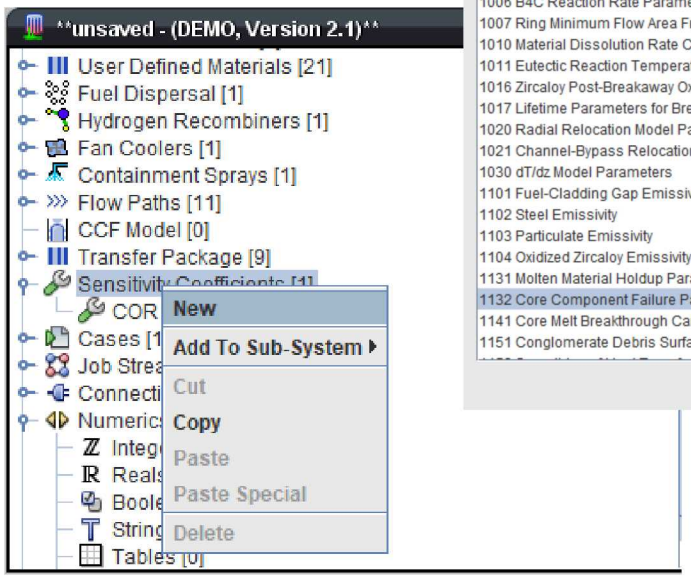




### Connect Numeric to Input

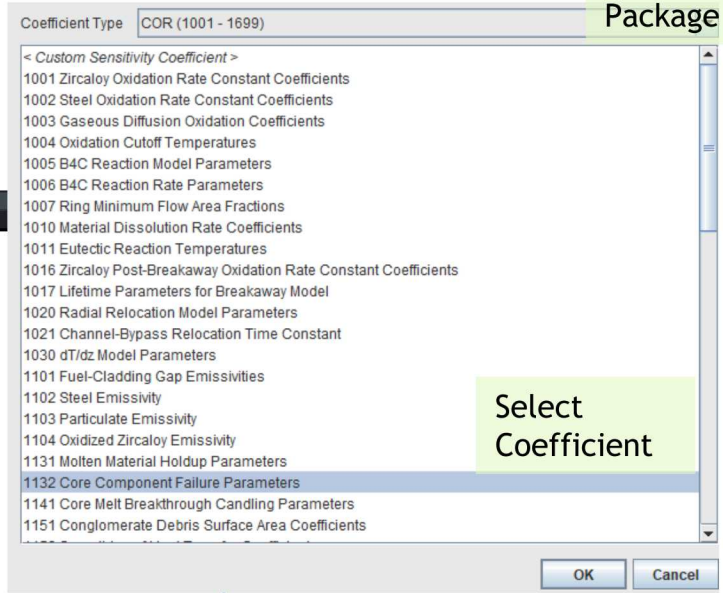


# Performing a Sensitivity Study with SNAP
## Step 2 – Adding a Sensitivity Coefficient (2)

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. **Create a Numeric value in your model**
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

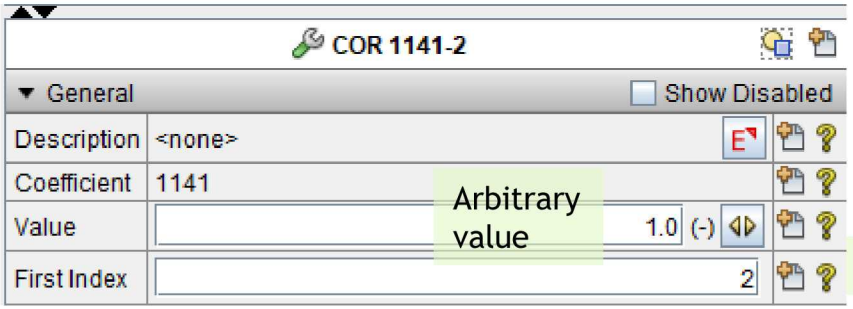



Select Package




Select Coefficient

Properties Window

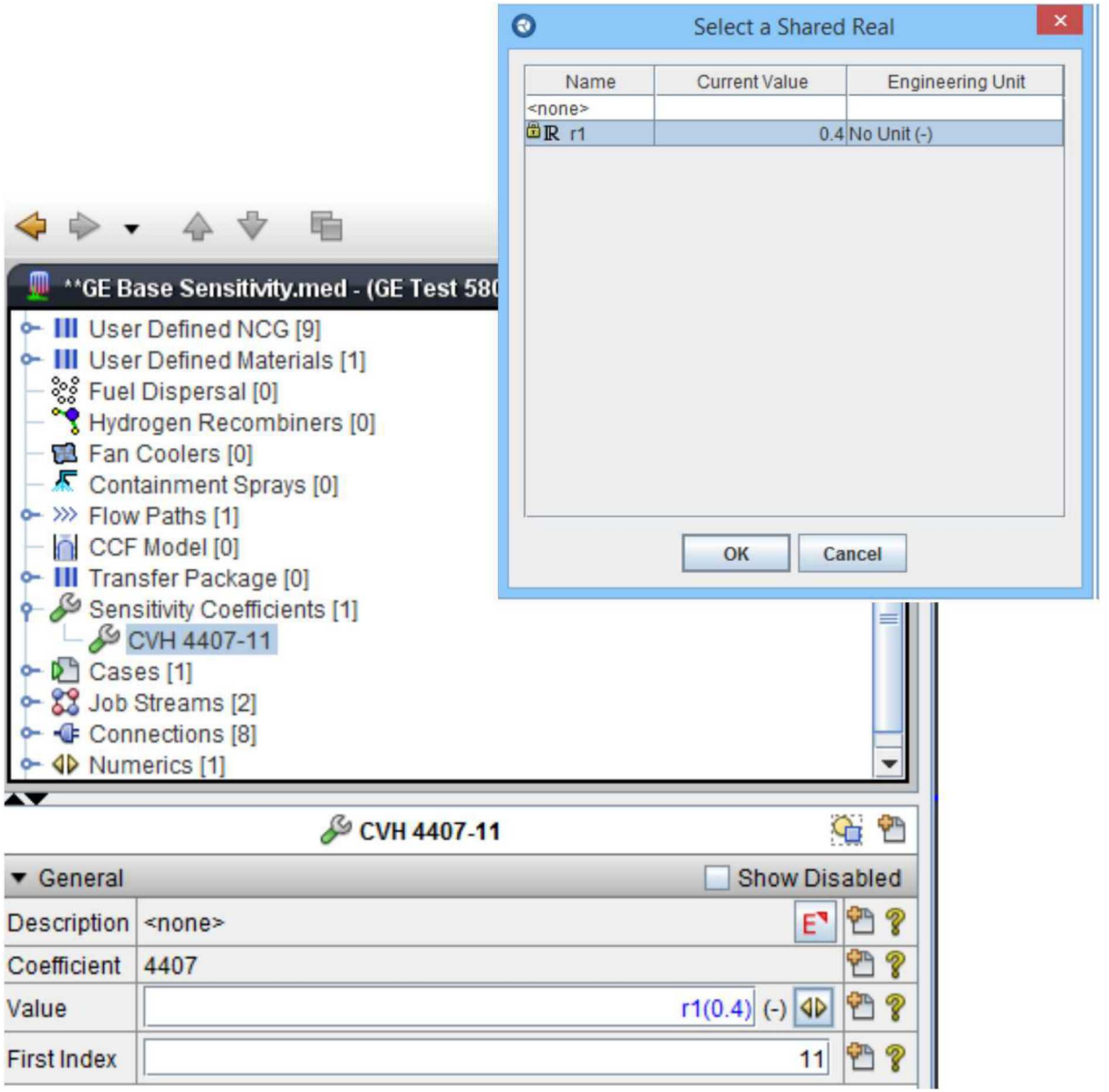



Arbitrary value

Select Index

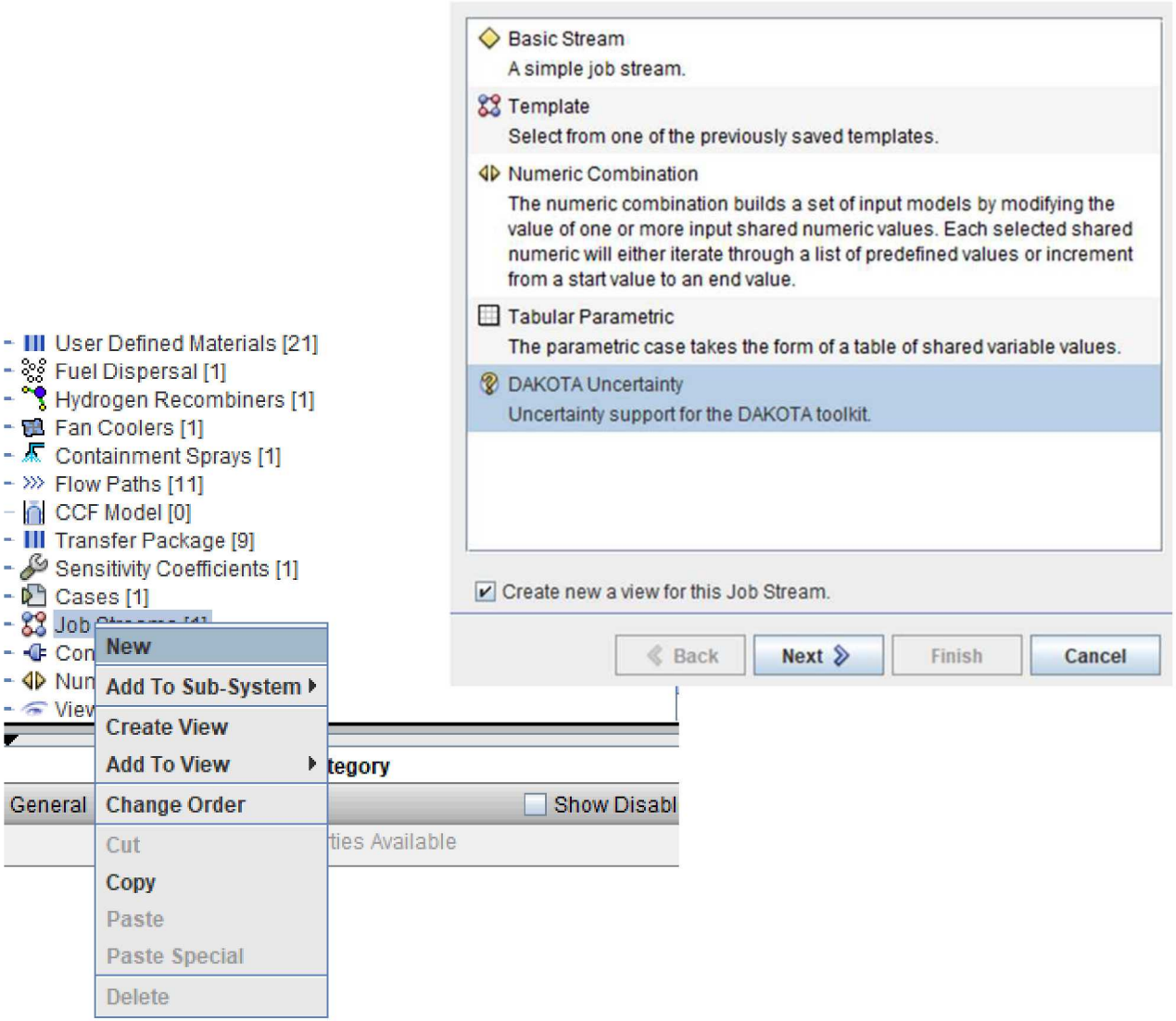
# Performing a Sensitivity Study with SNAP
## Step 3 – Assign the New Numeric

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. **Assign the Numeric value as an input value**
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job



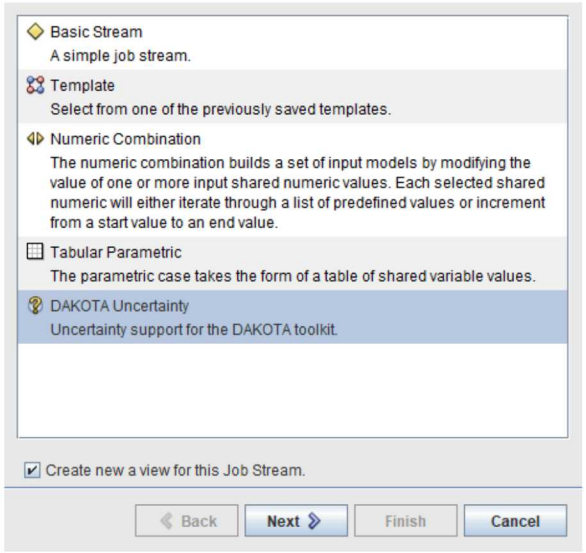
# Performing a Sensitivity Study with SNAP
## Step 4 – Dakota Job Stream (1)

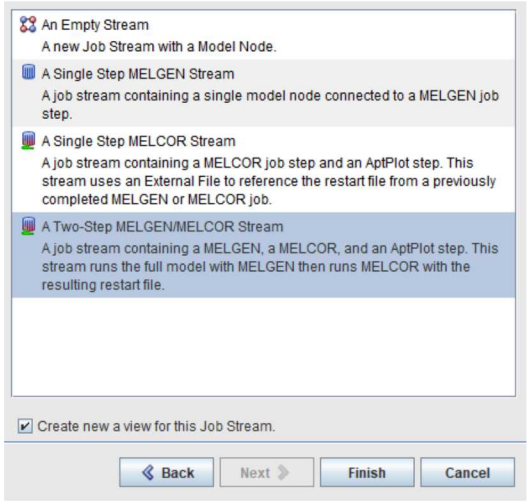
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. **Create a Dakota Run Stream**
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

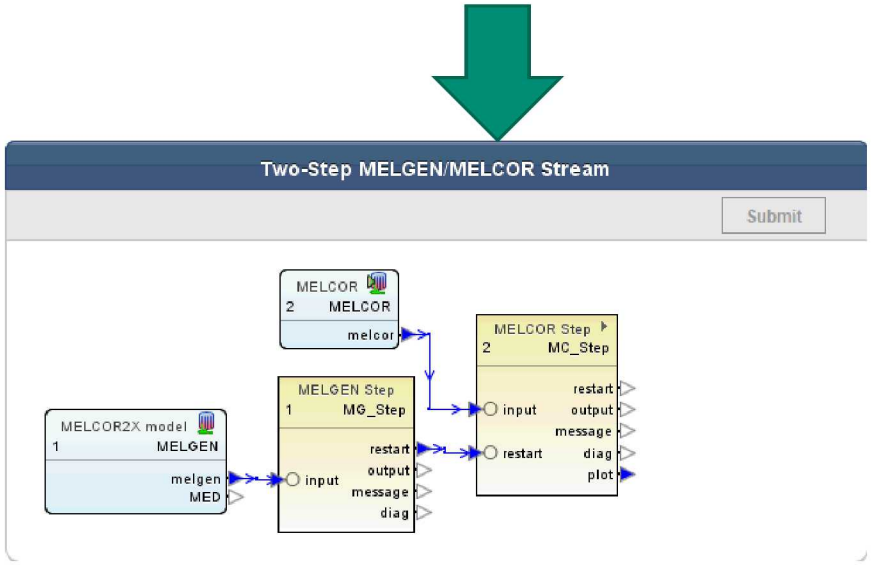


# Performing a Sensitivity Study with SNAP
## Step 4 – Dakota Job Stream (2)

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. **Create a Dakota Run Stream**
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

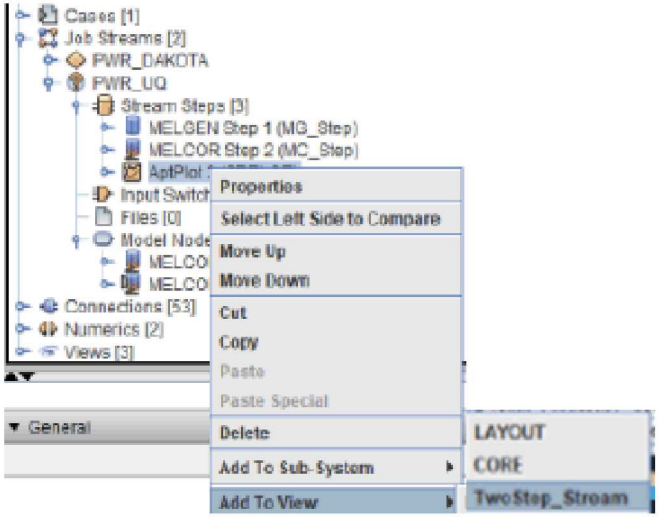


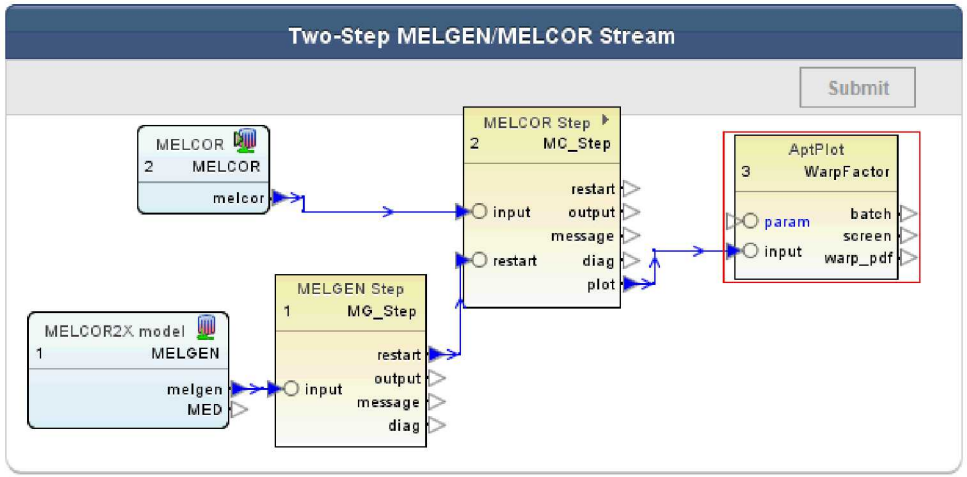



# Performing a Sensitivity Study with SNAP
## Step 4 –Dakota Run Stream (3) – Add AptPlot to view

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. **Create a Dakota Run Stream**
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

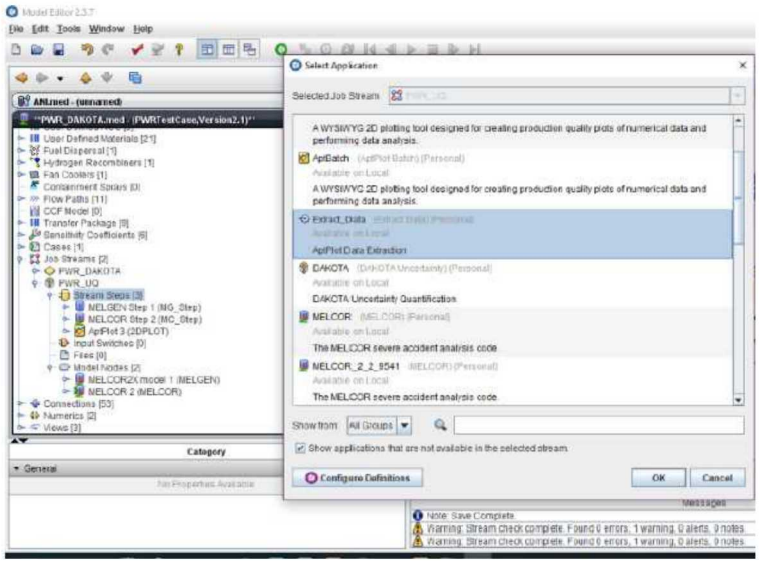


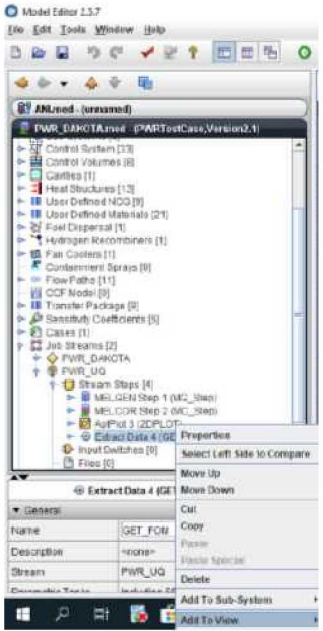



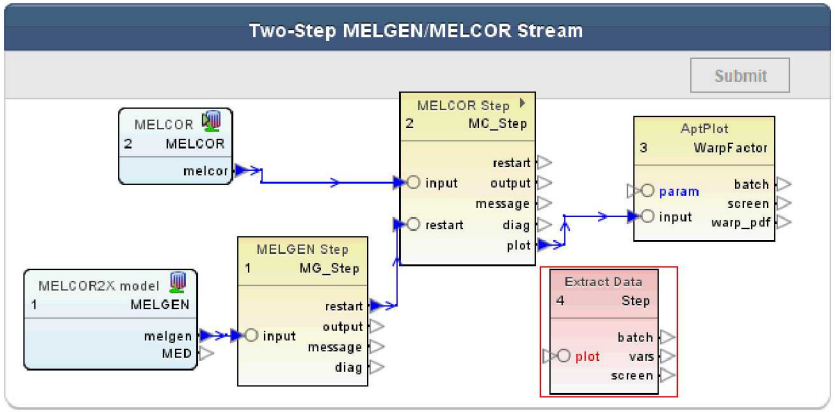
# Performing a Sensitivity Study with SNAP
# Step 4 –Dakota Run Stream (4) – Add Extract Data

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. **Create a Dakota Run Stream**
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

Add Extract Data to Job Stream

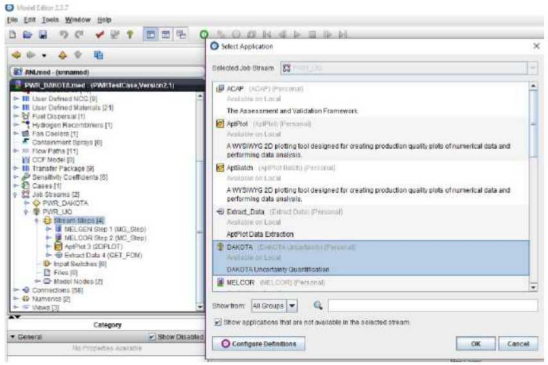


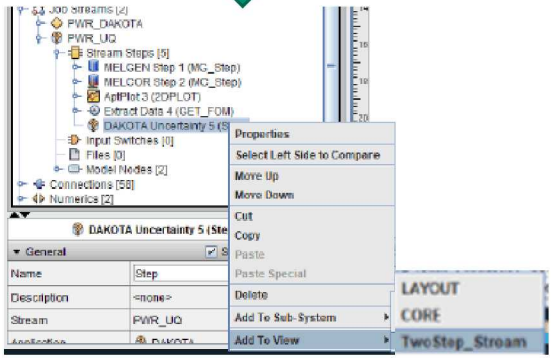



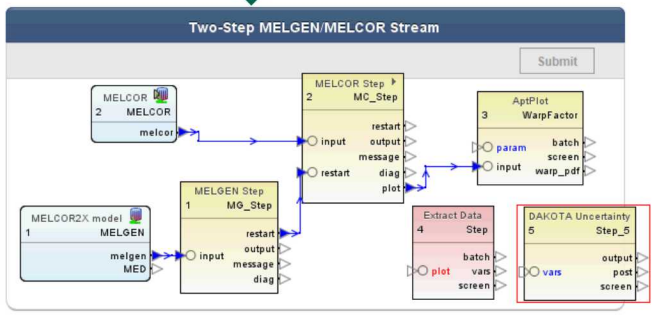



# Performing a Sensitivity Study with SNAP
## Step 4 –Dakota Run Stream (4) – Add DAKOTA to Job Stream

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job

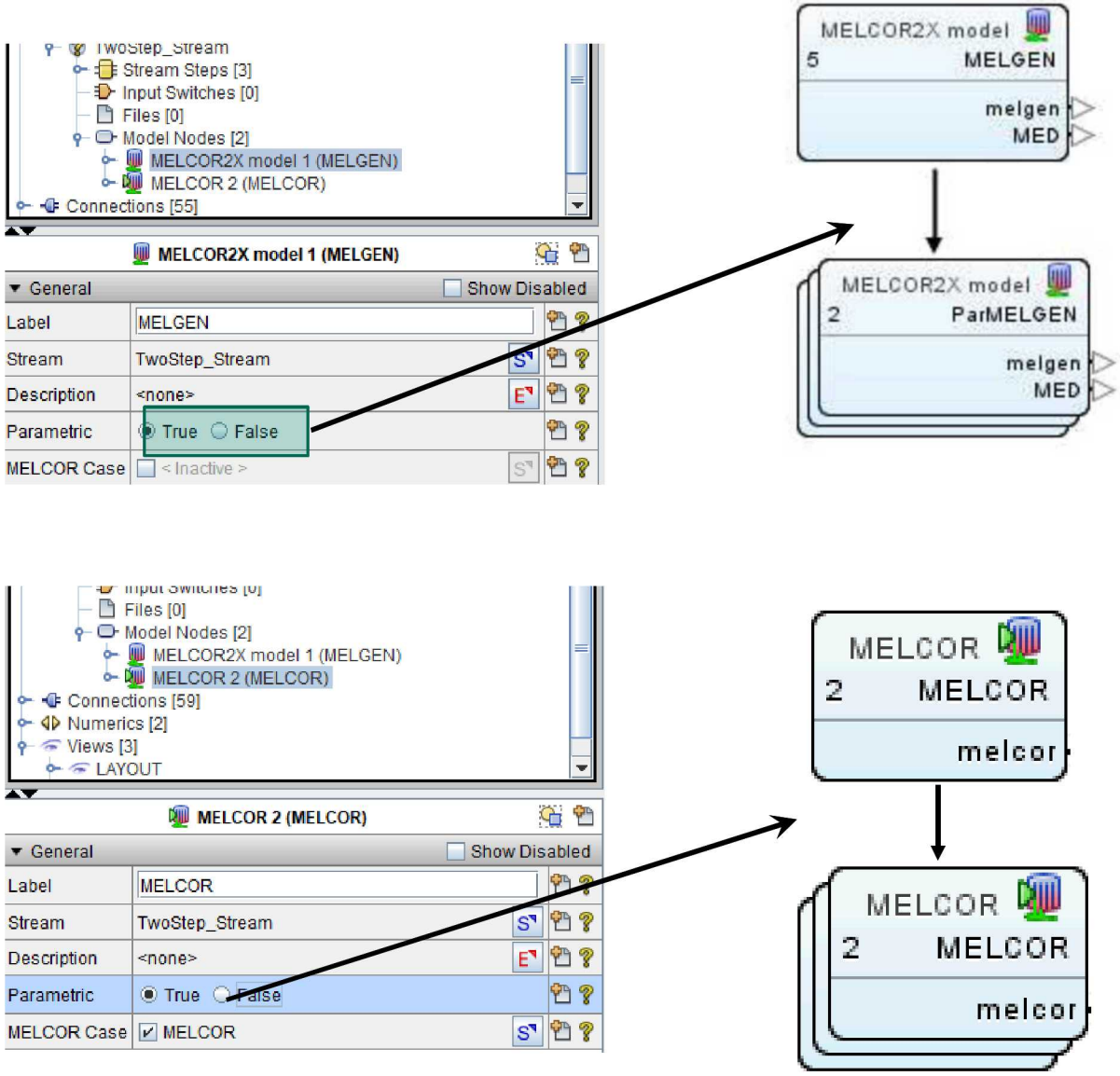




# Performing a Sensitivity Study with SNAP
## Step 5 – Parametric Model Node

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. **Specify a model node as parametric (MELGEN or MELCOR depending on input)**
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job



# Performing a Sensitivity Study with SNAP
## Step 6 – Parametric Properties (I)

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
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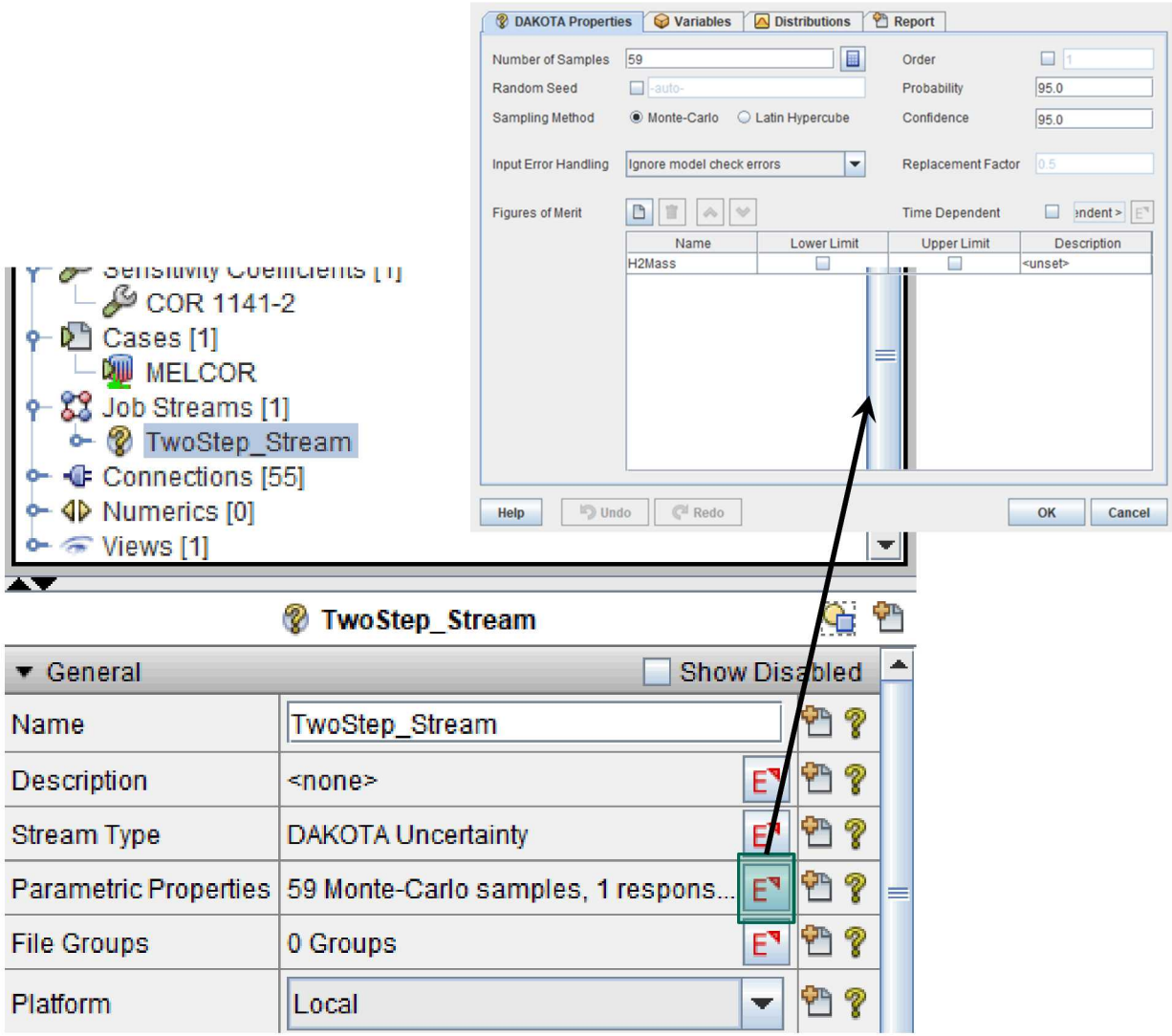
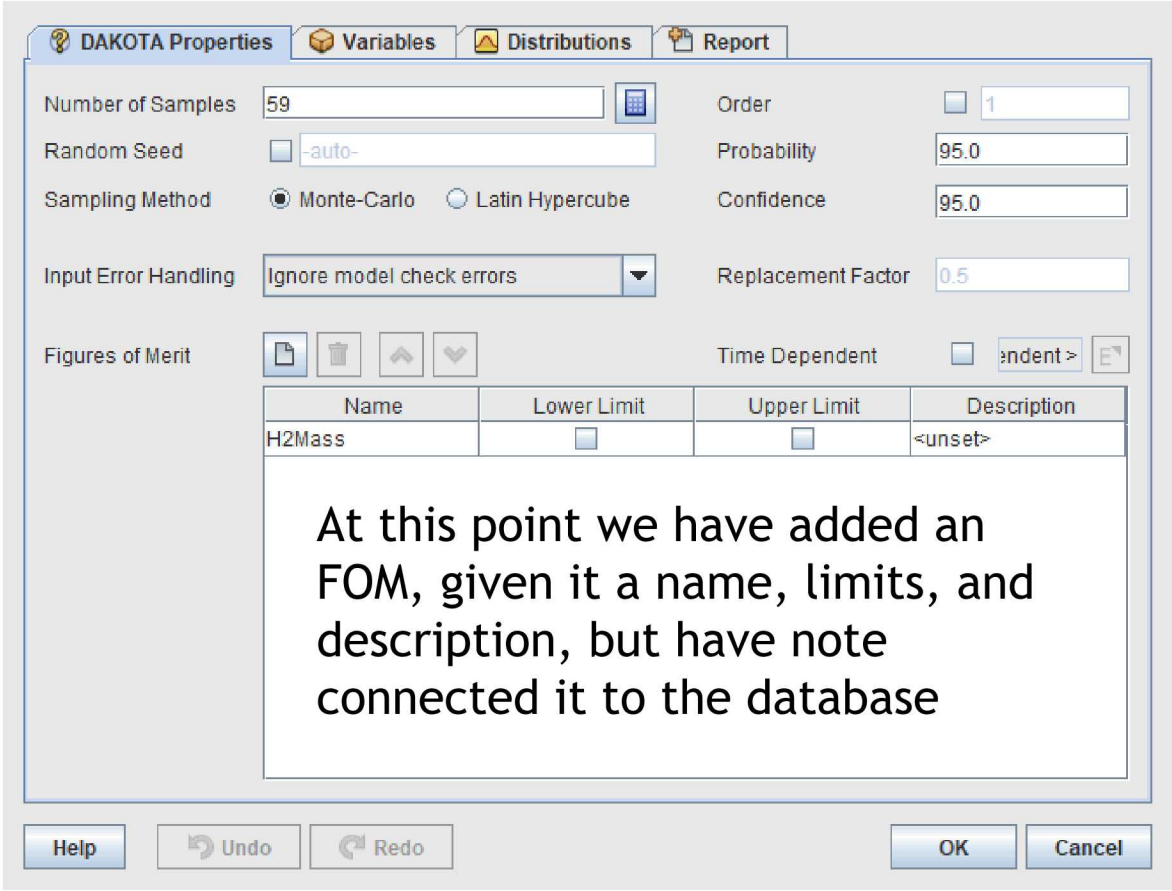


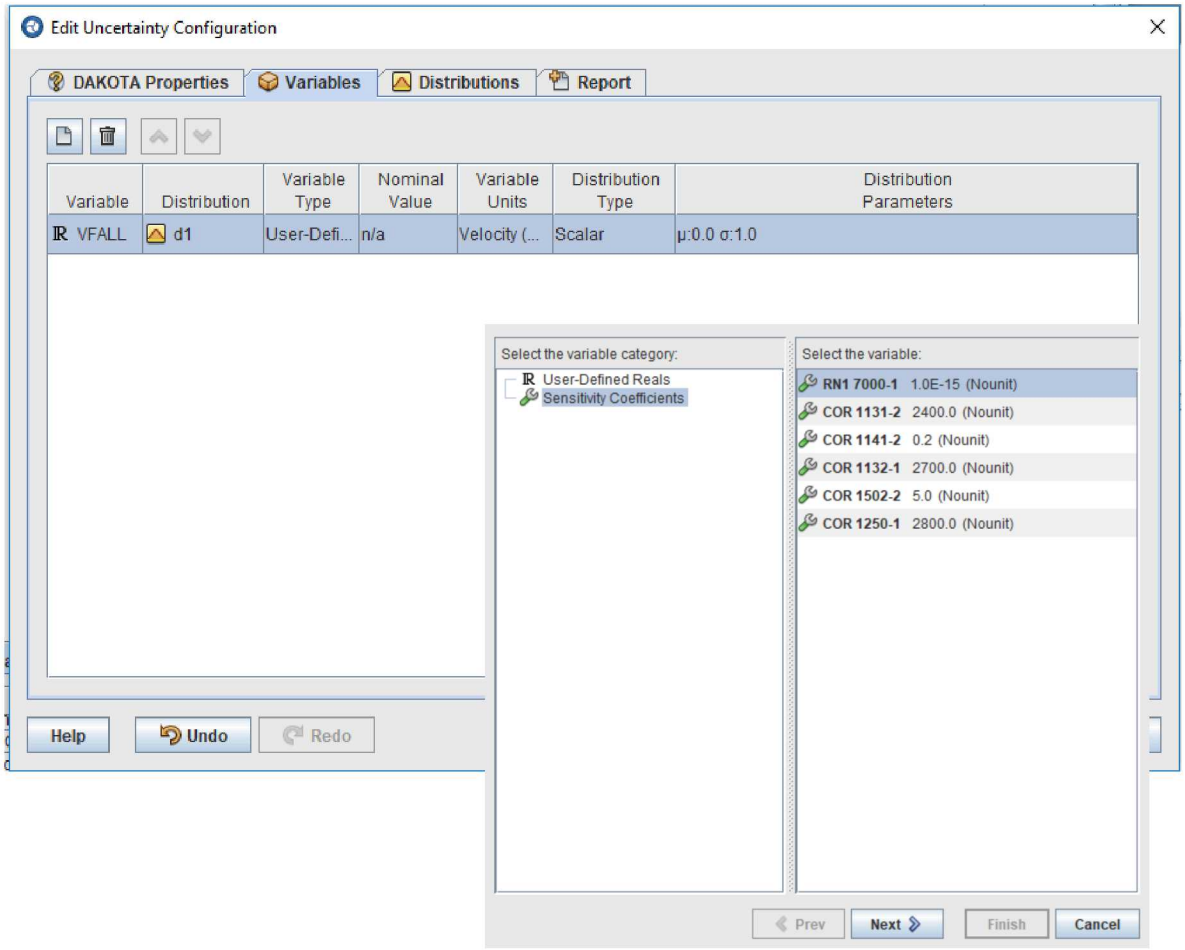
# Performing a Sensitivity Study with SNAP
## Step 6 – Parametric Properties (2) – Figures of Merit

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job



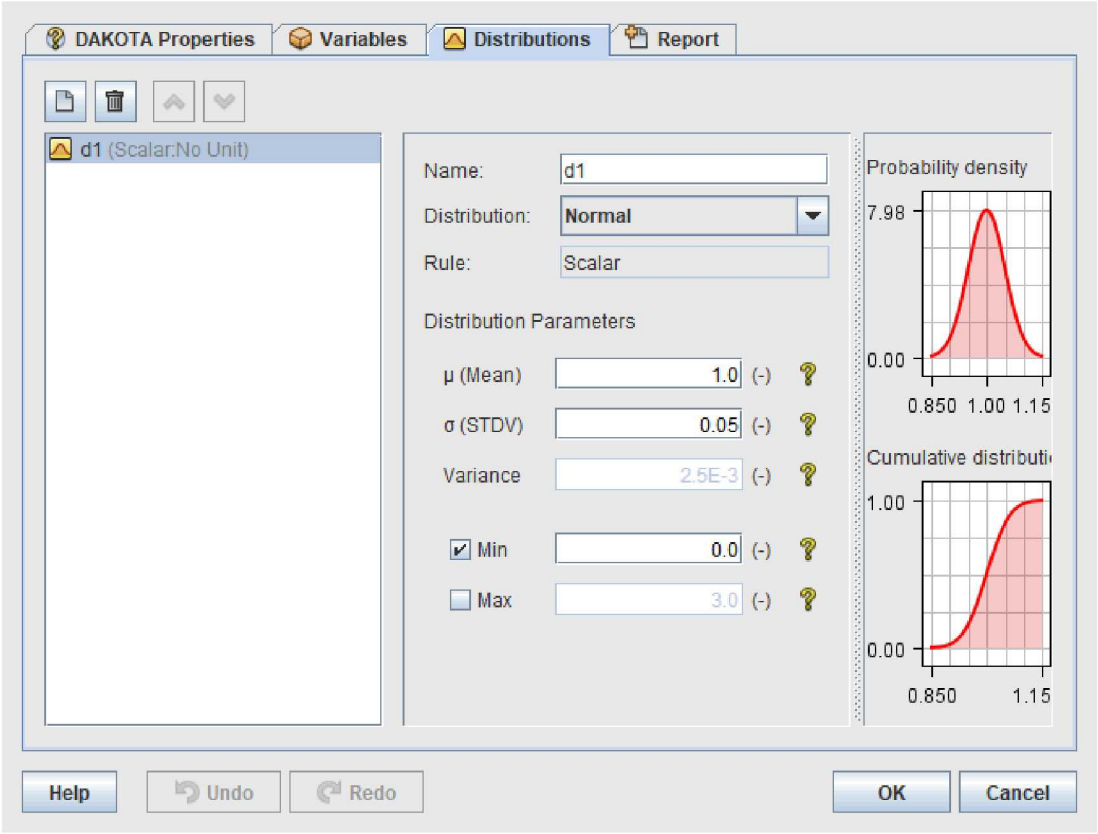
# Performing a Sensitivity Study with SNAP
## Step 6 – Parametric Properties (3) – Sensitivity Variables

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job



# Performing a Sensitivity Study with SNAP
## Step 6 – Parametric Properties (4) - Distributions

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job

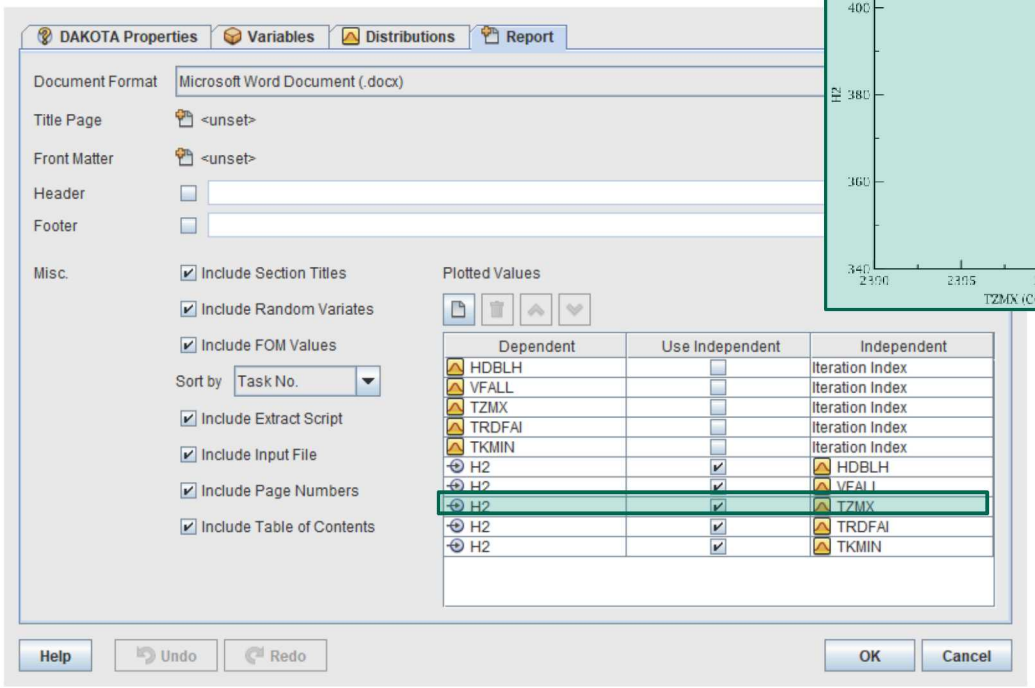


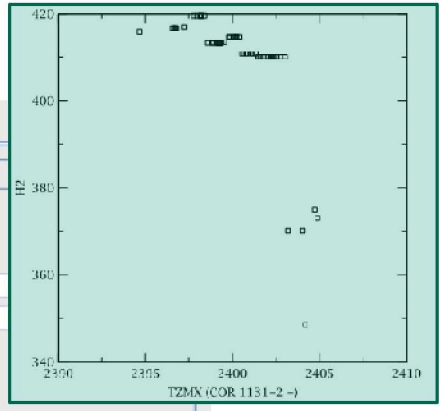

Available Distributions:

| | | |
|---|---|---|
| Normal | Triangular | Gumbel |
| Lognormal | Exponential | Frechet |
| Uniform | Beta | Weibull |
| Loguniform | Gamma | Histogram |

# Performing a Sensitivity Study with SNAP
## Step 6 – Parametric Properties (5) – Report Options

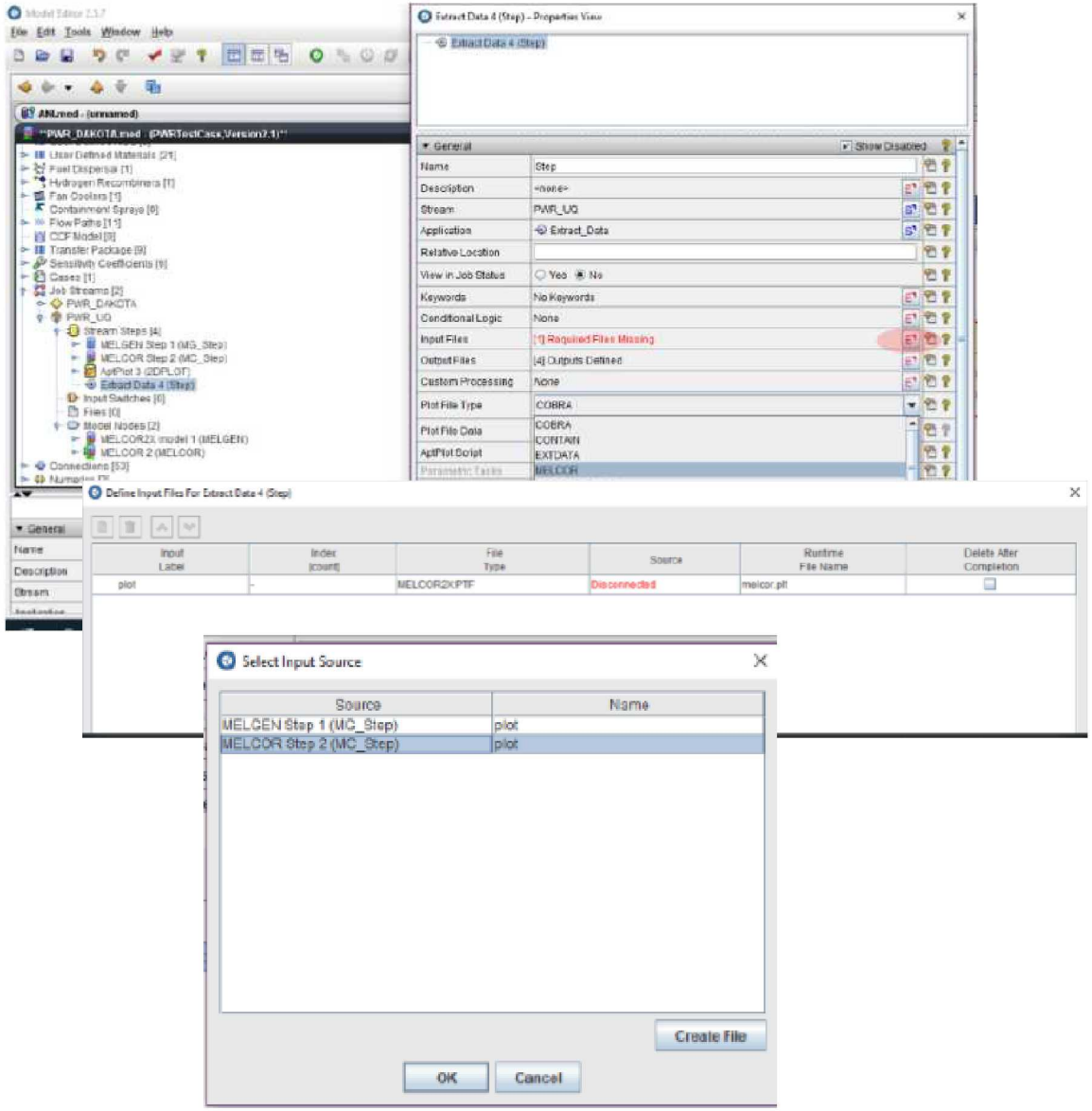
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job



# Performing a Sensitivity Study with SNAP
## Step 7 – Coordinate Data Flow (Extract Data 2)

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. **Coordinate data flow**
8. Run Job

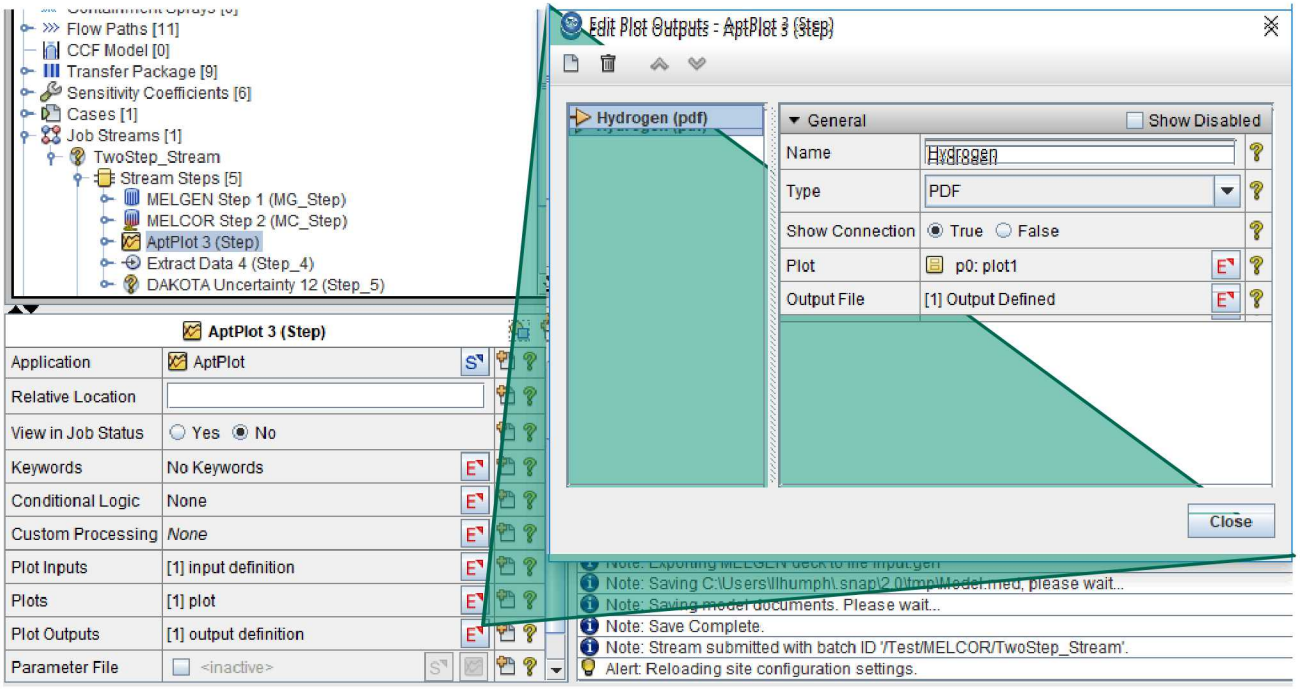


# Performing a Sensitivity Study with SNAP

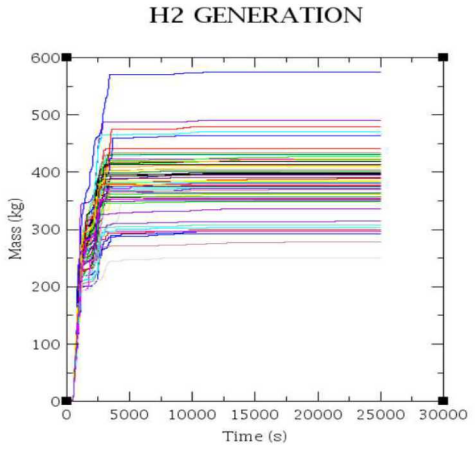
Performing a Sensitivity Study with SNAP

## Step 7– Configure AptPlot output

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. **Coordinate data flow**
8. Run Job

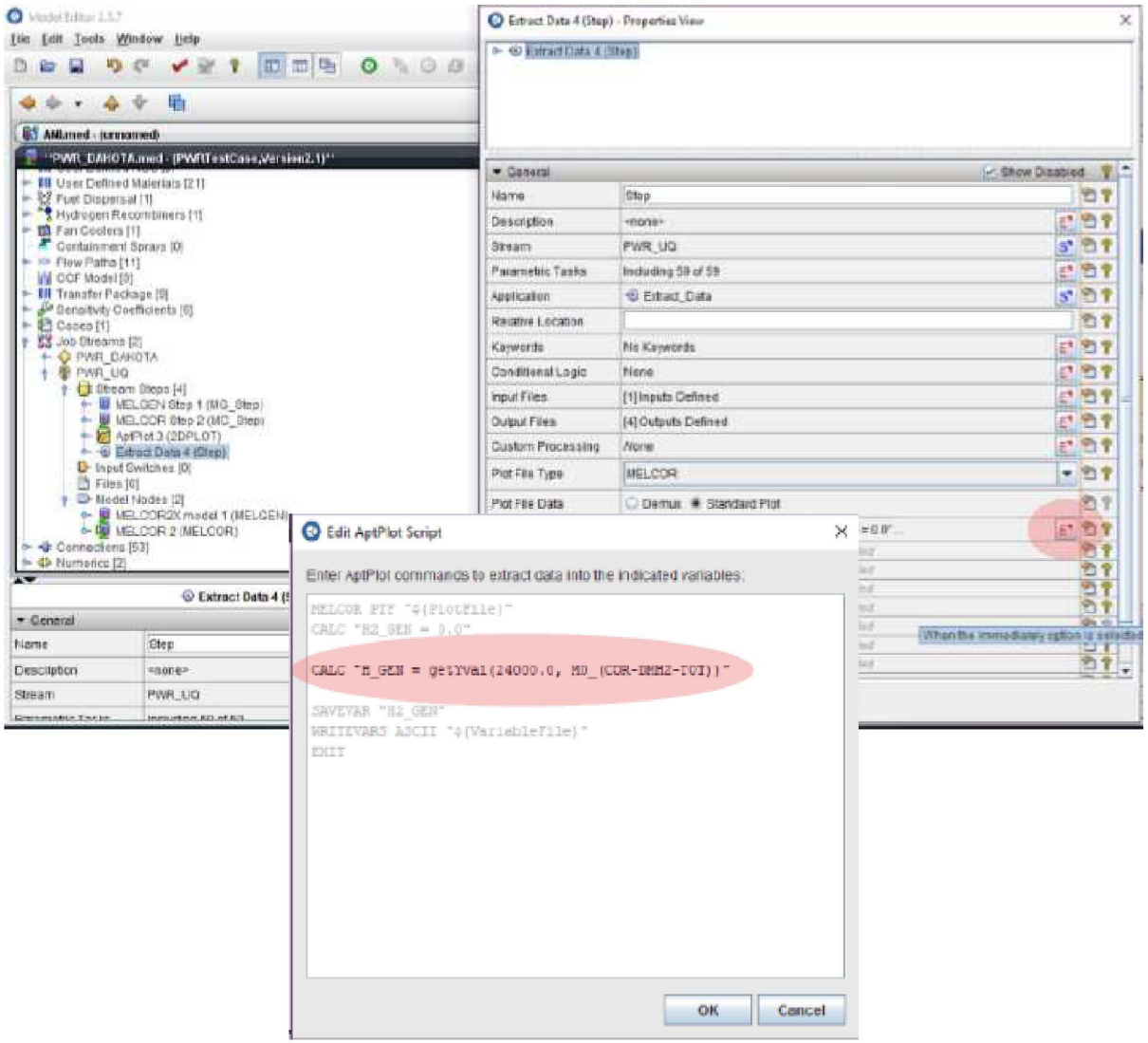



Write horsetail plots to PDF file



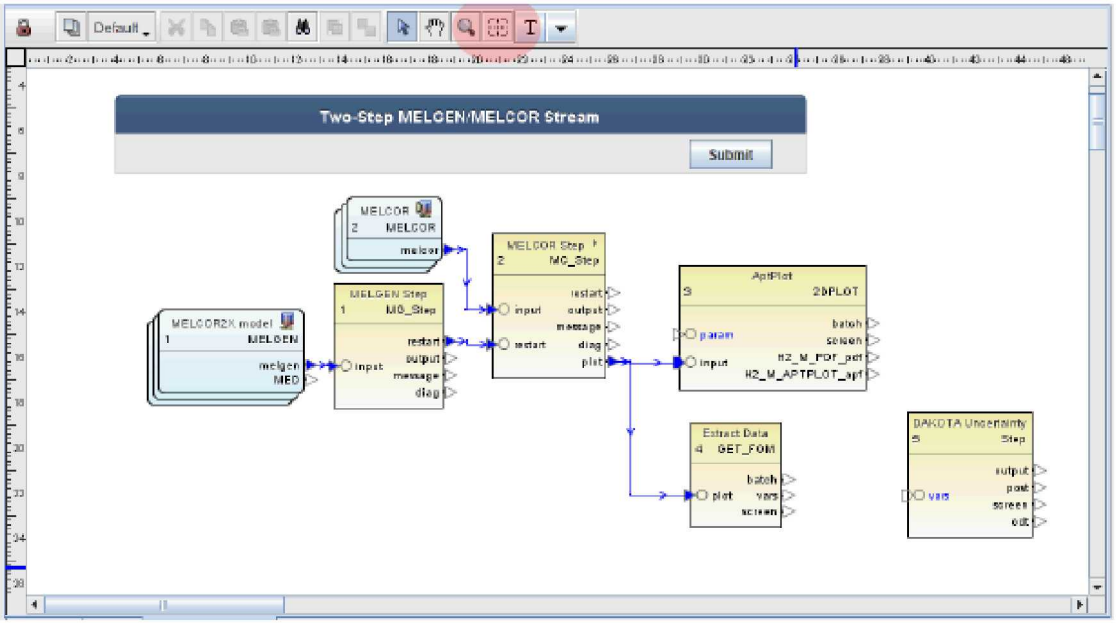
# Performing a Sensitivity Study with SNAP
# Step 7 – Coordinate Data Flow (Pipe Plot Data)

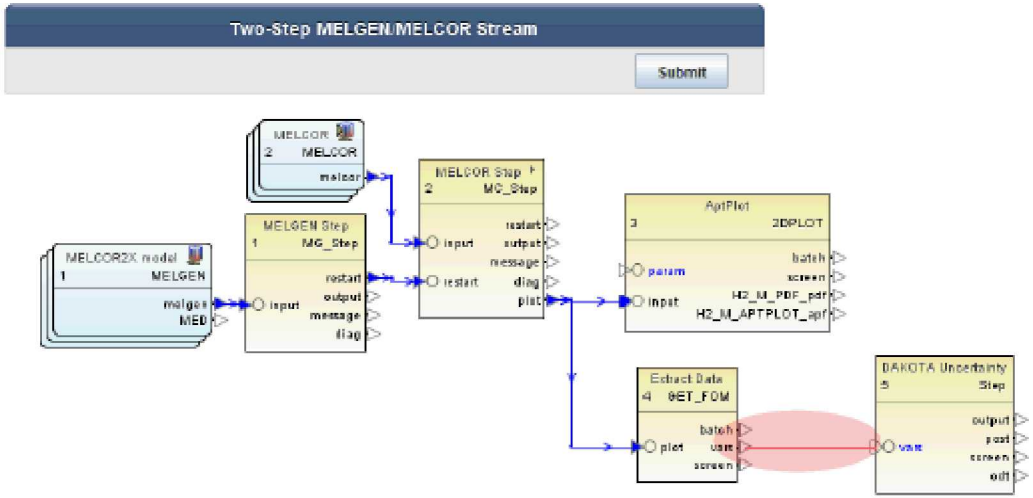
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. **Coordinate data flow**
8. Run Job



# Performing a Sensitivity Study with SNAP
## Step 7 – Coordinate Data Flow (Connect 'Extract Data' output to Dakota input)

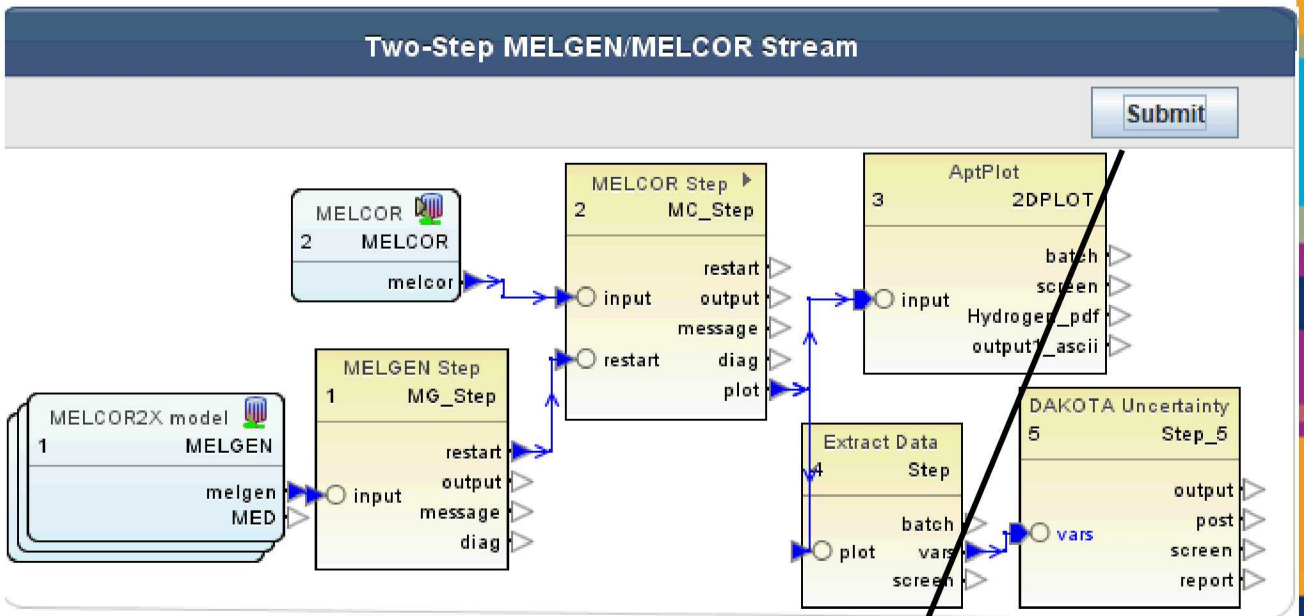
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. **Coordinate data flow**
8. Run Job

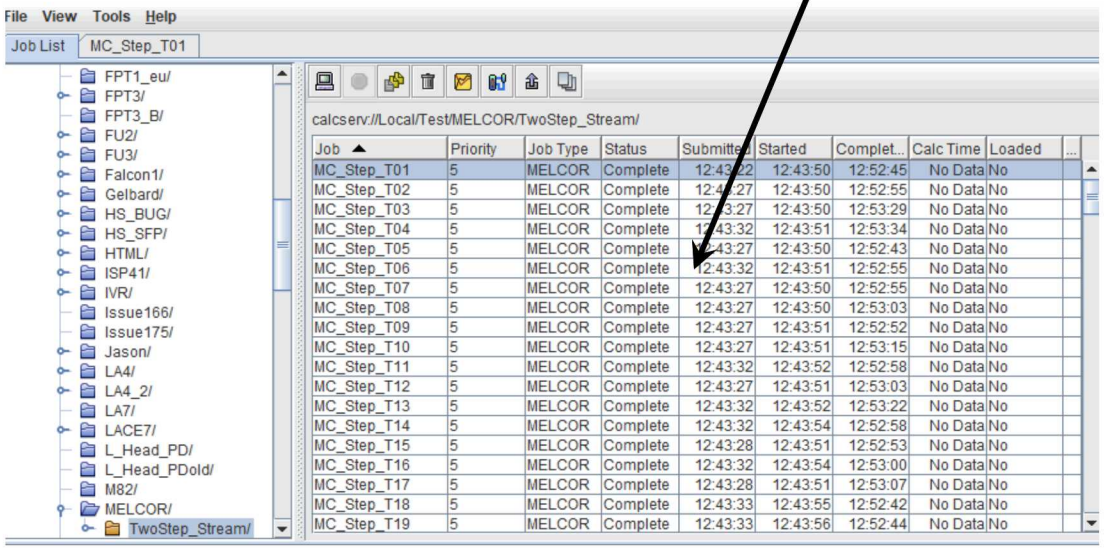


# Performing a Sensitivity Study with SNAP
## Step 7 – Run Dakota Job Stream

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. **Run Job**



# Statistics and Output

Statistical results based on 59 samples:

| Summary | Value | Task # |
|---|---|---|
| Min Value | 250.87505 | 54 |
| Max Value | 574.76666 | 51 |
| Mean | 381.43805 | - |
| Median | 382.44507 | 40 |
| Standard Deviation | 56.8461 | - |
| Coefficient of Variance | 0.38578 | - |

Response Correlations

| | Simple | Partial | Simple Rank | Partial Rank |
|---|---|---|---|---|
| d5 | 0.0979063 | 0.102384 | 0.135067 | 0.268539 |
| d6 | 0.110172 | 0.146704 | 0.0338983 | 0.0599765 |
| d7 | 0.098521 | 0.123725 | 0.126768 | 0.209831 |
| d1 | 0.737284 | 0.791904 | 0.765926 | 0.855157 |
| d2 | -0.495872 | -0.627241 | -0.379486 | -0.653184 |
| d3 | 0.03035 | 0.00594472 | 0.0189947 | 0.0516358 |
| d4 | -0.0188159 | 0.0125986 | -0.0151373 | 0.0108442 |