

# Providing Complete Distribution Function Analysis with NUBEAM FGen

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# Distribution Functions

Who cares?

You guys!

Simulated distribution functions help us understand...

- Fast-ion collective effects which can drive MHD instabilities
- RF wave-particle interactions (specifically ion RF heating)
- Comparison of numerical simulation to measured data

...and complete distribution function data can be used as initial conditions for other simulations.

# TRANSP

From the TRANSP web page:

*TRANSP is a time dependent transport analysis code for tokamak experiments.*

TRANSP is basically a collection of command line programs that simulate tokamak plasmas.

Input: experimental data from tokamak shots

Output: useful data that cannot be measured, but can be simulated

**This is awesome**

# TRANSP DF Generation

TRANSP can produce the full distribution function of all Monte Carlo particles in the simulation in energy, pitch,  $x$ , and  $\theta$  space. But there are two ways to do this:

Run TRANSP and specify times of interest in the namelist

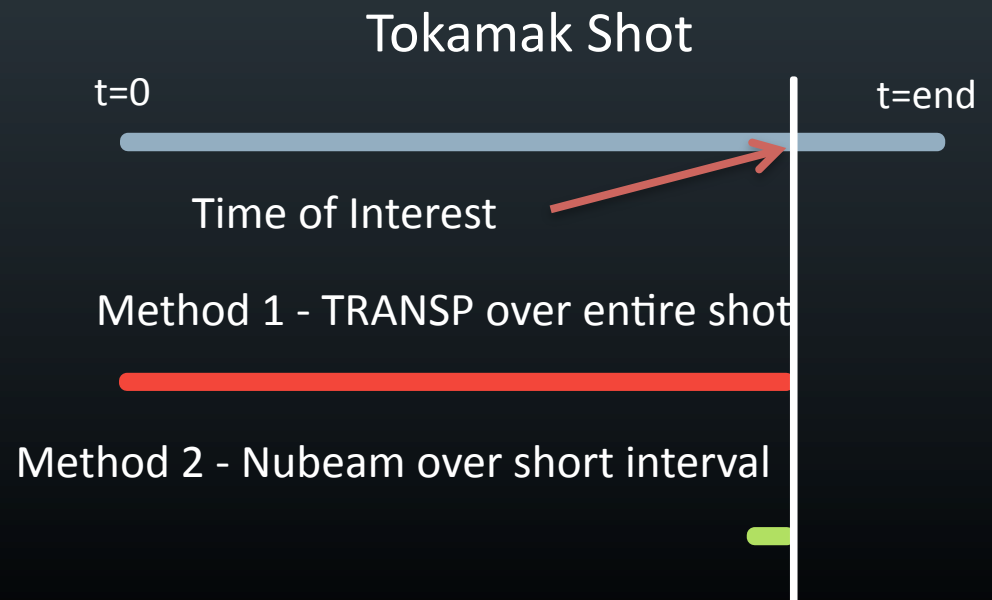
Pros: You just run TRANSP

Cons: Locks in your choices of toi's

Run TRANSP, extract plasma state at the time of interest, re-simulate deposition over a short time span

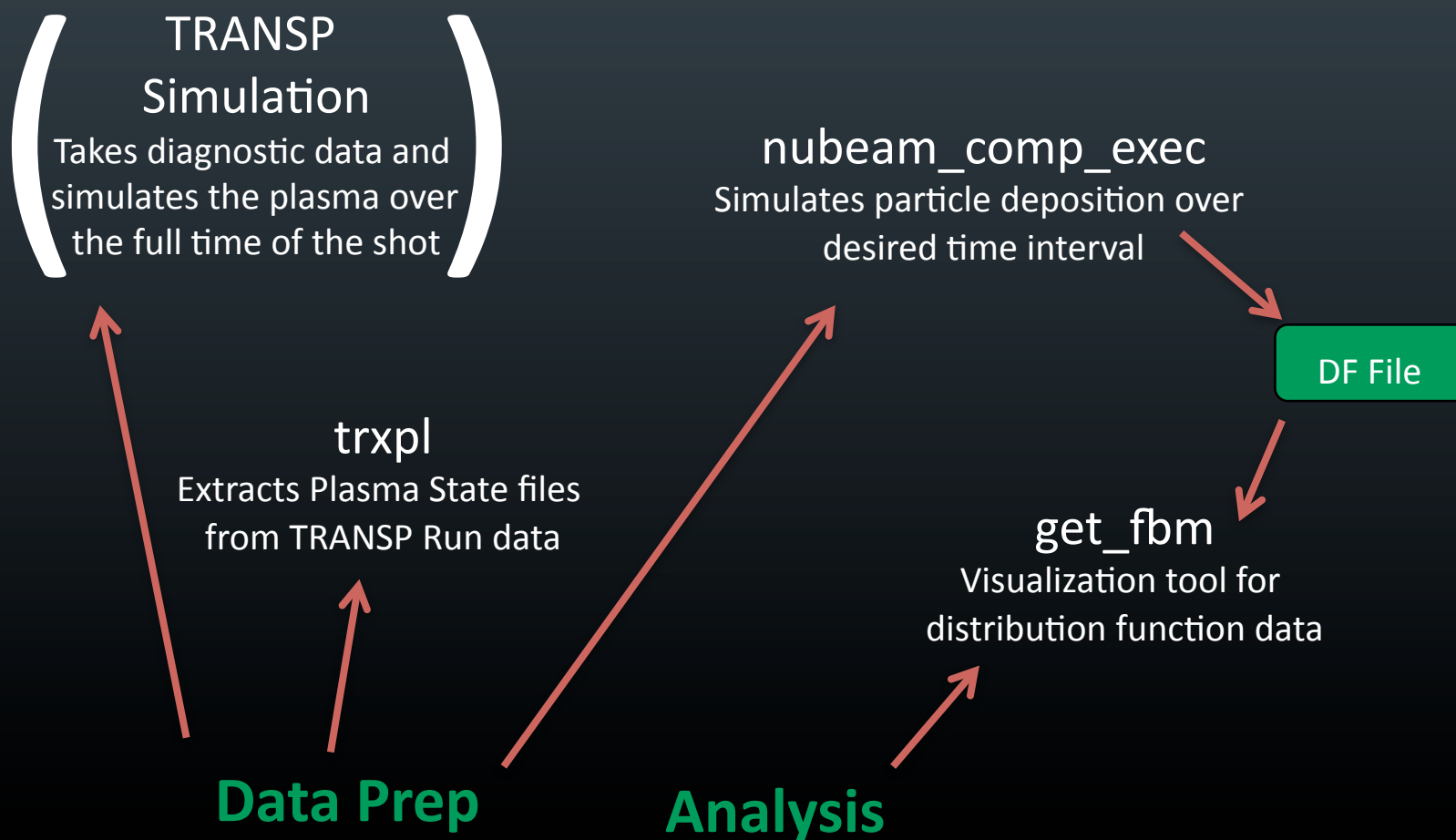
Pros: Very flexible

Cons: A longer process, but only if TRANSP hasn't been run



# NUBEAM FGen DF Analysis

This is a complicated process using 4 separate programs

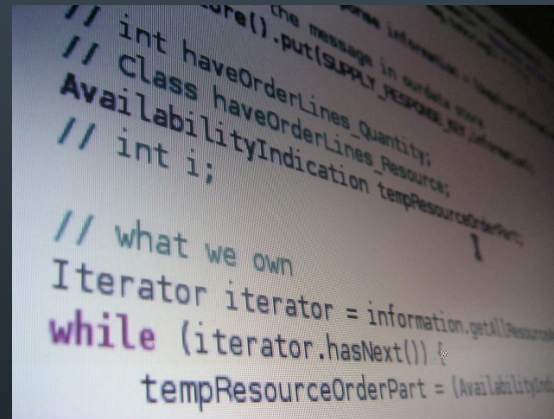


# The Catch

TRANSP is a very powerful tool for tokamak plasma research, but also presents a steep learning curve.



# Now What?



The Solution: Java Front-end  
**ELVis scientific graphic display**

NUBEAM FGen is one of the newest ELVis  
internal desktop applications.

# Introducing NUBEAM FGen

By lines of code:

1255 - GUI built into ELVis	}	Java
361 - Manager class		
83 - Servlet functions		
352 - Server-side scripts	}	Python
74 - 'Glue' files	}	Cshell

Total: 2125



# NUBEAM FGen

## *Job Submission Panel*

Connects to an MDS+ Server to retrieve TRANSP data (uses B Bariteau's MDSPanel class)

Users can:

Browse TRANSP Run using an interactive RPLOT Session

Produce plots at the given time of interest (using RPLOT)

Submit Job

# Instant Parallelization!

# NUBEAM FGen

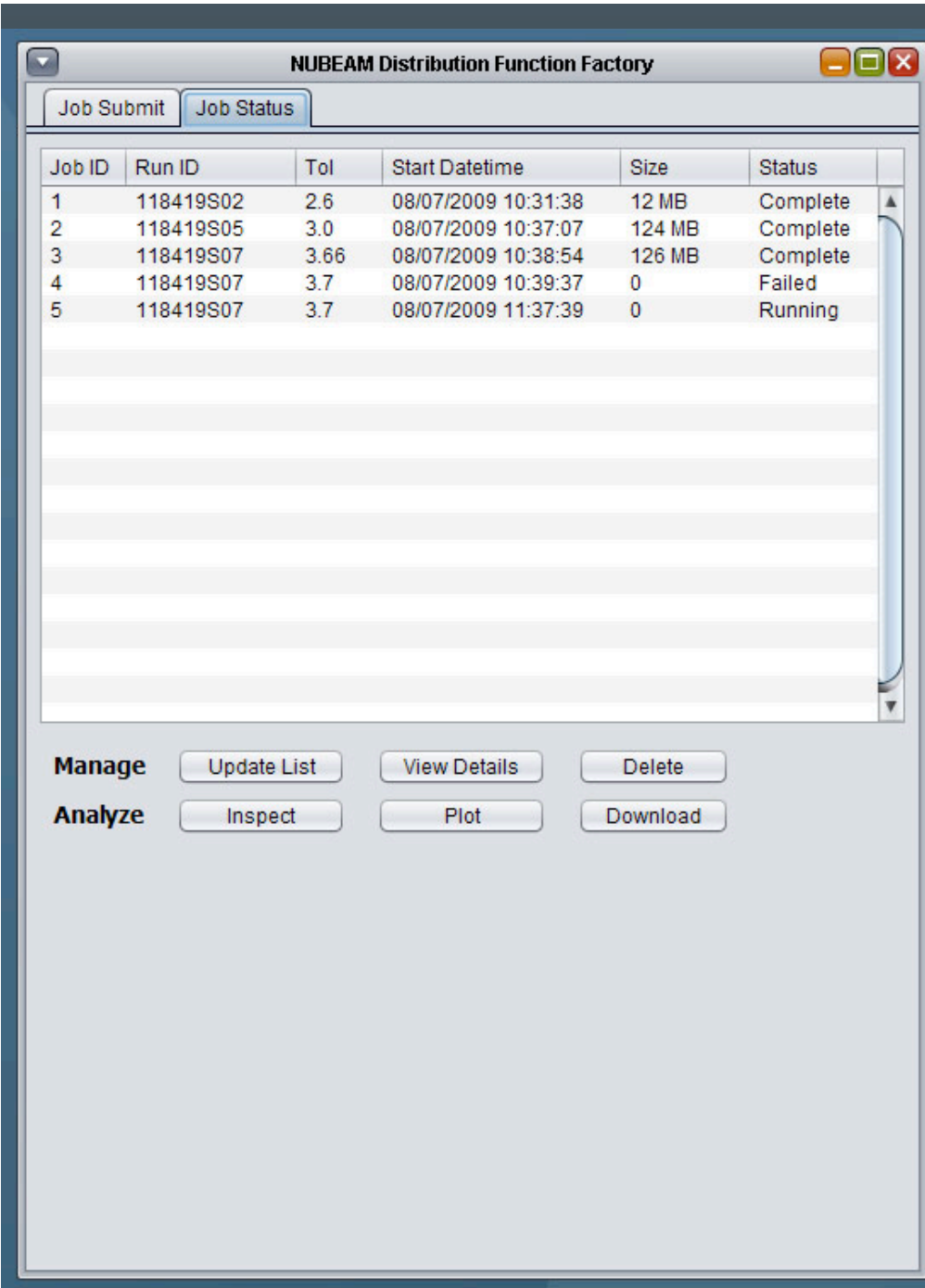
## *Job Status Panel*

NUBEAM simulations take anywhere from 10 minutes to hours. Users must be able to monitor runs and come back to them.

FGen jobs are stored in a flat file database which is (partially) loaded into the history table.

Users can select a run and

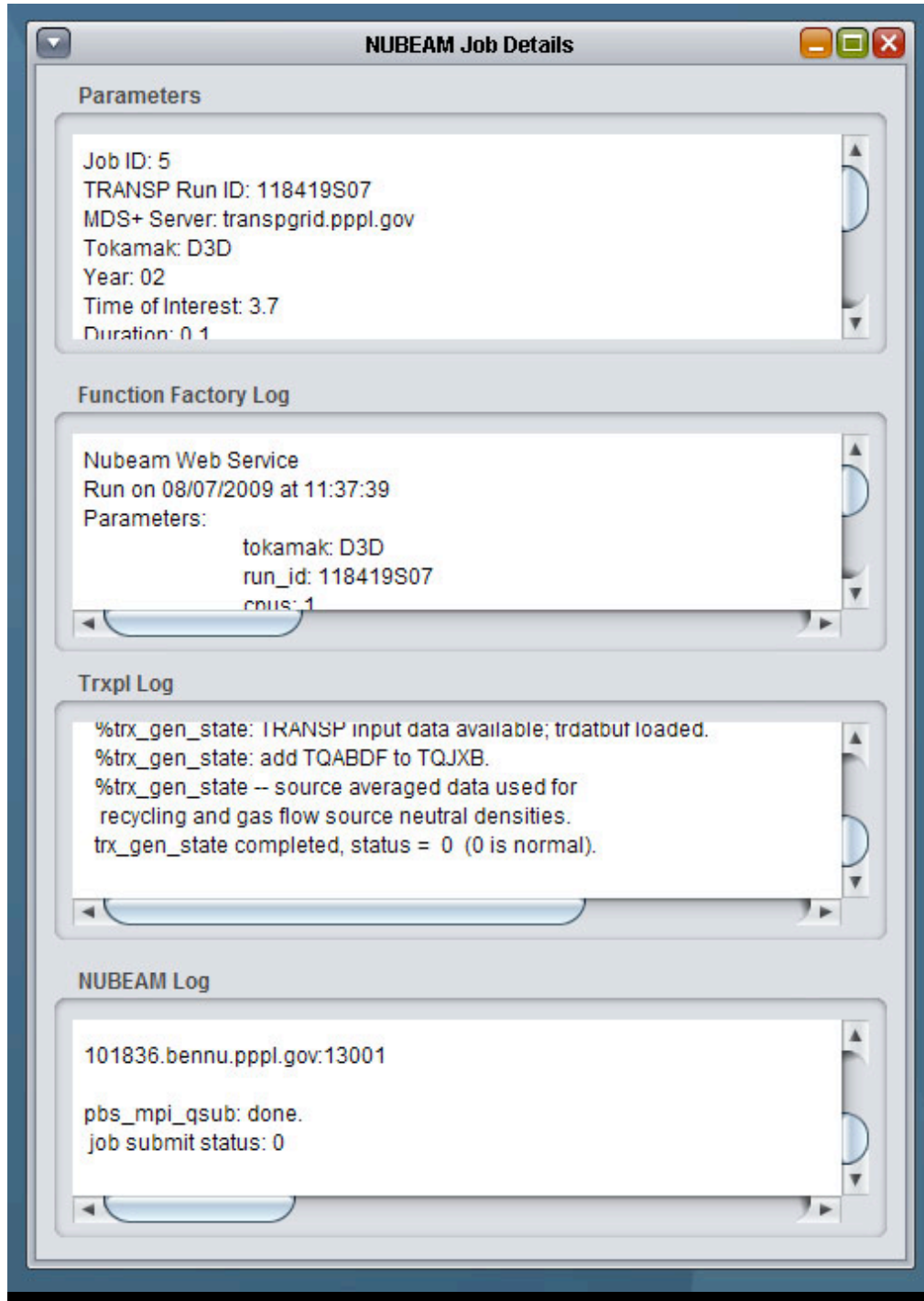
- Open in get\_fbm
- Plot
- Download
- Delete



Job ID	Run ID	Tol	Start Datetime	Size	Status
1	118419S02	2.6	08/07/2009 10:31:38	12 MB	Complete
2	118419S05	3.0	08/07/2009 10:37:07	124 MB	Complete
3	118419S07	3.66	08/07/2009 10:38:54	126 MB	Complete
4	118419S07	3.7	08/07/2009 10:39:37	0	Failed
5	118419S07	3.7	08/07/2009 11:37:39	0	Running

**Manage**   Update List   View Details   Delete

**Analyze**   Inspect   Plot   Download



# NUBEAM FGen

## *Job Detail Frame*

The backend of NUBEAM FGen (TRANSP programs) can break occasionally and we need to deal with that.

Loads all parameters for selected job from db and all log files created by runNubeam web service.

Allows users to help the TRANSP developers in the debugging process

get\_fbm

```
(8) Energy OR Pitch - SLICE MULTIPLOT
>ENTER CHOICE NUMBER BETWEEN 1 AND 8
GRF3SG: ENTER OPTION #:
8

DIMENSION #1: Energy          DIMENSION #2: Pitch

G3MSEL: CHOOSE DIMENSION FOR X AXIS (1 OR 2):
1

    50 SLICES OF Pitch          AVAILABLE FROM
-9.80000E-01 TO  9.80000E-01 vp11/v          NO INTER

OPTIONS--
A: SPECIFY ALL SLICES
B: SPECIFY STARTING SLICE, SPACING INTERVAL AND NUMBER
C: SPECIFY STARTING SLICE INDEX, NUMBER AND INCREMENT
X: SWITCH X AXIS
Q: QUIT

G3MSEL: ENTER SLICE OPCODE (A/B/C/X/Q):
b
SPECIFY Pitch          VALUES IN vp11/v
G3MSEL: ENTER START VALUE:
-.9
G3MSEL: ENTER INTERVAL:
.2
G3MSEL: ENTER NUMBER OF SLICES (INTEGER):
10
GRAOPT - OPTIONS: ENTER "C" TO SEE THE ENTIRE MENU
GRAOPT: ENTER ONE LETTER OPCODE (.C/A/S/X/Z/G/P/Q):
q

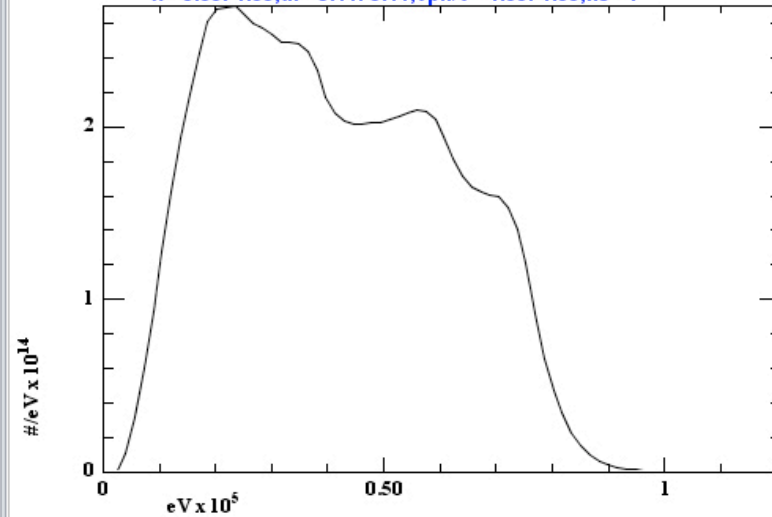
    50 SLICES OF Pitch          AVAILABLE FROM
-9.80000E-01 TO  9.80000E-01 vp11/v          NO INTER

OPTIONS--
A: SPECIFY ALL SLICES
B: SPECIFY STARTING SLICE, SPACING INTERVAL AND NUMBER
C: SPECIFY STARTING SLICE INDEX, NUMBER AND INCREMENT
X: SWITCH X AXIS
Q: QUIT

G3MSEL: ENTER SLICE OPCODE (A/B/C/X/Q):
```

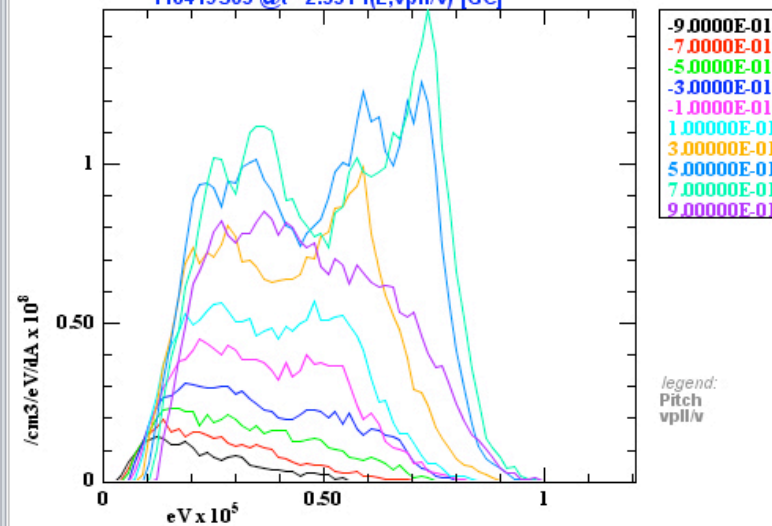
get\_fbm normalization test: densities should match.

118419S05 @t= 2.551 -- f(E) integrated over x,theta,vp11/v  
x= 0.00: 1.00,th=-3.14: 3.14,vp11/v=-1.00: 1.00,ns= 1



guiding center fast ion distribution function

x= 0.00 to 0.00, th= 0.00 to 0.00 (AVERAGED)  
118419S05 @t= 2.551 f(E,vp11/v) [GC]



Z= 1 A= 2 Beam VS Energy

NUBEAM Distribution Function Factory

Job Submit Job Status Help

Job ID	Run ID	Tol	Start Datetime	Size	Status
1	118419S02	2.6	08/07/2009 10:31:38	12 MB	Complete
2	118419S05	3.0	08/07/2009 10:37:07	124 MB	Complete
3	118419S07	3.66	08/07/2009 10:38:54	126 MB	Complete
4	118419S07	3.7	08/07/2009 10:39:37	0	Failed
5	118419S07	3.7	08/07/2009 11:37:39	126 MB	Complete
6	118419S05	3.4	08/10/2009 04:04:55	125 MB	Complete
7	118419S05	3.22	08/12/2009 05:49:46	124 MB	Complete

**Download DF NetCDF File**

<http://w3.pppl.gov/fqweb/nubeam/pshr0075/7/>

OK

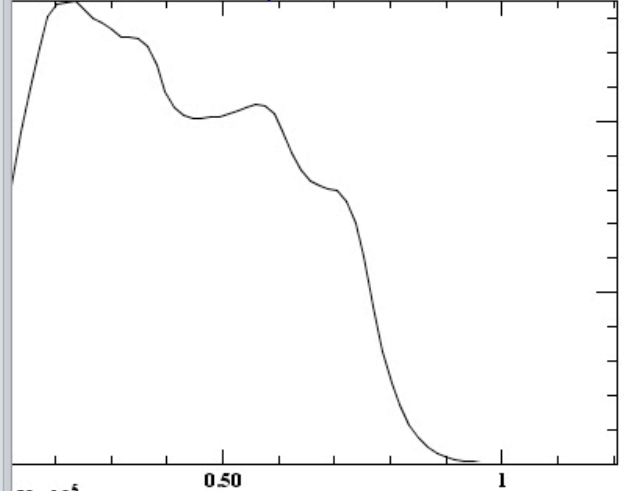
Manage Analyze

Inspect Plot Download

G3MSEL: ENTER SLICE OPCODE (A/B/C/X/Q):

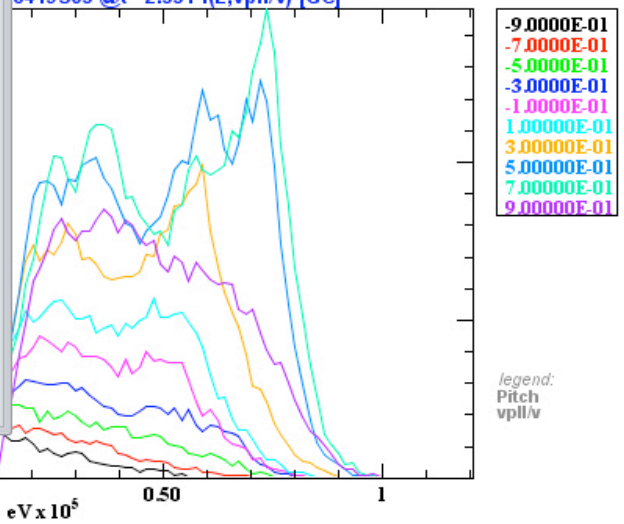
fbm normalization test: densities should match.

8419S05 @t= 2.551 -- f(E) integrated over x,theta,vp||/v  
= 0.00: 1.00,th=-3.14: 3.14,vp||/v=-1.00: 1.00,ns= 1



guiding center fast ion distribution function

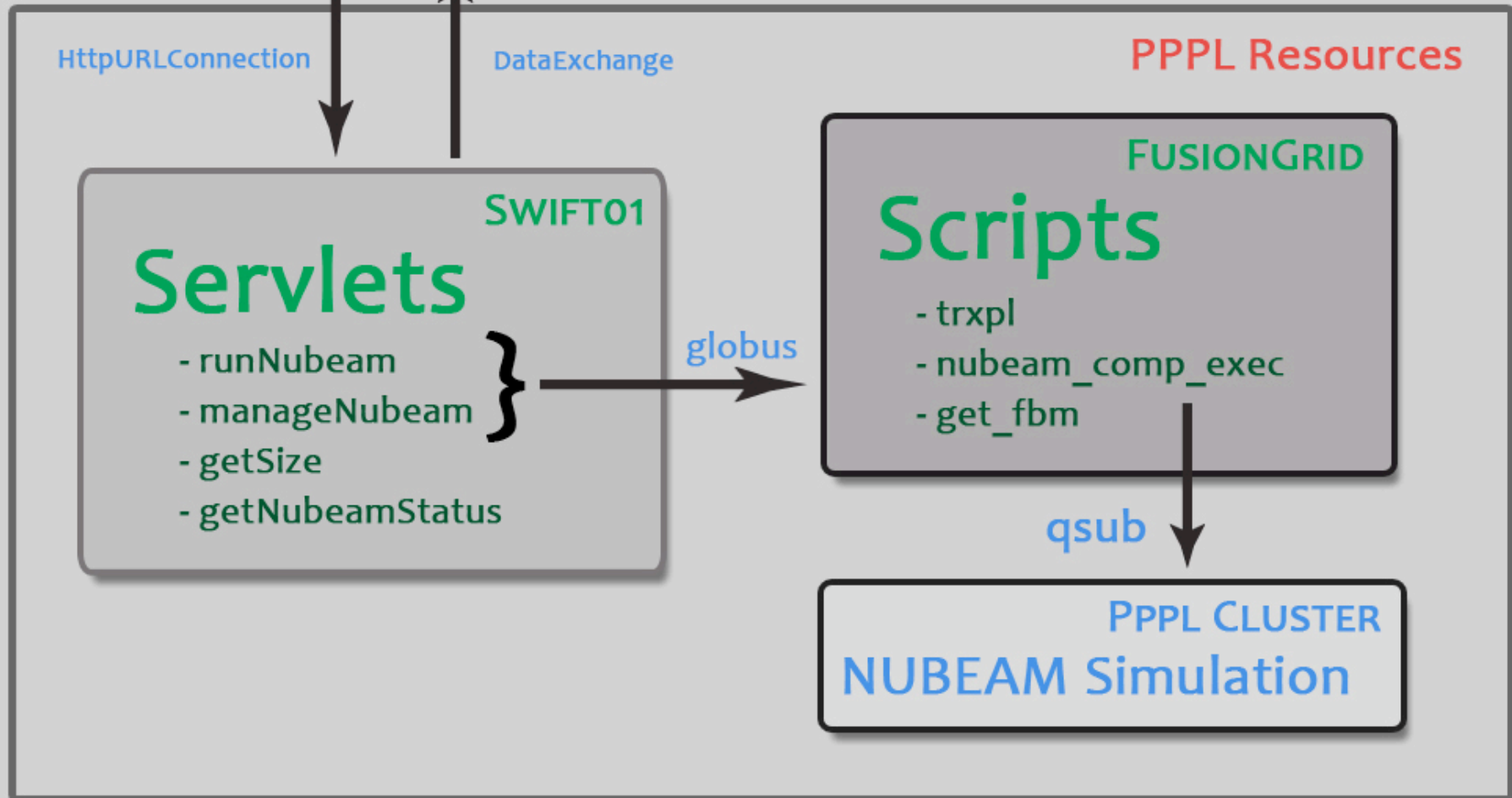
= 0.00 to 0.00, th= 0.00 to 0.00 (AVERAGED)  
8419S05 @t= 2.551 f(E,vp||/v) [GC]



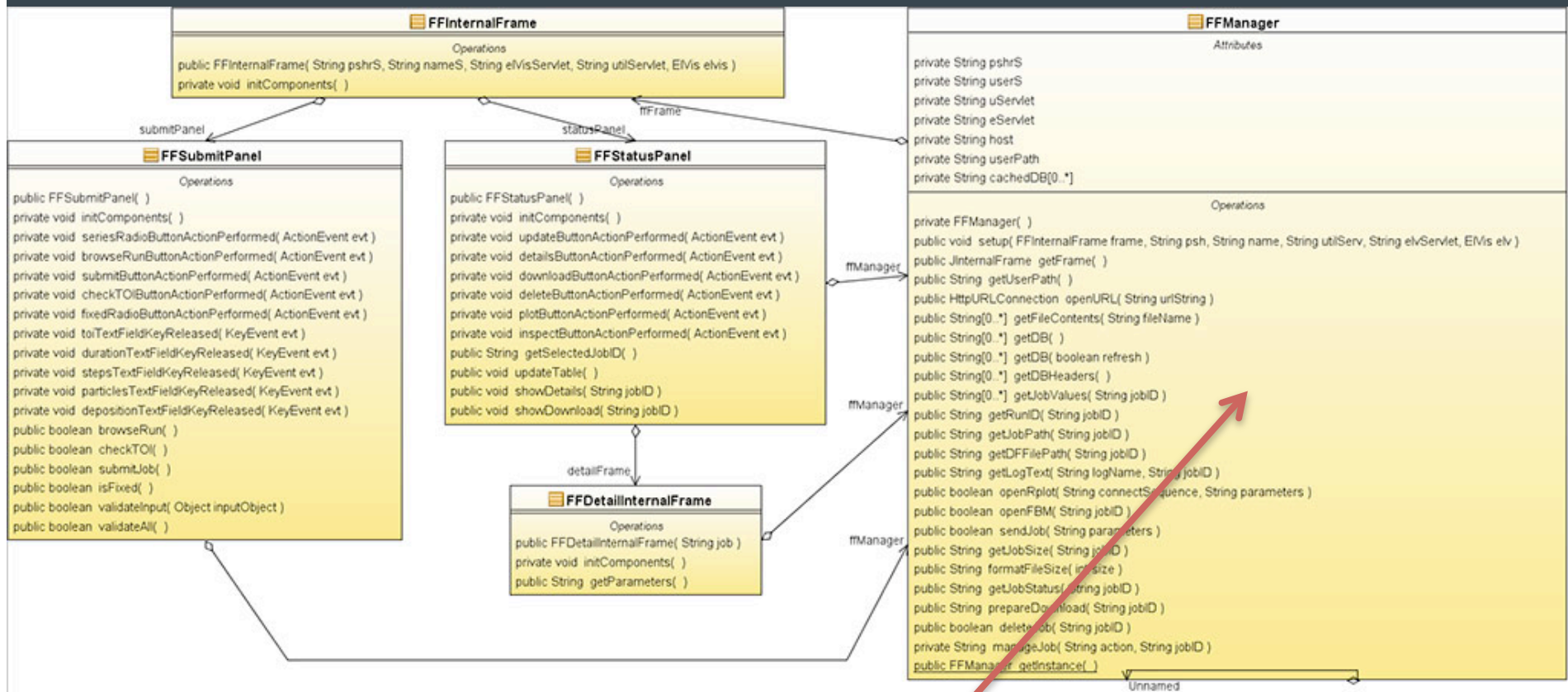
Z= 1 A= 2 Beam VS Energy

# ELVIS CLIENT

## Servlets and Scripts



# Java UML



Singleton!

# Summary

- (One of the) Newest ELVis applications
- Successfully creates full DF files (NetCDF)
- Provides complete monitoring/management tools
- Python and Java are well-documented (inline comments)



# Credits

All Flickr photo credits given in captions

TRANSP Homepage: <http://w3.pppl.gov/transp/>

ELVis Homepage: <http://w3.pppl.gov/elvis/>

Back-end code provided by PPPL Computational Plasma Physics Group

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[thestarseffect.com](http://thestarseffect.com)

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