# BOLITAS 2 DATA FILE FORMATS

Bolitas uses binary files for the simulation results generated by Particle-X and other fluidization simulation programs. To ensure maximum flexibility, each time-dependent variable is stored in a separate file, so that unnecessary files might be erased easily. Also, files might be temporarily copied into different locations for storage and/or transport.

Bolitas currently uses the following three types of files:

Icon	Extension	Description
	*.flu	This is the main data file. Bolitas will only open *.flu files. It should contain all static data and basic information about the simulation. It also contains a fingerprint that is used for matching *.flx files.
	*.flx	These are additional files, each containing data from one variable. Although they can contain static data, they are usually for dynamic data. The fingerprint in an *.flx file must match that of the corresponding *.flu file.
[none]	*.fls	This file is used for monitoring the status of a simulation as it is running.

Main fluidization data fiile (*.flu)

The purpose of this file is provide the main static information and should be written entirely at the beginning of the simulation. It consists in a preheader followed by a a series of data records.
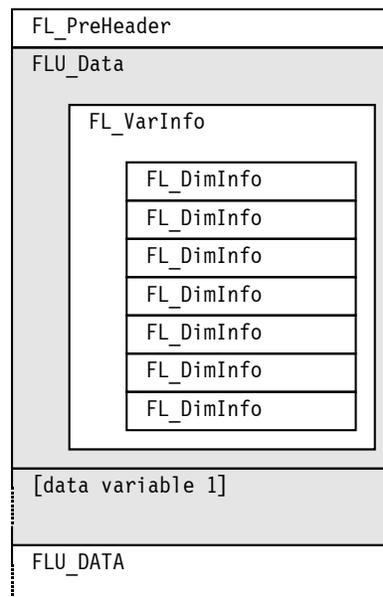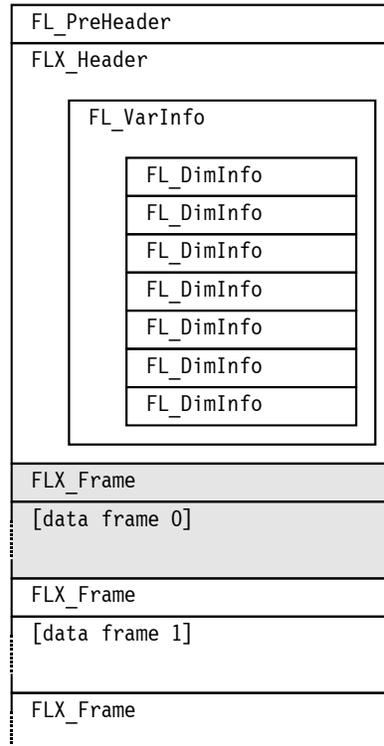

Figure 1. Main fluidization data file structure. Individual members of structures are not shown. Portion shown in gray is repeated as needed.

Extended data file (*.flx)

Each extended data file contains values corresponding to one simulation variable. The data can be static or dynamic, although static data is usually stored in the `*.flu` file. Dynamic data is stored at regular time intervals as specified by the variable `BOLITAS.FPS`. The file begins with a preheader, a main header, followed by a series of "frames" containing the data.

```
FL_PreHeader
FLX_Header

    FL_VarInfo

        FL_DimInfo
        FL_DimInfo
        FL_DimInfo
        FL_DimInfo
        FL_DimInfo
        FL_DimInfo
        FL_DimInfo

FLX_Frame
[data frame 0]

FLX_Frame
[data frame 1]

FLX_Frame
```

Figure 2. Extended data file structure. Individual members of structures are not shown. Portion shown in gray is repeated as needed.

Simulation status file (*.fls)

This file contains a single record that should be updated regularly by the simulation program. It provides basic information for on-the-fly progress monitoring. It consists on a preheader and a single record.

```
FL_PreHeader
FLS_Record
```
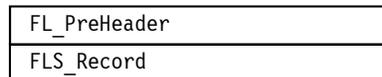
Figure 3. Simulation status file. Individual members of structures are not shown.

FL_PREHEADER (14 bytes)

Field	Type	Length	Description
FlMark	String	6 bytes	File type identifier, must be one of the following ▪ "F.L.U." ▪ "F.L.X." ▪ "F.L.S."
FlRevision	Integer	4 bytes	File revision number, must be 1 for this revision.
FlFingerPrint	Integer	4 bytes	Tag used to identify all auxiliary files corresponding to the same fluidization simulation. The fingerprint appearing in the *.flu file will be used for matching all other files. See the corresponding documentation for fingerprint rules.

FLU_DATA (296 bytes)

Field	Type	Length	Description
FluDataMark	String	8 bytes	Data record identifier, must always be "D.A.T.A."
FluVarInfo	FL_VARINFO	288 bytes	Structure containing information about the variable.
			Actual data follows; data length is variable, depending upon the data type and the number of data values.

FL_VARINFO (288 bytes)

Field	Type	Length	Description
viVariableID	String	32 bytes	Identifier for the variable.
viFriendlyName	String	32 bytes	Screen name for the variable.
viUnits	String	16 bytes	Screen representation of the units.
viDataType	Long	4 bytes	Type identifier for the data. Can be one of the following constants ▪ DataInteger = 2 ▪ DataLong = 3 ▪ DataSingle = 4 ▪ DataDouble = 5
viTimeBehavior	Long	4 bytes	Indicates whether data is static or dynamic. Can be one of the following constants ▪ TimeStatic = 0 → Data does not change during the simulation ▪ TimeDynRegular = 1 → Data is saved at the frame rate defined by the variable BOLITAS.FPS
viNumDim	Long	4 bytes	Number of dimensions (up to seven). Use 0 for scalar data.
viDimInfo(1 To 7)	FL_DIMINFO	196 bytes	Information about each dimension.

FL_DIMINFO (28 bytes)

Field	Type	Length	Description
DimLBound	Long	4 bytes	Actual lower bound of the array.
DimUBound	Long	4 bytes	Actual opper bound of the array.
DimLUse	Long	4 bytes	Lower bound of the portion of the array actually containing the data.
DimUUse	Long	4 bytes	Upper bound of the portion of the array actually containing the data.
DimLPhysical	Single	4 bytes	Physical location corresponding to the data in DimLUse.
DimUPhysical	Single	4 bytes	Physical location corresponding to the data in DimUUse.
DimStaggered	Long	4 bytes	Indicates if the data is staggered with respect to this dimension. Used mainly for fluid-cell face data. ▪ 0 → Data is not staggered ▪ 1 → Data is staggered half cell in the positive direction.

FLX_HEADER (296 bytes)

Field	Type	Length	Description
FlxDataOffset	Long	4 bytes	Position in the file where frames begin (first byte in the file is position 1).
FlxFrameLength	Long	4 bytes	Size in bytes of the frame, including the FLX_FRAME structure and the data.
FlxVarInfo	FL_VARINFO	288 bytes	Structure containing information about the variable.

FLX_FRAME (20 bytes)

Field	Type	Length	Description
FlxFrameMark	String	8 bytes	Frame record identifier, must always be "F.R.M.E."
FlxFrameSeq	Long	4 bytes	Sequential numbering of the frames, starting at 1. (NOTE: In some cases, the frist frame has been refered to as "frame 0", corresponding to time zero. There is a potential conflict with this notation)
FlxItCount	Long	4 bytes	Iteration counter from the simulation; a negative number should be interpreted as "not available".
FlxTimeStamp	Single	4 bytes	Time stamp from the simulation; a negative number should be interpreted as "not available".
			Actual data follows; data length is variable, depending upon the data type and the number of data values.

FLS_RECORD (20 bytes)			
Field	**Type**	**Length**	**Description**
FlsStatus	Long	4 bytes	Current status of the simulation, one of the following constants: ▪ FlsInProgress = 0 ▪ FlsDone = -1
FlsItCount	Long	4 bytes	Current iteration in the simulation.
FlsTimeStamp	Single	4 bytes	Current timestamp in the simulation.
FlsProgress	Single	4 bytes	A value between 0.0 and 1.0 indicating the progress of the simulation.
FlsFramesFlx	Long	4 bytes	Number of frames already written to *.flx regular dynamic files. Note that the frames available for Bolitas might be less than FlsFramesFlx due to file write cache delay.

Addendum: Primitive data types

Type	Size	Description
Integer	2 bytes	Signed 16-bit integer
Long	4 bytes	Signed 32-bit integer
Single	4 bytes	Floating point 32-bit single precision real
Double	8 bytes	Floating point 64-bit double precision real