

A horizontal banner image featuring a sequence of celestial bodies from left to right: a blue planet with white clouds, a brown planet, a reddish-brown planet, a white planet, and a large gas giant with orange and white bands. The text "Planetary Data System" is overlaid in white on the right side of the banner.

Planetary Data System

# **PDS4 Complex Table Example**

**PDS 2010 Tech Session**

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**PDS 2010 Data Design WG**

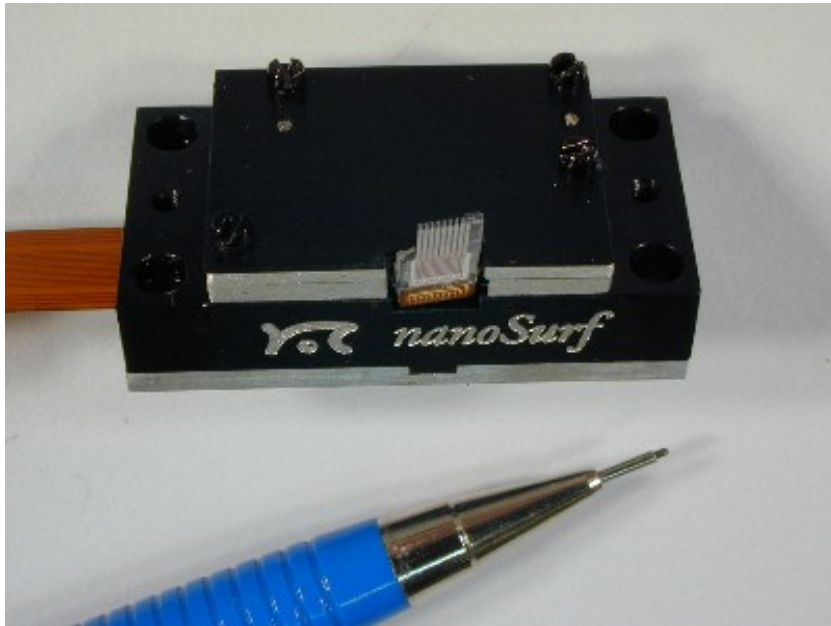
# Outline

- Description of Phoenix Atomic Force Microscope (AFM) and an AFM product with containers.
  - Makes the ASCII table a "complex" structure.
- Reasons why containers make sense to use.
- PDS3 label fragment of the repeating structure (container).
- PDS4 version of similar fragment.

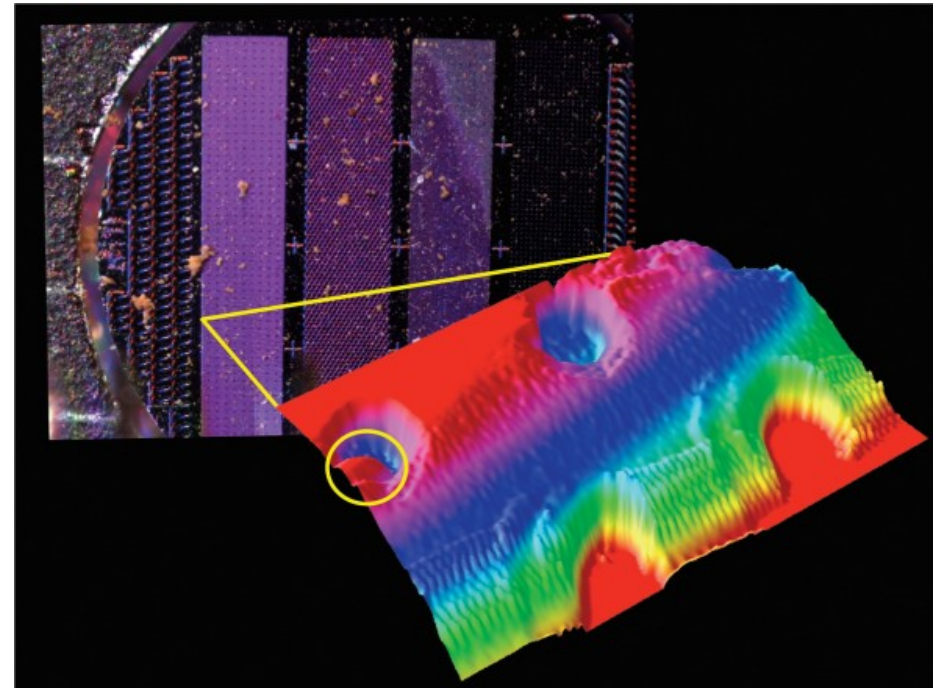
# Phoenix Atomic Force Microscope

- Instrument maps topography at atomic scale.
  - Characterize size, shape, and texture of small (few microns) particles.
- Series of springs measure deflections due to atomic forces that can be converted to heights.
- Data output is a 512x512 (or less) grid of measurements consisting of x, y, and some "z" value.
- The x and y are relative to calibrated sample grid, which can be at an angle to the scanning directions.

# Phoenix Atomic Force Microscope



AFM Instrument



Phoenix Optical  
Microscope image  
and AFM data from a  
small subarea.

# AFM RDR – example of a "complex" table structure

- One AFM reduced data record (RDR) product type consists of five data tables.
  - Header table with simple table structure.
  - Four data tables that use container object to group sets of repeating columns. Each uses the same structure.
- Each record has 512 data items and 512 records in the table.
- Each of the 512 data items has 3 elements
  - X, y, and some "z" value (height, error, derivative of height).

# AFM RDR – example of a "complex" table structure

Byte	19969 Bytes				Record
1	Row 1	AFM_D_HEADER_TABLE	<CR>	<LF>	1
19970	Row 2		<CR>	<LF>	2
39939	Row 3		<CR>	<LF>	3
59908	Row 4		<CR>	<LF>	4
79877	Row 1	AFM_F_ERROR_TABLE	<CR>	<LF>	5
...	Row 2		<CR>	<LF>	6
...	Row ...		<CR>	<LF>	...
...	Row 512		<CR>	<LF>	516
1030400	Row 1	AFM_F_HEIGHT_TABLE	<CR>	<LF>	517
...	Row 2		<CR>	<LF>	518
...	Row ...		<CR>	<LF>	...
...	Row 512		<CR>	<LF>	1028
20528133	Row 1	AFM_B_ERROR_TABLE	<CR>	<LF>	1029
...	Row 2		<CR>	<LF>	1030
...	Row ...		<CR>	<LF>	...
...	Row 512		<CR>	<LF>	1540
30752261	Row 1	AFM_B_HEIGHT_TABLE	<CR>	<LF>	1541
...	Row 2		<CR>	<LF>	1542
...	Row ...		<CR>	<LF>	...
...	Row 512		<CR>	<LF>	2052

## **AFM RDR – example of a "complex" table structure**

- PDS3 label uses a container to describe the repeating set of three data elements.
- The use of a container is what makes this example "complex".
- In the AFM example, the container contains three columns: x, y, z and repeats 512 times in each record.
- Columns with "items" would be another example of a "complex" table.

# Why have complex tables in PDS4?

- Produces a more compact label.
  - The AFM example as a simple table would need 1536 separate column definitions with each definition being similar to the others.
- Better shows how the data elements are organized and what the relationships are between columns.
- Easier to create tools to read and manipulate the specific data product using nested structures.



# Other PDS3 examples of "complex" tables

- Other data sets from Geosciences Node archives (not a complete list).
- Containers:
  - MER MB EDR.
  - MGS MOLA PEDR.
  - Phoenix TEGA EDR and RDR.
  - LRO LOLA EDR.
- Items:
  - Odyssey GRS EDR and RDR products (use items to define spectra within a table record).
  - Other data sets with spectra.

# PDS 3 label fragment

```
PDS_VERSION_ID           = "PDS3"  
LABEL_REVISION_NOTE     = "2008-11-14, Initial"  
  
/* File characteristics */  
RECORD_TYPE             = FIXED_LENGTH  
RECORD_BYTES           = 19969  
FILE_RECORDS           = 2052  
  
/* Pointers to object in file */  
^AFM_D_HEADER_TABLE    = ("FS004SDD_001_4E0111040000A0.TAB",1)  
^AFM_F_ERROR_TABLE    = ("FS004SDD_001_4E0111040000A0.TAB",5)  
^AFM_F_HEIGHT_TABLE    = ("FS004SDD_001_4E0111040000A0.TAB",517)  
^AFM_B_ERROR_TABLE     = ("FS004SDD_001_4E0111040000A0.TAB",1029)  
^AFM_B_HEIGHT_TABLE    = ("FS004SDD_001_4E0111040000A0.TAB",1541)
```



# PDS3 label fragment continued


```
OBJECT = AFM_F_ERROR_TABLE
INTERCHANGE_FORMAT = ASCII
COLUMNS = 1536
ROWS = 512
ROW_BYTES = 19969
START_BYTE = 79877
MISSING_CONSTANT = 0.00
DESCRIPTION = "This table contains the AFM scan ... "
```

```
OBJECT = CONTAINER
BYTES = 39
DESCRIPTION = "The container holds the X-Y-Z ... "
NAME = "FORWARD ERROR DERIVATIVE"
REPETITIONS = 512
START_BYTE = 1

OBJECT = COLUMN
COLUMN_NUMBER = 1
BYTES = 12
DATA_TYPE = ASCII_REAL
NAME = "FORWARD ERROR DERIVATIVE X COORDINATE"
START_BYTE = 1
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 2
BYTES = 12
DATA_TYPE = ASCII_REAL
NAME = "FORWARD ERROR DERIVATIVE Y COORDINATE"
START_BYTE = 14
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 3
BYTES = 12
DATA_TYPE = ASCII_REAL
NAME = "FORWARD ERROR DERIVATIVE VALUE"
START_BYTE = 27
END_OBJECT = COLUMN
END_OBJECT = CONTAINER
END_OBJECT = AFM_F_ERROR_TABLE
```



# PDS4 label fragment - part 1

```
/** (2) AFM_F_ERROR_TABLE = ("FS004SDD_001_4E0111040000A0.TAB",5) **/
```

```
OBJECT = TAGGED_TABLE_CHARACTER_GROUPED
```

```
COMMENT = "This table contains the AFM scan forward error  
derivative information. Each row represents a  
scan line along the fast scan axis"
```

```
DATA_LOCATION = ("FS004SDD_001_4E0111040000A0.TAB",5)
```

```
OBJECT = TABLE_CHARACTER_GROUPED
```

```
LOCAL_IDENTIFIER = "N/A"
```

```
NUMBER_OF_FIELDS = 1536
```

```
NUMBER_OF_ROWS = 512
```


```
ROW_BYTES = 19969
```

```
START_BYTE = 79877
```



# PDS4 label fragment - part 2

```
OBJECT = TABLE_CHARACTER_GROUPED_SEQUENCE
  REPETITIONS          = 512
  DESCRIPTION          = "The container holds the X-Y-Z
                        information for each AFM scan error
                        derivative data point. The table
                        contains 19969 bytes of table data of
                        which the last 2 bytes contain the
                        <CR><LF> pair. "
```



```
OBJECT = TABLE_CHARACTER_FIELD_SEQUENCE

OBJECT = TABLE_CHARACTER_GROUPED_FIELD
  FIELD_NUMBER         = 1           /* OPTIONAL */
  FIELD_NAME           = "FORWARD ERROR DERIVATIVE X COORDINATE"
  FIELD_DATA_TYPE      = ASCII_REAL
  FIELD_DESCRIPTION    = "N/A"
  FIELD_FORMAT         = "N/A"
  FIELD_LENGTH         = 12
  FIELD_LOCATION       = 1           /* OPTIONAL */

OBJECT = SPECIAL_CONSTANTS           /* OPTIONAL */
  MISSING_CONSTANT     = 0.00
END_OBJECT = SPECIAL_CONSTANTS

END_OBJECT = TABLE_CHARACTER_GROUPED_FIELD
.
.
.
```

# PDS4 label fragment - part 3

```
OBJECT = TABLE_CHARACTER_GROUPED_FIELD
  FIELD_NUMBER      = 3          /* OPTIONAL */
  FIELD_NAME        = "FORWARD ERROR DERIVATIVE VALUE"
  FIELD_DATA_TYPE   = ASCII_REAL
  FIELD_DESCRIPTION = "N/A"
  FIELD_FORMAT      = "N/A"
  FIELD_LENGTH      = 12
  FIELD_LOCATION    = 27        /* OPTIONAL */

OBJECT = SPECIAL_CONSTANTS      /* OPTIONAL */
  MISSING_CONSTANT = 0.00
END_OBJECT = SPECIAL_CONSTANTS

END_OBJECT = TABLE_CHARACTER_GROUPED_FIELD

END_OBJECT = TABLE_CHARACTER_FIELD_SEQUENCE

END_OBJECT = TABLE_CHARACTER_GROUPED_SEQUENCE

END_OBJECT = TABLE_CHARACTER_GROUPED

END_OBJECT = TAGGED_TABLE_CHARACTER_GROUPED
```