**THE CE5 SCIENTIFIC DATA PRODUCTS USING PDS4.** X. Tan [1,2] , J.J.Liu[1,2], X.G.Zeng[1,2], W.Zuo[1,2]and C.L.Li[1,2], [1]National Astronomical Observatories, Chinese Academy of Sciences,Beijing 100012,China., [2]Key Laboratory of Lunar and Deep Space Exploration,National Astronomical Observatories, Chinese Academy of Sciences,Beijing 100012,China. (tanx@nao.cas.cn, liujj@nao.cas.cn, zengxg@nao.cas.cn, zuow@nao.cas.cn, licl@nao.cas.cn)

**Introduction:** The Chang'e 5(CE5) will be launched in 2017. The CE5 data will be archived and distributed to the scientific community through the CNSA's ground research and application system (GRAS). All data will be compliant with NASA's Planetary Data System (PDS4) standards for formatting and labelling files. This paper summarizes the format and content of the CE5 data products and associated metadata.

**CE5 Scientific Payloads:** The CE5 spacecraft consists of four modules - a Service Module, a Return Vehicle, the Lander and the Ascent Vehicle. And the are four payloads are equipped on the lander, who are the Panoramic Camera (PCAM), the Descending Camera (LCAM), Lunar Regolith Penetrating Radar(LRPR) and Lunar Mineralogical Spectrometer(LMS), which will investigate the geological structures and minerals compositions of the sampling area, and integrate exploration of the structure of landing site interior.

**PDS4.0:** PDS4 is an object-oriented system based on a central Information Model, from which everything within the system is defined explicitly. This differs greatly from PDS3 and provides continuity across discipline nodes, which has not been present in the past.

PDS4 is product-centric. A "product" is defined as a label file and the object (data, document, etc.) it describes.The new system replaces the use of ODL (managed by JPL/Caltech, used only by PDS) with eXtensible Markup Language (XML)[1].

There are four fundamental data structures that may be used for archiving data in the PDS. All products delivered to the PDS must be constructed from one or more of these structures. These four fundamental structures are described using four base classes: Array (used for homogeneous Ndimensional arrays of scalars), Table_Base (used for repeating records of heterogeneous scalars), Parsable_Byte_Stream (a stream of bytes that can be parsed using standardized rules), and Encoded_Byte_Stream (an encoded stream of bytes). All other digital object classes in the PDS are derived from one of these four base classes.[2]

The PDS4 Data Dictionary (DD), which is an adjunct to the PDS4 Information Model (IM), define classes and attributes used in PDS4 XML files by specifying tags, their meanings, and the acceptable values (including structure) that may appear as content. The key words can be used to provide all of the information required to access and analyse the data. [3]

**CE5 data products:** Change's data product are categorized into three levels including level 0, level 1 and level 2. [4] Only Level1 and Level2 data products are compliant with NASA's Planetary Data System (PDS) Standards. Level1 data are uncorrected, and Level 2 data are further processed with radiometric calibration, approximate geometric correction, photometric calibration, etc.. One basic CE5 product includes one or more data objects and their lable. For each product, there is only one lable to describe the contents and format of each individual product. The Introduction of the CE5 data products are as follows:

*Data Lable.* CE5 data lables are followed the general structure which is defined by the PDS4(see Fig.1). We give the attribute value of each class according to the PDS Data Dictionary. As above mentioned, the mission specific classes and attributes are defined in CE5 local data dictionary, and these information are described in mission area- a subclass of the Observation_Area.

```
XML Declaration and Schema Reference
Root Tag
     Identification_Area
          Alias_List
          Citation_Information
          Modification_History
     Reference_List
          External_Reference
          Internal_Reference
     Observation_Area
          Investigation_Area
          Observing_System
          Target_Identification
          Time_Coordinates
          Discipline_Area
          Mission_Area
          Primary_Result_Summary
     File_Area_Definition
          File
          Data_Object_Definition
End Tag
```

Fig. 1 lable structure

*Data Object.* In CE5 mission, one or two data objects constitute a single observation, one is the main observation data(for example one or more image), the other (if there)is the auxiliary telemetry data, which prefix the observation data.The data structure of each

payload are as follows(see table1). i)We use the Array_3D_Image to store multiple image, the three dimensions are respectively time, line and samples. The Array_3D_Image are also used to storage a color image.(i.e. PCAM Level 2C data product is a color image which have a color restoration and color correction, based on level 2B data.). ii) We use the Table_Binary to store the LRPR data. iii) We use the Table_Character to store the spectral data and the auxiliary telemetry parameter.

Table 1: data structure of each payload

| | Level1 | Level2A | Level2B | Level2C |
|---|---|---|---|---|
| PCAM | Array_3D_Image Table_Character | Array_2D_Image | | Array_3D_Image |
| LCAM | Array_3D_Image | Array_2D_Image | | none |
| LRPR | Table_Binary | | | |
| LMS (Visible band) | Array_3D_Image Table_Character | | | none |
| LMS (medium wave, shortwave, and near infrared band) | Table_Character | | | |

*Local Data Dictionaries.* In CE5 mission, the data products are followed with PDS Data Dictionary Version 1.5.0.0. Beyond that, we also maintain our own 'CE5 Data Dictionary', appending many of our own 'local data dictionaries' to specify information pertinent only to individual CE5 mission.

Ten classes are defined in CE5 Data Dictionary, they are:

Work_Mode_Parm: Describes the parameters associated with the scientific payload work mode, including exposure_mode, automatic_exposure_mean_gray, exposure_gear, gain, etc..

Instrument_Parm: Describes the parameters of the sensor, including focal_length, pixel_size, principle_point_coordinate, etc..

Processing_Parm: Describes the coefficient of the data processing model for each level.

Lander_Location: The longitude, latitude and the reference_frame are given in this class.

Grid_Point_Location: The longitude and latitude with the row and column numbers where they form a subclass, to describe the location of the grid point in moon coordinate system.

Vector_Cartesian_3_Position: The Cartesian 3D position of antenna1 to antenna12 for LRPR are given in this class.

Vector_Cartesian_3_Pointing: The observation vector of four corner point and center point are given in this class.

Exterior_Orientation_Elements: The camera center position and rotation angle are given in this class.

Besides this, the pitch and yawing are given in "Rotation_angle" class as a attribute. And the incidence angle, azimuth angle and phase angle of four corner point and center point are given in "Angle_pointing_results" class.

**References:**

[1] Neakrase L. D., Huber L. F., Beebe R. F., et al.(2014) LPSC 45th , Abstract #1417. [2] PDS Standards Reference 1.4.0 (2015).[3] PDS4 Concepts Version 1.4.0(2015). [4] Tan, X., Liu, J. J., Li, C. L., Feng, J. Q., Ren, X., Wang, F. F., ... & Zhang, Z. B. (2014). Scientific data products and the data pre-processing subsystem of the Chang'e-3 mission. Research in Astronomy and Astrophysics, 14(12), 1682.