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1. General Description

- eXTP, the enhanced X-ray Timing and Polarimetry mission, is a science mission designed to study the state of matter under extreme conditions of density, gravity, and magnetism.
- The planned launch date of the mission is earlier than 2025.
- The next generation of the X-ray detected telescope after HXMT in China. The HXMT will be launched in the mid-year, 2017.
2. Design Evolution

- 2007  The conception of XTP was put forward by IHEP;
- 2008-2012  An advanced research of the XTP was carried out by ISSE;
- 2013-2014  Completed the system analysis and achieved the mission’s basic parameters. The first step design of the XTP was finished;
- 2015-2016  With the LAD and WFM adding into the XTP and the parameters of SFA & PFA has changed, redesigned the eXTP satellite;
### 3. Basic Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Orbit</strong></td>
<td>550 km, 28° or 14° (0°)</td>
</tr>
<tr>
<td><strong>Launch vehicle</strong></td>
<td>LM-3C (LM-7)</td>
</tr>
<tr>
<td><strong>SC dimensions</strong></td>
<td></td>
</tr>
<tr>
<td>Launch configuration</td>
<td>3608 mm × 3370 mm × 6330 mm</td>
</tr>
<tr>
<td>In orbit configuration</td>
<td>4737 mm × 16781 mm × 6330 mm</td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td></td>
</tr>
<tr>
<td>Launch Mass</td>
<td>3500 kg</td>
</tr>
<tr>
<td>Margin</td>
<td>310 kg</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td></td>
</tr>
<tr>
<td>Max demand</td>
<td>2400 W</td>
</tr>
<tr>
<td>Solar array</td>
<td>35 m²</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
</tr>
<tr>
<td>Frequency Band</td>
<td>Ka-band</td>
</tr>
<tr>
<td>Data Volume</td>
<td>3.2 Tb per day</td>
</tr>
<tr>
<td>Data Rate</td>
<td>2250 Mbps</td>
</tr>
<tr>
<td><strong>Control system</strong></td>
<td></td>
</tr>
<tr>
<td>Accuracy of attitude pointing</td>
<td>&lt; 0.01° (3σ)</td>
</tr>
<tr>
<td>Accuracy of attitude measurement</td>
<td>&lt; 0.002° (3σ)</td>
</tr>
<tr>
<td>Attitude Stabilization</td>
<td>0.005°/s (3σ)</td>
</tr>
<tr>
<td><strong>Mission duration</strong></td>
<td>5 years (10 years)</td>
</tr>
</tbody>
</table>
4. Preliminary Design

- **Launch Site**
  - There are four launch centers in China, **JSLC**, **TSLC**, **XSLC**, **WSLC**.

- **Telemetry and Control system**
  - The TC system applies the international USB system. Low tilt angle communication is achieved through utilizing relay satellites or building new TC station.

- **Satellite ground application system**
  - Data receiving is achieved by stations at Sanya. Or using the ground station at Malindi (3°S Kenya), built by Italian (LOFT team).
4. Preliminary Design

- **Observation Mode**
  - The –X axis point to the specific goals in the inertial space;
  - The sun vector is controlled in XOZ plane and in a obtuse angle with the +Z axis;
  - The sun vector will perpendicular to the solar array by rotate it;
  - According to the user’s observation plan to carry out attitude maneuver, aiming at the goals to carry on the observation.
4. Preliminary Design

- Configuration

Stowed in fairing

On orbit
4. Preliminary Design

- Configuration

- WFM Sunshield
- WFM×3
- LAD×40
- PFA
- PFA
- SFA×11
- Star tracker×3
4. Preliminary Design

- **LAD Configuration**

  - Stowed when launch
  - Blocking area of the Sunshield

  - Step 1: LAD deployed
  - Step 2: Sunshield panel deployed
4. Preliminary Design

WFM Configuration

- Stowed when launch

- FOV of WFM

Step 1: WFM deployed

Step 2: Sunshield panel deployed
Structure and mechanism

Composite Structures

For good dimensional stability, the principle of structure design as follows:

• Choose the materials with minimum coefficients of thermal expansion;
• Optimize the lay-up design for getting Zero Coefficient of Thermal Expansion;
• Thermal recycle test would be done to reduce the residual stress if necessary.
4. Preliminary Design

- Structure and mechanism

The DM Design consists of deployment hinge with a motor (DH), Hold Down and Release Mechanism (HDRM), LAD Panel Structure and LAD sunshield.
4. Preliminary Design

Structure and mechanism

- Type 2: panel using hinges
- Area: $13 \text{ m}^2$
- Pros:
  - Simple structure
  - Simple drive unit (spring), light (~ 25Kg),
- Cons:
  - Not fully covered, the edge of LAD will be uncovered

High thermal conductivity CFRP material
3. Preliminary Design

- **TCS: Outside heat flux**
  - Observation goals scope: celestial sphere latitude: 66.8°~58.82°, celestial sphere longitude: 25.92°~350.9°
  - Based on focus observation mode, the +Z direction side, ±Y direction side and ±X direction side are suitable for the satellite radiator, which albedo flux (3.6~86.2 W/m²) and infrared flux (57.6~81.7 W/m²) are correspondingly small.

![Observation goals scope](image)

![Graphs](image)
3. Preliminary Design

- **TCS: Radiators**
  - The satellite primary radiator locates on the +Z direction side, which is mainly used for the low temperature SFA payload.
  - The satellite accessorial radiators locate on the ±Y direction side and ±X direction side, which are mainly used for battery, data transmission equipment, etc.

![Diagram of satellite with radiators labeled](image)
3. Preliminary Design

- **TCS: SFA-SGO & PFA-Nickel optics thermal design**
  - The *insulating washers* (fiberglass) is used to limit the conductive heat transfer between the SFA-SGO & PFA-Nickel optics and optical bench.
  - The SFA-SGO & PFA-Nickel optics are covered by **15-layer MIL** to insulate heat radiation among internal or external parts of satellite.
  - The outside of central cylinder is used for the SFA-SGO & PFA-Nickel optics with SR-107ZK white painting. Electric heating loops (20W power) are applied around every SFA-SGO & PFA-Nickel optics. The total power needed is 240W.

![Diagram showing the thermal design of the satellite optics](image-url)
3. Preliminary Design

- **TCS: SFA-SDD thermal design**
  - The +X panel with 11 SFA-SDD is connected to the satellite primary structure by insulating washers.
  - The insulating washers is used to limit the conductive heat transfer between the SFA-SDD and +X panel.
  - The SFA-SDD are covered by 10-layer MIL.
  - The 11 SFA-SDD heat dissipation are firstly collected by the ethane loop heat pipe, then the collected heat dissipation is refrigerated by the pulse-tube refrigerator (5W@180K, power 120W). Finally, the hot junction heat dissipation of refrigerator is transmitted to the +Z panel individual radiator by the ethane heat pipe.

![Diagram of SFA-SDD thermal design](image)
3. Preliminary Design

➢ TCS- LAD thermal design

• The LAD sunshield could directly insulate heat radiation from the sun.
• The side of the sunshield face to LAD is covered by 15-layer.
• The LAD heat dissipation (5.4W*40=216W) is radiated by the top and the bottom face of itself.
• Electric heater (50W power) is applied in LAD for maintaining the -20°C lower limit.
4. Preliminary Design

- **Power system**
  - Two Identical Wings (4 panels each)
  - GaInP$_2$/InGaAs
  - 35m$^2$ effective area (2 wings)
  - More than 28.6% efficiency
  - Two Lithium Batteries (2 × 150 Ah)
  - DOD ≤ 20% (on average)
  - One Power Control Unit (PCU)
  - One Power Distribution Unit (PDU)
4. Preliminary Design

AOCS

Attitude Control Accuracy

- Zero-Momentum control is used in satellite attitude control, 3 high precision star trackers for attitude measurement, 6 big torques MW (or CMG) for attitude control and 3 magnetorquers for magnetic unloading. The configuration above can achieve 0.01°(3σ) attitude control accuracy.

The ability of 0.01° attitude control is similar to existing satellite platform product of CAST.

Attitude Maneuver

- Requirement: Finish 30° attitude maneuver in 10 mins
- Specification: angle rate of satellite body shall be 0.06°/s, angle acceleration shall be 0.001°/s²,
- Configuration: 6 big torques MW(0.5Nm)
5. Conclusions and recommendations

- The preliminary design of eXTP refers to the experiences of HXMT, do not use any unproven technologies;
- The key technologies, such as integrated structure, low temperature thermal control, have been solved;
- The preliminary design of eXTP satellite could meet the requirements of science;
- The requirement baseline of payload needs some consolidation (number/mass/power);
- We want to know more details about LAD and WFM in next step for detailed design of the eXTP satellite.
Thanks for your attention!