# Development of the Real-Time Light Curve Updating System for MAXI

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MAXI （Monitor of All-sky X-ray Image）

MAXI is the only all-sky X-ray monitor aboard the International Space Station (ISS).
By utilizing the ISS's orbital motion, it continuously scans the entire sky in X-rays.
MAXI observes various X-ray sources such as black holes, neutron stars, and active galactic nuclei (AGN).
It has detected numerous transient and long-term variations, discovered many new X-ray sources, and become a key facility for high-energy astrophysics by enabling international follow-up observations.
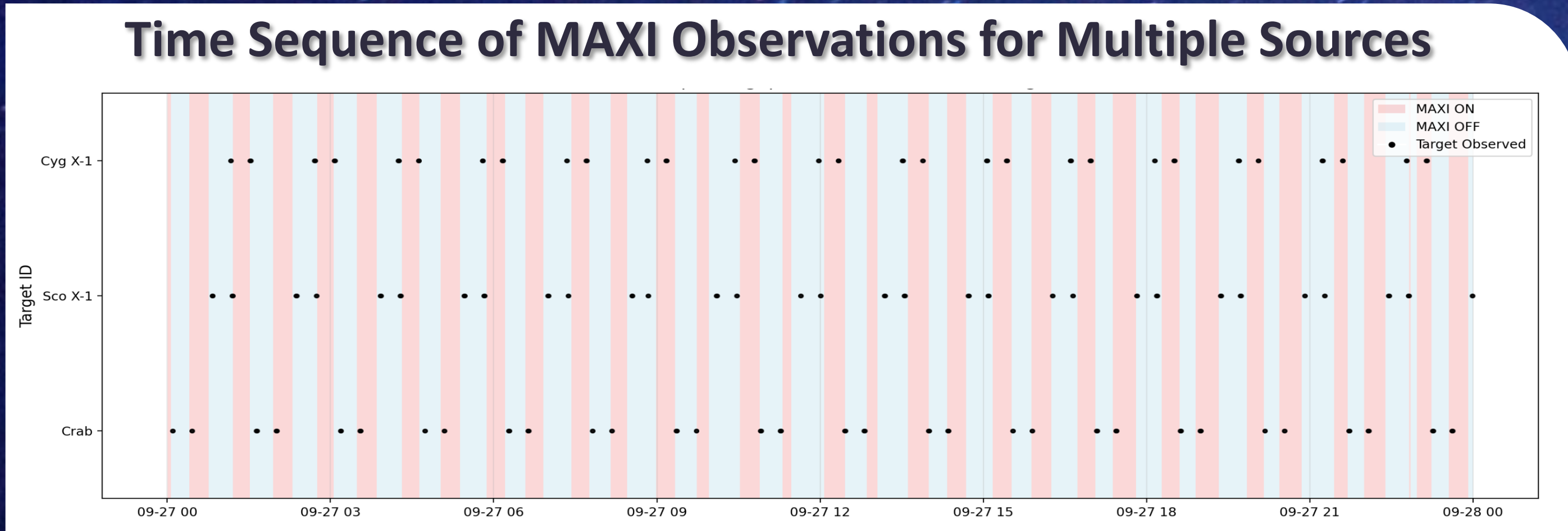

MAXI Scanning the Sky from the ISS

The celestial sphere
160 deg
1.5 deg (FWHM)
Credit: ISAS/JAXA
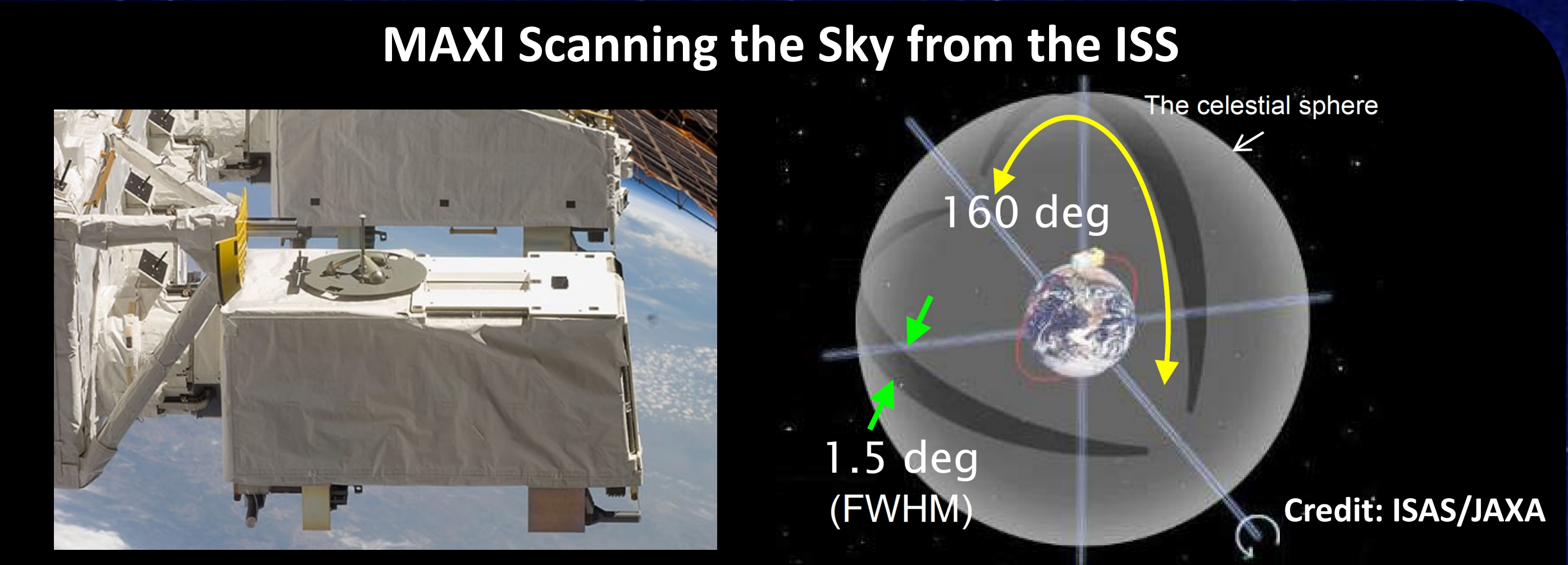
Launch: July 2009, aboard Space Shuttle mission (2J/A)
Operation: JAXA, RIKEN, and collaborators
Data archives: DARTS (https://darts.isas.jaxa.jp/missions/maxi/)
HEASARC (https://heasarc.gsfc.nasa.gov/docs/maxi/)

In **HEASoft 6.36**, a new analysis tool **mxpipeline** is available, allowing users to easily obtain and analyze MAXI data.

Data Flow and Observation Characteristics

MAXI data are transmitted from the ISS via NASA to the Tsukuba Space Center (TKSC) for processing, then sent to ISAS and RIKEN.
Communication with the ground occurs about **70%** of the time, allowing real-time downlink; during the rest, data are temporarily stored on the ISS and sent in batches.
ISAS releases the data immediately via DARTS, while RIKEN generates light curves every six hours.

Transition of MAXI Data Status Over Time

Normal Data
Error Data
No Data
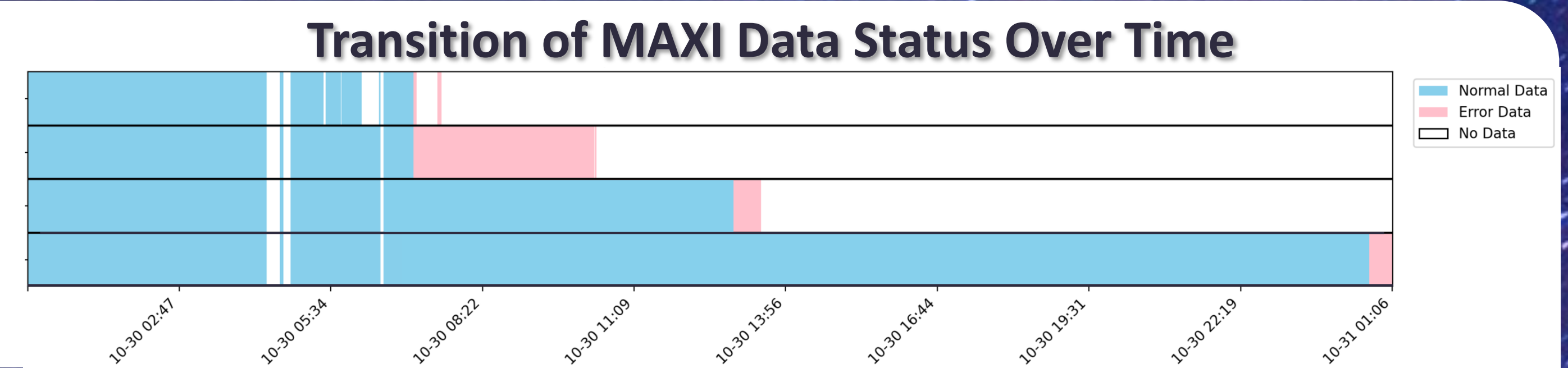
MAXI continuously monitors hundreds of X-ray sources. Observation and data arrival times vary by source, with each target observed roughly every 90 minutes for a few minutes per scan.
This periodic and intermittent pattern defines the time structure of MAXI data.

Time Sequence of MAXI Observations for Multiple Sources

MAXI ON
MAXI OFF
Target Observed

Cyg X-1
Sco X-1
Crab

Research Goal

The goal of this study is to develop a system that automatically analyzes MAXI data immediately after it is delivered and quickly publishes the results.
When a data update is detected, the system runs mxpipeline to analyze only the updated targets and automatically generates and publishes the corresponding X-ray light curves.
Since MAXI primarily observes transient X-ray events, reducing the lag the detection to the publication of the light curve.

RIKEN method: Re-analyze all sources every six hours.

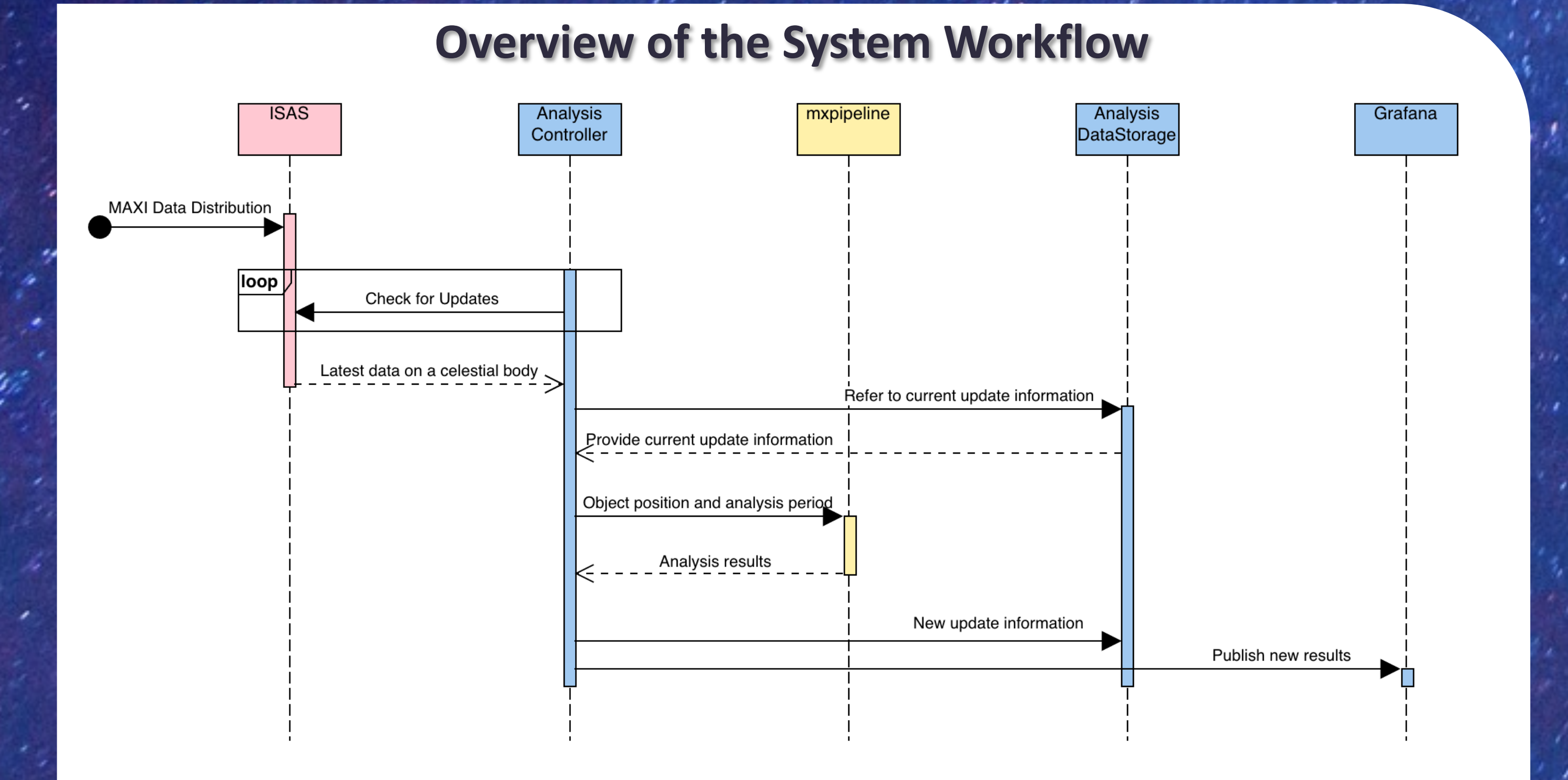**This study** : Analyze only updated sources immediately after data delivery.

This approach significantly shortens the time from data acquisition to the light-curve publication publication, improves processing efficiency, and enhances MAXI's real-time monitoring capability, enabling rapid detection of transient events and timely follow-up observations.

System Architecture

This system automatically detects data delivery from MAXI and performs end-to-end processing, from analysis to result publication.

The system is implemented in Python, and the resulting light curves are automatically published on Grafana Cloud, making them accessible to anyone via the web.

The system monitors MAXI observation files and runs analysis only for sources with updated data.
Since MAXI simultaneously monitors hundreds of sources, some targets in the latest dataset may not have new data.
By analyzing only the updated sources and automatically invoking mxpipeline, the system ensures efficient processing.

Overview of the System Workflow

ISAS | Analysis Controller | mxpipeline | Analysis DataStorage | Grafana

MAXI Data Distribution
loop
Check for Updates
Latest data on a celestial body
Refer to current update information
Provide current update information
Object position and analysis period
Analysis results
New update information
Publish new results

Current Status and Future Plan

The system is currently under development.
We plan to release it via DARTS within this fiscal year (by the end of March 2026), enabling timely access to MAXI light curves.