ICHNOS

A Web Application For Data Visualization

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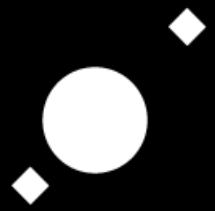

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Outiline

I. Introduction

ICHNOS: Real-time monitoring application for the Sardinia Radio Telescope (SRT)

II. System Architecture

Full-stack asynchronous design (Python/Flask/Socket.IO)

III. User Interface

Interactive Dashboard: Metadata, Feed Selector, Spectral Mode, and On-The-Fly (OTF) Diagnostics

IV. Performance

Benchmarking with high-resolution SKARAB datasets

V. Beyond ICHNOS

The SRT Software Suite

ICHNOS: Real-Time Monitoring Web-App

ICHNOS is Web-Application designed for immediate data quality assessment to ensure the scientific integrity of the observing session.

Key Goals:

- Identify hardware, configuration, or pointing issues in real-time.
- Detect RFI and backend instabilities.
- Optimize antenna time by adjusting parameters (bandwidth, integration, scans) on-the-fly.

Operational Impact: ICHNOS provides immediate awareness of the instrument status, minimizing antenna time wastage.

System Architecture Overview

A Full-Stack Asynchronous Design

- Backend: Python-based using the **Flask** microframework.
- Real-time Communication: **Flask-SocketIO** for bidirectional, low-latency data streaming via WebSockets.
- Frontend: Responsive UI built with **JavaScript** and **Bootstrap**.

Core Modular Components

- Server Core: Manages web connections and data transmission.
- I/O Monitoring: Powered by **Watchdog** (PollingObserver) for high compatibility with Network Storage (NFS/CIFS).
- Data Engine: **AstroPy** for FITS parsing and **Bokeh** for generating interactive, standalone visualizations.

ICHNOS Data Pipeline

[SRT Storage]
- NFS/CIFS Network
- Drives FITS file repository

[Watchdog]
- Continuous Polling Observer
- Real-time file detection

[AstroPy / Processor]
- FITS parsing & Metadata extraction
- Spectral averaging & Spatial mapping

[Socket.IO]
- Bidirectional WebSocket server
- Asynchronous data streaming

[Web Browser]
- Interactive Bokeh Plots
- Dynamic Point-Cloud visualization

Intelligent FITS Data Handling

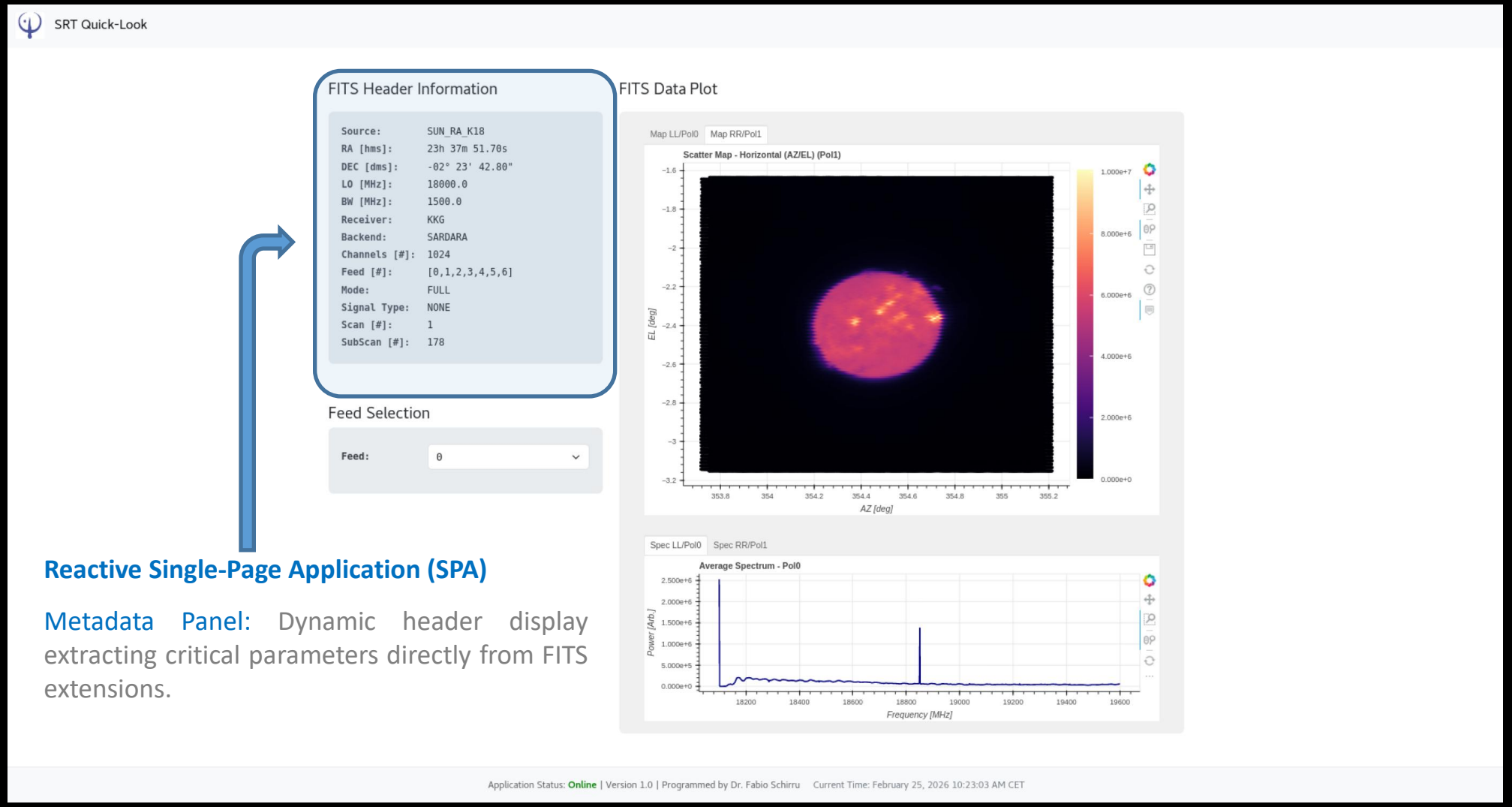
Dynamic Drive Discovery

- Multi-path Monitoring: According to the backend in use, recorded data are tracked on user-specific subdirectories.

Robust File System Watcher

- NFS/CIFS Reliability: Uses polling to guarantee event detection on network-mounted drives.
- Collision Avoidance: Lock-protected processing prevents duplicate analysis of the same FITS file.
- Ready-to-Process Logic: Ensures files are complete and closed before starting the analysis pipeline.

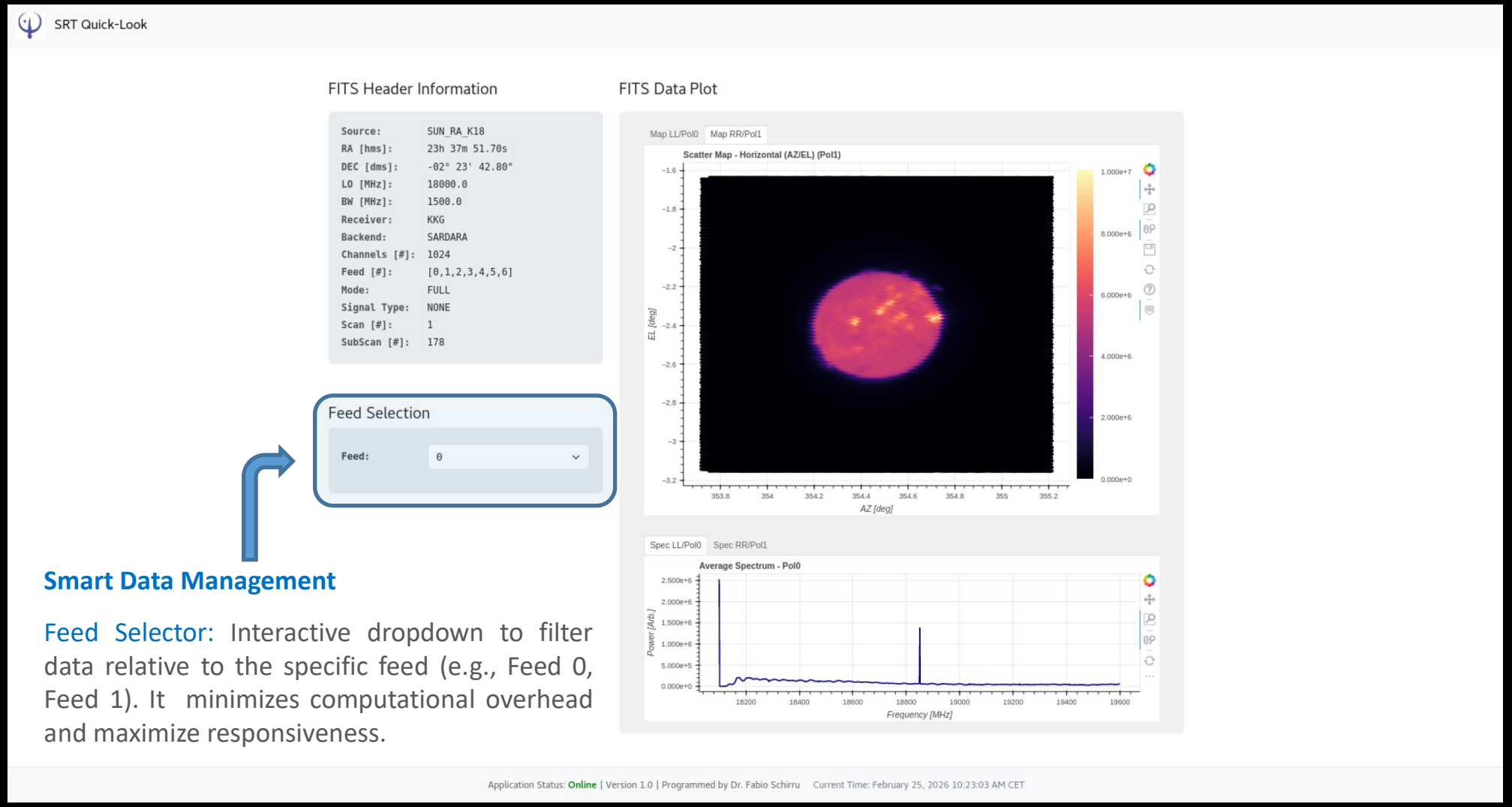
Graphical User Interface



Reactive Single-Page Application (SPA)

Metadata Panel: Dynamic header display extracting critical parameters directly from FITS extensions.

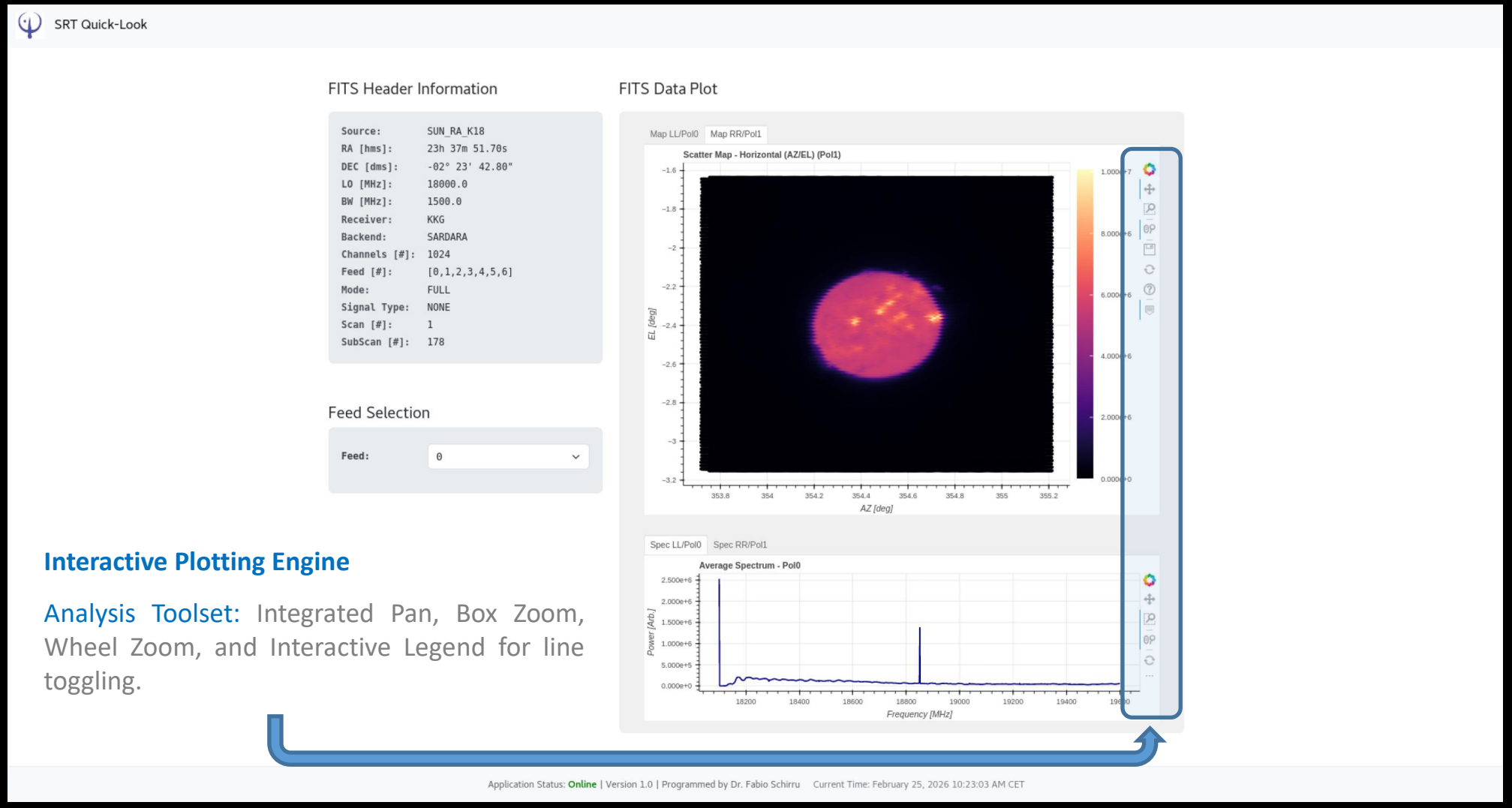
Graphical User Interface



Smart Data Management

Feed Selector: Interactive dropdown to filter data relative to the specific feed (e.g., Feed 0, Feed 1). It minimizes computational overhead and maximize responsiveness.

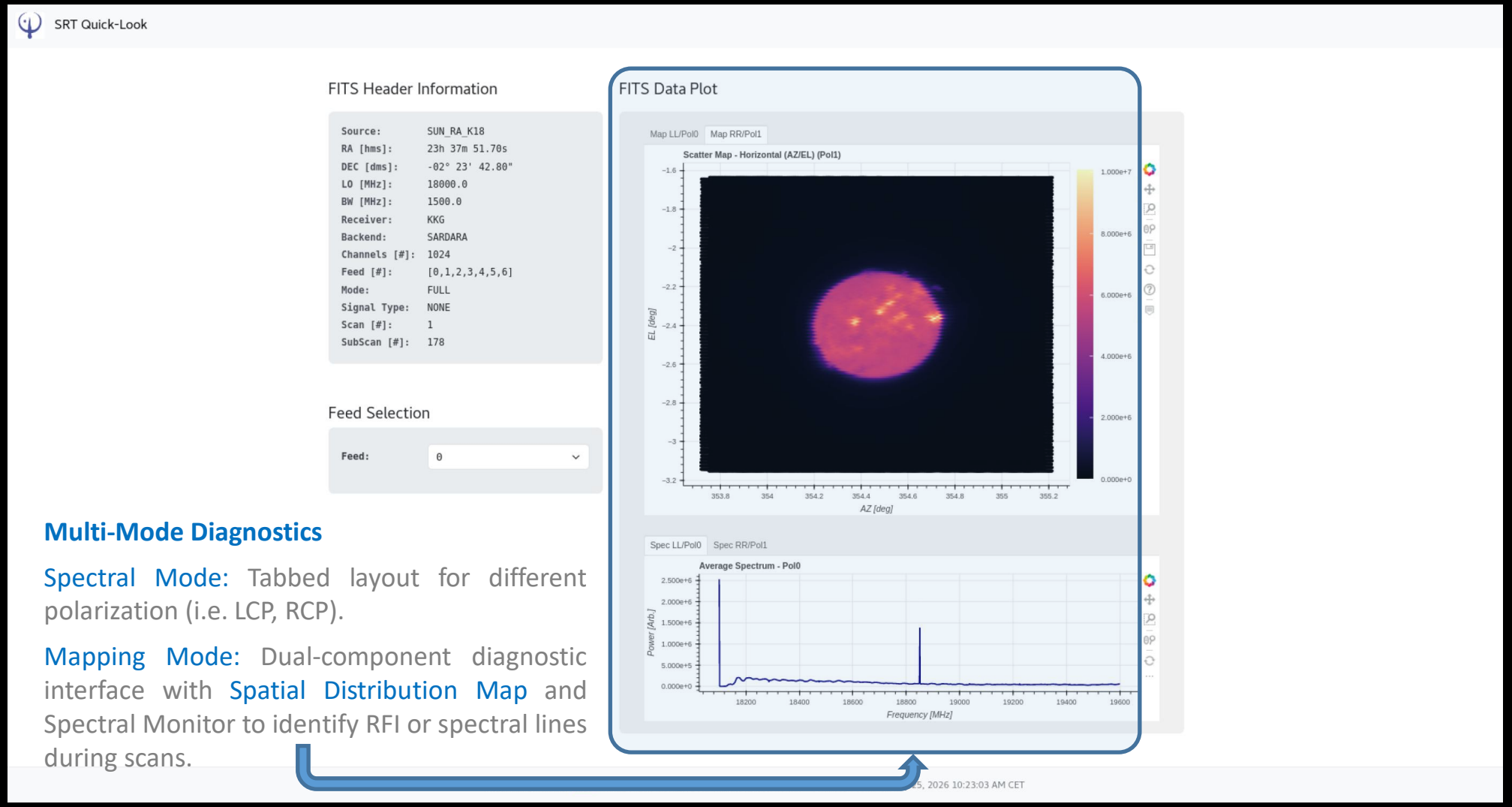
Graphical User Interface



Interactive Plotting Engine

Analysis Toolset: Integrated Pan, Box Zoom, Wheel Zoom, and Interactive Legend for line toggling.

Graphical User Interface



Multi-Mode Diagnostics

Spectral Mode: Tabbed layout for different polarization (i.e. LCP, RCP).

Mapping Mode: Dual-component diagnostic interface with Spatial Distribution Map and Spectral Monitor to identify RFI or spectral lines during scans.

Multi-Mode Diagnostics

Spectroscopic Mode

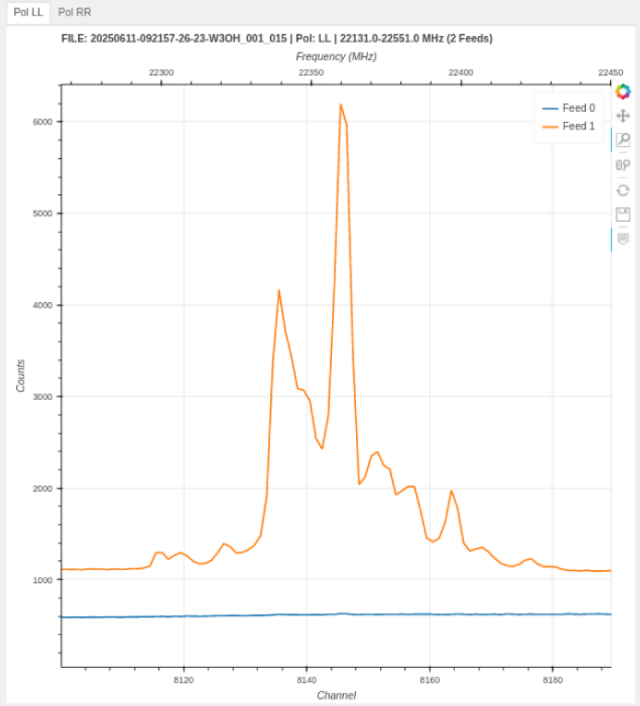
FITS Header Information

Source:	W3OH
RA [hms]:	02h 27m 04.10s
DEC [dms]:	+61° 52' 22.00"
LO [MHz]:	22031.02673
BW [MHz]:	420.0
Receiver:	KKG
Backend:	SARDARA
Channels [#]:	16384
Feed [#]:	[0,1]
Mode:	DUAL
Signal Type:	REFCAL
Scan [#]:	1
SubScan [#]:	15

Feed Selection

Feed: 0

FITS Data Plot



Mapping Mode

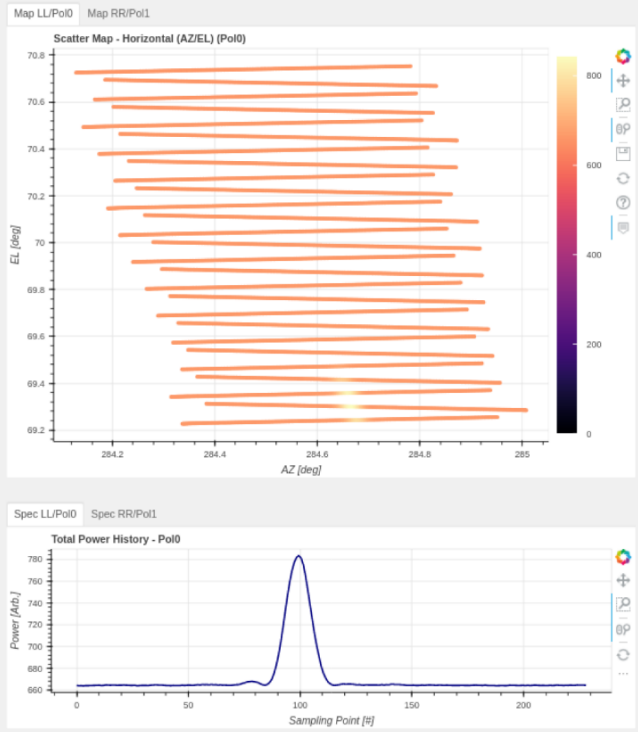
FITS Header Information

Source:	3C84AZ
RA [hms]:	03h 19m 48.10s
DEC [dms]:	+41° 30' 42.00"
LO [MHz]:	23900.0
BW [MHz]:	1250.0
Receiver:	KKG
Backend:	TotalPower
Channels [#]:	1
Feed [#]:	[0,1,2,3,4,5,6]
Mode:	DUAL
Signal Type:	NONE
Scan [#]:	1
SubScan [#]:	28

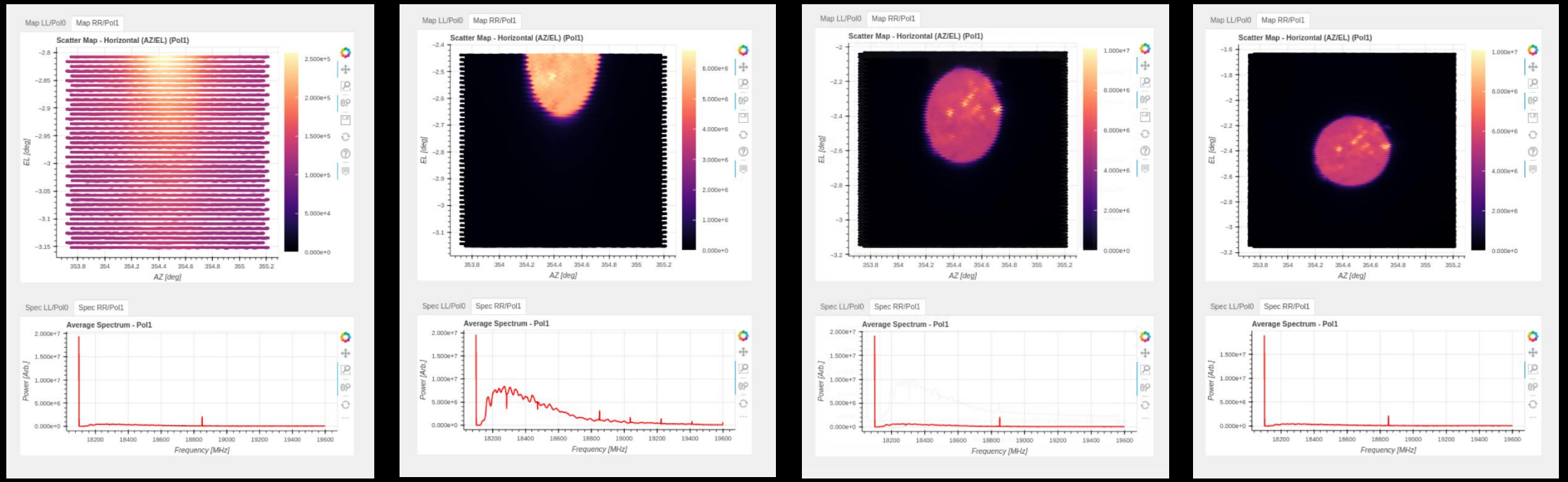
Feed Selection

Feed: 0

FITS Data Plot



Example: Solar Mapping



time

Performance Assessment: SKARAB Stress Test

Scenario Setup

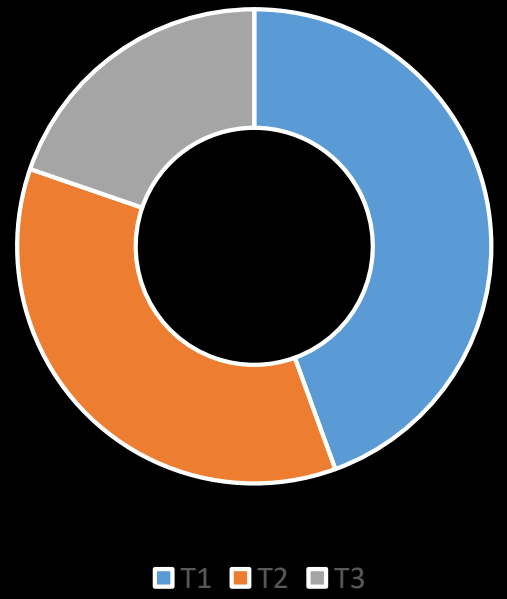
- Test Case: SKARAB FITS file (~ 908 MB).
- Data Volume: 65,536 channels X 1,732 rows (~ 113 million elements).
- Simulated Cadence: 30 seconds (standard SKARAB operational rate).

Key Results

- Total Processing Time: 0.83 s
- Performance Margin: The system is 30x faster than the data acquisition rate.
- Operational Impact: * Guaranteed non-blocking pipeline:
    - Zero risk of processing queues or backlogs under nominal load.
    - Near-instantaneous feedback for the observer.

Where is the time spent?

Step	Description	Time (s)	(%)
T1	I/O Disk + Data Extraction from disk (908 MB)	0.3675	44.5
T2	Performing vectorized mean calculations	0.2963	35.8
T3	Bokeh Object Construction and Visualization	0.163	19.7
	Total	0.83	100

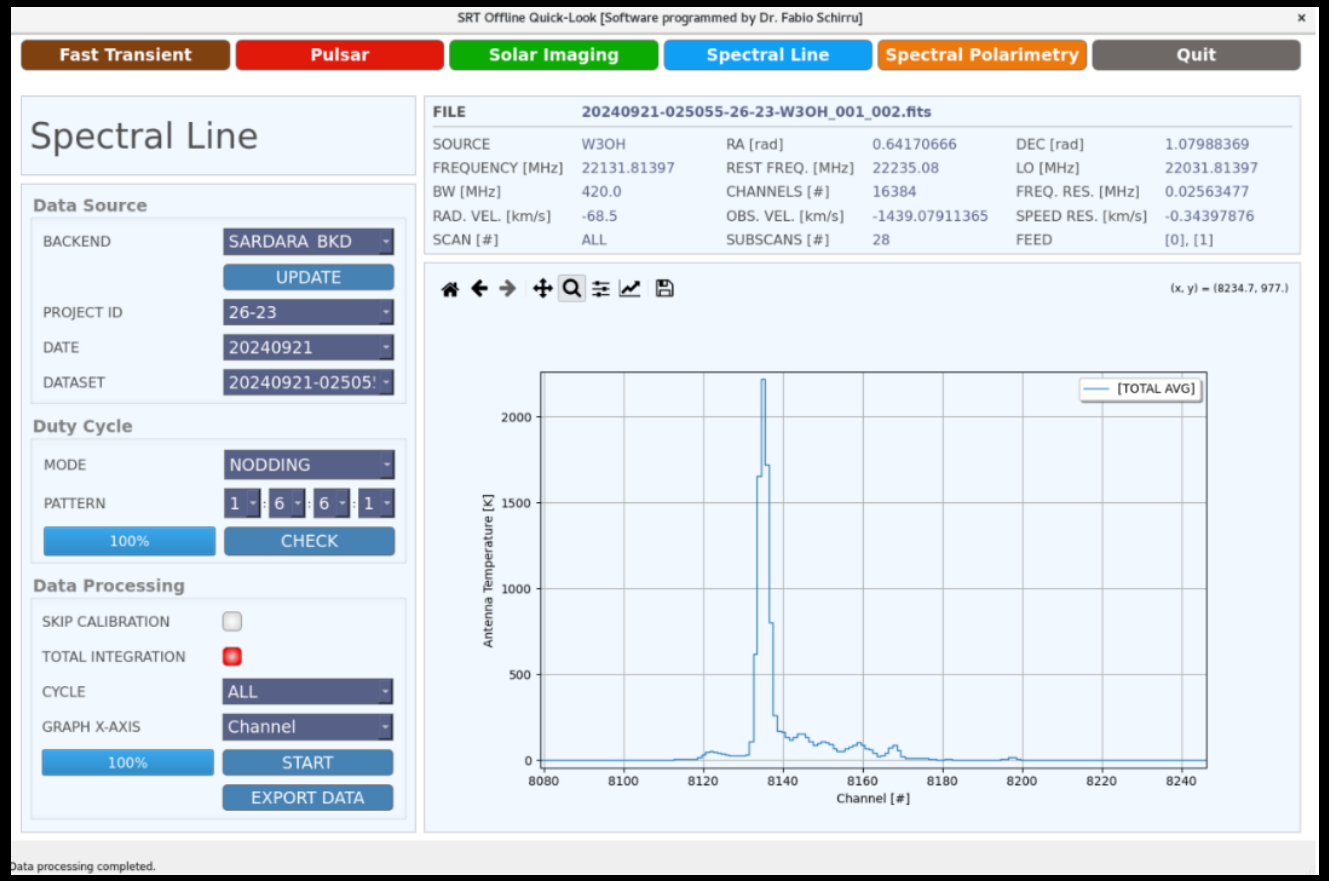


Beyond Real-Time: A Comprehensive Toolset

d2c-GUI: Data Interoperability

- Purpose: Seamless conversion of SRT data for the GILDAS/CLASS environment.
- Flexibility: Supports both GUI (user-friendly) and CLI (batch processing) modes.
- Validation: Successfully tested with SRT and Medicina spectroscopic data.
- Impact: Enables the use of international standard analysis pipelines for Italian radio telescopes.

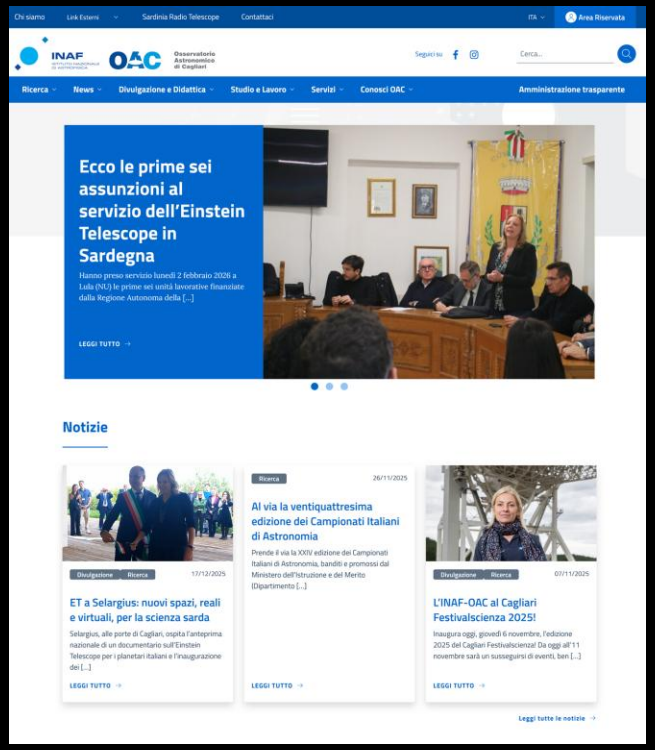
Beyond Real-Time: A Comprehensive Toolset

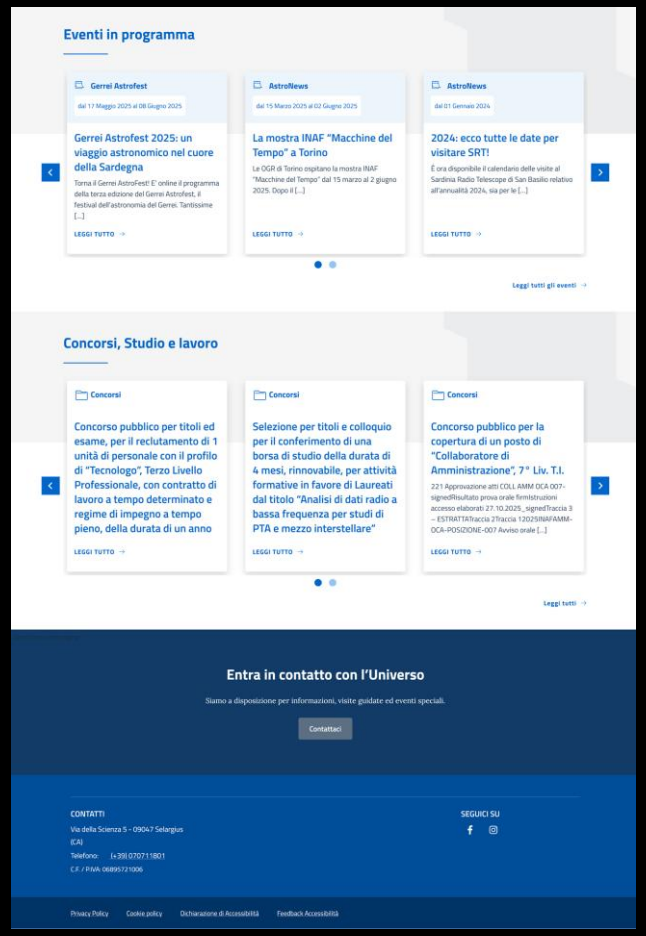


Scan-Viewer [under development]

- Two-Tier Approach: ICHNOS (Real-time) + Scan Viewer (Offline).
- Advanced Processing:
  - Generates processed plots such as (ON – OFF)/OFF.
  - Enhanced scientific insight beyond basic real-time monitoring.
- Flexibility: Supports a variety of plots according to the needs.
- Validation: Spectral Line mode successfully tested with SRT data [project 26-23].

The new OAC WebPage



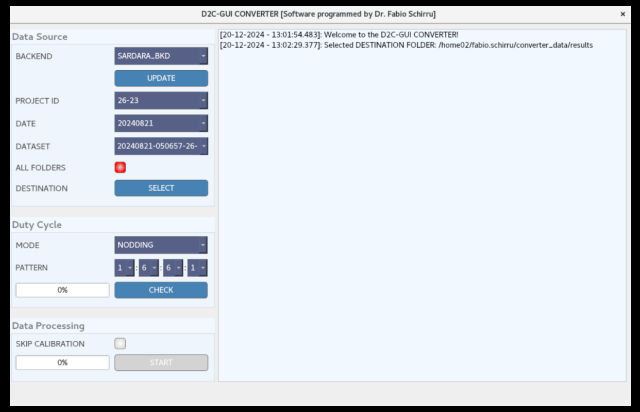


- Published: end of 2025.
- Accessibility Requirements: fully met.

The SRT Software Suite

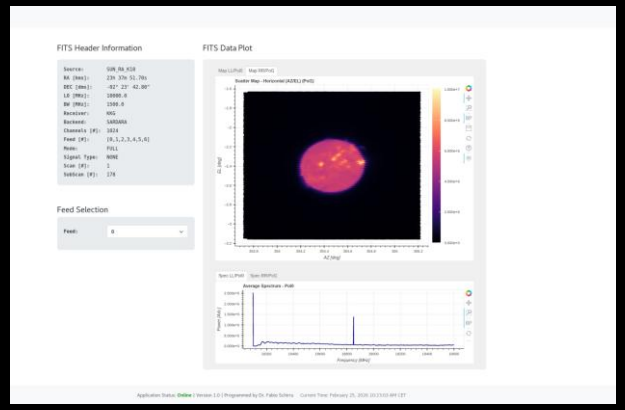
"From real-time monitoring with ICHNOS to CLASS interoperability via d2c-GUI and offline analysis with Scan Viewer: a unified suite designed to turn every minute of SRT antenna time into high-quality science."

D2c-GUI: Data Conversion



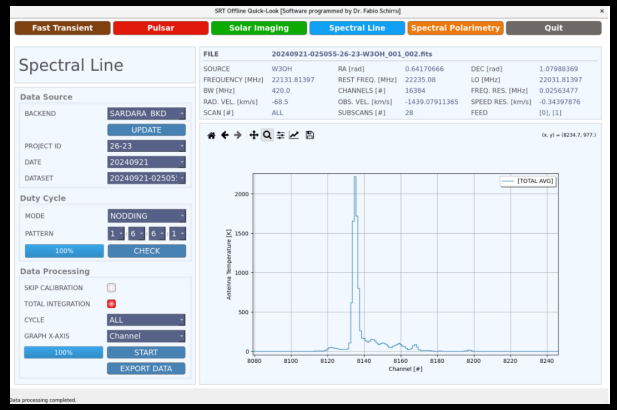
Raw Data to CLASS Format

ICHNOS: Real-Time Monitoring



Live Diagnostics & QA

Scan-Viewer: Offline Analysis



Advanced Scientific Processing